

Test Report 3620 A

Equipment Under Test:	DSU840
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: 02/23/2023

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

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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:



A2LA – American Association for Laboratory Accreditation

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

A2LA Certificate Number: 1255.01

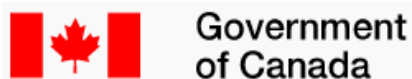
Scope of accreditation includes all test methods listed herein unless otherwise noted



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: Delphian Systems LLC	Page 3 of 20	Name: DSU840
Report: 3620 A		Model: DSU840
Quote: NBO-08-2022-005297		Serial:201-180112

1 TEST REPORT SUMMARY

During **November 3 to December 15, 2022**, the Equipment Under Test (EUT), **DSU840**, 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	DSU840
Model Number	DSU840
Serial Number	201-180112
FCC ID:	2AEHJDSU840
IC:	20053-DSU840

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

2.6 Antenna Information

Laird FlexPIFA 001-0022

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 $\pm$
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

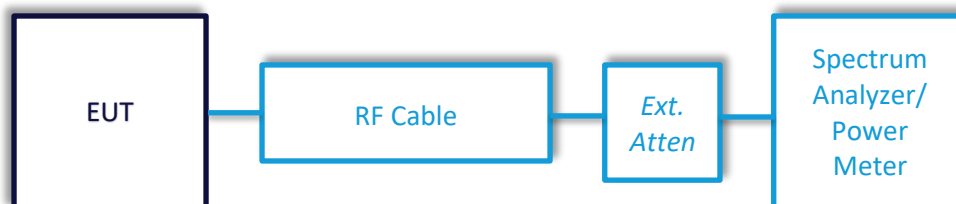
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9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

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 = 2.2 ms / 23.2 ms = 9.5 % Duty cycle correction = 20*log (on time / pulse period) = 20.5 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

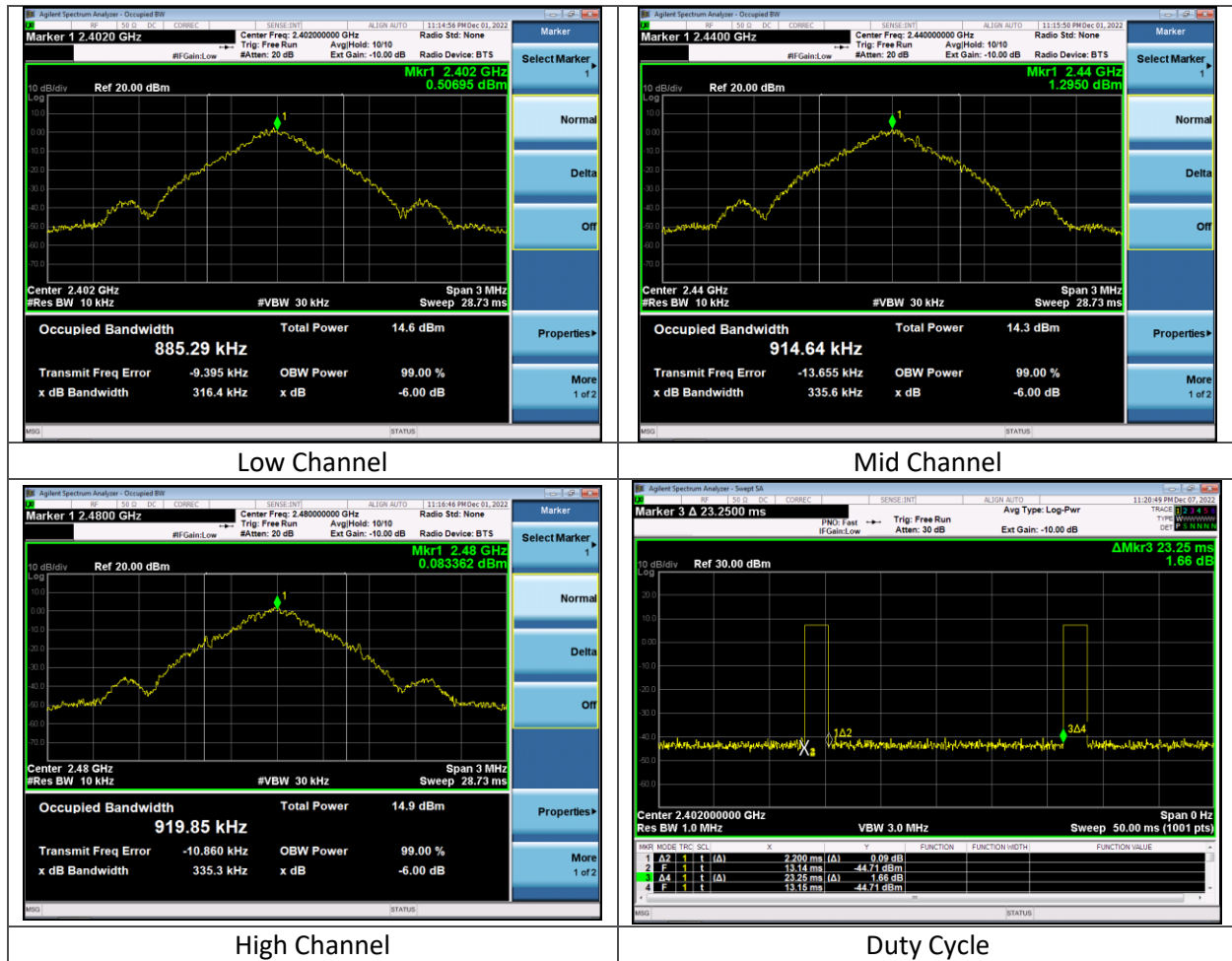
EUT Parameters

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

Data

Frequency MHz	99% BW (kHz)
2402	885.3
2440	914.6
2480	919.9

Plots



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	pos8dBm

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)
2402.0	V	H	120	10	103.1	114.0	10.9	82.6	94.0	11.4
2402.0	V	V	100	261	97.8	114.0	16.2	77.3	94.0	16.7
2402.1	H	V	125	310	103.5	114.0	10.5	83.0	94.0	11.0
2402.2	H	H	155	313	103.2	114.0	10.8	82.7	94.0	11.3
2402.3	F	H	127	40	103.3	114.0	10.7	82.8	94.0	11.2
2402.0	F	V	370	192	99.1	114.0	14.9	78.6	94.0	15.4
2440.2	V	H	100	15	100.7	114.0	13.3	80.2	94.0	13.8
2440.1	V	V	150	253	94.3	114.0	19.7	73.8	94.0	20.2
2439.8	H	V	111	306	100.5	114.0	13.5	80.0	94.0	14.0
2440.0	H	H	150	317	100.6	114.0	13.4	80.1	94.0	13.9
2440.1	F	H	150	45	100.9	114.0	13.1	80.4	94.0	13.6
2439.9	F	V	305	200	96.1	114.0	17.9	75.6	94.0	18.4
2480.1	V	H	100	15	100.6	114.0	13.4	80.1	94.0	13.9
2480.0	V	V	150	253	94.3	114.0	19.7	73.8	94.0	20.2
2480.0	H	H	150	317	100.3	114.0	13.7	79.8	94.0	14.2
2480.1	H	V	111	306	101.4	114.0	12.6	80.9	94.0	13.1
2480.1	F	H	110	40	101.5	114.0	12.5	81.0	94.0	13.0
2480.2	F	V	342	200	97.0	114.0	17.0	76.5	94.0	17.5

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)
2399.8	H	V	125	310	66.2	74.0	7.8	45.7	54.0	8.3
2484.2	F	H	110	40	65.2	74.0	8.8	44.7	54.0	9.3

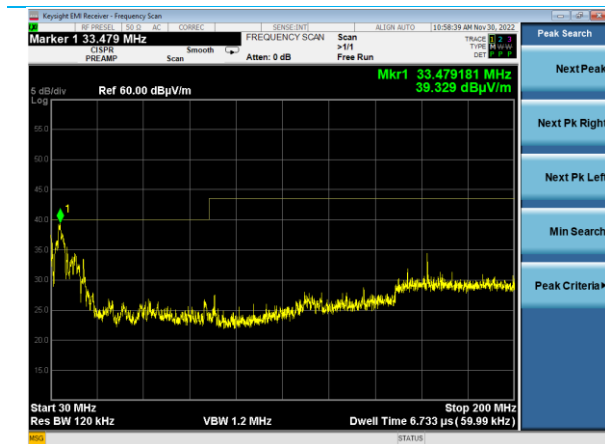
4-25 GHz

Frequency (MHz)	EUT	Channel	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)
7320.0	V	Mid	V	248	315	48.7	74.0	25.3	28.2	54.0	25.8
7320.0	V	Mid	H	149	354	52.1	74.0	21.9	31.6	54.0	22.4
7320.0	H	Mid	H	167	250	49.8	74.0	24.2	29.3	54.0	24.7
7320.0	H	Mid	V	195	297	51.2	74.0	22.8	30.7	54.0	23.3
7320.0	F	Mid	V	101	352	48.8	74.0	25.2	28.3	54.0	25.7
7320.0	F	Mid	H	125	342	50.8	74.0	23.2	30.3	54.0	23.7
7440.0	V	High	H	147	351	49.1	74.0	24.9	28.6	54.0	25.4
7206.0	V	Low	H	152	0	56.3	74.0	17.7	35.8	54.0	18.2

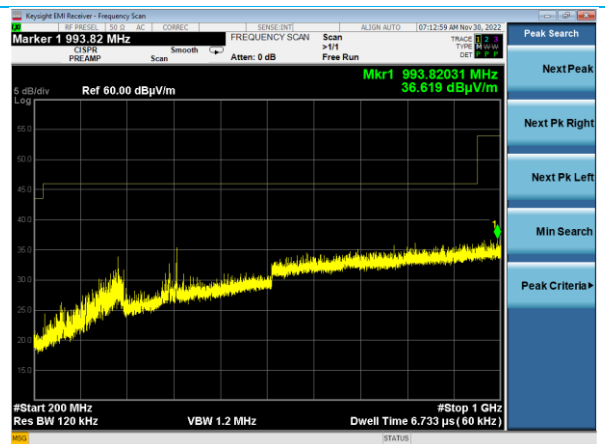
30-1000 MHz

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Quasi-Peak Margin (dB)
431.8	H	235	24	27.3	46.0	18.7
32.9	V	100	137	35.9	40.0	4.1

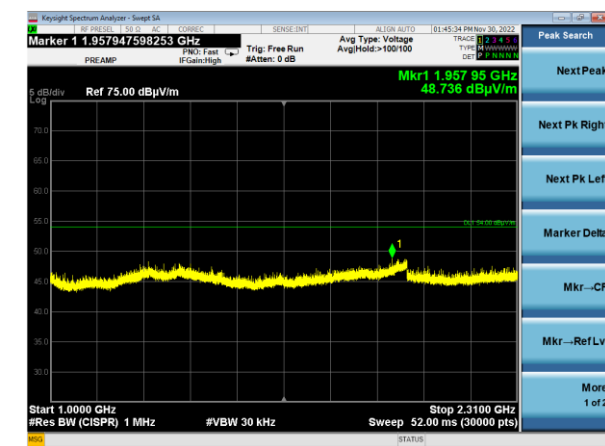
Plots



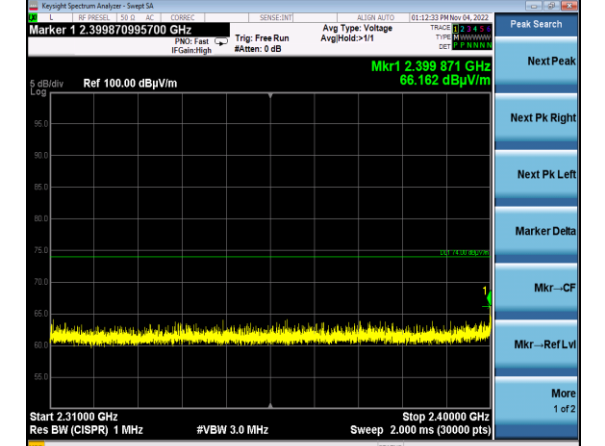
30-200 MHz



200-1000 MHz

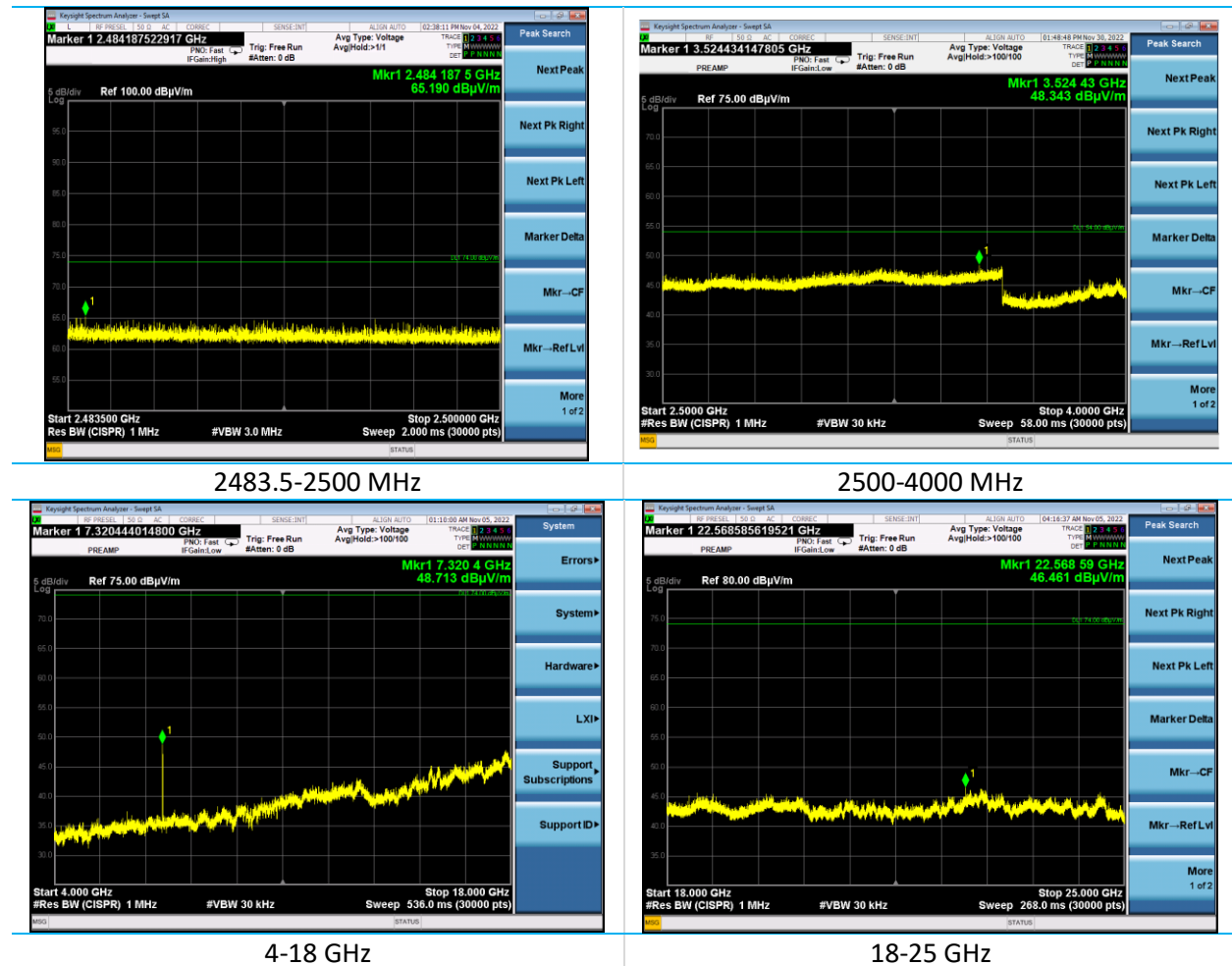


1000-2310 MHz



2310-2400 MHz

Plots



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.

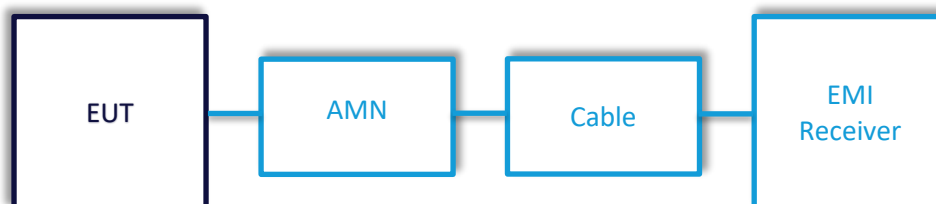
Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

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

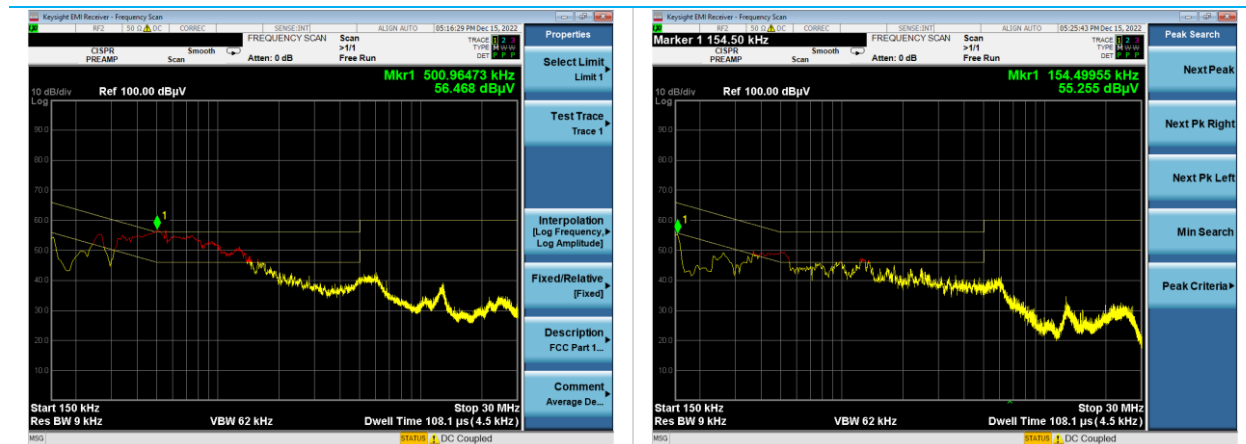
EUT Parameters

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	0.501	56.6	54.3	37.0	56.0	46.0	1.7	9.0
1	0.506	56.6	54.3	37.7	56.0	46.0	1.7	8.4
1	0.609	55.6	48.4	30.9	56.0	46.0	7.6	15.1
1	0.933	53.3	50.1	32.8	56.0	46.0	5.9	13.2
2	0.155	52.2	49.0	43.9	65.8	55.8	16.9	11.9
2	0.366	50.2	46.2	37.0	58.6	48.6	12.4	11.6
2	0.501	49.7	47.2	31.0	56.0	46.0	8.8	15.0

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

END OF REPORT