

FCC 15.249 2.4 GHz Report

for

Duke Energy Business Services LLC

**526 S. Church St, Charlotte, North Carolina,
28202 United States**

Product Name : Duke Energy Gateway
Model Name : DK-GW001-A01-C001
Brand : DUKE ENERGY
FCC ID : 2AUYW-A010001

**Prepared by: : AUDIX Technology Corporation,
EMC Department**



The statement is based on a single evaluation of one sample of the above-mentioned products. It does not imply an assessment of the whole production and does not permit the use of the test lab logo.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

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TEST REPORT CERTIFICATION

Applicant : Duke Energy Business Services LLC
Manufacturer : Duke Energy Corporation
EUT Description
(1) Product : Duke Energy Gateway
(2) Model : DK-GW001-A01-C001
(3) Brand : DUKE ENERGY
(4) Power Rating : DC 5V, 3A

Applicable Standards:

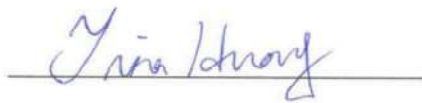
47 CFR FCC Part 15 Subpart C
ANSI C63.10:2013

Audix Technology Corp. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Audix Technology Corp. does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens and samples.

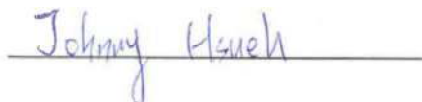
Date of Report: 2019. 12. 27

Reviewed by:



(Tina Huang/Administrator)

Approved by:



(Johnny Hsueh/Section Manager)



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1. REVISION RECORD OF TEST REPORT

Edition No	Issued Data	Revision Summary	Report Number
0	2019. 12. 27	Original Report	EM-F190516

2. SUMMARY OF TEST RESULTS

Rule	Description	Results
15.207	Conducted Emission	PASS
15.205/ 15.209/ 15.249(a)	Radiated Band Edge and Radiated Spurious Emission Fundamental Frequency	PASS
15.215	Emission Bandwidth	PASS
15.203	Antenna Requirement	PASS

3. GENERAL INFORMATION

3.1. Description of Application

Applicant	Duke Energy Business Services LLC 526 S. Church St, Charlotte, North Carolina, United States, 28202 United States
Manufacturer	Duke Energy Corporation 550 South Tryon Street Charlotte, NC 28202 United States
Product	Duke Energy Gateway
Model	DK-GW001-A01-C001
Brand	DUKE ENERGY

3.2. Description of EUT

Test Model	DK-GW001-A01-C001
Serial Number	N/A
Power Rating	DC 5V, 3A
RF Features	WLAN: 802.11 a/b/g/n/ac Bluetooth: BT and BLE ZigBee Z-Wave
Transmit Type	WLAN: 1T1R Bluetooth: 1T1R ZigBee: 1T1R Z-Wave: 1T1R
Sample Status	Mass production
Date of Receipt	2019. 11. 06
Date of Test	2019. 11. 27 ~ 12. 10
Interface Ports of EUT	• One LAN Port • One USB Port • One DC Input Port
Accessories Supplied	• AC Adapter • Ethernet Cord

3.3. Antenna Information

WLAN/ZigBee/BT Antenna				
Antenna Part Number	Manufacture	Antenna Type	Frequency (MHz)	Max Gain(dBi)
RFA-DB1-AP609-70-100	ARISTOTLE.	PCB	2400-2500	3.73
			5150-5875	3.92

Z-Wave Antenna				
Antenna Part Number	Manufacture	Antenna Type	Frequency (MHz)	Max Gain(dBi)
RFA-ZW-AP856-100-R2	ARISTOTLE.	PCB	868-928	3.15

3.4. EUT Specifications Assessed in Current Report

Mode	Operating Frequency Range	Channel Number	Modulation	Data Rate
Z-Wave	908.4 to 916MHz	3	2-Key FSK/GFSK	Up to 100kbps

Channel List	
Z-Wave	
Channel	Frequency (MHz)
1	908.4
2	912
3	916

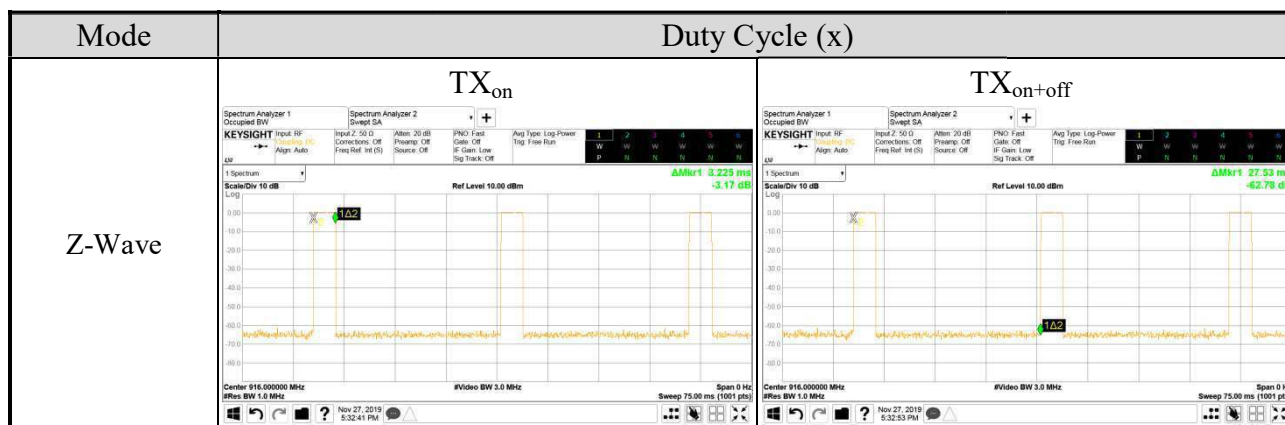
3.5. Description of Key Components

Item	Supplier	Model / Type	Character
CPU	Intel	E3805	1.33GHz
Storage (SSD)	Kingston.	EMMC16G-TB28	eMMC flash 16GB
Memory (RAM)	NANYA.	NT5CC256M16EP-EK	4GB DDR3
WLAN/BT Combo Card	AMPAK.	AP6255	---
Z-Wave Chip	SIGMA.	ZM5101A-CME3R	---
ZigBee Chip	Silicon Labs	EFR32MG1B232F256GM32-C0	---
Z-Wave Antenna	ARISTOTLE	RFA-ZW-AP856-100-R2	---
Wi-Fi/BT/ ZigBee Antenna	ARISTOTLE	RFA-DB1-AP609-70-100	---
AC Adapter (Wall-mount, 2C)	SUNNY COMPUTER TECHNOLOGY CO., LTD	SYS1639-1505-W2	I/P: 100-240Vac, 50-60Hz, 1.0A O/P: 5Vdc, 3A 15W MAX
	DC Cable: Unshielded, Detachable, 1.4m		
Cable	Ethernet Cord: Unshielded, Detachable, 0.9m		

Remark: For more detailed features description, please refer to the manufacturer's specifications or the user manual.

3.6. Test Configuration

Mode	TX _{on} (ms)	1/ TX _{on} (kHz)	Duty Cycle (x)	Duty Cycle Factor [10log(1/x)] (dB)
Z-Wave	3.225	0.31	0.12	N/A



AC Conduction	
Test Case	Normal operation

Item		Mode	Test Frequency (MHz)
Radiated Test Case	Radiated Spurious Emission (30MHz-1GHz) ^{Note1}	Z-Wave	908.4/912/916
	Radiated Spurious Emission (Above 1GHz) ^{Note1}	Z-Wave	908.4/912/916
	Fundamental Frequency	Z-Wave	908.4/912/916
	Occupied Bandwidth 99% Power	Z-Wave	908.4/912/916

Note : ☒ Mobile Device

☐ Portable Device, and 3 axis were assessed. The worst scenario for Radiated Spurious Emission as follow: ☐ Lie ☐ Side ☐ Stand

3.7. Tested Supporting System List

3.7.1. Support Peripheral Unit

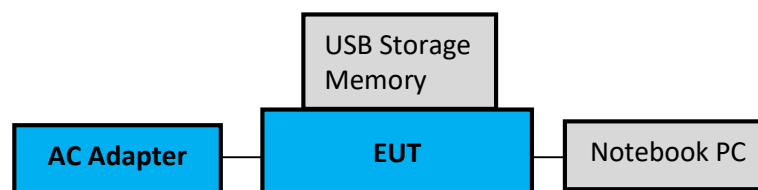
No.	Product	Brand	Model No.	Serial No.	Approval
1.	Notebook PC	hp	TPN-Q189	N/A	N/A
2.	USB Storage Memory (128GB)	SanDisk	N/A	N/A	N/A

3.7.1. Cable Lists

No.	Cable Description Of The Above Support Units
1.	AC Adapter: hp, M/N PPP-012C-S, DC Power Cord: Unshielded, Undetachable, 1.8m, Bonded a ferrite core AC Power Cord: Unshielded, Detachable, 1.0m
2.	USB Cable: Unshielded, Undetachable, 1.8m

3.8. Setup Configuration

3.8.1. EUT Configuration for Power Line & Radiated Emission



3.8.2. EUT Configuration for RF Conducted Test Items



3.9. Operating Condition of EUT

Test program “putty” is used for enabling EUT WLAN function under continues transmitting and choosing data rate/ channel.

3.10. Description of Test Facility

Name of Test Firm	Audix Technology Corporation / EMC Department No. 53-11, Dingfu, Linkou Dist., New Taipei City 244, Taiwan Tel: +886-2-26092133 Fax: +886-2-26099303 Website : www.audixtech.com Contact e-mail: attemc_report@audixtech.com
Accreditations	The laboratory is accredited by following organizations under ISO/IEC 17025:2017 (1) NVLAP(USA) NVLAP Lab Code 200077-0 (2) TAF(Taiwan) No. 1724 (3) FCC OET Designation No. TW1724
Test Facilities	FCC OET Designation Number under APEC MRA by NCC is : TW1724 ISED CAB Identifier Number under APEC TEL MRA by NCC is TW1724 (1) No.8 Shielded Room (2) No.1 3m Semi Anechoic Chamber (3) Fully Anechoic Chamber

3.11.Measurement Uncertainty

Test Items/Facilities		Frequency Range	Uncertainty
Conduction Test		150kHz~30MHz	±3.50dB
Radiation Test	No.1 3m Semi Anechoic Chamber	30MHz-200MHz, 3m, Horizontal	±3.9dB
		200MHz-1000MHz, 3m, Horizontal	±4.3dB
		30MHz-200MHz, 3m, Vertical	±4.5dB
		200MHz-1000MHz, 3m, Vertical	±4.1dB
		1GHz-6GHz, 3m	±5.1dB
		6GHz-18GHz, 3m	±5.5dB
	No.3 3m Semi Anechoic Chamber	30MHz-200MHz, 3m, Horizontal	±4.7dB
		200MHz-1000MHz, 3m, Horizontal	±4.5dB
		30MHz-200MHz, 3m, Vertical	±4.3dB
		200MHz-1000MHz, 3m, Vertical	±4.1dB
	No.4 3m Semi Anechoic Chamber	30MHz-200MHz, 3m, Horizontal	±4.1dB
		200MHz-1000MHz, 3m, Horizontal	±4.4dB
		30MHz-200MHz, 3m, Vertical	±4.2dB
		200MHz-1000MHz, 3m, Vertical	±5.0dB
		1GHz-6GHz, 3m	±4.4dB
		6GHz-18GHz, 3m	±4.1dB
	No.5 3m Semi Anechoic Chamber	30MHz-200MHz, 3m, Horizontal	±4.0dB
		200MHz-1000MHz, 3m, Horizontal	±4.0dB
		30MHz-200MHz, 3m, Vertical	±4.2dB
		200MHz-1000MHz, 3m, Vertical	±4.4dB
		1GHz-6GHz, 3m	±4.3dB
		6GHz-18GHz, 3m	±4.6dB
	Fully Anechoic Chamber	30MHz~1000MHz	±4.7dB
		1GHz~18GHz	±5.3dB

Remark : Uncertainty = $ku_c(y)$

Test Item	Uncertainty
Occupied Bandwidth 99% Power	± 1kHz

4. MEASUREMENT EQUIPMENT LIST

4.1. Conducted Emission Measurement

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Test Receiver	R&S	ESR3	101774	2019. 01. 23	1 Year
2.	A.M.N.	R&S	ENV4200	100169	2019. 11. 13	1 Year
3.	L.I.S.N.	Kyoritsu	KNW-407	8-855-9	2019. 12. 10	1 Year
4.	Pulse Limiter	R&S	ESH3-Z2	100354	2019. 01. 12	1 Year
5.	Signal Cable	Yeida	RG/58AU	CE-08	2019. 09. 20	1 Year
6.	Digital Thermo-Hygro Meter	iMax	HTC-1	No.8 S/R	2019. 04. 20	1 Year
7.	Test Software	Audix	e3	V6.120619c	N.C.R.	N.C.R.

4.2. Radiated Emission Measurement

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A-526	MY53400071	2019. 09. 11	1 Year
2.	Spectrum Analyzer	Keysight	N9010B-544	MY55460198	2019. 05. 06	1 Year
3.	Test Receiver	R & S	ESCS30	100338	2019. 06. 12	1 Year
4.	Amplifier	HP	8447D	2944A06305	2019. 01. 30	1 Year
5.	Amplifier	HP	8449B	3008A02678	2019. 03. 07	1 Year
6.	Amplifier	Keysight	83051A	MY53010042	2019. 08. 08	1 Year
7.	Bilog Antenna	TESEQ	CBL6112D	33821	2019. 01. 19	1 Year
8.	Loop Antenna	R&S	HFH2-Z2	891847/27	2017. 12. 18	2 Years
9	Double-Ridged Waveguide Horn	ETS-Lindgren	3117	00135902	2019. 03. 13	1 Year
10.	Horn Antenna	COM-POWER	AH-840	101092	2019 .05. 14	1 Year
11.	2.4GHz Notch Filter	K&L	7NSL10-244 1.5/E130.5-O /O	1	2019. 07. 24	1 Year
12.	3GHz Notch Filter	Microwave	H3G018G1	484796	2019. 08. 21	1 Year
13.	Coaxial Cable	MIYAZAKI	5D2W	RE-11	2019. 02. 01	1 Year
14.	Coaxial Cable	HUBER+SUHNER	SUCOFLEX 104	RF CABLE-01	2019. 09. 20	1 Year
15.	Coaxial Cable	HUBER+SUHNER	SUCOFLEX 102	No.1 18-40GHz Cable	2019. 09. 20	1 Year
16.	Digital Thermo-Hygro Meter	iMax	HTC-1	No.1 3m A/C	2019. 04. 20	1 Year
17.	Digital Thermo-Hygro Meter	EVERY DAY	E-512	RF-02	2019. 04. 20	1 Year
18.	Test Software	Audix	e3	V6.120619c	N.C.R.	N.C.R.
19.	Test Software	Audix	e3	V6.110601	N.C.R.	N.C.R.

4.3. RF Conducted Measurement

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
1.	Spectrum Analyzer	Keysight	N9020B-544	MY57120357	2019.01.17	1 Year
2.	Digital Thermo-Hygro Meter	Shenzhen Datronn Electronics	KT-905	RF	2019. 04. 20	1 Year

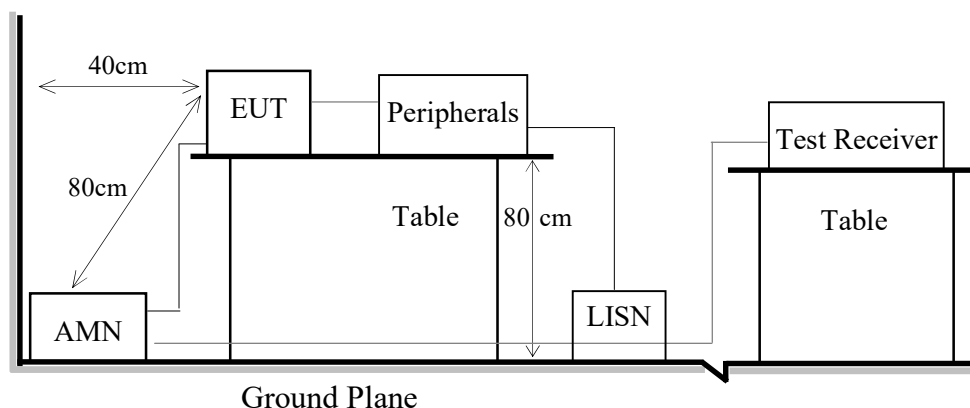
5. CONDUCTED EMISSION MEASUREMENT

5.1. Block Diagram of Test Setup

5.1.1. Block Diagram of EUT

Indicated as section 3.8

5.1.2. Shielded Room Setup Diagram



5.2. Conducted Emission Limit

Frequency	Conducted Limit	
	Quasi-Peak Level	Average Level
150kHz ~ 500kHz	66 ~ 56 dB μ V	56 ~ 46 dB μ V
500kHz ~ 5MHz	56 dB μ V	46 dB μ V
5MHz ~ 30MHz	60 dB μ V	50 dB μ V

Remark 1.: If the average limit is met when using a Quasi-Peak detector, the measurement using the average detector is not required.

2.: The lower limit applies to the band edges.

5.3. Test Procedure

- 5.3.1. To set up the EUT as indicated in ANSI C 63.10. The EUT was placed on the table which has 80 cm height to the ground and 40 cm distance to the conducting wall.
- 5.3.2. Power supplier of the EUT was connected to the AC mains through an Artificial Mains Network (A.M.N.).
- 5.3.3. The AC power supplies to all peripheral devices must be provided through line impedance stabilization network (L.I.S.N.)
- 5.3.4. To Check frequency range from 150 kHz to 30 MHz and record the emission which does not have 20 dB below limit.

5.4. Test Results

Please refer to Appendix A.

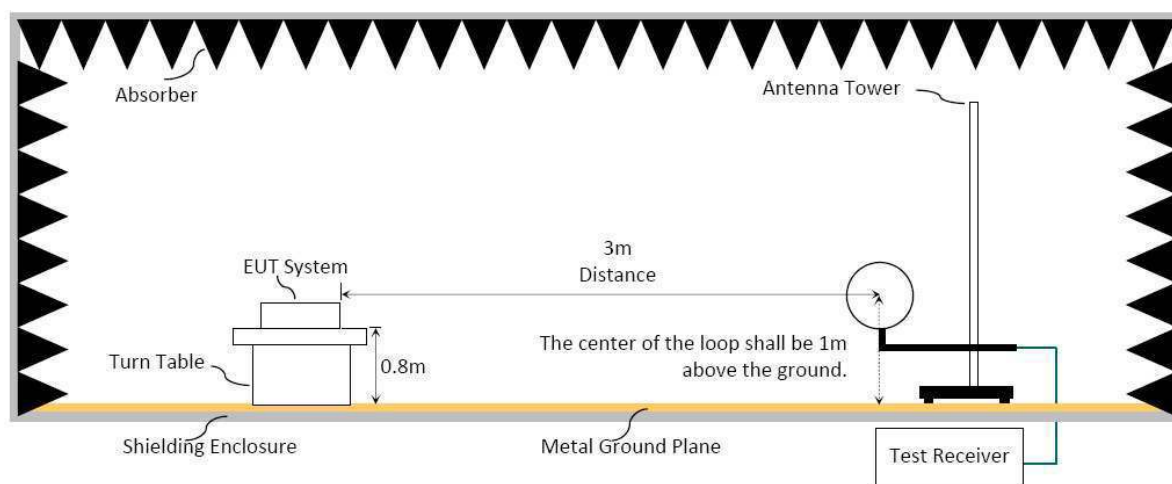
6. RADIATED EMISSION

6.1. Block Diagram of Test Setup

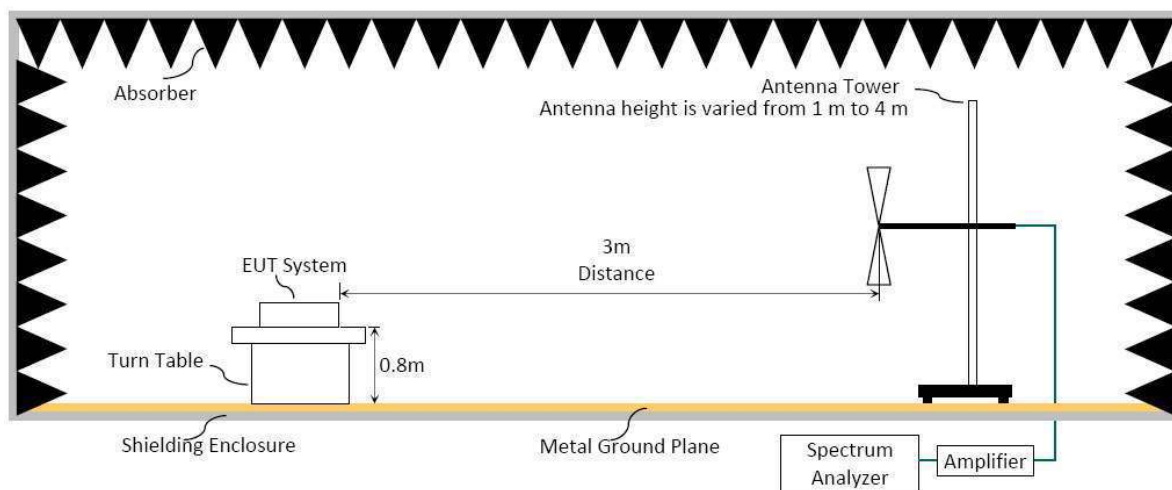
6.1.1. Block Diagram of EUT

Indicated as section 3.8

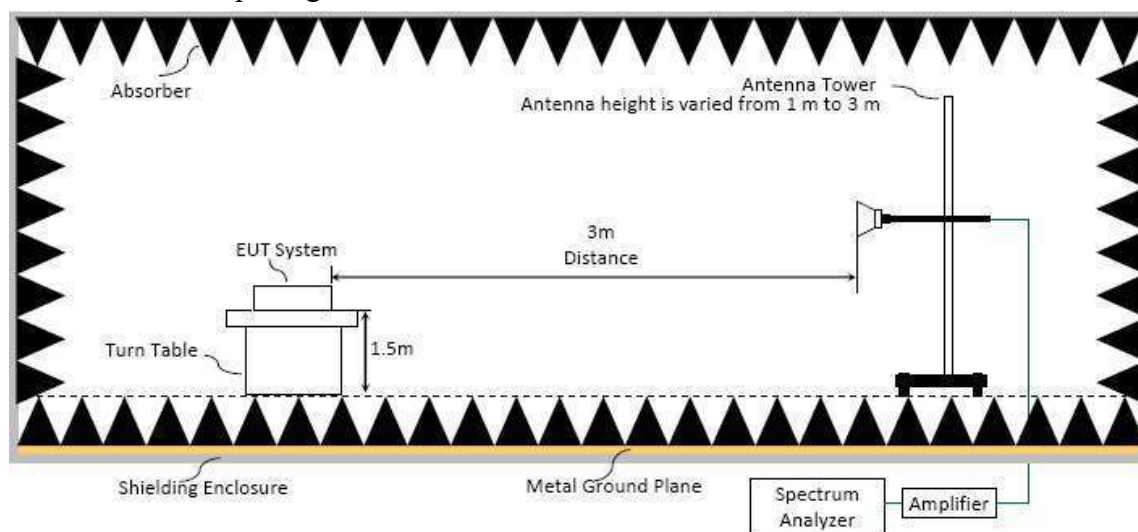
6.1.2. Setup Diagram for 9kHz-30MHz



6.1.3. Setup Diagram for 30-1000 MHz



6.1.4. Setup Diagram for above 1GHz



6.2. Radiated Emission Limits

6.2.1. General Limit

In any 100kHz bandwidth outside the frequency band, the radio frequency power produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level. In addition, radiated emissions which fall in restricted bands, as defined in FCC Section 15.205, must also comply with the radiated emission limits specified as below.

Frequency (MHz)	Distance (m)	Limits	
		dBμV/m	μV/m
0.009 - 0.490	300	67.6-20 log f(kHz)	2400/f kHz
0.490 - 1.705	30	87.6-20 log f(kHz)	24000/f kHz
1.705 - 30	30	29.5	30
30 - 88	3	40.0	100
88- 216	3	43.5	150
216- 960	3	46.0	200
Above 960	3	54.0	500
Above 1000	3	74.0 dBμV/m (Peak) 54.0 dBμV/m (Average)	

Remark : (1) $\text{dB}\mu\text{V/m} = 20 \log (\mu\text{V/m})$

- (2) The tighter limit applies to the edge between two frequency bands.
- (3) Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.
- (4) Fundamental and emission fall within operation band are exempted from this section.
- (5) Pursuant to ANSI C63.10: 6.6.4.3, if the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.

6.2.2. Limite for Fundamental & Harmonics Frequency

Fundamental Frequency	Field strength of fundamental		Field strength of harmonics	
	mV/m	dB μ V/m	mV/m	dB μ V/m
902-928MHz	50	94 (Quasi-Peak)	500	74 (Peak) 54 (Average)
2400-2483.5MHz	50	114 (Peak)	500	74 (Peak)
		94 (Average)		54 (Average)
5725-5875MHz	50	114 (Peak)	500	74 (Peak)
		94 (Average)		54 (Average)
24.0-24.25GHz	250	128 (Peak)	2500	88 (Peak)
		108 (Average)		68 (Average)

Remark: mV/m=1000 μ V/m; dB μ V/m = 20 log (μ V/m)

6.3. Test Procedure

Frequency Range 9kHz~30MHz:

The EUT setup on the turn table which has 0.8 m height to the ground. The turn table rotated 360 degrees and antenna fixed to 1 m to find the maximum emission level. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10-2013 regulation.

- (1) RBW = 9kHz with peak and average detector.
- (2) Detector: average and peak (9kHz-490kHz)
Q.P. (490kHz-30MHz)

Frequency Range 30MHz ~ 25GHz:

The EUT setup on the turn table which has 80 cm (for 30-1000 MHz) and 1.5m (for above 1GHz) height to the ground. The turn table rotated 360 degrees and antenna varied from 1 m to 4 m to find the maximum emission level. Both horizontal and vertical polarization are required. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10-2013 regulation.

Frequency below 1 GHz:

Spectrum Analyzer is used for pre-testing with following setting:

- (1)RBW = 120KHz
- (2)VBW $\geq$ 3 x RBW.
- (3)Detector = Peak.
- (4)Sweep time = auto.
- (5)Trace mode = max hold.
- (6)Allow sweeps to continue until the trace stabilizes.
- (7)When peak-detected value is lower than limit that the measurement using the Q.P. detector is not required, otherwise using Q.P. for final measurement.

Frequency above 1GHz to 10th harmonic (up to 25 GHz):

Peak Detector:

- (1) RBW = 1MHz
- (2) VBW $\geq 3 \times$ RBW.
- (3) Detector = Peak.
- (4) Sweep time = auto.
- (5) Trace mode = max hold.
- (6) Allow sweeps to continue until the trace stabilizes.
- (7) When peak-detected value is lower than limit that the measurement using the average detector is not required, otherwise using average detector for final measurement.

Average Detector:

☒ Option 1:

- (1) RBW = 1MHz
- (2) VBW $\geq 1/T$.
- (3) Detector = Peak.
- (4) Sweep time = auto.
- (5) Trace mode = max hold.
- (6) Allow sweeps to continue until the trace stabilizes.

☐ Option 2:

Average Emission Level = Peak Emission Level + D.C.C.F.

6.4. Measurement Result Explanation

☒ Peak Emission Level = Antenna Factor + Cable Loss + Meter Reading Meter Reading = Spectrum Analyzer Reading - Preamp factor

☒ Average Emission Level = Antenna Factor + Cable Loss + Meter Reading Meter Reading = Spectrum Analyzer Reading - Preamp factor

☐ Average Emission Level = Peak Emission Level + DCCF

Duty Cycle Correction Factor (DCCF) = $20\log(TX_{on}/TX_{on+off})$ presented in section 3.6

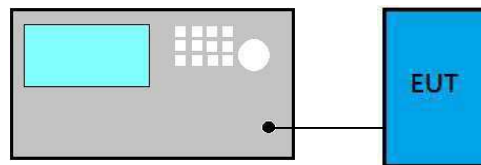
☐ ERP = Peak Emission Level - 95.2dB - 2.14dB

6.5. Test Results

Please refer to Appendix A.

7. EMISSION BANDWIDTH MEASUREMENT

7.1. Block Diagram of Test Setup



7.2. Test Procedure

- (1) Set RBW close to 1-5 % of OBW.
- (2) Set $VBW \geq RBW$.
- (3) Detector = Peak.
- (4) Trace mode = max hold.
- (5) Sweep = auto couple.
- (6) Allow the trace to stabilize.
- (7) Setting channel bandwidth function x dB to -6 dB to record the final bandwidth.

7.3. Test Results

Please refer to Appendix A



8. DEVIATION TO TEST SPECIFICATIONS

【NONE】



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APPENDIX A

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APPDNDIX A

TEST DATA AND PLOTS

(Model: DK-GW001-A01-C001)

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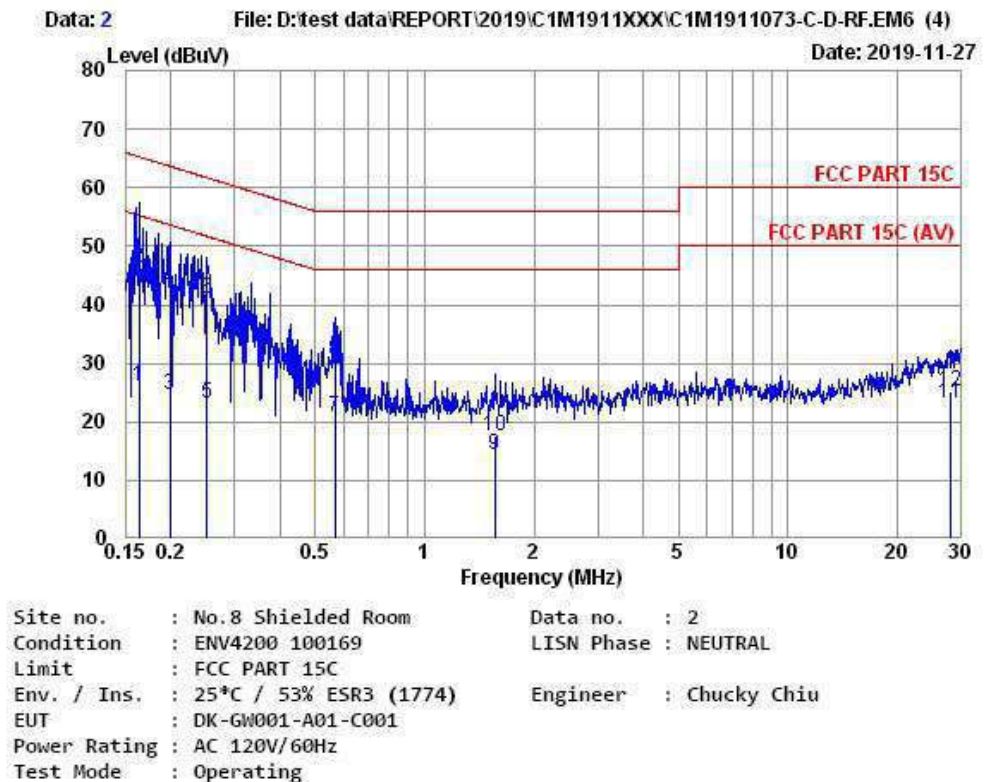
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A.1 CONDUCTED EMISSION

Test Phase	Neutral	Test Result	Pass
Test Voltage	AC 120V 60Hz (Via AC Adapter)		



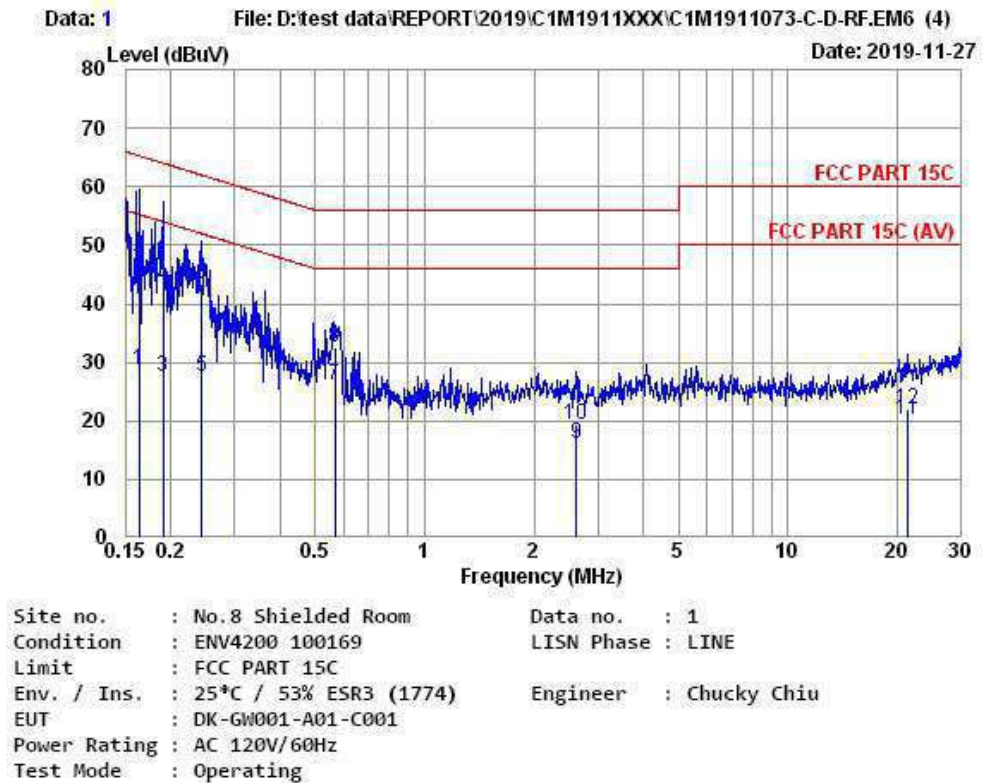
	Freq. (MHz)	AMN Factor (dB)	Cable Loss (dB)	Pulse Att. (dB)	Reading (dBμV)	Emission Level (dBμV)	Limits (dBμV)	Margin (dB)	Remark
1	0.163	10.68	0.04	9.86	5.40	25.98	55.30	29.32	Average
2	0.163	10.68	0.04	9.86	25.67	46.25	65.30	19.05	QP
3	0.199	10.62	0.04	9.86	4.17	24.69	53.67	28.98	Average
4	0.199	10.62	0.04	9.86	22.20	42.72	63.67	20.95	QP
5	0.252	10.58	0.04	9.86	2.72	23.20	51.69	28.49	Average
6	0.252	10.58	0.04	9.86	20.49	40.97	61.69	20.72	QP
7	0.567	10.48	0.04	9.86	0.49	20.87	46.00	25.13	Average
8	0.567	10.48	0.04	9.86	10.23	30.61	56.00	25.39	QP
9	1.560	10.50	0.06	9.86	-5.94	14.48	46.00	31.52	Average
10	1.560	10.50	0.06	9.86	-2.77	17.65	56.00	38.35	QP
11	28.003	15.79	0.24	10.00	-2.90	23.13	50.00	26.87	Average
12	28.003	15.79	0.24	10.00	-0.87	25.16	60.00	34.84	QP

Remarks: 1. Emission Level= AMN Factor + Cable Loss + Pulse Att. + Reading.
2. If the average limit is met when using a quasi-peak detector, the EUT shall be deemed to meet both limits and measurement with average detector is unnecessary.

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Test Phase	Line	Test Result	Pass
Test Voltage	AC 120V 60Hz (Via AC Adapter)		



	Freq. (MHz)	AMN Factor (dB)	Cable Loss (dB)	Pulse Att. (dB)	Reading (dBμV)	Emission Level (dBμV)	Limits (dBμV)	Margin (dB)	Remark
1	0.163	10.60	0.04	9.86	8.26	28.76	55.30	26.54	Average
2	0.163	10.60	0.04	9.86	25.64	46.14	65.30	19.16	QP
3	0.190	10.55	0.04	9.86	7.24	27.69	54.02	26.33	Average
4	0.190	10.55	0.04	9.86	22.75	43.20	64.02	20.82	QP
5	0.244	10.51	0.04	9.86	7.03	27.44	51.95	24.51	Average
6	0.244	10.51	0.04	9.86	22.83	43.24	61.95	18.71	QP
7	0.567	10.44	0.04	9.86	5.66	26.00	46.00	20.00	Average
8	0.567	10.44	0.04	9.86	12.27	32.61	56.00	23.39	QP
9	2.622	10.49	0.08	9.87	-4.38	16.06	46.00	29.94	Average
10	2.622	10.49	0.08	9.87	-1.07	19.37	56.00	36.63	QP
11	21.260	13.52	0.20	9.96	-3.60	20.08	50.00	29.92	Average
12	21.260	13.52	0.20	9.96	-1.77	21.91	60.00	38.09	QP

Remarks: 1. Emission Level= AMN Factor + Cable Loss + Pulse Att. + Reading.
2. If the average limit is met when using a quasi-peak detector, the EUT shall be deemed to meet both limits and measurement with average detector is unnecessary.

A.2 RADIATED EMISSION

Test Date	2019/12/06 ~ 10	Temp./Hum.	21-22°C/48-55%
Test Voltage	AC 120V 60Hz (Via AC Adapter)	Tested By	Sean Wang

A.2.1 Emissions Applied to General Requirement

A.2.1.1 Frequency 9kHz~30MHz

The emissions (9kHz~30MHz) not reported for there is no emission be found.

A.2.1.2 Frequency Below 1 GHz

Mode	Z-Wave	Frequency	TX 908.4MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
33.88	23.04	1.27	0.70	25.01	40.00	14.99	Peak
157.07	16.64	2.98	9.12	28.74	43.50	14.76	Peak
409.27	22.52	5.96	5.13	33.61	46.00	12.39	Peak
650.80	25.13	7.13	-0.56	31.70	46.00	14.30	Peak
912.70	27.41	8.53	1.72	37.66	46.00	8.34	Peak
978.66	27.92	8.92	0.27	37.11	54.00	16.89	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
32.91	23.73	1.25	2.78	27.76	40.00	12.24	Peak
177.44	15.53	3.20	7.30	26.03	43.50	17.47	Peak
482.02	23.49	6.61	0.43	30.53	46.00	15.47	Peak
685.72	25.35	7.30	2.89	35.54	46.00	10.46	Peak
844.80	26.87	8.15	1.98	37.00	46.00	9.00	Peak
977.69	27.92	8.91	1.61	38.44	54.00	15.56	Peak

Mode	Z-Wave	Frequency	TX 912MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
78.50	13.33	2.02	4.05	19.40	40.00	20.60	Peak
265.71	19.11	4.10	6.77	29.98	46.00	16.02	Peak
447.10	23.04	6.31	0.94	30.29	46.00	15.71	Peak
606.18	24.81	6.91	0.96	32.68	46.00	13.32	Peak
806.00	26.53	7.93	-0.05	34.41	46.00	11.59	Peak
975.75	27.89	8.90	-0.65	36.14	54.00	17.86	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
51.34	14.47	1.58	9.40	25.45	40.00	14.55	Peak
150.28	16.98	2.90	4.97	24.85	43.50	18.65	Peak
347.19	21.06	5.16	0.16	26.38	46.00	19.62	Peak
539.25	24.15	6.80	0.45	31.40	46.00	14.60	Peak
728.40	25.77	7.52	-0.33	32.96	46.00	13.04	Peak
981.57	27.94	8.94	-0.31	36.57	54.00	17.43	Peak

Mode	Z-Wave	Frequency	TX 916MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
33.88	23.04	1.27	-0.01	24.30	40.00	15.70	Peak
159.98	16.50	3.01	8.57	28.08	43.50	15.42	Peak
400.54	22.40	5.88	0.76	29.04	46.00	16.96	Peak
628.49	24.98	7.02	-0.50	31.50	46.00	14.50	Peak
790.48	26.40	7.85	0.29	34.54	46.00	11.46	Peak
968.96	27.84	8.86	0.26	36.96	54.00	17.04	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
32.91	23.73	1.25	3.14	28.12	40.00	11.88	Peak
127.00	18.24	2.62	2.57	23.43	43.50	20.07	Peak
266.68	19.13	4.11	1.23	24.47	46.00	21.53	Peak
453.89	23.14	6.37	0.39	29.90	46.00	16.10	Peak
623.64	24.93	7.00	-0.21	31.72	46.00	14.28	Peak
962.17	27.79	8.82	-0.33	36.28	54.00	17.72	Peak

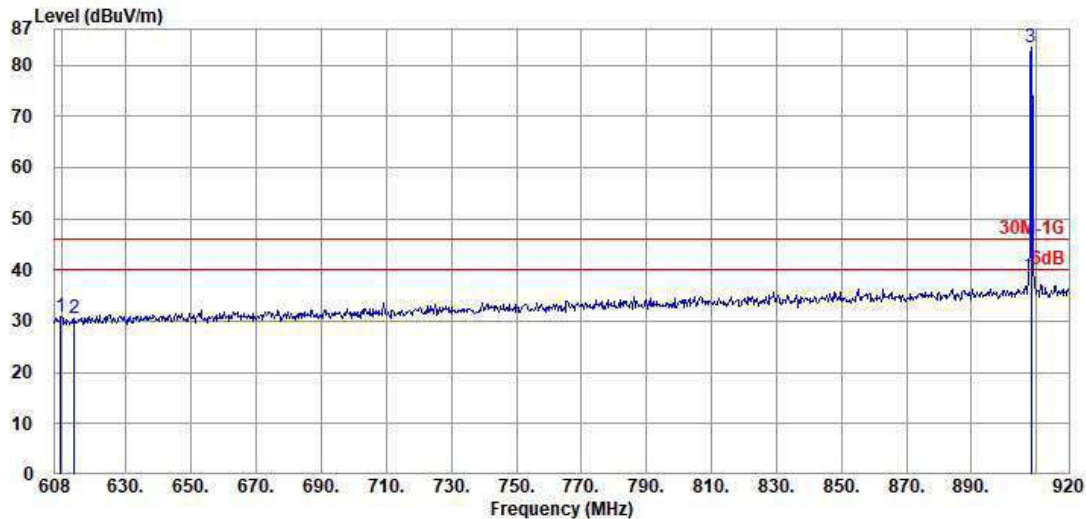
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A.2.1.3 Frequency Above 1 GHz to 10th harmonics

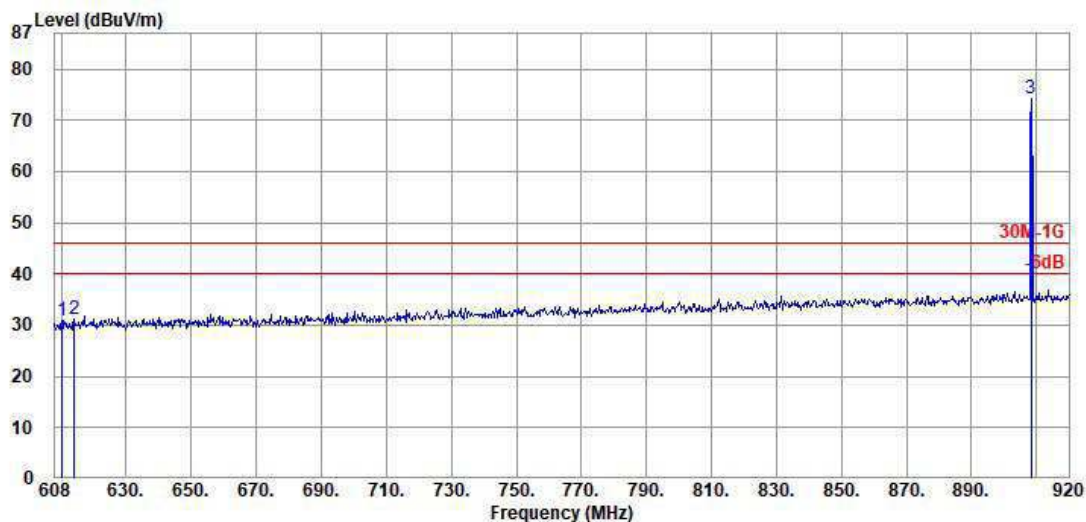
Band Edge:

Mode	Z-Wave	Frequency	TX 908.4MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
609.87	18.81	6.93	5.01	30.75	46.00	15.25	Peak
613.93	18.84	6.95	4.71	30.50	46.00	15.50	Peak
@ 908.46	21.51	8.50	53.54	83.55	---	---	Peak



Antenna at Vertical Polarization

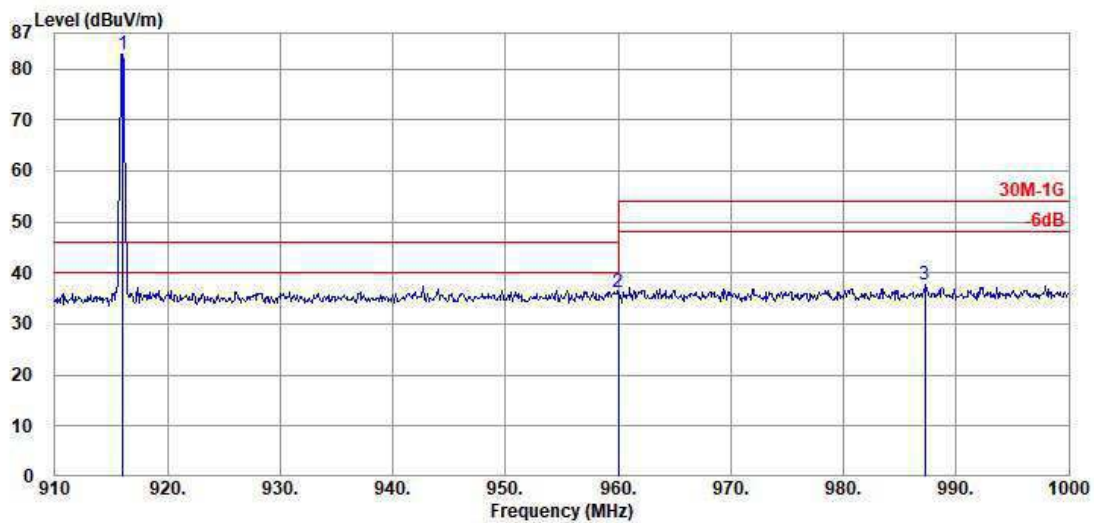
Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
610.18	18.81	6.93	5.06	30.80	46.00	15.20	Peak
613.93	18.84	6.95	5.40	31.19	46.00	14.81	Peak
@ 908.46	21.51	8.50	44.32	74.33	---	---	Peak

Remark: The “@” means fundamental frequency, it is ignored in this section.

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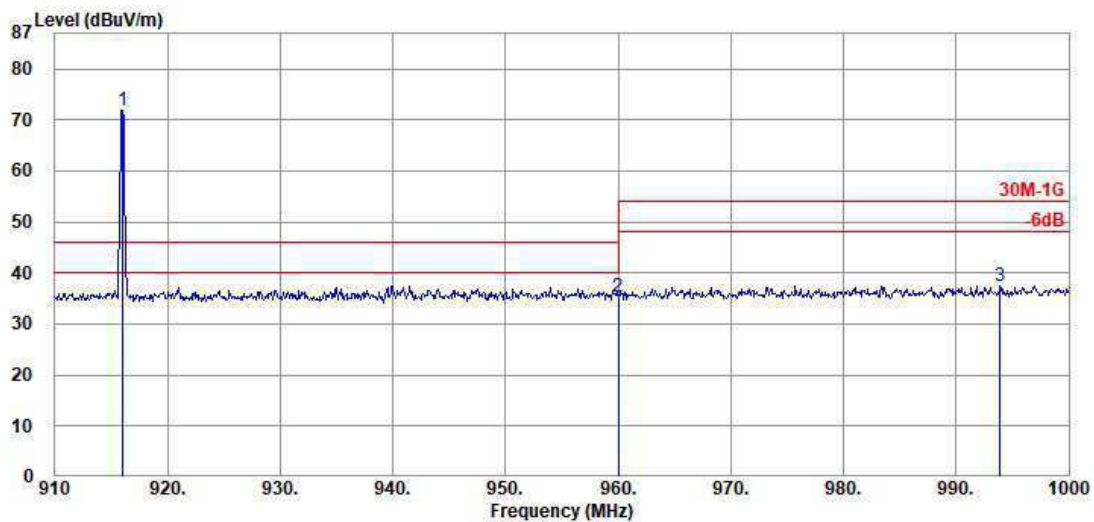
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Mode	Z-Wave	Frequency	TX 916MHz
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Antenna at Horizontal Polarization

	Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
@	916.03	21.55	8.55	52.87	82.97	---	---	Peak
	960.04	21.78	8.81	5.49	36.08	54.00	17.92	Peak
	987.22	21.93	8.97	6.91	37.81	54.00	16.19	Peak



Antenna at Vertical Polarization

	Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
@	916.03	21.55	8.55	41.77	71.87	---	---	Peak
	960.04	21.78	8.81	4.84	35.43	54.00	18.57	Peak
	993.88	21.96	9.01	6.58	37.55	54.00	16.45	Peak

Remark: The “@” means fundamental frequency, it is ignored in this section.

A.2.1.4 Frequency Above 1 GHz

Mode	Z-Wave	Frequency	TX 908.4MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6360.00	36.22	11.19	1.89	49.30	54.00	4.70	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6360.00	36.22	11.19	1.08	48.49	54.00	5.51	Peak

Mode	Z-Wave	Frequency	TX 912MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6385.00	36.27	11.19	1.22	48.68	54.00	5.32	Peak
9120.00	36.48	14.18	-4.05	46.61	54.00	7.39	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6385.00	36.27	11.19	0.46	47.92	54.00	6.08	Peak
9120.00	36.48	14.18	-2.02	48.64	54.00	5.36	Peak

Mode	Z-Wave	Frequency	TX 916MHz
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Antenna at Horizontal Polarization

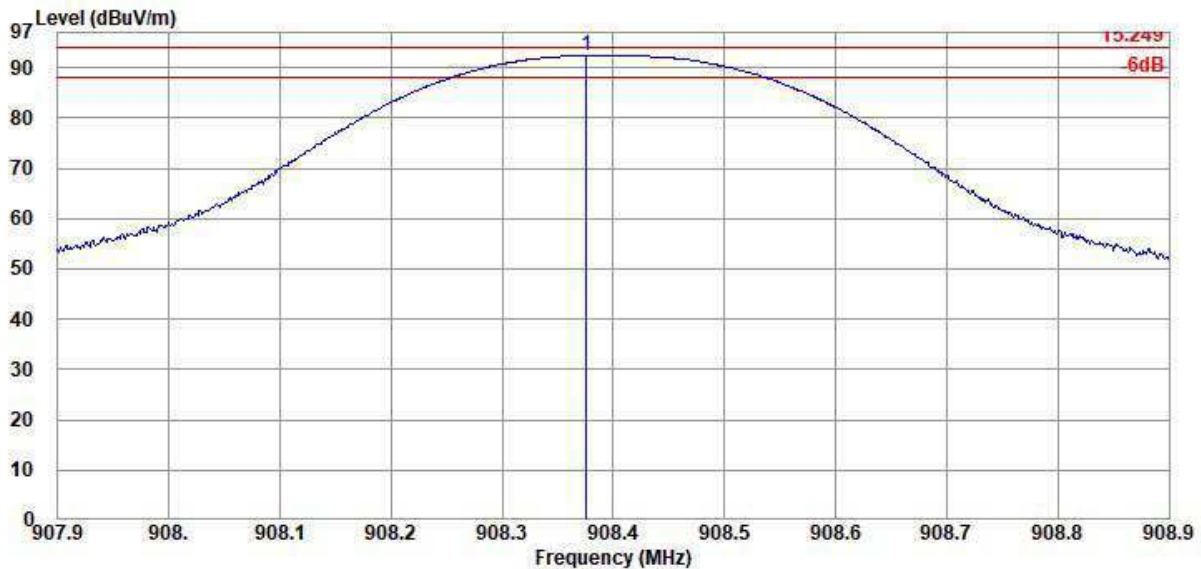
Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6410.00	36.24	11.19	1.27	48.70	54.00	5.30	Peak

Antenna at Vertical Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
6410.00	36.24	11.19	-0.18	47.25	54.00	6.75	Peak

A.2.2 Fundamental Frequency

Mode	Z-Wave	Frequency	TX 908.4MHz
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Antenna at Horizontal Polarization

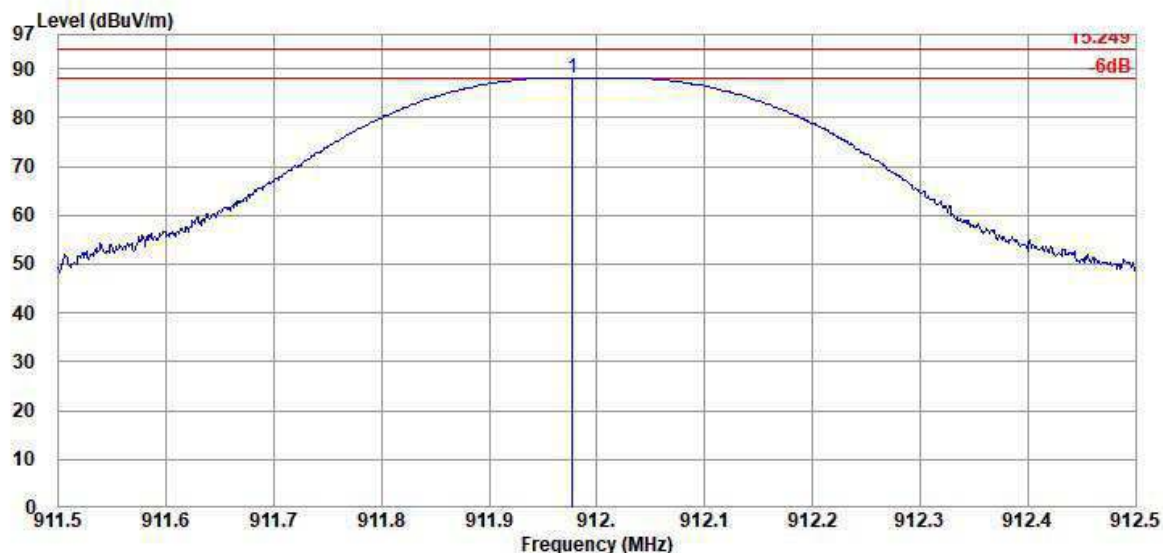
Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
908.38	27.39	8.50	56.45	92.34	94.00	1.66	Peak

Remark: Horizontal is the strongest polarization and peak value has complied with average limit, so horizontal won't be listed in test report.

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Mode	Z-Wave	Frequency	TX 912MHz
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Antenna at Horizontal Polarization

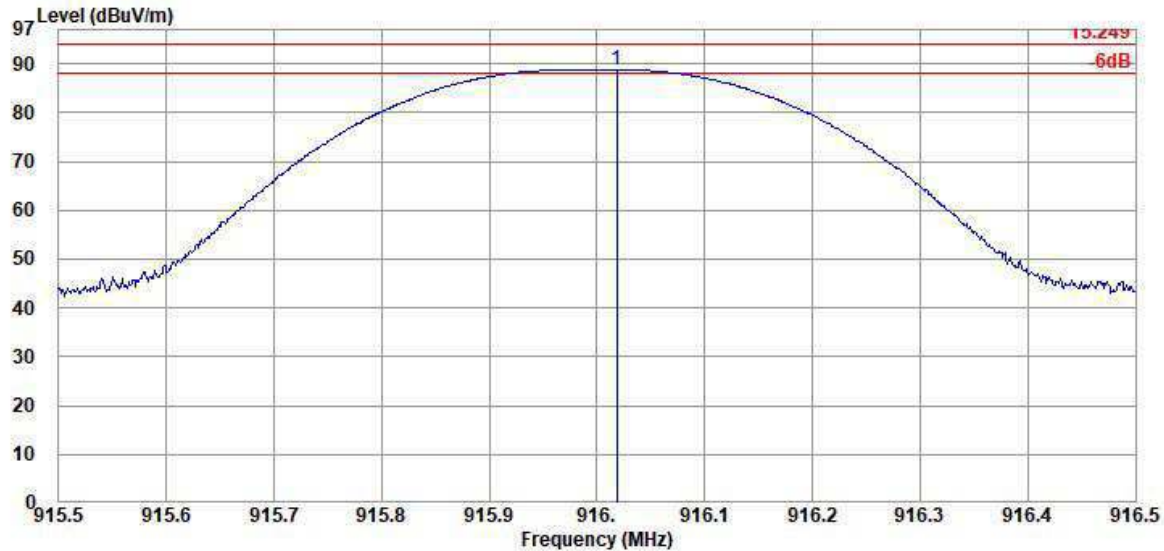
Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
911.98	27.41	8.52	52.25	88.18	94.00	5.82	Peak

Remark: Horizontal is the strongest polarization and peak value has complied with average limit, so horizontal won't be listed in test report.

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Mode	Z-Wave	Frequency	TX 916MHz
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Antenna at Horizontal Polarization

Emission Frequency (MHz)	Antenna Factor (dB/m)	Cable Loss (dB)	Meter Reading (dBμV)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector
916.02	27.44	8.55	52.75	88.74	94.00	5.26	Peak

Remark: Horizontal is the strongest polarization and peak value has complied with average limit, so horizontal won't be listed in test report.

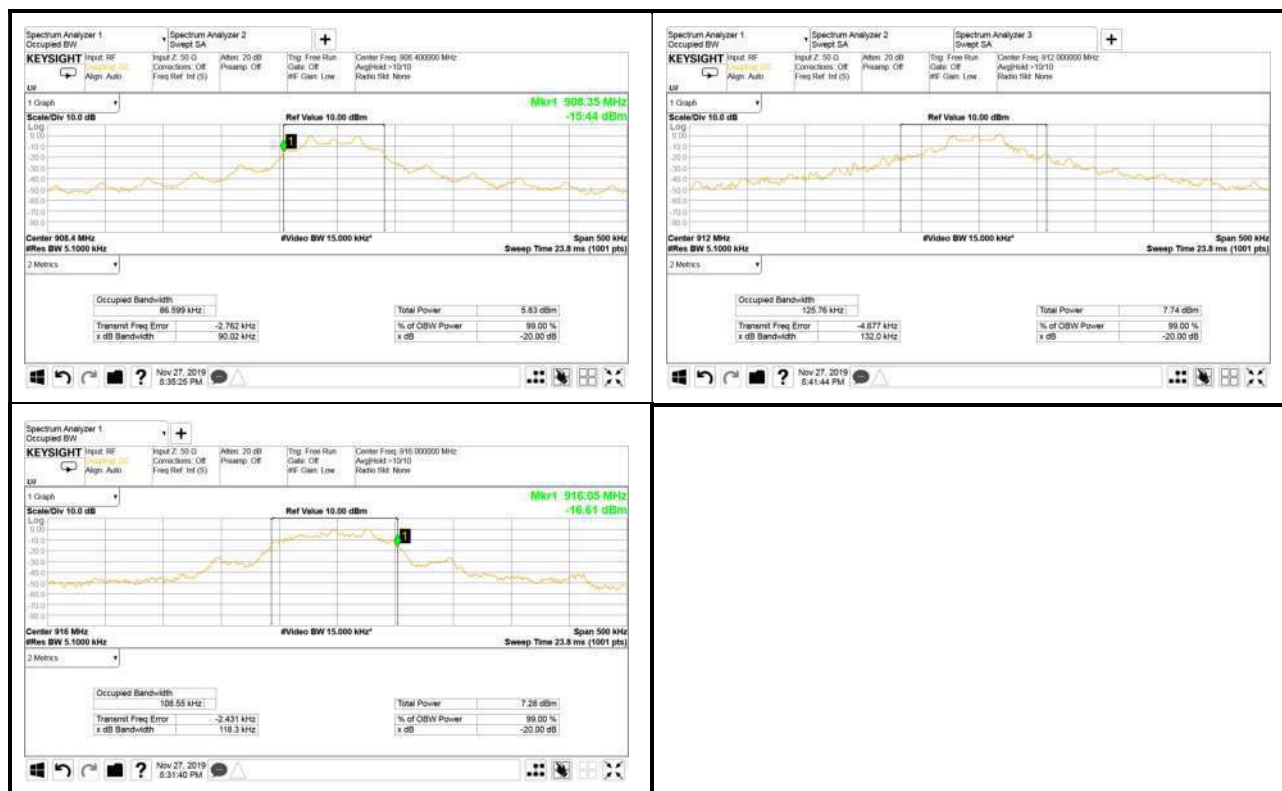
A.3 EMISSION BANDWIDTH MEASUREMENT

Test Date	2019/11/27	Temp./Hum.	24°C/50%
Test Voltage	AC 120V 60Hz (Via AC Adapter)	Tested By	Sean Wang

A.3.1 Emission Bandwidth

Mode	Centre Frequency (MHz)	20dB Occupied Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
Z-Wave	908.4	0.9002	0.86599
	912	0.1320	0.12576
	916	0.1183	0.10855

A.3.2 Measurement Plots





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APPENDIX B

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APPDNDIX B

TEST PHOTOGRAPHS

(Model: DK-GW001-A01-C001)