Electromagnetic Emission

F C C M E A S U R E M E N T R E P O R T

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	REMOTE RADAR
MODEL/TYPE NO	:	RL360 / Proto-type
FCC ID	:	W75-RL-RCU
BRAND NAME	:	CALIBRE
APPLICANT	:	ATTOWAVE CO., LTD. 1005, 10F Leader's Tower, 60-15 Gasan-dong, Gumchun-gu, Seoul, 153-801 Korea Attn. : Hyun Joo, Cho / Director
MANUFACTURER	:	ATTOWAVE CO., LTD. 1005, 10F Leader's Tower, 60-15 Gasan-dong, Gumchun-gu, Seoul, 153-801 Korea
FCC CLASSIFICATION	:	DSC : Part 15 Security/Remote Control Transmitter
FCC RULE PART(S)	:	FCC Title 47, Part 15 Subpart C
FCC PROCEDURE	:	ANSI C63.4-2003
TEST REPORT No.	:	ETLE100607.0124
DATES OF TEST	:	June 23, 2010 to June 24, 2010
REPORT ISSUE DATE	:	July 02, 2010
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

This is REMOTE RADAR, Model RL360 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2003 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.231.
I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.
The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Hyung Seok, Lee / Chief Engineer

ETL Inc.
#371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
Tel: 82-2-858-0786 Fax: 82-2-858-0788

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FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission(EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name : ATTOWAVE CO., LTD.

Address : 1005, 10F Leader's Tower, 60-15 Gasan-dong, Gumchun-gu, Seoul, 153-801 Korea

Attention : Hyun Joo, Cho / Director

- **EUT Type :** REMOTE RADAR
- **Model Number :** RL360
- **FCC ID :** W75-RL-RCU
- **S/N :** Proto-type
- **Freq. Range :** 433.92 MHz
- **FCC Rule Part(s) :** FCC Part 15 Subpart C section 15.231
- **Test Procedure :** ANSI C63.4-2003
- **FCC Classification :** DSC: Part 15 Security/Remote Control Transmitter
- **Dates of Tests :** June 23, 2010 to June 24, 2010
- **Place of Tests :** ETL Inc. Testing Lab.

  Radiated Emission test;
  #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,
  Gyeonggi-do, 445-882, Korea

  Conducted Emission test;
  ETL Inc. Testing Lab.
  371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
- **Test Report No. :** ETLE100607.0124

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1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2003 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.4-2003 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) was used in determining radiated and conducted emissions from the ATTOWAVE CO., LTD. Model: RL360

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2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the REMOTE RADAR, Model: RL360

2.2 General Specification

- Carrier Frequencies: 433.92 MHz (Single Channel)
- Frequency Stabilization Scheme: High-Q SAW Resonator Stabilization
- Modulation Method: Amplitude Shift Keying (By Carrier ON/OFF)
- Bit Duration: “1” - 2.25 msec / “0” - 1.125 msec
- Operating Temperature Range: -10 ℃ to +80 ℃
- Storage Temperature Range: -20 ℃ to +90 ℃
- Power Requirements: 3 V CR2032-type Li-Battery

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3. DESCRIPTION OF TESTS

3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.4-2003 "Measurement of Intentional radiators" The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site at 3 m. The test equipment was laced on a wooden turn-table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The detector function was set to CISPR Quasi-peak mode and the bandwidth of the receiver was set to 120 kHz or 1 MHz depending on the frequency of type of signal. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0,8 m high nonmetallic 1m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

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3.2 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1]Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

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4. TEST CONDITION

4.1 Test Configuration

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the EUT and the supported equipments were installed to meet FCC requirement and operated in a manner and which tends to maximize its emission level in a typical application.

4.2 EUT operation

The EUT was connected as user's guide. And during the test executed EUT is operating on the following

- Function of transmitter
The EUT (model: RL360) has been tested under operating condition.
Fixed Channel (433.92 MHz) was chosen for testing.

4.3 Support Equipment Used

Description	Model Name	Serial No.	Manufacturer
-	-	-	-

4.4 Type of Cables Used

Device from	Device to	Type of I/O port	Length[m]	Type of shield
-	-	-	-	-

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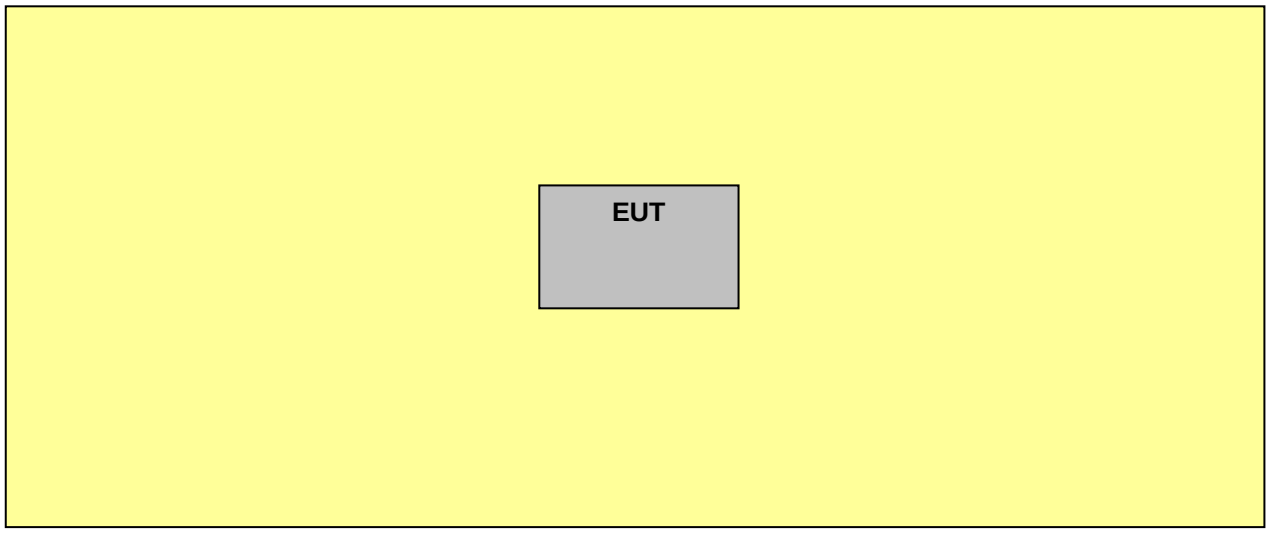
4.5 The setup drawing(s)



——————— : Data Line

▪▪▪▪▪▪▪▪▪▪▪▪▪▪▪ : DC Power Line

▬▬▬▬▬▬▬▬▬ : AC Power Line

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5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

Applied Standard : 47 CFR Part 15, Subpart C			
FCC Rule	**Measurement Required**	**Result**	**Remarks**
15.207(a)	Power line Conducted Emissions	**N/A**	**1)**
15.231(a)(1)	Manually operated transmitter	**Pass**	
15.231(a)(2)	Automatically activated transmitter	**Pass**	
15.231(a)(3)	Periodic transmissions at regular predetermined intervals	**Pass**	
15.231(a)(4)	Radiators used in cases of emergency	**Pass**	
15.231(a)(5)	Set-up information for security systems	**Pass**	
15.209(a),231(b)	Radiated Emissions	**Pass**	
15.231(c)	20 dB Bandwidth	**Pass**	
15.231(d)	Devices operating within the frequency band 40.66 MHz - 40.70 MHz	**N/A**	**2)**
15.231(e)	Radiated emissions for Periodic radiators	**N/A**	

Notes:
1) The EUT is powered by DC power supply that uses battery only.
2) The frequency range of EUT is 433.92 MHz fixed.

The data collected shows that the **ATTOWAVE CO., LTD. / REMOTE RADAR / RL360** complied with technical requirements of above rules part 15.209 and 15.231 limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

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5.2 20 dB Bandwidth

EUT	REMOTE RADAR / RL360
Limit apply to	FCC Part 15. 231(c)
Test Date	June 23, 2010
Operating Condition	Continues transmitter (433.92 MHz)
Result	Passed

Limit

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Test Data

Center Frequency [MHz]	Measured occupied bandwidth [MHz]	Limit [MHz]	Result
433.92	0.275	1.085 (0.25%)	Pass

NOTES:

1. **Please see the measured bandwidth plot in next page.**
2. **The bandwidth is determined at the points 20 dB down from the modulated carrier.**

Test Engineer: Hoon Pyo, Lee

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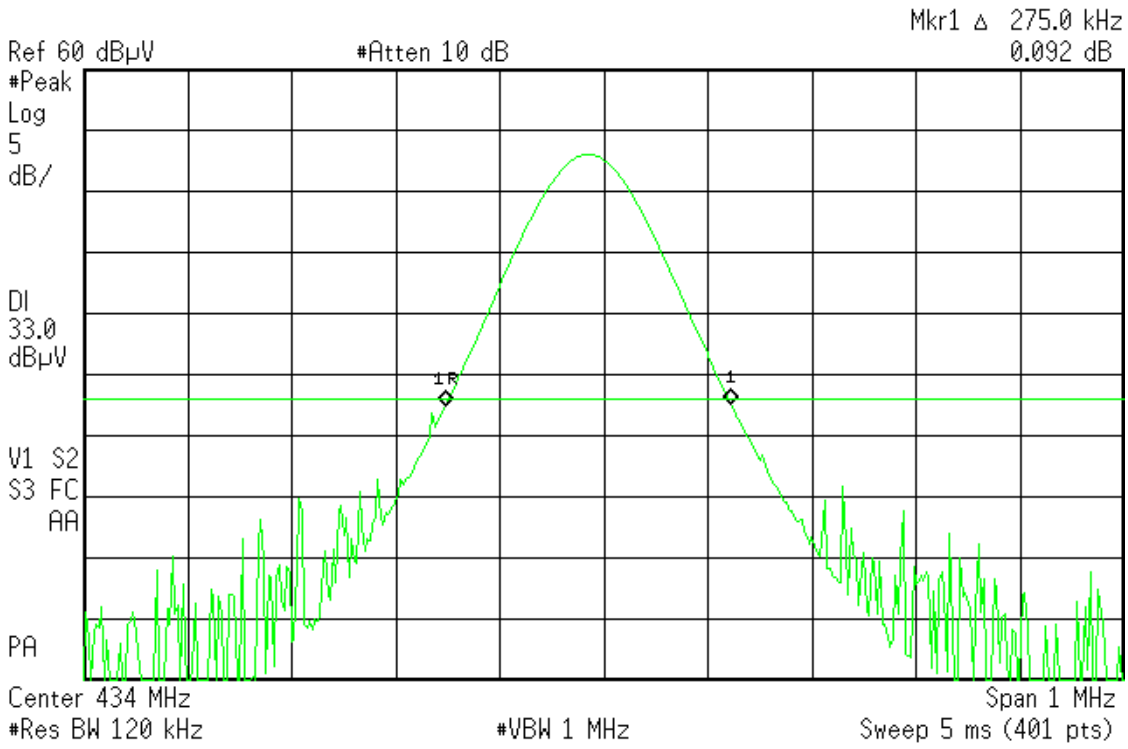
20 dB Bandwidth



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5.3 Radiated Emissions for Periodic radiators

EUT	REMOTE RADAR / RL360
Limit apply to	FCC Part 15. 209(a) & 15.231(b)
Test Date	June 24, 2010
Operating Condition	Continues transmitter (433.92 MHz)
Result	Passed

Part 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:

Frequencies [MHz]	Field Strength [μV/m]	Measurement Distance [m]
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

Part 15.231(b) In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency [MHz]	Field Strength of Fundamental [microvolts/meter]	Field Strength of Spurious Emission [microvolts/meter]
40.66 - 40.70	2 250	225
70 - 130	1 250	125
130 - 174	1 250 to 3 750**	125 to 375**
174 - 260	3 750	375
260 - 470	3 750to 12 500**	375 to 1 250**
Above 470	12 500	1 250

** linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, uV/m at 3 meters = 56,81818(F) - 6 136,3636; for the band 260-470 MHz, uV/m at 3 meters = 41,6667(F) - 7 083,3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]

Fundamental: uV/m at 3 meters = 41.6667(433.92) - 7 083.3333 = 10 996.681 = 20log*10 996.681
= 80.83 dB(μV/m)
Spurious emissions: uV/m at 3 meters = 20 dB below of fundamental level
= 60.83 dB(μV/m)

Test Results
- Refer to see the measured plot in next page.

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5.3.1 Radiated Emissions Data

9 kHz to 30 MHz

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi – Peak mode (100 Hz, 9 kHz)

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
	Emission attenuated more than 20 dB below the limit are not reported.						

Result: All emissions below noise floor of 20 dBμV/m

NOTES:

1. *** H : Horizontal polarization , ** V : Vertical polarization**
2. **Result = Reading + Antenna factor + Cable loss**
3. **Margin value = Limit - Result**
4. **The measurement was performed for the frequency range 9 kHz to 30 MHz according to FCC Part 15.209.**

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30 MHz to 4.4 GHz

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: Quasi-Peak mode (RBW: 120 kHz) below 1 GHz
Peak or AV mode (RBW: 1 MHz) above 1 GHz

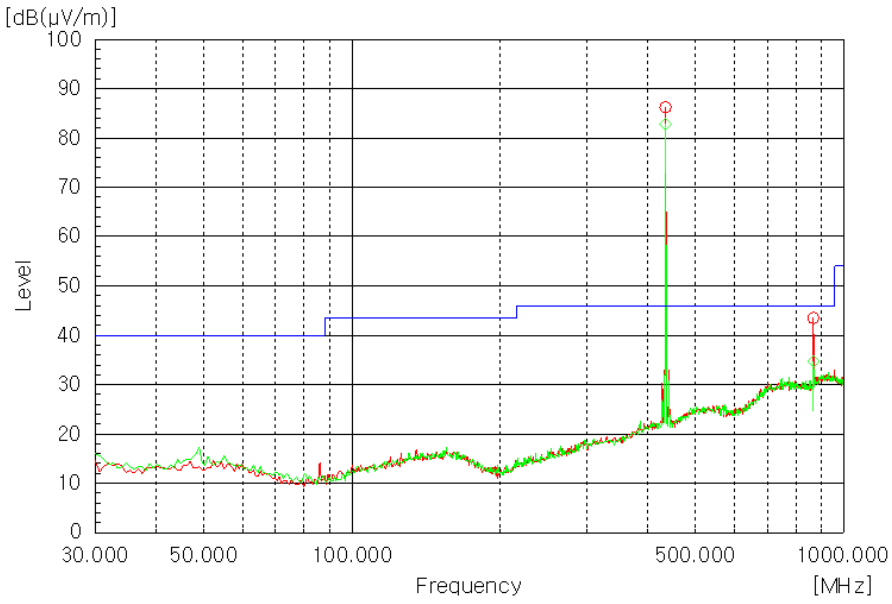
Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
	Emission attenuated more than 20 dB below the limit are not reported.						

Result: All emissions below noise floor of 20 dBμV/m

NOTES:

1. *** H : Horizontal polarization , ** V : Vertical polarization**
2. **Result = Reading + Antenna factor + Cable loss**
3. **Margin value = Limit – Result**
4. **Results found to be 20dB or greater under the limit have not been included.**
5. **The measurement was performed for the frequency range 30 MHz – 4.4 GHz according to the FCC Part 15.209(a)**

Test Engineer: Hoon Pyo, Lee



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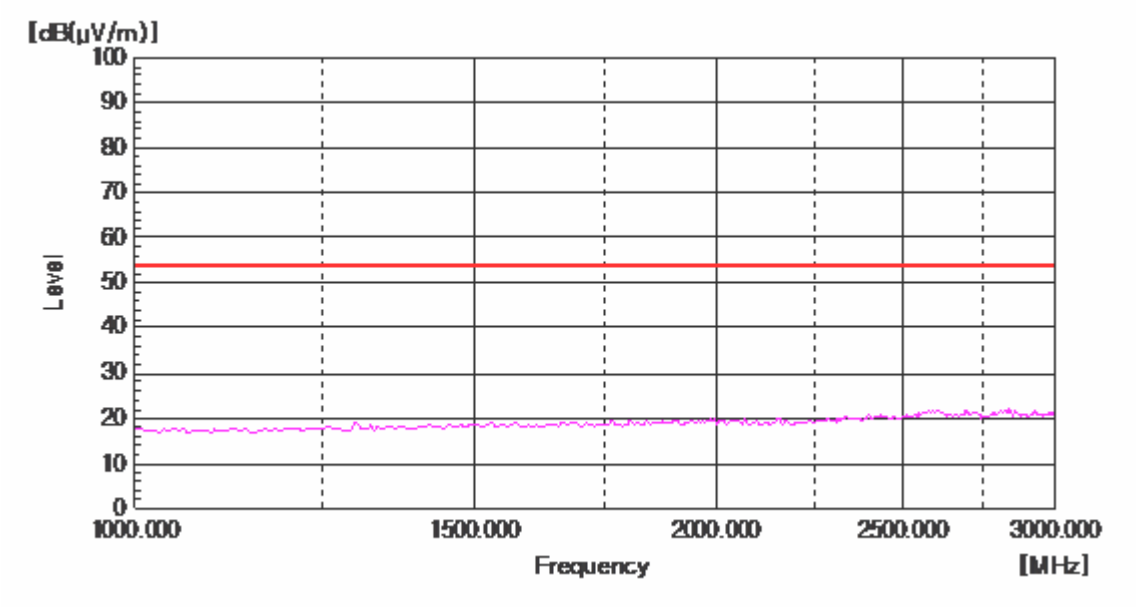

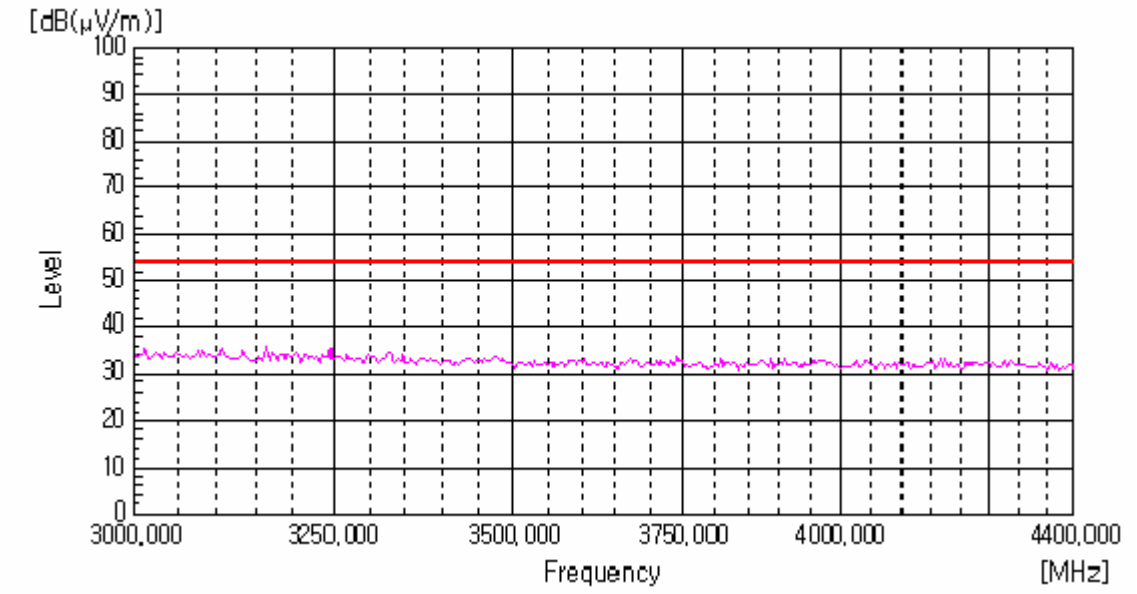

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5.3.2 Field Strength of Fundamental

Peak Mode Test Data

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
433.92	64.64	H	16.02	5.64	86.30	100.83	14.53

Average Mode Test Data

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Duty Cycle Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
433.92	64.64	H	16.02	5.64	-21.33	64.97	80.83	15.86

5.3.3 Spurious Emissions Data

Peak Mode Test Data

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
867.90	12.49	V	23.20	8.51	43.20	80.83	36.63
Other frequencies	-	–	-	-	-	-	-

Average Mode Test Data

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Duty Cycle Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
867.90	12.49	V	23.20	8.51	-21.33	21.87	60.83	38.96
Other frequencies	-	–	-	-	-	-	-	-

Result: No signal detect emissions above 1 GHz

NOTES:

1. **The test was searched from 30 MHz to the 10th Harmonic.(30MHz – 4.4GHz)**
2. **Average level = Peak level + Duty factor.**

Test Engineer : Hoon Pyo, Lee

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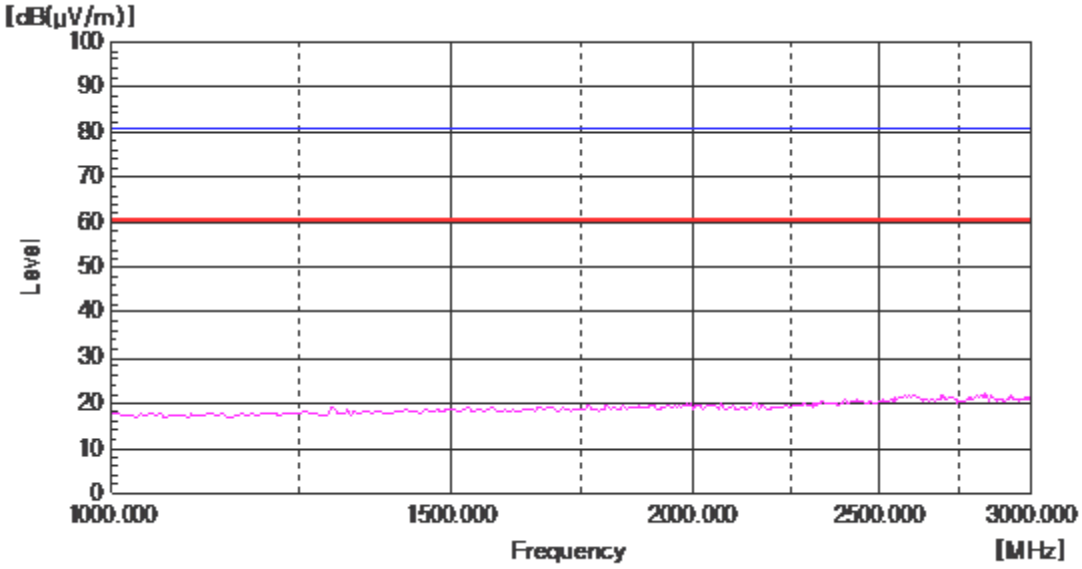
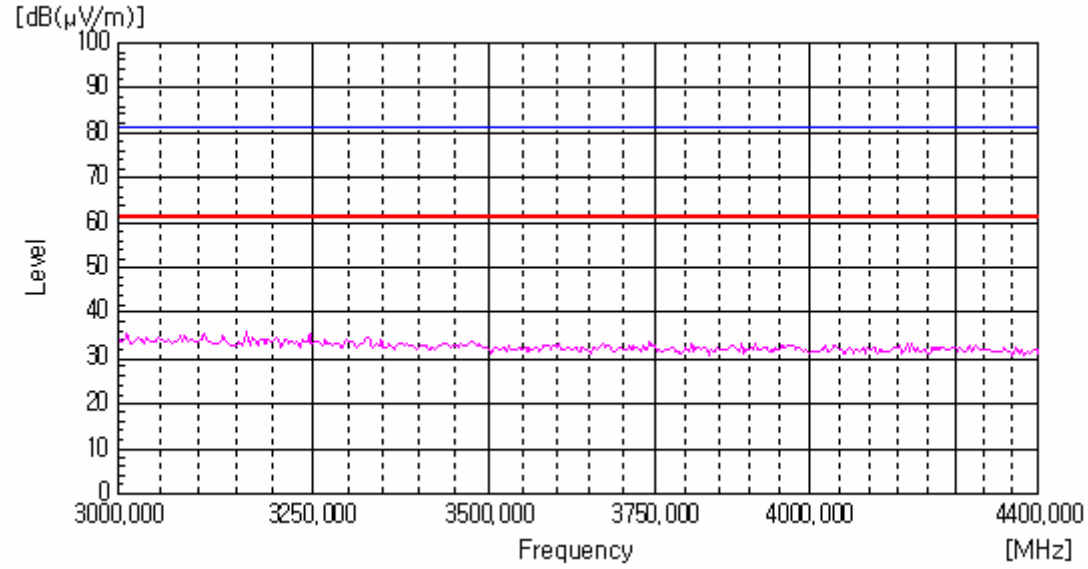
Peak Limit Line
AV Limit Line

Final data Peak





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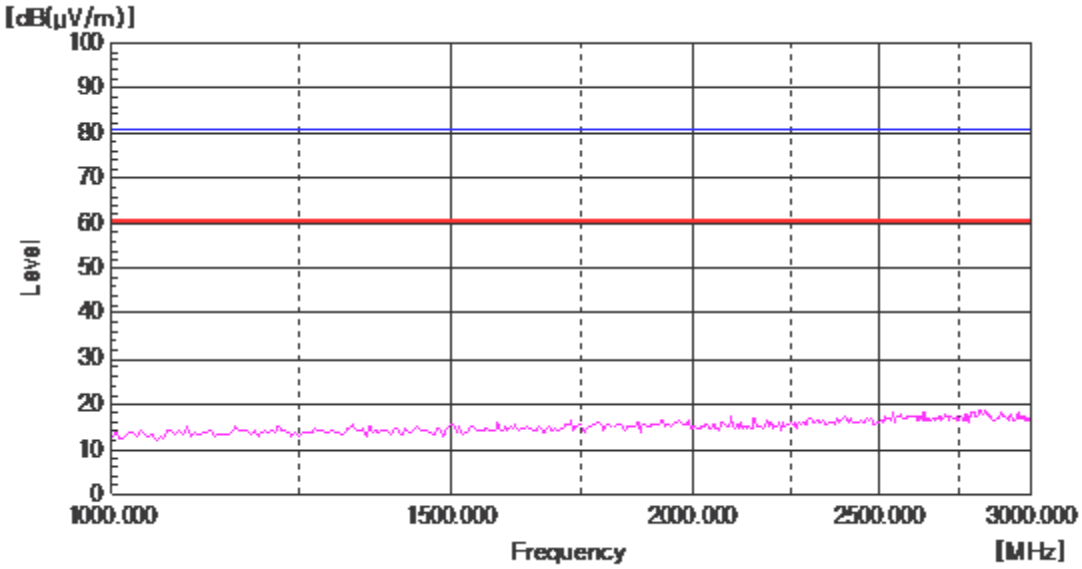
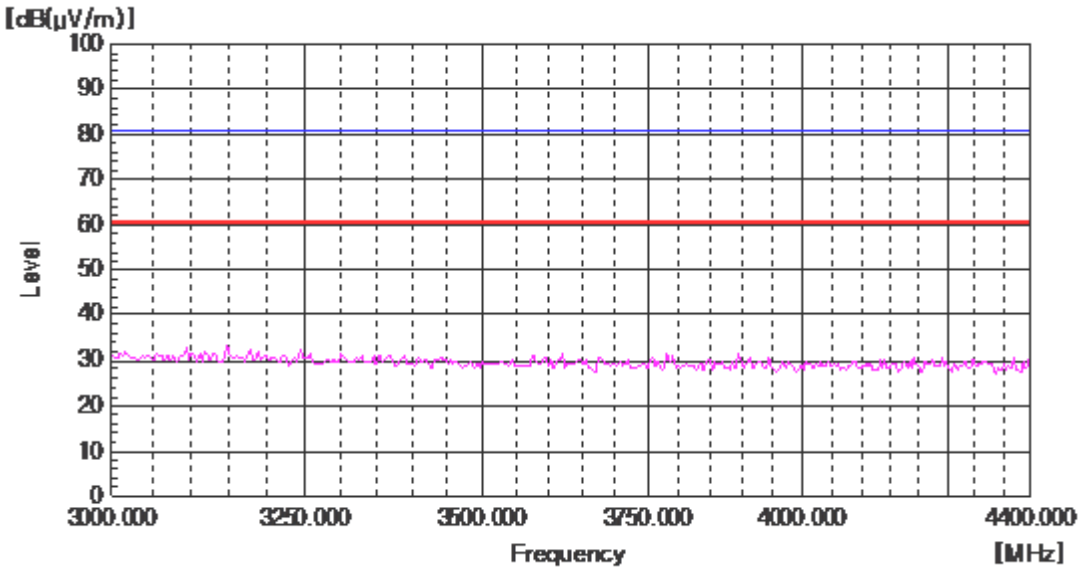
Peak Limit Line
AV Limit Line

Final data AV





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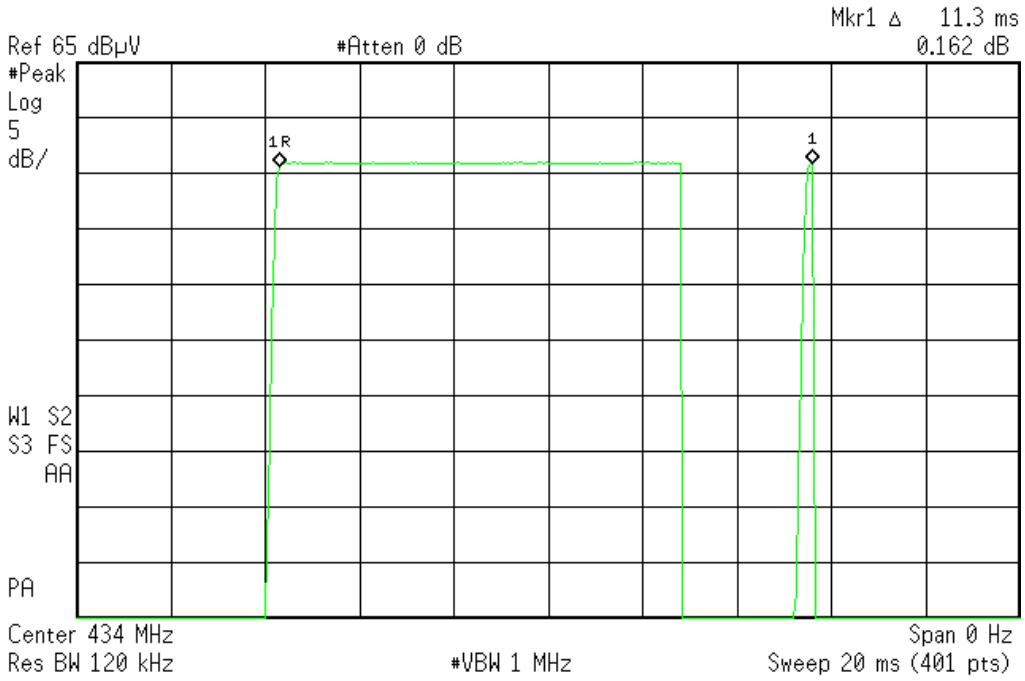
5.4 Periodic Operation Measurement Plot

TX on time = 11.30 ms

Limit(s) = 5 s

Result ■ Pass ☐ Fail



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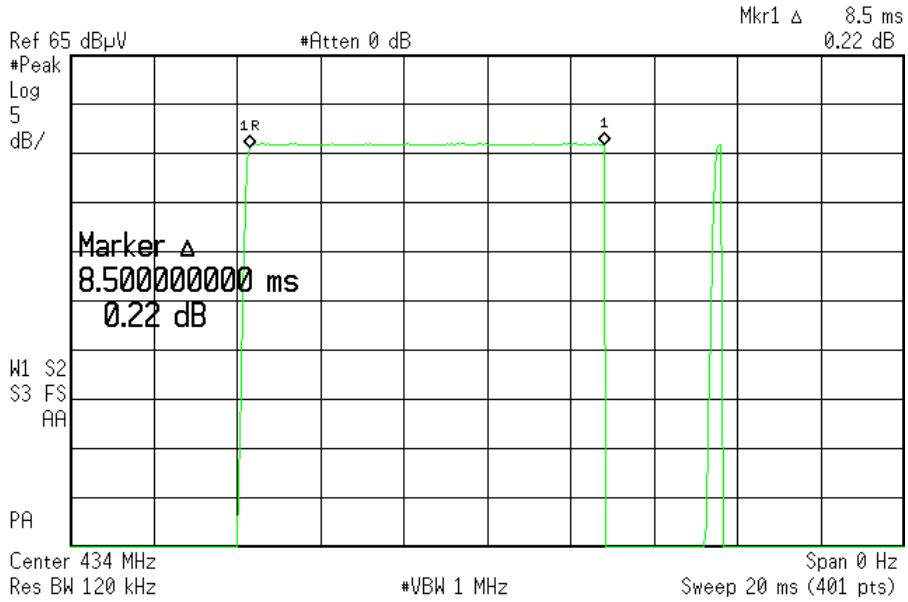
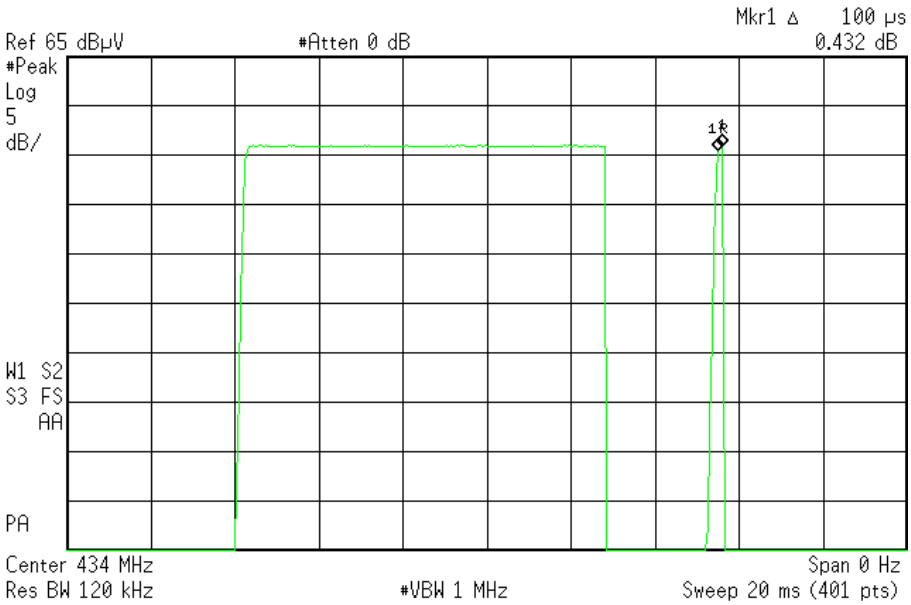
5.4.1 Duty cycle

Calculation;
Duty cycle factor = 20log (on time/period)
20log (8.6 ms/100.0 ms) = -21.33 dB

On time = 8.5 ms + 0.1 ms = 8.6 ms
Period = 100.0 ms





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6. SAMPLE CALCULATION

Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.
The basic equation with a sample calculation is as follows:

FS = RA + AF + CF

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor

$dB(\mu V) = 20 \log_{10} (\mu V)$
$dB\mu V = dBm + 107$

Example : @ 433.92 MHz

Limit = 100.83 dB(μV/m)

Reading = 64.64 dB(μV)

Antenna Factor + Cable Loss = 16.02 + 5.64 = 21.66 dB(μV/m)

Total = 86.30 dB(μV/m)

Margin = 100.83 – 86.30 = 14.53 dB

= 14.53 dB below Limit

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7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Due Date
☒	Spectrum Analyzer	E7405A	H.P.	US41160290	10.09.18
☒	EMI TEST Receiver	ESVS10	R & S	835165/001	11.04.02
☒	Horn Antenna	BBHA 9120D	Schwarzbeck	227	11.03.16
☒	LogBicon Antenna	VULB9165	Schwarzbeck	3082	11.01.25
☒	Loop Antenna	Com-Power	AL-130	17100	11.03.02
☒	Preamplifier	8348A	H.P.	3307A02865	10.09.17
☒	System Power Supply	6030A	Agilent	1036546	11.04.02
☒	Controller	HD2000	HD GmbH	C/125	N/A
☒	Antenna Master	MA2400	HD GmbH	N/A	N/A
☒	Turn-Table	MFT-120S	Max-Full Antenna Corp	N/A	N/A
☒	Antenna Master	MFA-440E	Max-Full Antenna Corp	N/A	N/A

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