
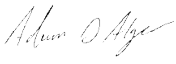



TR3818-301-489

Equipment Under Test:	SONA TI351
Requirement(s):	ETSI EN 301 489
Test Date(s):	10/31/2024 – 11/08/2024
Prepared for:	Ezurio Attn: Brian Petted W66 N220 Commerce Ct. Cedarburg, WI 53012

Report Issued by: Dylan Rosenfeldt, EMC Engineer	
Signature: 	Date: 01/10/2025
Report Reviewed by: Adam Alger, Manager EMC Laboratory	
Signature: 	Date: 01/10/2025
Report Constructed by: Dylan Rosenfeldt, EMC Engineer	
Signature: 	Date: 01/10/2025

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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 30	Name: SONA TI351
Report: TR3818-301-489		Model: SONA TI351
Job: C-3818		Serial: 00013 00008

1 TEST REPORT SUMMARY

During **10/31/2024-11/08/2024** the Equipment Under Test (EUT), **Sona TI351**, as provided by **Ezurio** was tested to the following requirements:

ETSI 301 489-17

Requirements	Description	Method	Compliant
ETSI 301 489-1	Radiated Emissions 30-6000 MHz Class B	CISPR 32	Yes
ETSI 301 489-1	AC Mains Conducted Emissions 0.150-30 MHz Class B	CISPR 32	Yes
ETSI 301 489-1	Electrostatic Discharge ± 4 kV Contact ± 8 kV Air	IEC 61000-4-2	Yes
ETSI 301 489-1	Radiated RF Immunity 80-6000 MHz 3 V/m	IEC 61000-4-3	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	Ezurio
Contact Person	Brian 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	SONA TI351
Model Number	SONA TI351
Serial Number	00013 00008
FCC ID	SQG-SONATI351
IC ID	3147A-SONATI351

2.2 Product Description

The TI351 is based upon TI CC3351 Wi-Fi 6 chipset. Feature-set includes 802.11 a/b/g/n/ac/ax Wi-Fi 6 and Bluetooth Low Energy v5.4.

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 - image-imx8mp-evk-rdvk 1.0.0.5

Ancillary Equipment

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

Development Kit, NXP 8MPLUS-BB

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

OUTPUT: USB Type C 45W, 5V/3A; 9V/3A; 15V/3 A; 20V/2.25 A

HP Elitebook 840G1

TeraTerm Version: 5.1

2.6 Antenna Information

Manufacturer	Model	Part Number	Dimension	Type	Peak Gain (dBi)	
					2400-2500 MHz	4900-5925 MHz
Ezurio	FlexPIFA 6E	EFB2471A3S-10MH4L	16mm X 36mm X 2.5mm	PIFA	2.2	3.9
Ezurio	Mini NanoBlade Flex 6E	EMF2471A3S-10MH4L	36mm X 12mm X 0.3mm	PCB Dipole	2.4	4.4
Ezurio	FlexPIFA	001-0021	38.5mm X 12.7mm X 2.5mm	PIFA	2.5	3.0
Joymax Electronics	N/A	TWX-100BRS3B	137mm X 13mm	Dipole	2.0	4.0
Ezurio	FlexPIFA	EFB2455A3S-15MH4L	2.5mm X 38.6mm X 12.7mm	PIFA	2.5	3.0
Ezurio	Mini NanoBlade Flex	EMF2449A1-10MH4L	36mm x 12mm x 0.1mm	PIFA	2.8	3.4
Ezurio	NanoBlade	ENB2449A1-10MH4L	50.8mm x 16.5mm	PCB Dipole	3.2	4.1

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
ETSI EN 301 489-1	V2.2.3	2019	-	-
ETSI EN 301 489-17	V3.2.4	2020	-	-
IEC CISPR 32	2.0	2015	2019	-
IEC 61000-4-2	2.0	2008	-	-
IEC 61000-4-3	4.0	2020	-	-

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 Radiated Emissions

Description of Measurement	<p>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.</p> <p>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.</p> <p>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.</p>
Example Calculations	<p>Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m)</p> <p>Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m)</p> <p>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</p>

Block Diagram



5.1.1 Radiated Emissions

Operator	Jon Dille	QA	Dylan Rosenfeldt
Temperature	19.9°C	R.H. %	33.90%
Test Date	10/31/2024	Location	Chamber 3
Requirement	CISPR 32	Method	CISPR 16-2-3

Limits:

Frequency	Quasi-Peak Limit (dBµV/m)	Peak Limit (dBµV/m)	Average Limit (dBµV/m)
30-230	40.0	-	-
230-1000	47.0	-	-
1000-3000	-	70.0	50.0
3000-6000	-	74.0	54.0

Test Parameters

Frequency	30-6000 MHz	Distance	3m
Detector(s)	Peak – Trace/Final Quasi-Peak – Final Average – Final	Table height	80cm
RBW	120kHz (<1GHz) 1MHz (>1GHz)	VBW	120kHz (<1GHz) 1MHz (>1GHz)

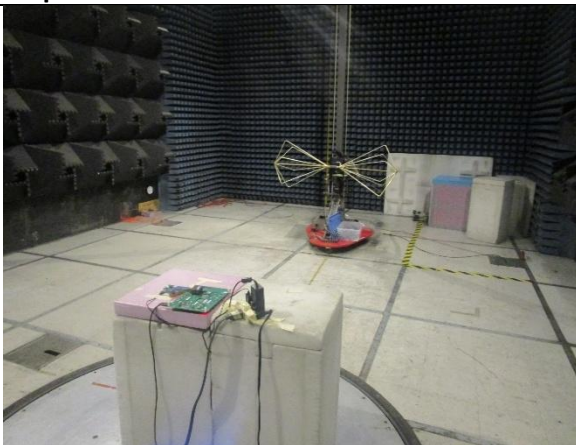
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/11/2024	4/11/2025	Active Calibration
LSC-546	Cable	A.H. Systems, Inc.	SAC-26G-6	546	7/17/2024	7/18/2025	Active Verification
AA 960218	Antenna - Biconical	A.H. Systems, Inc.	SAS-540	853	7/17/2024	7/17/2025	Active Calibration
AA 960215	Antenna - LPDA	A.H. Systems, Inc.	SAS-512-2	706	7/18/2024	7/18/2025	Active Calibration
AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	2/7/2024	2/7/2025	Active Calibration
AA 960211	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X- S+	977711030	2/7/2024	2/7/2025	Active Calibration

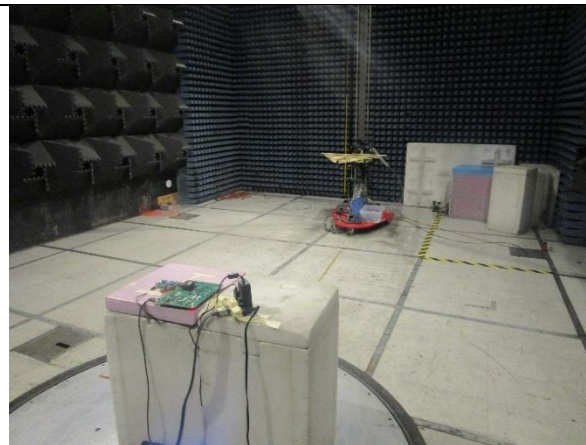
EUT Parameters

Input Power	120 VAC @ 60 Hz	Mode	Rx
EUT	X, Y, Z Plane Orientations	AE	HP Elitebook 840G1 Development Kit, NXP 8MPLUS- BB
Notes	<p><1000 MHz Emissions from auxiliary equipment. Not a function of the EUT. Emission at 4GHz and 6GHz is from auxiliary equipment. Emissions do not change with orientation or technology. No emissions within 10dB of the limit from the EUT were observed.</p>		

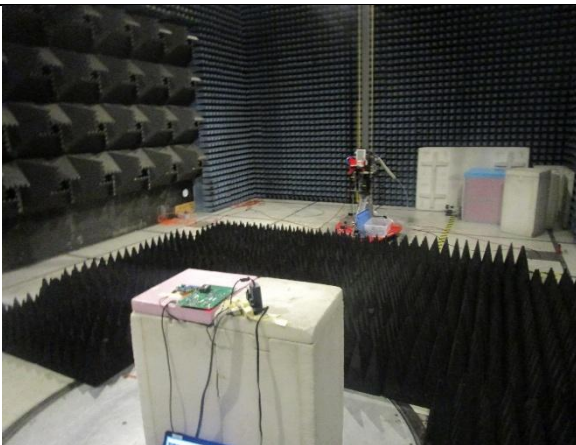
Setup Photos



30-200 MHz

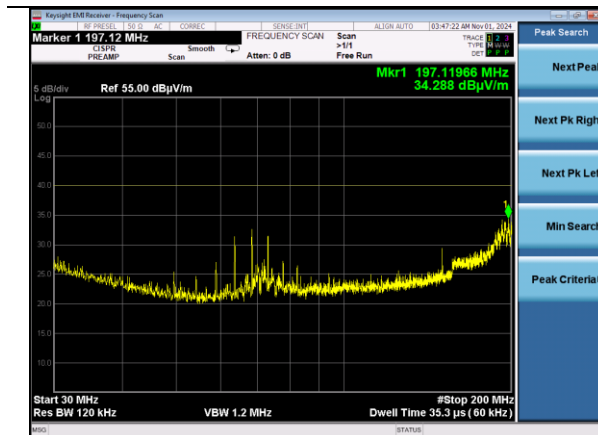


200-1000 MHz

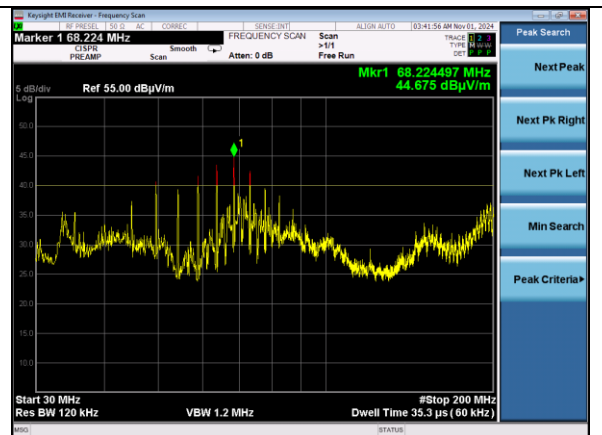


1000-6000 MHz

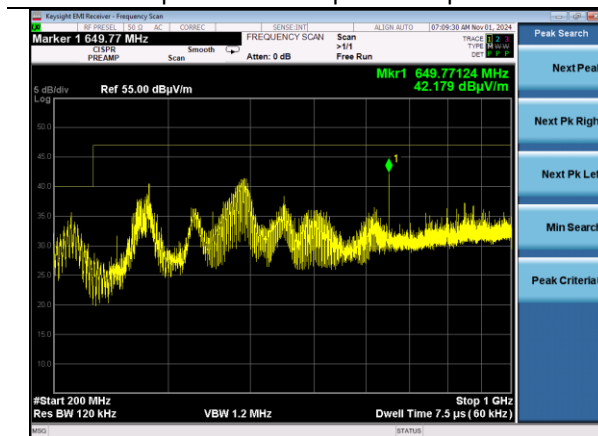
Plots



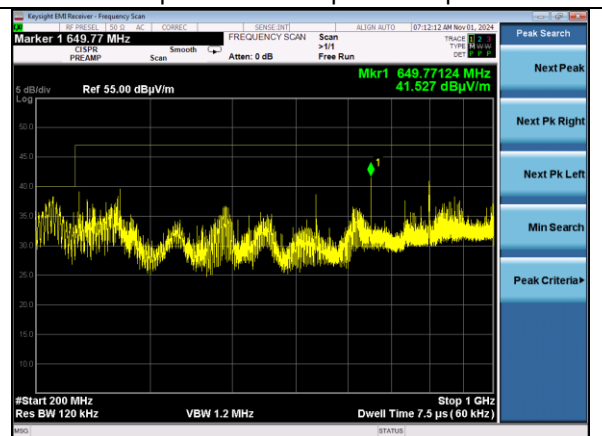
Baseline | 30-200 MHz | EUT off | Horizontal



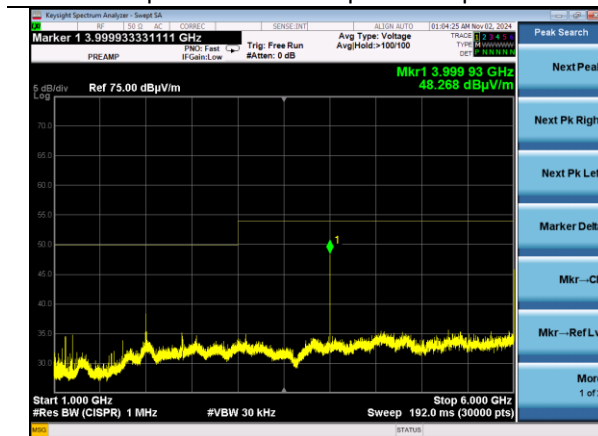
Baseline | 30-200 MHz | EUT off | Vertical



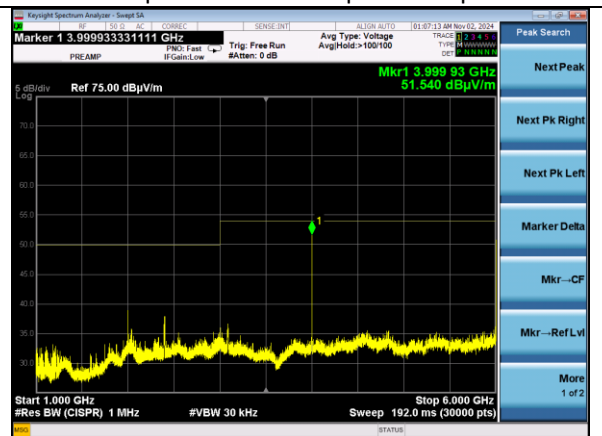
Baseline | 200-1000 MHz | EUT off | Horizontal



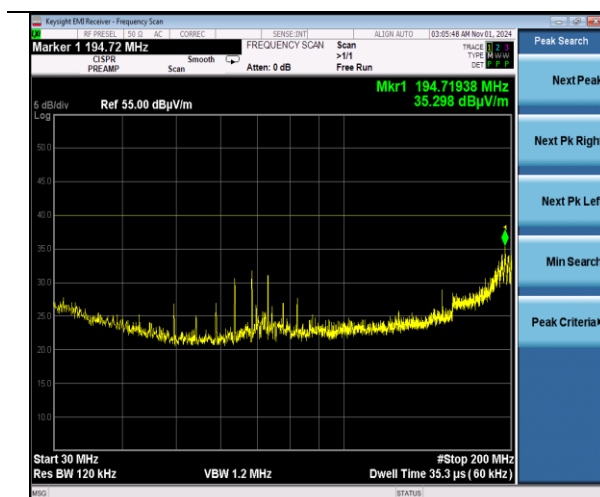
Baseline | 200-1000 MHz | EUT off | Vertical



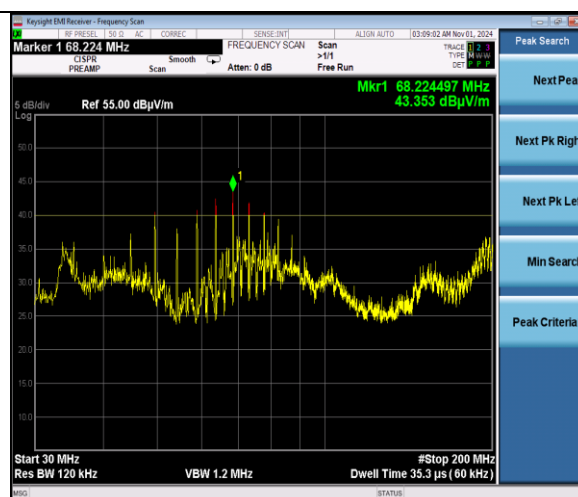
Baseline | 1000-6000 MHz | EUT off | Horizontal



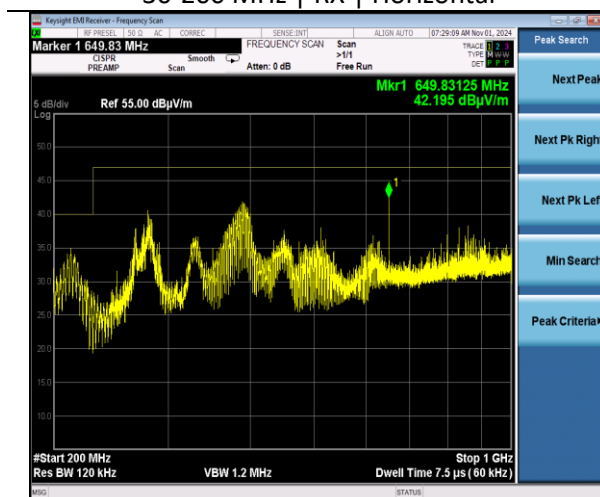
Baseline | 1000-6000 MHz | EUT off | Vertical



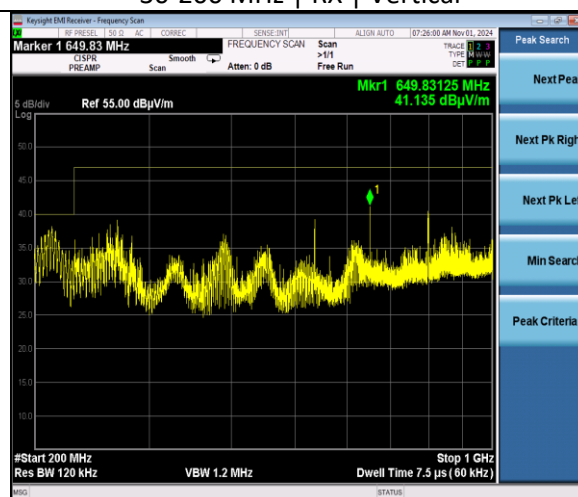
30-200 MHz | RX | Horizontal



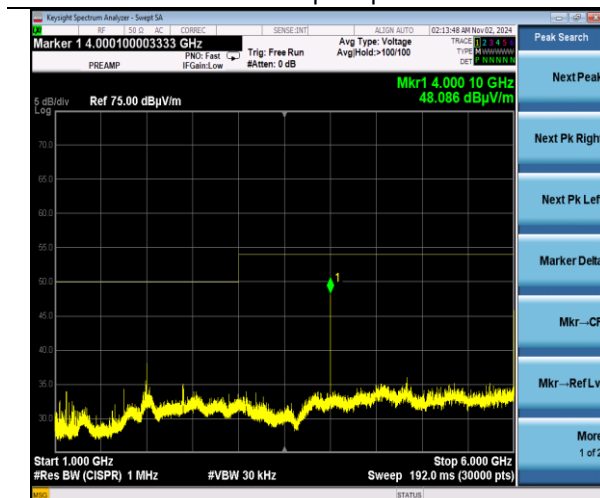
30-200 MHz | RX | Vertical



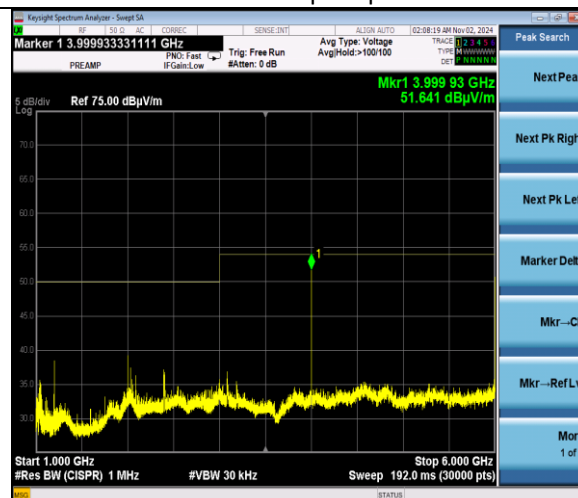
200-1000 MHz | RX | Horizontal



200-1000 MHz | RX | Vertical



1000-6000 MHz | RX | Horizontal



1000-6000 MHz | RX | Vertical

5.2 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.

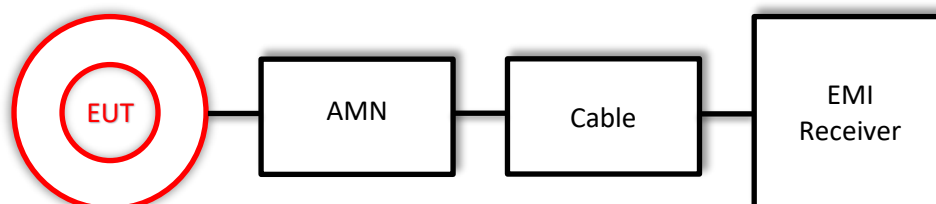
Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

Example Calculations

Measurement (dBμV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBμV)

Margin (dB) = Limit (dBμV) - Corrected Reading (dBμV)

Block Diagram



5.2.1 AC Mains Conducted Emissions

Operator	Jon Dille	QA	Dylan Rosenfeldt
Temperature	21.6°C	R.H. %	39.90%
Test Date	11/8/2024	Location	Conducted Emissions area
Requirement	ETSI 301 489-1	Method	CISPR 32

Limits:

Frequency (MHz)	Quasi-Peak Limit (dBμV)	Average Limit (dBμV)
0.15 – 0.5	66 – 56*	56 – 46*
0.5 – 5.0	56	46
5.0 – 30.0	60	50

* Decreases with logarithm of the frequency

Test Parameters

Frequency	150 kHz-30 MHz	Distance	40 cm from wall, 80 cm from LISN
Detector(s)	Peak – Trace Quasi-Peak – Final Average – Final	Table height	80 cm
RBW	9 kHz	VBW	62 kHz

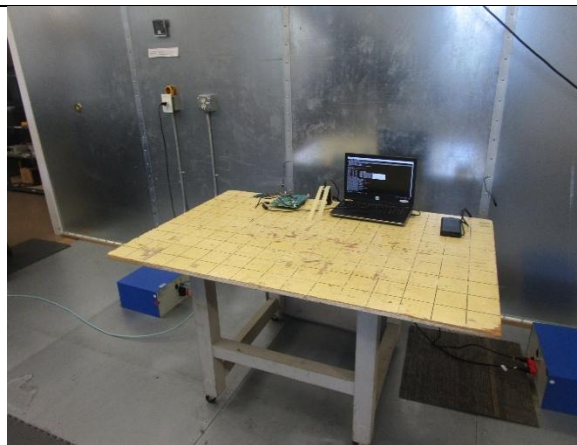
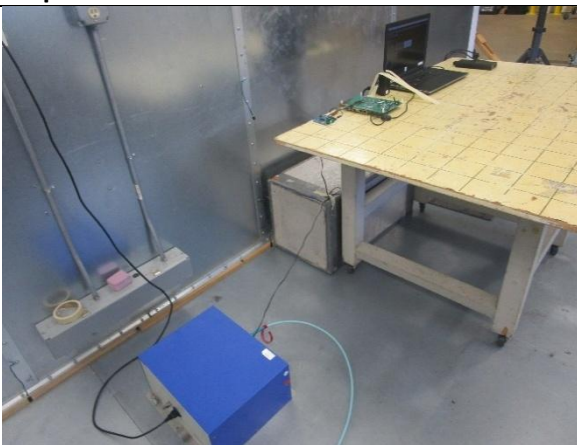
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	12/10/2024	12/10/2025	Active Calibration
EE 960089	LISN	COM-POWER	LI-215A	191943	4/8/2024	4/8/2025	Active Calibration
EE 960162	LISN	COM-POWER	LI-215A	191969	4/8/2024	4/8/2025	Active Calibration
LSC-211	Cable	Micro-Coax	UFB311A-0-1440-70U70U	64639 224071-002	1/8/2024	1/8/2025	Active Verification

EUT Parameters

Input Power	230 VAC @ 50 Hz	Mode	Rx
EUT	X, Y, Z Plane Orientations	AE	HP Elitebook 840G1 Development Kit, NXP 8MPLUS- BB
Notes	Emissions do not change with technology.		

Setup Photos



2.4GHz WLAN Table

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	0.150	39.9	66.0	26.1	30.1	56.0	25.9
1	0.545	26.8	56.0	29.2	22.2	46.0	23.8
1	18.166	30.6	60.0	29.4	20.0	50.0	30.0
2	0.150	39.9	66.0	26.1	30.0	56.0	26.0
2	0.527	40.0	56.0	16.0	30.1	46.0	15.9
2	18.758	29.2	60.0	30.8	18.4	50.0	31.6

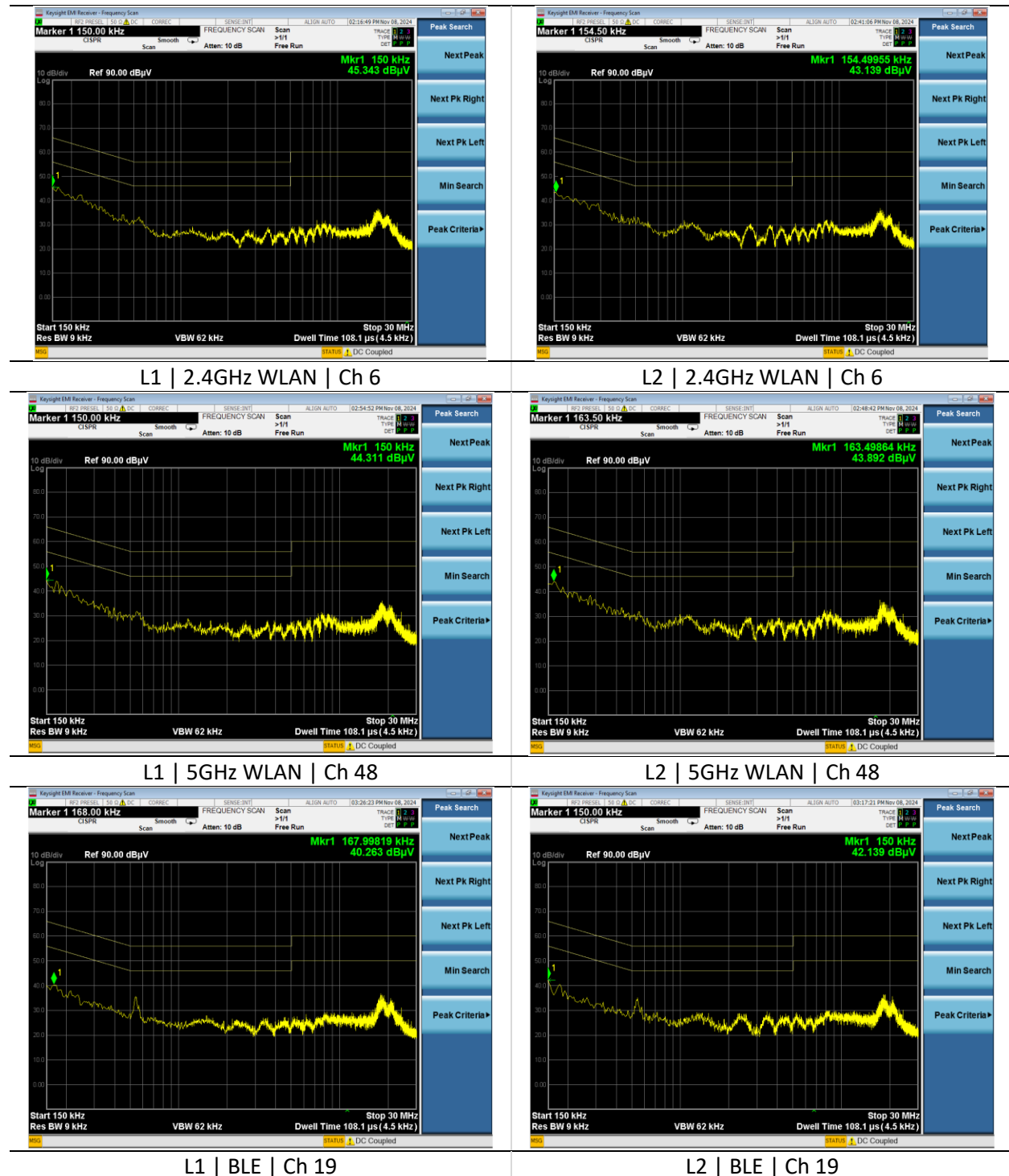
5GHz WLAN Table

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	0.159	39.5	65.5	26.0	29.5	55.5	26.0
1	0.545	30.5	56.0	25.5	24.2	46.0	21.8
1	18.782	29.2	60.0	30.8	19.5	50.0	30.5
2	0.159	39.7	65.5	25.8	29.4	55.5	26.1
2	0.505	27.9	56.0	28.1	19.3	46.0	26.7
2	18.112	29.4	60.0	30.6	17.9	50.0	32.1

BLE Table

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	0.163	35.9	65.3	29.4	28.2	55.3	27.1
1	0.545	32.3	56.0	23.7	25.7	46.0	20.3
1	18.182	29.6	60.0	30.4	19.1	50.0	30.9
2	0.154	36.6	65.8	29.2	28.9	55.8	26.9
2	0.541	31.4	56.0	24.6	21.1	46.0	24.9
2	17.763	28.6	60.0	31.4	16.7	50.0	33.3

Plots



5.3 Radiated Immunity

The EUT is illuminated with uniform electromagnetic radiation by means of a RF generator, power amplifier, and field generating antenna.

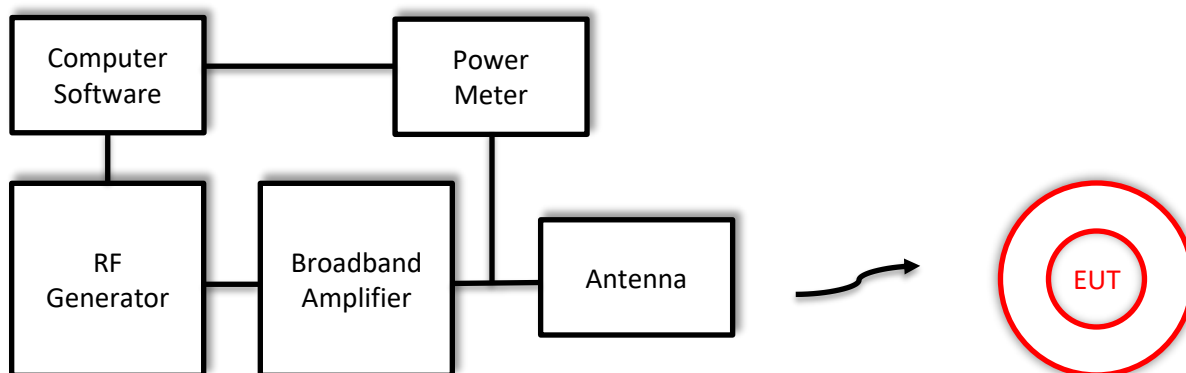
Ferrite panels and/or absorbers are placed on the ground between the antenna and EUT to achieve a uniform field area. The UFA is measured with an isotropic probe positioned in a planar grid at the desired test distance.

Description of Measurement

The power required to create a uniform test field strength is stored in a calibration file for each frequency and antenna polarity.

The response of the EUT during and after test is observed, recorded, and compared to the defined performance criteria.

Block Diagram



5.3.1 Radiated Immunity

Operator	Jon Dille / Adam Alger	QA	Dylan Rosenfeldt
Temperature	21.8-21.9 °C	R.H. %	43.1-48.9%
Test Date	11/4-6/2024	Location	Chamber 5
Requirement	ETSI EN 301 489-17	Method	IEC 61000-4-3

Test Parameters

Level	3 V/m	Frequency	80-6000 MHz with exclusion
Modulation	1 kHz 80% AM	Step	1% of the previous frequency
Dwell	3 seconds	Antenna Distance	3m
Exclusion Bands	BLE and 2.4GHz WLAN: 2280-2603.5 MHz UNII 1,2A,2C: 4830-6000 MHz UNII 3: 5285-6000 MHz		

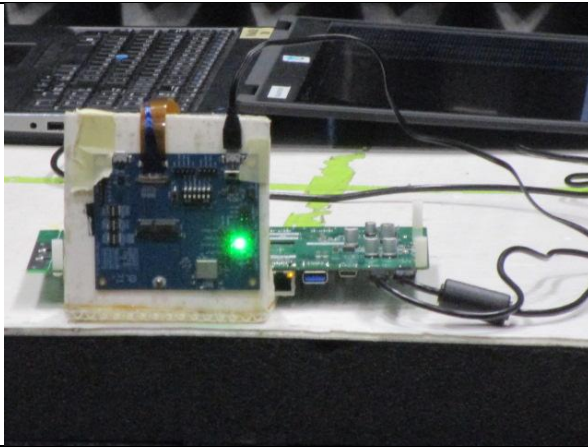
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960165	Antenna - Stacked Double Logarithmic-Periodic	Schwarzbeck	STLP 9128	9128 E 113	5/1/2024	5/1/2025	Active Validation
EE 960098	Generator - Signal	Teseq	ITS 6006	33022	4/11/2024	4/11/2025	Active Calibration
EE 960099	Sensor - RF Power	Teseq	PM 6006	73409	4/11/2024	4/11/2025	Active Calibration
EE 960100	Sensor - RF Power	Teseq	PM 6006	73402	4/11/2024	4/11/2025	Active Calibration
EE 960105	Amplifier	Milmega	80RF1000-500	1060498	5/1/2024	5/1/2025	Active Validation
EE 960106	Amplifier	Milmega	80RF1000-250	1060500	5/1/2024	5/1/2025	Active Validation

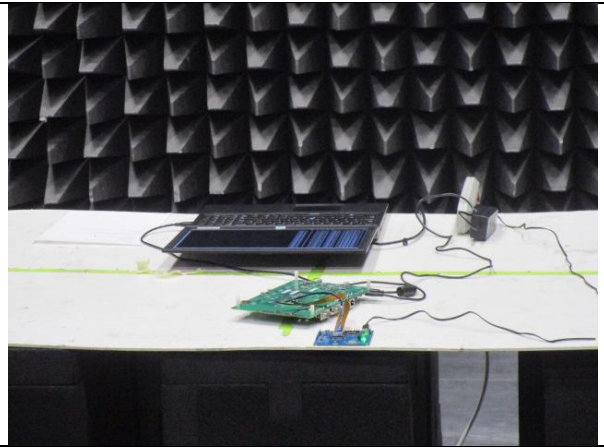
EUT Parameters

Input Power	5V	Operating Mode	WLAN connected to wireless access point, BLE connected to android app
Performance Criteria Required	Maintain connection	AE	Netgear Nighthawk R6900v2, Motorola Moto g power
Notes	BLE connected and sending packets to nRF connect android application, iperf used to send packets to WLAN access point.		
Notes	2.4GHz WLAN tested on channel 6, 5GHz WLAN tested on channel 100 and 157		

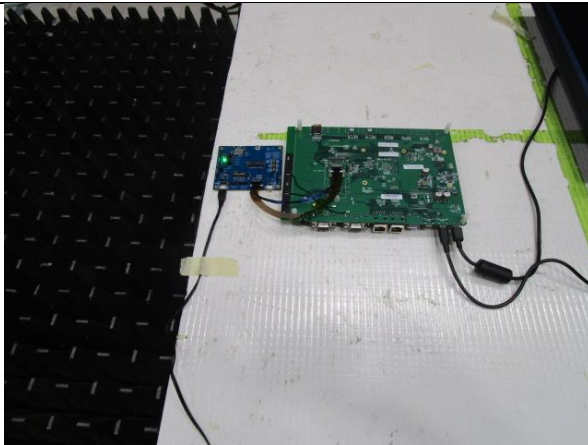
Setup Photos



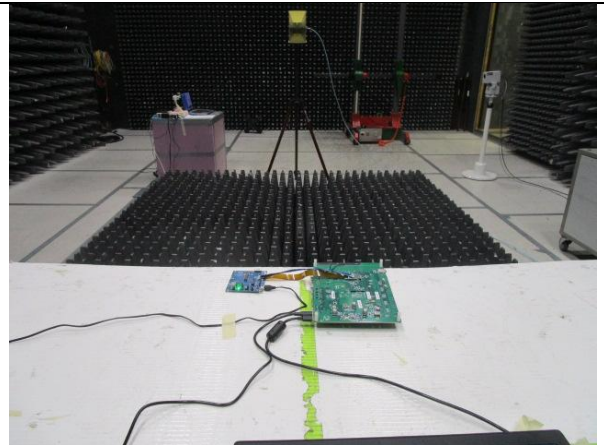
Vertical Orientation



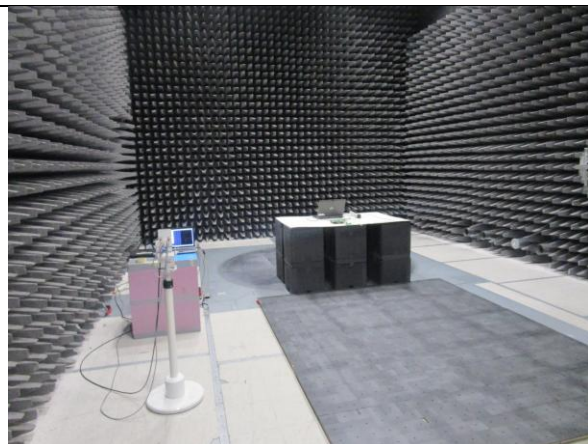
Flat Orientation



Left Orientation



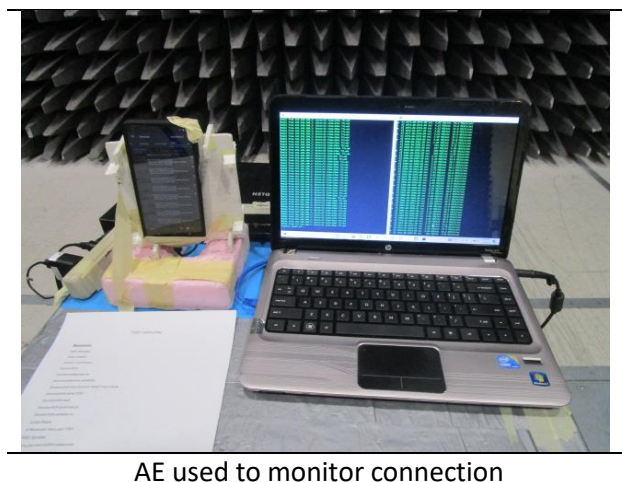
Right Orientation



Chamber Setup 80 – 1000 MHz



Chamber Setup 1000 – 6000 MHz



BLE and 2.4GHz WLAN 80-1000 MHz

Orientation	Antenna Polarity	Result
Flat	Vertical	Pass
Flat	Horizontal	Pass
Left	Horizontal	Pass
Left	Vertical	Pass
Right	Vertical	Pass
Right	Horizontal	Pass
Vertical	Horizontal	Pass
Vertical	Vertical	Pass

BLE and 2.4GHz WLAN 1000-2280 MHz, 2603.5-6000 MHz

Orientation	Antenna Polarity	Result
Flat	Vertical	Pass
Flat	Horizontal	Pass
Left	Horizontal	Pass
Left	Vertical	Pass
Right	Vertical	Pass
Right	Horizontal	Pass
Vertical	Horizontal	Pass
Vertical	Vertical	Pass

5GHz WLAN 80-1000 MHz

Orientation	Antenna Polarity	Result
Flat	Vertical	Pass
Flat	Horizontal	Pass
Left	Horizontal	Pass
Left	Vertical	Pass
Right	Vertical	Pass
Right	Horizontal	Pass
Vertical	Horizontal	Pass
Vertical	Vertical	Pass

5GHz WLAN 1000-4830 MHz, channel 100

Orientation	Antenna Polarity	Result
Flat	Vertical	Pass
Flat	Horizontal	Pass
Left	Horizontal	Pass
Left	Vertical	Pass
Right	Vertical	Pass
Right	Horizontal	Pass
Vertical	Horizontal	Pass
Vertical	Vertical	Pass

5GHz WLAN 1000-5285 MHz, channel 157

Orientation	Antenna Polarity	Result
Flat	Vertical	Pass
Flat	Horizontal	Pass
Left	Horizontal	Pass
Left	Vertical	Pass
Right	Vertical	Pass
Right	Horizontal	Pass
Vertical	Horizontal	Pass
Vertical	Vertical	Pass

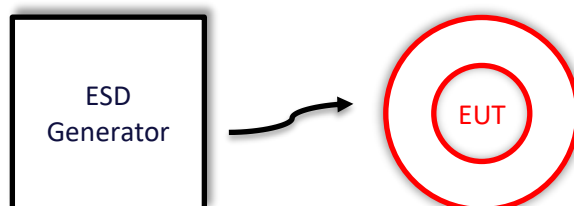
5.4 Electrostatic Discharge Immunity

The EUT is subject to a static electricity discharge by means of a generator network and electrode. This electrode is chosen to produce direct contact discharge or indirect air discharge in both positive and negative polarities.

Description of Measurement Contact discharges are applied directly to various points on the EUT, horizontal coupling plane, and vertical coupling plane as applicable.
The round tip electrode produces an indirect discharge to the EUT through the air.

The response of the EUT during and after test is observed, recorded, and compared to the defined performance criteria.

Block Diagram



5.4.1 Electrostatic Discharge Immunity

Operator	Jon Dille	QA	Mitchell Freund
Temperature	21.5°C	R.H. %	38.90%
Test Date	11/8/2024	Location	ESD Bench
Requirement	ETSI 301 489-1	Method	IEC 61000-4-2

Test Parameters

Level (+/-)	4kV	Network	15pF 330Ω
Number of discharges	10 positive, 10 negative	Discharge Repetition	1Hz

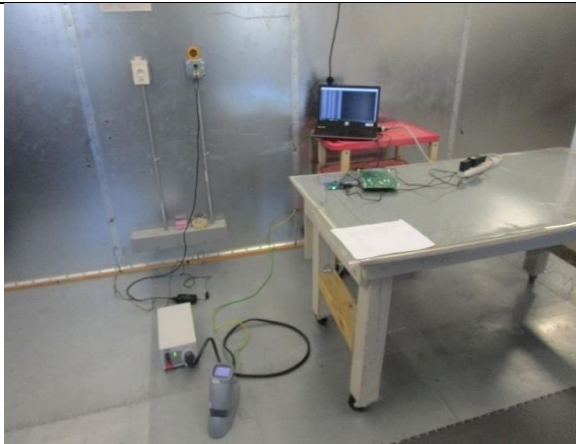
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
EE 960213	ESD Gun	Teseq	NSG 438A	346	4/11/2024	4/11/2025	Active Calibration
EE 960197	Meter - Hygro-Thermometer	Control Company	90080-03	180045461	12/17/2024	12/17/2025	Active Calibration

EUT Parameters

Input Power	5V	Operating Mode	WLAN connected to wireless access point, BLE connected to android app
Performance Criteria Required	Maintain connection	AE	Netgear Nighthawk R6900v2, Motorola Moto g power
Notes	BLE connected and sending packets to nRF connect android application, iperf used to send packets to WLAN access point.		

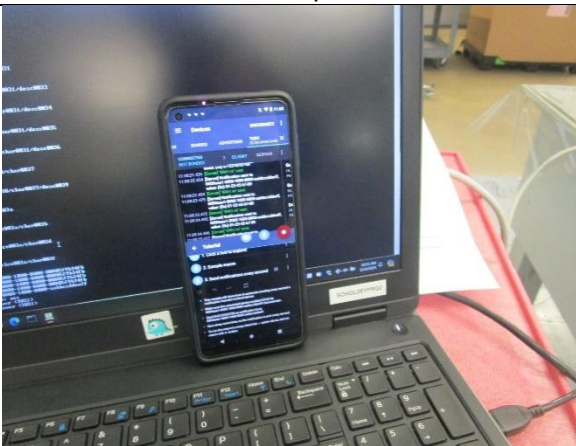
Setup Photos



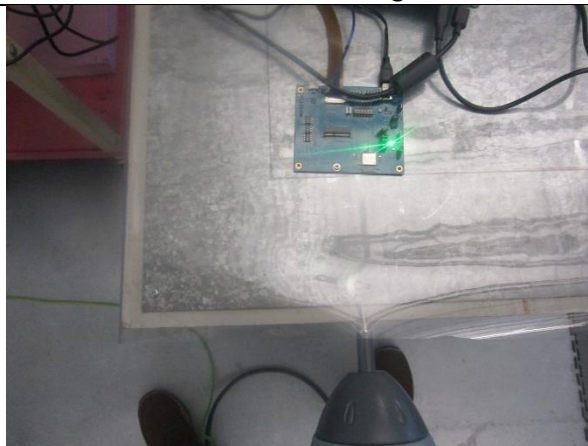
Setup



WLAN monitoring



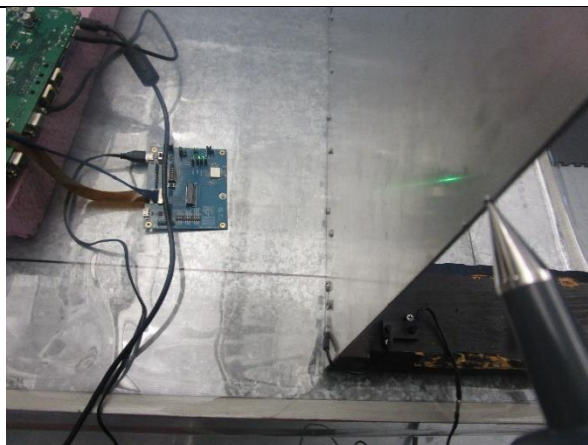
BLE monitoring



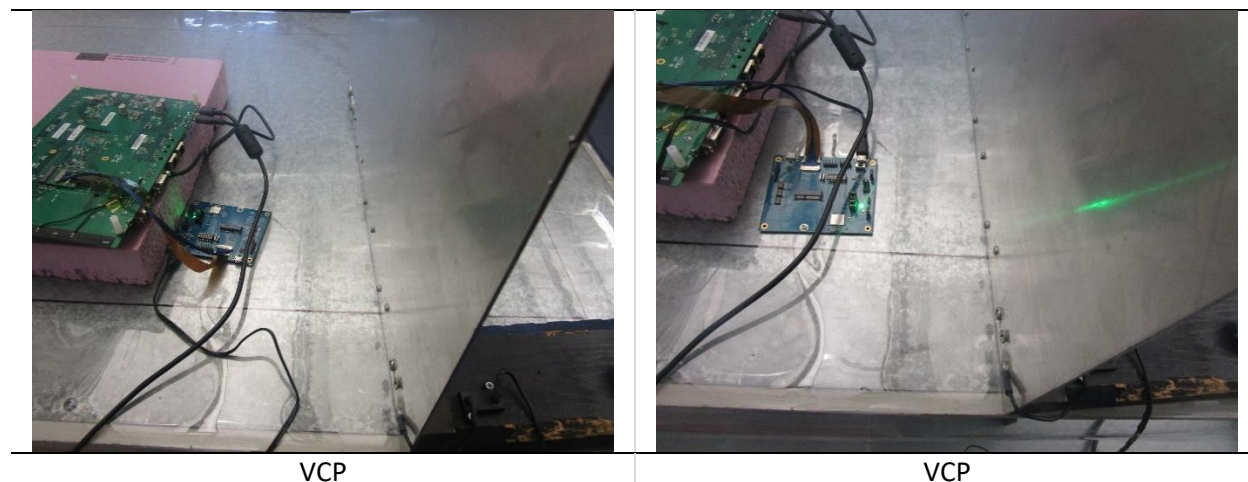
HCP



HCP



VCP



Table

Technology	Test Point	Method	Level
2.4GHz WLAN	HCP	Contact	± 4kV
	VCP	Contact	± 4kV
5GHz WLAN	HCP	Contact	± 4kV
	VCP	Contact	± 4kV
BLE	HCP	Contact	± 4kV
	VCP	Contact	± 4kV

6 REVISION HISTORY

Version	Date	Notes	Person
0	01/08/2025	Initial Draft	Dylan Rosenfeldt
1	01/10/2025	Final Draft	Dylan Rosenfeldt

END OF REPORT