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DFS TEST REPORT

REPORT NO.: RF990819E02-2

MODEL NO.: RT3593

RECEIVED: Aug. 19, 2010

TESTED: Sep. 09, 2010

ISSUED: Sep. 17, 2010

APPLICANT: Ralink Technology Corporation

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1. LAB DECLARATION

PRODUCT: 802.11a/b/g/n 3T3R WLAN Mini Card

MODEL: RT3593

BRAND: Ralink

APPLICANT: Ralink Technology Corporation

TESTED: Sep. 09, 2010

TEST SAMPLE: MASS-PRODUCTION

STANDARDS: FCC Part 15, Subpart E (Section 15.407)

FCC 06-96

The above equipment (model: RT3593) has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

PREPARED BY : Midoli Peng , **DATE:** Sep. 17, 2010
(Midoli Peng, Specialist)

TECHNICAL ACCEPTANCE : Hank Chung , **DATE:** Sep. 17, 2010
(Hank Chung, Deputy Manager)

APPROVED BY : May Chen , **DATE:** Sep. 17, 2010
(May Chen, Deputy Manager)

2. EUT INFORMATION

2.1 OPERATING FREQUENCY BANDS AND MODE OF EUT

TABLE 1: OPERATING FREQUENCY BANDS AND MODE OF EUT

OPERATIONAL MODE	OPERATING FREQUENCY RANGE	
	5250~5350MHz	5470~5725MHz
Client without radar detection and ad hoc function	✓	✓

2.2 EUT SOFTWARE AND FIRMWARE VERSION

TABLE 2: THE EUT SOFTWARE/FIRMWARE VERSION

NO.	PRODUCT	MODEL NO.	SOFTWARE/FIRMWARE VERSION
1	802.11a/b/g/n 3T3R WLAN Mini Card	RT3593	3.1.50.5

2.3 DESCRIPTION OF AVAILABLE ANTENNAS TO THE EUT

TABLE 3: ANTENNA LIST

Set 1				
Chain	Model name	Antenna Type	Operation Frequency Range (MHz)	Antenna Gain (dBi)
Chain (0)	TWX-614XRSXX-999	Dipole	5150 – 5850 MHz	5
Chain (1)	TWX-614XRSXX-999	Dipole	5150 – 5850 MHz	5
Chain (2)	TWX-614XRSXX-999	Dipole	5150 – 5850 MHz	5
Set 2				
Chain	Model name	Antenna Type	5150 – 5850 MHz	Antenna Gain (dBi)
Chain (0)	APP6P-700119	PIFA	5150 – 5850 MHz	5.01
Chain (1)	APP6P-700119	PIFA	5150 – 5850 MHz	5.01
Chain (2)	APP6P-700119	PIFA	5150 – 5850 MHz	5.01

2.4 EUT MAXIMUM CONDUCTED POWER

TABLE 4: THE MEASURED CONDUCTED OUTPUT POWER

IEEE 802.11a

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	19.4	87.1
Set 2	5470~5725	19.2	83.2

802.11n (20MHz)

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	21.9	153.9
Set 2	5470~5725	21.5	141.7

802.11n (40MHz)

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	21.8	151.6
Set 2	5470~5725	21.4	139.5

2.5 EUT MAXIMUM E.I.R.P. POWER

TABLE 5: THE E.I.R.P OUTPUT POWER LIST

IEEE 802.11a

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	24.41	276.06
Set 2	5470~5725	24.21	263.63

802.11n (20MHz)

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	26.91	490.91
Set 2	5470~5725	26.51	447.71

802.11n (40MHz)

ANT NO.	FREQUENCY BAND (MHz)	MAX. POWER	
		OUTPUT POWER(dBm)	OUTPUT POWER(mW)
Set 2	5250~5350	26.81	479.73
Set 2	5470~5725	26.41	437.52

2.6 TRANSMIT POWER CONTROL (TPC)

U-NII devices operating in the 5.25-5.35 GHz band and the 5.47-5.725 GHz band shall employ a TPC mechanism. The U-NII device is required to have the capability to operate at least 6 dB below the mean EIRP value of 30 dBm. A TPC mechanism is not required for systems with an e.i.r.p. of less than 500 mW.

Maximum E.I.R.P of this device is 490.91mW which less than 500mW, therefore it's not require TPC function.

2.7 STATEMENT OF MAUNFACTURER

This device (Client) is without radar detection, then the manufacturer statement confirming that information regarding the parameters of the detected Radar Waveforms is not available to the end user. **And the device doesn't have Ad Hoc mode on DFS frequency band.**

3. U-NII DFS RULE REQUIREMENTS

3.1 WORKING MODES AND REQUIRED TEST ITEMS

The manufacturer shall state whether the UUT is capable of operating as a Master and/or a Client. If the UUT is capable of operating in more than one operating mode then each operating mode shall be tested separately. See tables 1 and 2 for the applicability of DFS requirements for each of the operational modes.

TABLE 6: APPLICABILITY OF DFS REQUIREMENTS PRIOR TO USE A CHANNEL

REQUIREMENT	OPERATIONAL MODE		
	MASTER	CLIENT WITHOUT RADAR DETECTION	CLIENT WITH RADAR DETECTION
Non-Occupancy Period	✓	✓	✓
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	✓

TABLE 7: APPLICABILITY OF DFS REQUIREMENTS DURING NORMAL OPERATION

REQUIREMENT	OPERATIONAL MODE		
	MASTER	CLIENT WITHOUT RADAR DETECTION	CLIENT WITH RADAR DETECTION
DFS Detection Threshold	✓	Not required	✓
Channel Closing Transmission Time	✓	✓	✓
Channel Move Time	✓	✓	✓
U-NII Detection Bandwidth	✓	Not required	✓

3.2 TEST LIMITS AND RADAR SIGNAL PARAMETERS

DETECTION THRESHOLD VALUES

TABLE 8: DFS DETECTION THRESHOLDS FOR MASTER DEVICES AND CLIENT DEVICES WITH RADAR DETECTION

MAXIMUM TRANSMIT POWER	VALUE (SEE Note 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.

TABLE 9: DFS RESPONSE REQUIREMENT VALUES

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 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 80% of the UNII 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 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.

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.

PARAMETERS OF DFS TEST SIGNALS

Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

TABLE 10: SHORT PULSE RADAR TEST WAVEFORMS

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

**A D T****TABLE 11: LONG PULSE RADAR TEST WAVEFORM**

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

TABLE 12: FREQUENCY HOPPING RADAR TEST WAVEFORM

RADAR TYPE	PULSE WIDTH (μsec)	PRI (μsec)	PULSES PER HOP	HOPPING RATE (kHz)	HOPPING SEQUENCE LENGTH (msec)	MINIMUM PERCENTAGE OF SUCCESSFUL DETECTION	MINIMUM NUMBER OF TRIALS
6	1	333	9	0.333	300	70%	30

4. TEST & SUPPORT EQUIPMENT LIST

4.1 TEST INSTRUMENTS

TABLE 1: TEST INSTRUMENTS LIST.

DESCRIPTION & MANUFACTURER	MODEL NO.	BRAND	CALIBRATED UNTIL
R&S Spectrum analyzer	FSP40	R&S	May 16, 2011
Signal generator	8645A	Agilent	Sep. 02, 2011
Oscilloscope	TDS 5104	Tektronix	May 18, 2011

4.2 DESCRIPTION OF SUPPORT UNITS

TABLE 2: SUPPORT UNIT INFORMATION.

NO.	PRODUCT	BRAND	MODEL NO.	ID	SPEC.
1	802.11a/b/g/n Access Point	Cisco	AIR-AP1252A G-A-K9	LDK102061	The maximum EIRP is 26 dBm, Antenna Gain is 3.5dBi

NOTE: This device was functioned as a ☒ Master ☐ Slave device during the DFS test.

TABLE 3: SOFTWARE/FIRMWARE INFORMATION.

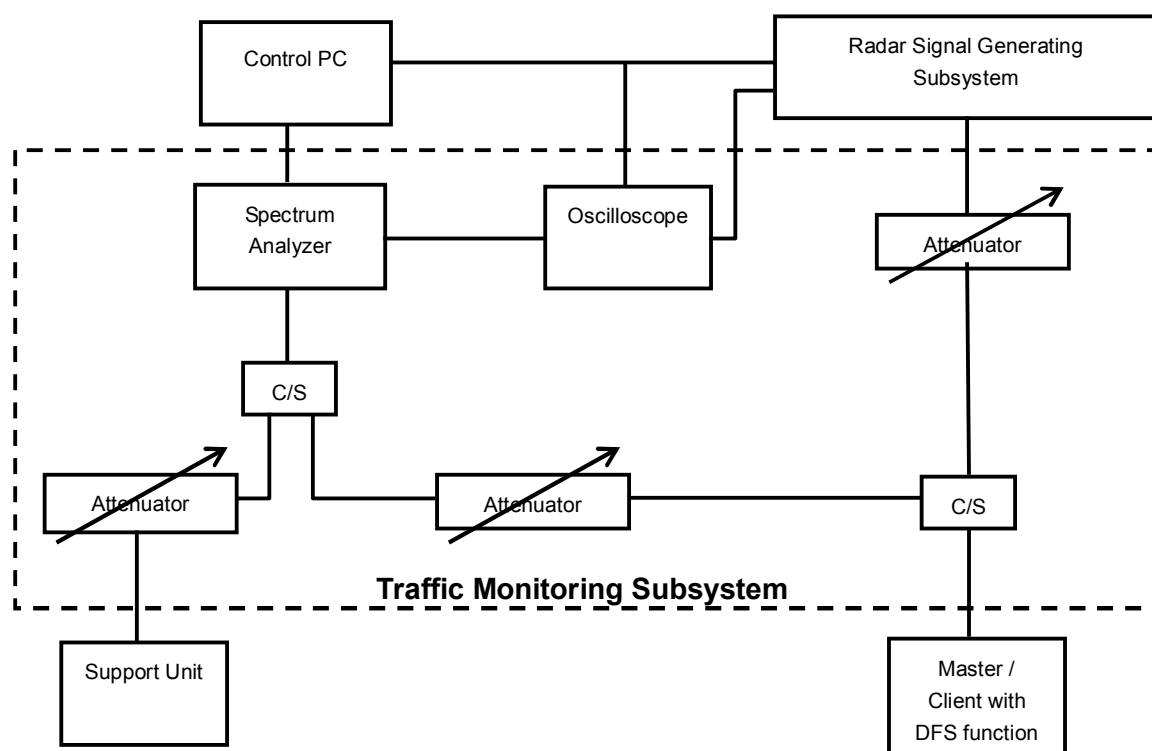
NO.	PRODUCT	MODEL NO.	SOFTWARE/FIRMWARE VERSION
1.	802.11a/b/g/n Access Point	AIR-AP1252AG-A-K9	12.4(10b)JA1

5. TEST PROCEDURE

5.1 ADT DFS MEASUREMENT SYSTEM:

A complete ADT DFS Measurement System consists of two subsystems: (1) the Radar Signal Generating Subsystem and (2) the Traffic Monitoring Subsystem. The control PC is necessary for generating the Radar waveforms in Table 6, 7 and 8. The traffic monitoring subsystem is specified to the type of unit under test (UUT).

CONDUCTED SETUP CONFIGURATION OF ADT DFS MEASUREMENT SYSTEM



The test transmission will always be from the Master Device to the Client Device. While the Client device is set up to associate with the Master device and play the MPEG file (6 $\frac{1}{2}$ Magic Hours) from Master device, the designated MPEG test file and instructions are located at:

<http://ntiacsd.ntia.doc.gov/dfs/>.

The measured channel is 5500 MHz. The radar signal was the same as transmitted channels, and injected into the antenna port of AP (master) or Client Device with Radar Detection, measured the channel closing transmission time and channel move time. The Master antenna gain is 3.5dBi and required detection threshold is -59.5dBm ($= -64 + 1 + 3.5$)dBm. The calibrated conducted detection threshold level is set to -59.5 dBm.

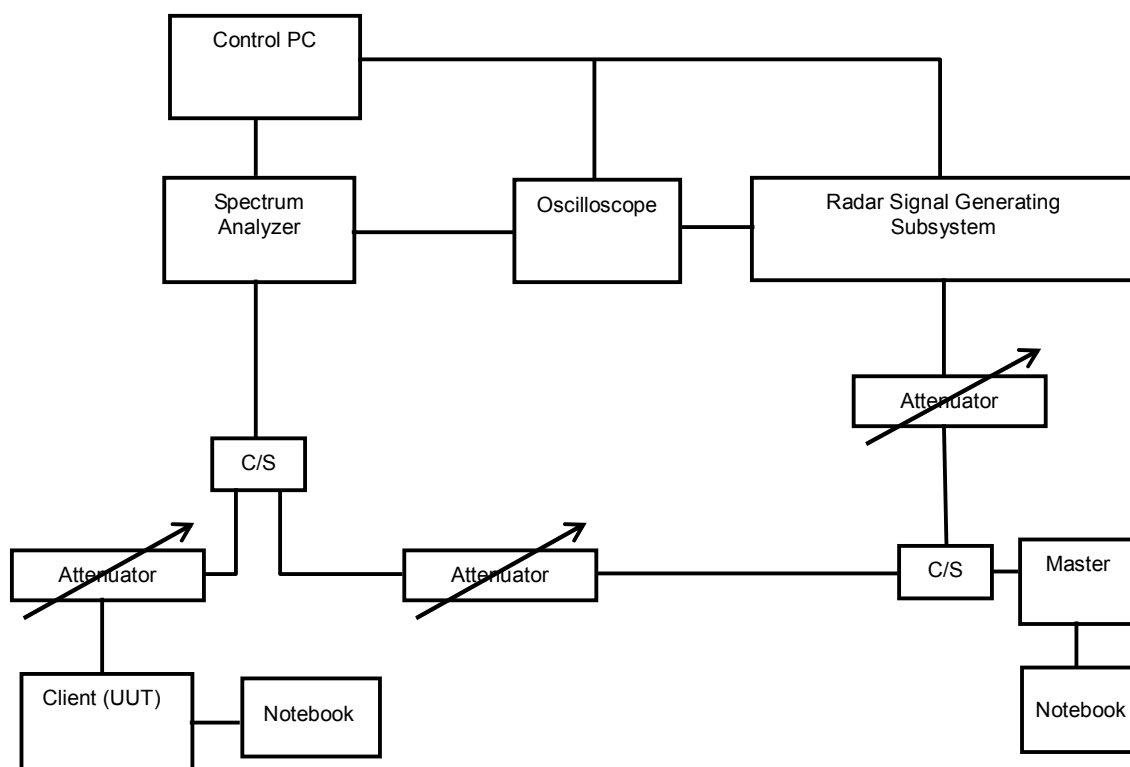
The diagram illustrates the test setup for the radar system. A Control PC is connected to a Spectrum Analyzer, an Oscilloscope, and a Radar Signal Generating Subsystem. The Spectrum Analyzer is also connected to the Oscilloscope. The Radar Signal Generating Subsystem is connected to an Attenuator, which is then connected to a C/S (Circulator/ Switch) block. The C/S block is connected to a 50Ω Load (Terminator) and another C/S block. The second C/S block is connected to another Attenuator, which is then connected to a 50Ω Load (Terminator). The 50Ω Load (Terminator) is also connected to the Spectrum Analyzer. The Attenuators are marked with a diagonal line through them, indicating they are variable or adjustable.

5.3 DEVIATION FROM TEST STANDARD

No deviation.

5.4 CONDUCTED TEST SETUP CONFIGURATION

5.4.1 CLIENT WITHOUT RADAR DETECTION MODE



The UUT is a U-NII Device operating in Client mode without radar detection. The radar test signals are injected into the Master Device.

6. TEST RESULTS

6.1 SUMMARY OF TEST RESULTS

CLAUSE	TEST PARAMETER	REMARKS	PASS/FAIL
15.407	DFS Detection Threshold	Not Applicable	NA
15.407	Channel Availability Check Time	Not Applicable	NA
15.407	Channel Move Time	Applicable	Pass
15.407	Channel Closing Transmission Time	Applicable	Pass
15.407	Non- Occupancy Period	Applicable	Pass
15.407	Uniform Spreading	Not Applicable	NA
15.407	U-NII Detection Bandwidth	Not Applicable	NA
15.407	Non-associated test	Applicable	Pass
15.407	Non-Co-Channel test	Applicable	Pass

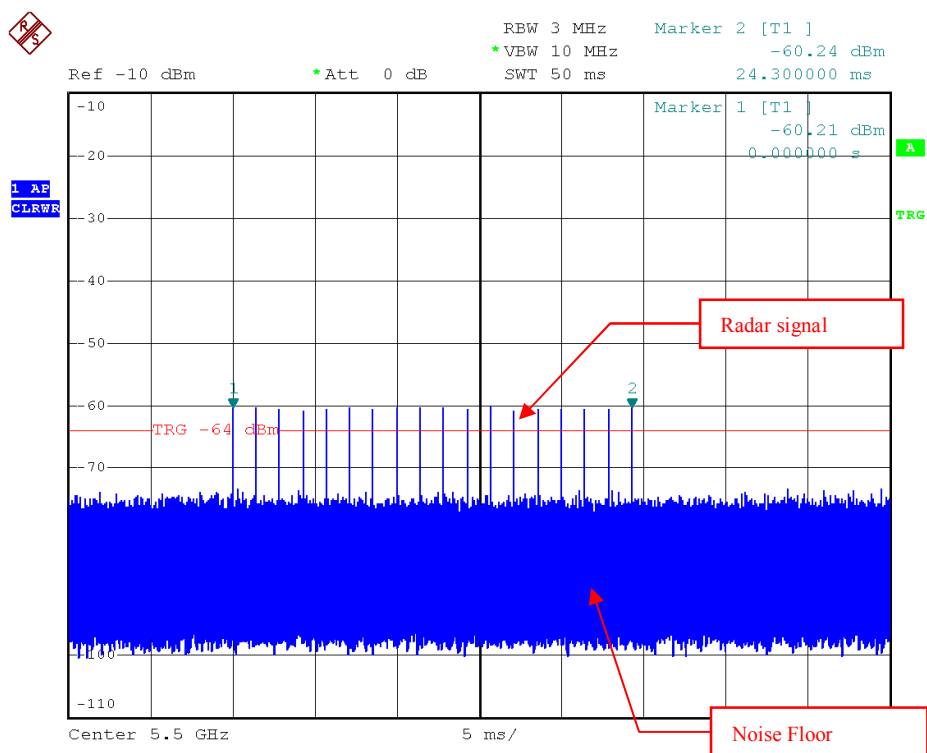
6.2 DETAIL TEST RESULTS

6.2.1 TEST MODE: DEVICE OPERATING IN CLIENT WITHOUT RADAR DETECTION MODE.

Client with injection at the Master. (The radar test signals are injected into the Master Device.

6.2.1.1 DFS DETECTION THRESHOLD

For a detection threshold level of -64dBm and the Master antenna gain is 3.5dBi . The Required detection threshold is -59.5dBm ($= -64 + 1 + 3.5$) dBm . The conducted radar burst level is set to -59.5dBm .

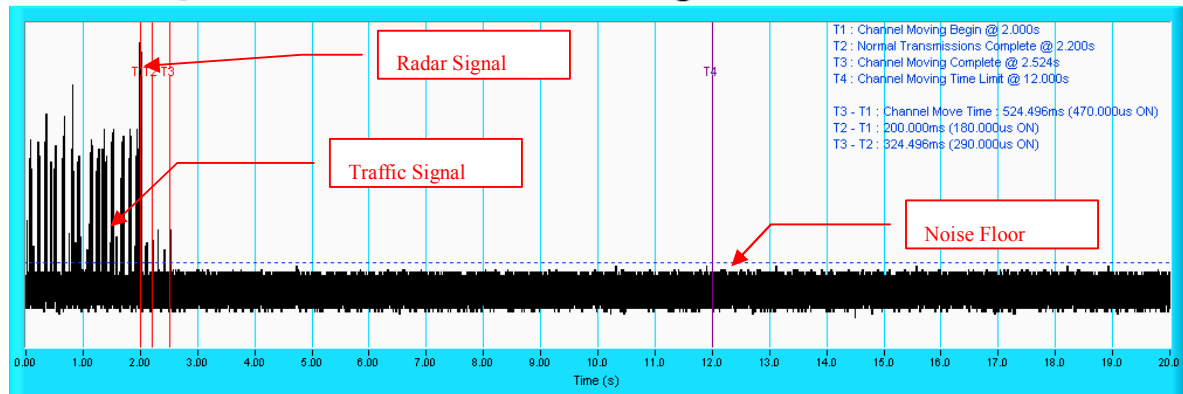


Radar Signal 1

6.2.1.2 CHANNEL CLOSING TRANSMISSION AND CHANNEL MOVE TIME

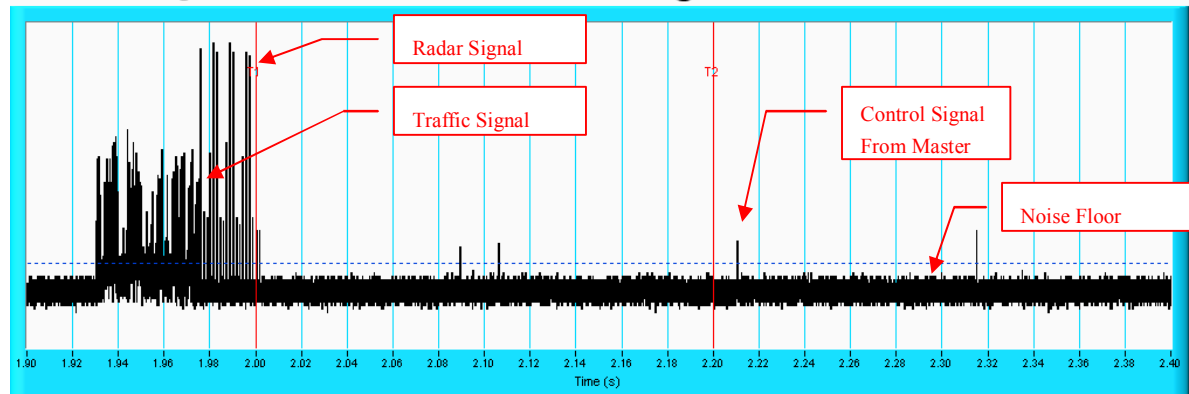
802.11n (20MHz)

Channel Closing Transmission Time & Channel Move Time @ CH100 - 5500MHz



NOTE: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

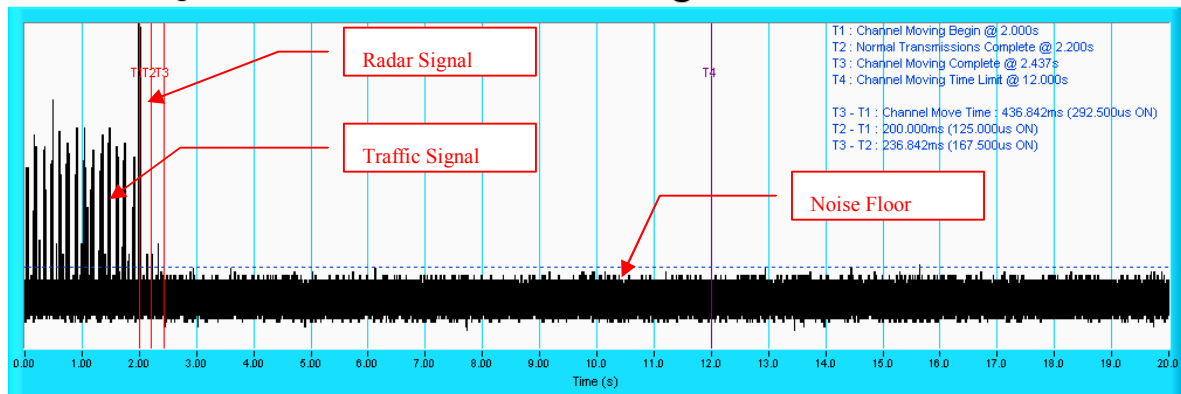
Channel Closing Transmission Time & Channel Move Time @ CH100 - 5500MHz



NOTE: An expanded plot for the device vacates the channel in the required 200ms.

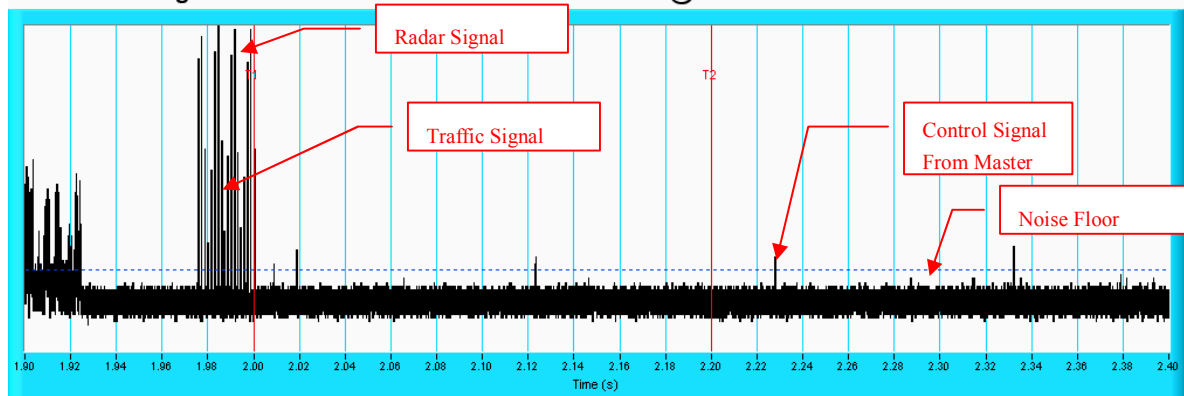
802.11n (40MHz)

Channel Closing Transmission Time & Channel Move Time @ CH102 - 5510MHz



NOTE: T1 denotes the start of Channel Move Time upon the end of the last Radar burst. T2 denotes the data transmission time of 200ms from T1. T4 denotes the 10 second from T1 to observe the aggregate duration of transmissions.

Channel Closing Transmission Time & Channel Move Time @ CH102 - 5510MHz

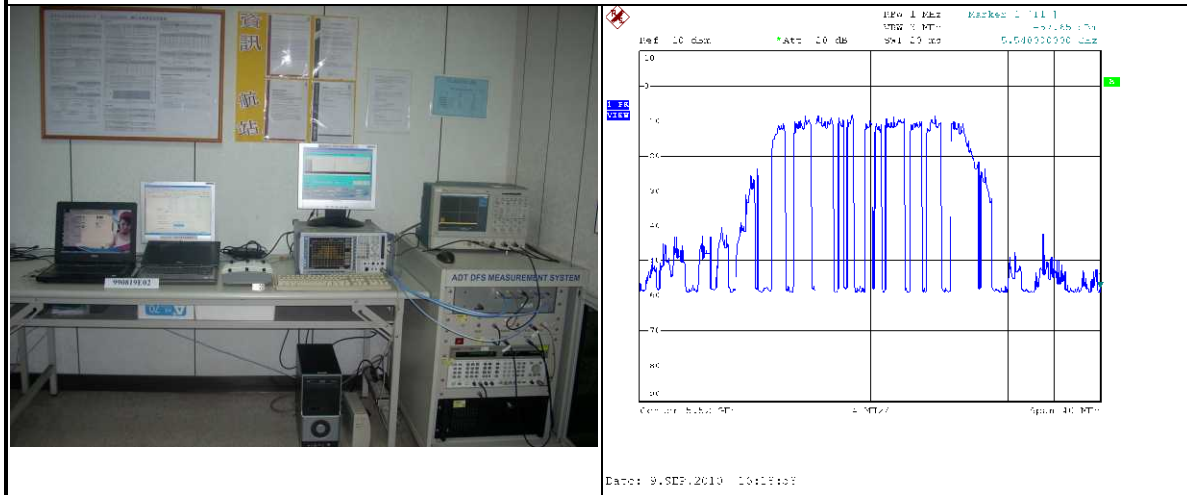


NOTE: An expanded plot for the device vacates the channel in the required 200ms.

6.2.1.3 NON- OCCUPANCY PERIOD

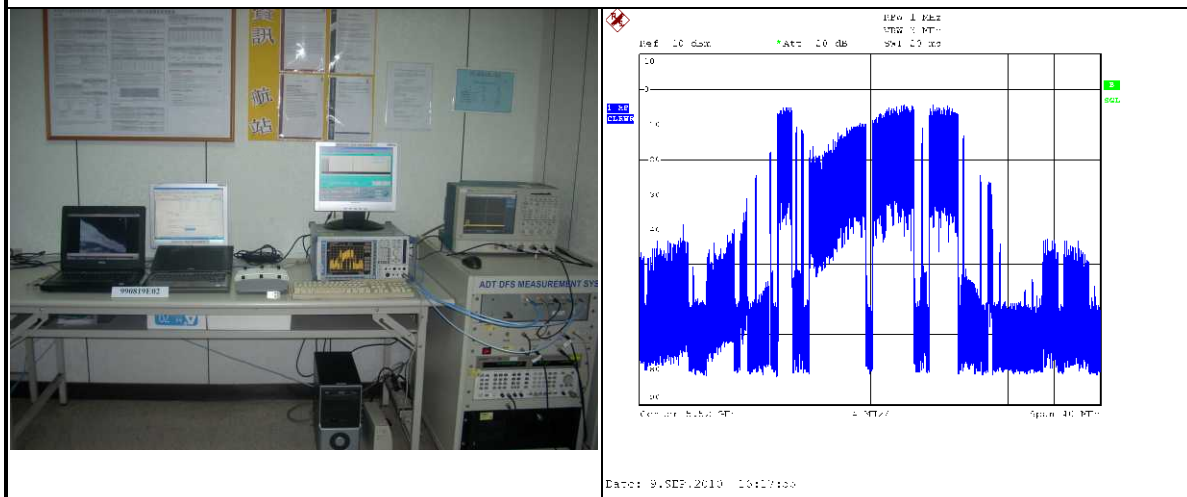
ASSOCIATED TEST

1) Test results demonstrating an associated client link is established with the master on a test frequency.



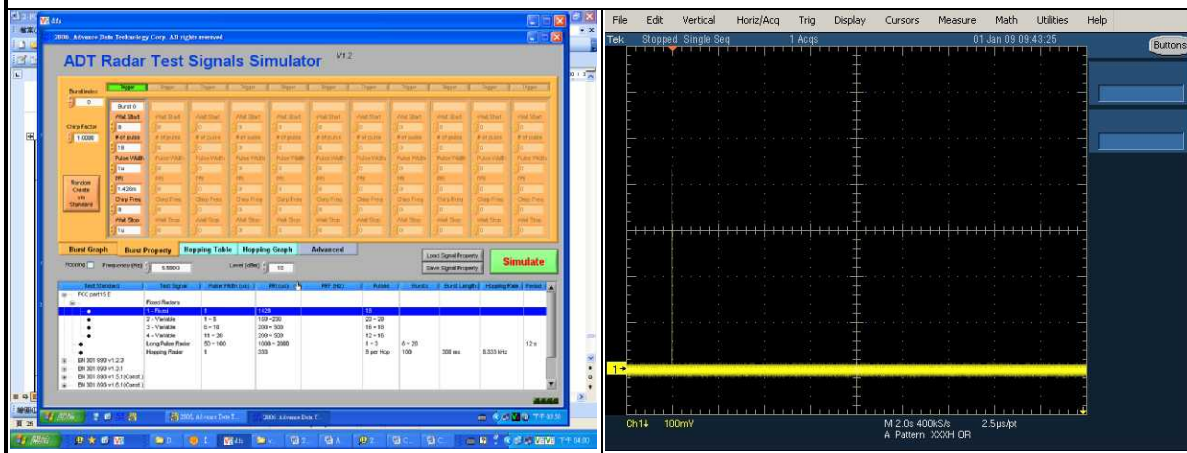
EUT (Client) links with master on 5520MHz

2) The client and DFS-certified master device are associated, and the movie can be streamed as specified in the DFS Order for a non-occupancy period test.



Client plays a specified files via master.

3). The device transmits one type of radar as specified in the DFS Order.



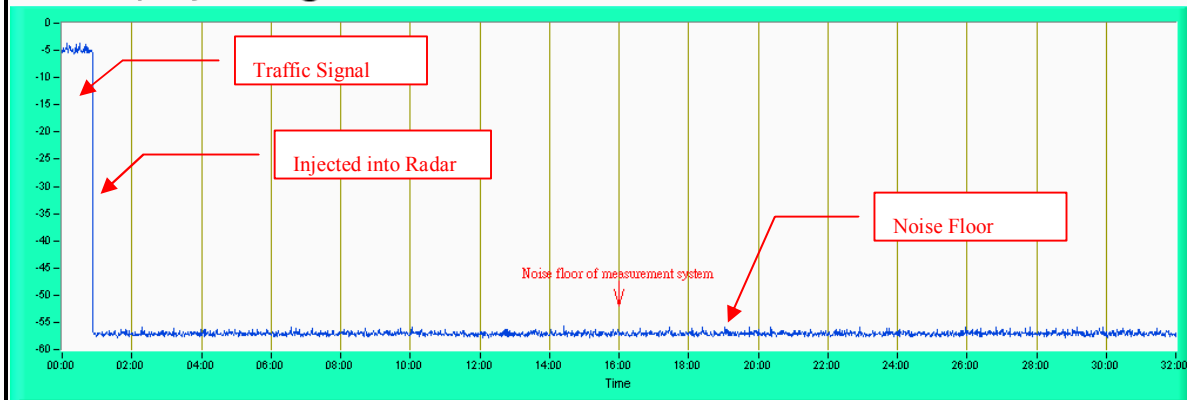
Radar 1 is used to test during DFS testing.

4) The test frequency has been monitored to ensure no transmission of any type has occurred for 30 minutes;

Note: If the client moves with the master, the device is considered compliant if nothing appears in the client nonoccupancy period test. For devices that shut down (rather than moving channels), no beacons should appear;

5)An analyzer plot that contains a single 30-minute sweep on the original test frequency.

Non - Occupancy Period @ CH100 - 5500MHz

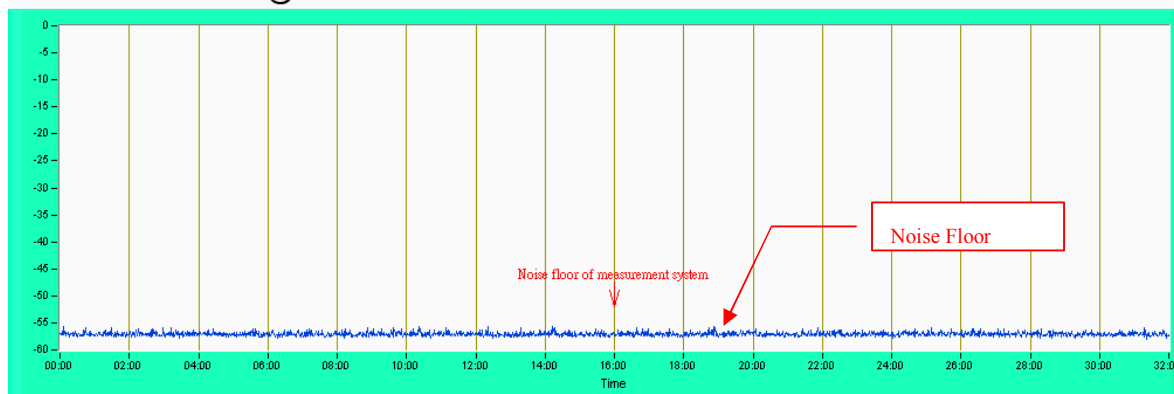


NON-ASSOCIATED TEST

Master was off.

During the 30 minutes observation time, The UUT did not make any transmissions in the DFS band after UUT power up.

Non - Associated Test @ CH100 - 5500MHz



6.2.1.4 NON- CO-CHANNEL TEST

The UUT was investigated after radar was detected the channel and made sure no co-channel operation with radars.



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7. INFORMATION ON THE TESTING LABORATORIES

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

Copies of accreditation certificates of our laboratories obtained from approval agencies can be downloaded from our web site:
www.adt.com.tw/index.5/phtml. If you have any comments, please feel free to contact us at the following:

Linko EMC/RF Lab:
Tel: 886-2-26052180
Fax: 886-2-26052943

Hsin Chu EMC/RF Lab:
Tel: 886-3-5935343
Fax: 886-3-5935342

Hwa Ya EMC/RF/Safety Telecom Lab:
Tel: 886-3-3183232
Fax: 886-3-3185050

Web Site: www.adt.com.tw

The address and road map of all our labs can be found in our web site also.



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8. APPENDIX A - MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications are made to the EUT by the lab during the test.

--- END ---