

REPORT: FCC / IC Radio Frequency (RF) test report

PRODUCT:

Test item description:	Mobile computer for data collection
Trade Mark:	NordicID Morphic
Model/Type reference:	HTB00015
Serial number:	K110205255 K103904107
Customer:	NordicID Oy Myllyojankatu 2A 24100 SALO FINLAND
Contact person:	Hannu Heino
Manufacturer:	NordicID Oy Myllyojankatu 2A 24100 SALO FINLAND

DATE: 22.3.2011

TESTED BY:



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APPROVED BY:



Tuomo Hahl ; Test engineer

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1 LABORATORY INFORMATION

Test Laboratory	Intertek ETL Semko OY Koneenkatu 12 / K17 05830 Hyvinkää FINLAND
FCC registration number: IC file number:	910391 (January 27, 2003) IC 2042C-1 (May 14, 2003)
Quality and Environmental :	

2 SUMMARY OF TEST RESULTS

The tests listed in this report have been done to demonstrate compliance to the FCC rules section §15.107, §15.109, §15.247 and IC standard RSS-GEN / RSS-210.

Transmitter measurements

Section in CFR 47	Section in RSS-210	Test	Result
15.247, a 1	A8.1 (b)	Carrier frequency separation	PASS
15.247, a 1 i	A8.1 (c)	Number of hopping frequencies	PASS
15.247, a 1 i	A8.1 (c)	Time of occupancy	PASS
15.247, a 1 i	A8.1 (c)	20dB bandwidth	PASS
15.247, b 2	A8.4 (1)	Peak output power	PASS
15.247, d	A8.5	Band-edge compliance of RF emissions	PASS
	RSS-GEN 4.6.1	99% bandwidth	PASS
15.247, d	A8.5	Spurious RF conducted emissions	PASS
		Field strength of fundamental	X
15.247, d	A8.5	Spurious radiated emissions	PASS

Receiver measurements

Section in CFR 47	Section in RSS-GEN	Section in ICES-003	Test	Result
§15.107	7.2.4	5.3	Conducted emissions to AC-power lines	PASS
§15.109	7.2.5	5.5	Radiated emissions	PASS

PASS Pass

FAIL Fail

X Measured, but there is no applicable performance criteria

- Not done

3 EUT INFORMATION

The EUT and accessories used in the tests are listed below. Later in this report only EUT numbers are used as reference.

	Device	Type	S/N	EUT number
EUT	NordicID Morphic	HTB00015	K110205255	1
	NordicID Morphic	HTB00015	K103904107	2 *
Accessories	Nordic Power switching adapter	SA115C-05	-	3

Notes:

* Antenna replaced with SMA-connector

3.1 EUT description

EUT is battery operated mobile computer for data collection purposes. Battery can be charged with charger. EUT was commanded to different modes with customers program FCC RFID 400_Morphic_FCC_3.pak

The EUT was not modified during the tests.

4 EUT TEST SETUPS

For each test the EUT was exercised to find out the worst case of operation modes and device configuration.

Two different test setups were used: one for conducted measurements, another for radiated measurements. One EUT was equipped with an external antenna connector for conductive measurements.

The test setup photographs are in the document referenced in section 19.

5 APPLICABLE STANDARDS

The tests were performed in guidance of:

CFR 47 Part:

- §15.107
- §15.109
- §15.209
- §15.247
- ANSI C63.4 (2003)

IC standard:

- RSS-GEN, Issue 3
- RSS-210, Issue 8
- CISPR 22, 2006

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method" for each test case.

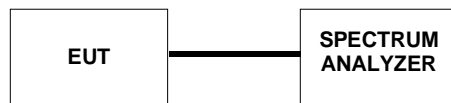
6 CARRIER FREQUENCY SEPARATION

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	15.247, a 1		
RSS-210 section	A8.1 (b)		
Measured by	Simo Ojanen		

6.1 Test setup and testing method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 1: Test setup for carrier frequency separation measurement

Spectrum analyzer was set to sweep the RFID operating band 902 – 930 MHz. 30 kHz resolution bandwidth and maximum hold function was used to measure the EUT transmission over sufficient time. Carrier frequency separation was read from the screen.

6.2 EUT operation mode

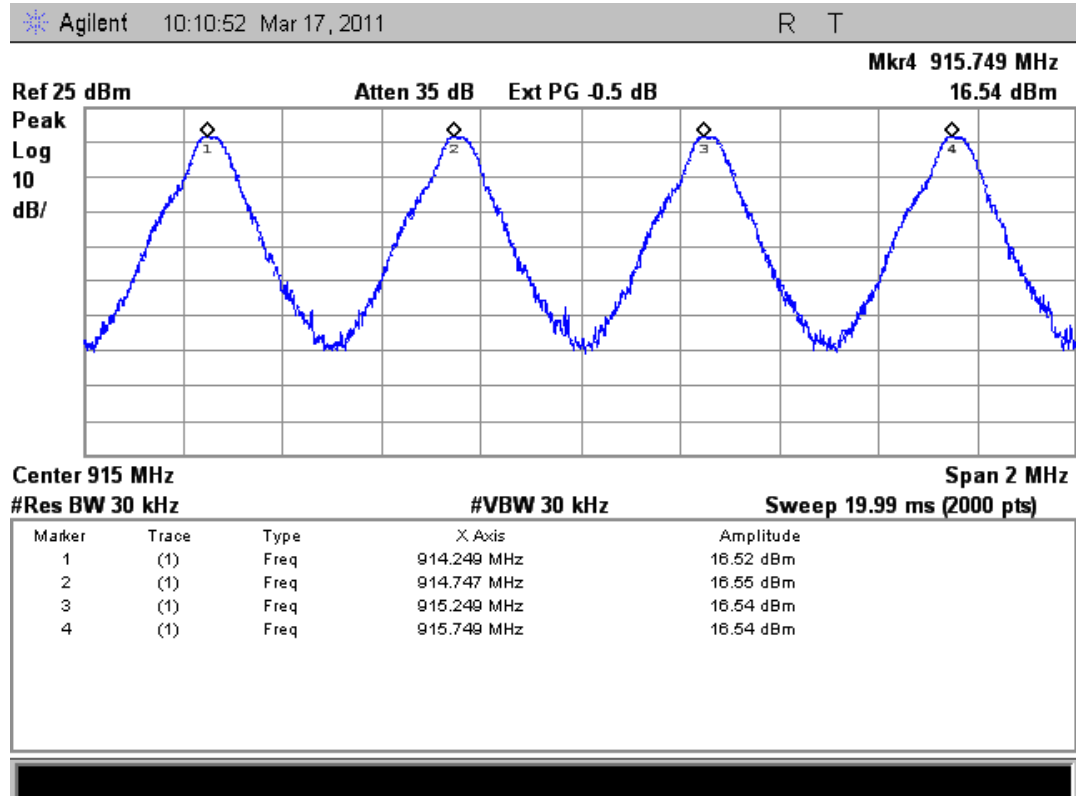
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

6.3 Results

Table 1: Carrier frequency separation measurement results

Limit	Result
>20dB Bandwidth	500 kHz

6.4 Screen shots



Picture 2: Carrier frequency separation, Channels 25-28

6.5 EUT operation mode

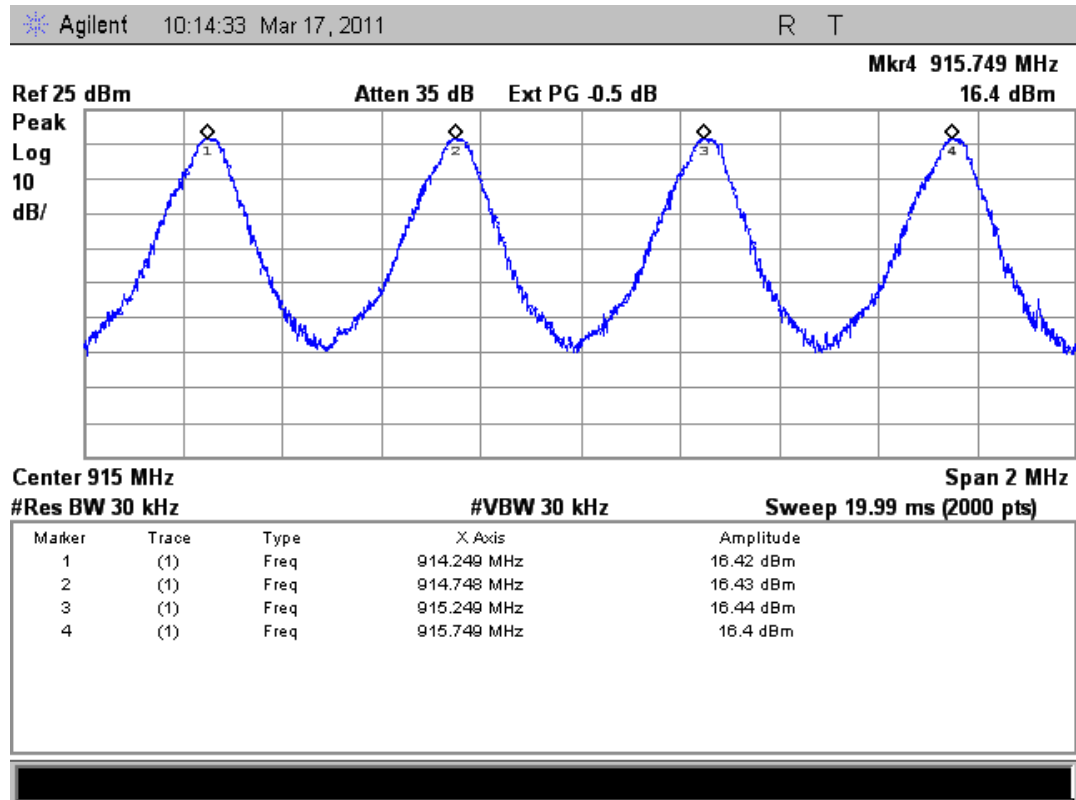
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

6.6 Results

Table 2: Carrier frequency separation measurement results

Limit	Result
>20dB Bandwidth	500 kHz

6.7 Screen shots



Picture 3: Carrier frequency separation, Channels 25-28

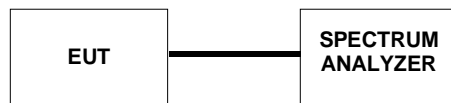
7 NUMBER OF HOPPING FREQUENCIES

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	15.247, a 1 i		
RSS-210 section	A8.1 (c)		
Measured by	Simo Ojanen		

7.1 Test setup

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 4: Test setup for measurement of number of hopping frequencies

Spectrum analyzer was set to sweep the RFID operating band 902 – 930 MHz. 300 kHz resolution bandwidth and maximum hold function was used to measure the EUT transmission over sufficient time. Number of hopping frequencies was calculated from the screen.

7.2 EUT operation mode

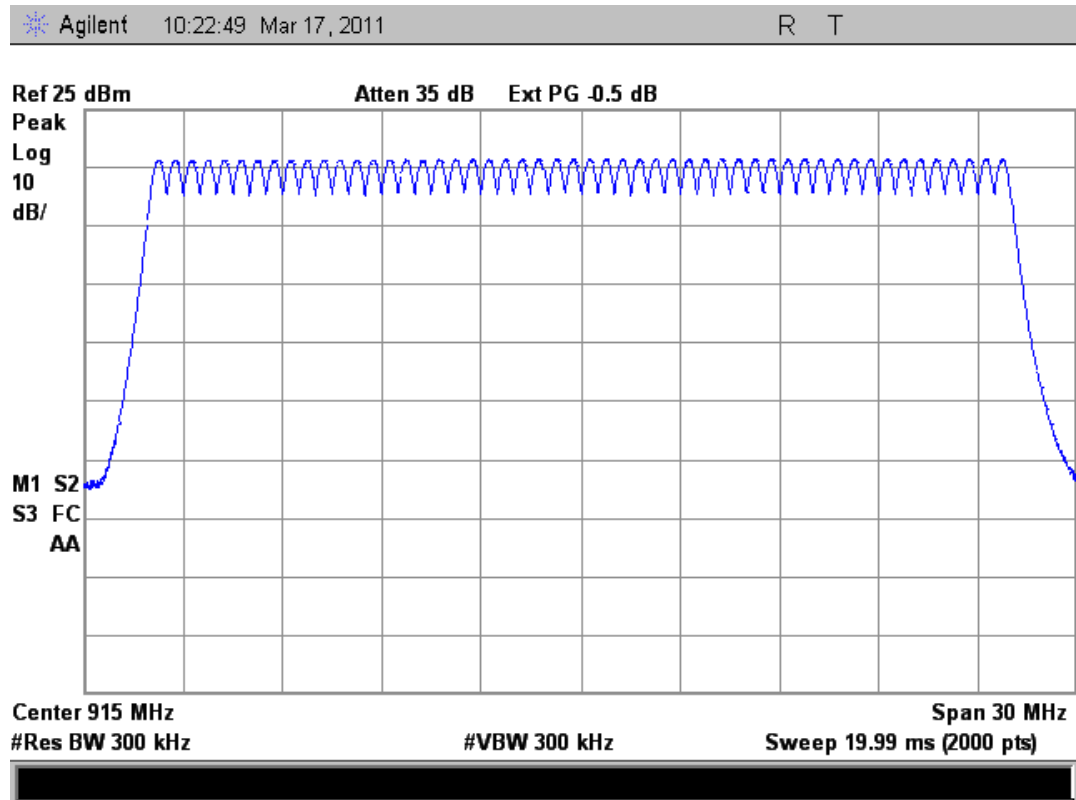
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

7.3 Results

Table 3: Number of hopping frequencies measurement results

Limit	Result
≥ 50	52

7.4 Screen shots



Picture 5: Number of hopping frequencies measurement

7.5 EUT operation mode

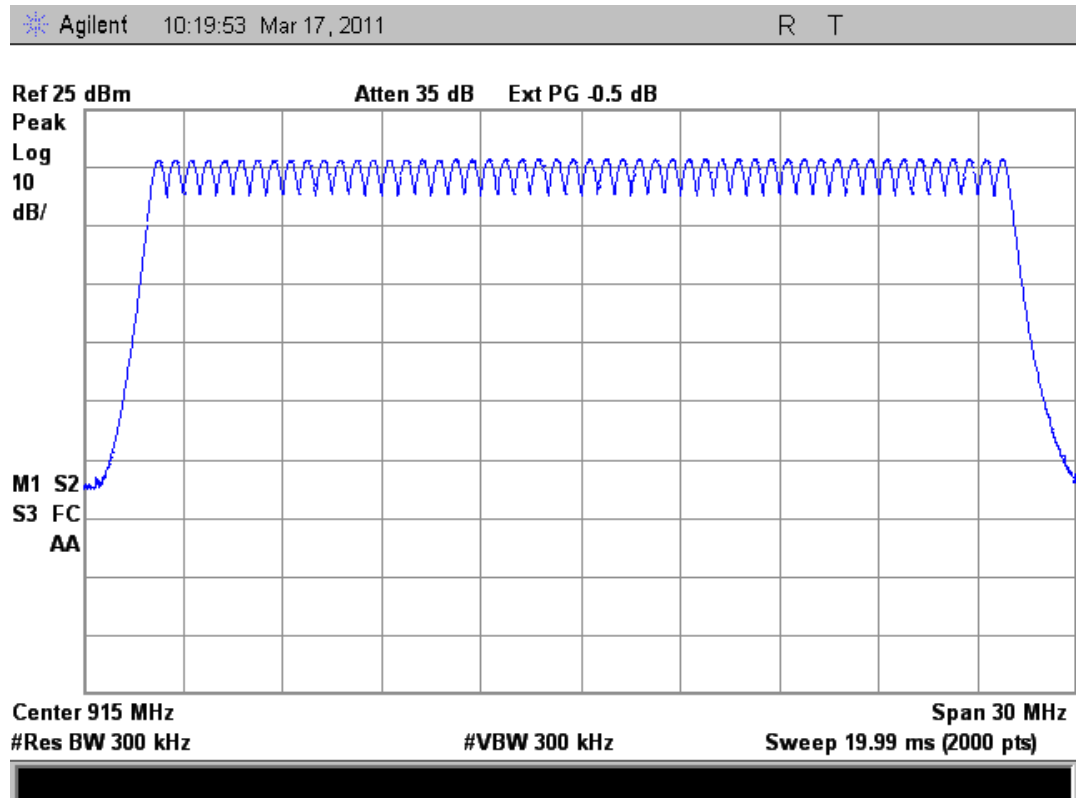
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

7.6 Results

Table 4: Number of hopping frequencies measurement results

Limit	Result
≥ 50	52

7.7 Screen shots



Picture 6: Number of hopping frequencies measurement

8 TIME OF OCCUPANCY

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	21 °C	25 %RH	1004 hPa
Date of measurement	March 21, 2011		
FCC rule part	15.247, a 1 i		
RSS-210 section	A8.1 (c)		
Measured by	Simo Ojanen		

8.1 Test setup and testing method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 7: Test setup for time of occupancy measurement

Spectrum analyzer with single sweep and 0 Hz span was used to monitor the transmitter operation over time.

8.2 EUT operation mode

EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

8.3 Results

Table 5: Time of occupancy during connection mode measurement results

Limit	Result
≤ 0,4 s over 20 s period	0,352 s

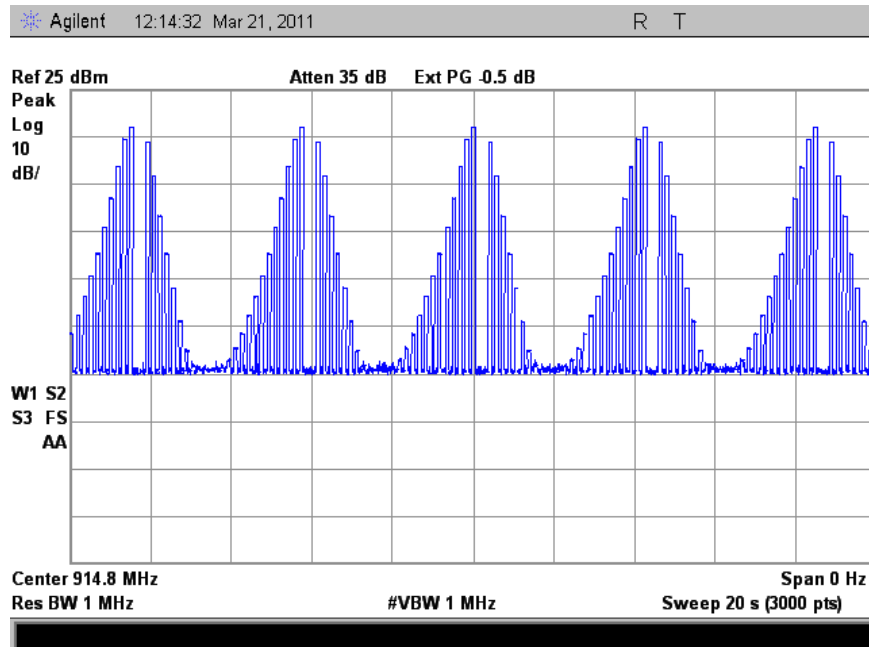
Limit:

In the connection mode RFID uses 52 channels. As defined in 15.247, a 1 i, the limit for time of occupancy is 0.4s within a 20 second period.

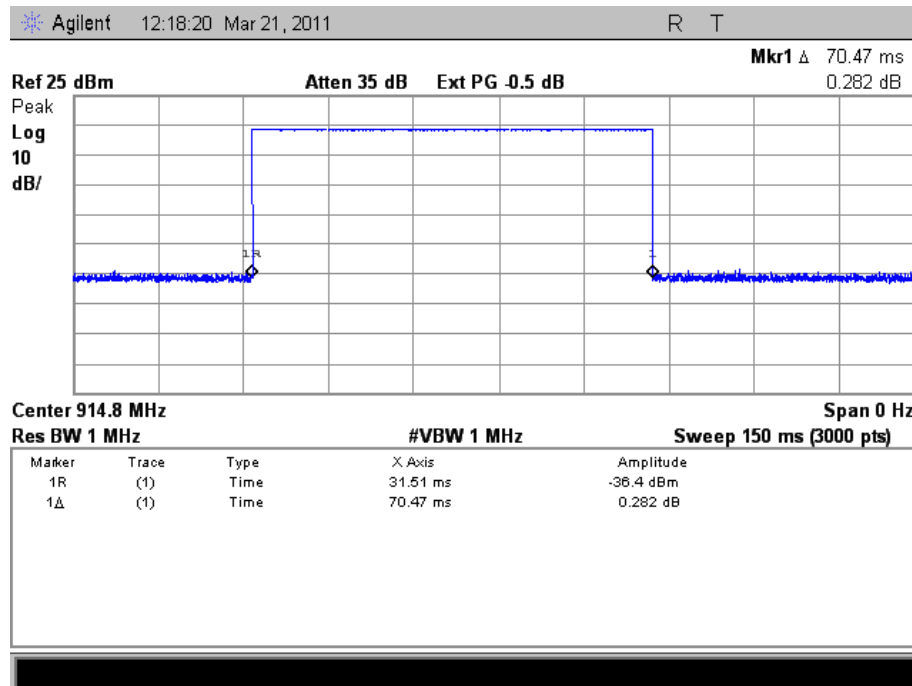
Results:

In measurement time of 20 s, total of 5 transmissions occurred. The duration of one transmission was 70,47 ms. Based on these measurements the transmitter operated $5 * 70,47 \text{ ms} = 0,352 \text{ s}$ during the 20 s period

8.4 Screen shots



Picture 8: Number of transmissions on connection state, channel 26



Picture 9: Duration of one transmission on connection state, channel 26

8.5 EUT operation mode

EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

8.6 Results

Table 6: Time of occupancy during connection mode measurement results

Limit	Result
≤ 0,4 s over 20 s period	0,354 s

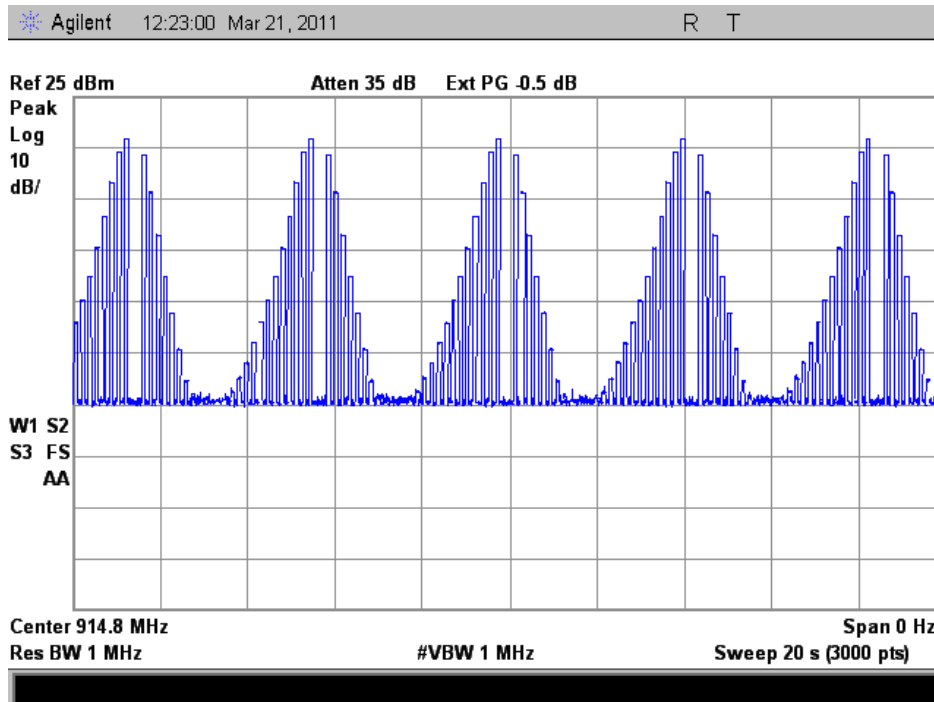
Limit:

In the connection mode RFID uses 52 channels. As defined in 15.247, a 1 i, the limit for time of occupancy is 0.4s within a 20 second period.

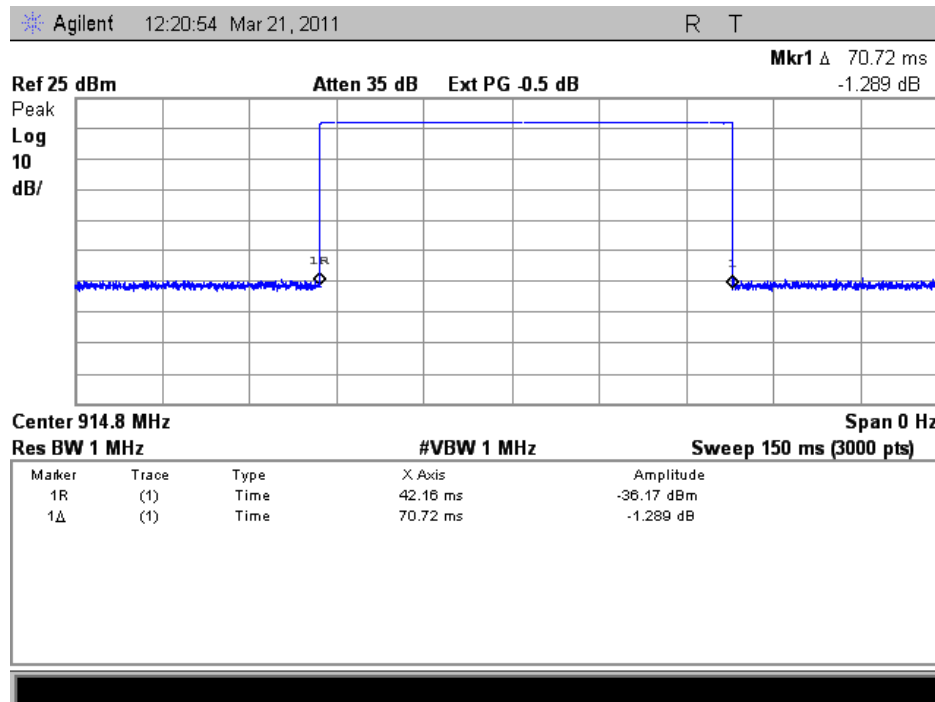
Results:

In measurement time of 20 s, total of 5 transmissions occurred. The duration of one transmission was 70,72 ms. Based on these measurements the transmitter operated $5 * 70,72 \text{ ms} = 0,354 \text{ s}$ during the 20 s period

8.7 Screen shots



Picture 10: Number of transmissions on connection state, channel 26



Picture 11: Duration of one transmission on connection state, channel 26

9 20 dB BANDWIDTH

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	15.247, a 1 i		
RSS-210 section	A8.1 (c)		
Measured by	Simo Ojanen		

9.1 Test setup and measurement method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 12: Test setup for 20 dB bandwidth measurement

The 20dB bandwidth was measured using 1 kHz resolution bandwidth and maximum hold function of the spectrum analyzer. 20dB bandwidth was defined by measuring the maximum level on the measured channel and by placing delta markers 20 dB below this value and read the value.

9.2 EUT operation mode

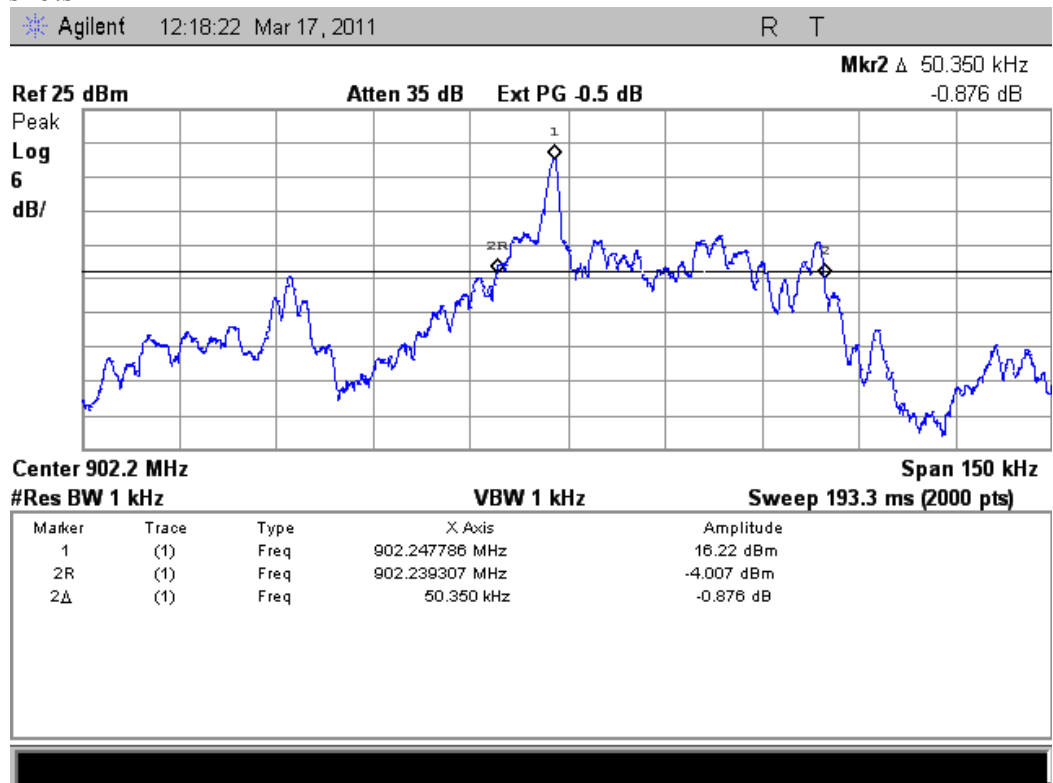
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

9.3 Results

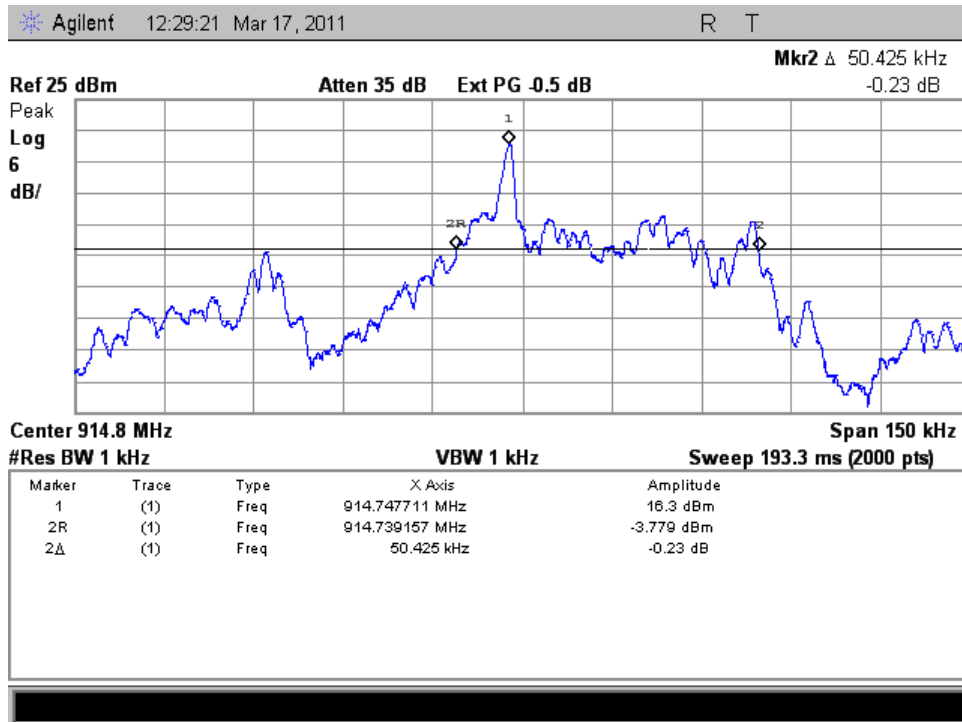
Table 7: 20dB bandwidth measurement results

EUT Channel	Limit (kHz)	Measured value (kHz)
1	≤ 500	50,35
26		50,43
52		48,47

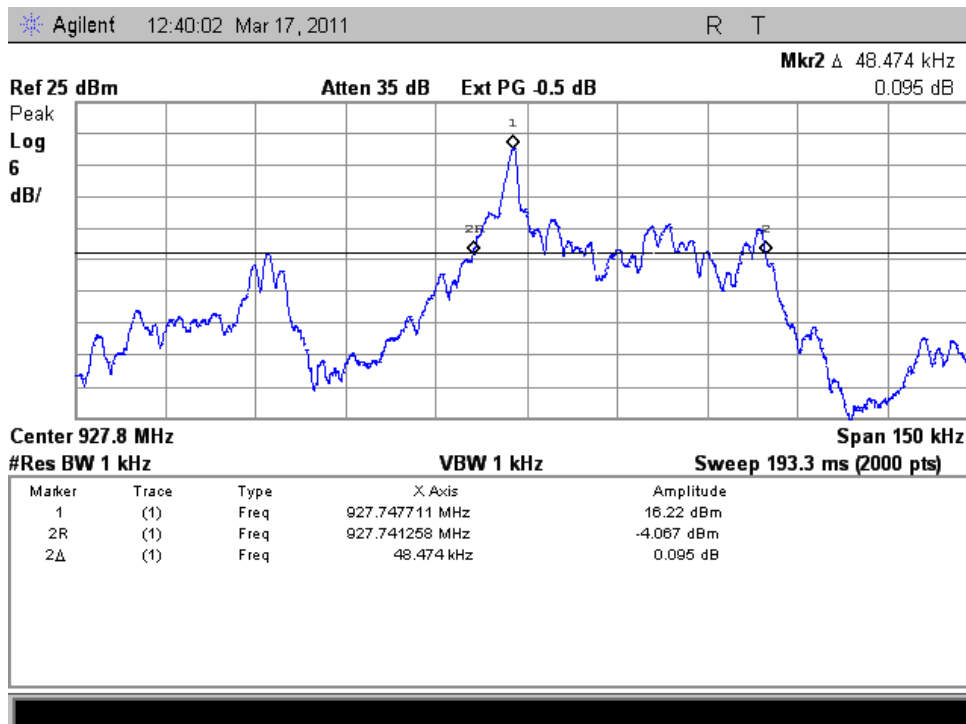
9.4 Screen shots



Picture 13: 20dB Bandwidth measurement result, Channel 1



Picture 14: 20dB Bandwidth measurement result, Channel 26



Picture 15: 20dB Bandwidth measurement result, Channel 52

9.5 EUT operation mode

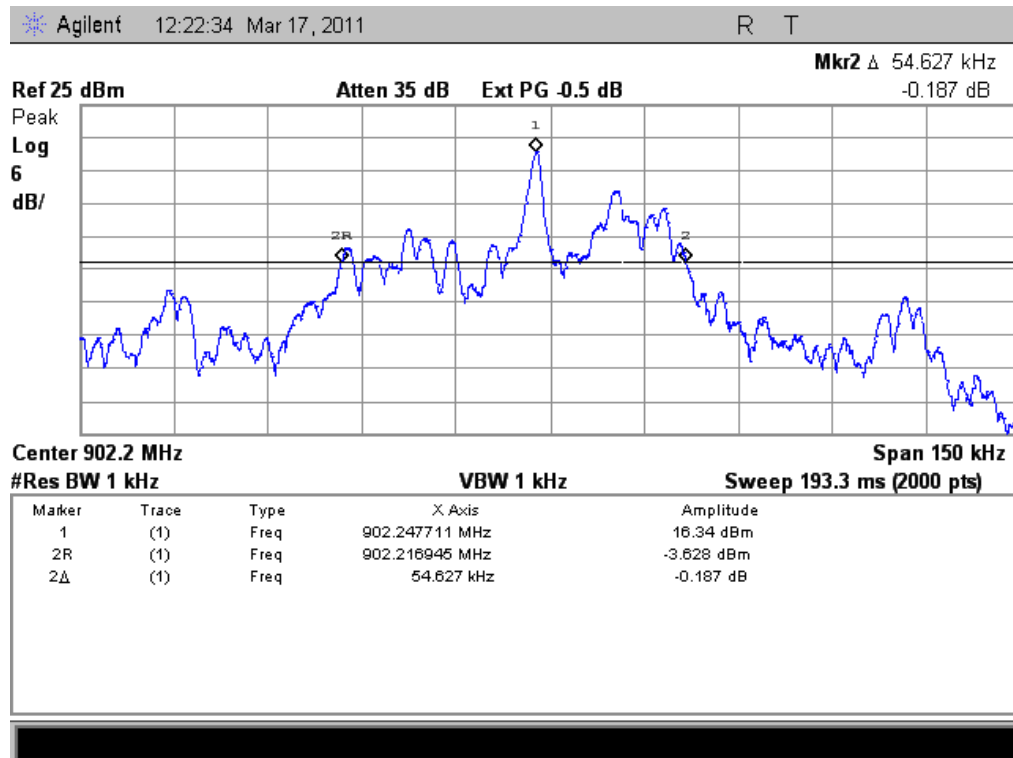
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

9.6 Results

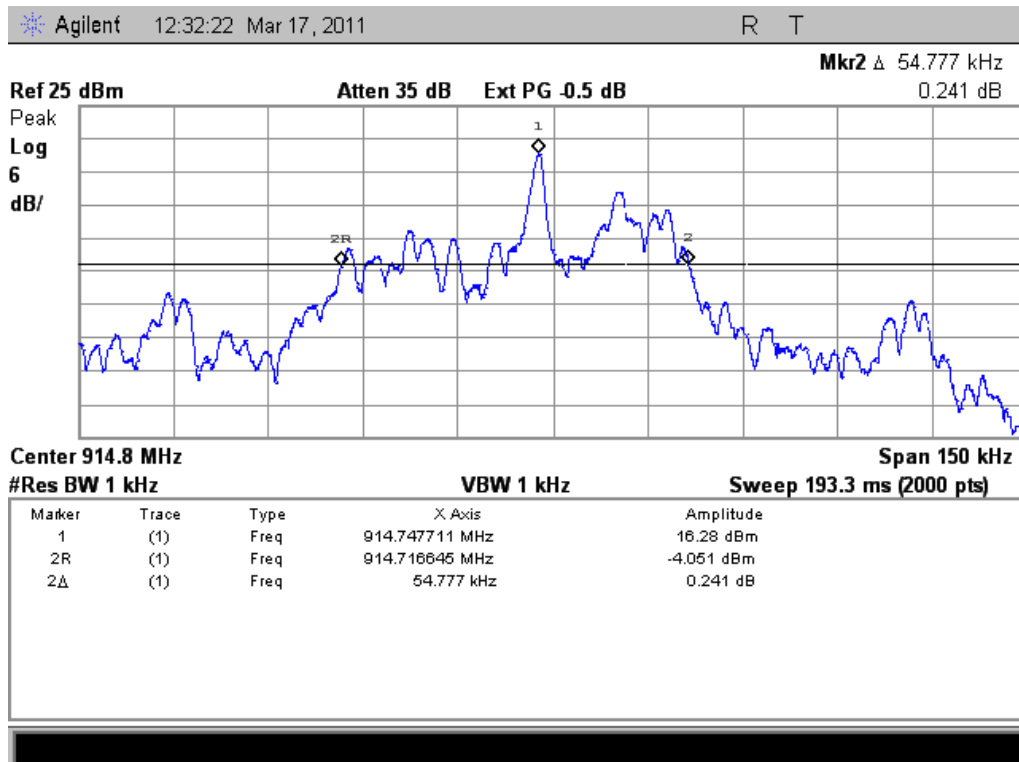
Table 8: 20dB bandwidth measurement results

EUT Channel	Limit (kHz)	Measured value (kHz)
1	≤ 500	54,63
26		54,78
52		54,33

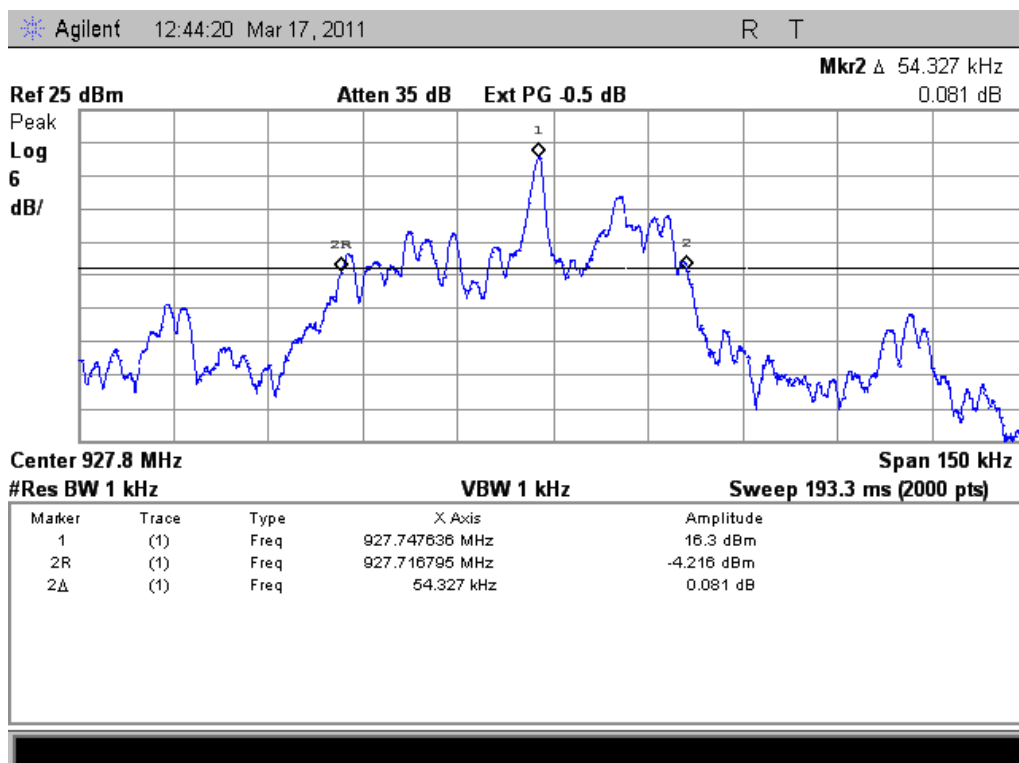
9.7 Screen shots



Picture 16: 20dB Bandwidth measurement result, Channel 1



Picture 17: 20dB Bandwidth measurement result, Channel 26



Picture 18: 20dB Bandwidth measurement result, Channel 52

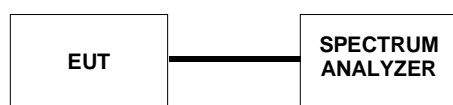
10 PEAK OUTPUT POWER

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	15.247, b 2		
RSS-210 section	A8.4 (1)		
Measured by	Simo Ojanen		

10.1 Test setup and measurement method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 19: Test setup for conducted RF output power measurement

In the peak output power measurement the cable attenuation was measured prior to the power measurement and set as parameter for external gain in the spectrum analyzer to correct the reading of the peak output power. Spectrum analyzer subtracts the set attenuation value from the measured reading.

The measurement was made using 100 kHz resolution bandwidth and 100 kHz video bandwidth and maximum hold function to record the maximum peak output power.

10.2 EUT operation mode

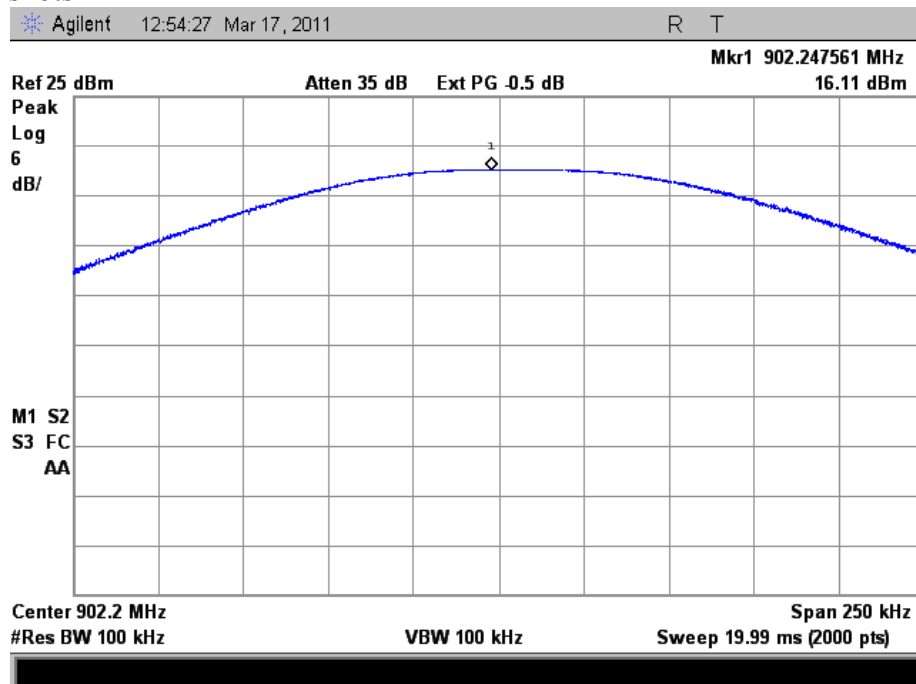
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

10.3 Results

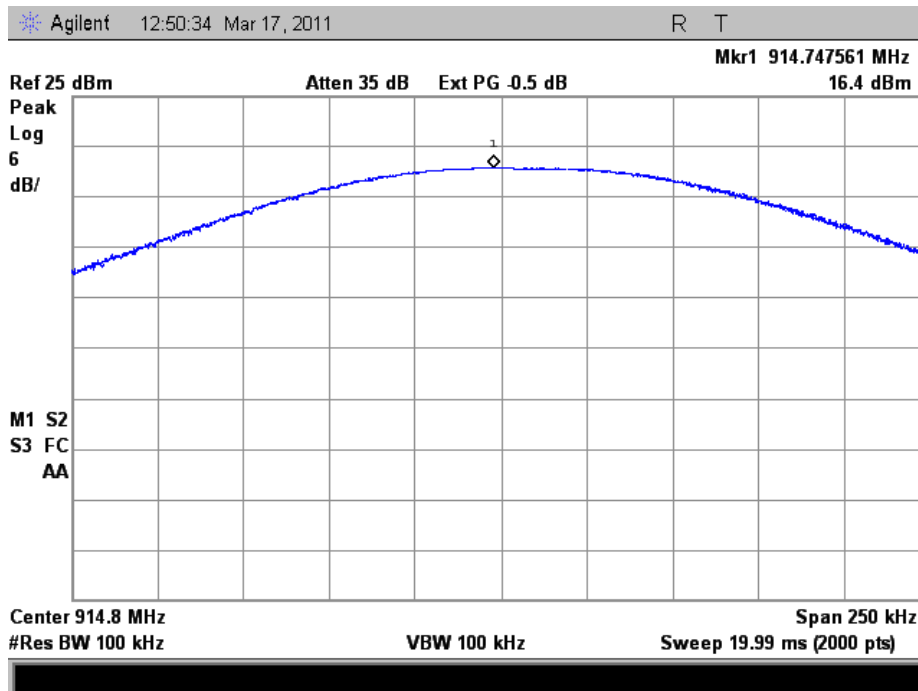
Table 9: Peak output power measurement results

EUT Channel	Limit (mW)	Test result (mW)	Limit (dBm)	Test result (dBm)
1	≤ 1000	40,7	≤ 30	16,1
26		43,7		16,4
52		42,7		16,3

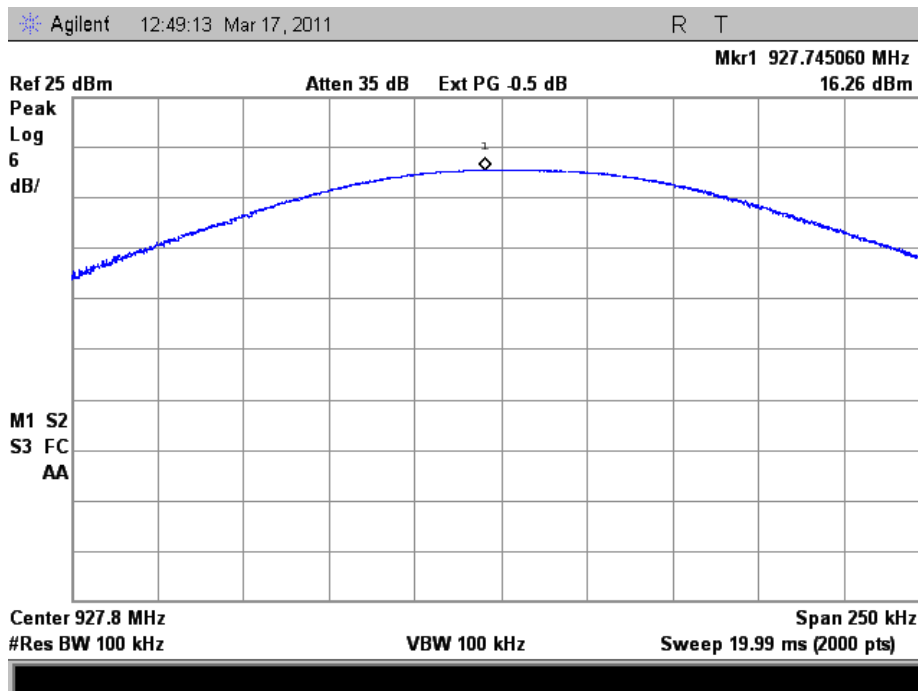
10.4 Screen shots



Picture 20: Peak output power, channel 1



Picture 21: Peak output power, channel 26



Picture 22: Peak output power, channel 52

10.5 EUT operation mode

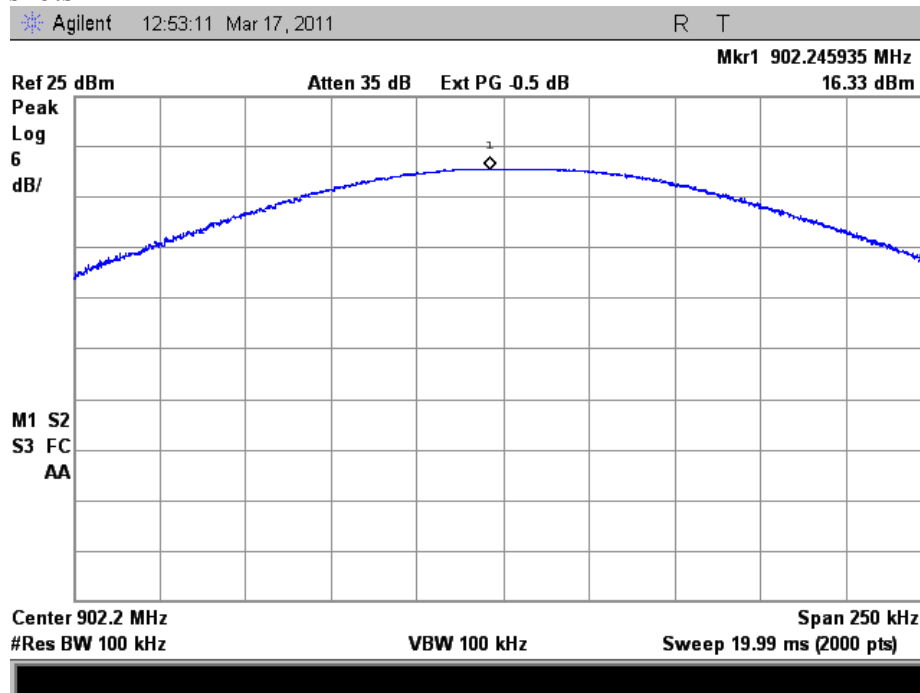
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

10.6 Results

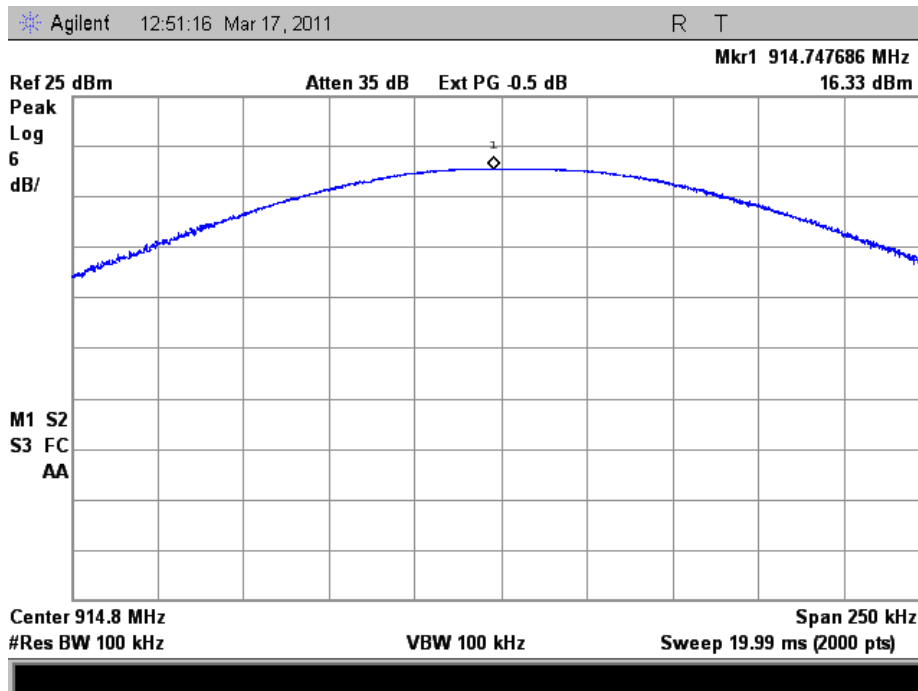
Table 10: Peak output power measurement results

EUT Channel	Limit (mW)	Test result (mW)	Limit (dBm)	Test result (dBm)
1	≤ 1000	42,7	≤ 30	16,3
26		42,7		16,3
52		42,7		16,3

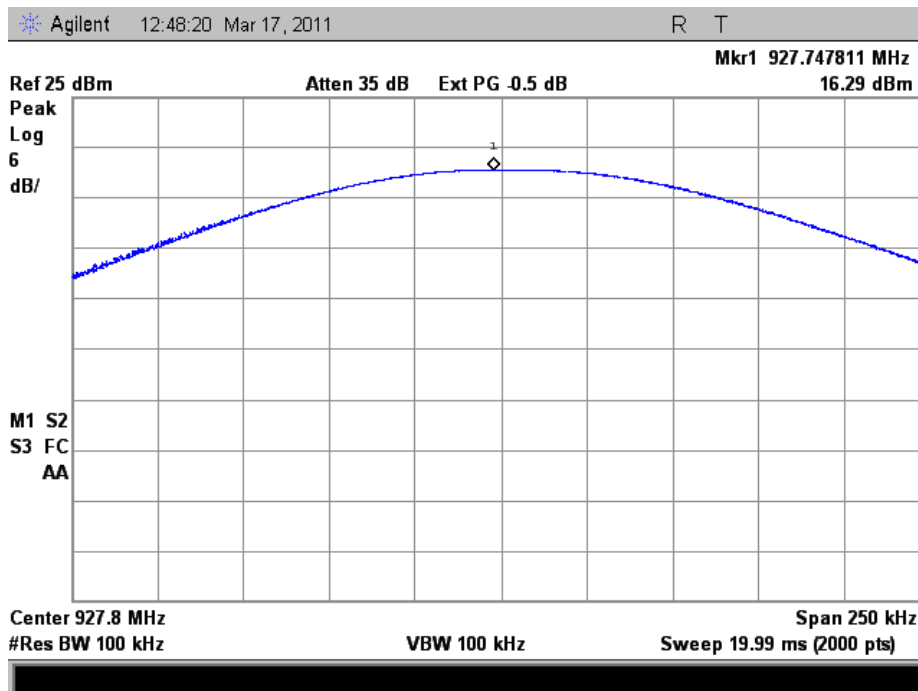
10.7 Screen shots



Picture 23: Peak output power, channel 1



Picture 24: Peak output power, channel 26



Picture 25: Peak output power, channel 52

11 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	15.247, d		
RSS-210 section	A8.5		
Measured by	Simo Ojanen		

11.1 Test setup and measurement method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 26: Test setup for band edge compliance measurement

Band edge compliance of RF-conducted emissions was measured by setting the band edge as center frequency in the spectrum analyzer and measuring the power on the transmission on channels 1 and 52. The measured power and power on the band edge was then compared.

11.2 Hopping enabled

11.2.1 EUT operation mode

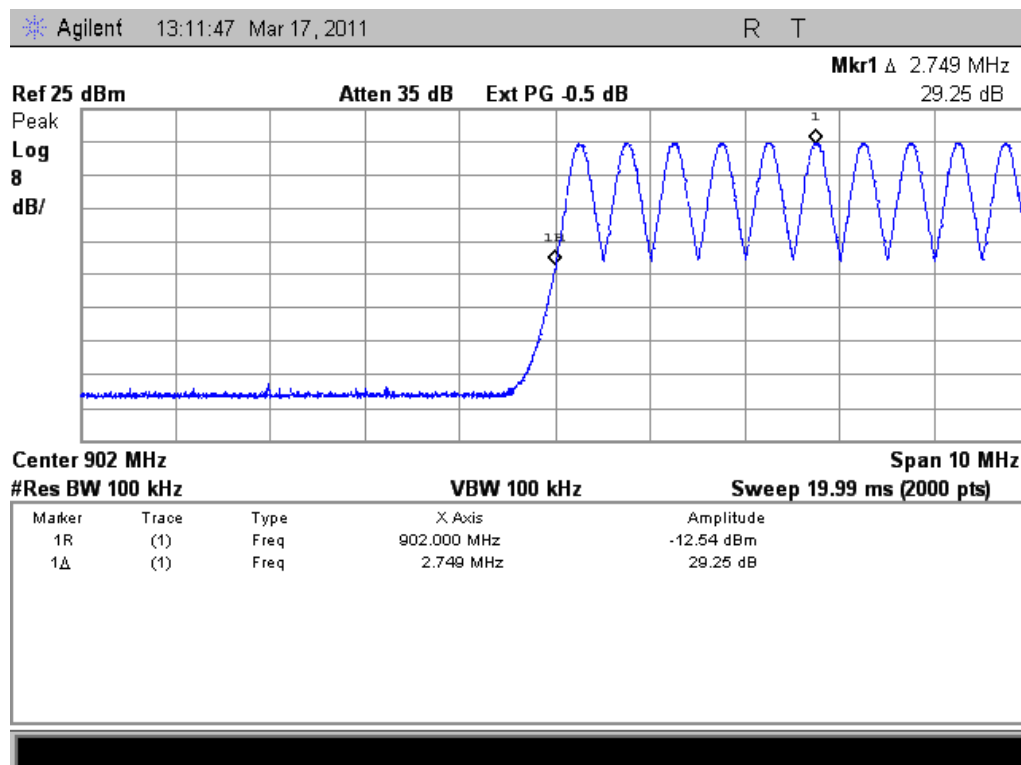
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

11.2.2 Results

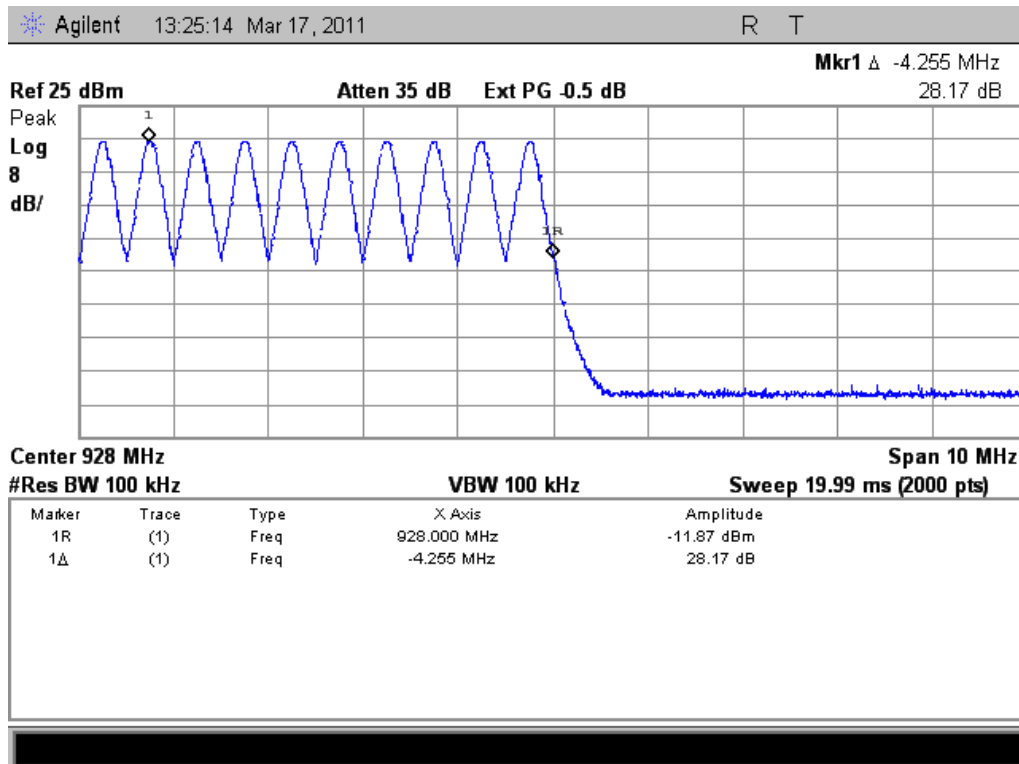
Table 11: Number of hopping frequencies measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
1	≤ -20	-29,25
52		-28,17

11.2.3 Screen shots



Picture 27: Band edge compliance, channel 1, hopping enabled



Picture 28: Band edge compliance, channel 52, hopping enabled

11.2.4 EUT operation mode

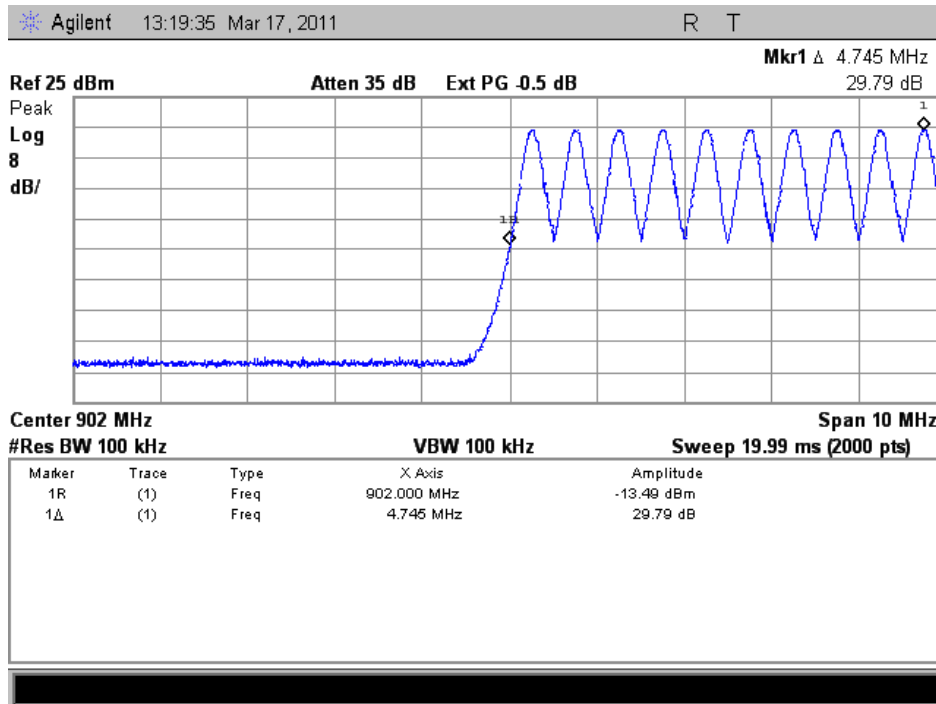
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	Hopping
EUT TX power level	TX level 0 (=max)

11.2.5 Results

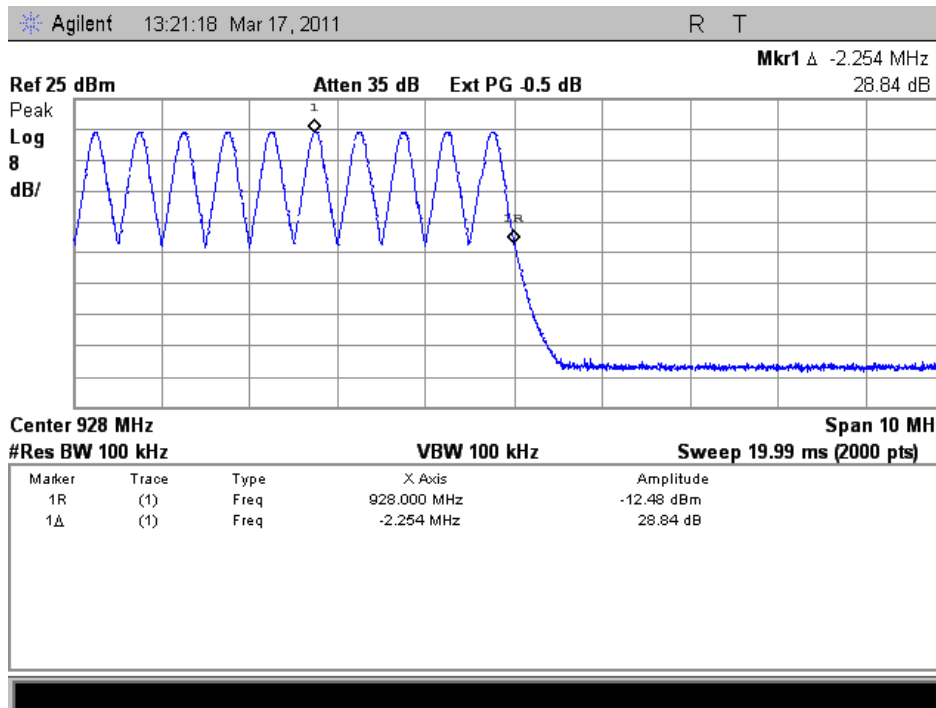
Table 12: Number of hopping frequencies measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
1	≤ -20	-29,79
52		-28,84

11.2.6 Screen shots



Picture 29: Band edge compliance, channel 1, hopping enabled



Picture 30: Band edge compliance, channel 52, hopping enabled

11.3 Hopping disabled

11.3.1 EUT operation mode

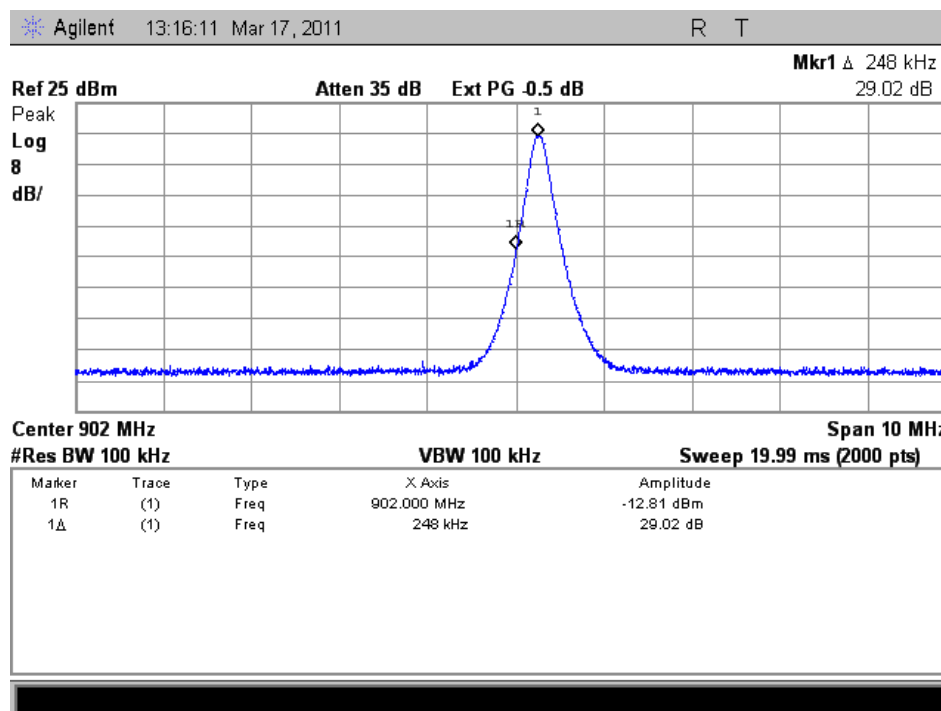
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT channel	1 (902,25MHz) and 52 (927,75MHz)
EUT TX power level	TX level 0 (=max)

11.3.2 Results

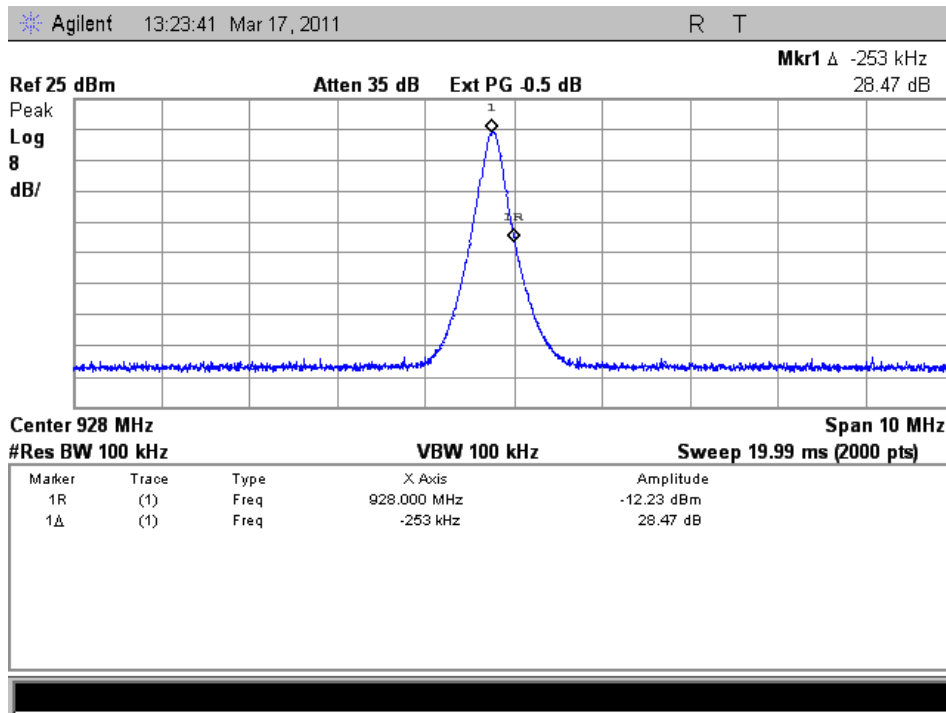
Table 13: Band edge compliance measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
0	≤ -20	-29,02
79		-28,47

11.3.3 Screen shots



Picture 31: Band edge compliance, channel 0, hopping disabled



Picture 32: Band edge compliance, channel 78, hopping disabled

11.3.4 EUT operation mode

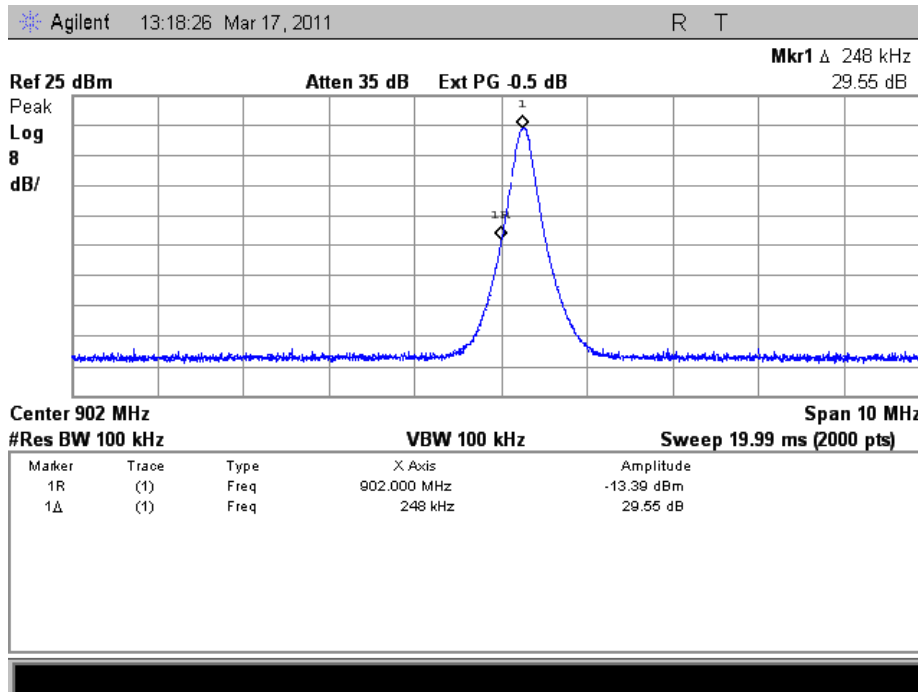
EUT operation mode	Modulation ON, PR-ASK modulation
EUT channel	1 (902,25MHz) and 52 (927,75MHz)
EUT TX power level	TX level 0 (=max)

11.3.5 Results

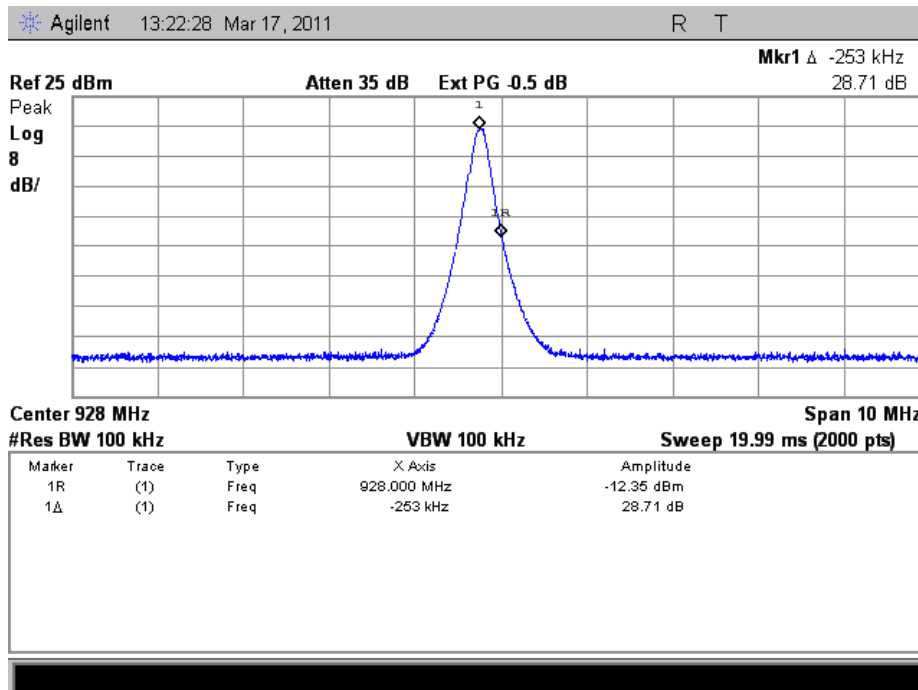
Table 14: Band edge compliance measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
0	≤ -20	-29,55
79		-28,71

11.3.6 Screen shots



Picture 33: Band edge compliance, channel 0, hopping disabled



Picture 34: Band edge compliance, channel 78, hopping disabled

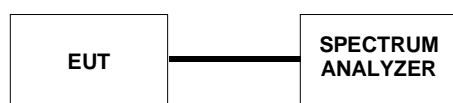
12 99 % BANDWIDTH

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part			
RSS-GEN section	4.6.1		
Measured by	Simo Ojanen		

12.1 Test setup and measurement method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 35: Test setup for 99% bandwidth measurement

The 99% occupied bandwidth was calculated from spectrum analyzer measurements. The measurement data was read from the analyzer to computer. Software in computer calculated the total power from the measurement data and defined the frequency band containing 99% of the total power. Markers in the spectrum analyzer were then placed between the calculated frequencies to show the calculated 99% power band in the screenshots.

12.2 EUT operation mode

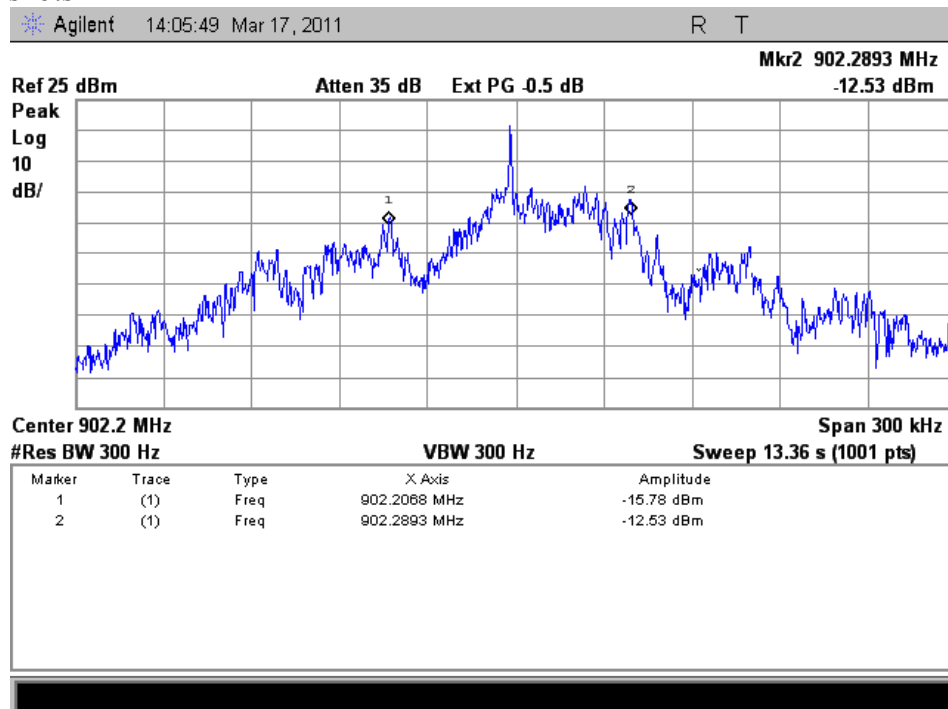
EUT operation mode	Modulation ON, DSB-ASK modulation
EUT frequency	ch1 (902,25 MHz), ch26 (914,75 MHz) and ch52 (927,75 MHz)
EUT TX power level	TX level 0 (=max)

12.3 Results

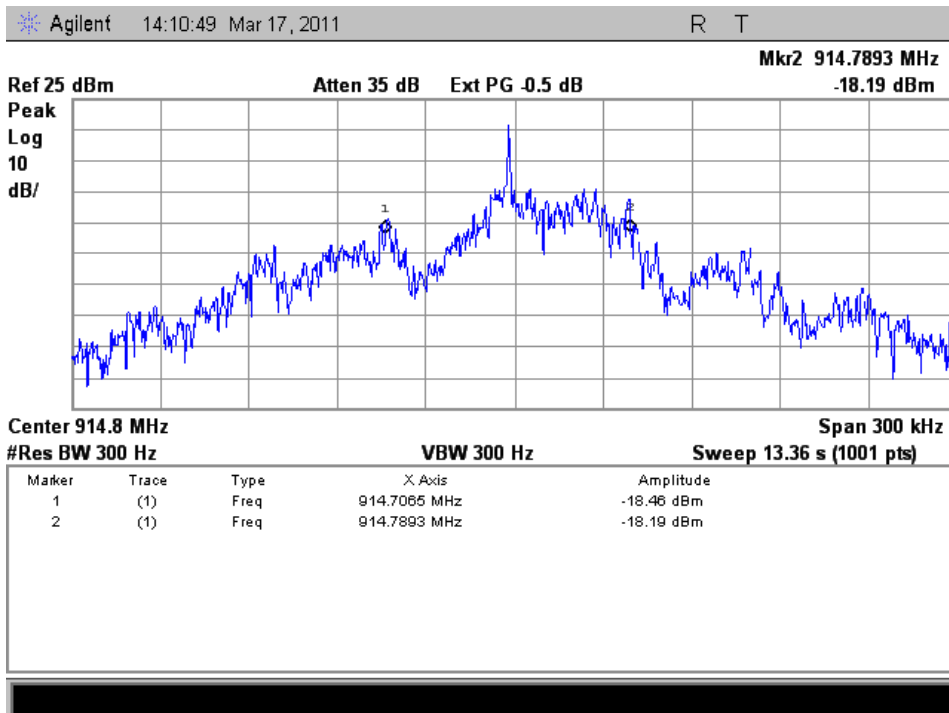
Table 15: 99% bandwidth measurement results

EUT Frequency MHz	Limit kHz	Measured value kHz
902,25	-	82,5
914,75	-	82,8
927,75	-	84,0

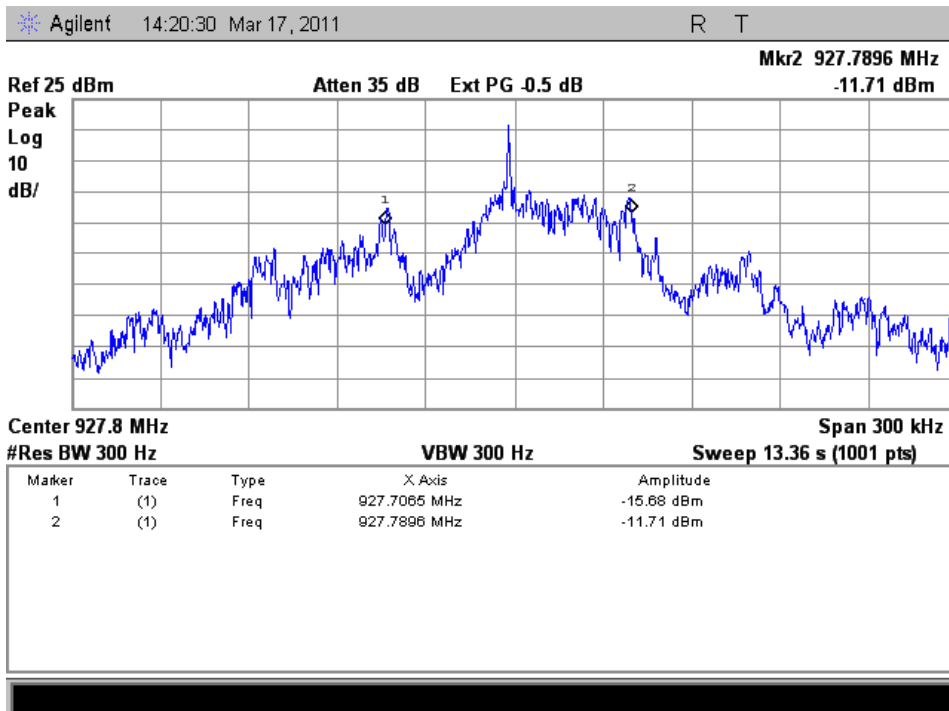
12.4 Screen shots



Picture 36: 99% Bandwidth measurement result, ch 1



Picture 37: 99% Bandwidth measurement result, ch 26



Picture 38: 99% Bandwidth measurement result, ch 52

12.5 EUT operation mode

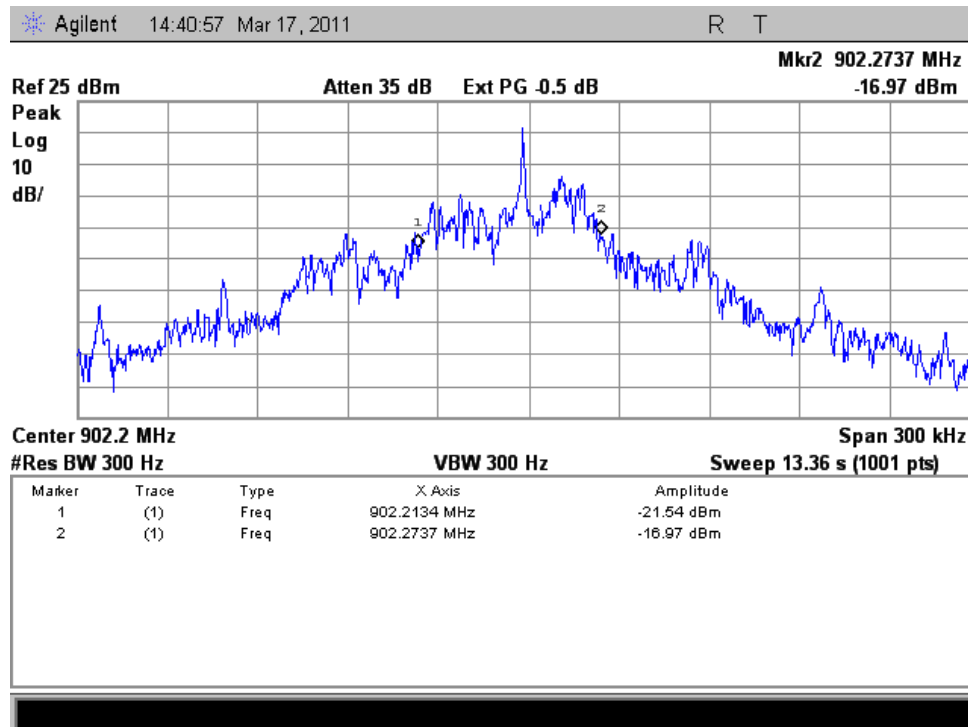
EUT operation mode	Modulation ON, PR-ASK modulation
EUT frequency	ch1 (902,25 MHz), ch26 (914,75 MHz) and ch52 (927,75 MHz)
EUT TX power level	TX level 0 (=max)

12.6 Results

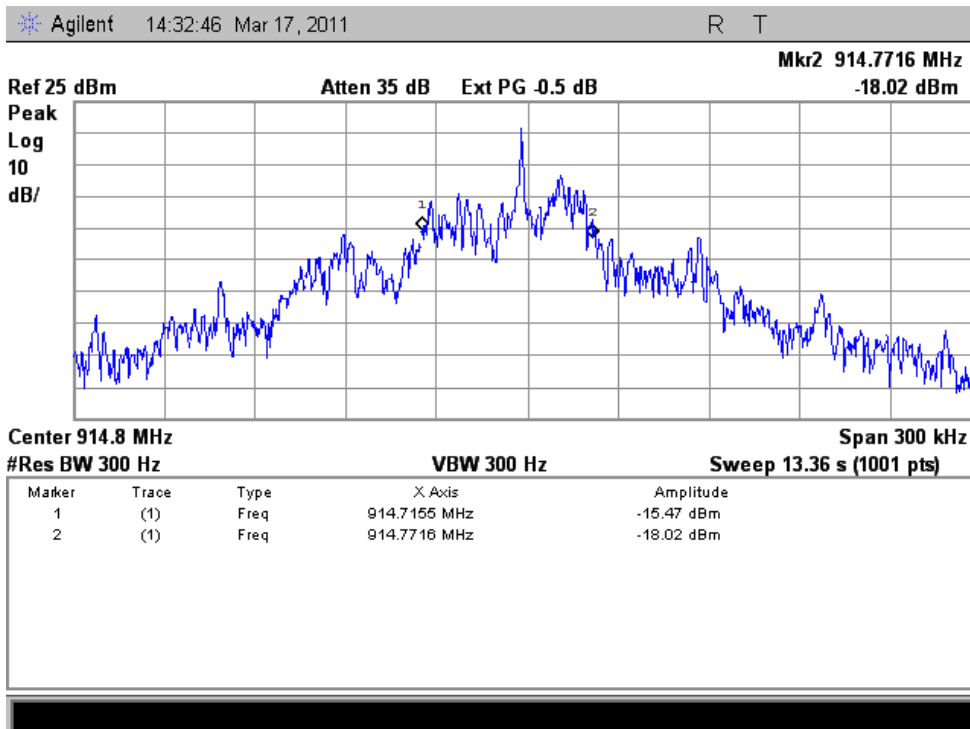
Table 16: 99% bandwidth measurement results

EUT Frequency MHz	Limit kHz	Measured value kHz
902,25	-	60,3
914,75	-	56,1
927,75	-	53,4

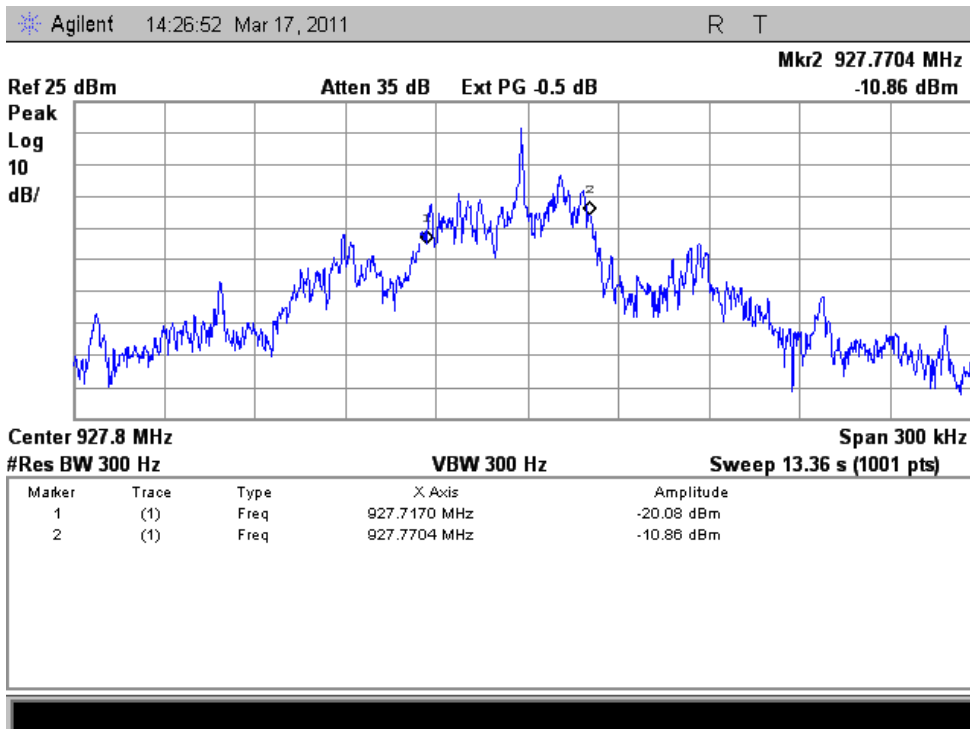
12.7 Screen shots



Picture 39: 99% Bandwidth measurement result, ch 1



Picture 40: 99% Bandwidth measurement result, ch 26



Picture 41: 99% Bandwidth measurement result, ch 52

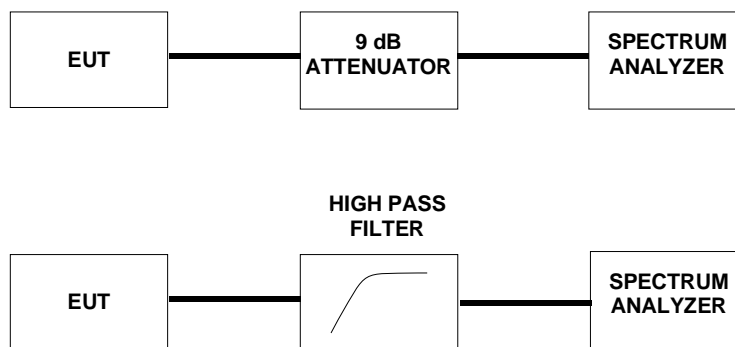
13 SPURIOUS RF CONDUCTED EMISSIONS

EUT	2		
Accessories	3		
Temp, Humidity, Air Pressure	22 °C	16 %RH	1028 hPa
Date of measurement	March 16, 2011		
FCC rule part	15.247, d		
RSS-210 section	A8.5		
Measured by	Simo Ojanen		

13.1 Test setup and measurement method

EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX or RX mode
- enable/disable frequency hopping
- select modulation type



Picture 42: Test setups for conducted spurious emission measurement

Spectrum analyzer and automated software were used to record conducted spurious emissions on frequency range 30 MHz – 25 GHz. Frequency range was scanned using 100 kHz resolution bandwidth and 50 kHz steps. High pass filter was used over 1GHz measurements to avoid spectrum analyzer input to generate spurious emissions. Spurious emissions levels relative to the carrier level were read from the measured results.

13.2 EUT operation mode

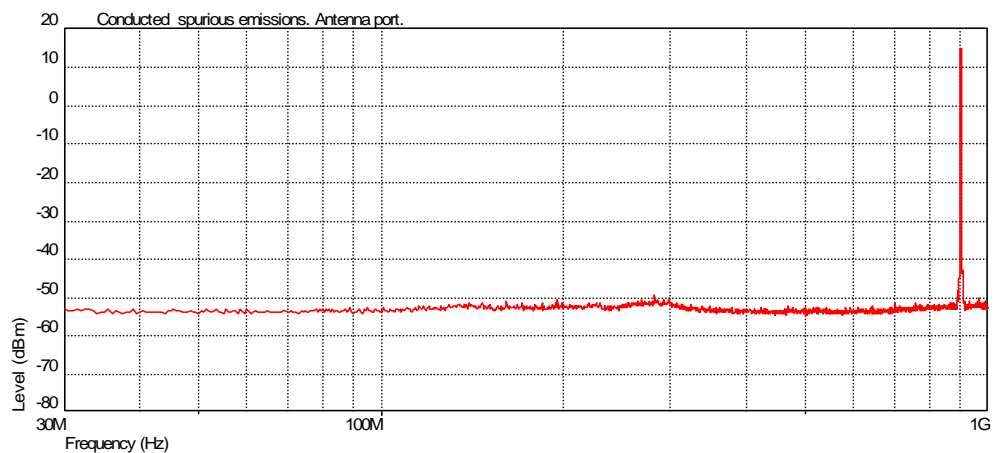
EUT operation mode	Continous transmission (CW)
EUT channel	1 (902,25 MHz), 26 (914,75 MHz) and 52 (927,75 MHz)
EUT TX power level	TX level 0 (=max)

13.3 Limit

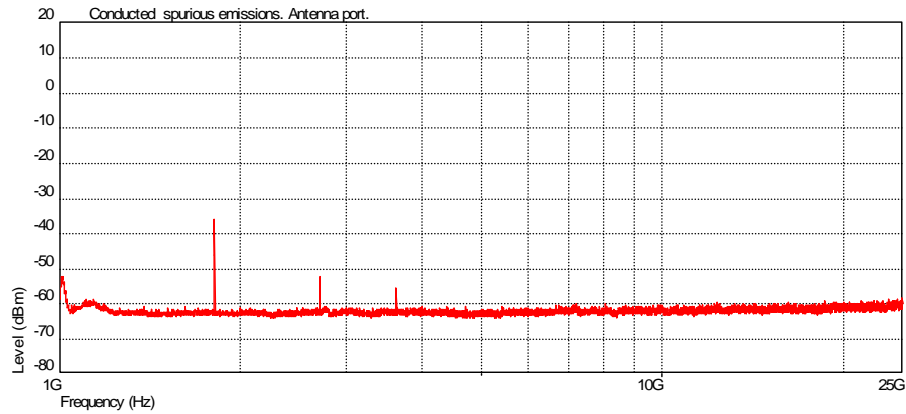
EUT Channel	Limit (dBc)
1	≤ -20
26	
52	

13.4 Results

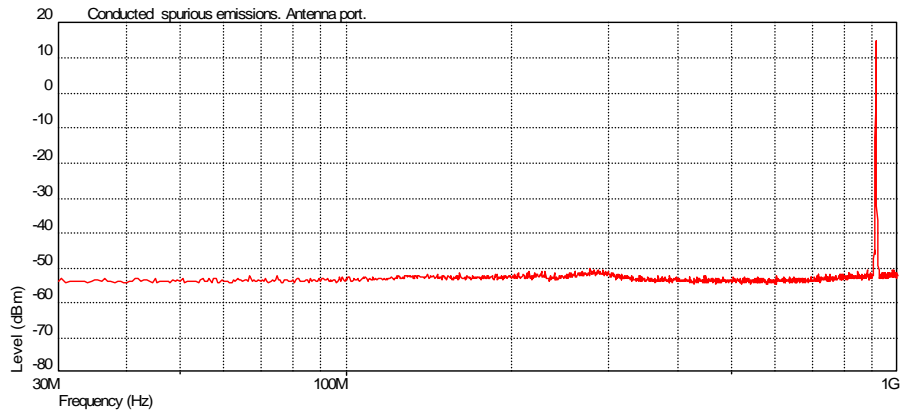
All spurious emissions measured were least 45 dB below the carrier level.



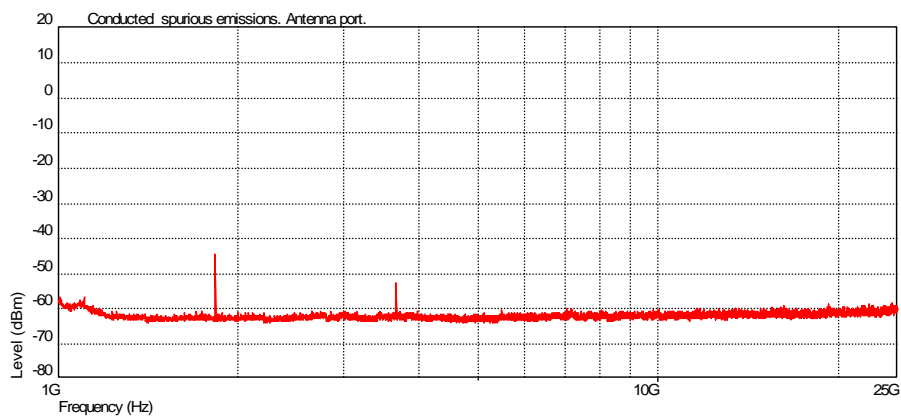
Picture 43: Conducted spurious emissions on antenna port, Channel 1, under 1GHz



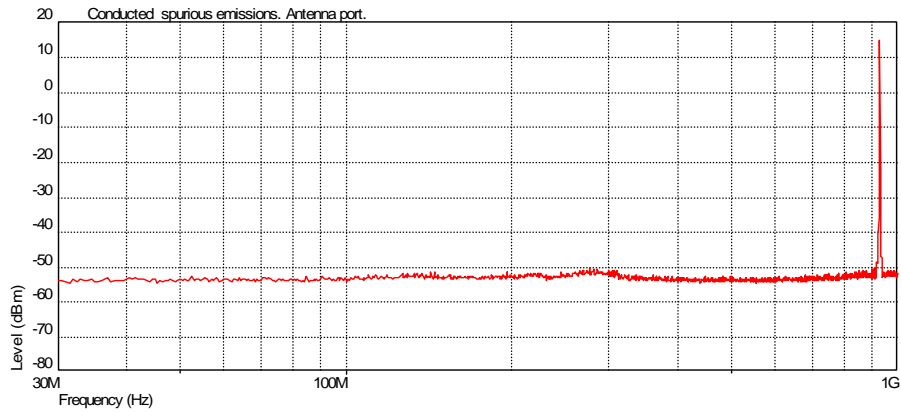
Picture 44: Conducted spurious emissions on antenna port, Channel 1 above 1GHz



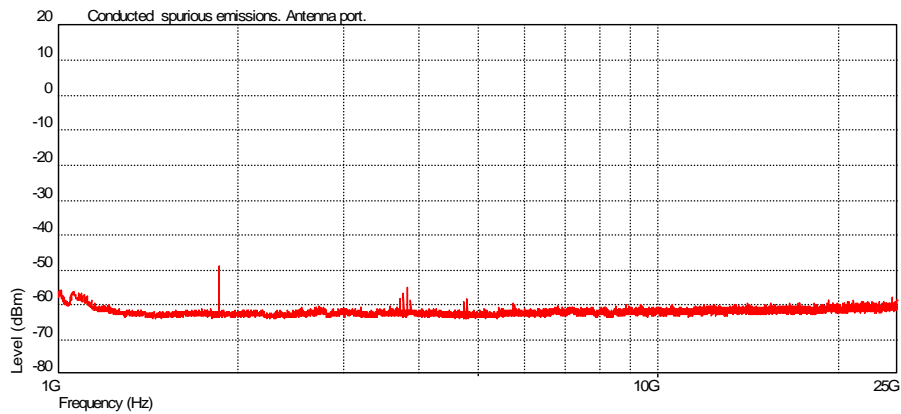
Picture 45: Conducted spurious emissions on antenna port, Channel 26, under 1GHz



Picture 46: Conducted spurious emissions on antenna port, Channel 26, above 1GHz



Picture 47: Conducted spurious emissions on antenna port, Channel 52, under 1GHz



Picture 48: Conducted spurious emissions on antenna port, Channel 52, above 1GHz

14 FIELD STRENGTH OF FUNDAMENTAL

EUT	1		
Accessories	3		
Temp, Humidity, Air Pressure	22 °C	16 %RH	1028 hPa
Date of measurement	March 16, 2011		
FCC rule part			
RSS-210 section			
Measured by	Simo Ojanen		

14.1 Test setup and measurement method

The EUT was set on a non-conductive turntable in a semi-anechoic chamber. The EUT was set at 0.8m height. Measuring antenna was scanned 1 – 4 m in height. The measurements were repeated in three EUT orientations and two antenna polarizations. The measured signal was routed from the measuring antenna to the spectrum analyzer. The measurement was made using 1 MHz resolution bandwidth and 1 MHz video bandwidth and maximum hold function to record the maximum peak output power.

14.2 EUT operation mode

EUT operation mode	Continous transmission, CW
EUT frequency	1 (902,25 MHz), 26 (914,75 MHz) and 52 (927,75 MHz)
EUT TX power level	TX level 0 (=max)

14.3 Results

Table 17: Maximum field strength of fundamental (Peak value)

Freq MHz	Measured Value dB μ V	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
902,25	81,0	20,5	101,6	Pos 2	Hor	1,0	269
914,75	86,4	20,6	107,1	Pos 2	Hor	1,0	164
927,75	79,8	20,7	100,6	Pos 2	Hor	1,0	154

15 RADIATED SPURIOUS EMISSIONS

EUT	1		
Accessories	3		
Temp, Humidity, Air Pressure	22 °C	26 %RH	1001 hPa
Date of measurement	March 14-16, 2011		
FCC rule part	15.247, d		
RSS-210 section	A8.5		
Measured by	Simo Ojanen		

15.1 Test setup

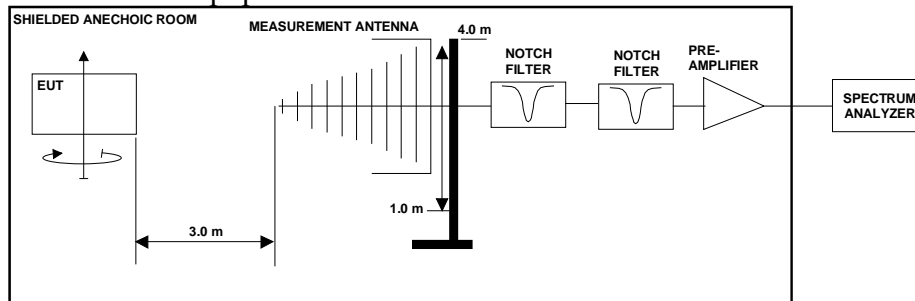
EUT software was used to:

- set the EUT channel (1 – 52)
- set the EUT to TX mode
- disable frequency hopping

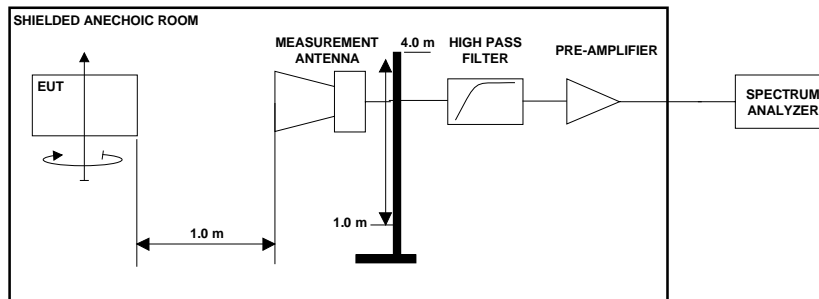
Also Bluetooth settings was controlled by EUT software:

- set the EUT channel (0 – 78)
- set the EUT to TX mode
- disable frequency hopping

The test was done using an automated test system, where a computer controlled the measurement equipment.



Picture 49: Test setup for radiated spurious emissions measurement
30 MHz - 3 GHz frequencies



Picture 50: Test setup for radiated spurious emissions measurement
3 GHz – 25 GHz frequencies

15.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB μ V/m at 3 m distance, are reported.

15.3 EUT operation mode

EUT RFID mode	Continous transmission, CW
EUT RFID channel	1 (902,25 MHz), 26 (914,75 MHz) and 52 (927,75 MHz)
EUT BT mode	Connection, GFSK modulation, PRBS packet type
EUT BT channel	0 (2402 MHz), 39 (2441 MHz) and 78 (2480 MHz)
EUT TX power level	max

15.4 Limit

Table 18: Radiated spurious emission limits at measurement distance 3m

Frequency band (MHz)	3m Limit (μ V/m)	3m Limit (dB μ V/m)	Detector
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 25000	500	54,0	AVG
1000 - 25000	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

15.5 Results

Measurement system noise level was at least 15 dB below the spurious emission limit. Only levels of suspicious signals and transmitter harmonic frequencies, which were above the measurement system noise, are reported.

Table 19: Emission levels PEAK (QP) detector, RFID channel 1, BT channel 0

Freq MHz	Measured Value dBμV	Correction Factor dB	Result dBμV/m	Marginal dB	EUT Position	Ant Pol.	Ant height m
1804,5	53,7	11,6	65,4	8,5	Pos 2	Hor	1,0
2706,5	35,5	19,0	54,6	19,3	Pos 1	Hor	1,3
3609	64,5	-20,0	44,4	29,5	Pos 3	Ver	1,0
4511,5	60,3	-17,9	42,3	31,6	Pos 1	Hor	1,1
4803,5	71,0	-16,9	54,1	19,8	Pos 1	Hor	1,0
5413,5	60,7	-16,1	44,6	29,3	Pos 1	Hor	1,1
7206,5	55,5	-7,5	47,9	26,0	Pos 1	Hor	1,2

Table 20: Emission levels PEAK (QP) detector, RFID channel 26, BT channel 39

Freq MHz	Measured Value dBμV	Correction Factor dB	Result dBμV/m	Marginal dB	EUT Position	Ant Pol.	Ant height m
1829,5	56,2	11,6	67,9	6,1	Pos 2	Hor	1,4
2744	37,3	19,4	56,8	17,1	Pos 1	Ver	1,0
3659	73,2	-19,9	53,2	20,7	Pos 1	Hor	1,0
4574	73,9	-17,7	56,2	17,7	Pos 1	Hor	1,0
4890	72,0	-16,7	55,3	18,7	Pos 1	Hor	1,0
5488,5	67,6	-16,0	51,6	22,3	Pos 3	Ver	1,1
11892	43,6	-1,9	41,6	32,3	Pos 3	Hor	1,4

Table 21: Emission levels PEAK (QP) detector, RFID channel 52, BT channel 78

Freq MHz	Measured Value dBμV	Correction Factor dB	Result dBμV/m	Marginal dB	EUT Position	Ant Pol.	Ant height m
1855,5	40,7	12,0	52,7	21,2	Pos 3	Hor	1,0
3711	64,9	-19,9	44,9	29,0	Pos 1	Hor	1,0
4966	67,6	-16,6	51,0	22,9	Pos 1	Hor	1,1

BT spurious emission peak values are under average limit. Since the RFID measurements are made with sample that is modified to continuous transmission, average results are calculated from peak results using duty cycle.

$$\text{Average level} \leq \text{Peak level} + 20 \log (\text{duty cycle}).$$

With PR-ASK modulation, measured transmission time in clause 8.3 was 70,72ms

Therefore,

$$\begin{aligned} \text{Average level} &\leq \text{Peak level} + 20 \log (70,72\text{ms}/100\text{ms}) \\ \text{Average level} &\leq \text{Peak level} - 3,009 \text{ dB} \end{aligned}$$

Table 22: Emission levels calculated average, RFID channel 1

Freq MHz	Peak Result dBμV/m	Average Result dBμV/m	Marginal dB
1804,5	65,4	62,4	-8,4 *
2706,5	54,6	51,6	2,3
3609	44,4	41,4	12,5
4511,5	42,3	39,3	14,6
5413,5	44,6	41,6	12,3
7206,5	47,9	44,9	9,0

* outside the restricted band and complies with the -20dBc requirement.

Table 23: Emission levels calculated average, RFID channel 26

Freq MHz	Peak Result dBμV/m	Average Result dBμV/m	Marginal dB
1829,5	67,9	64,8	-10,8 *
2744	56,8	53,8	0,2
3659	53,2	50,2	3,7
4574	56,2	53,2	0,7
5488,5	51,6	48,6	5,3
11892	41,6	38,6	15,3

* outside the restricted band and complies with the -20dBc requirement.

Table 24: Emission levels calculated average, RFID channel 52

Freq MHz	Peak Result dBμV/m	Average Result dBμV/m	Marginal dB
1855,5	52,7	49,7	4,3
3711	44,9	41,9	12,0

16 CONDUCTED EMISSIONS TO AC-MAINS

EUT	1		
Accessories	3		
Temp, Humidity, Air Pressure	23 °C	14 %RH	1022 hPa
Date of measurement	March 17, 2011		
FCC rule part	§15.107		
RSS-GEN section	7.2.4		
ICES-003 section	5.3		
Measured by	Simo Ojanen		

16.1 Test setup

Charger was connected to line impedance stabilization network and conducted emissions to AC-mains were measured using measurement receiver.

16.2 EUT operation mode

EUT was at idle mode.

16.3 Limits

Frequency of emission [MHz]	FCC / IC	
	Limit [dBµV] Quasi peak	Limit [dBµV] Average
0,15 – 0,50	66 – 56*	56 – 46*
0,50 – 5	56	46
5 – 30	60	50

* The limit decreases linearly with the logarithm of the frequency

16.4 Results

The measured interference values using peak and average detectors are shown in the Picture 51 and Picture 52 below.

All signals closer than 6 dB to the limit have been measured using quasi peak and average detectors and reported in tables 25 - 25.

Table 25: Quasi peak detector measurement results, AC live

Frequency [MHz]	Measured value [dBμV]	Limit [dBμV]	Margin to limit [dB]
N/A			

Table 26: Average detector measurement results, AC live

Frequency [MHz]	Measured value [dBμV]	Limit [dBμV]	Margin to limit [dB]
N/A			

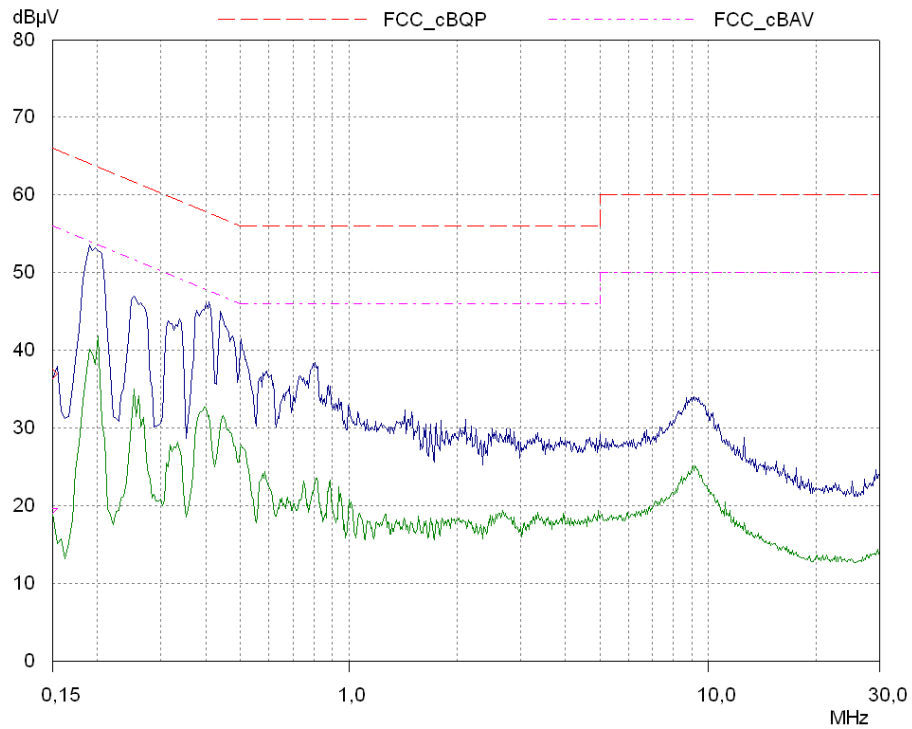
Table 27: Quasi peak detector measurement results, AC neutral

Frequency [MHz]	Measured value [dBμV]	Limit [dBμV]	Margin to limit [dB]
N/A			

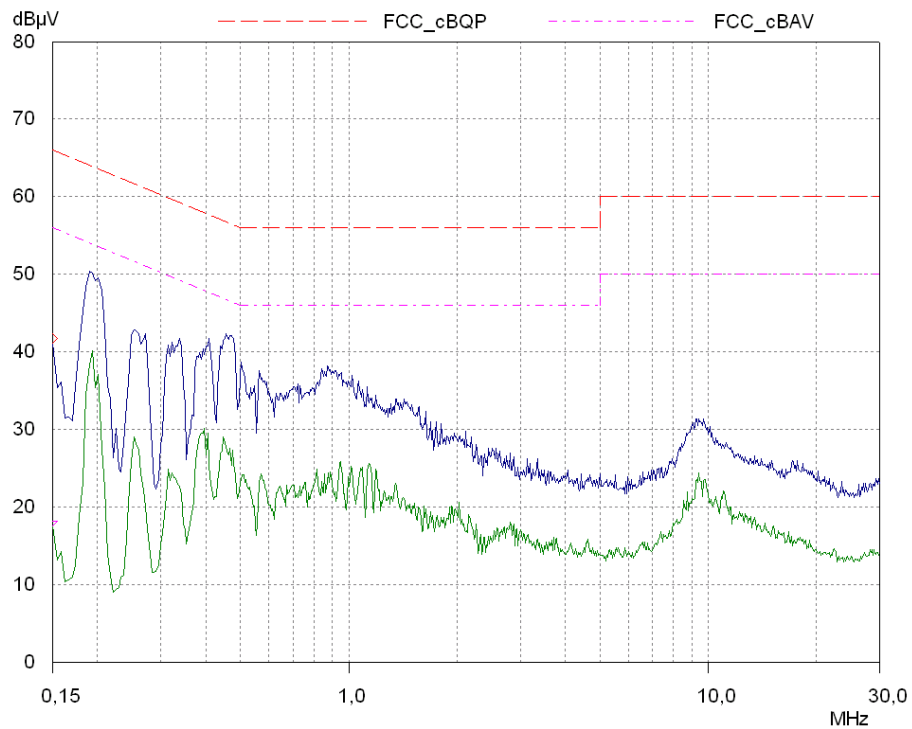
Table 28: Average detector measurement results, AC neutral

Frequency [MHz]	Measured value [dBμV]	Limit [dBμV]	Margin to limit [dB]
N/A			

16.5 Screen shots



Picture 51: AC-mains conducted emission measurement results, AC live



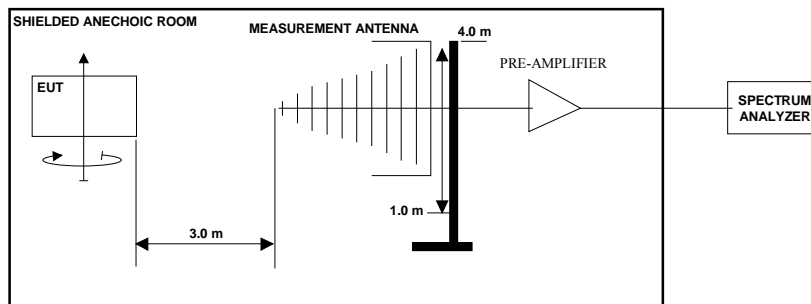
Picture 52: AC-mains conducted emission measurement results, AC neutral

17 RECEIVER RADIATED EMISSION

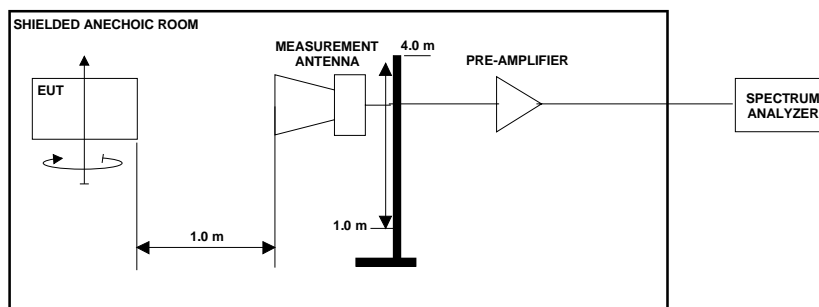
EUT	1		
Accessories	3		
Temp, Humidity, Air Pressure	22 °C	26 %RH	1001 hPa
Date of measurement	March 14-15, 2011		
FCC rule part	§15.109		
RSS-GEN section	7.2.5		
ICES-003 section	5.5		
Measured by	Simo Ojanen		

17.1 Test setup

The test was done using an automated test system, where a computer controlled the measurement equipments.



Picture 53: Test setup for radiated spurious emissions measurement
30 MHz - 1 GHz frequencies



Picture 54: Test setup for radiated spurious emissions measurement
1 GHz – 12,4 GHz frequencies

17.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB μ V/m at 3 m distance, are reported.

17.3 EUT operation mode

EUT operation mode	Receiver mode
EUT frequency	Na
EUT TX power level	Na

17.4 Limit

Table 29: Radiated spurious emission limits at measurement distance 3m

Frequency band (MHz)	3m Limit (μV/m)	3m Limit (dBμV/m)	Detector
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 12400	500	54,0	AVG
1000 - 12400	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

17.5 Results

The measured interference values using Quasi peak and average detectors are shown in the pictures below.

All signals closer than 6 dB to the limit below 1 GHz have been measured using quasi peak or average detector and reported in the table 30, 31 and 32.

Table 30: Radiated emissions using Quasi peak detector

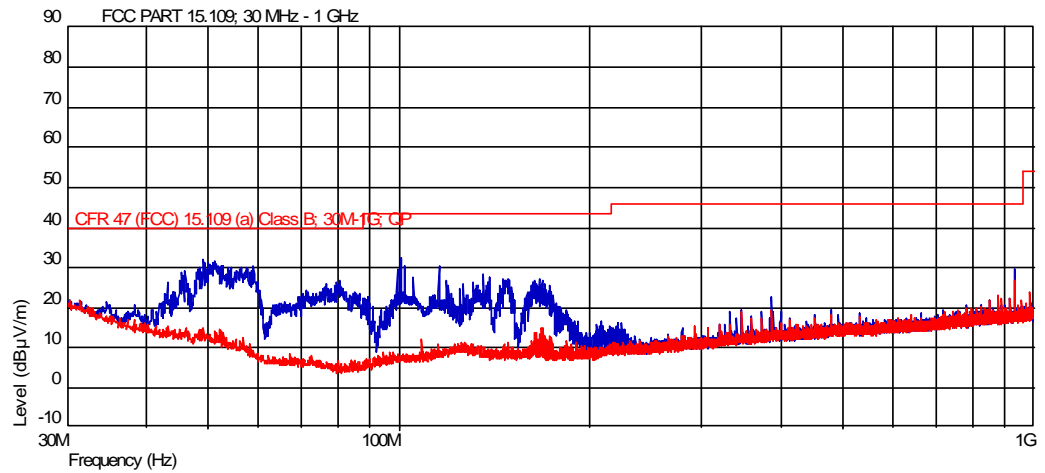
Freq MHz	Measured Value dB μ V	Correction Factor dB	Result dB μ V/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								

Table 31: Radiated emissions using Peak detector

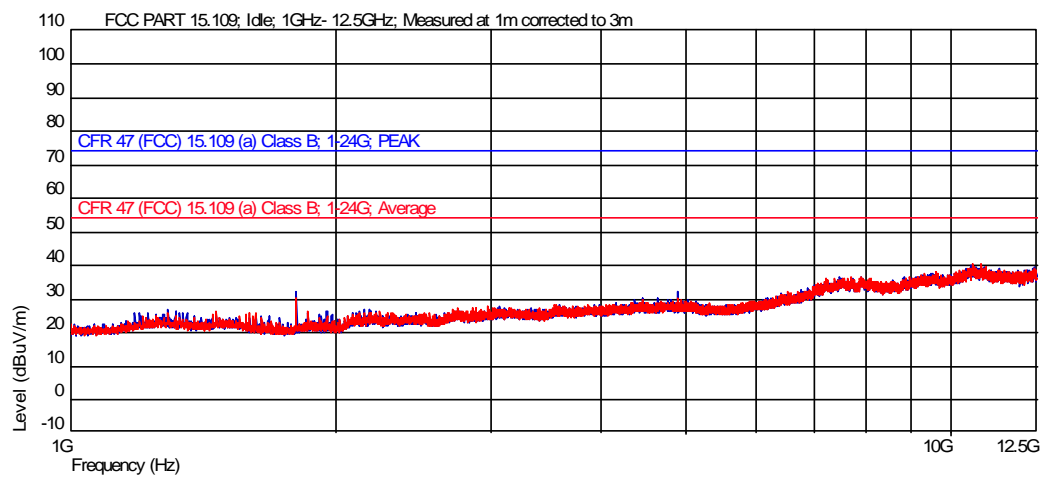
Freq MHz	Measured Value dB μ V	Correction Factor dB	Result dB μ V/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								

Table 32: Radiated emissions using Average detector

Freq MHz	Measured Value dB μ V	Correction Factor dB	Result dB μ V/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								



Picture 55: radiated emission results, 30 – 1000 MHz,
Red= horizontal polarization, blue = vertical polarization



Picture 56: radiated emission results, 1 – 12,4 GHz,
Red= horizontal polarization, blue = vertical polarization

18 TEST EQUIPMENT

18.1 Conducted measurements

DEVICE	MANUFACTURER	SPKTT	SERIAL
EMI test receiver	Rohde & Schwarz ESCS30	020	849650/0016
LISN	Rohde & Schwarz ESH3-Z5	049	833874/029
10dB trans.limiter	Teseq CFL9206A	222	26719
Measuring software	R&S ESxS-K1	-	Ver 2.20

DEVICE	MANUFACTURER	SPKTT	SERIAL
Spectrum analyser	Agilent E7405A	131	MY42000072

18.2 Radiated measurements

DEVICE	MANUFACTURER	SPKTT	SERIAL
Spectrum analyser	Agilent E7405A	131	MY42000072
Horn Antenna	Schwarzbeck BBHA9120D	138	365
X-wing BiLog antenna	Teseq CBL6143A	221	29611
Horn Antenna	Schwarzbeck BBHA9170	194	313
3 dB attenuator	Huber+Suhner 3dB/2W	214	-
Pre-amplifier	Agilent 87405B	143	MY39500154
Pre-amplifier	JCA 118-400	142	-
Pre-amplifier	Miteq AMF-6F-18002650-2	191	1128879
High pass filter	Wainwright Instruments WHK3.0/18GST	141	3
Band reject filter	Wainwright Instruments WRCT2400/2483	196	2
Band reject filter	Wainwright WRCT 800/900MHz	135	4
3m Semi-anechoic chamber	ETS Euroshield	081	-
Measuring software	Teseq Compliane3	-	Ver 4.01

19 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

100310A-RF_PHOTOS.doc