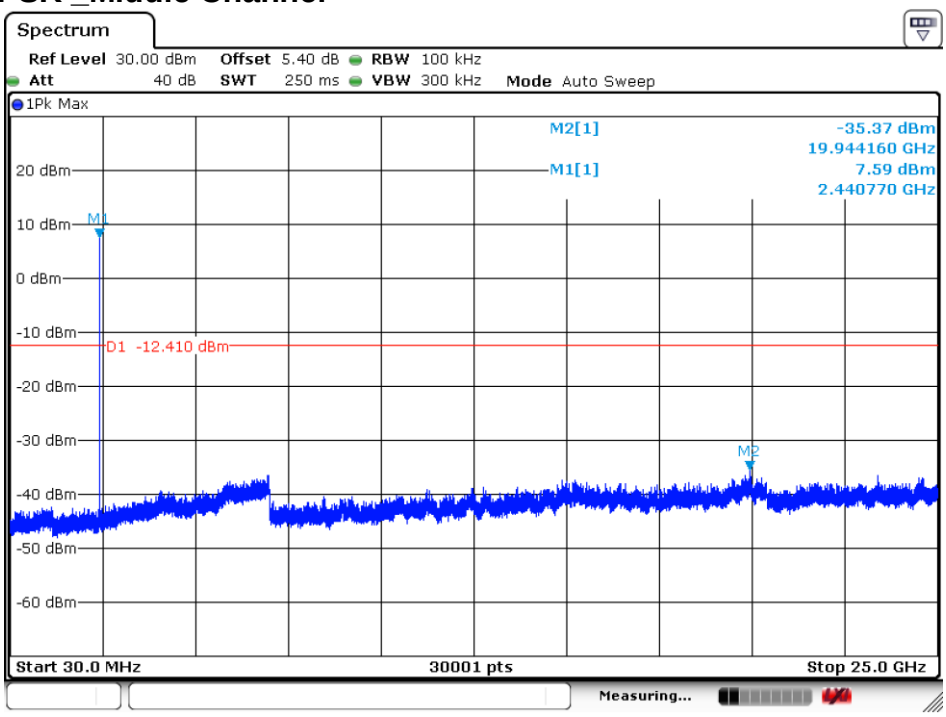
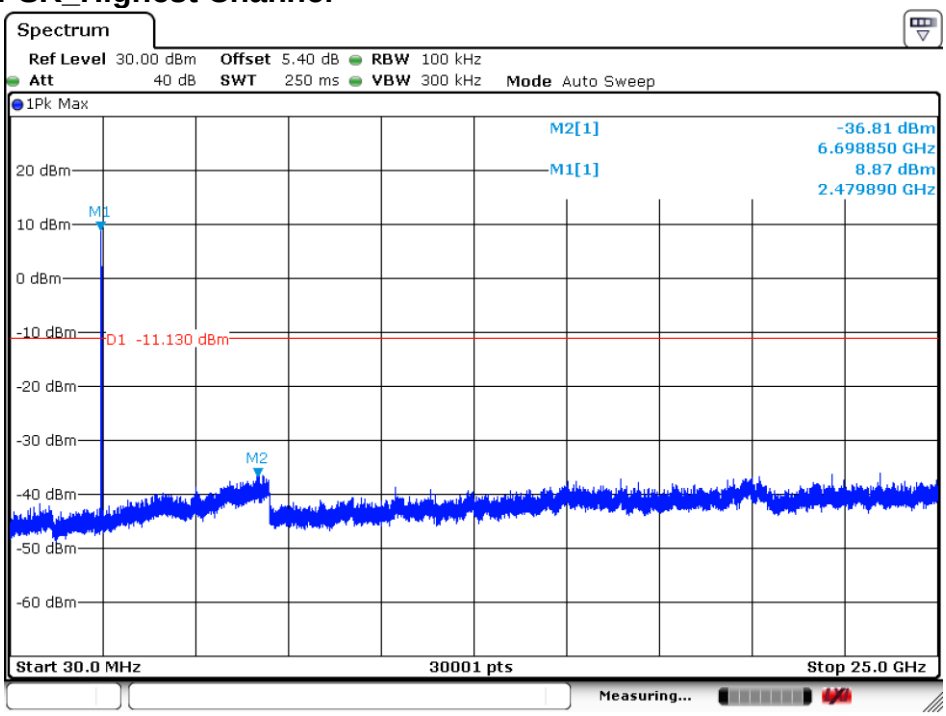
4.10.1.8 8DPSK _Middle Channel



Date: 20.NOV.2020 20:31:29

4.10.1.9 8DPSK_Highest Channel



Date: 20.NOV.2020 20:30:24

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Remark:

Scan from 9kHz to 25GHz, the disturbance between 9KHz to 30MHz was very low, and the above harmonics were the highest point could be found when testing, The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

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4.11 Radiated Spurious Emission

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10: 2013				
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	100 kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz	Average
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Remark: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				

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Test Setup:

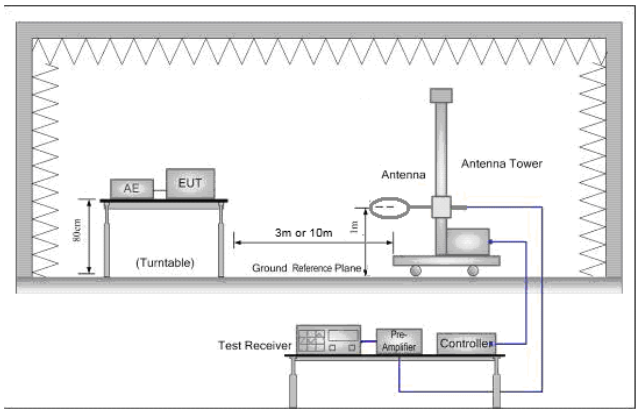

Figure 1. Below 30MHz

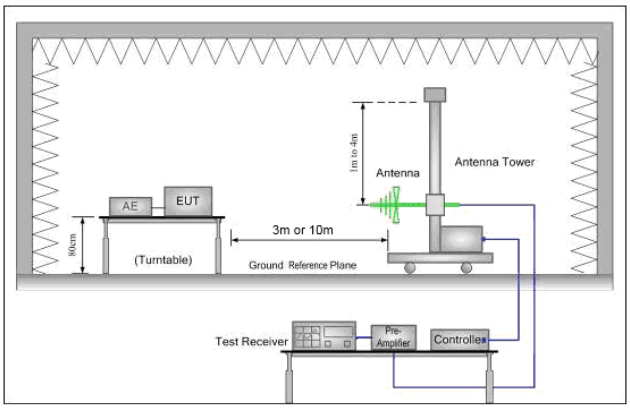

Figure 2. 30MHz to 1GHz

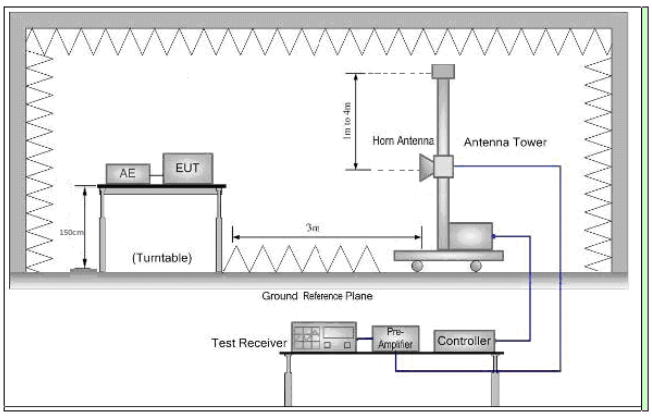

Figure 3. Above 1 GHz

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Test 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 camber. 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 semi-anechoic camber. 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. Use the following spectrum analyzer settings: (1) Span shall wide enough to fully capture the emission being measured; (2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak (3) For average measurement: use duty cycle correction factor method per 15.35(c). Duty cycle = On time/100 milliseconds On time = N 1 *L 1 +N 2 *L 2 +...+N n-1 *LN n-1 +N n *L n Where N 1 is number of type 1 pulses, L 1 is length of type 1 pulses, etc. Average Emission Level = Peak Emission Level + 20*log(Duty cycle) f. 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. g. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. h. 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. i. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) j. 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. k. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type

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	Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Pretest the EUT at Charge + Transmitting mode For below 1GHz part, through pre-scan, the worst case is the lowest channel. Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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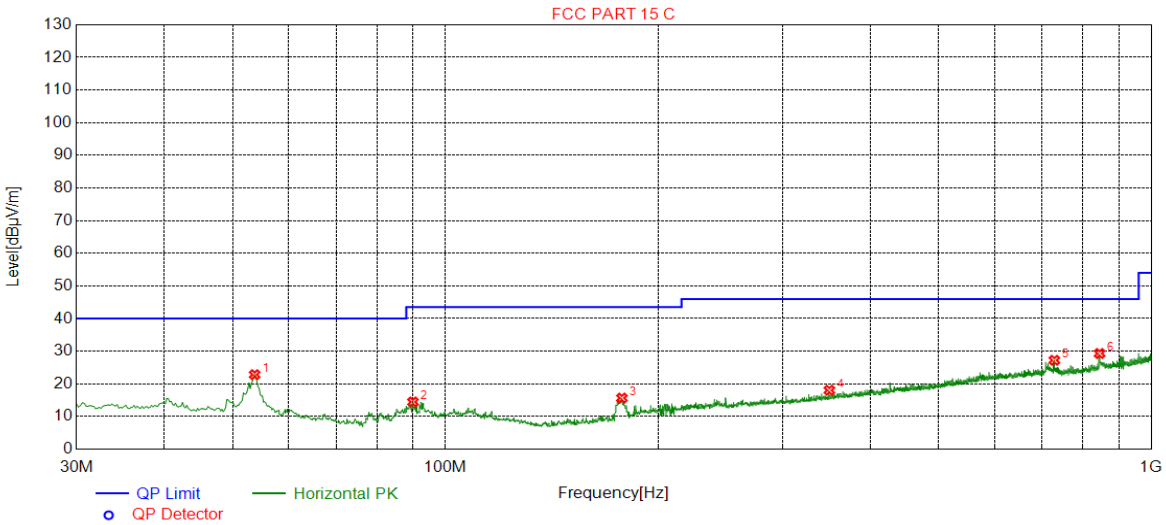
4.11.1 Radiated Emission below 1GHz

4.11.1.1 Charge + Transmitting, Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	53.6727	22.83	-30.92	40.00	17.17	161	228	Horizontal
2	89.9580	14.47	-33.72	43.50	29.03	207	291	Horizontal
3	177.857	15.67	-33.45	43.50	27.83	200	287	Horizontal
4	349.970	18.06	-26.87	46.00	27.94	110	247	Horizontal
5	729.121	27.24	-18.82	46.00	18.76	152	304	Horizontal
6	844.963	29.32	-16.97	46.00	16.68	232	311	Horizontal

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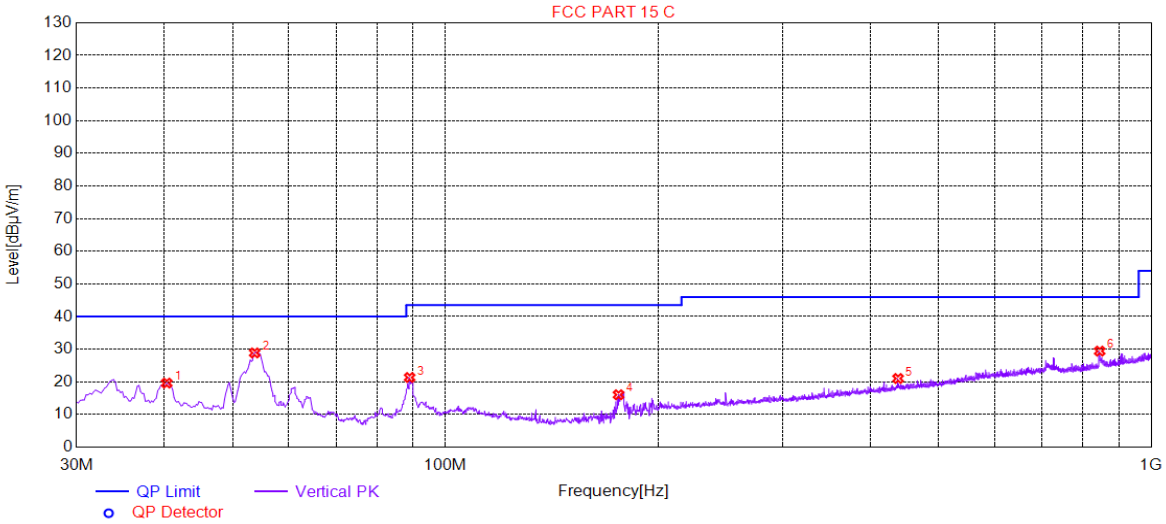
4.11.1.2 Charge + Transmitting, Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	40.2841	19.63	-28.46	40.00	20.37	296	291	Vertical
2	53.6727	28.87	-30.92	40.00	11.13	192	279	Vertical
3	88.9878	21.35	-33.96	43.50	22.15	221	346	Vertical
4	175.917	16.06	-33.60	43.50	27.44	285	168	Vertical
5	437.869	21.04	-24.61	46.00	24.96	227	279	Vertical
6	845.351	29.43	-16.96	46.00	16.57	264	230	Vertical

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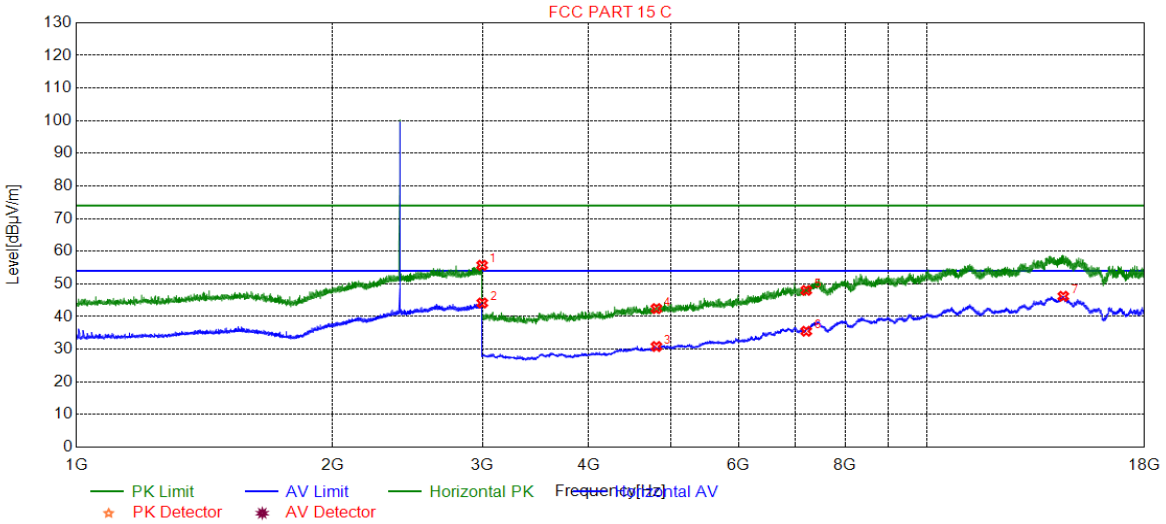
4.11.2 Transmitter Emission above 1GHz

4.11.2.1 GFSK_Channel 0 left



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2997.49	55.72	9.46	74.00	18.28	110	44	Horizontal
2	2998.99	44.16	9.45	54.00	9.84	180	99	Horizontal
3	4804.00	30.84	-17.19	54.00	23.16	149	209	Horizontal
4	4804.00	42.45	-17.19	74.00	31.55	215	193	Horizontal
5	7206.00	48.02	-8.64	74.00	25.98	112	225	Horizontal
6	7206.00	35.51	-8.64	54.00	18.49	229	111	Horizontal
7	14444.6	46.23	4.15	54.00	7.77	231	307	Horizontal

Final Data List

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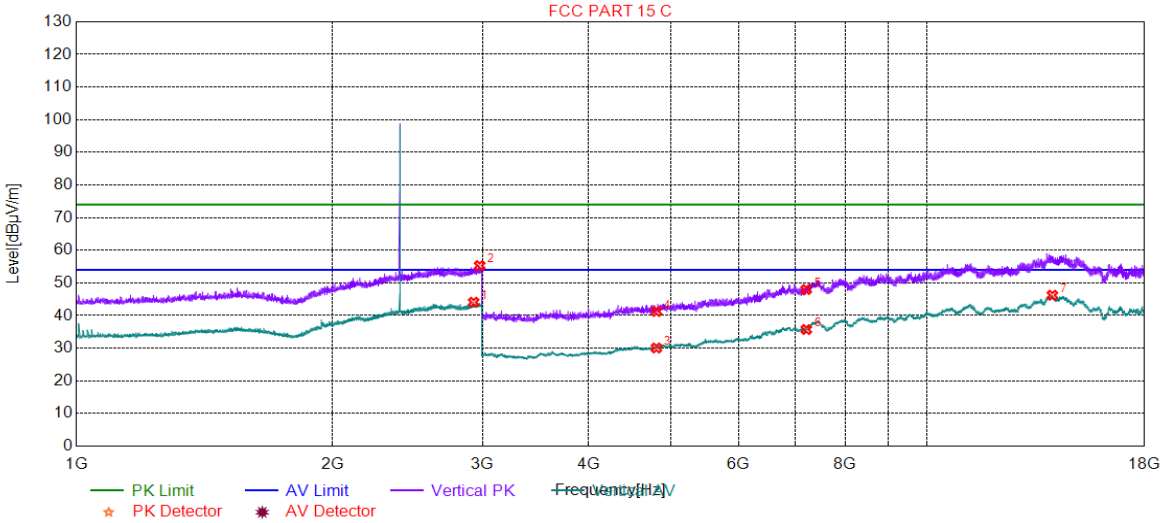
4.11.2.2 GFSK_Channel 0 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2929.48	44.10	9.46	54.00	9.90	160	164	Vertical
2	2977.99	55.31	9.55	74.00	18.69	260	54	Vertical
3	4804.00	30.08	-17.19	54.00	23.92	206	314	Vertical
4	4804.00	41.28	-17.19	74.00	32.72	184	167	Vertical
5	7206.00	48.00	-8.64	74.00	26.00	193	314	Vertical
6	7206.00	35.75	-8.64	54.00	18.25	159	346	Vertical
7	14024.6	46.25	4.33	54.00	7.75	213	232	Vertical

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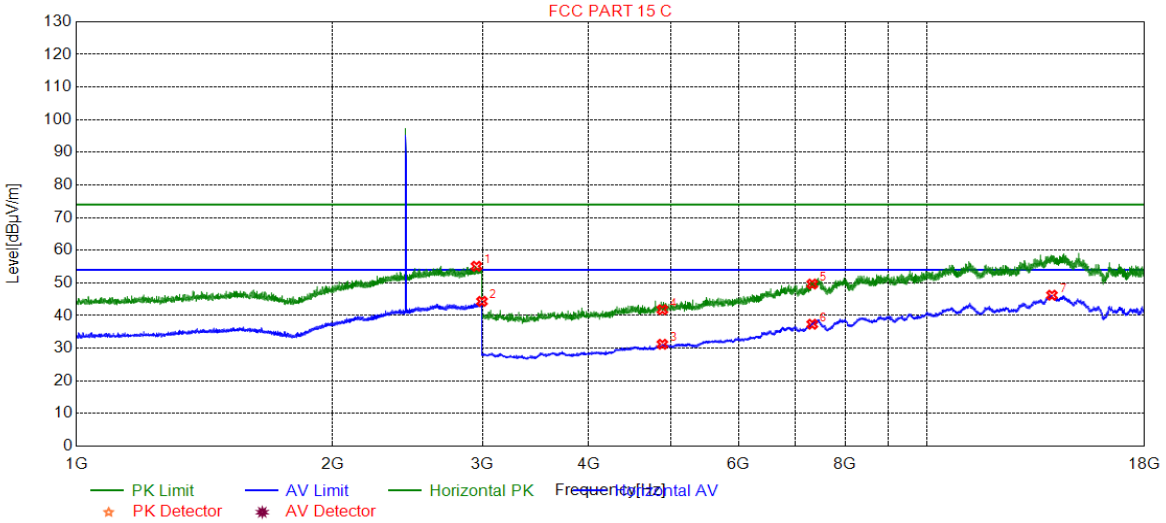
4.11.2.3 GFSK_Channel 39 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2952.48	55.12	9.67	74.00	18.88	116	44	Horizontal
2	2996.49	44.36	9.47	54.00	9.64	181	236	Horizontal
3	4882.00	31.23	-16.95	54.00	22.77	157	177	Horizontal
4	4882.00	41.81	-16.95	74.00	32.19	198	194	Horizontal
5	7323.00	49.68	-8.05	74.00	24.32	191	275	Horizontal
6	7323.00	37.36	-8.05	54.00	16.64	123	14	Horizontal
7	14006.6	46.25	4.38	54.00	7.75	173	128	Horizontal

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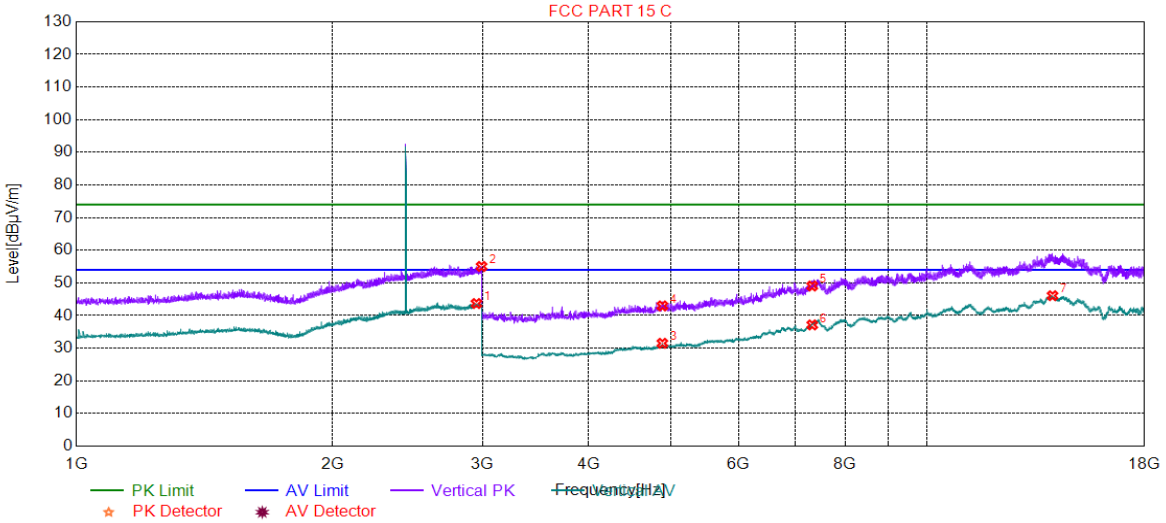
4.11.2.4 GFSK_Channel 39 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2951.98	43.70	9.67	54.00	10.30	165	274	Vertical
2	2993.49	55.05	9.48	74.00	18.95	204	2	Vertical
3	4882.00	31.52	-16.95	54.00	22.48	198	297	Vertical
4	4882.00	42.97	-16.95	74.00	31.03	275	166	Vertical
5	7323.00	49.07	-8.05	74.00	24.93	254	86	Vertical
6	7323.00	37.15	-8.05	54.00	16.85	213	53	Vertical
7	14029.1	46.10	4.31	54.00	7.90	281	281	Vertical

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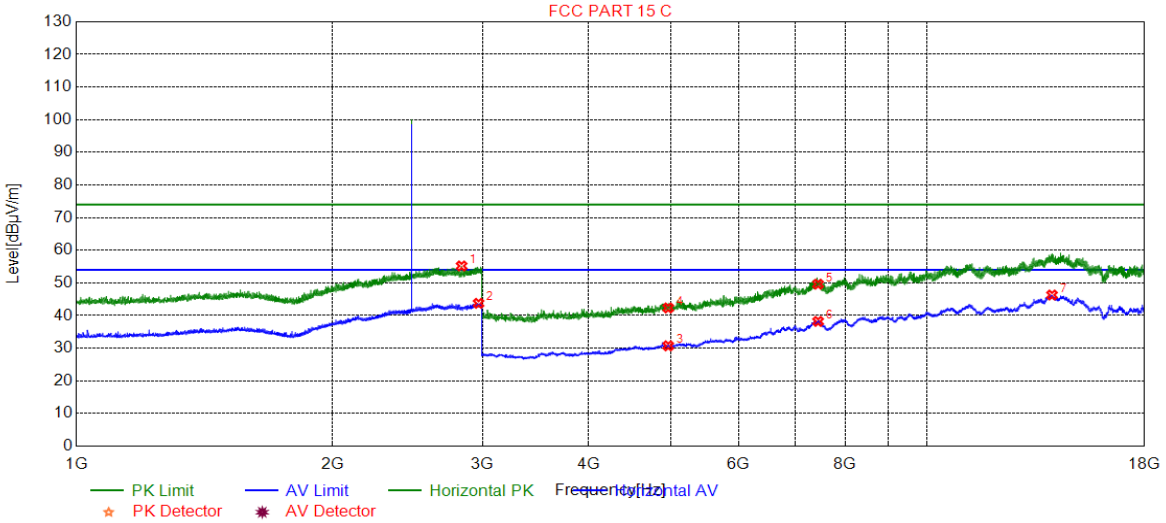
4.11.2.5 GFSK_Channel 78 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2835.95	55.20	9.17	74.00	18.80	218	331	Horizontal
2	2968.99	43.76	9.59	54.00	10.24	154	73	Horizontal
3	4960.00	30.74	-16.68	54.00	23.26	225	192	Horizontal
4	4960.00	42.35	-16.68	74.00	31.65	214	192	Horizontal
5	7440.00	49.62	-7.63	74.00	24.38	244	111	Horizontal
6	7440.00	38.22	-7.63	54.00	15.78	179	273	Horizontal
7	14009.6	46.31	4.37	54.00	7.69	248	111	Horizontal

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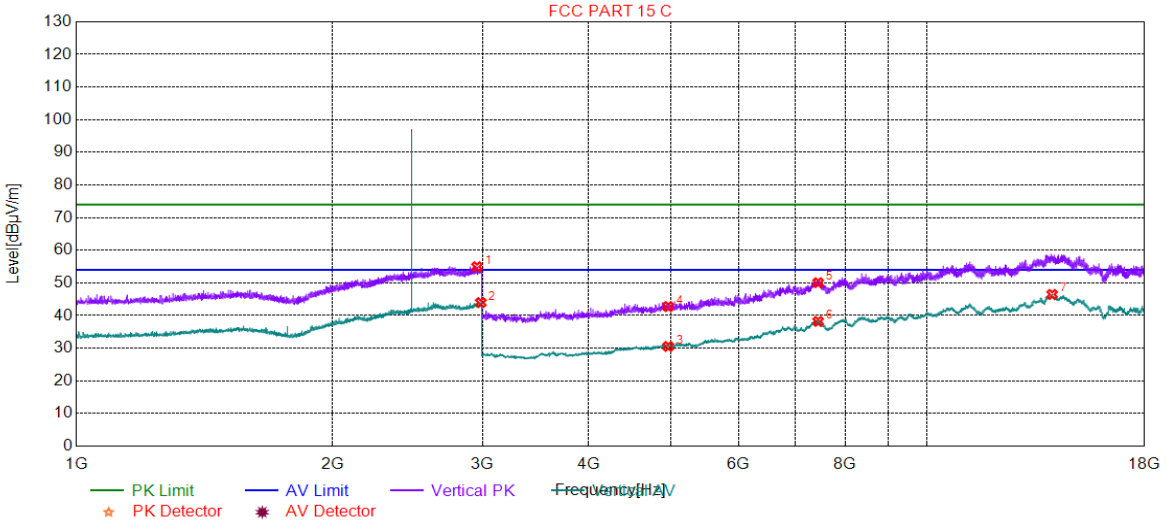
4.11.2.6 GFSK_Channel 78 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2956.48	54.98	9.65	74.00	19.02	169	191	Vertical
2	2987.49	43.98	9.51	54.00	10.02	224	273	Vertical
3	4960.00	30.55	-16.68	54.00	23.45	160	150	Vertical
4	4960.00	42.78	-16.68	74.00	31.22	167	183	Vertical
5	7440.00	50.08	-7.63	74.00	23.92	151	297	Vertical
6	7440.00	38.22	-7.63	54.00	15.78	196	346	Vertical
7	14014.1	46.50	4.36	54.00	7.50	154	19	Vertical

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4.11.2.7 GFSK(DH5) _Highest Channel _Vertical

Remark:
1) 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

2) Scan from 9kHz to 25GHz, the disturbance between 9KHz to 30MHz and 18GHz to 25GHz was very low, and the above harmonics were the highest point could be found when testing, The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) As shown in this section, 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. So, only the peak measurements were shown in the report.
4）All Modes have been tested, but only the worst case data displayed in this report.

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4.12 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2013		
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)		
Limit:	Frequency	Limit (dBuV/m @3m)	Remark
	30MHz-88MHz	40.0	Quasi-peak Value
	88MHz-216MHz	43.5	Quasi-peak Value
	216MHz-960MHz	46.0	Quasi-peak Value
	960MHz-1GHz	54.0	Quasi-peak Value
	Above 1GHz	54.0	Average Value
		74.0	Peak Value
Test Setup:			

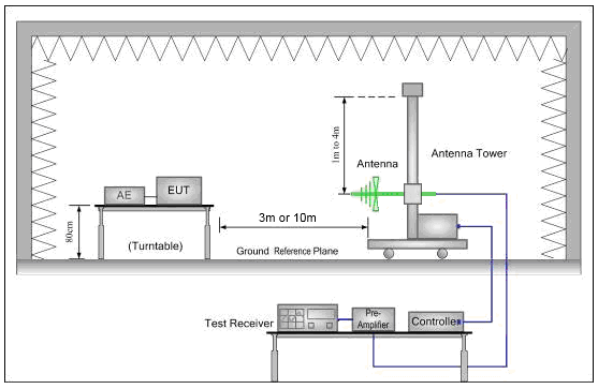

Figure 1. 30MHz to 1GHz

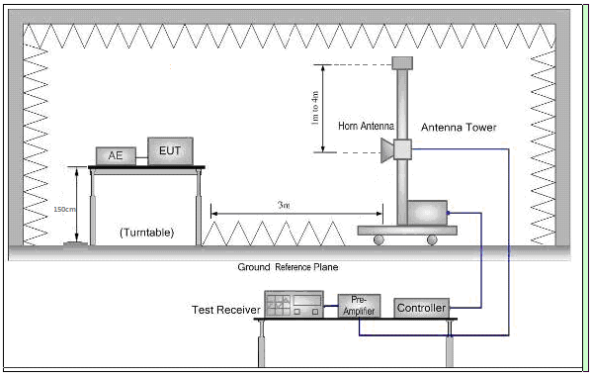

Figure 2. Above 1 GHz

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Test 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 camber. 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 semi-anechoic camber. 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 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. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel h. Test the EUT in the lowest 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.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Pretest the EUT at Charge + Transmitting mode, Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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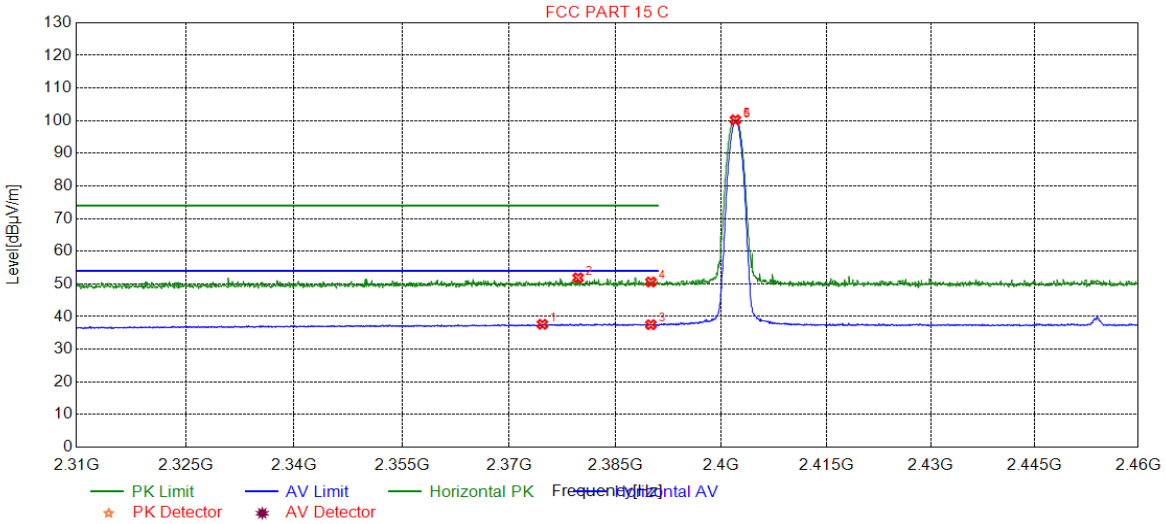
4.12.1 Test plots

4.12.1.1 GFSK_Channel 0 left



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2374.68	37.64	7.79	54.00	16.36	223	52	Horizontal
2	2379.70	51.89	7.78	74.00	22.11	192	308	Horizontal
3	2390.00	37.52	7.77	54.00	16.48	153	226	Horizontal
4	2390.00	50.61	7.77	74.00	23.39	138	106	Horizontal
5	2402.00	100.26	7.77	0.00	-100.26	129	253	Horizontal
6	2402.00	99.95	7.77	0.00	-99.95	160	253	Horizontal

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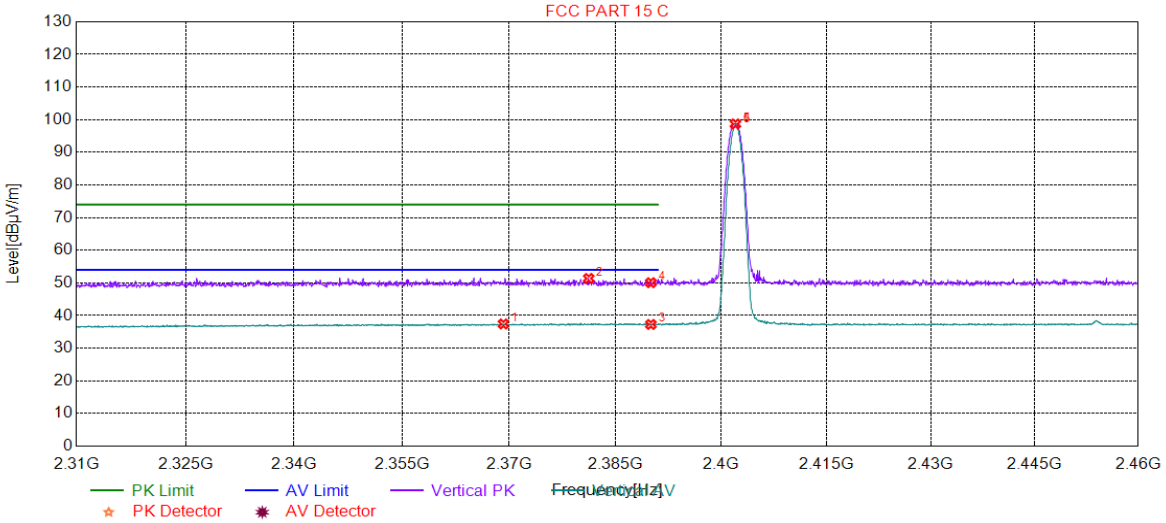
4.12.1.2 GFSK_Channel 0 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2369.20	37.44	7.79	54.00	16.56	179	105	Vertical
2	2381.21	51.39	7.78	74.00	22.61	209	110	Vertical
3	2390.00	37.30	7.77	54.00	16.70	181	330	Vertical
4	2390.00	50.09	7.77	74.00	23.91	294	110	Vertical
5	2402.00	98.71	7.77	0.00	-98.71	250	303	Vertical
6	2402.00	98.41	7.77	0.00	-98.41	205	303	Vertical

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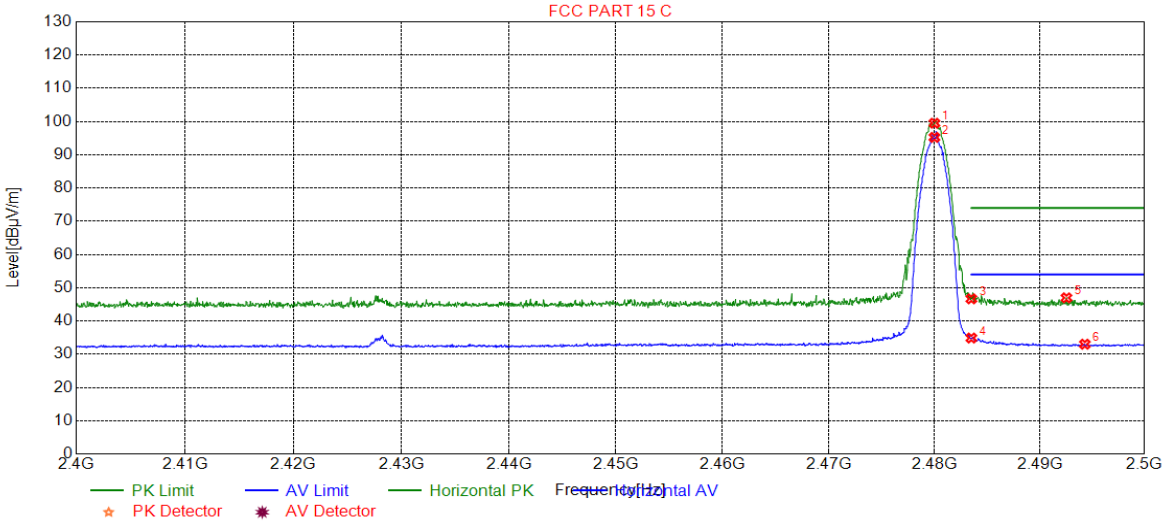
4.12.1.3 GFSK_Channel 78 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	99.50	8.01	0.00	-99.50	134	276	Horizontal
2	2480.00	95.25	8.01	0.00	-95.25	219	259	Horizontal
3	2483.50	46.69	8.01	74.00	27.31	149	298	Horizontal
4	2483.50	34.90	8.01	54.00	19.10	161	276	Horizontal
5	2492.54	46.99	8.02	74.00	27.01	210	36	Horizontal
6	2494.29	33.05	8.02	54.00	20.95	232	276	Horizontal

Final Data List

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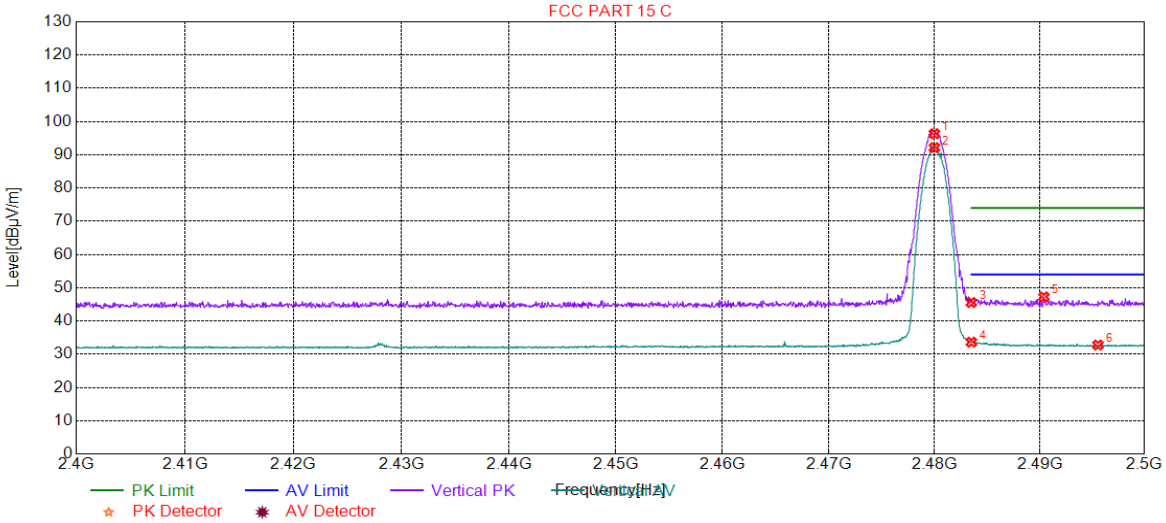
4.12.1.4 GFSK_Channel 78 left



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	96.35	8.01	0.00	-96.35	159	150	Vertical
2	2480.00	92.15	8.01	0.00	-92.15	159	123	Vertical
3	2483.50	45.58	8.01	74.00	28.42	266	118	Vertical
4	2483.50	33.66	8.01	54.00	20.34	269	134	Vertical
5	2490.39	47.27	8.02	74.00	26.73	196	96	Vertical
6	2495.54	32.81	8.02	54.00	21.19	270	161	Vertical

Final Data List

Remark:
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
All Modes have been tested, but only the worst case data displayed in this report.

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5 Measurement Uncertainty (95% confidence levels, k=2)

Lab A:

No.	Item	Measurement Uncertainty
1	Total RF power, conducted	±0.41dB
2	RF power density, conducted	±1.96dB
3	Spurious emissions, conducted	±0.41dB
4	Radio Frequency	$\pm 7.10 \times 10^{-8}$
5	Duty Cycle	±0.49%
6	Occupied Bandwidth	±0.2%

Lab B:

No.	Item	Measurement Uncertainty
1	Conduction Emission	± 3.0dB (150kHz to 30MHz)
2	Radiated Emission	± 4.8dB (Below 1GHz)
		± 4.8dB (1GHz to 6GHz)
		± 4.5dB (6GHz to 18GHz)
		± 5.02dB (Above 18GHz)

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6 Equipment List

RF conducted					
Test Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. Date (yyyy-mm-dd)**	**Cal. Due date (yyyy-mm-dd)**
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2020/4/16	2021/4/15
DC Power Supply	Rohde & Schwarz	HMP2020	W009-08	2020/7/15	2021/7/15
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2020/7/14	2021/7/13
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	HTC-1	W006-17	2020/4/21	2021/4/20

CE Test System					
Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal Date**	**Cal Due Date**
Shielding Room	Brilliant-emc	N/A	XAW03-35-01	2019-09-11	2022-09-10
Test receiver	ROHDE&SCHWARZ	ESR	XAW01-08-01	2020-09-11	2021-09-10
Artificial network	ROHDE&SCHWARZ	ENV216	XAW01-04-01	2020-08-04	2021-08-03
Temperature and humidity meter	MingGao	TH101B	XAW01-01-01	2020-11-06	2021-11-05
Measurement Software	Tonscend	TS+ CE V2.5	XAW02-05-02	NCR	NCR

RSE Test System					
Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal Date**	**Cal Due Date**
Semi-Anechoic Chamber	Brilliant-emc	N/A	XAW03-35-01	2019-09-11	2022-09-10
MXA signal analyzer	Keysight	N9020A	XAW01-06-01	2020-04-02	2021-04-01
Test receiver	ROHDE&SCHWARZ	ESR	XAW01-08-01	2020-09-11	2021-09-10
Receiving antenna (30MHz-3GHz)	Schwarzbeck	VULB 9163	XAW01-09-01	2019-10-13	2021-10-12
Receiving antenna (1GHz~18GHz)	Schwarzbeck	BBHA 9120D	XAW01-09-02	2019-10-13	2021-10-12
Receiving antenna (15GHz~40GHz)	Schwarzbeck	BBHA 9170	XAW01-09-03	2019-10-13	2021-10-12
Directional antenna rack controller	Max-Full	MF-7802BS	XAW03-03-01	NCR	NCR
High-speed antenna rack controller	Max-Full	MF-7802	XAW03-04-01	NCR	NCR
Filter bank	Tonscend	JS0806-F	XAW03-05-01	NCR	NCR
Filter bank	Tonscend	JS0806s	XAW03-05-02	NCR	NCR
Amplifier	Tonscend	TAP00903040	XAW01-41-01	2020-10-26	2021-10-25
Amplifier	Tonscend	TAP01018048	XAW01-41-02	2020-10-26	2021-10-25
Amplifier	Tonscend	TAP18040048	XAW01-41-03	2020-10-27	2021-10-26

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Amplifier	Shanghai Steed	YX28980930	XAW01-41-06	2020-10-26	2021-10-25
Temperature and humidity meter	MingGao	TH101B	XAW01-01-01	2020-11-06	2021-11-05
Measurement Software	Tonscend	TS+ RSE V3.0.0.2	XAW02-05-01	NCR	NCR

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7 Photographs - EUT Constructional Details

Refer to Appendix A - Photographs of Set-Up for ZR/2020/B0027.

The End

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