

FCC - TEST REPORT

Report Number : **60.790.21.100.01R01** Date of Issue : January 4, 2022

Model : **D3 CAD**

Product Type : **Cadence Transmitter**

Applicant : SIGMA-Elektro GmbH

Address : Dr. Julius Leber Str.15, Neustadt 67433, Germany

Production Facility : SIGMA-Elektro (Hong Kong) Ltd.

Address : Room 2010, 20/F, No.1 Hung To Road, Kwun Tong, Kowloon, HK.

Test Result : **nPositive** **o Negative**

Total pages
including
Appendices : 21

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2 Description of Equipment Under Test

Description of the Equipment Under Test

Product: Cadence Transmitter

Model no.: D3 CAD

FCC ID: TFO-13012

Rating: 3.0 VDC (CR2032 Battery)

Frequency: 112 kHz (Transmitter)

Modulation: AM

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.	REMARK
/	/	/	/

Auxiliary Software Used during Test:

DESCRIPTION	SOFTWARE NAME	VERSION	REMARK
/	/	/	/

3 Summary of Test Standards

Test Standards
FCC Part 15 Subpart C 10-1-20 Edition Federal Communications Commission, PART 15 — Radio Frequency Devices, Subpart C — Unintentional 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 Spurious Radiated Emission	Site 1
FCC Title 47 Part 15.207 Conduct Emission	N/A
FCC Title 47 Part 15.215 20dB & 99%Bandwidth	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	2022-6-29
Signal Analyzer	Rohde & Schwarz	FSV40	101031	2022-6-22
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100398	2022-7-7
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	707	2022-8-4
Horn Antenna	Rohde & Schwarz	HF907	102294	2022-7-5
Wideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	12827	2022-6-21
Pre-amplifier	Rohde & Schwarz	SCU 18	102230	2022-6-21
Pre-amplifier	Rohde & Schwarz	SCU 40A	100432	2022-7-30
Attenuator	Agilent	8491A	MY39264334	2022-6-21
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	2022-6-29
LISN	Rohde & Schwarz	ENV4200	100249	2022-6-12
LISN	Rohde & Schwarz	ENV432	101318	2022-6-12
LISN	Rohde & Schwarz	ENV216	100326	2022-6-12
LISN	Rohde & Schwarz	ENV216	102472	2022-6-12
ISN	Rohde & Schwarz	ENY81	100177	2022-6-12
ISN	Rohde & Schwarz	ENY81-CA6	101664	2022-6-12
High Voltage Probe	Schwarzbeck	TK9420(VT9420)	9420-584	2022-6-23
RF Current Probe	Rohde & Schwarz	EZ-17	100816	2022-6-28
Attenuator	Shanghai Huaxiang	TS2-26-3	080928189	2022-6-21
Test software	Rohde & Schwarz	EMC32	Version 9.15.00	N/A
Shielding Room	TDK	CSR #1	----	2022-11-07

20dB & 99% Bandwidth, Peak Output Power, Spurious Emissions at Antenna Terminals, 100kHz Bandwidth of band edges, Power Spectral Density – Site 1

DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	101030	2022-6-21
RF Switch Module	Rohde & Schwarz	OSP120/OSP-B157	101226/100851	2022-6-21

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}

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.

5 Summary of Test Results

Emission Tests				
FCC Part 15 Subpart C				
Test Condition	Pages	Test Result		
		Pas s	Fail	N/A
FCC Title 47 Part 15.205, 15.209 Spurious Radiated Emission	12-14	☒	☐	☐
FCC Title 47 Part 15.207 Conduct Emission (1)	---	☐	☐	☒
FCC Title 47 Part 15.215 20dB & 99% Bandwidth	15	☒	☐	☐

Remarks: (1) Test is not applicable for Battery Operated device.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for **FCC ID: TFO-13012**, complies with Section 15.205, 15.207, 15.209, 15.215 of the FCC Part 15, Subpart C rules for the DCD grant.

The Transmitter frequency range is 112kHz.

SUMMARY:

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

n - Performed

o - **Not** Performed

- The Equipment Under Test

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

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

Sample Received Date: December 10, 2021

Testing Start Date: December 13, 2021

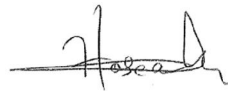
Testing End Date: December 27, 2021

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

Reviewed by:

Prepared by:

Tested by:



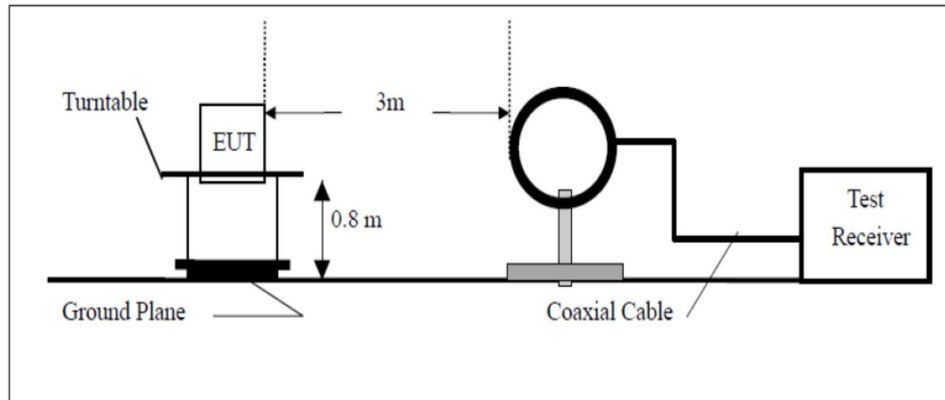
Eric LI
EMC Project Manager

Hosea CHAN
EMC Project Engineer

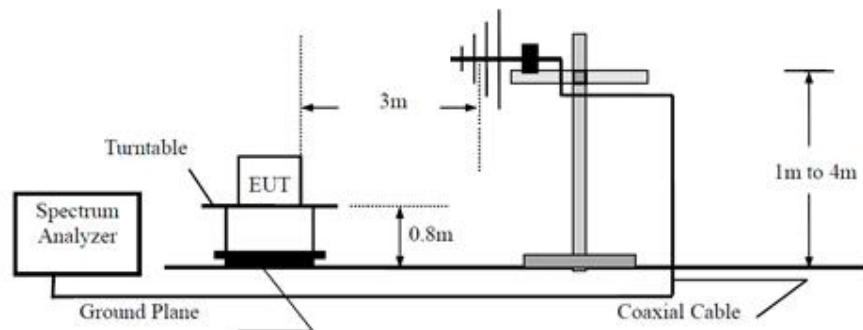
Louise Liu
EMC Test Engineer

7 Test Setups

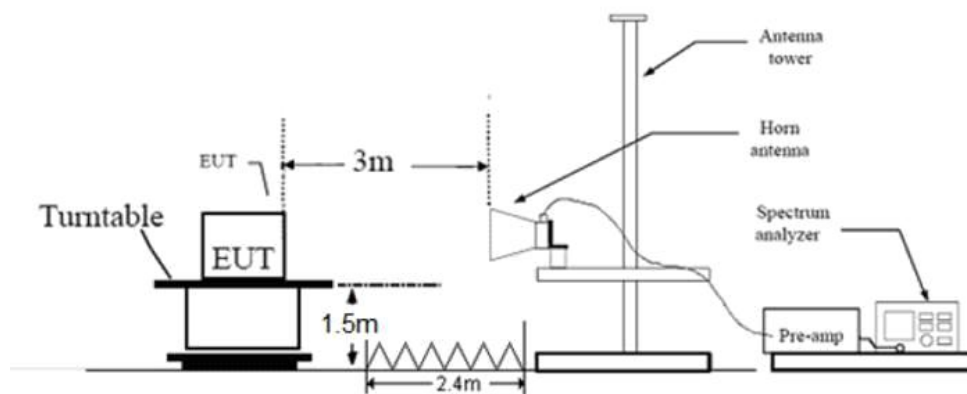
7.1 Radiated test setups 9kHz-30MHz



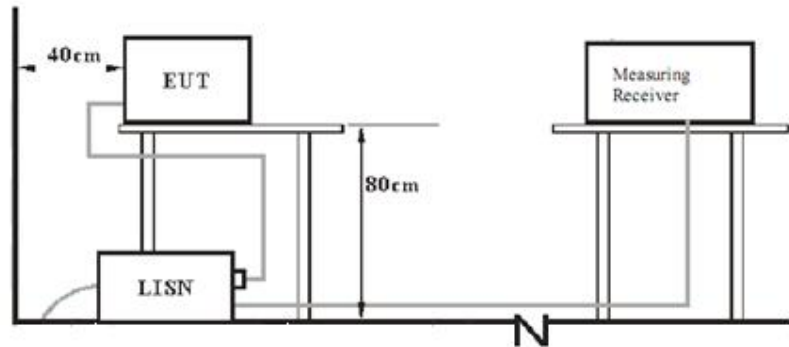
7.2 Radiated test setups 30MHz-1GHz



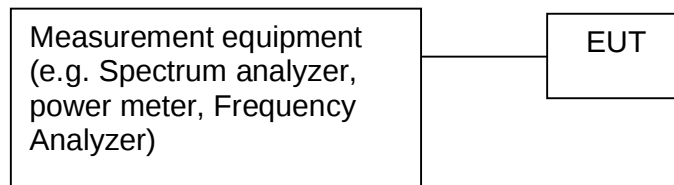
7.3 Radiated test setups Above 1GHz



7.4 AC Power Line Conducted Emission test setups



7.5 Conducted RF test setups



8 Emission Test Results

8.1 Spurious Radiated Emission

EUT: D3 CAD
 Op Condition: Operated, TX Mode
 Test Specification: FCC15.205, 15.209
 Comment: 3.0 VDC
 Remark: 9kHz to 30MHz

Test Result	
☒	Passed
☐	Not Passed

Frequency MHz	Result dB μ V/m	Limit dB μ V/m	Margin dB	Detector PK/QP/AV	RSE. or Fund.
0.112000	65.23	106.65	41.42	Peak	Fundamental
0.120014	36.39	106.01	69.62	Peak	Spurious emission
0.135994	35.78	104.93	69.15	Peak	Spurious emission
0.468400	38.69	94.19	55.51	Peak	Spurious emission
0.508200	32.88	73.48	40.60	Peak	Spurious emission
1.025600	32.35	67.40	35.06	Peak	Spurious emission
1.567875	33.24	63.73	30.49	Peak	Spurious emission
5.841400	33.16	69.50	36.34	Peak	Spurious emission
6.319000	33.26	69.50	36.24	Peak	Spurious emission
16.662025	32.94	69.50	36.56	Peak	Spurious emission

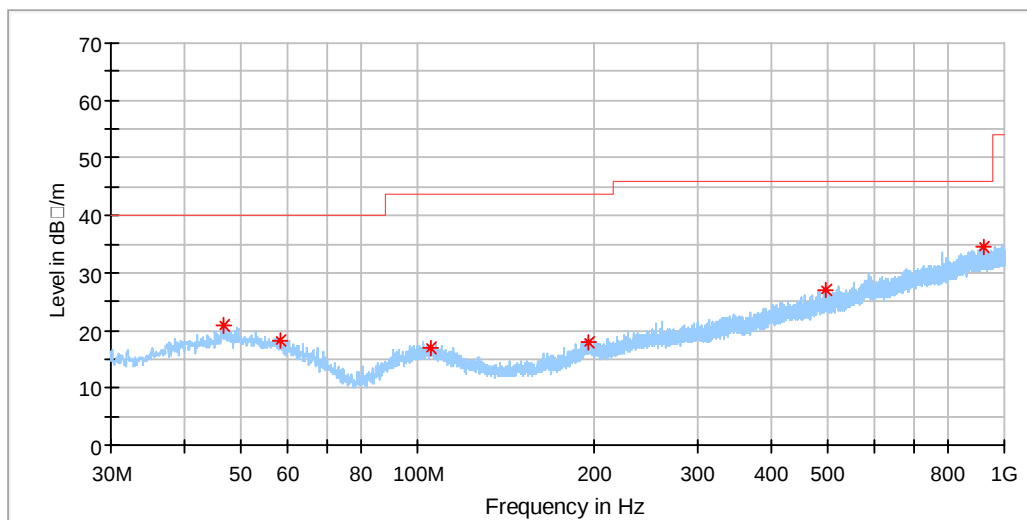
Remark:

1. According to C63.10, if the peak measured value complies with the quasi-peak limit, it is unnecessary to perform a quasi-peak measurement, so quasi-peak emission value did not show in data table if the peak value complies with quasi-peak 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)
3. The testing was performed at 3m distance, the limit has been transferred from 300m/30m to 3m.

Spurious Radiated Emission

EUT: D3 CAD
 Op Condition: Operated, TX Mode
 Test Specification: FCC15.205, 15.209
 Comment: 3.0 VDC
 Remark: 30MHz to 1GHz, Antenna: Horizontal

Test Result	
☒	Passed
☐	Not Passed

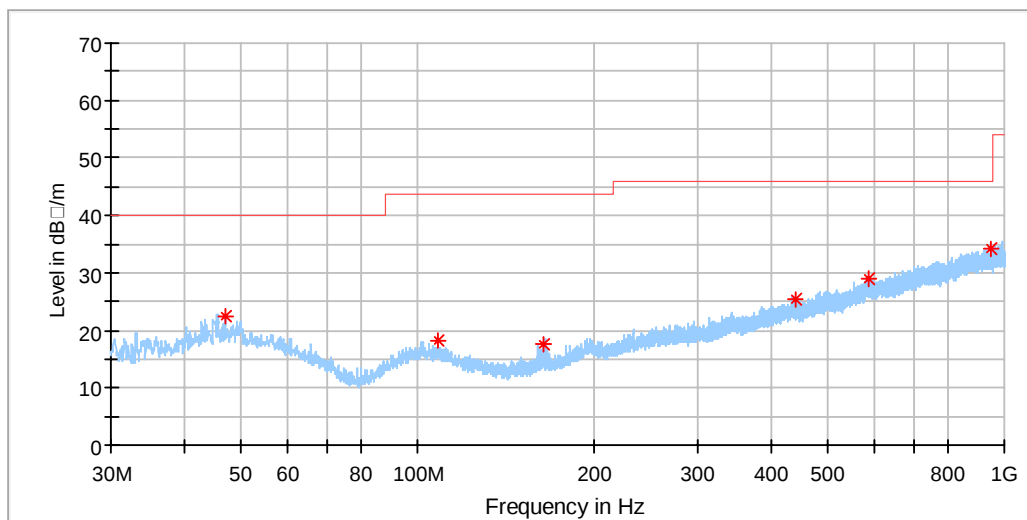


Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)
46.550625	20.79	40.00	19.21
58.433125	18.29	40.00	21.71
105.417500	17.03	43.50	26.47
195.021250	17.87	43.50	25.63
496.206250	27.15	46.00	18.85
925.370625	34.56	46.00	11.44

Spurious Radiated Emission

EUT: D3 CAD
 Op Condition: Operated, TX Mode
 Test Specification: FCC15.205, 15.209
 Comment: 3.0 VDC
 Remark: 30MHz to 1GHz, Antenna: Vertical

Test Result	
☒	Passed
☐	Not Passed

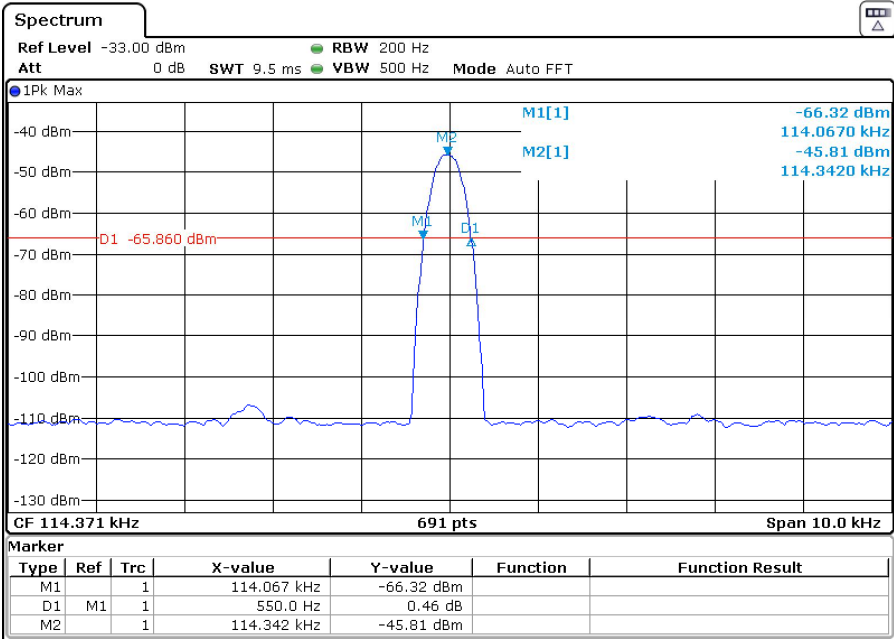


Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)
46.975000	22.58	40.00	17.42
108.206250	18.24	43.50	25.26
164.345000	17.73	43.50	25.77
440.128125	25.27	46.00	20.73
586.476875	29.04	46.00	16.96
951.621250	34.04	46.00	11.96

8.2 20dB & 99% Bandwidth

EUT: D3 CAD
Op Condition: Operated, TX Mode
Test Specification: FCC15.215, 20dB Bandwidth
Comment: 3.0 VDC

Test Result
☒ Passed
☐ Not Passed



Bandwidth	Measured Value
20dB bandwidth	550 Hz

9 Test setup procedure

9.1 Field strength of emissions and Restricted bands

Test Method

- 1: The EUT was placed 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 $\geq$ 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 $\geq$ 3RBW, Sweep = auto, Detector function = QP,
Trace = max hold.

Field strength of emissions and Restricted bands

Limits

According to §15.209 (a), the field strength of emissions from intentional radiators shall not exceed the field strength levels specified in the following table:

Fundamental frequency (MHz)	Field strength (microvolts/meter)	Field strength of harmonics (microvolts/meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

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 dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

*Decreasing linearly with logarithm of the frequency.

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: TFO-13012**

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

Step a)

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$
for 1-g SAR

Step b)

$\{[\text{Power allowed at numeric threshold for 50mm in step a)}] + [(\text{test separation distance} - 50\text{mm}) \cdot (f(\text{MHz})/150)]\}$
mW

Step c) 1)

For test separation distances $> 50\text{mm}$ and $< 200\text{mm}$, the power threshold at the corresponding test separation distance at 100MHz in step b) is multiplied by $[1 + \log(100/f(\text{MHz}))]$

Step c) 2)

For test separation distances $\leq 50\text{mm}$, the power threshold determined by the equation in c) 1) for 50mm and 100MHz is multiplied by $\frac{1}{2}$.

>> The fundamental frequency of the EUT is 112kHz, the test separation distance is $\leq 50\text{mm}$.
(Manufacturer specified the separation distance is: 20mm)

Step a)

>> Numeric threshold, $\text{mW} / 50\text{mm} \cdot \sqrt{0.1\text{GHz}} \leq 3.0$
Numeric threshold $\leq 474.3\text{mW}$

Step b)

>> Numeric threshold $\leq 474.3\text{mW} + (50\text{mm} - 50\text{mm}) \cdot 100\text{MHz}/150$
Numeric threshold $\leq 474.3\text{mW}$

Step c) 1) & c) 2)

>> Numeric threshold $\leq 474.3\text{mW} \cdot [1 + \log 100/100\text{MHz}] \cdot \frac{1}{2}$
Numeric threshold $\leq 237.15\text{mW}$

>> The power (calculated power + tune up tolerance) of EUT at 112kHz is: 0.001mW
Which is smaller than the Numeric threshold.
Therefore, the device is exempt from stand-alone SAR test requirements.

Appendix A

Power calculation (According to C63.10 chapter 9.5)

	Value	Unit
Field Strength Measured (E)	65.23	dB μ V/m
Measurement Distance (D)	3	m
Equivalent Isotropically Radiated Power (E.I.R.P in dBm)	-29.93	dBm
Equivalent Isotropically Radiated Power (E.I.R.P in mW)	0.001	mW

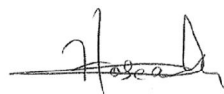
Remark: $EIRP = E + 20\log(D) - 104.7$ (EIRP is in dBm, E is in dB μ V/m, D is in meters)

Reviewed by:



Eric LI
EMC Project Manager

Prepared by:



Hosea CHAN
EMC Project Engineer