

## TEST REPORT

Product Name: Swittons IoT Edge-W2  
FCC ID: 2AUJP-SWIT500W-R  
Trademark:   
Model Number: SWIT500W-R, SWIT500W-N, SWIT300W  
Prepared For: OPTIKS SOLUTIONS, INC  
Address: 15 CORPORATE PLACE SOUTH SUITE 105 PISCATAWAY NJ 08854, USA  
Manufacturer: OPTIKS SOLUTIONS, INC  
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Prepared By: Shenzhen CTB Testing Technology Co., Ltd.  
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Sample Received Date: Nov. 26, 2021  
Sample tested Date: Nov. 26, 2021 to Dec. 7, 2021  
Issue Date: Dec. 7, 2021  
Report No.: CTB211207035RF  
Test Standards: FCC Part15.247  
ANSI C63.10:2013  
Test Results: PASS  
Remark: This is FRID radio test report.

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*(Note: N/A means not applicable)*

## 1. VERSION

Report No.	Issue Date	Description	Approved
CTB211207035RF	Dec. 7, 2021	Original	Valid

## 2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15 Subpart C Section 15.205/15.209/15.247(d)	ANSI C63.10-2013	PASS
Band edge and RF Conducted Spurious Emissions	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(2)	ANSI C63.10-2013	PASS
20dB Occupied Bandwidth	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Carrier Frequencies Separation	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Hopping Channel Number	47 CFR Part 15 Subpart C Section 15.247 (b)	ANSI C63.10-2013	PASS
Dwell Time	47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	ANSI C63.10-2013	PASS

Remark:

Test according to ANSI C63.4-2014 & ANSI C63.10-2013.



### 3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ .

Item	Uncertainty
Occupancy bandwidth	$U=\pm 54.3\text{Hz}$
Conducted output power Above 1G	$U=\pm 1.0\text{dB}$
Conducted output power below 1G	$U=\pm 0.9\text{dB}$
Power Spectral Density , Conduction	$U=\pm 1.0\text{dB}$
Conduction spurious emissions	$U=\pm 2.8\text{dB}$
Out of band emission	$U=\pm 54\text{Hz}$
3m chamber Radiated spurious emission(9KHz-30MHz)	$U=\pm 4.8\text{dB}$
3m chamber Radiated spurious emission(30MHz-1GHz)	$U=\pm 4.3\text{dB}$
3m chamber Radiated spurious emission(1GHz-18GHz)	$U=\pm 4.5\text{dB}$
humidity uncertainty	$U=\pm 5.3\%$
Temperature uncertainty	$U=\pm 0.59^{\circ}\text{C}$
Supply voltages	$U=\pm 3\%$
Time	$U=\pm 5\%$

## 4. PRODUCT INFORMATION AND TEST SETUP

### 4.1 Product Information

Model(s):	SWIT500W-R, SWIT500W-N, SWIT300W
Model Description:	All the model are the same circuit and RF module, only for model name. Test sample model: SWIT500W-R
Hardware Version:	V2.0
Software Version:	V1.0.8
Operation Frequency:	902-928MHz
Max. RF output power:	21.639dBm
Type of Modulation:	GFSK
Antenna installation:	PCB antenna
Antenna Gain:	1dBi
Ratings:	DC 5V charging from adapter Input:100-240Vac, 50/60Hz 0.5A Output:5.0V $\overline{\text{---}}$ 1A Battery DC 3.7V, 2000mAh

### 4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

### 4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1	POWER ADAPTER	OPTIKS SOLUTIONS, INC	M4-050100A1-ETL	N/A	AE
2	battery	AYRST	505060	N/A	N/A

#### Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

#### 4.4 Channel List

Channel List							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.75	14	909.25	27	915.75	40	922.25
2	903.25	15	909.75	28	916.25	41	922.75
3	903.75	16	910.25	29	916.75	42	923.25
4	904.25	17	910.75	30	917.25	43	923.75
5	904.75	18	911.25	31	917.75	44	924.25
6	905.25	19	911.75	32	918.25	45	924.75
7	905.75	20	912.25	33	918.75	46	925.25
8	906.25	21	912.75	34	919.25	47	925.75
9	906.75	22	913.25	35	919.75	48	926.25
10	907.25	23	913.75	36	920.25	49	926.75
11	907.75	24	914.25	37	920.75	50	927.25
12	908.25	25	914.75	38	921.25		
13	908.75	26	915.25	39	921.75		

#### 4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting (GFSK)	902.75MHz	914.75MHz	927.25MHz
Receiving (GFSK)	902.75MHz	914.75MHz	927.25MHz

#### 4.6 Test Environment

Humidity(%):	55
Atmospheric Pressure(kPa):	101.1
Normal Voltage(DC):	3.7
Normal Temperature(°C)	25
Low Temperature(°C)	0
High Temperature(°C)	40



## 5. TEST FACILITY AND TEST INSTRUMENT USED

### 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at Floor 1&2, Building A, No. 26 of Xinhe Road, Xinqiao Street, Baoan District, Shenzhen China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

### 5.2 Test Instrument Used

No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	2021.09.27	2022.08.05
2	Power Sensor	Agilent	U2021XA	MY56120032	2021.09.27	2022.08.05
3	Power Sensor	Agilent	U2021XA	MY56120034	2021.09.27	2022.08.05
4	Communication test set	R&S	CMW500	108058	2021.09.27	2022.08.05
5	Spectrum Analyzer	R&S	FSP40	100550	2021.09.27	2022.08.05
6	Signal Generator	Agilent	N5181A	MY49060920	2021.09.27	2022.08.16
7	Signal Generator	Agilent	N5182A	MY47420195	2021.09.27	2022.08.05
8	Communication test set	Agilent	E5515C	MY50102567	2021.09.27	2022.08.16
9	band rejection filter	Shenxiang	MSF2400-2483.5MS-1154	20181015001	2021.09.27	2022.08.05
10	band rejection filter	Shenxiang	MSF5150-5850 MS-1155	20181015001	2021.09.27	2022.08.05
11	band rejection filter	Xingbo	XBLBQ-DZA120	190821-1-1	2021.09.27	2022.08.05
12	BT&WI-FI Automatic test software	Microwave	MTS8310	Ver. 2.0.0.0	2021.09.27	2022.08.05
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	2021.09.27	2022.08.05
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	2021.09.27	2022.08.05
15	234G Automatic test software	Microwave	MTS8200	Ver. 2.0.0.0	2021.09.27	2022.08.05
16	966 chamber	C.R.T.	966 Room	966	2021.09.27	2024.08.11
17	Receiver	R&S	ESPI	100362	2021.09.27	2022.08.05
18	Amplifier	HP	8447E	2945A02747	2021.09.27	2022.08.05
19	Amplifier	Agilent	8449B	3008A01838	2021.09.27	2022.08.05
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	869	2021.09.27	2022.08.07

21	Horn Antenna	Schwarzbeck	BBHA9120D	1911	2021.09.27	2022.08.08
22	Software	Fala	EZ-EMC	FA-03A2 RE	2021.09.27	2022.08.05
23	3-Loop Antenna	Daze	ZN30401	17014	2021.09.27	2022.08.05
24	loop antenna	ZHINAN	ZN30900A	/	2021.09.27	2022.08.05
25	Horn antenna	A/H/System	SAS-574	588	2021.09.27	2022.08.05
26	Amplifier	AEROFLEX	/	S/N/ 097	2021.09.27	2022.08.05



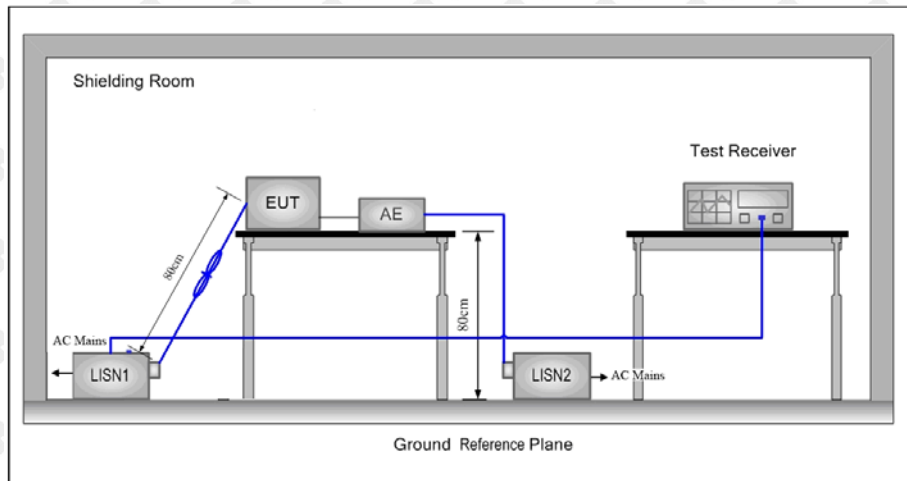
Conducted emissions						
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until	Calibrated until
1	AMN	ROHDE&SCHWARZ	ESH3-Z5	831551852	2021.09.27	2022.08.05
2	Pulse limiter	ROHDE&SCHWARZ	ESH3Z2	357881052	2021.09.27	2022.08.05
3	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCS30	834115/006	2021.09.27	2022.08.05
4	Coaxial cable	ZDECL	Z302S	18091904	2021.09.27	2022.08.05
5	AAN	Schwarzbeck	NTFM8158	183	2021.09.27	2022.08.05
6	Communication test set	Agilent	E5515C	MY50102567	2021.09.27	2022.08.16
7	Communication test set	R&S	CMW500	108058	2021.09.27	2022.08.05
8	EZ-EMC	Frad	EMC-con3A1.1	/	/	/

Radiated emission						
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until	Calibrated until
1	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120D	1911	2021.11.01	2022.08.08
2	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	869	2021.11.01	2021.11.01
3	Amplifier	Agilent	8449B	3008A01838	2021.09.27	2022.08.05
4	Amplifier	HP	8447E	2945A02747	2021.09.27	2022.08.05
5	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESPI7	100362	2021.09.27	2022.08.05
6	Coaxial cable	ETS	RFC-SNS-100-NMS-80 NI	/	2021.09.27	2022.08.05
7	Coaxial cable	ETS	RFC-SNS-100-NMS-20 NI	/	2021.09.27	2022.08.05
8	Coaxial cable	ETS	RFC-SNS-100-SMS-20 NI	/	2021.09.27	2022.08.05
9	Coaxial cable	ETS	RFC-NNS-100-NMS-30 0 NI	/	2021.09.27	2022.08.05
10	Communication test set	Agilent	E5515C	MY50102567	2021.09.27	2022.08.16
11	Communication test set	R&S	CMW500	108058	2021.09.27	2022.08.05
12	EZ-EMC	Frad	EMC-con3A1.1	/	/	/



## 6. AC POWER LINE CONDUCTED EMISSION

### 6.1 Block Diagram Of Test Setup



### 6.2 Limit

**Table 4 – AC power-line conducted emissions limits**

Frequency (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 <sup>Note 1</sup>	56 to 46 <sup>Note 1</sup>
0.5 - 5	56	46
5 - 30	60	50

**Note 1:** The level decreases linearly with the logarithm of the frequency.

\* Decreasing linearly with the logarithm of the frequency

### 6.3 Test procedure

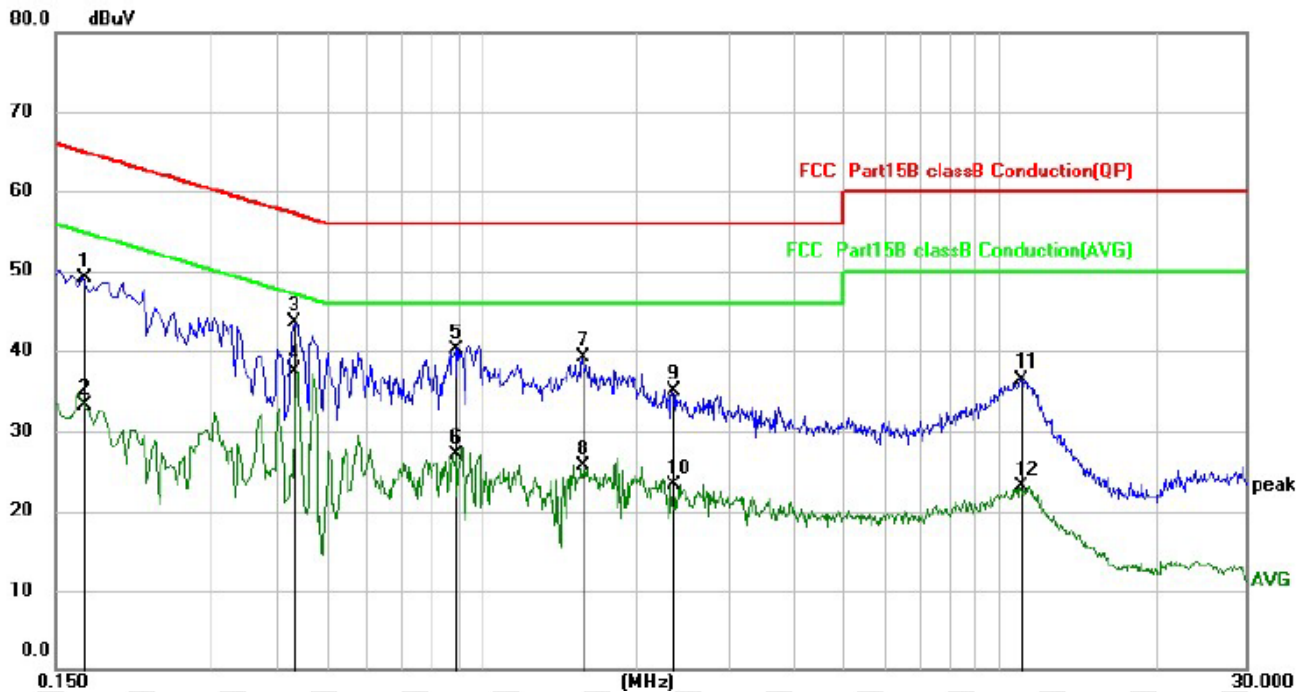
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50 $\Omega$ /50 $\mu$ H + 5 $\Omega$  linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0,4 m from the vertical ground reference plane. The vertical ground reference

plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0,8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0,8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

## 6.4 Test Result

L:



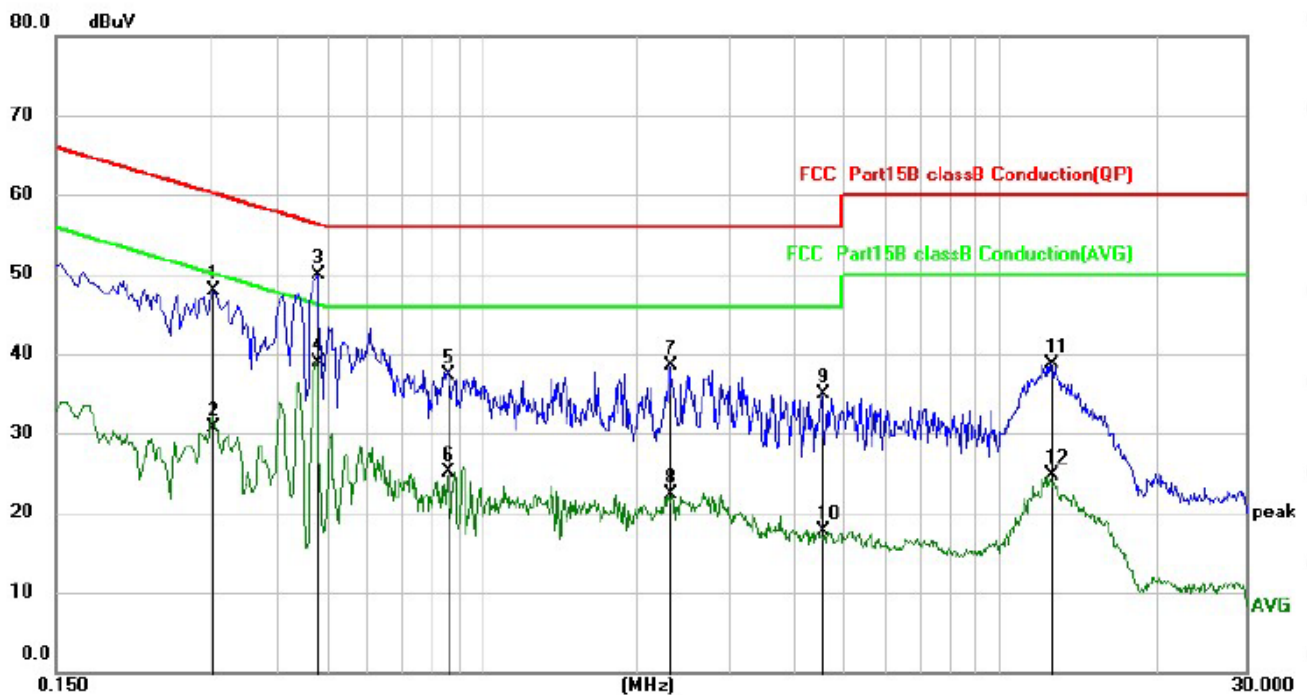
No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector
1		0.1700	38.34	10.71	49.05	64.96	-15.91	QP
2		0.1700	22.55	10.71	33.26	54.96	-21.70	AVG
3		0.4339	32.89	10.56	43.45	57.18	-13.73	QP
4	*	0.4339	27.03	10.56	37.59	47.18	-9.59	AVG
5		0.8900	29.56	10.60	40.16	56.00	-15.84	QP
6		0.8900	16.56	10.60	27.16	46.00	-18.84	AVG
7		1.5660	28.56	10.62	39.18	56.00	-16.82	QP
8		1.5660	15.14	10.62	25.76	46.00	-20.24	AVG
9		2.3340	24.45	10.63	35.08	56.00	-20.92	QP
10		2.3340	12.70	10.63	23.33	46.00	-22.67	AVG
11		10.9977	25.67	10.84	36.51	60.00	-23.49	QP
12		10.9977	12.23	10.84	23.07	50.00	-26.93	AVG

### Remark:

- Factor = Cable loss + LISN factor, Margin = Limit – Level
- All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- All the test modes completed for test. Only the worst result of GFSK Low Channel was reported.



N:



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector
1		0.3019	37.36	10.63	47.99	60.19	-12.20	QP
2		0.3019	20.09	10.63	30.72	50.19	-19.47	AVG
3	*	0.4818	39.28	10.53	49.81	56.31	-6.50	QP
4		0.4818	28.30	10.53	38.83	46.31	-7.48	AVG
5		0.8618	26.64	10.59	37.23	56.00	-18.77	QP
6		0.8618	14.50	10.59	25.09	46.00	-20.91	AVG
7		2.2980	27.81	10.63	38.44	56.00	-17.56	QP
8		2.2980	11.70	10.63	22.33	46.00	-23.67	AVG
9		4.5419	24.22	10.65	34.87	56.00	-21.13	QP
10		4.5419	7.01	10.65	17.66	46.00	-28.34	AVG
11		12.5176	27.94	10.86	38.80	60.00	-21.20	QP
12		12.5176	13.76	10.86	24.62	50.00	-25.38	AVG

## Remark:

- Factor = Cable loss + LISN factor, Margin = Limit – Level
- All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- All the test modes completed for test. Only the worst result of GFSK Low Channel was reported.

## 7. RADIATED SPURIOUS EMISSION

### 7.1 Block Diagram Of Test Setup

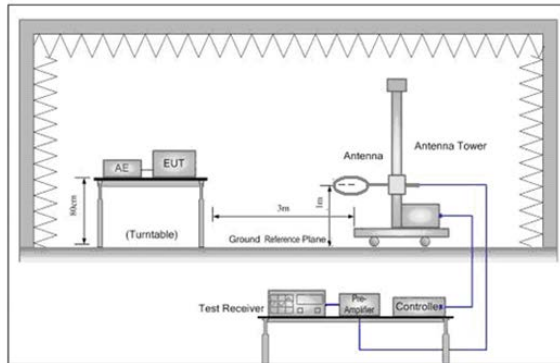


Figure 1. Below 30MHz

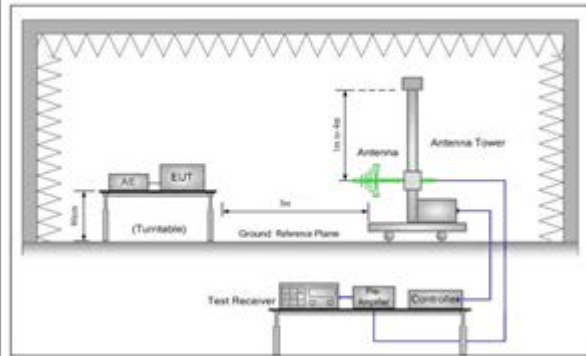


Figure 2. 30MHz to 1GHz

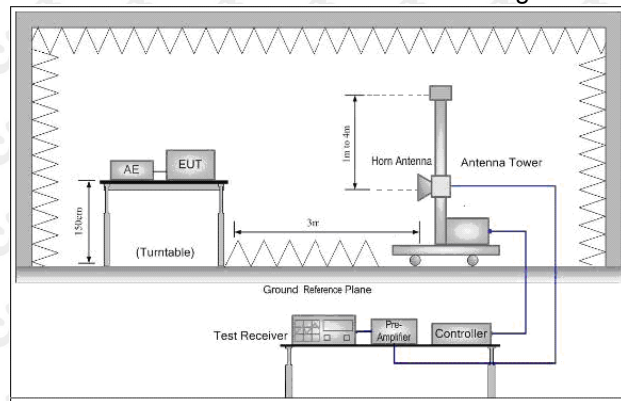


Figure 3. Above 1GHz

### 7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dB $\mu$ V/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

Note: a.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.

b. The lower limit shall apply at the transition frequencies.

c. Emission level(dBuV/m)=20log Emission level(uV/m)



### 7.3 Test procedure

#### Below 1GHz test procedure as below:

- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- 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.
- 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 rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 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.

#### Above 1GHz test procedure as below:

- Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter( Above 18GHz the distance is 1 meter and table is 1.5 meter).
- Test the EUT in the lowest channel ,the middle channel ,the Highest channel
- Repeat above procedures until all frequencies measured was complete.

Receiver set:

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

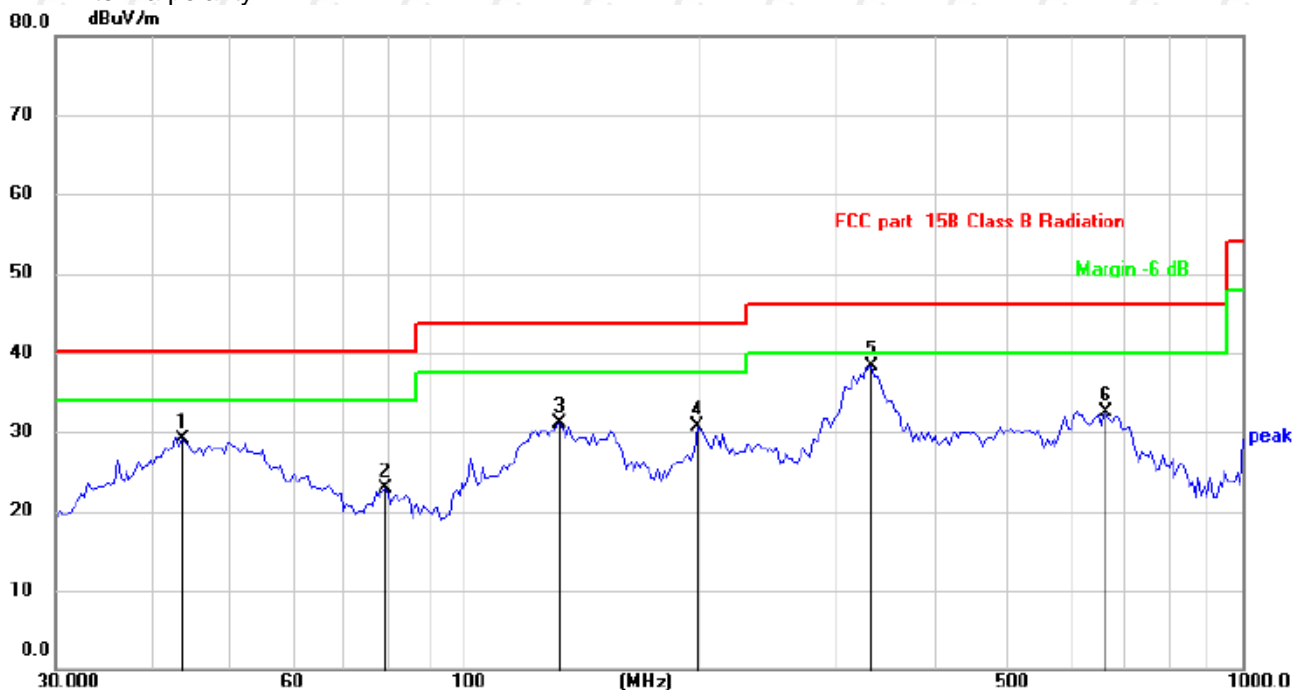
- After pre-scanning three directions, the report recorded the worst case



## 7.4 Test Result

Low channel below 1GHz Test Results:

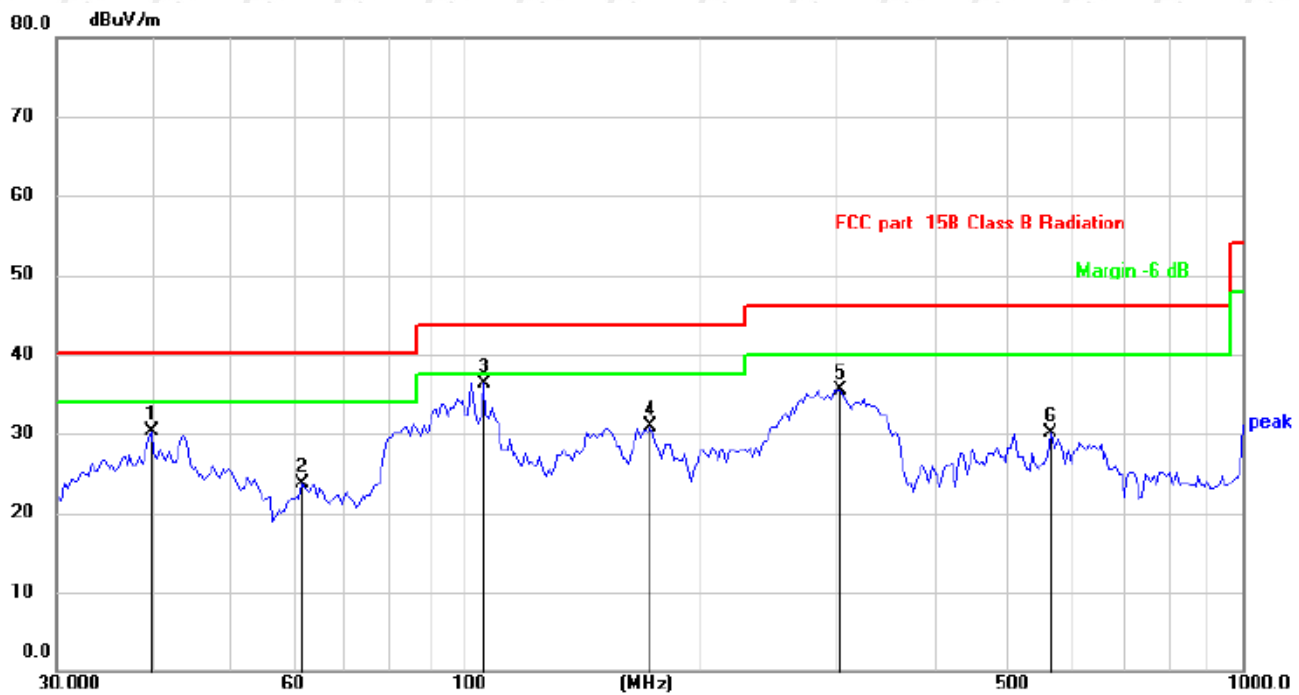
Antenna polarity: H



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector
1		43.7351	34.56	-5.41	29.15	40.00	-10.85	QP
2		79.3816	32.62	-9.65	22.97	40.00	-17.03	QP
3		133.1510	37.02	-5.93	31.09	43.50	-12.41	QP
4		199.2855	38.90	-8.27	30.63	43.50	-12.87	QP
5	*	334.2721	42.37	-4.01	38.36	46.00	-7.64	QP
6		668.1422	29.01	3.52	32.53	46.00	-13.47	QP

Remark: Transd = Cableloss + Antenna factor - Pre-amplifier; Margin = Limit - Level.

Antenna polarity: V



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector
1		39.7146	35.58	-5.34	30.24	40.00	-9.76	QP
2		62.1037	30.16	-6.54	23.62	40.00	-16.38	QP
3	*	106.0126	44.62	-8.25	36.37	43.50	-7.13	QP
4		173.2050	37.60	-6.68	30.92	43.50	-12.58	QP
5		303.5437	40.62	-5.09	35.53	46.00	-10.47	QP
6		565.6295	28.23	1.93	30.16	46.00	-15.84	QP

Remark: Transd = Cable loss + Antenna factor - Pre-amplifier; Margin = Limit - Level  
 1. The margin of 9K-30MHz measurement exceeds 20dB, so the test chart is not included.

Above 1 GHz Test Results:  
CH Low

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1805.5	108.89	-5.84	53.26	74	-20.74	peak
1805.5	95.69	-5.84	46.63	54	-7.37	AVG
2708.25	56.60	-3.64	52.96	74	-21.04	peak
2708.25	47.62	-3.64	43.98	54	-10.02	AVG
3611	58.88	-0.95	57.93	74	-16.07	peak
3611	48.16	-0.95	47.21	54	-6.79	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1805.5	108.43	-5.84	52.69	74	-21.31	peak
1805.5	95.60	-5.84	43.65	54	-10.35	AVG
2708.25	56.37	-3.64	52.73	74	-21.27	peak
2708.25	47.11	-3.64	43.47	54	-10.53	AVG
3611	58.22	-0.95	57.27	74	-16.73	peak
3611	48.09	-0.95	47.14	54	-6.86	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.



## CH Middle

## Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1829.5	108.35	-5.71	52.67	74	-21.33	peak
1829.5	95.05	-5.71	45.61	54	-8.39	AVG
2744.25	56.07	-3.51	52.56	74	-21.44	peak
2744.25	46.74	-3.51	43.23	54	-10.77	AVG
3659	58.02	-0.82	57.20	74	-16.80	peak
3659	47.98	-0.82	47.16	54	-6.84	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

## Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1829.5	108.19	-5.71	52.69	74	-21.31	peak
1829.5	93.09	-5.71	42.68	54	-11.32	AVG
2744.25	55.99	-3.51	52.48	74	-21.52	peak
2744.25	46.86	-3.51	43.35	54	-10.65	AVG
3659	57.95	-0.82	57.13	74	-16.87	peak
3659	47.85	-0.82	47.03	54	-6.97	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH High  
Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1854.5	56.32	-5.65	52.36	74	-21.64	peak
1854.5	47.24	-5.65	46.89	54	-7.11	AVG
2781.75	56.13	-3.43	52.70	74	-21.30	peak
2781.75	47.44	-3.43	44.01	54	-9.99	AVG
3709	57.23	-0.75	56.48	74	-17.52	peak
3709	47.57	-0.75	46.82	54	-7.18	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

## Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1854.5	56.70	-5.65	53.66	74	-20.34	peak
1854.5	47.85	-5.65	45.62	54	-8.38	AVG
2781.75	55.94	-3.43	52.51	74	-21.49	peak
2781.75	47.54	-3.43	44.11	54	-9.89	AVG
3709	56.85	-0.75	56.10	74	-17.90	peak
3709	47.49	-0.75	46.74	54	-7.26	AVG

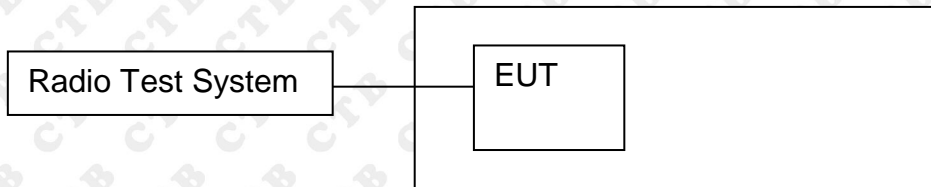
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

## Remark:

- (1) Measuring frequencies from 1 GHz to the 25 GHz °
- (2) All modes of operation were investigated and the worst-case emissions are reported.
- (3) Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

## 8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

### 8.1 Block Diagram Of Test Setup



### 8.2 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)).

### 8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

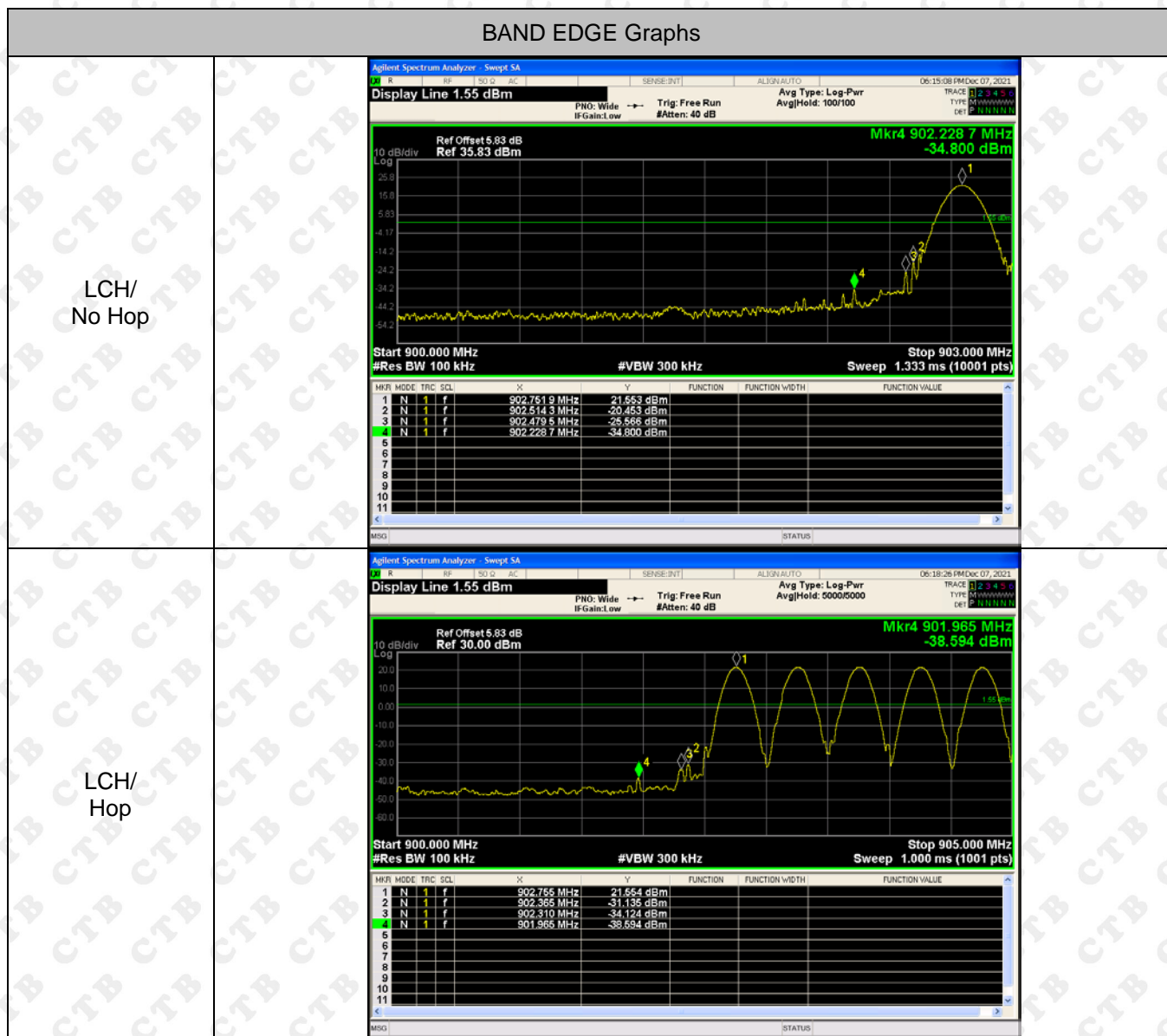
Above 30MHz:

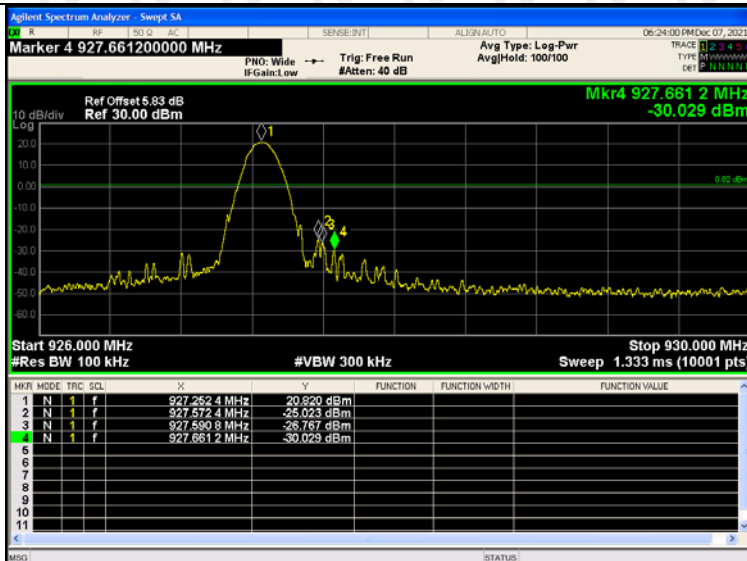
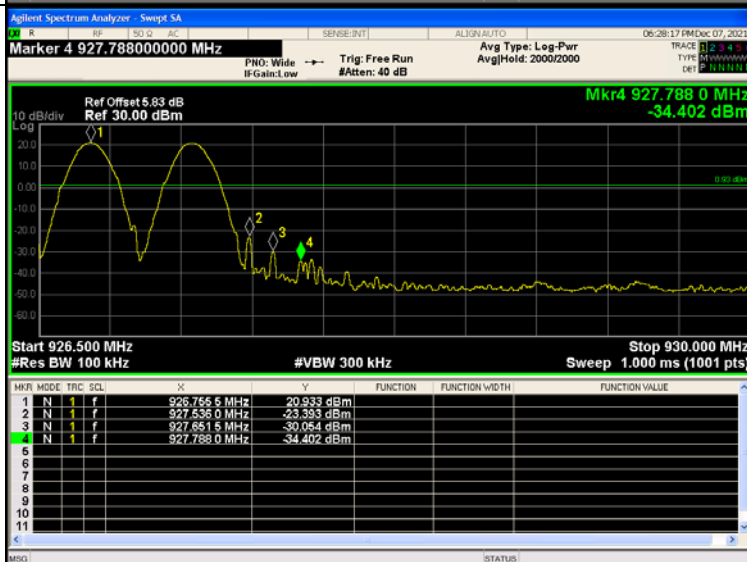
RBW = 100KHz, VBW = 300KHz, Sweep = auto

Detector function = peak, Trace = max hold



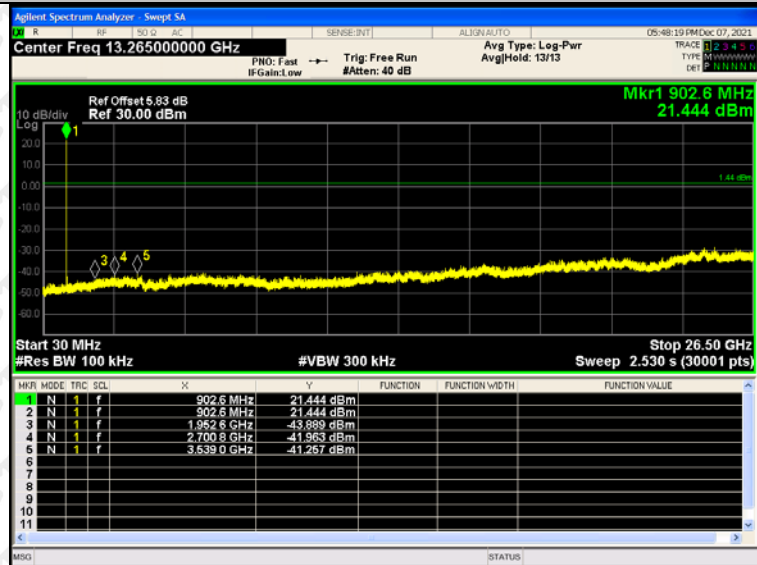
## 8.4 Test Result



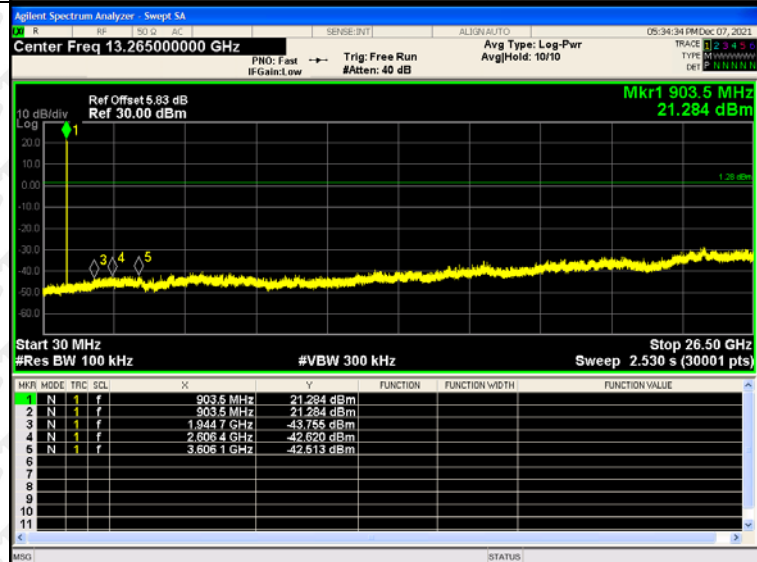
HCH/  
No Hop

HCH/  
Hop


## RF Conducted Spurious Emissions Graphs

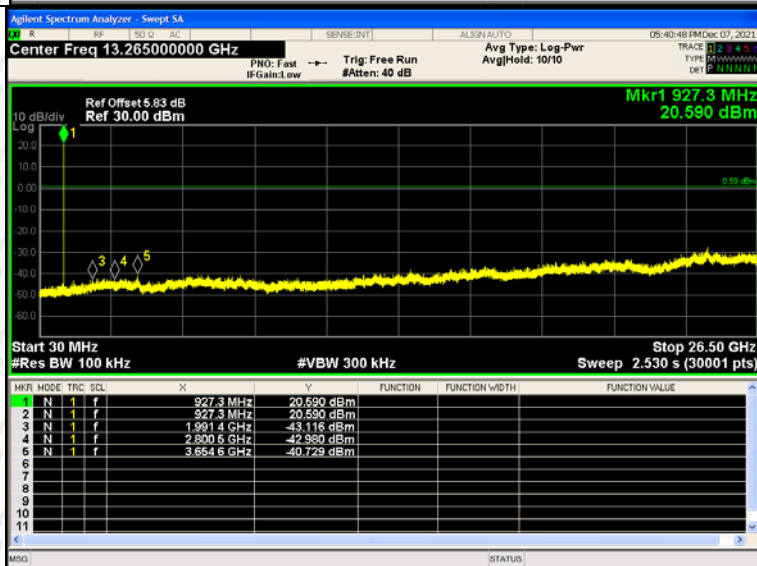
LCH



MCH



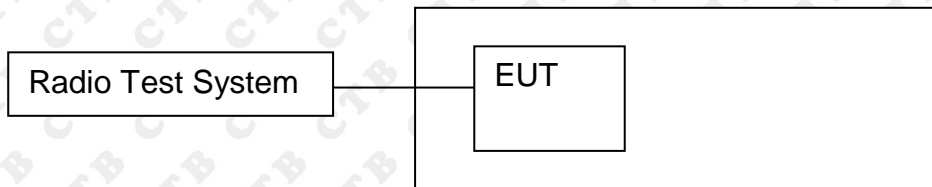
HCH





## 9. COUDUCTED PEAK OUTPUT POWER

### 9.1 Block Diagram Of Test Setup



### 9.2 Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

- (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
- (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
- (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
- (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Peak output Power:  $<1W=30\text{dBm}$

### 9.3 Test procedure

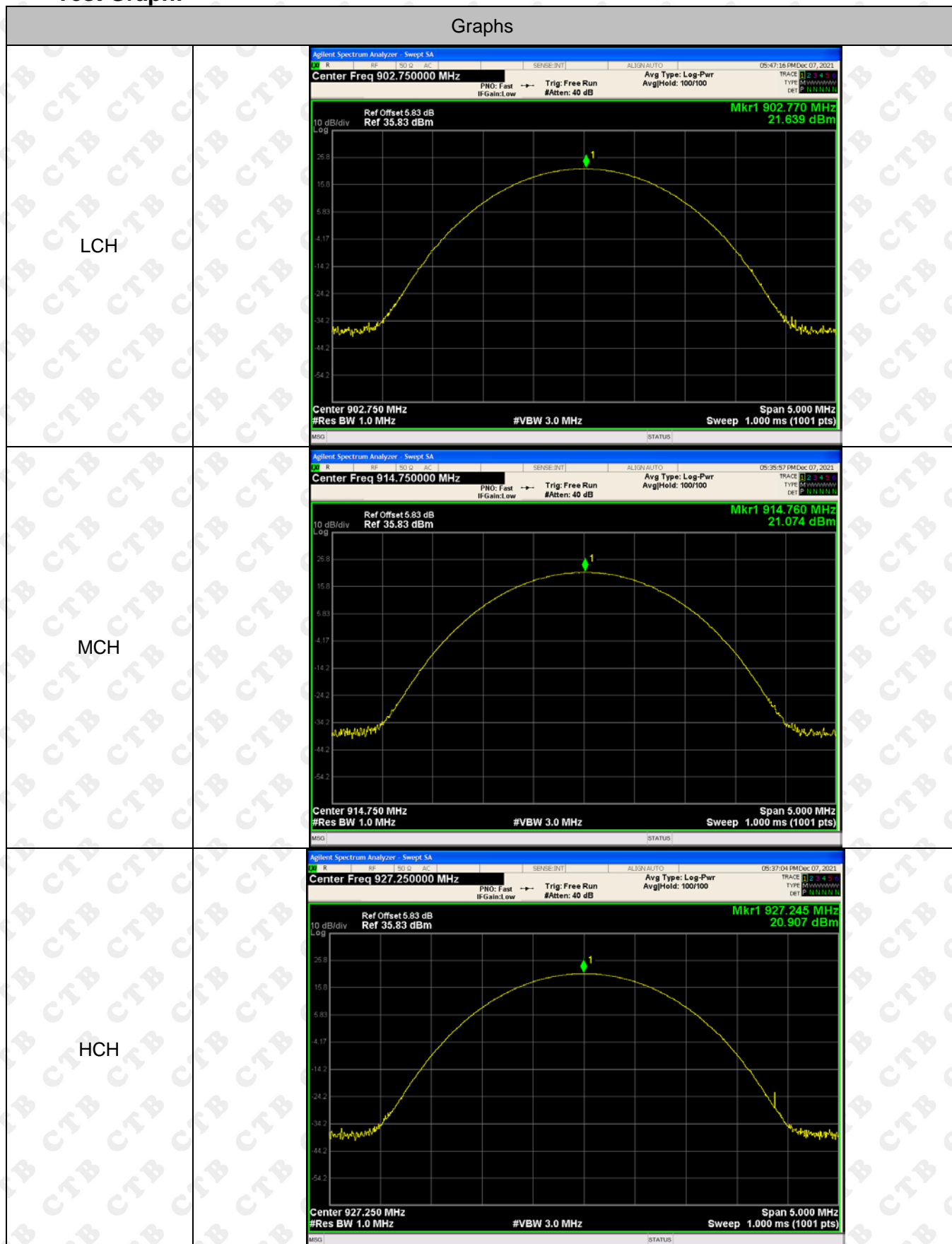
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 1MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

## 9.4 Test Result

Antenna Gain: 1.0dBi

Channel.	Maximum Peak Output Power [dBm]	Limit [dBm]	Verdict
LCH	21.639	30	PASS
MCH	21.074	30	PASS
HCH	20.907	30	PASS

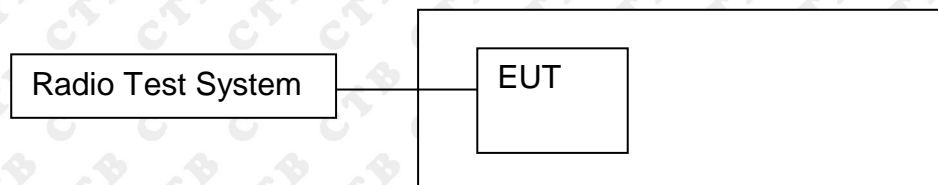
# Test Graph:





## 10. 20DB OCCUPIED BANDWIDTH

### 10.1 Block Diagram Of Test Setup



### 10.2 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

### 10.3 Test procedure

1. Rem1. Set RBW = 5 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times \text{RBW}$ .
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 10.4 Test Result

Frequency	20dB Bandwidth (kHz)	Result
Low channel	101	<b>PASS</b>
Mid channel	103	<b>PASS</b>
High channel	99	<b>PASS</b>

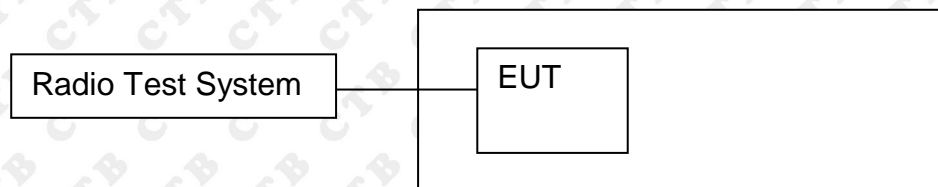
Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

# Test Graph:

Low channel	 <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 902.750000 MHz</p> <p>Center Freq: 902.750000 MHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 100/100</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset 5.83 dB</p> <p>Ref 25.83 dBm</p> <p>Mkr3 902.801 MHz</p> <p>0.91991 dBm</p> <p>Center 902.8 MHz</p> <p>#Res BW 10 kHz</p> <p>#VBW 30 kHz</p> <p>Span 500 kHz</p> <p>Sweep 4.8 ms</p> <p>Occupied Bandwidth 96.696 kHz</p> <p>Total Power 23.3 dBm</p> <p>Transmit Freq Error 385 Hz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 100.8 kHz</p> <p>x dB -20.00 dB</p>
Mid channel	 <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 914.750000 MHz</p> <p>Center Freq: 914.750000 MHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 100/100</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset 5.83 dB</p> <p>Ref 25.83 dBm</p> <p>Mkr3 914.803 MHz</p> <p>0.84796 dBm</p> <p>Center 914.8 MHz</p> <p>#Res BW 10 kHz</p> <p>#VBW 30 kHz</p> <p>Span 500 kHz</p> <p>Sweep 4.8 ms</p> <p>Occupied Bandwidth 99.989 kHz</p> <p>Total Power 23.0 dBm</p> <p>Transmit Freq Error 1.200 kHz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 103.2 kHz</p> <p>x dB -20.00 dB</p>
High channel	 <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 927.250000 MHz</p> <p>Center Freq: 927.250000 MHz</p> <p>Trig: Free Run</p> <p>Avg/Hold: 100/100</p> <p>Radio Std: None</p> <p>Radio Device: BTS</p> <p>Ref Offset 5.83 dB</p> <p>Ref 25.83 dBm</p> <p>Mkr3 927.3 MHz</p> <p>1.8270 dBm</p> <p>Center 927.3 MHz</p> <p>#Res BW 10 kHz</p> <p>#VBW 30 kHz</p> <p>Span 500 kHz</p> <p>Sweep 4.8 ms</p> <p>Occupied Bandwidth 97.739 kHz</p> <p>Total Power 22.6 dBm</p> <p>Transmit Freq Error 510 Hz</p> <p>OBW Power 99.00 %</p> <p>x dB Bandwidth 99.03 kHz</p> <p>x dB -20.00 dB</p>

## 11. CARRIER FREQUENCIES SEPARATION

### 11.1 Block Diagram Of Test Setup



### 11.2 Limit

At least 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

### 11.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz , Span = 2.0MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

### 11.4 Test Result

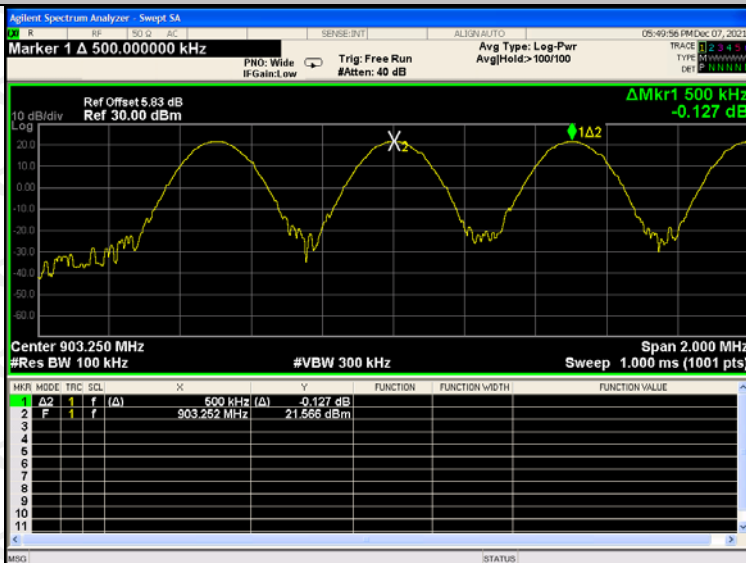
Channel.	Carrier Frequency Separation [MHz]	Verdict
LCH	0.500	PASS
MCH	0.500	PASS
HCH	0.502	PASS



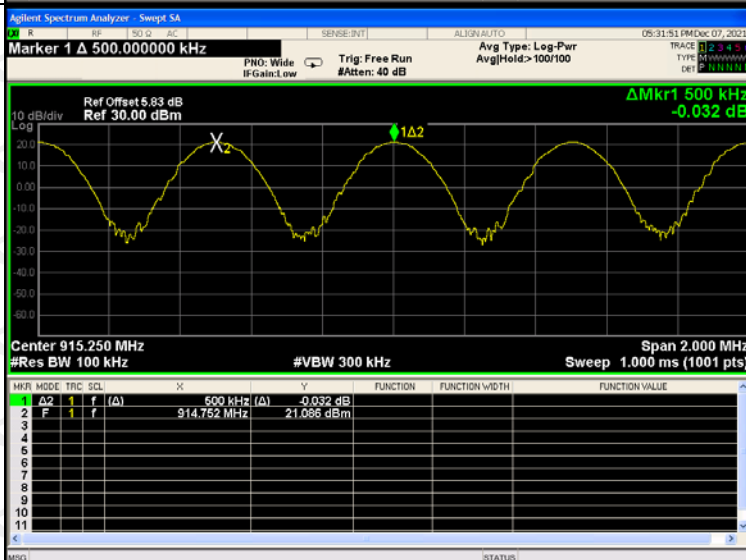
# Test Graph

## Graphs

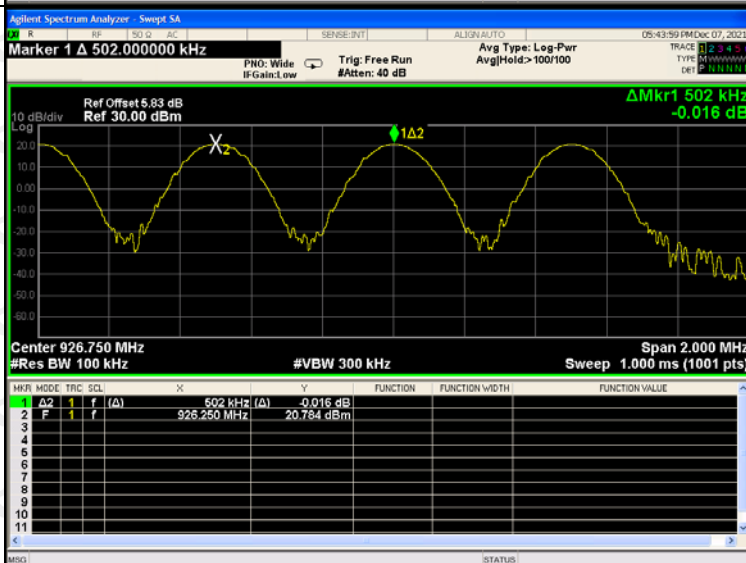
LCH



MCH

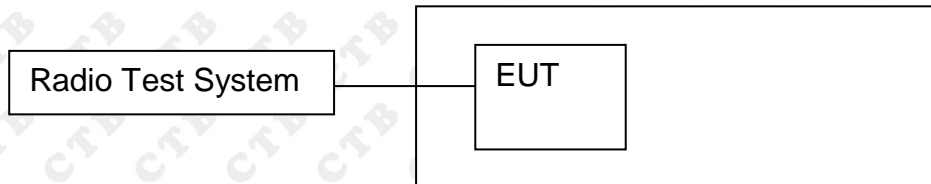


HCH



## 12. HOPPING CHANNEL NUMBER

### 12.1 Block Diagram Of Test Setup



### 12.2 Limit

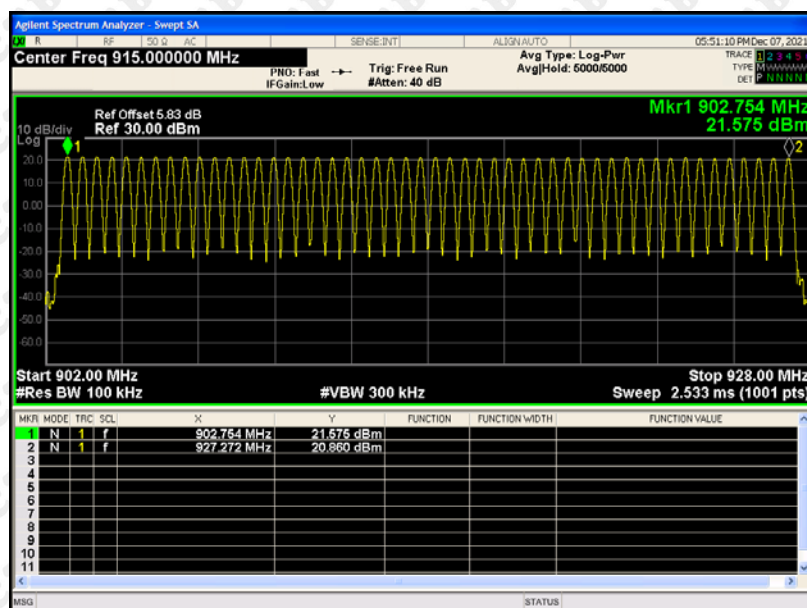
Frequency hopping systems in the 920-928 MHz band shall use at least 50 channels.

### 12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

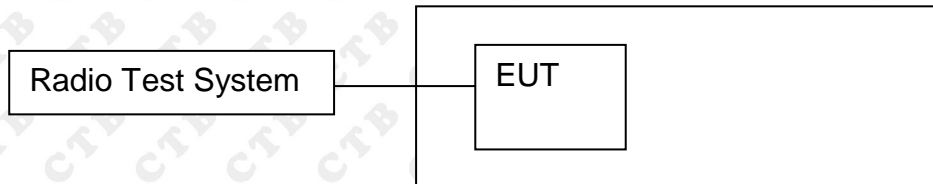
### 12.4 Test Result

Mode	Channel.	Number of Hopping Channel	Verdict
GFSK	Hop	50	PASS



## 13. DWELL TIME

### 13.1 Block Diagram Of Test Setup



### 13.2 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

### 13.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

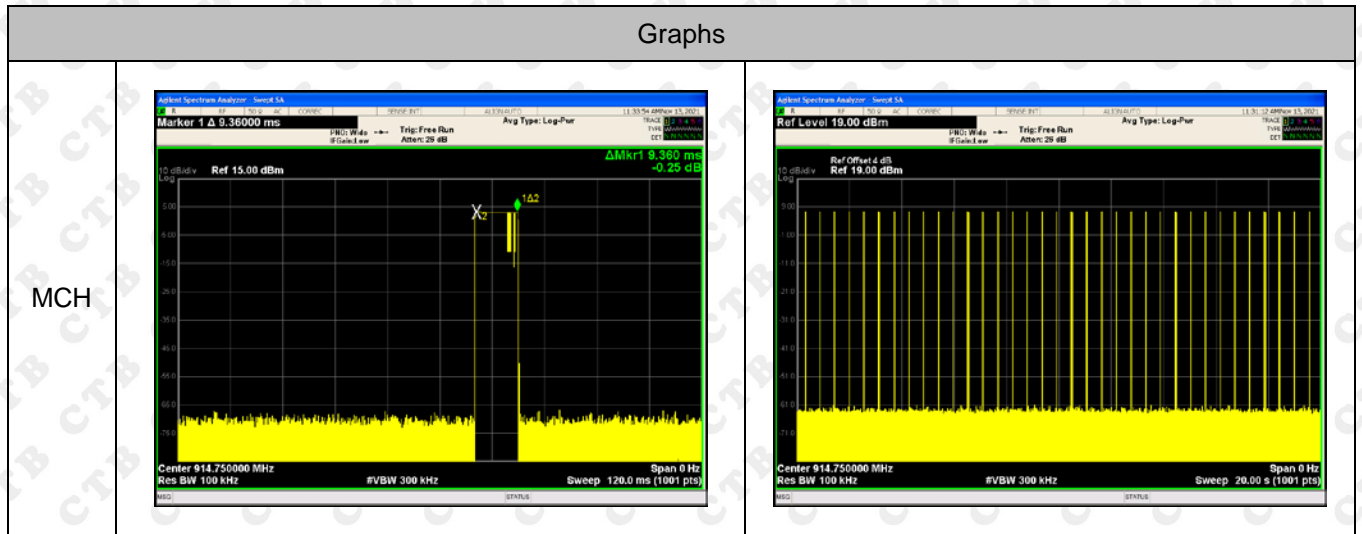


## 13.4 Test Result

Channel	No. of transmission in 20s (a)	Pulse Time (ms)(b)	Total Dwell Time in 20s (ms) (c)	Limit (ms)	Verdict
MCH	35	9.36	327.6	400	PASS

Remark: Total dwell time in 20s,  $c=(a)*(b)$

## Test Graph



## 14. ANTENNA REQUIREMENT

### 15.203 requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

### 15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### EUT Antenna:

The antenna is PCB antenna and no consideration of replacement. The best case gain of the antenna is 1dBi.



## 15. EUT PHOTOGRAPHS

EUT Photo 1



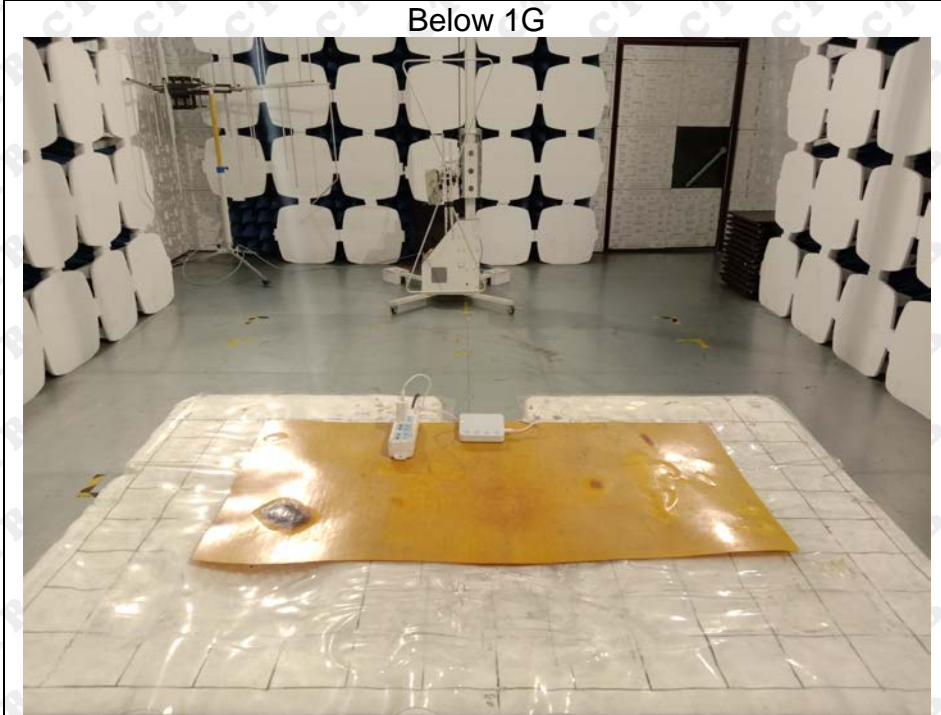
EUT Photo 2



## 16. EUT TEST SETUP PHOTOGRAPHS

### Radiated Emission

Below 1G



Above 1G





## Conducted Emission



\*\*\*\*\* END OF REPORT \*\*\*\*\*