

TEST REPORT

FCC ID: U8O-OBC5-LTE

Product: Micronet SmartHub LTE

Model No.: Micronet SmartHub

Additional Model No.: N/A

Trade Mark: Micronet

Report No.: TCT190228E005

Issued Date: Feb. 28, 2019

Issued for:

Micronet

1865 West 2100 South, Suite 2, Salt Lake City, Utah, 84119 United States

Issued By:

Shenzhen Tongce Testing Lab.

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This test report was based on TCT180806E022; Only added external photos of another devices.

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Appendix A: Photographs of Test Setup**Appendix B: Photographs of EUT**

1. Test Certification

Product:	Micronet SmartHub LTE
Model No.:	Micronet SmartHub
Additional Model:	N/A
Trade Mark:	Micronet
Applicant:	Micronet
Address:	1865 West 2100 South, Suite 2, Salt Lake City, Utah, 84119 United States
Manufacturer:	Micronet
Address:	1865 West 2100 South, Suite 2, Salt Lake City, Utah, 84119 United States
Date of Test:	Aug. 07, 2018 - Sep. 05, 2018
Applicable Standards:	FCC CFR Title 47 Part 15 Subpart C Section 15.247

The above equipment has been tested by Shenzhen Tongce Testing Lab. and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Tested By:

Jin Wang

Date: Sep. 05, 2018

Reviewed By:

Beryl Zhao

Date: Feb. 28, 2019

Approved By:

Tomsin

Date: Feb. 28, 2019

2. Test Result Summary

Requirement	CFR 47 Section	Result
Antenna Requirement	§15.203/§15.247 (c)	PASS
AC Power Line Conducted Emission	§15.207	N/A
Conducted Peak Output Power	§15.247 (b)(1) §2.1046	PASS
20dB Occupied Bandwidth	§15.247 (a)(1) §2.1049	PASS
Carrier Frequencies Separation	§15.247 (a)(1)	PASS
Hopping Channel Number	§15.247 (a)(1)	PASS
Dwell Time	§15.247 (a)(1)	PASS
Radiated Emission	§15.205/§15.209 §2.1053, §2.1057	PASS
Band Edge	§15.247(d) §2.1051, §2.1057	PASS

Note:

1. PASS: Test item meets the requirement.
2. Fail: Test item does not meet the requirement.
3. N/A: Test case does not apply to the test object.
4. The test result judgment is decided by the limit of test standard.
5. The photo shows the two device has some different, such as the appearance, an key and GPS antenna, they were tested, and the worst result had been recorded in the report.

3. EUT Description

Product Name:	Micronet SmartHub LTE
Model :	Micronet SmartHub
Additional Model:	N/A
Trade Mark:	Micronet
Hardware Version:	P1
Software Version:	0.1.8.0
Bluetooth version:	V4.0 (This report is for BDR+EDR)
Operation Frequency:	2402MHz~2480MHz
Transfer Rate:	1/2/3 Mbits/s
Number of Channel:	79
Modulation Type:	GFSK, $\pi/4$ -DQPSK, 8DPSK
Modulation Technology:	FHSS
Antenna Type:	Internal Antenna
Antenna Gain:	2.9dBi
Power Supply:	DC 12/24V

Operation Frequency each of channel for GFSK, $\pi/4$ -DQPSK, 8DPSK

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
...
10	2412MHz	30	2432MHz	50	2452MHz	70	2472MHz
11	2413MHz	31	2433MHz	51	2453MHz	71	2473MHz
...
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz	-	-

Remark: Channel 0, 39 & 78 have been tested for GFSK, $\pi/4$ -DQPSK, 8DPSK modulation mode.

4. General Information

4.1. Test environment and mode

Operating Environment:	
Temperature:	25.0 °C
Humidity:	56 % RH
Atmospheric Pressure:	1010 mbar
Test Mode:	
Engineering mode:	Keep the EUT in continuous transmitting by select channel and modulations with Fully-charged battery
<p>The sample was placed 0.8m & 1.5m for the measurement below & above 1GHz above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.</p>	

4.2. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Equipment	Model No.	Serial No.	FCC ID	Trade Name
/	/	/	/	/

Note:

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.
3. For conducted measurements (Output Power, 20dB Occupied Bandwidth, Carrier Frequencies Separation, Hopping Channel Number, Dwell Time, Spurious Emissions), the antenna of EUT is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.

5. Facilities and Accreditations

5.1. Facilities

The test facility is recognized, certified, or accredited by the following organizations:

- FCC - Registration No.: 645098

Shenzhen Tongce Testing Lab

The 3m Semi-anechoic chamber has been registered and fully described in a report with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

- IC - Registration No.: 10668A-1

The 3m Semi-anechoic chamber of Shenzhen TCT Testing Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing

5.2. Location

Shenzhen Tongce Testing Lab

Address: 1B/F., Building 1, Yibaolai Industrial Park, Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

Tel: 86-755-27673339

5.3. Measurement Uncertainty

The reported uncertainty of measurement $y \pm U$, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95 %.

No.	Item	MU
1	Conducted Emission	$\pm 2.56\text{dB}$
2	RF power, conducted	$\pm 0.12\text{dB}$
3	Spurious emissions, conducted	$\pm 0.11\text{dB}$
4	All emissions, radiated(<1G)	$\pm 3.92\text{dB}$
5	All emissions, radiated(>1G)	$\pm 4.28\text{dB}$
6	Temperature	$\pm 0.1^\circ\text{C}$
7	Humidity	$\pm 1.0\%$

6. Test Results and Measurement Data

6.1. Antenna requirement

Standard requirement:	FCC Part15 C Section 15.203 /247(c)
------------------------------	-------------------------------------

15.203 requirement:

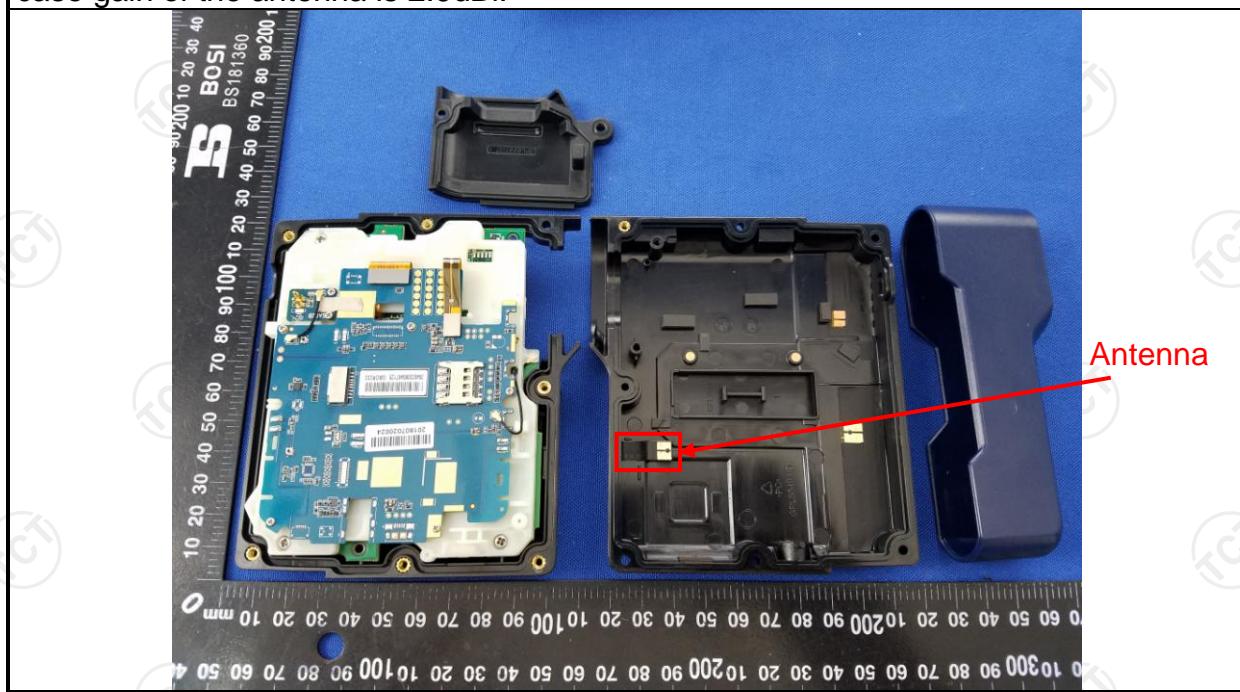
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit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

15.247(c) (1)(i) requirement:

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

E.U.T Antenna:

The Bluetooth antenna is internal antenna which permanently attached, and the best case gain of the antenna is 2.9dBi.



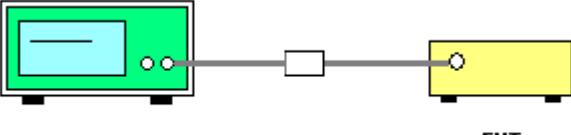
6.2. Conducted Emission

6.2.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.207														
Test Method:	ANSI C63.10:2013														
Frequency Range:	150 kHz to 30 MHz														
Receiver setup:	RBW=9 kHz, VBW=30 kHz, Sweep time=auto														
Limits:	<table border="1"> <thead> <tr> <th rowspan="2">Frequency range (MHz)</th> <th colspan="2">Limit (dBuV)</th> </tr> <tr> <th>Quasi-peak</th> <th>Average</th> </tr> </thead> <tbody> <tr> <td>0.15-0.5</td> <td>66 to 56*</td> <td>56 to 46*</td> </tr> <tr> <td>0.5-5</td> <td>56</td> <td>46</td> </tr> <tr> <td>5-30</td> <td>60</td> <td>50</td> </tr> </tbody> </table>	Frequency range (MHz)	Limit (dBuV)		Quasi-peak	Average	0.15-0.5	66 to 56*	56 to 46*	0.5-5	56	46	5-30	60	50
Frequency range (MHz)	Limit (dBuV)														
	Quasi-peak	Average													
0.15-0.5	66 to 56*	56 to 46*													
0.5-5	56	46													
5-30	60	50													
Test Setup:	<p>Reference Plane</p>  <p>Remark: E.U.T: Equipment Under Test LISN: Line Impedance Stabilization Network Test table height=0.8m</p>														
Test Mode:	Refer to item 4.1														
Test Procedure:	<ol style="list-style-type: none"> 1. The E.U.T is connected to an adapter through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment. 2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs). 3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement. 														
Test Result:	N/A; Because the EUT is powered by the battery, so the item is not applicable.														

6.3. Conducted Output Power

6.3.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (b)(3)
Test Method:	ANSI C63.10:2013
Limit:	Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.
Test Setup:	 <p style="text-align: center;">Spectrum Analyzer EUT</p>
Test Mode:	Transmitting mode with modulation
Test Procedure:	<p>Use the following spectrum analyzer settings: Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel RBW > the 20 dB bandwidth of the emission being measured $VBW \geq RBW$</p> <p>Sweep = auto Detector function = peak Trace = max hold Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission.</p>
Test Result:	PASS

6.3.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.3.3. Test Data

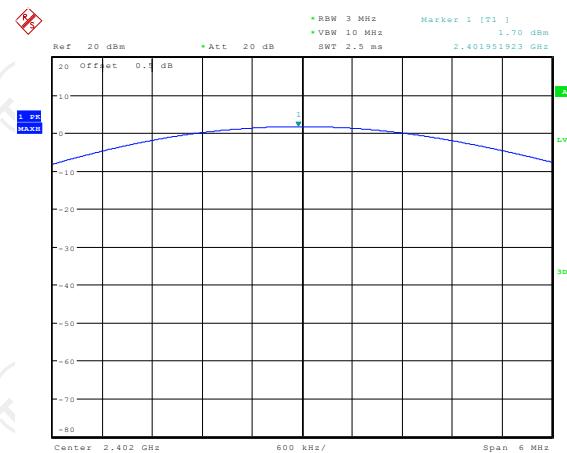
GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	1.70	30.00	PASS
Middle	4.09	30.00	PASS
Highest	0.99	30.00	PASS

Pi/4DQPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	1.61	21.00	PASS
Middle	4.01	21.00	PASS
Highest	0.86	21.00	PASS

8DPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	1.94	21.00	PASS
Middle	4.16	21.00	PASS
Highest	1.23	21.00	PASS

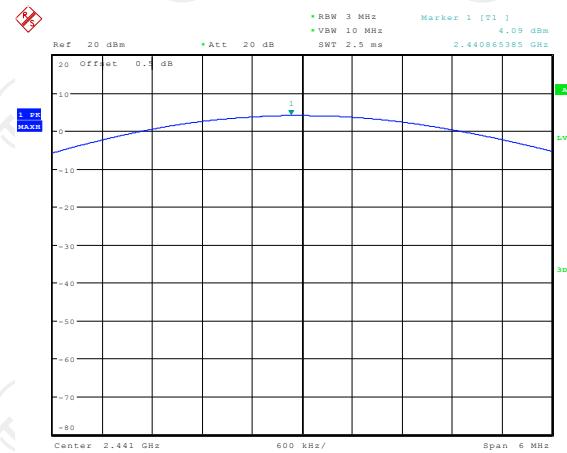
Test plots as follows:

Lowest channel



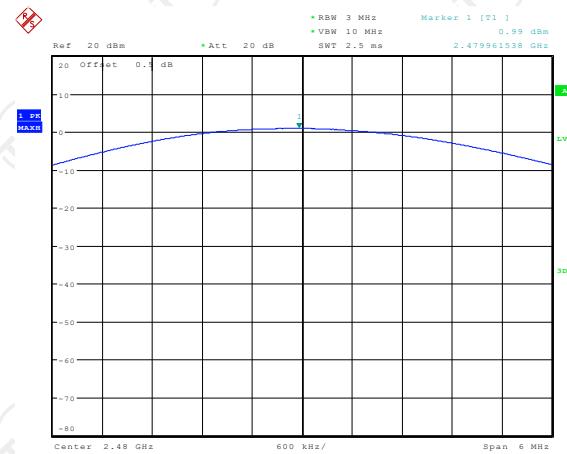
Date: 13.AUG.2018 10:35:03

Middle channel



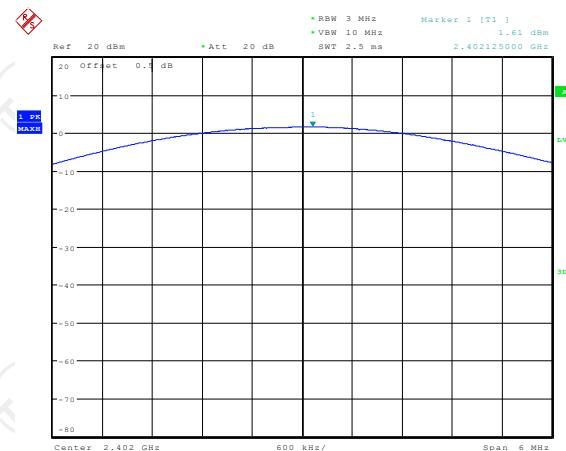
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Highest channel



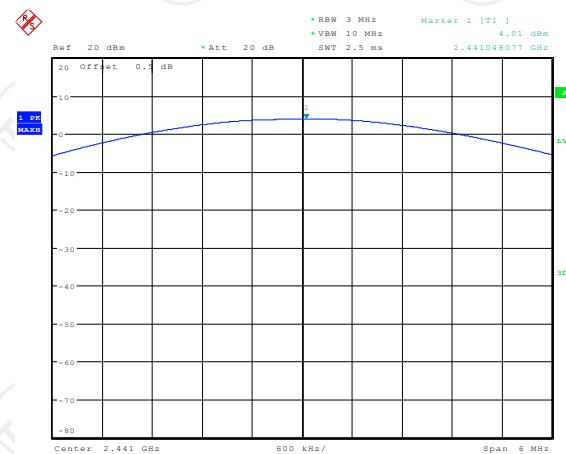
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Lowest channel



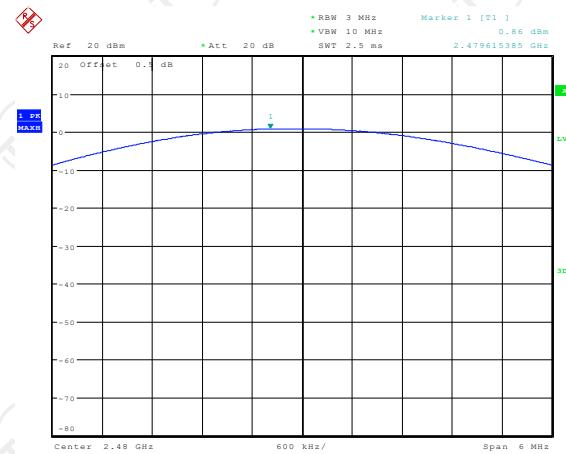
Date: 13.AUG.2018 10:37:34

Middle channel



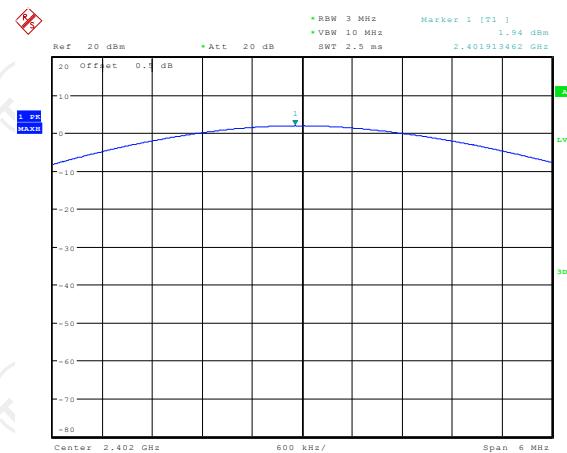
Date: 13.AUG.2018 10:39:04

Highest channel



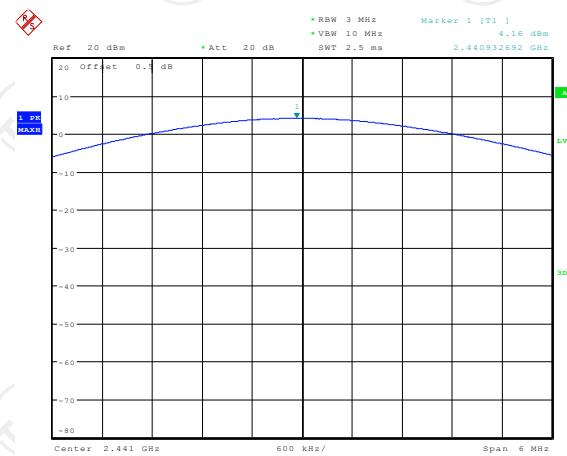
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Lowest channel



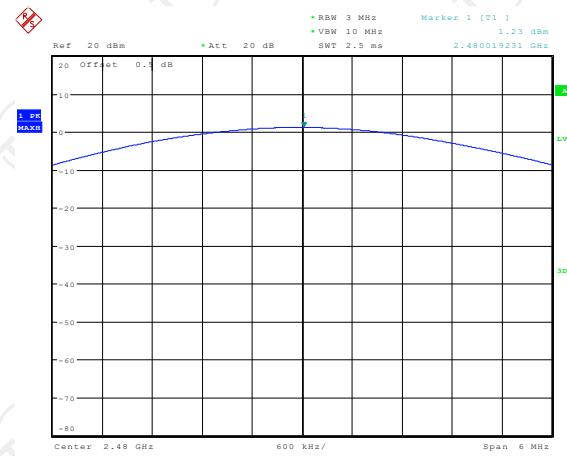
Date: 13.AUG.2018 10:42:08

Middle channel



Date: 13.AUG.2018 10:42:59

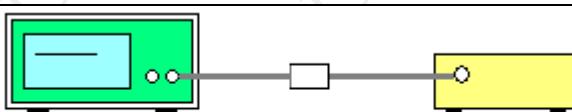
Highest channel



Date: 13.AUG.2018 10:44:21

6.4. 20dB Occupy Bandwidth

6.4.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Limit:	N/A
Test Setup:	 <p>Spectrum Analyzer EUT</p>
Test Mode:	Transmitting mode with modulation
Test Procedure:	<ol style="list-style-type: none"> 1. The testing follows ANSI C63.10:2013 Measurement Guidelines. 2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Use the following spectrum analyzer settings for 20dB Bandwidth measurement. Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel; $1\% \leq RBW \leq 5\%$ of the 20 dB bandwidth; $VBW \geq 3RBW$; Sweep = auto; Detector function = peak; Trace = max hold. 5. Measure and record the results in the test report.
Test Result:	PASS

6.4.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

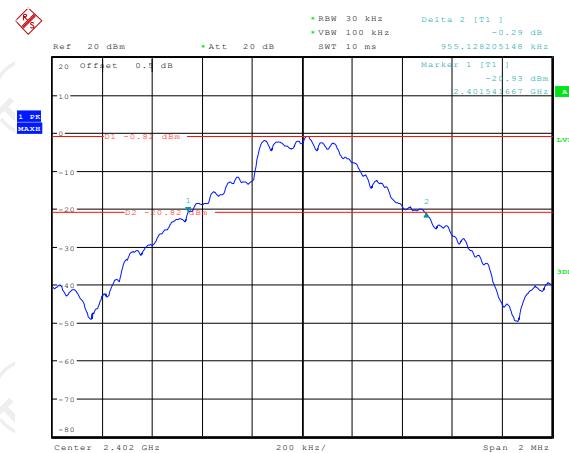
Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.4.3. Test data

Test channel	20dB Occupy Bandwidth (kHz)			
	GFSK	$\pi/4$ -DQPSK	8DPSK	Conclusion
Lowest	955.13	1272.44	1259.62	PASS
Middle	951.92	1275.64	1262.82	PASS
Highest	967.95	1285.26	1262.82	PASS

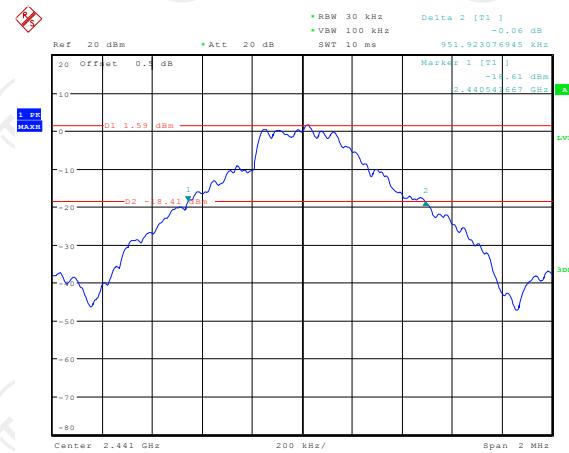
Test plots as follows:

Lowest channel



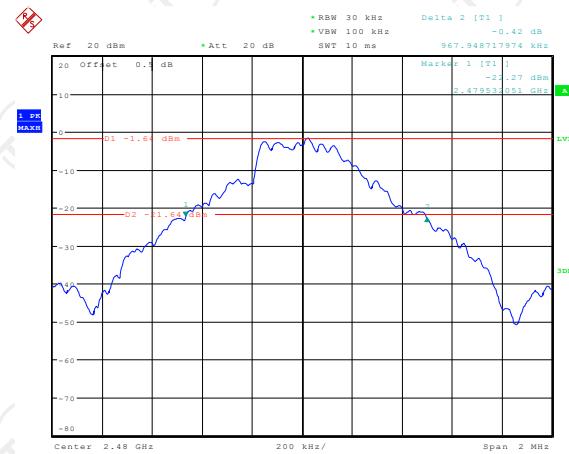
Date: 13.AUG.2018 10:06:28

Middle channel



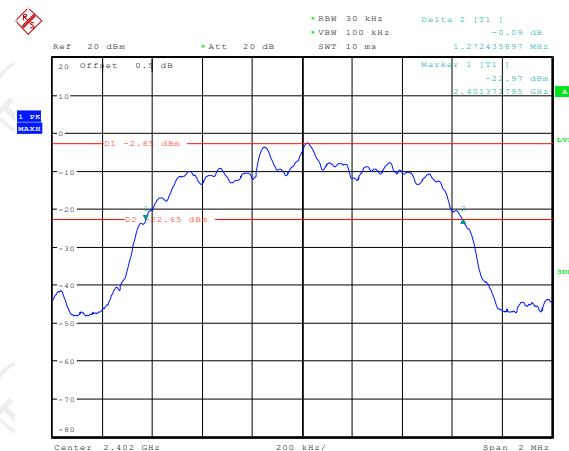
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Highest channel



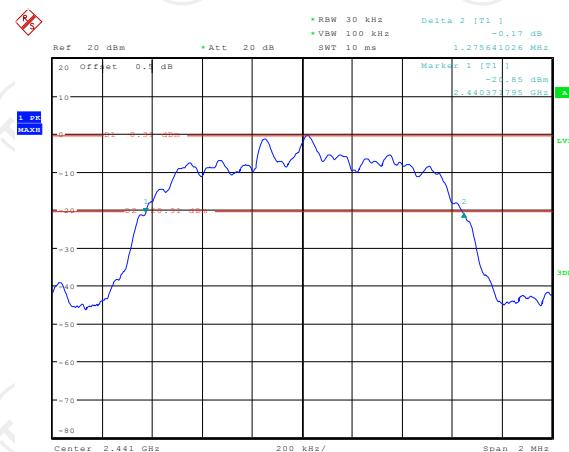
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Lowest channel



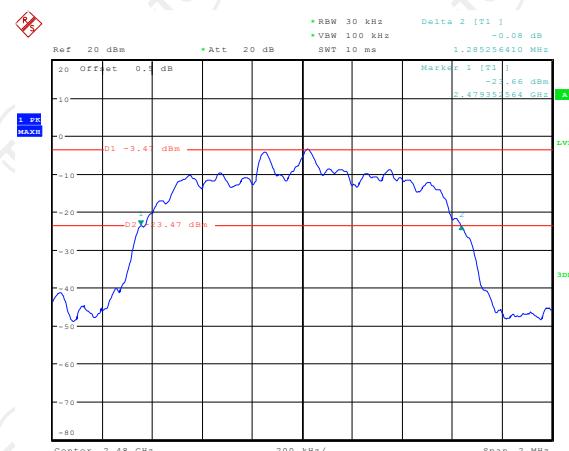
Date: 13.AUG.2018 10:11:47

Middle channel



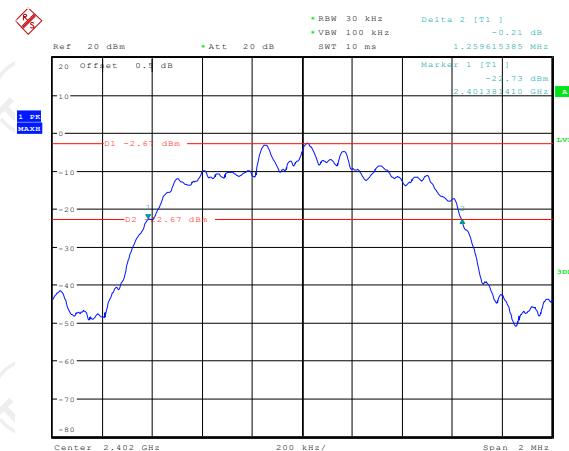
Date: 13.AUG.2018 10:13:08

Highest channel



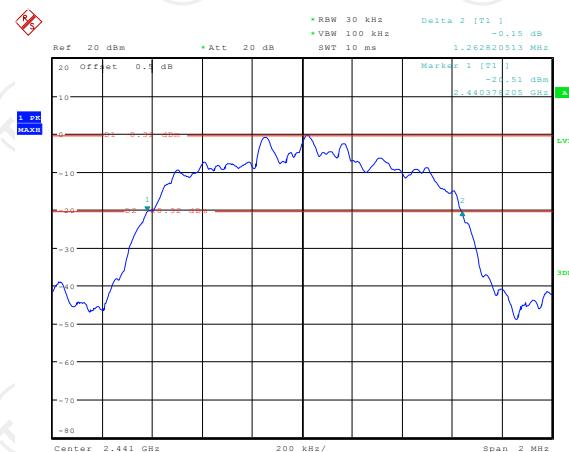
Date: 13.AUG.2018 10:15:03

Lowest channel



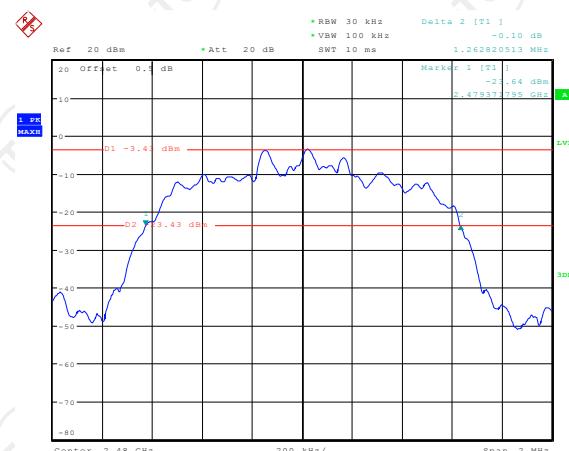
Date: 13.AUG.2018 10:20:55

Middle channel



Date: 13.AUG.2018 10:25:27

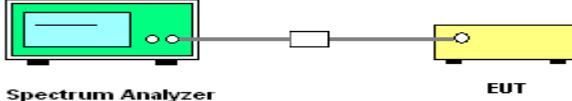
Highest channel



Date: 13.AUG.2018 10:32:10

6.5. Carrier Frequencies Separation

6.5.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Limit:	Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.
Test Setup:	
Test Mode:	Hopping mode
Test Procedure:	<ol style="list-style-type: none"> 1. The testing follows ANSI C63.10:2013 Measurement Guidelines. 2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Enable the EUT hopping function. 5. Use the following spectrum analyzer settings: Span = wide enough to capture the peaks of two adjacent channels; RBW is set to approximately 30% of the channel spacing, adjust as necessary to best identify the center of each individual channel; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold. 6. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Record the value in report.
Test Result:	PASS

6.5.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.5.3. Test data

GFSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Lowest	1000.00	967.95	PASS
Middle	1000.00	967.95	PASS
Highest	1000.00	967.95	PASS

Pi/4 DQPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Lowest	1000.00	856.84	PASS
Middle	1003.21	856.84	PASS
Highest	1000.00	856.84	PASS

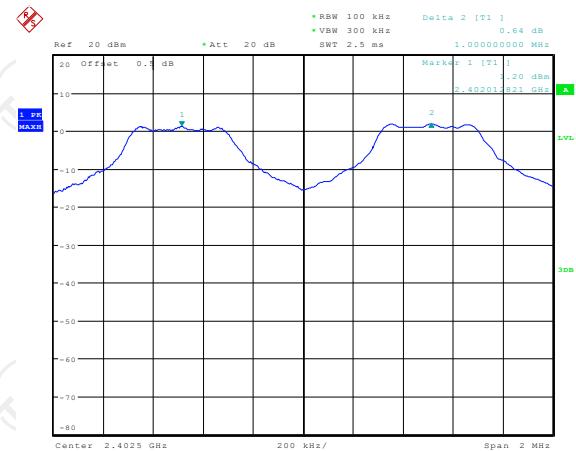
8DPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Lowest	1000.00	841.88	PASS
Middle	1000.00	841.88	PASS
Highest	1000.00	841.88	PASS

Note: According to section 6.4

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	967.95	967.95
$\pi/4$ -DQPSK	1285.26	856.84
8DPSK	1262.82	841.88

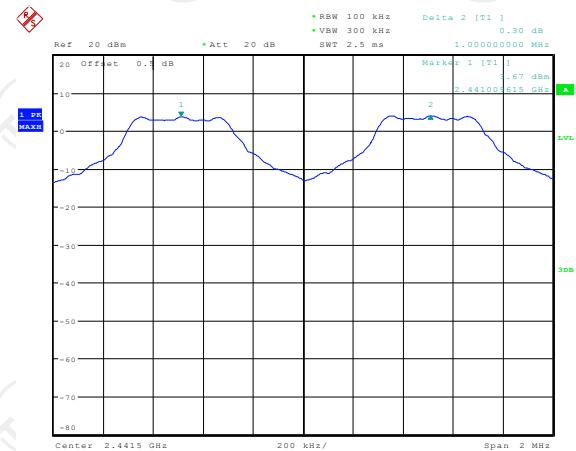
Test plots as follows:

Lowest channel



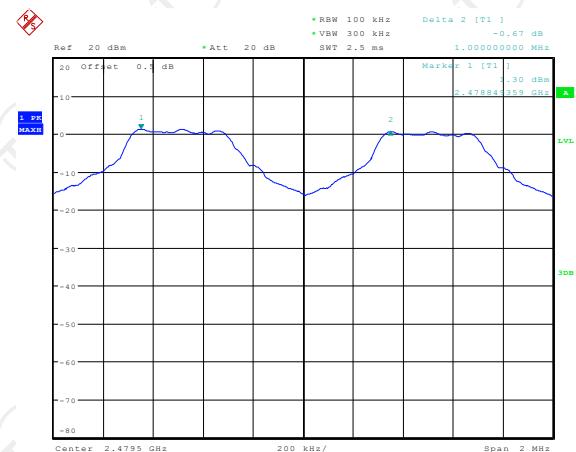
Date: 13.AUG.2018 10:47:14

Middle channel



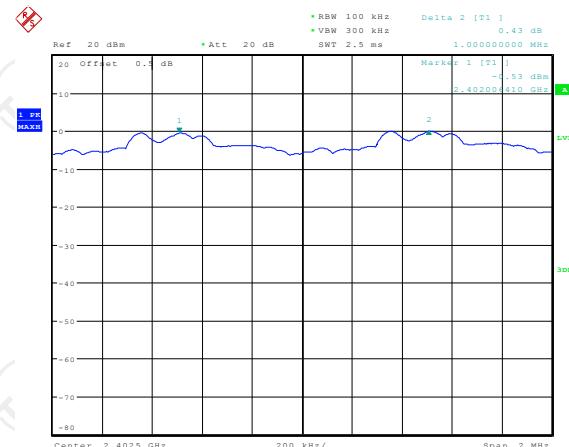
Date: 13.AUG.2018 10:49:32

Highest channel



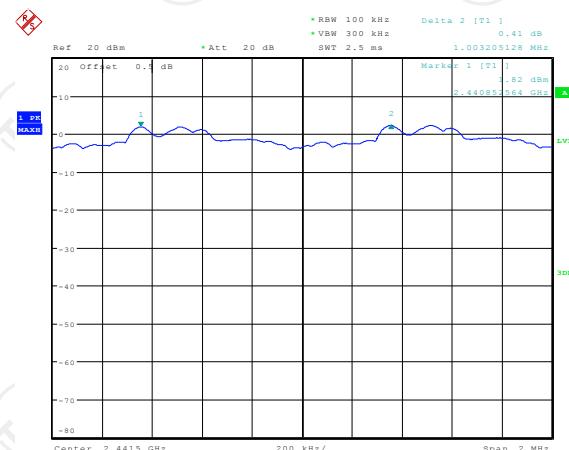
Date: 13.AUG.2018 10:50:44

Lowest channel



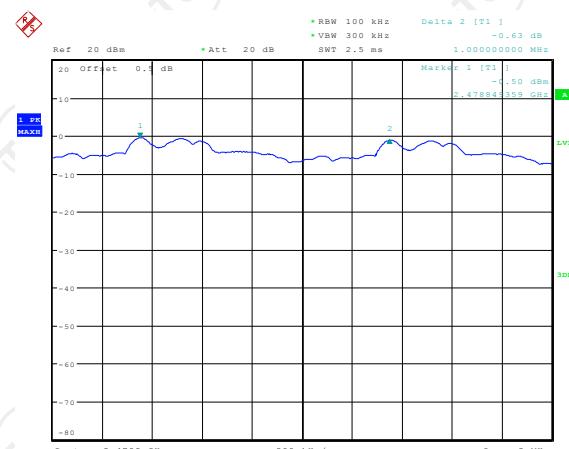
Date: 13.AUG.2018 10:52:42

Middle channel



Date: 13.AUG.2018 10:54:16

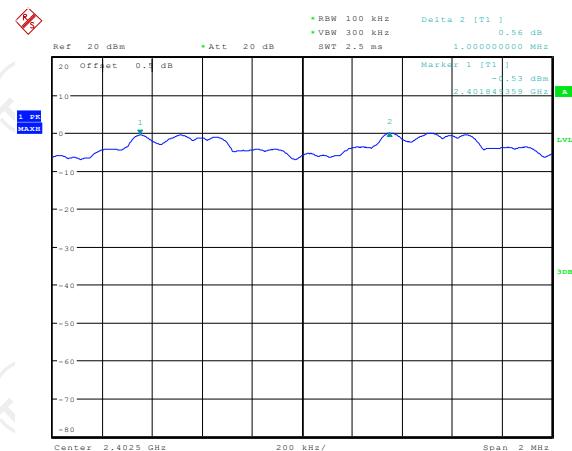
Highest channel



Date: 13.AUG.2018 10:56:03

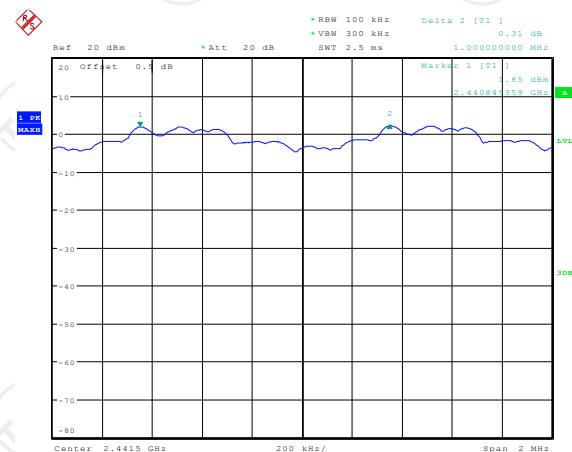
8DPSK Modulation

Lowest channel



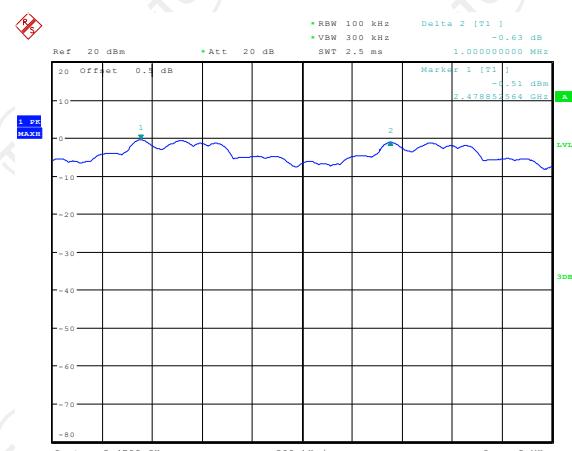
Date: 13.AUG.2018 10:58:46

Middle channel



Date: 13.AUG.2018 11:02:03

Highest channel



Printed: 12-NIC-2010 11:04:44

6.6. Hopping Channel Number

6.6.1. Test Specification

6.6.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

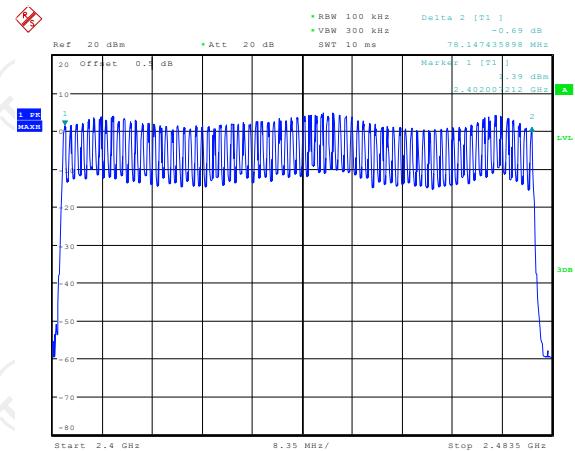
Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.6.3. Test data

Mode	Hopping channel numbers	Limit	Result
GFSK, Pi/4DQPSK, 8DPSK	79	15	PASS

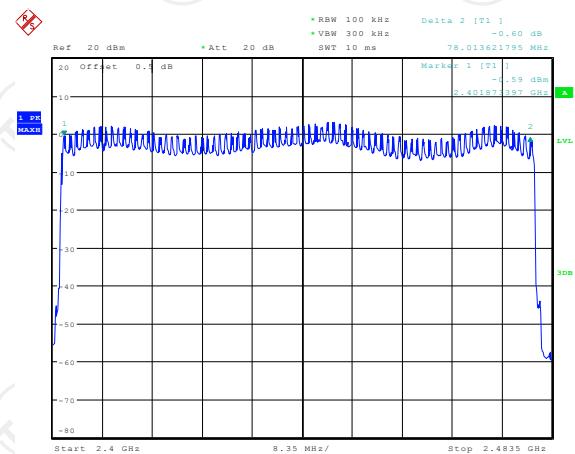
Test plots as follows:

GFSK



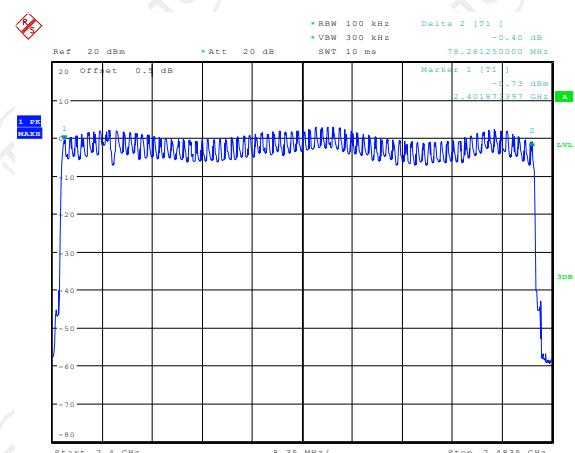
Date: 13.AUG.2018 11:07:25

Pi/4DQPSK



Date: 13.AUG.2018 11:13:42

8DPSK



Date: 13.AUG.2018 11:19:39

6.7. Dwell Time

6.7.1. Test Specification

6.7.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.7.3. Test Data

Mode	Packet	Hops Over Occupancy Time (hops)	Package Transfer Time (ms)	Dwell time (second)	Limit (second)	Result
GFSK	DH1	320	0.409	0.131	0.4	PASS
GFSK	DH3	160	1.679	0.269	0.4	PASS
GFSK	DH5	106.67	2.939	0.314	0.4	PASS
Pi/4 DQPSK	2-DH1	320	0.410	0.131	0.4	PASS
Pi/4 DQPSK	2-DH3	160	1.670	0.267	0.4	PASS
Pi/4 DQPSK	2-DH5	106.67	2.952	0.315	0.4	PASS
8DPSK	3-DH1	320	0.415	0.133	0.4	PASS
8DPSK	3-DH3	160	1.670	0.267	0.4	PASS
8DPSK	3-DH5	106.67	2.939	0.314	0.4	PASS

Note: 1. In normal mode, hopping rate is 1600 hops/s with 6 slots in 79 hopping channels.

For DH1, With channel hopping rate $(1600 / 2 / 79)$ in Occupancy Time Limit (0.4×79) (s), Hops Over Occupancy Time comes to $(1600 / 2 / 79) \times (0.4 \times 79) = 320$ hops

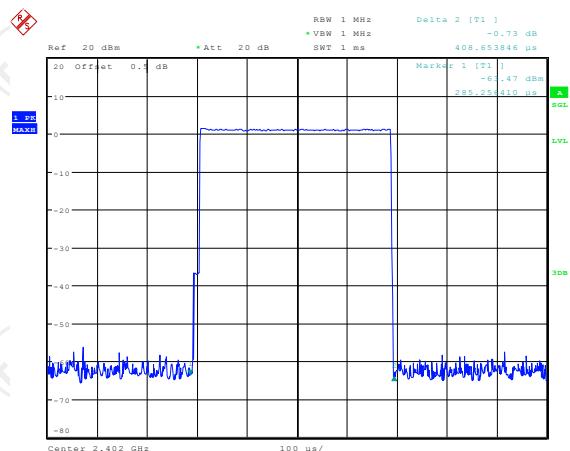
For DH3, With channel hopping rate $(1600 / 4 / 79)$ in Occupancy Time Limit (0.4×79) (s), Hops Over Occupancy Time comes to $(1600 / 4 / 79) \times (0.4 \times 79) = 160$ hops

For DH5, With channel hopping rate $(1600 / 6 / 79)$ in Occupancy Time Limit (0.4×79) (s), Hops Over Occupancy Time comes to $(1600 / 6 / 79) \times (0.4 \times 79) = 106.67$ hops

2. Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

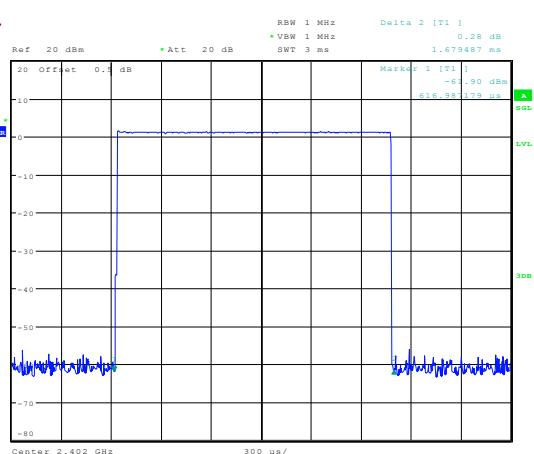
Test plots as follows:

**GFSK
DH1**



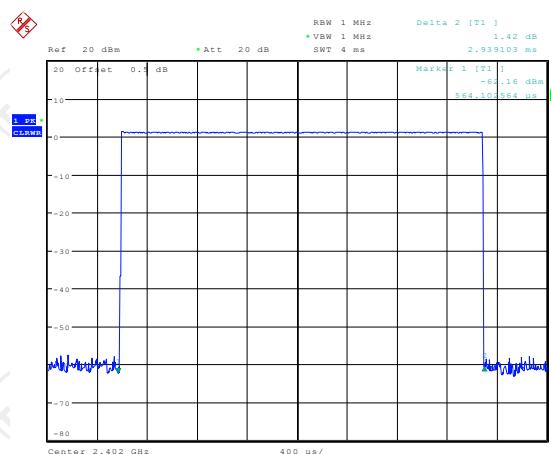
Date: 13.AUG.2018 11:21:40

DH3



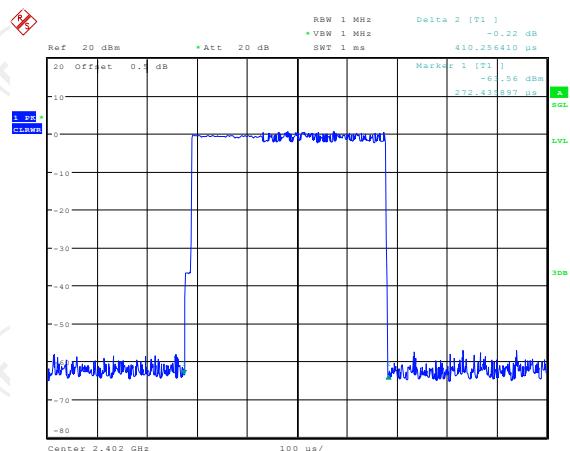
Date: 13.AUG.2018 11:24:00

DH5



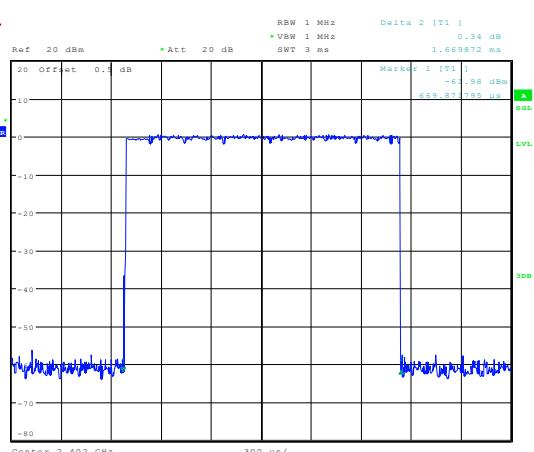
Date: 13.AUG.2018 11:27:36

Pi/4DQPSK
2-DH1



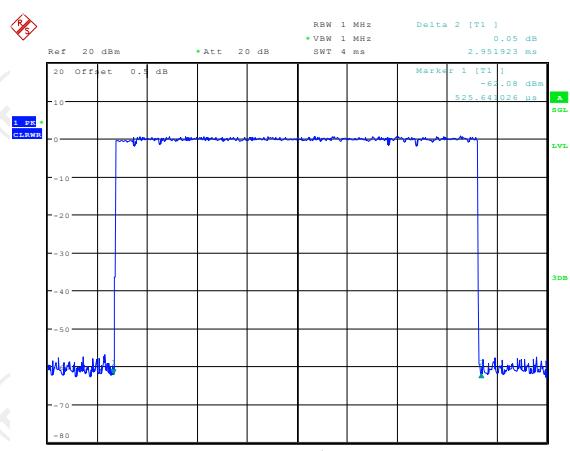
Date: 13.AUG.2018 11:22:25

2-DH3



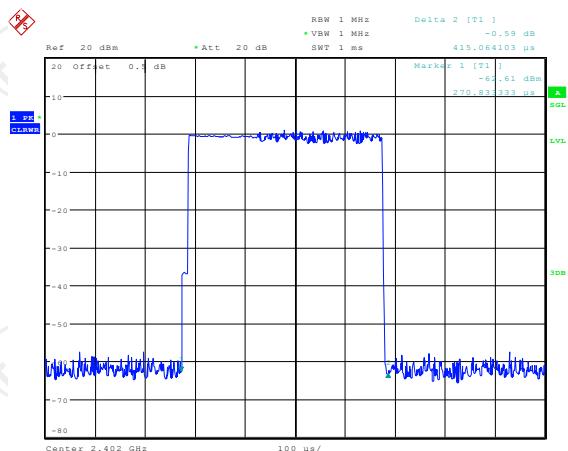
Date: 13.AUG.2018 11:25:05

2-DH5



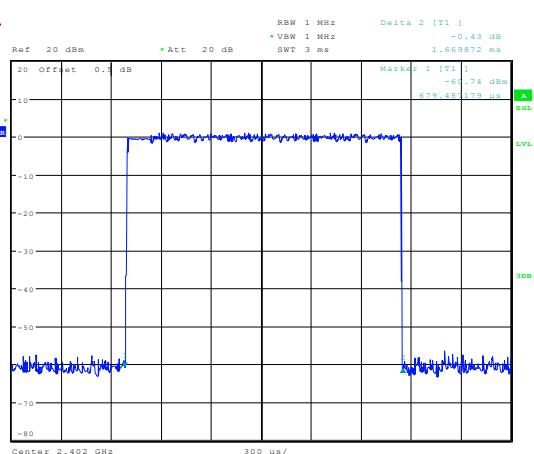
Date: 13.AUG.2018 11:28:32

8DPSK
3-DH1



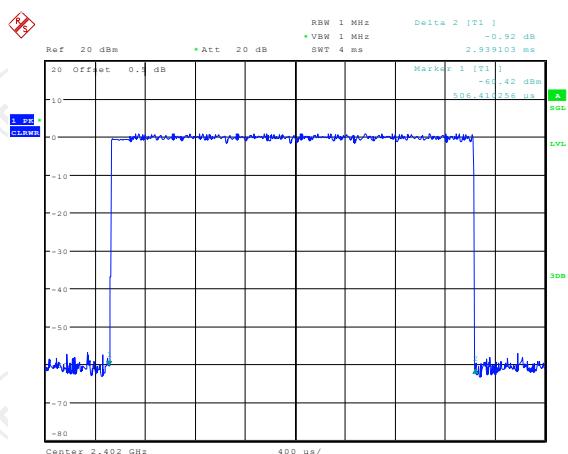
Date: 13.AUG.2018 11:23:15

3-DH3



Date: 13.AUG.2018 11:26:08

3-DH5



Date: 13.AUG.2018 11:29:24

6.8. Pseudorandom Frequency Hopping Sequence

Test Requirement:	FCC Part15 C Section 15.247 (a)(1) requirement:
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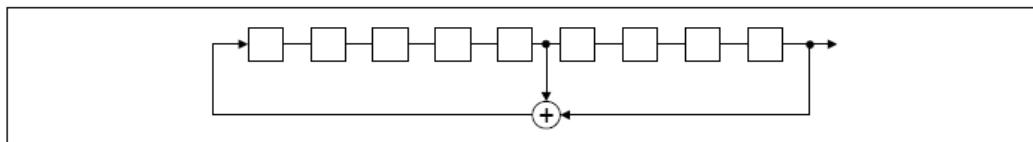
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence

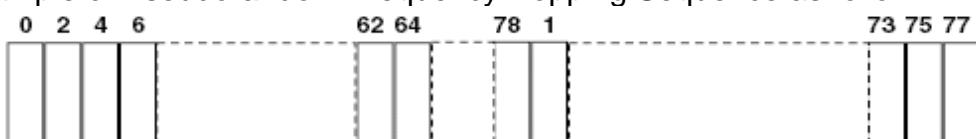
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.

The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

6.9. Conducted Band Edge Measurement

6.9.1. Test Specification

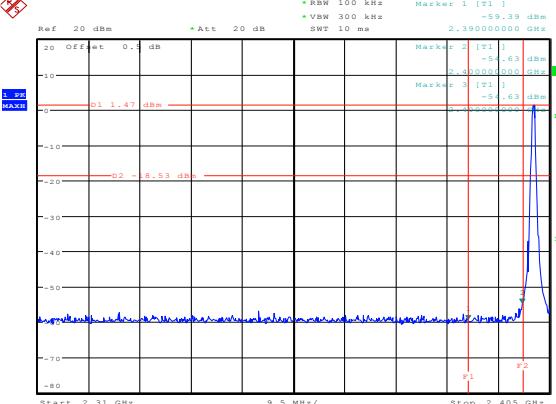
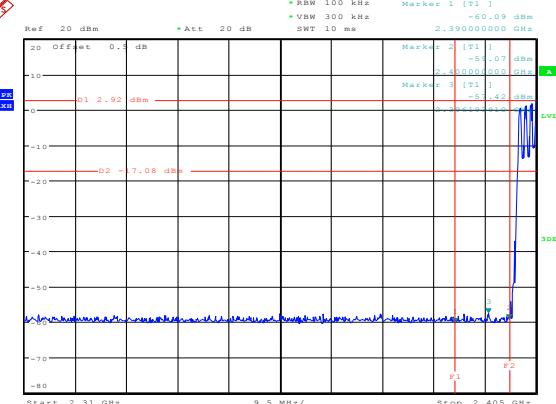
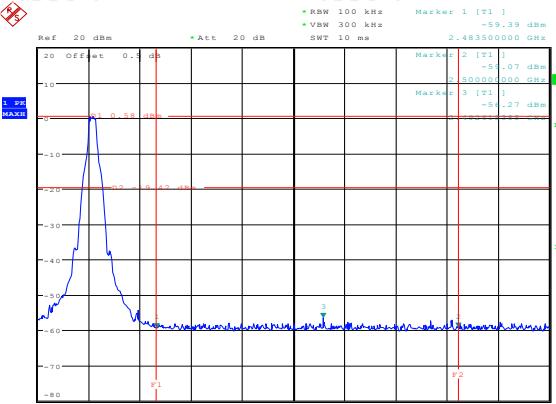
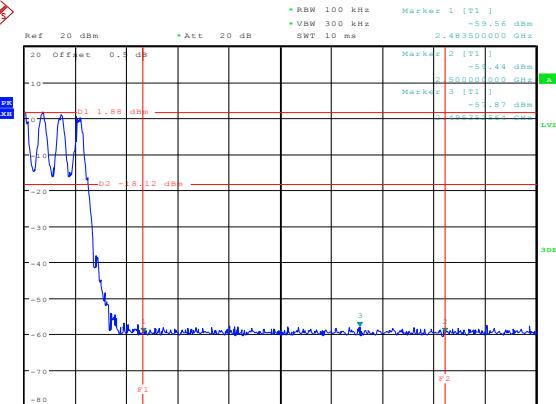
6.9.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.9.3. Test Data

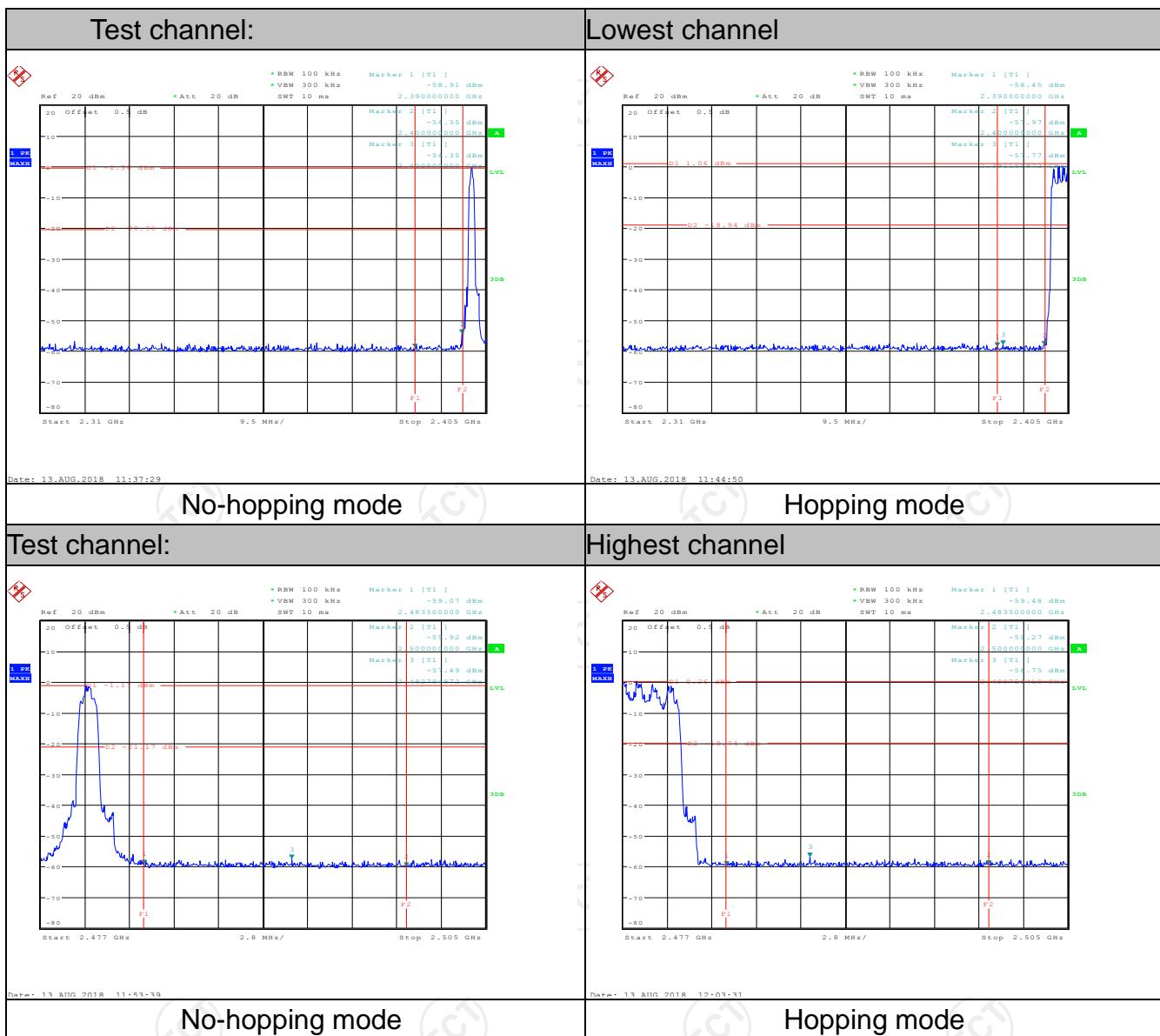
GFSK Modulation

Test channel:	Lowest channel
 <p>RBW 100 kHz, VBW 300 kHz, SWT 10 ms, 2.390000000 GHz</p> <p>Marker 1 (T1) -59.39 dBm Marker 2 (T2) -54.63 dBm Marker 3 (T1) -54.42 dBm Marker 4 (T2) -54.42 dBm</p> <p>D1 1.47 dBm D2 -18.53 dBm</p> <p>Start 2.31 GHz, Stop 2.405 GHz, Step 9.5 MHz</p>	 <p>RBW 100 kHz, VBW 300 kHz, SWT 10 ms, 2.390000000 GHz</p> <p>Marker 1 (T1) -60.09 dBm Marker 2 (T2) -54.07 dBm Marker 3 (T1) -54.42 dBm Marker 4 (T2) -54.42 dBm</p> <p>D1 2.92 dBm D2 -7.08 dBm</p> <p>Start 2.31 GHz, Stop 2.405 GHz, Step 9.5 MHz</p>
Date: 13.AUG.2018 11:33:26	Date: 13.AUG.2018 11:39:40
No-hopping mode	Hopping mode
Test channel:	Highest channel
 <p>RBW 100 kHz, VBW 300 kHz, SWT 10 ms, 2.483500000 GHz</p> <p>Marker 1 (T1) -59.56 dBm Marker 2 (T2) -54.44 dBm Marker 3 (T1) -54.87 dBm Marker 4 (T2) -54.87 dBm</p> <p>D1 1.88 dBm D2 -18.12 dBm</p> <p>Start 2.477 GHz, Stop 2.505 GHz, Step 2.6 MHz</p>	 <p>RBW 100 kHz, VBW 300 kHz, SWT 10 ms, 2.483500000 GHz</p> <p>Marker 1 (T1) -59.56 dBm Marker 2 (T2) -54.44 dBm Marker 3 (T1) -54.87 dBm Marker 4 (T2) -54.87 dBm</p> <p>D1 1.88 dBm D2 -18.12 dBm</p> <p>Start 2.477 GHz, Stop 2.505 GHz, Step 2.6 MHz</p>
Date: 13.AUG.2018 11:48:49	
No-hopping mode	Hopping mode

Pi/4DQPSK Modulation

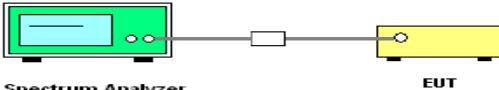
Test channel:	Lowest channel
<p>RBW 100 kHz Marker 1 [T1] -59.53 dBm VBW 300 kHz Marker 2 [T1] -51.93 dBm SWT 10 ms 2.390000000 GHz</p> <p>Ref 20 dBm Att 20 dB 20 Offset 0.5 dB Start 2.31 GHz Stop 2.405 GHz</p>	<p>RBW 100 kHz Marker 1 [T1] -58.19 dBm VBW 300 kHz Marker 2 [T1] -51.93 dBm SWT 10 ms 2.390000000 GHz</p> <p>Ref 20 dBm Att 20 dB 20 Offset 0.5 dB Start 2.31 GHz Stop 2.405 GHz</p>
Date: 13.AUG.2018 11:35:17	Date: 13.AUG.2018 11:41:28
No-hopping mode	Hopping mode
Test channel:	Highest channel
<p>RBW 100 kHz Marker 1 [T1] -58.48 dBm VBW 300 kHz Marker 2 [T1] -51.65 dBm SWT 10 ms 2.483500000 GHz</p> <p>Ref 20 dBm Att 20 dB 20 Offset 0.5 dB Start 2.477 GHz Stop 2.505 GHz</p>	<p>RBW 100 kHz Marker 1 [T1] -59.04 dBm VBW 300 kHz Marker 2 [T1] -51.53 dBm SWT 10 ms 2.483500000 GHz</p> <p>Ref 20 dBm Att 20 dB 20 Offset 0.5 dB Start 2.477 GHz Stop 2.505 GHz</p>
Date: 13.AUG.2018 11:51:15	Date: 13.AUG.2018 11:59:42
No-hopping mode	Hopping mode

8DPSK Modulation



6.10. Conducted Spurious Emission Measurement

6.10.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Limit:	In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.
Test Setup:	 <p>The diagram illustrates the test setup. A green 'Spectrum Analyzer' is connected to a yellow 'EUT' (Equipment Under Test) through a grey 'RF cable' and a small white 'attenuator' box.</p>
Test Mode:	Transmitting mode with modulation
Test Procedure:	<ol style="list-style-type: none"> 1. The testing follows the guidelines in Spurious RF Conducted Emissions of ANSI C63.10:2013 Measurement Guidelines 2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. 5. Measure and record the results in the test report. 6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
Test Result:	PASS

6.10.2. Test Instruments

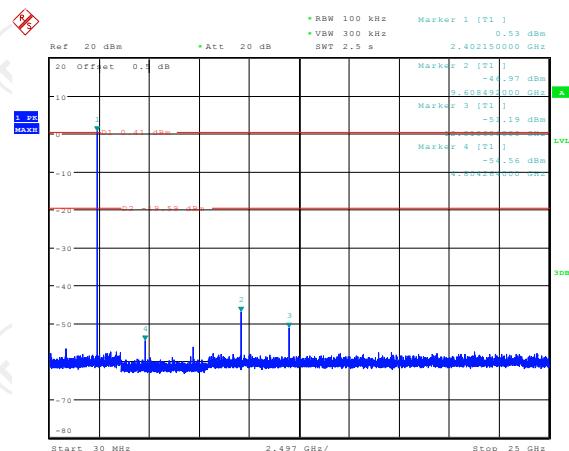
Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	R&S	FSU	200054	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.10.3. Test Data

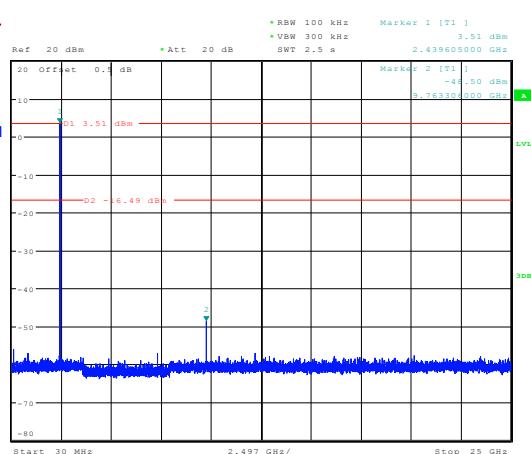
GFSK mode

Lowest Channel



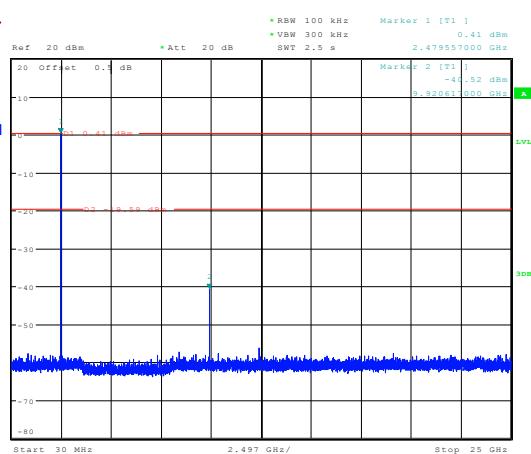
Date: 13 AUG 2018 13:37:27

Middle Channel



Date: 13 AUG 2018 13:39:16

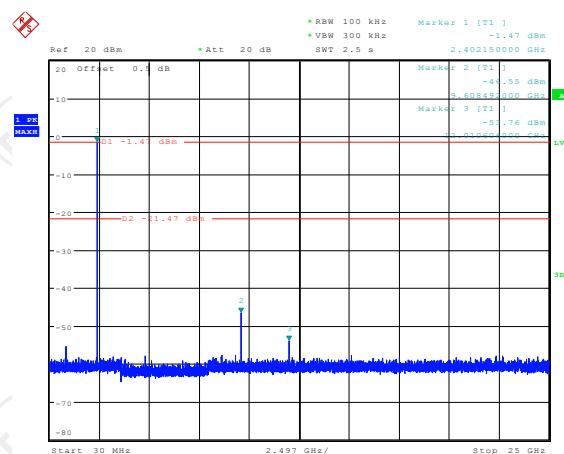
Highest Channel



Date: 13 AUG 2018 13:40:29

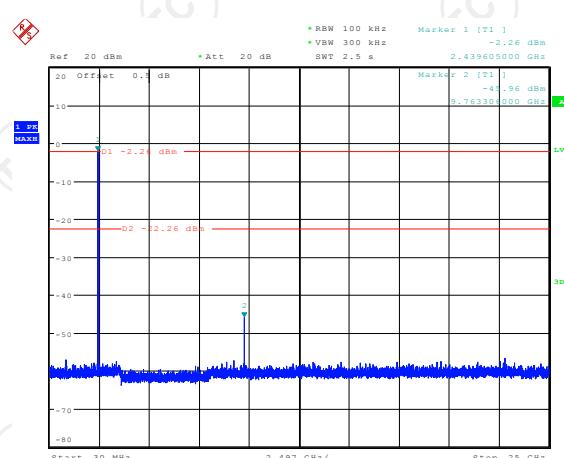
Pi/4DQPSK mode

Lowest Channel



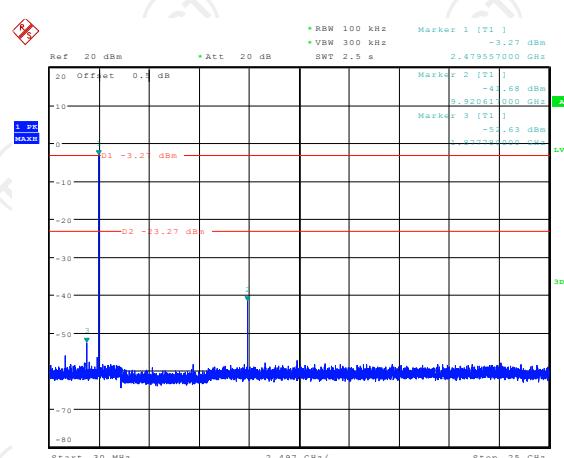
Date: 13.AUG.2018 13:41:51

Middle Channel



Date: 13.AUG.2018 13:43:49

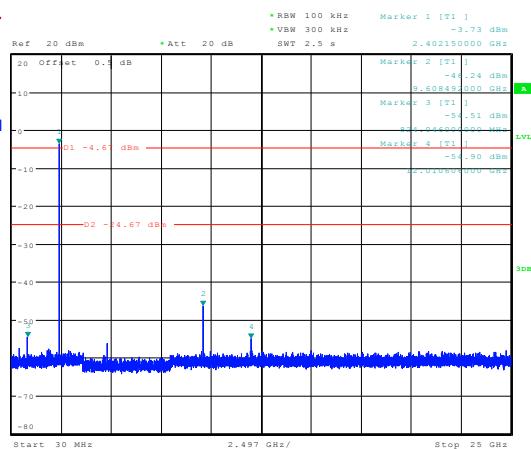
Highest Channel



Date: 13.AUG.2018 13:47:39

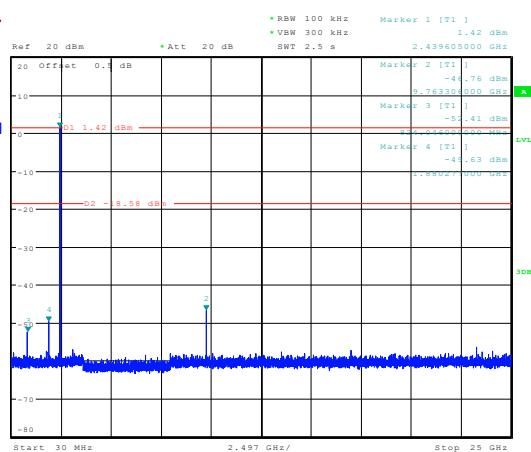
8DPSK mode

Lowest Channel



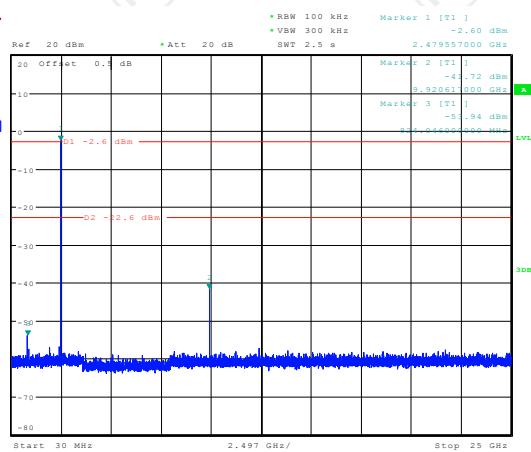
Date: 13.AUG.2018 13:49:32

Middle Channel



Date: 13.AUG.2018 13:52:29

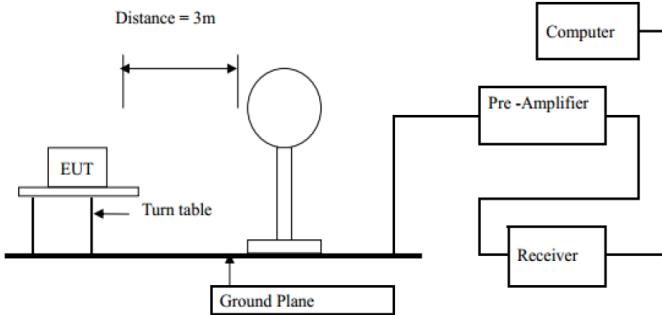
Highest Channel

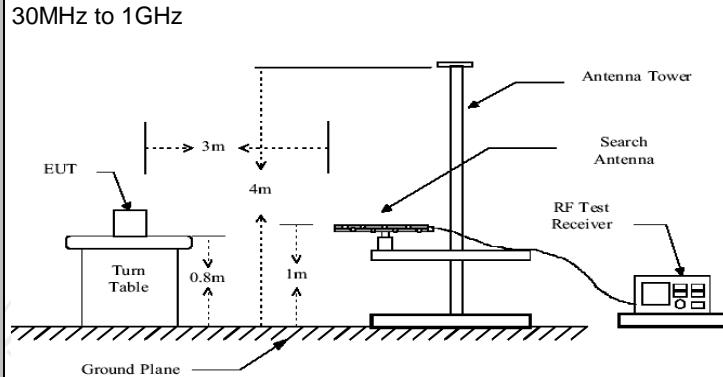


Date: 13.AUG.2018 13:54:25

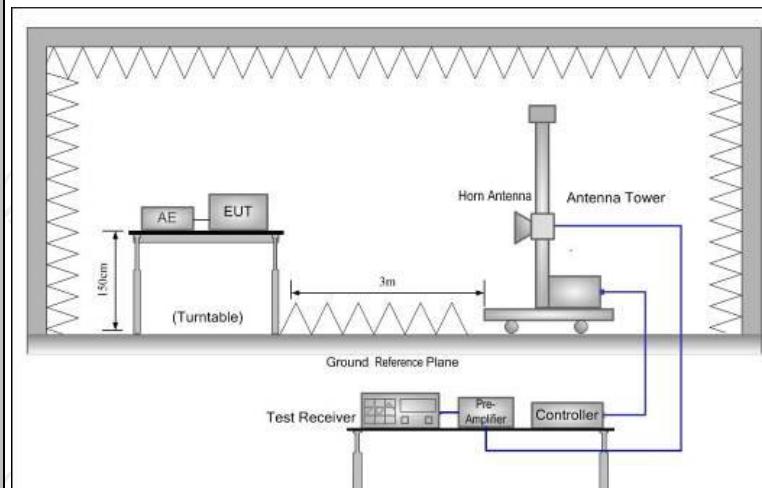
6.11. Radiated Spurious Emission Measurement

6.11.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.209																																							
Test Method:	ANSI C63.10:2013																																							
Frequency Range:	9 kHz to 25 GHz																																							
Measurement Distance:	3 m																																							
Antenna Polarization:	Horizontal & Vertical																																							
Receiver Setup:	<table border="1"> <thead> <tr> <th>Frequency</th> <th>Detector</th> <th>RBW</th> <th>VBW</th> <th>Remark</th> </tr> </thead> <tbody> <tr> <td>9kHz- 150kHz</td> <td>Quasi-peak</td> <td>200Hz</td> <td>1kHz</td> <td>Quasi-peak Value</td> </tr> <tr> <td>150kHz- 30MHz</td> <td>Quasi-peak</td> <td>9kHz</td> <td>30kHz</td> <td>Quasi-peak Value</td> </tr> <tr> <td>30MHz-1GHz</td> <td>Quasi-peak</td> <td>100KHz</td> <td>300KHz</td> <td>Quasi-peak Value</td> </tr> <tr> <td rowspan="2">Above 1GHz</td><td>Peak</td> <td>1MHz</td> <td>3MHz</td> <td>Peak Value</td> </tr> <tr> <td>Peak</td> <td>1MHz</td> <td>10Hz</td> <td>Average Value</td> </tr> </tbody> </table>					Frequency	Detector	RBW	VBW	Remark	9kHz- 150kHz	Quasi-peak	200Hz	1kHz	Quasi-peak Value	150kHz- 30MHz	Quasi-peak	9kHz	30kHz	Quasi-peak Value	30MHz-1GHz	Quasi-peak	100KHz	300KHz	Quasi-peak Value	Above 1GHz	Peak	1MHz	3MHz	Peak Value	Peak	1MHz	10Hz	Average Value						
Frequency	Detector	RBW	VBW	Remark																																				
9kHz- 150kHz	Quasi-peak	200Hz	1kHz	Quasi-peak Value																																				
150kHz- 30MHz	Quasi-peak	9kHz	30kHz	Quasi-peak Value																																				
30MHz-1GHz	Quasi-peak	100KHz	300KHz	Quasi-peak Value																																				
Above 1GHz	Peak	1MHz	3MHz	Peak Value																																				
	Peak	1MHz	10Hz	Average Value																																				
Limit:	<table border="1"> <thead> <tr> <th>Frequency</th> <th>Field Strength (microvolts/meter)</th> <th>Measurement Distance (meters)</th> </tr> </thead> <tbody> <tr> <td>0.009-0.490</td> <td>2400/F(KHz)</td> <td>300</td> </tr> <tr> <td>0.490-1.705</td> <td>24000/F(KHz)</td> <td>30</td> </tr> <tr> <td>1.705-30</td> <td>30</td> <td>30</td> </tr> <tr> <td>30-88</td> <td>100</td> <td>3</td> </tr> <tr> <td>88-216</td> <td>150</td> <td>3</td> </tr> <tr> <td>216-960</td> <td>200</td> <td>3</td> </tr> <tr> <td>Above 960</td> <td>500</td> <td>3</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Frequency</th> <th>Field Strength (microvolts/meter)</th> <th>Measurement Distance (meters)</th> <th>Detector</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Above 1GHz</td><td>500</td> <td>3</td> <td>Average</td> </tr> <tr> <td>5000</td> <td>3</td> <td>Peak</td> </tr> </tbody> </table>					Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)	0.009-0.490	2400/F(KHz)	300	0.490-1.705	24000/F(KHz)	30	1.705-30	30	30	30-88	100	3	88-216	150	3	216-960	200	3	Above 960	500	3	Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)	Detector	Above 1GHz	500	3	Average	5000	3	Peak
Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)																																						
0.009-0.490	2400/F(KHz)	300																																						
0.490-1.705	24000/F(KHz)	30																																						
1.705-30	30	30																																						
30-88	100	3																																						
88-216	150	3																																						
216-960	200	3																																						
Above 960	500	3																																						
Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)	Detector																																					
Above 1GHz	500	3	Average																																					
	5000	3	Peak																																					
Test setup:	<p>For radiated emissions below 30MHz</p>  <p>Distance = 3m</p> <p>Turn table</p> <p>EUT</p> <p>Computer</p> <p>Pre -Amplifier</p> <p>Receiver</p> <p>Ground Plane</p>																																							



Above 1GHz



Test Mode:

Transmitting mode with modulation

1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10:2013 Measurement Guidelines.

2. For the radiated emission test below 1GHz:
The EUT was placed on a turntable with 0.8 meter above ground. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high PASS filter are used for the test in order to get better signal level.

For the radiated emission test above 1GHz:

Place the measurement antenna on a turntable with 1.5 meter above ground, which is 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

Test Procedure:

	<p>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.</p> <p>3. Set to the maximum power setting and enable the EUT transmit continuously.</p> <p>4. Use the following spectrum analyzer settings:</p> <ol style="list-style-type: none"> (1) Span shall wide enough to fully capture the emission being measured; (2) Set RBW=100 kHz for $f < 1$ GHz, RBW=1MHz for $f > 1$ GHz ; $VBW \geq RBW$; Sweep = auto; Detector function = peak; Trace = max hold for peak (3) For average measurement: use duty cycle correction factor method per 15.35(c). Duty cycle = On time/100 milliseconds On time = $N_1 \cdot L_1 + N_2 \cdot L_2 + \dots + N_{n-1} \cdot L_{n-1} + N_n \cdot L_n$ Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc. Average Emission Level = Peak Emission Level + $20 \cdot \log(\text{Duty cycle})$ Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
Test results:	PASS

6.11.2. Test Instruments

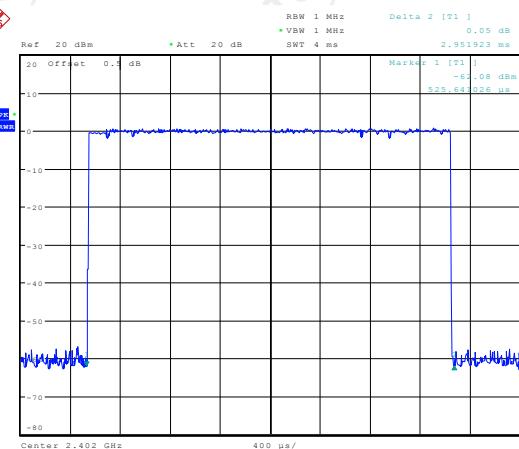
Radiated Emission Test Site (966)				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Test Receiver	ROHDE&SCHW ARZ	ESVD	100008	Sep. 27, 2018
Spectrum Analyzer	ROHDE&SCHW ARZ	FSQ	200061	Sep. 27, 2018
Pre-amplifier	EM Electronics Corporation CO.,LTD	EM30265	07032613	Sep. 27, 2018
Pre-amplifier	HP	8447D	2727A05017	Sep. 27, 2018
Loop antenna	ZHINAN	ZN30900A	12024	Sep. 27, 2018
Broadband Antenna	Schwarzbeck	VULB9163	340	Sep. 27, 2018
Horn Antenna	Schwarzbeck	BBHA 9120D	631	Sep. 27, 2018
Horn Antenna	Schwarzbeck	BBH 9170	582	Sep. 27, 2018
Antenna Mast	Keleto	CC-A-4M	N/A	N/A
Coax cable (9KHz-1GHz)	TCT	RE-low-01	N/A	Sep. 27, 2018
Coax cable (9KHz-40GHz)	TCT	RE-high-02	N/A	Sep. 27, 2018
Coax cable (9KHz-1GHz)	TCT	RE-low-03	N/A	Sep. 27, 2018
Coax cable (9KHz-40GHz)	TCT	RE-high-04	N/A	Sep. 27, 2018
EMI Test Software	Shurples Technology	EZ-EMC	N/A	N/A

Note: The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).

6.11.3. Test Data

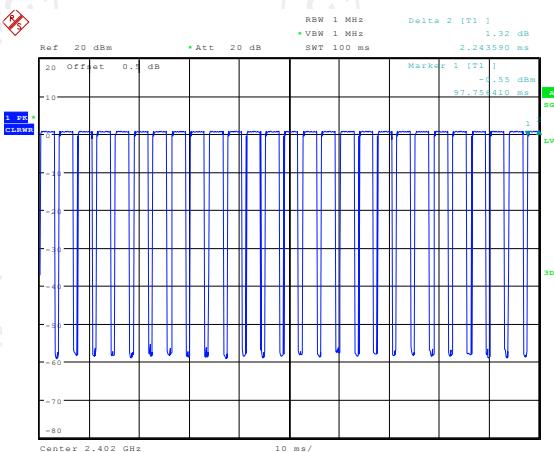
Duty cycle correction factor for average measurement

2DH5 on time (One Pulse) Plot on Channel 00



Date: 13.AUG.2018 11:28:32

2DH5 on time (Count Pulses) Plot on Channel 00



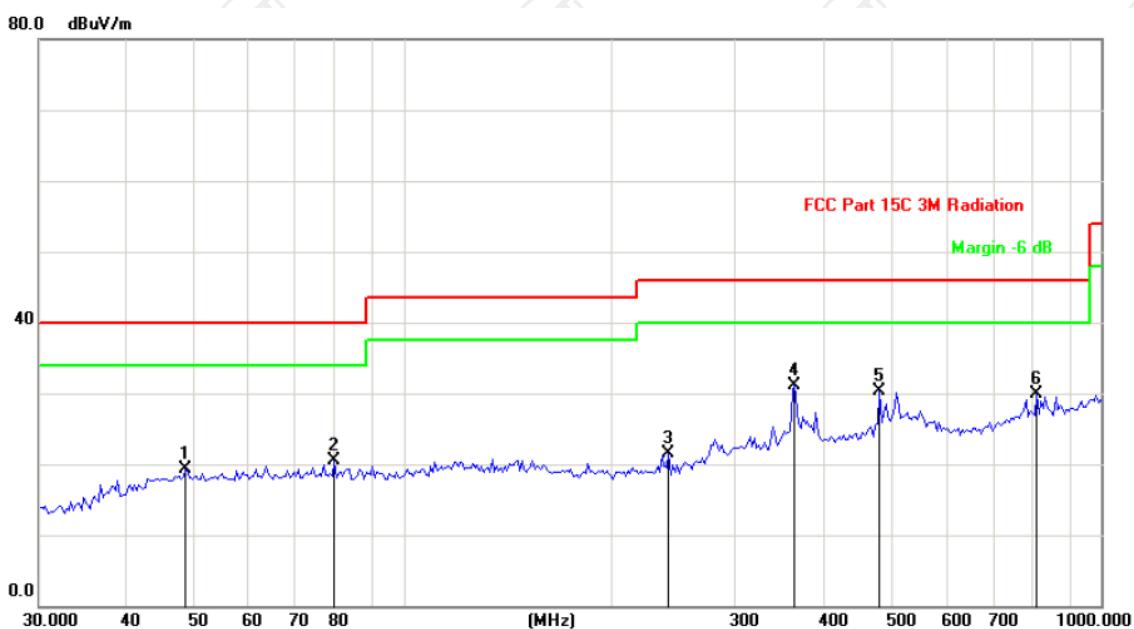
Note:

1. Worst case Duty cycle = on time/100 milliseconds = $(2.952 \times 26 + 2.244)/100 = 0.7900$
2. Worst case Duty cycle correction factor = $20 \times \log_{10}(\text{Duty cycle}) = -2.05 \text{ dB}$
3. 2DH5 has the highest duty cycle worst case and is reported.
4. The average levels were calculated from the peak level corrected with duty cycle correction factor (-2.05dB) derived from $20 \log_{10}(\text{dwell time}/100\text{ms})$. This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

Please refer to following diagram for individual

Below 1GHz

Horizontal:



Site

Polarization: **Horizontal**

Temperature: 25

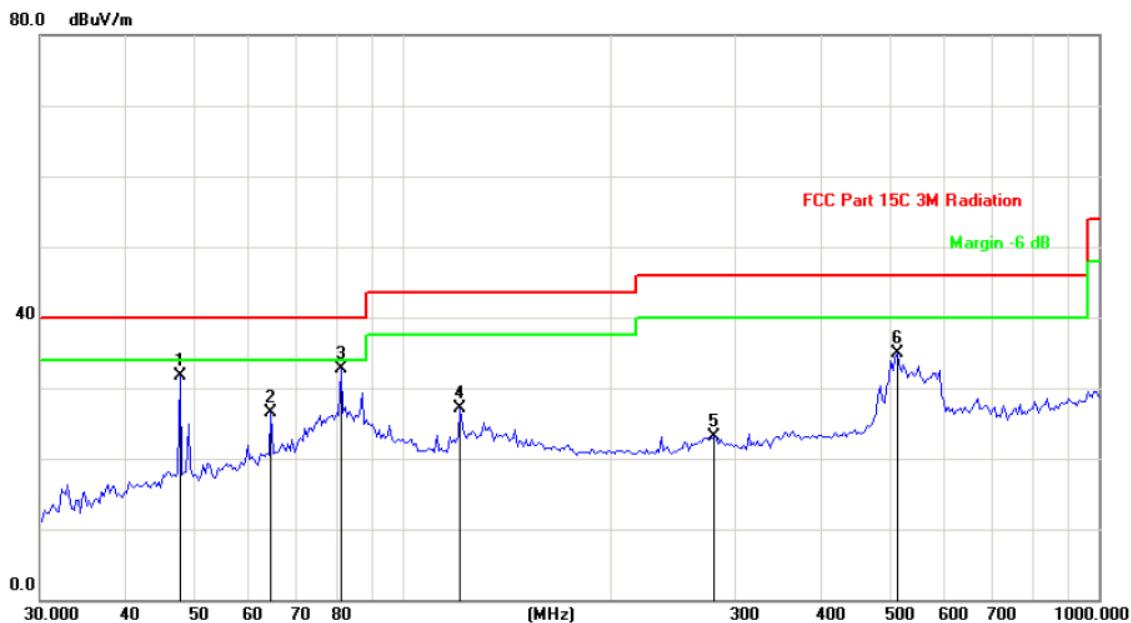
Limit: FCC Part 15C 3M Radiation

Power: DC 12V

Humidity: 55 %

No.	Mk.	Freq. MHz	Reading	Correct	Measure-	Limit dB/m	Over dB	Antenna Height cm	Table Degree	
			Level dBuV	Factor	ment dBuV/m				degree	Comment
1		48.7190	32.16	-12.93	19.23	40.00	-20.77	peak		
2		79.6764	38.05	-17.61	20.44	40.00	-19.56	peak		
3		240.1442	34.55	-13.03	21.52	46.00	-24.48	peak		
4	*	363.5230	40.75	-9.55	31.20	46.00	-14.80	peak		
5		481.5110	37.46	-7.16	30.30	46.00	-15.70	peak		
6		809.9238	33.18	-3.26	29.92	46.00	-16.08	peak		

Vertical:



Site

 Polarization: **Vertical**

Temperature: 25

Limit: FCC Part 15C 3M Radiation

Power: DC 12V

Humidity: 55 %

No. Mk.	Freq. MHz	Reading Level	Correct Factor	Measure- ment	Limit	Over	Antenna Height	Table Degree	Comment
		dBuV	dB	dBuV/m	dB/m	dB	Detector	cm	
1	47.7028	44.55	-12.94	31.61	40.00	-8.39	peak		
2	64.5318	42.03	-15.48	26.55	40.00	-13.45	peak		
3 *	81.3739	49.84	-17.15	32.69	40.00	-7.31	peak		
4	120.6118	42.47	-15.33	27.14	43.50	-16.36	peak		
5	280.2936	34.82	-11.63	23.19	46.00	-22.81	peak		
6	512.9477	41.40	-6.56	34.84	46.00	-11.16	peak		

Note: 1. The low frequency, which started from 9KHz-30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported

2. Measurements were conducted in all three channels (high, middle, low) and three modulation (GFSK, Pi/4DQPSK, 8DPSK) and the worst case Mode (Lowest channel and Pi/4DQPSK) was submitted only.

Above 1GHz

Modulation Type: Pi/4DQPSK									
Low channel: 2402 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dB μ V)	AV reading (dB μ V)	Correction Factor (dB/m)	Emission Level		Peak limit (dB μ V/m)	AV limit (dB μ V/m)	Margin (dB)
					Peak (dB μ V/m)	AV (dB μ V/m)			
2390	H	44.37	---	-8.27	36.10	---	74	54	-17.90
4804	H	46.85	---	0.66	47.51	---	74	54	-6.49
7206	H	39.42	---	9.50	48.92	---	74	54	-5.08
---	H	---	---	---	---	---	---	---	---
2390	V	43.64	---	-8.27	35.37	---	74	54	-18.63
4804	V	44.13	---	0.66	44.79	---	74	54	-9.21
7206	V	38.09	---	9.50	47.59	---	74	54	-6.41
---	V	---	---	---	---	---	---	---	---

Middle channel: 2441 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dB μ V)	AV reading (dB μ V)	Correction Factor (dB/m)	Emission Level		Peak limit (dB μ V/m)	AV limit (dB μ V/m)	Margin (dB)
					Peak (dB μ V/m)	AV (dB μ V/m)			
4882	H	43.50	---	0.99	44.49	---	74	54	-9.51
7323	H	38.28	---	9.87	48.15	---	74	54	-5.85
---	H	---	---	---	---	---	---	---	---
4882	V	44.96	---	0.99	45.95	---	74	54	-8.05
7323	V	39.71	---	9.87	49.58	---	74	54	-4.42
---	V	---	---	---	---	---	---	---	---

High channel: 2480 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dB μ V)	AV reading (dB μ V)	Correction Factor (dB/m)	Emission Level		Peak limit (dB μ V/m)	AV limit (dB μ V/m)	Margin (dB)
					Peak (dB μ V/m)	AV (dB μ V/m)			
2483.5	H	46.84	---	-7.83	39.01	---	74	54	-14.99
4960	H	47.69	---	1.33	49.02	---	74	54	-4.98
7440	H	39.07	---	10.22	49.29	---	74	54	-4.71
---	H	---	---	---	---	---	---	---	---
2483.5	V	48.40	---	-7.83	40.57	---	74	54	-13.43
4960	V	47.26	---	1.33	48.59	---	74	54	-5.41
7440	V	37.13	---	10.22	47.35	---	74	54	-6.65
---	V	---	---	---	---	---	---	---	---

Note:

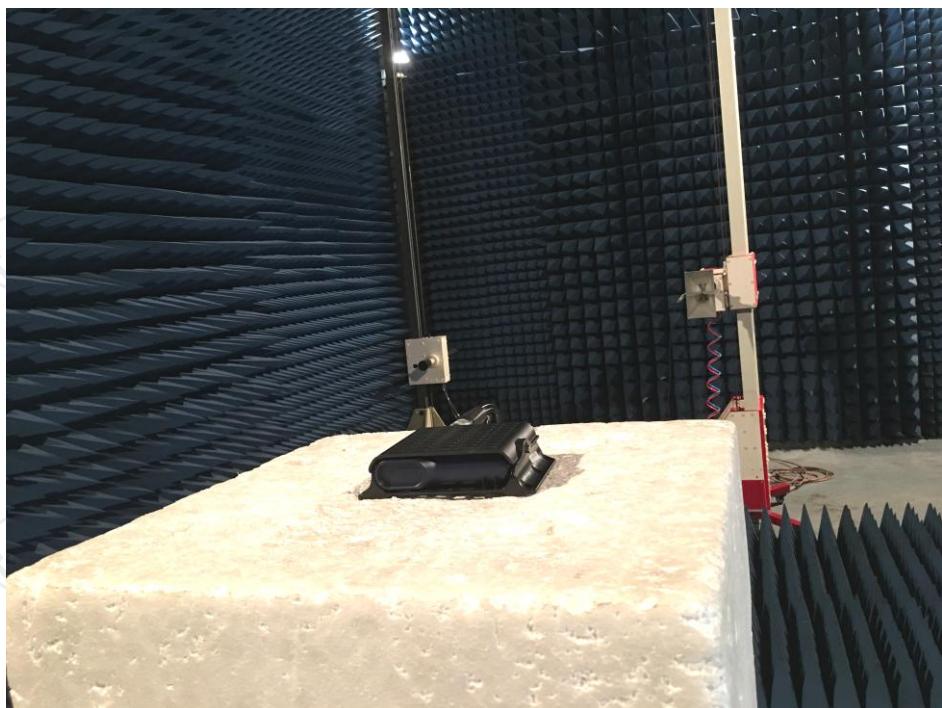
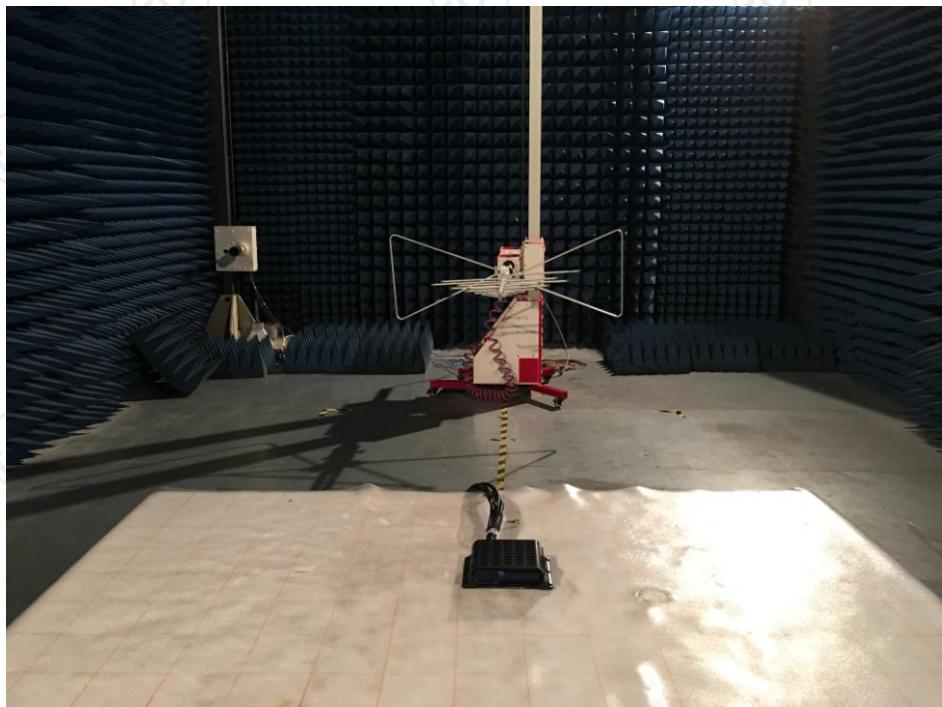
1. Emission Level=Peak Reading + Correction Factor; Correction Factor= Antenna Factor + Cable loss – Pre-amplifier
2. Margin (dB) = Emission Level (Peak) (dB μ V/m)-Average limit (dB μ V/m)
3. The emission levels of other frequencies are very lower than the limit and not show in test report.
4. Measurements were conducted from 1 GHz to the 10th harmonic of highest fundamental frequency.
5. Data of measurement shown “---” in the above table mean that the reading of emissions is attenuated more than 20 dB below the limits or the field strength is too small to be measured.
6. Measurements were conducted in all three modulation (GFSK, Pi/4DQPSK, 8DPSK), and the worst case Mode (Pi/4DQPSK) was submitted only.

Appendix A: Photographs of Test Setup

Product: Micronet SmartHub LTE

Model: Micronet SmartHub

Radiated Emission



Appendix B: Photographs of EUT

Product: Micronet SmartHub LTE

Model: Micronet SmartHub

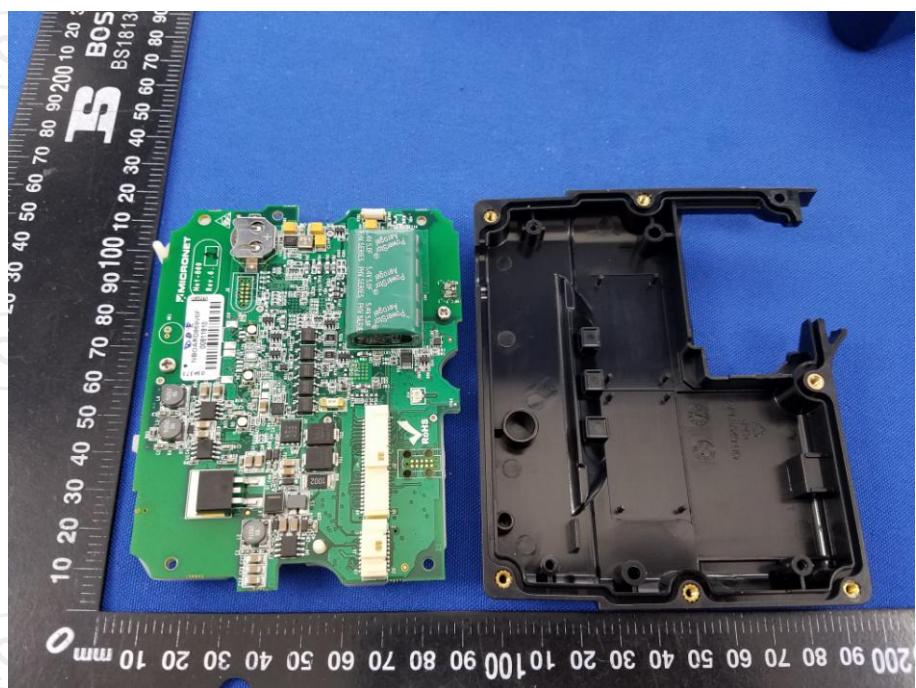
External Photos

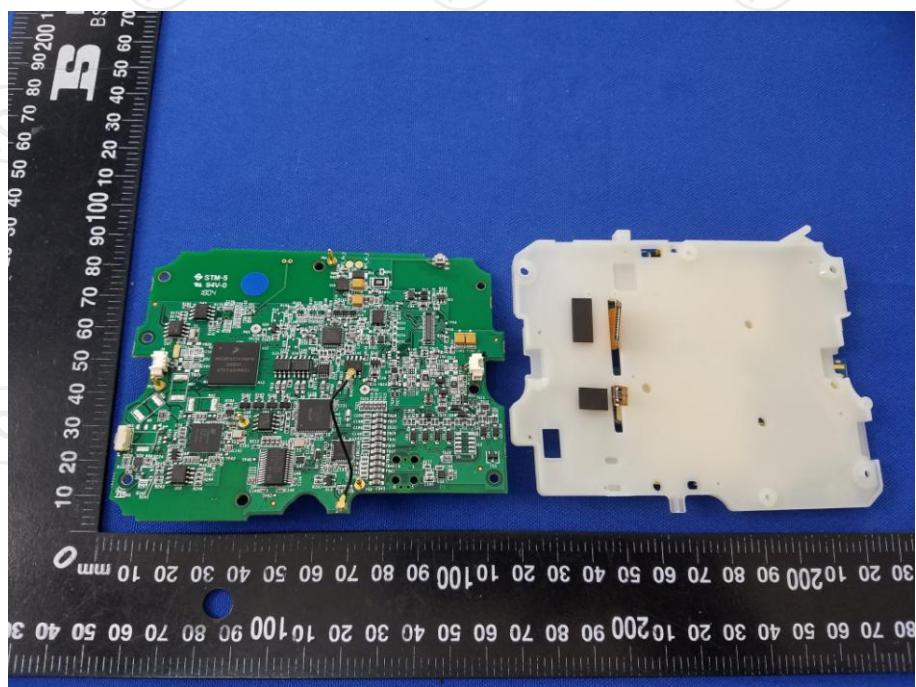
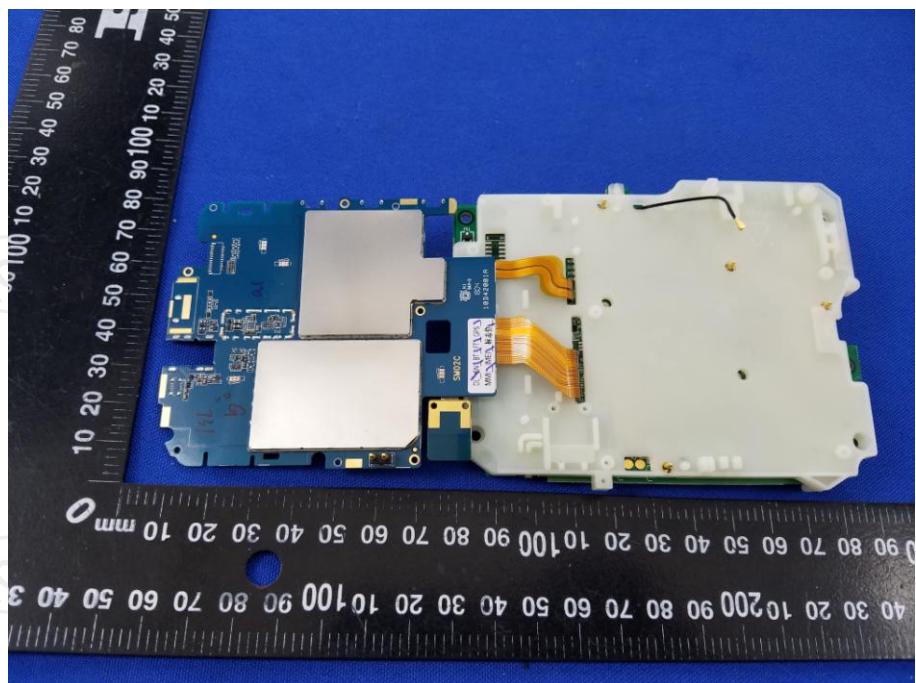


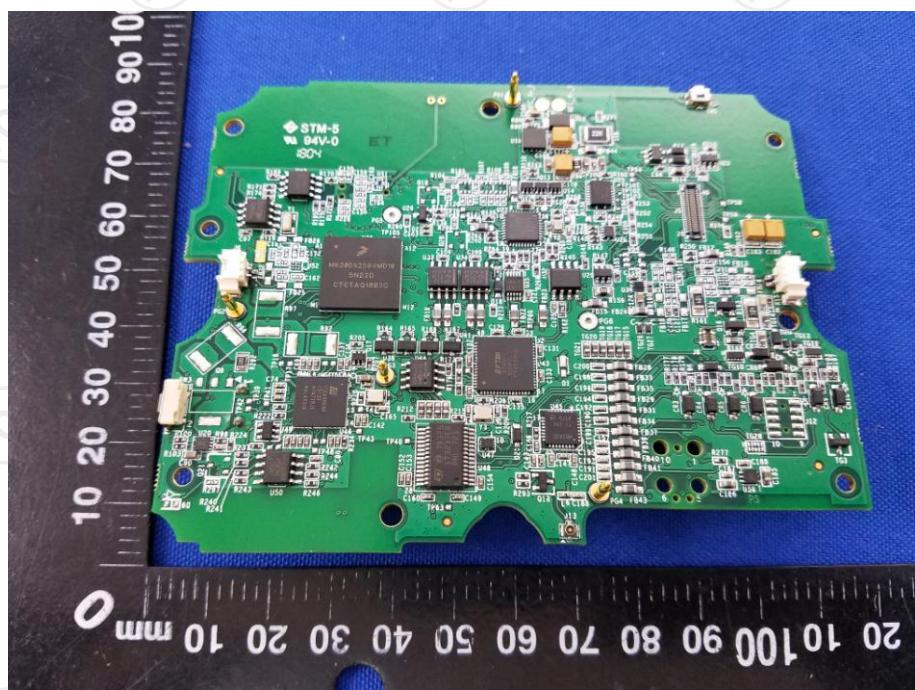
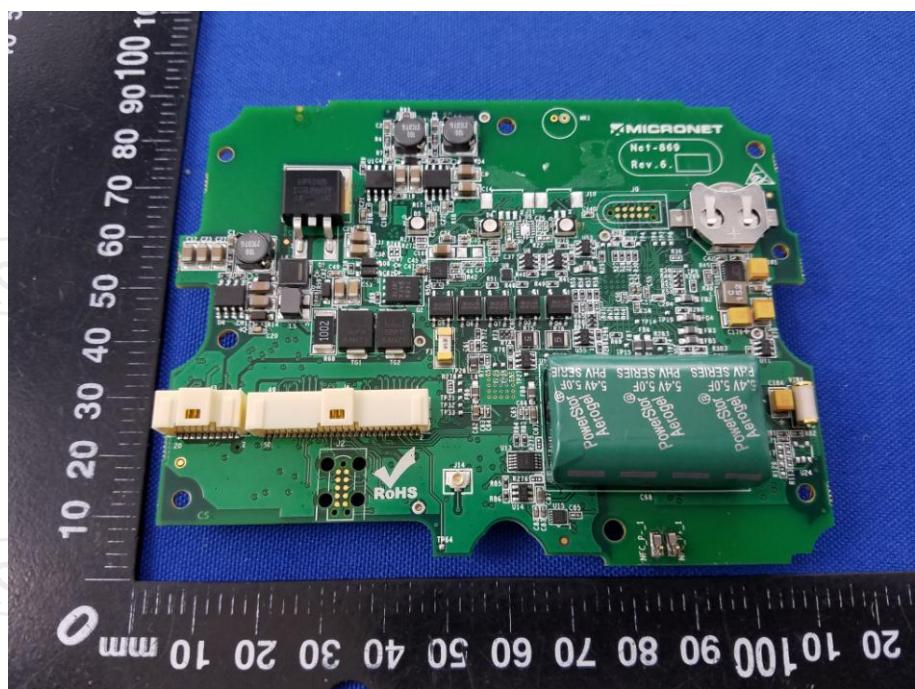


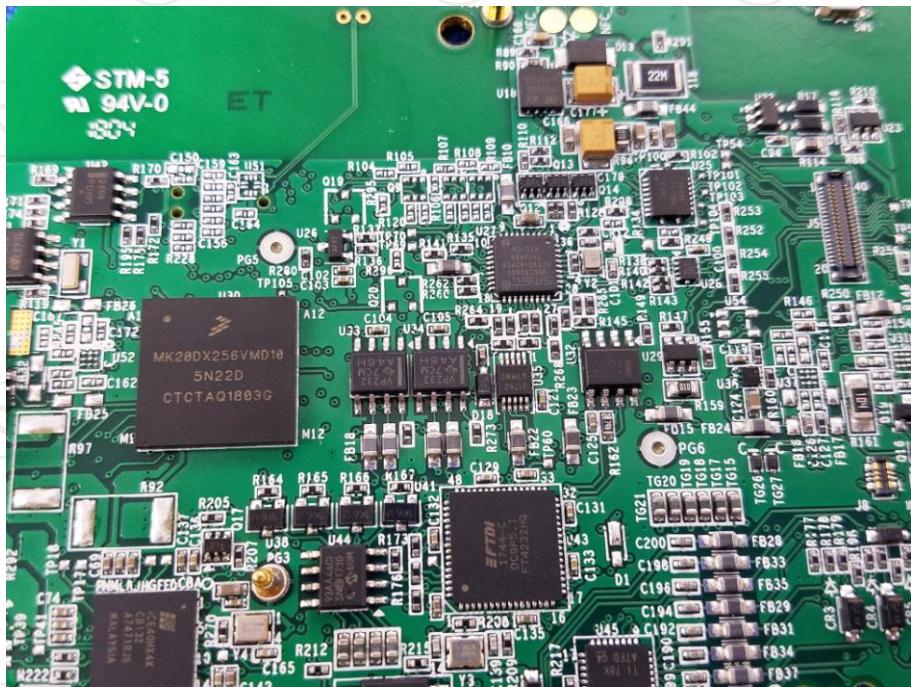
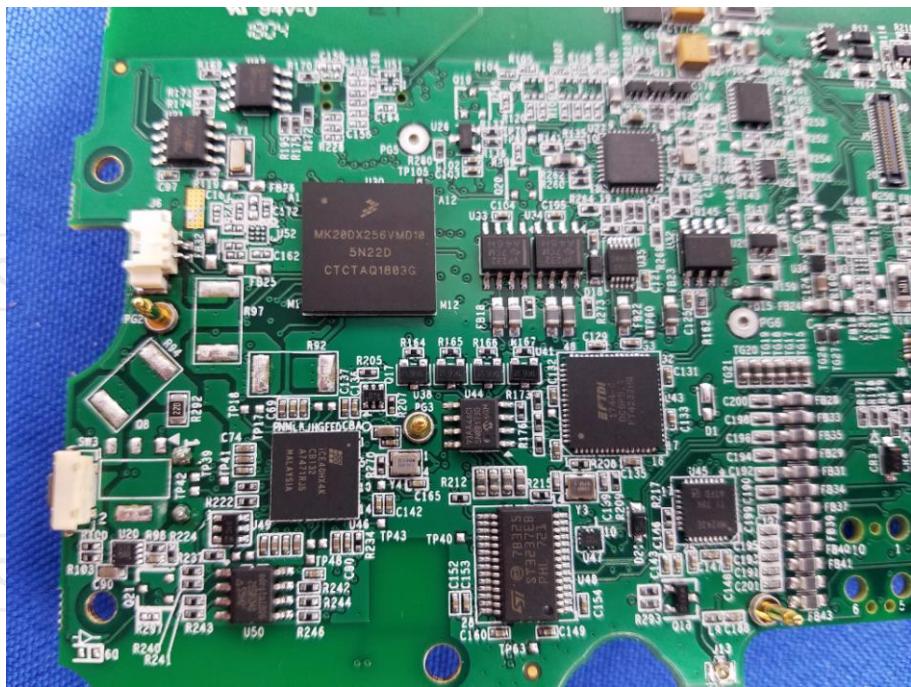


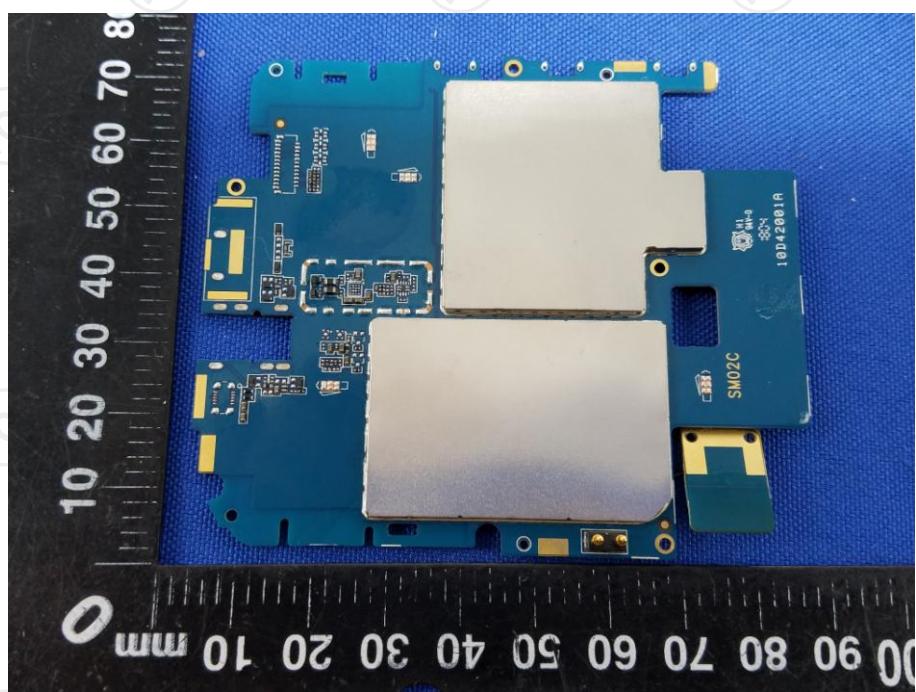
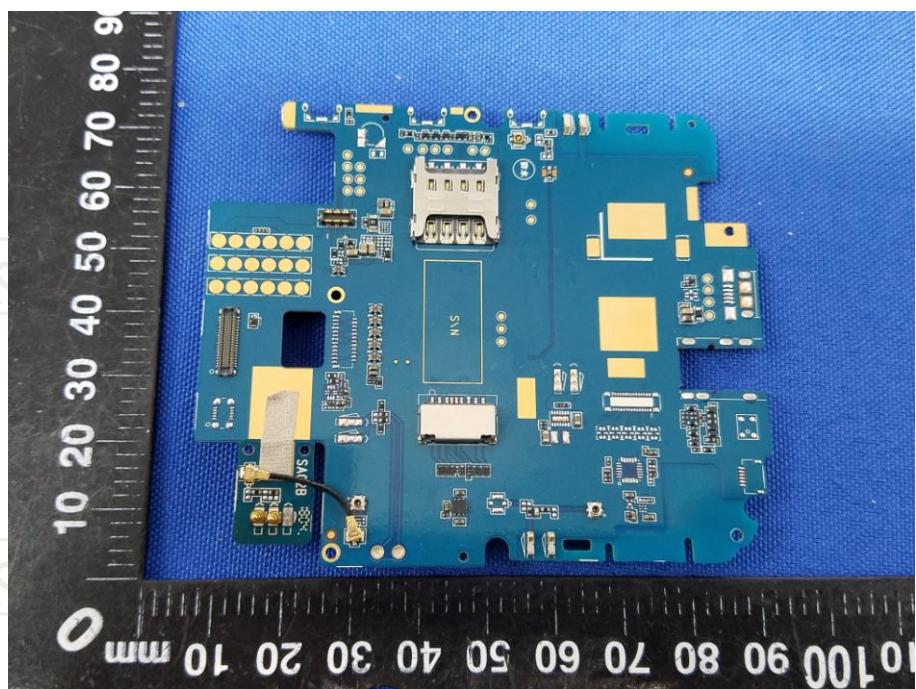
Product: Micronet SmartHub LTE
Model: Micronet SmartHub
Internal Photos

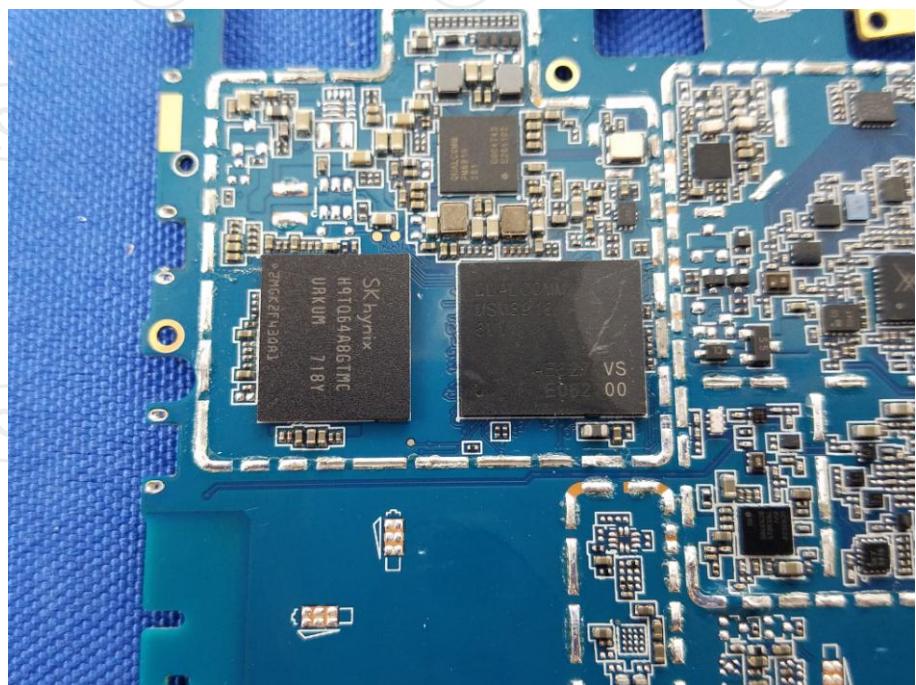
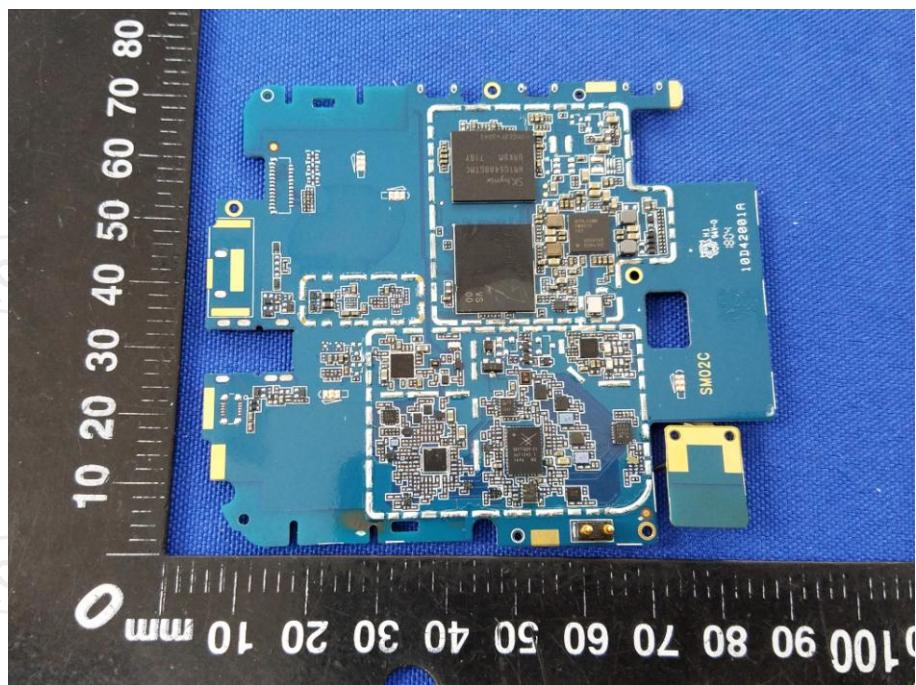












*******END OF REPORT*******