PHOENIX TESTLAB
Königswinkel 10
32825 Blomberg, Germany
Phone +49 (0) 52 35 95 00-0
Fax +49 (0) 52 35 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F160921E1 2nd Version

Equipment under Test (EUT):

ODIN-W160

Applicant:

u-blox Malmö AB

Manufacturer:

u-blox Malmö AB

ilac-MRA DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15 (June 2015)**, Radio Frequency Devices

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Test engineer:	Paul NEUFELD		25.05.2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		25.05.2016
	Name	Signature	Date

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

This test report is valid in hardcopy form as well as in electronic form.

Contents Page

1 Identification

1.1 Applicant

Name:	u-blox Malmö AB
Address:	Östra Varvsgatan 4, 5 tr, 211 75 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats Andersson
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	u-blox Malmö AB
Address:	Östra Varvsgatan 4, 5 tr, 211 75 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats Andersson
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Applicant represented during the test by the following person:	None

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with DIN EN ISO/IEC 17025 under Reg. No. **< *D-PL-17186-01-02* >**.

1.4 EUT (Equipment Under Test)

Test object: *	WLAN / Bluetooth module
Type: *	ODIN-W160
FCC ID: *	**PVH0953**
IC: *	**5325A-0953**
Serial number: *	WLAN: 29200625921
PCB identifier: *	0953-03
Hardware version: *	HW 3.1
Software version: *	FW 2.0

Channel 149	RX:	5745 MHz	TX:	5745 MHz
Channel 153	RX:	5765 MHz	TX:	5765 MHz
Channel 157	RX:	5785 MHz	TX:	5785 MHz
Channel 161	RX:	5805 MHz	TX:	5805 MHz
Channel 165	RX:	5825 MHz	TX:	5825 MHz

1.5 Technical Data of Equipment

Fulfills WLAN specification: *	IEEE, 802.11b, 802.11g, 802.11n, 802.11a					
Antenna type: *	See Table 1					
Antenna gain: *	See Table 1					
Antenna connector: *	See Table 1					
Power supply - EUT	3.0 – 3.6 VDC					
Power supply Host	U_{nom}=	5 V DC	U_{min}=	3.6 V DC	U_{max}=	6 V DC
Type of modulation: *	802.11a:OFDM 802.11b: CCK, DQPSK, DBPSK 802.11g: OFDM 802.11n: OFDM					
Operating frequency range:*	2412 MHz to 2462 MHz, 5180 MHz to 5240 MHz, 5260 MHz to 5320 MHz, 5500 MHz to 5700 MHz (except 5600 MHz to 5650 MHz) 5745 MHz to 5825 MHz					
Number of channels: *	32					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest Internal clock frequency: *	32768 Hz / 26.000 MHz					

* declared by the applicant.

Table 1 Antenna specifications

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
"InSide-EPA-WLAN"	ProAnt	Patch	circular polarization	3 dBi @ 5 GHz
InSide-WLAN	ProAnt	Patch	dual band 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Ex-IT WLAN - SMA - RP-SMA -MHF	ProAnt	Monopole	dual band SMA RSMA 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
InSide Fold-WLAN	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
InSide-WLAN Square	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz

The following external I/O cables were used:

Identification	Length
DC power cable	2 m *
RS232 cable	2 m *

*: Length during the test if not other specified.

1.6 Dates

Date of receipt of test sample:	09.05.2016
Start of test:	10.05.2016
End of test:	10.05.2016

2 Operational States

The equipment under test (EUT) is a WLAN dual band and Bluetooth dual mode module soldered on to a carrier board. The WLAN / Bluetooth module is equipped with an U.FL. antenna connector.
A RS232 connector and the power supply connector are located at the carrier board.

The tests were carried out with an unmodified sample of the EUT.

The carrier board was connected via a RS232 connection to a laptop computer. With a testsoftware running on the laptop the operation mode as seen in the table below could be chosen.

During the tests, the test samples were powered with 5 V via the power supply connection of the carrier board from a laboratory power supply.

The following operation modes were identified as worst case condition and used during the tests:

Operation mode	Description of the operation mode	WLAN mode	WLAN channel	Modulation	Data rate / Mbps
1	Continuous transmitting on 5745 MHz	a	149	OFDM	6 MBit/s
2	Continuous transmitting on 5785 MHz	a	157	OFDM	6 MBit/s
3	Continuous transmitting on 5825 MHz	a	165	OFDM	6 MBit/s
4	Continuous transmitting on 5745 MHz	n 20 MHz	149	OFDM	6.5 MBit/s
5	Continuous transmitting on 5785 MHz	n 20 MHz	157	OFDM	6.5 MBit/s
6	Continuous transmitting on 5825 MHz	n 20 MHz	165	OFDM	6.5 MBit/s
7	Normal operation Mode with automatic channel selection from Access Points	-	-	OFDM	-

3 Additional Information

The power was set to the values shown in the table below.

Channel	149 - 165
Power a/n20 modes (for 5 GHz)	18.0

This report contains the results of the EUT operating in the UNII3 band only.

The aim of this report is a class 2 permissive change. Only the measurements that were changed from the old UNII rules to the new ones were repeated in this report.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 247 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
Maximum Output Power	5725 - 5850	15.407 (a)	6.2.1 (1)[3] 6.2.2 (1)[3] 6.2.3 (1)[3] 6.2.4 (1)[3]	Passed	10 et seq
UNII Bandwidth	5725 - 5850	15.403 (i)	- - - 6.2.4 (1) [3]	Passed	12 et seq
Peak Power Spectral Density	5725 - 5850	15.407 (a)(5)	6.2.1 (1)[3] 6.2.2 (1)[3] 6.2.3 (1)[3] 6.2.4 (1)[3]	Passed	14 et seq
Frequency Stability	15.407 (g)	15.407 (g)	-	Passed*	16 et seq.
Band edge compliance	5725 - 5850	15.407 (b)	6.2.1 (2)[3] 6.2.2 (2)[3] 6.2.3 (2)[3] 6.2.4 (2)[3]	Passed*[2]	16 et seq.
Radiated emissions (transmitter)	0.009 – 40,000	15.407 (b) 15.205 (a) 15.209 (a)	7.2.2 [4], 6.2.1 (2)[3] 6.2.2 (2)[3] 6.2.3 (2)[3] 6.2.4 (2)[3]	Passed*	19 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [4]	Passed*	19 et seq.

* Not performed See report F136117E2
*[2] Passed with spectrum mask criteria

5 Results

5.1 Duty cycle

The EUT was transmitting with a duty cycle higher than 99.9 % duty cycle, therefore no duty cycle measurements and duty cycle related reductions needed to be performed for the following test cases.

5.2 Maximum conducted output power

5.2.1 Method of measurement

The EUT has to be connected to the power meter via a low loss cable.

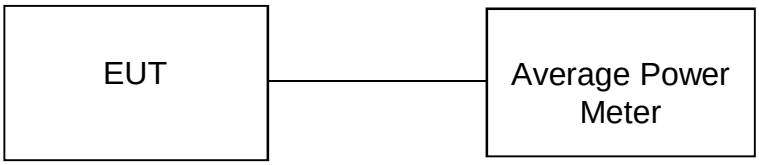
Acceptable measurement configurations

The measurement procedures described herein are based on the use of an antenna-port conducted test configuration.

“Measurement using a power meter (PM)” was used for this test. The procedure is described in chapter 12.3.3.1 of document [1].

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band.

Test set-up:



5.2.2 Test results

Ambient temperature	22 °C	Relative humidity	62 %

The highest antenna gain is 3 dBi. Therefore no reduction of the power limit is necessary.

Operation Mode	Antenna gain combined [dBi]	Maximum average output power [dBm]	Margin [dB]	Average power limit [dBm]
1	3	15.7	14.3	30
2	3	15.3	14.7	30
3	3	14.9	15.1	30
4	3	15.5	14.5	30
5	3	15.2	14.8	30
6	3	14.9	15.1	30
Measurement uncertainty		+0.66 dB / -0.72 dB		

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

60, 61

5.3 UNII Bandwidth

5.3.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 12.4.1 of document [1].

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- Measure the maximum width of the emission that is 26 dB or 6 dB down from the peak of the emission. Compare this with the RBW setting of the analyser. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

The measurements were carried out at each antenna port separately.

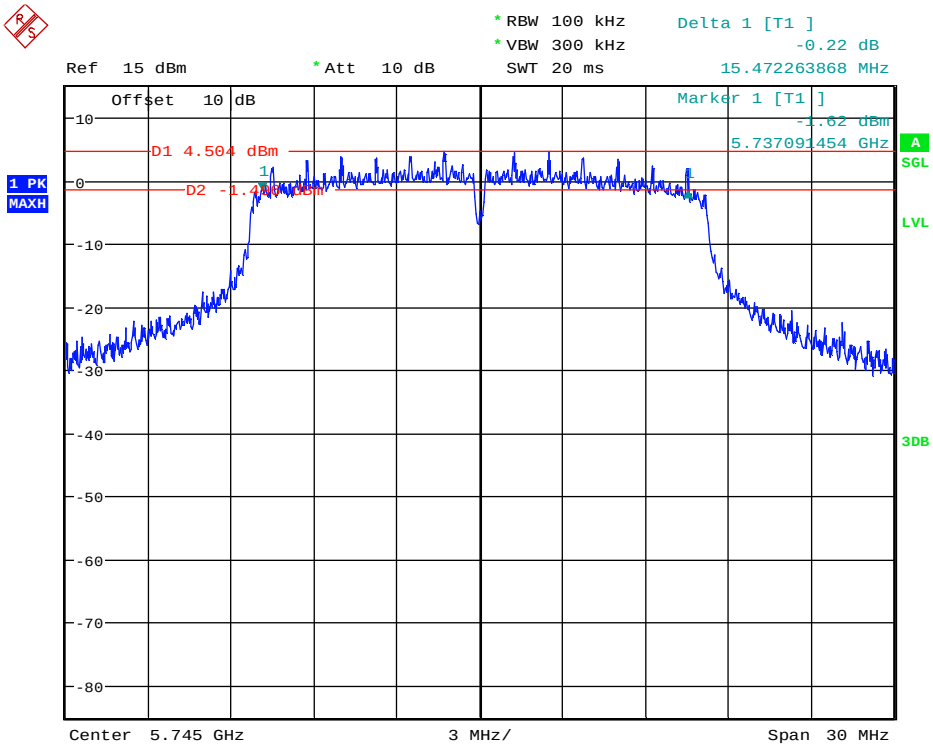
5.3.2 Test results

Ambient temperature	22 °C

Relative humidity	62 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

OdinW160__6dB-BW_a_149.wmf: UNII Bandwidth (operation mode 1):



Operation Mode	Nominal Channel frequency [MHz]	99% Bandwidth [MHz]	6 dB Bandwidth [MHz]	Limit 6 dB Bandwidth [MHz]	Result
1	5745 MHz	18.200	15.472	0.5	Passed
2	5785 MHz	18.150	15.637	0.5	Passed
3	5825 MHz	18.100	15.472	0.5	Passed
4	5745 MHz	19.350	16.162	0.5	Passed
5	5785 MHz	19.100	15.637	0.5	Passed
6	5825 MHz	19.100	15.472	0.5	Passed
Measurement uncertainty		+0.66 dB / -0.72 dB			

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.4 Peak Power Spectral Density

5.4.1 Method of measurement

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly connected to a spectrum analyser. The measurement procedure refers to part 12.5 of document [1].

Method SA-2 was used for this measurement.

- Measure the duty cycle D of the transmitter output signal as described in 12.2.
- Set span to encompass the entire 26 dB EBW or 99% OBW of the signal.
- Set RBW = 1 MHz.
- Set VBW ≥ 3 MHz.
- Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.Do not use sweep triggering. Allow the sweep to “free run.”
- Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the ON and OFF periods of the transmitter.
- Use the peak search function on the instrument to find the peak of the spectrum.
- add [10 log (1 / D)], where D is the duty cycle, to the peak of the spectrum.
- The result is the PPSD.

The measurements were carried out at each antenna port separately.

5.4.2 Test result

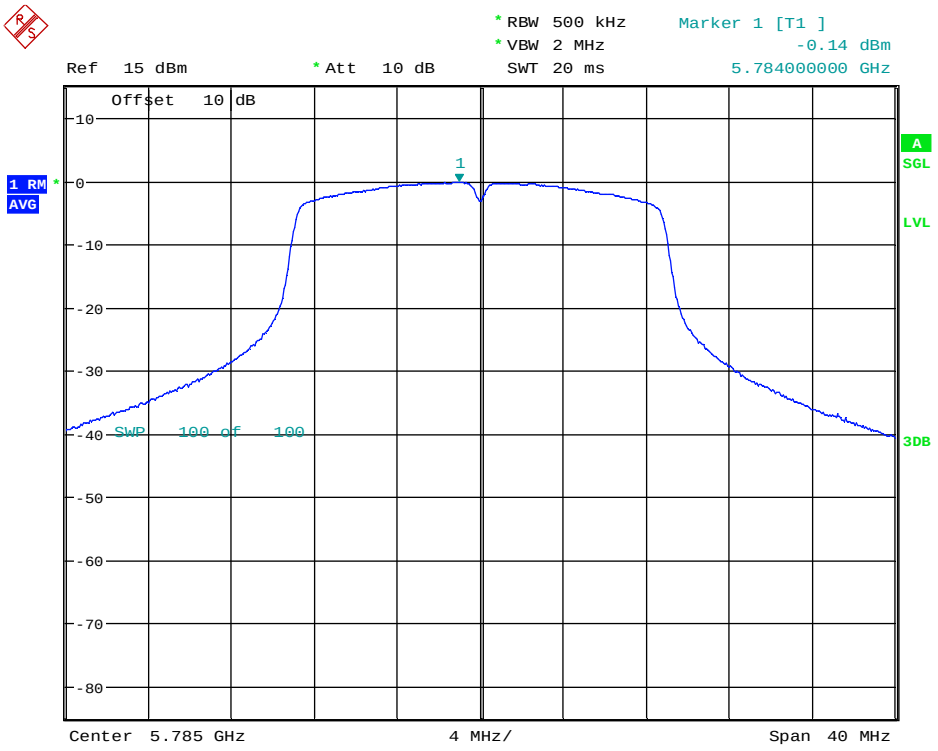
Ambient temperature	22 °C

Relative humidity	59 %

The following results were measured at the antenna port of the EUT. The plot shows an exemplary measurement result for the worst documented case. The other results are listed in the following table.

The highest antenna gain is 3 dBi. Therefore no reduction of the Peak power limit is necessary.

OdinW160_PeakPwrSpecDens_n20_157.wmf: Power Spectral Density (operation mode 5):



Operation Mode	Nominal Channel frequency [MHz]	Peak Frequency [MHz]	Power Spectral Density Limit [dBm / 500 kHz]	Peak Power Spectral Density Level [dBm / 500 kHz]	Margin [dB]	Result
1	5745 MHz	5743.770	30	0.7	29.3	Passed
2	5785 MHz	5783.980	30	0.1	29.9	Passed
3	5825 MHz	5823.650	30	-0.6	30.6	Passed
4	5745 MHz	5744.080	30	0.3	29.7	Passed
5	5785 MHz	5783.840	30	1.6	28.4	Passed
6	5825 MHz	5823.840	30	1.2	28.8	Passed

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

30

5.5 Frequency Stability

The frequency stability was already performed in the test report F136117E2 by PHOENIX TESTLAB GmbH. The test procedures did not change compared to the new procedures, therefore these tests were not repeated in this report.

5.6 Band-edge compliance

In the original report (F136117E2 by PHOENIX TESTLAB GmbH), there were not found any emissions at the band edges during the radiated measurements, therefore these measurements don't need to be repeated in this report.

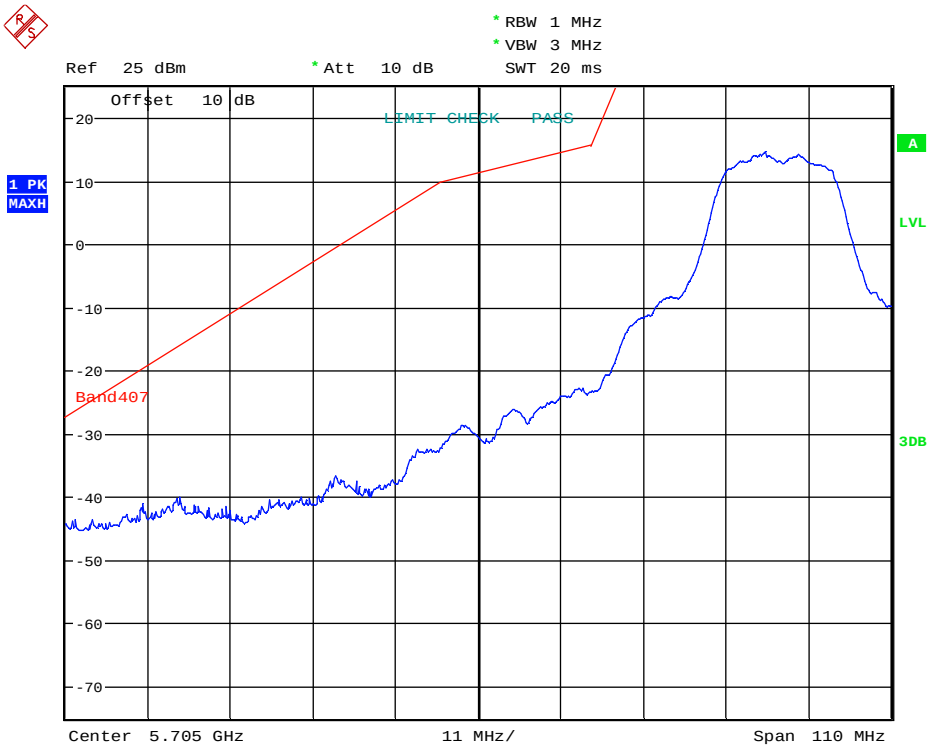
5.6.1 Method of measurement (band edges next to unrestricted bands (conducted))

The tests were performed, following the presentation U-NII DFS Bin 5 Test Frequencies and Memorandum Opinion & Order (FCC 16-24) U-NII-3 Band" at the 2016/04 TCB Council Workshop. Pages 9 & 10 of this presentation define a limit line for the band-edge limits for the UNII-3 band.

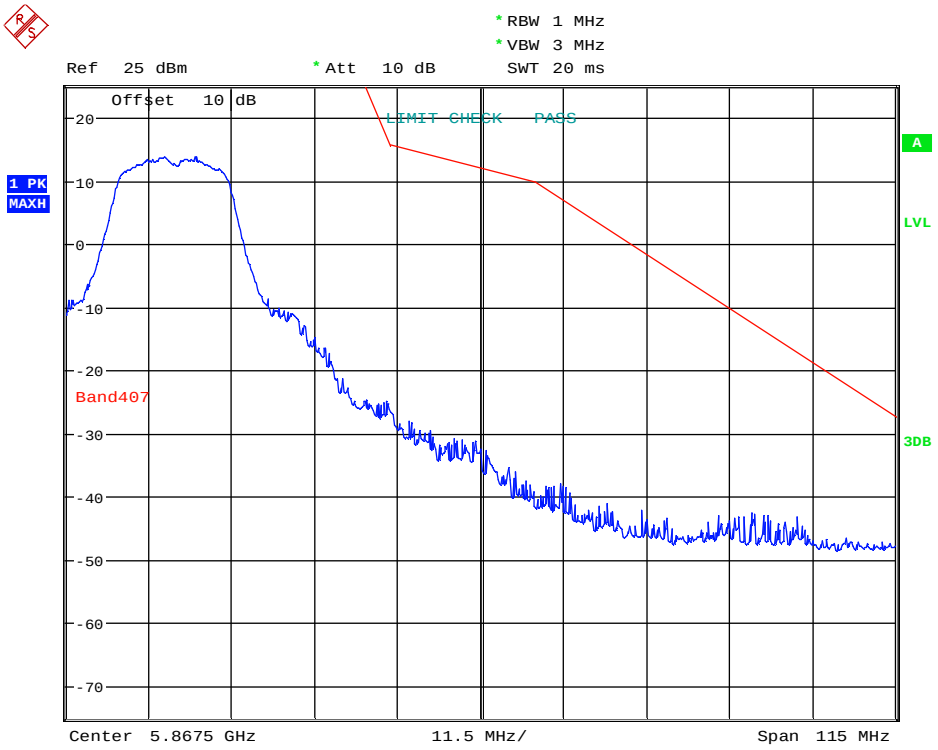
The tests were performed as conducted measurement. The successful limit check shows, that the limit line was not violated by the observed signal.

5.6.2 Test results

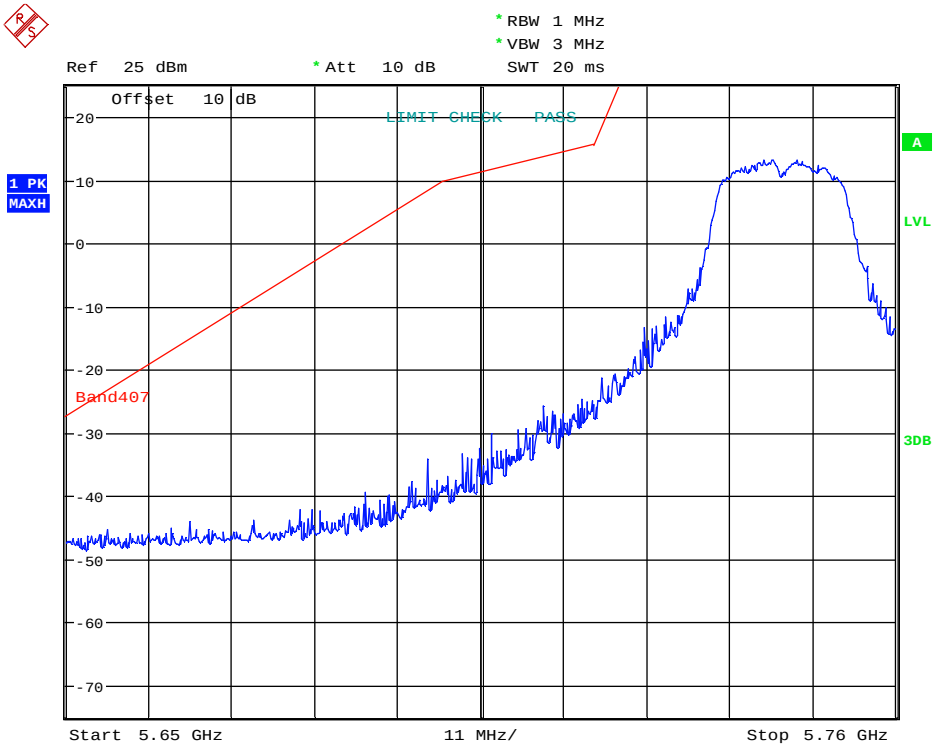
OdinW160_BandEdge__a_149.wmf: conducted band-edge compliance (operation mode 1)



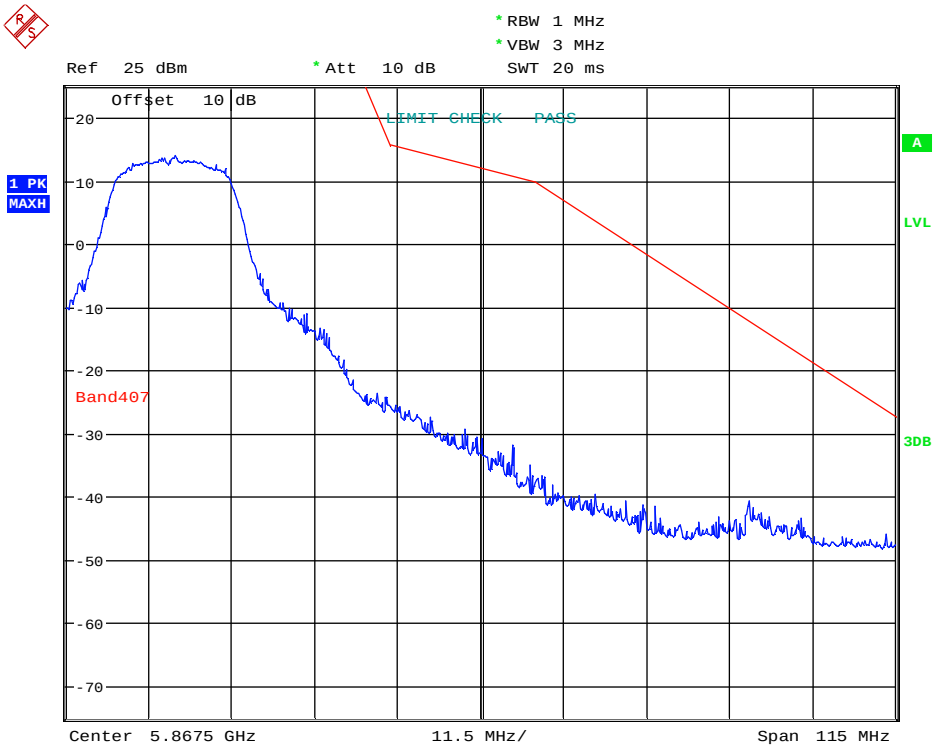
OdinW160_BandEdge__a_165.wmf: conducted band-edge compliance (operation mode 2)



OdinW160_BandEdge__n20_149.wmf: conducted band-edge compliance (operation mode 4)



OdinW160_BandEdge__n20_165.wmf: conducted band-edge compliance (operation mode 6)



TEST EQUIPMENT USED FOR THE TEST:M20

30

5.7 Maximum unwanted emissions

The procedure for the maximum emissions did not change compared to the one already performed in the test report F136117E2 by PHOENIX TESTLAB GmbH, therefore these tests are not repeated in this report.

5.8 Conducted emissions on power supply lines (150 kHz to 30 MHz)

Since the measurement procedures for conducted emission on power supply lines were not changed when comparing the old ANSI 63.4 2009 and the recent ANSI 63.10-2013, these measurements were not repeated in this test report.

6 Test equipment and ancillaries used for test

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
30	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	17.02.2016	17.02.2017
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	16.04.2016	16.04.2017
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
36	Antenna	3115 A	EMCO	9609-4918	480183	10.11.2014	10.11.2016
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
40	Standard Gain Horn Antenne 26.4 – 40.1 GHz	22240-20	Flann Microwave	469	480299	Six month verification (system cal.)	
41	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
42	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
46	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire	-	480302	Six month verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	18.02.2016	18.02.2018
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	18.02.2016	18.02.2018
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	17.02.2016	17.02.2018
60	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	18.02.2016	18.02.2018
61	Thermal Power Sensor	NRV-Z51	Rohde & Schwarz	825948/004	480247	18.02.2016	18.02.2018
72	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	
80	High-pass Filter	H26G40G1	Microwave Circuits, Inc.	33471	480593	Six month verification (system cal.)	

7 Report History

Report Number	Date	Comment
F160912E1	20.05.2016	Initial Test Report
F160912E1 2nd Version	25.05.2016	Retest Power Settings with RMS sensor

8 List of Annexes

ANNEX A	TEST SETUP PHOTOS	1 page
160912_1.jpg	Test setup - conducted tests	
ANNEX B	EXTERNAL PHOTOS	2 pages
160912_2.jpg	EUT + test PCB – top view	
160912_3.jpg	EUT + test PCB – bottom view	
ANNEX C	INTERNAL PHOTOS	3 pages
160912_4.jpg	EUT – Top View with shielding	
160912_5.jpg	EUT – bottom view	
160912_6.jpg	EUT – Top View without shielding	