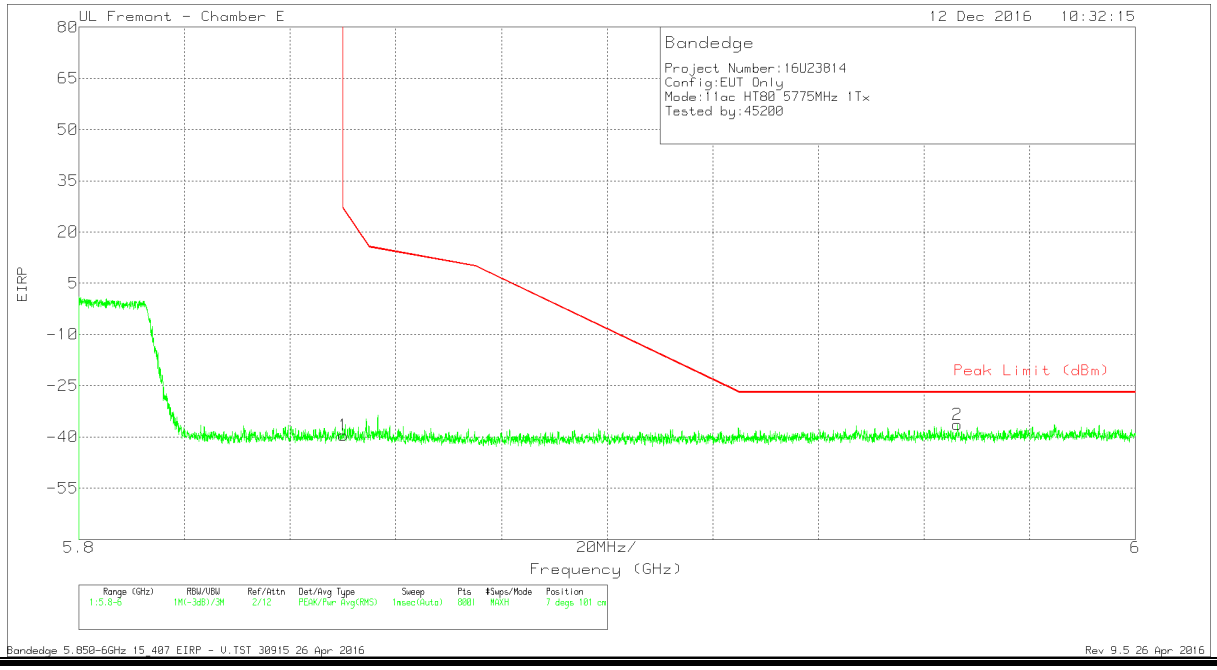
HIGH CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T711 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Conversion Factor (dB)	Corrected Reading EIRP	Peak Limit (dBm)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	5.85	-66.77	Pk	34.9	-19.5	11.8	-39.57	26.94	-66.51	7	101	V
2	5.966	-64.15	Pk	35	-19	11.8	-36.35	-27	-9.35	7	101	V

Pk - Peak detector

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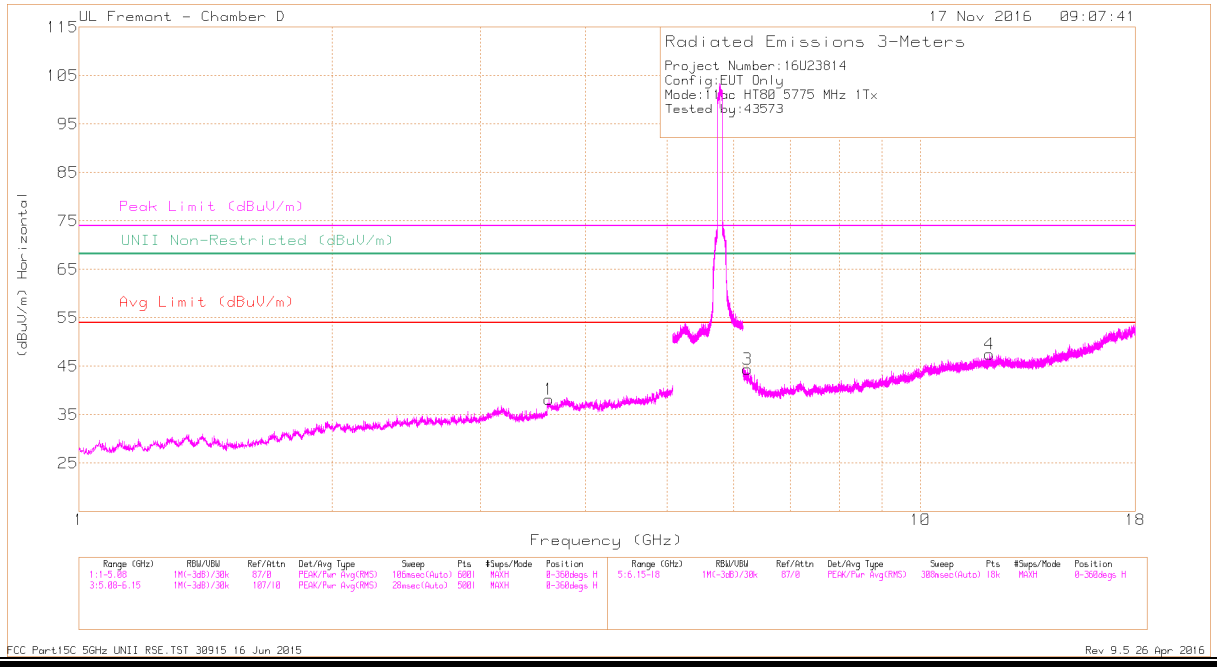
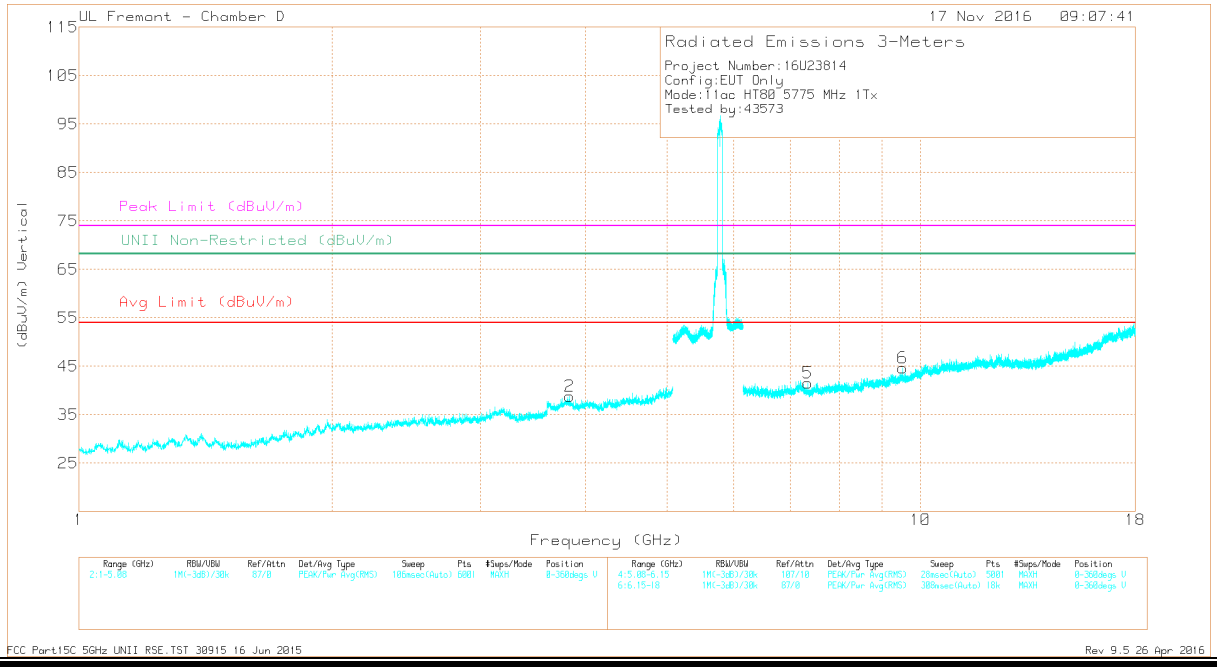
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL



LOW CHANNEL VERTICAL



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Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	UNII Non-Restricted (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 3.62	39.44	PK-U	33.3	-28.8	0	43.94	-	-	74	-30.06	-	-	36	135	H
	* 3.621	29.36	ADR	33.3	-28.8	.21	34.07	54	-19.93	-	-	-	-	36	135	H
2	* 3.824	39.21	PK-U	33.5	-28.5	0	44.21	-	-	74	-29.79	-	-	108	157	V
	* 3.827	29.48	ADR	33.5	-28.5	.21	34.69	54	-19.31	-	-	-	-	108	157	V
4	* 12.08	35.31	PK-U	39	-21.3	0	53.01	-	-	74	-20.99	-	-	89	108	H
	* 12.08	25.5	ADR	39	-21.3	.21	43.41	54	-10.59	-	-	-	-	89	108	H
5	* 7.34	36.91	PK-U	35.6	-25.5	0	47.01	-	-	74	-26.99	-	-	210	287	V
	* 7.342	26.75	ADR	35.6	-25.4	.21	37.16	54	-16.84	-	-	-	-	210	287	V
3	6.234	38.31	PK-U	35.6	-26.3	0	47.61	-	-	-	-	68.2	-20.59	70	208	H
6	9.526	35.26	PK-U	36.6	-21.5	0	50.36	-	-	-	-	68.2	-17.84	89	113	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

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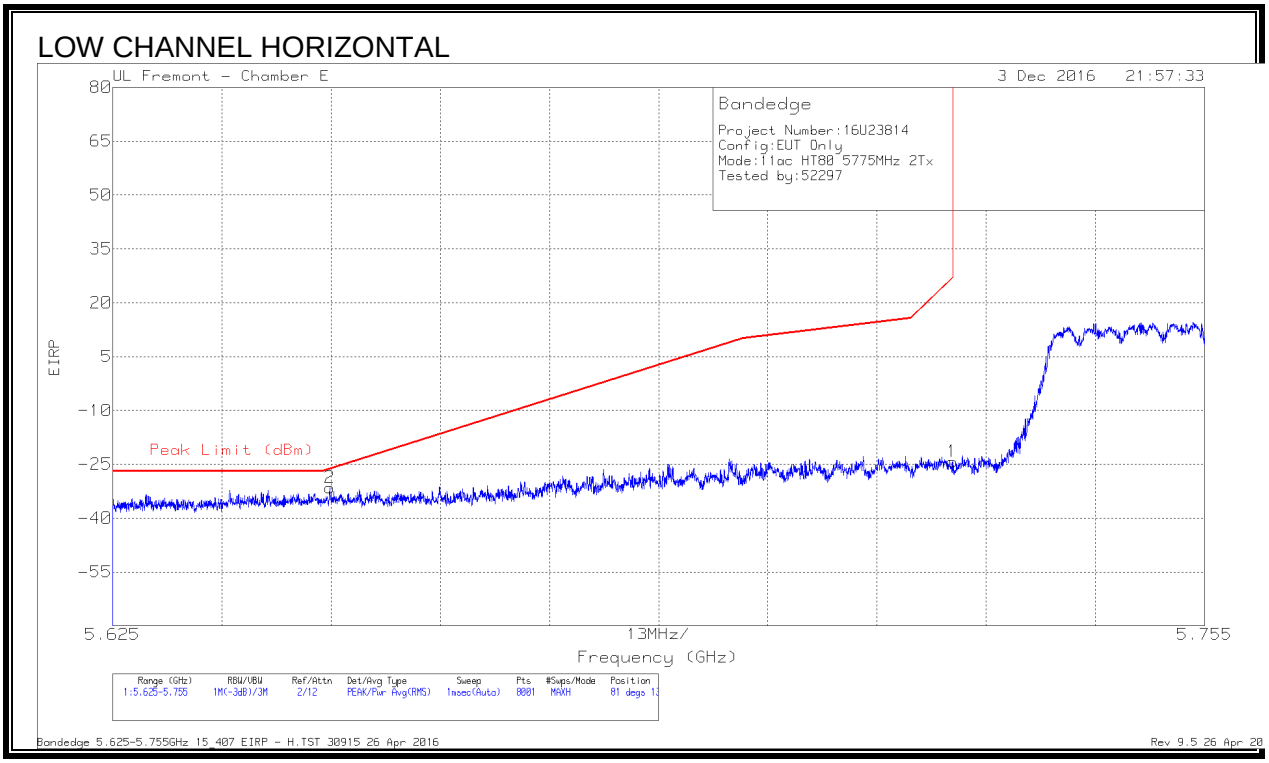
9.2.45. 11ac HT80 2TX CDD MIMO MODE IN THE 5.8GHz BAND

RESTRICTED BANDEDGE (LOW CHANNEL)



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T711 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Conversion Factor (dB)	DC Corr (dB)	Corrected Reading EIRP	Peak Limit (dBm)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	5.651	-58.67	Pk	34.8	-19.5	11.8	0	-31.57	-26.36	-5.21	81	139	H
1	5.725	-51.4	Pk	34.9	-19.6	11.8	0	-24.3	26.97	-51.27	81	139	H

Pk - Peak detector

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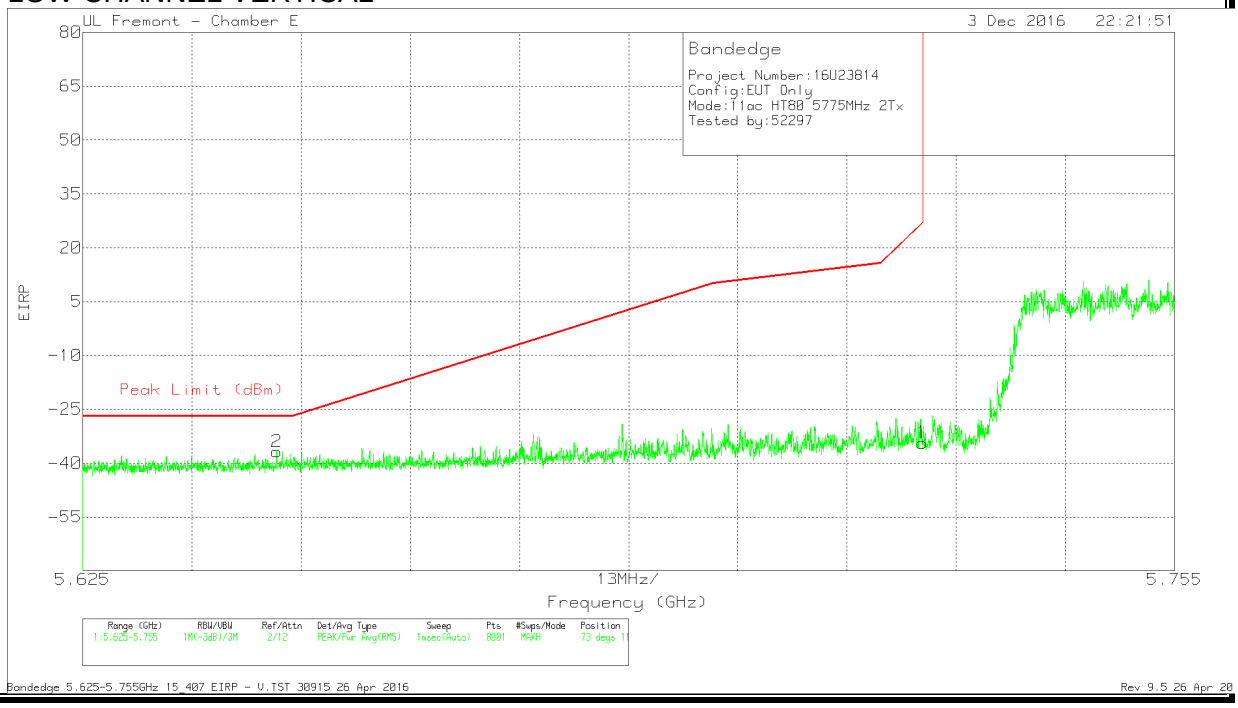
LOW CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T711 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Conversion Factor (dB)	DC Corr (dB)	Corrected Reading EIRP	Peak Limit (dBm)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	5.725	-61.45	Pk	34.9	-19.6	11.8	0	-34.35	26.97	-61.32	73	110	V
2	5.648	-63.88	Pk	34.8	-19.5	11.8	0	-36.78	-27	-9.78	73	110	V

Pk - Peak detector

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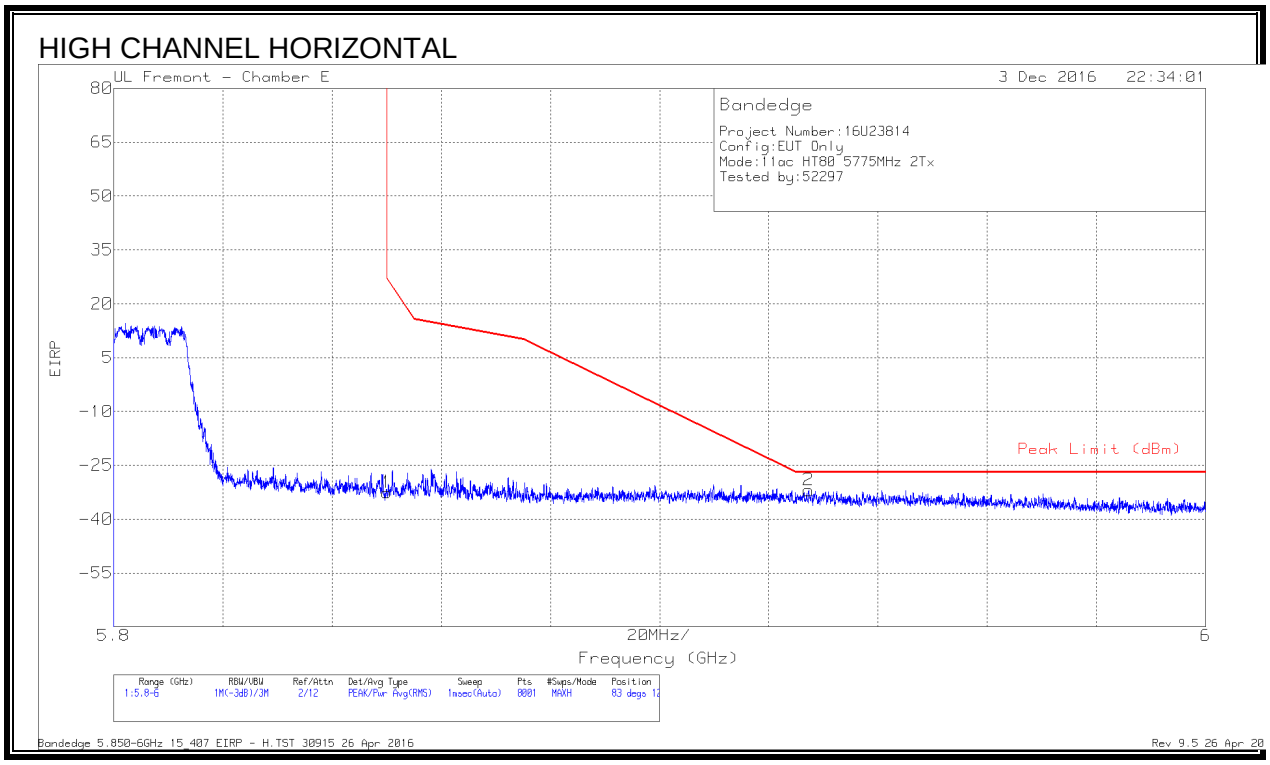
RESTRICTED BANDEDGE (HIGH CHANNEL)



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T711 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Conversion Factor (dB)	DC Corr (dB)	Corrected Reading EIRP	Peak Limit (dBm)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	5.85	-59.78	Pk	34.9	-19.5	11.8	0	-32.58	26.94	-59.52	83	128	H
2	5.927	-59.56	Pk	35	-19.2	11.8	0	-31.96	-27	-4.96	83	128	H

Pk - Peak detector

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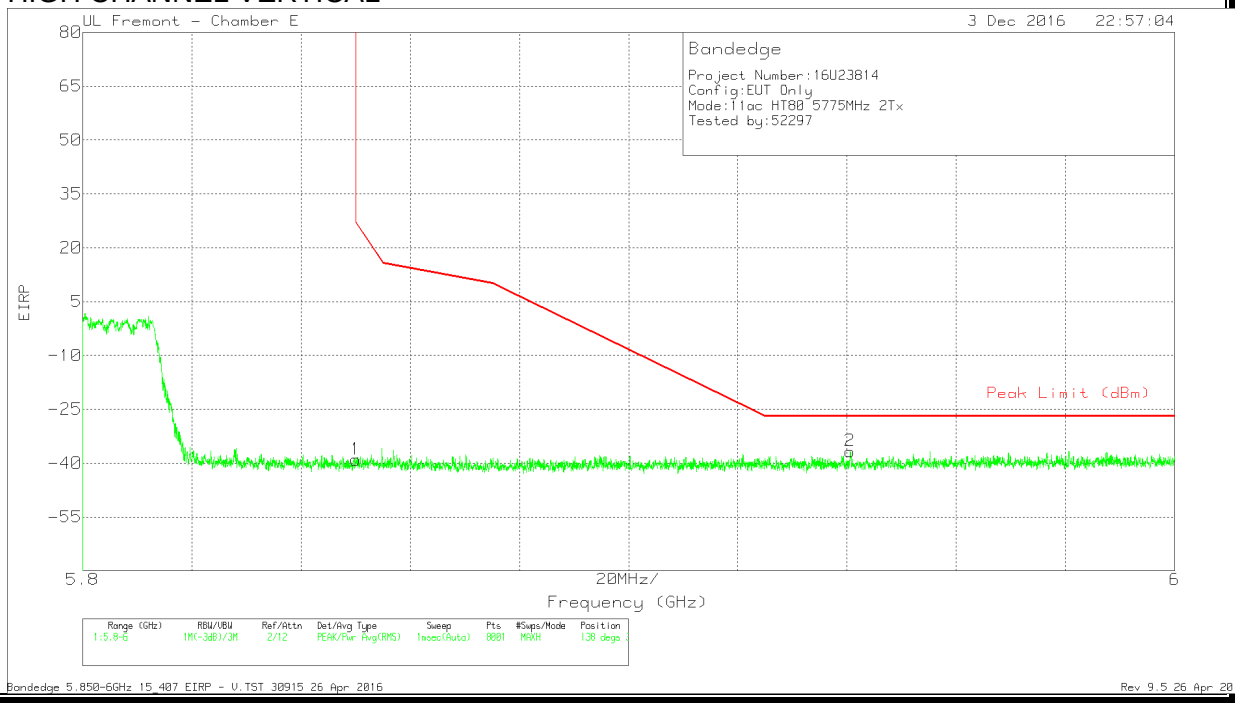
HIGH CHANNEL VERTICAL



Marker	Frequency (GHz)	Meter Reading (dBm)	Det	AF T711 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Conversion Factor (dB)	DC Corr (dB)	Corrected Reading EIRP	Peak Limit (dBm)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	5.85	-66.21	Pk	34.9	-19.5	11.8	0	-39.01	26.94	-65.95	138	314	V
2	5.941	-64.2	Pk	35	-19.3	11.8	0	-36.7	-27	-9.7	138	314	V

Pk - Peak detector

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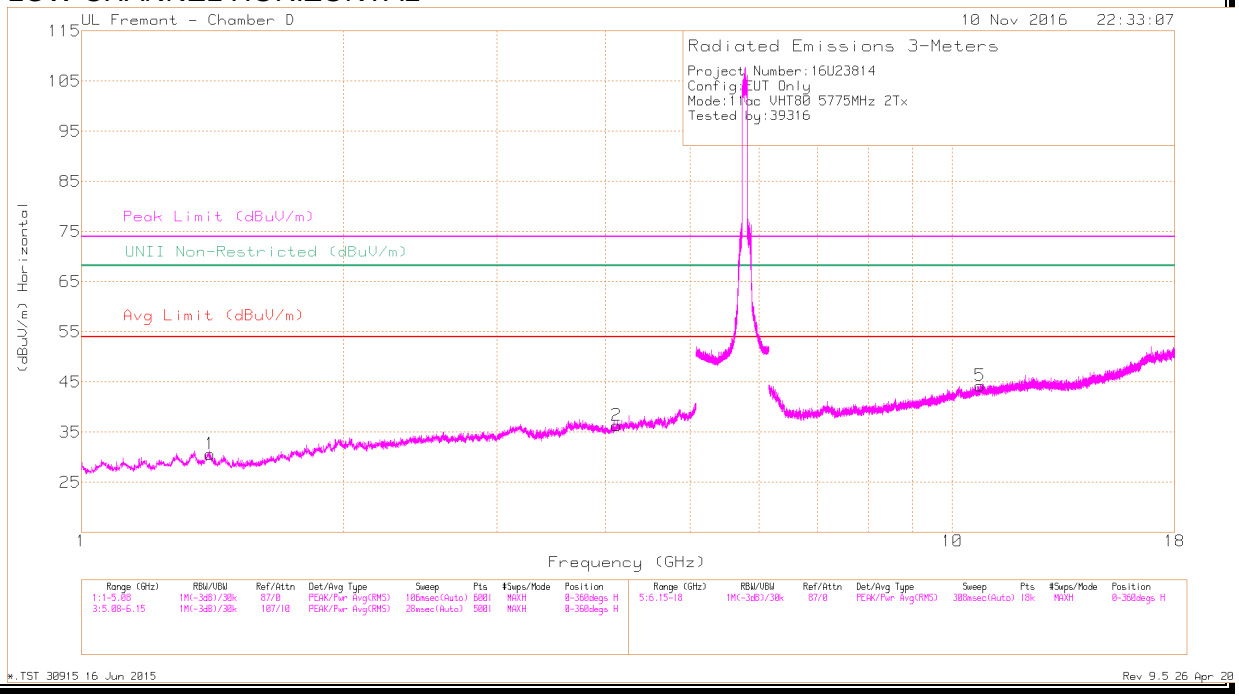
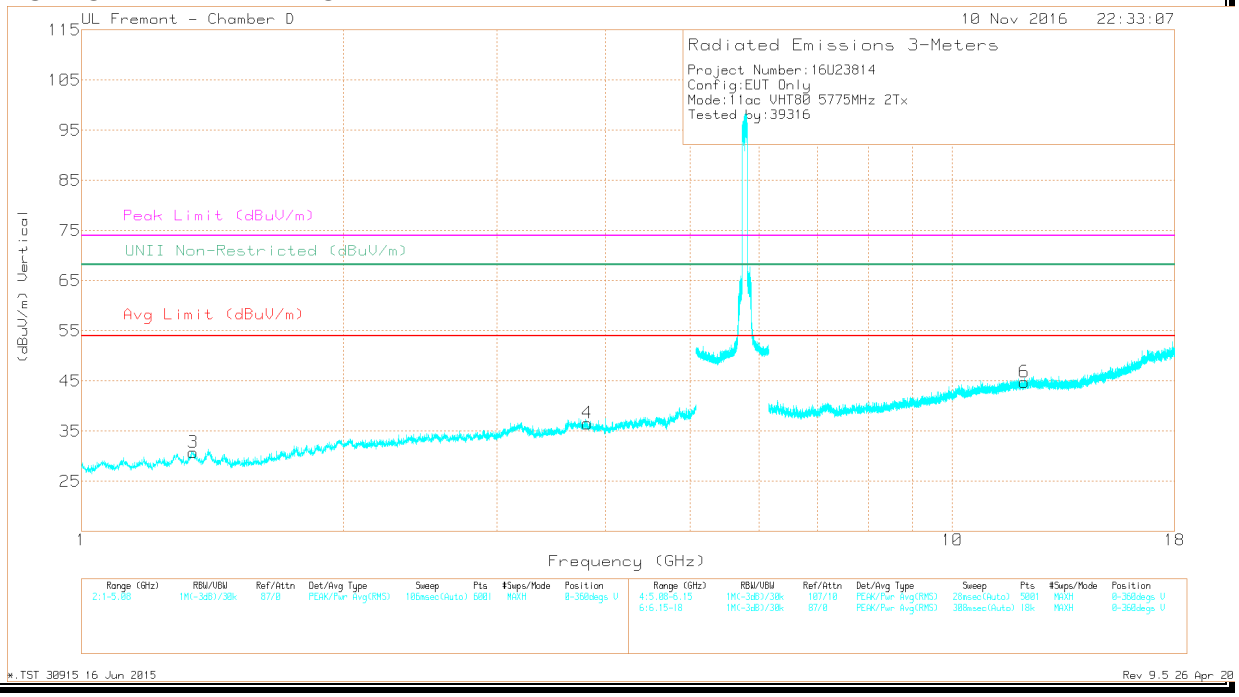
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL HORIZONTAL



LOW CHANNEL VERTICAL



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Markers	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T712 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	UNII Non-Restricted (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 1.405	41.15	PK-U	28.9	-31.2	0	38.85	-	-	74	-35.15	-	-	49	115	H
	* 1.405	29.74	ADR	28.9	-31.2	.2	27.64	54	-26.36	-	-	-	-	49	115	H
2	* 4.118	38.28	PK-U	33.6	-28.3	0	43.58	-	-	74	-30.42	-	-	99	131	H
	* 4.118	27.8	ADR	33.6	-28.3	.2	33.3	54	-20.7	-	-	-	-	99	131	H
3	* 1.343	40.13	PK-U	28.9	-31.3	0	37.73	-	-	74	-36.27	-	-	155	170	V
	* 1.342	30.11	ADR	28.9	-31.3	.2	27.91	54	-26.09	-	-	-	-	155	170	V
4	* 3.813	38.67	PK-U	33.6	-28.5	0	43.77	-	-	74	-30.23	-	-	123	186	V
	* 3.812	27.74	ADR	33.6	-28.5	.2	33.04	54	-20.96	-	-	-	-	123	186	V
5	* 10.762	34.35	PK-U	37.9	-20.7	0	51.55	-	-	74	-22.45	-	-	179	167	H
	* 10.763	23.42	ADR	37.9	-20.7	.2	40.82	54	-13.18	-	-	-	-	179	167	H
6	* 12.097	35.09	PK-U	39	-21.2	0	52.89	-	-	74	-21.11	-	-	239	217	V
	* 12.097	23.86	ADR	39	-21.1	.2	41.96	54	-12.04	-	-	-	-	239	217	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

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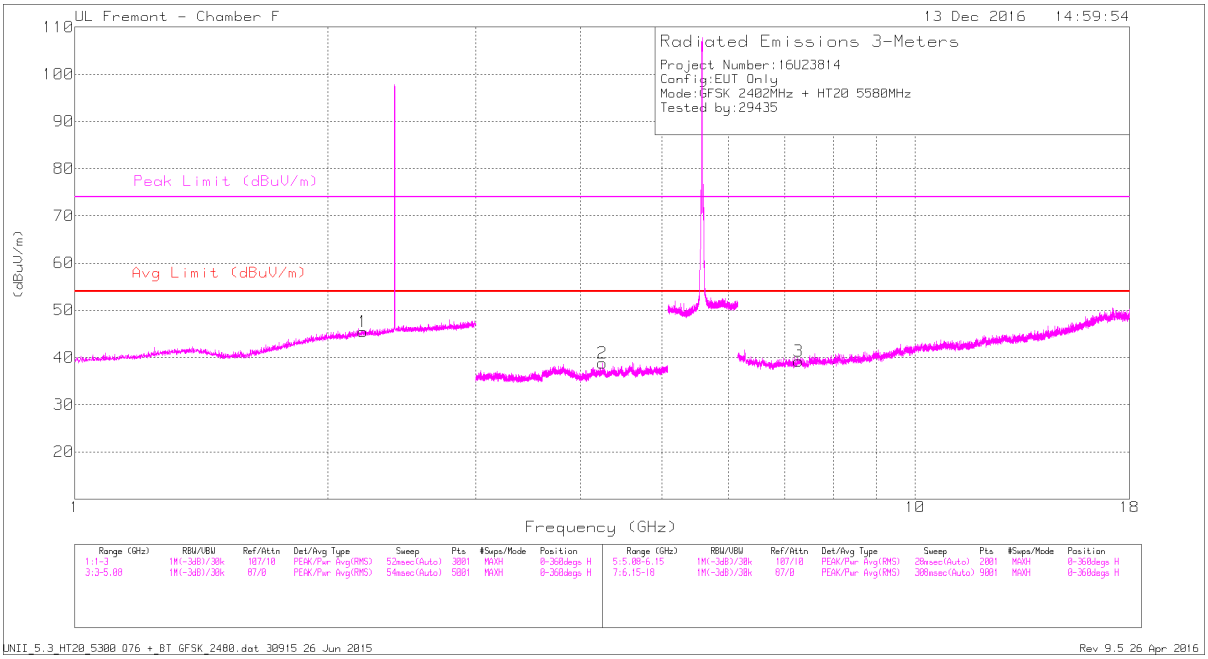
9.3. RADIATION CO-LOCATION

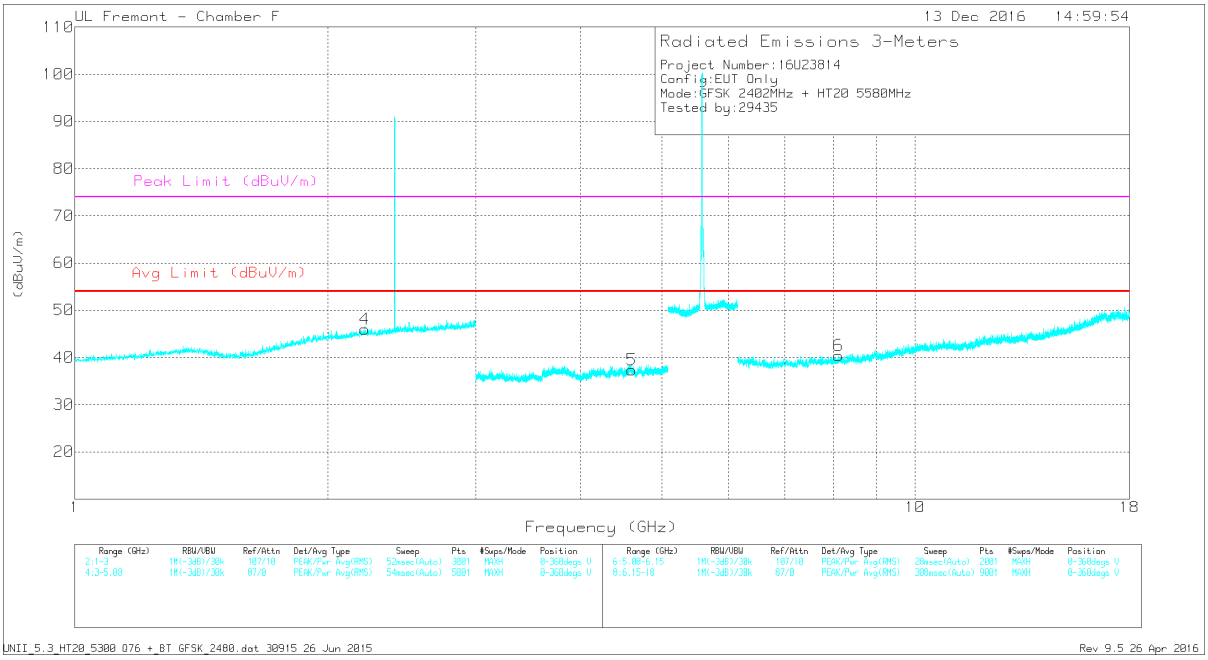
BLUETOOTH AND 802.11 HT20 2Tx CDD MODE IN THE 5.6GHz BAND

HORIZONTAL PLOT



Range (GHz)	RBW/VBW	Ref/Attn	Det/Avg Type	Sweep	Pts	#Swps/Mode	Position
1:1-3	1M(-3dB)/30k	10?/10	PEAK/Pwr Avg(RMS)	52msec(Auto)	3001	MAXH	0-360degs H
3:3-5.00	1M(-3dB)/30k	0?/0	PEAK/Pwr Avg(RMS)	54msec(Auto)	5001	MAXH	0-360degs H
Range (GHz)	RBW/VBW	Ref/Attn	Det/Avg Type	Sweep	Pts	#Swps/Mode	Position
5:5.00-6.15	1M(-3dB)/30k	10?/10	PEAK/Pwr Avg(RMS)	28msec(Auto)	2001	MAXH	0-360degs H
7:6.15-18	1M(-3dB)/30k	0?/0	PEAK/Pwr Avg(RMS)	300msec(Auto)	9001	MAXH	0-360degs H

VERTICAL PLOT



Range (GHz)	RBW/VBW	Ref/Attn	Det/Avg Type	Sweep	Pts	#Swps/Mode	Position
2:1-3	1M(-3dB)/30k	10?/10	PEAK/Pwr Avg(RMS)	52msec(Auto)	3001	MAXH	0-360degs V
4:3-5.00	1M(-3dB)/30k	0?/0	PEAK/Pwr Avg(RMS)	54msec(Auto)	5001	MAXH	0-360degs V
Range (GHz)	RBW/VBW	Ref/Attn	Det/Avg Type	Sweep	Pts	#Swps/Mode	Position
6:5.00-6.15	1M(-3dB)/30k	10?/10	PEAK/Pwr Avg(RMS)	28msec(Auto)	2001	MAXH	0-360degs V
8:6.15-18	1M(-3dB)/30k	0?/0	PEAK/Pwr Avg(RMS)	300msec(Auto)	9001	MAXH	0-360degs V

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DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T344 (dB/m)	Amp/Cbl /Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	2.2	41.54	PK-U	31.9	-21	52.44	53.97	-1.53	74	-21.56	130	360	H
	2.199	30.4	ADR	31.9	-21	41.3	53.97	-12.67	-	-	130	360	H
4	* 2.216	41.48	PK-U	31.9	-21	52.38	53.97	-1.59	74	-21.62	170	267	V
	* 2.216	30.19	ADR	31.9	-21	41.09	53.97	-12.88	-	-	170	267	V
2	* 4.249	38.46	PK-U	33.7	-28.1	44.06	53.97	-9.91	74	-29.94	90	144	H
	* 4.248	27.4	ADR	33.7	-28.1	33	53.97	-20.97	-	-	90	144	H
5	* 4.603	37.81	PK-U	34.1	-27.8	44.11	53.97	-9.86	74	-29.89	24	236	V
	* 4.603	27.14	ADR	34.1	-27.8	33.44	53.97	-20.53	-	-	24	236	V
3	* 7.261	36.13	PK-U	35.5	-25.3	46.33	53.97	-7.64	74	-27.67	9	201	H
	* 7.262	25.51	ADR	35.5	-25.3	35.71	53.97	-18.26	-	-	9	201	H
6	* 8.114	36.74	PK-U	35.7	-24.7	47.74	53.97	-6.23	74	-26.26	189	392	V
	* 8.115	25.07	ADR	35.7	-24.7	36.07	53.97	-17.9	-	-	189	392	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

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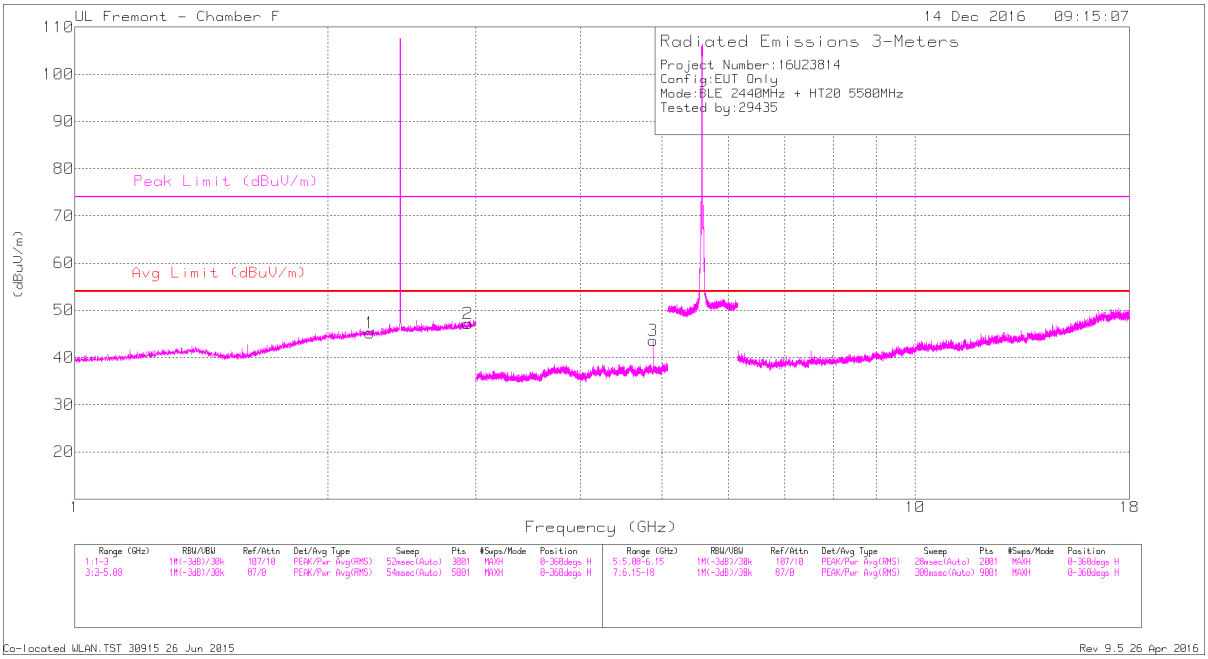
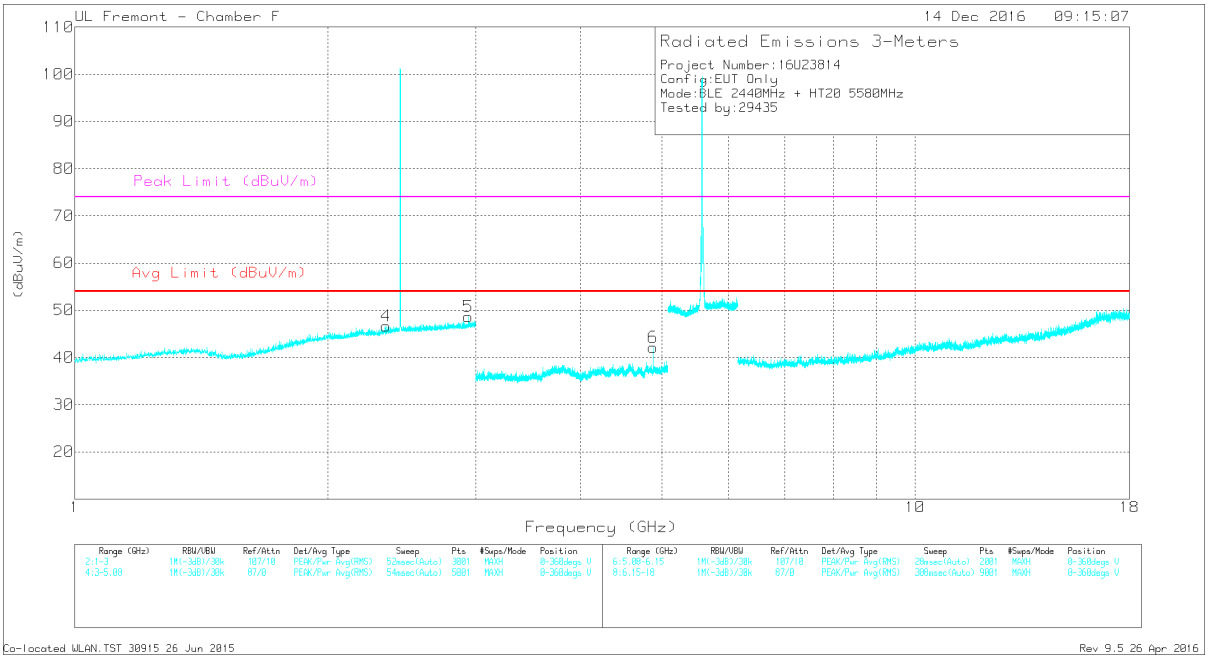
BLUETOOTH LOW ENERGY AND 802.11 HT20 2Tx CDD MODE IN THE 5.6GHz BAND

HORIZONTAL PLOT



VERTICAL PLOT



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DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T344 (dB/m)	Amp/Cbl/Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.244	41.39	PK-U	31.8	-21	52.19	53.97	-1.78	74	-21.81	216	194	H
	* 2.243	30.43	ADR	31.8	-21	41.23	-	-	-	-	216	194	H
2	2.938	41.65	PK-U	32.7	-20.4	53.95	53.97	-.02	74	-20.05	14	377	H
	2.937	30.25	ADR	32.7	-20.4	42.55	-	-	-	-	14	377	H
4	* 2.345	42.23	PK-U	31.9	-21	53.13	53.97	-.84	74	-20.87	261	243	V
	* 2.347	30.38	ADR	31.9	-21	41.28	-	-	-	-	261	243	V
5	2.942	41.23	PK-U	32.7	-20.4	53.53	53.97	-.44	74	-20.47	94	132	V
	2.94	30.28	ADR	32.7	-20.4	42.58	-	-	-	-	94	132	V
3	* 4.88	41.86	PK-U	34.1	-27.8	48.16	53.97	-5.81	74	-25.84	308	251	H
	* 4.88	34.04	ADR	34.1	-27.8	40.34	-	-	-	-	308	251	H
6	* 4.88	41.57	PK-U	34.1	-27.8	47.87	53.97	-6.1	74	-26.13	248	125	V
	* 4.88	33.88	ADR	34.1	-27.8	40.18	-	-	-	-	248	125	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
PK-U - U-NII: Maximum Peak
ADR - U-NII AD primary method, RMS average

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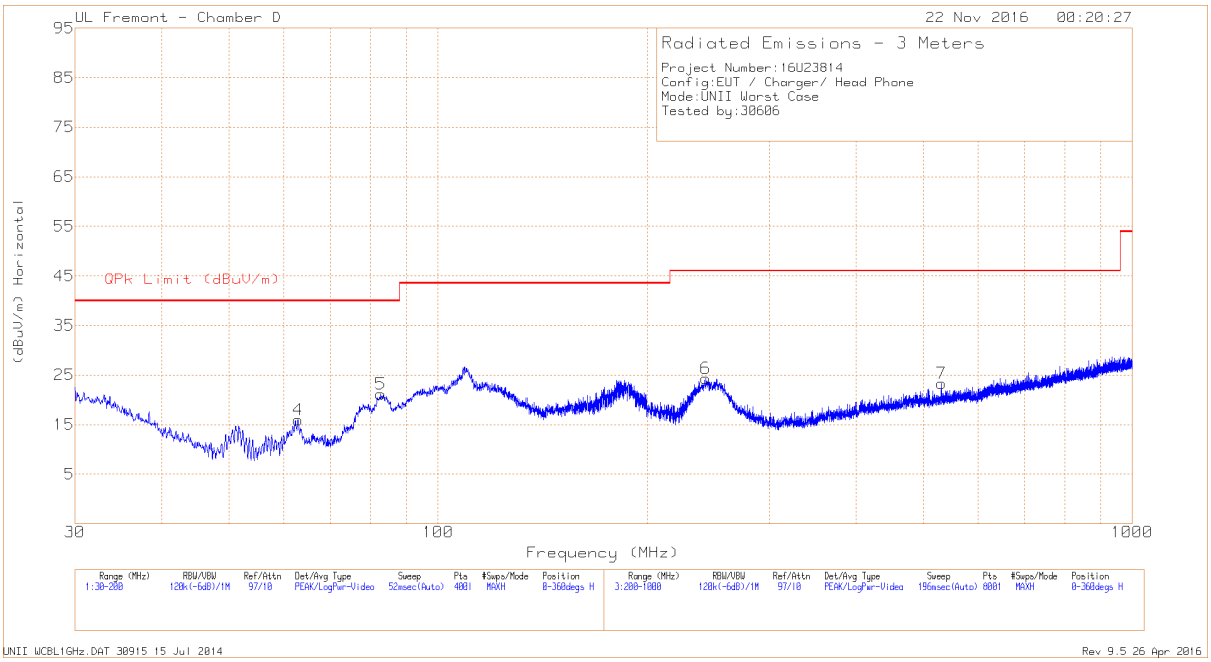
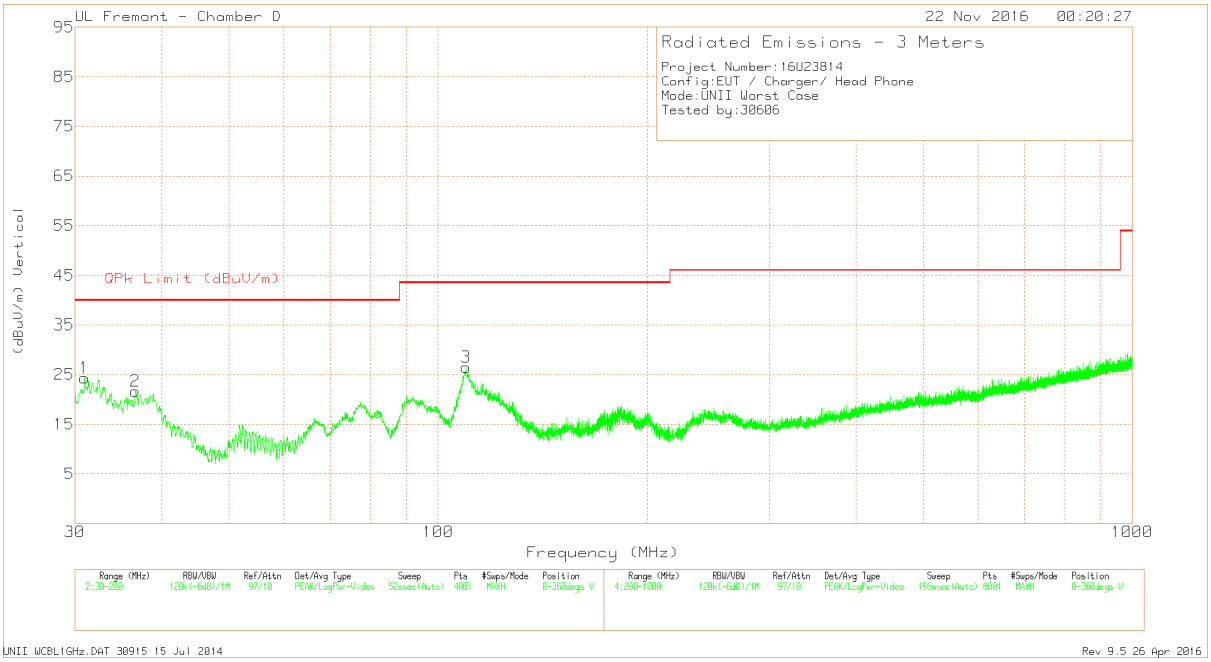
9.4. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)

HORIZONTAL PLOT



VERTICAL PLOT



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DATA

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T243 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
3	* 109.7725	41.14	Pk	16.7	-31.3	26.54	43.52	-16.98	0-360	100	V
6	* 243.2	39.28	Pk	15.6	-30.6	24.28	46.02	-21.74	0-360	100	H
1	30.9775	31.68	Pk	24.6	-31.9	24.38	40	-15.62	0-360	100	V
2	36.6725	33.21	Pk	20.3	-31.8	21.71	40	-18.29	0-360	100	V
4	62.8525	36.01	Pk	11.6	-31.6	16.01	40	-23.99	0-360	299	H
5	82.7425	41.36	Pk	11.3	-31.5	21.16	40	-18.84	0-360	399	H
7	530.8	30.98	Pk	21.9	-29.6	23.28	46.02	-22.74	0-360	100	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
Pk - Peak detector

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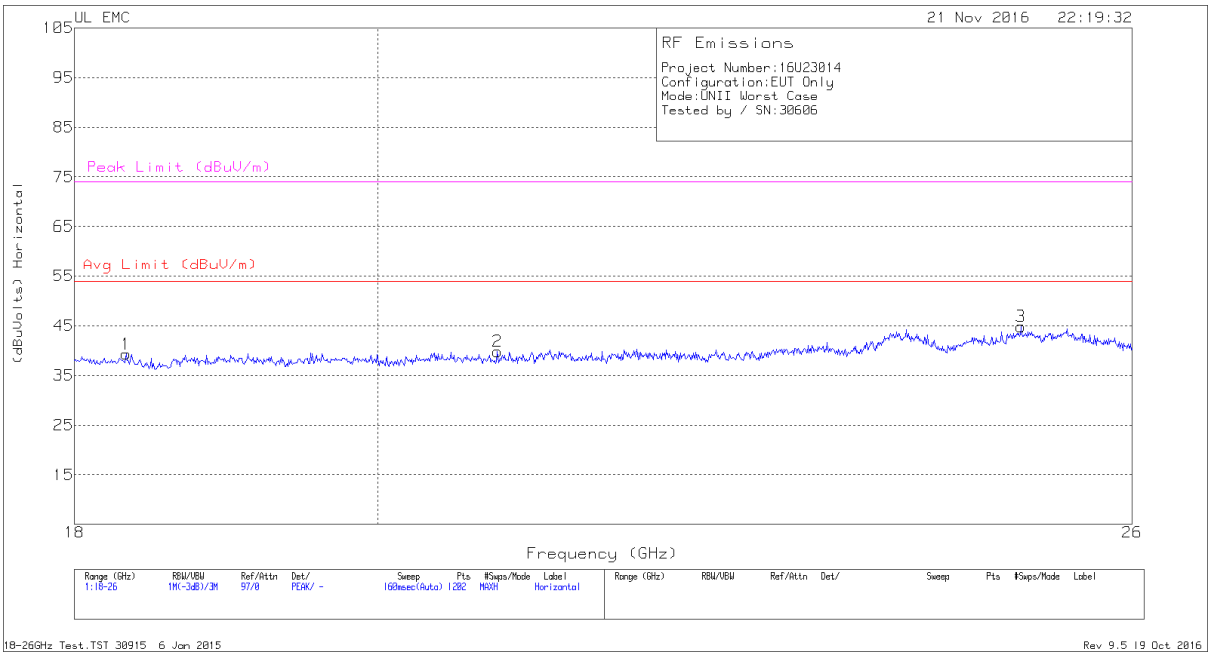
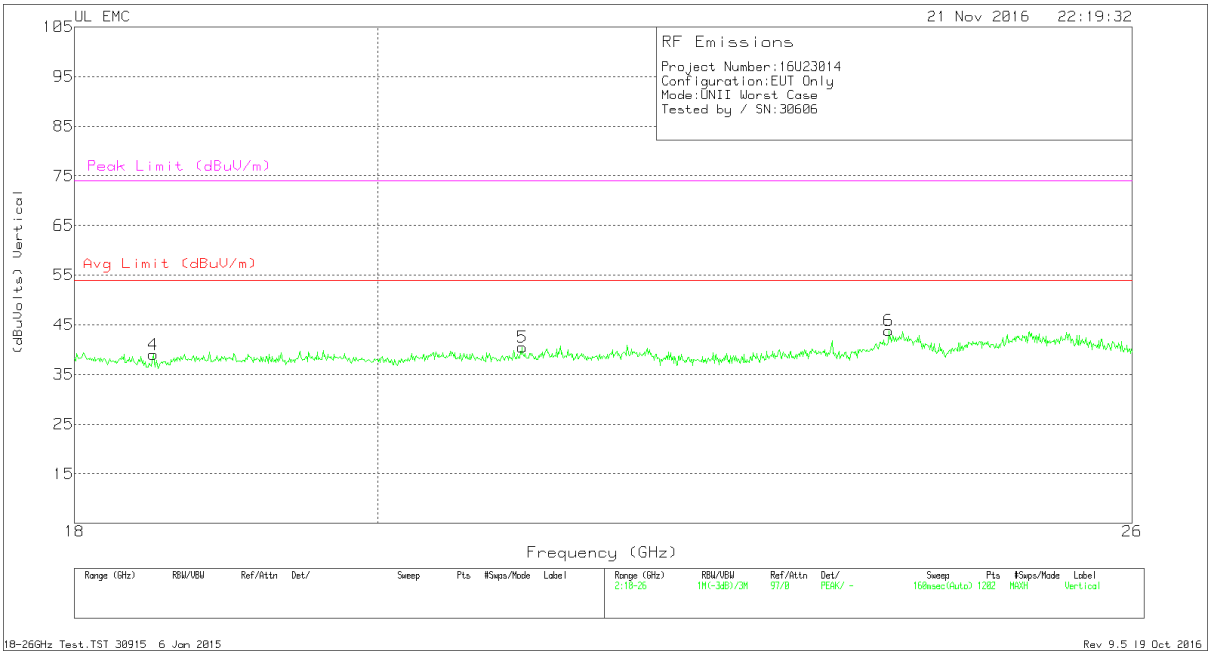
9.5. WORST-CASE 18 to 26 GHz

SPURIOUS EMISSIONS 18 TO 26 GHz (WORST-CASE CONFIGURATION, HORIZONTAL & VERTICAL)

HORIZONTAL PLOT



VERTICAL PLOT



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DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T449 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	18.326	41.73	Pk	32.4	-25.3	-9.5	39.33	54	-14.67	74	-34.67
2	20.851	41.73	Pk	33	-25.4	-9.5	39.83	54	-14.17	74	-34.17
3	25.014	44.63	Pk	34.2	-24.5	-9.5	44.83	54	-9.17	74	-29.17
4	18.5	41.6	Pk	32.6	-25.7	-9.5	39	54	-15	74	-35
5	21.031	42.2	Pk	33.1	-25.3	-9.5	40.5	54	-13.5	74	-33.5
6	23.888	43.43	Pk	33.9	-24	-9.5	43.83	54	-10.17	74	-30.17

Pk - Peak detector

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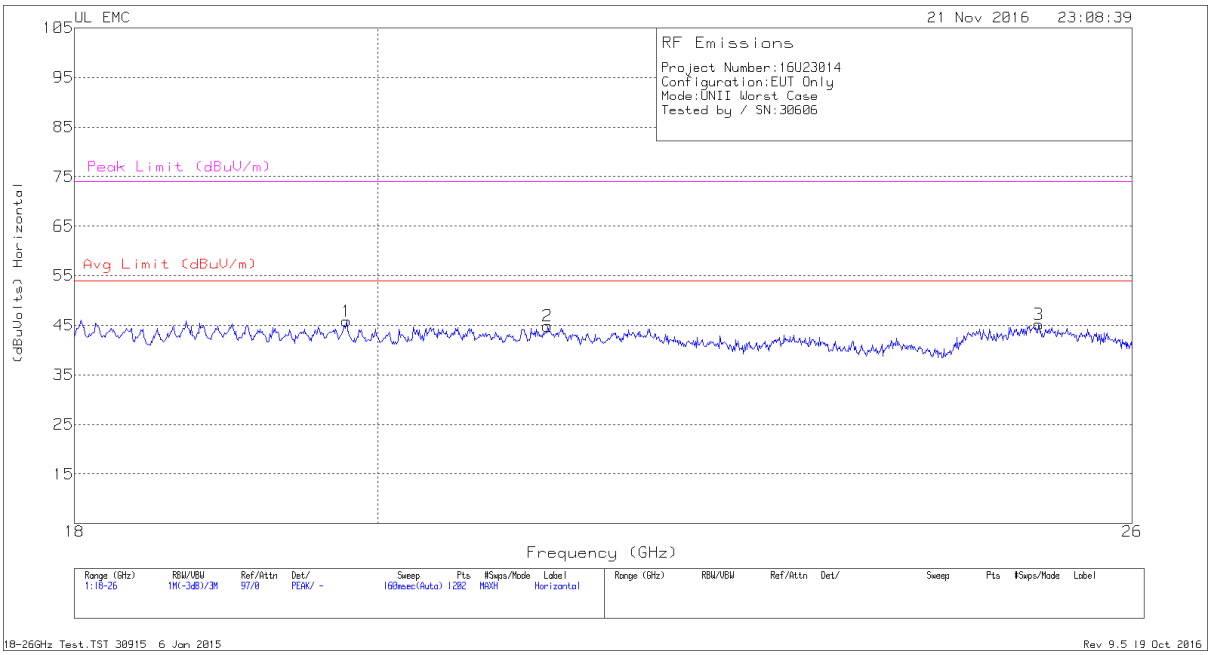
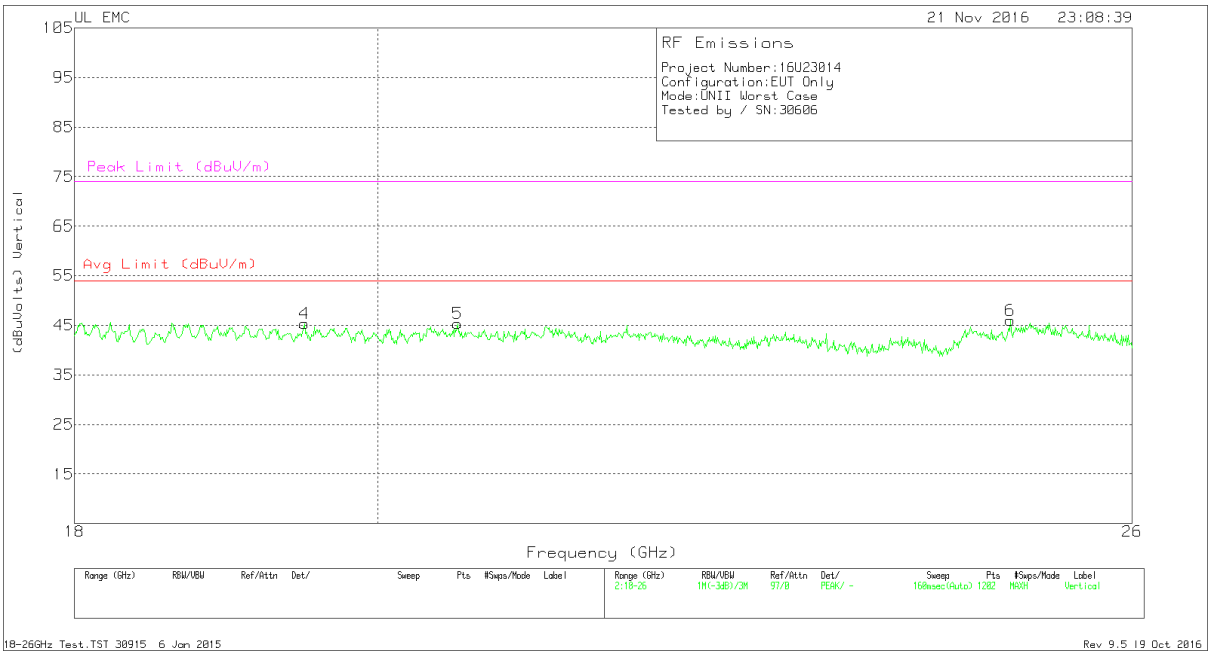
9.6. WORST-CASE 26 to 40 GHz

SPURIOUS EMISSIONS 26 TO 40 GHz (WORST-CASE CONFIGURATION)

HORIZONTAL PLOT



VERTICAL PLOT



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DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T449 (dB/m)	Amp/Cbl (dB)	Dist Corr (dB)	Corrected Reading (dBuVolts)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)
1	19.785	47.33	Pk	32.7	-24.7	-9.5	45.83	54	-8.17	74	-28.17
2	21.217	46.03	Pk	33.1	-24.8	-9.5	44.83	54	-9.17	74	-29.17
3	25.167	45.27	Pk	34.3	-24.9	-9.5	45.17	54	-8.83	74	-28.83
4	19.499	47.23	Pk	32.7	-25.1	-9.5	45.33	54	-8.67	74	-28.67
5	20.565	47.33	Pk	32.9	-25.4	-9.5	45.33	54	-8.67	74	-28.67
6	24.921	45.5	Pk	34.2	-24.2	-9.5	46	54	-8	74	-28

Pk - Peak detector

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10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

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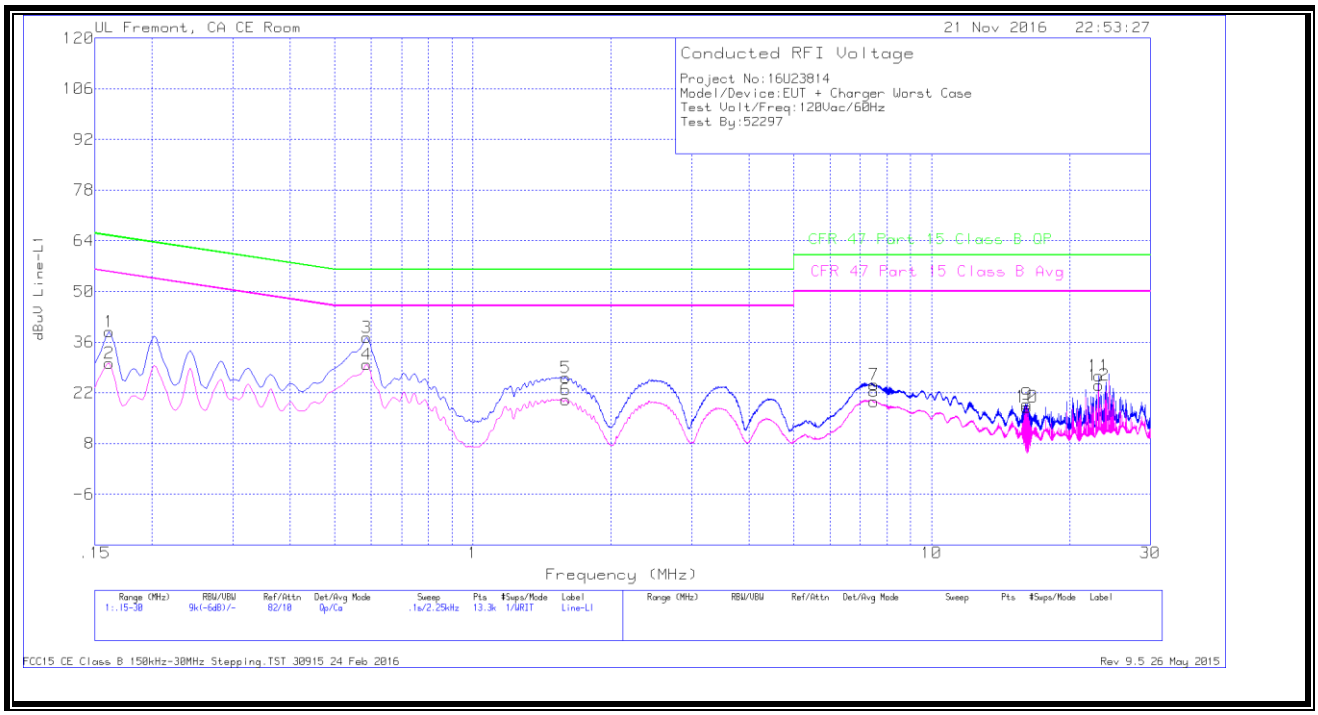
10.1. EUT POWERED BY AC/DC ADAPTER VIA USB CABLE

LINE 1 RESULTS



WORST EMISSIONS

Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables 1&3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
1	.16125	28.7	Qp	0	0	10.1	38.8	65.4	-26.6	-	-
2	.16125	20.04	Ca	0	0	10.1	30.14	-	-	55.4	-25.26
3	.5865	27.19	Qp	0	0	10.1	37.29	56	-18.71	-	-
4	.5865	19.78	Ca	0	0	10.1	29.88	-	-	46	-16.12
5	1.5945	16.03	Qp	0	.1	10.1	26.23	56	-29.77	-	-
6	1.59225	9.93	Ca	0	.1	10.1	20.13	-	-	46	-25.87
7	7.48725	13.91	Qp	0	.1	10.2	24.21	60	-35.79	-	-
8	7.48388	9.21	Ca	0	.1	10.2	19.51	-	-	50	-30.49
9	16.14075	8.33	Qp	0	.2	10.3	18.83	60	-41.17	-	-
10	16.14075	7.6	Ca	0	.2	10.3	18.1	-	-	50	-31.9
11	23.1315	15.95	Qp	.1	.2	10.4	26.65	60	-33.35	-	-
12	23.1315	13.4	Ca	.1	.2	10.4	24.1	-	-	50	-25.9

Qp - Quasi-Peak detector
Ca - CISPR average detection

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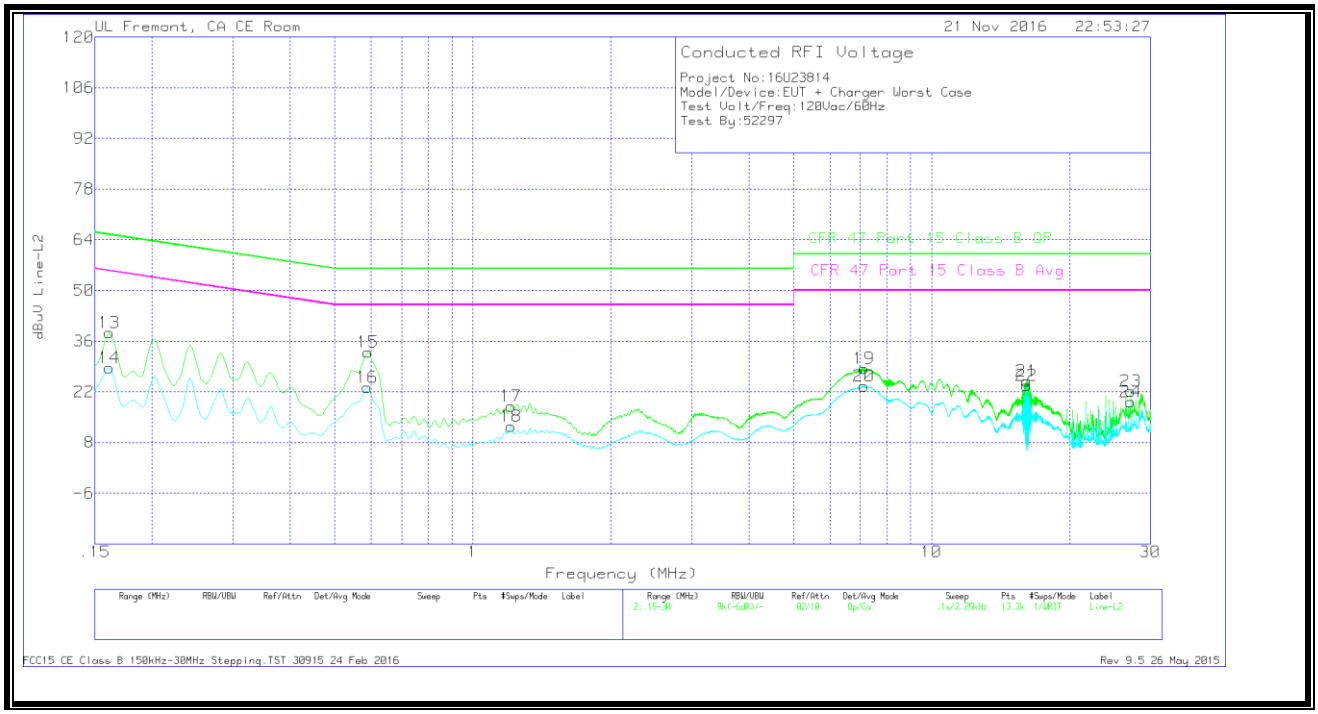
LINE 2 RESULTS



WORST EMISSIONS

Range 2: Line-L2 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L2	LC Cables 2&3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
13	.16125	28.29	Qp	0	0	10.1	38.39	65.4	-27.01	-	-
14	.16125	18.56	Ca	0	0	10.1	28.66	-	-	55.4	-26.74
15	.591	22.81	Qp	0	0	10.1	32.91	56	-23.09	-	-
16	.58875	13.13	Ca	0	0	10.1	23.23	-	-	46	-22.77
17	1.212	7.91	Qp	0	0	10.1	18.01	56	-37.99	-	-
18	1.212	2.3	Ca	0	0	10.1	12.4	-	-	46	-33.6
19	7.116	18.15	Qp	0	.1	10.2	28.45	60	-31.55	-	-
20	7.1205	13.3	Ca	0	.1	10.2	23.6	-	-	50	-26.4
21	16.1385	14.43	Qp	0	.2	10.3	24.93	60	-35.07	-	-
22	16.1385	13.21	Ca	0	.2	10.3	23.71	-	-	50	-26.29
23	27.16125	11.27	Qp	.1	.3	10.5	22.17	60	-37.83	-	-
24	27.1635	8.28	Ca	.1	.3	10.5	19.18	-	-	50	-30.82

Qp - Quasi-Peak detector
Ca - CISPR average detection

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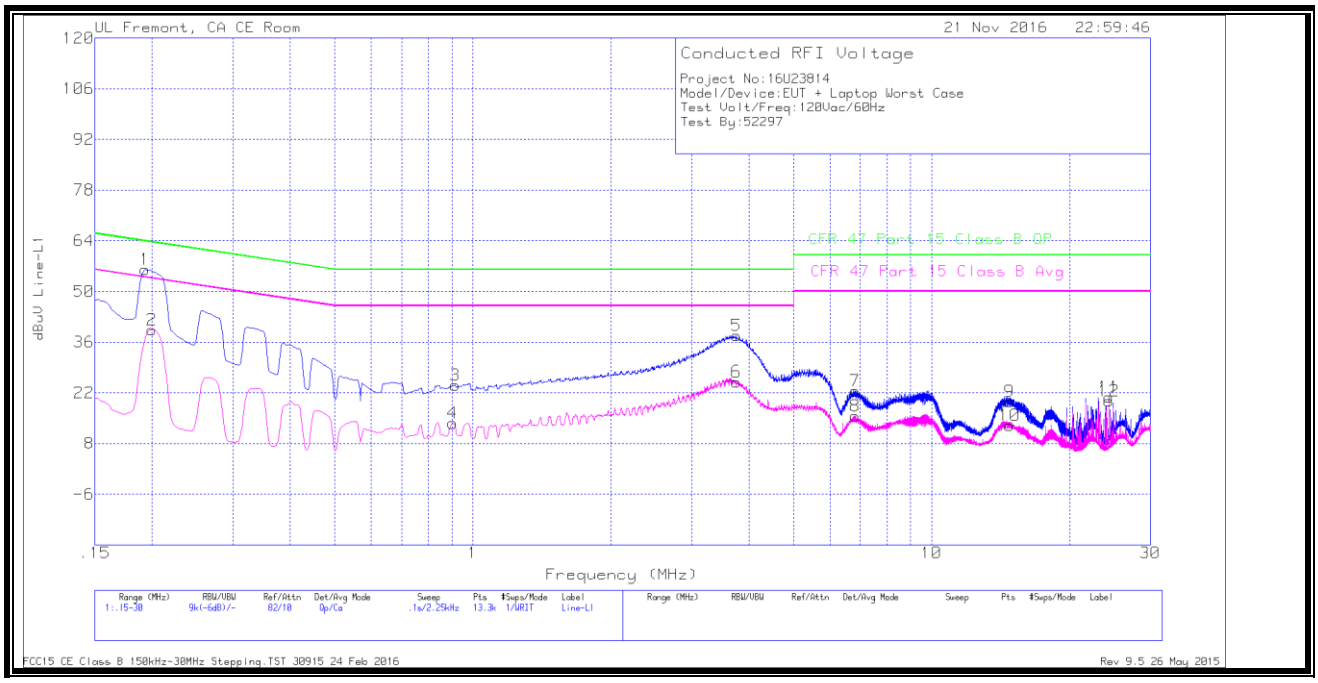
10.2. EUT POWERED BY HOST PC VIA USB CABLE

LINE 1 RESULTS



WORST EMISSIONS

Range 1: Line-L1 .15 - 30MHz											
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L1	LC Cables 1&3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
1	.19275	45.94	Qp	0	0	10.1	56.04	63.92	-7.88	-	-
2	.1995	29.32	Ca	0	0	10.1	39.42	-	-	53.63	-14.21
3	.915	14.01	Qp	0	0	10.1	24.11	56	-31.89	-	-
4	.90375	3.49	Ca	0	0	10.1	13.59	-	-	46	-32.41
5	3.7545	27.68	Qp	0	.1	10.1	37.88	56	-18.12	-	-
6	3.75225	14.85	Ca	0	.1	10.1	25.05	-	-	46	-20.95
7	6.80775	12.3	Qp	0	.1	10.2	22.6	60	-37.4	-	-
8	6.80775	5.23	Ca	0	.1	10.2	15.53	-	-	50	-34.47
9	14.79525	9.24	Qp	0	.2	10.2	19.64	60	-40.36	-	-
10	14.81325	2.63	Ca	0	.2	10.2	13.03	-	-	50	-36.97
11	24.35325	10	Qp	.1	.2	10.5	20.8	60	-39.2	-	-
12	24.35325	9.01	Ca	.1	.2	10.5	19.81	-	-	50	-30.19

Qp - Quasi-Peak detector
Ca - CISPR average detection

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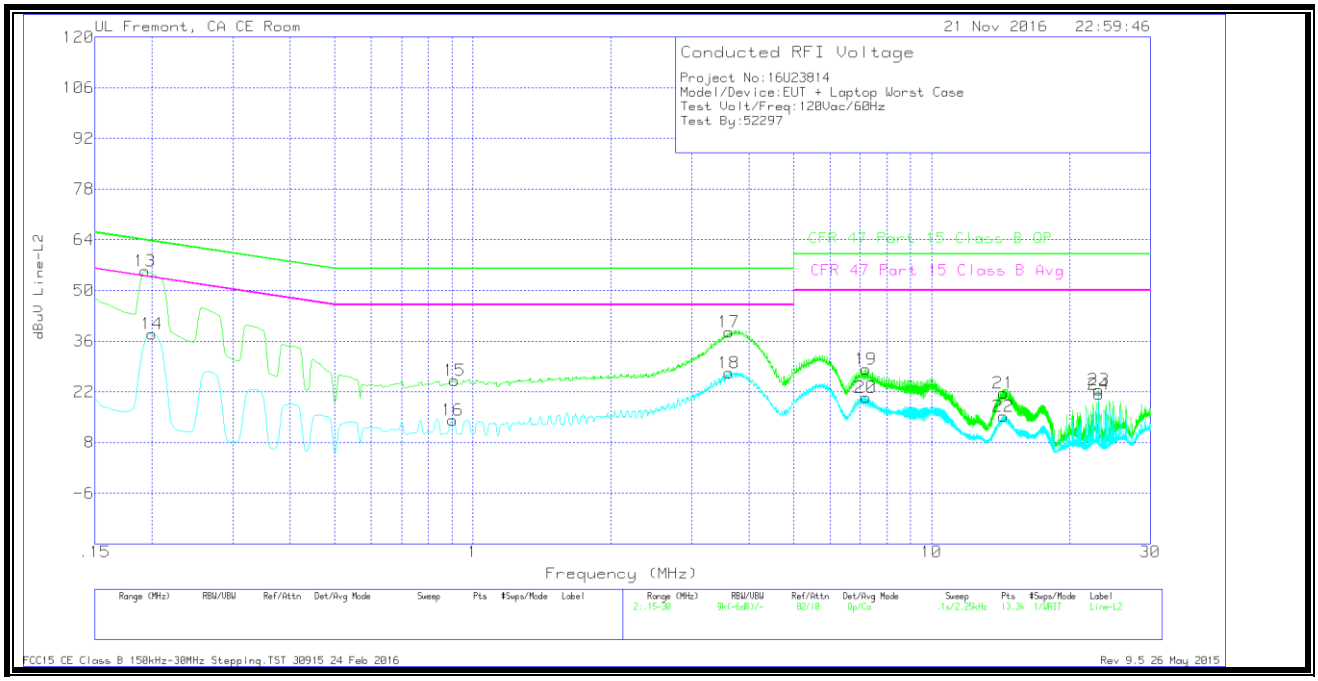
LINE 2 RESULTS



WORST EMISSIONS

Range 2: Line-L2 .15 - 30MHz

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN L2	LC Cables 2&3	Limiter (dB)	Corrected Reading dBuV	CFR 47 Part 15 Class B QP	QP Margin (dB)	CFR 47 Part 15 Class B Avg	Av(CISPR)Margin (dB)
13	.19275	45.3	Qp	0	0	10.1	55.4	63.92	-8.52	-	-
14	.1995	27.96	Ca	0	0	10.1	38.06	-	-	53.63	-15.57
15	.91275	15.02	Qp	0	0	10.1	25.12	56	-30.88	-	-
16	.90375	4.17	Ca	0	0	10.1	14.27	-	-	46	-31.73
17	3.62175	28.25	Qp	0	.1	10.1	38.45	56	-17.55	-	-
18	3.6195	17.02	Ca	0	.1	10.1	27.22	-	-	46	-18.78
19	7.18125	17.98	Qp	0	.1	10.2	28.28	60	-31.72	-	-
20	7.18125	10.13	Ca	0	.1	10.2	20.43	-	-	50	-29.57
21	14.35088	11.2	Qp	.1	.2	10.2	21.7	60	-38.3	-	-
22	14.3475	4.78	Ca	.1	.2	10.2	15.28	-	-	50	-34.72
23	23.1315	11.9	Qp	.1	.2	10.4	22.6	60	-37.4	-	-
24	23.1315	10.54	Ca	.1	.2	10.4	21.24	-	-	50	-28.76

Qp - Quasi-Peak detector
Ca - CISPR average detection

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11. DYNAMIC FREQUENCY SELECTION

11.1. OVERVIEW

11.1.1. LIMITS

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”.

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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

Requirement	Operational Mode		
	Master	Client **(without DFS)**	Client **(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.		

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

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

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Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (usec)	PRI (usec)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in table 5a	Roundup: {(1/360) x (19 x 10^6 PRI_{usec})}	60%	30
		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 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.

Table 6 – Long Pulse Radar Test Signal

Radar Waveform Type	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7 – Frequency Hopping Radar Test Signal

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

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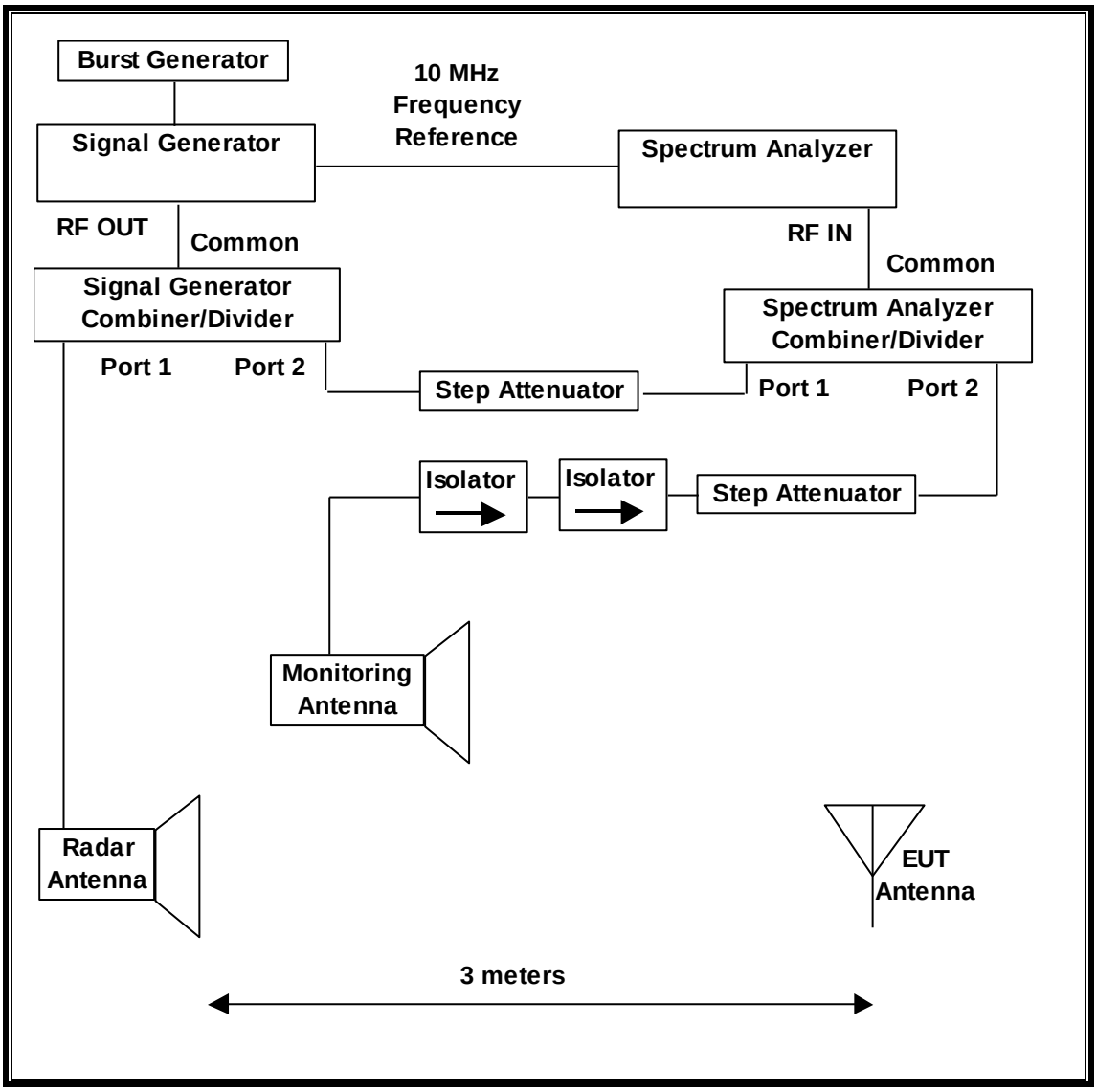
11.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



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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:

TEST SOFTWARE LIST		
Name	**Version**	**Test / Function**
Aggregate Time-PXA	3.0.0.9	Channel Loading and Aggregate Closing Time
PXA Read	3.0	Signal Generator Screen Capture
SGXProject.exe	1.7	Radar Waveform Generation and Download

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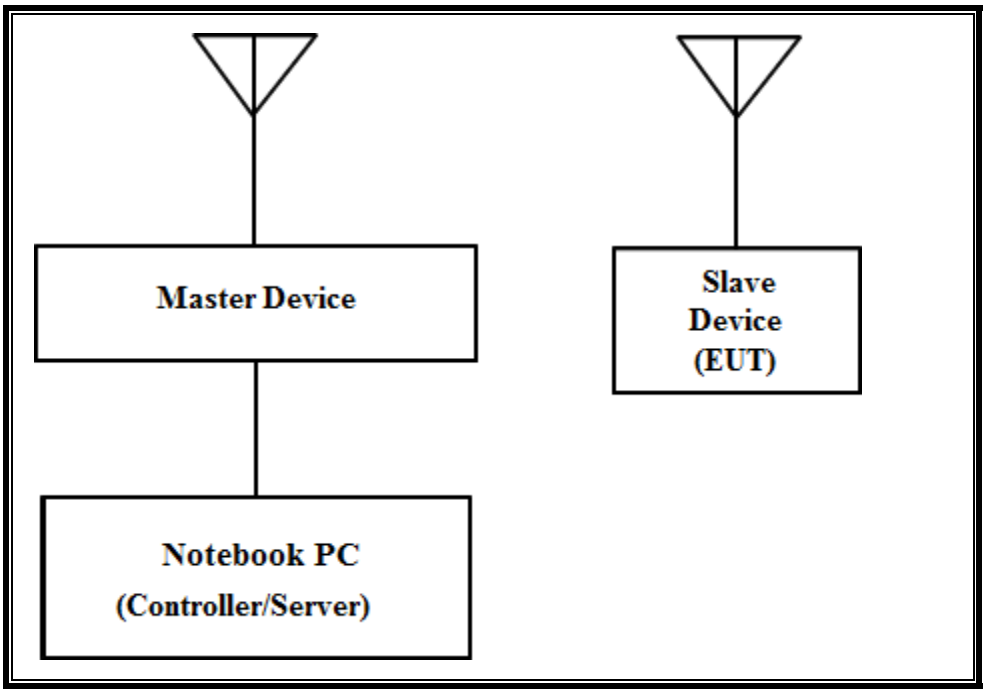
11.1.4. SETUP OF EUT (CLIENT MODE)

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	C86L3BA8FJ1R	BCGA1521
Notebook PC (Controller/Server)	Apple	A1181	4H629022WLV	DoC
AC Adapter (Controller/Server PC)	Delta Electronics	A1344	MV05104CNAL1A	DoC

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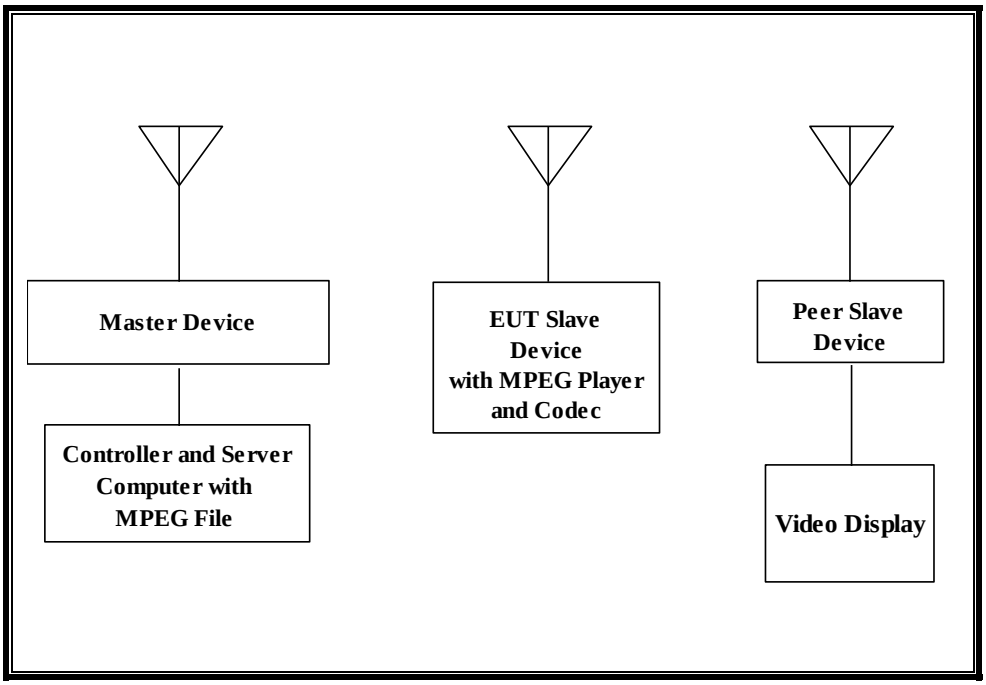
11.1.5. SETUP OF EUT (CLIENT-TO-CLIENT COMMUNICATIONS MODE)

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	C86L3BA8FJ1R	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.

The EUT is a Slave Device without Radar Detection.

The highest power level within these bands is 22.52 dBm EIRP in the 5250-5350 MHz band and 23.03 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a gain of Antenna A, 2.24 dBi & Antenna B, 2.77 dBi in the 5250-5350 MHz band and Antenna A, 3.39 dBi & Antenna B, 3.17 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 Version 10.3 (14E220).

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

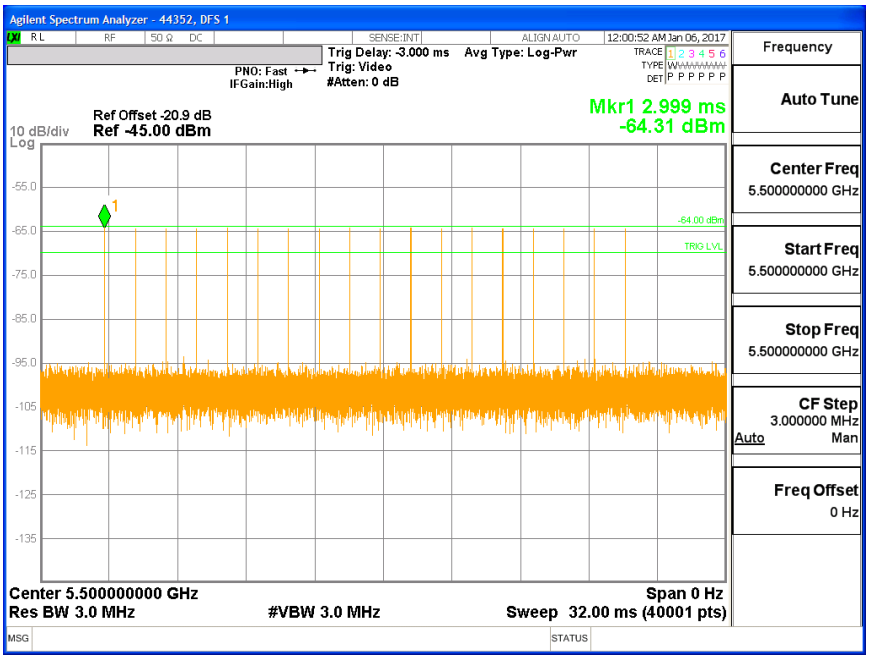
11.2.1. TEST CHANNEL

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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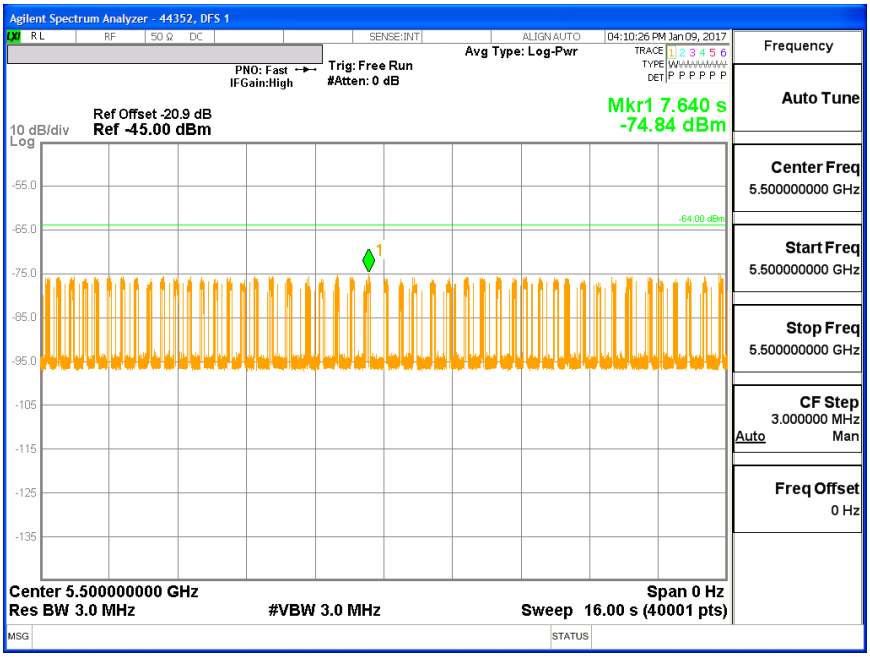
TRAFFIC

SLAVE TRAFFIC



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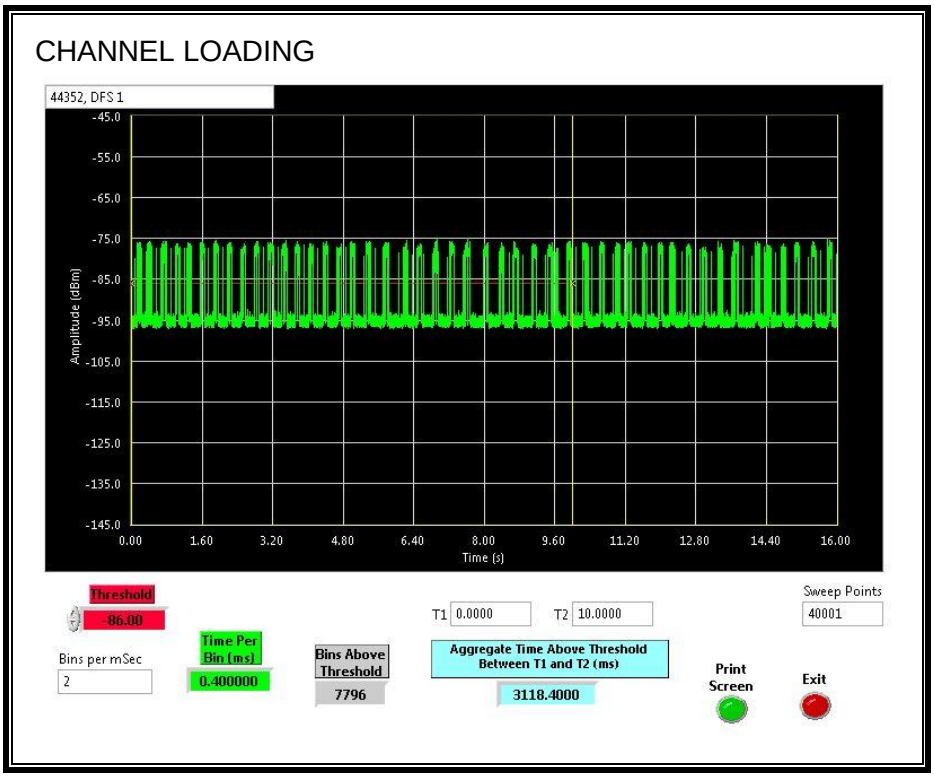
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 31.18%

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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)
0.0948	**10**

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

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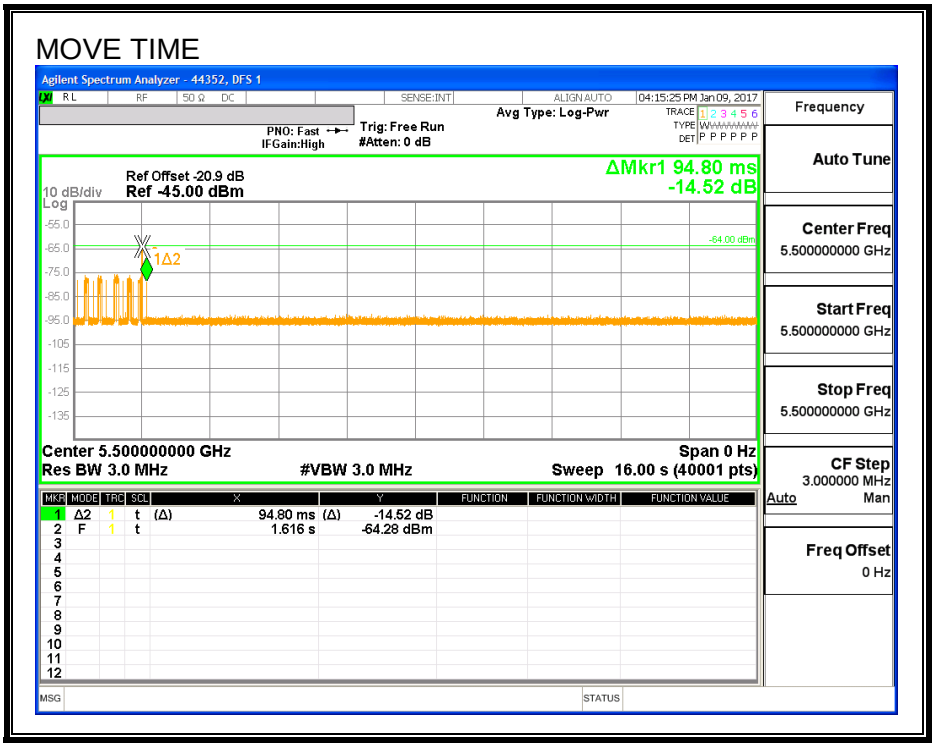
MOVE TIME



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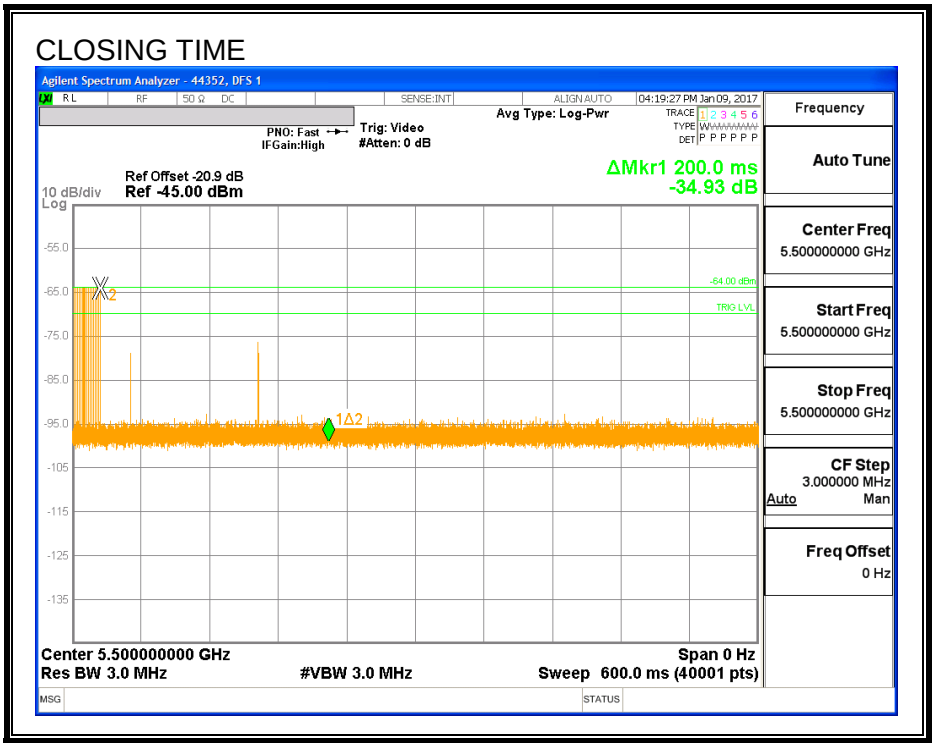
CHANNEL CLOSING TIME



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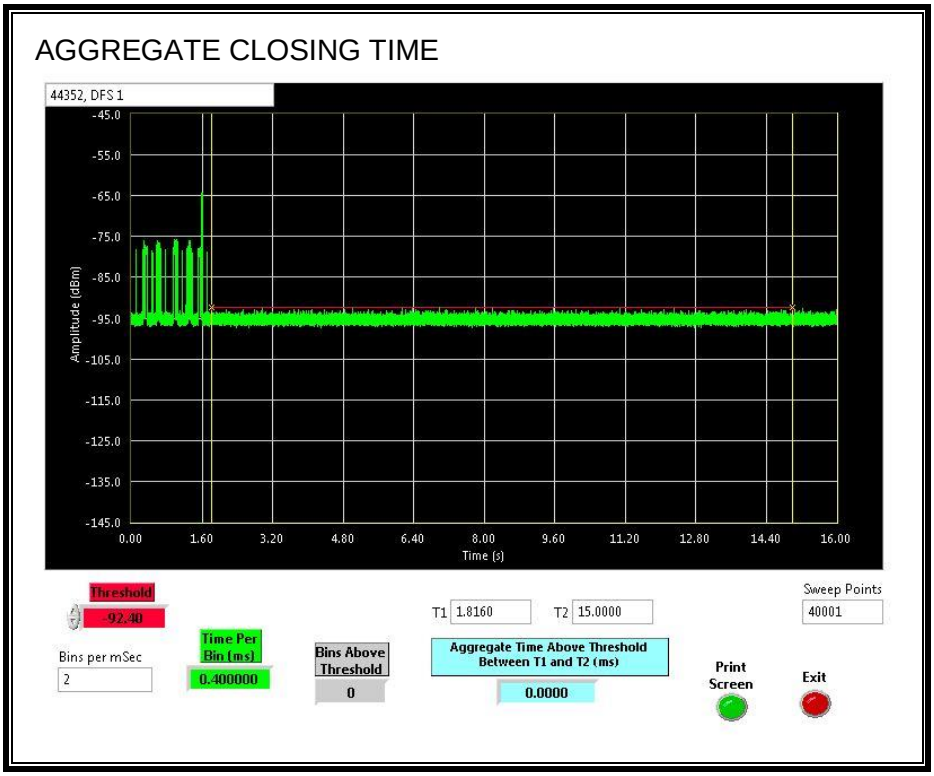
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.



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11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH

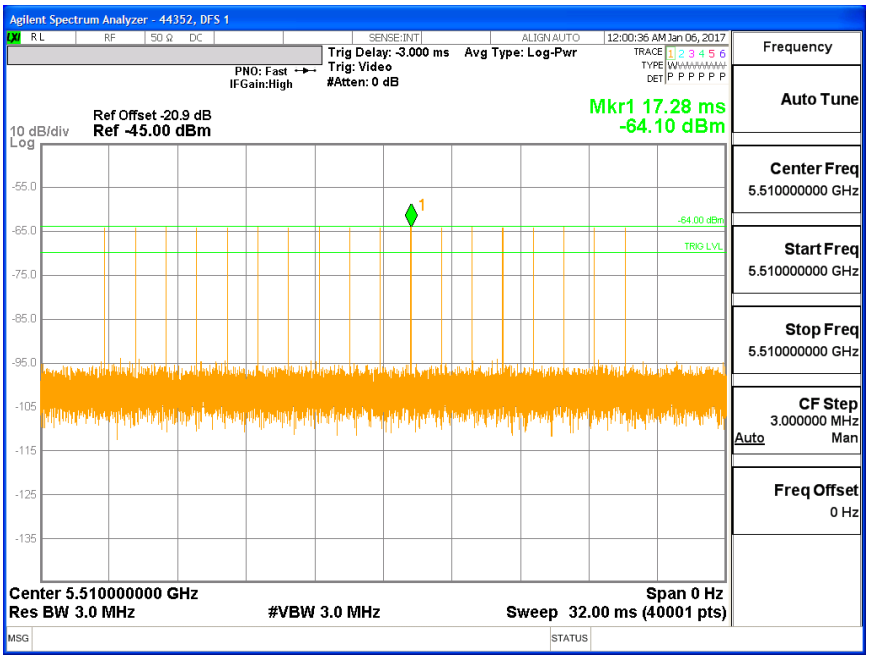
11.3.1. TEST CHANNEL

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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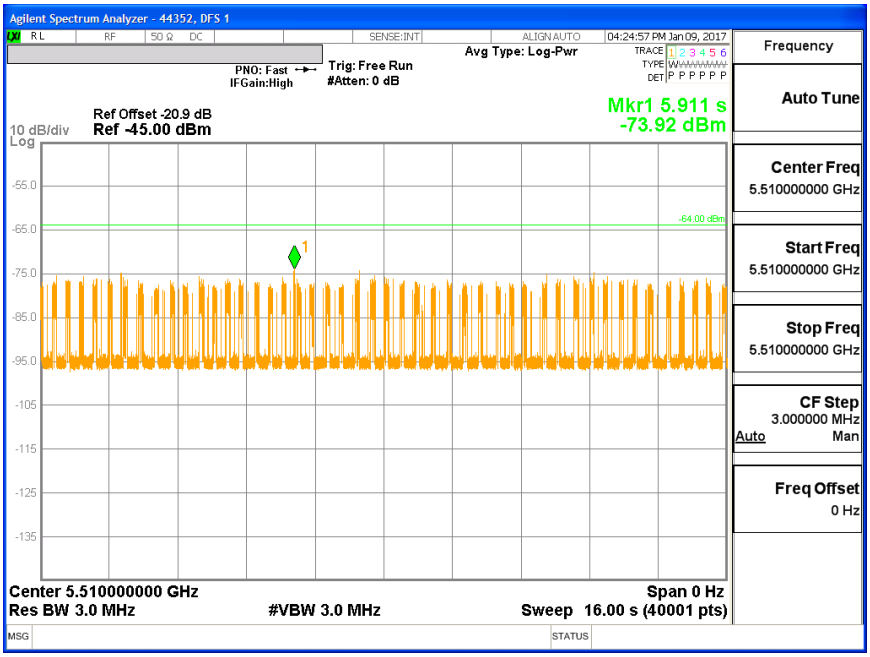
TRAFFIC

SLAVE TRAFFIC



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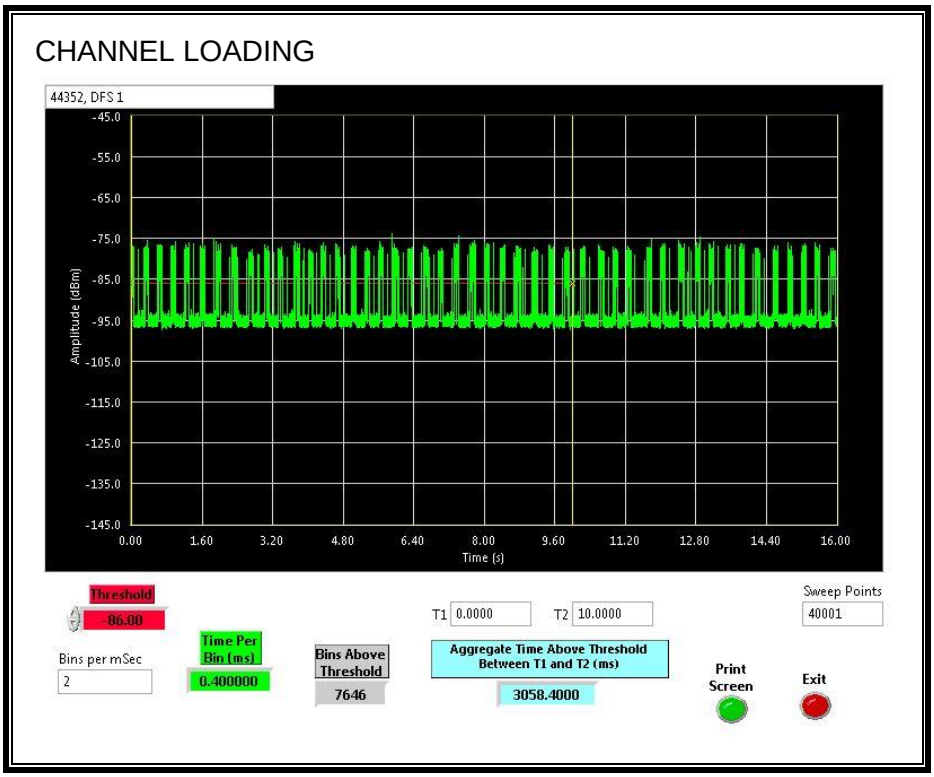
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 30.584%

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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)
0.0024	10

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

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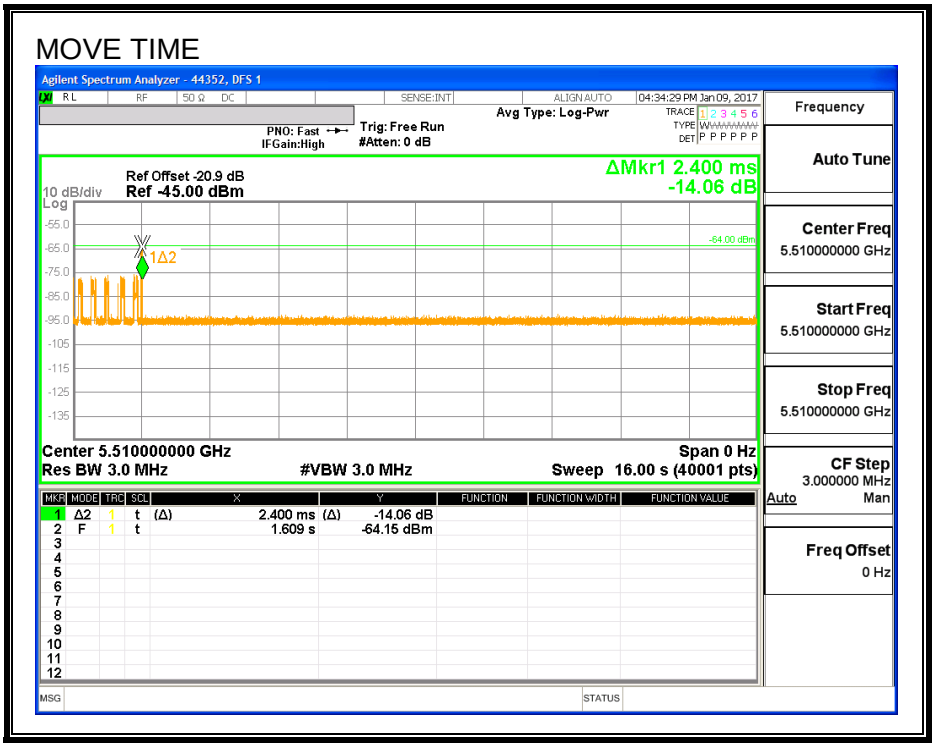
MOVE TIME



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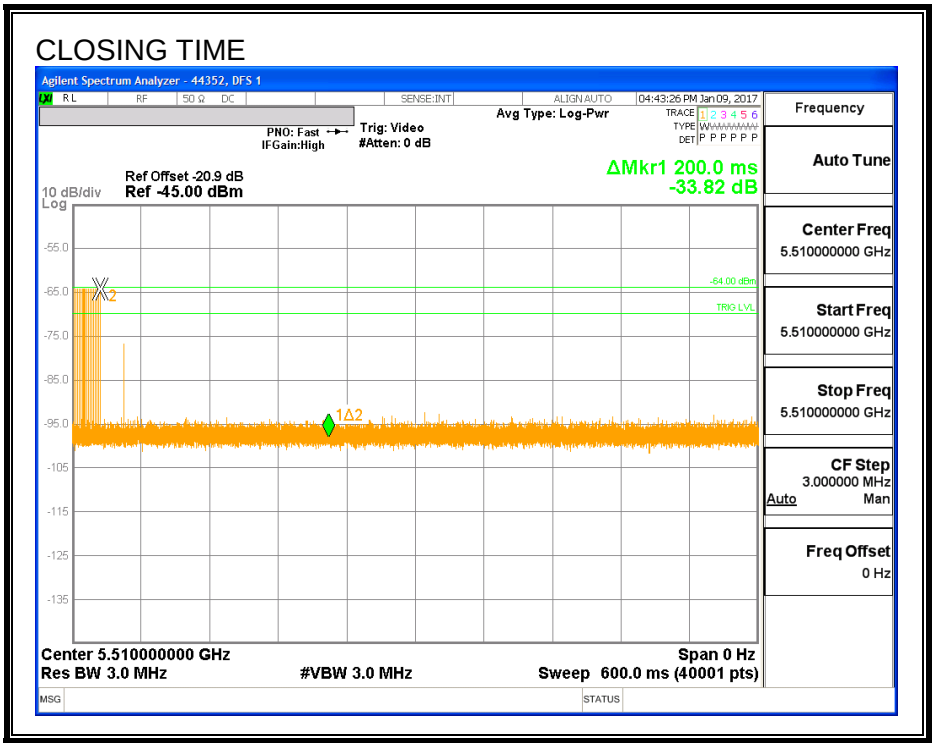
CHANNEL CLOSING TIME



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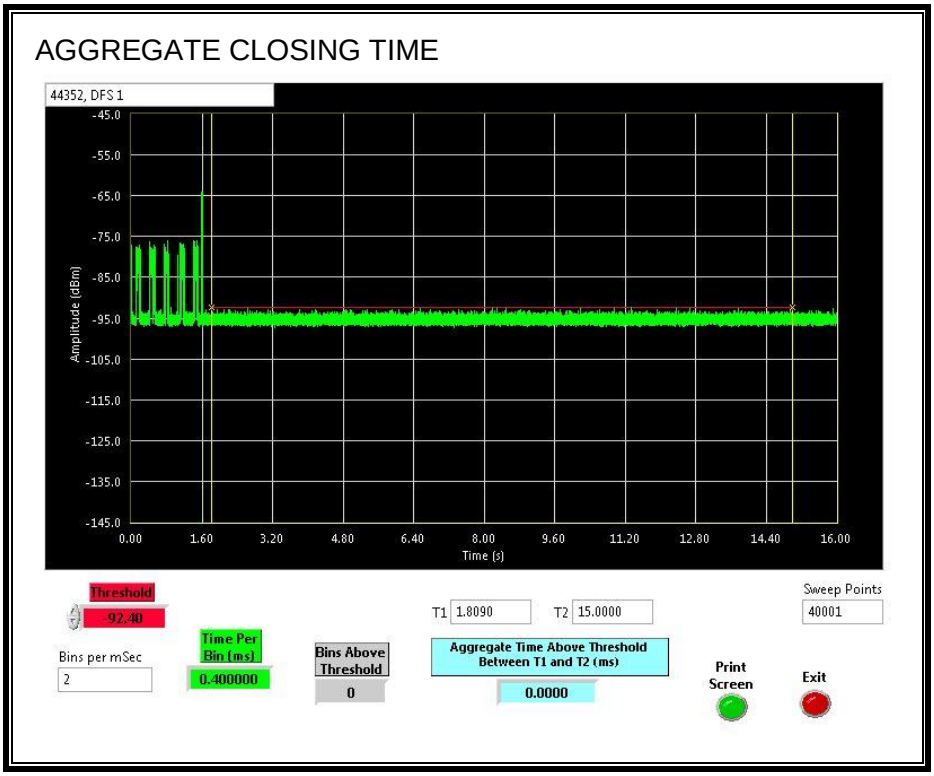
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.



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11.4. CLIENT MODE RESULTS FOR 80 MHz BANDWIDTH

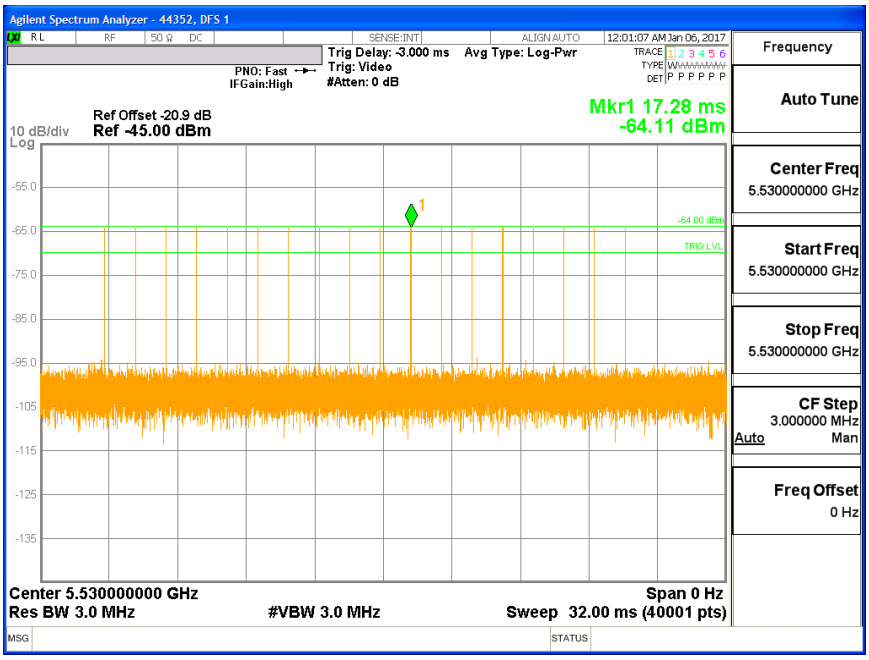
11.4.1. TEST CHANNEL

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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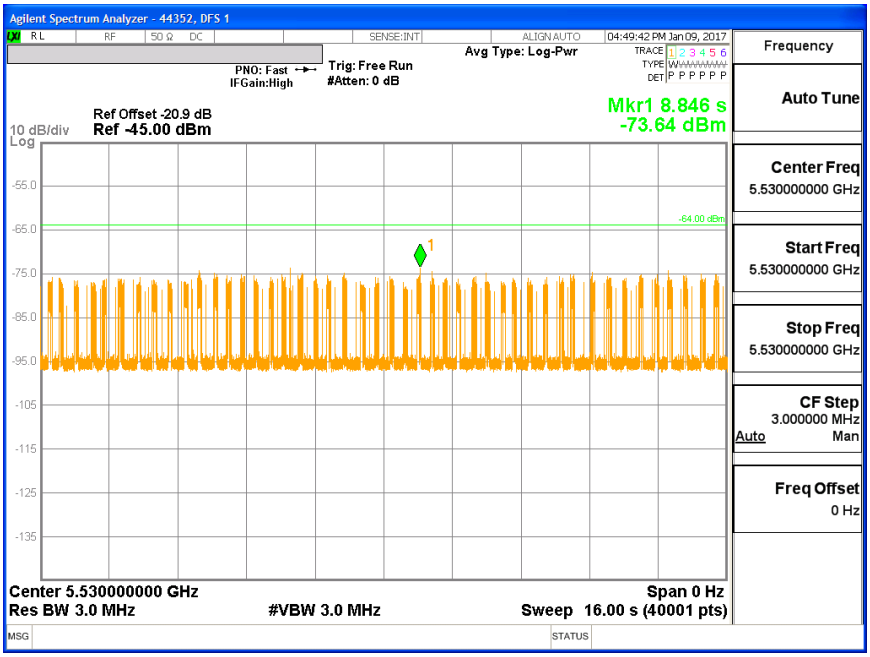
TRAFFIC

SLAVE TRAFFIC



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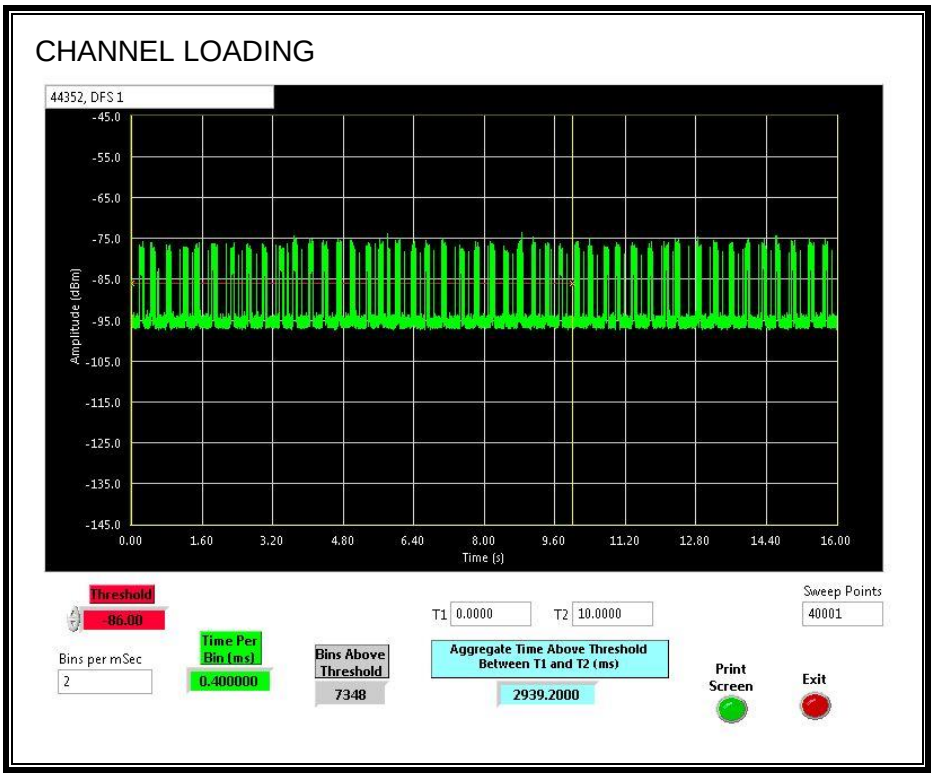
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 29.392%

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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)
0.000	10

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

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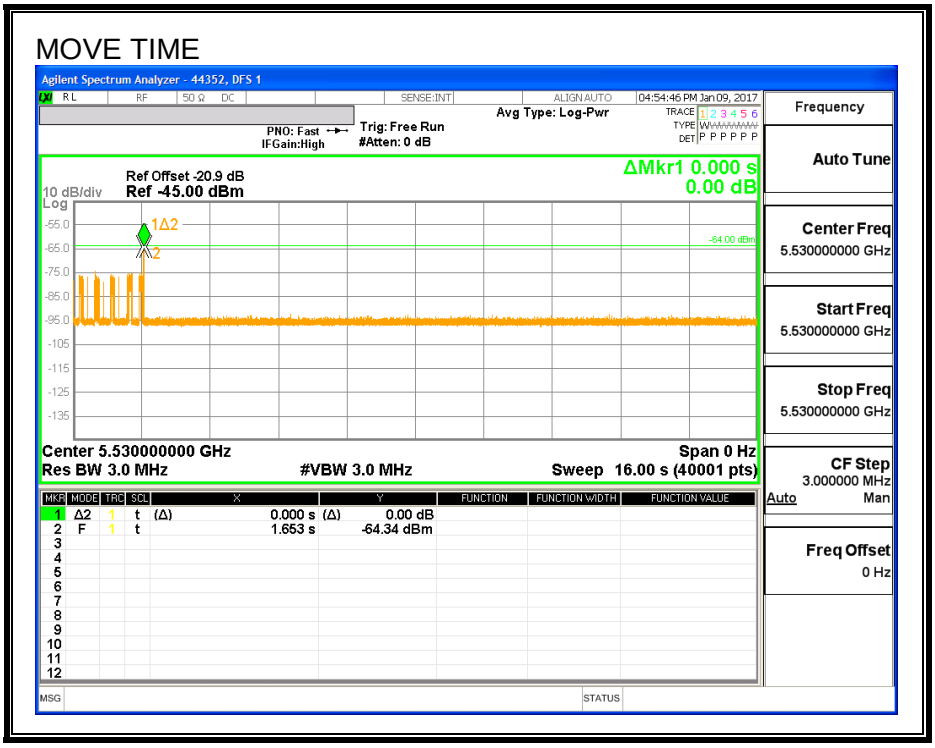
MOVE TIME



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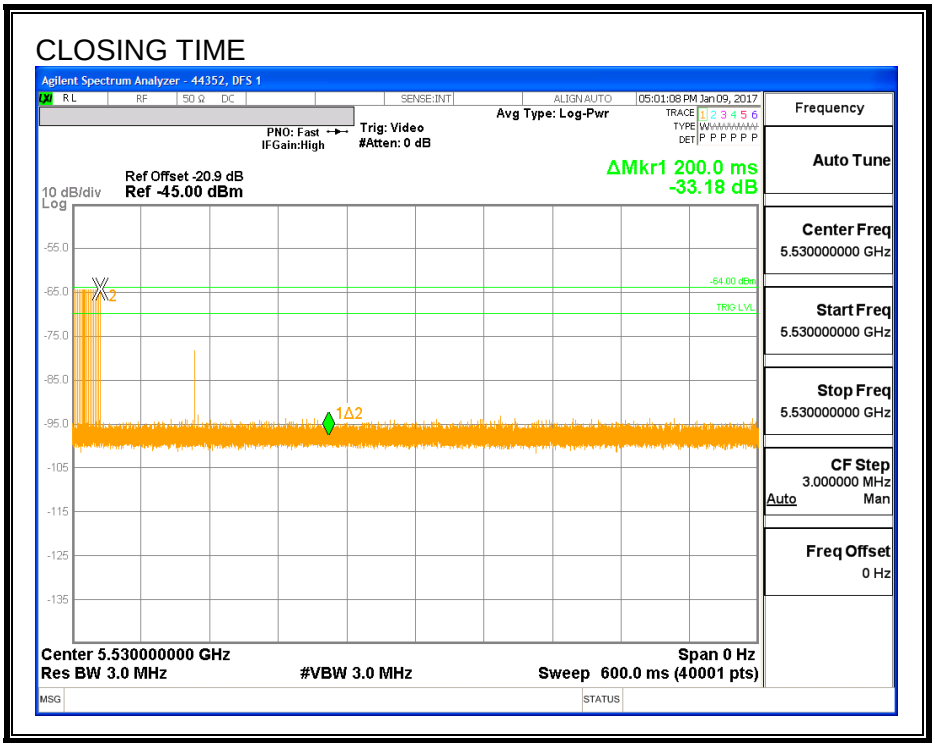
CHANNEL CLOSING TIME



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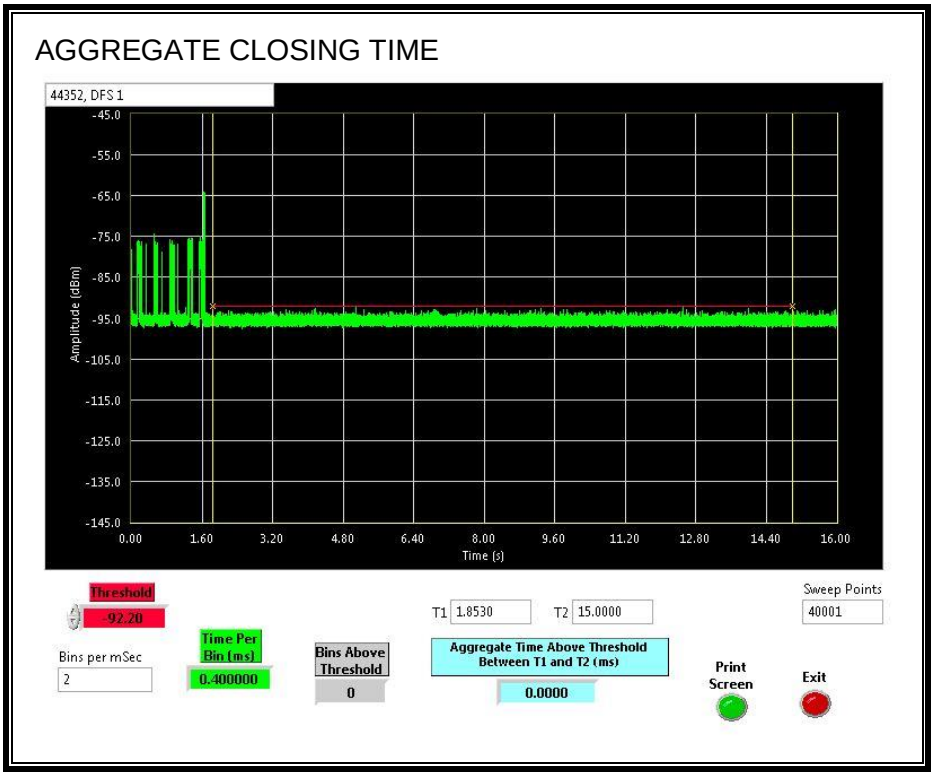
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.



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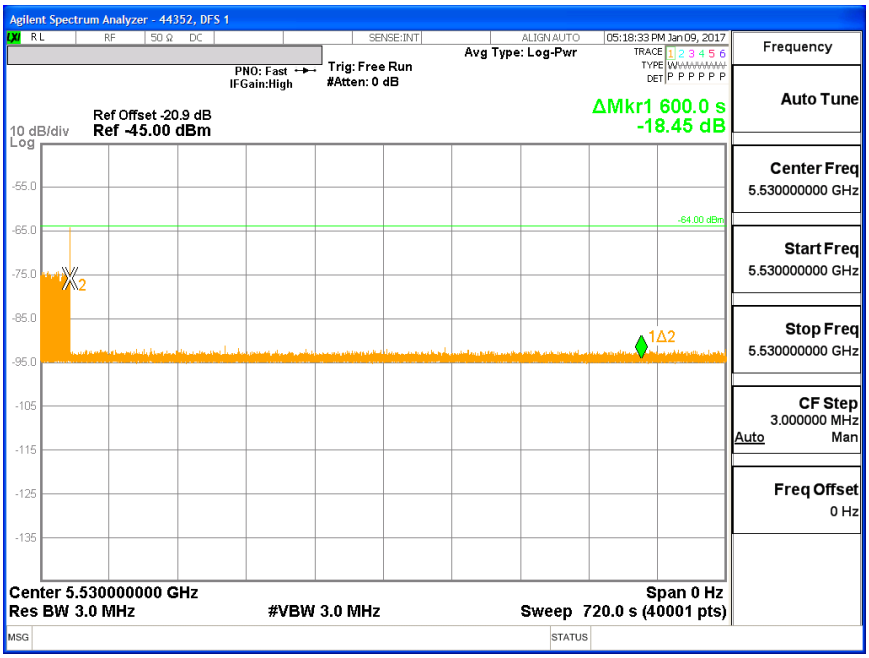
11.4.5. 10-MINUTE CLIENT Tx MONITORING PERIOD

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

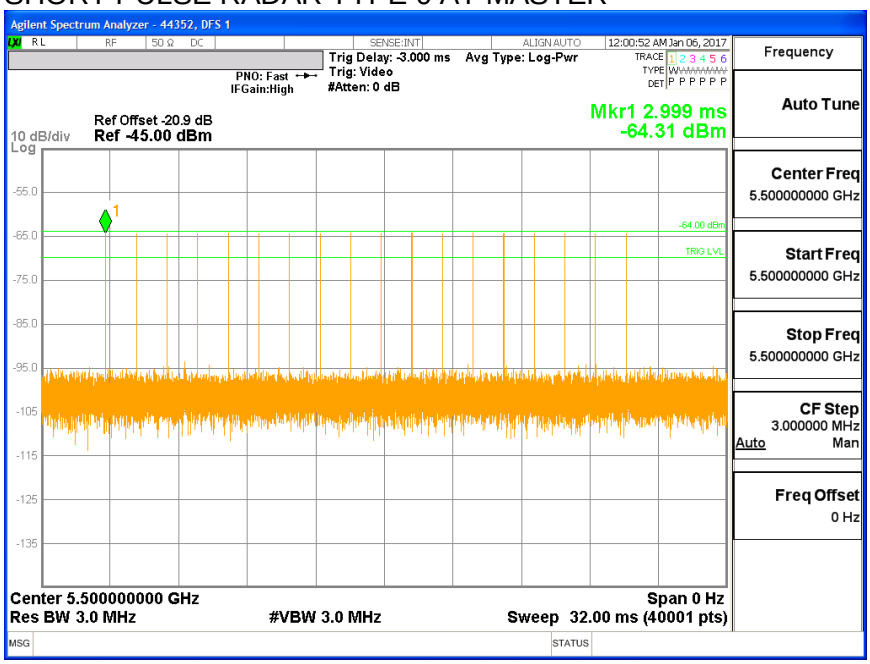
11.5.1. TEST CHANNEL

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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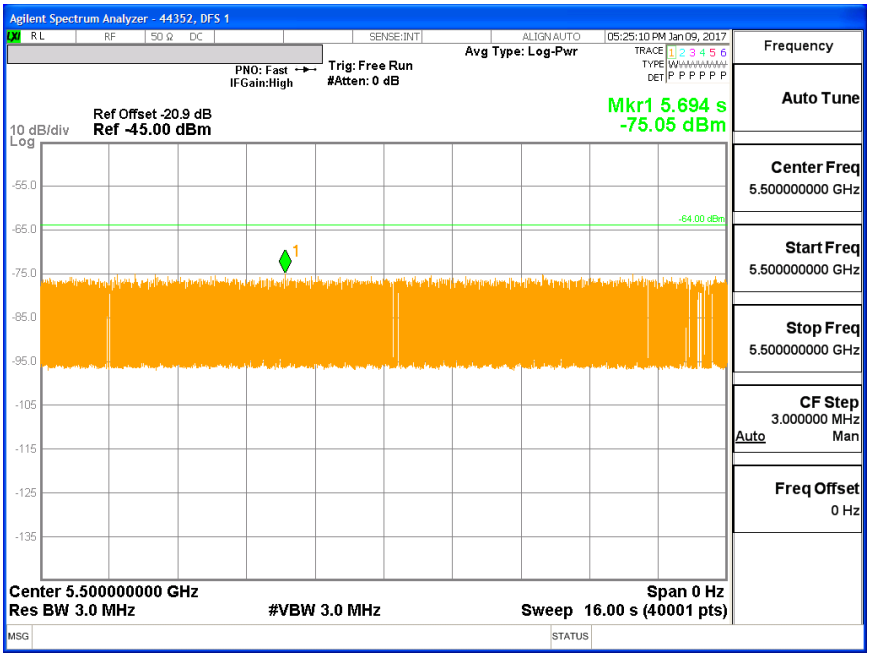
TRAFFIC

SLAVE TRAFFIC



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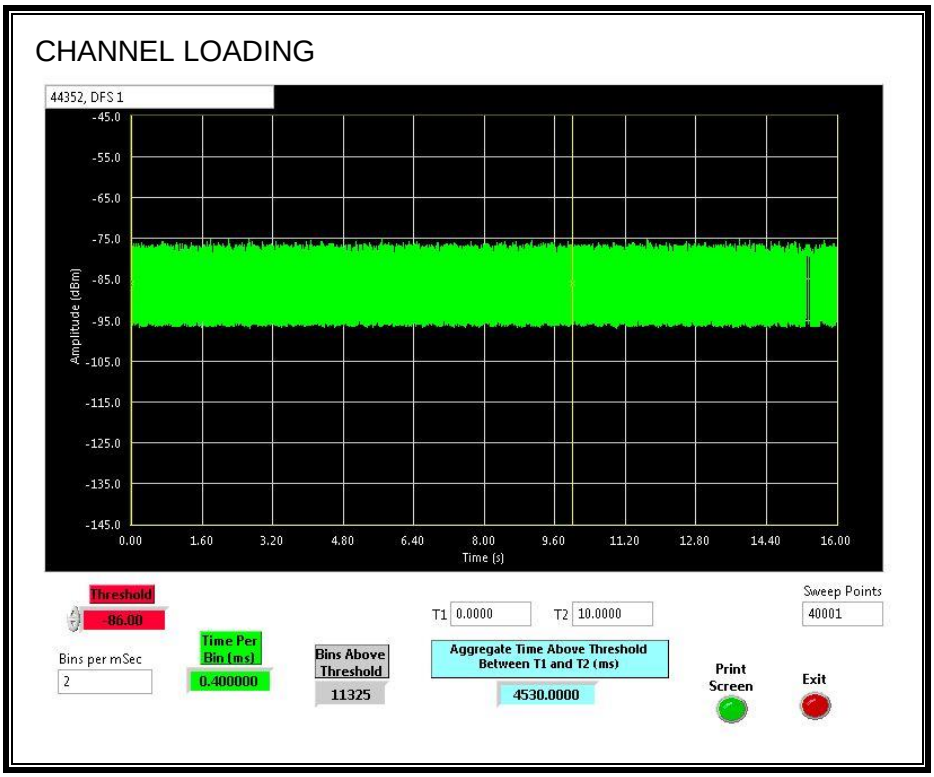
CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 45.3%.

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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)
0.182	10

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

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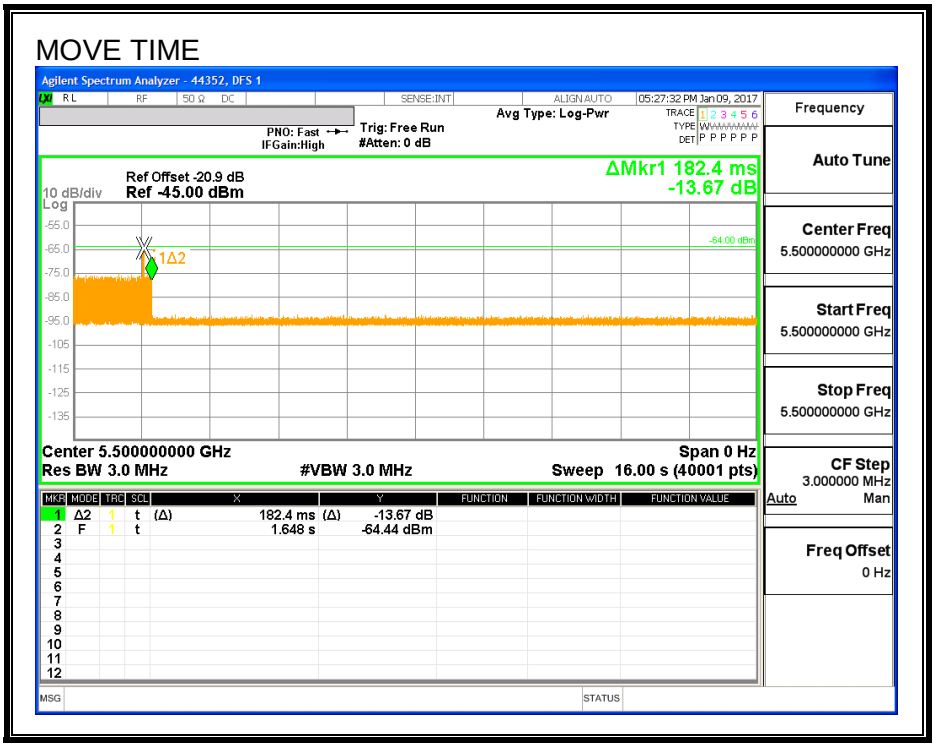
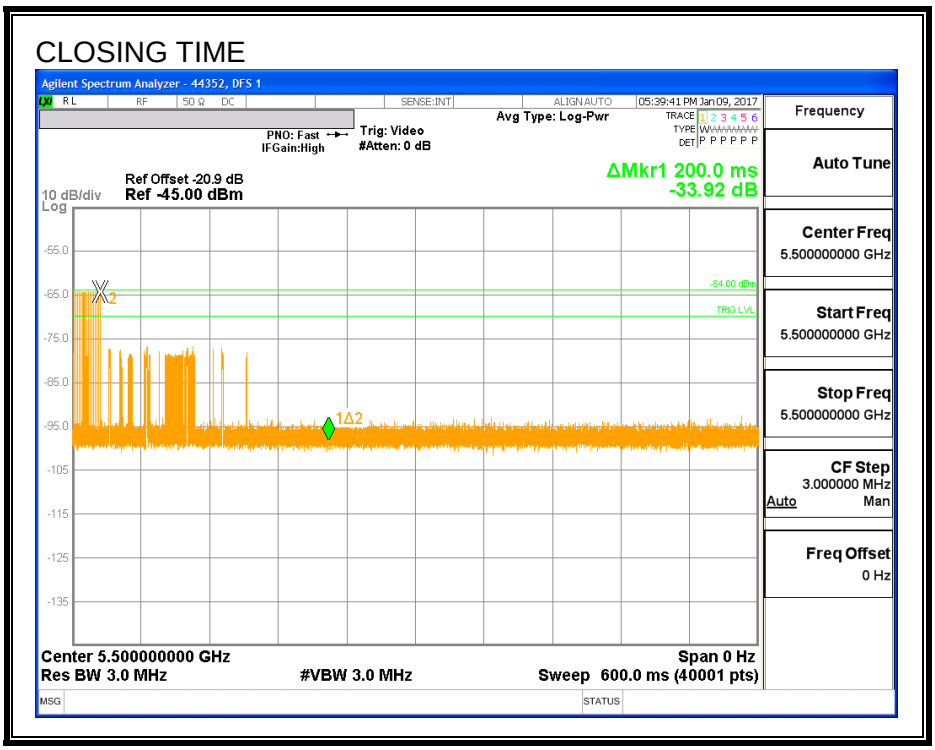
MOVE TIME



CHANNEL CLOSING TIME



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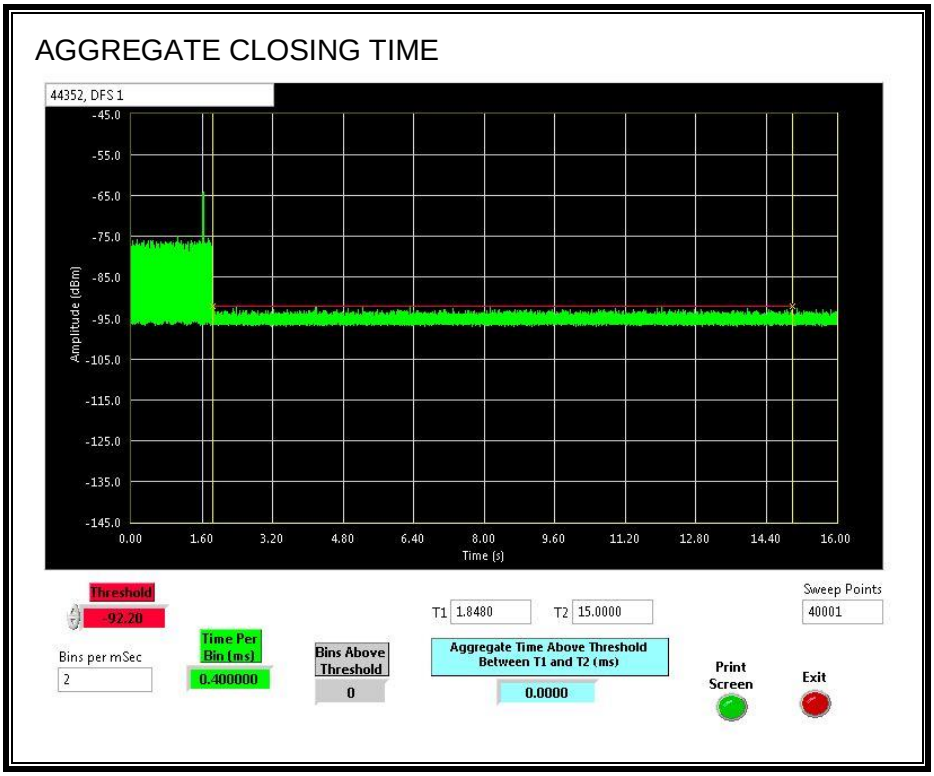
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.



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

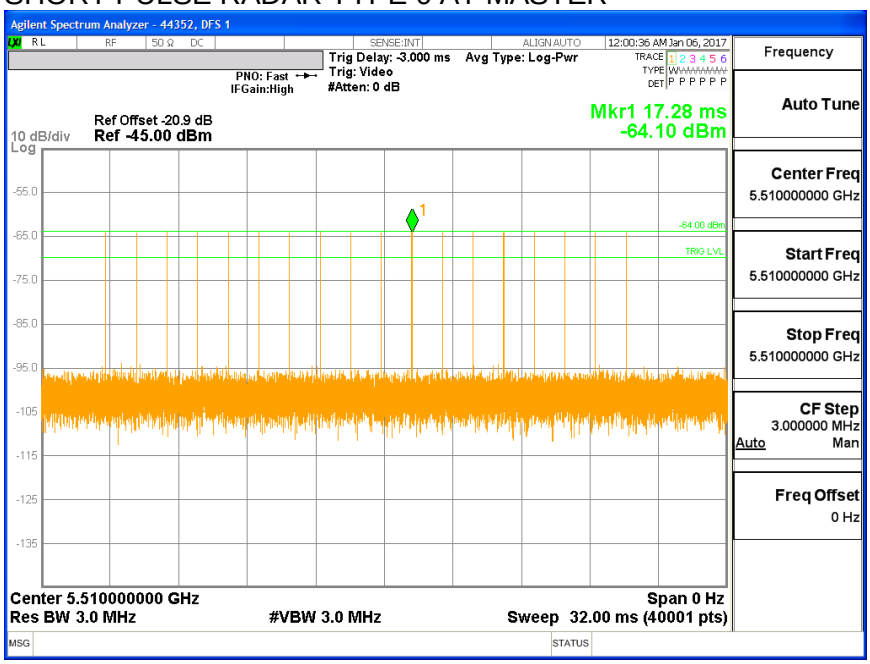
11.6.1. TEST CHANNEL

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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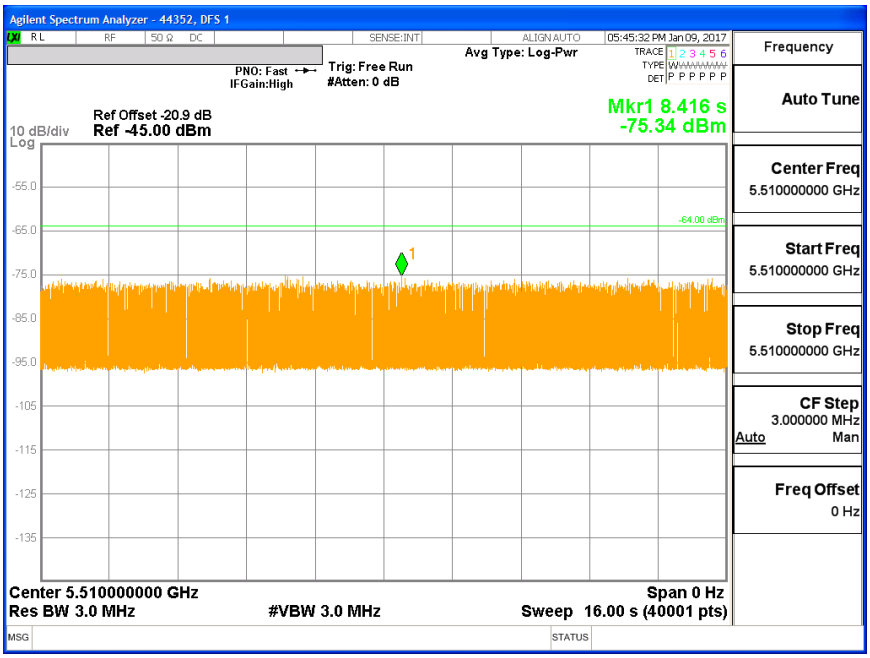
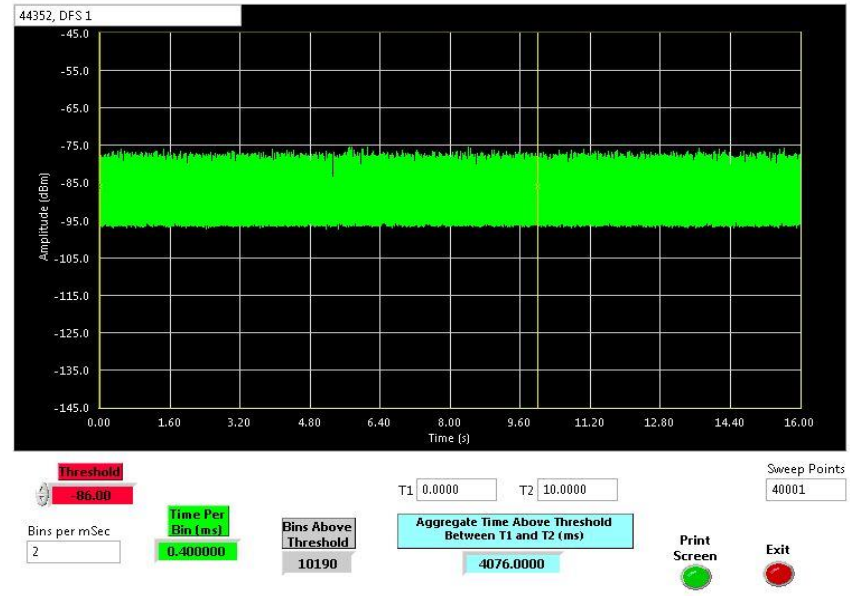
TRAFFIC

SLAVE TRAFFIC



CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 40.76%

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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)
0.1608	10

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

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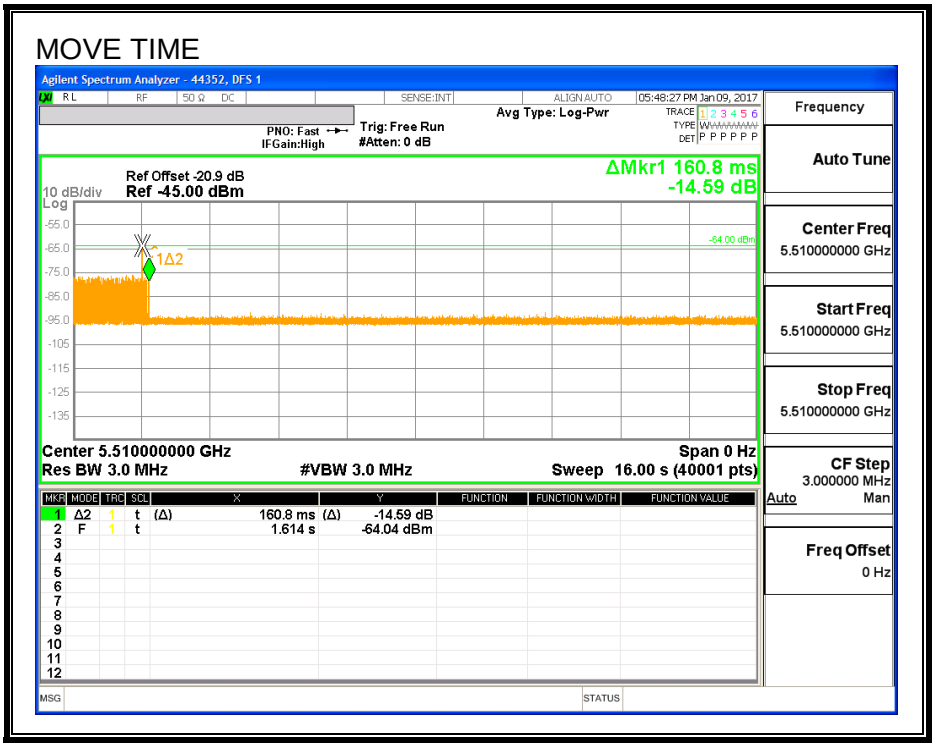
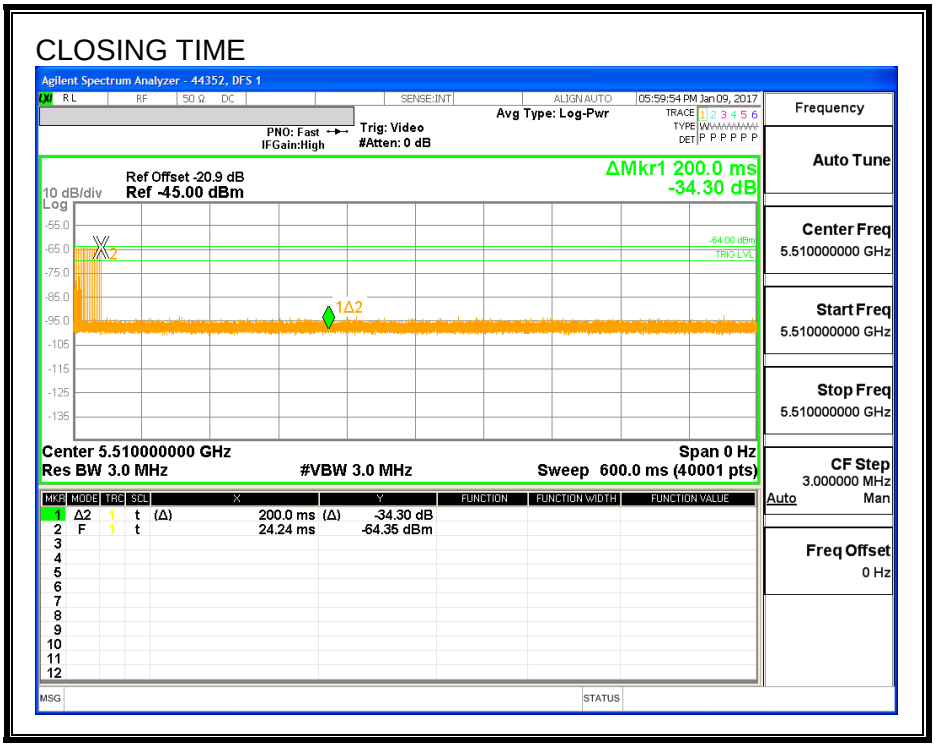
MOVE TIME



CHANNEL CLOSING TIME



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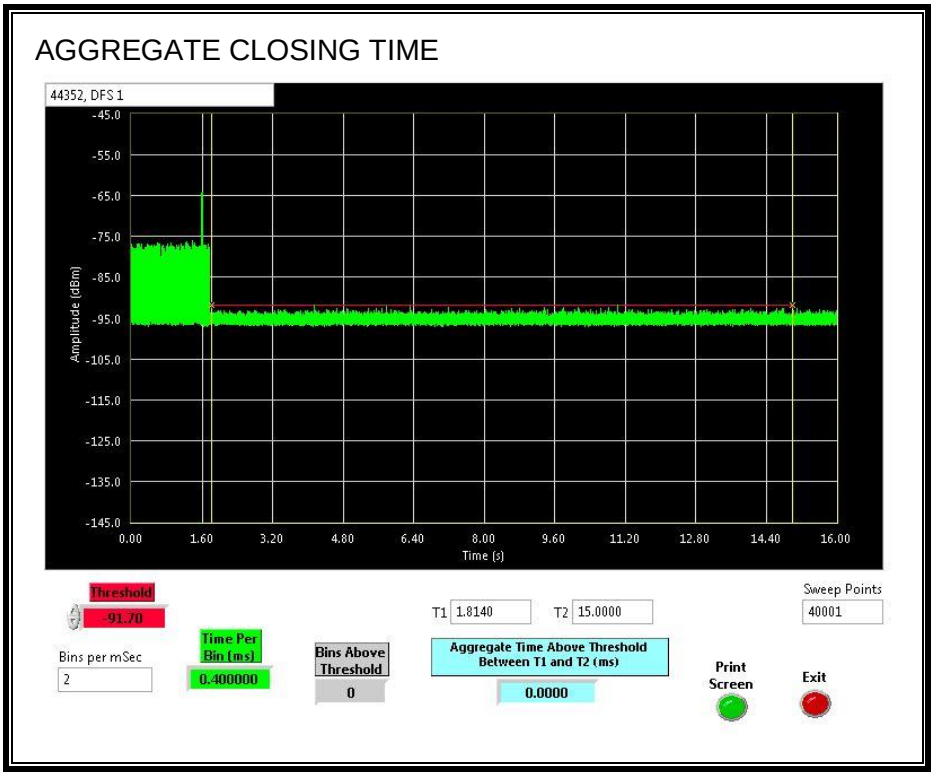
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the aggregate monitoring period.



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

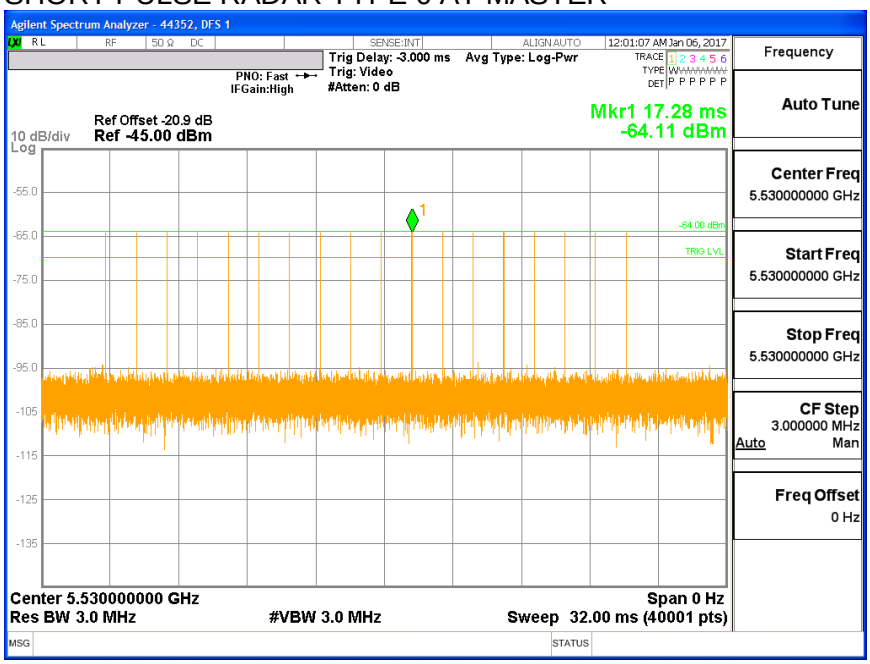
11.7.1. TEST CHANNEL

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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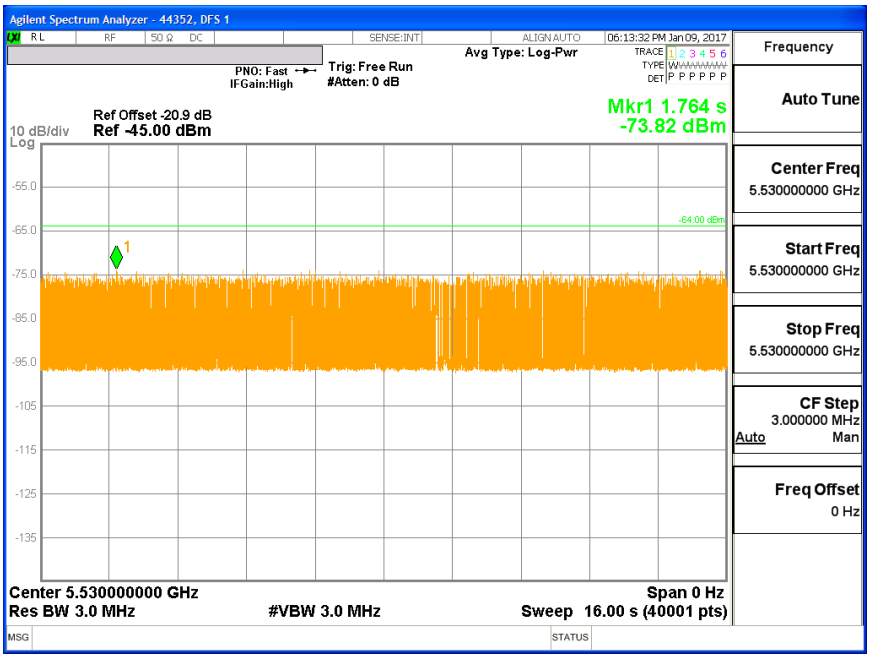
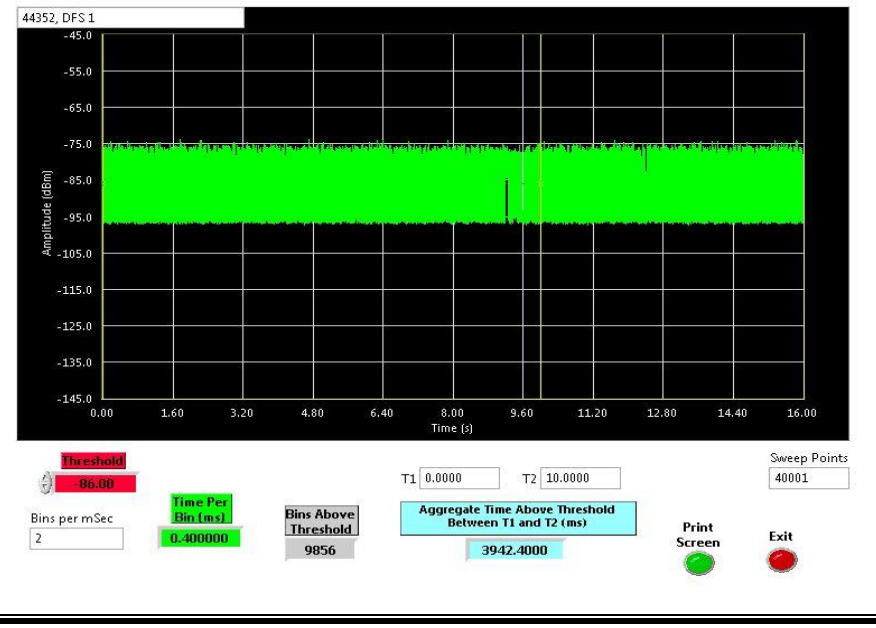
TRAFFIC

SLAVE TRAFFIC



CHANNEL LOADING

CHANNEL LOADING



The level of traffic loading on the channel by the EUT is 39.424%

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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)
0.1076	10

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

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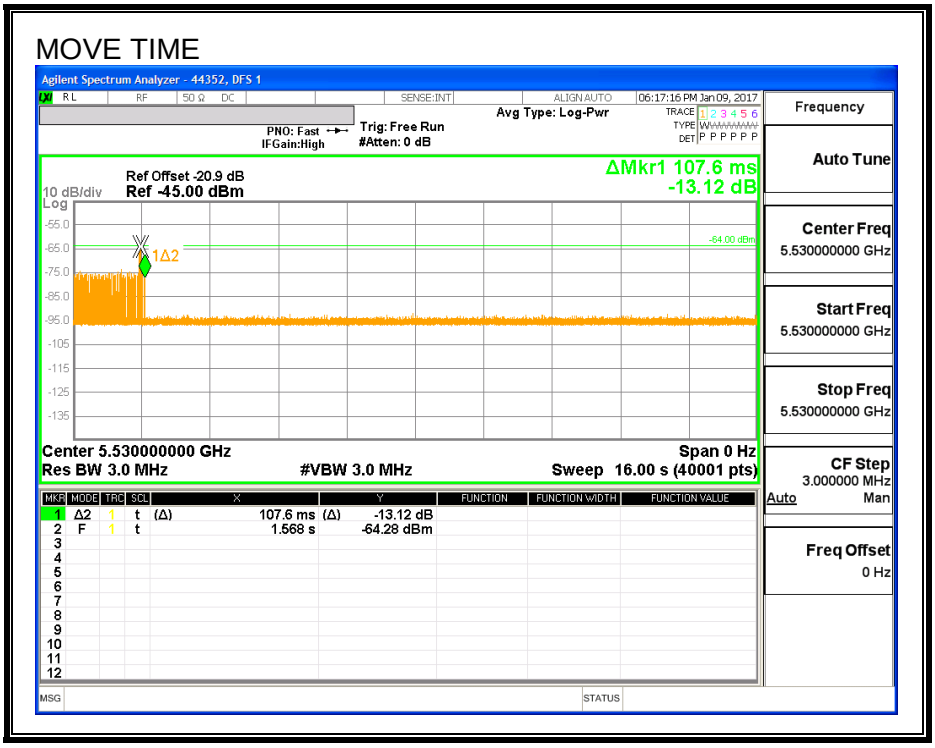
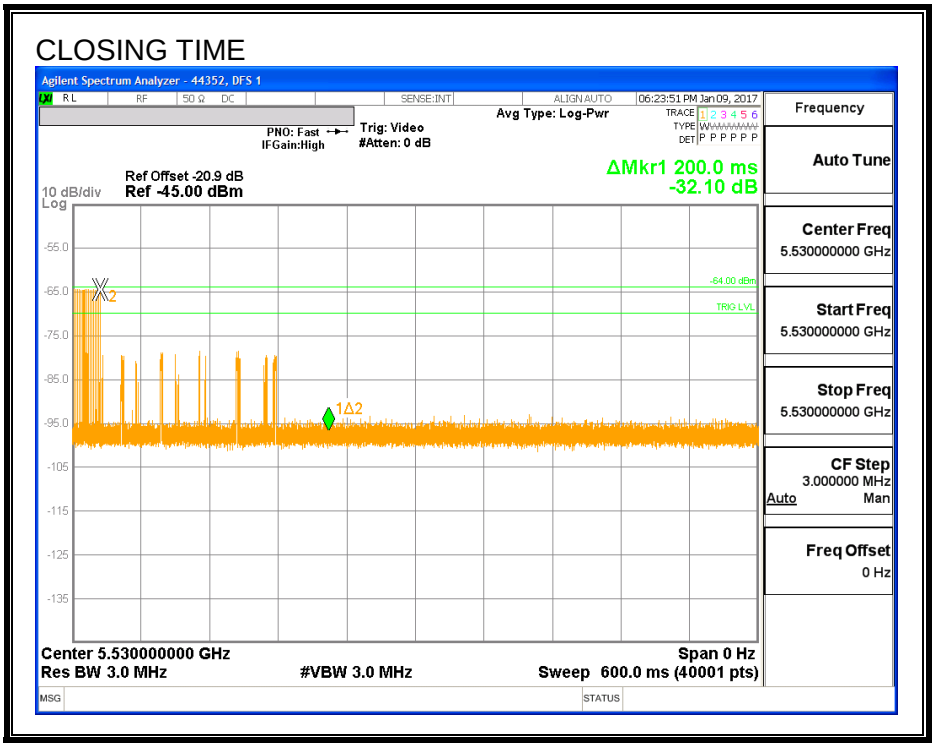
MOVE TIME



CHANNEL CLOSING TIME



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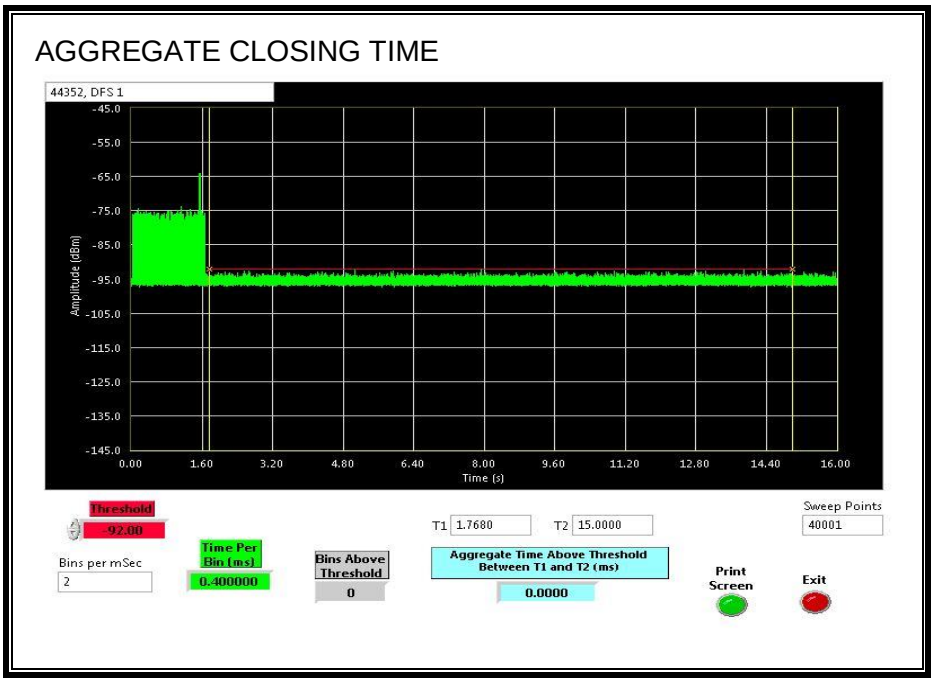
AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

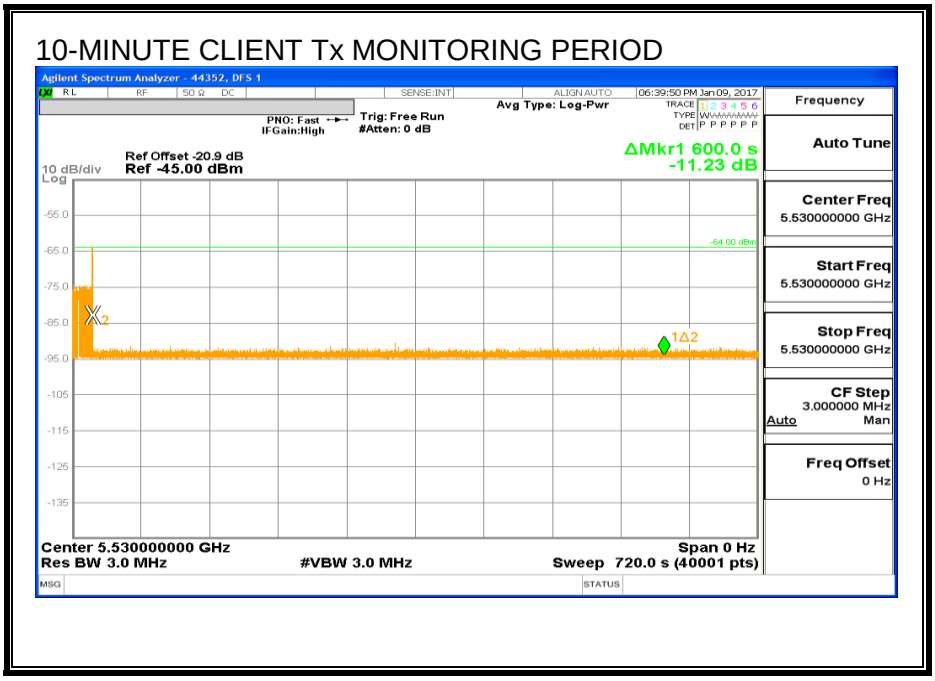
Only intermittent transmissions are observed during the aggregate monitoring period.



10-MINUTE CLIENT Tx MONITORING PERIOD

RESULTS

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



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