InterLab

FCC Measurement/Technical Report on

C2GWSU13

RFID reader 13.56 MHz

Report Reference: MDE_FAKT_1214_FCCc

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0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an intentional radiator operating at 13.560 MHz

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-11 Edition) and 15 (10-1-11 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.215 Additional provisions to the general radiated emission limitations

§ 15.225 Operation within the band 13.110-14.010 MHz

Note:
Instead of applying ANSI C63.4–2003 which is referenced in the FCC Public Note, the newer ANSI C63.4–2009 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

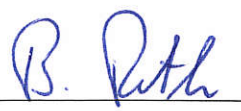
0.2 Measurement Summary

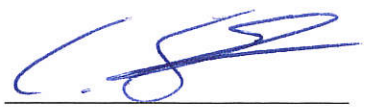
FCC Part 15, Subpart C	**§15.209**		
Radiated Emissions			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.215**		
Occupied Bandwidth			
The measurement was performed according to FCC § 2.1049			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.225**		
Spectrum Mask			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.225**		
Frequency Tolerance			
The measurement was performed according to FCC § 2.1055			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

Responsible for Accreditation Scope: 

Responsible for Test Report: 

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers AG
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2012-03-14

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Carsten Steinröder
Date of Test(s):	2012-11-21 to 2013-02-27
Date of Report:	2013-04-16

1.3 Applicant Data

Company Name:	FAKT S.r.l.
Address:	Via Lithos, 53 25086 Rezzato (BS) Italy
Contact Person:	Mr. Nicola Scartapacchio

1.4 Manufacturer Data

Company Name:	Magneti Marelli
Address:	V.le A. Borletti, 61/63 20011 Corbetta (MI) Italy
Contact Person:	please see the applicant data

2 Test object Data

2.1 General EUT Description

Equipment under Test	RFID card reader
Type Designation:	C2GWSU13
Kind of Device:	13.56 MHz card reader
Voltage Type:	DC (from vehicle power supply)
Voltage level:	12 V ± 3 V

General product description:

The EUT is a 13.56 MHz contactless RFID reader, part of the Signal Acquisition and Control Module Car2Go. The system consists of two main hardware units, the windshield (WSU) and the head unit (HU). Both components are connected via power, control and RF connectors. The power supply for both units is provided by the HU.
Both 13.56 MHz transmitters are located in the WSU, their antennas in the HU.

Specific product description for the EUT:

On the Head Unit a special software was installed which allows to activate the different transmitters. After activating the wanted transmitter the Head Unit was switched off, because it's active components are not part of the RFID System.

The EUT provides the following ports:

Ports
Enclosure
HF port to HU
Power and control connector

The main components of the EUT are listed and described in Chapter 2.2.

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A (Code: DA212a01)	Windshield Unit	C2GWSU13	-	PRS2	-	-
Remark: EUT A is equipped with a passive 125 kHz integral antenna.						
EUT B Code: DA210a01	Head Unit	Car2Go (HU)	HPV00LJC	PRS4	-	-
Remark: EUT B is equipped with two passive 13.56 MHz integral antennas						

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
-	-	-	-	-	-	-

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
-	-	-	-	-	-	-

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description
Setup_01	EUT A + EUT B	setup for testing radiated emissions

2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
op-mode 1	unmodulated carrier signal	EUT A is transmitting CW signal on transmitter 1 at 13.56 MHz
op-mode 2	unmodulated carrier signal	EUT A is transmitting CW signal on transmitter 2 at 13.56 MHz
op-mode 3	unmodulated carrier signal	EUT A is transmitting CW signal on transmitter 1 + 2 at 13.56 MHz

2.7 Product labelling

2.7.1 FCC ID label

Please refer to the documentation of the applicant.

2.7.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.4

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4-2009 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.
Step 1: pre-measurement
- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 200 Hz – 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan

Preliminary test are done to identify the highest amplitudes relative to the limit.
Settings for step 1:

- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180° to 180°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by +/– 22.5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by +/– 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –22.5° to +22.5° around the determined value
- Height variation range: –0.25 m to +0.25 m around the determined value

Step 4: final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated, which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.4 m height in the fully-equipped anechoic chamber. The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18-25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.
EMI receiver settings:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit(dBµV/m @10m)
0.009 – 0.49	2400/F(kHz)	300	Limit (dBµV/m)+59.1 dB
0.49 – 1.705	24000/F(kHz)	30	Limit (dBµV/m)+19.1 dB
1.705 – 30	30	30	Limit (dBµV/m)+19.1 dB

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b)
..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

3.1.3 Test Protocol

Temperature: 24 °C
Air Pressure: 1012 hPa
Humidity: 36 %

3.1.3.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Antenna Position	Frequency kHz	Measured value dBµV/m			Limit dBµV/m			Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP
90°	715.0	–	33.3	–	–	49.8	–	16.5
90°	1240.0	–	35.7	–	–	45.1	–	9.4
90°	1400.0	–	38.4	–	–	43.8	–	5.4
90°	1450.0	–	37.2	–	–	43.2	–	6.0
90°	1500.0	–	35.5	–	–	43.2	–	7.7
90°	1780.0	–	41.3	–	–	48.6	–	7.3
90°	1820.0	–	43.5	–	–	48.6	–	6.2
90°	1860.0	–	44.3	–	–	48.6	–	4.3
90°	1900.0	–	46.1	–	–	48.6	–	2.5
90°	2020.5	–	46.2	–	–	48.6	–	2.4
90°	2065.0	–	44.8	–	–	48.6	–	3.8
90°	2150.0	–	43.3	–	–	48.6	–	5.3

Remark: No further spurious emissions in the range 20 dB below the limit found. Step 2 was not performed because all found emission where below the applicable limit.

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Antenna Position	Frequency kHz	Measured value dBµV/m			Limit dBµV/m			Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP
90°	720.0	–	40.7	–	–	49.8	–	9.1
90°	1010.0	–	31.6	–	–	49.8	–	18.2
90°	1210.0	–	32.2	–	–	45.1	–	12.9
90°	1310.0	–	33.3	–	–	44.4	–	11.1
90°	1415.5	–	35.4	–	–	43.8	–	8.4
90°	1515.0	–	35.2	–	–	43.2	–	8.0
90°	1800.0	–	36.9	–	–	48.6	–	11.7
90°	1810.0	–	36.6	–	–	48.6	–	12.0
90°	1850.0	–	37.4	–	–	48.6	–	11.2
90°	1915.0	–	37.1	–	–	48.6	–	11.5
90°	2060.0	–	35.2	–	–	48.6	–	13.4
90°	2105.0	–	35.0	–	–	48.6	–	13.6

Remark: No further spurious emissions in the range 20 dB below the limit found. Step 2 was not performed because all found emission where below the applicable limit.

3.1.3.2 Measurement above 30 MHz

Op. Mode	Setup	Port
op-mode 3	Setup_01	Enclosure

Polari-sation	Frequency MHz	Measured value dBµV/m			Limit dBµV/m			Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP
Vertical	40.68	–	25.1	–	–	40.0	–	14.9
Vertical	54.24	–	11.2	–	–	40.0	–	28.8
Vertical	67.8	–	35.0	–	–	43.0	–	8.0
Vertical	94.90	–	25.2	–	–	43.0	–	17.8
Vertical	108.48	–	31.1	–	–	43.0	–	11.9
Vertical	122.04	–	8.5	–	–	43.0	–	34.5
Vertical	135.60	–	36.8	–	–	43.0	–	6.2
Vertical	162.72	–	37.3	–	–	43.0	–	5.7
Vertical	189.84	–	21.3	–	–	43.0	–	21.7
Vertical	488.16	–	44.6	–	–	46.0	–	1.4
Vertical	515.28	–	22.6	–	–	46.0	–	23.4
Vertical	542.4	–	45.9	–	–	46.0	–	0.1
Vertical	569.52	–	43.6	–	–	46.0	–	2.4
Vertical	886.86	–	22.6	–	–	46.0	–	23.4
Vertical	889.62	–	22.5	–	–	46.0	–	23.5

Remark: No further spurious emissions in the range 20 dB below the limit found.

3.1.4 Test result: Spurious radiated emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed
	op-mode 2	passed
	op-mode 3	passed

3.2 Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.215

3.2.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produces the worst-case (widest) occupied bandwidth.

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.215 (c)
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. …

3.2.3 Test Protocol

Temperature: 22° C
Air Pressure: 1000 hPa
Humidity: 35 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

20 dB bandwidth Hz	99% bandwidth Hz	Remarks
25.84	21.84	The 20 dB bandwidth from 13.559856 MHz to 13.559883 MHz is contained within the designated frequency band 13.110 MHz to 14.010 MHz.

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

20 dB bandwidth Hz	99% bandwidth Hz	Remarks
26.052	21.84	The 20 dB bandwidth from 13.559899 MHz to 13.559925 MHz is contained within the designated frequency band 13.110 MHz to 14.010 MHz.

Remark: Please see annex for the measurement plots.

3.2.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed
	op-mode 2	passed

3.3 Spectrum mask

Standard FCC Part 15, Edition Subpart C

The test was performed according to: FCC §15.225

3.3.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4.
The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S.
The Loop antenna HFH2-Z2 is used.

- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time: 100 ms

3.3.2 Test Limits

FCC Part 15, Subpart C, §15.225 (a-d), and §15.209, corrected by the means of the extrapolation of §15.31 due to the reduced measuring distance from 30 m to 10 m.

3.3.3 Test Protocol

Temperature: 24 °C
Air Pressure: 1004 hPa
Humidity: 32 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Maximum value dBµV/m	Limit dBµV/m	Remarks
35.0	103.1	measuring distance 10 m

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Maximum value dBµV/m	Limit dBµV/m	Remarks
45.0	103.1	measuring distance 10 m

3.3.4 Test result: Spectrum mask

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed
	op-mode 2	passed

3.4 Frequency tolerance

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.225

3.4.1 Test Description

The Equipment Under Test (EUT) is placed in a temperature chamber.
The frequency drift during temperature and voltage variation is measured by the means of a spectrum analyzer with frequency counter function.
The temperature was varied from –20 °C to +50 °C. At +20 °C the extreme power supply voltages of 85% and 115% are applied. After reaching each target temperature and waiting sufficient time allowing the temperature to stabilize, one measurement is performed immediately after powering on the EUT, and two further measurements are performed after 5 and 10 minutes continuous operation of EUT.

3.4.2 Test Limits

FCC Part 15, Subpart C, §15.225 (e): The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

3.4.3 Test Protocol

3.4.3.1 RFID Reader 1

Temperature: -20 to +50 °C
Air Pressure: 1009 hPa
Humidity: 34 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Temperature / °C	Voltage / V	Time / min.	Frequency / MHz	Delta / Hz
50	12.00	0	13.559753	-247
50	12.00	5	13.559721	-279
50	12.00	10	13.559682	-318
40	12.00	0	13.559812	-188
40	12.00	5	13.559777	-223
40	12.00	10	13.559762	-238
30	12.00	0	13.559903	-97
30	12.00	5	13.559859	-141
30	12.00	10	13.559840	-160
20	9.00	0	13.559951	-49
20	9.00	5	13.559938	-62
20	9.00	10	13.559934	-66
20	12.00	0	13.559953	-47
20	12.00	5	13.559938	-62
20	12.00	10	13.559937	-63
20	15.00	0	13.559950	-50
20	15.00	5	13.559939	-61
20	15.00	10	13.559932	-68
10	12.00	0	13.560086	86
10	12.00	5	13.560043	43
10	12.00	10	13.560024	24
0	12.00	0	13.560110	110
0	12.00	5	13.560093	93
0	12.00	10	13.560084	84
-10	12.00	0	13.560402	402
-10	12.00	5	13.560143	143
-10	12.00	10	13.560138	138
-20	12.00	0	13.560132	132
-20	12.00	5	13.560165	165
-20	12.00	10	13.560175	175

Remark: The limit is a delta of max. ±1356 Hz (0.01 %).

RFID Reader 2
Temperature: -20 to +50 °C
Air Pressure: 1009 hPa
Humidity: 34 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Temperature / °C	Voltage / V	Time / min.	Frequency / MHz	Delta / Hz
50	12.00	0	13.559820	-180
50	12.00	5	13.559808	-192
50	12.00	10	13.559805	-195
40	12.00	0	13.559888	-112
40	12.00	5	13.559829	-171
40	12.00	10	13.559823	-177
30	12.00	0	13.559966	-34
30	12.00	5	13.559873	-127
30	12.00	10	13.559864	-136
20	9.00	0	13.559964	-36
20	9.00	5	13.559911	-89
20	9.00	10	13.559907	-93
20	12.00	0	13.559981	-19
20	12.00	5	13.559911	-89
20	12.00	10	13.559905	-95
20	15.00	0	13.559947	-53
20	15.00	5	13.559912	-88
20	15.00	10	13.559905	-95
10	12.00	0	13.560096	96
10	12.00	5	13.560013	13
10	12.00	10	13.560037	37
0	12.00	0	13.560132	132
0	12.00	5	13.560112	112
0	12.00	10	13.560063	63
-10	12.00	0	13.560174	174
-10	12.00	5	13.560120	120
-10	12.00	10	13.560117	117
-20	12.00	0	13.560184	184
-20	12.00	5	13.560135	135
-20	12.00	10	13.560173	173

Remark: The limit is a delta of max. ±1356 Hz (0.01 %).

3.4.4 Test result: Frequency tolerance

3.4.4.1 RFID Reader 1

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed
	op-mode 2	passed

4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 3**
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m³

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Air compressor	none	-	Atlas Copco
Anechoic Chamber	10.58 x 6.38 x 6.00 m³ FCC listing 96716 3m Part15/18 IC listing 3699A-1 3m	none	Frankonia 2011/01/11 2014/01/10 2011/02/07 2014/02/06
Controller Maturo	MCU	961208	Maturo GmbH
EMC camera	CE-CAM/1	-	CE-SYS
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita

Test Equipment Auxiliary Equipment for Conducted emissions

Lab ID:	**Lab 1**
Manufacturer:	Rohde & Schwarz GmbH & Co.KG
Description:	EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
Cable "LISN to ESI"	RG214 Path Calibration	W18.03+W48.03	Huber&Suhner 2011/11/11 2012/11/10
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG
	DKD calibration		2011/01/20 2013/01/19

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Antenna mast	AS 620 P	620/37	HD GmbH	
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2008/10/27	2013/10/26
	Standard Calibration		2012/01/18	2015/01/17
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
	Path Calibration		2012/05/24	2012/11/23
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
	Path Calibration		2012/05/24	2012/11/23
	Path Calibration		2012/05/24	2012/11/23
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/05/18	2015/05/17
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/06/26	2015/06/25
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
	Path Calibration		2012/05/24	2012/11/23
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
	Path Calibration		2012/05/24	2012/11/23
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic	
	Path Calibration		2012/05/24	2012/11/23
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
	Path Calibration		2012/05/24	2012/11/23
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170			
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/10/27	2014/10/26
Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH	
Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH	

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.510kg /024/3790709	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 3, Lab 4**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
	Customized calibration		2011/10/19 2013/10/18
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID:	**Lab 1, Lab 3, Lab 4**
Description:	Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/24	2014/11/23
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial factory calibration		2012/01/26	2014/01/25
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/05/26	2013/05/25
	HW/SW Status		*Date of Start*	*Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/12/07	2014/12/06
	HW/SW Status		*Date of Start*	*Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02	
	SW: K62, K69		2008/11/03	

Test Equipment Emission measurement devices

Lab ID:	**Lab 1, Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Personal Computer	Dell	30304832059	Dell	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/22	2013/05/21
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/21	2013/05/20
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	standard calibration		2011/05/12	2014/05/11
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2011/12/05	2013/12/04
	HW/SW Status		*Date of Start*	*Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03	

Test Equipment Radio Lab Test Equipment

Lab ID: **Lab 4**
Description: Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates	
Coax Cable Huber&Suhner	Sucotest 2,0m		Rosenberger Micro-Coax	
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/22	2013/05/21
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG	
Rubidium Frequency Standard	Datum, Model: MFL	2689/001	Datum-Beverly	
	Standard calibration		2012/06/21	2013/06/20
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/21	2013/05/20
Signal Generator	SMY02	829309/018	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/04	2014/11/03
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2011/11/25	2014/11/24
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG	
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/02/10	2013/02/09
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11

Single Devices for Radio Lab Test Equipment (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Vector Signal Generator	SMIQ 03B	837747/020	Rohde & Schwarz GmbH & Co. KG

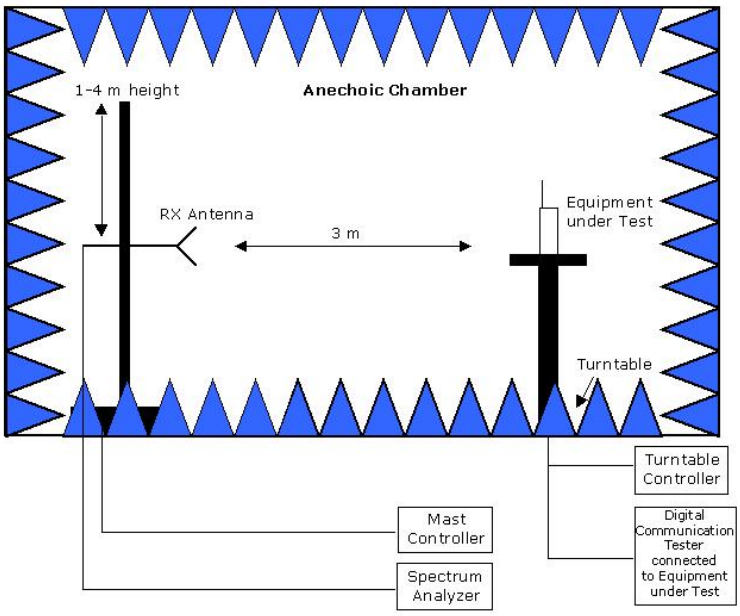
Test Equipment Shielded Room 02

Lab ID:	**Lab 1**
Manufacturer:	Frankonia
Description:	Shielded Room for conducted testing
Type:	12 qm
Serial Number:	none

5 Photo Report

Photos are included in an external report.

6 Setup Drawings



Drawing 1: Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces.

7 FCC and IC Correlation of measurement requirements

The following tables show the correlation of measurement requirements for RFID equipment and Digital Apparatus from FCC and IC standards.

RFID equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC mains	§ 15.207	RSS-Gen: 7.2.4
Spurious radiated emissions	§ 15.209	RSS-Gen: 6; RSS-210: A2.6
Occupied bandwidth	§ 15.215	RSS-Gen: 4.6
Spectrum Mask	§ 15.225	RSS-210: A2.6
Frequency Tolerance	§ 15.225	RSS-210: A2.6

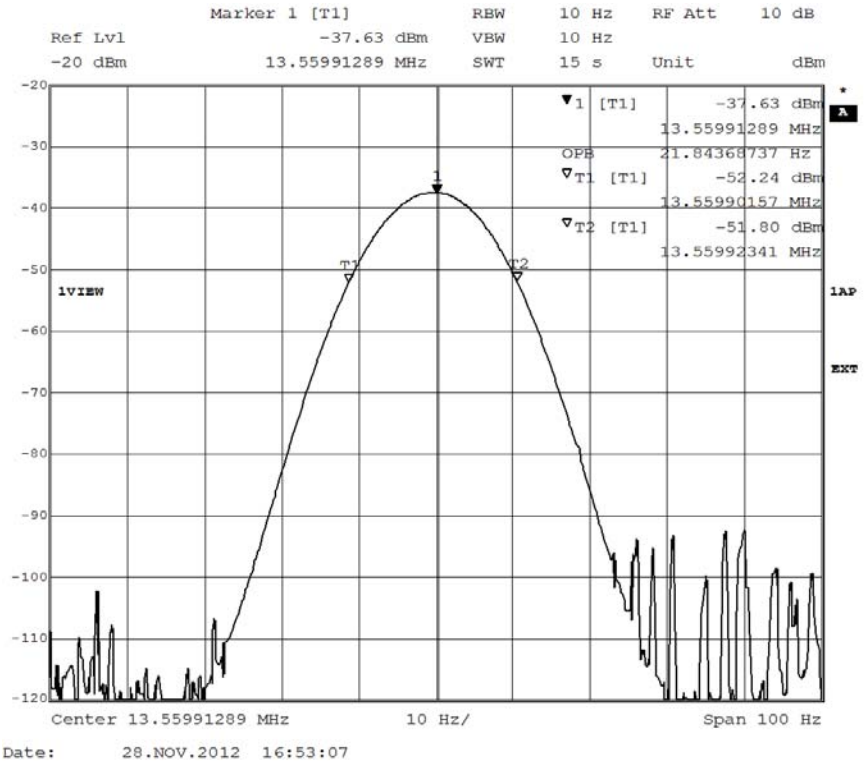
Digital Apparatus

Measurement	FCC reference	IC reference
Conducted Emissions (AC Power Line)	§ 15.107	ICES-003
Spurious Radiated Emissions	§ 15.109	ICES-003

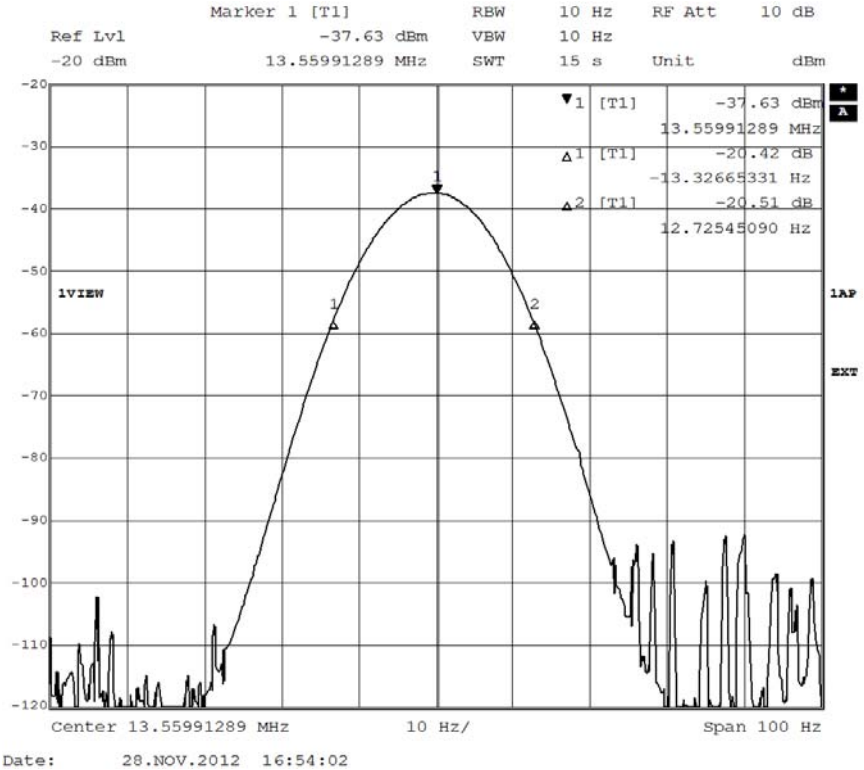
8 Annex measurement plots

8.1 Occupied bandwidth: Reader 1

8.1.1 99% bandwidth

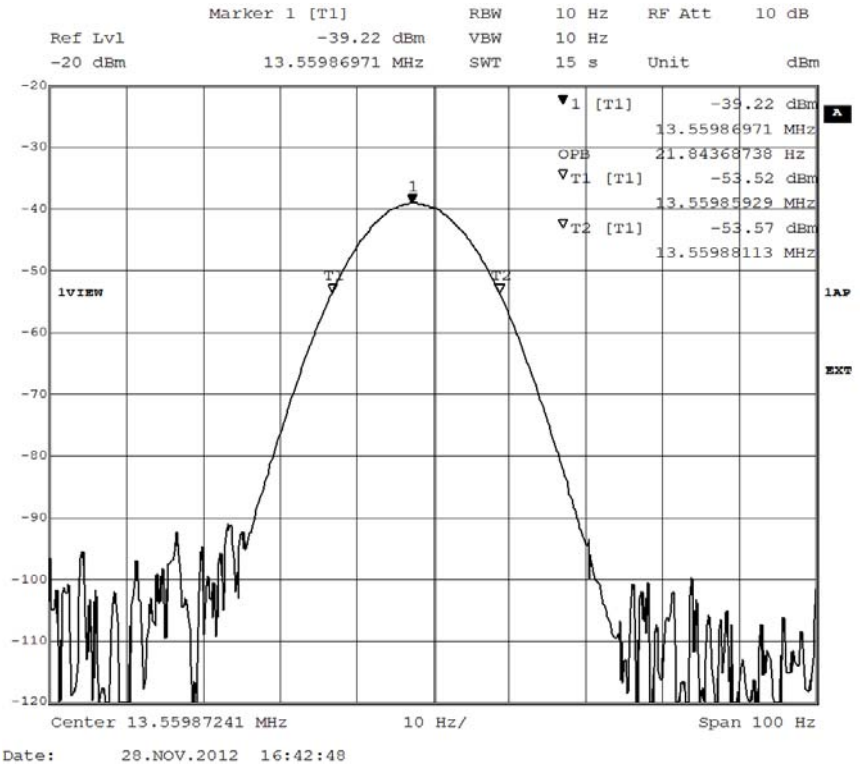


8.1.2 20 dB bandwidth



8.2 Occupied bandwidth: Reader 2

8.2.1 99% bandwidth



8.2.2 20 dB bandwidth