

# DFS PORTION of FCC 47 CFR PART 15 SUBPART E DFS PORTION of INDUSTRY CANADA RSS-247 ISSUE 1

## **CERTIFICATION TEST REPORT**

**FOR** 

WIFI COMMUNICATIONS MODULE

**MODEL NUMBER: COM2** 

FCC ID: 2AHES-COM2 IC: 21152-COM2

**REPORT NUMBER: 11673430-D1V1** 

**ISSUE DATE: 2017-10-31** 

Prepared for

BSH HOME APPLIANCES CORPORATION 100 BOSCH BLVD NEW BERN, NC 28562-6924 USA

Prepared by UL LLC

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# **Revision History**

Rev.	Date	Revisions	Revised By
V1	2017-10-31	Initial Issue	C. Cheung

## DATE: 2017-10-31 IC: 21152-COM2

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** BSH Home Appliance Corporation

100 Bosch Blvd

New Bern, NC 28562-6924 USA

**EUT DESCRIPTION:** WiFi Communications Module

MODEL: COM2

**SERIAL NUMBER:** 4421010000521

**DATE TESTED:** 2017-10-03 and 2017-10-04

#### APPLICABLE STANDARDS

STANDARD TEST RESULTS

DFS Portion of CFR 47 Part 15 Subpart E Pass

INDUSTRY CANADA RSS-247 Issue 1 Pass

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

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Wankelson

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## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with the DFS portion of FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 06-96, FCC KDB 789033, KDB 905462 D02 and D03 and RSS-247 Issue 1.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 2800 Suite B, Perimeter Park Dr., Morrisville, NC 27560.

UL LLC (Morrisville) is accredited by NVLAP, Laboratory Code 200246-0. The full scope of accreditation can be viewed at <a href="http://www.nist.gov/nvlap/">http://www.nist.gov/nvlap/</a>.

## 4. CALIBRATION AND UNCERTAINTY

#### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

#### 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB) 36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

## 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Time	± 0.02 %

Uncertainty figures are valid to a confidence level of 95%.

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# 5. DYNAMIC FREQUENCY SELECTION

## 5.1. OVERVIEW

#### 5.1.1. LIMITS

#### **INDUSTRY CANADA**

IC RSS-247 is closely harmonized with FCC Part 15 DFS rules. The deviations are as follows:

RSS-247 Issue 1

**Note:** For the band 5600–5650 MHz, no operation is permitted.

Until further notice, devices subject to this annex shall not be capable of transmitting in the band 5600–5650 MHz. This restriction is for the protection of Environment Canada weather radars operating in this band.

#### **FCC**

§15.407 (h), FCC KDB 905462 D02 "COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVICES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION" and KDB 905462 D03 "U-NII CLIENT DEVICES WITHOUT RADAR DETECTION CAPABILITY".

Table 1: Applicability of DFS requirements prior to use of a channel

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		
U-NII Detection Bandwidth	Yes	Not required	Yes		

Table 2: Applicability of DFS requirements during normal operation

table 217 pp nearmity of 21 o requirements atting normal epotation								
Requirement	Operationa	Operational Mode						
	Master	Client	Client					
		(without DFS)	(with DFS)					
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					

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar DFS	Client (without DFS)
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 bandwidth. For 802.11 devices it is suggested to select frequencies in all 20 MHz channel blocks and a null frequency between the bonded 20 MHz channel blocks.

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

monitoring	
Maximum Transmit Power	Value
	(see notes)
E.I.R.P. ≥ 200 mill watt	-64 dBm
E.I.R.P. < 200 mill watt and	-62 dBm
power spectral density < 10 dBm/MHz	
E.I.R.P. < 200 mill watt that do not meet power spectral	-64 dBm
density requirement	

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:** E.I.R.P. is based on the highest antenna gain. For MIMO devices refer to KDB publication 662911 D01.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds (See Note 1)
Channel Closing Transmission Time	200 milliseconds + approx. 60 milliseconds over remaining 10 second period. (See Notes 1 and 2)
U-NII Detection Bandwidth	Minimum 100% of the U- NII 99% transmission power bandwidth. (See Note 3)

**Note 1:** Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. 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.

Table 5 - Short Pulse Radar Test Waveforms

	Table 5 - Offort Tuise Nadar Test Waveforms									
Radar	Pulse	PRI	Pulses	Minimum	Minimum					
Туре	Width	(usec)		Percentage	Trials					
	(usec)			of Successful						
				Detection						
0	1	1428	18	See Note 1	See Note					
					1					
1	1	Test A: 15 unique		60%	30					
		PRI values randomly								
		selected from the list	Roundup:							
		of 23 PRI values in	{(1/360) x (19 x 10 <sup>6</sup> PRI <sub>usec</sub> )}							
		table 5a								
		Test B: 15 unique								
		PRI values randomly								
		selected within the								
		range of 518-3066								
		usec. With a								
		minimum increment								
		of 1 usec, excluding								
		PRI values selected								
		in Test A								
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 T	ypes 1-4)	80%	120					
NI . 4 . 4										

**Note 1:** Short Pulse Radar Type 0 should be used for the *Detection Bandwidth* test, *Channel Move Time*, and *Channel Closing Time* tests.

Table 6 – Long Pulse Radar Test Signal

	rable e zong rales radar rest eignar							
	Radar	Pulse	Chirp	PRI	Pulses	Number	Minimum	Minimum
	Waveform	Width	Width	(µsec)	per	of	Percentage	Trials
	Type	(µsec)	(MHz)	,	Burst	Bursts	of Successful	
		,	, ,				Detection	
Ī	5	50-100	5-20	1000-	1-3	8-20	80%	30
				2000				

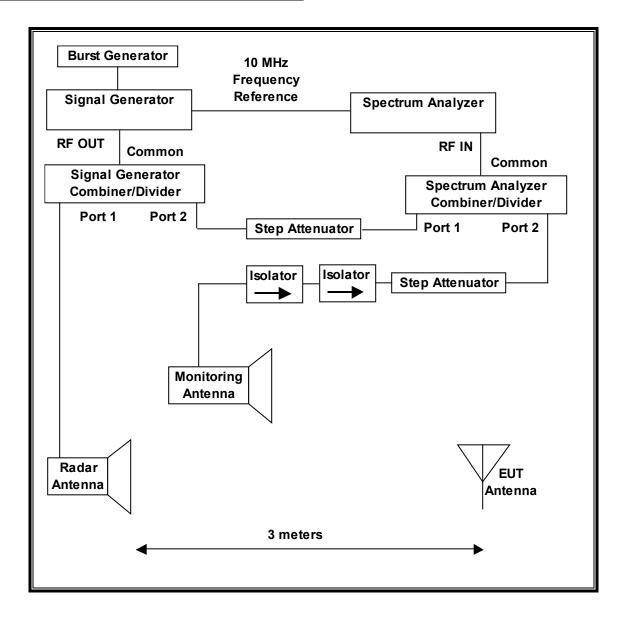
**Table 7 – Frequency Hopping Radar Test Signal** 

Radar	Pulse	PRI	Pulses	Hopping	Hopping	Minimum	Minimum
Waveform	Width	(µsec)	per	Rate	Sequence	Percentage of	Trials
Type	(µsec)	,	Hop	(kHz)	Length	Successful	
• •	,		-	, ,	(msec)	Detection	
6	1	333	9	0.333	300	70%	30

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## **5.1.2. TEST AND MEASUREMENT SYSTEM**

#### RADIATED METHOD SYSTEM BLOCK DIAGRAM



#### **SYSTEM OVERVIEW**

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

The short pulse types 1, 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of KDB 905462 D02. The frequency of the signal generator is incremented in 1 MHz steps from  $F_L$  to  $F_H$  for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

#### **SYSTEM CALIBRATION**

A 50-ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected to a horn antenna via a coaxial cable, with the reference level offset set to (horn antenna gain – coaxial cable loss). The signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –64 dBm as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. The Reference Level Offset of the spectrum analyzer is adjusted so that the displayed amplitude of the signal is –64 dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –64 dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

## **ADJUSTMENT OF DISPLAYED TRAFFIC LEVEL**

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. The video test file is streamed to generate WLAN traffic. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

#### TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the DFS tests documented in this report:

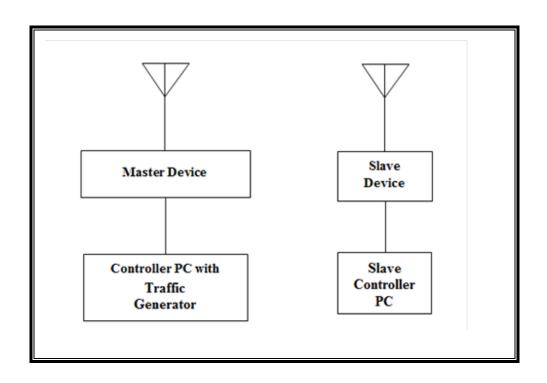
Channel Move Time	Limit
(sec)	(sec)
0.067	10

Aggregate Channel Closing Transmission Time	Limit
(msec)	(msec)
0.0	60

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## **5.1.3. SETUP OF EUT**

## **RADIATED METHOD EUT TEST SETUP**



## **SUPPORT EQUIPMENT**

The following support equipment was utilized for the DFS tests documented in this report:

Description	Manufacturer	Model	Serial Number	FCC ID
802.11 ac Dual Band Wireless Access Point (Master Device)	Cisco	AIR-CAP3702E-A- K9	FTX1827R5FF	LDK102087
P.O.E. Injector (Master AP)	Cisco	DPSN-35FBA	DCA183510NA	DoC
Notebook PC (Master Controller)	Lenovo	20B6-002AUS	PC-041B0F 15/03	DoC
AC Adapter (Master Controller)	Lenovo	ADLX90NLC2A	11S45N0247Z1ZS9B4BV J0H	Doc
Notebook PC (Slave Controller	Dell	E5540	63XGK32	DoC
AC Adapter (Slave Controller)	Dell	HA65NM130	CN-06TFFF-75661-4AR- OCWY-A00	Doc
EUT Power Supply	Circuit Specialists	CS13005X5	76022	DoC

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FORM NO: 03-EM-F00858 TEL: (919) 549-1400

#### 5.1.4. DESCRIPTION OF EUT

For FCC the EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges.

For IC the EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges, excluding the 5600-5650 MHz range.

The EUT is a Slave Device without Radar Detection.

The EUT is an 802.11b/g/n transceiver module. It is a SISO module that contains two antenna ports for diversity. Additionally, there is an option to install an external antenna on Antenna Port 0 for improved performance. The external antenna in not intended to be installed on Chain 1.

The highest power level within these bands is 17.06 dBm EIRP in the 5250-5350 MHz band and 15.30 dBm EIRP in the 5470-5725 MHz band.

The highest gain antenna assembly utilized with the EUT has a gain of 0 dBi in the 5250-5350 MHz band and 0 dBi in the 5470-5725 MHz band. The lowest gain antenna assembly utilized with the EUT has a gain of -6 dBi in the 5250-5350 MHz band and -6 dBi in the 5470-5725 MHz band.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm.

The EUT uses one transmitter/receiver chain connected to an antenna to perform radiated tests.

WLAN traffic is generated by transferring a data stream from the Master Device to the Slave Device using iPerf version 2.0.5 software package.

TPC is not required since the maximum EIRP is less than 500 mW (27 dBm).

The EUT utilizes the 802.11a/n architecture. Two nominal channel bandwidths are implemented: 20 MHz and 40 MHz.

The software installed in the access point is AP3G2-K9W7-XX 153-3.JAB revision 15.3(3)JAB.

#### **UNIFORM CHANNEL SPREADING**

This is requirement not applicable to Slave Devices.

#### OVERVIEW OF MASTER DEVICE WITH RESPECT TO §15.407 (h) REQUIREMENTS

The Master Device is a Cisco Access Point, FCC ID: LDK102087. The minimum antenna gain for the Master Device is 6 dBi.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is -64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is -64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to -64 dBm. The tested level is lower than the required level hence it provides a margin to the limit.

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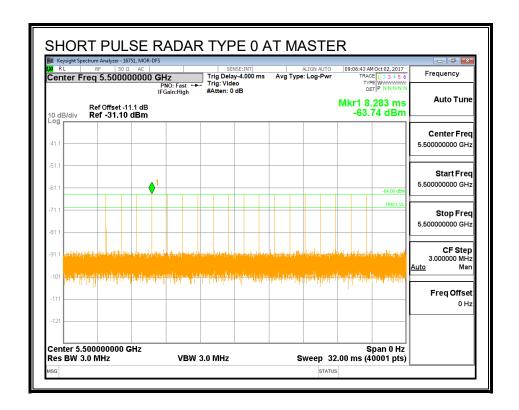
## 5.2. RESULTS FOR 20 MHz BANDWIDTH

## **5.2.1. TEST CHANNEL**

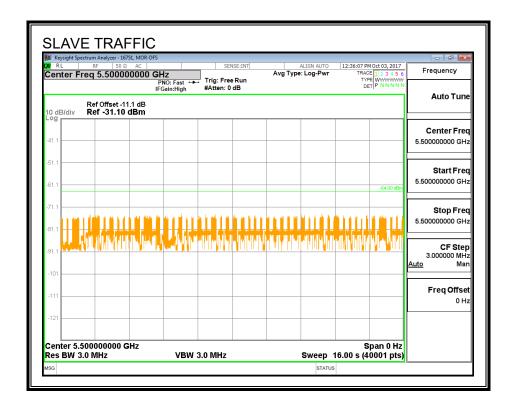
All tests were performed at a channel center frequency of 5500 MHz.

#### 5.2.2. RADAR WAVEFORM AND TRAFFIC

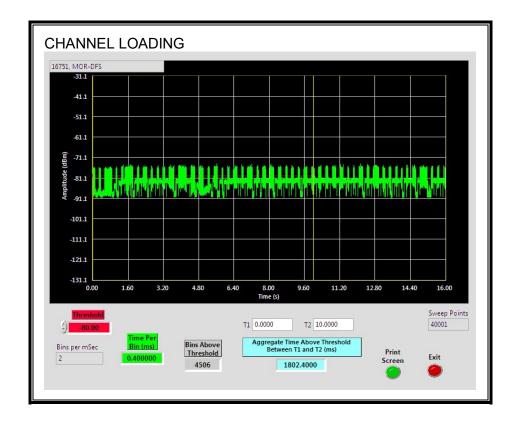
## **RADAR WAVEFORM**



#### **TRAFFIC**



## **CHANNEL LOADING**



The level of traffic loading on the channel by the EUT is 18.02%.

FORM NO: 03-EM-F00858 TEL: (919) 549-1400

#### **5.2.3. OVERLAPPING CHANNEL TESTS**

## **RESULTS**

These tests are not applicable.

#### 5.2.4. MOVE AND CLOSING TIME

#### **REPORTING NOTES**

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time = (Number of analyzer bins showing transmission) \* (dwell time per bin)

The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

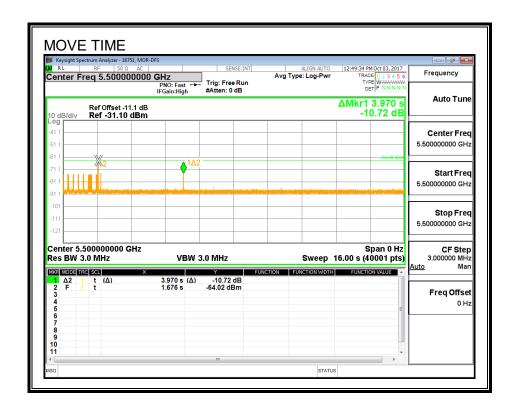
#### **RESULTS**

Channel Move Time	Limit
(sec)	(sec)
3.970	10

Aggregate Channel Closing Transmission Time	Limit
(msec)	(msec)
0.8	60

TEL: (919) 549-1400

## **MOVE TIME**



## **CHANNEL CLOSING TIME**



## AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

Only intermittent transmissions are observed during the aggregate monitoring period.



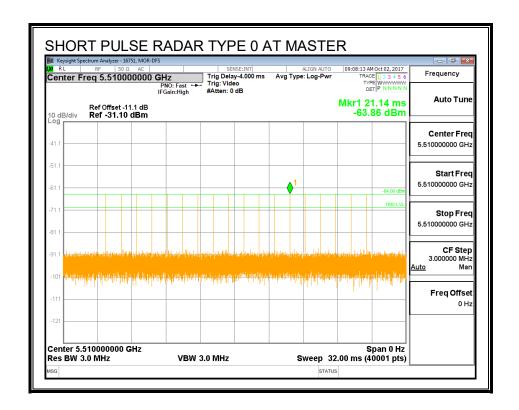
## 5.3. RESULTS FOR 40 MHz BANDWIDTH

## 5.3.1. TEST CHANNEL

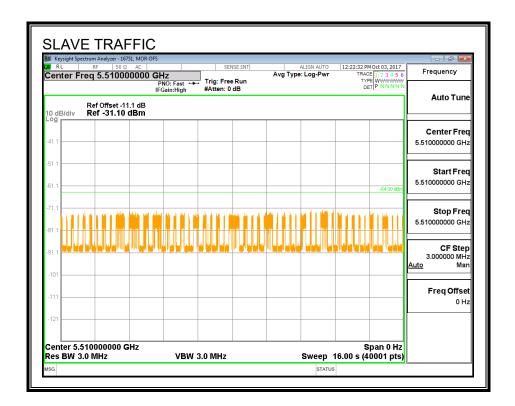
All tests were performed at a channel center frequency of 5510 MHz.

#### 5.3.2. RADAR WAVEFORM AND TRAFFIC

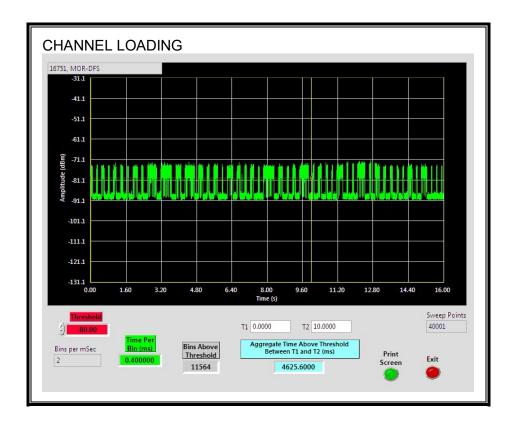
## **RADAR WAVEFORM**



#### **TRAFFIC**



## **CHANNEL LOADING**



The level of traffic loading on the channel by the EUT is 46.26%

FORM NO: 03-EM-F00858 TEL: (919) 549-1400

#### **5.3.3. OVERLAPPING CHANNEL TESTS**

## **RESULTS**

These tests are not applicable.

#### 5.3.4. MOVE AND CLOSING TIME

#### **REPORTING NOTES**

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time = (Number of analyzer bins showing transmission) \* (dwell time per bin)

The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

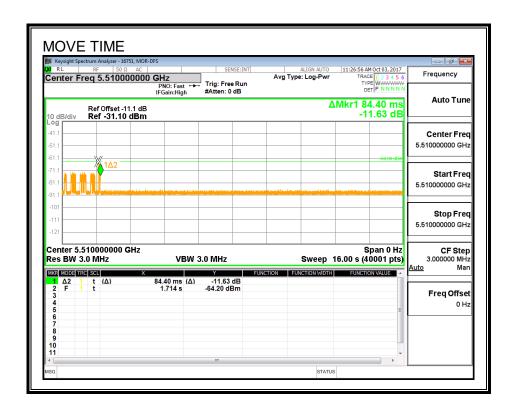
## **RESULTS**

Channel Move Time	Limit
(sec)	(sec)
0.084	10

Aggregate Channel Closing Transmission Time	Limit
(msec)	(msec)
0.0	60

TEL: (919) 549-1400

#### **MOVE TIME**

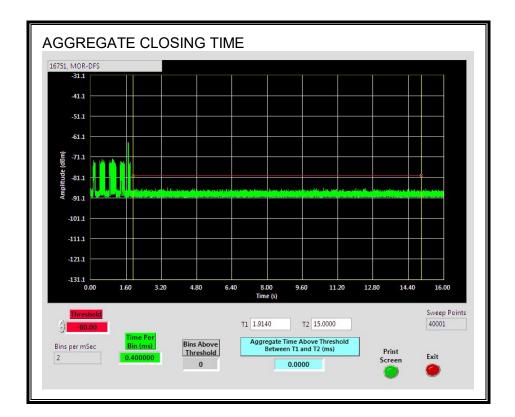


## **CHANNEL CLOSING TIME**



## AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

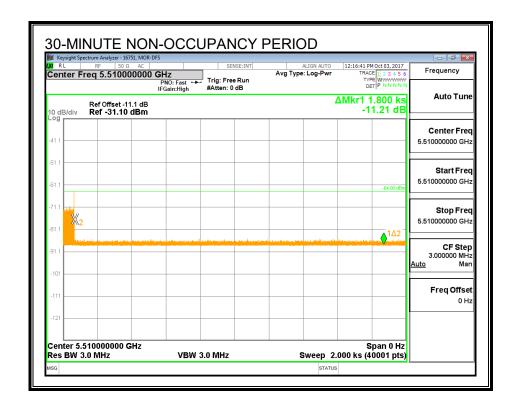
Only intermittent transmissions are observed during the aggregate monitoring period.



## 5.3.5. 30-MINUTE NON-OCCUPANCY PERIOD

## **RESULTS**

No EUT transmissions were observed on the test channel during the 30-minute observation time.



TEL: (919) 549-1400

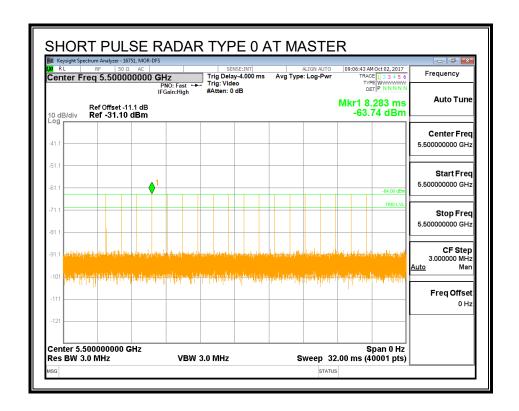
## 5.4. RESULTS FOR 20 MHz BANDWIDTH – EXTERNAL ANTENNA

## **5.4.1. TEST CHANNEL**

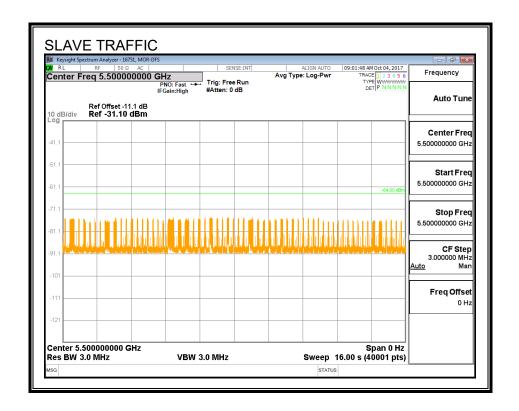
All tests were performed at a channel center frequency of 5500 MHz.

## **5.4.2. RADAR WAVEFORM AND TRAFFIC**

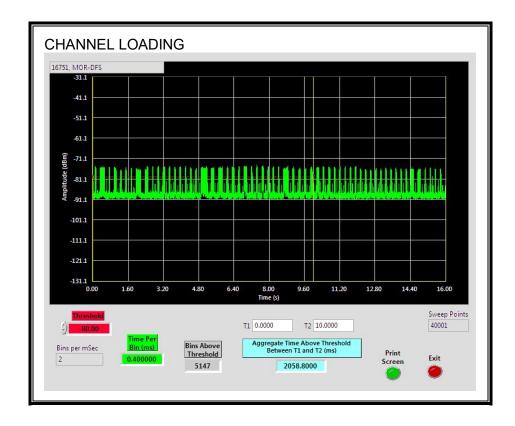
## **RADAR WAVEFORM**



#### **TRAFFIC**



## **CHANNEL LOADING**



The level of traffic loading on the channel by the EUT is 20.59%.

FORM NO: 03-EM-F00858 TEL: (919) 549-1400

#### **5.4.3. OVERLAPPING CHANNEL TESTS**

## **RESULTS**

These tests are not applicable.

#### **5.4.4. MOVE AND CLOSING TIME**

#### **REPORTING NOTES**

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time = (Number of analyzer bins showing transmission) \* (dwell time per bin)

The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

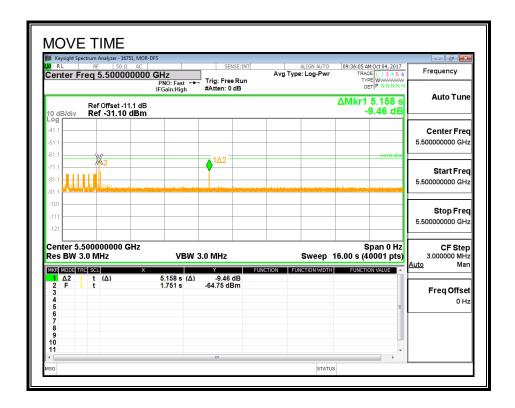
#### **RESULTS**

Channel Move Time	Limit
(sec)	(sec)
5.158	10

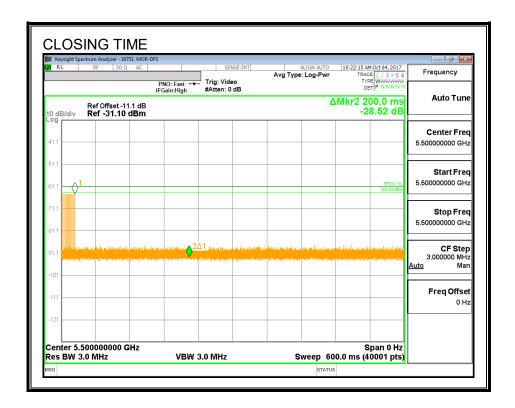
Aggregate Channel Closing Transmission Time	Limit
(msec)	(msec)
1.2	60

TEL: (919) 549-1400

#### **MOVE TIME**



## **CHANNEL CLOSING TIME**



## AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

Only intermittent transmissions are observed during the aggregate monitoring period.



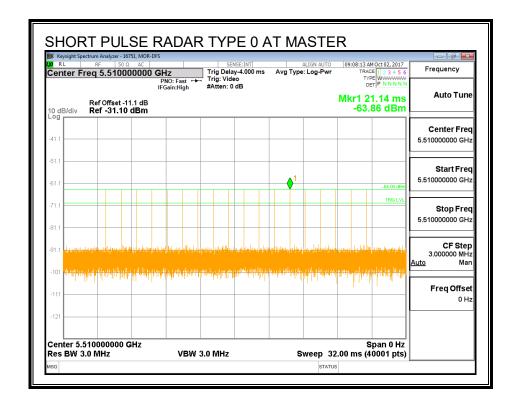
## 5.5. RESULTS FOR 40 MHz BANDWIDTH – EXTERNAL ANTENNA

#### 5.5.1. TEST CHANNEL

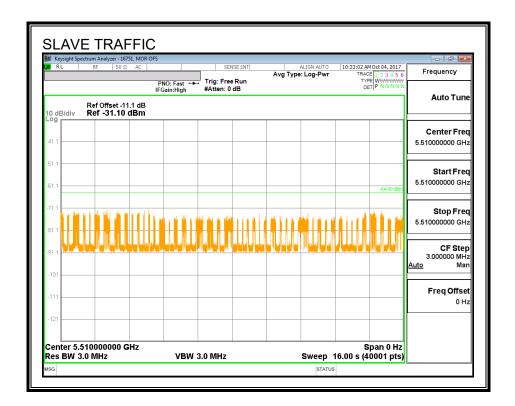
All tests were performed at a channel center frequency of 5510 MHz.

#### 5.5.2. RADAR WAVEFORM AND TRAFFIC

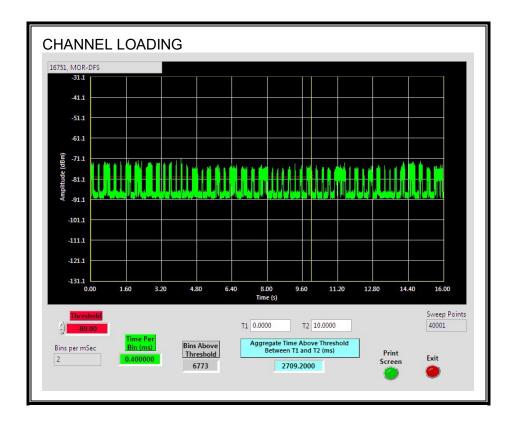
## **RADAR WAVEFORM**



#### **TRAFFIC**



## **CHANNEL LOADING**



The level of traffic loading on the channel by the EUT is 27.09%.

#### 5.5.3. OVERLAPPING CHANNEL TESTS

## **RESULTS**

These tests are not applicable.

#### 5.5.4. MOVE AND CLOSING TIME

#### **REPORTING NOTES**

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time = (Number of analyzer bins showing transmission) \* (dwell time per bin)

The observation period over which the aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

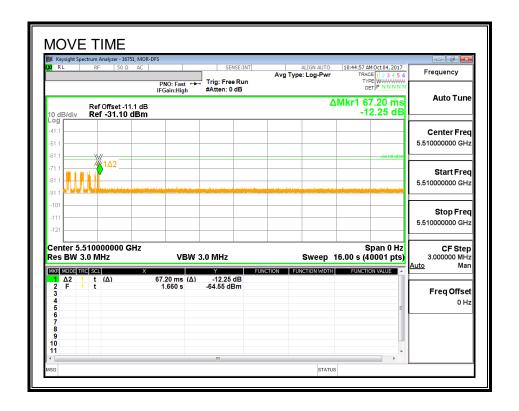
#### **RESULTS**

Channel Move Time	Limit
(sec)	(sec)
0.067	10

Aggregate Channel Closing Transmission Time	Limit
(msec)	(msec)
0.0	60

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#### **MOVE TIME**

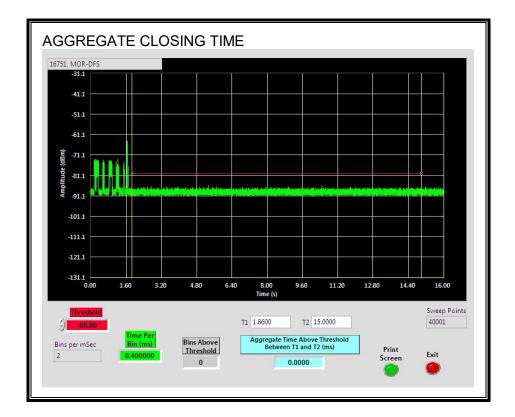


## **CHANNEL CLOSING TIME**



## AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

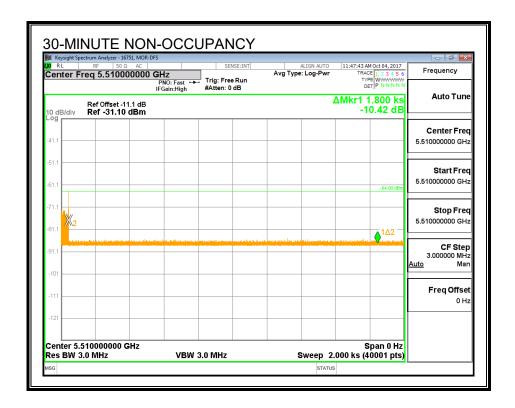
Only intermittent transmissions are observed during the aggregate monitoring period.



## 5.5.5. 30-MINUTE NON-OCCUPANCY PERIOD

## **RESULTS**

No EUT transmissions were observed on the test channel during the 30-minute observation time.



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