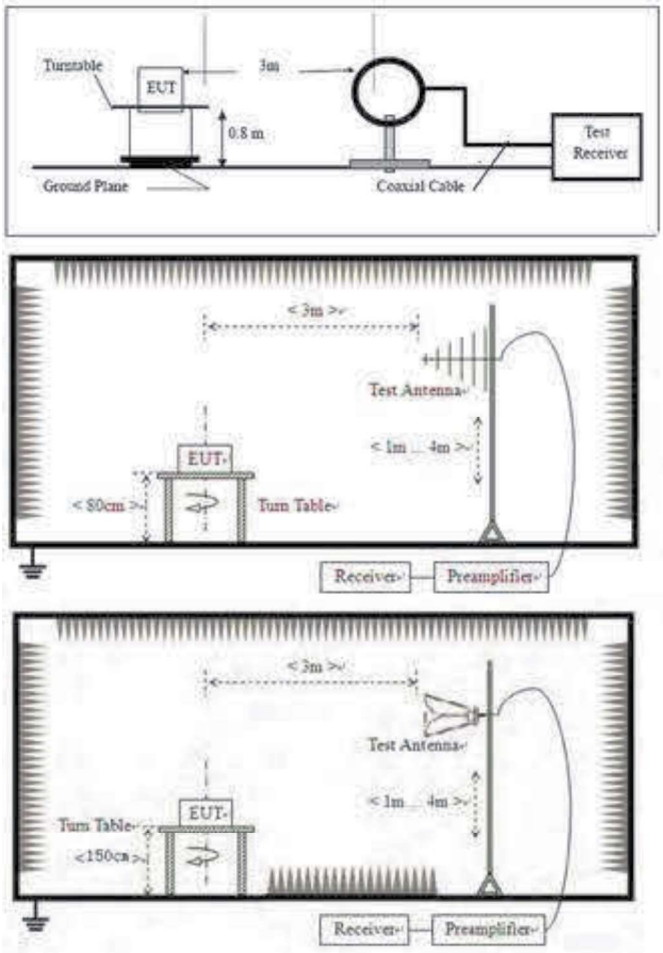
8.2 BLOCK DIAGRAM OF TEST SETUP



8.3 PROCEDURE

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
j. Repeat above procedures until all frequencies measured was complete.

Remark:
1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.
2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level =Receiver Reading + Antenna Factor + Cable Factor -Preamplifier Factor
3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.
4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

8.4 TEST DATA

[TestMode: Pi/4QPSK]

Remark: During the test, pre-scan the GFSK, Pi/4QPSK modulation, and found the Pi/4QPSK modulation which it is worse case.

[TestMode: TX]						
Test channel:lowest						
Peak value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	48.88	2.38	51.26	74	-22.74	Vertical
7206.00	48.56	2.17	50.73	74	-23.27	Vertical
9608.00	47.31	2.06	49.37	74	-24.63	Vertical
12010.00	*			74		Vertical
14412.00	*			74		Vertical
4804.00	58.03	2.38	60.41	74	-13.59	Horizontal
7206.00	57.16	2.17	59.33	74	-14.67	Horizontal
9608.00	56.79	2.06	58.85	74	-15.15	Horizontal
12010.00	*			74		Horizontal
14412.00	*			74		Horizontal
Average value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	40.79	2.38	43.17	54	-10.83	Vertical
7206.00	40.28	2.17	42.45	54	-11.55	Vertical
9608.00	39.88	2.06	41.94	54	-12.06	Vertical
12010.00	*			54		Vertical
14412.00	*			54		Vertical
4804.00	50.05	2.38	52.43	54	-1.57	Horizontal
7206.00	49.63	2.17	51.80	54	-2.20	Horizontal
9608.00	48.51	2.06	50.57	54	-3.43	Horizontal
12010.00	*			54		Horizontal
14412.00	*			54		Horizontal

Test channel:Middle						
Peak value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	51.94	0.17	52.11	74	-21.89	Vertical
7323.00	51.26	1.43	52.69	74	-21.31	Vertical
9764.00	50.71	1.26	51.97	74	-22.03	Vertical
12205.00	*			74		Vertical
14646.00	*			74		Vertical
4882.00	59.5	0.17	59.67	74	-14.33	Horizontal
7323.00	58.67	1.43	60.10	74	-13.90	Horizontal
9764.00	57.45	1.26	58.71	74	-15.29	Horizontal
12205.00	*			74		Horizontal
14646.00	*			74		Horizontal
Average value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	42.97	0.17	43.14	54	-10.86	Vertical
7323.00	42.53	1.43	43.96	54	-10.04	Vertical
9764.00	41.89	1.26	43.15	54	-10.85	Vertical
12205.00	*			54		Vertical
14646.00	*			54		Vertical
4882.00	51.68	0.17	51.85	54	-2.15	Horizontal
7323.00	50.46	1.43	51.89	54	-2.11	Horizontal
9764.00	50.11	1.26	51.37	54	-2.63	Horizontal
12205.00	*			54		Horizontal
14646.00	*			54		Horizontal

Test channel:Highest						
Peak value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4960.00	47.96	1.04	49.00	74	-25.00	Vertical
7440.00	46.86	2.59	49.45	74	-24.55	Vertical
9920.00	46.27	2.74	49.01	74	-24.99	Vertical
12400.00	*			74		Vertical
14880.00	*			74		Vertical
4960.00	56.93	1.04	57.97	74	-16.03	Horizontal
7440.00	55.84	2.59	58.43	74	-15.57	Horizontal
9920.00	55.18	2.74	57.92	74	-16.08	Horizontal
12400.00	*			74		Horizontal
14880.00	*			74		Horizontal
Average value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4960.00	39.52	1.04	40.56	54	-13.44	Vertical
7440.00	38.66	2.59	41.25	54	-12.75	Vertical
9920.00	38.05	2.74	40.79	54	-13.21	Vertical
12400.00	*			54		Vertical
14880.00	*			54		Vertical
4960.00	49.84	1.04	50.88	54	-3.12	Horizontal
7440.00	49.13	2.59	51.72	54	-2.28	Horizontal
9920.00	48.22	2.74	50.96	54	-3.04	Horizontal
12400.00	*			54		Horizontal
14880.00	*			54		Horizontal
Test Result: Pass						

9 RADIATED EMISSIONS WHICH FALL IN THE RESTRICTED BANDS

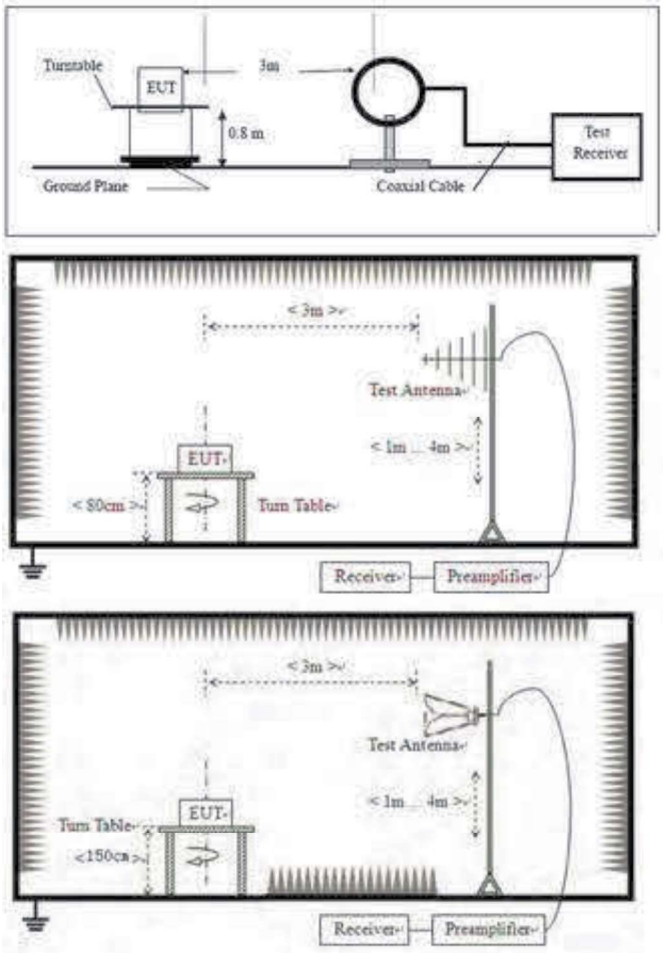
Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 6.10.5
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

9.1 LIMITS

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

9.2 BLOCK DIAGRAM OF TEST SETUP



9.3 PROCEDURE

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
j. Repeat above procedures until all frequencies measured was complete.
Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor
Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

9.4 TEST DATA

[TestMode: Pi/4QPSK]

Remark: During the test, pre-scan the GFSK, Pi/4QPSK modulation, and found the Pi/4QPSK modulation which it is worse case.

[TestMode: TX]						
Test channel:lowest; Peak value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2310	57.85	-14.42	43.43	74	-30.57	Horizontal
2390	57.68	-14.11	43.57	74	-30.43	Horizontal
2310	60.99	-14.71	46.28	74	-27.72	Vertical
2390	59.77	-14.44	45.33	74	-28.67	Vertical
Average value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor(dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2310	43.43	-14.42	29.01	54	-24.99	Horizontal
2390	44.57	-14.11	30.46	54	-23.54	Horizontal
2310	45.23	-14.71	30.52	54	-23.48	Vertical
2390	44.35	-14.44	29.91	54	-24.09	Vertical
Test channel:Highest, Peak value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.5	66.35	-13.61	52.74	74	-21.26	Horizontal
2500	54.12	-13.53	40.59	74	-33.41	Horizontal
2483.5	60.21	-14.00	46.21	74	-27.79	Vertical
2500	54.02	-13.93	40.09	74	-33.91	Vertical
Average value:						
Frequency (MHz)	Read Level (dBuV)	Correct factor(dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.5	52.41	-13.61	38.80	54	-15.20	Horizontal
2500	43.06	-13.53	29.53	54	-24.47	Horizontal
2483.5	49.95	-14.00	35.95	54	-18.05	Vertical
2500	43.75	-13.93	29.82	54	-24.18	Vertical
Test Result: Pass						

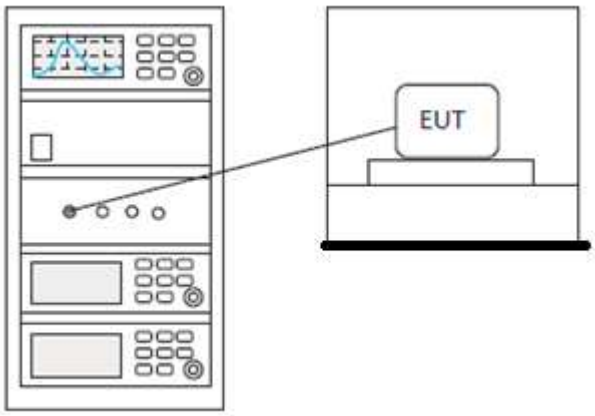
10 CONDUCTED BAND EDGES MEASUREMENT

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 7.8.8 & Section 11.13.3.2
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

10.1 LIMITS

Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

10.2 BLOCK DIAGRAM OF TEST SETUP



10.3 TEST DATA

Pass: Please Refer To Appendix: For Details

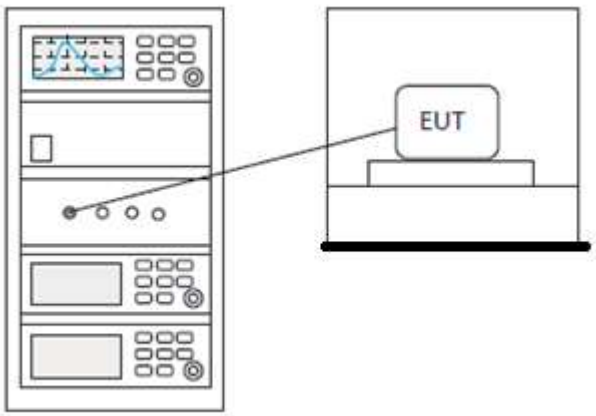
11 DWELL TIME

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 7.8.4
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

11.1 LIMITS

Frequency(MHz)	Limit
902-928	0.4S within a 20S period(20dB bandwidth<250kHz)
	0.4S within a 10S period(20dB bandwidth≥250kHz)
2400-2483.5	0.4S within a period of 0.4Smultiplied by the number of hopping channels
5725-5850	0.4S within a 30S period

11.2 BLOCK DIAGRAM OF TEST SETUP



11.3 TEST DATA

Pass: Please Refer To Appendix: For Details

10 APPENDIX

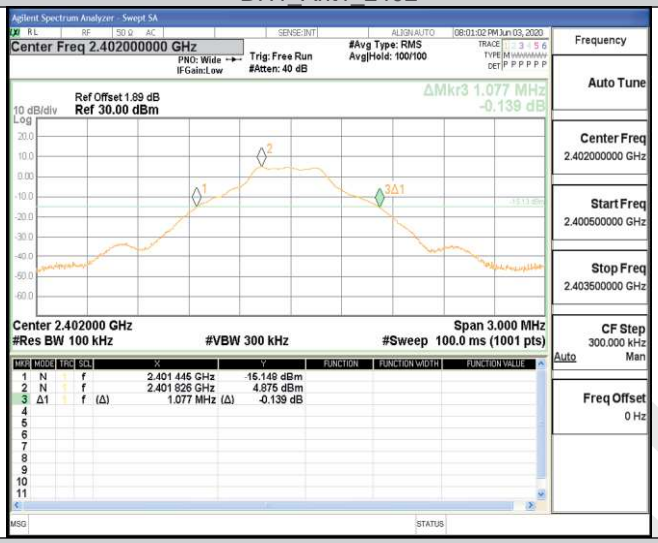
10.1 APPENDIX:20DBEMISSION BANDWIDTH

Test Result

TestMode	Antenna	Channel	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	1.077	2401.445	2402.522	---	PASS
		2441	1.080	2440.442	2441.522	---	PASS
		2480	1.086	2479.439	2480.525	---	PASS
2DH1	Ant1	2402	1.377	2401.292	2402.669	---	PASS
		2441	1.377	2440.292	2441.669	---	PASS
		2480	1.377	2479.289	2480.666	---	PASS

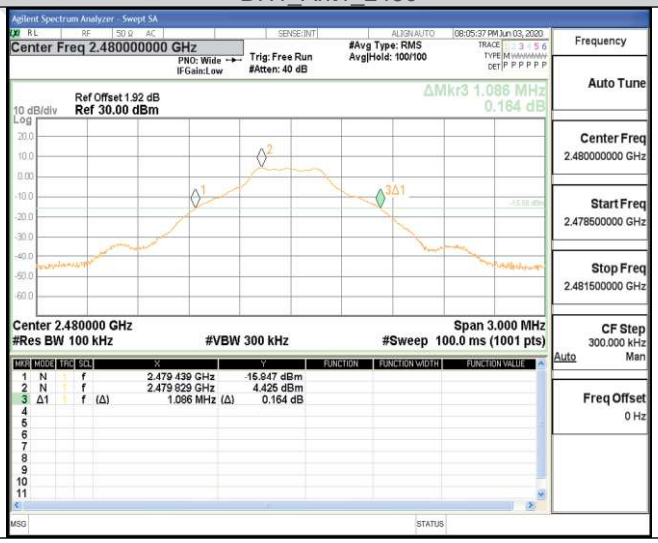
Test Graphs

DH1_Ant1_2402

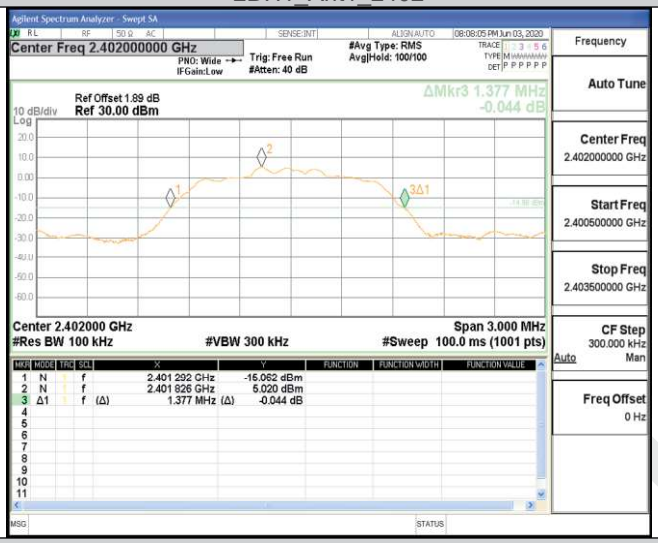


DH1_Ant1_2441

DH1_Ant1_2480

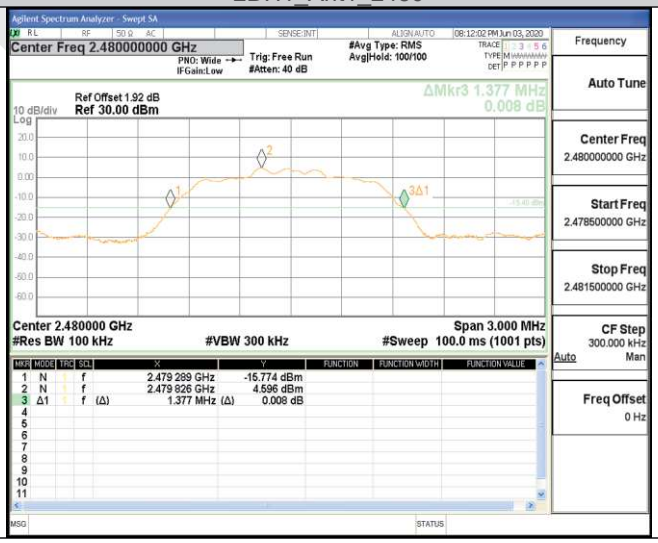


2DH1_Ant1_2402



2DH1_Ant1_2441

2DH1_Ant1_2480



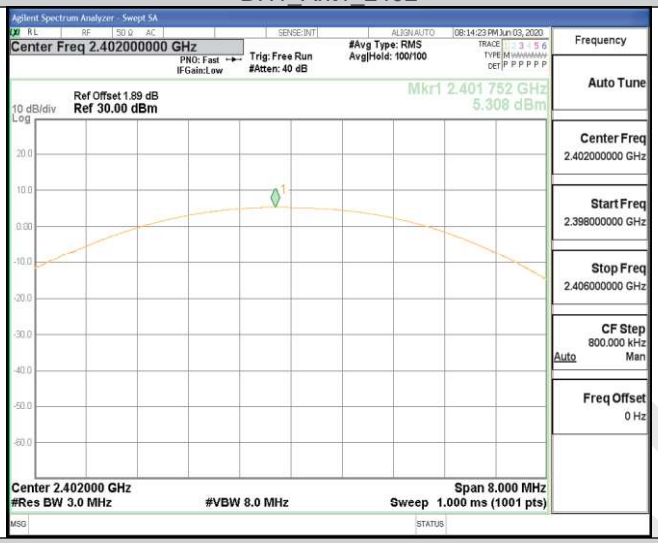
10.2 APPENDIX:MAXIMUM CONDUCTED OUTPUT POWER

Test Result

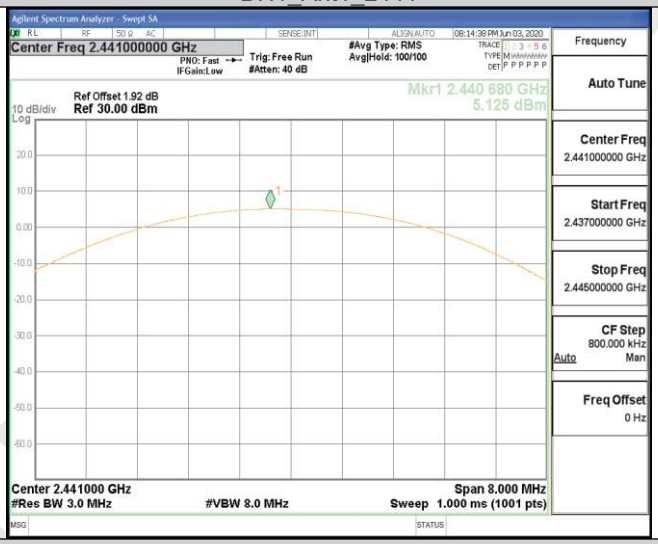
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	5.31	<=20.97	PASS
		2441	5.13	<=20.97	PASS
		2480	4.76	<=20.97	PASS
2DH1	Ant1	2402	5.8	<=20.97	PASS
		2441	5.65	<=20.97	PASS
		2480	5.31	<=20.97	PASS

Test Graphs

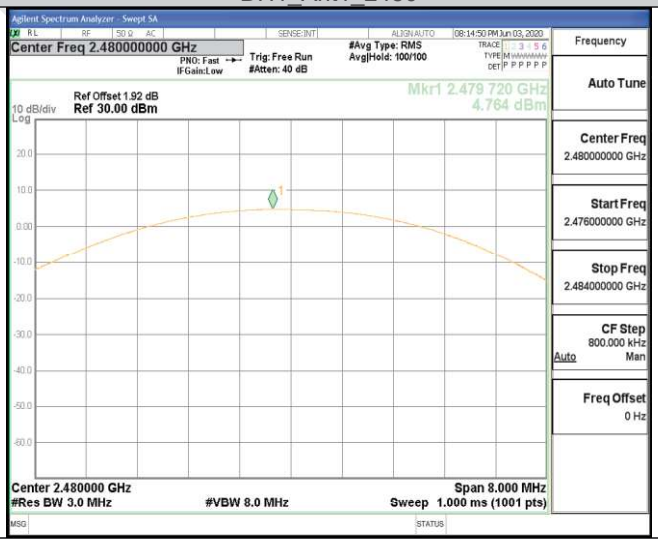
DH1_Ant1_2402



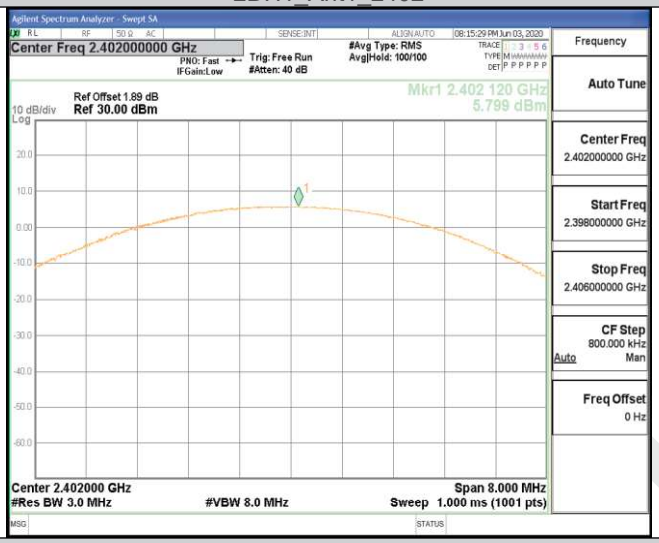
DH1_Ant1_2441



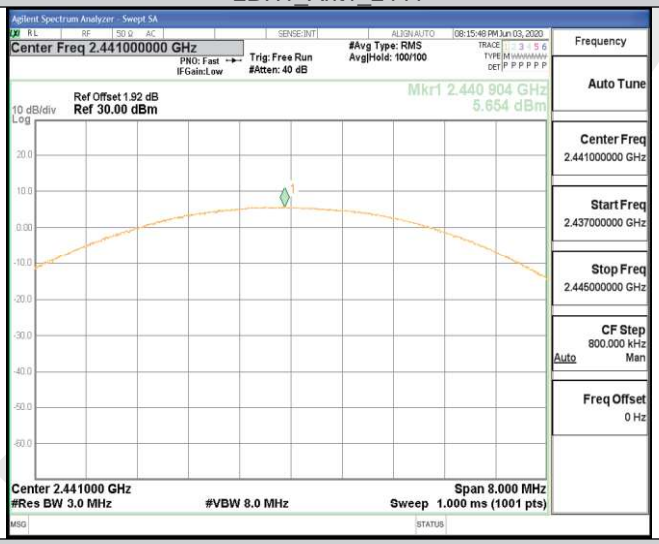
DH1_Ant1_2480



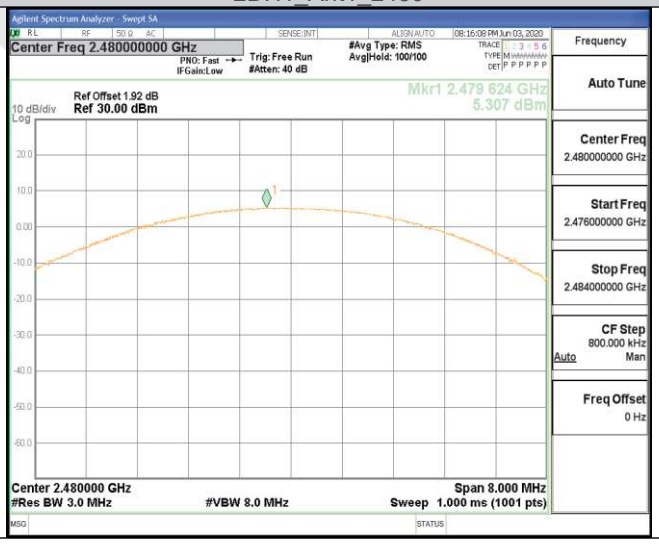
2DH1_Ant1_2402



2DH1_Ant1_2441



2DH1_Ant1_2480



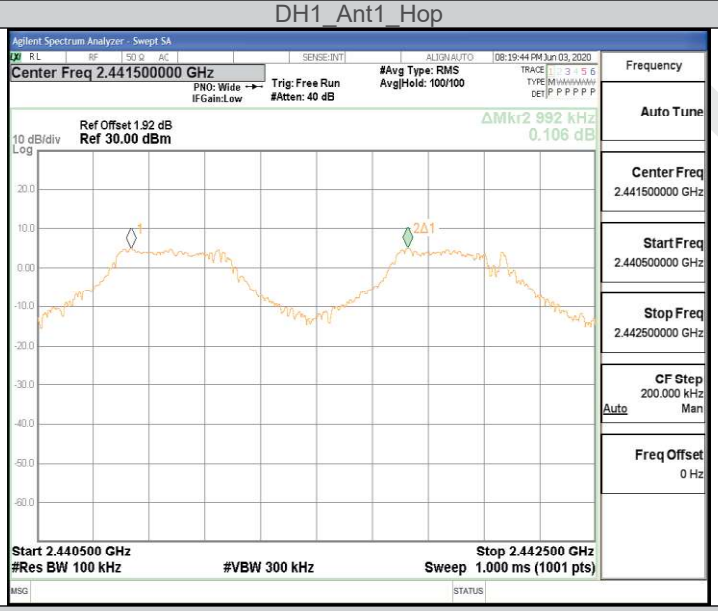
10.3 APPENDIX:CARRIER FREQUENCY SEPARATION

Test Result

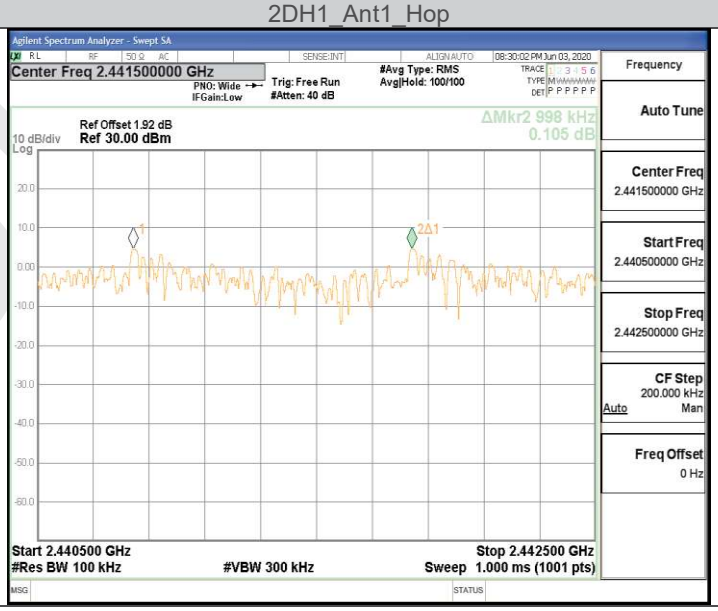
TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	0.992	>=0.724	PASS
2DH1	Ant1	Hop	0.998	>=0.918	PASS

Test Graphs

DH1_Ant1_Hop



2DH1_Ant1_Hop

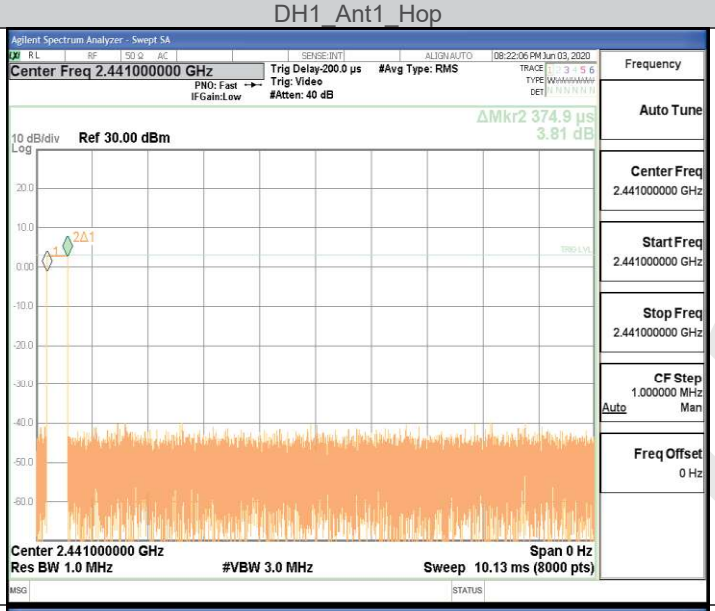
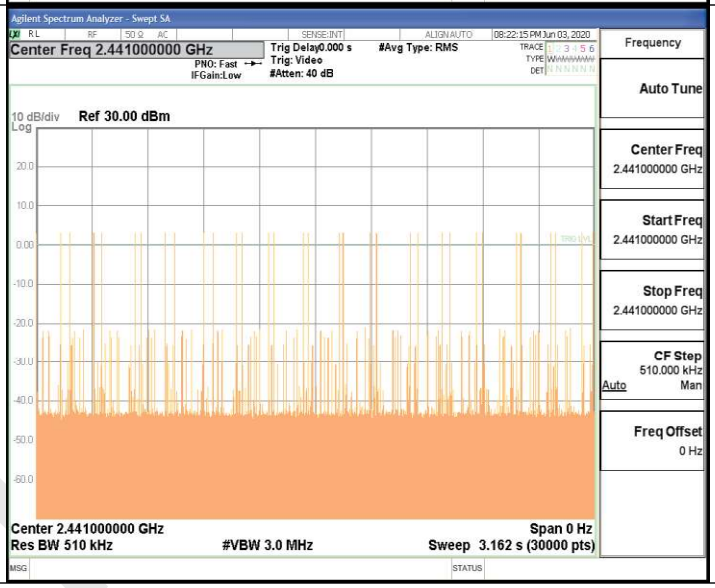


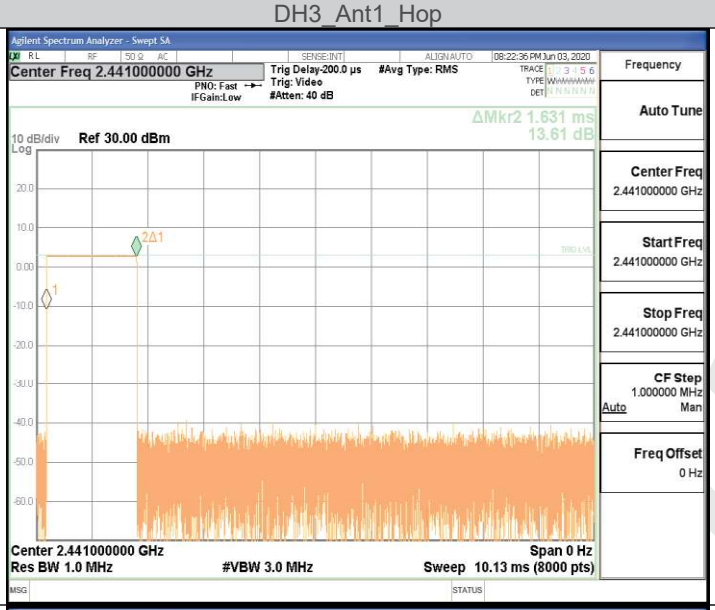
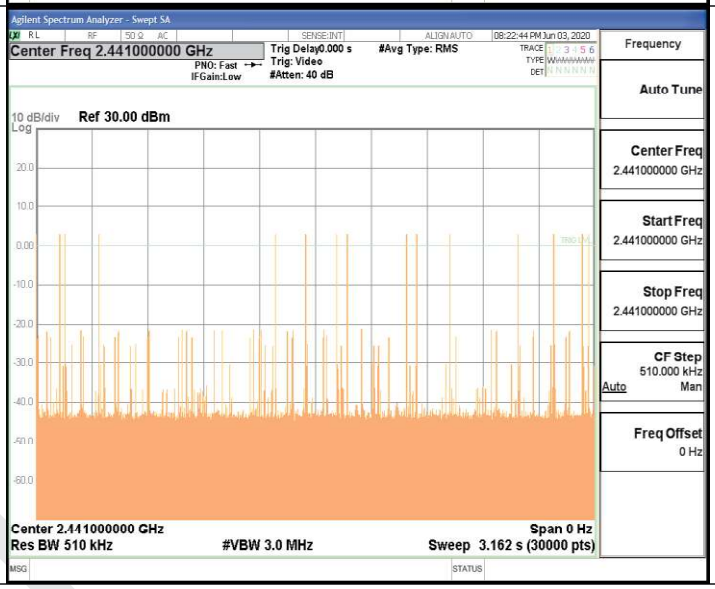
10.4 APPENDIX:TIME OF OCCUPANCY

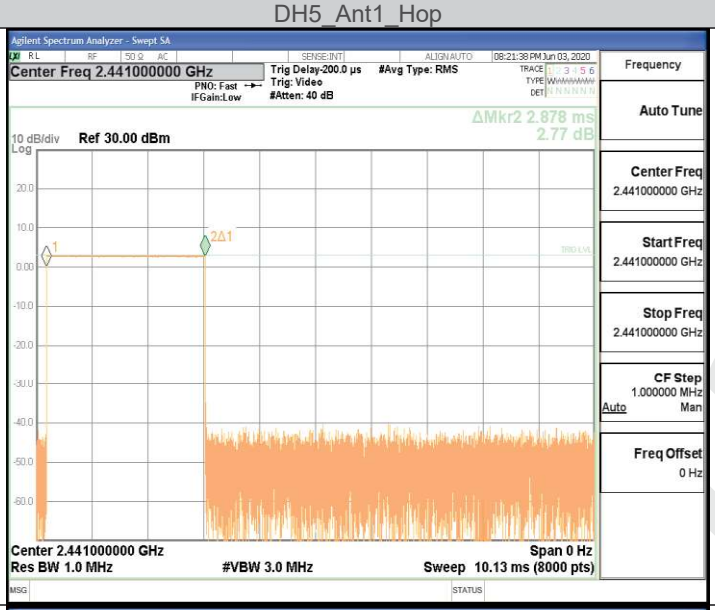
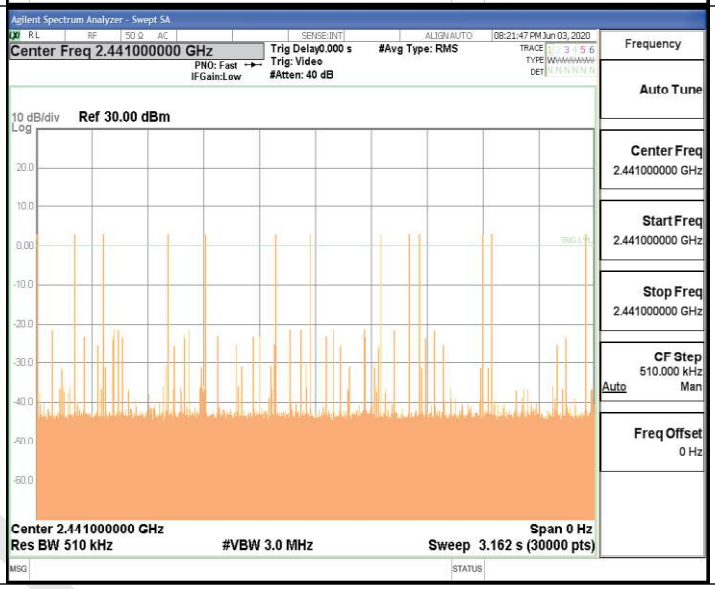
Test Result

TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.37	330	0.124	<=0.4	PASS
DH3	Ant1	Hop	1.63	150	0.245	<=0.4	PASS
DH5	Ant1	Hop	2.88	130	0.374	<=0.4	PASS

Test Graphs

DH1_Ant1_Hop



DH3_Ant1_Hop



DH5_Ant1_Hop



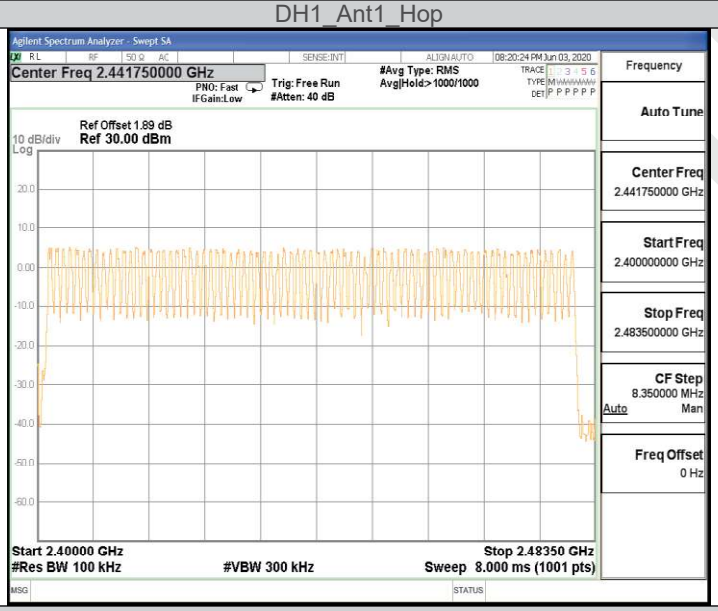
10.5 APPENDIX:NUMBER OF HOPPING CHANNELS

Test Result

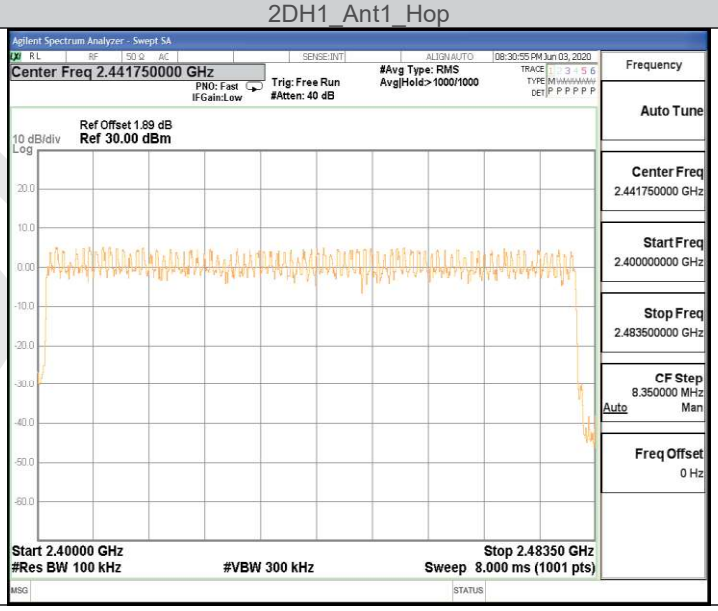
TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	>=15	PASS
2DH1	Ant1	Hop	79	>=15	PASS

Test Graphs

DH1_Ant1_Hop



2DH1_Ant1_Hop



10.6 APPENDIX:BAND EDGE MEASUREMENTS

Test Result

TestMode	Antenna	ChName	Channel	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH1	Ant1	Low	2402	4.83	-53.34	<=-15.17	PASS
		High	2480	4.39	-49.66	<=-15.61	PASS
		Low	Hop_2402	5.05	-53.15	-14.96	PASS
		High	Hop_2480	4.64	-49.02	-15.36	PASS
2DH1	Ant1	Low	2402	4.97	-53.48	<=-15.03	PASS
		High	2480	4.57	-49.25	<=-15.43	PASS
		Low	Hop_2402	4.81	-54.19	-15.19	PASS
		High	Hop_2480	4.66	-49.91	-15.34	PASS