Report on the IC Testing of the IEE S.A.

Model: VitaSense1.5

In accordance with CFR 47, Part 15, Subpart C

Prepared for: IEE S.A.
1, rue du Campus
L-7795 Bissen
Luxembourg

FCC ID: NSZVITA015
IC: 3019A-VITA015

Product Service

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Date: 2024-02-15
Document Number: TR-713301683-07 | Revision 0

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alex Fink	2024-02-15	SIGN-ID 883674
Authorised Signatory	Matthias Stumpe	2024-02-15	SIGN-ID 883705

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

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15, Subpart C. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alex Fink	2024-02-15	SIGN-ID 883674

Laboratory Accreditation
DAkkS Reg. No. D-PL-11321-11-03
DAkkS Reg. No. D-PL-11321-11-04

Laboratory recognition
Registration No. BNetzA-CAB-16/21-15

ISED Canada test site registration
3050A-2

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15, Subpart C, §15.255 (2018) and KDB 364244 D01 Meas 15.255 Radars v01.

Bundesnetzagentur
BNetzA-CAB-16/21-15

Trade Register Munich
HRB 85742
VAT ID No. DE129484267
Information pursuant to Section 2(1)
DL-InfoV (Germany) at
www.tuev-sued.com/imprint

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Summary

Prüfergebnisse / *Test Results*	Auftragsnummer / *Order No.* **2305238405**

Die Prüfungen wurden nach folgenden Vorschriften durchgeführt:
Tests were performed according to:
CFR 47, Part 15, Subpart C, §15.255
KDB 364244 D01 Meas 15.255 Radars v01

Durchgeführte Prüfung ***Test performed***	**Prüfergebnis** ***Test result***			
	Erfüllt *Passed*	Nicht erfüllt *Not Passed*	Nicht zutreffend *Not applicable*	Nicht durchgeführt *Not performed*
Power Density	☒	☐	☐	☐
Occupied Bandwidth	☒	☐	☐	☐
Spurious Radiated Emissions	☒	☐	☐	☐
Frequency Stability	☒	☐	☐	☐
Duty Cycle	☒	☐	☐	☐

Bemerkungen / *Remarks:*

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1 Administrative Data

Application details	
Applicant:	IEE S.A. 1, rue du Campus L-7795 Bissen Luxembourg
Contact person:	Mr. Johann Bar
Order number:	2305238405
Receipt of EUT:	2023-07-19
Return of EUT:	---
Date(s) of test:	2023-08-07 to 2023-10-27
Note(s):	---
Responsible for testing:	Mr. Alex Fink
Responsible for test report:	Mr. Alex Fink
Test report checked by:	Mr. Matthias Stumpe

Report details	
Report number:	TR-713301683-07
Revision:	0
Issue date:	2024-02-15

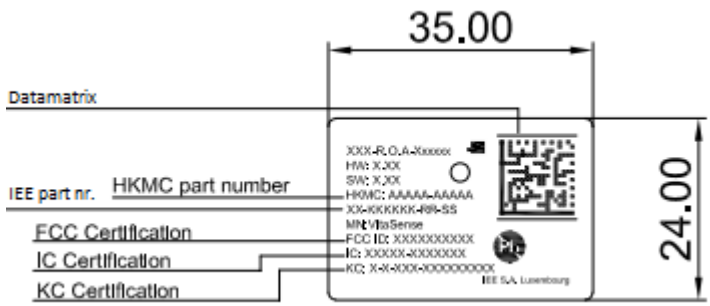
2 Details about the Test Laboratory

Details about the Test Laboratory	
Company name:	TÜV SÜD Product Service GmbH
Address:	Äußere Frühlingstraße 45 D-94315 Straubing Germany
Laboratory accreditation:	DAkkS Registration No. D-PL-11321-11-03 DAkkS Registration No. D-PL-11321-11-04
Laboratory recognition:	Registration No. BNetzA-CAB-16/21-15
Industry Canada test site registration:	3050A-2
Contact:	Mr. Markus Biberger Phone: +49 9421 5682-0 Fax: +49 9421 5682-199

3 Description of the Equipment Under Test

Equipment characteristics	
Type designation:	VitaSense1.5
Parts of the system:	Main device: radar sensor
Options and accessories:	---
Type of equipment:	Automotive in-cabin radar sensor
Serial number:	02
HVIN:	A.00
Manufacturer:	IEE S.A.
Power supply:	Battery supply (regulated lead-acid) Nominal: 12.0 V Minimum: 9 V Maximum: 16 V Nominal frequency: 0 Hz (DC)
Highest internal frequency:	64 GHz for Radar
Version of EUT:	---

Marking Plate



4 Operation Mode and Configuration of EUT

Operation Mode(s)
Frequency Modulated Continuous Wave (FMCW)

List of ports and cables

No.	*Description*	*Classification*[1]	*Cable type*	*Cable length used*	*Cable length maximum*[2]
S1-1	V+	DC power	Unshielded	---	---
S1-2	CAN H	signal/control	Unshielded TP	---	---
S1-3	CAN L	Signal/control	Unshielded TP	---	---
S1-4	GND	DC power	Unshielded	---	---
S1-1	V+	DC power	Unshielded	---	---

List of devices connected to EUT

No.	*Description*	*Type designation*	*Serial no. or ID*	*Manufacturer*
1	USB CAN/LIN interface	VECTOR VN1610	007150066360	VECTOR

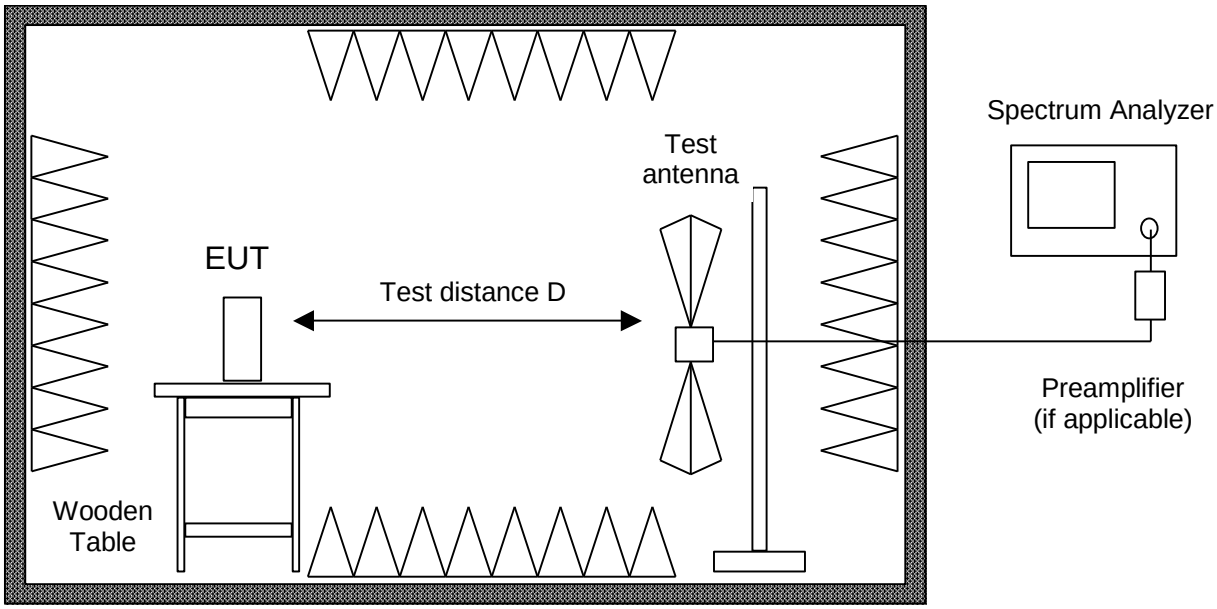
List of support devices

No.	*Description*	*Type designation*	*Serial no. or ID*	*Manufacturer*
2	USB CAN/LIN interface	VECTOR VN1610	007150066360	VECTOR

[1] Ports shall be classified as ac power, dc power or signal/control port.
[2] As specified by applicant

5 Test Setups

Radiated Emission in Fully or Semi Anechoic Room



Fully or semi anechoic room

Radiated emission in fully or semi anechoic room is measured in the frequency range from 30 MHz to the maximum frequency as specified in CFR 47 Part 15 section 15.33.

Measurements are made in both the horizontal and vertical planes of polarization using a spectrum analyzer with the detector function set to peak and resolution as well as video bandwidth set to 100 kHz (below 1 GHz) or 1 MHz (above 1 GHz).

Testing up to 1 GHz is performed with a linear polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna"). For testing above 1 GHz horn antennas are used.

All tests below 8.2 GHz are performed at a test distance D of 3 meters. For higher frequencies the test distance may be reduced (e.g. to 1 meter) due to the sensitivity of the measuring instrument(s) and the test results are calculated according to CFR 47 Part 15 section 15.31(f)(1) using an extrapolation factor of 20 dB/decade. If required, preamplifiers are used for the whole frequency range. Special care is taken to avoid overload, using appropriate attenuators and filters, if necessary.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

During testing the EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

For final testing below 1 GHz a semi anechoic room complying with the NSA requirements of ANSI C63.4 for alternative test sites is used (see 0). If prescans are recorded in fully anechoic room they are indicated appropriately.

According to section 13 of KDB558074 the requirement for radiated emissions on the band edges was performed with a reduced bandwidth of 100 kHz instead of 1 MHz.

Radiated emission in the frequency range 9 kHz to 30 MHz is measured using an active loop antenna. First the whole spectrum of emission caused by the equipment is recorded at a distance of 3 meters in a fully or semi anechoic room with the detector of the spectrum analyzer or EMI receiver set to peak. This configuration is also used for recording the spectrum of intentional radiators.

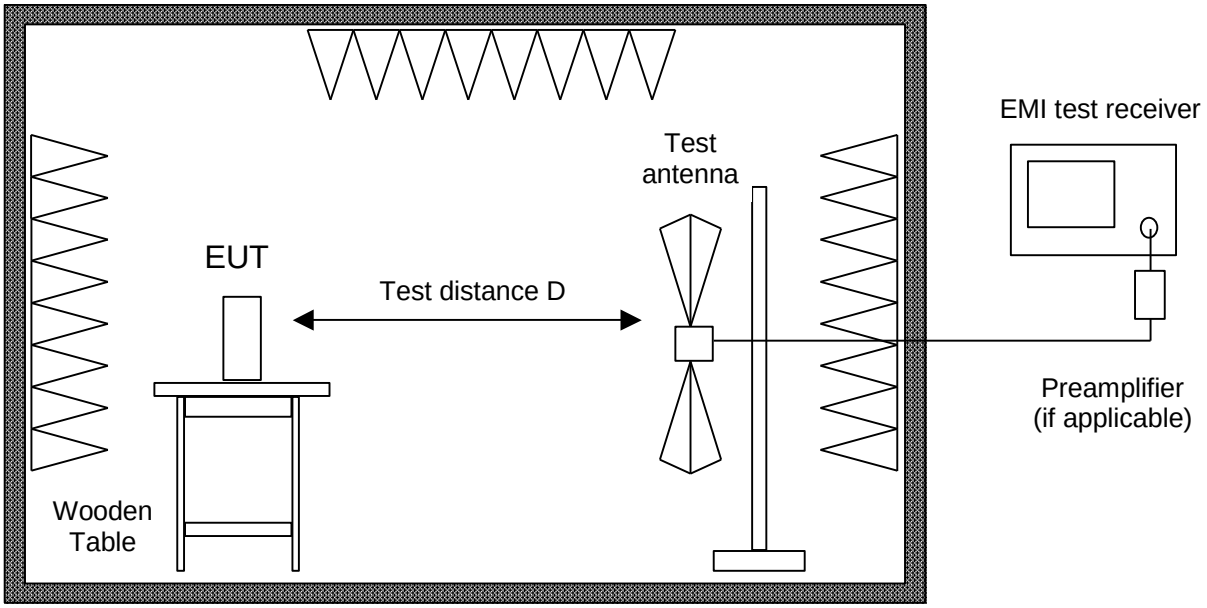
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

EUT is rotated all around to find the maximum levels of emissions. Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.
If worst case emission of the EUT cannot be recorded with EUT in standard position and loop antenna in vertical polarization the EUT (or the radiating part of the EUT) is rotated by 90 degrees instead of changing the loop antenna to horizontal polarization. This procedure is selected to minimize the influence of the environment (e.g. effects caused by the floor especially with longer distances).

Final measurement is performed at a test distance D of 30 meters using an open field test site. In case the regulation requires testing at other distances, the result is extrapolated by either making measurements at an additional distance D of 10 meters to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). In cases of very low emissions measurements are performed at shorter distances and results are extrapolated to the required distance. The provisions of CFR 47 Part 15 sections 15.31(d) and (f)(2) apply. According to CFR 47 Part 15 section 15.209(d) final measurement is performed with detector function set to quasi-peak except for the frequency bands 9 to 90 kHz and 110 to 490 kHz where, for non-pulsed operation, average detector is employed.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Radiated Emission at Alternative Test Site



Alternate test site (semi anechoic room)

Radiated emission in the frequency range 30 MHz to 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 polarized logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used. The measurement bandwidth of the test receiver is set to 120 kHz with quasi-peak detector selected.

If the radiated emission limits are expressed in terms of the average value of the emission there also is a peak limit corresponding to 20 dB above the maximum permitted average limit. Additionally, if pulsed operation is employed, the average field strength is determined by averaging over one complete pulse train, including blanking intervals, as specified in CFR 47 Part 15 section 15.35(c). If the pulse train exceeds 0.1 second that 0.1 second interval during which the value of the emission is at its maximum is selected for calculation. The pulse train correction is added to the peak value of the emission to get the average value.

Hand-held or body-worn devices are tested in the position producing the highest emission relative to the limit as verified by prescans in fully anechoic room.

If no prescan in a fully anechoic room is used first a peak scan is performed in four positions to get the whole spectrum of emission caused by EUT with the measuring antenna raised and lowered from 1 to 4 m to find table position, antenna height and antenna polarization for the maximum emission levels.
Data reduction is applied to these results to select those levels having less margin than 10 dB to or exceeding the limit using subranges and limited number of maximums. Further maximization is following.
With detector of the test receiver set to quasi-peak final measurements are performed immediately after frequency zoom (for drifting disturbances) and maximum adjustment.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

In cases where prescans in a fully anechoic room are taken (e. g. if EUT is operating for a short time only or battery is dircharged quickly) final measurements with quasi-peak detector are performed manually at frequencies indicated by prescan with EUT rotating all around and receiving antenna raising and lowering within 1 meter to 4 meters to find the maximum levels of emission.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

For measuring emissions of intentional radiators and receivers a test distance D of 3 meters is selected. Testing of unintentional radiators is performed at a distance of 10 meters. If limits specified for 3 meters shall be used for measurements performed at 10 meters distance the limits are calculated according to CFR 47 Part 15 section 15.31(d) and (f)(1) using an inverse linear-distance extrapolation factor of 20 dB/decade.

6 Photographs Taken During Testing

See “Annex to Test Report TR-713301683-07”

7 Referenced Regulations

Publication	*Title*
CFR 47, Part 2	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communications Comission (FCC)
CFR 47, Part 15, Subpart C	Code of Federal Regulations Part 15 (Personal Radio Services), Subpart C (Intentional Radiators) of the Federal Communications Comission (FCC)
ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

8 Measurement Uncertainty Values

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

Radio Testing			
Test Name	kp	Expanded Uncertainty	Note
Occupied Bandwidth	2.0	±1.14 %	2
RF-Frequency error	1.96	±1 · 10-7	7
RF-Power, conducted carrier	2	±0.079 dB	2
RF-Power uncertainty for given BER	1.96	+0.94 dB / -1.05	7
RF power, conducted, spurious emissions	1.96	+1.4 dB / -1.6 dB	7
RF power, radiated			
25 MHz – 4 GHz	1.96	+3.6 dB / -5.2 dB	8
1 GHz – 18 GHz	1.96	+3.8 dB / -5.6 dB	8
18 GHz – 26.5 GHz	1.96	+3.4 dB / -4.5 dB	8
40 GHz – 170 GHz	1.96	+4.2 dB / -7.1 dB	8
Spectral Power Density, conducted	2.0	±0.53 dB	2
Maximum frequency deviation			
300 Hz – 6 kHz	2	±2,89 %	2
6 kHz – 25 kHz	2	±0.2 dB	2
Maximum frequency deviation for FM	2	±2,89 %	2
Adjacent channel power 25 MHz – 1 GHz	2	±2.31 %	2
Temperature	2	±0.39 K	4
(Relative) Humidity	2	±2.28 %	2
DC- and low frequency AC voltage			
DC voltage	2	±0.01 %	2
AC voltage up to 1 kHz	2	±1.2 %	2
Time	2	±0.6 %	2

Radio Interference Emission Testing			
Test Name	kp	Expanded Uncertainty	Note
Conducted Voltage Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB	1
Discontinuous Conducted Emission			
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB	1
Conducted Current Emission			
9 kHz to 200 MHz	2	± 3.5 dB	1
Magnetic Fieldstrength			
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB	1
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB	1
Radiated Emission			
Test distance 1 m (ALSE)			
9 kHz to 150 kHz	2	± 4.6 dB	1
150 kHz to 30 MHz	2	± 4.1 dB	1
30 MHz to 200 MHz	2	± 5.2 dB	1
200 MHz to 2 GHz	2	± 4.4 dB	1
2 GHz to 3 GHz	2	± 4.6 dB	1
Test distance 3 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 5.0 dB	1
1 GHz to 6 GHz	2	± 4.6 dB	1
Test distance 10 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 4.9 dB	1
Radio Interference Power			
30 MHz to 300 MHz	2	± 3.5 dB	1
Harmonic Current Emissions			4
Voltage Changes, Voltage Fluctuations and Flicker			4

Immunity Testing			
Test Name	kp	Expanded Uncertainty	Note
Electrostatic Discharges			4
Radiated RF-Field			
Pre-calibrated field level	2	+32.2 / -24.3 %	5
Dynamic feedback field level	2.05	+21.2 / -17.5 %	3
Electrical Fast Transients (EFT) / Bursts			4
Surges			4
Conducted Disturbances, induced by RF-Fields			
via CDN	2	+15.1 / -13.1 %	6
via EM clamp	2	+42.6 / -29.9 %	6
via current clamp	2	+43.9 / -30.5 %	6
Power Frequency Magnetic Field	2	+20.7 / -17.1 %	2
Pulse Magnetic Field			4
Voltage Dips, Short Interruptions and Voltage Variations			4
Oscillatory Waves			4
Conducted Low Frequency Disturbances			
Voltage setting	2	± 0.9 %	2
Frequency setting	2	± 0.1 %	2
Electrical Transient Transmission in Road Vehicles			4

Note 1:
The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 2:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 3:
The expanded uncertainty reported according to UKAS Lab 34 (Edition 1, 2002-08) is based on a standard uncertainty multiplied by a coverage factor of kp = 2.05, providing a level of confidence of p = 95.45%
Note 4:
It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95%confidence.
Note 5:
The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 6:
The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%
Note 7:
The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%
Note 8:
The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of kp = 1.96, providing a level of confidence of p = 95.45%

9 Test Equipment used

T-ID	*Designation*	*Type*	*Last Cal.*	*Next Cal.*
18874	Horn antenna	3160-07	Verified	
18875	Horn antenna	3160-08	Verified	
19125	Horn antenna	3160-09	Verified	
19383	Double ridged waveguide horn antenna	3115	2023-04	2026-04
19442	Horn antenna	3160-10	Verified	
19533	Spectrum analyser	FSW43	2023-04	2024-04
40089	Double ridged horn antenna	HF907	2022-10	2024-10
19946	Horn antenna	24240-20	Verified	
20219	Signal and Spectrum Analysator	FSV40 for TS8997	2022-02	2024-02
22553	Waveguide mixer	FS-Z170	2023-06	2026-06
25849	Waveguide mixer	FS-Z60	2023-05	2026-05
25850	Waveguide mixer	FS-Z90	2023-05	2026-05
25851	Waveguide mixer	FS-Z110	2023-06	2026-06
27898	Horn antenna	26240-20	Verified	
27899	Horn antenna	27240-20	Verified	
39897	EMI test receiver	ESW44	2023-04	2024-04
36954	Harmonic Mixer	FS-Z220	2023-05	2026-05
36955	Harmonic Mixer	FS-Z325	2023-05	2026-05
37863	Horn antenna	30240-20 WG30	Verified	
37864	Horn antenna	32240-20 WG32	Verified	
61491	ULTRALOG Antenna	HL562E	2023-04	2026-04

Test software for: EMC32 V10.

10 Test Results

CFR 47, Part 2			
Section(s)	*Test performed*	*Page*	*Test Result*
§ 2.202 (a); § 2.1049	Occupied Bandwidth	21	Test passed

CFR 47, Part 15, Subpart C,			
Section(s)	*Test performed*	*Page*	*Test Result*
§ 15.255 (c)	Radiated Power	19	Test passed
§ 15.255 (d)	Spurious Emissions	22	Test passed
§ 15.255 (f)	Frequency Stability	32	Test passed
§ 15.255 (c)(2)(iii)(A)	Duty Cycle	36	Test passed

10.1 Radiated Power

Date of Test	2023-08-07
Operator	Alex Fink
Test Site	Semi anechoic room, cabin no. 11

Test Result	
☒	**Passed**
☐	**Not Passed**

Barometric pressure:	976 hPa
Relative humidity:	50 %
Ambient temperature:	24 °C

Specifications:	Part 15, Subpart C, §15.255 (c)(2)(iii)(A) KDB 364244 D01 Meas 15.255 Radars v01
Description:	The peak EIRP shall not exceed 14 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds, except as specific in paragraph (c)(2)(iii)(B) of this section
Operation mode: Comment :	Transmitting continuously Test was performed as radiated test. The test distance was 1.0 m. A correction factor of -43 dB (Factor(dB) and mixer conversion loss table were used to account for the test antenna gain, free-space loss and external mixer loss.

Detector	*EIRP*	*Tested Distance*	*Limit*	*Note*
Peak	-6.14 dBm	1m	14 dBm	#1

***Note #1**
Wavelength = Speed of light / Measurement frequency = c / f = 0.0047 with c = 300000000 m/s and f = 64000000000 Hz
$R_{(Far\ Field)}$ = (2* (Max antenna length of EUT)^2)/Wavelength (2* (0.0082)^2/0.0047) = 0.0287 m
Our measurement is performed at a minimum distance of 1 m > $R_{(Far\ field)}$

Calculation of test results
•Factor (dB): Mixer Loss(dB) + Cable Loss(dB) + FSPL(dB) - Antenna Gain(dBi) = -43 dB
•Meas Result (dBm): Reading(dBm) + Factor(dB)

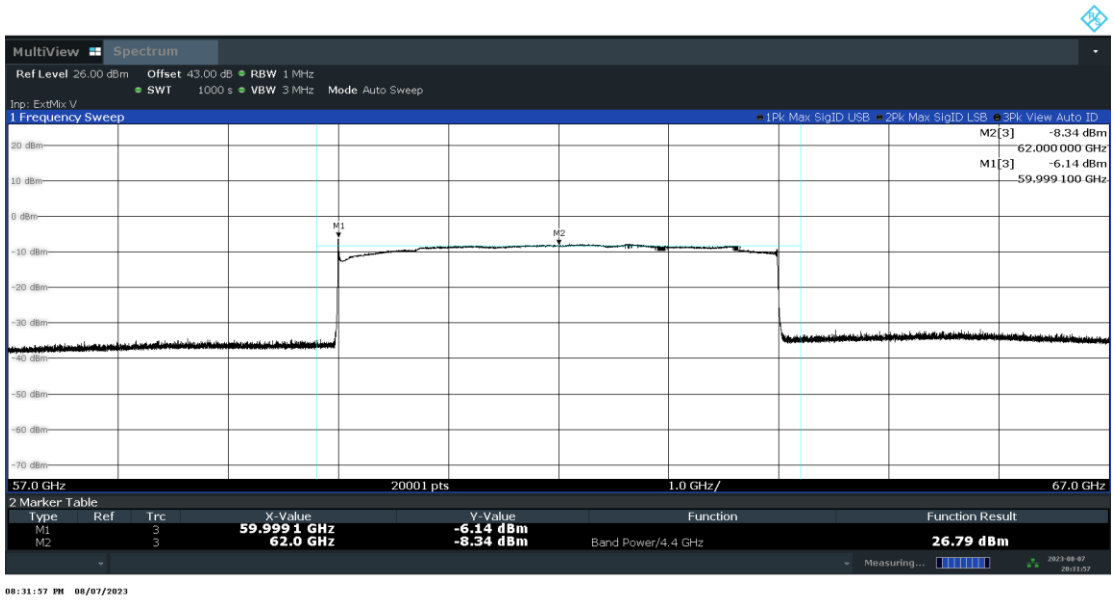
FSPL calculation
•FSPL = $20*LOG_{10}(d)+20*LOG_{10}(f)+20*LOG_{10}(4*\pi/c)$;
with d = 1m, c = 300000000 m/s and f = 64000000000 Hz
These calculation results are same as results which were calculated with formulas described in the section 9 of ANSI C63.10-2013

FMCW desensitization factor
Pulse Desensitization Factor not necessary according to R&S FSW spectrum analyser application note “RBW influence on peak or mean power measurement of pulsed signals” when signal is wider then 1µs and RBW > 1 MHz

Plots taken during test

Measurement Procedure:
Test settings:

1. Radiated Power measurements are performed using the signal analyser swept mode measurement capability for signals with continuous operation.
2. RBW = 1 MHz
3. VBW ≥ 3 MHz
4. Span as required, enough to observe the fundamentals emission around 62 GHz.
5. No. of sweeppoints ≥ 2 x span / RBW
6. Detector = Peak
7. Trace mode = max hold
8. The trace was allowed to stabilise.



10.2 Occupied Bandwidth

Date of Test	2023-08-21
Operator	Alex Fink
Test Site	Non shielded room

Test Result

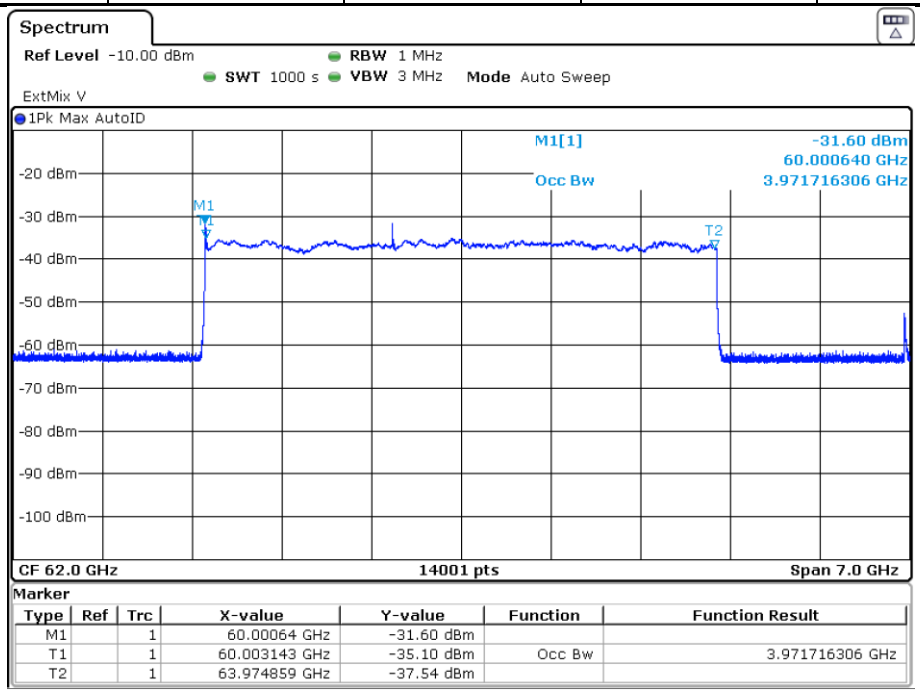
☒ **Passed**

☐ **Not Passed**

Barometric pressure:	985 hPa
Relative humidity:	30 %
Ambient temperature:	20 °C

Specifications:	CFR 47, Part 2, Clause 2.1049 and 2.202(a)
Description:	The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.
Operation mode: Comment :	Transmitting continuously ---

Temperature	Voltage	Frequency Low f_L (GHz)	Frequency High f_H (GHz)	Occupied Bandwidth (GHz)
+20.0 °C	12.0 V DC	60.003143	63.974859	3.971716306



10.3 Spurious Radiated Emisions

Date of Test	2023-07-21 and 2023-08-22
Operator	Alex Fink
Test Site	Semi anechoic room, cabin no. 11

Test Result	
☒	**Passed**
☐	**Not Passed**

Barometric pressure:	976 hPa
Relative humidity:	51 %
Ambient temperature:	26 °C

Specifications:	CFR 47, Part 15, Subpart C, § 15.255 (d)
Description:	(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions. (2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209. (3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters. (4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.
Operation mode:	Transmitting continuously
Comment :	This test was performed as radiated test in the frequency range 30 MHz to 300 GHz. No significant spurious emissions were observed. The test distance was 3 m in the frequency ranges 9 kHz to 1 GHz and 18 GHz to 40 GHz, 1 m in the frequency ranges 1 GHz to 18 GHz and 40 GHz to 170 GHz, 0.5 m in the frequency ranges 170 GHz to 200 GHz The measurement below was done using EMC 32 V10.40.00 automated software. See plots for details.

Sample calculation of field final values:

Final Value (dBµV/m) = Reading Value (dBµV) +(Antenna Correction Factor (dB/m) + Cable Correction Factor (dB))

Radiated emission limits 9 kHz – 40 GHz		
Frequency (MHz)	*Field strength (µV/m)*	*Measurement distance (m)*
0.009 – 0.490	2400/f(kHz)	300
0.490 – 1.705	24000/f(kHz)	30
1.705 – 30	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
960 – 40000	500	3

Note(s):

1 In the emissions table the tighter limit applies at the band edges.

2 The limits are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emission shall not exceed the level of the fundamental frequency.

3 The emissions limits shown in the table are based on measurement employing CISPR quasi-peak detector except for the frequency bands 9.0 – 90 kHz, 110.0 – 490 kHz, and above 1 GHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with 1 MHz RBW.

Table 1: Radiated emission limits 9 kHz – 40 GHz

Radiated emission limits 40 GHz – 200 GHz		
Frequency (GHz)	*Power Density (pW/cm²)*	*Measurement distance (m)*
40 – 200	90	3

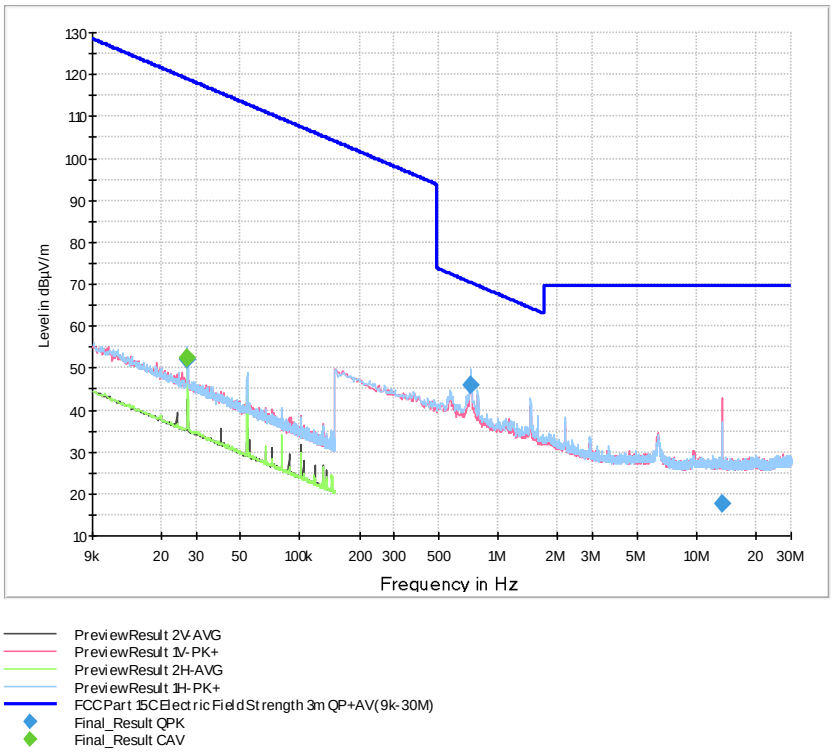
Note(s):

1 According to 47 CFR, Part 15, § 15.255(d)(3): Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters.

2 The power density of 90 pW/cm² corresponds to a field strength of 85.31 dBµV/m for 3 m distance, 94.85 dBµV/m for 1 m distance.

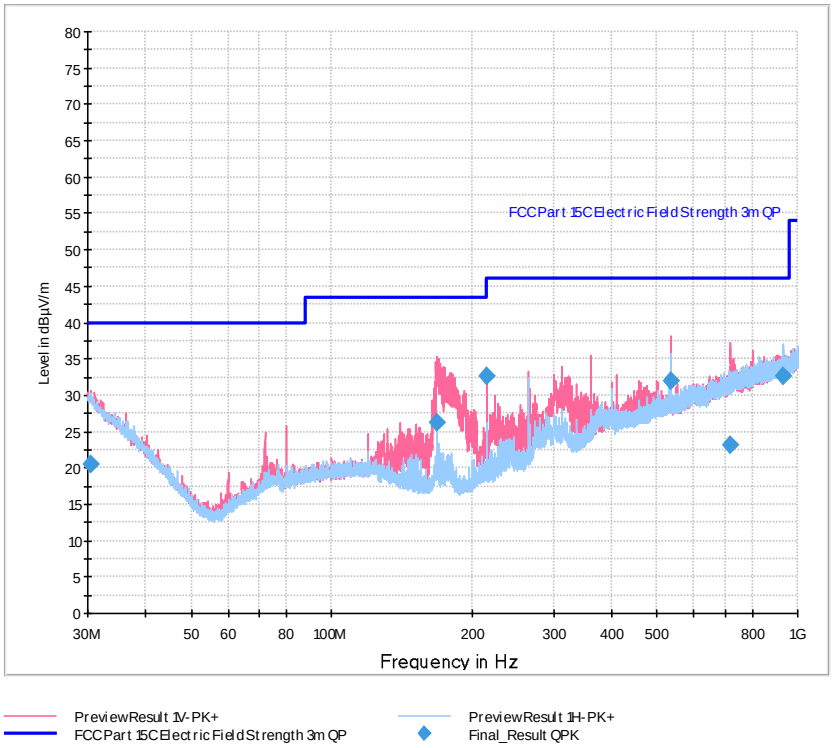
Table 2: Radiated emission limits above 40 GHz

Plots taken during measurement



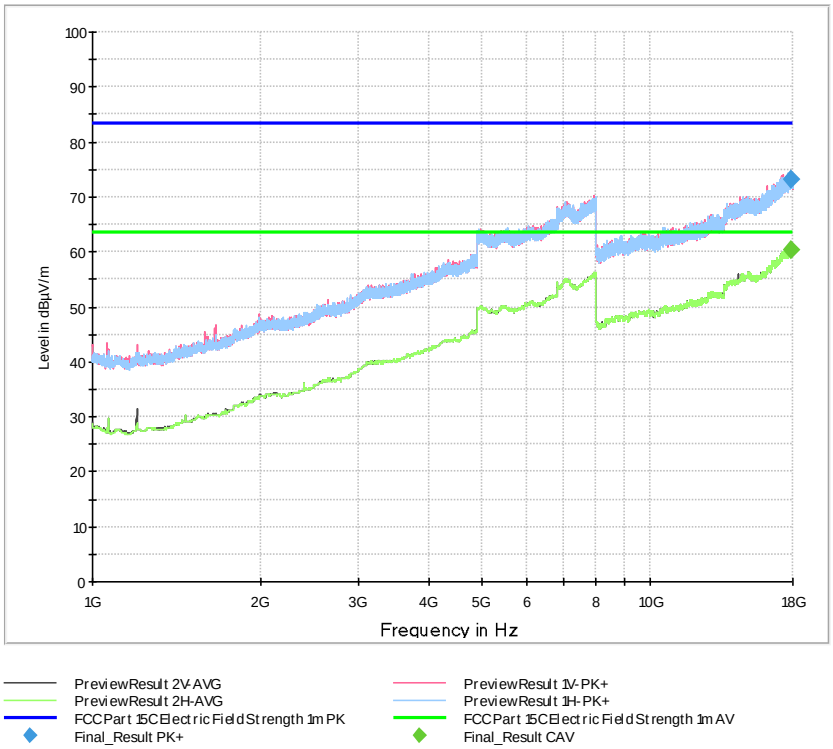
Final Results:

Frequency *MHz*	*QuasiPeak* *dBµV/m*	*CAverage* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
0.027100	---	52.28	---	---	1000.0	0.200	100.0	H	6.0	19.7
0.027100	51.94	---	118.95	67.00	1000.0	0.200	100.0	H	6.0	19.7
0.726000	46.04	---	70.39	24.35	1000.0	9.000	100.0	H	189.0	19.4
13.578000	17.83	---	69.54	51.71	1000.0	9.000	100.0	V	156.0	19.2



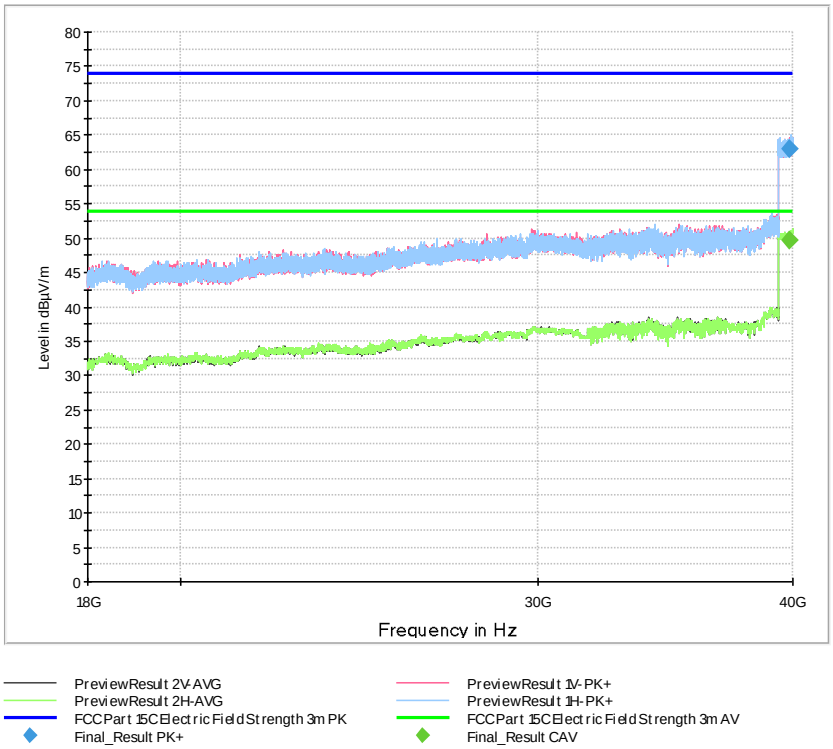
Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
30.390000	20.57	40.00	19.43	1000.0	120.000	203.0	V	54.0	25.0
168.000000	26.14	43.50	17.36	1000.0	120.000	100.0	V	136.0	15.2
216.000000	32.69	43.50	10.81	1000.0	120.000	102.0	V	86.0	16.2
533.340000	31.87	46.02	14.15	1000.0	120.000	104.0	V	-126.0	25.1
719.760000	23.04	46.02	22.98	1000.0	120.000	117.0	V	-89.0	28.1
933.330000	32.60	46.02	13.42	1000.0	120.000	162.0	H	64.0	30.6



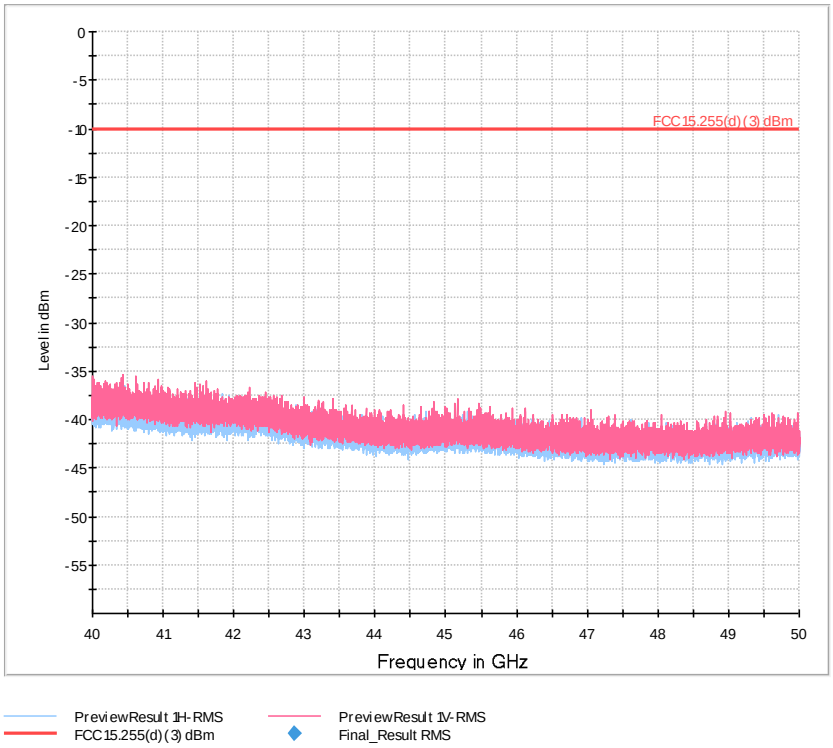
Final Results:

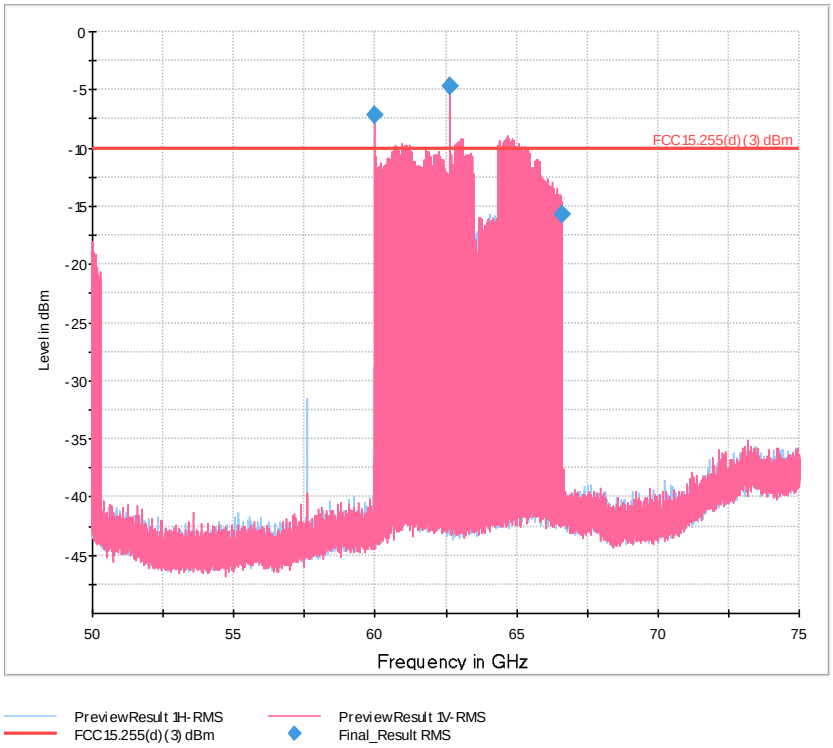
Frequency *MHz*	*MaxPeak* *dBµV/m*	*CAverage* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
17887.750000	---	60.24	63.50	3.26	1000.0	1000.000	117.0	V	-28.0	58.9
17887.750000	73.06	---	83.50	10.44	1000.0	1000.000	117.0	V	-28.0	58.9



Final Results:

Frequency *MHz*	*MaxPeak* *dBµV/m*	*CAverage* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
39840.250000	---	49.74	53.98	4.24	1000.0	1000.000	167.0	V	-162.0	35.9
39840.250000	62.88	---	73.98	11.10	1000.0	1000.000	167.0	V	-162.0	35.9

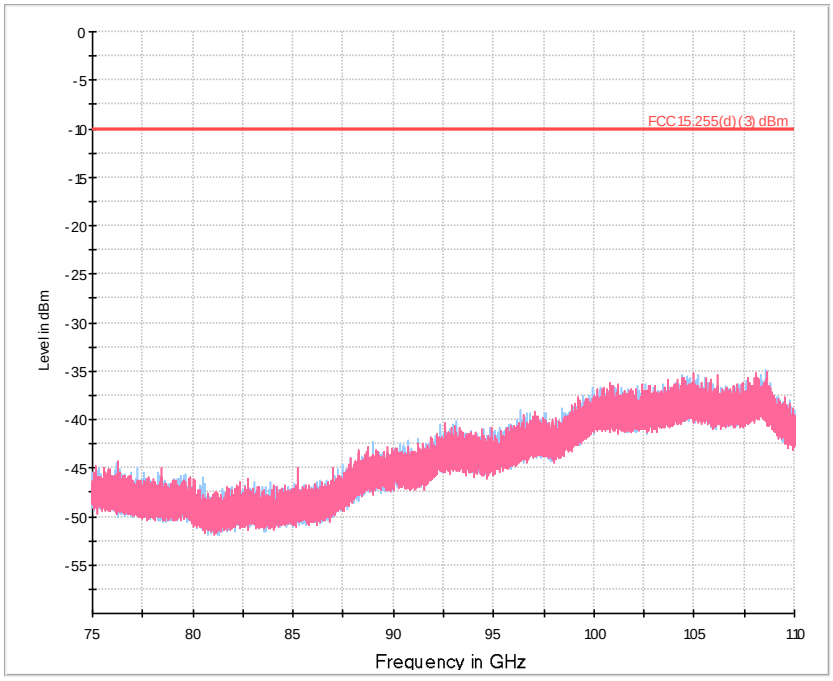

FCC 15.255(d)(3) dBm
Level in dBm
Frequency in GHz
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
40
41
42
43
44
45
46
47
48
49
50
PreviewResult 1H-RMS
FCC 15.255(d)(3) dBm
PreviewResult 1V-RMS
Final_Result RMS



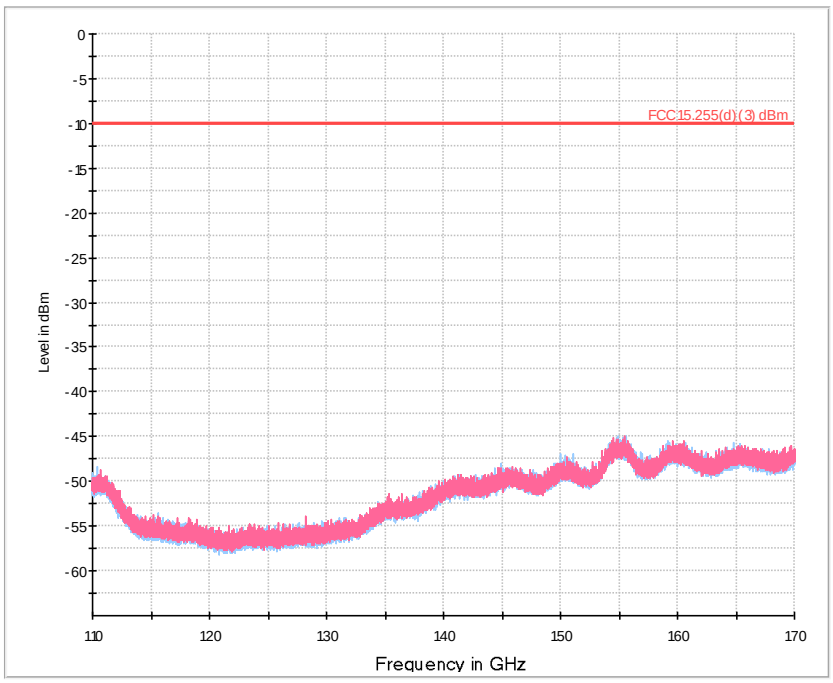
Final Results:

Frequency MHz	*RMS dBm*	*Limit dBm*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB*
59999.218750	-7.19	#1	#1	2.5	1000.000	150.0	V	207.0	-64
62633.593750	-4.72	#1	#1	2.5	1000.000	150.0	V	191.0	-64
66614.843750	#2	#2	#2	2.5	1000.000	150.0	V	233.0	-64

Note #1: intentional radiation
Note #2: mixing product, measurement was performed without AutoID, so that operating frequency is visible with a 2.5ms sweep time.



PreviewResult 1H-RMS
FCC15.255(d)(3) dBm
PreviewResult 1V-RMS
Final_Result RMS



PreviewResult 1H-RMS
FCC15.255(d)(3) dBm
PreviewResult 1V-RMS
Final_Result RMS

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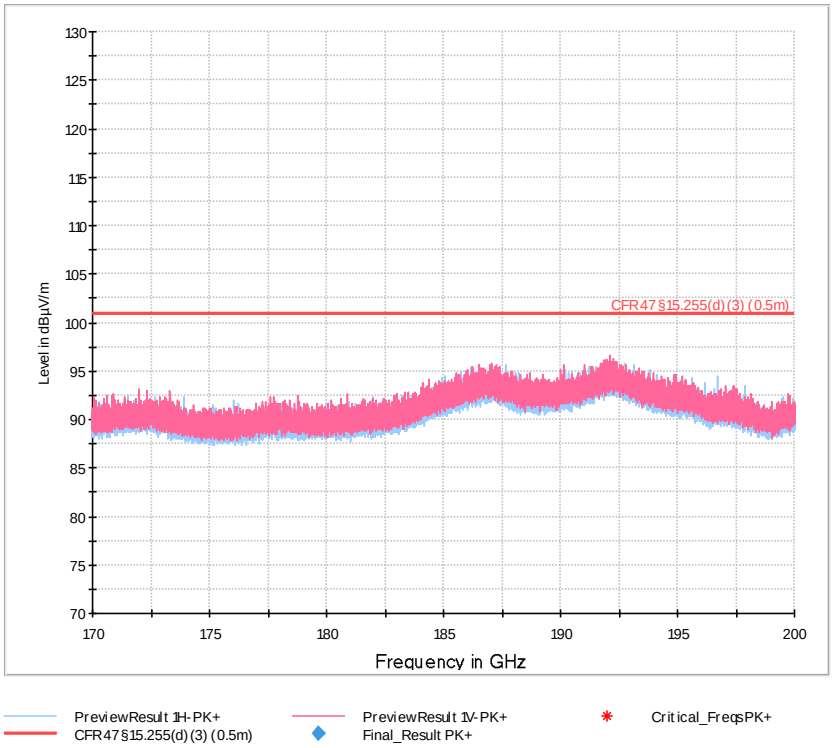

10.4 Frequency Stability

Date of Test	2023-08-18 and 2023-08-21
Operator	Alex Fink
Test Site	Non shielded room

Prüfergebnis / *Test Result*
☒ **Erfüllt / *Passed***
☐ **Nicht erfüllt / *Not passed***

Barometric pressure:	985 hPa
Relative humidity:	30 %
Ambient temperature:	20 °C

Specifications:	CFR 47, Part 15, Subpart C, §15.255(f) KDB 364244 D01 Meas 15.255 Radars v01
Description:	Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 °C to 50 °C with a input voltage varation of 85 % to 115 % of rated input voltage unless justification is presented to demonstrate otherwise.
Operation mode:	Transmitting continuously
Comment :	See plots of tests for details.

Temperature	Voltage	Frequency Low f_L (GHz)	Frequency High f_H (GHz)
+20.0 °C	10.2 V DC	60.004143	63.976859
+20.0 °C	12.0 V DC	60.003143	63.974859
+20.0 °C	13.8 V DC	60.004643	63.973859
-20.0 °C	12.0 V DC	60.023641	63.975859
-10.0 °C	12.0 V DC	60.016642	63.980359
0.0 °C	12.0 V DC	60.011142	63.982358
+10.0 °C	12.0 V DC	60.011142	63.976359
+30.0 °C	12.0 V DC	60.002143	63.976859
+40.0 °C	12.0 V DC	60.001643	63.973359
+50.0 °C	12.0 V DC	60.000143	63.973359

All emissions are within the 57 – 71 GHz frequency band.
See plots for details

Sample Test plots taken during test

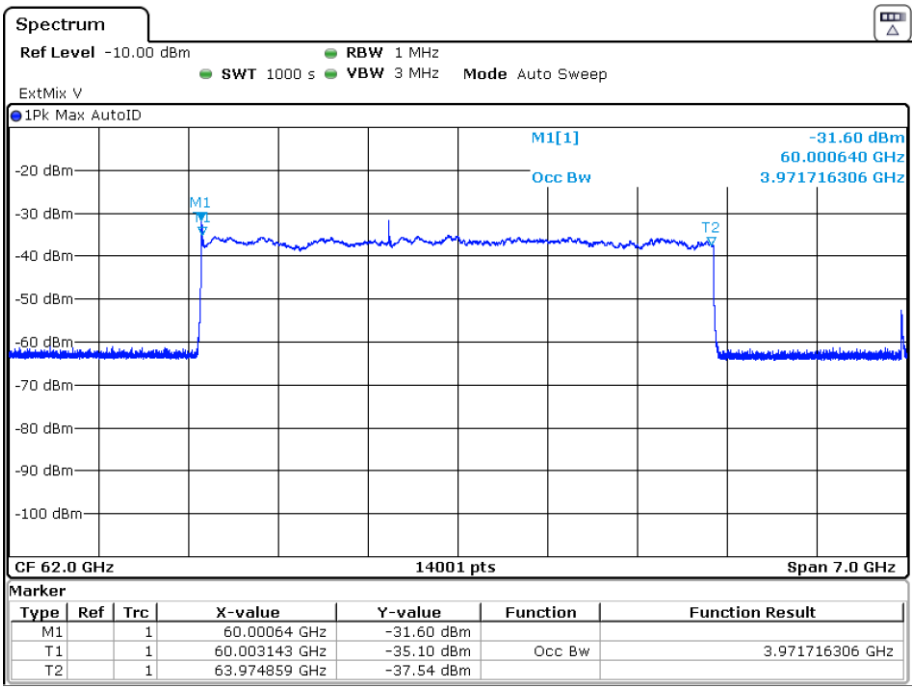

Figure 1 – 20°C and 12 V DC

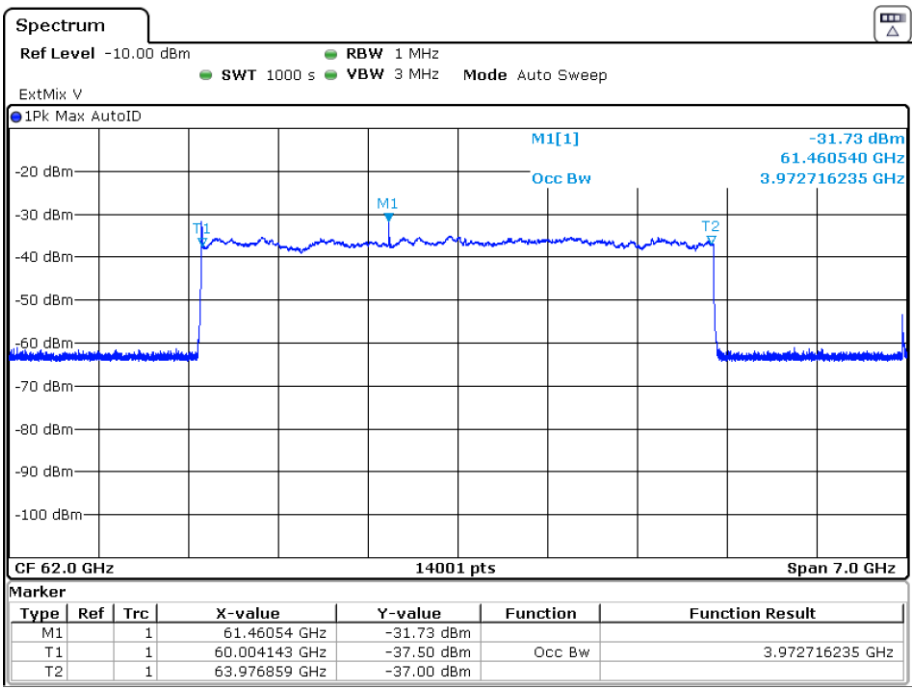

Figure 2 – 20°C and 10.2 V DC

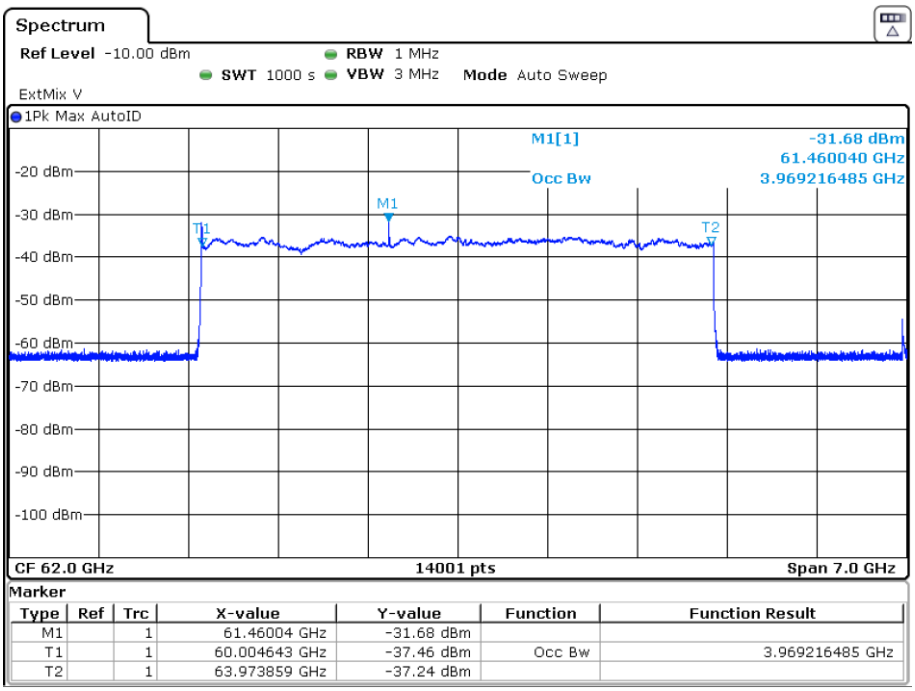

Figure 3 – 20°C and 13.8 V DC

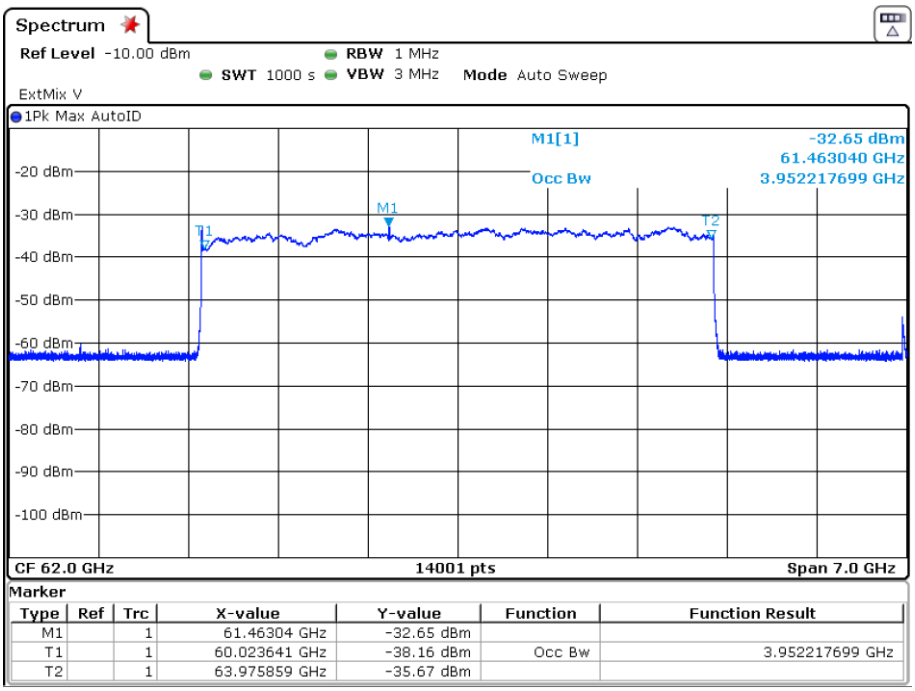

Figure 4 – -20°C and 12.0 V DC

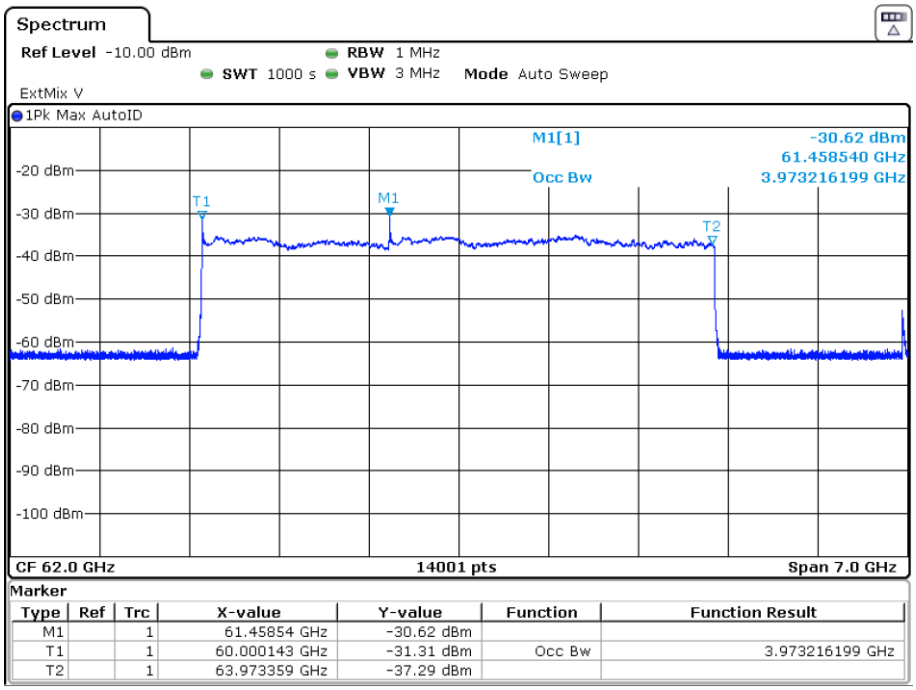

Figure 5 – 50°C and 12.0 V DC

10.5 Duty Cycle

Date of Test	2023-08-21
Operator	Alex Fink
Test Site	Non shielded room

Prüfergebnis / *Test Result*
☒ **Erfüllt / *Passed***
☐ **Nicht erfüllt / *Not passed***

Barometric pressure:	993 hPa
Relative humidity:	30 %
Ambient temperature:	20 °C

Specifications*:*	47 CFR 15.255(c)(2)(iii)(A) KDB 364244 D01 Meas 15.255 Radars v01
Description:	The sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds
Operation mode:	Normal operation mode
Comment :	---

Result	*T_{OFF}*	*Limit*	*Note*
Pass	T_{OFF} = 33 ms – 3.96 ms = 29.04 ms	T_{OFF} ≥ 25.5 ms	NA

Note(s):

See plots on next page.

Sample Test plots taken during test

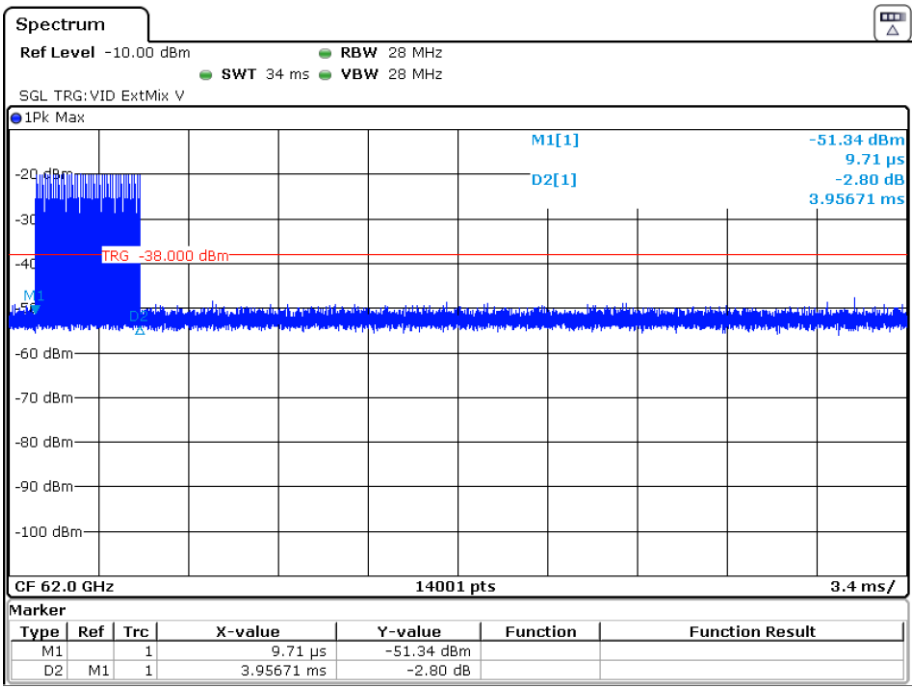

Figure 6 – 33 ms time frame

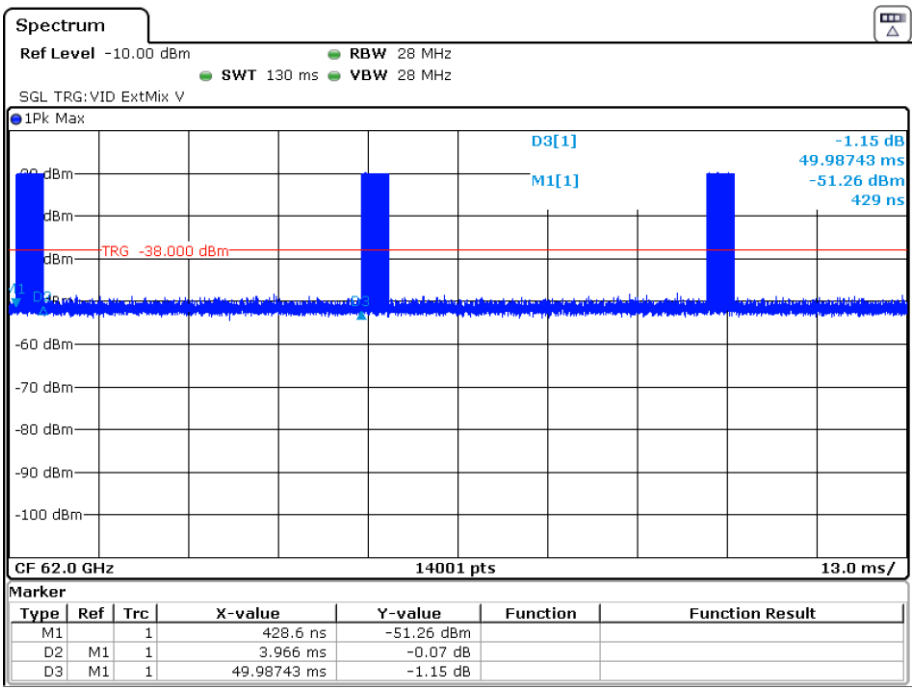

Figure 7 – 130 ms time frame

11 Revision History

Revision History			
Edition	*Date*	*Issued by*	*Modifications*
0	2024-02-15	Alex Fink	First Edition