FCC Measurement/Technical Report on

GCM - NA
Global Cellular Modem - GCM

contains FCC ID: PV7-WIBEAR11N-SF1
contains IC: 7738A-WB11NSF1

Test Report Reference: MDE_UBLOX_1629_FCCa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Note:
The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

Table of Contents

1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

Applicable FCC Rules

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

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1043 Changes in certificated equipment

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz

Note 1: (DTS Equipment)
The tests were selected and performed with reference to the FCC Public Notice “Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r05, 2016-04-08”. ANSI C63.10–2013 is applied.

Note 2: (Class II permissive change)
The test plan was agreed between the laboratory and the applicant. Not all applicable tests were performed. The aim of the test plan was, to show that the performance characteristics of the device still meet the minimum requirements of the applicable rules.

Selected test cases from FCC Test Report G0M-1211-2443-TFC247W-V02, Eurofins Product Service GmbH:
Maximum peak conducted power, per mode (DSSS, OFDM, HT20, HT40) only channel with highest power. The power supply voltage of the radio module was not accessible. Therefore was the device supply voltage at the USB port variated (U_{nom}, U_{min}, U_{max}).
Transmitter radiated emissions (including radiated band edge), only HT40 mode with F_{LOW} and F_{HIGH} and 3 different antenna configurations.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for DTS (e.g. WLAN 2.4 GHz, BT LE) equipment from FCC and IC

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-247 Issue 1: 5.2 (1)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-247 Issue 1: 5.4 (4)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-247 Issue 1: 5.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-247 Issue 1: 5.5
Band edge compliance	§ 15.247 (d)	RSS-247 Issue 1: 5.5
Power density	§ 15.247 (e)	RSS-247 Issue 1: 5.2 (2)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	–

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (b) (3)**

Peak Power Output
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	**Setup**	**FCC**	**IC**
Operating Frequency, Measurement method			
WLAN b, mid, conducted	L201 13	Passed	Passed
WLAN g, mid, conducted	L201 13	Passed	Passed
WLAN n 20 MHz, mid, conducted	L201 13	Passed	Passed
WLAN n 40 MHz, low, conducted	L201 13	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (d)**

Transmitter Spurious Radiated Emissions
The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	**Setup**	**FCC**	**IC**
Radio Technology, Operating Frequency, Measurement range			
WLAN n 40 MHz, high, 9 kHz - 30 MHz	Setup_AA01	Passed	Passed
WLAN n 40 MHz, high, 30 MHz - 1 GHz	Setup_AA01	Passed	Passed
WLAN n 40 MHz, high, 1 GHz - 26 GHz	Setup_AA01	Passed	Passed
WLAN n 40 MHz, low, 1 GHz - 8 GHz	Setup_AA01	Passed	Passed
WLAN n 40 MHz, high, 9 kHz - 30 MHz	Setup_AB01	Passed	Passed
WLAN n 40 MHz, high, 30 MHz - 1 GHz	Setup_AB01	Passed	Passed
WLAN n 40 MHz, high, 1 GHz - 26 GHz	Setup_AB01	Passed	Passed
WLAN n 40 MHz, low, 1 GHz - 8 GHz	Setup_AB01	Passed	Passed
WLAN n 40 MHz, high, 1 GHz - 8 GHz	Setup_AC01	Passed	Passed
WLAN n 40 MHz, low, 1 GHz - 8 GHz	Setup_AC01	Passed	Passed

47 CFR CHAPTER I FCC PART 15 Subpart C § 15.247 (d) §15.247

Band Edge Compliance Radiated

The measurement was performed according to ANSI C63.10 **Final Result**

OP-Mode	**Setup**	**FCC**	**IC**
Radio Technology, Operating Frequency, Band Edge			
WLAN n 40 MHz, high, high	Setup_AA01	Passed	Passed
WLAN n 40 MHz, low, low	Setup_AA01	Passed	Passed
WLAN n 40 MHz, high, high	Setup_AB01	Passed	Passed
WLAN n 40 MHz, low, low	Setup_AB01	Passed	Passed
WLAN n 40 MHz, high, high	Setup_AC01	Passed	Passed
WLAN n 40 MHz, low, low	Setup_AC01	Passed	Passed

MARCO KULLIK
2016.12.29
15:42:53 +01'00'

(responsible for accreditation scope)
Marco Kullik

WOLFGANG PETER
RICHTER
2016.12.29 10:43:58
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(responsible for testing and report)
Wolfgang Richter

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

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

This facility has been fully described in a report submitted to the IC and accepted under the registration number: Site# 3699A-1.

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

Laboratory accreditation no:	DAkkS D-PL-12140-01-00
Responsible for accreditation scope:	Marco Kullik
Report Template Version:	2016-06-07

2.2 PROJECT DATA

Responsible for testing and report:	Wolfgang Richter
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2016-12-29
Testing Period:	2016-12-07 to 2016-12-13

2.3 APPLICANT DATA

Company Name:	The Nielsen Company, LLC
Address:	770 Broadway 10003-9595 New York USA
Contact Person:	Aleksandar Savic

2.4 MANUFACTURER DATA

Company Name:	The Nielsen Company, LLC
Address:	770 Broadway 10003-9595 New York USA
Contact Person:	Jeff Landes

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

<table>
<tr><td>Kind of Device product description</td><td>Communication module containing u-blox module ELLA-W131</td></tr>
<tr><td>Product name</td><td>Global Cellular Modem - GCM</td></tr>
<tr><td>Type</td><td>GCM - NA</td></tr>
<tr><td colspan="2">Declared EUT data by the supplier</td></tr>
<tr><td>Voltage Type</td><td>DC</td></tr>
<tr><td>Voltage Level</td><td>5 V +/- 0.25 V</td></tr>
<tr><td>General product description</td><td>Nielsen Global Cellular Modem (GCM) enables connecting multiple Nielsen TAM (Television Audience Meters) devices within the same household to Nielsen Data Center using broadband technologies available in households or cellular data transfer technologies available from local cellular network providers.</td></tr>
<tr><td>Specific product description for the EUT</td><td>GCM is connected to the TAM (host) as an USB 2.0 device. The USB connection provides power and serves as the sole wired communication channel to the host device. GCM hardware architecture is based on Wi-Fi/Cellular bridge solution from u-blox (TOBY-L20x/ELLA-W1).</td></tr>
<tr><td>The EUT provides the following ports:</td><td>USB</td></tr>
<tr><td>RF-Parameter</td><td>
<table>
<tr><th>Channel</th><th>Modu-lation</th><th>Channel bandwidth</th><th>Data rates</th><th>Maximum power setting</th></tr>
<tr><td>1-11</td><td>CCK and DSSS</td><td></td><td>1, 2, 5.5, 11 Mbps</td><td>17 dBm</td></tr>
<tr><td>1-11</td><td>OFDM</td><td>20 MHz</td><td>6 - 54 Mbps</td><td>15 dBm</td></tr>
<tr><td>1-11</td><td>OFDM</td><td>20 MHz</td><td>MCS0-MCS7</td><td>15 dBm</td></tr>
<tr><td>3-9</td><td>OFDM</td><td>40 MHz</td><td>MCS0-MCS7</td><td>15 dBm</td></tr>
</table>
</td></tr>
</table>

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
L201 01	DE1015048ab01	J2 antenna connector active and using Taoglas Antenna GSA.8827R.A.201911
Sample Parameter	**Value**	
Integral Antenna	No (2 antenna ports J1, J2)	
Serial No.	L201 01	
HW Version	BoM reference: 126-1907-001, PCB version: 119-1738-000	
SW Version	Not applicable, refer to TOBY FW version.	
Comment	-	

Sample Name	Sample Code	Description
L201 13	DE1015048ac01	Sample used in Setup_AA01 or Setup_AC01
Sample Parameter	**Value**	
Integral Antenna	No (2 antenna ports J1, J2)	
Serial No.	L201 13	
HW Version	BoM reference: 126-1907-001, PCB version: 119-1738-000	
SW Version	Not applicable, refer to TOBY FW version.	
Comment		

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

3.3 ANCILLARY EQUIPMENT

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

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
Evercom antenna	Evercom, WG-UMB-TC883, -	Antenna at port J2
Sample Name	**Description**	
Evercom antenna		

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
Taoglas antenna GSA.8827R.A.201911	Taoglas, Taoglas GSA.8827R.A.201911, -	Antenna at port J2 (with 2 m cable and MMCX (M) connector)
Sample Name	**Description**	
Taoglas		

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
Taoglas antenna FXP73.09.0016A	Taoglas, FXP73.09.0016A , -	Antenna at port J1 (with customized 16 mm cable)
Sample Name	**Description**	
Taoglas antenna		

3.4 AUXILIARY EQUIPMENT

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

Device	**Details (Manufacturer, HW, SW, S/N)**	**Description**
Adapter Cable	unspecified, -, -, -	Banana to Jack adapter cable
Laptop	Compaq, -, -, CNU6361HMP	Compaq nw8440
Power Adapter	Compaq, -, -, 6802388502	for Laptop
Splitter	Nielsen, -, -, -	Nielsen Power USB
USB Cable	unspecified, -, -, -	A-A Male 0.15m

3.5 EUT SETUPS

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

Setup	**Combination of EUTs**	**Description and Rationale**
Setup_ AA01	L201 13, Taoglas antenna , Power Adapter, Adapter Cable, USB Cable, Splitter, Laptop,	Setup using sample DE1016048ac01 and Taoglas antenna (FXP73.09.0016A) at antenna port J1 (J2 open)
Setup_ AB01	L201 01, Taoglas, Power Adapter, Adapter Cable, USB Cable, Splitter, Laptop,	Setup using sample DE1016048ab01 and Taoglas antenna (GSA.8827R.A.201911) at antenna port J2 (J1 open)
Setup_ AC01	L201 13, Evercom antenna, Power Adapter, Adapter Cable, USB Cable, Splitter, Laptop,	Setup using sample DE1016048ac01 and Evercom antenna (WG-UMB-TC883) at antenna port J2 (J1 open)

3.6 OPERATING MODES

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

Mode	Radio Technology	Modulation	Data Rate	Channel Bandwidth	Power setting
DSSS	WLAN b	DSSS	1 Mbps	20 MHz	17 dBm
OFDM	WLAN g	OFDM	6 Mbps	20 MHz	15 dBm
HT20	WLAN n 20 MHz	OFDM	MCS0	20 MHz	15 dBm
HT40	WLAN n 40 MHz	OFDM	MCS0	40 MHz	15 dBm

3.6.1 TEST CHANNELS

WLAN	2.4 GHz ISM 2400 - 2483.5 MHz		
20 MHz Test Channels:	low	mid	high
Channel:	1	6	11
Frequency [MHz]	2412	2437	2462

40 MHz Test Channels:	low	mid	high
Channel:	3	6	9
Frequency [MHz]	2422	2437	2452

3.6.2 DUTY CYCLE

The tests are performed with 100 % duty cycle.

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.1.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweep time: 5 ms
- Detector: Peak

The channel power function of the spectrum analyser was used (Used channel bandwidth = DTS bandwidth)

4.1.2 TEST REQUIREMENTS / LIMITS

DTS devices:
FCC Part 15, Subpart C, §15.247 (b) (3)
For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

==> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Frequency Hopping Systems:
FCC Part 15, Subpart C, §15.247 (b) (1)
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

FCC Part 15, Subpart C, §15.247 (b) (2)
For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)

4.1.3TEST PROTOCOL

Sample	DE1015048ac01	Temperature	24 °C	Humidity	34 %

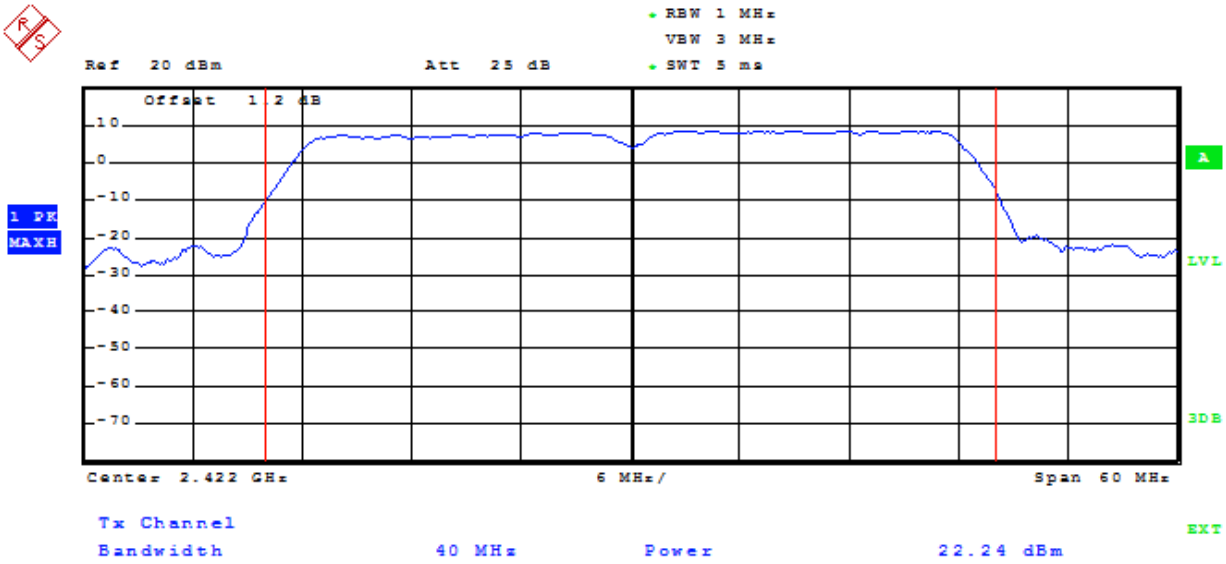
measured at	Antenna Port J1 (J2 open)					
Channel	Frequency	Voltage	Mode	Data Rate	Peak Power	Power Settings
	MHz				dBm	dBm
F_{mid}	2437	low (4.75 V)	DSSS	1 Mbps	19.6	17
F_{mid}	2437	mid (5 V)	DSSS	1 Mbps	19.7	17
F_{mid}	2437	high (5.25 V)	DSSS	1 Mbps	19.5	17
F_{mid}	2437	low (4.75 V)	OFDM	6 Mbps	20.7	15
F_{mid}	2437	mid (5 V)	OFDM	6 Mbps	20.8	15
F_{mid}	2437	high (5.25 V)	OFDM	6 Mbps	20.7	15
F_{mid}	2437	low (4.75 V)	HT20	MSC0	21.1	15
F_{mid}	2437	mid (5 V)	HT20	MSC0	21.1	15
F_{mid}	2437	high (5.25 V)	HT20	MSC0	21.0	15
F_{low}	2422	low (4.75 V)	HT40	MSC0	21.8	15
F_{low}	2422	mid (5 V)	HT40	MSC0	21.9	15
F_{low}	2422	high (5.25 V)	HT40	MSC0	**22.2**	15

measured at	Antenna Port J2 (J1 open)					
Channel	Frequency	Voltage	Mode	Data Rate	Peak Power	Power Settings
	MHz				dBm	dBm
F_{mid}	2437	low (4.75 V)	DSSS	1 Mbps	16.3	17
F_{mid}	2437	mid (5 V)	DSSS	1 Mbps	16.4	17
F_{mid}	2437	high (5.25 V)	DSSS	1 Mbps	16.1	17
F_{mid}	2437	low (4.75 V)	OFDM	6 Mbps	18.2	15
F_{mid}	2437	mid (5 V)	OFDM	6 Mbps	18.4	15
F_{mid}	2437	high (5.25 V)	OFDM	6 Mbps	18.2	15
F_{mid}	2437	low (4.75 V)	HT20	MSC0	18.8	15
F_{mid}	2437	mid (5 V)	HT20	MSC0	18.6	15
F_{mid}	2437	high (5.25 V)	HT20	MSC0	18.6	15
F_{low}	2422	low (4.75 V)	HT40	MSC0	19.3	15
F_{low}	2422	mid (5 V)	HT40	MSC0	**19.4**	15
F_{low}	2422	high (5.25 V)	HT40	MSC0	19.3	15

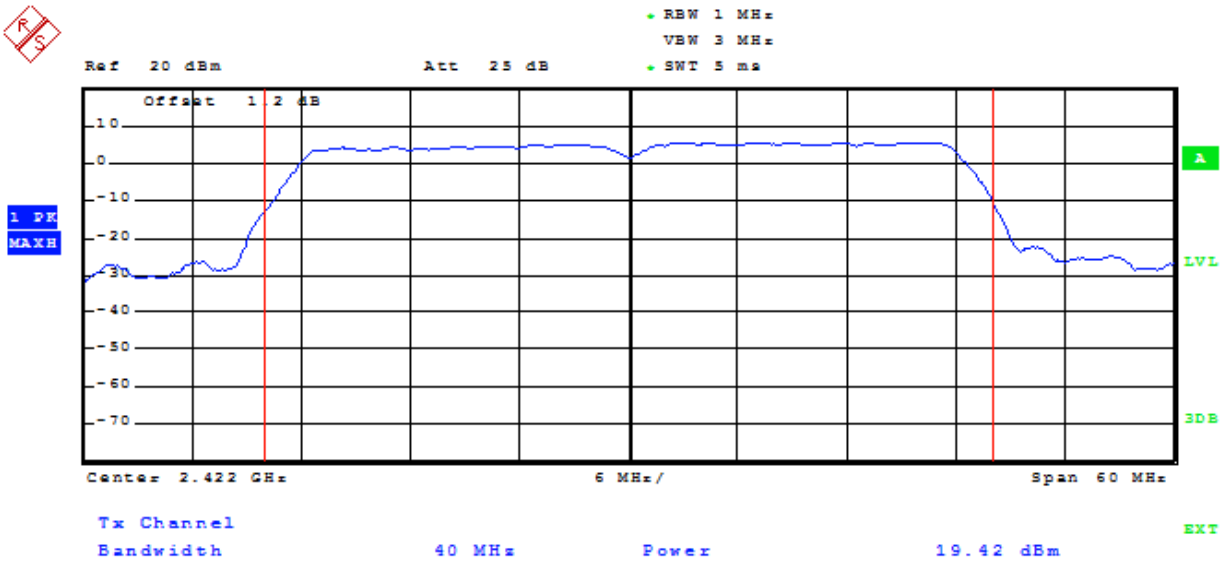
Remark: Please see next sub-clause for the measurement plot.

4.1.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, “WORST CASE”)

Radio Technology = WLAN n (HT40), Operating Frequency = low, voltage = high
Measurement method = conducted, Port J1



Radio Technology = WLAN n (HT40), Operating Frequency = low, voltage = mid
Measurement method = conducted, Port J2



4.1.5TEST EQUIPMENT USED

TP098 - R&S TS8980 RF

4.2 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.2.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S.
Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes.
A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

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

Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms

- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

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

Step 2: Adjustment measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

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

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

Step 1:

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.

All steps were performed with one height (1.5 m) of the receiving antenna only.

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.

The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

Step 2:

Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size ± 45° for the elevation axis is performed.

The turn table azimuth will slowly vary by ± 22.5°.

The elevation angle will slowly vary by ± 45°

EMI receiver settings (for all steps):

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 3:

Spectrum analyser settings for step 3:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

4.2.2TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

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

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

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

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

4.2.3TEST PROTOCOL

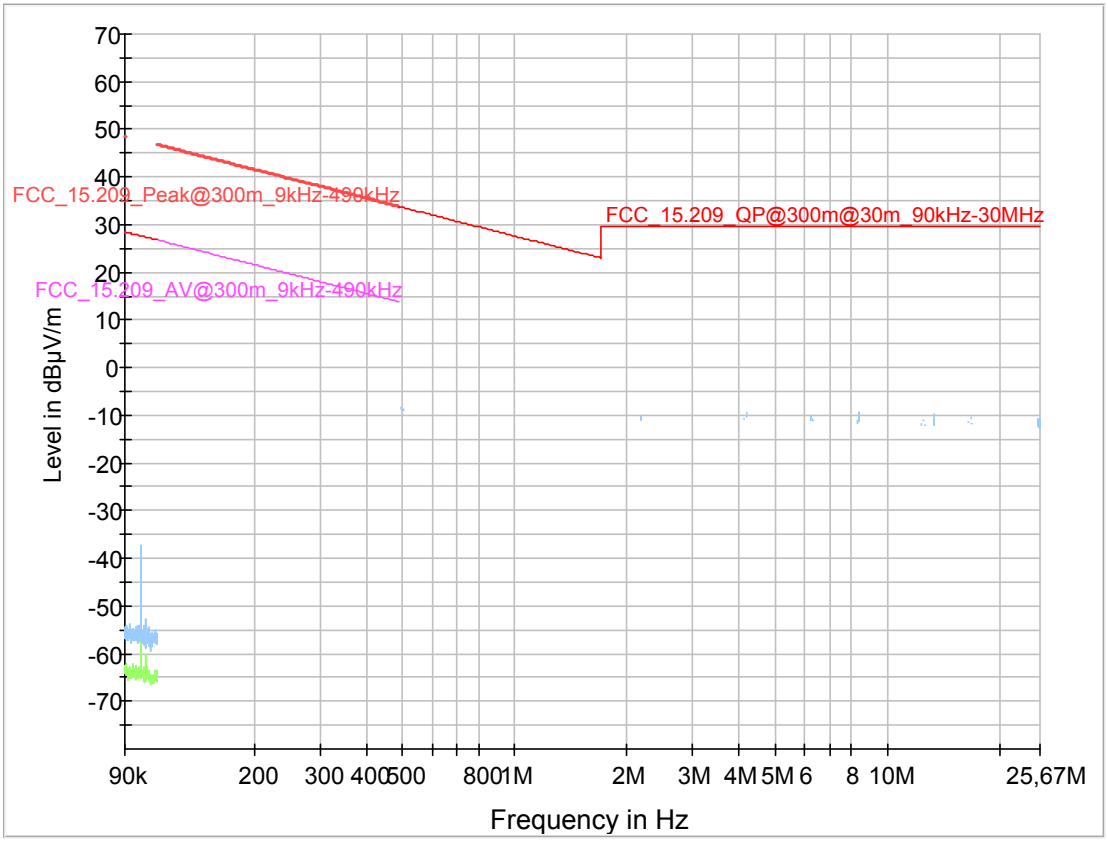
WLAN n-Mode; HT40; 40 MHz; MSC0; Duty Cycle 100%, Power Level 15 dBm
Applied duty cycle correction (AV): 0 dB

Setup	Freq. Range	Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
Setup_AA01	9 kHz - 30 MHz	9	2452	- - -	- - -	QP	- - -	- - -	> 20	RB
Setup_AB01	9 kHz - 30 MHz	9	2452	- - -	- - -	QP	- - -	- - -	> 20	RB
Setup_AA01	30 MHz - 1 GHz	9	2452	- - -	- - -	QP	- - -	- - -	> 20	RB
Setup_AB01	30 MHz - 1 GHz	9	2452	- - -	- - -	QP	- - -	- - -	> 20	RB
Setup_AA01	1 GHz - 24 GHz	9	2452	2484.407500	42.5	AV	1000	54,0	11.5	RB
Setup_AA01	1 GHz - 24 GHz	9	2452	2484.407500	59.3	PEAK	1000	74,0	14.7	RB
Setup_AB01	1 GHz - 24 GHz	9	2452	2484.077500	42.1	AV	1000	54,0	11.9	RB
Setup_AB01	1 GHz - 24 GHz	9	2452	2484.160000	57.2	PEAK	1000	74,0	16.8	RB
Setup_AC01	1 GHz - 7.75 GHz	9	2452	2484.242500	40.8	AV	1000	54,0	13.2	RB
Setup_AC01	1 GHz - 7.75 GHz	9	2452	2484.242500	55.5	PEAK	1000	74,0	18.5	RB
Setup_AA01	1 GHz - 7.75 GHz	3	2422	2388.800000	50.1	AV	1000	54,0	3.9	RB
Setup_AA01	1 GHz - 7.75 GHz	3	2422	2388.800000	67.3	PEAK	1000	74,0	6.7	RB
Setup_AB01	1 GHz - 7.75 GHz	3	2422	2388.640000	43.1	AV	1000	54,0	10.9	RB
Setup_AB01	1 GHz - 7.75 GHz	3	2422	2388.640000	58.9	PEAK	1000	74,0	15.1	RB
Setup_AC01	1 GHz - 7.75 GHz	3	2422	2388.400000	36.5	AV	1000	54,0	17.6	RB
Setup_AC01	1 GHz - 7.75 GHz	3	2422	2388.400000	56.6	PEAK	1000	74,0	17.5	RB

Remark: Please see next sub-clause for the measurement plot.

4.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = WLAN b, Operating Frequency = mid,
Measurement range = 9 kHz - 30 MHz



Critical_Freqs

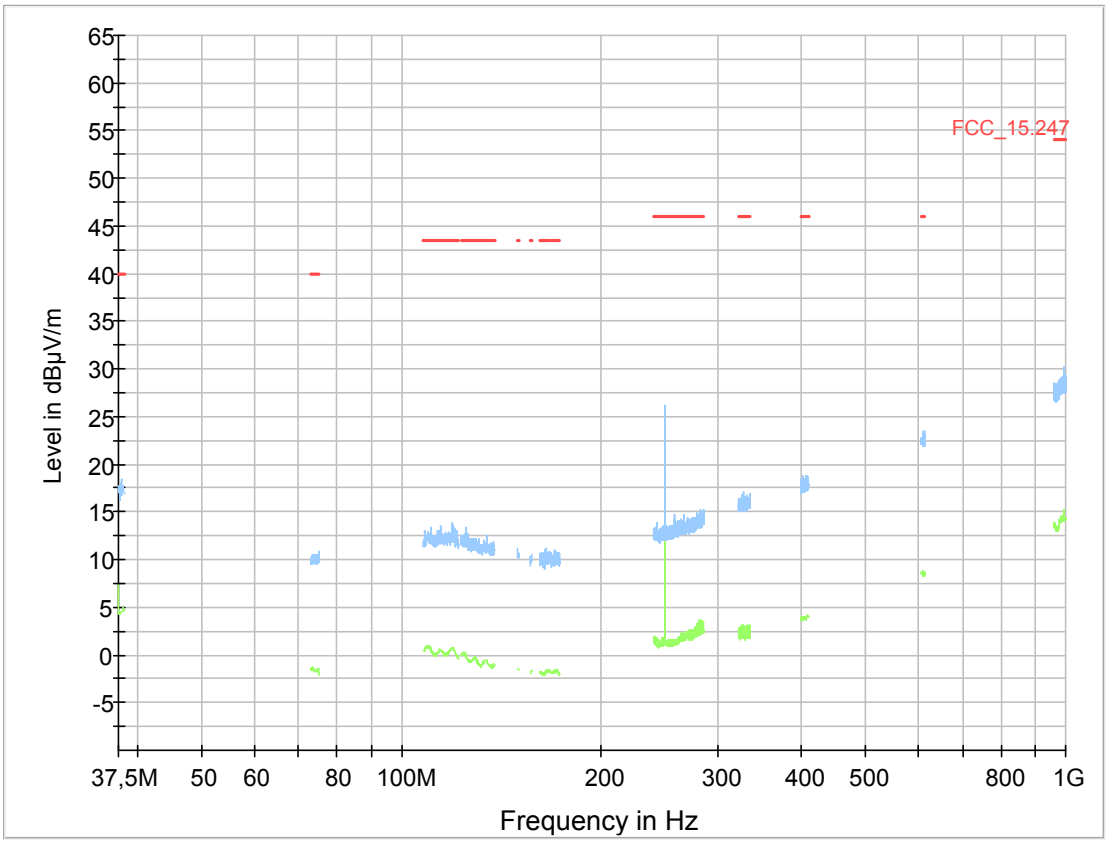
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
---	---	---	---	---	---	---	---		---	---

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
---	---	---	---	---	---	---	---		---	---

Setup_AA01, 5 V, HT40, Ch. 9, 15 dBm

Radio Technology = WLAN b, Operating Frequency = high,
Measurement range = 30 MHz - 1 GHz



Critical_Freqs

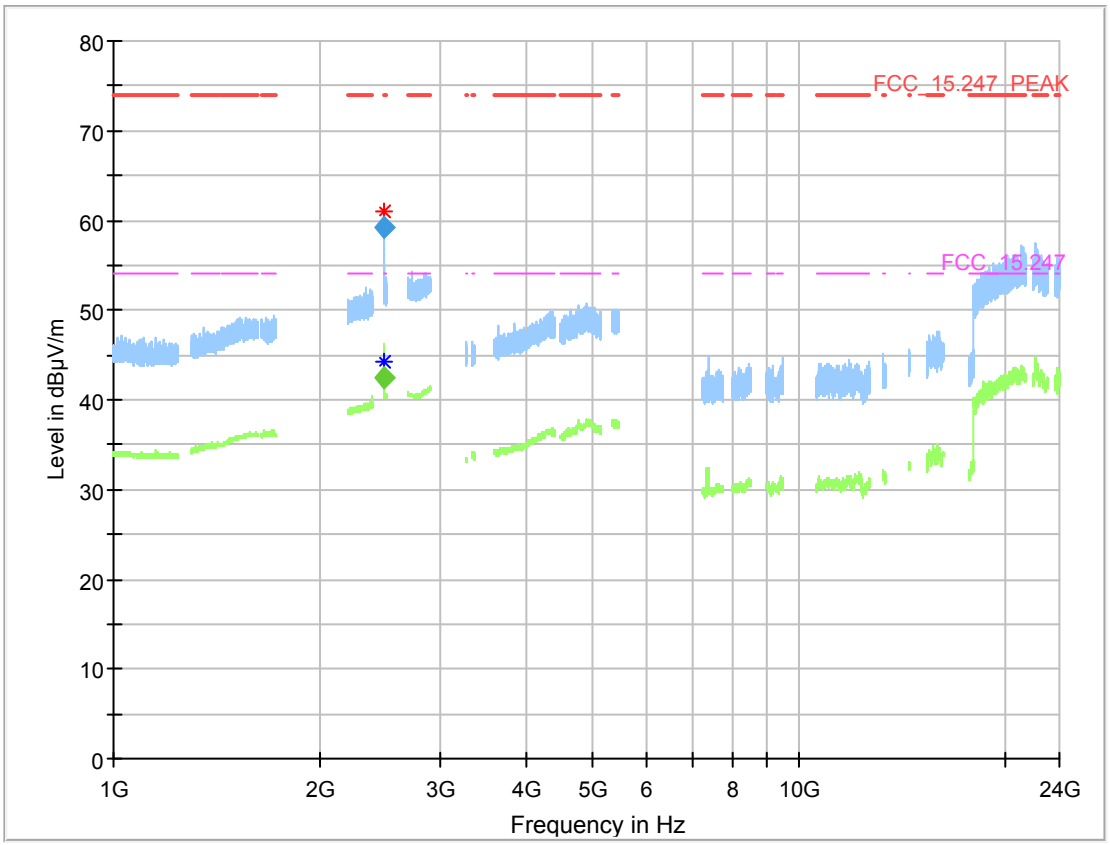
Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
---	---	---	---	---	---	---	---		---	---

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
---	---	---	---	---	---	---		---	---

Setup_AA01, 5 V, HT40, Ch. 9, 15 dBm

Radio Technology = WLAN n 40 MHz, Operating Frequency = high,
Measurement range = 1 GHz - 26 GHz



Critical_Freqs

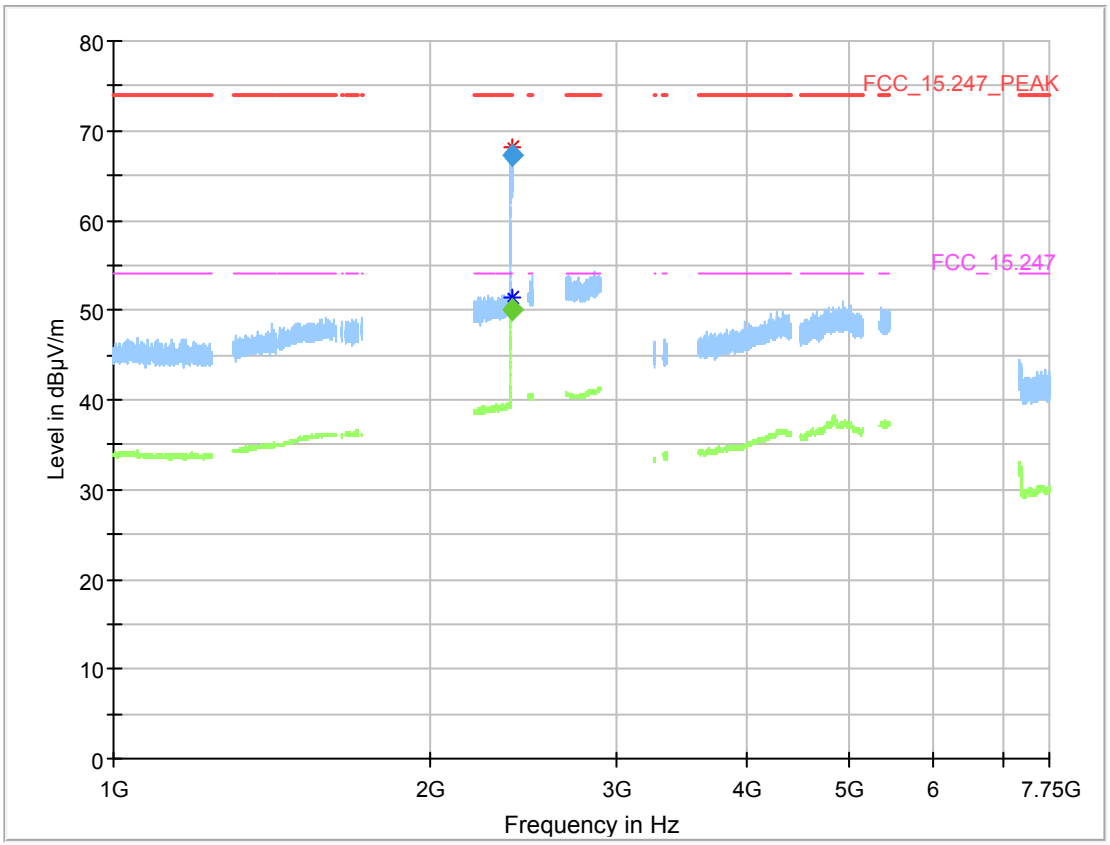
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2484.407500	60.98	---	74.00	13.02	---	---	150.0	V	-146.0	88.9
2484.407500	---	44.28	54.00	9.72	---	---	150.0	V	-150.0	86.0

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2484.407500	---	42.51	54.00	11.49	1000.0	1000.000	150.0	V	-150.0	86.0
2484.407500	59.26	---	74.00	14.74	1000.0	1000.000	150.0	V	-146.0	88.8

Setup_AA01, 5 V, HT40, Ch. 9, 15 dBm

Radio Technology = WLAN n 40 MHz, Operating Frequency = low,
Measurement range = 1 GHz - 26 GHz



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2388.800000	68.20	---	74.00	5.80	---	---	150.0	V	83.0	79.7
2388.800000	---	51.41	54.00	2.59	---	---	150.0	V	86.0	78.2

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2388.800000	---	50.11	54.00	3.89	1000.0	1000.000	150.0	V	86.0	77.9
2388.800000	67.34	---	74.00	6.66	1000.0	1000.000	150.0	V	83.0	79.8

Setup_AA01, 5 V, HT40, Ch. 3, 15 dBm

4.2.5TEST EQUIPMENT USED

Radiated Emissions

4.3 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.3.1 TEST DESCRIPTION

Please see test description for the test case “Spurious Radiated Emissions”

4.3.2 TEST REQUIREMENTS / LIMITS

For band edges connected to a restricted band, the limits are specified in Section 15.209(a)

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

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

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

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

4.3.3TEST PROTOCOL

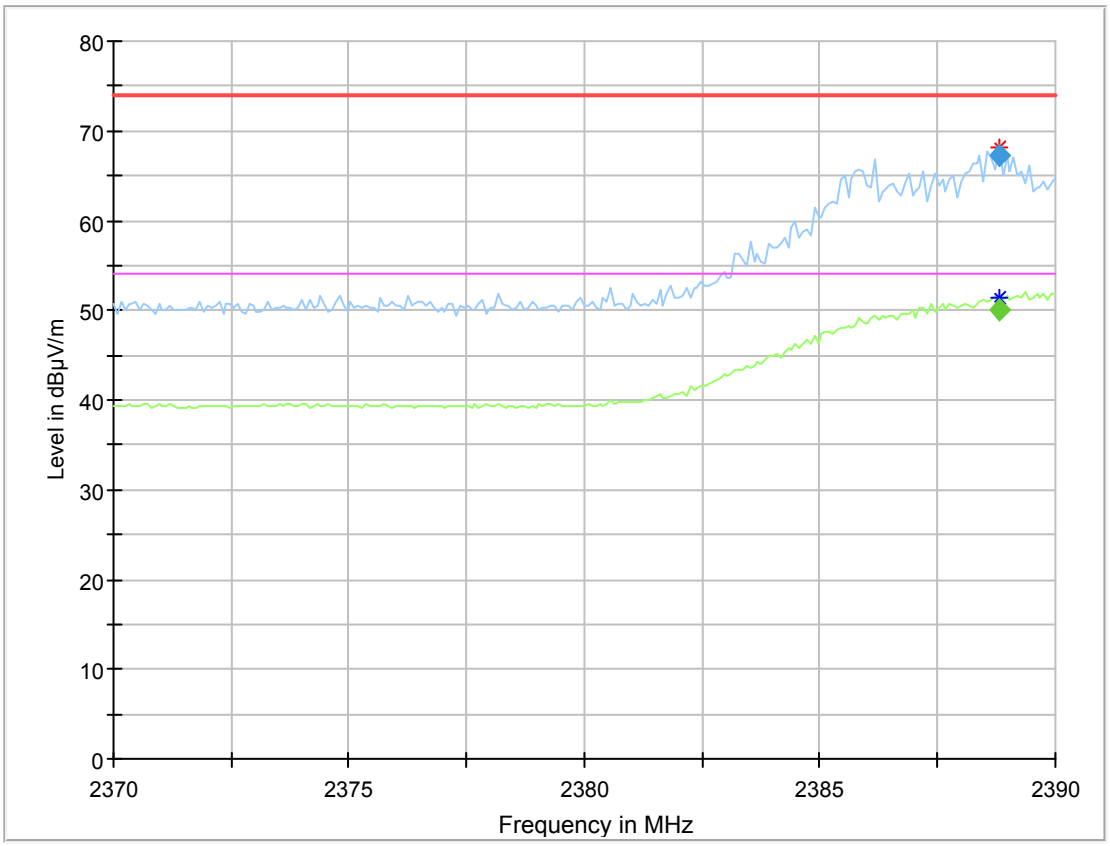
WLAN n-Mode; HT40; 40 MHz; MSC0; Duty Cycle 100%, Power Level 15 dBm
Applied duty cycle correction (AV): 0 dB

Setup	Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
Setup_AA01	9	2452	2483.5	61.0	PEAK	1000	74.0	13.0	BE
Setup_AA01	9	2452	2483.5	46.0	AV	1000	54.0	8.0	BE
Setup_AA01	3	2422	2390.0	67.3	PEAK	1000	74.0	**6.7**	BE
Setup_AA01	3	2422	2390.0	50.1	AV	1000	54.0	**3.9**	BE
Setup_AB01	9	2452	2483.5	57.2	PEAK	1000	74.0	16.8	BE
Setup_AB01	9	2452	2483.5	42.1	AV	1000	54.0	11.9	BE
Setup_AB01	3	2422	2390.0	58.9	PEAK	1000	74.0	15.1	BE
Setup_AB01	3	2422	2390.0	43.1	AV	1000	54.0	10.9	BE
Setup_AC01	9	2452	2483.5	55.5	PEAK	1000	74.0	18.5	BE
Setup_AC01	9	2452	2483.5	40.8	AV	1000	54.0	13.2	BE
Setup_AC01	3	2422	2390.0	59.8	PEAK	1000	74.0	14.2	BE
Setup_AC01	3	2422	2390.0	43.8	AV	1000	54.0	10.2	BE

Remark: Please see next sub-clause for the measurement plot.

4.3.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = WLAN n 40 MHz, Operating Frequency = high, Band Edge = high



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2388.800000	68.20	---	74.00	5.80	---	---	150.0	V	83.0	79.7
2388.800000	---	51.41	54.00	2.59	---	---	150.0	V	86.0	78.2

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
2388.800000	---	50.11	54.00	3.89	1000.0	1000.000	150.0	V	86.0	77.9
2388.800000	67.34	---	74.00	6.66	1000.0	1000.000	150.0	V	83.0	79.8

Setup_AA01, 5 V, HT40, Ch. 3, 15 dBm

4.3.5TEST EQUIPMENT USED

Radiated Emissions

5 TEST EQUIPMENT

1 Radiated Emissions
Lab to perform radiated emission tests

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
1.2	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
1.3	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
1.4	Datum MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2016-09	2017-09
1.5	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
1.6	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
1.7	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
1.8	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.9	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2014-01	2017-01
1.10	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
1.11	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
1.12	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
1.13	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
1.14	AS 620 P	Antenna mast	HD GmbH	620/37		
1.15	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2016-05	2017-05
1.16	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
1.17	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.18	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
1.19	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
1.20	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
1.21	Opus10 THI (8152.00)	Thermo-Hygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2015-03	2017-03
1.22	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
1.23	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2014-11	2017-11
1.24	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-11	2018-11
1.25	Opus10 TPR (8253.00)	Thermo-Airpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2015-02	2017-02
1.26	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
1.27	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
1.28	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
1.29	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
1.30	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05

2 TP098 - R&S TS8980 RF
3G/LTE Conformance test system

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	FSQ	Signal Analyzer	Rohde & Schwarz	101424	2016-05	2017-05
2.2	Opus10 T/H	Thermo-Hygro Datalogger 05	Lufft Mess- und Regeltechnik GmbH	7480	2015-02	2017-02

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0,15		10,1	0,1	10,0
5		10,3	0,1	10,2
7		10,5	0,2	10,3
10		10,5	0,2	10,3
12		10,7	0,3	10,4
14		10,7	0,3	10,4
16		10,8	0,4	10,4
18		10,9	0,4	10,5
20		10,9	0,4	10,5
22		11,1	0,5	10,6
24		11,1	0,5	10,6
26		11,2	0,5	10,7
28		11,2	0,5	10,7
30		11,3	0,5	10,8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24,4	-19,4	0,99	0,31	-21,51	0,79		
2000	28,5	-17,4	1,44	0,44	-20,63	1,38		
3000	31,0	-16,1	1,87	0,53	-19,85	1,33		
4000	33,1	-14,7	2,41	0,67	-19,13	1,31		
5000	34,4	-13,7	2,78	0,86	-18,71	1,40		
6000	34,7	-12,7	2,74	0,90	-17,83	1,47		
7000	35,6	-11,0	2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31,0	-23,4	0,47	1,87	0,53	-27,58	1,33	
4000	33,1	-23,3	0,56	2,41	0,67	-28,23	1,31	
5000	34,4	-21,7	0,61	2,78	0,86	-27,35	1,40	
6000	34,7	-21,2	0,58	2,74	0,90	-26,89	1,47	
7000	35,6	-19,8	0,66	2,82	0,86	-25,58	1,46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35,6	-57,3	0,56	1,28	-62,72	2,66	0,94	1,46
8000	36,3	-56,3	0,69	0,71	-61,49	2,84	1,00	1,53
9000	37,1	-55,3	0,68	0,65	-60,80	3,06	1,09	1,60
10000	37,5	-56,2	0,70	0,54	-61,91	3,28	1,20	1,67
11000	37,5	-55,3	0,80	0,61	-61,40	3,43	1,27	1,70
12000	37,6	-53,7	0,84	0,42	-59,70	3,53	1,26	1,73
13000	38,2	-53,5	0,83	0,44	-59,81	3,75	1,32	1,83
14000	39,9	-56,3	0,91	0,53	-63,03	3,91	1,40	1,77
15000	40,9	-54,1	0,98	0,54	-61,05	4,02	1,44	1,83
16000	41,3	-54,1	1,23	0,49	-61,51	4,17	1,51	1,85
17000	42,8	-54,4	1,36	0,76	-62,36	4,34	1,53	2,00
18000	44,2	-54,7	1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40,2	-23,5	0,72	-35,85	6,20	2,81	2,65
18500	40,2	-23,2	0,69	-35,71	6,46	2,76	2,59
19000	40,2	-22,0	0,76	-35,44	6,69	3,15	2,79
19500	40,3	-21,3	0,74	-35,07	7,04	3,11	2,91
20000	40,3	-20,3	0,72	-34,49	7,30	3,07	3,05
20500	40,3	-19,9	0,78	-34,46	7,48	3,12	3,15
21000	40,3	-19,1	0,87	-34,07	7,61	3,20	3,33
21500	40,3	-19,1	0,90	-33,96	7,47	3,28	3,19
22000	40,3	-18,7	0,89	-33,57	7,34	3,35	3,28
22500	40,4	-19,0	0,87	-33,66	7,06	3,75	2,94
23000	40,4	-19,5	0,88	-33,75	6,92	3,77	2,70
23500	40,4	-19,3	0,90	-33,35	6,99	3,52	2,66
24000	40,4	-19,8	0,88	-33,99	6,88	3,88	2,58
24500	40,4	-19,5	0,91	-33,89	7,01	3,93	2,51
25000	40,4	-19,3	0,88	-33,00	6,72	3,96	2,14
25500	40,5	-20,4	0,89	-34,07	6,90	3,66	2,22
26000	40,5	-21,3	0,86	-35,11	7,02	3,69	2,28
26500	40,5	-21,1	0,90	-35,20	7,15	3,91	2,36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

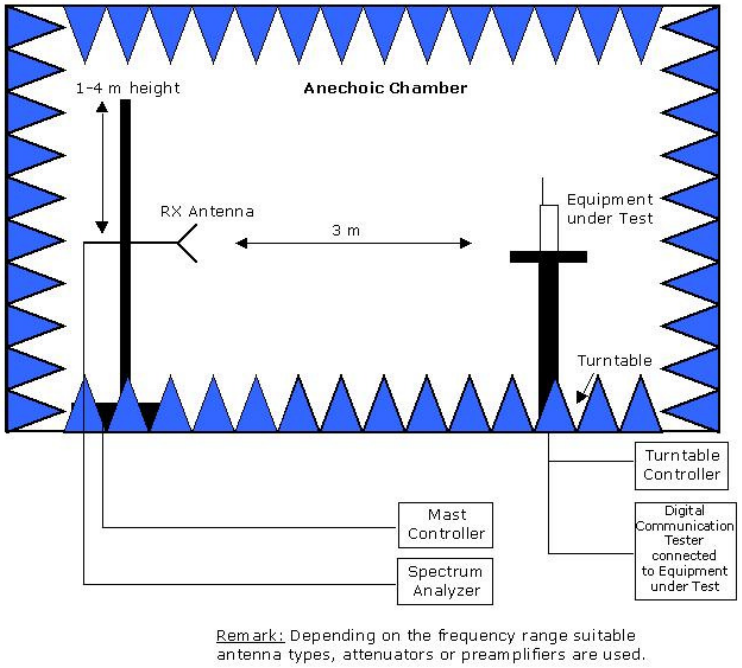
6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26,5	43,4	-11,2	4,4				-15,6	3	0,5
27,0	43,4	-11,2	4,4				-15,6	3	0,5
28,0	43,4	-11,1	4,5				-15,6	3	0,5
29,0	43,5	-11,0	4,6				-15,6	3	0,5
30,0	43,5	-10,9	4,7				-15,6	3	0,5
31,0	43,5	-10,8	4,7				-15,6	3	0,5
32,0	43,5	-10,7	4,8				-15,6	3	0,5
33,0	43,6	-10,7	4,9				-15,6	3	0,5
34,0	43,6	-10,6	5,0				-15,6	3	0,5
35,0	43,6	-10,5	5,1				-15,6	3	0,5
36,0	43,6	-10,4	5,1				-15,6	3	0,5
37,0	43,7	-10,3	5,2				-15,6	3	0,5
38,0	43,7	-10,2	5,3				-15,6	3	0,5
39,0	43,7	-10,2	5,4				-15,6	3	0,5
40,0	43,8	-10,1	5,5				-15,6	3	0,5

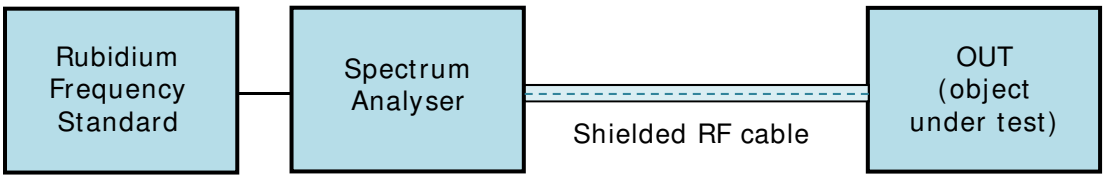
Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

7 SETUP DRAWINGS



Drawing 1: Setup in the anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.



Drawing 2: Setup for conducted radio tests.

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

9 PHOTO REPORT

Please see separate photo report.