TEST REPORT



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1. Client

- ${\scriptstyle \circ}$ Name : KAONMEDIA Co., Ltd.
- Address : KAONMEDIA Building, 884-3, Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
- Date of Receipt : 2018-05-17

2. Manufacturer

- Name : KAONMEDIA Co., Ltd.
- Address : KAONMEDIA Building, 884-3, Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
- 3. Use of Report : For FCC Certification
- 4. Test Sample / Model: KSTB2020_NCTC_STB / KSTB2020
- 5. Date of Test : 2018-07-07 to 2018-08-10
- 6. Test Standard(method) used : FCC 47 CFR part 15 subpart E 15.407
- **7. Testing Environment:** Temp.: (23 ± 1) °C, Humidity: (48 ± 5) % R.H.
- 8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by Bongseok Kim: (Signature)	Technical Manager Young-taek Lee: (Signature)
		2018-08-10
Republic of KOREA CTK Co., Ltd.		



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REPORT REVISION HISTORY

Date	Revision	Page No
2018-07-13	Issued (CTK-2018-02033)	all
2018-08-10	Issued (CTK-2018-02033-1) (Add 40 MHz bandwidth test data)	all

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1 General Product Description

1.1 Client Information

Company	KAONMEDIA Co., Ltd.
Contact Point	KAONMEDIA Building, 884-3, Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
Contact Person	Name : Choi Sung Ho E-mail : shchoi@kaonmedia.com Tel : +82-31-724-8861

1.2 Product Information

FCC ID	WQTKSTB2020
Product Description	KSTB2020_NCTC_STB
Model name	KSTB2020
Variant Model name	KSTB2076 (Variant model has no difference from basic model, except for model name)
Device Type(DFS)	Client without radar detection(only support client mode)
TPC mechanism	Not support
Operating band	5 150 MHz - 5 250 MHz 5 250 MHz - 5 350 MHz 5 470 MHz - 5 725 MHz 5 725 MHz - 5 850 MHz
Channel bandwidth	IEEE 802.11a : 20 MHz IEEE 802.11n : 20 MHz, 40 MHz IEEE 802.11ac : 20 MHz, 40 MHz, 80 MHz
Number of Transmit chains	2
Antenna type	PCB Antenna
Antenna gain	2 dBi(peak)
Modulation	OFDM



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1.3 DFS Band Carrier Frequencies

Frequency Band	Channel No.	Frequency[MHz]	Channel No.	Frequency[MHz]
	52	5 260	60	5 300
5 250 - 5 350 MHz	54	5 270	62	5 310
Band 2	56	5 280	64	5 320
	58	5 290		
	100	5 500	124	5 620
	102	5 510	126	5 630
	104	5 520	128	5 640
5 470 - 5 725 MHz	106	5 530	132	5 660
	108	5 540	134	5 670
	110	5 550	136	5 680
Barlu S	112	5 560	138	5 690
	116	5 580	140	5 700
	118	5 590	142	5 710
	120	5 600	144	5 720
	122	5 610		

1.4 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Access Point(Master)	Cisco Systems, Inc.	WAP371	6002-85030041R
AC ADAPTER	LITE-ON POWER TECHNOLOGY(DONGGUAN) CO.,LTD	PA-1041-71	L21432051723
Note Computer	HP	15-bs563TU	CND7253R6P
AC/DC Adapter	HP	HSTNN-LA40	7628011101
Vector Signal Generator	R&S	SMBV100A	258008
Monitor	SAMSUNG	933HD	CF19H9XZ913077J



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2 Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Registration Number	Logo
USA	FCC	FCC Part 15 & 18 EMI (Electromagnetic Interference / Emission)	805871	F
CANADA	ISED	ISED EMI (3/10m test site)	8737A-2	+
JAPAN	VCCI	VCCI V-3 EMI (Electromagnetic Interference / Emission)	C-986 T-1843 R-3627 G-387	VEI
KOREA	NRRA	EMI (Electromagnetic Interference / Emission) EMS (Electromagnetic Susceptibility / Immunity)	KR0025	

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.



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3.1 Standards

FCC Part Section(s)	Requirement(s)	Status (Note 1)	Test Condition
15.407(h)(2)(iii)	Channel move time and channel closing transmission time	С	Conducted
15.407(h)(2)(iv)	Non-Occupancy Period	С	Conducted
<u>Note 1</u> : C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
Note 2: The data in this test report are traceable to the national or international standards.			

The following documents listed in this section are referred for testing. KDB 905462 D02 : UNII DFS Compliance Procedures New Rules v02 KDB 905462 D03 : UNII Clients Without Radar Detection New Rules v01r02



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3.2 Mode of operation during the test

The UUT is operated in a manner representative of the typical of the equipments. During at testing, system components were manipulated within the confines of typical usage to maximize each emission.

The results are only attached worst cases.

Test Frequency

IEEE Std.	Test Channel Freq.	
802.11n (HT20)	5 500 MHz	
802.11n (HT40)	5 510 MHz	

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter. Coverage factor k = 2, Confidence levels of 95 %

Description	Uncertainty	
Conducted emission	1.5 dB	



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4 Dynamic Frequency Selection(DFS) Test

4.1 General DFS Information

DFS Parameters

Parameter	Value	
Non-occupancy period	Minimum 30 Minutes	
Channel Availability Check Time	60 seconds	
Channel Move Time	10 seconds (Note 1)	
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second periods (Note 1 and 2)	
U-NII Detection Bandwidth Minimum 100% of the U-NII 9% transmission power (Note 3)		
Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar		
Type0. The measurement timing begins at the end of the Radar Type 0 burst.		

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 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

DFS Detection Thresholds

Maximum Transmit Power	Value (See note)
$EIRP \ge 200 \text{ mW}$	-64 dBm
EIRP < 200 mW and Power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 mW that do not meet the power spectral density requirement	-64 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.

Note 3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.



	DFS Operational mode			
Requirement	Master	Client without radar detection	Client with radar detection	
Non-Occupancy Period	Yes	Not required (See the note)	Yes	
DFS Detection Threshold	Yes	Not required	Yes	
Channel Availability Check Time	Yes	Not required	Not required	
U-NII Detection Bandwidth	Yes	Not required	Yes	

Note : According to KDB 905462 D03 Client Without DFS New Rules v01r02 (b) 6. "An analyzer plot that contains a single 30-minute sweep on the original channel"

Applicability of DFS Requirements during Normal Operation

	Operational Mode			
Requirement	Master Device or Client with Radar Detection	Client Without Radar Detection		
DFS Detection Threshold	Yes	Not required		
Channel Closing Transmission Time	Yes	Yes		
Channel Move Time	Yes	Yes		
U-NII Detection Bandwidth	Yes	Not required		

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection		
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required		
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link		
All other tests	Any single BW mode	Not required		
Note : Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection				

frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.

Channel Loading/Data Streaming

	The data file (MPEG-4) has been transmitting in a streaming mode.
\times	Software to ping the client is permitted to simulate data transfer with random ping intervals.
\times	Minimum channel loading of approximately 17%
	Unicast protocol has been used.



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4.2 RADAR TEST WAVEFORMS

Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1A	1	15 unique PRI in KDB 905462 D02 Table 5a	$\left[\left(\frac{1}{360}\right)\cdot\right]$	60%	15
1B	1	15 unique PRI within 518-3066, Excluding 1A PRI	$\left\{ \left(\frac{19 \cdot 10^{6}}{\text{PRI}_{\mu \text{sec}}}\right) \right\}$	60%	15
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
Aggregat	e (Radar Types 1-	-4)		80%	120
Note 1 : Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests					

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous B generated with Test B and must also be unique and not repeated from the previous B generated with Test B and must also be unique and not repeated from the previous B generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.



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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

Each waveform is defined as follows:

- The transmission period for the Long Pulse Radar test signal is 12 seconds.
- There are a total of 8 to 20 Bursts in the 12 second period, with the number of Bursts being randomly chosen. This number is Burst Count.
- Each Burst consists of 1 to 3 pulses, with the number of pulses being randomly chosen. Each Burst within the 12 second sequence may have a different number of pulses.
- The pulse width is between 50 and 100 microseconds, with the pulse width being randomly chosen. Each pulse within a Burst will have the same pulse width. Pulses in different Bursts may have different pulse widths.
- Each pulse has a linear frequency modulated chirp between 5 and 20 MHz, with the chirp width being randomly chosen. Each pulse within a transmission period will have the same chirp width. The chirp is centered on the pulse. For example, with a radar frequency of 5300 MHz and a 20 MHz chirped signal, the chirp starts at 5290 MHz and ends at 5310 MHz.
- If more than one pulse is present in a Burst, the time between the pulses will be between 1000 and 2000 microseconds, with the time being randomly chosen. If three pulses are present in a Burst, the random time interval between the first and second pulses is chosen independently of the random time interval between the second and third pulses.
- The 12 second transmission period is divided into even intervals. The number of intervals is equal to Burst Count. Each interval is of length (12,000,000 / Burst Count) microseconds. Each interval contains one Burst. The start time for the Burst, relative to the beginning of the interval, is between 1 and [(12,000,000 / Burst Count) – (Total Burst Length) + (One Random PRI Interval)] microseconds, with the start time being randomly chosen. The step interval for the start time is 1 microsecond. The start time for each Burst is chosen randomly.

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

Frequency Hopping Radar Test Waveform

The FCC Type 6 waveform uses a static waveform with 100 burst in the instruments ARB. In addition, the RF list mode is operated with a list containing 100 frequencies from a randomly generated list and it had be ensured that at least one of the random frequencies falls into the UNI Detection Bandwidth of the DUT. Each burst from the waveform file initiates a trigger pulse at the beginning that switches the RF list from one item to the next one.



DFS Threshold Level

DFS Threshold Level				
DEC Threshold layely 62 dBm	It at the antenna connector			
DrS Threshold level: -05 ubit	in front of the antenna			
The Interference Radar Detection Threshold Level is -64dBm + 0[dBi] + 2dB = -62dBm. That had been taken				
into account the output power range and antenna gain.				

Radar Waveform calibration Plot





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Test Setup

A spectrum analyzer is used a monitor to verify that the EUT has vacated the Channel within the Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the detection and Channel move.





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In-service Monitoring Limit

In-service Monitoring Limit				
Channel Move Time 10sec				
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 sec periods.			
Non-occupancy period	Minimum 30 minutes			

Measuring Instruments

Refer a test equipment and calibration data table in this test report.

Test Procedures

Test Method
☑ Verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time. Client Device will associate with the EUT. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for duration greater than 10 seconds. Measure and record the transmissions from the EUT during the observation time (Channel Move Time). Compare the Channel Move Time and Channel Closing Transmission Time limits.
☑ Verified during In-Service Monitoring; Channel Closing Transmission Time, Channel Move Time. One 12 sec plot needs to be reported for the Short Pulse Radar Types 0. And zoom-in a 60 ms plot verified c hannel closing time for the aggregate transmission time starting from 200ms after the end of the rad ar signal to the completion of the channel move.
☑ Verified during In-Service Monitoring; Non-Occupancy Period. Client Device will associate with the EUT. Observe the transmissions of the EUT at the end of the radar Burst on the Operating Channel for dur ation greater than 10 seconds. Measure and record the transmissions from the EUT during the observ ation time (Non- Occupancy Period). Compare the Occupancy Period limits.

Test Result of In-service Monitoring

Parameter	Test	Limit	
Test Frequency [MHz]	5 500 5 510		-
Channel Move Time [sec.]	0.473	Below 10s	< 10s
Channel Closing Transmission Time [ms] (Note)	3.6	4.4	< 60ms
Non-Occupancy Period [min.]	≥ 30	≥ 30	≥ 30 min

Note: 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 seconds period. The aggregate duration of control signals will not count quiet periods in between transmissions.



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Test Plot of In-Service Monitoring for Channel Move Time





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Test Plot of In-Service Monitoring for Channel Closing Transmission Time





Number of transmission(9) X Time per one transmission(400 μ s) = 3.6 ms



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Closing transmission time :

Number of transmission(11) X Time per one transmission(400 μ s) = 4.4 ms



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Test Plot of In-Service Monitoring for Non-Occupancy Period





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APPENDIX A – Test Equipment Used For Tests

	Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Spectrum Analyzer	Rohde & Schwarz	FSP-30	100994	2017-11-01	2018-11-01
2	Vector Signal Generator	Rohde & Schwarz	SMBV100A	258008	2018-01-26	2019-01-26
3	Dual Directional Coupler	HP	11692D	1212A03629	2017-11-02	2018-11-02
4	Divider	Weinschel	1580	SQ369	2017-11-02	2018-11-02