Report on the FCC and IC Testing of the Marquardt GmbH Passive Car Entry Key Model: BK1 In accordance with FCC 47 CFR Part 15 F and ISED RSS-220 and ISED RSS-Gen

Product Service

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Prepared for: Marquardt GmbH
Schloss-Str. 16
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Germany

FCC ID: IYZBK1
IC: 2701A-BK1

COMMERCIAL-IN-CONFIDENCE

Date: 2020-10-01
Document Number: TR-64038-83123-07 | Issue 2

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alex Fink	2020-10-01	SIGN-ID 405743
Authorised Signatory	Markus Biberger	2020-10-01	SIGN-ID 405840

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

Engineering Statement:
This measurement shown in this report were made in accordance with the procedures described on test pages.
All reporded testing was carried out on a sample equipment to demonstrate limited compilance with with FCC 47 CFR Part 15 F and ISED RSS-220 and RSS-GEN.
The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alex Fink	2020-10-01	SIGN-ID 405743

Laboratory Accreditation	Laboratory recognition	Industry Canada test site registration
DAkkS Reg. No. D-PL-11321-11-02 DAkkS Reg. No. D-PL-11321-11-03	Registration No. BNetzA-CAB-16/21-15	3050A-2

Executive Statement:
A sample of this product was tested and found to be compilant with FCC 47 CFR Part 15 F:2019 and ISED RSS-220:2018 and ISED RSS-Gen:2019

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VAT ID No. DE129484267
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DL-InfoV (Germany) at
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Product Service

Content

Annex to Test Report TR-64038-83123-07 | Issue: 01

1 Report Summary

1.1 Modification Report

Alternations and additions of this report will be issued to the holders of each copy in the form of a complete document.

Issue	*Description of changes*	*Date of Issue*
1	First Issue	2020-08-21
2	UWB device subclass and section for signal deactivation added	2020-10-01

Table 1: Report of Modifications

1.2 Introduction

Applicant	Marquardt GmbH
Manufacturer	Marquardt GmbH
Model Number(s)	BK1
Serial Number(s)	47BA99B6
Hardware Version(s)	---
Software Version(s)	---
UWB device subclass	Hand-held Communication Device
Additional information	No data port in the radio terminal available
Number of Samples Tested	1
Test Specification(s) / Issue / Date	FCC 47 CFR Part15 F: 2019, FCC 47 CFR Part15 C: 2019 and ISED RSS-220, Issue 1, Amd. 1: 2018 ISED RSS-Gen, Issue 5, Amd. 1: 2019
Test Plan/Issue/Date	---
Order Number	6200401493-G51
Date	2020-02-28
Date of Receipt of EUT	2020-07-29
Start of Test	2020-07-28
Finish of Test	2020-08-21
Name of Engineer(s)	Alex Fink
Related Document(s)	ANSI C63.10:2013

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15 F and ISED RSS-220 and RSS-Gen is shown below.

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	15.503(d)	Bandwidth of Signal	Pass
2.2	15.519(e), 15.521	Peak Power	Pass
2.3	15.505(a), 15.519(c), 15.209	Radiated Emissions	Pass
2.4	15.519(d)	Radiated Emissions in GPS bands	Pass
N/A	15.505(a), 15.207	Conducted Disturbance at Mains Terminal	Not applicable, battery supply
2.5	15.519(a)	Signal deactivation	Pass

Table 2: Results according to FCC 47 CFR Part 15 F

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	2	Bandwidth of Signal	Pass
2.2	5.3.1(g), Annex 4	Peak Power	Pass
2.3	5.3.1(c) 5.3.1(d)	Radiated Emissions	Pass
2.4	5.3.1(e)	Radiated Emissions in GPS bands	Pass
2.5	5.3.1(b)	Signal deactivation	Pass

Table 3: Results according to ISED RSS-220

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	6.7	Bandwidth of Signal	Pass
2.3	8.9	Radiated Emissions	Pass
N/A	8.8	AC Power Line Conducted Emissions	Not applicable, battery supply
2.3	8.9, 8.10	Radiated Emissions	Pass

Table 4: Results according to ISED RSS-Gen

1.4 Product Information

1.4.1 Technical Description

The BK1, as a passive entry vehicle key, is part of a driving authorisation system, which further consists of a Body Control Unit and up to 6 UWB vehicle modules. The Body Control Unit sends an LF signal for wake up. The BK1 corresponds in return over RF bidirectionally. In the meantime, a time-of-flight measurement is triggered bidirectionally between the UWB vehicle module and the BK1. The distance is measured between the UWB vehicle module and the BK1 by means of the time of flight based on speed of light. The components exchange encrypted data for car access, to start the engine and to locate the key.

User manual
The BK1 has up to four keys. Open, Close, Trunk and Panic (optional for North American market).
On each button press it initiates the communication to the Body Control Module and the range measurement process. Wireless transmission is indicated by a flashing red LED.

Open Button
- To unlock the vehicles doors when the button is pressed short.
- In case the button is pressed long the windows will open additionally.

Close Button
- Locks the vehicles doors when the button is pressed short.
- When the button is pressed long the windows will close additionally.
- To activate the power save mode when pressed twice. This mode is deactivated by pressing
any button.

Trunk Button
To unlock and open the vehicles trunk lid.

Optional the car can be accessed without handling the key. In this case RF signals are exchanged bidirectional when touching the door handle.

In case the battery is low car access is possible by means of an integrated mechanic emergency key. The BK1 is then to be placed into a dedicated slot inside the vehicles centre console to be powered wireless by means of a magnetic field for passive Transponder communication.

Working temperature: -20° to +65° C (UHF and UWB)
Rough mechanical dimensions: 87 X 44 X 13 mm
Weight: 50 g

Data of UWB-Part

Transmission mode:	bidirectional RF 4 channels

Receiver

Channel frequencies (center):	Channel 5: 6489,6 MHz Channel 6: 6988,8 MHz Channel 8: 7488,0 MHz Channel 9: 7987,2 MHz
10 dB bandwidth:	> 500 MHz per channel
Frequency tolerance: (production, aging, temperature)	+/-25 ppm
Sensitivity:	-90 dBm
Modulation:	BFSK
Frequency deviation:	+/- 125 MHz
Modulation content: pulse rate data rate	digital binary data stream, 16 pulses per bit 4 Mpulse/s 250 kBit/s
Antenna:	integrated PCB antenna, combined for Rx / Tx

Transmitter:

Center frequency:	see Rx
Frequency tolerance: (production, aging, temperature)	+/-25 ppm
Transmitter power:	Max. -41.3 dBm/MHz EIRP with PCB antenna
Modulation:	BFSK
Frequency deviation:	+/- 125 MHz
Antenna:	integrated PCB antenna, combined for Rx / Tx

1.5 EUT Modifications Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the customer SN: 47BA99B6 – test sample with antenna	Not Applicable	Not Applicable

Table 5

1.6 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing test laboratory:

Test Name	Name of Engineer(s)
Transmitting continuously	
Bandwidth of Signal	Alex Fink
Peak Power	Alex Fink
Radiated Emissions	Alex Fink
Radiated Emissions in GPS bands	Alex Fink
Signal deactivation	Alex Fink
RF Exposure	Alex Fink

Office Address:
Äußere Frühlingstraße 45
94315 Straubing
Germany

2 Test Details

2.1 Bandwidth of Signal

2.1.1 Specification Reference

FCC 47 CFR Part 15 F, Clause 15.503(d)
ISED RSS-220, Clause 2
ISED RSS-Gen, Clause 6.7

2.1.2 Equipment under Test and Modification State

BK1, S/N: 47BA99B6 - Modification State 0

2.1.3 Date of Test

2020-07-28 and 2020-08-21

2.1.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	35 %

2.1.5 Specification Limits

A UWB device is an intentional radiator that has either a -10 dBc bandwidth ($\frac{f_H+f_L}{2}$) of at least 500 MHz or a -10 dB ($2\frac{f_H-f_L}{f_H+f_L}$) fractional bandwidth greater than 0.2.

2.1.6 Test Method

The test was performed according to ANSI C63.10, clauses 6.9 and 10.1
See section 2.3 of this test report for details.

2.1.7 Test Results

Frequency Channel	*f_L (GHz)*	*f_H (GHz)*	*f_M (GHz)*	*-10 dB Fractional Band-width (MHz)*
5	6.223	6.809	6.568	586
9	7.684	8.252	7.790	567

Table 6: 10 dB bandwidth

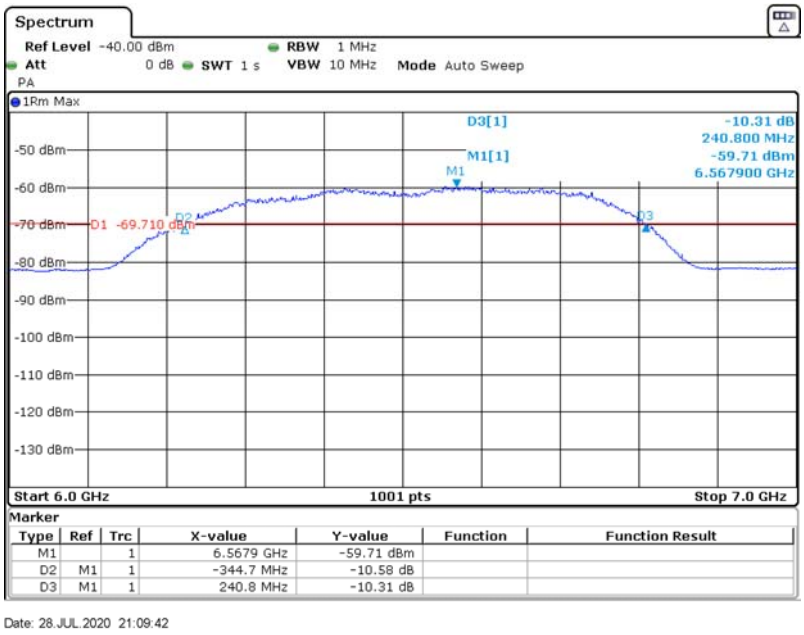


Figure 1 – 10 dB Bandwidth for Channel 5

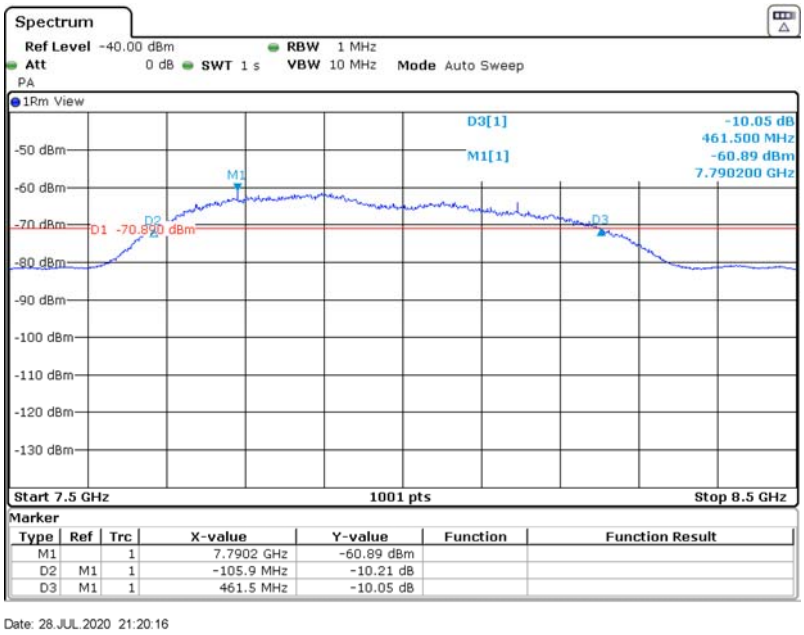


Figure 2 – 10 dB Bandwidth for Channel 9

Frequency Channel	*99% Bandwidth (MHz)*
5	601
9	616

Table 7: 99% bandwidth

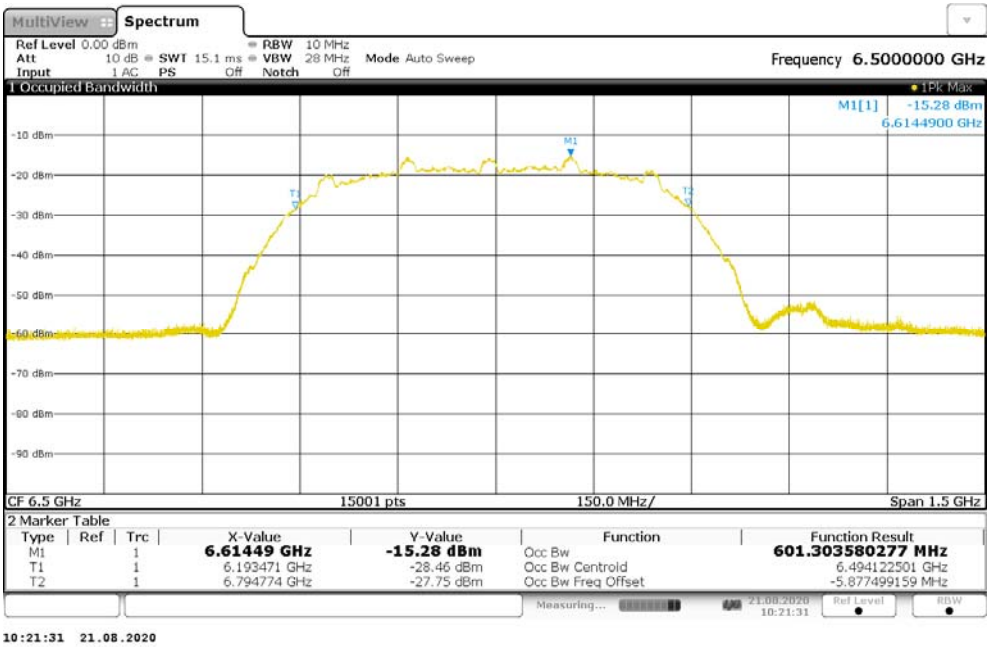


Figure 3 – 10 dB Bandwidth for Channel 5

Figure 4 – 10 dB Bandwidth for Channel 9

2.1.8 Test Location and Test Equipment

This test was carried out in Semi anechoic room - cabin no. 11.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	03/20	03/21
Horn antenna	Rohde & Schwarz	HF907	40089	02/19	02/21
Semi anechoic room	Rohde & Schwarz	No. 11	---	---	---

Table 8

2.2 Peak Power

2.2.1 Specification Reference

FCC 47 CFR Part 15 F, Clause 15.519(e) and 15.521
ISED RSS-220, Clauses 4. 5.3.1(g) and Annex 4

2.2.2 Equipment under Test and Modification State

BK1, S/N: 47BA99B6 - Modification State 0

2.2.3 Date of Test

2020-07-27

2.2.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	35 %

2.2.5 Specification Limits

There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M. That limit is 0 dBm e.i.r.p. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures.

2.2.6 Test Method

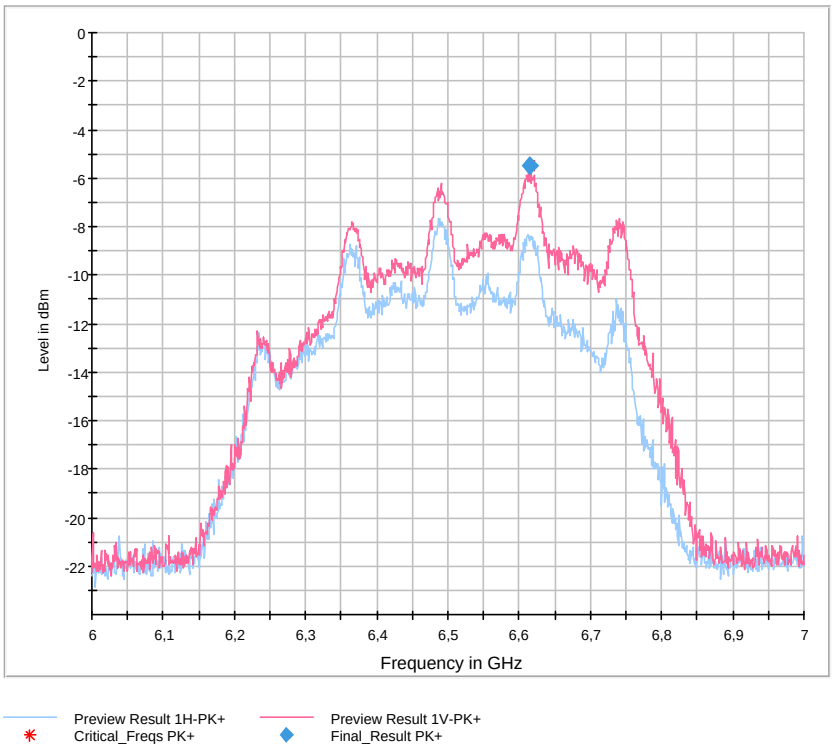
The test was performed according to ANSI C63.10, section 10.3.5
See section 2.3 of this test report for details.

2.2.7 Test Results

Frequency Channel	*f_M (GHz)*	*Resolution Bandwidth (MHz)*	*Peak Power (dBm)*	*Peak Power Limit (dBm)*
6.4896	6.614	50	-5.51	0
7.9872	7.861	50	-8.31	0

Table 9: Peak Power

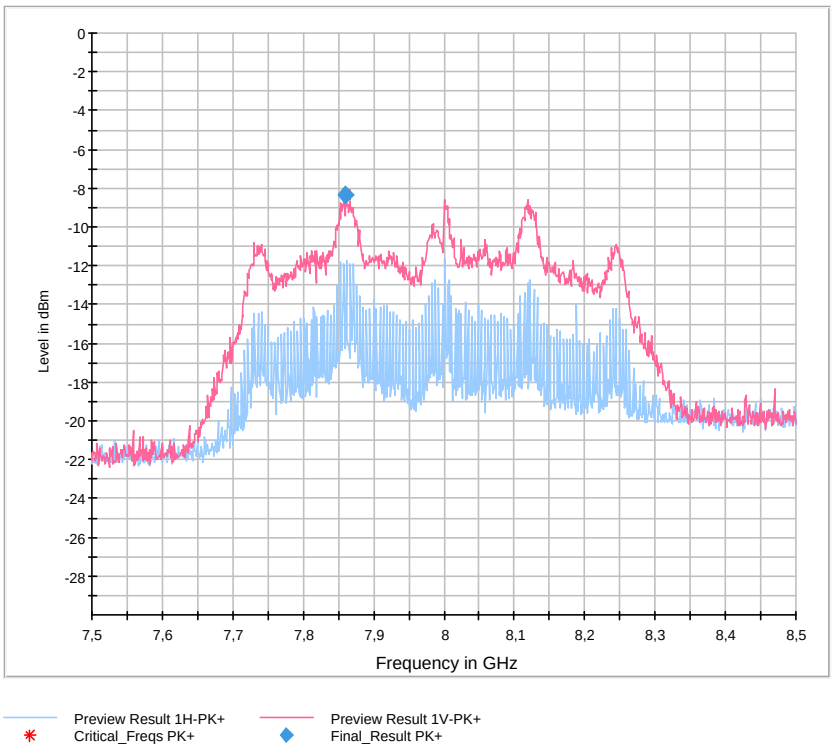
Mean Power Spectral Density for Channel 5



Final Results:

Frequency MHz	*MaxPeak dBm*	*Limit dBm*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
6614.000000	-5.51	0.00	5.51	500.0	50000.000	150.0	V	-158.0	-53.3

Mean Power Spectral Density for Channel 9



Final Results:

Frequency MHz	*MaxPeak dBm*	*Limit dBm*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
7861.000000	-8.31	0.00	8.31	500.0	50000.000	150.0	V	-121.0	-51.8

2.2.8 Test Location and Test Equipment

This test was carried out in Semi anechoic room - cabin no. 11.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	03/20	03/21
Horn antenna	Rohde & Schwarz	HF907	40089	02/19	02/21
Semi anechoic room	Rohde & Schwarz	No. 11	---	---	---

Table 10

2.3 Radiated Emissions

2.3.1 Specification Reference

FCC 47 CFR Part 15 F, Clauses 15.505(a) and 15.519(c)
FCC 47 CFR Part 15 C, Clauses 15.209
ISED RSS-220, Clause 5.3.1(c), 5.3.1(d)
ISED RSS-Gen, Clauses 8.9

2.3.2 Equipment under Test and Modification State

BK1, S/N: 47BA99B6 - Modification State 0

2.3.3 Date of Test

2020-08-03 to 2020-08-13

2.3.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	35 %

2.3.5 Specification Limits

2.3.5.1 Radiated emissions up to 960 MHz according to 47 CFR 15.517(c), 15.519(c) and ISED RSS-220, Clause 5.2.1 (c), 5.2.1 (c), 5.3.1 (d), 5.3.1 (d)

The radiated emissions at or below 960 MHz from a device operating under the provisions of this sections shall not exceed the general radiated emission limits:

General radiated emission limits:					
Frequency Range (MHz)	*Test distance (m)*	*Field strength*		*Field strength*	
		(µA/m)	*(dBµA/m)*	*(µV/m)*	*(dBµV/m)*
0.009 – 0.49	300	6.37 / *f*	20*lg(6.37 / *f*)	2400 / *f*	20*lg(2400 / *f*)
0.49 – 1.705	30	63.7 / *f*	20*lg(63.7 / *f*)	24000 / *f*	20*lg(24000 / *f*)
1.705 - 30	30	0.08	20*lg(0.08 / *f*)	30	20*lg(30 / *f*)
30 – 88	3	---	---	100	40
88 – 216	3	--	---	150	43.5
126 – 960	3	--	---	200	46
Note 1: *f* in kHz					

Table 11 General radiated emission limits

2.3.5.2 Radiated emissions above 960 MHz according to 47 CFR 15.517(c)

The radiated emissions above 960 MHz shall not exceed the following average (RMS) limits when measured using a resolution bandwidth of 1 MHz:

Frequency range	*EIRP*
960 MHz – 1610 MHz	-75.3 dBm
1610 MHz – 1990 MHz	-53.3 dBm
1990 MHz – 3.1 GHz	-51.3 dBm
3.1 GHz – 10.6 GHz	-41.3 dBm
above 10.6 GHz	-51.3 dBm

2.3.5.3 Radiated emissions above 960 MHz according to 47 CFR 15.519(c)

The radiated emissions above 960 MHz shall not exceed the following average (RMS) limits when measured using a resolution bandwidth of 1 MHz:

Frequency range	*EIRP*
960 MHz – 1610 MHz	-75.3 dBm
1610 MHz – 1990 MHz	-63.3 dBm
1990 MHz – 3.1 GHz	-61.3 dBm
3.1 GHz – 10.6 GHz	-41.3 dBm
above 10.6 GHz	-61.3 dBm

2.3.5.4 Radiated emissions above 960 MHz according to ISED RSS-220, Clause 5.2.1 (d)

The radiated emissions above 960 MHz shall not exceed the following average (RMS) limits when measured using a resolution bandwidth of 1 MHz:

Frequency range	*EIRP*
960 MHz – 1610 MHz	-75.3 dBm
1610 MHz – 4750 MHz	-70.0 dBm
4750 MHz – 10.6 GHz	-41.3 dBm
above 10.6 GHz	-51.3 dBm

2.3.5.5 Radiated emissions above 960 MHz according to ISED RSS-220, Clause 5.3.1 (d)

The radiated emissions above 960 MHz shall not exceed the following average (RMS) limits when measured using a resolution bandwidth of 1 MHz:

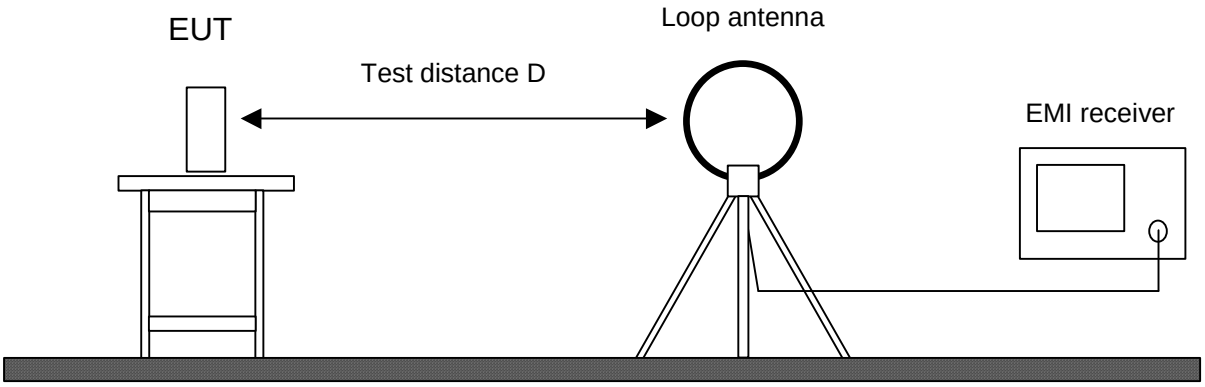
Frequency range	*EIRP*
960 MHz – 1610 MHz	-75.3 dBm
1610 MHz – 4750 MHz	-70.0 dBm
4750 MHz – 10.6 GHz	-41.3 dBm
above 10.6 GHz	-61.3 dBm

2.3.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11 and 11.12

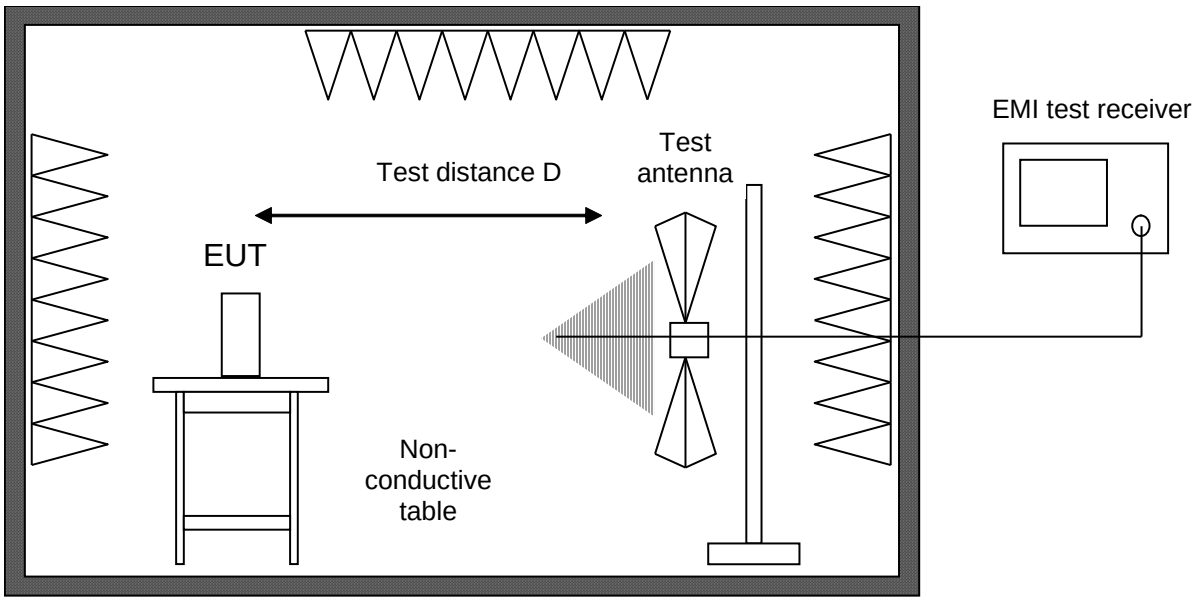
Prescans are performed in six positions of the EUT to get the full spectrum of emission caused by the EUT with the measuring antenna raised and lowered from 1 m to 4 m with vertical and horizontal polarisation to find the combination of table position, antenna height and antenna polarisation for the maximum emission levels.
Data reduction is applied to these results to select those levels having less margin than 10 dB or exceeding the limit using subranges and limited number of maximums.
Further maximisation for adjusting the maximum position is following.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

2.3.6.1 Frequency range 9 kHz – 30 MHz



The EUT was placed on a non-conductive table, 0.8 m above the ground.
Radiated emissions in the frequency 9 kHz – 30 MHz is measured within a semi-anechoic room with an active loop antenna with the measurement detector set to peak. In addition in the frequency range 9 kHz to 490 kHz also an average detector was used. The measurement bandwidth of the receiver was set to 300 Hz in the frequency range 9 kHz to 150 kHz and 10 kHz in the frequency range 150 kHz to 30 MHz. Prescans were performed in six positions of the EUT.
For final measurements the detector was set to CISPR quasi-peak and in addition to CISPR average in the frequency range 9 kHz to 490 kHz with a resolution bandwidth 200 Hz in the frequency range 9 kHz to 150 kHz and 9 kHz in the frequency range 150 kHz to 30 MHz. Final tests were performed immediately after a final frequency and zoom (for drifting disturbances) and maximum adjustment.

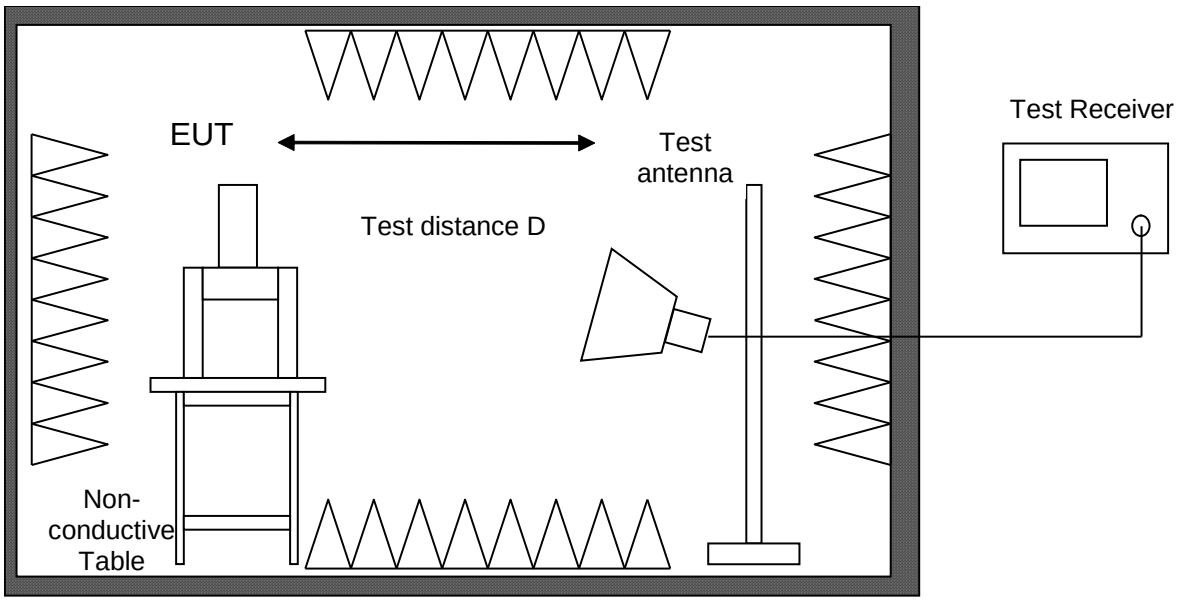
2.3.6.2 Frequency range 30 MHz – 1 GHz



Alternate test site (semi anechoic room)

The EUT was placed on a non-conductive table, 0.8 m above the ground plane
Radiated emissions in the frequency range 30 MHz – 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4. for alternative test sites. A linear polarised logarithmic periodic antenna combined with a 4:1 broadband dipole (“Trilog broadband antenna”) is used.
For prescan tests the test receiver is set to peak-detector with a bandwidth of 120 kHz.
With the measurement bandwidth of the test receiver set to 120 kHz CISPR quasi-peak detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

2.3.6.3 Frequency range above 1 GHz



Fully anechoic room

The EUT was placed on a non-conductive table, 1.5 m above the ground plane
Radiated emission tests above 1 GHz are performed in a fully anechoic room with the S_{VSWR} requirements of ANSI C63.4. Measurements are performed both in the horizontal and vertical planes of polarisation using a test receiver with the detector function set to peak and average and the resolution bandwidth set to 1 MHz. Testing above 1 GHz is performed with horn antennas with the EUT in boresight of the antenna.
For prescan tests the test receiver is set to peak- and average-detector with a bandwidth of 1 MHz. With the measurement bandwidth of the test receiver set to 1 MHz and peak- and CISPR average-detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

2.3.7 Test Results

Frequency range	*Test distance*
9 kHz to 1 GHz	3 m
1 GHz to 8 GHz	1 m
8 GHz to 40 GHz	0.5 m

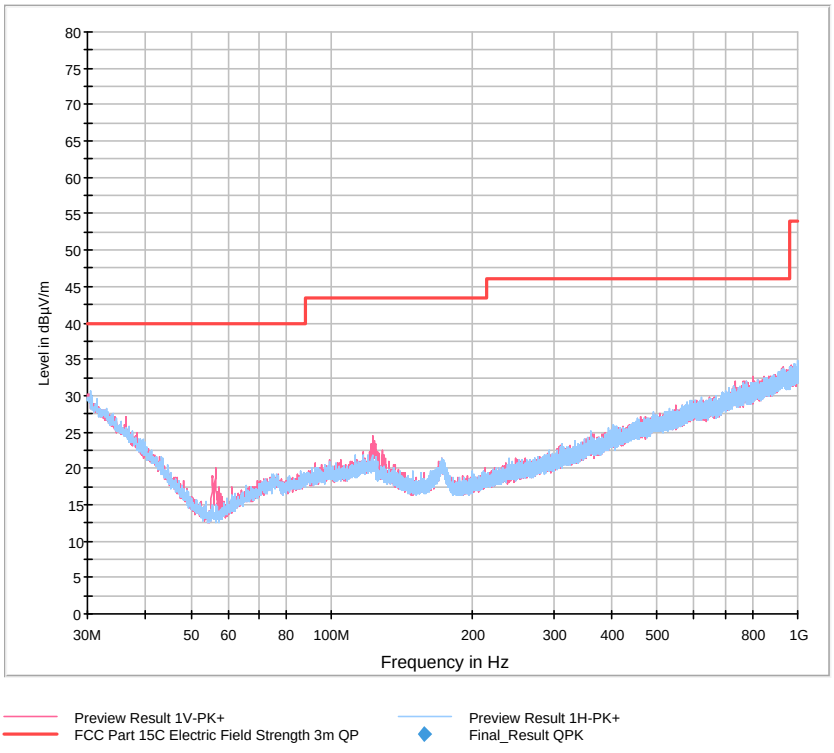
Table 12

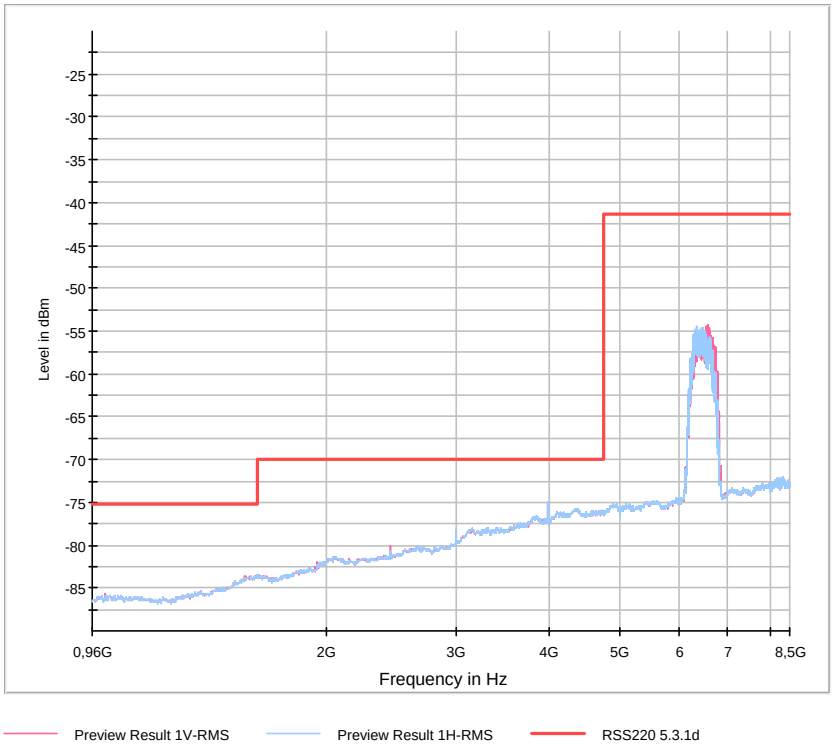
Sample calculation:

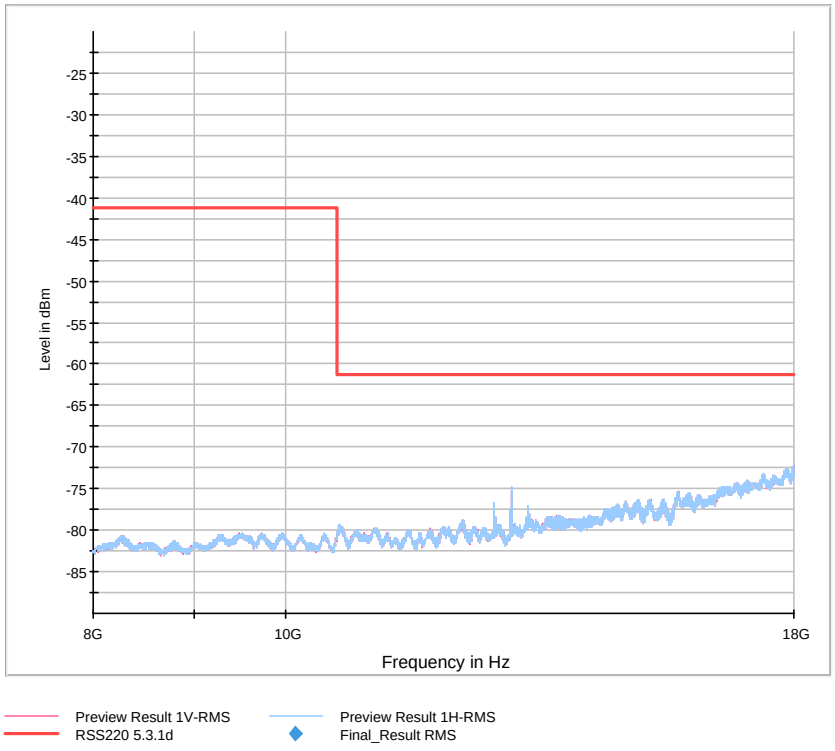
Final Value (dBµV/m) = Reading Value (dBµV) + (Cable attenuation (dB) + Antenna Transducer (dB(1/m)))

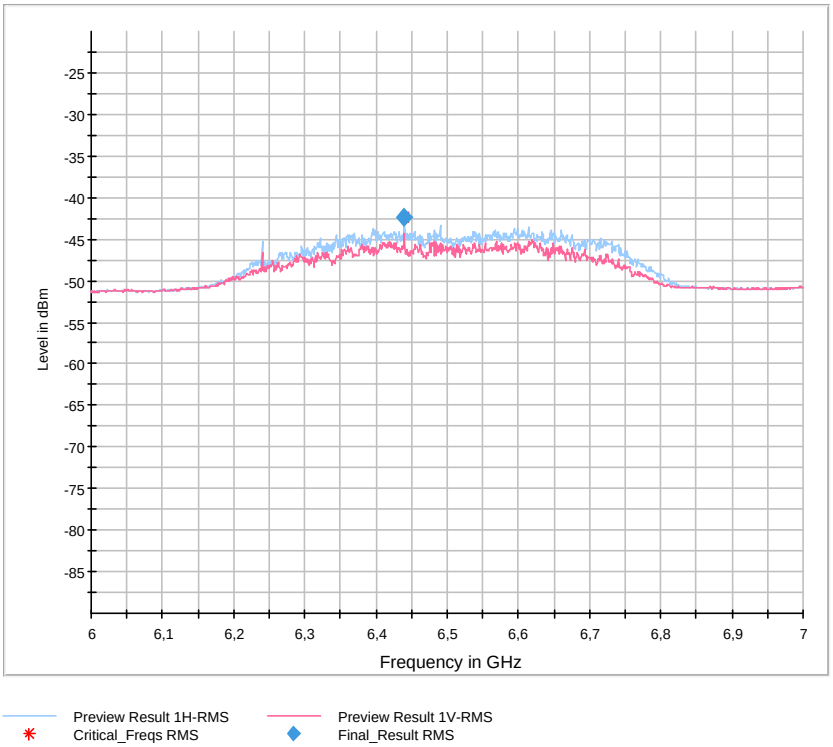
Transmitting continuously, Channel 5 - Preliminary pre-scans for the worst-case orientation

x axis




-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
Level in dBm
0,96G
2G
3G
4G
5G
6
7
8,5G
Frequency in Hz
Preview Result 1V-RMS
Preview Result 1H-RMS
RSS220 5.3.1d

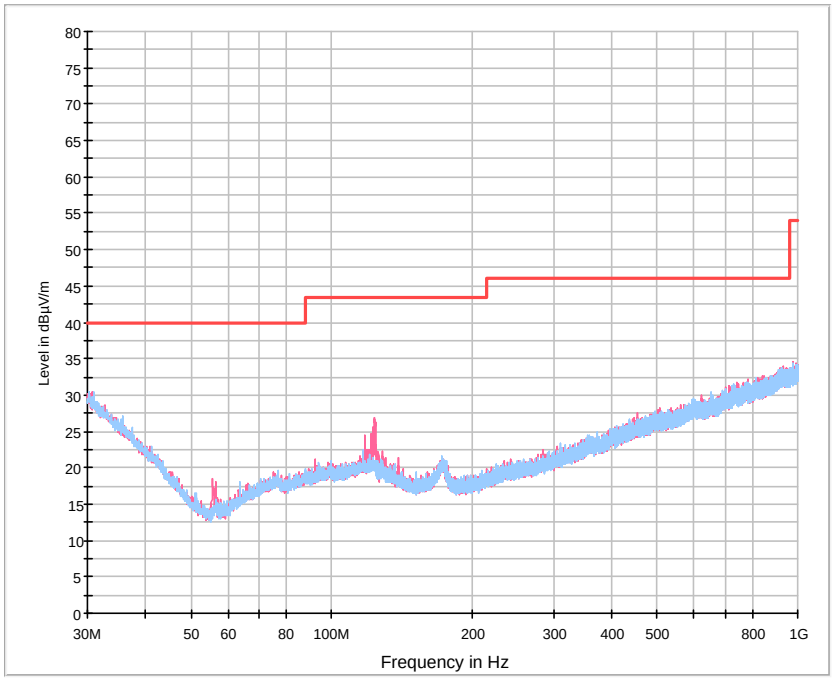

-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
Level in dBm
8G
10G
18G
Frequency in Hz
Preview Result 1V-RMS
RSS220 5.3.1d
Preview Result 1H-RMS
Final_Result RMS

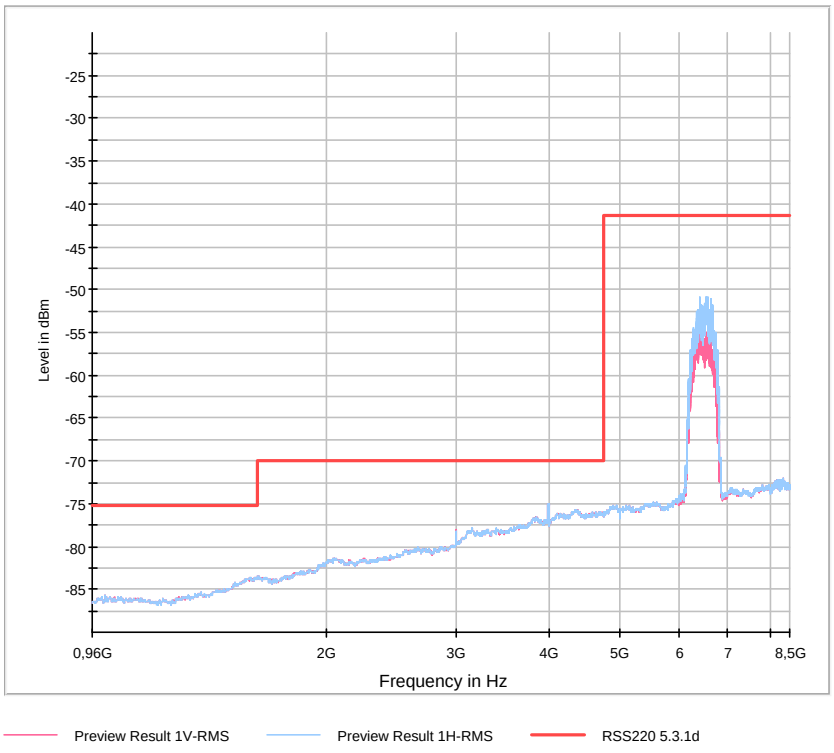


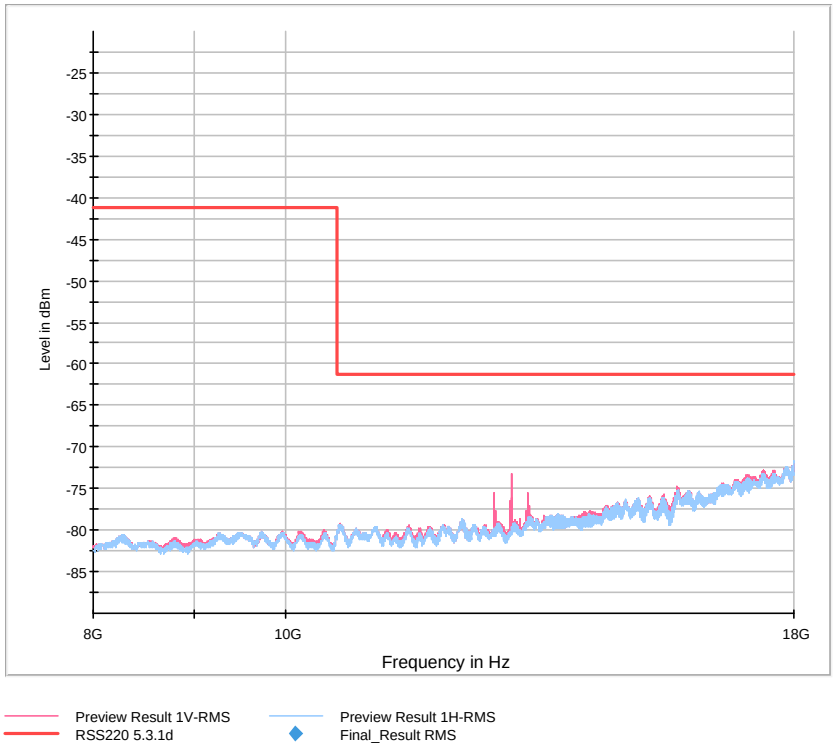
Final Results:

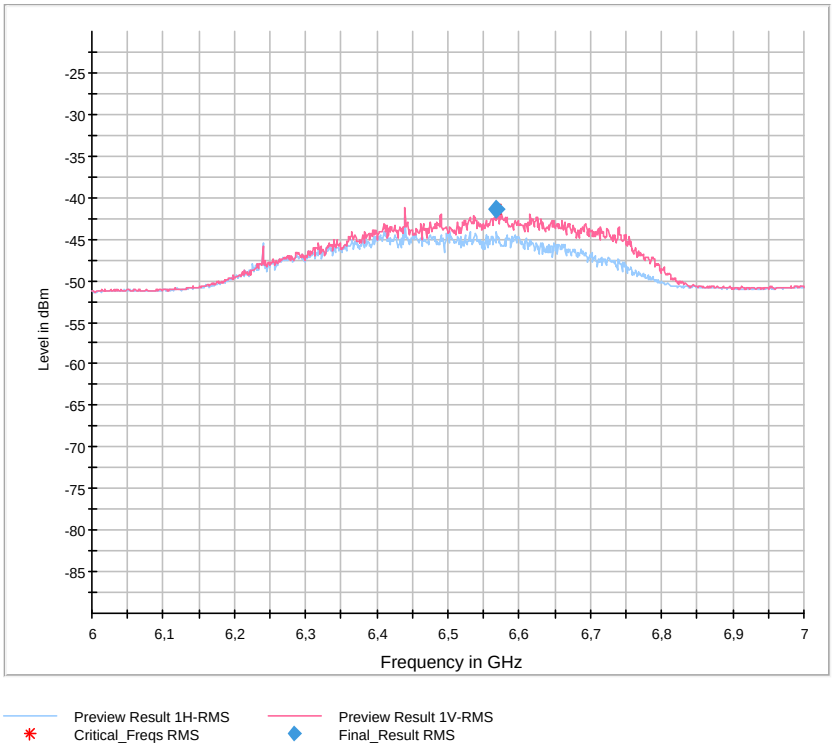
Frequency MHz	RMS dBm	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
6440.000000	-42.37	1000.0	1000.000	150.0	H	-11.0	-53.8

y axis


Level in dBµV/m
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
30M
50
60
80
100M
200
300
400
500
800
1G
Frequency in Hz
Preview Result 1V-PK+
FCC Part 15C Electric Field Strength 3m QP
Preview Result 1H-PK+
Final_Result QPK


Level in dBm
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
0,96G
2G
3G
4G
5G
6
7
8,5G
Frequency in Hz
Preview Result 1V-RMS
Preview Result 1H-RMS
RSS220 5.3.1d


-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
Level in dBm
8G
10G
18G
Frequency in Hz
Preview Result 1V-RMS
RSS220 5.3.1d
Preview Result 1H-RMS
Final_Result RMS

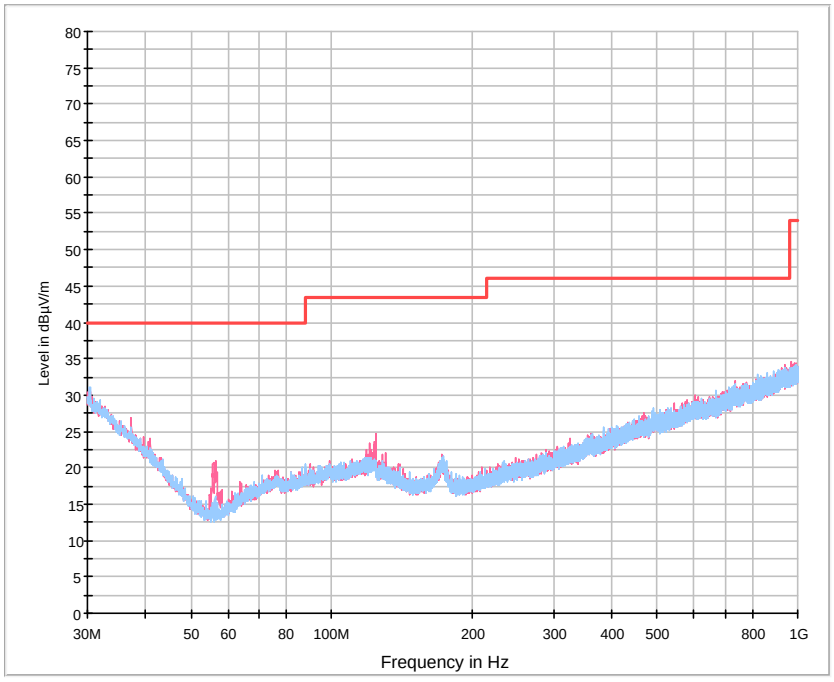


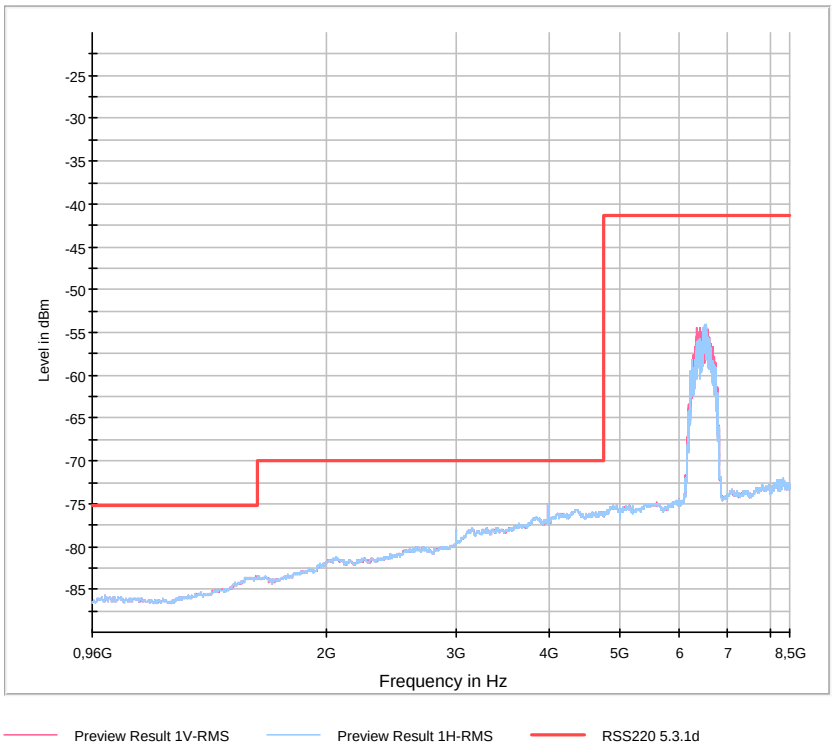
Final Results:

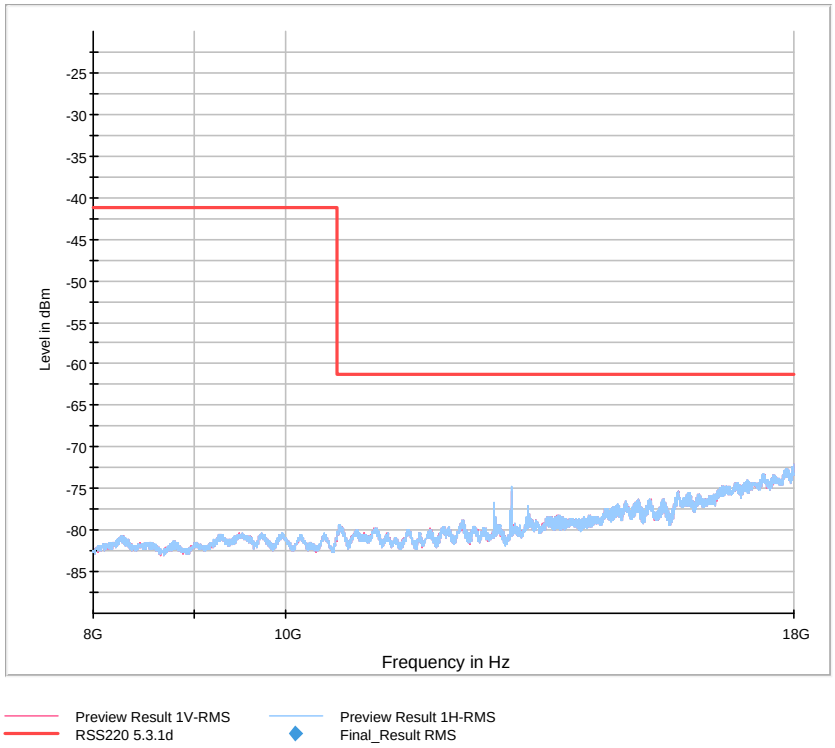
Frequency MHz	*RMS dBm*	*Limit dBm*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
6568.000000	-41.50	-41.30	0.20	1000.0	1000.000	150.0	V	-149.0	-53.4

➔ Worst case orientation is y axis

z axis


Level in dBµV/m
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
30M
50
60
80
100M
200
300
400
500
800
1G
Frequency in Hz
Preview Result 1V-PK+
FCC Part 15C Electric Field Strength 3m QP
Preview Result 1H-PK+
Final_Result QPK


Level in dBm
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
0,96G
2G
3G
4G
5G
6
7
8,5G
Frequency in Hz
Preview Result 1V-RMS
Preview Result 1H-RMS
RSS220 5.3.1d


-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
Level in dBm
8G
10G
18G
Frequency in Hz
Preview Result 1V-RMS
RSS220 5.3.1d
Preview Result 1H-RMS
Final_Result RMS