EMC TEST REPORT for Intentional Radiator

No. 131100628SHA-001

Applicant	: TELE RADIO AB Datavägen 21, SE-436 32 Askim, Sweden
Manufacturer	: TELE RADIO AB Datavägen 21, SE-436 32 Askim, Sweden
Equipment	: Transceiver Radio Modular
Type/Model	: D00005-11

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2010): Radio Frequency Devices

ANSI C63.4 (2003): American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

RSS-210 Issue 8 (December 2010): Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment

RSS-Gen Issue 3 (December 2010): General Requirements and Information for the Certification of Radiocommunication Equipment

Date of issue: November 28, 2013

Prepared by:	Reviewed by:
Nemo Li	
Nemo Li (*Project Engineer*)	Daniel Zhao (*Reviewer*)

Description of Test Facility

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IC Assigned Code: 2042B-1

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Content

1. General Information

1.1 Applicant Information

Applicant:		TELE RADIO AB Datavägen 21, SE-436 32 Askim, Sweden
Name of contact:		Jesper Ribbe
Tel:		+46 31 7485460
Fax:		+46 31 685464
Manufacturer:		TELE RADIO AB Datavägen 21, SE-436 32 Askim, Sweden
Sample received date	:	November 20, 2013
Date of test	:	November 20, 2013 ~ November 27, 2013

1.2 Identification of the EUT

Equipment:	Transceiver Radio Modular
Type/model:	D00005-11
FCC ID:	ONFC1303A
IC:	4807A-C1303A

1.3 Technical specification

Frequency Range:	902 - 928 MHz
Modulation:	2FSK
Gain of Antenna:	Dipole antenna, 3.0dBi max
Rating:	DC 3.3V powered by the host device indirectly *Rating of host device:* *Input 12-250V DC: 24-230V AC, 50/60Hz, Max 2A*
Description of EUT:	The EUT is a wireless module working in the 902-928MHz ISM band.
Channel Description:	EUT has 15 banks and each bank has 64 channels. EUT can be chosen to work on each bank.

1.4 Mode of operation during the test / Test peripherals used

EUT has two dipole antennas, only one antenna can work at the same time. After pretest and evaluation, the antenna with max output power was chosen to do all the tests.

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

The lowest, middle and highest channel were tested as representatives (903.0125MHz, 914.8125MHz and 926.9875MHz).

Test Peripherals:
PC: HP Compaq 6280 Pro Microtower

2. Test Specification

2.1 Instrument list

Test Receiver	ESIB 26	R&S	EC 3045	2013-10-20	2014-10-19
Semi-anechoic chamber	-	Albatross project	EC 3048	2013-5-12	2014-5-11
Bilog Antenna	CBL 6112D	TESEQ	EC 4206	2013-4-28	2015-4-27
Horn antenna	HF 906	R&S	EC 3049	2013-4-28	2015-4-27
Horn antenna	3117	ETS	EC 4792-1	2012-4-17	2014-4-16
Pre-amplifier	Pre-amp 18	R&S	EC 3222	2012-4-12	2013-4-11
Pre-amplifier	Tpa0118-40	R&S	EC 4792-2	2012-4-12	2013-4-11
Test Receiver	ESCS 30	R&S	EC 2107	2013-10-21	2014-10-20
A.M.N.	ESH2-Z5	R&S	EC 3119	2013-1-9	2014-1-8
A.M.N.	ENV 216	R&S	EC 3394	2013-8-9	2014-8-8
High Pass Filter	WHKX 1.0/15G-10SS	Wainwright	EC4297-1	2013-1-9	2014-1-8
High Pass Filter	WHKX 2.8/18G-12SS	Wainwright	EC4297-2	2013-4-12	2014-4-11
High Pass Filter	WHKX 7.0/1.8G-8SS	Wainwright	EC4297-3	2013-1-9	2014-1-8
Band Reject Filter	WRCGV 2400/2483-2390/2493-35/10SS	Wainwright	EC4297-4	2013-1-9	2014-1-8
Test Receiver	FSP40	R&S	/	2013-10-15	2014-10-14

2.2 Test Standard

47CFR Part 15 (2010)
ANSI C63.4: 2003
RSS-210 Issue 8 (December 2010)
RSS-Gen Issue 3 (December 2010)

2.3 Test Summary

This report applies to tested sample only. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERANCE	IC REFERANCE	RESULT
20 dB Bandwidth	15.247(a)(1)	RSS-210 Issue 8 Annex 8	Tested
Carrier Frequency Separation	15.247(a)(1)	RSS-210 Issue 8 Annex 8	Pass
Output power	15.247(b)(1)	RSS-210 Issue 8 Annex 8	Pass
Radiated Spurious Emissions	15.205 & 15.209	RSS-210 Issue 8 Clause 2	Pass
Conducted Spurious Emissions & Band Edge	15.247(d)	RSS-210 Issue 8 Annex 8	Pass
Power line conducted emission	15.207	RSS-Gen Issue 3 Clause 7.2.4	Pass
Number of Hopping Frequencies	15.247(a)(1)(iii)	RSS-210 Issue 8 Annex 8	Pass
Dwell time	15.247(a)(1)(iii)	RSS-210 Issue 8 Annex 8	Pass
Occupied bandwidth	-	RSS-Gen Issue 3 Clause 4.6.1	Tested
Spurious emission for receiver	-	RSS-310 Issue 3 Clause 3.1	NA

Note: “NA” means “not applied”.

3. 20 dB Bandwidth

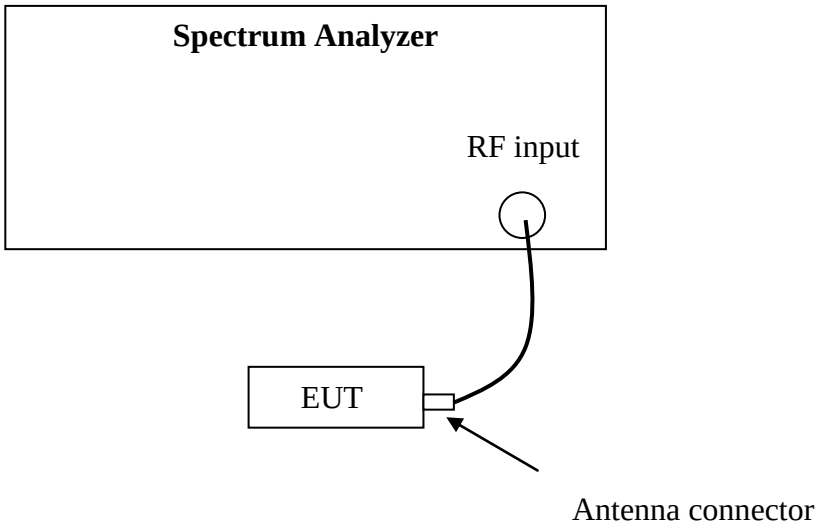
Test result: Tested

3.1 Limit

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

☐ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

3.2 Test Configuration



3.3 Test Procedure and test setup

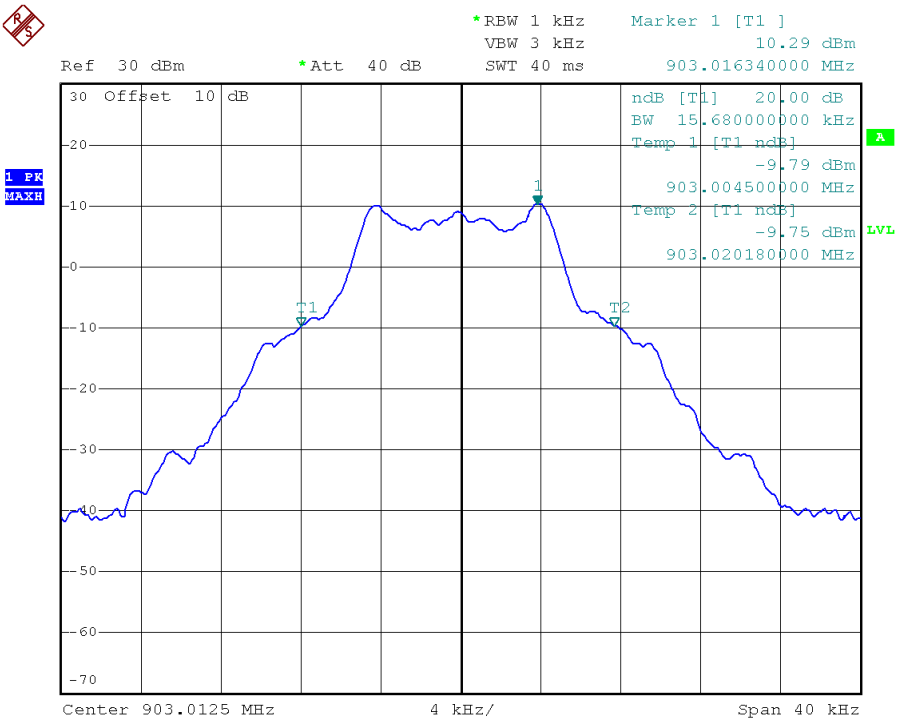
The 20 bandwidth per FCC § 15.247(a)(1) is measured using the Spectrum Analyzer with Span = 2 to 3 times the 20 dB bandwidth, RBW≥1% of the 20 dB bandwidth, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

3.4 Test Protocol

Temperature : 25°C
Relative Humidity : 55 %

CH	Bandwidth (kHz)
L	15.68
M	15.60
H	15.68

Channel L



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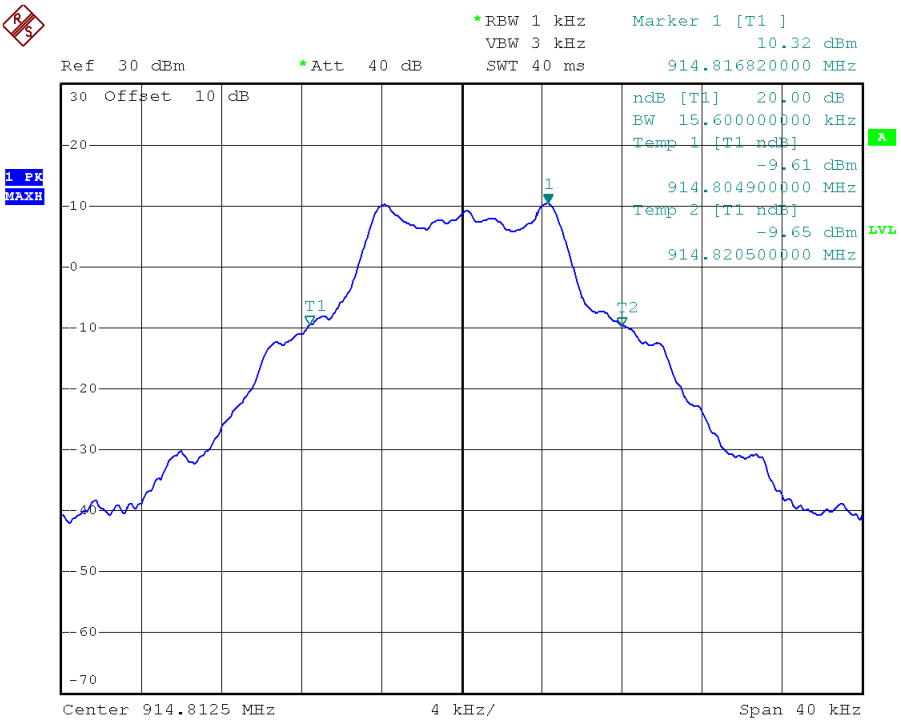
Channel M



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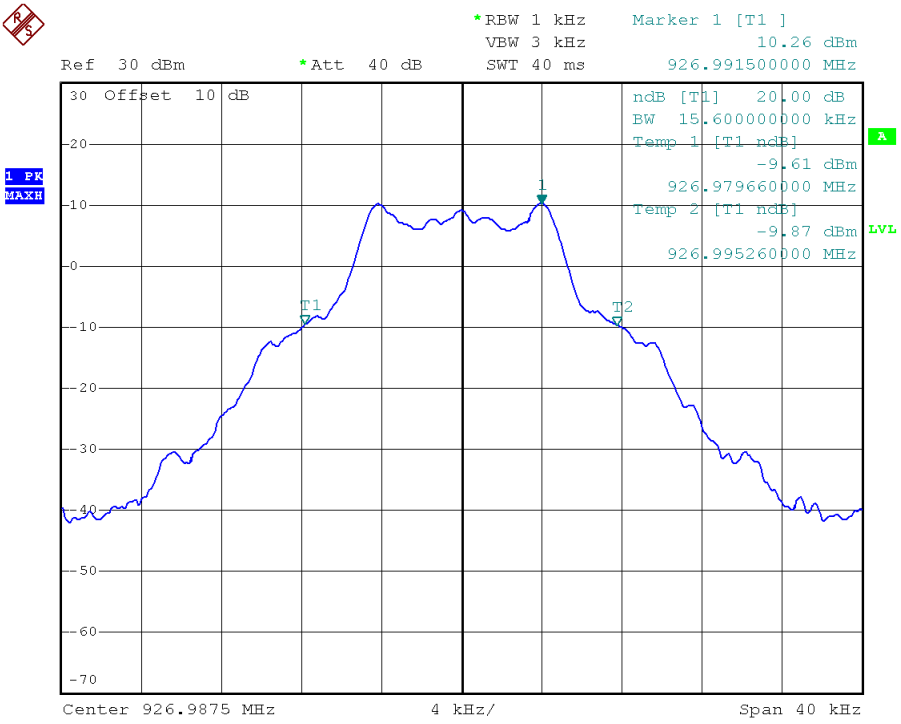
Channel H



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4. Carrier Frequency Separation

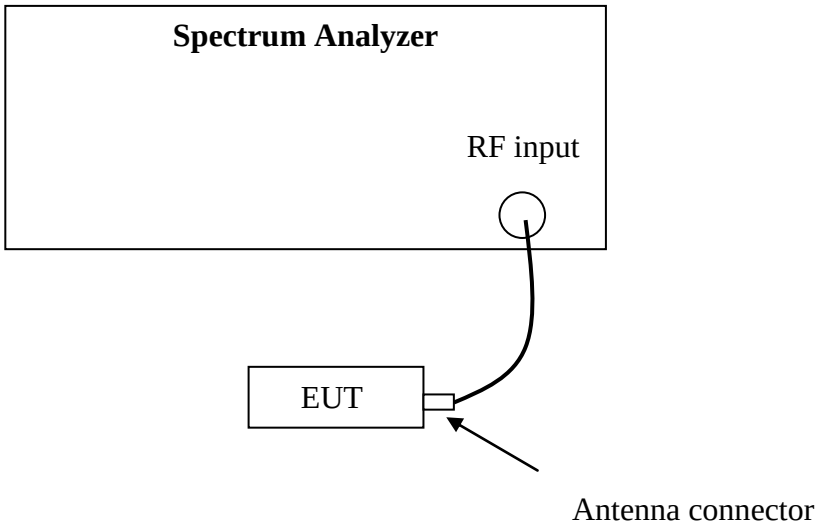
Test result: Pass

4.1 Limit

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

☐ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

4.2 Test Configuration



4.3 Test Procedure and test setup

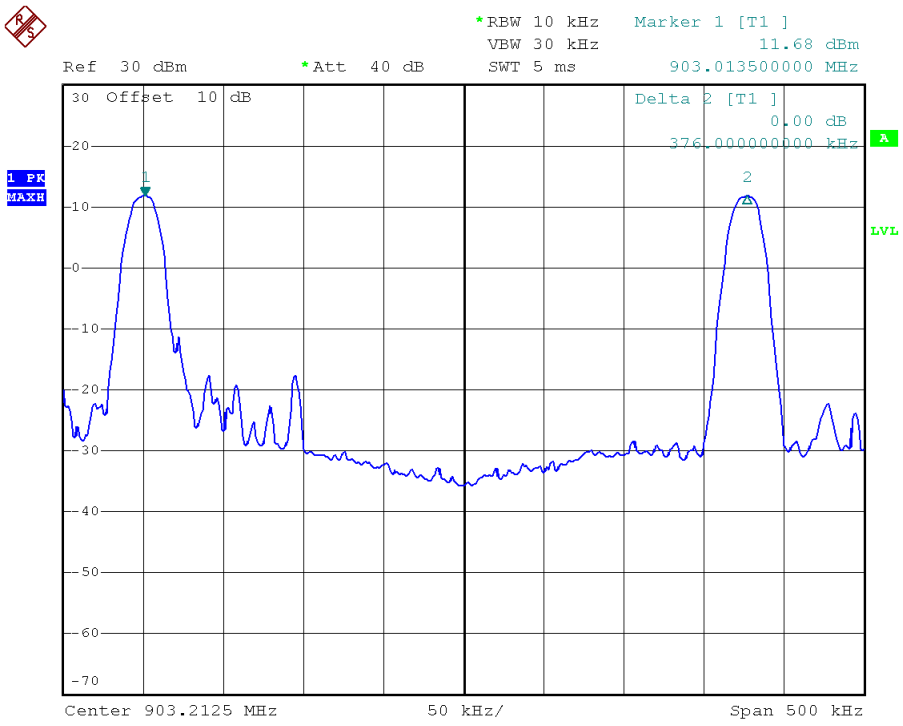
The Carrier Frequency Separation per FCC § 15.247(a)(1) is measured using the Spectrum Analyzer with Span can capture two adjacent channels, RBW≥1% of the span, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

4.4 Test Protocol

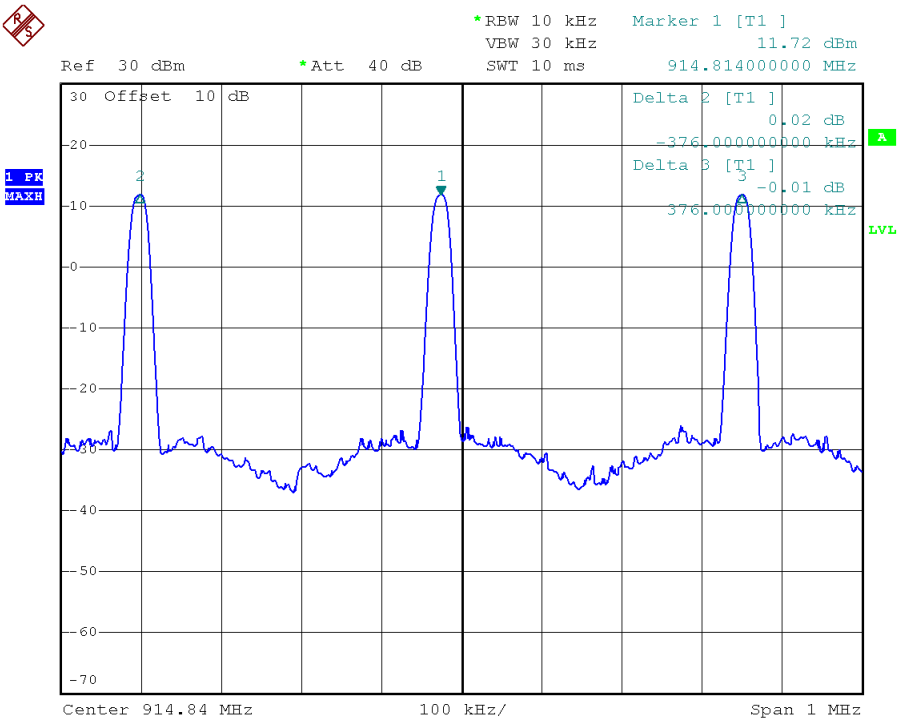
Temperature : 25°C
Relative Humidity : 55 %

CH	Frequency Separation (kHz)	Limit (kHz)
L	376.00	15.68
M	376.00	15.60
H	375.00	15.68

Channel L



Channel M



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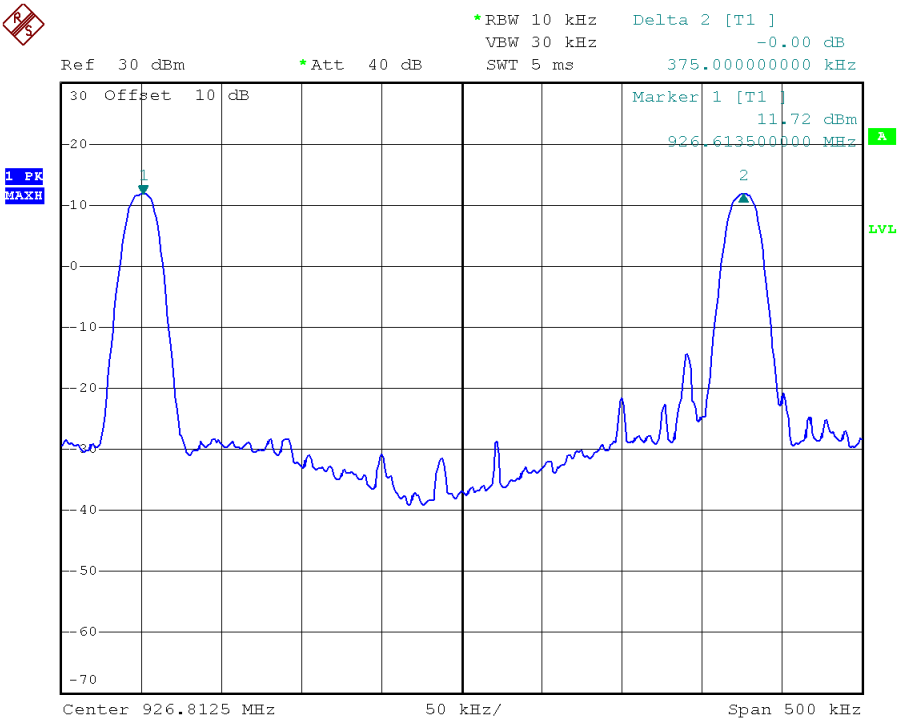
Channel H



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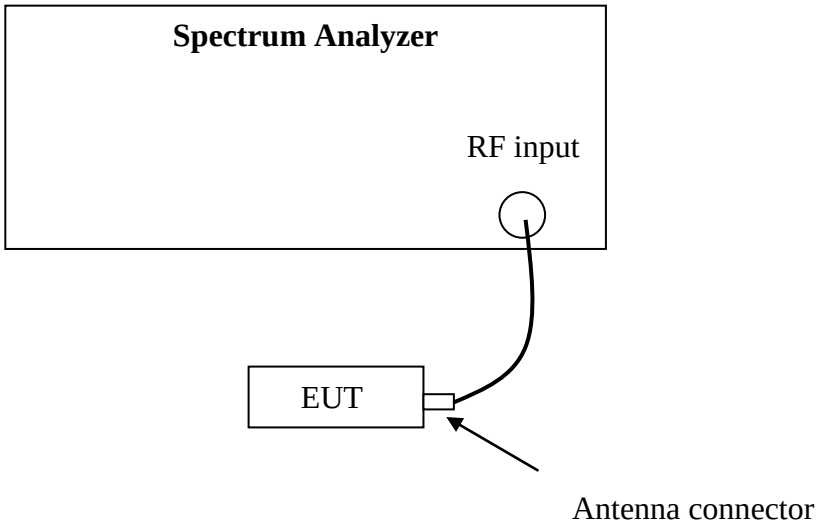
5. Maximum peak output power

Test result: Pass

5.1 Test limit

☐ For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt
☐ For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts
If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.
☒ For frequency hopping system operating in the 902-928 MHz band, 1watt for systems employing at least 50 hopping channels.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC § 15.247(b) is measured using the Spectrum Analyzer with Span = 5 times the 20 dB bandwidth, RBW≥ the 20 dB bandwidth, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

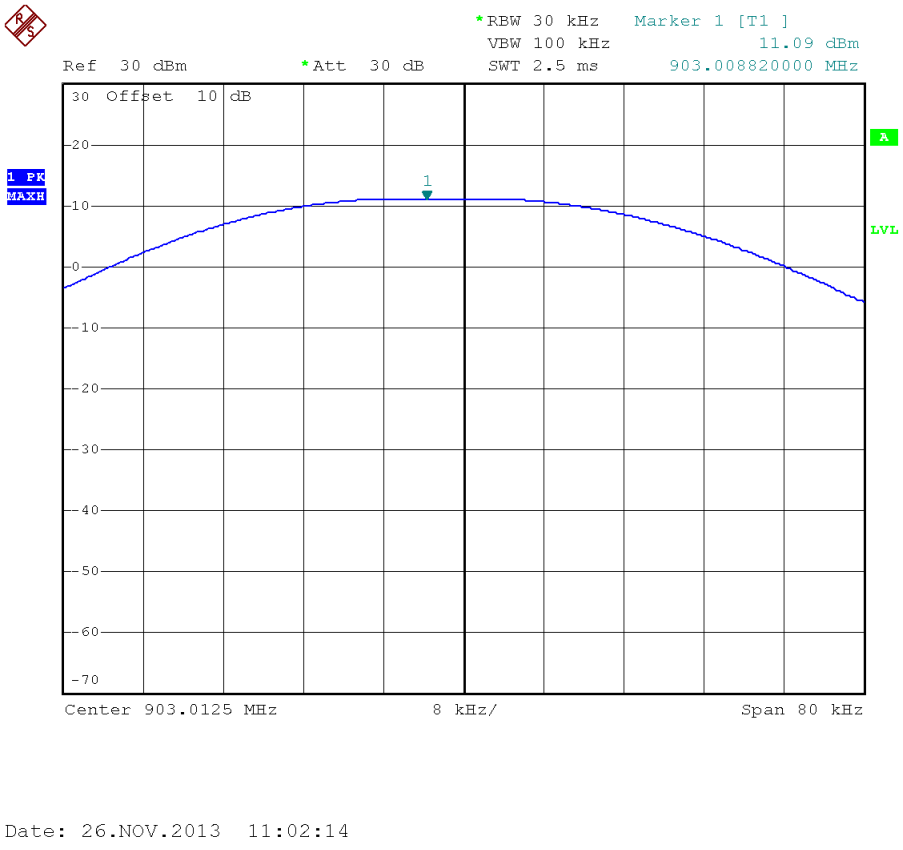
5.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

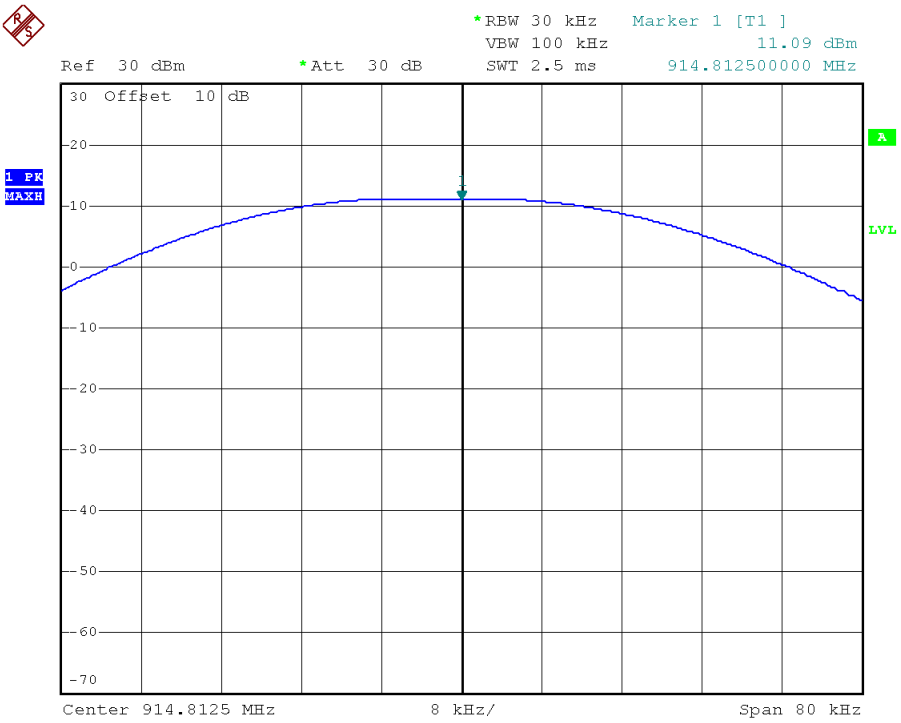
CH	Cable loss (dB)	Corrected reading (dBm)	Limit (dBm)
L	0.50	11.59	≤30
M	0.50	11.59	≤30
H	0.50	11.62	≤30

Conclusion: The maximum EIRP = 11.62 + 3.00 = 14.62dBm = 28.97mW which is lower than the limit of 4W listed in RSS-210.

Channel L



Channel M



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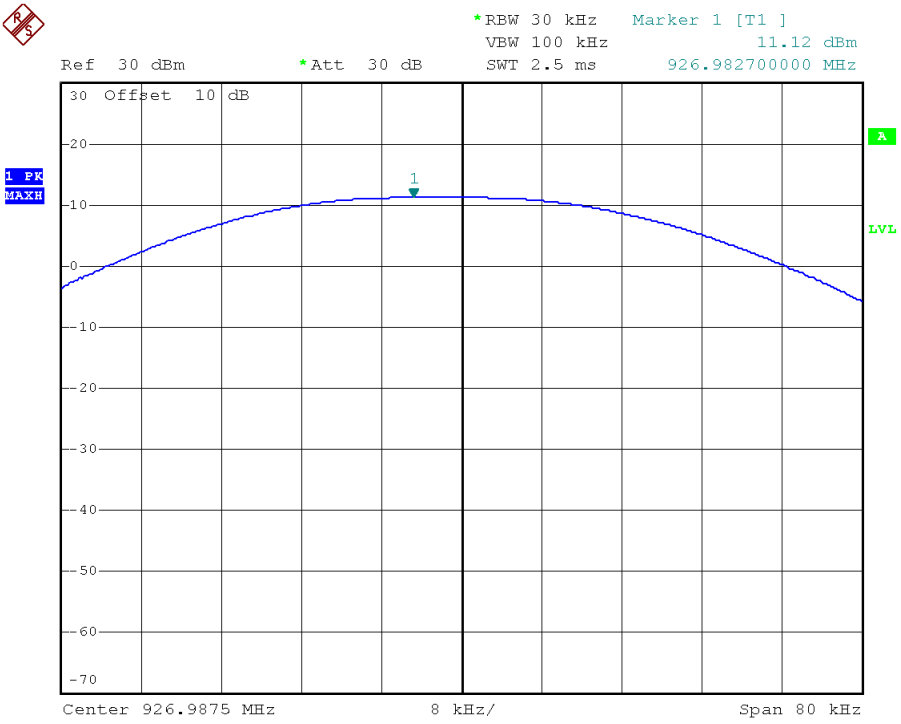
Channel H



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6. Radiated Spurious Emissions

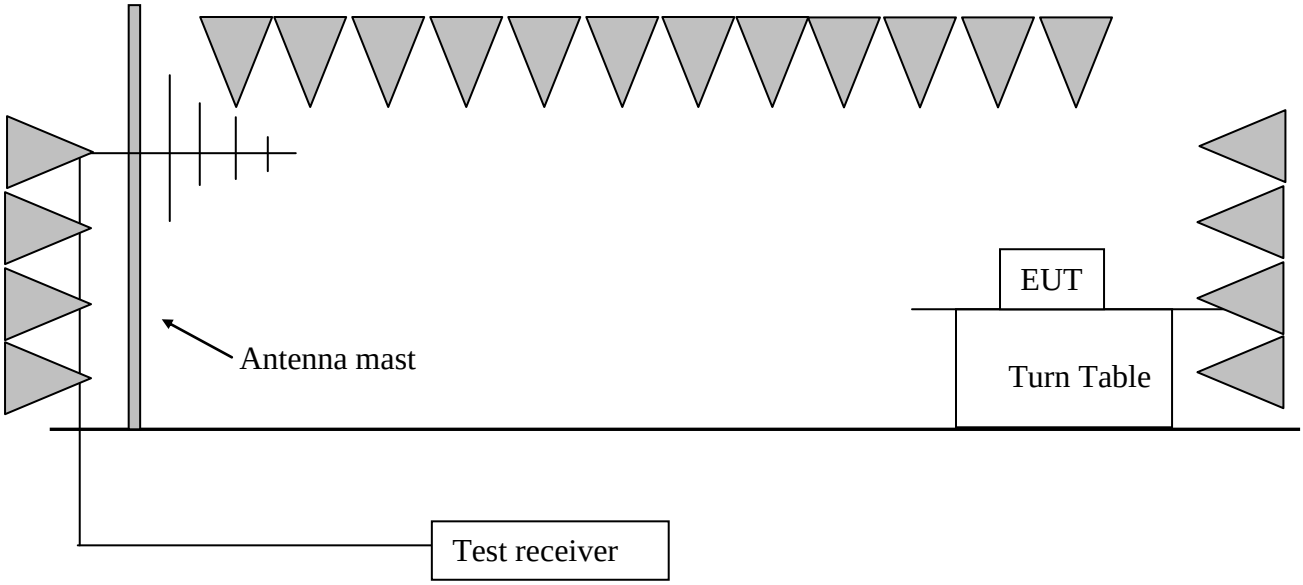
Test result: PASS

6.1 Test limit

The radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.
The EUT and simulators were placed on a 0.8m high wooden turntable above the horizontal metal ground plane. The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 100kHz, VBW = 300kHz (30MHz~1GHz)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);
RBW = 1MHz, VBW = 10Hz (>1GHz for AV);

If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a “duty cycle correction factor”.

6.4 Test protocol

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	903.0125	25.00	109.25	Fundamental	/	PK
	H	2709.0501	-10.28	66.63	74.00	7.37	PK
	H	3612.0541	-6.53	50.44	74.00	23.56	PK
	V	4515.0541	-4.21	66.34	74.00	7.66	PK
	V	8127.0741	4.10	57.59	74.00	16.41	PK
	H	2709.0501	-27.74	48.88	54.00	5.12	AV
	H	3612.0541	-23.99	30.50	54.00	23.5	AV
	V	4515.0541	-21.67	48.34	54.00	5.66	AV
	V	8127.0741	-13.36	38.27	54.00	15.73	AV
M	H	903.0125	25.00	109.10	Fundamental	/	PK
	H	2744.448898	-10.11	66.54	74.00	7.46	PK
	H	3659.248497	-6.38	50.62	74.00	23.38	PK
	V	4574.068136	-4.07	65.38	74.00	8.62	PK
	H	2744.448898	-27.57	48.79	54.00	5.21	AV
	H	3659.248497	-23.84	48.37	54.00	5.63	AV
	V	4574.068136	-21.53	48.29	54.00	6.71	AV
H	H	903.0125	25.00	108.90	Fundamental	/	PK
	V	2780.971944	-9.93	64.32	74.00	9.68	PK
	V	3707.931864	-6.23	52.15	74.00	21.85	PK
	V	4634.9499	-3.94	59.47	74.00	14.53	PK
	V	7415.871743	2.71	49.71	74.00	24.29	PK
	H	2780.971944	-27.39	46.43	54.00	7.57	AV
	H	3707.931864	-23.69	32.41	54.00	21.59	AV
	H	4634.9499	-21.4	40.88	54.00	13.12	AV
	H	7415.871743	-14.75	26.38	54.00	27.62	AV

Remark: 1. For fundamental emission, no amplifier is employed.
2. Correct Factor = Antenna Factor + Cable Loss + (-Amplifier, is employed) + duty cycle correction factor (only for AV value)
3. Corrected Reading = Original Receiver Reading + Correct Factor
4. Margin = limit – Corrected Reading
5. If the PK reading is lower than AV limit, the AV test can be elided.
6. The emission was conducted from 30MHz to 10GHz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
The dwell time = 13.4ms, 20log(dwell time)/100 = -17.46dB
Then Correct Factor for PK = 30.20 + 2.00 – 32.00 = 0.20dB; Corrected Reading = 10dBuV/m + 0.20dB = 10.20dBuV/m
Assuming limit = 74dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 74 -10.20 = 63.80dBuV/m
Then Correct Factor for AV = 30.20 + 2.00 – 32.00 -17.46dB = -17.26dB;
Corrected Reading = 10dBuV/m -17.26dB = -7.26dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = -7.26dBuV/m, then Margin = 54 +7.26= 61.26dBuV/m

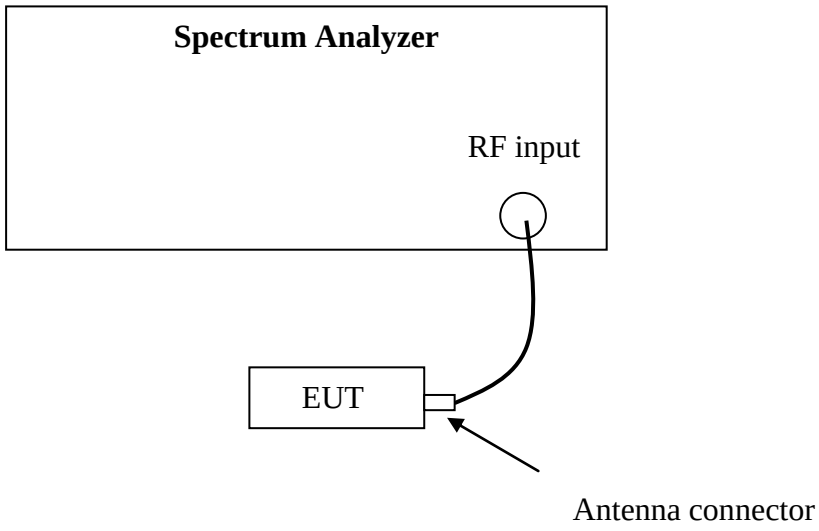
7. Conducted Spurious Emissions & Band Edge

Test result: **PASS**

7.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

7.2 Test Configuration



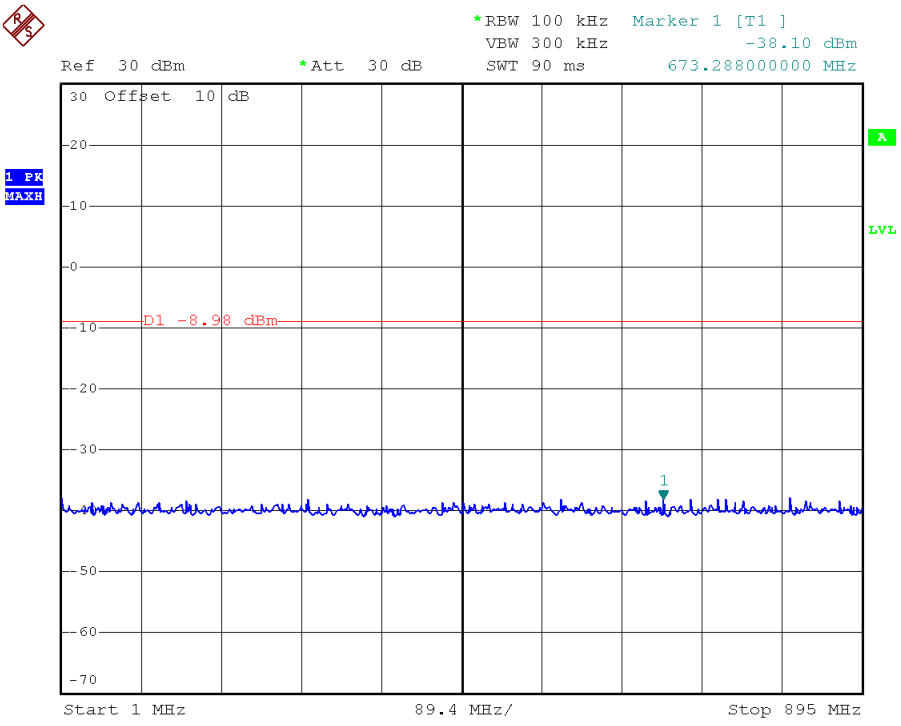
7.3 Test procedure and test setup

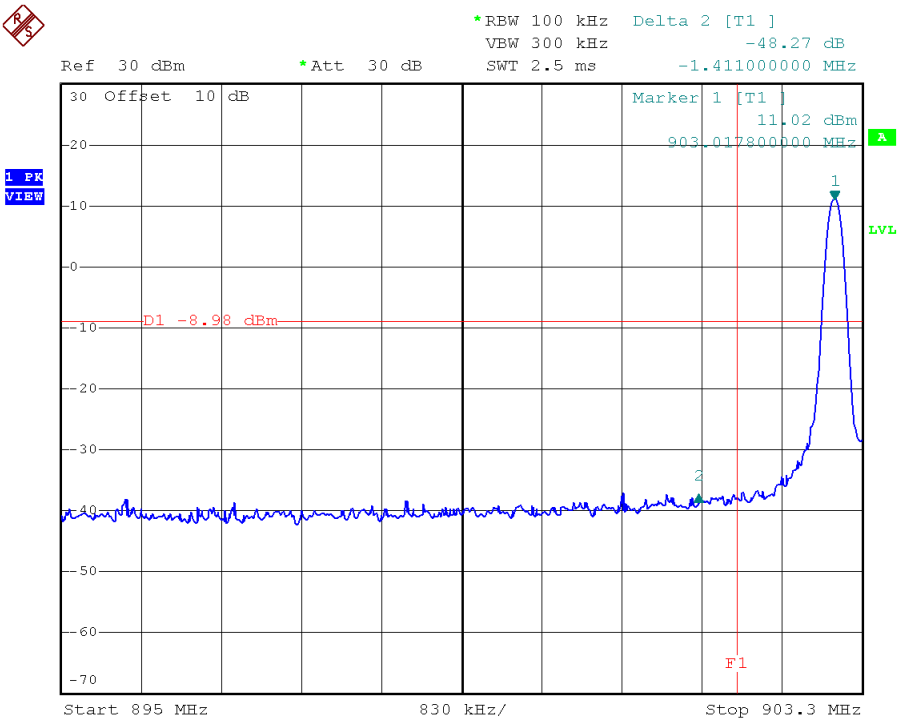
The Conducted Spurious Emissions per FCC § 15.247(d) is measured using the Spectrum Analyzer with Span wide enough capturing all spurious from the lowest emission frequency of the EUT up to 10th harmonics, RBW = 100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

7.4 Test protocol

CH	Max reading among band (dBm)	The most restrict Attenuation outside band (dB)	Limit (dB)
L	-37.27	48.27	≥20
M	-37.32	44.41	
H	-37.46	48.50	

Channel L





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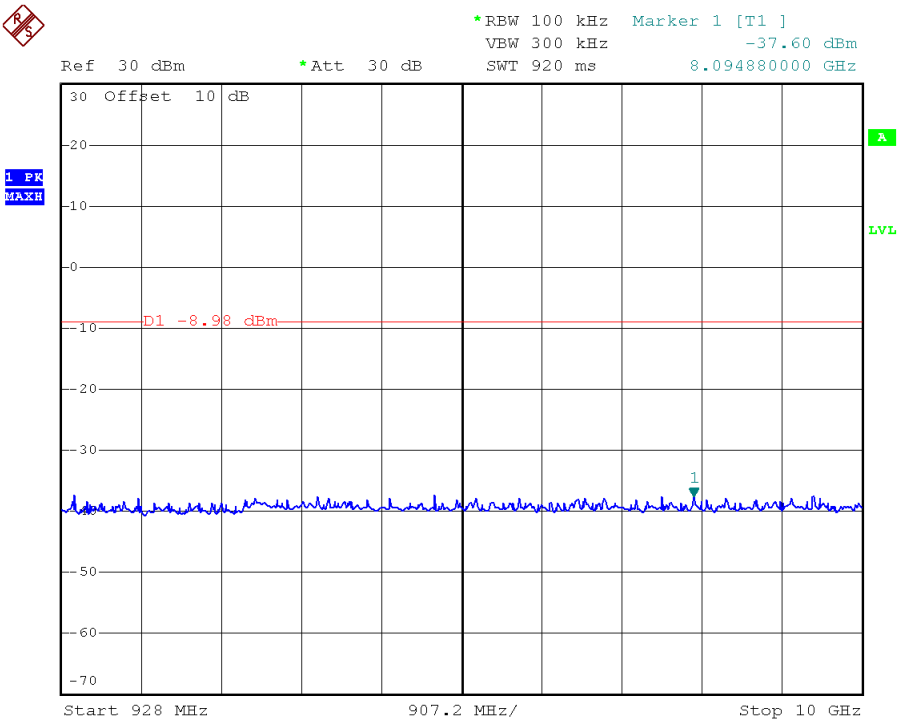

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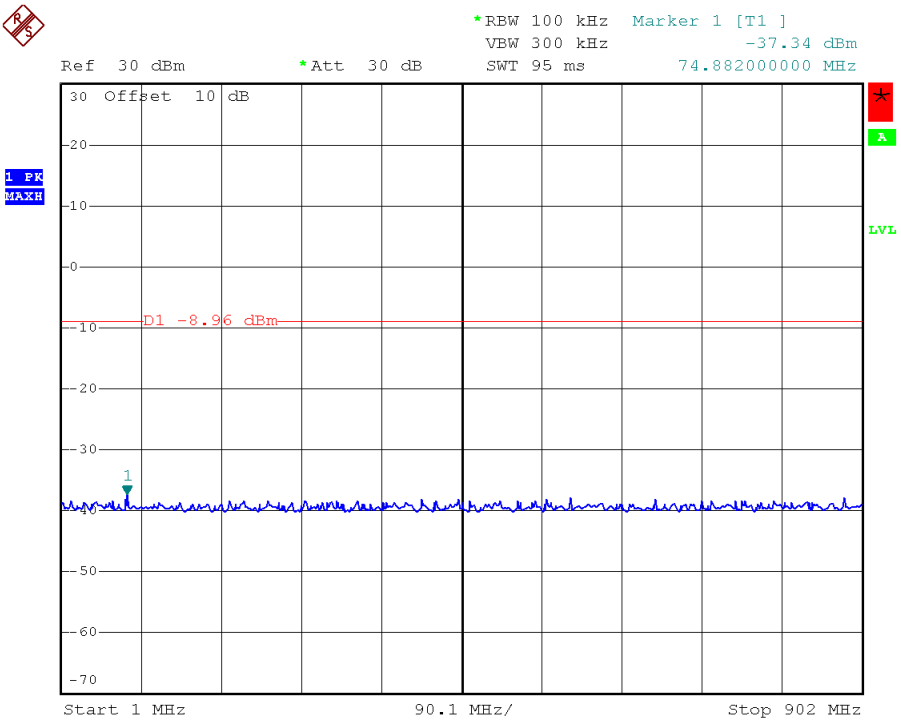
Channel M



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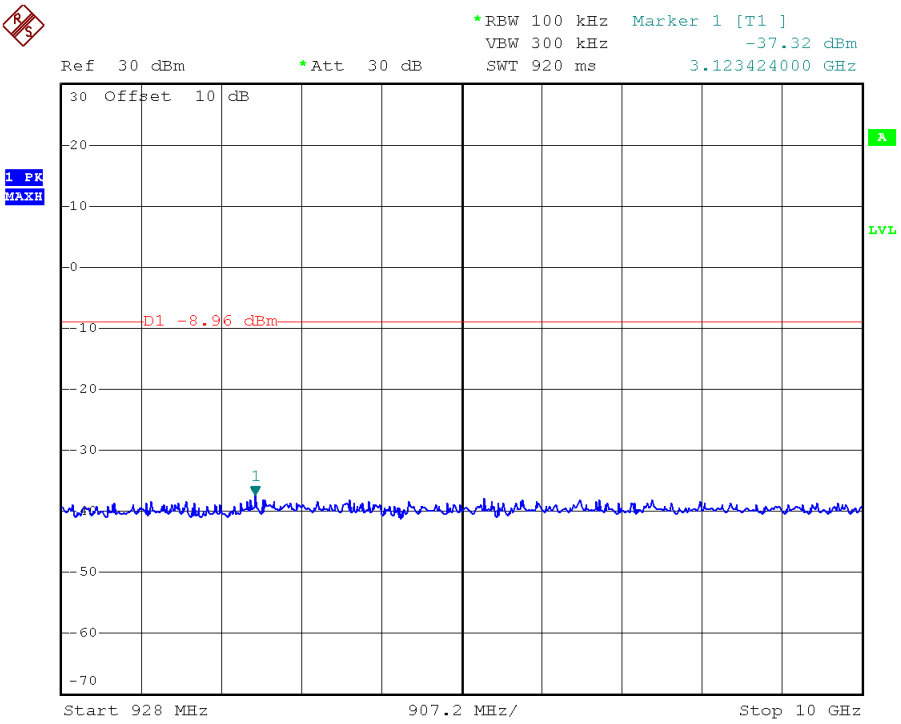

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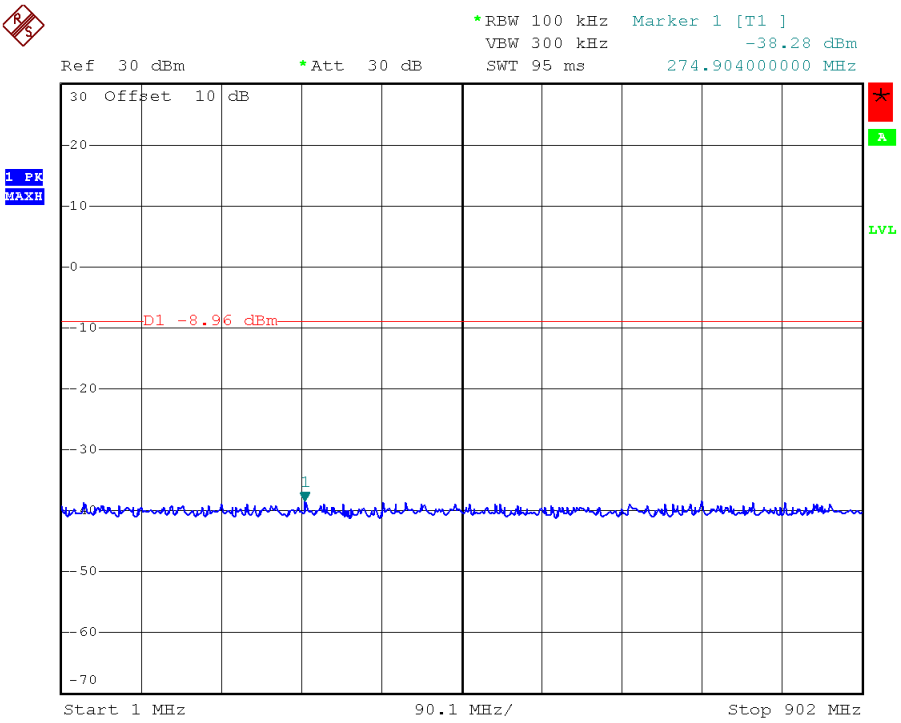
Channel H



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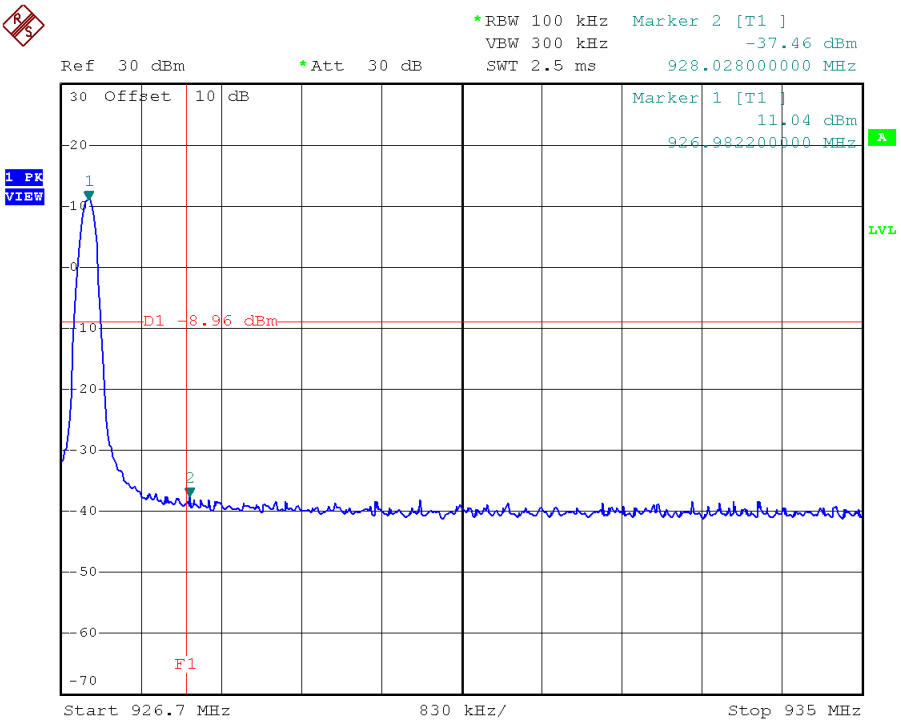

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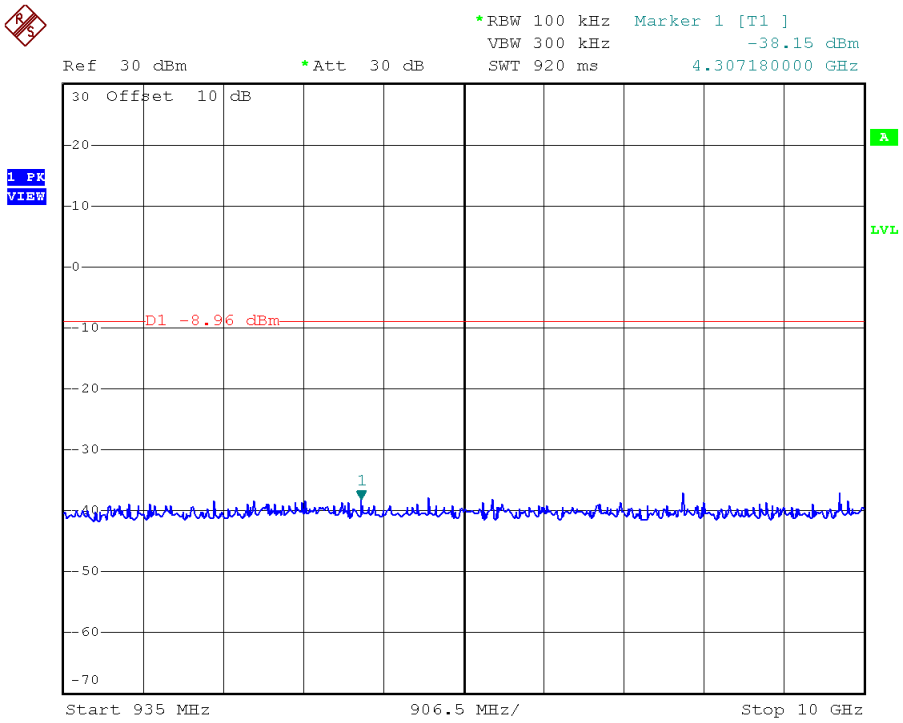

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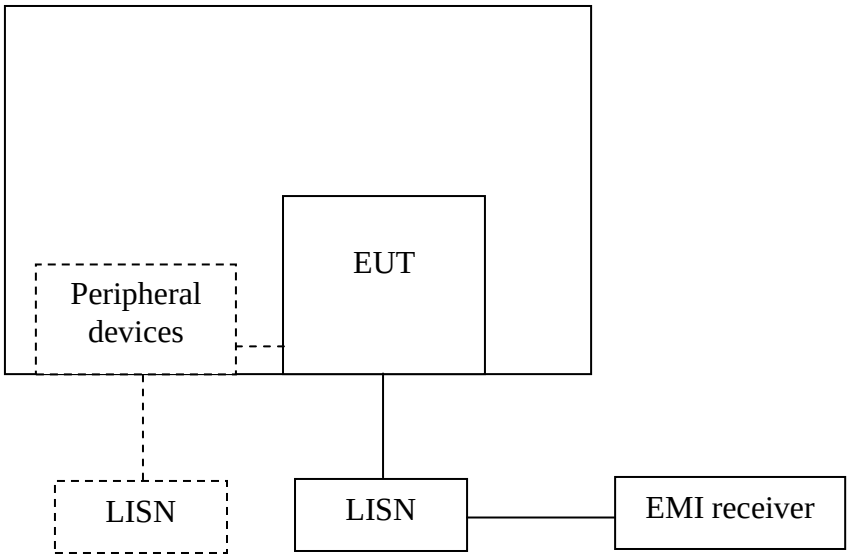
8. Power line conducted emission

Test result: **Pass**

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

8.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

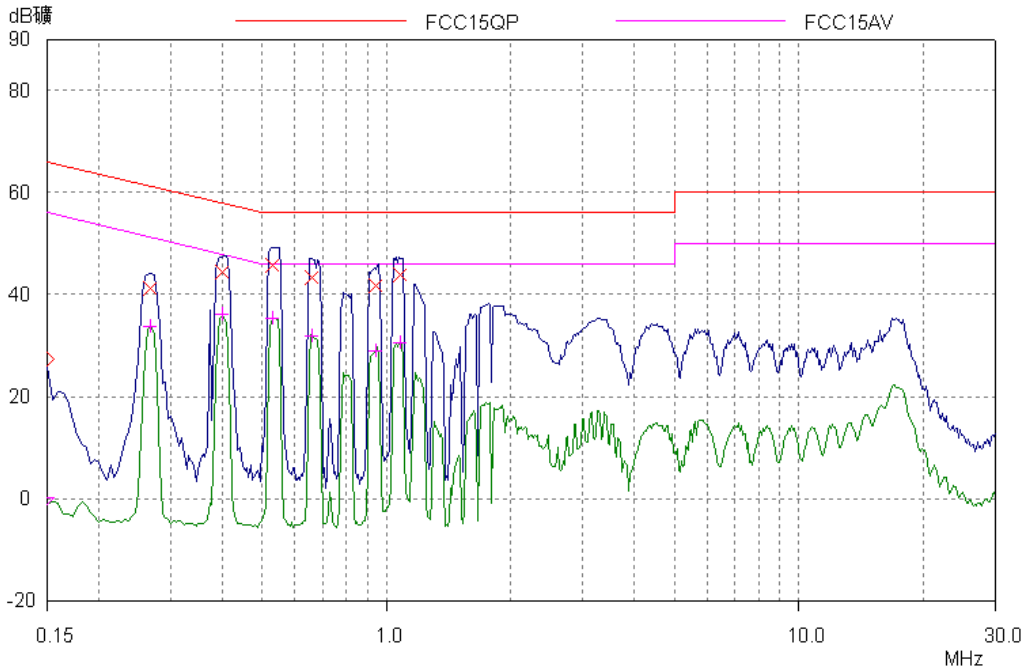
☐ For floor standing equipment, wooden support is 0.1m height rack.

8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.

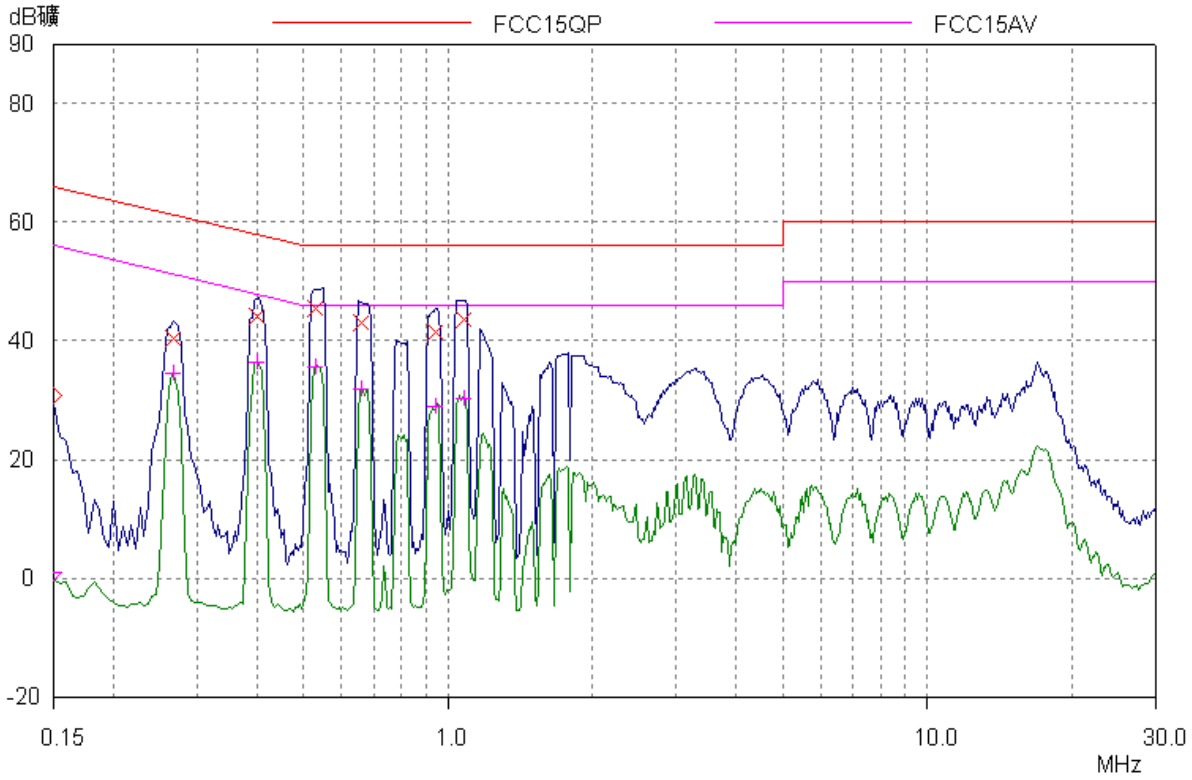
8.4 Test protocol

Phase L



Frequency	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
	QP	AV	QP	AV	QP	AV
0.267	41.31	33.86	61.21	51.21	19.90	17.35
0.398	44.37	36.11	57.91	47.91	13.54	11.80
0.528	45.66	35.44	56.00	46.00	10.34	10.56
0.659	43.29	31.82	56.00	46.00	12.71	14.18
0.934	41.71	29.04	56.00	46.00	14.29	16.96
1.073	43.92	30.56	56.00	46.00	12.08	15.44

Phase N



Frequency	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
	QP	AV	QP	AV	QP	AV
0.267	40.41	34.49	61.21	51.21	20.80	16.72
0.398	44.08	36.38	57.91	47.91	13.83	11.53
0.528	45.42	35.52	56.00	46.00	10.58	10.48
0.659	43.09	31.82	56.00	46.00	12.91	14.18
0.934	41.57	28.87	56.00	46.00	14.43	17.13
1.073	43.72	30.35	56.00	46.00	12.28	15.65

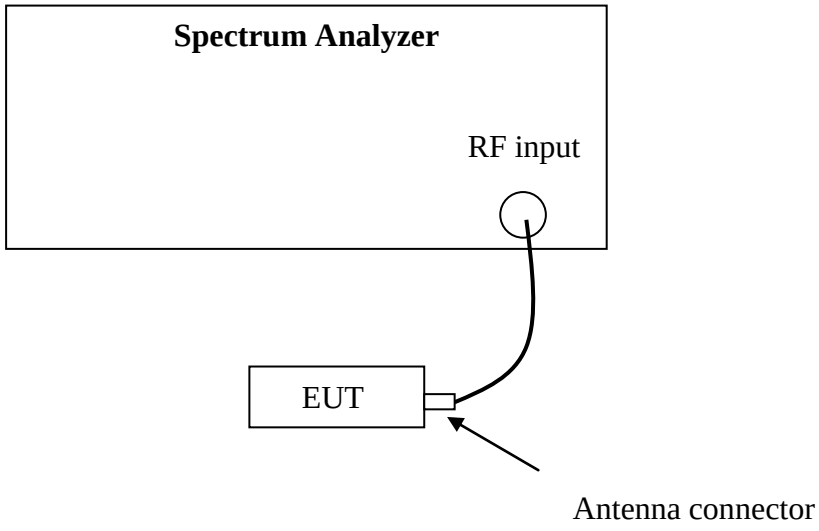
9. Number of Hopping Frequencies

Test result: **Pass**

9.1 Limit

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

9.2 Test Configuration

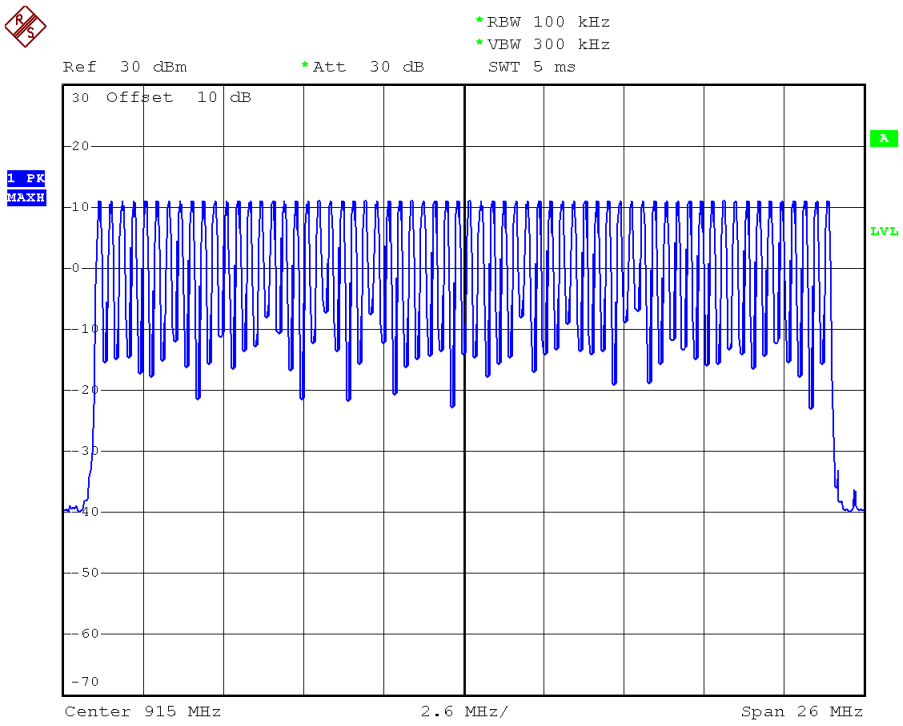


9.3 Test procedure and test setup

The channel number per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with RBW=100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold. The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

9.4 Test protocol

Channel Number	Limit
64	≥50



10. Dwell Time

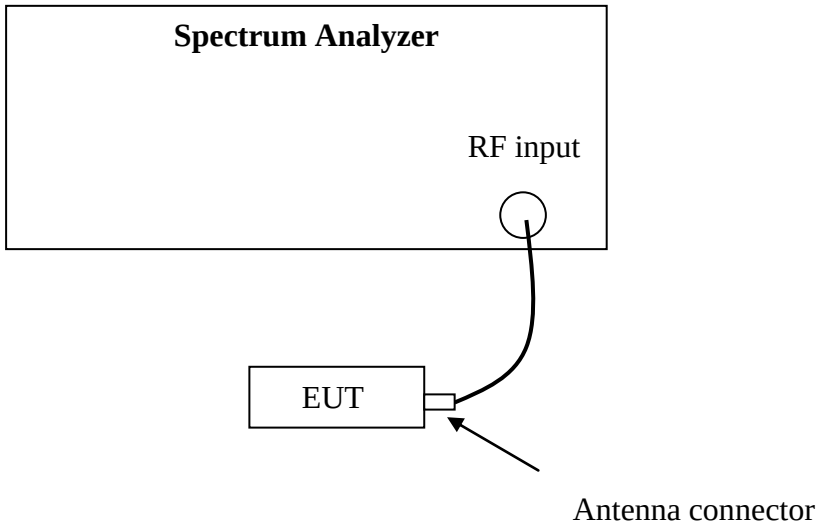
Test result: **Pass**

10.1 Limit

The dwell time on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

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 average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period

10.2 Test Configuration



10.3 Test procedure and test setup

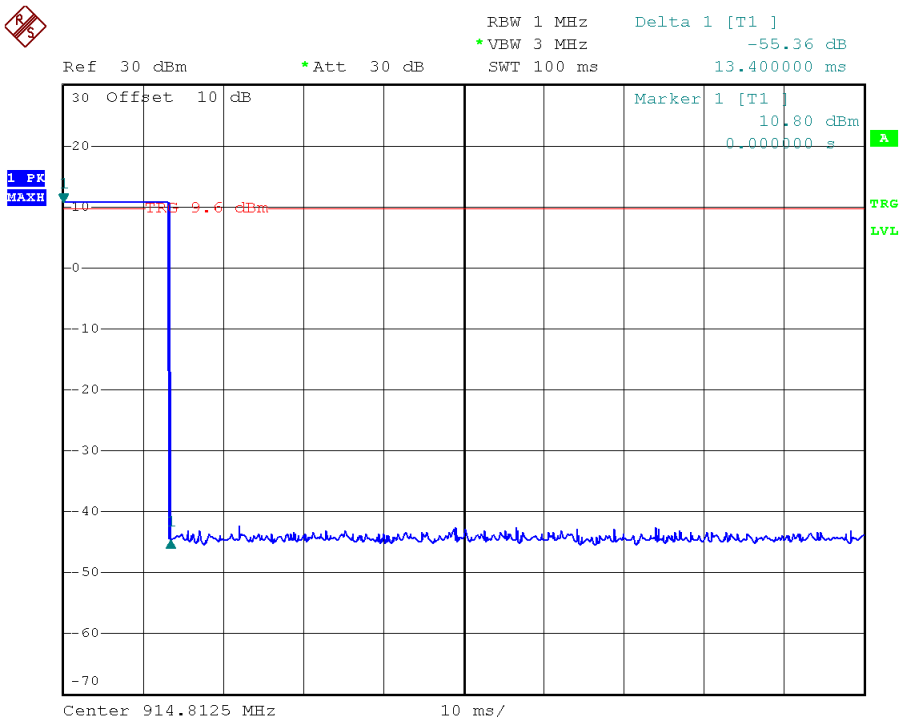
Dwell time per FCC § 15.247(a)(1)(iii) is measured using the Spectrum Analyzer with Span = 0, RBW=1MHz, VBW≥RBW, Sweep can capture the entire dwell time, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

10.4 Test protocol

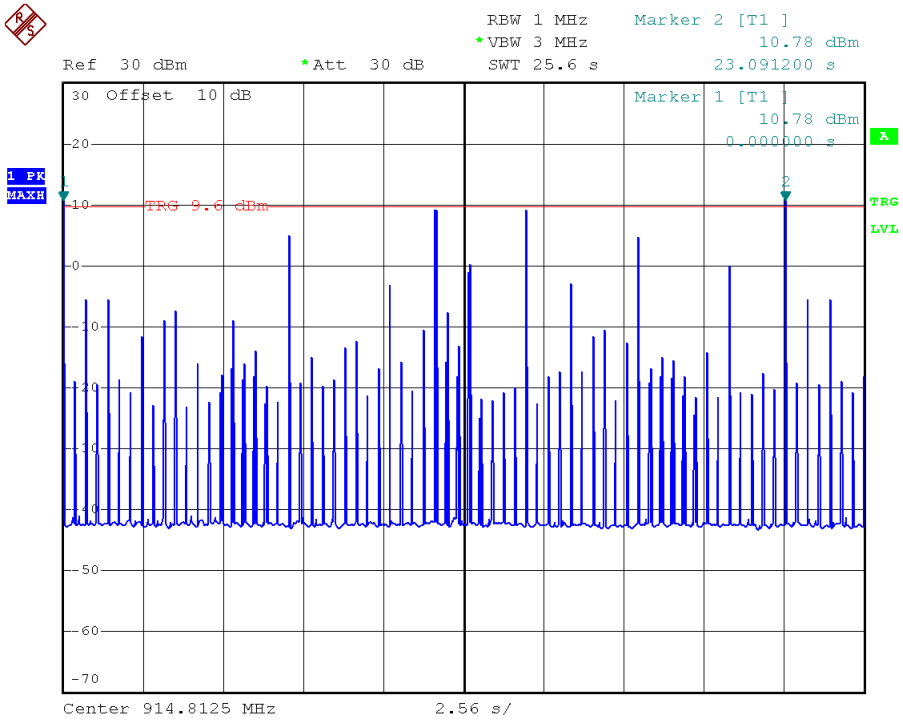
Occupancy time for single hop (ms) **O**	CH	Real observed period (s) **P**	Hops among Observed period **I**	Dwell time (s) **T**	Limit (s)
13.4	L	25.6	2	0.0268	≤0.4
	M	25.6	2	0.0268	
	H	25.6	2	0.0268	

Remark: 1.There are 64 channels in all. So the complete observed period P = 0.4 * 64 = 25.6 s.

Single pulse



Pulses on 25.6s



Note: The emissions below the triggering levels are generated by the channels adjacent to the one evaluated.

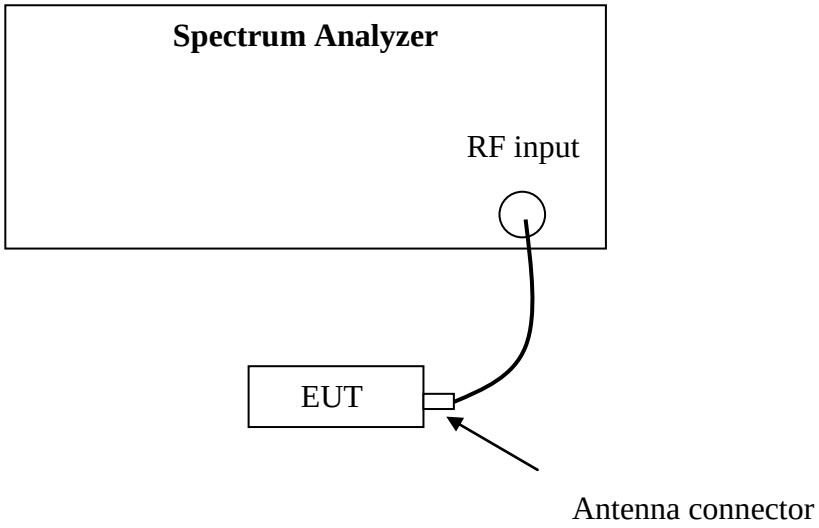
11. Occupied Bandwidth

Test Status: Tested

11.1 Test limit

None

11.2 Test Configuration



11.3 Test procedure and test setup

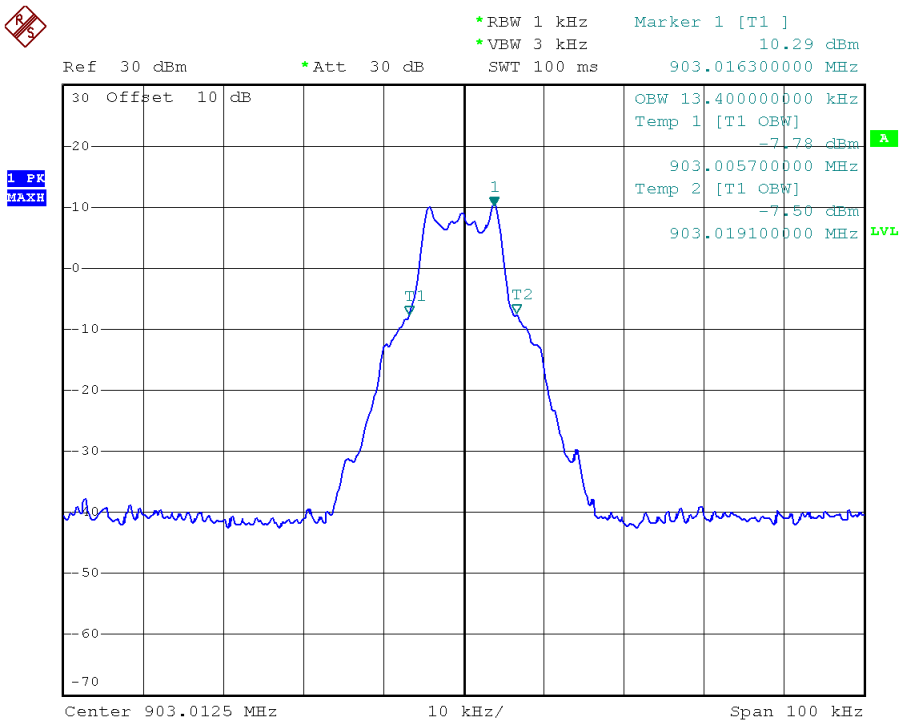
The occupied bandwidth per RSS-Gen Issue 3 Clause 4.6.1 was measured using the Spectrum Analyzer with the RBW close to 1% of the selected span, VBW = 3 * RBW Detector = Sample, Sweep = Auto.

11.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

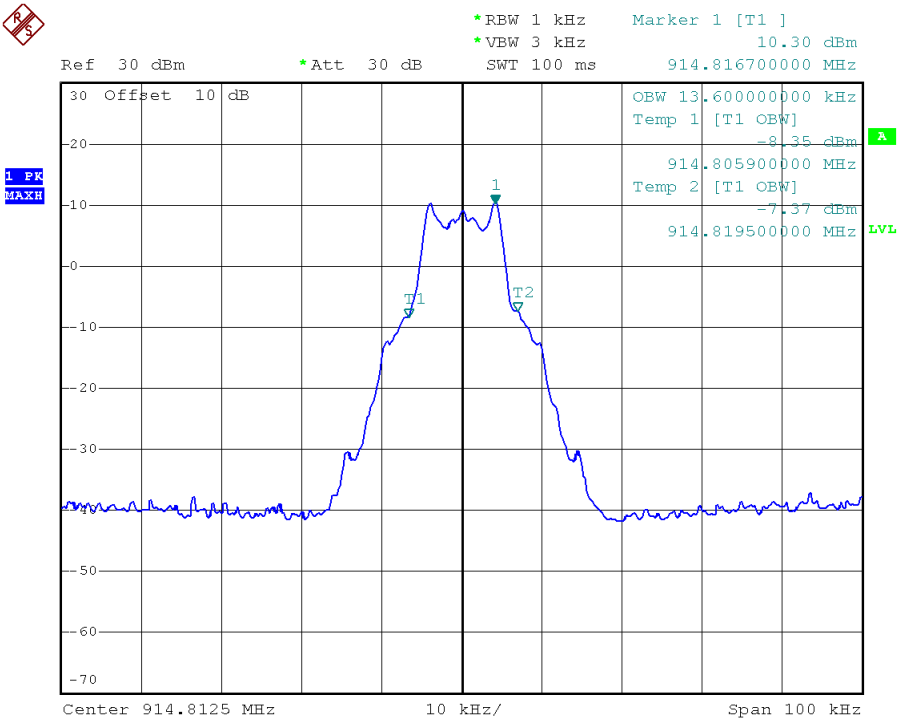
Channel	Occupied Bandwidth (kHz)
L	13.4
M	13.6
H	13.6

Channel L



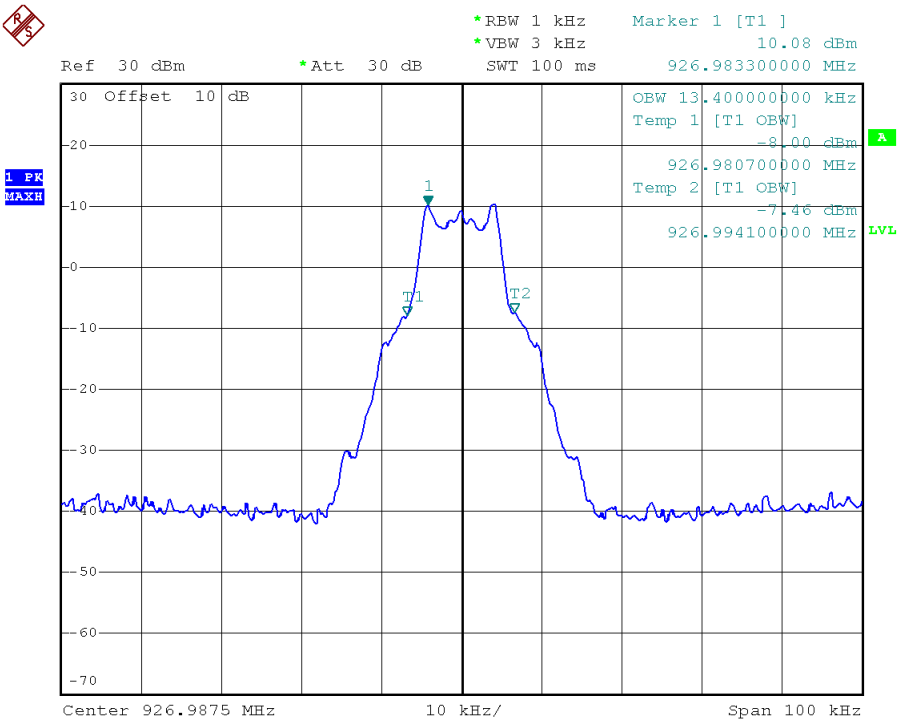
Date: 26.NOV.2013 13:52:05

Channel M



Date: 26.NOV.2013 13:50:24

Channel H



Date: 26.NOV.2013 13:56:08

12. Spurious emission for receiver

Test result: **NA**

12.1 Test limit

The spurious emission shall test through 3 times tuneable or local oscillator frequency whichever is the higher, without exceeding 40 GHz.

☐ If a conducted measurement is made, no spurious output signals appearing at the antenna terminals shall exceed 2nW per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5nW above 1 GHz.

☐ If a radiated measurement is made, all spurious emissions shall comply with the limits of Table below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

12.2 Test Configuration

Please refer to clause 6.2

12.3 Test procedure and test setup

Please refer to clause 6.3.

12.4 Test protocol

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
M	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
H	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
"*" means the value is more than 20dB below the limit.							

Remark: 1. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = limit – Corrected Reading

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 = 32.20dB/m; Corrected Reading = 10dBuV + 32.20dB/m = 42.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 42.20dBuV/m, then Margin = 54 -42.20 = 11.80dBuV/m