EN302502 DFS Test Report

Product Name : WIRELESS-ABGN 3X3 NETWORK MINI PCIE ADAPTER

Model No. : WLE350NX

Applicant : Compex Systems Pte Ltd

Address : 135 Joo Seng Road, #08-01 PM Industrial Building Singapore 368363

Date of Receipt : 04/02/2013

Test Date : 05/02/2013~08/04/2013

Issued Date : 08/04/2013

Report No. : 132S008R-RF-CE-P16V02

Report Version : V1.0

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Applicant	:	Compex Systems Pte Ltd
Address	:	135 Joo Seng Road, #08-01 PM Industrial Building Singapore 368363
Manufacturer	:	Compex Systems Pte Ltd
Address	:	135 Joo Seng Road, #08-01 PM Industrial Building Singapore 368363
Model No.	:	WLE350NX
EUT Voltage	:	DC: 3.3V
Trade Name	:	COMPEX
Applicable Standard	:	ETSI EN 302502 V1.2.1 (2008-07) Clause 4.6
Test Result	:	Pass
Performed Location	:	Suzhou EMC Laboratory No.99 Hongye Rd., Suzhou Industrial Park Loufeng Hi-Tech Development Zone., Suzhou, China TEL: +86-512-6251-5088 / FAX: +86-512-6251-5098
Operation Mode (5725~5850MHz)	:	☒ Master device ☐ Slaver device with radar detection function ☐ Slaver device without radar detection function
MAX/MIN Antenna Gain	:	7dBi/2dBi
EIRP Density (Max)	:	17.05dBm/MHz (Total 17.32dBm/MHz for three streams)

Documented By	:	Alice Ni (Alice Ni)
Reviewed By	:	Jame Yuan (Jame Yuan)
Approved By	:	Robin Wu (Robin Wu)

Laboratory Information

We, **QuieTek Corporation**, are an independent EMC and safety consultancy that was established the whole facility in our laboratories. The test facility has been accredited/accepted(audited or listed) by the following related bodies in compliance with ISO 17025, EN 45001 and specified testing scope:

Taiwan R.O.C.	**:**	**BSMI, NCC, TAF**
Germany	**:**	**TUV Rheinland**
Norway	**:**	**Nemko, DNV**
USA	**:**	**FCC, NVLAP**
Japan	**:**	**VCCI**
China	**:**	**CNAS**

The related certificate for our laboratories about the test site and management system can be downloaded from QuieTek Corporation's Web Site :http://www.quietek.com/tw/ctg/cts/accreditations.htm
The address and introduction of QuieTek Corporation's laboratories can be founded in our Web site : http://www.quietek.com/
If you have any comments, Please don't hesitate to contact us. Our contact information is as below:

HsinChu Testing Laboratory :
No.75-2, 3rd Lin, Wangye Keng, Yonghxing Tsuen, Qionglin Shiang, Hsinchu County 307, Taiwan, R.O.C.
TEL:+886-3-592-8858 / FAX:+886-3-592-8859 E-Mail : service@quietek.com

LinKou Testing Laboratory :
No.5-22, Ruishukeng, Linkou Dist., New Taipei City 24451, Taiwan, R.O.C.
TEL : 886-2-8601-3788 / FAX : 886-2-8601-3789 E-Mail : service@quietek.com

Suzhou Testing Laboratory :
No.99 Hongye Rd., Suzhou Industrial Park Loufeng Hi-Tech Development Zone., SuZhou, China
TEL : +86-512-6251-5088 / FAX : 86-512-6251-5098 E-Mail : service@quietek.com

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1. General Information

The UUT operates in the following bands: 5725-5850 MHz

The UUT is Master Device that has radar interference detection function. The highest gain antenna assembly utilized with the EUT has a maximum gain of 23dBi in 5GHz frequency band. The 50-ohm Tx/Rx antenna port is connected to the test system to perform conducted tests.

The detection threshold value was calculated as follows:

-69dBm + 23dBm – 23dBm + 2dBi = -67dBm

Thus, we chose -49dBm as detection threshold.

Antenna	Manufacturer	Peak Gain
Panel Antenna	A*STAR Institute for Infocomm Research	3dBi for 2.4GHz, 5dBi for 5GHz
Dipole Antenna 1#	SmartAnt Telecom Co., Ltd.	4.5dBi for 2.4GHz, 7dBi for 5GHz
Dipole Antenna 2#	Kunshan Wavelink Electronic Co., Ltd.	2dBi for 2.4GHz and 5GHz

The UUT utilizes 802.11a/n IP based architecture. One nominal channel bandwidth, 20 MHz was implemented.

The auxiliary device is Intel WiFi module 5100.

The test set-up is using Set-up A which UUT is a RLAN device operating in master mode, and test items as follows requirements:

Test Items	Requirement
Channel availability check and channel revalidation period	√
In-Service Monitoring	√
Channel Shutdown	√
Non-Occupancy Period	√

2. Test Equipment

Dynamic Frequency Selection (DFS) / TR-8

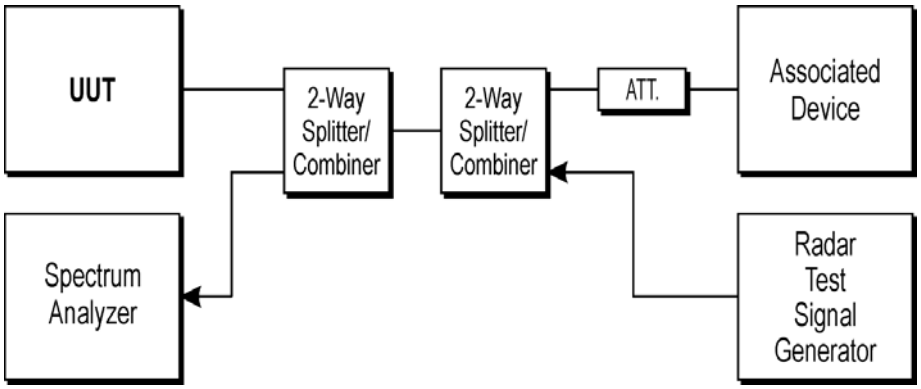
Instrument	Manufacturer	Type No.	Serial No	Cal. Date
Spectrum Analyzer	Agilent	N9020A	MY49100159	2013-03-30
Vector Signal Generator	Agilent	E4438C	102168	2013-03-30

Instrument	Manufacturer	Type No.	Serial No
Splitter/Combiner (Qty: 2)	Mini-Circuits	ZAPD-50W 4.2-6.0 GHz	NN256400424
Splitter/Combiner (Qty: 2)	MCLI	PS3-7	4463/4464
ATT (Qty: 1)	Mini-Circuits	VAT-30+	30912
Laptop PC	Asus	N80V	8BN0AS226971468
RF Cable (Qty: 6)	Mini-Circuits	N/A	DFS-1~6

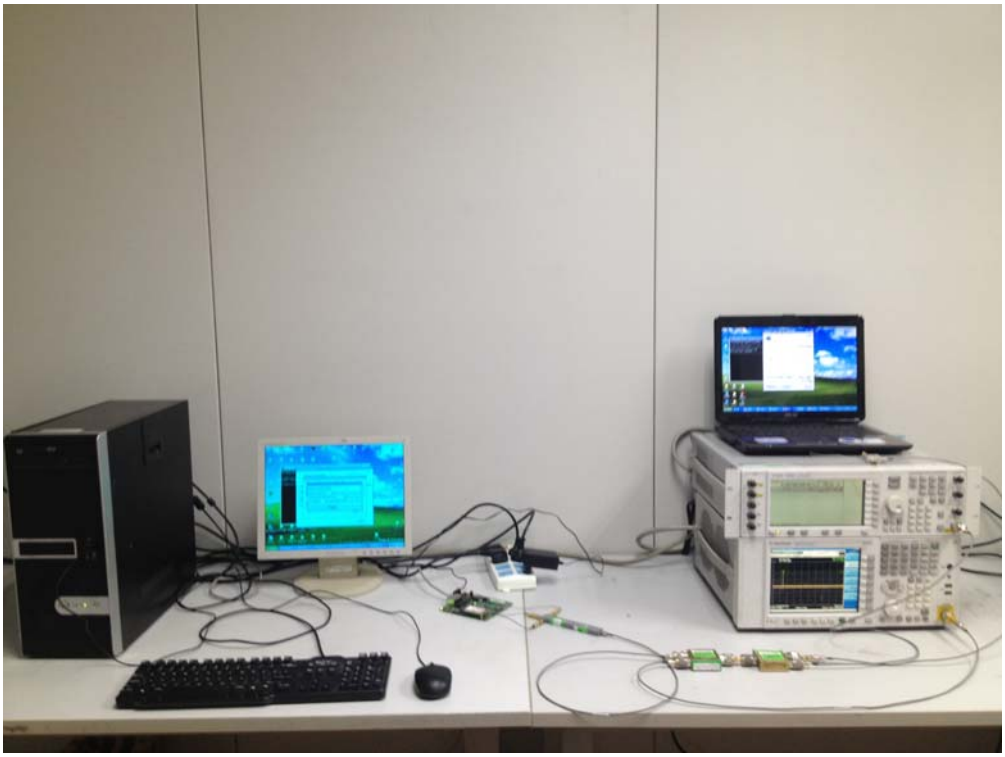
Software	Manufacturer	Function
Pulse Building	Agilent	Radar Signal Generation Software
DFS Tool	Agilent	DFS Test Software

3. Test Setup

For the purposes of the test, the UUT as well as other devices used in the set-up may be equipped with a specific user interface to allow monitoring of the behaviour of the different devices of the set-up during the tests.
The UUT is capable of transmitting a test transmission sequence as described in clause 5.1.2.2. The signal generator is capable of generating any of the radar test signals defined in tables D.3.1 and D.3.2.
Adequate measurement equipment, e.g. spectrum analyser, shall be used to measure the aggregate transmission time of the UUT.
Radar test signals are injected into the UUT. The set-up also contains a device which is associated with the UUT.
Figure 3 shows an example test set-up.



DFS Set-up Photo: UUT and Spectrum Analyzer



4. Test Items Description

4.1. Channel availability check and channel revalidation period

4.1.1. Definition

The *Channel Availability Check* is defined as the mechanism by which a device checks a channel for the presence of radar signals.

There shall be no transmissions by the device within the channel being checked during this process.

If no radars have been detected by this mechanism, the channel becomes an *Available Channel.*

Following a channel availability check during which no radars were detected, the *Channel Revalidation Period* is defined as the period of time during which a channel identified as an Available Channel remains valid as such.

The device shall only start transmissions on Available Channels.

At each power-up, the device is assumed to have no Available Channels.

4.1.2. Limit

The *Channel Availability Check* shall be performed during a continuous period in time (*Channel Availability Check Time*) which shall not be less than the value defined in table D.1.

During the *Channel Availability Check*, the device shall be capable of detecting any of the radar signals that fall within the range given by tables D.3.1 and D.3.2 with a level above the *Interference Detection Threshold* defined in table D.2.

The detection probability for a given radar signal shall be greater than the value defined in tables D.3.1 and D.3.2.

The Channel Revalidation Period for Available Channels remains valid for a maximum period as defined in table D.1.

4.1.3. Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

4.2. In-Service Monitoring

4.2.1. Definition

The *In-Service Monitoring* is defined as the process by which a device monitors the Operating Channel for the presence of radar signals.

4.2.2. Limit

The *In-Service Monitoring* shall be used to continuously monitor an Operating Channel.

The *In-Service-Monitoring* shall start immediately after the device has started transmissions on an *Operating Channel*.

During the *In-Service Monitoring*, the device shall be capable of detecting any of the radar signals that fall within the range given by tables D.3.1 and D.3.2 with a level above the *Interference Detection Threshold* defined in table D.2.

The detection probability for a given radar signal shall be greater than the value defined in tables D.3.1 and D.3.2.

4.2.3. Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

4.3. Channel Shutdown

4.3.1. Definition

The *Channel Shutdown* is defined as the process initiated by the equipment immediately after a radar signal has been detected on an Operating Channel.

The equipment shall stop transmitting on this channel, which it shall do within the *Channel Move Time*.

The aggregate duration of all transmissions of the equipment on this channel during the *Channel Move Time* shall be limited to the *Channel Closing Transmission Time*. The aggregate duration of all transmissions shall not include quiet periods in between transmissions.

4.3.2. Limit

The *Channel Shutdown* process shall start immediately after a radar signal has been detected.

The *Channel Move Time* shall not exceed the limit defined in table D.1.

The *Channel Closing Transmission Time* shall not exceed the limit defined in table D.1.

4.3.3. Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

4.4. Non-Occupancy Period

4.4.1. Definition

The *Non-Occupancy Period* is defined as the time during which the device shall not make any transmissions on a Channel after a radar signal was detected on that channel by either the *Channel Availability Check* or the *In-Service Monitoring*.

NOTE: A new Channel Availability Check is required before the channel can be identified again as an *Available Channel*

4.4.2. Limit

The Non-Occupancy Period shall not be less than the value defined in table D.1.

4.4.3. Conformance

Conformance tests for this requirement are defined in clause 5.3.6.

5. Radar Wave Parameters

Table D.1: DFS requirement values

Parameter	Value
Channel Availability Check Time	60 s
Channel Move Time	10 s
Channel Closing Transmission Time	260 ms
Non-Occupancy Period	30 min
Channel Revalidation Period	24 hours

Table D.2: Interference threshold values

EIRP Spectral Density dBm/MHz	Value (see notes 1 and 2)
23	-69 dBm
NOTE 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. NOTE 2: For FWA devices employing lower EIRP spectral density and a receive antenna gain G (dBi) the threshold follows the following relationships: DFS Detection Threshold (dBm) = -69 + 23 -EIRP Spectral Density (dBm/MHz) + G (dBi). See table D.4 for example calculations.	

Table D.3.1: DFS Test Signals simulating fixed frequency radars

Radar test signal (see notes 2)	Pulse width W [µs](see note 5) Choose one value	Pulse repetition frequency PRF (PPS) Choose one value	Pulses per burst (see notes 1 and 3)	Detection probability with 30% channel load (see note 4)
1-Fixed	1	750	15	P_d > 60 %
2-Variable	1,2,5	200,300,500,800,1000	10	P_d > 60 %
3-Variable	10,15	200,300,500,800,1000	15	P_d > 60 %
4-Variable	1,2,5,10,15	1200,1500,1600	15	P_d > 60 %
5-Variable	1,2,5,10,15	2300,3000,3500,4000	25	P_d > 60 %
6-Variable modulated (see note 6)	20,30	2000,3000,4000	20	P_d > 60 %

NOTE 1: This represents the number of pulses seen at the device per radar scan:

N = [{antenna beamwidth (deg)} x {pulse repetition rate (pps)}] / [{scan rate (deg/s)}].

NOTE 2: The test signals above only contain a single burst of pulses. See figure D.1.

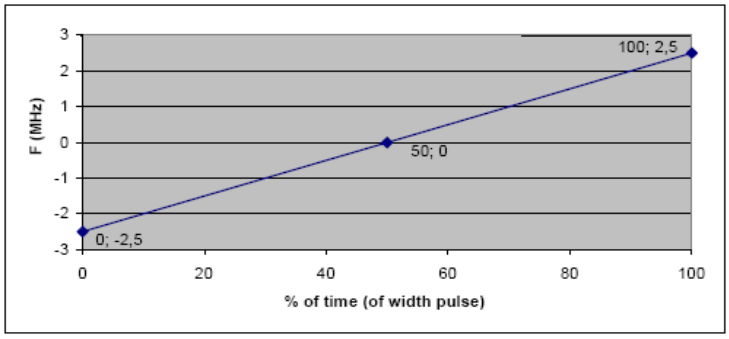
NOTE 3: The number of pulses per burst given in this table simulate real radar systems and take into account the effects of pulse repetition rate and pulse width on the detection probability for a single burst.

NOTE 4: Pd gives the probability of detection per simulated radar burst and represents a minimum level of detection performance under defined conditions - see clause 5.1.2.2.

Therefore Pd does not represent the overall detection probability for any particular radar under real life conditions. In general 5 sequential bursts are needed to achieve a real life detection rate of better that 99 % for any radar that falls within the scope of the above table.

NOTE 5: The pulse width used in these tests is assumed to be representative of real radar systems with different pulse widths and different modulations. The pulse width is assumed to have an accuracy of ±5 %.

NOTE 6: The modulation to be used for the radar test signal 6 is a chirp modulation with a ±2,5 MHz frequency deviation which is illustrated below.



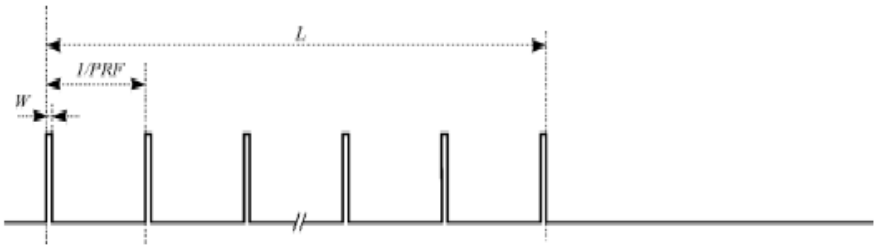


Figure D.1: General structure of a single burst DFS test transmission

Table D.3.2: DFS Test Signals simulating Frequency Hopping radars

Radar test signal	Pulse width W[µs]	Pulse repetition Frequency PRF [pps]	Pulses Per burst	Burst Length [ms]	Bursts per Trial (see note 4)	Pulse modulation (see note 1)	Detection Probability Pd with 30 % channel load (see note 2)
1	1	3000	9	3	8	none	see note 3
2	20	4500	9	2	2	chirp	see note 3

NOTE 1: Modulation used is defined in note 6, Table D.3.1.

NOTE 2: Pd gives the probability of detection per simulated radar test signal and represents a minimum level of Detection performance under defined conditions - see clause 5.1.2.2.

The test is performed using a minimum of 30 trials per test signal. The probability of detection is calculated by

$$\mathrm{Pd} = \frac{TotalSetDetections}{TotalSetTrials} \times 100 .$$

NOTE 3: For ChS = 10 MHz, Pd > 60 %; for ChS = 20 MHz, Pd > 70 %.

NOTE 4: For each of the trials, the burst interval will increase from 1,25 ms to 37,5 ms in Steps of 1,25 ms for radar signal 1 and from 5 ms to 150 ms in Steps of 5 ms for radar signal 2.

Table D.3.2: DFS Test Signals simulating Frequency Hopping radars

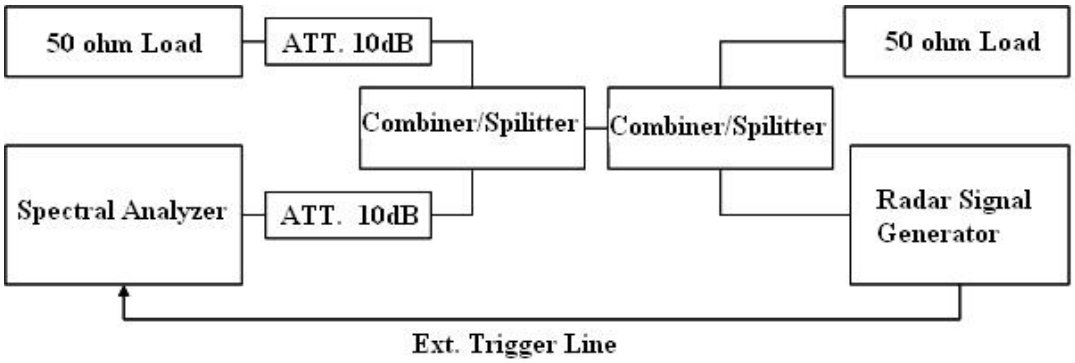
Maximum EIRP (dBm)	Channel Width (MHz) ChS	EIRP Spectral Density (dBm/MHz)	Interference Threshold (dBm)	Antenna Gain (dBi)	DFS Detection Threshold (dBm)
36	20	23	-69	0	-69
36	20	23	-69	10	-59
33	20	20	-66	0	-69
33	10	23	-69	10	-59
30	20	17	-63	0	-63
30	10	20	-66	10	-56

6. Radar Waveform Calibration

The following equipment setup was used to calibrate the conducted radar waveform. A spectrum analyzer was used to establish the test signal level for each radar type. During this process there were no transmissions by either the master or client device. The spectrum analyzer was switched to the zero spans (time domain) at the frequency of the radar waveform generator. Peak detection was utilized. The spectrum analyzer resolution bandwidth (RBW) and video bandwidth (VBW) were set to 1 MHz and 3 MHz.

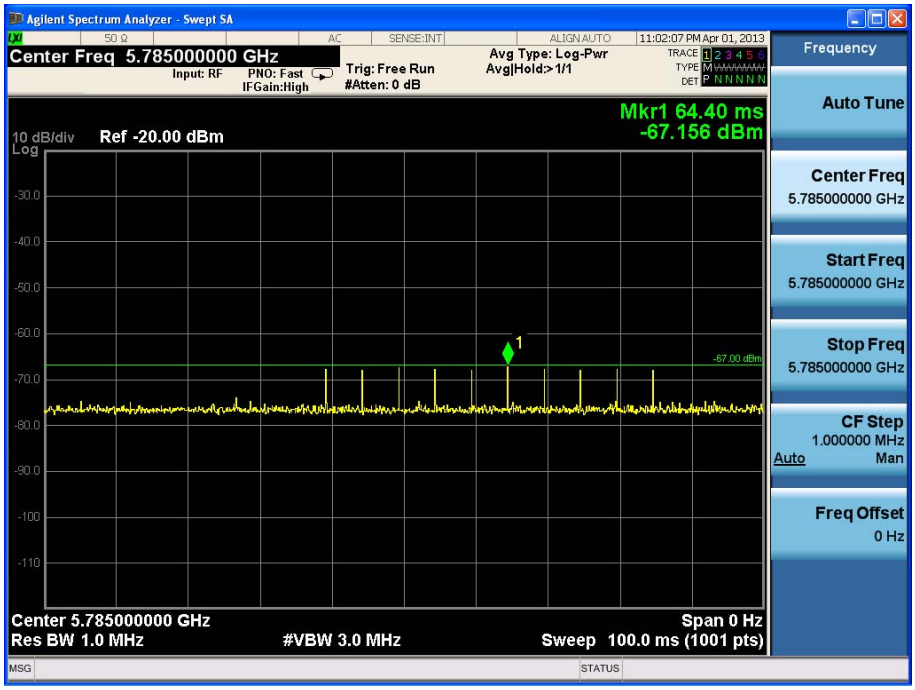
The signal generator amplitude was set so that the power level measured at the spectrum analyzer was -55dBm due to the interference threshold level is not required.

Conducted Calibration Setup

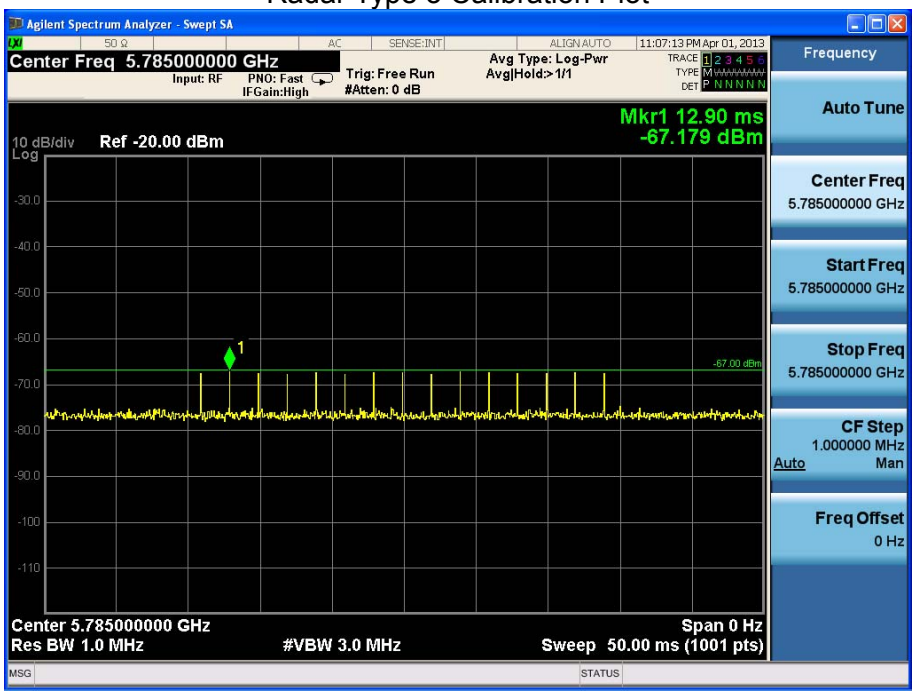


Radar Type 1 Calibration Plot

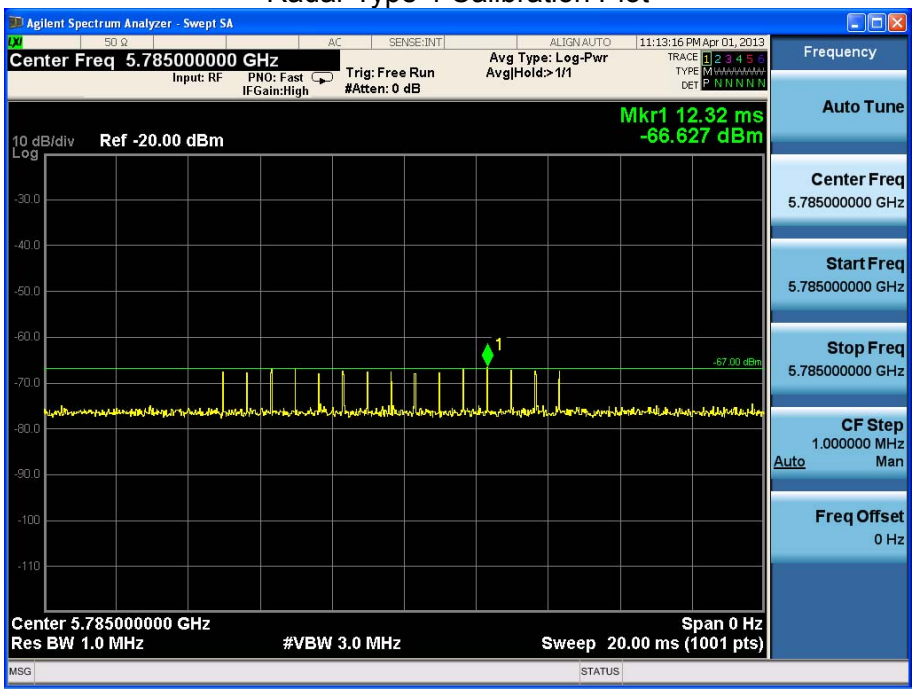
Radar Type 2 Calibration Plot



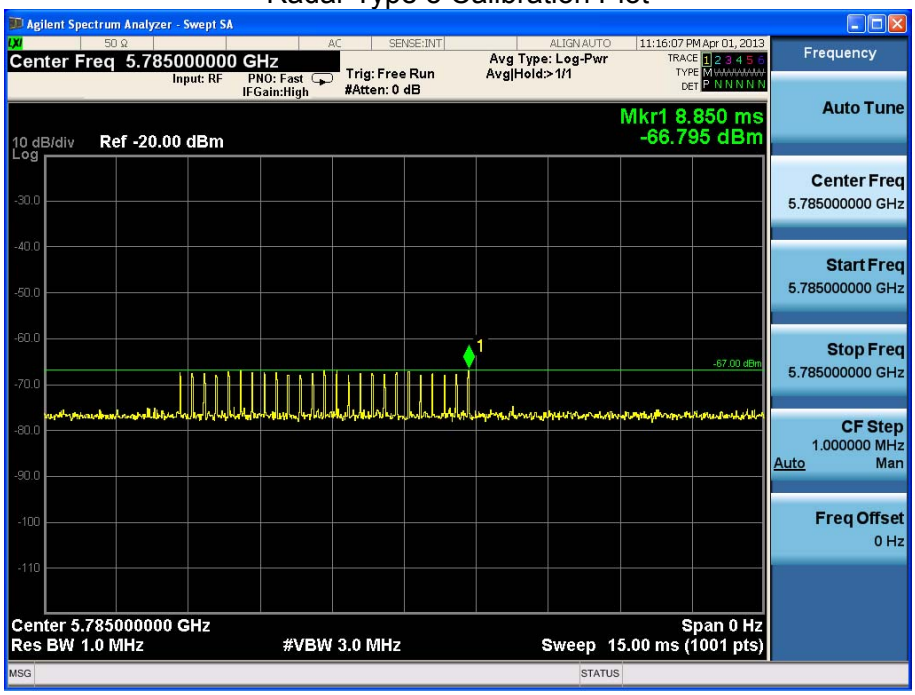
Radar Type 3 Calibration Plot



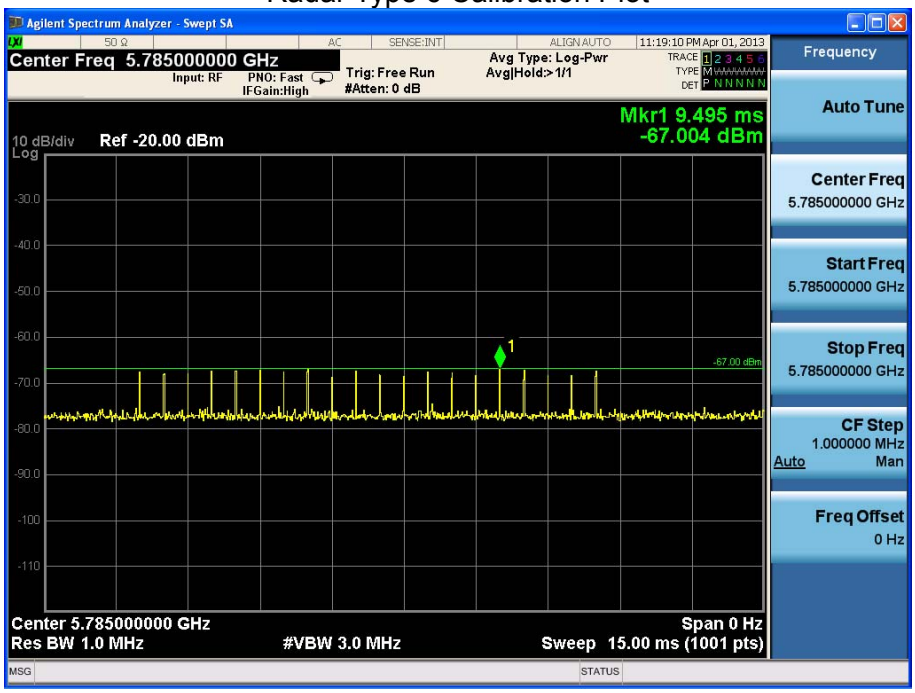
Radar Type 4 Calibration Plot



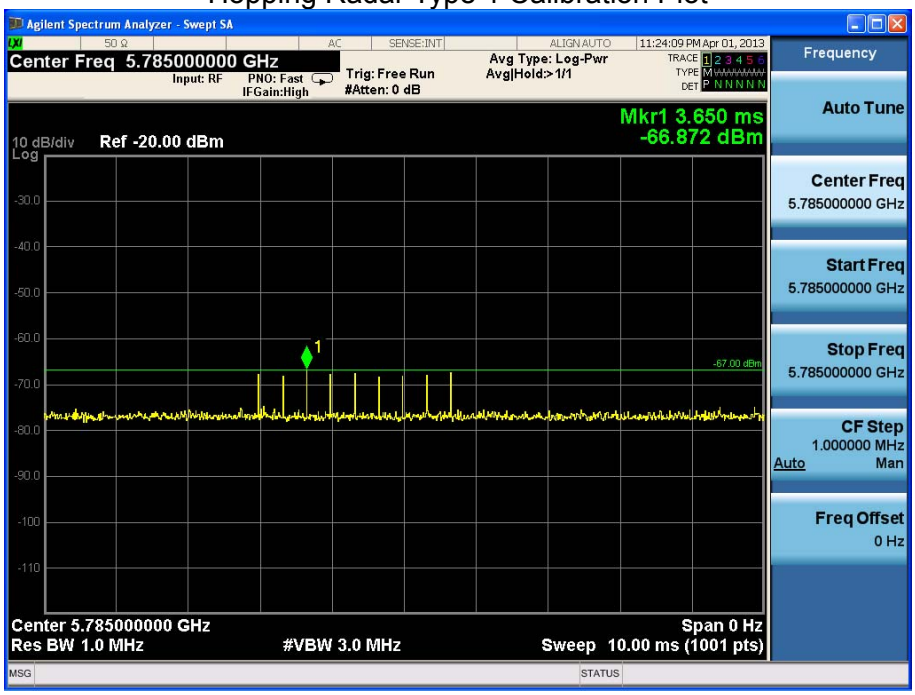
Radar Type 5 Calibration Plot



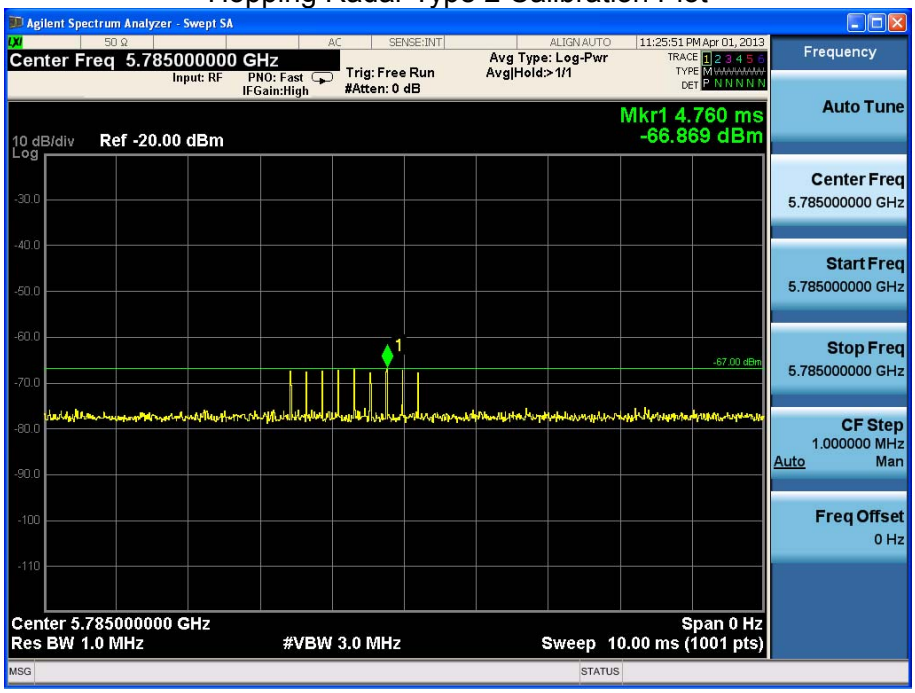
Radar Type 6 Calibration Plot



Hopping Radar Type 1 Calibration Plot



Hopping Radar Type 2 Calibration Plot



7. Test Procedure

For a UUT with antenna connector(s) and using dedicated external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector provided, conducted measurements shall be used.

The UUT shall be configured to operate at P_{cond_1}.

The output power of the signal generator producing the radar test signals, as selected using clause 5.3.6.1.1, shall (unless otherwise specified) provide a received signal power at the antenna connector of the UUT with a level equal to (*Interference Detection Threshold* + G), see table D.2. Parameter G [dBi] corresponds to the gain of the antenna assembly stated by the manufacturer. If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the lowest gain shall be used.

A channel shall be selected in accordance with clause 5.1.3. This channel is designated as Ch_r (channel occupied by a radar). The UUT shall be configured to select Ch_r as the first Operating Channel.

About details of each test items, please refer to ETSI EN301893 V1.7.1 Clause 5.3.8.2.1.1 ~ 5.3.8.2.1.5.

8. Test Result

8.1. Channel Available Check

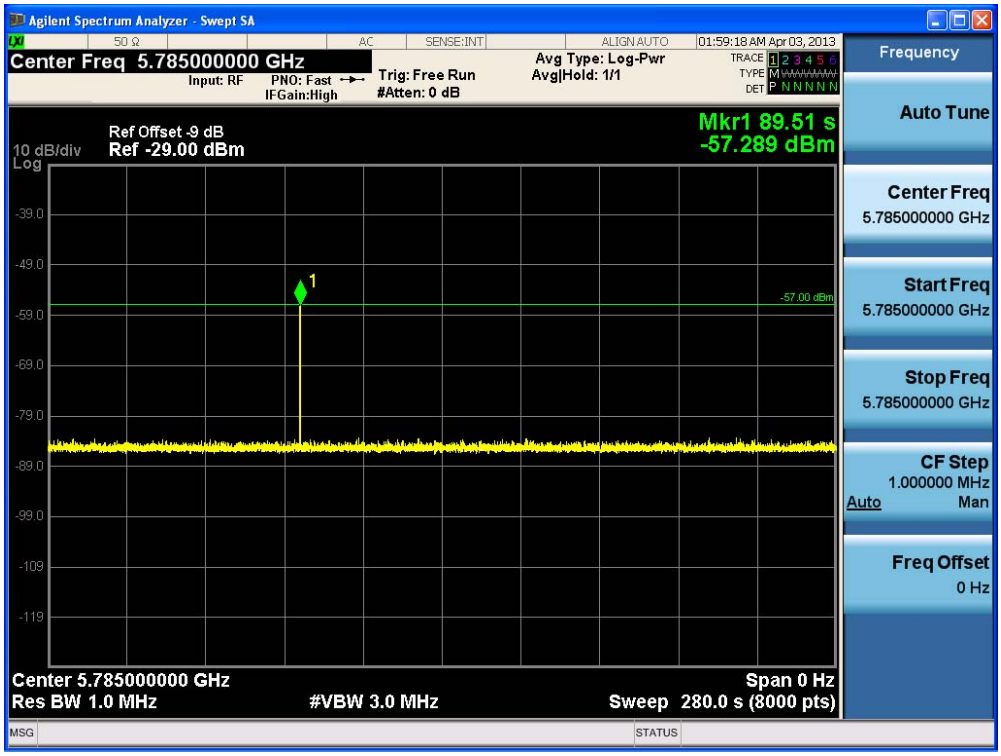
8.1.1. Test result with a radar burst at the beginning of the Channel Availability Check Time

802.11a channel 157 5785MHz

Test Item	Limit	Results
Channel Availability Check Time 5725~5850MHz	60 s	Pass

8.1.2. Test result with radar burst at the end of the Channel Availability Check Time

802.11a channel 157 5785MHz



Test Item	Limit	Results
Channel Availability Check Time 5725~5850MHz	60 s	Pass

8.2. Radar Detection Threshold (during the Channel Availability Check)

802.11a channel 157 5785MHz

Radar Wave Type	Detection Threshold	Trail Number	Detection Result	Limit	Note
Type 1	-57dBm	20	100%	60%	Pass
Type 2	-57dBm	20	100%	60%	Pass
Type 3	-57dBm	20	100%	60%	Pass
Type 4	-57dBm	20	100%	60%	Pass
Type 5	-57dBm	20	100%	60%	Pass
Type 6	-57dBm	20	100%	60%	Pass
Hopping Type 1	-57dBm	20	100%	60%	Pass
Hopping Type 2	-57dBm	20	100%	60%	Pass

8.3. In-Service Monitoring

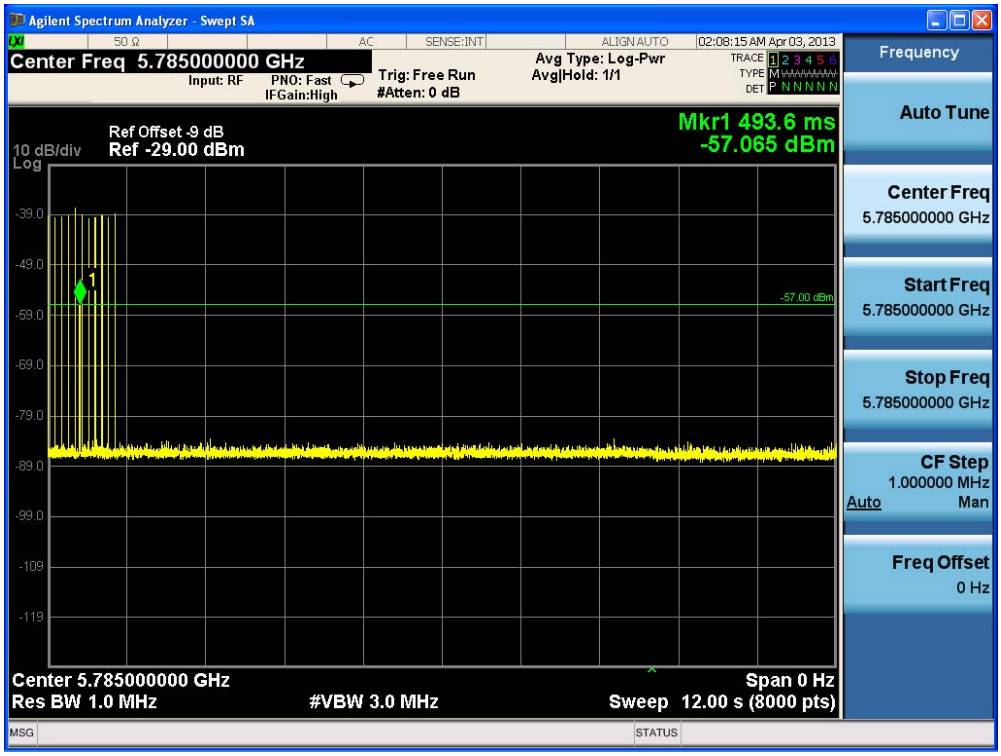
802.11a channel 157 5785MHz

Radar Wave Type	Detection Threshold	Trail Number	Detection Result	Limit	Note
Type 1	-57dBm	20	100%	60%	Pass
Type 2	-57dBm	20	100%	60%	Pass
Type 3	-57dBm	20	100%	60%	Pass
Type 4	-57dBm	20	100%	60%	Pass
Type 5	-57dBm	20	100%	60%	Pass
Type 6	-57dBm	20	100%	60%	Pass
Hopping Type 1	-57dBm	20	100%	60%	Pass
Hopping Type 2	-57dBm	20	100%	60%	Pass

8.4. Channel Shutdown and Non-Occupancy period

8.4.1. Channel Closing Transmission Time and Channel Move Time

802.11a channel 157 5785MHz



Test Item	Limit	Results
Channel Move Time	10 s	Pass
Channel Closing Transmission Time	260 ms	Pass

8.4.2. Non-Occupancy Period

802.11a channel 157 5785MHz

Test Item	Limit	Results
Non-Occupancy Period	30 minutes	Pass

8.5. Off-Channel CAC

8.5.1. Radar Detection Threshold (during Off-Channel CAC)

This device didn't support Off-Channel CAC mechanism, so it was not performed.

8.5.2. Detection Probability (Pd)

This device didn't support Off-Channel CAC mechanism, so it was not performed.

8.6. Uniform Spreading

The working channel is selected by software control mechanism to ensure that each of declared channels makes use of at least 60 % of the spectrum available in the applicable sub-bands. Each of the Usable Channels is used with approximately equal probability.

8.7. User Access Restriction

The manufacturer doesn't allow user to disable or alter the DFS detect function through neither hardware nor software. User website will not support fixed operation channel configuration in DFS band.