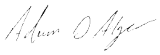
Test Report 3620 B

Equipment Under Test:	DSU840PA
Requirement(s):	FCC Part 15.249, 1.1310 ISED Canada RSS-210 Annex B.10, RSS-102
Test Date(s):	November 3, 4, 30 and December 1, 15, 2022
Prepared for:	Delphian Systems LLC Attn: George Garifalis 720 Dartmouth Ln Buffalo Grove, IL 60089

Report Issued by: Adam Alger, Laboratory Manager

Signature:  Date: 02/27/2023

Report Reviewed by: Anthony Smith, EMC Engineering Specialist

Signature:  Date: 12/19/2022

Report Constructed by: Adam Alger, Laboratory Manager

Signature:  Date: 12/2/2022

CONTENTS

Laird Connectivity Test Services in Review

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

Certificate #1255.01

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

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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

1 TEST REPORT SUMMARY

During **November 3 to December 15, 2022,** the Equipment Under Test (EUT), **DSU840PA**, as provided by **Delphian Systems LLC** was tested to the following **FCC and ISED Canada** requirements:

Requirements	Description	Method	Compliant
FCC Part 2.1049 RSS-GEN 6.7	Occupied bandwidth	ANSI C63.10	Reported
FCC Part 15.249 RSS-210 Annex B.10	Operation within the band 2400-2483.5 MHz	ANSI C63.10	Yes
FCC Part 15.207 RSS-GEN 8.8	AC power line 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	1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

2 CLIENT INFORMATION

Company Name	Delphian Systems LLC
Contact Person	George Garifalis
Address	720 Dartmouth Ln. Buffalo Grove, IL 60089

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	DSU840PA
Model Number	DSU840PA
Serial Number	750-03101
FCC ID:	2AEHJDSU840PA
IC:	20053-DSU840PA

2.2 Product Description

ANT protocol device

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 Setup

EVK powered 5 VDC from laboratory PC running teraterm for programming. EUT Firmware version 4.2.0

2.6 Antenna Information

Walsin RFDPA870900SBAB8G1 (Dipole RPSMA)

2.7 Channels

Low (2402 MHz), Mid (2440 MHz), High (2480 MHz)

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
FCC eCFR Title 47	-	2022		
ANSI C63.10	-	2013		
RSS-210	10	12/2019	04/2020	
RSS-GEN	5	04/2018	03/2019	02/2021
RSS-102	5	2015	2021	
KDB 447498	-	2015	-	

4 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 ±
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

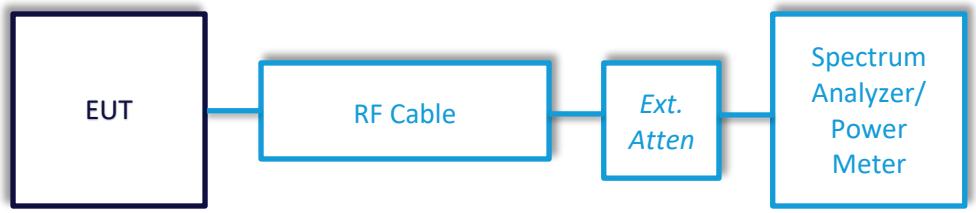
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 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



5.1.1 Duty Cycle and 99% Bandwidth

Operator	Anthony Smith	**QA**	Adam Alger
Temperature	21.3°C	**R.H. %**	21.8
Test Date	12/1/2022	**Location**	Bench
Requirement	FCC 15.249, RSS-GEN	**Method**	ANSI C63.10

Test Parameters

Frequency	2402-2480 MHz	**Setup**	RF Conducted
RBW	10 kHz	**VBW**	30 kHz
Detector(s)	Peak	**Settings**	Occupied bandwidth
Example Calculations	Duty cycle = (on time / pulse period)*100 = 1.14 ms / 11.84 ms = 9.6 % Duty cycle correction = 20*log (on time / pulse period) = 20.3 dB		

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	3/22/2022	3/22/2023	Active Verification
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/12/2022	4/12/2023	Active Calibration

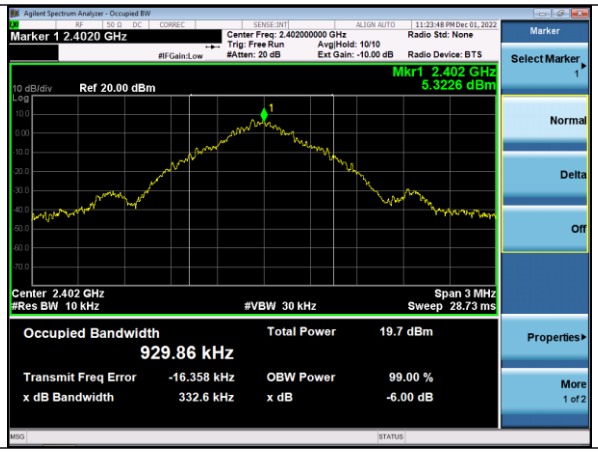
EUT Parameters

Input Power	5 VDC (USB)	**Mode**	Transmit modulated
Frequency	2402, 2440, 2480 MHz	**Channel**	Low, mid, high

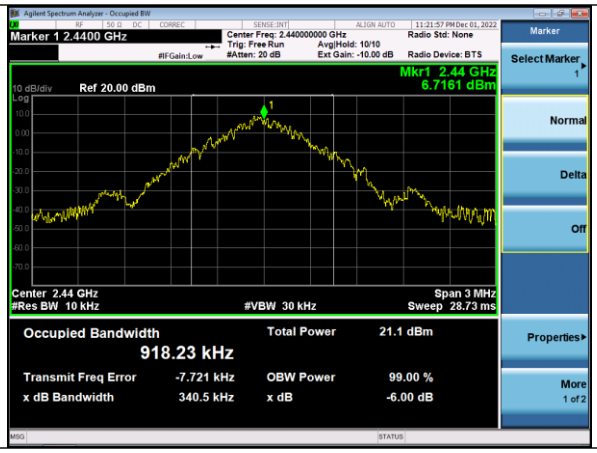
Data

Frequency MHz	99% BW (kHz)
2402	929.9
2440	918.2
2480	926.1

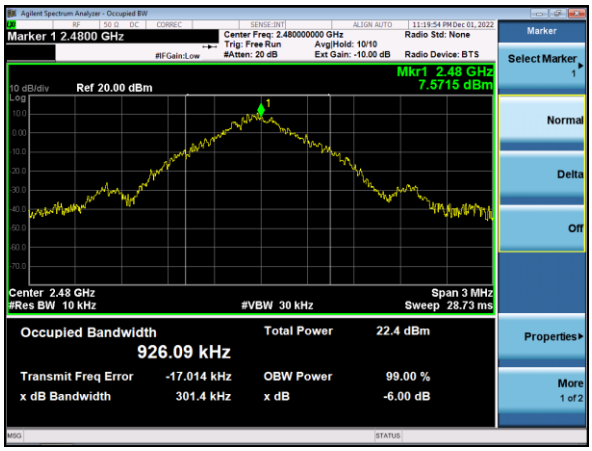
Plots



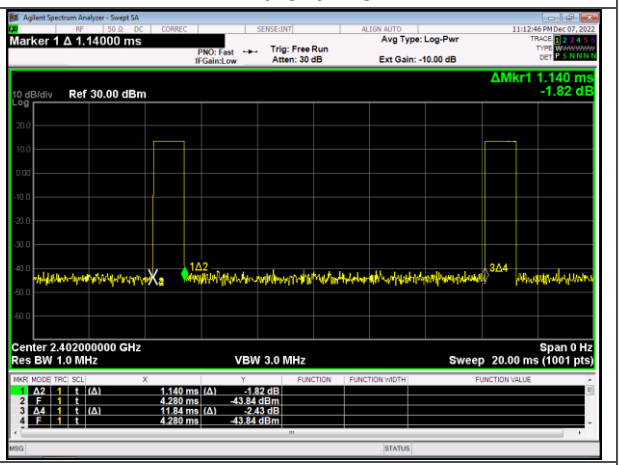
Low Channel



Mid Channel



High Channel

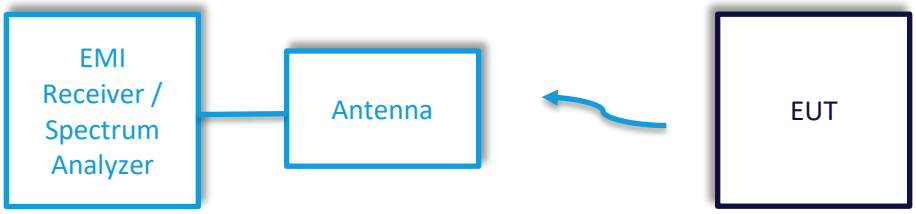


Duty Cycle

5.2 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



5.2.1 Radiated Emissions

Operator	Braden Smith	**QA**	Anthony Smith
Temperature	23.8°C	**R.H. %**	45.30%
Test Date	11/3,4,30/2022	**Location**	Chamber 5
Requirement	FCC 15.249, RSS-210	**Method**	ANSI C63.10

Average Limits:

Fundamental Frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of fundamental (dBµV/m)	Field strength of harmonics (microvolts/meter)	Field strength of harmonics (dBµV/m)
2400-2483.5	50	94	500	54

Peak limit = Average limit + 20 dB

15.209 Limits @ 3m distance

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

Test Parameters

Frequency	30 MHz - 25 GHz	**Distance**	3m
Detector(s)	Peak, QP	**Table height**	80cm Below 1 GHz 150cm Above 1 GHz
RBW	120 kHz Below 1 GHz 1 MHz Above 1 GHz	**VBW**	1.2 MHz Below 1 GHz 3 MHz Above 1 GHz
Example Calculations	Calculated average = Peak reading – duty cycle correction		

EUT Parameters

Input Power	5 VDC (USB)	**Mode**	Tx_Modulated
Channels	2402, 2440, 2480 MHz	**Power Setting**	neg8dBm

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/13/2022	4/13/2023	Active Calibration
AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	9/27/2021	9/27/2023	Active Calibration
AA 960163	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	500	8/25/2022	8/25/2023	Active Calibration
AA 960171	Cable	A.H. Systems, Inc.	SAC-26G-6	386	3/22/2022	3/22/2023	Active Verification
AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	9/27/2022	9/27/2023	Active Calibration
AA 960211	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	9/27/2021	9/27/2023	Active Calibration
AA 960218	Antenna - Biconical	A.H. Systems, Inc.	SAS-540	853	6/9/2022	6/9/2023	Active Calibration
EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/11/2022	4/11/2023	Active Calibration
EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/13/2022	4/13/2023	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	4/26/2022	4/26/2023	Active Verification
LSC-500	Cable	Chamber 5 Emissions	-	-	4/25/2022	4/25/2023	Active Verification

Data Tables

Fundamental

Frequency (MHz)	EUT	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Calculated Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2402.2	F	H	158	234	111.7	114.0	2.3	91.4	94.0	2.6
2439.8	F	H	125	238	111.9	114.0	2.1	91.6	94.0	2.4
2480.1	H	H	110	150	111.0	114.0	3.0	90.7	94.0	3.3

1-4 GHz (Band-Edge)

Frequency (MHz)	EUT	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Calculated Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2400.0	F	H	158	234	66.5	74.0	7.5	46.2	54.0	7.8
2483.5	H	H	110	150	65.6	74.0	8.4	45.3	54.0	8.7

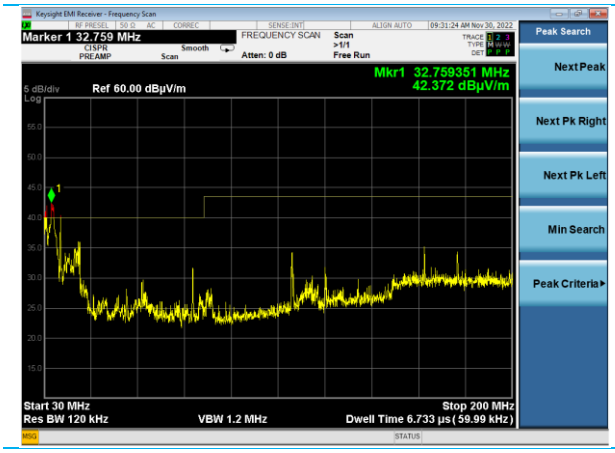
4-25 GHz

Frequency (MHz)	Channel	Antenna Polarity	EUT Orientation	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Calculated Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
19521.1	Mid	Vertical	Vertical	240	0	60.2	74.0	13.8	39.9	54.0	14.1
19521.2	Mid	Horizontal	Vertical	175	314	57.8	74.0	16.2	37.5	54.0	16.5
19521.2	Mid	Horizontal	Horizontal	172	289	58.9	74.0	15.1	38.6	54.0	15.4
19521.2	Mid	Vertical	Horizontal	154	0	57.9	74.0	16.1	37.6	54.0	16.4
19518.4	Mid	Vertical	Flat	275	0	59.4	74.0	14.6	39.1	54.0	14.9
19518.7	Mid	Horizontal	Flat	178	146	55.1	74.0	18.9	34.8	54.0	19.2
19217.0	Low	Vertical	Vertical	250	0	55.2	74.0	18.8	34.9	54.0	19.1
19838.7	High	Vertical	Vertical	252	349	57.7	74.0	16.3	37.4	54.0	16.6
7320.0	Mid	Horizontal	Vertical	132	70	46.3	74.0	27.7	26.0	54.0	28.0
7320.0	Mid	Vertical	Vertical	301	351	46.9	74.0	27.1	26.6	54.0	27.4
7320.0	Mid	Vertical	Horizontal	238	205	44.6	74.0	29.4	24.3	54.0	29.7
7319.8	Mid	Horizontal	Horizontal	240	35	47.4	74.0	26.6	27.1	54.0	26.9
7320.0	Mid	Horizontal	Flat	219	6	32.7	74.0	41.3	12.4	54.0	41.6
7320.0	Mid	Vertical	Flat	260	42	48.4	74.0	25.6	28.1	54.0	25.9
17080.0	Mid	Horizontal	Vertical	112	58	54.4	74.0	19.6	34.1	54.0	19.9
17080.0	Mid	Vertical	Vertical	285	16	57.4	74.0	16.6	37.1	54.0	16.9
17080.0	Mid	Vertical	Horizontal	253	337	54.9	74.0	19.1	34.6	54.0	19.4
17078.8	Mid	Horizontal	Horizontal	250	305	58.7	74.0	15.3	38.4	54.0	15.6
17081.3	Mid	Horizontal	Flat	250	128	54.2	74.0	19.8	33.9	54.0	20.1
17078.7	Mid	Vertical	Flat	250	31	58.2	74.0	15.8	37.9	54.0	16.1
7205.4	Low	Vertical	Flat	188	24	47.2	74.0	26.8	26.9	54.0	27.1
16812.8	Low	Horizontal	Horizontal	247	300	55.3	74.0	18.7	35.0	54.0	19.0
7440.4	High	Vertical	Flat	250	130	46.5	74.0	27.5	26.2	54.0	27.8
17361.1	High	Horizontal	Horizontal	250	306	55.8	74.0	18.2	35.5	54.0	18.5

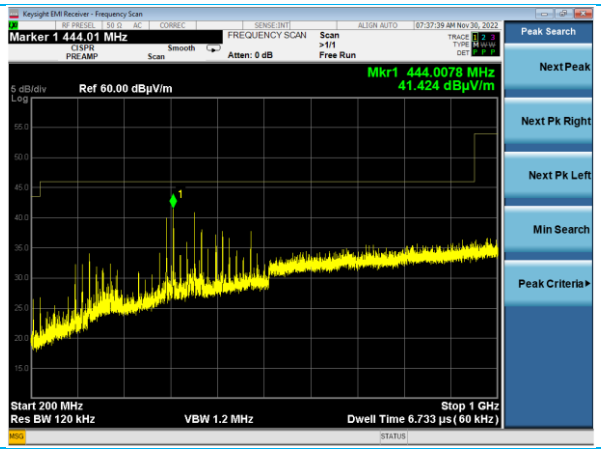
30-1000 MHz

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Quasi-Peak Margin (dB)
444.1	H	226	160	31.9	46.0	14.1
32.8	V	100	21	36.9	40.0	3.1

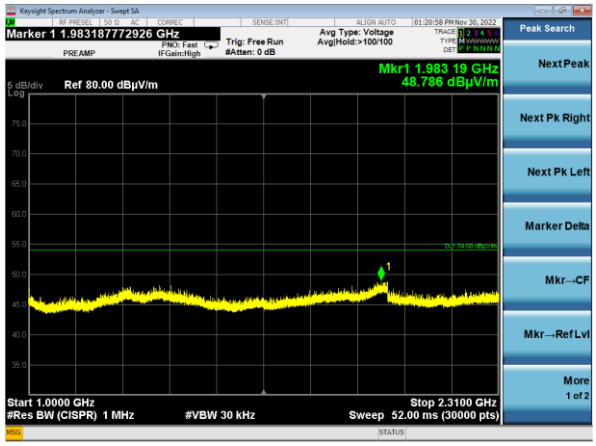
Plots



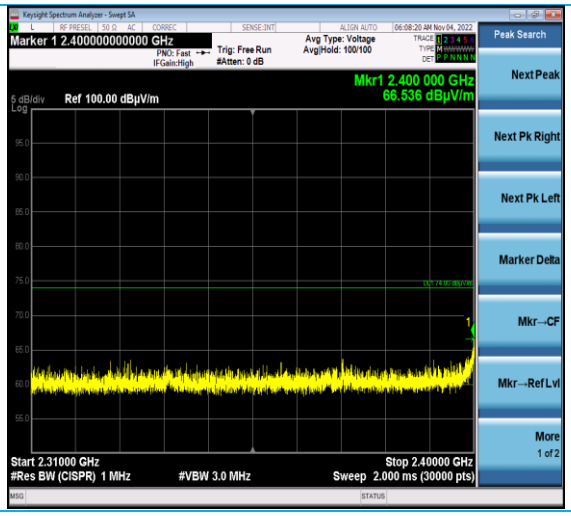
30-200 MHz



200-1000 MHz

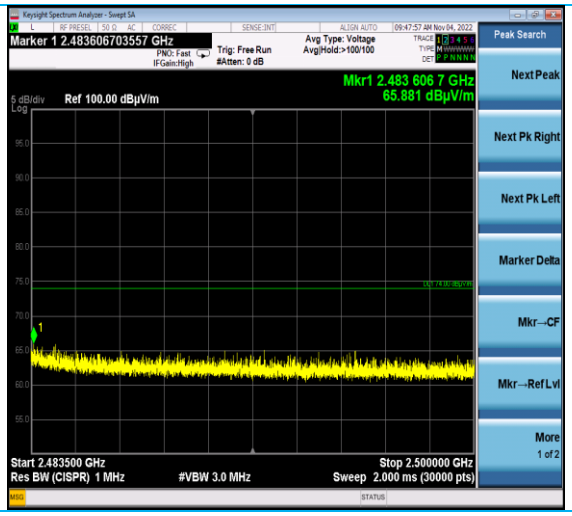


1000-2310 MHz

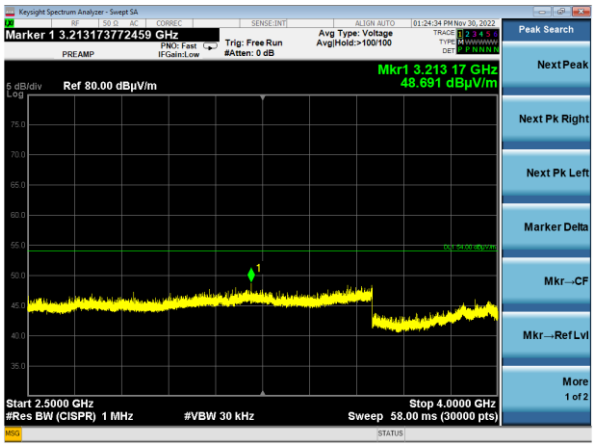


2310-2400 MHz

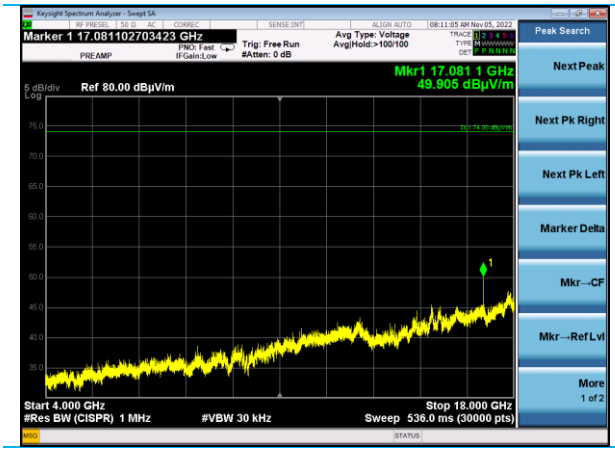
Plots



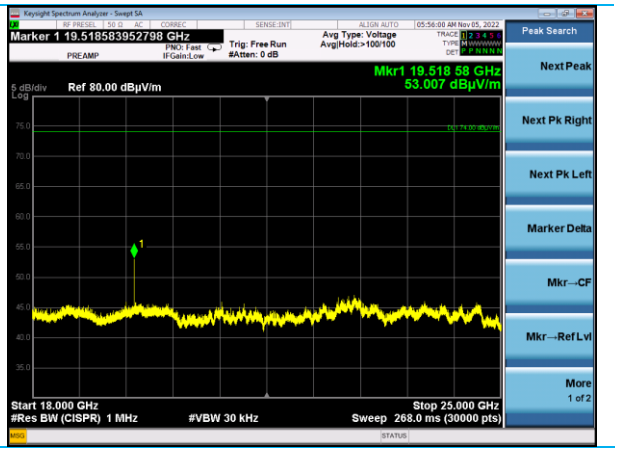
2483.5-2500 MHz



2500-4000 MHz



4-18 GHz

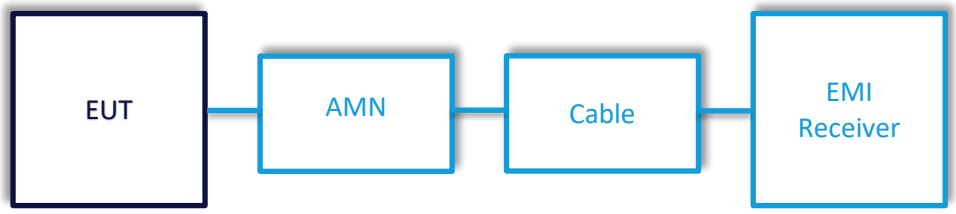


18-25 GHz

5.3 AC Mains Conducted Emissions

	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.
Description of Measurement	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



5.3.1 AC Mains Conducted Emissions

Operator	Braden Smith	**QA**	Adam Alger
Temperature	20.6° C	**R.H. %**	34.9%
Test Date	12/15/2022	**Location**	Conducted Emissions ground plane area
Requirement	15.207, RSS-GEN	**Method**	ANSI C63.10

Limits:

Frequency (MHz)	Quasi-Peak (dBµV/m)	Average (dBµV/m)
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency

Test Parameters

Frequency	0.15-30 MHz	**Distance**	40 cm from vertical ground plane
Detector(s)	Peak – Trace Quasi-Peak, Average – Final	**Table height**	80 cm
RBW	9 kHz	**VBW**	62 kHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/12/2022	4/12/2023	Active Calibration
EE 960162	LISN	COM-POWER	LI-215A	191969	4/11/2022	4/11/2023	Active Calibration
LSC-203	Cable	Micro-Coax	UFB311A-0-1440-70U70U	64639 224071-005	4/25/2022	4/25/2023	Active Verification

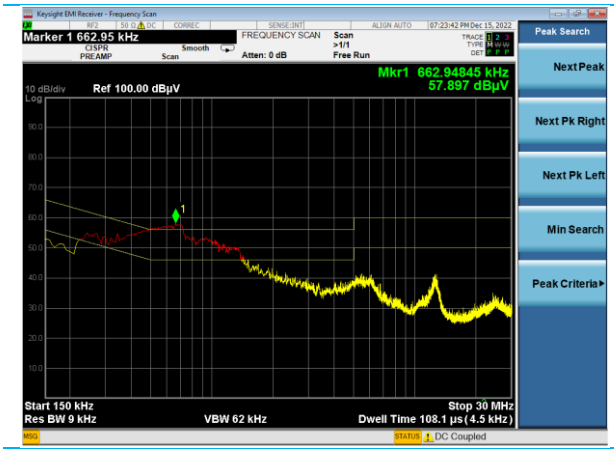
EUT Parameters

Input Power	120 VAC 60 Hz	**Mode**	USB 5 VDC
PSU	Model: HA180PM180	**PC**	Model: P53F (Dell Precision 7520)

Table

Line	Frequency (MHz)	Peak Reading (dBµV)	Quasi-Peak Reading (dBµV)	Average Reading (dBµV)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)	Quasi-Peak Margin (dB)	Average Margin (dB)
1	0.663	54.2	52.5	40.6	56.0	46.0	3.5	5.4
1	0.672	54.3	52.6	41.4	56.0	46.0	3.4	4.6
1	0.501	56.5	54.0	35.5	56.0	46.0	2.1	10.5
2	0.150	52.7	49.0	43.2	66.0	56.0	17.0	12.8
2	1.306	47.6	43.4	29.3	56.0	46.0	12.6	16.7
2	0.469	49.2	46.5	27.1	56.6	46.6	10.1	19.5

Plots



Line 1

Line 2

6 REVISION HISTORY

Version	Date	Notes	Person
0	12-2-2022	Initial Draft	Adam Alger
1	12-19-2022	Draft	Adam Alger
1	12-19-2022	Final	Adam Alger
2	02-23-2023	Extracted MPE section to separate report	Adam Alger
3	02-27-2023	Added EUT firmware information	Adam Alger

END OF REPORT