



Appendix C. Radiated Spurious Emission

Test Engineer :	Leo Lee, Mancy Chou and Bigshow Wang	Temperature :	21.4~22.9°C
		Relative Humidity :	52~61%

<Open Mode>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
BT CH00 2402MHz		2320.92	46.61	-27.39	74	42.44	28.06	7.29	31.18	265	2	P	H	
		2320.92	21.85	-32.15	54	-	-	-	-	-	-	A	H	
	*	2402	105.43	-	-	101.42	27.7	7.45	31.14	265	2	P	H	
	*	2402	80.67	-	-	-	-	-	-	-	-	A	H	
													H	
			2333.52	46.75	-27.25	74	42.58	28.03	7.31	31.17	234	100	P	V
			2333.52	21.99	-32.01	54	-	-	-	-	-	-	A	V
	*		2402	101.1	-	-	97.09	27.7	7.45	31.14	234	100	P	V
	*		2402	76.34	-	-	-	-	-	-	-	-	A	V
														V
BT CH 39 2441MHz		2379.58	46.56	-27.44	74	42.48	27.82	7.41	31.15	293	1	P	H	
		2379.58	21.8	-32.2	54	-	-	-	-	-	-	A	H	
	*	2441	110.91	-	-	106.89	27.62	7.52	31.12	293	1	P	H	
	*	2441	86.15	-	-	-	-	-	-	-	-	A	H	
			2496.15	46.52	-27.48	74	42.48	27.51	7.62	31.09	293	1	P	H
			2496.15	21.76	-32.24	54	-	-	-	-	-	-	A	H
			2371.6	46.78	-27.22	74	42.67	27.87	7.39	31.15	195	111	P	V
			2371.6	22.02	-31.98	54	-	-	-	-	-	-	A	V
	*		2441	106.5	-	-	102.48	27.62	7.52	31.12	195	111	P	V
	*		2441	81.74	-	-	-	-	-	-	-	-	A	V
			2493.35	46	-28	74	41.97	27.51	7.61	31.09	195	111	P	V
			2493.35	21.24	-32.76	54	-	-	-	-	-	-	A	V



BT CH 78 2480MHz	*	2480	112.4	-	-	108.37	27.54	7.59	31.1	272	2	P	H
	*	2480	87.64	-	-	-	-	-	-	-	-	A	H
		2483.52	55.93	-18.07	74	51.9	27.53	7.6	31.1	272	2	P	H
		2483.52	31.17	-22.83	54	-	-	-	-	-	-	A	H
													H
													H
	*	2480	107.79	-	-	103.76	27.54	7.59	31.1	179	75	P	V
	*	2480	83.03	-	-	-	-	-	-	-	-	A	V
		2483.68	51.3	-22.7	74	47.27	27.53	7.6	31.1	179	75	P	V
		2483.68	26.54	-27.46	54	-	-	-	-	-	-	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz
BT (Harmonic @ 3m)

BT	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
BT CH 00 2402MHz		4804	41.31	-32.69	74	58.53	31.21	10.65	59.08	100	0	P	H	
		4804	16.55	-37.45	54	-	-	-	-	-	-	A	H	
													H	
													H	
		4804	39.88	-34.12	74	57.1	31.21	10.65	59.08	100	0	P	V	
		4804	15.12	-38.88	54	-	-	-	-	-	-	-	A	V
														V
														V
BT CH 39 2441MHz		4882	40.33	-33.67	74	57.5	31.24	10.72	59.13	100	0	P	H	
		4882	15.57	-38.43	54	-	-	-	-	-	-	A	H	
		7323	45.65	-28.35	74	55.07	36.55	12.58	58.55	100	0	P	H	
		7323	20.89	-33.11	54	-	-	-	-	-	-	A	H	
		4882	41	-33	74	58.17	31.24	10.72	59.13	100	0	P	V	
		4882	16.24	-37.76	54	-	-	-	-	-	-	-	A	V
		7323	45.24	-28.76	74	54.66	36.55	12.58	58.55	100	0	P	V	
		7323	20.48	-33.52	54	-	-	-	-	-	-	-	A	V
BT CH 78 2480MHz		4960	40.76	-33.24	74	57.6	31.54	10.8	59.18	100	0	P	H	
		4960	16	-38	54	-	-	-	-	-	-	A	H	
		7440	46.62	-27.38	74	55.73	36.56	12.71	58.38	100	0	P	H	
		7440	21.86	-32.14	54	-	-	-	-	-	-	A	H	
		4960	41.16	-32.84	74	58	31.54	10.8	59.18	100	0	P	V	
		4960	16.4	-37.6	54	-	-	-	-	-	-	A	V	
		7440	46.8	-27.2	74	55.91	36.56	12.71	58.38	100	0	P	V	
		7440	22.04	-31.96	54	-	-	-	-	-	-	-	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.													



Emission below 1GHz

2.4GHz BT (LF)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
2.4GHz BT LF		72.68	23.08	-16.92	40	41.8	12.74	1.12	32.58	-	-	P	H	
		87.23	22.13	-17.87	40	38.75	14.53	1.24	32.39	-	-	P	H	
		187.14	22.65	-20.85	43.5	38.11	15	1.92	32.38	-	-	P	H	
		298.69	28.13	-17.87	46	39.21	19.08	2.36	32.52	-	-	P	H	
		705.12	33.44	-12.56	46	35.87	26.29	3.68	32.4	-	-	P	H	
		908.82	38.62	-7.38	46	37.46	28.67	4.31	31.82	100	0	P	H	
														H
														H
														H
														H
														H
														H
			40.67	21.82	-18.18	40	34.29	19.11	0.76	32.34	-	-	P	V
			72.68	23.66	-16.34	40	42.38	12.74	1.12	32.58	-	-	P	V
			258.92	20.89	-25.11	46	31.6	19.49	2.23	32.43	-	-	P	V
			714.82	35.48	-10.52	46	37.56	26.62	3.71	32.41	-	-	P	V
			745.86	34.86	-11.14	46	35.86	27.65	3.81	32.46	-	-	P	V
			902.03	39.23	-6.77	46	38.28	28.59	4.29	31.93	100	0	P	V
														V
														V
													V	
													V	
													V	
													V	
Remark	1. No other spurious found. 2. All results are PASS against limit line.													



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	Peak or Average
H/V	Horizontal or Vertical



A calculation example for radiated spurious emission is shown as below:

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
					(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 00		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H
2402MHz													

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)
= 55.45 (dBμV/m)
2. Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)
= 43.54 (dBμV/m)
2. Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 43.54(dBμV/m) – 54(dBμV/m)
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.



Appendix D. Radiated Spurious Emission Plots

Test Engineer :	Leo Lee, Mancy Chou and Bigshow Wang	Temperature :	21.4~22.9°C
		Relative Humidity :	52~61%

Note symbol

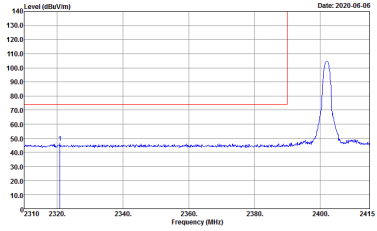
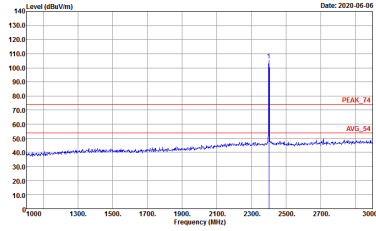
-L	Low channel location
-R	High channel location



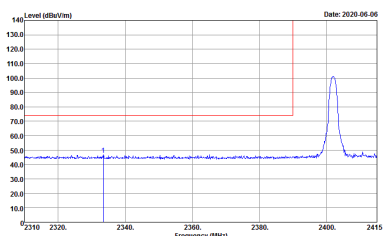
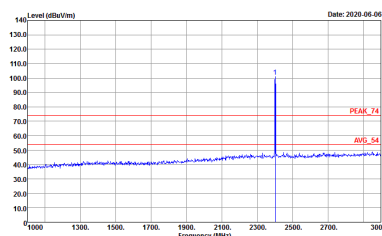
<Open Mode>

2.4GHz 2400~2483.5MHz

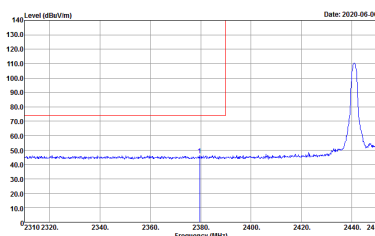
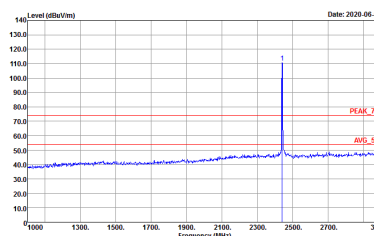
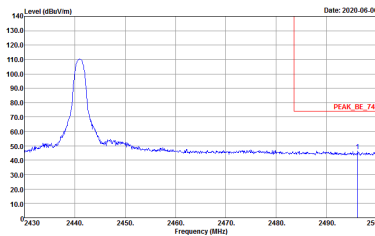
BT (Band Edge @ 3m)

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Horizontal	Fundamental
Peak	 <p>Site : 03CH15-1RV Condition : PEAK_BE_74 3m 91200_15_1620 HORIZONTAL Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-1RV Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL Detector : Peak Project : 051232</p>

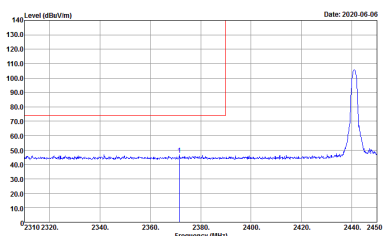
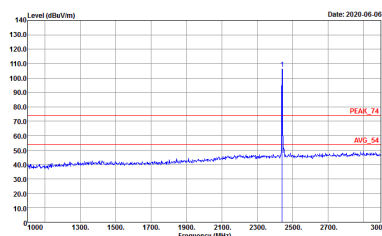
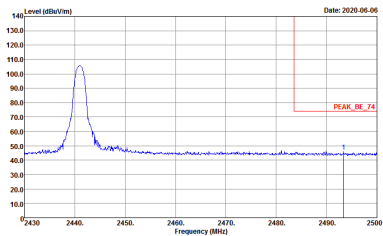


BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Vertical	Fundamental
Peak	 <p data-bbox="430 705 702 772">Site : 03CH15-HY Condition : PEAK_8E_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	 <p data-bbox="901 705 1173 772">Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>

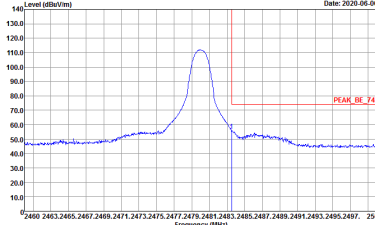
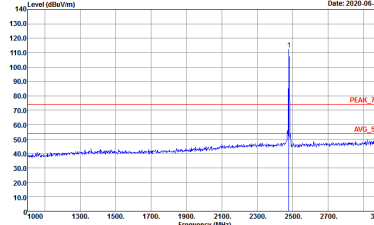


BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
BT CH39 2441MHz		
	Horizontal	Fundamental
<p>Peak</p>	 <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>
<p>Peak</p>	 <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	<p>Left blank</p>

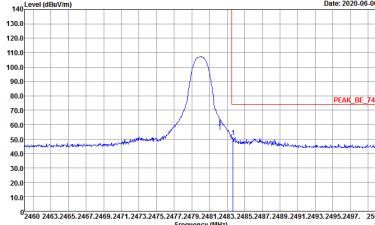
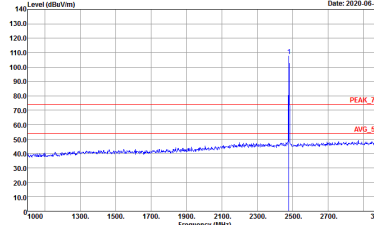


BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
BT CH39 2441MHz		
	Vertical	Fundamental
<p>Peak</p>	 <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>
<p>Peak</p>	 <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	<p>Left blank</p>



BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
BT CH78 2480MHz		
Horizontal		Fundamental
Peak	 <p>Date: 2020-06-06</p> <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	 <p>Date: 2020-06-06</p> <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>



BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
BT CH78 2480MHz		
	Vertical	Fundamental
Peak	 <p>Date: 2020-06-06</p> <p>Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>	 <p>Date: 2020-06-06</p> <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 051232</p>

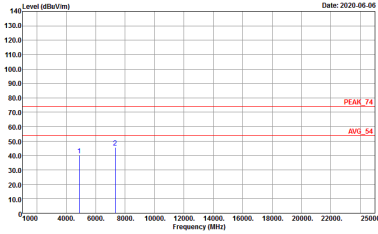
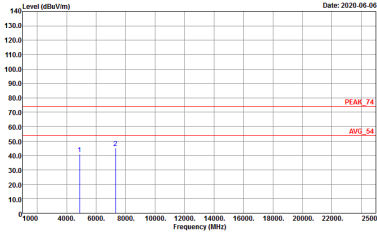


2.4GHz 2400~2483.5MHz

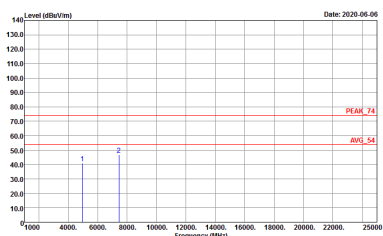
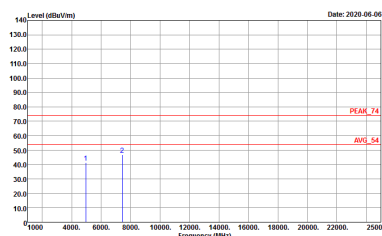
BT (Harmonic @ 3m)

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH15-1FY Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL Detector : Peak Project : 051232</p>	<p>Site : 03CH15-1FY Condition : PEAK_74 3m 91200_15_1620 VERTICAL Detector : Peak Project : 051232</p>



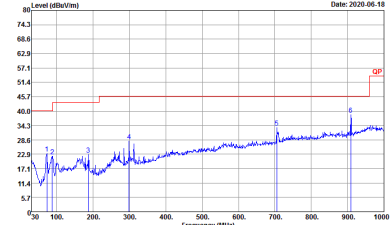
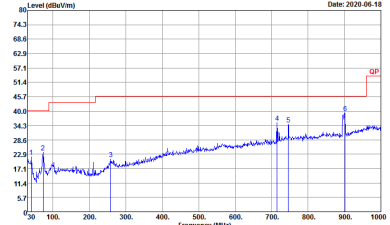
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH39 2441MHz	
	Horizontal	Vertical
Peak Avg.	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 VERTICAL Detector : Peak Project : 051232</p>



BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
BT CH78 2480MHz		
Horizontal		Vertical
<p>Peak</p> <p>Avg.</p>	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 HORIZONTAL Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-HY Condition : PEAK_74 3m 91200_15_1620 VERTICAL Detector : Peak Project : 051232</p>



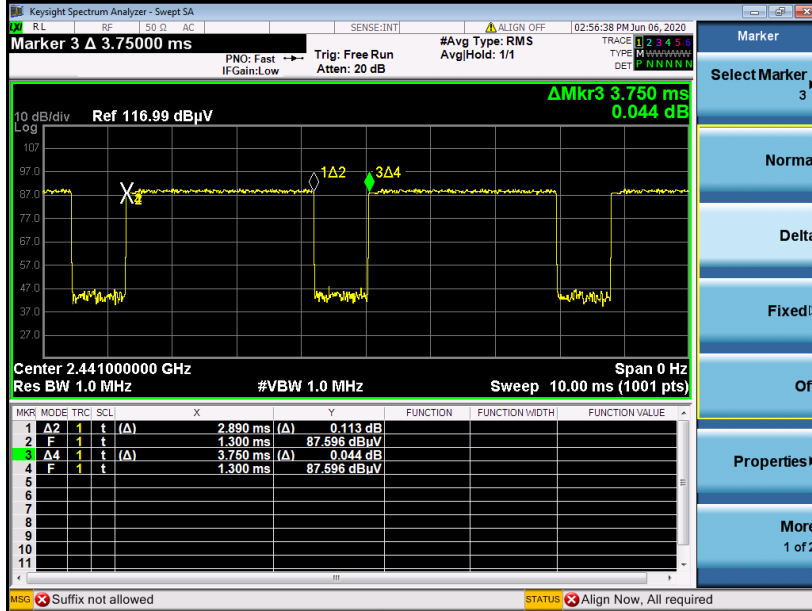
Emission below 1GHz
2.4GHz BT (LF)

BT	2.4GHz 2400~2483.5MHz	
BT LF		
Horizontal		Vertical
QP / Peak	 <p>Site : 03CH15-FY Condition : QP 3m BTLOG_15_41912 HORIZONTAL Detector : Peak Project : 051232</p>	 <p>Site : 03CH15-FY Condition : QP 3m BTLOG_15_41912 VERTICAL Detector : Peak Project : 051232</p>

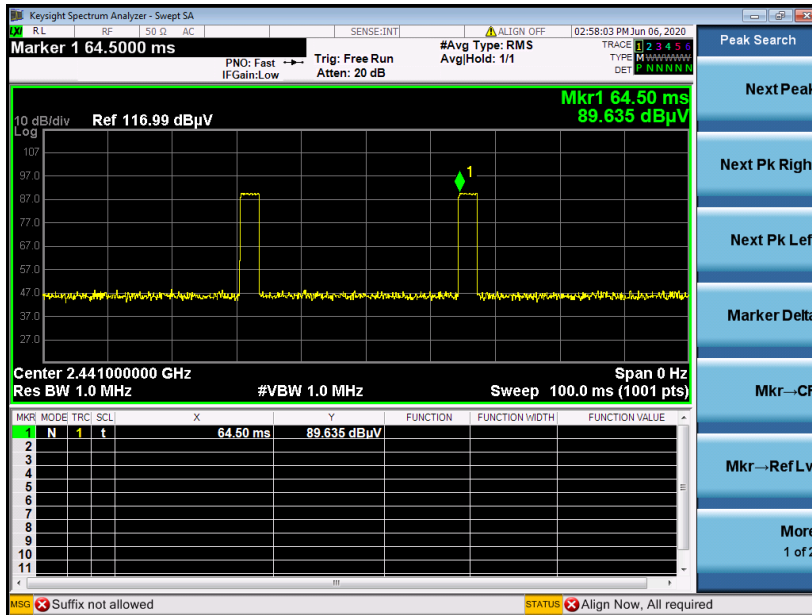


Appendix E. Duty Cycle Plots

DH5 on time (One Pulse) Plot on Channel 39



on time (Count Pulses) Plot on Channel 39



Note:

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.89 / 100 = 5.78 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.76 \text{ dB}$
3. DH5 has the highest duty cycle worst case and is reported.



Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the period to have DH5 packet completing one hopping sequence is

$$2.89 \text{ ms} \times 20 \text{ channels} = 57.8 \text{ ms}$$

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. $[100 \text{ ms} / 57.8 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.89 \text{ ms} \times 2 = 5.78 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.78 \text{ ms}/100 \text{ ms}) = -24.76 \text{ dB}$$

—————THE END—————