



FCC ID:LYH-IEWSNPA1

## EMI -- TEST REPORT

- FCC Part 15.247 FHSS -

<b>Test Report No. :</b> <b>T33545-02-00HS</b>	11. October 2010 Date of issue
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Type / Model Name : IE WSN-PA Link

Product Description : Wireless HART gateway

**Applicant** : Siemens AG

Address : Östliche Rheinbrückenstr. 50  
76187 KARLSRUHE, GERMANY

**Manufacturer** : Siemens AG

Address : Östliche Rheinbrückenstr. 50  
76187 KARLSRUHE, GERMANY

**Licence holder** : Siemens AG

Address : Östliche Rheinbrückenstr. 50  
76187 KARLSRUHE, GERMANY

<b>Test Result</b> according to the standards listed in clause 1 test standards:	<b>POSITIVE</b>
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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 (October, 2009)**

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

## **FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (October, 2009)**

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
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

## **FCC Rules and Regulations Part 15 Subpart B - Unintentional Radiators (October, 2009)**

Part 15, Subpart B, Section 15.107	AC Line conducted emissions <input type="checkbox"/> Class A device <input checked="" type="checkbox"/> Class B device
Part 15, Subpart B, Section 15.109	Radiated emissions, general requirements

## **FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969**

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

## **OET Bulletin 65, 65A, 65B, 65C Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.**

ANSI C63.4: 2003	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C95.1: 1992	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment

## 2 SUMMARY

### GENERAL REMARKS:

The EUT uses a transceiver module based on wireless HART protocol. The output power can not be accessed by the user.

Item	Description
Module type	APM2510-10EP-S3A0-ES
Modulation	FHSS (FSK)
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	15
Antenna type	Extern

### EUT:

Type	Order number	Option
IE WSN-PA Link	6GK1 411-6CA40-0BA0	External antenna port

### Operation modes:

- There is only TX mode.
- There is no standby mode.

### External antenna:

Type	Order number	Description	Antenna gain
ANT792-6MN	6GK5 792-6MN00-0AA6	External antenna	6 dBi

### Channel list:

Channel	Frequency
11	2405 MHz
12	2410 MHz
13	2415 MHz
14	2420 MHz
15	2425 MHz
16	2430 MHz
17	2435 MHz
18	2440 MHz
19	2445 MHz
20	2450 MHz
21	2455 MHz
22	2460 MHz
23	2465 MHz
24	2470 MHz
25	2475 MHz

The frequency range was scanned from 9 kHz to 25000 MHz. All emissions not reported in this test report are more than 20 dB below the specified limit.

**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. September 2010

Testing concluded on : 15. September 2010

Checked by:

Tested by:

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Klaus Gegenfurtner  
Dipl.-Ing.(FH)  
Manager: Radio Group

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Hermann Smetana  
Dipl.-Ing.(FH)  
Radio Expert

### 3 EQUIPMENT UNDER TEST

#### 3.1 Photo documentation of the EUT

External view:

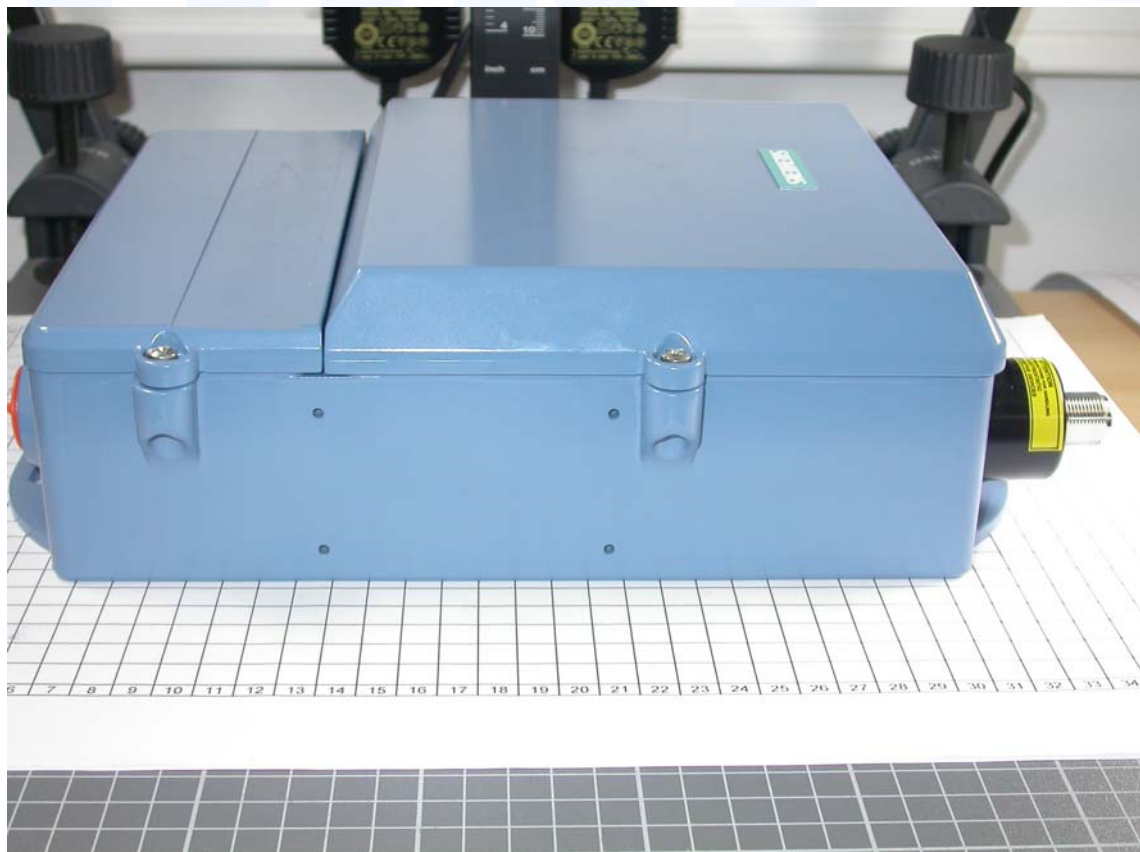


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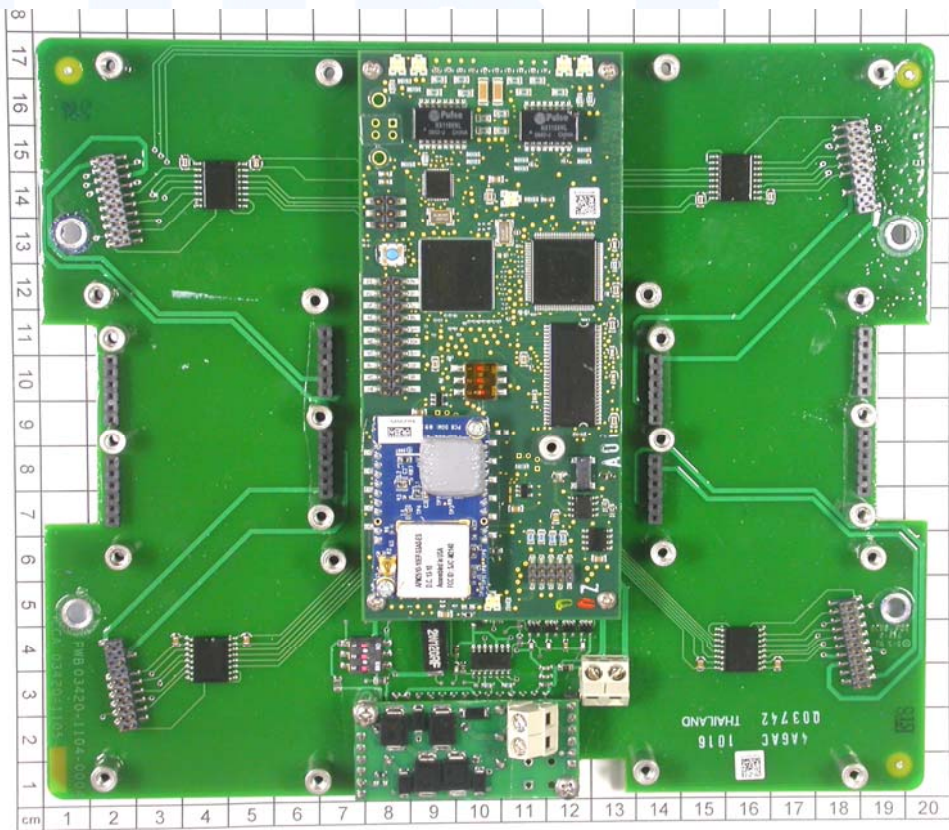
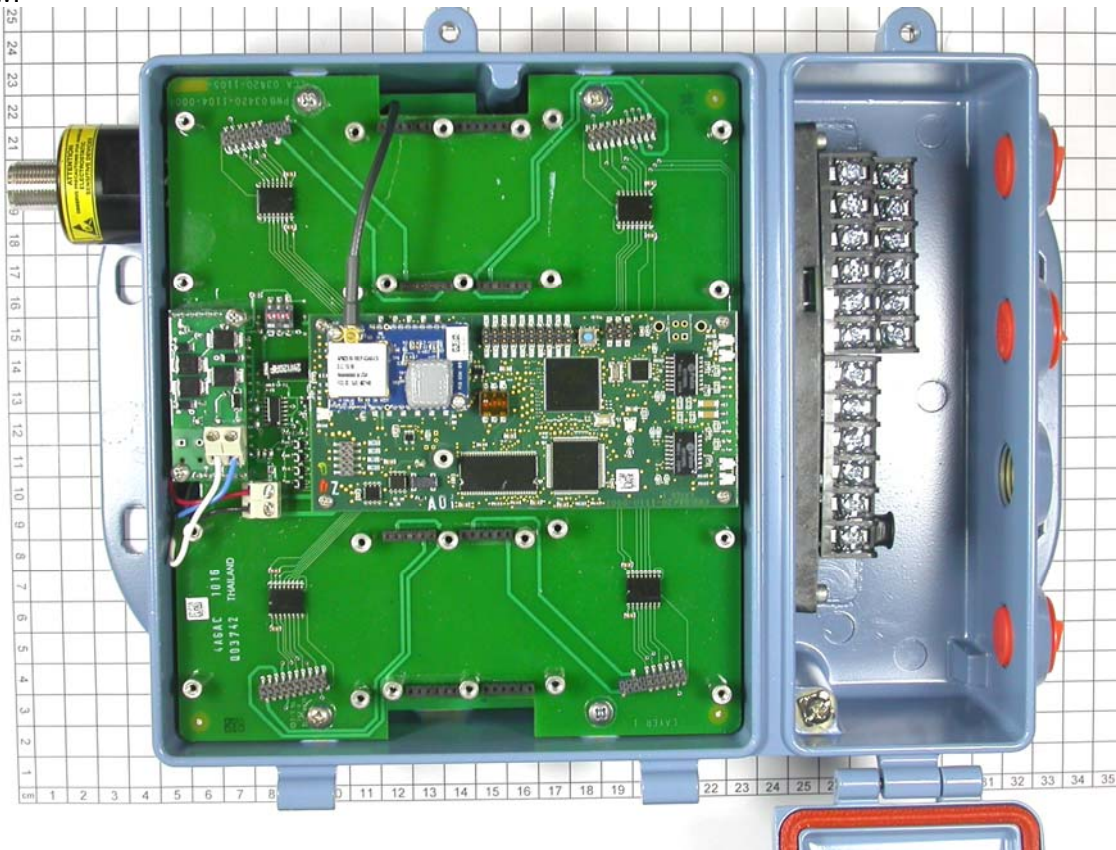
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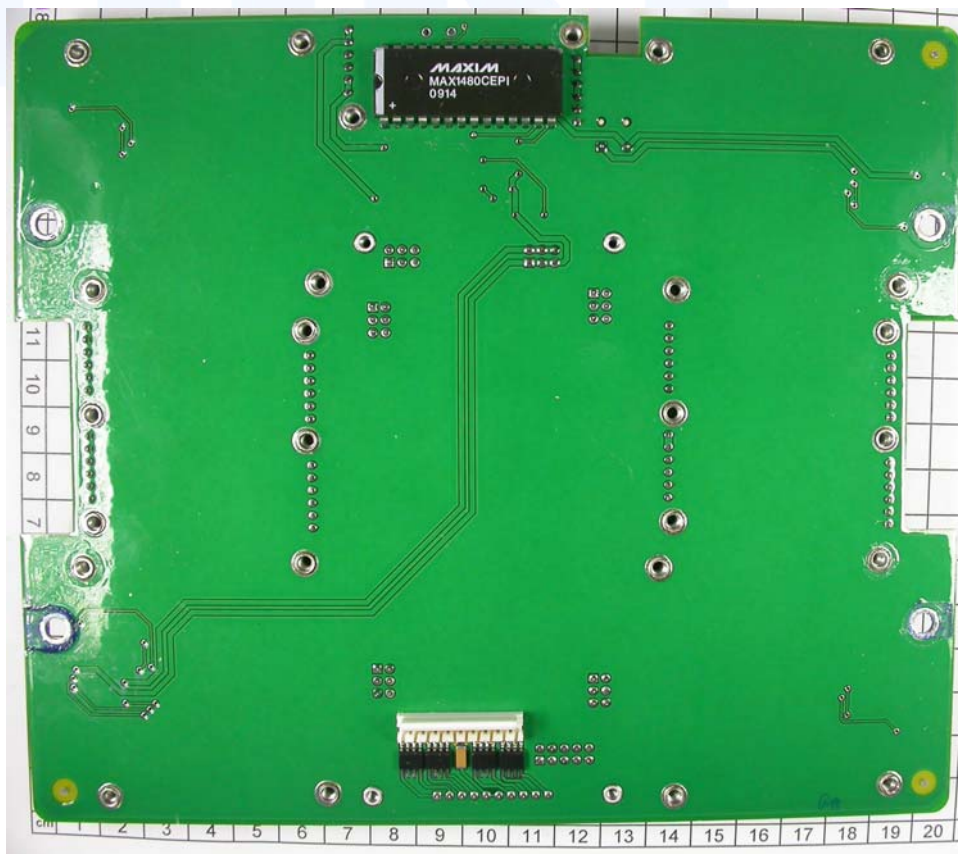
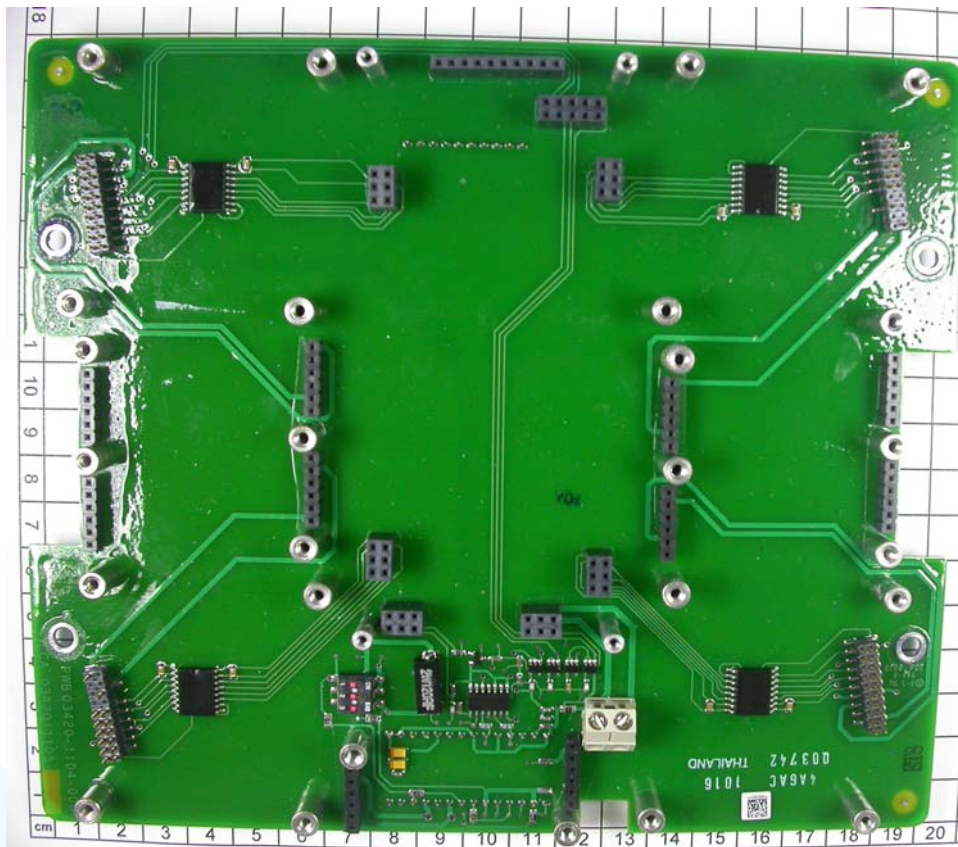
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Internal view:

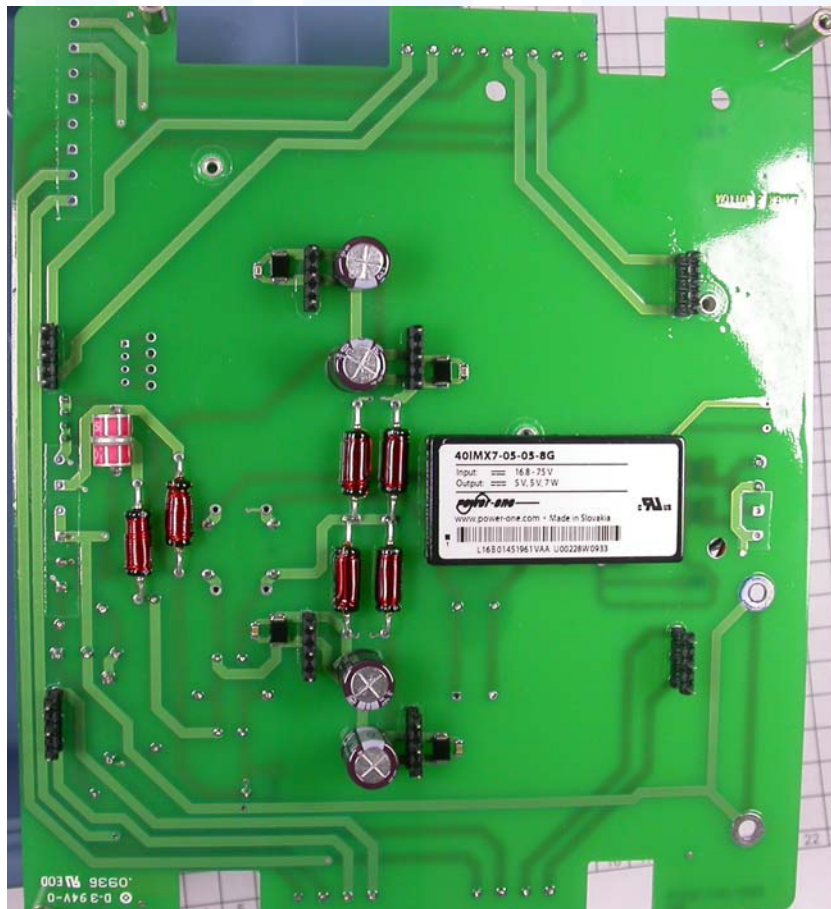
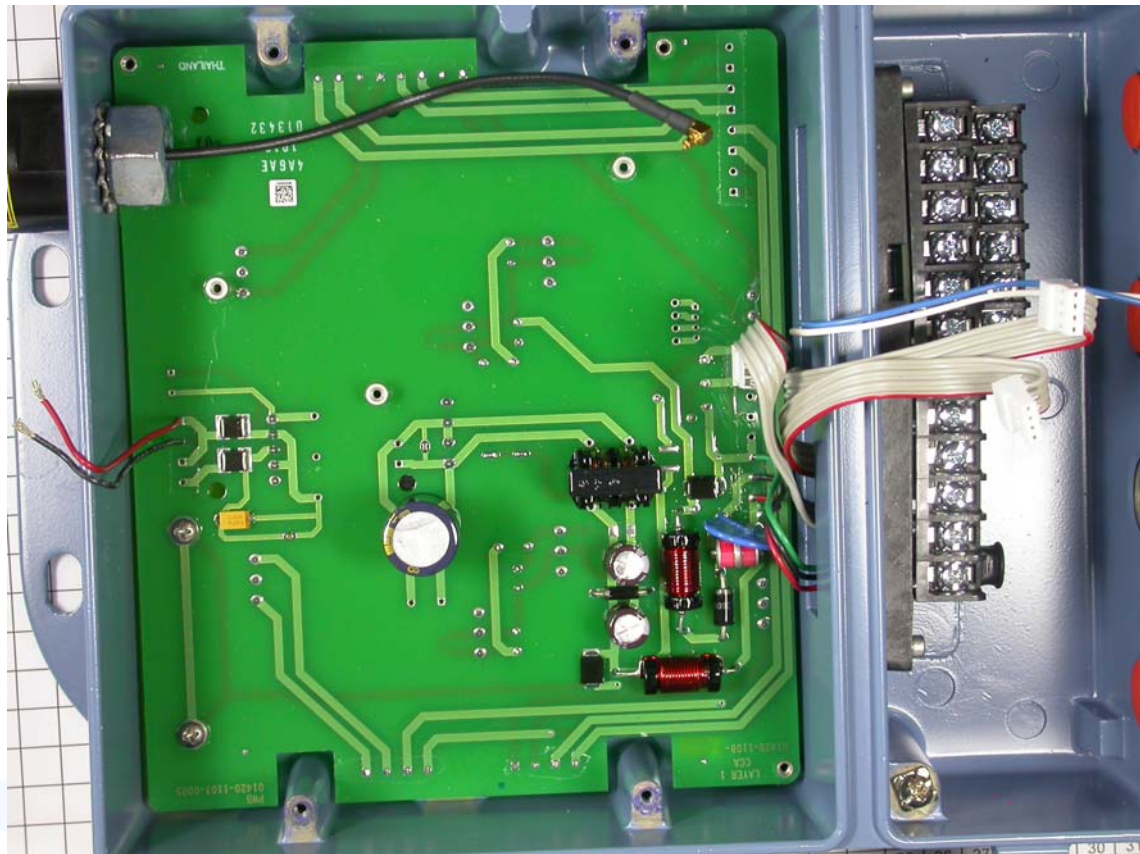




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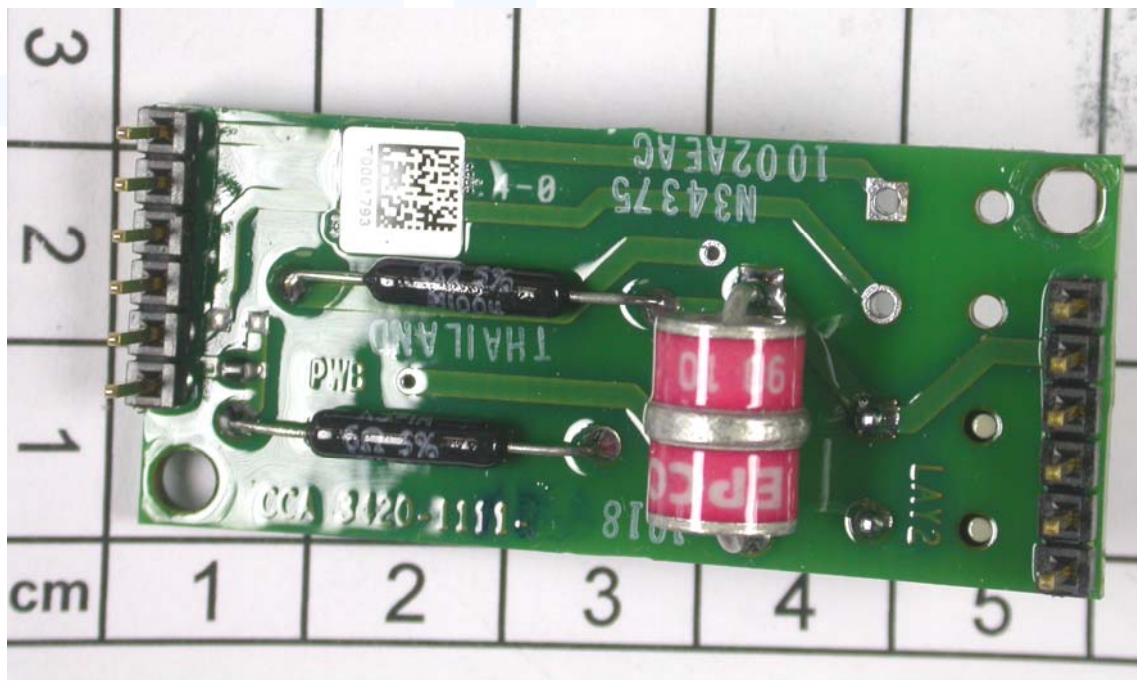
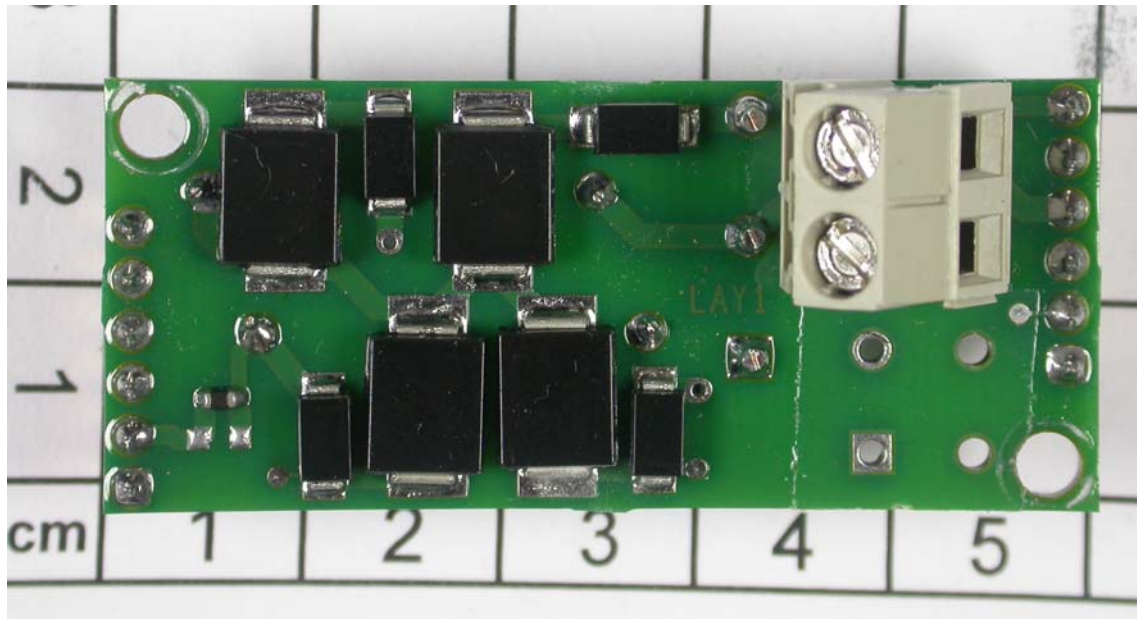


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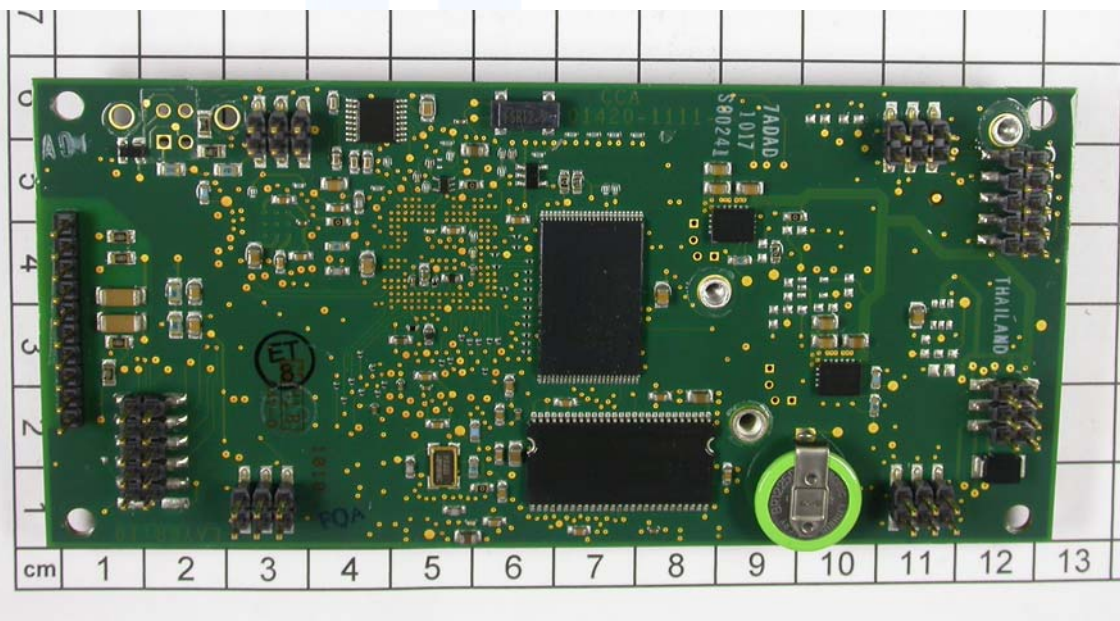
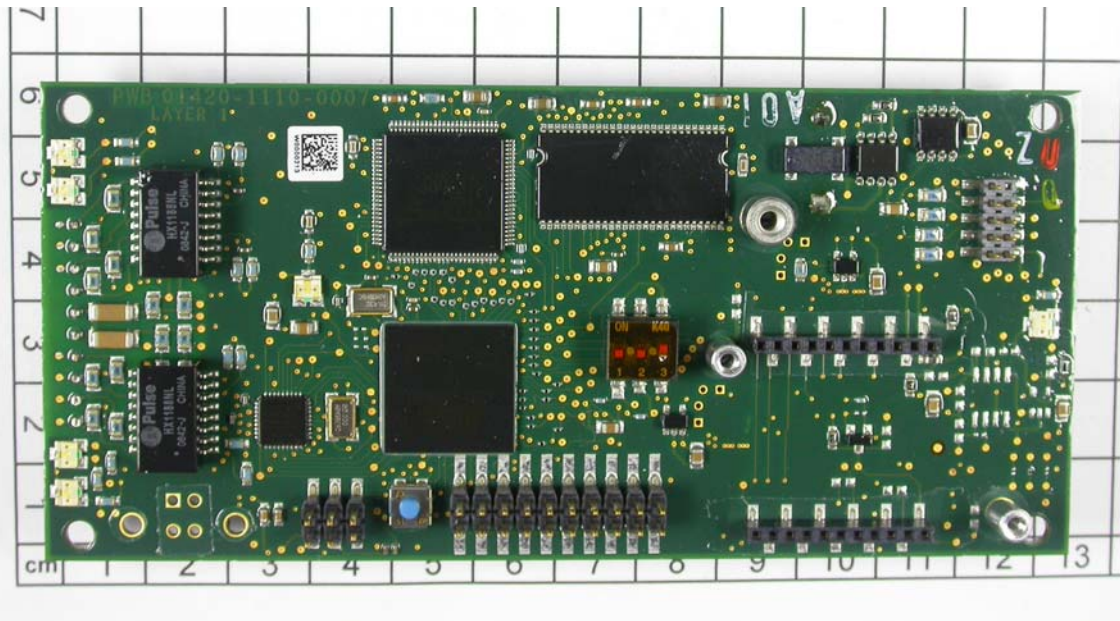




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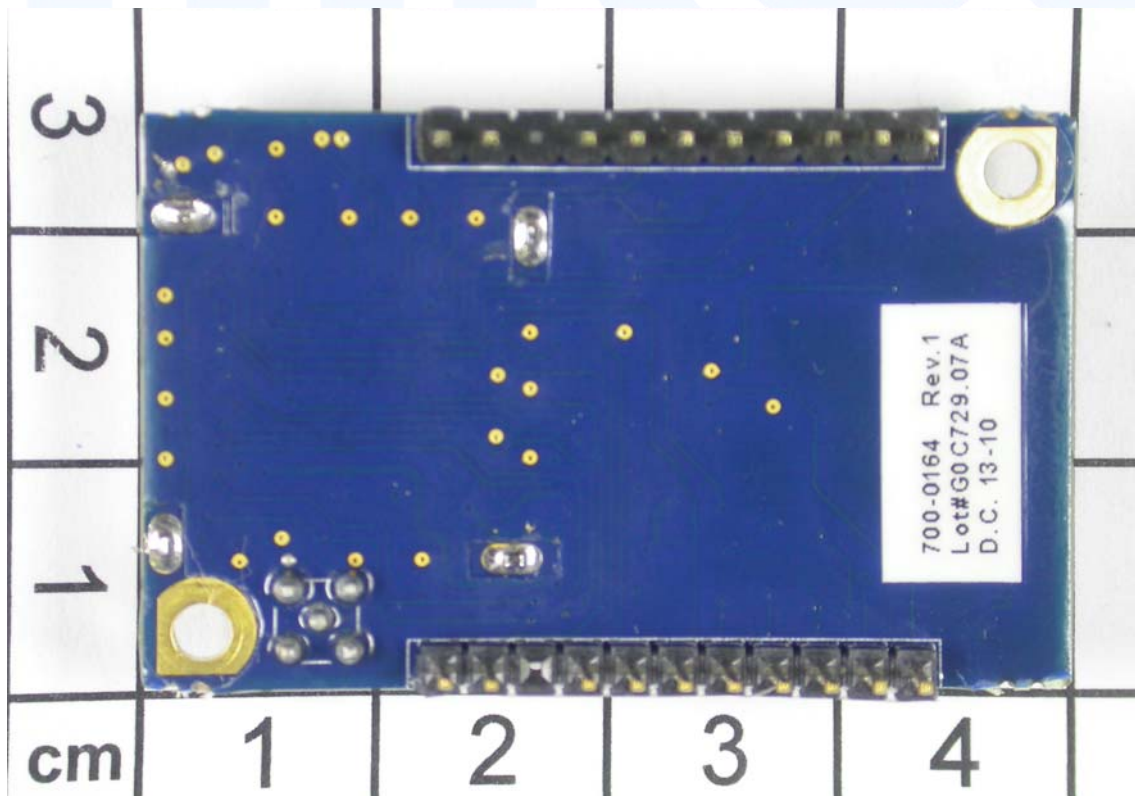
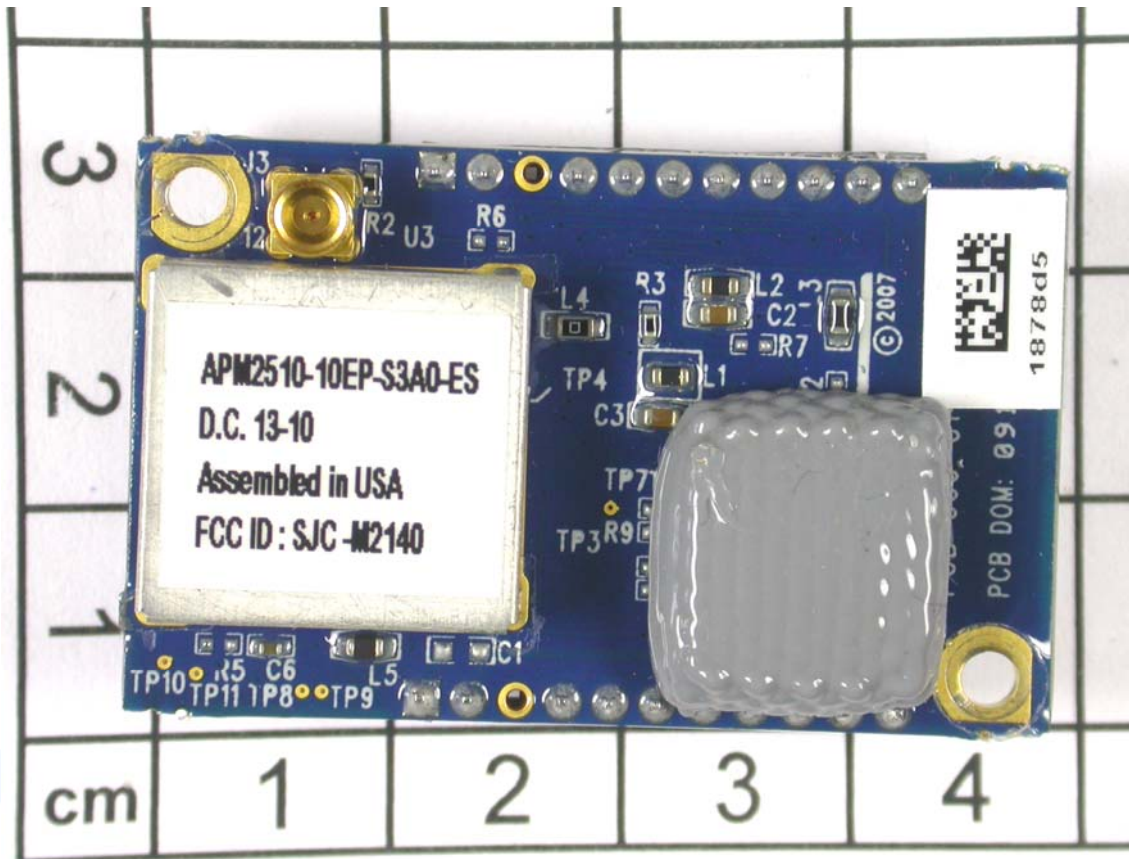


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Antenna:



### 3.2 Power supply system utilised

Power supply voltage: : 24 VDC (industrial application)

### 3.3 Short description of the EUT

The EUT is an gateway for industrial wireless automation based on the wireless HART protocol. The EUT handles up to 100 clients for data gathering and surveillance.

Number of tested samples: 1 pc  
Serial number: 65812

#### EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- TX mode

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#### EUT configuration:

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

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

- Power supply, 100 VAC – 240 VAC Model : Omron S82K
- \_\_\_\_\_ Model : \_\_\_\_\_
- \_\_\_\_\_ Model : \_\_\_\_\_

## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

**mikes-testingpartners gmbh**  
**Ohmstrasse 2-4**  
**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. The reader may notice that tolerances within the calibration of the equipment and facilities may cause additional uncertainty. The measurement uncertainty is calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurement“ and documented in the mikes-testingpartners gmbh quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners 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 diversity and modifications in production process of devices may result in additional deviation. If necessary, refer to the test lab for the actual measurement uncertainty for the specific test. The manufacturer has the sole responsibility of continued compliance of the EUT.

### 4.4 Measurement protocol for FCC

#### 4.4.1 GENERAL INFORMATION

##### 4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

**4.4.1.2 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.

**4.4.1.3 Details of test procedures**

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". 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 C63.4 and applying the CISPR 22 limits.

**4.4.1.4 Conducted emission**

The final level, expressed in dBµV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC limit or to the CISPR limit.

To convert between dBµV and µV, the following conversion formula apply:

$$\begin{aligned} \text{dB}\mu\text{V} &= 20 \cdot \log(\mu\text{V}); \\ \mu\text{V} &= 10^{(\text{dB}\mu\text{V}/20)}; \end{aligned}$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50Ω/50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin of a peak mode measurement appears to be less than 20 dB, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

**4.4.1.5 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 C63.4. The interface cables that are closer than 40 cm to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 cm 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 m 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 m and the EUT is rotated 360 degrees.

The final level in dBµV/m is calculated by add on the reading value from the EMI receiver (level dBµV) the correction factor. 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/m)	=	Level (dBµV/m)	-	CISPR Limit (dBµV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4



#### 4.4.1.6 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 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 following set out in ANSI C63.4. 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 analyser set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak and 10 Hz for average 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.

#### 4.5 **Determination of worst case measurement conditions**

Measurements have been made in all three orthogonal axes and the settings of the EUT were changed to locate at which position and at what setting of the EUT produce the maximum of the emissions.

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## **5 TEST CONDITIONS AND RESULTS**

### **5.1 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 15.107(a):

Except for Class A devices, for equipment 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 C63.4 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 remeasured 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                   -6.0 dB at 18.54 MHz

Limit according to FCC Part 15, Section 15.107(a):

Frequency of Emission (MHz)	Conducted Limit (dB $\mu$ V)	
	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 see following test protocols.

Due to the TDD-Method of transmission in wireless HART specification a RX time slot is

concatenated by a TX time slot. A special firmware for setting RX only can not provided. So a RX

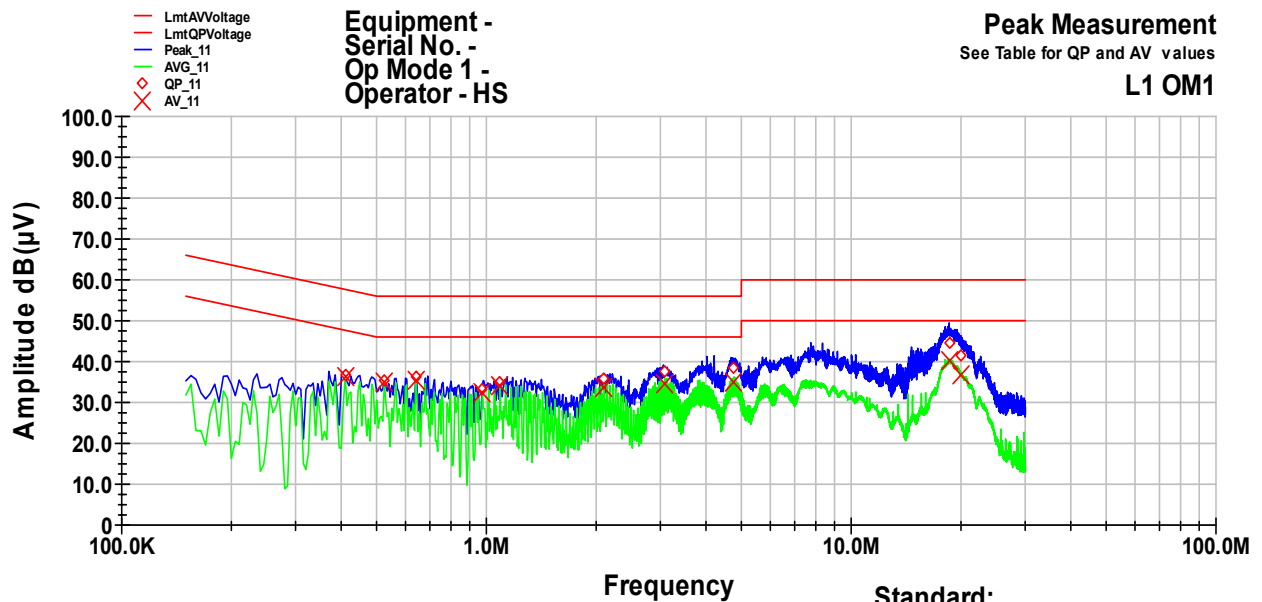
only measurement is not possible.

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5.1.6 Test protocol

Test point L1  
 Operation mode: Wireless connection, LAN connection  
 Remarks:

Result: Passed

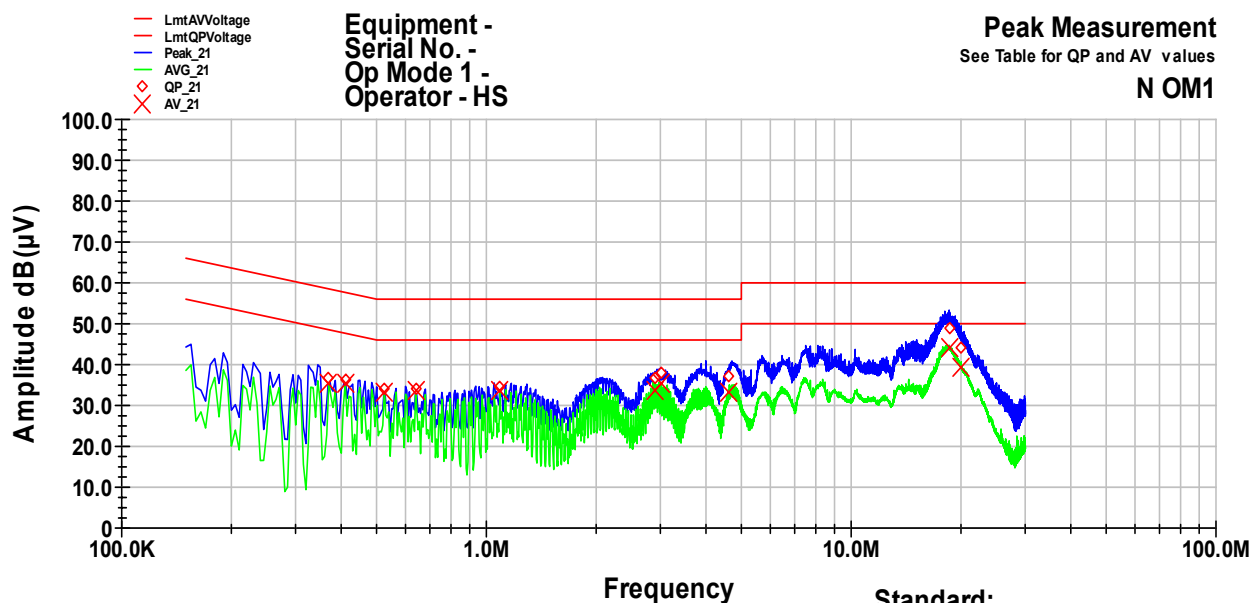


Standard:  
File Number: T33545

Frequency MHz	QP Level dB(µV)	QP Margin dB	QP Limit dB	AV Level dB(µV)	AV Margin dB	AV Limit dB
0.41	36.8	-20.8	57.6	36.1	-11.5	47.6
0.525	35.5	-20.5	56.0	34.9	-11.1	46.0
0.64	36.1	-19.9	56.0	35.4	-10.6	46.0
0.975	33.3	-22.7	56.0	32.5	-13.5	46.0
1.09	35.0	-21.0	56.0	34.3	-11.7	46.0
2.105	35.8	-20.2	56.0	33.8	-12.2	46.0
3.08	37.4	-18.6	56.0	34.7	-11.3	46.0
4.775	38.6	-17.4	56.0	34.9	-11.1	46.0
18.56	44.7	-15.3	60.0	40.0	-10.0	50.0
20.075	41.4	-18.6	60.0	36.5	-13.5	50.0

Test point: N  
 Operation mode: Wireless connection, LAN connection  
 Remarks:

Result:



Standard:  
File Number: T33545

Frequency MHz	QP Level dB(µV)	QP Margin dB	QP Limit dB	AV Level dB(µV)	AV Margin dB	AV Limit dB
0.37	36.5	-22.0	58.5	35.5	-13.0	48.5
0.41	36.4	-21.2	57.6	35.3	-12.4	47.6
0.525	34.3	-21.7	56.0	33.4	-12.6	46.0
0.64	34.3	-21.7	56.0	33.6	-12.4	46.0
1.09	34.4	-21.6	56.0	33.6	-12.4	46.0
2.9	36.8	-19.2	56.0	33.6	-12.4	46.0
3.015	37.8	-18.2	56.0	35.3	-10.7	46.0
4.63	37.2	-18.8	56.0	33.1	-12.9	46.0
18.54	48.7	-11.3	60.0	44.0	-6.0	50.0
20.005	44.0	-16.0	60.0	39.3	-10.7	50.0

## 5.2 Emission bandwidth

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

### 5.2.1 Description of the test location

Test location: AREA4

### 5.2.2 Photo documentation of the test set-up



### 5.2.3 Applicable standard

According to FCC Part 15C, Section 15.247(a):

Frequency hopping systems shall have hopping carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

### 5.2.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB. The reference level is the level of the highest signal amplitude observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation including the unmodulated carrier, even if atypical.

5.2.5 Test result

Channel No.	20 dB Bandwidth (MHz)
CH11	2.48
CH18	2.56
CH25	2.52

There is no bandwidth limit according to FCC Part15C, Section 15.247(a).

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

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5.2.6 Test protocol

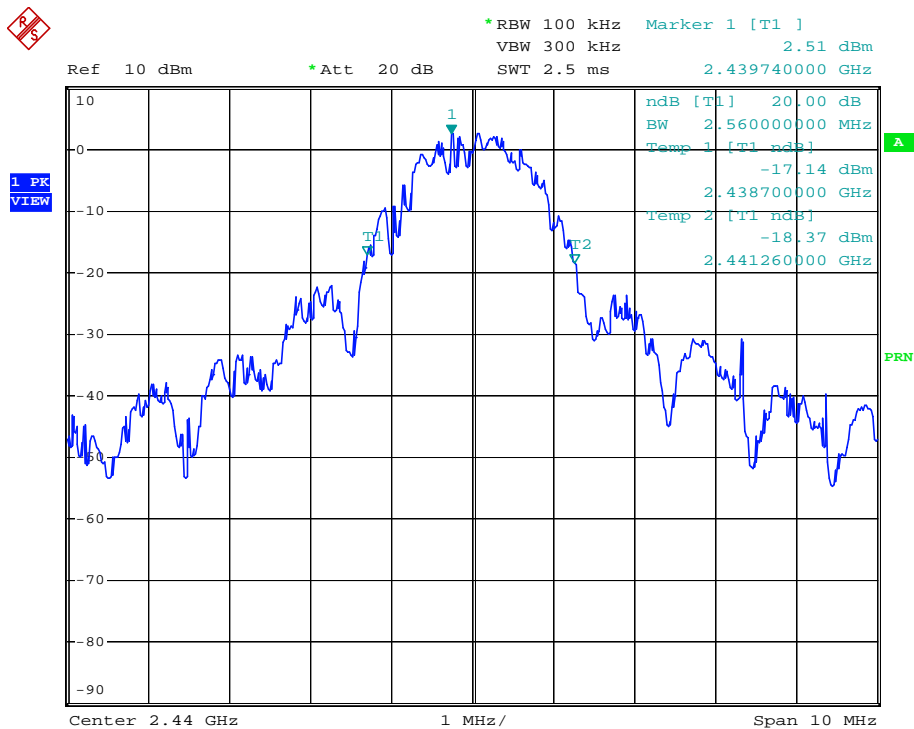
Emission bandwidth, channel 11



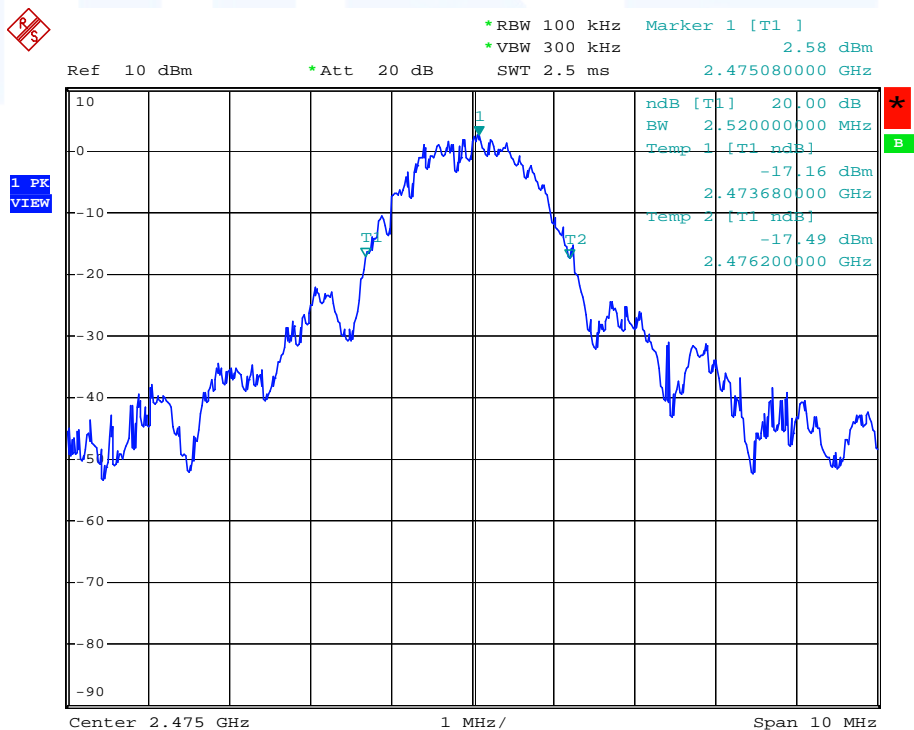


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Emission bandwidth, channel 18



Emission bandwidth, channel 25



### 5.3 Maximum peak conducted output power

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

#### 5.3.1 Description of the test location

Test location: AREA4

#### 5.3.2 Photo documentation of the test set-up



#### 5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(1, 2):

The maximum peak output power of an intentional radiator shall not exceed the limit defined in dependency of the channel separation and of the number of hopping channels.

#### 5.3.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode using the assigned frequency.

Analyser settings according DA 00-705:

Trace:	Max. hold
Detector:	Max. peak
RBW:	greater than 20 dB bandwidth
VBW:	≥ RBW
Sweep Time:	Coupled

**5.3.5 Test result**

Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)	Delta (dB)
11	2405	7.4	21.0	-13.6
18	2440	8.1	21.0	-12.9
25	2475	7.7	21.0	-13.3

Note: The power measured conducted including cable loss of 0.7 dB @2.45 GHz.

Peak Power Limit according to FCC Part 15C, Section 15.247(b)(1):

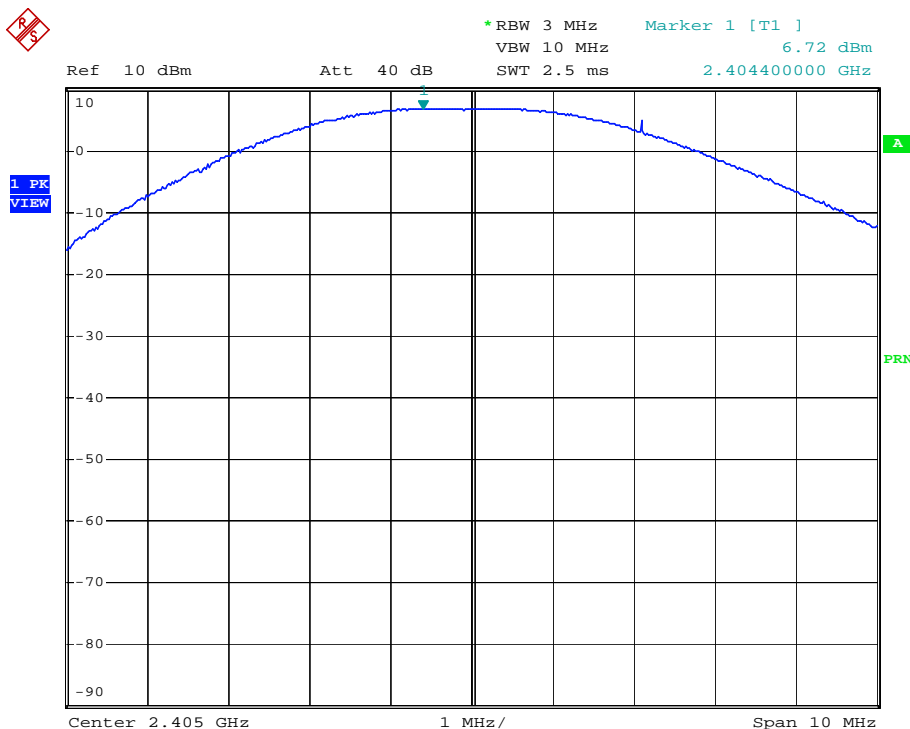
Frequency (MHz)	Channel separation	Hop Channels	Peak power limit	
			(dBm)	(Watt)
2400-2483.5	20 dB bandwidth	≥ 75	30	1.0
<b>2400-2483.5</b>	<b>2/3 20 dB bandwidth</b>	<b>&lt; 75</b>	<b>21</b>	<b>0.125</b>

The requirements are **FULFILLED**.

**Remarks:** For detailed results, please see the test protocol below.

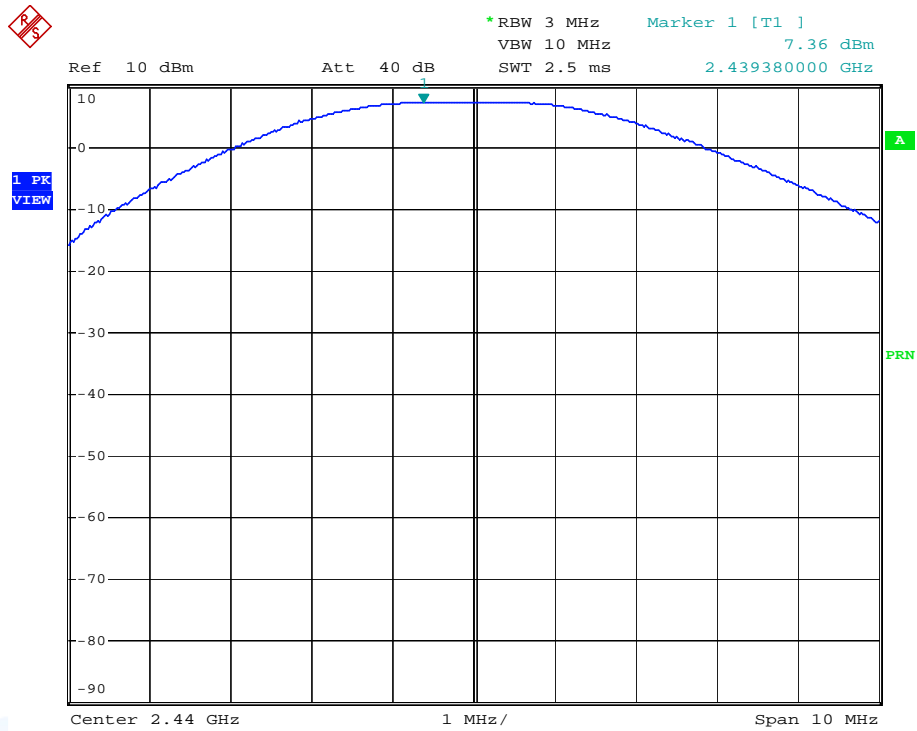
**5.3.6 Test protocol**

Peak power, Channel 11

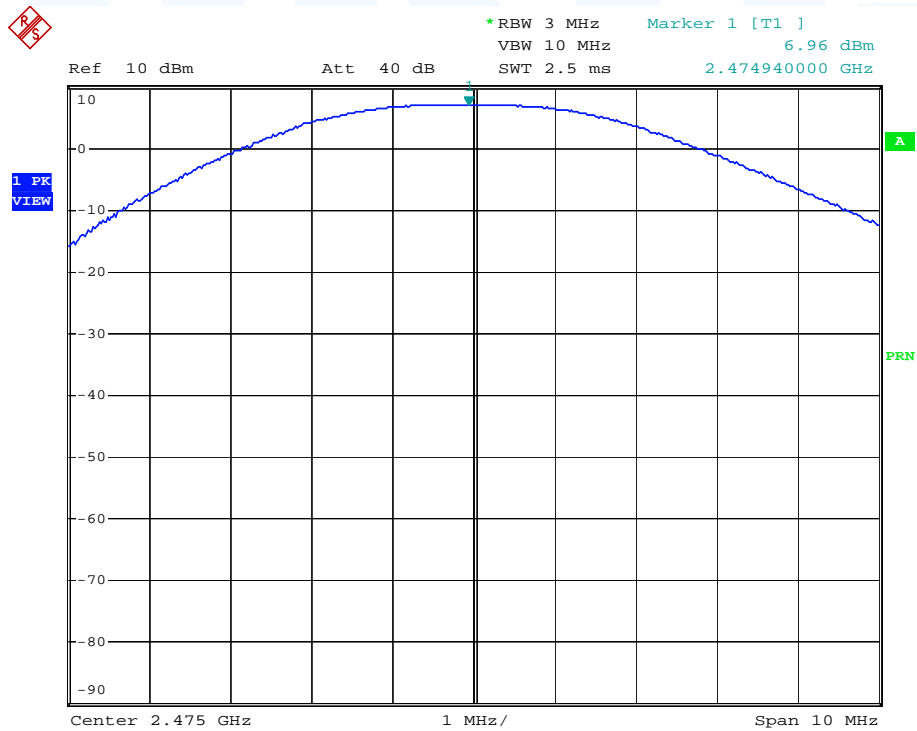


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Peak power, Channel 18



Peak power, Channel 25



## 5.4 Spurious emissions conducted

For test instruments and accessories used see section 6 Part **SEC1**, **SEC2**, **SEC3**.

### 5.4.1 Description of the test location

Test location: AREA4

### 5.4.2 Photo documentation of the test set-up



### 5.4.3 Applicable standard

According to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.5 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

### 5.4.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency.

5.4.5 Test result

Channel 11, max. level 108.8 dBµV			Channel 18, max. level 105.5 dBµV			Channel 25, max. level 107.9 dBµV		
f (MHz)	Level PK (dBµV)	Limit (-20 dB)	f (MHz)	Level PK (dBµV)	Limit (-20 dB)	f (MHz)	Level PK (dBµV)	Limit (-20 dB)
1920	70.1	88.8	1976	78.9	85.5	1976	71.6	87.9
Measurement uncertainty					± 3 dB			

Peak-Limit according to FCC Part 15C, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

Restricted bands of operation:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

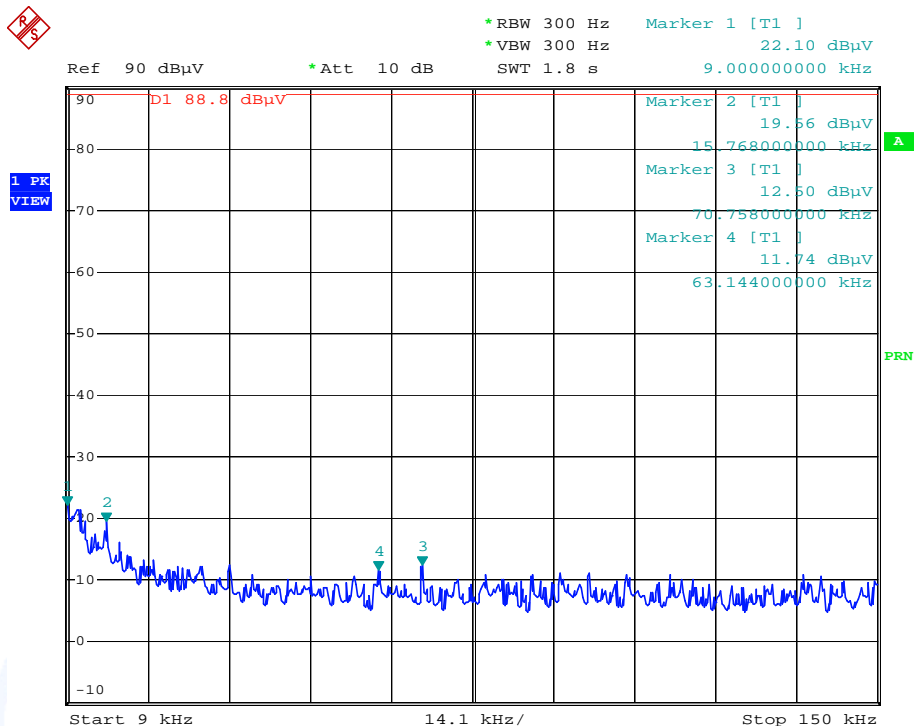
The requirements are **FULFILLED**.

Remarks: For detailed results, please see the test protocol below.

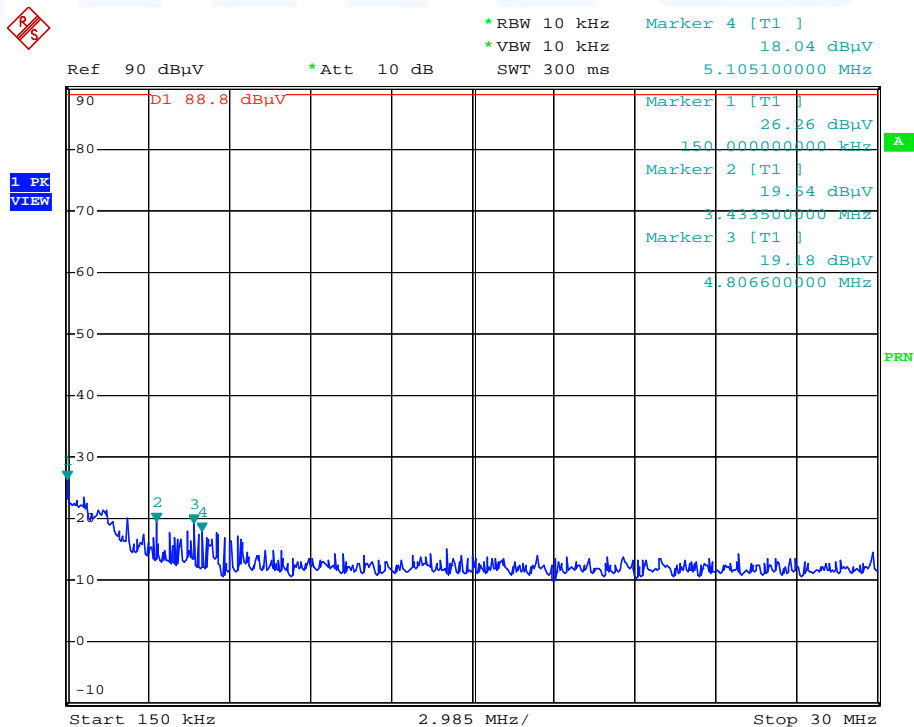
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5.4.6 Test protocol

Spurious emissions conducted  
9 kHz – 150 kHz, Channel 11



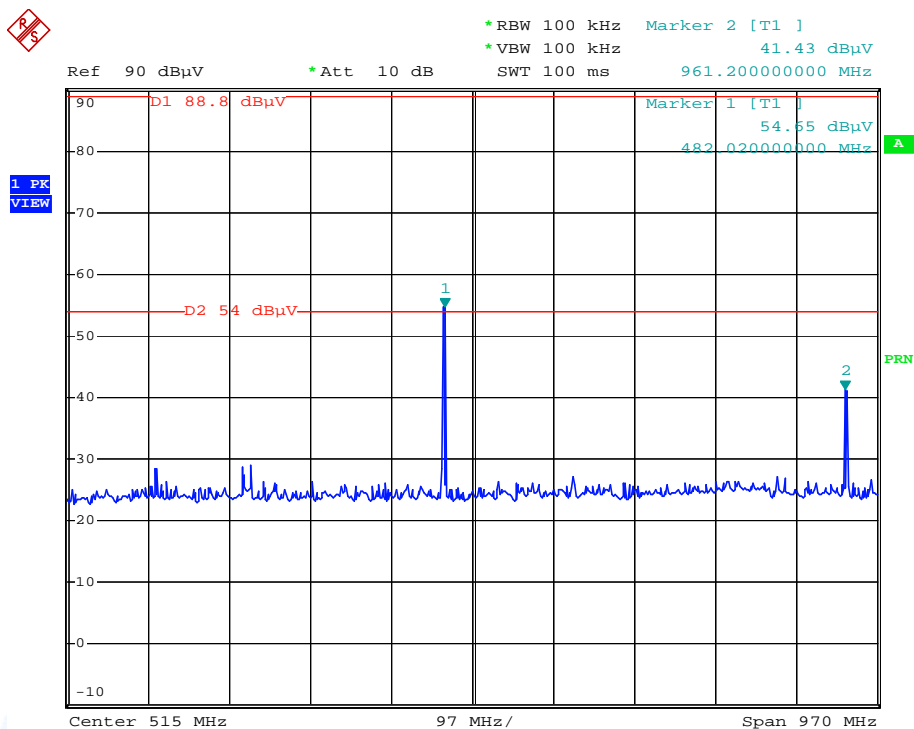
150 kHz – 30 MHz, Channel 11



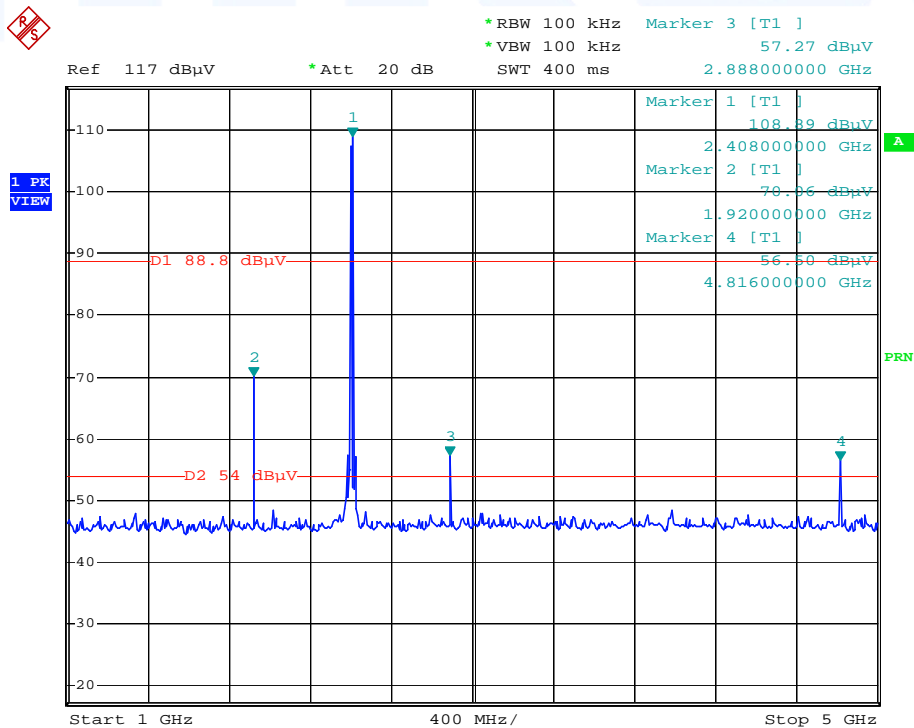


FCC ID:LYH-IEWSNPA1

Spurious emissions conducted  
30 MHz – 1 GHz, Channel 11

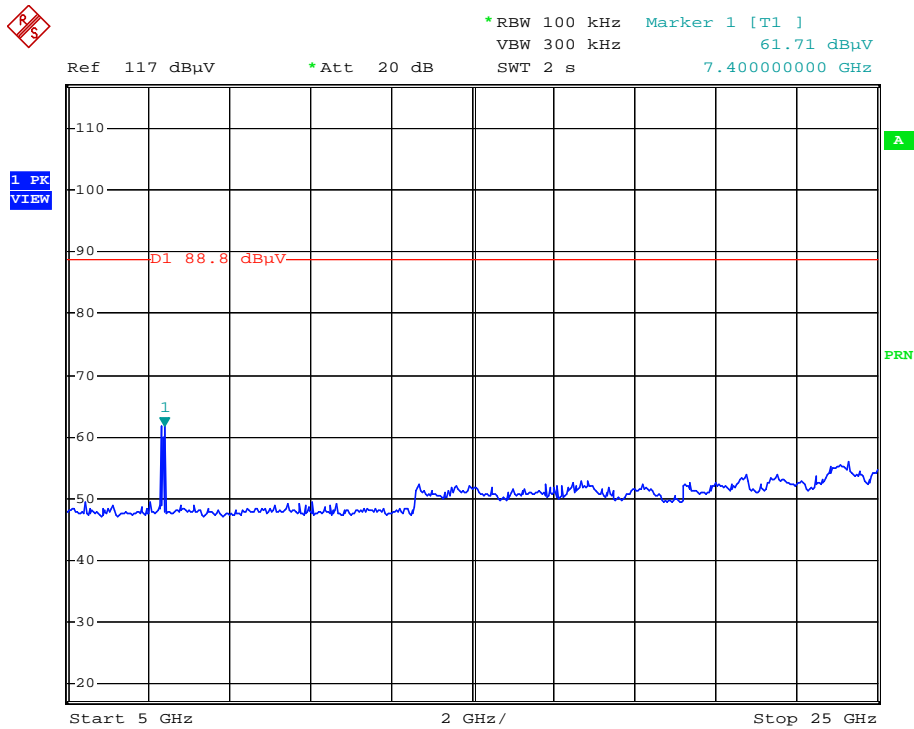


1 GHz – 5 GHz, Channel 11

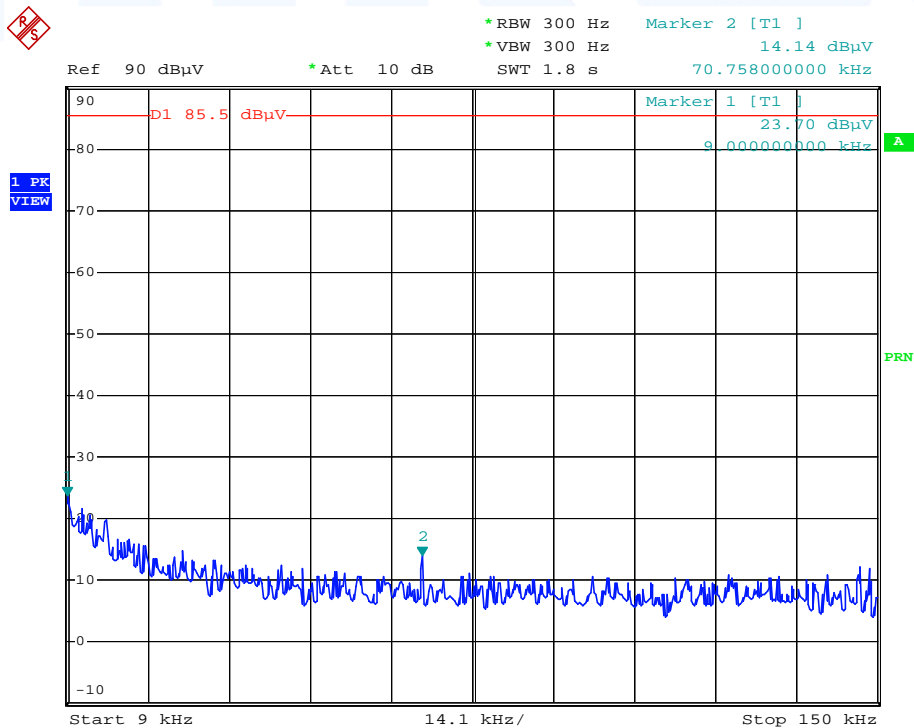


FCC ID:LYH-IEWSNPA1

5 GHz – 25 GHz, Channel 11

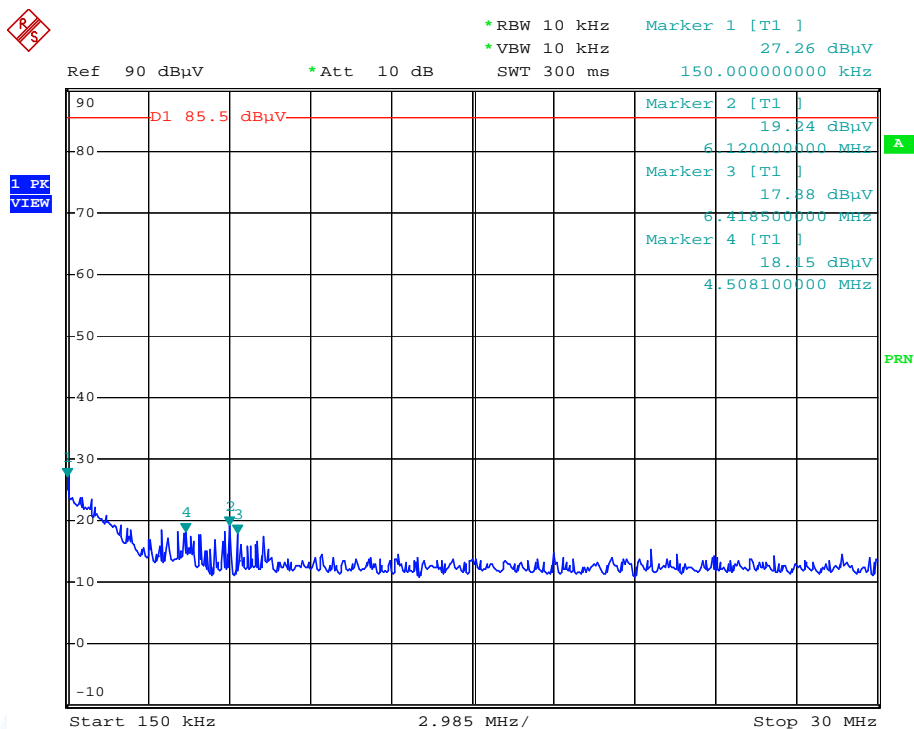


Spurious emissions conducted  
9 kHz – 150 kHz, Channel 18

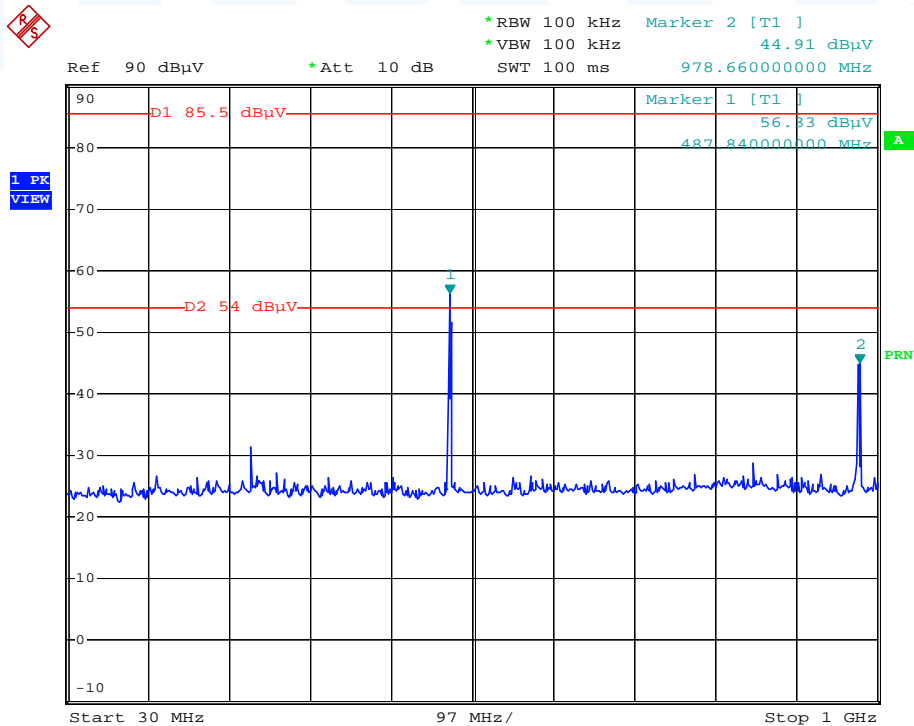


FCC ID:LYH-IEWSNPA1

Spurious emissions conducted  
150 kHz – 30 MHz, Channel 18

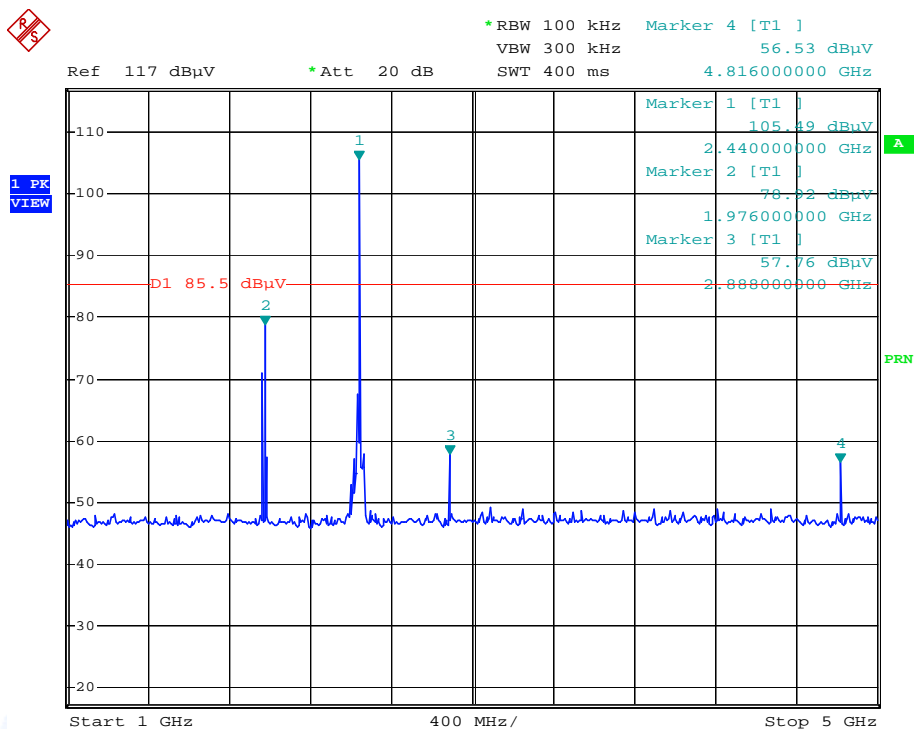


30 MHz – 1 GHz, Channel 18

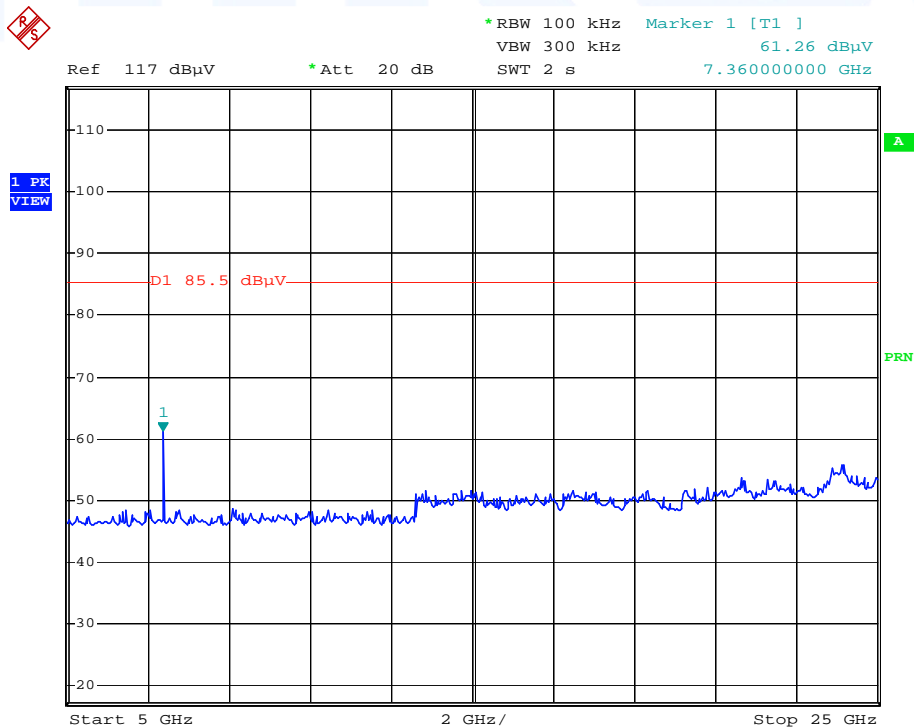


FCC ID:LYH-IEWSNPA1

Spurious emissions conducted  
1 GHz – 5 GHz, Channel 18



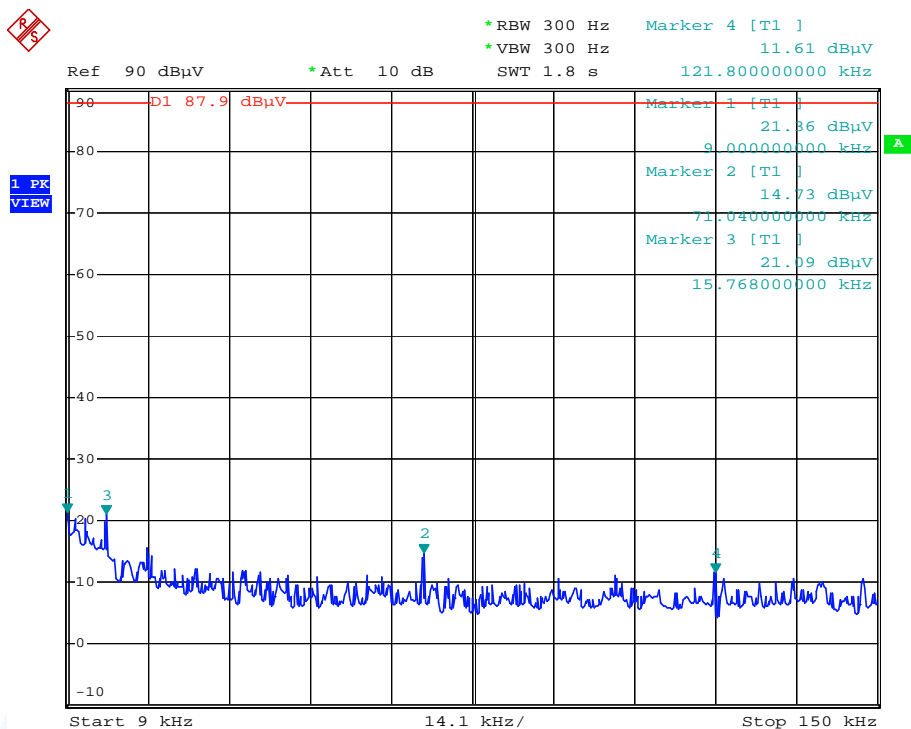
5 GHz – 25 GHz, Channel 18



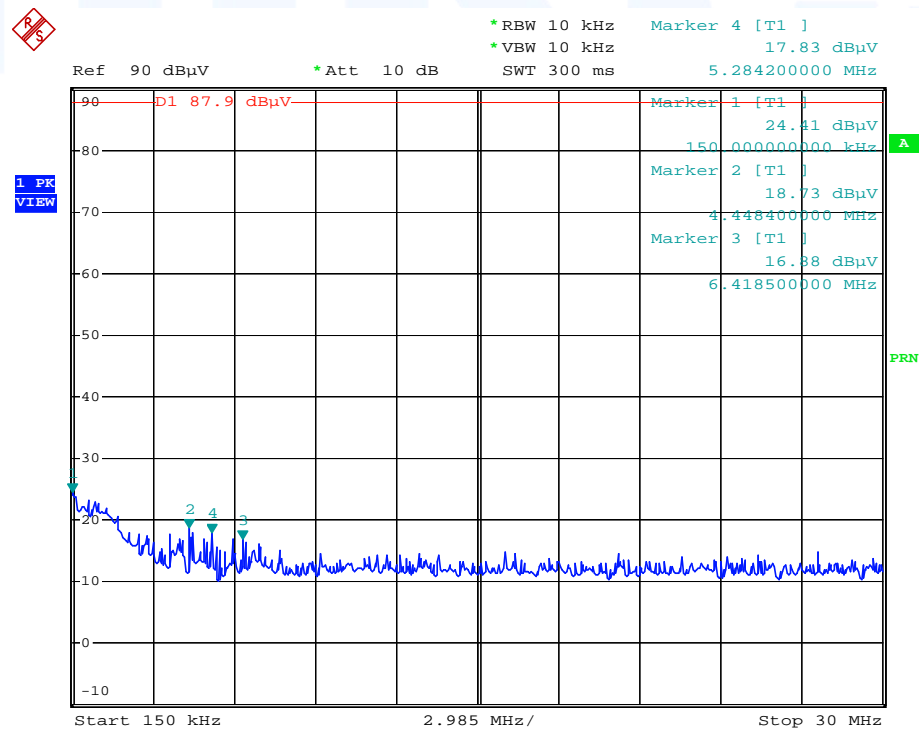


FCC ID:LYH-IEWSNPA1

Spurious emissions conducted  
9 kHz – 150 kHz, Channel 25

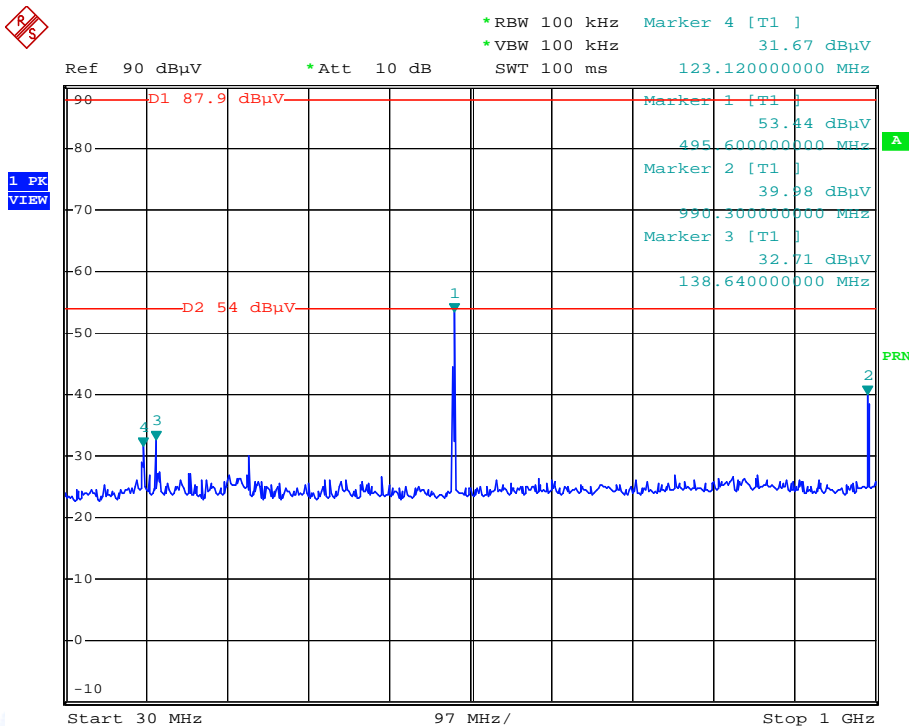


150 kHz – 30 MHz, Channel 25

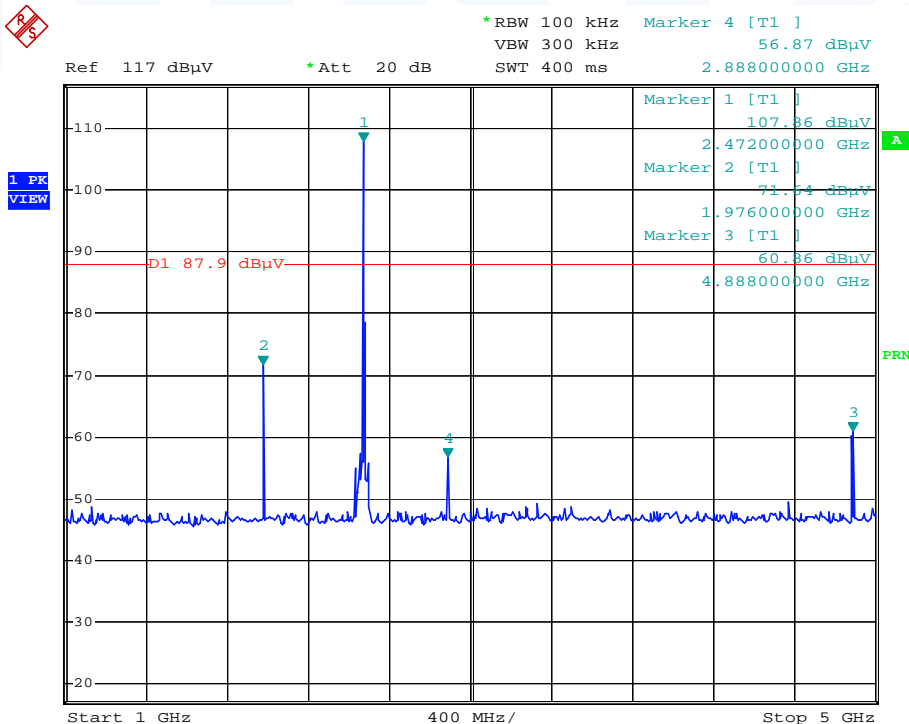


FCC ID:LYH-IEWSNPA1

Spurious emissions conducted  
30 MHz – 1 GHz, Channel 25



1 GHz – 5 GHz, Channel 25





## 5.5 Spurious emissions radiated

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

### 5.5.1 Description of the test location

Test location: OATS1  
Test location: Anechoic Chamber A2  
Test distance: 3 metres

### 5.5.2 Photo documentation of the test set-up

Open area test site



Anechoic chamber



### 5.5.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a) (see Section 15.205(c)).

### 5.5.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.4. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

Measuring receiver settings: for f < 1 GHz RBW: 120 kHz  
Spectrum analyzer settings: for f > 1 GHz RBW: 1 MHz  
Detector: Max peak Trace: Max hold Sweep: Auto

### 5.5.5 Test result

#### 5.5.5.1 Radiated emission test f < 1 GHz)

Channel 11

Corrected field strength of fundamental wave as reference for radiated emissions: 114.8 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Level QP (dB $\mu$ V)	Correct. factor (dB)	Corrected Level QP dB( $\mu$ V/m)	Corrected Level AV dB( $\mu$ V/m)	Limit PK dB( $\mu$ V/m)	Limit QP dB( $\mu$ V/m)	Delta (dB)
250	X	19.6	15.4	35.0			46.0	-11.0
264	X	24.0	15.9	39.9			46.0	-6.1

Channel 18

Corrected field strength of fundamental wave as reference for radiated emissions: 111.5 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Level QP (dB $\mu$ V)	Correct. factor (dB)	Corrected Level PK dB( $\mu$ V/m)	Corrected Level AV dB( $\mu$ V/m)	Limit PK dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
250	X	19.6	15.4	35.0			46.0	-11.0
264	X	24.0	15.9	39.9			46.0	-6.1

Channel 25

Corrected field strength of fundamental wave as reference for radiated emissions: 113.9 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Level QP (dB $\mu$ V)	Correct. factor (dB)	Corrected Level PK dB( $\mu$ V/m)	Corrected Level AV dB( $\mu$ V/m)	Limit PK dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
250	X	19.6	15.4	35.0			46.0	-11.0
264	X	24.0	15.9	39.9			46.0	-6.1



**5.5.5.2 Radiated emission test f > 1GHz**

Channel 11

Corrected field strength of fundamental wave as reference for radiated emissions: 114.8 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB $\mu$ V)	Correction (dB)	L: PK dB( $\mu$ V/m)	L: AV dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
4688	X	-			44.6		54.0	-9.4
7216		-			48.8		94.8	-46.0

Channel 18

Corrected field strength of fundamental wave as reference for radiated emissions: 111.5 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB $\mu$ V)	Correction (dB)	L: PK dB( $\mu$ V/m)	L: AV dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
-								

Channel 25

Corrected field strength of fundamental wave as reference for radiated emissions: 113.9 dB $\mu$ V/m

Frequency (MHz)	Restricted band	Duty Cycle (dB)	L: AV (dB $\mu$ V)	Correction (dB)	L: PK dB( $\mu$ V/m)	L: AV dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
7360	X	-			48.6		54.0	-5.4
7424	X	-			47.9		54.0	-6.1

Peak-limit according to FCC Part 15C, Section 15.247(d) for emissions falling not in restricted bands:

In any 100 kHz bandwidth outside the frequency band 2400 – 2483.5 MHz, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required.

Limits dB( $\mu$ V/m)		
Ch11	Ch18	Ch25
94.8	91.5	93.9

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

Frequency (MHz)	Limits acc. 15.209		Measurement distance (m)
	( $\mu$ V/m)	dB( $\mu$ V/m)	
0.009-0.490	2400/f (kHz)	2400/f (kHz)	300
0.490-1.705	24000/f (kHz)	24000/f (kHz)	30
1.705-30	30	30	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

**FCC ID:LYH-IEWSNPA1**

**Restricted bands of operation:**

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209:

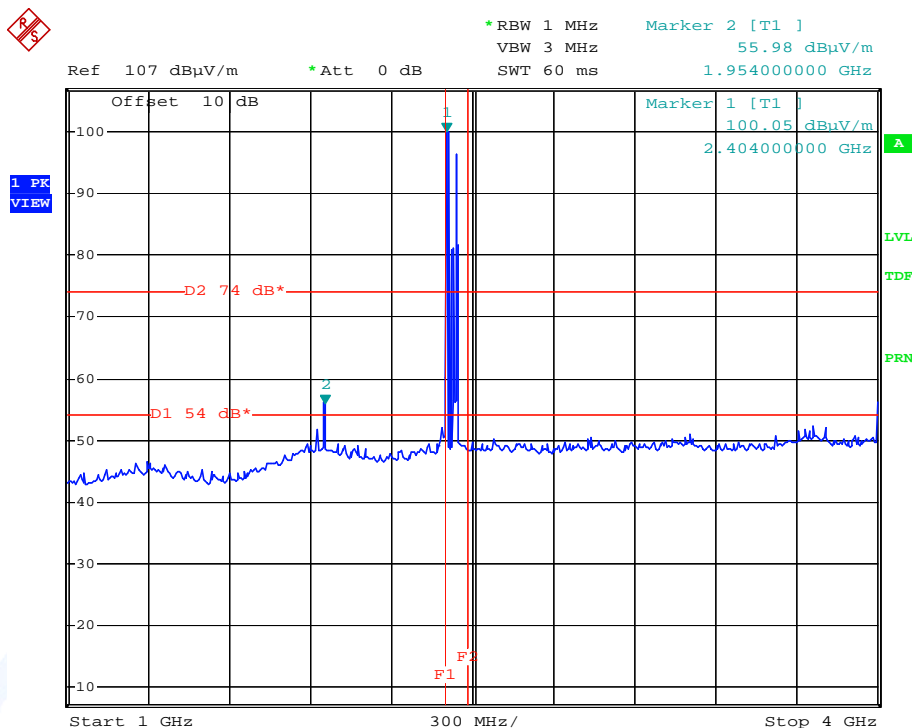
MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

The requirements are **FULFILLED**.

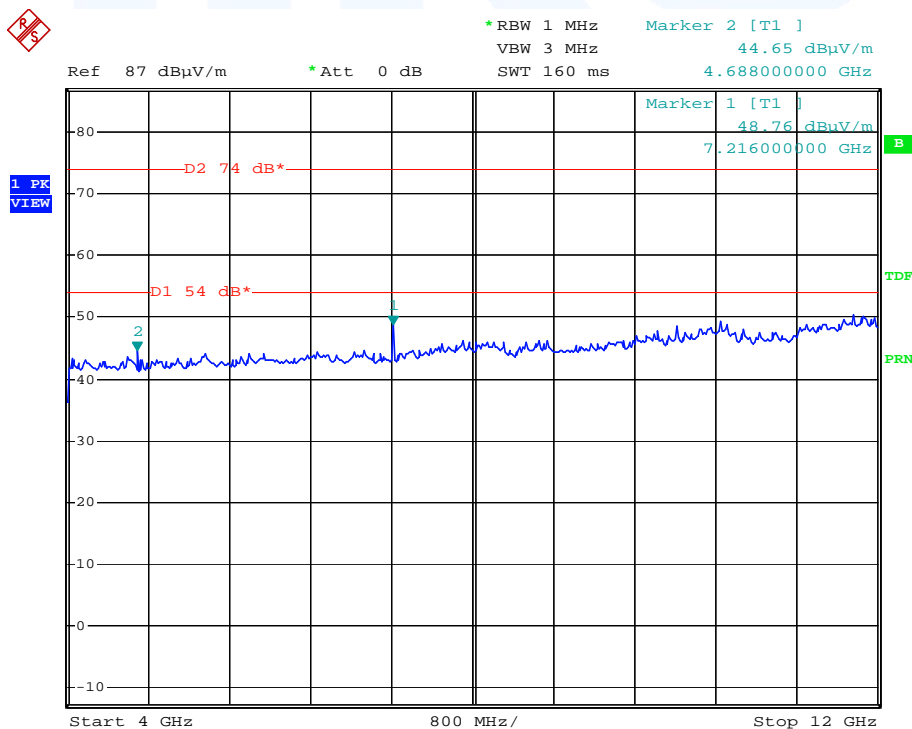
**Remarks:** The measurement was performed up to the 10<sup>th</sup> harmonic (25000 MHz). In the frequency range 12 GHz – 25 GHz no emission could be detected. Emissions falling into restricted bands were measured radiated. For detailed results, please see the test protocol below.

5.5.6 Test protocol

Spurious emissions radiated  
1 GHz – 4 GHz, Channel 11

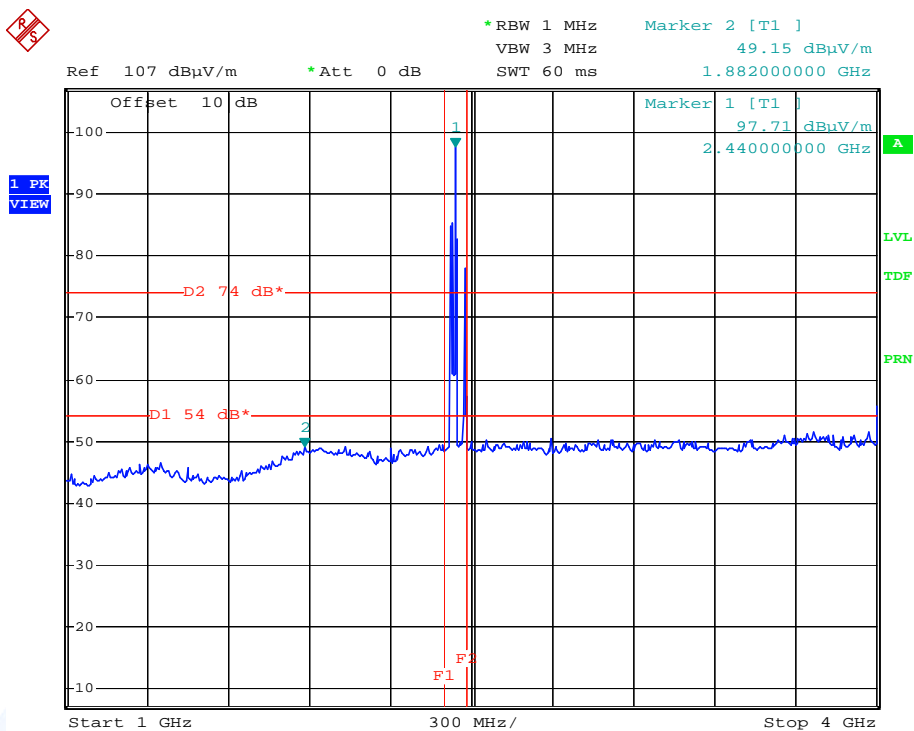


4 GHz – 12 GHz, Channel 11

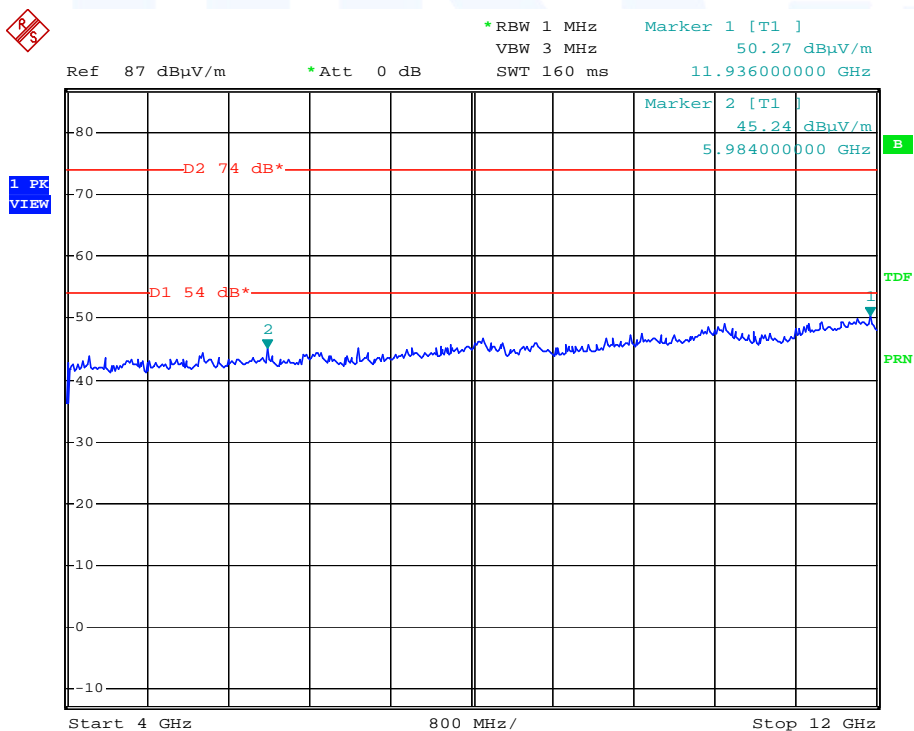


FCC ID:LYH-IEWSNPA1

Spurious emissions radiated  
1 GHz – 4 GHz, Channel 18

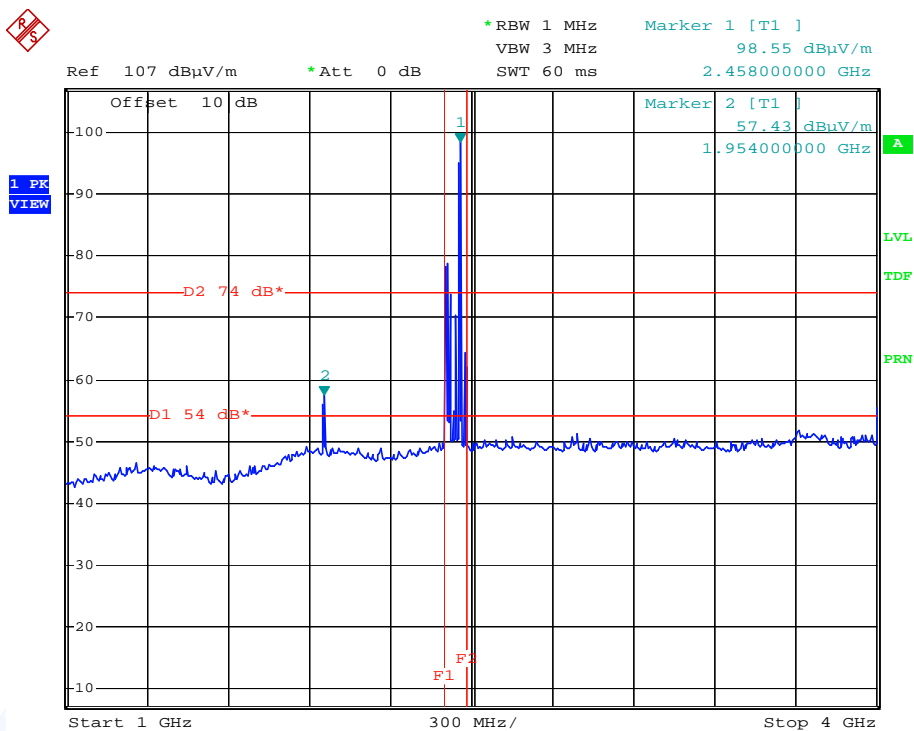


4 GHz – 12 GHz, Channel 18

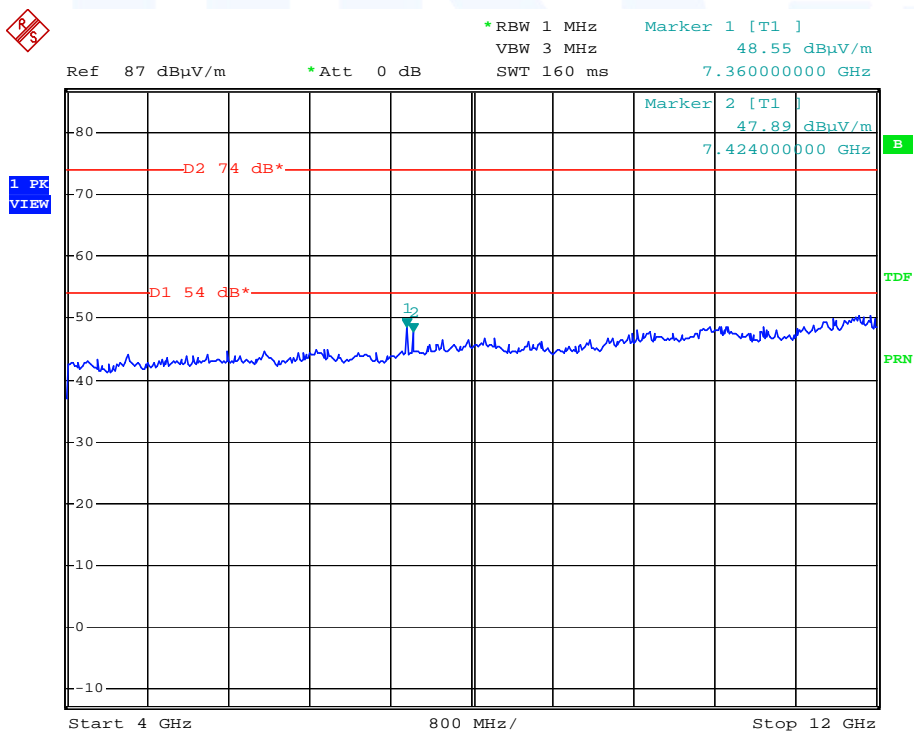


FCC ID:LYH-IEWSNPA1

Spurious emissions radiated  
1 GHz – 4 GHz, Channel 25



4 GHz – 12 GHz, Channel 25





## 5.6 Band edge compliance

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

### 5.6.1 Description of the test location

Test location: AREA4

### 5.6.2 Photo documentation of the test set-up



### 5.6.3 Applicable standard

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

### 5.6.4 Description of Measurement

The band edge was measured radiated. The span of the spectrum analyser was set wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

**5.6.5 Test result**

Channel 11, nearest restricted band: 2310 – 2390 MHz:

Frequency (MHz)	Restricted band	L: PK dB( $\mu$ V/m)	L: AV dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
2384	X	52.3		54.0	-1.7

Channel 25, nearest restricted band: 2483.5 – 2500 MHz:

Frequency (MHz)	Restricted band	L: PK dB( $\mu$ V/m)	L: AV dB( $\mu$ V/m)	Limit AV dB( $\mu$ V/m)	Delta (dB)
2494	X	52.3		54.0	-1.7

Peak-Limit according to FCC Part 15C, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

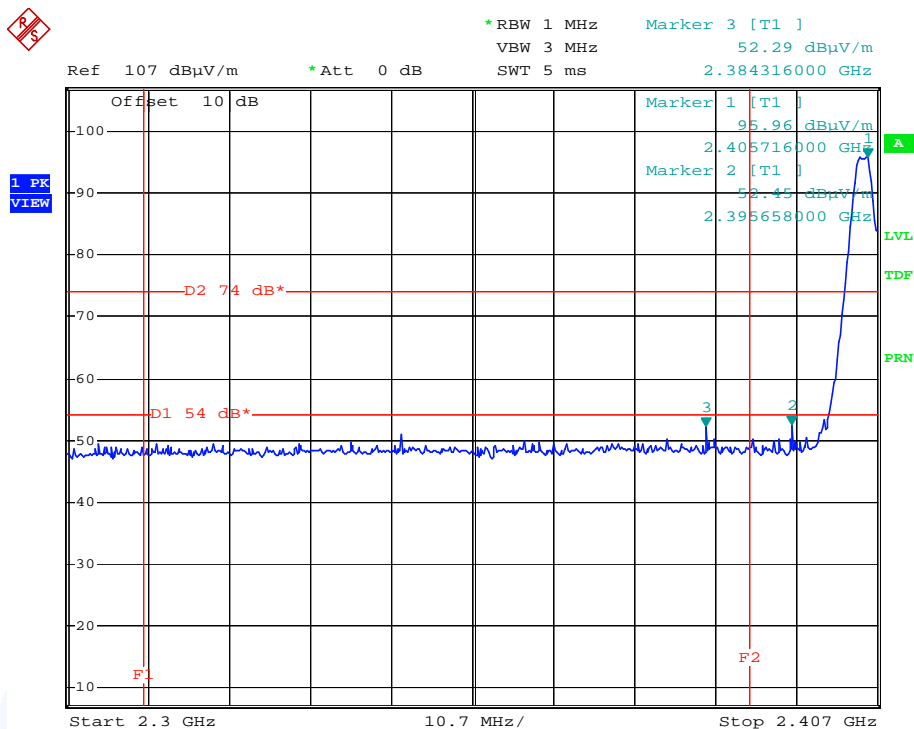
The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocol.

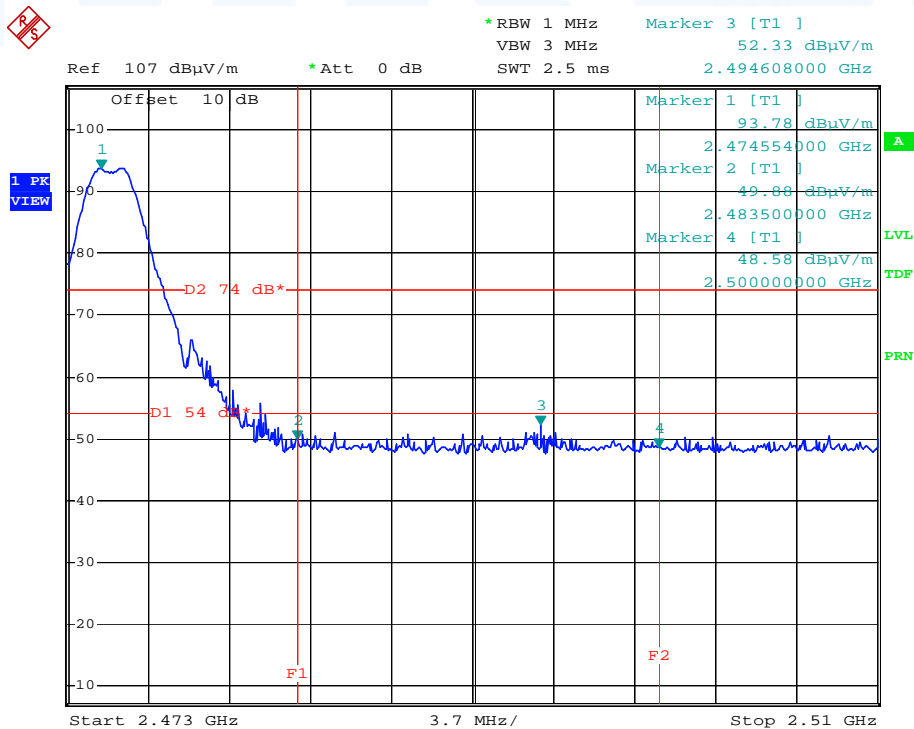
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5.6.6 Test protocol

Band edge compliance, lower channel



Band edge compliance, higher channel



### 5.7 Pseudorandom frequency hopping sequence

Requirement according to FCC Part 15C, Section 15.247(a):

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies.

The system hops from one preselected channel to the next. All channels are selected at every sequence.

Remarks:

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### 5.8 Equal hopping frequency use

Requirement according to FCC Part 15C, Section 15.247(a):

Each frequency must be used equally on the average by each transmitter.

The generation of the hopping sequence in connection mode is always the same, all selected channels are part of the hopping sequence. This circumstance is always the same therefore the average of the frequency use is the same on all transmitters.

Remarks:

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### 5.9 Receiver input bandwidth

Requirement according to FCC Part 15C, Section 15.247(a):

The system receivers shall have input bandwidth that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signal.

The receiver bandwidth is equal to the transmitter bandwidth in the 15 hopping channel mode, which is 2.5 MHz.

Remarks:

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## 5.10 Dwell time

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

### 5.10.1 Description of the test location

Test location: AREA4

### 5.10.2 Photo documentation of the test set-up



### 5.10.3 Applicable standard

According to FCC Part 15, Section 15.247(a):

In Section 15.247(a)(1iii) are dwell times defined for the special frequency ranges should not exceed by a frequency hopping system.

### 5.10.4 Description of Measurement

The measurement was done using a spectrum analyser in time domain function on one channel frequency in the middle of the band. A trigger takes care of display the dwell time of this channel when the hop set applies the channel at once. The measurement has been done again for the occupancy of one channel over the whole period and recorded. The particular time intervals are added over the value of occupancy in the several operation modes.



**5.10.5 Test result**

TX mode permits maximum 7.5 hops per second.

Hops per period:  $7.5 * 6 = 45$   
 Occupancy per hop: 2.32 ms  
 Occupancy per period:  $2.32 \text{ ms} * 45 = 104.4 \text{ ms}$

Operating mode	Time of period (s)	Time of 1 burst (ms)	Number of Bursts (per period)	Dwell time per period (ms)
TX	$0.4 \text{ ms} * 15 = 6.0$	2.32	45	104.4

Requirement according to FCC Part15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	time of one period (s)	Limit dwell time, AV (ms)
902-928	$\geq 50$	20	< 400
902-928	25 - < 50	10	< 400
<b>2400-2483.5</b>	<b><math>\geq 15</math></b>	<b>0.4*(number of channels)</b>	<b>&lt; 400</b>
5725-5850	$\geq 75$	30	< 400

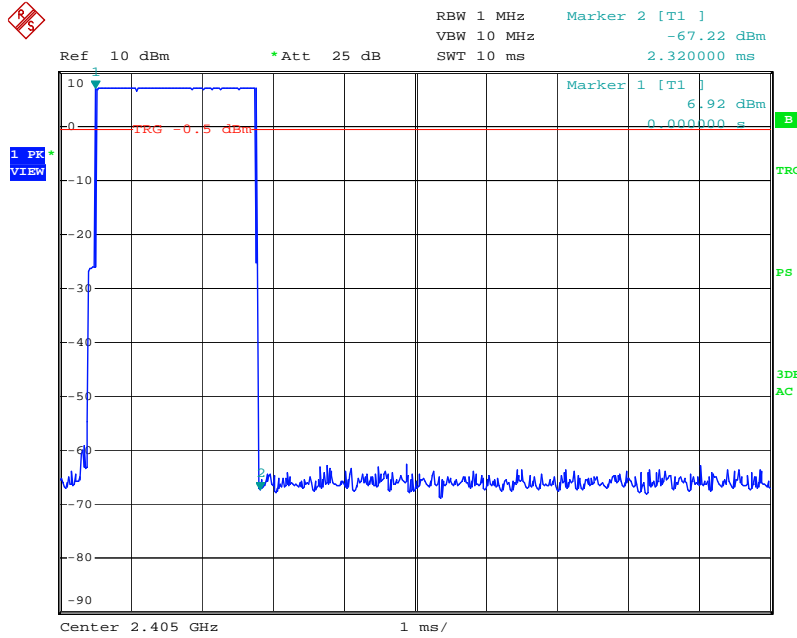
The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocol.

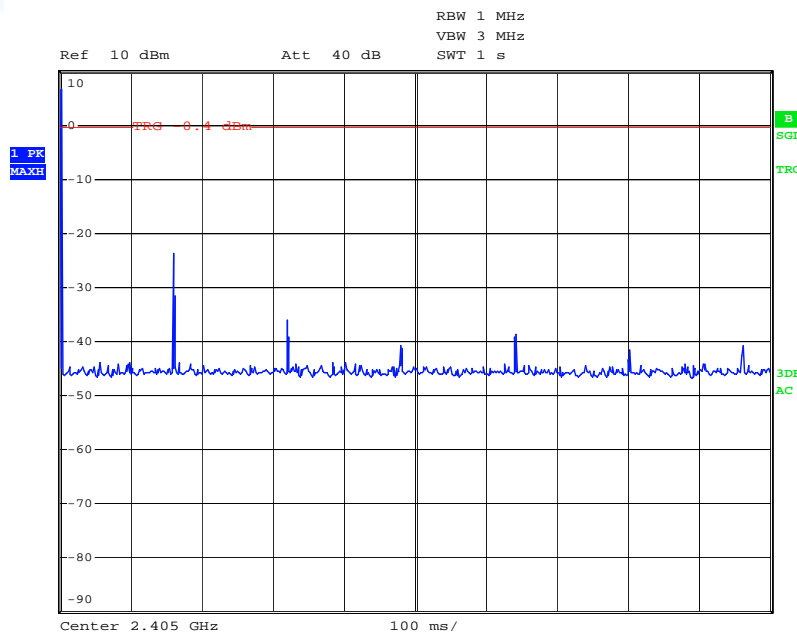
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5.10.6 Test protocol

Time of occupancy of one burst



Number of occupancies per second



## 5.11 Carrier frequency separation

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

### 5.11.1 Description of the test location

Test location: AREA4

### 5.11.2 Photo documentation of the test set-up



### 5.11.3 Applicable standard

According to FCC Part 15, Section 15.247(a):

Frequency hopping systems operating in the frequency band of 2400 MHz – 2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or 2/3 of the 20 dB bandwidth of the hopping channel.

### 5.11.4 Description of Measurement

The measurement is performed using a spectrum analyser in single sweep mode. The frequency separation is measured using the delta marker function of the spectrum analyser between the peaks of the adjacent channels. The 20 dB OBW has to be measured before to compare whether the OBW requirement is fulfilled.

### 5.11.5 Test result

Distance between the adjacent channels: 9.982 MHz  
Channel frequency separation:  $9.982 \text{ MHz} / 2 = 4.991 \text{ MHz}$

2/3 of 20 dB bandwidth (MHz)	Hopping channels	Channel frequency separation (MHz)	Limit (MHz)
1.7	15	5.0	> 1.7

Limit according to FCC Part 15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	Limit channel separation (kHz)
All systems		> 25 kHz or 20 dB bandwidth, which ever is greater
2400 - 2483.5	≥ 15	> 25 kHz or 2/3 of 20 dB bandwidth, which ever is greater

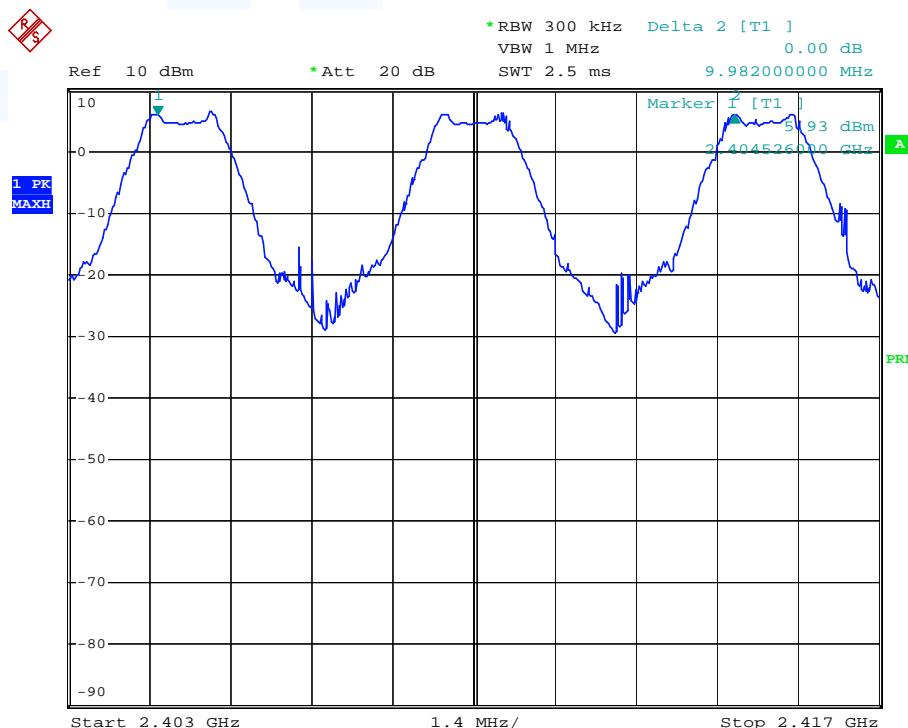
The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocol.

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**5.11.6 Test protocol**

**Channel separation**



## 5.12 Number of hopping channels

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

### 5.12.1 Description of the test location

Test location: AREA4

### 5.12.2 Photo documentation of the test set-up



### 5.12.3 Test result

Hopping channel frequency range	Number of all available hopping channels	Number of hopping channels minimum limit
2400 – 2483.5	15	15

Limit according to FCC Part 15C, Section 15.247(1):

Frequency range (MHz)	LIMIT (Number of Hopping Channels)			
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz	20dB Bandwidth < 1 MHz	20dB Bandwidth > 1MHz
902 - 928	50	25	---	---
<b>2400 – 2483,5</b>	15	15	15	<b>15</b>
5725 - 5850	n.A	n.A	75	---

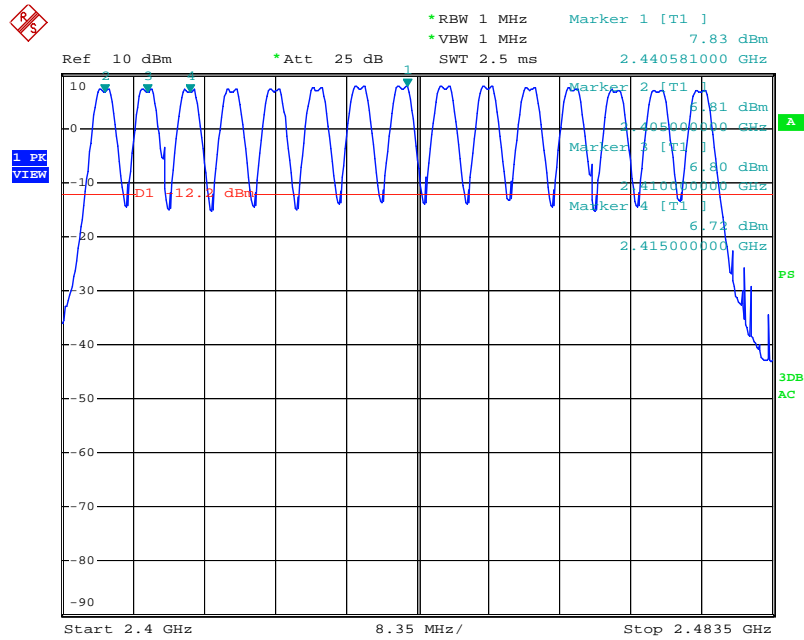
The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocol.



5.12.4 Test protocol

Number of hopping channels



## 5.13 Antenna application

### 5.13.1 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.

This paragraph does not apply because of the professional installing of the system.  
The EUT is intended for industrial use and will be operated by professional operators.  
The manufacturer delivers the appropriate antenna with the system.

Remarks:

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### 5.13.2 Antenna requirements

According to FCC Part 15C, Section 15.247 (b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The antenna gain of 6 dBi will not exceeded, the output power need not to be reduced.

Remarks:

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## 5.14 Maximum permissible exposure (MPE)

For test instruments and accessories used see section 6 Part HE.

### 5.14.1 Description of the test location

Test location: AREA4

### 5.14.2 Applicable standard

According to FCC Part 15, Section 15.247(i):

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".

This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

### 5.14.3 Description of Measurement

The maximum total power input to the antenna has been measured conducted as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, can be calculated the MPE in a defined distance away from the product.

Friis transmission formula:

$$P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$$

where

$P_d$  = power density (mW/cm<sup>2</sup>)

$P_{out}$  = output power to antenna (mW)

$G$  = gain of antenna (linear scale)

$r$  = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. ( $r = 20$  cm)

5.14.4 Test result

**Worst case:** Antenna ANT792-6MN with an antenna gain of 6 dBi.

Channel No.	Frequency	Max power output to antenna		Antenna gain	Power density	Limit of power density
	(MHz)	(dBm)	(mW)		(mW/cm <sup>2</sup> )	(mW/cm <sup>2</sup> )
11	2405	7.4	5.49	3.98	0.004	1.0
18	2440	8.1	6.46	3.98	0.006	1.0
25	2475	7.7	5.89	3.98	0.005	1.0

Limits for maximum permissible exposure (MPE):

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minutes)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/f	2.19/f	180/f <sup>2</sup>	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	f/1500	30
<b>1500-100000</b>	---	---	<b>1.0</b>	<b>30</b>

f = Frequency (MHz)

The requirements are **FULFILLED**.

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.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Next Verif.
A 4	ESHS 30	02-02/03-05-002	18/06/2011	18/06/2010		
	ESH 2 - Z 5	02-02/20-05-004	13/03/2011	13/03/2008	11/12/2010	11/06/2010
	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			07/04/2011	07/10/2010
CPC 3	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	N-1500-NW	02-02/50-06-041				
	VLP-1602 PRO	02-02/50-10-015				
CPR 3	AFS4-01000400-10-10P-4	02-02/17-05-003				
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	10/02/2011	10/02/2010		
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				
	VLP-1602 PRO	02-02/50-10-015				
HE	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	N-1500-NW	02-02/50-06-041				
	VLP-1602 PRO	02-02/50-10-015				
MB	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	N-1500-NW	02-02/50-06-041				
	VLP-1602 PRO	02-02/50-10-015				
SEC 1-3	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	N-1500-NW	02-02/50-06-041				
	VLP-1602 PRO	02-02/50-10-015				
SER 2	ESVS 30	02-02/03-05-006	11/06/2011	11/06/2010		
	VULB 9168	02-02/24-05-005	06/05/2011	06/05/2008	16/03/2011	16/09/2010
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
	VLP-1602 PRO	02-02/50-10-015				
SER 3	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	AFS4-01000400-10-10P-4	02-02/17-05-003				
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	10/02/2011	10/02/2010		
	R1 - 18 - 30 GHz	02-02/30-09-002			17/02/2011	17/02/2010
	Sucoflex N-1000-SMA	02-02/50-05-072				
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				
	C12-K1K1-157	02-02/50-06-001				
	H26G40G1	02-02/50-10-011				
	VLP-1602 PRO	02-02/50-10-015				