Report on the IC Testing of the
IEE S.A.
Radar Sensor. Model: VitaSense
In accordance with CFR 47, Part 15, Subpart C

Product Service

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

FCC ID: NSZVITA001

COMMERCIAL-IN-CONFIDENCE

Date: 2021-04-19
Document Number: TR-06504-80561-09 | Issue: 2

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alex Fink	2021-04-19	SIGN-ID 495518
Authorised Signatory	Matthias Stumpe	2021-04-19	SIGN-ID 495535

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	2021-04-19	SIGN-ID 495518

Laboratory Accreditation	Laboratory recognition	ISED 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 SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15, Subpart C, §15.255 (2018).

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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Product Service

Summary

Prüfergebnisse / *Test Results*	Auftragsnummer / *Order No.* **2001290205**

Die Prüfungen wurden nach folgenden Vorschriften durchgeführt:
Tests were performed according to:
CFR 47, Part 15, Subpart C, §15.255

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:*
The VitaSense device does not meet the technical requirements described in CFR 47, Part 15, Subpart C, §15.255. Particularly, the device does not meet the 500 MHz or less occupied bandwidth within the frequency band 61-61.5 GHz, described in B (2). This technical requirement was waived.

Table of Contents

1 Administrative Data

Application details	
Applicant:	IEE S.A. 1, rue du Campus L-7795 Bissen Luxembourg
Contact person:	Mr. Jochen LANDWEHR
Order number:	2001290205
Receipt of EUT:	2020-04-06
Return of EUT:	---
Date(s) of test:	2020-04-06 to 2020-05-11 and 2021-03-29
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-06504-80561-09
Edition:	2
Issue date:	2021-04-19

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-11321-11-02 DAkkS Registration No. D-PL-11321-11-03
Laboratory recognition:	Registration No. BNetzA-CAB-16/21-15
Industry Canada test site registration:	3050A-2
Contact:	Mr. Markus Biberger Phone: +49 9421 5522-0 Fax: +49 9421 5522-99

3 Description of the Equipment Under Test

Equipment characteristics	
Type designation:	VitaSense
Parts of the system:	Main device: radar sensor
Options and accessories:	---
Type of equipment:	Radar Sensor
Serial number:	CZ-4100 #1
HVIN:	HW:330/1.00
Manufacturer:	IEE S.A.
Power supply:	Battery supply (regulated lead-acid) Nominal: 12.0 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)
Transmitting continuously

List of ports and cables					
No.	*Description*	*Classification*[1]	*Cable type*	*Cable length used*	*maximum*[2]
D1	DC 12 V supply	dc power	Unshielded	2 m	---
S1	Wiring harness (CAN, Ethernet)	signal/control port	Unshielded	2 m	---

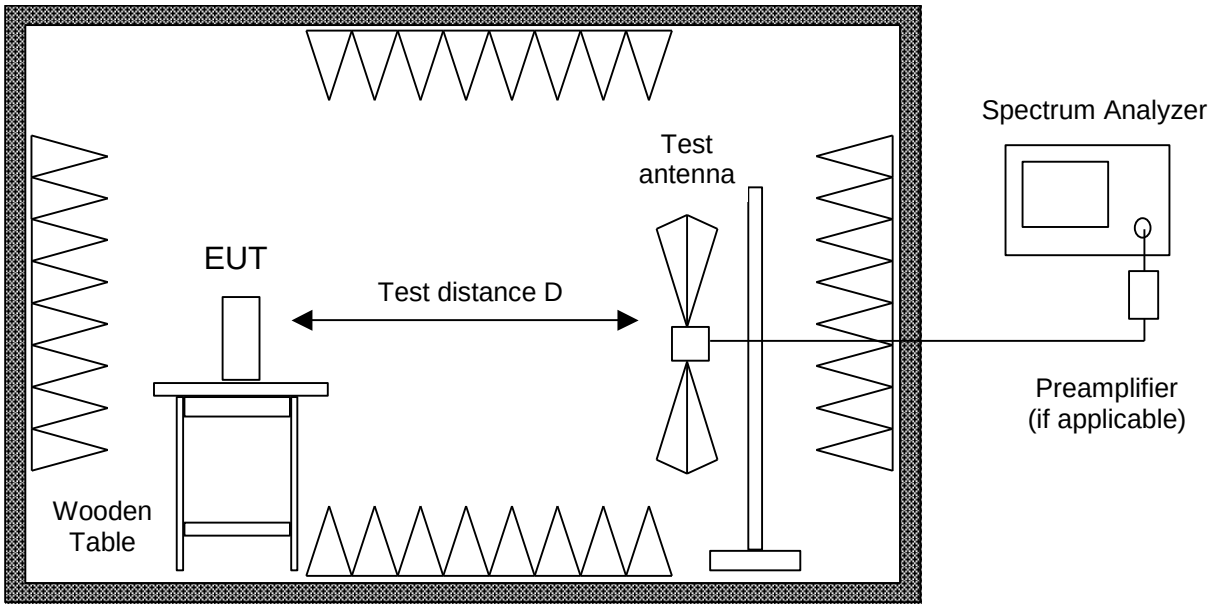
List of devices connected to EUT				
No.	*Description*	*Type designation*	*Serial no. or ID*	*Manufacturer*
1	USB CAN/LIN interface	VECTOR VN1610	007150066360	VECTOR

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.

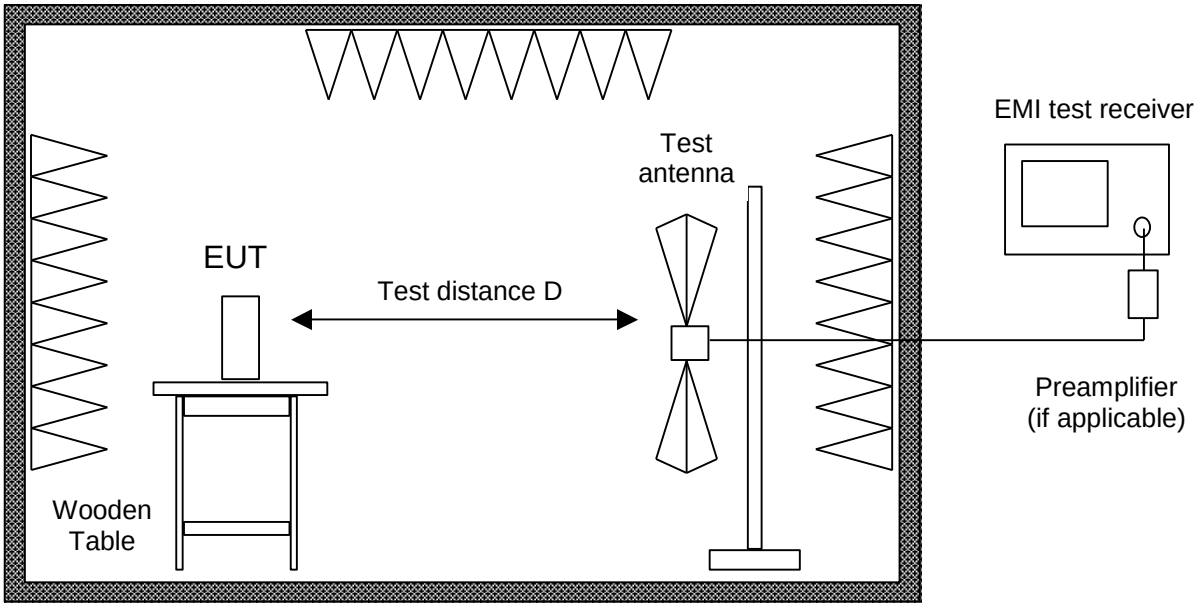
Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration produces the highest emission relative to the limit and therefore shall be used for final testing.

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 A to Test Report TR-06504-80561-09 | Issue: 01”

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	2020-03	2023-03
19442	Horn antenna	3160-10	Verified	
19533	Spectrum analyser	FSP30	2020-09	2022-03
19933	Double ridged horn antenna	HF907	2021-02	2020-23
19946	Horn antenna	24240-20	Verified	
20219	Signal and Spectrum Analysator	FSV40 for TS8997	2020-01	2022-01
22553	Waveguide mixer	FS-Z170	2020-02	2023-02
25849	Waveguide mixer	FS-Z60	2020-02	2023-02
25850	Waveguide mixer	FS-Z90	2020-02	2023-02
25851	Waveguide mixer	FS-Z110	2020-02	2023-02
27898	Horn antenna	26240-20	Verified	
27899	Horn antenna	27240-20	Verified	
28268	EMI test receiver	ESW26	2020-09	2021-09
39897	EMI test receiver	ESW44	2020-03	2021-03
36954	Harmonic Mixer	FS-Z220	2020-02	2023-02
36955	Harmonic Mixer	FS-Z325	2020-02	2023-02
37863	Horn antenna	30240-20 WG30	Verified	
37864	Horn antenna	32240-20 WG32	Verified	
38401	ULTRALOG Antenna	HL562E	2018-05	2021-05

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	23	Test passed

CFR 47, Part 15, Subpart C,			
Section(s)	*Test performed*	*Page*	*Test Result*
§ 15.255 (b)	Radiated Power – Average	19	Test passed
§ 15.255 (e)	Radiated Power – Peak	19	Test passed
§ 15.255 (d)	Spurious Emissions	25	Test passed
§ 15.255 (f)	Frequency Stability	37	Test passed
---	Duty Cycle	40	Test passed

10.1 Radiated Power

Date of Test	2020-05-07
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:	Part 15, Subpart C, §15.255 (c)(2) and §15.255 (e) FCC waiver, FCC DA 18-1308
Description:	Per paragraph 14 of the associated waiver, FCC DA 18-1308, The radar shall be certified for compliance with all the technical specifications applicable to operation under 47 CFR Part 15, with the exception of the following provisions in 47 CFR §§ 15.255(a)(2) and (c)(3), which are waived to allow the device to operate as a radar on new passenger motor vehicles in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density.
Operation mode: Comment :	Transmitting continuously Test was performed as radiated test. The test distance was 1.0 m. A correction factor of -50 dB and mixer conversion loss table were used to account for the test antenna gain, free-space loss and external mixer loss. Reading value of figures is thereby dBm not dBµV.

Detector	*EIRP*	*Limit*	*Note*
RMS	7.15 dBm	13 dBm	--
RMS	-29.99 dBm/1MHz	13 dBm/1MHz	#1
Peak	8.96 dBm/80MHz	13 dBm/1MHz	#2

Note(s):

#1 See figure 2.

#2 Peak PSD measurement was performed with a RBW of 80 MHz.
A conversion formula can be applied to calculated test result.
Calculated test result is -29.10 dBm/MHz = 8.96 dBm/80MHz - 20log(80MHz/1MHz)

Detector	*Conducted Output Power*	*Limit*	*Note*
Peak	2.56 dBm (1.80 mW)	10 dBm	#1

Note(s):

#1 Antenna gain of 6.4 dBi substracted from EIRP result of 8.96 dBm.

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Plots taken during test

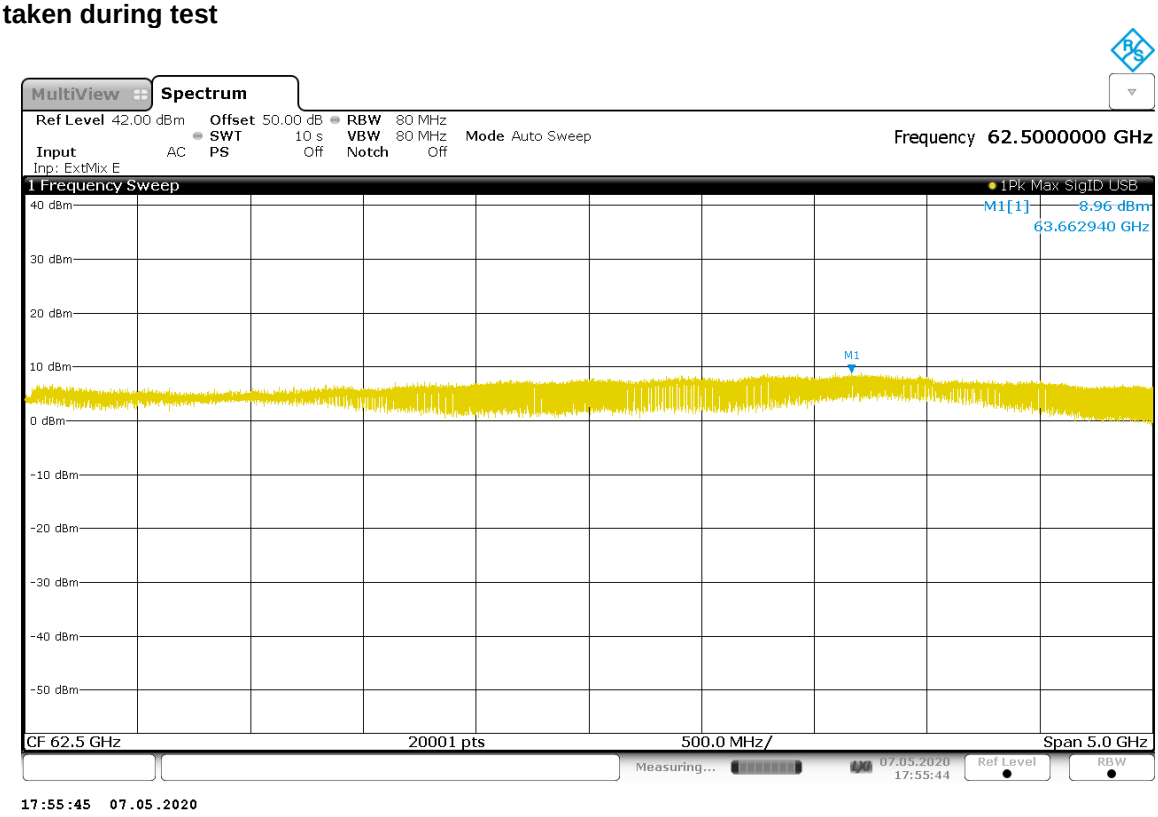

Figure 1 - Peak

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94315 Straubing
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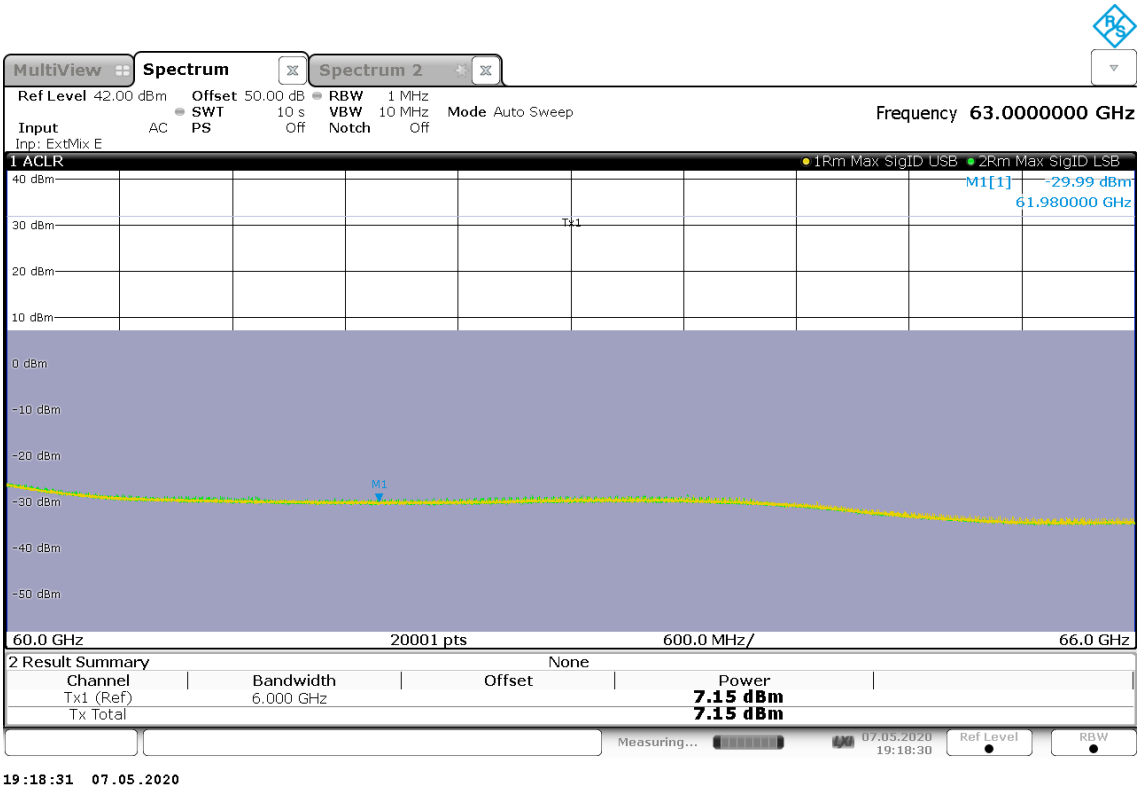


Figure 2 - Average

10.2 Occupied Bandwidth

Date of Test	2020-05-08
Operator	Alex Fink
Test Site	Non shielded room

Test Result

☒ **Passed**

☐ **Not Passed**

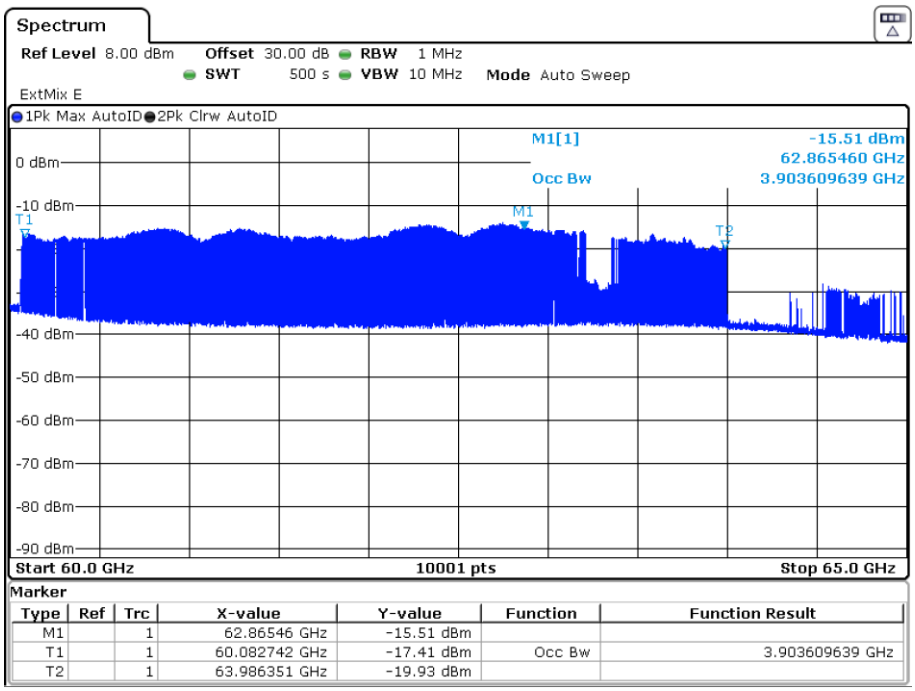
Barometric pressure:	985 hPa
Relative humidity:	30 %
Ambient temperature:	20 °C

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 VitaSense device may operate using an occupied bandwidth of 4 GHz within the 60-64 GHz frequency band, in lieu of the occupied bandwidth requirement of 500 MHz or less specified in section B (2)due to an FCC waiver.

Temperature	Voltage	Frequency Low f_L (GHz)	Frequency High f_H (GHz)	Occupied Bandwidth (GHz)
+20.0 °C	12.0 V DC	60.08274	63.98635	3.90361

See attached test plots.

Plots taken during test



Date: 8.MAY.2020 21:50:32

10.3 Spurious Radiated Emisions

Date of Test	2020-04-06 to 2020-05-07
Operator	Alex Fink
Test Site	Semi anechoic room, cabin no. 11 Fully anechoic room, cabin no. 2

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 12 GHz and 18 GHz to 40 GHz, 1 m in the frequency ranges 12 GHz to 18 GHz and 40 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

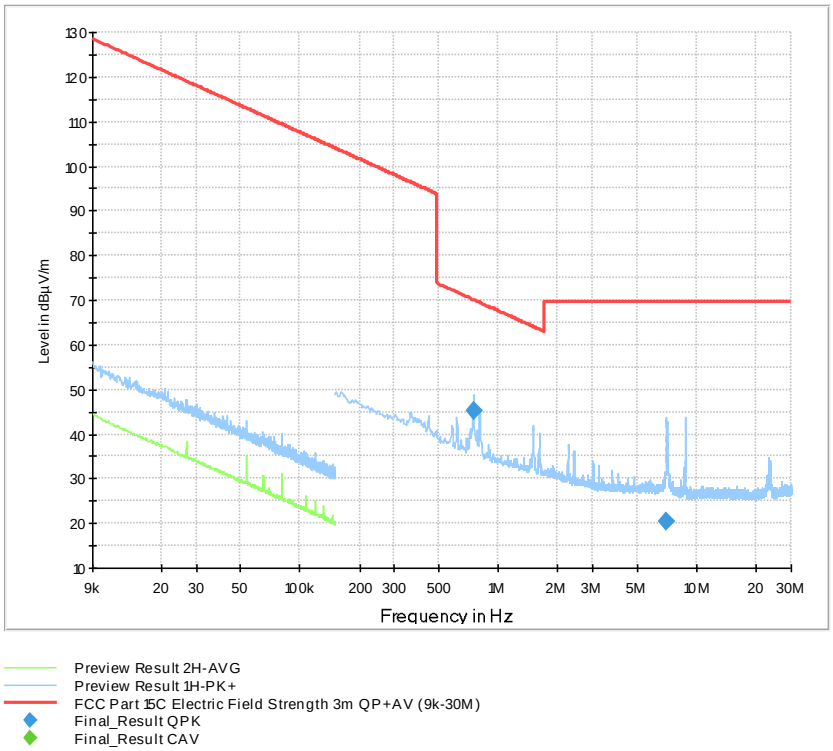
Note(s):

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.

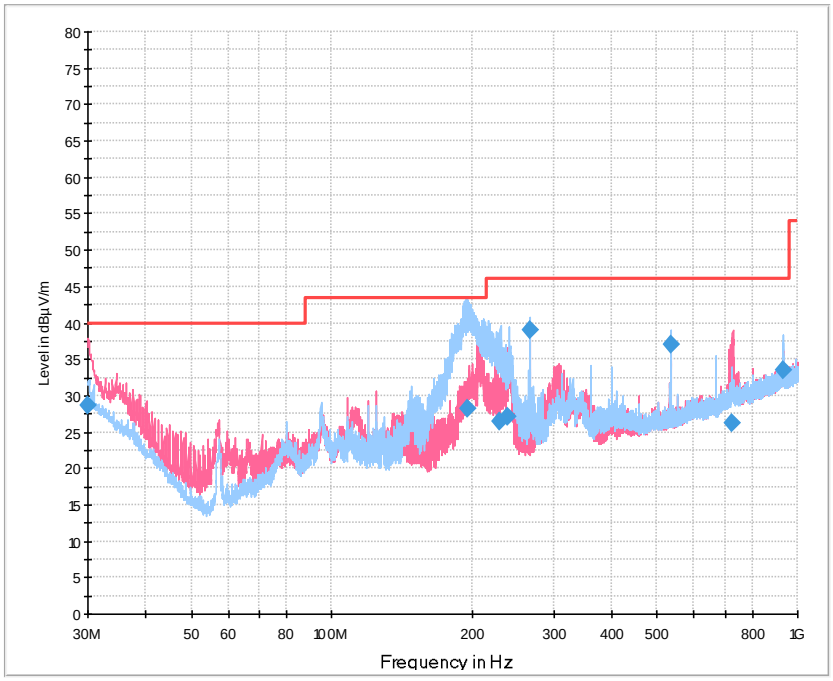
Table 2: Radiated emission limits above 40 GHz

Plots taken during measurement



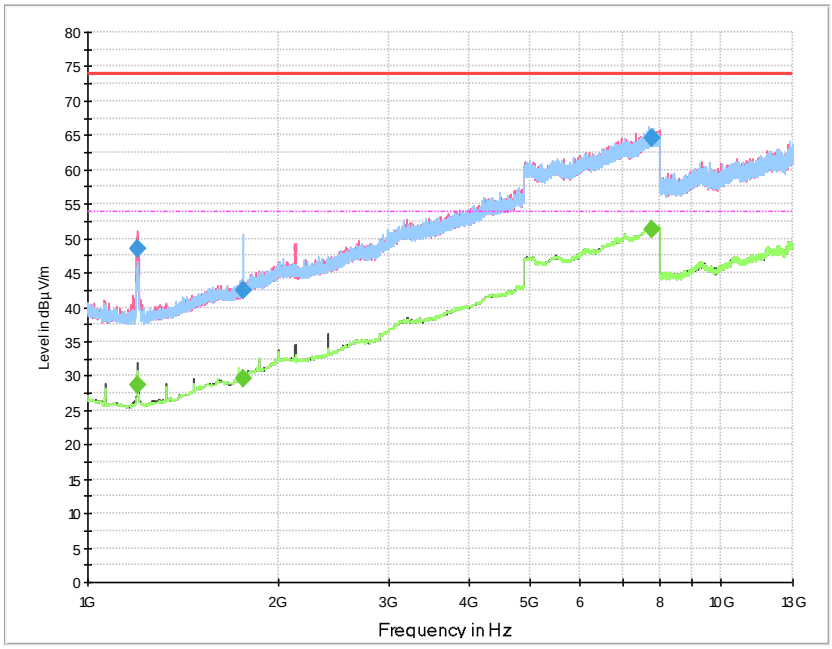
Final Results:

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*
0.748500	45.32	---	70.12	24.80	1000.0	9.000	100.0	H	-49.0	19.1
7.041750	20.57	---	69.54	48.97	1000.0	9.000	100.0	H	240.0	19.1

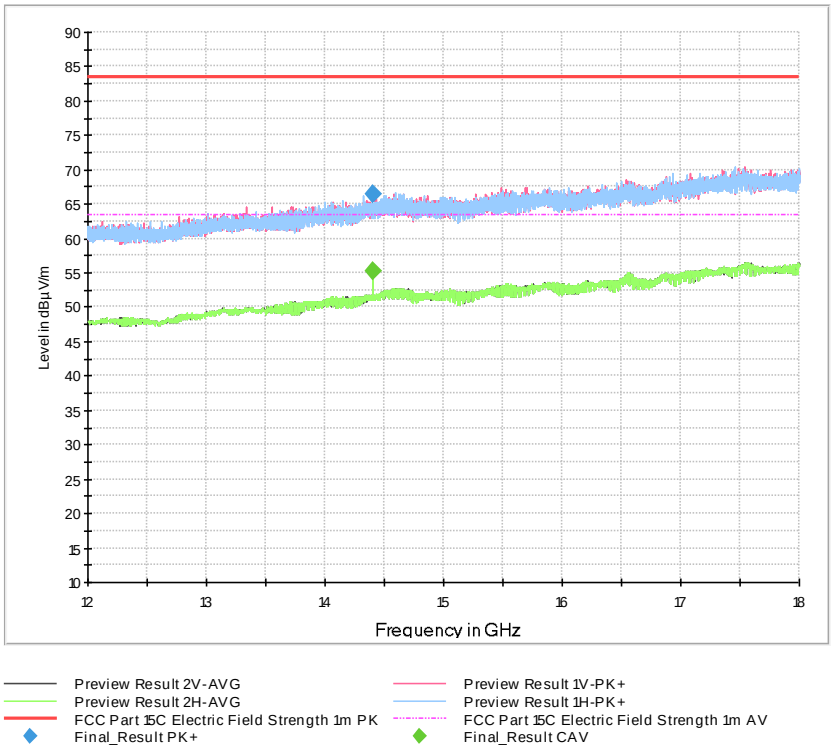


Final Results:

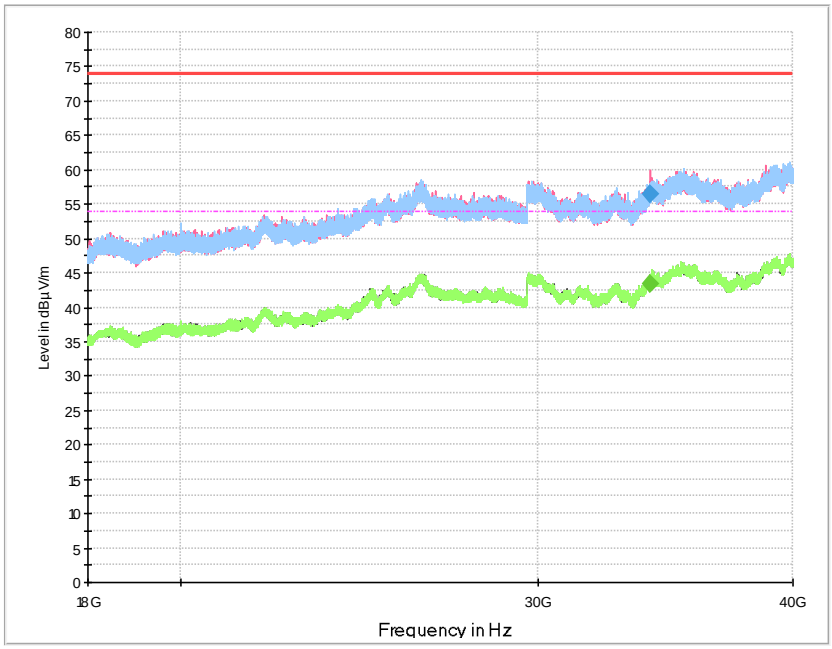
Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
30.090000	28.60	40.00	11.40	1000.0	120.000	128.0	V	231.0	25.8
195.990000	28.26	43.50	15.24	1000.0	120.000	111.0	H	-78.0	16.0
229.740000	26.35	46.02	19.67	1000.0	120.000	134.0	H	-75.0	17.3
238.890000	27.17	46.02	18.85	1000.0	120.000	121.0	H	-21.0	17.6
266.670000	38.98	46.02	7.04	1000.0	120.000	143.0	H	-14.0	18.1
533.310000	37.04	46.02	8.98	1000.0	120.000	144.0	H	2.0	24.0
725.670000	26.15	46.02	19.87	1000.0	120.000	198.0	V	-17.0	27.1
933.450000	33.59	46.02	12.43	1000.0	120.000	119.0	H	0.0	29.1



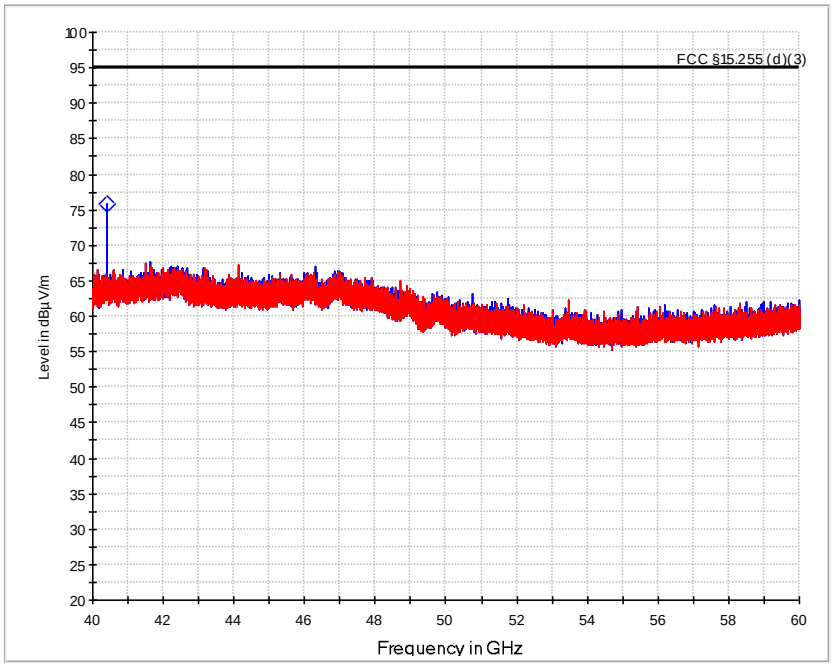
Frequency *MHz*	*MaxPeak* *dBµV/m*	*CAverage* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
1200.500000	48.40	---	73.98	25.58	1000.0	1000.000	321.0	V	68.0	26.7
1200.500000	---	28.59	53.98	25.39	1000.0	1000.000	321.0	V	68.0	26.7
1761.000000	42.38	---	73.98	31.60	1000.0	1000.000	115.0	H	29.0	29.7
1761.000000	---	29.58	53.98	24.40	1000.0	1000.000	115.0	H	29.0	29.7
7790.750000	---	51.37	53.98	2.61	1000.0	1000.000	400.0	V	203.0	43.4
7790.750000	64.70	---	73.98	9.28	1000.0	1000.000	400.0	V	203.0	43.4



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*
14399.500000	---	55.14	63.50	8.36	1000.0	1000.000	165.0	H	69.0	50.2
14399.500000	66.51	---	83.50	16.99	1000.0	1000.000	165.0	H	69.0	50.2

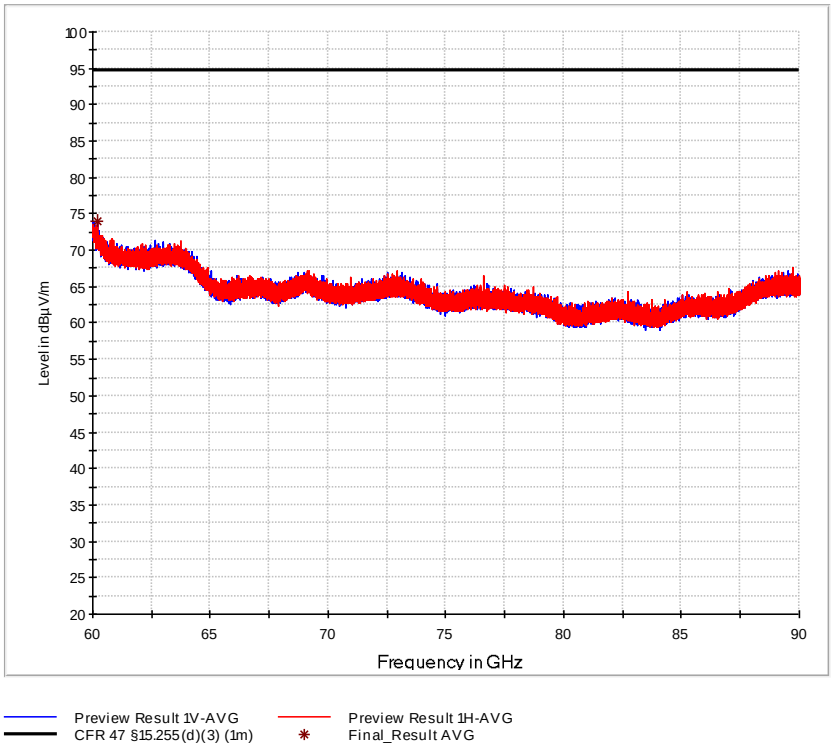


Frequency *MHz*	*MaxPeak* *dBµV/m*	*CAverage* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
34048.500000	---	43.37	53.98	10.61	1000.0	1000.000	159.0	V	-27.0	24.4
34048.500000	56.55	---	73.98	17.43	1000.0	1000.000	159.0	V	-27.0	24.4



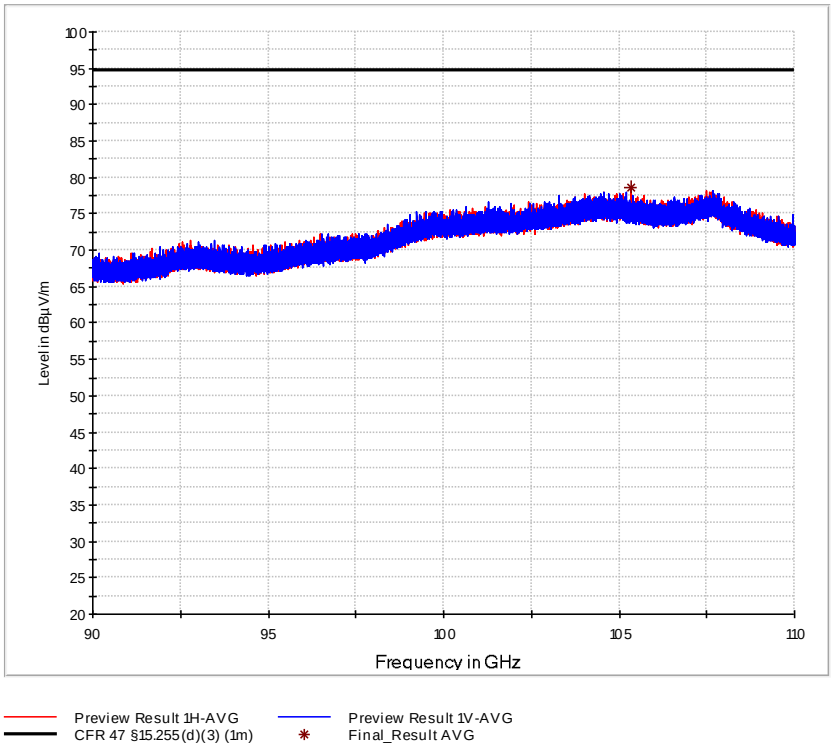
Final Results:

Frequency *MHz*	*MaxPeak* *dBµV/m*	*Average* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
40413.125000	---	75.72	63.50	-12.22	5.0	1000.000	150.0	V	70.0	44



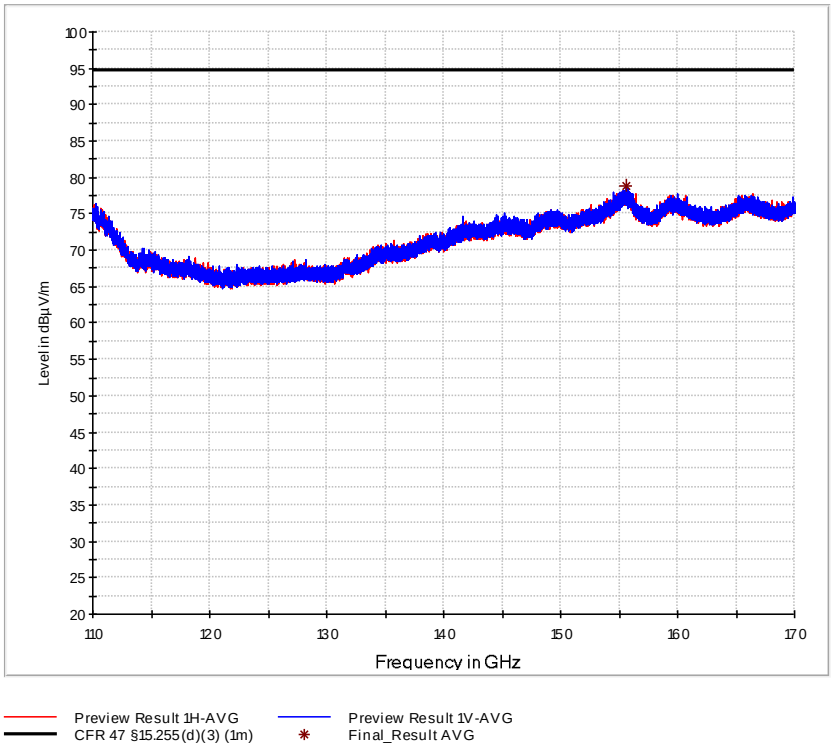
Final Results:

Frequency MHz	*Average dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
60179.062500	73.96	94.65	20.69	2.5	1000.000	150.0	H	25.0	48



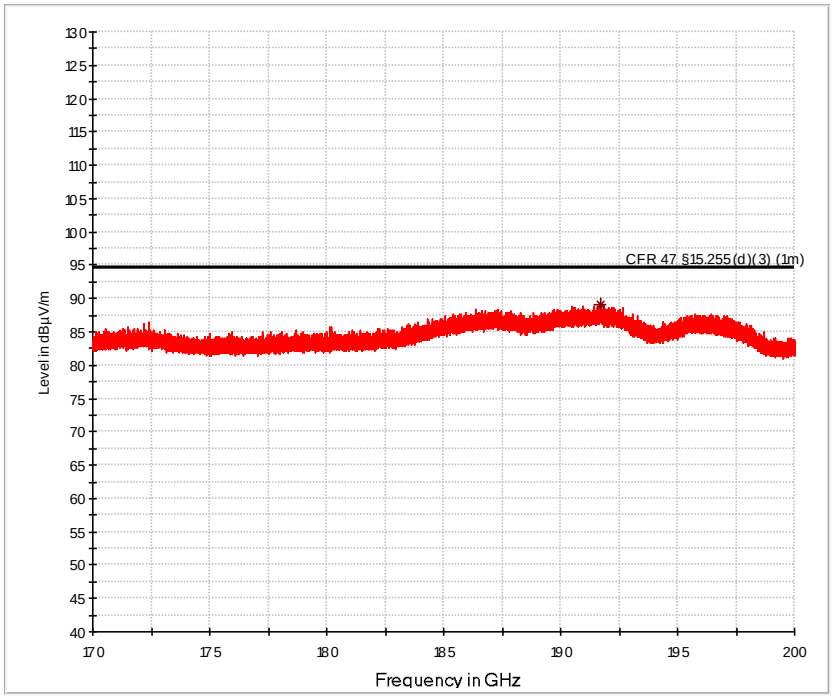
Final Results:

Frequency *MHz*	*Average* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
105324.375000	78.56	94.65	16.09	2.5	1000.000	150.0	H	89.0	50



Final Results:

Frequency *MHz*	*Average* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
155616.875000	78.78	94.65	15.87	2.5	1000.000	150.0	V	4.0	50



Final Results:

Frequency *MHz*	*Average* *dBµV/m*	*Limit* *dBµV/m*	*Margin* *dB*	*Meas. Time* *ms*	*Bandwidth* *kHz*	*Height* *cm*	*Pol*	*Azimuth* *deg*	*Corr.* *dB/m*
191727.500000	89.14	94.65	5.51	2.5	1000.000	150.0	H	228.0	55

10.4 Frequency Stability

Date of Test	2020-05-08
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)
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	60.08074	63.98885
+20.0 °C	12.0 V DC	60.08274	63.98635
+20.0 °C	13.8 V DC	60.08374	63.98435
-20.0 °C	12.0 V DC	60.15312	63.98928
-10.0 °C	12.0 V DC	60.12547	64.00047
0.0 °C	12.0 V DC	60.07682	64.00047
+10.0 °C	12.0 V DC	60.07402	64.00047
+30.0 °C	12.0 V DC	60.05512	64.00047
+40.0 °C	12.0 V DC	60.05337	64.00047
+50.0 °C	12.0 V DC	60.07402	64.00047

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

Sample Test plots taken during test

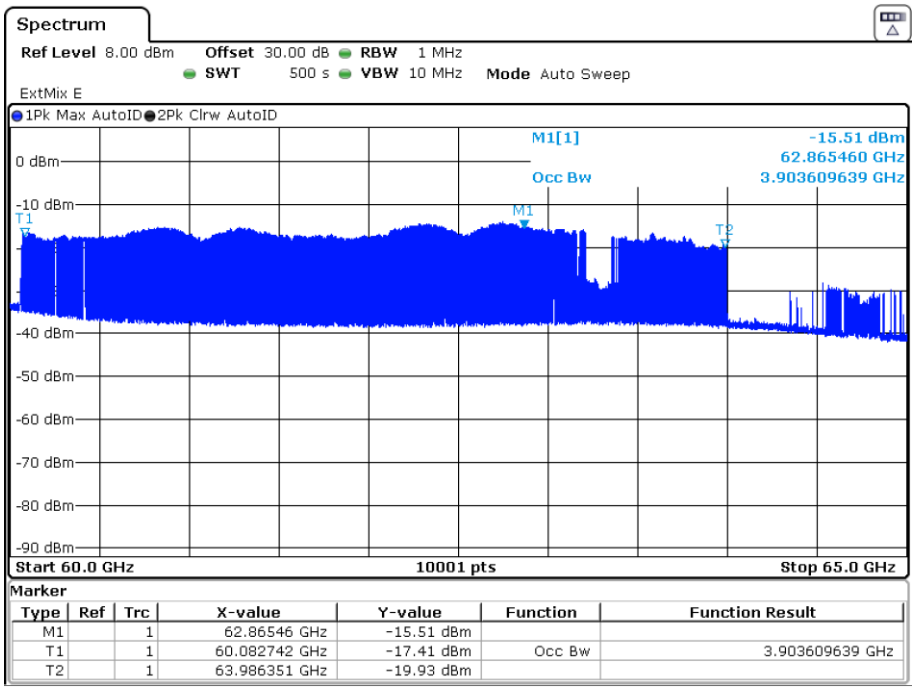


Figure 3 – 20°C and 12 V DC

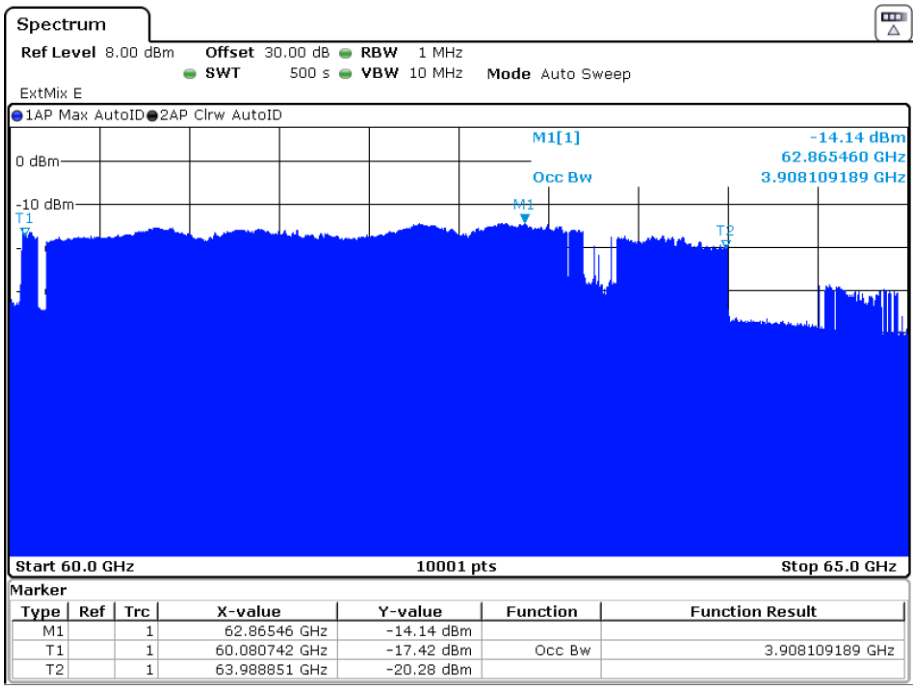


Figure 4 – 20°C and 10.2 V DC

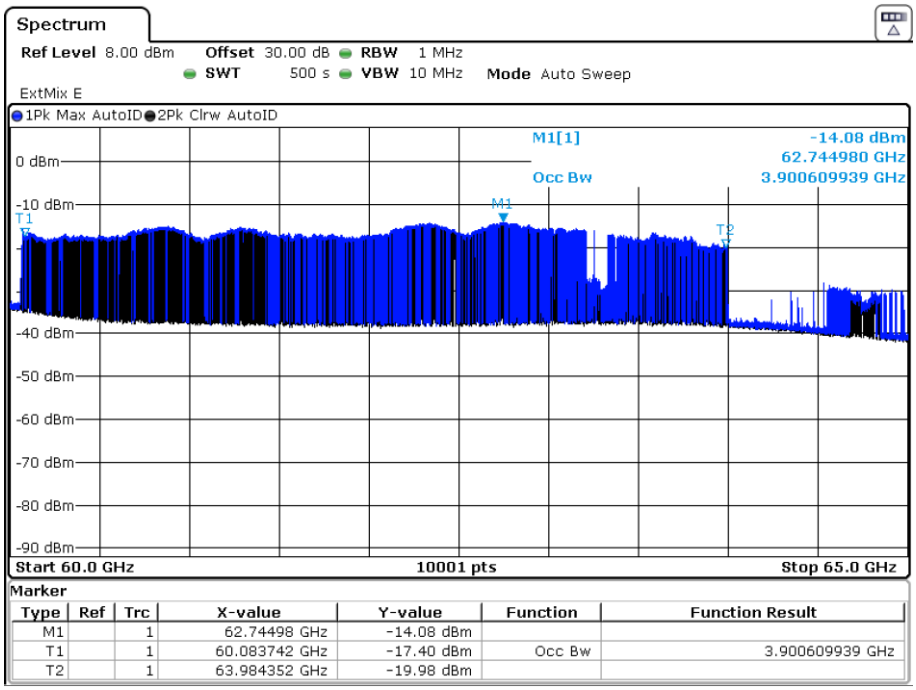


Figure 5 – 20°C and 13.8 V DC

10.5 Duty Cycle

Date of Test	2021-03-29
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*:*	Authorization document DA 21-407; 53. Waiver Conditions
Description:	The transmit duty cycle shall not exceed 10% in any 33ms.
Operation mode:	Normal operation mode
Comment :	---

Result	*Duty Cycle*	*Limit*	*Note*
Pass	$\left(\frac{2.442\ ms}{33.000\ ms}\right) = 7.4\ \%$	10 %	NA
Note(s): ---			

See plots on next page.

Sample Test plots taken during test

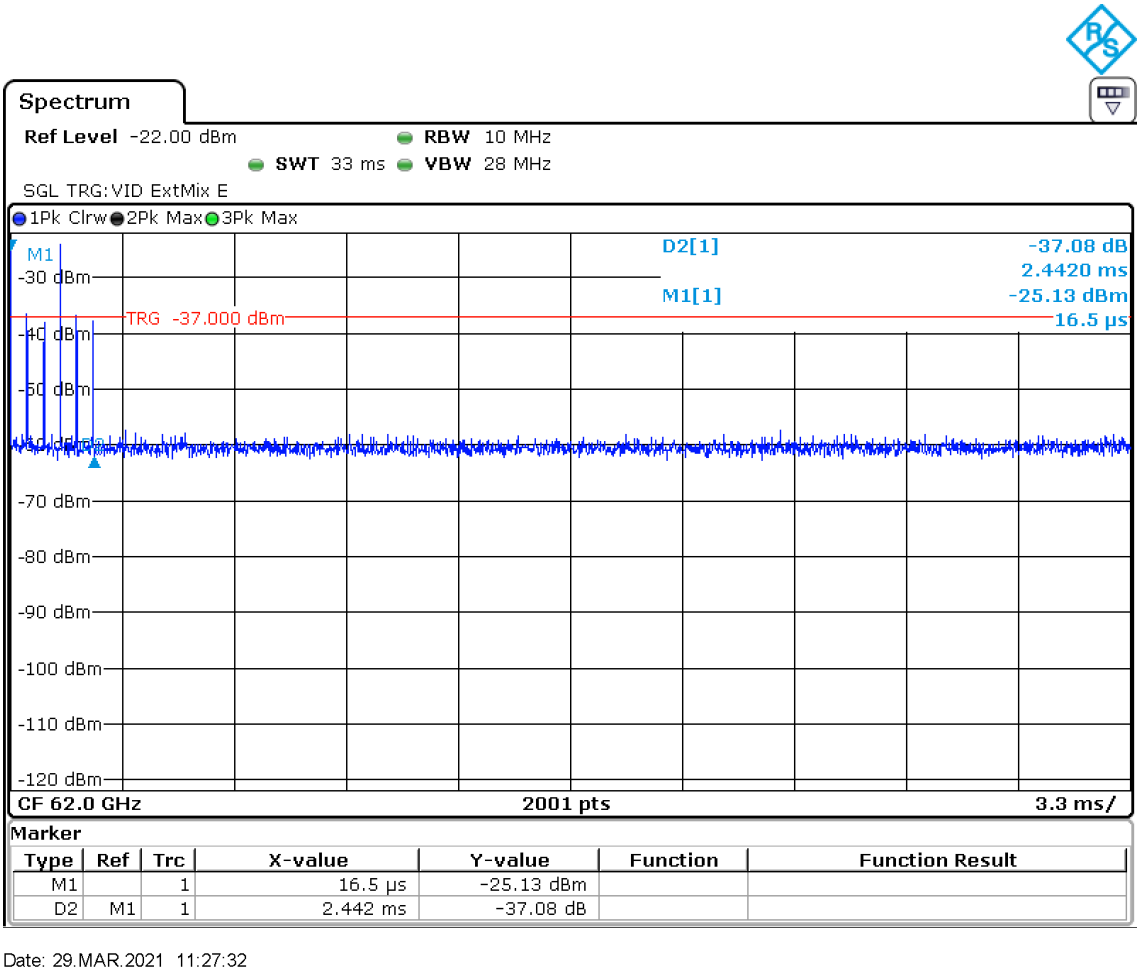


Figure 6 – 33 ms time frame

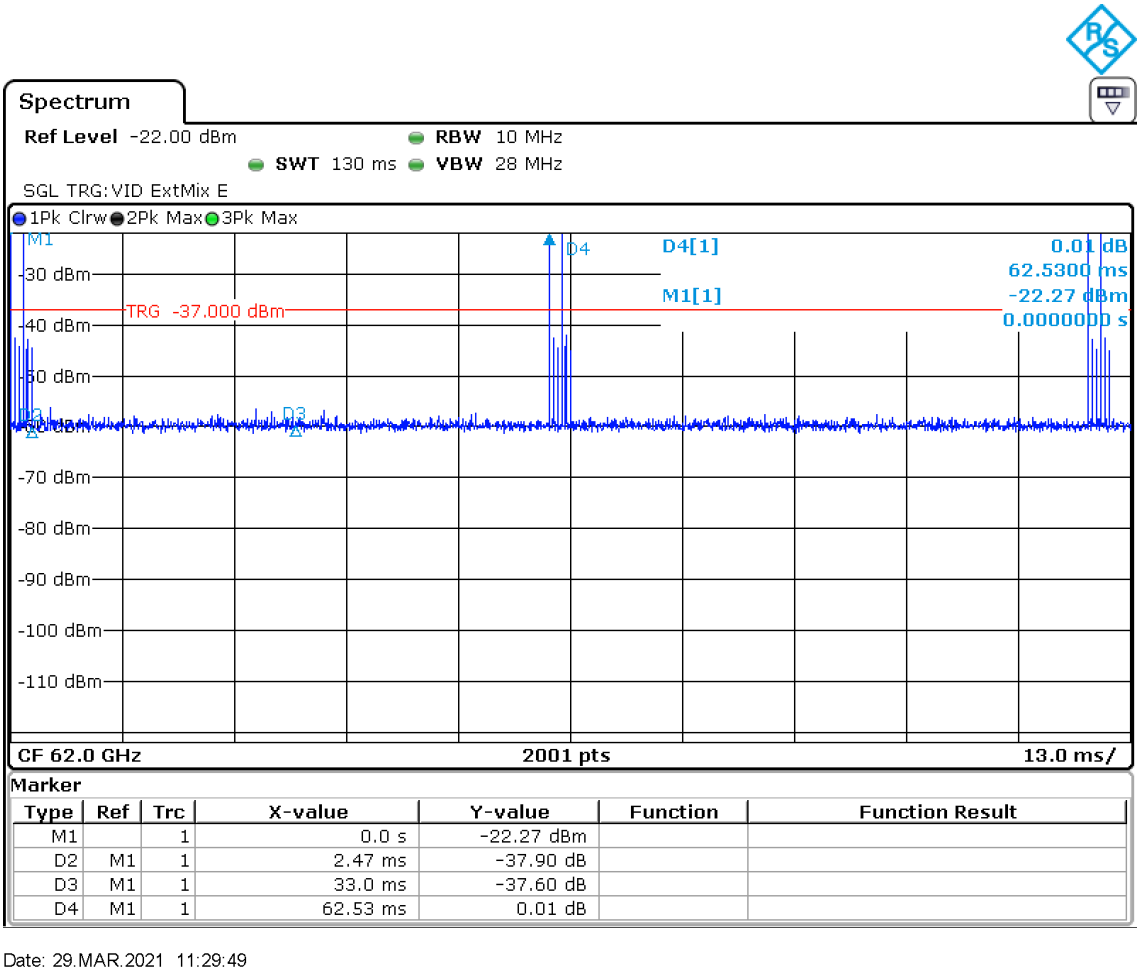


Figure 7 – 130 ms time frame

11 Revision History

Revision History			
Edition	*Date*	*Issued by*	*Modifications*
1	2021-04-15	Alex Fink	First Edition
2	2021-04-19	Alex Fink	Section 10.1, test results updated.