

# **RADIO TEST REPORT**

The device described below is tested by Dongguan Nore Testing Center Co., Ltd. to determine the maximum emission levels emanating from the device, the severe levels which the device can endure and E.U.T.'s performance criterion. The test results, data evaluation, test procedures, and equipment of configurations shown in this report were made in accordance with the procedures in ANSI C63.10(2013).

Applicant	Gemlink Ltd.				
Address	Flat 17, 8/F International Plaza, 20 Sheung Yuet Road, Kowloon Bay, Kowloon, Hong Kong				
Manufacturer /Factory	Guoguang Electric (Zhongshan) Ltd.				
Address	#6 Building, #58 ChuangYe Road, ZhuYuan Estate, XiaoLan Town, ZhongShan, GuangDong, China				
E.U.T.	Karaoke Party Machine				
Brand Name	GPX, CAWA				
Model No.	JB179B, B-448(For model difference refer to section 1)				
FCC ID	HDOJLA98BT				
Measurement Standard	FCC PART 15.247: 2017				
Date of Receiver	May 30, 2019				
Date of Test	May 30, 2019 to June 17, 2019				
Date of Report	June 17, 2019				
This Test Report is Issued Under the Authority of :					
Prepa	by Approved & Signer				
Sundiy jiang / Engineer Iori Fan / Autoplized Signatory					
This test report is for the customer shown above and their specific product only. This report applies to above tested sample only and shall not be reproduced in part without written approval of Dongguan Nore Testing Center Co., Ltd.					

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# **Revision History of This Test Report**

Report Number	Description	Issued Date
NTC1905352FV00	Initial Issue	2019-06-17



# **1. GENERAL INFORMATION**

# **1.1 Product Description for Equipment under Test**

Product Name	:	Karaoke Party Machine		
Main Model Name	:	JB179B		
Additional Model Name	:	B-448		
Model difference	:	Both of models have the same circuit schematic, construction, PCB Layout and critical components. The differences are models number, brand name and appearance (color, silk-screen) only due to trading purpose.		
Brand Name	:	GPX (For model JB179B ), CAWA (For model B-448 )		
Rating	:	DC 5V,1A (form External adapter)		
Adapter	:	N/A		
Test voltage	:	AC 120V 60Hz (Adapter input)		
Adapter	:	Manufacturer: DONGGUAN PENGJU ELECTRONICS&TECHNOLOGY CO.,LTD Model: PTH-0501000-15U Input: AC 100-240V ~50/60Hz, 0.7A Max Output: DC 5V 1000mA		
Cable	:	DC Line: 1.51m unshielded.		
Hardware version	:	V01		
Software version	:	V01		
Note	:	<ol> <li>According to the model difference, all tests were performed on model JB179B.</li> <li>USB port could be used for charging or USB drive playing.</li> </ol>		



# **Technical parameters**

Bluetooth Version	: V5.0 +EDR
Frequency Range	: 2402-2480MHz
Modulation	: GFSK, π/4-DQPSK
Number of Channel	: 79
Channel space	: 1MHz
Date Rate	: 1Mbps for GFSK
	2Mbps for $\pi/4$ -DQPSK
Antenna Type	: PCB antenna
Antenna Gain	: -0.58 dBi (Declaration by manufacturer)



## **Channel List**

Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz	Channel	Frequency MHz
1	2402	21	2422	41	2442	61	2462
2	2403	22	2423	42	2443	62	2463
3	2404	23	2424	43	2444	63	2464
4	2405	24	2425	44	2445	64	2465
5	2406	25	2426	45	2446	65	2466
6	2407	26	2427	46	2447	66	2467
7	2408	27	2428	47	2448	67	2468
8	2409	28	2429	48	2449	68	2469
9	2410	29	2430	49	2450	69	2470
10	2411	30	2431	50	2451	70	2471
11	2412	31	2432	51	2452	71	2472
12	2413	32	2433	52	2453	72	2473
13	2414	33	2434	53	2454	73	2474
14	2415	34	2435	54	2455	74	2475
15	2416	35	2436	55	2456	75	2476
16	2417	36	2437	56	2457	76	2477
17	2418	37	2438	57	2458	77	2478
18	2419	38	2439	58	2459	78	2479
19	2420	39	2440	59	2460	79	2480
20	2421	40	2441	60	2461		

**Note:** According to section 15.31(m), regards to the operating frequency range over 10MHz, the Lowest, middle, and the Highest frequency of channel were selected to perform the test. The selected frequency and test software see below:

Channel	Frequency MHz
1	2402
40	2441
79	2480

Test SW version	FCC Assist_1.5
-----------------	----------------



### 1.2 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: HDOJLA98BT** filing to comply with Section 15.247 of the FCC Part 15 (2017), Subpart C Rule.

## 1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters.

## **1.4 Equipment Modifications**

Not available for this EUT intended for grant.

# 1.5 Support Device

Notebook	:	Manufacturer: IBM Model: 1834 P/N: 13N5615
Adapter (For Notebook)	:	Manufacturer: Huntkey Model: HKA09019047-6D I/P: AC 100-240V 50-60Hz, 1.5A O/P: DC 19V 4.74A



# 1.6 Test Facility and Location

Site Description EMC Lab	<ul> <li>Listed by CNAS, August 13, 2018</li> <li>The certificate is valid until August 13, 2024</li> <li>The Laboratory has been assessed and proved to be in compliance with CNAS/CL01</li> <li>The Certificate Registration Number is L5795.</li> </ul>
	Listed by A2LA, November 01, 2017 The certificate is valid until December 31, 2019 The Laboratory has been assessed and proved to be in compliance with ISO17025 The Certificate Registration Number is 4429.01
	Listed by FCC, November 06, 2017 The Designation Number is CN1214 Test Firm Registration Number: 907417
Name of Firm	Listed by Industry Canada, June 08, 2017 The Certificate Registration Number. Is 46405-9743 Dongguan Nore Testing Center Co., Ltd. (Dongguan NTC Co., Ltd.)
Site Location	<ul> <li>Building D, Gaosheng Science and Technology Park, Hongtu Road, Nancheng District, Dongguan City, Guangdong Province, China</li> </ul>



# 1.7 Summary of Test Results

FCC Rules	Description Of Test	Uncertainty	Result
§15.247(a)(1)	Channel Separation test	±1.42 x10 <sup>-4</sup> %	Compliant
§15.247(a)(1)	20dB Bandwidth	±1.42 x10 <sup>-4</sup> %	Compliant
§15.247(a)(1)(iii)	Hopping Channel Number	±1.42 x10 <sup>-4</sup> %	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	±5%	Compliant
§15.247(b)	Max Peak output Power test	±1.06dB	Compliant
§15.247(d)	Band edge test	±1.70dB	Compliant
§15.207 (a)	AC Power Conducted Emission	±1.06dB	Compliant
§15.247(d),§15.209, §15.205	Radiated Emission	±3.70dB	Compliant
§15.203	Antenna Requirement	N/A	Compliant
§15.247(d)	Conducted Spurious Emission	±1.70dB	Compliant



# 2. System Test Configuration

#### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

#### 2.2 Special Accessories

Not available for this EUT intended for grant.

#### 2.3 Description of test modes

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and normal mode is programmed. The Lowest, middle and highest channel were chosen for testing, and all packets DH1, DH3, DH5, 2-DH1, 2-DH3 and 2-DH5 mode in all modulation type GFSK,  $\pi$ /4-DQPSK were tested.

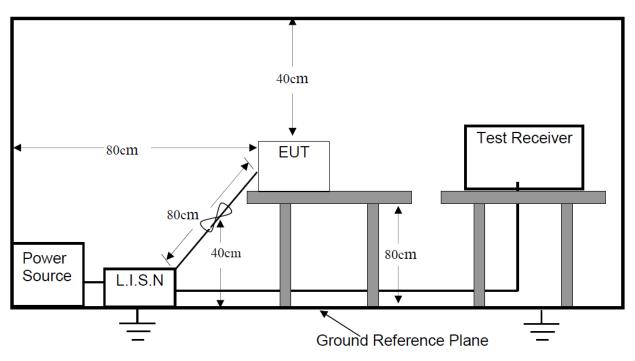
#### 2.4 EUT Exercise

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.



# 3. Conducted Emissions Test

## 3.1 Test SET-UP (Block Diagram of Configuration)



#### **3.2 Test Condition**

Test Requirement: FCC Part 15.207

Frequency Range: 150KHz ~ 30MHz

Detector: RBW 9KHz, VBW 30KHz

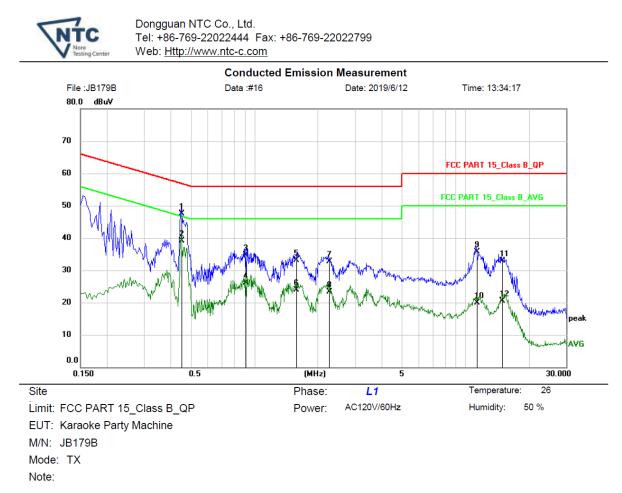
**Operation Mode: TX** 

3.3 Measurement Results

#### PASS

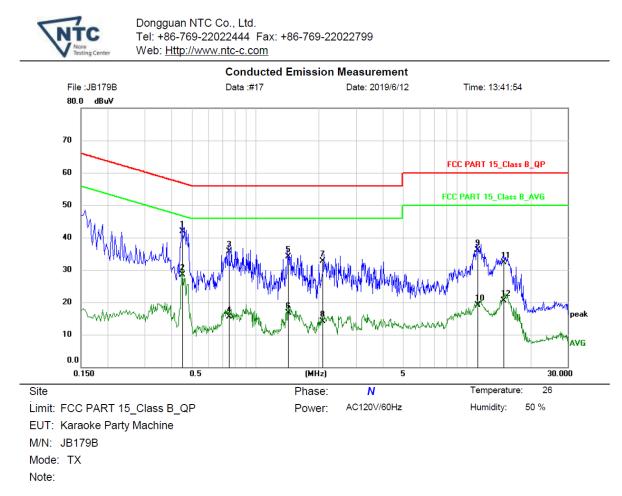
Please refer to the following pages of the worst case:  $\pi/4$ -DQPSK Low Channel





No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.4500	36.88	10.62	47.50	56.88	-9.38	QP	
2	*	0.4500	28.58	10.62	39.20	46.88	-7.68	AVG	
3		0.9100	24.16	10.64	34.80	56.00	-21.20	QP	
4		0.9100	15.56	10.64	26.20	46.00	-19.80	AVG	
5		1.5820	22.45	10.65	33.10	56.00	-22.90	QP	
6		1.5820	13.35	10.65	24.00	46.00	-22.00	AVG	
7		2.2540	22.05	10.65	32.70	56.00	-23.30	QP	
8		2.2540	12.75	10.65	23.40	46.00	-22.60	AVG	
9		11.3339	25.13	10.67	35.80	60.00	-24.20	QP	
10		11.3339	9.23	10.67	19.90	50.00	-30.10	AVG	
11		14.8619	22.23	10.67	32.90	60.00	-27.10	QP	
12		14.8619	9.83	10.67	20.50	50.00	-29.50	AVG	





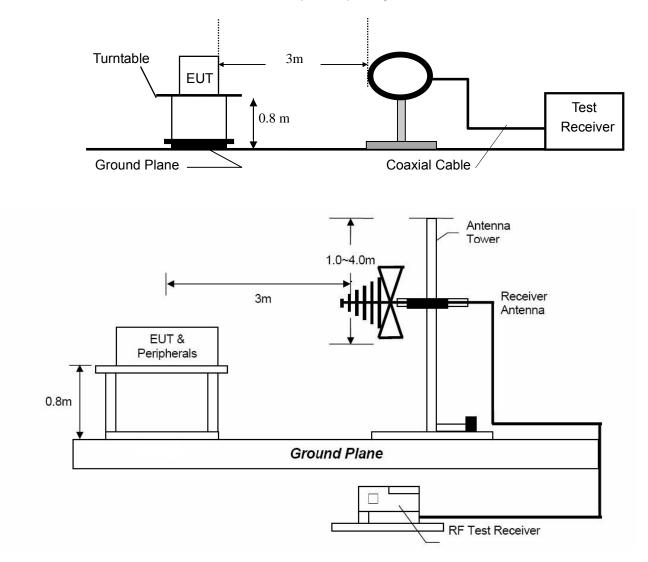
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.4500	31.28	10.62	41.90	56.88	-14.98	QP	
2		0.4500	17.88	10.62	28.50	46.88	-18.38	AVG	
3		0.7500	25.06	10.64	35.70	56.00	-20.30	QP	
4		0.7500	4.86	10.64	15. <mark>5</mark> 0	46.00	-30.50	AVG	
5		1.4299	23.55	10.65	34.20	56.00	-21.80	QP	
6		1.4299	6.15	10.65	16.80	46.00	-29.20	AVG	
7		2.0779	22.15	10.65	32.80	56.00	-23.20	QP	
8		2.0779	3.45	10.65	14.10	46.00	-31.90	AVG	
9		11.2459	25.53	10.67	36.20	60.00	-23.80	QP	
10		11.2459	8.43	10.67	19.10	50.00	-30.90	AVG	
11		14.8739	21.63	10.67	32.30	60.00	-27.70	QP	
12		14.8739	9.93	10.67	20.60	50.00	-29.40	AVG	



# 4. Radiated Emission Test

## 4.1 Test SET-UP (Block Diagram of Configuration)

4.1.1 Radiated Emission Test Set-Up, Frequency Below 30MHz





# 4.1.2 Radiated Emission Test Set-Up, Frequency above 1GHz

#### 4.2 Measurement Procedure

- a. Blow 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.
- b. For the radiated emission test above 1GHz:

The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

- c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The height of antenna 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. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
- f. A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.



During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Level	Resolution Bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
Above 1000	Average	1 MHz	10 Hz

#### 4.3 Limit

Frequency range	<b>Distance Meters</b>	Field Strengths Limit (15.209)
MHz		μV/m
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960	3	500

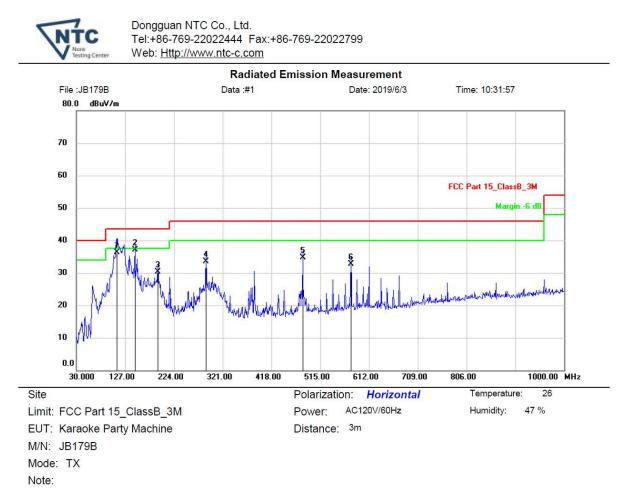
Remark : (1) Emission level (dB) $\mu$ V = 20 log Emission level  $\mu$ V/m

- (2) The smaller limit shall apply at the cross point between two frequency bands.
- (3) As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.
- (4) The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

#### 4.4 Measurement Results

Please refer to following plots of the worst case: TX ( $\pi$ /4-DQPSK Low channel)

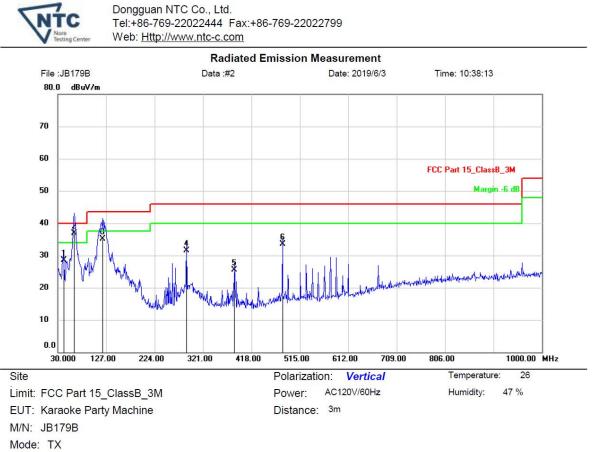




No. M	/lk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		110.5100	48.66	-12.26	36.40	43.50	-7.10	QP			
2 *	8	146.4000	52.68	-15.58	37.10	43.50	-6.40	QP			
3		191.9900	43.91	-13.51	30.40	43.50	-13.10	QP			
4		288.0200	44.40	-1 <mark>0.8</mark> 0	33.60	46.00	-12.40	QP			
5	1	480.0800	41.91	-7.21	34.70	46.00	-11.30	QP			
6		576.1100	38.50	-5.70	32.80	46.00	-13.20	QP			

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.





Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		41.6400	43.29	-14.69	28.60	40.00	-11.40	QP			
2	*	62.9800	51.97	-15.07	36.90	40.00	-3.10	QP			
3		120.2100	52. <mark>1</mark> 8	- <mark>17.0</mark> 8	35.10	43.50	<mark>-8.40</mark>	QP			
4		288.0200	44.30	-12.80	31.50	46.00	-14.50	QP			
5	1	384.0500	36.79	-11.19	25.60	46.00	-20.40	QP			
6		480.0800	42.71	-9.21	33.50	46.00	-12.50	QP			

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.



4-DQPSK (the wo	orst case)	
25GHz	Test Date :	June 06, 2019
ASS	Temperature :	<b>24</b> ℃
n	Humidity :	47 %
ance		
	25GHz ASS n	ASS Temperature : n Humidity :

Freq.	Ant.Pol.		ading (dBuV) Factor	Emissio (dBi			t 3m V/m)		rgin B)	
(MHz)	(H/V)	PK	AV	(dB/m)	PK	AV	PK	AV	PK	AV
	I			ation Mo	ode: TX N			,		
4804	V	59.24	42.81	6.30	65.54	49.11	74.00	54.00	-8.46	-4.89
7206	V	50.94	36.86	10.44	61.38	47.30	74.00	54.00	-12.62	-6.70
4804	Н	56.66	41.16	6.30	62.96	47.46	74.00	54.00	-11.04	-6.54
7206	Н	50.17	36.55	10.44	60.61	46.99	74.00	54.00	-13.39	-7.01
			Ope	ration Mo	ode: TX N	lode (Mi	d)		_	
4882	V	57.16	41.96	6.60	63.76	48.56	74.00	54.00	-10.24	-5.44
7323	V	52.87	38.55	10.55	63.42	49.10	74.00	54.00	-10.58	-4.90
4882	Н	55.89	41.05	6.60	62.49	47.65	74.00	54.00	-11.51	-6.35
7323	Н	51.62	37.56	10.55	62.16	48.11	74.00	54.00	-11.84	-5.89
			Oper	ation Mo	de: TX M	ode (Hig	gh)			
4960	V	52.89	39.22	6.89	59.78	46.11	74.00	54.00	-14.22	-7.89
7440	V	51.39	37.97	10.60	61.99	48.57	74.00	54.00	-12.01	-5.43
4960	Н	52.92	38.94	6.89	59.81	45.83	74.00	54.00	-14.19	-8.17
7440	Н	52.15	38.59	10.60	62.75	49.19	74.00	54.00	-11.25	-4.81

**Note:** (1) All Readings are Peak Value and AV.

- (2) Emission Level= Reading Level + Factor
- (3) Factor= Antenna Gain + Cable Loss Amplifier Gain
- (4) Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 10dB below the permissible limits.
- (5) Measurement uncertainty : ±3.7dB.
- (6) Horn antenna used for the emission over 1000MHz.



# 5. Channel Separation test

#### **5.1 Measurement Procedure**

Minimum Hopping Channel Carrier Frequency Separation, FCC Rule 15.247(a)(1):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable, and using the MARKER and Max-Hold function to record the separation of two adjacent channels.

#### 5.2 Test SET-UP (Block Diagram of Configuration)

EUT Spectrum Analyzer

#### 5.3 Measurement Results

Modulation:	GFSK, π/4-DQPS	SK	
RBW:	100KHz	VBW:	300KHz
Packet:	DH5, 2-DH5	Spectrum Detector:	PK
Test By:	Lee	Test Date :	June 06, 2019
Temperature :	<b>22</b> °C	Humidity :	53 %
Test Result:	PASS		

Channel number	Channel	Separation Read	Separation Limit						
	frequency (MHz)	Value (KHz)	2/3 20dB Bandwidth						
			(KHz)						
GFSK									
Lowest	2402	1002	>631.00						
Middle	2441	1002	>631.47						
Highest	2480	1002	>630.80						
	π/	/4-DQPSK							
Lowest	2402	1002	>872.00						
Middle	2441	1002	>872.67						
Highest	2480	1002	>872.67						



	<b>GI 3</b> K	Lowesi		71	
Keysight Spectrum Analyzer - Swept SA					
RF 50 Ω AC	MLI-	SENSE:INT SOURCE OFF	ALIGN AUTO Type: Log-Pwr	09:42:10 AM Jun 06, 2019 TRACE 1 2 3 4 5	
arker 2 Δ 1.00200000	PNO: Wide Trig:	Free Run Avg	Hold:>100/100		¥
	IFGain:Low Atter	n: 20 dB		DET	Select Marke
			ΔN	kr2 1.002 MHz	
dB/div Ref 10.00 dBm				-0.003 dE	
a and a second s	<u>\</u> 1		<b>∮</b> 2∆1		
					Relative T
).0					
).0					
					X Axis Sca
0.0					Frequenc
1.0 Marmarka					<u>Auto</u> M
					Marker Trac
).0					[Trace1, Auto Ini
0.0					
enter 2.402000 GHz				Span 3.000 MHz	
Res BW 100 kHz	#VBW 300 k	KHZ	Sweep 1.	000 ms (1001 pts)	L
R MODE TRC SCL X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	On .
1 N 1 f 2.4		1 dBm	T ONCE TO A VIDE T	TONCHON VALUE	
2 Δ1 1 f (Δ)	1.002 MHz (Δ) -0.0	003 dB			
4					
5				=	
6 7					
8					
9					
				•	
3			STATUS		

**GFSK Lowest Channel** 

# GFSK Middle Channel

Keysight Spectrum Analyzer - Swept SA				- ē 🔀
Marker 1 2.439749000000	GHZ PNO: Wide Trig: Free Run	AVG Type: Log-Pwr Avg Hold:>100/100	09:42:46 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P N N N N N	Peak Search
10 dB/div Ref 10.00 dBm	IFGain:Low Atten: 20 dB	Mkr1	2.439 749 GHz 0.896 dBm	Next Peak
Log	2Δ1			Next Pk Right
-200				Next Pk Left
-60.0 -70.0 -80.0				Marker Delta
Center 2.441000 GHz #Res BW 100 kHz	#VBW 300 kHz	Sweep 1	Span 3.000 MHz .000 ms (1001 pts)	Mkr→CF
1         N         1         f         2.439           2         Δ1         1         f         (Δ)         1           3         4         5         5         6         6         6         6         6         6         6         6         6         1	9 749 GHz 0.896 dBm 1.002 MHz (Δ) 0.008 dB		=	Mkr→RefLvl
7 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9				More 1 of 2
MSG		STATUS	3	



Keysight Spectrum Analyzer - Swept SA						- ē 💌
Marker 2 Δ -1.002000000	MHz	SENSE:INT		ALIGN AUTO	09:43:13 AM Jun 06, 2019 TRACE 1 2 3 4 5 6	Peak Search
	PNO: Wide ⊂⊾ IFGain:Low	Trig: Free Run Atten: 20 dB	Avg Ho	oid:>100/100 ΔΜ	kr2 -1.002 MHz 0.028 dB	NextPeak
10 dB/div Ref 10.00 dBm 0 g 2Δ1 10 0						Next Pk Right
-20.0				~		Next Pk Left
-60.0 -70.0 -80.0						Marker Delta
Center 2.480000 GHz #Res BW 100 kHz	#VBW	300 kHz	FUNCTION	Sweep 1.	Span 3.000 MHz 000 ms (1001 pts)	Mkr→CF
1         N         1         f         2.4;           2         Δ1         1         f         (Δ)           3         -         -         -           4         -         -         -           5         -         -         -           6         -         -         -         -	79 751 GHz -1.002 MHz (Δ)	0.423 dBm 0.028 dB	FUNCTION			Mkr→RefLv
7 8 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10		III				More 1 of 2
ISG				STATUS		

# **GFSK Highest Channel**

# π/4-DQPSK Lowest Channel

Keysight Spectrum Analyzer - Swept SA				- ē 🔀
🕅 RF 50 Ω AC Marker 1 2.402744000000		SOURCE OFF ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	09:44:07 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE M WWWWW	Peak Search
10 dB/div Ref 10.00 dBm	IFGain:Low Atten: 20 dB	Mkr1	2.402 744 GHz 1.237 dBm	Next Peak
-10.0			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Next Pk Right
-30.0 -40.0 -50.0				Next Pk Left
-60.0 -70.0 -80.0				Marker Delta
Center 2.402000 GHz #Res BW 100 kHz	#VBW 300 kHz	Sweep 1	Span 3.000 MHz .000 ms (1001 pts)	Mkr→CF
1 N 1 f 2.402	2 744 GHz 1.237 dBm 1.002 MHz (Δ) 0.036 dB	PONCTION	FORCHONVALUE	Mkr→RefLv
7 8 9 10 11 11				More 1 of 2
MSG		STATUS		



Keysight Spectrum Analyzer - Swept SA           RF         50 Ω         AC		SENSE:INT S	OURCE OFF ALIGN AUTO	09:45:12 AM Jun 06, 2019	
arker 2 Δ 1.002000000	MHz PNO: Wide	Trig: Free Run	Avg Type: Log-Pwr Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWW	Peak Search
	IFGain:Low	Atten: 20 dB		DET P NNNNN	NextPea
dB/div Ref 10.00 dBm			Δ	Mkr2 1.002 MHz 0.068 dB	Nextrea
pg		<b>⊘1</b> 1	2/	<u>\1</u>	
					Next Pk Rig
1.0					
3.0					
0.0					Next Pk Le
0.0					NEXLERE
0.0					
0.0					
0.0					Marker De
0.0					
enter 2.441000 GHz		<b>A</b>		Span 3.000 MHz	
Res BW 100 kHz	#VBW	300 kHz	Sweep	1.000 ms (1001 pts)	Mkr→C
R MODE TRC SCL X		Y F	UNCTION FUNCTION WIDT	H FUNCTION VALUE	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	40 766 GHz 1.002 MHz (Δ)	0.764 dBm 0.068 dB			
		0.008 0B			Mkr→RefL
4				=	
6					
8					Мо
9					1 0
1				-	
G			STAT	15	
<u></u>			STAT		

# $\pi$ /4-DQPSK Middle Channel

# $\pi/4$ -DQPSK Highest Channel

Keysight Spectrum Analyzer - Swept SA							_ # <mark>*</mark>
Marker 2 Δ 1.002000000 MH	17	SENSE:INT SOUR	Avg Type:		TRACI	Jun 06, 2019	Marker
	PNO Wide	: Free Run en: 20 dB	Avg Hold:>	>100/100	TYP		Select Marker
				ΔM	kr2 1.0	02 MHz	
10 dB/div Ref 10.00 dBm					-0.	360 dB	
	2∆	1					
-10.0			m				Normal
-20.0							
-30.0							
-40.0				AP4000	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	- marine of	Delta
-50.0							
-60.0							
-70.0							Fixed⊳
-80.0							
Center 2.480000 GHz		<b>k</b>			Snan 3	000 MHz	
#Res BW 100 kHz	#VBW 300	kHz	s	weep 1.	000 ms (1	001 pts)	Off
MKR MODE TRC SCL X	Y		CTION FUNC	TION WIDTH	FUNCTIO	N VALUE	
	7 <u>37 GHz 0.7</u> 002 MHz (Δ) -0	96 dBm .360 dB					
3							Properties►
5						=	
7							
8 9							More
10						-	1 of 2
						•	
MSG				STATUS			

Page 24 of 49



# 6. 20dB Bandwidth

#### 6.1 Measurement Procedure

Maximum 20dB RF Bandwidth, FCC Rule 15.247(a)(1):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

#### 6.2 Test SET-UP (Block Diagram of Configuration)



#### 6.3 Measurement Results

Refer to attached data chart.

Modulation:	GFSK, π/4-DQPS	бК	
RBW:	30KHz	VBW:	100KHz
Packet:	DH5, 2-DH5	Spectrum Detector:	PK
Test By:	Lee	Test Date :	June 06, 2019
Temperature :	22 °C	Humidity :	53 %
Test Result:	PASS		

Channel frequency (MHz)	20dB Down BW(kHz)			
GI	FSK			
2402	946.5			
2441	947.2			
2480	946.2			
π/4-Ε	DQPSK			
2402	1308.0			
2441	1309.0			
2480	1309.0			



GFSK Lowest Channel					
Keysight Spectrum Analyzer - Occupied B	W				
LX RF 50 Ω AC		SENSE:INT SOURCE OFF	ALIGN AUTO 09:36:59 AM Radio Std:	IJun 06, 2019 None Frequency	
Center Freq 2.40200000		: Free Run Avg Hold		None	
	#IFGain:Low #Atte	en: 20 dB	Radio Devi	ce: BTS	
15 dB/div Ref 25.00 dB	m				
Log					
10.0				Center Freq	
-5.00				2.402000000 GHz	
-20.0		- Marine			
-35.0					
-50.0					
-65.0				Man market	
-80.0					
-95.0					
-110					
-110					
Center 2.402 GHz			Spa	n 3 MHz CF Step	
#Res BW 30 kHz	-	#VBW 100 kHz	Sweep 4	4.133 ms 300.000 kHz	
		T-4-1 D	0.40	<u>Auto</u> Man	
Occupied Bandwid		Total Power	8.18 dBm		
8	39.06 kHz			Freq Offset	
<b>T</b>	00.070.111-			0 Hz	
Transmit Freq Error	-98.370 kHz	% of OBW Pow	er 99.00 %		
x dB Bandwidth	946.5 kHz	x dB	-20.00 dB		
MSG			STATUS		
			0		

## **GFSK Lowest Channel**

# **GFSK Middle Channel**





Keysight Spectru	um Analyzer - Occupied BW	1							<b>F</b> X
Center Free	RF 50 Ω AC q 2.480000000	GH7	SENSE:INT SO Center Freq: 2.480	000000 GHz	ALIGN AUTO	09:37:28 A Radio Std	M Jun 06, 2019 : None	Frequ	ency
		#IFGain:Low	Trig: Free Run #Atten: 20 dB	Avg Hold:	>10/10	Radio Dev	rice: BTS		
15 dB/div	Ref 25.00 dBn	۱ <u> </u>							
Log 10.0								Cent	ter Freq
-5.00									000 GHz
-20.0		mar and a		~~					
-35.0		~~			<u>}</u>				
-50.0					- John Starter	man	the second		
-65.0									
-80.0									
-95.0									
-110									
Center 2.48			#\/D\// 400			Sp	an 3 MHz		CF Step
#Res BW 3			#VBW 100	KHZ		sweep	4.133 ms	300 Auto	.000 kHz Man
Occupi	ed Bandwidt	h	Total	Power	7.43	dBm		Auto	Iviali
	8	40.32 kH	z					Free	q Offset
Tranomi	t Freq Error	-100.85 k		BW Powe		.00 %		110	0 Hz
x dB Bar	nawiath	946.2 kl	Hz xdB		-20.0	00 dB			
MSG					STATUS				

# GFSK Highest Channel

# π/4-DQPSK Lowest Channel

Keysight Spectrum Analyzer - Occupied B	W							d X
RF         50 Ω         Ac           Center Freq 2.40200000         Comparison         <	0 GHz #IFGain:Low	SENSE:INT SOUR Center Freq: 2.40200 Trig: Free Run #Atten: 20 dB		>10/10	09:37:46 Al Radio Std: Radio Dev		Freque	ncy
15 dB/div Ref 25.00 dB	m							
10.0		m	mm				Cente 2.4020000	e <b>r Freq</b> 000 GHz
-20.0				·~~~	<b>~</b> ~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
-65.0								
-95.0								
Center 2.402 GHz #Res BW 30 kHz		#VBW 1001	KHZ			an 3 MHz 4.133 ms		F Step 000 kHz Man
Occupied Bandwid	<sup>th</sup> .1787 MH	Total P Z	ower	7.78	dBm			Offset
Transmit Freq Error	-96.954 kl	lz % of O	BW Powe	r 99.	00 %			0 Hz
x dB Bandwidth	1.308 MH	lz xdB		-20.0	0 dB			
MSG				STATUS				





# π/4-DQPSK Middle Channel

# $\pi$ /4-DQPSK Highest Channel

Keysight Spectrum Analyzer - Occupied BW						
Center Freq 2.480000000	GHz #FGain:Low	SENSE:INT SOUR Center Freq: 2.48000 Trig: Free Run #Atten: 20 dB		Radio Std:		Frequency
15 dB/div Ref 25.00 dBm						
-5.00		~~~~~	~~~			Center Freq 2.480000000 GHz
-20.0 -35.0 -50.0				~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
-65.0						
-95.0						
Center 2.48 GHz #Res BW 30 kHz		#VBW 1001	(Hz		an 3 MHz 4.133 ms	CF Step 300.000 kHz Auto Man
Occupied Bandwidt		Total P	ower	7.17 dBm		<u>Auto</u> Mari
	1771 MH			<u></u>		Freq Offset 0 Hz
Transmit Freq Error x dB Bandwidth	-100.24 ki 1.309 Mi		BW Power -	99.00 % 20.00 dB		
MSG			s	TATUS		



# 7. Hopping Channel Number

### 7.1 Measurement Procedure

Minimum Number of Hopping Frequencies, FCC Rule 15.247(a)(1)(iii):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum, and the spectrum analyzer set to MAX HOLD readings were taken for 3-5 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

## 7.2 Test SET-UP (Block Diagram of Configuration)



#### 7.3 Measurement Results

Modulation	GFSK, π/4-DQPSK		
RBW:	100KHz	VBW:	300KHz
Packet:	DH5, 2-DH5	Spectrum Detector:	PK
Test By:	Lee	Test Date :	June 06, 2019
Temperature :	<b>22</b> ℃	Humidity :	53 %
Test Result:	PASS		

Hopping Channel Frequency Range	Number of Hopping Channels	Limit
2402-2480	79	≥15



GFSK ctrum Analyzer - Swept SA 09:54:44 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P N N N N N Marker Marker 1 2.480010500000 GHz Avg Type: Log-Pwr Avg|Hold:>100/100 Trig: Free Run Atten: 30 dB PNO: Fast IFGain:Low Select Marker Mkr1 2.480 010 5 GHz 0.833 dBm 10 d Log dB/div Ref 20.00 dBm ∆<mark>2∆1</mark> 1 Normal Delta Fixed⊳ Start 2.40000 GHz #Res BW 100 kHz Stop 2.48350 GHz Sweep 8.000 ms (1001 pts) #VBW 300 kHz Off MKR N FUNCTION FUN 2.480 010 5 GHz -78.173 5 MHz (Δ) 0.833 dBm 0.018 dB N 1 f Δ1 1 f (Δ) 2 Properties► More 1 of 2 STATUS

## $\pi/4$ -DQPSK

Keysight Spectrum Analyzer - Swept SA				
RF 50 Ω AC arker 2 Δ -78.257000000		AVG Type: Log-Pwr Avg Hold:>100/100	10:03:28 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE M WWWW DET P NNNNN	Marker
DdB/div Ref 20.00 dBm	IFGain:Low Atten: 50 dB	ΔMkr2	2 -78.257 0 MHz 1.780 dB	Select Marker 2
°g 100 - 2Δ1	wwwwwwwww	mmmmmm	nnnn 1	Norm
0.0 J				Delt
0.0				Fixed
tart 2.40000 GHz Res BW 100 kHz	#VBW 300 kHz	-	Stop 2.48350 GHz .000 ms (1001 pts)	o
1 N 1 f 2.480 (	010 5 GHz -0.087 dBm 257 0 MHz (Δ) 1.780 dB	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	Properties
7 8 9 9 0 1				Moi 1 of
L			•	



# 8. Time of Occupancy (Dwell Time)

#### 8.1 Measurement Procedure

Average Channel Occupancy Time, FCC Ref:15.247(a)(1)(iii):

Connect EUT antenna terminal to the spectrum analyzer with a low loss cable. The spectrum analyzer center frequency was set to one of the known hopping channels. The Sweep was set to 10 ms, the SPAN was set to Zero SPAN. The time duration of the transmissions so captured was measured with the Marker Delta function

#### 8.2 Measurement Results

The maximum number of hopping channels in 31.6s (0.4s/Channel x 79 Channel)

Refer to attached data chart.

Modulation :	GFSK, π/4-DQPSK		
RBW :	1MHz	VBW :	1MHz
Spectrum Detector:	PK	Test By:	Lee
Test Date :	June 06, 2019	Temperature :	<b>22°</b> ℃
Test Result:	PASS	Humidity :	53 %

Packet	Frequency		Result		Limit
	(MHz)		(msec)		(msec)
			GFSK		
DH1	2441	0.3757	(ms)*(1600/(2*79))*31.6=	120.224	400
DH3	2441	1.6320	(ms)*(1600/(4*79))*31.6=	261.120	400
DH5	2441	2.8800	(ms)*(1600/(6*79))*31.6=	307.200	400
			π/4-DQPSK		
2-DH1	2441	0.3872	(ms)*(1600/(2*79))*31.6=	123.904	400
2-DH3	2441	1.6390	(ms)*(1600/(4*79))*31.6=	262.240	400
2-DH5	2441	2.8870	(ms)*(1600/(6*79))*31.6=	307.947	400



Keysight Spectrum Analyzer - Swept SA SENSE:INT SOURCE OFF ALIGN AUTO Avg Type: Log-Pwr Free Run Avg|Hold: 1/1 10:04:23 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P NNNNN Marker Marker 2 Δ -375.667 μs PNO: Fast +++ Trig: Free Run IFGain:Low Atten: 30 dB Select Marker ΔMkr2 -375.7 μs 0.625 dB 2 Ref 20.00 dBm 10 dB/div Log<del>∢</del> <u>2Δ1</u> <u>\</u>1 Normal Delta in the first of the second state of the second s a la desta de la completa de la contra de la completa de la completa de la completa de la completa de la comple Center 2.441000000 GHz Res BW 1.0 MHz Fixed⊳ films, daulauly, adjustice of the second Span 0 Hz Sweep 2.500 ms (15001 pts) #VBW 1.0 MHz Off FUNCTION N 1 t Δ1 1 t (Δ) 1.507 ms -375.7 μs (Δ) -5.005 dBm 0.625 dB **Properties**► More 1 of 2 STATUS

# **GFSK DH1**

# **GFSK DH3**

						- ē 赵
Arker 1 2.46150 ms	PNO: Fast			ALIGN AUTO Type: Log-Pwr Iold: 1/1	10:06:08 AM Jun 06, 2019 TRACE 1 2 3 4 5 TYPE M WWWW DET P N N N N	6 Marker
10 dB/div Ref 20.00 dBm	IFGain:Low	Atten: 30 dB			Mkr1 2.462 ms -4.648 dBm	Select Marker
• <b>9 1</b> 0.0 <b>2∆1</b> 10.0 <b>1</b> 0.0		1				Norma
20.0 						Delt
			Charles of a transmission in the state of the s	nin osinti osinti osinti <mark>, kiyo ay</mark> a yatingalo	alt "alt pour l'ore d' Ne complete de la complete	Fixed
Center 2.441000000 GHz Res BW 1.0 MHz	#VE	W 1.0 MHz			Span 0 Hz 000 ms (15001 pts	0
MKR MODE TRC SCL X 1 N 1 t 2 Δ1 1 t (Δ) 3	2.462 ms -1.632 ms (/	-4.648 dBm Δ) 2.238 dB	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Properties
4 5 6					E	
5						More 1 of 2

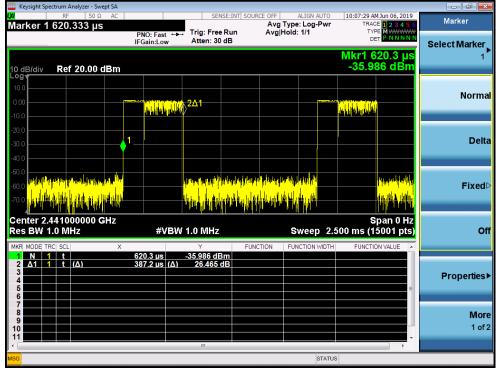


Keysight Spectrum Analyzer - Swept SA - di - X 10:06:55 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N Avg Type: Log-Pwr Avg|Hold: 1/1 Marker Marker 1 5.24550 ms Trig: Free Run Atten: 30 dB PNO: Fast ↔→→ IFGain:Low Select Marker Mkr1 5.246 ms -1.956 dBm Ref 20.00 dBm 10 dB/div <u>2Δ1</u> Normal Delta <mark>tuk dan anda</mark> pan **Fixed**⊳ aline sum of the fight of particulation of Hederlander (h. 1997) telei krall på føderler av s Center 2.441000000 GHz Res BW 1.0 MHz Span 0 Hz Sweep 7.500 ms (15001 pts) #VBW 1.0 MHz Off 5.246 ms -1.956 dBm -2.880 ms (Δ) -2.943 dB 
 N
 1
 t

 Δ1
 1
 t
 (Δ)
 Properties► More 1 of 2 STATUS

# **GFSK DH5**

# π/4-DQPSK 2-DH1





			<u>SK Z-DHS</u>		
Keysight Spectrum Analyzer - Swe					- F
		SENSE:INT SO	Avg Type: Log-Pwr	10:08:03 AM Jun 06, 2019 TRACE 1 2 3 4 5 6	Marker
	PNO: Fast ↔ IFGain:Low	<ul> <li>Trig: Free Run Atten: 30 dB</li> </ul>	Avg Hold: 1/1		Select Marker
				Mkr1 3.000 ms	1
dB/div Ref 20.00 d	Bm			-17.319 dBm	
				<u>2Δ1</u>	Norm
00 <mark>lyndersteleren blendelstele</mark> 3.0			1		
0.0					_
.0					De
0.0					
).0	in a haim hadiana hiki kata da ata ata ata	sa tu atara ka sa sa di ka sa kika sa k	1. tr	al and the	
	. Notion for table to a sub-Matrix whereas the State	a hatatatikk maari salin	1.0 <sup>4</sup>	J allahuth	Fixe
0.0	n tertilise name i subi e da				
enter 2.441000000 G		4 A A MUL-	<b>0</b> 6	Span 0 Hz	
R MODE TRC SCL		V 1.0 MHz		000 ms (15001 pts)	c
1 N 1 t	× 3.000 ms	-17.319 dBm	UNCTION FUNCTION WIDTH	FUNCTION VALUE	
2 Δ1 1 t (Δ) 3	1.639 ms (Δ)	12.102 dB			Propertie
5				E	Fioperue
6					
8					Mo
1					1 c
G			STATU	3	

π/4-DQPSK 2-DH3

# π/4-DQPSK 2-DH5

Keysight Spectrum Analyzer - Swept SA					
Marker 1 1.39200 ms		ree Run Avg	ALIGN AUTO Type: Log-Pwr Hold: 1/1	10:08:35 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE M WWWW DET P N N N N N	Marker
10 dB/div Ref 20.00 dBm	IFGain:Low Atten	: 30 dB		Mkr1 1.392 ms -4.404 dBm	Select Marker
10.0 0.00 ↓ 1		201			Normal
-10.0 -20.0 -30.0 -40.0					Delta
-50 0 -60 0 000000000000000000000000000000				la daga sa sa daga sa daga daga sa daga pangan kanga sa daga sa daga sa daga	Fixed⊳
Center 2.441000000 GHz Res BW 1.0 MHz MKRI MODE TRCI SCLI X	#VBW 1.0 MI	HZ	Sweep 7.	Span 0 Hz 500 ms (15001 pts)	Off
1         N         1         t           2         Δ1         1         t         (Δ)           3         4         4         4           5         4         4         4           6         4         4         4	1.392 ms -4.404				Properties⊁
7 8 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10	m			•	More 1 of 2
MSG			STATUS	3	



# 9. MAXIMUM PEAK OUTPUT POWER

#### 9.1 Measurement Procedure

Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1):

Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm. Cable loss was considered during this measurement.

#### 9.2 Measurement Results

Refer to attached data chart.

Modulation :	GFSK, π/4-DQPS	δK	
RBW :	3MHz	VBW :	3MHz
Spectrum Detector:	PK	Test Date :	June 06, 2019
Test By:	Lee	Temperature :	<b>22</b> °C
Test Result:	PASS	Humidity :	53 %

Channel Frequency	Peak Power	Peak Power	Peak Power	Pass/Fail			
(MHz)	output(dBm)	output(mW)	Limit(dBm)				
	GI	FSK					
2402.00	1.329	1.35800	21	PASS			
2441.00	0.863	1.21983	21	PASS			
2480.00	0.730	1.18304	21	PASS			
	π/4-DQPSK						
2402.00	1.909	1.55203	21	PASS			
2441.00	1.613	1.44977	21	PASS			
2480.00	1.414	1.38484	21	PASS			



		owest chan		
Keysight Spectrum Analyzer - Swept SA				- ē 🗙
RF 50 Ω AC		NSE:INT SOURCE OFF ALIGN A Avg Type: Log-I		
Center Freq 2.40200000	PNO: Fast Trig: Free IFGain:Low Atten: 20	Run Avg Hold:>100/1		N
			Mkr1 2.401 71 GH	Auto Tune
10 dB/div Ref 10.00 dBm			1.329 dBn	
				Center Free
0.00				2.402000000 GH
				2.40200000 011
10.0				
				Start Free
20.0				2.397000000 GH
30.0				Stop Free
			- Vig.	2.407000000 GH
40.0				
				CF Step
50.0				1.000000 MH
				<u>Auto</u> Ma
60.0				
				Freq Offse
70.0				он
80.0				Scale Type
				Scale Type
Center 2.402000 GHz			Span 10.00 MH:	Log <u>Lir</u>
Res BW 3.0 MHz	#VBW 3.0 MHz	Swee	ep 1.000 ms (1001 pts	)
SG		5	STATUS	

**GFSK Lowest Channel** 

# GFSK Middle Channel

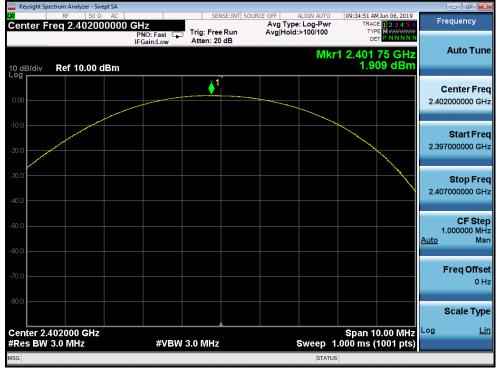
🔤 Keysight Spectrum Analyzer - Sw					- ē 🔀
ໝ RF 50 Ω Center Freq 2.44100		SENSE:INT SOU	ALIGN AUTO	09:34:22 AM Jun 06, 2019 TRACE 1 2 3 4 5 6	Frequency
10 dB/div Ref 10.00 (	PNO: Fast 🖵 IFGain:Low	Trig: Free Run Atten: 20 dB	Avg Hold:>100/100	1 2.440 57 GHz 0.863 dBm	Auto Tune
		<u> </u>			Center Freq 2.441000000 GHz
-10.0					Start Freq 2.436000000 GHz
-30.0					<b>Stop Freq</b> 2.446000000 GHz
-50.0					CF Step 1.000000 MHz <u>Auto</u> Man
-70.0					<b>Freq Offset</b> 0 Hz
Center 2.441000 GHz #Res BW 3.0 MHz		3.0 MHz	Sween 1	Span 10.00 MHz .000 ms (1001 pts)	Scale Type
MSG	#VBW	CAVENIII/4	Sweep	· · · · ·	



			<u>in riigin</u>	51 Channe		
Keysight Spec	ctrum Analyzer - Swept SA					
M	RF 50 Ω AC eq 2.48000000	0 647	SENSE:INT SO	AVG Type: Log-Pwr	09:34:37 AM Jun 06, 20 TRACE 1 2 3 4	
senter Fr	eq 2.48000000	PNO: Fast	Trig: Free Run Atten: 20 dB	Avg Hold:>100/100	TYPE MWWW DET P NNN	
0 dB/div	Ref 10.00 dBm			Mkr	1 2.479 71 GF 0.730 dB	z Auto Tun n
. <sup>og</sup>			Y			
			<u></u>			Center Fre
0.00						2.480000000 GH
10.0						
10.0						Start Fre
						2.475000000 GH
20.0						
30.0						Stop Fre
						2.485000000 GH
40.0						2.40000000000
50.0						CF Ste 1.000000 MH
						Auto Ma
60.0						<u>Auto</u> Ma
70.0						Freq Offse
						0 H
80.0						
						Scale Typ
enter 2.4	80000 GHz				Span 10.00 MH	z Log Li
Res BW		#VBW	3.0 MHz	Sweep 1	.000 ms (1001 pt	
sg				STATUS		
				STATUS		

### **GFSK Highest Channel**

# π/4-DQPSK Lowest Channel







### π/4-DQPSK Middle Channel

# π/4-DQPSK Highest Channel





### 10. Band Edge

#### **10.1 Measurement Procedure**

Out of Band Conducted Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. The resolution bandwidth is set to100KHz, and the video bandwidth set to 300KHz.

#### 10.2 Limit

15.247(d)In any 100KHz 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 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### **10.3 Measurement Results**

Please see below test table and plots. For Radiated Emission The worst case:  $\pi/4$ -DQPSK

#### Hopping-on mode

Freq.	•		ding dBuV)	Factor (dB/m)	Emissio (dBı		Limi (dBu	t 3m V/m)	Ma (d	•
	(H/V)	PK	AV	(ub/III)	PK	AV	PK	AV	PK	AV
2390.000	Н	43.62	29.74	0.09	43.71	29.83	74.00	54.00	-30.29	-24.17
2390.000	V	45.18	30.12	0.09	45.27	30.21	74.00	54.00	-28.73	-23.79
2483.500	H	62.33	43.89	0.34	62.67	44.23	74.00	54.00	-11.33	-9.77
2483.500	V	59.18	40.87	0.34	59.52	41.21	74.00	54.00	-14.48	-12.79

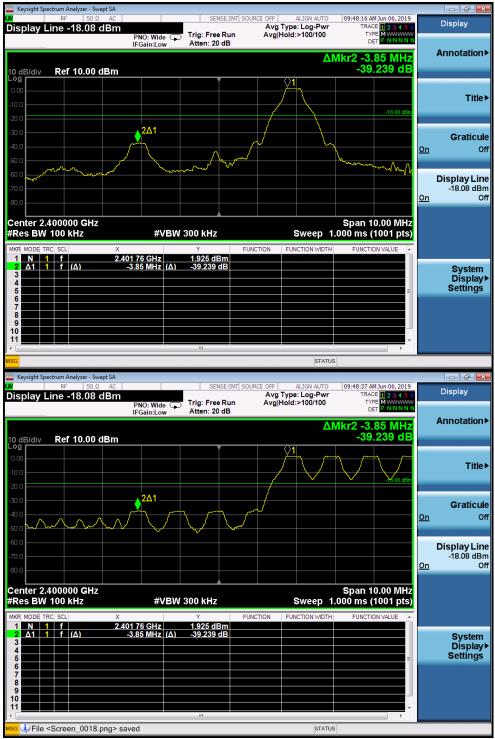
**Note:** (1) Emission Level= Reading Level + Factor

(2) Factor= Antenna Gain + Cable Loss – Amplifier Gain

(3) Horn antenna used for the emission over 1000MHz.



#### For RF Conducted



GFSK Lowest Channel



Keysight Spectrum Analyzer - Swept SA							_	- đ ×
₩ RF 50 Ω AC Display Line -18.85 dBm	PNO: Wide 😱 Tri	SENSE:INT SOU	Avg Type: I Avg Hold:>	_og-Pwr	09:49:29 AM Ju TRACE TYPE	23456		Display
		ten: 20 dB			DET	1 MHz		Annotation
10 dB/div Ref 10.00 dBm		Ť			-51.2	25 dB		
-10.0						-18.85 dBm		Title∍
-30.0								Graticule
-40.0			2Δ1				<u>On</u>	Of
-60.0		m hours		-man		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Display Line
-70.0				- 44-46			<u>On</u>	-18.85 dBm Of
-80.0								
Center 2.483500 GHz #Res BW 100 kHz	#VBW 300	) kHz	SI	weep 1.0	Span 10. 00 ms (10			
MKR MODE TRC SCL X 1 N 1 f 2.		Y FUN 149 dBm	CTION FUNCT	FION WIDTH	FUNCTION	VALUE		
2 Δ1 1 f (Δ) 3	4.61 MHz (Δ) -5	1.225 dB						System Display▶
4 5 6						=		Settings
7								
9 10								
11						•		
MSG								
				STATUS			_	
Keysight Spectrum Analyzer - Swept SA		SENSE:INT SOU		IGN AUTO	09:49:55 AM Ju	n 06, 2019	_	
	PNO: Wide 😱 Tri	SENSE:INT SOU g: Free Run ten: 20 dB	IRCE OFF AL Avg Type: I Avg Hold:>	IGN AUTO L <b>og-Pwr</b>	TRACE	n 06, 2019 2 3 4 5 6 4 WWWWW 9 N N N N N		Display
274 RF 50 Ω AC Display Line -18.85 dBm	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	23456 WWWW NNNNN MHz		Display
RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 g         ()1	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	23456 1000000 200000000000000000000000000000		Display
RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	23456 WWWW NNNNN MHz		Display Annotation
RF         50.Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 00         1	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	23456 WWWW NNNNN MHz		Display Annotation
XI         RF         50.Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           -0.00         1         -           -10.0         -         -           -30.0         -         -	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I Avg Hold:>	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	2 3 4 5 6 		Display Annotation Title
XI         RF         50.Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           -0.00         1         1           -10.0         -20.0         -	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	2 3 4 5 6 	On	Display Annotation Title Graticule
XI         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           -0.00         1           -10.0         1           -20.0         -30.0           -30.0         -60.0	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I Avg Hold:>	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	2 3 4 5 6 	<u>On</u>	Display Annotation Title Graticula Of Display Line
XI         RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 00         1         1           -10.0         -1         -1           -20 0         -30 0         -40 0           -50 0         -5         -5	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I Avg Hold:>	IGN AUTO Log-Pwr 100/100	TRACE TYPE DET	123456 4444444 144444 15444 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 18854 1994	<u>On</u>	Display Annotation Title Graticula Of Display Lina -18.86 dBn
XI         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           -00         1           -100         1           -200         -300           -300         -400           -600         -700           -700         -700	PNO: Wide 😱 Tr	g: Free Run	Avg Type: I Avg Hold:>	IGN AUTO -og-Pwr 100/100	TRACE TYPE Det	18.85 dBm	<u>On</u>	Display Annotation Title Graticule Of Display Line -18.85 dBm
XI         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           0.00         1           -10.0         1           -20.0         -30.0           -30.0         -60.0           -70.0         -70.0	PNO: Wide 😱 Tr	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100	TRACE TYPE Det 1kr2 4.6' -51.2	2 3 4 5 6 - NNNNN - NNNNN - NNNNN - NNNNN - 16.85 dBm - 16.85 dBm	<u>On</u>	Display Annotation Title Graticula Of Display Lina -18.85 dBn
N         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           -99         -10 dB/div           -10 dB/div         Ref 10.00 dBm           -99         -10 dB/div           -10 dB/div         Ref 10.00 dBm           -90         -10 dB/div           -20 0         -10 dB/div           -30 0         -10 dB/div           -40 0         -10 dB/div           -50 0         -10 dB/div           -60 0         -10 dB/div           -70 0         -10 dB/div           -60 0         -10 dB/div           -70 0         -10 dB/div           -80 0         -10 dB/div           -70 0         -10 dB/div	PNO: Wide Tri IFGain:Low Tri At	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100	TRACE TYPE Det 1kr2 4.6' -51.2	2 3 4 5 6 - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNNNNN	<u>On</u>	Display Annotation Title Graticula Of Display Lina -18.85 dBn
XI         RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0.00         1         1           0.00         1         1           10.0         1         1           10.0         1         1           10.0         1         1           10.0         1         1           10.0         1         1           10.0         1         1           10.0         1         1           1         1         1           1         1         1           1         1         1	PNO: Wide Tri IFGain:Low Tri At	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100 AM	TRACE TYPE Det Ikr2 4.6' -51.2 Span 10.00 ms (10	2 3 4 5 6 - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNNNNN	<u>On</u>	Display Annotation Title Graticule Of Display Line -18.85 dBm Of System
XI         RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 00         1         1           -00         1         1           -10.0         -1         1           -10.0         -1         1           -10.0         -1         -1           -20.0         -1         -1           -20.0         -1         -1           -20.0         -1         -1           -20.0         -1         -1           -60.0         -1         -1           -60.0         -1         -1           -70.0         -1         -1           -80.0         -1         -1           Center 2.483500 GHz         #           #Res BW 100 kHz         X           MRR MODE TRC SCL         X           1         1         f           2         A1         1         f           3         -1         -1         (Δ)	PNO: Wide Tri IFGain:Low Tri At	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100 AM	TRACE TYPE Det Ikr2 4.6' -51.2 Span 10.00 ms (10	2 3 4 5 6 - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNN - NNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNN - NNNNNNNNNN	<u>On</u>	Display Annotation Title Graticule Of Display Line -18.85 dBm Of System
XI         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           -99         -10           -100         -11           -200         -11           -300         -10           -400         -10           -500         -10           -600         -10           -700         -10           -800         -10           -700         -10           -800         -10           -700         -10           -800         -10           -800         -10           -800         -10           -800         -10           -800         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10           -900         -10	PNO: Wide Tri IFGain:Low Tri At	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100 AM	TRACE TYPE Det Ikr2 4.6' -51.2 Span 10.00 ms (10	2 3 4 5 6 WWWWWWW WWWWWWW WWWWWWW WWWWWWW WWWWWW	<u>On</u>	Display Annotation Title Graticule Of Display Line -18.85 dBm Of System Display
XI         RF         50 Ω         AC           Display Line -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 00         1         1           -00         1         1           -10.0         -1         1           -10.0         -1         -1           -10.0         -1         -1           -20.0         -1         -1           -20.0         -1         -1           -30.0         -1         -1           -60.0         -1         -1           -60.0         -1         -1           -70.0         -1         -1           -80.0         -1         -1           Center 2.483500 GHz         #           #Res BW 100 kHz         X           MRR MODE TRC SCL         X           1         1         f           2         A1         1         f           4         -1         -1         -1           5         -1         -1         -1           6         -1         -1         -1           7         -1         -1         -1           8         -1	PNO: Wide Tri IFGain:Low Tri At	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100 AM	TRACE TYPE Det Ikr2 4.6' -51.2 Span 10.00 ms (10	2 3 4 5 6 WWWWWWW WWWWWWW WWWWWWW WWWWWWW WWWWWW	<u>On</u>	Display Annotation Title Graticule Of Display Line -18.85 dBn Of System Display I
XI         RF         50 Ω         AC           Display Line         -18.85 dBm           10 dB/div         Ref 10.00 dBm           0 c0         -1           -20 0         -2           -30 0         -40 0           -60 0         -2           -80 0         -40 0           -60 0         -2           -70 0         -2           -80 0         -2           -70 0         -2<	PN0: Wide IFGain:Low Tr A1 A1 A1 A1 A1 A1 A1 A1 A1 A1	g: Free Run ten: 20 dB	Avg Type: Avg Hold:>	IGN AUTO -og-Pwr 100/100 AM	TRACE TYPE Det Ikr2 4.6' -51.2 Span 10.00 ms (10	2 3 4 5 6 WWWWWWW WWWWWWW WWWWWWW WWWWWWW WWWWWW	<u>On</u>	Display Annotation> Title> Graticule Off Display Line -18.85 dBm Off System Display>

# **GFSK Highest Channel**



Kausiaht Casataun Anakana Curat CA	- 4			Ulla	inci			
Keysight Spectrum Analyzer - Swept SA RF 50 Ω AC		SENSE:INT SOU		ALIGN AUTO		Jun 06, 2019	-	Display
Display Line -18.17 dBm	PNO: Wide 😱 Tri	g: Free Run	Avg Type Avg Hold	e: Log-Pwr :>100/100	TVP	123456 MWWWW		Display
	IFGain:Low At	ten: 20 dB			DE	PNNNNN		Annotation
				ΔN	lkr2 -4.1		•	Annotatior
10 dB/div Ref 10.00 dBm					-39.	509 dB		
0.00			~~~	<u>2</u>				
-10.0			L /					Title
-20.0			+/			-18.17 dBm		
-30.0	<mark>_</mark> 2∆1	~		- L,	~~~~			Graticu
-40.0	~~~				$\rightarrow$		<u>On</u>	(
-50.0					- how	www.h		
60.0						··· 'lu~	-	Display Lii
70.0								-18.17 dB
80.0							<u>On</u>	(
Center 2.400000 GHz		<b>A</b>			Span 10	0.00 MHz		
Res BW 100 kHz	#VBW 300	) kHz		Sweep 1.0	000 ms (1	001 pts)		
MKR MODE TRC SCL X				NCTION WIDTH	FUNCTIO	N VALUE		
1 N 1 f 2.4 2 Δ1 1 f (Δ)	02 08 GHz 1. -4.17 MHz (Δ) -3	826 dBm 9.509 dB						System
3 4								Display
5						E		Settings
6 7								
8								
10						-		
<						•		
<mark>sg</mark>				STATUS				
Keysight Spectrum Analyzer - Swept SA				ALIGN AUTO	00.51.10.00		_	- ē
<sup>d</sup> RF 50 Ω AC Display Line -18.17 dBm		SENSE:INT SOU	Avg Type	e: Log-Pwr	TRACI	Jun 06, 2019 <b>1 2 3 4 5 6</b>		Display
		g: Free Run ten: 20 dB	Avg Hold	:>100/100	DE			
				ΔN	lkr2 -4.:	17 MHz	1	Annotatior
0 dB/div Ref 10.00 dBm						509 dB		
-og 0.00			00	$\lambda^1$		00		
10.0				~~~ v		~~~~ ·		Title
20.0						-18.17 dBm		
30.0	2∆1		/					
		$\wedge$						Graticu
40.0	m _m_	m	<i></i>				On	
	- Marina	~m²					<u>On</u>	
40.0 50.0			<i>ل</i> مر 					(
50.0								( Display Lii
50.0								( Display Lii -18.17 dB
					Spap 44			( Display Lii -18.17 dB
50.0	#VBW 300	) kHz		Sweep 1.		).00 MHz		( Display Lii -18.17 dB
50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	#VBW 300			Sweep 1.		0.00 MHz 1001 pts)		( Display Lii -18.17 dB
50.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		( Display Lii -18.17 dB (
60.0	02 08 GHz 1.	Y FUN			000 ms (1	0.00 MHz 1001 pts)		Display Lii -18.17 dE ( Systen
50.0 60.0 70.0 80.0 Center 2.400000 GHz #Res BW 100 kHz MKR MODE TRC SCL Χ 1 N 1 f 2.4 2 Δ1 1 f (Δ) 3 4 5	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		Display Lii -18.17 dB ( Systen Display
50 0 60 0 70 0 80 0 Center 2.400000 GHz #Res BW 100 kHz MKR MODE TRCI SCL X 1 N 1 f 2.4 3 1 1 f (Δ) 3 4 6 0	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		Display Lii -18.17 dB ( Systen Display
50.0 60.0 70.0 Center 2.400000 GHz #Res BW 100 kHz MKR MODE TRC SCL X 1 N 1 f 2.4 3 4 5 5 6 7 8	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		Display Lii -18.17 dB ( Systen Display
50.0	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		Display Lii -18.17 dB ( Systen Display
50 0 60 0 70 0 60 0 Center 2.400000 GHz Res BW 100 kHz MKR MODE TRC SCI X 1 N 1 f 2.4 3 Δ1 1 f (Δ) 3 4 5 6 6 7 8 9	02 08 GHz 1.	Y FUN 826 dBm			000 ms (1	0.00 MHz 1001 pts)		System Display Lin -18.17 dB ( System Display Settings

### π/4-DQPSK Lowest Channel



Display Line -1			SENSE:INT SC		ALIGN AUTO	09:52:02 AM	Jun 06, 2019		Disalau
	l9.05 dBm	PNO: Wide 😱	Trig: Free Run	Avg Typ	be: Log-Pwr d:>100/100	TRACE	123456 MWWWW PNNNNN		Display
		IFGain:Low	Atten: 20 dB			DE	PNNNN		
					Δ	Mkr2 4.0			Annotation
00	10.00 dBm		•			-50.	708 dB		
0.00	)1 //								
-10.0	<u> </u>								Title
-20.0							-19.05 dBm		
-30.0	-	~~~							Graticu
-40.0	~			<u>_</u> 2∆1 —				<u>On</u>	(
-50.0		- marin		X					
-60.0				the way was a way of the second	www.l.m		m		Display Lii
-70.0									-19.05 dE
-80.0								<u>On</u>	(
Center 2.48350	0 GHz					Snan 1(	.00 MHz		
#Res BW 100 k		#VBW	300 kHz		Sweep 1.	000 ms (1	001 pts)		
MKR MODE TRC SCL	Х		Y FI	JNCTION   FL	INCTION WIDTH	FUNCTIO			
1 N 1 f 2 Δ1 1 f (	2.47	79 76 GHz	0.954 dBm						_
3	Δ	4.62 MHz (Δ)	-50.708 dB						System Display
4							=		Settings
6 7									
8									
9 10									
ISG					STATUS				
Keysight Spectrum An	alvzer - Swept SA								
XI RF	50 Ω AC		SENSE:INT SC		ALIGN AUTO		Jun 06, 2019		′iew/Display
Display Line -1	19.04 aBM		Trim Free Day			TRACE		V	
		PNO: Wide 😱	Trig: Free Run	Avg Hol	be: Log-Pwr d:>100/100	TRACE	1 2 3 4 5 6 MWWWWW	V	
		PNO: Wide IFGain:Low	Atten: 20 dB	Avg Hol	d:>100/100	TYPI DE	PNNNN	V	
			Atten: 20 dB	Avg Hol	d:>100/100	TYPE DE	P NNNNN S2 MHz	V	
10 dB/div Ref	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	PNNNN		
10 dB/div Ref			Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	P NNNNN S2 MHz		Display
	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	2 MHz 711 dB	V	Display
0.00	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	P NNNNN S2 MHz		Display
-10.0	10.00 dBm		Atten: 20 dB	AvgiHold	d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm
-10.0	10.00 dBm		Atten: 20 dB		d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm
-10.0 -20.0 -30.0	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm
0.00	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm
0.00	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm Spectrogra
0.00	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	TYPE DE	2 MHz 711 dB		Display Norm Spectrogra
0.00 -10.0 -20.0 -30.0 -40.0 -50.0 -50.0 -60.0 -70.0 -80.0 -7	10.00 dBm		Atten: 20 dB	Avg Hold	d:>100/100	-50.	2 MHz 32 MHz 711 dB		Display Norm Spectrogra
0.00 -10.0 -20.0 -30.0 -40.0 -50.0 -60.0 -70.0 -80	10.00 dBm	IFGain:Low	Atten: 20 dB	Avg Hold	d:>100/100	••••••••••••••••••••••••••••••••••••••	2 MHz 711 dB		Display Norm Spectrogra Trace Zoo
0.00 -10.0 -20.0 -30.0 -40.0 -50.0 -60.0 -70.0 -80	10.00 dBm	IFGain:Low	Atten: 20 dB	Avg Hold		••••••••••••••••••••••••••••••••••••••	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0 00 -10 0 -20 0 -20 0 -30 0 -30 0 -40 0 -50 0 -5	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0 00 -20 0 -20 0 -30 0 0 0 -30 0 0 0 0 -30 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0.00 -20.0 -20	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo Zone Spa
Log 0.00 -20.0	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0.00 -0.00 -0.00 -20.0 -20	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0.00 -20.0 -20	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo
0.00 -10.0 -20.0 -30.0 -30.0 -40.0 -50	10.00 dBm	#VBW	Atten: 20 dB	Avg Hold	d:>100/100	Span 10 000 ms (1	2 MHz 32 MHz 11 dB 1904 dB 00 MHz 001 pts)		Display Norm Spectrogra Trace Zoo

# $\pi$ /4-DQPSK Highest Channel



### 11.Antenna Application

### **11.1 Antenna requirement**

According to of FCC part 15C section 15.203 and 15.240:

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.

Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

#### **11.2 Measurement Results**

The antenna is PCB antenna and no consideration of replacement, and the best case gain of the antenna is -0.58dBi. Therefore, the antenna is consider meet the requirement.



### **12. Conducted Spurious Emissions**

### **12.1 Measurement Procedure**

Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

The transmitter output is connected to spectrum analyzer. All spurious emission and up tp the tenth harmonic was measured and they were found to be at least 20dB below the highest level of the desired power in the passband.

#### **12.2. Measurement Results**

Please refer to following plots, the worst case ( $\pi$ /4-DQPSK) was shown.



	Lowest C	hannel		
Keysight Spectrum Analyzer - Swept SA RF 50 Ω AC	SENSE:INT SOUR	CE OFF ALIGN AUTO	10:10:44 AM Jun 06, 2019	- ē Z
larker 1 96.0246666667 MHz PNO: Fa IFGain:Ld	st 🕞 Trig: Free Run	Avg Type: Log-Pwr Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N N	Peak Search
0 dB/div Ref 10.00 dBm	W Atten: 20 db	Mk	r1 96.02 MHz -56.224 dBm	Next Pea
og 			-17.94 dBm	Next Pk Rigl
0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0				Next Pk Le
		a for the processing story of the processing of the story	warging the flames that have named a second state of the second st	Marker Del
tart 0.0300 GHz Res BW 100 kHz #	VBW 300 kHz		top 1.0000 GHz ms (30001 pts)	Mkr→C
N         1         f         96.02 MHz           2         3         -         -           3         -         -         -           4         -         -         -           5         -         -         -           6         -         -         -			E	Mkr→RefL
				<b>M</b> o 1 o
G <mark>.</mark>	III	STATUS	→	
Keysight Spectrum Analyzer - Swept SA RF   50 Ω AC   Splay Line -17.94 dBm PNO: Fa	SENSE:INT SOUR	CE OFF ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	10:10:24 AM Jun 06, 2019 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P N N N N	Display
dB/div Ref 10.00 dBm	W Atten: 20 dB	Mkr2	4.804 0 GHz -35.144 dBm	Annotatior
			-17.94 dBm	Title
			Nielestar unterstanden	Graticu On (
				Display Lii -17.94 dB On (
3.0				
tart 1.00 GHz Res BW 1.0 MHz # KR MODE TRC SCL X 1 N 1 f 2.402 4 GHz	VBW 3.0 MHz		Stop 25.00 GHz ms (30001 pts)	

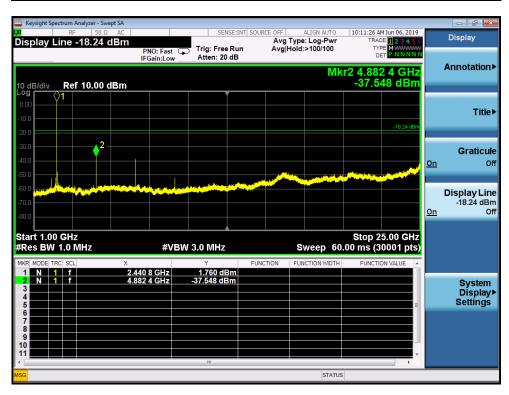
STATUS

Lowest Channel



Keysight Spectrum Analyzer - Swept SA	SENSE:INT S	DURCE OFF ALIGN AUTO	10:12:01 AM Jun 06, 2019	- ē <mark>-</mark>
Marker 1 96.0246666667	MHz	Avg Type: Log-Pwr Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWW	Peak Search
10 dB/div Ref 10.00 dBm	PNO: Fast 🕞 Trig: Free Run IFGain:Low Atten: 20 dB		Ikr1 96.02 MHz -56.177 dBm	NextPea
- <b>0</b> g 0.00 			-18.24 dBm	Next Pk Righ
40.0				Next Pk Le
	lag stag stage. I have to be a since the same start in the lage start in the same start in the same start in the	ne sta policie se positiva (ne consegura da la forma de la form	sina fasilaraan kasha sa Marsaraha na maara Ananan yaa sa sa sa sa sa	Marker Delt
Start 0.0300 GHz Res BW 100 kHz	#VBW 300 kHz	Sweep 94.	Stop 1.0000 GHz 00 ms (30001 pts)	Mkr→C
1         N         1         f           2	96.02 MHz -56.177 dBm		E	Mkr→RefL
7 8 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10				Mor 1 of
SG		STATUS		

# **Middle Channel**





		Highest	Channel		
Keysight Spectrum Analyzer - Sw RF 50 Ω	AC	SENSE:INT	SOURCE OFF ALIGN AUTO	10:12:55 AM Jun 06, 2019	
larker 1 96.024666		Trig: Free Run Atten: 20 dB	Avg Type: Log-Pwr Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE M WWWWW DET P N N N N N	Peak Search
			Ν	/kr1 96.02 MHz -56.137 dBm	NextPea
0 dB/div Ref 10.00	dBm			-30.137 UBII	
10.0					Next Pk Righ
20.0				-18.76 dBm	
40.0					Next Pk Le
	The second s	aya kanagana sa katikati katiya sa juat	A Margan Second Amagen to \$50,000 and a strend destination	a in the set of some first in the set of the estimated in the set of the set	Marker Del
SO.O			n en		
tart 0.0300 GHz Res BW 100 kHz	#VB	W 300 kHz	Sweep 94	Stop 1.0000 GHz .00 ms (30001 pts)	Mkr→C
IKR MODE TRC SCL	× 96.02 MHz	Ƴ -56.137 dBm	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	
2 3					Mkr→RefL
4 5 6				E	
7 8 9					Mor
10 11 11				-	1 of
		III	STATUS	•	
Keysight Spectrum Analyzer - Sw RF 50 Ω Display Line -18.76	AC		SOURCE OFF ALIGN AUTO Avg Type: Log-Pwr	10:12:35 AM Jun 06, 2019 TRACE 1 2 3 4 5 6	Display
	PNO: Fast C IFGain:Low	Trig: Free Run Atten: 20 dB	Avg Hold:>100/100		Annotation
0 dB/div Ref 10.00	dBm		Mł	r2 4.960 0 GHz -38.942 dBm	Annotation
					Title
20.0				-18.76 dBm	The
30.0					Graticu
40.0					<u>On</u> 0
50.0 particular in the second second		and the state of the			Display Lin
70.0					-18.76 dBi <u>On</u> O
start 1.00 GHz				Stop 25.00 GHz	
KR MODE TRC SCL	#VB	W 3.0 MHz	Sweep 60	FUNCTION VALUE	
1 N 1 f 2 N 1 f	2.480 0 GHz 4.960 0 GHz	1.236 dBm -38.942 dBm	PONCTION PONCTION WIDTH	PONCTION VALUE	System
3 4 5				=	Display Settings
6 7				=	gu
8 9 10					
SG			STATUS	3	

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Note: Sweep points=30001pts



# **13. Test Equipment List**

Description	Manufacturer	Model Number	Serial Number	Characteristics	Calibration Date	Calibration Due Date
Test Receiver	Rohde & Schwarz	ESCI7	100837	9KHz~7GHz	Mar. 14, 2019	1 year
Antenna	Schwarzbeck	VULB9162	9162-010	30MHz~7GHz	Mar. 23, 2019	1 year
Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	20Hz~26.5GHz	Mar. 14, 2019	1 year
Spectrum Analyzer	Keysight	N9020A	MY54200831	20Hz~26.5GHz	Apr. 24, 2019	1 year
Spectrum Analyzer	Rohde & Schwarz	FSV40	101003	10Hz~40GHz	Apr. 24, 2019	1 year
Horn Antenna	Schwarzbeck	BBHA9170	9170-372	15GHz~40GHz	Mar. 23, 2019	1 year
Pre-Amplifier	EMCI	EMC 184045	980102	18GHz~40GHz	Apr. 24, 2019	1 year
Power Sensor	DARE	RPR3006W	15I00041SN O64	100MHz~6GHz	Mar. 14, 2019	1 year
Communication Tester	Rohde & Schwarz	CMW500	149004	70MHz~6GHz	Mar. 14, 2019	1 year
Horn Antenna	COM-Power	AH-118	071078	500MHz~18GHz	Mar. 23, 2019	1 year
Pre-Amplifier	HP	HP 8449B	3008A00964	1GHz~26.5GHz	Mar. 14, 2019	1 year
Pre-Amplifier	HP	HP 8447D	1145A00203	100KHz~1.3GHz	Mar. 14, 2019	1 year
Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	9KHz~30MHz	Apr. 24, 2019	1 year
Temperature & Humidity Chamber	REMAFEE	SYHR225L	N/A	- <b>40~150</b> ℃	Apr. 24, 2019	1 year
DC Source	MY	MY8811	N/A	0~30V	N/A	N/A
Temporary antenna connector	TESCOM	SS402	N/A	9KHz~25GHz	N/A	N/A
Power Meter	Anritsu	ML2495A	1139001	100k-65GHz	Apr. 24, 2019	1 year
Power Sensor	Anritsu	MA2411B	100345	300M-40GHz	Apr. 24, 2019	1 year
Test Software	EZ	EZ_EMC	N/A	N/A	N/A	N/A

Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna coSnnector is listed in the equipment list.

---End----