FCC ID: N5GUF80

EMI – TEST REPORT

- FCC Part 15.247 -

DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-01

Test Report No. :	**T36103-00-00HU**	21. June 2012 Date of issue

Type / Model Name : UF80

Product Description : RFID UHF Reader

Applicant **:** Brooks Automation GmbH

Address : Gartenstr. 19

D-95490 Mistelgau

Manufacturer **:** Brooks Automation GmbH

Address : Gartenstr. 19

D-95490 Mistelgau

Licence holder **:** Brooks Automation GmbH

Address : Gartenstr. 19

D-95490 Mistelgau

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

ilac-MRA

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, 2011)

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 B - Unintentional Radiators (October, 2011)

Part 15, Subpart B, Section 15.107	AC Line conducted emissions,
Part 15, Subpart B, Section 15.109	Radiated emissions, general requirements

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (October, 2011)

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 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 C63.10: 2009	Testing Unlicensed Wireless Devices
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 frequency range was scanned from 9 kHz to 10 GHz.
All emissions not reported in this test report were more than 10 dB below the specified limit.
The EuT is a frequency hopping system using 50 channels in the frequency band from 902 to 928 MHz.

Following antenna is provided with the UF:80

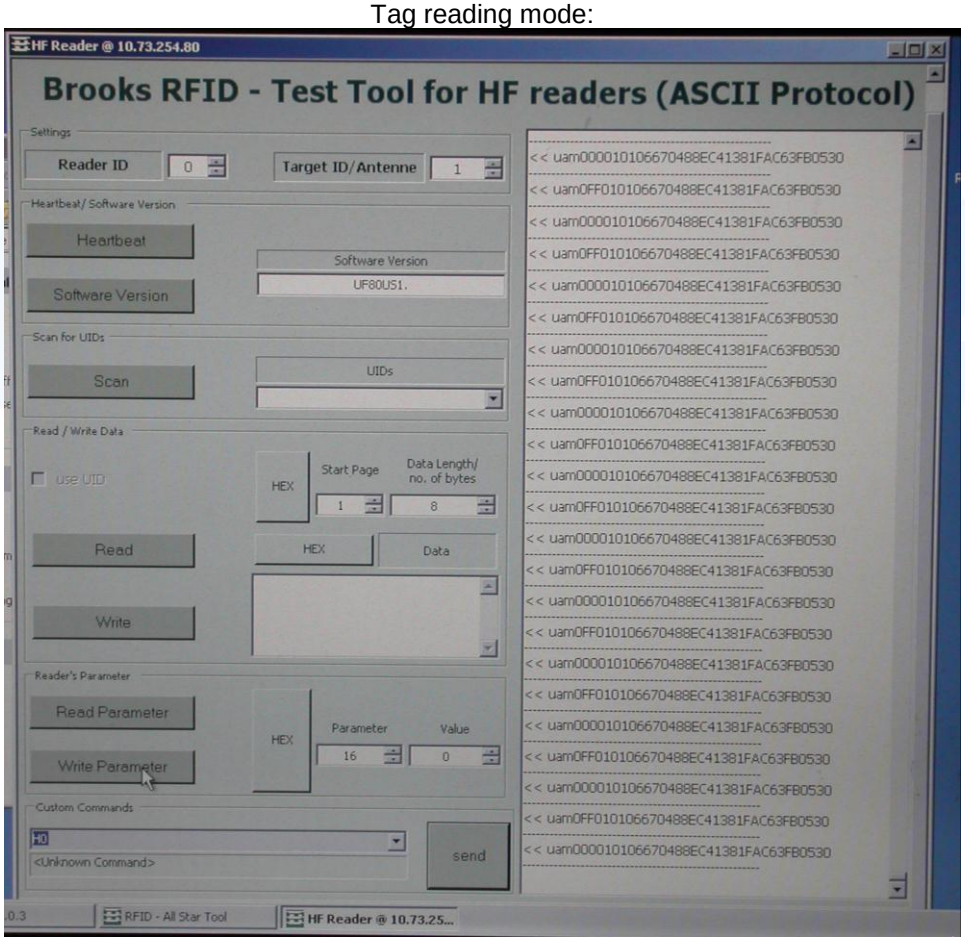
- Internal antenna: UF80 Loop with 3.0 dBic

The EuT is declared as Class B digital device.

It is not possible to set the EuT only in receiving mode.

Screenshot of the supportet test software:

Tag reading mode:



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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 : 05. June 2012

Testing concluded on : 18. June 2012

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2012.06.21 16:14:29 +02'00'

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

Tested by:

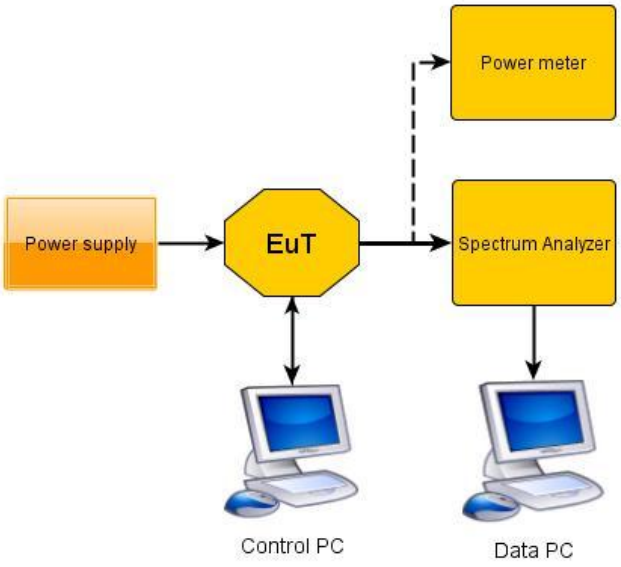
Markus Huber
I'm the author of this document
2012.06.21 14:09:42 +02'00'

Markus Huber

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EUT – Detailed photos see Attachment A

3.2 Test setup



3.3 Power supply system utilised

Power supply voltage: : Primary: 100-240 V / 50-60 Hz / 1ϕ
Secondary: 24 V DC

3.4 Short description of the EUT

The EuT is a UHF RFID reader system. It can read active and passive Tags in the frequency range from 902 to 928 MHz.

Number of tested samples: 1
Serial number: 120MIS10059

EUT operation mode:

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

- TAG reading mode supplying 22.0 dBm

- Standby mode

-

-

FCC ID: N5GUF80

EUT configuration:

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

-	Test software	Model :	Supplied by manufacturer
-	Lap Top	Model :	Fa. mikes-testingpartners gmbh
-	Antenna	Model :	Internal antenna UF80 Loop
-	Power supply – I.T.E. Power supply	Model :	FW7333S/24
-		Model :	

- customer specific cables

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, VCCI and AUSTEL

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.
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.

4.4.1.2 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.

5 TEST CONDITIONS AND RESULTS

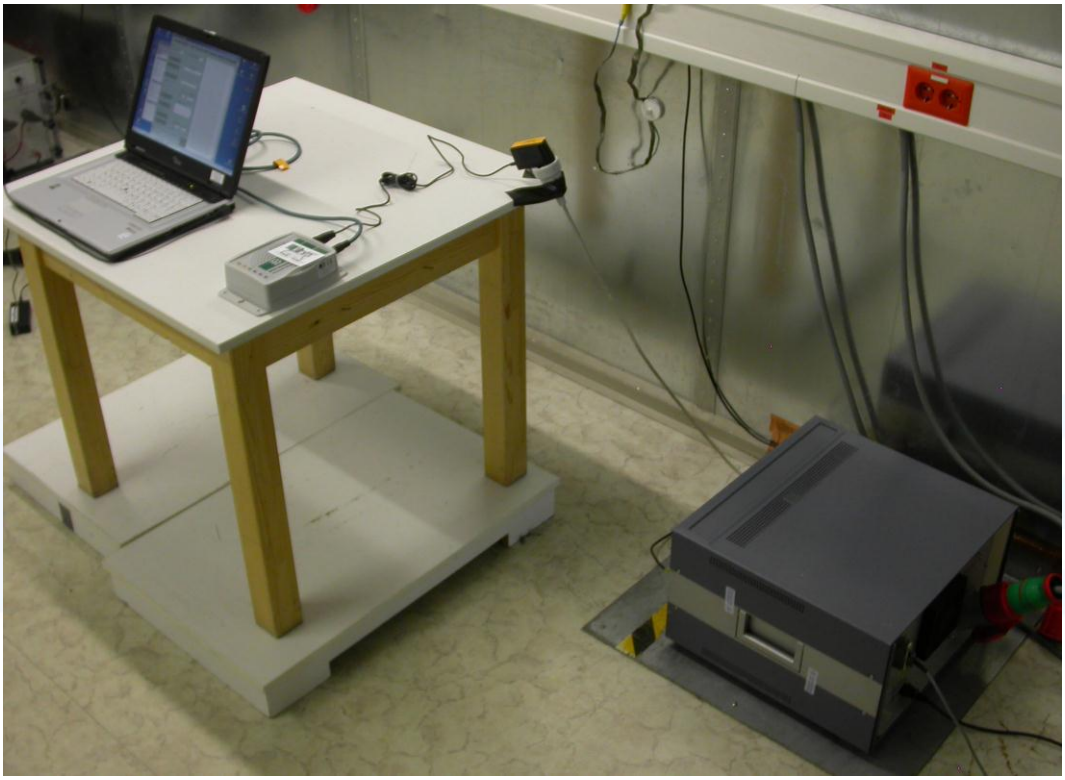
5.1 Conducted emissions

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 15C, 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 limits in the following table.

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

5.1.4 Description of Measurement

The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a line impedance stabilization network (LISN) with 50 Ω/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 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.
To convert between dBµV and µV, the following conversions apply:

dBµV = 20 log µV
µV = 10^(dBµV/20)

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

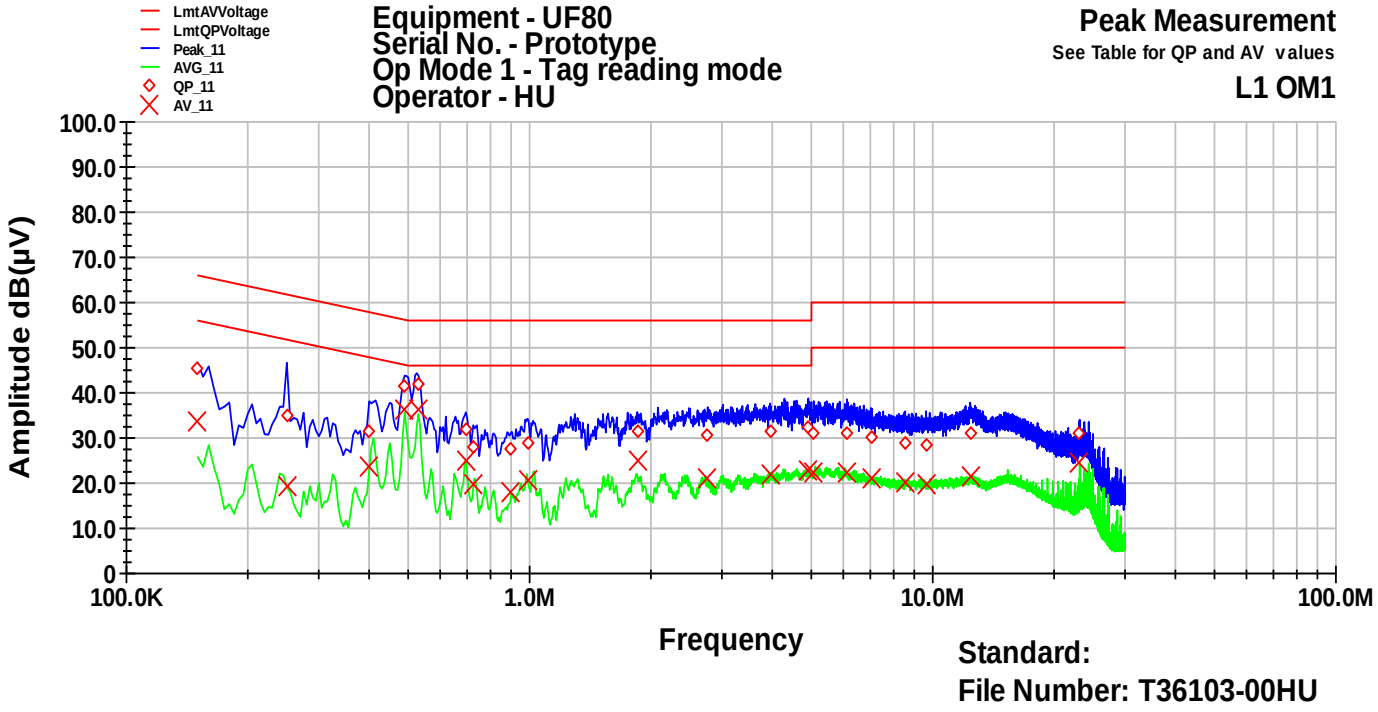
Min. limit margin 9.6 dB at 0.53 kHz

The requirements are **FULFILLED.**

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

5.1.6 Test protocol

Test point L1 Result: Passed
Operation mode: Tag reading mode supplying 30.0 dBm
Remarks:



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.15	45.5	-20.5	66.0	33.7	-22.3	56.0
0.25	34.9	-26.8	61.8	19.5	-32.3	51.8
0.4	31.5	-26.4	57.9	23.7	-24.2	47.9
0.49	41.6	-14.6	56.2	36.1	-10.0	46.2
0.53	41.8	-14.3	56.0	36.4	-9.6	46.0
0.695	32.0	-24.0	56.0	25.0	-21.0	46.0
0.725	28.0	-28.0	56.0	19.6	-26.4	46.0
0.9	27.6	-28.4	56.0	18.0	-28.0	46.0
0.99	29.0	-27.0	56.0	20.5	-25.5	46.0
1.85	31.5	-24.5	56.0	25.0	-21.0	46.0
2.765	30.8	-25.2	56.0	21.0	-25.0	46.0
3.95	31.3	-24.7	56.0	22.0	-24.0	46.0
4.91	32.2	-23.8	56.0	22.9	-23.1	46.0
5.065	31.0	-29.0	60.0	22.1	-27.9	50.0
6.12	31.1	-28.9	60.0	22.6	-27.4	50.0
7.02	30.1	-29.9	60.0	21.1	-28.9	50.0
8.54	29.0	-31.0	60.0	20.3	-29.7	50.0
9.625	28.2	-31.8	60.0	19.8	-30.2	50.0
12.38	31.1	-28.9	60.0	21.4	-28.6	50.0
23.125	30.9	-29.1	60.0	24.7	-25.3	50.0

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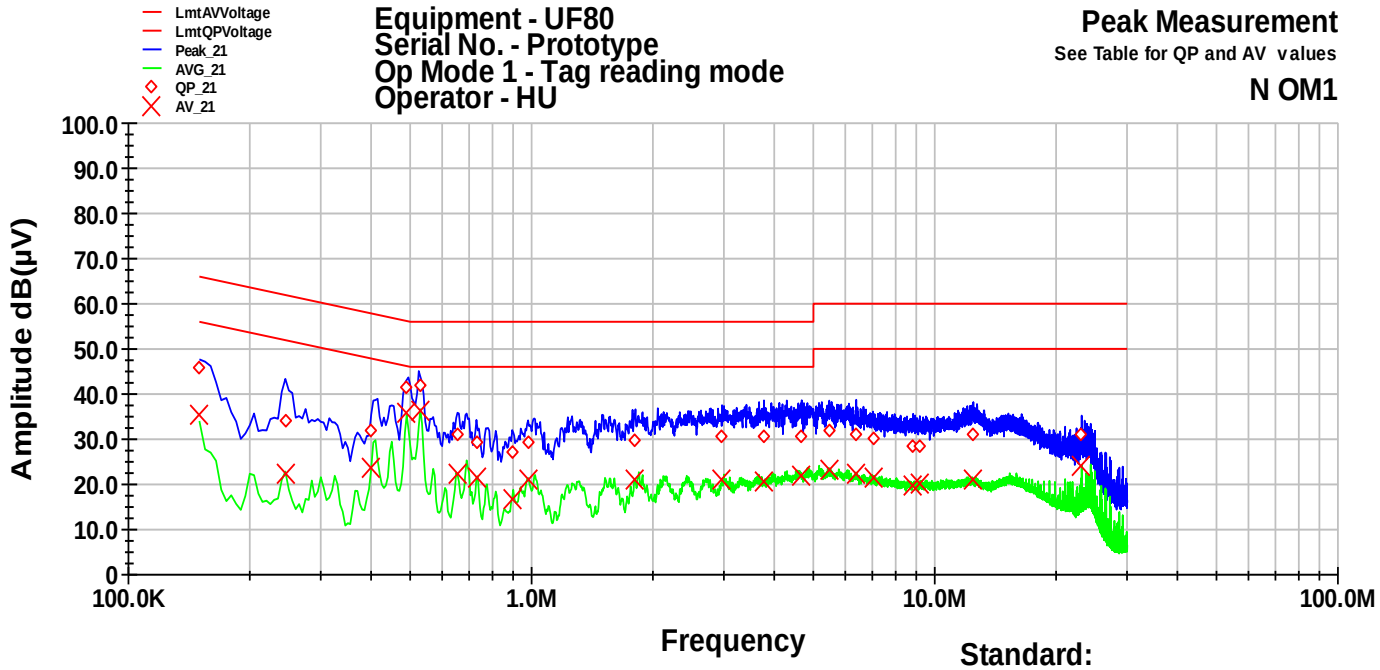
Test point N
Operation mode: Tag reading mode supplying 30.0 dBm
Remarks:

Result: Passed

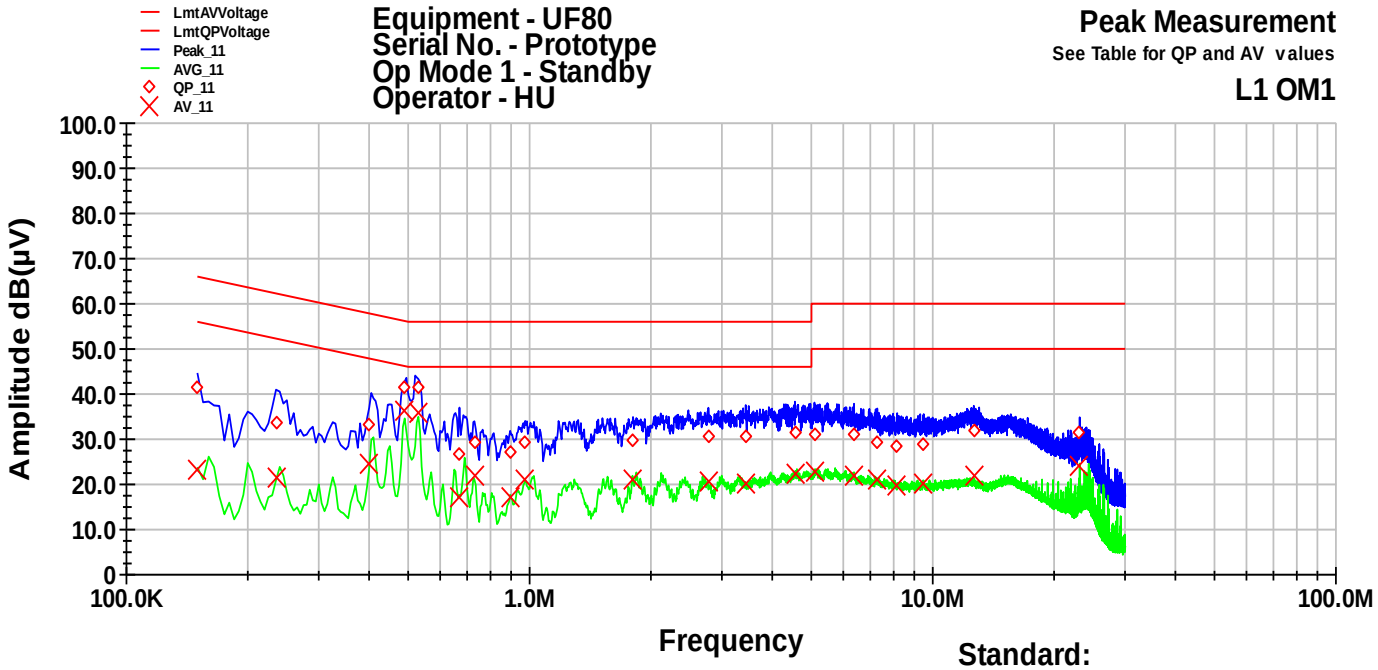


Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.15	45.7	-20.3	66.0	35.5	-20.5	56.0
0.245	34.0	-28.0	61.9	22.2	-29.7	51.9
0.4	31.9	-26.0	57.9	23.5	-24.4	47.9
0.49	41.6	-14.5	56.2	36.0	-10.2	46.2
0.53	41.7	-14.3	56.0	36.3	-9.7	46.0
0.655	30.9	-25.1	56.0	22.4	-23.6	46.0
0.73	29.2	-26.8	56.0	21.4	-24.6	46.0
0.895	27.0	-29.0	56.0	16.8	-29.2	46.0
0.98	29.4	-26.6	56.0	21.2	-24.8	46.0
1.81	29.8	-26.2	56.0	21.0	-25.0	46.0
2.965	30.5	-25.5	56.0	21.2	-24.8	46.0
3.77	30.8	-25.2	56.0	20.8	-25.2	46.0
4.675	30.5	-25.5	56.0	22.0	-24.0	46.0
5.47	31.9	-28.1	60.0	23.4	-26.6	50.0
6.385	30.9	-29.1	60.0	22.4	-27.6	50.0
7.03	30.0	-30.0	60.0	21.3	-28.7	50.0
8.835	28.4	-31.6	60.0	19.8	-30.2	50.0
9.18	28.5	-31.5	60.0	20.2	-29.8	50.0
12.46	31.0	-29.0	60.0	21.2	-28.8	50.0
23.13	31.1	-28.9	60.0	24.2	-25.8	50.0

FCC ID: N5GUF80

Test point L1
Operation mode: Standby mode
Remarks:

Result: Passed



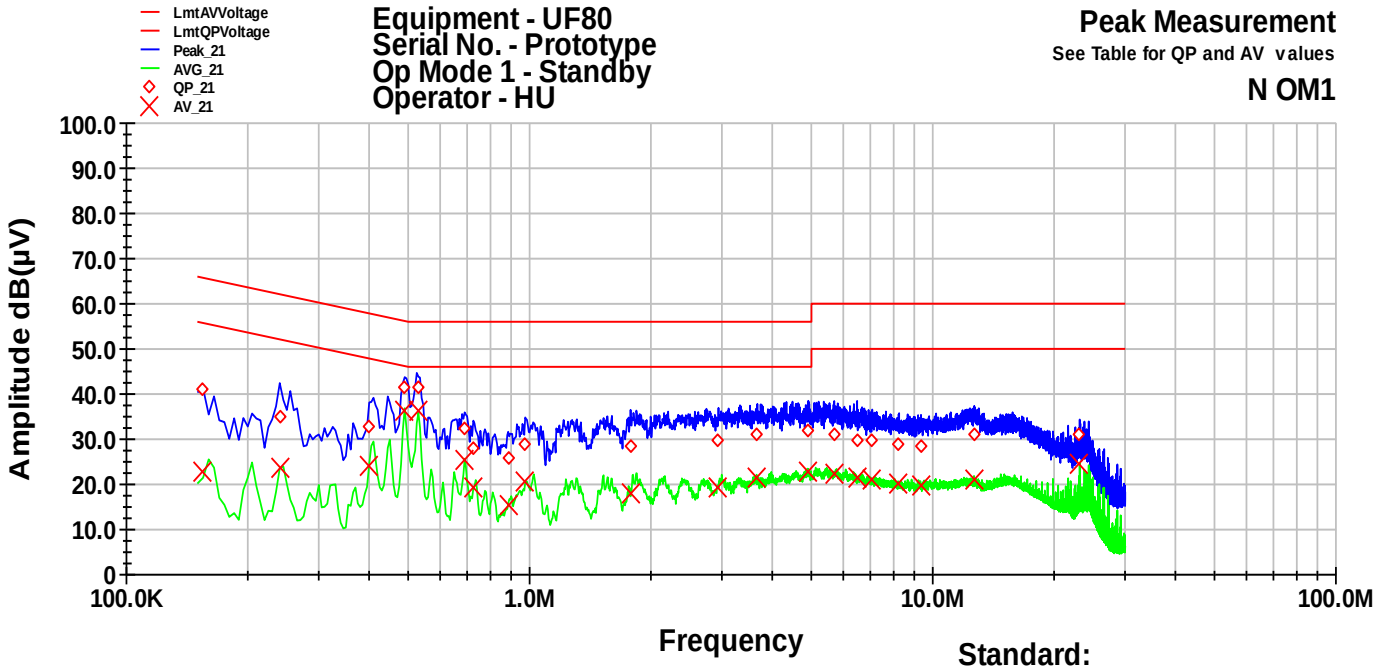
Standard:
File Number: T36103-00HU

Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.15	41.3	-24.7	66.0	23.3	-32.7	56.0
0.235	33.5	-28.8	62.3	21.7	-30.6	52.3
0.4	33.2	-24.7	57.9	24.5	-23.4	47.9
0.49	41.5	-14.6	56.2	36.1	-10.1	46.2
0.53	41.3	-14.7	56.0	35.9	-10.1	46.0
0.67	26.6	-29.4	56.0	17.1	-28.9	46.0
0.73	29.2	-26.8	56.0	21.9	-24.1	46.0
0.895	27.2	-28.8	56.0	17.0	-29.0	46.0
0.975	29.1	-26.9	56.0	20.9	-25.1	46.0
1.805	29.7	-26.3	56.0	20.9	-25.1	46.0
2.775	30.7	-25.3	56.0	20.6	-25.4	46.0
3.435	30.6	-25.4	56.0	20.2	-25.8	46.0
4.55	31.3	-24.7	56.0	22.4	-23.6	46.0
5.085	31.3	-28.8	60.0	22.7	-27.3	50.0
6.375	30.9	-29.1	60.0	22.0	-28.0	50.0
7.28	29.3	-30.7	60.0	21.0	-29.0	50.0
8.155	28.5	-31.5	60.0	19.8	-30.2	50.0
9.49	28.8	-31.2	60.0	20.2	-29.8	50.0
12.635	31.8	-28.2	60.0	21.9	-28.1	50.0
23.13	31.4	-28.6	60.0	24.1	-25.9	50.0

FCC ID: N5GUF80

Test point N
Operation mode: Standby mode
Remarks:

Result: Passed



Standard:
File Number: T36103-00HU

Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.155	41.0	-24.7	65.7	22.8	-32.9	55.7
0.24	35.0	-27.1	62.1	23.9	-28.2	52.1
0.4	32.6	-25.2	57.9	24.3	-23.6	47.9
0.49	41.6	-14.5	56.2	36.1	-10.0	46.2
0.53	41.6	-14.4	56.0	36.2	-9.8	46.0
0.69	32.4	-23.6	56.0	25.3	-20.7	46.0
0.725	27.8	-28.2	56.0	19.2	-26.8	46.0
0.885	25.8	-30.2	56.0	15.6	-30.4	46.0
0.975	28.7	-27.3	56.0	20.6	-25.4	46.0
1.78	28.5	-27.5	56.0	18.2	-27.8	46.0
2.94	30.0	-26.0	56.0	19.5	-26.5	46.0
3.67	31.0	-25.0	56.0	21.3	-24.7	46.0
4.91	32.1	-23.9	56.0	22.9	-23.1	46.0
5.695	31.0	-29.0	60.0	22.2	-27.8	50.0
6.49	29.6	-30.4	60.0	21.3	-28.7	50.0
7.075	29.8	-30.3	60.0	20.9	-29.1	50.0
8.25	29.0	-31.0	60.0	20.2	-29.8	50.0
9.345	28.5	-31.5	60.0	19.6	-30.4	50.0
12.67	31.0	-29.0	60.0	21.1	-28.9	50.0
23.125	30.9	-29.1	60.0	24.7	-25.3	50.0

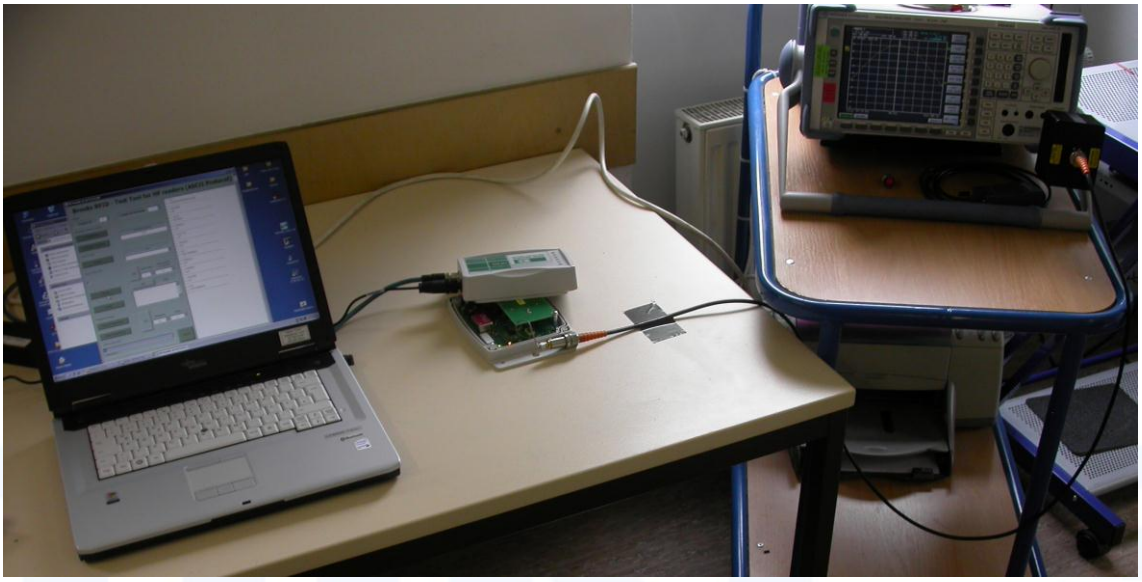
5.2 20 dB bandwidth

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

5.2.1 Description of the test location

Test location: Area 4

5.2.2 Photo documentation of the test set-up



5.2.1 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.

5.2.2 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 amplitude signal 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.

5.2.3 Test result

Power setting 22.0 dBm:

Channel No.	-20 dB Bandwidth below peak (kHz)
CH 1 (902.75 MHz)	99.0
CH 26 (915.25 MHz)	99.6
CH 50 (927.25 MHz)	99.6

Bandwidth limit according to FCC Part15C, Section 15.247(a):

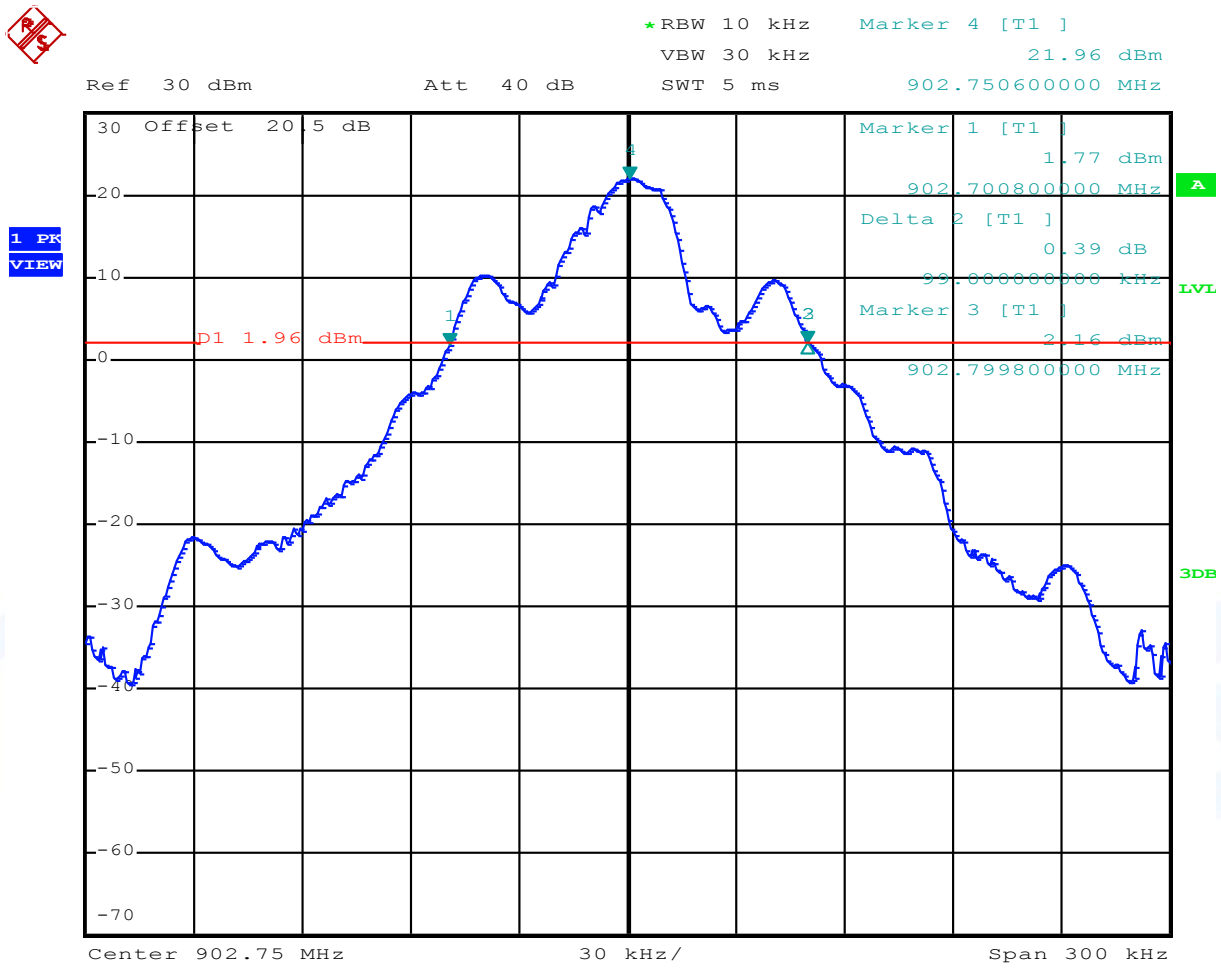
Frequency	Hopping channels	Limit -20 db bandwidth
(MHz)		(kHz)
902-928	**≥ 50**	**< 250**

The requirements are **FULFILLED.**

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

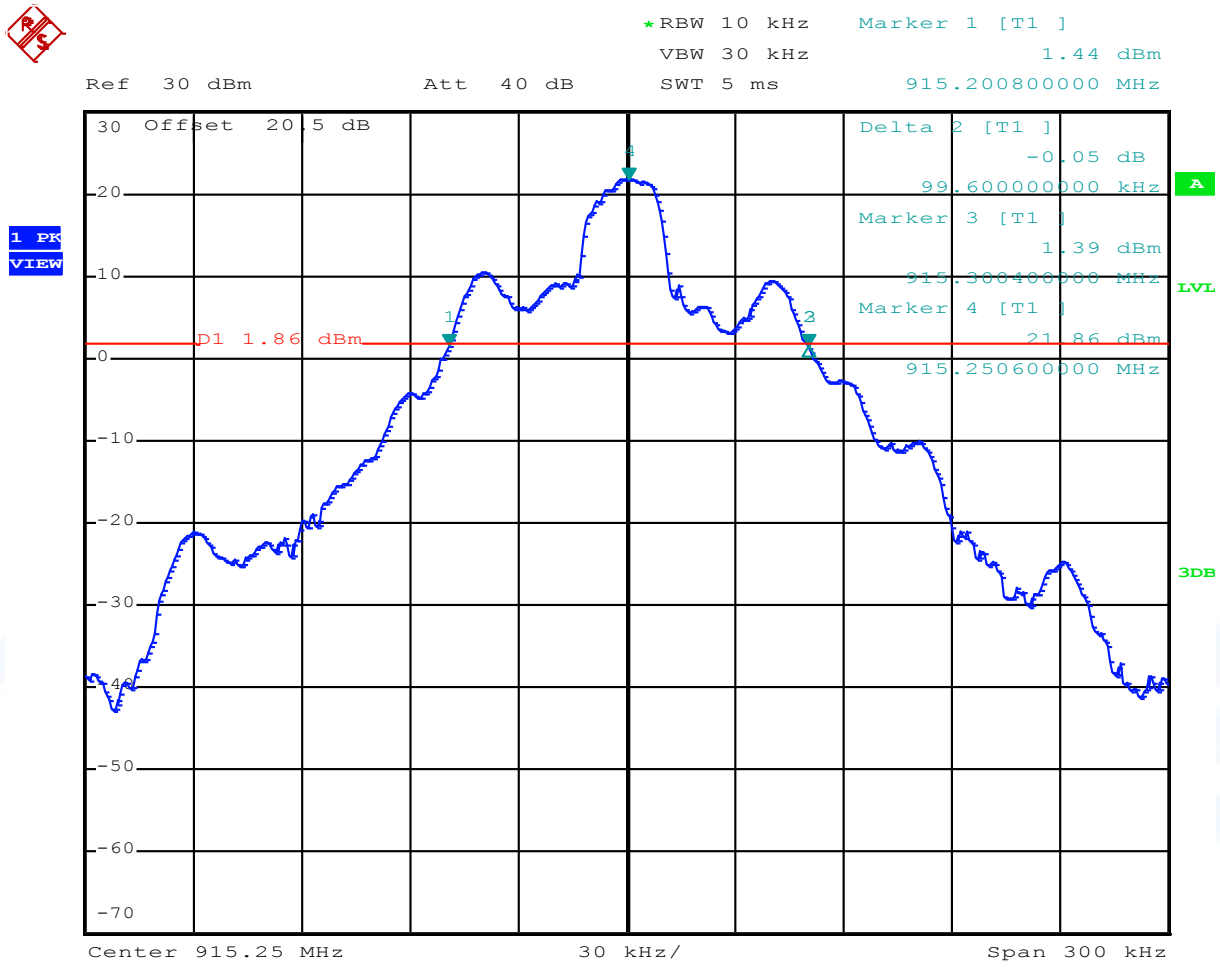
5.2.4 Test protocol

Channel 1
902.75 MHz

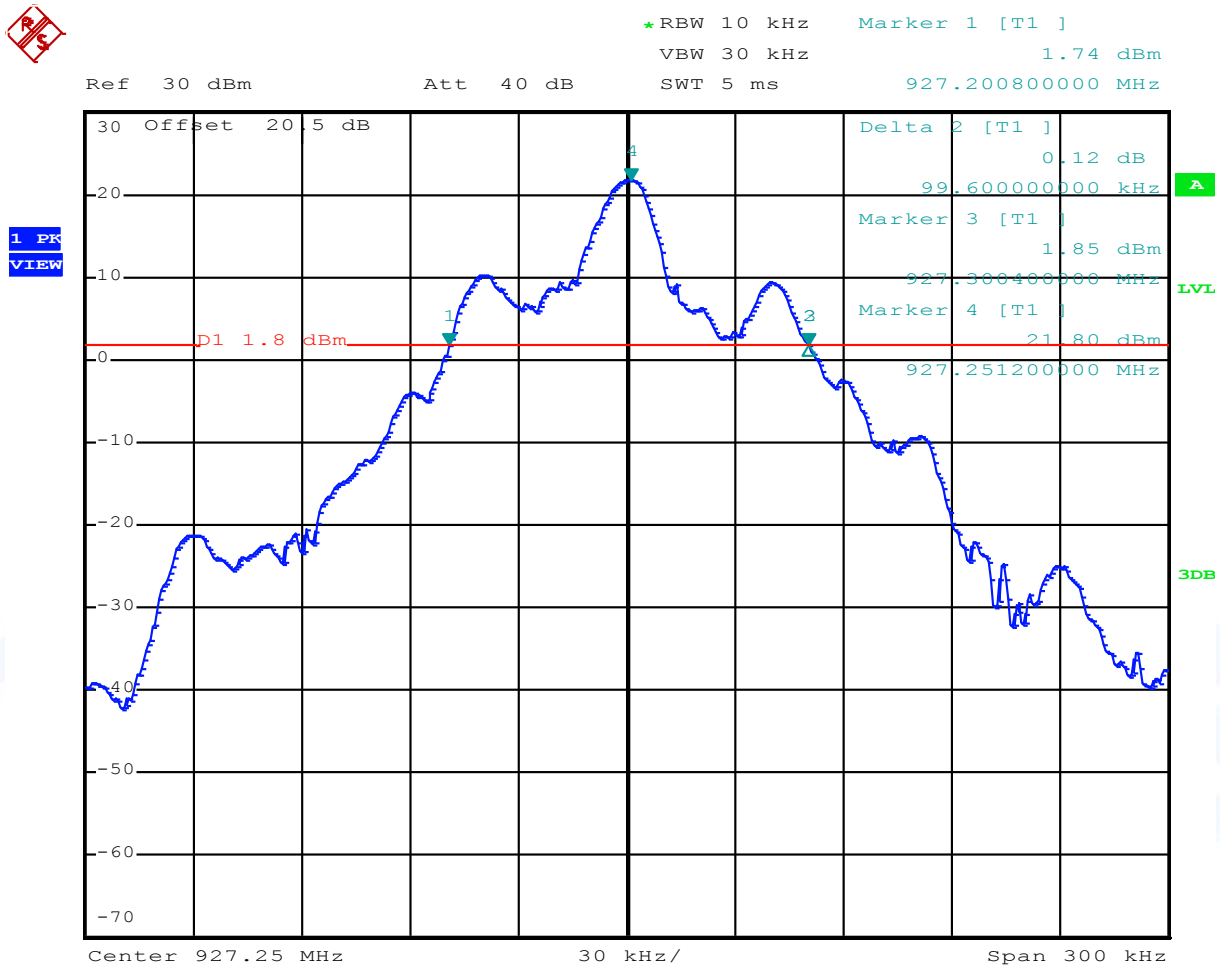


FCC ID: N5GUF80

Channel 26
915.25 MHz



Channel 50
927.25 MHz



5.3 Maximum peak conducted output power

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

5.3.1 Description of the test location

Test location: Area 4

5.3.2 Photo documentation of the test set-up

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(2):
For frequency hopping systems operating in the 902-928 MHz band the maximum peak conducted output power shall not exceed the limit of 1 watt for systems employing at least 50 hopping channels.

The conducted output power limit specified in paragraph (b) of this section 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 the intentional radiator shall be reduced below the stated values in paragraphs (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.

5.3.4 Description of Measurement

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

Spectrum analyser settings:

RBW	100 kHz	Sweep time	5 ms (Auto)
VBW	100 kHz	Power Mode	Max. hold
Detector	Peak	Span	400 kHz

5.3.5 Test result

Power setting 22.0 dBm
=>Internal Antenna – UF80 Loop, antenna gain: 3.0 dBic

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Delta (dB)
1	902.75	21.74	30.0	-8.3
26	915.25	21.75	30.0	-8.2
50	927.25	21.81	30.0	-8.2

Note: Test cable loss and fixed attenuation of 20 dB are included in the analyzer reading (Transducer factor).

Peak Power Limit according to FCC Part 15C, Section 15.247(b)(2):

Frequency	Hopping channels	Hop. CH carrier frequ. separation	Peak Power Limit	
(MHz)			(dBm)	(W)
902-928	**≥ 50**		**30**	**1.0**

The requirements are **FULFILLED.**

Remarks: _____

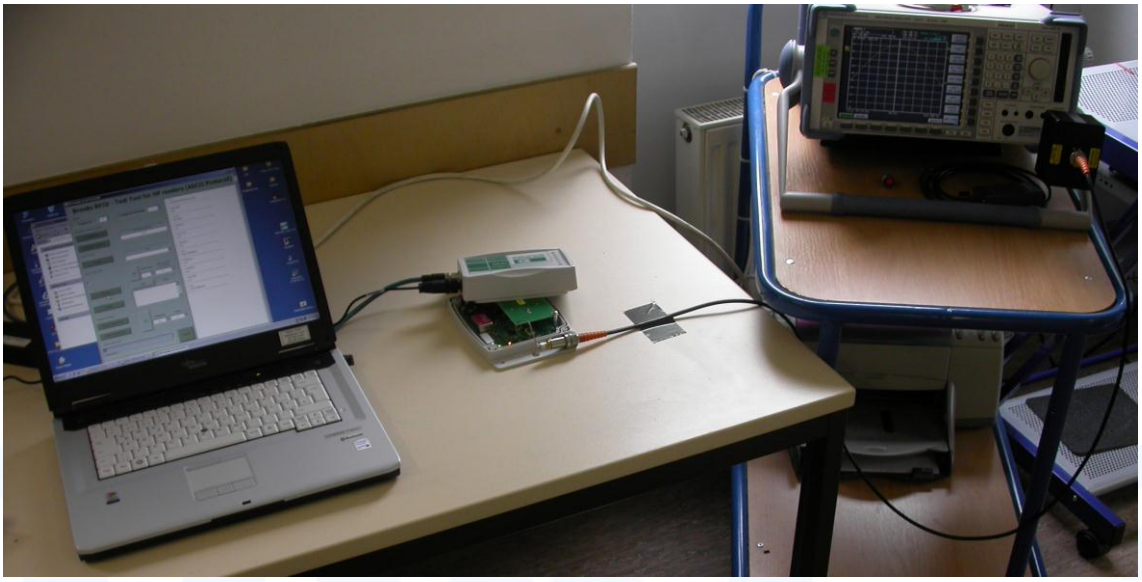
5.4 Spurious RF conducted emissions

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

5.4.1 Description of the test location

Test location: Area 4

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 band 902 to 928 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).

5.4.4 Description of Measurement

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

Spectrum analyzer settings:

RBW	100 kHz
VBW	300 kHz
Detector	Max. peak
Trace:	Max. hold
Sweep time	auto

5.4.5 Test result

Power setting 22.0 dBm

Hopping frequency from 902.75 to 927.25 MHz, max. level 21.77 dBm			
Frequency (MHz)	Peak power * (dBm)	Limit (-20 dB) (dBm)	Delta (dB)
1792.0	-51.51	1.77	-53.3
2746.0	-57.11	1.77	-58.9
4618.0	-44.00	1.77	-45.8

* Fixed attenuation of 20 dB is included in the Peak power.

The requirements are **FULFILLED.**

Remarks: All spurious emissions falling in restricted bands have been measured radiated.

For detailed results please refer to following test protocols.

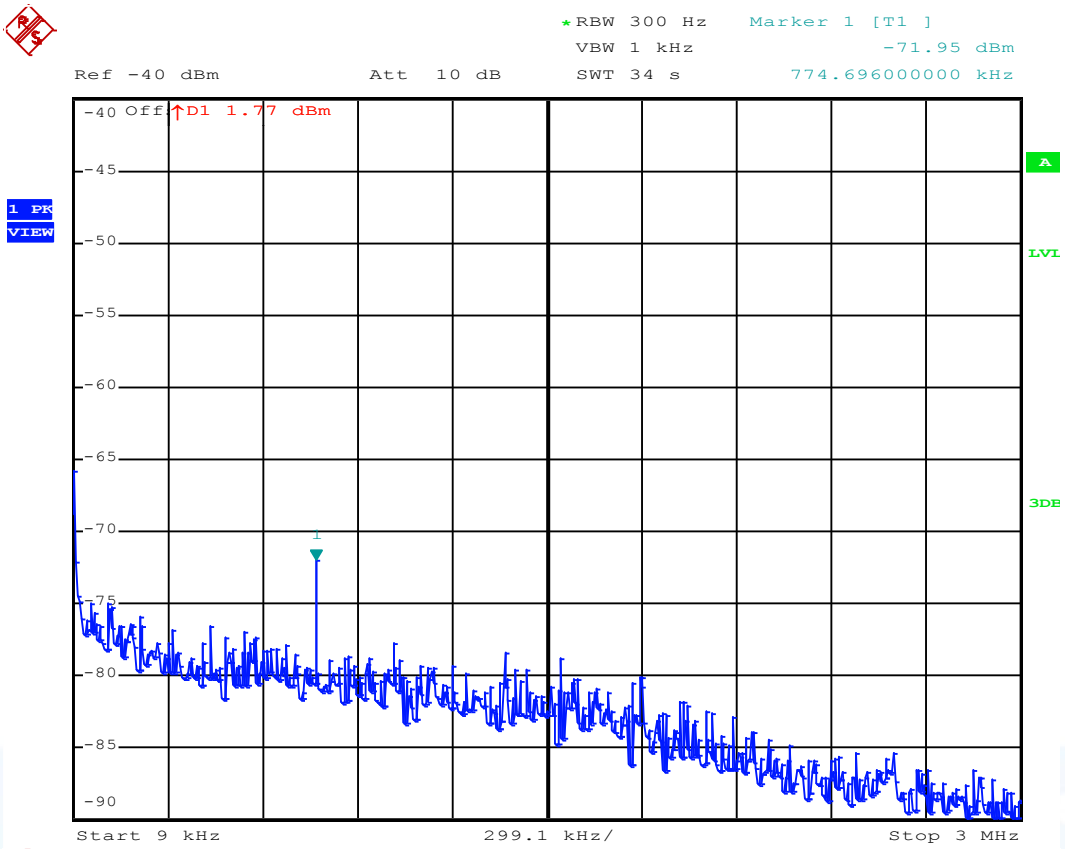
In the frequency range from 9 kHz to 30 MHz no emissions could be measured.

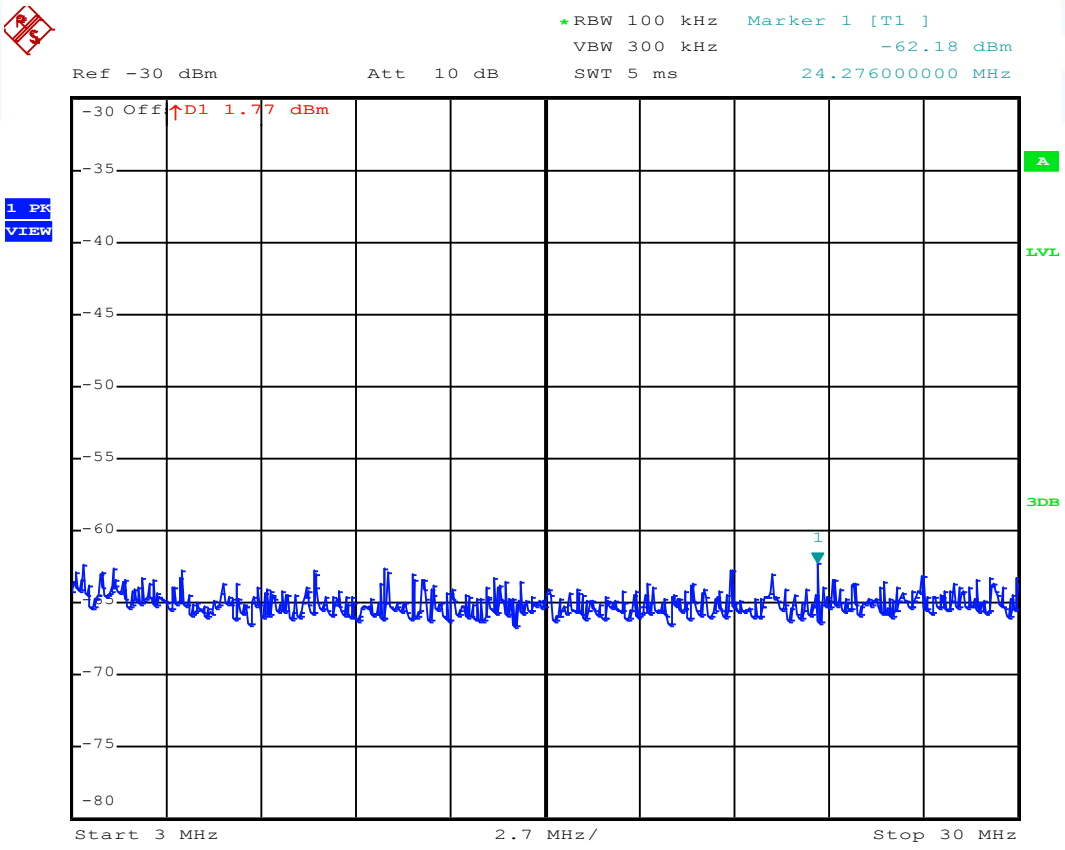
Test was performed in frequency hopping mode from 902.75 to 927.25 MHz.

This mode represents the worst case mode of the EuT.

FCC ID: N5GUF80

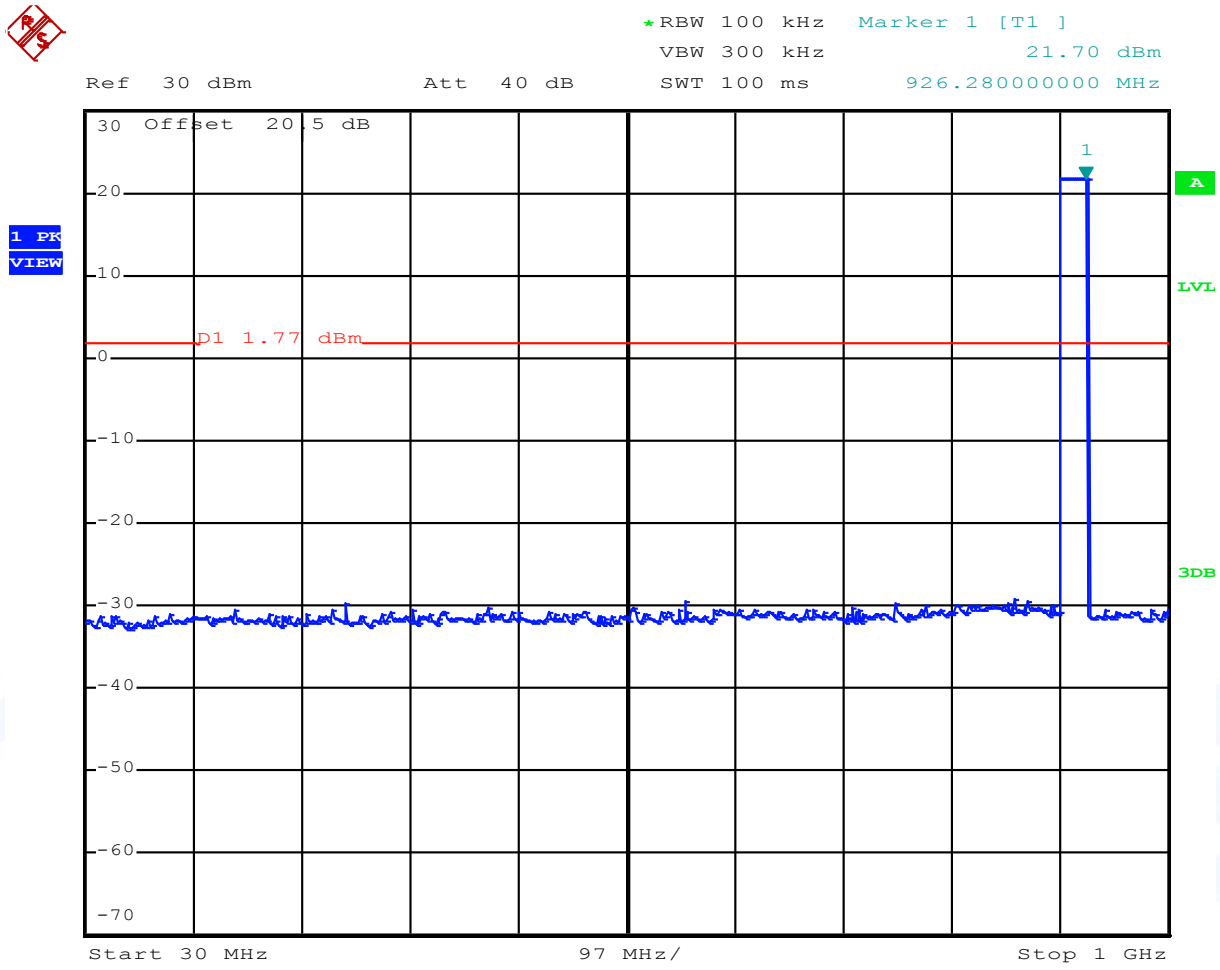
Conducted RF emission from 9 kHz to 30 MHz





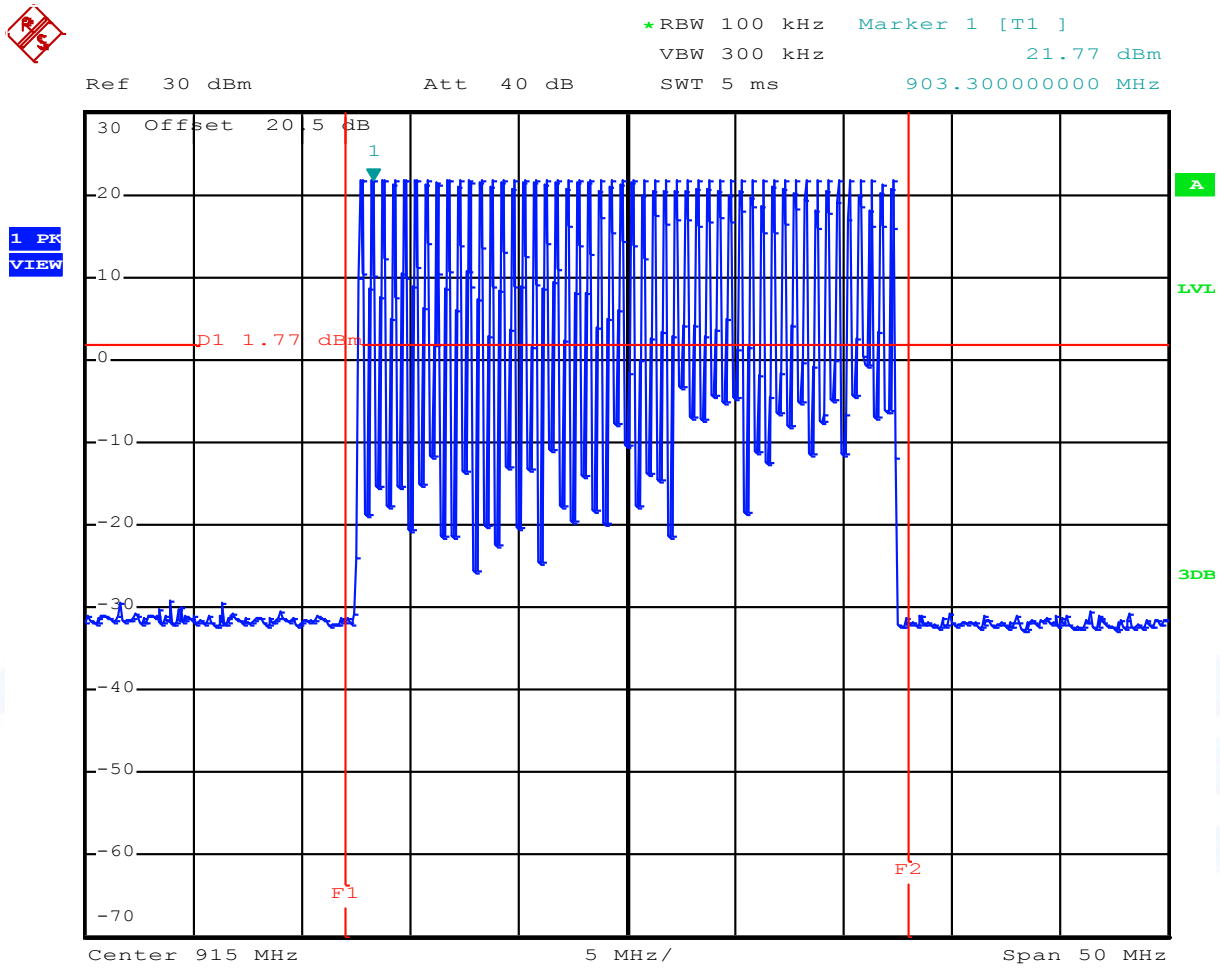
FCC ID: N5GUF80

Conducted RF emission from 30 to 1000 MHz



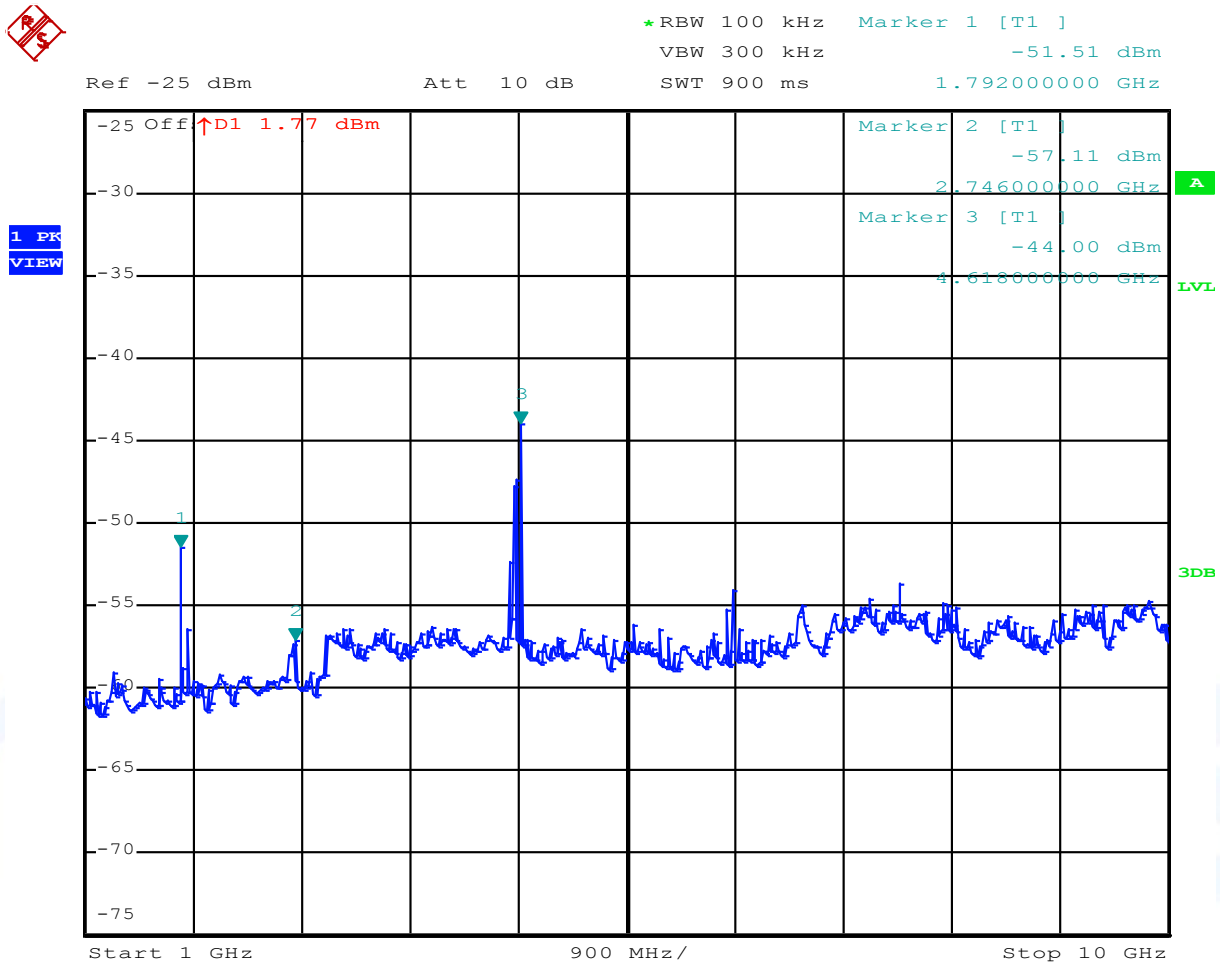
FCC ID: N5GUF80

Conducted RF emission from 30 to 1000 MHz
(Band edge)



FCC ID: N5GUF80

Conducted RF emission from 1 to 10 GHz



Note: Signal level no. 2 is located in restricted band (2690 – 2900 MHz)
Signal level no. 3 is located in restricted band (4500 – 5150 MHz)

5.5 Spurious radiated emissions

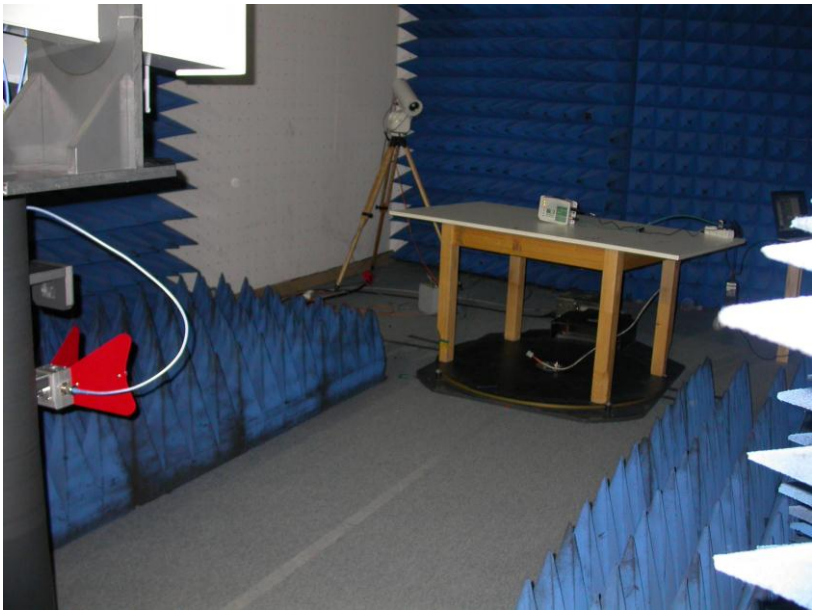
For test instruments and accessories used see section 6 Part **SER 1, SER 2, SER 3**.

5.5.1 Description of the test location

Test location: OATS1
Test distance: 3 metres

Test location: Anechoic Chamber A2
Test distance: 3 metres

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

According to FCC Part 15, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency bands 902 to 928 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

Radiated spurious emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linear polarized antennas. The measurements are made with 120 kHz bandwidth and quasi-peak detection (200 Hz, 9 kHz up to 30 MHz). The EUT was placed on a 1.0 X 1.5 metres non-conducting table 80 centimetres above the ground plane. The set up of the equipment under test will be in accordance to ANSI C63.4. The antenna was positioned 3 metres horizontally from the EUT. To locate maximum emissions from the EUT the antenna is shifted in height from 1 to 4 metres, after the EUT is rotated 360 degrees. The measurement scan is made in horizontal and vertical polarization of the antenna.

For the radiated measurement up from 1 GHz to maximum frequency as specified in Section 15.33, a spectrum analyzer and appropriate linear polarized antennas are used. The EUT is placed on a 1.0 X 1.5 metres non-conducting table 80 centimetres above the ground plane. The set up of the EUT will be in accordance to ANSI C63.4. The antenna was positioned 3 m horizontally from the EUT. To locate maximum emissions the EUT was rotated 360 degrees in the fully anechoic chamber. The measurement scan is made in horizontal and vertical polarization of the antenna. For testing above 1 GHz, 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.

5.5.5 Test result

5.5.5.1 Radiated emission test f < 1 GHz

In the frequency range from 9 kHz to 30 MHz no radiated emissions could be measured.

In frequency range from 30 MHz to 1 GHz:
The table shows an extract of the critical values:

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)
48,25	15,1	5,6	15,0	13,9	30,1	19,5	40,0	-9,9
54,00	13,2	11,3	14,9	13,9	28,1	25,2	40,0	-11,9
125,00	17,2	13,9	11,9	12,7	29,1	26,6	43,5	-14,4
132,56		14,3		13,2		27,5	43,5	-16,0
150,01	12,5	15,4	13,3	14,0	25,8	29,4	43,5	-14,1
80,15	20,4	8,7	10,8	10,2	31,2	18,9	40,0	-8,8
48,25	13,9		15,0		28,9		40,0	-11,1

5.5.5.2 Radiated emission test f > 1GHz

Power setting 22.0 dBm
⇨ Internal Antenna – UF80 Loop, antenna gain: 3.0 dBic

Frequency (GHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	L: PK dB(µV/m)	L: AV dB(µV/m)	Limit AV dB(µV/m)	Delta (dB)
1.828	68.7	57.1	1000	-11.8	56.9	45.3	54.0	-8.7
2.746	63.5	49.8	1000	-9.8	53.7	40.1	54.0	-13.9
3.664	60.8	47.8	1000	-8.9	51.9	38.9	54.0	-15.1

*) Average values were measured with spectrum analyzer by the following settings
RBW: 1 MHz
VBW: 10 Hz
Sweep: Auto

Radiated limits according to FCC Part 15C, Section 15.209(a) for spurious emissions:

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009 - 0.490	2400/F(kHz)		300
0.490 - 1.705	24000/F(kHz)		30
1.705 - 30	30	29,5	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209: (Refer to section 5.5.5.1)

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: During the test the EUT was set into TX continuous mode with normal modulation.

The measurement was performed up to the 10th harmonic (10000 MHz).

Test was performed in frequency hopping mode from 902.75 to 927.25 MHz.

This mode represents the worst case mode of the EuT.

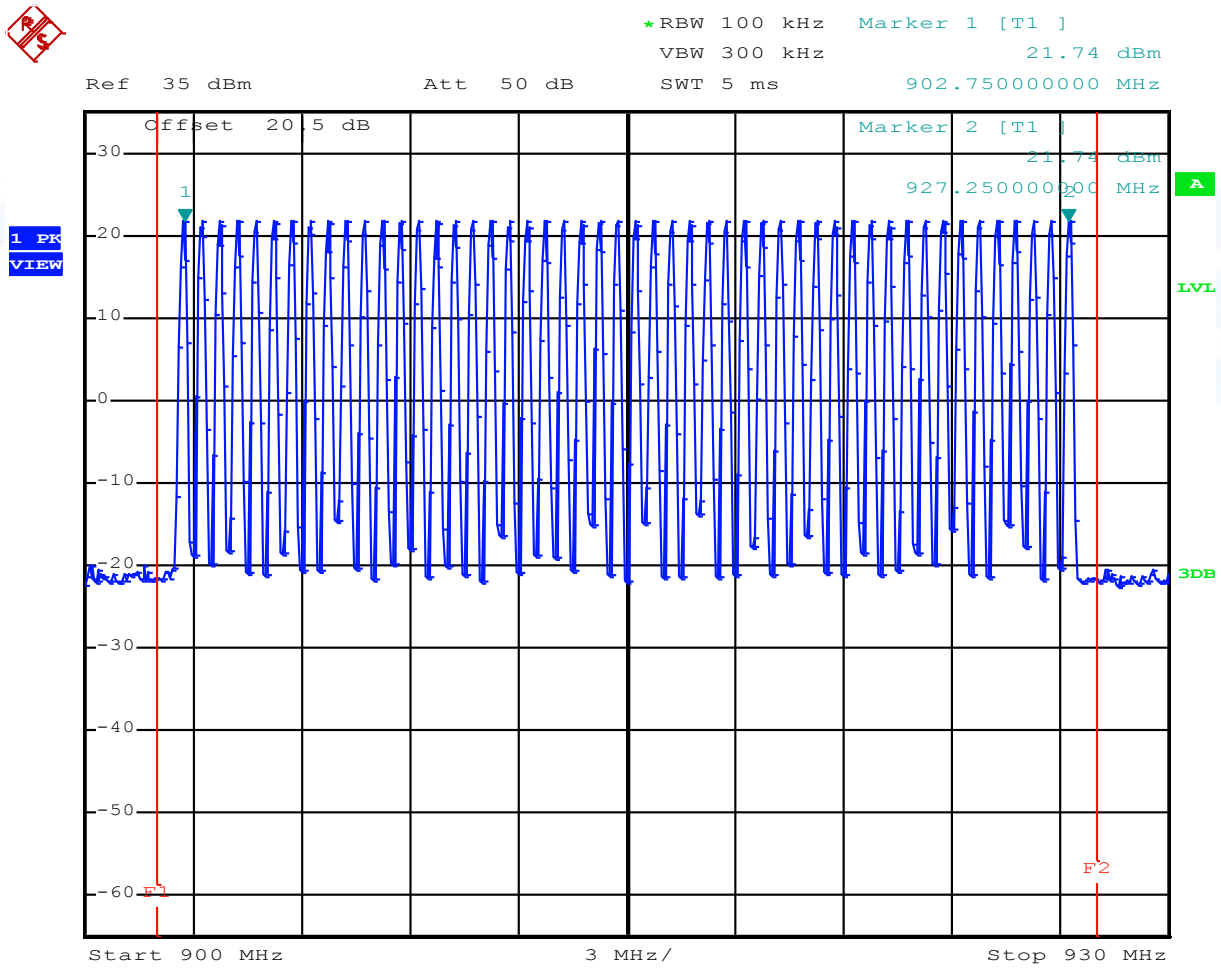
5.6 Hopping sequence

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.

Remarks: The channel is represented by a pseudo-random hopping sequence hopping through the 50 RF-channels.

For detailed information about the hopping sequence, please refer to "Theory of Operation Manual".

5.6.1 Test protocol



5.7 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.

Remarks: The device fulfills the requirement according to FCC Part 15C, Section 15.247(a).

The manufacturer declares in the system manual that this function is controlled via software.

For detailed information about the hopping sequence, please refer to

"Theory of Operation Manual".

5.8 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.

Remarks: The receiver bandwidth is equal to the transmitter bandwidth in the 50 hopping channel mode.

(Declared by the manufacturer.)

For detailed information about the hopping sequence, please refer to

"Theory of Operation Manual".

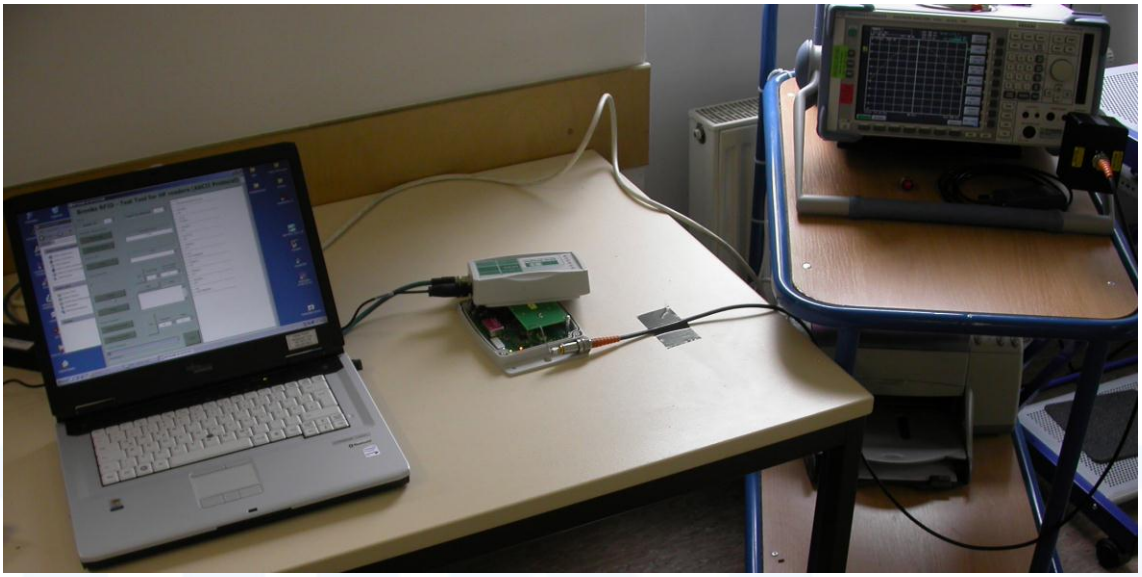
5.9 Dwell time

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

5.9.1 Description of the test location

Test location: Area 4

5.9.2 Photo documentation of the test set-up



5.9.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(i):
Frequency hopping systems operating in the 902-928 MHz band: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

5.9.4 Description of Measurement

The measurement was done using a spectrum analyser in time domain function and able to store the maximum time of a period. This time period has been stored an added up the appropriate time intervals the hopping system has applied this channel.

5.9.5 Test result

Channel frequency (MHz)	Pulse Time (ms)	Number of Bursts (in 1 time period)	Dwell time (ms)
914.75	380	1	380

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

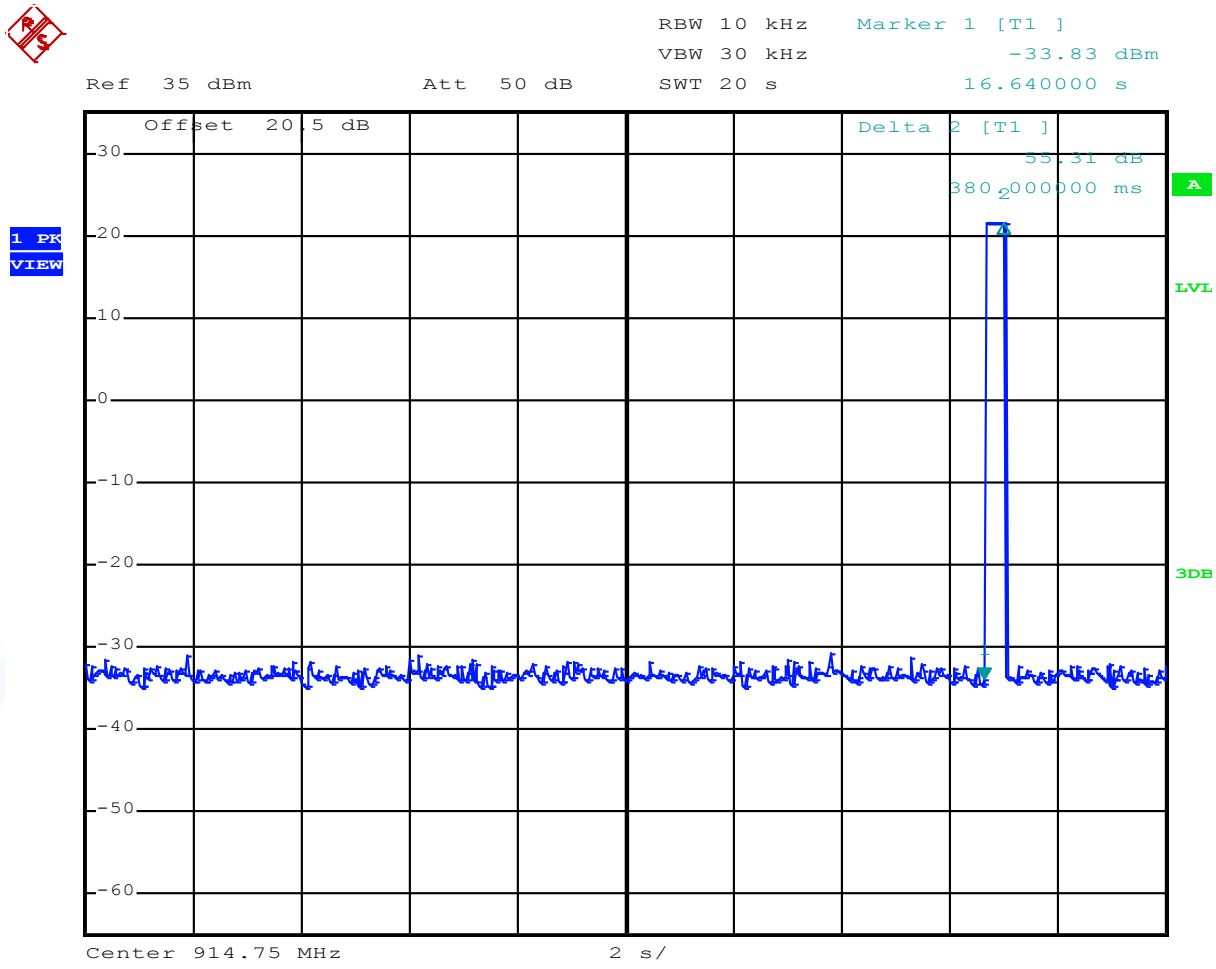
Frequency	Hopping channels	time of one period	Limit dwell time, AV
(MHz)		(s)	(ms)
902-928	**≥ 50**	**20**	**< 400**

The requirements are **FULFILLED.**

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

5.9.6 Test protocol

Time of occupancy (Dwell time)



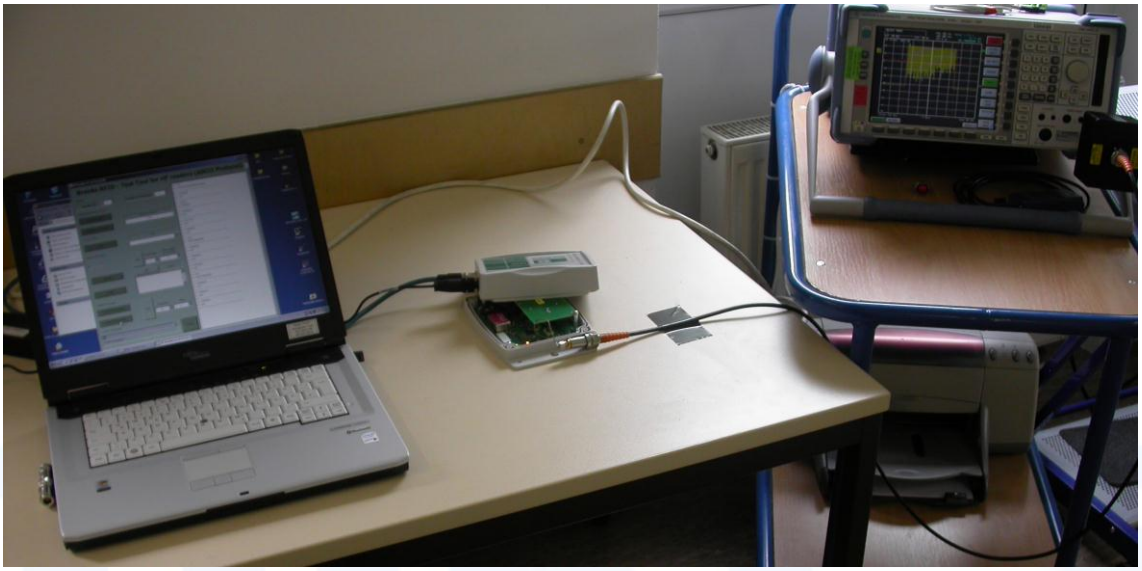
5.10 Channel separation

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

5.10.1 Description of the test location

Test location: Area 4

5.10.2 Photo documentation of the test set-up



5.10.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(1):
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

5.10.4 Description of Measurement

This measurement was done by using a spectrum analyser. The Span of the analyzer was set wide enough to capture 2 frequencies. The result of the channel separation was compared with the 20 dB bandwidth and recorded.

5.10.5 Test result

Channel 1 (MHz)	Channel 2 (MHz)	Channel separation (kHz)
902.75	903.25	500

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

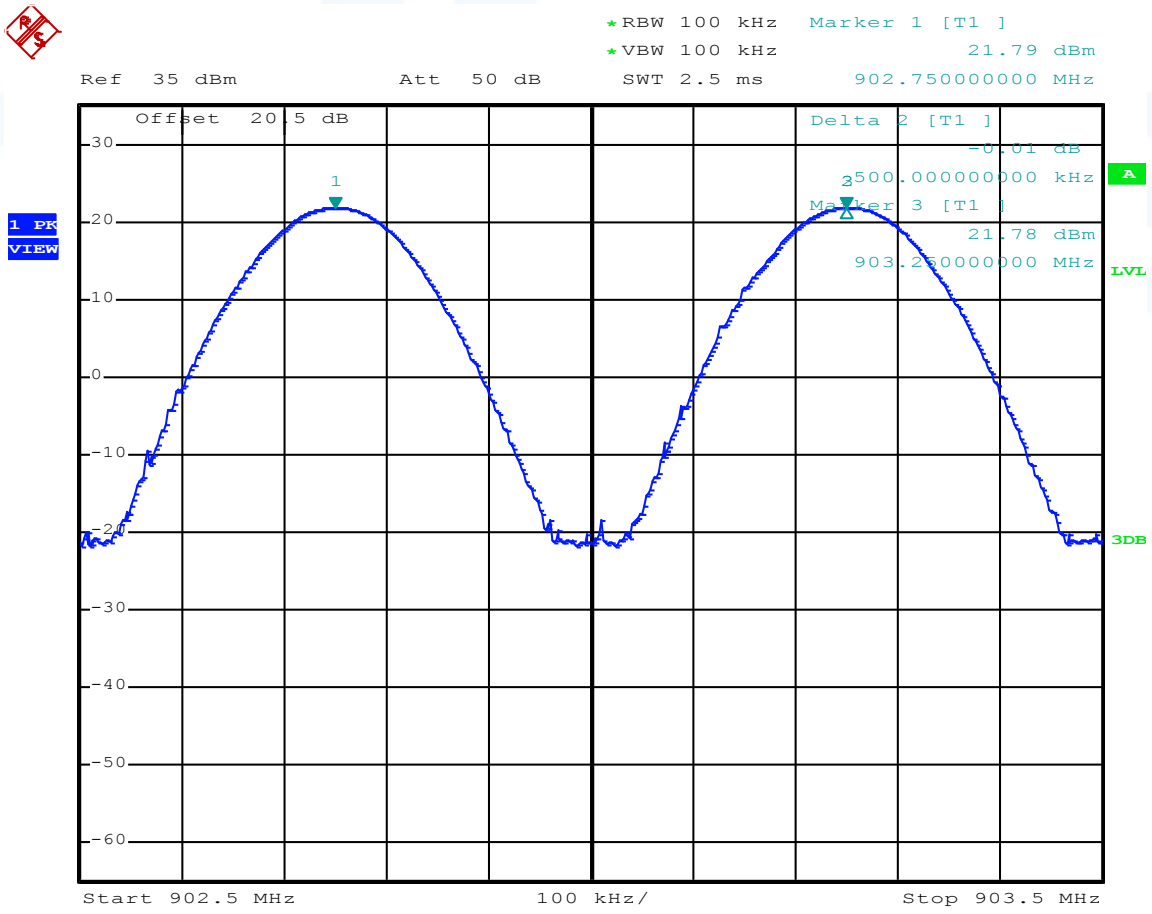
Frequency	Hopping channels	Limit channel separation
(MHz)		(kHz)
All systems		> 25 kHz or 20 dB bandwidth, which ever is greater
2400-2483.5	≥ 15	

The requirements are **FULFILLED.**

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

5.10.6 Test protocol

Channel separation



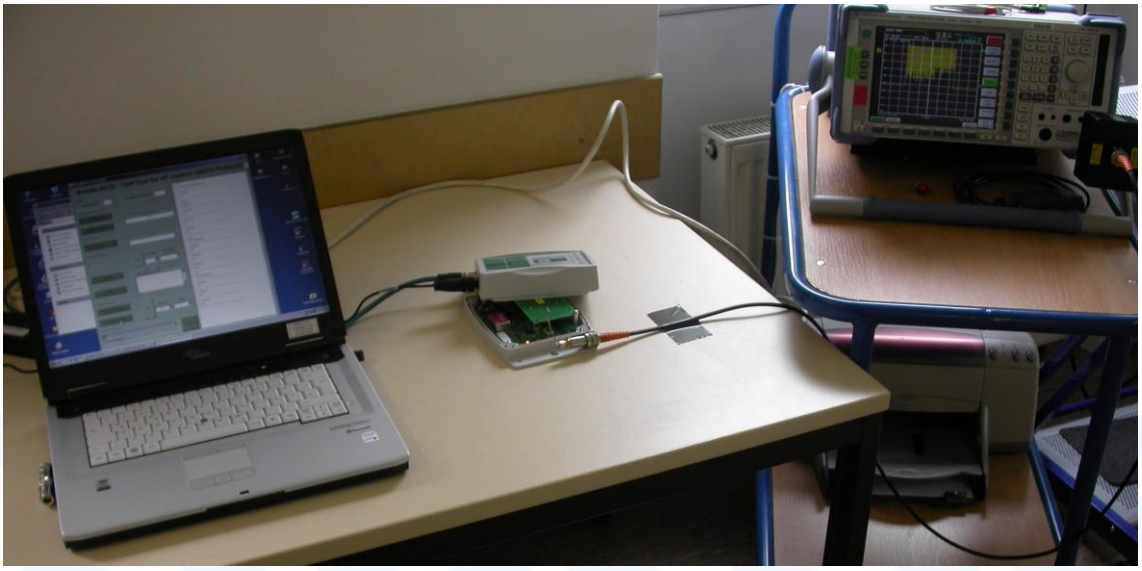
5.11 Quantity of hopping channels

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

5.11.1 Description of the test location

Test location: Area 4

5.11.2 Photo documentation of the test set-up



5.11.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(1)(i):
For frequency hopping systems operating in the 902-928 MHz band: If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

5.11.4 Description of Measurement

This measurement was done by using a spectrum analyser. The EuT was transmitting at its maximum data rate. The Span of the analyzer was set wide enough to capture the frequency band from 902-928 MHz.

5.11.5 Test result

Hopping channel frequency range	Quantity of hopping channels value	Quantity of hopping channels minimum limit
902-928 MHz	50	50

FCC ID: N5GUF80

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

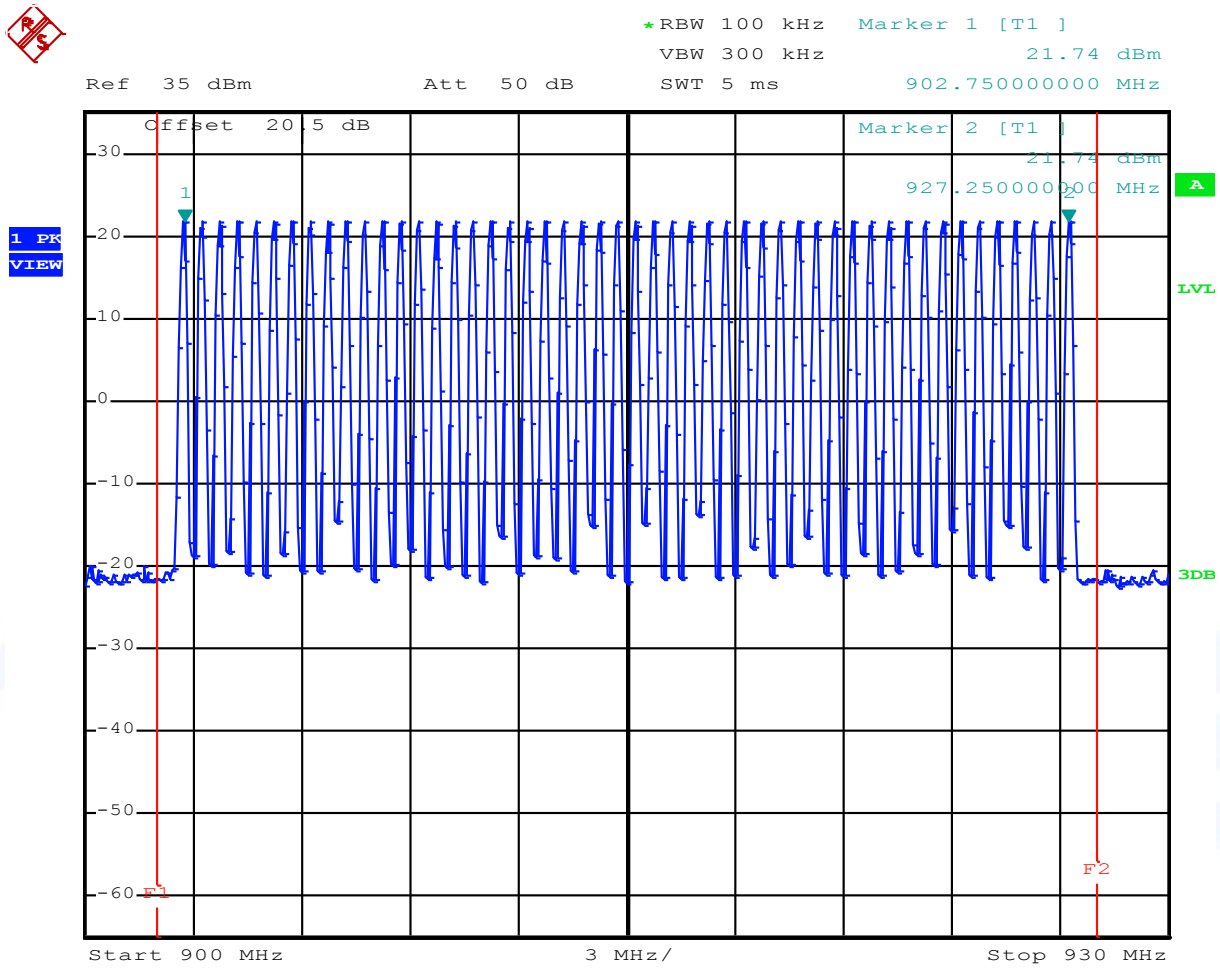
Frequency range (MHz)	LIMIT (Quantity of Hopping Channels)			
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz	20dB Bandwidth < 1 MHz	20dB Bandwidth > 1MHz
902 - 928	**50**	25	---	---

The requirements are **FULFILLED.**

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

5.11.6 Test protocol

Quantity of hopping channel



5.12 Antenna application - Detailed photos see Attachment A

5.12.1 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 internal antenna and no external antenna plugs.

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

5.12.2 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.

5.13 Maximum permissible exposure (MPE) – See Attachment B

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

5.13.1 Description of the test location

Test location: None

5.13.2 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).

5.13.3 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, the MPE can be calculated 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^2)
P_{out} = output power to antenna (mW)
G = gain of antenna (linear scale)
r = distance between antenna and observation point (cm)

Remarks: For detailed test result please refer Attachment B.

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	ESHS 30	02-02/03-05-002	30/06/2012	30/06/2011		
	ESH 2 - Z 5	02-02/20-05-004	12/05/2013	12/05/2011	09/07/2012	09/01/2012
	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			05/10/2012	05/04/2012
	SP 103 /3.5-60	02-02/50-05-182				
CPC 2	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	Inmet 18N50W-20 dB	02-02/50-10-001				
DC	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	Inmet 18N50W-20 dB	02-02/50-10-001				
MB	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	Inmet 18N50W-20 dB	02-02/50-10-001				
SEC 1-3	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	WHJS 1000-10EE	02-02/50-05-070				
	Inmet 18N50W-20 dB	02-02/50-10-001				
SER 1	FMZB 1516	01-02/24-01-018			16/02/2013	16/02/2012
	ESCI	02-02/03-05-005	21/11/2012	21/11/2011		
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 2	ESVS 30	02-02/03-05-006	20/06/2012	20/06/2011		
	VULB 9168	02-02/24-05-005	16/03/2013	16/03/2012	16/09/2012	16/03/2012
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 3	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	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	16/02/2013	16/02/2012		
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				