

# EMI – TEST REPORT

- FCC Part 15.519 -

**Type / Model Name** : Tag

**Product Description** : UWB Sensor

**Applicant** : Kinexon Sports & Media Inc.

Address : 22 west 38th

New York, NY 10018

**Manufacturer** : Kinexon GmbH

Address : Schellingstraße 35

80799 München

**Licence holder** : Kinexon Sports & Media Inc.

Address : 22 west 38th

New York, NY 10018

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

**POSITIVE**

**Test Report No. :** T40233-03-00GK

05. July 2017

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.

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## 1 TEST STANDARDS

The tests were performed according to following standards:

## FCC Rules and Regulations Part 15, Subpart A - General (April 2017)

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 (April 2017)

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 (April 2017)**

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

## **2 EQUIPMENT UNDER TEST**

### **2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A**

### **2.2 Equipment type**

Portable UWB device

### **2.3 Short description of the equipment under test (EUT)**

The technology is used in sports as well as industrial environments.

The Kinexon Tags are attached to tracked objects and communicate with surrounding Anchors to obtain information on their position.

Number of tested samples: 2 (1 radiated and 1 conducted sample)  
Serial number: pre-production sample  
Firmware version: 2.8.0

#### **EUT configuration:**

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

### **2.4 Variants of the EUT**

### **2.5 Operation frequency and channel plan**

The operating frequency band is 3100 MHz to 10600 MHz.

Channel plan:

Channel 1: 3494.4 MHz

Channel 2: 3993.6 MHz

Channel 3: 4492.8 MHz

Channel 5: 6489.6 MHz

### **2.6 Transmit operating modes**

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

Data rate: 6.8 Mbit/s

## 2.7 Antennas

The following antenna shall be used with the EUT:

Integrated SMD antenna with following gain: 1.5 dBi (peak) -3.5 dBi (average)

## 2.8 Power supply system utilised

Power supply voltage,  $V_{nom}$  3.7 V DC

## 2.9 Peripheral devices and interface cables

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

- None \_\_\_\_\_ Model : \_\_\_\_\_
- \_\_\_\_\_ Model : \_\_\_\_\_

## 2.10 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes.

### 2.10.1 Test jig

None

### 2.10.2 Test software

None

### **3 TEST RESULT SUMMARY**

UWB device using digital modulation:

Operating in the 3100 MHz – 10600 MHz:

FCC Rule Part	Description	Result
15.207(a)	AC power line conducted emissions	not applicable
15.519(b)	UWB Bandwidth	passed
15.209(a) 15.519(c)	Radiated Emissions 9 kHz to 40 GHz	passed
15.519(d)	Radiated Emissions at 1164-1240 MHz and 1559-1610 MHz	passed
15.519(e)	Peak Power radiated	passed

#### **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 : 17 November 2016

Testing concluded on : 04 July 2017

Checked by:

Tested by:

\_\_\_\_\_  
Klaus Gegenfurtner  
Teamleader Radio

\_\_\_\_\_  
Konrad Graßl  
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 / 11.2003 „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 power line conducted emissions	0.15 MHz to 30 MHz	95%	$\pm 3.29 \text{ dB}$
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	$\pm 2.71 \text{ dB}$
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	$\pm 2.71 \text{ dB}$
Power spectral density	2400 MHz to 3000 MHz	95%	$\pm 0.62 \text{ dB}$
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	$\pm 2.15 \text{ dB}$
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	$\pm 3.47 \text{ dB}$
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	$\pm 3.53 \text{ dB}$
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	$\pm 4.44 \text{ dB}$
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	$\pm 2.34 \text{ dB}$
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	$\pm 5.13 \text{ dB}$



## 4.4 Measurement protocol for FCC and ISCED

### 4.4.1 General information

#### 4.4.1.1 General Standard information

In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.10 and applying the CISPR 22 limits.

##### 4.4.1.1.1 Radiated emission (electrical field 30 MHz - 1 GHz)

##### Description of measurement

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 dB $\mu$ V/m is calculated by taking the reading from the EMI receiver (Level dB $\mu$ V) 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	Level	+	Factor	=	Level	-	CISPR Limit	=
Delta								
(MHz)	(dB $\mu$ V)		(dB)		(dB $\mu$ V/m)		(dB $\mu$ V/m)	(dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	= -2.4

**4.4.1.1.2 Radiated emission (electrical field 1 GHz - 40 GHz)**Description of measurement

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**

Remarks: Not applicable, because the EUT has no AC power port.

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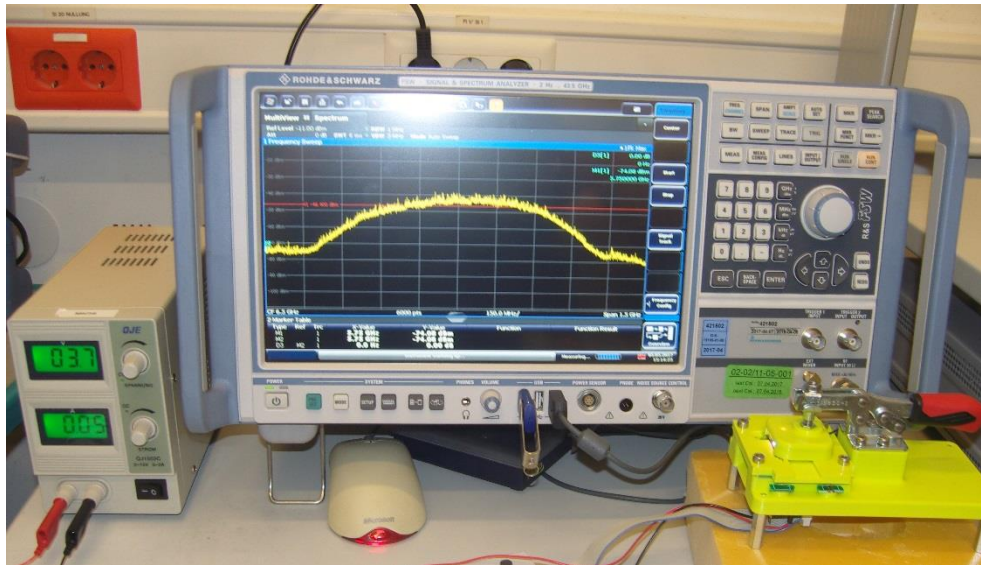
## 5.2 UWB Bandwidth

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

### 5.2.1 Description of the test location

Test location:                      Shielded room 6

### 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 conducted with the sample with a temporary SMA connector.  
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: Max peak

**5.2.5 Test result**

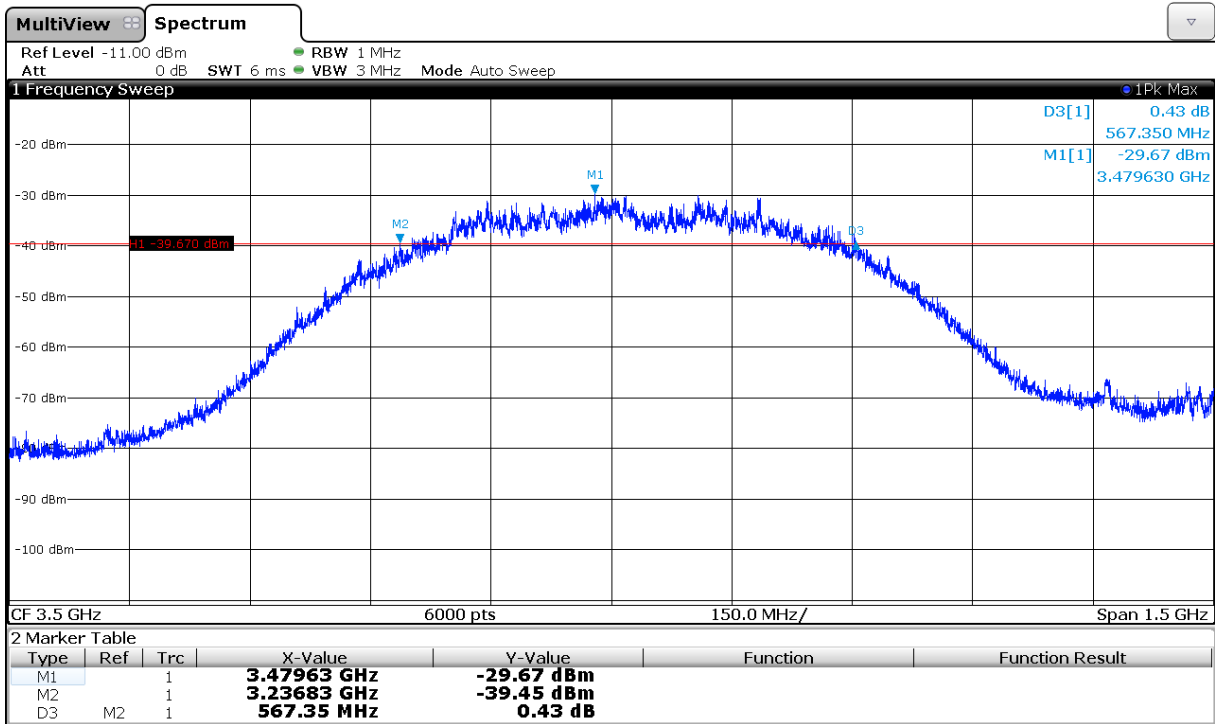
channel	lowest frequency $f_L$ (MHz)	highest frequency $f_H$ (MHz)	permitted frequency range (GHz)	UWB bandwidth (MHz)	required UWB bandwidth (MHz)	result
1	3236.8	3804.1	3.1 to 10.6	567.3	> 500	passed
2	3685.4	4233.4	3.1 to 10.6	548.0	> 500	passed
3	4141.9	4842.3	3.1 to 10.6	700.4	> 500	passed
5	6176.6	6842.6	3.1 to 10.6	666.0	> 500	passed

The requirements are **FULFILLED**.

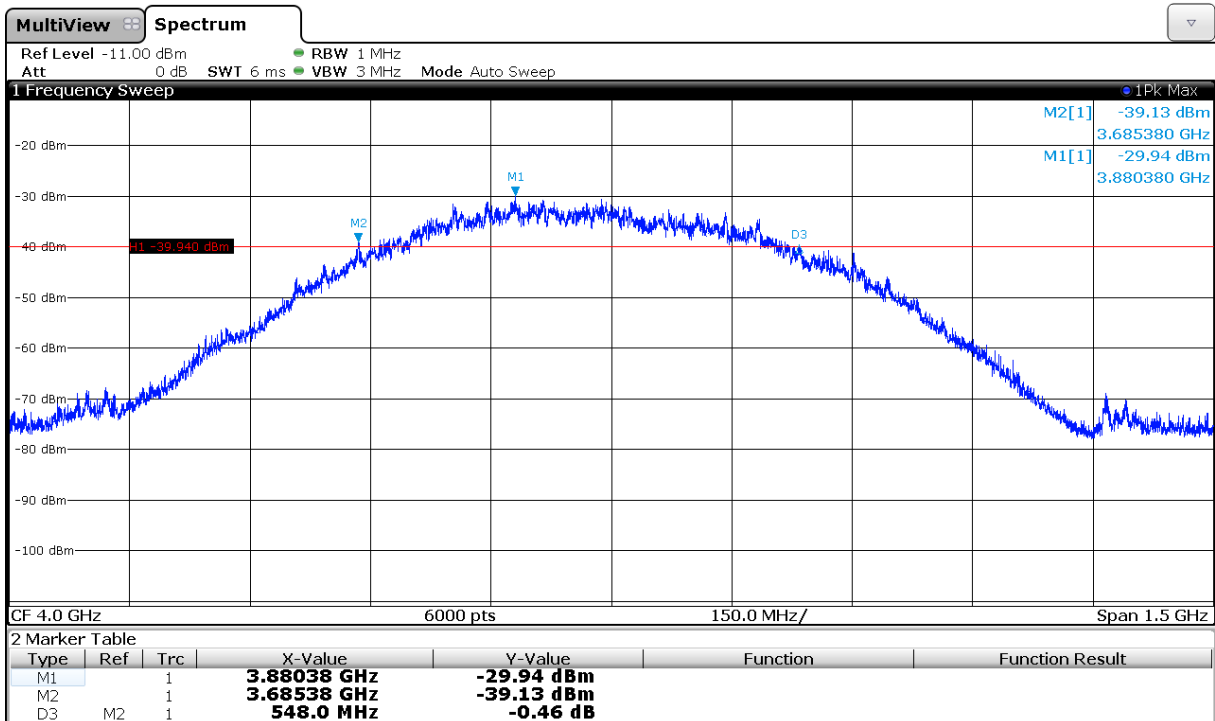
**Remarks:** For detailed test results please refer to following test protocols.

## 5.2.6 Test protocols

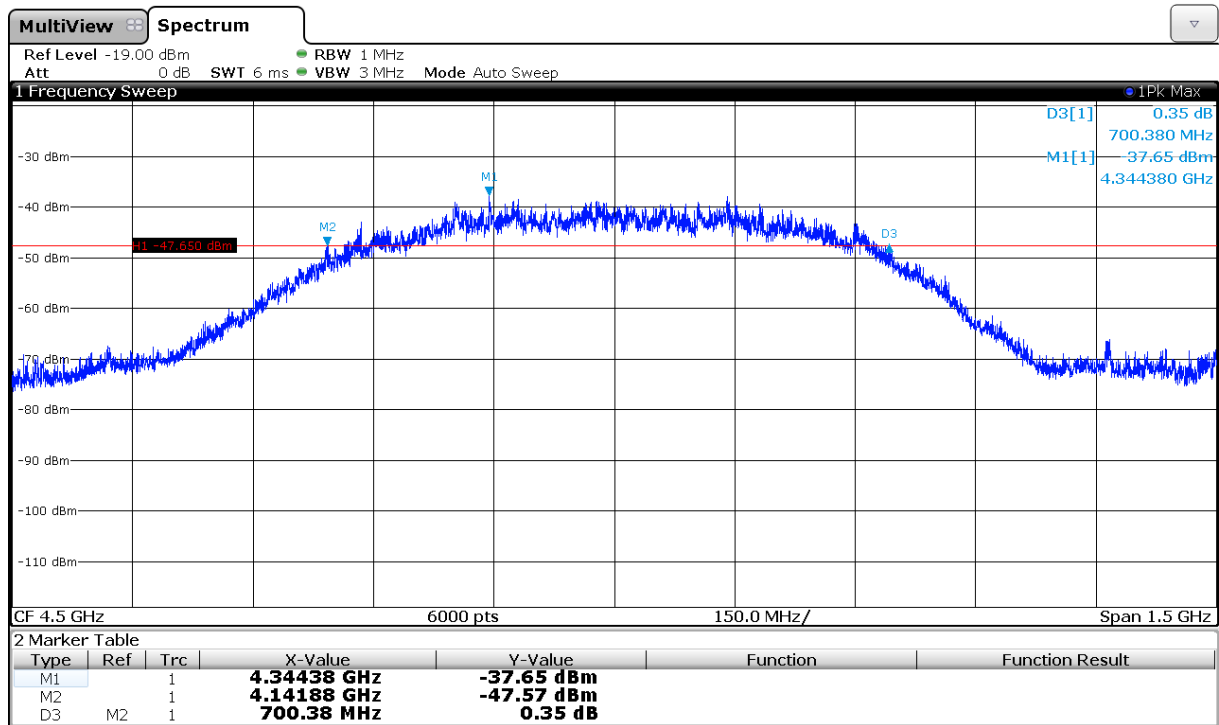
Channel 1:



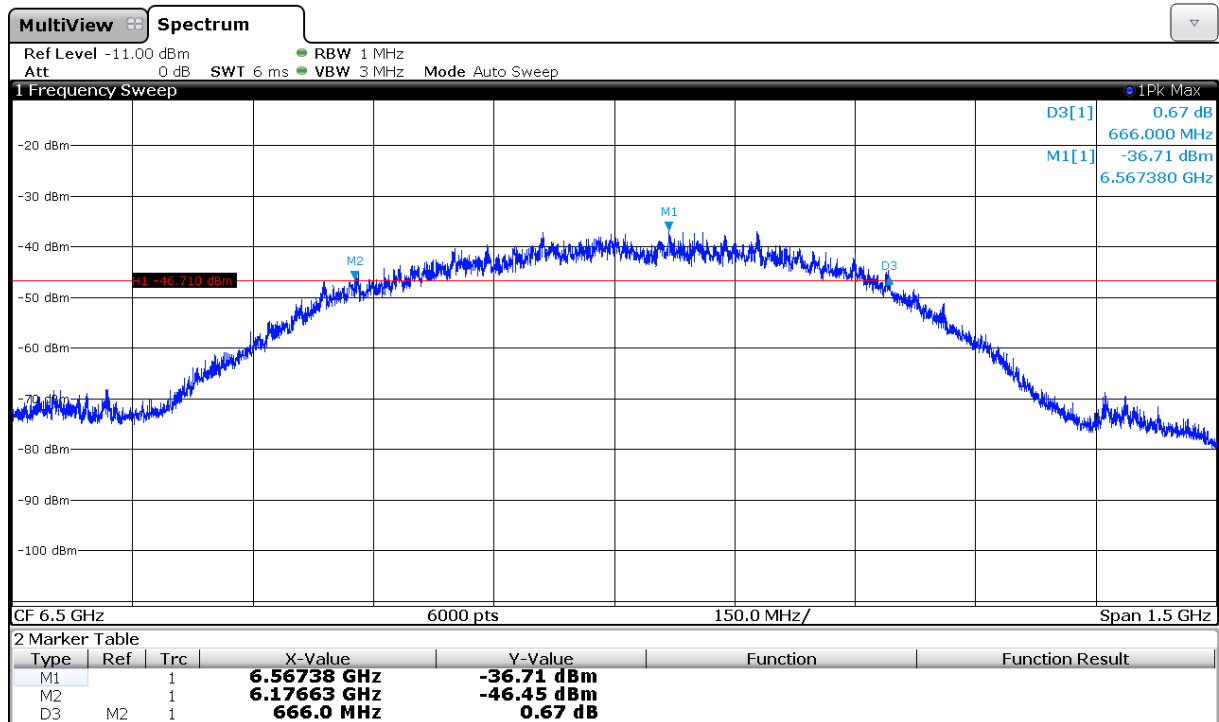
Channel 2:



Channel 3:



Channel 5:



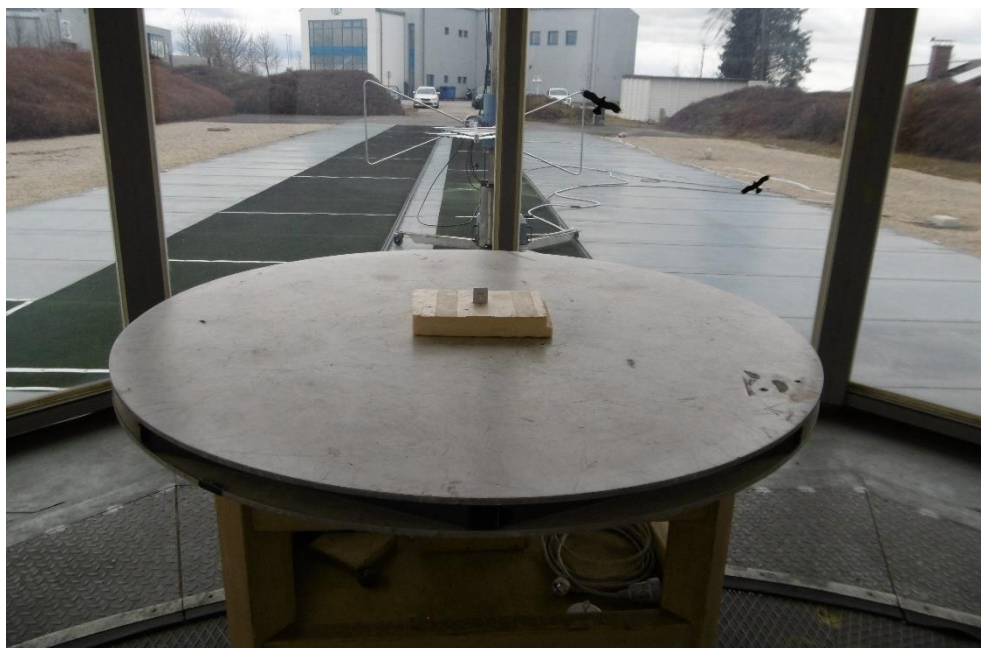
### 5.3 Radiated Emissions 9 kHz to 40 GHz

For test instruments and accessories used see section 6 Part **SER 2**, **SER3**.

#### 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



### 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

30 MHz – 960 MHz      RBW: 120 kHz      Detector: QP

960 MHz – 40 GHz      RBW: 1 MHz      VBW: 3 MHz      Detector: RMS      Sweeptime: 1 ms per MHz

### 5.3.5 Test result

#### Measurement 9 kHz to 30 MHz:

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

#### 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)
115.11	6.6	15.4	11.5	12.2	18.1	27.6	43.5	-15.9
230.35	6.8	6.8	12.8	13.2	19.6	20.0	46.0	-26.0
499.14	8.3	8.2	22.5	22.2	30.8	30.4	46.0	-15.2
558.80	8.2	7.6	24.2	24.0	32.4	31.6	46.0	-13.6
699.74	7.5	7.6	27.0	26.5	34.5	34.1	46.0	-11.5

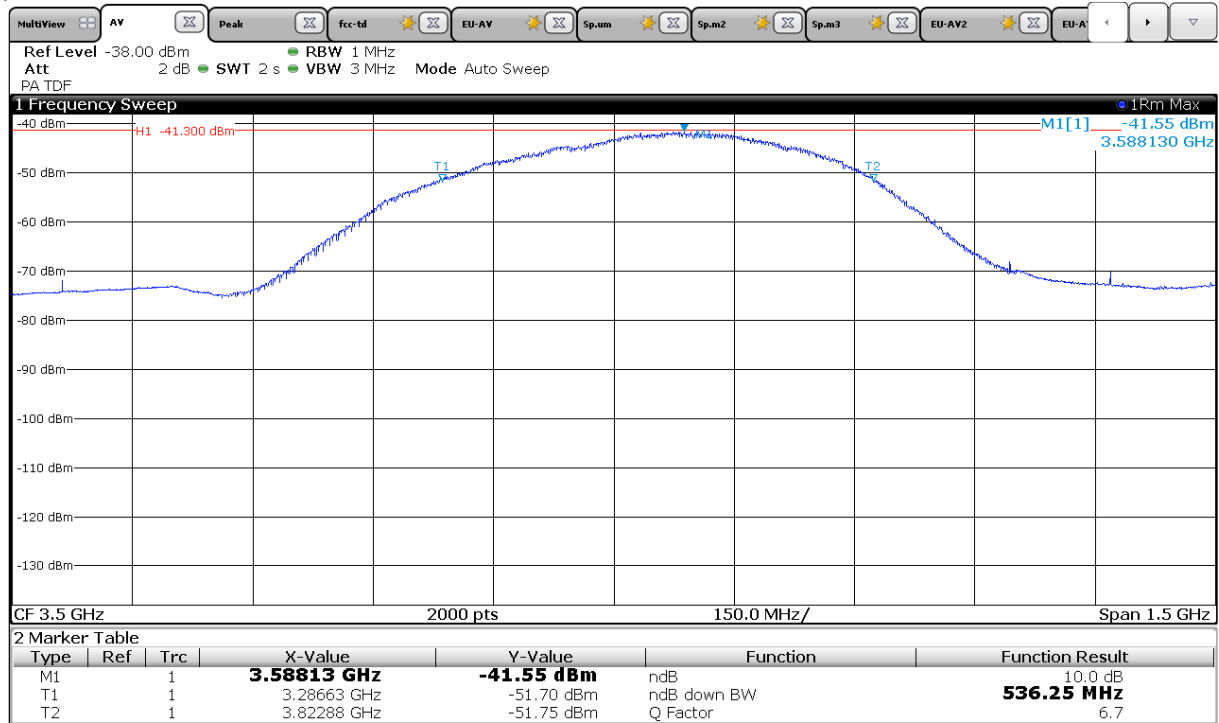
Note: Pre-measurements have shown, there is no difference of the emissions between the different channels.



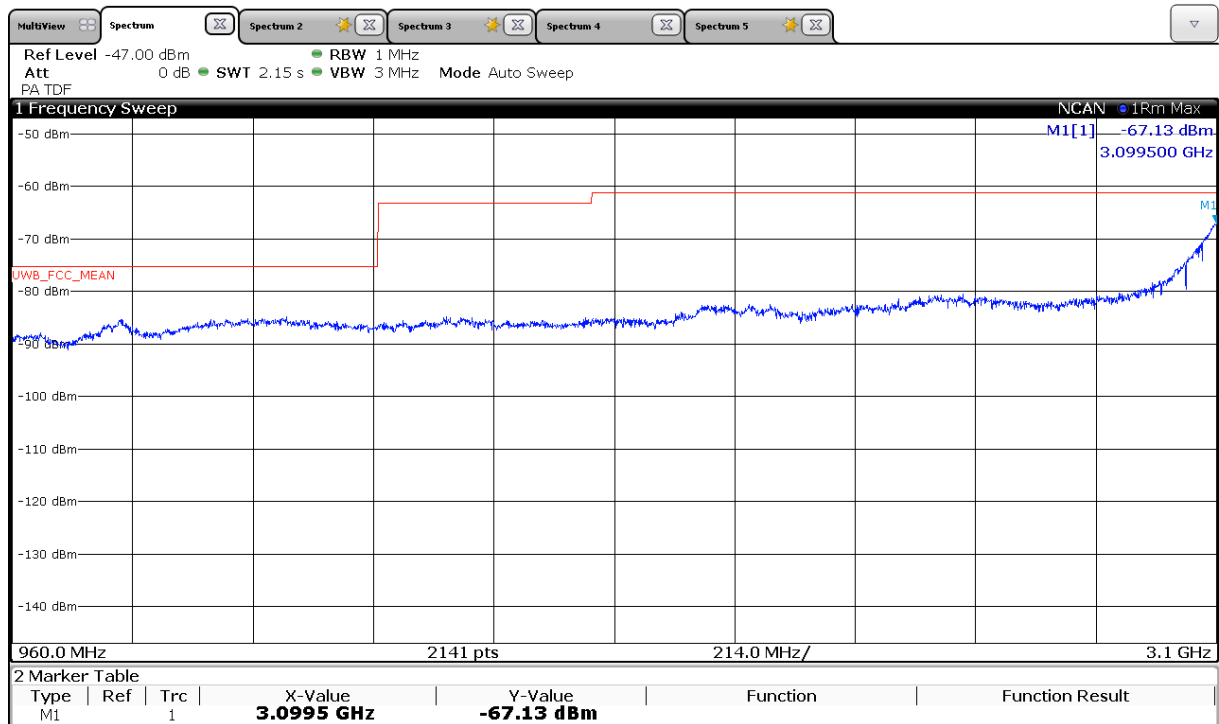
Measurement 960 MHz to 40 GHz:

Channel 1:

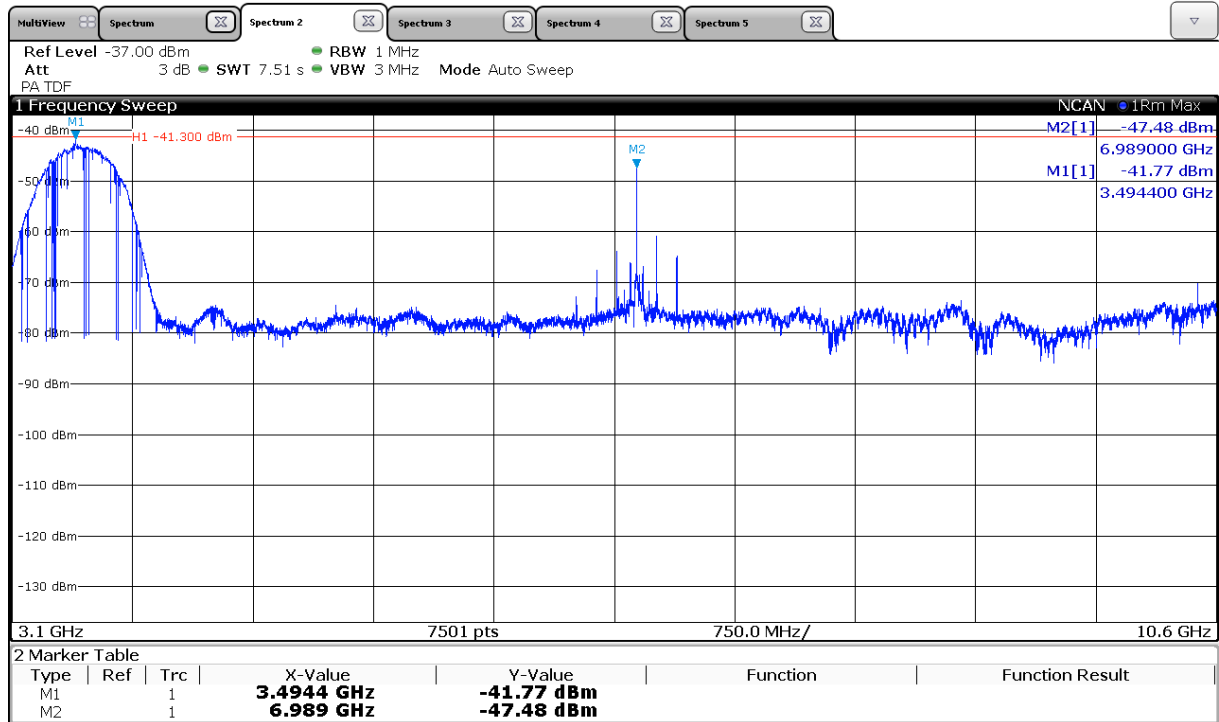
Mean power:



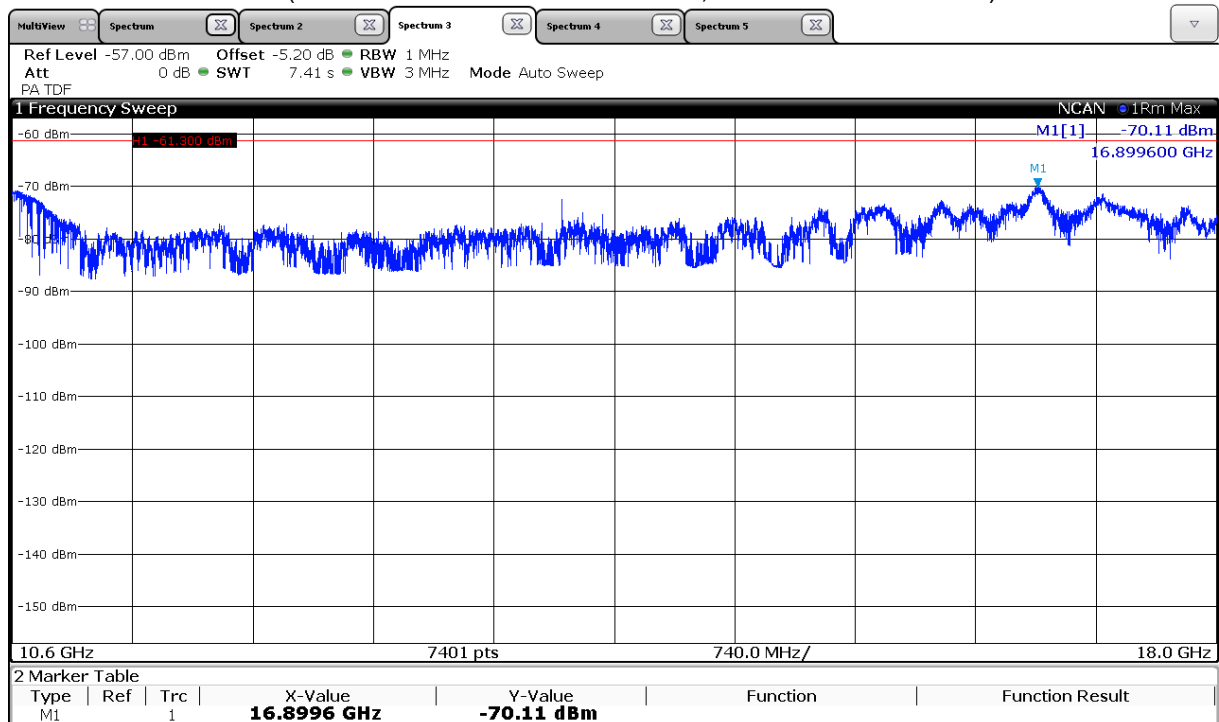
960 MHz to 3.1 GHz at 1 m



3.1 GHz to 10.6 GHz at 1 m

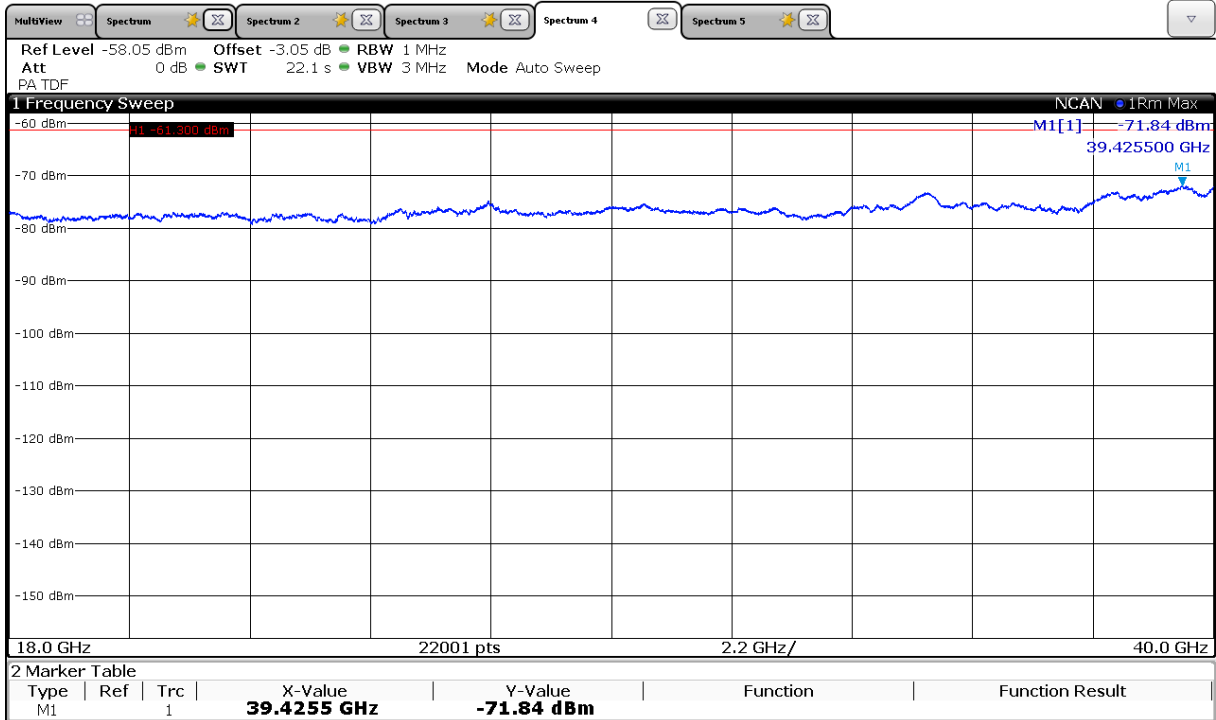


10.6 GHz to 18 GHz at 30 cm (EIRP transducer for 1 m was used, therefore offset -5.2 dB)



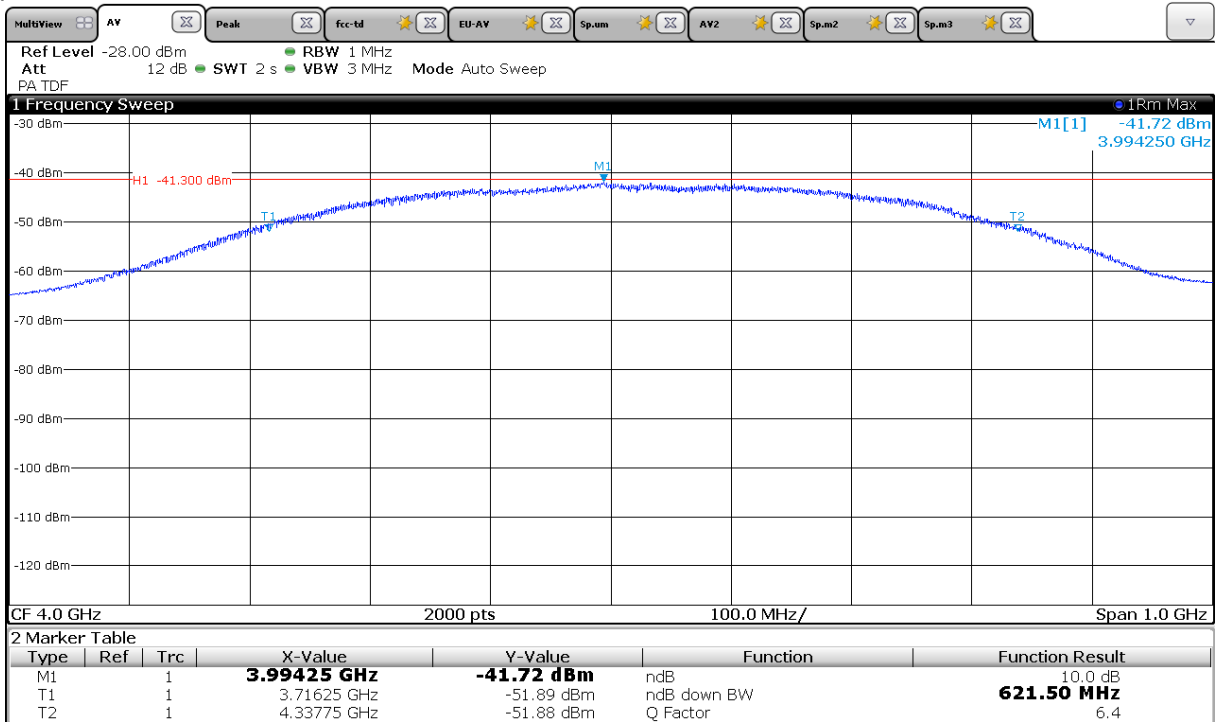
## FCC ID: 2ALC5-KNX-HTAG1

18 GHz to 40 GHz at 30 cm (ERP transducer for 1 m was used, therefore offset 2.15 dB (EIRP) and -5.2 dB (30 cm))

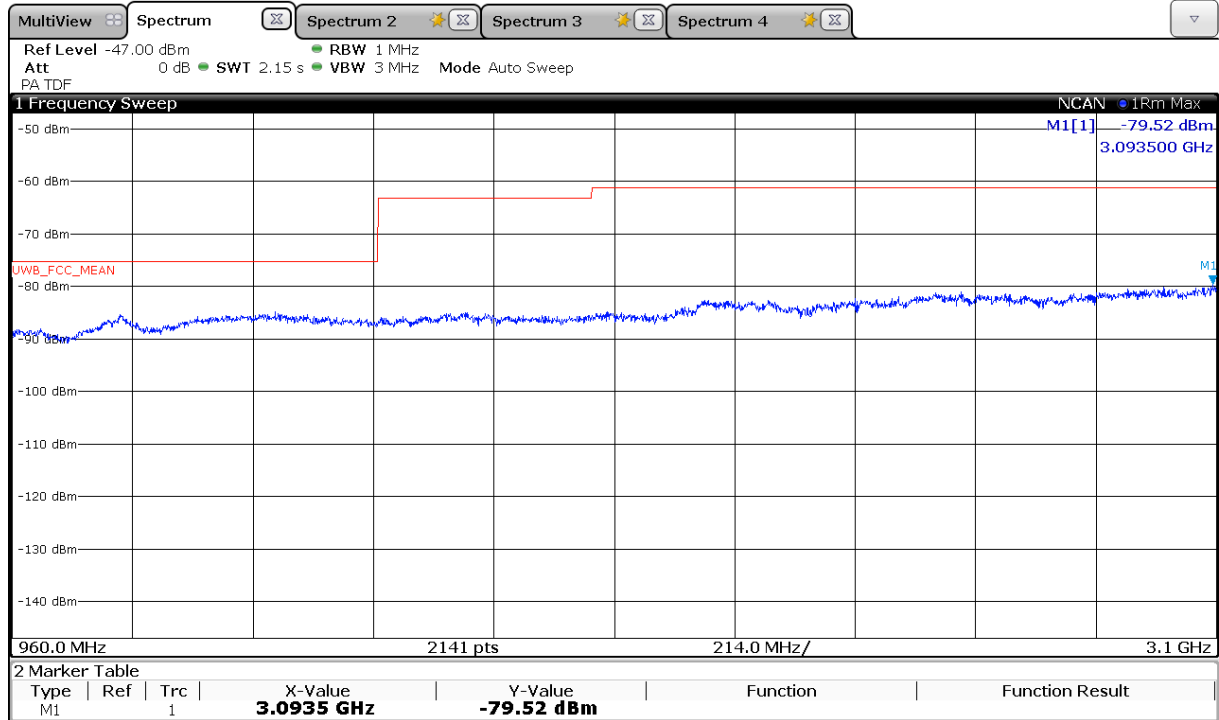


### Channel 2:

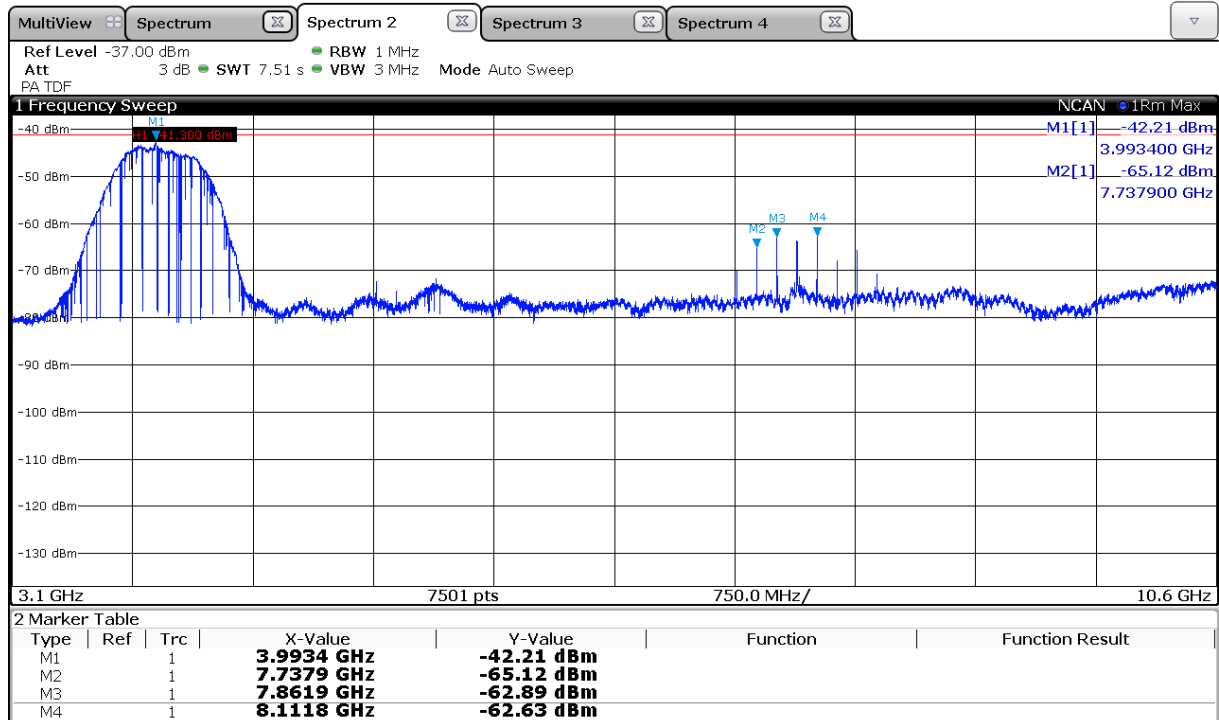
Mean power:



960 MHz to 3.1 GHz at 1 m

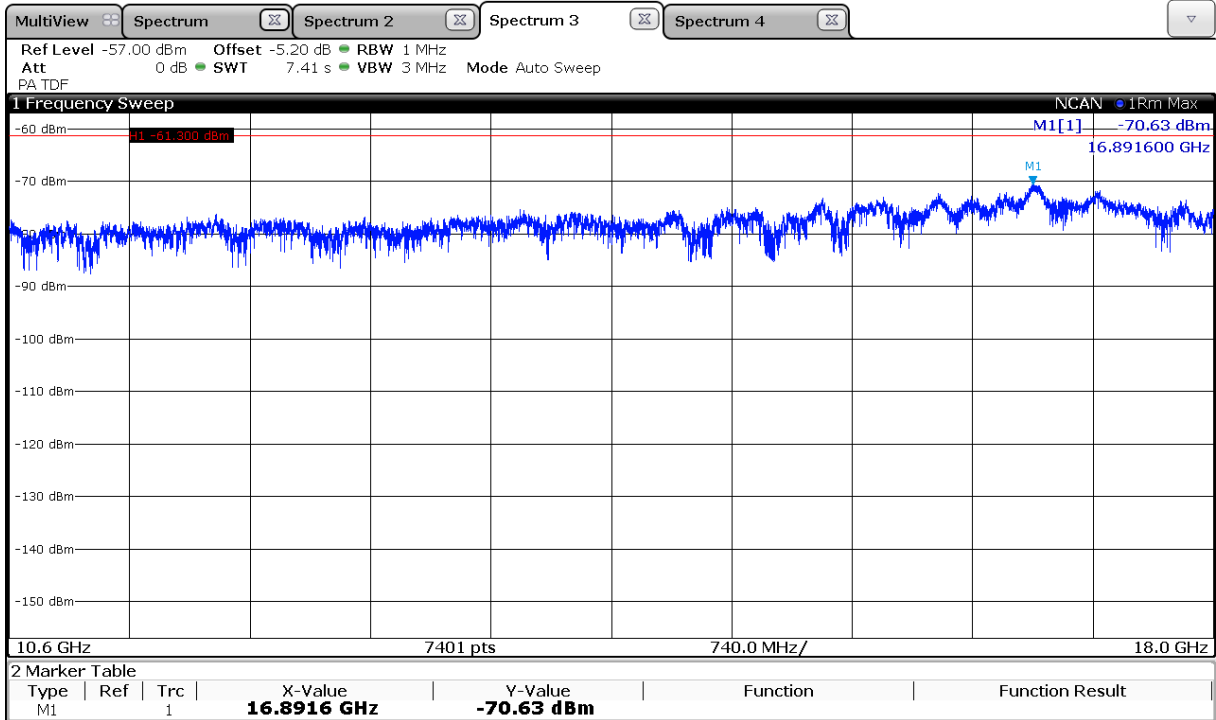


3.1 GHz to 10.6 GHz at 1 m

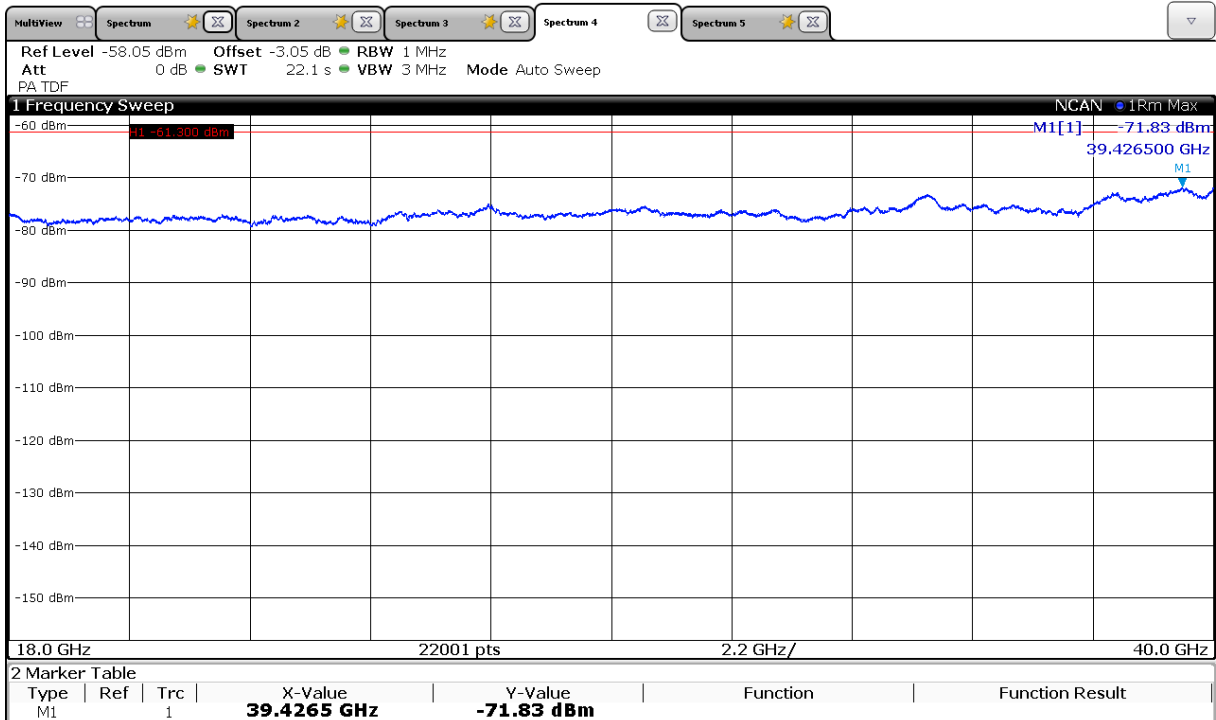


## FCC ID: 2ALC5-KNX-HTAG1

10.6 GHz to 18 GHz at 30 cm (EIRP transducer for 1 m was used, therefore offset -5.2 dB)

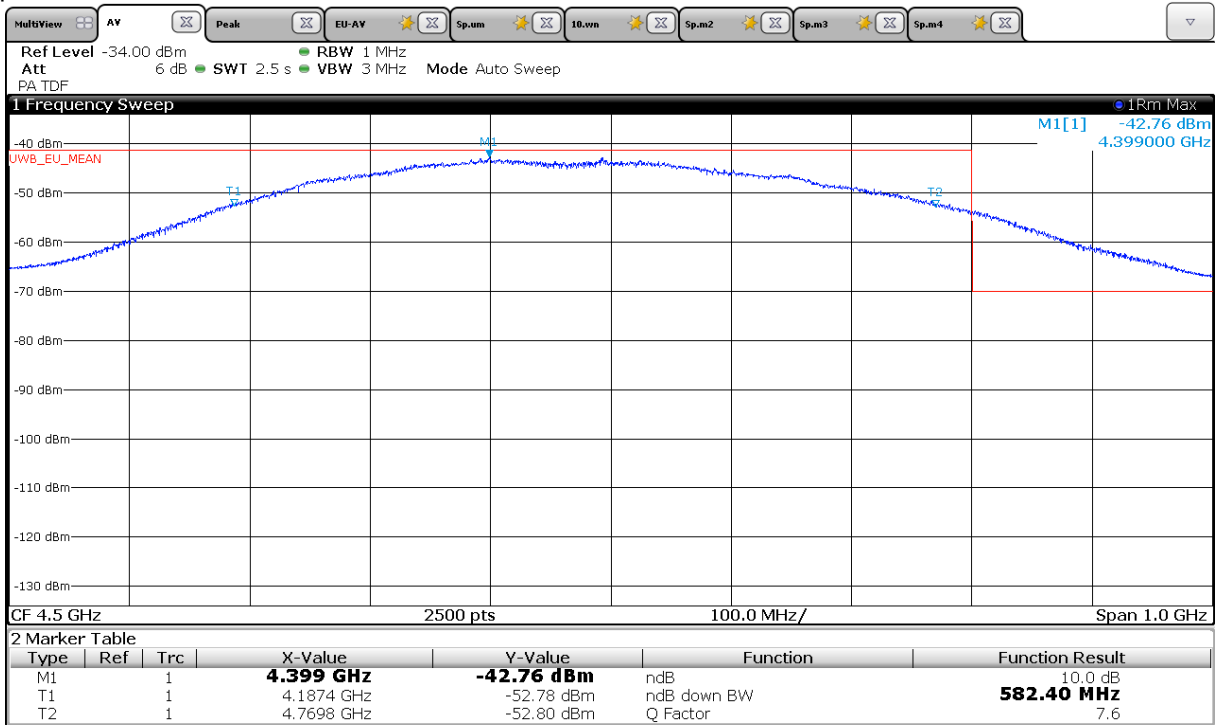


18 GHz to 40 GHz at 30 cm (ERP transducer for 1 m was used, therefore offset 2.15 dB (EIRP) and -5.2 dB (30 cm))

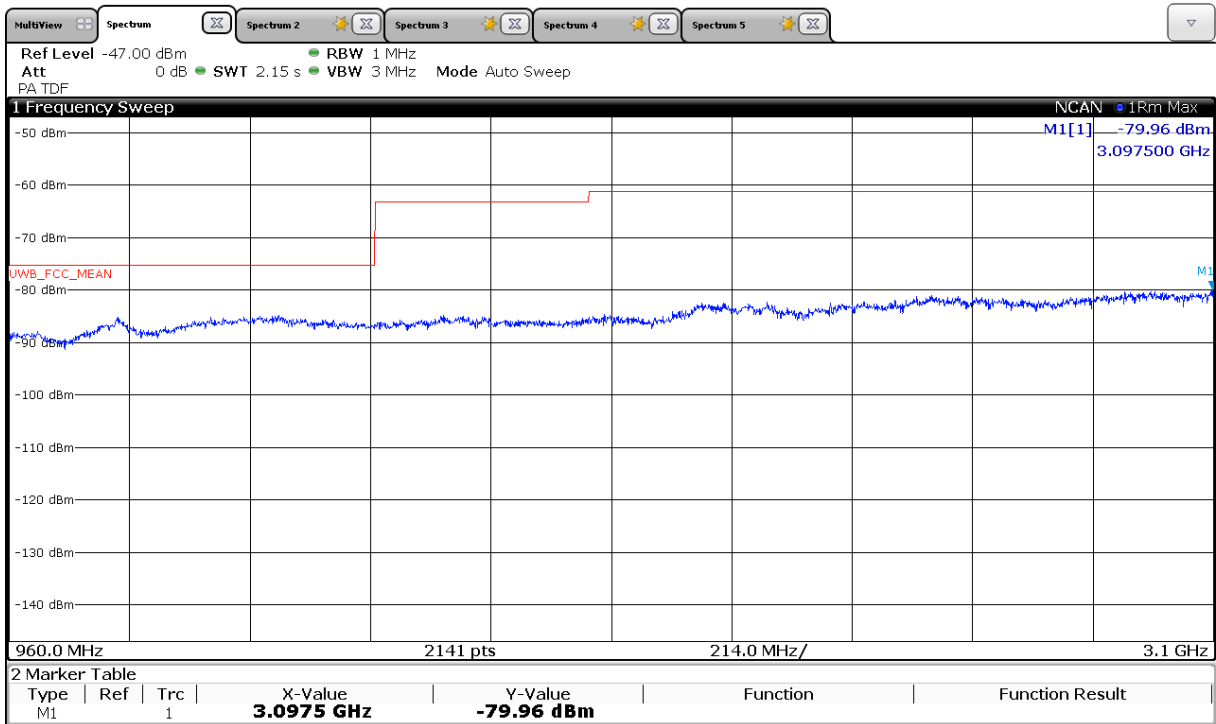


Channel 3:

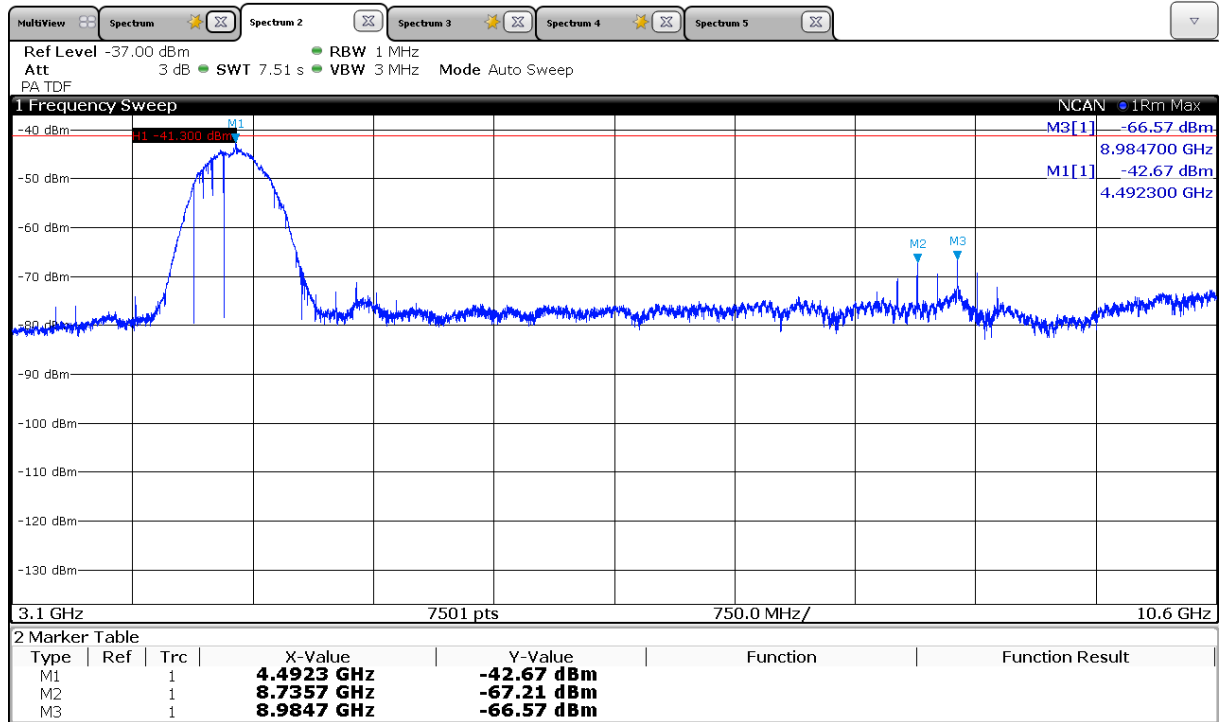
Mean power:



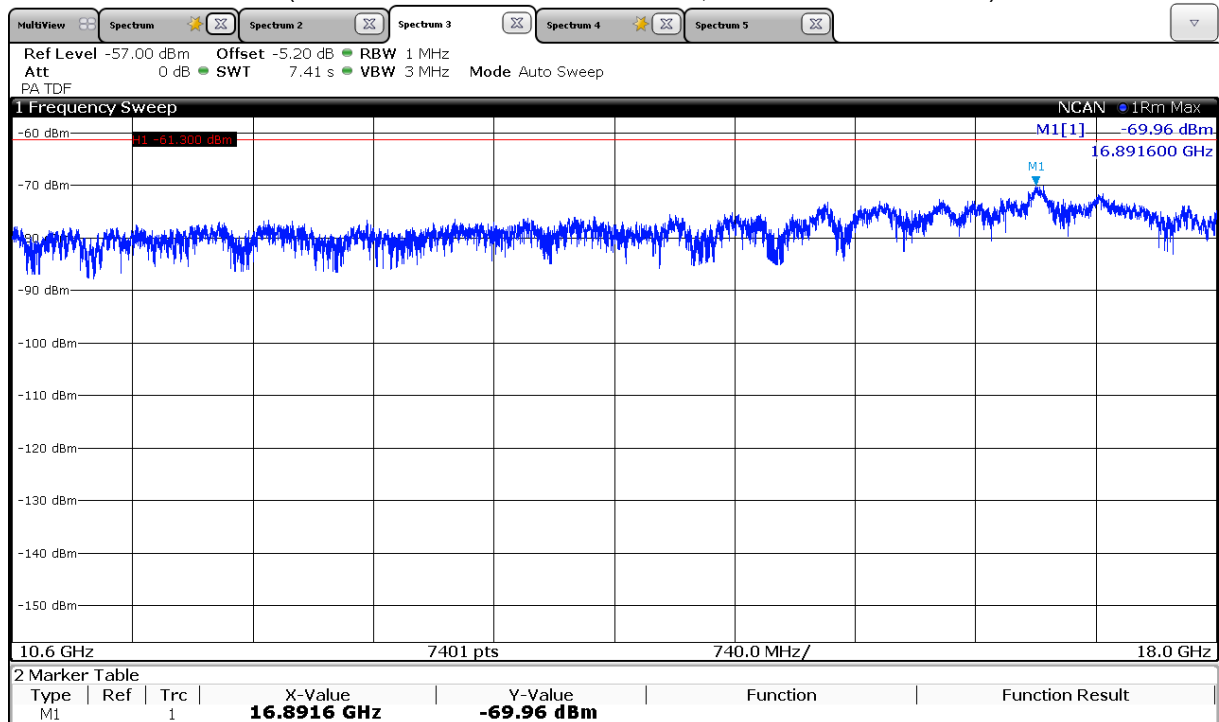
960 MHz to 3.1 GHz at 1 m



3.1 GHz to 10.6 GHz at 1 m

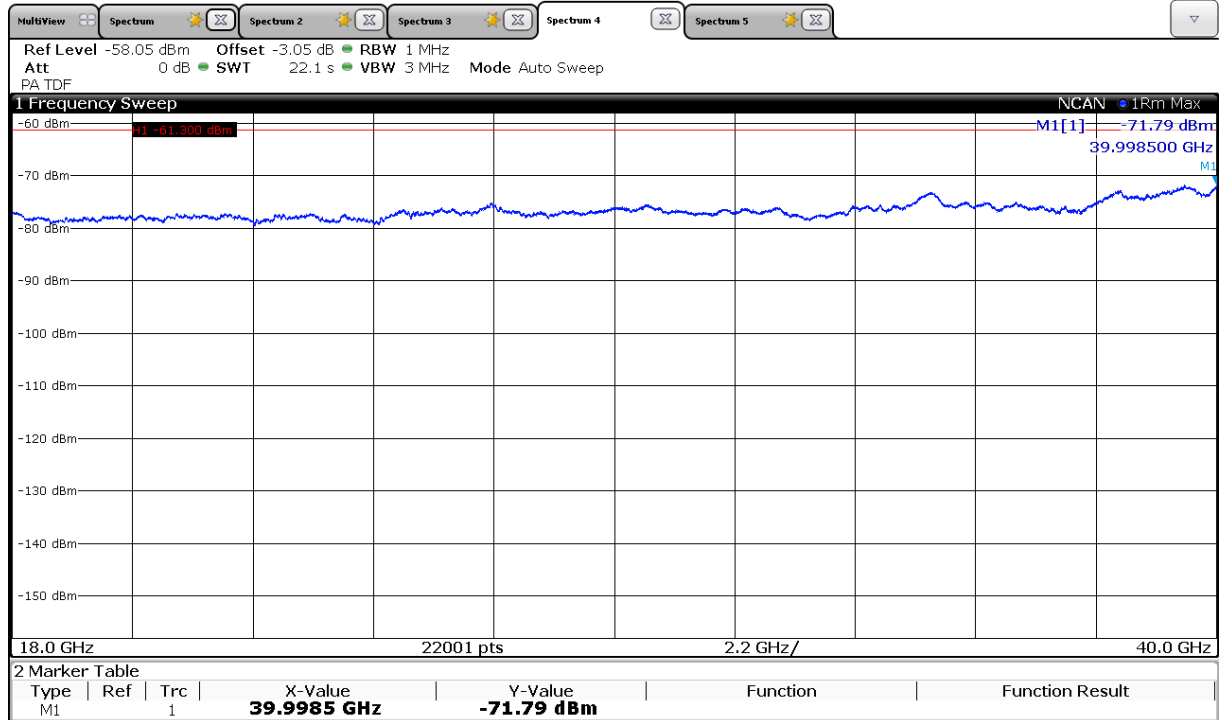


10.6 GHz to 18 GHz at 30 cm (EIRP transducer for 1 m was used, therefore offset -5.2 dB)



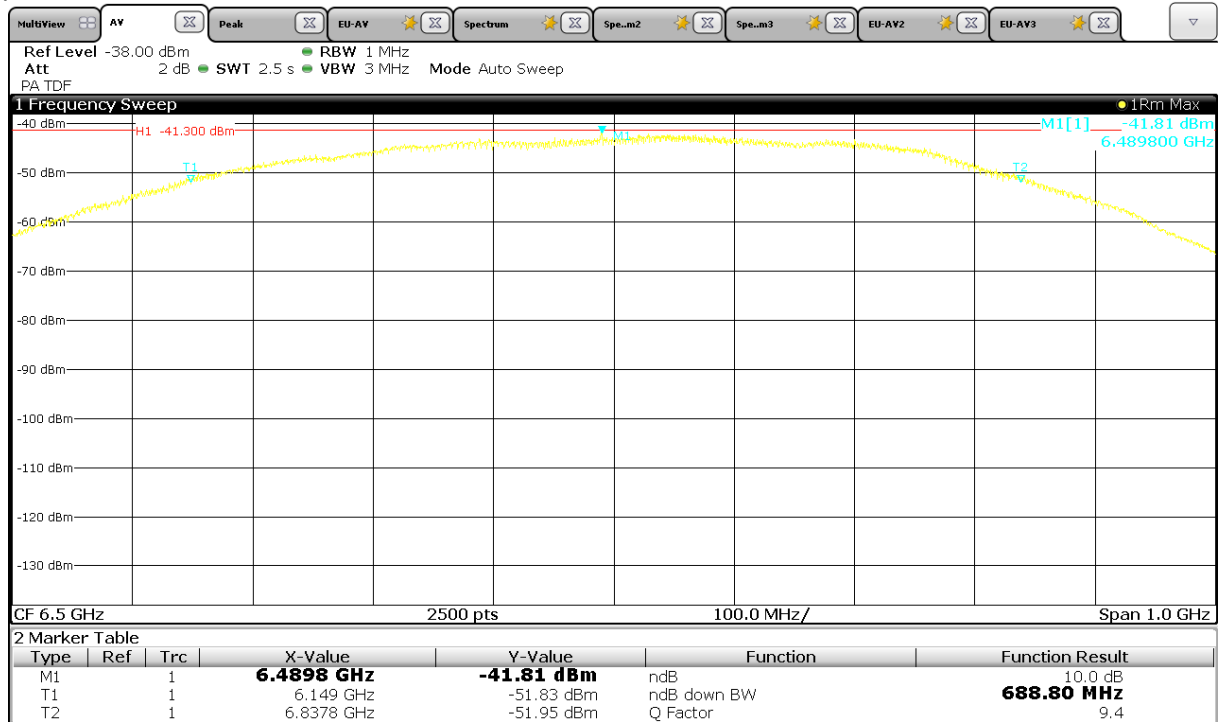
## FCC ID: 2ALC5-KNX-HTAG1

18 GHz to 40 GHz at 30 cm (ERP transducer for 1 m was used, therefore offset 2.15 dB (EIRP) and -5.2 dB (30 cm))



### Channel 5:

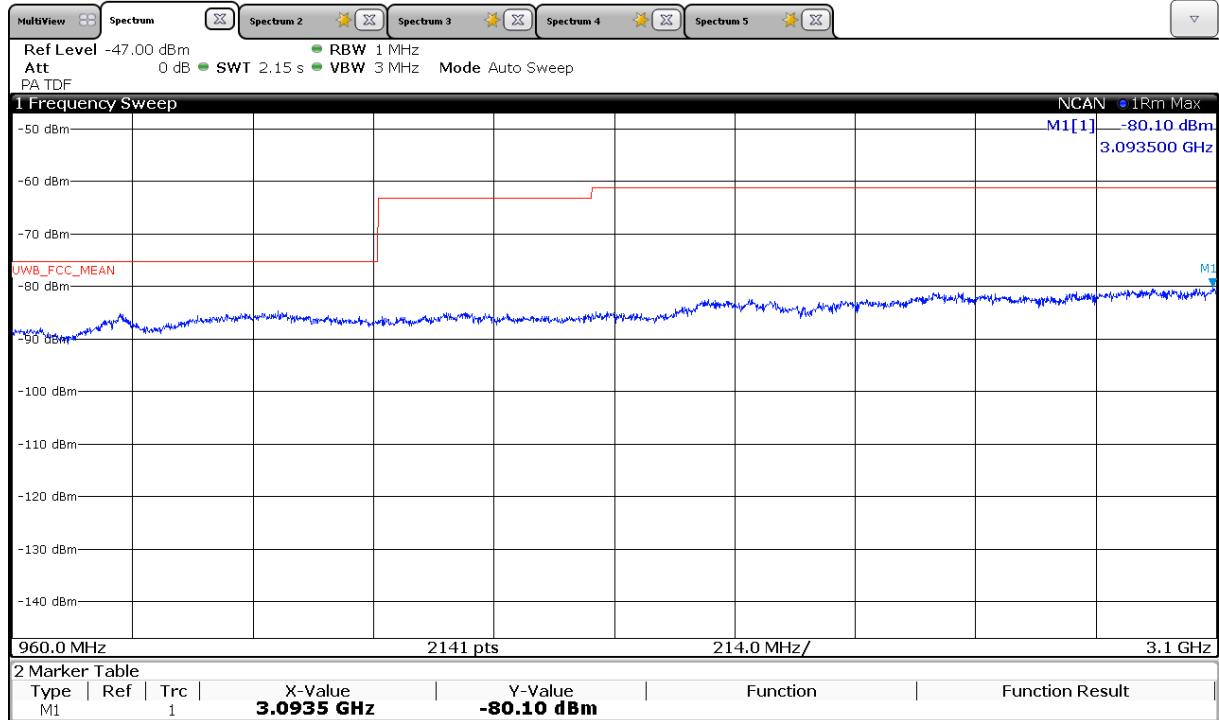
Mean power:



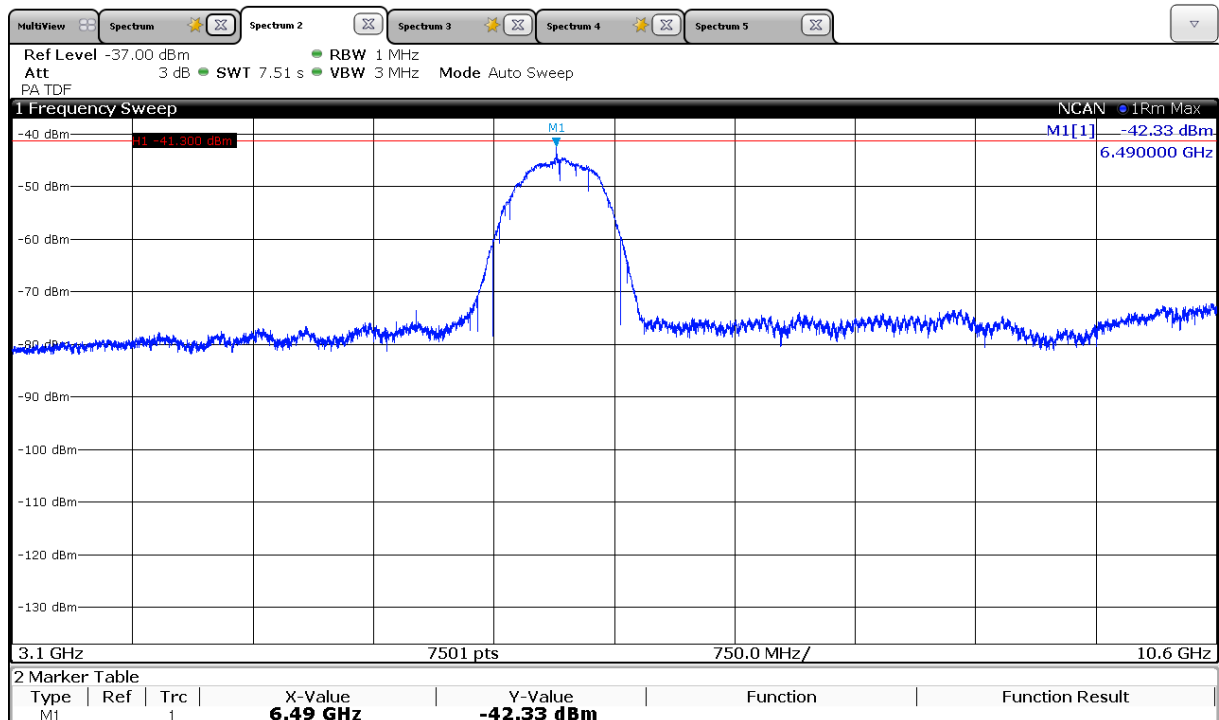


## FCC ID: 2ALC5-KNX-HTAG1

960 MHz to 3.1 GHz at 1 m

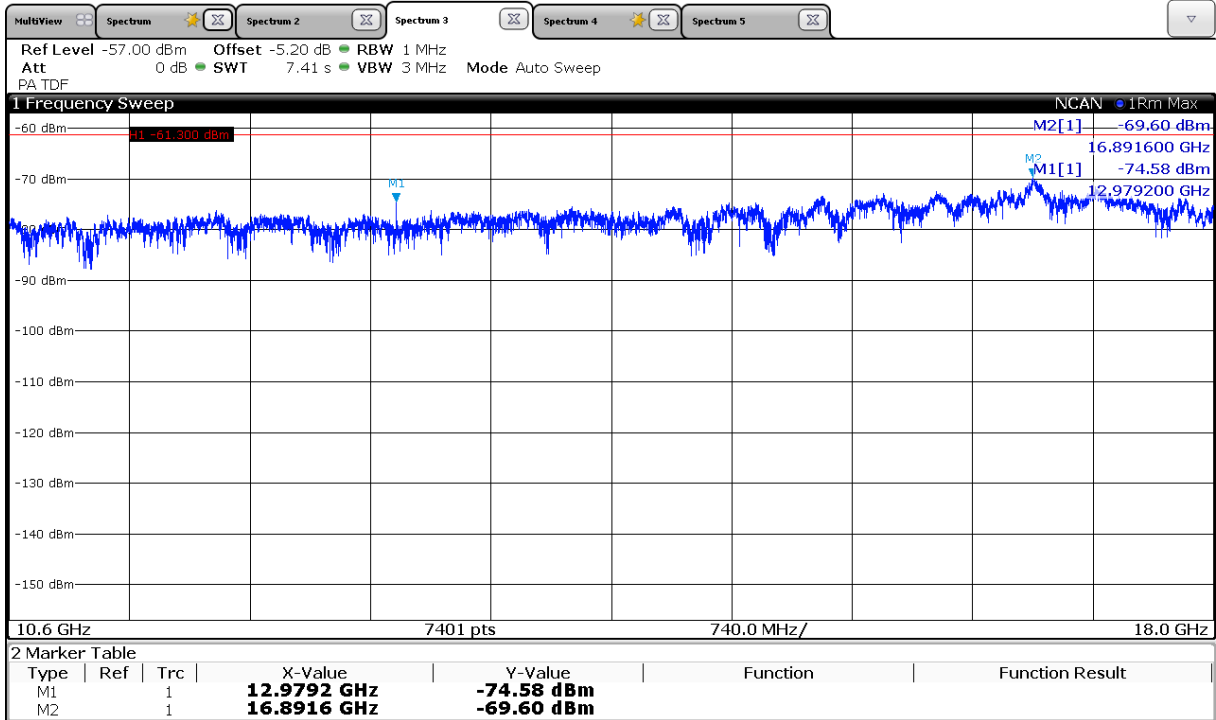


3.1 GHz to 10.6 GHz at 1 m

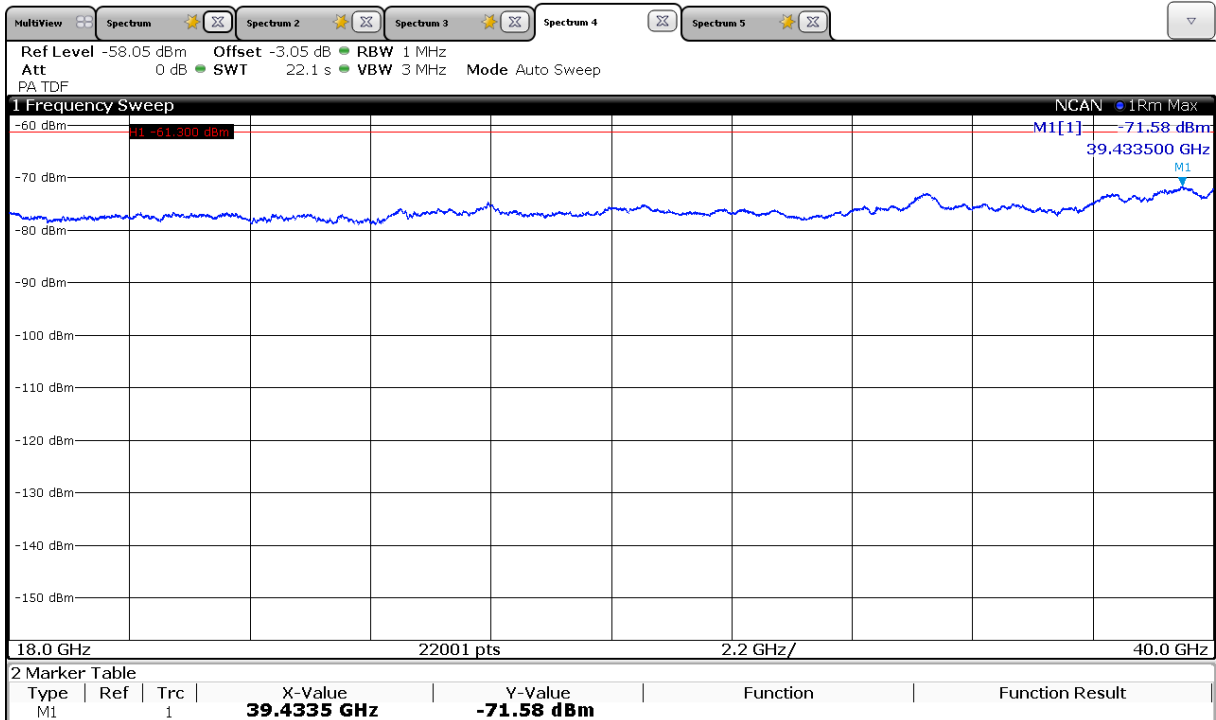


## FCC ID: 2ALC5-KNX-HTAG1

10.6 GHz to 18 GHz at 30 cm (EIRP transducer for 1 m was used, therefore offset -5.2 dB)



18 GHz to 40 GHz at 30 cm (ERP transducer for 1 m was used, therefore offset 2.15 dB (EIRP) and -5.2 dB (30 cm))



**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

The requirements are **FULFILLED**.

**Remarks:**

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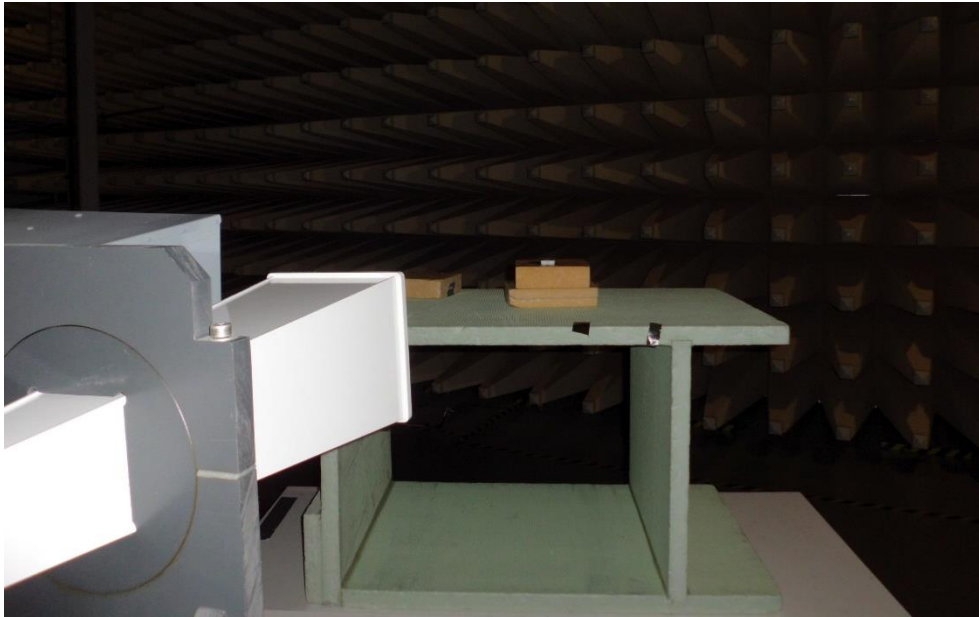
## 5.4 Radiated Emissions at 1164-1240 MHz and 1559-1610 MHz

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.

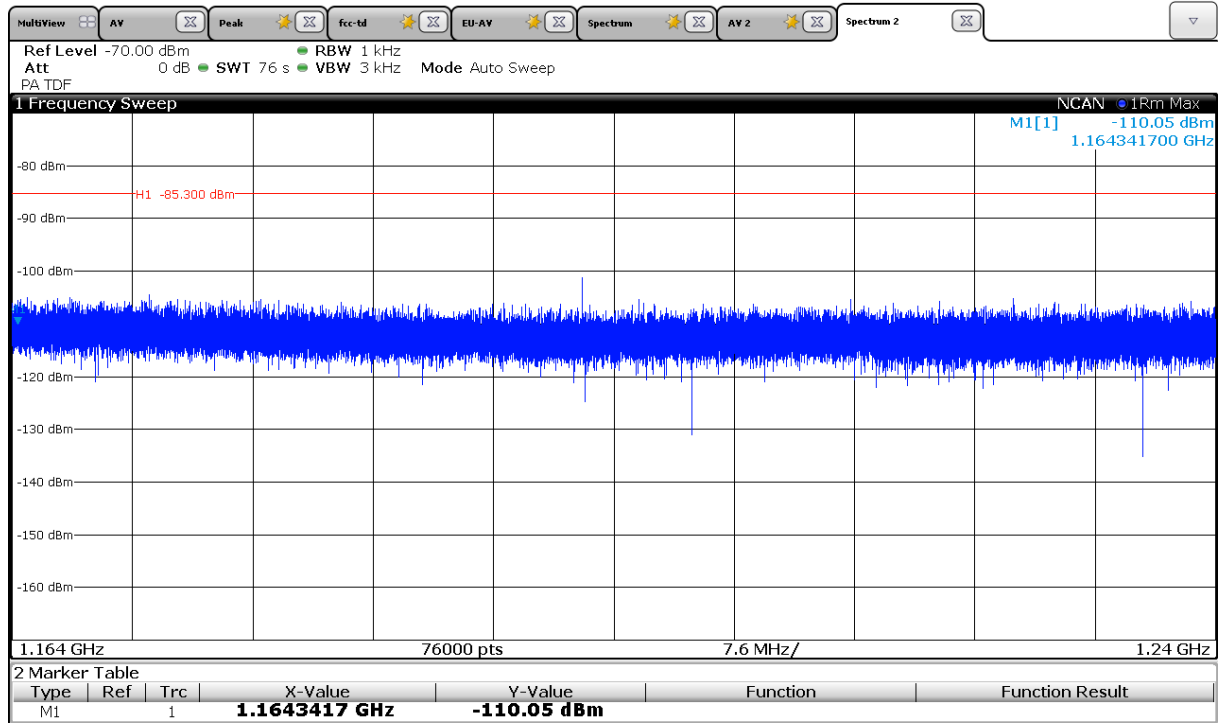
### 5.4.4 Analyser settings

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

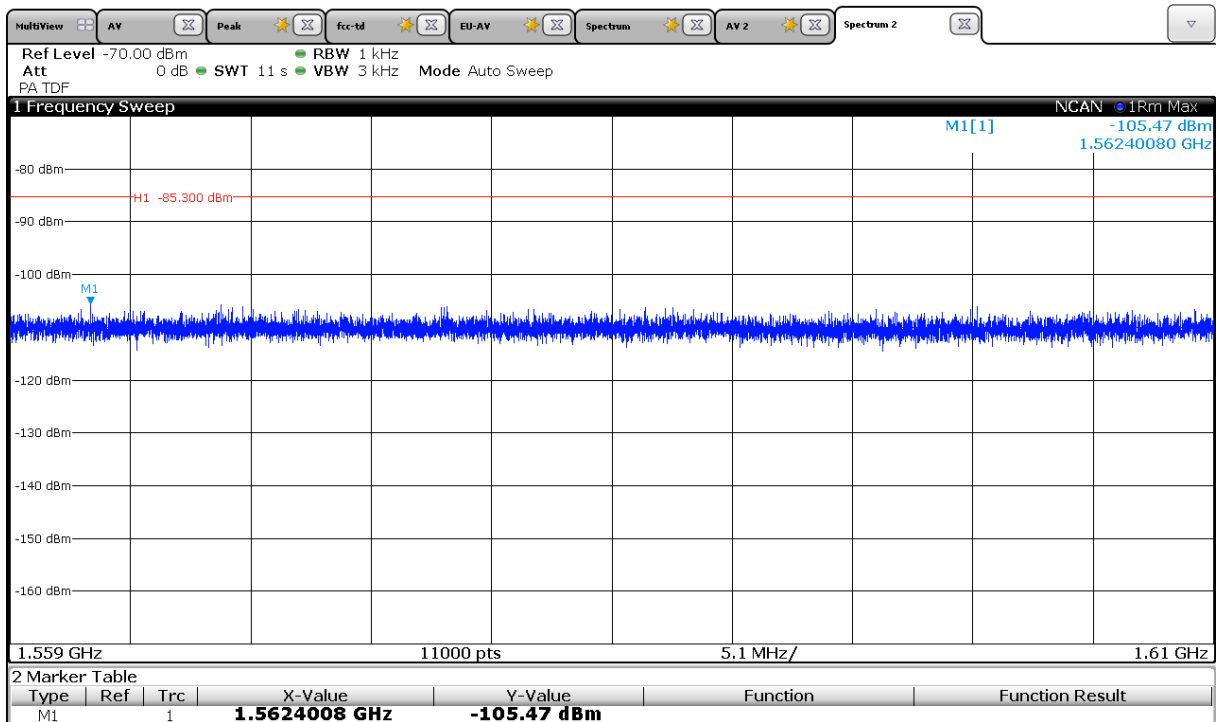
## 5.4.5 Test result

### Channel 1:

1164 MHz to 1240 MHz

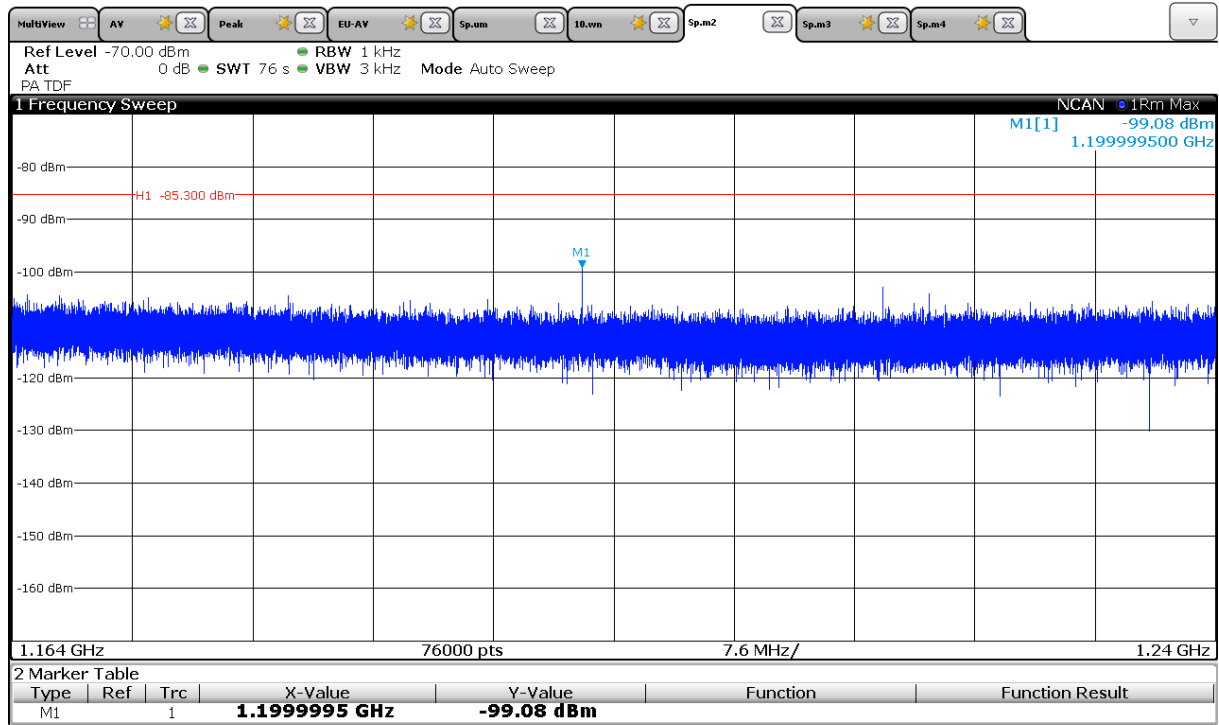


1559 MHz to 1610 MHz

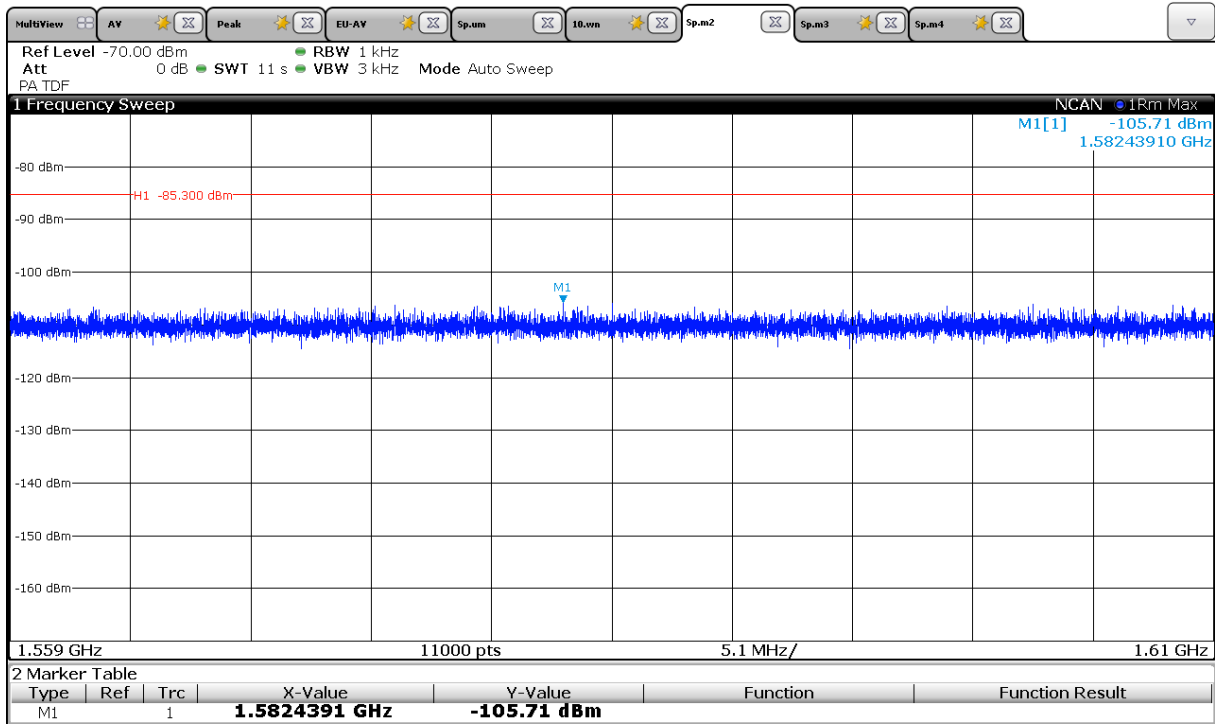


Channel 2:

1164 MHz to 1240 MHz

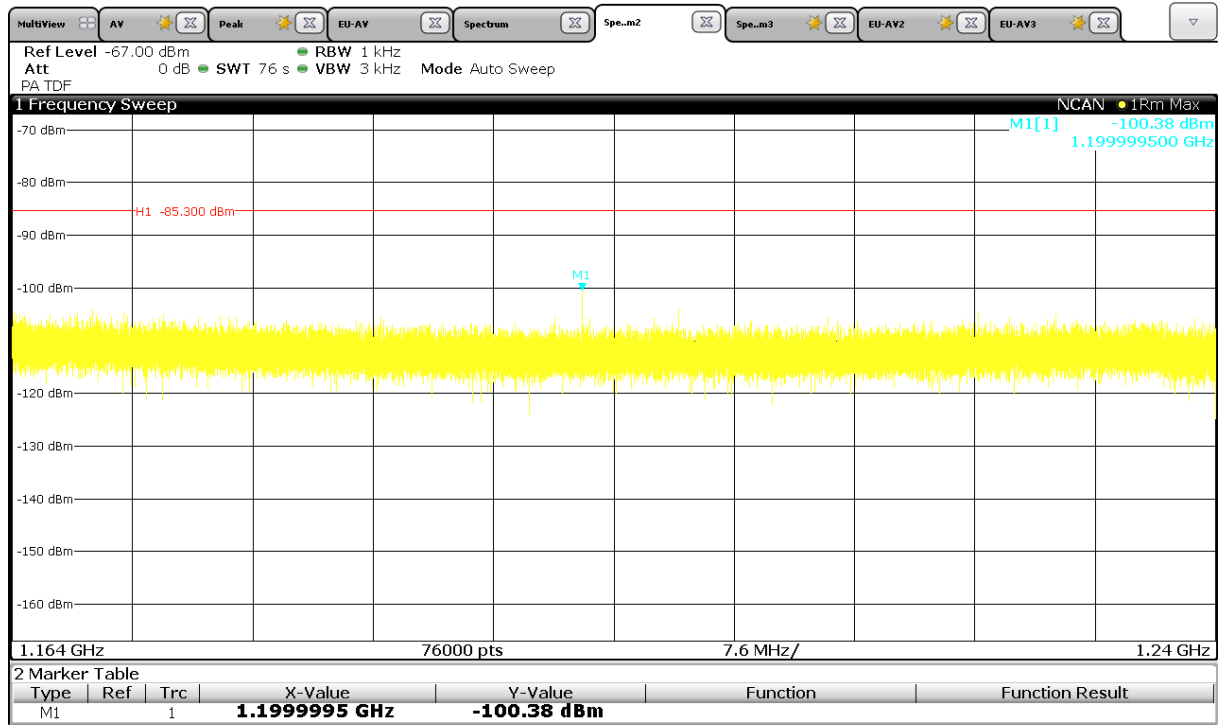


1559 MHz to 1610 MHz

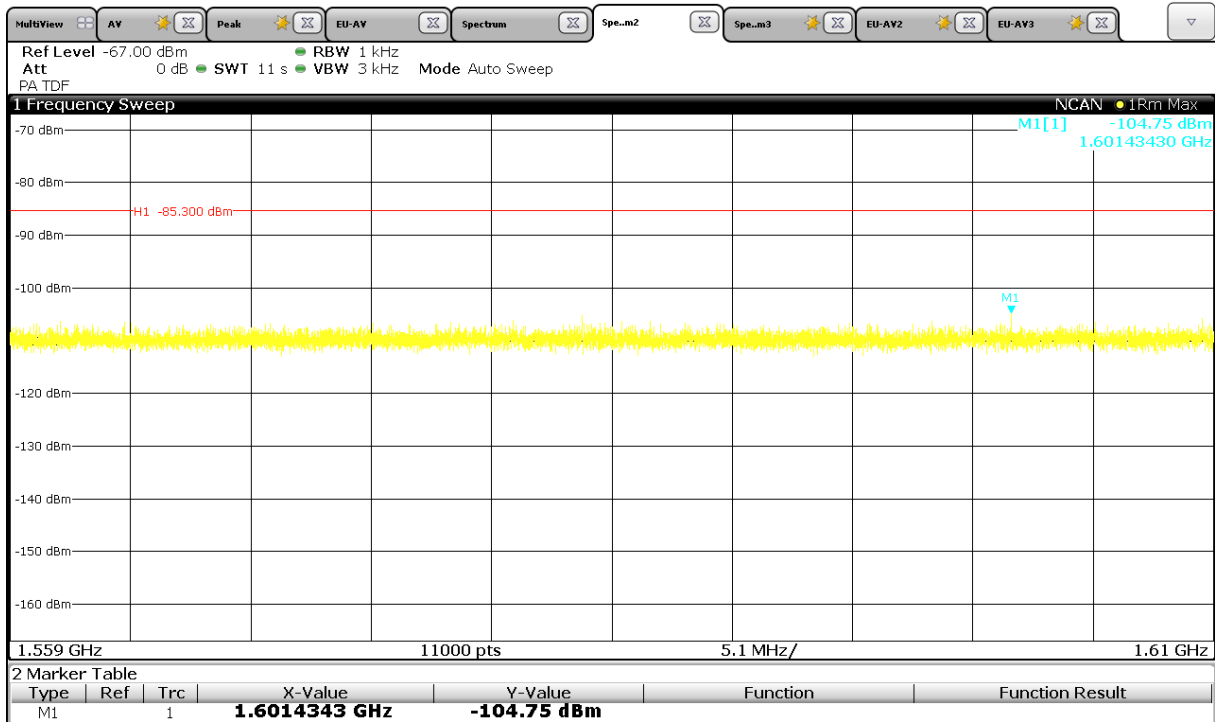


Channel 3:

1164 MHz to 1240 MHz

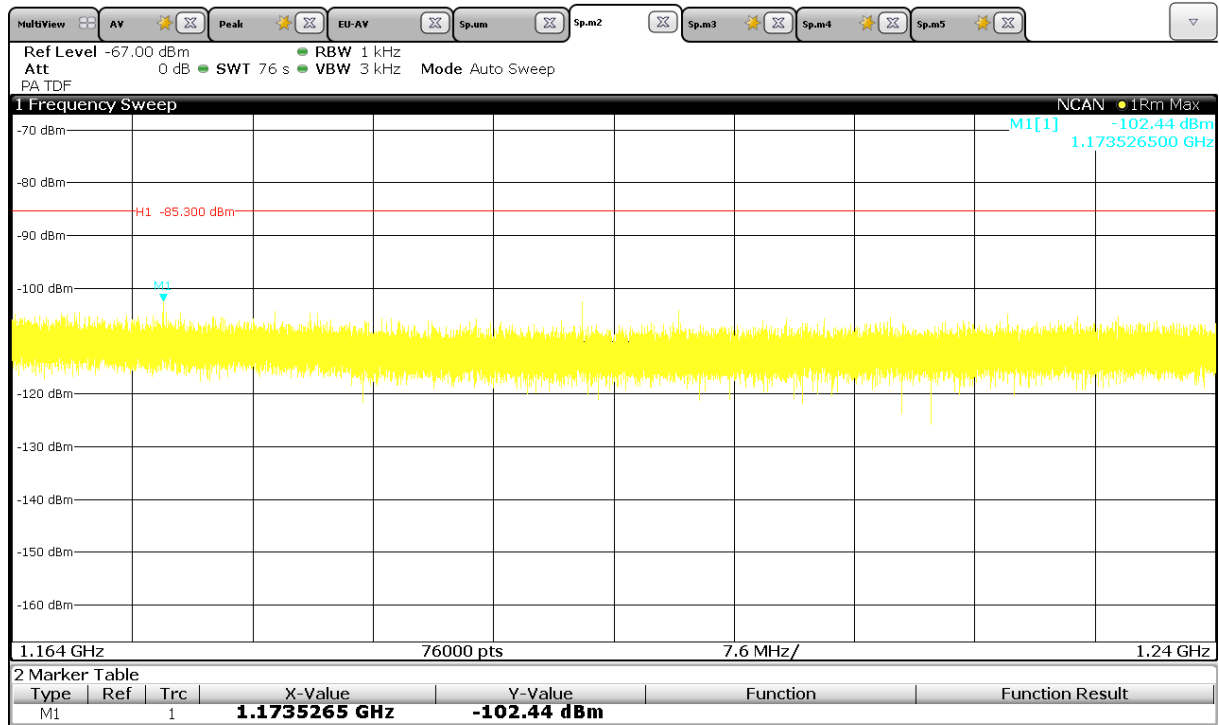


1559 MHz to 1610 MHz

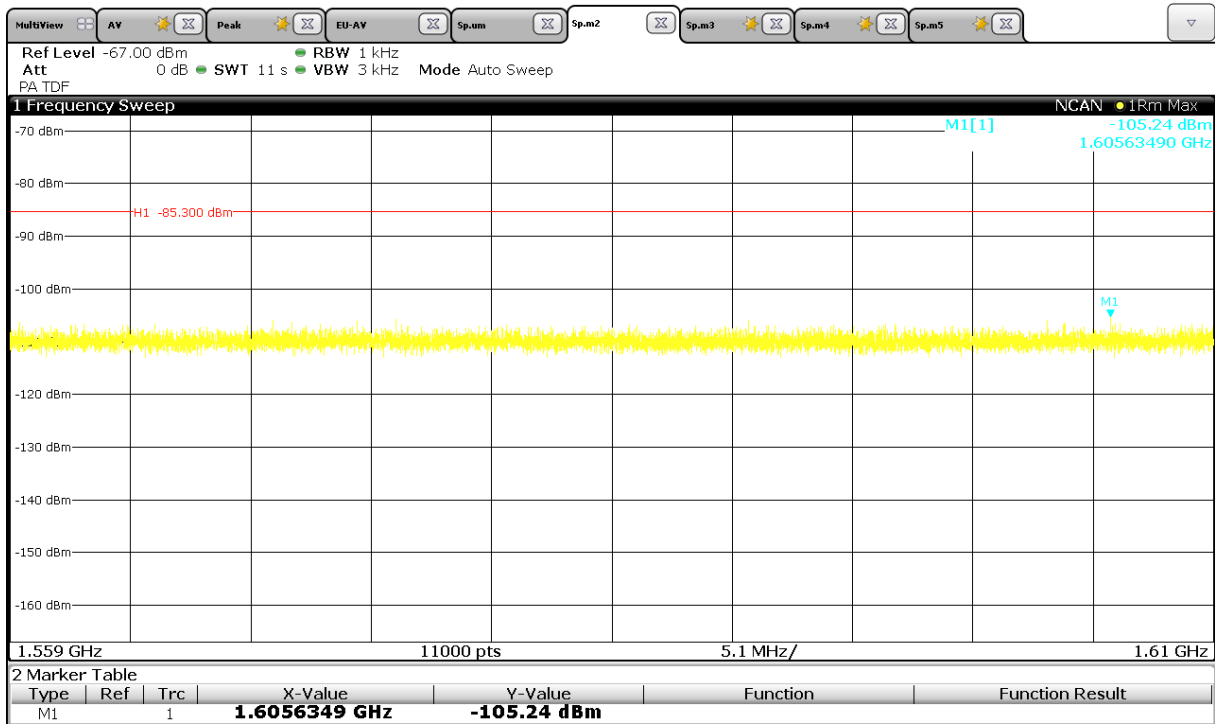


Channel 5:

1164 MHz to 1240 MHz



1559 MHz to 1610 MHz





**FCC ID: 2ALC5-KNX-HTAG1**

Limit according §15.519(d) in the frequency ranges 1164 MHz-1240 MHz and 1559 MHz-1610 MHz

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

The requirements are **FULFILLED**.

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

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## 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



### 5.5.3 Applicable standard

According to FCC Part 15, Section 15.519(e):

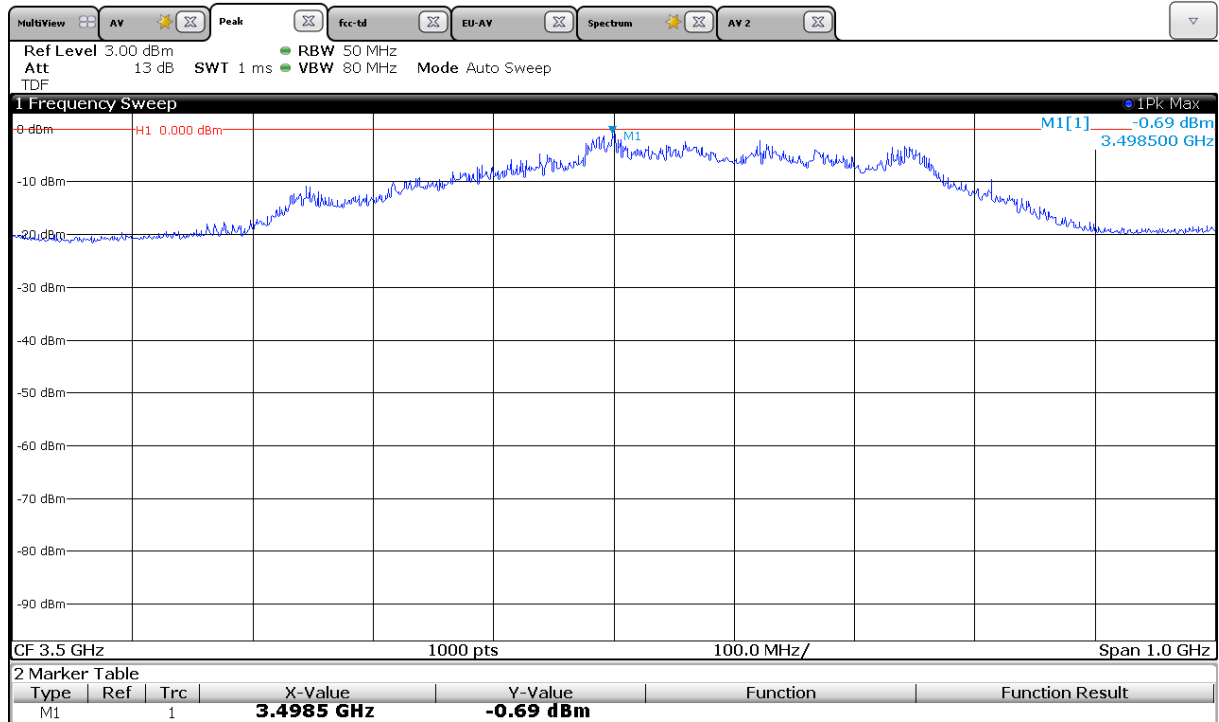
There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_m$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

### 5.5.4 Analyser settings

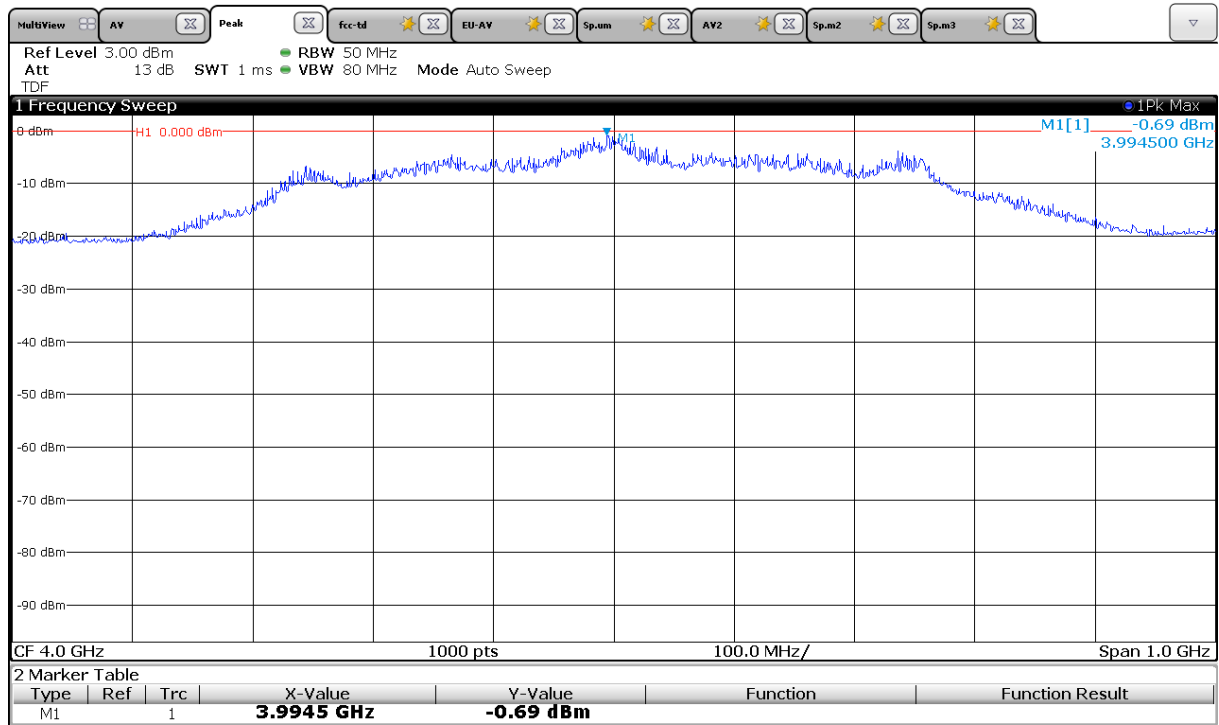
RBW: 50 MHz, VBW: 80 MHz, Detector: Peak, Trace Mode: Max hold

## 5.5.5 Test result

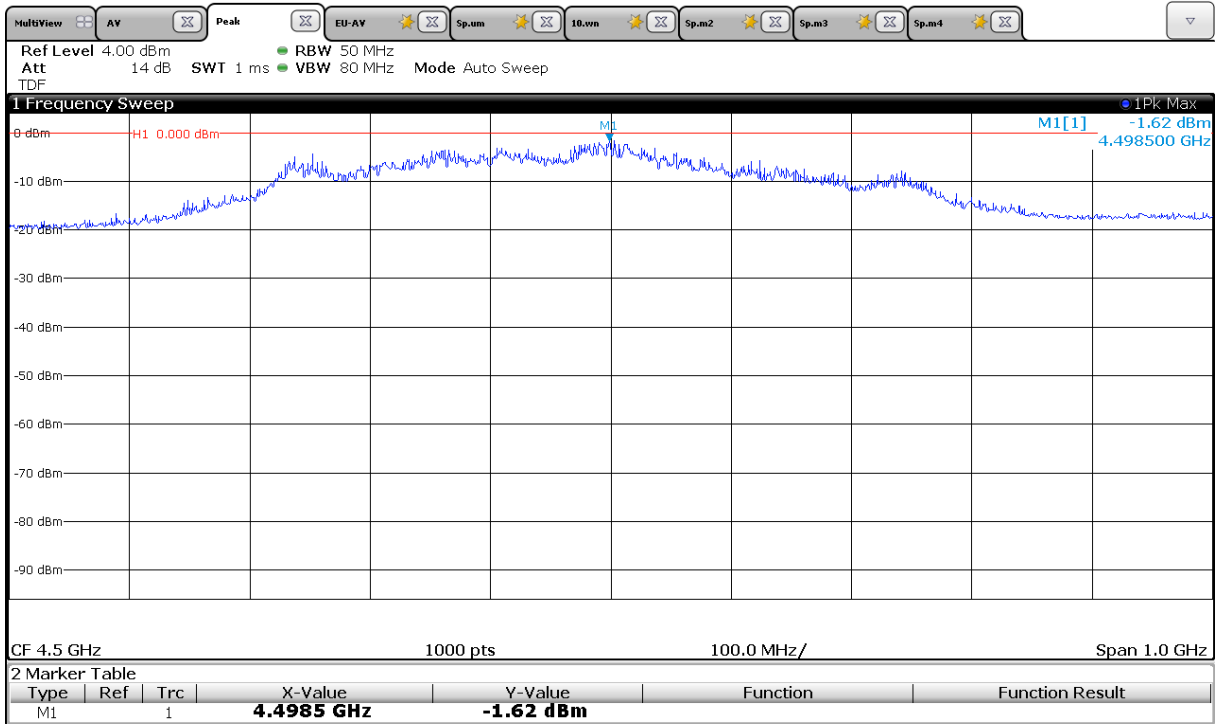
### Channel 1:



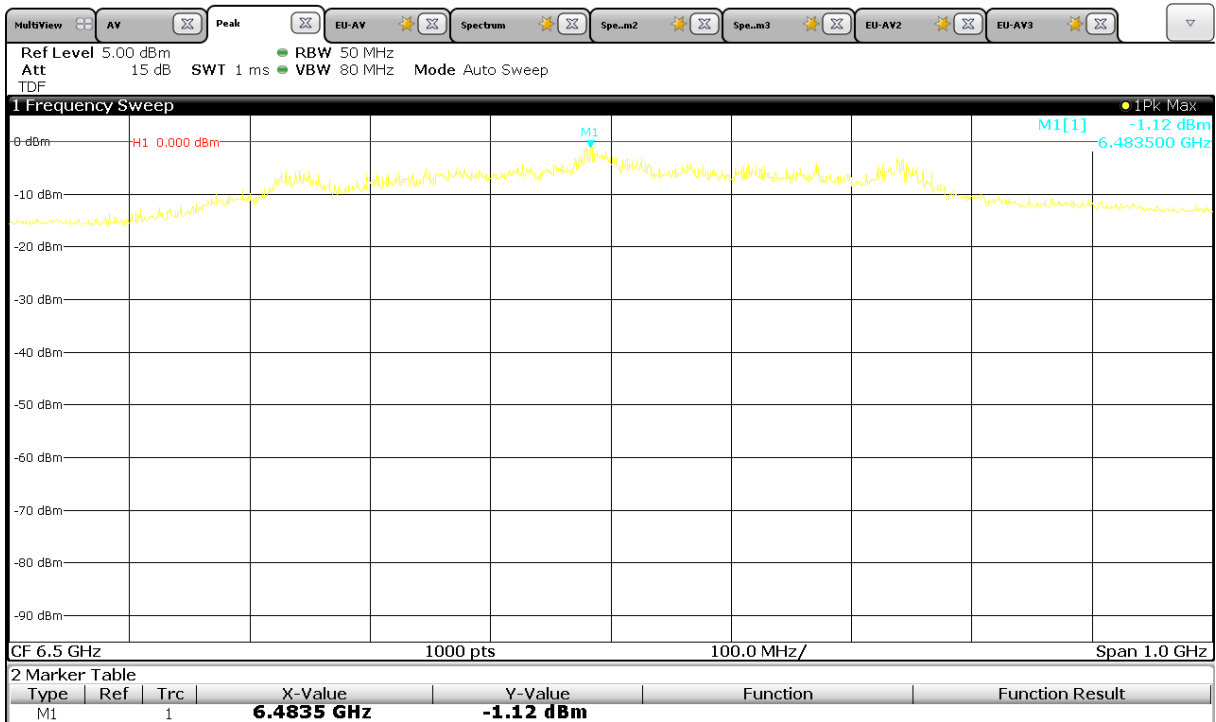
### Channel 2:



Channel 3:



Channel 5:



**FCC ID: 2ALC5-KNX-HTAG1**

Limit 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.

The requirements are **FULFILLED**.

**Remarks:**

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## 5.6 Antenna application

### 5.6.1 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.

The supplied antenna meets the requirements of part 15.203 and 15.204.

Remarks:

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## **6 USED TEST EQUIPMENT AND ACCESSORIES**

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

<b>Test ID</b>	<b>Model Type</b>	<b>Equipment No.</b>	<b>Next Calib.</b>	<b>Last Calib.</b>	<b>Next Verif.</b>	<b>Last Verif.</b>
CPR 3	FSW43	02-02/11-15-001	07/04/2018	07/04/2017		
	BBHA 9120 E 251	02-02/24-05-006	27/04/2018	27/04/2017	27/10/2017	27/04/2017
	WBH2-18NHG	02-02/24-08-002	27/04/2018	27/04/2017	27/10/2017	27/04/2017
	WHJS 1000-10EE	02-02/50-05-070				
	SR104/11SMA/11N/2000MM	02-02/50-15-002				
MB	FSW43	02-02/11-15-001	07/04/2018	07/04/2017		
SER 2	ESVS 30	02-02/03-05-003	08/07/2017	08/07/2016		
	VULB 9168	02-02/24-05-005	12/04/2018	12/04/2017	12/10/2017	12/04/2017
	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	FSW43	02-02/11-15-001	07/04/2018	07/04/2017		
	JS4-18004000-30-5A	02-02/17-05-017				
	BBHA 9120 E 251	02-02/24-05-006	27/04/2018	27/04/2017	27/10/2017	27/04/2017
	BBHA 9170	02-02/24-05-014	02/06/2018	02/06/2015	09/12/2017	09/12/2016
	WBH2-18NHG	02-02/24-08-002	27/04/2018	27/04/2017	27/10/2017	27/04/2017
	WHJS 1000-10EE	02-02/50-05-070				
	KMS102-0.2 m	02-02/50-11-020				
	SR104/11SMA/11N/2000MM	02-02/50-15-002				