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 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.

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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:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset Number**	**Cal Due**
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	US51350187	06/13/17
Signal Generator, MXG X-Series RF Vector	Agilent	N5172B	MY51350337	03/11/17

11.1.3. TEST AND MEASUREMENT SOFTWARE

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

Slave Device Testing

TEST SOFTWARE LIST		
Name	**Version**	**Test / Function**
Aggregate Time-PXA	2.0.0.6	Channel Loading and Aggregate Closing Time
PXA Read	3.0.0.7	Signal Generator Screen Capture
SGXProject.exe	2	Radar Waveform Generation and Download

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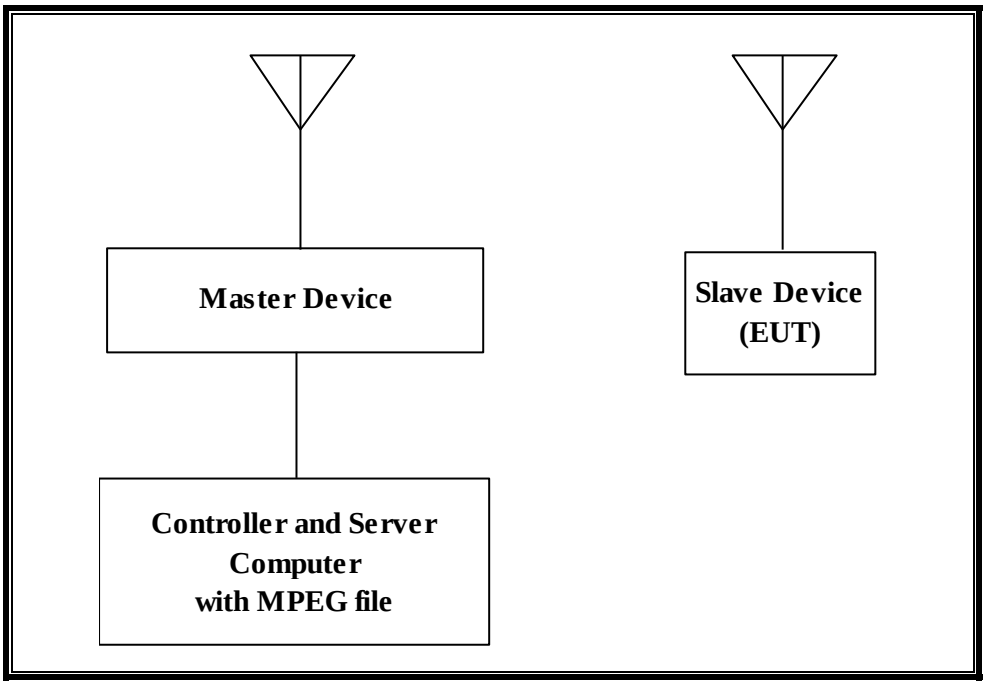
11.1.4. SETUP OF EUT (CLIENT MODE)

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

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

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
3x3 MIMO Base Station (Master Device)	Apple	A1521	C86PJ60JFJ1R	BCGA1521
Notebook PC (Controller/Server)	Apple	A1181	4H629022WLV	DoC
AC Adapter (Controller/Server PC)	Delta Electronics	A1344	MV05104CNAL1A	DoC

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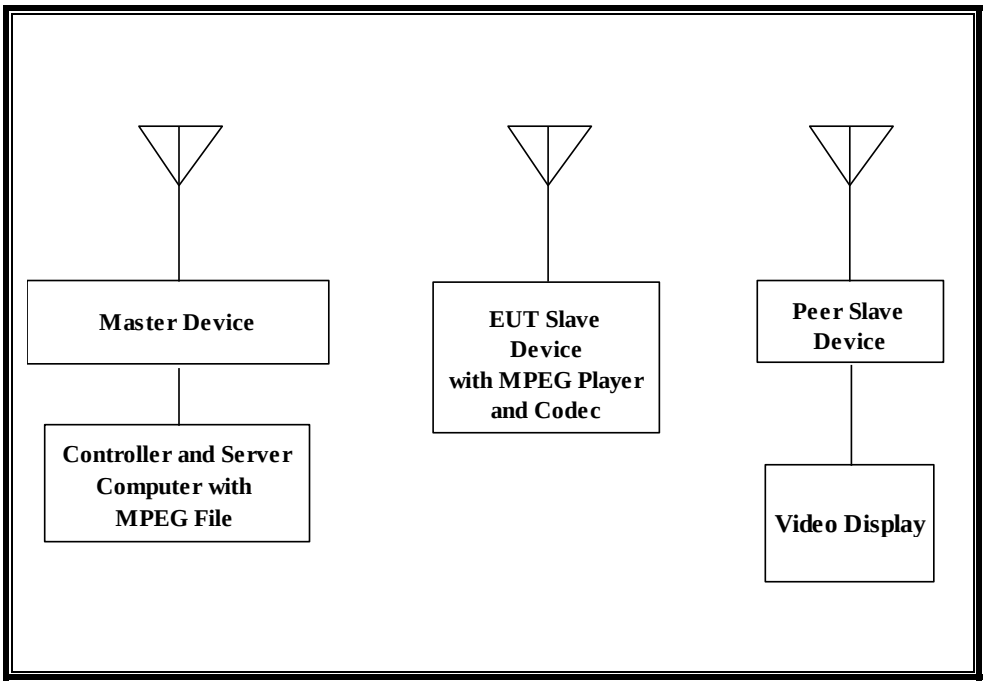
11.1.5. SETUP OF EUT (CLIENT-TO-CLIENT COMMUNICATIONS MODE)

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

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

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
3x3 MIMO Base Station (Master Device)	Apple	A1521	C86PJ60JFJ1R	BCGA1521
Notebook PC (Controller/Server)	Apple	A1181	4H629022WLV	DoC
AC Adapter (Controller/Server PC)	Delta Electronics	A1344	MV05104CNAL1A	DoC
Apple TV (Peer Slave Device)	Apple	A1625	C07PR001GPWK	BCGA1625
Video Display	Polaroid	TLX-01511C	02006	DoC

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11.1.6. 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 highest power level within these bands is 19.98 dBm EIRP in the 5250-5350 MHz band and 21.37 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a gain of –3.75 dBi and -1.38 dBi in the 5250-5350 MHz band and 0.17 dBi and -0.8 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. 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.

The EUT uses two transmitter/receiver chains connected to an antenna to perform radiated tests.

In standard client mode WLAN traffic that meets or exceeds the minimum required loading was generated by streaming the compressed version of the video test file “6 ½ Magic Hours” from the Master to the Slave.

In client to client mode WLAN traffic is generated by streaming the compressed version of the video test file “6 ½ Magic Hours” from the Master to the Slave and then on to the peer slave device in full motion video mode using QuickTime media player and embedded proprietary AirPlay software.

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

The EUT utilizes the 802.11ac architecture. Three nominal channel bandwidths are implemented: 20 MHz, 40 MHz and 80 MHz.

The software installed in the EUT is 14A268.

The software installed in the access point is 7.7.2d0 dev

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UNIFORM CHANNEL SPREADING

This function is not applicable Slave Devices.

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

The Master Device is an Apple, Inc. Access Point, FCC ID: BCGA1521. The minimum antenna gain for the Master Device is 1.4 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.

The software installed in the access point is 7.7.2d0 dev.

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11.2. CLIENT MODE RESULTS FOR 20 MHz BANDWIDTH

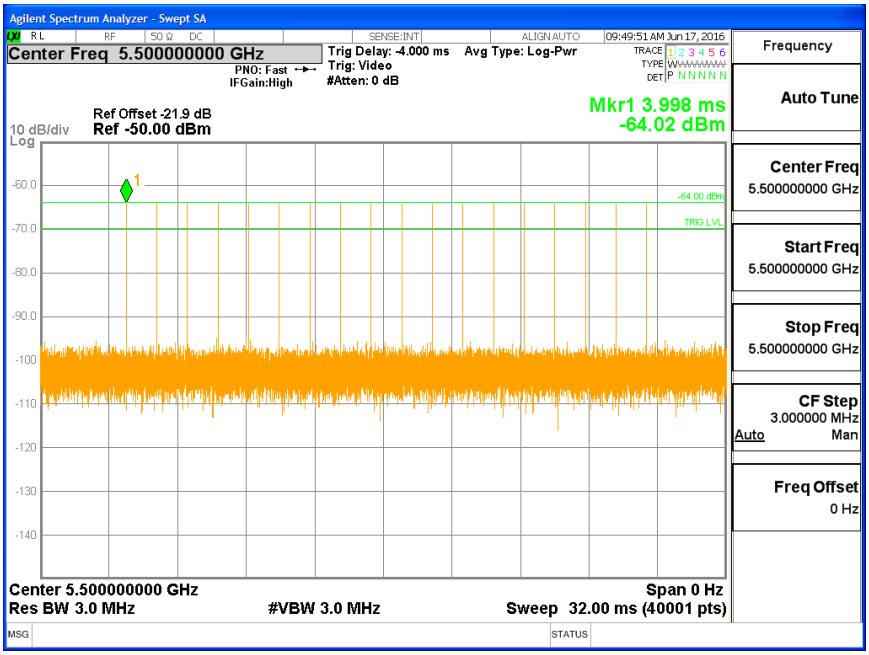
11.2.1. TEST CHANNEL

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

11.2.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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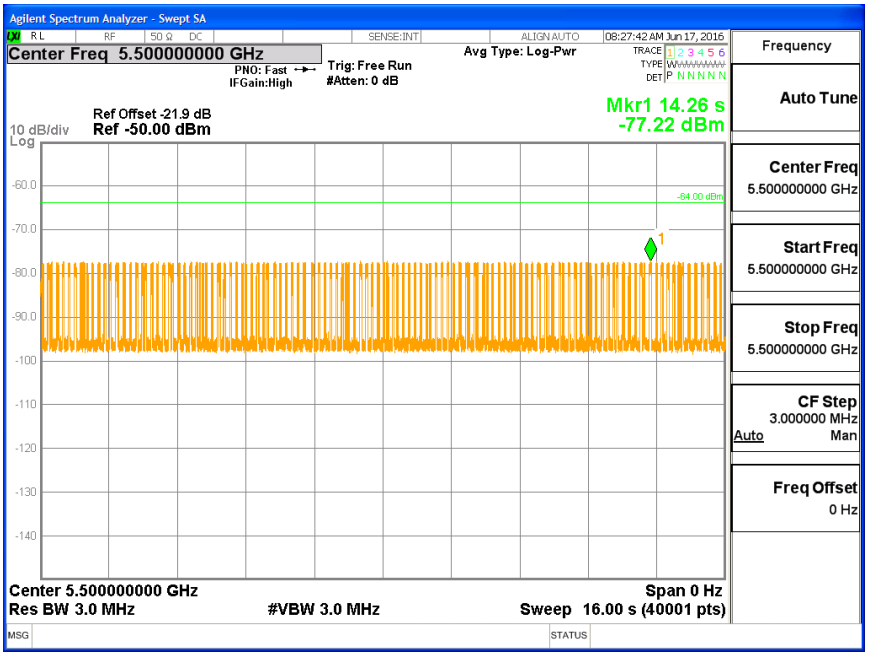
TRAFFIC

SLAVE TRAFFIC



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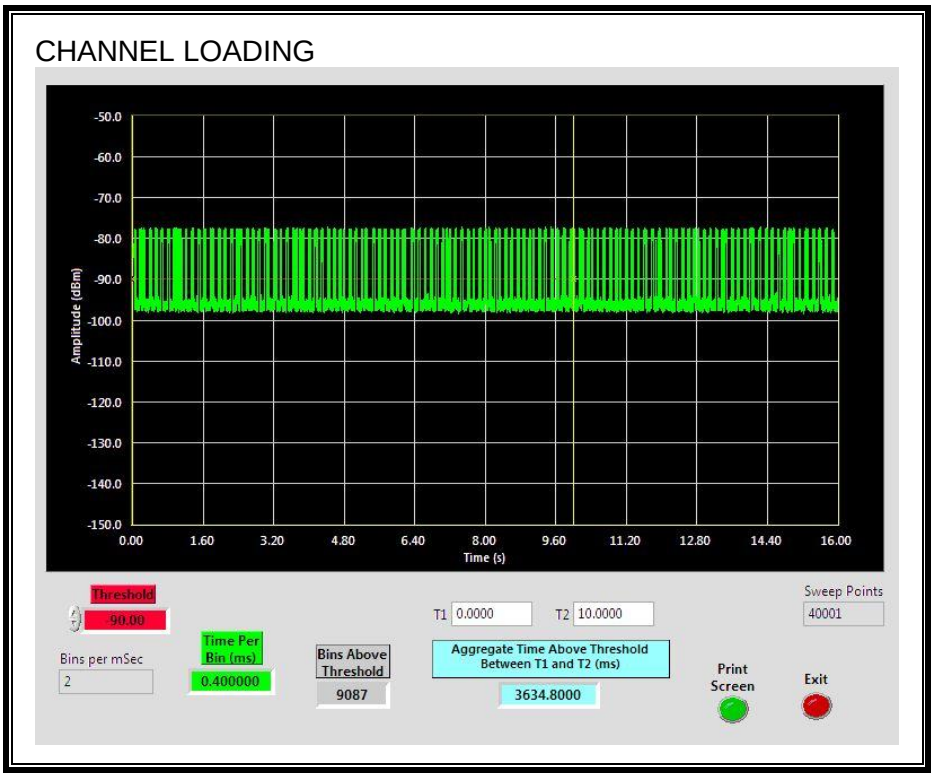
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 36.34%

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11.2.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.2.4. 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 (sec)	Limit (sec)
0.0828	10

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

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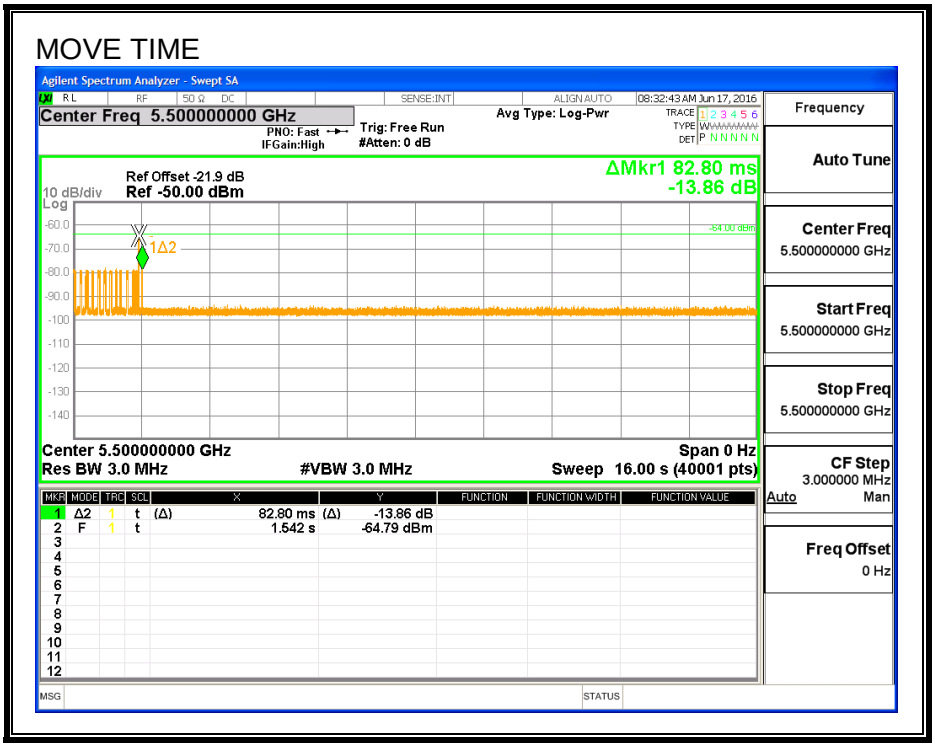
MOVE TIME



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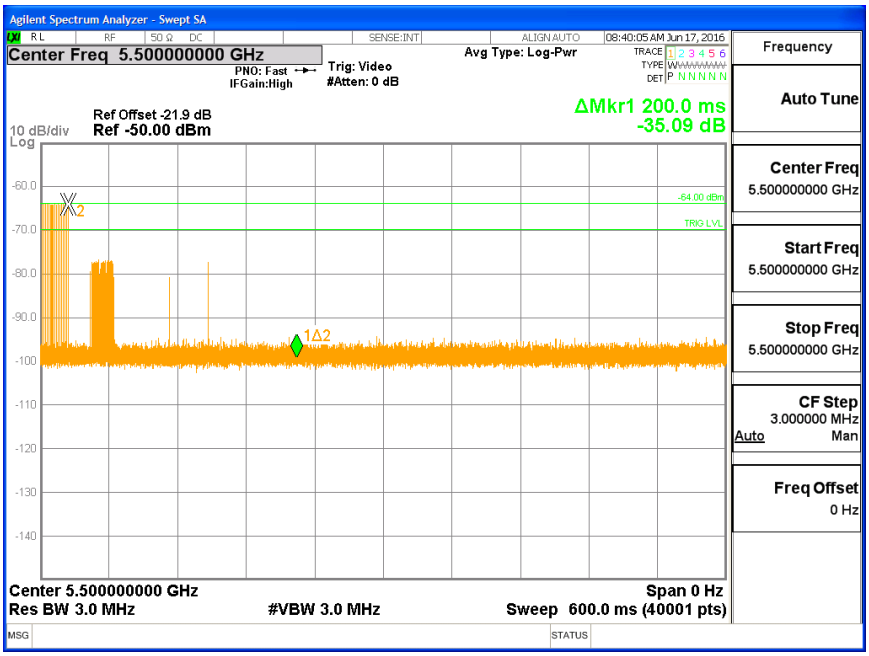
CHANNEL CLOSING TIME

CLOSING TIME



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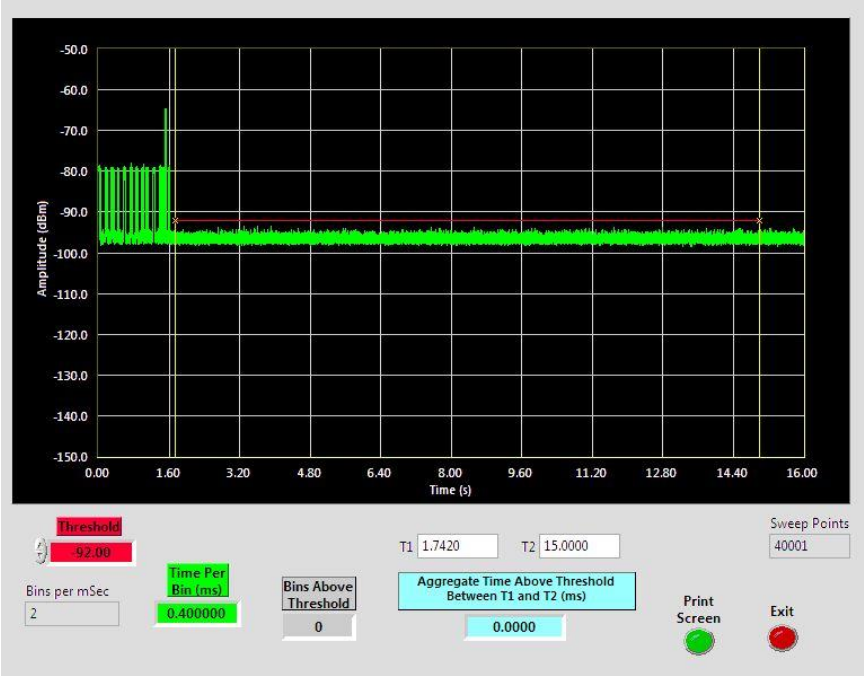
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH

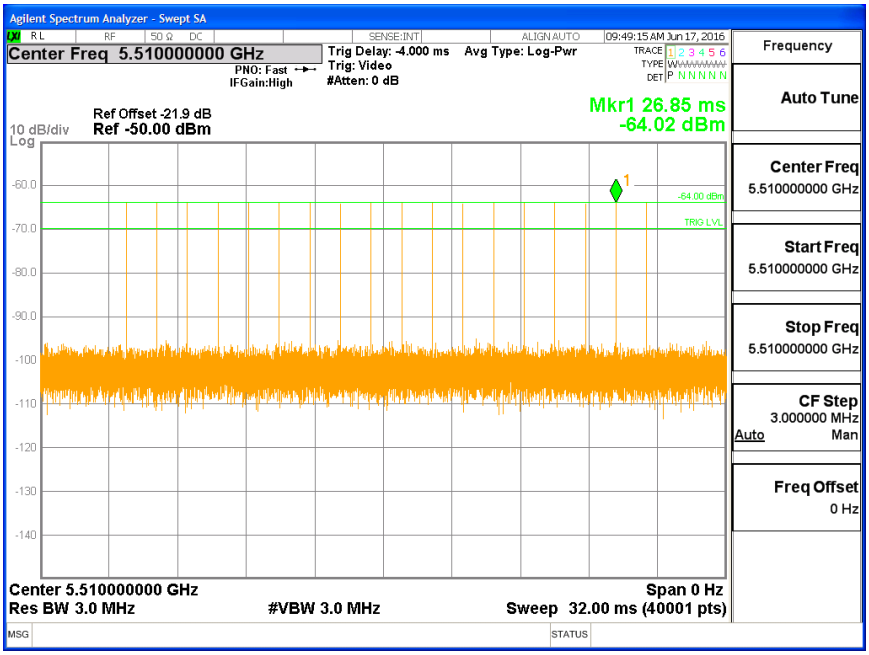
11.3.1. TEST CHANNEL

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

11.3.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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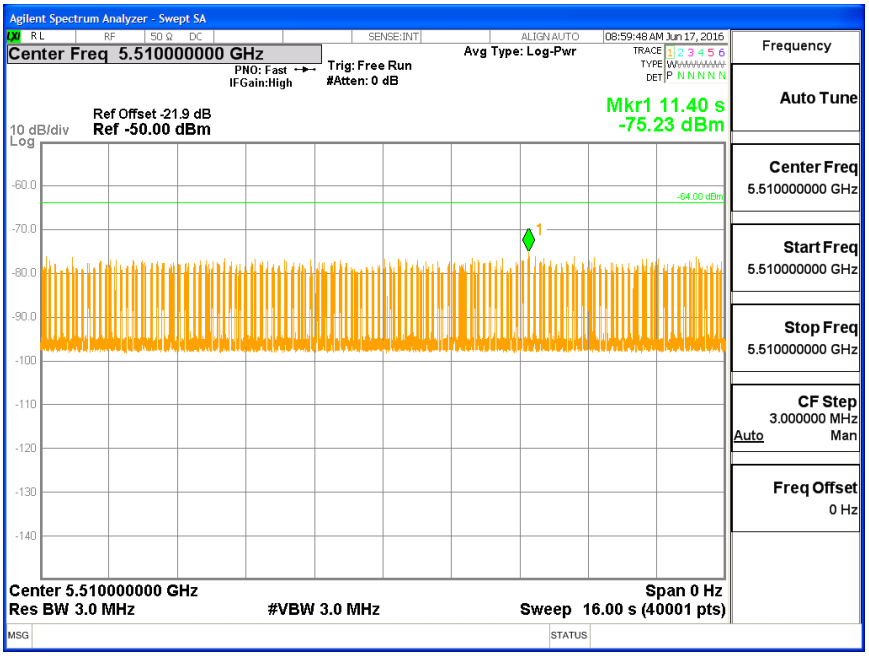
TRAFFIC

SLAVE TRAFFIC



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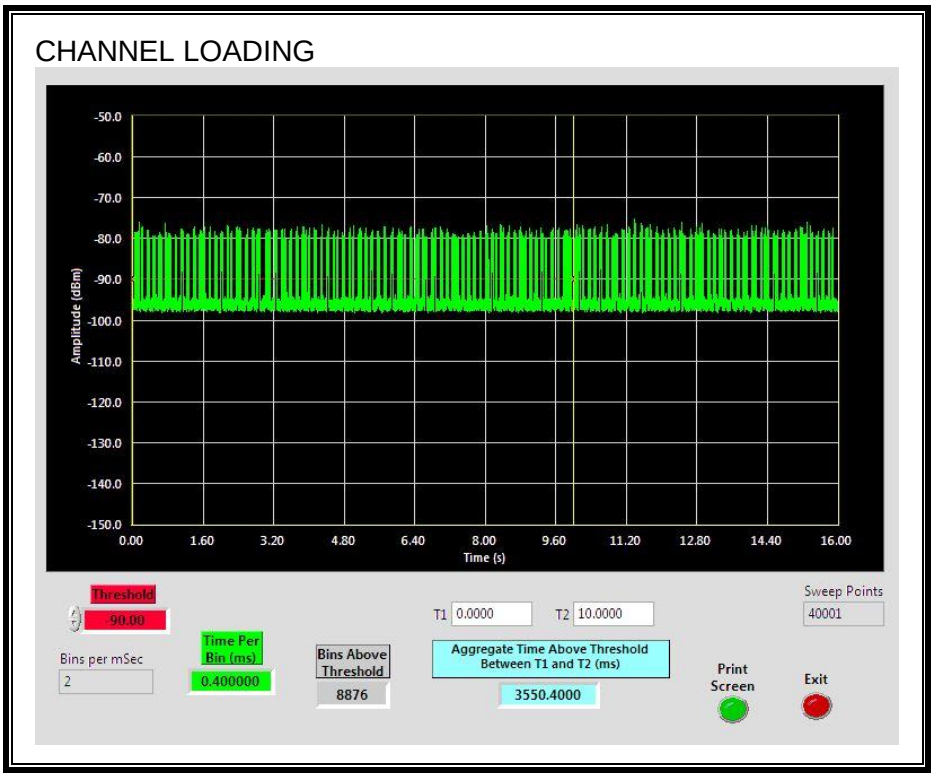
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 35.5%

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11.3.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.3.4. 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 (sec)	Limit (sec)
0.1344	**10**

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

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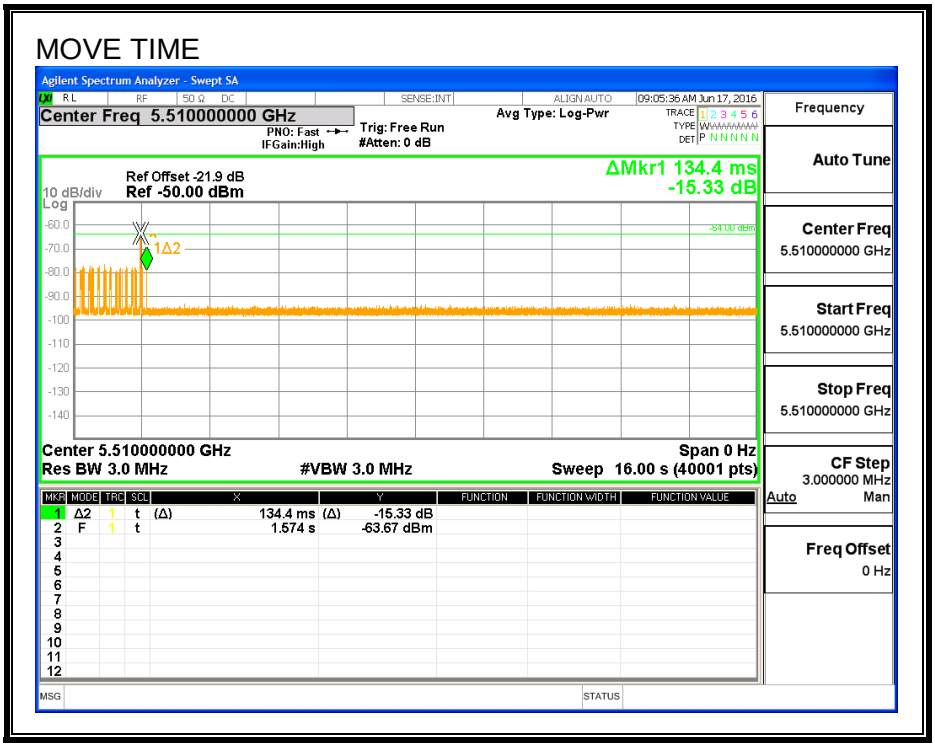
MOVE TIME



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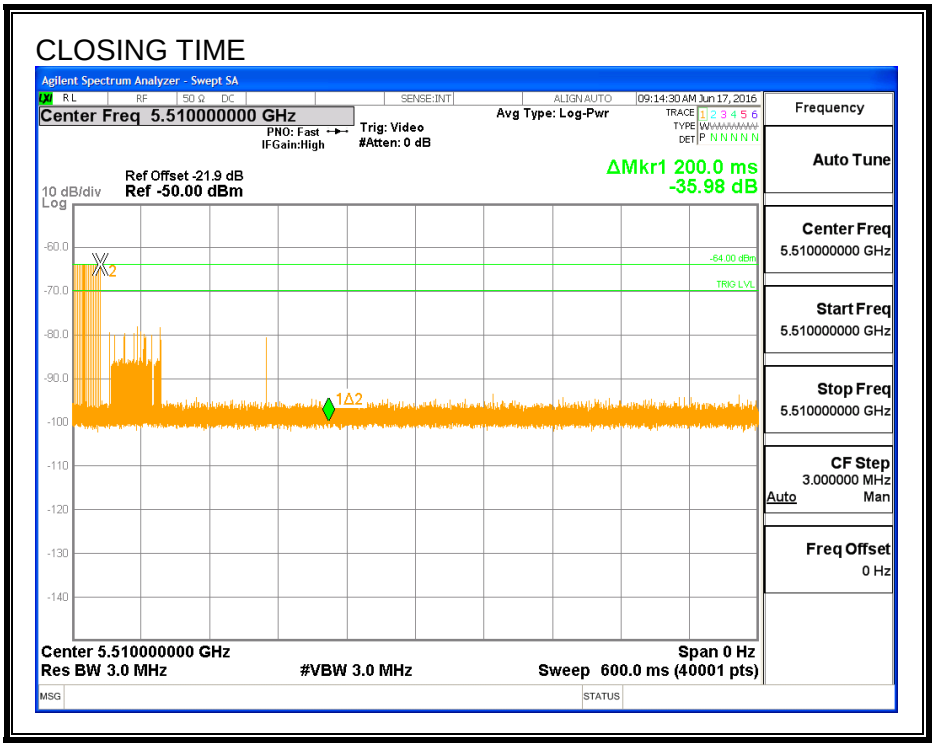
CHANNEL CLOSING TIME



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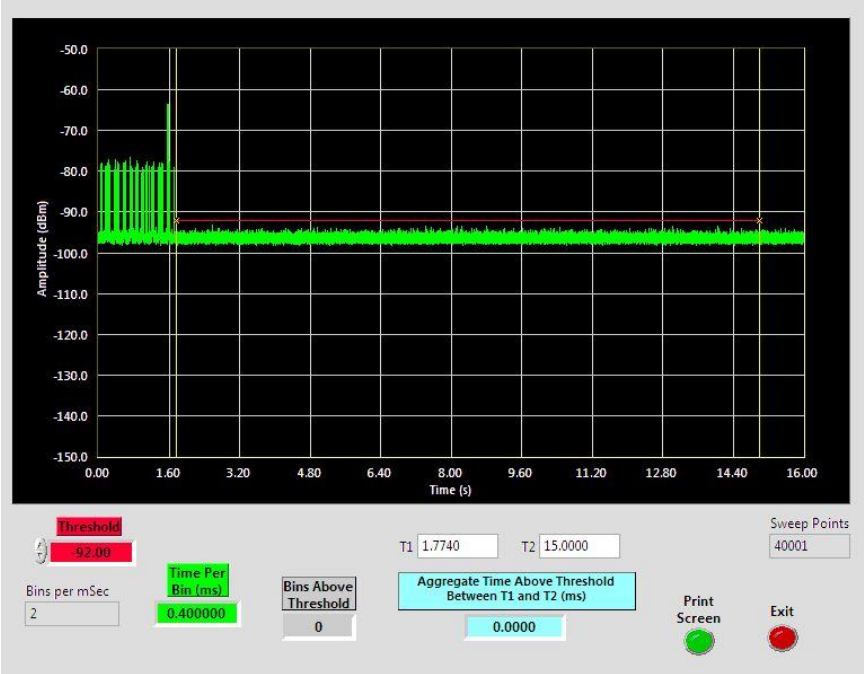
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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11.4. CLIENT MODE RESULTS FOR 80 MHz BANDWIDTH

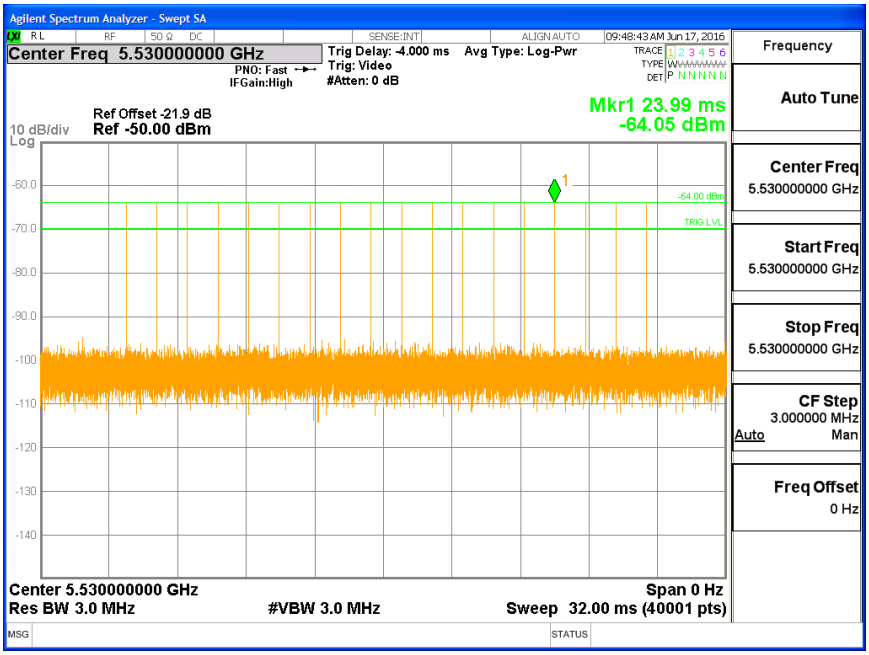
11.4.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5530 MHz.

11.4.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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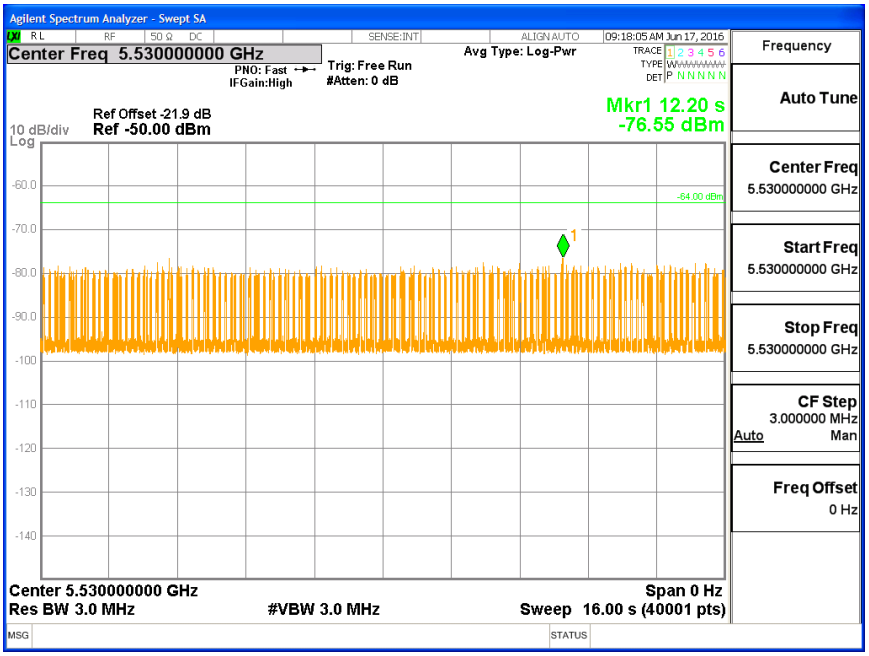
TRAFFIC

SLAVE TRAFFIC



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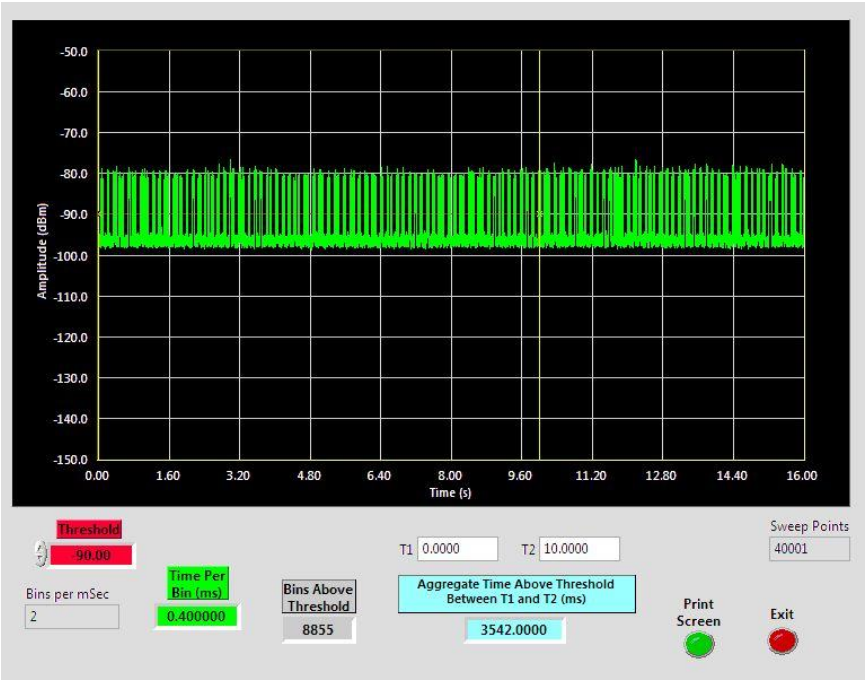
CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 35.42%

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11.4.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.4.4. 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 (sec)	Limit (sec)
0.2052	10

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

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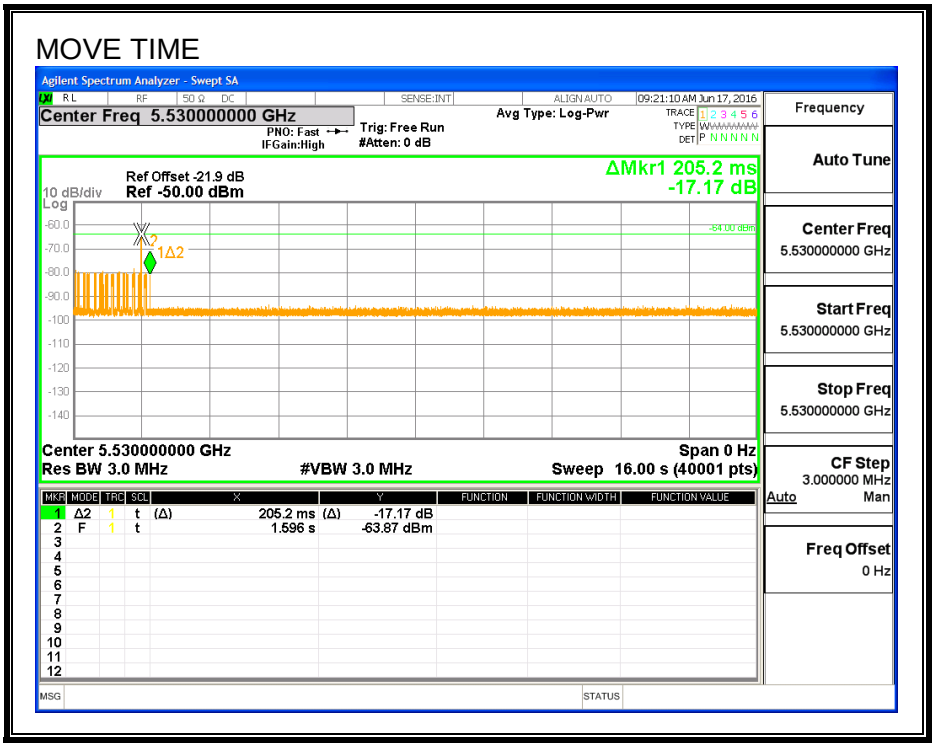
MOVE TIME



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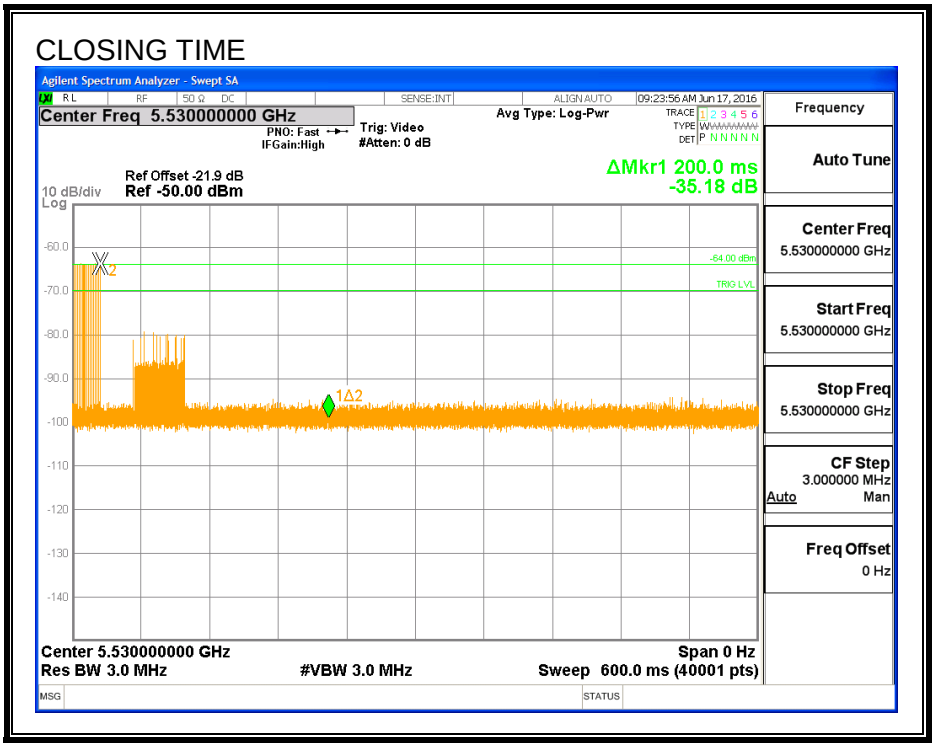
CHANNEL CLOSING TIME



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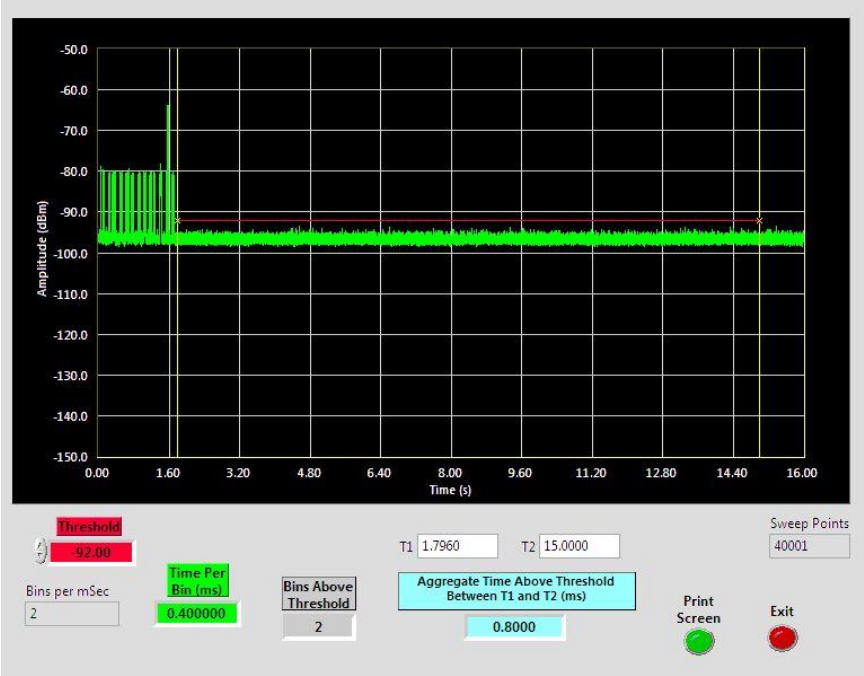
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

Only intermittent transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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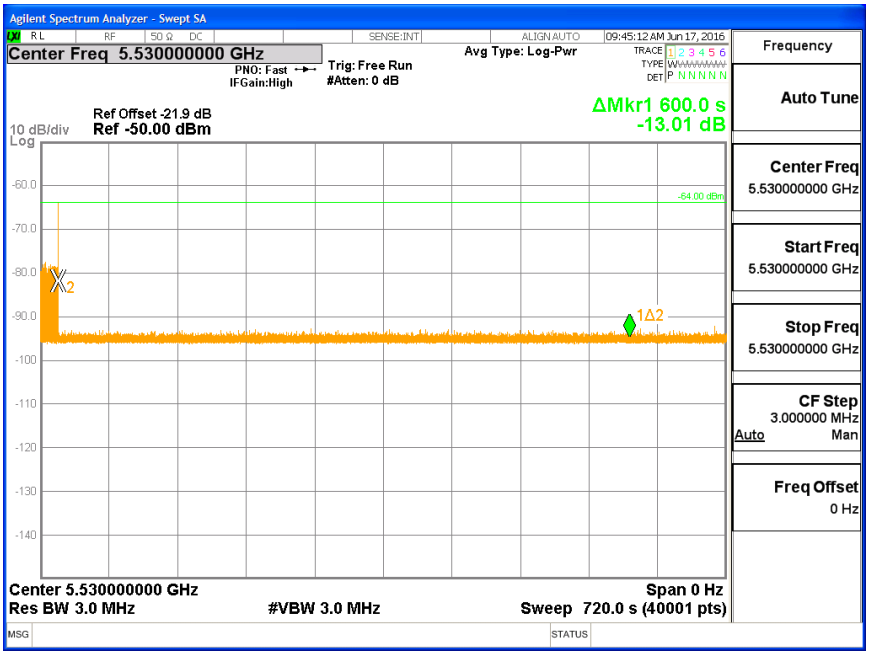
11.4.5. 10-MINUTE CLIENT Tx MONITORING PERIOD

RESULTS

No EUT transmissions were observed on the test channel during the 10-minute observation time.

10-MINUTE CLIENT Tx MONITORING PERIOD



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11.5. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 20 MHz BANDWIDTH

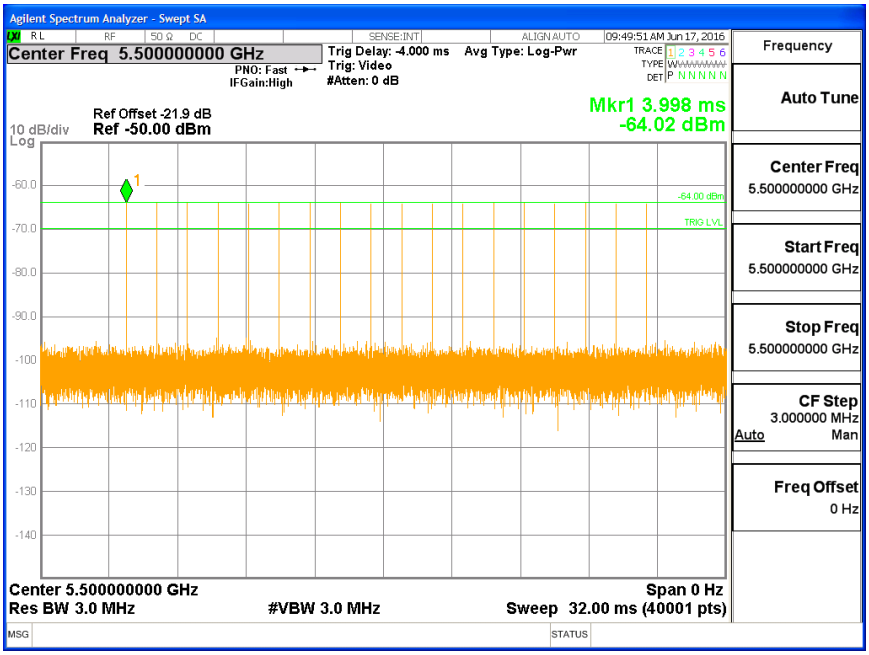
11.5.1. TEST CHANNEL

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

11.5.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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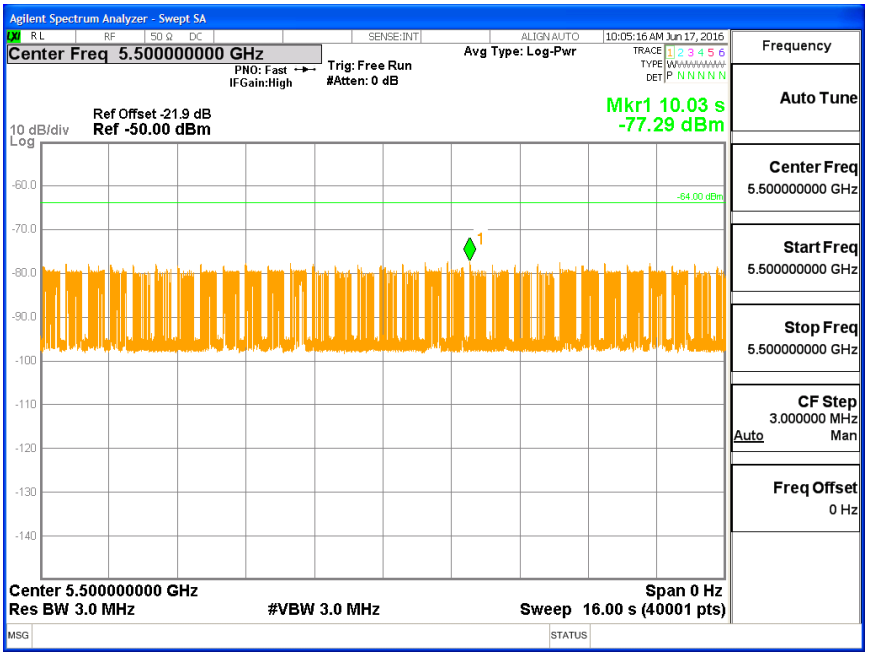
TRAFFIC

SLAVE TRAFFIC



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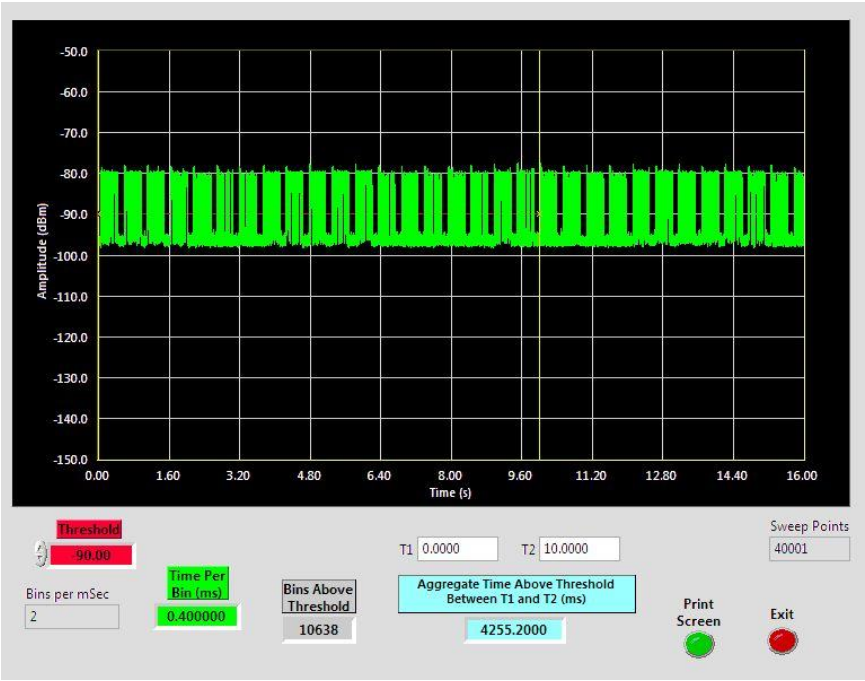
CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 42.55%

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11.5.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.5.4. 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 (sec)	Limit (sec)
0.0462	10

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

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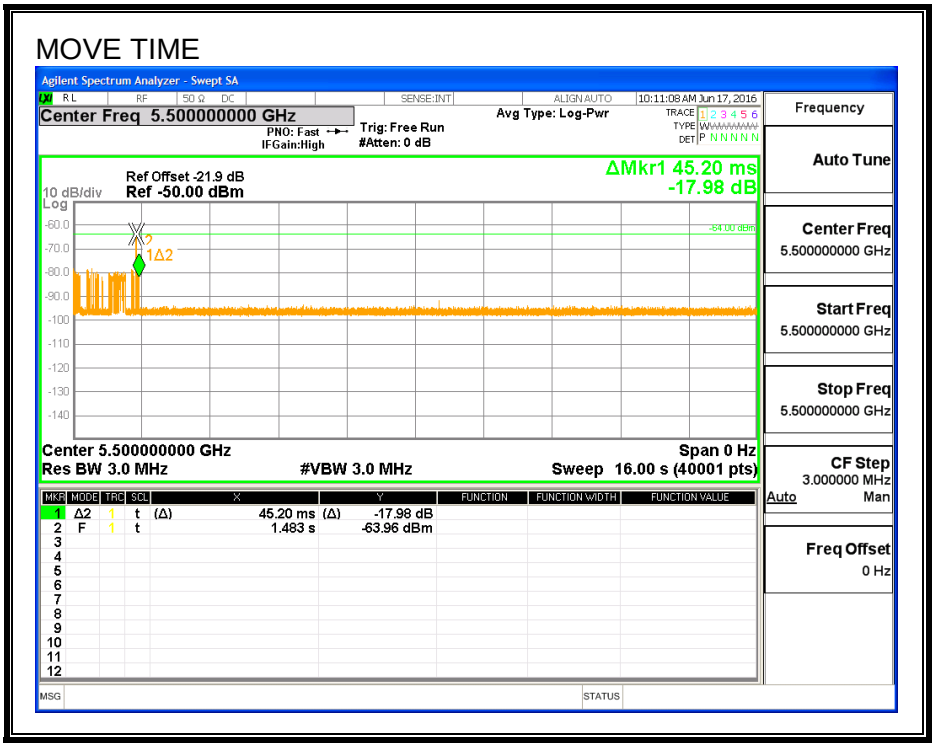
MOVE TIME



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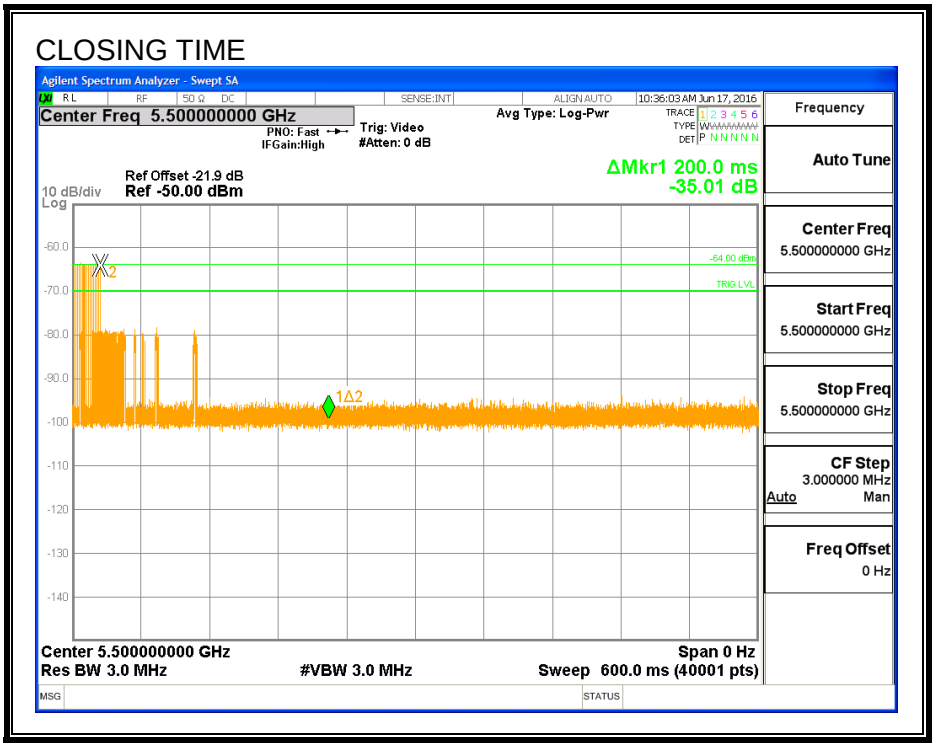
CHANNEL CLOSING TIME



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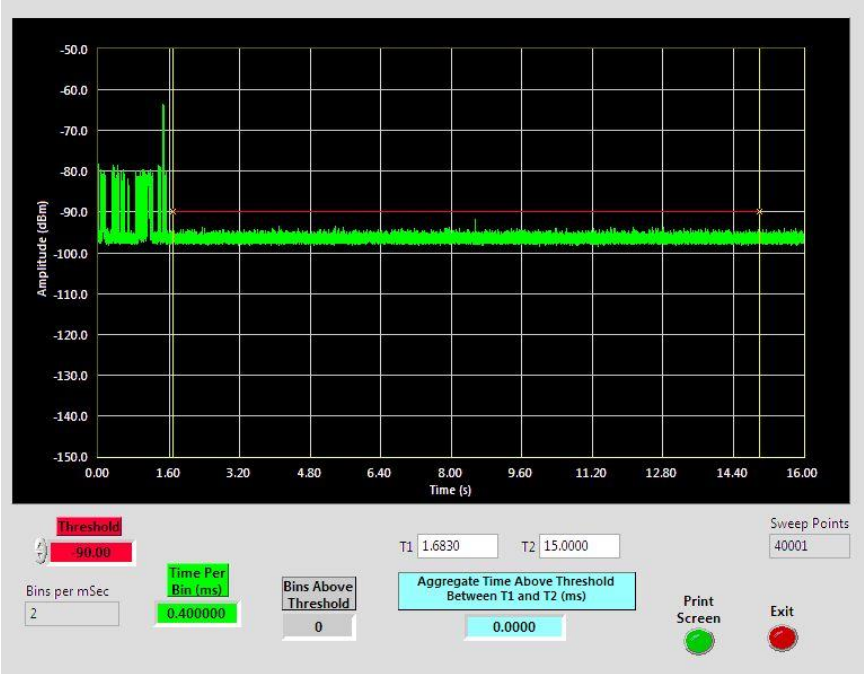
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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11.6. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 40 MHz BANDWIDTH

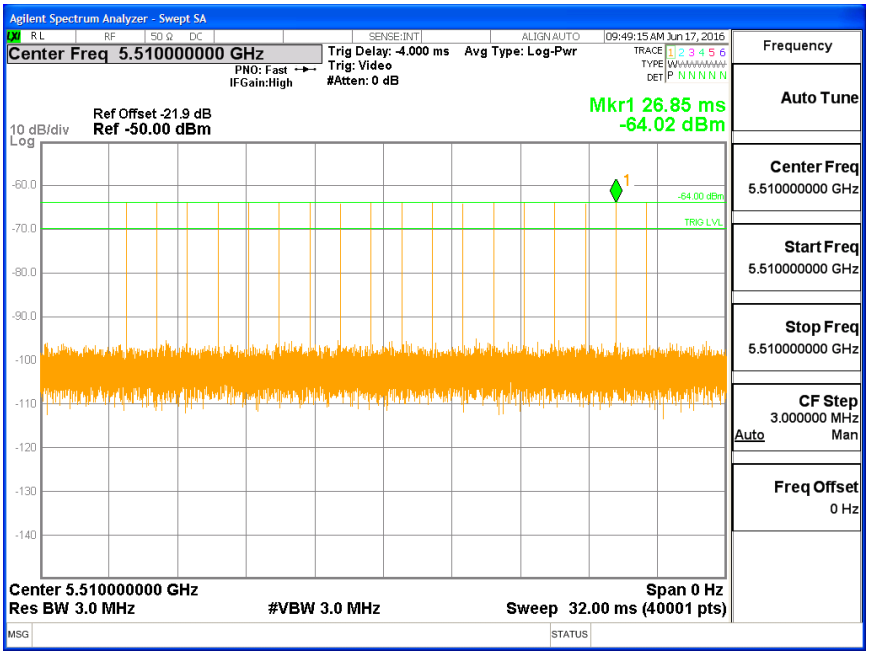
11.6.1. TEST CHANNEL

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

11.6.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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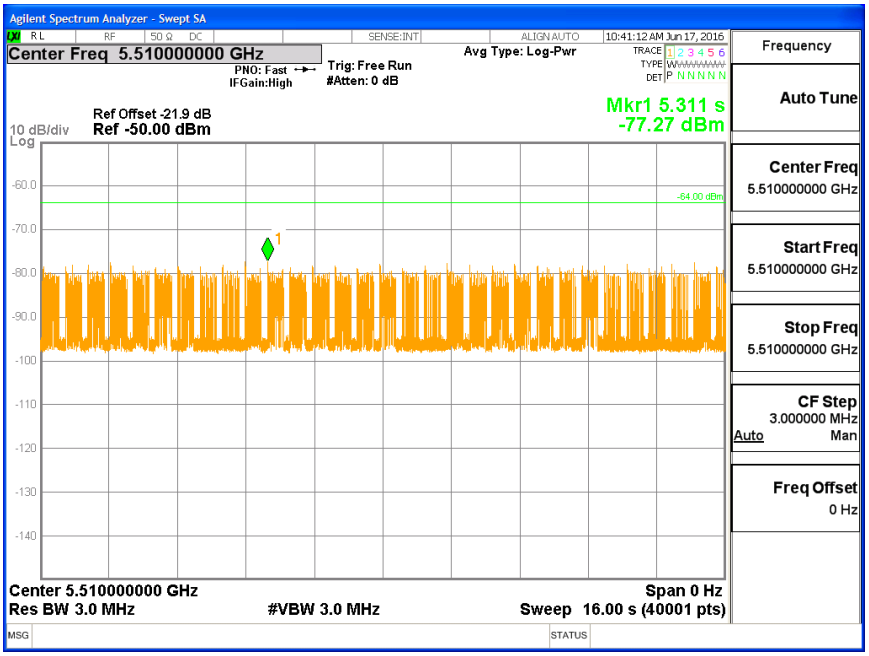
TRAFFIC

SLAVE TRAFFIC



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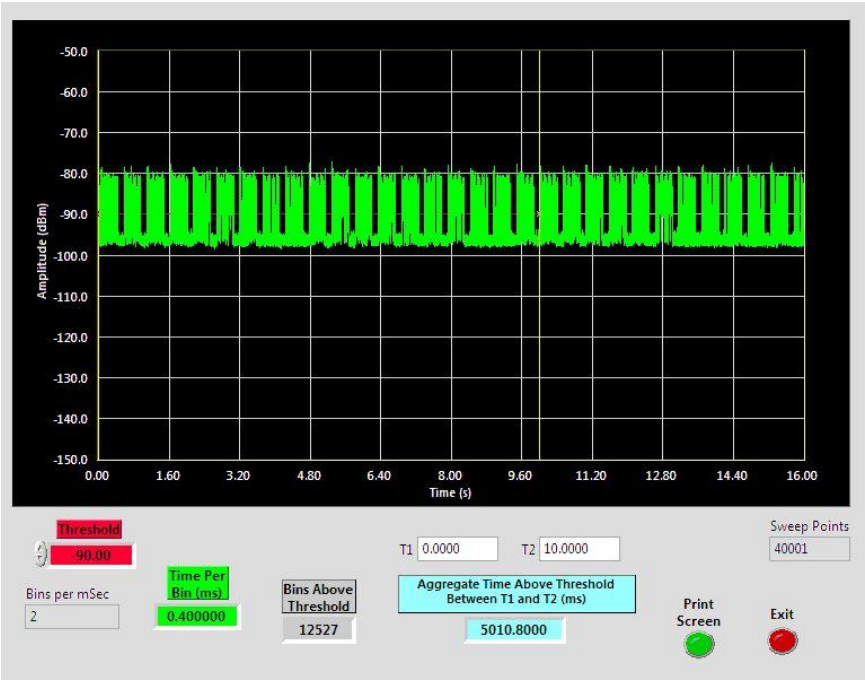
CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 50.1%

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11.6.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.6.4. 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 (sec)	Limit (sec)
0.2544	**10**

Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
5.6	**60**

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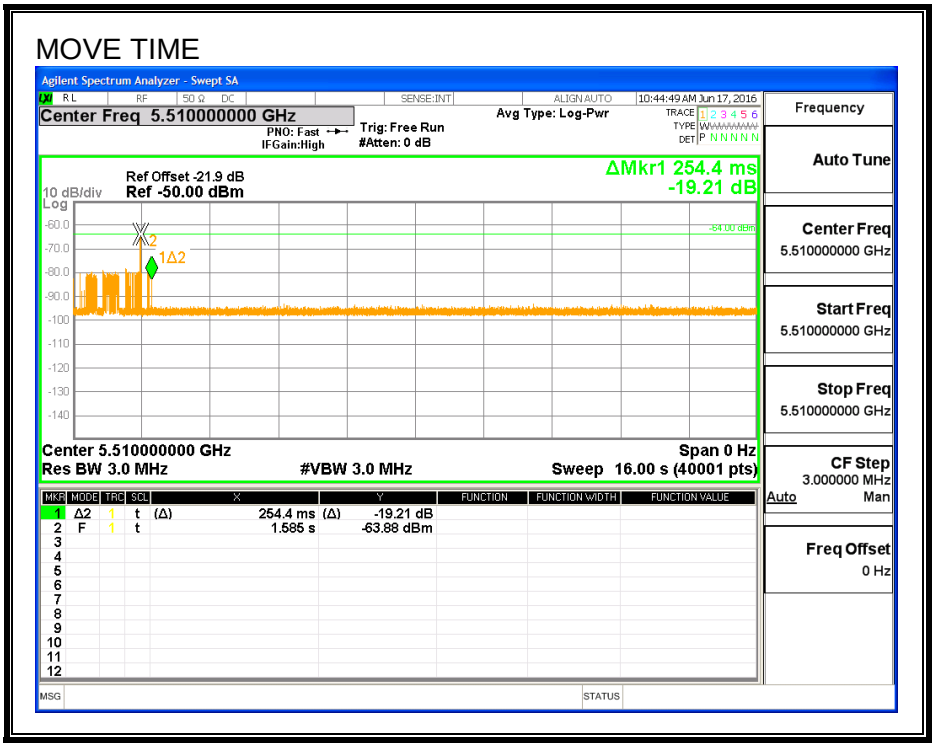
MOVE TIME



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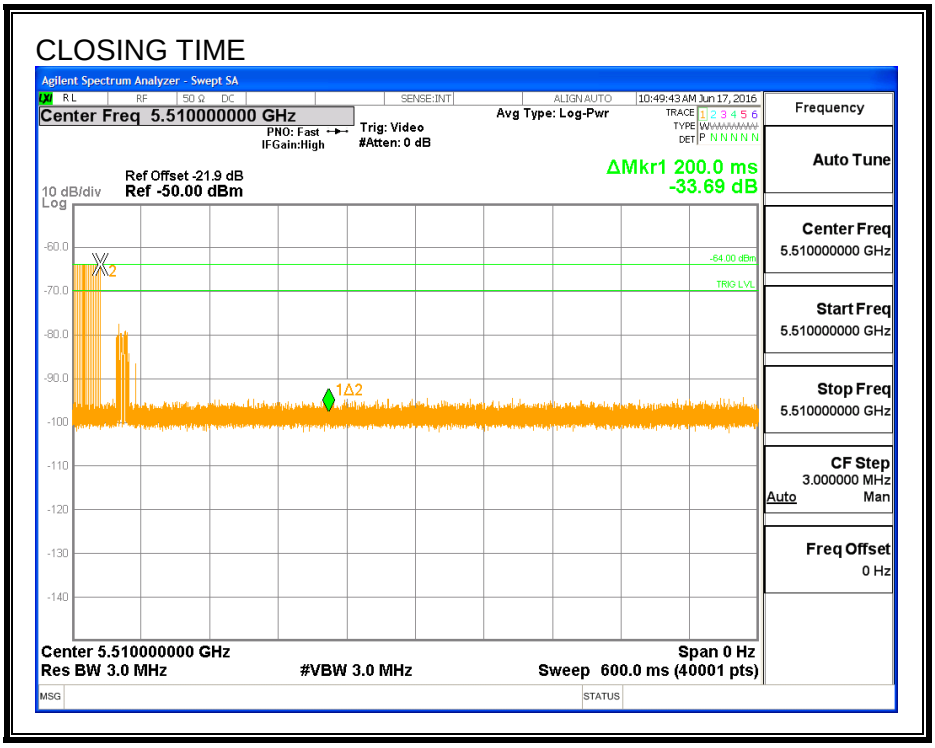
CHANNEL CLOSING TIME



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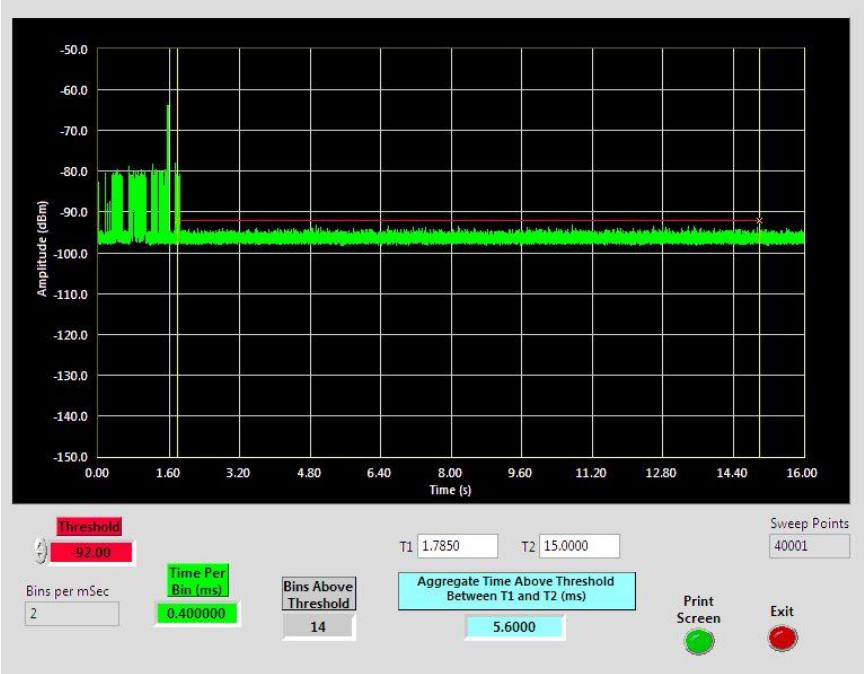
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

Only intermittent transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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11.7. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 80 MHz BANDWIDTH

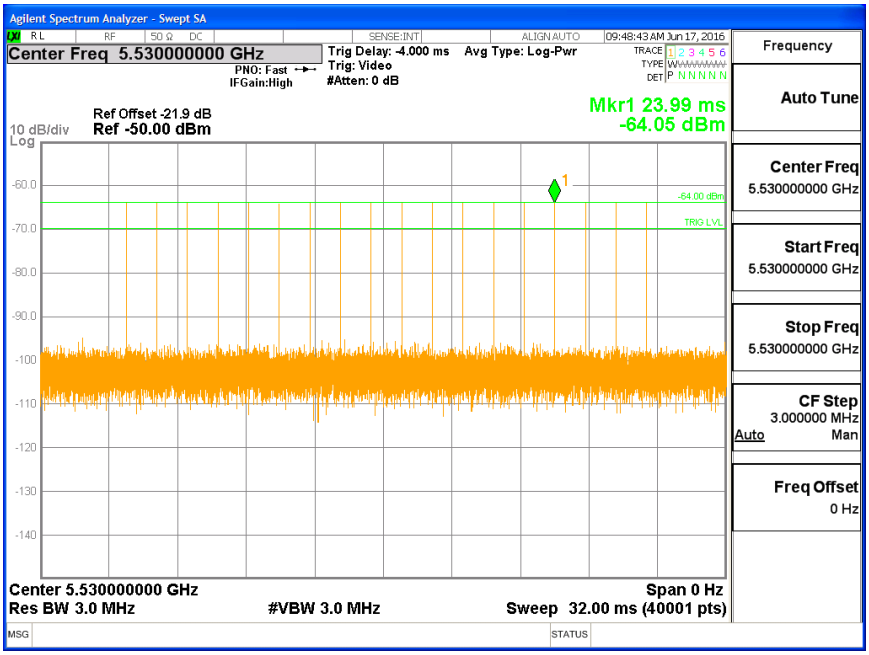
11.7.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5530 MHz.

11.7.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM

SHORT PULSE RADAR TYPE 0 AT MASTER



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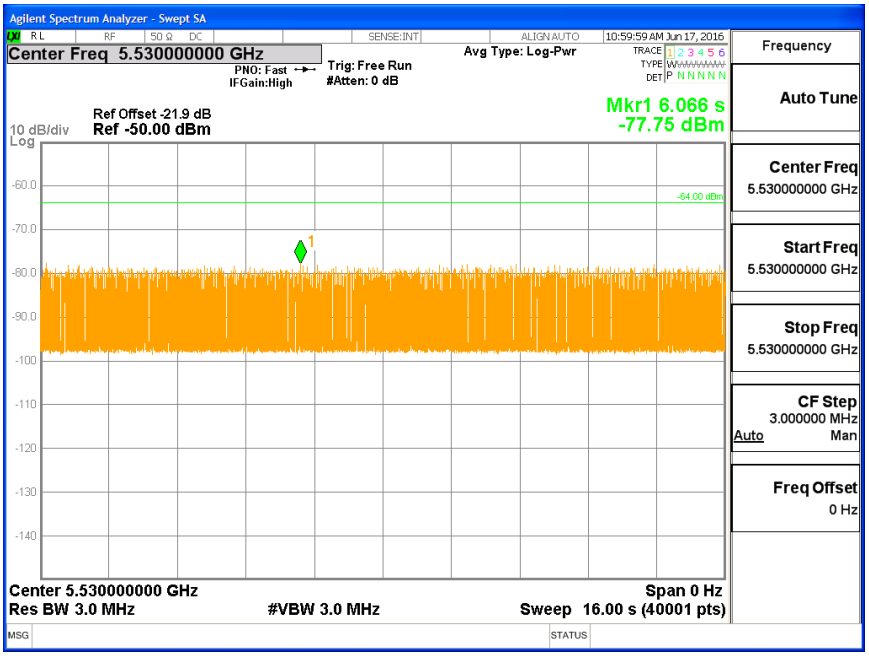
TRAFFIC

SLAVE TRAFFIC



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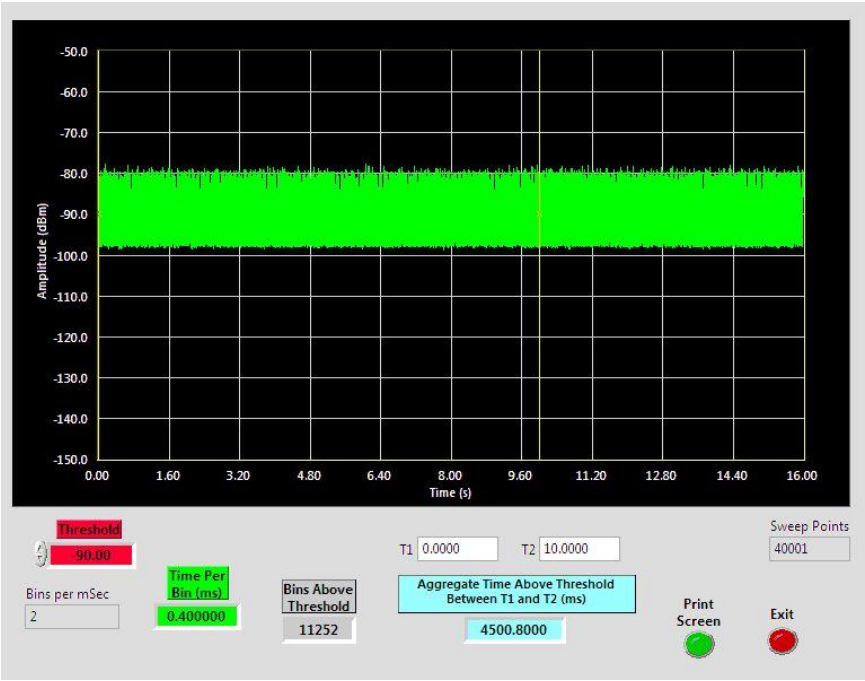
CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 45.0%

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11.7.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.7.4. 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 (sec)	Limit (sec)
0.1804	10

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

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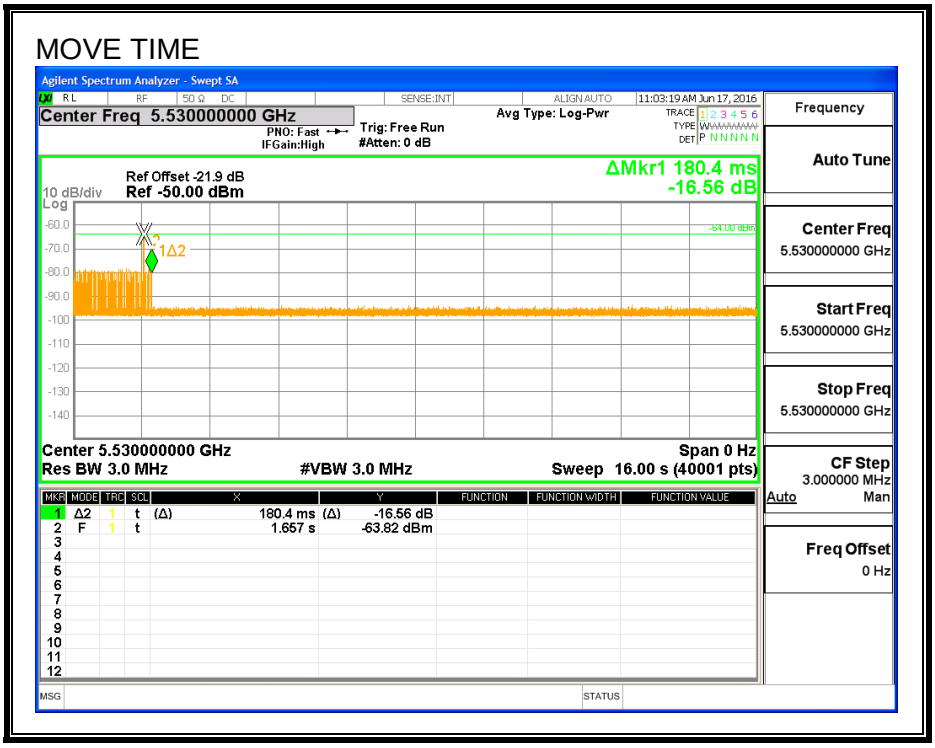
MOVE TIME



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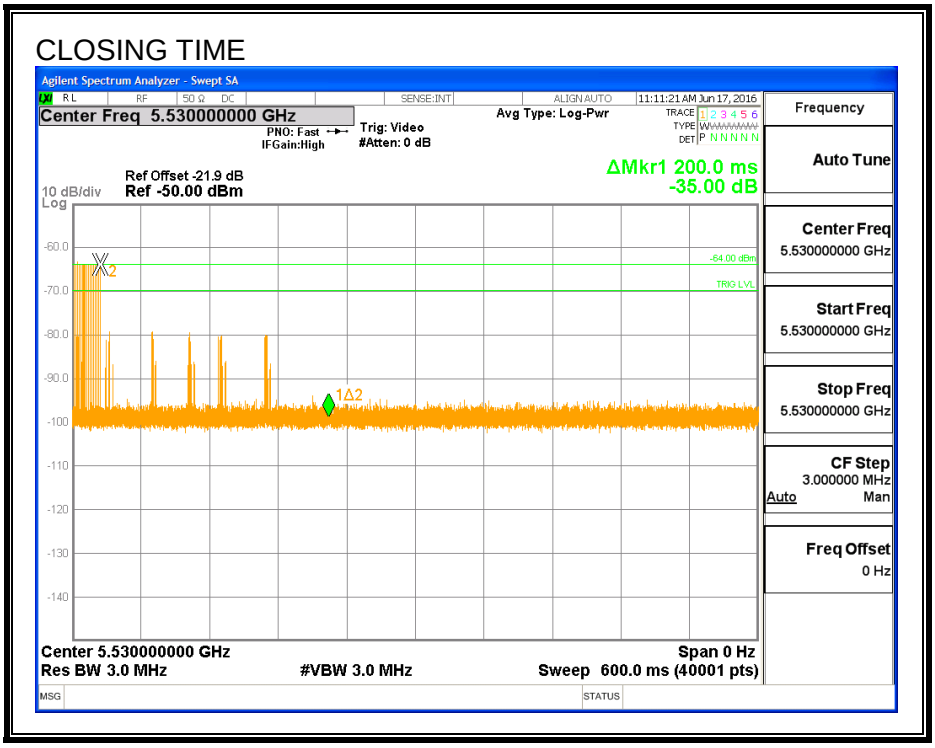
CHANNEL CLOSING TIME



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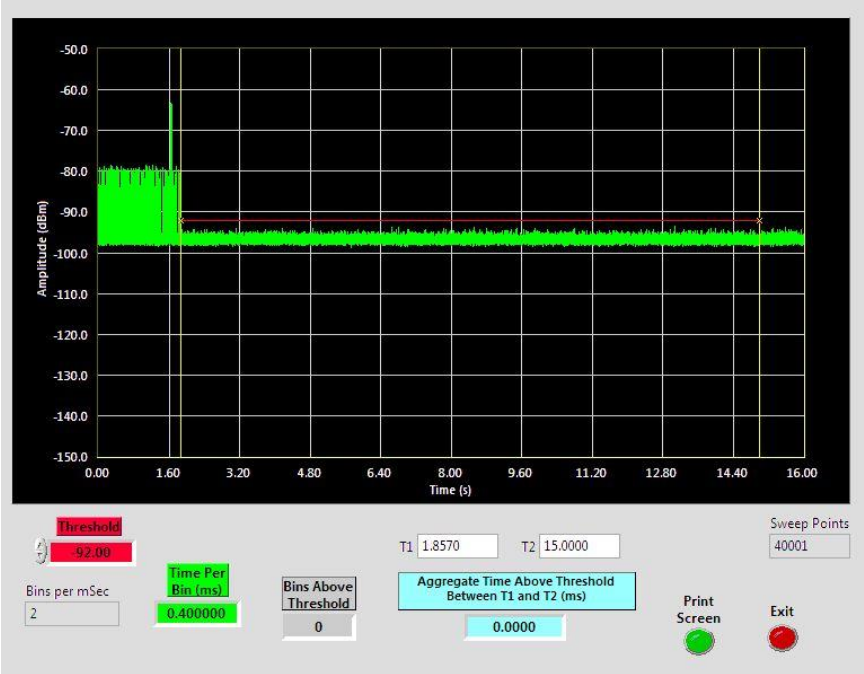
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.

AGGREGATE CLOSING TIME



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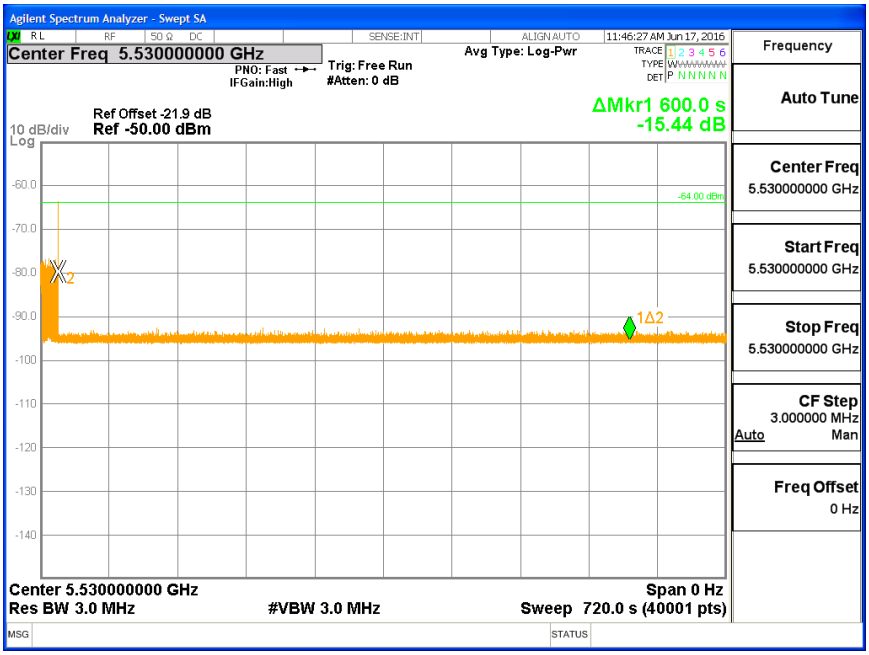
11.7.1. 10-MINUTE CLIENT Tx MONITORING PERIOD

RESULTS

No EUT transmissions were observed on the test channel during the 10-minute observation time.

10-MINUTE CLIENT Tx MONITORING PERIOD



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