Test Report

RF Test Report

Industry Canada

Industrie Kanada

268.067-1

Elatec Vertriebs GmbH

RFID Reader

TWN3 Reader Mifare 13,56 MHz
(TWN3MF)

Customer:

Elatec Vertriebs GmbH
Max-Plank-Strasse 16
82223 Eichenau
Germany
Tel.: +49.8141.53498-0
Fax: +49.8414.53498-29

EMV TESTHAUS

The test result refers exclusively
to the model tested.

Revision: 2.0

Deutscher
Akkreditierungs
Rat
DAR

Registration number: DAT-P-224/95-02

EMV **TESTHAUS** GmbH

Gustav-Hertz-Straße 35
94315 Straubing
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
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Accreditation:

Registration number: DAT-P-224/95-02
Valid until 08.06.2011

CAB (EMC) registration number: BNetzA-CAB-02/21-02/1
Valid until 27.11.2008

FCC facility registration number: 221458
Valid until 04.09.2011

Industry Canada registration number: 3472A-1
Valid until 17.07.2010

Place of Inspection:

EMV **TESTHAUS** GmbH
Gustav-Hertz-Strasse 35
94315 Straubing
Germany

The technical accuracy is guaranteed through the quality management of the
EMV **TESTHAUS** GmbH

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Fehler! Es wurden keine Einträge für das Inhaltsverzeichnis gefunden.

1 Test regulations

CFR 47 Part 2: 10-2007	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15: 09-2007	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
ANSI C63.4: December 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
RSS-Gen Issue 2 June 2007	Radio Standards Specification RSS-Gen Issue 2 containing General Requirements and Information for the Certification of Radiocommunication Equimpment, published by Industry Canada
RSS-102: Issue 2 November 2005	Radio Standards Specification RSS-102 Issue 2 Radio Frequency Exposure Compliance of Radiocommunications Apperatus
RSS-210: Issue 7 June 2007	Radio Standards Specification RSS-210 Issue 7 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, published by Industry Canada

2 Summery of test results separated by FCC and Industry Canada

FCC CFR 47 Part 2 and Part 15			
Section	**Test**	**Page**	**Result**
2.1046(a)	Conducted output power	----	Not applicable
2.202(a)	Occupied bandwidth	35	Recorded
15.215(c)	Occupied bandwidth	38	Passed
2.201, 2.202	Class of emission	48	Calculated
15.35(c)	Pulse train measurement	----	Not applicable
15.205(a) 15.205(d)(7)	Restricted bands of operation	----	Passed
15.207	Conducted emission at AC power line 0,150MHz to 30MHz	14	Passed
15.225(a)-(d)	Spectrum mask	10	Passed
15.205(b) 15.215(b) 15.225(a)(d)	Radiated emission 0,009MHz to 30MHz	21	Passed
15.205(b) 15.225(d)	Radiated emission 30MHz to 1000MHz	28	Passed
15.225(e)	Carrier frequency stability	45	Passed

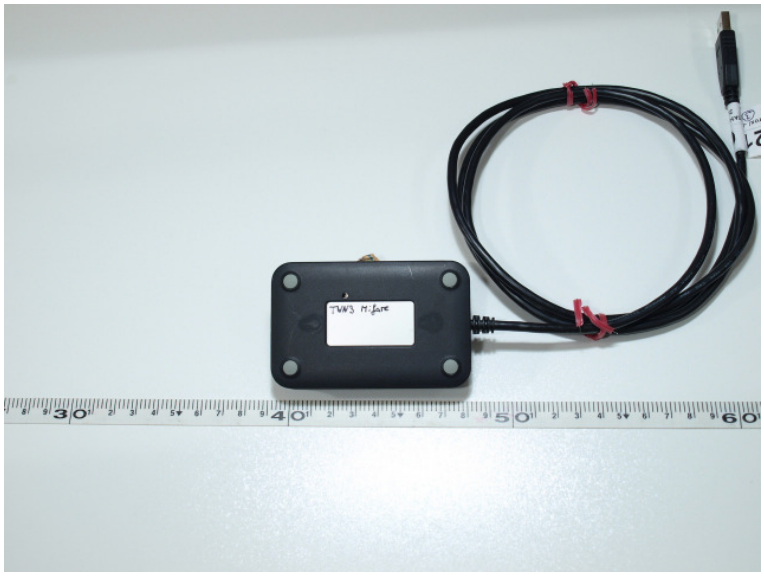
Industry Canada RSS Gen Issue 2			
Section	**Test**	**Page**	**Result**
4.8	Transmitter output power	----	Not applicable
4.6.1	Occupied bandwidth	42	Recorded
3.2(h)	Emission designator	48	Calculated
4.5	Pulsed operation	----	Not applicable
7.2.2	Transmitter AC conducted emission	14	Passed
5.5	Exposure of humans to RF fields	49	Exempted form SAR and RF evaluation

Industry Canada RSS 210 Issue 7			
Section	**Test**	**Page**	**Result**
2.2(a)	Restricted bands and unwanted emission frequencies	----	Passed
A2.6	Spectrum mask	10	Passed
2.2(b)(c), 2.6, A2.6	Unwanted emission 0,009MHz to 30MHz	21	Passed
2.2(b)(c), 2.6, A2.6	Unwanted emission 30MHz to 1000MHz	28	Passed
A2.6	Carrier frequency stability	45	Passed

3 Equipment under Test (EUT)

Device name:	TWN3 Reader Mifare (TWN3MF)
Manufacturer:	Elatec Vertriebs GmbH
Serial number:	Engineering Sample
FCC ID:	WP5TWN3M1
Canada IC:	7948A-TWN3M1
Application freq. band:	13.110MHz – 14.010MHz
Frequency range:	13,1466 MHz – 13,8906 MHz
Operating frequency:	13,56023 MHz
Class of emission:	10K0A1D
Type of modulation:	ASK
Channel spacing:	N/A
Number of RF-channels:	1
Pulse train:	none
Pulse width:	none
Antenna type:	Integrated PCB antenna
	☐ detachable ☑ not detachable
Power supply:	USB powered nominal: 5.0 V minimum: 4.50 V maximum: 5.50 V
Temperature range:	-20°C to +55°C
Interfaces:	N/A

3.1 Photo documentation



Picture 3.1: EUT TWN3 Reader Mifare (TWN3MF)

Picture 3.2: USB cable for EUT TWN3 Reader Mifare (TWN3MF)

3.2 Short description of the EUT

The EUT is a RFID Reader with the operating frequency of 13,56 MHz

3.3 Operation Mode

The EUT was tested in the following operation modes:
- Reading tags continuously. For this mode a software form Elatec was used.

3.4 Configuration

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

Device	Model:	S/N
RFID Reader (EUT)	TWN3 Reader Mifare (TWN3MF)	Engineering Sample
USB Cable	Standard cable form Elatec 1,5m	Engineering Sample
Test Monitor	Belinea 10 17 05 with 1,8m cable attached. Ferrite 10cm away from VGA connector. Power cord 1.8m from Longwell	AA1117230420AC10400802
Test PC	Monitor Test PC 3 with 1,8m power cord form Longwell	302822800136
Mouse	Microsoft Basic Optical 1.0A 950010 with cable 1.5m, ferrite on USB plug side	X8008998

4 Spectrum Mask

according to CFR 47 Part 15, section 15.225 (a)-(d),
RSS-210 Issue 7,section 2.6 and section A2.6

4.1 Test location

☐ Scan with peak detector in 3 m CDC
☐ CISPR measurement with quasi peak detector on 10m open area test site.
☑ Measurement with peak detector on 3m open area test site

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089
Open area test site	EMV **TESTHAUS** GmbH	200017

4.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC)	Rohde & Schwarz	100132
☑	HFH2-Z2	Rohde & Schwarz	100005
☐	VULB 9163 (CDC)	Schwarzbeck	100077
☐	VULB 9160 (FF)	Schwarzbeck	100064

4.3 Limits

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
1.705 – 13.110	30	29.5	30
13.110 -13.410	106	40.5	30
13.410 – 13.553	334	50.5	30
13.553 – 13.567	15848	84.0	30
13.567 – 13.710	334	50.5	30
13.710 – 14.010	106	40.5	30
14.010 – 30.000	30	29.5	30

To calculate the limit for 3m measurement distance the following calculation was used.

$$L_{dm} = L_d + (-40\frac{dB}{dec} * (\log(dm) - \log(d)) - 20$$

L_{dm} = Limit at the new distance

L_d = Limit according ANSI 63.4
dm = Distance according to ANSI 63.4
d = New distance for limit

$$L_{dm} = 29{,}5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) - 20 = 49.5dB$$

$$L_{dm} = 40.5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) - 20 = 60{,}5dB$$

$$L_{dm} = 50.5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) - 20 = 70{,}5dB$$

$$L_{dm} = 84\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) - 20 = 104dB$$

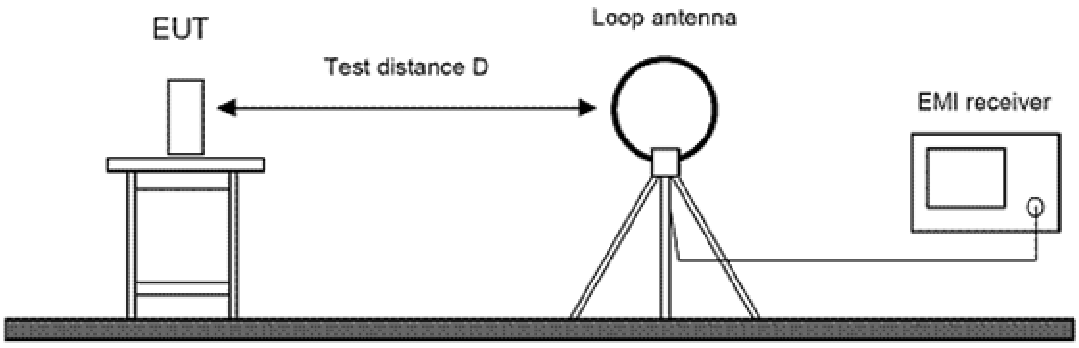
4.4 Test method to demonstrate compliance

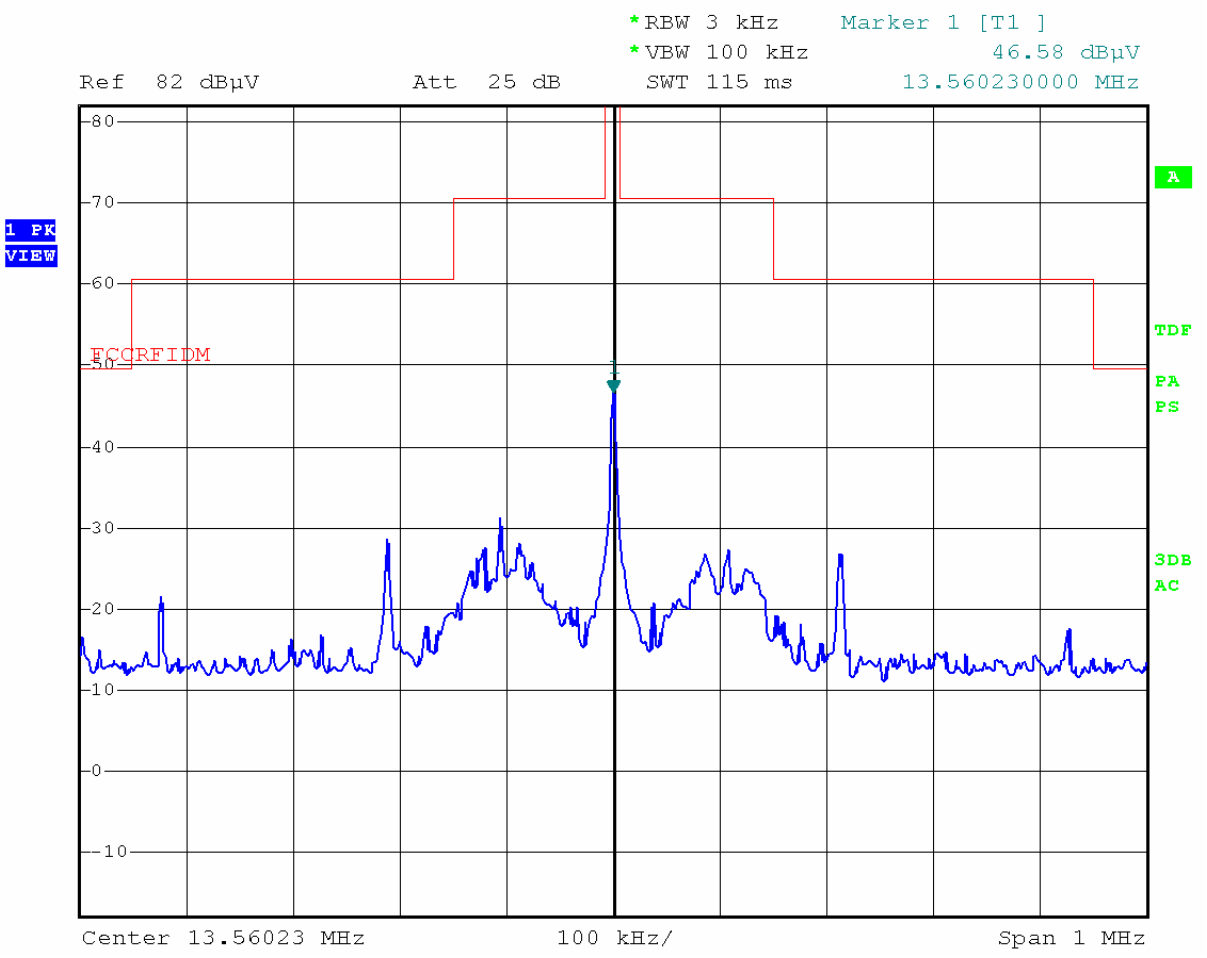
A spectrum analyzer was used and set to a center frequency equal to transmitter frequency. The resolution bandwidth was adjusted to 1 kHz and the video bandwidth at least 3 times higher than the resolution bandwidth. Span was set to 1MHz to cover the whole spectrum mask. The detector was set to maxpeak with hold function.

The spectrum analyzer was connected to a loop antenna with vertical polarization at a measurement distance of 3m on an open area test site. This loop antenna has a correction factor of 20dB. Due to better visibility in the printing the actual spectrum mask limit was reduced by this 20dB. Therefore the picture 3-1: shows the correct distance to the limit, to get the correct field strength 20dB has to be added to the marker value T1.

The EUT was placed on a turntable and rotate 360° to find maximum value. To find the maximum in horizontal polarization the EUT was rotated by 90°.

4.5 Test setup





Picture 4.1:Result of spectrum mask measurement

The actual field strength of the carrier is:

F_S = T1 + 20dB = 46,58dBµV/m + 20dB = 66,58dBµV/m

Expanded uncertainty (0,009 to 30MHz):
$E_{(y)}$ = (y ± 4,25) dBµA/m; k=2.00
y = Indicated value

Comments:

5 Conducted emission test

according to CFR 47 Part 15, section 15.207
RSS-Gen Issue 2, section 7.2.2

5.1 Test Location

Description	Manufacturer	Inventory No.
Shielded chamber	Siemens - Matsushita	200016

5.2 Test Instruments

	Description	Manufacturer	Inventory No.
☑	ESH 3	Rohde & Schwarz	100002
☐	ESCS 30	Rohde & Schwarz	100072
☐	ESCI	Rohde & Schwarz	100132
☑	ESH3 Z2	Rohde & Schwarz	200051
☑	ESH 2-Z5	Rohde & Schwarz	100040

5.3 Limits

Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 - 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

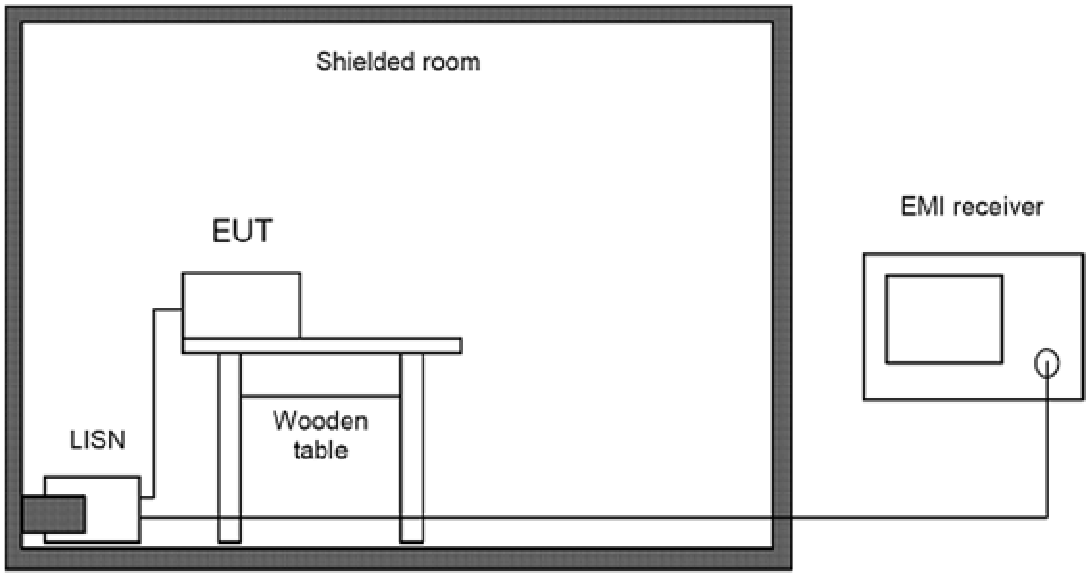
5.4 Test method to demonstrate compliance

The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50µH/50ohms and a EMI test receiver.
The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9kHz in the frequency range form 0.15MHz to 30MHz.
The EUT was placed on a wooden table and connected to the LISN.
To accelerate the measurement the detector of the EMI test receiver was set to peak and the whole frequency range form 0.15MHz to 30MHz were scanned. After that all peaks values with fewer margins than 10dB to quasi-peak limit or exceeding the limit were marked and re-measured with quasi-peak detector. 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 than these values were re-measured again with an average detector.

These measurements were done on all current carrying conductors.

According to ANSI C63.4, section 13.1.3.1 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.

5.5 Test setup



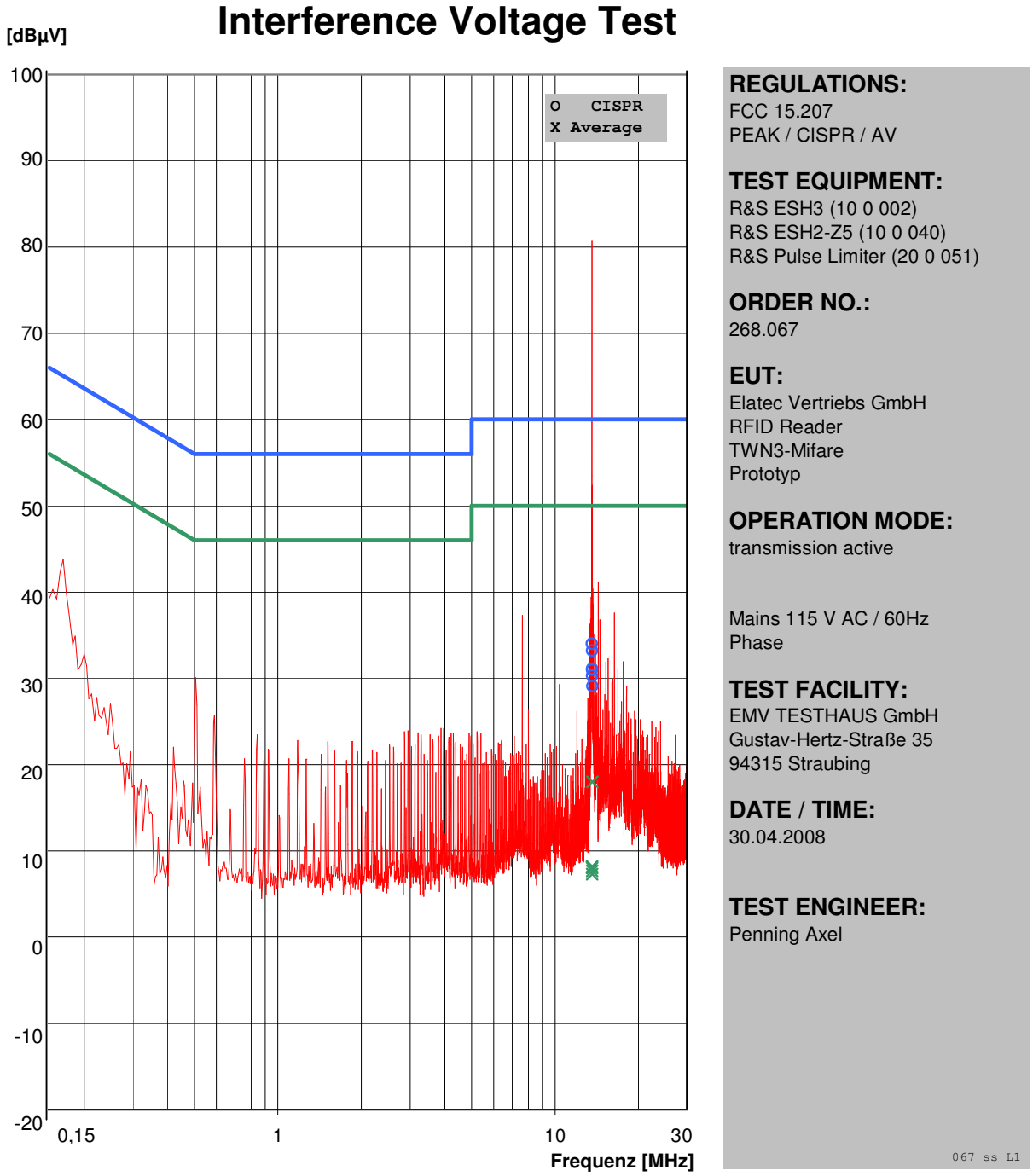
Expanded Uncertainty (9kHz to 150kHz): $U_{(y)}$ = (y ± 4.024) dBµV; k=2.00 y = Indicated value

Expanded Uncertainty (150kHz to 30MHz): $U_{(y)}$ = (y ± 3.604) dBµV; k=2.00 y = Indicated value

Comments: The 13,56MHz disturbance belongs to the carrier frequency, which is exempted for this test. Due to fixed internal antenna a test with 50ohm dummy was not possible.

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

5.6 Test result



Picture 5.1 Conducted emission on mains, phase 1

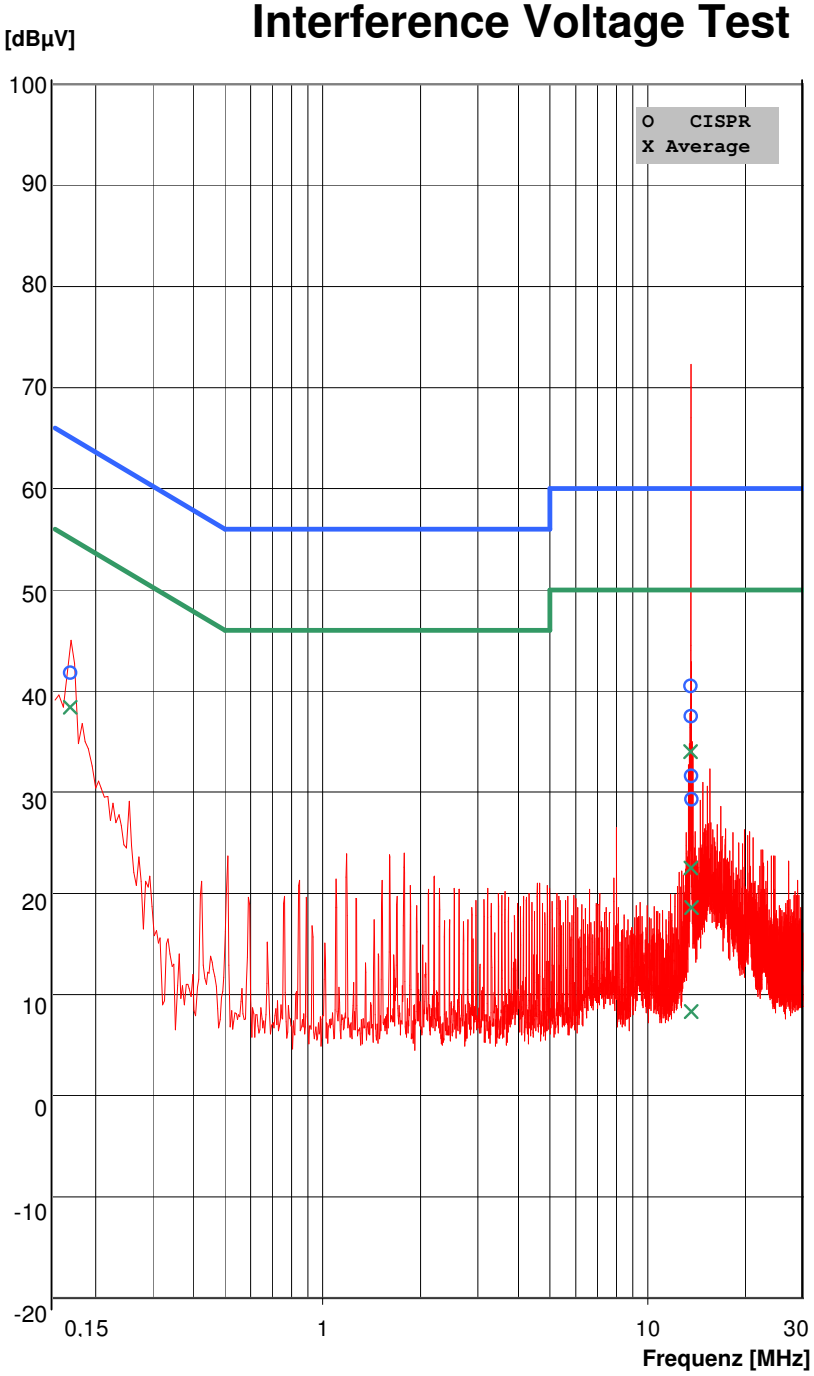
Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
13,58	34,0	60,0	26,0	8,1	50,0	41,9	0,0	
13,59	33,2	60,0	26,8	8,2	50,0	41,8	0,0	
13,60	31,0	60,0	29,0	7,7	50,0	42,3	0,0	
13,60	31,1	60,0	28,9	8,0	50,0	42,0	0,0	
13,61	30,3	60,0	29,7	7,3	50,0	42,7	0,0	
13,61	29,1	60,0	30,9	18,0	50,0	32,0	0,0	

067 ss L1

Table 1 Conducted emission on mains, phase 1

Interference Voltage Test



REGULATIONS:
FCC 15.207
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESH3 (10 0 002)
R&S ESH2-Z5 (10 0 040)
R&S Pulse Limiter (20 0 051)

ORDER NO.:
268.067

EUT:
Elatec Vertriebs GmbH
RFID Reader
TWN3-Mifare
Prototyp

OPERATION MODE:
transmission active

Mains 115 V AC / 60Hz
Neutral

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

DATE / TIME:
30.04.2008

TEST ENGINEER:
Penning Axel

067 ss N Mifare.E10

Picture 5.2 Conducted emission on mains, neutral

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark 067 ss N Mifare.E10
0,17	41,8	65,1	23,3	38,4	55,1	16,7	0,0	
13,55	40,5	60,0	19,5	34,0	50,0	16,0	0,0	
13,57	37,5	60,0	22,5	22,5	50,0	27,5	0,0	
13,60	31,6	60,0	28,4	8,3	50,0	41,7	0,0	
13,61	29,3	60,0	30,7	18,6	50,0	31,4	0,0	

Table 2 Conducted emission on mains, neutral

6 Measurement of radiated emission

according to CFR 47 Part 15, section 15.205(d7), 15.209
RSS-210 Issue 7, section 2.6

6.1 Radiated emission measurement from 9kHz to 30MHz:

6.1.1 Location of measurement

☑ Scan with peak detector in 3 m CDC

☑ Final CISPR measurement with quasi peak detector on 3m open site area.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089
Open site area	EMV **TESTHAUS** GmbH	200017

6.1.2 Measurement equipment

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC and FF)	Rohde & Schwarz	100132
☐	ESVP (FF)	Rohde & Schwarz	100001
☐	VULB 9163 (CDC)	Schwarzbeck	100077
☐	VULB 9160 (FF)	Schwarzbeck	100064
☑	Feedline OATS	Huber & Suhner	200024
☑	HFH2-Z2 (CDC and FF)	Rohde & Schwarz	100005

6.1.3 Limits

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
0.009 – 0.490	266.7 – 4.9	48.5 – 13.8	300
0.490 – 1.705	49.0 – 14.1	33.8 – 23.0	30
1.705 - 30	30	29.5	30

To calculate the limit for 3m measurement distance the following calculation was used.

$$L_{dm} = L_d + (-40\frac{dB}{dec} * (\log(dm) - \log(d))$$

L_{dm} = Limit at the new distance

L_d = Limit according ANSI 63.4
dm = Distance according to ANSI 63.4
d = New distance for limit

$$L_{dm} = 48.5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(300m)) = 128{,}5dB$$ for 0.009MHz

$$L_{dm} = 13.8\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(300m)) = 93.8dB$$ for 0.490MHz (high)

$$L_{dm} = 33.8\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) = 73.8dB$$ for 0.490MHz (low)

$$L_{dm} = 23\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) = 63dB$$ for 1.705MHz (high)

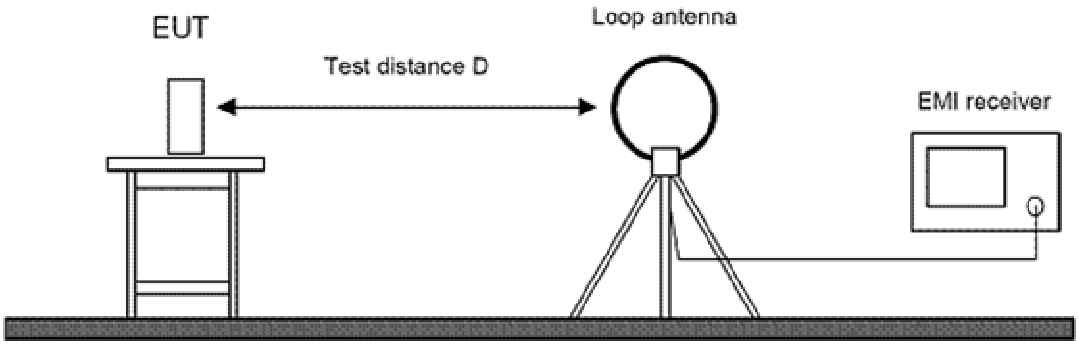
$$L_{dm} = 29.5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) = 69.5dB$$ for 1.705MHz (low)

6.1.4 Test method to demonstrate compliance

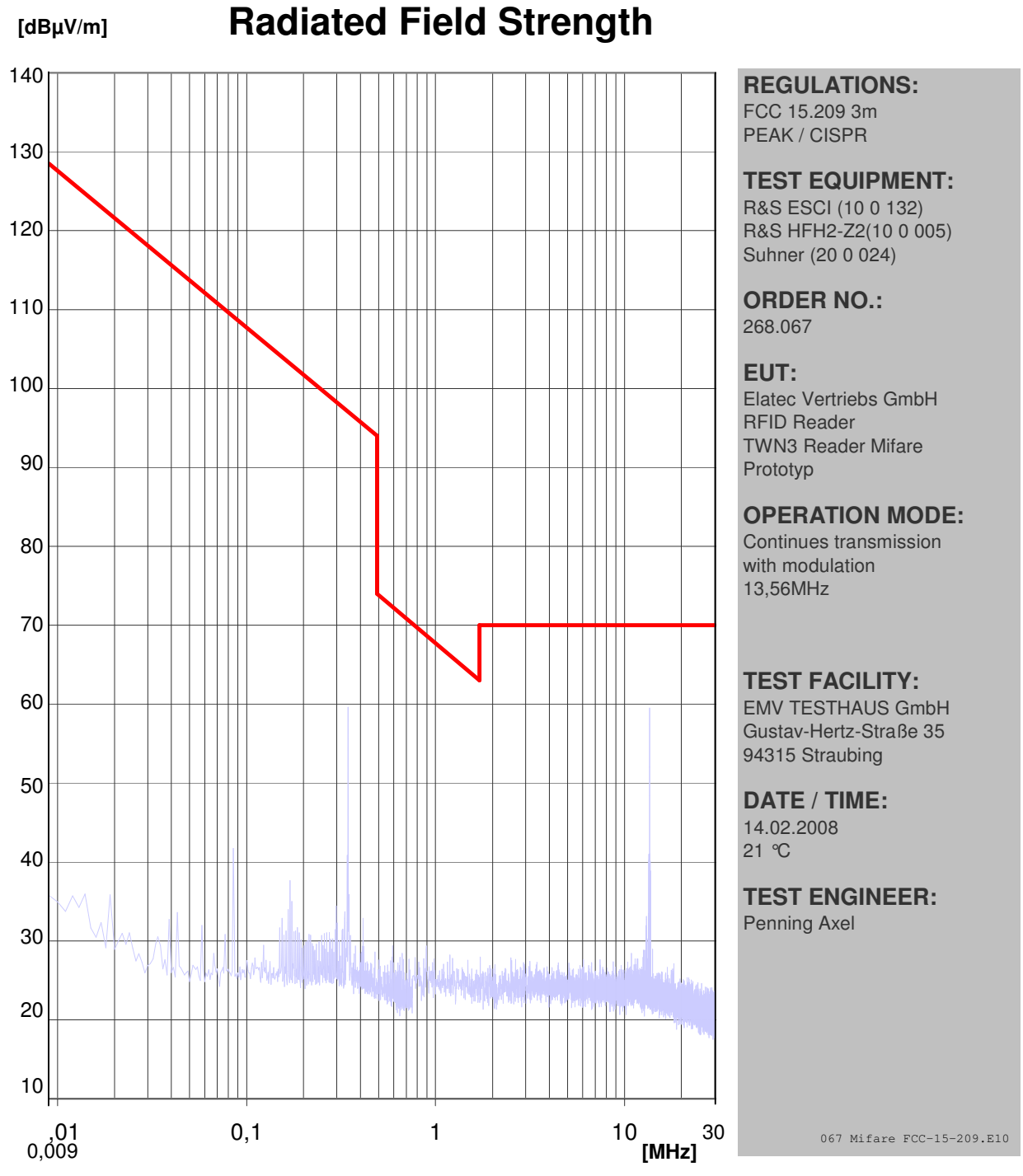
An EMI test receiver was used and connected to the loop antenna. The EUT was placed on a wooden table in a distance of 3m inside a compact diagnostic chamber.. The loop antenna was placed in vertical polarization at an angle of 0° and the EMI receiver performed a scan form 0.009MHz to 30MHz with the detector set to peak and the measurement bandwidth to 200Hz. At .150kHz the measurement bandwidth was changed to 9kHz.
This procedure was repeated at 6 different positions of the EUT by rotating turn table. All peak values over the limit or with less distance to limit then 6dB were marked and re-measured with a quasi-peak detector with the following method on a 3m open area test site.
The turn table was turned 360° to find the position of maximum field strength. After reaching this position the loop antenna was rotated 360° to find the maxima. The measured value was recorded. This measurement was done for all marked frequencies with respect to the appropriate bandwidth for the frequency ranges.

To check the horizontal polarization the EUT was rotated by 90° instead of the loop antenna and the procedure was repeated. Both results are combined inside on graphic.

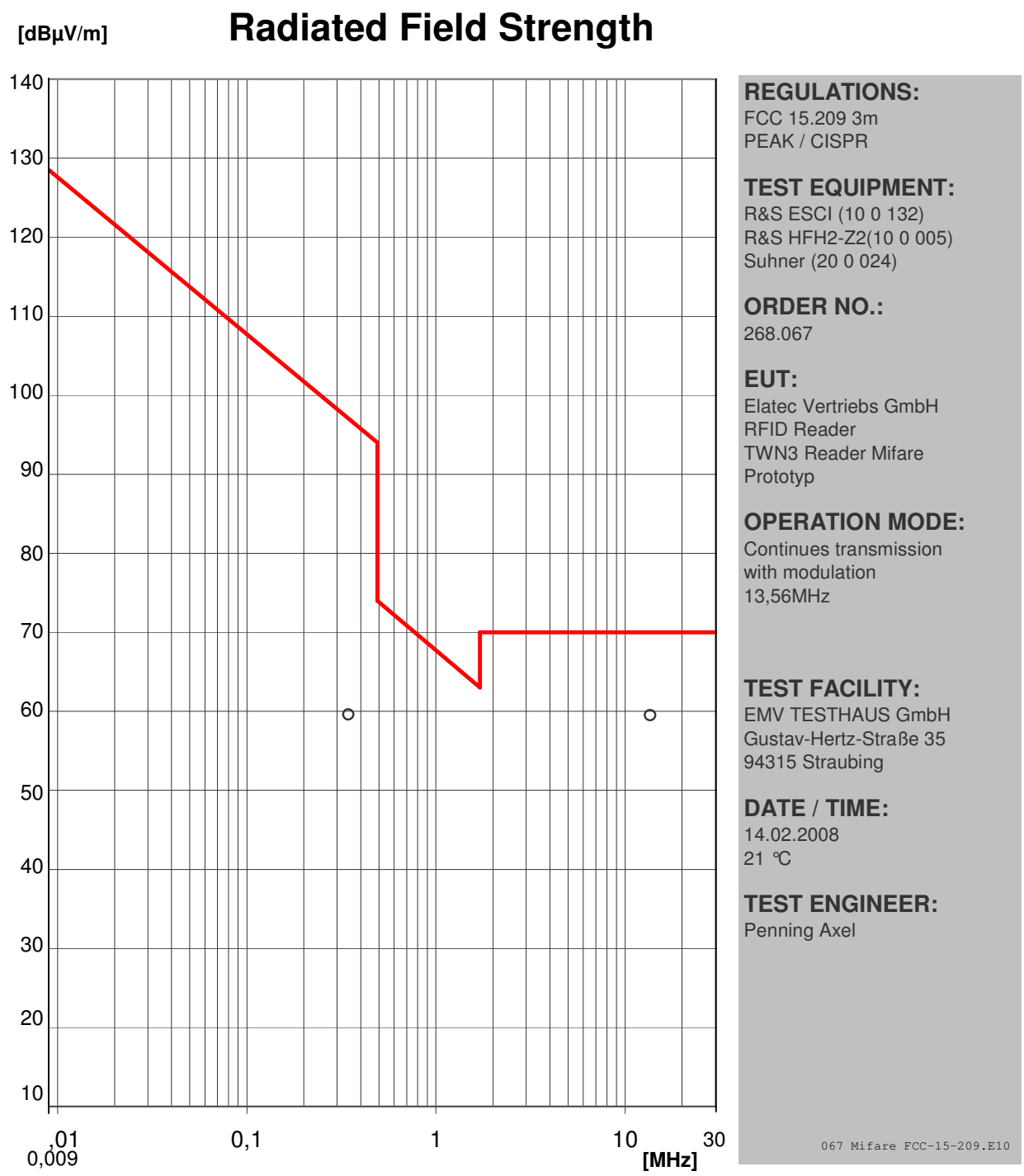
6.1.5 Test setup



6.1.6 Test result



Picture 6.1 Radiated field strength 0,009 MHz – 30 MHz (pre scan)



Picture 6.2 Radiated field strength 0,009 MHz – 30 MHz (final)

Radiated Field Strength

Freq. [MHz]	I_Rec [dBm]	Limit [dBm]	Corr. [dB]	I_Ant. [dBm]	delta_I [dB]	Turn-table	Antenna	Pol.	Remark 067 Mifare FCC-15-209.E10
0,34	59,6	97,1	51,5	8,1	37,4	270°	250 cm	H	
13,56	59,5	70,0	51,5	8,0	10,5	270°	250 cm	H	

Table 3 **Radiated field strength 0,009 MHz – 30 MHz (final)**

Expanded Uncertainty (9kHz to 150kHz):

$U_{(y)}$ = (y ± 4.024) dBµV; k=2.00

y = Indicated value

Expanded Uncertainty (150kHz to 30MHz):

$U_{(y)}$ = (y ± 3.604) dBµV; k=2.00

y = Indicated value

6.2 Radiated emission measurement from 30kHz to 1000MHz

6.2.1 Location of measurement

- ☑ Scan with peak detector in 3 m CDC witch is correlated to the 10m open site area.
- ☑ Final CISPR measurement with quasi peak detector on 10m open site area.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089
Open site area	EMV **TESTHAUS** GmbH	200017

6.2.2 Measurement equipment

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC)	Rohde & Schwarz	100132
☑	ESVP (FF)	Rohde & Schwarz	100001
☑	VULB 9163 (CDC)	Schwarzbeck	100077
☑	VULB 9160 (FF)	Schwarzbeck	100064
☐	HFH2-Z2	Rohde & Schwarz	100005
☑	Feedline OATS	Huber & Suhner	200024

6.2.3 Limits

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

To calculate the limit for 10m measurement distance the following calculation was used.

$$L_{dm} = L_d + (-20\frac{dB}{dec} * (\log(dm) - \log(d))$$

L_{dm} = Limit at the new distance

L_d = Limit according ANSI 63.4
d = Distance according to ANSI 63.4
dm = New distance for limit

$$L_{dm} = 40\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(10m) - \log(3m)) = 30dB$$ for 30MHz to 88MHz

$$L_{dm} = 43{,}5\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(10m) - \log(3m)) = 33.5dB$$ for 88MHz to 216MHz

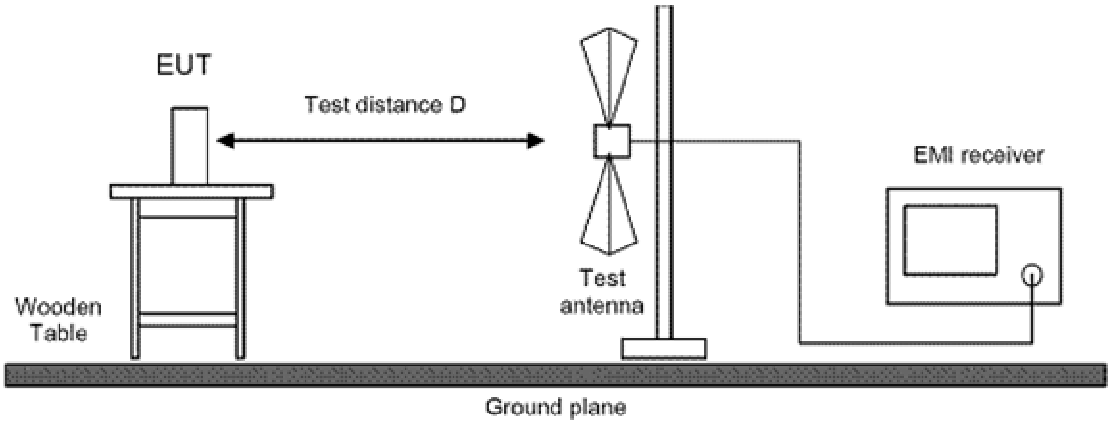
$$L_{dm} = 46\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(10m) - \log(3m)) = 36dB$$ for 216MHz to 960MHz

$$L_{dm} = 54\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(10m) - \log(3m)) = 44dB$$ above 960MHz

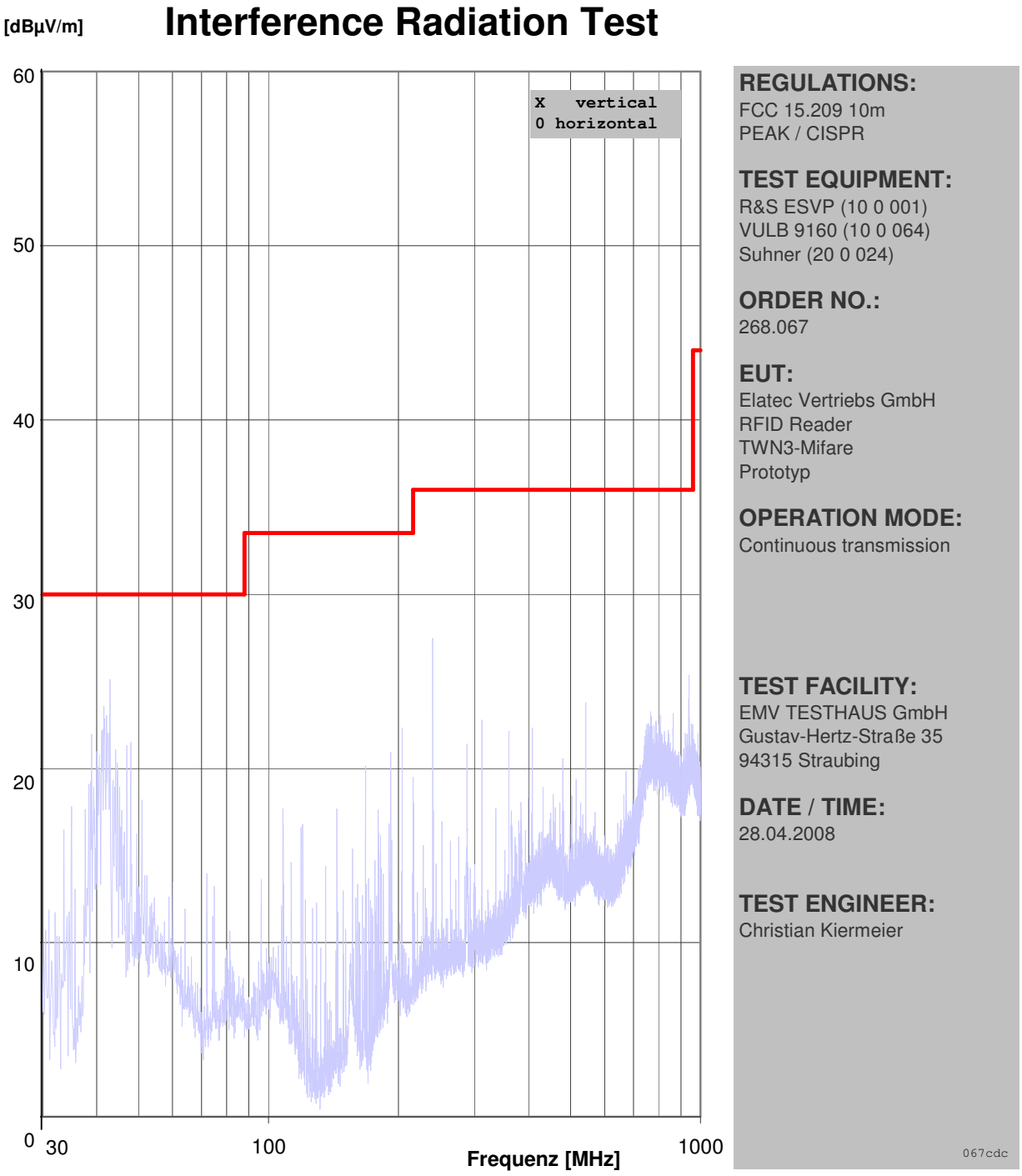
6.2.4 Test method to demonstrate compliance

An EMI test receiver was used and connected to a broadband antenna. The EUT was placed on a wooden table in a distance of 3m inside a compact diagnostic chamber. This chamber is a fully anechoic chamber and correlated to our 10m open site. Therefore the 10m limit was applicable for the pre-scan inside this chamber.
The broadband antenna was placed in vertical polarization and the EMI receiver performed a scan from 30MHz to 1000MHz with the detector set to peak and the measurement bandwidth to 120kHz.
This procedure was repeated at 6 different positions of the EUT by rotating turn table. After that die polarization switched to horizontal and repeated this procedure. After all 12 scans the results of the two polarizations were combined.
All peak values over or with less distance to limit then 6dB were marked and re-measured with a quasi-peak detector with the following method on a 10m open area test site.
The turn table was turned 360° to find the position of maximum field strength. After reaching this position the antenna was moved form 1m to 4m height to find the maximum value. This value was recorded.

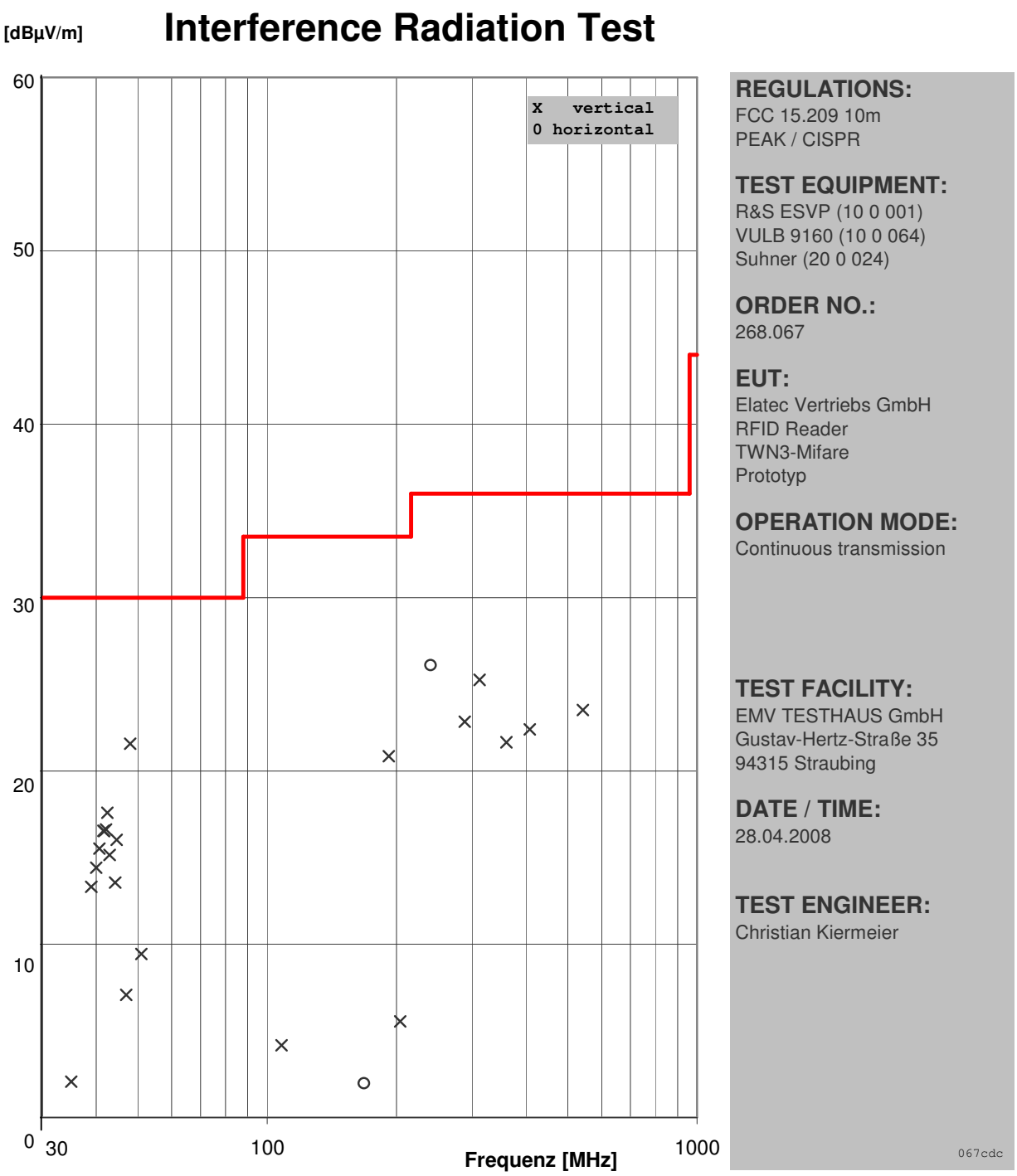
6.2.5 Test setup



6.2.6 Test result



Picture 6.3 Radiated emission 30 MHz – 1000MHz (pre scan)



Picture 6.4 Radiated emission 30 MHz – 1000MHz (final)

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 067cdc
35,00	2,1	30,0	5,3	-3,2	27,9	238°	100 cm	V	
39,00	13,3	30,0	7,5	5,8	16,7	204°	100 cm	V	
40,00	14,4	30,0	8,0	6,4	15,6	203°	100 cm	V	
40,70	15,5	30,0	8,3	7,2	14,5	223°	100 cm	V	
41,60	16,5	30,0	8,8	7,8	13,5	204°	100 cm	V	
41,80	16,5	30,0	8,9	7,7	13,5	188°	100 cm	V	
42,20	16,6	30,0	9,1	7,6	13,4	204°	100 cm	V	
42,50	17,6	30,0	9,2	8,4	12,4	217°	100 cm	V	
43,00	15,1	30,0	9,4	5,7	14,9	236°	100 cm	V	
44,30	13,6	30,0	10,0	3,5	16,4	211°	100 cm	V	
44,70	16,0	30,0	10,2	5,8	14,0	220°	100 cm	V	
47,00	7,1	30,0	10,6	-3,5	22,9	204°	100 cm	V	
48,00	21,6	30,0	10,7	10,9	8,4	217°	100 cm	V	
51,00	9,4	30,0	10,7	-1,2	20,6	218°	100 cm	V	
108,00	4,2	33,5	7,6	-3,4	29,3	292°	100 cm	V	
167,80	2,0	33,5	3,2	-1,3	31,5	255°	100 cm	H	
192,00	20,8	33,5	8,7	12,1	12,7	68°	100 cm	V	
204,00	5,6	33,5	8,6	-3,0	27,9	81°	100 cm	V	
240,00	26,1	36,0	10,4	15,7	9,9	54°	100 cm	H	
288,00	22,8	36,0	10,1	12,7	13,2	296°	100 cm	V	
312,00	25,3	36,0	10,7	14,5	10,7	292°	100 cm	V	
360,00	21,7	36,0	11,7	10,0	14,3	97°	100 cm	V	
408,00	22,4	36,0	13,3	9,1	13,6	124°	100 cm	V	
542,40	23,5	36,0	14,0	9,5	12,5	97°	100 cm	V	

Table 4 Radiated emission 30 MHz – 1000MHz (final)

Expanded uncertainty (30MHz to 300MHz): $E_{(y)}$ = (y ± 4.994) dBµV/m; k=2.00 y = Indicated value

Expanded uncertainty (300MHz to 1000MHz): $E_{(y)}$ = (y ± 5.276) dBµV/m; k=2.00 y = Indicated value

Comments:

7 Occupied Bandwidth (99%)

according to CFR 47 Part 2 section 2.202

7.1 Test location

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089

7.2 Test Instruments

	Description	Manufacturer	Inventory No.
☑	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC)	Rohde & Schwarz	100132
☑	HFH2-Z2	Rohde & Schwarz	100005
☐	VULB 9163 (CDC)	Schwarzbeck	100077
☐	VULB 9160 (FF)	Schwarzbeck	100064

7.3 Test method to demonstrate compliance

The EUT has no detachable antenna therefore the radiated method was used

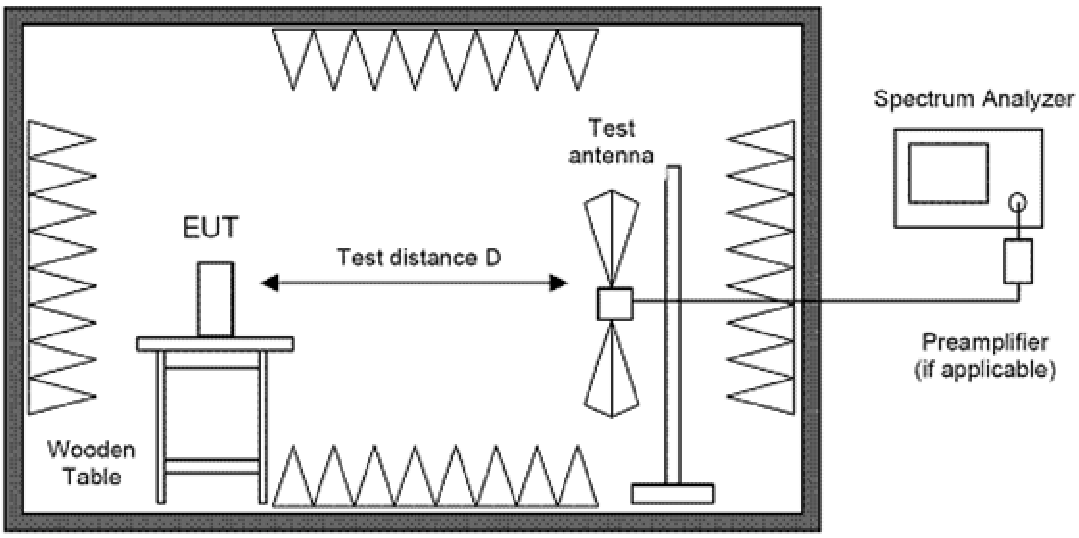
The occupied bandwidth is measured as the 99% bandwidth. For this measurement the occupied bandwidth function of the spectrum analyzer was used.

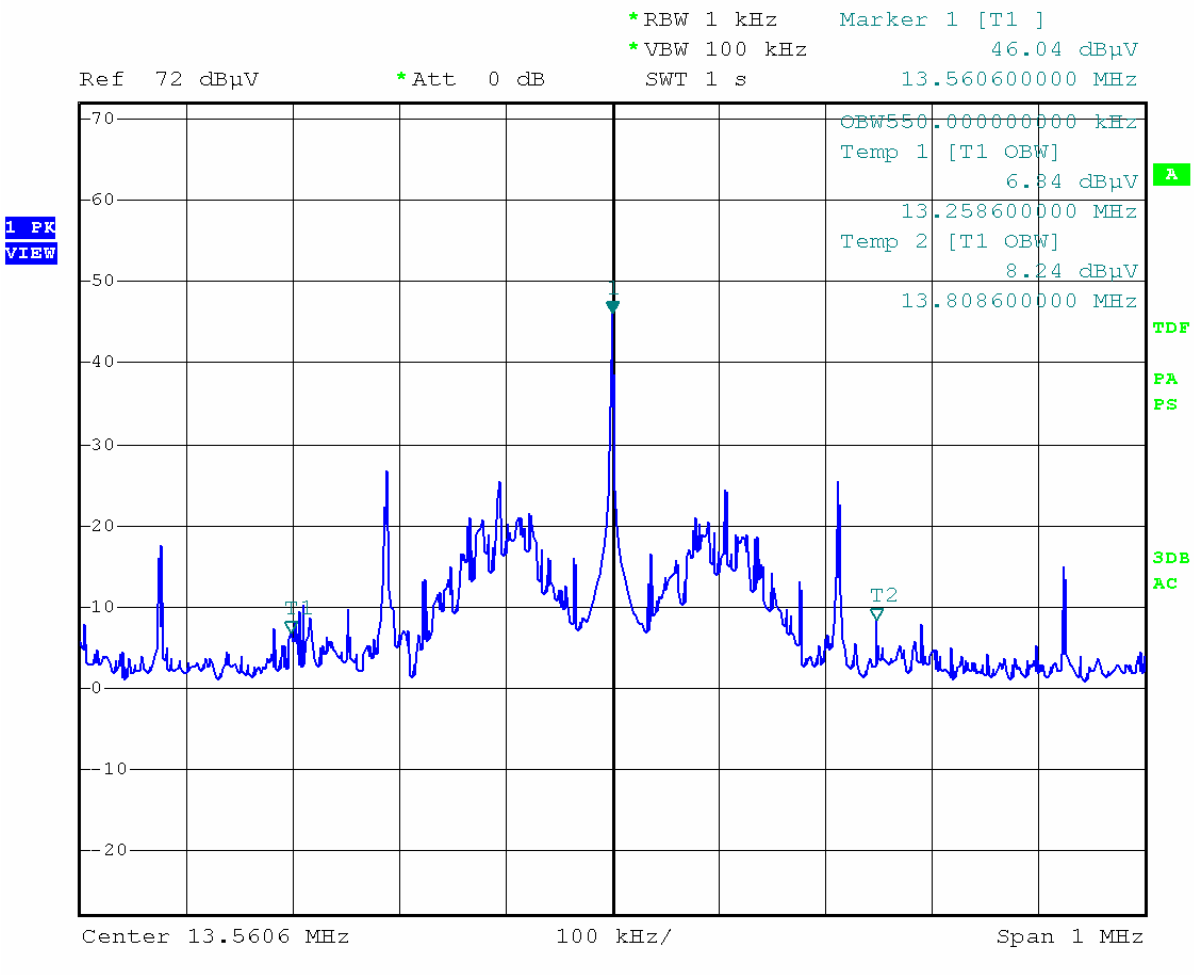
The resolution bandwidth of the spectrum analyzer shall be set to a greater value than 5% of the allowed bandwidth.
Because no resolution bandwidth was given the following guideline from ANSI C63.4 annex H6 was consulted.

Fundamental frequency	Minimum resolution bandwidth
0.009MHz to 30MHz	1kHz
30MHz to 1000MHz	10kHz
1000MHz to 40000MHz	100kHz

The video bandwidth was adjusted at least 3 times wider than the resolution bandwidth

7.4 Test setup





Picture 7.1: Occupied bandwidth 99%

Frequency lower value:	13,258MHz	Limit: 13,110MHz
Frequency upper value:	13,808MHz	Limit: 14,010MHz
Occupied Bandwidth:	550kHz	

8 Occupied Bandwidth (20dB)

according to FCC Part 15, section 15.215(c)

8.1 Test location

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089

8.2 Test Instruments

	Description	Manufacturer	Inventory No.
☑	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC)	Rohde & Schwarz	100132
☑	HFH2-Z2	Rohde & Schwarz	100005
☐	VULB 9163 (CDC)	Schwarzbeck	100077
☐	VULB 9160 (FF)	Schwarzbeck	100064

8.3 Test method to demonstrate compliance

The EUT has no detachable antenna therefore the radiated method was used

The 20 dB bandwidth of the emission is measured as the frequency range defined by the points that are 20 dB down relative to the maximum level of the modulated carrier.
For intentional radiators operating under the alternative provisions to the general emission limits the requirement to contain the 20 dB bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature

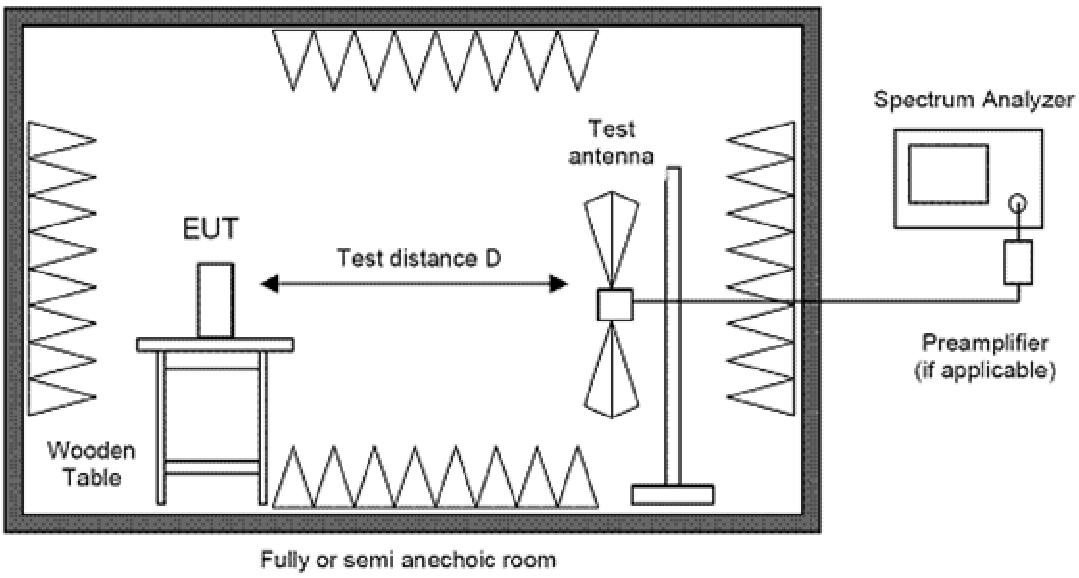
and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation

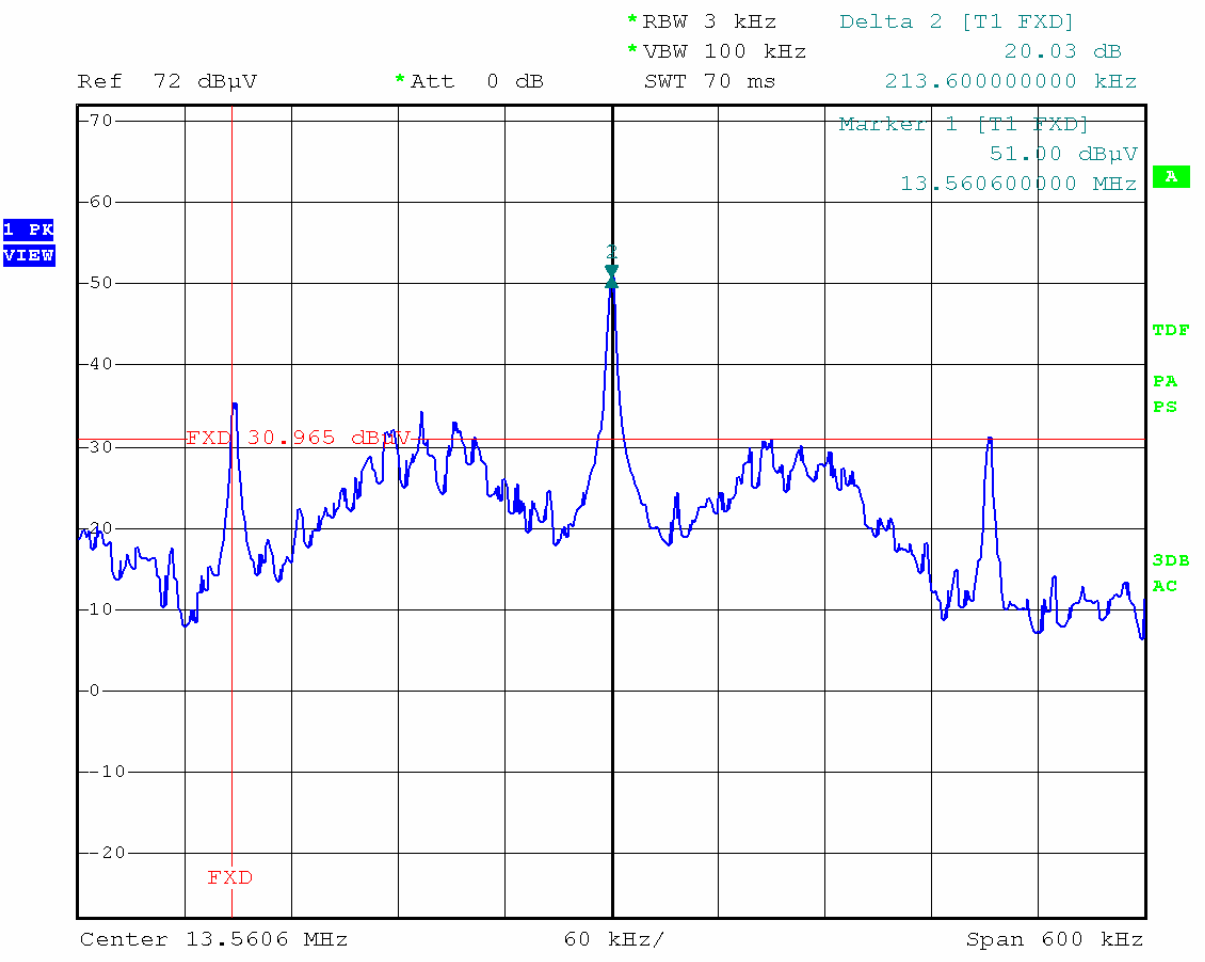
The resolution bandwidth of the spectrum analyzer shall be set to a greater value than 5% of the allowed bandwidth.
Because no resolution bandwidth was given the following guideline from ANSI C63.4 annex H6 was consulted.

Fundamental frequency	Minimum resolution bandwidth
0.009MHz to 30MHz	1kHz
30MHz to 1000MHz	10kHz
1000MHz to 40000MHz	100kHz

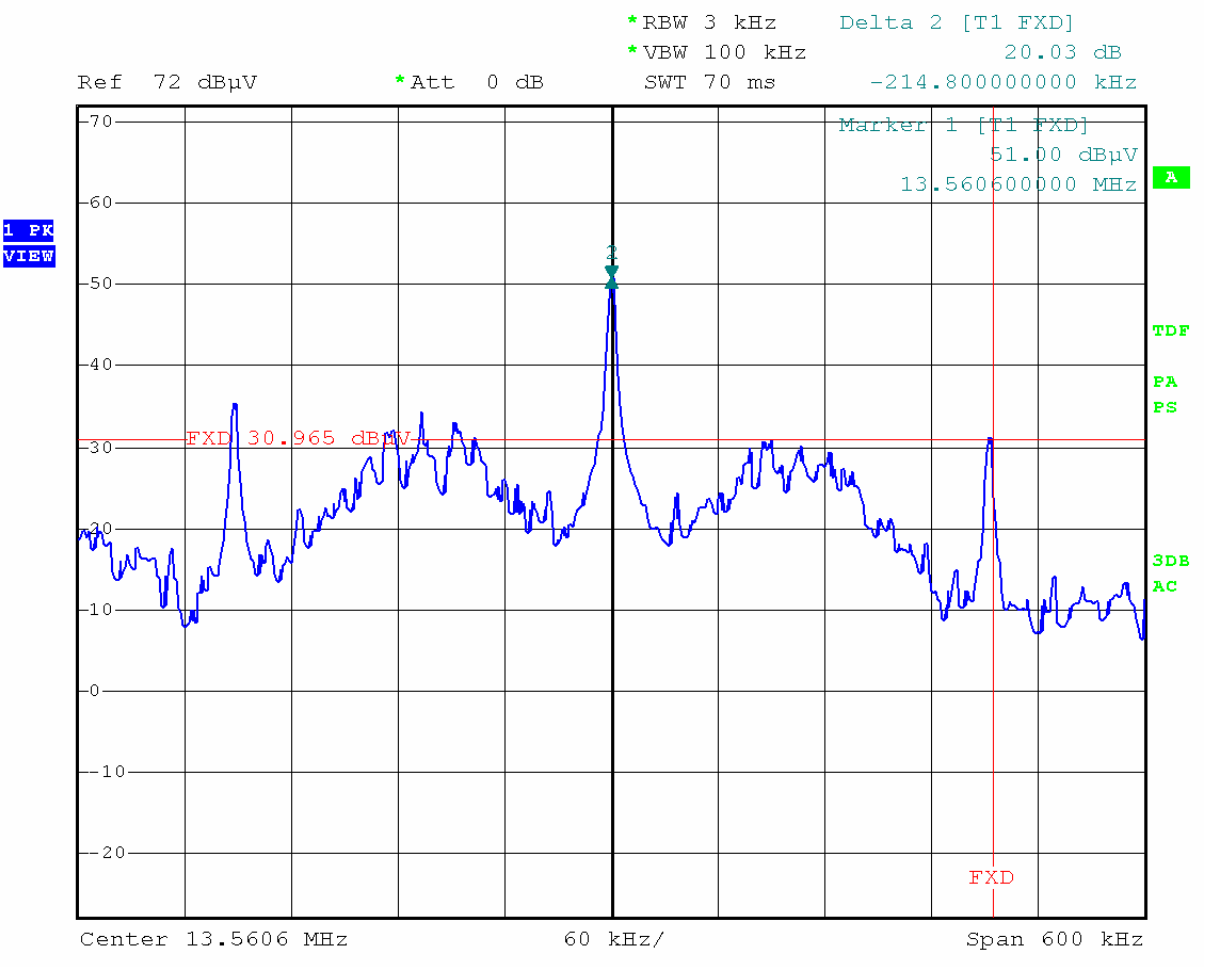
The video bandwidth was adjusted at least 3 times wider than the resolution bandwidth

8.4 Test setup





Picture 8.1: Occupied bandwidth lower value



Picture 8.2: Occupied bandwidth upper value

Frequency lower value:	13,3470MHz	Limit: 13,110MHz
Frequency upper value:	13,7754MHz	Limit: 14,010MHz
Occupied Bandwidth:	428,4kHz	

9 Occupied Bandwidth (99%)

according to RSS Gen Issue 2, section 4.6.1

9.1 Test location

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	100089

9.2 Test Instruments

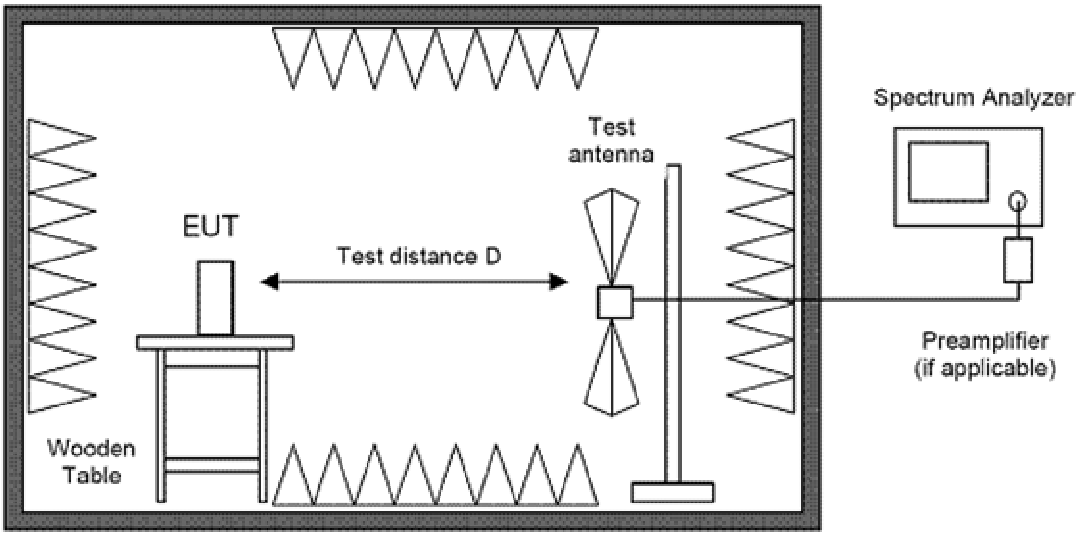
	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	100072
☑	ESCI (CDC)	Rohde & Schwarz	100132
☑	HFH2-Z2	Rohde & Schwarz	100005
☐	VULB 9163 (CDC)	Schwarzbeck	100077
☐	VULB 9160 (FF)	Schwarzbeck	100064

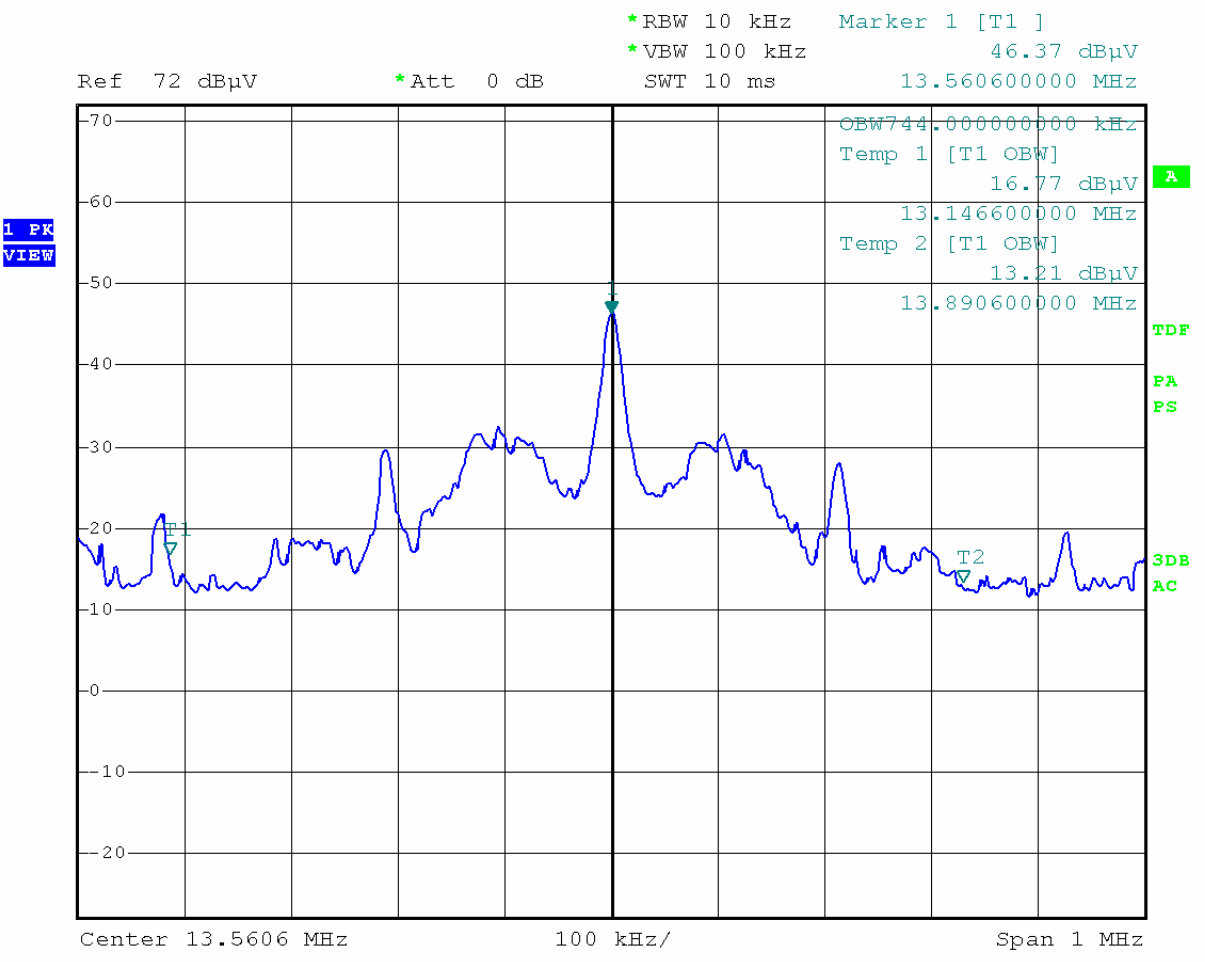
9.3 Test method to demonstrate compliance

The EUT has no detachable antenna therefore the radiated method was used

If not specified in the applicable RSS the occupied bandwidth is measured as the 99% emission bandwidth.
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.
The trace data points are recovered and are 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 also recorded. The span between the two recorded frequencies is the occupied bandwidth.

9.4 Test setup





Picture 9.1: Occupied bandwidth 99%

Frequency lower value:	13,1466MHz	Limit: 13,110MHz
Frequency upper value:	13,8906MHz	Limit: 14,010MHz
Occupied Bandwidth:	744kHz	

10 Carrier frequency stability

according to CFR 47 Part 15, section 15.225(e)
RSS-Gen Issue 2, section 7.2.4 and 4.7(b)

10.1 Test location

	Description	Manufacturer	Inventory No.
☑	Climatic Chamber VC4100	Vötsch	110023
☐	Climatic Chamber VC^{3}4043	Vötsch	110040

10.2 Test Instruments

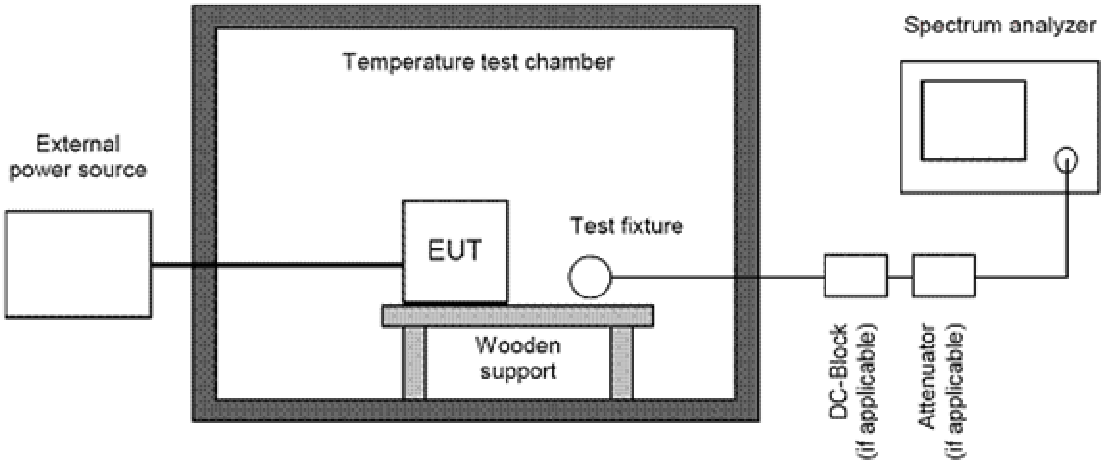
	Description	Manufacturer	Inventory No.
☑	ESCI	Rohde & Schwarz	100132
☑	Test Probe RFR400-1	Langer	200086
☑	Power Supply	Statron	300193
☑	Multimeter	Metra Hit 29S	100080
☐	USLP 9142	USLP 9142	100044

10.3 Test method to demonstrate compliance

The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °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 °C.
If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as dc block and appropriate attenuators (50 Ohms). In cases where the EUT does not provide an antenna connector a test fixture is used.

For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:
• the maximum battery voltage as delivered by a new battery or 115% of the battery nominal voltage
• the battery nominal voltage
• 85% of the battery nominal voltage
• the battery operating end point voltage which shall be specified by the equipment manufacturer
The EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and the 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

10.4 Test setup



10.5 Carrier vs. temperature

Supply Voltage 5V		Nominal frequency 13.56023 MHz	
Temperature	Carrier frequency	Δ Frequency	Deviation
℃	MHz	Hz	Ppm
-20	13,56060	+370	+27,3
-10	13,56048	+250	+18,4
0	13,56035	+120	+8,8
+10	13,56025	+20	+1,5
+20	13,56023	0	0
+30	13,56030	+70	+5,2
+40	13,56056	+330	+25,3
+50	13,56070	+470	+34,7
Limit ± 100ppm			

10.6 Carrier vs. input voltage

Temperature 20℃		Nominal frequency 13.56023 MHz	
Voltage	Carrier frequency	Δ Frequency	Deviation
V	MHz	Hz	ppm
4,25	13,56024	+10	+0,7
5V	13,56023	0	0
5,75	13,56026	+30	+2,2
Limit ± 100ppm			

11 Designation of Emissions

according to CFR 47 Part 2, Sections 2.201 and 2.202
RSS-Gen Issue 2, Sections 3.2(h) and 8

11.1 Designation

Type of Modulation:	Amplitude Modulation
Necessary Bandwidth: Modulation Rate: Overall numerical Factor:	$B_n = 2 \cdot B \cdot K$ $B = 5kHz$ $K = 1$ $B_n = 2 \cdot 5kHz \cdot 1 = 10kHz$
Designation of Emissions according ITU-R:	**10K0A1D**

Remarks:

12 Exposure of Humans to RF Fields

according to RSS-Gen Issue 2, section 5.5 and RSS-102 Issue 2, section 2.5

12.1 Antenna type and power calculation

☐ Antenna detachable

$$EIRP = G \cdot CP$$

G: numerical antenna gain
CP: conducted output power [W]

☑ Antenna not detachable

$$EIRP = \frac{(F_s \cdot D)^2}{30}$$

Fs: field strength [V/m]
D: distance between antennas [m]

$$EIRP = \frac{(1.30 \cdot 3)^2}{30} = 507nW$$

12.2 Distance between user and transmitting device*

☑ Distance >20cm

☐ Distance <20cm

*declared by applicant

12.3 Exemption from SAR evaluation

SAR evaluation is required if separation distance between user and devices is less than, or equal to 20cm, except the device operates:

☑ from 3 kHz up to 1 GHz inclusively and its source based time-averaged output power is <= 200 mW for general public use and <= 1000 mW for controlled use.

☐ above 1 GHz up to 2.2 GHz inclusively and its source-based time-averaged output power is <= 100 mW for general public use and <= 500 mW for controlled use.

☐ above 2.2 GHz up to 3 GHz inclusively and its source-based time-averaged output power is <= 20 mW for general public use and <= 100 mW for controlled use.

☐ above 3 GHz up to 6 GHz inclusively and its source-based time-averaged Output power is <= 10 mW for general public use and <= 50 mW for controlled use.

See output power calculation 12.1

12.4 Exemption from RF exposure evaluation

RF exposure evaluation is required if separation distance between user and devices is greater than 20cm, except the device operates:

☑ below 1,5GHz and its e.i.r.p is equal to, or less than 2.5W.

☐ above 1,5GHz and the e.i.r.p of the device is equal to or less than 5W.

See output power calculation 12.1

13 Equipment Calibration Status

Inventory Number	Model Number	Manufacturer	Last calibration	Next calibration	Cycle of calibration
100132	ESCI	Rohde & Schwarz	June 07	June 09	2 Years
100005	HFH2-Z2	Rohde & Schwarz	July 07	July 09	2 Years
100002	ESH 3	Rohde & Schwarz	Oct. 07	Oct. 08	1 Year
200051	ESH3 Z2	Rohde & Schwarz	Oct. 07	Oct. 08	1 Year
100040	ESH 2-Z5	Rohde & Schwarz	Oct. 07	Oct. 09	2 Years
100041	ESH 2-Z5	Rohde & Schwarz	Aug. 08	Aug. 10	2 Years
100072	ESCS 30	Rohde & Schwarz	July 08	July 09	1 Year
100001	ESVP	Rohde & Schwarz	Sep. 07	Sep. 08	1 Year
100077	VULB 9163	Schwarzbeck	April 08	April 10	2 Years
100064	VULB 9160	Schwarzbeck	March 07	March 09	2 Years
110040	VC^{3}4034	Vötsch	June 08	June 10	2 Years
110023	VC4100	Vötsch	January 07	January 09	2 Years
100080	Multimeter	Metra Hit 29S	Mai 08	Mai 09	1 Year

14 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, September 15, 2008

Christian Kiermeier	Dipl. Ing. (FH) Axel Penning
EMI / EMC Test Engineer	TM / EMV **TESTHAUS** GmbH