PHOENIX TESTLAB

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Test Report

- DFS tests only -

Report Number:

F231636E3

Equipment under Test (EUT):

Dual band Wi-Fi 6 / Bluetooth 5.3 low energy module

IRIS-W1

Applicant:

u-blox AG

Manufacturer:

u-blox AG

ilac-MRA

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

[1] **KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02 (April 2016)**
Compliance measurement procedures for Unlicensed - National Information Infrastructure (U-NII) Devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating Dynamic Frequency Selection.

[2] **FCC CFR 47 Part 15**, Radio Frequency Devices

[3] **KDB 905462 D03 Client without DFS New Rules v01r02 (August 2016)**
Client Devices without radar detection capability.

[4] **RSS-247, Issue 3 (2023-08)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[5] **RSS-Gen, Issue 5 (2021-02)** General Requirements for Compliance of Radio Apparatus

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.
“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 1.3 of ANSI C63.10 (2013). However, the measurement uncertainty is calculated and shown in this test report.

Tested and written by:		Paul NEUFELD 10.07.2024
	Signature	
Reviewed and approved by:		Bernward ROHDE 10.07.2024
	Signature	

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.

Contents: Page

1 Identification

1.1 Applicant

Name:	u-blox AG
Address:	Zürcherstrasse 68, 8800 Thalwil
Country:	Switzerland
Name for contact purposes:	Mr. Filip Kruzela
Phone:	+46 733 20 71 70
eMail address:	filip.kruzela@u-blox.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	u-blox AG
Address:	Zürcherstrasse 68, 8800 Thalwil
Country:	Switzerland
Name for contact purposes:	Mr. Filip Kruzela
Phone:	+46 733 20 71 70
eMail address:	filip.kruzela@u-blox.com
Manufacturer 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 (DAkkS) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

EUT	
Test object: *	Dual band Wi-Fi 6 / Bluetooth 5.3 low energy module
Model name: *	IRIS-W1
Model number: *	IRIS-W101-00B IRIS-W106-00B
Order number: *	IRIS-W101-00B IRIS-W106-00B
FCC ID: *	XPYIRISW1
IC certification number: *	8595A-IRISW1
PMN: *	IRIS-W101-00B IRIS-W106-00B
HVIN: *	IRIS-W101-00B IRIS-W106-00B
FVIN: *	922600.0200.000 922700.0200.000
HMN: *	not applicable

	EUT number		
	1* (IRIS-W101-00B)	2	3
Serial number: *	D601E8		-
PCB identifier: *	UBXH60-0001009		-
Hardware version: *	922600.0200.000		-
Software version: *	MFG-RW61X-1.0.0.12.0-18.80.2.p55.1		-

* Declared by the applicant

1 EUT was used for the tests. In the overview (chapter 4) is shown which EUT was used for each test case.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

Power supply EUT / evaluation board: *	DC		
Supply voltage EUT: *	U_{Nom}= 3.3 V_{DC}	U_{Min}= 3.15 V_{DC}	U_{Max}= 3.45 V_{DC}
Supply voltage Evaluation board: *	U_{Nom}= 4.0 V_{DC}	U_{Min}= 5.0 V_{DC}	U_{Max}= 6.0 V_{DC}
Temperature range: *	-40°C to +85°C		
Lowest internal clock / radio radio frequency: *	40 MHz		
Highest internal clock / radio radio frequency: *	5825 MHz		

Ports / Connectors - EUT				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
J41, U.FL Antenna connector (IRIS-W101 only)	EVB-IRIS-W1	SMA 50Ω termination / Spectrum analyzer	120 mm	Yes
-	-	-	-	-

Ports / Connectors Evaluation board				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
J101, USB-C power supply, MCU-link serial interface	USB-C	USB-C (Laptop computer)	1.8 m	No
J98, USB-C power supply, FTDI 4 x serial interface	USB-C	Not connected	NA	No
J72, USB-C power supply, USB OTG (On The Go)	USB-C	Not connected	NA	No
T1, RJ45 connects to RMII Ethernet phy	RJ45	Not connected	NA	No
-	-	-	-	-
-	-	-	-	-

IEEE 802.11 frequencies (5 GHz)	
20 MHz	
Channel 36	5180 MHz
Channel 40	5200 MHz
Channel 44	5220 MHz
Channel 48	5240 MHz
Channel 52	5260 MHz
Channel 48	5280 MHz
Channel 60	5300 MHz
Channel 64	5320 MHz
Channel 100	5500 MHz
Channel 104	5520 MHz
Channel 108	5540 MHz
Channel 112	5560 MHz
Channel 116	5580 MHz
Channel 120*	5600 MHz
Channel 124*	5620 MHz
Channel 128*	5640 MHz
Channel 132	5660 MHz
Channel 136	5680 MHz
Channel 140	5700 MHz
Channel 149	5745 MHz
Channel 153	5765 MHz
Channel 157	5785 MHz
Channel 161	5805 MHz
Channel 165	5825 MHz

* Only passive scanning on these channels

IEEE 802.11 radio mode (5GHz)		
Fulfils radio specification: *	IEEE 802.11 a IEEE 802.11 n (20 MHz) IEEE 802.11 ac (20 MHz) IEEE 802.11 ax (20 MHz)	
Radio IC: *	NXP RW612ET	
Type of modulation: *	IEEE 802.11 a	BPSK, QPSK, 16-QAM, 64-QAM (6/9/12/18/24/36/48/54 Mbit/s)
	IEEE 802.11 n20	BPSK, QPSK, 16-QAM, 64-QAM (up to 72.2 Mbit/s 1 spatial stream) (up to 144.4 Mbit/s 2 spatial stream)
	IEEE 802.11 ac20	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (up to 86.65 Mbit/s 1 spatial stream) (up to 173.3 Mbit/s 2 spatial stream)
Type of modulation: * (cont.)	IEEE 802.11 ax20	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM (up to 143.4 Mbit/s 1 spatial stream) (up to 286.8 Mbit/s 2 spatial stream)
Operating frequency range: *	IEEE 802.11a	5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11n 20 MHz	5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11ac 20 MHz	5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11ax 20 MHz	5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,

* Declared by the applicant

Antenna list			
Antenna type	Antenna name	Antenna gain	Antenna connector
PCB trace*	Abracon	+1.74 dBi (2.4 GHz) / +1.63 dBi (5 GHz)	None
PCB Patch	PRO-IS-432 by Abracon	+0.8 dBi (2.4 GHz), +3.4 dBi (5 GHz)	U.FL
PCB patch	ANTX100P002B24553 by Pulse Electronics / Yageo	+0.7 dBi (2.4 GHz), +1.9 dBi (5 GHz)	U.FL
Monopole (¼ wave)	W1039B030 by Pulse Electronic / Yageo	+1.5 dBi (2.4 GHz), +3.2 dBi (5 GHz)	U.FL
Monopole (½ wave)	GW.59.3153 by taoglas	+2.37 dBi (2.4 GHz), +2.93 dBi (5 GHz)	Reverse Polarity SMA plug*2
Antenna data was declared by the applicant			

* On-board antenna on the IRIS-W106-00B
*2 Inner thread and pin receptacle; Connection only possible with appropriate adapter cable (U.FL to Reverse polarity SMA)

2.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing	
Evaluation board*1	EVB-IRIS-W1
Laptop computer*1	Latitude 7280 by Dell
-	-

*1 Provided by the applicant

Ancillary Equipment	
DFS Master AP	WLAN 1100 by Phoenix Contact GmbH Contains FCC ID: YG3-SXPCEAN2 Contains IC ID: 4720B-SXPCEAN2

2.2 Dates

Date of receipt of test sample:	13.11.2023
Start of test:	18.04.2024
End of test:	18.04.2024

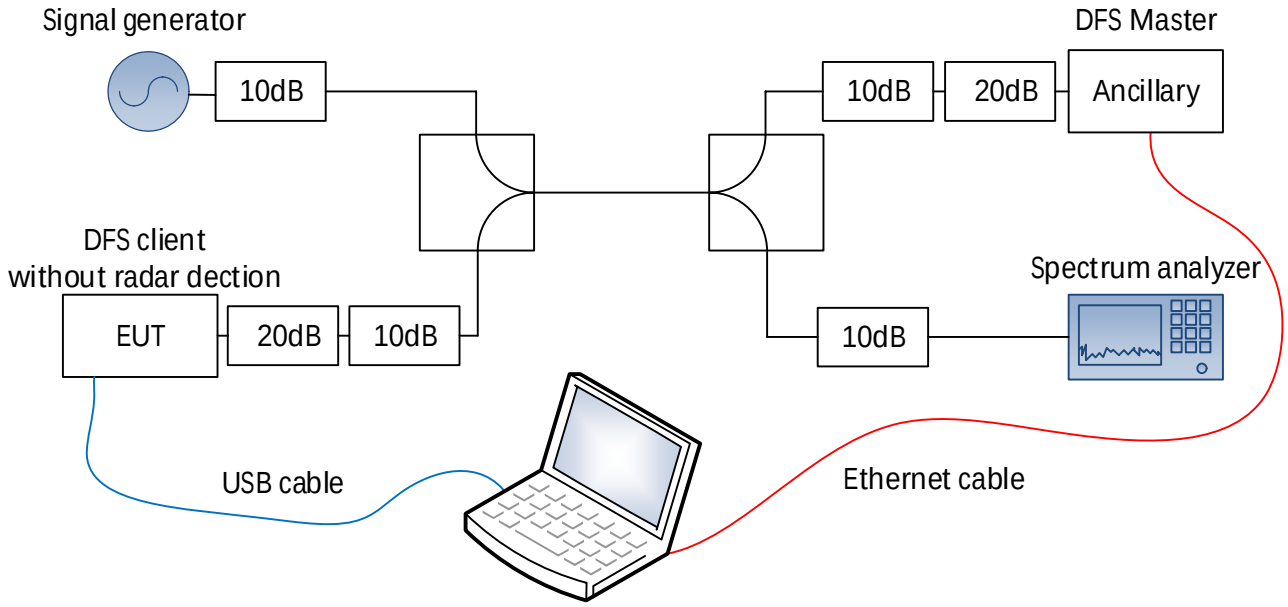
3 Operational States

3.1 Description of function of the EUT

The u-blox IRIS-W1 is a dual-band Wi-Fi 6 (802.11ac/ax/a/b/g/n), Bluetooth Low Energy 5.3 and Thread connectivity module for country specific specifications.

3.2 Test Setup DFS

For the radio tests, the EUT was soldered to an evaluation board. For the tests the EUT operated as a DFS slave without radar detection, which was connected to a DFS master (WLAN 1100 by Phoenix Contact GmbH).
The setup for the DFS tests is depicted below.



For test the EUT (DFS slave) was connected to the test laptop via an USB cable and the Ancillary device (DFS master) was connected to the test laptop via an Ethernet cable.
To create sufficient traffic, the DFS master transmitted an iperf stream to the DFS client.
The command used on the DFS client to set up an iperf server was “iperf -s”.
The command used on the DFS master to set up an iperf client was “iperf-2-2-0-rc-win.exe -c 192.254.2.123 -I 1 -b 10M -t 1000”.

3.3 Power Settings WLAN

Channel	802.11a	802.11n20	11ac20	802.11ax20	802.11ax20 RU Modes
36	16	16	16	16	13
40	17	17	17	17	13
44	17	17	17	17	13
48	17	17	17	17	13
52	17	17	17	17	14
56	17	17	17	17	14
60	17	17	17	17	14
64	16	16	16	16	14
100	13	13	13	13	11
104	16	16	16	16	11
108	17	17	17	17	11
112	17	17	17	17	11
116	17	17	17	17	11
120	17	17	17	17	11
124	17	17	17	17	11
128	17	17	17	17	11
132	17	17	17	17	11
136	17	17	17	17	11
140	17	17	17	17	11
149	17	17	17	17	17
153	17	17	17	17	17
157	17	17	17	17	17
161	17	17	17	17	17
165	17	17	17	17	17

3.4 Additional Information

The EUT was not labeled as required by FCC / IC.
All radiated tests were performed using an unmodified EUT.

4 Overview

Application	Frequency range in MHz	FCC 47 CFR Part 15 section [2]	RSS-247 [5] RSS-Gen [6]	Tested EUT	Status
Dynamic Frequency Selection (DFS)	5250 – 5350 5470 – 5725	15.407 (h) (2)	6.3 [4]	1	Passed

4.1 Test frequencies

One frequency will be chosen from the operating channels of the EUT within the 5250-5350 MHz or 5470-5725 MHz bands.

4.2 Applicability of DFS requirements Prior to Use of a Channel

Requirement	**DFS Operational mode**		
	Master	**Client** (without DFS)	**Client** (with DFS)
Non-Occupancy Period	✓	Not required*	✓
DFS Detection Threshold	✓	Not required	✓
Channel Availability Check Time	✓	Not required	Not required
Uniform Spreading	✓	Not required	Not required
U-NII Detection Bandwidth	✓	Not required	✓

* An analyser plot containing a single 30-minute sweep on the original channel is stipulated by [3].

4.3 Applicability of DFS requirements during normal operation

Requirement	**DFS Operational mode**		
	Master	**Client** (without DFS)	**Client** (with DFS)
DFS Detection Threshold	✓	Not required	✓
Channel Closing Transmission Time	✓	✓	✓
Channel Move Time	✓	✓	✓
U-NII Detection Bandwidth	✓	Not required	✓

4.4 DFS detection thresholds for master devices and client devices with radar detection

Maximum transmit power	Value (see Notes 1 and 2)
≥ 200 mW (23 dBm)	-64 dBm
< 200 mW (23 dBm)	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

4.5 4.5 DFS response requirement values

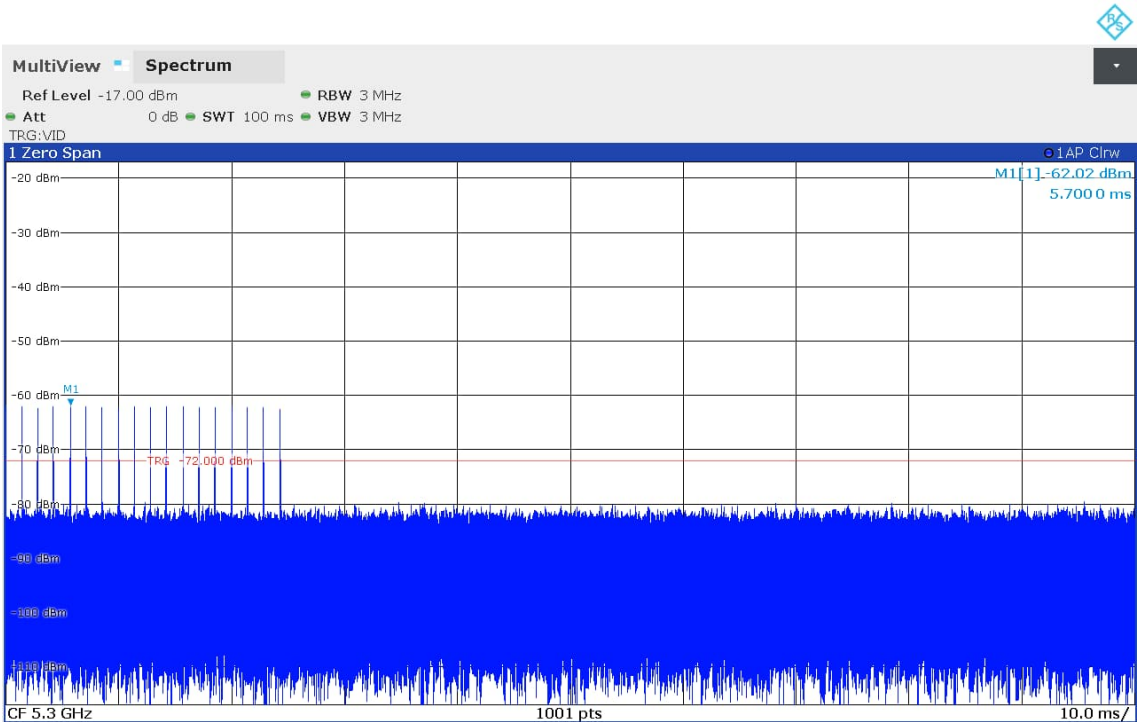
Parameter	Value
Non-Occupancy Period	Minimum 30 minutes
Channel Availability Check Time	60 s
Channel Move Time	10 s See Note 1
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 s period See Notes 1 and 2
Note 1: The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows: • For the Short Pulse Radar Test Signals this instant is the end of the *Burst*. • For the Frequency Hopping radar Test Signal, this instant is the end of the last radar *Burst* generated. • For the Long Pulse Radar Test Signal this instant is the end of the 12 second period defining the *Radar Waveform*. **Note 2:** The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required to facilitate a *Channel* move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

4.6 Radar test waveforms

Short pulse radar test waveform used for the tests:

Radar type	Pulse width [µs]	Pulse repetition interval [µs]	Number of pulses
0	1	1428	18

Radar test signal 0 at 5.3 GHz (detection threshold calibration plot)

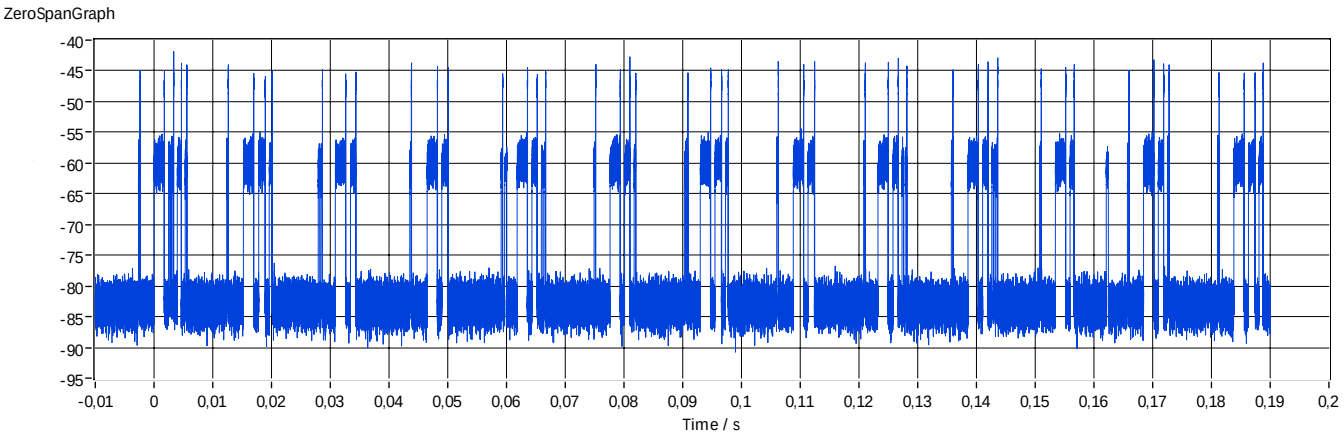


4.7 Channel loading

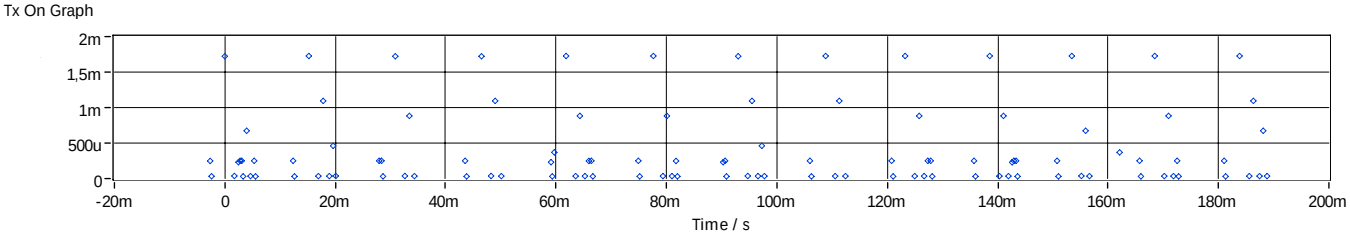
System testing will be performed with channel-loading using means appropriate to the data types that are used by the unlicensed device. The following requirements apply:

a) The data file must be of a type that is typical for the device (i.e., MPEG-2, MPEG-4, WAV, MP3, MP4, AVI, etc.) and must generally be transmitting in a streaming mode.
b) Software to ping the client is permitted to simulate data transfer but must have random ping intervals.
c) Timing plots are required with calculations demonstrating a minimum channel loading of approximately 17% or greater. For example, channel loading can be estimated by setting the spectrum analyzer for zero span and approximate the Time On / (Time On + Off Time). This can be done with any appropriate channel BW and modulation type.
d) Unicast or Multicast protocols are preferable but other protocols may be used. The appropriate protocol used must be described in the test procedures.

Channel load at 5.3 GHz:



The following shows the distribution of the Tx on times showing the randomness of the transmitted signals



Analyzing the trace using a PC program shows the following results:

- Duty cycle 22.7 % (Limit min. 17%)

5 Results

5.1 Channel Shutdown and Non-Occupancy period

The measurement procedure and limits are described in clause 7.8.3 [1].

Operation mode: EUT is in continuous transmission mode with specified test transmission load generated by specific load data (minimum 17 % channel load) from the master to the slave. After the radar event the master initiates the *Channel Shutdown* process given in the table below:

Channel Shutdown	Channel Closing Transmission Time	200 ms + 60 ms*
	Channel Move Time	10 s
Non-Occupancy period		30 min

* see chapter 4.3, note 2

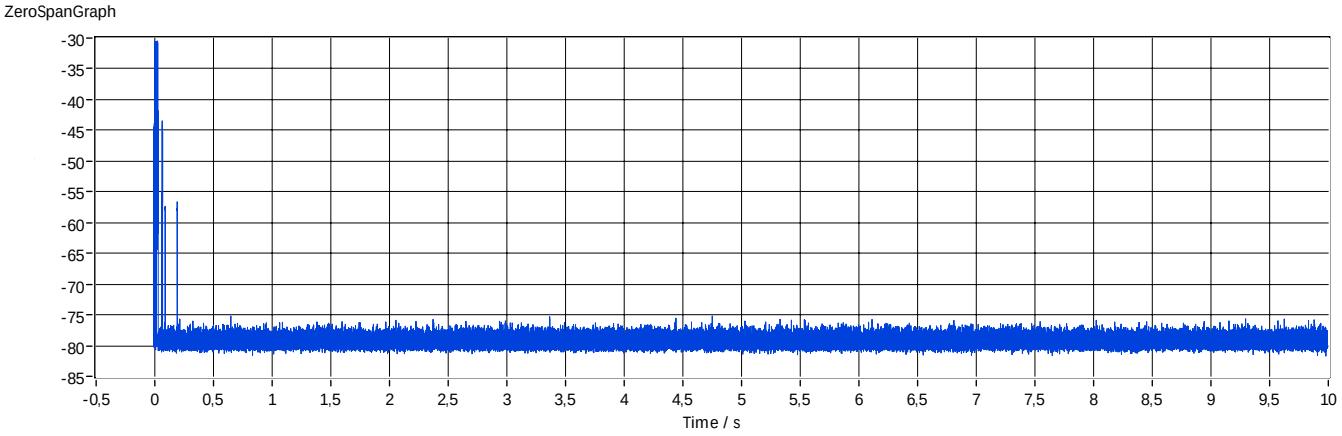
The following table and measurement plots show the results of the *Channel Shutdown*.

Measurement results Channel Shutdown	
Master and slave connected, data traffic active / Radar detection threshold level: -62 dBm	
Radar pulse	Radar type 0
Operating frequency	5 300 MHz
Channel bandwidth	20 MHz
Channel closing time	< 200 ms
Channel move time	< 10 s

Measurement results Non-Occupancy period	
Master and slave connected, data traffic active / Radar detection threshold level: -62 dBm	
Radar pulse	Radar type 0
Operating frequency	5 300 MHz
Non occupancy period	> 30 min
Measurement uncertainty: < 10 %	

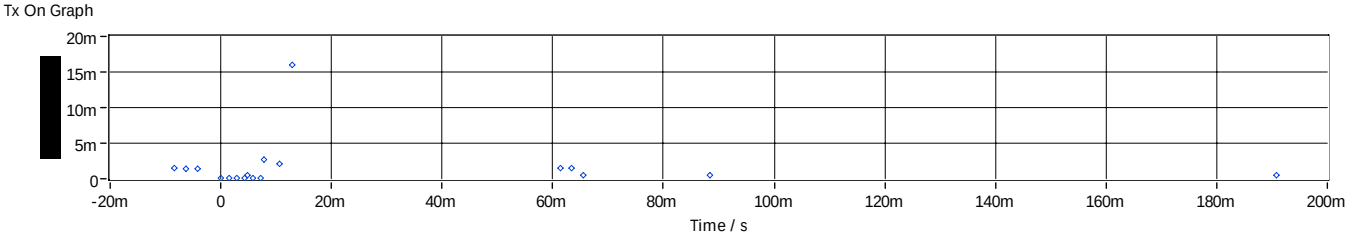
5.2 IRIS-W101 operating on 5300 MHz

Channel closing transmission and channel move time at 5300 MHz:



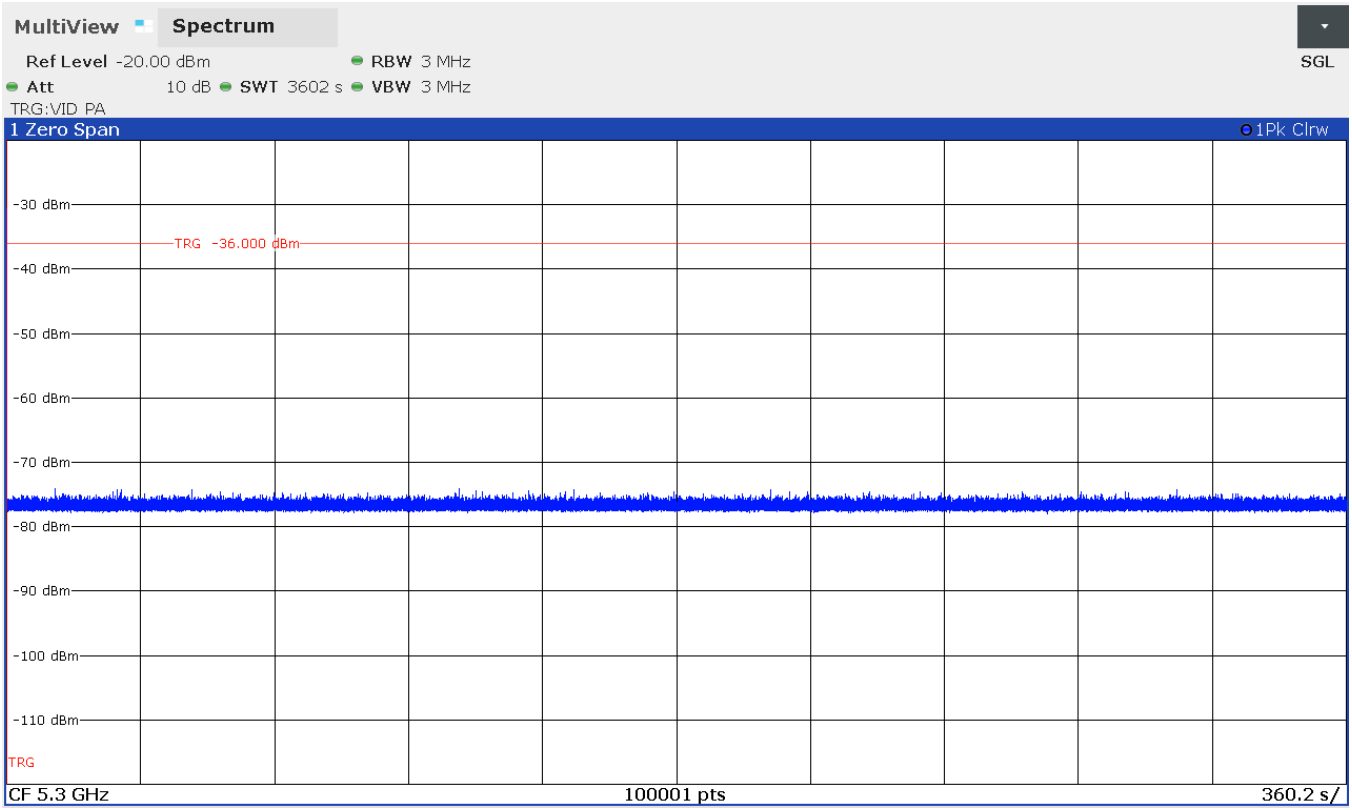
The highest signal in the graph is the DFS signal.
The second highest signal is the EUT signal (DFS slave without radar detection).
The lowest signal is the ancillary device (DFS master).

As seen in the Tx On Graph below no emission occur after 200 ms (whether from the EUT, nor from the Ancillary device). Therefore, the EUT fulfills bot the requirement for the Channel Closing Transmission Time and for the Channel Move Time.



The Tx On Graph shows the bursts with the according tx-on time. Whereby the time for each individual burst is shown on the y-axis and the time of occurrence of each burst is shown by its place on the x axis.

Non occupancy period at 5300 MHz type 0 radar event



Test result: Passed

Test equipment (please refer to chapter 7 for details)
1, 2

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	17.03.2023	03.2025
2	Signal Generator	SMBV100A	Rohde & Schwarz	255092	481326	15.03.2024	03.2026
3	Power divider	ZN2PD2-63-S+	Mini circuits	893300815	482344	Calibration not necessary*	
4	Attenuators	4T-10	Weinschel	-	-	Calibration not necessary*	

* No calibration necessary because all signals and levels were verified using the spectrum analyzer.

7 Report History

Report Number	Date	Comment
F231636E3	10.07.2024	Initial Test Report
-	-	
-	-	-

8 List of Annexes

Annex A Test Setup Photos 5 pages