




TR3818-62311

Equipment Under Test:	SONA TI351
Requirement(s):	IEC 62311
Test Date(s):	01/10/2025
Prepared for:	Ezurio Attn: Brian Petted W66 N220 Commerce Ct. Cedarburg, WI 53012

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CONTENTS

Contents.....	2
Ezurio Test Services in Review	4
1 Test Report Summary	5
2 Client Information.....	6
2.1 Equipment Under Test (EUT) Information.....	6
2.2 Product Description.....	6
2.3 Modifications Incorporated for Compliance	6
2.4 Deviations and Exclusions from Test Specifications.....	6
2.5 EUT Information	6
2.6 Ancillary Equipment	7
2.7 Antenna Information	7
2.8 Test Channels 2.4 GHz WLAN	7
2.9 Test Channels 5 GHz WLAN	8
2.10 Test Channels BLE.....	8
3 References	9
4 Uncertainty Summary	10
5 Test Data	11
5.1 Antenna Port Conducted Emissions	11
6 RF Exposure Evaluation.....	17
6.1 Limits	17
6.2 Spherical Evaluation Formula for Far-Field	18
7 2.4GHz WLAN.....	19
7.1 Power Calculation 2.4GHz WLAN	19
7.2 Minimum Separation Distance Calculation 2.4GHz WLAN.....	19
7.3 Power Density 2.4GHz WLAN	19
7.4 2.4GHz WLAN Result	19
8 5GHz WLAN.....	20
8.1 Power Calculation 5GHz WLAN	20
8.2 Minimum Separation Distance Calculation 2.4GHz WLAN.....	20
8.3 Power Density 5GHz WLAN	20
8.4 5GHz WLAN Result	20
9 BLE.....	21

9.1	Power Calculation BLE	21
9.2	Minimum Separation Distance Calculation BLE	21
9.3	Power Density BLE	21
9.4	BLE Result	21
10	Result	22
11	Revision History	23

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 4 of 23	Name: SONA TI351
Report: TR3818-62311		Model: SONA TI351
Job: C-3818		Serial: 00013 00008

1 TEST REPORT SUMMARY

During **01/10/2025** the Equipment Under Test (EUT), **SONA TI351**, as provided by **Ezurio** was tested to the following requirements:

Requirements	Description	Method	Compliant
IEC 62311	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields	IEC 62311 Annex A	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

2.6 Ancillary Equipment

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

2.7 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

2.8 Test Channels 2.4 GHz WLAN

Channel	Frequency (MHz)	Bandwidth (MHz)	Data Rates
1	2412	20	802.11b – 1 and 11 Mbps
7	2442	20	802.11g – 6 and 54 Mbps
13	2472	20	802.11n – MCS0 and MCS7 802.11ax – MCS0 and MCS7

2.9 Test Channels 5 GHz WLAN

Channel	Frequency (MHz)	Bandwidth (MHz)	Data Rates
36	5180	20	802.11a – 6 and 54 Mbps 802.11n – MCS0 and MCS7 802.11ac – MCS0 and MCS7 802.11ax – MCS0 and MCS7
64	5320	20	
100	5500	20	
140	5700	20	
149	5745	20	
157	5785	20	
165	5825	20	

2.10 Test Channels BLE

Channel	Frequency (MHz)	Data Rates
0	2402	125k, 500k, 1M and 2M
19	2440	
39	2480	

3 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
IEC 62311	2	2019	-	-
IEC 62232	2	2017	-	-
ICNIRP	-	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

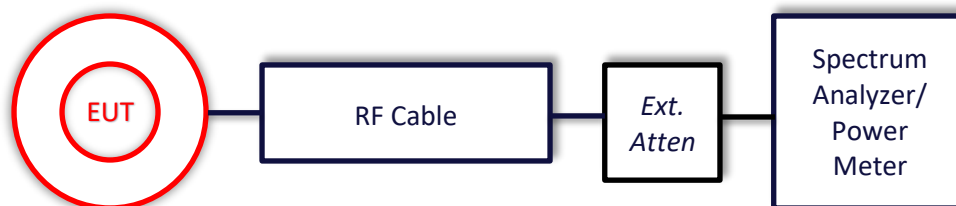
Parameter	ETSI U.C. \pm	U.C. \pm
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %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

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	<p>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.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
Example Calculations	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p>

Block Diagram



5.1.1 Antenna Port Conducted Emissions – RF Output Power 2.4GHz WLAN (-40°C)

Mode	Rate	Channel	Average Output Power (dBm)	Duty Cycle Correction (dB)	Corrected Output Power (dBm)	Limit (dBm)	Margin (dB)	Power Setting
802.11b	1 Mbps	1	14.2	3.2	17.4	20.0	2.6	26
		7	14.2	3.2	17.4	20.0	2.6	26
		13	14.5	3.2	17.7	20.0	2.3	26
	11 Mbps	1	14.3	3.2	17.5	20.0	2.5	26
		7	14.3	3.2	17.5	20.0	2.5	26
		13	14.3	3.2	17.5	20.0	2.5	26
802.11g	6 Mbps	1	15.1	3.2	18.3	20.0	1.7	28
		7	15.2	3.2	18.4	20.0	1.6	28
		13	15.3	3.2	18.5	20.0	1.5	28
	54 Mbps	1	15.3	3.2	18.5	20.0	1.5	28
		7	15.3	3.2	18.5	20.0	1.5	28
		13	15.3	3.2	18.5	20.0	1.5	28
802.11n	MCS0	1	15.0	3.2	18.2	20.0	1.8	28
		7	15.1	3.2	18.3	20.0	1.7	28
		13	15.1	3.2	18.3	20.0	1.7	28
	MCS7	1	15.2	3.2	18.4	20.0	1.6	28
		7	15.1	3.2	18.3	20.0	1.7	28
		13	15.1	3.2	18.3	20.0	1.7	28
802.11ax	MCS0	1	14.9	3.2	18.1	20.0	1.9	28
		7	15.0	3.2	18.2	20.0	1.8	28
		13	15.0	3.2	18.2	20.0	1.8	28
	MCS7	1	14.9	3.2	18.1	20.0	1.9	28
		7	15.1	3.2	18.3	20.0	1.7	28
		13	15.1	3.2	18.3	20.0	1.7	28

Mode	Rate and RU	Channel	Average Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	PWR Setting
802.11ax	MCS0 RU26	1	8.9	3.2	12.1	20.0	7.9	21
		7	9.0	3.2	12.2	20.0	7.8	21
		13	9.0	3.2	12.2	20.0	7.8	21
	MCS7 RU26	1	9.1	3.2	12.3	20.0	7.7	21
		7	9.2	3.2	12.4	20.0	7.6	21
		13	9.2	3.2	12.4	20.0	7.6	21
	MCS0 RU52	1	11.1	3.2	14.3	20.0	5.7	23
		7	11.2	3.2	14.4	20.0	5.6	23
		13	11.2	3.2	14.4	20.0	5.6	23
	MCS7 RU52	1	11.5	3.2	14.7	20.0	5.3	23
		7	11.5	3.2	14.7	20.0	5.3	23
		13	11.5	3.2	14.7	20.0	5.3	23
	MCS0 RU106	1	14.8	3.2	18.0	20.0	2.0	27
		7	14.9	3.2	18.1	20.0	1.9	27
		13	14.7	3.2	17.9	20.0	2.1	27
	MCS7 RU106	1	15.3	3.2	18.5	20.0	1.5	27
		7	15.3	3.2	18.5	20.0	1.5	27
		13	15.2	3.2	18.4	20.0	1.6	27
	MCS0 RU242	1	14.9	3.2	18.1	20.0	1.9	27
		7	15.1	3.2	18.3	20.0	1.7	27
		13	15.1	3.2	18.3	20.0	1.7	27
	MCS7 RU242	1	15.2	3.2	18.4	20.0	1.6	27
		7	15.3	3.2	18.5	20.0	1.5	27
		13	15.3	3.2	18.5	20.0	1.5	27

5.1.2 Antenna Port Conducted Emissions – RF Output Power 5GHz WLAN (-40°C)

Channel	Mode	Data Rate	Avg Output Power (dBm)	Antenna Gain	Corrected Measurement	Limit (dBm)	Margin (dB)	Power Setting
36	802.11a	6M	15.8	4.4	20.2	23.0	2.8	29
	802.11n	MCS0	14.8	4.4	19.2	23.0	3.8	28
	802.11ac	MCS0	16.0	4.4	20.4	23.0	2.6	29
	802.11ax	MCS0	15.9	4.4	20.3	23.0	2.7	29
	802.11ax	MCS0 RU26	8.6	4.4	13.0	23.0	10.0	21
	802.11ax	MCS0 RU52	9.9	4.4	14.3	23.0	8.7	22
	802.11ax	MCS0 RU106	12.8	4.4	17.2	23.0	5.8	30
	802.11ax	MCS0 RU242	12.8	4.4	17.2	23.0	5.8	30
64	802.11a	6M	16.1	4.4	20.5	23.0	2.5	29
	802.11n	MCS0	15.1	4.4	19.5	23.0	3.5	28
	802.11ac	MCS0	16.2	4.4	20.6	23.0	2.4	29
	802.11ax	MCS0	16.1	4.4	20.5	23.0	2.5	29
	802.11ax	MCS0 RU26	8.8	4.4	13.2	23.0	9.8	21
	802.11ax	MCS0 RU52	10.1	4.4	14.5	23.0	8.5	22
	802.11ax	MCS0 RU106	13.0	4.4	17.4	23.0	5.6	30
	802.11ax	MCS0 RU242	13.1	4.4	17.5	23.0	5.5	30
100	802.11a	6M	15.7	4.4	20.1	23.0	2.9	29
	802.11n	MCS0	14.7	4.4	19.1	23.0	3.9	28
	802.11ac	MCS0	15.8	4.4	20.2	23.0	2.8	29
	802.11ax	MCS0	15.6	4.4	20.0	23.0	3.0	29
	802.11ax	MCS0 RU26	8.2	4.4	12.6	23.0	10.4	21
	802.11ax	MCS0 RU52	9.5	4.4	13.9	23.0	9.1	22
	802.11ax	MCS0 RU106	12.4	4.4	16.8	23.0	6.2	30
	802.11ax	MCS0 RU242	12.6	4.4	17.0	23.0	6.0	30
140	802.11a	6M	15.5	4.4	19.9	23.0	3.1	29
	802.11n	MCS0	14.5	4.4	18.9	23.0	4.1	28
	802.11ac	MCS0	15.5	4.4	19.9	23.0	3.1	29
	802.11ax	MCS0	15.5	4.4	19.9	23.0	3.1	29
	802.11ax	MCS0 RU26	8.0	4.4	12.4	23.0	10.6	21
	802.11ax	MCS0 RU52	9.4	4.4	13.8	23.0	9.2	22
	802.11ax	MCS0 RU106	12.3	4.4	16.7	23.0	6.3	30
	802.11ax	MCS0 RU242	12.3	4.4	16.7	23.0	6.3	30

Channel	Mode	Data Rate	Avg Output Power (dBm)	Antenna Gain	Corrected Measurement	Limit (dBm)	Margin (dB)	Power Setting
149	802.11a	6M	7.7	4.4	12.1	14.0	1.9	21
	802.11n	MCS0	7.6	4.4	12.0	14.0	2.0	21
	802.11ac	MCS0	7.7	4.4	12.1	14.0	1.9	21
	802.11ax	MCS0	7.6	4.4	12.0	14.0	2.0	21
	802.11ax	MCS0 RU26	7.8	4.4	12.2	14.0	1.8	21
	802.11ax	MCS0 RU52	8.1	4.4	12.5	14.0	1.5	21
	802.11ax	MCS0 RU106	8.0	4.4	12.4	14.0	1.6	21
	802.11ax	MCS0 RU242	7.4	4.4	11.8	14.0	2.2	20
157	802.11a	6M	7.4	4.4	11.8	14.0	2.2	21
	802.11n	MCS0	7.4	4.4	11.8	14.0	2.2	21
	802.11ac	MCS0	7.6	4.4	12.0	14.0	2.0	21
	802.11ax	MCS0	7.3	4.4	11.7	14.0	2.3	21
	802.11ax	MCS0 RU26	7.7	4.4	12.1	14.0	1.9	21
	802.11ax	MCS0 RU52	8.0	4.4	12.4	14.0	1.6	21
	802.11ax	MCS0 RU106	8.0	4.4	12.4	14.0	1.6	21
	802.11ax	MCS0 RU242	7.1	4.4	11.5	14.0	2.5	20
165	802.11a	6M	7.4	4.4	11.8	14.0	2.2	21
	802.11n	MCS0	7.5	4.4	11.9	14.0	2.1	21
	802.11ac	MCS0	7.6	4.4	12.0	14.0	2.0	21
	802.11ax	MCS0	7.4	4.4	11.8	14.0	2.2	21
	802.11ax	MCS0 RU26	7.4	4.4	11.8	14.0	2.2	21
	802.11ax	MCS0 RU52	8.1	4.4	12.5	14.0	1.5	21
	802.11ax	MCS0 RU106	7.9	4.4	12.3	14.0	1.7	21
	802.11ax	MCS0 RU242	7.2	4.4	11.6	14.0	2.4	20

5.1.3 Antenna Port Conducted Emissions – RF Output Power BLE (-40°C)

Mode	Channel	Avg Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Power Setting
1M	0	5.4	3.2	8.6	20.0	14.6	8
	19	4.9	3.2	8.1	20.0	15.1	8
	39	4.1	3.2	7.3	20.0	15.9	8
2M	1	5.5	3.2	8.7	20.0	14.5	8
	19	5.0	3.2	8.2	20.0	15.0	8
	38	4.2	3.2	7.4	20.0	15.8	8
125k	0	5.3	3.2	8.5	20.0	14.7	8
	19	4.8	3.2	8.0	20.0	15.2	8
	39	4.0	3.2	7.2	20.0	16.0	8
500k	0	5.3	3.2	8.5	20.0	14.7	8
	19	4.8	3.2	8.0	20.0	15.2	8
	39	4.0	3.2	7.2	20.0	16.0	8

6 RF EXPOSURE EVALUATION

6.1 Limits

The device shall comply with the relevant limits for Equivalent plane wave power density for the general public, as stated by ICNIRP in the table below.

ICNIRP Guidelines • ICNIRP

Table 5. Reference levels for exposure, averaged over 30 min and the whole body, to electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values).^a

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} ($V\ m^{-1}$)	Incident H-field strength; H_{inc} ($A\ m^{-1}$)	Incident power density; S_{inc} ($W\ m^{-2}$)
Occupational	0.1 – 30 MHz	$660/f_M^{0.7}$	$4.9/f_M$	NA
	>30 – 400 MHz	61	0.16	10
	>400 – 2000 MHz	$3f_M^{0.5}$	$0.008f_M^{0.5}$	$f_M/40$
	>2 – 300 GHz	NA	NA	50
General public	0.1 – 30 MHz	$300/f_M^{0.7}$	$2.2/f_M$	NA
	>30 – 400 MHz	27.7	0.073	2
	>400 – 2000 MHz	$1.375f_M^{0.5}$	$0.0037f_M^{0.5}$	$f_M/200$
	>2 – 300 GHz	NA	NA	10

^aNote:

1. "NA" signifies "not applicable" and does not need to be taken into account when determining compliance.
2. f_M is frequency in MHz.
3. S_{inc} , E_{inc} , and H_{inc} are to be averaged over 30 min, over the whole-body space. Temporal and spatial averaging of each of E_{inc} and H_{inc} must be conducted by averaging over the relevant square values (see eqn 8 in Appendix A for details).
4. For frequencies of 100 kHz to 30 MHz, regardless of the far-field/near-field zone distinctions, compliance is demonstrated if neither E_{inc} or H_{inc} exceeds the above reference level values.
5. For frequencies of >30 MHz to 2 GHz: (a) within the far-field zone: compliance is demonstrated if either S_{inc} , E_{inc} or H_{inc} , does not exceed the above reference level values (only one is required); S_{eq} may be substituted for S_{inc} ; (b) within the radiative near-field zone, compliance is demonstrated if either S_{inc} , or both E_{inc} and H_{inc} , does not exceed the above reference level values; and (c) within the reactive near-field zone: compliance is demonstrated if both E_{inc} and H_{inc} do not exceed the above reference level values; S_{inc} cannot be used to demonstrate compliance, and so basic restrictions must be assessed.
6. For frequencies of >2 GHz to 300 GHz: (a) within the far-field zone: compliance is demonstrated if S_{inc} does not exceed the above reference level values; S_{eq} may be substituted for S_{inc} ; (b) within the radiative near-field zone, compliance is demonstrated if S_{inc} does not exceed the above reference level values; and (c) within the reactive near-field zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

Figure 1: Radio Frequency exposure reference levels from ICNIRP guidelines

6.2 Spherical Evaluation Formula for Far-Field

B.4.2.1.1.2 Applicability of spherical formulas

The far-field spherical formulas can be used to evaluate the spatial-peak and spatially-averaged RF field strengths. The spatially-averaged and spatial-peak equivalent power densities can be evaluated as follows:

$$S = \frac{\overline{P}_{\text{net}} G_{\theta, \phi}}{4\pi r^2} \quad (\text{B.15})$$

Figure 2: Spherical formula to calculate power density from IEC 62232

S = Power density (W/m²)

P = Conducted power output (W)

G = Antenna gain

r = distance to center of radiating antenna (m)

7 2.4GHz WLAN

7.1 Power Calculation 2.4GHz WLAN

Max Power of Channel (EIRP) = 18.5 dBm (802.11g, 54 MBPS, channel 13)

Tune-up Tolerance = 1.00 dB

Total Power = 18.5 dBm + Tune-up Tolerance = 19.5 dBm = 89.1 mW

7.2 Minimum Separation Distance Calculation 2.4GHz WLAN

$$S = \left[\frac{(0.089W)}{4\pi(r)^2} \right] = 10 W/m^2$$

$$r = 0.027m$$

7.3 Power Density 2.4GHz WLAN

$$S = \left[\frac{(0.089W)}{4\pi(0.028)^2} \right] = 9.0 W/m^2$$

7.4 2.4GHz WLAN Result

2.4GHz WLAN is compliant with IEC 62311 and the ICNIRP guidelines for all separation distances greater than or equal to 28mm.

8 5GHz WLAN

8.1 Power Calculation 5GHz WLAN

Max Power of Channel (EIRP) = 20.6 dBm (802.11ac, MCS0, channel 64)

Tune-up Tolerance = 1.00 dB

Total Power = 20.6 dBm + Tune-up Tolerance = 21.6 dBm = 144.5 mW

8.2 Minimum Separation Distance Calculation 2.4GHz WLAN

$$S = \left[\frac{(0.145W)}{4\pi(r)^2} \right] = 10 \text{ W/m}^2$$

$$r = 0.034m$$

8.3 Power Density 5GHz WLAN

$$S = \left[\frac{(0.145W)}{4\pi(0.35)^2} \right] = 9.42 \text{ W/m}^2$$

8.4 5GHz WLAN Result

5GHz WLAN is compliant with IEC 62311 and the ICNIRP guidelines for all separation distances greater than or equal to 35mm.

9 BLE

9.1 Power Calculation BLE

Max Power of Channel (EIRP) = 8.7 dBm (2M, channel 1)

Tune-up Tolerance = 1.00 dB

Total Power = 8.7 dBm + Tune-up Tolerance = 9.7 dBm = 9.3 mW

9.2 Minimum Separation Distance Calculation BLE

$$S = \left[\frac{(0.0093W)}{4\pi(r)^2} \right] = 10 W/m^2$$

$$r = 0.0086m$$

9.3 Power Density BLE

$$S = \left[\frac{(0.0093W)}{4\pi(0.0087)^2} \right] = 9.8 W/m^2$$

9.4 BLE Result

BLE is compliant with IEC 62311 and the ICNIRP guidelines for all separation distances greater than or equal to 8.7mm.

10 RESULT

The EUT is not capable of transmitting multiple technologies simultaneously. The separation distance between the EUT and the user must be greater than or equal to the largest separation distance calculated in the previous sections according to the technology being used.

- **5GHz WLAN and/or 2.4GHz, BLE**
 - Minimum separation distance $\geq 35\text{mm}$
- **2.4GHz WLAN and/or BLE (no 5GHz WLAN)**
 - Minimum separation distance $\geq 28\text{mm}$
- **BLE only**
 - Minimum separation distance $\geq 8.7\text{mm}$

11 REVISION HISTORY

Version	Date	Notes	Person
0	01/10/2025	Initial Draft	Dylan Rosenfeldt
1	01/14/2025	Added minimum distance calculations	Dylan Rosenfeldt
2	01/14/2025	Final Draft	Dylan Rosenfeldt

END OF REPORT