FCC Measurement/Technical Report on

WLAN and Bluetooth module JODY-W164-04A

FCC ID: XPYJODYW164-07A
IC: 8595A-JODYW16407A

Test Report Reference: MDE_UBLOX_1828_FCCa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-17 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz

Note 1: (DTS Equipment)
The tests were selected and performed with reference to the FCC Public Notice "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 15.247 Meas Guidance v05, 2018-08-24". ANSI C63.10–2013 is applied.

Note 2:
Not all possible operating modes were tested. Worst case operating modes were determined at the beginning of the test period.

Note 3:
Bluetooth LE mode like Bluetooth BDR uses GFSK modulation while Bluetooth BDR uses a higher output power. Therefore Bluetooth BDR mode worst case for "Transmitter spurious radiated emissions" and "Band Edge Compliance Radiated" and covers also Bluetooth LE mode.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 1.3 Measurement Summary / Signatures.

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for DTS (e.g. WLAN 2.4 GHz, BT LE) equipment from FCC and IC

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-247 Issue 2: 5.2 (a)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-247 Issue 2: 5.4 (d)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5
Band edge compliance	§ 15.247 (d)	RSS-247 Issue 2: 5.5
Power density	§ 15.247 (e)	RSS-247 Issue 2: 5.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 5: 8.3
Receiver spurious emissions	–	–

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 Subpart C §15.247 **§ 15.247 (d)**

Restricted Band Band Edge Compliance Conducted
The measurement was performed according to ANSI C63.10

OP-Mode	**Setup**	**Final Result**	
		FCC	**IC**
Radio Technology, Operating Frequency, Band Edge			
Bluetooth BDR, high, high	S01_AA01	Passed	Passed
Bluetooth BDR, low, low	S01_AA01	Passed	Passed
WLAN b, high, high	S01_AA01	Passed	Passed
WLAN b, low, low	S01_AA01	Passed	Passed
WLAN g, high, high	S01_AA01	Passed	Passed
WLAN g, low, low	S01_AA01	Passed	Passed
WLAN n 20 MHz, high, high	S01_AA01	Passed	Passed
WLAN n 20 MHz, low, low	S01_AA01	Passed	Passed

N/A: Not applicable
N/P: Not performed

Another variant of the JODY-W1 family was already tested against the requirements of this standard. This report only covers Band Edge spot checks to show that this variant gives similar results.
Reference to test report of fully tested variant: MDE_UBLOX_1701_FCCa (equivalent variant for WLAN part) and MDE_UBLOX_1701_FCCd (equivalent variant for Bluetooth part)

(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

(responsible for testing and report)
Dipl.-Ing. Daniel Gall

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2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the ISED and accepted under the registration number: Site# 3699A-1.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-00
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2017-07-14

2.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2018-11-30
Testing Period:	2018-10-24 to 2018-11-06

2.3 APPLICANT DATA

Company Name:	u-blox AG
Address:	Zürcherstrasse 68 8800 Thalwil Switzerland
Contact Person:	Mr. Filip Kruzela

2.4 MANUFACTURER DATA

Company Name:	Please see applicant data

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	The EUT is a module supporting WLAN in the 2.4 GHz and 5 GHz bands as well as Bluetooth (BT) 4.2 including Bluetooth Low Energy (BT LE)
Product name	JODY-W164-04A
Type	JODY-W164-04A
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	3.3 V
Tested Modulation Types and Data Rates	BT: GFSK Modulation, DHx packets, 1 Mbps WLAN: Mode b: DSSS Modulation, 1Mbps Mode g/n: OFDM Modulation, 6Mbps / MCS 0 (20 MHz only)
Specific product description for the EUT	The JODY-W1 is a compact automotive grade module that provides Wi-Fi, Bluetooth, and Bluetooth low energy communication. The JODY-W164-04A module can be operated in the following modes: Wi-Fi (SISO) 802.11ac in 2.4 / 5 GHz real simultaneous dual band Dual-mode Bluetooth v4.2, can be operated fully simultaneous with both Wi-Fi modes It is equipped with two antenna pins connected to two SMA antenna connectors on the evaluation board. Maximum supported bandwidth in 2.4 GHz WLAN mode: 20 MHz, 5 GHz WLAN mode: 80 MHz
The EUT provides the following ports:	DC Power Supply Antenna ports Signal ports
Special software used for testing	The test modes were set using scripts that were run on a board computer with Linux operating system provided by the applicant.

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

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3.2 EUT MAIN COMPONENTS

Sample Name	**Sample Code**	**Description**
EUT A	DE1015103aa01	Module on evaluation board
Sample Parameter	**Value**	
Integral Antenna	None, two external 50 Ohm connectors on evaluation board. Antenna gain used for evaluation of test results: 2dBi	
Serial No.	C69D4CA6ED133D40100	
HW Version	00	
SW Version	P8.1	
Comment		

NOTE:The short description is used to simplify the identification of the EUT in this test report.

3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
Evaluation Board	UBLOX, REV. B, - , -	Board the EUT is mounted to, providing ports to the EUT (DC, Antennas, wired communication)

3.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	**Details (Manufacturer, HW, SW, S/N)**	**Description**
Board Computer	Toradex, Ixora, - , -, -	Computer used for setting the test modes

3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	**Combination of EUTs**	**Description and Rationale**
S01_AA01	EUT A, Evaluation Board, Board Computer	Representative setup conducted tests

3.6 OPERATING MODES

This chapter describes the operating modes of the EUTs used for testing.

3.6.1 TEST CHANNELS

	2.4 GHz ISM 2400 - 2483.5 MHz		
WLAN			
20 MHz Test Channels:	**Low**	**mid**	**High**
Channel:	1	-	11
Frequency [MHz]	2412	-	2462

	2.4 GHz ISM 2400 - 2483.5 MHz		
BT Test Channels:	**low**	**mid**	**high**
Channel:	0	-	78
Frequency [MHz]	2402	-	2480

1) Since in WLAN mode g and n the lowest and highest channels have lower output power than the other channels, additional testing was performed for the second lowest and highest channels in those modes.

Output power per channel and mode to be set in EUT WLAN script acc. to customer declaration:

Channel No.	1	2	3	4	5	6	7	8	9	10	11
Channel freq. [MHz]	2412	2417	2422	2427	2432	2437	2442	2447	2452	2457	2462
WLAN mode b	18	18	18	18	18	18	18	18	18	18	18
WLAN mode g	13	15	15	15	15	15	15	15	15	15	13
WLAN mode n	13	15	15	15	15	15	15	15	15	15	13

3.7 PRODUCT LABELLING

3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

4.1.1 TEST DESCRIPTION

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room.
The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Band Edge at restricted bands:

For the conducted emissions in restricted bands the Value is measured in dBm and then converted to dBµV/m as given in KDB 558074:

1. Measure the conducted output power in dBm.
2. Add the maximum antenna gain in dBi
3. Add the appropriate ground reflection factor
   6 dB for frequencies ≤ 30 MHz;
   4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and
   0 dB for frequencies > 1000 MHz).
4. Convert the resultant EIRP level to an equivalent electric field strength level using the following relationship:
   E = EIRP – 20 log D + 104.8
   Where E is the electric field strength in dBµV/m,
   EIRP is the equivalent isotropically radiated power in dBm
   D is the specified measurement distance in m

Value [dBµV/m] = Measured value [dBm] + Maximum Antenna Gain [dBi] + Ground reflection factor – 20 log D + 104.8

4.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

4.1.3 TEST PROTOCOL

Ambient temperature: 23 °C
Air Pressure: 1012 hPa
Humidity: 41 %

In Restricted Bands:

BT GFSK (1-DH1)

Channel Center Frequency [MHz]	Measured freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Spurious Level converted [dBµV/m]	Limit [dBm]	Margin to Limit [dB]
2402	2389.3	2390.0	-55.6	PEAK	1000	41.6	54 [1)]	12.4
2480	2483.8	2483.5	-44.7	PEAK	1000	52.5	54 [1)]	1.5

WLAN b-Mode; 20 MHz; 1 Mbit/s

Channel Center Frequency [MHz]	Measured freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Spurious Level converted [dBµV/m]	Limit [dBm]	Margin to Limit [dB]
2412	2386.1	2390.0	-38.7	PEAK	1000	58.5	74	15.5
2412	2387.4	2390.0	-47.5	RMS	1000	49.7	54	4.3
2462	2488.0	2483.5	-39.1	PEAK	1000	58.1	74	15.9
2462	2486.2	2483.5	-47.7	RMS	1000	49.5	54	4.5

WLAN g-Mode; 20 MHz; 6 Mbit/s

Channel Center Frequency [MHz]	Measured freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Spurious Level converted [dBµV/m]	Limit [dBm]	Margin to Limit [dB]
2412	2389.4	2390.0	-31.4	PEAK	1000	65.8	74	8.2
2412	2390.0	2390.0	-45.6	RMS	1000	51.6	54	2.4
2462	2484.5	2483.5	-36.6	PEAK	1000	60.6	74	13.4
2462	2483.5	2483.5	-47.1	RMS	1000	50.1	54	3.9

WLAN n-Mode; 20 MHz; 6,5 Mbit/s MCS0

Channel Center Frequency [MHz]	Measured freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Spurious Level converted [dBµV/m]	Limit [dBm]	Margin to Limit [dB]
2412	2389.9	2390.0	-32.3	PEAK	1000	64.9	74	9.1
2412	2390.0	2390.0	-44.6	RMS	1000	52.6	54	1.4
2462	2483.6	2483.5	-35.3	PEAK	1000	61.9	74	12.1
2462	2483.5	2483.5	-46.6	RMS	1000	50.6	54	3.4

1) Peak value below Average limit, no final measurement with average detector performed

Comparison between result of full testing and spot check:

Bluetooth:

BT GFSK (1-DH1)

Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level JODY-W164-04A [dBm]	Spurious Level JODY-W164-07A [dBm]	Deviation [dB]
2402	2390.0	-55.6	-54.2	-1.4
2480	2483.5	-44.7	-45.7	1.0

WLAN:

WLAN b-Mode; 20 MHz; 1 Mbit/s

Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level JODY-W164-04A [dBm]	Spurious Level JODY-W164-07A [dBm]	Deviation [dB]
2412	2390.0	-38.7	-39.9	1.2
2412	2390.0	-47.5	-47.6	0.1
2462	2483.5	-39.1	-41.1	2.0
2462	2483.5	-47.7	-50.3	2.6

WLAN g-Mode; 20 MHz; 6 Mbit/s

Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level JODY-W164-04A [dBm]	Spurious Level JODY-W164-07A [dBm]	Deviation [dB]
2412	2390.0	-31.4	-35.2	3.8
2412	2390.0	-45.6	-47.0	1.4
2462	2483.5	-36.6	-35.7	-0.9
2462	2483.5	-47.1	-47.8	0.7

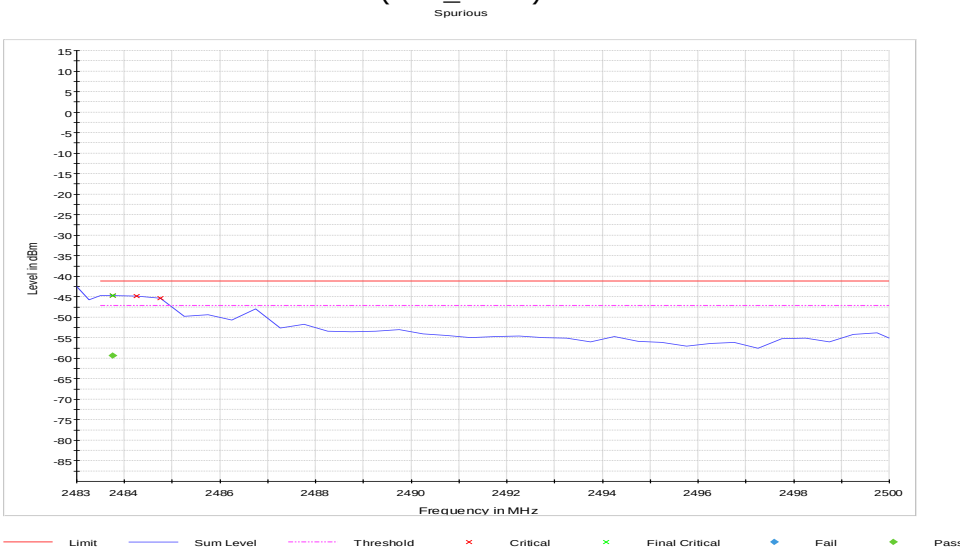
WLAN n-Mode; 20 MHz; 6,5 Mbit/s MCS0

Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level JODY-W164-04A [dBm]	Spurious Level JODY-W164-07A [dBm]	Deviation [dB]
2412	2390.0	-32.3	-36.7	4.4
2412	2390.0	-44.6	-46.7	2.1
2462	2483.5	-35.3	-36.4	1.1
2462	2483.5	-46.6	-47.1	0.5

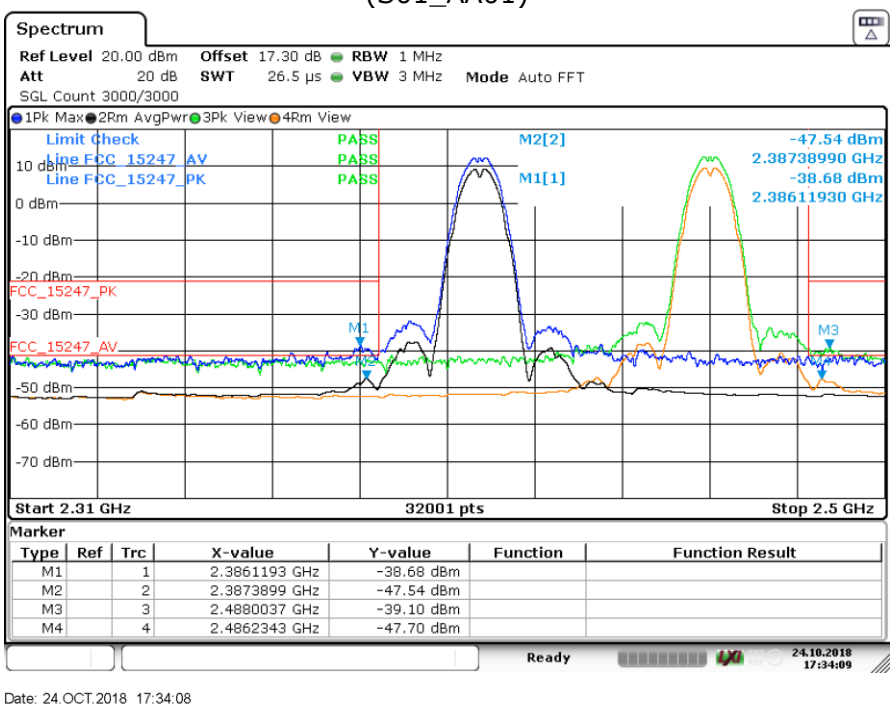
4.1.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

In Restricted Bands:

Radio Technology = Bluetooth GFSK (1-DH1), Operating Frequency = high, Band Edge = high (S01_AA01)



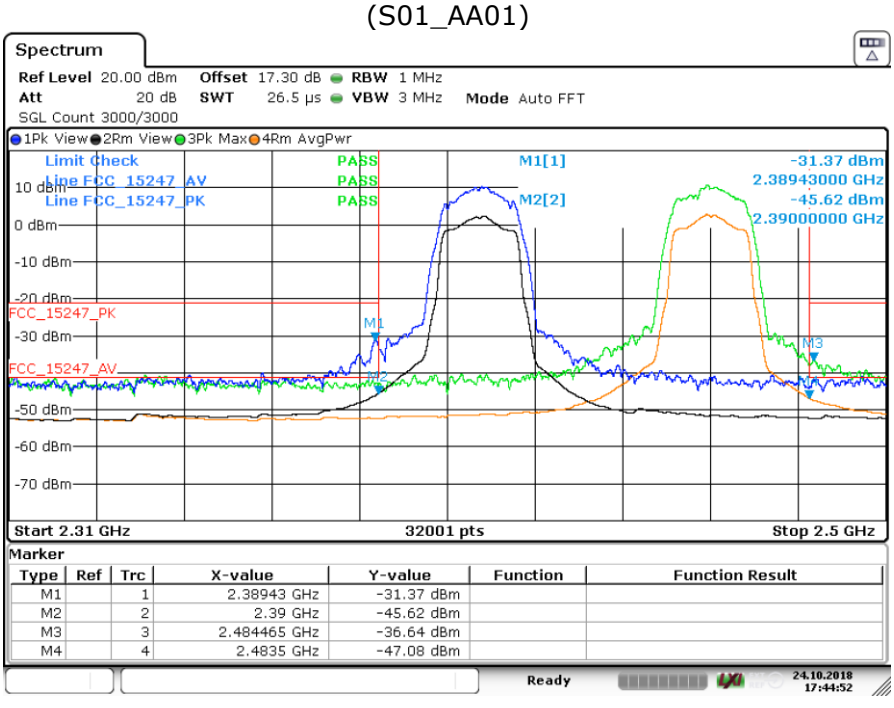
Radio Technology = WLAN b, Operating Frequency = low + high, Band Edge = low + high (S01_AA01)



Date: 24.OCT.2018 17:34:08

TX on 2412 + 2462 MHz

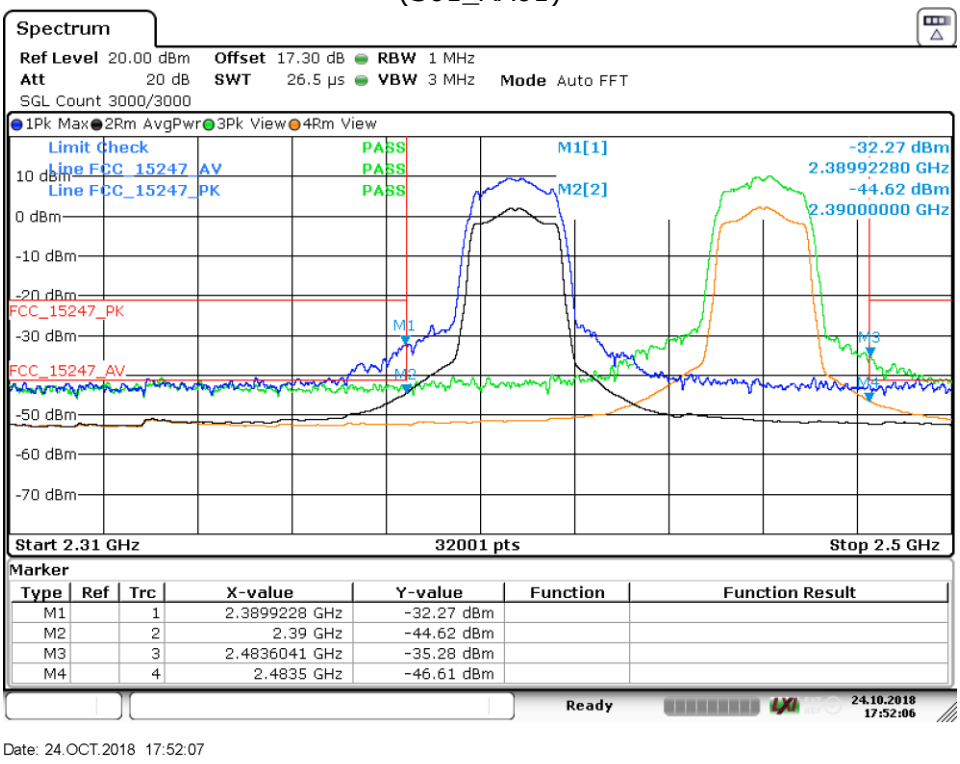
Radio Technology = WLAN g, Operating Frequency = low + high, Band Edge = low + high (S01_AA01)



Date: 24.OCT.2018 17:44:53

TX on 2412 + 2462 MHz

Radio Technology = WLAN n, Operating Frequency = low + high, Band Edge = low + high (S01_AA01)



TX on 2412 + 2462 MHz

4.1.5 TEST EQUIPMENT USED

- R&S TS8997

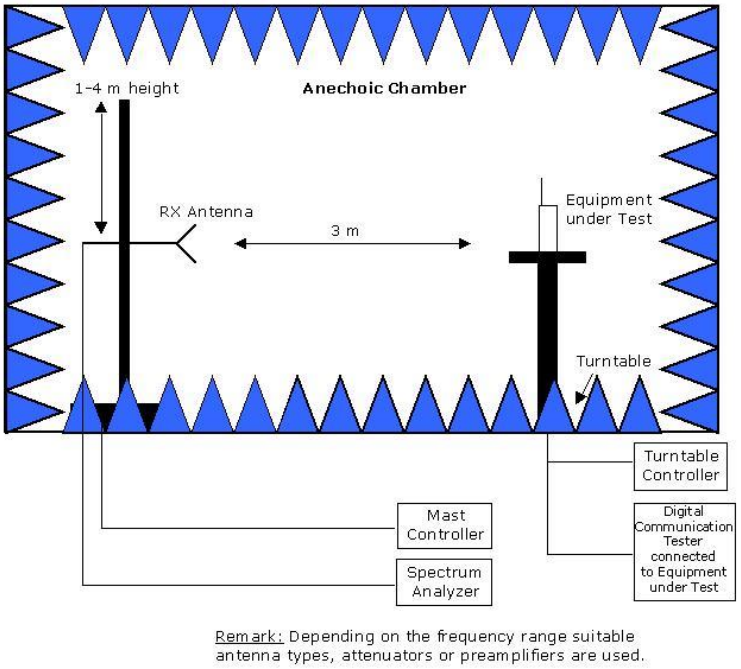
5 TEST EQUIPMENT

1 R&S TS8997
EN300328/301893 Test Lab

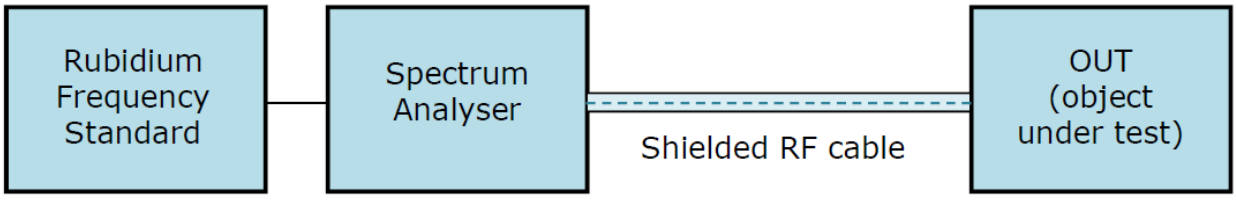
Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
1.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2018-07	2019-07
1.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
1.4	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
1.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
1.6	VT 4002	Climatic Chamber	Vötsch	58566002150010	2018-04	2020-04
1.7	A8455-4	4 Way Power Divider (SMA)		-		
1.8	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2017-03	2019-03
1.9	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
1.10	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2018-05	2021-05

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

6 SETUP DRAWINGS



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting groundplane.



Drawing 2: Setup for conducted radio tests.

7 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

8 PHOTO REPORT

Please see separate photo report.