DAT-PL-002/91-03

# Center for Quality Engineering

# Test Report No.: D15F0002

# FCC ID: SZV-STM311C
# IC: 5713A-STM311C

**Order No.:** D15F **Pages:** 28 **Munich,** Sep 24, 2010

| | |
|---|---|
| Client: | EnOcean GmbH |
| Equipment Under Test: | Transmitter Module STM320C (Helical antenna, 3cm) |
| Manufacturer: | EnOcean GmbH |
| Task: | Conformance test according to the test specifications mentioned below |
| Test Specification(s): | FCC 47 CFR Part 15<br>IC RSS-210 |
| Result: | The EUT complies with the requirements of the specification. |

The results relate only to the items tested as described in this test report.

| **edited by:** | **Date** | **Signature** |
|---|---|---|
| Steinmüller<br>Qualification Engineer | Sep 24, 2010 | |

| **approved by:** | **Date** | **Signature** |
|---|---|---|
| Bauer<br>Lab Manager EMC | Sep 24, 2010 | |

This document was signed electronically.

## CONTENTS

# 1 Summary

The measurements described in this report were conducted pursuant to 47 CFR § 2.947, § 2.1041 and [1] § 15.31. All applicable paragraphs of the [1] 47 CFR part 15 of the most current version of the rules were considered.

The following tests were performed according to the FCC rules in order to verify the compliance of the EUT with the FCC requirements:

| Test No. | Measurement | FCC Rule | Page Number of this Report | Result |
|---|---|---|---|---|
| 1 | Conducted Emissions | [1] § 15.207 | 10 | n/a[1] |
| 2 | Field strength correction for pulse operation (Duty Cycle) | [1] § 15.35(c) | 10 | - |
| 3 | Field strength of the fundamental wave | [1] § 15.231(b)<br>[3] Annex 1.1.2, Table 4 | 13 | compliant |
| 4 | Radiated Emissions (9kHz – 30MHz) | [1] § 15.209<br>[3] Table 1 and 3 | 15 | compliant |
| 5 | Radiated Emissions (30MHz – 1GHz) | [1] § 15.205, 15.209 15.231(b)<br>[3] Table 1 and 2 | 18 | compliant |
| 6 | Radiated Emissions (1GHz – 4GHz) | [1] § 15.205, 15.209 15.231(b)<br>[3] Table 1 and 2 | 21 | compliant |
| 7 | Emission Bandwidth | [1] § 15.231(c)<br>[3] Annex 1.1.3 | 24 | compliant |
| 8 | Transmit Duration | [1] § 15.231(a)<br>[3] Annex 1.1.1 | 26 | compliant |

1) Measurement is not applicable since the EUT has no AC mains connection

**Table 1-1: Results – Summary**

# 2 References

## 2.1 Specifications

| No. | Standard | Title | Date |
|---|---|---|---|
| [1] | FCC 47 CFR Part 15 | Code of Federal Regulations,<br>Title 47: Telecommunication<br>Part 15: Radio Frequency Devices | 2009-10 |
| [2] | ANSI C63.4-2003 | American National Standard for<br>Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz | 2004-01 |
| [3] | RSS-210 Issue 7 | Radio Standards Specification<br>Low-power Licence-exempt Radiocommunication Devices<br>(All Frequency Bands):<br>Category I Equipment | 2007-06 |



## 2.2 Glossary of Terms

| | |
|---|---|
| °C | Degree Celsius |
| AC | Alternating Current |
| ANT | Antenna |
| chk | checked against a calibrated reference |
| cnn | calibration not necessary |
| DAR | Deutscher Akkreditierungsrat (German Accreditation Council) |
| DATech | Deutsche Akkreditierungsstelle Technik e.V. |
| dB | Decibel |
| dBc | Decibel per Carrier |
| dBm | Decibel per Milliwatt |
| EUT | Equipment Under Test |
| ind | for indication only |
| kbps | Kilobits per second |
| max | Maximum |
| min | Minimum |
| n/a | Not Applicable |
| n/p | Not Performed |
| P | Power |
| Pmax | Maximum Output Power |
| Prat | Rated Output Power |
| RBW | Resolution Bandwidth |
| Ref | Reference |
| RF | Radio Frequency |
| RMS | Root Mean Square |
| RX | Receive Path |
| SW | Software |
| T | Temperature |
| TRX | Transceiver |
| TX | Transmit Path |
| V | Volt |
| W | Watt |
| w/ | with |
| w/o | without |

# 3 General Information

## 3.1 Identification of Client

EnOcean GmbH
Kolpingstr. 18a
82041 Oberhaching
Dr. Wolfgang Hellerl

## 3.2 Test Laboratory

Center for Quality Engineering
SGS Germany GmbH
Hofmannstraße 50
81379 München

Federal Communications Commission (FCC):
Testfirm registration numbers – MZ2: 97242

Industry Canada (IC):
Company number: 9058A
- Test-site number: – MZ2: 9058A-2



## 3.3 Time Schedule

| Test No.: | 2,7,8 | 3,4,5,6 |
|---|---|---|
| Start of Test: | 27.08.2010 | 24.09.2010 |
| End of Test: | 27.08.2010 | 24.09.2010 |

## 3.4 Participants

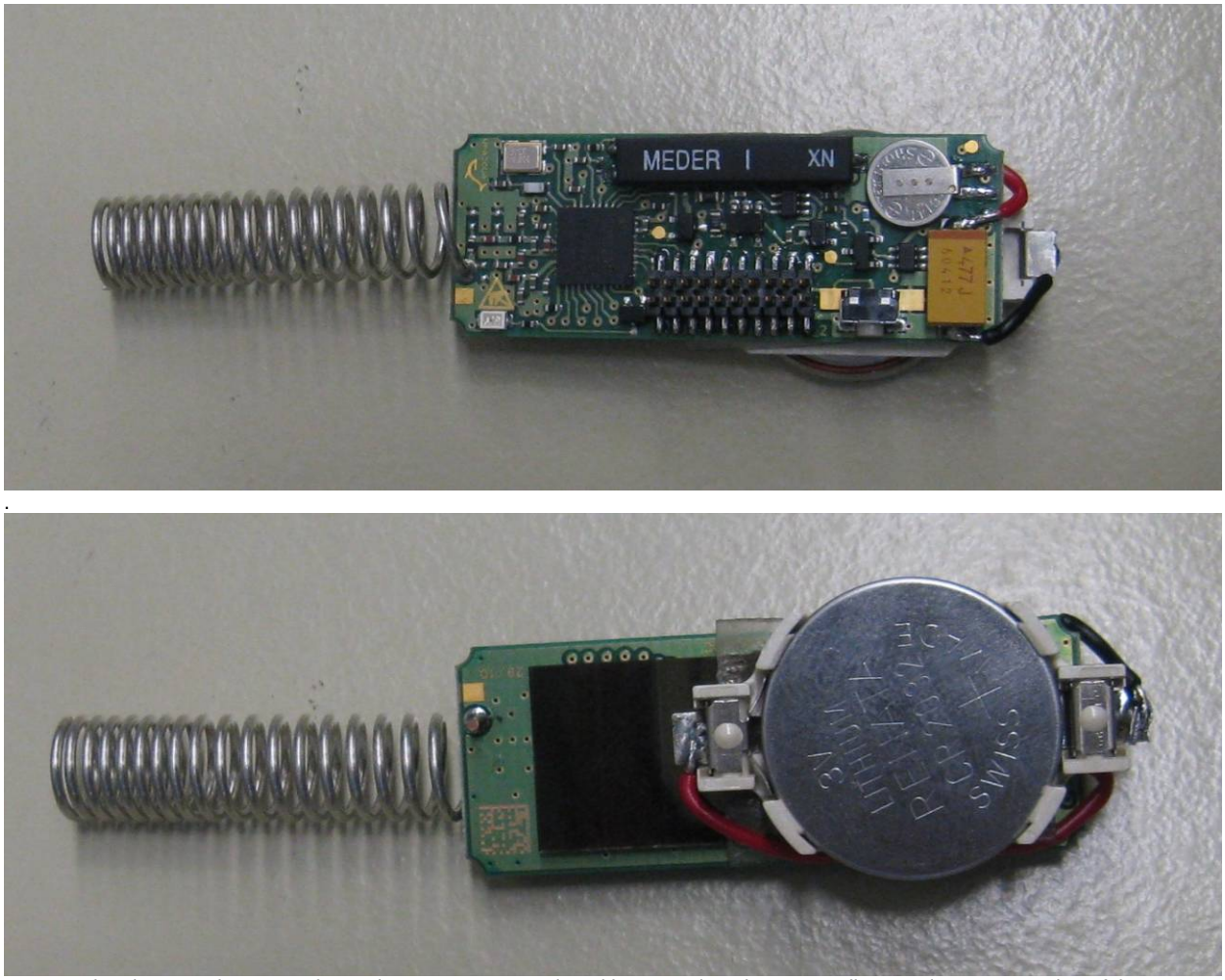
| Name | Function |
|---|---|
| Michael Steinmüller | Accredited Testing, Editor |

# 4 Equipment Under Test

The tested equipment is representative for serial production.

## 4.1 Description of EUT

The tested Transmitter-Module transmits control data by using ASK modulation through its 315MHz carrier signal.

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Note: During the tests the energy havesting system was replaced by a 3V Li Mn battery to allow continuous operation of the EUT.

**Figure 4-1: Photos of EUT**

## 4.2 Configuration of EUT

The used different EUT configurations are shown by the following tables.

| | | | |
|---|---|---|---|
| **Module Type** | | | Transmitter-Module |
| **Operating Band** | | | 315MHz |
| **Operating Frequency** | | | 315MHz |
| **Rated Output Power (Prat)** | | | n/a |
| **Modulation** | **Type** | | ASK (OOK) |
| | **Operation w/o modulation** | | No |
| | **Emission designator** | | 398KA1D |
| **Antenna** | **Type** | | Helical antenna (3cm) |
| | **Number of Antenna Ports** | | 1 |
| | **Gain** | | n/a |
| **Power Src.** | **Type** | | Energy harvesting DC supply system[1] |
| | **Battery type (if applicable)** | | Li Mn (CR2032)[1] |
| | **Voltage** | **nominal** | 3V |
| | | **minimal** | 3V |
| | | **maximum:** | 6V |

1) During the tests the energy havesting system was replaced by a 3V Li Mn battery to allow continuous operation of the EUT.

**Table 4-1: Overview of EUT Configuration**

The tests were performed with one EUT.

The used different EUT configurations are shown by the following table.

| Module Name | Serial-No. | Module Type |
|---|---|---|
| STM320C | none | Transmitter-Module |

1) Except of some none RF relevant differences the tested STM320C and the module types STM311C and STM321C are functionally identical. The provided measurement results are worst case values.

**Table 4-2: Configuration of EUT**

For a functional description of the modules, please refer to the appropriate related parts and exhibit sections of this certification application.

## 4.3 Operating Conditions

If not stated otherwise, the following standard setup procedure for the EUT was used:

The EUT was set up in a continuously transmitting operating mode. The TX signal was thus permanently activated during the test. To do so the pulse train which will be sent only once (after manual activation) during normal operation was repeated each second.

The EUT was supplied with 3V DC by a new Li Mn battery.

## 4.4 Compliance Criteria

The EUT must fulfil the requirements (described in the specifications mentioned in chapter 2.1, Specifications) for the selected test cases.

# 5 General Description of Tests

## 5.1 Tested Carrier Frequencies

The measurements were performed on 1 carrier frequency, according to the following table:

| Frequency [MHz] | Remark |
|---|---|
| 315 | Only possible carrier frequency |

**Table 5-1: Carrier Frequency**

## 5.2 Calibration of the Test Equipment

All relevant test equipment has a valid calibration from an external calibration laboratory. Additionally the used spectrum and EMI analyzers have a built-in self-calibration procedure. This calibration procedure was activated prior to the measurements so that the analyzer is deemed accurate. High quality cables were used to connect the measurement equipment. The actual loss of the attenuators and the cables was measured with a high precision network analyzer and taken into account for all measurements.

# 6 Test Results

## 6.1 Test No. 1: Conducted Emissions ([1] § 15.207)

Not applicable since the EUT power input terminals are not directly connected to a public power network.

## 6.2 Test No. 2: Field strength correction for pulse operation (Duty Cycle) ([1] § 15.35(c))

### 6.2.1 Purpose

When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed according to [1] § 15.35(c) the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.
As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted.

### 6.2.2 Limits

According to [1] § 15.35(b) the duty cycle correction factor must be not below -20dB.

### 6.2.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.2.4 Test Configuration

The measurement of the duty cycle of the EUT's pulse train was performed with a probe antenna by means of a spectrum analyzer operating in the zero span mode.
For the parts list of used test equipment see chapter 7.1

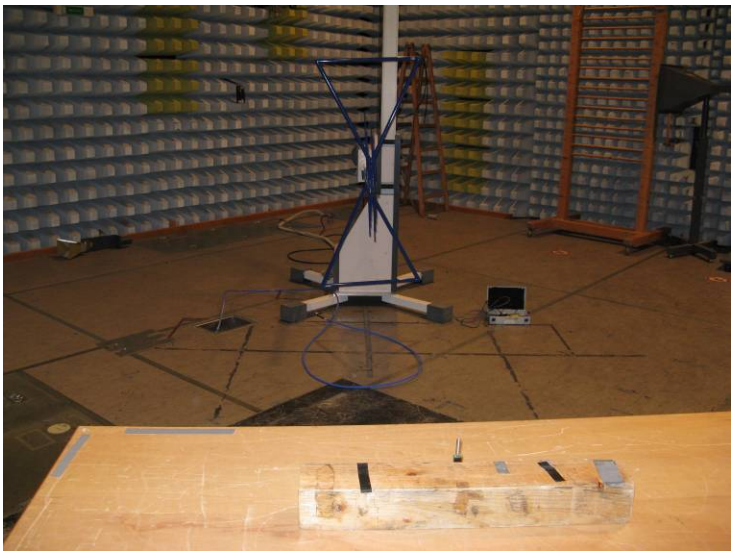

**Figure 6-1: Test Configuration – Duty Cycle**

### 6.2.5 Test Procedure and Results

The duty cycle correction factor (dB) was calculated with following formula:

$$CF = 20 \log \frac{t_p}{t_t}$$

With:
*CF*: Duty cycle correction factor
$t_t$: Puls train duration
$t_p$: Puls duration

| $t_p$ [ms] | $t_t$ [ms] | *CF* [dB] calculated | *CF* [dB] used (≥ -20dB) |
|---|---|---|---|
| 3x1.31 | 100.0 | -28.1 | -20.0 |

**Table 6-1: Results – Duty Cycle**

### 6.2.6 Test Protocol

The following figures show the pulse train details (time domain)

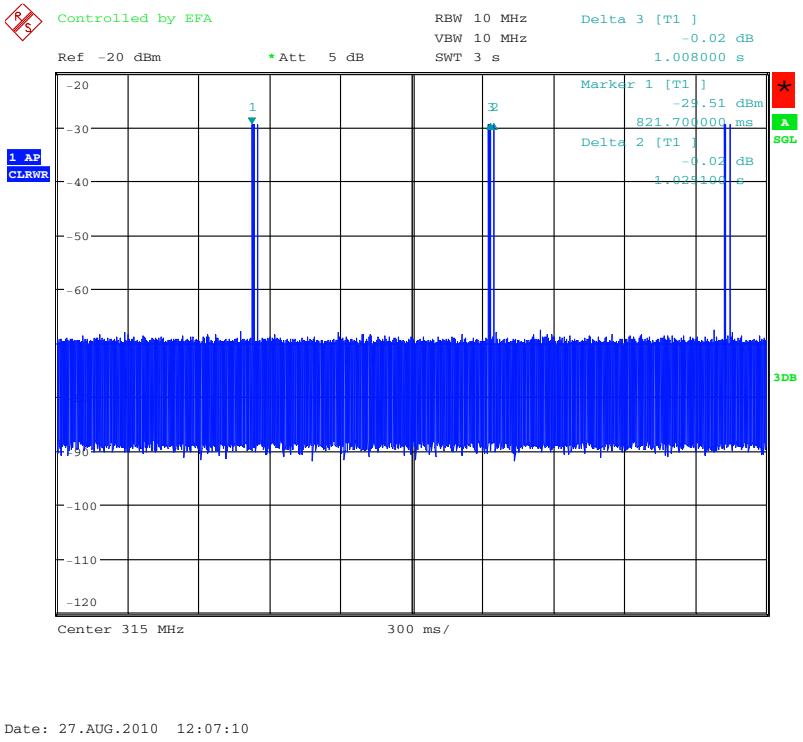


**Figure 6-2: Duty Cycle (Pulse Train repetition)**

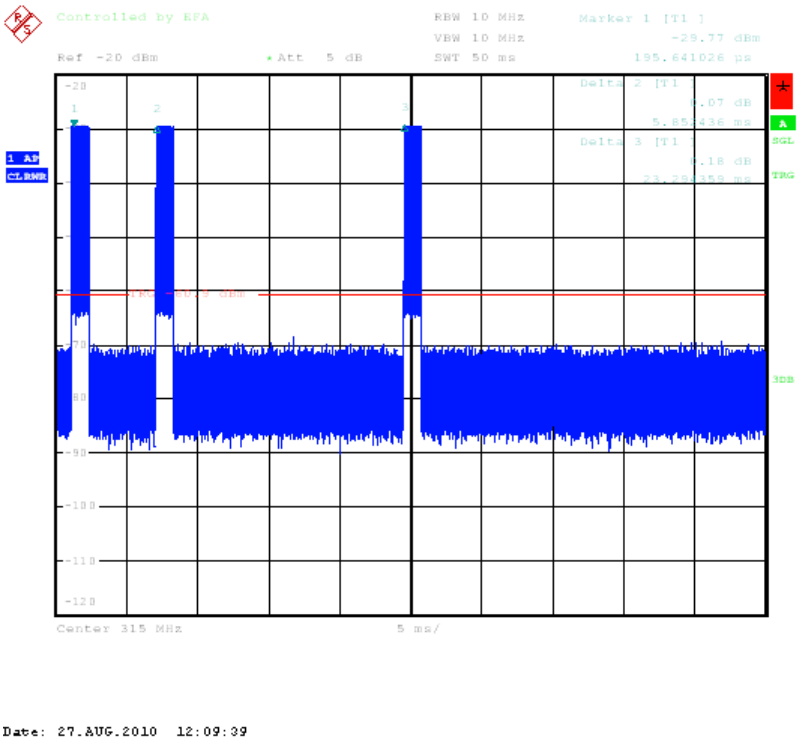


**Figure 6-3: Duty Cycle (Complete Pulse train)**

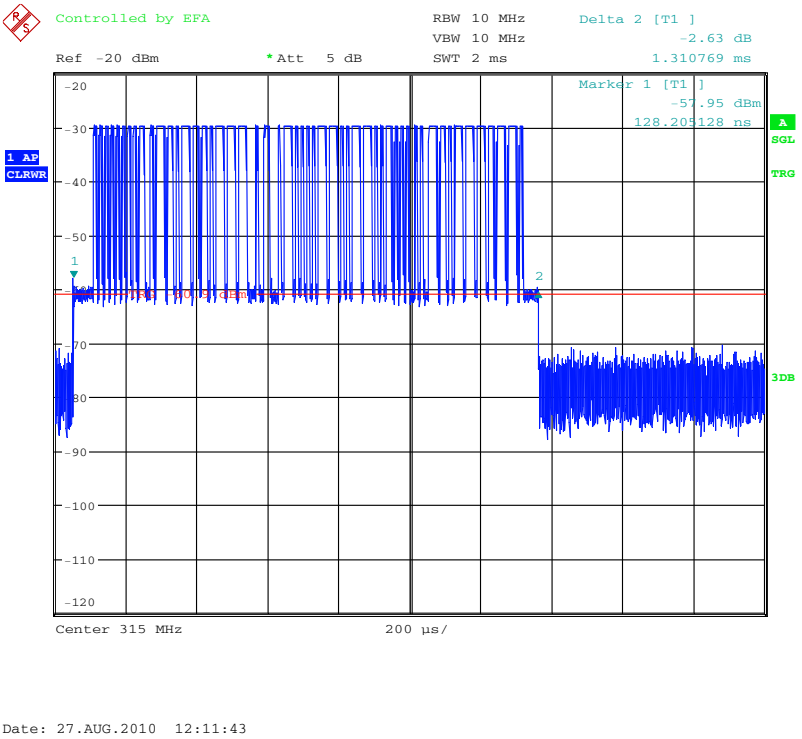


**Figure 6-4: Duty Cycle (Pulse details)**

**The determined duty cycle correction factor will be applied for the field strength and radiated emission measurements**

## 6.3 Test No. 3: Field strength of the fundamental wave ([1] § 15.231(b), [3] A1.1.2)

### 6.3.1 Purpose

The measurement of the field strength of the fundamental wave of the EUT was performed pursuant to [2] Clause 13.1.4 to verify that the field strength of the fundamental wave does not exceed the specified limit.

### 6.3.2 Limits

According to [1] § 15.231(b) and [3] A1.1.2, the field strength of the fundamental wave must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| 40.66–40.70 | 2250 | 67.0 | 3 |
| 70–130 | 1250 | 61.9 | 3 |
| 130–174 | 1250–3750[1] | 61.9–71.5 | 3 |
| 174–260 | 3750 | 71.5 | 3 |
| 260–470 | 3750–12500[1] | 71.6–81.9 | 3 |
| **315** | **6042**[2] | **75.6** | **3** |
| Above 470 | 12500 | 81.9 | 3 |

1) Linear interpolation
2) Calculated by linear interpolation

**Table 6-2: Limits – Field Strength of Fundamental Wave**

### 6.3.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.3.4 Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements of [2] and is listed with the FCC and IC. The resolution bandwidth used during the emission measurement was as follows:

30MHz – 1GHz: 120kHz

For the parts list of used test equipment see chapter 7.1

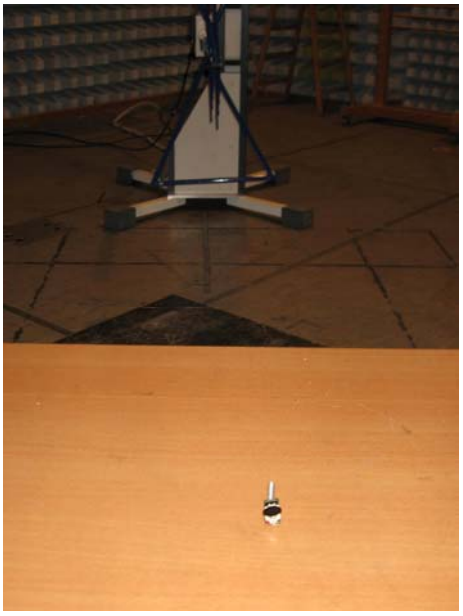

**Figure 6-5: Test Configuration – Field Strength of Fundamental Wave**



### 6.3.5 Test Procedure and Results

This investigation is performed with a broadband antenna and a receiver with peak detector. The field strength is measured in a distance of 3m with an antenna in horizontal and vertical polarization, the antenna height is varied from 1 to 4 m and the EUT is turned around 360° to maximize the emission. The used bandwidth for the measurement is 120 kHz.

| Frequency (MHz) | Average (dBµV/m)[1] | Meas. Time (ms) | Height (cm) | Polarization | Azimuth (deg) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 315.000 | 72.74 | 1000.0 | 100.0 | H | 124.0 | 2.86 | 75.6 |
| Measurement Uncertainty: | | | | | | +3.1 dB / -3.9 dB | |

1) The average field strength was calculated by applying the duty cycle correction factor of -20dB (see chapter 6.2) to the measured peak field strength.

**Table 6-3: Results – Field Strength of Fundamental Wave**

### 6.3.6 Test Protocol

See chapter 6.5.6 for the test protocol of the fundamental wave field strength measurement.

**The measured filed strength of the fundamental wave was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

## 6.4 Test No. 4: Radiated Emissions (9kHz – 30MHz) ([1] § 15.209; [3] T1, 3)

### 6.4.1 Purpose

The radiated emissions of the EUT were measured pursuant to [2] Clause 13.1.4. The measurement was performed to verify that emissions radiated directly from the cabinet, control circuits, power leads or intermediate circuit elements are attenuated below the specified limits.

### 6.4.2 Limits

At frequencies equal to or less than 1000MHz, compliance with the limits in [1] § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. According to [1] § 15.209 and [3] Table 1 and 3 the radiated emissions of an intentional radiator must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| 0.009–0.490 | 2400/F [kHz] | 88.5 – 53.8[1] | 300 |
| 0.490–1.705 | 24000/F [kHz] | 53.8 – 43[1] | 30 |
| 1.705–30 | 30 | 49.5[1] | 30 |

1): Limit adapted to a measurement distance of 3m!

**Table 6-4: Limits – Radiated Emissions (9kHz – 30MHz)**

According to [1] § 15.205(a) the field strength of emissions in the following restricted bands of operation shall not exceed the limits of [1] § 15.209.

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 6.215–6.2 | 8.41425–8.41475 | 16.69475–16.69525 |
| 0.495–0.505 | 6.26775–6.26825 | 12.29–12.293 | 16.80425–16.80475 |
| 2.1735–2.1905 | 6.31175–6.31225 | 12.51975–12.52025 | 25.5–25.67 |
| 4.125–4.128 | 8.291–8.294 | 12.57675–12.57725 | |
| 4.17725–4.17775 | 8.362–8.366 | 13.36–13.41 | |
| 4.20725–4.20775 | 8.37625–8.38675 | 16.42–16.423 | |

**Table 6-5: Restricted Bands (9kHz – 30MHz)**

### 6.4.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.4.4 Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements of [2] and is listed with the FCC and IC.
The resolution bandwidth used during the emission measurement was as follows:

9kHz – 150 kHz: 200Hz
150kHz – 30MHz: 9kHz

For the parts list of used test equipment see chapter 7.1

**Figure 6-6: Test Configuration – Radiated Emissions (9kHz – 30MHz)**



### 6.4.5 Test Procedure and Results

This investigation is performed with the EUT turned around 360° to maximize the emission. The spectrum analyzer is set to 'peak' mode from 9 kHz to 30 MHz. On any emission over the limit, the spectrum analyzer is set to 'average' mode for 9 kHz to 150 kHz and the spectrum analyzer is set to quasi-peak mode between 150 kHz and 30 MHz. The rod antenna is positioned 3 meters from the closest point of any part of the test sample. The antenna counterpoise is grounded.

| Frequency (MHz) | Peak (dBµV/m) | Meas. Time (ms) | Polarization | Azimuth (deg) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|
| -- | -- | -- | V | -- | >30 | -- |
| Measurement Uncertainty: | | | | | +3.1 dB / -3.9 dB | |

Note: Margin of pre measurement was >30dB, so no final measurement was performed

**Table 6-6: Results – Radiated Emissions (9kHz – 30MHz)**

### 6.4.6 Test Protocol

The following figure shows the test protocol of the radiated emissions (9kHz – 30MHz) measurement.

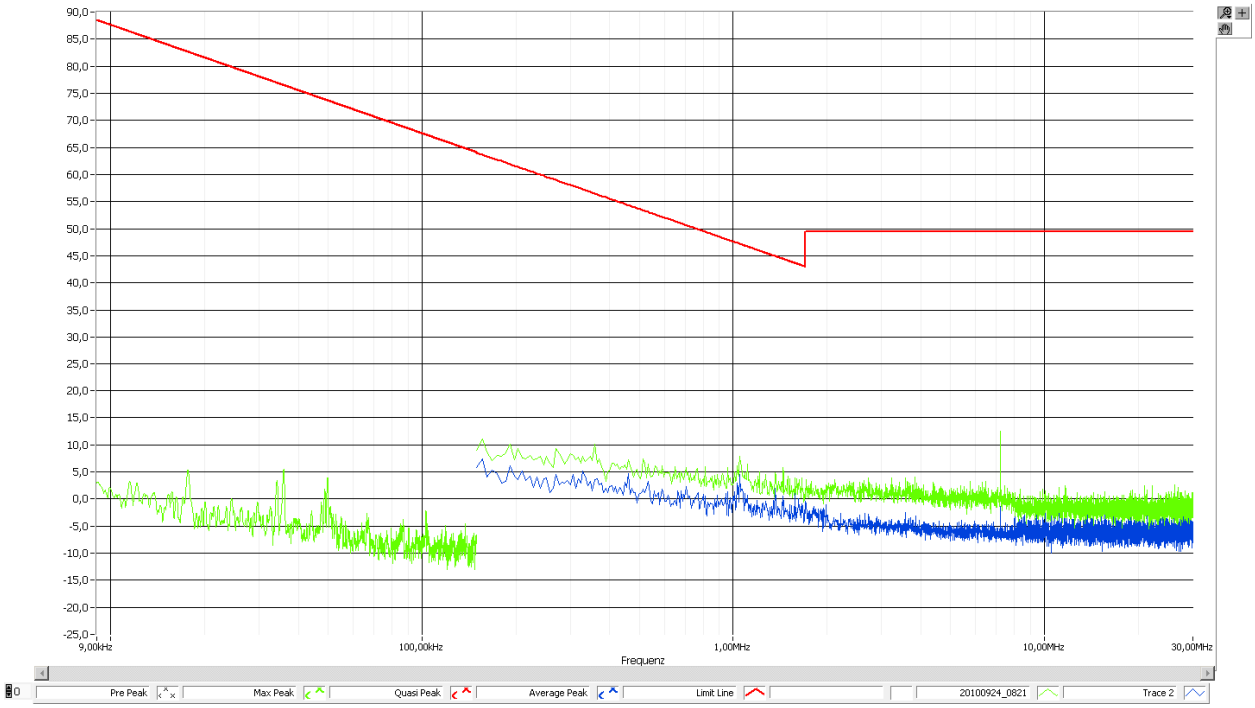


**Figure 6-7: Radiated Emissions (9kHz – 30MHz)**

**The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

## 6.5 Test No. 5: Radiated Emissions (30MHz – 1GHz) ([1] § 15.209, 231(b); [3] T1, 2)

### 6.5.1 Purpose

The radiated emissions of the EUT were measured pursuant to [2] Clause 13.1.4. The measurement was performed to verify that emissions radiated directly from the cabinet, control circuits, power leads or intermediate circuit elements are attenuated below the specified limits.

### 6.5.2 Limits

At frequencies equal to or less than 1000MHz radiated emissions shall be attenuated to CISPR quasi peak limits specified by [1] § 15.209 and [3] Table 1 and 2 (general limits) or to the limits specified by [1] § 15.231(b), whichever limit permits a higher field strength.

According to [1] § 15.209 and [3] Table 1 and 2 the radiated emissions of an intentional radiator must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| 30–88 | 100 | 40 | 3 |
| 88–216 | 150 | 43.5 | 3 |
| 216–960 | 200 | 46 | 3 |
| Above 960 | 500 | 54 | 3 |

**Table 6-7: Limits – Radiated Emissions (30MHz – 1GHz) (§ 15.209)**

According to [1] § 15.231(b) the radiated emissions of an intentional radiator must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| 40.66–40.70 | 225 | 47.0 | 3 |
| 70–130 | 125 | 41.9 | 3 |
| 130–174 | 125–375[1] | 41.9–51.5 | 3 |
| 174–260 | 375 | 51.5 | 3 |
| 260–470 | 375–1250[1] | 51.6–61.9 | 3 |
| **315** | **604.2**[2] | **55.6** | **3** |
| Above 470 | 1250 | 61.9 | 3 |

1) Linear interpolation
2) Calculated by linear interpolation

**Table 6-8: Limits – Radiated Emissions (30MHz – 1GHz) (§ 15.231(b))**

According to [1] § 15.205(a) the field strength of emissions in the following restricted bands of operation shall not exceed the limits of [1] § 15.209.

| MHz | MHz | MHz | MHz |
|---|---|---|---|
| 37.5–38.25 | 123–138 | 162.0125–167.17 | 399.9–410 |
| 73–74.6 | 149.9–150.05 | 167.72–173.2 | 608–614 |
| 74.8–75.2 | 156.52475–156.52525 | 240–285 | 960–1000 |
| 108–121.94 | 156.7–156.9 | 322–335.4 | |

**Table 6-9: Restricted Bands (30MHz – 1GHz)**

### 6.5.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.5.4 Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements of [2] and is listed with the FCC and IC.
The resolution bandwidth used during the emission measurement was as follows:

30MHz – 1GHz: 120kHz

For the parts list of used test equipment see chapter 7.1

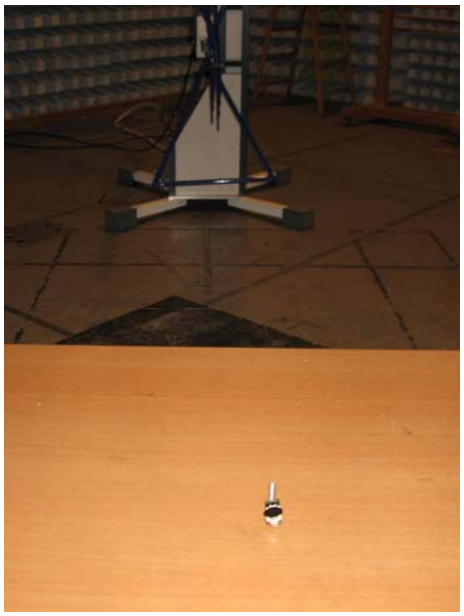

**Figure 6-8: Test Configuration – Radiated Emissions (30MHz – 1GHz)**



### 6.5.5 Test Procedure and Results

This investigation is performed with a broadband antenna and a receiver with peak detector. The field strength is measured in a distance of 3m with an antenna in horizontal and vertical polarization, the antenna height is varied from 1 to 4 m and the EUT is turned around 360° to maximize the emission. The used bandwidth for the measurement is 120 kHz and a step size of 60 kHz is applied.

| Frequency (MHz) | Average (dBµV/m)[1] | Meas. Time (ms) | Height (cm) | Polarization | Azimuth (deg) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 315.000 | 72.74 | 1000.0 | 100.0 | H | 124.0 | 2.86 | 75.6 |
| 314.453 | 44.60 | 1000.0 | 100.0 | H | 111.0 | 31.0 | 75.6 |
| 316.198 | 34.23 | 1000.0 | 100.0 | H | 111.0 | 41.37 | 75.6 |
| 316.878 | 26.48 | 1000.0 | 100.0 | H | 97.0 | 49.12 | 75.6 |
| 317.557 | 20.10 | 1000.0 | 100.0 | H | 111.0 | 55.5 | 75.6 |
| 630.042 | 37.88 | 1000.0 | 100.0 | H | 266.0 | 17.72 | 55.6 |
| Measurement Uncertainty: | | | | | | +3.1 dB / -3.9 dB | |

1) The average field strength was calculated by applying the duty cycle correction factor of -20dB (see chapter 6.2) to the measured peak field strength.

**Table 6-10: Results – Radiated Emissions (30MHz – 1GHz)**

### 6.5.6 Test Protocol

The following figure shows the test protocol of the radiated emissions (30MHz – 1GHz) measurement.

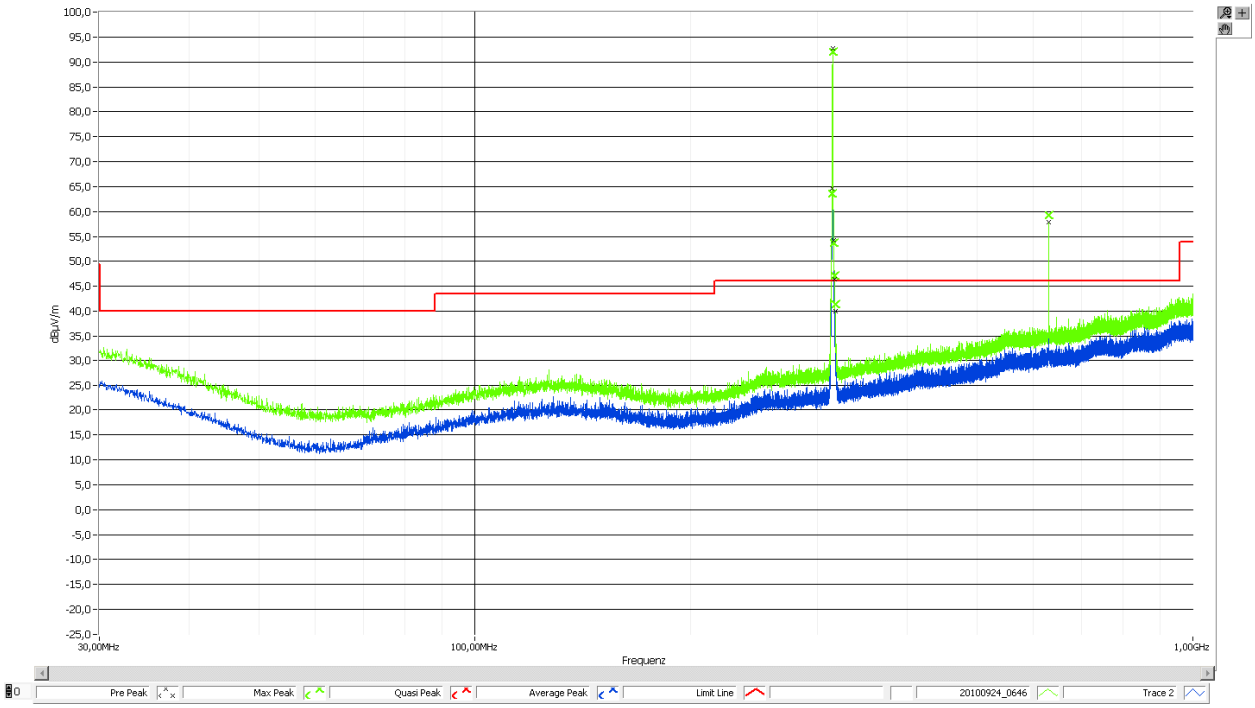


**Figure 6-9: Radiated Emissions (30MHz – 1GHz)**

**The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

## 6.6 Test No. 6: Radiated Emissions (1GHz – 4GHz) ([1] § 15.209, 231(b); [3] T1, 2)

### 6.6.1 Purpose

The radiated emissions of the EUT were measured pursuant to [2] Clause 13.1.4. The measurement was performed to verify that emissions radiated directly from the cabinet, control circuits, power leads or intermediate circuit elements are attenuated below the specified limits.

### 6.6.2 Limits

At frequencies above 1GHz radiated emissions shall be attenuated to average limits specified by, [1] § 15.209 and [3] Table 1 and 2 (general limits) or to the limits specified by [1] § 15.231(b), whichever limit permits a higher field strength.

According to [1] § 15.209 and [3] Table 1 and 2 the radiated emissions of an intentional radiator must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| Above 960 | 500 | 54 | 3 |

**Table 6-11: Limits – Radiated Emissions (1GHz – 4GHz) (§ 15.209)**

According to [1] § 15.231(b) the radiated emissions of an intentional radiator must not exceed following field strength levels:

| Frequency of Emission [MHz] | Field strength [µV/m] | Field strength [dBµV/m] | Meas. Distance [m] |
|---|---|---|---|
| 40.66–40.70 | 225 | 47.0 | 3 |
| 70–130 | 125 | 41.9 | 3 |
| 130–174 | 125–375[1] | 41.9–51.5 | 3 |
| 174–260 | 375 | 51.5 | 3 |
| 260–470 | 375–1250[1] | 51.6–61.9 | 3 |
| **315** | **604.2**[2] | **55.6** | **3** |
| Above 470 | 1250 | 61.9 | 3 |

1) Linear interpolation
2) Calculated by linear interpolation

**Table 6-12: Limits – Radiated Emissions (1GHz – 4GHz) (§ 15.231(b))**

According to [1] § 15.205(a) the field strength of emissions in the following restricted bands of operation shall not exceed the limits of [1] § 15.209.

| MHz | MHz | MHz | MHz |
|---|---|---|---|
| 1000–1240 | 1660–1710 | 2483.5–2500 | 3345.8–3358 |
| 1300–1427 | 1718.8–1722.2 | 2690–2900 | 3600–4000 |
| 1435–1626.5 | 2200–2300 | 3260–3267 | |
| 1645.5–1646.5 | 2310–2390 | 3332–3339 | |

**Table 6-13: Restricted Bands (1GHz – 4GHz)**

### 6.6.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.6.4 Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements of [2] and is listed with the FCC and IC.
The resolution bandwidth used during the emission measurement was as follows:

1GHz – 4GHz: 1MHz

For the parts list of used test equipment see chapter 7.1

**Figure 6-10: Test Configuration – Radiated Emissions (1GHz – 4GHz)**



### 6.6.5 Test Procedure and Results

This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

| Frequency (MHz) | Average (dBµV/m)[1] | Meas. Time (ms) | Height (cm) | Polarization | Azimuth (deg) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 1890 | 27.64 | 1000 | 100 | H | 52.0 | 26.36 | 54.0 |
| 2520 | 33.29 | 1000 | 100 | V | 253.0 | 20.71 | 54.0 |
| 3936 | 29.99 | 1000 | 100 | V | 107.0 | 24.01 | 54.0 |
| Measurement Uncertainty: | | | | | | +4.4 dB / -6.3 dB | |

1) The average field strength was calculated by applying the duty cycle correction factor of -20dB (see chapter 6.2) to the measured peak field strength.

**Table 6-14: Results – Radiated Emissions (1GHz – 4GHz)**

### 6.6.6 Test Protocol

The following figure shows the test protocol of the radiated emissions (1GHz – 4GHz) measurement.

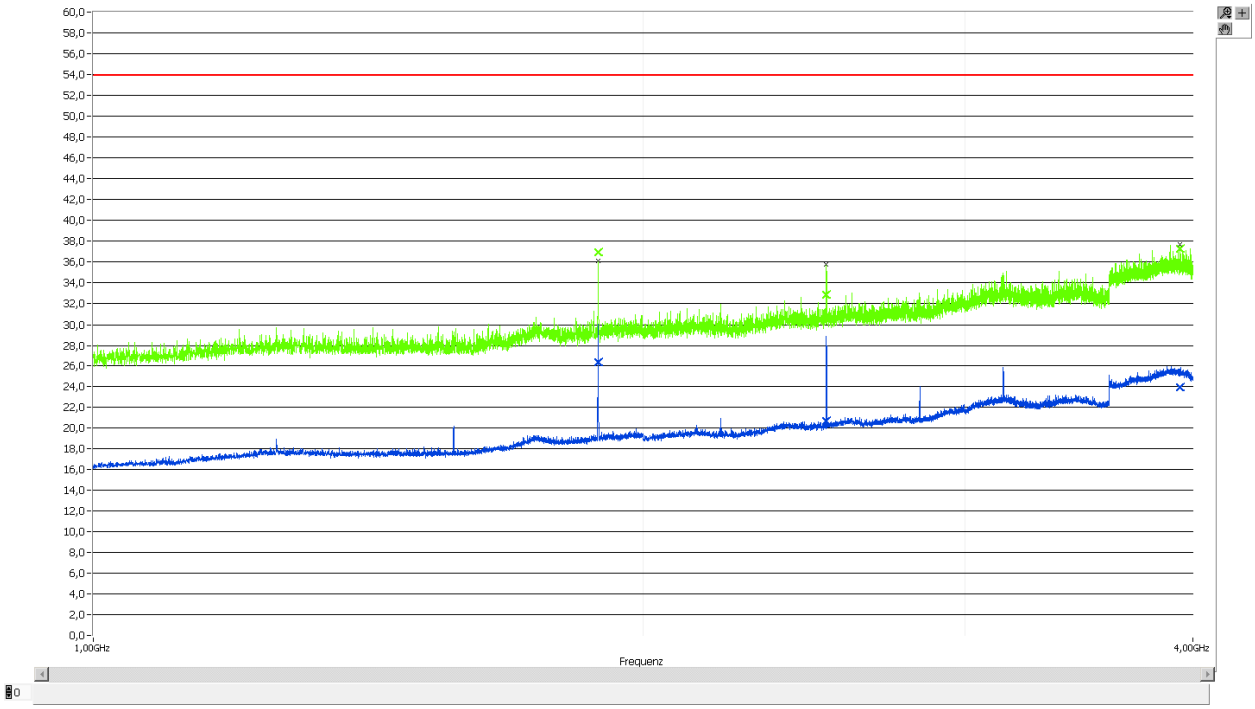


**Figure 6-11: Radiated Emissions (1GHz – 4GHz)**

**The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

## 6.7 Test No. 7: Emission Bandwidth ([1] § 15.231(c); [3] A1.1.3)

### 6.7.1 Purpose

The emission bandwidth of the EUT was measured pursuant to [2] Clause 13.1.7. The measurement was performed to verify the 20 dB bandwidth of emission.

### 6.7.2 Limits

According to § 15.231(c) and [3] Annex 1.1.3 the bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. For the EUT with a center frequency of 315MHz therefore an emission bandwidth limit of 787.5kHz applies.

According to § 15.231(c) the bandwidth is determined at the points 20 dB down from the modulated carrier.
Instead of the 99% bandwidth according to [3] A1.1.3 the 20 dB bandwidth of emission was determined.



### 6.7.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.7.4 Test Configuration

The measurement was performed with activated modulation by using a probe antenna and a spectrum analyzer. The analyzer frequency span was set wide enough to capture the most of the power envelope of the modulated signal.
For the parts list of used test equipment see chapter 7.1

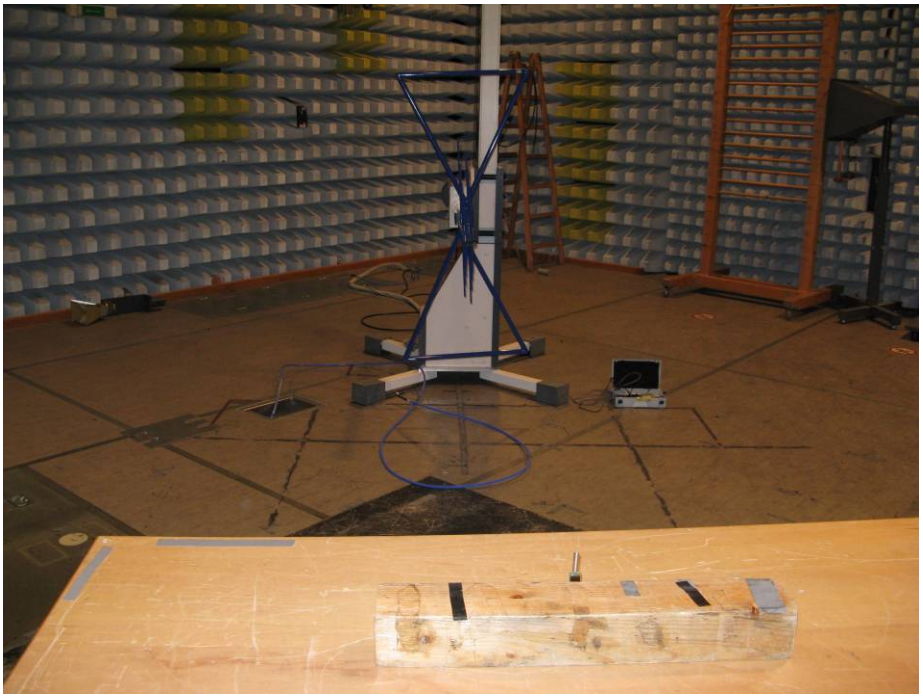

**Figure 6-12: Test Configuration – Emission Bandwidth**

### 6.7.5 Test Procedure and Results

The 20 dB bandwidth of the carrier emission is measured using a spectrum analyzer.
In order to measure the modulated signal properly, a resolution bandwidth that is small compared with the emission bandwidth limit shall be used on the measuring instrument.
According to [2] the resolution bandwidth was set to 10kHz.
For the determination of the 20 dB bandwidth the delta marker function of the signal analyzer was used to measure the maximum bandwidth including side bands.
The following table summarizes the results:

| Carrier Frequency | 20dB Emission Bandwidth | Result |
|---|---|---|
| [MHz] | [kHz] | |
| 315 | 397.8 | compliant |
| Measurement Uncertainty: | | ±3.2kHz |

**Table 6-15: Results – 20dB Emission Bandwidth**

### 6.7.6 Test Protocol

The following figure shows the test protocol of the emission bandwidth measurement.

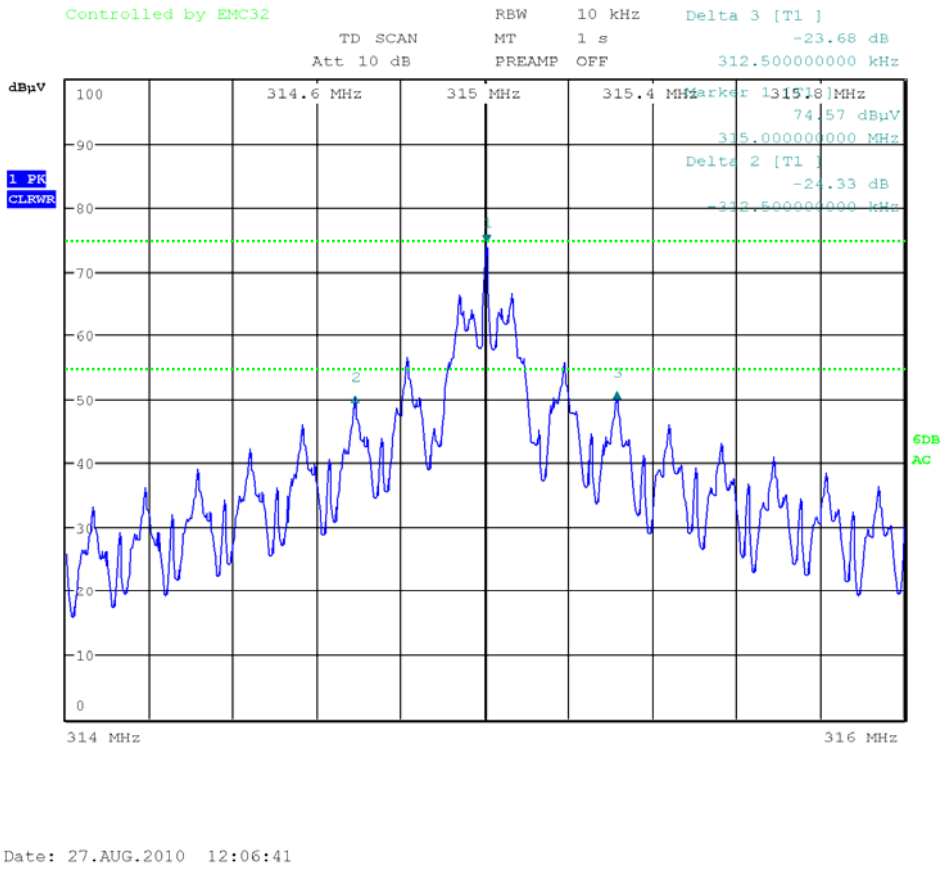


**Figure 6-13: 20dB Emission Bandwidth**

**The occupied bandwidth was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

## 6.8 Test No. 8: Transmit Duration ([1] § 15.231(a))

### 6.8.1 Purpose

The measurement was performed to verify if the transmit duration limit is met.

### 6.8.2 Limits

According to § 15.231(a) and [3] Annex 1.1.1 the following transmit duration limitation applies:
A manually or automatically operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

### 6.8.3 EUT Operating Condition

The standard setup procedure as described in section 4.3 of this report was used.

### 6.8.4 Test Configuration

The measurement of the transmit duration of the EUT was performed by means of a spectrum analyzer operating in the zero span mode.
For the parts list of used test equipment see chapter 7.1

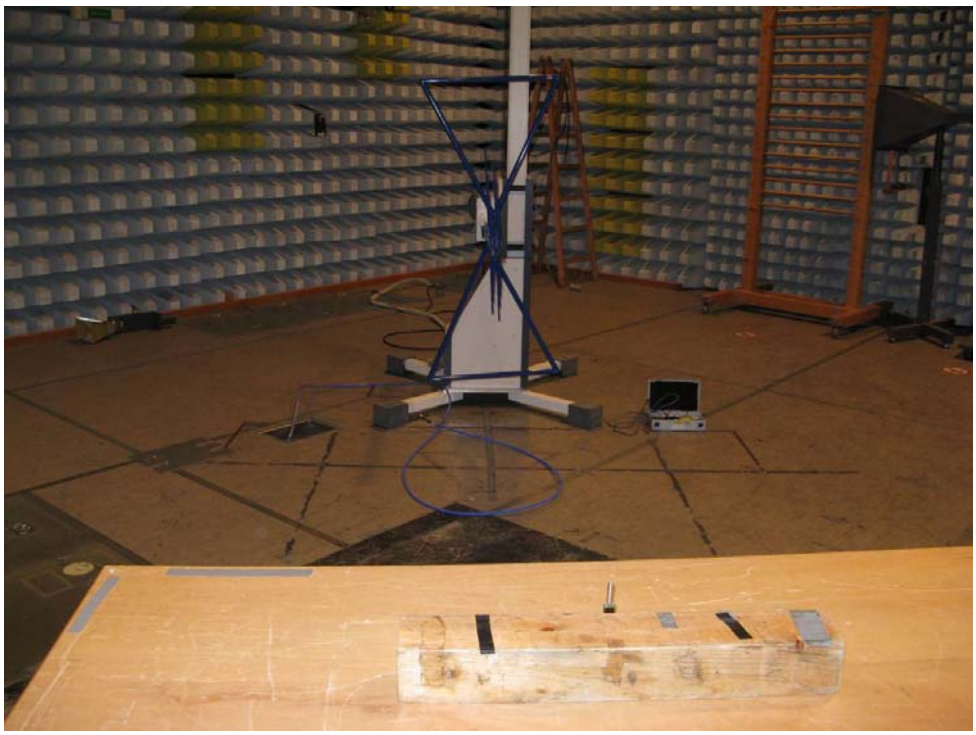

**Figure 6-14: Test Configuration – Transmit Duration**

### 6.8.5 Test Procedure and Results

The following table summarizes the transmit duration results:

| Transmit Condition | Transmit Duration [ms] | Result |
|---|---|---|
| After releasing the button | 24 | compliant |

**Table 6-16: Results – Transmit Duration**

### 6.8.6 Test Protocol

The following figure shows the test protocol of the transmit duration measurement

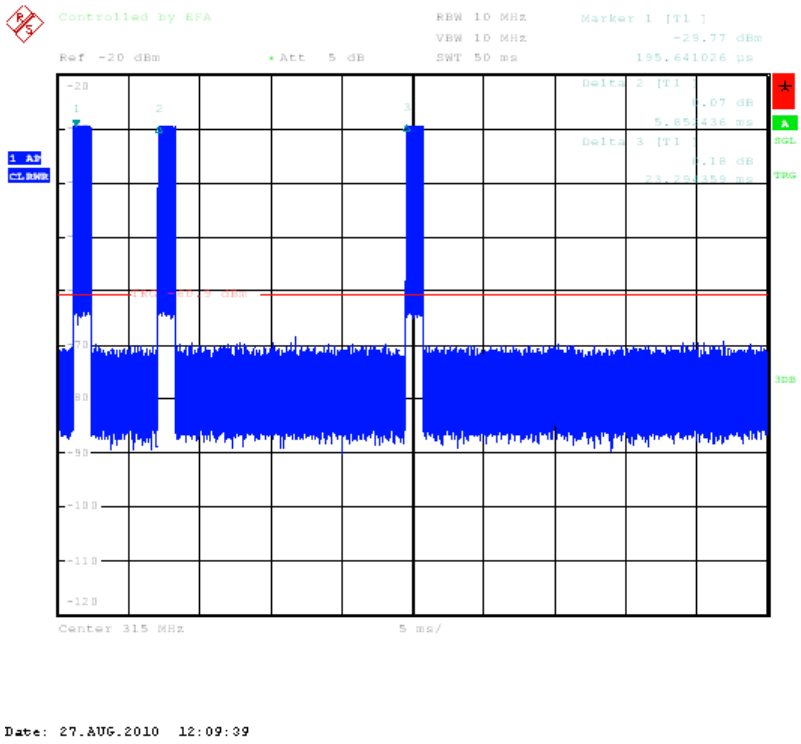


**Figure 6-20: Transmit Duration**

**The transmit duration was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.**

# 7 Test Data

## 7.1 Part List of the Test Equipment

| No. | Test Equipment | Type (Manufacturer) | Identification No. | Calibration date | Calibration due | Test No. |
|---|---|---|---|---|---|---|
| 1 | EMI receiver | ESPI-3 | P1325 | 03/2009 | 03/2011 | 3-5 |
| 2 | Controller | CO 2000 | P1304 | cnn | cnn | 3-5 |
| 3 | Antenna | 95010-1 | P0065 | 07/2009 | 07/2011 | 4 |
| 4 | Mast | MA 4000 | P1303 | cnn | cnn | 3, 5 |
| 5 | Antenna | CBL6111 | P0311 | 04/2010 | 04/2011 | 3, 5 |
| 6 | Test Chamber 2 | - | P0337 | 02/2010 | 02/2011 | 6 |
| 7 | EMI receiver | ESU40 | P1327 | 07/2009 | 07/2011 | 6 |
| 8 | Controller | CO 2000 | P1284 | cnn | cnn | 6 |
| 9 | Mast | MA 4000 | P1283 | cnn | cnn | 6 |
| 10 | Antenna | 3115 | P0961 | 04/2010 | 04/2012 | 6 |

**Table 7-1: Part List of the EMC Measurement Test Equipment**

| No. | Test Equipment | Type (Manufacturer) | Identification No. | Calibration date | Calibration due | Test No. |
|---|---|---|---|---|---|---|
| 1 | Spectrum Analyzer | FSU26 (R&S) | P1523 | 11/2009 | 11/2011 | 2, 7, 8 |
| 2 | Network Analyzer | ZVM (R&S) | F0092 | 10/2009 | 10/2011 | 2, 7, 8 |
| 3 | Frequency Standard | Rubisource (Datum) | F0076 | 11/2009 | 05/2011 | 2, 7, 8 |

**Table 7-2: Part List of the RF Measurement Test Equipment**