FCC Measurement/Technical Report on

IEEE 802.11p module for OBU units VERA-P173

FCC ID: XPYVERAP173

Test Report Reference: MDE_UBLOX_1704_FCCa_rev1

Test Laboratory:
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Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

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Applied Standards and Test Summary

1.1 APPLIED STANDARDS

Type of Authorization
Certification for a DSRCS On-Board Units.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (23-10-17 Edition) and 95 (23-10-17 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 95, Subpart L – DSRCS On-Board Units

FCC §2.1046, §95.3167 & ASTM E2213-03 §8.9.1

FCC §2.1049

ASTM E2213-03 §8.9.2

FCC §2.1055 & ASTM E2213-03 §8.9.4

FCC §2.1051 & ASTM E2213-03 §8.9.2

§2.1053 & ASTM E2213-03 §8.9.3

The tests were performed according ANSI C63.26:2015

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.2 Measurement Summary / Signatures.

1.2 MEASUREMENT SUMMARY / SIGNATURES

FCC §2.1046, §95.3167 & ASTM E2213-03 §8.9.1

RF Output Power

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, low channel	Setup_01	Passed
IEEE 802.11p, mid channel	Setup_01	Passed
IEEE 802.11p, channel 180	Setup_01	Passed
IEEE 802.11p, channel 182	Setup_01	Passed
IEEE 802.11p, high channel	Setup_01	Passed

FCC §2.1049

Emission Bandwidth

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, low channel	Setup_01	Performed
IEEE 802.11p, mid channel	Setup_01	Performed
IEEE 802.11p, high channel	Setup_01	Performed

FCC §95.635 & ASTM E2213-03 §8.9.2

Transmit Spectrum Mask

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, low channel	Setup_01	Passed
IEEE 802.11p, mid channel	Setup_01	Passed
IEEE 802.11p, high channel	Setup_01	Passed

FCC §2.1055 & ASTM E2213-03 §8.9.4

Frequency Tolerance

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, mid channel	Setup_01	Passed

FCC §2.1051, ASTM E2213-03 §8.9.3

Transmit Spurious Emissions Conducted

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, low channel	Setup_01	Passed
IEEE 802.11p, mid channel	Setup_01	Passed
IEEE 802.11p, high channel	Setup_01	Passed

FCC §2.1053 & ASTM E2213-03 §8.9.3

Transmit Spurious Emissions Radiated

		Final Result
OP-Mode	**Setup**	**FCC**
Radio Technology, Operating Frequency		
IEEE 802.11p, low channel	Setup_01	Passed
IEEE 802.11p, mid channel	Setup_01	Passed
IEEE 802.11p, high channel	Setup_01	Passed

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2017-11-22	--	invalid
rev1	2017-12-04	Corrected Standards in chapter "Applied standards and test summary" and "Transmit Spurious Emissions Radiated"	valid

(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

(responsible for testing and report)
Dipl.-Ing. Daniel Gall

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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 929146.

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:	Dipl.-Ing. Marco Kullik
Report Template Version:	2017-10-25

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2017-12-04
Testing Period:	2017-10-26 to 2017-11-07

2.3 APPLICANT DATA

Company Name:	u-blox AG
Address:	Zürcherstrasse 68 8800 Thalwil Switzerland
Contact Person:	Mr. Filip Kruzela

2.4 MANUFACTURER DATA

Company Name:	please see applicant data
Address:	
Contact Person:	

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	IEEE 802.11p V2X transceiver module for on-board units
Product name	VERA-P173-00A
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	Module: 1.8V line: Min.: 1.65 V, Nominal: 1.8 V, Max.: 1.95 V 3.3V line: Min.: 3.0 V, Nominal: 3.3 V, Max.: 3.6 V 5V line: Min.: 4.5 V, Nominal: 5.0 V, Max.: 5.5 V Evaluation Board: Nominal 12 V (Tests in nominal condition were performed with 12 V at the development board only, which generates the nominal supply voltages for the module)
Tested Modulation Type	OFDM, ½ BPSK, 10 MHz BW
Specific product description	IEEE 802.11p V2X transceiver module for on-board units transmitting in the 5850-5925 MHz frequency band using 10 MHz bandwidth per channel. It supports the data rates 3Mbps up to 27 Mbps and transceivers on 2 antennas simultaneously (diversity only) Supported Channels: 172, 174, 176, 178, 180, 182, 184
Ports of the device	DC Antenna 1 Antenna 2 USB
Antenna	External antennas, 6 dBi gain
Tested Datarates	3 Mbps
Special software used for testing	Test script provided by applicant run on Linux laptop.

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
DE1015080aa01	aa01	conducted sample
Sample Parameter	**Value**	
Integral Antenna	None, External antenna only	
Serial No.	D4CA6EF01288	
HW Version	917400.0200.000	
SW Version	LLC Remote V14.0.0	
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
-	-	-

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
Evaluation Board "Vera Board"	UBLOX EVK VERA-P1 "Vera Board", Rev A, -, 10000000805735003003	Board module is mounted to providing antenna connectors
Evaluation Board "USB-Supply Board"	UBLOX EVK VERA-P1 "USB-Supply Board", Rev A, -, 10000000805740001002	Board providing providing USB and DC power ports, connected to "Vera Board"

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_01	DE1015080aa01 + Evaluation Board "Vera Board" + Evaluation Board "USB-Supply Board"	Test Setup for Module

3.6 OPERATING MODES

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

3.6.1 TEST CHANNELS

Channel	172 (low)	178 (mid)	180	182	184 (high)
Frequency [MHz]	5860	5890	5900	5910	5920

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 RF OUTPUT POWER

Standard **FCC Part 95 Subpart L**

The test was performed according to:
FCC §2.1046, §95.3167 & ASTM E2213-03 §8.9.1

4.1.1TEST 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: Average (Power Averaging)
- Sweeps: 1000
- Sweeptime: coupled
- Detector: Average
- Trigger: free run (Duty cycle >98 %)

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

4.1.2TEST REQUIREMENTS / LIMITS

According to ASTM E2213-03 §8.9.1, Private OBU operations in Channels 172, 174, 176, 178 and 184 shall not exceed 28.8 dBm antenna input power and 33 dBm EIRP. Private OBU operations in Channel 175 shall not exceed 10 dBm antenna input power and 23 dBm EIRP. Private OBU operations in Channels 180, 181 and 182 shall not exceed 20 dBm antenna input power and 23 dBm EIRP.

4.1.3TEST PROTOCOL

Ambient temperature: 24 °C

Air Pressure: 1017 hPa

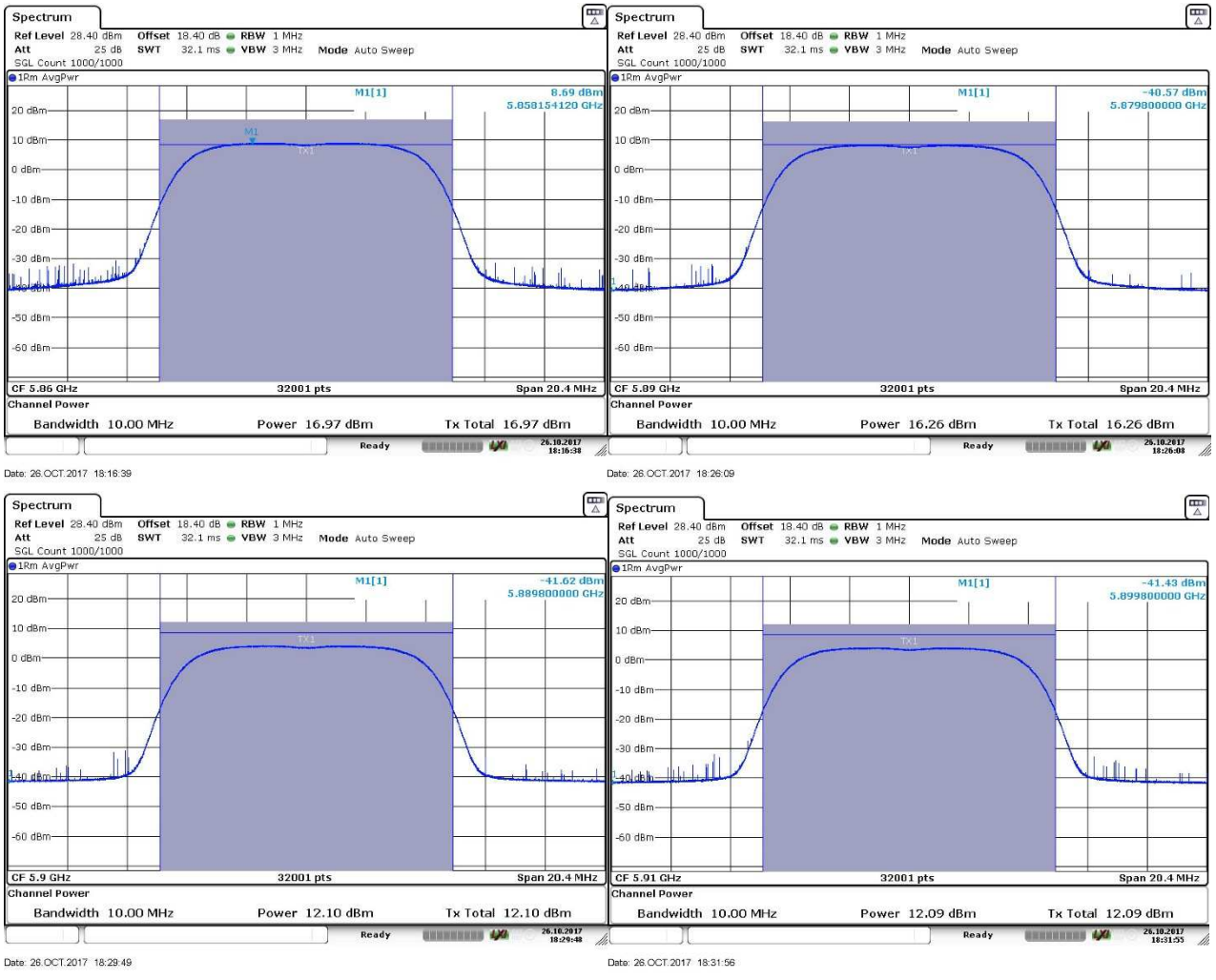
Humidity: 49 %

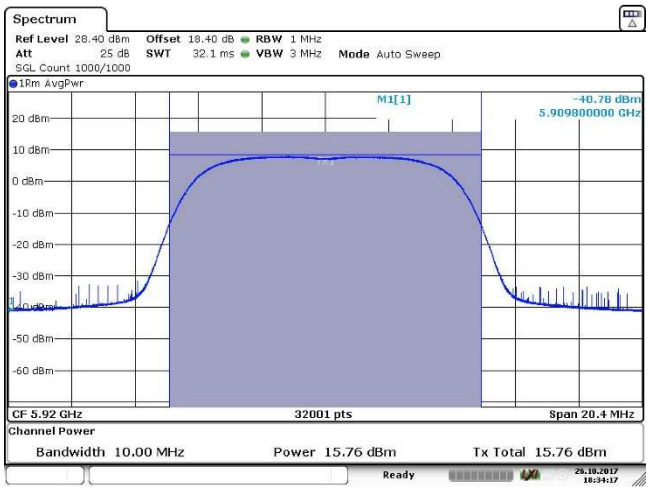
Channel No.	Frequency [MHz]	Power Antenna 1 [dBm]	Power Antenna 2 [dBm]	Antenna Gain [dBi]	Combined Power [dBm]	E.I.R.P. Combined Power [dBm]	Limit conducted power [dBm]	E.I.R.P. Limit conducted power [dBm]	Margin to Limit cond. power [dB]	Margin to Limit E.I.R.P. cond. power [dB]	Verdict
172	5860	17.0	19.2	6.0	21.3	27.3	28.8	33.0	7.5	5.7	Passed
178	5890	16.3	18.3	6.0	20.4	26.4	28.8	33.0	8.4	6.6	Passed
180	5900	12.1	14.2	6.0	16.3	22.3	20.0	23.0	3.7	0.7	Passed
182	5910	12.1	13.9	6.0	16.1	22.1	20.0	23.0	3.9	0.9	Passed
184	5920	15.8	17.6	6.0	19.8	25.8	28.8	33.0	9.0	7.2	Passed

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

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

Antenna 1





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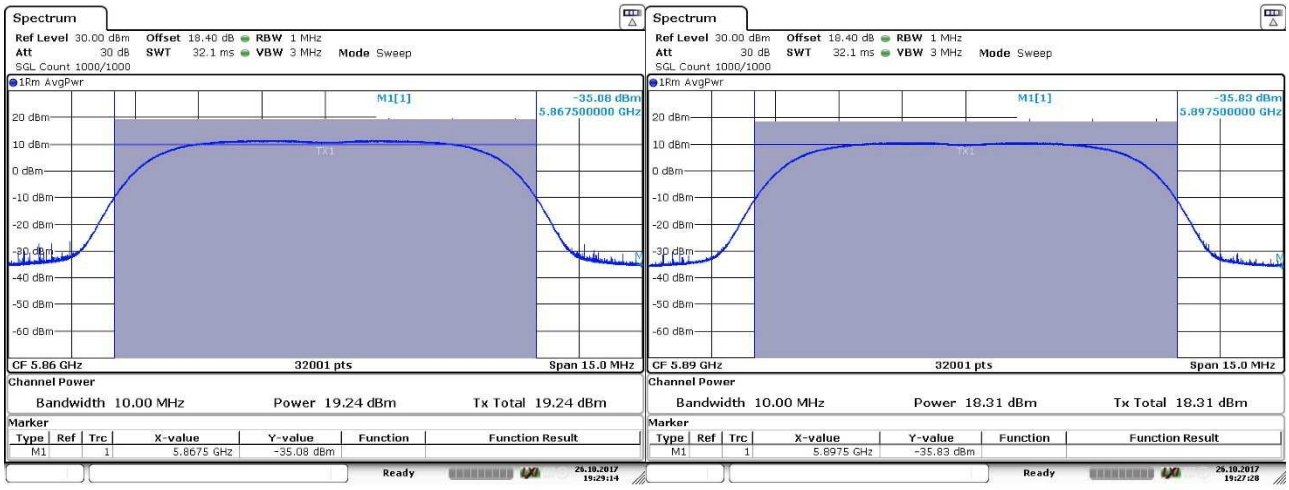
Antenna 2



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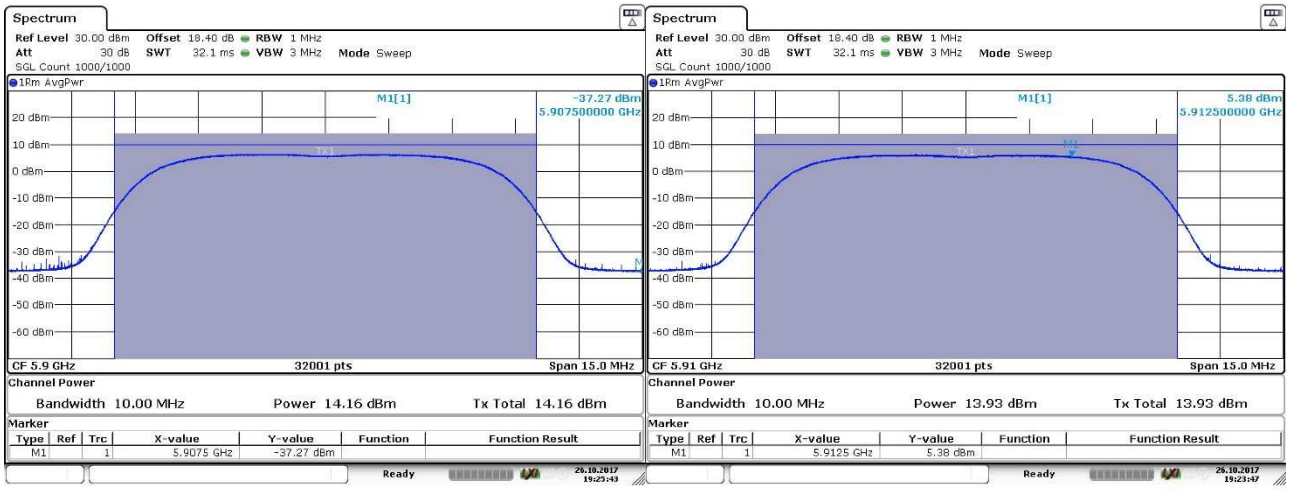

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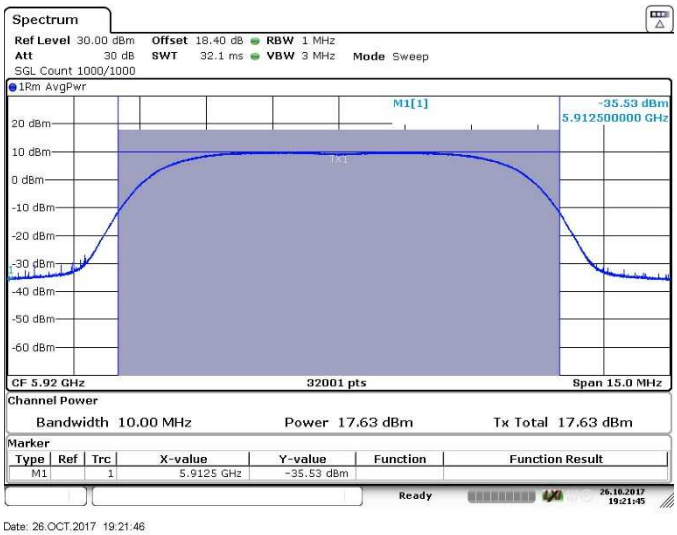


4.1.5TEST EQUIPMENT USED

Radio Lab

4.2 EMISSION BANDWIDTHS

Standard **FCC Part 95 Subpart L**

The test was performed according to:
FCC §2.1049

4.2.1TEST DESCRIPTION

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (smallest) emission bandwidth.

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

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

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

Analyzer settings:
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 15 MHz
- Trace: Maxhold
- Sweeptime: coupled
- Detector: Peak

4.2.2TEST REQUIREMENTS / LIMITS

No limit specified

4.2.3TEST PROTOCOL

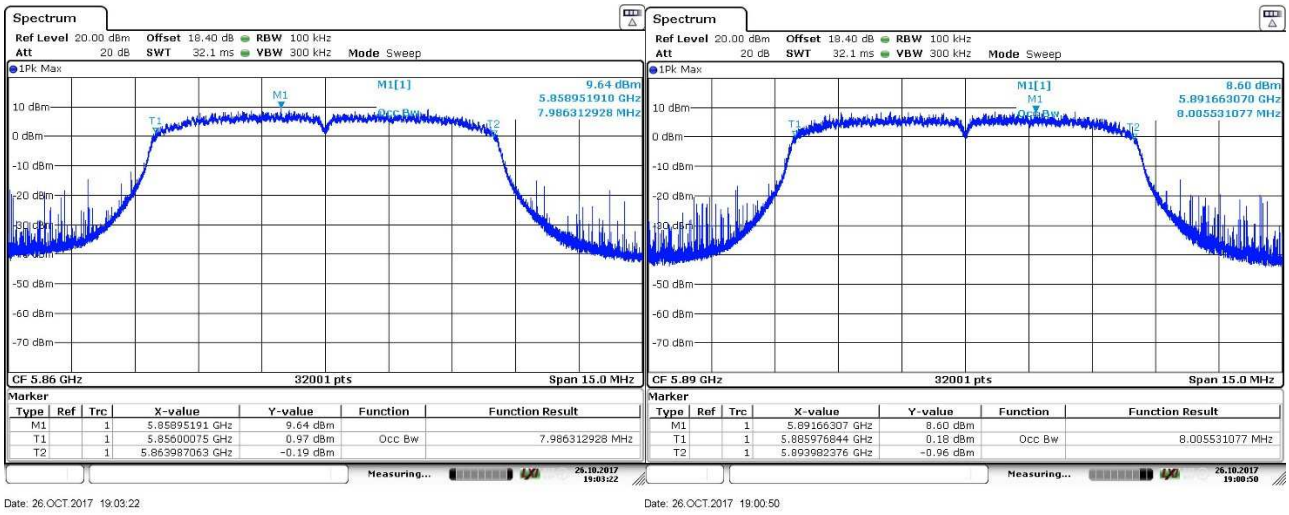
Ambient temperature: 24 °C
Air Pressure: 1017 hPa
Humidity: 49 %

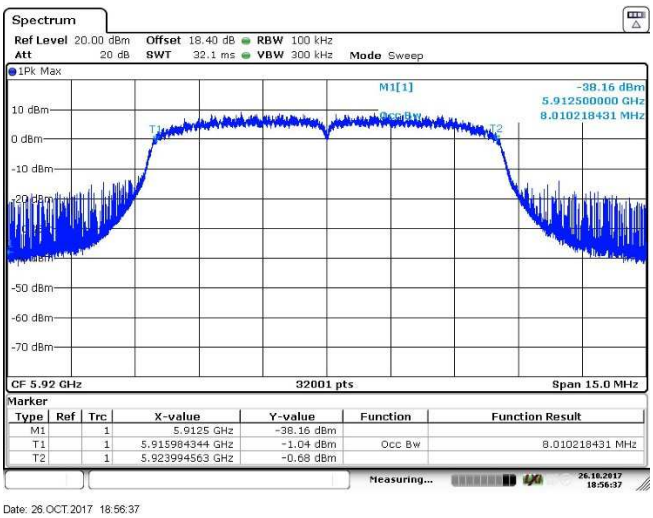
Channel No.	Frequency [MHz]	99 % BW Antenna 1 [MHz]	99 % BW Antenna 2 [MHz]
172	5860	7.986	7.999
178	5890	8.006	8.005
184	5920	8.010	7.985

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

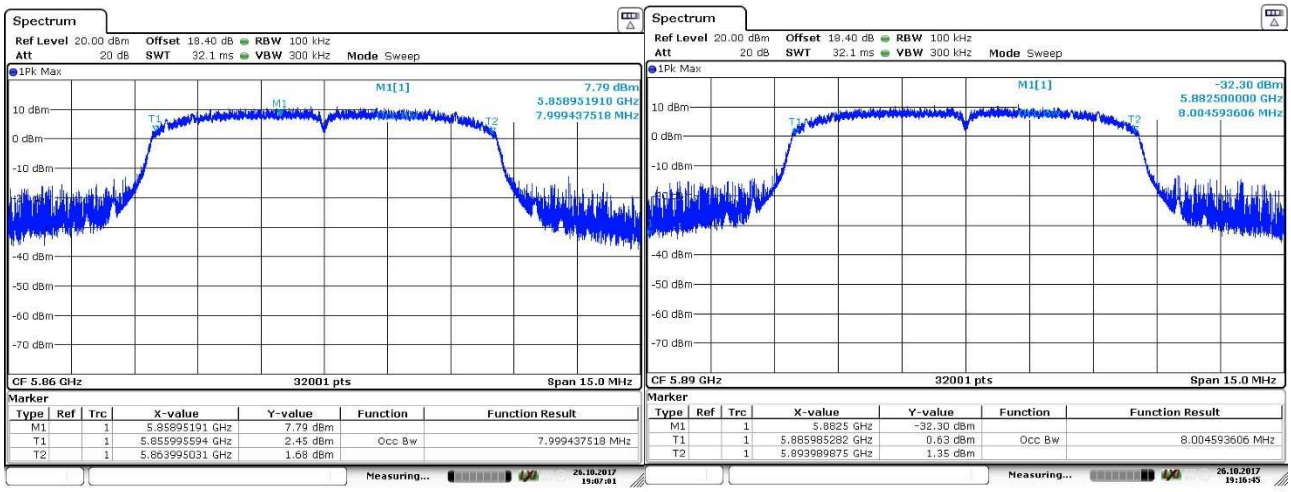
4.2.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

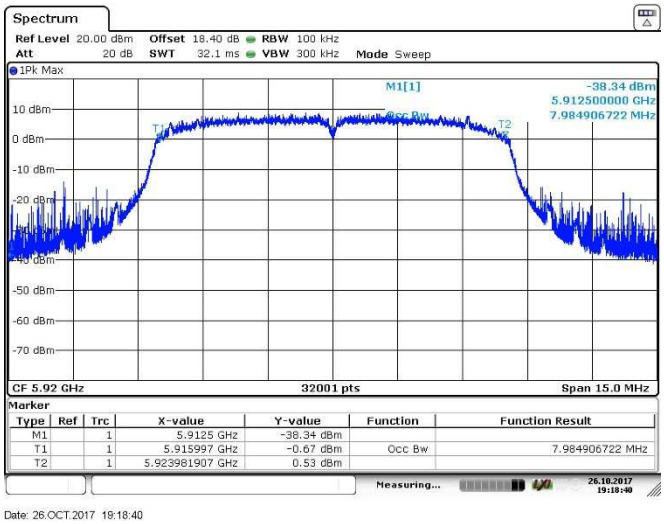
Antenna 1





Antenna 2





4.2.5TEST EQUIPMENT USED

Radio Lab

4.3 TRANSMIT SPECTRUM MASK

Standard **FCC Part 95 Subpart L**

The test was performed according to:
ASTM E2213-03 §8.9.2

4.3.1TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the transmit spectrum mask measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (widest) emission bandwidth.

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

Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 30 kHz
- Span: 30 MHz
- Trace: Average (Power Averaging)
- Sweeps: 1000
- Sweeptime: coupled
- Detector: RMS

4.3.2TEST REQUIREMENTS / LIMITS

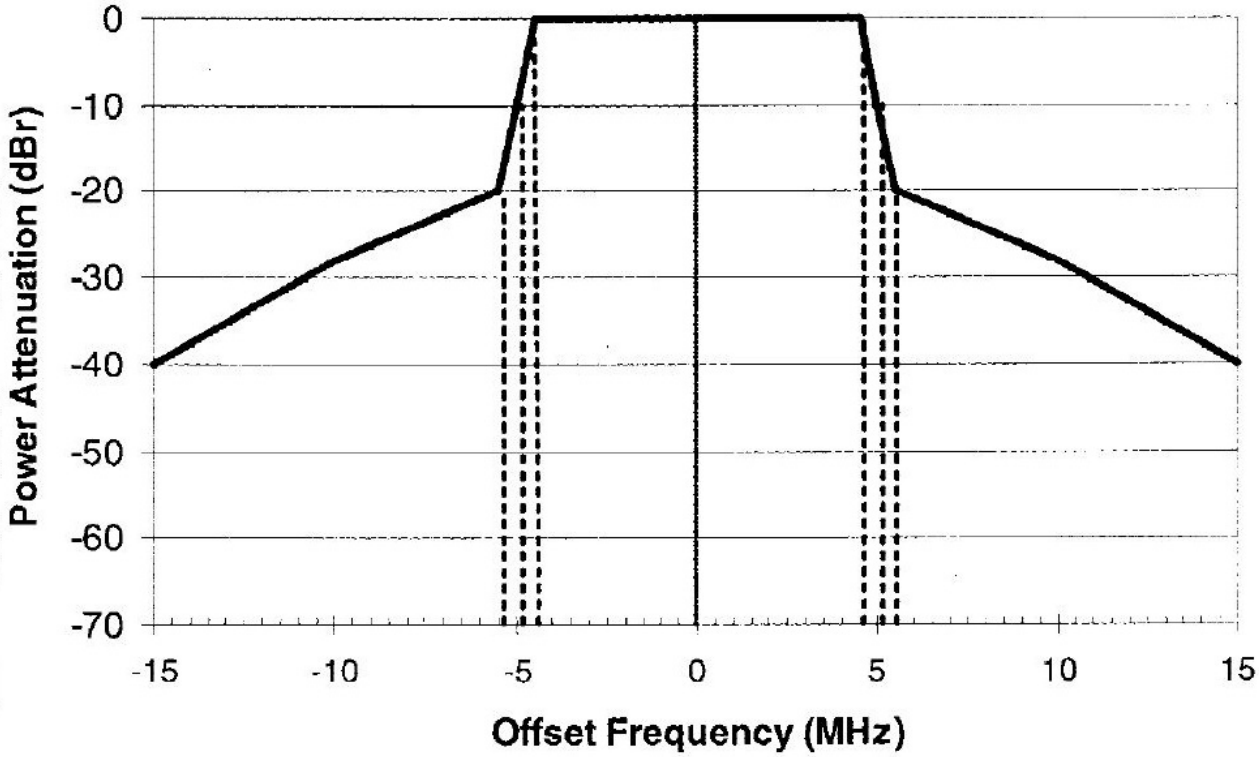
The DSRC transmitted spectrum mask is relative to the device class of operation.The power in the transmitted spectrum for all DSRC devices shall be -25 dBm or less within 100 kHz outside all channel and band edges. This will be accomplished by attenuating the transmitted signal 100 kHz outside the channel and band edges by 55 + 10log(P) dB, where P is the total transmitted power in watts. The transmitted spectral density of the transmitted signal for all devices shall fall within the spectral mask. The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

DSRC Spectrum Mask[A]

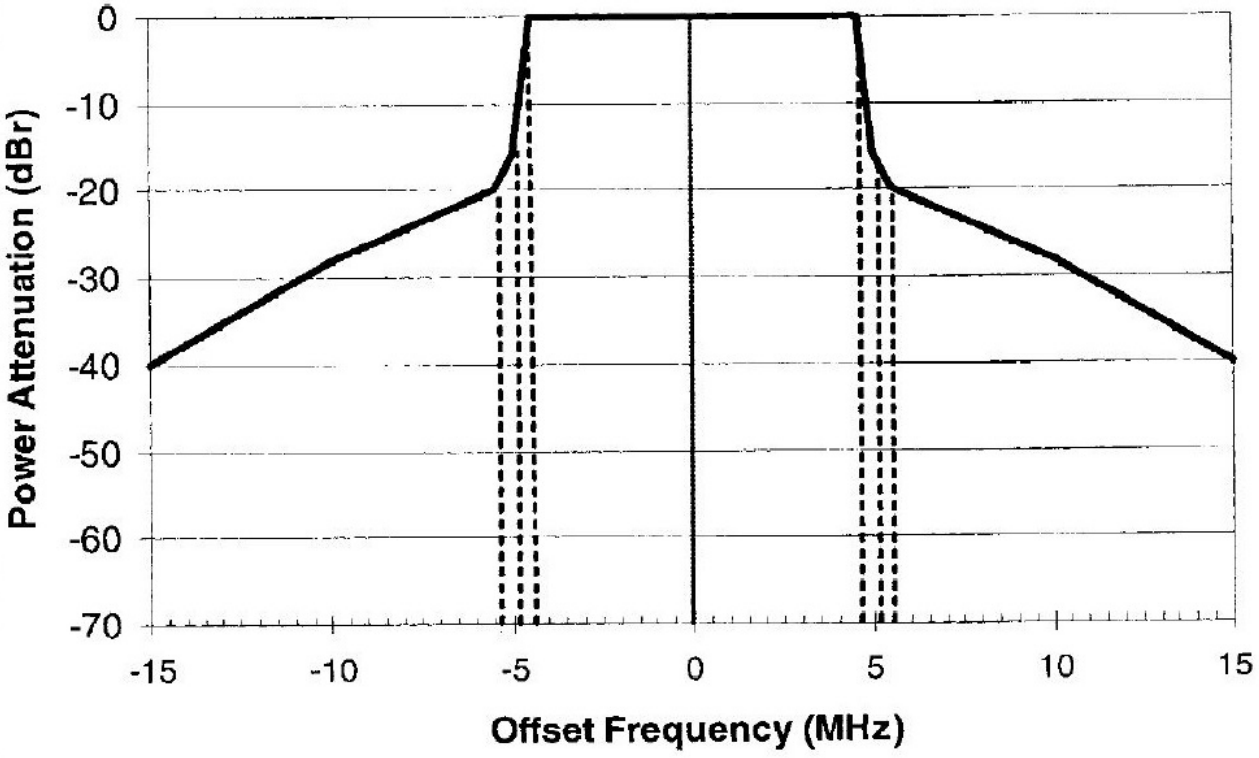
NOTE—Reduction in Power Spectral Density, dBr.

Class	± 4.5-MHz Offset	± 5.0-MHz Offset	± 5.5-MHz Offset	± 10-MHz Offset	± 15-MHz Offset
Class A	0	-10	-20	-28	-40
Class B	0	-16	-20	-28	-40
Class C	0	-26	-32	-40	-50
Class D	0	-35	-45	-55	-65

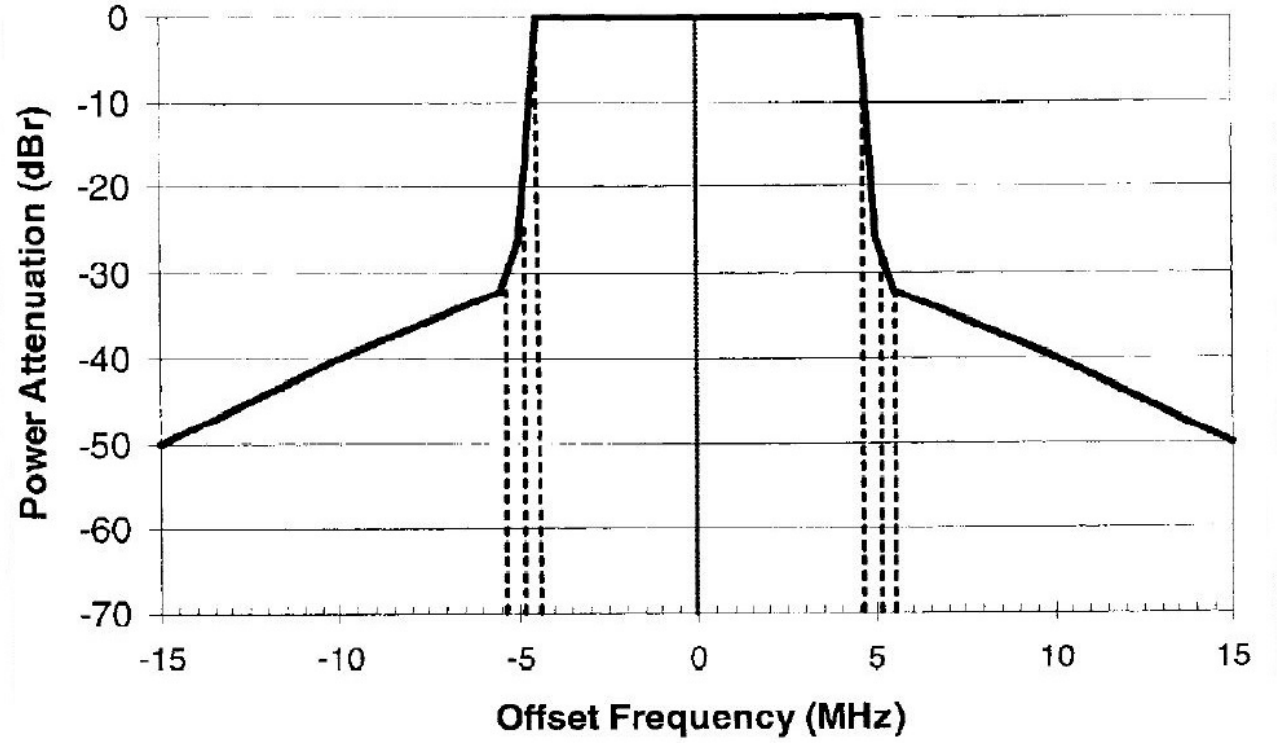
[A] From IEEE 802.11a. Copyright 1999 IEEE. All rights reserved.



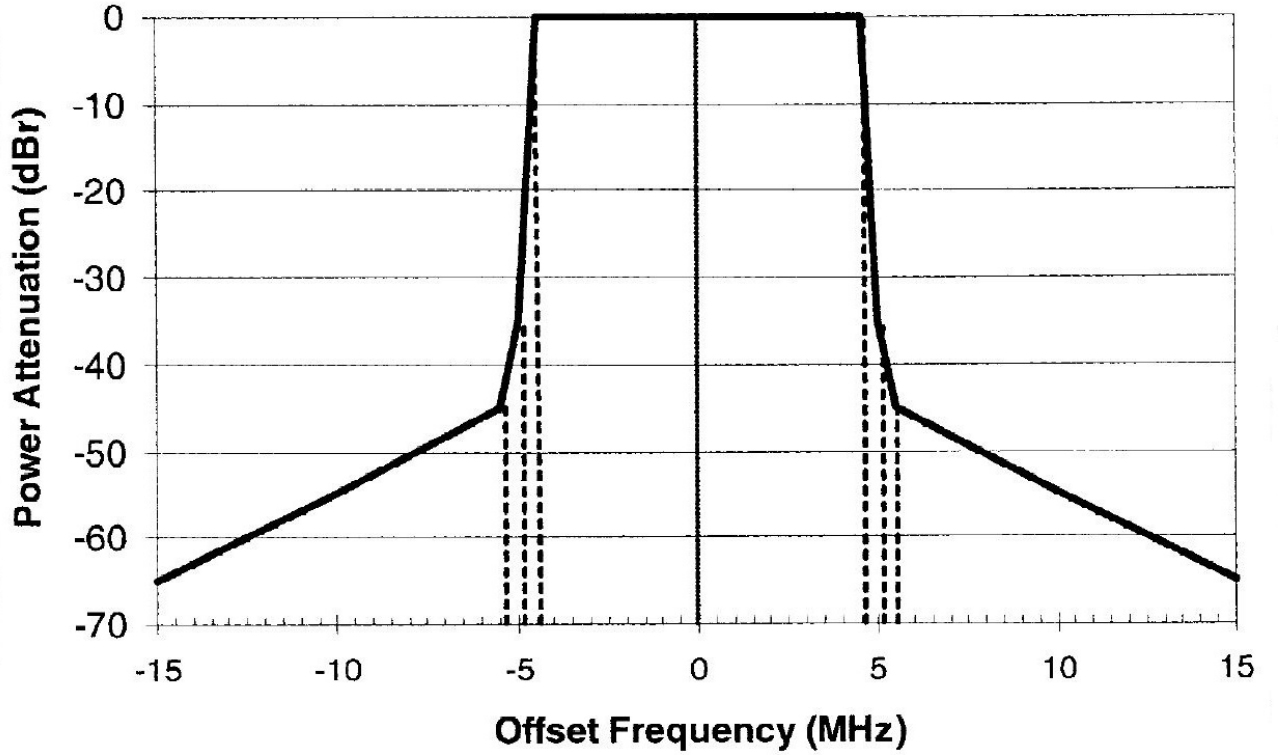
Class A Transmit Spectrum Mask



Class B Transmit Spectrum Mask



Class C Transmit Spectrum Mask



Class D Transmit Spectrum Mask

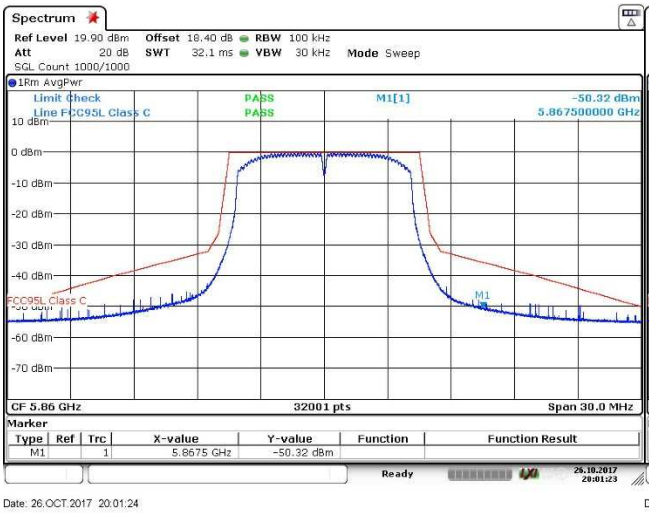
4.3.3TEST PROTOCOL

Ambient temperature: 24 °C
Air Pressure: 1017 hPa
Humidity: 49 %

Please see next sub-clause for the result plots

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

Antenna 1



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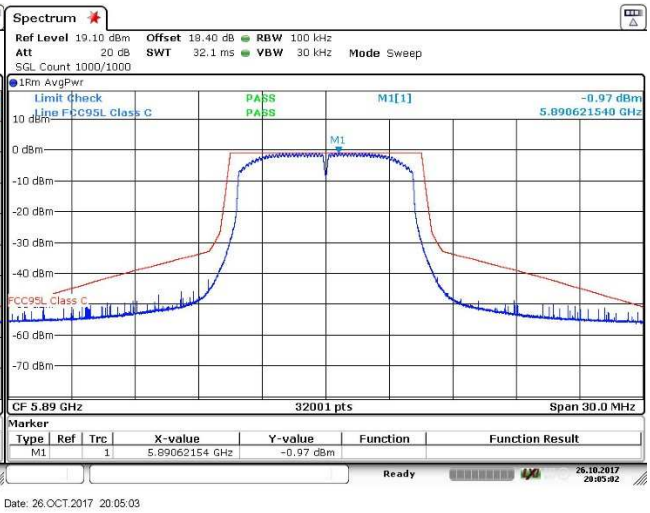

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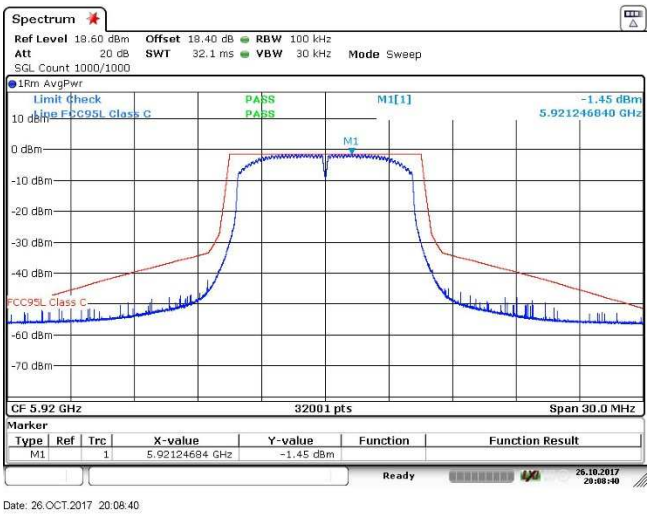

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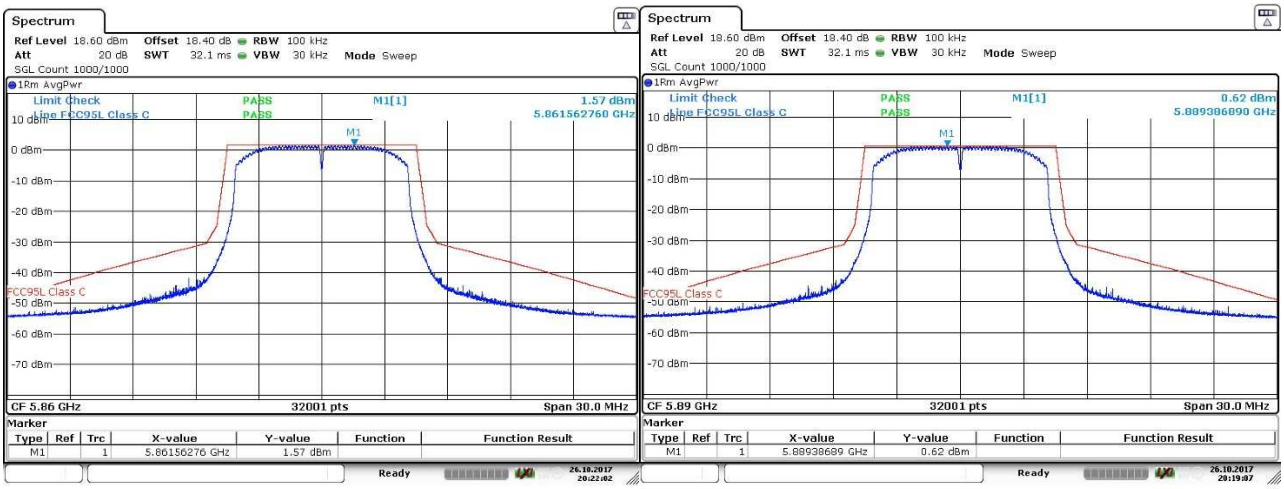
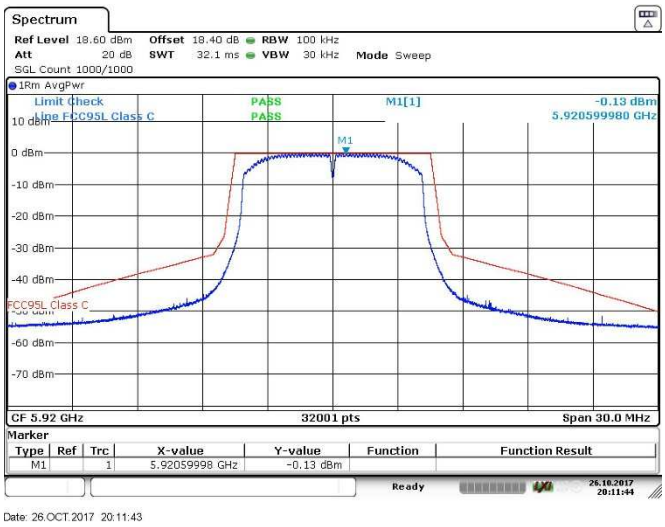
Antenna 2





4.3.5TEST EQUIPMENT USED

Radio Lab

4.4 FREQUENCY TOLERANCE

Standard **FCC Part 95 Subpart L**

The test was performed according to:
FCC §2.1055 and ASTM E2213-03 §8.9.4

4.4.1TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the frequency tolerance 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): 100 kHz
- Video Bandwidth (VBW): 30 kHz
- Trace: Average (Power Averaging)
- Sweeps: 1000
- Sweeptime: coupled
- Detector: RMS
- Span: 12 MHz
- Sweep Points: 32001

Since the EUT could not be set to CW mode, the modulated signal was recorded and markers were set to the 20 dBc positions.
The Center frequency is then calculated by calculating the span between the two markers, dividing it by half and adding it to the marker located at the lower frequency position.

4.4.2TEST REQUIREMENTS / LIMITS

According to ANSI/TIA-D 2010 section 2.2.2, the carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

The measurement method is as following:
- Operate the equipment in standby conditions for 15 minutes before proceeding.
- Record the carrier frequency of the transmitter as MCF MHz.
- Calculate the ppm frequency error by the following:

$$\text{Ppm error} = ((MCF/ACF) - 1) * 10^6$$

Where
MCF is the Measured Carrier Frequency in MHz
ACF is the Assigned Carrier Frequency in MHz

- The value recorded above is the carrier frequency stability.

According to RSS-Gen issue 3 Section 4.7, frequency stability is a measure of freqeuncy drift due to temperature and supply voltage variations with reference to the frequency measurement at an appropriate reference temeprature and the rated supply voltage.

Unless specified otherwiese in the RSS that is applicable to the device, the reference temperature for transmitters is +20 °C.
A hand-held device that is only capable of operating using internal battreies shall be tested a new battery without any further requirement to vary the supply voltage. Alternatively, an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer.

The operating carrier frequency shall be set up in accordance with the manufacturer's published operation and nistruction manual prior to the commencement of these tests. No adjustment of any frequency-determining circuit element shall be made subsequent to this initial set-up.

With the transmitter installed in an enviroement test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabiliziation period at each temperature shall be used prior to each frequency measurement. The following temperatures and supply voltage ranges apply, unless specified otherwise in the applicable RSS.

a) At temperature of -30 °C, +20 °C and +50 °C, and at the manufacturer's rated supply voltage; and
b) At a temperature of +20 °C and at +- 15 percent of the manufacturer's rated supply voltage.

If the frequency stability limits are only met at a different temperature range than specified in (a), the frequency stability requirement will be deemed met if the transmitter is automatically inhibited from operating outside this different temperature range and the published equipment operating characteristics are revised to reflect this different temperature range.

If an unmodulated carrier is not available, the measurement method shall be described in the test report.

4.4.3TEST PROTOCOL

Ambient temperature: 24 °C
Air Pressure: 1017 hPa
Humidity: 49 %

Temperature [°C]	Voltage	Nominal Center Frequency [MHz]	Calculated Center Frequency Antenna 1 [MHz]	Deviation [ppm]	Limit [ppm]	Result	Low 20 dBc point [MHz]	High 20 dBc point [MHz]
85 °C	Nominal	5890	5890.00544	0.92	10	Passed	5885.75813	5894.25274
80 °C	Nominal	5890	5889.99738	0.45	10	Passed	5885.74951	5894.24524
70 °C	Nominal	5890	5889.99119	1.50	10	Passed	5885.74538	5894.23699
60 °C	Nominal	5890	5889.99288	1.21	10	Passed	5885.74651	5894.23924
50 °C	Nominal	5890	5889.99156	1.43	10	Passed	5885.74163	5894.24149
40 °C	Nominal	5890	5889.99381	1.05	10	Passed	5885.74538	5894.24224
30 °C	Nominal	5890	5889.99588	0.70	10	Passed	5885.75288	5894.23887
20 °C	Low	5890	5889.99681	0.54	10	Passed	5885.74913	5894.24449
20 °C	Nominal	5890	5890.00375	0.64	10	Passed	5885.74538	5894.26212
20 °C	High	5890	5889.99625	0.64	10	Passed	5885.74913	5894.24337
10 °C	Nominal	5890	5889.99982	0.03	10	Passed	5885.75476	5894.24487
0 °C	Nominal	5890	5890.00000	0.00	10	Passed	5885.75963	5894.24037
-10 °C	Nominal	5890	5889.99850	0.25	10	Passed	5885.75663	5894.24037
-20 °C	Nominal	5890	5889.99700	0.51	10	Passed	5885.75326	5894.24074
-30 °C	Nominal	5890	5889.99963	0.06	10	Passed	5885.76038	5894.23887
-40 °C	Nominal	5890	5890.00056	0.10	10	Passed	5885.75213	5894.24899

Remark: None.

4.4.4TEST EQUIPMENT USED

Radio Lab

4.5 TRANSMITTER SPURIOUS EMISSIONS CONDUCTED

Standard **FCC Part 95 Subpart L**

The test was performed according to:
FCC §2.1051, §95.635 & ASTM E2213-03 §8.9.2

4.5.1TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room to perform the transmit conducted spurious emissions measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

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

Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 30 kHz
- Trace: MAXHOLD
- Sweeptime: coupled
- Detector: PEAK

4.5.2TEST REQUIREMENTS / LIMITS

According to ASTM E2213-03 §8.9.2.2 the transmitted spectral mask for Class A, B, C and D devices are shown in Figs. 12-15. In addition, all DSRC site installations shall limit the EIRP in the transmitted spectrum to -2 dBm or less in the 100 kHz at the channel edges and the band edges. Additional filtering that supplements the filtering provided by the transmitter may be needed for some antenna/transmitter combinations.

The DSRC transmitted spectrum mask is relative to the device class of operation. The power in the transmitted spectrum for all DSRC devices shall be -25 dBm or less within 100 kHz outside all channel and band edges. This will be accomplished by attenuation the transmitted signal 100 kHz outside the channel and band edges by 55 + 10log(p) dB, where P is the total transmitted power in watts. The transmitted spectral density of the transmitted signal for all devices shall fall within the spectral mask, as detailed in Table 10.5 The measurements shall be made using a 100 kHz resolution bandwidth and 30 kHz video bandwidth.

4.5.3TEST PROTOCOL

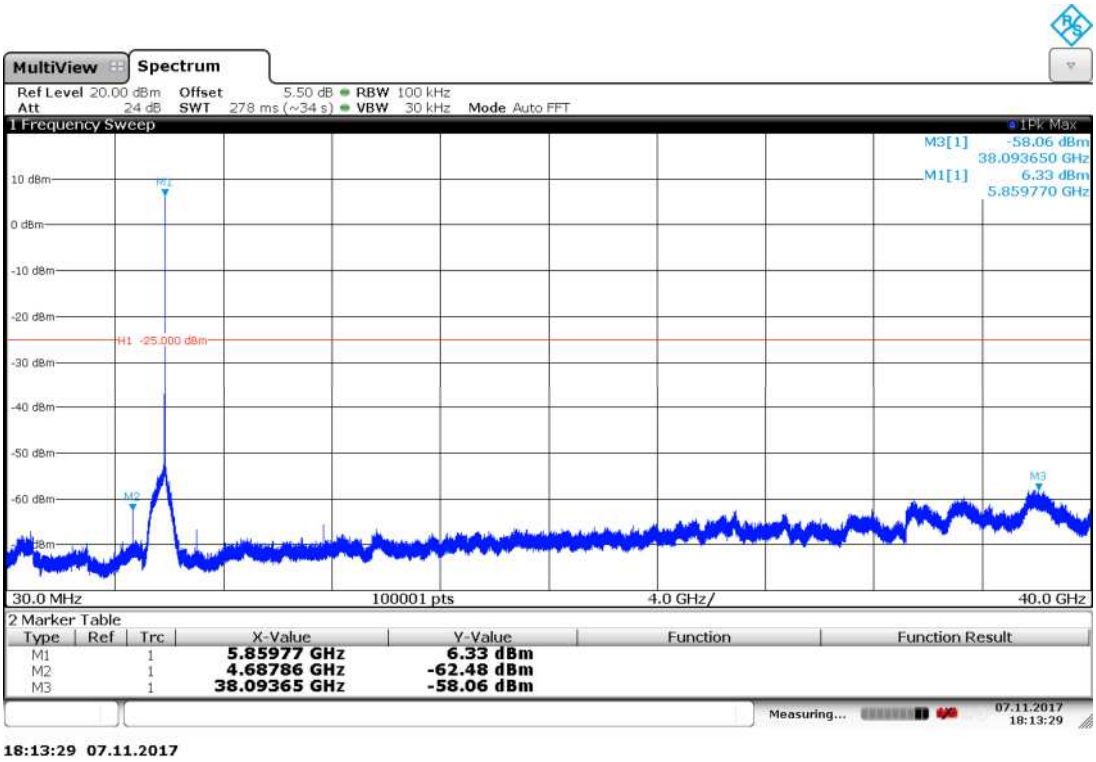
Ambient temperature: 24 °C
Air Pressure: 1017 hPa
Humidity: 49 %

Transmitter Frequency [MHz]	Antenna	Spurious Frequency [MHz]	Spurious Level Peak Detector [dBm]	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Verdict
5860	1	-	-	100	-23.0	> 20	Passed
5890	1	-	-	100	-23.0	> 20	Passed
5920	1	-	-	100	-23.0	> 20	Passed
5860	2	-	-	100	-23.0	> 20	Passed
5890	2	-	-	100	-23.0	> 20	Passed
5920	2	-	-	100	-23.0	> 20	Passed

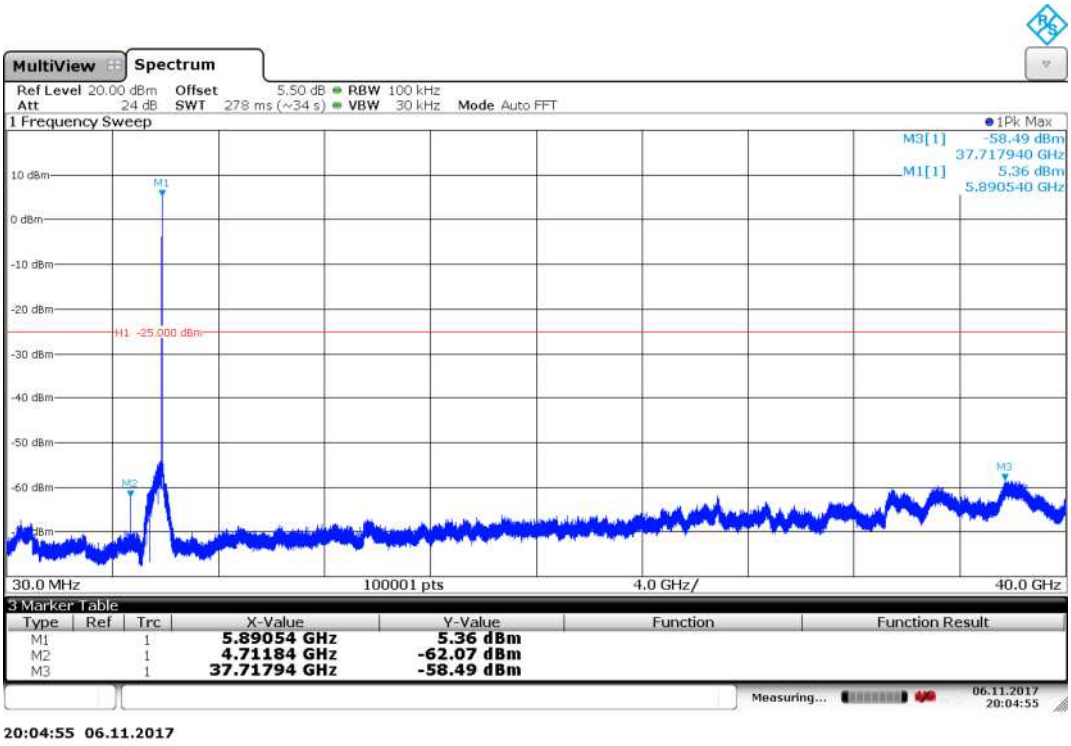
Remark: Please see next sub-clause for the measurement plot.
Antenna gain not included in values shown in plots.

4.5.4MEASUREMENT PLOTS

Antenna 1



Low Channel



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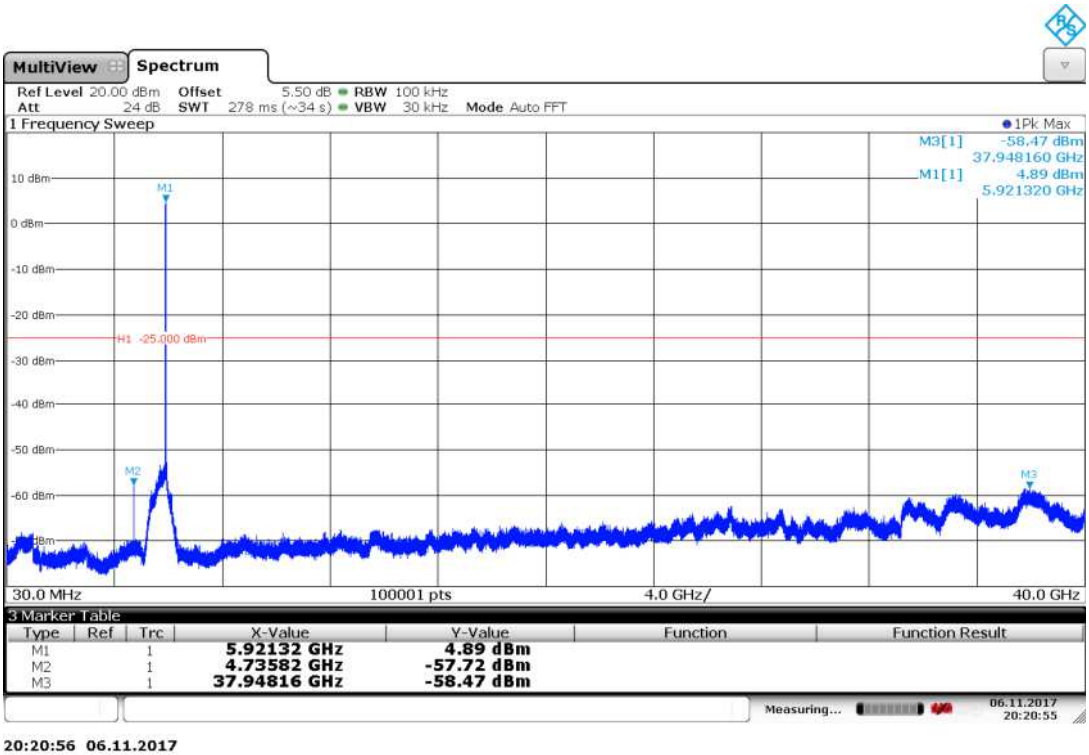
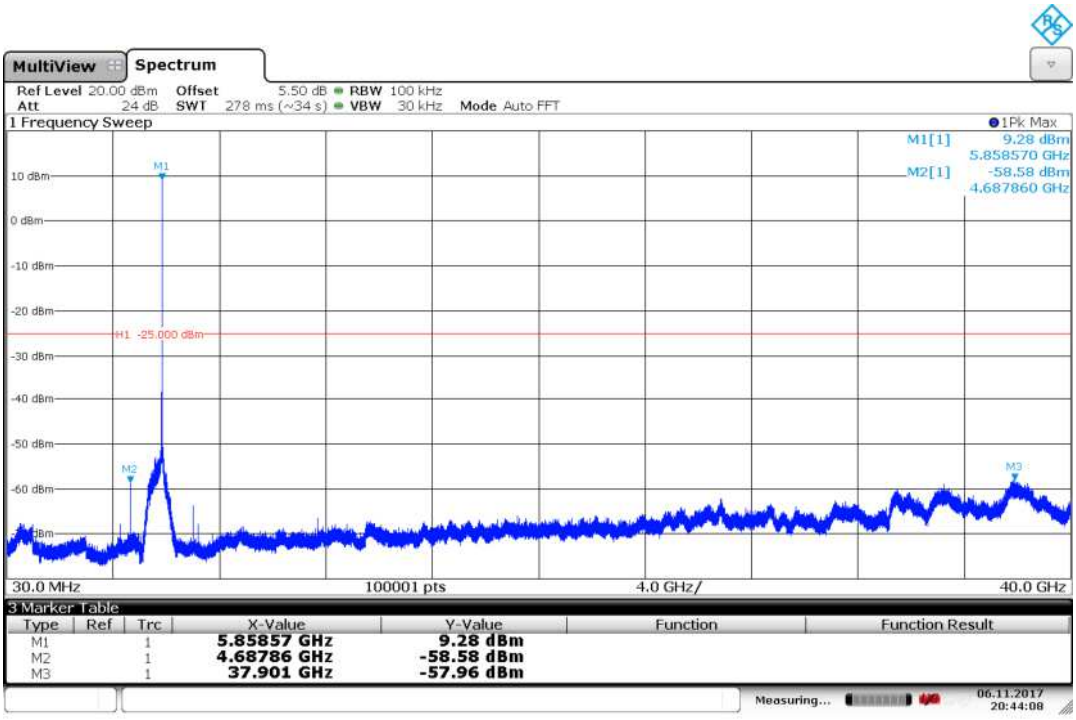
Mid Channel



20:20:56 06.11.2017

High Channel

Antenna 2



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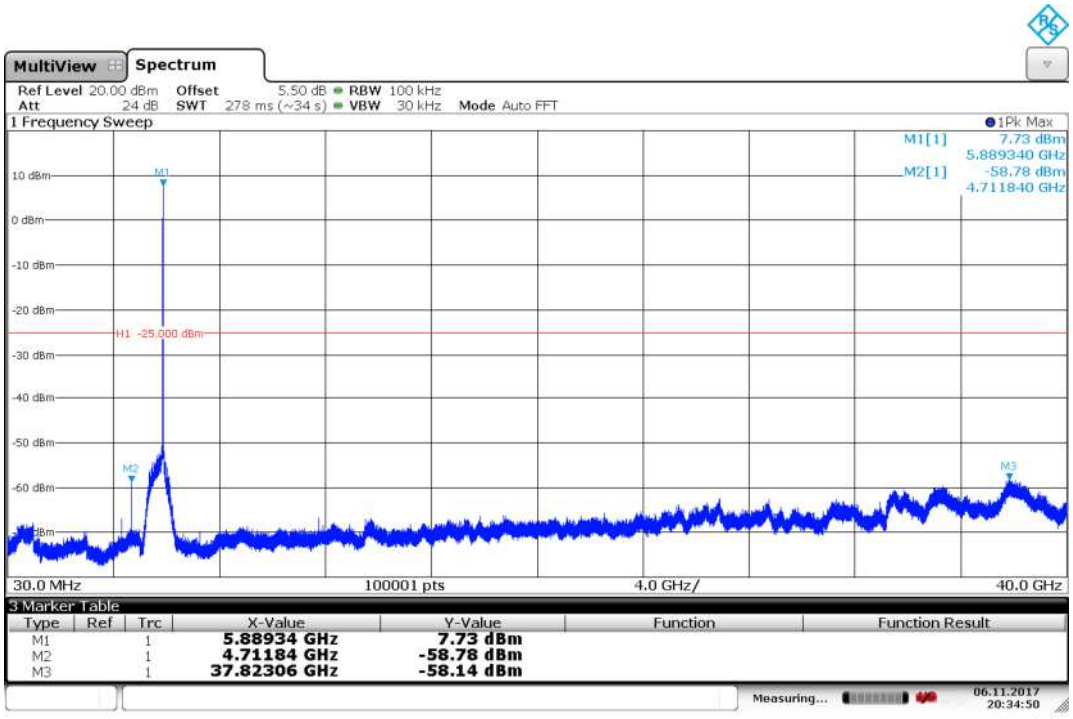
Low Channel



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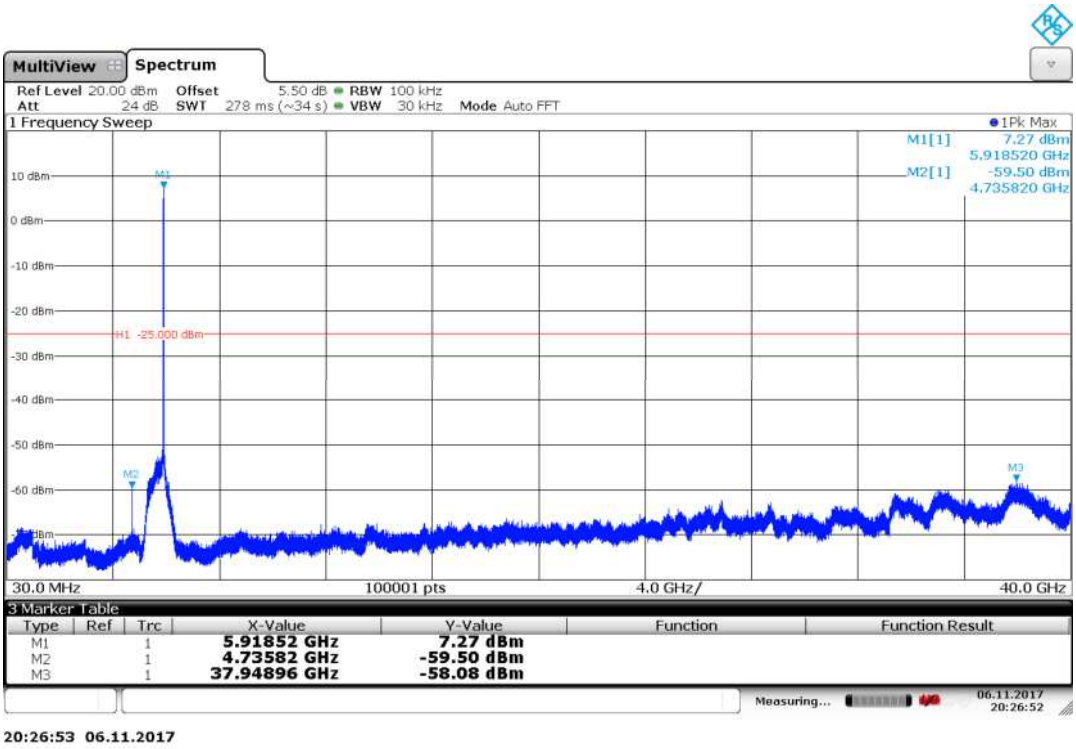
Mid channel



High Channel

4.5.5TEST EQUIPMENT USED

Radiated Emissions

4.6 TRANSMIT SPURIOUS EMISSIONS RADIATED

Standard **FCC Part 95 Subpart L**

The test was performed according to:
ANSI C63.26

4.6.1TEST 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 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
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 100 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: 100 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: 100 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.

2. 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 °.
Above 26 GHz the measurement distance is reduced to 1 m.
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 = 100 kHz
Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 100 kHz
- Measuring time: 1 s

4.6.2TEST REQUIREMENTS / LIMITS

According to ASTM E2213-03 §8.9.2.2 the transmitted spectral mask for Class A, B, C and D devices are shown in Figs. 12-15. In addition, all DSRC site installations shall limit the EIRP in the transmitted spectrum to -2 dBm or less in the 100 kHz at the channel edges and the band edges. Additional filtering that supplements the filtering provided by the transmitter may be needed for some antenna/transmitter combinations.

The DSRC transmitted spectrum mask is relative to the device class of operation. The power in the transmitted spectrum for all DSRC devices shall be -25 dBm or less within 100 kHz outside all channel and band edges. This will be accomplished by attenuation the transmitted signal

100 kHz outside the channel and band edges by 55 + 10log(p) dB, where P is the total transmitted power in watts. The transmitted spectral density of the transmitted signal for all devices shall fall within the spectral mask, as detailed in Table 10. The measurements shall be made using a 100 kHz resolution bandwidth and 30 kHz video bandwidth.

ASTM E2213-03 §8.9.3 Spurious transmissions from compliant devices shall comply with national regulations.

4.6.3TEST PROTOCOL

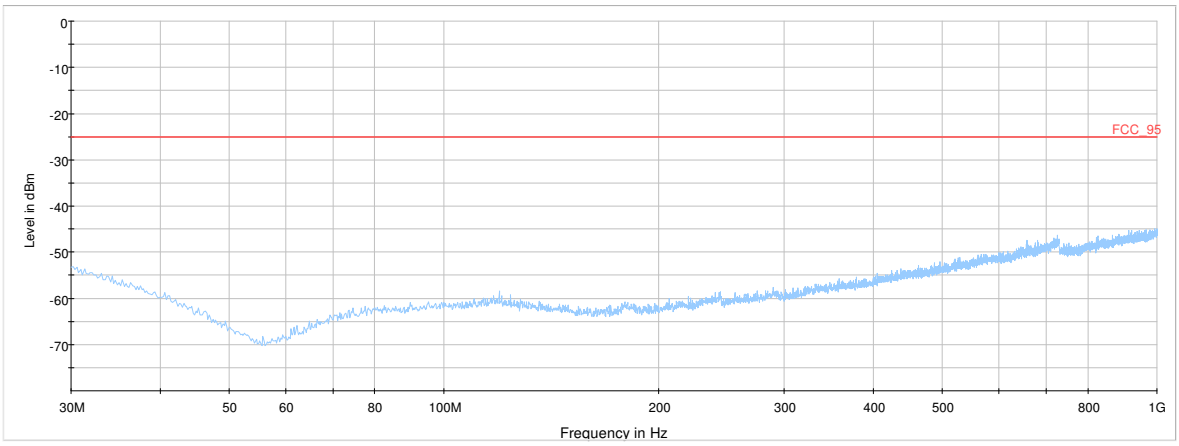
Ambient temperature: 24 °C
Air Pressure: 1017 hPa
Humidity: 49 %

Transmitter Frequency [MHz]	Antenna	Spurious Frequency [MHz]	Spurious Level Peak Detector [dBm]	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Verdict
5860	Terminated by 50 Ohm	-	-	-	-	-	Passed
5890	Terminated by 50 Ohm	-	-	-	-	-	Passed
5920	Terminated by 50 Ohm	-	-	-	-	-	Passed

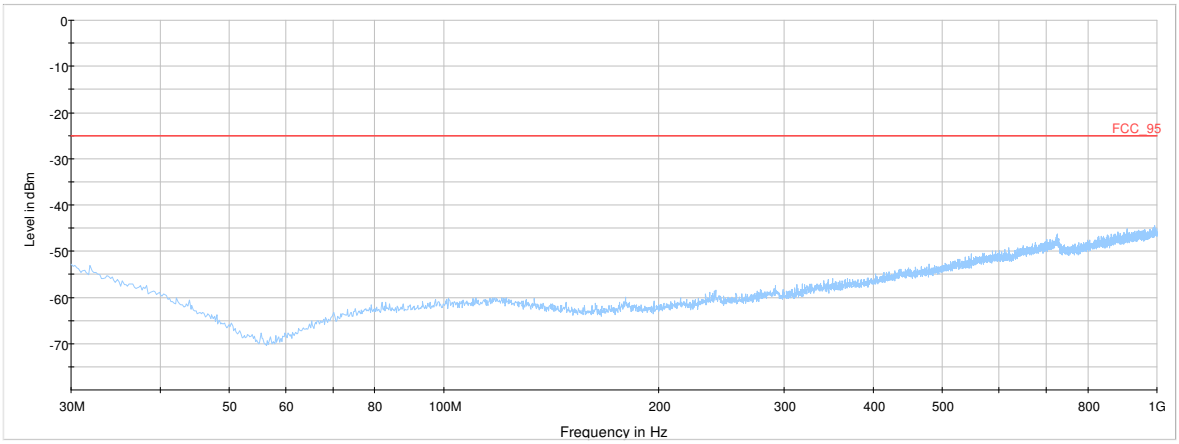
Remark: Please see next sub-clause for the measurement plot.

4.6.4MEASUREMENT PLOTS

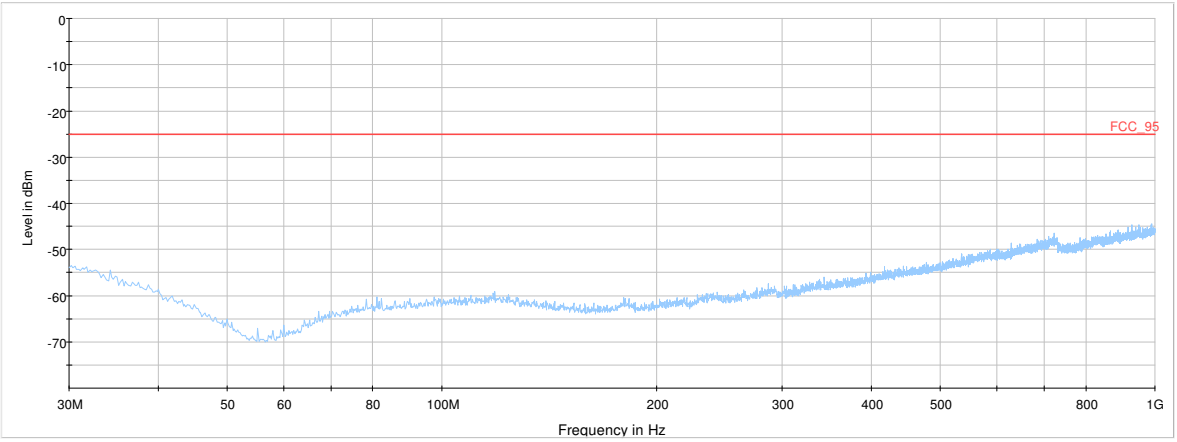
30 MHz – 1 GHz



TX frequency 5860 MHz

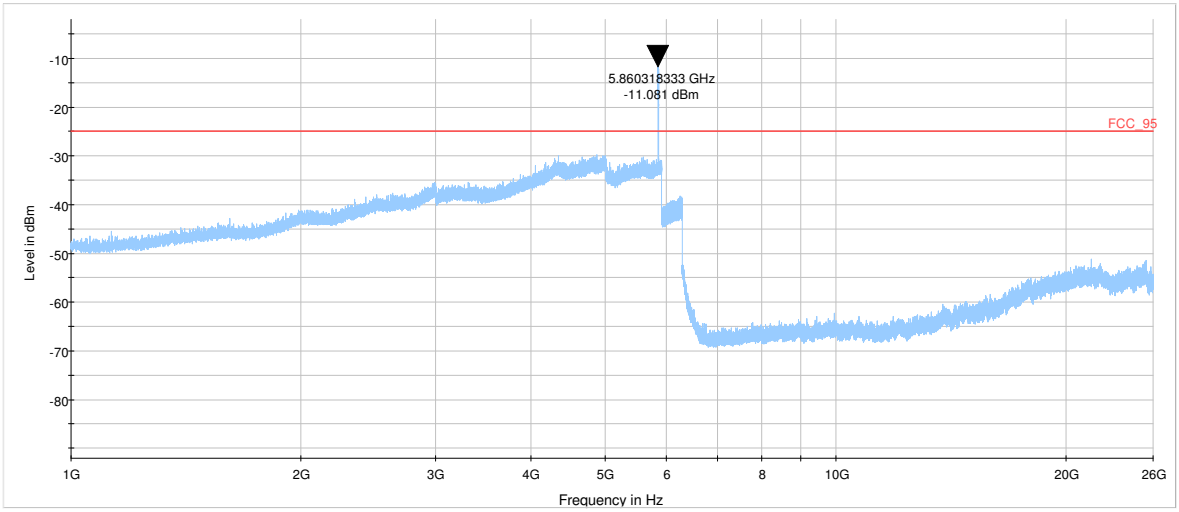


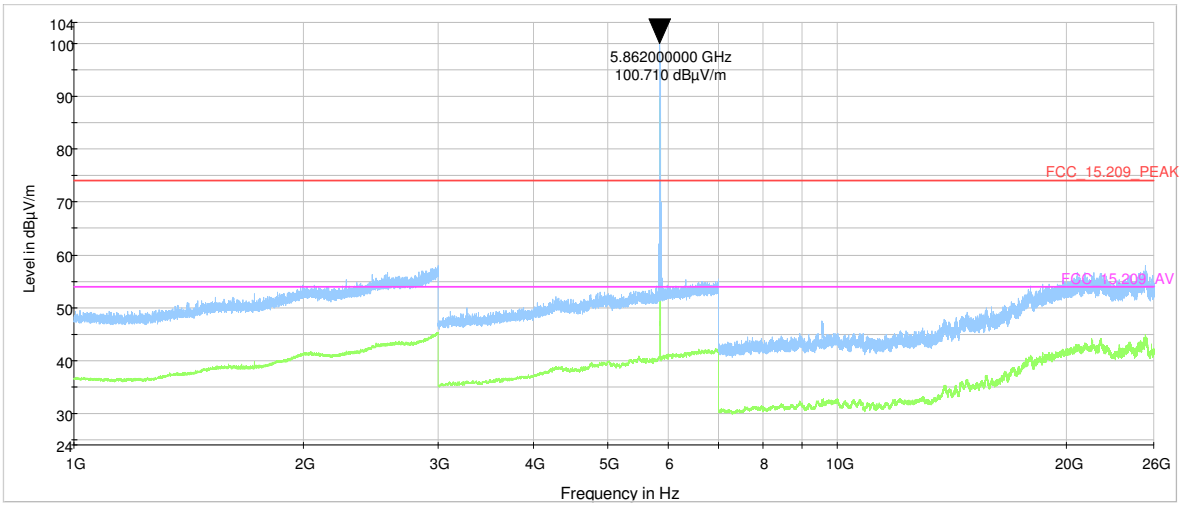
TX frequency 5890 MHz



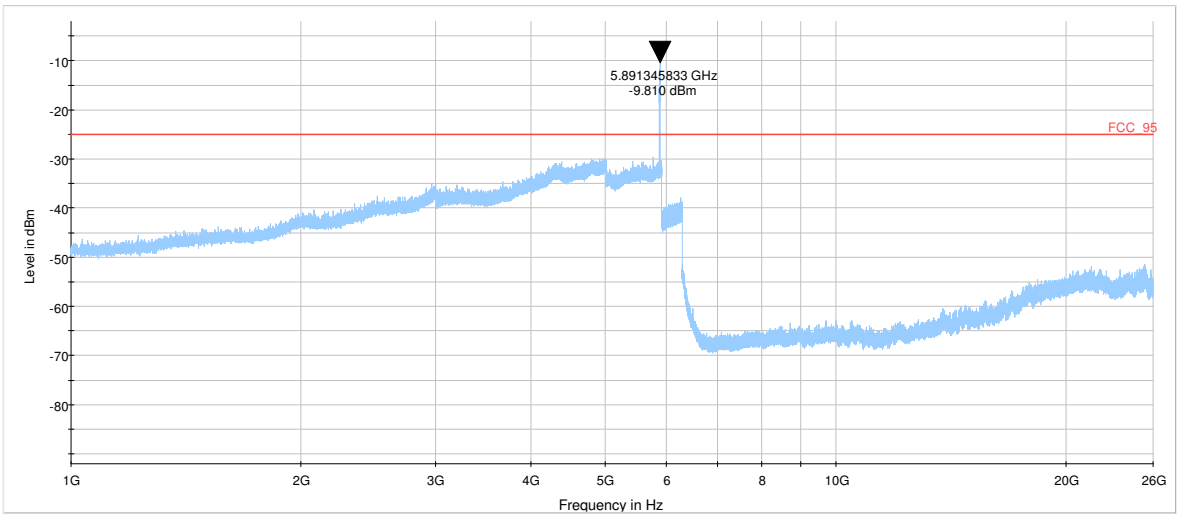
TX frequency 5920 MHz

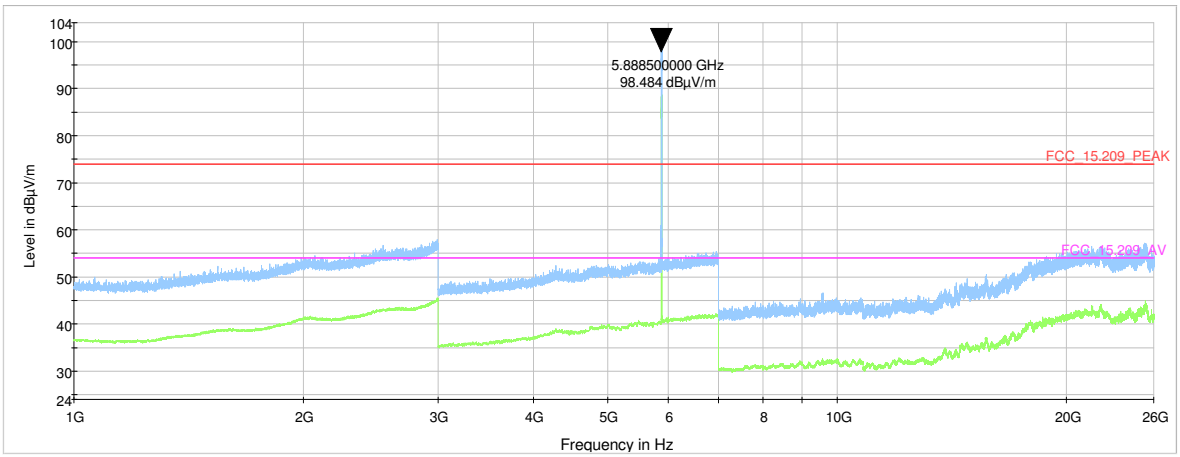
1 GHz – 26 GHz



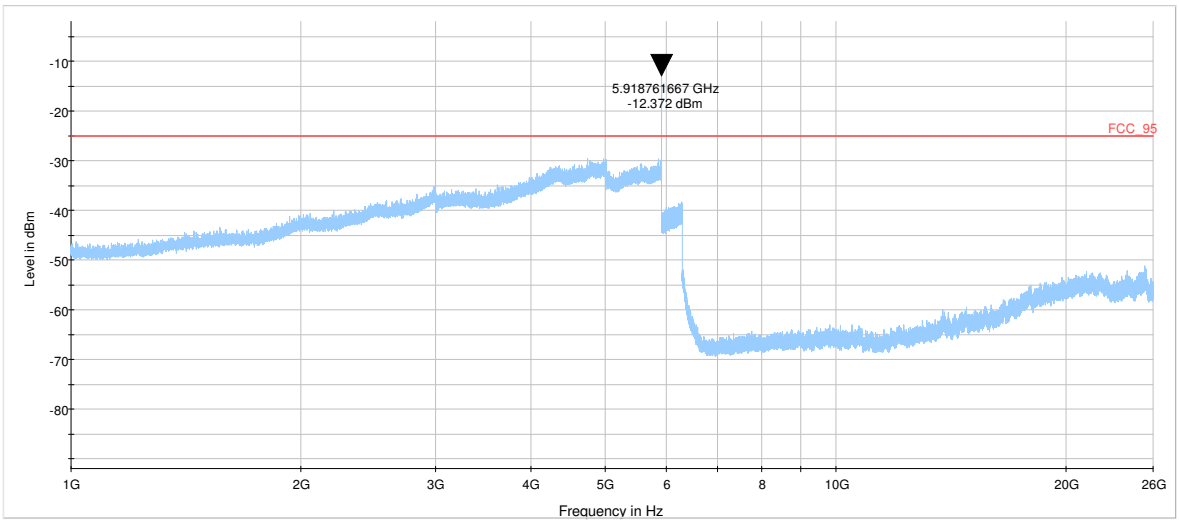


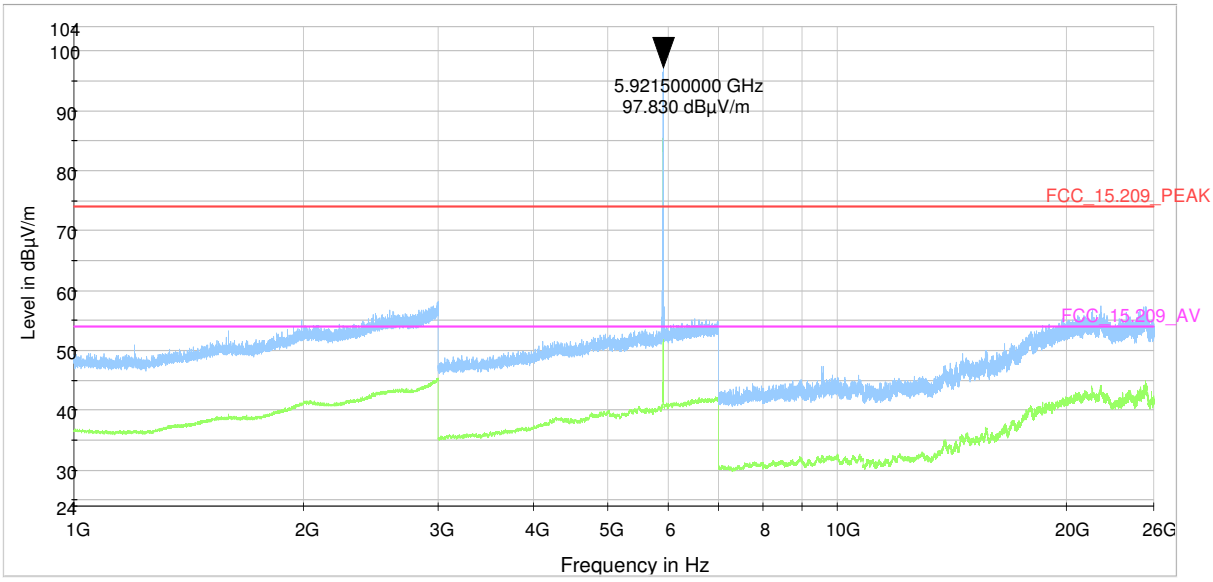
TX frequency 5860 MHz, peak is from the intentional transmitter





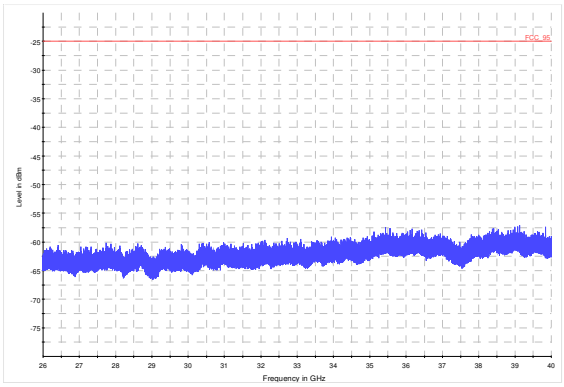
TX frequency 5890 MHz, peak is from the intentional transmitter

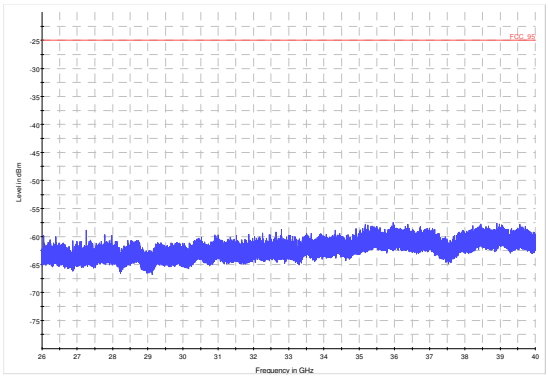




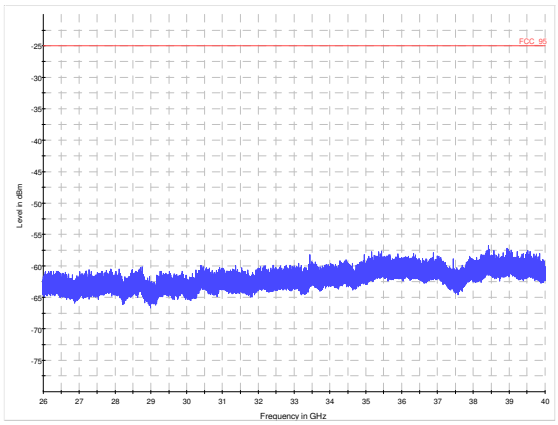
TX frequency 5920 MHz, peak is from the intentional transmitter

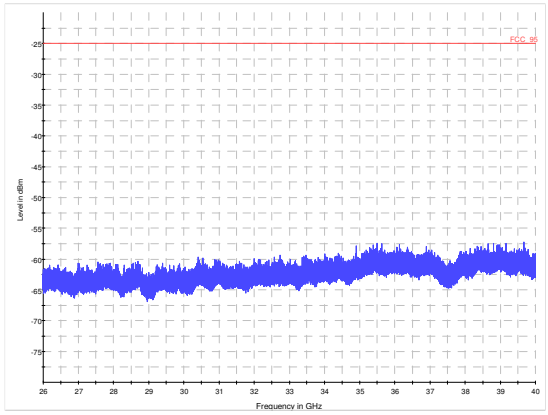
26 GHz – 40 GHz



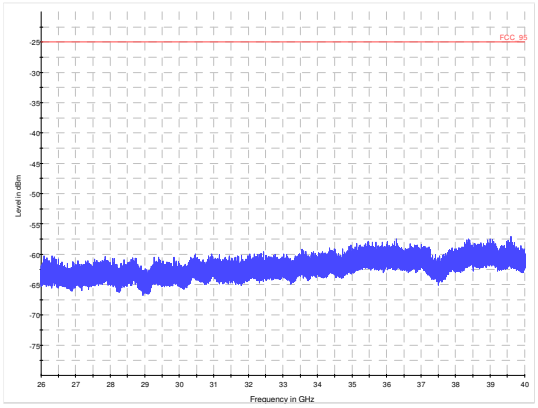


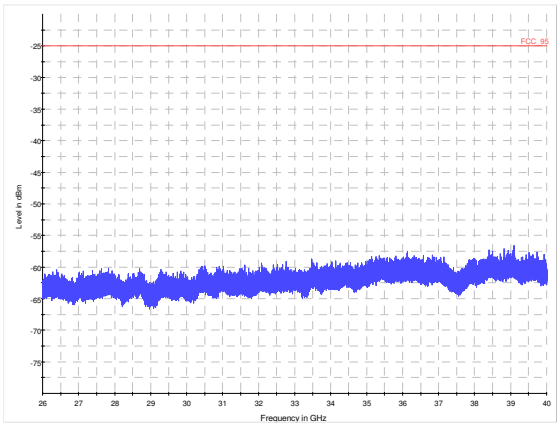
Horizontal antenna polarisation TX on 5860 MHz Vertical antenna polarisation





Horizontal antenna polarisation TX on 5890 MHz Vertical antenna polarisation





Horizontal antenna polarisation TX on 5920 MHz Vertical antenna polarisation

4.6.5TEST EQUIPMENT USED

Radiated Emissions

5 TEST EQUIPMENT

1 Radio Lab
Conducted Radio Test Lab

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02
1.2	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482		
1.3	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
1.4	VT 4002	Climatic Chamber	Vötsch	58566002150010	2016-03	2018-03
1.5	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2016-02	2018-02
1.6	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
1.7	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2017-07	2018-07

2 Radiated Emissions
Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2017-05	2018-05
2.2	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
2.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-04	2019-04
2.4	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2016-05	2019-05
2.5	HL 562	Ultralog new biconicals	Rohde & Schwarz	830547/003	2015-06	2018-06
2.6	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
2.7	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
2.8	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2015-06	2018-06
2.9	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2016-02	2018-02

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.10	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
2.11	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-12	2018-12
2.12	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
2.13	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright	09		
2.14	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
2.15	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304		
2.16	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
2.17	TT 1.5 WI	Turn Table	Maturo GmbH	-		
2.18	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz	100609	2016-04	2019-04
2.19	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		
2.20	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
2.21	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2014-11	2017-11
2.22	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03	2019-03
2.23	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11	2018-11
2.24	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
2.25	AS 620 P	Antenna mast	HD GmbH	620/37		
2.26	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
2.27	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2015-12	2017-12
2.28	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
2.29	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513		
2.30	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2015-05	2018-05

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.

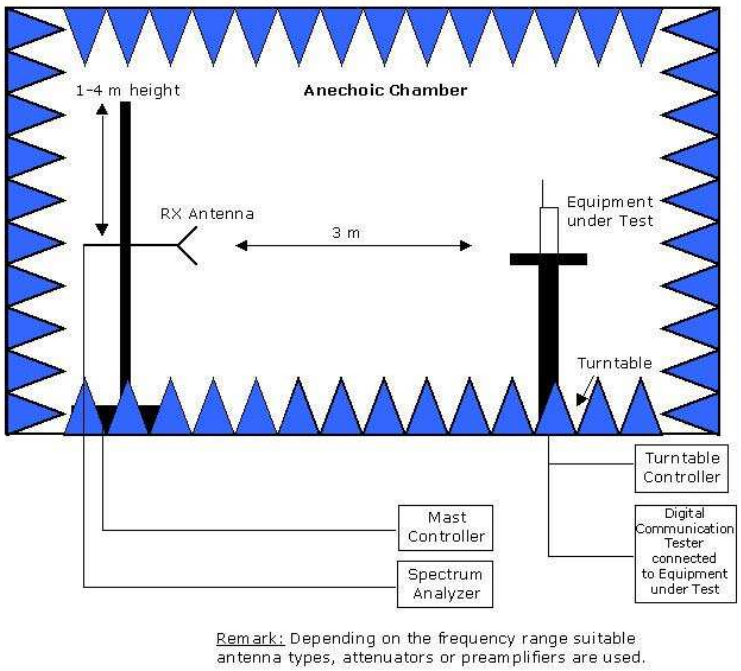
6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

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 groundplane.

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.