

Test Report



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C and INDUSTRY CANADA REQUIREMENTS

Equipment Under Test: RFID Module

Type/ Model: NUR-05WL2

Manufacturer: Nordic ID Oy
Myllyojankatu 2 A
24100 Salo
FINLAND

Customer: Nordic ID Oy
Myllyojankatu 2 A
24100 Salo
FINLAND

FCC Rule Part: 15.247: 2012
IC Rule Part: RSS-210, Issue 8, 2010

KDB: RSS-GEN Issue 3, 2010
Filing and Measurement Guidelines for
Frequency Hopping Spread Spectrum Systems
DA 00-705 (March 30, 2000)

Date: June 17, 2013

Issued by:


Niklas Karpatskij
Testing Engineer

Date: June 17, 2013

Checked by:


Jari Merikari
Technical Manager

Table of Contents

| | |
|--|----|
| PRODUCT DESCRIPTION | 3 |
| Equipment Under Test (EUT)..... | 3 |
| Ratings and declarations..... | 3 |
| Power Supply..... | 3 |
| GENERAL REMARKS | 4 |
| Disclaimer..... | 4 |
| SUMMARY OF TESTING | 5 |
| EUT Test Conditions during Testing | 5 |
| TEST RESULTS | 6 |
| Conducted Emissions In The Frequency Range 150 kHz - 30 MHz | 6 |
| Maximum Peak Conducted Output Power | 8 |
| Transmitter Radiated Emissions 30 MHz to 26.5 GHz | 11 |
| Receiver Radiated Emissions 30 MHz to 26.5 GHz | 20 |
| Conducted Spurious Emissions 30 MHz to 26.5 GHz and Band Edge..... | 22 |
| 20 dB Bandwidth of the Hopping Channel | 29 |
| Hopping Channel Carrier Frequencies Separation..... | 33 |
| Number of Hopping Channels | 34 |
| Average Time of Occupancy of Hopping Frequency | 35 |
| 99% Occupied Power Bandwidth | 37 |
| LIST OF TEST EQUIPMENT | 41 |

Equipment Under Test (EUT)

RFID module
Type/ Model: NUR-05WL2
Serial Number: -

NUR-05WL2 is a frequency hopping spread spectrum RFID module operating in the frequency range of 902 – 928 MHz.

One sample was used in the tests. Conducted measurements were made from the antenna connector (SMA).

Classification of the device

| | |
|--|-------------------------------------|
| Fixed device | <input type="checkbox"/> |
| Mobile Device (Human body distance > 20cm) | <input checked="" type="checkbox"/> |
| Portable Device (Human body distance < 20cm) | <input type="checkbox"/> |

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing

Ratings and declarations

RFID:

Operating Frequency Range (OFR): 902 – 928 MHz
Channels: 52
Channel separation: 500 kHz
Conducted power: +25.89 dBm
Transmission technique: FHSS
Modulation: ASK, PR-ASK
Maximum antenna gain: 8 dBi

Power Supply

The module was powered by a laboratory power supply with 3.6 Vdc.

Disclaimer

This test report is issued under SGS Fimko general terms of delivery (available on request and accessible at www.fi.sgs.com). Attention is drawn to the limitations of liability, indemnification and jurisdictional issues defined therein. Unless otherwise stated: (a) the results shown in this document refer only to the sample(s) tested and (b) such sample(s) are retained for three months. This document cannot be reproduced except in full, without prior approval of SGS Fimko.

Any unauthorized alteration, forgery or falsification of the content or appearance of this report is unlawful and offenders may be prosecuted to the fullest extent of the law.

SUMMARY OF TESTING

| Test Specification | Description of Test | Result |
|---------------------------------------|--|-------------|
| §15.207(a) / RSS-GEN 7.2.2 | Conducted Emissions on Power Supply Lines | PASS |
| §15.247(b)(1) / RSS-210 8.4 | Maximum Peak Conducted Output Power | PASS |
| 15.247(a)(1) / RSS-210 A8.1 | Hopping Channel Carrier Frequency Separation | PASS |
| §15.247(a)(1)(iii) / RSS-210 A8.1 | Number of Hopping Frequencies | PASS |
| §15.247(a)(1)(iii) / RSS-210 A8.1 | Average Time of Occupancy of Hopping Frequency | PASS |
| §15.247(a)(1) / RSS-210 A8.1 | 20 dB Bandwidth | PASS |
| RSS-GEN 4.6.1 | 99 % Occupied Bandwidth | PASS |
| §15.247(d) / RSS-210 A8.5 | 100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions | PASS |
| §15.209(a), §15.247(d) / RSS-210 A8.5 | Radiated Emissions Within The Restricted Bands | PASS |
| §15.209 / RSS-GEN 7.2.3.2 | Unintentional Radiated Emissions | PASS |

EUT Test Conditions during Testing

The EUT was configured into the wanted channel and was in continuous transmit mode during all the tests. All of the tests were performed in the PR-ASK modulation, 20 dB bandwidth and 99 % occupied bandwidth measurements were also done in the ASK modulation. The decision was based on the test results of the previous evolution of the NUR05 module, there were no major differences in the results of the other tests than the ones that were made with both modulations.

Following channels were used during the tests:

| Channel | Frequency/ MHz |
|--------------|----------------|
| LOW (CH 1) | 902.250 |
| MID (CH 40) | 914.750 |
| HIGH (CH 79) | 927.750 |

Test Facility

| | |
|--|--|
| <input type="checkbox"/> Testing Location / address: FCC registration number: 90598 | SGS Fimko Ltd Särkinenmentie 3 FI-00210, HELSINKI FINLAND |
| <input checked="" type="checkbox"/> Testing Location / address: FCC registration number: 178986 Industry Canada registration number: 8708A-2 | SGS Fimko Ltd Karakaarenkuja 4 FI-02610, ESPOO FINLAND |

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz.

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 12.6.2013
Temperature: 23.5 °C
Humidity: 43 % RH
Barometric pressure: 1013.3 hPa
Measurement uncertainty: ± 2.9 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)

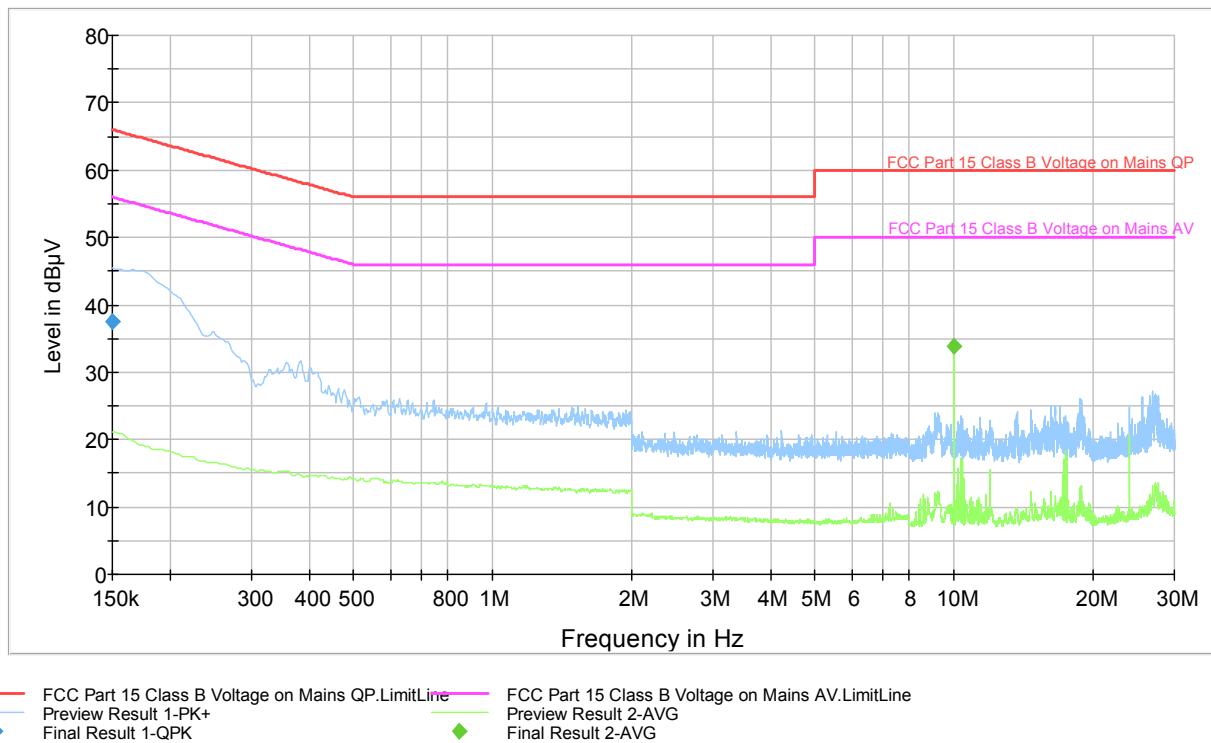
Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with 4.5 kHz steps and a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.

During the test the EUT was powered from the separate power supply (115VAC / 60 Hz) through the LISN.

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|------------------------------------|--|----------------|
| | 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.

Conducted Emission Mains FCC Part 15 Class B with ESH3-Z5 8019

**Figure 1.** The measured curves with peak- and average detector.**Table 1.** Final measurement results with Quasi-peak detector.

| Frequency (MHz) | QuasiPeak (dB μ V) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dB μ V) | Comment |
|-----------------|------------------------|-----------------|-----------------|----|------|------------|-------------|--------------------|---------|
| 0.150000 | 37.6 | 1000.0 | 9.000 | GN | N | 10.7 | 28.4 | 66.0 | |

Table 2. Final measurement results with Average detector.

| Frequency (MHz) | Average (dB μ V) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dB μ V) | Comment |
|-----------------|----------------------|-----------------|-----------------|----|------|------------|-------------|--------------------|---------|
| 10.000000 | 33.8 | 1000.0 | 9.000 | GN | N | 10.9 | 16.2 | 50.0 | |

Maximum Peak Conducted Output Power

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 13.6.2013
Humidity: 44 % RH
Temperature: 23.3 °C
Measurement uncertainty ± 2.87dB Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b) (2)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

Results:

| Channel | Conducted Power [dBm] | Limit [dBm] | Margin [dBm] | Result |
|---------|-----------------------|-------------|--------------|--------|
| Low | 25.20 | 28 | 2.80 | PASS |
| Mid | 25.55 | 28 | 2.45 | PASS |
| High | 25.89 | 28 | 2.11 | PASS |

Note 1: As required by FCC rule part 15.247(b)(4), the maximum conducted power limit has been reduced from 30 dBm to 28 dBm due to the use of an antenna with the maximum antenna gain of 8 dBi.

Maximum Peak Conducted Output Power

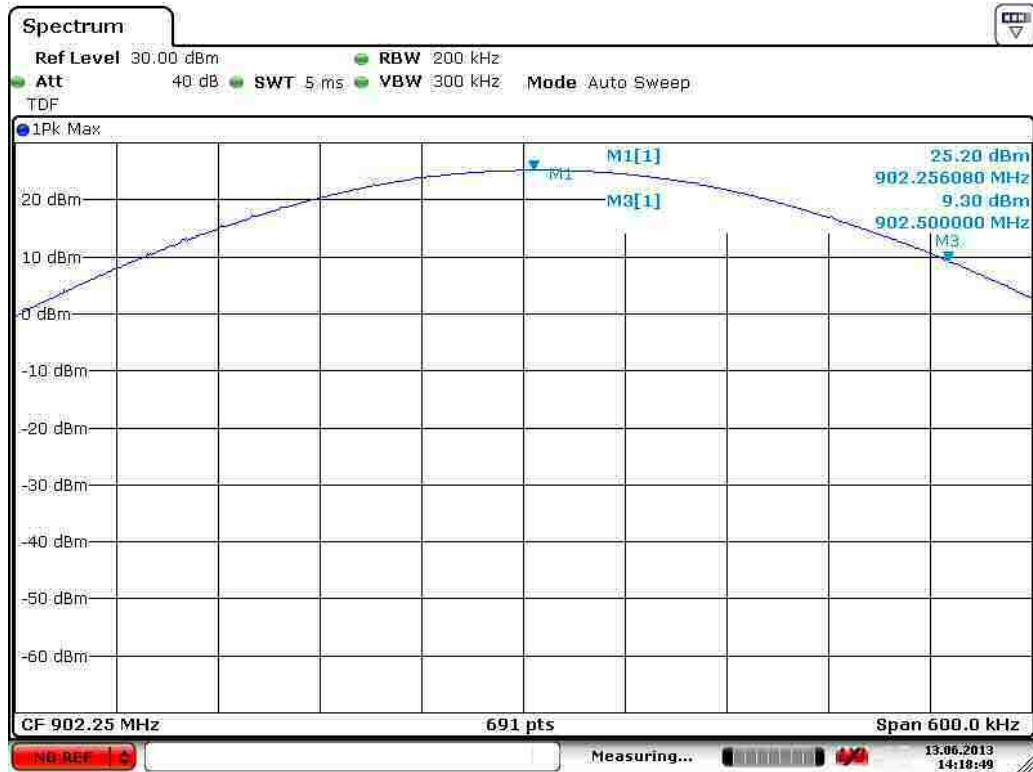


Figure 2. Channel LOW.



Figure 3. Channel MID.

Maximum Peak Conducted Output Power



Figure 4. Channel HIGH.

Transmitter Radiated Emissions 30 MHz to 26.5 GHz

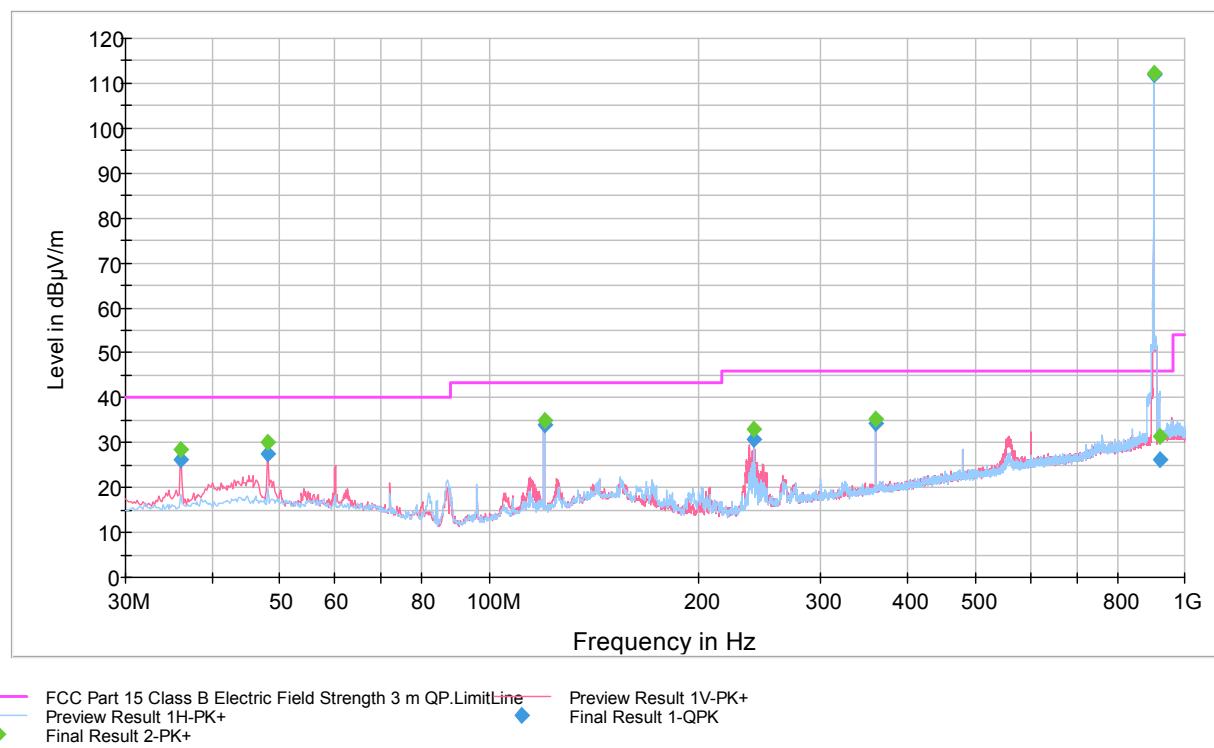
| | | |
|--------------------------------|------------------|----------------------------------|
| Standard: | ANSI C63.10 | (2009) |
| Tested by: | NKA | |
| Date: | 11.6.- 12.6.2013 | |
| Temperature: | 23.5 - 24 °C | |
| Humidity: | 33 - 43 % RH | |
| Measurement uncertainty | ± 4.51 dB | Level of confidence 95 % (k = 2) |

FCC Rule: 15.247(d), 15.209(a)

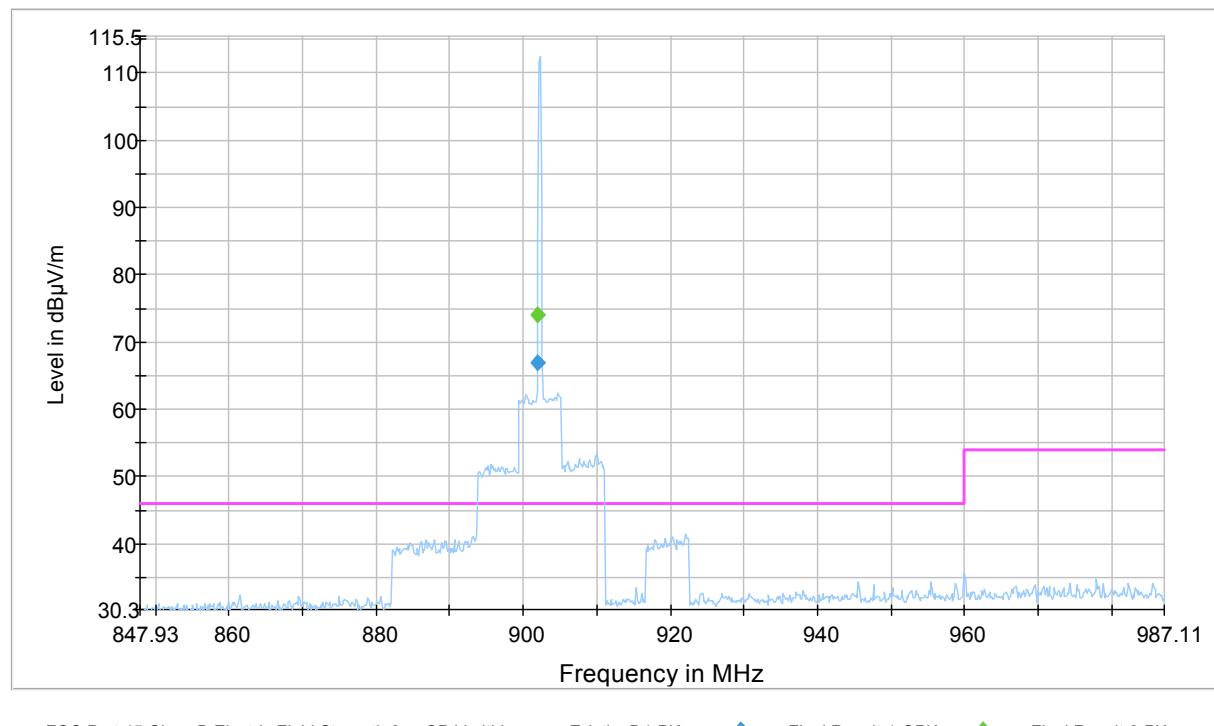
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the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

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables). The result value is the measured value corrected with the correction factor.

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m (optimized 900 MHz TX)

**Figure 5.** Measured curve with peak-detector Channel LOW.

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m (optimized 900 MHz TX)

**Figure 6.** Low channel band edge.

Final measurements from the worst frequencies**Table 3.** Final results.

| Frequency (MHz) | QuasiPeak (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|--------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|------------|
| 35.995000 | 26.3 | 1000.0 | 120.000 | 150.0 | V | -4.0 | 14.7 | 13.7 | 40.0 | |
| 47.995000 | 27.5 | 1000.0 | 120.000 | 100.0 | V | 2.0 | 15.4 | 12.5 | 40.0 | |
| 119.995000 | 34.0 | 1000.0 | 120.000 | 100.0 | V | 50.0 | 13.1 | 9.5 | 43.5 | |
| 240.015000 | 30.9 | 1000.0 | 120.000 | 100.0 | V | 350.0 | 13.3 | 15.1 | 46.0 | |
| 359.995000 | 34.2 | 1000.0 | 120.000 | 100.0 | H | 300.0 | 16.6 | 11.8 | 46.0 | |
| 902.000000 | 66.9 | 1000.0 | 120.000 | 252.0 | V | 127.0 | 26.4 | -20.9 | 46.0 | See Note 2 |
| 902.245000 | 112.0 | 1000.0 | 120.000 | 227.0 | H | 243.0 | 26.4 | --- | --- | RF signal |
| 922.585000 | 26.1 | 1000.0 | 120.000 | 150.0 | H | 237.0 | 26.9 | 19.9 | 46.0 | |

Note 2: The measurement result at band edge is not on a restricted frequency and it complies with the 20 dB limit described in FCC Rule 15.247(d).

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m (optimized 900 MHz TX)

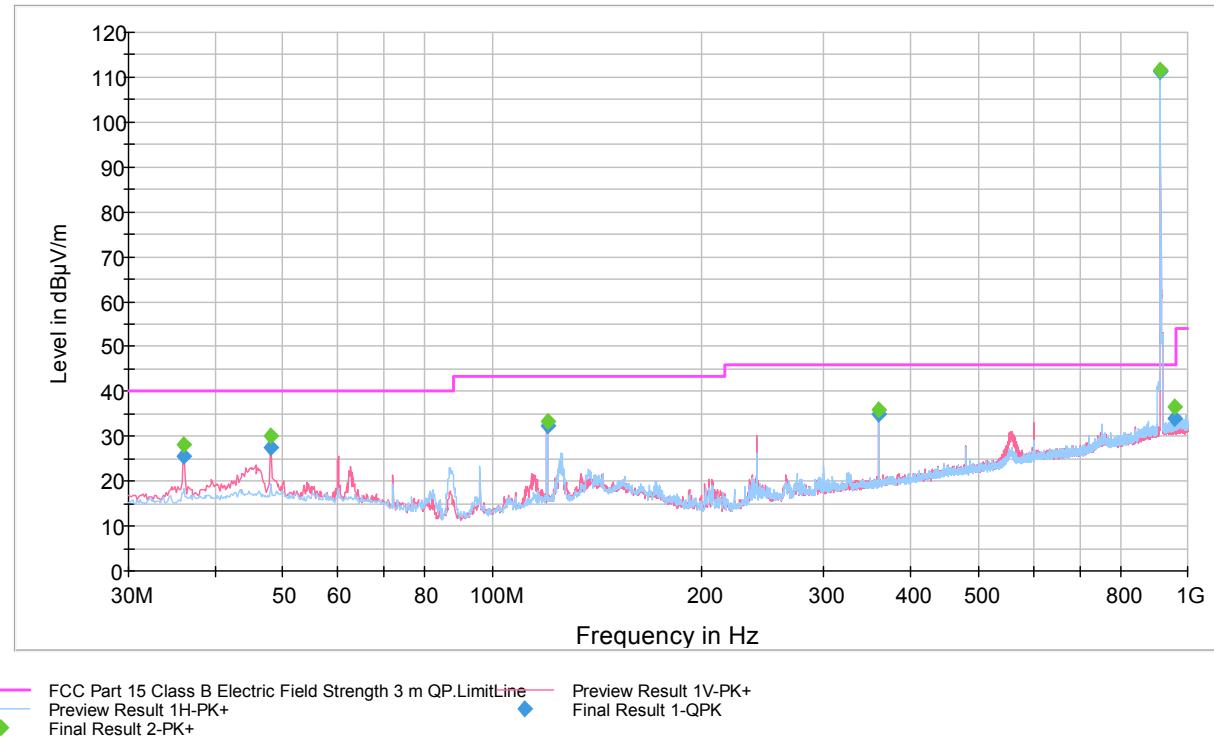


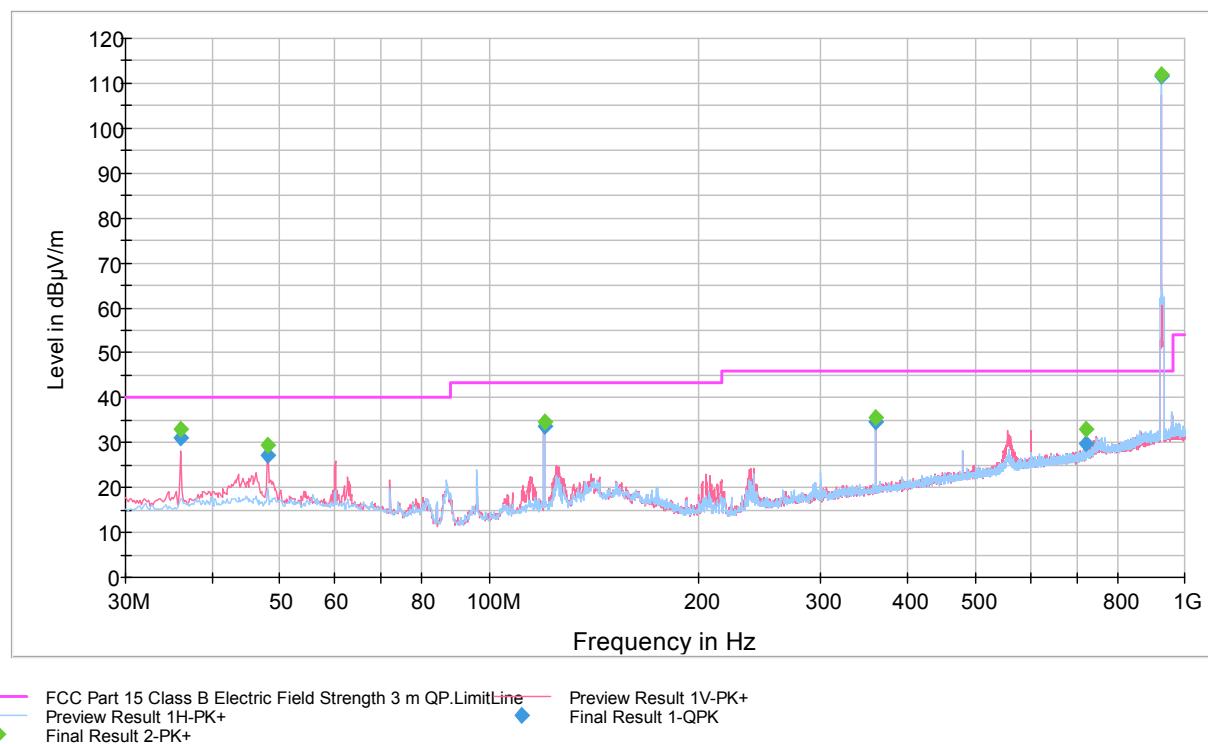
Figure 7. Measured curve with peak-detector Channel MID.

Final measurements from the worst frequencies

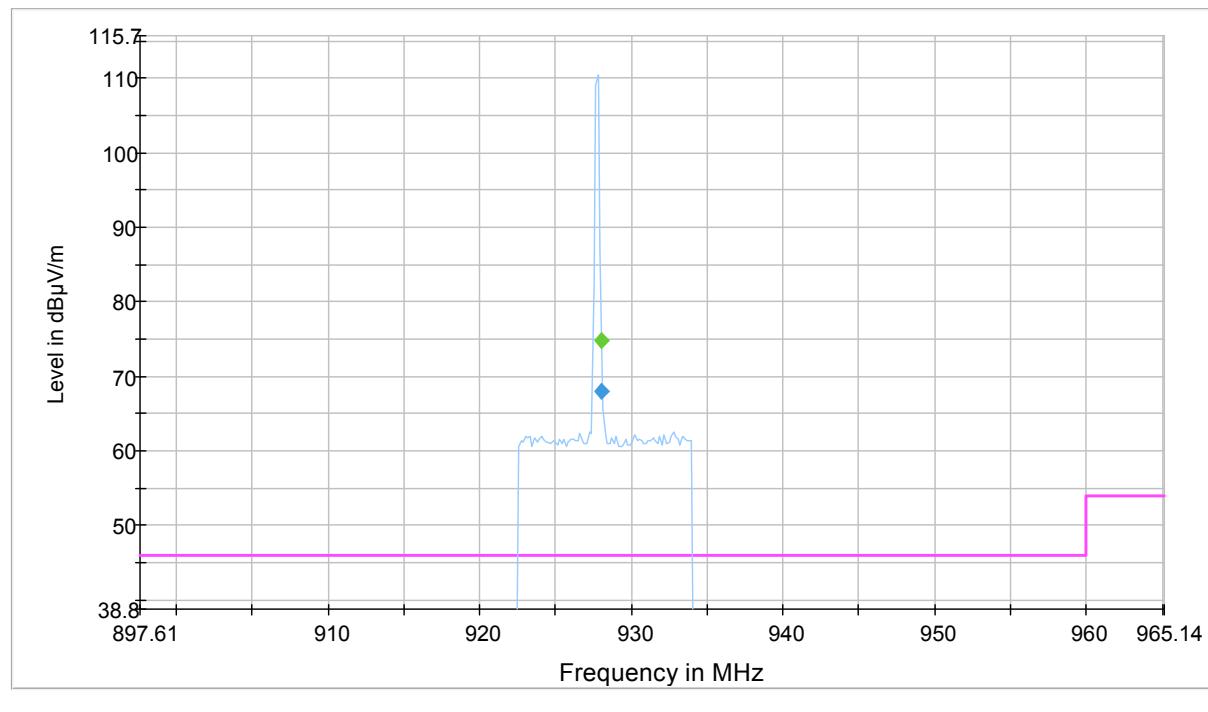
Table 4. Final results.

| Frequency (MHz) | QuasiPeak (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|--------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|---------|
| 35.995000 | 25.5 | 1000.0 | 120.000 | 150.0 | V | 1.0 | 14.7 | 14.5 | 40.0 | |
| 47.995000 | 27.4 | 1000.0 | 120.000 | 110.0 | V | 163.0 | 15.4 | 12.6 | 40.0 | |
| 119.995000 | 32.2 | 1000.0 | 120.000 | 109.0 | V | 105.0 | 13.1 | 11.3 | 43.5 | |
| 359.995000 | 34.8 | 1000.0 | 120.000 | 100.0 | H | 289.0 | 16.6 | 11.2 | 46.0 | |
| 914.755000 | 111.2 | 1000.0 | 120.000 | 230.0 | H | 240.0 | 26.7 | -65.2 | 46.0 | |
| 959.965000 | 33.9 | 1000.0 | 120.000 | 100.0 | H | 73.0 | 27.1 | 12.1 | 46.0 | |

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m (optimized 900 MHz TX)

**Figure 8.** Measured curve with peak-detector Channel HIGH.

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m (optimized 900 MHz TX)

**Figure 9.** High channel band edge.

Final measurements from the worst frequencies**Table 5.** Final results.

| Frequency (MHz) | QuasiPeak (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|--------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|------------|
| 35.995000 | 31.2 | 1000.0 | 120.000 | 100.0 | V | 20.0 | 14.7 | 8.8 | 40.0 | |
| 47.995000 | 27.1 | 1000.0 | 120.000 | 100.0 | V | 37.0 | 15.4 | 12.9 | 40.0 | |
| 119.995000 | 33.6 | 1000.0 | 120.000 | 100.0 | V | 56.0 | 13.1 | 9.9 | 43.5 | |
| 359.995000 | 34.5 | 1000.0 | 120.000 | 100.0 | H | 293.0 | 16.6 | 11.5 | 46.0 | |
| 719.965000 | 29.9 | 1000.0 | 120.000 | 100.0 | V | 131.0 | 23.5 | 16.1 | 46.0 | |
| 927.745000 | 111.4 | 1000.0 | 120.000 | 313.0 | H | 330.0 | 26.9 | --- | --- | RF Signal |
| 928.000000 | 68.0 | 1000.0 | 120.000 | 262.0 | H | 119.0 | 26.9 | -22.0 | 46.0 | See note 3 |

Note 3: The measurement result at band edge is not on a restricted frequency and it complies with the 20 dB limit described in FCC Rule 15.247(d).

FCC Part 15 Class B Spurious Emission 1-18GHz 3m Rx

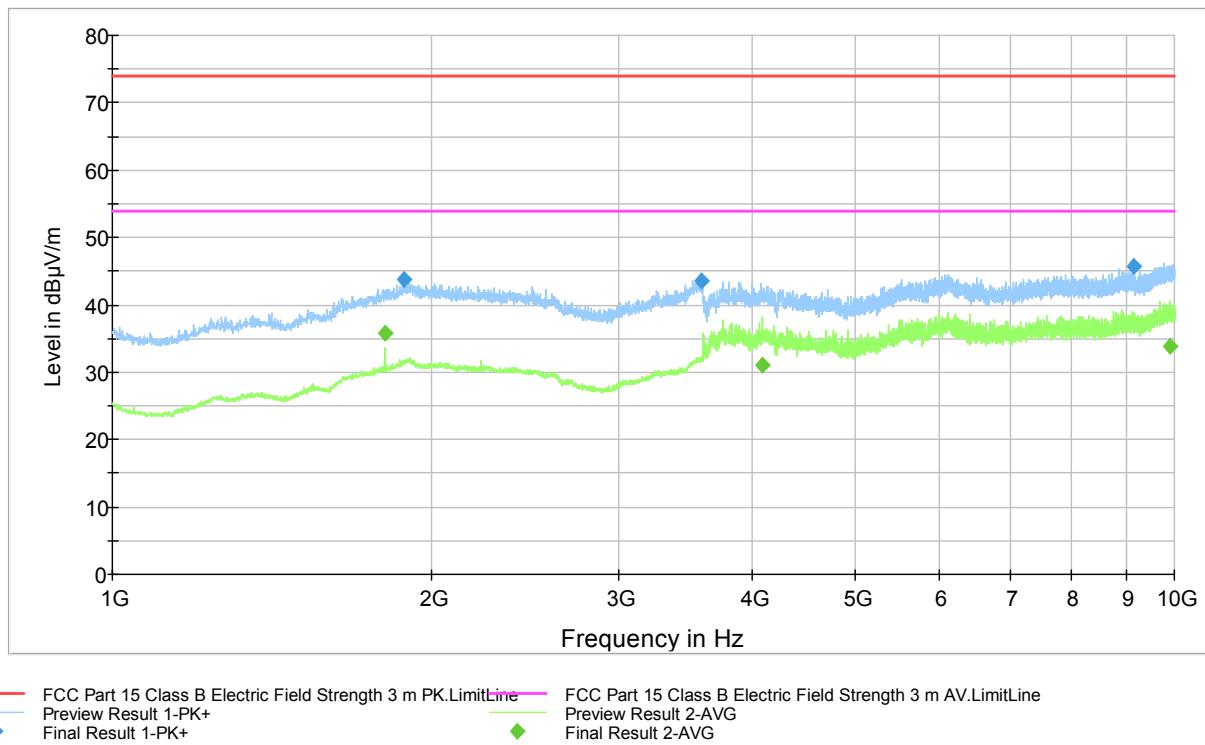


Figure 10. Measured curve with peak- and average detector channel LOW.

Final measurements from the worst frequencies

Table 6. Final Max Peak results.

| Frequency (MHz) | MaxPeak (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|---------|
| 1882.100000 | 43.7 | 1000.0 | 1000.000 | 400.0 | H | 139.0 | 2.9 | 30.2 | 73.9 | |
| 3587.600000 | 43.5 | 1000.0 | 1000.000 | 159.0 | H | 96.0 | 7.1 | 30.4 | 73.9 | |
| 9146.900000 | 45.7 | 1000.0 | 1000.000 | 160.0 | V | 353.0 | 14.4 | 28.2 | 73.9 | |

Table 7. Final Average results.

| Frequency (MHz) | Average (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|---------|
| 1804.400000 | 35.7 | 1000.0 | 1000.000 | 236.0 | H | 304.0 | 1.8 | 18.2 | 53.9 | |
| 4094.700000 | 31.0 | 1000.0 | 1000.000 | 130.0 | H | 286.0 | 8.5 | 22.9 | 53.9 | |
| 9917.600000 | 33.8 | 1000.0 | 1000.000 | 100.0 | V | 9.0 | 16.0 | 20.1 | 53.9 | |

FCC Part 15 Class B Spurious Emission 1-18GHz 3m Rx

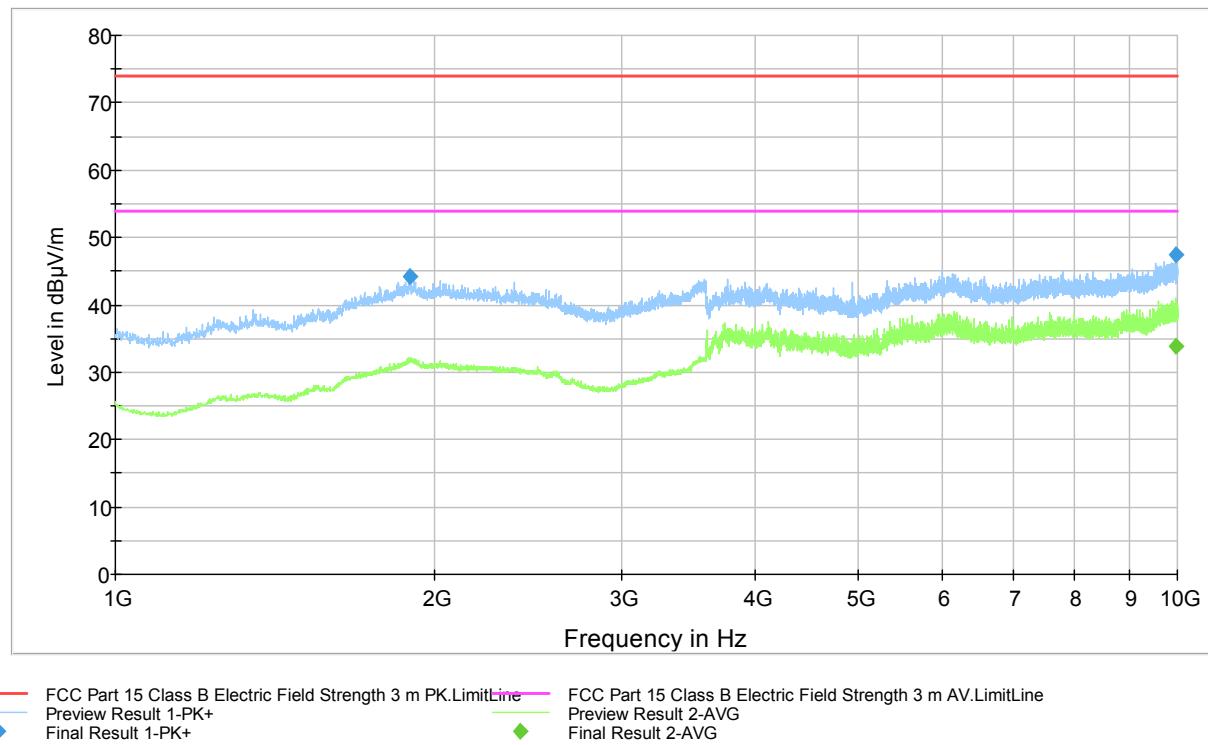


Figure 11. Measured curve with peak- and average detector channel MID.

Final measurements from the worst frequencies

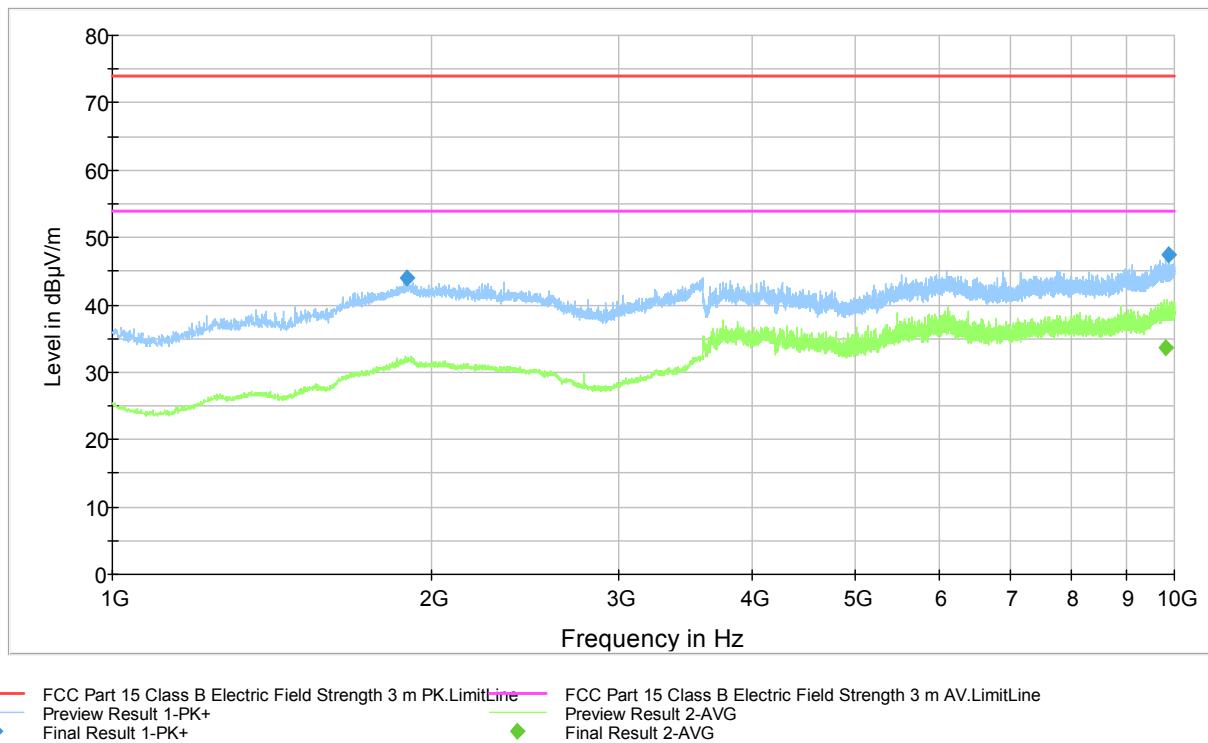
Table 8. Final Max Peak results.

| Frequency (MHz) | MaxPeak (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|---------|
| 1896.100000 | 44.1 | 1000.0 | 1000.000 | 311.0 | H | 10.0 | 3.2 | 29.8 | 73.9 | |
| 9957.000000 | 47.5 | 1000.0 | 1000.000 | 283.0 | H | 110.0 | 16.0 | 26.4 | 73.9 | |

Table 9. Final Average results.

| Frequency (MHz) | Average (dB μ V/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dB μ V/m) | Comment |
|-----------------|------------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------------|---------|
| 9965.700000 | 33.8 | 1000.0 | 1000.000 | 100.0 | V | 175.0 | 16.0 | 20.1 | 53.9 | |

FCC Part 15 Class B Spurious Emission 1-18GHz 3m Rx

**Figure 12.** Measured curve with peak- and average detector channel HIGH.**Final measurements from the worst frequencies****Table 10.** Final Max Peak results.

| Frequency (MHz) | MaxPeak (dBμV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBμV/m) | Comment |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|---------|
| 1893.200000 | 44.0 | 1000.0 | 1000.000 | 327.0 | H | 352.0 | 3.1 | 29.9 | 73.9 | |
| 9890.100000 | 47.5 | 1000.0 | 1000.000 | 345.0 | H | 41.0 | 15.9 | 26.4 | 73.9 | |

Table 11. Final Average results.

| Frequency (MHz) | Average (dBμV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBμV/m) | Comment |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|---------|
| 9827.200000 | 33.7 | 1000.0 | 1000.000 | 224.0 | H | 315.0 | 15.7 | 20.2 | 53.9 | |

Receiver Radiated Emissions 30 MHz to 26.5 GHz

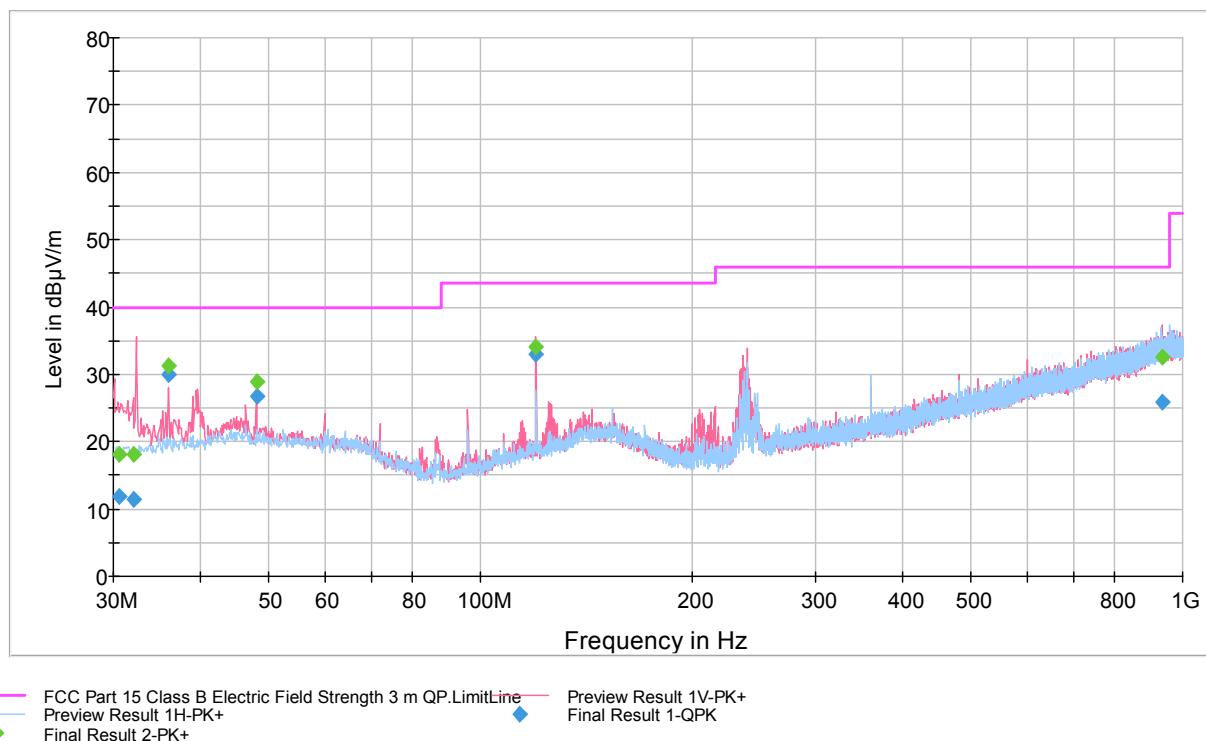
Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 12.6.2013
Temperature: 23.5 °C
Humidity: 43 % RH
Measurement uncertainty ± 4.51 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.109

The EUT was in a receiving mode and measurement was performed on middle channel only.
 The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).
 The result value is the measured value corrected with the correction factor.

Test Results:

FCC Part 15 Class B Spurious Emission 30-1000MHz 3m

**Figure 13.** Measured curve with peak-detector.**Final measurements from the worst frequencies****Table 12.** Final Quasi Peak results.

| Frequency (MHz) | QuasiPeak (dBμV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBμV/m) | Comment |
|-----------------|--------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|---------|
| 30.540000 | 11.8 | 1000.0 | 120.000 | 141.0 | V | 47.0 | 14.3 | 28.2 | 40.0 | |
| 32.068000 | 11.5 | 1000.0 | 120.000 | 121.0 | V | 124.0 | 14.4 | 28.5 | 40.0 | |
| 35.994000 | 29.9 | 1000.0 | 120.000 | 100.0 | V | 25.0 | 14.7 | 10.1 | 40.0 | |
| 48.005000 | 26.8 | 1000.0 | 120.000 | 106.0 | V | 115.0 | 15.4 | 13.2 | 40.0 | |
| 119.996000 | 32.9 | 1000.0 | 120.000 | 100.0 | V | 171.0 | 13.1 | 10.6 | 43.5 | |
| 934.239000 | 25.8 | 1000.0 | 120.000 | 363.0 | V | 72.0 | 27.0 | 20.2 | 46.0 | |

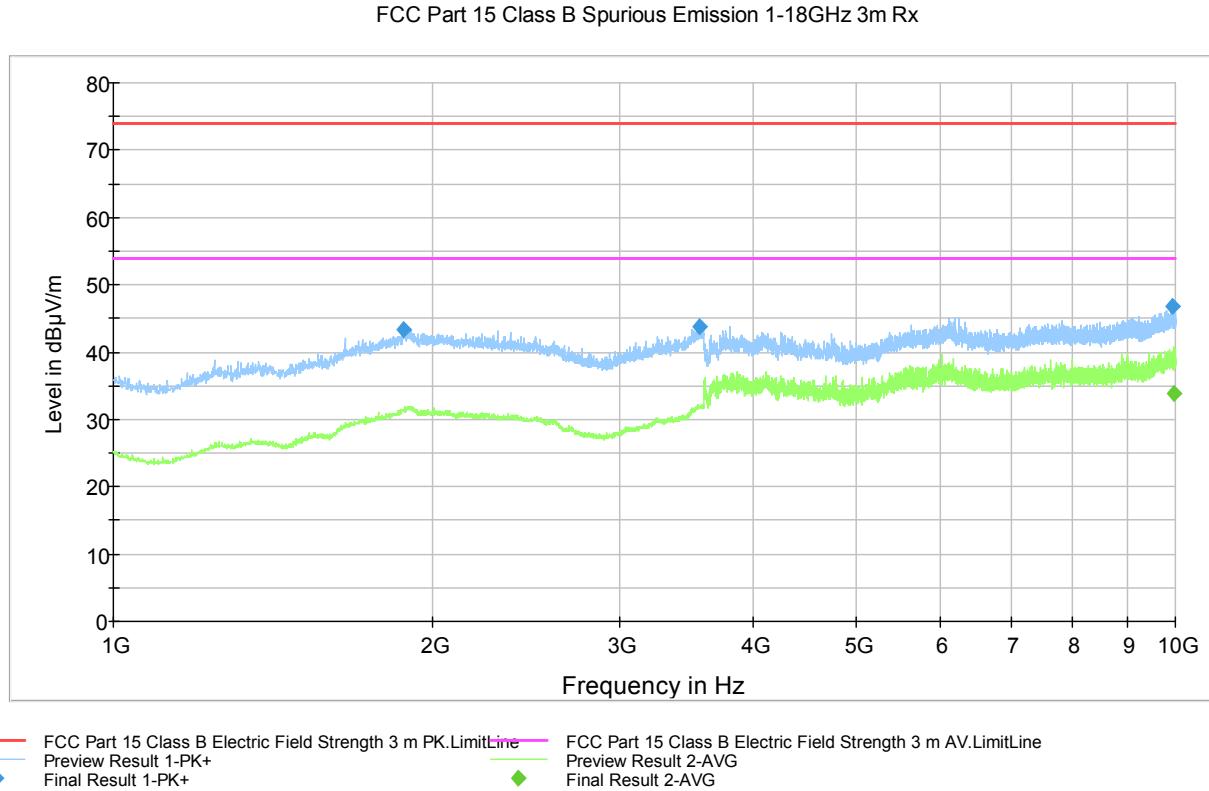


Figure 14. Measured curve with peak-and average detector.

Final measurements from the worst frequencies

Table 13. Final Max Peak results.

| Frequency (MHz) | MaxPeak (dBμV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBμV/m) | Comment |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|---------|
| 1878.800000 | 43.4 | 1000.0 | 1000.000 | 332.0 | H | 125.0 | 2.8 | 30.5 | 73.9 | |
| 3563.500000 | 43.8 | 1000.0 | 1000.000 | 374.0 | V | 319.0 | 7.2 | 30.1 | 73.9 | |
| 9925.500000 | 46.9 | 1000.0 | 1000.000 | 243.0 | H | 118.0 | 16.0 | 27.0 | 73.9 | |

Table 14. Final Average results.

| Frequency (MHz) | Average (dBμV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBμV/m) | Comment |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|---------|
| 9965.700000 | 33.8 | 1000.0 | 1000.000 | 100.0 | V | 10.0 | 16.0 | 20.1 | 53.9 | |

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge

Conducted Spurious Emissions 30 MHz to 26.5 GHz and Band Edge

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 14.6.2013
Temperature: 23 °C
Humidity: 49 % RH

FCC Rule: 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

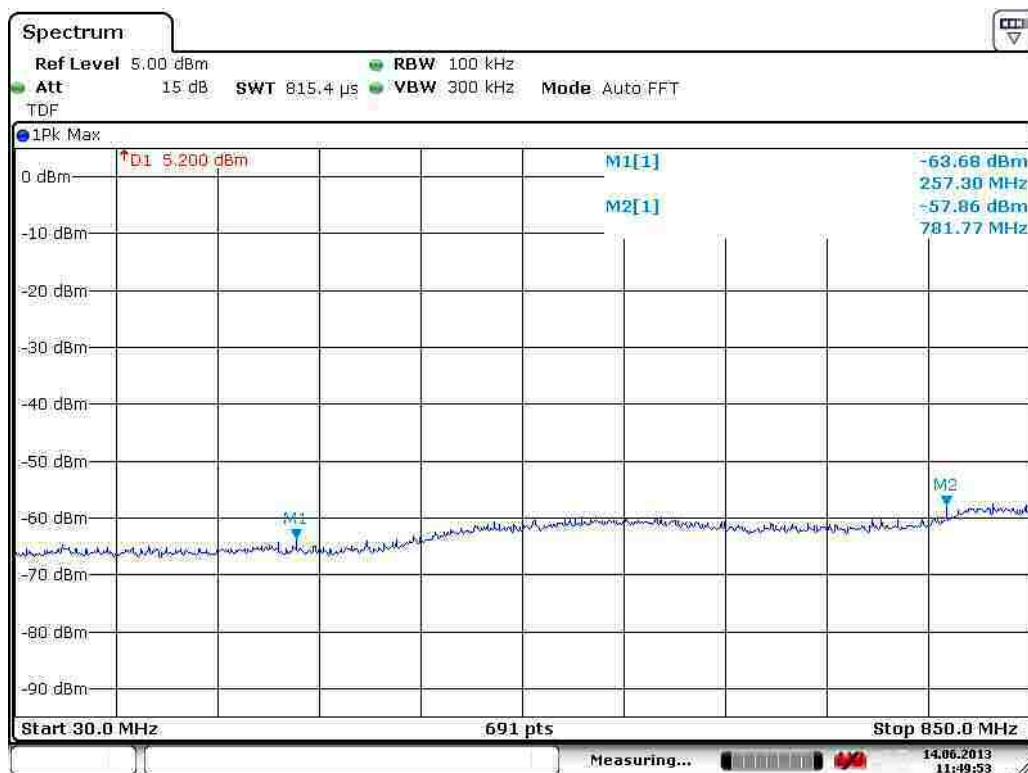


Figure 15. Low channel conducted emission 30 MHz to 850 MHz.

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge

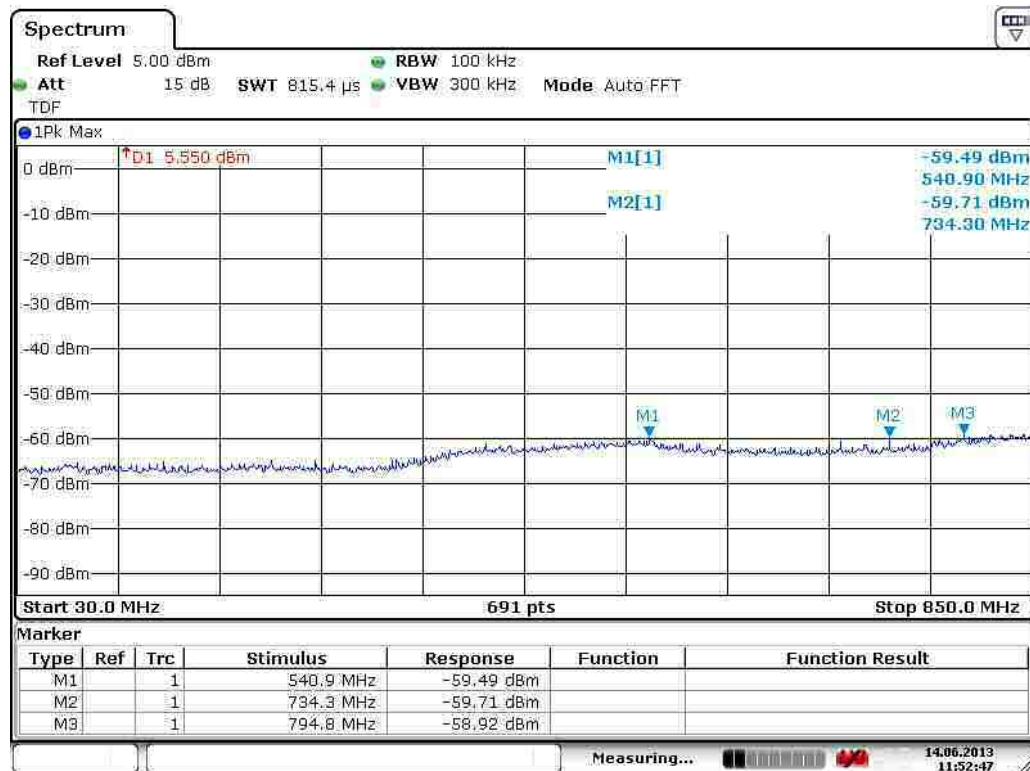


Figure 16. Mid channel conducted emission 30 MHz to 850 MHz.

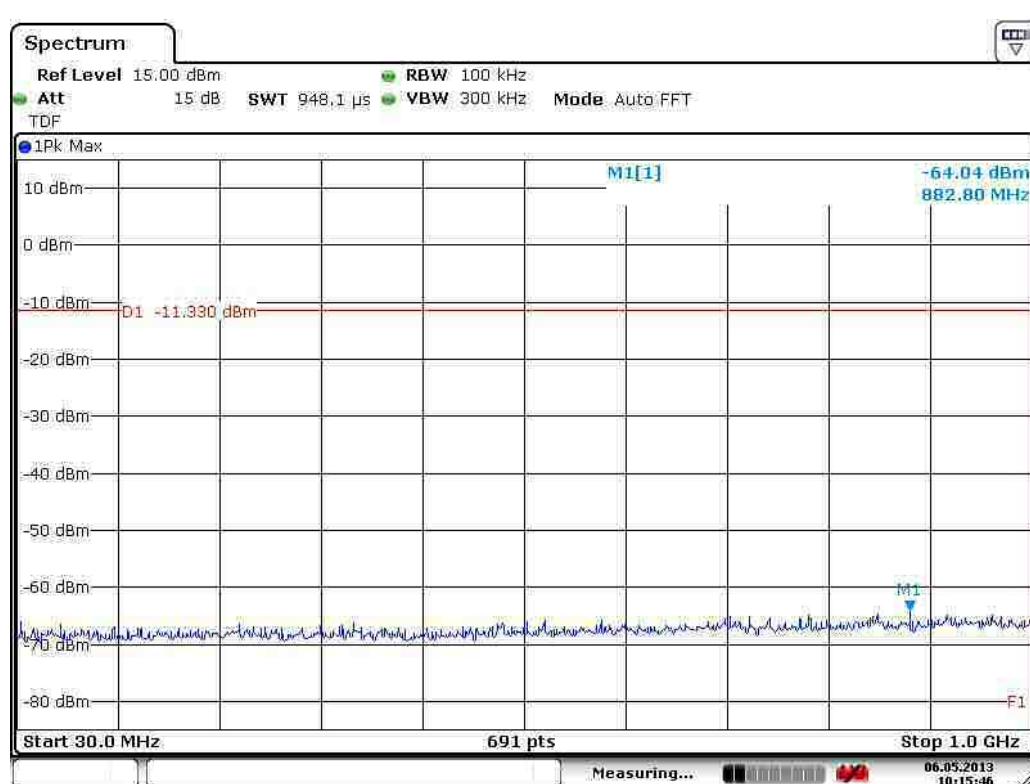
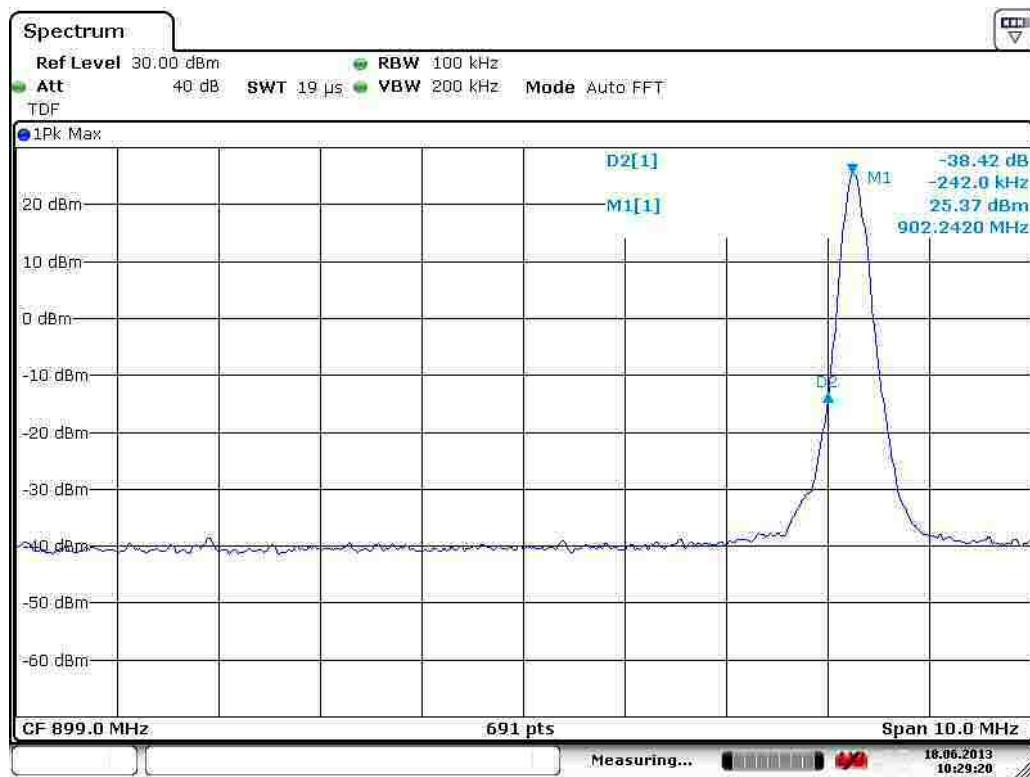


Figure 17. High channel conducted emission 30 MHz to 850 MHz.

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge



Date: 18.JUN.2013 10:29:19

Figure 18. Conducted emission at low band edge (fixed channel).

Date: 18.JUN.2013 10:33:07

Figure 19. Conducted emission at low band edge (hopping).

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge

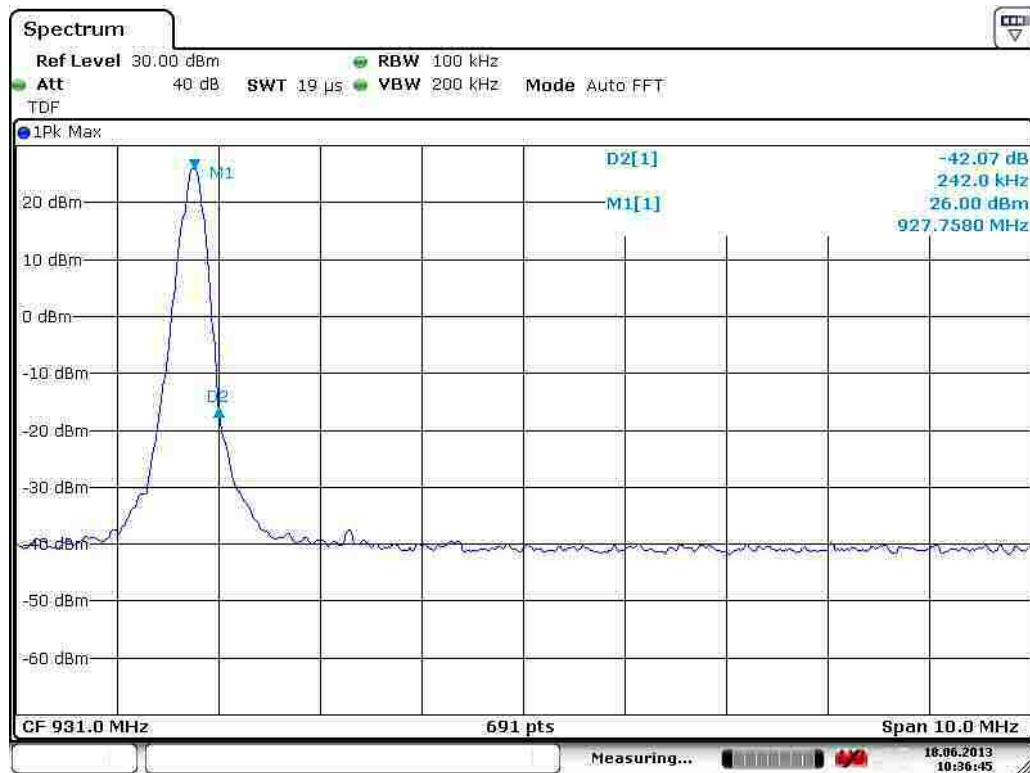


Figure 20. Conducted emission at high band edge (fixed channel).

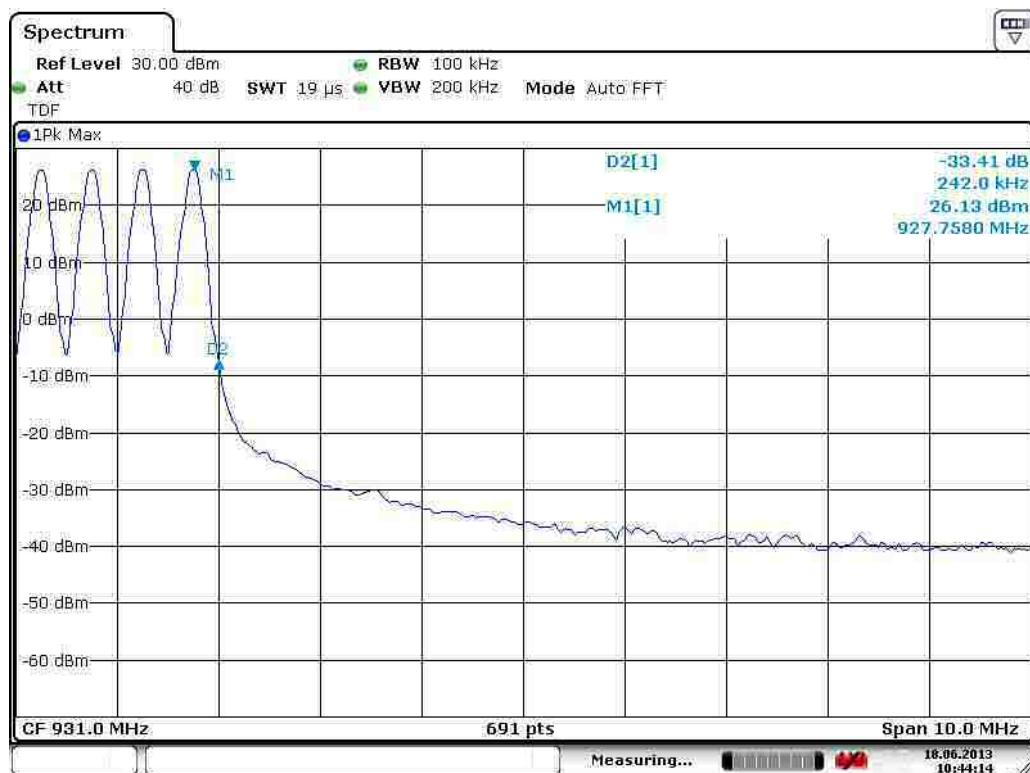


Figure 21. Conducted emission at high band edge (hopping).

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge

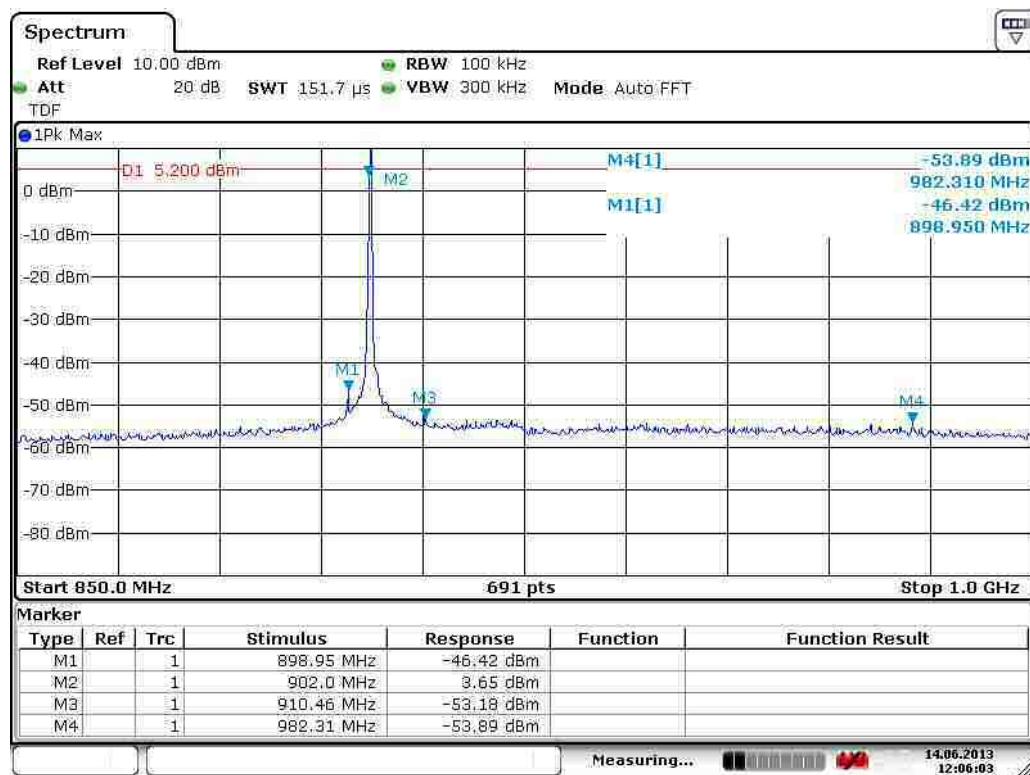


Figure 22. Low channel conducted emission 850 MHz to 1 GHz.

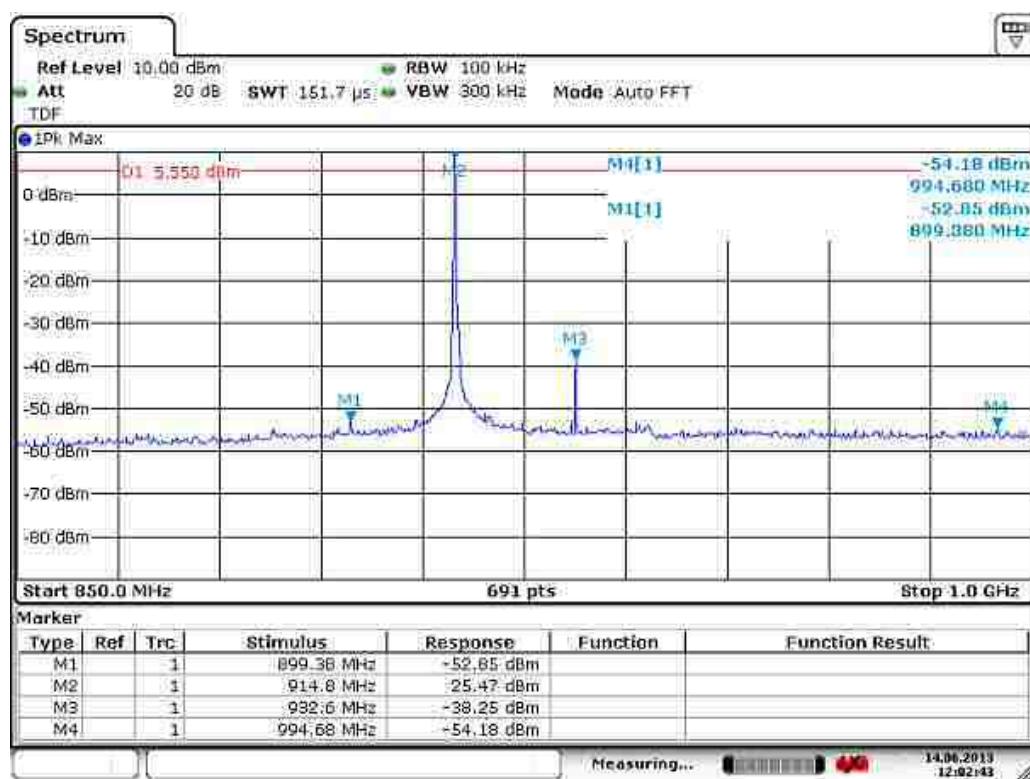


Figure 23. Mid channel conducted emission 850 MHz to 1 GHz.

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge

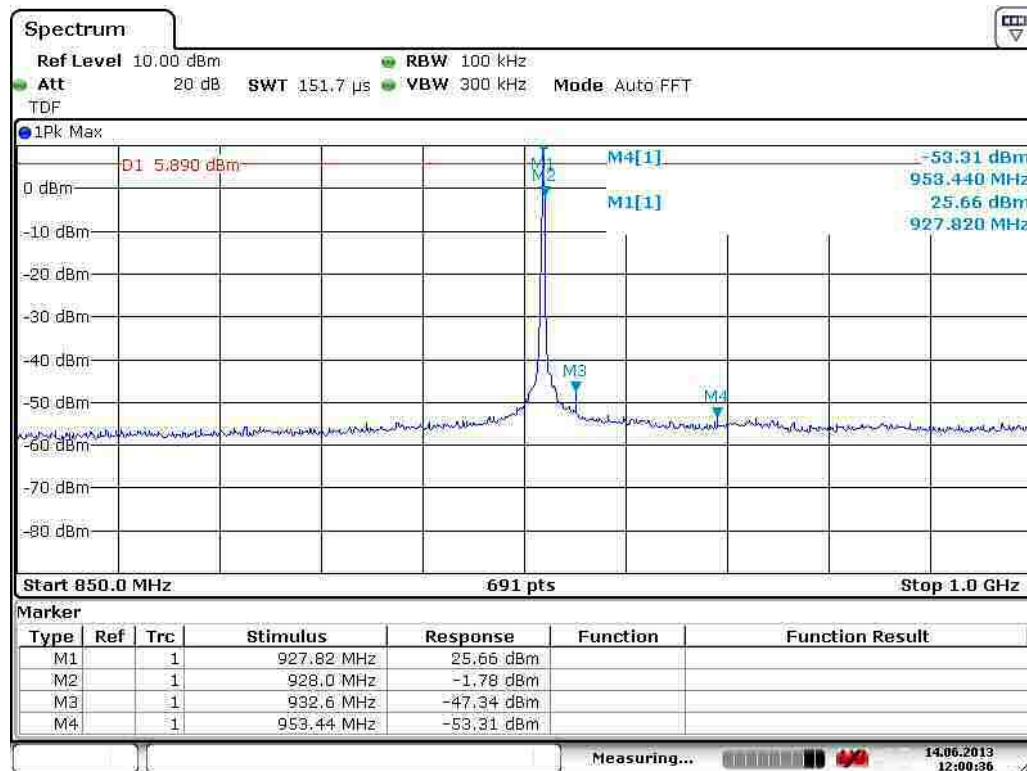


Figure 24. High channel conducted emission 850 MHz to 1 GHz.

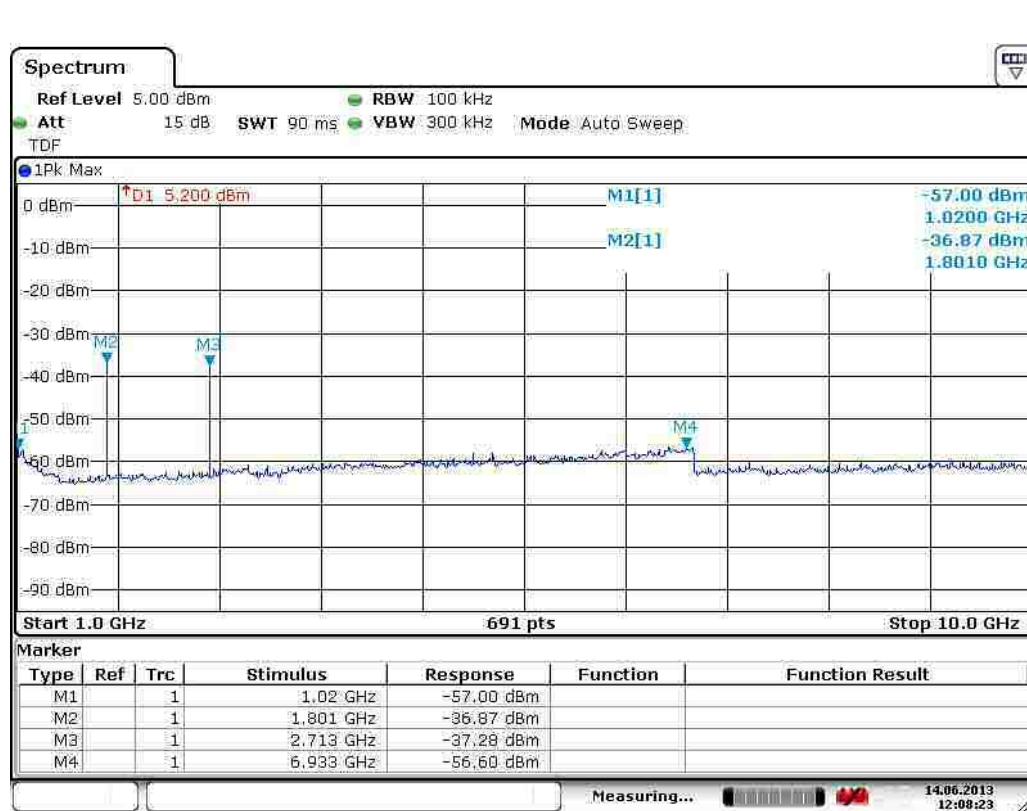
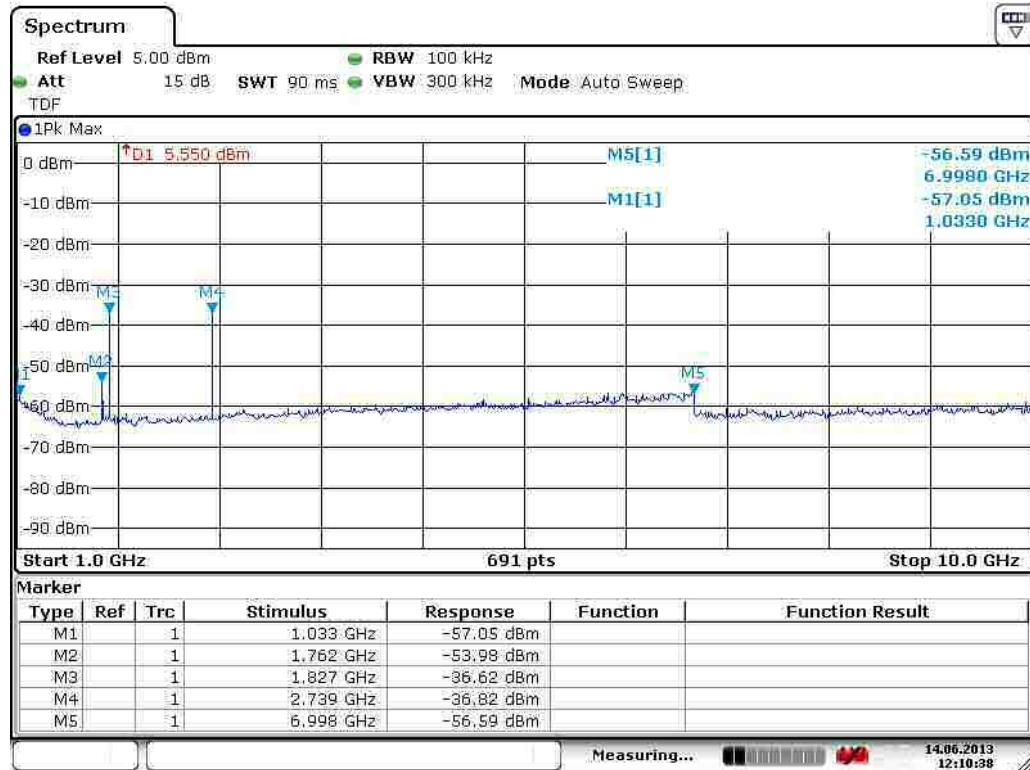
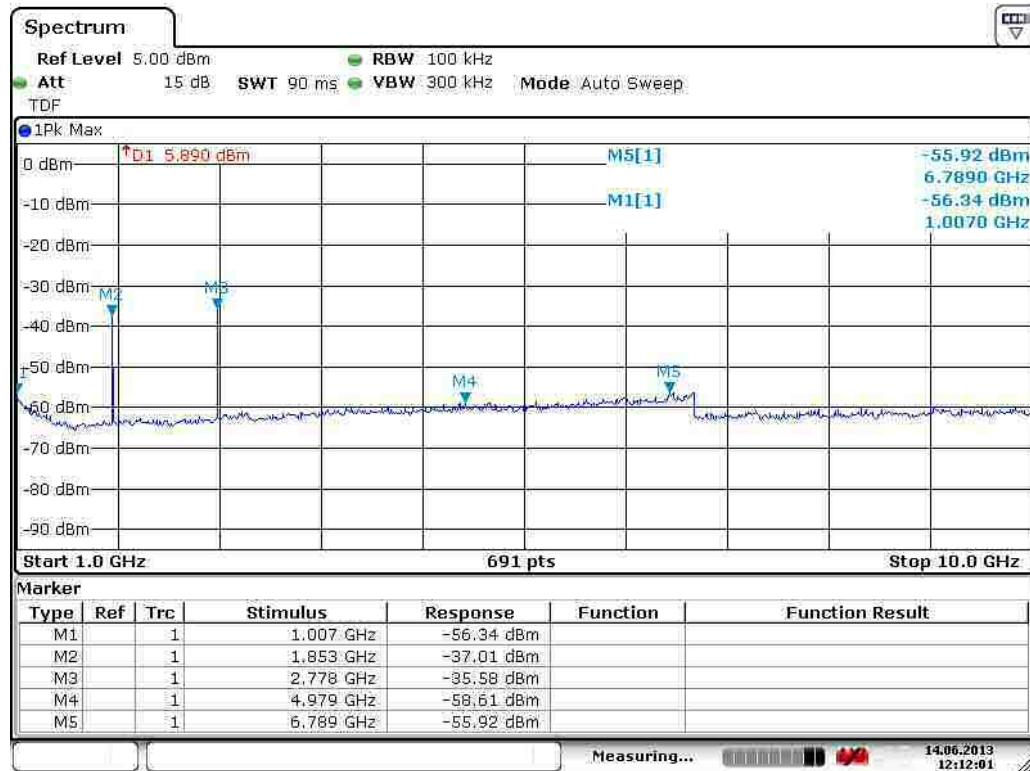


Figure 25. Low channel conducted emission 1 GHz to 10 GHz.

Conducted Spurious Emission 30 MHz to 26.5 GHz and Band Edge



Date: 14.JUN.2013 12:10:38

Figure 26. Mid channel conducted emission 1 GHz to 10 GHz.

Date: 14.JUN.2013 12:12:01

Figure 27. High channel conducted emission 1 GHz to 10 GHz.

20 dB Bandwidth of the Hopping Channel

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 14.6.2013 / 18.6.2013
Temperature: 23.0 °C / 23.3 °C
Humidity: 49 % RH / 34 % RH

FCC Rule: 15.247(a)(1)

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

The test was performed with two different modulations, PR-ASK and ASK.

Results:**Table 15.** 20 dB bandwidth test results.

| Channel | 20 dB BW [kHz] | |
|----------------|-----------------------|------------|
| | PR-ASK | ASK |
| Low | 112.88 | 173.660 |
| Mid | 123.01 | 173.660 |
| High | 112.16 | 173.660 |

20 dB Bandwidth of the Hopping Channel

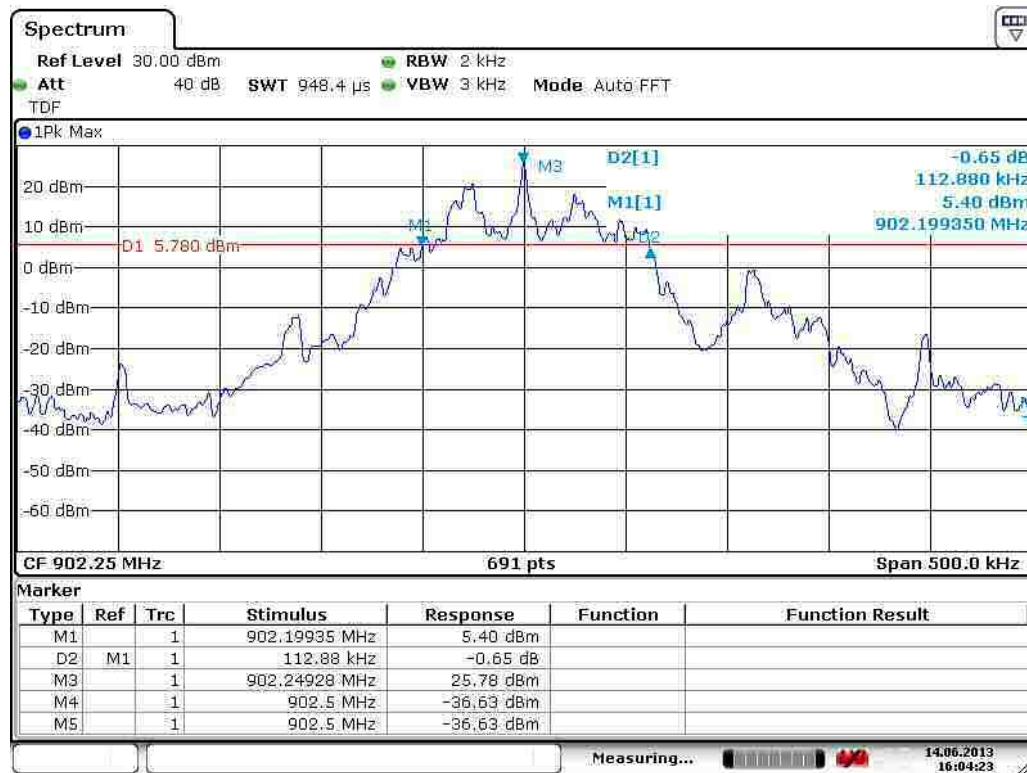


Figure 28. 20 dB BW modulation PR-ASK Channel LOW.



Figure 29. 20 dB BW modulation PR-ASK Channel MID.

20 dB Bandwidth of the Hopping Channel



Figure 30. 20 dB BW modulation PR-ASK Channel HIGH.



Figure 31. 20 dB BW modulation ASK Channel LOW.

20 dB Bandwidth of the Hopping Channel



Figure 32. 20 dB BW modulation ASK Channel MID.



Figure 33. 20 dB BW modulation ASK Channel HIGH.

Hopping Channel Carrier Frequencies Separation

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 14.6.2013
Temperature: 23 °C
Humidity: 49 % RH

FCC Rule: 15.247(a)(1)

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

Test result

Table 16. Hopping channel carrier frequencies separation test result.

| Measured separation | Measured 20 dB Bandwidth | Result |
|---------------------|--------------------------|--------|
| 499.30 kHz | 123.01 kHz | PASS |

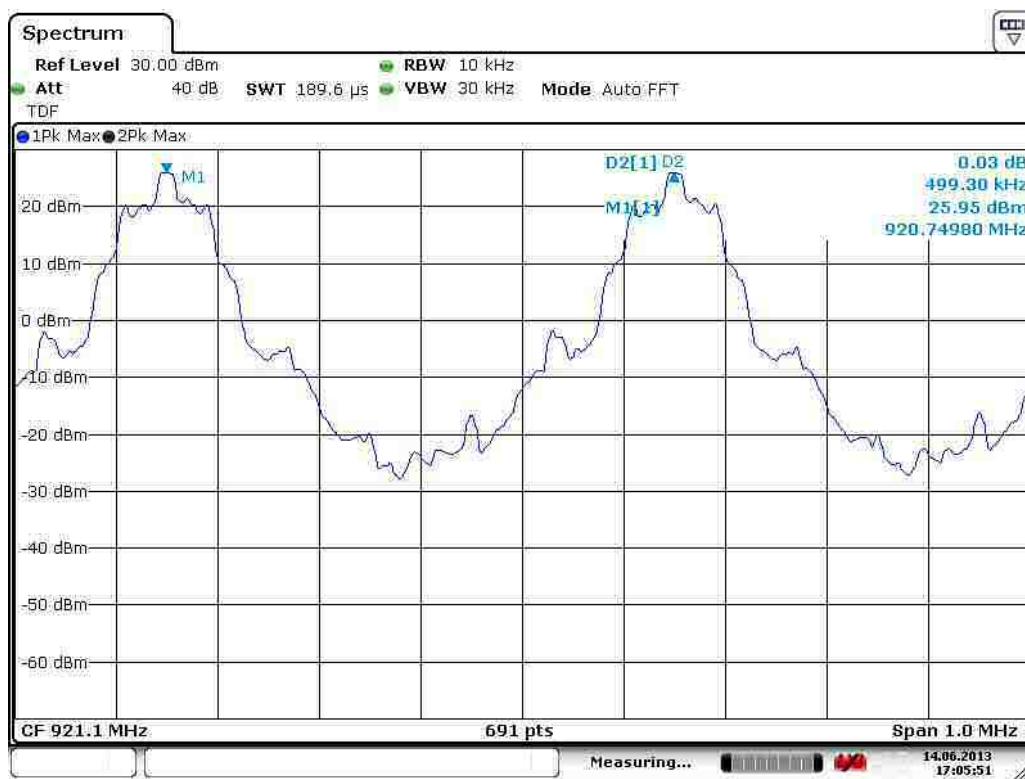


Figure 34. Measured hopping channels carrier frequency separation.

Number of Hopping Channels

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 14.6.2013
Temperature: 23 °C
Humidity: 49 % RH

FCC Rule: 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.

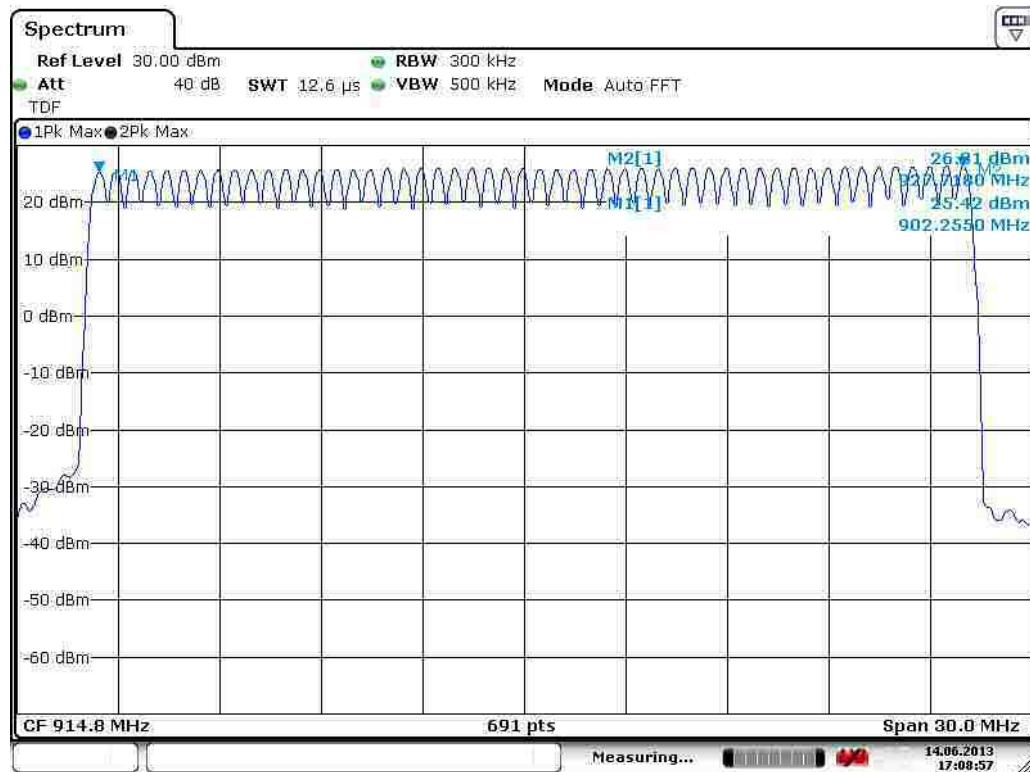


Figure 35. Number of hopping channels.

Average Time of Occupancy of Hopping Frequency**Average Time of Occupancy of Hopping Frequency**

Standard: ANSI C63.10 (2009)
Tested by: NKA
Date: 14.6.2013
Temperature: 23 °C
Humidity: 49 % RH

FCC Rule: 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.

Time of occupancy calculation:

Number of channels = 52

Measurement period = 20 s

One channel occupancy time = 3.78261 ms

Number of transmission cycles in measurement period = 39

Time of occupancy = (single duration) x (repetition) = 3.78261ms x 39 times = 147.52179 ms

Average Time of Occupancy of Hopping Frequency

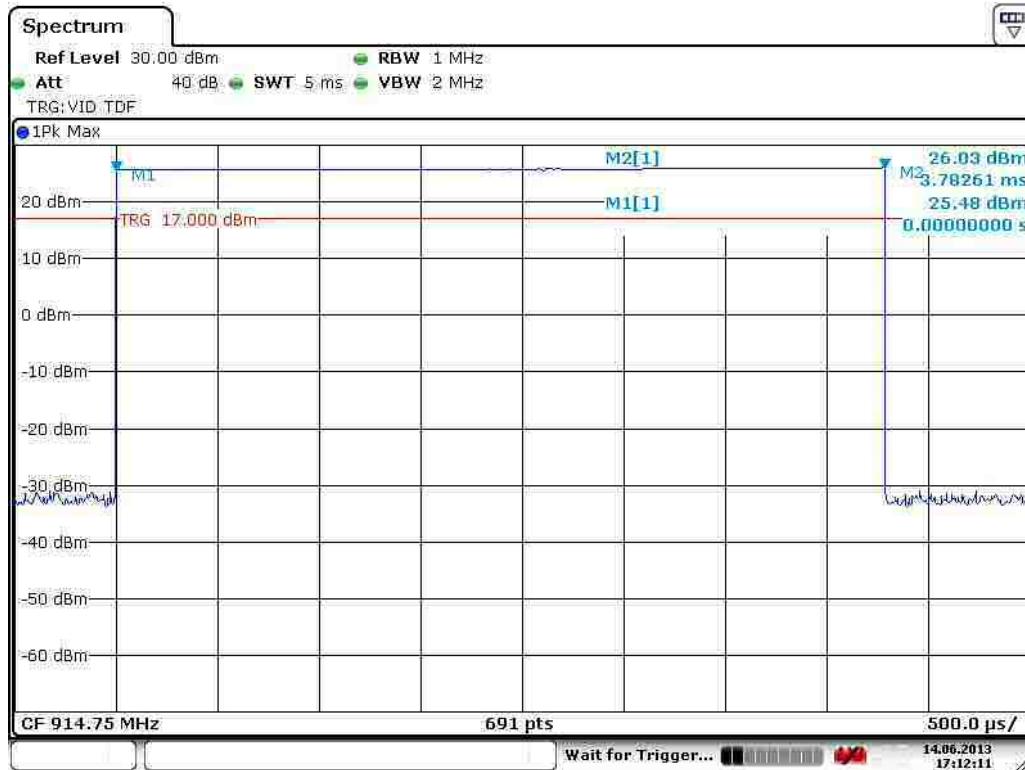


Figure 36. Dwell time on one channel.

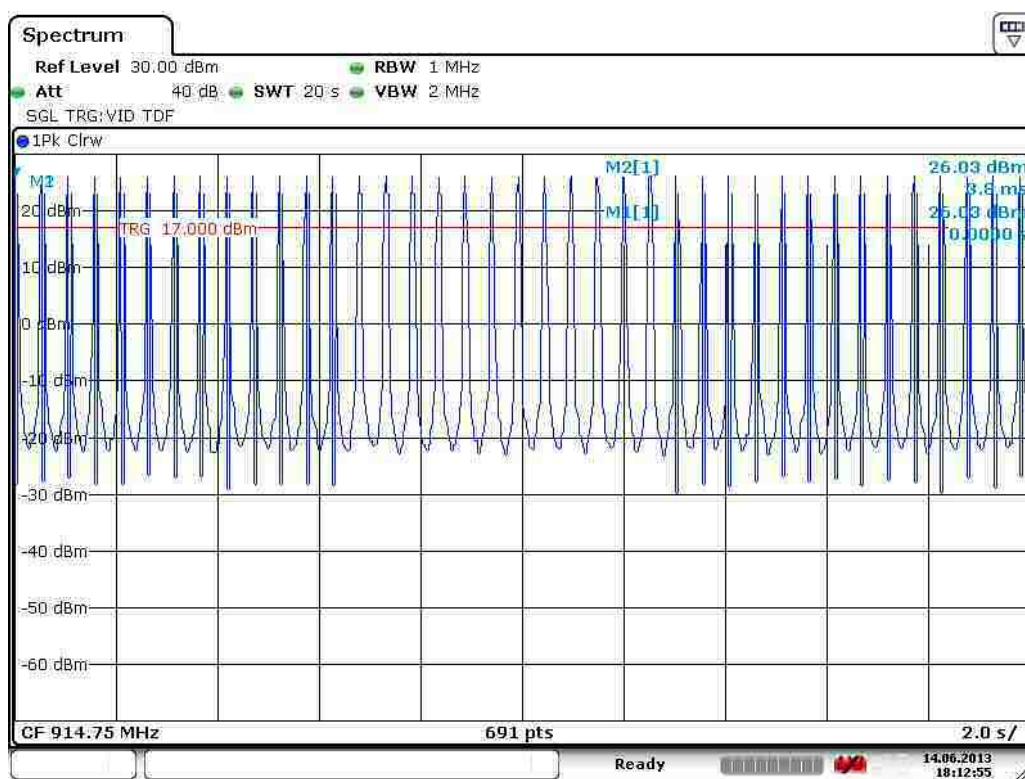


Figure 37. Measured repetition of the channel occupancy in 20 seconds

99% Occupied Power Bandwidth

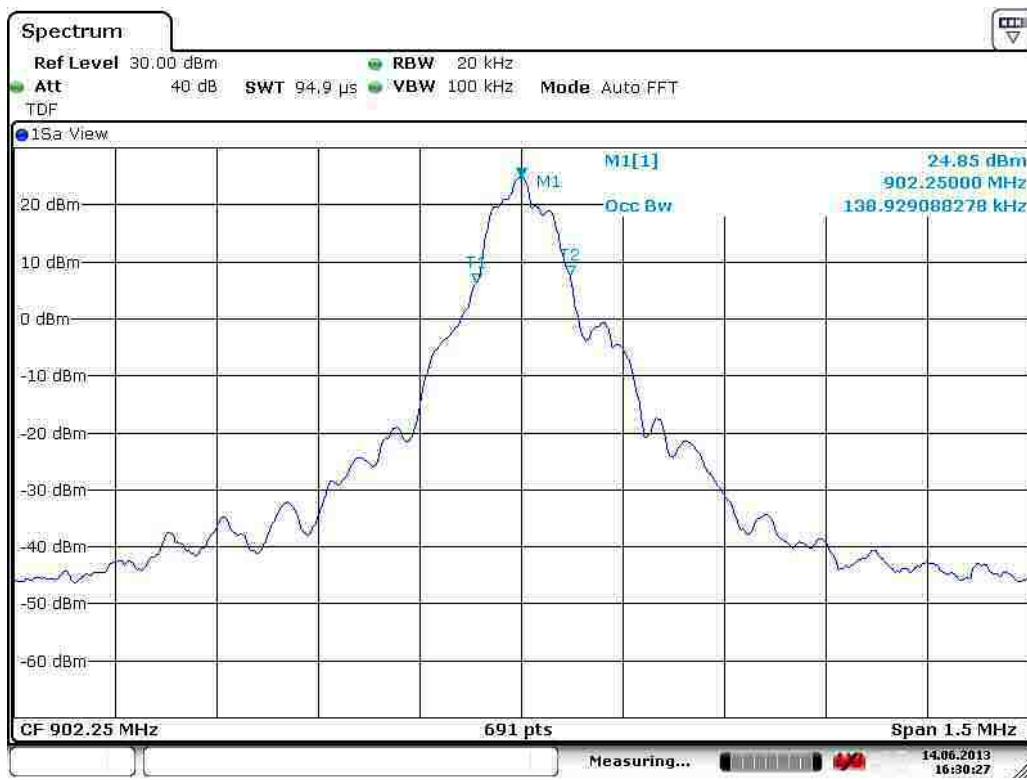
Standard: RSS-GEN (2010)
Tested by: NKA
Date: 14.6.2013 / 18.6.2013
Temperature: 23.0 °C / 23.3 °C
Humidity: 49 % RH / 34 % RH

RSS-GEN 4.6.

The test was performed with two different modulations, PR-ASK and ASK.

Table 17. Occupied Bandwidth

| Channel | 99% BW [kHz] | | Limit | Result |
|---------|---------------|---------------|-------|--------|
| | PR-ASK | ASK | | |
| Low | 138.929088278 | 193.198263386 | - | PASS |
| Mid | 136.758321273 | 193.198263386 | - | PASS |
| High | 156.295224313 | 195.369030391 | - | PASS |

**Figure 38.** Low channel 99% Occupied Power Bandwidth with PR-ASK modulation.

99% Occupied Power Bandwidth

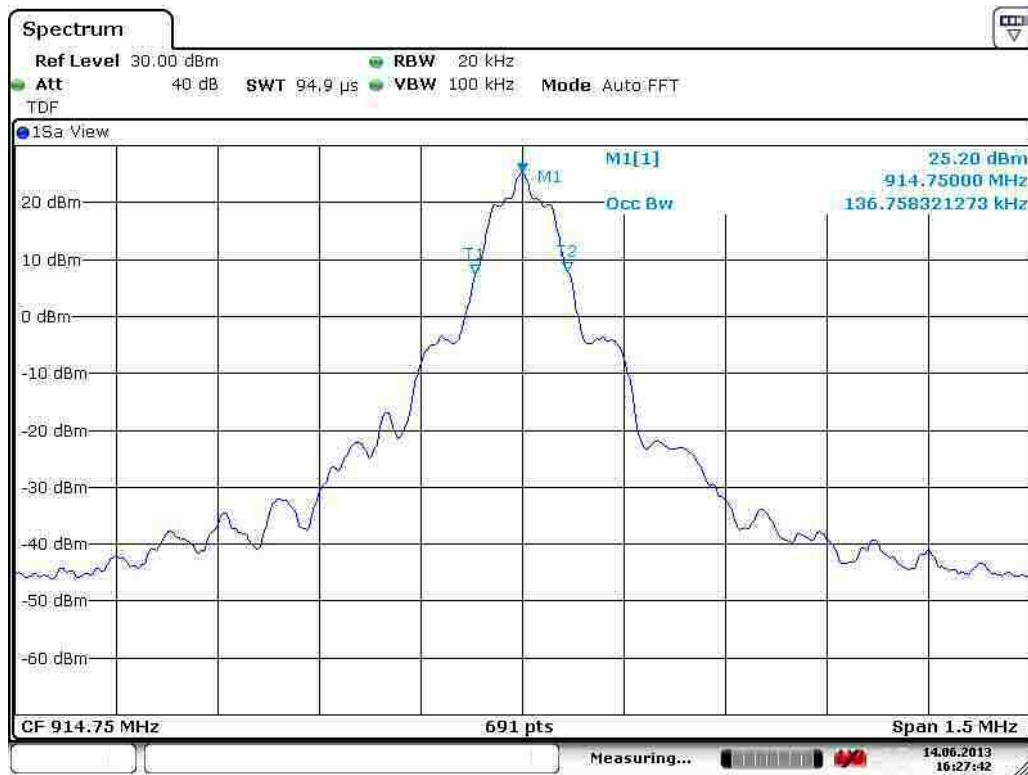


Figure 39. Mid channel 99% Occupied Power Bandwidth with PR-ASK modulation.



Figure 40. High channel 99% Occupied Power Bandwidth with PR-ASK modulation.

99% Occupied Power Bandwidth

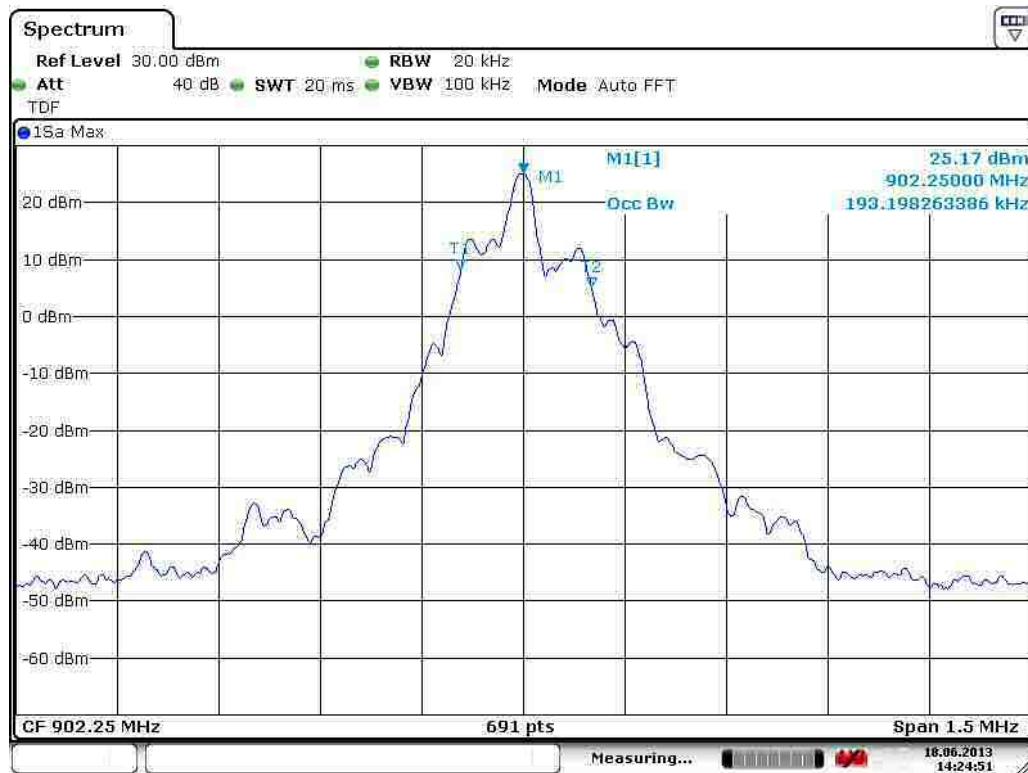


Figure 41. Low channel 99% Occupied Power Bandwidth with ASK modulation.

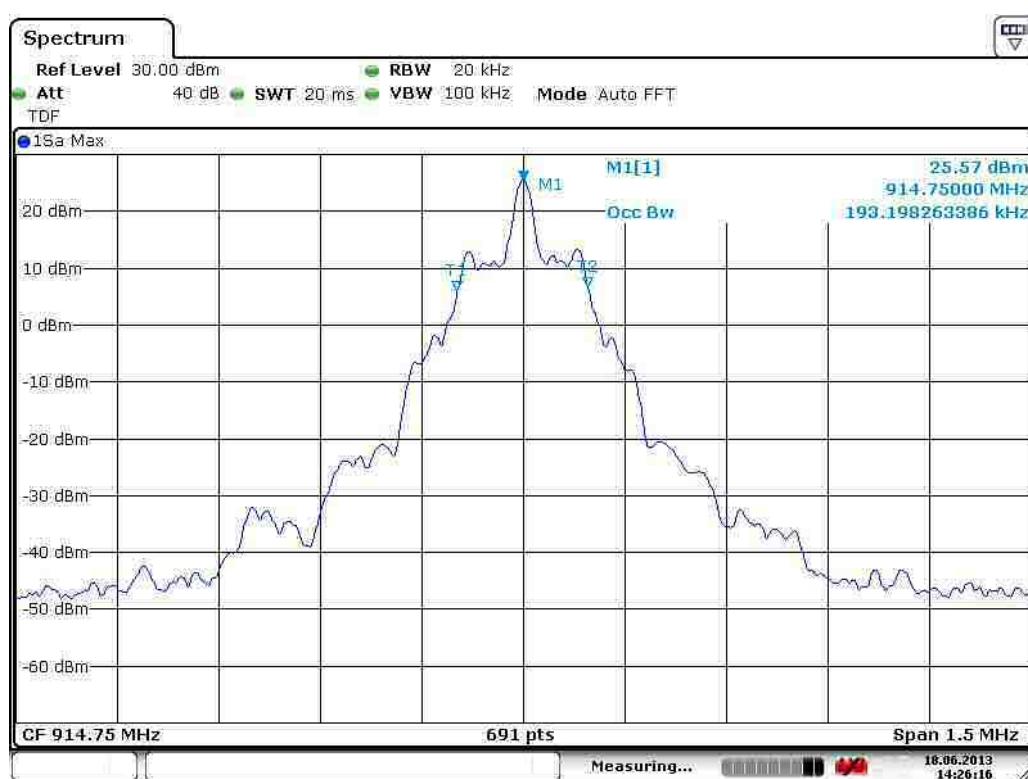


Figure 42. Mid channel 99% Occupied Power Bandwidth with ASK modulation.

99% Occupied Power Bandwidth

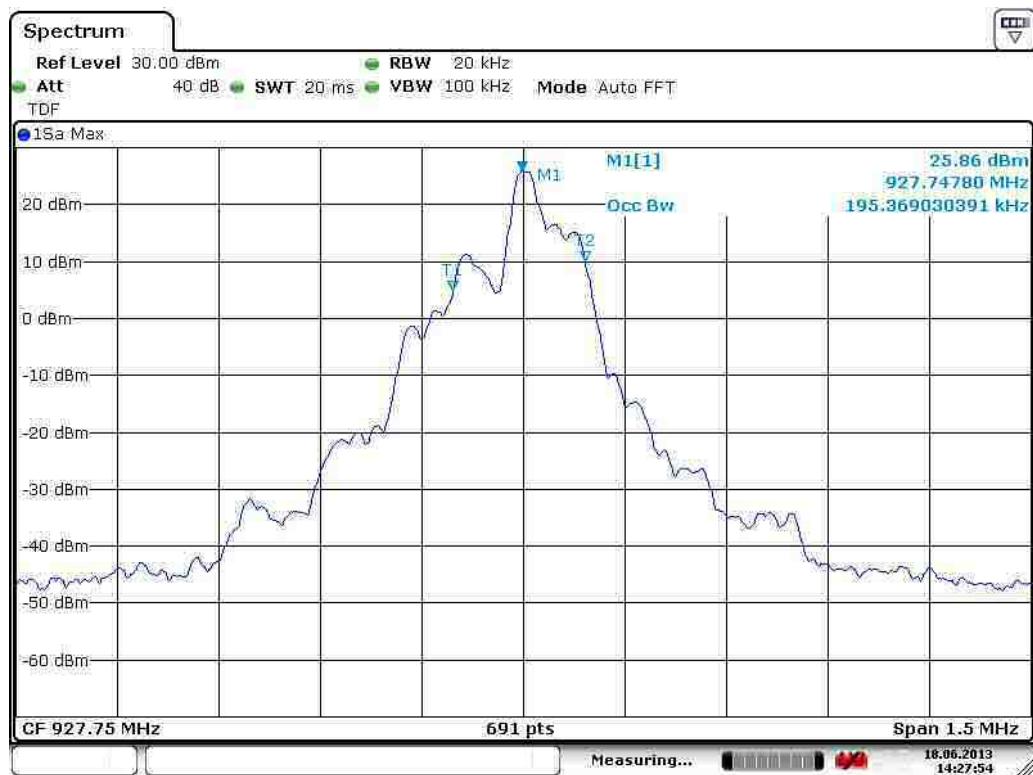


Figure 43. High channel 99% Occupied Power Bandwidth with ASK modulation.

LIST OF TEST EQUIPMENT

| Manufacturer | Type | Serial no | Inv. no |
|----------------------------|------------------|------------------|----------------|
| ROHDE & SCHWARZ | | | |
| Signal Analyzer | FSV40 | 101068 | 9093 |
| EMI Test receiver | ESU 26 | 100185 | 8453 |
| Test software | EMC32 | - | - |
| DAVIS | | | |
| Weather station | Vantage Pro | - | 5297 |
| EMCO | | | |
| Antenna (1 - 18 GHz) | 3117 | 29617 | 7293 |
| SCHWARZBECK | | | |
| Antenna (30 MHz - 1 GHz) | VULB 9168 | 9168-503 | 8911 |
| HEWLETT- PACKARD | | | |
| Microwave amplifier | 83017A | - | 5226 |
| HUBER-SUHNER | | | |
| Attenuator 10dB | 6810.17B | - | - |
| DEISEL | | | |
| Antenna mast | MA 240 | 240/455 | 7896 |
| Turntable | DS 430 | - | - |
| WAINWRIGHT | | | |
| High Pass Filter | WPKX1.0/15G-10SS | 5 | 8267 |

All used measurement equipment was calibrated (if required).