RF TEST REPORT FOR FCC

RZBG(W)20230110001-1

Applicant : Zhejiang Tianze Communication Technology Co., Ltd

Manufacture : 8F, 3760 Nanhuan Road, Binjiang District, Hangzhou ,Zhejiang, China

Product Name : T900

Type/Model : T900-30-IPEX

FCC ID : 2A9NZ-T900

TEST RESULT: PASS

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 Sub-part C 15.247: Radio Frequency Device:Sub-part C;Intentional radiators.

ANSI C63.10 (2013): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

Date of issue:Apr. 18, 23

Prepared by	Reviewed by:	Issued by:
Hao Wei (Project engineer)	Haohui Qiu (Reviewer)	Bing Cai (General Manager)
Hao Wei	Haohui Qiu	Bing Cai

Content

1. GENERAL INFORMATION of EUT

1.1 Applicant information

Applicant	Zhejiang Tianze Communication Technology Co., Ltd
Address	8F, 3760 Nanhuan Road, Binjiang District, Hangzhou , Zhejiang, China
Contact person	Shanxue Ke
Phone number	+86 571 28118173

1.2 Manufacture information

Manufacture	Zhejiang Tianze Communication Technology Co., Ltd
Address	8F, 3760 Nanhuan Road, Binjiang District, Hangzhou , Zhejiang, China

1.3 General Description for Equipment under Test(EUT)

Eut name	T900
Trade name	TianZe
Under test mode name	T900-30-IPEX
Series model name	N/A
Description of different model name	N/A
Hardware version	60136C-30-IPEX
Software version	0030-20221017-0A
Temperature range	-20℃-40℃
Network and Wireless connectivity	902MHz-928MHz

1.4 Technical information of equipment under test (EUT)

The requirement for the following technical information of the EUT was tested in this report:

Test channel	57600bps：Low(902.3 MHz), Middle (914.9MHz), High(927.5MHz) 172800bps：Low(902.3 MHz), Middle (915.05MHz), High(927.8MHz) 230400bps：Low(902.3 MHz), Middle (915.06MHz), High(927.82MHz) 276400bps：Low(902.3 MHz), Middle (914.9MHz), High(927.5MHz)
Modulation Technology	FHSS
Modulation Type	GFSK
FCC ID	2A9NZ-T900
Equipment type	☒ Mobile ☐ Portable ☐ Fix Location
Transfer Rate	57600kbps,172800kbps，230400kbps，276400kbps
Frequency Range	The frequency range used is 902 MHz to 928 MHz.
Number of Channel	57600kbps:127 172800kbps：103 230400kbps：89 276400kbps：73
Maximum RF Output Power(dBm)	57600kbps:27.76 172800kbps:27.48 230400kbps:27.42 276400kbps:26.52
Antenna Type	Rubber rod antenna
Antenna Gain	2.5dbi

Note:The antenna gain is obtained from the antenna specification provided by the customer.

1.5 Additional Instructions

EUT Software Settings:

Mode	☒ Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.

During testing, Channel and 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.The device operates in the worst-case mode during Conducted Emissions testing

Power level setup in software			
Test Software Version	JS0806-3 V2.6.88.0346		
Transmitting signal software	T900 Control serial port V3.7		
Mode(Kbps)	Channel	Frequency (MHz)	Soft Set
57600	1	902.3	Power parameter Settings is 1W
	64	914.9	
	127	927.5	
172800	1	902.3	Power parameter Settings is 1W
	52	915.05	
	103	927.8	
230400	1	902.3	Power parameter Settings is 1W
	45	915.06	
	89	927.82	
276400	1	902.3	Power parameter Settings is 1W
	37	914.9	
	73	927.5	

Sample received date : 2023.01.0
Date of test : 2023-01-10 ~ 2023.04.06

2. Description of Test Facility

☒	Company Name	Hangzhou TDT Technologies Co., Ltd.
	Address	Room 101, Building 3, No. 12, Binwen Road, Xixing Street, Binjiang district, Hangzhou, Zhejiang, China
	Telephone	+86571-88317620
	Telefax	+86571-88316350
	Test Location	Hangzhou TDT Technologies Co., Ltd.
	Address	Room 101, Building 3, No. 12, Binwen Road, Xixing Street, Binjiang district, Hangzhou, Zhejiang, China
	Telephone	+86571-88317620
	Telefax	+86571-88316350
	A2LA Certification number	4037.01
	CNAS Certification number	CNAS L7728
	VCCI Site registration number	C-14683, G-10832, R-14200, T-12223
	FCC Site registration number	645845
	Designation number	CN1197

Announce：

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2	The test report is invalid if not marked with the signatures of the persons responsible For preparing and approving the test report.
3	The test report is invalid if there is any evidence and/or falsification.
4	The result documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein
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8	This is the second version of the report, which replaces the previous one. See the revision history for details

3. SUMMARY OF TEST RESULT

3.1 Test standard

No.	Identify	Document title
1	47 CFR Part 15 Subpart C	Miscellaneous Wireless Communications Services
2	KDB Publication 558074 D01v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
3	ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

3.2 Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	--	Pass
2	Number of Hopping Frequencies	15.247(a)	ANNEX A.1	Pass
3	Peak Output Power and E.I.R.P	15.247(b)	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	ANNEX A.3	Pass
5	Carrier Frequency Separation	15.247(a)	ANNEX A.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	ANNEX A.5	Pass
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	ANNEX A.6	Pass
8	Conducted Emission	15.207	ANNEX A.7	Pass
9	Radiated Spurious Emission	15.209 15.247(d)	ANNEX A.8	Pass
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	ANNEX A.9	Pass
11	Receiver Spurious Emissions	--	--	N/A Note 1

Note 1: Only radio communication receivers operating in stand-alone mode within the band 30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.

Auto Test Software Information			
Test Item	**Manufacturer**	**MODEL**	**Version**
Radiated Spurious Emission	AUDIX	E3	V 8.2014-7-10A
Conducted emission	TONSCEND	TS+	V2.5.0.0
Conducted	Tonscend	JS0806-3	V2.6.88.0346

4. GENERAL TEST CONFIGURATION

4.1 Test Enviroments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	45% - 55%	
Atmospheric Pressure	100 kPa - 102 kPa	
Temperature	NT (Normal Temperature)	+22℃ to +25℃
	LT (Low Temperature)	-20℃
	HT (High Temperature)	+40℃
Working Voltage of the EUT	NV (Normal Voltage)	12 V

4.2 Test Equipment

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Cal. Period	Use
Spectrum Analyzer	R&S	FSV40	101015	Jun.6, 2022	1 year	√
Analog signal generator	Agilent	N5183A	MY50141794	Oct.19, 2022	1 year	×
LOOP Antenna	Com-power	AL-130R	10160053	Jul.04,2021	2 year	√
Automatic control unit	Tonscend	JS0806-2	T1326593	Oct.19, 2022	1 year	√
EMI Test receiver	R&S	ESR26	101617	Oct.19, 2022	1 year	√
PRE-AMPLIFIER (1-18GHz)	Connphy	CLN-1G18G-4060-S	718005	Aug.20, 2022	1 year	√
PRE-AMPLIFIER (18-40GHz)	CERNEX	CBL18404035	24496/24495	Jun.14, 2022	1 year	√
Bi-conical and log-periodic Antenna (30MHz-1GHz)	SCHWARZBECK	VULB 9168	796	Apr.12,2021	2year	√
HORN Antenna (1GHz-18GHz)	SCHWARZBECK	BBHA 9120D	1935	Oct.19, 2022	1 year	√
Coaxial RF Cable	Talent Microwave	SUCOFLEX 104EA+SUCOFLEX 100	NA	Jun.14, 2022	1 year	√
	Talent Microwave	SA360-2.92M2.92M-11M-3#	NA	Jun.14, 2022	1 year	√
High-pass Filter	tonscend	ZHPF-M3-18G-SS	186101682	Jul.10, 2022	2year	√
HORN Antenna	Com-power	AH-840	101076	Dec.05, 2022	1year	√
Band Elimination Filter （902MHz-928MHz）	COM-MW	ZBSF6-C904-928-3498	2235224	Jan.07, 2023	2year	√

Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT 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.

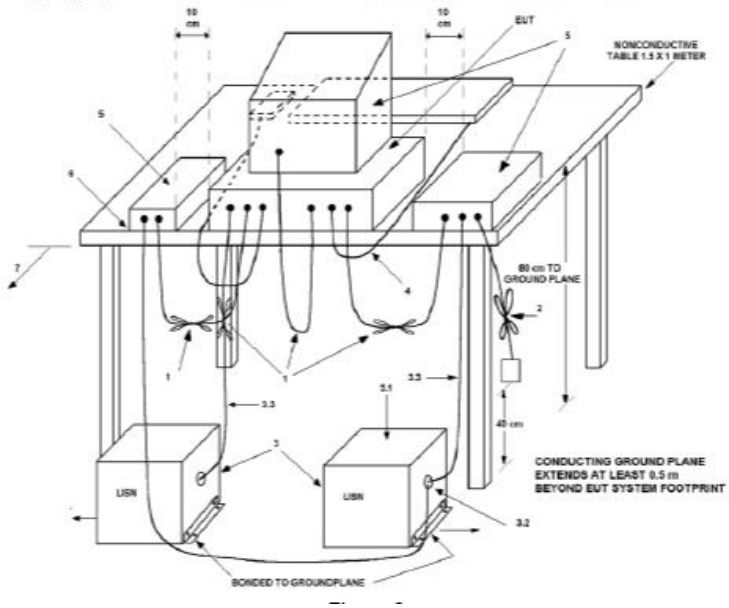
Measurement	Value
Occupied Channel Bandwidth	±2MHz
RF output power, conducted	±1.24dB
Power Spectral Density, conducted	±1.88 dB
Unwanted Emissions, conducted （30MHz-1GHz）	±0.746 dB
Unwanted Emissions, conducted （above 1GHz）	±1.328 dB
Temperature	±1 °C
Humidity	±4 %

4.3 Description of Test Setup

4.4.1 For conducted Test

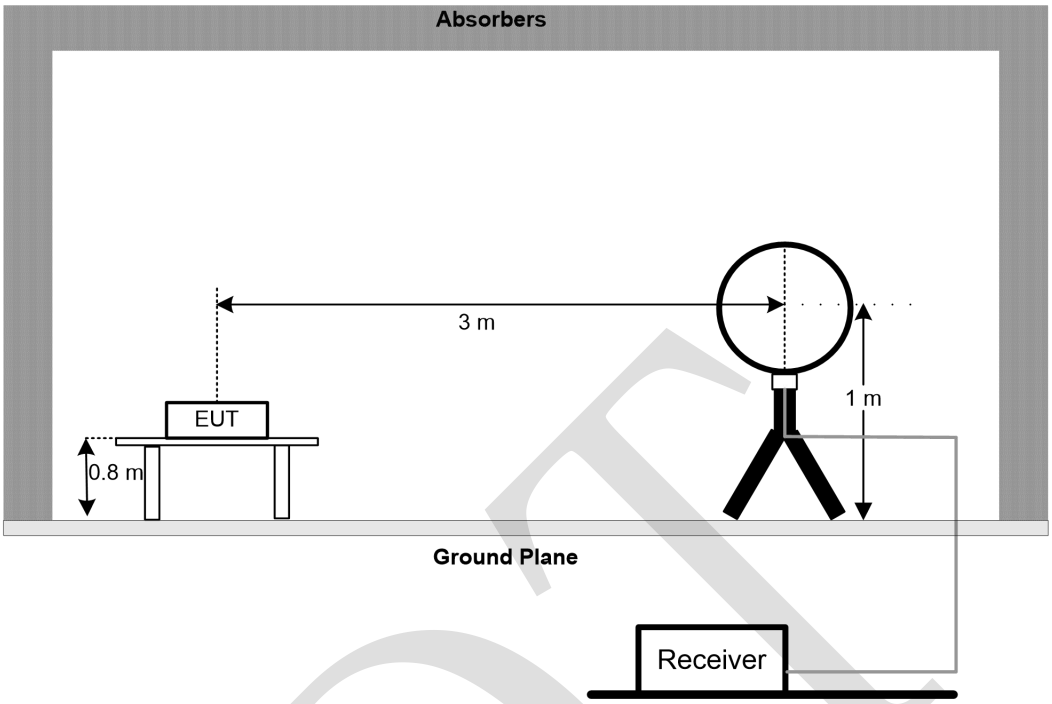
Conducted value (dBm) =Measurement value (dBm) + cable loss (dB)
For example: the measurement value is 10dBm and the cable 0.5dBm used, then the final result of EUT: Conducted value (dBm) = 10dBm + 0.5dB = 10.5dBm

4.4.2 For AC Power Supply port Test



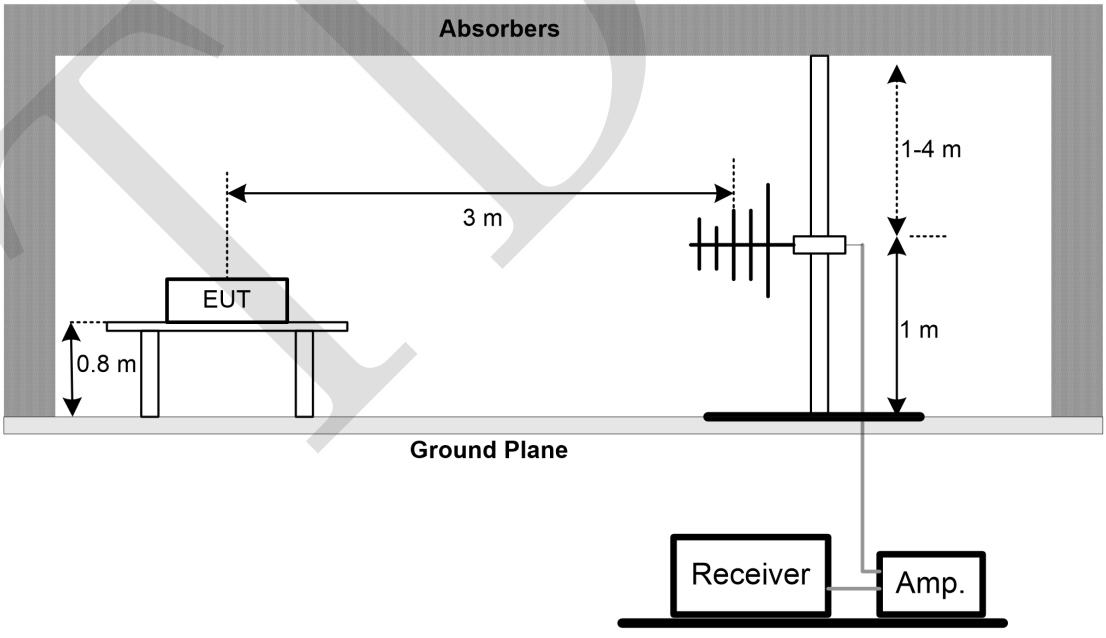
(Diagram 1)

4.4.3 For Radiated Test (Below 30 MHz)



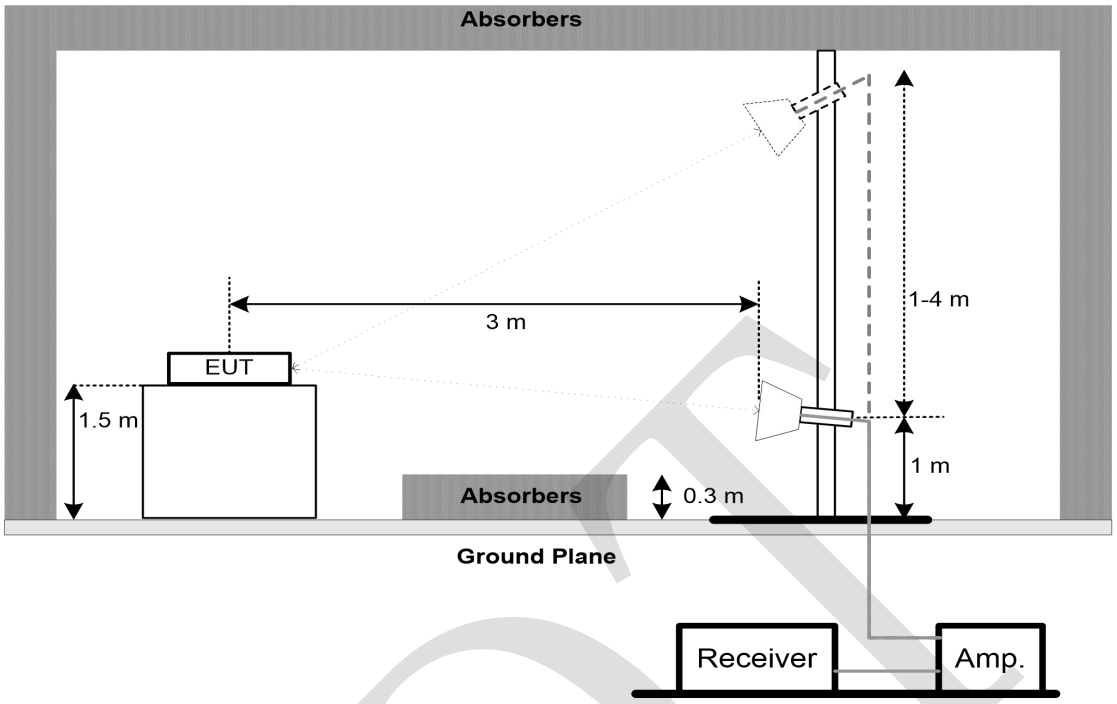
(Diagram 2)

4.4.4 For Radiated Test(30MHz-1GHz)



(Diagram 3)

4.4.5 For Radiated Test （Above 1 GHz）



(Diagram 4)

4.4 Measurement Results Explanation Example

4.5.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

4.5.2 For radiated band edges and spurious emission test:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

EIRP= Measure Conducted output power Value (dBm) + Maximum transmit antenna gain (dBi) + the appropriate maximum ground reflection factor (dB)

5. TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)
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 shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	The antenna of this product is not permanently connected and can be replaced at any time.

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

Antenna Gain

The antenna peak gain of EUT is 2.5dBi less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Frequency Hopping Systems

Relevant Standards

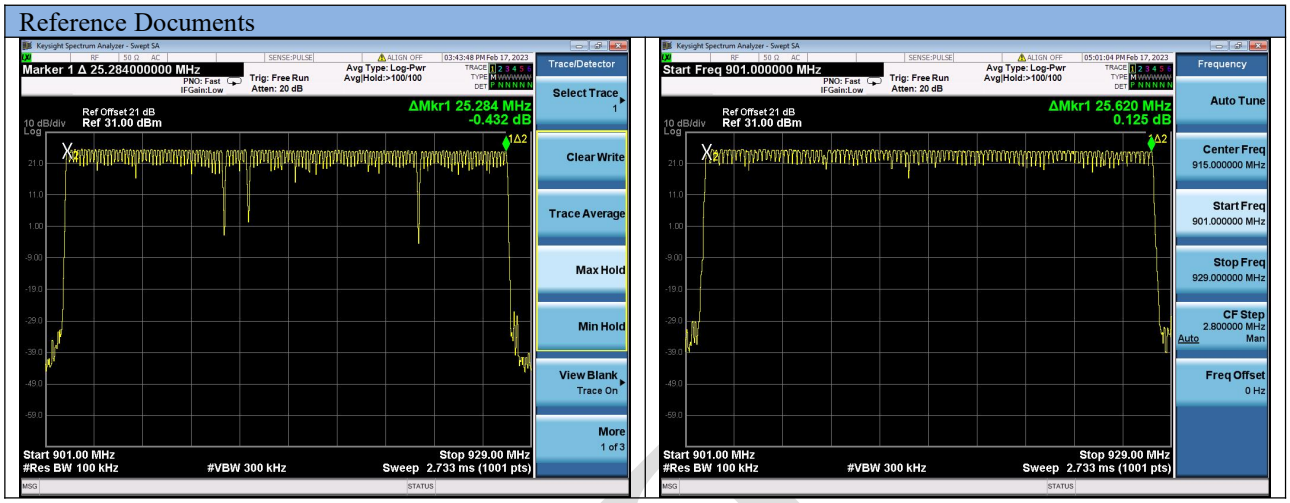
FCC §15.247(a) (1) (i) (ii) (iii) (iv); FCC §15.247(g); FCC §15.247(h)

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, to demonstrate that the sequence meets the requirement specified in the definition of an FHSS system. Per the definition in Section 2.1(c), the hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.
Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).
Describe how the associated receiver(s) complies with the requirement that the input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.
Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.
For short burst systems, describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system. Specifically, the device shall comply with the equal frequency use and pseudorandom hopping sequence requirement when transmitting in short bursts, and shall be designed to comply when presented with continuous data (or information) stream.
Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Description of the systems

According to the preset procedure of the whole network, all the stations in the automatic control network synchronously change the frequency multiple times within one second, and temporarily stay on each frequency hopping channel. Periodic synchronization signaling is sent from the primary station, instructing all slaves to simultaneously change the operating frequency, then the hopping sequence is generated.
The hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.

Reference Documents



Channels are classified into two categories, used and unused, where used channels are part of the hopping sequence and unused channels are replaced in the hopping sequence by used channels in a pseudo-random way. Make each individual EUT meets the requirement that each of its hopping channels is used equally on average.

The input bandwith and transmitted bandwith are both 1MHz, the associated receiver(s) complies with the requirement that the input bandwidth matches the bandwidth of the transmitted signal.

Connected devices communicate on the same physical channel by synchronizing with a common clock and hopping sequence.

EUT isn't short burst systems.

EUT can't have the ability to be coordinated with other FHSS systems in an effort.

5.3 Number of Hopping Frequencies

Limit

FCC §15.247(a) (1) (iii); RSS-247, 5.1 (4)

Frequency hopping systems operating in the 2400 MHz to 2483.5 MHz bands shall use at least 15 hopping frequencies.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel

spacing or the 20 dB bandwidth, whichever is smaller.

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

Test Result

Please refer to ANNEX A.1.

5.4 Peak Output Power and EIRP

Limit

FCC § 15.247(b); RSS-247, 5.4 (4)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Maximum peak conducted output power

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Maximum conducted (average) output power (Reporting Only)

a) As an alternative to spectrum analyzer or EMI receiver measurements, measurements may be performed

using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

1) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.

2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power con trol level.

3) The integration period of the power meter exceeds the repetition period of the transmitted sig nal by at least a

factor of five.

b) If the transmitter does not transmit continuously, measure the duty cycle (x) of the transmitte r output signal as

described in Section 6.0.

c) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

d) Adjust the measurement in dBm by adding 10log (1/x), where x is the duty cycle to the meas urement result.

Measurements of duty cycle

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal.

Set the center frequency of the instrument to the center frequency of the transmission.

Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.

Set VBW ≥ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

Test Result

Please refer to ANNEX A.2.

5.5 Occupied Bandwidth

Limit

FCC §15.247(a); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

Test Result

Please refer to ANNEX A.3.

5.6 Carrier Frequency Separation

Limit

FCC §15.247(a); RSS-247, 5.1 (2)

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 shall have hopping channel carrier frequencies separated by a minimum of 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.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Test Result

Please refer to ANNEX A.4.

5.7 Time of Occupancy (Dwell time)

Limit

FCC §15.247(a); RSS-247, 5.1 (4)

Frequency hopping systems in the 2400 MHz - 2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
Span: Zero span, centered on a hopping channel
RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel
Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel
Detector function: Peak
Trace: Max hold
Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.
The average time of occupancy on any channel within the Period can be calculated with formulas:
For GFSK and 8-DPSK:
For DH1 package type
{Total of Dwell} = {Pulse Time} * (1600 / 2) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH3 package type
{Total of Dwell} = {Pulse Time} * (1600 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH5 package type
{Total of Dwell} = {Pulse Time} * (1600 / 6) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For AFH Mode:
For DH1 package type
{Total of Dwell} = {Pulse Time} * (800 / 2) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For DH3 package type
{Total of Dwell} = {Pulse Time} * (800 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH5 package type
{Total of Dwell} = {Pulse Time} * (800 / 6) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

Test Result

Please refer to ANNEX A.5

5.8 Conducted Spurious Emission

Limit

FCC §15.247(d); RSS-247, 5.5

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.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).

c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

The following procedures shall be used to demonstrate compliance to these limits. Note that these procedures can be used in either an antenna-port conducted or radiated test set-up. Radiated tests must conform to the test site requirements and utilize maximization procedures defined herein.

Reference level measurement

Establish a reference level by using the following procedure:

Set instrument center frequency to DTS channel center frequency.

Set the span to ≥ 1.5 times the DTS bandwidth.

Set the RBW = 100 kHz.

Set the VBW ≥ 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum PSD level.

Emission level measurement

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

Set the RBW = 100 kHz.

Set the VBW ⩾ 3 x RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

Test Result

Please refer to ANNEX A.6

5.9 Band Edge (Authorized-band band-edge)

Limit

FCC §15.247(d); RSS-GEN, 8.9, RSS-247, 5.5

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.

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

Test Procedure

The following procedures may be used to determine the peak or average field strength or power of an unwanted emission that is within 2 MHz of the authorized band edge. If a peak detector is utilized, use the procedure described in 13.2.1. Use the procedure described in 13.2.2 when using an average detector and the EUT can be configured to transmit continuously (i.e., duty cycle $\geqslant$ 98%). Use the procedure described in 13.2.3 when using an average detector and the EUT cannot be configured to transmit continuously but the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent). Use the procedure described in 13.2.4 when using an average detector for those cases where the EUT cannot be configured to transmit continuously and the duty cycle is not constant (duty cycle variations equal or exceed 2 percent).

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used.

Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).

Set span to 2 MHz

RBW = 100 kHz.

VBW $\geqslant$ 3 x RBW.

Detector = peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)

Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency (femission) ± 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by femission ± 0.5 MHz.

Standard method(The 99% OBW of the fundamental emission is without 2 MHz of the authorized band):

Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

Attenuation: Auto (at least 10 dB preferred).

Sweep time: Coupled.

Resolution bandwidth: 100 kHz.

Video bandwidth: 300 kHz.

Detector: Peak.

Trace: Max hold.

Test Result

Please refer to ANNEX A.7.

5.10 Conducted Emission

Limit

FCC §15.207; RSS-GEN, 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.
Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

Test Result

Please refer to ANNEX A.8.

5.11 Radiated Spurious Emission

Limit

FCC §15.209&15.247(c); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
2. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

Test Procedure

Since the emission limits are specified in terms of radiated field strength levels, measurements performed to demonstrate compliance have traditionally relied on a radiated test configuration. Radiated measurements remain the principal method for demonstrating compliance to the specified limits; however antenna-port conducted measurements are also now acceptable to demonstrate compliance (see below for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 shall be followed.

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified (see guidance

regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

E = EIRP – 20log D + 104.8

where:

E = electric field strength in dBμV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

f) Compare the resultant electric field strength level to the applicable limit.

g) Perform radiated spurious emission test.

Quasi-Peak measurement procedure

The specifications for measurements using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Frequency Interference (CISPR) of the International Electrotechnical Commission.

As an alternative to CISPR quasi-peak measurement, compliance can be demonstrated to the applicable emission limits using a peak detector.

Peak power measurement procedure

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 1.

b) VBW ≥ 3 x RBW.

c) Detector = Peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be longer for low duty cycle applications).

Table 1—RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction

If continuous transmission of the EUT (i.e., duty cycle ≥ 98 percent) cannot be achieved and the duty cycle is constant (i.e., duty cycle variations are less than ± 2 percent), then the following procedure shall be used:

a) The EUT shall be configured to operate at the maximum achievable duty cycle.

b) Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.

c) RBW = 1 MHz (unless otherwise specified).

d) VBW ≥ 3 x RBW.

e) Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

f) Averaging type = power (i.e., RMS).

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.

2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

g) Sweep time = auto.

h) Perform a trace average of at least 100 traces.

i) A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step f), then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

2) If linear voltage averaging mode was used in step f), then the applicable correction factor is 20 log(1/x), where x is the duty cycle.

3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

NOTE: Reduction of the measured emission amplitude levels to account for operational duty factor is not permitted. Compliance is based on emission levels occurring during transmission - not on an average across on and off times of the transmitter.

Determining the applicable transmit antenna gain

A conducted power measurement will determine the maximum output power associated with a restricted band emission; however, in order to determine the associated EIRP level, the gain of the transmitting antenna (in dBi) must be added to the measured output power (in dBm).

Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

See KDB 662911 for guidance on calculating the additional array gain term when determining the effective antenna gain for a EUT with multiple outputs occupying the same or overlapping frequency ranges in the same band.

Radiated spurious emission test

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

The measurement frequency range is from 30 MHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Test Result

Please refer to ANNEX A.9.

5.12 Band Edge(Restricted-band band-edge)

Limit

FCC §15.209&15.247(c); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B

Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

For transmitters operating above 1 GHz repeat the measurement with an average detector..

Test Result

Please refer to ANNEX A.10..

Annex A TEST RESULT

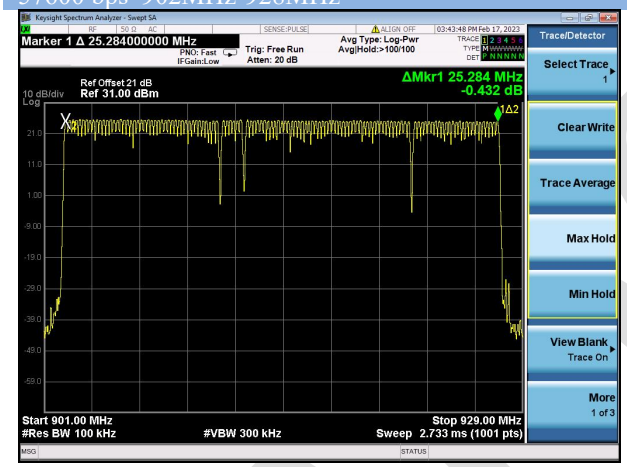
A.1 Number of Hopping Frequency

Test Result:

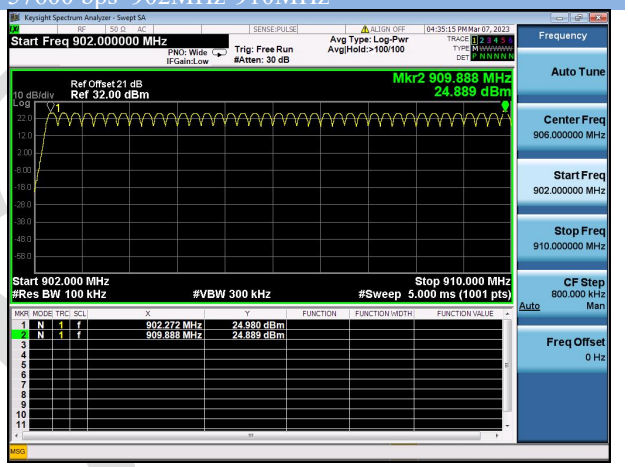
Test Rate	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
57600	902.3 - 928	127	15	Pass
172800	902 .3- 928	103	15	Pass
230400	902.3 - 928	89	15	Pass
276400	902.3 - 928	73	15	Pass

Test plots

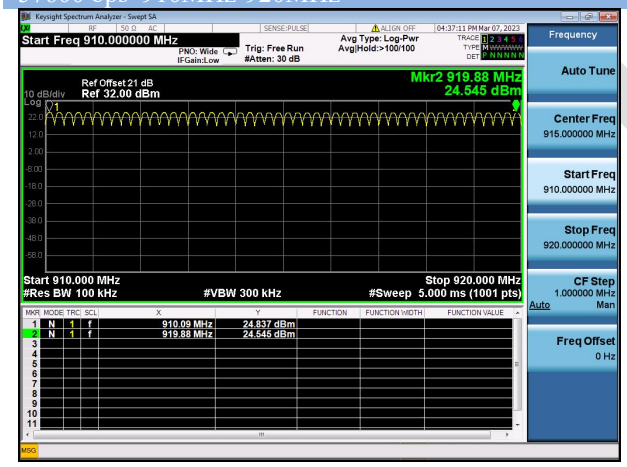
57600 bps 902MHz-928MHz



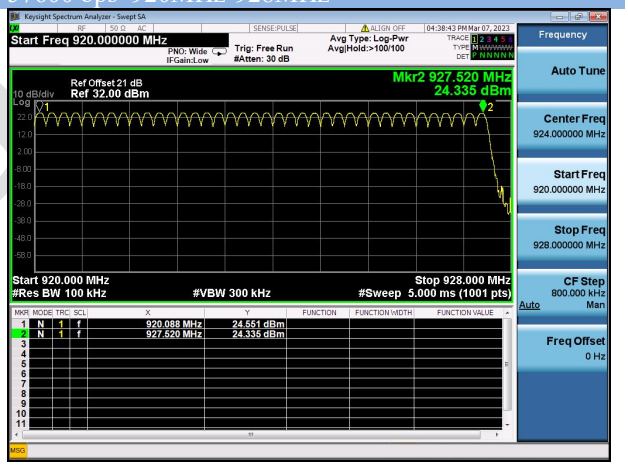
57600 bps 902MHz-910MHz



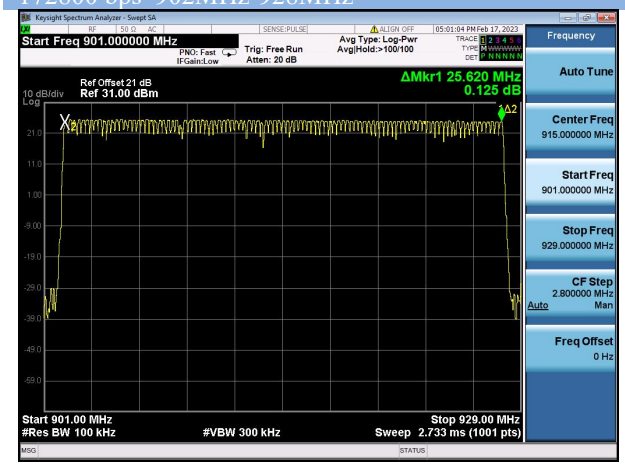
57600 bps 910MHz-920MHz



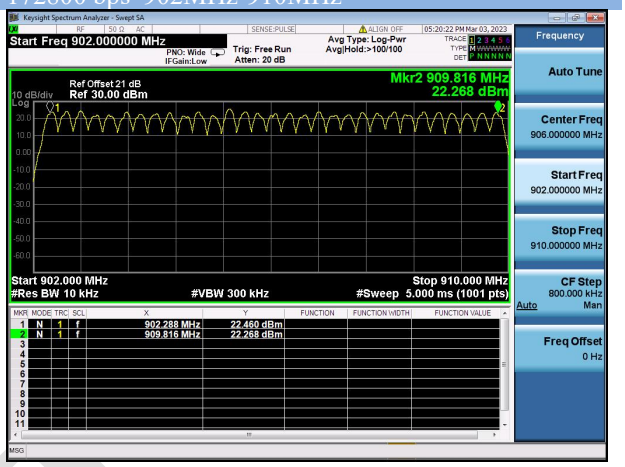
57600 bps 920MHz-928MHz



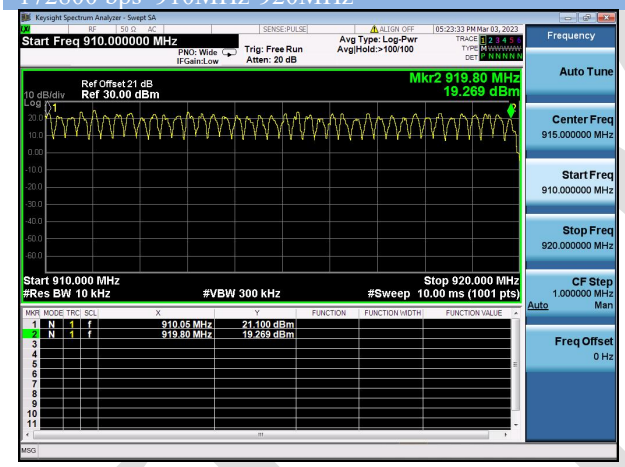
172800 bps 902MHz-928MHz



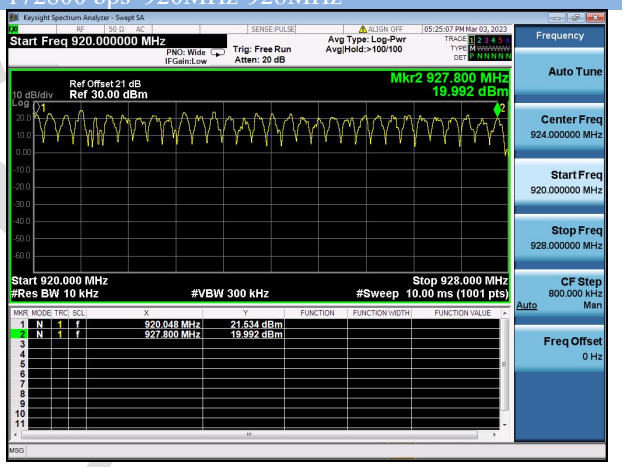
172800 bps 902MHz-910MHz



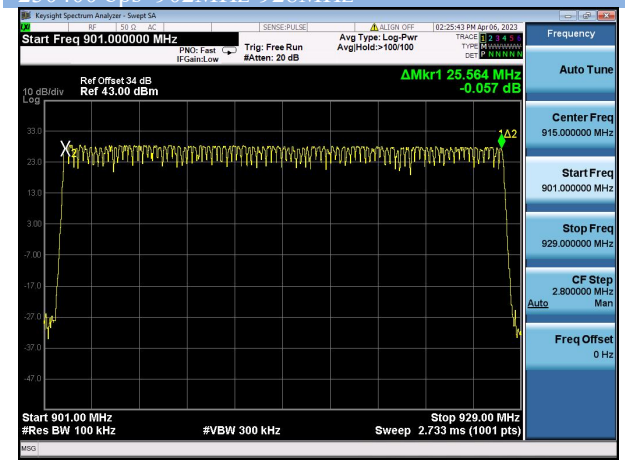
172800 bps 910MHz-920MHz



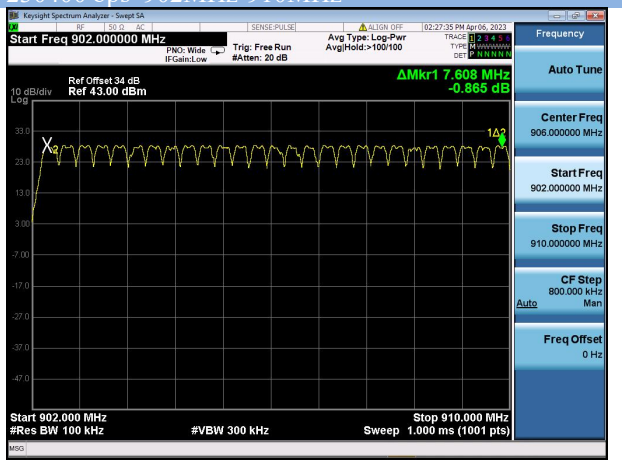
172800 bps 920MHz-928MHz



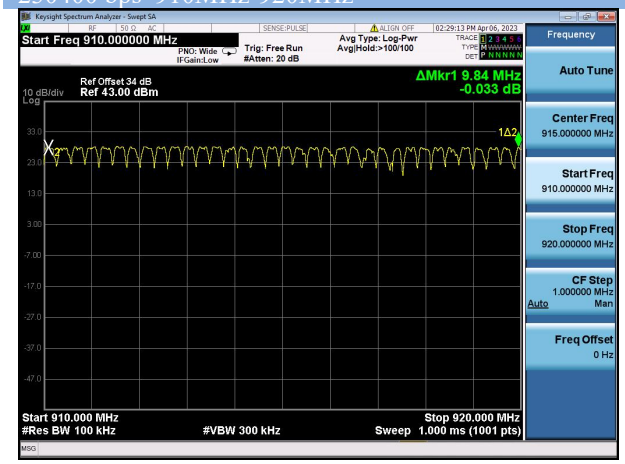
230400 bps 902MHz-928MHz



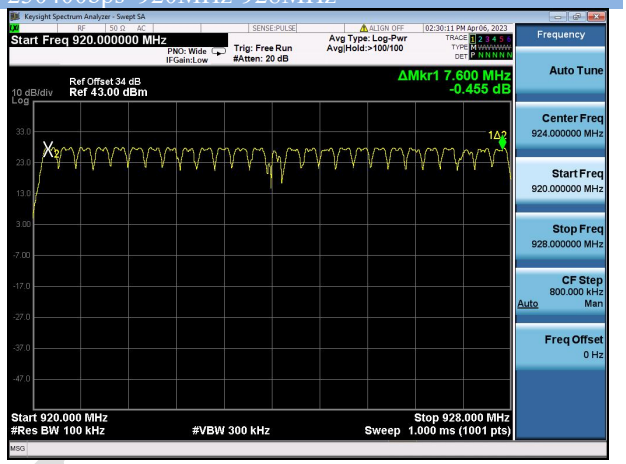
230400 bps 902MHz-910MHz



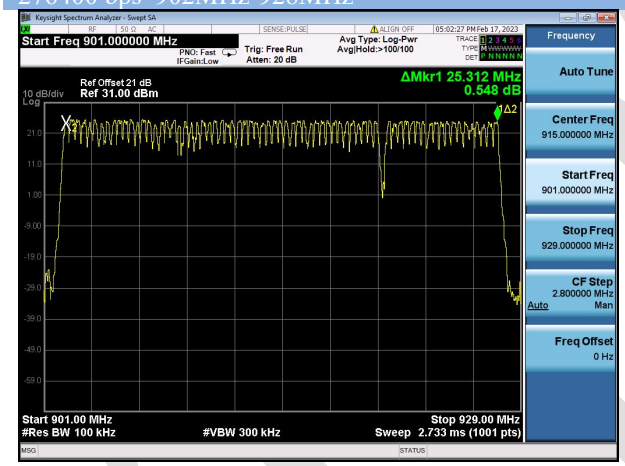
230400 bps 910MHz-920MHz



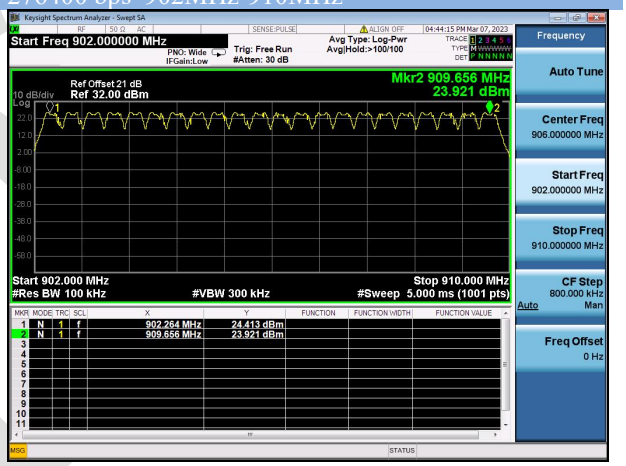
230400bps 920MHz-928MHz



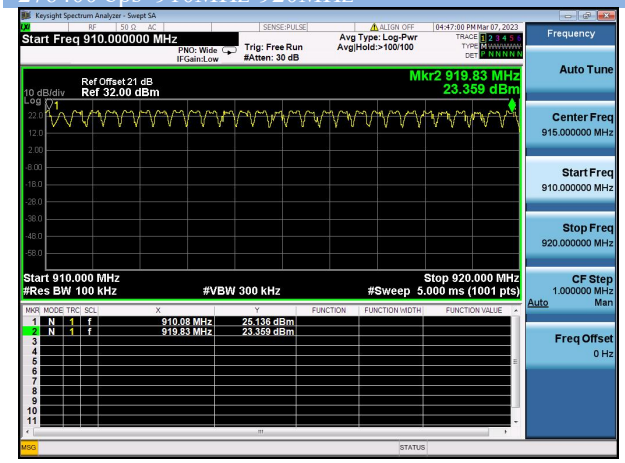
276400 bps 902MHz-928MHz



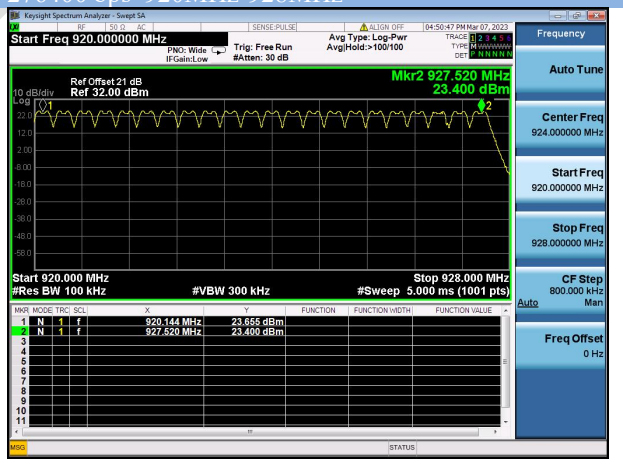
276400 bps 902MHz-910MHz



276400 bps 910MHz-920MHz



276400 bps 920MHz-928MHz



A.2 Peak Output Power and E.I.R.P

Peak Power Test Data

Rate（kbps）	Frequency (MHz)	GFSK		Limit		Verdict
		Peak Power	E.I.R.P	Conducted power	E.I.R.P	
57600	902.3	27.59	30.09	30	36	Pass
	914.9	27.62	30.12			Pass
	927.5	27.76	30.26			Pass
172800	902.3	27.41	29.91			Pass
	915.05	27.43	29.93			Pass
	927.8	27.48	29.98			Pass
230400	902.3	27.21	29.71			Pass
	915.06	27.41	29.91			Pass
	927.82	27.42	29.92			Pass
276400	902.3	26.41	28.91			Pass
	914.9	26.48	28.98			Pass
	927.5	26.52	29.02			Pass

Note：According to the antenna report, the antenna gain is 2.5 dbi

A.3 20 dB bandwidth

Test Data

GFSK		
Rate （kbps）	Frequency (MHz)	20 dB Bandwidth (MHz)
57600	902.3	0.0785
	914.9	0.078
	927.5	0.0775
Rate （kbps）	Frequency (MHz)	20 dB Bandwidth (MHz)
172800	902.3	0.23
	915.05	0.236
	927.8	0.23
Rate （kbps）	Frequency (MHz)	20 dB Bandwidth (MHz)
230400	902.3	0.289
	915.06	0.286
	927.82	0.282
Rate （kbps）	Frequency (MHz)	20 dB Bandwidth (MHz)
276400	902.3	0.335
	914.9	0.333
	927.5	0.329

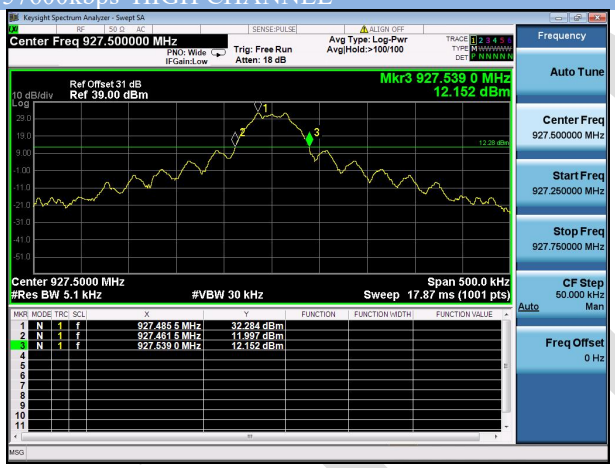
Test plots

20 dB Bandwidth

57600kbps LOW CHANNEL

57600kbps MIDDLE CHANNEL

57600kbps HIGH CHANNEL



172800kbps LOW CHANNEL

172800kbps MIDDLE CHANNEL