DFS TEST REPORT

Test Report No.	: TK-FR11014
Date of Issue	: 04/07/2011
Description of Product	: 5G-WiFi
FCC ID	: **ZD7DNMM-K1**
Model No.	: DNMM-K1
Applicant	: Nimbus, Inc. Suite 619 Hanshin S-meca,1359, Gwanpyeong-dong, Yuseong-g, Daejeon, Korea
Manufacturer	: **Wistron NeWeb Corp.** NO. 10-1, Lin-hsin I Road, Science-Based Industry Park, Hsinchu 300, Taiwan, R.O.C
Standards	: FCC Part 15 Subpart E §15.407
Test Date	: 03/30/2011 ~ 05/18/2011
Test Results	: ☒ **PASS** ☐ **FAIL**

The test results relate only to the items tested.

Tested by:
Kyu-Chul Shin
Test Engineer
Date:05/18/2011

Reviewed by:
KT Kang
Technical Manager
Date: 05/18/2011

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1.0 General Product Description

Equipment model name	: DNMM-K1
Serial number	: Prototype
EUT condition	: Pre-production, not damaged
Antenna type	: External Antenna (Supporting MIMO) : Dipole antenna Gain 3.94dBi
Frequency Range	: 5250MHz ~ 5350MHz
RF output power(HT40)	:13.10 dBm Conducted Peak Power
Number of channels	: 2CH
Channel Spacing	: 40 MHz
Transfer Rate	: 270Mbps
Type of Modulation	: 64-QAM for OFDM _ Only HT40
Power Source	: DC 3.3V

1.1 Tested Frequency

Band		CH	Test Frequency
Band 1	5250 ~ 5350	54	5270
		62	5310

2.0 TEST RESULTS

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 operating mode shall be tested separately. See tabes1 for the applicability of DFS requirements for each of the operational modes.

Table 1

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**	○

* In client(slave) mode, the Nimbus 802.11n adapter has no Support for radar detection

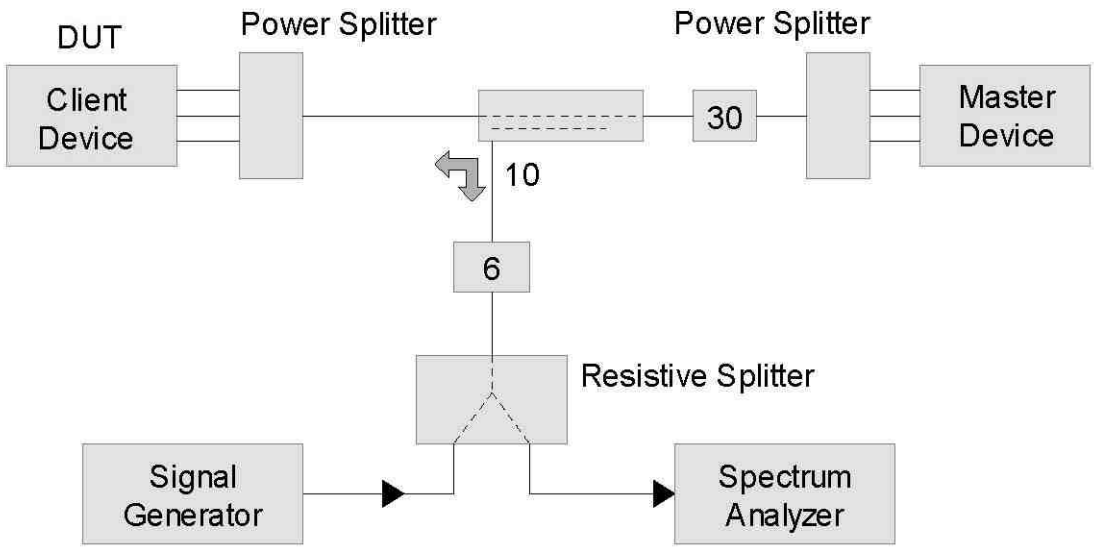
2.1 Operating Frequency of U-NII Device

Table 23: Operating frequency range of UUT

Operational Mode	Operating Frequency Range
	5250~5350MHz
Master	Not Apply
Client without radar detection	O
Client with radar detection	Not Apply

Test Procedure

Conducted setup configuration of DFS Measurement System



- DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note1
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 Note3.

Note1: 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.

Not 3: During the U-NII Detection Bandwidth detection test, radar type1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

EQUIPMENT UNDER TEST (EUT) DETAILS

Operating Modes (5250-5350 MHz)

☐ Master Device

☒ Client Device (no In Service Monitoring, no Ad-Hoc mode)

☐ Client Device with In-Service Monitoring

Antenna Gain / EIRP (5250-5350 MHz)

	5250-5350 MHz
Highest Antenna Gain(dBi)	3.94

☐ Power can exceed 200mW eirp

Channel Protocol

☒ IP Based

☐ Frame Based

☐ OTHER _____

SUPPORT EQUIPMENT
The following equipment was used as local support equipment for testing :

Manufacturer	Model	Description	Serial Number	FCC ID
Wistron NeWeb Corp.	L D N M M – K 1	EUT	-	-
Lenovo(Singapore)Pte.Ltd.	2 9 5 7	Notebook	-	DoC
L e n o v o	P A - 1 4 0 0 - 1 2	DC Power Supply		-
Netgear Incorporated.	W N D R 3 3 0 0	Master Wireless AP	-	PY308100078

The italicized device was the master device.

EUT INTERFACE PORTS
The I/O cabling configuration during testing was as follows :

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
None	-	-	-	-

EUT OPERATION
The EUT was operating with the following software. The software is secured by encryption to prevent the user from disabling the DFS function.

During the channel moving tests the system was configured with a streaming video file from the master device (sourced by the PC connected to the master device via an Ethernet interface) to the client device.

The streamed file was the "FCC" test file and the client device was using Windows Media Player Classic as required by FCC Part 15 Subpart E

RADAR WAVEFORMS

Table 1 FCC Short Pulse Radar Test Waveforms					
Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses / burst	Minimum Detection Percentage	Minimum Number of Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-50	16-18	60%	30
4	11-20	200-50	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Table 2 FCC Short Pulse Radar Test Waveforms							
Radar Type	Pulse Width (μsec)	Chirp Width (MHz)	PRI (μsec)	Pulses / burst	Number of Bursts	Minimum Detection Percentage	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 3 FCC Short Pulse Radar Test Waveforms							
Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses / Hop	Hopping Rated (kHz)	Hopping Sequence Length (msec)	Minimum Detection Percentage	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

TEST RESULTS

TEST RESULTS SUMMARY – FCC Part 15, CLIENT DEVICE

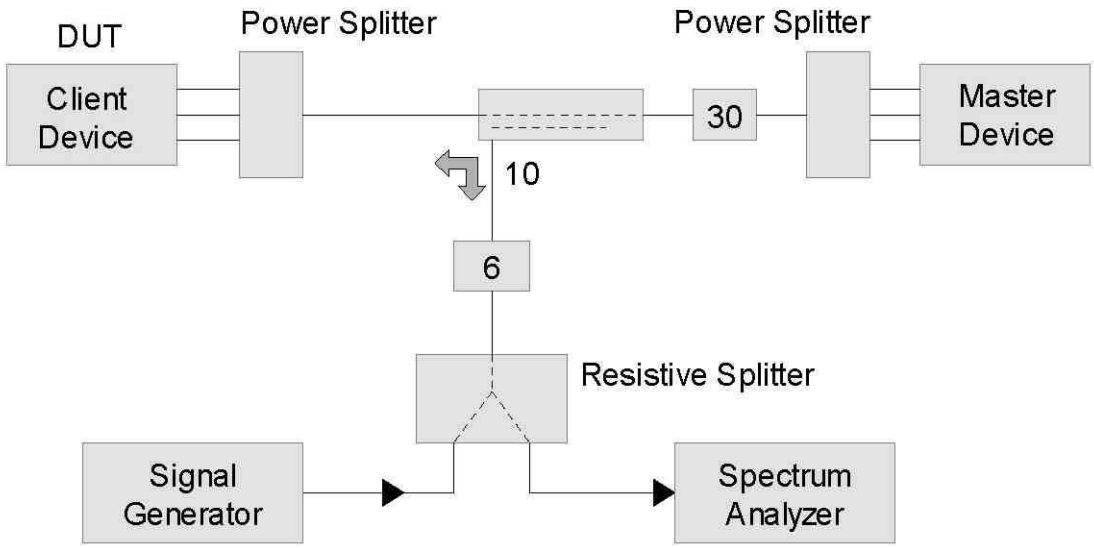
Table 4 FCC Part 15 Subpart E Client Device Test Result Summary						
Description	Radar Type	Radar Frequency	Measured Value	Requirement	Test Data	Status
Channel closing Transmission time (n40 mode)	Type 1	5270MHz	1ms	60ms	Appendix B	Complied
Channel move time (n40 mode)	Type 1	5270MHz	504ms	10s	Appendix B	Complied
Non-occupancy period – associated (n40 mode)	Type 1	5270MHz	>30 minutes	>30 minutes	Appendix B	Complied

Notes :
1) Tests were performed using the radiated test method.
2) Channel availability check, detection threshold and non-occupancy period are not applicable to client devices.

DFS TEST METHODS

Test Procedure

Conducted setup configuration of DFS Measurement System



- DFS Response Requirement Values

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Not 3: During the U-NII Detection Bandwidth detection test, radar type1 is used and for each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

The signal level of the simulated waveform is set to a reference level equal to the threshold level (plus 1 dB if testing against FCC requirements). Lower levels may also be applied on request of the manufacturer. The level reported is the level at the RDD antenna and so it is not corrected for the RDD's antenna gain. The RDD is configured with the lowest gain antenna assembly intended for use with the device.

The signal level is verified by measuring the CW signal level from the radar generation system using a reference antenna of gain G (dBi). The radar signal level is calculated from the measured level, R (dBm), and any cable loss, L (dB), between the reference antenna and the measuring instrument :

Applied level (dBm) = R – GREF + L

If both master and client devices have radar detection capability then the device not under test is positioned with absorbing material between its antenna and the radar generating antenna, and the radar level at the non RDD is verified to be at least 20dB below the threshold level to ensure that any responses are due to the RDD detecting radar.

The antenna connected to the channel monitoring subsystem is positioned to allow both master and client transmissions to be observed, with the level of the EUT's transmissions between 6 and 10dB higher than those from the other device.

DFS MEASUREMENT INSTRUMENTATION

RADAR GENERATION SYSTEM

AN R&S SMBV2100A is used as the radar-generating source. The integral arbitrary waveform generators are programmed using Agilent's "Pulse Building" software and Elliott custom software to produce the required waveforms, with the capability to produce both un-modulated and modulated (FM Chirp) pulses. Where there are multiple values for a specific radar parameter then the software selects a value at random and, for FCC tests, the software verifies that the resulting waveform is truly unique.

With the exception of the hopping waveforms required by the FCC's rules (see below), the radar generator is set to a single frequency within the radar detection bandwidth of the EUT. The frequency is varied from trial to trial by stepping in 5MHz steps.

Frequency hopping radar waveforms are simulated using a time domain model. A randomly hopping sequence algorithm (Which uses each channel in the hopping radar's range once in a hopping e\sequence) generates a hop sequence. A segment of the first 100 elements of the hop sequence are then examined to determine if it contains one or more frequencies within the radar detection bandwidth of the EUT. If it does not then the first element of the segment is discarded and the next frequency in the sequence is added. The process repeats until a valid segment is produced. The radar system is then programmed to produce bursts at time slots coincident with the frequencies within the segment that fall in the detection bandwidth. The frequency of the generator is stepped in 1 MHz increments across the EUT's detection range.

The radar signal level is verified during testing using a CW signal with the AGC function switched on. Correction factors to account for the fact that pulses are generated with the AGC functions switched off are measured annually and an offset is used to account for this in the software.

The generator output is connected to the coupling port of the conducted set-up or to the radar-generating antenna.

CHANNEL MONITORING SYSTEM

Channel monitoring is achieved using a spectrum analyzer and digital storage oscilloscope. The analyzer is configured in a zero-span mode, center frequency set to the radar waveform's frequency or the center frequency of the EUT's operating channel. The IF output of the analyzer is connected to one input of the oscilloscope.

A signal generator output is set to send either the modulating signal directly or a pulse gate with an output pulse co-incident with each radar pulse. This output is connected to a second input on the oscilloscope and the oscilloscope displays both the channel traffic (via the if input) and the radar pulses on its display.

For in service monitoring tests the analyzer sweep time is set to > 20 seconds and the oscilloscope is configured with a data record length of 10 seconds for the short duration and frequency hopping waveforms, 20 seconds for the long duration waveforms. Both instruments are set for a single acquisition sequence. The analyzer is triggered 500ms before the start of the waveform and the oscilloscope is triggered directly by the modulating pulse train. Timing measurements for aggregate channel transmission time and channel move time are made from the oscilloscope data, with the end of the waveform clearly identified by the pulse train on one trace. The analyzer trace data is used to confirm that the last transmission occurred within the 10-second record of the oscilloscope. If necessary the record length of the oscilloscope is expanded to capture the last transmission on the channel prior to the channel move.

Channel availability check time timing plots are made using the analyzer. The analyzer is triggered at start of the EUT's channel availability check and used to verify that the EUT does not transmit when radar is applied during the check time.

The analyzer detector and oscilloscope sampling mode is set to peak detect for all plots.

DFS MEASUREMENT METHODS

DFS – CHANNEL CLOSING TRANSMISSION TIME AND CHANNEL MOVE TIME

Channel clearing and closing times are measured by applying a burst of radar with the device configured to change channel and by observing the channel for transmissions. The time between the end of the aoolied radar waveform and the final transmission on the channel is the channel move time.

The aggregate transmission closing time is measured in one of two ways :

> FCC – the total time of all individual transmissions from the EUT that are observed starting 200ms at the end of the last radar pulse in the waveform. This value is required to be less than 60ms.
>
> ETSI[1] – the total time of all individual transmissions from the EUT that are observed from the end of the last radar pulse in the waveform. This value is required to be less than 260ms.

DFS – CHANNEL NON-OCCUPANCY AND VERIFICATION OF PASSIVE SCANNING

The channel that was in use prior to radar detection by the master is additionally monitored for 30 minutes to ensure no transmissions on the vacated channel over the required non-occupancy period. This is achieved by tuning the spectrum analyzer to the vacated channel in zero-span mode and connecting the IF output to an oscilloscope. The oscilloscope is triggered by the radar pulse and set to provide a single sweep (in peak detect mode) that lasts for at least 30 minutes after the end of the channel move time.

For devices with a client-mode that are being evaluated against FCC rules the manufacturer must supply an attestation letter stating that the client device does not employ any active scanning techniques (i.e. does not transmit in the DFS bands without authorization from a Master device).

DFS CHANNEL AVAILABILITY CHECK TIME

It is preferred that the EUT report when it starts the radar channel availability check. If the EUT does not report the start of the check time, then the time to start transmitting on a channel after switching the device on is measured to approximate the time from power-on to the end of the channel availability check. The start of the channel availability check is assumed to be 60 seconds prior to the first transmission on the channel.

To evaluate the channel availability check, a single burst of one radar type is applied within the first 2 seconds of the start of the channel availability check and it is verified that the device does not use the channel by continuing to monitor the channel for a period of at least 60 seconds. The test is repeated by applying a burst of radar in the last 2 seconds (i.e. between 58 and 60 seconds after the start of CAC when evaluating a 60-second CAC) of the channel availability check.

TRANSMIT POWER CONTROL (TPC)

Compliance with the transmit power control requirements for devices is demonstrated through measurements showing multiple power levels and manufacturer statements explaining how the power control is implemented.

SAMPLE CALCULATIONS

DETECTION PROBABILITY / SUCCESS RATE
The detection probability, or success rate, for any one radar waveform equals the number of successful trials divided by the total number of trials for that waveform.

THRESHOLD LEVEL
The threshold level is the level of the simulated radar waveform at the EUT's antenna. If the test is performed in a conducted fashion then the level at the rf input equals the level at the antenna plus the gain of the antenna assembly, in dBi. The gain of the antenna assembly equals the gain of the antenna minus the loss of the cabling between the rf input and the antenna. The lowest gain value for all antenna assemblies intended for use with the device is used when making this calculation.

If the test is performed using the radiated method then the threshold level is the level at the antenna.

Appendix A Test Equipment Calibration Data

Equipment	Manufacturer	Model	Calibration due.
Spectrum Analyzer	R&S	FSV30	2012-01-07
Vector Signal Generator	R&S	SMBV2100A	2012-01-07
Horn Antenna	Schwarzbeck	BBHA9120D	2012-10-13

Appendix B Test Data Tables and Plots for Channel Closing

FCC PART 15 SUBPART E Channel Closing Measurements

Table 5 FCC Part 15 Subpart E Channel Closing Test Results					
Waveform Type	Channel Closing Transmission Time[1]		Channel Move Time		Result
	Measured	Limit	Measured	Limit	
Radar Type 1 5270MHz n40 mode	8ms	60ms	3.83s	10s	Complied

After the final channel closing test the channel was monitored for a further 30 minutes. No transmissions occurred on the channel.

Timing Plots – Channel Closing and Move Time

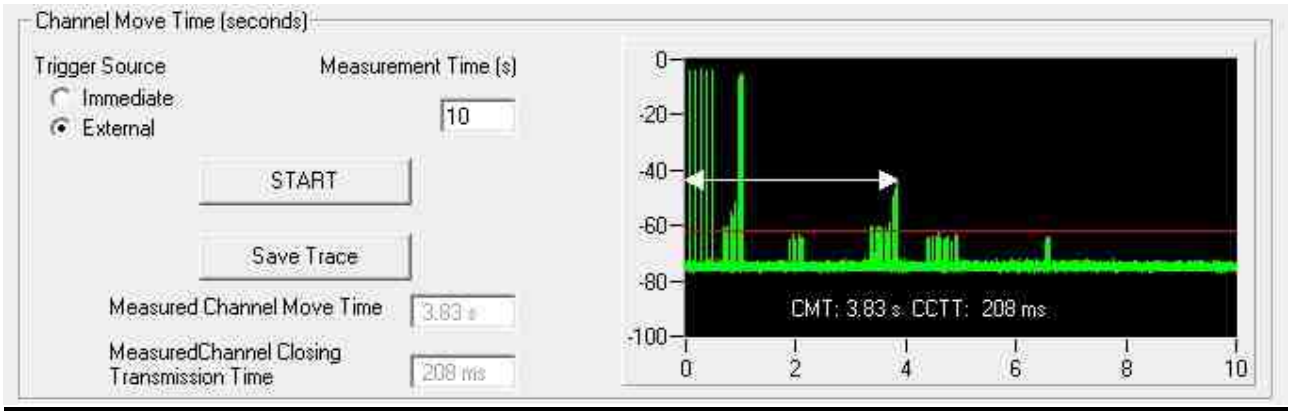

Figure 1 Channel Closing Time and Channel Move Time

Channel closing transmission tim : 200ms + 8ms = 208ms

Non-Occupancy Plot

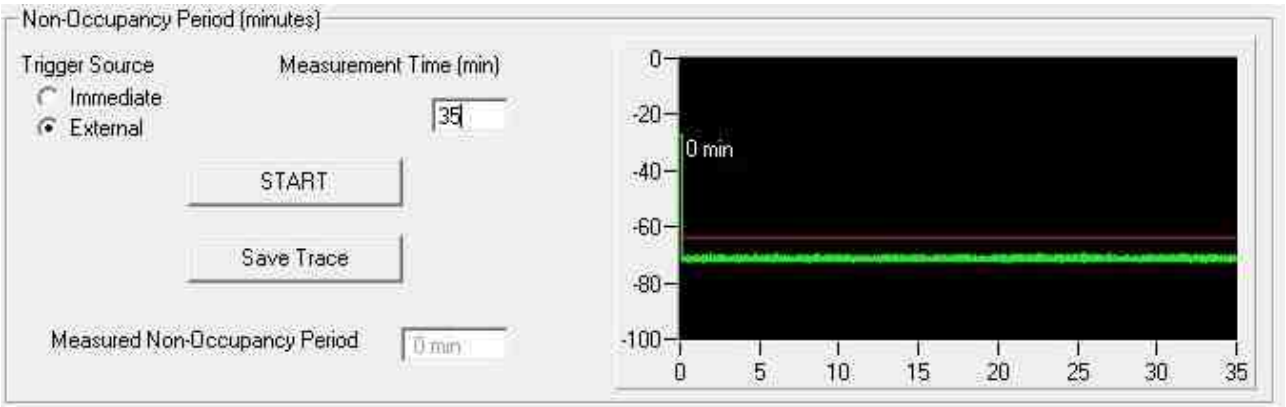

Figure 2 Radar Channel Non-Occupancy Plot, n40 mode

The non-occupancy plot was made over a 30-minute time period following the channel move time with the analyzer IF output connected to the scope and tuned to the vacated channel. No transmissions were observed after the channel move had been completed.

After the channel move the client re-associated with the master device on the new channel. After the channel move the client device stopped transmitting on the original channel.