



Test Report

Test Report No.:	KTI18EF10004		
Registration No.:	KR0023		
Applicant:	Pium, Inc.		
Applicant Address:	100 OLD PALISADE RD Unit 3610, FORT LEE, NJ 07024		
Product:	Air Refreshener	Model No.	P3001
FCC ID:	2ARWJ -P3001	Date of Incoming:	Oct 10, 2018
Receipt No.:	KTI18EK10004	Test Start Date:	Oct 18, 2018
Date of Issue:	Oct 23, 2018	Test End Date:	Oct 22, 2018
Testing location	Korea Technology Institute Co., Ltd. 51-19, Sanglim-3ri, Docheok-Myun, Gwangju-Shi, Kyeongki-Do, Korea		
Test Standards:	ANSI C63.10-2013		
Rule Parts: FCC	Part 15, Class C		
Test Result:	The above-mentioned product has been tested with compliance.		

Tested by: W. J. Yun.
/ Engineer

Signature Date Oct 23, 2018

Approved by: S. H. Song
/ Technical Manager

Signature Date Oct 23, 2018

Other Aspects:	
Abbreviations:	* OK, Pass=passed * Fail=failed * N/A=not applicable

- ☞ - This test report is not permitted to copy partly without our permission.
- This test result is dependent on only equipment to be used.
- This test result is based on a single evaluation of one sample of the above mentioned.
- We certify this test report has been based on the measurement standards that is traceable to the national or international standards



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1. Verification of compliance

Applicant : Pium

Address : 100 OLD PALISADE RD Unit 3610, FORT LEE, NJ 07024

FCC ID : 2ARWJ-P3001

Model Name : P3001

Brand Name : Pium Diffuser

Serial Number : N/A

Test Date : Oct 10, 2018

Equipment Class	DXC – Low Power Communication Device Transmitter
Kind of Equipment	RFID
Measurement Procedures	ANSI C63.10-2013
Type of Equipment Tested	Pre-Production
Kind of Equipment Authorization Requested	Certification
Equipment Will Be Operated Under FCC Rules Part(s)	FCC PART 15, Class C
Modifications On The Equipment To Achieve Compliance	None
Final Test was Conducted On	10m Open area test site

- The device is equipped with a Wi-Fi / Bluetooth module and is FCC-certified.

(2AC7Z-ESPWROOM32D)

- The above equipment was tested by Korea Technology Institute Co., Ltd. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanation from equipment are within the compliance requirements.



2. General Information

2.1 Product Description

P3001 (referred to in this report as EUT) is used as a Air Refreshener

The product specification described herein was obtained from product data sheet or user's manual.

Equipment Name	Air Refreshener
Operating Frequency	802.11 / Bluetooth: 2402 MHz ~ 2480 MHz RFID: 13.56 MHz
Frequency Type	RFID: F1D Bluetooth :GFSK 802.11b/g/n(HT20/HT40): DSSS, OFDM
List of Each OSC. Or Crystal. Freq.	32 MHz
Rated Supply Voltage	DC 12 V
Operating Environment Temperature	-20 °C ~ 65 °C

3. Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 13.56 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is "XZ" axis, but the worst data was recorded in this report.



4.Configuration of Test System

4.1 Radiated Emission Test

Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10-2013 to determine the worse operating conditions.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

4.2 Antenna Requirement

For intentional device, according to section 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.



5. Test Summary

5.1 Test Items and results

SECTION	TEST ITEMS	RESULT
15.203	Antenna Requirement	Pass
15.209 & 15.205	Conducted Emissions	Pass
	Radiated Emissions Field strength 9 kHz to 30 MHz	Pass
	Radiated Emissions Field strength 30 MHz to 1000 MHz	Pass
15.225(a),(b),(c)&(d)	Spectrum mask and Occupied bandwidth	Pass
15.225(e)	Frequency Tolerance of the Carrier Signal	Pass

Notes: - According to the Section 15.33(b)(1)&(c), Radiated Emissions & Conducted Emissions were reported in Report

- The device is equipped with a Wi-Fi / Bluetooth module and is FCC-certified.
(2AC7Z-ESPWROOM32D)

N/A : The test was not applicable in the standard.

5.2 Additions, deviations, exclusions from standard

No additions, deviations or exclusions have been made from standard.

5.3 Related Submittal(s) / Grant(s)

Original submittal only

5.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in section 2.1.

5.5 Test Methodology

The radiated testing was performed according to the procedures in ANSI C63.4 : 2014 at a distance of 3 m from EUT to the antenna

5.6 Test Facility

The open area test site and conducted measurement facilities are located on at 51-19, Sanglim-3ri, Docheok-Myun, Gwangju-Shi, Kyeongki-Do, Korea



6. System test Configuration

6.1 Characteristics of equipment

This is a RFID, WIFI, Bluetooth device.

Frequency band is 13.56 Mhz, 2 402 Mhz - 2 480 Mhz Power source is supplied 12 Vdc.

6.2 Used Peripherals list

DEVICE TYPE	Manufacturer	Model	S/N

6.3 List of Test and Measurement Equipment

Test equipment used

Kind of Equipment	Type	S/N	Next Cal
Constant temp & humid chamber	KPCT800	DX-9	2018.12.21
Fiel Strength Meter	ESCI	100025	2018.11.02
Spectrum Analyzer	E4440A	US40420682	2019.07.12
LISN	AFJ LS16C	16011328326	2018.12.06
LISN	ESH2-Z5	100017	2019.07.23
RECEIVER	ESIB40	100093	2019.07.16
RECEIVER	ESCI	100025	2019.11.06
Biconic Logarithmic Periodic Antenna	VULB9163	9163-281	2018.11.21
Horn Antenna	KTI-HD-1080	130001	2018.11.14
Loop Antenna	6502	3434	2018.11.07
PREAMPLIFIER	8449B	3008A02104	2019.08.09
Attenuator	8498A	2702A05499	2019.05.02
Attenuator	47-10-34	BD1402	2018.10.24
DC Power Supply	E3634A	MY40000983	2019.04.05
EMC Cable(Rad, 1G,N-N)	N/A	N/A	-
EMC Cable(Rad,1-6G,N-N)	N/A	N/A	-
EMC Cable(Con,N-N)	N/A	N/A	-
RF Cable(N to SMA)	N/A	N/A	-
TURNTABLE	N/A	N/A	-
Antenna Mast	K401	K100	-



6.3 Uncertainty

- Radiated Emissions from 30 MHz to 6000 MHz

Expanded Uncertainty

$$U = k \times U_c(x_i) = 2 \times 2.61 = \pm 5.22 \text{ dB (for 30 MHz to 1000 MHz)}$$

$$U = k \times U_c(x_i) = 2 \times 2.53 = \pm 5.06 \text{ dB (for 1000 MHz to 6000 MHz)}$$

The coverage factor $k=2$ yields approximately a 95 % level of confidence.

- Conducted emissions from 150 kHz to 30 MHz

Expanded uncertainty

$$U = k \times U_c(x_i) = 2 \times 1.40 = \pm 2.8 \text{ dB}$$

The coverage factor $k=2$ yields approximately a 95 % level of confidence..

6.4 Test setup of EUT





7. Measurement results

7.1 Radiated Emissions

FCC 47CFR15 – 15.209

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength limit (uV/m)	Field strength limit (dBuV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	48.5-13.8	300
0.490 – 1.705	24000/F(kHz)	33.8-23.0	30
1.705 – 30.0	30	29.5	30
30 – 88	100	40.0	3
88 – 216	150	43.5	3
216 – 960	200	46.0	3
Above 960	500	54.0	3

- Measurement Procedure

Radiated Emissions Test, 9kHz to 30MHz (Magnetic Field Test)

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions at a distance of 3 meters according to Section 15.31(f)(2).
2. The EUT was placed on the top of the 0.8-meter height, 1 x 1.5 meter non-metallic table.
3. Emissions from the EUT are maximized by adjusting the orientation of the Loop antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions if applicable.
4. To obtain the final measurement data, each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector with specified bandwidth.



Radiated Emissions Test, 30 MHz to 1000 MHz

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 x 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1000 MHz using the Biconical and Logperiodue broadband antenna,
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 x 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
6. The presence of ambient signals was verified by turning the EUT off. In case an ambient signal was detected, the measurement bandwidth was reduced temporarily and verification was made that an additional adjacent peak did not exist. This ensures that the ambient signal does not hide any emissions from the EUT

5.2.2.3 Calculation of the field strength limits below 30 MHz

1. No special calculation for obtaining the field strength in dBuV/m is necessary, because the EMI receiver and the active loop antenna operate as a system, where the reading gives directly the field strength result (dBuV/m). The antenna factors and cable losses are already taken into consideration.
2. For test distance other than what is specified, but fulfilling the requirements of section 15.31 (f)(2) the field strength is calculated by adding additionally an extrapolation factor of 40dB/decade (inverse linear distance for field strength measurements).
3. All following emission measurements were performed using the test receiver's average, peak, and quasi-peak detector function with specified bandwidth.



7.1.1 Test Results

Test Data, Fundamental Frequency (Ver / Hor)

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Cable Loss	Ant. Factor	Total (dBμV/m)	Limits (dBμV/m)
13.56	32.70	Peak	H	1.11	9.49	43.3	69.50
13.56	49.30	Peak	V	1.11	9.49	59.9	69.50

Test Data, Radiated Emission below 30 MHz

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Cable Loss	Ant. Factor	Total (dBμV/m)	Limits (dBμV/m)
12.57	15.4	Peak	H	1.06	9.59	15.4	69.50
13.22	21.1	Peak	H	1.10	9.53	21.1	69.50
13.45	30.1	Peak	H	1.11	9.51	30.1	69.50
13.66	25.5	Peak	V	1.11	9.48	25.5	69.50
13.84	20.9	Peak	V	1.11	9.47	20.9	69.50
14.51	12.2	Peak	V	1.10	9.4	12.2	69.50

Test Data, Radiated Emission above 30 MHz

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Cable Loss	Ant. Factor	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)
42.84	16.75	Peak	H	1.38	13.58	27.64	4.08	40.0
132.00	29.33	Peak	H	2.45	8.28	27.59	12.46	43.5
379.68	26.74	Peak	H	4.22	15.32	28.01	18.27	46.0
60.00	24.73	Peak	V	1.69	12.42	27.62	11.21	40.0
135.64	50.05	Peak	V	2.49	8.08	27.59	33.02	43.5
460.92	27.10	Peak	V	4.73	16.93	28.11	20.65	46.0

Margin (dB) = Limit – Actual

[Actual = FS + AF + CL]

- 1. H = Horizontal, V = Vertical Polarization
- 2. AF/CL = Antenna Factor and Cable Loss
- 3. FS = RA + DF

Where FS = Field strength in dBuV/m, RA = Receiver Amplitude in dBuV/m,

DF = Distance Extrapolation Factor in dB



7.2 Spectrum mask and Occupied bandwidth

FCC 47CFR15 – 15.225

- (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
- (b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- (c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

Frequency (MHz)	Field strength limit (uV/m) @ 30m	Field strength limit (dBuV/m) @ 30m	Field strength limit (dBuV/m) @ 3m
13.110 – 13.410	106	40.5	80.5
13.410 – 13.553	334	50.5	90.5
13.553 – 13.567	15,848	84.0	124.0
13.567 – 13.710	334	50.5	90.5
13.710 – 14.010	106	40.5	80.5

Spectrum Mask

1. Place the EUT in the test fixture and switch it on
2. Use the following spectrum analyzer settings: RBW = VBW =1 kHz, Span = wide enough to capture the whole 13 MHz band including the frequency ranges where the 15.209 limit applies, Trace mode = Max Hold, select the limit line 15.225(a),(b),(c)
3. After trace stabilization, set the marker to the single peak.
4. The reference level will be calculated by the amount of the margin of the wanted signal to its 30 m emission limit plus marker value.
5. The whole signal trace has to be below the limit line.

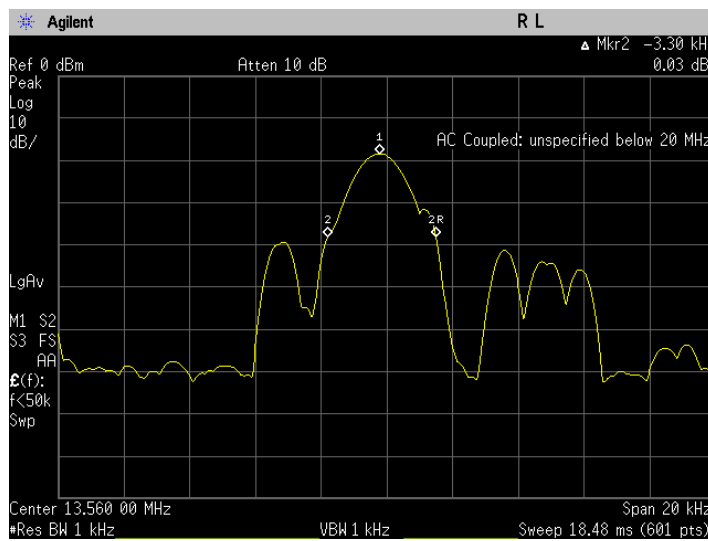


Occupied Bandwidth

1. Place the EUT in the test fixture and switch it on.
2. Use the following spectrum analyzer settings: RBW = VBW = 1 kHz, Span = wide enough to capture the 20 dB bandwidth, Trace mode = Max Hold.
3. After trace stabilization, set the first marker and the first display line to the signal peak. Set the second display line 20 dB below the first display line. The Second marker and its delta marker shall be set to cross point of the spectrum line and the second display line and note these frequencies.
4. Alternatively the 20 dB down function of the analyzer could be used, if this function will be applicable to the displayed spectrum.

5.3.3 Test Results

Frequency Band
3.3 kHz





7.3 FREQUENCY TOLERANCE OF CARRIER SIGNAL

FCC 47CFR15 – 15.225(e)

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery-operated equipment, the equipment tests shall be performed using a new battery.

5.4.2 Measurement Procedure

Frequency stability versus environmental temperature

1. Supply the EUT with nominal DC voltage.
2. Turn the EUT off, and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.
3. RF output was connected to a frequency counter or other frequency-measuring instrument via feed through attenuators.
4. Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.
5. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized.
6. After all measurements have been made at the highest specified temperature turn the EUT off.
7. Repeat the above measurement process for the EUT with the test chamber set at the appropriate temperature.

Frequency Stability versus Input Voltage

1. At temperature ($20 \pm 5^{\circ}\text{C}$), supply the EUT with nominal DC voltage.
2. Couple RF output to a frequency counter or other frequency-measuring instrument.
3. Turn the EUT on, and measure the EUT operating frequency at startup and two, five, and ten minutes after startup.
4. Supply it with 85% of the nominal DC voltage and repeat above procedure.
5. Supply it with 115% of the nominal DC voltage and repeat above procedure.



Test Results

TEST MODE : TX on

Test Data, Frequency Tolerance of carrier signal

Reference Frequency : 13.56 MHz, LIMIT : within ±1356 Hz

Environment Temperature [°C]	Power Supplied [V _{DC}]	Carrier Frequency Measured with Time Elapsed							
		STARTUP		2 minutes		5 minutes		10 minutes	
		[MHz]	Err[Hz]	[MHz]	Err[Hz]	[MHz]	Err[Hz]	[MHz]	Err[Hz]
+50	12	13.559829	-171	13.559834	-166	13.559823	-177	13.559829	-171
+40	12	13.559837	-163	13.559833	-167	13.559841	-159	13.559830	-170
+30	12	13.559846	-154	13.559839	-161	13.559843	-157	13.559834	-166
+20	12	13.559840	-160	13.559846	-154	13.559851	-149	13.559849	-151
+10	12	13.559844	-156	13.559834	-166	13.559859	-141	13.559846	-154
0	12	13.559850	-150	13.559843	-157	13.559849	-151	13.559854	-146
-10	12	13.559847	-153	13.559844	-156	13.559845	-155	13.559850	-150
-20	12	13.559843	-157	13.559845	-155	13.559839	-161	13.559843	-157

Reference Frequency : 13.56 MHz, LIMIT : within ±1356 Hz

Power Supplied [V _{AC}]	Carrier Frequency Measured with Time Elapsed							
	STARTUP		2 minutes		5 minutes		10 minutes	
	[MHz]	Err[Hz]	[MHz]	Err[Hz]	[MHz]	Err[Hz]	[MHz]	Err[Hz]
85 %	13.559847	-153	13.559848	-152	13.559852	-148	13.559853	-147
100 %	13.559834	-166	13.559843	-157	13.559847	-153	13.559842	-158
115 %	13.559839	-161	13.559847	-153	13.559844	-156	13.559846	-154

Err[Hz] = Measured carrier frequency (MHz) – Reference Frequency (13.56 MHz)



7.4 Conducted Emissions

Test set-up for radiated measurement

AC power line conducted emissions from the EUT were measured according to the dictates ANSI C63.4:2014.

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold.

While the measurement, EUT had its hopping function disabled at the middle channels in line with Section 15.31(m).

Measurement Data

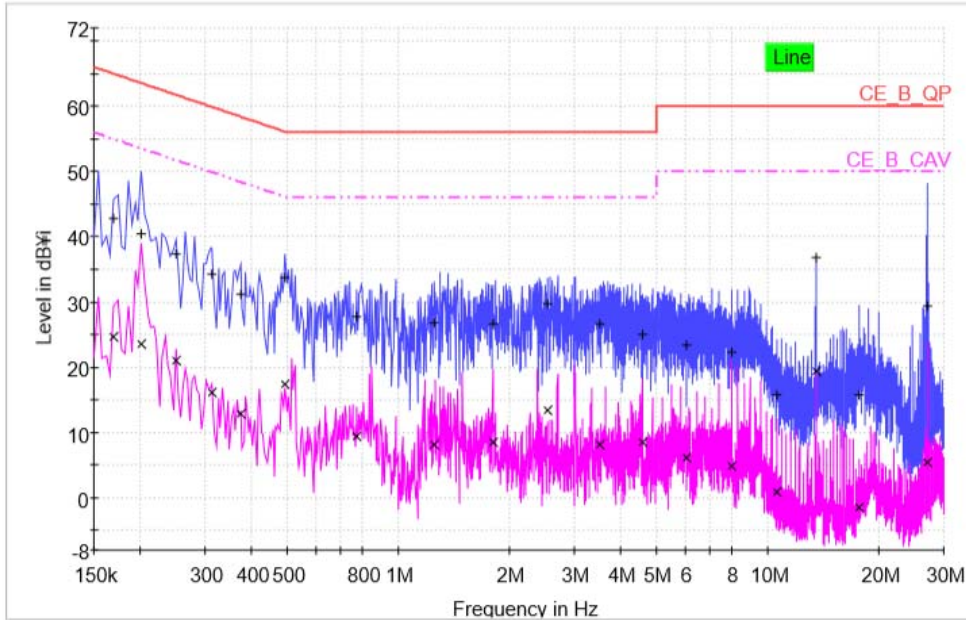
Frequency (MHz)	(1) Reading (dBµV)		Line	(2) Limit (dBµV)		(3) Margin (B)	
	QP	AV		QP	AV	QP	AV
0.17	42.7	24.7	L1	65.0	55.0	22.3	30.3
1.80	26.7	8.5	L1	56.0	46.0	29.3	37.5
17.65	15.7	-1.4	L1	60.0	50.0	44.3	51.4
0.16	42.2	19.7	L2	65.4	55.4	23.1	35.7
1.89	22.8	6.0	L2	56.0	46.0	33.2	40.0
19.99	14.1	1.4	L2	60.0	50.0	45.9	48.6

NOTES:

1. All modes of operation were investigated and the worst-case emissions are reported.
2. All other emissions are non-significant.
3. All readings are calibrated by self-mode in receiver.
4. Measurements using CISPR quasi-peak mode.
5. L1 = LINE-PE, L2 = NEUTRAL-PE
6. The limit for Class B digital device is 66dBuV to 56dBuV from 150KHz to 500KHz, 56dBuV from 500KHz to 5MHz, 60dBuV Above 5MHz.



Line



Neutral

