DAT-P-002/91-02

Center for Quality Engineering

Test Report No.: D12L0001

FCC ID: SZV-STM300C
IC: 5713A-STM300C

Order No.: D12L	**Pages:** 26	**Munich,** Aug 31, 2010

Client:	EnOcean GmbH
Equipment Under Test:	Transmitter Module STM300C/TCM300C + Helix Antenna
Manufacturer:	EnOcean GmbH
Task:	Conformance test according to the test specifications mentioned below
Test Specification(s):	FCC 47 CFR Part 15 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.

approved by:	**Date**	**Signature**
Neuhäusler Lab Manager Wireless & Software	Aug 31, 2010	
Gabel Qualification Engineer	Aug 31, 2010	

This document was signed electronically.

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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	11	n/p
2	Field strength correction for pulse operation (Duty Cycle)	[1] § 15.35(c)	11	-
3	Field strength of the fundamental wave	[1] § 15.231(b) [3] Annex 1.1.2, Table 4	14	compliant
4	Radiated Emissions (9kHz – 30MHz)	[1] § 15.209 [3] Table 1 and 3	16	compliant
5	Radiated Emissions (30MHz – 1GHz)	[1] § 15.205, 15.209 15.231(b) [3] Table 1 and 2	19	compliant
6	Radiated Emissions (1GHz – 4GHz)	[1] § 15.205, 15.209 15.231(b) [3] Table 1 and 2	22	compliant
7	Emission Bandwidth	[1] § 15.231(c) [3] Annex 1.1.3	25	n/p
8	Transmit Duration	[1] § 15.231(a) [3] Annex 1.1.1	25	n/p

Table 1-1: Results – Summary

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2 References

2.1 Specifications

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

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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 Heller

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.:	1, 7, 8	2	3, 4, 5, 6
Start of Test:	n/p	Aug 12, 2010	Aug 12, 2010
End of Test:		Aug 12, 2010	Aug 12, 2010

3.4 Participants

Name	Function
Michael Sperling	Accredited Testing, Editor
Katarzyna Jagiello	Accredited Testing

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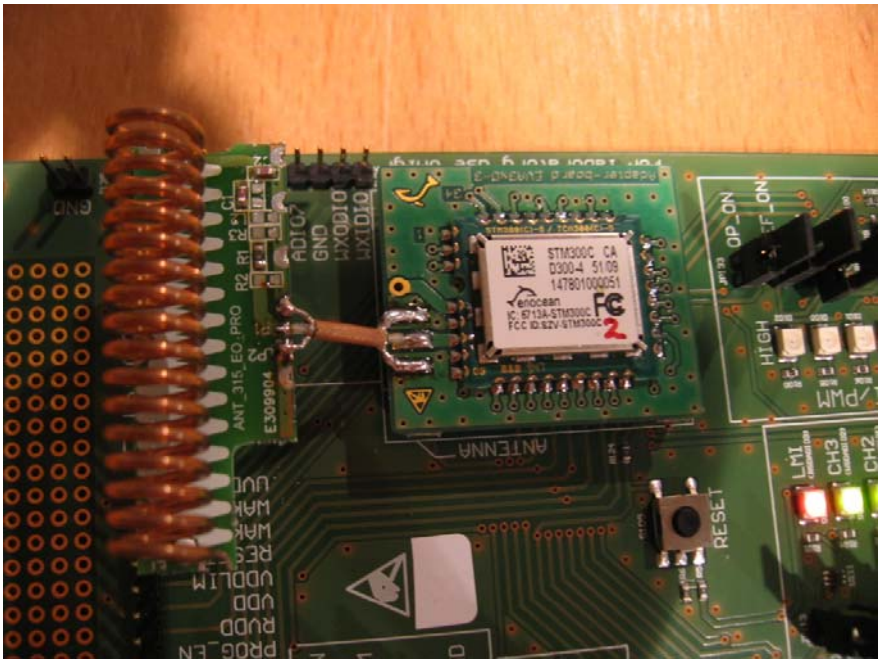
4 Equipment Under Test

The tested equipment is representative for serial production.

4.1 Description of EUT

The tested Transmitter-Module (extended by a helix antenna module) transmits control data by using ASK modulation through its 315MHz carrier signal.



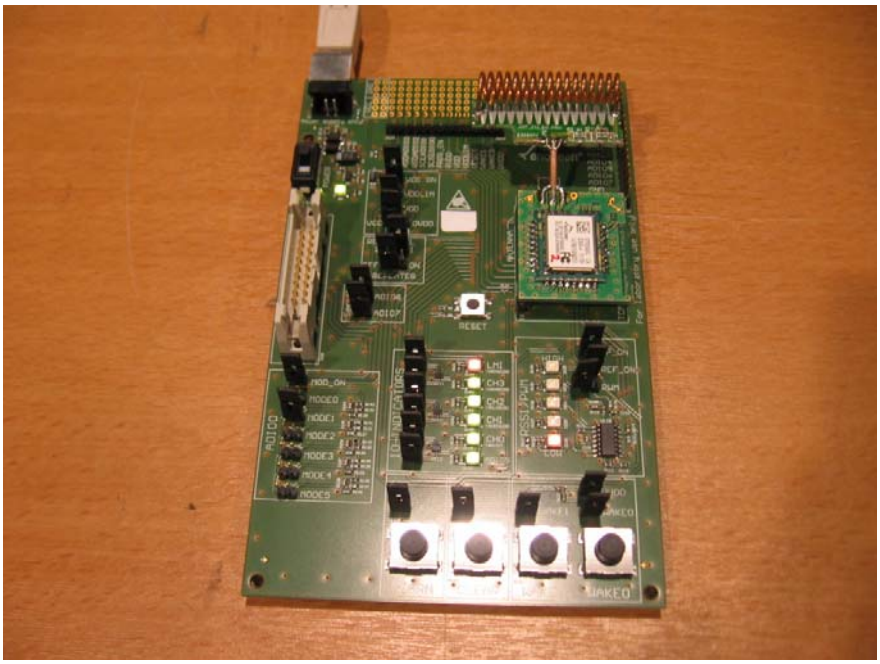


Figure 4-1: Photo of EUT (Transmitter Modul and Helix Antenna)

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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		373KA1D
Antenna	**Type**		Helix Antenna
	Number of Antenna Ports		1
	Gain		n/a
Power Src.	**Type**		Electro-dynamic DC supply system/Battery[1]
	Battery type (if applicable)		Li Mn (CR2032)[1]
	Voltage	**nominal**	3V
		minimal	3V
		maximum:	6V

1) During the tests the electro-dynamic DC supply 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 EUT configuration is shown by the following table.

Module Name	Serial-No.	Module Type	Config.
Transmitter Module STM300C[1] + Helix Antenna ANT_315_EO_PRO	none	Transmitter-Module	A

1) Except of 4 none RF relevant IO pins TCM300C and STM300C are functionally identical.

Table 4-2: Configuration of EUT

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

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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 250ms.

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.

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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.

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6 Test Results

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

Not performed.

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

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6.2.5 Test Procedure and Results

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

$$CF = 20 \log \frac{t_p}{100ms}$$

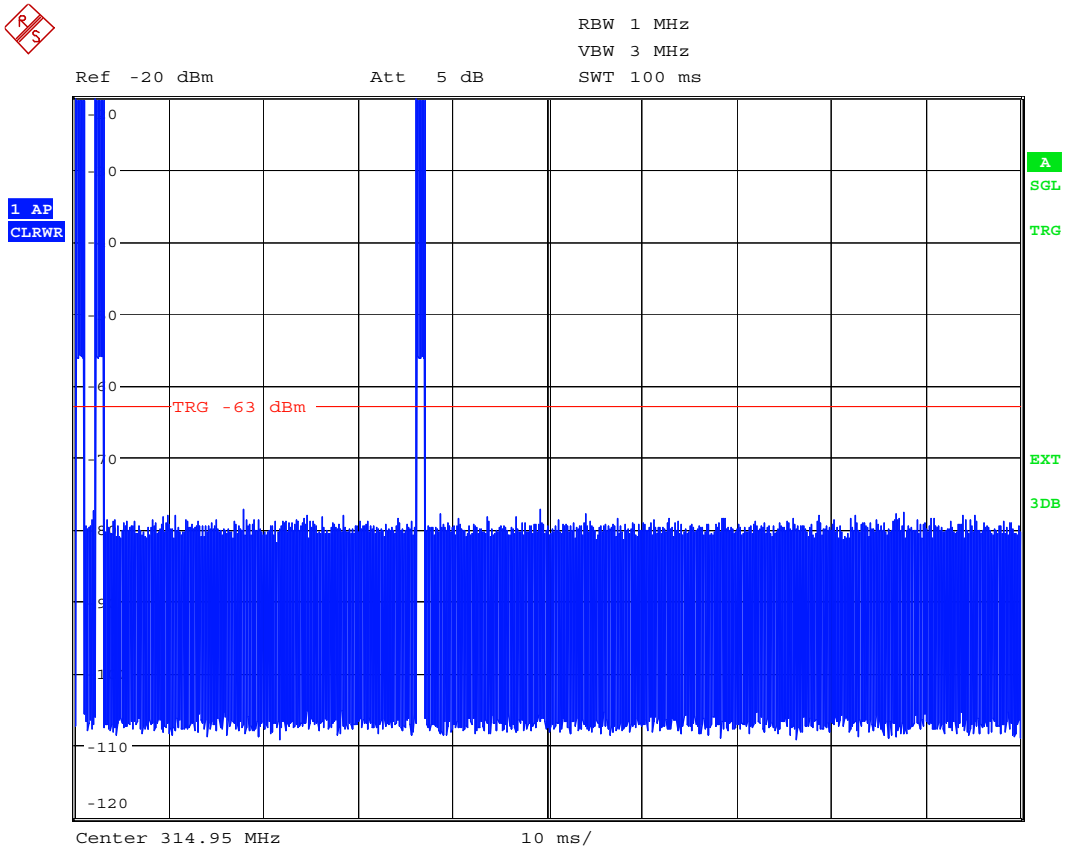
With:
CF: Duty cycle correction factor
t_p: Puls duration

t_p [ms]	t_t [ms]	*CF* [dB] calculated	*CF* [dB] used (≥-20dB)
3 x 0.994	100	-30.5	-20.0

Table 6-1: Results – Duty Cycle

6.2.6 Test Protocol

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



Transient Power x -10Ch

Date: 12.AUG.2010 13:18:51

Figure 6-2: Duty Cycle (100ms with complete Pulse Train)

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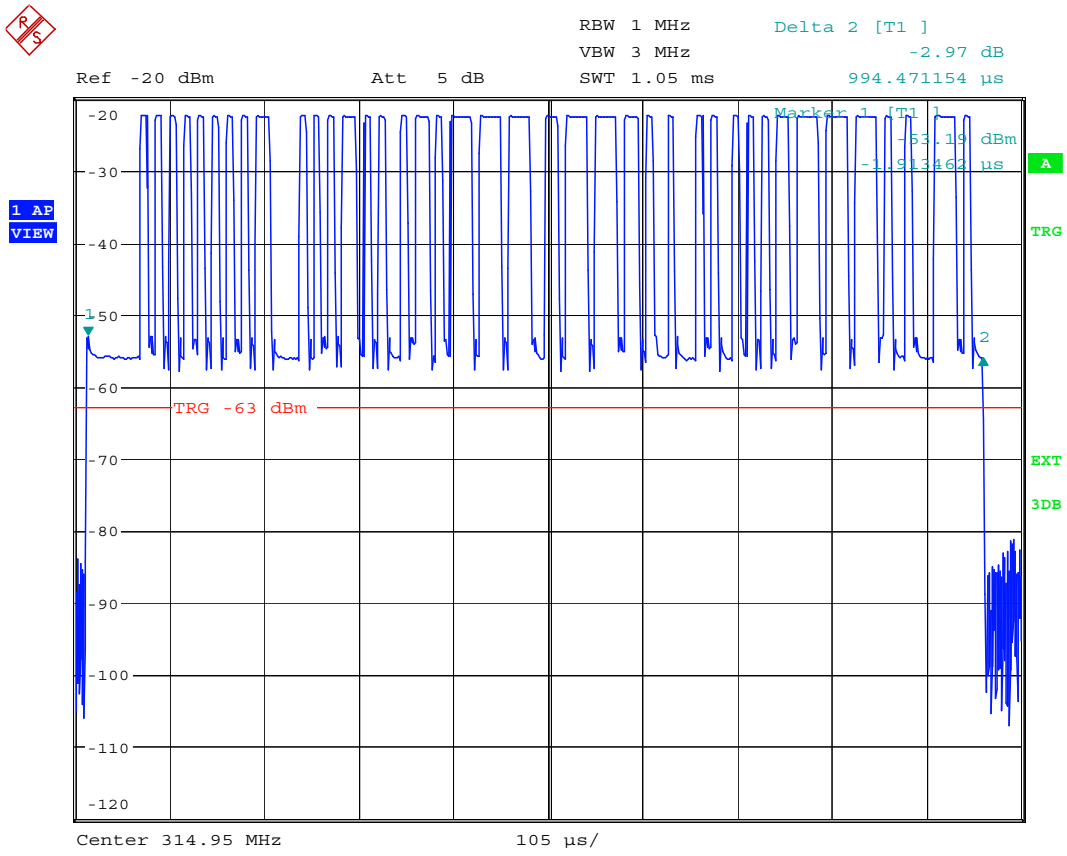

Figure 6-3: Duty Cycle (Pulse details)

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

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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

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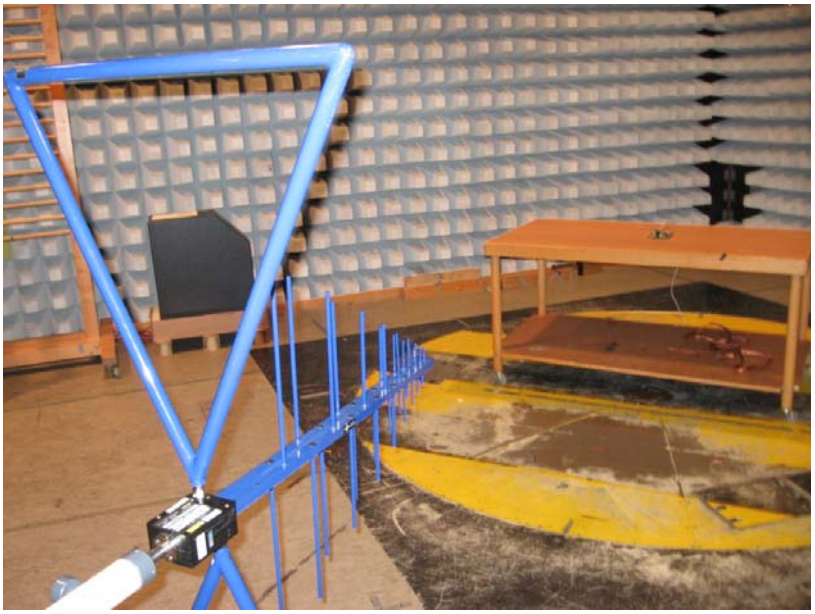

Figure 6-4: Test Configuration – Field Strength of Fundamental Wave

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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]	Corr. [dB]	Margin [dB]	Limit [dBµV/m]
315.000000	54.0	1000.0	1000.0	H	113.0	15.2	21.6	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.

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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

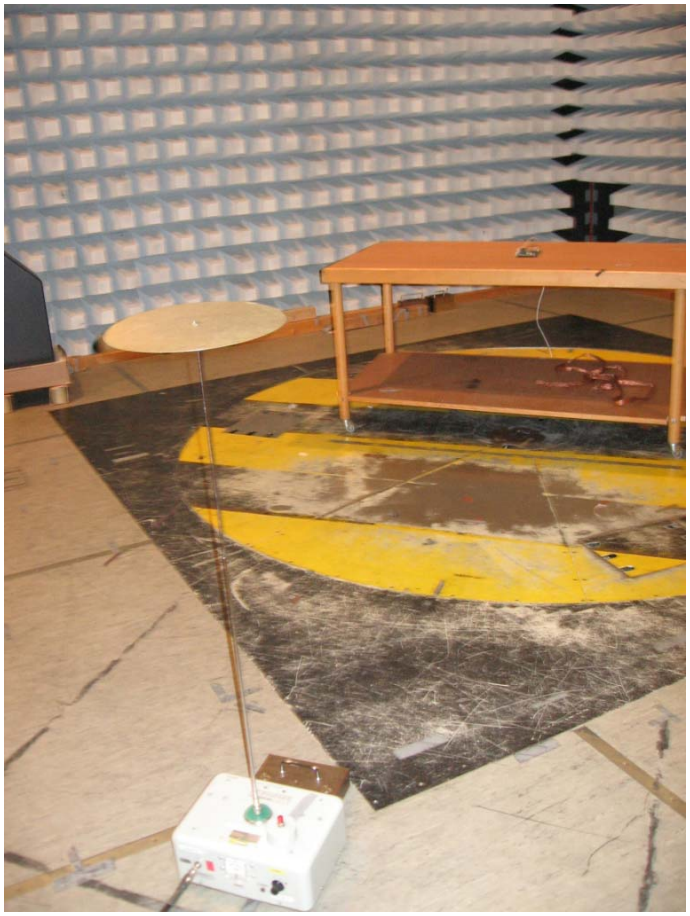

Figure 6-5: Test Configuration – Radiated Emissions (9kHz – 30MHz)

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.

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6.4.6 Test Protocol

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

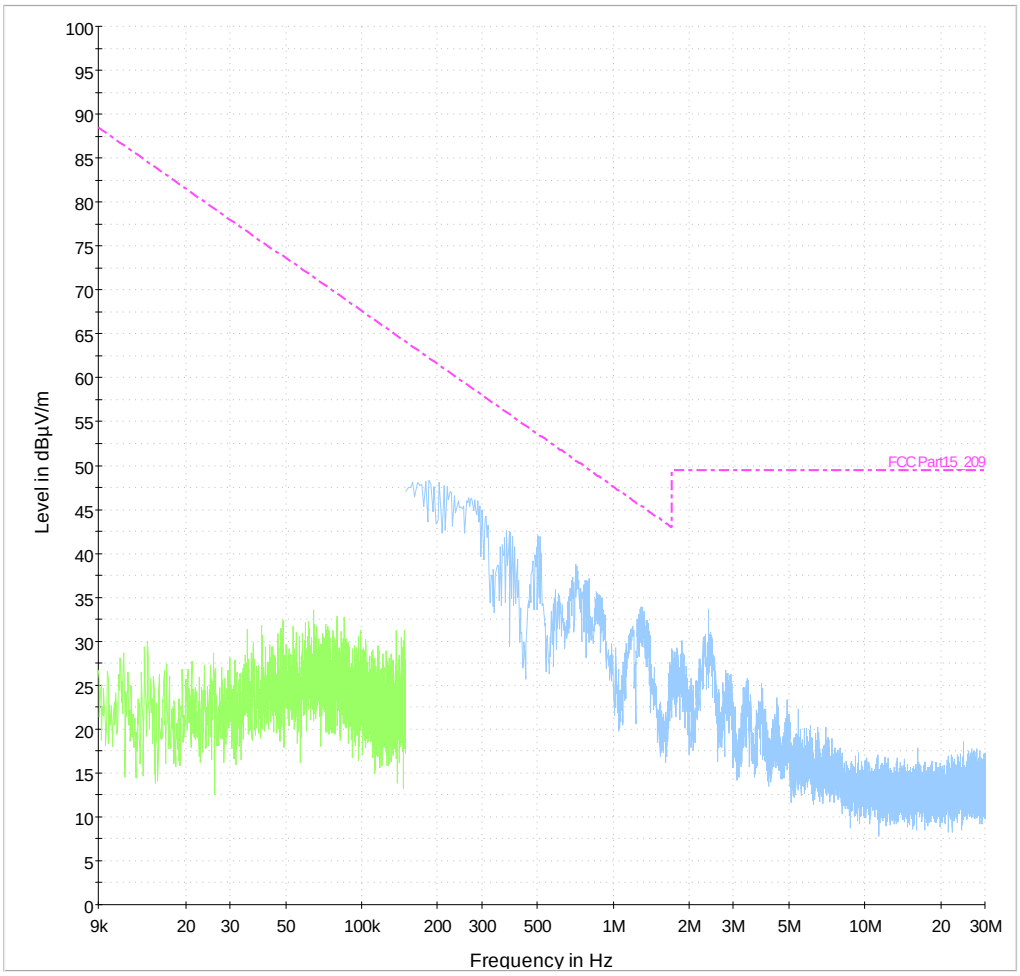

Figure 6-6: Radiated Emissions (9kHz – 30MHz)

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

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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 6-6: 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 6-7: 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 6-8: Restricted Bands (30MHz – 1GHz)

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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

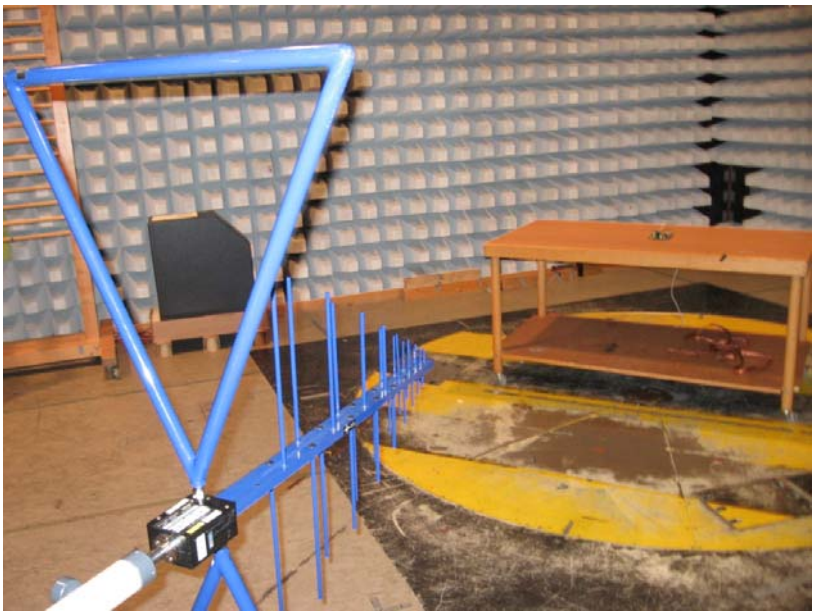

Figure 6-7: Test Configuration – Radiated Emissions (30MHz – 1GHz)

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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]	Corr. [dB]	Margin [dB]	Limit [dBµV/m]
315.000000	54.0	1000.0	150.0	H	113.0	15.2	-	Carrier
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 6-9: Results – Radiated Emissions (30MHz – 1GHz)

6.5.6 Test Protocol

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

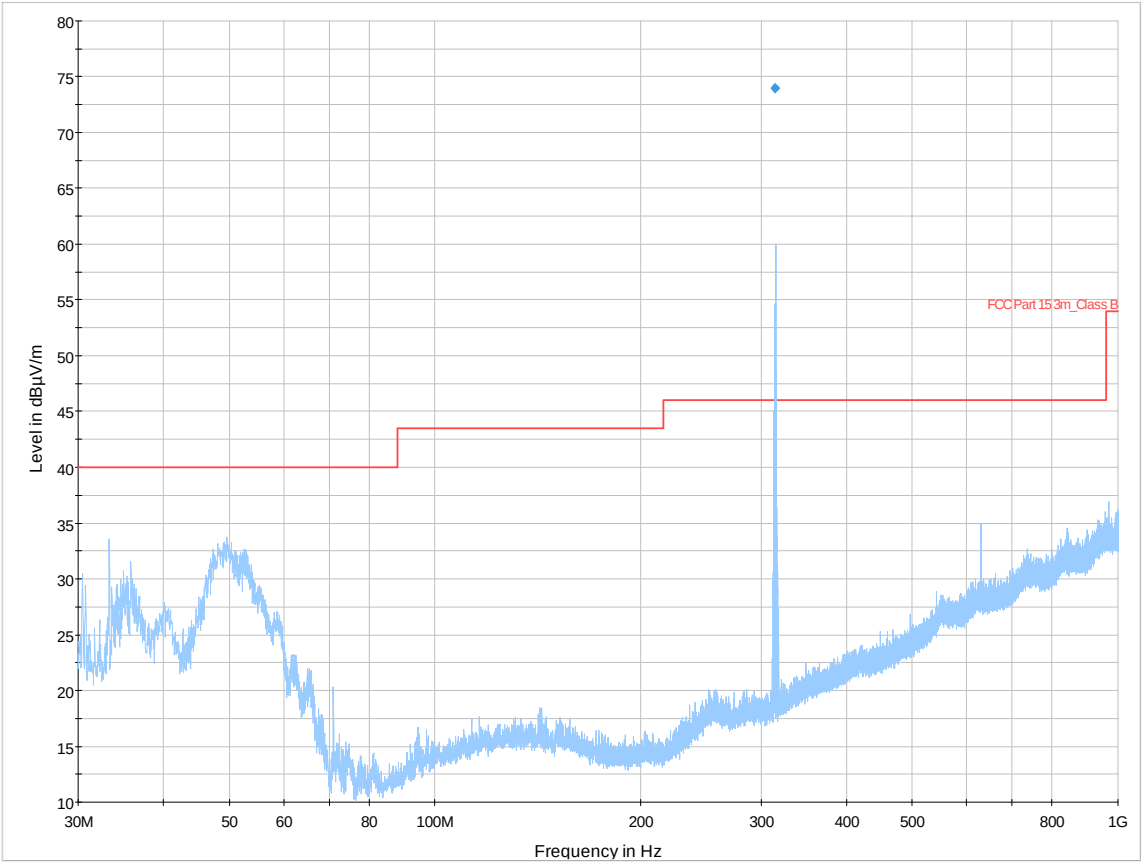

Figure 6-8: Radiated Emissions (30MHz – 1GHz)

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

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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 6-10: 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 6-11: 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 6-12: Restricted Bands (1GHz – 4GHz)

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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

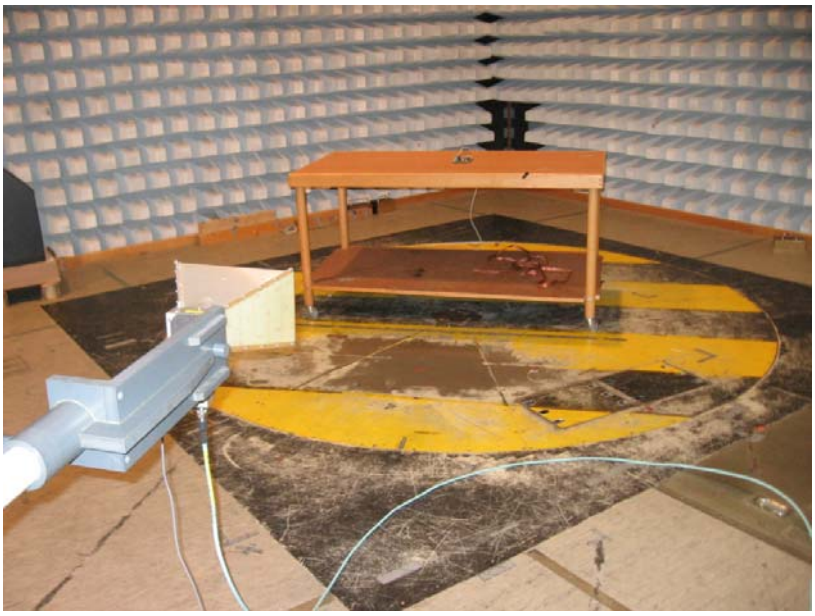

Figure 6-9: Test Configuration – Radiated Emissions (1GHz – 4GHz)

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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.

6.6.6 Test Protocol

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

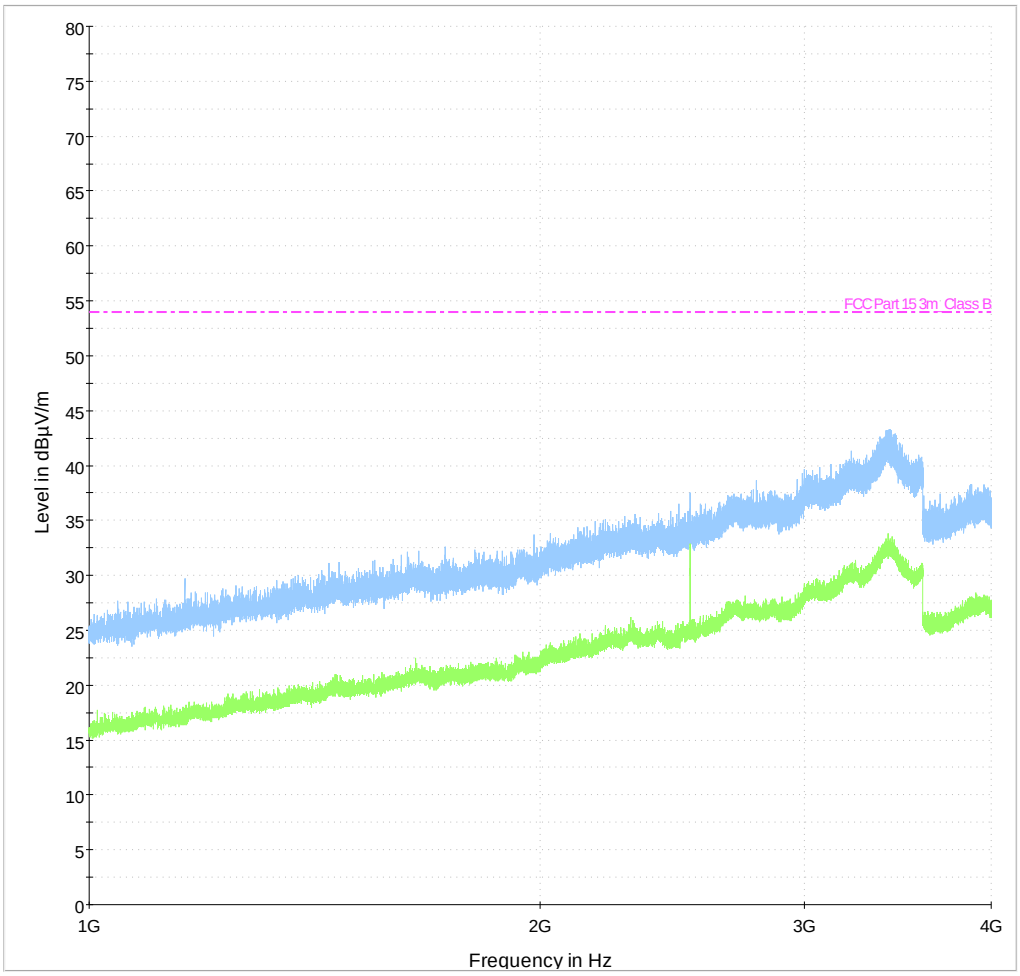

Figure 6-10: Radiated Emissions (1GHz – 4GHz)

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

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

Not performed

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

Not performed

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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	ESU26 R&S	P1326	07/2009	07/2011	4,5,6
2	Test Chamber 2	-	P0337	02/2010	02/2011	4,5,6
3	Antenna (MZ2)	3115 Emco	P0961	04/2010	04/2012	6
4	Preamplifier (MZ2)	AFS4-00101800-35-S-4-L Miteq	P1193	12/2009	12/2010	6
5	Antenna	CBL6111 Chase	P0018	03/2010	03/2011	5
6	Antenna	95010-1	P0065	07/2009	07/2011	4

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	Signal Analyzer	FSG 13 (R&S)	F0995	04/2009	11/2010	2
2	Frequency Standard	Rubisource (Datum)	F0076	11/2009	05/2011	2

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

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