EMI – TEST REPORT

- FCC Part 15.519, RSS-220 -

Type / Model Name	:	Vehicle Tag / KNX-T3.6
Product Description	:	Tracking System for intra-logistics vehicles
Applicant	:	KINEXON Inc.
Address	:	25 Broadway Floor 9
		NEW YORK, NY 10004, USA
Manufacturer	:	KINEXON Inc.
Address	:	Schellingstraße 35
		80799 MÜNCHEN, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. : T46318-00-03FX	27. April 2021 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

CSA Group Bayern GmbH
Ohmstrasse 1-4 · 94342 STRASSKIRCHEN · GERMANY
Tel.: +49(0)9424-94810 · Fax: +49(0)9424-9481440

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Contents

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2019)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2019)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements

FCC Rules and Regulations Part 15, Subpart F – Ultra Wideband Operation (October 2019)

Part 15, Subpart F, Section 15.503	Definitions
Part 15, Subpart F, Section 15.505	Cross reference
Part 15, Subpart F, Section 15.519	Technical requirements for hand held UWB systems
Part 15, Subpart F, Section 15.521	Technical requirements applicable to all UWB devices

ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
KDB 393764 D01 v02 (January 29, 2018)	Ultra-Wideband (UWB) Devices – Frequently Asked Questions
KDB 178919 D01 v06 (October 16, 2015)	Permissive Change Policy

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.4 Equipment type

Portable UWB Device

2.5 Short description of the equipment under test (EUT)

The technology is an UWB Real Time Location System (RTLS) which is used in an indoor industrial environment. The tag is installed on forklifts, trolleys, cranes or other industrial vehicular devices. The EUT communicates with further devices in order to obtain information on the tag position. The equipped vehicles can be globally localized in a factory wide coordinate system.

Number of tested samples:	3
Serial number:	60820 (continuous transmission on channel 3) 60816 (continuous transmission on channel 5) 60815 (signal deactivation)
UWB driver version:	4.27.0

EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.6 Variants of the EUT

There are no variants. The EUT does not contain serial data interfaces or USB interfaces.

2.7 Operation frequency and channel plan

The operating frequency band is 3100 MHz to 10600 MHz.

Channel plan FCC:

Channel number	f_c (MHz)
Channel 3	4492.8
Channel 5	6489.6

Channel plan IC

Channel number	f_c (MHz)
Channel 5	6489.6

2.8 Transmit operating modes

Modulation: variable pulse position modulation (PPM) in combination with binary phase shift keying (BPSK).

Data rate: 6.8 Mbit/s

2.9 Antenna

The following antennas shall be used with the EUT:

Number	Characteristic	Model number	Plug	f-range (GHz)	Gain (dBi)
1	Omni	M82-04a	U.FL (UMCC) connector 50 ohms	3 – 8	3.3

2.10 Power supply system utilised

Power supply voltage, V_{nom} : 9 - 30 VDC
Test Voltage : 24 VDC

2.11 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Cable for power supply Model : Self-made
- _____ Model : _____
- _____ Model : _____

2.12 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes with horizontal and vertical antenna positions to determine the worst case condition.

2.12.1 Test jig

No test jig is used.

2.12.2 Test software

No test software was used. The EUT is in a continuous transmission mode, when voltage is applied.

3 TEST RESULT SUMMARY

UWB device using digital modulation:

Operating in the 3100 MHz – 10600 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	passed
15.519(b)	RSS-220, 2, 5.1(a)	UWB Bandwidth	passed
15.209(a) 15.519(c)	RSS-Gen, 8.9 RSS-220, 3.4, 5.3.1(c), 5.3.1(d)	Radiated Emissions 9 kHz to 40 GHz	passed
15.519(d)	RSS-220, 5.3.1(e)	Radiated Emissions at 1164-1240 MHz and 1559-1610 MHz	passed
15.519(e)	RSS-220, 5.3.1(g)	Peak Power radiated	passed
15.519(a)	RSS-220, 5.3.1(b)	Signal deactivation	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS-Gen, Issue 5, March 2019
RSS-220, Issue 1, July 2018

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 01 April 2020

Testing concluded on : 12 May 2020

Checked by:

Klaus Gegenfurtner
Teamleader Radio

Tested by:

I am the author of this document
2021.04.27 19:39:39 +02'00'

Franz-Xaver Schrettenbrunner
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
20 dB Bandwidth	Center frequency of EUT	95%	$\pm 2.5 \times 10^{-7}$
99% Occupied Bandwidth	Center frequency of EUT	95%	$\pm 2.5 \times 10^{-7}$
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	± 3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 3.71 dB
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	± 2.34 dB
Peak conducted output power	902 MHz to 928 MHz	95%	± 0.35 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB

4.4 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

4.5 Measurement protocol for FCC and ISED

4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011
ISED: DE0009

4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.5.2.2 Radiated emission (electrical field 30 MHz - 1 GHz)

Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.10.The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.
The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC or CISPR limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	CISPR Limit (dBµV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

4.5.2.3 Radiated emission (electrical field 1 GHz - 40 GHz)

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table, 1.5 metre above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyzer set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

5 TEST CONDITIONS AND RESULTS

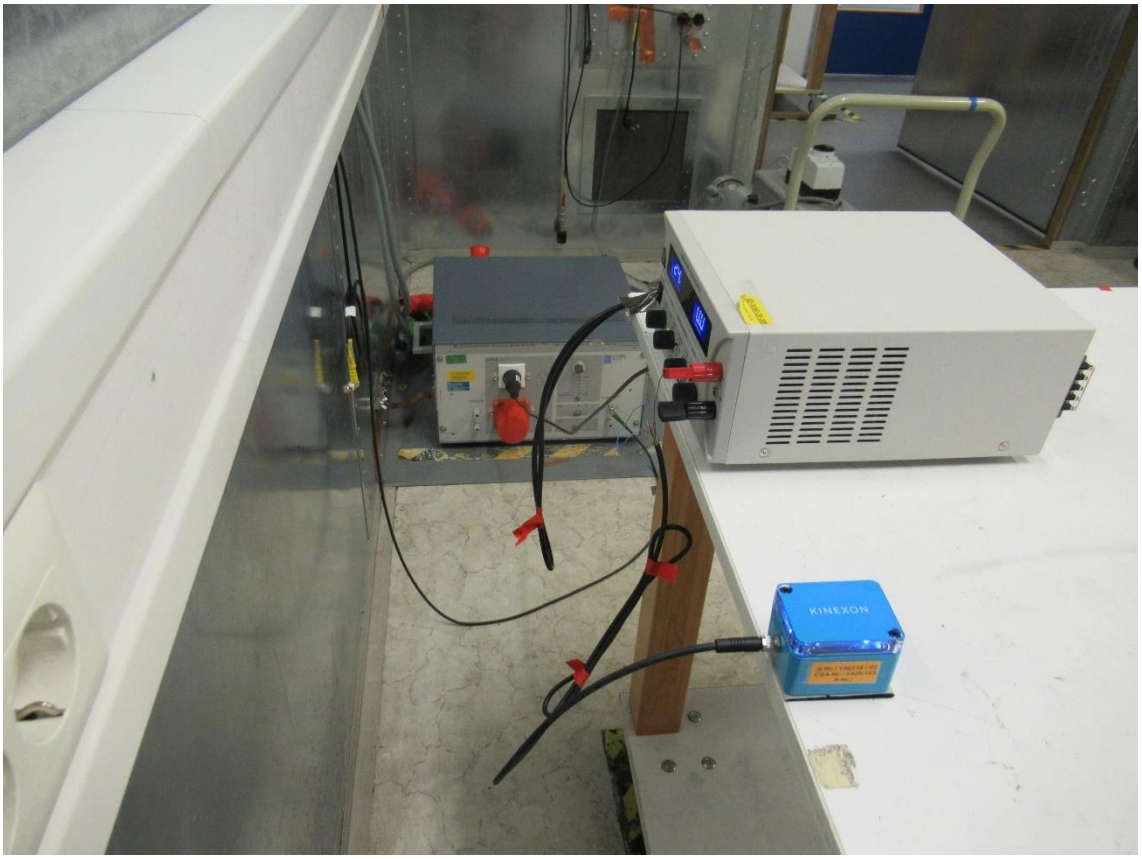
5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin -17.31 dB at 20.001 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

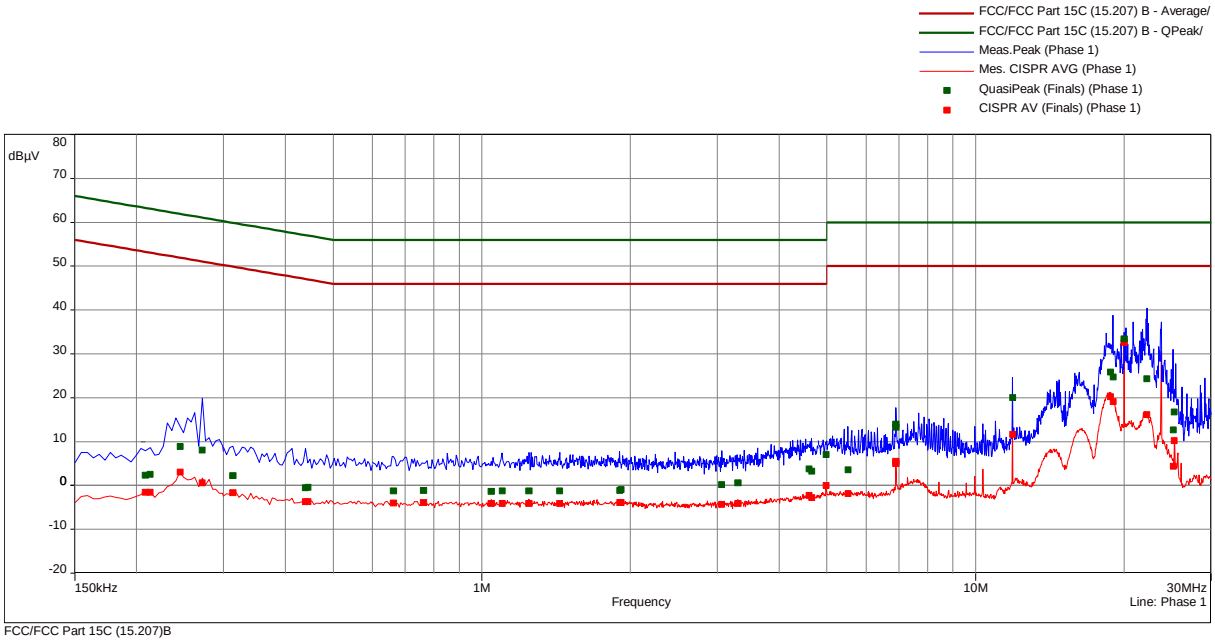
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols.

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

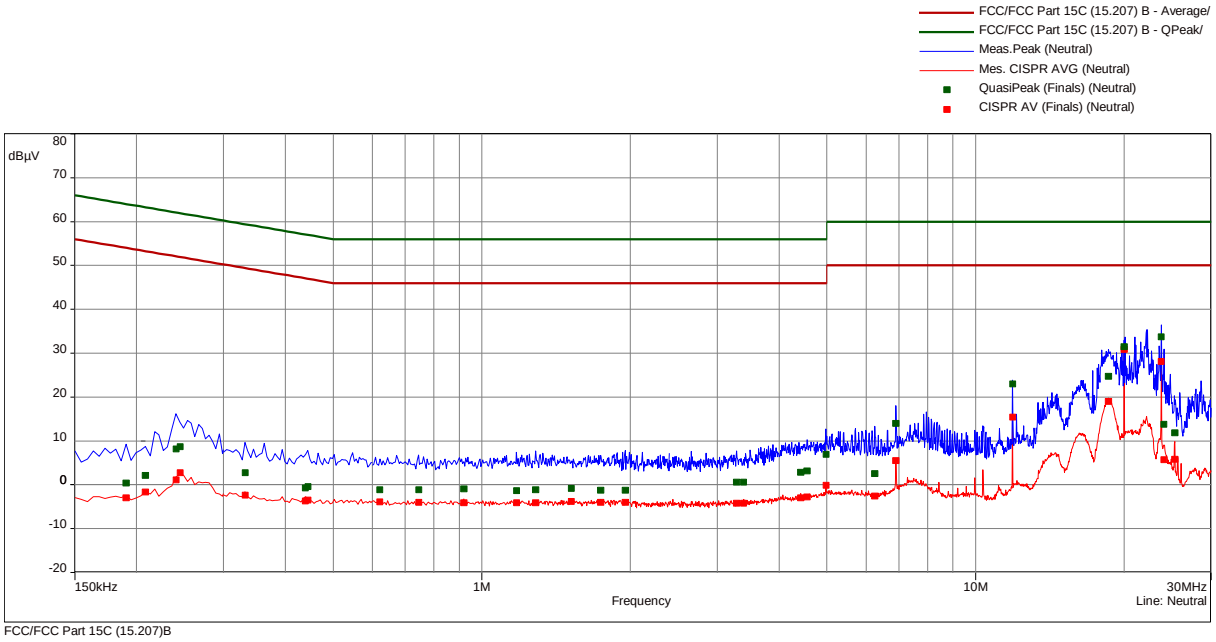
5.1.6 Test protocol



FCC/FCC Part 15C (15.207)B

freq	QP	margin	limit	AV	margin	limit	corr
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB	dB
0.209	2.40	-60.87	63.26	-1.47	-54.73	53.26	10.11
0.213	2.62	-60.46	63.09	-1.52	-54.61	53.09	10.11
0.245	8.93	-53.01	61.94	3.07	-48.88	51.94	10.12
0.272	8.09	-52.98	61.07	0.61	-50.46	51.07	10.13
0.314	2.26	-57.62	59.88	-1.55	-51.43	49.88	10.14
0.440	-0.50	-57.57	57.07	-3.59	-50.66	47.07	10.16
0.444	-0.34	-57.33	56.99	-3.62	-50.60	46.99	10.16
0.663	-1.22	-57.22	56.00	-3.92	-49.92	46.00	10.18
0.762	-1.04	-57.04	56.00	-3.88	-49.88	46.00	10.19
1.046	-1.28	-57.28	56.00	-4.06	-50.06	46.00	10.21
1.100	-1.19	-57.19	56.00	-4.05	-50.05	46.00	10.22
1.245	-1.17	-57.17	56.00	-4.06	-50.06	46.00	10.24
1.439	-1.14	-57.14	56.00	-4.00	-50.00	46.00	10.26
1.902	-1.05	-57.05	56.00	-3.88	-49.88	46.00	10.27
1.911	-0.88	-56.88	56.00	-3.83	-49.83	46.00	10.27
3.062	0.27	-55.73	56.00	-4.20	-50.20	46.00	10.35
3.305	0.71	-55.29	56.00	-4.02	-50.02	46.00	10.35
4.601	3.79	-52.21	56.00	-2.21	-48.21	46.00	10.43
4.650	3.31	-52.69	56.00	-2.75	-48.75	46.00	10.43
4.980	7.06	-48.94	56.00	0.06	-45.94	46.00	10.44
5.507	3.65	-56.35	60.00	-1.76	-51.76	50.00	10.49
6.897	13.34	-46.66	60.00	5.07	-44.93	50.00	10.59
6.902	14.01	-45.99	60.00	5.57	-44.43	50.00	10.60
11.877	20.05	-39.95	60.00	11.70	-38.30	50.00	10.92
18.767	25.89	-34.11	60.00	20.30	-29.70	50.00	11.40
18.983	24.77	-35.23	60.00	19.13	-30.87	50.00	11.42
20.001	33.46	-26.54	60.00	32.69	-17.31	50.00	11.46
22.238	24.35	-35.65	60.00	16.24	-33.76	50.00	11.57
25.113	12.73	-47.27	60.00	4.45	-45.55	50.00	11.68
25.293	16.80	-43.20	60.00	10.27	-39.73	50.00	11.68

FCC ID: 2ALC5-KNX-VTAG1 IC: 25557-KNXVTAG1



FCC/FCC Part 15C (15.207)B

freq	QP	margin	limit	AV	margin	limit	corr
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB	dB
0.191	0.44	-63.57	64.01	-2.93	-56.95	54.01	10.12
0.209	2.25	-61.02	63.26	-1.62	-54.88	53.26	10.13
0.240	8.18	-53.91	62.10	1.22	-50.88	52.10	10.13
0.245	8.78	-53.17	61.94	2.80	-49.15	51.94	10.13
0.332	2.83	-56.59	59.41	-2.34	-51.75	49.41	10.15
0.440	-0.66	-57.73	57.07	-3.59	-50.66	47.07	10.16
0.444	-0.34	-57.33	56.99	-3.44	-50.42	46.99	10.16
0.623	-1.06	-57.06	56.00	-3.88	-49.88	46.00	10.18
0.744	-1.12	-57.12	56.00	-3.95	-49.95	46.00	10.19
0.920	-0.87	-56.87	56.00	-3.99	-49.99	46.00	10.20
1.176	-1.26	-57.26	56.00	-4.01	-50.01	46.00	10.23
1.286	-1.07	-57.07	56.00	-4.05	-50.05	46.00	10.24
1.520	-0.80	-56.80	56.00	-3.78	-49.78	46.00	10.27
1.74	-1.13	-57.13	56.00	-3.97	-49.97	46.00	10.28
1.952	-1.14	-57.14	56.00	-3.91	-49.91	46.00	10.27
3.282	0.62	-55.38	56.00	-4.14	-50.14	46.00	10.35
3.395	0.62	-55.38	56.00	-4.13	-50.13	46.00	10.35
4.425	2.90	-53.10	56.00	-2.87	-48.87	46.00	10.41
4.560	3.21	-52.79	56.00	-2.71	-48.71	46.00	10.42
4.980	6.99	-49.01	56.00	-0.06	-46.06	46.00	10.44
6.254	2.60	-57.40	60.00	-2.49	-52.49	50.00	10.52
6.902	14.02	-45.98	60.00	5.55	-44.45	50.00	10.57
11.882	23.09	-36.91	60.00	15.47	-34.53	50.00	10.81
18.600	24.75	-35.25	60.00	19.05	-30.95	50.00	11.19
20.001	31.56	-28.44	60.00	30.88	-19.12	50.00	11.25
23.763	33.78	-26.22	60.00	28.12	-21.88	50.00	11.26
24.101	13.84	-46.16	60.00	5.77	-44.23	50.00	11.26
25.302	11.88	-48.12	60.00	5.83	-44.17	50.00	11.24

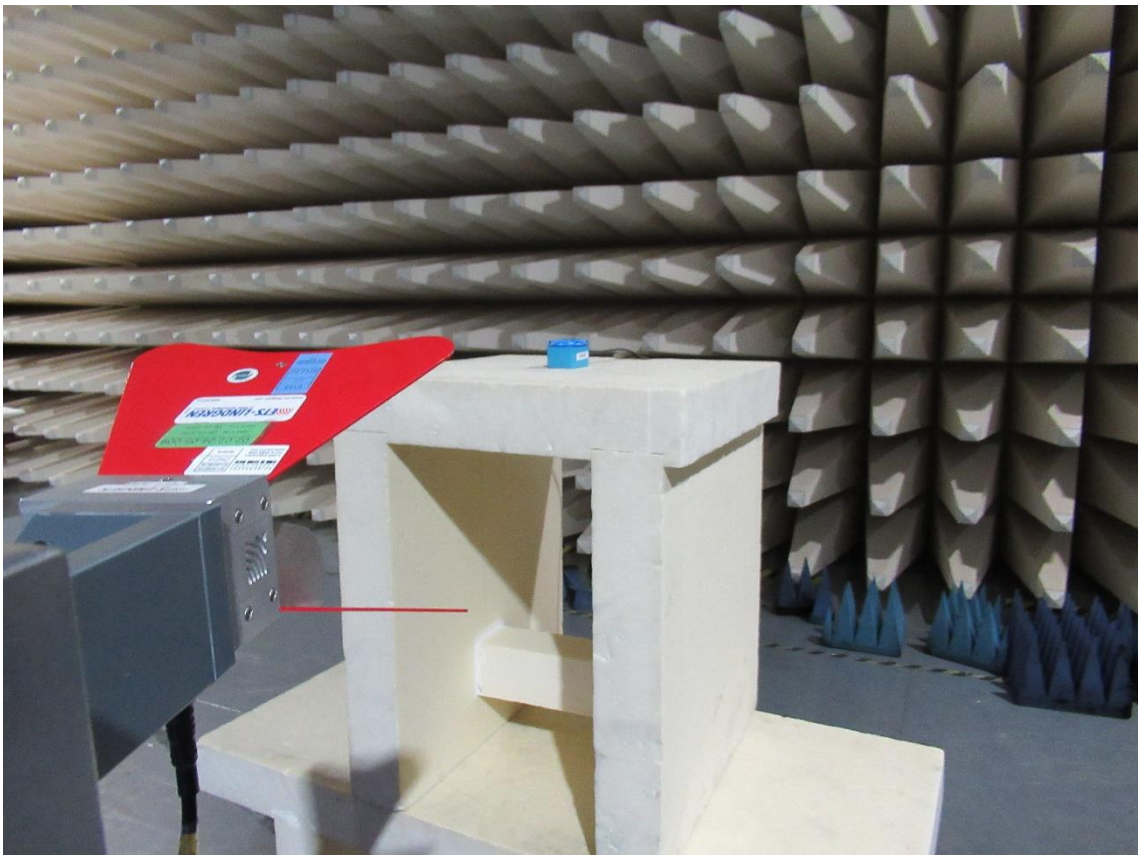
5.2 UWB Bandwidth

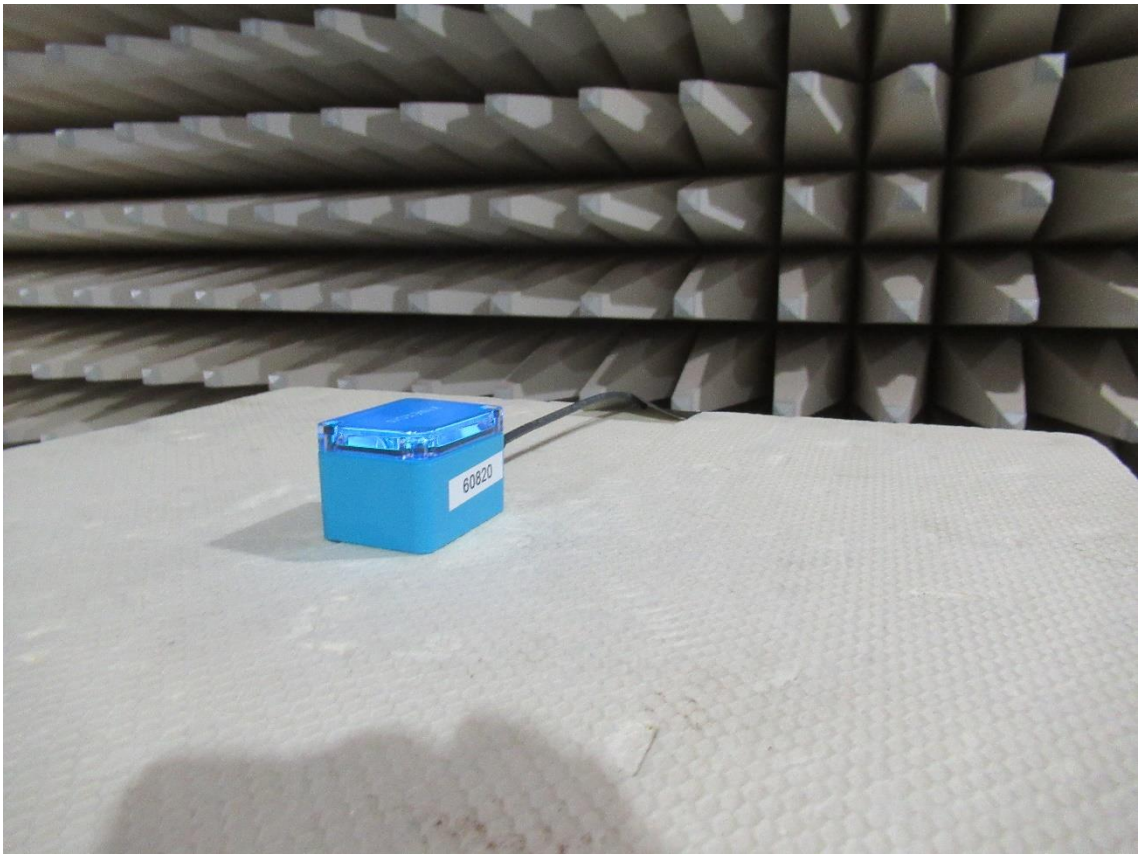
For test instruments and accessories used see section 6 Part **CPR 3**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1

5.2.2 Photo documentation of the test set-up





5.2.3 Applicable standard

According to FCC Part 15, Section 15.519(b):
The UWB bandwidth of a UWB system operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

According to FCC Part 15, Section 15.503(d):
Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

5.2.4 Description of Measurement

The measurement was performed radiated at a distance of 3 m. The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -10 dB.

Spectrum analyser settings:
RBW: 1 MHz, VBW: 3 MHz, Detector: Peak

5.2.5 Test result

channel	lowest frequency f_L (MHz)	highest frequency f_H (MHz)	permitted frequency range (GHz)	UWB bandwidth (MHz)	required UWB bandwidth (MHz)	result
3	4301.07	4804.91	3.1 – 10.6	503.84	> 500	passed
5	6222.61	6810.05	3.1 – 10.6	587.44	> 500	passed

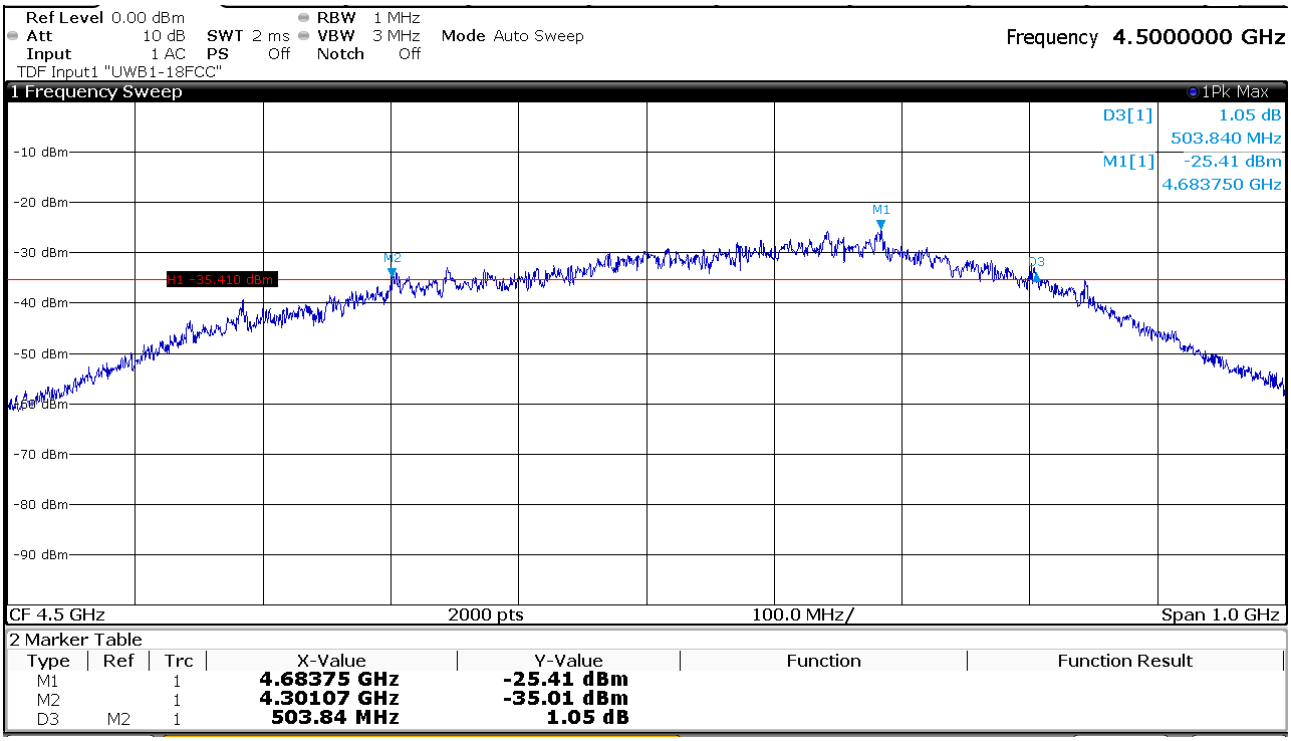
The requirements are **FULFILLED.**

Remarks: For detailed test results please refer to following test protocols.

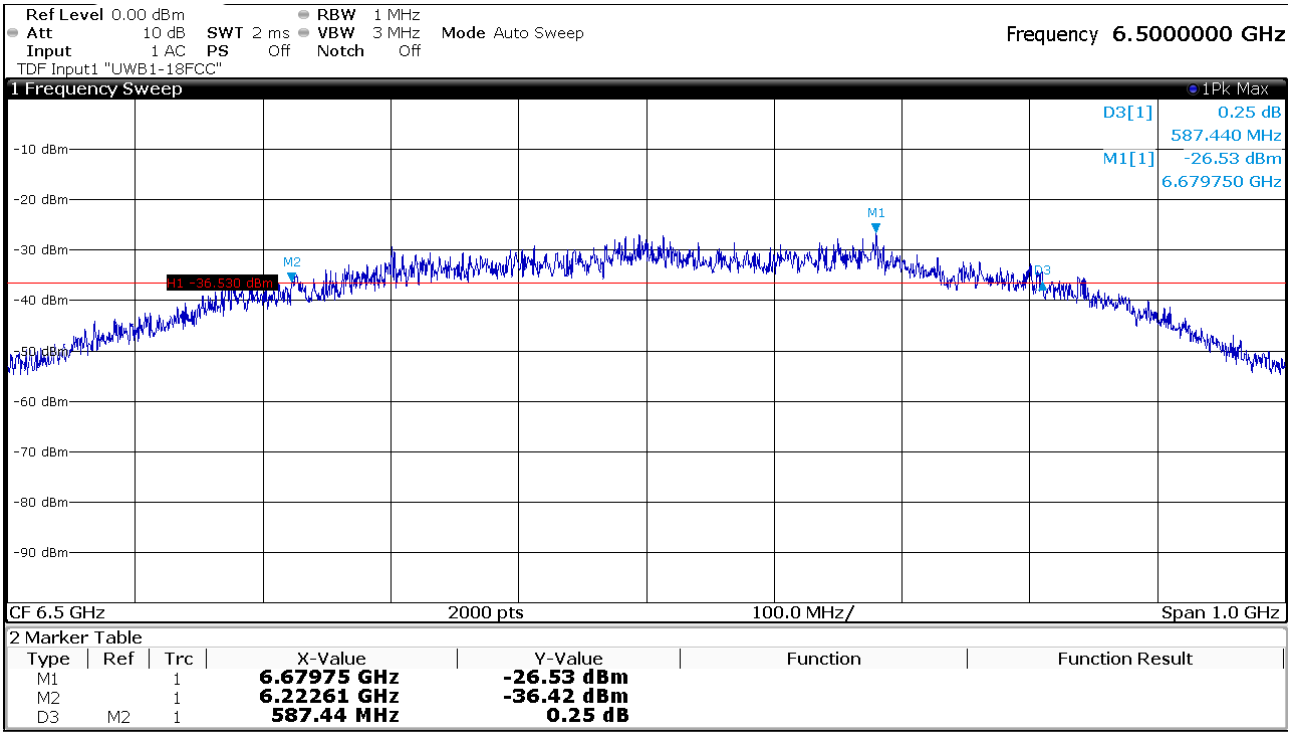
FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

5.2.6 Test protocols EBW

Channel 3



Channel 5



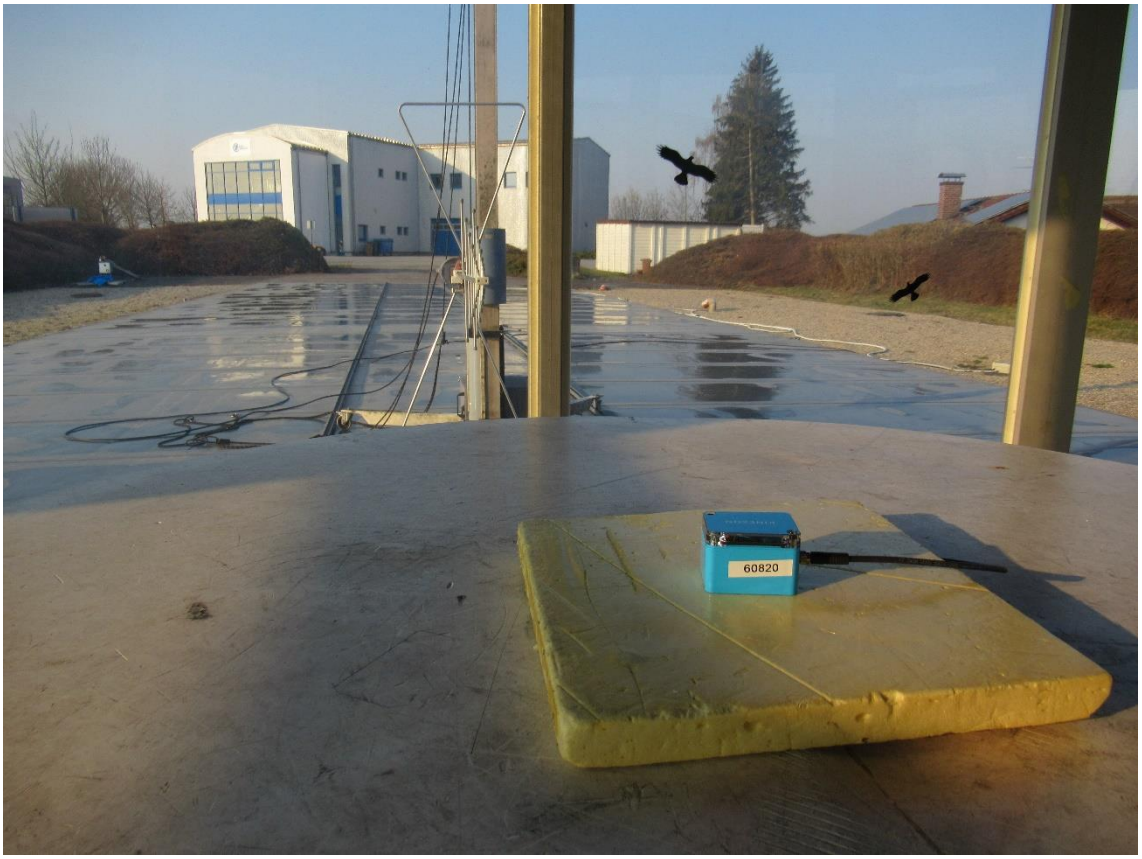
5.3 Radiated Emissions 9 kHz to 40 GHz

For test instruments and accessories used see section 6 Part **SER 2** and **SER 3**.

5.3.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 1

5.3.2 Photo documentation of the test set-up



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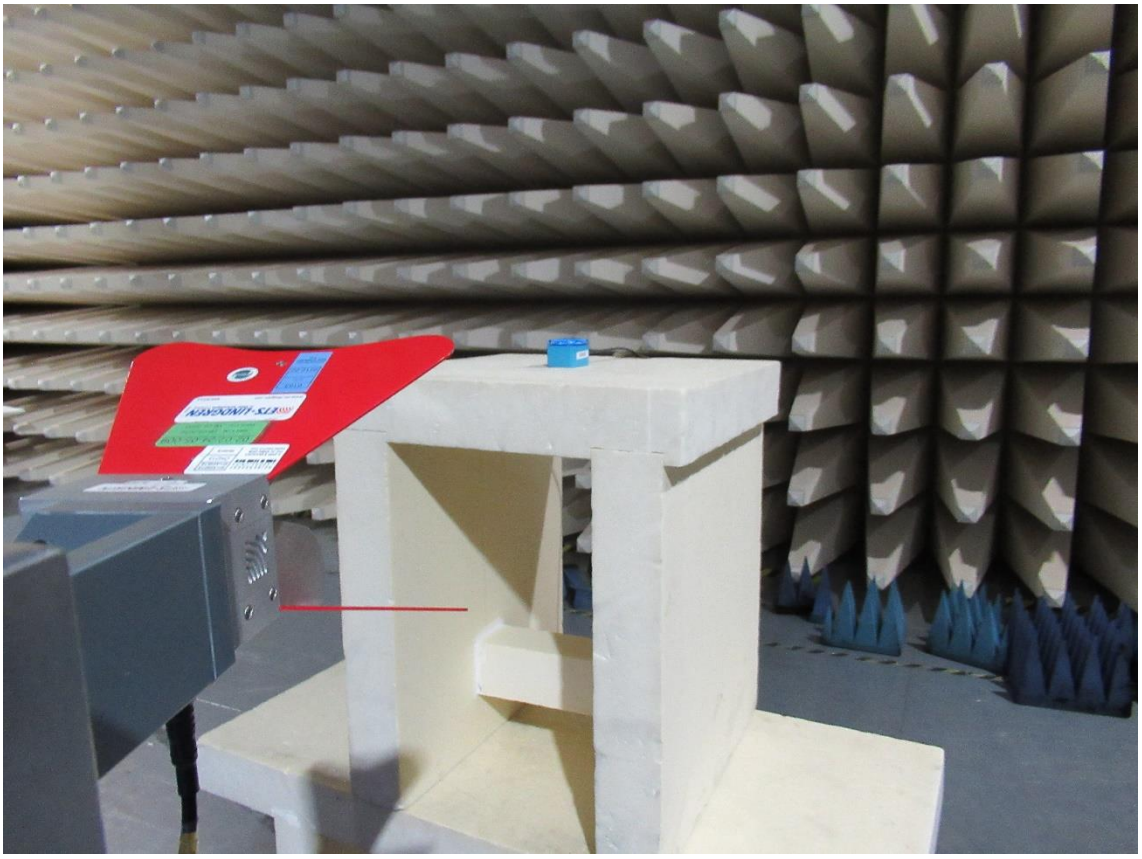
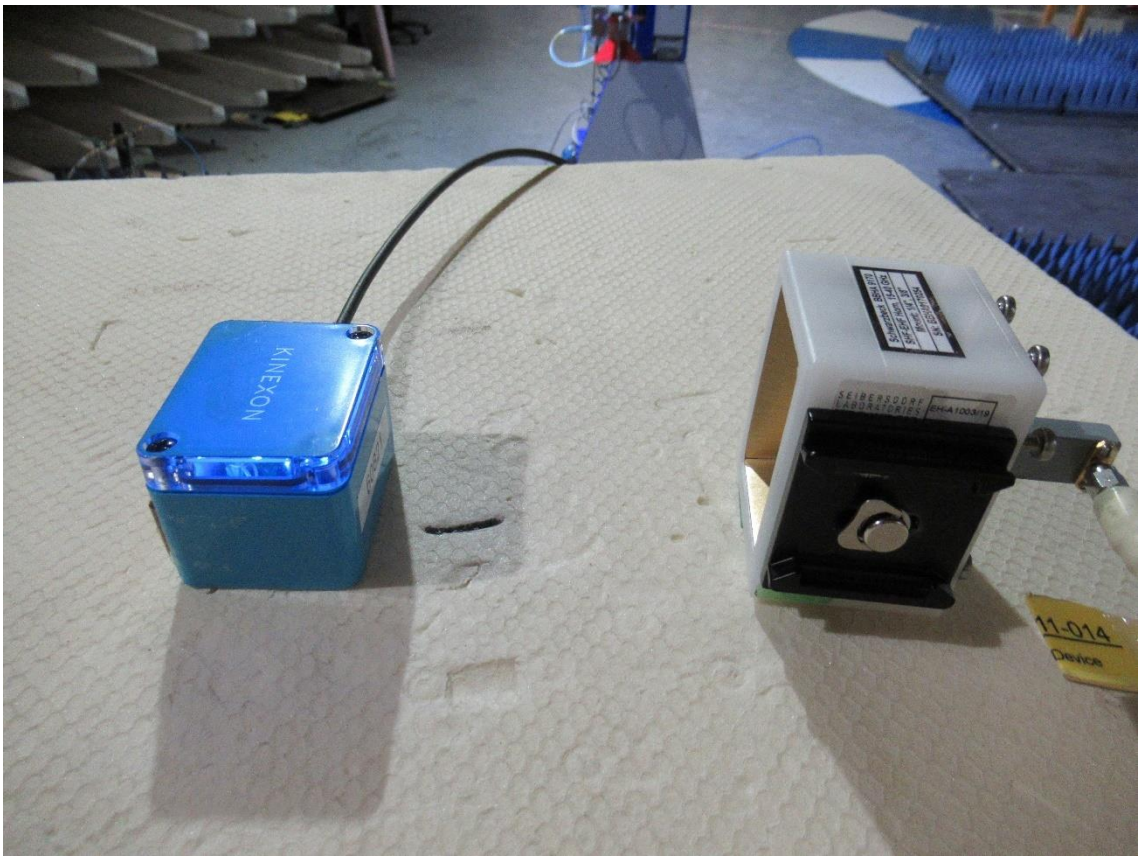




5.3.3 Applicable standard

According to FCC Part 15, Section 15.519(c):
The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

5.3.4 Analyser settings

9 kHz – 150 kHz	RBW: 200 Hz			
150 kHz - 30 MHz	RBW: 9 kHz			
30 MHz – 960 MHz	RBW: 120 kHz	Detector: QP		
960 MHz – 40 GHz	RBW: 1 MHz	VBW: 3 MHz	Detector: RMS	Sweeptime: 1ms per MHz

5.3.5 Test result

5.3.5.1 Measurement 9 kHz to 30 MHz

Note: Pre-measurements have shown, there are no detectable emissions in this frequency range.

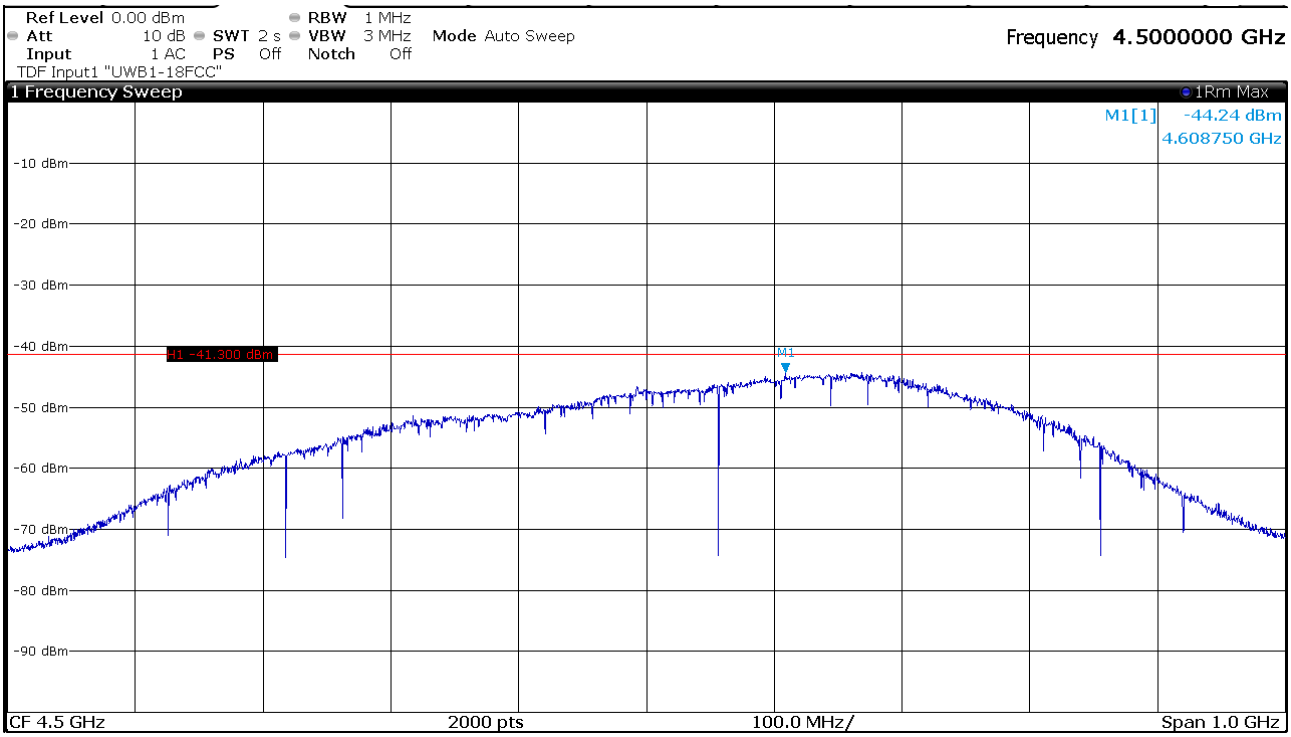
5.3.5.2 Measurement 30 MHz to 960 MHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
65,89	1,4	-1,0	14,3	13,5	15,7	12,5	40,0	-24,3
148,50	8,9	8,1	13,8	14,7	22,7	22,8	43,5	-20,7
297,04	2,2	12,6	16,7	16,3	18,9	28,9	46,0	-17,1
445,55	-1,9	-0,8	21,1	20,8	19,2	20,0	46,0	-26,0
742,49	10,0	6,2	28,1	27,5	38,1	33,7	46,0	-7,9
841,41	-1,3	-1,7	30,2	29,7	28,9	28,0	46,0	-17,1

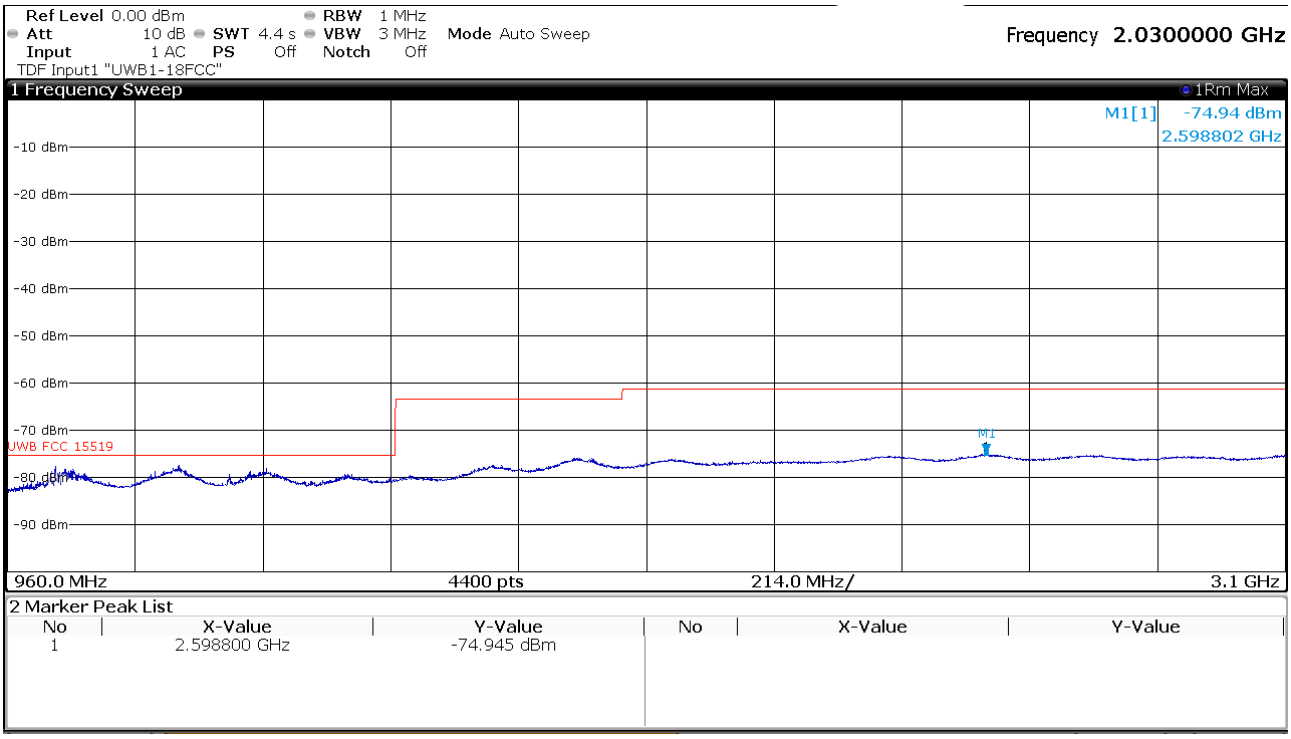
5.3.5.3 Measurement 960 MHz to 40 GHz

Channel 3

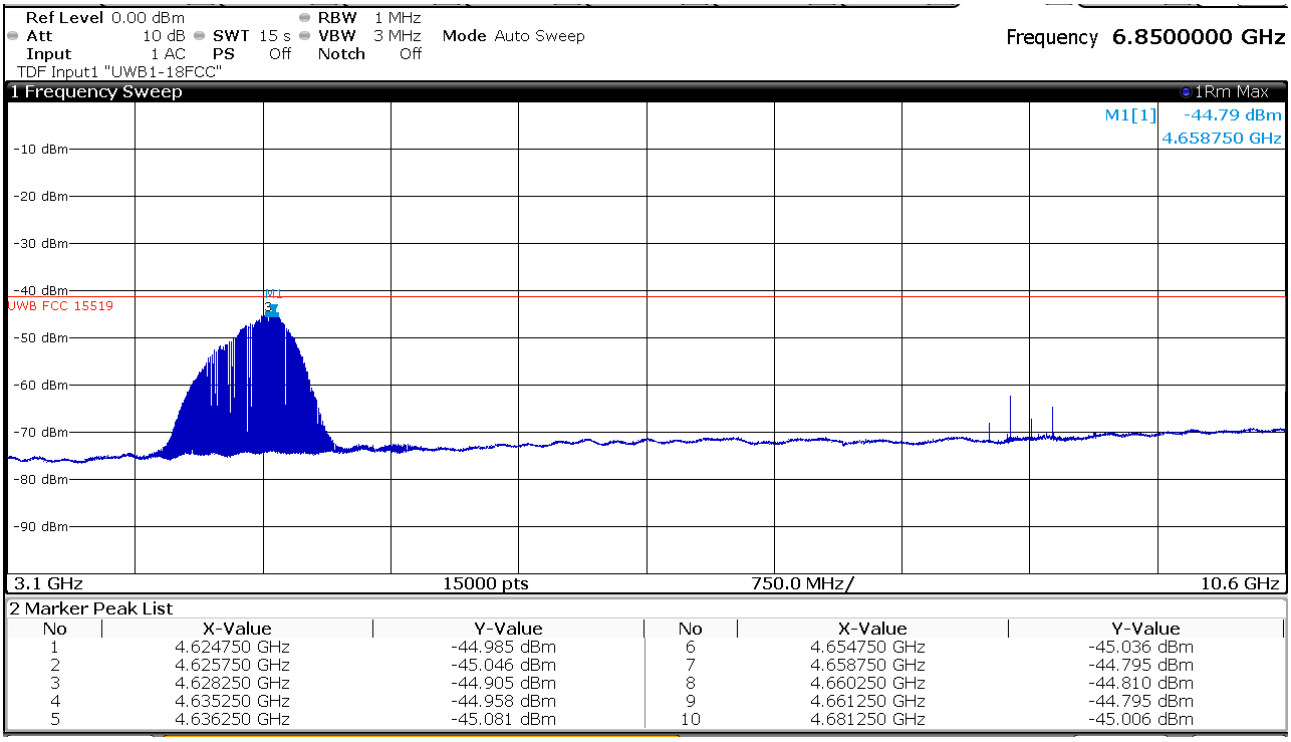
Mean Power



960 MHz to 18 GHz

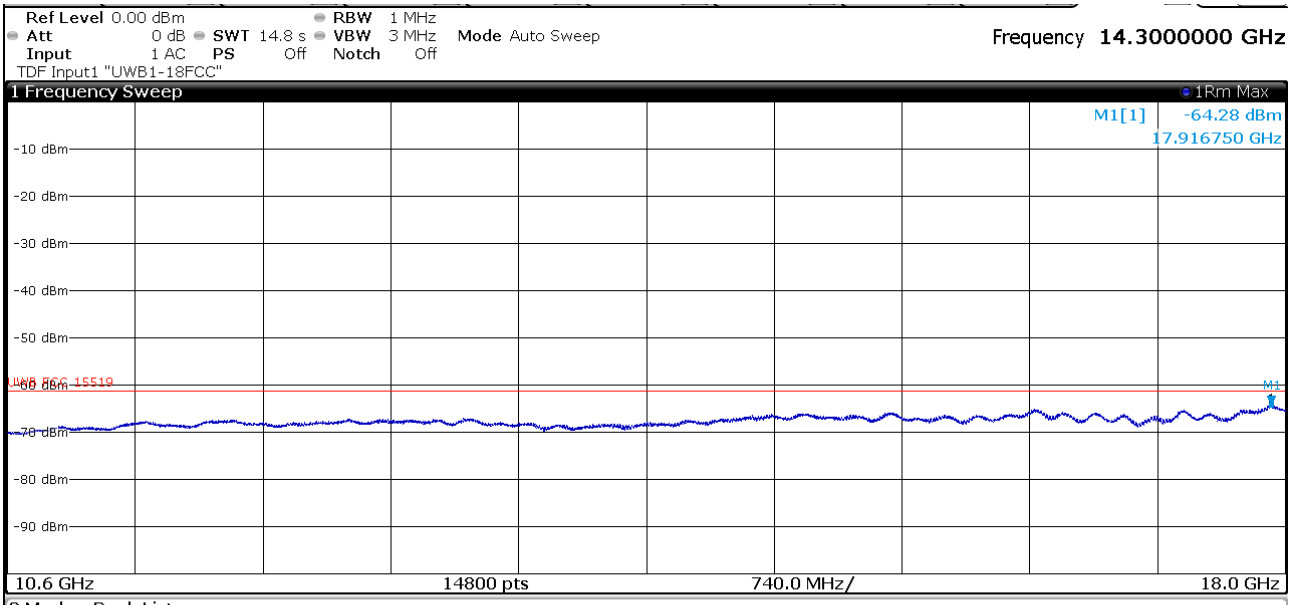


FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	4.624750 GHz	-44.985 dBm	6	4.654750 GHz	-45.036 dBm
2	4.625750 GHz	-45.046 dBm	7	4.658750 GHz	-44.795 dBm
3	4.628250 GHz	-44.905 dBm	8	4.660250 GHz	-44.810 dBm
4	4.635250 GHz	-44.958 dBm	9	4.661250 GHz	-44.795 dBm
5	4.636250 GHz	-45.081 dBm	10	4.681250 GHz	-45.006 dBm

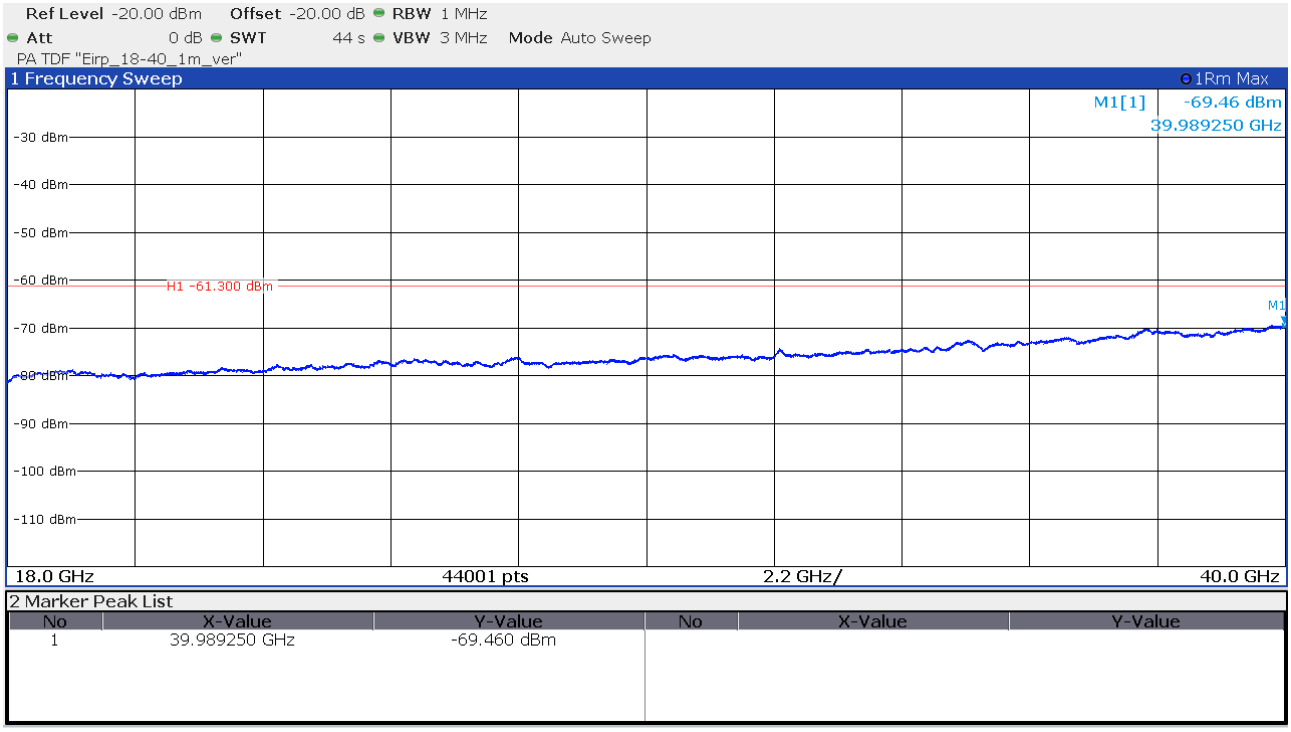


2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	17.916750 GHz	-64.281 dBm			

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

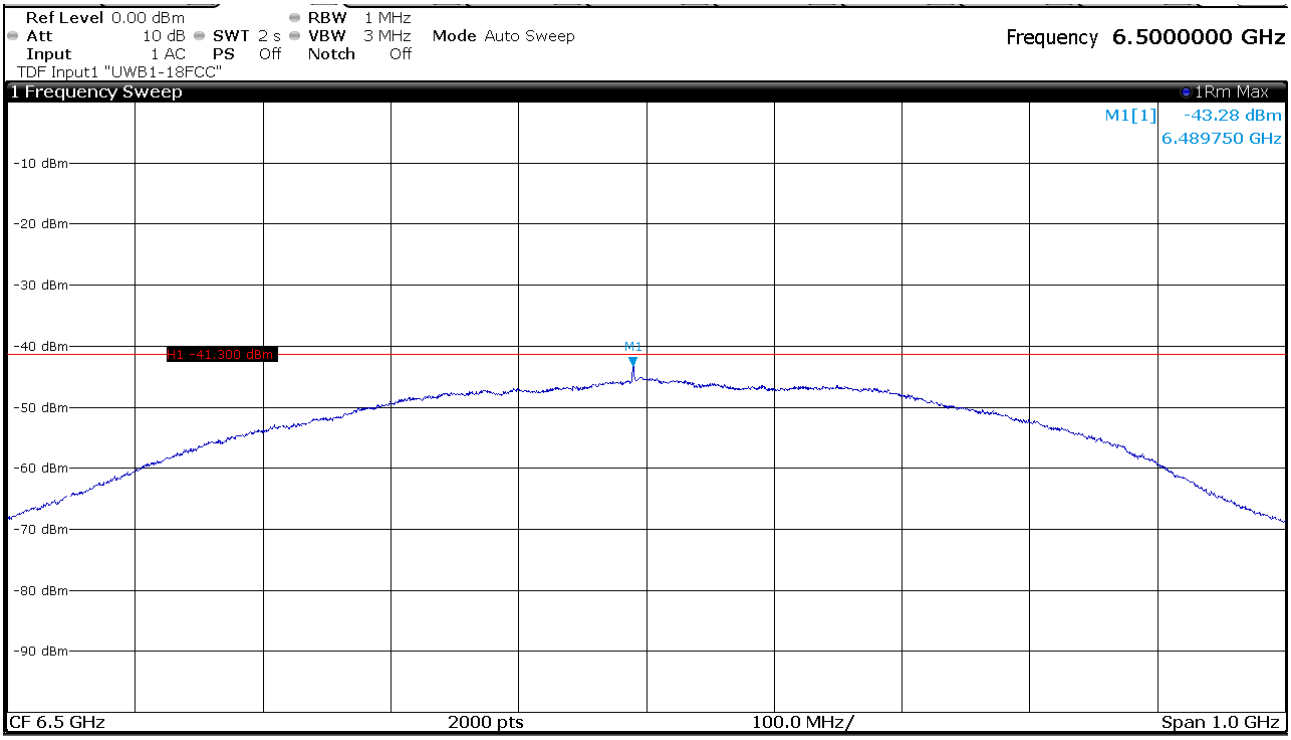
18 GHz to 40 GHz at 10 cm distance



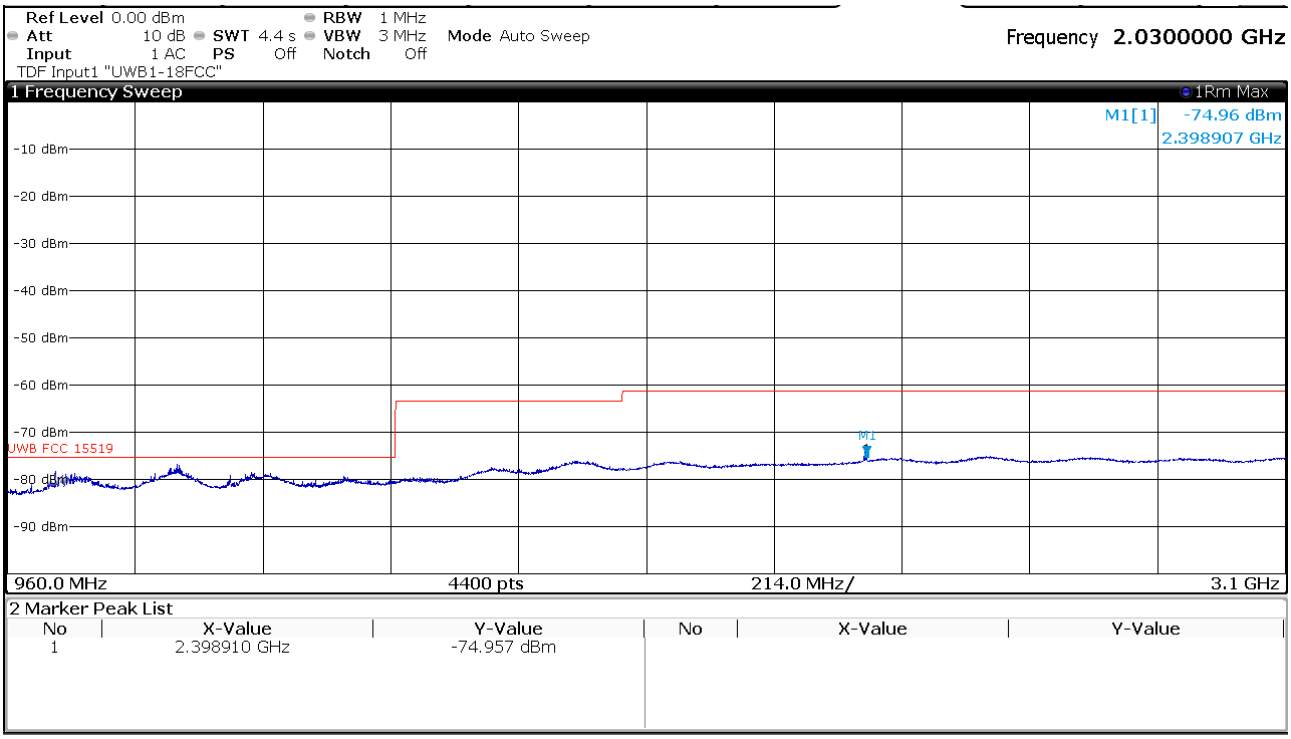
FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Channel 5

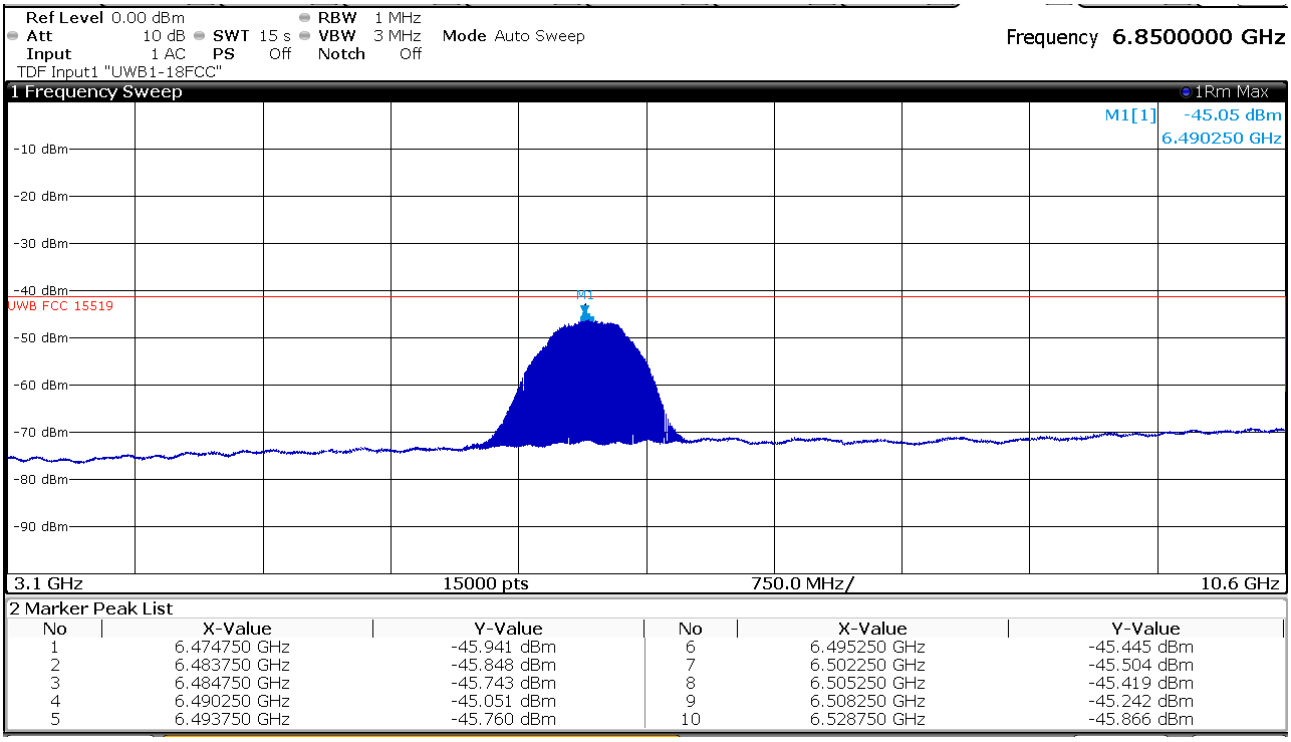
Mean Power



960 MHz to 18 GHz (FCC limit)

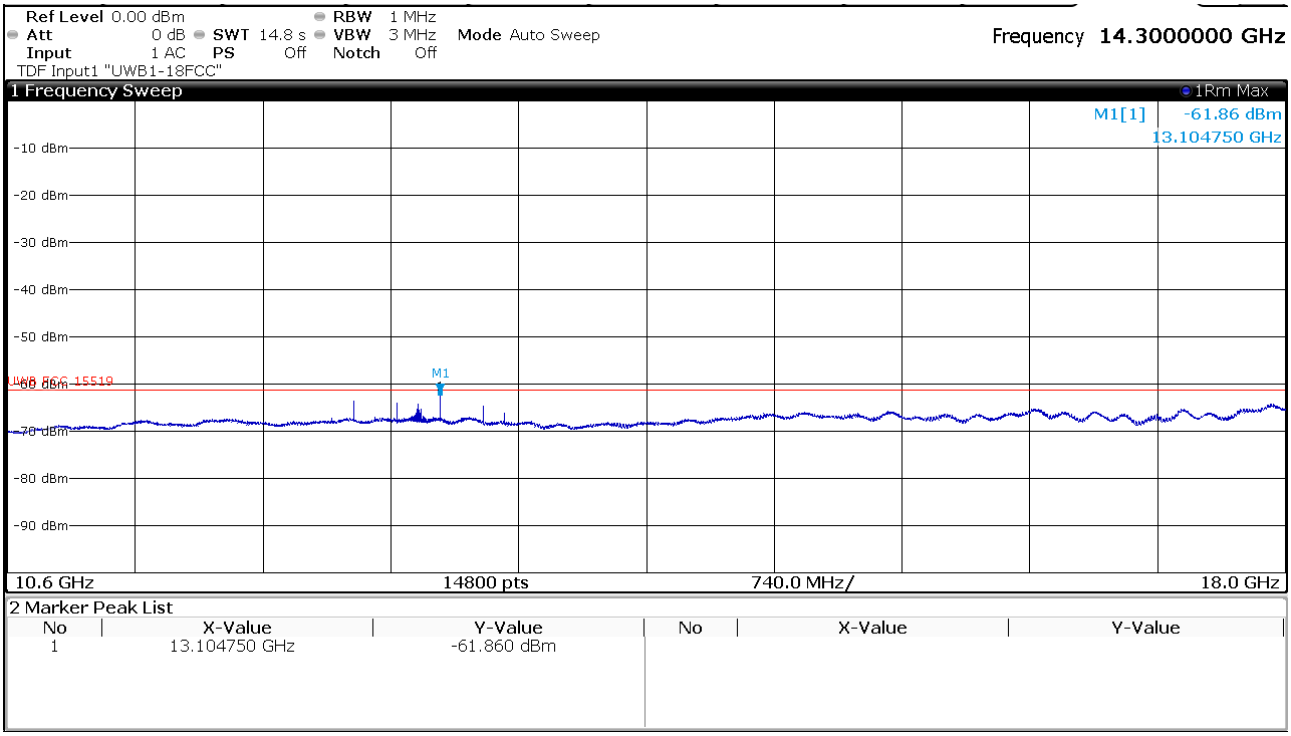


FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	6.474750 GHz	-45.941 dBm	6	6.495250 GHz	-45.445 dBm
2	6.483750 GHz	-45.848 dBm	7	6.502250 GHz	-45.504 dBm
3	6.484750 GHz	-45.743 dBm	8	6.505250 GHz	-45.419 dBm
4	6.490250 GHz	-45.051 dBm	9	6.508250 GHz	-45.242 dBm
5	6.493750 GHz	-45.760 dBm	10	6.528750 GHz	-45.866 dBm

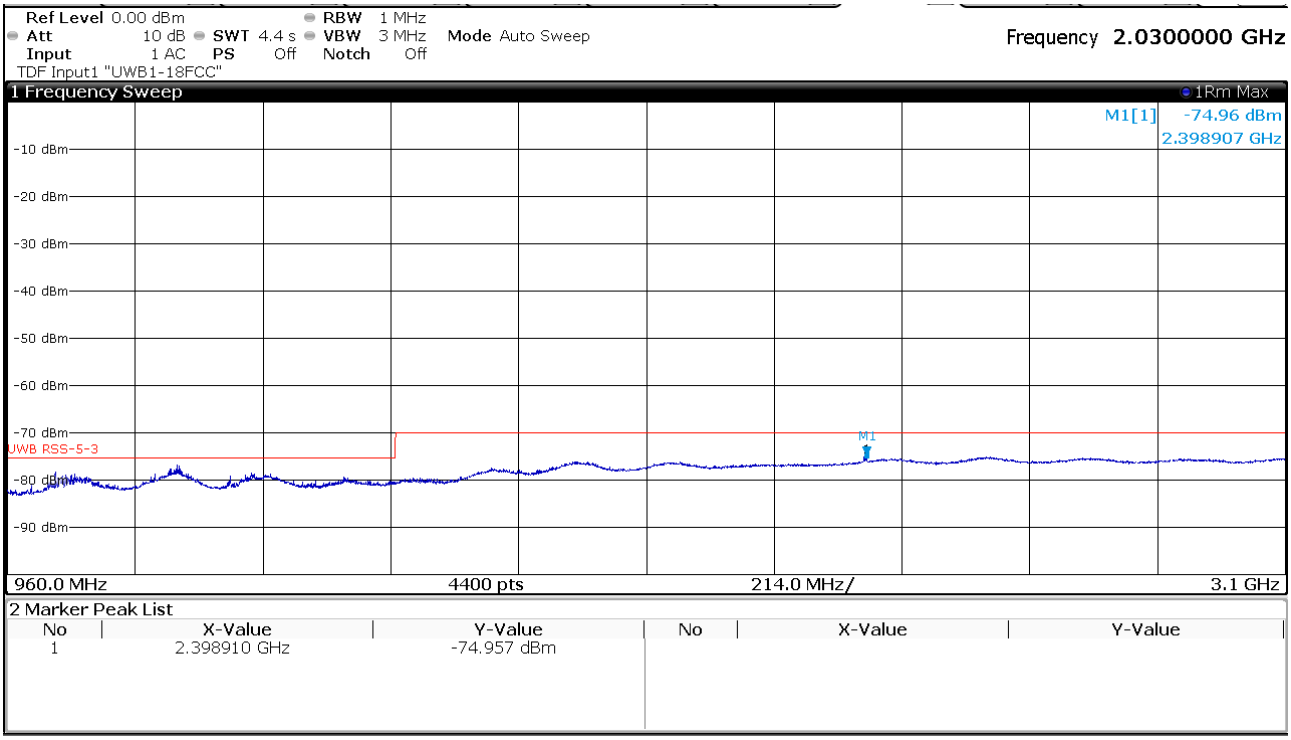


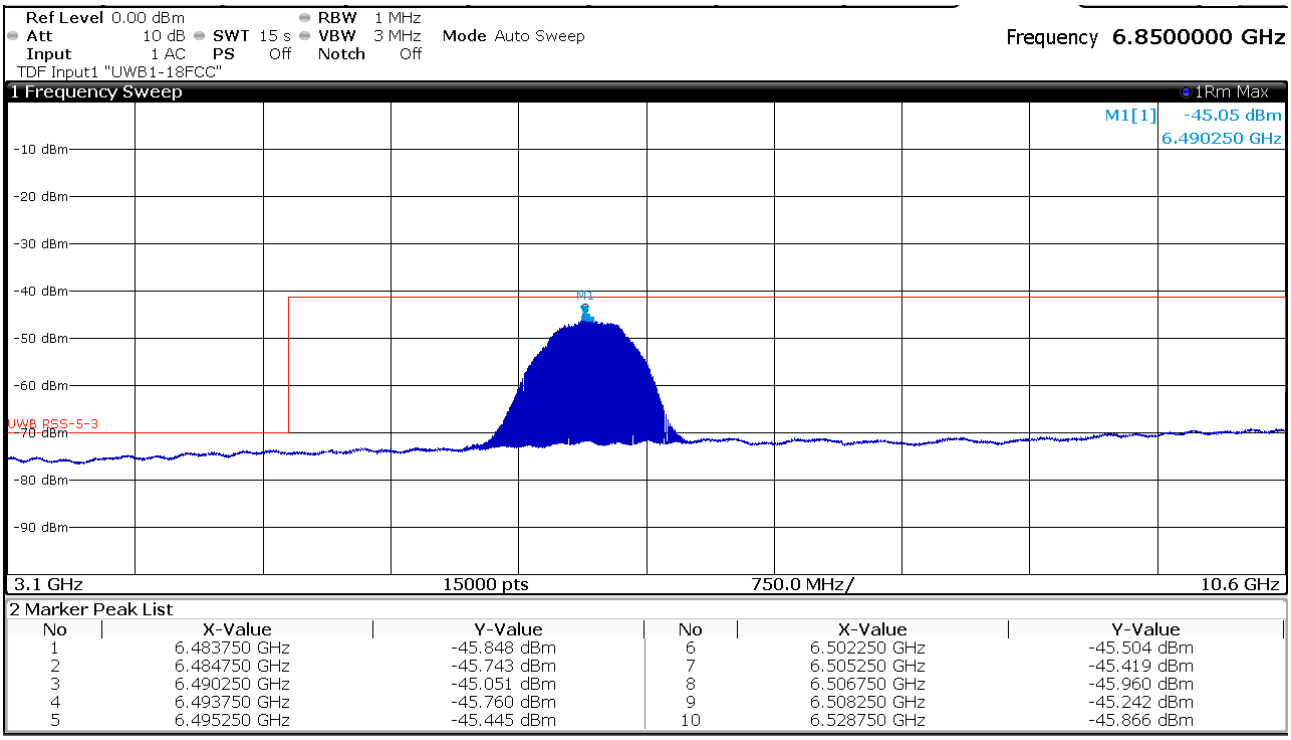
2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	13.104750 GHz	-61.860 dBm			

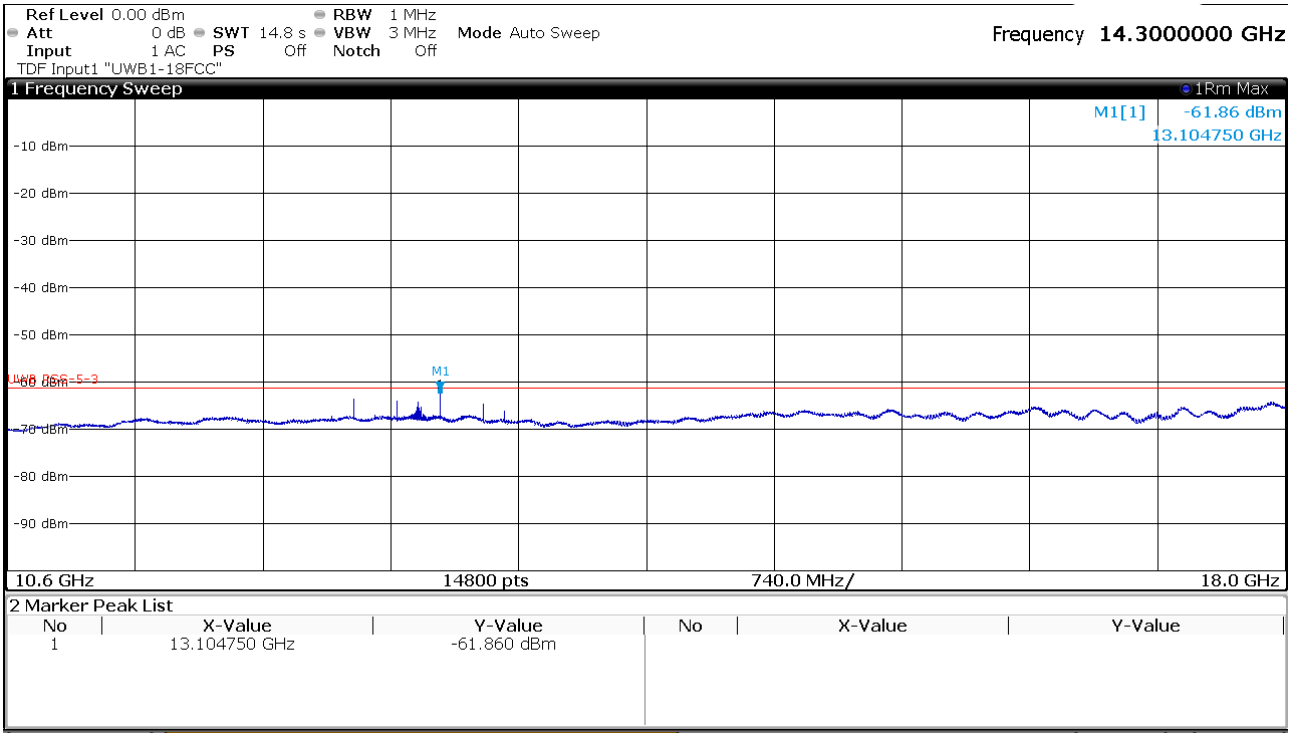
FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

960 MHz to 18 GHz (IC limit)

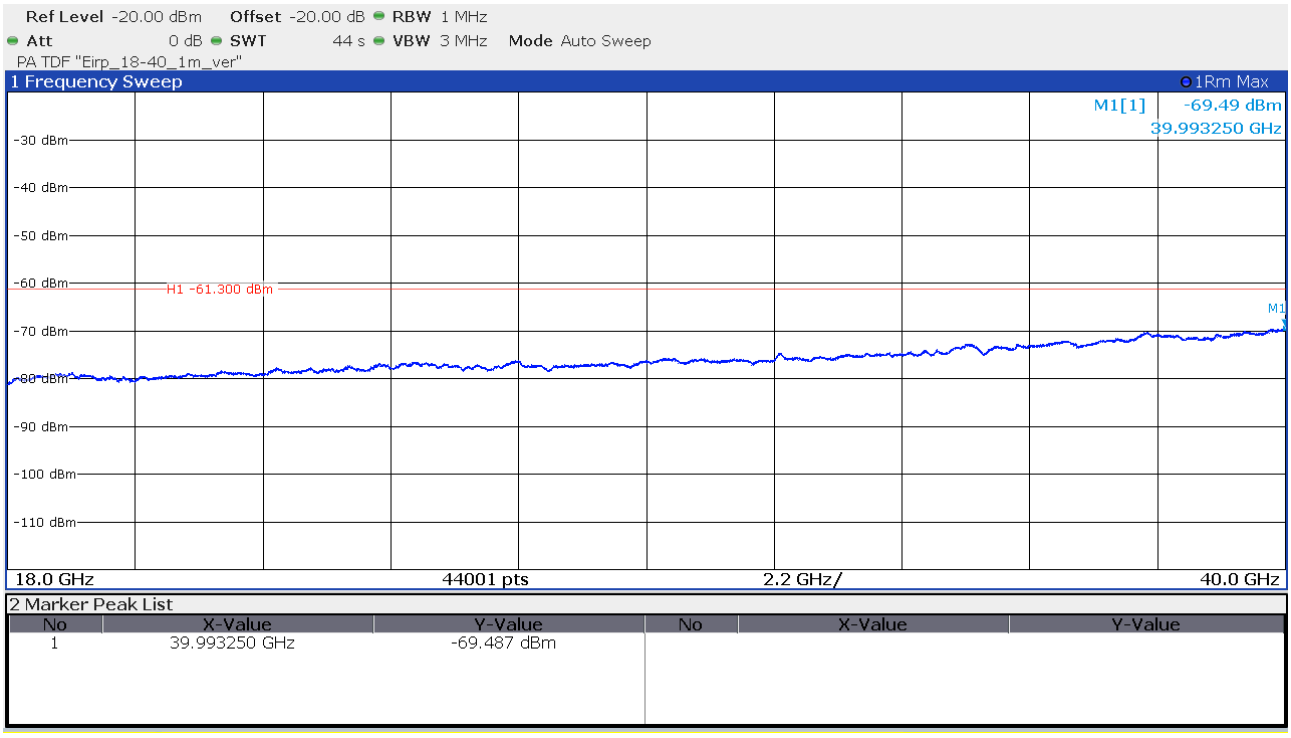




FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1



18 GHz to 40 GHz at 10 cm distance



FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Limits:

Limit according §15.209(a) in the frequency range 9 kHz 960 MHz:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Limit according §15.519(c) in the frequency range 960 MHz to 40 GHz:

Frequency in MHz	EIRP in dBm
960-1610	−75.3
1610-1990	−63.3
1990-3100	−61.3
3100-10600	−41.3
Above 10600	−61.3

Limit according RSS-220 5.3.1 (d) in the frequency range 960 MHz to 40 GHz:

Frequency in MHz	EIRP in dBm
960-1610	−75.3
1610-4750	−70.0
4750-10600	−41.3
Above 10600	−61.3

The requirements are **FULFILLED.**

Remarks: None.

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

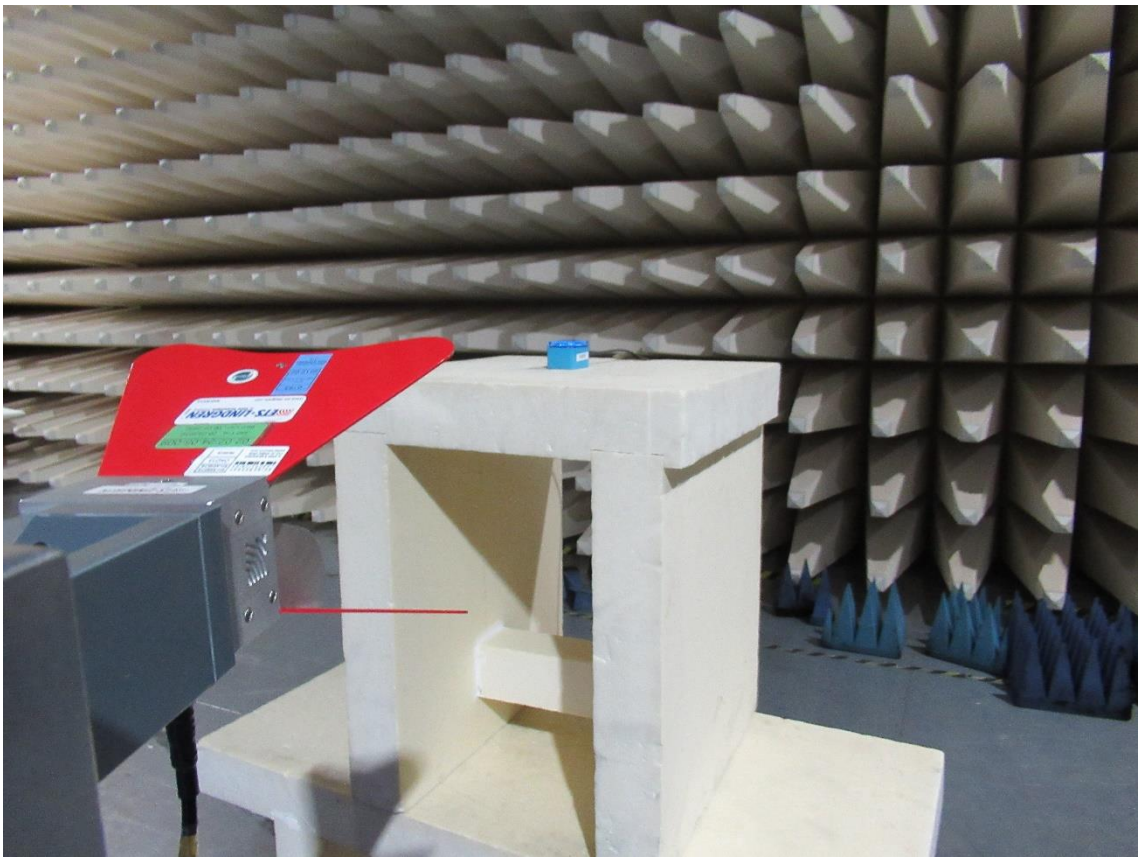
5.4 Radiated Emissions at 1164-1240 MHz and 1559-1610 MHz

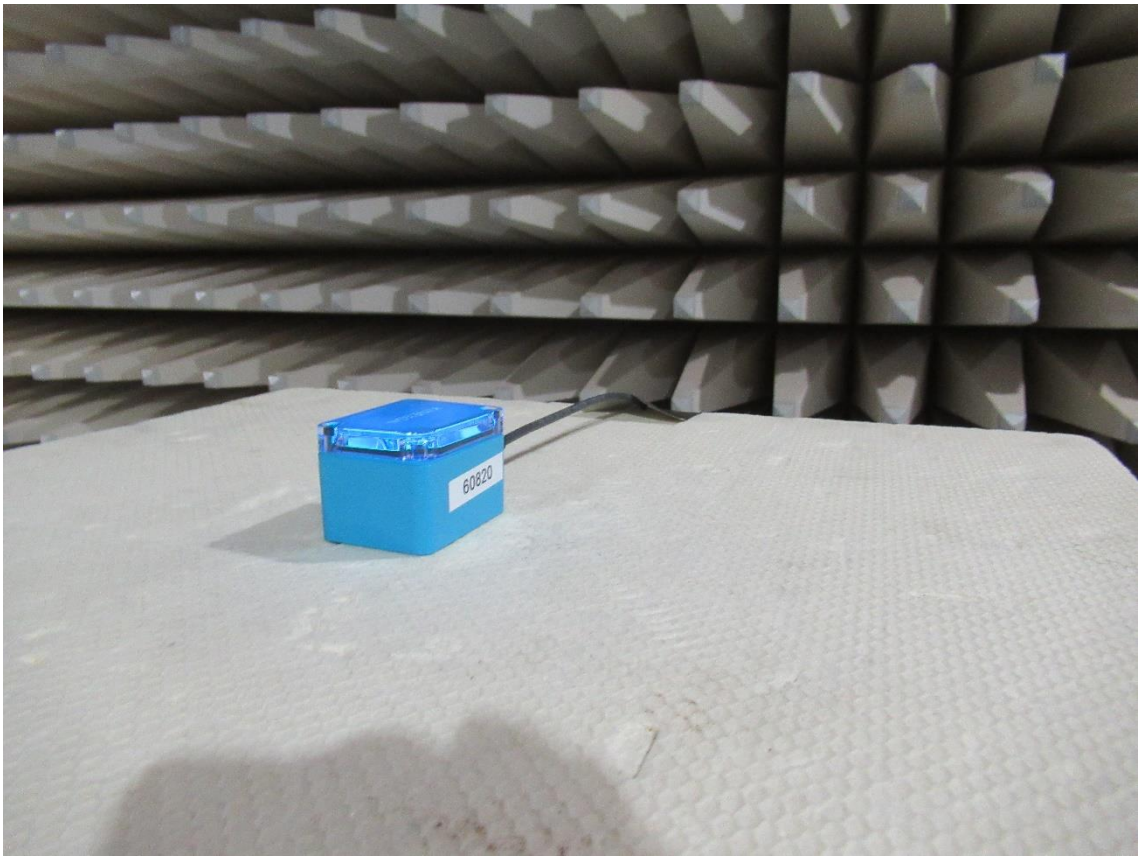
For test instruments and accessories used see section 6 Part **SER 3**.

5.4.1 Description of the test location

Test location: Anechoic chamber 1

5.4.2 Photo documentation of the test set-up





5.4.3 Applicable standard

According to FCC Part 15, Section 15.519(d):
In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz.

5.4.4 Analyser settings

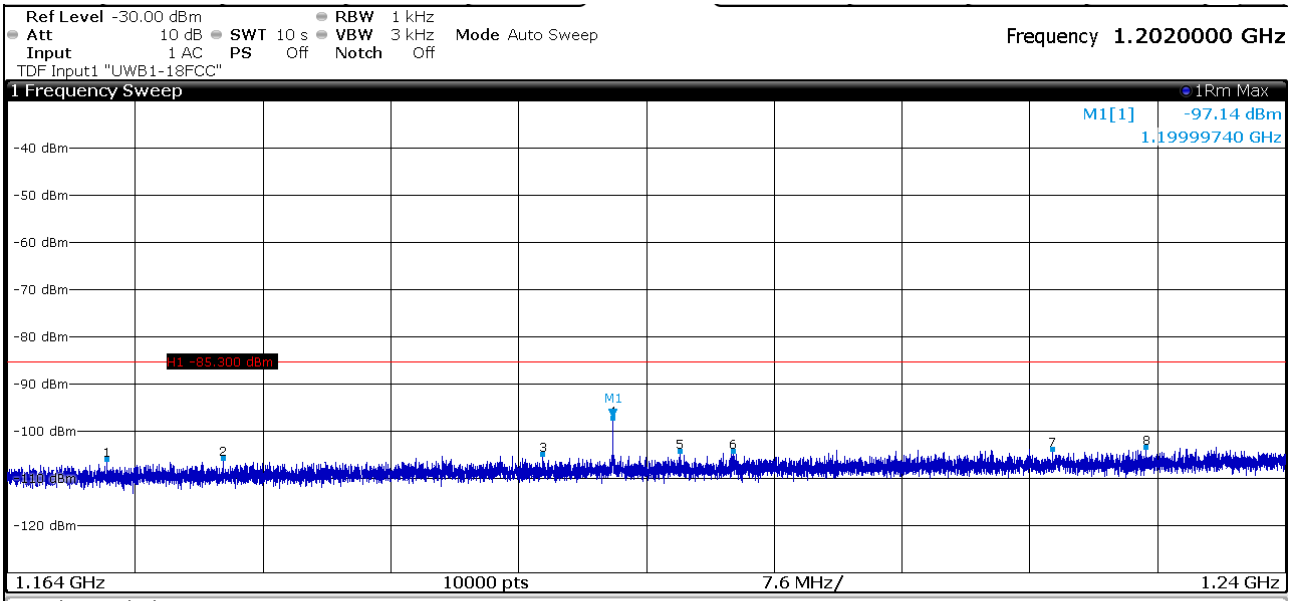
RBW: 1 kHz, VBW: 3 kHz, Detector: RMS, Sweep time: 1 ms/1kHz,

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

5.4.5 Test result

Channel 3:

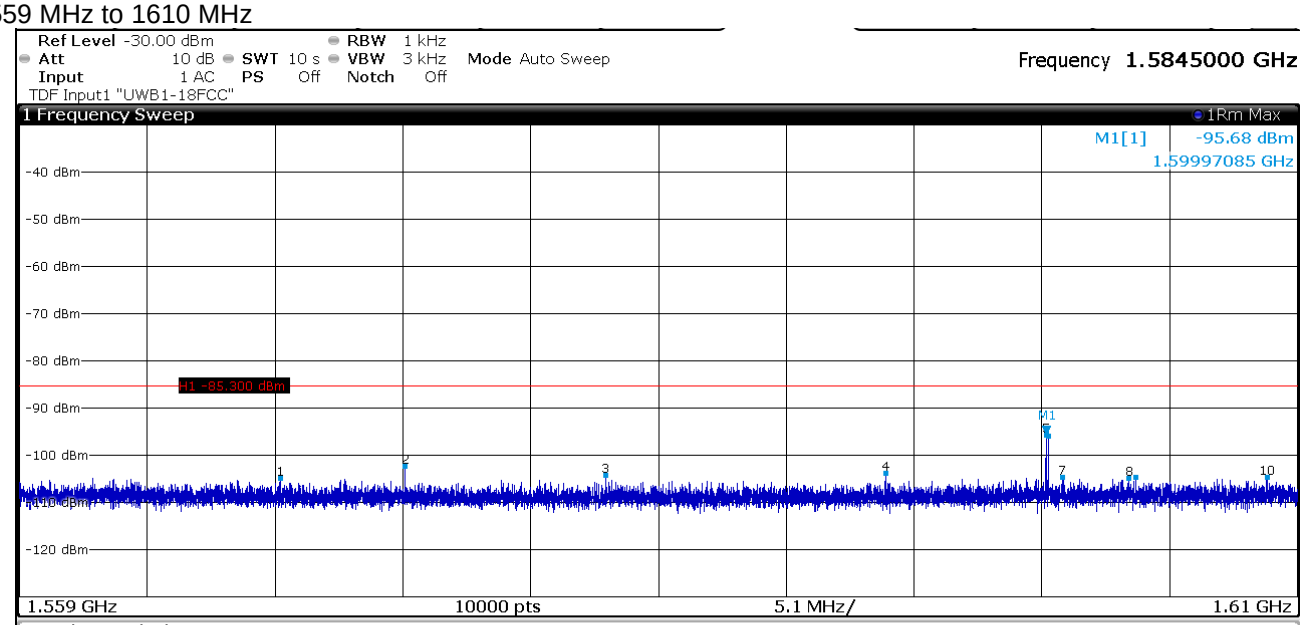
1164 MHz to 1240 MHz



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.169909 GHz	-106.014 dBm	5	1.203972 GHz	-104.198 dBm
2	1.176817 GHz	-105.849 dBm	6	1.207149 GHz	-104.261 dBm
3	1.195825 GHz	-104.949 dBm	7	1.226126 GHz	-103.727 dBm
4	1.199997 GHz	-97.142 dBm	8	1.231712 GHz	-103.407 dBm

1559 MHz to 1610 MHz



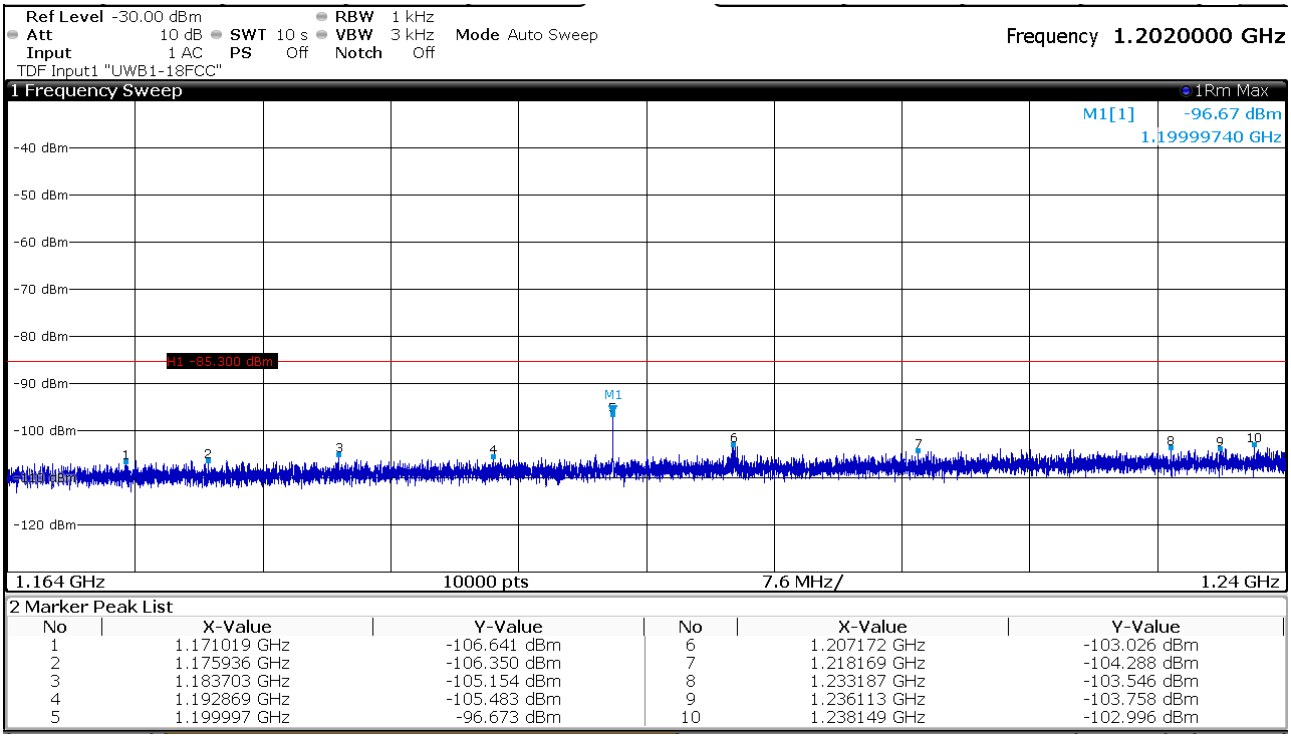
2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.569422 GHz	-104.808 dBm	6	1.600053 GHz	-95.944 dBm
2	1.574389 GHz	-102.436 dBm	7	1.600608 GHz	-104.723 dBm
3	1.582391 GHz	-104.340 dBm	8	1.603286 GHz	-104.838 dBm
4	1.593565 GHz	-103.844 dBm	9	1.603541 GHz	-104.772 dBm
5	1.599971 GHz	-95.680 dBm	10	1.608779 GHz	-104.602 dBm

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Channel 5:

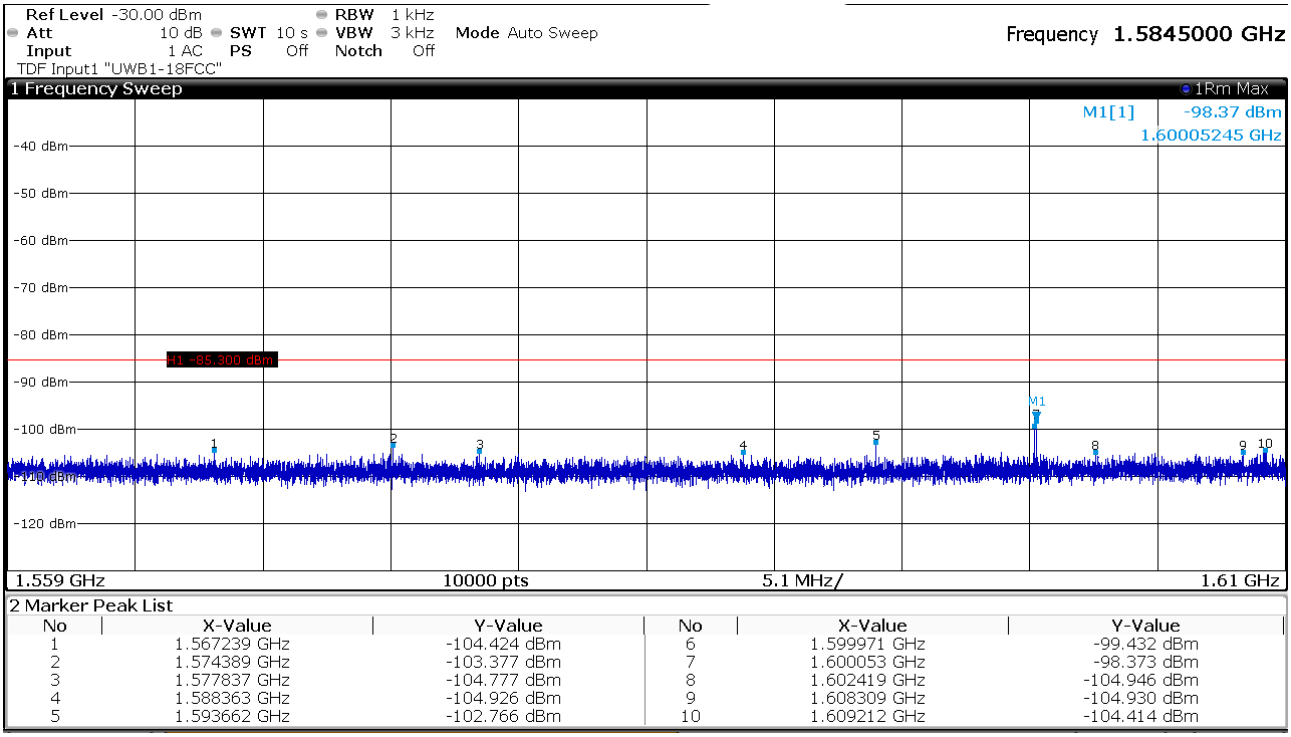
1164 MHz to 1240 MHz



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.171019 GHz	-106.641 dBm	6	1.207172 GHz	-103.026 dBm
2	1.175936 GHz	-106.350 dBm	7	1.218169 GHz	-104.288 dBm
3	1.183703 GHz	-105.154 dBm	8	1.233187 GHz	-103.546 dBm
4	1.192869 GHz	-105.483 dBm	9	1.236113 GHz	-103.758 dBm
5	1.199997 GHz	-96.673 dBm	10	1.238149 GHz	-102.996 dBm

1559 MHz to 1610 MHz



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.567239 GHz	-104.424 dBm	6	1.599971 GHz	-99.432 dBm
2	1.574389 GHz	-103.377 dBm	7	1.600053 GHz	-98.373 dBm
3	1.577837 GHz	-104.777 dBm	8	1.602419 GHz	-104.946 dBm
4	1.588363 GHz	-104.926 dBm	9	1.608309 GHz	-104.930 dBm
5	1.593662 GHz	-102.766 dBm	10	1.609212 GHz	-104.414 dBm

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Limit according §15.519(c) in the frequency

Frequency in MHz	EIRP in dBm
1164-1240	−85.3
1559-1610	−85.3

The requirements are **FULFILLED.**

Remarks: Tests were performed with both vertically and horizontally orientated receiving antenna.

The plots presented show the worst-case situation (vertically polarized receiving antenna).

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

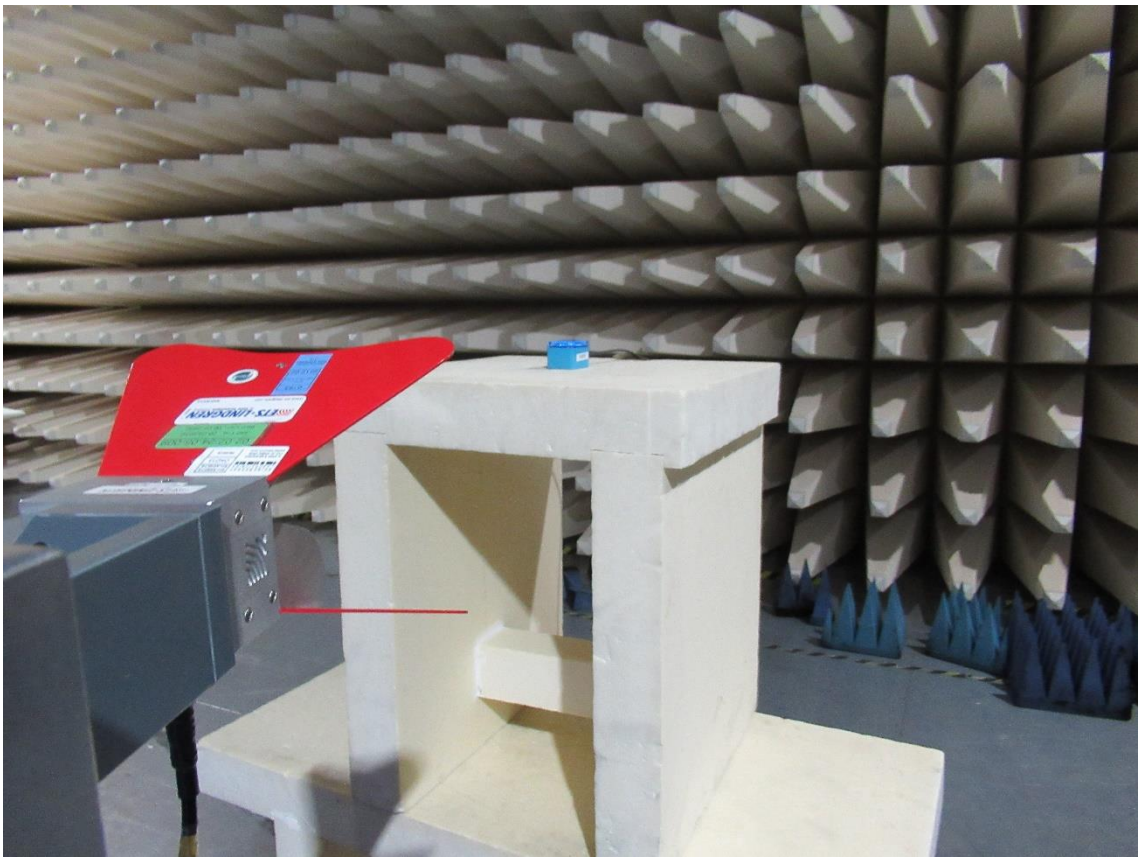
5.5 Peak Power radiated

For test instruments and accessories used see section 6 Part **CPR 3**.

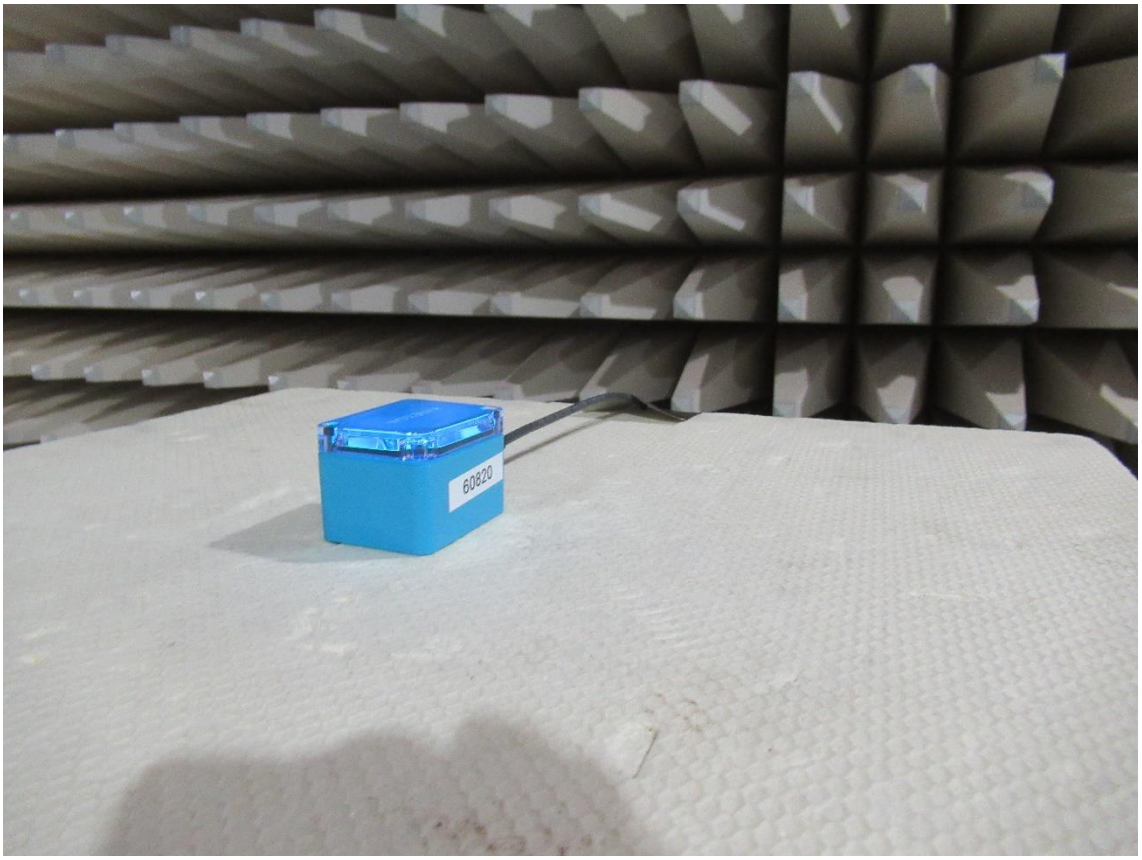
5.5.1 Description of the test location

Test location: Anechoic chamber 1

5.5.2 Photo documentation of the test set-up



FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1



5.5.3 Applicable standard

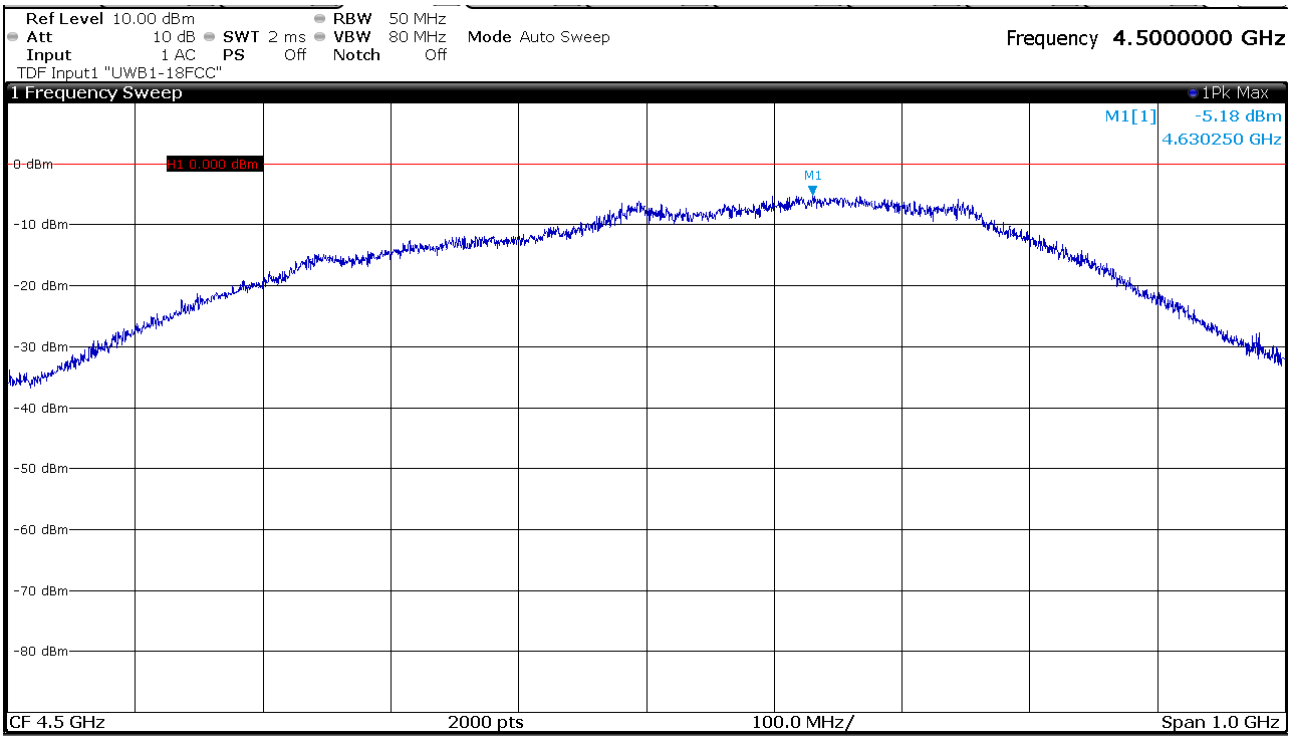
According to FCC Part 15, Section 15.519(e):
There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M. That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

5.5.4 Analyser settings

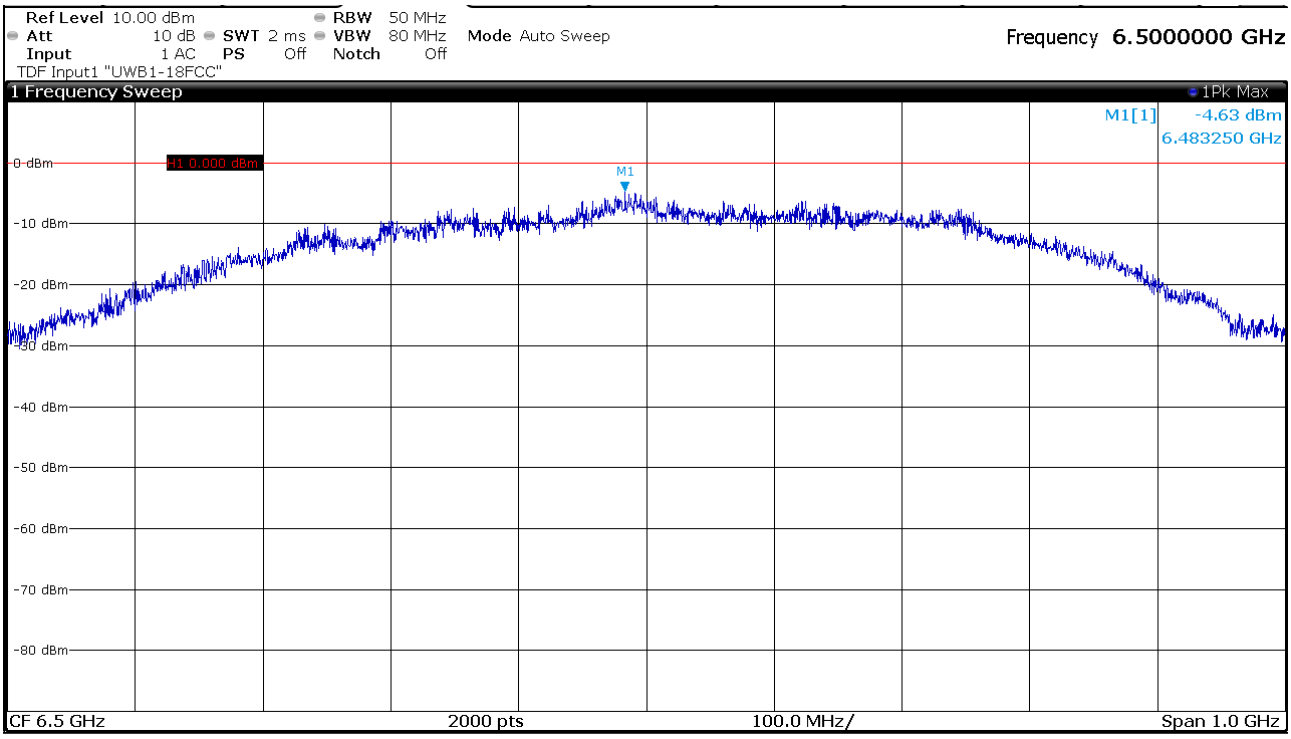
RBW: 50 MHz, VBW: 80 MHz, Detector: Peak, Trace Mode: Max hold

5.5.5 Test result

Channel 3



Channel 5



FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Min. limit margin: 4.63 dB at 6483.25 GHz

The requirements are **FULFILLED.**

Remarks: None.

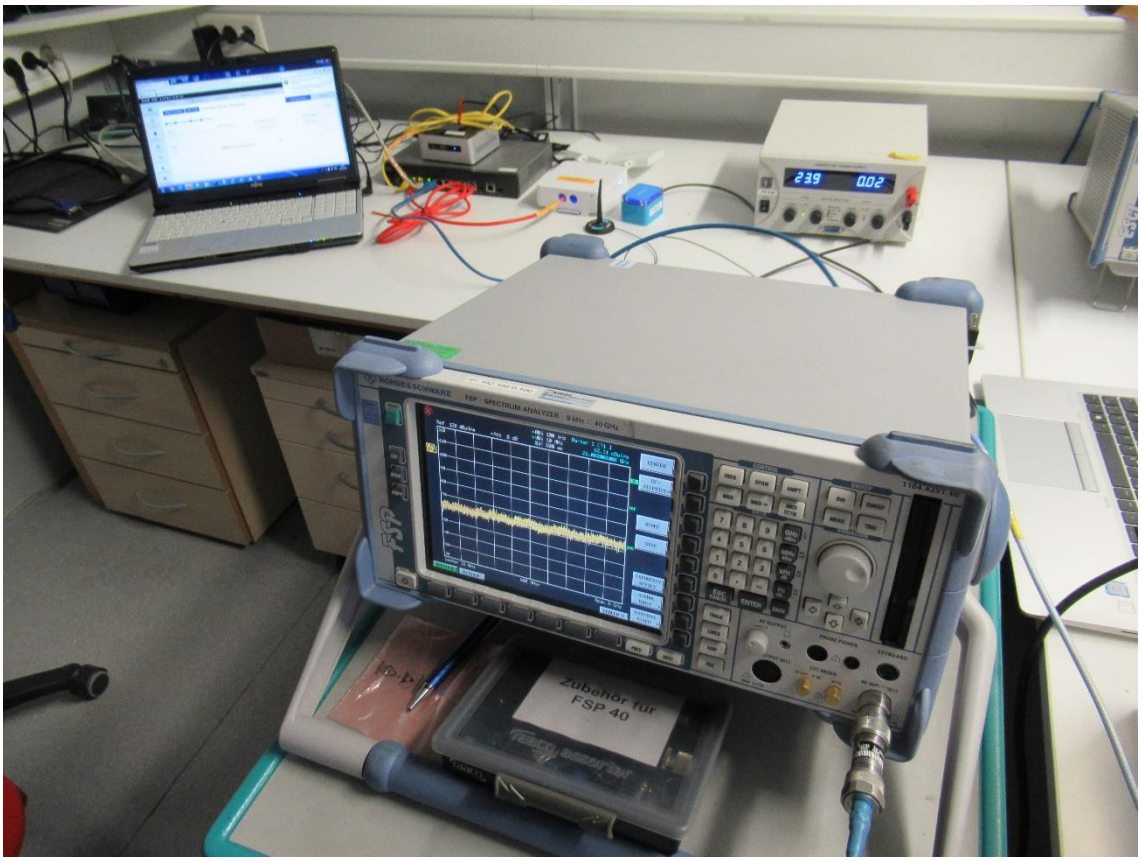
5.6 Signal deactivation

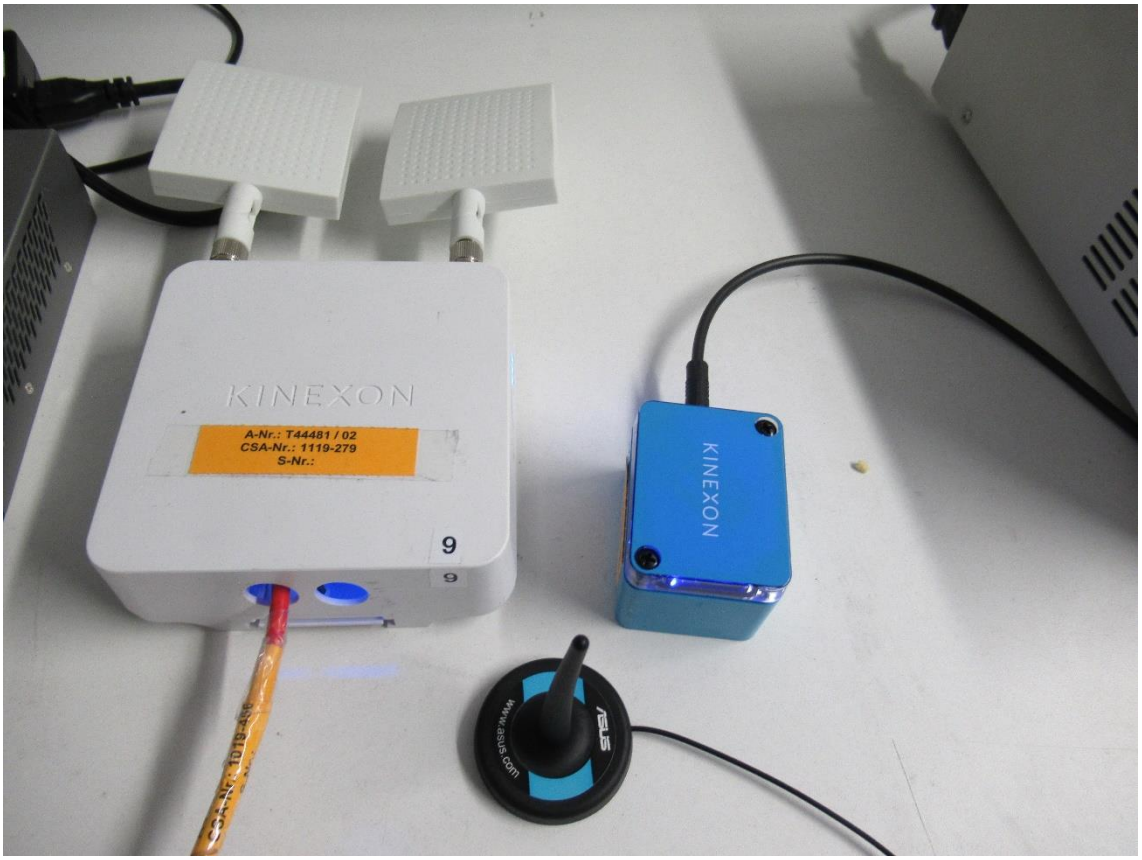
For test instruments and accessories used see section 6 Part **MB**.

5.6.1 Description of the test location

Test location: Shielded room S6

5.6.2 Photo documentation of the test set-up





5.6.3 Applicable standard

According to FCC Part 15, Section 15.519(a)(1):
A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

According to KDB 393764 D01 UWB FAQ v02 section 4:
An acknowledgement of reception must continue to be received by the UWB device at least once every 10 seconds, or else the device shall cease transmission of any information other than periodic signals for use in the establishment or re-establishment of a communications link with an associated receiver.

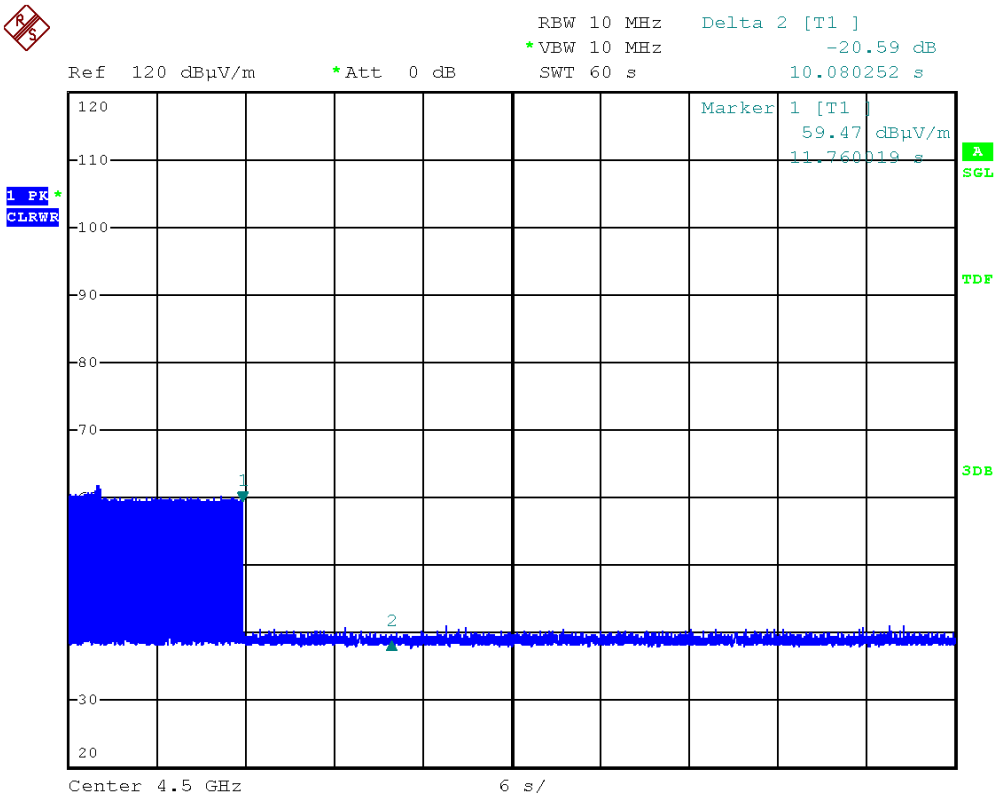
5.6.4 Description of Measurement

The measurement was performed radiated. The following devices are used additionally to establish a permanent UWB connection:

- Fujitsu Notebook Lifebook (MESS_FUNK1) Model: 01°-Z110316001166Z
- Intel NUC Model: NUC6i5SYH
- DC power adapter Model: CSA ID: 01-02/50-16-038
- CISCO (8-port 10/100 PoE + Managed Switch) Model: SF302-08PP
- KINEXON Model: A-08

Spectrum analyser settings:
RBW: 10 MHz, VBW: 10 MHz, Detector: peak, zero span

5.6.5 Test result



FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

Explanation:

The tests were performed with an EUT, which supports a total of two channels. The signal deactivation is independent of the chosen channel and shown here for a signal with channel 3.

At the time at Marker M1 the companion device is powered off. The EUT stops transmissions immediately. The EUT makes no additional attempts to get a connection.

This behaviour is in accordance with the applicable standards.

The requirements are **FULFILLED.**

Remarks: None.

5.7 Antenna application

5.7.1 Applicable standard

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated antenna. No other antenna can be used with the device.

All supplied antennas meet the requirements of part 15.203 and 15.204.

Remarks: None.

FCC ID: 2ALC5-KNX-VTAG1 **IC:** 25557-KNXVTAG1

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 3.18.0.26	01-02/68-13-001				
	ESCI	02-02/03-15-001	02/07/2020	02/07/2019		
	ESH 2 - Z 5	02-02/20-05-004	31/10/2021	31/10/2019	04/11/2020	04/05/2020
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	13/11/2022	13/11/2019	13/05/2020	13/11/2019
CPR 3	ESW26	02-02/03-17-002	16/01/2021	16/01/2020		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	06/06/2020	06/06/2019		
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
MB	FSP 40	02-02/11-11-001	07/10/2020	07/10/2019		
SER 2	ESVS 30	02-02/03-05-006	19/08/2020	19/08/2019		
	VULB 9168	02-02/24-05-005	19/07/2020	19/07/2019		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	ESW26	02-02/03-17-002	16/01/2021	16/01/2020		
	FSW43	02-02/11-15-001	02/04/2021	02/04/2020		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	06/06/2020	06/06/2019		
	BBHA 9170	02-02/24-05-014	12/06/2021	12/06/2018	14/01/2021	14/01/2020
	KMS102-0.2 m	02-02/50-11-020				
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				