Test Report

Customer:

SCM Microsystems (India) Pvt. Ltd.
D' Block South, 5th Floor
Tidel Park, 4 Canal Bank Road
600113 Chennai
Tel.: +91 44 2254 / 0020
Fax: +91 44 2254 / 0029561

RF test report

100264-AU01+W02

SCM Microsystems Pvt. Ltd.

USB RFID reader

SDI011

EMV TESTHAUS

The test result refers exclusively to the model tested.

This report must not be copied without the written authorization by the lab.
Revision: 2.0

Deutscher Akkreditierungs Rat DAR

Registration number: DGA-PL-224/95-03

EMV **TESTHAUS** GmbH

Gustav-Hertz-Straße 35
94315 Straubing
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: company@emv-testhaus.com

Accreditation:

Registration number: DGA-PL-224/95-03
CAB (EMC) registration number: BNetzA-CAB-02/21-02/3
FCC facility registration number: 221458
MRA US-EU, FCC designation number: DE0010

Location of Test:

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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1 Test regulations

CFR 47 Part 2: 10-2008	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: 10-2008	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

2 Summary of test results

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	44	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 0.150 MHz to 30 MHz	14	Passed
15.225(a)-(d)	Spectrum mask	10	Passed
15.205(b) 15.215(b) 15.225(a)(d)	Radiated emission 0.009 MHz to 30 MHz	25	Passed
15.205(b) 15.225(d)	Radiated emission 30 MHz to 1000 MHz	29	Passed
15.225(e)	Carrier frequency stability	41	Passed

3 Equipment under Test (EUT)

Device name:	USB RFID reader SDI011
Manufacturer:	SCM Microsystems Pvt. Ltd.
Serial number:	Prototype
FCC ID:	MBPSDI011-1000
Application freq. band:	13.110MHz – 14.010MHz
Frequency range:	13.5600 MHz
Operating frequency:	13.5600 MHz
Class of emission:	10K0A1D
Type of modulation:	ASK
Channel spacing:	---
Number of RF-channels:	1
Pulse train:	none
Pulse width:	none
Antenna type:	Internal PCB loop antenna
	☐ detachable ☑ not detachable
Power supply:	USB-Bus powered nominal: 5 VDC
Temperature range:	-20°C to +55°C
Interfaces:	N/A

3.1 Photo documentation

See annex C

3.2 Short description of the EUT

The EUT is a USB RFID Reader with an operating frequency of 13.56 MHz

3.3 Operation Mode

The EUT was tested in the following operation modes:

- Reading tags continuously. The EUT was preconfigured for this operation mode.
- The EUT employs a combined receiver and transmitter that cannot be operated separately.
- The Software used for the tests was TestResMan Version 1.49.
- The EUT was operated in contactless mode with an RFID tag and in contact mode with a smart card.

3.4 Configuration

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

Device	Model:	S/N
RFID Reader (EUT)	SDI011	Prototype
Test Notebook	ECO 4000 IW	N/A

Used cables

Numbers:	Description: (type / lengths / remarks)	Serial No
1	EUT: non-detachable USB cable (shielded / 1.5m)	N/A
2	Power cord (unshielded / 1.2m)	N/A

4 Spectrum Mask

according to CFR 47 Part 15, section 15.225 (a)-(d)

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	E00026
Open area test site	EMV **TESTHAUS** GmbH	200017

4.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☑	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (CDC)	Schwarzbeck	E00013
☐	VULB 9160 (FF)	Schwarzbeck	E00011

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

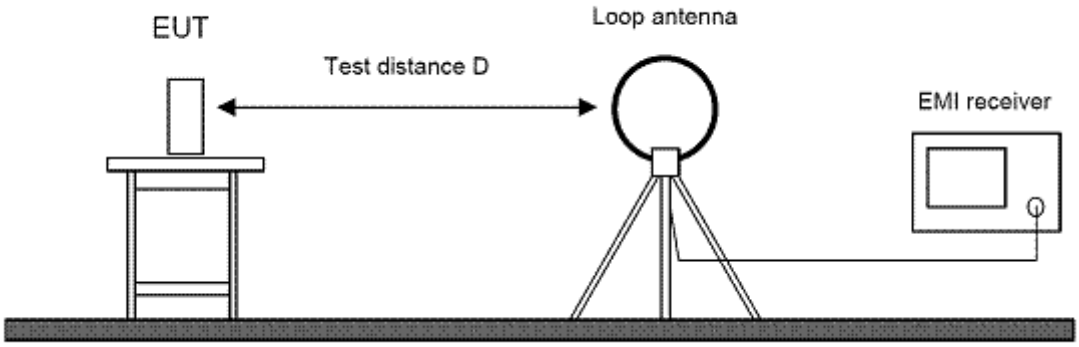
A spectrum analyzer was used and set to a center frequency equal to transmitter frequency. The resolution bandwidth was adjusted to 10 kHz and the video bandwidth at least 3 times higher than the resolution bandwidth. Span was set to 1 MHz to cover the whole spectrum mask. The detector was set to maxpeak with hold function.

The spectrum analyzer was connected to a loop antenna in vertical polarization at a measurement distance of 3 m on an open area test site. This loop antenna has a correction factor of 20 dB.

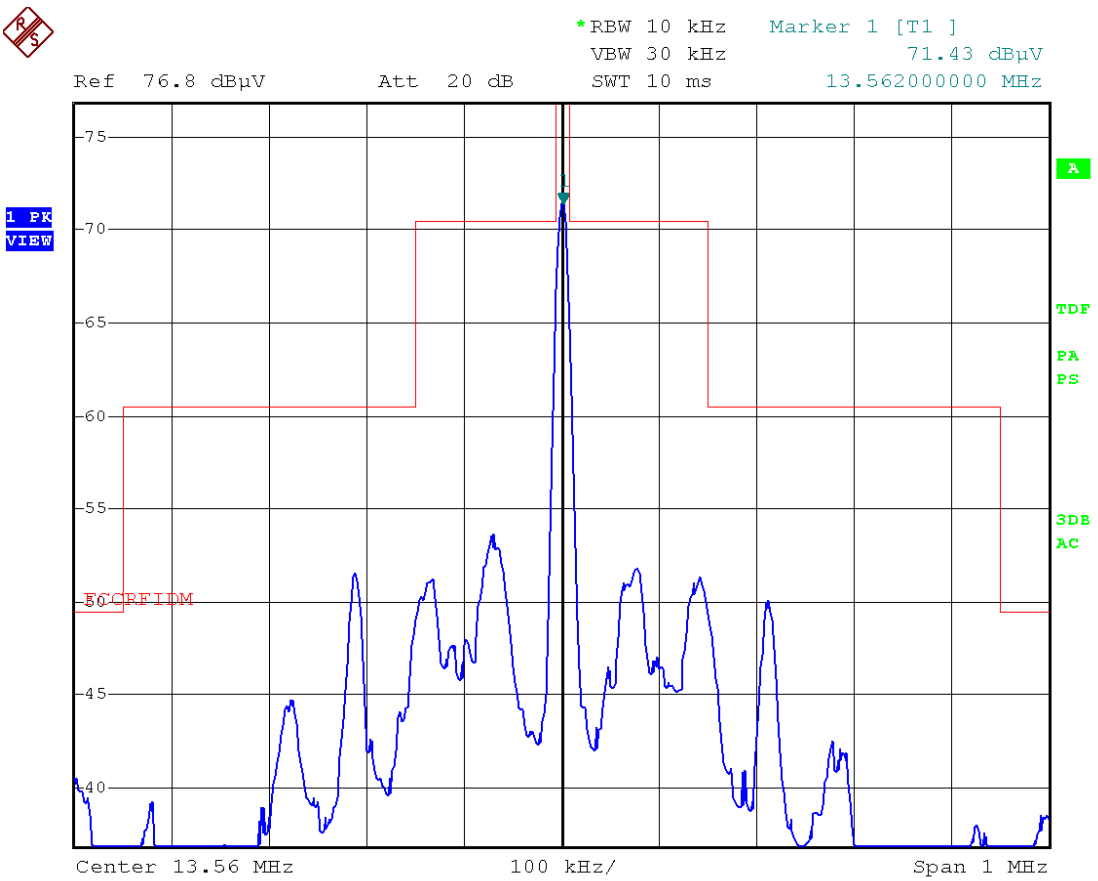
Due to better visibility in the printing the actual spectrum mask limit was reduced by this 20 dB. For the significance of the test result this limit line has no relevance.

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 1: Outline of setup for spectrum mask test



Picture 2: Result of spectrum mask measurement

The actual field strength of the carrier is:

FS = T1 = 71.43 dBµV/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

5.1 Test Location

Description	Manufacturer	Inventory No.
Shielded chamber	Siemens - Matsushita	E00107

5.2 Test Instruments

	Description	Manufacturer	Inventory No.
☑	ESCS 30	Rohde & Schwarz	E00003
☐	ESCI	Rohde & Schwarz	E00001
☑	ESH3 Z2	Rohde & Schwarz	E00028
☑	ESH 2-Z5	Rohde & Schwarz	E00004
☑	ESH 2-Z5	Rohde & Schwarz	E00005

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

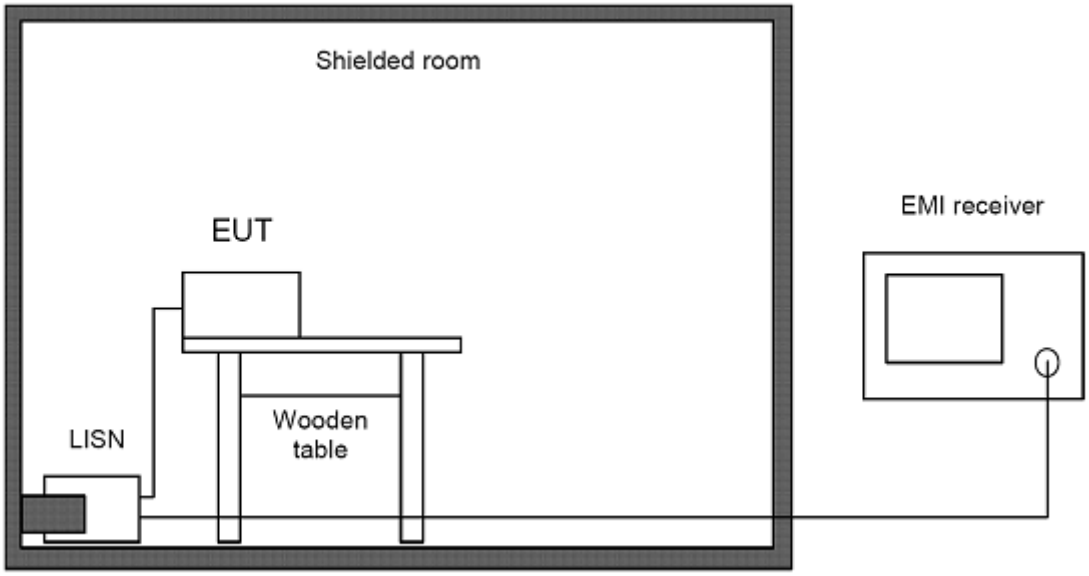
5.4 Test method to demonstrate compliance

The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50 µH/50 Ohms and an EMI test receiver.
The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range form 0.15 MHz to 30 MHz.
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 0.15 MHz to 30 MHz were scanned. After that all peaks values with fewer margins than 10 dB 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



Picture 3: Outline of conducted emission test setup

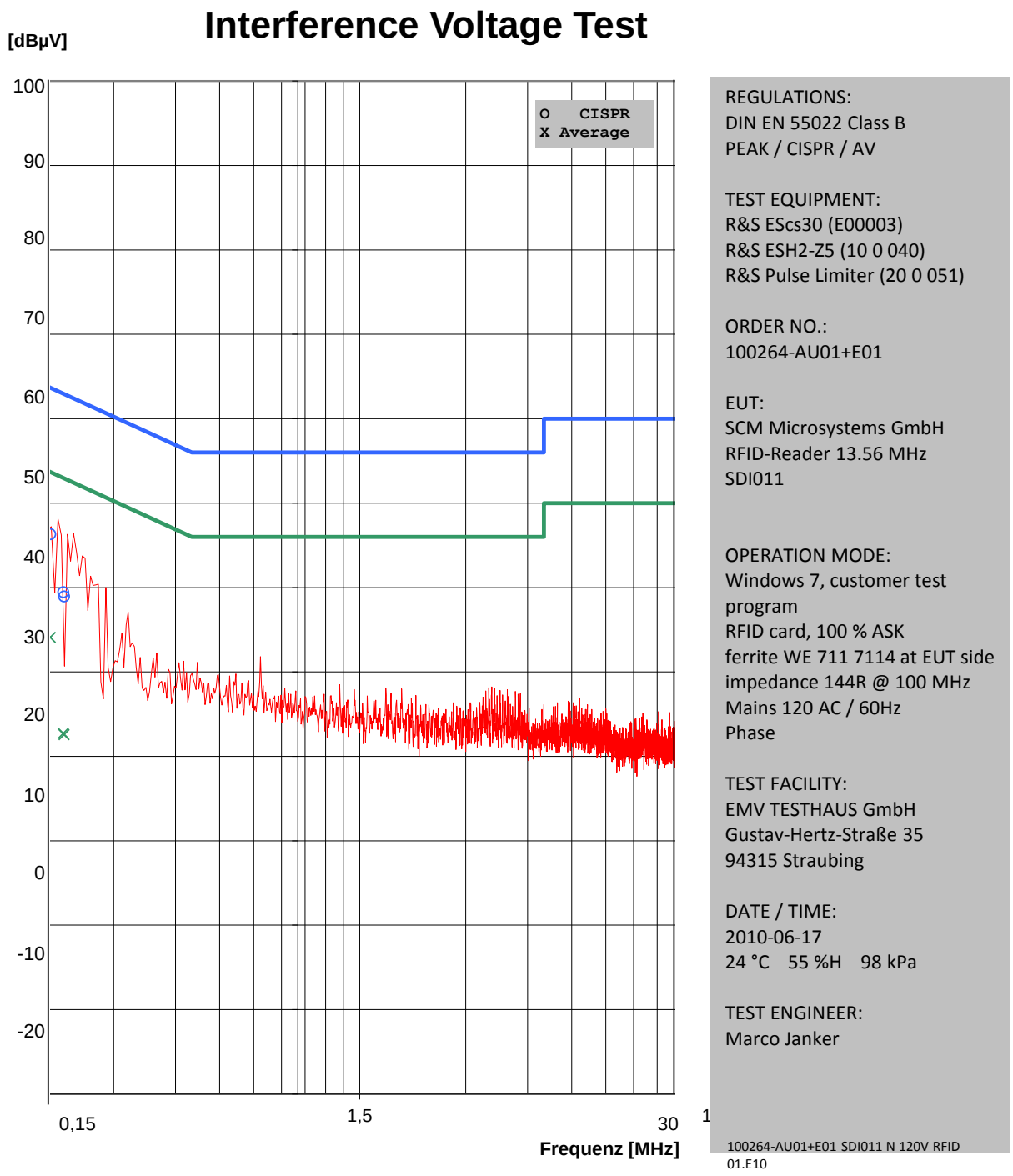
Expanded Uncertainty (9kHz to 150kHz): $U_{(y)}$ = (y ± 4.024) dBµV; k=2.00 y = Indicated value

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

Comments: The 13.56 MHz disturbance belongs to the carrier frequency, which is exempted for this test. Due to a fixed internal antenna a test with 50 Ohm dummy was not possible.

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

5.6 Test result



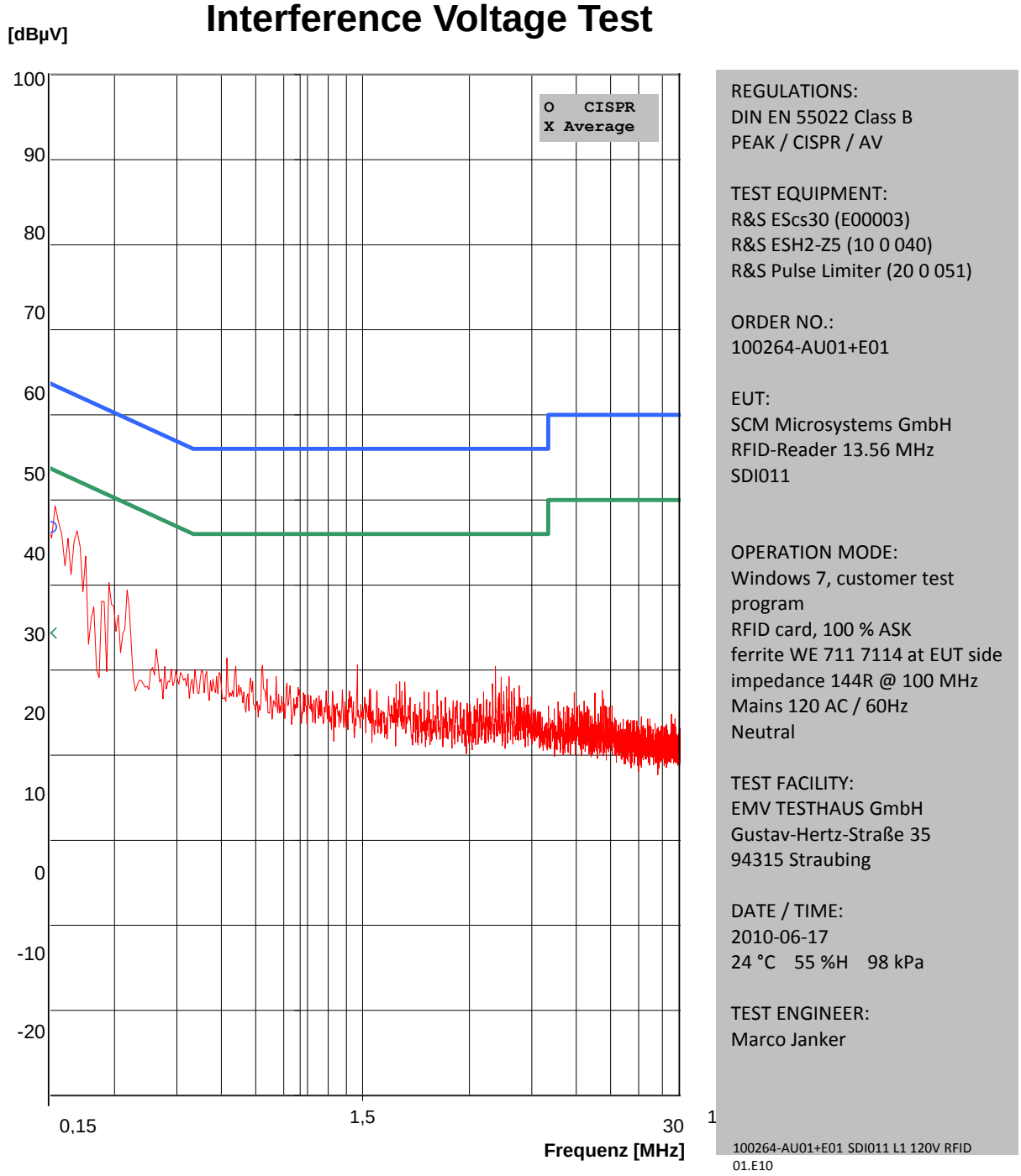
Picture 4: Conducted emission on mains, phase 1, RFID card

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								100264-AU01+F01 SDI011 N 120V
0,20	46,3	63,7	17,4	34,1	53,7	19,6	0,0	RFID 01.E10
0,22	38,9	62,9	24,0	22,6	52,9	30,4	0,0	
0,22	39,4	63,0	23,5	22,7	53,0	30,3	0,0	

Picture 5: Conducted emission on mains, phase 1, RFID card

Interference Voltage Test



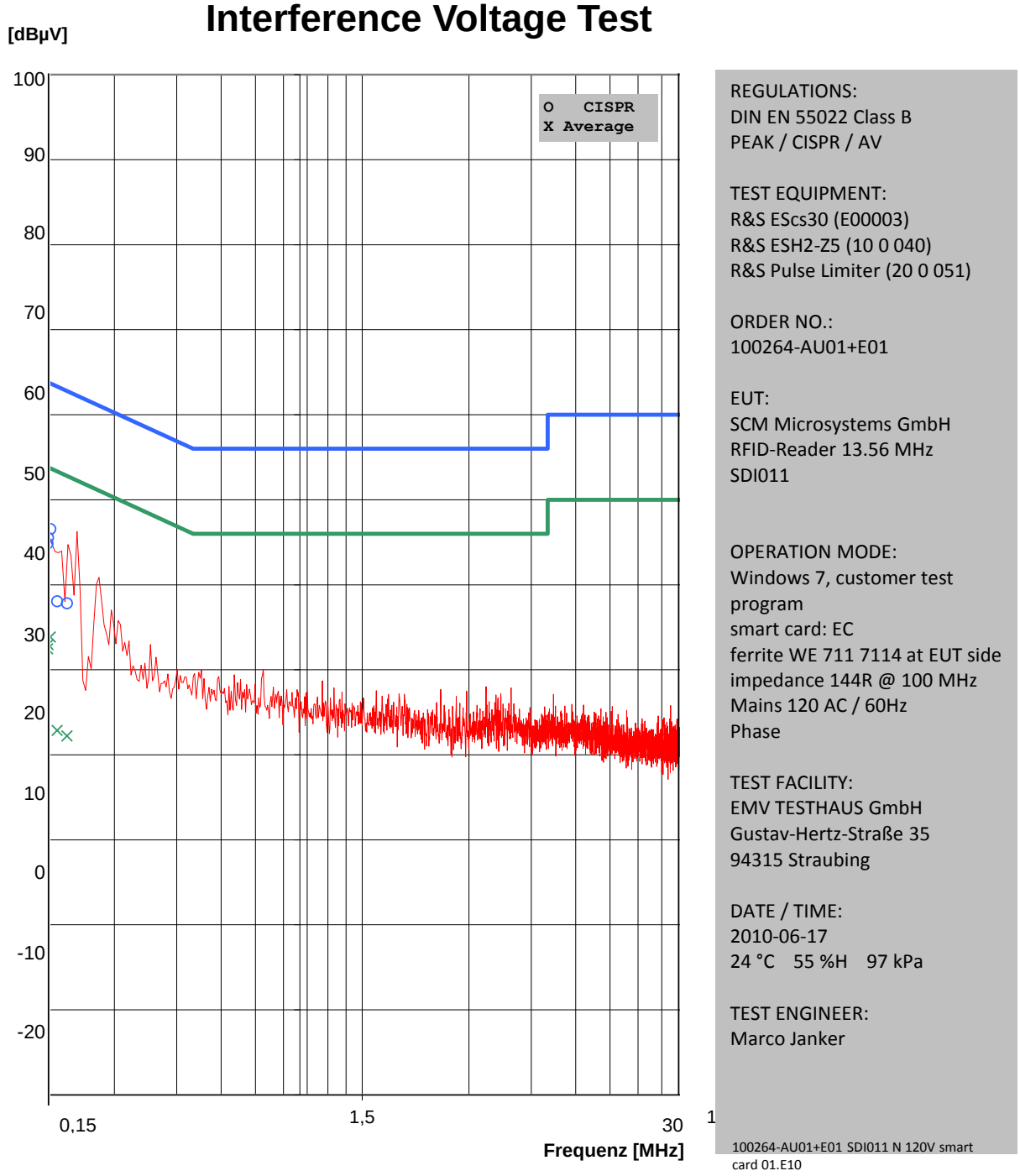
Picture 6: Conducted emission on mains, neutral, RFID card

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark 100264-AU01+E01_SDI011 L1 120V RFID 01.E10
0,15	46,1	66,0	19,9	25,1	56,0	30,9	0,0	
0,15	43,8	65,8	21,9	24,9	55,8	30,9	0,0	
0,20	46,8	63,7	16,8	34,3	53,7	19,3	0,0	

Picture 7: Conducted emission on mains, neutral, RFID card

Interference Voltage Test



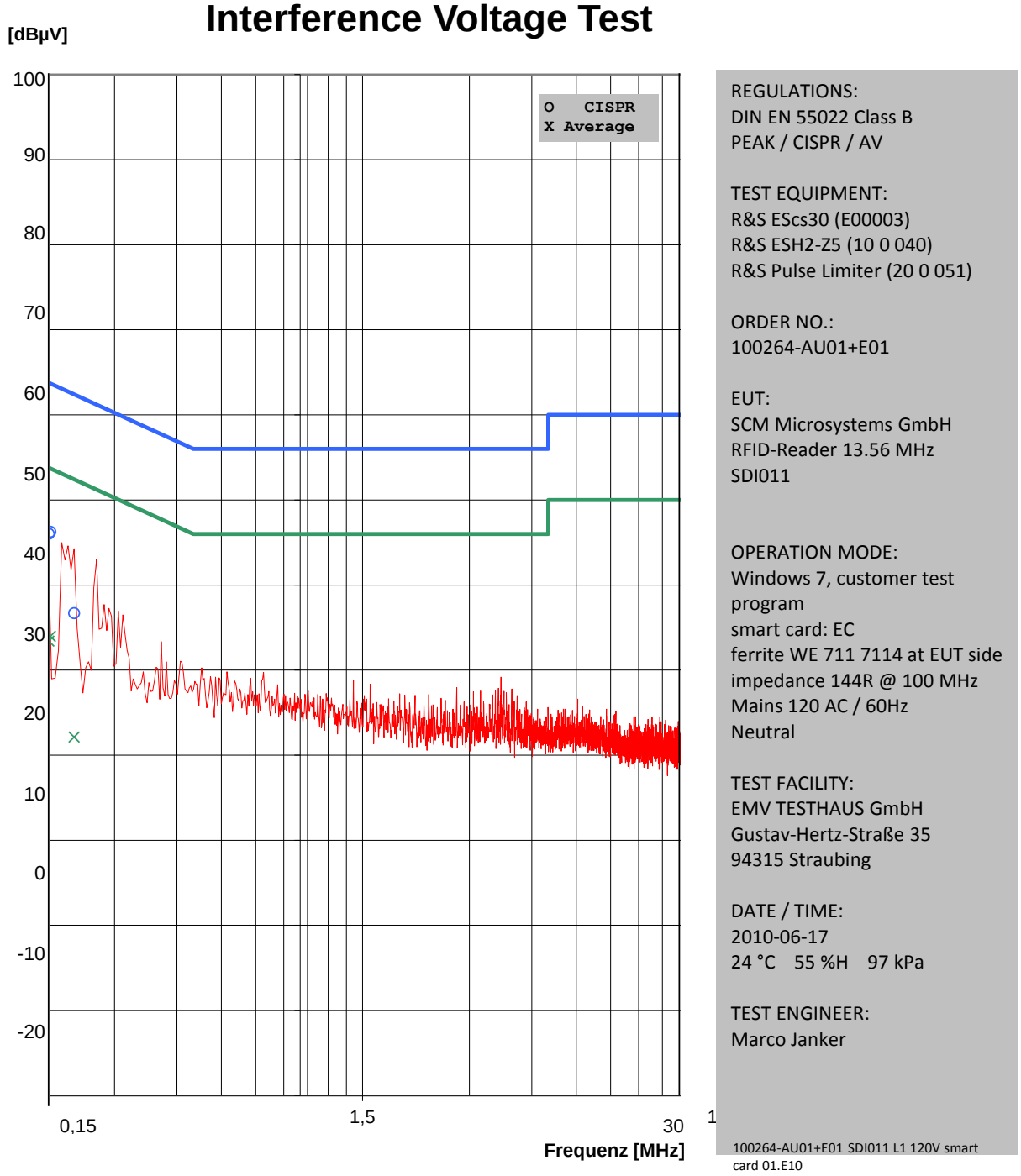
Picture 8: Conducted emission on mains, phase 1, smart card

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								100264-AU01+F01 SDI011 N 120V
0,15	44,5	66,0	21,5	24,6	56,0	31,4	0,0	smart card 01.E10
0,20	45,5	63,8	18,3	32,9	53,8	20,9	0,0	
0,19	44,8	63,8	19,0	32,5	53,8	21,4	0,0	
0,20	46,6	63,7	17,1	33,8	53,7	19,9	0,0	
0,21	38,0	63,3	25,3	22,8	53,3	30,5	0,0	
0,22	37,8	62,8	25,0	22,2	52,8	30,6	0,0	

Picture 9: Conducted emission on mains, phase 1, smart card

Interference Voltage Test



Picture 10: Conducted emission on mains, neutral, smart card

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								100264-AU01+E01_SDI011 L1 120V
0,15	44,3	66,0	21,7	24,6	56,0	31,4	0,0	smart card 01.E10
0,15	42,4	65,8	23,4	24,3	55,8	31,4	0,0	
0,15	42,6	65,8	23,2	24,3	55,8	31,5	0,0	
0,20	46,0	63,8	17,8	33,4	53,8	20,4	0,0	
0,20	46,2	63,7	17,5	34,0	53,7	19,7	0,0	
0,23	36,7	62,4	25,7	22,1	52,4	30,3	0,0	

Picture 11: Conducted emission on mains, neutral, smart card

6 Measurement of radiated emission (9 kHz to 30 MHz)

according to CFR 47 Part 15, section 15.205(d7), 15.209

6.1 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	E00026
Open site area	EMV **TESTHAUS** GmbH	200017

6.2 Measurement equipment

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU	Rohde & Schwarz	W00002
☐	ESCI (CDC and FF)	Rohde & Schwarz	E00001
☐	VULB 9163 (CDC)	Schwarzbeck	E00013
☐	VULB 9160 (FF)	Schwarzbeck	E00014
☑	Feedline OATS	Huber & Suhner	200024
☑	HFH2-Z2 (CDC and FF)	Rohde & Schwarz	E00060

6.3 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)

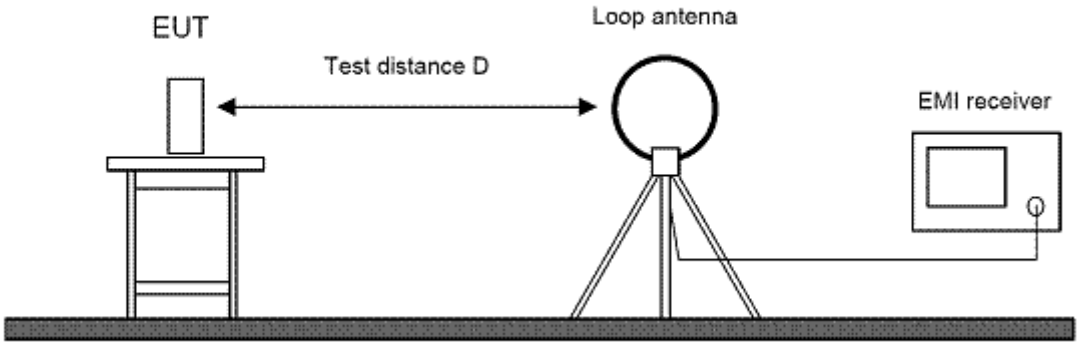
$$L_{dm} = 29.5\frac{dB\mu V}{m} + (-40\frac{dB}{dec} * (\log(3m) - \log(30m)) = 69.5dB$$ for 1.705MHz (low)

6.4 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 0.009 MHz to 30 MHz with the detector set to peak and the measurement bandwidth to 200 Hz. At .150 kHz the measurement bandwidth was changed to 9 kHz.
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.

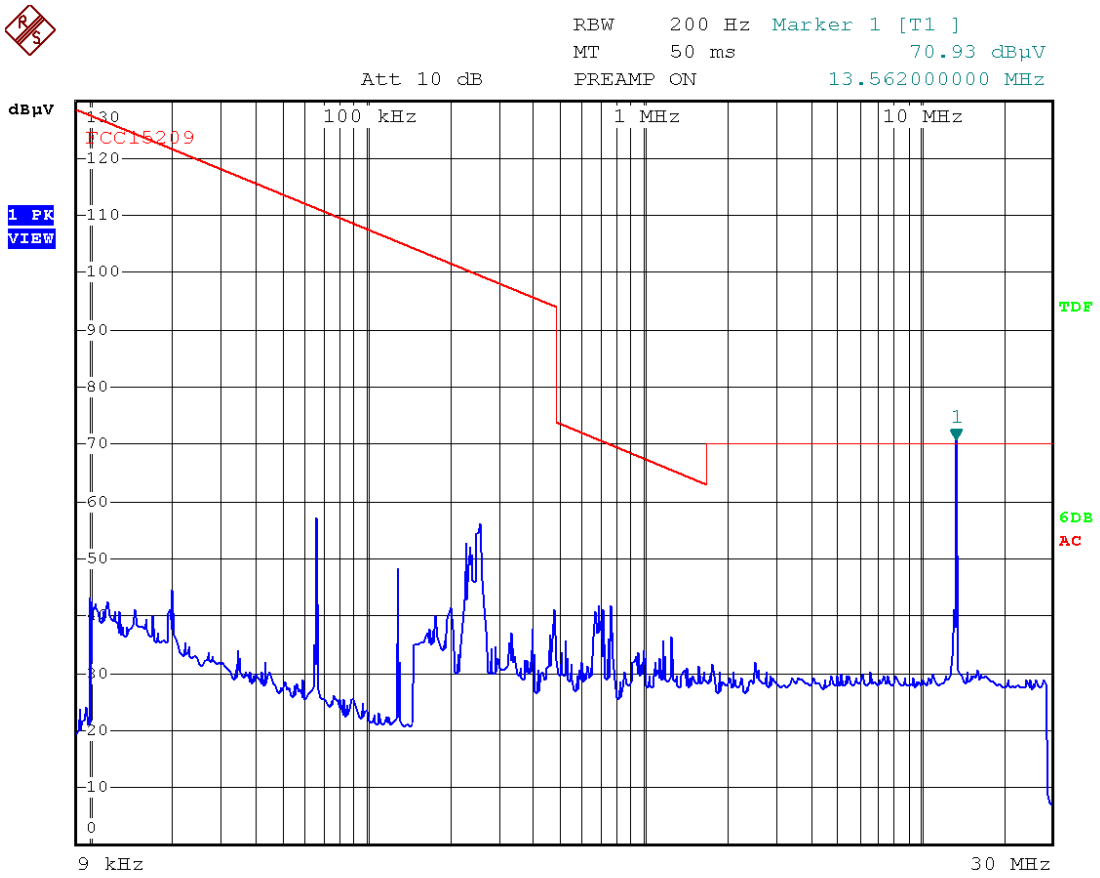
To check the horizontal polarization the EUT was rotated by 90° instead of the loop antenna and the procedure was repeated. Both results are combined inside on graphic.

6.5 Test setup



Picture 12: Outline of radiated emission test setup

6.6 Test result



Picture 13: Radiated field strength from 9 kHz to 30 MHz

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

Comment: All frequencies are more than 20 dB below the limit. The wanted transmitter frequency was excluded from the test.

7 Measurement of radiated emission (30 MHz to 1 GHz)

according to CFR 47 Part 15, section 15.205(d7), 15.209

7.1 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 3m open site area.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open site area	EMV **TESTHAUS** GmbH	200017

7.2 Measurement equipment

	Description	Manufacturer	Inventory No.
☑	ESCS 30 (FF)	Rohde & Schwarz	E00003
☐	ESU	Rohde & Schwarz	W00002
☑	ESCI (CDC)	Rohde & Schwarz	E00001
☑	VULB 9163 (FF)	Schwarzbeck	E00013
☑	VULB 9160 (CDC)	Schwarzbeck	E00011
☐	HFH2-Z2	Rohde & Schwarz	E00060
☑	Feedline OATS	Huber & Suhner	200024

7.3 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 30 MHz to 88 MHz

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

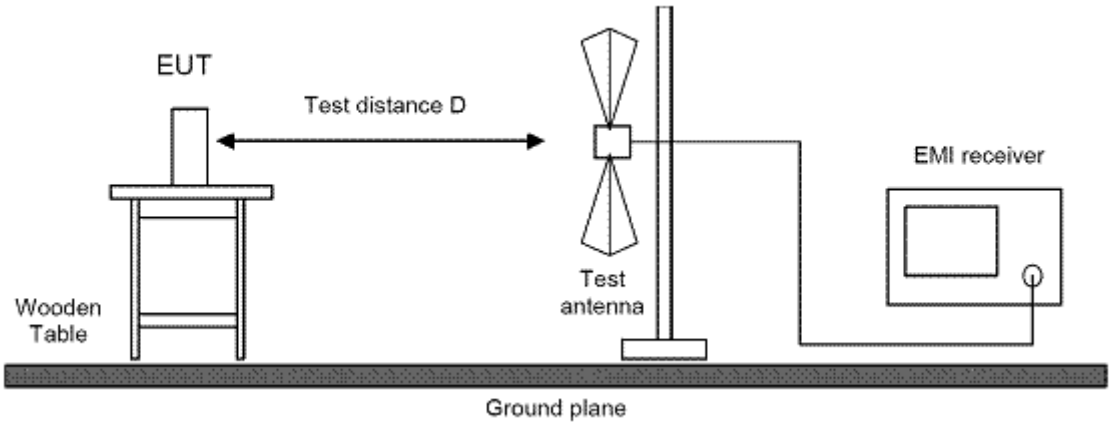
$$L_{dm} = 46\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(10m) - \log(3m)) = 36dB$$ for 216 MHz to 960 MHz

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

7.4 Test method to demonstrate compliance

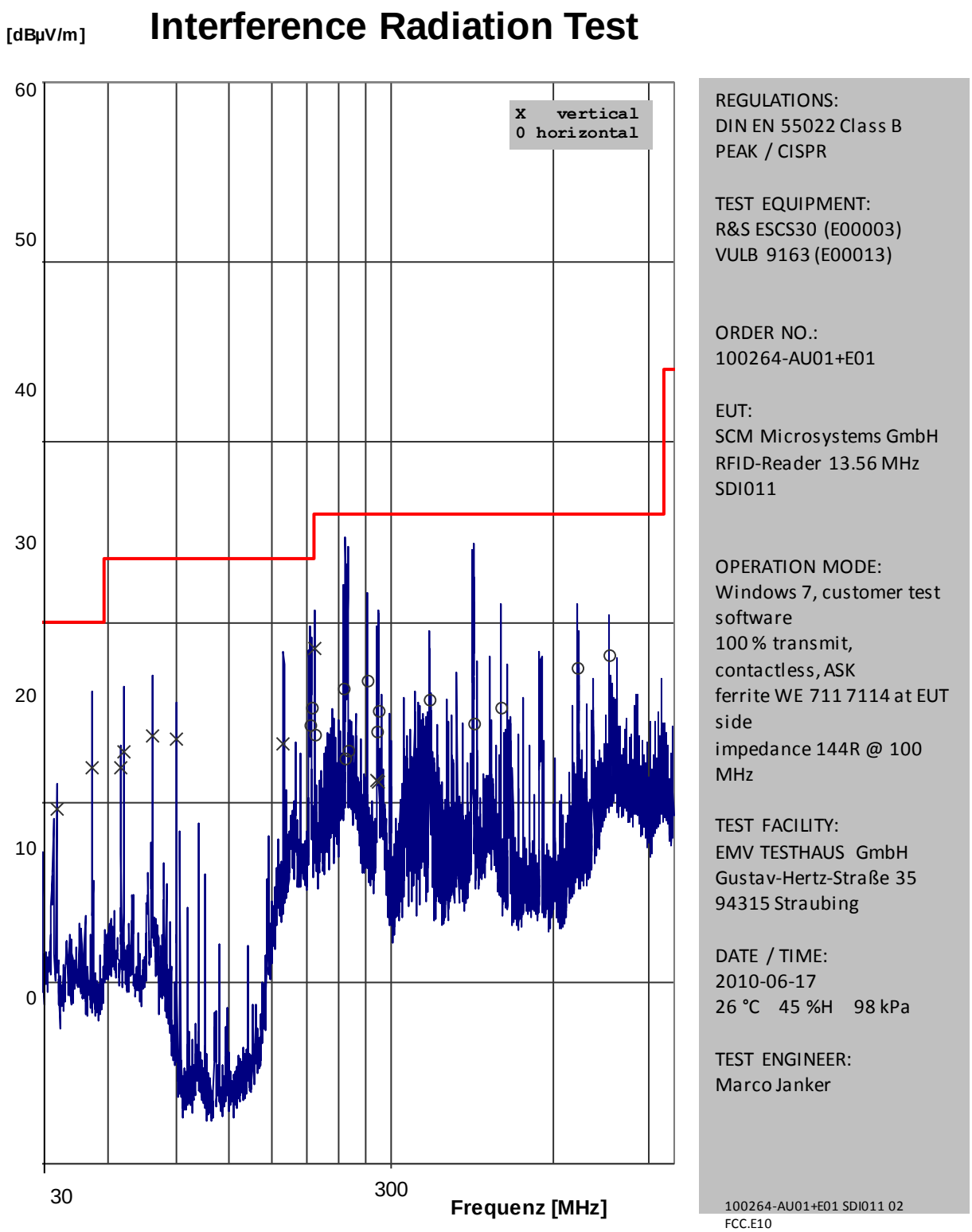
An EMI test receiver was used and connected to a broadband antenna. The EUT was placed on a wooden table in a distance of 3m inside a compact diagnostic chamber. The broadband antenna was placed in vertical polarization and the EMI receiver performed a scan from 30 MHz to 1000 MHz with the detector set to peak and the measurement bandwidth to 120 kHz.
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 6 dB were marked and re-measured with a quasi-peak detector with the following method on a 3 m 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 1 m to 4 m height to find the maximum value. This value was recorded.

7.5 Test setup



Picture 15: Outline of radiated emission test setup

7.6 Test result



Picture 16: Radiated emission 30 MHz – 1000MHz

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 100264-AU01+E01_SDI011.02
48,00	22,8	30,0	13,5	9,3	7,2	319°	110 cm	V	FCC.E10
72,00	19,7	30,0	8,4	11,2	10,3	146°	110 cm	V	
84,00	21,9	30,0	10,3	11,6	8,1	112°	110 cm	V	
94,90	21,9	33,5	7,3	14,6	11,6	171°	100 cm	V	
96,00	22,8	33,5	7,5	15,3	10,7	150°	100 cm	V	
108,50	23,7	33,5	12,6	11,1	9,8	113°	110 cm	V	
120,00	23,5	33,5	11,1	12,5	10,0	206°	110 cm	V	
189,80	23,2	33,5	8,6	14,7	10,3	270°	100 cm	V	
211,80	24,3	33,5	12,8	11,5	9,2	292°	250 cm	H	
213,50	25,3	33,5	12,8	12,5	8,2	283°	250 cm	H	
217,00	23,7	36,0	13,0	10,8	12,3	275°	250 cm	H	
217,00	28,6	36,0	13,0	15,6	7,4	141°	110 cm	V	
244,10	26,3	36,0	14,3	12,0	9,7	276°	250 cm	H	
247,20	22,4	36,0	14,3	8,2	13,6	283°	250 cm	H	
249,20	22,9	36,0	14,3	8,7	13,1	267°	250 cm	H	
271,20	26,7	36,0	14,8	12,0	9,3	93°	250 cm	H	
282,20	23,9	36,0	15,1	8,8	12,1	231°	250 cm	H	
282,20	21,3	36,0	15,1	6,1	14,8	360°	110 cm	V	
284,70	25,1	36,0	15,2	9,9	10,9	246°	250 cm	H	
284,70	21,2	36,0	15,2	6,0	14,9	359°	110 cm	V	
352,60	25,7	36,0	17,2	8,5	10,3	102°	250 cm	H	
426,70	24,4	36,0	18,8	5,6	11,6	40°	250 cm	H	
480,00	25,3	36,0	19,8	5,6	10,7	207°	250 cm	H	
663,70	27,5	36,0	23,2	4,3	8,5	9°	250 cm	H	
761,60	28,2	36,0	24,5	3,7	7,8	114°	250 cm	H	

Picture 17: Radiated emission 30 MHz – 1000MHz (table)

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:

8 Occupied Bandwidth (99%)

according to CFR 47 Part 2 section 2.202

8.1 Test location

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026

8.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☐	ESU	Rohde & Schwarz	W00002
☑	ESCI (CDC)	Rohde & Schwarz	E00001
☑	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (CDC)	Schwarzbeck	E00013
☐	VULB 9160 (FF)	Schwarzbeck	E00011

8.3 Test method to demonstrate compliance

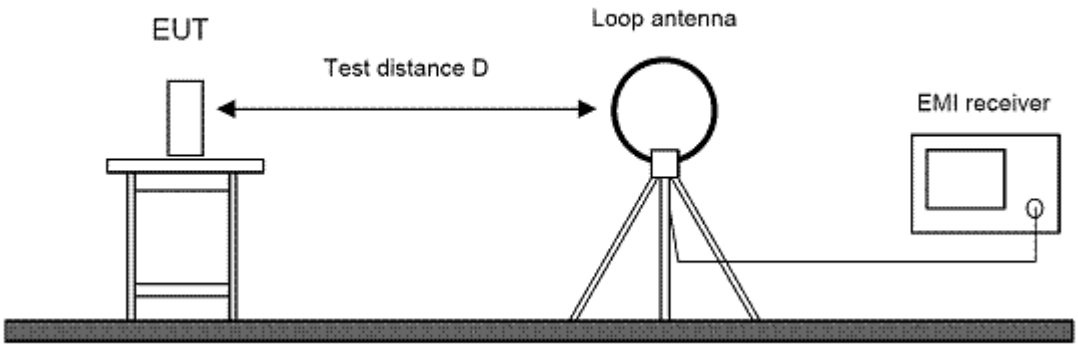
The EUT has detachable antenna therefore the conducted method was used

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.

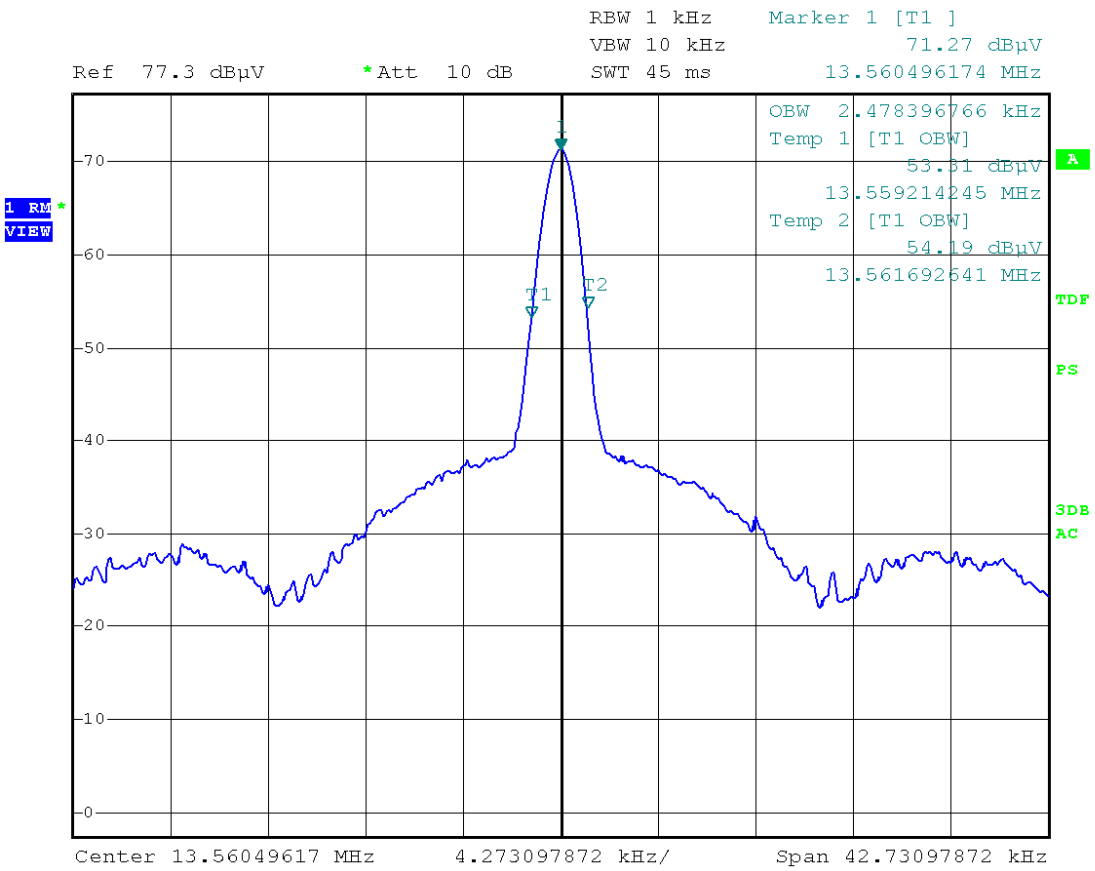
Fundamental frequency	Minimum resolution bandwidth
0.009MHz to 30MHz	1kHz
30MHz to 1000MHz	10kHz
1000MHz to 40000MHz	100kHz

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

8.4 Test setup



Picture 18: Outline of test setup for occupied bandwidth measurement



Picture 19: Occupied bandwidth 99%

Occupied Bandwidth: 2.478 kHz

9 Occupied Bandwidth (20dB)

according to FCC Part 15, section 15.215(c)

9.1 Test location

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026

9.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCS 30 (FF)	Rohde & Schwarz	E00003
☑	ESU	Rohde & Schwarz	W00002
☐	ESCI (CDC)	Rohde & Schwarz	E00001
☑	HFH2-Z2	Rohde & Schwarz	E00060
☐	VULB 9163 (CDC)	Schwarzbeck	E00013
☐	VULB 9160 (FF)	Schwarzbeck	E00011

9.3 Test method to demonstrate compliance

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

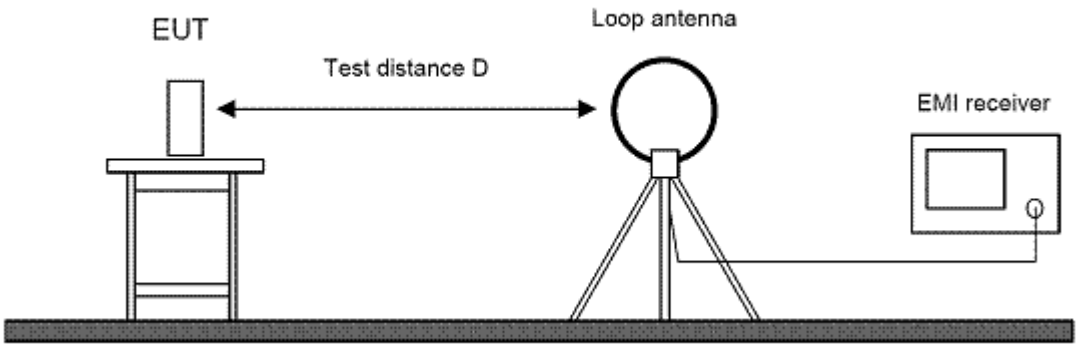
The resolution bandwidth of the spectrum analyzer shall be set to a greater value than 5% of the allowed bandwidth.

Because no resolution bandwidth was given the following guideline from ANSI C63.4 annex H6 was consulted.

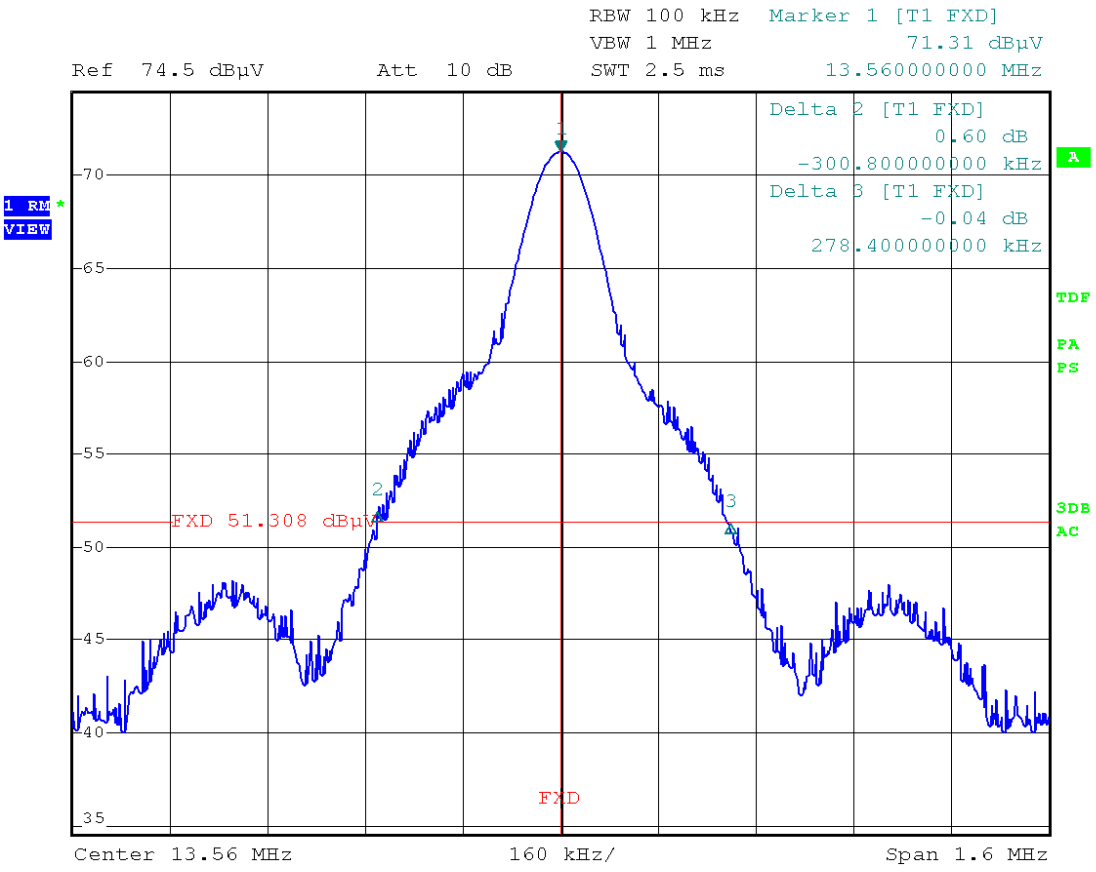
Fundamental frequency	Minimum resolution bandwidth
0.009MHz to 30MHz	1kHz
30MHz to 1000MHz	10kHz
1000MHz to 40000MHz	100kHz

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

9.4 Test setup



Picture 20: Outline of occupied bandwidth test setup



Picture 21: Occupied bandwidth 20dB

f_c = 13.5600 MHz

Δf_1 = -300 kHz = 13.2600 MHz Limit: 13.110 MHz

Δf_2 = +278.4 kHz = 13.8384 MHz Limit: 14.010 MHz

Occupied Bandwidth: 578.4 kHz

10 Carrier frequency stability

according to CFR 47 Part 15, section 15.225(e)

10.1 Test location

	Description	Manufacturer	Inventory No.
☑	Climatic Chamber VC4100	Vötsch	C00014
☐	Climatic Chamber VC^{3}4043	Vötsch	C00015

10.2 Test Instruments

	Description	Manufacturer	Inventory No.
☐	ESCI	Rohde & Schwarz	E00001
☑	ESU	Rohde & Schwarz	W00002
☑	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

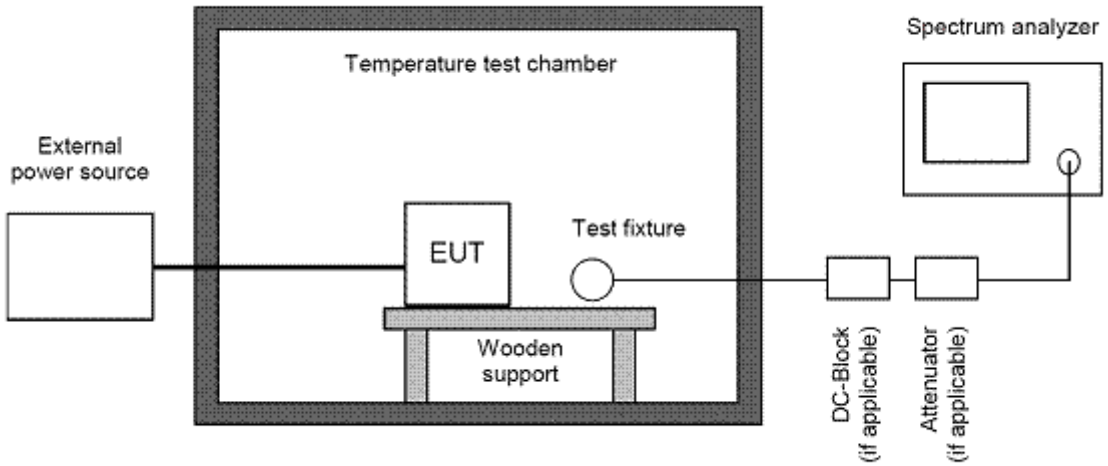
The frequency tolerance of the carrier signal is measured over a temperature variation of -20°C to +50°C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20°C.
If the EUT provides an antenna connector the spectrum 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 bandwidth as well as the video bandwidth is 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



Picture 22: Outline of carrier frequency stability test setup

10.5 Carrier vs. temperature vs. voltage

Supply Voltage 5V			Nominal frequency: 13,56041667 MHz	
Temperature (°C)	**Voltage (V)**	**Carrier frequency (MHz)**	**Δ Frequency (Hz)**	**Deviation (ppm)**
-20	4.5	13.56054487	128.205	9.454355507
	5.5	13.56060897	192.307	14.18149639
-10	4.5	13.56054487	128.205	9.454355507
	5.5	13.56060897	192.307	14.18149639
0	4.5	13.56054487	128.205	9.454355507
	5.5	13.56060897	192.307	14.18149639
10	4.5	13.56051282	96.154	7.090785067
	5.5	13.56057692	160.256	11.81792595
20	4.5	13.56048077	64.102	4.727140882
	5.5	13.56054487	128.205	9.454355507
30	4.5	13.56044872	32.051	2.363570441
	5.5	13.56051282	96.154	7.090785067
40	4.5	13.56044487	28.2048	2.079936088
	5.5	13.56051282	96.154	7.090785067
50	4.5	13.56044872	32.051	2.363570441
	5.5	13.56048077	64.102	4.727140882
Limit ± 100ppm				

Table 1: Carrier vs. temperature vs. voltage

11 Designation of Emissions

according to CFR 47 Part 2, Sections 2.201 and 2.202

11.1 Designation

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

12 Equipment Calibration Status

Inventory Number	Model Number	Manufacturer	Last calibration	Next calibration	Cycle of calibration
W00002	ESU26	Rohde & Schwarz	Sep 09	Sep 11	2 Years
E00001	ESCI	Rohde & Schwarz	Sep 09	Mar 11	2 Years
E00003	ESCS 30	Rohde & Schwarz	Aug 08	Aug 10	2 Year
E00004	ESH 2-Z5	Rohde & Schwarz	Oct. 08	Oct. 10	2 Years
E00005	ESH 2-Z5	Rohde & Schwarz	Sep 09	Sep 11	2 Years
E00060	HFH2-Z2	Rohde & Schwarz	Oct 08	Oct 11	2 Years
E00012	VULB 9163	Schwarzbeck	Apr. 09	Apr. 11	2 Years
E00013	VULB 9163	Schwarzbeck	Apr. 08	Apr. 10	2 Years
E00011	VULB 9160	Schwarzbeck	Sep. 09	Sep. 11	2 Years
C00015	VC34034	Vötsch	Jan 08	Jan 12	4 Years
C00014	VC4100	Vötsch	Jan 07	Jan 11	4 Years

Table 2: Equipment Calibration status

13 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, July 6, 2010

Marco Janker	Markus Biberger
EMI / EMC Test Engineer	Technical executive
	EMV **TESTHAUS** GmbH