

Delta Electronics, Inc.

TEST REPORT

SCOPE OF WORK:

47 CFR FCC Part 15.247 – Radio Spectrum report

Model:

RPI703M260000-C

REPORT NUMBER

211100338THC-001

ISSUE DATE

Feb. 08, 2022

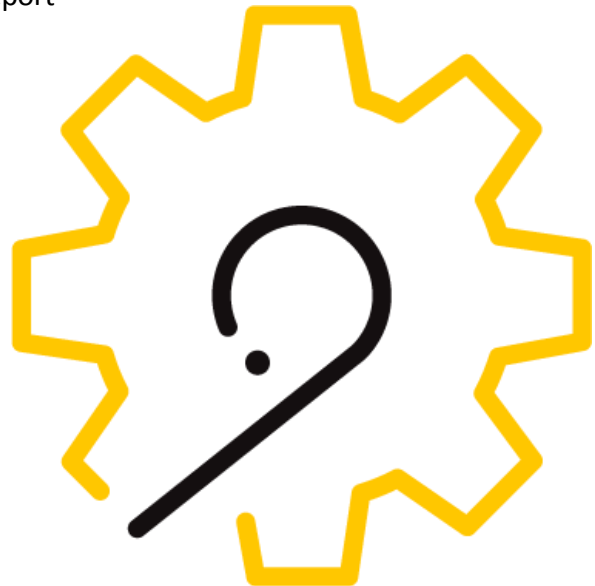
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DOCUMENT CONTROL NUMBER

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Radio Spectrum TEST REPORT

Applicant:	Delta Electronics, Inc. No.39, Sec. 2, Huandong Rd., Shanhua Dist., Tainan City 741, Taiwan
Product:	Sub 1G & BLE module
Model No.:	RPI703M260000-C
FCC ID:	2ARTO-RPI703M26000C
Test Method/ Standard:	47 CFR FCC Part 15.247 & ANSI C63.10 2013 KDB 558074 D01 v05r02
Test By:	Intertek Testing Services Taiwan Ltd., Hsinchu Laboratory No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li, Shiang-Shan District, Hsinchu City, Taiwan



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TEST REPORT

Revision History

Report No.	Issue Date	Revision Summary
211100338THC-001	Feb. 08, 2022	Original report

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Summary of Test Data

Test Requirement	Applicable Rule (Section 15.247)	Result
Minimum 6 dB Bandwidth	15.247(a)(2)	Pass
Maximum Peak Conducted Output Power	15.247(b)(3)	Pass
Power Spectral Density	15.247(e)	Pass
Emissions In Non-Restricted Frequency Bands	15.247(d)	Pass
Emissions In Restricted Frequency Bands (Radiated emission measurements)	15.247(d), 15.205, 15.209	Pass
AC Power Line Conducted Emission	15.207	N/A
Antenna Requirement	15.203	Pass

Note: Please note that the test results with statement of conformity, the decision rules which are based on: Safety Testing: the specification, standard or IEC Guide 115.

Other Testing: the specification, standard and not taking into account the measurement uncertainty.

1. General Information

1.1 Identification of the EUT

Product:	Sub 1G & BLE module
Model No.:	RPI703M260000-C
Operating Frequency:	903 MHz ~ 927 MHz
Channel Number:	33 channels
Rated Power:	DC 12V
Power Cord:	N/A
Sample receiving date:	2021/08/30
Sample condition:	Workable
Test Date(s):	2022/01/07 ~ 2022/01/19

1.2 Antenna description

Antenna 1

Antenna Type : Dipole antenna
Connector Type : SMA
Antenna Gain : 2.26 dBi

Antenna 2

Antenna Type : Dipole antenna
Connector Type : SMA
Antenna Gain : 1.73 dBi

1.3 Operation mode

Connected to Notebook PC via USB Cable, executing “QCOM_V1.6” and to select different frequency and modulation.

Mode	Channel	Frequency (MHz)	Signal on time (ms)	Signal on & off time (ms)	Duty cycle	Duty factor (dB)
Lora	mid	915	135.5	236	0.574	2.410

1.4 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Data cable
Notebook PC	HP	HP Probook 440 G3	5CD8021S9H	N/A
USB Converter	TRP	TRP-C08	N/A	USB shielded cable 2m
DC Power Supply	Twintex	TP-1603C	N/A	N/A

2. Minimum 6 dB Bandwidth

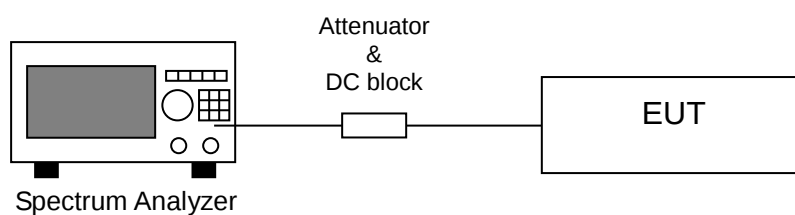
2.1 Instrument Setting

Spectrum Parameter	Setting
Detector	Peak
RBW	100kHz
VBW	$\geq 3 \times \text{RBW}$
Sweep	Auto couple
Trace	Allow the trace to stabilize.
Span	Between two times and five times the occupied bandwidth
Attenuation	Auto

2.2 Test Procedure

Step 1	The transmitter output was connected to the spectrum analyzer.
Step 2	Test was performed accordance with ANSI C63.10.
Step 3	Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

2.3 Test Diagram



2.4 Limit

The minimum 6 dB bandwidth shall be at least 500 kHz.

2.5 Test Results

Temperature (°C) :	16
Relative Humidity (%) :	59
Test date :	2022/01/19

Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Lora	low	903	0.655	>0.5	Pass
	mid	915	0.629	>0.5	Pass
	high	927	0.637	>0.5	Pass

Chain 0: 6dB Bandwidth @ Sub 1G Mode Ch low



Chain 0: 6dB Bandwidth @ Sub 1G Mode Ch mid



Chain 0: 6dB Bandwidth @ Sub 1G Mode Ch high



3. Maximum Peak Conducted Output Power

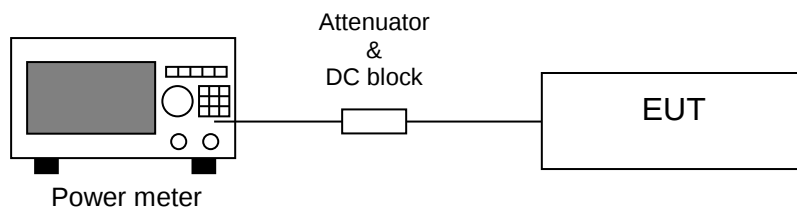
3.1 Instrument Setting

Power Meter Parameter	Setting
Bandwidth	65MHz bandwidth is greater than the EUT emission bandwidth
Detector	Peak & Average

3.2 Test Procedure

The preferred methodology is to use integrated average power measurements, as described in 11.9.2 and 11.13.3 of ANSI C63.10. The peak integrated band power methods of 11.9.1.2 and 11.13.3.2 of ANSI C63.10 are not applicable for FCC compliance testing purposes.

3.3 Test Diagram



3.4 Limit

For systems using digital modulation in the 2400-2483.5 MHz: 1 Watt (30dBm)

3.5 Test Results

Temperature (°C) :	16
Relative Humidity (%) :	59
Test date :	2022/01/19

Mode	Channel	Frequency (MHz)	Output Power [AV] (dBm)	Total Power [AV] (mW)	Maximum Power [PK] (dBm)	Maximum Power [PK] (mW)	Limit (dBm)	Margin (dB)
Lora	low	903	14.06	25.47	14.21	26.36	30	-15.79
	mid	915	14.15	26.00	14.30	26.92	30	-15.70
	high	927	14.22	26.42	14.40	27.54	30	-15.60

4. Power Spectral Density

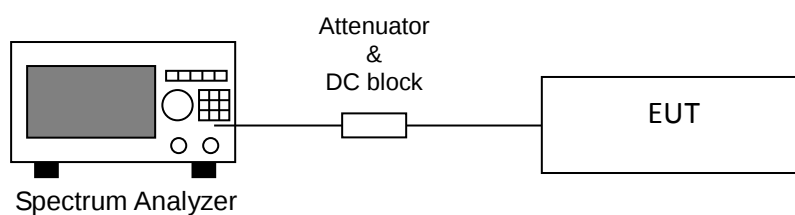
4.1 Instrument Setting

Spectrum Function	Setting
Detector	Peak
RBW	≥ 3 kHz
VBW	$\geq 3 \times$ RBW
Sweep	Auto couple
Trace	Max hold
Span	1.5 times x 6dB bandwidth
Attenuation	Auto

4.2 Test Procedure

Step 1	Test procedure refer to subclause 11.10 of ANSI C63.10.
Step 2	Using the maximum conducted output power in the fundamental emission demonstrates compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
Step 3	Use the peak marker function to determine the maximum amplitude level within the RBW.

4.3 Test Diagram



4.4 Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

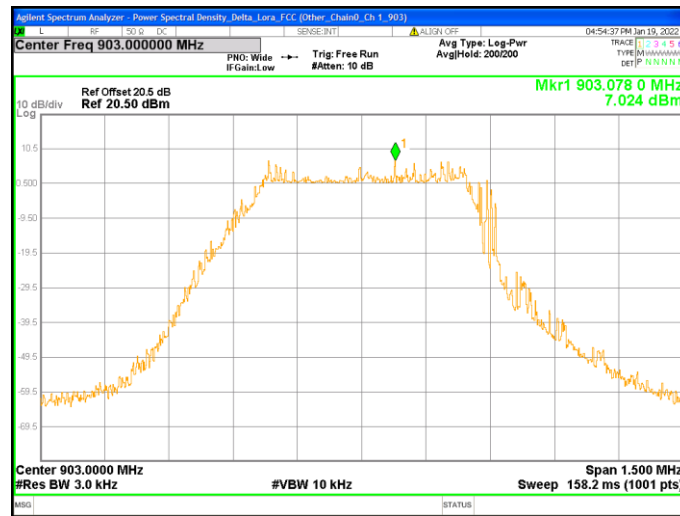
4.5 Test Results

Temperature (°C) :	16
Relative Humidity (%) :	59
Test date :	2022/01/19

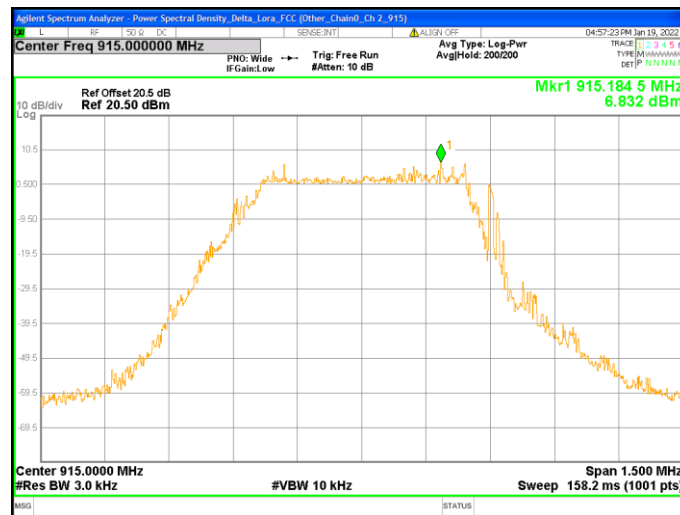
Mode	Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Lora	low	903	7.024	8	-0.980
	mid	915	6.832	8	-1.170
	high	927	5.599	8	-2.400

Correction (RBW) Factor in 3kHz = $10\log(10\text{kHz}/3\text{kHz}) = 5.23$

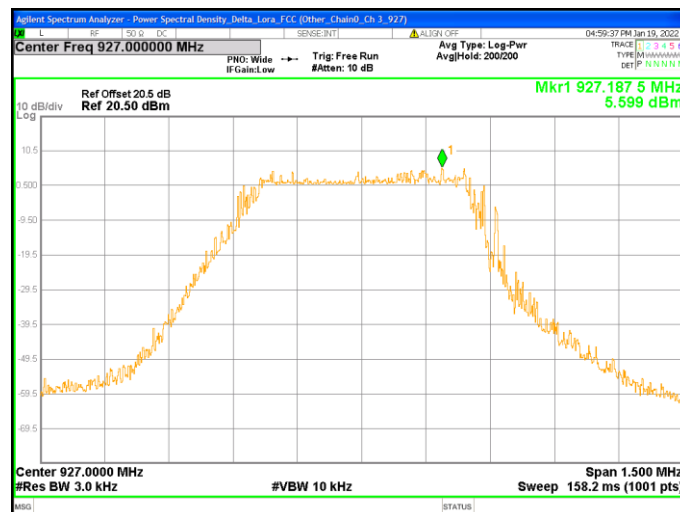
Chain 0: Power Spectral Density @ Sub 1G Mode Ch low



Chain 0: Power Spectral Density @ Sub 1G Mode Ch mid



Chain 0: Power Spectral Density @ Sub 1G Mode Ch high



5. Emissions in Non-Restricted Frequency Bands

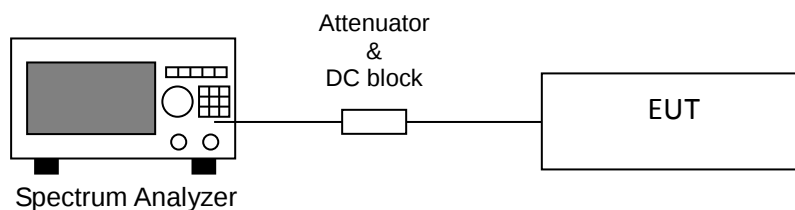
5.1 Instruments Setting

Spectrum Function	Setting (Reference Level)	Setting (Emission Level)
Detector	Peak	Peak
RBW	≥ 100 kHz	≥ 100 kHz
VBW	$\geq 3 \times$ RBW	$\geq 3 \times$ RBW
Sweep	Auto couple	Auto couple
Trace	Max hold	Max hold
Span	≥ 1.5 time 6dB bandwidth	
Attenuation	Auto	Auto

5.2 Test Procedure

- Step 1 The procedure was used in antenna-port conducted and connected to the spectrum analyzer.
- Step 2 Set instrument center frequency to center frequency.
- Step 3 Use the parameter configured in subclause 11.11 of ANSI C63.10 to measure.
- Step 4 Use the peak marker function to determine the maximum amplitude level.

5.3 Test Diagram



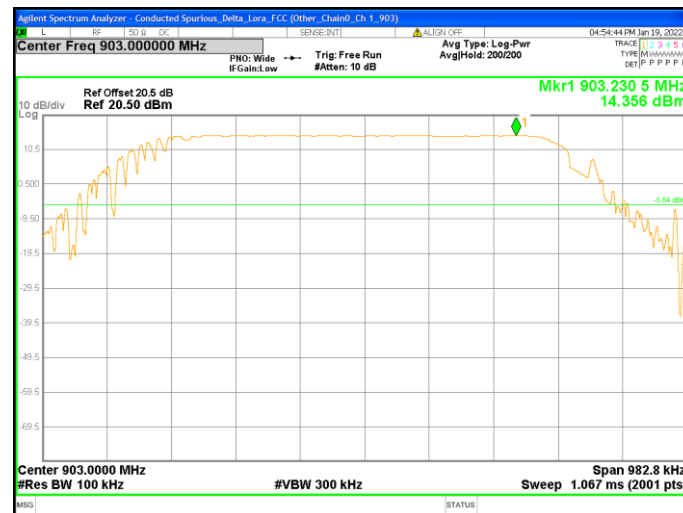
5.4 Limit

The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz

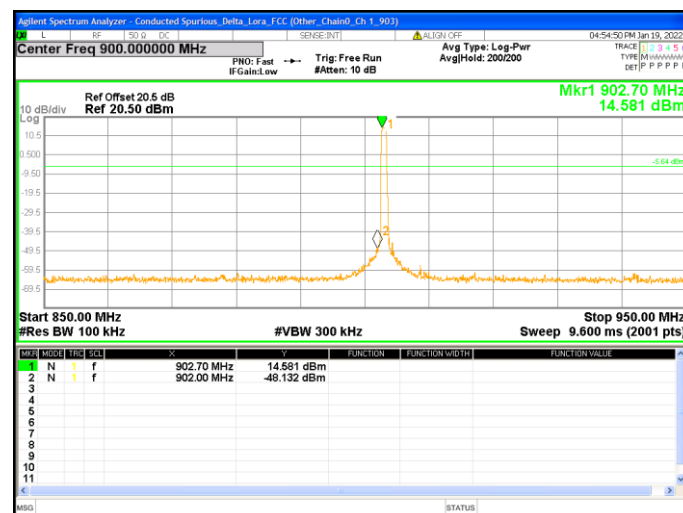
5.5 Test Results

Temperature (°C) :	16
Relative Humidity (%) :	59
Test date :	2022/01/19

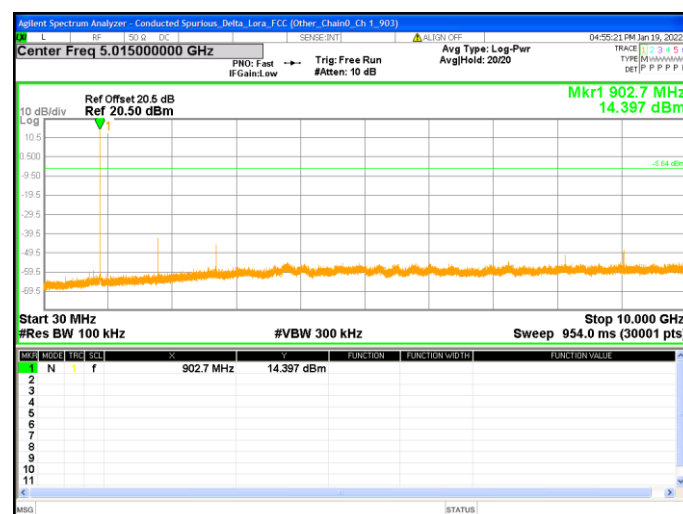
Chain 0: Conducted Spurious @ Sub 1G Mode Ch low



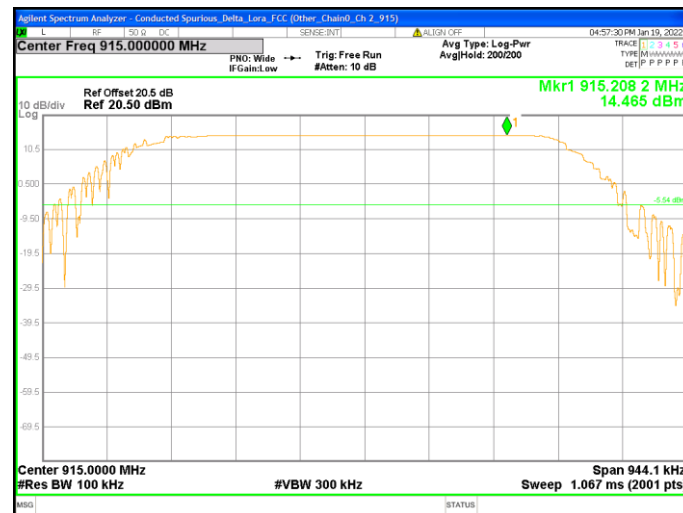
Chain 0: Conducted Spurious @ Sub 1G Mode Ch low



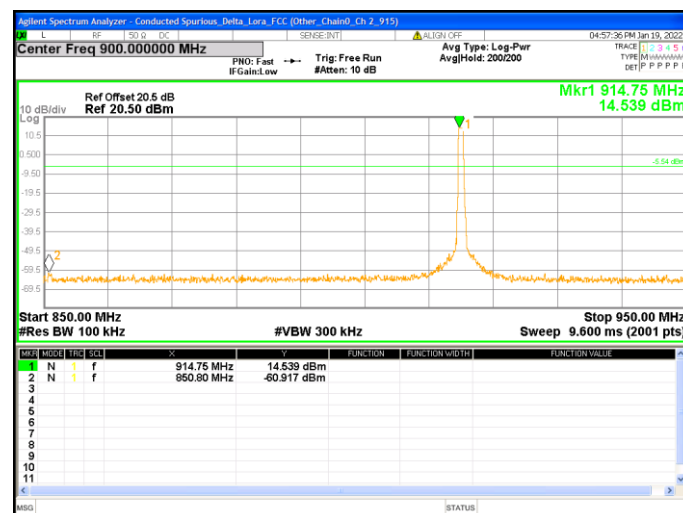
Chain 0: Conducted Spurious @ Sub 1G Mode Ch low



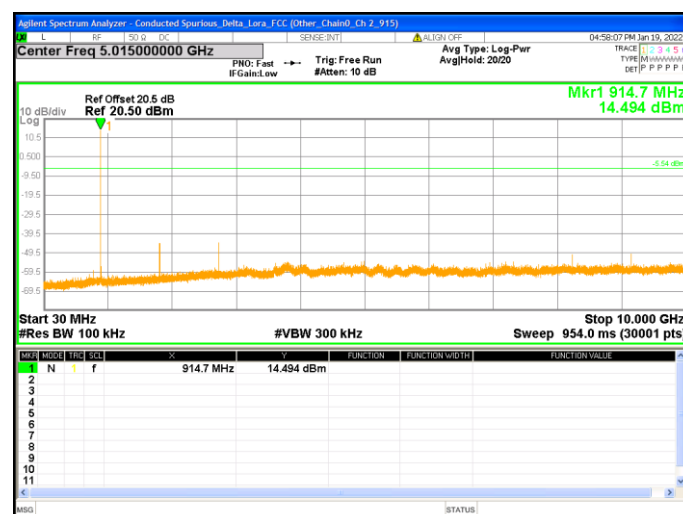
Chain 0: Conducted Spurious @ Sub 1G Mode Ch mid



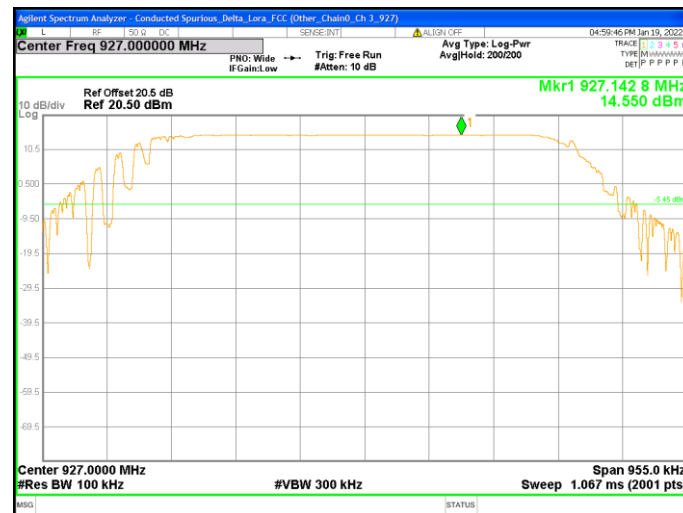
Chain 0: Conducted Spurious @ Sub 1G Mode Ch mid



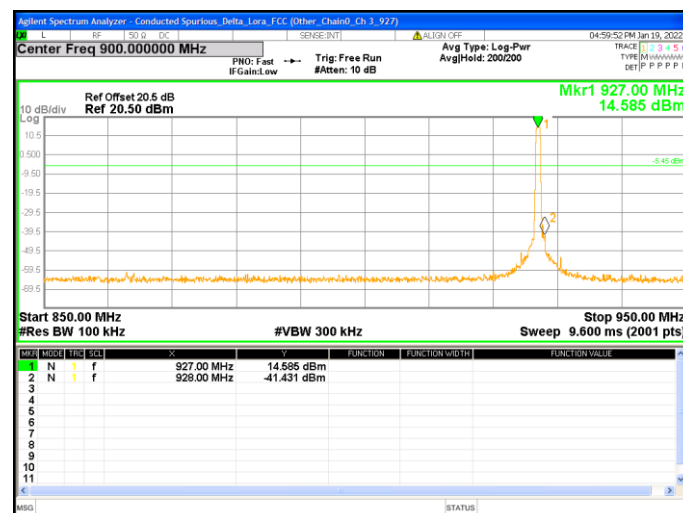
Chain 0: Conducted Spurious @ Sub 1G Mode Ch mid



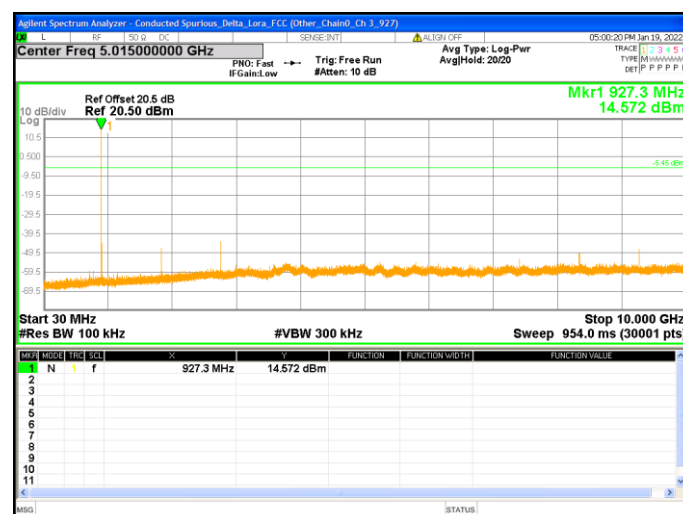
Chain 0: Conducted Spurious @ Sub 1G Mode Ch high



Chain 0: Conducted Spurious @ Sub 1G Mode Ch high



Chain 0: Conducted Spurious @ Sub 1G Mode Ch high



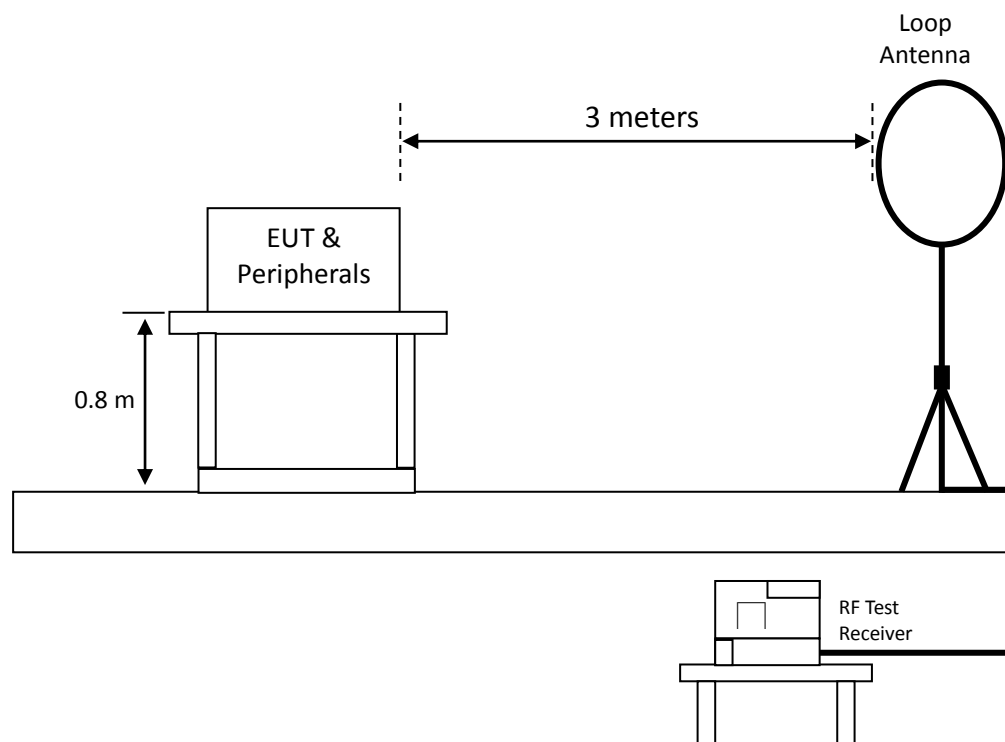
6. Emissions in Restricted Frequency Bands (Radiated emission measurements)

6.1 Instrument Setting

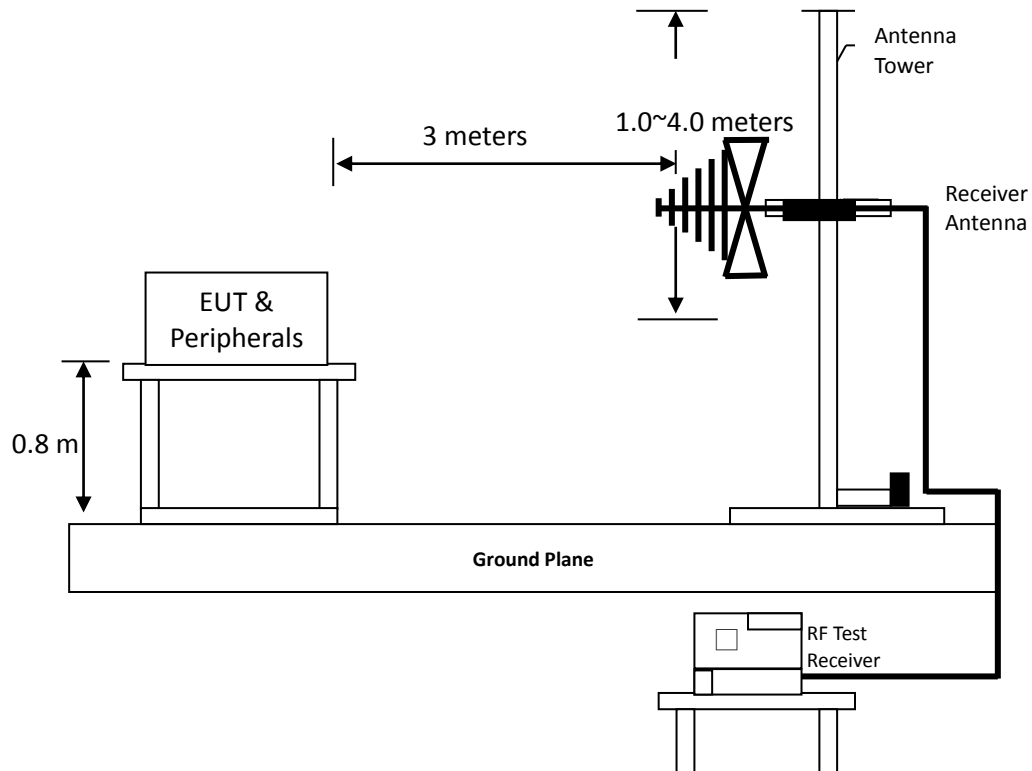
Receiver Function	Setting (Below 1GHz)	Setting (Above 1GHz)
Detector	QP	Peak and Average
RBW	9-150 kHz ; 200-300 Hz 0.15-30 MHz; 9-10 kHz 30-1000 MHz; 100-120 kHz	1MHz
VBW	$\geq 3 \times \text{RBW}$	3MHz & 1/T Minimum VBW
Sweep	Auto couple	Auto couple
Start Frequency	9 kHz	1GHz
Stop Frequency	1 GHz	Tenth harmonic
Attenuation	Auto	Auto

6.2 Test setup & procedure

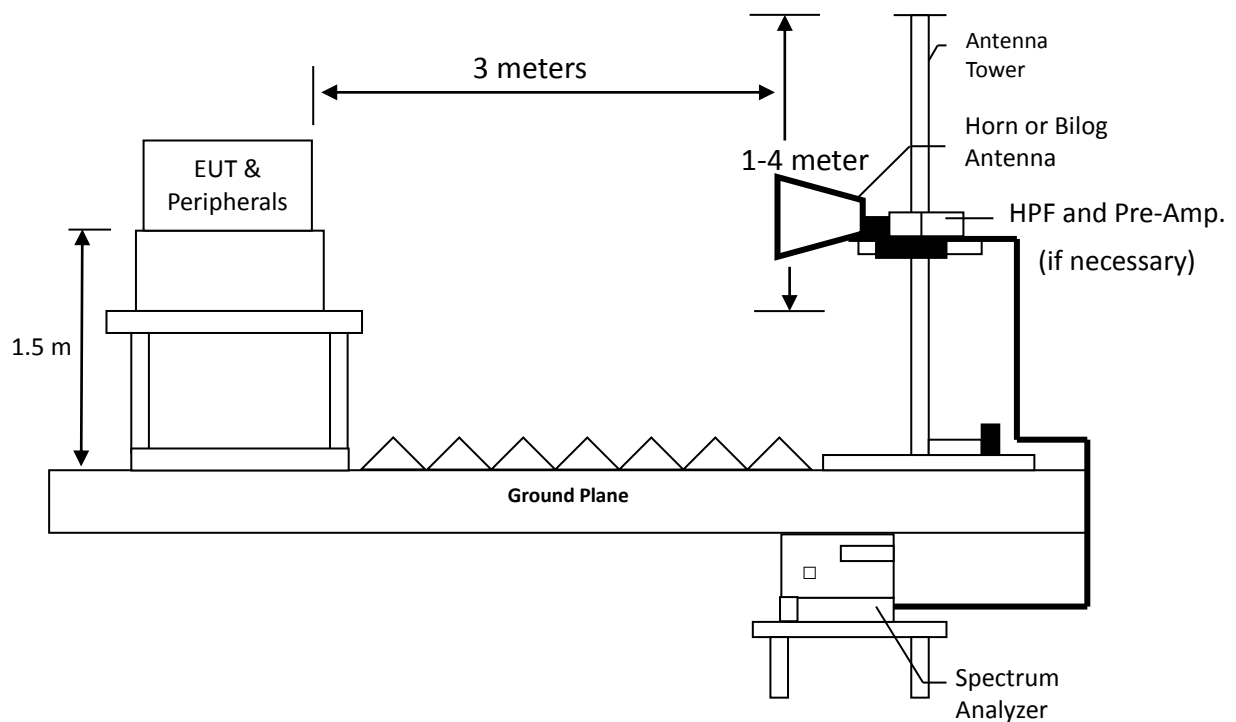
Radiated emission from 9kHz to 30MHz uses Loop Antenna:



Radiated emission below 1GHz using Bilog Antenna



Radiated emission above 1GHz using Horn Antenna



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Radiated emissions were investigated cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading, and the frequency over 1GHz using a spectrum analyzer RBW of 1MHz and 10Hz VBW record Average reading. (15.209 paragraph), the Peak reading (1 MHz RBW/ 3 MHz VBW) recorded also on the report.

The EUT for testing is arranged on a turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

6.3 Limit

Frequency(MHz)	Field Strength(uV/m)	Measurement distance(m)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	24000/F(kHz)	30
1.705~30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

6.4 Test Result

6.4.1 Measurement results: frequencies 9kHz to 30MHz

Temperature (°C) :	18
Relative Humidity (%) :	61
Test date :	2022/01/07

The test was performed on EUT under continuously transmitting mode. The worst case occurred at Ch_high.

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Perpendicular	0.159	AV	18.57	52.38	70.95	103.58	-32.63
Perpendicular	0.909	QP	19.61	33.21	52.82	68.43	-15.61
Perpendicular	1.209	QP	19.49	26.63	46.12	65.96	-19.84
Perpendicular	1.389	QP	19.48	24.76	44.24	64.75	-20.51
Perpendicular	1.868	QP	19.45	23.63	43.08	69.54	-26.46
Perpendicular	2.798	QP	19.53	17.57	37.10	69.54	-32.44

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Parallel	0.159	AV	18.57	52.39	70.96	103.58	-32.62
Parallel	0.849	QP	19.64	30.84	50.48	69.03	-18.55
Parallel	1.209	QP	19.49	24.49	43.98	65.96	-21.98
Parallel	1.389	QP	19.48	20.11	39.59	64.75	-25.16
Parallel	1.778	QP	19.46	19.00	38.46	69.54	-31.08
Parallel	2.378	QP	19.49	16.45	35.94	69.54	-33.60

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dB μ V)	Corrected Reading (dB μ V/m)	Limit @ 3 m (dB μ V/m)	Margin (dB)
Ground-parallel	0.159	AV	18.57	51.78	70.35	103.58	-33.23
Ground-parallel	0.819	QP	19.65	31.71	51.36	69.34	-17.98
Ground-parallel	1.209	QP	19.49	20.09	39.58	65.96	-26.38
Ground-parallel	1.389	QP	19.48	22.06	41.54	64.75	-23.21
Ground-parallel	1.868	QP	19.45	16.61	36.06	69.54	-33.48
Ground-parallel	2.798	QP	19.53	13.27	32.80	69.54	-36.74

6.4.2 Measurement results: frequencies below 1 GHz

Temperature (°C) :	21
Relative Humidity (%) :	54
Test date :	2022/01/19

The test was performed on EUT under continuously transmitting mode. The worst case occurred at Ch_high.

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Vertical	65.15	QP	16.14	18.32	34.46	40.00	-5.54
Vertical	96.07	QP	18.94	18.56	37.50	43.50	-6.00
Vertical	143.87	QP	21.90	12.11	34.01	43.50	-9.49
Vertical	491.10	QP	26.31	9.90	36.21	46.00	-9.79
Vertical	522.03	QP	26.85	9.47	36.32	46.00	-9.68
Vertical	800.38	QP	30.43	7.96	38.39	46.00	-7.61

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Horizontal	96.07	QP	18.94	20.52	39.46	43.50	-4.04
Horizontal	107.32	QP	21.95	16.91	38.86	43.50	-4.64
Horizontal	143.87	QP	21.90	15.79	37.69	43.50	-5.81
Horizontal	193.07	QP	16.71	23.44	40.15	43.50	-3.35
Horizontal	277.42	QP	21.63	18.79	40.42	46.00	-5.58
Horizontal	288.67	QP	21.99	21.26	43.25	46.00	-2.75

Remark: Corr. Factor = Antenna Factor + Cable Loss

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6.4.3 Measurement results: frequency above 1GHz to 25GHz

Temperature (°C) :	21
Relative Humidity (%) :	54
Test date :	2022/01/19

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch Low	2709	PK	H	5.09	52.65	57.74	74	-16.26
	2709	AV	H	5.09	48.50	53.59	54	-0.41
	6321	PK	H	15.78	36.99	52.77	74	-21.23
	7224	PK	H	17.25	39.30	56.55	74	-17.45
	7224	AV	H	17.25	28.00	45.25	54	-8.75
	8127	PK	H	17.70	37.00	54.70	74	-19.30
	8127	AV	H	17.70	26.50	44.20	54	-9.80
	2709	PK	V	5.09	50.10	55.19	74	-18.81
	2709	AV	V	5.09	46.00	51.09	54	-2.91
	6321	PK	V	15.78	36.79	52.57	74	-21.43
	7224	PK	V	17.25	40.90	58.15	74	-15.85
	7224	AV	V	17.25	30.50	47.75	54	-6.25
	8127	PK	V	17.70	41.80	59.50	74	-14.50
	8127	AV	V	17.70	29.70	47.40	54	-6.60
	9030	PK	V	18.64	36.50	55.14	74	-18.86
	9030	AV	V	18.64	25.00	43.64	54	-10.36

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

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Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch Mid	2745	PK	H	5.16	51.81	56.97	74	-17.03
	2745	AV	H	5.16	48.61	53.77	54	-0.23
	4575	PK	H	12.63	42.49	55.12	74	-18.88
	4575	AV	H	12.63	37.59	50.22	54	-3.78
	6405	PK	H	15.57	39.30	54.87	74	-19.13
	6405	AV	H	15.57	28.50	44.07	54	-9.93
	7320	PK	H	17.55	40.00	57.55	74	-16.45
	7320	AV	H	17.55	29.10	46.65	54	-7.35
	8235	PK	H	18.00	42.00	60.00	74	-14.00
	8235	AV	H	18.00	30.50	48.50	54	-5.50
	2745	PK	V	5.16	47.61	52.77	74	-21.23
	3660	PK	V	11.70	41.29	52.99	74	-21.01
	6405	PK	V	15.57	40.50	56.07	74	-17.93
	6405	AV	V	15.57	29.70	45.27	54	-8.73
	7320	PK	V	17.55	40.40	57.95	74	-16.05
	7320	AV	V	17.55	30.10	47.65	54	-6.35
	8235	PK	V	18.00	42.20	60.20	74	-13.80
	8235	AV	V	18.00	30.30	48.30	54	-5.70
	9150	PK	V	18.62	38.20	56.82	74	-17.18
	9150	AV	V	18.62	25.60	44.22	54	-9.78
Ch High	2781	PK	H	5.26	52.99	58.25	74	-15.75
	2781	AV	H	5.26	48.49	53.75	54	-0.25
	6489	PK	H	15.58	38.50	54.08	74	-19.92
	6489	AV	H	15.58	28.40	43.98	54	-10.02
	7416	PK	H	17.74	38.60	56.34	74	-17.66
	7416	AV	H	17.74	27.80	45.54	54	-8.46
	8343	PK	H	18.09	41.40	59.49	74	-14.51
	8343	AV	H	18.09	29.50	47.59	54	-6.41
	9270	PK	H	18.65	36.30	54.95	74	-19.05
	9270	AV	H	18.65	24.50	43.15	54	-10.85
	2781	PK	V	5.26	50.99	56.25	74	-17.75
	2781	AV	V	5.26	47.99	53.25	54	-0.75
	3708	PK	V	12.05	40.00	52.05	74	-21.95
	6489	PK	V	15.58	41.40	56.98	74	-17.02
	6489	AV	V	15.58	34.00	49.58	54	-4.42
	7416	PK	V	17.74	37.84	55.58	74	-18.42
	7416	AV	V	17.74	34.30	52.04	54	-1.96
	8343	PK	V	18.09	43.00	61.09	74	-12.91
	8343	AV	V	18.09	33.70	51.79	54	-2.21
	9270	PK	V	18.65	37.70	56.35	74	-17.65
	9270	AV	V	18.65	27.40	46.05	54	-7.95

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

7. AC Power Line Conducted Emission

Since the EUT is not connected to AC source, therefore, the test can be waived.

Appendix A: Test equipment list

Test Equipment/ Test site	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	Rohde & Schwarz	ESR7	101822	2021/08/16	2022/08/15
Signal Analyzer	Agilent	N9030A	MY51380492	2021/08/17	2022/08/16
Active Loop Antenna	SCHWARZBECK MESS-ELEKTRONIC	FMZB1519	1519-067	2021/04/14	2022/04/13
Bilog Hybrid Antenna	ETC	MCTD 2786B	BLB17J04019 & JB-5-019	2021/10/15	2022/10/14
Horn Antenna	EMCO	3115	9906-5822	2021/05/12	2022/05/11
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170159	2020/08/20	2023/08/19
Microwave Amplifier	HP	8348A	3111A00567	2021/10/19	2022/10/18
Pre-amplifier	SGH	SGH184	20201124-1	2021/12/06	2022/12/05
Power Meter	Anritsu	ML2495A	0844001	2021/10/17	2022/10/16
Power Sensor	Anritsu	MA2411B	0738452	2021/10/17	2022/10/16
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2021/03/08	2022/03/07
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2021/03/08	2022/03/07
966-2 Cable	SUHNER	SUCOFLEX 104P	9403/4P	2021/11/30	2022/11/29
RF Cable	SUHNER	SUCOFLEX 104P	CB0006	2021/04/29	2022/04/28
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2022/01/14	2023/01/13
20dB Attenuator	Mini-Circuits	BW-S20W5+	N/A	2021/05/26	2022/05/25
Test software	Audix	e3	V9	NCR	NCR

Note: No Calibration Required (NCR).

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of k=2.

Item	Uncertainty
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.16 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.02 dB
Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	5.17 dB
Vertically polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.39 dB
Horizontally polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.39 dB
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.70 dB
Emission on the Band Edge Test	4.32 dB
RF Antenna Conducted Spurious Test	1.27 dB
Maximum Output Power Test	0.44 dB
Occupied Bandwidth Test	7.78 %
Carrier Frequency Separation Test	1.27 dB
Number of Hopping Frequencies Test	1.27 dB
Time of Occupancy (Dwell Time) Test	1.27 dB
AC Power Line Conducted Emission	3.08 dB