

Test Report

Customer:

Elatec GmbH

Lilienthalstraße 3

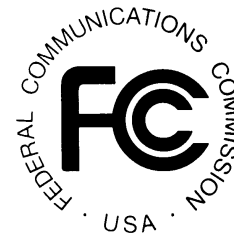
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RF test report

140528-AU01+W04



Industry Industrie
Canada Canada

Elatec GmbH

RFID / Card Reader

TWN4 SmartCard MIFARE NFC USB



The test result refers exclusively to the tested model.
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Revision: 1.0



Deutsche
Akkreditierungsstelle
D-PL-12155-01-01

EMV **TESTHAUS** GmbH

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Accreditation:



FCC facility registration number: 221458
Test Firm Type "2.948 listed": Valid until 2017-04-22
Test Firm Type "accredited": Valid until 2015-06-11
MRA US-EU, FCC designation number: DE0010
BnetzA-CAB-02/21-02/04 Valid until 2018-11-27

Industry Canada test site number: 3472A-1
Registration expiry date: 2015-10-02

Test Laboratory:

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1 Test regulations

47 CFR Part 2: 10-2013	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
47 CFR Part 15: 10-2013	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
ANSI C63.4: September 2009	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
ICES-003 Issue 5, August 2012	Spectrum Management and Telecommunications Interference-Causing Equipment Standard Information Technology Equipment (ITE) – Limits and methods of measurement
RSS-Gen Issue 4, November 2014	Spectrum Management and Telecommunications Radio Standards Specification General Requirements for Compliance of Radio Apparatus
RSS-102 Issue 4, March 2010, updated December 2010	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-210 Issue 8, December 2010	Spectrum Management and Telecommunications Radio Standards Specification Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

1.1 Summary of test results

Standard	Test result
47 CFR Part 15, sections 15.207 and 15.225	Passed
RSS-210 Issue 8 Annex A2.6 (with appropriate references to RSS-Gen Issue 4)	Passed



2 Equipment under Test (EUT)

Product type: RFID / Card Reader
Model Name: TWN4 SmartCard MIFARE NFC USB
Manufacturer: Elatec GmbH
Serial number: Engineering Sample
FCC ID: WP5TWN4F2
IC certification number: 7948A-TWN4F2
Application frequency band(s): 13.110 to 14.010 MHz
Frequency range: 13.560 MHz
Additional frequency ranges: 125 kHz, 134.2 kHz,
Operating frequencies: 125 kHz, 134.2 kHz, 13.560 MHz
Number of RF-channels: 1 at each frequency
Modulation: ASK
Antenna types: PCB antenna
 detachable not detachable

Power supply: External power source
nominal: 5.0 VDC

Temperature range: -20°C to +50°C

Remark:
The tests were performed with 120V AC / 60Hz.



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2.1 Photo documentation

For photos of the EUT see annexes B (external) and C (internal).
For photos taken during testing and the EUT-positions, see annex A.

2.2 Short description of the EUT

RFID card reader with a not detachable PCB antenna working at three different frequencies (125 kHz, 134.2 kHz and 13.56 MHz).

2.3 Operation mode

During the pre-tests it was observed that the “continuous-tag-searching-mode” is the respective worst- case. Therefore this mode was selected for final testing. The device was configured by manufacturer to activate the RFID reader for continuous transmission via RFID card.

The EUT was tested in the 3 orthogonal positions. This is documented in annex A.



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2.4 Configuration

The following peripheral devices and interface cables were connected during the tests:

Device	Model:	Serial or inventory number
RFID / Card Reader	TWN4 SmartCard MIFARE NFC USB	Engineering Sample
RFID tag (13.56 MHz)	MIFARE Classic 1K	w/o
RFID tag (125 kHz)	EM4200	w/o
RFID tag (134.2 kHz)	ISO FDK-B	w/o
Power Supply	Statron 3231.1	E00017
Multimeter	METRAHIT 29S	E00099
Notebook	MAXDATA	30403720019
Transceiver optoUSB 2.0	OptoUSB 2.0	121679
Transceiver optoUSB 2.0	OptoUSB 2.0	121680

2.5 Used cables

Numbers:	Description: (type / lengths / remarks)	Serial No
1	USB-USB / 1m	w/o
2	LWL / 2m	w/o
2	Laboratory cables with banana connector, 2.0m	w/o



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3 AC power line conducted emissions

according to 47 CFR Part 15, section 15.207, and
RSS-210, section 2.1 with RSS-Gen, section 8.8

3.1 Test location

Description	Manufacturer	Inventory No.
Shielded room	Siemens - Matsushita	E00107

3.2 Test instruments

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	ESCS 30	Rohde & Schwarz	E00003
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input type="checkbox"/>	ESCI	Rohde & Schwarz	E00001
<input type="checkbox"/>	ESH3-Z2	Rohde & Schwarz	E00028
<input checked="" type="checkbox"/>	ESH2-Z5	Rohde & Schwarz	E00004
<input type="checkbox"/>	ESH2-Z5	Rohde & Schwarz	E00005

3.3 Limits

Frequency [MHz]	Quasi-peak [dB μ V]	Average [dB μ V]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50



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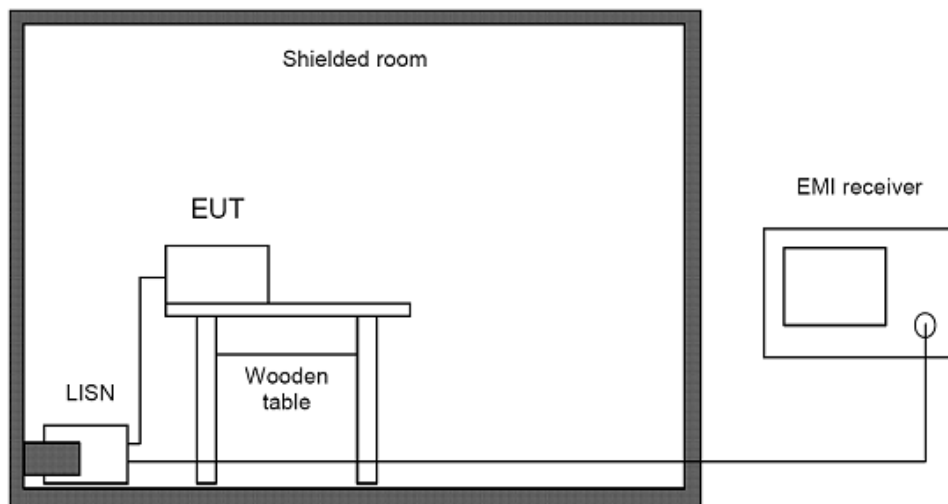
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3.4 Test procedure

1. The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50 μ H/50 Ohms and an EMI test receiver.
2. The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 0.15 MHz to 30 MHz.
3. The EUT was placed on a wooden table and connected to the LISN.
4. To accelerate the measurement the detector of the EMI test receiver was set to peak and the whole frequency range from 0.15 MHz to 30 MHz was scanned.
5. After that all peaks values with less margin than 10 dB to quasi-peak limit or exceeding the limit were marked and re-measured with quasi-peak detector.
6. If after that all values are under the average limit no addition measurement is necessary. In case there are still values between quasi-peak and average limit then these values were re-measured with average detector.
7. These measurements were done on all power lines.

According to ANSI C63.4, section 13.3.1 testing of intentional radiators with detachable antennas shall be done with a dummy load otherwise the tests should be done with connected antenna and if adjustable fully extended.

3.5 Test setup



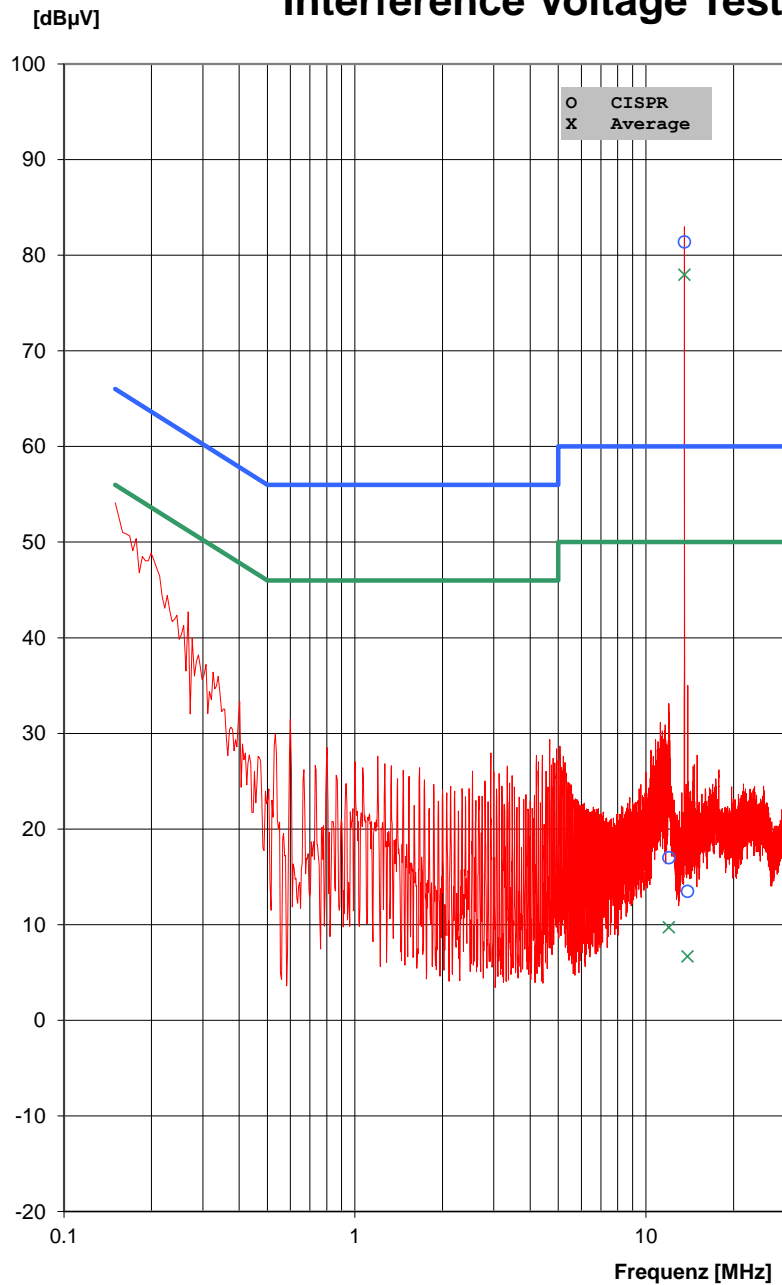
Picture 1: Outline of conducted emission test setup

Comments: All peripheral devices were additionally decoupled by means of a line stabilization network.

3.6 Test results

Temperature:	22°C	Humidity:	45%
Tested by:	Franz Achatz	Test date:	2014-10-07

Interference Voltage Test



REGULATIONS:
 47 CFR, 15.207
 PEAK / CISPR / AV

TEST EQUIPMENT:
 R&S ESCS30 (E00003)
 R&S ESH2-Z5 (E00004)

ORDER NO.:
 140528-AU01+W04

EUT:
 Elatec GmbH
 RFID / Card Reader
 TWN4 SmartCard Mifare NFC
 USB

OPERATION MODE:
 continuous tag reading

Mains 120V AC /60Hz
 Phase

TEST FACILITY:
 EMV TESTHAUS GmbH
 Gustav-Hertz-Straße 35
 94315 Straubing

DATE / TIME:
 2014-10-07 15:44:18
 22°C 45% 98kPa

TEST ENGINEER:
 Franz Achatz

140528-AU01+W04 SS L1 Tag reading.E10

Picture 2: Graphic - Conducted emission on mains, phase 1 (without termination)



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Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
12.00	17.0	60.0	43.0	9.7	50.0	40.3	0.0	140528-AU01+W04_SS.L1.Tag reading.E10
13.57	81.4	60.0	-21.4	78.0	50.0	-28.0	0.0	
13.91	13.5	60.0	46.5	6.7	50.0	43.3	0.0	

Picture 3: Table - Conducted emission on mains, phase 1 (without termination)



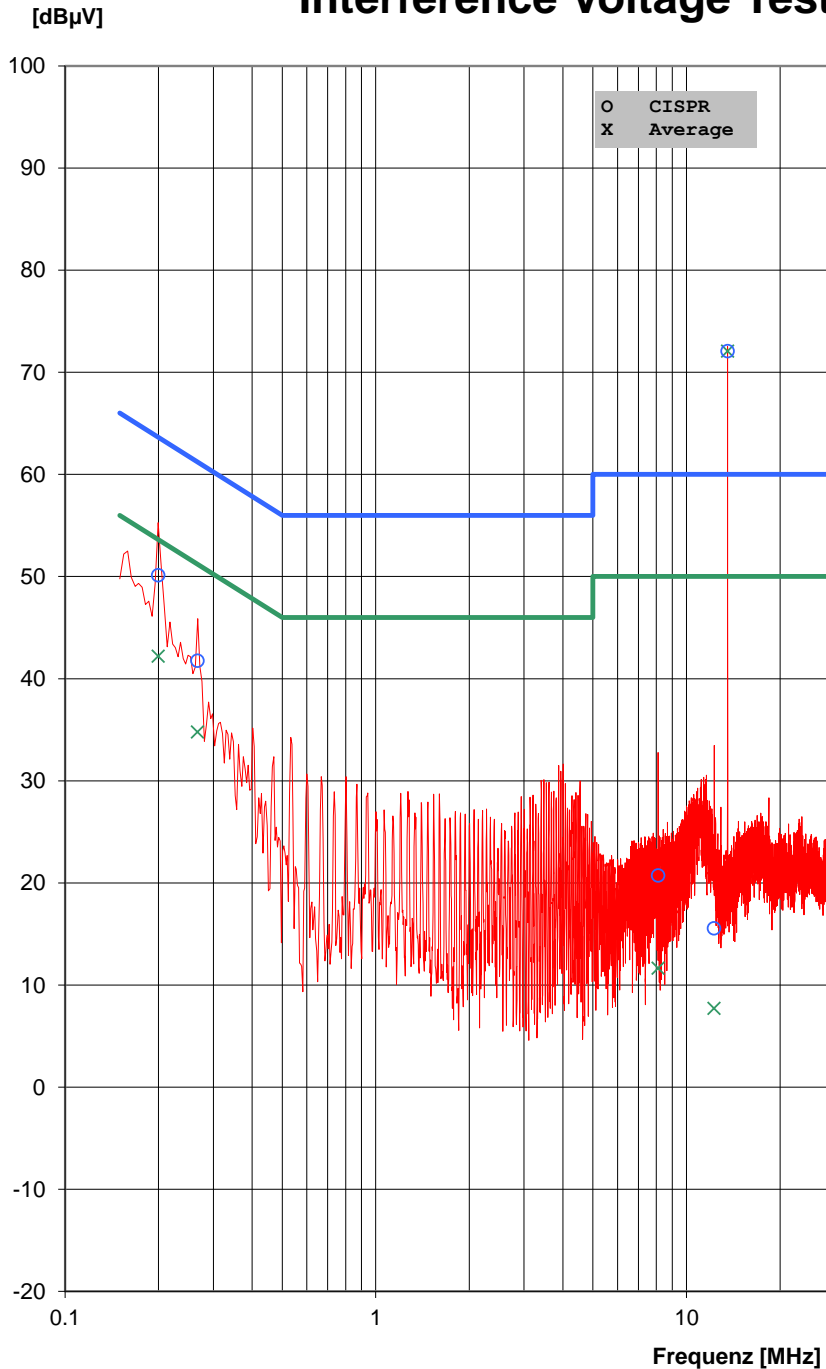
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Interference Voltage Test



REGULATIONS:
47 CFR, 15.207
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140528-AU01+W04

EUT:
Elatec GmbH
RFID / Card Reader
TWN4 SmartCard Mifare NFC
USB

OPERATION MODE:
continuous tag reading
continuous tag reading

Mains 120V AC /60Hz
Neutral

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-10-07 15:46:05
22°C 45% 98kPa

TEST ENGINEER:
Franz Achatz

140528-AU01+W04 SS N Tag reading.E10

Picture 4: Graphic - Conducted emission on mains, neutral (without termination)



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Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0.20	50.1	63.6	13.5	42.2	53.6	11.4	0.0	140528-AU01+W04_SS_N.Tag reading.E10
0.27	41.8	61.2	19.5	34.8	51.2	16.5	0.0	
8.12	20.7	60.0	39.3	11.6	50.0	38.4	0.0	
12.29	15.5	60.0	44.5	7.7	50.0	42.3	0.0	
13.56	72.1	60.0	-12.1	72.1	50.0	-22.1	0.0	

Picture 5: Table - Conducted emission on mains, neutral (without termination)



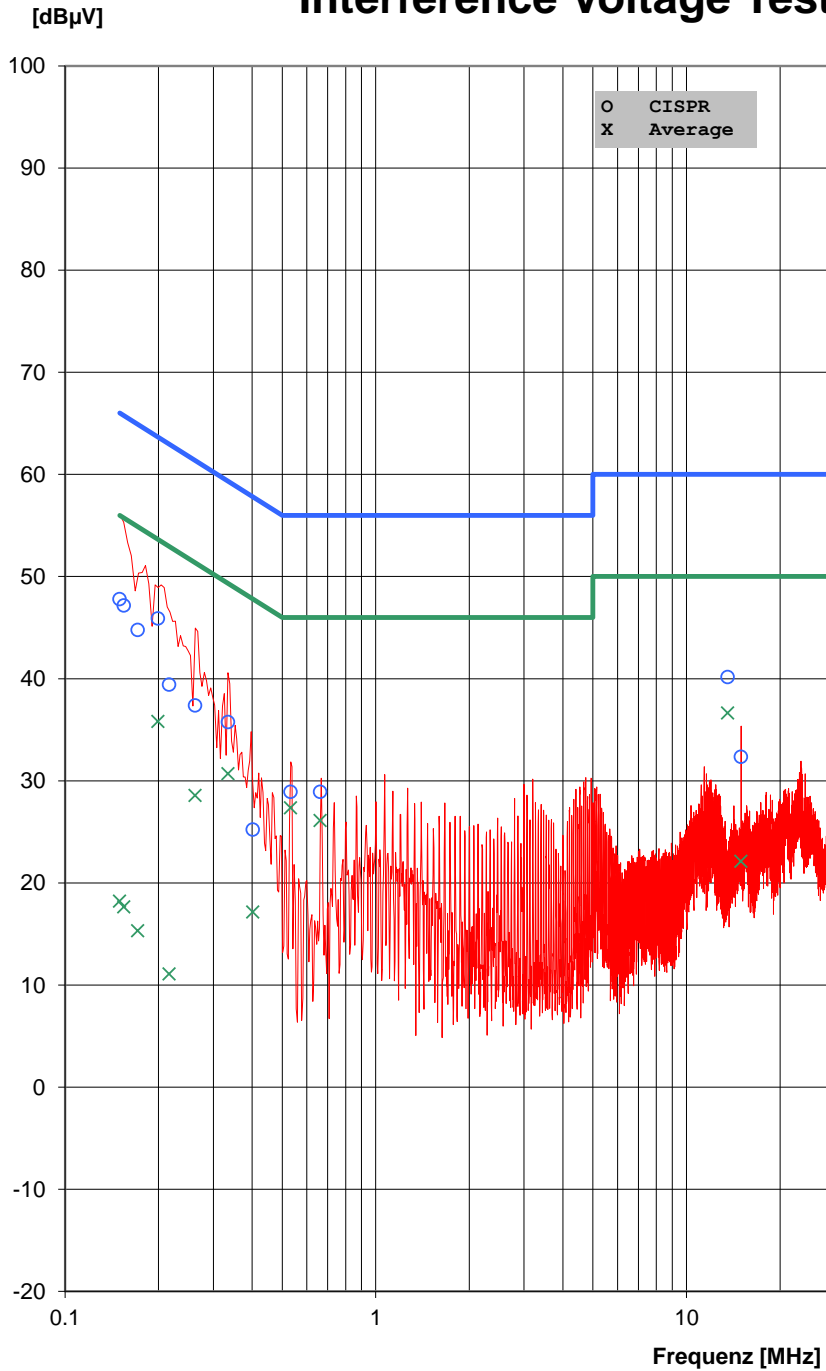
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Interference Voltage Test



REGULATIONS:
 47 CFR, 15.207
 PEAK / CISPR / AV

TEST EQUIPMENT:
 R&S ESCS30 (E00003)
 R&S ESH2-Z5 (E00004)

ORDER NO.:
 140528-AU01+W04

EUT:
 Elatec GmbH
 RFID / Card Reader
 TWN4 SmartCard Mifare NFC
 USB

OPERATION MODE:
 antennas terminated

Mains 120V AC /60Hz
 Phase

TEST FACILITY:
 EMV TESTHAUS GmbH
 Gustav-Hertz-Straße 35
 94315 Straubing

DATE / TIME:
 2014-10-07 16:08:57
 22°C 45% 98kPa

TEST ENGINEER:
 Franz Achatz

140528-AU01+W04 SS L1 terminated
 03.E10

Picture 6: Graphic - Conducted emission on mains, phase 1 (with termination 50 Ω)



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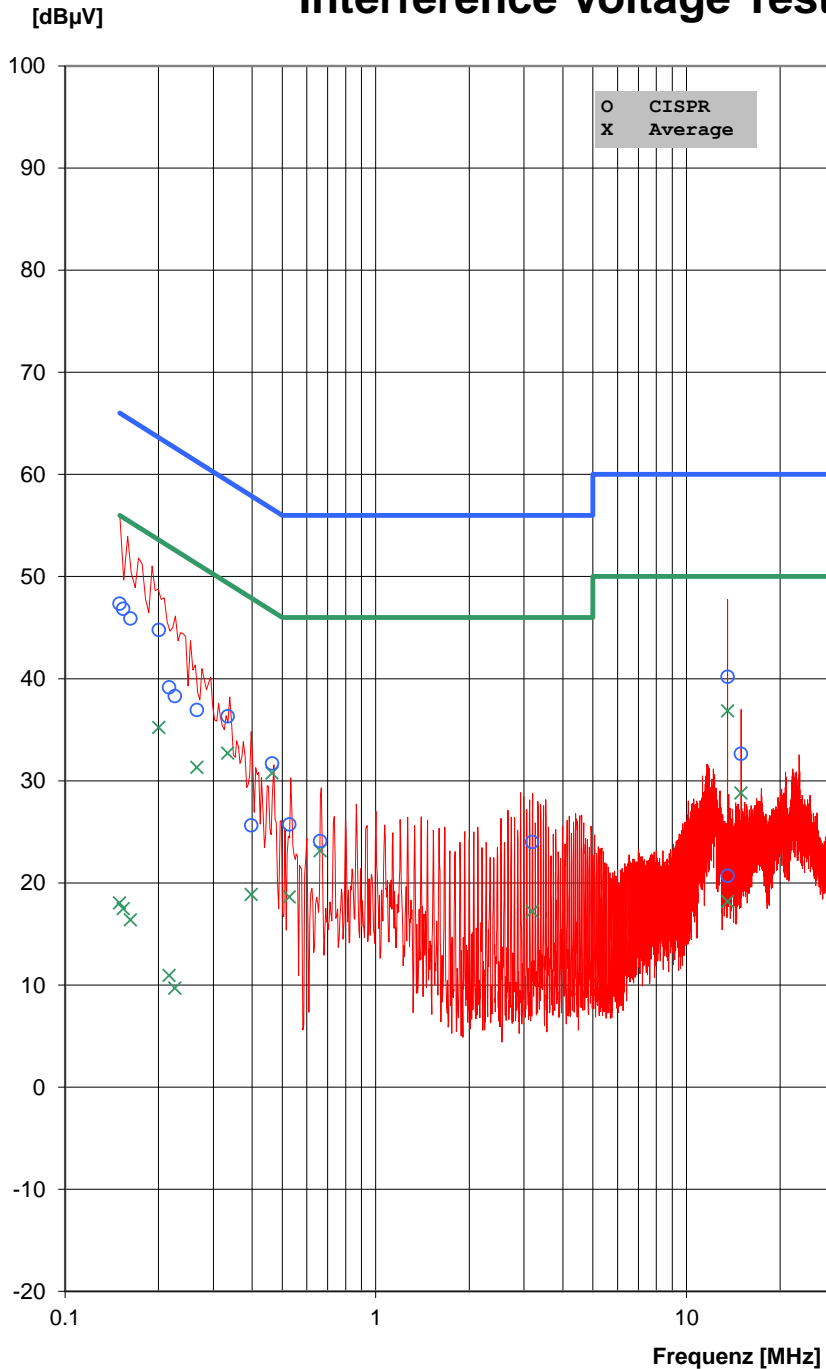
Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0.15	47.8	66.0	18.2	18.2	56.0	37.8	0.0	140528-AU01+W04_SS.L1 terminated 03.E10
0.15	47.2	65.8	18.6	17.7	55.8	38.1	0.0	
0.17	44.8	64.9	20.1	15.3	54.9	39.6	0.0	
0.20	45.9	63.7	17.8	35.8	53.7	17.8	0.0	
0.22	39.4	63.0	23.6	11.1	53.0	41.9	0.0	
0.26	37.4	61.4	24.0	28.6	51.4	22.8	0.0	
0.33	35.7	59.3	23.6	30.7	49.3	18.7	0.0	
0.40	25.2	57.8	32.6	17.2	47.8	30.7	0.0	
0.53	28.9	56.0	27.1	27.3	46.0	18.7	0.0	
0.66	28.9	56.0	27.1	26.1	46.0	19.9	0.0	
13.56	40.1	60.0	19.9	36.6	50.0	13.4	0.0	
15.00	32.4	60.0	27.7	22.1	50.0	27.9	0.0	

Picture 7: Table - Conducted emission on mains, phase 1 (with termination 50 Ω)



Interference Voltage Test



REGULATIONS:
47 CFR, 15.207
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140528-AU01+W04

EUT:
Elatec GmbH
RFID / Card Reader
TWN4 SmartCard Mifare NFC
USB

OPERATION MODE:
antennas terminated

Mains 120V AC /60Hz
Neutral

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-10-07 16:08:40
22°C 45% 98kPa

TEST ENGINEER:
Franz Achatz

140528-AU01+W04 SS N terminated 03.E10

Picture 8: Graphic - Conducted emission on mains, neutral (with termination 50 Ω)



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Interference Voltage Test

Freq. [MHz]	U_CISPR [dB μ V]	Limit [dB μ V]	delta_U [dB]	U_AV [dB μ V]	Limit [dB μ V]	delta_U [dB]	Corr. [dB]	Remark
0.15	47.4	66.0	18.7	18.0	56.0	38.0	0.0	140528-AU01+W04_SS_N terminated 03.E10
0.15	46.8	65.8	19.0	17.5	55.8	38.3	0.0	
0.16	45.9	65.3	19.4	16.4	55.3	39.0	0.0	
0.20	44.8	63.6	18.8	35.2	53.6	18.4	0.0	
0.22	39.1	63.0	23.8	10.9	53.0	42.0	0.0	
0.23	38.3	62.6	24.3	9.7	52.6	42.9	0.0	
0.27	36.9	61.2	24.3	31.3	51.2	19.9	0.0	
0.33	36.3	59.4	23.1	32.7	49.4	16.6	0.0	
0.40	25.6	57.9	32.3	18.9	47.9	29.1	0.0	
0.46	31.7	56.6	24.9	30.7	46.6	15.9	0.0	
0.53	25.7	56.0	30.3	18.6	46.0	27.4	0.0	
0.66	24.1	56.0	31.9	23.1	46.0	22.9	0.0	
3.19	24.0	56.0	32.0	17.2	46.0	28.8	0.0	
13.56	20.7	60.0	39.3	36.9	50.0	13.2	0.0	
13.57	40.2	60.0	19.8	18.2	50.0	31.8	0.0	
15.00	32.7	60.0	27.4	28.8	50.0	21.2	0.0	

Picture 9: Table - Conducted emission on mains, neutral (with termination 50 Ω)



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4 Radiated emission measurement (<1 GHz)

according to 47 CFR Part 15, section 15.205(a), 15.209(a), 15.225(a) to (e), and RSS-210, section 2.5 and Annex 2.6 with RSS-Gen, sections 8.9 and 8.10

4.1 Test Location

- Scan with peak detector in 3 m CDC.
- Final CISPR measurement with quasi peak detector on 3 m open area test site.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site (OATS)	EMV TESTHAUS GmbH	E00354

4.2 Test instruments

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	ESCS 30 (FF)	Rohde & Schwarz	E00551
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/>	ESCI (CDC)	Rohde & Schwarz	E00001
<input checked="" type="checkbox"/>	VULB 9163 (FF)	Schwarzbeck	E00013
<input checked="" type="checkbox"/>	VULB 9160 (CDC)	Schwarzbeck	E00011
<input checked="" type="checkbox"/>	HFH2-Z2	Rohde & Schwarz	E00060
<input checked="" type="checkbox"/>	Feedline OATS	Huber & Suhner	200024



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4.3 Limits

The field strength of any emissions appearing outside of the 13.110 to 14.010 MHz band including spurious emissions falling into restricted bands as specified in 15.205(a) shall not exceed the general radiated emission limits as specified in 15.209.

Frequency [MHz]	Field strength Fs [$\mu\text{V/m}$]	Field strength [dB $\mu\text{V/m}$]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

As noted in 15.205(d)(7) devices according to 15.225 are exempt from complying with restricted band requirements for the 13.36 to 13.41 MHz band. Instead they have to comply with the limits as specified in 15.225 (a) to (d):

Frequency [MHz]	Field strength Fs [$\mu\text{V/m}$]	Field strength [dB $\mu\text{V/m}$]	Measurement distance d [m]
13.553 - 13.567	15,848	84	30
13.410 - 13.553	334	50.47	30
13.567 - 13.710	334	50.47	30
13.110 - 13.410	106	40.51	30
13.710 - 14.010	106	40.51	30
f < 13.110	according to limits in §15.209		
f > 14.010			

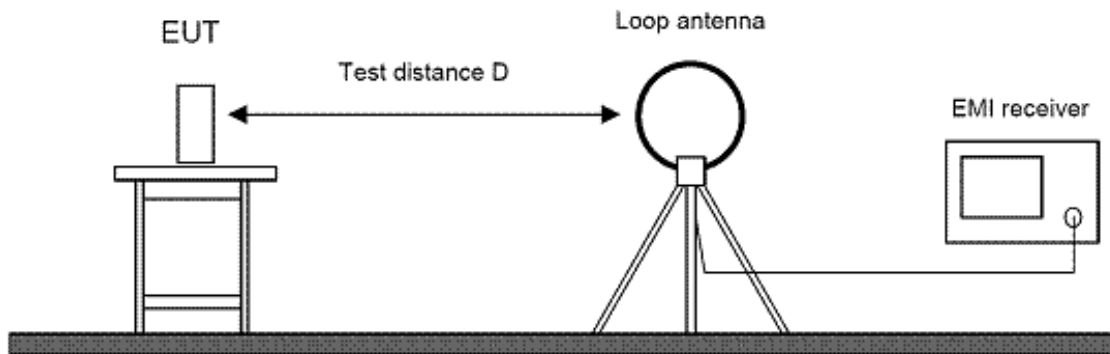


4.4 Test procedure

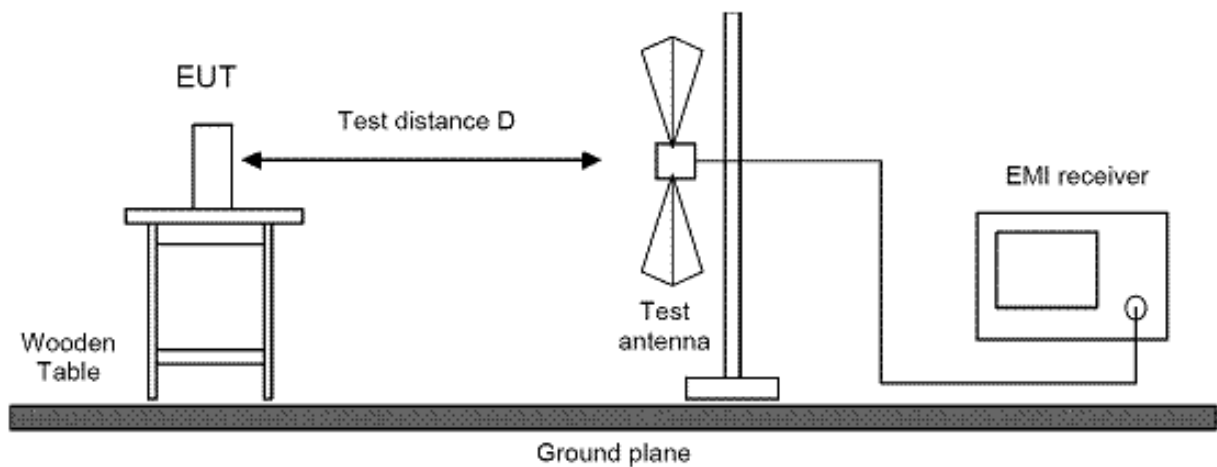
1. EUT was configured according to ANSI C63.4. It was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a compact diagnostic chamber.
2. EUT and all peripherals were powered on.
3. The broadband antenna was set to vertical polarization.
4. The EMI receiver performed a scan from 30 MHz to 1000 MHz with peak detector peak and measurement bandwidth set to 120 kHz.
5. The turn table was rotated to 6 different positions ($360^\circ / 6$) and the antenna polarization was changed to horizontal.
6. Test procedure at step 4 and 5 was repeated.
7. The test setup was then placed in an OATS at 3 m distance and all peak values over or with less margin to the limit than 6dB were marked and re-measured with a quasi-peak detector.
8. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization. The highest value was recorded.
10. For emissions below 30 MHz measurements were done using a loop antenna. Prescan was performed with peak detector and final measurements with quasi-peak except for the frequency bands 9 to 90 kHz and 110 to 490 kHz where average detector applies. Antenna height was not changed during this test. Appropriate CISPR bandwidths of 200 Hz for frequencies up to 150 kHz and 9 or 10 kHz for frequencies above were used.



4.5 Test setup



Picture 10: Test setup for radiated emission measurement (< 30 MHz)



Picture 11: Test setup for radiated emission measurement (< 1 GHz)

4.6 Test deviation

There is no deviation from the standards referred to.

4.7 Test results

Temperature:	21°C	Humidity:	41%
Tested by:	Franz Achatz	Test date:	2014-09-12

Radiated Emission Measurement 9 kHz - 30 MHz

Test procedure

The EUT was placed in a full anechoic chamber and the spurious emission testing was performed in accordance with ANSI C63.4, 47 CFR Part 15, Subpart C. The measurement distance was 3 m.



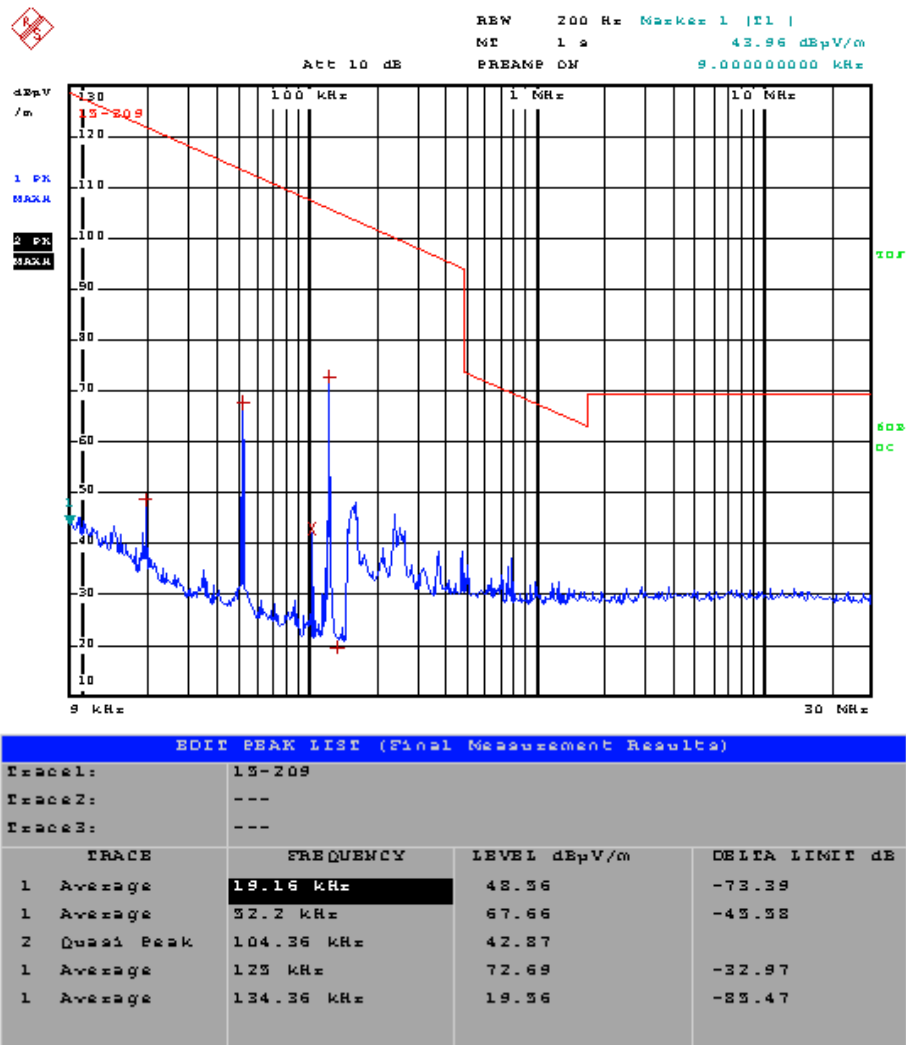
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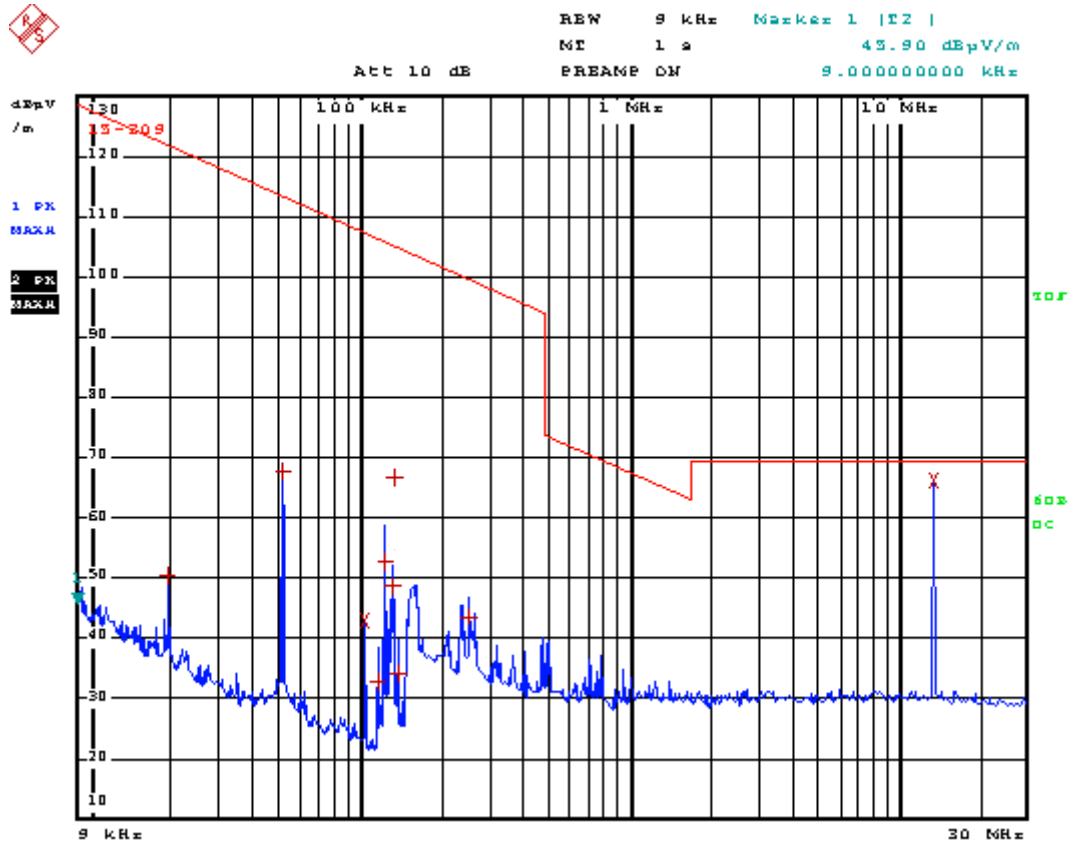
The following picture shows the worst-case-emissions at EUT-position 2 with 125 kHz tag, loop-antenna polarized to "1"



Picture 12: Radiated emission 9 kHz – 30 MHz @ 3m distance (125 kHz)

Comment: Spurious emission at 52.2 kHz is not caused by carrier.

The following picture shows the worst-case-emissions at EUT-position 3 with 134 kHz tag, loop-antenna polarized to "1"



EDIT PEAK LIST (Final Measurement Results)			
Trace1:	13-209		
Trace2:	---		
Trace3:	---		
TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
1 Average	19.24 kHz	50.61	-71.31
1 Average	52.2 kHz	67.66	-43.33
2 Quasi Peak	104.36 kHz	42.91	
1 Average	117.36 kHz	32.75	-73.44
1 Average	124.76 kHz	52.82	-52.83
1 Average	132.68 kHz	48.69	-56.45
1 Average	134.68 kHz	67.56	-31.70
1 Average	139.24 kHz	33.95	-70.77
1 Average	250 kHz	43.61	-56.03
2 Quasi Peak	13.562 MHz	66.17	

Picture 13: Radiated emission 9 kHz – 30 MHz @ 3m distance (134.2 kHz)

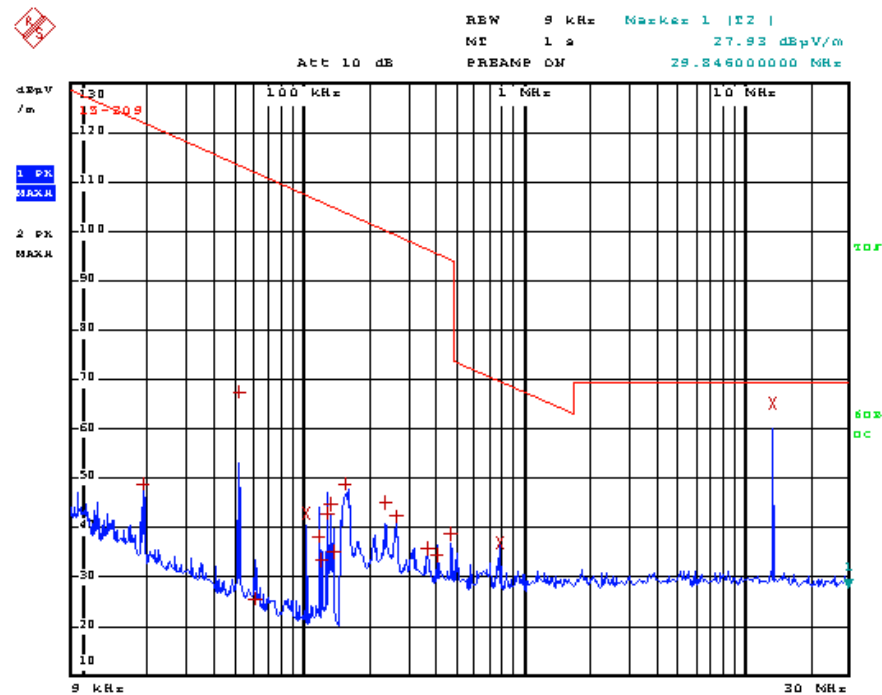
Comment: Spurious emission at 52.2 kHz is not caused by carrier.



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The following picture shows the worst-case-emissions at EUT-position 2 with 13.56 MHz tag, loop-antenna polarized to "1"



EDIT PEAK LIST (Final Measurement Results)			
TRACE	FREQUENCY	LEVEL dBµV/m	DELTA LIMIT dB
Trace1:	15-209		
Trace2:	---		
Trace3:	---		
1 Average	1.9 kHz	48.98	-73.04
1 Average	32.2 kHz	67.62	-43.62
1 Average	61.24 kHz	23.39	-86.27
2 Quasi Peak	104.36 kHz	42.89	
1 Average	119.08 kHz	38.13	-67.93
1 Average	122.12 kHz	33.40	-72.43
1 Average	131.72 kHz	42.97	-62.23
1 Average	134.92 kHz	44.91	-60.09
1 Average	138.76 kHz	33.12	-69.63
1 Average	158 kHz	48.89	-54.73
1 Average	234 kHz	44.98	-53.23
1 Average	262 kHz	42.26	-56.97
1 Average	366 kHz	33.71	-60.62
1 Average	402 kHz	34.49	-61.02
1 Average	470 kHz	38.83	-53.32
2 Quasi Peak	782 kHz	36.84	
2 Quasi Peak	13.562 MHz	63.37	

Picture 14: Radiated emission 9 kHz – 30 MHz @ 3m distance (13.56 MHz)

Comment: Spurious emission at 52.2 kHz is not caused by carrier.



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Frequency (MHz)	Measured value (dBµV/m)	Detector	Recalculation factor (dB/decade)	Field strength (dBµV/m)	Limit (dBµV/m)	Margin	Result
13.56	65.37	QP	40	25.37	84	-58.63	PASS

Note:

Measured value = 65.37 dBµV/m @ 3 m

Recalculation factor = 40 dB / decade

Recalculated value = 65.00 dBµV/m @ 3 m - 40 dB = **25.37 dBµV/m @ 30 m**



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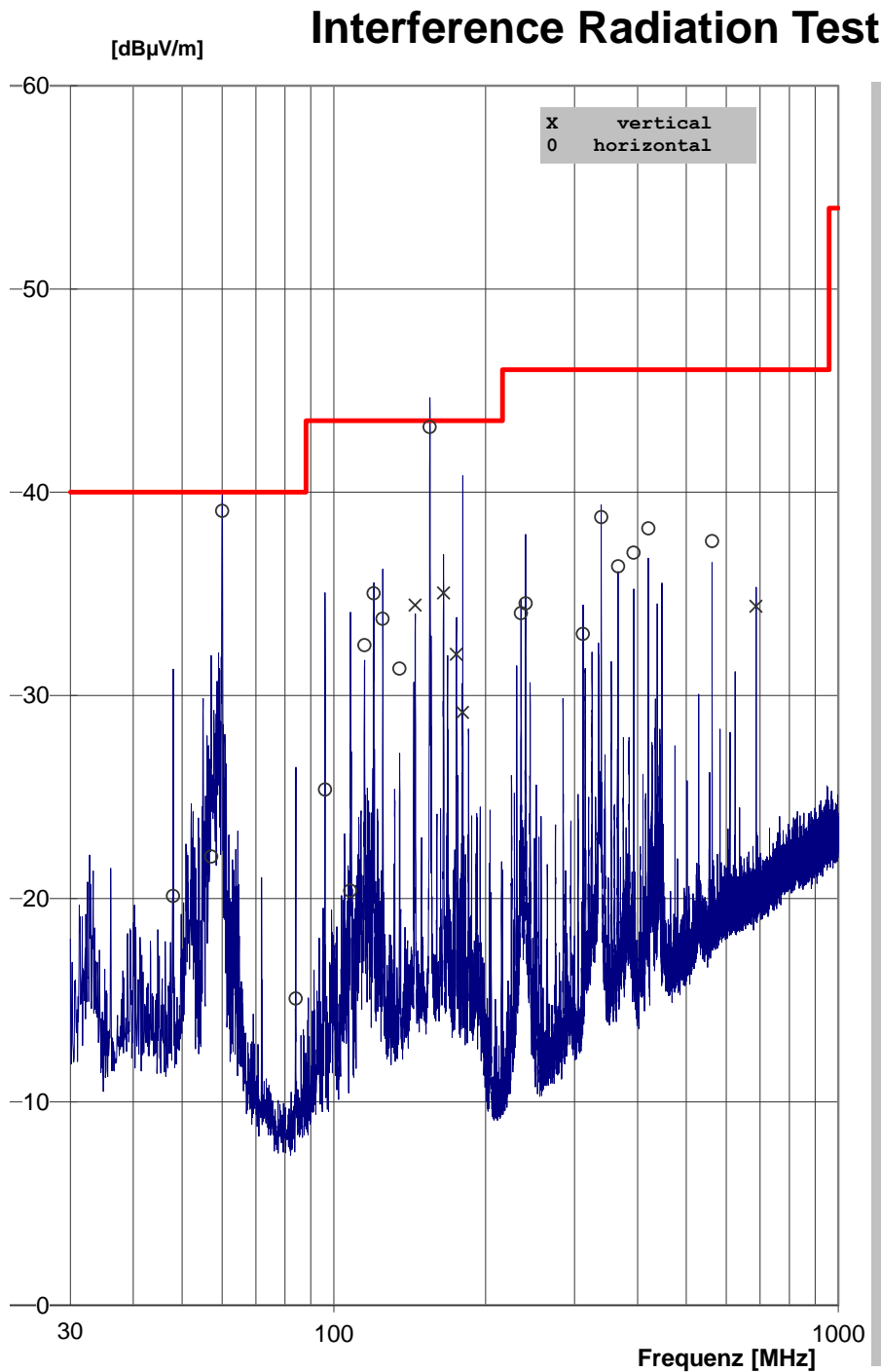
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Radiated Emission Measurement 30 MHz - 1000 MHz

The following pictures show the worst-case-emissions at EUT-position 3 and in continuous tag searching mode.



REGULATIONS:
 CFR 47 Part 15.209
 PEAK / QP

TEST EQUIPMENT:
 R&S ESCI (E00001)
 VULB 9160 (E00011)

ORDER NO.:
 140528-AU01+W01

EUT:
 Elatec GmbH
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EUT position:
 POS 3

OPERATION MODE:
 continuous tag searching
 new firmware

TEST FACILITY:
 EMV TESTHAUS GmbH
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 94315 Straubing

DATE / TIME:
 2014-10-27 15:45:23
 12°C 42% 98kPa

TEST ENGINEER:
 Franz Achatz

140528-AU01+W04 Funk_ANSI_30M-1G OATS 02.E10



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Interference Radiation Test

Freq. [MHz]	U_Rec [dBµV/m]	Limit [dBµV/m]	Corr. [dB]	U_Ant. [dBµV]	delta_U [dB]	Turn- table	Antenna	Pol.	Remark
48.00	20.1	40.0	12.7	7.5	19.9	247°	100 cm	H	140528-AU01+W04 Funk_ANSI_30M-1G OATS 02.E10
57.12	22.1	40.0	12.5	9.6	17.9	74°	100 cm	H	
60.06	39.1	40.0	13.4	25.7	0.9	205°	295 cm	H	
84.06	15.1	40.0	9.1	6.0	24.9	277°	100 cm	H	
96.00	25.4	43.5	10.2	15.2	18.2	286°	100 cm	H	
107.82	20.4	43.5	11.3	9.1	23.1	277°	100 cm	H	
115.02	32.5	43.5	12.0	20.5	11.1	112°	100 cm	H	
120.00	35.0	43.5	12.5	22.5	8.5	112°	100 cm	H	
124.98	33.8	43.5	11.0	22.7	9.8	288°	100 cm	H	
135.00	31.3	43.5	13.0	18.3	12.2	115°	100 cm	H	
144.96	34.4	43.5	13.6	20.9	9.1	192°	100 cm	V	
154.98	43.2	43.5	9.8	33.4	0.3	310°	190 cm	H	
165.00	35.0	43.5	10.3	24.8	8.5	345°	100 cm	V	
175.02	32.0	43.5	10.8	21.2	11.5	75°	100 cm	V	
180.06	29.2	43.5	11.8	17.3	14.4	178°	100 cm	V	
234.96	34.0	46.0	11.0	23.0	12.0	223°	100 cm	H	
240.06	34.5	46.0	11.2	23.3	11.5	232°	100 cm	H	
311.88	33.0	46.0	13.0	20.0	13.0	237°	100 cm	H	
339.00	38.8	46.0	13.5	25.3	7.3	124°	100 cm	H	
366.12	36.3	46.0	14.0	22.3	9.7	128°	100 cm	H	
393.24	37.0	46.0	14.5	22.5	9.0	153°	100 cm	H	
420.36	38.2	46.0	15.1	23.1	7.8	140°	100 cm	H	
562.50	37.6	46.0	17.7	19.9	8.4	112°	100 cm	H	
687.48	34.4	46.0	19.5	14.9	11.6	169°	100 cm	V	

Picture 15: Radiated emission 30 MHz - 1000MHz @ 3m distance



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Spectrum Mask

Test procedure

The EUT was placed in a fully anechoic chamber and the testing was performed in accordance with ANSI C63.4 and 47 CFR Part 15, section 15.225 (a) to (d). The measurement distance was 3 m. To find the closest margin of the spectrum to the limit mask adapted to the test distance the EUT was rotated by 360 degrees with detector of the test receiver set to peak. The loop antenna placed in a fixed height of 1 meter was rotated by 360 degrees to get the maximum of emission. In case of exceeding the limits the detector is switched to quasi peak for final testing in position of maximum emission.

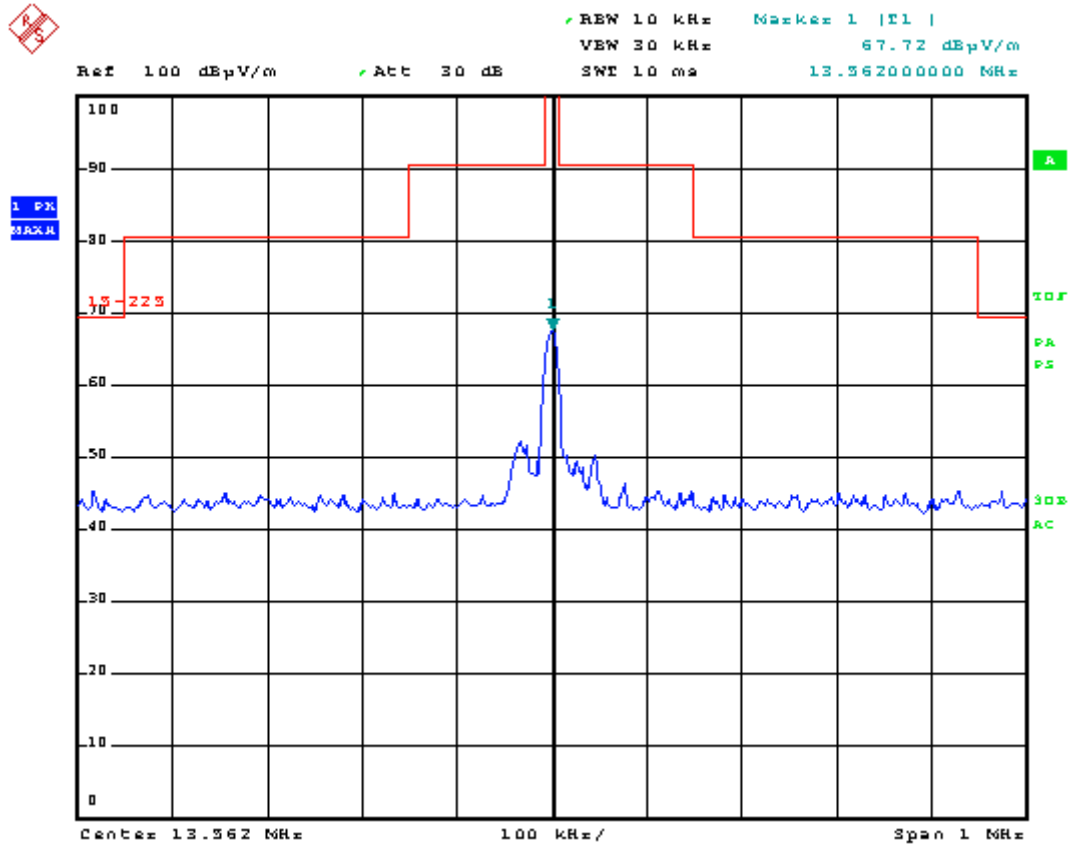


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Test result

Temperature:	21°C	Humidity:	41%
Tested by:	Franz Achatz	Test date:	2014-09-12



Picture 16: Spectrum mask for 13.56 MHz @ 3m distance

f _{meas} [MHz]	E _{meas} @ 3m [dBµV/m]	Correction 3m -> 30m	Calc. Value [dBµV/m]	Limit @ 30m	Result
13.562	67.72	-40 dB	27.72	84 dBµV/m	Pass



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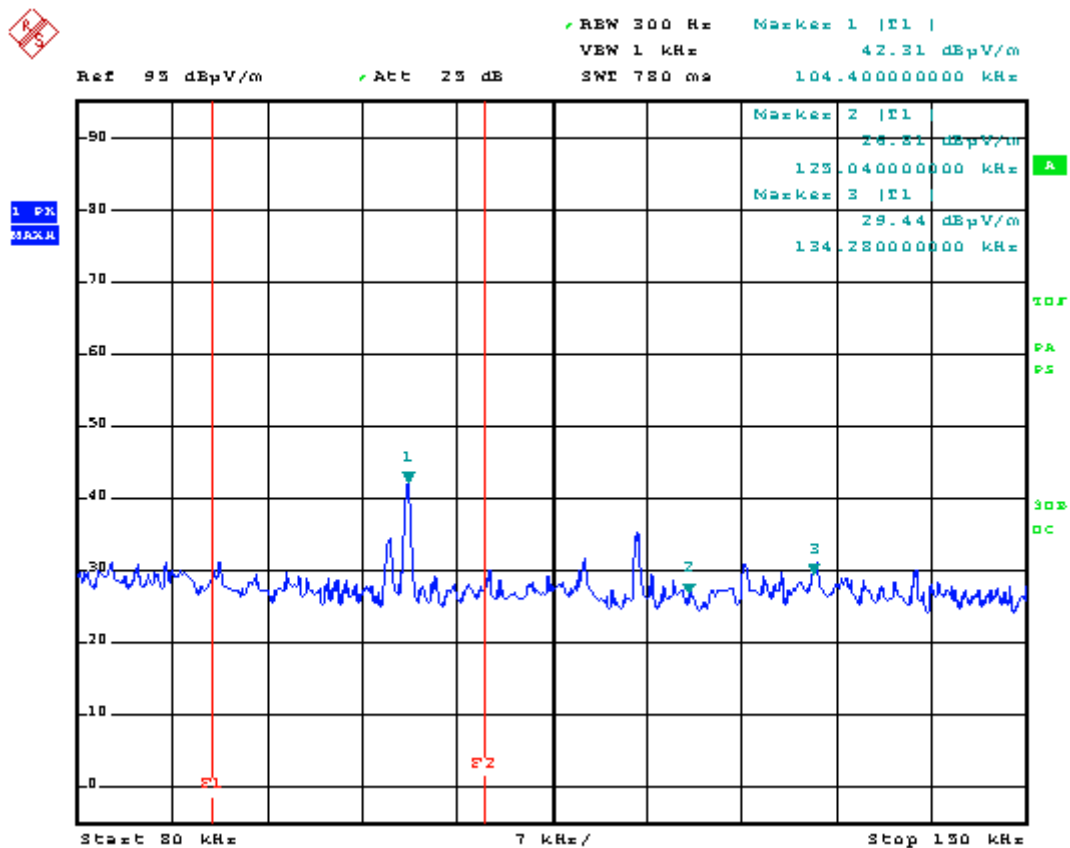
Restricted bands of operation

Limits

Only spurious emissions are permitted in the restricted frequency bands. The restricted frequency bands of interest for the EUT according to 47 CFR Part 15, section 15.205, and RSS-Gen, section 8.10, are summarized in following table:

Frequency band (MHz)
0.090 – 0.110

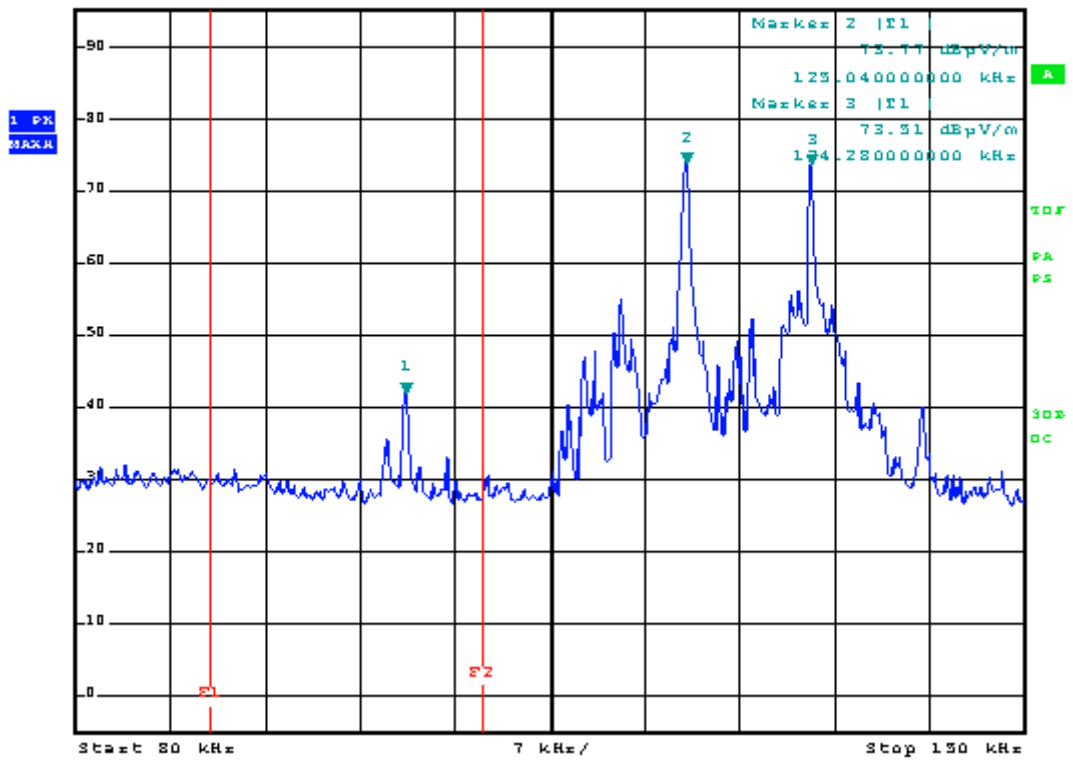
Test result



Picture 17: Restricted band 0.090 MHz (F1) – 0.110 MHz (F2), tag reader disconnected



REF 95 dBµV/m Att 25 dB REW 300 Hz Maskes 1 |IT1|
VBN 1 kHz 41.99 dBµV/m
SWE 780 ms 104.40000000 kHz



Picture 18: Restricted band 0.090 MHz (F1) – 0.110 MHz (F2), EUT position 3



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5 Radiated emission measurement (>1 GHz)

according to 47 CFR Part 15, section 15.209(a),
RSS-210, section 2.5 and Annex 2.6 with RSS-Gen, section 8.9

Remark:

This measurement needs not to be applied because

- the intentional radiator operates below 10 GHz and tenth harmonic of the highest fundamental frequency is lower than 1 GHz (see 47 CFR Part 15, section 15.33(a)(1), and RSS-Gen, section 6.13), and
- the digital part of the device does not generate or use internal frequencies higher than 108 MHz (see 47 CFR Part 15 section 15.33(b)(1), and RSS-Gen, section 2.3.3 with ICES-003, section 6.2).



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6 Carrier frequency stability

according to CFR 47 Part 15, section 15.225(e), and
RSS-210, Annex A2.6 with RSS-Gen, section 6.11

6.1 Test Location

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	Climatic chamber VC 4100	Vötsch Industrietechnik	C00014
<input type="checkbox"/>	Climatic chamber VC ³ 4034	Vötsch Industrietechnik	C00015

6.2 Test instruments

	Description	Manufacturer	Inventory No.
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/>	ESCI 3	Rohde & Schwarz	E00552
<input checked="" type="checkbox"/>	RF-R 400-1	Langer EMV-Technik	E00270

6.3 Limits

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ (100 ppm) 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.

For battery operated equipment, the equipment tests shall be performed using a new battery. Alternatively, an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer.



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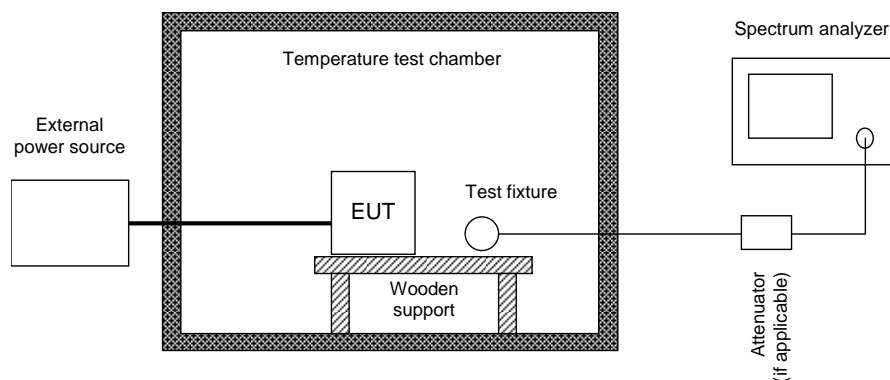
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6.4 Test procedure

1. If possible EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to the shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point on the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1% of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance allowed is larger than the uncertainty of the measured frequency tolerance.
2. The carrier frequency is measured depending on the variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer. Alternatively, tests shall be performed using a new battery.
3. The carrier frequency is measured over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage.

6.5 Test setup



Picture 19: Test setup for carrier frequency stability measurement

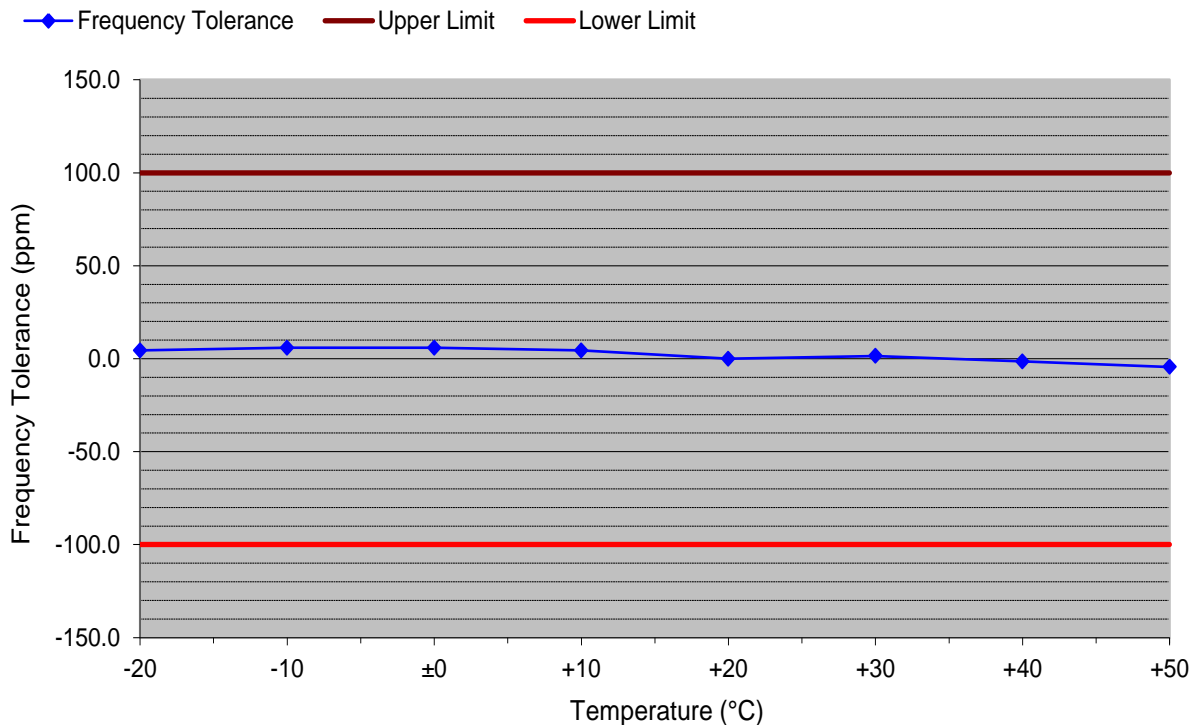
6.6 Test deviation

There is no deviation from the standards referred to.

Test result

Temperature:	22°C	Humidity:	45%
Tested by:	Franz Achatz	Test date:	2014-09-17

Carrier frequency stability vs. temperature



Supply voltage:	5 V	Frequency under normal conditions:	13.560500 MHz			
Temperature (°C)	Frequency (MHz)	Frequency Tolerance (Hz)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)	
-20	13.560560	60	4.4	+100.0	-100.0	95.6
-10	13.560580	80	5.9	+100.0	-100.0	94.1
±0	13.560580	80	5.9	+100.0	-100.0	94.1
+10	13.560560	60	4.4	+100.0	-100.0	95.6
+20	13.560500	0	0.0	+100.0	-100.0	100.0
+30	13.560520	20	1.5	+100.0	-100.0	98.5
+40	13.560480	-20	-1.5	+100.0	-100.0	98.5
+50	13.560440	-60	-4.4	+100.0	-100.0	95.6

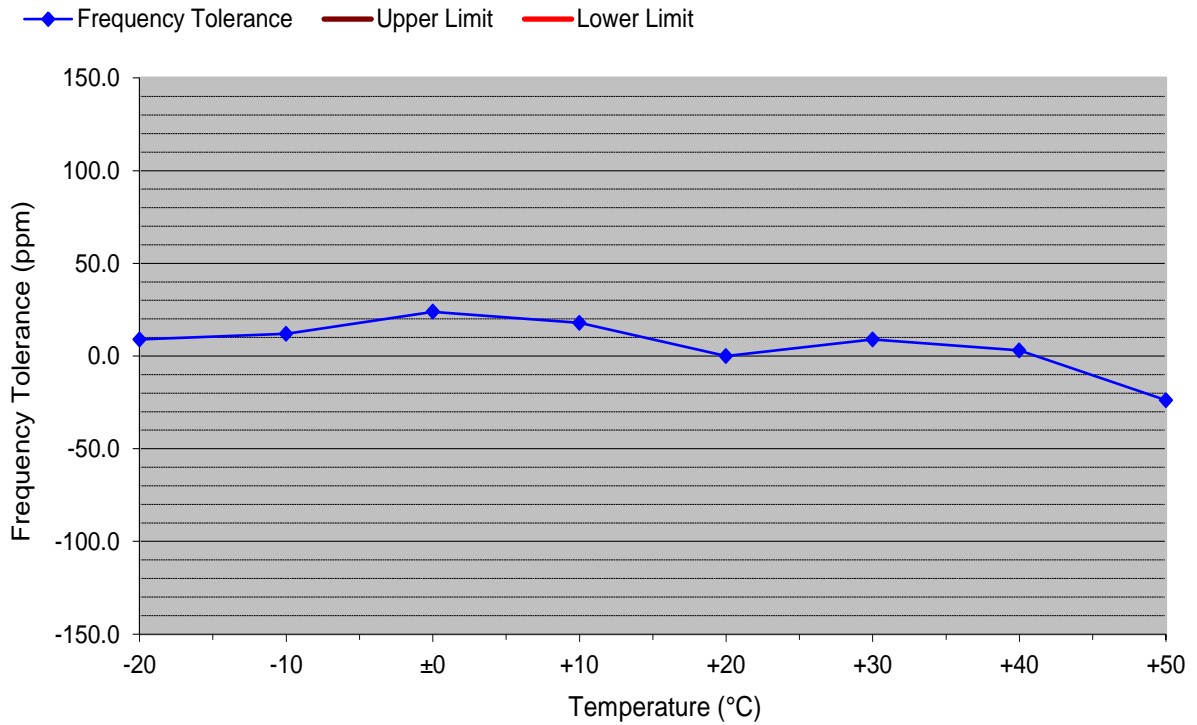


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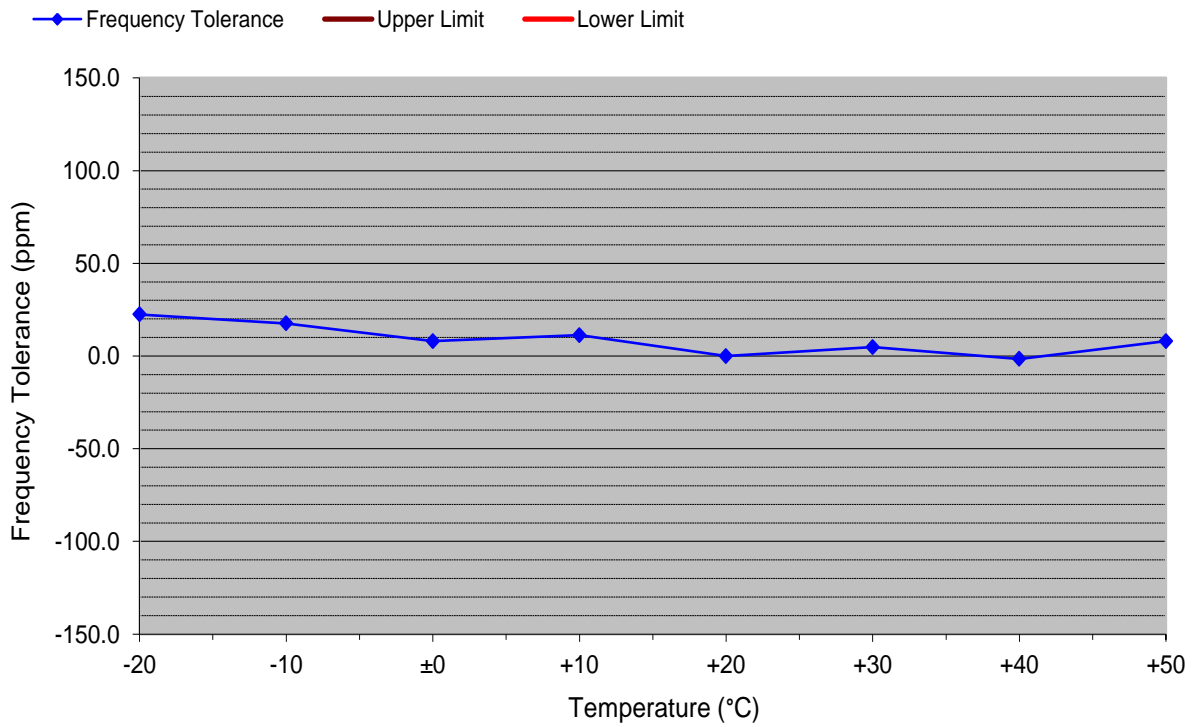


Supply voltage:		5 V		Frequency under normal conditions:		134.2248 kHz	
Temperature (°C)	Frequency (kHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)	
-20	134.226000	1.20	8.9				
-10	134.226400	1.60	11.9				
±0	134.228000	3.20	23.8				
+10	134.227200	2.40	17.9				
+20	134.224800	0.00	0.0				
+30	134.226000	1.20	8.9				
+40	134.225200	0.40	3.0				
+50	134.221600	-3.20	-23.8				



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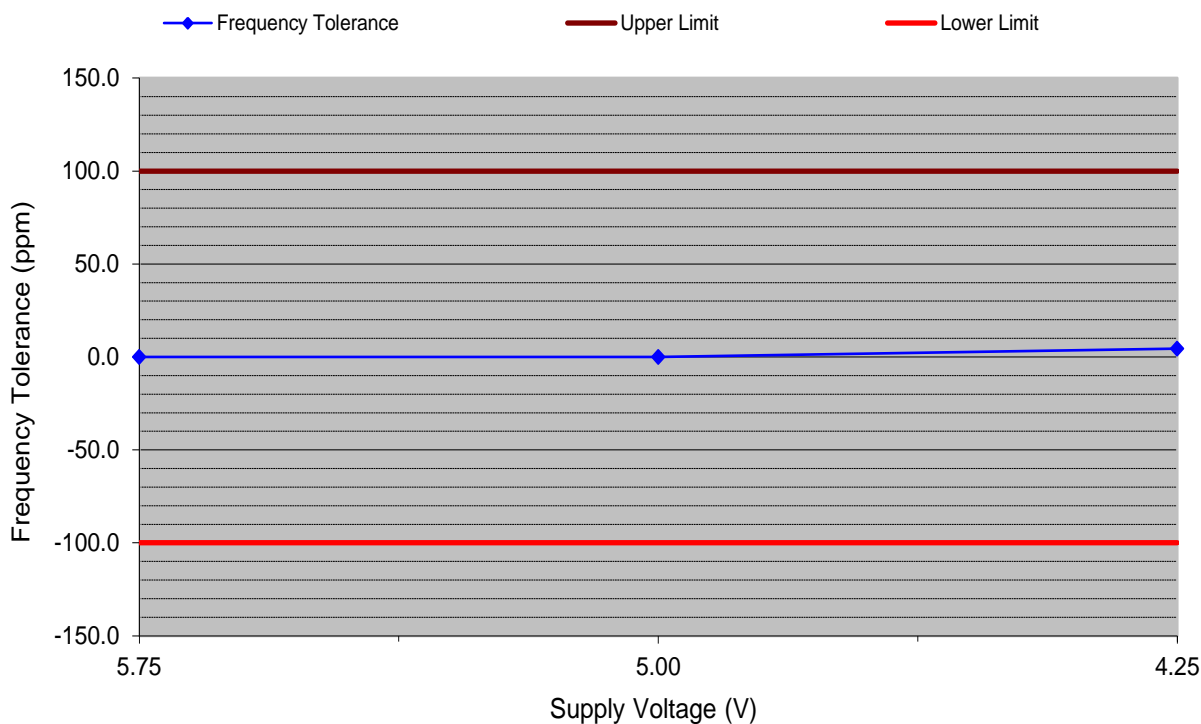
Supply voltage:		5 V		Frequency under normal conditions:		124.9958 kHz	
Temperature (°C)	Frequency (kHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)	
-20	124.998600	2.80	22.4				
-10	124.998000	2.20	17.6				
±0	124.996800	1.00	8.0				
+10	124.997200	1.40	11.2				
+20	124.995800	0.00	0.0				
+30	124.996400	0.60	4.8				
+40	124.995600	-0.20	-1.6				
+50	124.996800	1.00	8.0				



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Carrier frequency stability vs. supply voltage



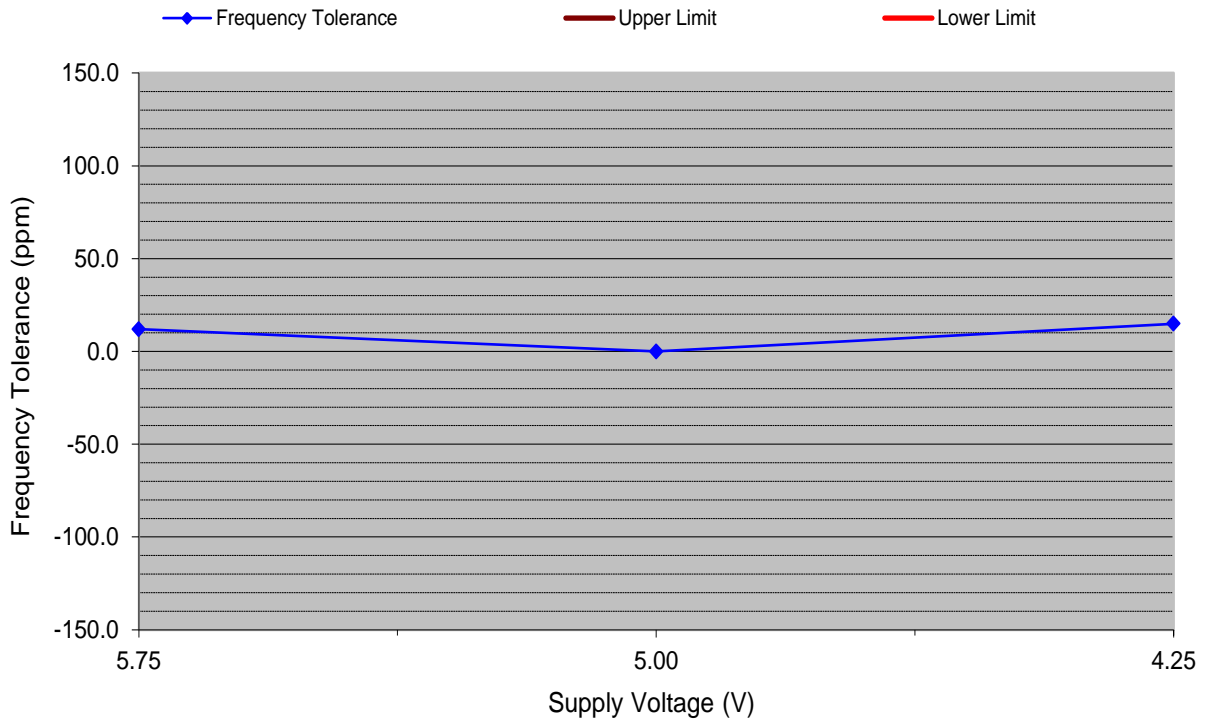
Temperature: +20 °C Battery End Point: Not applicable
 Frequency under normal conditions: 13.560500 MHz

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
5.75	13.560500	0	0.0	+100.0	-100.0	100.0
5.00	13.560500	0	0.0	+100.0	-100.0	100.0
4.25	13.560560	60	4.4	+100.0	-100.0	95.6



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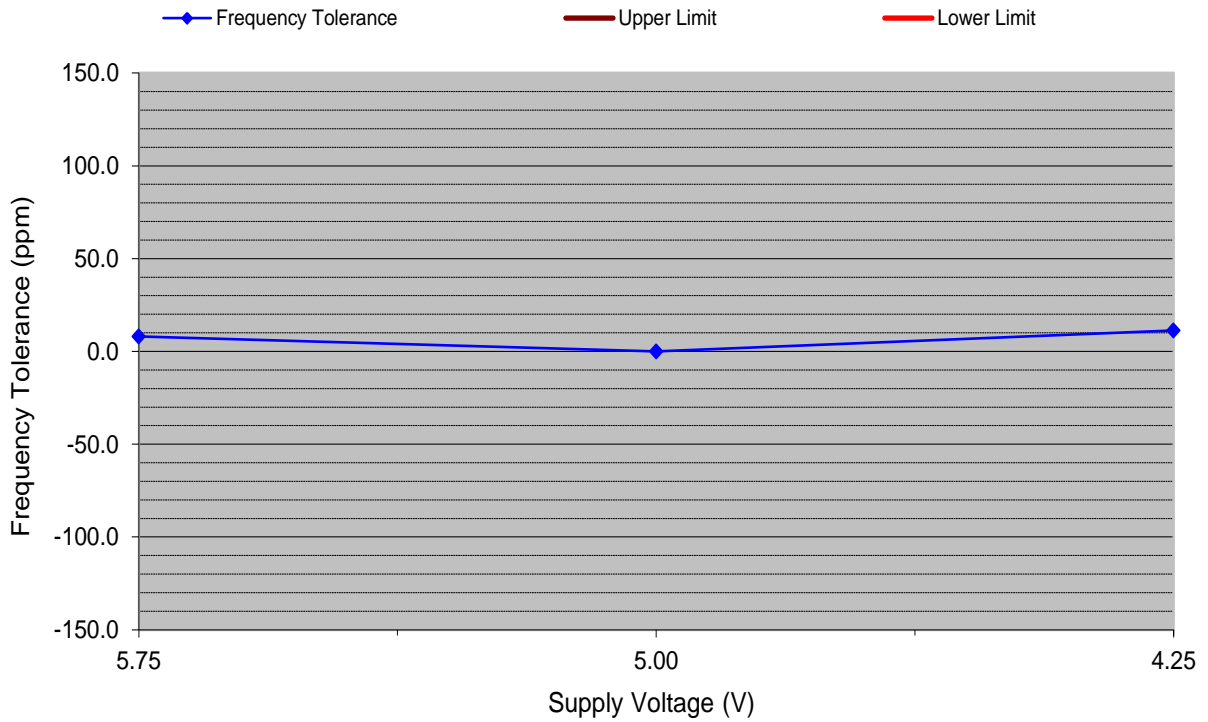
Temperature: +20 °C Battery End Point: Not applicable
 Frequency under normal conditions: 134.2248 kHz

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
5.75	134.226400	1.60	11.9			
5.00	134.224800	0.00	0.0			
4.25	134.226800	2.00	14.9			



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Temperature: +20 °C Battery End Point: Not applicable
 Frequency under normal conditions: 124.9958 kHz

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
5.75	124.996800	1.00	8.0			
5.00	124.995800	0.00	0.0			
4.25	124.997200	1.40	11.2			



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7 Bandwidths

according to CFR 47 Part 2, section 2.202(a), and RSS-Gen, section 6.6

7.1 Test Location

See clause 4.1 on page 20.

7.2 Test instruments

See clause 4.2 on page 20.

7.3 Limits

The bandwidths are recorded only. There are no limits specified in CFR 47 Part 15, section 15.225, and RSS-210, Annex 2.6

7.4 Test setup

See clause 4.5 on page 23.

7.5 Test deviation

There is no deviation from the standards referred to.



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7.6 Test results

Temperature:	22°C	Humidity:	45%
Tested by:	Franz Achatz	Test date:	2014-09-17

Occupied bandwidth (99 %)

Test procedure

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured. The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth. For this purpose the appropriate measurement function of the spectrum analyzer is used.

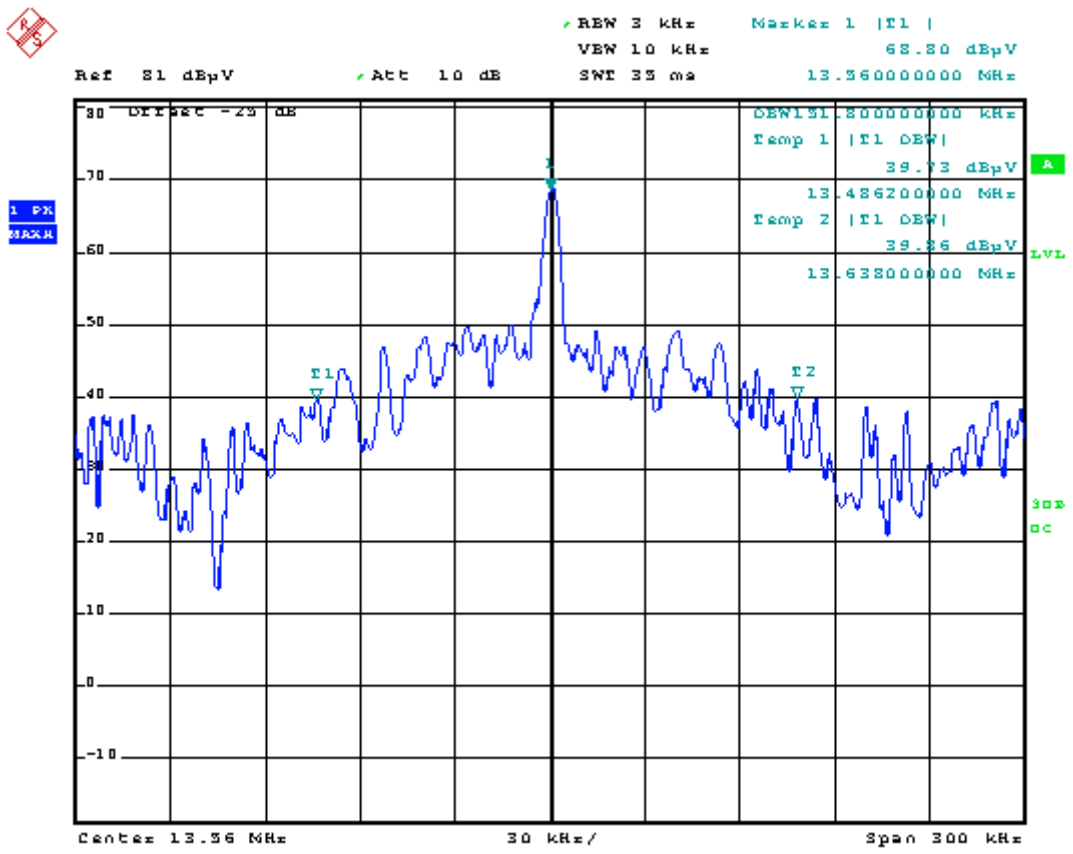


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Picture 20: Occupied bandwidth (99 %) for 13.56 MHz

Measured occupied bandwidth (99 %) for 13.56 MHz: 151.80 kHz

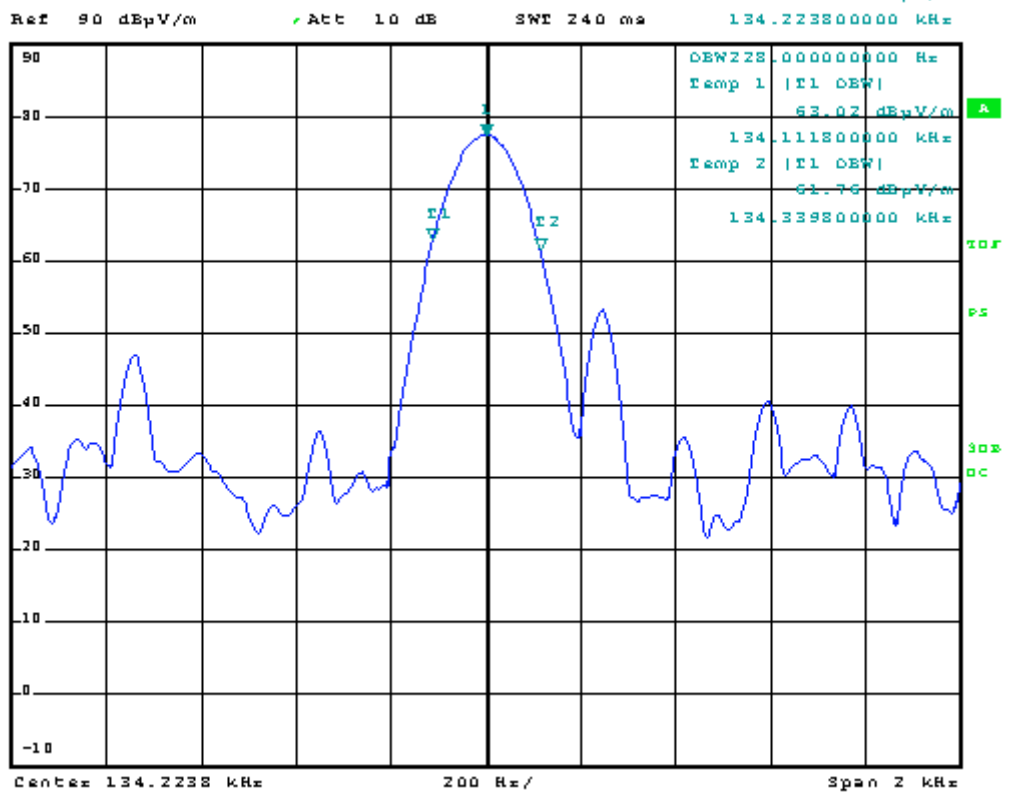


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✓ REW 100 Hz Maskes 1 | T1 |
 VEW 300 Hz 77.55 dBµV/m
 SWI 240 ma 134.223800000 kHz



Picture 21: Occupied bandwidth (99 %) for 134.2 kHz

Measured occupied bandwidth (99 %) for 134.2 kHz: 228 Hz



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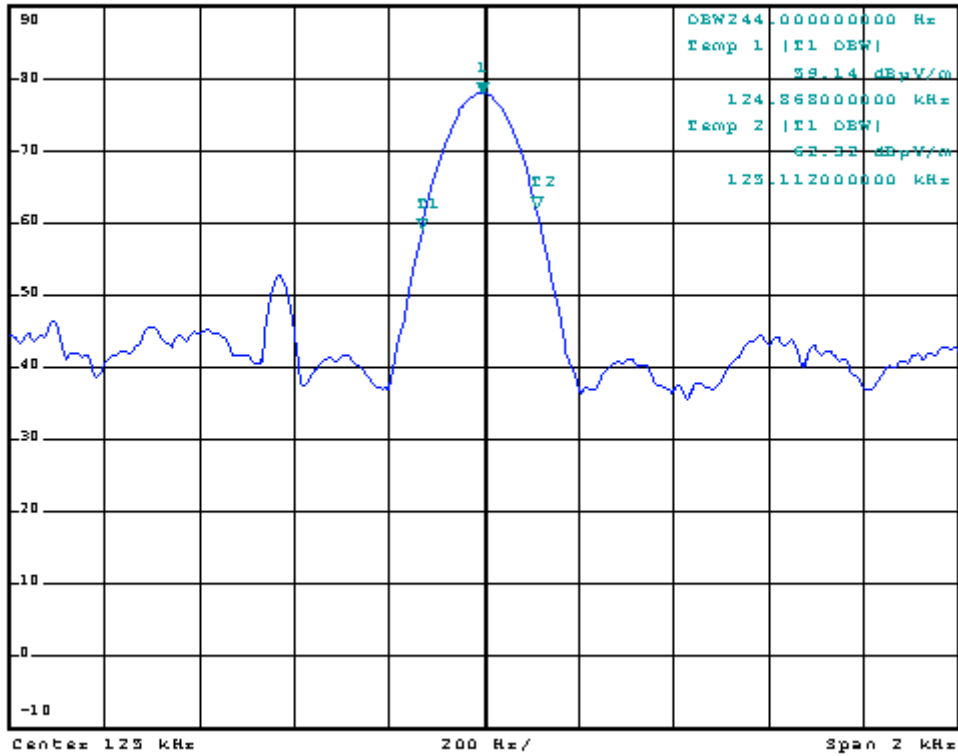
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RBW 100 Hz MaxKHz 1 |E1 |
 VBW 300 Hz 78.08 dBµV/m
 SWE 240 ms 124.996000000 kHz

Ref 90 dBµV/m Att 10 dB

1 Pk
MAX



Picture 22: Occupied bandwidth (99 %) for 125 kHz

Measured occupied bandwidth (99 %) for 125 kHz: 244 Hz



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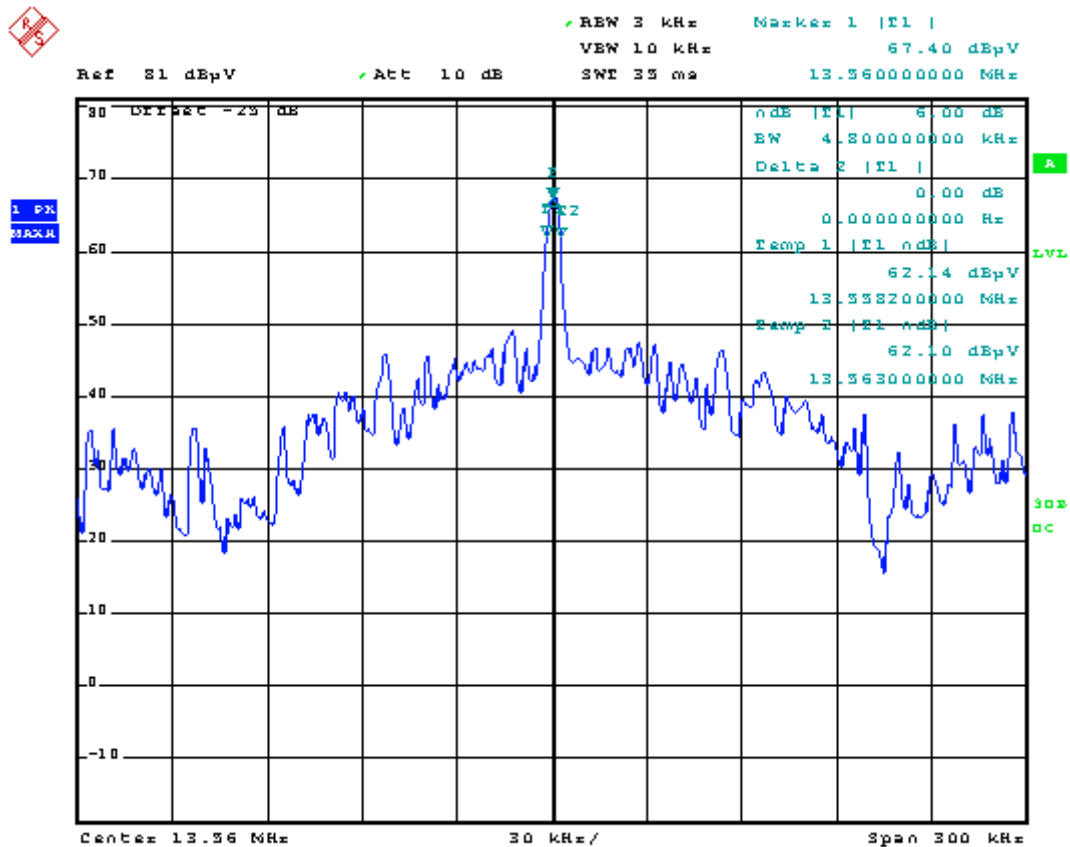
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-6 dB emission bandwidth

Test procedure

Where indicated, the -6 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 6 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth



Picture 23: -6 dB emission bandwidth for 13.56 MHz

Measured -6 dB emission bandwidth for 13.56 MHz: 4.80 kHz

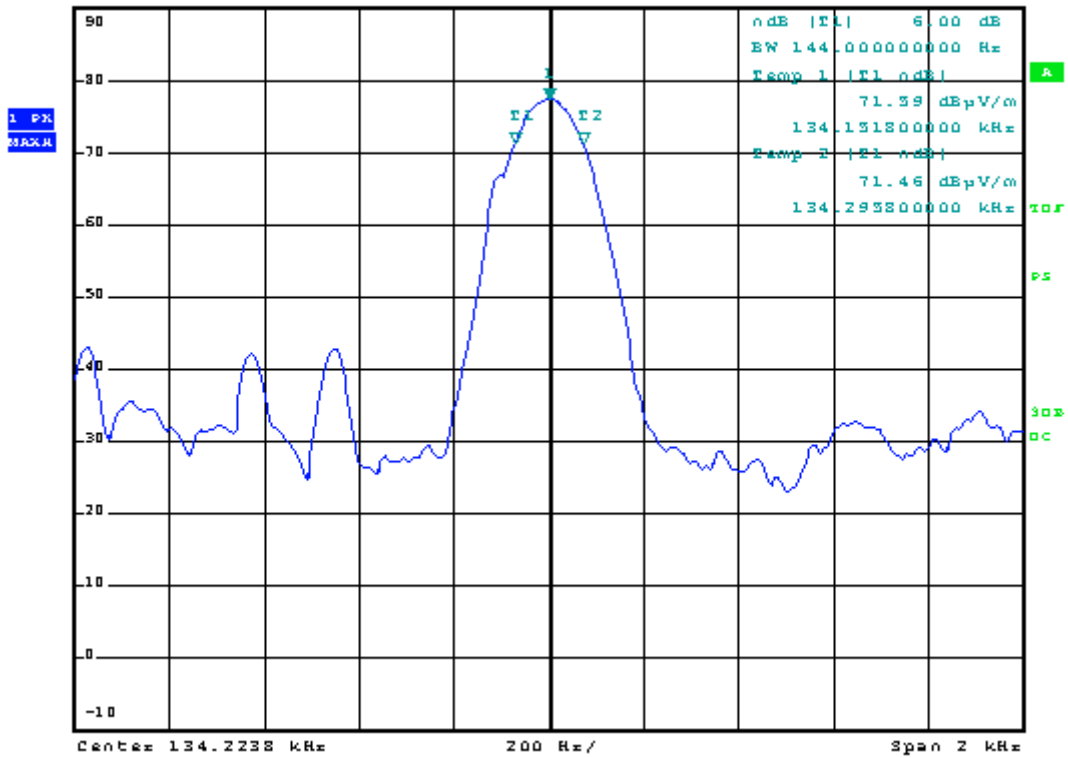


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Ref 90 dB μ V/m Att 1.0 dB REW 100 Hz Mask 1 | [F1] |
VEN 300 Hz 77.54 dB μ V/m
SWT 240 ms 134.22380000 kHz



Picture 24: -6 dB emission bandwidth for 134 kHz

Measured -6 dB emission bandwidth for 134 kHz: 144 Hz



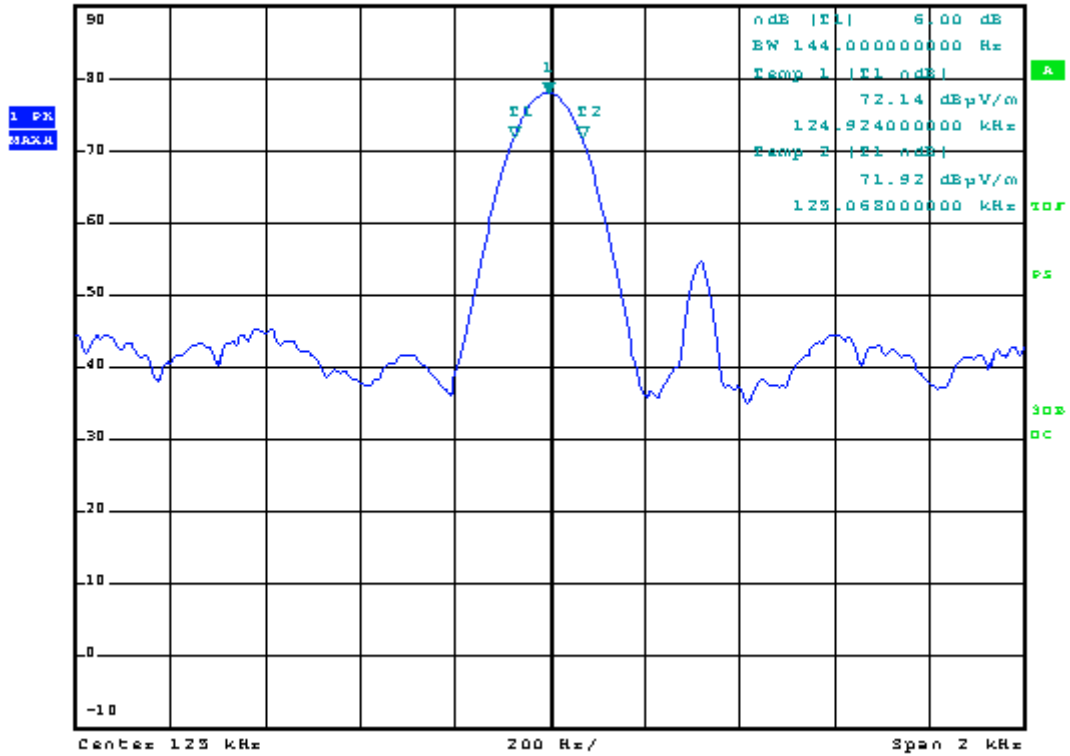
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REW 100 Hz Maskes 1 (T1)
 VBW 300 Hz 78.08 dBµV/m
 SWI 240 ms 124.996000000 kHz

Ref 90 dBµV/m Att 10 dB



Picture 25: -6 dB emission bandwidth for 125 kHz

Measured -6 dB emission bandwidth for 125 kHz: 144 Hz



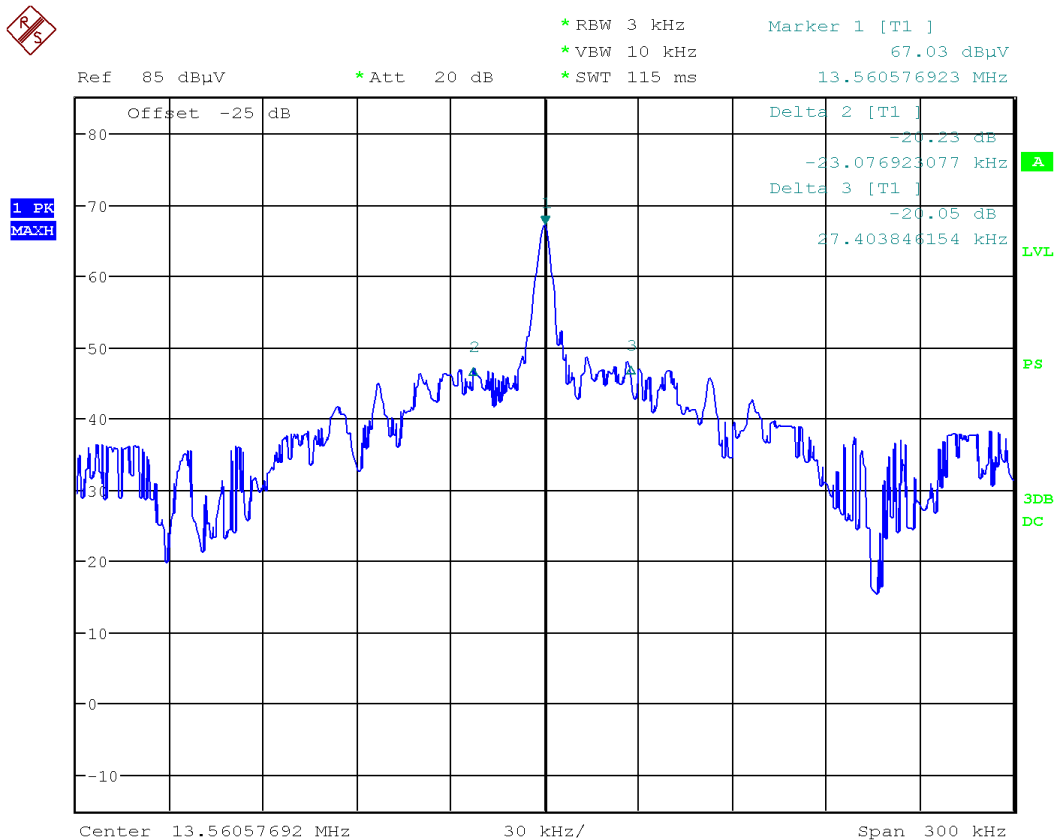
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-20 dB emission bandwidth

Test procedure

Where indicated, the -20 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.



Picture 26: -20 dB emission bandwidth for 13.56 MHz

Measured -20 dB emission bandwidth for 13.56 MHz: 50.48 kHz



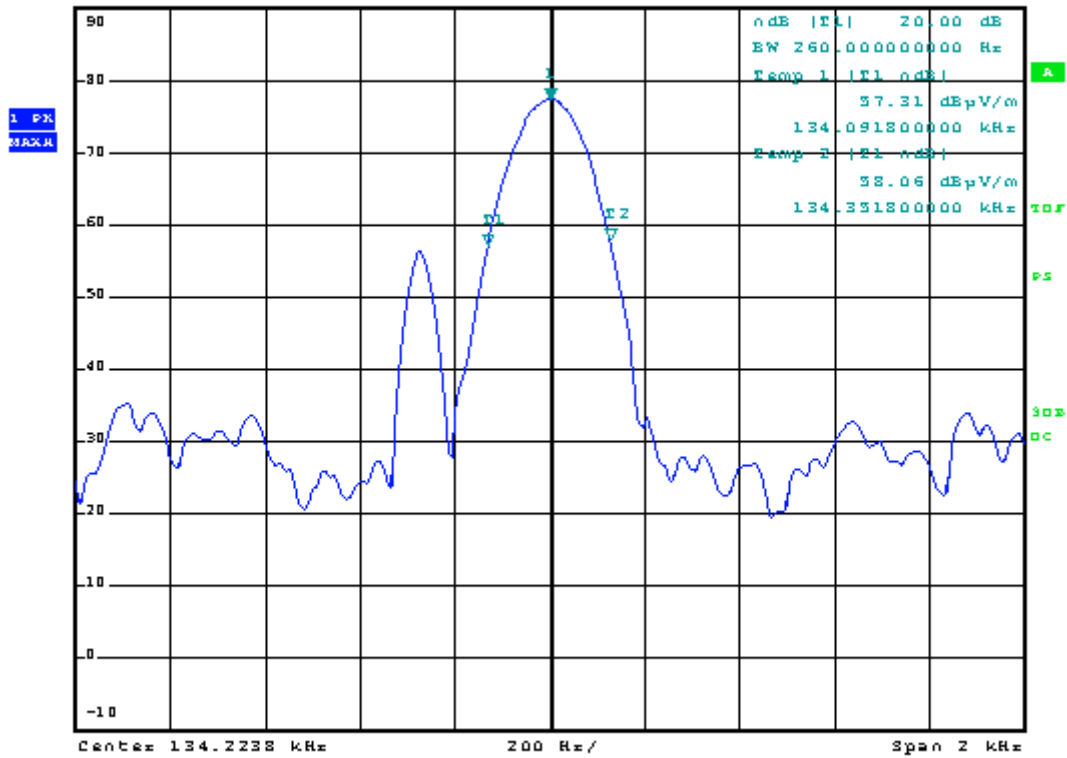
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✓ REW 100 Hz Masker 1 (F1)
 VBW 300 Hz 77.54 dBµV/m
 SWI 240 ma 134.22380000 kHz

Ref 90 dBµV/m ✓ Att 10 dB



Picture 27: -20 dB emission bandwidth for 134 kHz

Measured -20 dB emission bandwidth for 134 kHz: 260 Hz



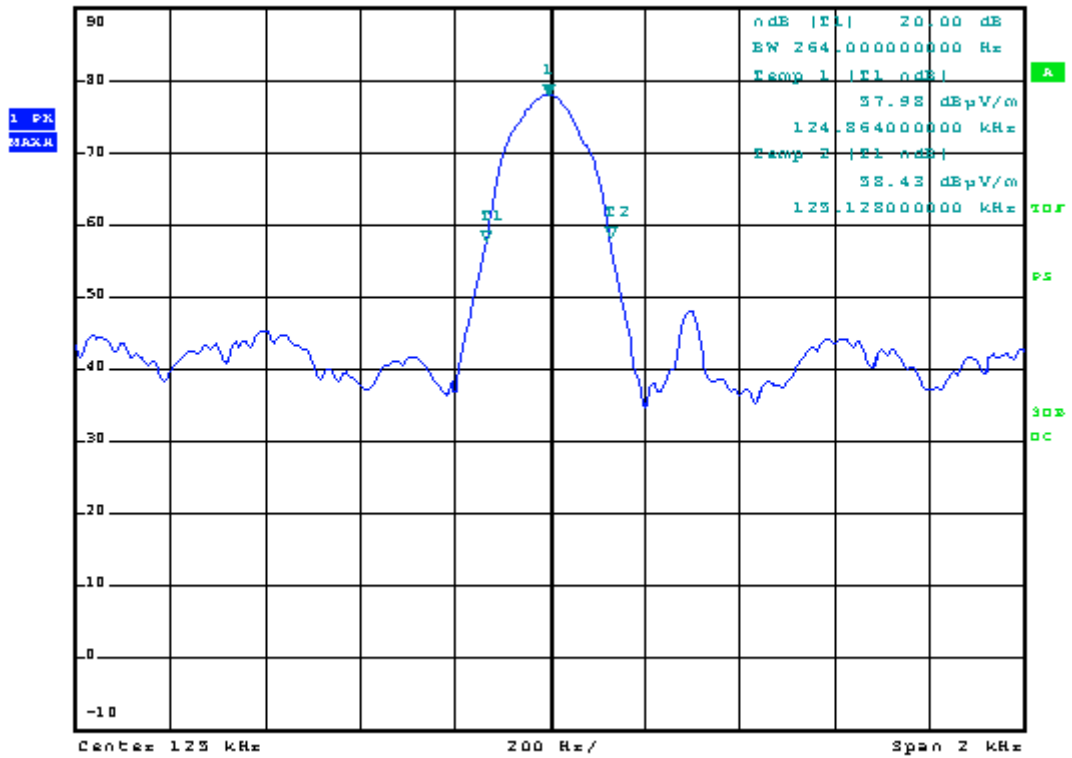
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✓ REW 100 Hz Mask: 1 (|T1|)
 VBW 300 Hz 78.08 dBµV/m
 SWT 240 ms 124.996000000 kHz

Ref 90 dBµV/m ✓ Att 10 dB



Picture 28: -20 dB emission bandwidth for 125 kHz

Measured -20 dB emission bandwidth for 125 kHz: 264 Hz



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7 Equipment calibration status

Description	Modell number	Serial number	Inventory number	Last calibration	Next calibration
Test receiver	ESU 26	100026	W00002	2014-02	2016-02
Test receiver	ESCI 3	100013	E00001	2013-12	2015-12
Test receiver	ESCI 3	100328	E00552	2014-07	2016-07
Test receiver	ESCS 30	825442/0002	E00003	2014-02	2015-02
Test receiver	ESCS 30	845552/0008	E00551	2014-01	2015-01
LISN	ESH2-Z5	881362/037	E00004	2013-03	2015-03
LISN	ESH2-Z5	893406/009	E00005	2014-01	2016-01
Broadband antenna	VULB 9163	9163-114	E00013	2015-09	2015-09
Loop antenna	HFH2-Z2	871398/0050	E00004	2016-07	2016-07
Magnetic field probe	RF-R 400-1	02-1165	E00270	N/A (see note 1)	
Shielded room	P92007	B83117C1109T211	E00107	N/A	
Compact Diagnostic Chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Open area test site (OATS)	---	---	E00354	2014-10	2015-10
Climatic chamber 340 I	VC ³ 4034	58566123250010	C00015	2014-09	2016-09

Table 1: Equipment calibration status

Note 1: Used for relative measurements only (see test instruments for “Carrier frequency stability”, clause 6.2)

Note 2: Expiration date of measurement facility registration (OATS) by
 - FCC (registration number 221458): 2017-04
 - Industry Canada (test site number 3472A-1): 2015-10



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8 Measurement uncertainty

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 3.8 dB	2
Radiated emission open field (3 m) (30 MHz to 300 MHz) (300MHz to 1 GHz)	± 5.4 dB ± 5.9 dB	2
Radiated emission absorber chamber (> 1000 MHz)	± 4.5 dB	2

Table 2: Measurement uncertainty

The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.



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9 Summary

The EMC Regulations according to the marked specifications are

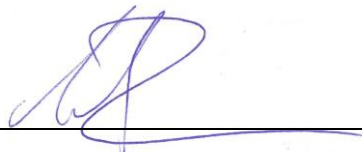
KEPT

The EUT does fulfill the general approval requirements mentioned.

NOT KEPT

The EUT does not fulfill the general approval requirements mentioned.

Place, Date: Straubing, November 24th, 2014



Franz Achatz

Test engineer

EMV **TESTHAUS** GmbH



Rainer Heller

Head of EMC / radio department

EMV **TESTHAUS** GmbH



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10 Revision History

Date	Description	Person	Revision
2014-11-24	First edition	F. Achatz	

Template used: A_1.0_FCC 15.225_EN_PB



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