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Chamber of Commerce
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telefication

FCC and IC Test report for parts 15.205, 15.207, 15.225, RSS-210, RSS-Gen

Product name	: Wireless RFID reader
Applicant	: Ultimaker B.V.
FCC ID	: 2AL8M-1726A
IC	: 23486-1726A

Test report No. : P000132198 004 Ver 3.00

Laboratory information

Accreditation

Telefication complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2017. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

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The Industry Canada company number for Telefication is: 4173A. The CABID is NL0001.

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Documentation

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Testing Location

Test Site	Kiwa Telefication BV
Test Site location	Wilmersdorf 50 7327 AC Apeldoorn The Netherlands Tel. +31 88998 3393
Test Site FCC	NL0001
CABID	NL0001

Revision History

Version	Date	Remarks	By
v0.50	01-11-2022	First draft	KK
v1.00	15-11-2022	Final version	KK
v2.00	22-11-2022	Product name and section 1.3 updated	KK
v3.00	12-01-2023	EUT information added section 1.8 Standard information corrected in section 1.6, 3.1.4 and 3.2.4 Test setup added in section 2.2 Section 3.3.5, Max field strength distance corrected	KK

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Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.225(d)	RSS-Gen 8.9	Radiated spurious emissions	3.1	Pass
15.205 (a)	RSS Gen 8.10	Spurious emissions in the restricted bands	3.1	Pass
15.207 (c)	RSS-Gen 8.8	Conducted spurious emissions on AC mains	3.2	Pass
15.225(a),(b),(c)	RSS-210 B.6	Field strength of emissions	3.3	Pass
15.225(e)	RSS-210 B.6	Frequency Stability	3.4	Pass
15.215(c)	-	20 dB Bandwidth	3.5	Pass

1 General Description

1.1 Applicant

Client name:	Ultimaker B.V.
Address:	Stationsplein 32, Utrecht, Netherlands
Zip code:	3511 ED
Telephone:	+31 (0) 6 2366 2732
E-mail:	product-compliance@ultimaker.com
Contact name:	Yordanka Tchifligarova

1.2 Manufacturer

Manufacturer name:	Ultimaker B.V.
Address:	Stationsplein 32, Utrecht, Netherlands
Zip code:	3511 ED
Telephone:	+31 (0) 6 2366 2732
E-mail:	product-compliance@ultimaker.com
Contact name:	Yordanka Tchifligarova

1.3 Tested Equipment Under Test (EUT)

Product name:	Wireless RFID reader
Brand name:	Ultimaker
FCC ID:	2AL8M-1726A
IC:	23486-1726A
Product type:	1726-A
Model(s):	-
Batch and/or serial No.	-
Software version:	-
Hardware version:	1726-B
Date of receipt	25-07-2022
Tests started:	10-08-2022
Testing ended:	24-10-2022

1.4 Product specifications of Equipment under test

Tx Frequency:	NFC: 13.56 MHz
Rx frequency:	NFC: 13.56 MHz
Occupied Channel Width:	4.3 kHz
Antenna type:	NFC antenna
Antenna gain:	1.67 dBi
Type of modulation:	ASK
Emission designator	2K30K1D

Disclaimer: The antenna gain and operating frequency bands are declared by the applicant

1.5 Environmental conditions

Test date	24-10-2022
Ambient temperature	21.6 C°
Humidity	48.7 %

1.6 Measurement standards

- ANSI C63.10:2013

1.7 Applicable standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C
- RSS-Gen Issue 5
- RSS-210 Issue 9

1.8 Observation and remarks

The EUT has been tested together with a host which has been prepared by the customer for the testing. EUT tested with a passive reading tag attached as a highest emission configuration.

1.9 Conclusions

The sample of the product showed **NO NON-COMPLIANCES** to the specifications stated in paragraph 1.7 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Telefication accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.7 *"Applicable standards".*

All conducted tests are performed by:

Name : Koray Korcum, MSc

Review of test methods and report by:

Name : Raoul Tolud, MSc

The above conclusions have been verified by the following signatory:

Date : 16-20-2023

Name : ing. R. van Barneveld

Function : Test engineer

Signature :

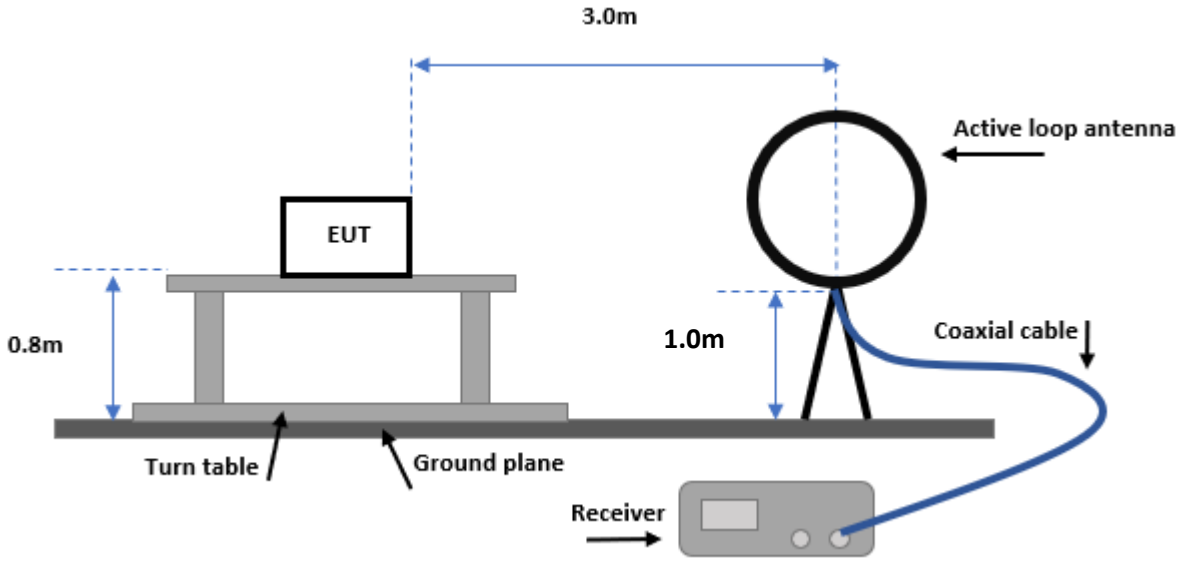
2 Test configuration of the Equipment Under Test

2.1 Test mode

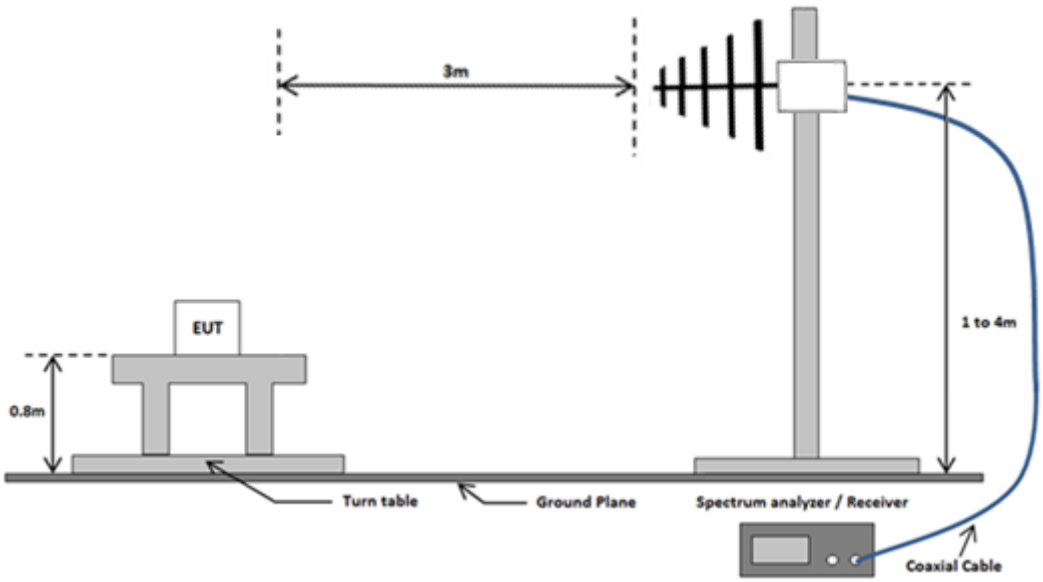
Customer provided test mode that we can operate the EUT in normal operation mode.

2.2 Test setups

Radiated emissions test setup 9 kHz – 30 MHz

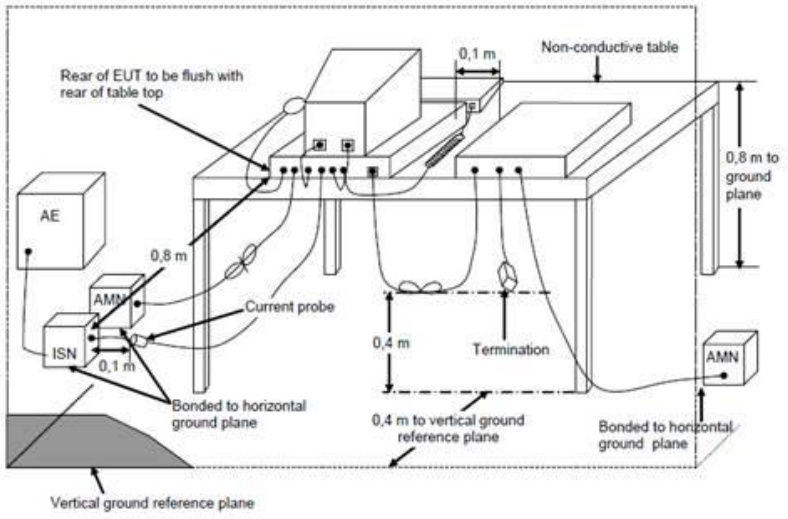


Radiated emissions test setup 30 MHz - 1 GHz

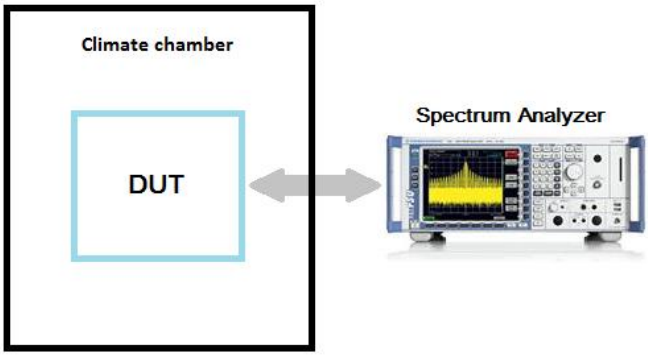


Conducted emissions test setup

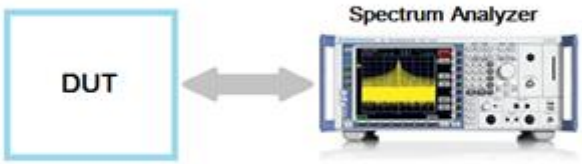
Emissions test at AC mains



Frequency stability test setup



20 dB Bandwidth test setup



2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Cal. Done date	Cal. due date	Used at Par.
EMI Receiver	Rohde & Schwarz	ESR7	114534	01-2022	01-2023	3.1 – 3.5
Active loop antenna	EMCO	6502	114515	01-2022	01-2024	3.1, 3.3
Biconical antenna + 6dB attenuator	Schwarzbeck + HP	VHA9103 + 8491A	114436 + 114254	03-2021	03-2024	3.1
Logperiodic antenna	EMCO	3147	114385	03-2021	03-2024	3.1
Preamplifier 18-40 GHz	Miteq	JS4-18004000-33-8P	114693	01-2022	01-2023	3.1
Test software	Raditeq	Radimation Version 2021.1.9	TE 02008	--	--	3.1-3.2
Two line V-network	Rohde & Schwarz	ESH3-Z5	114379	07-2021	07-2022	3.2
Climate chamber	CTS	C-40/350	TE00741	01-2021	01-2023	3.4

*Note: Standard gain horn antennas do not need calibration

2.4 Sample calculations

All formulas for data conversions and conversion factors are reported in chapter 4 of this test report.

3 Test results

3.1 Radiated spurious emissions

3.1.1 Limit

15.225(d)
The field strength of any emissions appearing outside of the 13.110 -14.010 MHz band shall not exceed the general radiated emission limits in part 15.209.

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
0.009 – 0.490	2400/F(kHz)	20*{log[2400]-log[F(kHz)]}	300*
0.490 – 1.705	24000/F(kHz)	20*{log[24000]-log[F(kHz)]}	30*
1.705 – 13.11 14.01 – 30.0	30	29.5	30*
30 -88	100	40	3
88 - 216	150	43,5	3
216-960	200	46	3
Above 960	500	54	3

*Note: Measured values in the plots 9 kHz to 30 MHz corrected to 3m measurement distance according to the method described in ANSI C63.10-2013, clause 6.4

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.1.4 Test procedure

Prior to running the measurements, the EUT has been investigated in the X, Y and Z dimensions to determine the worst case configuration for spurious emissions.

9 kHz – 30 MHz: According to ANSI C63.10-2013, section 5.4.2 and 8.2.3
30 MHz to 26.5 GHz: According to ANSI C63.10-2013, section 8.3

9 kHz to 30 MHz: IRN 026 – Method 10
30 MHz to 1 GHz: IRN 026 – Method 1

3.1.5 Measurement Uncertainty

Frequency range	Polarization	Uncertainty
9 kHz – 30 MHz	--	±1.6 dB
30 – 200 MHz	Horizontal	±4.5 dB
	Vertical	±5.4 dB
200 -1000 MHz	Horizontal	±3.6 dB
	Vertical	±4.6 dB

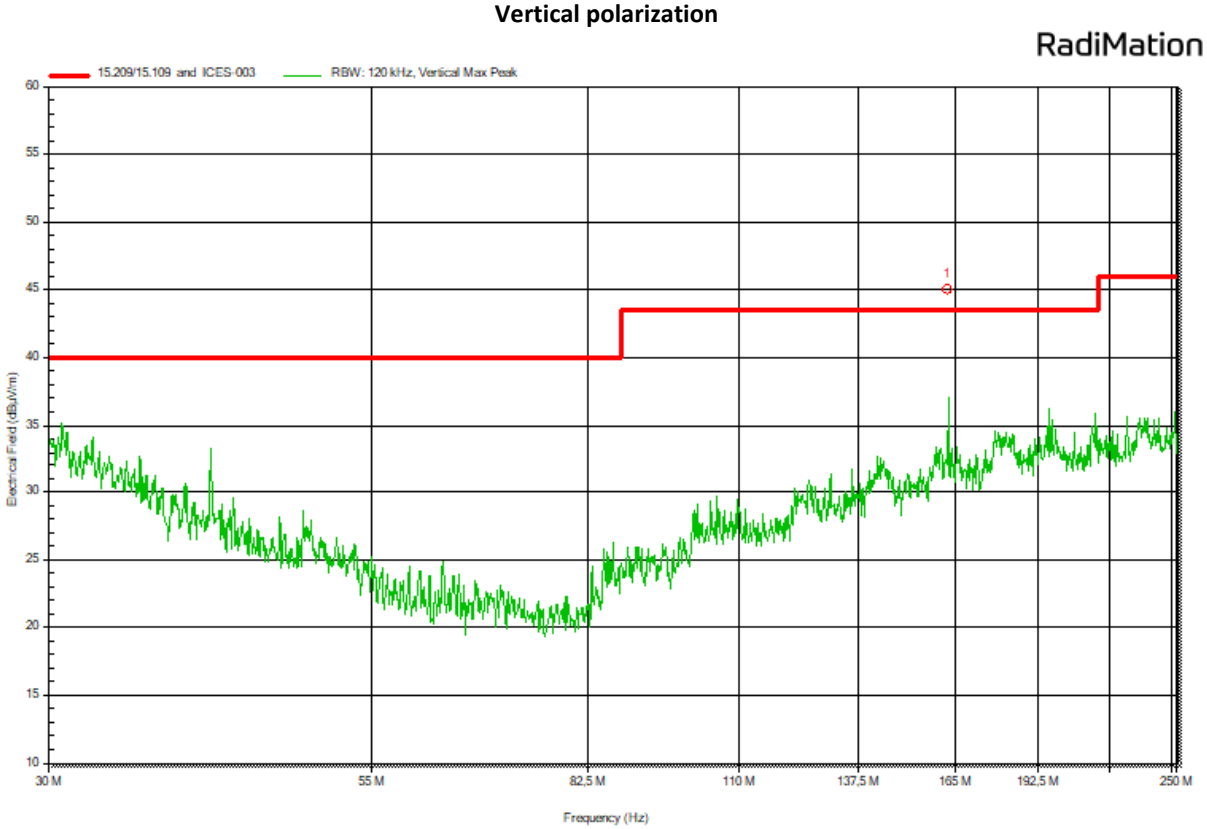
3.1.6 Peak tables of the radiated spurious emissions measurement

Peak Number	Frequency	Peak	Peak Limit	Quasi-Peak	Quasi-Peak Limit	Status	Angle	Height	Polarization
1	786,48 MHz	46,2 dBµV/m	46 dBµV/m	42,1 dBµV/m	46 dBµV/m	Pass	136 degrees	1 m	Horizontal
2	515,27 MHz	43 dBµV/m	46 dBµV/m	37,8 dBµV/m	46 dBµV/m	Pass	297 degrees	1,5 m	Horizontal
3	813,59 MHz	45,2 dBµV/m	46 dBµV/m	40 dBµV/m	46 dBµV/m	Pass	136 degrees	1 m	Horizontal
4	162,721 MHz	45 dBµV/m	43,5 dBµV/m	41,7 dBµV/m	43,5 dBµV/m	Pass	49 degrees	1,2 m	Horizontal

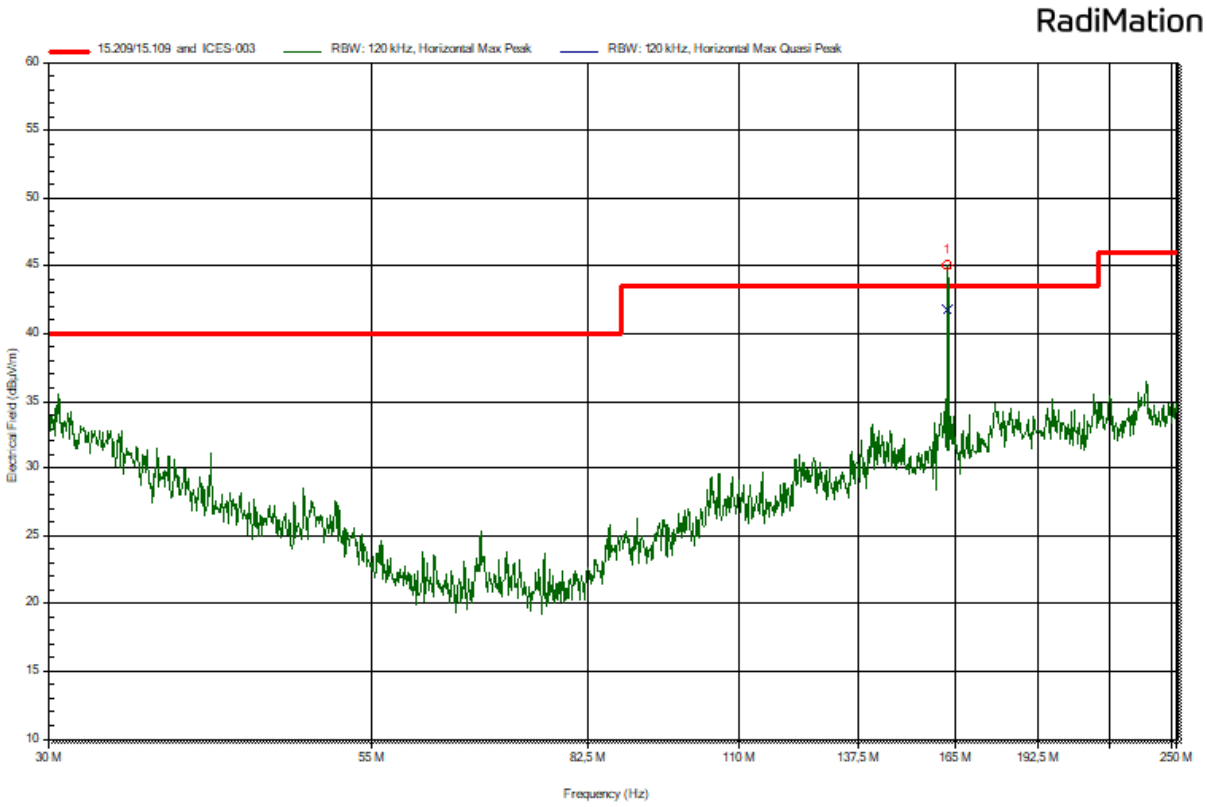
3.1.7 Plots of the Radiated Spurious Emissions Measurement

30 -250 MHz

Vertical polarization

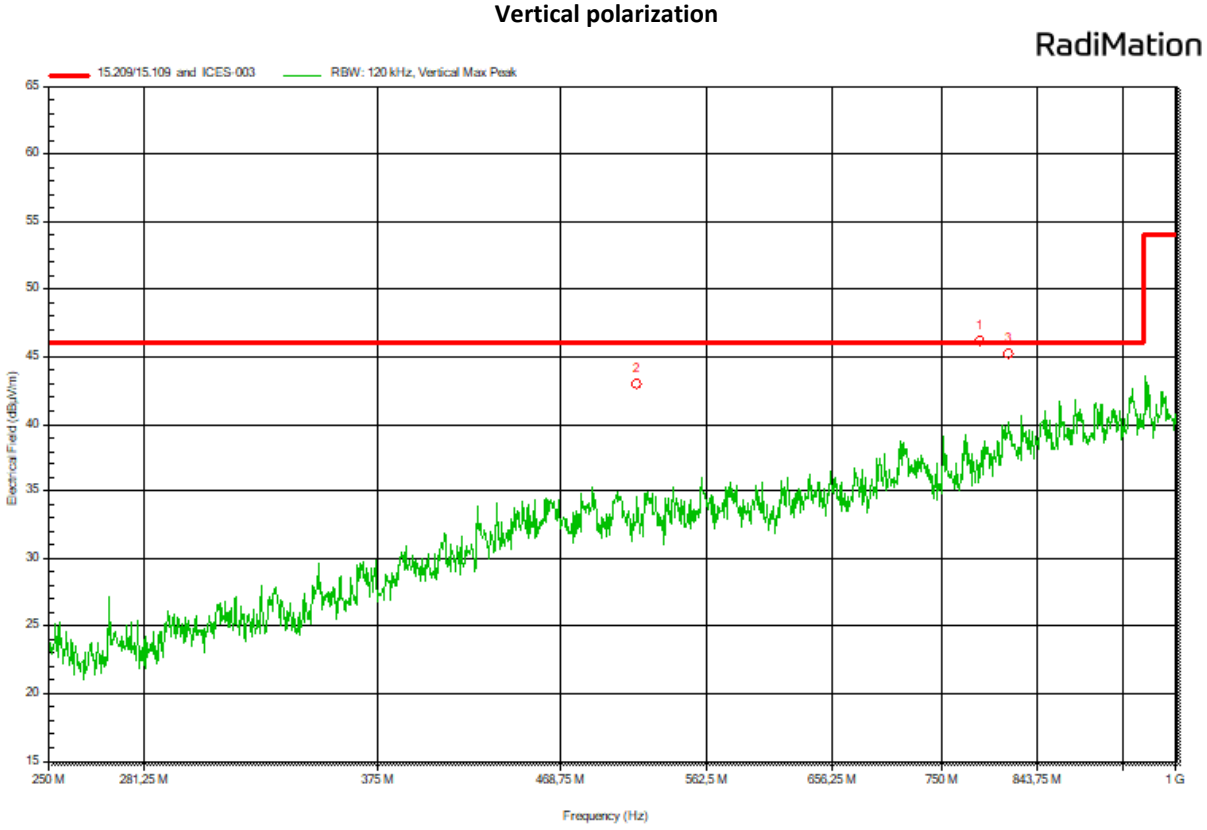


Horizontal polarization

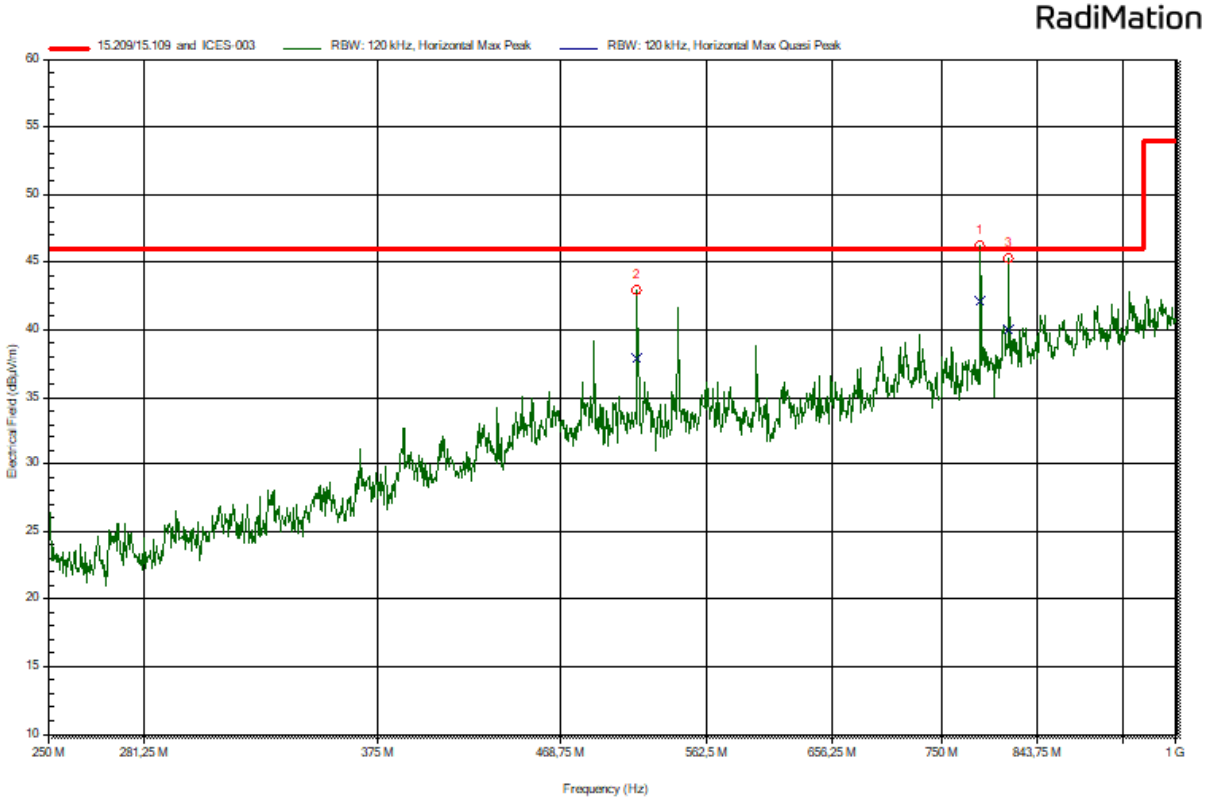


250 -1000 MHz

Vertical polarization



Horizontal polarization



3.2 AC power line conducted emissions

3.2.1 Limit

According to 15.207 (c)

Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.2.4 Test procedure

According to ANSI C63.10: 2013, section 13.3
IRN 029 – Method 1

3.2.5 Peak table of the AC power line emission measurement

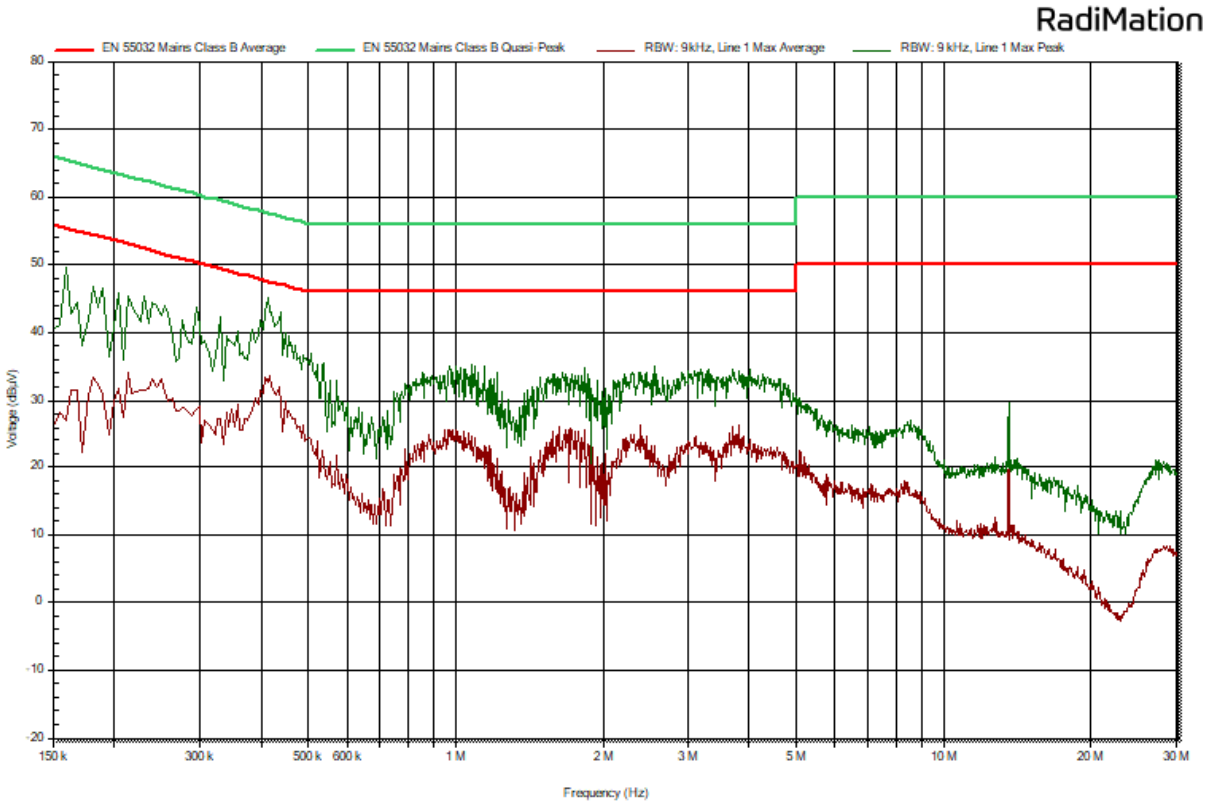
Frequency	Peak	Peak Limit	Average	Average Limit	Quasi-Peak	Quasi-Peak Limit	Status	LISN
150 kHz	50,3 dBµV	66 dBµV	22,8 dBµV	56 dBµV	45,4 dBµV	66 dBµV	Pass	Neutral
250,8 kHz	45,2 dBµV	61,7 dBµV	27 dBµV	51,7 dBµV	47,3 dBµV	61,7 dBµV	Pass	Neutral

3.2.6 Measurement uncertainty

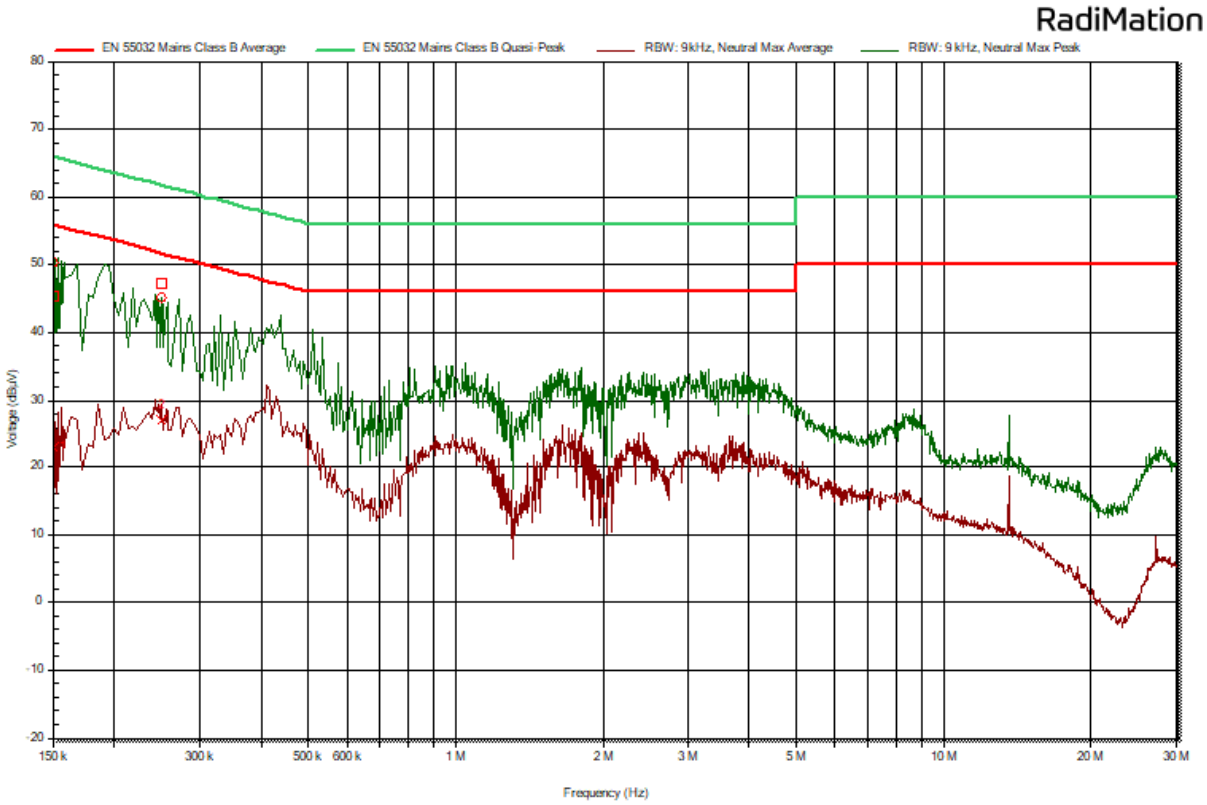
+/- 3.6 dB

3.2.7 Plots of the AC mains conducted spurious measurement

Phase



Neutral



3.3 Field strength of emissions

3.3.1 Limit

Frequency (MHz)	µV/m at 30 meter	dBµV/m at 30 meter
13.553 – 13.567	15,848	84
13.410 – 13.553 and 13.567 – 13.710	334	50.5
13.110 – 13.410 and 13.710 - 14.010	106	40.5

15.225(d)

Frequency (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance(m)
0.009 - 0.490	2400/F(kHz)	67.6-20 log(F(kHz))	300
0.490 – 1.705	24000/F(kHz)	87.6-20 log(F(kHz))	30
14.010 - 30	30	29.5	30

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.3.4 Test procedure

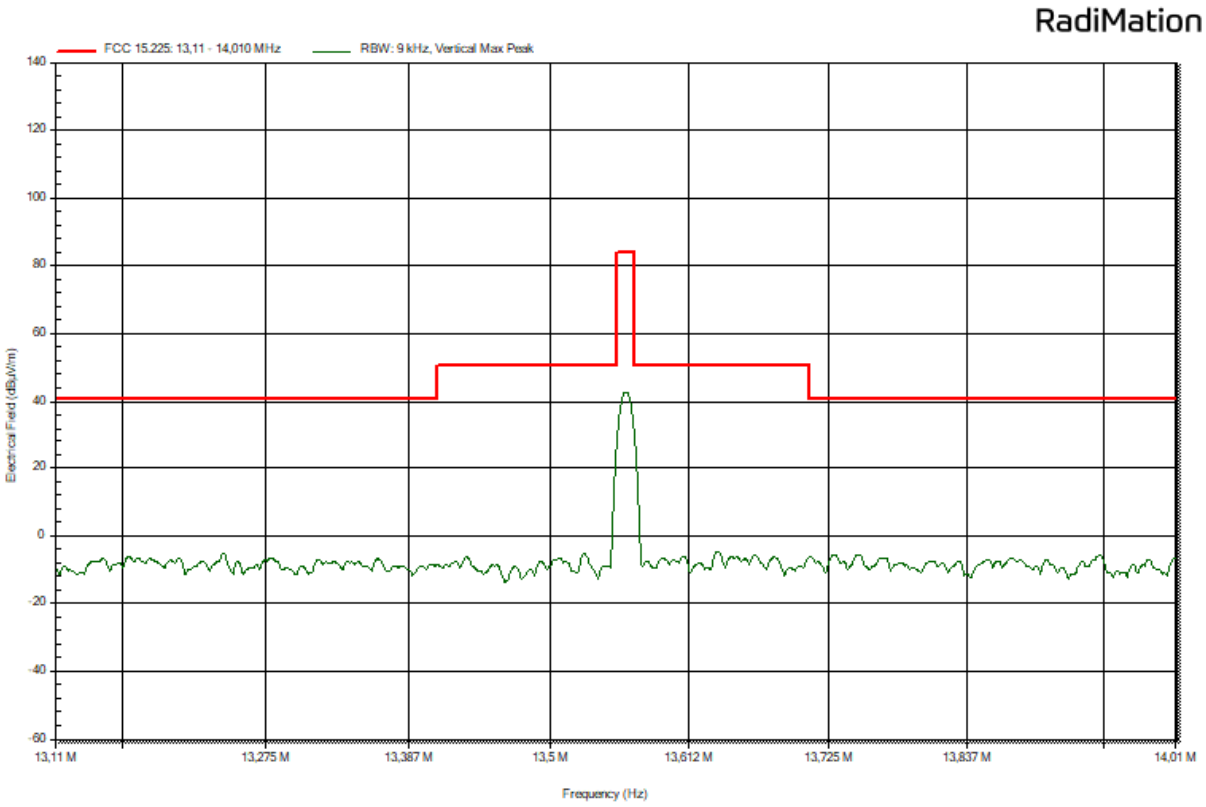
According to ANSI C63.10-2013, section 6.4.4.2
IRN 026 – Method 10

3.3.5 Test results of Field strength of emissions

Frequency (MHz)	Max Field strength at 30m (dBµV/m)
13.56	42.8
Uncertainty	+3.0 / -2.5 dB

3.3.6 Plots of Field strength of emissions Measurement

13.56 MHz



Note: The measurement in the plot above has been performed at 3m distance and converted the 30m in the measurement software. A distance factor of - 40 dB/decade conversion factor has been used to covert 3m measured value to 30m (ref. 47 CFR part 15B, §15.31 f (2)).

3.4 Frequency Stability

3.4.1 Limit

The frequency stability of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

The measured frequency for the 13.56 MHz radio should fall within the limits 13558.644 kHz ≤ f ≤ 13561.356 kHz.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.4.3 Test setup

The test has been performed in a climatic chamber using a test fixture

3.4.4 Test procedure

According to ANSI C63.10-2013, section 6.8
IRN 005 – Method 2

3.4.5 Test results of Frequency Stability Measurements

Temperature variation:

	Time after power on	2 minutes	5 minutes	10 minutes
Temperature				
50°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
40°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
30°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
20°C		15.559943 MHz	15.559943 MHz	15.559943 MHz
10°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
0°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
-10°C		15.559934 MHz	15.559934 MHz	15.559934 MHz
-20°C		15.559943 MHz	15.559943 MHz	15.559943 MHz

Voltage variation:

Voltage	Frequency (MHz)	Deviation (%)*)	Limit (%)
195.5	13.5599531	0.001	0.01
264.5	13.5599531	0.001	0.01

*) w.r.t. nominal frequency of 13.56 MHz

3.4.6 Measurement Uncertainty

Measurement uncertainty = + /- 10 Hz

3.5 20dB bandwidth Measurement

3.5.1 Limit

The 20 dB Bandwidth of the emission must be contained within the frequency band designated in the rule section under which the equipment is operated.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.5.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.5.4 Test procedure

According to ANSI C63.10

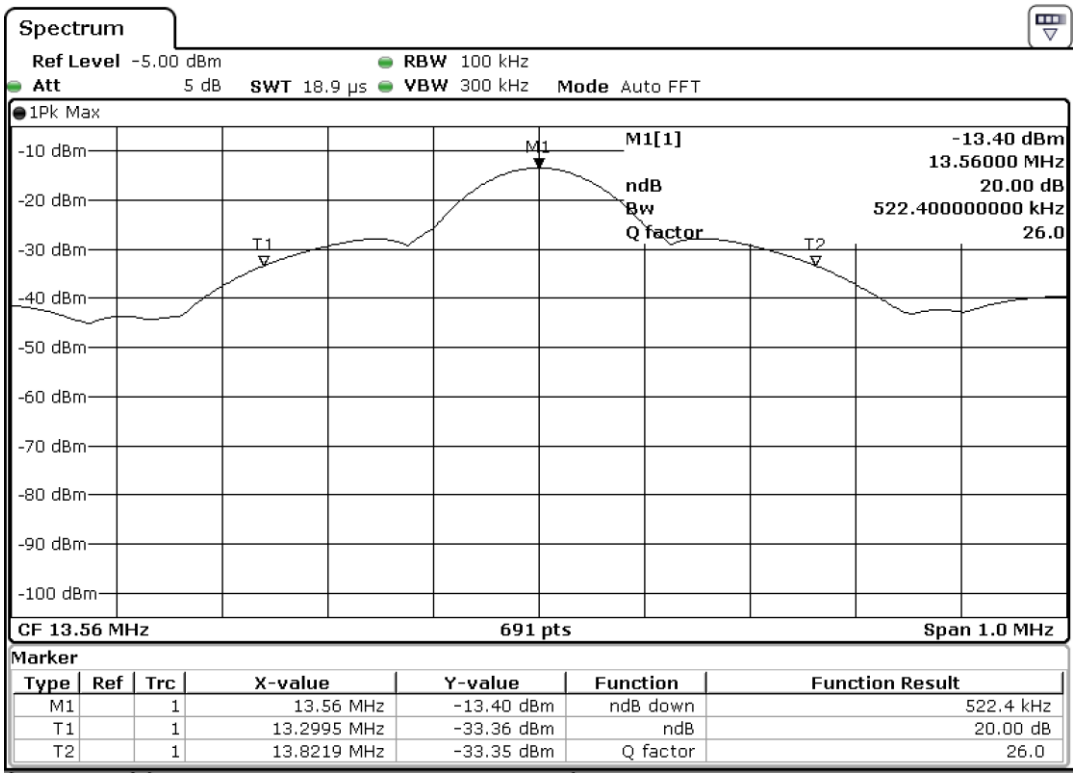
IRN 017 - Occupied bandwidth (Hz) Method 4 – DTS Bandwidth.

3.5.5 Test Results of the 20 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	20dB bandwidth (kHz)
NFC	1	13.56	-	522.4
Uncertainty	± 36.2 kHz			

Note: plots are provided on the next page.

3.5.6 Plots of the 20 dB bandwidth



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	13.56 MHz	-13.40 dBm	ndB down	522.4 kHz
T1		1	13.2995 MHz	-33.36 dBm	ndB	20.00 dB
T2		1	13.8219 MHz	-33.35 dBm	Q factor	26.0

4 Sample calculations

All formulas for data conversions and conversion factors are reported in this chapter.

Conducted emission Measurement:

U_{lisn} (dBµV) = U (dBµV) + Corr. (dB)

Where:
U = Measuring receiver voltage
LISN insertion loss = Voltage division factor of LISN
Corr. = sum of single correction factors of used LISN, cables and pulse limiter.
Linear interpolation will be used for frequencies in between the values in the table.

Frequency (Mhz)	**Voltage division LISN (db)**	**Cable loss (dB)**	**Corr. (dB)**
	114379 Rohde & Schwarz ENV216	**TE 11134**	
0,15	9.6	0,02	9.62
0,3	9.6	0,03	9.63
0,5	9.6	0,08	9.68
0,7	9.7	0,25	9.95
1	9.6	0,11	9.71
3	9.6	0,21	9.81
5	9.6	0,21	9.81
7	9.7	0,25	9.95
10	9.7	0,29	9.99
15	9.7	0,34	10.04
20	9.8	0,37	10.17
22	9.6	0,39	9.99
24	9.6	0,43	10.03
30	9.6	0,45	10.05

Magnetic field strength measurement:

$$H\left[dB\left(\mu\frac{A}{m}\right)\right] = V[dB(\mu V)] + L_c[dB] + AF^H[\frac{dB}{\Omega m}]$$

Where:
H is the magnetic field strength (to be compared to the limit)
V is the voltage level measured by the receiver or spectrum analyzer
L_C is the cable loss
AF^H is the magnetic antenna factor

Frequency (MHz)	AF (dB/Ωm) 114515 EMCO 6505 S/N:9112-2710	CL (dB) SAR cable	Corr. (dB)
0,009	-32,35	0,7	-31,65
0,01	-33,16	0,05	-33,11
0,02	-37,56	0,07	-37,49
0,03	-39,29	0,1	-39,19
0,04	-40,11	0,1	-40,01
0,1	-41,27	0,1	-41,17
0,2	-41,48	0,1	-41,38
0,5	-41,58	0,1	-41,48
1	-41,62	0,2	-41,42
3	-41,6	0,2	-41,4
5	-41,65	0,3	-41,35
10	-42,11	0,6	-41,51
15	-42,88	0,9	-41,98
20	-43,78	1	-42,78
25	-44,85	0,7	-44,15
27	-45,36	1,2	-44,16
30	-46,25	1	-45,25

Field Strength Measurement:

E (dBµV/m) = U(dBµV) + AF (dB/m) + Corr. (dB)

Where:
E = Electric field strength
U = Measuring receiver voltage
AF = Antenna factor
CL = Cable loss

Corr. = sum of single correction factors of used cable and amplifier (if applicable).
Linear interpolation will be used for frequencies in between the values in the table.
Tables shows an extract of the values.

Frequency (Mhz)	**AF (dB/m)**	**Cable loss (dB)**	**Corr. (dB)**
	Id: 114436 Schwarzbeck VHA9103+BBA9106 SN: 9856	**Id: SAR cable**	
30	18,64	0,68	19,32
100	10,43	1,15	11,58
150	14,76	1,41	16,17
200	16,04	1,63	17,67
250	16,89	1,93	18,82

Frequency (Mhz)	**AF (dB/m)**	**Cable loss (dB)**	**Corr. (dB)**
	Id: 114385 EMCO 3147 SN: 9104-1031	**Id: SAR cable**	
250	11,8	1,93	13,73
300	13	2,12	15,12
350	14,2	2,2	16,4
400	15,6	2,29	17,89
450	17,1	2,53	19,63
500	17,3	2,67	19,97
550	17,7	2,9	20,6
600	18,4	3,02	21,42
650	19,2	3,09	22,29
700	19,7	3,22	22,92
750	20,3	3,56	23,86
800	21,4	3,69	25,09
900	22,1	3,81	25,91
950	22,6	3,91	26,51
1000	22,5	4,3	26,8

Frequency (Mhz)	AF (dB/m) TE 00531 Emco 3115 SN: 9412-4377	Gain (dB) TE 11132 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
1000	23,6	40,4	2,0	66
1500	25,1	40,5	2,4	68
2000	27,1	40,5	2,7	70,3
2500	28,6	40,7	3,2	72,5
3000	30,5	40,7	3,2	74,4
3500	31,2	40,7	3,4	75,3
4000	32,7	40,9	4,9	78,5
4500	32,4	40,9	4,4	77,7
5000	33,2	40,7	4,6	78,5
5500	34,0	40,5	4,5	79
6000	34,6	40,0	5,2	79,8
6500	34,3	39,4	5,9	79,6
7000	35,2	38,6	5,7	79,5
7500	36,4	39,2	5,9	81,5
8000	37,0	38,9	6,3	82,2
8500	37,5	38,4	6,4	82,3
9000	38,1	37,4	6,5	82
9500	37,8	37,0	7,1	81,9
10000	38,2	36,5	7,3	82
10500	38,1	36,7	7,6	82,4
11000	38,3	36,9	8,3	83,5
11500	38,5	37,6	8,1	84,2
12000	39,1	38,3	8,4	85,8
12500	38,7	38,5	8,3	85,5
13000	39,2	38,9	9,2	87,3
13500	40,5	40,2	8,3	89
14000	41,1	40,0	8,2	89,3
14500	41,4	40,1	8,2	89,7
15000	40,2	41,4	8,3	89,9
15500	37,9	41,4	8,6	87,9
16000	37,5	42,8	9,2	89,5
16500	38,6	42,3	8,8	89,7
17000	41,1	43,1	9,4	93,6
17500	42,7	43,2	9,4	95,3
18000	44,0	44,2	9,8	98

Frequency (Mhz)	AF (dB/m) TE 00818 Flann 20240-25 SN: 163703	Gain (dB) TE 11131 Miteq JS4-18004000-30-8P-A1	Cable loss (dB) TE 01315	Corr. (dB)
18000	31,3	26,2	9,8	67,3
19000	31,5	26,1	9,6	67,2
20000	31,7	25,9	11	68,6
21000	31,9	24,3	10,7	66,9
22000	32,1	18,3	10,5	60,9
23000	32,2	18,9	10,8	61,9
24000	32,3	23,6	11,4	67,3
25000	32,4	24,5	11,6	68,5
26000	32,5	25,3	11,7	69,5

< End of Report >