TEST REPORT

For

RW module for UHF RFID

In conformity with

FCC CFR 47 Part15 (October 1, 2010) / RSS-210 Issue 8, RSS-Gen Issue 3

Model: L-E1001-F00001

FCC ID/ IC Certification No.: A2JL-E1001-F00001 / 10057A-E1001F00001

Test Item: RW module for UHF RFID

Report No: RY1112J09R1

Issue Date: 09 December, 2011

Prepared for

Hitachi Information & Communication Engineering, Ltd.
Minatomirai Business Square 14F, 3-6-4,
Minatomirai, Nishi-Ku, Yokohama, 220-0012 Japan

Prepared by

RF Technologies Ltd.
472, Nippa-cho, Kohoku-ku, Yokohama, 223-0057, Japan
Telephone: +81+(0)45- 534-0645
FAX: +81+(0)45- 534-0646

Table of contents

History

Report No.	Date	Revisions	Issued By
RY1112J09R1	09 December, 2011	Initial Issue	R.Kojima

1 General information

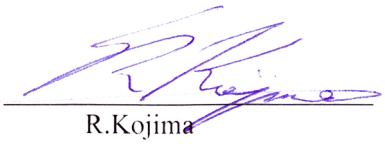
1.1 Product description

Test item	: RW module for UHF RFID
Manufacturer	: Hitachi Information & Communication Engineering, Ltd.
Address	: Minatomirai Business Square 14F, 3-6-4, Minatomirai, Nishi-Ku, Yokohama, 220-0012 Japan
Model	: L-E1001-F00001
FCC ID	: A2JL-E1001-F00001
IC Certification No	: 10057A-E1001F00001
Serial numbers	: A000001
Operating frequency band	: Tx/Rx Freq. (902 - 928 MHz)
Operating frequency range	: 902.25 MHz (0ch) – 927.75 MHz (51ch)
Oscillator frequencies	: 19.2MHz, 18.432MHz
Type of Modulation	: ASK100%
Number of channels	: 52ch
RF Output Power	: 5.9 dBm (measured at the antenna terminal)
Antenna Gain	: 0 dBi (Manufacturer declared)
Antenna Type	: Patch antenna
Receipt date of EUT	: 22 November, 2011
Nominal power source voltages	: DC 3.3V

1.2 Test(s) performed/ Summary of test result

Test specification(s)	: FCC CFR 47. Part 15 (October 1, 2010) / RSS-210 Issue 8, RSS-Gen Issue 3
Test method(s)	: ANSI C63.4: 2003
Test(s) started	: 22 November, 2011
Test(s) completed	: 09 December, 2011
Purpose of test(s)	: Grant for Certification of FCC / IC
Summary of test result	: Complied

Note: The above judgment is only based on the measurement data and it does not include the measurement uncertainty. Accordingly, the statement below is applied to the test result.
The EUT complies with the limit required in the standard in case that the margin is not less than the measurement uncertainty in the Laboratory.
Compliance of the EUT is more probable than non-compliance is case that the margin is less than the measurement uncertainty in the Laboratory.

Test engineer : 
R.Kojima
Engineer
EMC testing Department

Reviewer : 
K.Ohnishi
Manager
EMC testing Department

1.3 Test facility

The Federal Communications Commission has reviewed the technical characteristics of the test facilities at **RF Technologies Ltd.**, located in 472, Nippa-cho, Kohoku-ku, Yokohama, 223-0057, Japan, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948, per October 1, 2010. The description of the test facilities has been filed under registration number 319924 at the Office of the Federal Communications Commission. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.
The list of all public test facilities is available on the Internet at http://www.fcc.gov.

Registered by Voluntary Control Council for Interference by Information Technology Equipment (VCCI)
Each registered facility number is as follows;
Test site (Semi Anechoic chamber 3m) R-2393
Test site (Shielded room) C-2617

Registered by Industry Canada (IC) Each registered facility number is as follows;
Test site No.1 (Semi Anechoic chamber 3m): 6974A-1

Accredited by **National Voluntary Laboratory Accreditation Program** (NVLAP) for the emission tests stated in the scope of the certificate under Certificate Number 200780-0

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

NVLAP LAB CODE 200780-0

1.4 Measurement uncertainty

The treatment of uncertainty is based on the general matters on the definition of uncertainty in “Guide to the expression of uncertainty in measurement (GUM)” published by ISO. The Lab’s uncertainty is determined by referring UKAS Publication LAB34: 2002 “The Expression of Uncertainty in EMC Testing” and CISPR16-4-2: 2003 “Uncertainty in EMC Measurements”.
The uncertainty of the measurement result in the level of confidence of approximately 95% (k=2) is as follows;

RF Conducted emission (30MHz – 26GHz): ± 1.1dB
Conducted emission (10kHz – 30MHz) : ± 1.9 dB
Radiated emission (9 kHz - 30MHz): ± 2.8 dB
Radiated emission (30MHz - 1000MHz): ± 5.9 dB
Radiated emission (1.0GHz – 18.0GHz): ± 5.8 dB

1.5 Summary of test results

Table of test summary

Requirement of;	Section in FCC15	Section in RSS210/ RSS-Gen	Result	Section in this report
Occupied Bandwidth (20 dB/99%)	15.247(a)(1)	A8.1(b)	Complied	2.1
Hopping Carrier Frequency Separation	15.247(a)(1) (i)	A8.1(c)	Complied	2.2
Number of Hopping Channel	15.247(a)(1)(i)	A8.1(c)	Complied	2.3
Average Time of Occupancy	15.247(a)(1)(i)	A8.1(c)	Complied	2.4
Peak Output Power	15.247(a)(1)/(b)(2)	A8.4(1)	Complied	2.5
Conducted Spurious Emissions	15.247(d)	A8.5	Complied	2.6
Transmitter Radiated Spurious Emissions	15.205(b)/15.209	RSS-Gen 7.2.5	Complied	2.7
Transmitter AC power line Conducted emissions	15.207	RSS-Gen 7.2.4	Complied	2.8
Receiver Radiated Spurious Emissions	15.109	RSS-Gen 6	Complied	2.9
Receiver AC power line Conducted emissions	15.107	RSS-Gen 7.2.4	Complied	2.10

1.6 Setup of equipment under test (EUT)

1.6.1 Test configuration of EUT

Equipment(s) under test:

	Item	Manufacturer	Model No.	Serial No.	Remarks
A	RW module for UHF RFID	HOKUBU Communication & Industrial Co., Ltd.	L-E1001-F00001	A000001	EUT

Support Equipment(s):

	Item	Manufacturer	Model No.	Serial No.	Remarks
B	Evaluation kit	Hitachi Information & Communication Engineering Ltd.	PHM2009	A10037	-
C	PC	DELL	PP11S	10663514349	-
D	AC adaptor	TOSHIBA	HA65NS0-00	CN-0DF261-47890-697-0986 REV A02	-

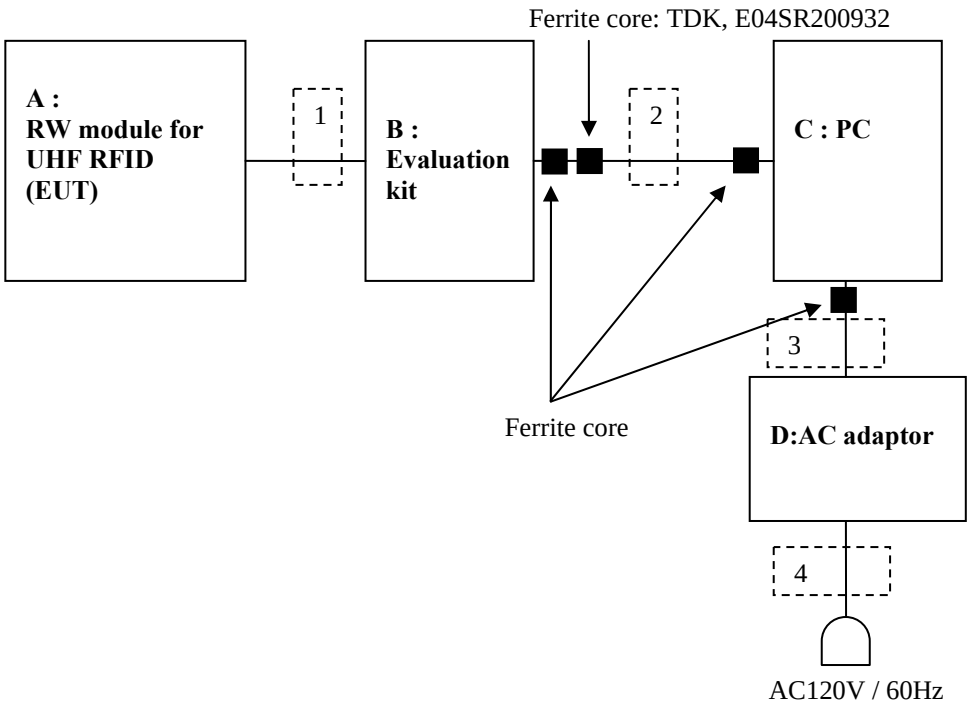
Connected cable(s):

No.	Item	Identification (Manu.e.t.c)	Shielded YES / NO	Ferrite Core YES / NO	Connector Type Shielded YES / NO	Length (m)
1	Flat cable	HOKUBU Communication & Industrial Co., Ltd.	No	No	No	0.15
2	USB cable	-	Yes	Yes	Yes	1.8
3	DC power cable	DELL	No	Yes	No	1.8
4	AC power cable	DELL	No	No	No	0.8

1.6.2 Operating condition:

Operating mode:
The EUT was tested under the following test mode prepared by the applicant:
(1-1) ASK100% modulation, Continuous transmission (902.25MHz)
(1-2) ASK100% modulation, Continuous transmission (914.25MHz)
(1-3) ASK100% modulation, Continuous transmission (927.75MHz)
(1-4) ASK100% modulation, Hopping
(2-1) Continuous receiving (902.25MHz)
(2-2) Continuous receiving (914.25MHz)
(2-3) Continuous receiving (927.75MHz)

1.6.3 Setup diagram of tested system:



1.7 Equipment modifications

No modifications have been made to the equipment in order to achieve compliance with the applicable standards described in clause 1.2.

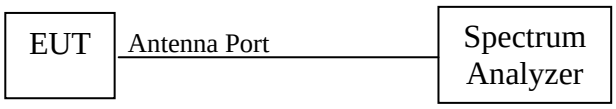
1.8 Deviation from the standard

No deviations from the standards described in clause 1.2.

2 Test procedure and test data

2.1 Occupied Bandwidth (20dB / 99%)

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure
Measurement procedures were implemented according to the method of ANSI C63.4: 2003 clauses 13.1.7.
The EUT antenna port connected to the spectrum analyzer. The RBW is set to ≥ 1% of the 20 dB bandwidth bandwidth. The VBW is set to 3 times of the RBW. The sweep time is coupled appropriate.

Limitation
There are no limitations. The measurement value is used to calculation of the limitation of the channel separation and the emission designator.

Test equipment used (refer to List of utilized test equipment)

TR06					

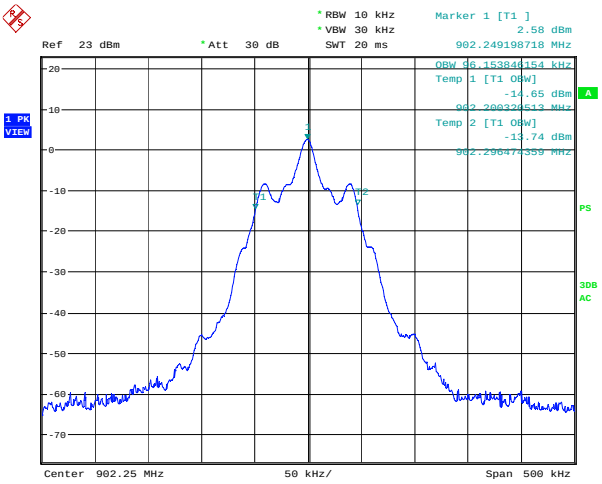
Test results

Transmission Channel	Transmission Frequency	Bandwidth [kHz]	
		20dB	99%
Low	902.25	100.962	96.154
Middle	914.25	101.763	96.955
High	927.75	101.763	96.955

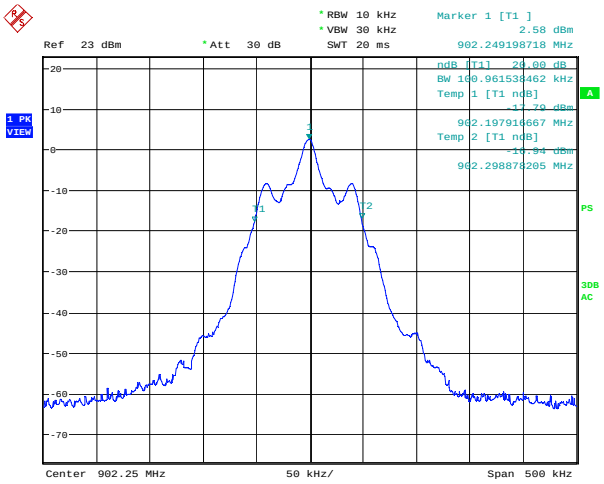
Test Data

Tested Date: 22 November, 2011

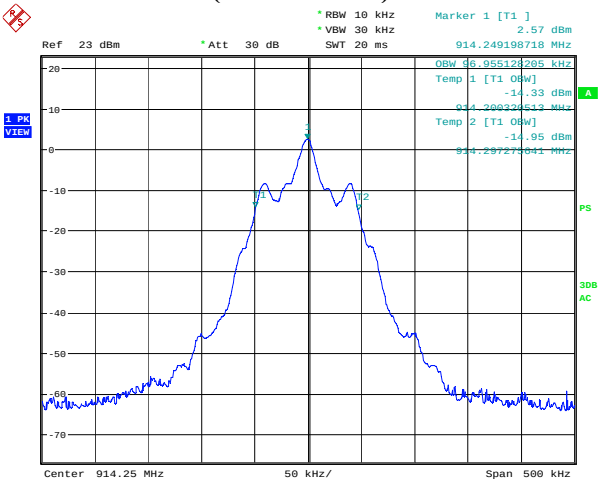
Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa



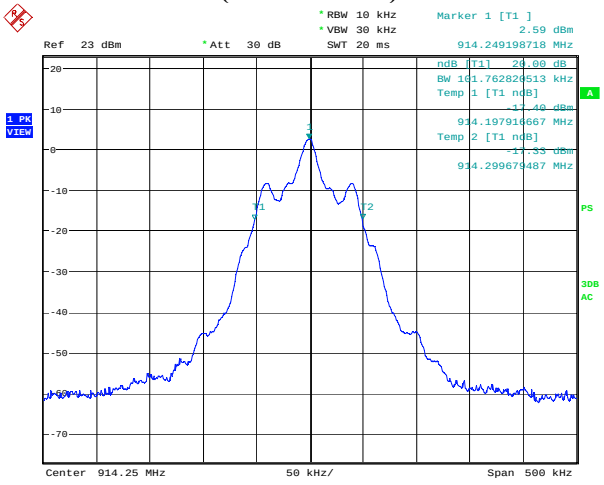
99% bandwidth (Low cahnnel)



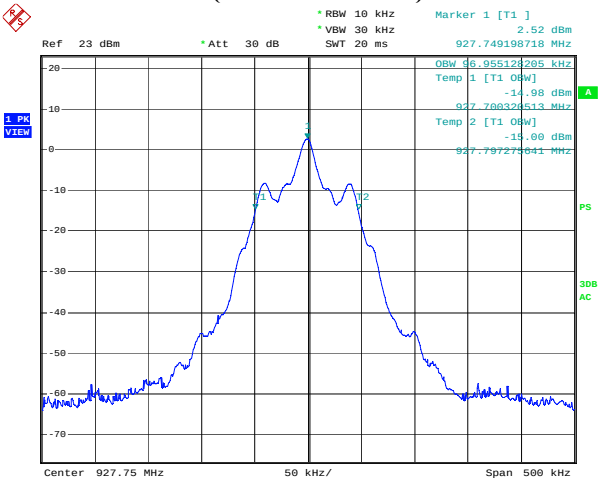
20dB bandwidth (Low cahnnel)



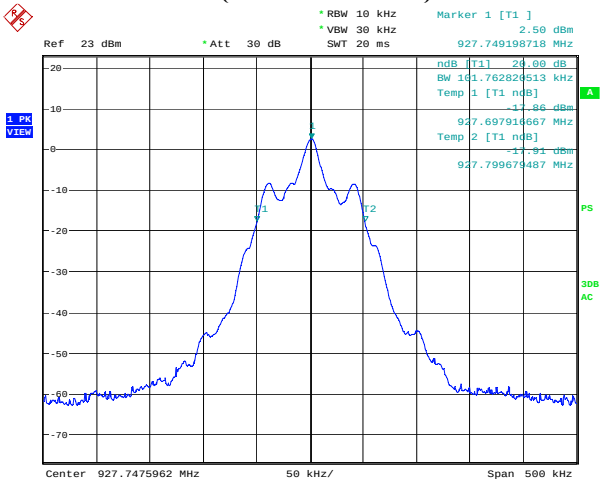
99% bandwidth (Middle cahnnel)



20dB bandwidth (Middle cahnnel)



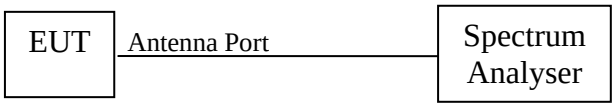
99% bandwidth (High cahnnel)



20dB bandwidth (High cahnnel)

2.2 Hopping Carrier Frequency Separation

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure
The EUT antenna port connected to the spectrum analyzer. The RBW is set to more than 1% of its span. The VBW is set to more than RBW. The sweep time is coupled appropriate.

Limitation
Carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel

Test equipment used (refer to List of utilized test equipment)

TR06	CL23				

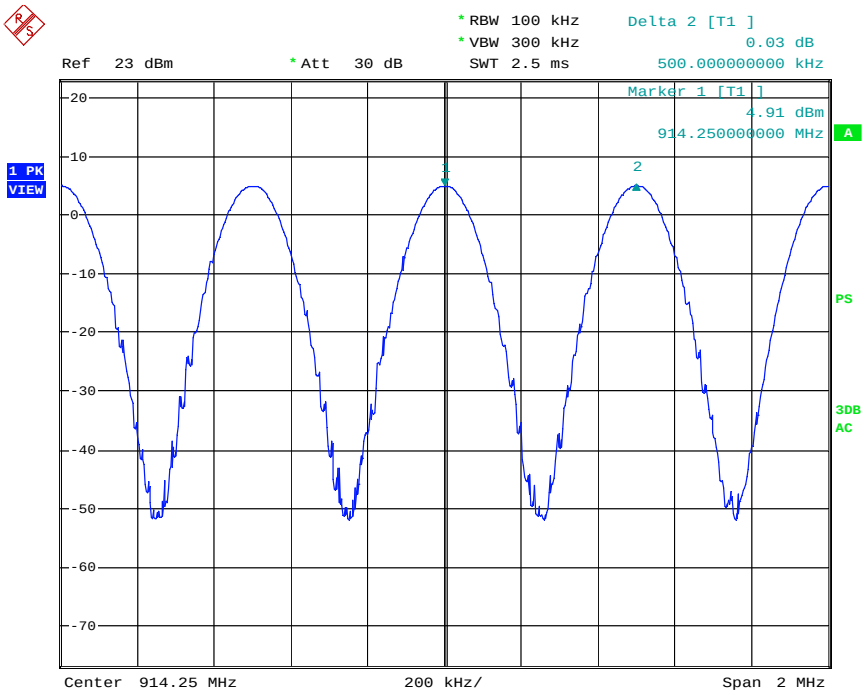
Test results – comply with the limitation

Measured Channel	Measured Frequency (MHz)	Two-third of the 20dB bandwidth (kHz)	Frequency Separation (kHz)
Middle channel	914.250	67.308	500.000

Tested Date
22 November, 2011

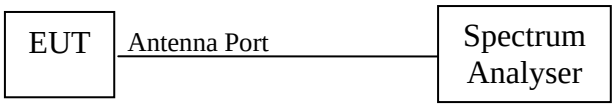
Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa

Middle channel



2.3 Number of Hopping Channel

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure
The EUT antenna port connected to the spectrum analyzer. The RBW is set to more than 1% of its span. The VBW is set to more than RBW. The sweep time is coupled appropriate. The span is set to cover the authorized band. The analyzer is set to MAX HOLD. The EUT is hopping operation.

Limitation
15.247(a) (1) (i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

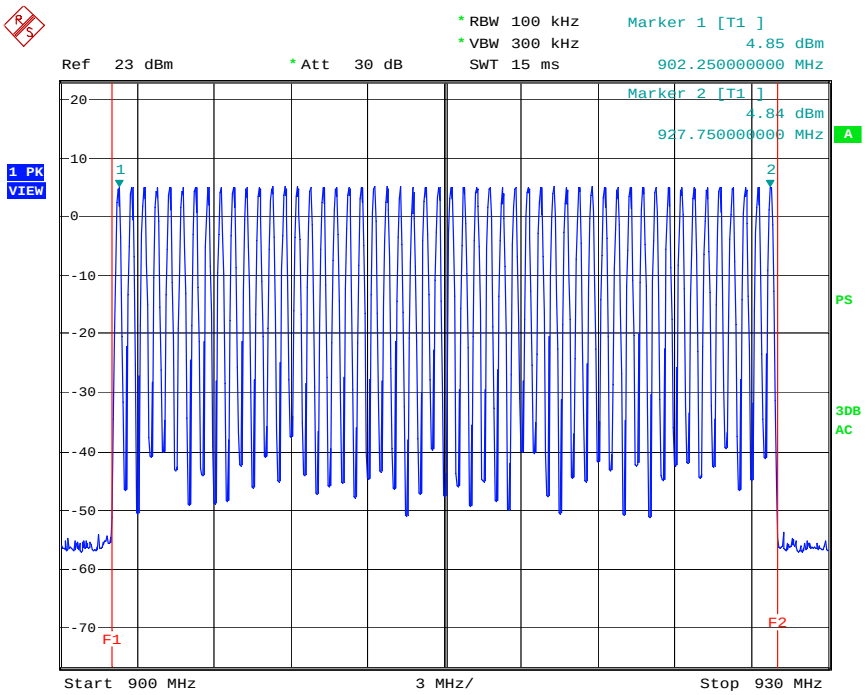
Test equipment used (refer to List of utilized test equipment)

TR06	CL23				

Test results – Comply with the limitation
Hopping channel: 52 channels

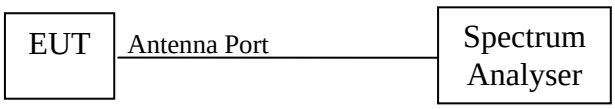
Test Data
22 November, 2011

Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa



2.4 Average Time of Occupancy

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure
The EUT antenna port connected to the spectrum analyzer. The RBW is set to 1 MHz. The VBW is set to more than RBW. The sweep time is set to 20s. The span is set to 0 MHz and single sweep with video triggered. The EUT is hopping operation.

Limitation
15.247(a)(1)(i) For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Test equipment used (refer to List of utilized test equipment)

TR06	CL23				

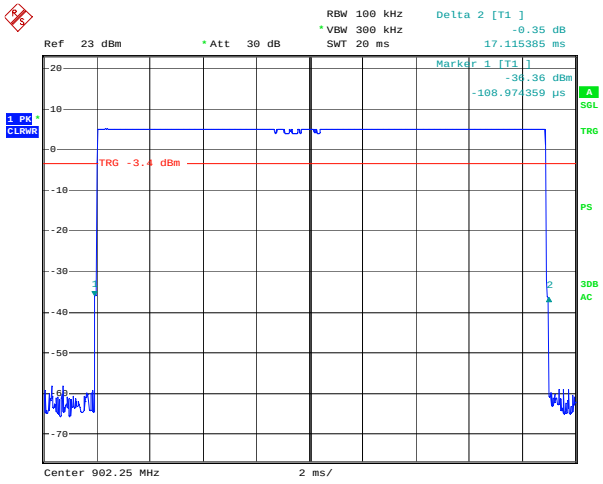
Test results – comply with the limitation.

Test channels	Single pulse width [ms]	The number of the pulses in 20 seconds.	Average time of occupancy [ms]	Limitation [ms]	Results
Low channel	17.115	16	273.840	400.000	Pass
Middle channel	17.564	16	281.024	400.000	Pass
High cahnnel	17.404	16	278.464	400.000	Pass

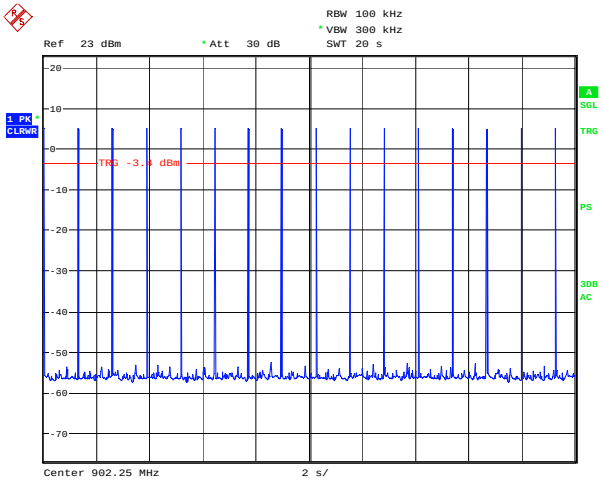
Test Data

22 November, 2011

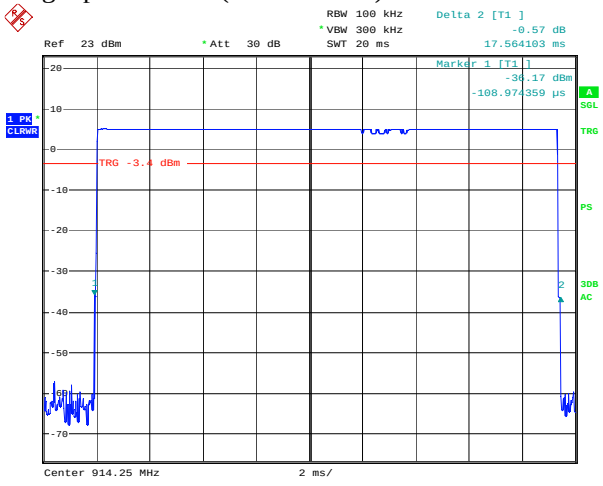
Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa



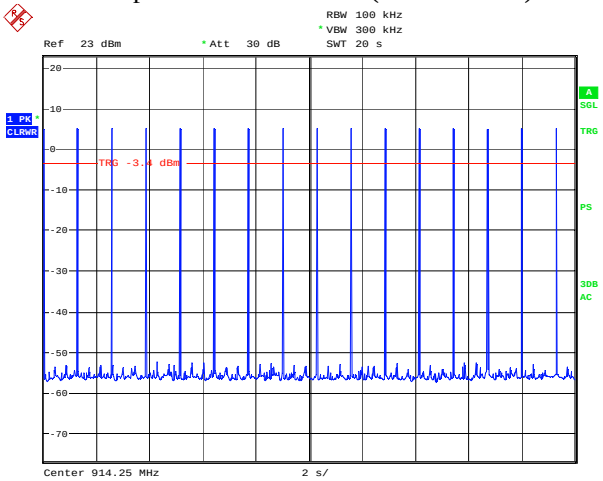
Single pulse width (Low channel)



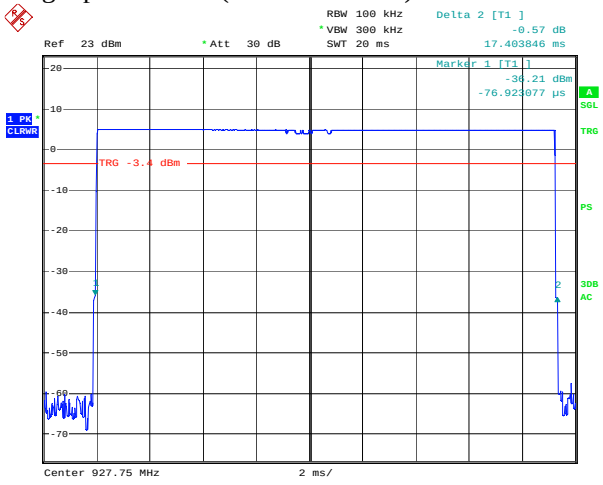
Number of pulses in 20 seconds (Low channel)



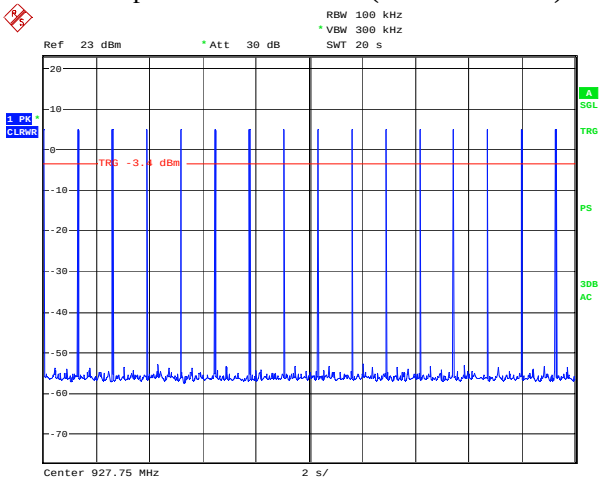
Single pulse width (Middle channel)



Number of pulses in 20 seconds (Middle channel)



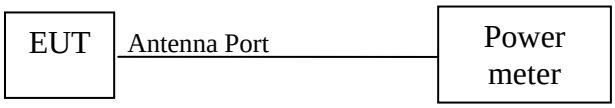
Single pulse width (High channel)



Number of pulses in 20 seconds (High channel)

2.5 Peak Output Power

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the power meter.



Test procedure
The EUT antenna port connected to the Power meter.

Limitation
For frequency hopping systems operating in the 902–928 MHz band: 1 Watt for systems employing at least 50 hopping channels;

Test equipment used (refer to List of utilized test equipment)

PM05	PU06				

Test Data
Tested Date: 22 November, 2011

Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa

Test results – comply with the limitation. (Peak)

Transmission Channel (Frequency: MHz)	Output power (dBm) [Result]	Output power (mW) [Result]
Low (902.25)	**5.90**	**3.89**
Middle (914.25)	**5.90**	**3.89**
High (927.75)	5.80	3.80

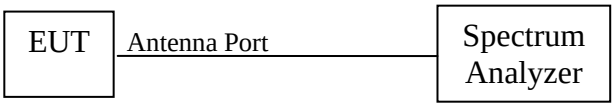
Average output power

Highest output power is 2.24mW more than 60mW/F (GHz), SAR evaluation is not required.

Transmission Channel (Frequency: MHz)	Output power (dBm) [Result]	Output power (mW) [Result]
Low (902.25)	**3.50**	**2.24**
Middle (914.25)	**3.50**	**2.24**
High (927.75)	3.40	2.19

2.6 Conducted Spurious Emissions (Antenna Port)

Test setup
Test setup is the following drawing. The antenna port of EUT was connected to the spectrum analyzer.



Test procedure
The EUT antenna port connected to the spectrum analyzer. The RBW is set to 100 kHz. The VBW is set to 300 kHz. The sweep time is set to the coupled. The spectrum is cheated from 30 MHz to 10 GHz.

Limitation
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.

Test equipment used (refer to List of utilized test equipment)

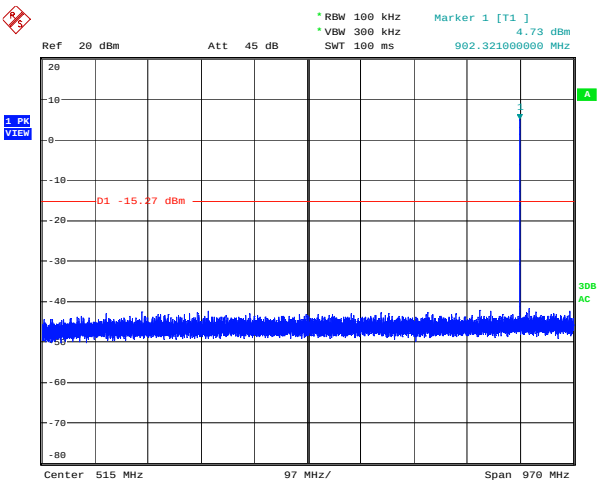
TR06	CL23				

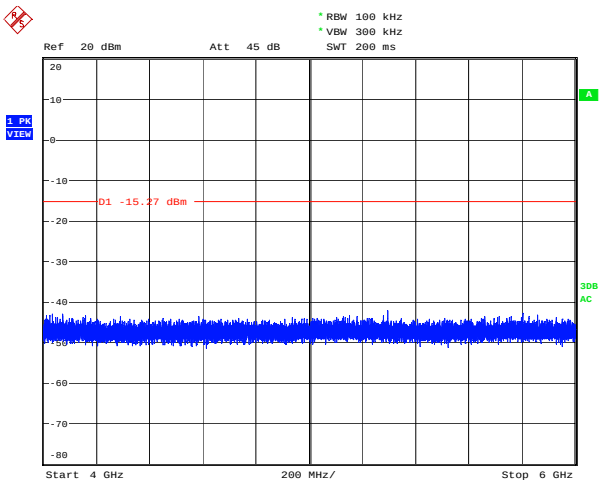
Test results – comply with the limitation.
There were no conducted spurious emissions with levels of more than 20 dB below the applicable limit.

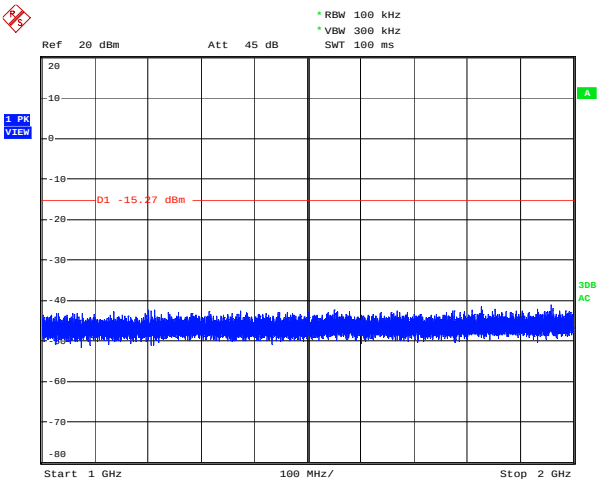
Test Data
Tested Date:
22 November, 2011

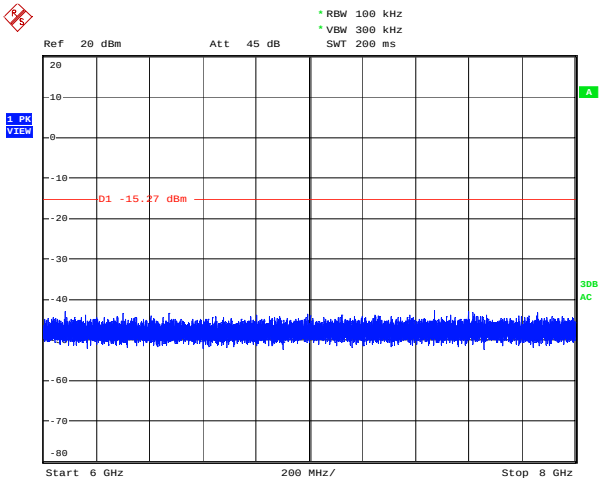
Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa

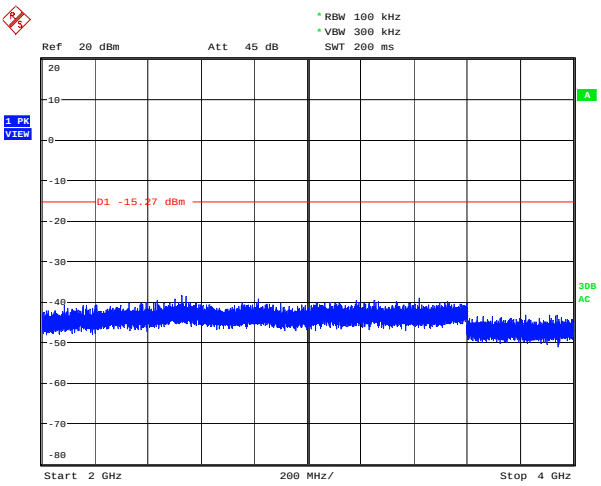
Worst Configuration (Low ch: 902.25 MHz)

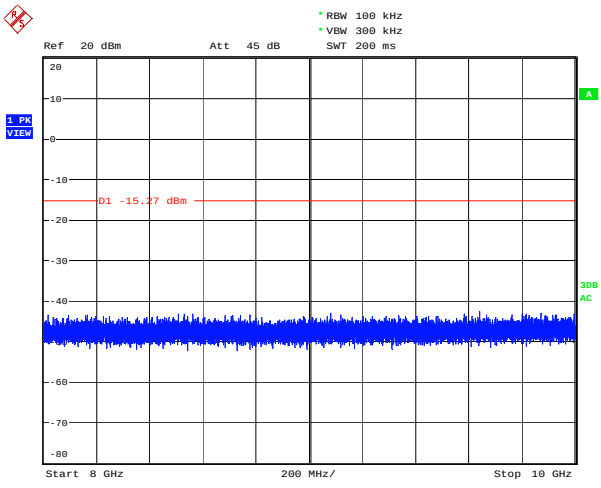








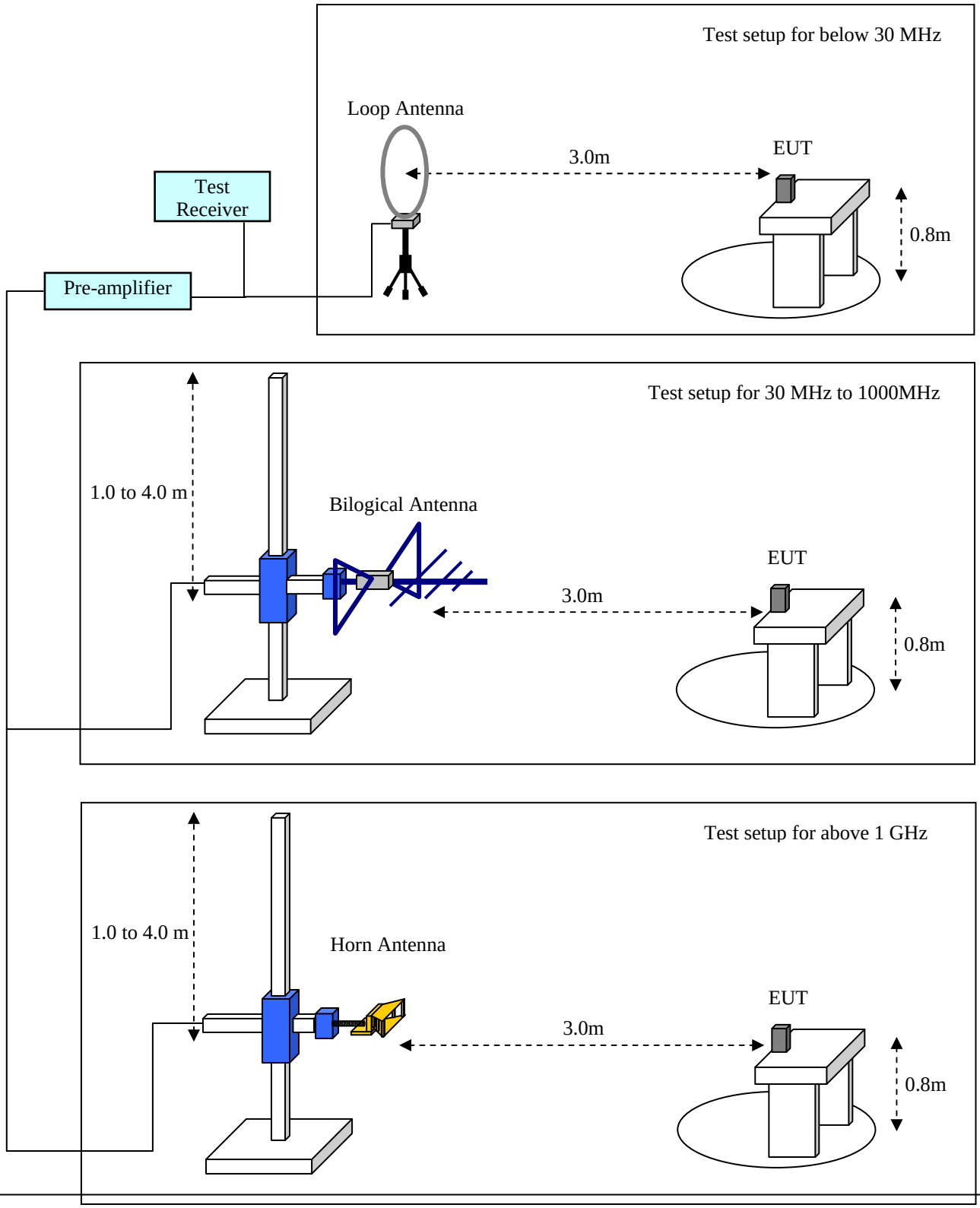




2.7 Transmitter Radiated spurious emissions

Test setup

Test setup was implemented according to the method of ANSI C63.4: 2003 clause 6 “General requirements for EUT equipment arrangements and operation”, clause 8.2 and Annex H.3 “Radiated emission measurements setup”.



Test procedure

Measurement procedures were implemented according to the method of ANSI C63.4: 2003 clauses 8.2.
The EUT is place on a non-conducted table which is 0.8m height from a ground plane and the measurement antenna to EUT distance is 3 meters. The turn table is rotated for 360 degrees to determine the maximum emission level.
In the frequency range of 9 kHz to 30 MHz, a calibrated loop antenna was positioned with its plane vertical at the distance 3m from the EUT with an extrapolation of corrected distance factor and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna also needs to be positioned horizontally. The center of the loop shall be 1 m above the ground.
In the frequency above 30 MHz, the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.
EUT is placed at three different orientations (X, Y and Z axis) in order to find the worst orientation.
The spectrum analyzer and receiver are set to the followings;

Below 30 MHz:	RBW=10 kHz, VBW= 10 kHz Final measurement is carried out with a receiver RBW of 9 kHz (QP)
Between 30 - 1000 MHz:	RBW=100 kHz, VBW= 100 kHz Final measurement is carried out with a receiver RBW of 120 kHz (QP)
Above 1000 MHz:	Peak measurement- RBW=1 MHz, VBW= 1 MHz Average measurement – RBW=1 MHz, VBW=10 Hz

Applicable rule and limitation

§15.205 restricted bands of operation

Except as shown in paragraph 15.205 (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.490 - 0.510	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	(1)

15.205(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.

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 (uV/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

In the emission table above, the tighter limit applies at the band edges.
The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission.
The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz.

Test results - Complied with requirement.

Test Data

2.7.1 Below 30 MHz

Test equipment used (refer to List of utilized test equipment)

LP01	CL11	TR06	

Tested Date:
23 November, 2011

Temperature: 20 ˚C
Humidity: 36 %
Atmos. Press: 1022 hPa

Result

There is no spurious emission with levels of more than 20 dB below the applicable limit

2.7.2 Between 30 – 1000 MHz

Test equipment used (refer to List of utilized test equipment)

BA04	CL11	PR03	TR06	BRF7

Tested Date: 22 November 2011

Temperature: 21 ˚C
Humidity: 35 %
Atmos. Press: 1024 hPa

Operating mode: Continuous Communication (Lch: 902.25MHz: Worst configuration)
EUT position: X-plane (Maximum position)
Measurement distance: 3 m

There are no spurious emissions other than listed below;

No.	Frequency [MHz]	Reading [dBuV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Antenna Polarization
1	33.289	35.0	16.7	7.0	29.8	28.9	40.0	11.1	Hori.
2	47.999	49.2	9.2	7.3	29.7	36.0	40.0	4.0	Vert.
3	100.674	33.6	10.9	8.1	29.6	23.0	43.5	20.5	Hori.
4	101.614	40.1	10.9	8.1	29.6	29.5	43.5	14.0	Vert.
5	232.811	53.2	11.5	9.5	29.6	44.6	46.0	1.4	Vert.
6	233.932	50.9	11.6	9.5	29.6	42.4	46.0	3.6	Hori.
7	565.582	38.5	18.8	12.1	29.9	39.5	46.0	6.5	Vert.
8	698.982	34.4	19.3	12.8	29.7	36.8	46.0	9.2	Hori.

Calculation method
The Correction Factors and RESULT are calculated as followings.

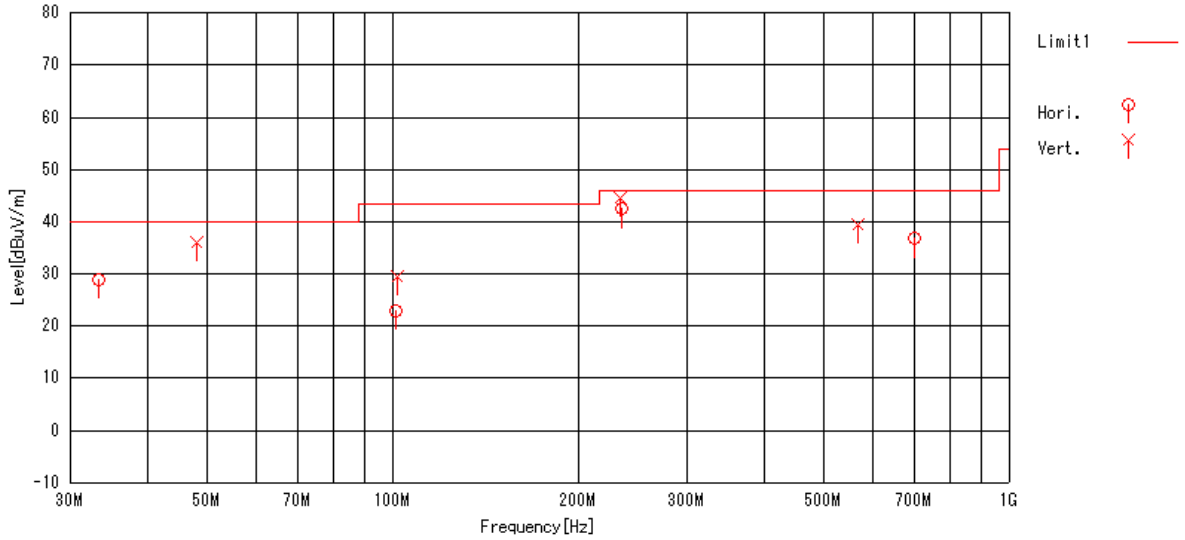
Correction Factor [dB/m] = FACTOR [dB/m] + LOSS [dB] – GAIN [dB]

RESULT [dBuV/m] =READING [dBuV] + Correction Factor [dB/m]

Sample calculation at 232.811 MHz vertical result as follow:

Result [dBuV/m] = Reading + C.F = 53.2 + 11.5 + 9.5 - 29.6 = 44.6
Margin = Limit – Result = 46.0 – 44.6 = 1.4 [dB]

Graphical express of test result (30MHz-1000MHz)



2.7.3 Above 1000 MHz

Test equipment used (refer to List of utilized test equipment)

PR12	TR06	CL23	CL24	CL28	HPF2	DH01	AC01	AT33

Harmonics and Spurious Emission above 1000 MHz

Tested Date:
23 November, 2011

Temperature: 20 ˚C
Humidity: 36 %
Atmos. Press: 1022 hPa

Operating mode: Continuous Communication (Mch: 902.25MHz: Worst configuration)
EUT position: Z-plane (Maximum position)
Measurement distance: 3 m

There are no spurious emissions other than listed below;

No.	Frequency [MHz]	Reading [dBuV]		C.F. [dB]	Result [dBuV/m]		Limit [dBuV/m]		Margin [dB]		Polarization
		Peak	Ave.		Peak	Ave.	Peak	Ave.	Peak	Ave.	
1	1804.497	49.9	40.3	2.3	52.2	42.6	73.9	53.9	21.7	11.3	Vert.
2	2706.465	59.0	54.6	-3.3	55.7	51.3	73.9	53.9	18.2	2.6	Hori.
3	2706.745	58.7	54.0	-3.3	55.4	50.7	73.9	53.9	18.5	3.2	Vert.
4	3608.992	51.9	47.8	-1.4	50.5	46.4	73.9	53.9	23.4	7.5	Hori.
5	3608.995	52.8	49.4	-1.4	51.4	48.0	73.9	53.9	22.5	5.9	Vert.

Calculation method
The Correction Factors and RESULT are calculated as followings.

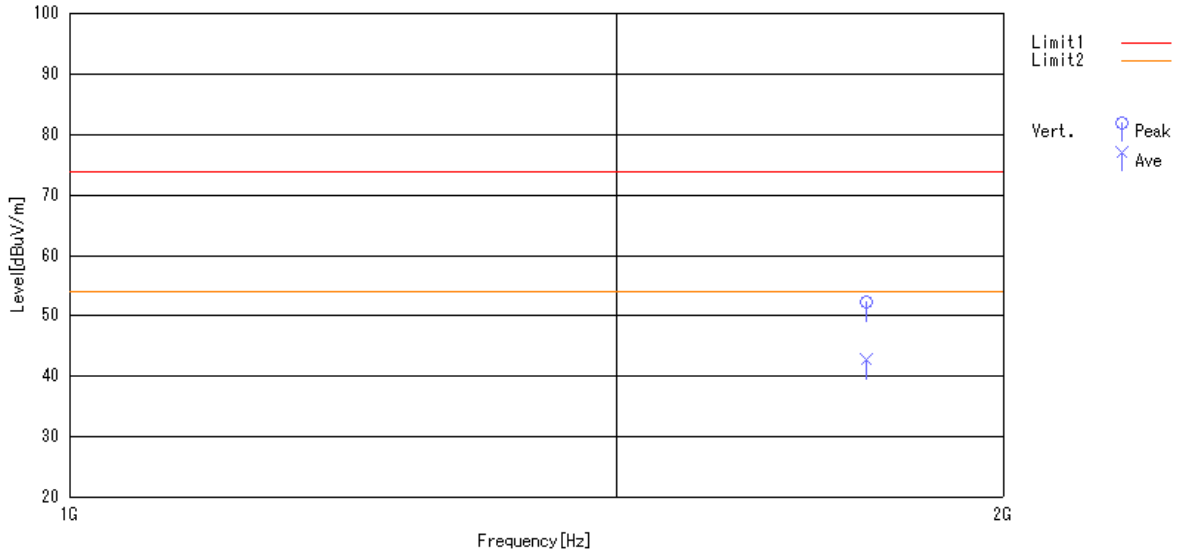
Correction Factor [dB/m] = FACTOR [dB/m] + LOSS [dB] – GAIN [dB]

RESULT [dBuV/m] =READING [dBuV] + Correction Factor [dB/m]

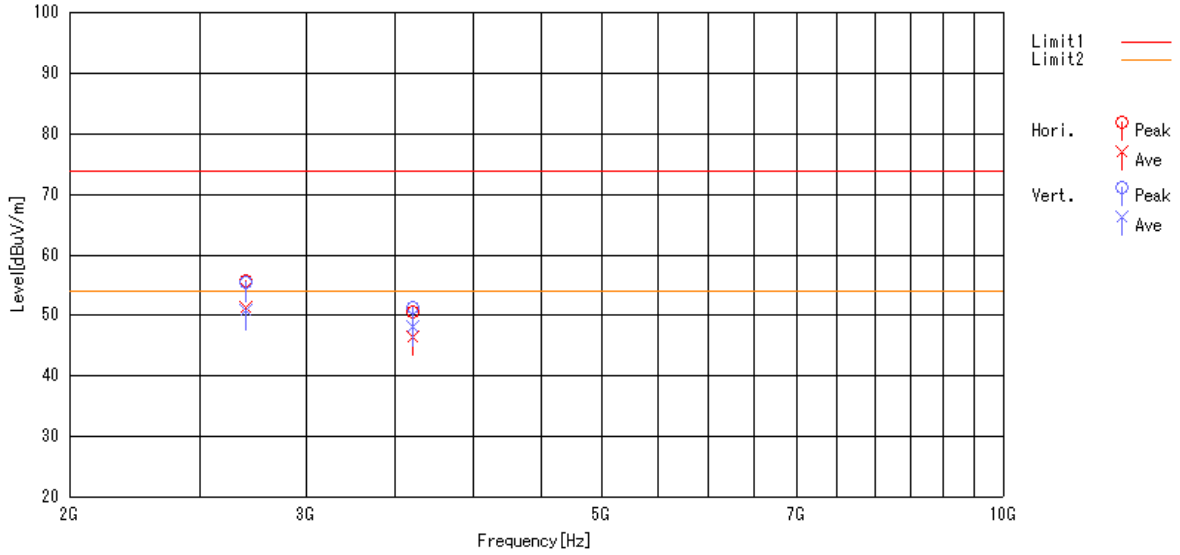
Sample calculation at 2706.465 MHz average, horizontal result as follow:

Result [dBuV/m] = Reading + C.F = 54.6 – 3.3 = 51.3
Margin = Limit – Result = 53.9 – 51.3 = 2.6 [dB]

Graphical express of test result (1000MHz-2000MHz)



Graphical express of test result (1000MHz-2000MHz)



2.8 Transmitter AC power line conducted emissions

Test setup
Test setup was implemented according to the method of ANSI C63.4: 2003 clause 6 “General requirements for EUT equipment arrangements and operation” and Annex H.1 “AC power line conducted emission measurements setup”.

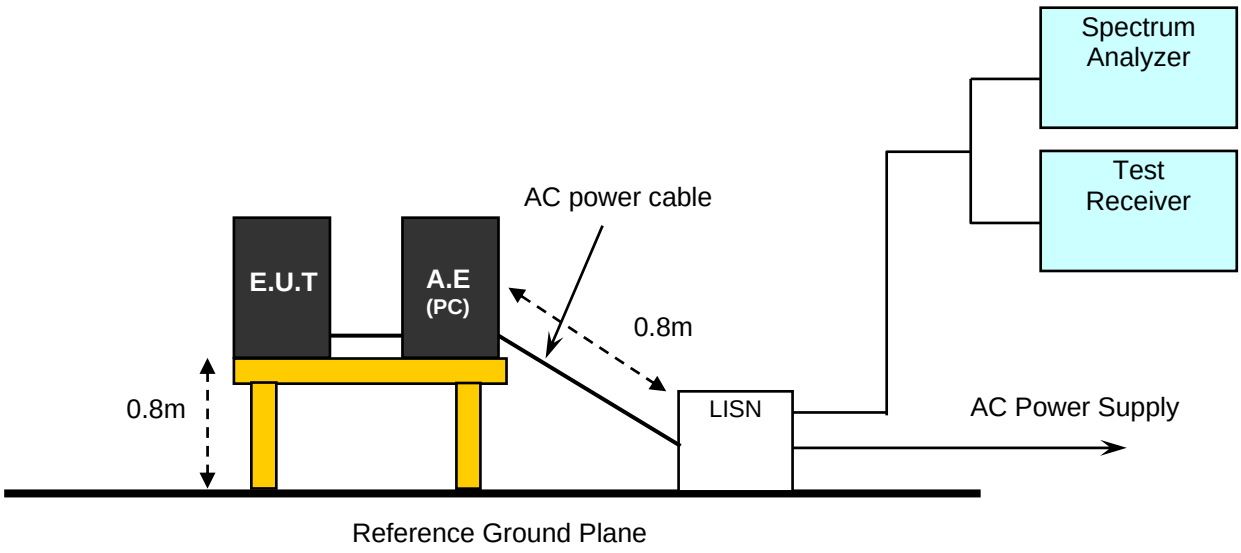
Test procedure
Measurement procedures were implemented according to the method of ANSI C63.4: 2003 clauses 7, clause 13.1.3 and Annex H.2 “AC power line conducted emission measurements”.
Exploratory measurements were used the spectrum analyzer to identify the frequency of the emission that has the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable positions, and with a typical system equipment configuration and arrangement.
Final ac power line conducted emission measurements were performed based on the exploratory tests.
The EUT cable configuration and arrangement and mode of operation that produced the emission with the highest amplitude relative to the limit are selected for the final measurement.
When the measurement value is greater than average limitation the average detection measurements were performed.

Applicable rule and limitation

§15.207 (a) AC power line conducted limits

Frequency of Emission (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.
The lower limit applies at the band edges.



Test equipment used (refer to List of utilized test equipment)

TR06	PL06	LN05	CL18

Test results - Complied with requirement.

Test Data

Tested Date:
24 November, 2011

Temperature: 24 ˚C
Humidity: 57 %
Atmos. Press: 1010 hPa

Operating mode: Continuous Communication (Mch: 914.25MHz: Worst configuration)

No.	Frequency [MHz]	Reading		C.F. [dB]	Result		Limit		Margin		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB]	AV [dB]	
1	0.15000	31.0	5.6	10.2	41.2	15.8	66.0	56.0	24.8	40.2	Va
2	0.15000	30.4	5.2	10.2	40.6	15.4	66.0	56.0	25.4	40.6	Vb
3	0.17422	29.2	23.1	10.1	39.3	33.2	64.8	54.8	25.5	21.6	Va
4	0.17963	29.4	24.8	10.1	39.5	34.9	64.5	54.5	25.0	19.6	Vb
5	0.48150	22.2	20.9	10.0	32.2	30.9	56.3	46.3	24.1	15.4	Va
6	0.55984	18.6	17.6	10.0	28.6	27.6	56.0	46.0	27.4	18.4	Vb
7	1.68128	19.2	17.2	10.0	29.2	27.2	56.0	46.0	26.8	18.8	Vb
8	2.17167	23.8	20.5	10.0	33.8	30.5	56.0	46.0	22.2	15.5	Va
9	15.82648	22.4	16.4	10.2	32.6	26.6	60.0	50.0	27.4	23.4	Vb
10	20.15806	23.5	18.1	10.4	33.9	28.5	60.0	50.0	26.1	21.5	Va
11	23.07220	22.0	16.3	10.4	32.4	26.7	60.0	50.0	27.6	23.3	Va
12	23.42400	22.2	13.4	10.4	32.6	23.8	60.0	50.0	27.4	26.2	Vb

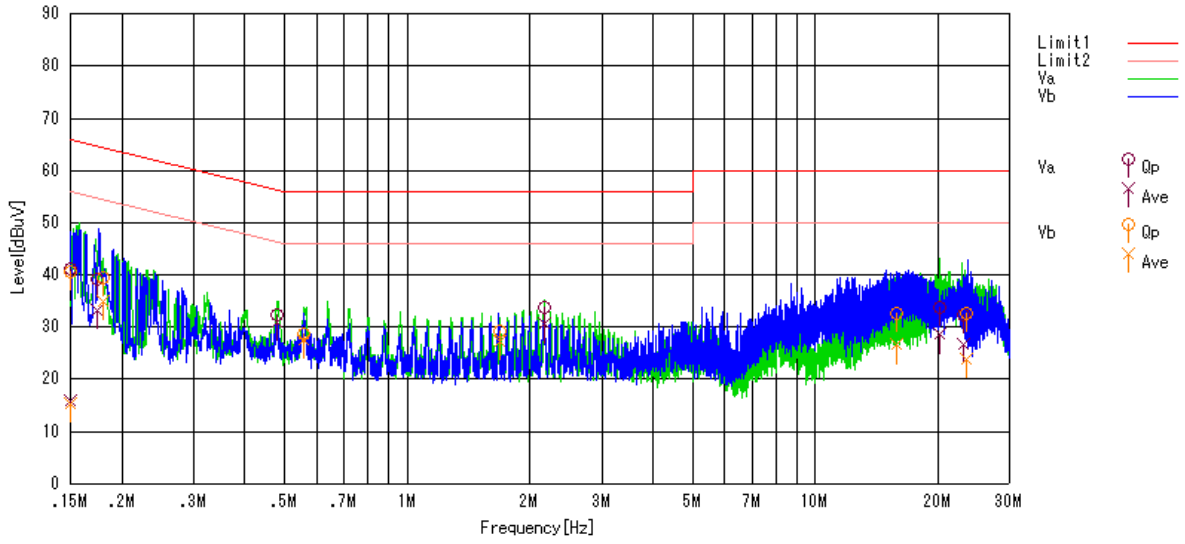
The power line conducted emission voltage is calculated by adding the LISN factor and Cable loss attenuation from the measured reading. The calculation is as follows:

Result = Reading + C. F
where C.F = LISN Factor + Cable Loss [dB]

Sample calculation at 0.48150 MHz AV result as follow:

Result [dBuV] = Reading + C.F = 20.9 + 10.0 = 30.9 [dBuV]
Margin = Limit – Result = 46.3 – 30.9 = 15.4 [dB]

Graphical express of test result (0.15 MHz-30MHz)



2.9 Receiver Radiated spurious emissions

Test setup - Same as clause 2.5

Test procedure - Same as clause 2.5

Applicable rule and limitation at 3m
§15.109 radiated emission limitation

Frequency (MHz)	Measurement Distance (m)	Field Strength (uV/m)	Field Strength (dBuV/m)
30 – 88	3	100	40.0
88 –216	3	150	43.5
216 – 960	3	200	46.0
Above 960	3	500	53.9

In the emission table above, the tighter limit applies at the band edges.
The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector.
Radiated emission limits in the above bands are based on measurements employing an average detector.

Test results - Complied with requirement.

2.9.1 Between 30 – 1000 MHz

Test equipment used (refer to List of utilized test equipment)

BA04	CL11	PR03	TR06

Test Data

Tested Date: 09 December, 2011

Temperature: 20 ˚C
Humidity: 37 %
Atmos. Press: 1013 hPa

Operating mode: Continuous Receiving (Lch: 902.25 MHz: Worst configuration)
EUT position: X-plane (Maximum position)
Measurement distance: 3 m

There are no spurious emissions other than listed below;

No.	Frequency [MHz]	Reading [dBuV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Antenna Polarization
1	47.998	33.6	9.2	7.2	29.7	20.3	40.0	19.7	Hori.
2	48.000	47.0	9.2	7.2	29.7	33.7	40.0	6.3	Vert.
3	232.994	49.9	11.6	9.2	29.6	41.1	46.0	4.9	Hori.
4	232.994	44.8	11.6	9.2	29.6	36.0	46.0	10.0	Vert.
5	565.856	38.8	18.9	11.5	29.9	39.3	46.0	6.7	Vert.
6	565.980	41.3	18.9	11.5	29.9	41.8	46.0	4.2	Hori.

Calculation method
The Correction Factors and RESULT are calculated as followings.

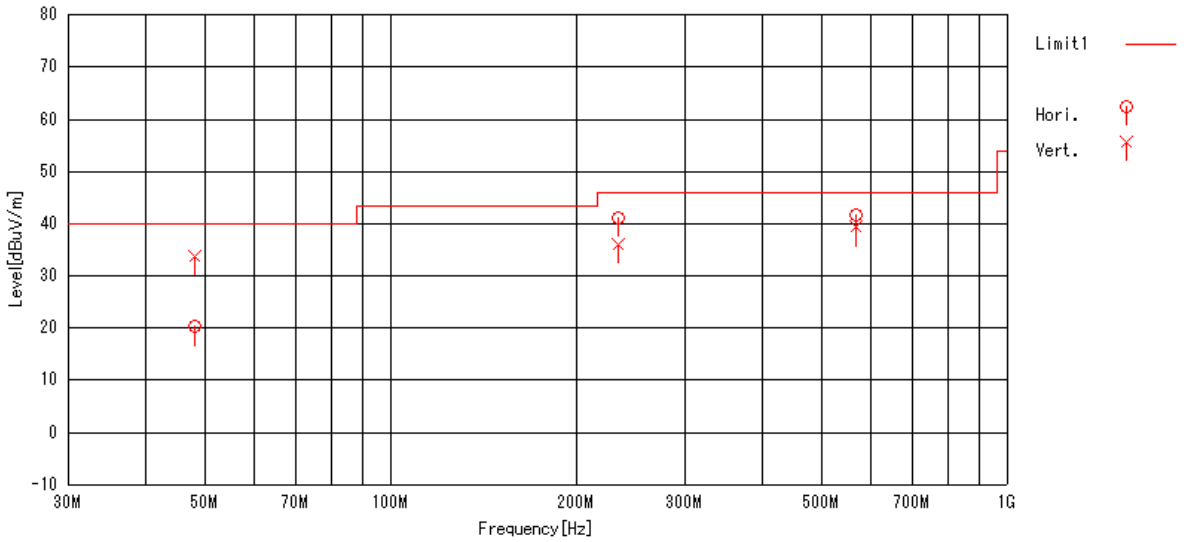
Correction Factor [dB/m] = FACTOR [dB/m] + LOSS [dB] – GAIN [dB]

RESULT [dBuV/m] =READING [dBuV] + Correction Factor [dB/m]

Sample calculation at 565.980 MHz horizontal result as follow:

Result [dBuV/m] = Reading + C.F = 41.3 + 18.9 + 11.5 - 29.9 = 41.8
Margin = Limit – Result = 46.0– 41.8 = 4.2 [dB]

Graphical express of test result (30MHz-1000MHz)



2.9.2 Above 1000 MHz

Test equipment used (refer to List of utilized test equipment)

PR12	TR06	CL24	CL28	DH01		

Tested Date:
09 December, 2011

Temperature: 20 ˚C
Humidity: 37 %
Atmos. Press: 1013 hPa

Operating mode: Continuous Communication (Mch: 914.25MHz: Worst configuration)
EUT position: Z-plane (Maximum position)
Measurement distance: 3 m

There are no spurious emissions other than listed below;

No.	Frequency [MHz]	Reading [dBuV]		C.F. [dB]	Result [dBuV/m]		Limit [dBuV/m]		Margin [dB]		Polarization
		Peak	Ave.		Peak	Ave.	Peak	Ave.	Peak	Ave.	
1	1291.698	56.5	36.6	-10.2	46.3	26.4	73.9	53.9	27.6	27.5	Vert.
2	3657.194	51.5	45.3	-1.6	49.9	43.7	73.9	53.9	24.0	10.2	Hori.

Calculation method
The Correction Factors and RESULT are calculated as followings.

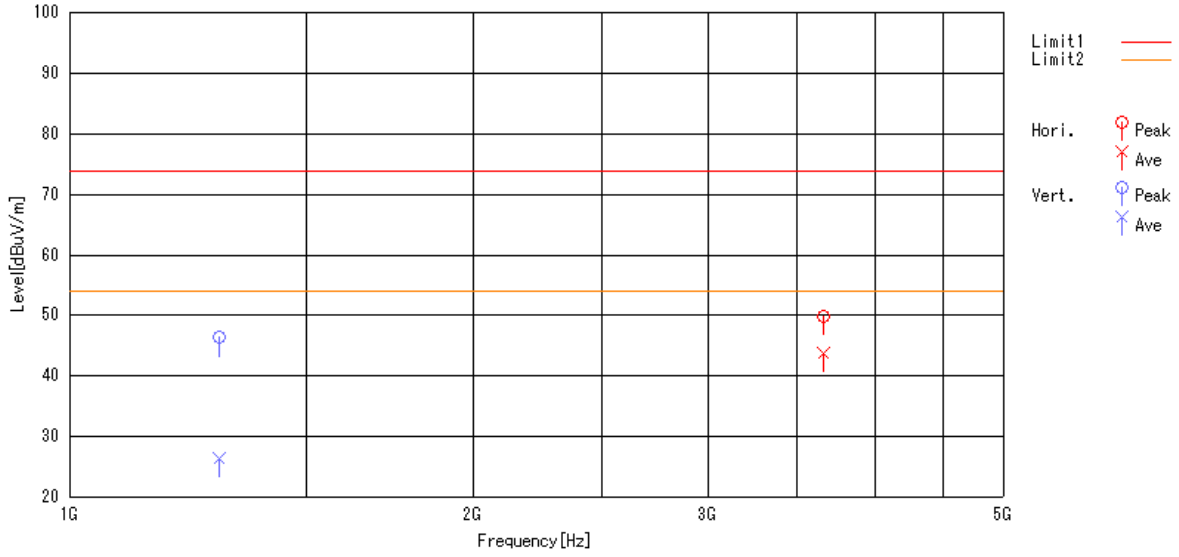
Correction Factor [dB/m] = FACTOR [dB/m] + LOSS [dB] – GAIN [dB]

RESULT [dBuV/m] =READING [dBuV] + Correction Factor [dB/m]

Sample calculation at 3657.194 MHz average, horizontal result as follow:

Result [dBuV/m] = Reading + C.F = 43.5 – 1.6 = 43.7
Margin = Limit – Result = 53.9 – 43.7 = 10.2 [dB]

Graphical express of test result (1000MHz-5000MHz)



2.10 Receiver AC power line conducted emissions

Test setup - Same as clause 2.6

Test procedure - Same as clause 2.6

Applicable rule and limitation

§15.107 (a) AC power line conducted limits

Frequency of Emission (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.
The lower limit applies at the band edges.

Test equipment used (refer to List of utilized test equipment)

TR04	PL06	LN05	CL18

Test results - Complied with requirement.

Test Data

Tested Date: 09 December, 2011

Temperature: 23 ˚C
Humidity: 58 %
Atmos. Press: 1013 hPa

Operating mode: Continuous Receiving (Mch: 914.25MHz: Worst configuration)

No.	Frequency [MHz]	Reading		C.F. [dB]	Result		Limit		Margin		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dB	AV [dB]	
1	0.18168	30.5	25.5	10.1	40.6	35.6	64.4	54.4	23.8	18.8	Vb
2	0.18224	30.9	25.7	10.1	41.0	35.8	64.4	54.4	23.4	18.6	Va
3	0.48599	21.5	20.1	10.0	31.5	30.1	56.2	46.2	24.7	16.1	Vb
4	1.61723	21.3	18.8	10.0	31.3	28.8	56.0	46.0	24.7	17.2	Va
5	1.62052	23.3	20.6	10.0	33.3	30.6	56.0	46.0	22.7	15.4	Vb
6	2.43048	25.1	22.3	10.0	35.1	32.3	56.0	46.0	20.9	13.7	Vb
7	3.15498	16.9	14.0	10.0	26.9	24.0	56.0	46.0	29.1	22.0	Va
8	3.24095	21.3	17.6	10.0	31.3	27.6	56.0	46.0	24.7	18.4	Vb
9	5.50214	17.3	14.0	10.0	27.3	24.0	60.0	50.0	32.7	26.0	Va
10	18.53382	18.8	13.5	10.3	29.1	23.8	60.0	50.0	30.9	26.2	Va
11	21.72187	26.3	21.3	10.4	36.7	31.7	60.0	50.0	23.3	18.3	Vb
12	23.42009	20.3	12.2	10.4	30.7	22.6	60.0	50.0	29.3	27.4	Va

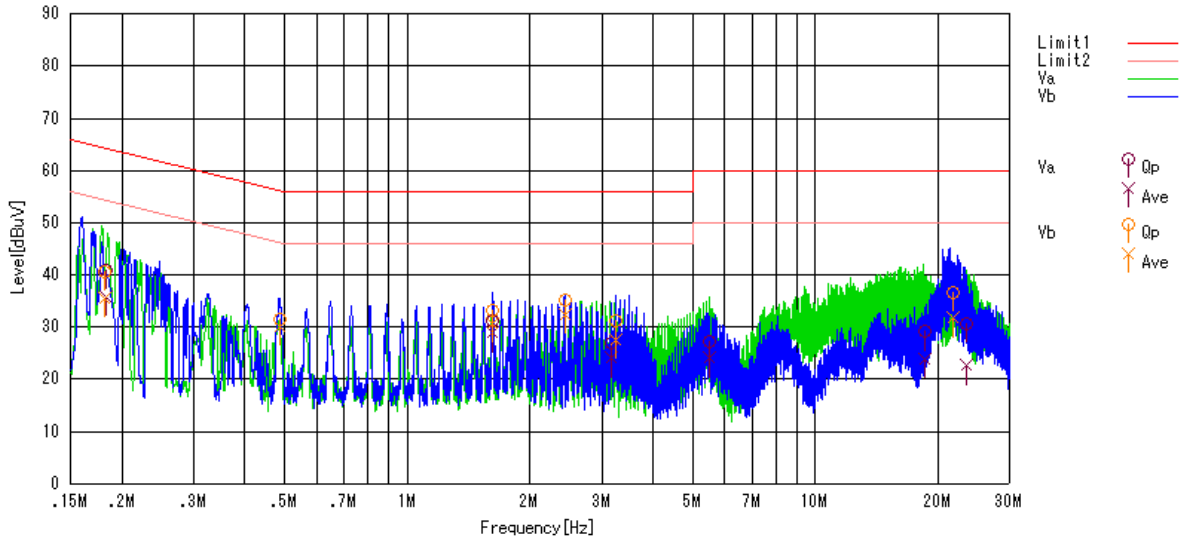
The power line conducted emission voltage is calculated by adding the LISN factor and Cable loss attenuation from the measured reading. The calculation is as follows:

Result = Reading + C. F
where C.F = LISN Factor + Cable Loss [dB]

Sample calculation at 2.43048 MHz avarage result as follow:

Result [dBuV] = Reading + C.F = 22.3 + 10.0 = 32.3 [dBuV]
Margin = Limit – Result = 46.0 – 32.3 = 13.7 [dB]

Graphical express of test result (0.15 MHz-30MHz)



2.11 Maximum Permissible Exposure (Exposure of Humans to RF Fields)

Limitation

15.247(i) systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.
See 1.1307(b) (1) of this Chapter.
1.1310 The criteria of "General Population/ Uncontrolled Exposure" listed in the below table shall be used to evaluated the environmental impact of human exposure to radio-frequency radiation as specified in 1.1307(b), except in the case of portable devices which shall be evaluated according to the previsions of 2.1093 of this chapter.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

NOTE 2: ***General population/uncontrolled*** exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

The MPE distance calculations:

The Maximum Permissible Exposure (MPE) distance between the EUT's antenna and human body is calculated in accordance with FCC OET Bulletin 65 and Safety Code 6 of IC.
The MPE distance where the exposure level reaches the permitted exposure level can be calculated as bellow;

$$S = P * G / 4\pi R^2$$

Rearranging terms to calculate the MPE Distance

$$R = (P * G / 4\pi S)^{1/2}$$

Where:

R = MPE Distance in cm
P = Power in dBm (3.89 mW (902.25MHz), Refer to page 13 in this report)
G = Antenna Gain in numeric
(1 = 0dBi, Max. Antenna Gain)
S = Power Density Limit in mW/cm2
(0.60 mW/cm2, Max. permissible exposure limit above)

Then MPE Distance is 0.718 cm.

4 List of utilized test equipment/ calibration

RFT ID No.	Kind of Equipment and Precision	Manufacturer	Model No.	Serial Number	Calibration Date	Calibrated until
AC01(EM)	Anechoic Chamber (1st test room)	JSE	203397C	-	2011/4/23	2012/4/30
AC01(EG)	Anechoic Chamber (1st test room)	JSE	203397C	-	2011/11/12	2012/11/30
BA04	Bilogical Antenna	SCHAFFNER	CA2855	2903	2011/1/26	2012/1/31
CL11	Antenna Cable for RE	RFT	-	-	2011/10/27	2012/10/31
CL18	Antenna Cable for CE	RFT	-	-	2011/5/13	2012/5/31
CL23	RF Cable 0.5m	SUHNER	SUCOFLEX104PE	48773	2011/6/17	2012/6/30
CL24	RF Cable 5.0m	SUHNER	SUCOFLEX104PE	48775	2011/6/17	2012/6/30
CL28	RF Cable 1.0m	SUHNER	SUCOFLEX104PE	75769	2011/8/8	2012/8/31
LN05	LISN	Kyoritsu	KNW-407F	8-1773-2	2011/5/31	2012/5/31
PL06	Pulse Limiter	PMM	PL-01	0000J10109	2011/1/31	2012/1/31
PR03	Pre. Amplifier	Anritsu	MH648A	M41984	2011/5/12	2012/5/31
PR12	Pre. Amplifier (1-26G)	Agilent Technologies	8449B	3008A02513	2011/1/18	2012/1/31
HPF2	High Pass Filter (1500MHz)	M-City	HPF0900-01	RF0003-01	2011/6/17	2012/6/30
BRF7	Band Reject Filter (SRD900)	M-City	BRF0915-03	RF0007-02	2011/11/2	2012/11/30
TR04	Test Receiver (F/W : 4.32)	Rohde & Schwarz	ESCI	100447	2011/9/2	2012/9/30
TR06	Test Receiver (F/W : 3.93 SP2)	Rohde & Schwarz	ESU26	100002	2011/9/16	2012/9/30
DH01	DRG Horn Antenna	A.H. Systems	SAS-571	785	2010/1/20	2012/1/31
PM05	Power Meter	Anritsu	ML2487A	6K00004724	2011/9/6	2012/9/30
PU06	Power Sensor (Peak/Ave)	Anritsu	MA2491A	033696	2011/9/6	2012/9/30

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.