China

FCC - TEST REPORT

Report Number	:	60.790.20.069.01R02	Date of Issue	: September 30, 2020
Model	:	SBC-D07		
Product Type	:	TCU 2		
Applicant	:	Dayton Industrial Co., Ltd.		
Address	:	Block A, 11/F, 2-12 Kwai Fat Road, Kwai Chung, New Territories, Hong Kong		
Production Facility	:	Kendy Electronics (Dongguan) Co., Ltd		
Address	:	Xin Si Huang Tang Village, Heng Li Town, Dongguang City, Guangdong, China		
Test Result	:	■Positive ☐Negative		
Total pages including Appendices	:	22		

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1 Table of Contents

2 Description of Equipment Under Test

Description of the Equipment Under Test

Product:	TCU 2
Model no.:	SBC-D07
FCC ID:	O4GTCU2
Rating:	12.0V DC (form E-bike battery) 3.7V DC (form rechargeable battery which is for backup purpose) 5.0V DC (Charge the rechargeable battery through USB port)
Frequency:	2457MHz
Antenna gain:	0 dBi
Number of operated channel:	1
Modulation:	GFSK

Auxiliary Equipment and Software Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.	S/N
Computer	Lenovo	X220	0A72168
AC/DC adapter	Apple	A1537	/

Auxiliary Software Used during Test:

DESCRIPTION	SOFTWARE NAME	VERSION	REMARK
RF Test Mode Software	nRFgo	1.16	Provided by applicant

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3 Summary of Test Standards

Test Standards
FCC Part 15 Subpart C 10-1-19 Edition Federal Communications Commission, PART 15 — Radio Frequency Devices, Subpart C — Intentional Radiators

All the tests were performed using the procedures from ANSI C63.4(2014) and ANSI C63.10 (2013).

4 Details about the Test Laboratory

Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13 Zhiheng Wisdomland Business Park,
Nantou Checkpoint Road 2,
Shenzhen 518052, P.R.China
FCC Registration Number: 514049
ISED test site number: 10320A

Emission Tests	
Test Item	Test Site
FCC Part 15 Subpart C	
FCC Title 47 Part 15.205, 15.209 & 15.249 & Radiated Emission	Site 1
FCC Title 47 Part 15.207 Conduct Emission	Site 1
FCC Title 47 Part 15.215 20dB & 99% Bandwidth	Site 1
FCC Title 47 Part 15.203 Antenna Requirement	Site 1

4.1 Test Equipment Site List

Radiated emission Test – Site 1

DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 26	101269	2021-6-29
Signal Analyzer	Rohde & Schwarz	FSV40	101031	2021-6-22
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100398	2021-7-7
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	707	2021-8-4
Horn Antenna	Rohde & Schwarz	HF907	102294	2021-7-5
Wideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	12827	2021-6-21
Pre-amplifier	Rohde & Schwarz	SCU 18	102230	2021-6-21
Pre-amplifier	Rohde & Schwarz	SCU 40A	100432	2021-7-30
Attenuator	Agilent	8491A	MY39264334	2021-6-21
3m Semi-anechoic chamber	TDK	9X6X6	----	2022-10-28
Test software	Rohde & Schwarz	EMC32	Version 9.15.00	N/A

Conducted Emission Test – Site 1

DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 3	101782	2021-6-29
LISN	Rohde & Schwarz	ENV4200	100249	2021-6-12
LISN	Rohde & Schwarz	ENV432	101318	2021-6-12
LISN	Rohde & Schwarz	ENV216	100326	2021-6-12
LISN	Rohde & Schwarz	ENV216	102472	2021-6-12
ISN	Rohde & Schwarz	ENY81	100177	2021-6-12
ISN	Rohde & Schwarz	ENY81-CA6	101664	2021-6-12
High Voltage Probe	Schwarzbeck	TK9420(VT9420)	9420-584	2021-6-23
RF Current Probe	Rohde & Schwarz	EZ-17	100816	2021-6-28
Attenuator	Shanghai Huaxiang	TS2-26-3	080928189	2021-6-21
Test software	Rohde & Schwarz	EMC32	Version9.15.00	N/A
Shielding Room	TDK	CSR #1	----	2020-11-07

20dB & 99% Bandwidth – Site 1

DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	101030	2021-6-21
RF Switch Module	Rohde & Schwarz	OSP120/OSP-B157	101226/100851	2021-6-21

4.2 Measurement System Uncertainty

Measurement System Uncertainty Emissions

System Measurement Uncertainty	
Items	**Extended Uncertainty**
Uncertainty for Radiated Emission in 3m chamber 9kHz-30MHz	4.76dB
Uncertainty for Radiated Emission in 3m chamber 30MHz-1000MHz	Horizontal: 5.12dB; Vertical: 5.10dB;
Uncertainty for Radiated Emission in 3m chamber 1000MHz-25000MHz	Horizontal: 5.01dB; Vertical: 5.00dB;
Uncertainty for Conducted Emission at AC Power Line 150kHz-30MHz	3.21dB
Uncertainty for conducted power test	1.16dB
Uncertainty for frequency test	0.6×10^{-7}

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5 Summary of Test Results

Emission Tests				
FCC Part 15 Subpart C				
Test Condition	Pages	Test Result		
		Pass	Fail	N/A
FCC Title 47 Part 15.205,15.209 & 15.249 Radiated Emission	12-13	☒	☐	☐
FCC Title 47 Part 15.207 Conduct Emission	14-15	☒	☐	☐
FCC Title 47 Part 15.215 20dB & 99% Bandwidth	16	☒	☐	☐
FCC Title 47 Part 15.203 Antenna Requirement	17	☒	☐	☐

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for **FCC ID: O4GTCU2**, complies with Section 15.203, 15.205, 15.207, 15.209, 15.249 of the FCC Part 15, Subpart C rules.

The TX and RX range is 2457MHz.

The 3.7V battery is a backup in case the E-bike 12V batter run out, normally sample is powered by the 12V battery, therefore all RF test results on this report are based on 12V power supplier. However, we have checked the result on 3.7V, no obvious difference.

SUMMARY:

- All tests according to the regulations cited on page 8 were

■ - Performed

☐ - **Not** Performed

- The Equipment Under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date: September 3, 2020

Testing Start Date: September 4, 2020

Testing End Date: September 25, 2020

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch -

Reviewed by:	Prepared by:	Tested by:
Eric LI	Hosea CHAN	Louise Liu
EMC Project Manager	EMC Project Engineer	EMC Test Engineer

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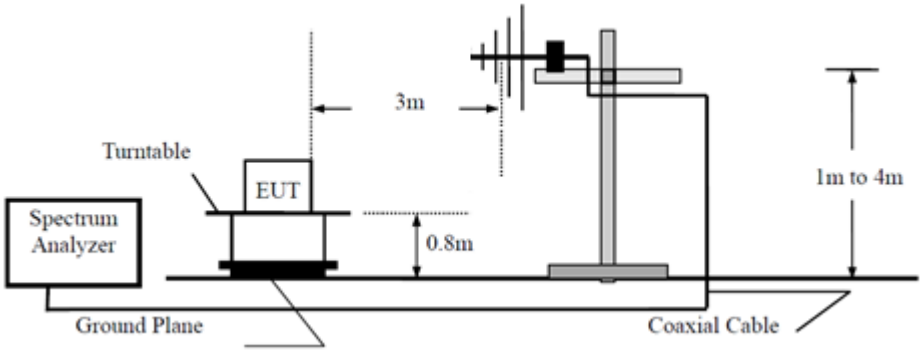
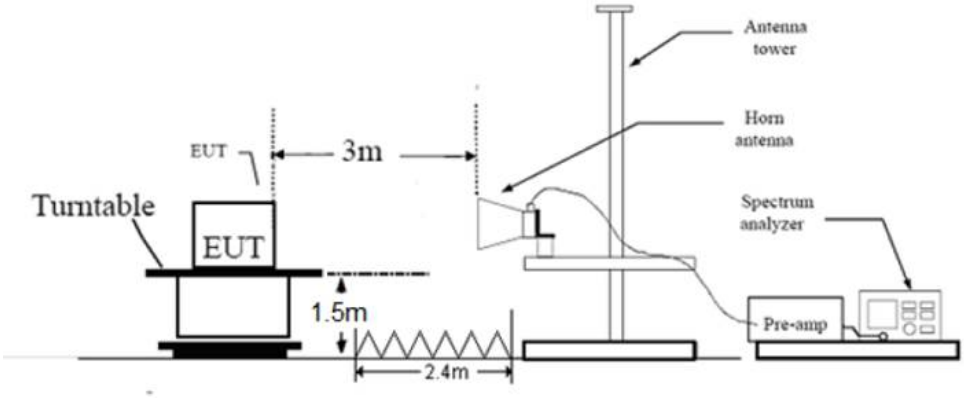
7 Test Setups

7.1 Radiated test setups Below 1GHz



7.2 Radiated test setups Above 1GHz



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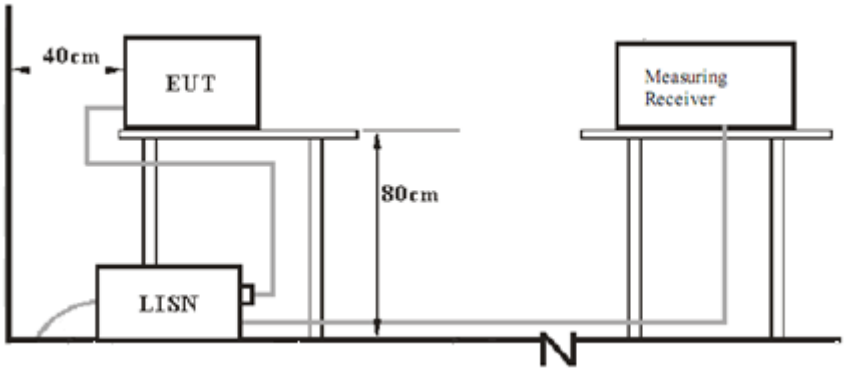
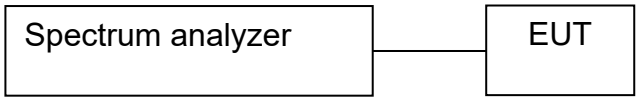
7.3 AC Power Line Conducted Emission test setups



7.4 Conducted RF test setups



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8 Emission Test Results

8.1 Radiated Emission

EUT: SBC-D07
Op Condition: Operated, TX Mode (2457MHz)
Test Specification: FCC15.249 & 15.209, Antenna: Horizontal
Comment: 12V DC
Remark: Measurement range up to 25GHz

Test Result
☒ Passed
☐ Not Passed

Frequency MHz	Result dBµV/m	Limit dBµV/m	Over Limit dB	Detector PK/QP/AV	Corr. (dB)	RSE. or Fund.
53.765000	22.16	40.00	-17.84	Quasi Peak	18	Spurious emission
100.749375	19.29	43.50	-24.21	Quasi Peak	16	Spurious emission
191.929375	23.06	43.50	-20.44	Quasi Peak	16	Spurious emission
362.588750	27.67	46.00	-18.33	Quasi Peak	21	Spurious emission
599.814375	30.61	46.00	-15.39	Quasi Peak	26	Spurious emission
932.281875	35.15	46.00	-10.85	Quasi Peak	30	Spurious emission
2457.000000	89.87	114.00	-24.13	Peak	-3.8	Fundamental
2457.000000	75.30	94.00	-18.70	Average	-3.8	Fundamental
2987.000000	44.67	74.00	-29.33	Peak	-1.5	Spurious emission
5876.500000	49.16	74.00	-24.84	Peak	5.5	Spurious emission
10032.500000	45.04	74.00	-28.96	Peak	9.0	Spurious emission
16549.500000	48.89	74.00	-25.11	Peak	15.7	Spurious emission

Remark:
1. According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in data table if the peak value complies with average limit.
2. Consequence Level=Reading Level + Correction Factor
   Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
   Below 1GHz: Corrector factor = Antenna Factor + Cable Loss
   (The Reading Level is recorded by software which is not shown in the sheet)

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Radiated Emission

EUT:	SBC-D07
Op Condition:	Operated, TX Mode (2457MHz)
Test Specification:	FCC15.249 & 15.209, Antenna: Vertical
Comment:	12V DC
Remark:	Measurement range up to 25GHz

Test Result
☒ Passed
☐ Not Passed

Frequency MHz	Result dBµV/m	Limit dBµV/m	Over Limit dB	Detector PK/QP/AV	Corr. (dB)	RSE. or Fund.
53.765000	34.63	40.00	-5.37	Quasi Peak	18	Spurious emission
58.008750	34.19	40.00	-5.81	Quasi Peak	17	Spurious emission
104.750625	20.33	43.50	-23.17	Quasi Peak	16	Spurious emission
287.959375	27.35	46.00	-18.65	Quasi Peak	18	Spurious emission
361.679375	32.14	46.00	-13.86	Quasi Peak	21	Spurious emission
801.756250	33.99	46.00	-12.01	Quasi Peak	28	Spurious emission
2457.000000	91.41	114.00	-22.59	Peak	-3.8	Fundamental
2457.000000	77.46	94.00	-16.54	Average	-3.8	Fundamental
1941.000000	46.58	74.00	-27.42	Peak	-4.5	Spurious emission
5567.000000	49.21	74.00	-24.79	Peak	4.3	Spurious emission
10015.000000	45.20	74.00	-28.80	Peak	8.8	Spurious emission
16965.000000	48.96	74.00	-25.04	Peak	16.4	Spurious emission

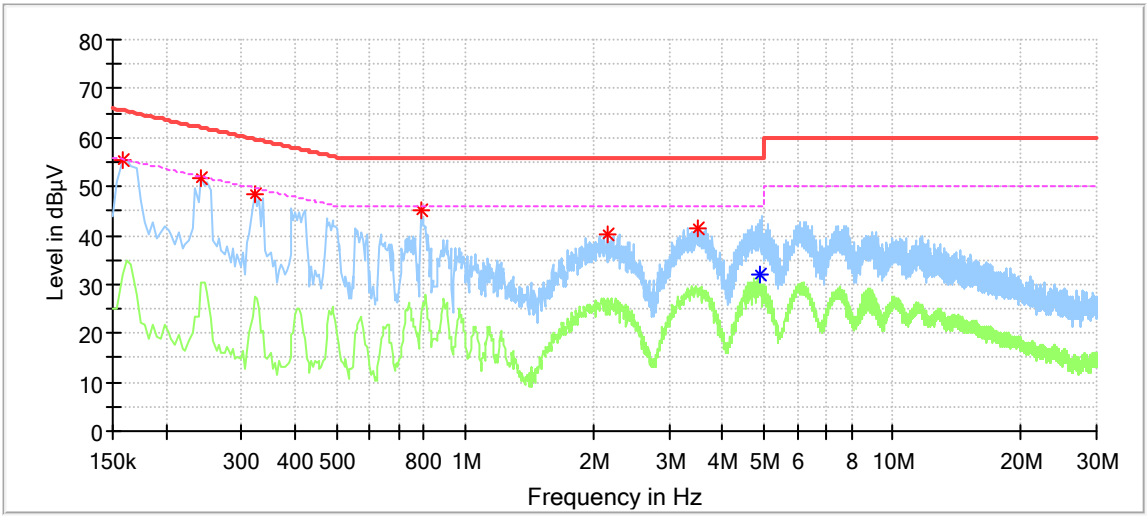
Remark:

1. According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in data table if the peak value complies with average limit.
2. Consequence Level=Reading Level + Correction Factor
   Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
   Below 1GHz: Corrector factor = Antenna Factor + Cable Loss
   (The Reading Level is recorded by software which is not shown in the sheet)

8.2 Conducted Emission at AC Power line

EUT:	SBC-D07
Op Condition:	Charging mode
Test Specification:	AC Mains, L Line
Comment:	120V AC, 60Hz (supporting adapter input)

Test Result
☒ Passed
☐ Not Passed



Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)
0.158000	55.53	---	65.57	-10.04
0.242000	51.67	---	62.03	-10.35
0.322000	48.50	---	59.66	-11.15
0.790000	45.17	---	56.00	-10.83
2.154000	40.12	---	56.00	-15.88
3.502000	41.42	---	56.00	-14.58
4.898000	---	31.99	46.00	-14.01

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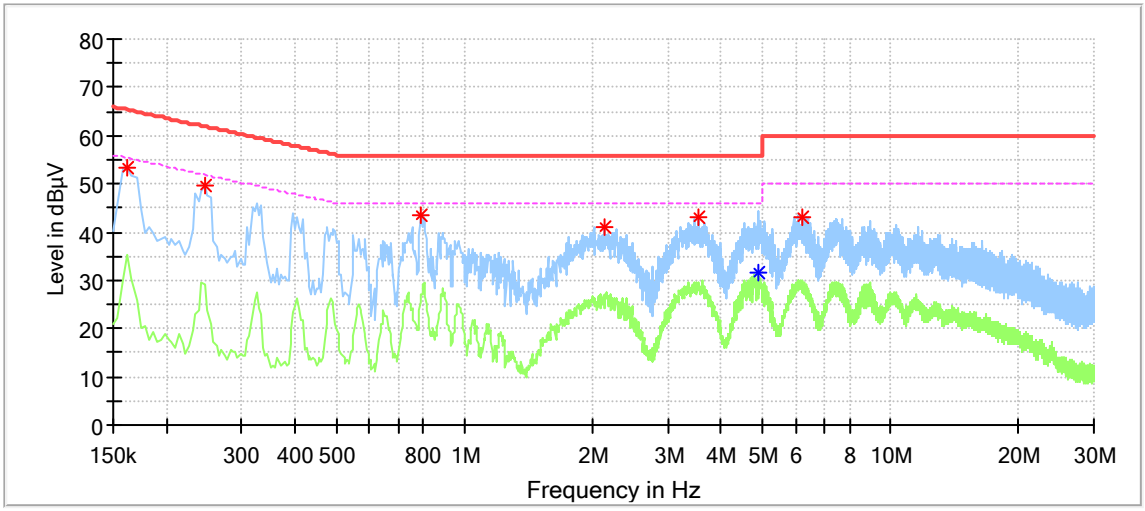
Conducted Emission Test

EUT:	SBC-D07
Op Condition:	Charging mode
Test Specification:	AC Mains, L Line
Comment:	120V AC, 60Hz (supporting adapter input)

Test Result
☒ Passed
☐ Not Passed



Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)
0.162000	53.41	---	65.36	-11.95
0.246000	49.60	---	61.89	-12.29
0.794000	43.40	---	56.00	-12.60
2.122000	41.00	---	56.00	-15.00
3.542000	42.99	---	56.00	-13.01
4.870000	---	31.52	46.00	-14.48
6.226000	43.03	---	60.00	-16.97

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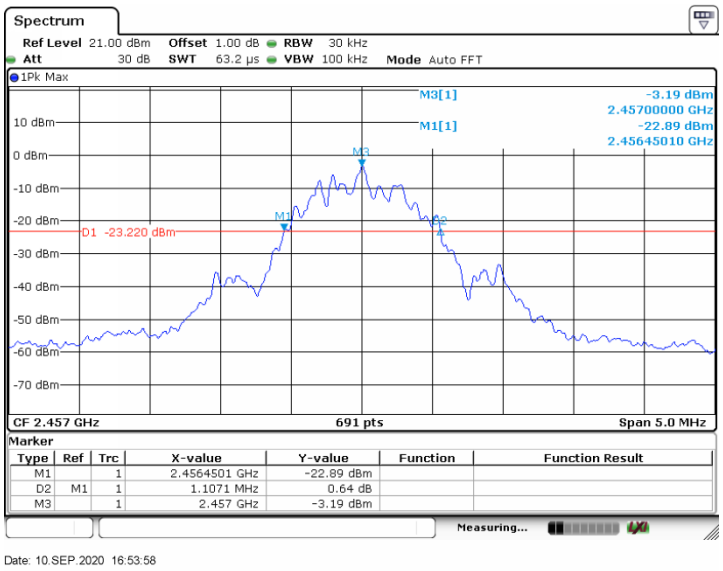
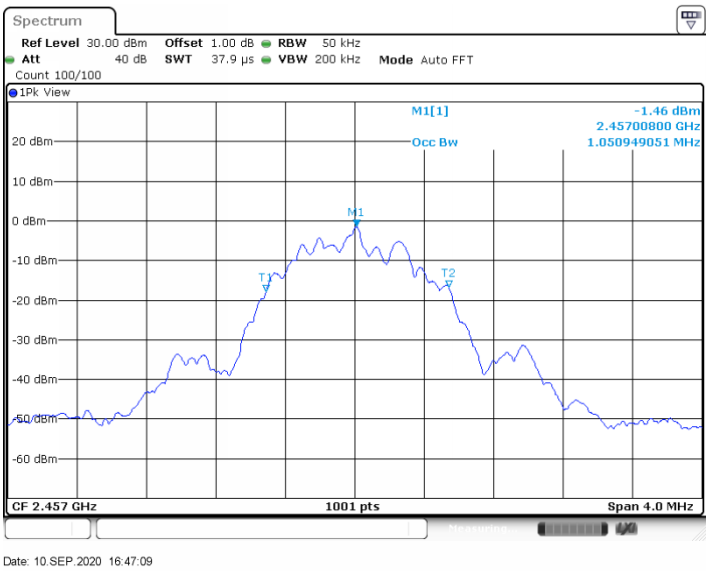
8.3 20dB & 99% Bandwidth

EUT: SBC-D07
Op Condition: Operated, TX Mode (2457MHz)
Test Specification: FCC15.215
Comment: 12V DC

Test Result
☒ Passed
☐ Not Passed





Bandwidth	Measured Value
20dB bandwidth	1.107 MHz
99% OCB	1.051 MHz

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8.4 Antenna Requirement

EUT:	SBC-D07
Op Condition:	Operated, TX Mode
Test Specification:	FCC15.203 (b)
Comment:	12V DC

Test Result
☒ Passed
☐ Not Passed

Limit

For intentional device, according to FCC Title 47 Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Connector Construction

The antenna used in this product is an integrated antenna on PCB, which in accordance to section 15.203, is considered sufficient to comply with the antenna requirement.

9 Test setup procedure

9.1 Field strength of emissions and Restricted bands

Test Method

1: The EUT was place on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3-meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5: Use the following spectrum analyzer settings According to C63.10:

For Above 1GHz
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW≥3RBW, Sweep = auto, Detector function = peak and average,
Trace = max hold.

For Below 1GHz
Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 120KHz, VBW≥3RBW, Sweep = auto, Detector function = QP,
Trace = max hold.

Field strength of emissions and Restricted bands

Limits

According to §15.249 (a), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

According to §15.249 (c), Field strength limits are specified at a distance of 3 meters.
According to §15.249 (d, Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
According to §15.205 Unwanted emissions falling into restricted bands in §15.205 (a) shall comply with the limits specified in §15.209.

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

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9.2 Conducted Emission at AC Power line

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Limit

Frequency MHz	QP Limit dBµV	AV Limit dBµV
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

*Decreasing linearly with logarithm of the frequency.

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9.3 20dB & 99% Bandwidth

Test Method

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to spectrum analyser. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.

Limits:

According to 15.215 (c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

10 Appendix A - General Product Information

Radiofrequency radiation exposure evaluation

This exposure evaluation is intended for **FCC ID: O4GTCU2**

According to KDB 447498 D01v06 section 4.3.1, For frequencies between 100 MHz to 6GHz and test separation distances ≤ 50 mm, the Numeric threshold is determined as:

Step a)
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR

>> The fundamental frequency of the EUT is 2457MHz,
the test separation distance is ≤ 50mm.
(Manufacturer specified the separation distance is: 5mm)

Step b)
>> Numeric threshold (2457MHz), mW / 5mm * √2.457GHz ≤ 3.0
Numeric threshold (2457MHz) ≤ 9.569mW

>> The power (calculated power + tune up tolerance) of EUT at 2457MHz is: 0.42mW

Which is smaller than the Numeric threshold.
Therefore, the device is exempt from stand-alone SAR test requirements.

Power calculation (According to C63.10 chapter 9.5)

	Value	Unit
Field Strength Measured (E)	91.41	dBμV/m
Measurement Distance (D)	3	m
Equivalent Isotropically Radiated Power (E.I.R.P in dBm)	-3.75	dBm
Equivalent Isotropically Radiated Power (E.I.R.P in mW)	0.42	mW

Remark: EIRP = E + 20log(D) −104.7
(EIRP is in dBm, E is in dBμV/m, D is in metres)

Reviewed by: Prepared by:

Eric LI
EMC Project Manager

Hosea CHAN
EMC Project Engineer