PHOENIX TESTLAB

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Test Report

- DFS tests only -

Report Number: F136117E13

Applicant:

u-blox Malmö AB

Manufacturer:

u-blox Malmö AB

Equipment under Test (EUT):

ODIN-W160

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

Laboratory accredited by
Deutsche Akkreditierungsstelle GmbH
in compliance with DIN EN ISO/IEC 17025

REFERENCES

[1] **FCC CFR 47 Part 15 (May 2014)** Radio Frequency Devices

[2] **FCC 06/96** Appendix, 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 (DFS).

[3] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[4] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radiocommunication Equipment

[5] **KDB 905462 (January 2014)** Unlicensed Service Rules and Procedures

[6] **KDB 848637 (January 2014)** UNII Client Device without Radar Detection

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:	Manuel BASTERT		27 May 2014
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		27 May 2014
	Name	Signature	Date

RESERVATION

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:

1 Identification

1.1 Applicant

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Name for contact purposes:	Mr. Mats Andersson
Phone:	+ 46 40 63 07 100
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1.2 Manufacturer

Name:	u-blox Malmö AB
Address:	Norra Vallgatan 64 3V, SE-211 22 Malmö
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Name for contact purposes:	Mr. Mats Andersson
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
Mail address:	mats.andersson@u-blox.com

1.3 Test laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under the Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	WLAN module
Type: *	ODIN-W160
FCC ID: *	**PVH0953**
IC: *	**5325A-0953**
Serial number: *	292006259622 (cB-driver) / 292006259618 (TI-driver)
PCB identifier: *	cB-0953-03
Hardware version: *	3.1
Software version: *	u-blox driver version: 4.2.13668 TI driver version: Linux kernel 3.12

* declared by the applicant

1.5 Technical data of equipment

Fulfills WLAN specification: *	IEEE, 802.11b, 802.11g, 802.11n (HT20), 802.11a
Antenna type: *	See Table 1
Antenna gain: *	See Table 1
Antenna connector: *	See Table 1
Power supply Carrier Board	3.6 – 6.0 V DC
Power supply EUT	8 – 12 V DC
Power supply carrier board	8.0 - 12.0 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, 5250 MHz to 5350 MHz, 5470 MHz to 5725 MHz (except 5600 MHz to 5650 MHz)
Temperature range: *	-40 °C to +85 °C
Lowest / highest Internal clock frequency: *	32768 Hz / 26.000 MHz
Number of transmit chains *	One
Number of receive chains *	One
Nominal channel bandwidth*	20 MHz only
DFS Operation mode *	Client without radar detection

* declared by the applicant.

Table 1 Antenna specifications

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
WCR-2400 -IP04 -IP10 -SMA -SMRP	Centurion	Monopole	10cm flying lead U.FL 25cm flying lead U.FL SMA RSMA	2 dBi @ 2.4 GHz
SDM2-2400/1575	Mobile Mark	Patch	flying lead U.FL	2 dBi @ 2.4 GHz
PSTG0-2400HS	Mobile Mark	Monopole	SMA/RSMA	0 dBi @ 2.4 GHz
FlatWhip-2400	ProAnt	Monopole	SMA/RSMA	3 dBi @ 2.4 GHz
“InSide-EPA 2400”	ProAnt	Patch	circular polarization	3 dBi @ 2.4 GHz
“InSide-EPA-WLAN”	ProAnt	Patch	circular polarization	3 dBi @ 5 GHz
InSide-2400	ProAnt	Patch	10cm flying lead U.FL	3 dBi @ 2.4 GHz
InSide-WLAN	ProAnt	Patch	dual band 10cm flying lead U.FL	3 dBi @ 2.4 GHz 3 dBi @ 5 GHz
Outside-2400	ProAnt	Patch	10 cm flying lead U.FL 25 cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -SMA 28-001 -RP-SMA 28-001 - MHF 28-001	ProAnt	Monopole	SMA RSMA 10 cm flying lead U.FL	3 dBi @ 2.4 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
Ex-IT 2400 -MHF 70-001	ProAnt	Monopole	10cm flying lead U.FL	3 dBi @ 2.4 GHz
Ex-IT 2400 -SMA 70-002 -RP-SMA 70-002	ProAnt	Monopole	SMA RSMA	3 dBi @ 2.4 GHz
InSide Fold-2400	ProAnt	Patch	10 cm flying lead U.FL	3 dBi @ 2.4 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

5.15 - 5.25 GHz band (Non-DFS-band)

Channel 36	RX:	5180 MHz	TX:	5180 MHz
Channel 40	RX:	5200 MHz	TX:	5200 MHz
Channel 44	RX:	5220 MHz	TX:	5220 MHz
Channel 48	RX:	5240 MHz	TX:	5240 MHz

5.25 - 5.35 GHz band

Channel 52	RX:	5260 MHz	TX:	5260 MHz
Channel 56	RX:	5280 MHz	TX:	5280 MHz
Channel 60	RX:	5300 MHz	TX:	5300 MHz
Channel 64	RX:	5320 MHz	TX:	5320 MHz

5.47 - 5.725 GHz band

Channel 100	RX:	5500 MHz	TX:	5500 MHz
Channel 104	RX:	5520 MHz	TX:	5520 MHz
Channel 108	RX:	5540 MHz	TX:	5540 MHz
Channel 112	RX:	5560 MHz	TX:	5560 MHz
Channel 116	RX:	5580 MHz	TX:	5580 MHz
Channel 120	RX:	5600 MHz	TX:	5600 MHz
Channel 124	RX:	5620 MHz	TX:	5620 MHz
Channel 128	RX:	5640 MHz	TX:	5640 MHz
Channel 132	RX:	5660 MHz	TX:	5660 MHz
Channel 136	RX:	5680 MHz	TX:	5680 MHz
Channel 140	RX:	5700 MHz	TX:	5700 MHz

The grey-marked channels are not supported by the EUT.

1.6 Ancillary equipment

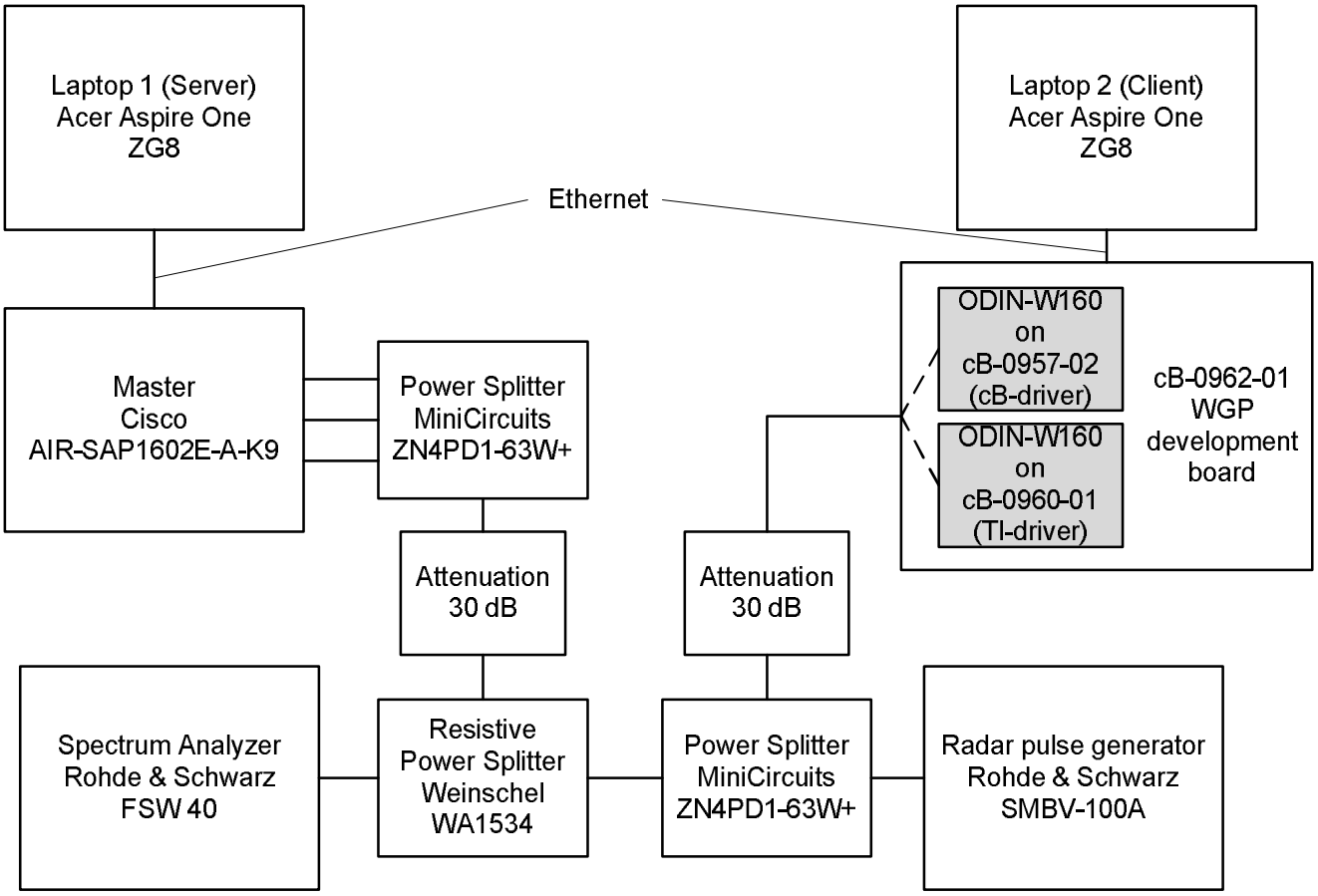
- DFS Master Cisco AIR-SAP1602E-A-K9 (Serial-No.: FGL1739X1LS)
  FCC ID: LDK102084 / IC number: 2461B-102084
- Test laptop 1 Acer Aspire one ZG8 (Serial-No.: LUS750B02191210A782500)
- Test laptop 2 Acer Aspire one ZG8 (Serial-No.: LUS750B021912126EA2500)
- connectBlue carrier board

1.7 Dates

Date of receipt of test sample:	07 April 2014
Start of test:	05 May 2014
Finish of test:	16 May 2014

2 Operational states

The EUT is an industrial Wireless LAN slave device without own radar detection mechanism working in the 5 GHz U-NII band. The measurements were carried out according to setup shown in the drawing below. The traffic was generated using the mandated video streamed from the master to the client device. A Cisco Access Point AIR-SAP1602E-A-9 was used as DFS master. The attenuation of the test system was adjusted to reach the DFS detection threshold of -62 dBm at the antenna ports of the master. The test setup is shown in the following picture.
Two modules with different drivers were investigated, one module with connectBlue driver (cB-driver) mounted on a cB-0957 adapter board and one module with Texas Instruments driver (TI-driver) mounted on a cB-0960 WGP development board. Both variants were mounted on a cB-0962 Wireless Gateway Platform OEM Board, which is a complete self-contained computer running Linux.



3 Additional information

None.

4 Test overview and DFS parameters

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [1]	RSS 210, Issue 8 [3]	Status	Refer page
Dynamic Frequency Selection (DFS)	5250 – 5350 5470 – 5725	15.407 (h) (2)	A9.3 [4]	Passed	12 et seq

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	✓

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 DFS response requirement values

Parameter	Value
Non-Occupancy Period	Minimium 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.

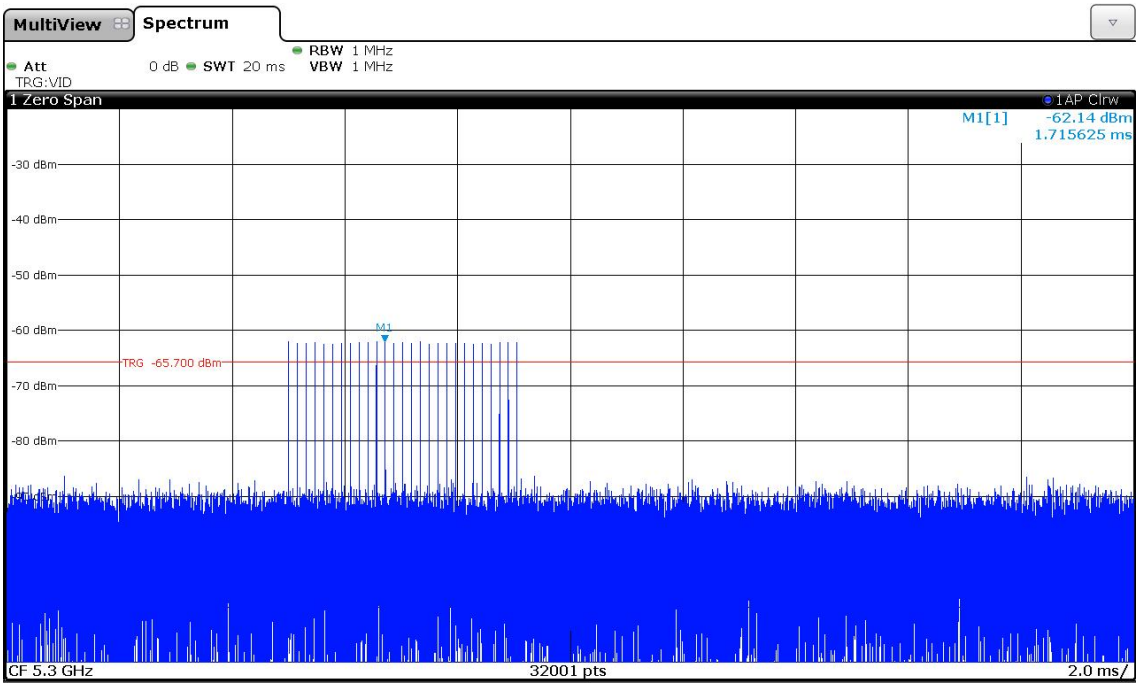
4.6 Radar test waveforms

Short pulse radar test waveform used for the tests:

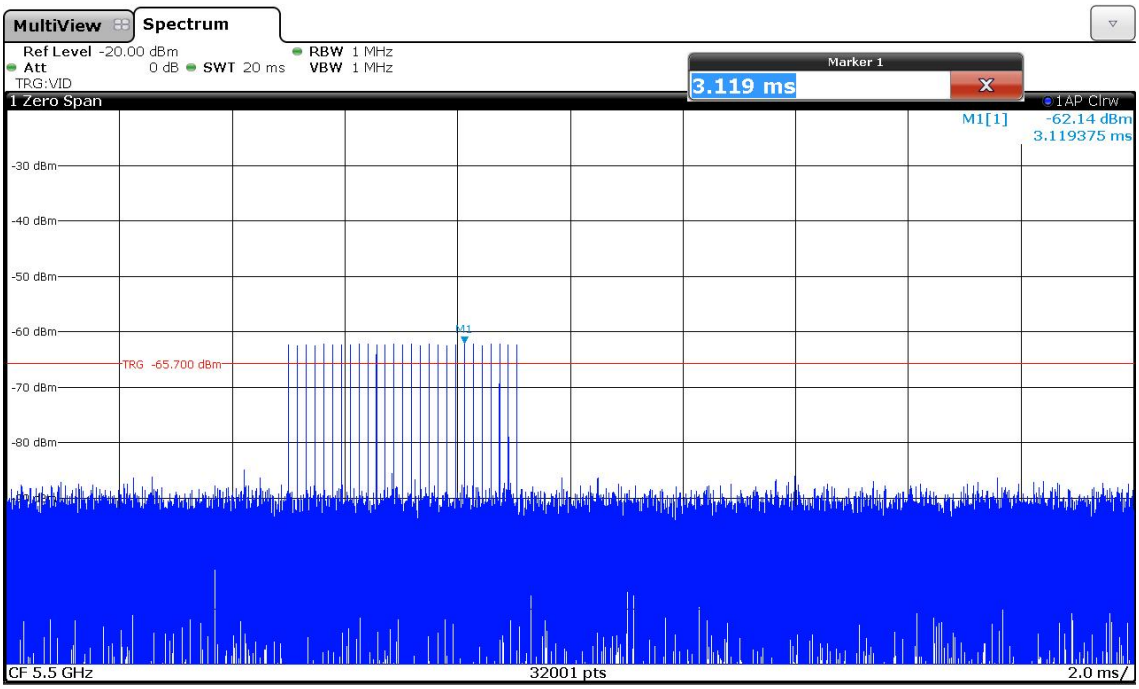
Radar type	Pulse width [µs]	Pulse repetition interval [µs]	Number of pulses
2	1-5	150-230	23-29

4.7 Radar test signal plots

Radar test signal used for 5250-5350 MHz band (detection threshold calibration plot)



Radar test signal used in 5470-5725 MHz band (detection threshold calibration plot)



5 Test results

5.1 Channel Shutdown and Non-Occupancy period

The measurement procedure and limits are described in clause 7.8 [2].

Operation mode: EUT is in continuous transmission mode with specified test transmission load generated by streaming the mandatory mpeg-video file 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

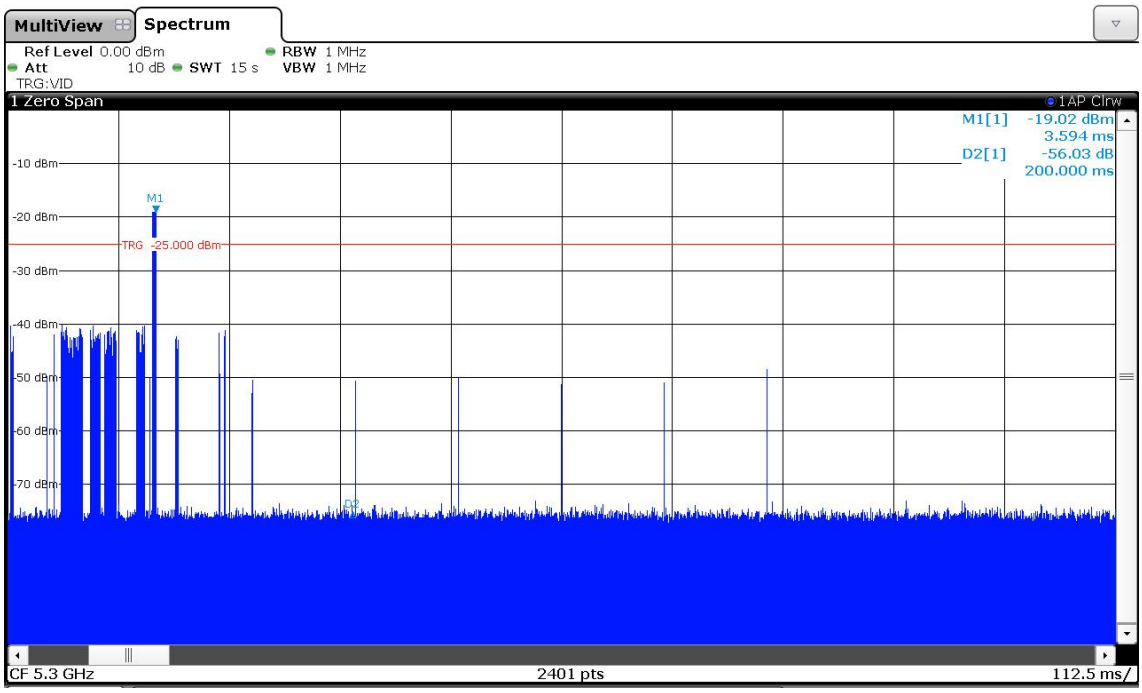
* see chapter 4.3, note 2

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

Measurement results Channel Shutdown and Non-Occupancy period				
Master and slave connected, data traffic active / Radar detection threshold level: -62 dBm				
Radar pulse	Radar type 2			
Used module	ODIN-W160 with cB-driver		ODIN-W160 with TI-driver	
Operating frequency	5 300 MHz	5 660 MHz	5 280 MHz	5 540 MHz
Channel bandwidth	20 MHz	20 MHz	20 MHz	20 MHz
Channel closing time	< 200 ms	< 200 ms	< 200 ms	< 200 ms
Channel move time	< 10 s	< 10 s	< 10 s	< 10 s
Measurement uncertainty: < 10 %				

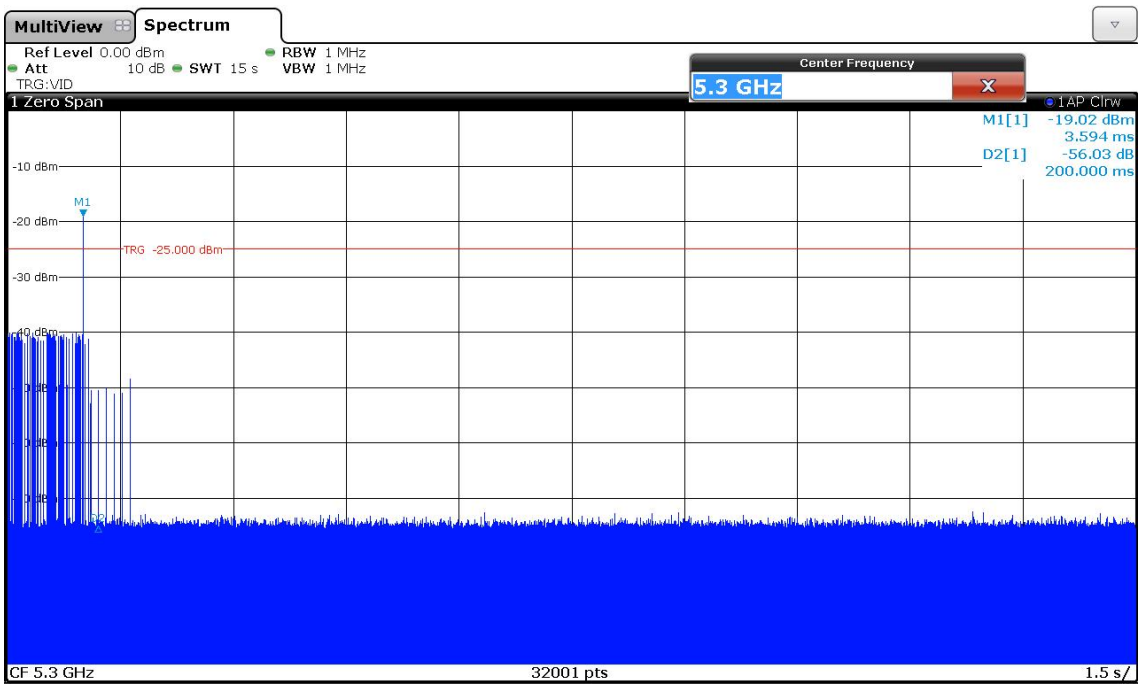
ODIN-W160 with cB-driver operating in 5250-5350 MHz band

Channel closing transmission time at 5300 MHz



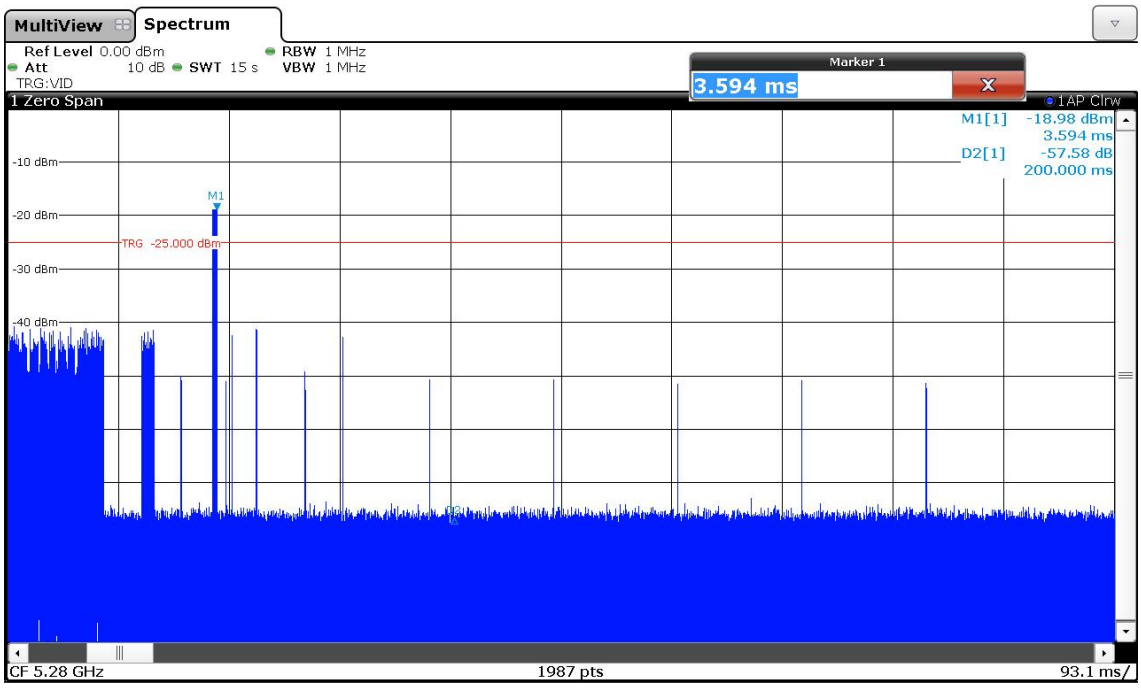
The beacons after the channel closing transmission time of 200 ms are additional intermittent control signals caused by the master (See Note 2 in 4.5).

Channel move time at 5300 MHz



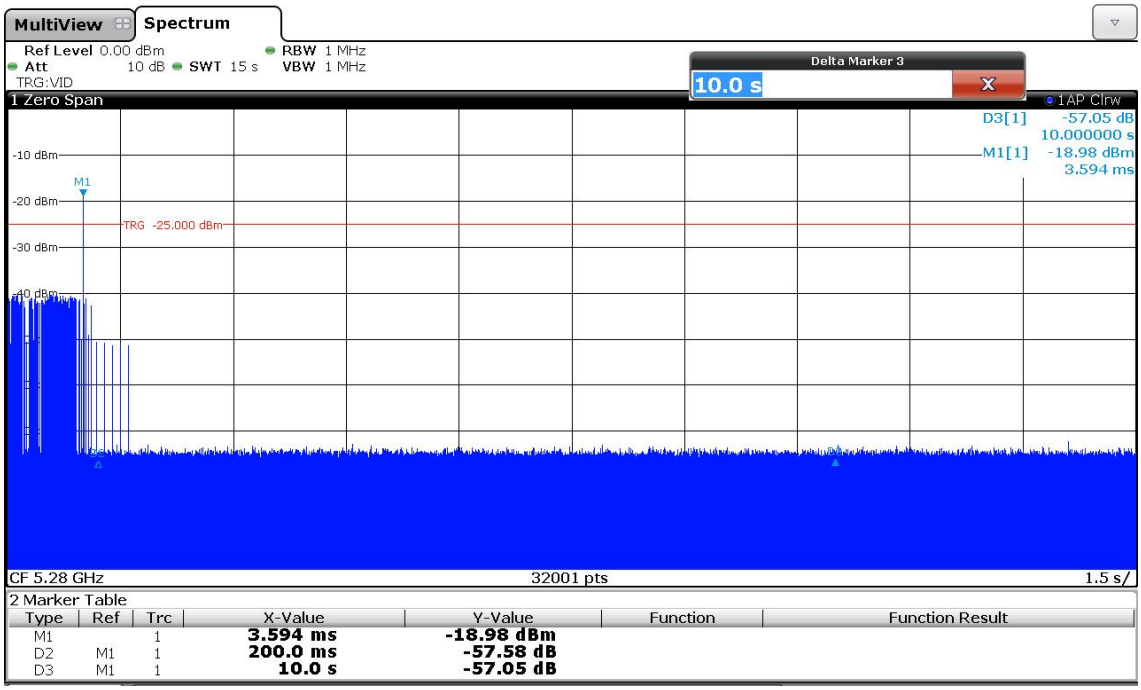
ODIN-W160 with TI-driver operating in 5250-5350 MHz band

Channel closing transmission time at 5280 MHz



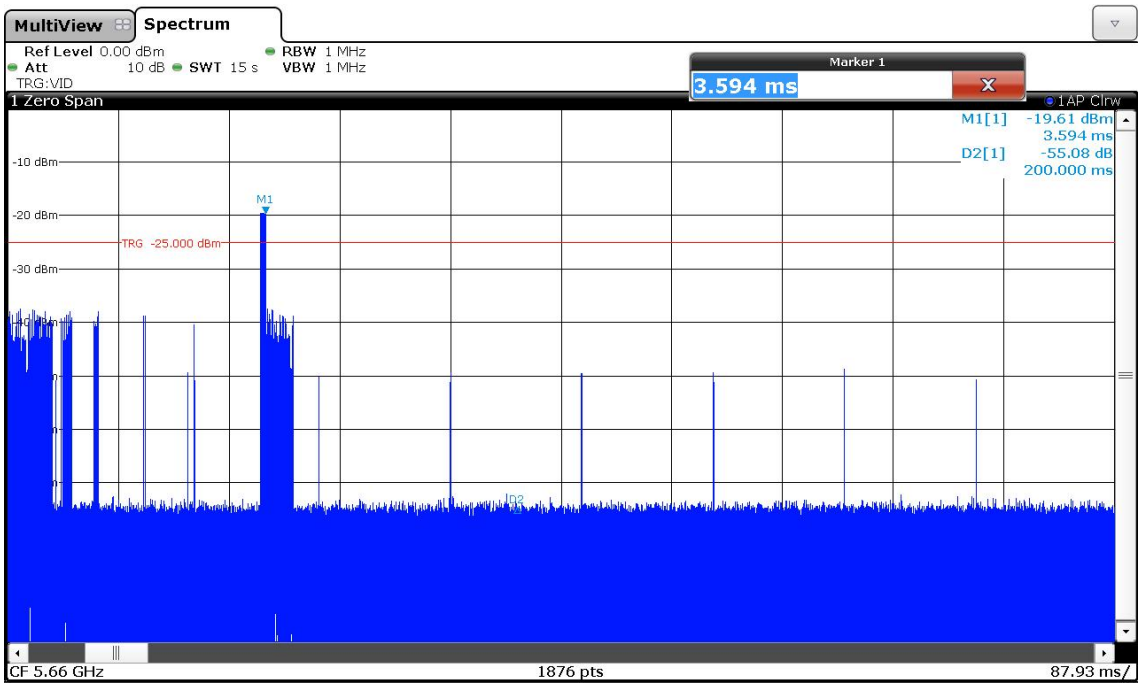
The beacons after the channel closing transmission time of 200 ms are additional intermittent control signals caused by the master (See Note 2 in 4.5).

Channel move time at 5280 MHz



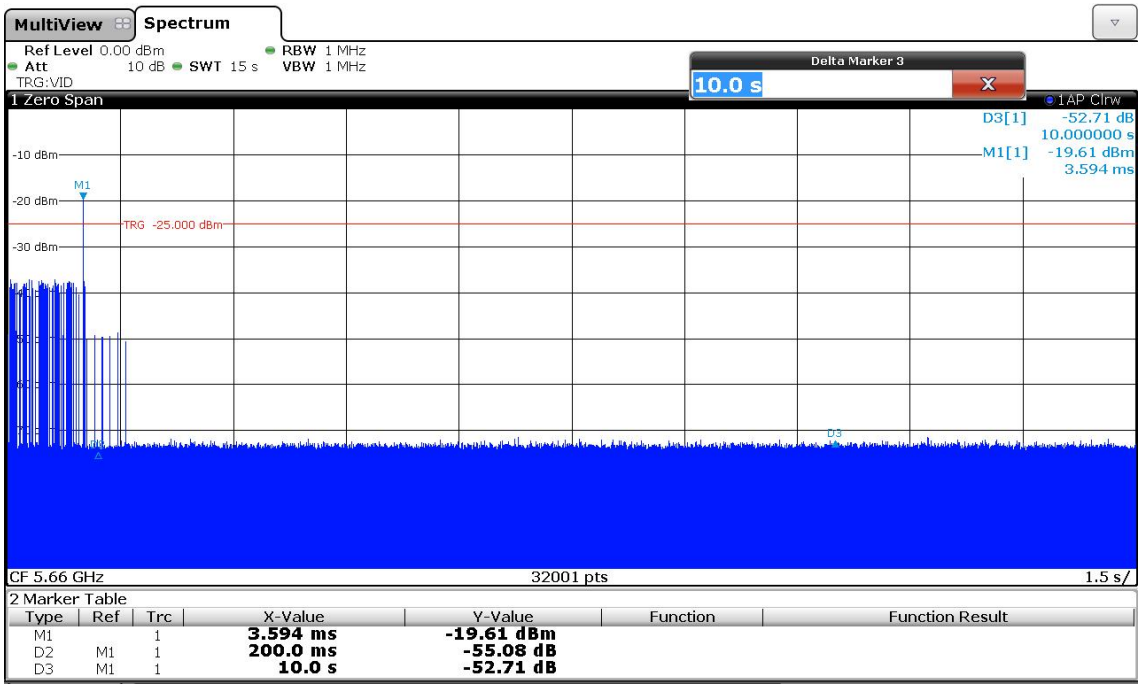
ODIN-W160 with cB-driver operating in 5470-5725 MHz band

Channel closing transmission time at 5660 MHz



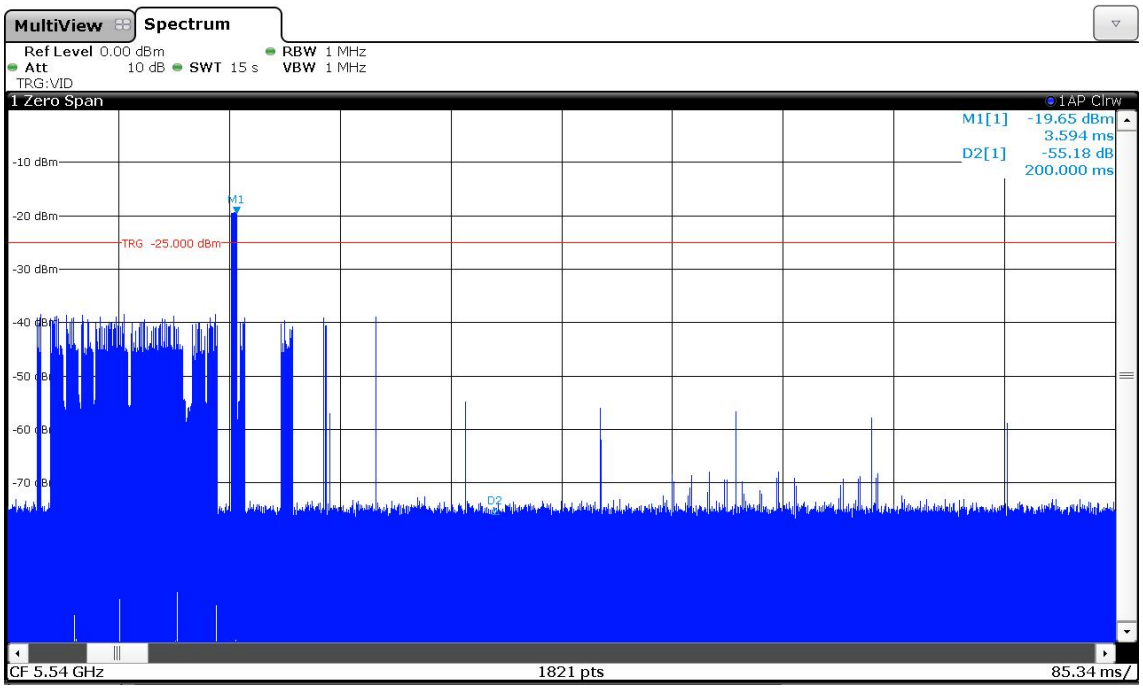
The beacons after the channel closing transmission time of 200 ms are additional intermittent control signals caused by the master (See Note 2 in 4.5).

Channel move time at 5660 MHz



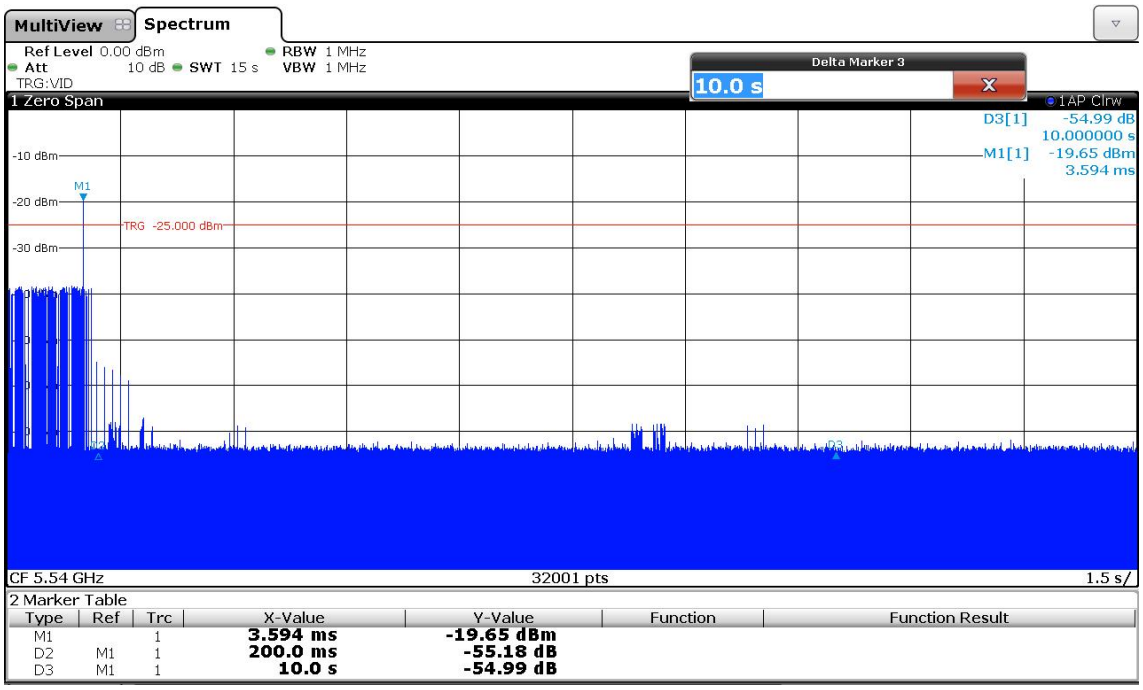
ODIN-W160 with TI-driver operating in 5470-5725 MHz band

Channel closing transmission time at 5540 MHz



The beacons after the channel closing transmission time of 200 ms are additional intermittent control signals caused by the master (See Note 2 in 4.5).

Channel move time at 5540 MHz



6 Test equipment

No.	Test equipment	Type	Manufacturer	Serial No.	PM-No	Date of calibration	
01	Spectrum analyser	FSW43	Rohde & Schwarz	100586	481720	02/27/2014	02/2016
02	Vector signal generator	SMBV-100A	Rohde & Schwarz	255092	481326	02/24/2014	02/2015
03	DC Power supply	TOE8951	Toellner	81996	481253	-	
04	Attenuator 11 dB	8494B	Hewlett-Packard	3308A38264	480264	Weekly verification	
05	Attenuator 110 dB	8496B	Agilent	00626	480265	Weekly verification	
06	4-way power divider	ZN4PD1-63W-S+	Mini Circuits	-	481787	Weekly verification	
07	4-way power divider	ZN4PD1-63W-S+	Mini Circuits	-	481788	Weekly verification	
08	2-way resistive divider	WA1534	Weinschel	A106	481453	Weekly verification	
09	Attenuator 10 dB	WA8/18-10-34	Weinschel	-	481448	Weekly verification	
10	Attenuator 20 dB	WA8/18-20-34	Weinschel	-	481451	Weekly verification	
11	Voltmeter	971A	Hewlett Packard	JP39009361	480725	01/17/2014	01/2016

7 Report history

Report Number	Date	Comment
F136117E13	26 May 2014	Document created

8 List of Annexes

ANNEX A TEST SETUP PHOTOS 2 pages

136117_DFS1.jpg Test set-up
136117_DFS2.jpg Test set-up

ANNEX B EXTERNAL PHOTOS 7 pages

136117_DFS3.jpg ODIN-W160 (cB driver), soldered on cB-0957, top view
136117_DFS4.jpg ODIN-W160 (cB driver), soldered on cB-0957, bottom view
136117_DFS5.jpg ODIN-W160 (TI driver), soldered on cB-0960, top view
136117_DFS6.jpg ODIN-W160 (TI driver), soldered on cB-0960, bottom view
136117_DFS7.jpg cB-0962 WGP development board, top view
136117_DFS8.jpg cB-0962 WGP development board, bottom view
136117_DFS9.jpg Type plate Cisco Access Point

ANNEX C INTERNAL PHOTOS 3 pages

136117_11.jpg ODIN-W160, top view with shielding
136117_13.jpg ODIN-W160, top view, shielding removed
136117_12.jpg ODIN-W160, bottom view