FCC:BV5SMALLENGINE

EMI – TEST REPORT

- FCC Part 15.407, DFS -

Deutsche Akkreditierungsstelle D-PL-12030-01-01

Test Report No. :	**T34325-02-04HS**	09 June 2011 Date of issue

Type / Model Name : Small Engine

Product Description : WLAN Module

Applicant **:** Bang & Olufsen A/S

Address : Peter-Bangs-Vej 15

7600 STRUER, DENMARK

Manufacturer **:** Bang & Olufsen A/S

Address : Peter-Bangs-Vej 15

7600 STRUER, DENMARK

Licence holder **:** Bang & Olufsen A/S

Address : Peter-Bangs-Vej 15

7600 STRUER, DENMARK

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

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart E – Unlicensed National Information Infrastructure Devices (October, 2009)

Part 15, Subpart E, Section 15.407	Operation within the bands 5.15 - 5.25 GHz, 5.25 - 5.35 GHz, 5.47 - 5.725 GHz and 5.725 - 5.825 GHz
ET Docket No. 03-122, FCC 06-96	Released June 30, 2006, Memorandum Opinion and Order concerning DFS

2 SUMMARY

The product is client without radar detection function, channel move time, channel closing transmission time and non-occupancy period are required to be performed.

FCC to Canada standard correlation Matrix:

Operating in the 5250 MHz - 5350 MHz and 5475 MHz – 5725 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.407(g)(2)	RSS210, A9.3	Dynamic frequency selection	passed
15.407(i)(B)iii	RSS210, A9.3(b)iii	Channel move time	passed
15.407(i)(B)iii	RSS210, A9.3(b)iv	Channel closing transmission time	passed
15.407(i)(B)iv	RSS210, A9.3(b)v	Non-Occupancy period	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 3, December 2010
RSS 210, Issue 8, December 2010
RSS 102, Issue 4, March 2010

GENERAL REMARKS:

The EUT “small engine” is a WLAN module with host PCB. For the compliance testing the “small engine” is implemented in a reference integration BeoSound5-Encore to provide with the necessary operating voltages and control interfaces.

Available Features:
The “small engine” is compatible with 802.11n technology. It is operating in the 5 GHz frequency bands. The operation in the 2.4 GHz band is disabled by firmware. The EUT can operate as client only. The client has no radar detection and no TPC. The EUT has no ad hoc modes. The output power is not accessible by the user. The EUT use the MIMO function with multiple antennas without beam forming.

- 802.11n mode 5.150 GHz – 5.250 GHz
  5.250 GHz – 5.350 GHz
  5.470 GHz – 5.725 GHz

The module use OFDM modulation and is capable to provide following data rates:
- 802.11a 54, 48, 36, 24, 18, 12, 9, 6 Mbps;
- 802.11n HT20, MCS 0 – 7;
- 802.11n HT40, MCS 0 – 15;

HT20

MCS Index	Modulation	R	$N_{BPSCS(i_{SS})}$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI (see NOTE)
0	BPSK	1/2	1	52	4	52	26	6.5	7.2
1	QPSK	1/2	2	52	4	104	52	13.0	14.4
2	QPSK	3/4	2	52	4	104	78	19.5	21.7
3	16-QAM	1/2	4	52	4	208	104	26.0	28.9
4	16-QAM	3/4	4	52	4	208	156	39.0	43.3
5	64-QAM	2/3	6	52	4	312	208	52.0	57.8
6	64-QAM	3/4	6	52	4	312	234	58.5	65.0
7	64-QAM	5/6	6	52	4	312	260	65.0	72.2
NOTE—Support of 400 ns GI is optional on transmit and receive.									

HT40

MCS Index	Modulation	R	$N_{BPSCS(i_{SS})}$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
0	BPSK	1/2	1	108	6	108	54	13.5	15.0
1	QPSK	1/2	2	108	6	216	108	27.0	30.0
2	QPSK	3/4	2	108	6	216	162	40.5	45.0
3	16-QAM	1/2	4	108	6	432	216	54.0	60.0
4	16-QAM	3/4	4	108	6	432	324	81.0	90.0
5	64-QAM	2/3	6	108	6	648	432	108.0	120.0
6	64-QAM	3/4	6	108	6	648	486	121.5	135.0
7	64-QAM	5/6	6	108	6	648	540	135.0	150.0

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
8	BPSK	1/2	1	108	6	216	108	27.0	30.0
9	QPSK	1/2	2	108	6	432	216	54.0	60.0
10	QPSK	3/4	2	108	6	432	324	81.0	90.0
11	16-QAM	1/2	4	108	6	864	432	108.0	120.0
12	16-QAM	3/4	4	108	6	864	648	162.0	180.0
13	64-QAM	2/3	6	108	6	1296	864	216.0	240.0
14	64-QAM	3/4	6	108	6	1296	972	243.0	270.0
15	64-QAM	5/6	6	108	6	1296	1080	270.0	300.0

Symbol	Explanation
N_{SS}	Number of spatial streams
R	Coding rate
N_{BPSC}	Number of coded bits per single carrier (total across spatial streams)
$N_{BPSCS}(i_{SS})$	Number of coded bits per single carrier for each spatial stream, $i_{SS} = 1,...,N_{SS}$
N_{SD}	Number of complex data numbers per spatial stream per OFDM symbol
N_{SP}	Number of pilot values per OFDM symbol
N_{CBPS}	Number of coded bits per OFDM symbol
N_{DBPS}	Number of data bits per OFDM symbol
N_{ES}	Number of BCC encoders for the DATA field
N_{TBPS}	Total bits per subcarrier

Channel plan:

HT20 mode:

Channel	Frequency
36	5180
40	5200
44	5220
48	5240
52	5260
56	5280
60	5300
64	5320
100	5500
104	5520
108	5540
112	5560
116	5580
120	5600
124	5620
128	5640
132	5660
136	5680
140	5700

HT40 mode:

Channel	Frequency
38	5190
46	5230
54	5270
62	5310
102	5510
110	5550
134	5670

There is only the following integrated antenna used with the module:

Number	Characteristic	Name	Connector	Frequency band	Gain
1	MIMO	ASSY PN: 1551359	U.FL	4.9 – 5.875 GHz	5 dBi

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMC requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 06 October 2010

Testing concluded on : 21 December 2010

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2011.06.28 10:25:53 +02'00'

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

Tested by:

Hermann Smetana
I am the author of this document
2011.06.28 10:12:23 +02'00'

Hermann Smetana
Dipl.-Ing.(FH)
Radio Expert

3 EQUIPMENT UNDER TEST

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

3.2 Power supply system utilised

Power supply voltage : 100 - 120 VAC
V_{nom}= 110 V
V_{min}= 100 V
V_{max}= 120 V

3.3 Short description of the equipment under test (EUT)

The EUT is a WLAN module with host PCB using the 802.11n standard in the 5 GHz bands only. The EUT has a compatibility mode to 802.11a and 802.11h. Three antenna ports supply 2 TX/RX antennas and 1 RX antenna for MIMO operation. The EUT operates as WLAN client without radar interference detection and without TPC.

Number of tested samples: 1 for radiated measurements and 1 for conducted measurements.
Serial number: Reference integration 22008588 and 22008589

EUT operation mode:

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

- WLAN transmission

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

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

- Power supply 110 – 120 VAC Model : ENCORE EST-3700, #22017610
- _____ Model : _____
- _____ Model : _____

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.

5 TEST CONDITIONS AND RESULTS

5.1 DFS (slave mode)

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

5.1.1 Description of the test location

Test location: AREA 4

5.1.2 General

The requirements and measurements applies are based on a **client device without radar detection**. The associated master device was an FCC approved Cisco AIR-AP1250 access point, certified under FCC ID: LDK102061. Due to the fully compliance of the master it is interfered only with the radar pulse 1 for testing the client channel moving behaviour.

5.1.3 Applicable standard

According to FCC Part 15 Subpart D, Section 15.407, (h)(2):
Devices operating in the bands 5250 – 5350 MHz and 5470 – 5725 MHz shall comply with the following.

5.2 DFS requirements

Table 1: Applicability of DFS requirements prior to use of a channel (FCC 06-96)

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

Table 2: Applicability of DFS requirements during normal operation (FCC 06-96)

Requirement	Operational mode		
	Master	**Client without radar detection**	Client with radar detection
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	**Yes**	Yes
Channel Move Time	Yes	**Yes**	Yes
U-NII Detection Bandwidth	Yes	Not required	Yes

5.2.1 Description of measurement

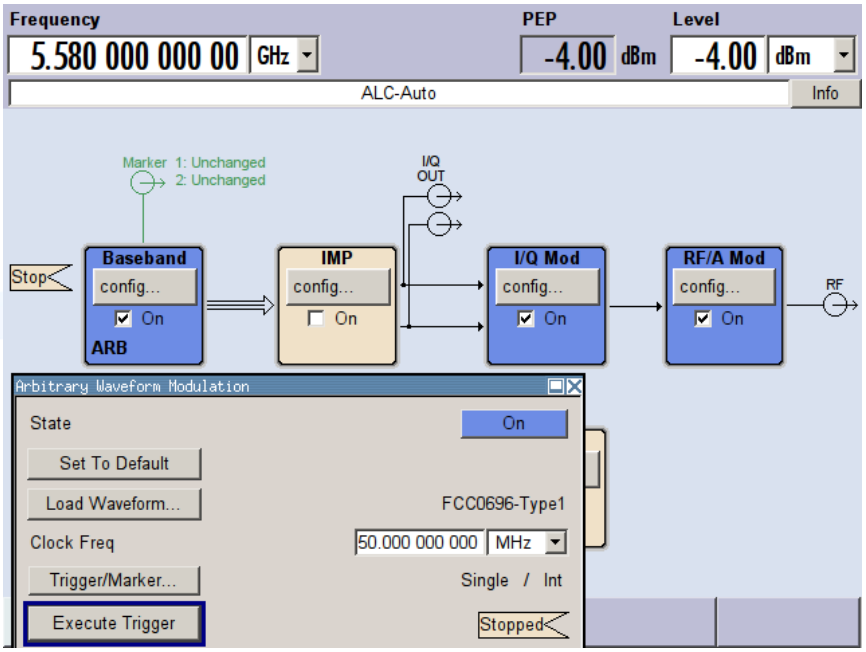
The measurement setup is regarding the ET Docket No.03-122 of FCC 06-96. The client is not able to handle the video mpeg-file recommended for generating traffic on the system. Therefore traffic for testing from AP to the client is generated through transmitting a sound file in mp3 format as in the real application.

5.3 Radar test waveforms

Table 5 – Short pulse radar test waveforms (FCC 06-96)

Radar type	Pulse width (µsec)	PRI (µsec)	Number of pulses	Minimum percentage of successful detection	Minimum number of trials
1	**1**	**1428**	**18**	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

FCC Radar Types 1 to 4 system diagram

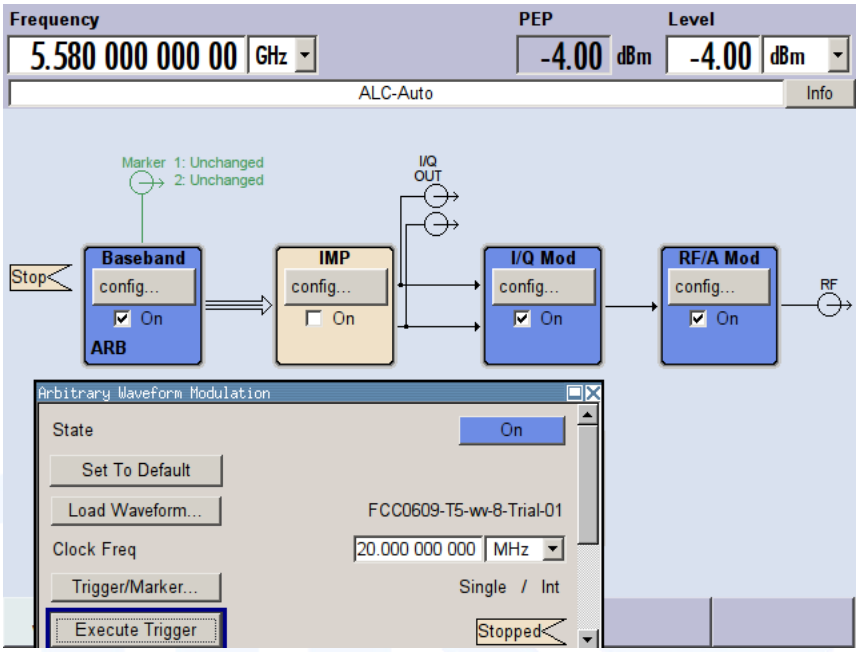


The appropriate radar test pattern is generated by an R&S SMBV100A (Vector SG with one ARB). The K6 sequencer software has been used for creating complex waveforms to generate the puls and burst sequence.

Table 6 – Long pulse radar test waveform (FCC 06-96)

Radar type	Pulse width (µsec)	Chirp width (MHz)	PRI (µsec)	Number of pulses per *burst*	Number of *bursts*	Minimum percentage of successful detection	Minimum number of trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

FCC Radar Type 5 system diagram

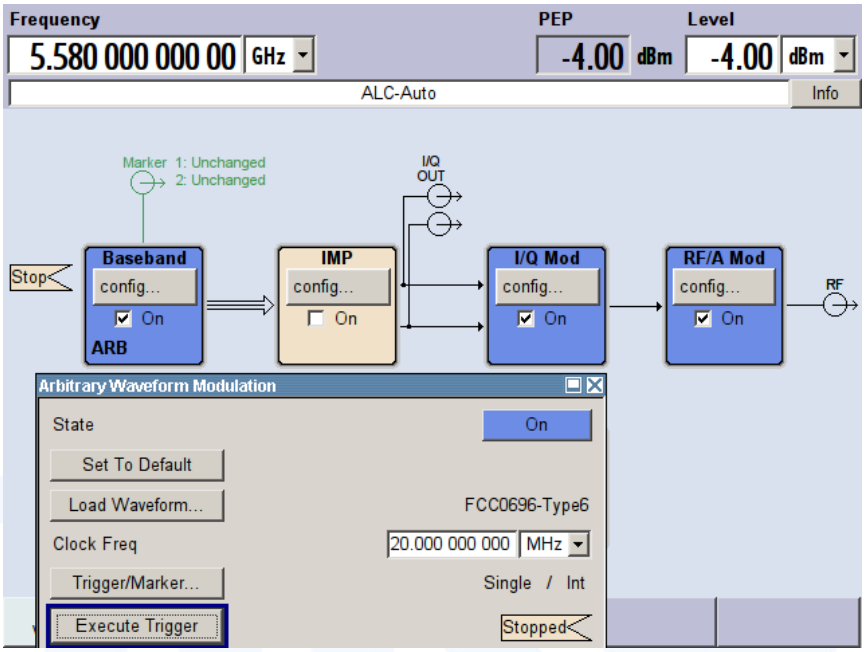


The appropriate radar test pattern is generated by an R&S SMBV100A (Vector SG with one ARB). The K6 sequencer software has been used for creating complex waveforms to generate the puls and burst sequence.

Table 7 – Frequency hopping radar test waveform (FCC 06-96)

Radar type	Pulse width (µsec)	PRI (µsec)	Pulses per hop	Hopping rate (kHz)	Hopping sequence length (ms)	Minimum percentage of successful detection	Minimum number of trials
6	1	333	9	0.333	300	70%	30

FCC Radar Type 6 system diagram



The appropriate radar test pattern is generated by an R&S SMBV100A (Vector SG with one ARB). The K6 sequencer software has been used for creating complex waveforms to generate the puls and burst sequence.

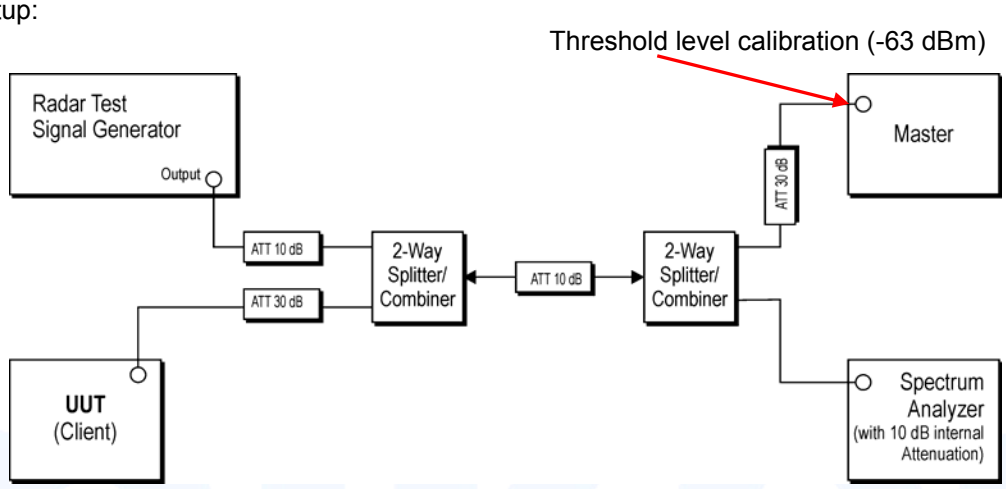
Due to testing a client without radar detection the target is to show the performance in channel moving and closing and not in detecting several kinds of pulses. Therefore the client is tested with the radar puls 1 only.

5.4 Radar waveform calibration procedure

The interference radar detection threshold level is -64 dBm + 1 dB = -63 dBm; A vector signal generator is used to establish the test signal level for each radar type. During the calibration process the slave device and the master device was set on no transmission. The spectrum analyser is set to zero span (time domain) at the frequency of the radar waveform generator. Peak detection is used for the measurement. The level of the signal generator is varied till the spectrum analyser reading shows the -63 dBm at the input of the master. The plot on the short radar puls was captured to demonstrate the right threshold level.

Test setup and conducted calibration diagram for client with injection at the master

Calibration setup:



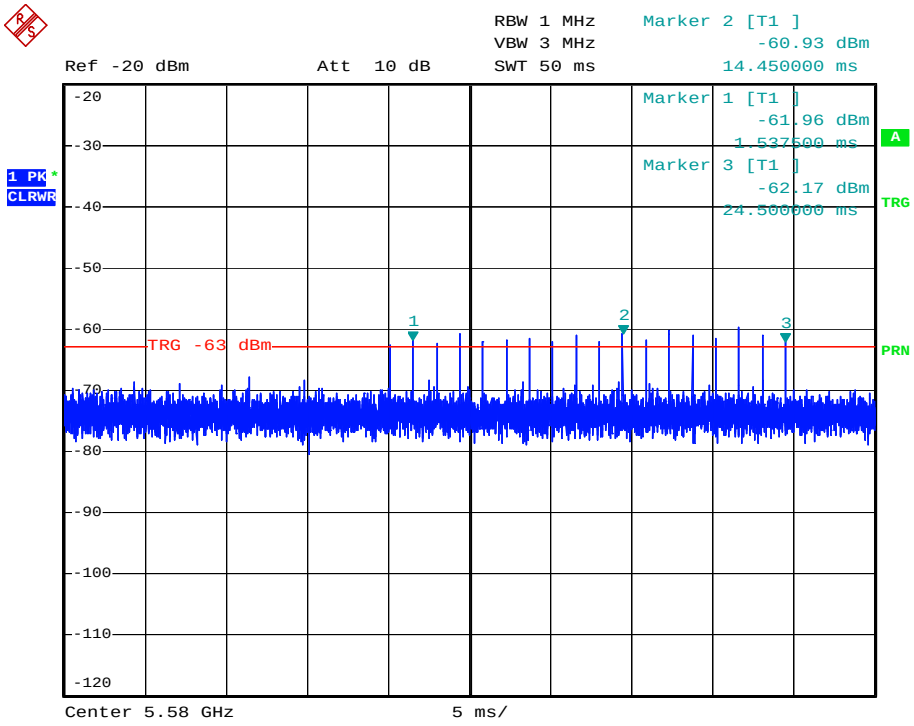
The interference radar detection threshold is as follows:

Table 3: DFS detection thresholds for master devices and client devices with radar detection (FCC 06-96)

Maximum Transmit Power	Value (See Notes 1 and 2)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-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.	

The applied interference radar detection threshold conducted at the input of the AP is -64 dBm. Therefore the level at the AP connector + 1 dB variation in measurement equipment = -63 dBm. This calibration level is shown with the plot below.

FCC:BV5SMALLENGINE
Calibrated level at channel 116



5.5 Channel move time

Requirement according to FCC Part 15 Subpart D, Section 15.407, (h)(2)(iii):
The requirement for channel move time applies in both the master and the slave operational modes.

Table 4: DFS response requirement values (FCC 06-96)

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	**10 seconds, See Note 1.**
Channel Closing Transmission Time	**200 ms + an aggregate of 60 ms over remaining 10 s period. See Notes 1 and 2.**
U-NII Detection Bandwidth	Minimum 80% of the U-NII 99% transmission power bandwidth. See Note 3.

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*.

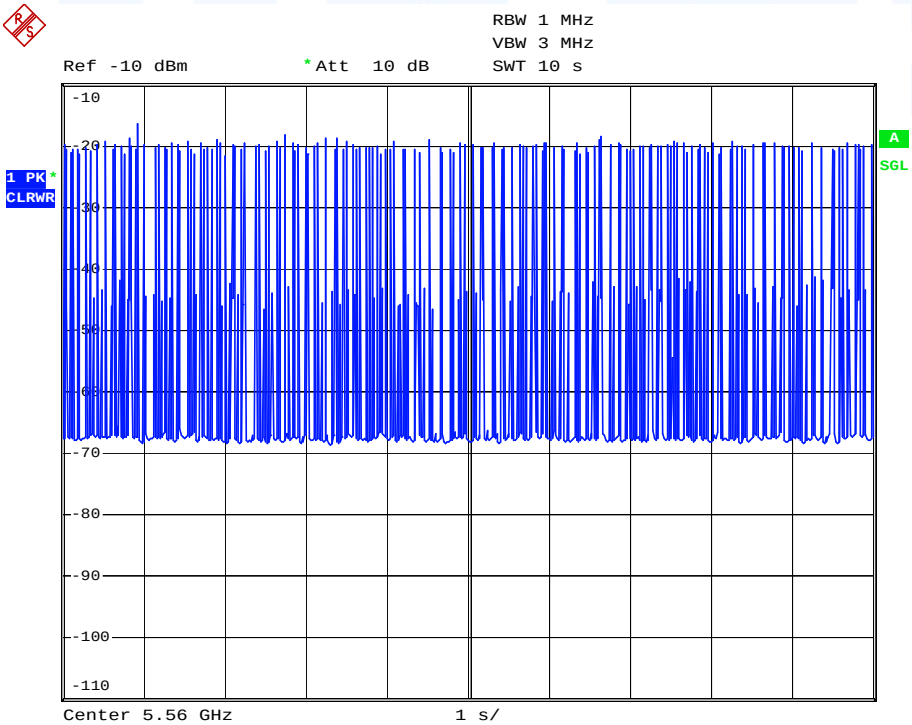
Note 2: The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required facilitating a *Channel* move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the *U-NII Detection Bandwidth* detection test, radar type 1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

5.5.1.1 Photo documentation of the test set-up

5.5.1.2 Test result

Channel 112, with normal traffic of audio data transmission:



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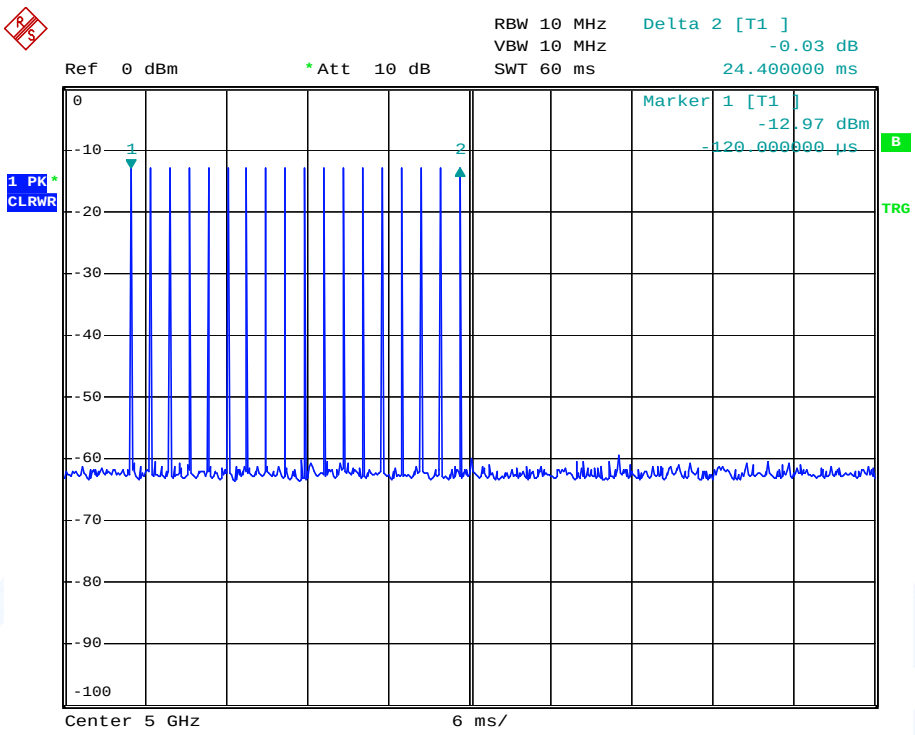
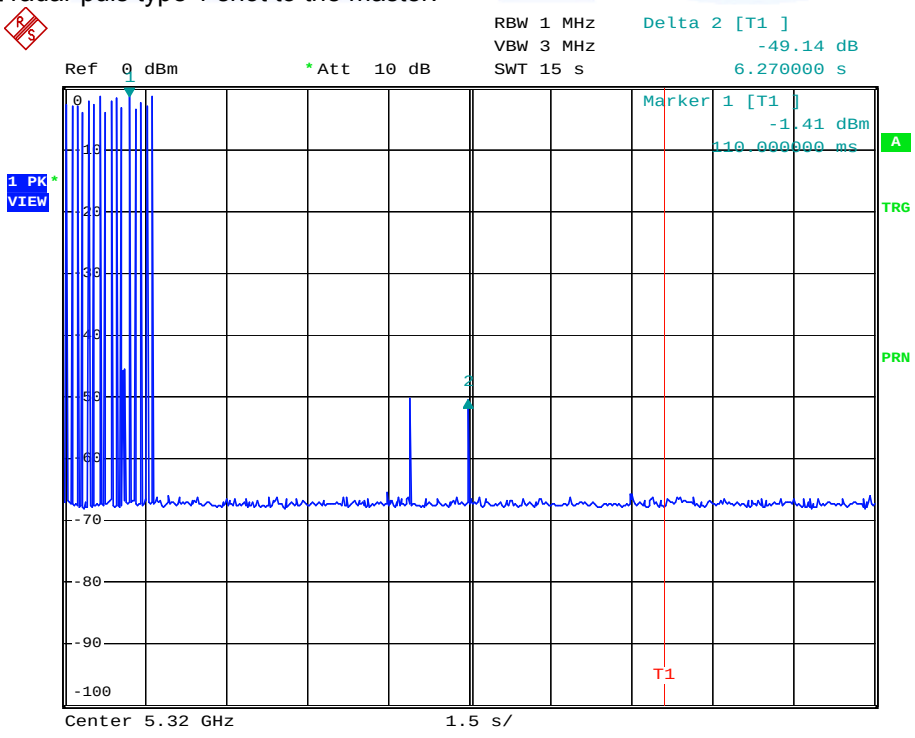
Applied sample short puls radar type 1:

RADAR TYPE 1				Rohde & Schwarz K6 Pulse Sequencer
Trial #	**Number of Pulses per Burst**	**Pulse Width (µsec)**	**PRI (µs)**	**Detection (yes/no)**
1	18	1	1428	y



Channel 64, short radar puls type 1 shot to the master:



T_{cmt} = all transmissions from T1 to T2

T_{cmt} = 6.27 s;

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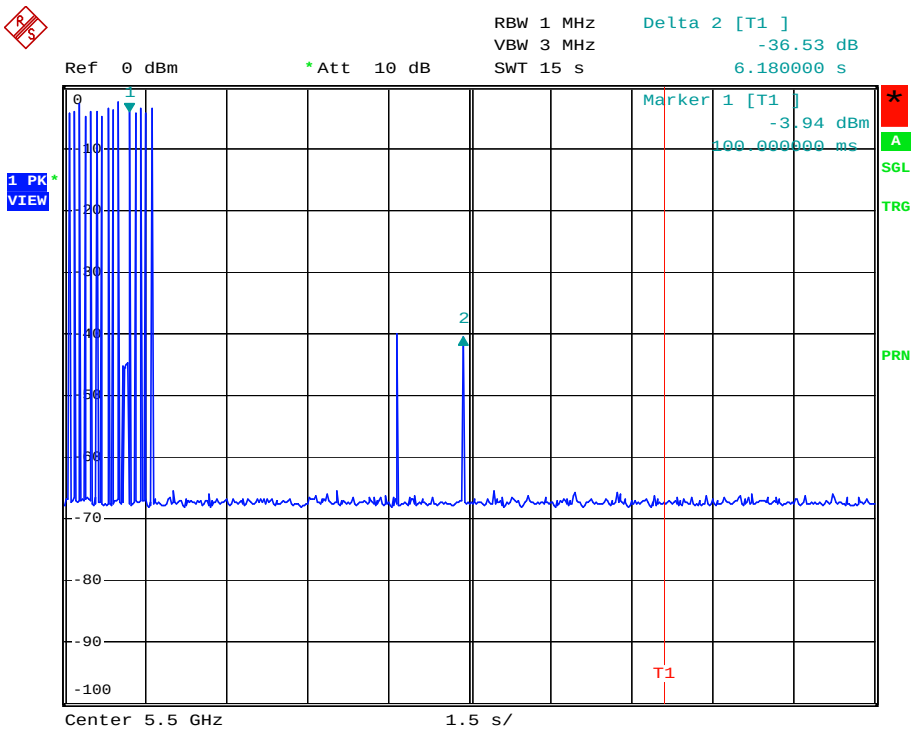
Channel 100:



T_{cmt} = all transmissions from T1 to T2
T_{cmt} = 6.18 s;

Limit according to FCC Part 15 Subpart D, Section 15.407, (h)(2)(iii):
After the radar signal is detected, the device shall cease all transmissions on the operating channel within 10 s. Transmission during this period shall consist of normal traffic for a minimum 200 ms after detection of the radar signal. In addition, the intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

The requirements are **FULFILLED.**

Remarks: _____

5.6 Channel closing transmission time

Requirement according to FCC Part 15 Subpart D, Section 15.407, (h)(2)(iv):
The requirement for channel closing time is 200 ms + 60 ms. (See table 4)

5.6.1.1 Test result

Calculation of the Channel closing transmission time:

Channel 64:
T_{cctt} = aggregate duration of all transmission from T1 to T2;
7 transmission pulses are left after the radar puls (one transmission pulswidth 60.8 µs).
T_{cctt} = 7 times 60.8 µs = 425.6 µs;

Channel 100:
T_{cctt} = aggregate duration of all transmission from T1 to T2;
7 transmission pulses are left after the radar puls (one transmission pulswidth 60.8 µs).
T_{cctt} = 7 times 60.8 µs = 425.6 µs;

Limit according to FCC Part 15 Subpart D, Section 15.407, (h)(2)(iii):
After the radar signal is detected, the device shall cease all transmissions on the operating channel within 10 s. Transmission during this period shall consist of normal traffic for a minimum 200 ms after detection of the radar signal. In addition, the intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

The requirements are **FULFILLED.**

Remarks: _____

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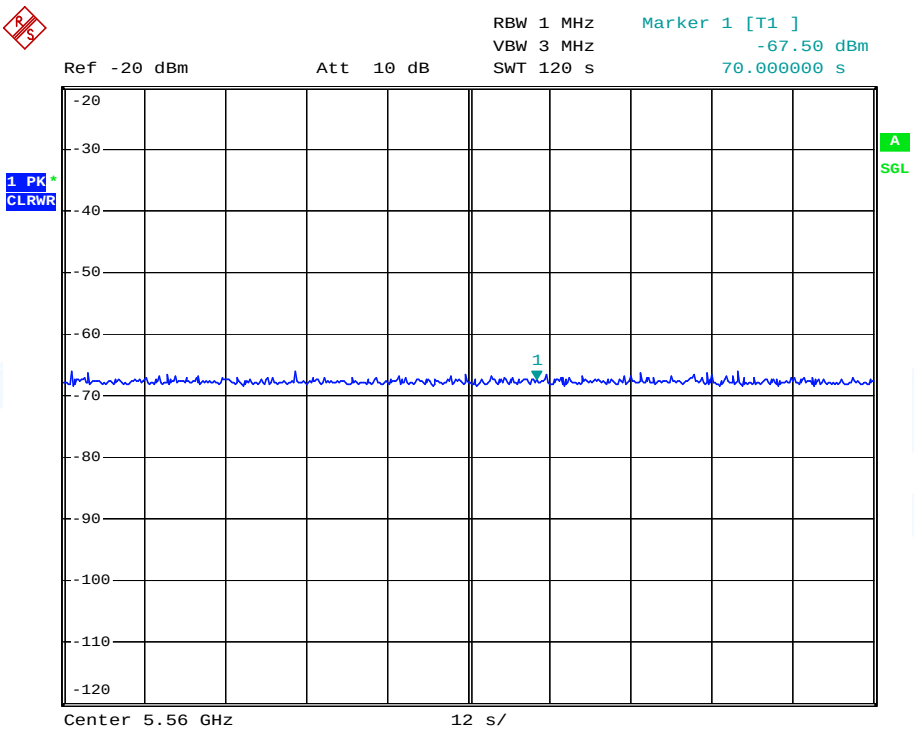
5.7 Non-Occupancy period

Requirement according to FCC Part 15 Subpart D, Section 15.407, (h)(2)(iv):
The requirement for testing the non-occupancy period does not exist (see Table 1) but the EUT has to ensure that no transmission of any type before having received appropriate control signals from a master device. See requirement 06-96, item 5.2.

5.7.1.1 Test result

Non associated mode (AP off) measured from “power on”:
During the power on observation the EUT did not try to search for an AP or send any beacons by itself.



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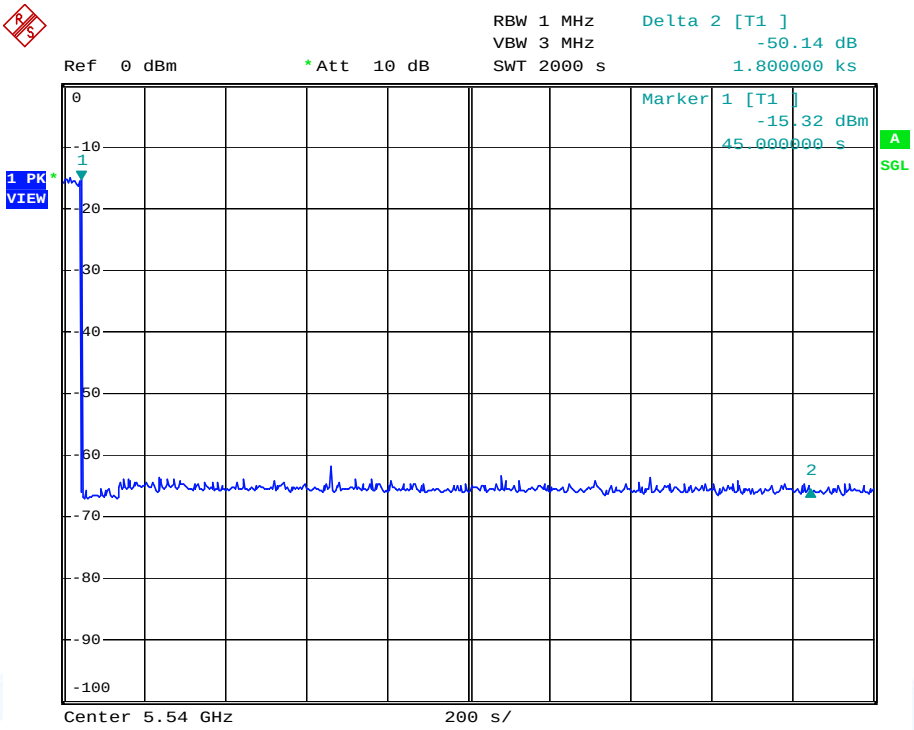
Behaviour after channel changing from 108, AP has detected a radar signal:
During the 30 minutes observation after channel changing the EUT dosn't transmit any signals on the channel.



The requirements are **FULFILLED.**

Remarks: _____

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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.
DFS	SMBV100A	02-02/05-09-001	12/03/2012	12/03/2009	04/03/2011	04/03/2010
	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	JFW 50FH-006-100-2	02-02/50-05-056				
	10 dB / 50 Ohm / 18 GHz	02-02/50-05-078				
	6011	02-02/50-05-079				
	6011	02-02/50-05-080				
	6011	02-02/50-05-081				
	Sucoflex N-1500-SMA	02-02/50-06-042				
	10 dB / 50 Ohm / 18 GHz	02-02/50-07-067				
	Multiflex 141-SMA-N-1500	02-02/50-09-013				