Product Service

Report on the FCC and IC Testing of the Marquardt GmbH

Model: YK2

In accordance with FCC 47 CFR Part 15 C, ISED RSS-210, ISED RSS-GEN and ISED RSS-102

Product Service

Add value.
Inspire trust.

Prepared for: Marquardt GmbH
Schloss-Str. 16
78604 Rietheim-Weilheim
Germany

FCC ID: 2AHMVYK2
IC: 21263-YK2

COMMERCIAL-IN-CONFIDENCE

Date: 2025-07-29
Document Number: TR-713316115-00 | Revision: 2

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alexander Deese	2025-07-29	SIGN-ID 1062614
Authorised Signatory	Matthias Stumpe	2025-07-30	SIGN-ID 1062684

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

Engineering Statement:

These measurements 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 compliance with FCC 47 CFR Part 15 C and ISED RSS-210 and RSS-GEN.
The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alexander Deese	2025-07-29	SIGN-ID 1062614

Laboratory Accreditation	Laboratory recognition	Industry Canada test site registration
DAkkS Reg. No. D-PL-11321-11-03 DAkkS Reg. No. D-PL-11321-11-04	Registration No. BNetzA-CAB-16/21-15	3050A-2

Executive Statement:

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15 C:2021, ISED RSS-210 Issue 11, 2024, RSS-GEN:2021 and ISED RSS-102 Issue 6

Product Service

Content

Annex to Test Report TR-713316115-00 | Revision: 1 5 pages

Product Service

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.

Revision	*Description of changes*	*Date of Issue*
0	First Issue	2024-05-23
1	RSS-210 Issue 11 and RSS-102 Issue 6 added. Measurement height in section 2.4.6.3 corrected. Photo in section 2.4.6.3 corrected. Margin values at page 32 and 39 corrected. Measurement value at page 39 corrected.	2025-07-11
2	Updated to RSS-210 Issue 11 and RSS-102 in chapter 2 test details.	2025-07-29

Table 1: Report of Modifications

1.2 Introduction

Applicant	Marquardt GmbH
Manufacturer	Alpha Vehicle Security Solutions Czech s.r.o. V. Opatrného 1050 Týniště nad Orlicí CZ-517 21
Model Number(s)	YK2
Serial Number(s)	---
Hardware Version(s)	---
Software Version(s)	---
Number of Samples Tested	1
Test Specification(s) / Issue / Date	FCC 47 CFR Part 15 C: 2021 ISED RSS-210, Issue 11, 2024 ISED RSS-GEN, Issue 5, Amendment 1: 2019 and Amendment 2: 2021 ISED RSS-102, Issue 6, 2023
Test Plan/Issue/Date	---
Order Number	6200659963-G61
Date	2023-11-29
Date of Receipt of EUT	2024-03-28
Start of Test	2024-04-02
Finish of Test	2024-04-04
Name of Engineer(s)	Alexander Deese
Related Document(s)	ANSI C63.4: 2014 ANSI C63.10: 2013 FCC 47 CFR Part 2 J: 2019 KDB 558074 D01 V05R02 ISED RSS-102, Issue 6, 2023 KDB 447498 D04 Interim General RF Exposure Guidance v01

Product Service

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15 C, ISED RSS-210 and ISED RSS-GEN is shown below.

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	15.231(c)	Bandwidth of momentary signals	Pass
2.2	15.231(a)/ 15.231(3)	Periodic operation requirement	Pass
2.4	15.231(a) 15.205, 15.209	Radiated Emissions	Pass
N/A	15.207	Conducted Emissions on Mains Terminals	Not applicable, battery supply

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

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	A1.3	Bandwidth of momentary signals	Pass
2.2	A.1.1	Periodic operation requirement	Pass
2.4	A.1.1	Radiated Emissions	Pass

Table 3: Results according to ISED RSS-210

Section	*Specification Clause*	*Test Description*	*Result*
Transmitting continuously			
2.1	6.7	Bandwidth of momentary signals	Pass
2.4	8.9, 8.10	Spurious Emissions	Pass
2.3	6.11	Temperature Stability	Pass
N/A	8.8	Conducted Emissions on Mains Terminals	Not applicable, battery supply

Table 4: Results according to RSS-Gen

Product Service

1.4 Product Information

1.4.1 Technical Description

The YK2 (vehicle key) is a component of a driving authorisation system of a car.

The component exchange encrypted data with the vehicle for car access, to start the engine and to locate the key. The YK2 contains four buttons for car access. By pressing the dedicated button, the YK2 sends over RF authorization data to the control unit to open the doors. The 2nd button releases data to lock the doors. A third button is dedicated to open the trunk deck. A fourth button opens the engine hood. An additional “PANIC” button is implemented optional for the US market.
Moreover, car access is also released after touching the door handles. The key is wakened by the magnetic field of the LF antennas, driven by the Body control unit of the vehicle. The YK2 sends over RF encrypted data in return for authentication.
In case the battery is low car access is possible by means of an integrated mechanic emergency key. The YK2 is then to be placed into a dedicated slot inside the centre console to be powered wireless by means of a magnetic field.

The RF Transmitter sends encrypted data to the vehicle modulated on an RF carrier of 433MHz. A version with 315MHz is available for the Japanese market only. When pressing a button on the YK2 a dedicated command with the encrypted data for authentication is sent:

Open-Button:
- Pressed short: unlocks the doors
- Pressed long: unlocks the doors and opens the windows

Close-Button:
- Pressed short: locks the doors
- Pressed long: locks the doors and closes the windows

Trunk-Button:
- to unlock the boot lid.

An LED indicates that appropriate data was sent.

Product Service

Temperature range:

Working temperature:	-20 ...+70 °C

RF-Part

Transmission mode:	simplex

Multi channel Transmitter:

Frequencies:	314.00* / 314.45 / 314.90* MHz 433.47* / 433.92 / 434.37* MHz *) optional configurable during training routine, depending on the local regulations
Frequency tolerance: (production, aging, temperature)	+/- 80 ppm
Transmitter power (EIRP):	typ. -20 dBm @315,00 MHz typ. -14 dBm @433,92 MHz
Modulation:	2-FSK
Frequency deviation:	+/- 20 kHz @ 20kBit/s +/- 5 kHz @ 5kBit/s
Modulation content:	digital data
Data rate:	5 kBit/s ; 20 kBit/s
Coding:	Manchester
Antenna:	PCB loop antenna

Passive Transponder (only active when placed into slot of centre console)

Transmission mode:	simplex
Center frequency:	21,85 kHz
Modulation:	BPSK-signal
Modulation content:	digital data
Data rate:	5,4 kBit/s ; 2,7 kBit/s
Antenna:	3D coil

Product Service

1.5 EUT Modifications Record

The table below details modifications made to the EUT during the test program.
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	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 momentary signals	Alexander Deese
Periodic operation requirement	Alexander Deese
Radiated Emissions	Alexander Deese
Temperature Stability	Alexander Deese

Office Address:
Äußere Frühlingstraße 45
94315 Straubing
Germany

Product Service

2 Test Details

2.1 Bandwidth of Momentary Signals

2.1.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.231(c)
ISED RSS-210, Clause A.1.4
ISED RSS-Gen, Clause 6.7

2.1.2 Equipment under Test and Modification State

YK2, S/N: --- - Modification State 0

2.1.3 Date of Test

2024-04-03

2.1.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	39 %

2.1.5 Specification Limits

FCC 47 CFR, clause 15.231(c)
The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 dB down from the modulation carrier.

ISED RSS-210 Issue 11, clause A1.4
The occupied bandwidth of the momentary devices shall be less than or equal to 0.25 % of the center frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the occupied bandwidth shall be less than or equal to 0.5 % of the center frequency.

2.1.6 Test Method

The test was performed according to ANSI C63.10, clauses 6.9
See section 2.4.6 of this test report for details.

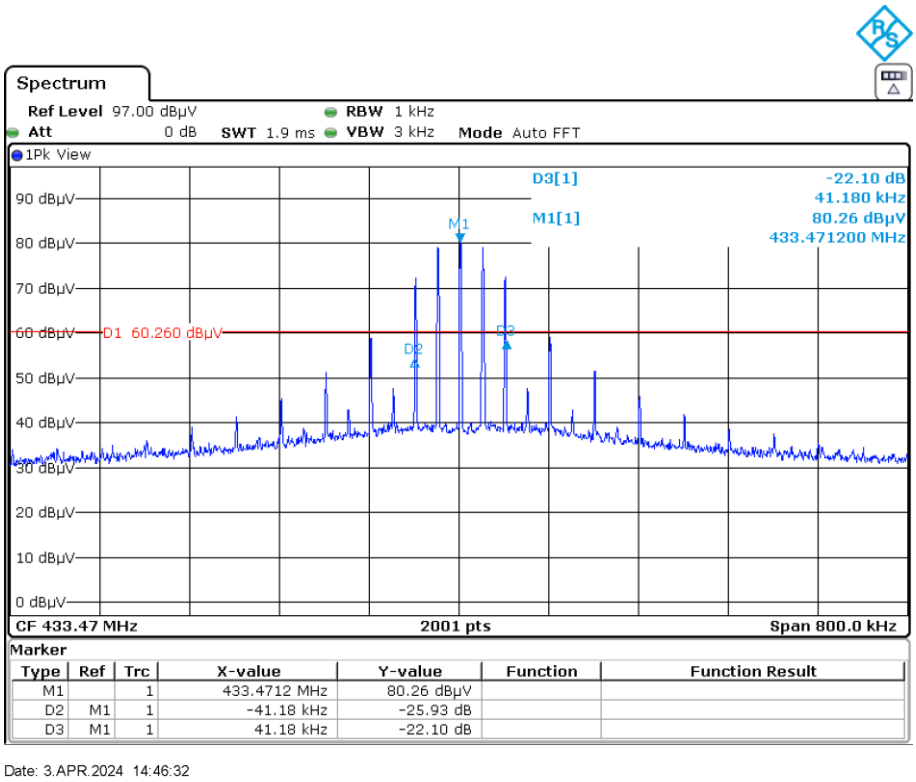
Product Service

2.1.7 Test Results

Transmitting continuously on 433.47 MHz

Center frequency	*20 dB Bandwidth*	*Limit*
433.47 MHz	82.36 kHz	1083.675 kHz

Table 6: 20 dB Bandwidth

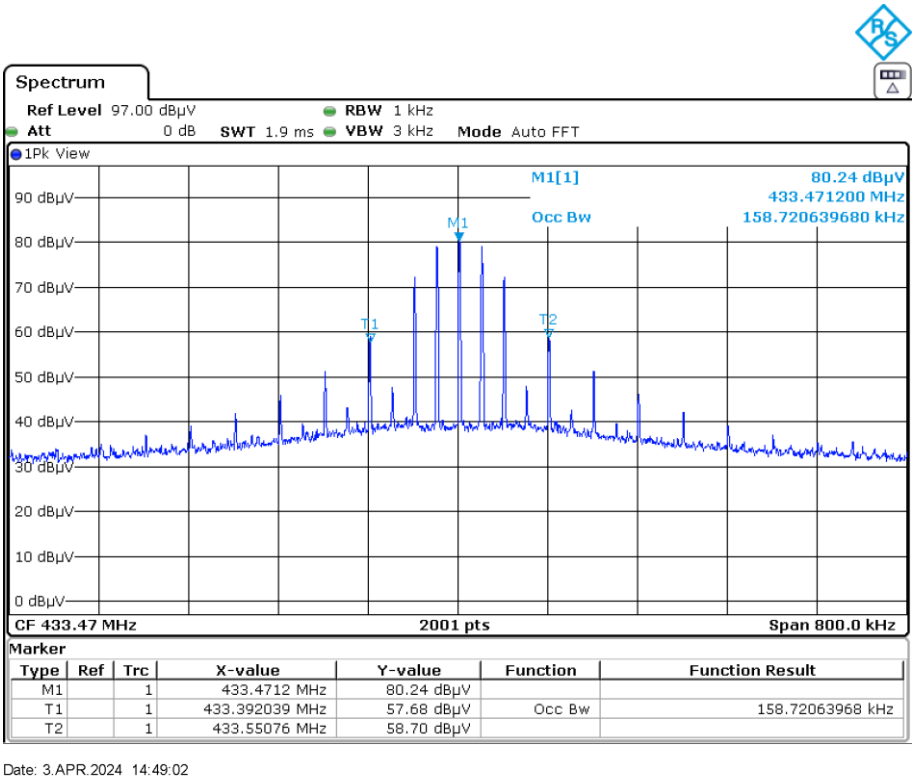


Product Service

Transmitting continuously on 433.47 MHz

Centre Frequency	*99% Bandwidth*	*Limit*
433.47 MHz	158.721 kHz	1083.675 kHz

Table 7: 99% Bandwidth

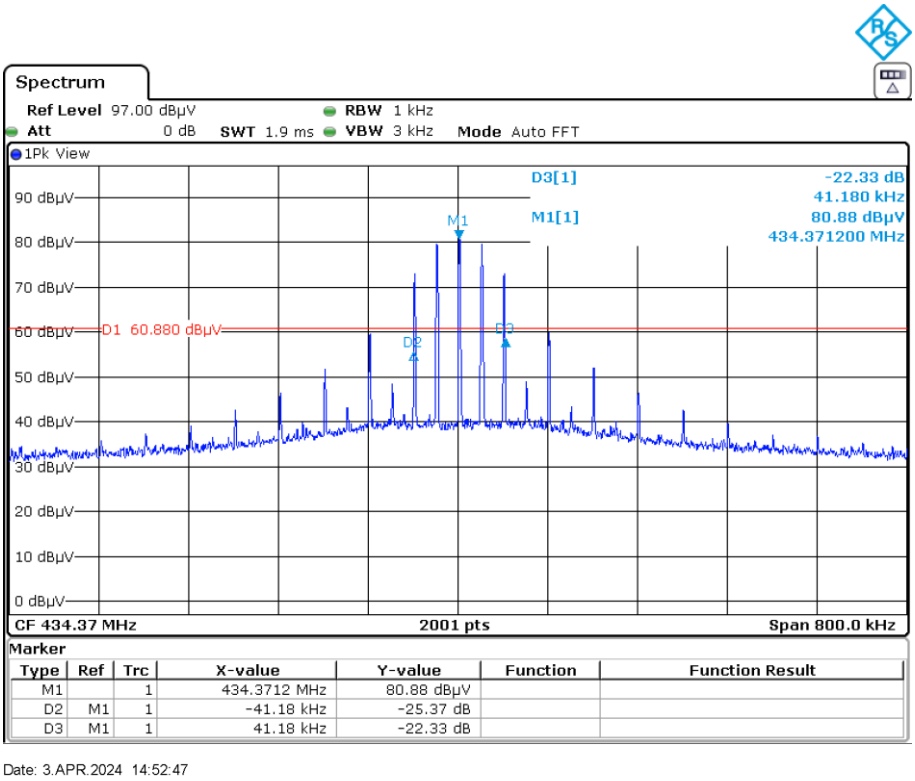


Product Service

Transmitting continuously on 434.37 MHz

Center frequency	*20 dB Bandwidth*	*Limit*
434.37 MHz	82.36 kHz	1085.925 kHz

Table 8: 20 dB Bandwidth

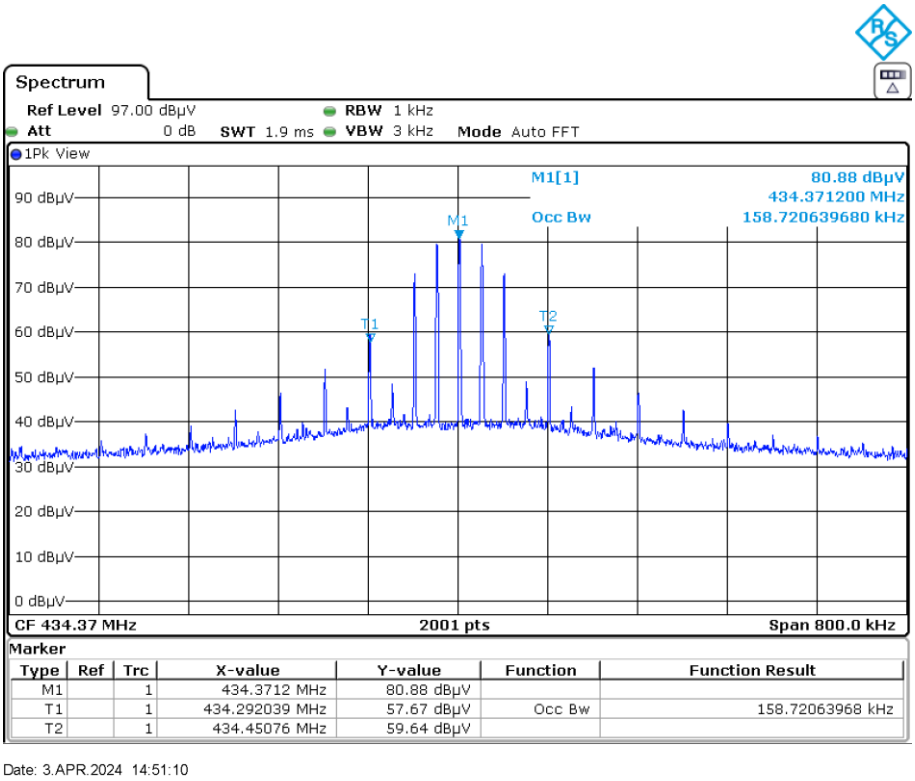


Product Service

Transmitting continuously on 434.37 MHz

Centre Frequency	*99% Bandwidth*	*Limit*
434.37 MHz	158.721 kHz	1085.925 kHz

Table 9: 99% Bandwidth



Product Service

2.1.8 Test Location and Test Equipment

The test was carried out in a non-shielded room:

Instrument	*Manufacturer*	*Type No*	*TE No*	*Calibration Period (months)*	*Calibration Due*
Spectrum and signal analyser	Rohde & Schwarz	FSV40	20219	24	2026-03-31

Table 10

Product Service

2.2 Periodic Operation Requirement

2.2.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.231(a)
ISED RSS-210, Clause A.1.1

2.2.2 Equipment under Test and Modification State

YK2, S/N: --- - Modification State 0

2.2.3 Date of Test

2024-04-04

2.2.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	42 %

2.2.5 Test Method

The test was performed using a spectrum analyzer in zero-span-mode with the frequency set to the center frequency of the transmitter and the resolution bandwidth set to a value greater of the emission bandwidth to cover the full output power of the transmitter. Sweep time and sweep points were set to values given a reasonable resolution of test results.

Center frequency:	434 MHz
RBW:	3 MHz
Sweep time:	10 sec
Sweep points:	2001

Product Service

2.2.6 Specification Limits

FCC 47 CFR 15.231(a) and ISED RSS-210 A1.1

1. A manually operated transmitter shall employ a push-to-operate switch that will automatically de-activate the transmitter within not more than5 s of being released.
2. A transmitter activated automatically shall cease transmission within 5 s after activation.
3. Periodic transmissions at regular predetermined intervals are not permitted (except as defined in FCC 47 CFR 15.231(e) and ISED RSS-210 A1.5). However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour (2 s/h) for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed 2 s/h.
4. Intentional radiators which are employed for radio control purposes during emergencies involving fire, security of goods (e.g. burglar alarms), and safety-of-life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

FCC 47 CFR 15.231(e) and ISED RSS-210 A1.5

In additions, devices operated under these sections shall be capable of automatically limiting their operation so that the duration of each transmission is not greater than 1 s and the silent period between transmission is at least 30 times the duration of the transmission, but not less than 10 s und all circumstances.

Product Service

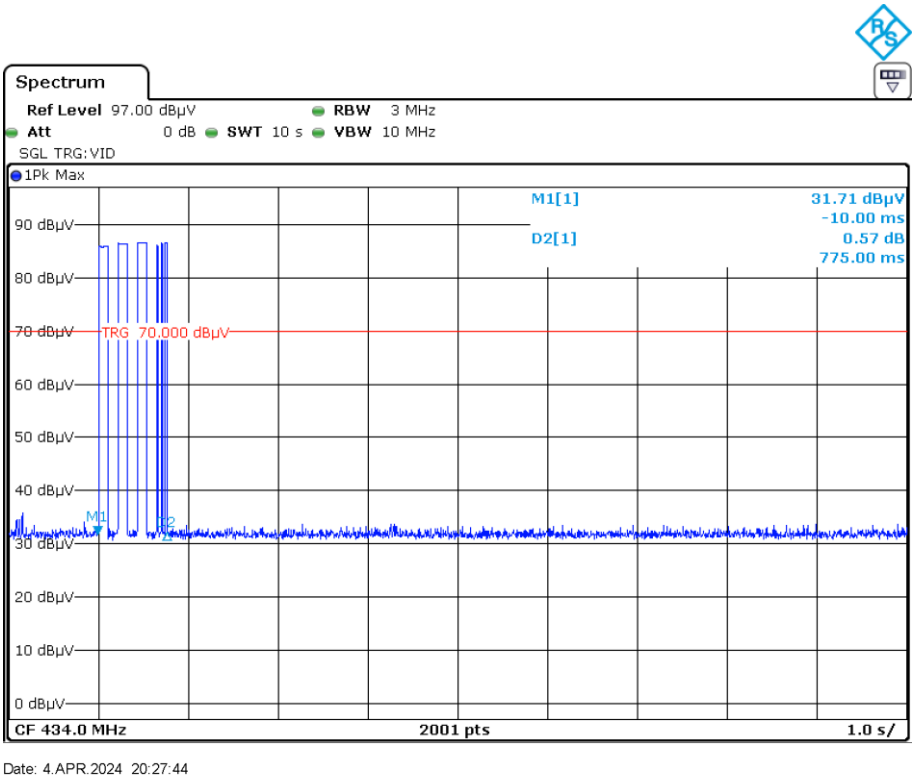
2.2.7 Test Results

General information on transmitter:

The transmitter is used for	
☐ Security or safety applications	☐ Declared by applicant
☒ other applications	☐ Declared by applicant
The transmitter is operated	
☒ manually	☐ Declared by applicant [1]
☐ automatically	☐ Declared by applicant
Periodic operation according to CFR 47 Part 15, clause 15.231(a) ISED RSS-210, Issue 11, section A1.2	
☐ Only control signals are sent and there is no continuous transmission.	☐ Declared by applicant
☐ A manually operated transmitter employs a switch that will automatically deactivate the transmitter within not more than 5 s of being released.	☐ Test performed ☐ Passed
☒ A transmitter activated automatically ceased transmission within 5 s after activation	☒ Test performed ☒ Passed
☐ Periodic transmissions at regular predetermined intervals are:	
☐ not performed	☐ Declared by applicant
☐ performed with total time of two seconds per hour or less (for polling or supervision transmissions to determine system integrity of transmitters used in security or safety applications)	☐ Declared by applicant ☐ Test performed ☐ Passed

[1] Please refer to external photos in annex for details.

Product Service



Result: transmission stopped after 0.775 s

Product Service

2.2.8 Test Location and Test Equipment

The test was carried out in a non-shielded room:

Instrument	*Manufacturer*	*Type No*	*TE No*	*Calibration Period (months)*	*Calibration Due*
Spectrum and signal analyser	Rohde & Schwarz	FSV40	20219	24	2026-03-31

Table 11

Product Service

2.3 Temperature Stability

2.3.1 Specification Reference

ISED RSS-Gen, Clause 6.11, 8.11

2.3.2 Equipment under Test and Modification State

YK2, S/N: --- - Modification State 0

2.3.3 Date of Test

2024-04-03 to 2024-04-04

2.3.4 Environmental Conditions

Ambient Temperature	21 °C
Relative Humidity	40 %

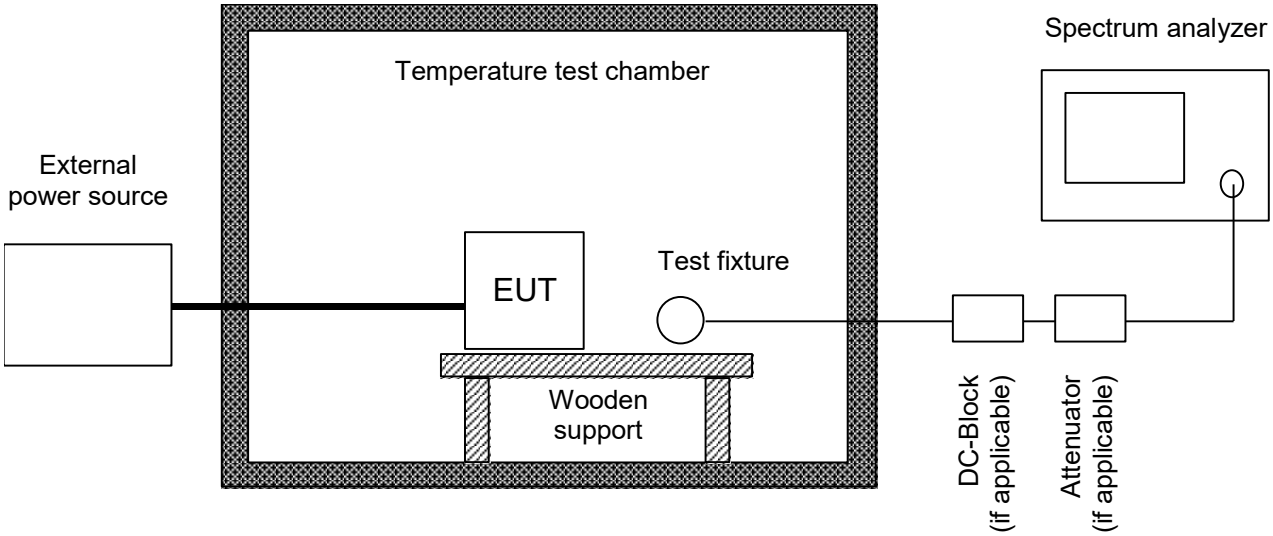
2.3.5 Specification Limits

If the stability of the license-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80 % of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In additions, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 85 MHz – 72 MHz, 76 MHz – 88 MHz, 174 MHz – 216 MHz, and 470 MHz – 602 MHz, unless otherwise indicated.

Product Service

2.3.6 Test Method

The test was performed according to ANSI C63.10, section 6.8.



The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rates supply voltage at a temperature of 20 °C. Temperature and voltage range may vary if the manufacturer states another temperature or voltage range.
If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as a DC block and appropriate (50 Ω) attenuators. In case where the EUT does not provide an antenna connector or a test fixture is used.
For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:

- The maximum battery voltage as delivered by a new battery or 115 % of the battery nominal voltage;
- The battery nominal voltage
- 85 % of the battery nominal voltage
- The battery operating end point voltage which shall be specified by the equipment manufacturer.

The EUT is operating providing an unmodulated carrier for frequency error tests. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point of the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1 % of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance is larger than the uncertainty of the measured frequency tolerance.

Product Service

2.3.7 Test Results

Transmitting continuously on 433.47 MHz

Temperature	*Supply Voltage*	*Tested Centre Frequency*	*Frequency drift*
-20 °C	3.0 V	433.4732	20 kHz
-10 °C	3.0 V	433.4744	32 kHz
0 °C	3.0 V	433.4744	32 kHz
10 °C	3.0 V	433.4736	24 kHz
20 °C	3.0 V	433.4712	0
20°C	2.2 V	433.4712	0
20 °C	3.3 V	433.4712	0
30 °C	3.0 V	433.4700	-12 kHz
40 °C	3.0 V	433.4684	-28 kHz
50 °C	3.0 V	433.4664	-48 kHz
60 °C	3.0 V	433.4648	-64 kHz
70 °C	3.0 V	433.4636	-76 kHz

Table 12

Transmitting continuously on 434.37 MHz

Temperature	*Supply Voltage*	*Tested Centre Frequency*	*Frequency drift*
-20 °C	3.0 V	434.3724	12 kHz
-10 °C	3.0 V	434.3740	28 kHz
0 °C	3.0 V	434.3744	32 kHz
10 °C	3.0 V	434.3736	24 kHz
20 °C	3.0 V	434.3712	0
20°C	2.2 V	434.3712	0
20 °C	3.3 V	434.3712	0
30 °C	3.0 V	434.3700	-12 kHz
40 °C	3.0 V	434.3680	-32 kHz
50 °C	3.0 V	434.3660	-52 kHz
60 °C	3.0 V	434.3644	-68 kHz
70 °C	3.0 V	434.3636	-76 kHz

Table 13

Product Service

2.3.8 Test Location and Test Equipment

The test was carried out in a non-shielded room:

Instrument	*Manufacturer*	*Type No*	*TE No*	*Calibration Period (months)*	*Calibration Due*
Spectrum and signal analyser	Rohde & Schwarz	FSV40	20219	24	2026-03-31
Climatic test chamber	Feutron	KPK200-2	19868	18	2024-08-31

Table 14

Product Service

2.4 Radiated emissions

2.4.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.205, 15.209 and 15.231(a)
ISED RSS-210, Clause A.1.1
ISED RSS-Gen, Clauses 8.9 and 8.10

2.4.2 Equipment under Test and Modification State

YK2, S/N: --- - Modification State 0

2.4.3 Date of Test

2024-04-02

2.4.4 Environmental Conditions

Ambient Temperature	20 °C
Relative Humidity	42 %

Product Service

2.4.5 Specification Limits

General radiated emission limits:					
Frequency Range	*Test distance*	*Field strength*		*Field strength*	
(MHz)	*(m)*	*(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
above 960	3	--	---	500	54
Note 1: *f* in kHz					

Table 15 General radiated emission limits

FCC 47 CFR Part 15 C, Clause 15.231(a); ISED RSS-210, Clause A.1.1

Frequency Range	*Field strength of fundamental*		*Field strength of spurious emissions*	
(MHz)	*(µV/m)*	*(dBµV/m)*	*(µV/m)*	*(dBµV/m)*
40.66 – 40.70	2500	67.96	225	47.96
70 – 130	1250	61.94	125	41.94
130 – 174	1250 – 3750 *	61.94 – 71.48 *	125 – 375 *	41.94 – 51.48 *
174 – 260	3750	71.48	375	51.48
260 – 470	3750 – 12500 *	71.48 – 81.94 *	375 – 1250 *	51.48 – 61.94 *
Above 470	12500	81.94	1250	61.94

* linear interpolation

The above field strength limits are specified at a distance of 3 m. The tighter limits apply at the band edges.

Intentional radiators shall demonstrate compliance with the limits above based on the (linear) average value of the measured emissions. As an alternative, compliance with these limits may be based on the use of measurement instrumentations with a CISPR quasi-peak detector. If average emission measurements are employed, the provisions for averaging pulsed emissions and for limiting peak emissions apply.

The limits on the field strength of the spurious emissions in the table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or alternatively, CISPR quasi-peak) limits shown in this table or to the general spurious emission limits, whichever limit permits a higher field strength.

Product Service

FCC 47 CFR Part 15 C, Clause 15.231(e); ISED RSS-210, Clause A.1.4

Frequency Range	*Field strength of fundamental*		*Field strength of spurious emissions*	
(MHz)	*(µV/m)*	*(dBµV/m)*	*(µV/m)*	*(dBµV/m)*
40.66 – 40.70	1000	60	100	40
70 – 130	500	53.98	50	33.98
130 – 174	500 – 1500 *	53.98 – 63.52 *	50 – 150 *	33.98 – 43.52
174 – 260	1500	63.52	150	43.52
260 – 470	1500 – 5000 *	63.52 – 73.98 *	150 – 500 *	43.52 – 53.98
Above 470	5000	73.98	500	53.98

* linear interpolation

The above field strength limits are specified at a distance of 3 m. The tighter limits apply at the band edges.

Intentional radiators shall demonstrate compliance with the limits above based on the (linear) average value of the measured emissions. As an alternative, compliance with these limits may be based on the use of measurement instrumentations with a CISPR quasi-peak detector. If average emission measurements are employed, the provisions for averaging pulsed emissions and for limiting peak emissions apply.

The limits on the field strength of the spurious emissions in the table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or alternatively, CISPR quasi-peak) limits shown in this table or to the general spurious emission limits, whichever limit permits a higher field strength.

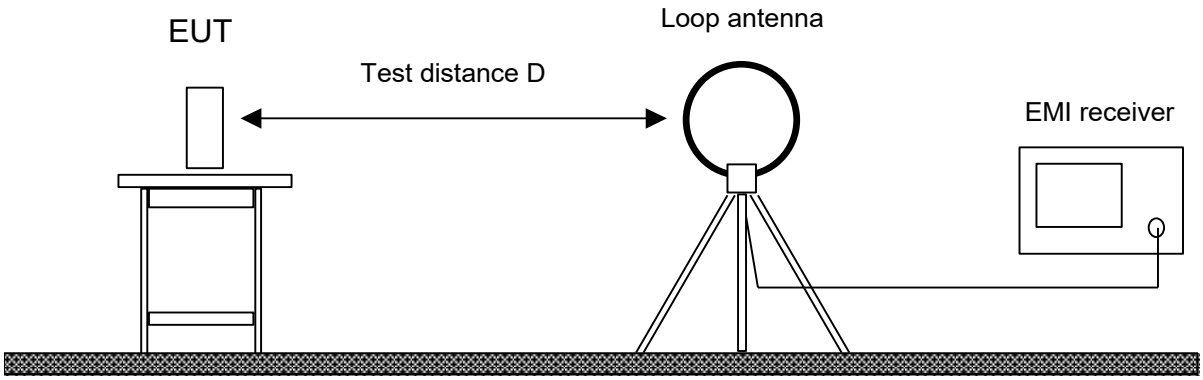
Product Service

2.4.6 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.

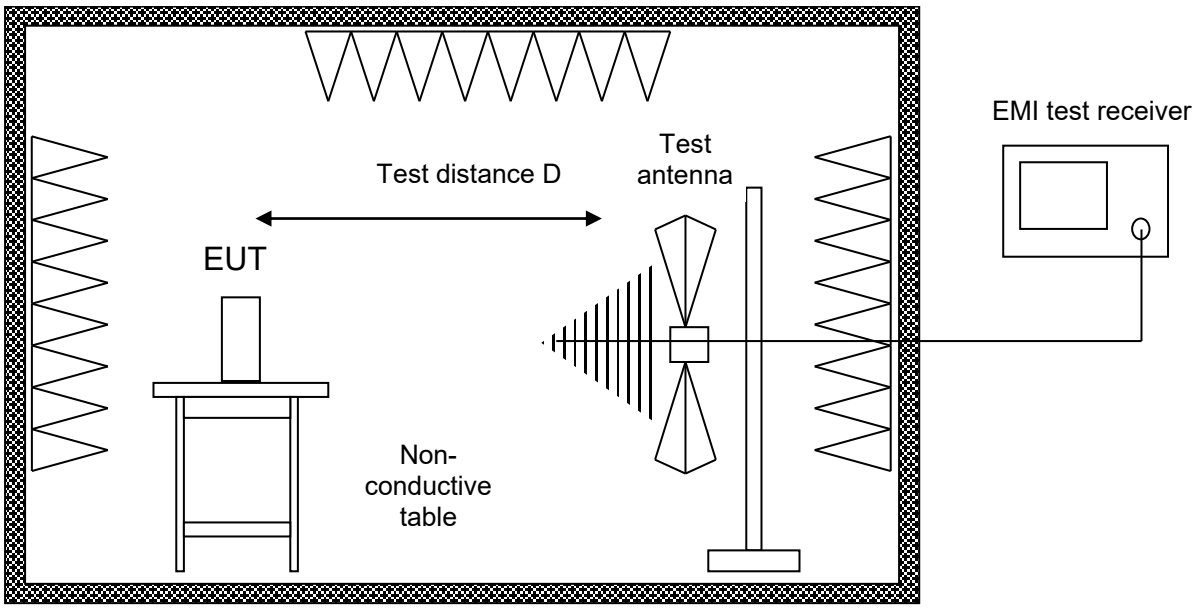
2.4.6.1 Frequency range 9 kHz – 30 MHz



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.

Product Service

2.4.6.2 Frequency range 30 MHz – 1 GHz

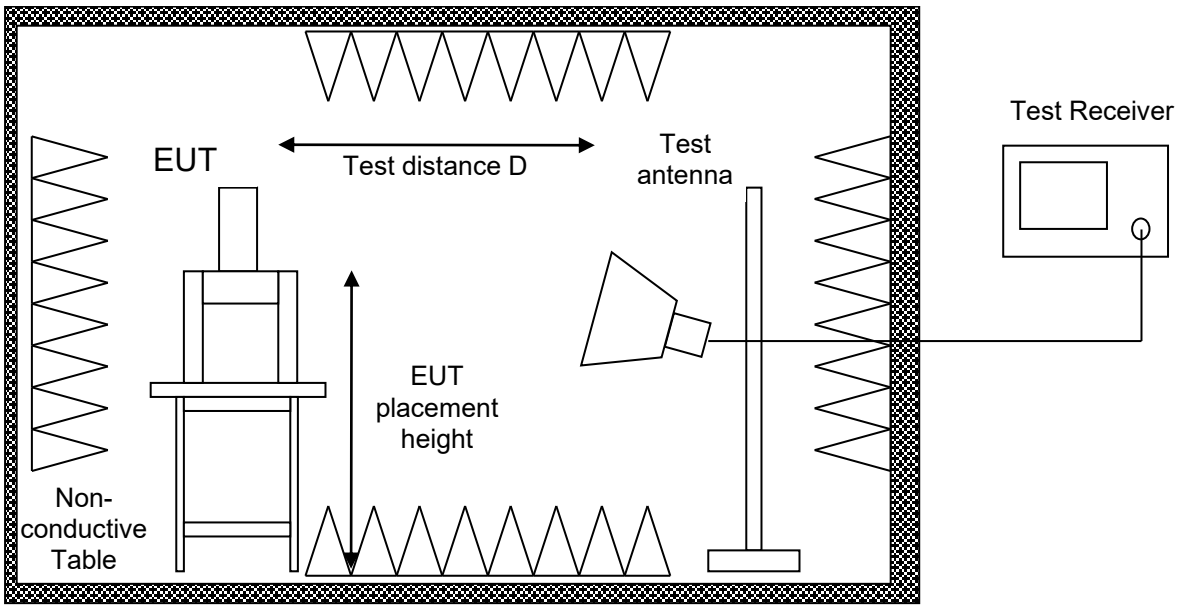


Alternate test site (semi anechoic room)

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.

Product Service

2.4.6.3 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.

Product Service

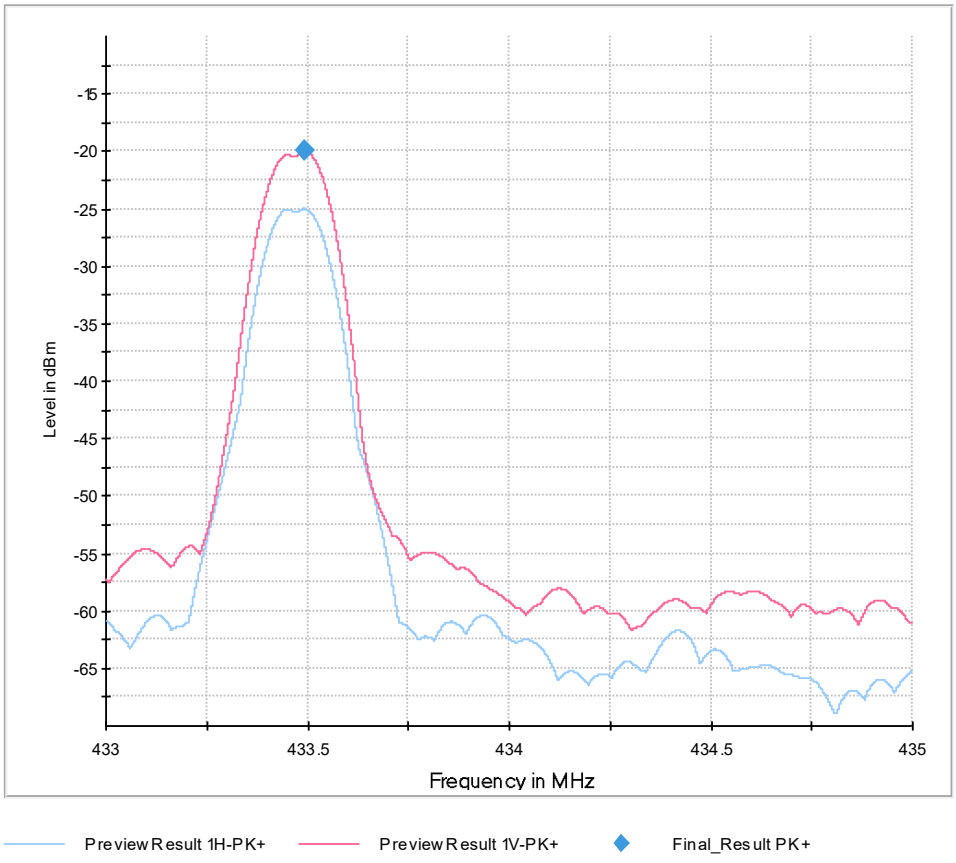
2.4.7 Test Results

Sample calculation:

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

Transmitting continuously on 433.47 MHz - Preliminary pre-scans for the worst-case orientation

x axis

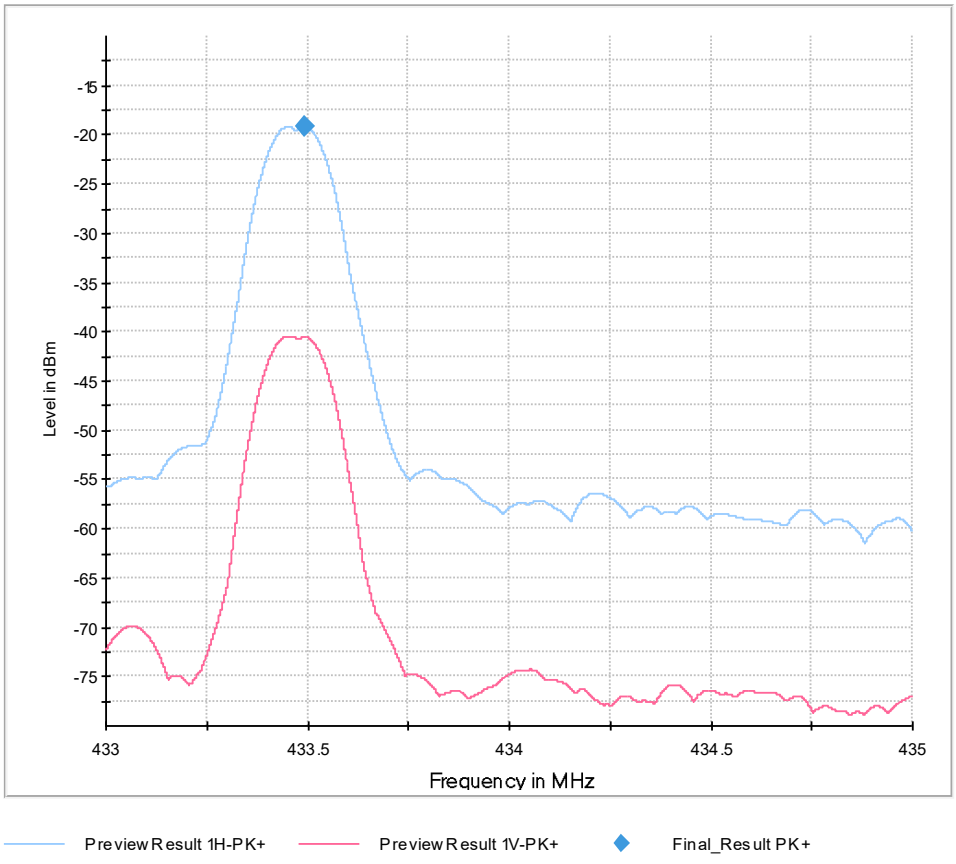


Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
433.493200	-20.03	2.5	100.000	150.0	V	84.0	-80

Product Service

y axis



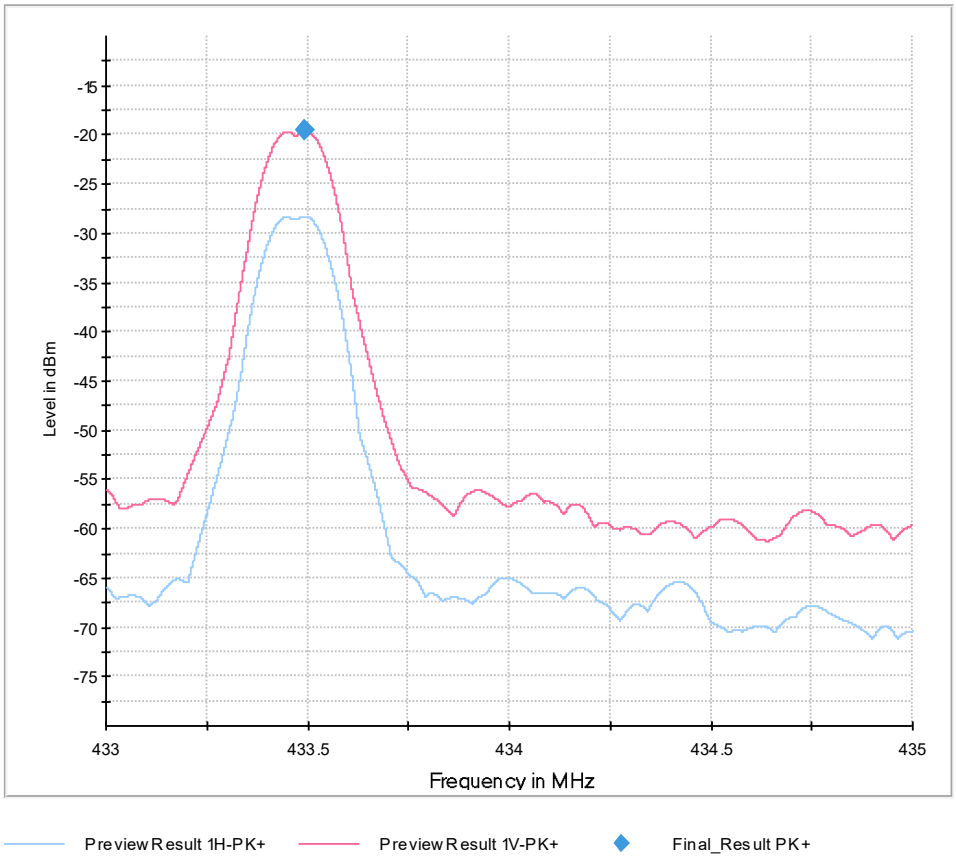
Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
433.491600	-19.17	2.5	100.000	150.0	H	313.0	-81

➔ Worst case orientation is y axis

Product Service

z axis



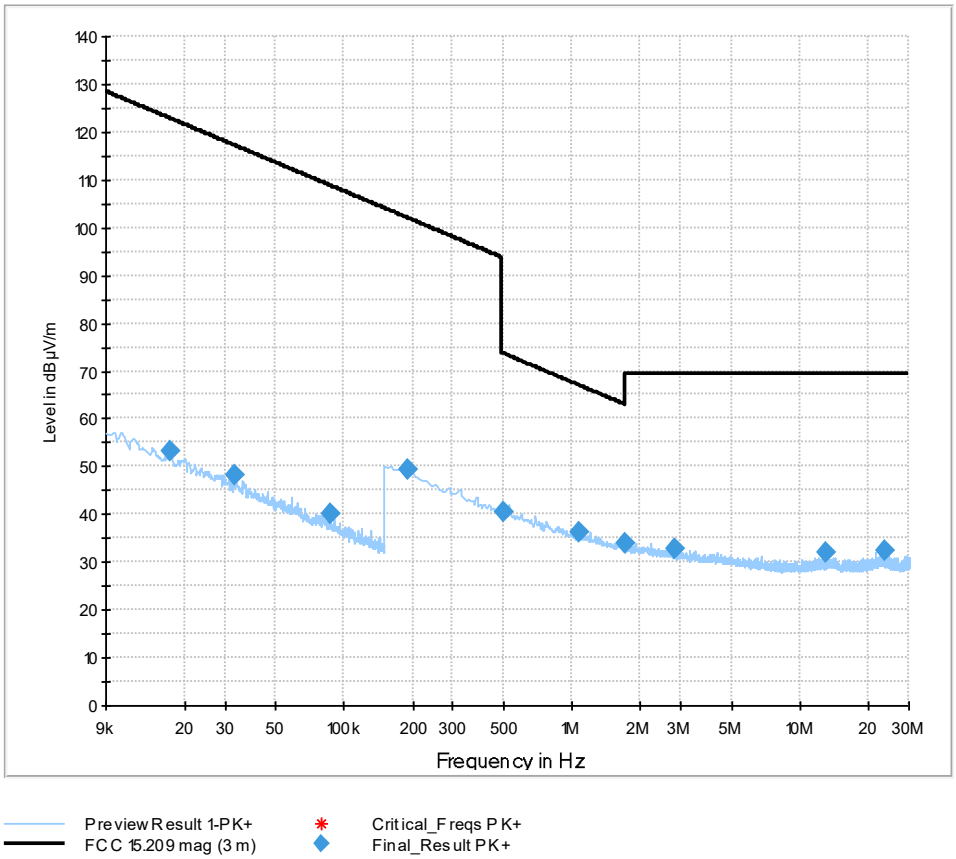
Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
433.494700	-19.64	2.5	100.000	150.0	V	262.0	-80

Product Service

Transmitting continuously on 433.47 MHz – final measurement in y axis

Frequency range 9 kHz – 30 MHz:

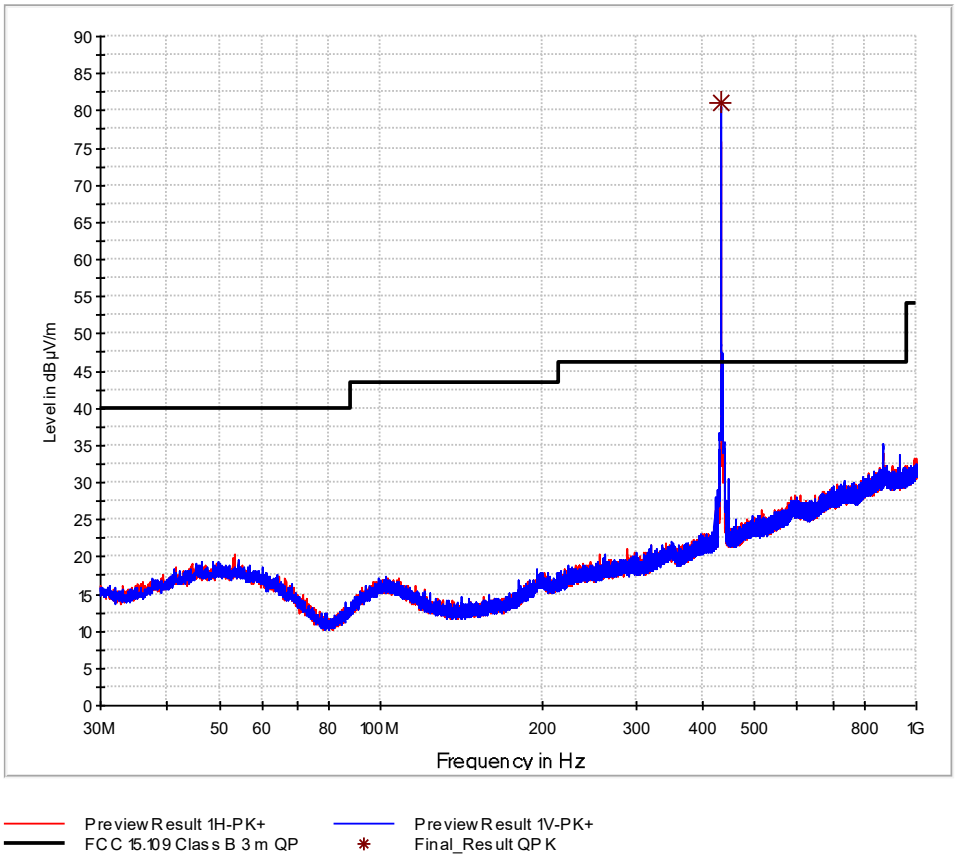


Final Results:

Frequency MHz	*MaxPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Pol*	*Azimuth deg*	*Corr. dB/m*
0.017319	53.06	122.82	69.76	10.0	0.300	H	212.0	20
0.032829	48.25	117.27	69.02	10.0	0.300	V	60.0	20
0.087255	40.06	108.78	68.72	10.0	0.300	V	214.0	20
0.189800	49.46	102.03	52.57	10.0	10.000	H	258.0	20
0.498250	40.69	73.66	32.97	10.0	10.000	V	224.0	20
1.070375	36.23	67.03	30.81	10.0	10.000	V	339.0	20
1.702200	34.05	63.01	28.96	10.0	10.000	H	56.0	20
2.806650	32.77	69.50	36.73	10.0	10.000	H	307.0	20
13.005400	31.95	69.50	37.55	10.0	10.000	H	333.0	20
23.651900	32.40	69.50	37.10	10.0	10.000	H	60.0	20

Product Service

Frequency range 30 MHz – 1 GHz:

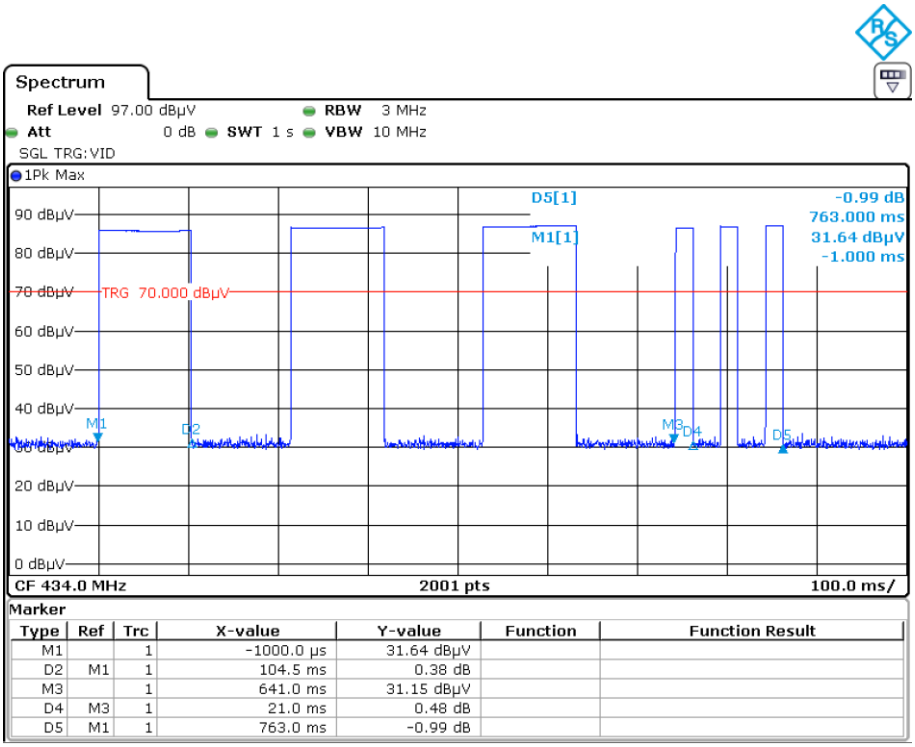


Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
433.500000	75.03*	80.81	5.78	1000.0	120.000	119.0	V	-88.0	22.0

*: Final Value of 75.03 dBµV/m derived after applying correction factor (see next page).

Product Service

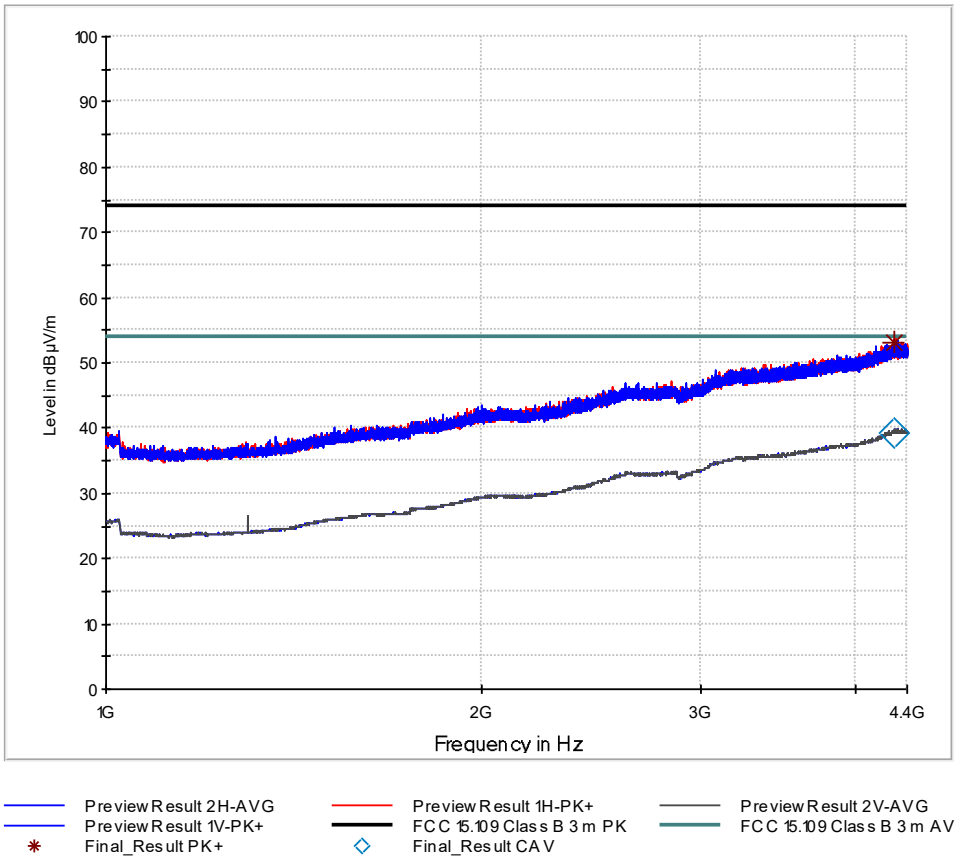


Date: 4.APR.2024 20:37:16

Correction factor = 20 log(3 * (104.5 ms + 21 ms) / 763 ms) dB = -6.13 dB

Product Service

Frequency range 1 GHz – 4.4 GHz:



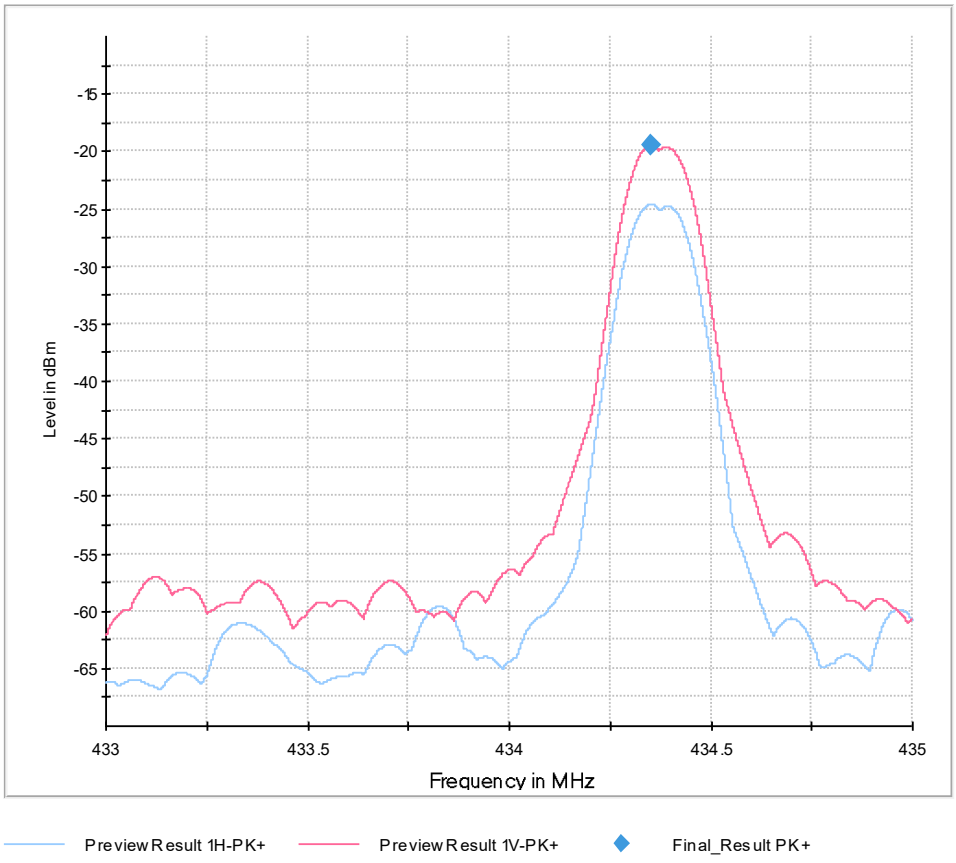
Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB*
4299.750000	---	39.27	53.98	14.71	1000.0	1000.000	143.0	H	23.0	40.5
4299.750000	53.03	---	73.97	20.94	1000.0	1000.000	143.0	H	23.0	40.5

Product Service

Transmitting continuously on 434.37 MHz - Preliminary pre-scans for the worst-case orientation

x axis

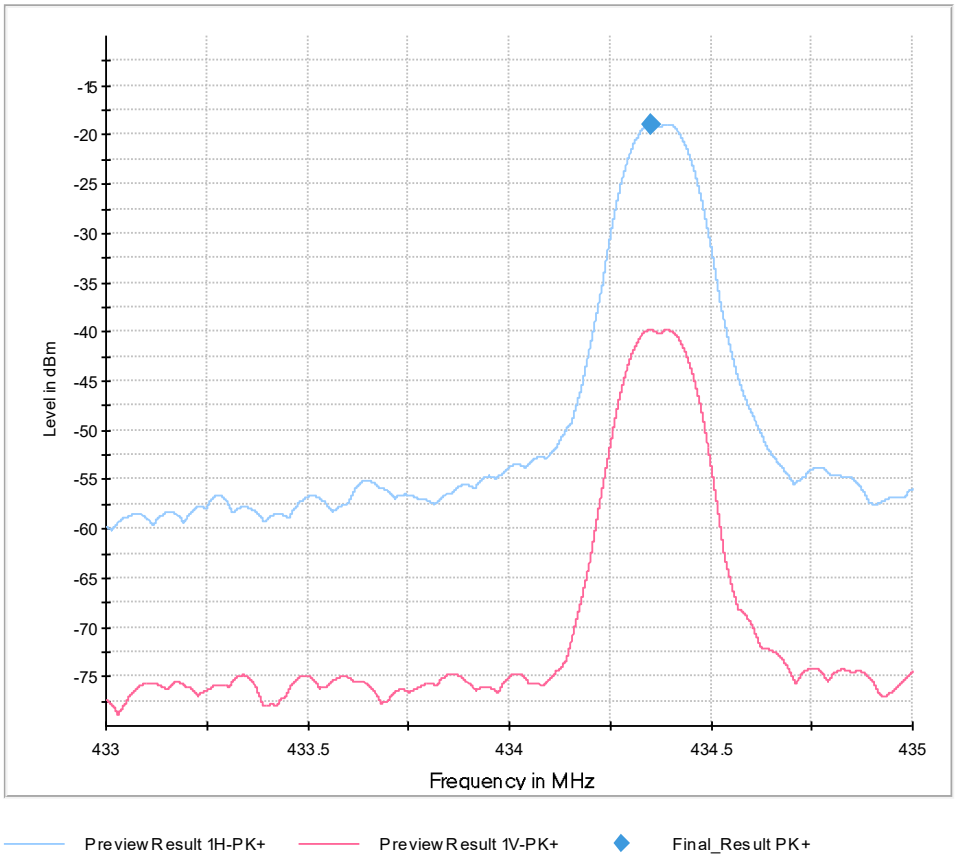


Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
434.350900	-19.46	2.5	100.000	150.0	V	79.0	-80

Product Service

y axis



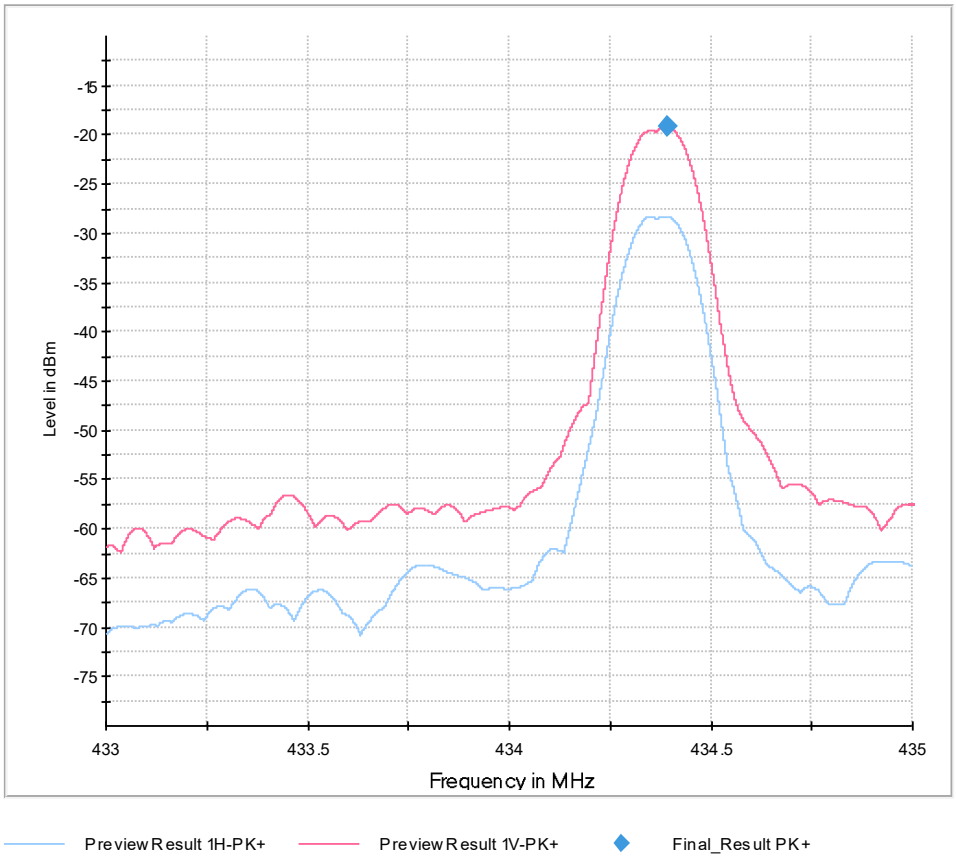
Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
434.351400	-18.90	2.5	100.000	150.0	H	323.0	-81

➔ Worst case orientation is y axis

Product Service

z axis



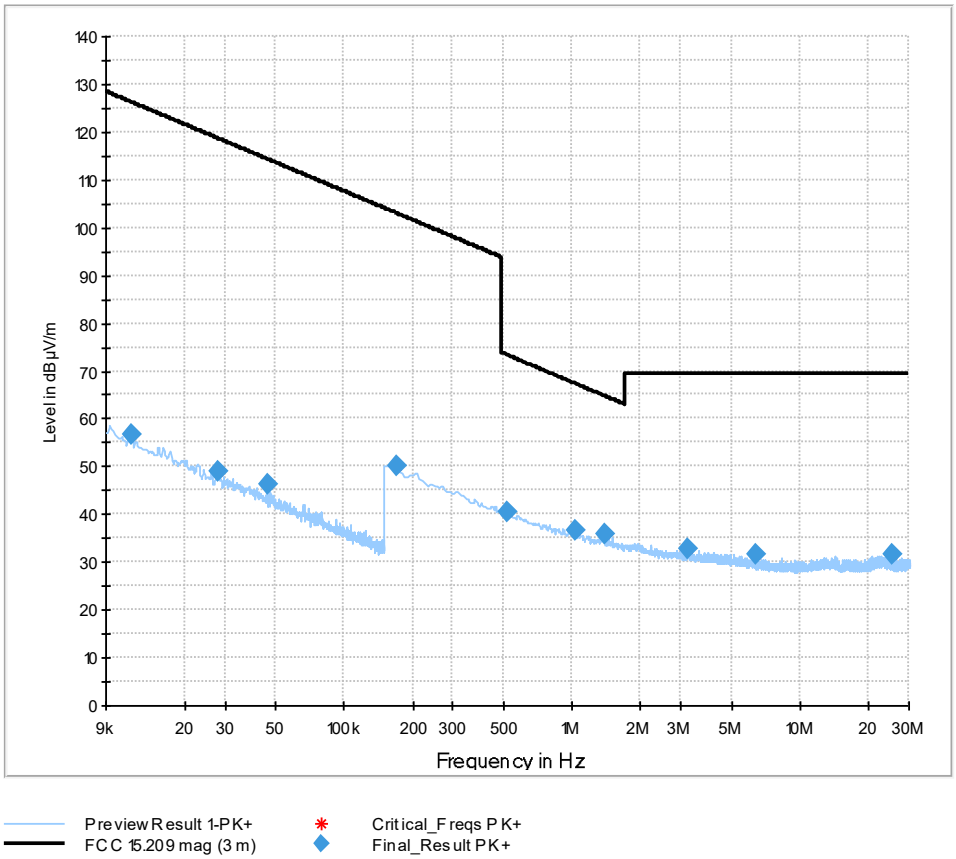
Final Results:

Frequency MHz	*MaxPeak dBm*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
434.391200	-19.23	2.5	100.000	150.0	V	262.0	-80

Product Service

Transmitting continuously on 434.37 MHz – final measurement in y axis

Frequency range 9 kHz – 30 MHz:

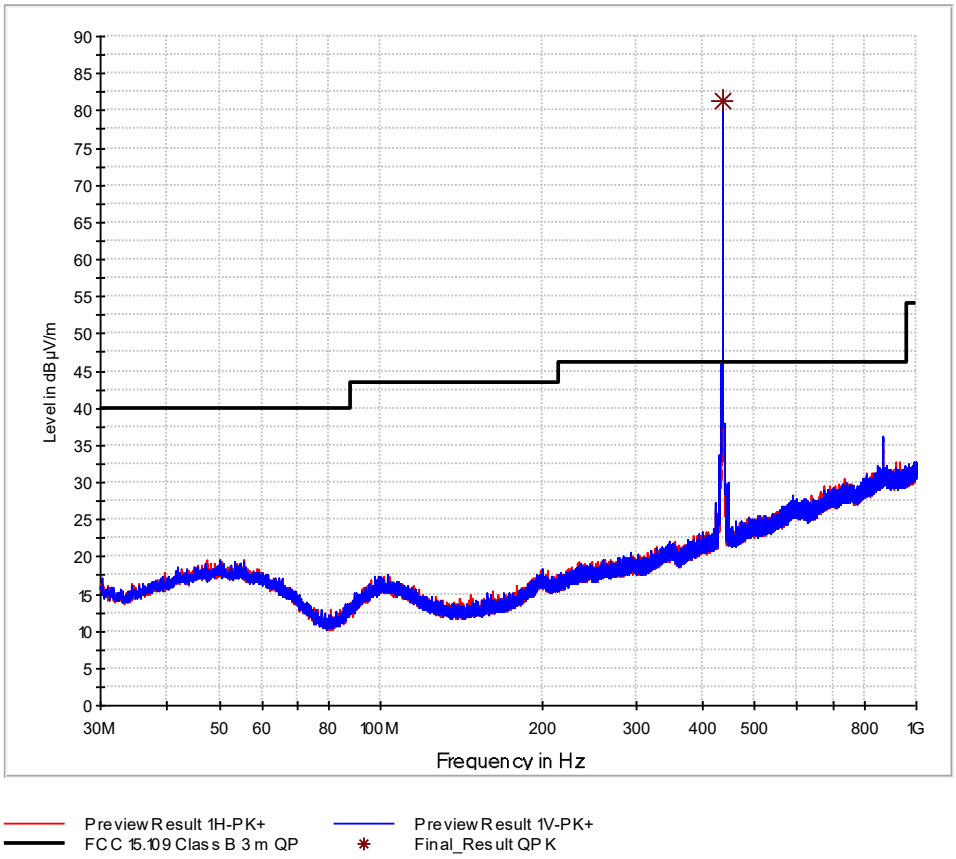


Final Results:

Frequency MHz	*MaxPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Pol*	*Azimuth deg*	*Corr. dB*
0.011679	56.85	126.24	69.39	10.0	0.300	H	84.0	20.2
0.027753	49.11	118.72	69.62	10.0	0.300	V	120.0	19.7
0.046083	46.11	114.32	68.21	10.0	0.300	H	102.0	19.6
0.169900	50.28	103.00	52.72	10.0	10.000	H	346.0	20.0
0.518150	40.57	73.32	32.75	10.0	10.000	H	231.0	20.0
1.030575	36.67	67.36	30.69	10.0	10.000	V	211.0	20.0
1.388775	36.04	64.78	28.73	10.0	10.000	V	332.0	20.1
3.224550	32.80	69.50	36.70	10.0	10.000	H	174.0	20.1
6.363775	31.61	69.50	37.89	10.0	10.000	H	63.0	20.1
25.517525	31.70	69.50	37.80	10.0	10.000	V	253.0	20.4

Product Service

Frequency range 30 MHz – 1 GHz:

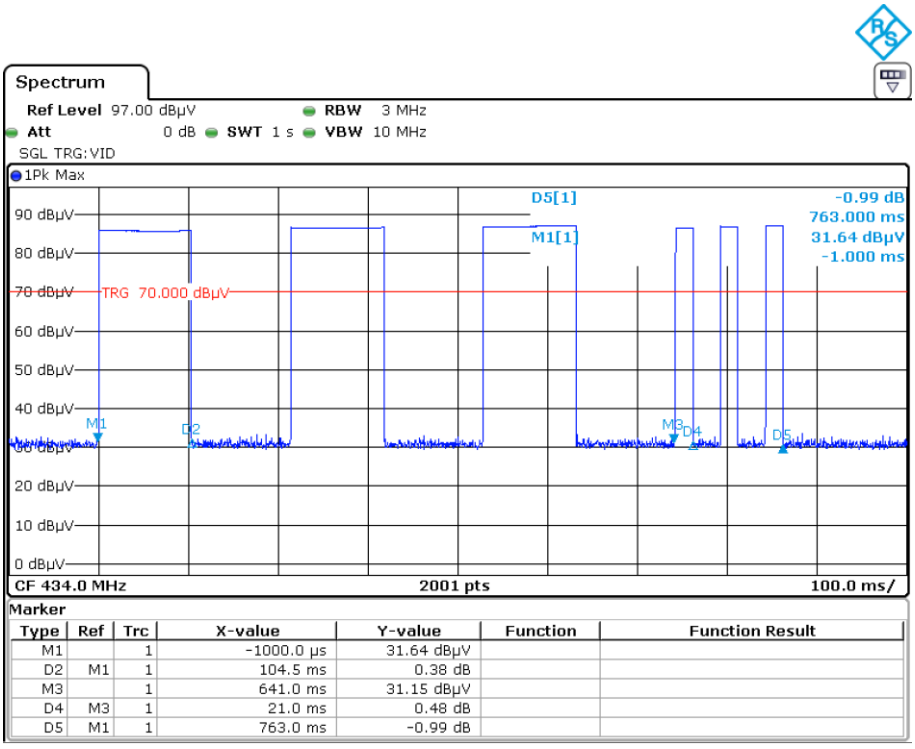


Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
434.400000	75.27*	80.81	5.54	1000.0	120.000	121.0	V	-87.0	22.0

*: Final Value of 75.27 dBµV/m derived after applying correction factor (see next page).

Product Service



Marker

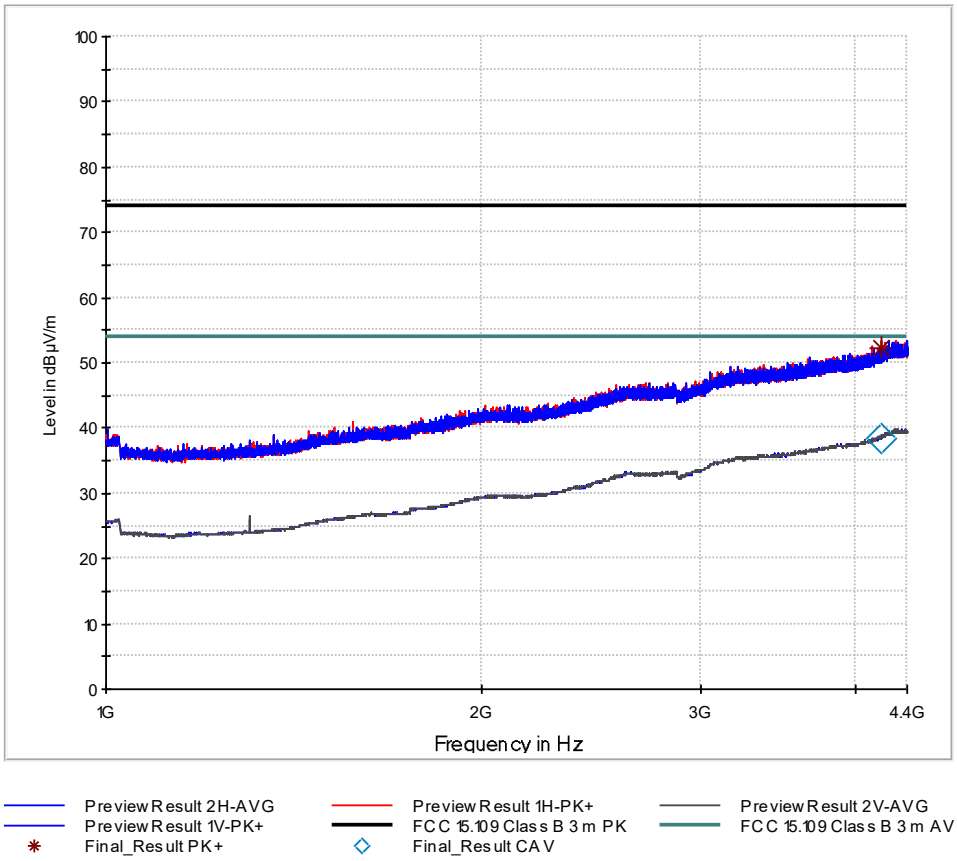
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	-1000.0 µs	31.64 dBµV		
D2	M1	1	104.5 ms	0.38 dB		
M3		1	641.0 ms	31.15 dBµV		
D4	M3	1	21.0 ms	0.48 dB		
D5	M1	1	763.0 ms	-0.99 dB		

Date: 4.APR.2024 20:37:16

Correction factor = 20 log(3 * (104.5 ms + 21 ms) / 763 ms) dB = -6.13 dB

Product Service

Frequency range 1 GHz – 4.4 GHz:



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
4198.000000	---	38.54	53.98	15.44	1000.0	1000.000	195.0	H	-30.0	40.0
4198.000000	52.21	---	73.97	21.76	1000.0	1000.000	195.0	H	-30.0	40.0

Product Service

2.4.8 Test Location and Test Equipment

The test was carried out in Semi anechoic room - cabin no. 8

Instrument	*Manufacturer*	*Type No*	*TE No*	*Calibration Period (months)*	*Calibration Due*
EMI test receiver	Rohde & Schwarz	ESR7	61814	12	2024-06-30
Loop antenna	Schwarzbeck	FMZB 1519 B	44334	36	2026-06-30
TRILOG Broadband Antenna	Rohde & Schwarz	VULB 9162	20116	36	2025-01-31
Double ridged horn antenna	Rohde & Schwarz	HF907	19933	24	2025-09-30
EMC measurement software	Rohde & Schwarz	EMC32 Emis-sion K8 - V10.60.20	19927	---	---
Semi Anechoic Room	Albatross	Cabin No. 8	19917	36	2025-07-31

Table 16

Product Service

3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 (U_{CISPR}). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Conducted Voltage Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB
Discontinuous Conducted Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
Conducted Current Emission		
9 kHz to 200 MHz	2	± 3.5 dB
Magnetic Fieldstrength		
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB
Radiated Emission		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 5.0 dB
1 GHz to 6 GHz	2	± 4.6 dB
Test distance 10 m		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 4.9 dB
The expanded uncertainty reported according to to CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 17 Measurement uncertainty based on CISPR 16-4-2

Product Service

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Occupied Bandwdith	2	± 5 %
Conducted Power		
9 kHz ≤ f < 30 MHz	2	± 1.0 dB
30 MHz ≤ f < 1 GHz	2	± 1.5 dB
1 GHz ≤ f ≤ 40 GHz	2	± 2.5 dB
1 MS/s power sensor (TS8997)	2	± 1.5 dB
Occupied Bandwidth	2	± 5 %
Power Spectral Density	2	± 3.0 dB
Radiated Power		
9 kHz ≤ f < 26.5 GHz	2	± 5.6 dB
26.5 GHz ≤ f < 60 GHz	2	± 8.0 dB
60 GHz ≤ f < 325 GHz	2	± 10 dB
Conducted Spurious Emissions	2	± 3.0 dB
Radiated Spurious Emissions	2	± 6.0 dB
Voltage		
DC	2	± 1.0 %
AC	2	± 2.0 %
Time (automatic)	2	± 5 %
Frequency	2	± 10^{-7}
The expanded uncertainty reported according to to ETSI TR 100 028:2001 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 18 Measurement uncertainty based on ETSI TR 100 028