

# **TEST REPORT**

Report No.:	BCTC2102855277E
Applicant:	ShenZhen Mossloo Industrial Co.,Ltd
Product Name:	Auto Pair True Wireless Earbuds
Model/Type Ref.:	MSL-DZ001
Tested Date:	2021-02-23 to 2021-03-05
Issued Date:	2021-03-08
She	nzhen Berchesting Co., Ltd.
No. : BCTC/RF-EMC-005	Page: 1 of 71



# FCC ID: 2AN8FMSL-DZ001

Product Name:	Auto Pair True Wireless Earbuds
Trademark:	N/A
Model/Type Ref.:	MSL-DZ001 7197-46
Prepared For:	ShenZhen Mossloo Industrial Co.,Ltd
Address:	Road One No.4, Science Industrial Park, Shangxue Village, Bantian Street, Longgang District, Shenzhen, China
Manufacturer:	ShenZhen Mossloo Industrial Co.,Ltd
Address:	Road One No.4, Science Industrial Park, Shangxue Village, Bantian Street, Longgang District, Shenzhen, China
Prepared By:	Shenzhen BCTC Testing Co., Ltd.
Address:	1-2/F., Building B, Pengzhou Industrial Park, No.158, Fuyuan 1st Road, Tangwei, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China
Sample Received Date:	2021-02-23
Sample tested Date:	2021-02-23 to 2021-03-05
Issue Date:	2021-03-08
Report No.:	BCTC2102855277E
Test Standards	FCC Part15.247 ANSI C63.10-2013
Test Results	PASS
Remark:	This is Bluetooth Classic radio test report.

Tested by: Zil au

Eric Yang/Project Handler

Approved by:

Zero Zhou/Reviewer

The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen BCTC Testing Co., Ltd, this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client.



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(Note: N/A means not applicable)

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## 1. VERSION

Report No.	Issue Date	Description	Approved
BCTC2102855277E	2021-03-08	Original	Valid



## 2. TEST SUMMARY

The Product has been tested according to the following specifications:

No.	Test Parameter	Clause No	Results
1	Conducted emission AC power port	§15.207	PASS
2	Conducted peak output power for FHSS	§15.247(b)(1)	PASS
3	20dB Occupied bandwidth	§15.247(a)(1)	PASS
4	Number of hoppingfrequencies	§15.247(a)(1)(iii)	PASS
5	Dwell Time	§15.247(a)(1)(iii)	PASS
6	Spurious RF conducted emissions	§15.247(d)	PASS
7	Band edge	§15.247(d)	PASS
8	Spurious radiated emissions for transmitter	§15.247(d) & §15.209 & §15.205	PASS
9	Antenna Requirement	15.203	PASS





## 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.

No.	Item	Uncertainty
1	3m camber Radiated spurious emission(9kHz-30MHz)	U=3.7dB
2	3m camber Radiated spurious emission(30MHz-1GHz)	U=4.3dB
3	3m chamber Radiated spurious emission(1GHz-18GHz)	U=4.5dB
4	3m chamber Radiated spurious emission(18GHz-40GHz)	U=3.34dB
5	Conducted Adjacent channel power	U=1.38dB
6	Conducted output power uncertainty Above 1G	U=1.576dB
7	Conducted output power uncertainty below 1G	U=1.28dB
8	humidity uncertainty	U=5.3%
9	Temperature uncertainty	<b>U=0.59</b> ℃



## 4. PRODUCT INFORMATION AND TEST SETUP

## 4.1 Product Information

Model/Type Ref.:	MSL-DZ001 7197-46
Model differences:	All the model are the same circuit and RF module, except model names.
Operation Frequency:	Bluetooth: 2402-2480MHz
Type of Modulation:	Bluetooth: GFSK, Pi/4 DQPSK, 8DPSK
Number Of Channel	79CH
Antenna installation:	Bluetooth: CHIP antenna
Antenna Gain:	Bluetooth: 1dBi
Ratings:	DC 3.7V From Battery

## 4.2 Test Setup Configuration

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

Conducted Emission:



Radiated Spurious Emission

E-1 EUT	
------------	--



## 4.3 Support Equipment

No.	Device Type	Brand	Model	Series No.	Note
E-1	Auto Pair True Wireless Earbuds	N/A	MSL-DZ001	N/A	EUT
E-2	Adapter	N/A	BCTC001	N/A	Auxiliary

Item	Shielded Type	Ferrite Core	Length	Note	
C-1	NO	NO	0.3M	DC cable unshielded	

#### 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

СН	Frequency (MHz)	СН	Frequency (MHz)	СН	Frequency (MHz)	СН	Frequency (MHz)
0	2402	1	2403	2	2404	3	2405
4	2406	5	2407	6	2408	7	2409
8	2410	9	2411	10	2412	<u>11</u>	2413
12	2414	13	2415	14	2416	15	2417
16	2418	17	2419	18	2420	19	2421
20	2422	21	2423	22	2424	23	2425
24	2426	25	2427	26	2428	27	2429
28	2430	29	2431	30	2432	31	2433
32	2434	33	2435	34	2436	35	2437
36	2438	37	2439	38	2440	39	2441
40	2442	41	2443	42	2444	43	2445
44	2446	45	2447	46	2448	47	2449
48	2450	49	2451	50	2452	51	2453
52	2454	53	2455	54	2456	55	2457
56	2458	57	2459	58	2460	59	2461
60	2462	61	2463	62	2464	63	2465
64	2466	65	2467	66	2468	67	2469
68	2470	69	2471	70	2472	71	2473
72	2474	73	2475	74	2476	75	2477
76	2478	77	2479	78	2480	79	



## 4.5 Test Mode

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Test Mode	Test mode	Low channel	Middle channel	High channel
1	Transmitting(GFSK)	2402MHz	2441MHz	2480MHz
2	Transmitting(Pi/4DQPSK)	2402MHz	2441MHz	2480MHz
3	Transmitting(8DPSK)	2402MHz	2441MHz	2480MHz
4	Charging (Conducted emission)			
5	Transmitting (Radiated emission)			

Note:

(1) The measurements are performed at the highest, middle, lowest available channels.

(2) Fully-charged battery is used during the test

## 4.6 table of parameters of text software setting

During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters

Test software Version	FCC_assist 1.0.2.2			
Frequency	2402 MHz	2441 MHz	2480 MHz	
Parameters	DEF	DEF	DEF	



## 5. TEST FACILITY AND TEST INSTRUMENT USED

## 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at Shenzhen BCTC Testing Co., Ltd. Address: 1-2/F., Building B, Pengzhou Industrial Park, No.158, Fuyuan 1st Road, Tangwei, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

FCC Test Firm Registration Number: 712850

IC Registered No.: 23583

## 5.2 Test Instrument Used

Conducted emissions Test					
Equipment	Manufacturer	Model#	Serial#	Last Cal.	Next Cal.
Receiver	R&S	ESR3	102075	Jun. 08, 2020	Jun. 07, 2021
LISN	R&S	ENV216	101375	Jun. 04, 2020	Jun. 03, 2021
ISN	HPX	ISN T800	S1509001	Jun. 04, 2020	Jun. 03, 2021
Software	Frad	EZ-EMC	EMC-CON 3A1	/	١.

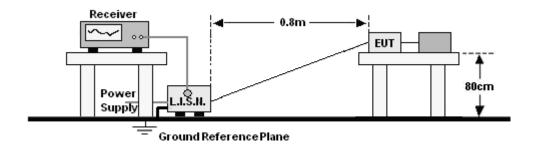


	Radiated	d emissions	Test (966 cha	amber)	
Equipment	Manufacturer	Model#	Serial#	Last Cal.	Next Cal.
966 chamber	ChengYu	966 Room	966	Jun. 06. 2020	Jun. 05, 2023
Receiver	R&S	ESR3	102075	Jun. 08, 2020	Jun. 07, 2021
Receiver	R&S	ESRP	101154	Jun. 08, 2020	Jun. 07, 2021
Amplifier	Schwarzbeck	BBV9718	9718-309	Jun. 04, 2020	Jun. 03, 2021
Amplifier	Schwarzbeck	BBV9744	9744-0037	Jun. 04, 2020	Jun. 03, 2021
TRILOG Broadband Antenna	schwarzbeck	VULB 9163	VULB9163- 942	Jun. 08, 2020	Jun. 07, 2021
Horn Antenna	SCHWARZBE CK	BBHA9120 D	1201	Jun. 10, 2020	Jun. 09, 2021
Horn Antenna (18GHz-40 GHz)	SCHWARZBE CK	BBHA9170	822	Jun. 10, 2020	Jun. 09, 2021
Amplifier (18GHz-40 GHz)	MITEQ	TTA1840-3 5-HG	2034381	Jun. 08, 2020	Jun. 07, 2021
Loop Antenna (9KHz-30M Hz)	SCHWARZBE CK	FMZB1519 B	014	Jun. 08, 2020	Jun. 07, 2021
RF cables1 (9kHz-30MH z)	Huber+Suhnar	9kHz-30M Hz	B1702988- 0008	Jun. 08, 2020	Jun. 07, 2021
RF cables2 (30MHz-1G Hz)	Huber+Suhnar	30MHz-1G Hz	1486150	Jun. 08, 2020	Jun. 07, 2021
RF cables3 (1GHz-40G Hz)	Huber+Suhnar	1GHz-40G Hz	1607106	Jun. 08, 2020	Jun. 07, 2021
Power Metter	Keysight	E4419B	<u> </u>	Jun. 08, 2020	Jun. 07, 2021
Power Sensor (AV)	Keysight	E9 300A	\	Jun. 08, 2020	Jun. 07, 2021
Signal Analyzer 20kHz-26.5 GHz	KEYSIGHT	N9020A	MY491000 60	Jun. 04, 2020	Jun. 03, 2021
Spectrum Analyzer 9kHz-40G Hz	Agilent	FSP40	100363	Jun. 13, 2020	Jun. 12, 2021
Software	Frad	EZ-EMC	FA-03A2 RE		
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## 6. CONDUCTED EMISSIONS

6.1 Block Diagram Of Test Setup



## 6.2 Limit

FREQUENCY (MHz)	Limit (dBuV)		
FREQUENCT (MHZ)	Quas-peak	Average	
0.15 -0.5	66 - 56 *	56 - 46 *	
0.50 -5.0	56.00	46.00	
5.0 -30.0	60.00	50.00	
	•		

Notes:

1. \*Decreasing linearly with logarithm of frequency.

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

## 6.3 Test procedure

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

a. The Product was placed on a nonconductive table 0.8 m above the horizontal ground reference plane, and 0.4 m from the vertical ground reference plane, and connected to the main through Line Impedance Stability Network (L.I.S.N).

b. The RBW of the receiver was set at 9 kHz in 150 kHz ~ 30MHz with Peak and AVG detector in Max Hold mode. Run the receiver's pre-scan to record the maximum disturbance generated from Product in all power lines in the full band.

c. For each frequency whose maximum record was higher or close to limit, measure its QP and AVG values and record.



## 6.4 EUT operating Conditions

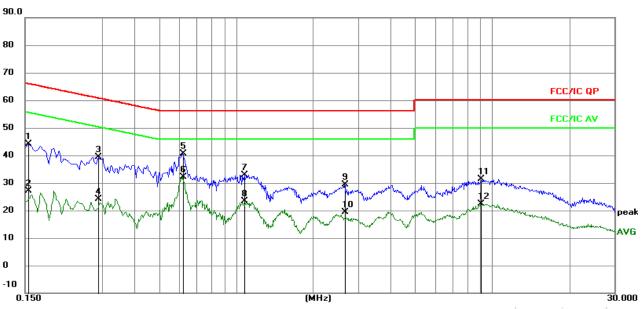
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

No. : BCTC/RF-EMC-005



## 6.5 Test Result

Temperature :	<b>26</b> ℃	Relative Humidity :	54%
Pressure :	101kPa	Phase :	L
Test Voltage :	AC 120V/60Hz	Test Mode :	Mode 4



#### Remark:

1. All readings are Quasi-Peak and Average values.

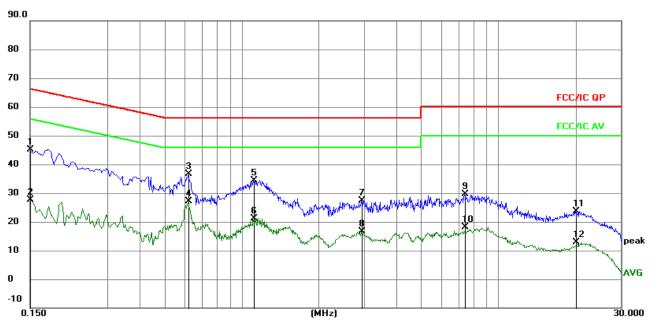
2. Factor = Insertion Loss + Cable Loss.

No. Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
	MHz		dB	dBuV	dBuV	dB	Detector
1	0.1544	34.68	9.51	44.19	65.76	-21.57	QP
2	0.1544	17.51	9.51	27.02	55.76	-28.74	AVG
3	0.2895	29.74	9.57	39.31	60.54	-21.23	QP
4	0.2895	14.51	9.57	24.08	50.54	-26.46	AVG
5	0.6179	30.64	9.94	40.58	56.00	-15.42	QP
6 *	0.6179	22.28	9.94	32.22	46.00	-13.78	AVG
7	1.0814	23.40	9.57	32.97	56.00	-23.03	QP
8	1.0814	13.84	9.57	23.41	46.00	-22.59	AVG
9	2.6565	19.84	9.64	29.48	56.00	-26.52	QP
10	2.6565	9.84	9.64	19.48	46.00	-26.52	AVG
11	9.0285	21.63	9.70	31.33	60.00	-28.67	QP
12	9.0285	12.69	9.70	22.39	50.00	-27.61	AVG



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Temperature :	<b>26</b> ℃	Relative Humidity :	54%
Pressure :	101kPa	Phase :	Ν
Test Voltage :	AC 120V/60Hz	Test Mode :	Mode 4



#### Remark:

All readings are Quasi-Peak and Average values.
 Factor = Insertion Loss + Cable Loss.

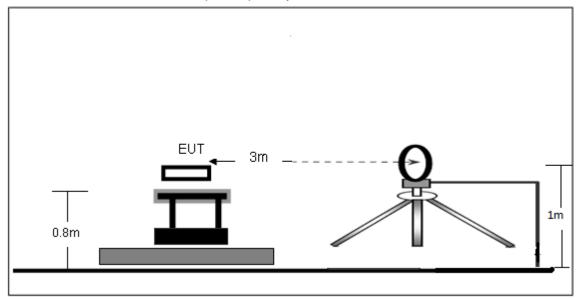
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz		dB	dBuV	dBuV	dB	Detector
1		0.1500	35.62	9.52	45.14	66.00	-20.86	QP
2		0.1500	18.15	9.52	27.67	56.00	-28.33	AVG
3		0.6223	26.72	9.92	36.64	56.00	-19.36	QP
4	*	0.6223	17.22	9.92	27.14	46.00	-18.86	AVG
5		1.1129	24.78	9.57	34.35	56.00	-21.65	QP
6		1.1129	11.59	9.57	21.16	46.00	-24.84	AVG
7		2.9355	17.80	9.66	27.46	56.00	-28.54	QP
8		2.9355	6.97	9.66	16.63	46.00	-29.37	AVG
9		7.3905	19.91	9.72	29.63	60.00	-30.37	QP
10		7.3905	8.32	9.72	18.04	50.00	-31.96	AVG
11		19.9814	13.94	9.79	23.73	60.00	-36.27	QP
12		19.9814	3.21	9.79	13.00	50.00	-37.00	AVG

No.: BCTC/RF-EMC-005

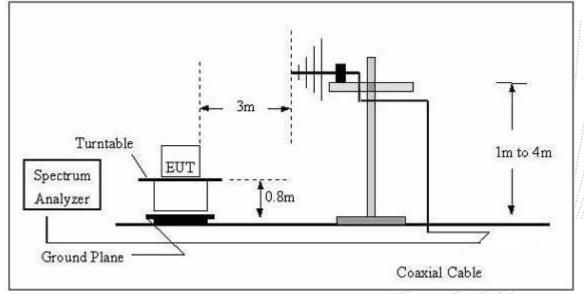


## 7. RADIATED EMISSIONS

- 7.1 Block Diagram Of Test Setup
  - (A) Radiated Emission Test-Up Frequency Below 30MHz

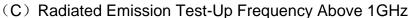


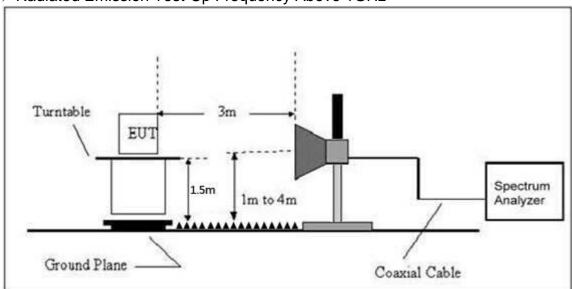
(B) Radiated Emission Test-Up Frequency 30MHz~1GHz





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## 7.2 Limit

20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequency	Field Strength	Distance	Field Strength Limit at 3m Distance		
(MHz)	uV/m	(m)	uV/m	dBuV/m	
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	20log <sup>(2400/F(kHz))</sup> + 80	
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	20log <sup>(24000/F(kHz))</sup> + 40	
1.705 ~ 30	30	30	100 * 30	20log <sup>(30)</sup> + 40	
30 ~ 88	100	3	100	20log <sup>(100)</sup>	
88 ~ 216	150	3	150	20log <sup>(150)</sup>	
216 ~ 960	200	3	200	20log <sup>(200)</sup>	
Above 960	500	3	500	20log <sup>(500)</sup>	

## LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

FREQUENC	Limit (dBuV/m) (at 3M)		
Y (MHz)	PEAK	AVERAGE	
Above 1000	74	54	

### Notes:

(1)The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

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



## 7.3 Test procedure

Receiver Parameter	Setting
Attenuation	Auto
9kHz~150kHz	RBW 200Hz for QP
150kHz~30MHz	RBW 9kHz for QP
30MHz~1000MHz	RBW 120kHz for QP

Spectrum Parameter	Setting	
1-25GHz	RBW 1 MHz /VBW 1 MHz for Peak, RBW 1 MHz / VBW 10Hz for Average	

Below 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. 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.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. 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:

g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 metre to 1.5 metre( Above 18GHz the distance is 1 meter and table is 1.5 metre).

h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel.

Note:



Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

Above 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b.The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c.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.

d.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 rota table was turned from 0 degrees to 360 degrees to find the maximum reading.

e.The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. 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.

g.Test the EUT in the lowest channel, the Highest channel.

Note:

Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

## 7.4 EUT operating Conditions

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.



## 7.5 Test Result

Below 30MHz

Temperature:	<b>26</b> ℃	Relative Humidtity:	24%
Pressure:	101 kPa	Test Voltage :	DC 3.7V
Test Mode :	Mode 5	Polarization :	

Freq.	Reading	Limit	Margin	State
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F
				PASS
				PASS

Note:

The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Distance extrapolation factor =40 log (specific distance/test distance)(dB); Limit line = specific limits(dBuv) + distance extrapolation factor.

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Between 30MHz – 1GHz					
Temperature:	<b>26</b> ℃	Relative Humidtity:	54%		
Pressure:	101 kPa	Test Voltage :	DC 3.7V		
Test Mode :	Mode 5	Polarization :	Horizontal		

#### N / I I ---1047

0.0 dBu∀/m							
							ECC/IC QP
			4				6 ×
1 Janot Managarating Pandagara	2	3	bury www. www.	M. W.	Hundreich	untitellumentationale	durender the deriver
.0 30.000 40 50		30	(MHz)	300	400 50	0 600	700 1000.00

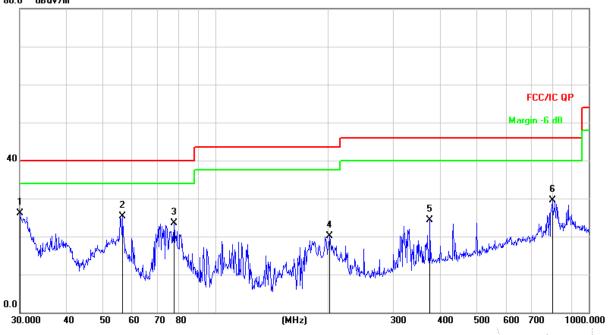
#### Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.

								• • •	
-	No.	Mk	. Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
_			MHz	dBu∨	dB	dBuV/m	dB/m	dB	Detector
-	1		30.4238	28.77	-16.06	12.71	40.00	-27.29	QP
	2		56.5929	26.99	-14.46	12.53	40.00	-27.47	QP
-	3		109.0286	28.16	-16.06	12.10	43.50	-31.40	QP
-	4	*	204.2377	41.54	-15.17	26.37	43.50	-17.13	QP
_	5		372.0045	34.79	-10.46	24.33	46.00	-21.67	QP
-	6		884.5029	26.56	-0.32	26.24	46.00	-19.76	QP



Temperature:	<b>26</b> ℃	Relative Humidtity:	54%
Pressure:	101 kpa	Test Voltage :	DC 3.7V
Test Mode :	Mode 5	Polarization :	Vertical

80.0 dBuV/m



## Remark:

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

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBu∨	dB	dBuV/m	dB/m	dB	Detector
1	*	30.0000	42.20	-16.11	26.09	40.00	-13.91	QP
2		56.5929	39.81	-14.46	25.35	40.00	-14.65	QP
3		77.5928	42.41	-18.96	23.45	40.00	-16.55	QP
4		202.8104	35.32	-15.20	20.12	43.50	-23.38	QP
5		375.9385	34.60	-10.35	24.25	46.00	-21.75	QP
6	-	798.9797	31.59	-2.01	29.58	46.00	-16.42	QP



#### Between 1GHz – 25GHz

Polar	Frequency	Reading Level	Correct Factor	Measure- ment	Limits	Over	Detector
(H/V)	(MHz)	(dBuV/m)	(dB)	(dBuV/m)	(dBuV/ m)	(dB)	Туре
		G	FSK Low cł	nannel			
V	4804.00	52.90	-0.43	52.47	74.00	-21.53	PK
V	4804.00	42.78	-0.43	42.35	54.00	-11.65	AV
V	7206.00	42.19	8.31	50.50	74.00	-23.50	PK
V	7206.00	32.24	8.31	40.55	54.00	-13.45	AV
Н	4804.00	50.37	-0.43	49.94	74.00	-24.06	PK
Н	4804.00	40.98	-0.43	40.55	54.00	-13.45	AV
Н	7206.00	39.23	8.31	47.54	74.00	-26.46	PK
Н	7206.00	30.56	8.31	38.87	54.00	-15.13	AV
		GF	SK Middle o	channel	-		
V	4882.00	49.61	-0.38	49.23	74.00	-24.77	PK
V	4882.00	43.03	-0.38	42.65	54.00	-11.35	AV
V	7323.00	41.60	8.83	50.43	74.00	-23.57	PK
V	7323.00	32.91	8.83	41.74	54.00	-12.26	AV
Н	4882.00	48.58	-0.38	48.20	74.00	-25.80	PK
Н	4882.00	38.21	-0.38	37.83	54.00	<sub>1</sub> -16.17	AV
Н	7323.00	40.06	8.83	48.89	74.00	-25.11	PK
Н	7323.00	31.67	8.83	40.50	54.00	-13.50	AV
		G	SK High c	hannel			
V	4960.00	51.99	-0.32	51.67	74.00	-22.33	PK
V	4960.00	41.25	-0.32	40.93	54.00	-13.07	AV
V	7440.00	44.34	9.35	53.69	74.00	-20.31	PK
V	7440.00	33.99	9.35	43.34	54.00	-10.66	AV
Н	4960.00	50.36	-0.32	50.04	74.00	-23.96	PK
Н	4960.00	39.80	-0.32	39.48	54.00	-14.52	AV
Н	7440.00	42.05	9.35	51.40	74.00	-22.60	PK
Н	7440.00	34.31	9.35	43.66	54.00	-10.34	AV

#### Remark:

1.Emission Level = Meter Reading + Factor,

Factor = Antenna Factor + Cable Loss - Pre-amplifier.

Over= Emission Level - Limit

2.If peak below the average limit, the average emission was no test.

3. In restricted bands of operation, The spurious emissions below the permissible value more than 20dB

4. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

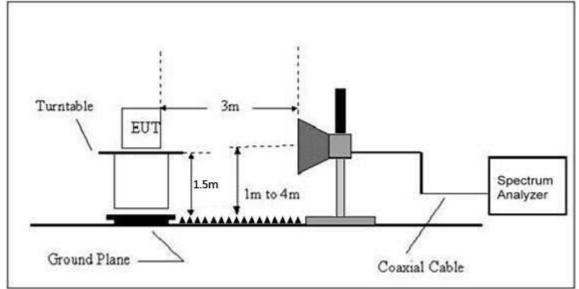
5.All the Modulation are test, the worst mode is GFSK, the data recording in the report.



# 8. RADIATED BAND EMISSION MEASUREMENT AND RESTRICTED BANDS OF OPERATION

## 8.1 Block Diagram Of Test Setup

Radiated Emission Test-Up Frequency Above 1GHz



## 8.2 Limit

## FCC Part15 C Section 15.209 and 15.205

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
<sup>1</sup> 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

 LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

 FREQUENC
 Limit (dBuV/m) (at 3M)

 Y (MHz)
 PEAK
 AVERAGE

. (=)	FLAN	AVENAGE
Above 1000	74	54

#### Notes:

(1)The limit for radiated test was performed according to FCC PART 15C.



(2)The tighter limit applies at the band edges.(3)Emission level (dBuV/m)=20log Emission level (uV/m).

## 8.3 Test procedure

Receiver Parameter	Setting		
Attenuation	Auto		
Start Frequency	2300MHz		
Stop Frequency	2520		
RB / VB (emission in restricted band)	1 MHz / 1 MHz for Peak, 1 MHz / 1/T Hz for Average		

Above 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b.The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c.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.

d.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 rota table was turned from 0 degrees to 360 degrees to find the maximum reading.

e.The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. 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.

g.Test the EUT in the lowest channel, the Highest channel.

Note:

Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

## 8.4 EUT operating Conditions

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.



## 8.5 Test Result

	Polar (H/V)	Frequency (MHz)	Reading Level	Correct Factor	Measure- ment (dBuV/m)		nits V/m)	Result		
	(111 • )	(11112)	(dBuV/m)	(dB)	PK	PK	AV			
			Low	Channel 2	402MHz					
	Н	2390.00	56.38	-6.70	49.68	74.00	54.00	PASS		
	Н	2400.00	48.57	-6.71	41.86	74.00	54.00	PASS		
	V	2390.00	56.76	-6.70	50.06	74.00	54.00	PASS		
	V	2400.00	47.95	-6.71	41.24	74.00	54.00	PASS		
GFSK			High	Channel 2	2480MHz					
	Н	2483.50	55.66	-6.79	48.87	74.00	54.00	PASS		
	Н	2485.00	48.72	-6.81	41.91	74.00	54.00	PASS		
	V	2483.50	55.48	-6.79	48.69	74.00	54.00	PASS		
	V	2485.00	47.80	-6.81	40.99	74.00	54.00	PASS		
			Low	Channel 2	2402MHz					
	Н	2390.00	57.59	-6.70	50.89	74.00	54.00	PASS		
	Н	2400.00	50.13	-6.71	43.42	74.00	54.00	PASS		
	V	2390.00	56.66	-6.70	49.96	74.00	54.00	PASS		
Pi/4DQPSK	V	2400.00	48.52	-6.71	41.81	74.00	54.00	PASS		
FI/4DQF3N		High Channel 2480MHz								
	Н	2483.50	56.83	-6.79	50.04	74.00	54.00	PASS		
	Н	2485.00	50.48	-6.81	43.67	74.00	54.00	PASS		
	V	2483.50	55.42	-6.79	48.63	74.00	54.00	PASS		
	V	2485.00	47.36	-6.81	40.55	74.00	54.00	PASS		
			Low	Channel 2	2402MHz					
	Н	2390.00	57.27	-6.70	50.57	74.00	54.00	PASS		
	H	2400.00	48.96	-6.71	42.25	74.00	54.00	PASS		
	V	2390.00	56.69	-6.70	49.99	74.00	54.00	PASS		
8DPSK	V	2400.00	49.57	-6.71	42.86	74.00	54.00	PASS		
ODLOV			High	Channel 2	2480MHz					
	Н	2483.50	57.41	-6.79	50.62	74.00	54.00	PASS		
	Н	2485.00	49.28	-6.81	42.47	74.00	54.00	PASS		
	V	2483.50	55.91	-6.79	49.12	74.00	54.00	PASS		
	V	2485.00	48.64	-6.81	41.83	74.00	54.00	PASS		

#### Remark:

1. Emission Level = Meter Reading + Factor,

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

Over= Emission Level - Limit

2. If the PK measured levels comply with average limit, then the average level were deemed to comply with average limit.

3 In restricted bands of operation, The spurious emissions below the permissible value more than 20dB

4. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.



## 9. CONDUCTED EMISSION

## 9.1 Block Diagram Of Test Setup



## 9.2 Limit

Regulation 15.247 (d), 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))

## 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:

Below 1GHz:

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

Detector function = peak, Trace = max hold

Above 1GHz:

RBW = 1MHz, VBW = 3MHz, Sweep = auto

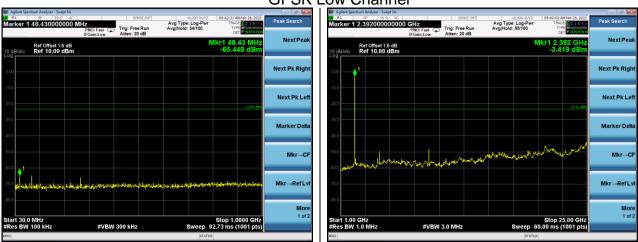
Detector function = peak, Trace = max hold



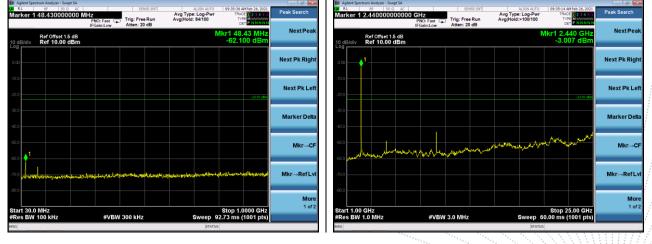
#### Test Result 9.4

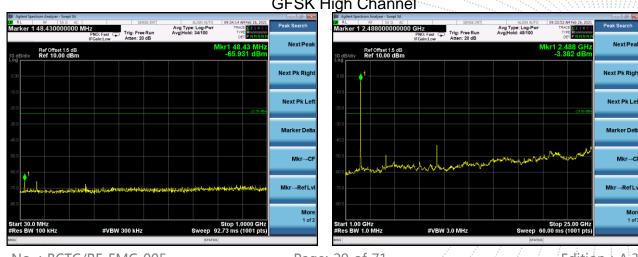
Temperature :	<b>26</b> ℃	Relative Humidity :	54%
Test Voltage :	DC 3.7V	Remark:	N/A

#### 30MHz – 25GHz **GFSK Low Channel**



## **GFSK Middle Channel**





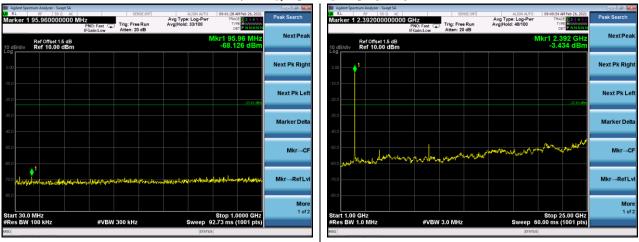
## **GFSK High Channel**

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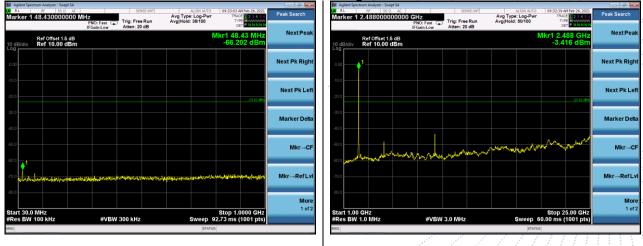
## Pi/4 DQPSK Low Channel

## Pi/4 DQPSK Middle Channel

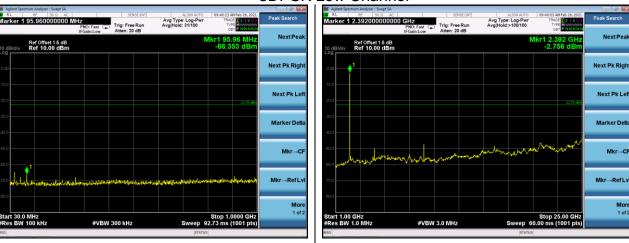
arker 1	RF 50 Ω 48.43000000	0 MHz PNO: Fast G	SENSE:INT Trig: Free Run Atten: 20 dB	Avg Type: Log-Pwr Avg Hold: 44/100	09:37:14 AM Feb 26, 2021 TRACE 2 3 4 5 0 TYPE MONINAL DET PNNNN	Peak Search
dB/div	Ref Offset 1.5 d Ref 10.00 dB	3 m		N	kr1 48.43 MHz -65.410 dBm	NextPeak
°						Next Pk Right
					-22 47 ebn	Next Pk Lef
						Marker Delta
						Mkr→CF
Wanter	balance and	and and the state of the second s	nga kita atau kataka kata	ni falqinna da birdi minimlari k	ingaliraturalirles <sup>in</sup> ag <sup>ant</sup> ing	Mkr→RefLv
rt 30.0	MHz 100 kHz	#VBW	300 kHz	Sweep 9	Stop 1.0000 GHz 2.73 ms (1001 pts)	More 1 of 2
				STATUS		



## Pi/4 DQPSK High Channel

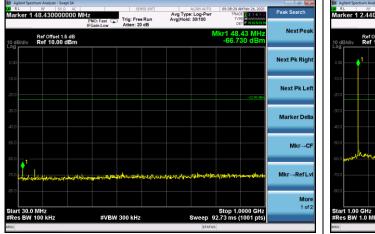






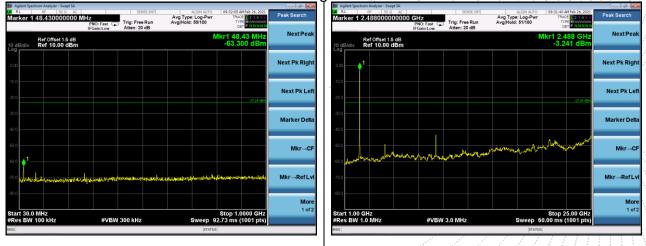
## 8DPSK Low Channel

## 8DPSK Middle Channel





#### 8DPSK High Channel

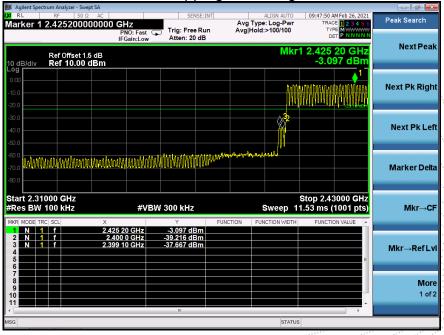




🍯 Agilent Spectrum Analyzer - Swept SA				
x RL RF 50Ω AC Marker 1 2.401900000000	OGHZ PNO: Fast Trig: Free Run	ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	09:43:22 AM Feb 26, 2021 TRACE 1 2 3 4 5 6 TYPE MWWWWW	Peak Search
Ref Offset 1.5 dB 10 dB/div Ref 10.00 dBm	IFGain:Low Atten: 20 dB		1 2.401 9 GHz -3.289 dBm	Next Peak
Log			1 -23.29 dBm	Next Pk Righ
-30.0			2 2 2 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Next Pk Lef
-60.0 -70.0 -80.0	torrespersive and a figure interesting to the second s	enter Martin and Marine	ereneter V from	Marker Delta
Start 2.31000 GHz #Res BW 100 kHz	#VBW 300 kHz		Stop 2.41000 GHz 500 ms (1001 pts)	Mkr→CF
1 N 1 f 2.4 2 N 1 f 2.4	401 9 GHz3.289 dBm 400 0 GHz53.351 dBm 399 1 GHz37.495 dBm		E	Mkr→RefLv
7 8 9 10 11 11	m			More 1 of 2
ISG		STATUS		

## GFSK Transmitting Band edge-left side

GFSK Hopping Band edge-left side

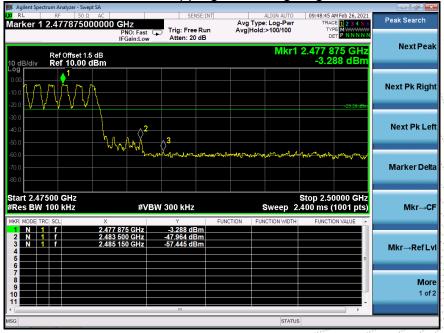




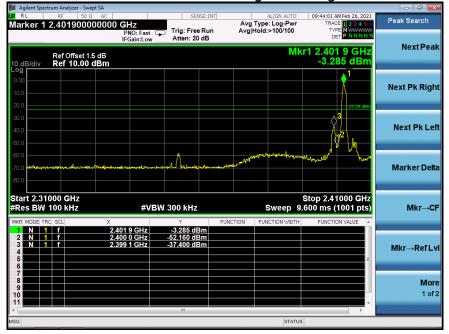
鱦 Agilent Spe	trum Analyze:	r - Swept SA						
Warker 1	<sup>RF</sup> 2.4798	50 Ω AC 92000000	GHz	SENSE	Avg	ALIGN AUTO Type: Log-Pwr Hold:>100/100	09:52:52 AM Feb 26, 20 TRACE 1 2 3 4 5 TYPE MWWWW	6 Peak Search
10 dB/div	Ref Offs Ref 10	set 1.5 dB 1.00 dBm	PNO: Fast IFGain:Low	Atten: 20 dB			2.479 892 GH -3.315 dBr	NextPeak
Log 0.00 -10.0 -20.0							-23.33 til	Next Pk Right
-30.0 -40.0 -50.0		mĵ	2			3		Next Pk Left
-60.0 -70.0 -80.0			hennelman	N WAY THE AND A CONTRACT OF			nt and a start and a start and a start and a start a st	A Marker Delta
Start 2.47 #Res BW	100 kHz	x		BW 300 kHz Y	FUNCTION	Sweep 2	Stop 2.50000 GH .133 ms (1001 pt FUNCTION VALUE	z s) Mkr→CF
1 N 2 2 N 2 3 N 4 5 6		2.483	892 GHz 500 GHz 410 GHz	<u>-3.315 dBm</u> -47.392 dBm -57.696 dBm				Mkr→RefLvl
7 8 9 10 11								More 1 of 2
MSG						STATUS	5	

## GFSK Transmitting Band edge-right side

GFSK Hopping Band edge-right side







## Pi/4 DQPSK Transmitting Band edge-left side

Pi/4 DQPSK Hopping Band edge-left side

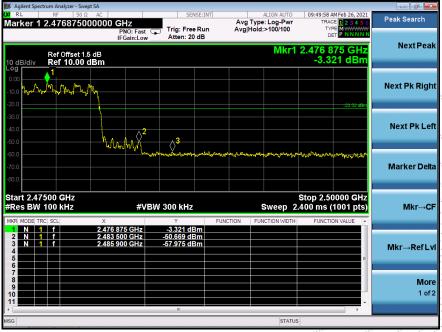
RL RF 50 Ω AC		SENSE:INT		ALIGN AUTO e: Log-Pwr I:>100/100	09:46:52 AM Feb 26, 2021 TRACE 1 2 3 4 5 6 TYPE M WWWWW	Peak Search
Ref Offset 1.5 dB dB/div Ref 10.00 dBm	PNO: Fast IFGain:Low	Atten: 20 dB	Avginoid		1 2.419 92 GHz -3.123 dBm	NextPea
				MW		Next Pk Rig
.0						Next Pk Le
0 0 0	WARDER AND	hartanlinan Jahayan ya	gappender og hjær i segen er og her er o Letter og her er og her	shwing.		Marker De
art 2.31000 GHz les BW 100 kHz	#VBW			Sweep 1'	Stop 2.43000 GHz I.53 ms (1001 pts)	Mkr→0
N         1         f         2.4           N         1         f         2.4           N         1         f         2.4           N         1         f         2.3	#VBW 419 92 GHz 400 0 GHz 398 98 GHz			Sweep 1	1.53 ms (1001 pts)	
Note         Trc         Scl         X           N         1         f         2.4           N         1         f         2	419 92 GHz .400 0 GHz	Ƴ -3.123 dBm -39.478 dBm		Sweep 1	1.53 ms (1001 pts)	Mkr→C Mkr→RefL Mo 1 o



	trum Analyzer - Swep	t SA					
Marker 1	RF 50 Ω 2.47989200	AC 00000 GHz PNO: Fast	SENSE:II	Avg Type	ALIGN AUTO e: Log-Pwr :>100/100	09:52:19 AM Feb 26, 202 TRACE 1 2 3 4 5 TYPE M	Peak Search
10 dB/div	Ref Offset 1.5 Ref 10.00 d	IFGain:Low			Mkr1	2.479 892 GH -3.321 dBn	Next Peak
Log 0.00 -10.0 -20.0						-23.32 UB	Next Pk Right
-30.0 -40.0 -50.0	h	$M^2 \sqrt{3}$					Next Pk Left
-60.0 -70.0 -80.0			www.man.com.com.com		and the second	Land Carles	Marker Delta
Start 2.47 #Res BW	100 kHz	Х	BW 300 kHz Y		Sweep 2.	Stop 2.50000 GH 133 ms (1001 pts FUNCTION VALUE	z }) Mkr→CF
1 N 1 2 N 1 3 N 1 4 5 6	f	2.479 892 GHz 2.483 500 GHz 2.484 236 GHz	-3.321 dBm -47.869 dBm -58.080 dBm				Mkr→RefLvl
7 8 9 10 11			m				More 1 of 2
MSG					STATUS		

## Pi/4 DQPSK Transmitting Band edge-right side

Pi/4 DQPSK Hopping Band edge-right side

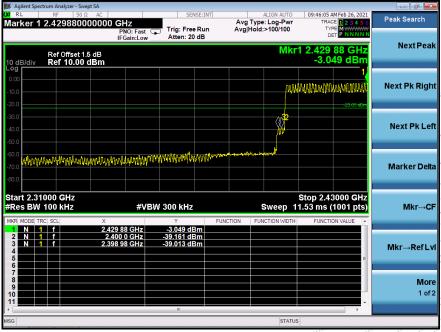




📁 Agilent Spectrum Analyzer - Swept SA				
🗱 RL RF 50Ω AC Marker 1 2.401900000000	CHZ PNO: Fast Trig: Free Run	ALIGN AUTO 09: Avg Type: Log-Pwr Avg/Hold:>100/100	14:24 AM Feb 26, 2021 TRACE 1 2 3 4 5 6 TYPE MWWWWW	Peak Search
Ref Offset 1.5 dB 10 dB/div Ref 10.00 dBm	IFGain:Low Atten: 20 dB		.401 9 GHz 3.307 dBm	Next Peak
-20.0			-23.31 uBm	Next Pk Right
-30.0 -40.0 -60.0			3 	Next Pk Left
-60.0 -70.0 <del> </del>	mushan ph have proved	have a second that the second s		Marker Delta
Start 2.31000 GHz #Res BW 100 kHz	#VBW 300 kHz	Sweep 9.600	2.41000 GHz ms (1001 pts)	Mkr→CF
2 N 1 f 2. 3 N 1 f 2. 4 5 6 6	399 1 GHz -51.679 dBm 399 1 GHz -37.312 dBm		E	Mkr→RefLvl
7 8 9 10 11 11				More 1 of 2
MSG		STATUS		

## 8DPSK Transmitting Band edge-left side

8DPSK Hopping Band edge-left side

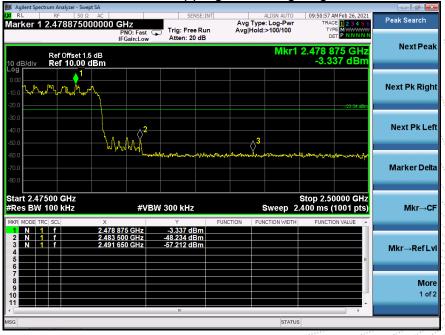




📁 Agilent Spectrum Analyzer - Swept SA				
W RL RF 50 Ω AC Marker 1 2.479892000000		ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	09:51:43 AM Feb 26, 2021 TRACE 1 2 3 4 5 6 TYPE M	Peak Search
Ref Offset 1.5 dB 10 dB/div Ref 10.00 dBm	PNO: Fast Trig: Free Run IFGain:Low Atten: 20 dB		2.479 892 GHz -3.327 dBm	Next Peak
Log 0.00 -10.0 -20.0			-23.33 uBm	Next Pk Right
-40.0 -50.0	2 ^3			Next Pk Left
-60.0	Annon and and and and and and and and and an		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Marker Delta
Start 2.47800 GHz #Res BW 100 kHz	#VBW 300 kHz		Stop 2.50000 GHz 133 ms (1001 pts)	Mkr→CF
1 N 1 f 2.479 2 N 1 f 2.483	9 892 GHz -3.327 dBm 5 500 GHz -47.688 dBm 1 104 GHz -56.839 dBm		E	Mkr→RefLvl
7 8 9 10 11				More 1 of 2
MSG		STATUS		

## 8DPSK Transmitting Band edge-right side

8DPSK Hopping Band edge-right side





## 10. 20 DB BANDWIDTH

## 10.1 Block Diagram Of Test Setup



10.2 Limit

N/A

- 10.3 Test procedure
- 1. Set RBW = 30kHz.
- 2. Set the video bandwidth (VBW)  $\ge$  3 x 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 20 dB relative to the maximum level measured in the fundamental emission.



## 10.4 Test Result

Temperature :	26°C	Relative Humidity:	54%
Test Voltage :	DC 3.7V	Remark	N/A

Modulation	Test Channel	Bandwidth(MHz)
GFSK	Low	0.880
GFSK	Middle	0.879
GFSK	High	0.878
Pi/4 DQPSK	Low	1.260
Pi/4 DQPSK	Middle	1.261
Pi/4 DQPSK	High	1.258
8DPSK	Low	1.250
8DPSK	Middle	1.222
8DPSK	High	1.246

## Test plots GFSK Low Channel







#### **GFSK Middle Channel**

## **GFSK High Channel**







#### Pi/4 DQPSK Low Channel

## **Pi/4 DQPSK Middle Channel**





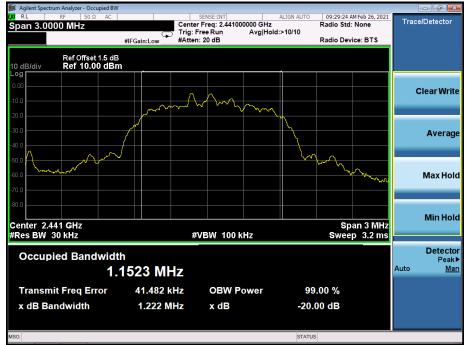


## Pi/4 DQPSK High Channel

## **8DPSK Low Channel**







#### 8DPSK Middle Channel

## **8DPSK High Channel**





## 11. MAXIMUM PEAK OUTPUT POWER

## 11.1 Block Diagram Of Test Setup



## 11.2 Limit

	F	CC Part15 (15.247)	, Subpart C	
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(1)	Peak Output Power	0.125 watt or 21dBm	2400-2483.5	PASS

## 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 = 3MHz. VBW = 3MHz. Sweep = auto; Detector Function = Peak.

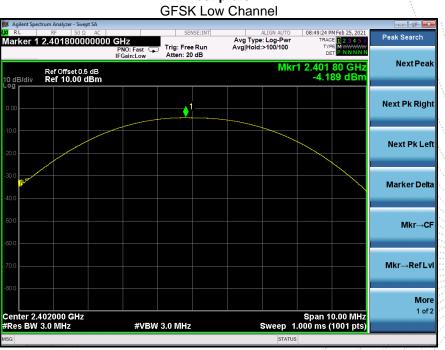
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.



## 11.4 Test Result

Temperature :	26%	Relative Humidity:	54%
Test Voltage :	DC 3.7V	Remark:	N/A

Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	-4.189	21
GFSK	Middle	-3.893	21
GFSK	High	-4.268	21
Pi/4 DQPSK	Low	-3.346	21
Pi/4 DQPSK	Middle	-3.030	21
Pi/4 DQPSK	High	-3.419	21
8DPSK	Low	-2.704	21
8DPSK	Middle	-2.415	21
8DPSK	High	-2.766	21



## **Test plots**



	1				
				nalyzer - Swept SA	
Peak Search	08:47:42 PM Feb 25, 2021 TRACE 1 2 3 4 5 6 TYPE M WWWWW DET P N N N N N	ALIGN AUTO Avg Type: Log-Pwr Avg Hold:>100/100	SENSE:INT	50 Ω AC 10770000000 GHz PNO: Fast G	
NextPea			Atten: 20 dB	IFGain:Low	
Nextrea	2.440 77 GHz -3.893 dBm	Mkr		Offset 0.5 dB * 10.00 dBm	
Next Pk Righ					
NEXTERNIS					).00
					0.0
Next Pk Le					20.0
					0.0
Marker Delf					land a
					0.0
Mkr→C					50.0
					60.0
Mkr→RefL					0.0
MIKI →KEI L					
Mor					80.0
1 of	Span 10.00 MHz				enter 2.44
	000 ms (1001 pts)	Sweep 1	3.0 MHz		Res BW 3.
		STATUS			SG

**GFSK Middle Channel** 

#### **GFSK High Channel**

