

RF TEST REPORT

Test item : UHF RFID Reader
Model No. : AT287-UHF
Order No. : DEMC1212-02951
Date of receipt : 2012-12-17
Test duration : 2013-01-10 ~ 2013-01-15
Date of issue : 2013-04-30
Use of report : FCC Original Grant

Applicant : ATID Co., Ltd.
#1210 Byuksan/Gyungin digital valley II #481-10Gasam-Dong,
Gumchon-Gu, Seoul 153-803, Korea

Test laboratory : Digital EMC Co., Ltd.
683-3, Yubang-Dong, Cheoin-Gu, Yongin-Si, Kyunggi-Do, 449-080, Korea

Test specification : FCC Part 15 Subpart C 247
Test environment : See appended test report
Test result : Pass Fail

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DIGITAL EMC CO., LTD.

Tested by:

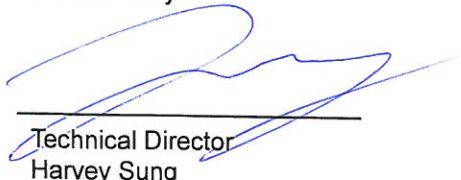


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Witnessed by:

N/A

Reviewed by:



Technical Director
Harvey Sung

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1. General Information

1.1 Testing Laboratory

Digital EMC Co., Ltd.

683-3, Yubang-Dong, Cheoin-Gu, Yongin-Si, Kyunggi-Do, 449-080, Korea

www.digitalemc.com

Telephone : + 82-31-321-2664

FAX : + 82-31-321-1664

1.2 Details of Applicant

Applicant : ATID Co., Ltd.

Address : #1210 Byuksan/Gyungin digital valley II #481-10Gasam-Dong,
Gumchon-Gu, Seoul 153-803, Korea

Contact person : Nam-Jung, Kim

Phone No. : +82-2-522-1436

1.3 Description of EUT

Product	UHF RFID Reader
Model Name	AT287-UHF
Serial Number	Identical prototype
Power Supply	DC 3.7 V
Frequency Range	902.75 ~ 927.25 MHz
Modulation Technique	A1D
Number of Channels	50(Channel Spacing 500kHz)
Antenna Type	Patch Antenna
Antenna Gain	Max. PK -0.35 dBi

1.4. Declaration by the manufacturer

- N/A

1.6. Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	E4440A	12/09/18	13/09/18	MY45304199
Digital Multimeter	H.P	34401A	12/03/05	13/03/05	3146A13475, US36122178
Signal Generator	Rohde Schwarz	SMR20	12/03/05	13/03/05	101251
Vector Signal Generator	Rohde Schwarz	SMJ100A	12/01/09	13/01/09	100148
			13/01/08	14/01/08	
Thermo hygrometer	BODYCOM	BJ5478	12/06/20	13/06/20	120612-2
DC Power Supply	HP	6622A	12/03/05	13/03/05	3448A03760
High-Pass Filter	Wainwright	WHKX1.0	12/09/17	13/09/17	9
Attenuator (20dB)	WEINSCHEL	86-20-11	12/09/17	13/09/17	432
LOOP Antenna	Schwarzbeck	FMZB1513	12/09/24	13/09/24	1513-128
BILOG ANTENNA	SCHAFFNER	CBL6112D	12/11/16	14/11/16	2737
HORN ANT	ETS	3115	12/02/20	14/02/20	6419
Amplifier (22dB)	H.P	8447E	12/01/09	13/01/09	2945A02865
			13/01/08	14/01/08	
Amplifier (30dB)	Agilent	8449B	12/03/05	13/03/05	3008A00370
EMI TEST RECEIVER	R&S	ESU	12/01/09	13/01/09	100014
			13/01/08	14/01/08	
EMI TEST RECEIVER	R&S	ESCI	12/03/06	13/03/06	100364
CVCF	NF Electronic	4420	12/03/06	13/03/06	304935/337980
ARTIFICIAL MAINS NETWORK	R&S	ESH2-Z5	12/09/18	13/09/18	828739/006
RFI/FIELD Intensity Meter	KYORITSU	KNM-2402	12/07/02	13/07/02	4N-170-3

1.7. Summary of Test Results

FCC Part Section(s)	Parameter	Test Condition	Status Note 1	
I. Transmit mode (TX)				
15.247(a)	Carrier Frequency Separation	Conducted	C	
	Number of Hopping Frequencies		C	
	20 dB Bandwidth		C	
	Dwell Time		C	
15.247(b)	Transmitter Output Power			C
15.247(d)	Band-edge /Conducted			C
	Conducted Spurious Emissions			C
15.205, 15.209	Radiated Spurious Emissions	Radiated	C Note.2	
15.207	AC Conducted Emissions	AC Line Conducted	C	
15.203	Antenna Requirements	-	C	
<p>Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable Note 2: This test item was performed in each axis. And the worst case data were reported. Semi anechoic chamber registration Number : 678747</p>				

1.8 Conclusion of worst-case and operation mode

The field strength of spurious emission was measured in three orthogonal EUT positions(X-axis, Y-axis and Z-axis).

Tested frequency information,

- Hopping Function: Enable

	TXFrequency(MHz)	RX Frequency(MHz)
Hopping Band	902.75 ~ 927.25	902.75 ~ 927.25

- Hopping Function: Disable

	TXFrequency(MHz)	RX Frequency(MHz)
Lowest Channel	902.75	902.75
Middle Channel	915.25	915.25
Highest Channel	927.25	927.25

1.9 Test report revision

Test Report No.	Date	Description
DRTFCC1304-0409	Apr. 30, 2013	Final version for Approval

2. Radiated Spurious Emissions and Conducted Spurious Emission

2.1. Test Setup

Refer to the APPENDIX I.

2.2. Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

According to § 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)	Limit (uV/m) @ 3m
30 ~ 88	100 **
88 ~ 216	150 **
216 ~ 960	200 **
Above 960	500

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~ 12.52025	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.57675 ~ 12.57725	156.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	13.36 ~ 13.41	156.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	16.42 ~ 16.423	156.7 ~ 156.9	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.69475 ~ 16.69525	162.0125 ~ 167.17	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.80425 ~ 16.80475	167.72 ~ 173.2	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	25.5 ~ 25.67	240 ~ 285	2655 ~ 2900		
8.291 ~ 8.294	37.5 ~ 38.25	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	73 ~ 74.6	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	74.8 ~ 75.2	608 ~ 614	3345.8 ~ 3358		
		960 ~ 1240	3600 ~ 4400		

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

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the DA 00-705 and ANSI C63.4:2003

2.3.1. Test Procedures for Radiated Spurious Emissions

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a broadband antenna, and its height 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 table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE ;

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz for Average detection (AV) at frequency above 1 GHz.

2.3.2. Test Procedures for Conducted Spurious Emissions

1. The transmitter output was connected to the spectrum analyzer.
2. The reference level of the fundamental frequency was measured with the spectrum analyzer using RBW=100 kHz, VBW ≥ RBW.
3. The conducted spurious emission was performed using the spectrum analyzer's spurious from the lowest frequency generator used up to the 10th harmonics. The following spectrum settings was, RBW=100 kHz, VBW ≥ RBW, SWEEP TIME = AUTO, DETECTOR = PEAK, TRACE = MAX HOLD.

2.4. Test Results

Ambient temperature : 22°C
 Relative humidity : 41%

2.4.1. Radiated Emission

9kHz ~ 10GHz Data

▪ Lowest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F. (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1805.420	V	Y	PK	65.76	-5.73	N/A	60.03	74.00	13.97
1805.420	V	Y	AV	56.73	-5.73	N/A	51.00	54.00	3.00
2708.220	V	Y	PK	54.97	-1.57	N/A	53.40	74.00	20.60
2708.250	V	Y	AV	47.51	-1.57	N/A	45.94	54.00	8.06

▪ Middle Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F. (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1830.510	V	Y	PK	67.87	-5.73	N/A	62.14	74.00	11.86
1830.510	V	Y	AV	57.39	-5.73	N/A	51.66	54.00	2.34
2745.850	V	Y	PK	52.02	-1.57	N/A	50.45	74.00	23.55
2745.750	V	Y	AV	42.71	-1.57	N/A	41.14	54.00	12.86

▪ Highest Channel

Frequency (MHz)	ANT Pol	The worst case EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F. (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1854.460	V	Y	PK	66.81	-5.73	N/A	61.08	74.00	12.92
1854.500	V	Y	AV	58.46	-5.73	N/A	52.73	54.00	1.27
2781.770	V	Y	PK	62.68	-1.57	N/A	61.11	74.00	12.89
2781.770	V	Y	AV	53.34	-1.57	N/A	51.77	54.00	2.23

Note.

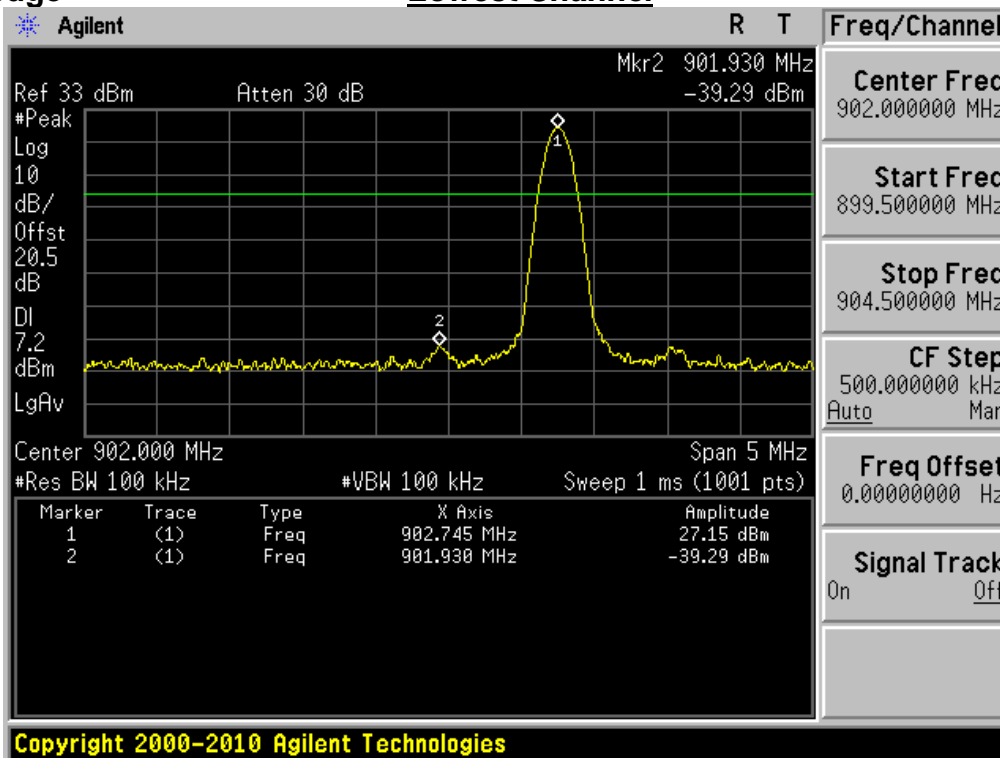
1. No other spurious and harmonic emissions were reported greater than listed emissions above table.
2. Above listed point data is the worst case data.
3. Sample Calculation.

Margin = Limit – Result / Result = Reading + T.F+ DCF / T.F = AF + CL – AG
 Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
 DCF = Duty Cycle Correction Factor

2.4.2. Conducted Spurious Emissions

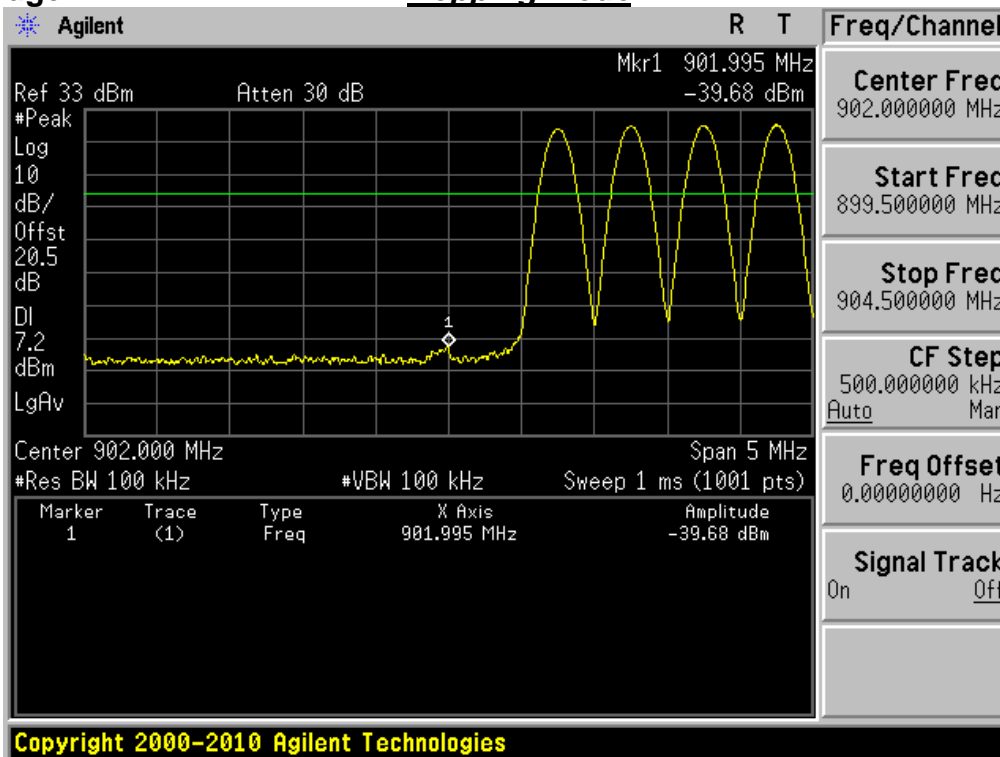
Low Band-edge

Lowest Channel



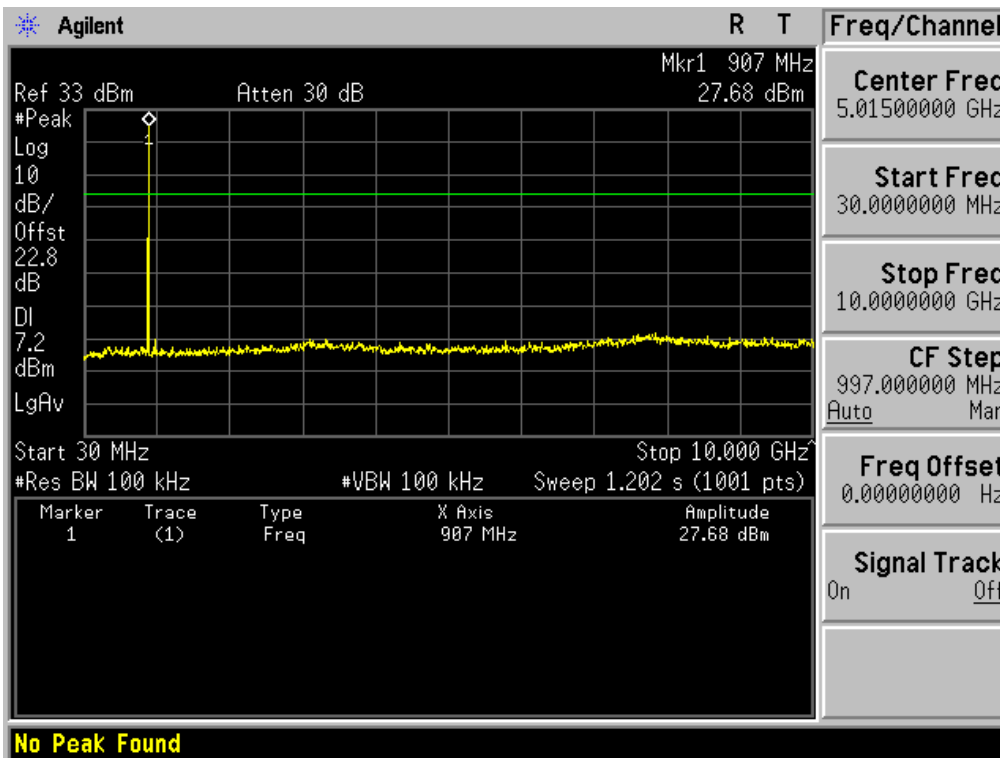
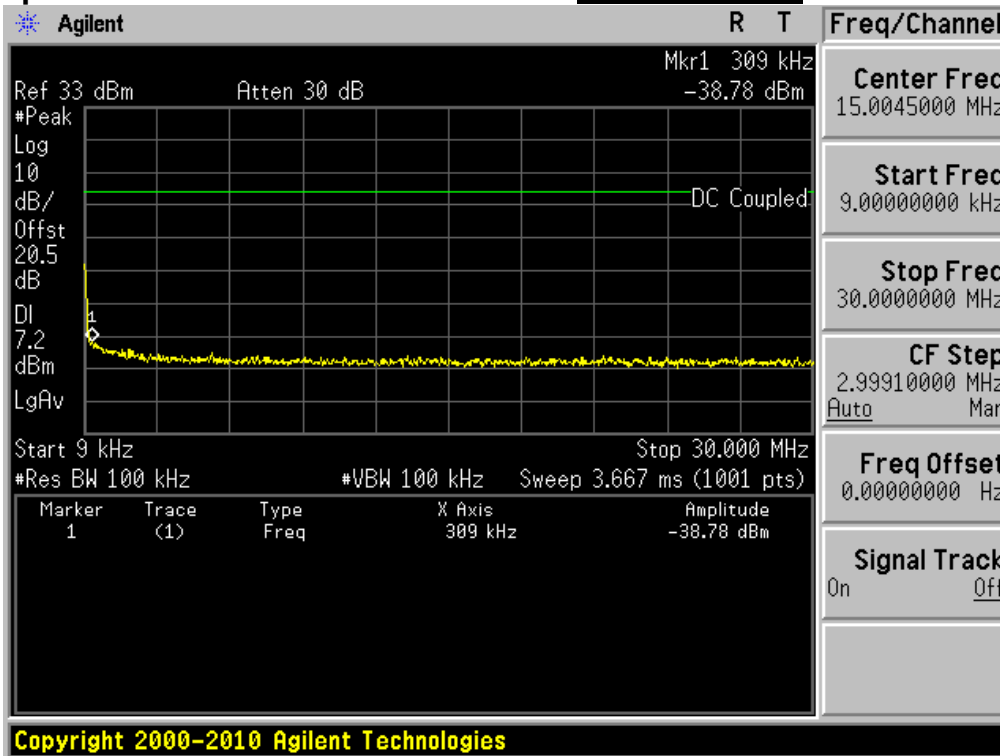
Low Band-edge

Hopping mode



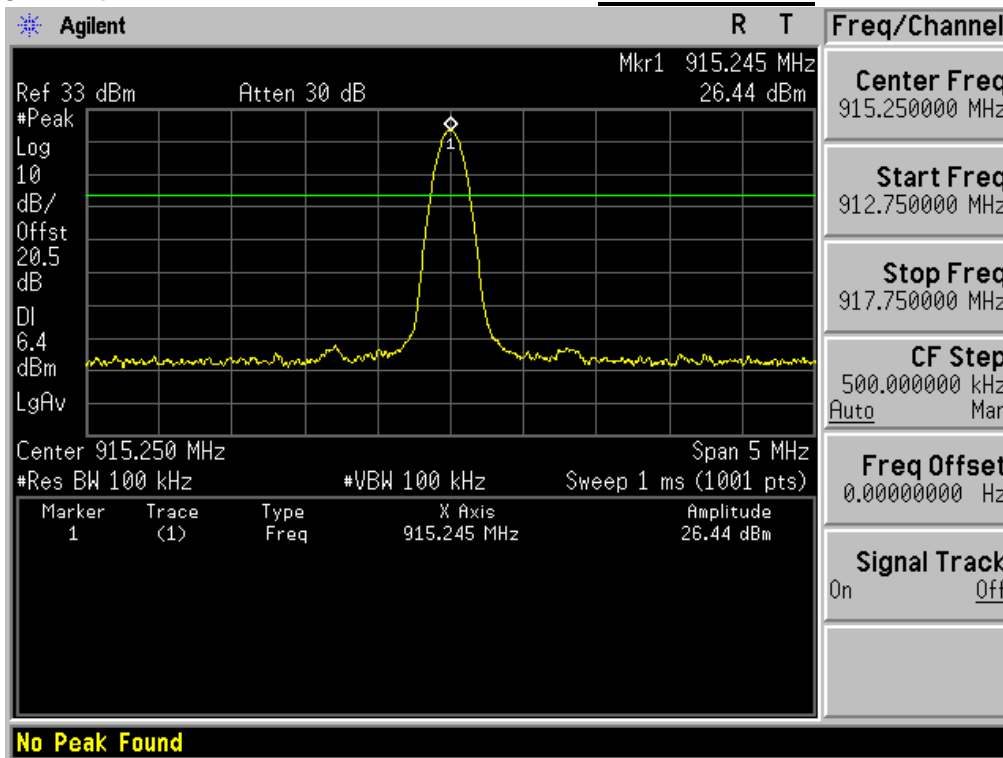
Conducted Spurious Emissions

Lowest Channel



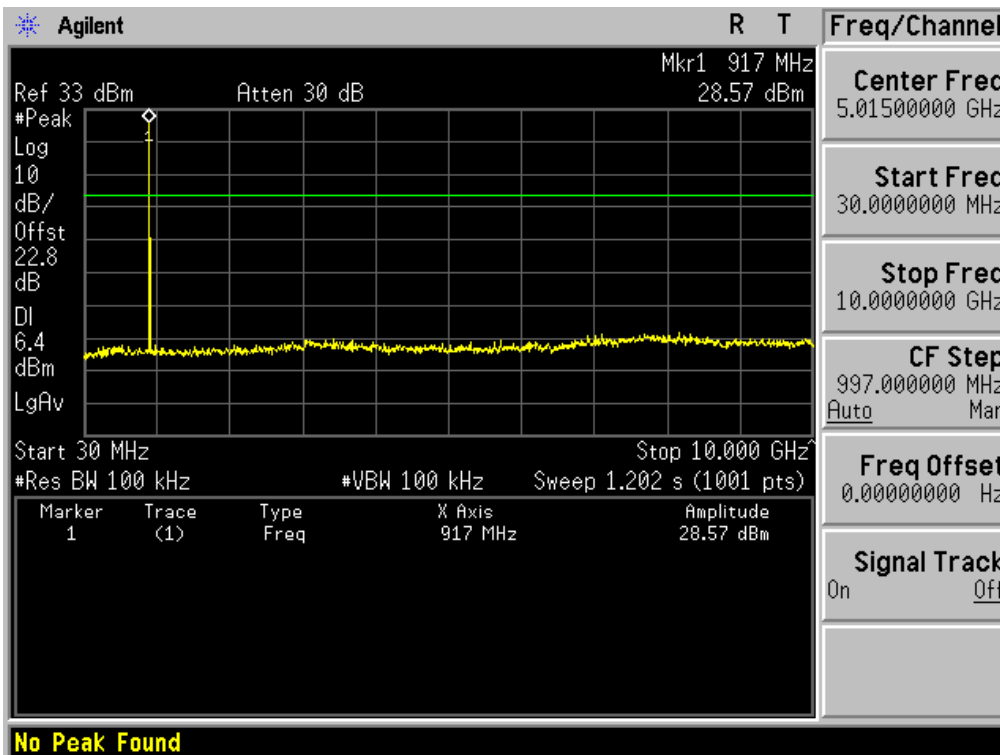
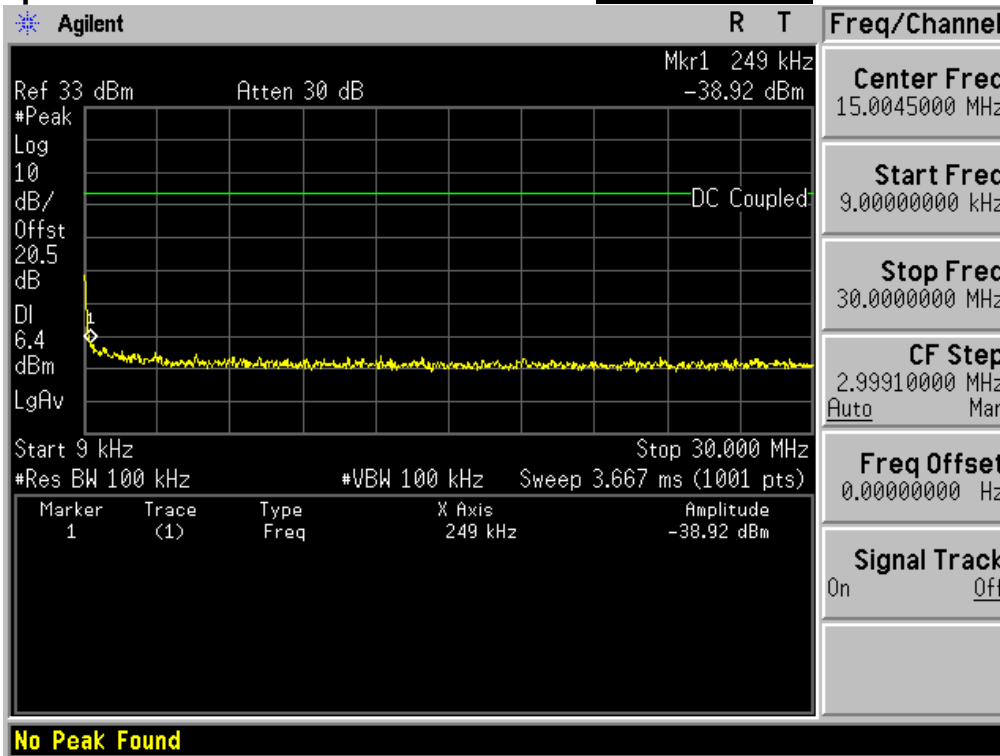
Reference for limit

Middle Channel



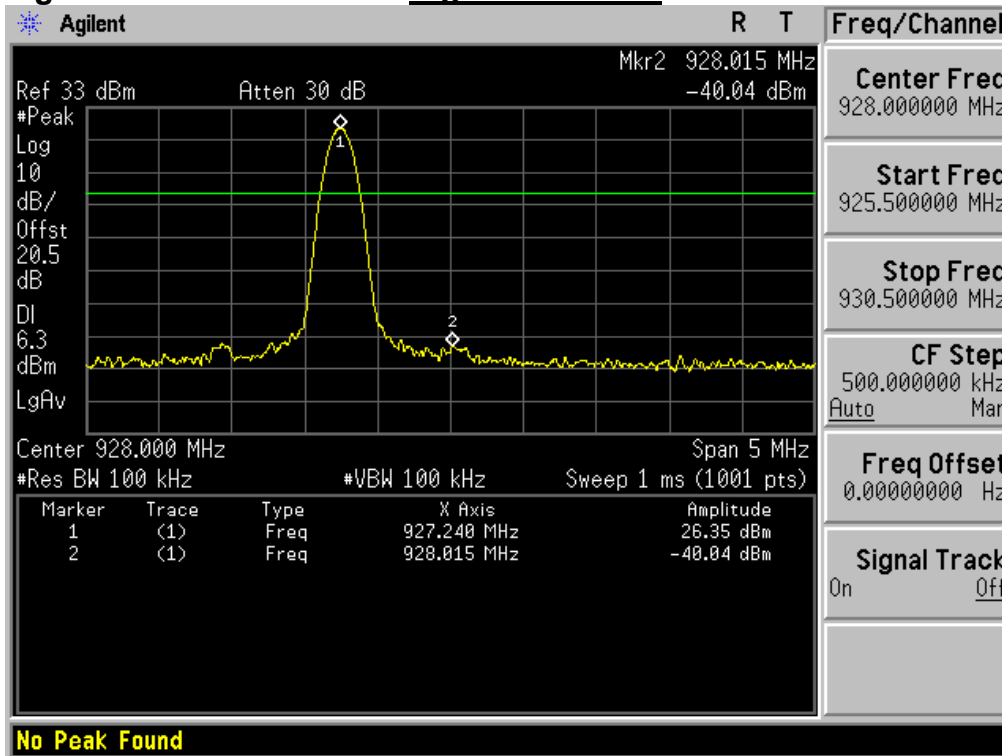
Conducted Spurious Emissions

Middle Channel



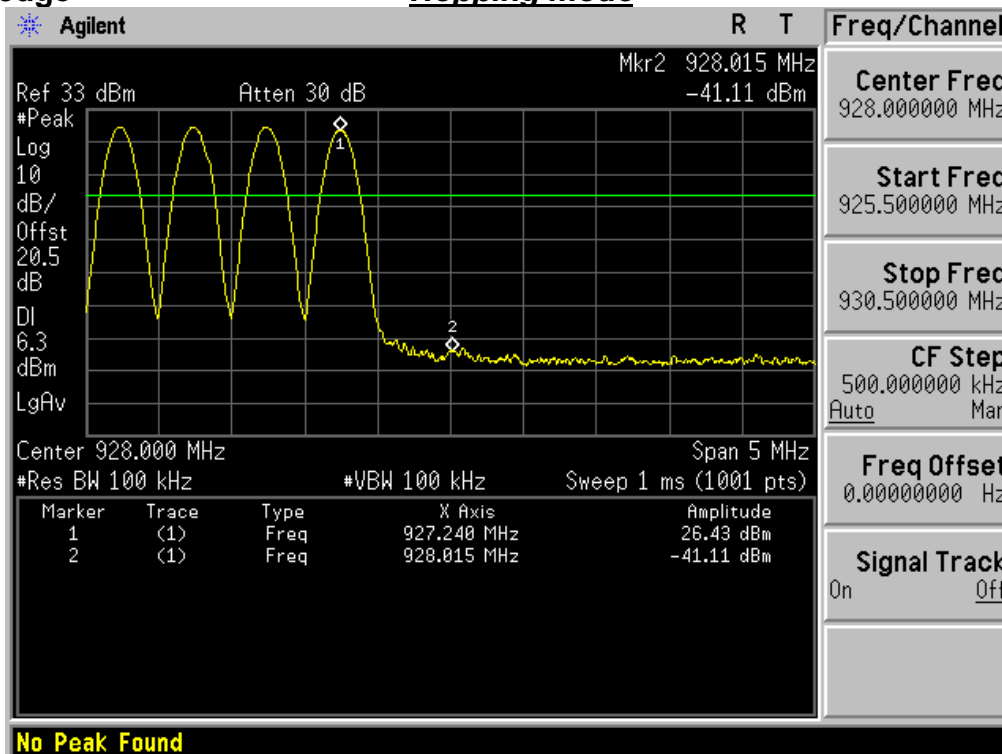
High Band-edge

Highest Channel



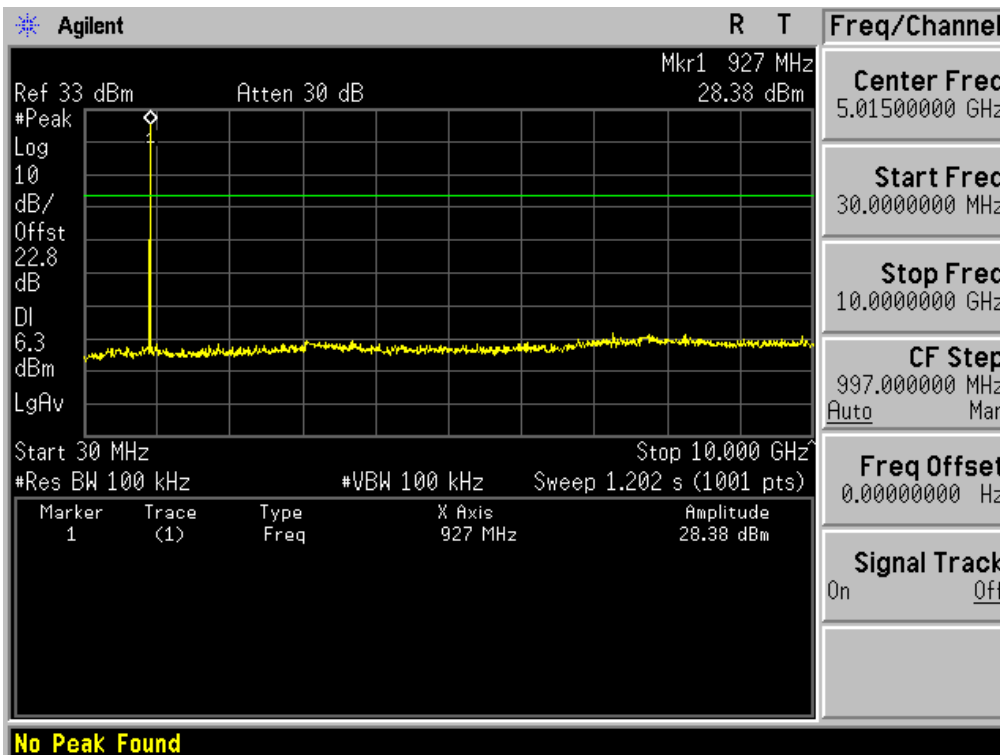
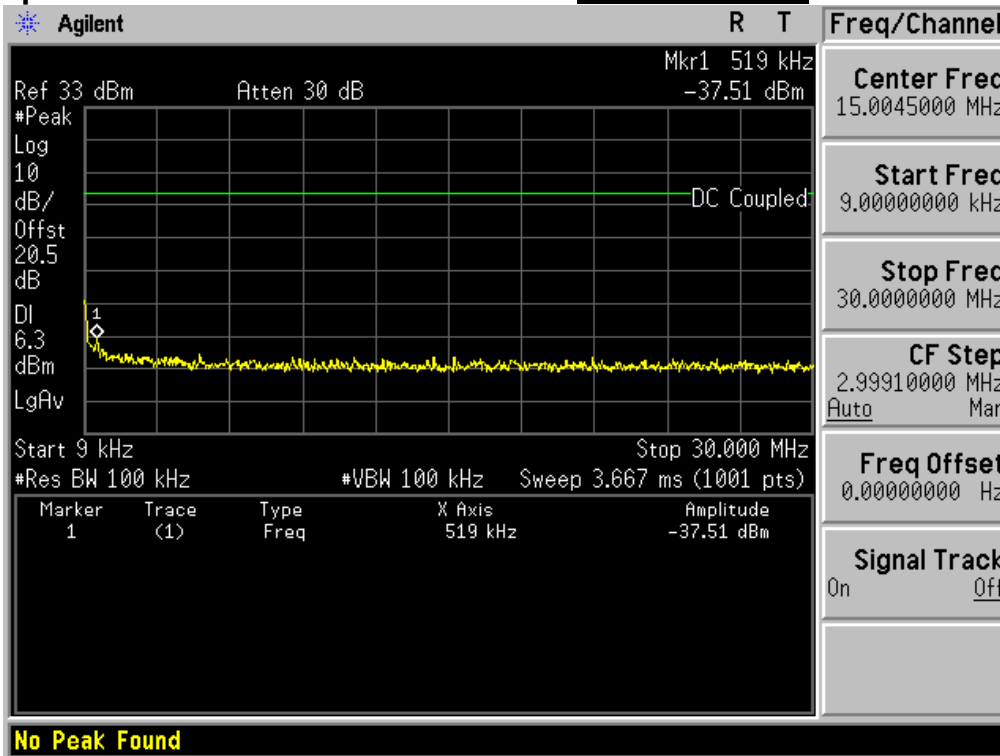
High Band-edge

Hopping mode



Conducted Spurious Emissions

Highest Channel



3. Carrier Frequency Separation

3.1. Test Setup

Refer to the APPENDIX I.

3.2. Limit

The EUT shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

3.3 Test Procedure:

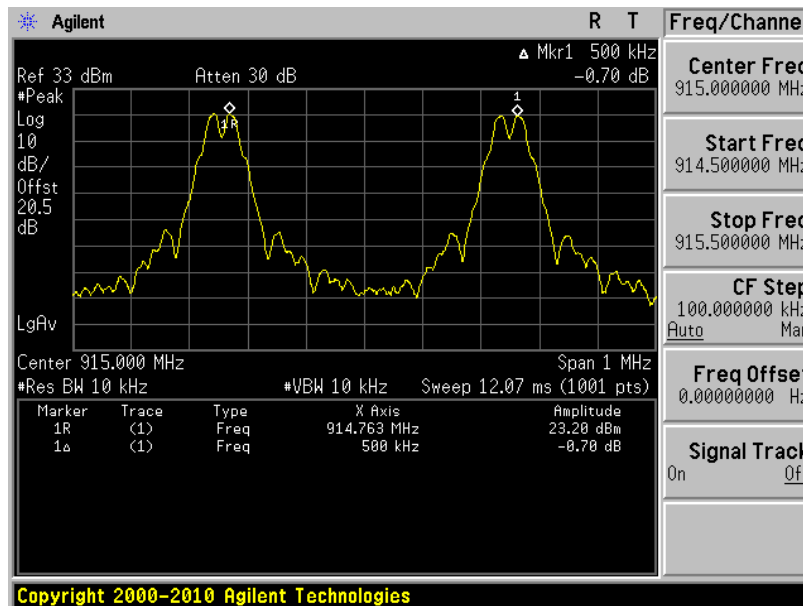
The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled. After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to:

- Span = wide enough to capture the peaks of two adjacent channels
- RBW = 1% of the span
- VBW = ≥ RBW
- Trace = max hold
- Sweep = auto
- Detector function = peak

3.4 Test Results:

Hopping Mode	Peak of center channel (MHz)	Peak of adjacent Channel (MHz)	Test Result (kHz)
Enable	914.763	915.263	500



4. Number of Hopping Frequencies

4.1. Test Setup

Refer to the APPENDIX I.

4.2. Limit

Limit: >= 50 hops

4.3 Test Procedure:

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

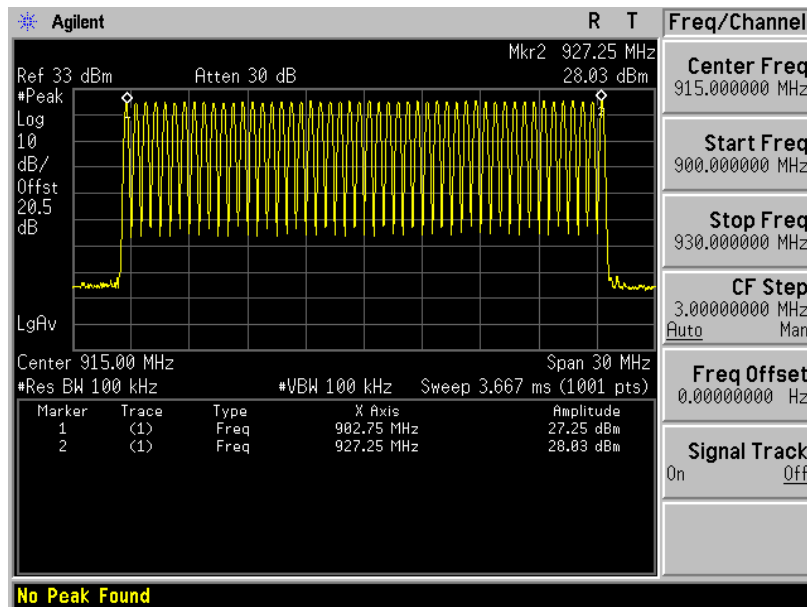
To get higher resolution, four frequency ranges within the 902 ~ 930 MHz FH band were examined.

The spectrum analyzer is set to:

- Span = 30 MHz(Start Frequency = 900 MHz / Stop Frequency = 930 MHz)
- RBW = 1% of the span or more
- VBW = ≥ RBW
- Trace = max hold
- Sweep = auto
- Detector function = peak

4.4 Test Results:

Hopping mode	Test Result (Total Hops)
Enable	50



5. 20dBc BW

5.1. Test Setup

Refer to the APPENDIX I.

5.2. Limit

Limit: < 250kHz for applying the hopping frequencies and the average time of occupancy

5.3. Test Procedure

The bandwidth at 20 dB below the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disabled at the highest, middle and the lowest available channels.

After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

Span = 2 MHz

RBW = 1 kHz

Sweep = auto

VBW = ≥ RBW

Detector function = peak

Trace = max hold

5.4. Test Results

Ambient temperature : 22°C

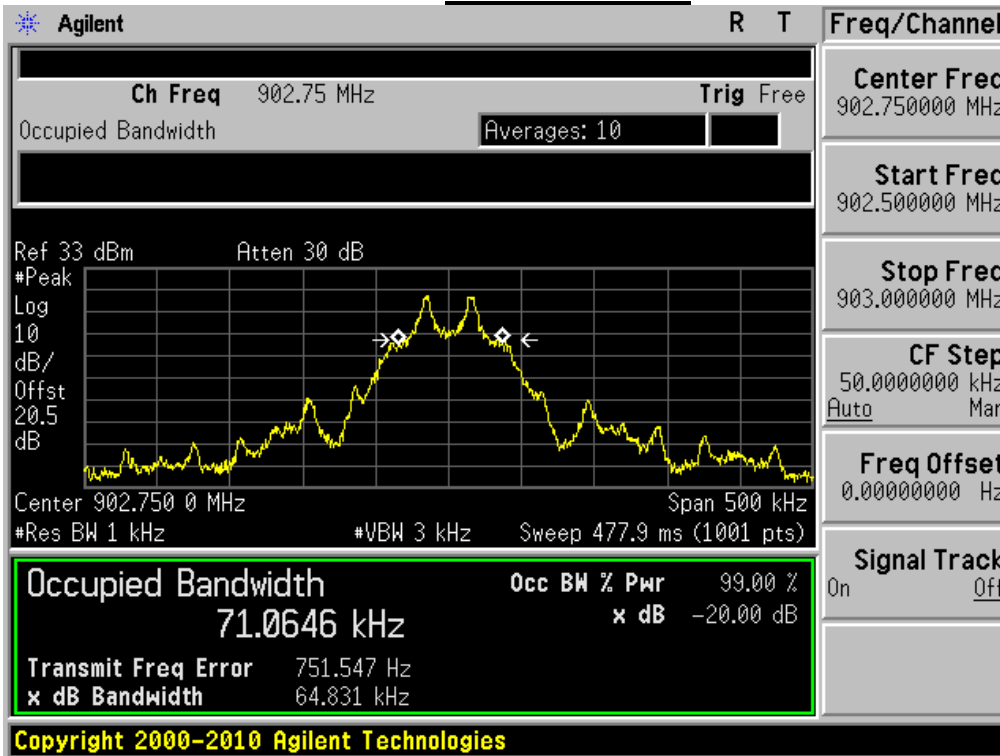
Relative humidity : 53%

Frequency (MHz)	Tested Channel	20dBc BW (kHz)
902.75	Lowest	64.831
915.25	Middle	68.190
927.25	Highest	67.545

Note 1: See next pages for actual measured spectrum plots.

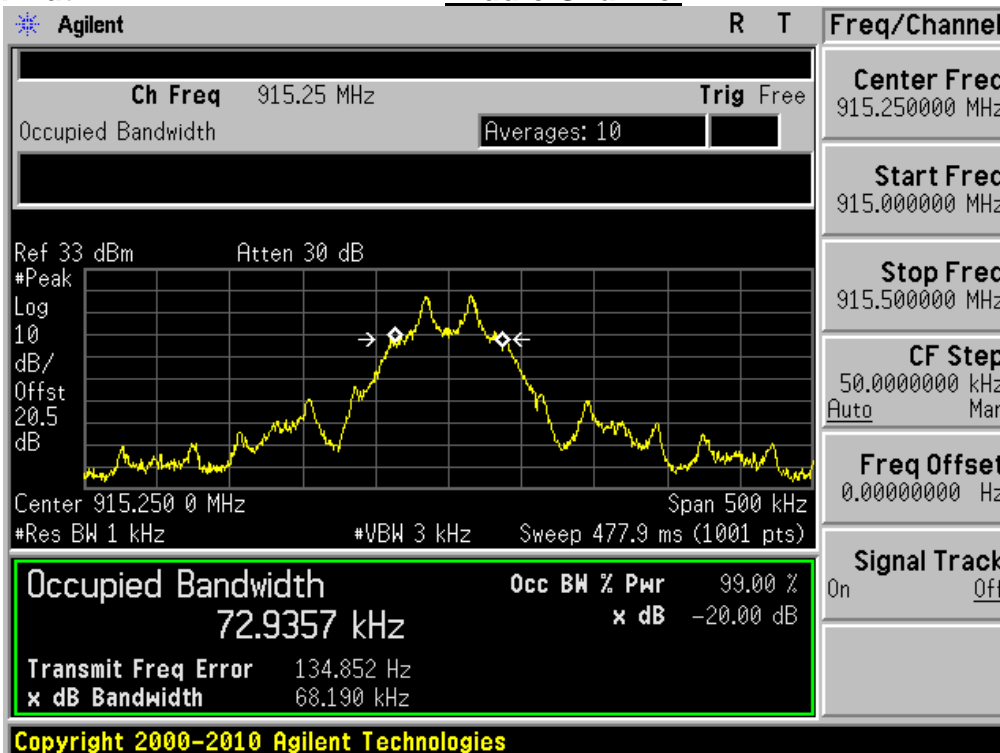
20dBc Bandwidth

Lowest Channel



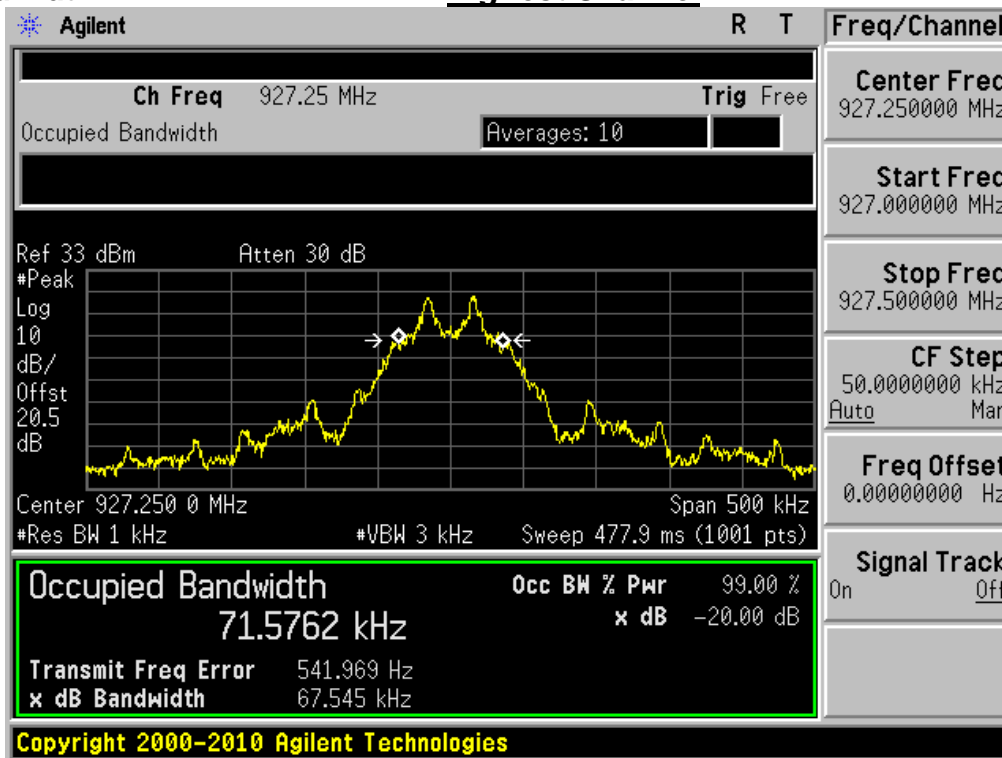
20dBc Bandwidth

Middle Channel



20dBc Bandwidth

Highest Channel



6. Time of Occupancy (Dwell Time)

6.1. Test Setup

Refer to the APPENDIX I.

6.2. Limit

Limit: < 0.4 seconds within a 20 second period

6.3. Test Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

RBW = 1MHz

VBW = ≥ RBW

Span = zero

Detector function = peak

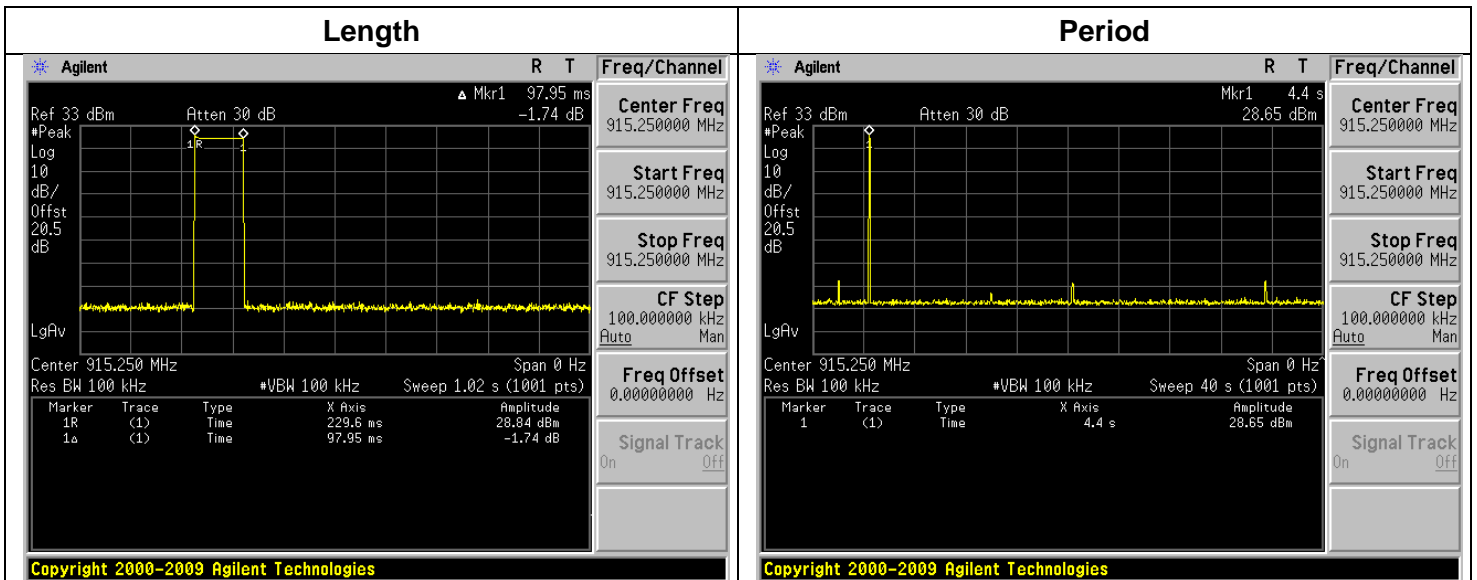
Trace max hold

6.4. Test Results

Ambient temperature : 22°C

Relative humidity : 53 %

Channel Frequency (MHz)	Length (ms)	Number	Dwell Time (ms)
915.25	97.95	1	97.95



7. Maximum Peak Output Power Measurement

7.1. Test Setup

Refer to the APPENDIX I.

7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following :

- §15.247(b)(2), For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels,

7.3. Test Procedure

- The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
- The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;
 RBW ≥ 20dB BW
 VBW ≥ RBW
 Sweep = auto
 Detector function = peak
 Trace = max hold

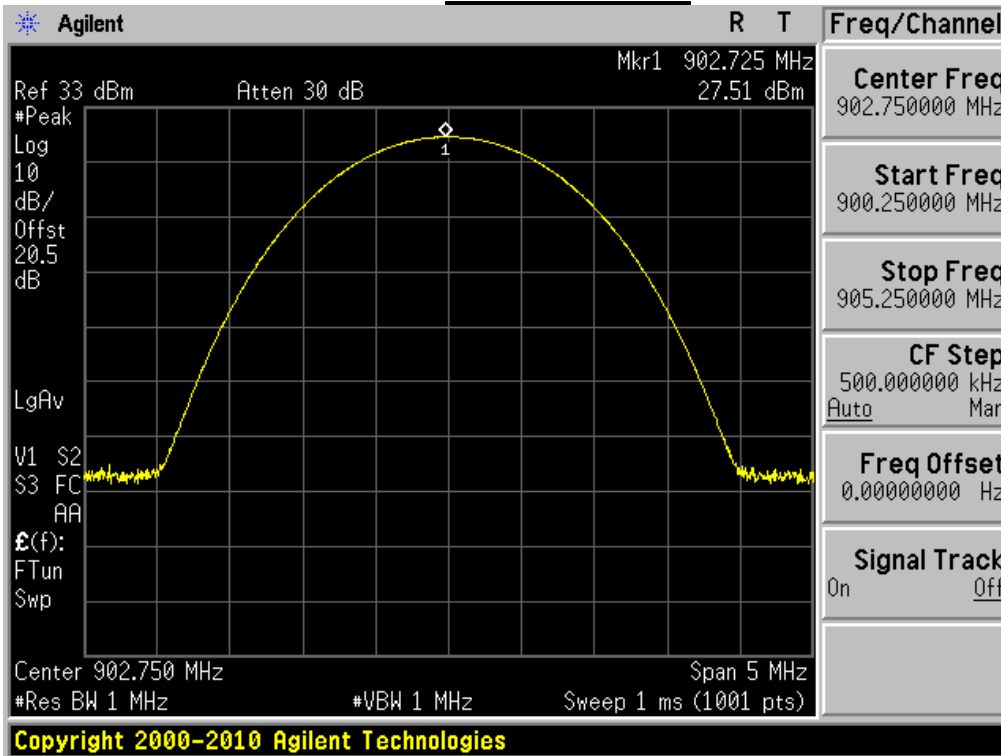
7.4. Test Results

Ambient temperature : 22°C
 Relative humidity : 53 %

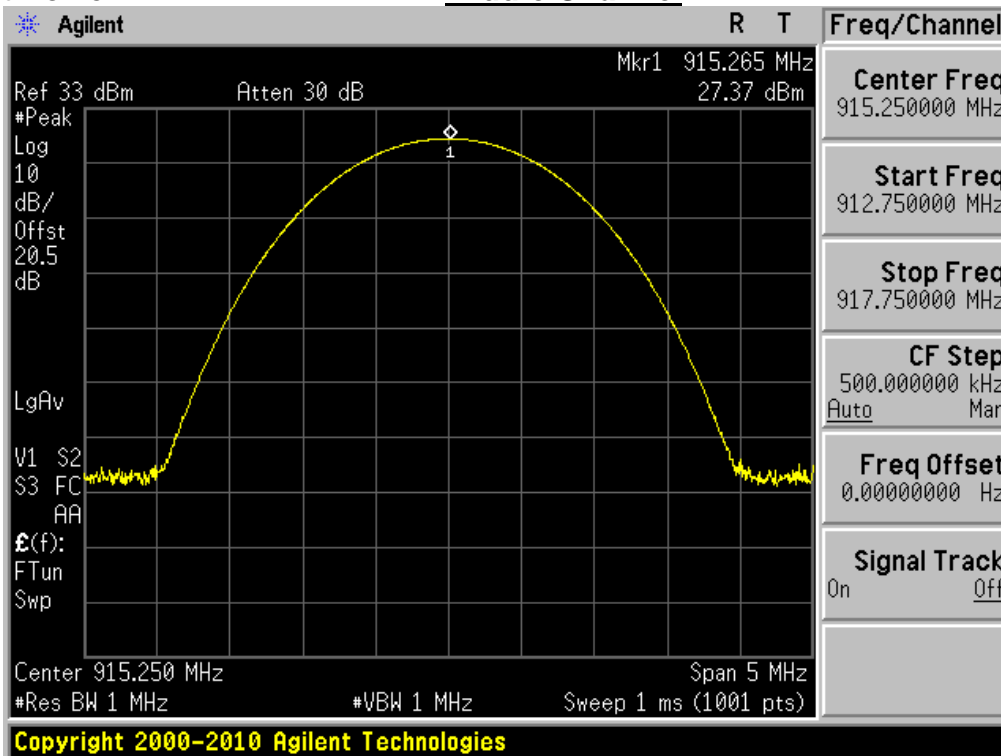
Tested Channel	Peak Output Power	
	dBm	mW
Lowest	27.510	563.638
Middle	27.370	545.758
Highest	27.180	522.396

Note 1: See next pages for actual measured spectrum plots.

Peak Output Power Lowest Channel

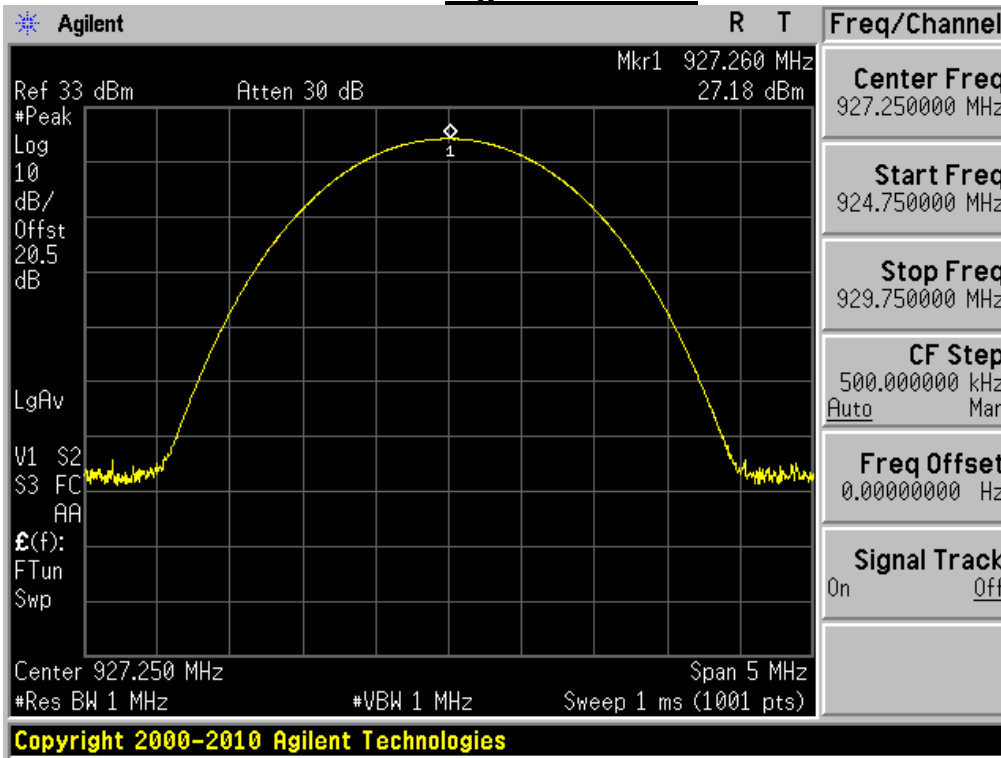


Peak Output Power Middle Channel



Peak Output Power

Highest Channel



8. Transmitter AC Power Line Conducted Emission

8.1. Test Setup

Refer to test setup photo.

8.2. Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network(LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

8.3. Test Procedures

Conducted emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

8.4. Test Results

AC Line Conducted Emissions (Graph)

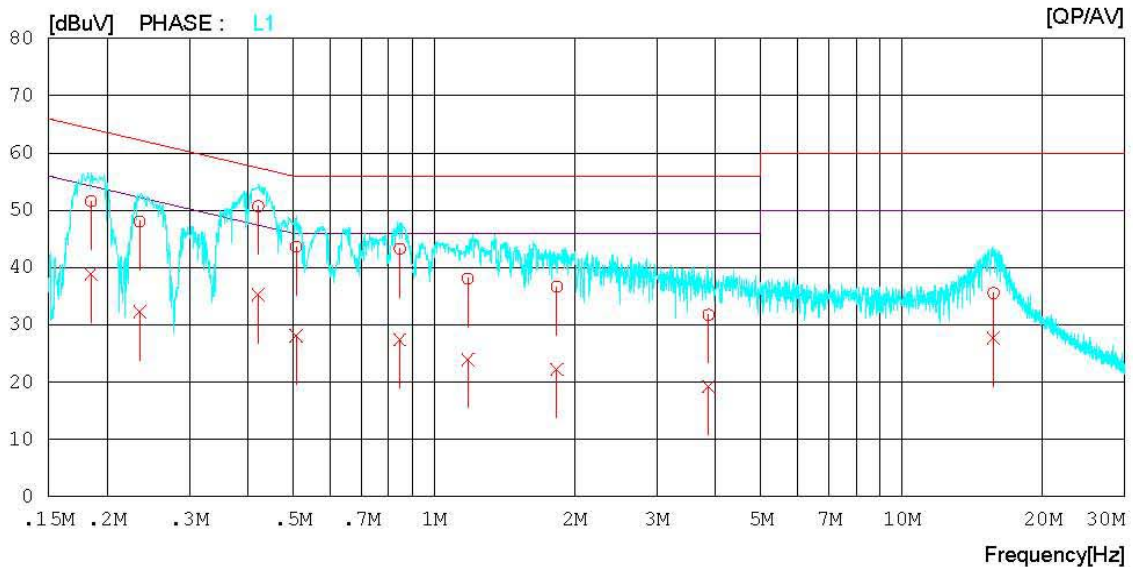
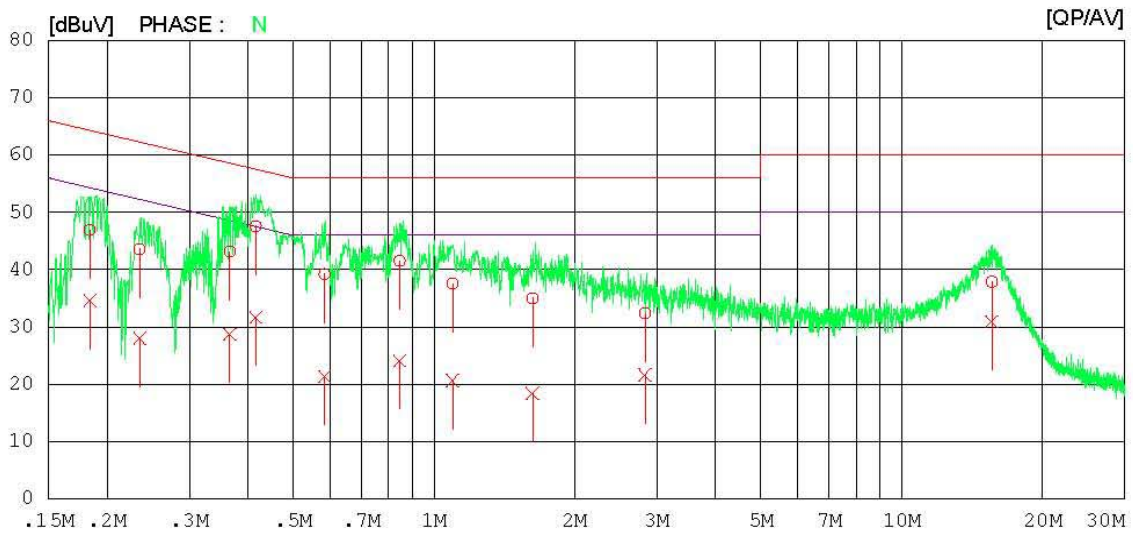


Results of Conducted Emission

Digital EMC
 Date : 2013-01-15

Model No.	: AT287-UHF	Reference No.	:
Type	:	Power Supply	: 120 V 60 Hz
Serial No.	:	Temp/Humi.	: 23 °C 39 % R.H.
Test Condition	:	Operator	:

Memo :
 LIMIT : CISPR22_B QP
 CISPR22_B AV



9. Antenna Requirement

9.1. Test Setup

N/A

9.2 Limit

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions.

9.3 Test Procedure

N/A

9.4 Conclusion:

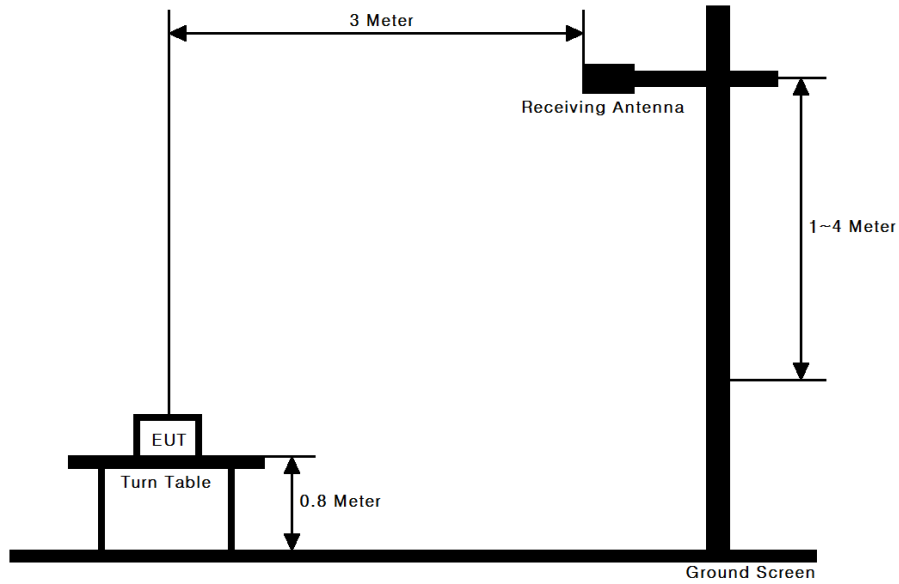
The internal antenna of this E.U.T is permanently attached on the main PCB.(Refer to Internal Photo.)

APPENDIX I

Test set up Diagrams

▪Radiated Measurement

The diagram below shows the test setup that is utilized to make the measurements for emission from 9kHz to 10GHz Emissions.



▪Conducted Measurement

