RF TEST REPORT For FCC

RZBG(W) 20220421002-4

Applicant : TianJin HuaLai Technology Co.,Ltd.

Address : No.10 JinPing Road, Ya An Street, Nankai District Tianjin, China.

Product Name : Ailofy Bulb Color

Type/Model : AIBC-A

FCC ID : 2ANJH-AIBC-A

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:Aug. 9, 22

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	TianJin HuaLai Technology Co.,Ltd.
Address	No.10 JinPing Road, Ya An Street, Nankai District Tianjin, China.
Contact person	Mengli Li
Phone number	15102259016

1.2 Manufacture information

Manufacture	TianJin HuaLai Technology Co.,Ltd.
Address	No.10 JinPing Road, Ya An Street, Nankai District Tianjin, China.

1.3 General Description for Equipment under Test(EUT)

Eut name	Ailofy Bulb Color
Trade name	Ailofy
Under test mode name	AIBC-A
Series model name	N/A
Description of different model name	N/A
Hardware version	0.0.0.0
Software version	4.13.0.0
Temperature range	-20℃-50℃
Network and Wireless connectivity	1Mbps，2Mbps

1.4 Technical Information of Test(EUT)

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

Test channel	0(2402 MHz), 19 (2440MHz), 39(2480MHz)
Modulation Technology	DTS
Modulation Type	GFSK
FCC ID	2ANJH-AIBC-A
Equipment type	☒ Mobile ☐ Portable ☐ Fix Location
Transfer Rate	1Mbps，2Mbps
Number of Channel	40 (at intervals of 2 MHz)
Antenna Type	Monopole Rod Antenna
Antenna Gain	1.33 dBi
Note: The antenna gain was declared by the manufacturer.	

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

Support channel:

Note: the three bold fonts channels are test low, middle and high channels.

channel	frequency	channel	frequency	channel	frequency
0	**2402**	14	2430	28	2458
1	2404	15	2432	29	2460
2	2406	16	2434	30	2462
3	2408	17	2436	31	2464
4	2410	18	2438	32	2466
5	2412	**19**	**2440**	33	2468
6	2414	20	2442	34	2470
7	2416	21	2444	35	2472
8	2418	22	2446	36	2474
9	2420	23	2448	37	2476
10	2422	24	2450	38	2478
11	2424	25	2452	**39**	**2480**
12	2426	26	2454		
13	2428	27	2456		

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.

Power level setup in software			
Test Software Version	EspRFTestTool_v2.8		
Support Units (Software installation media)	Description	Manufacturer	Model
	Notebook	Lenovo	L540
Mode	Channel	Frequency (MHz)	Soft Set
GFSK	CH0	2402	Power parameter Settings is 5
	CH19	2440	
	CH39	2480	

Sample received date : 2022.05.20
Date of test : 2022-05-20 ~ 2022.06.12

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

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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
5	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; 15.247(b)	N/A	Pass Note 1
2	Output Power	15.247(b)	ANNEX A.1	Pass
3	6dB Bandwidth	15.247(a)	ANNEX A.2	Pass
4	Conducted Spurious Emission	15.247(d)	ANNEX A.3	Pass
5	Band Edge(Authorized-band band-edge)	15.209; 15.247(d)	ANNEX A.4	Pass
6	Conducted Emission	15.207	ANNEX A.5	Pass
7	Radiated Spurious Emission	15.209; 15.247(d)	ANNEX A.6	Pass
8	Band Edge(Restricted-band band-edge)	15.209; 15.247(d)	ANNEX A.7	Pass
9	Power spectral density (PSD)	15.247(e)	ANNEX A.8	Pass
10	Receiver Spurious Emissions	N/A	N/A	N/A Note 2

Note 1: Please refer to section 5.1.
Note 2: 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.

4. GENERAL TEST CONFIGURATION

4.1 Test Enviroments

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

Relative Humidity	45% - 56%	
Atmospheric Pressure	100.0 kPa – 100.2 kPa	
Temperature	NT (Normal Temperature)	+22℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	120V

4.2 Test Equipment

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Cal. Period	Use
Spectrum Analyzer	R&S	FSV40	101015	Jul.01, 2021	1 year	✓
Analog signal generator	Agilent	N5183A	MY50141794	Oct.27, 2021	1 year	×
LOOP Antenna	Com-power	1900/1/0	10160053	Jul.04,2021	1 year	✓
Automatic control unit	Tonscend	JS0806-2	T1326593	Oct.27, 2021	1 year	✓
EMI Test receiver	R&S	ESR26	101617	Oct.27, 2021	1 year	✓
PRE-AMPLIFIER (1-18GHz)	Connphy	CLN-1G18G-4060-S	718005	Aug.07, 2021	1 year	✓
PRE-AMPLIFIER (18-40GHz)	CERNEX	CBL18404035	24496/24495	Aug.07, 2021	1 year	✓
Bi-conical and log-periodic Antenna (30MHz-1GHz)	SCHWARZBECK	VULB 9168	796	Oct.27, 2021	1 year	✓
HORN Antenna (1GHz-18GHz)	SCHWARZBECK	BBHA 9120D	1935	Oct.27, 2021	1 year	✓
Coaxial RF Cable	Hubersuhner	SUCOFLEX 104EA+SUCOFLEX 100	NA	Aug.07, 2021	1 year	✓
	SCHWARZBECK	SA360-2.92M2.92M-11M-3#	NA	Aug.07, 2021	1 year	✓
Coaxial RF Cable	Hubersuhner	SUCOFLEX 104EA+SUCOFLEX 100	02-1L	Oct.27, 2021	1 year	✓
	Gore	3545-2.92J2.92J-8M-2#	02-2H	Aug.07, 2021	1 year	✓
Coaxial cable	R&S	SPARE	1#	Oct.27, 2021	1 year	✓
High-pass Filter	Dongsheng	ZHPF-M3-18G-SS	186101682	Jul.10, 2020	2 year	✓

4.3 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.

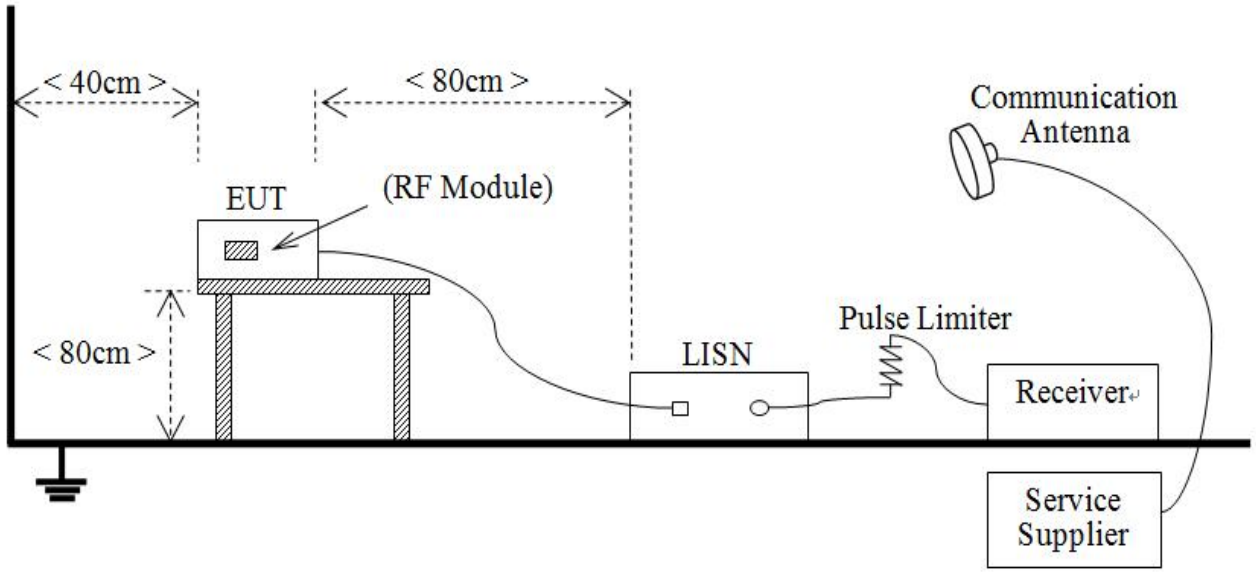
Measurement	Value
Occupied Channel Bandwidth	±2MHz
RF output power, conducted	±1.24dB
Power Spectral Density, conducted	±1.88 dB
Unwanted Emissions, conducted （30MHz-1GHz）	±0.746 dB
Unwanted Emissions, conducted （above 1GHz）	±1.328 dB
All emissions, radiated	±1.328 dB
Temperature	±1 °C
Humidity	±4 %

4.3 Description of Test Setup

4.4.1 For conducted Test

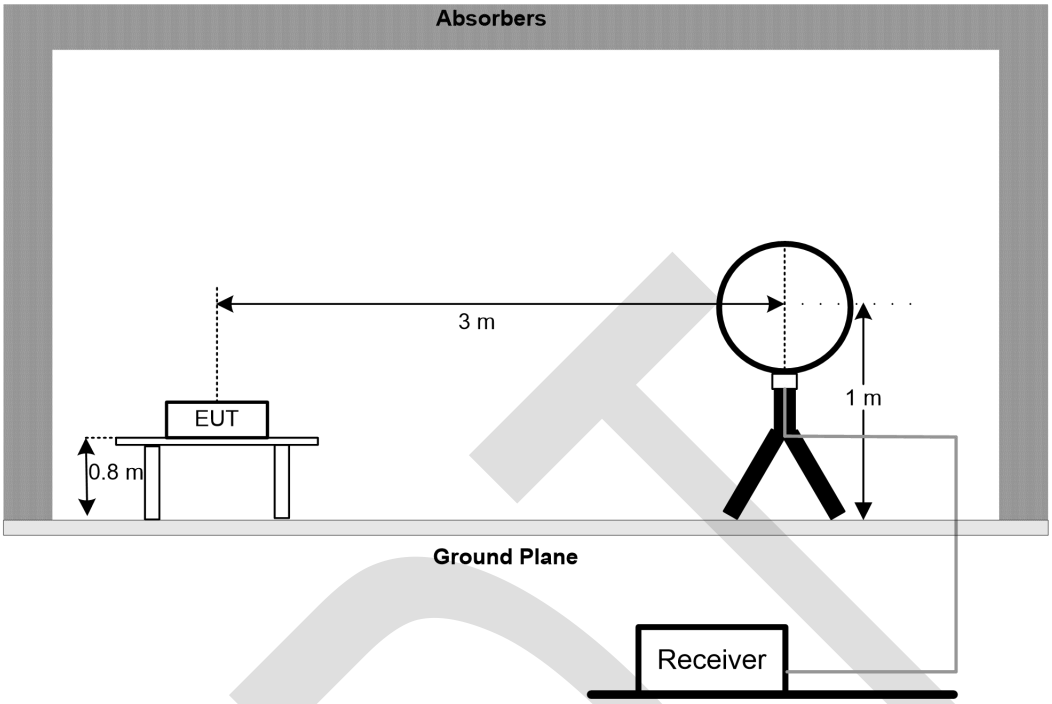
Conducted value (dBm) =Measurement value (dBm) + cable loss (dB)
For example: the measurement value is 10dBm and the cable 0.5dBm used, then the final result of EUT: Conducted value (dBm) = 10dBm + 0.5dB = 10.5dBm

4.4.2 For AC Power Supply port Test



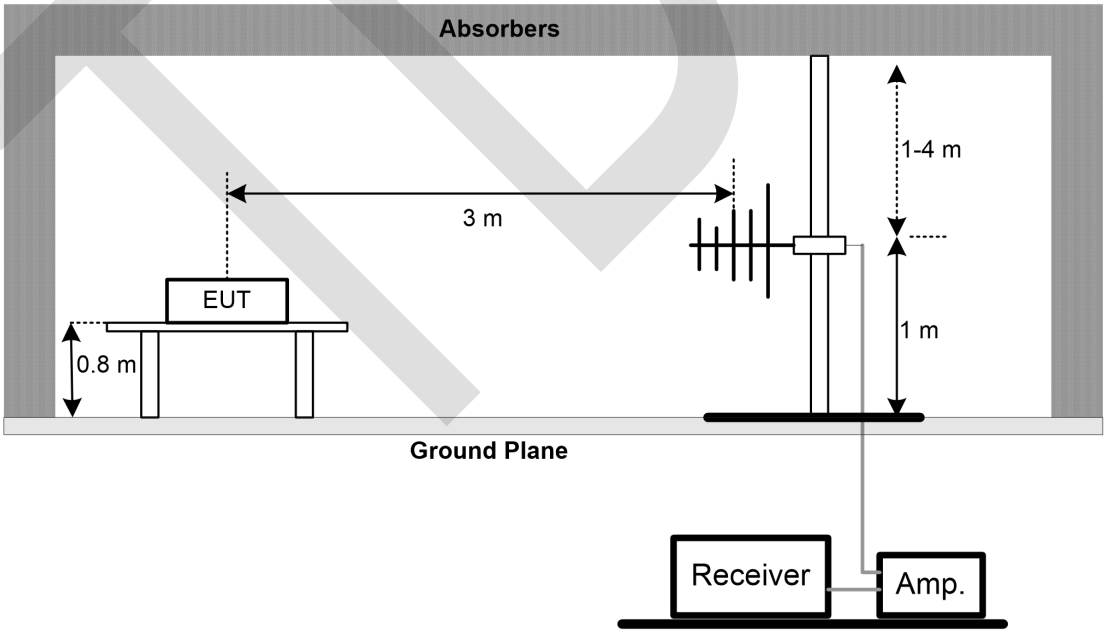
(Diagram 1)

4.4.3 For Radiated Test (Below 30 MHz)



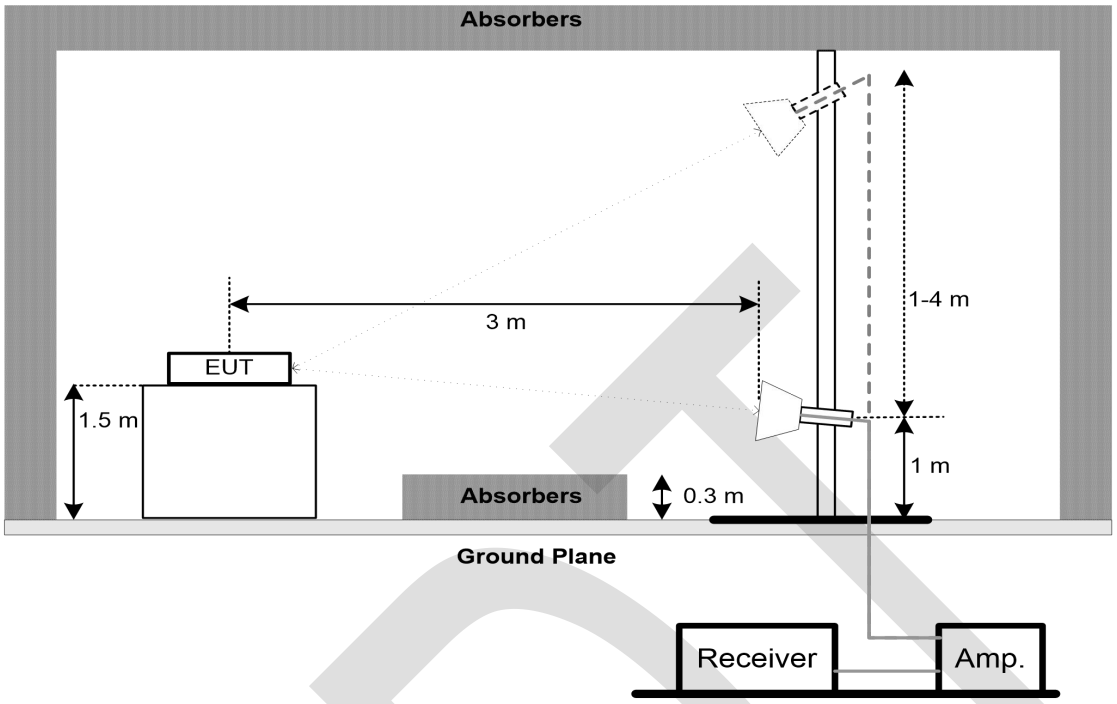
(Diagram 2)

4.4.4 For Radiated Test(30MHz-1GHz)



(Diagram 3)

4.4.5 For Radiated Test （Above 1 GHz）



(Diagram 4)

4.5Measurement 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:

$$E = EIRP - 20\log D + 104.8$$

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 antennas of the product are permanently attached. There are no provisions for connection to an external antenna.

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

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

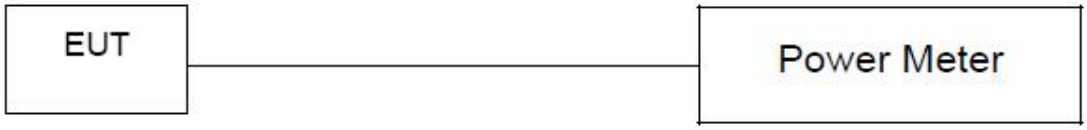
5.2 Output Power

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



Test Procedure

a.The EUT was directly connected to the power meter and antenna output port as show in the block diagram below.

b.The maximum conducted output power was performed in accordance with method 11.9.1.1 (for peak power) or 11.9.2.2 (for AVG power) of ANSI C63.10-2013.

Test Result

Please refer to ANNEX A.1.

5.3 6dB Bandwidth

Limit

FCC §15.247(a); RSS-GEN, 6.6

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW. The 6 dB bandwidth must be greater than 500 kHz.

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:

Set RBW = 100 kHz.

Set the video bandwidth (VBW) $\geqslant$ 3 RBW.

Detector = Peak.

Trace mode = max hold.

Sweep = auto couple.

Allow the trace to stabilize.

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Result

Please refer to ANNEX A.2.

5.4 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.3

5.5 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.4.

5.6 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)	
	Quasi-peak	Average
0.15 - 0.50	66 to 56*	56 to 46*
0.50 - 5	56	46
5 - 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.5.

5.7 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:

$E = EIRP – 20\log D + 104.8$

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.6.

5.8 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.7.

5.9 Power Spectral density(PSD)

Limit

FCC §15.247(d); RSS-247, 5.2 (2)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be 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

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: 3 kHz $\leqslant$ RBW $\leqslant$ 100 kHz.

Set the VBW $\geqslant$ 3 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 within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Test Result

Please refer to ANNEX A.8.

Annex A TEST RESULT

A.1 Maximum conducted output power

Test Result:

Duty cycle:

TestMode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
GFSK/1M	Ant1	2402	2.10	2.50	0.8400
		2440	2.10	2.50	0.8400
		2480	2.10	2.50	0.8400
GFSK/2M	Ant1	2402	1.06	1.88	0.5638
		2440	1.06	1.88	0.5638
		2480	1.06	1.87	0.5668

Maximum conducted output power （peak）

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
GFSK/1M	Ant1	2402	2.2	<=30	PASS
		2440	2.33	<=30	PASS
		2480	2.5	<=30	PASS
GFSK/2M	Ant1	2402	2.38	<=30	PASS
		2440	2.08	<=30	PASS
		2480	2.37	<=30	PASS

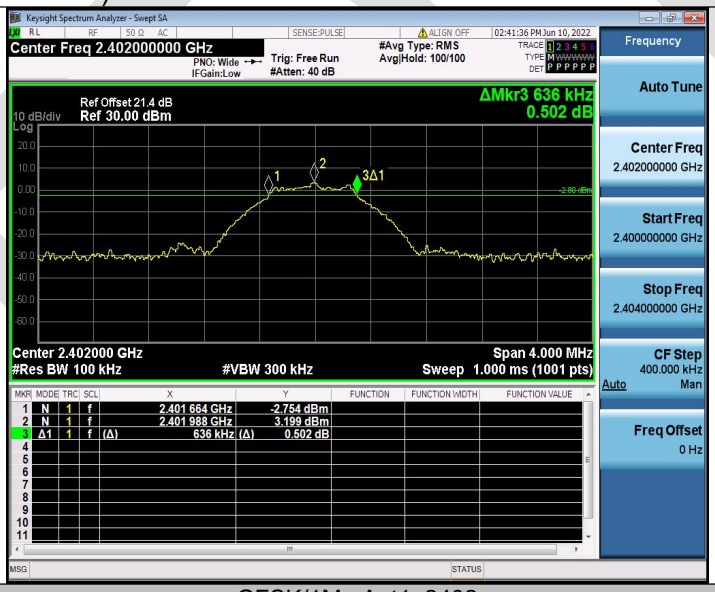
A.2 DTS Bandwidth and Occupied Channel Bandwidth

Test Result:

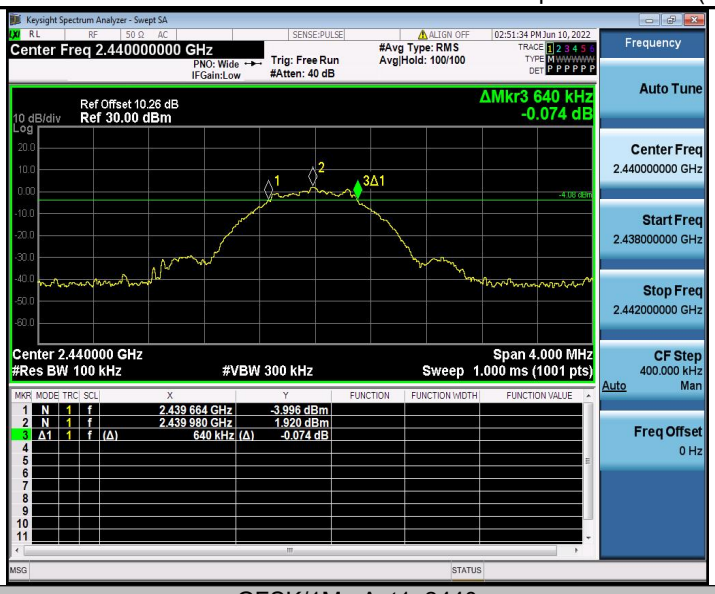
TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
GFSK/1M	Ant1	2402	0.636	2401.664	2402.300	0.5	PASS
		2440	0.640	2439.664	2440.304	0.5	PASS
		2480	0.672	2479.640	2480.312	0.5	PASS
GFSK/2M	Ant1	2402	1.088	2401.444	2402.532	0.5	PASS
		2440	1.108	2439.444	2440.552	0.5	PASS
		2480	1.104	2479.448	2480.552	0.5	PASS

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
GFSK/1M	Ant1	2402	1.0712	2401.452	2402.523	---	PASS
		2440	1.0223	2439.475	2440.497	---	PASS
		2480	1.0343	2479.467	2480.501	---	PASS
GFSK/2M	Ant1	2402	2.0234	2400.981	2403.004	---	PASS
		2440	2.0432	2438.970	2441.013	---	PASS
		2480	2.0533	2478.971	2481.025	---	PASS

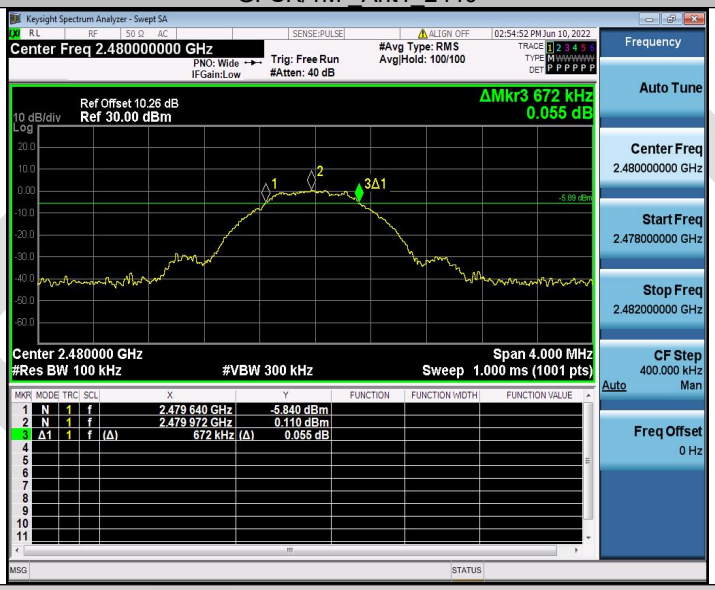
Test Graphs(DTS Bandwidth)



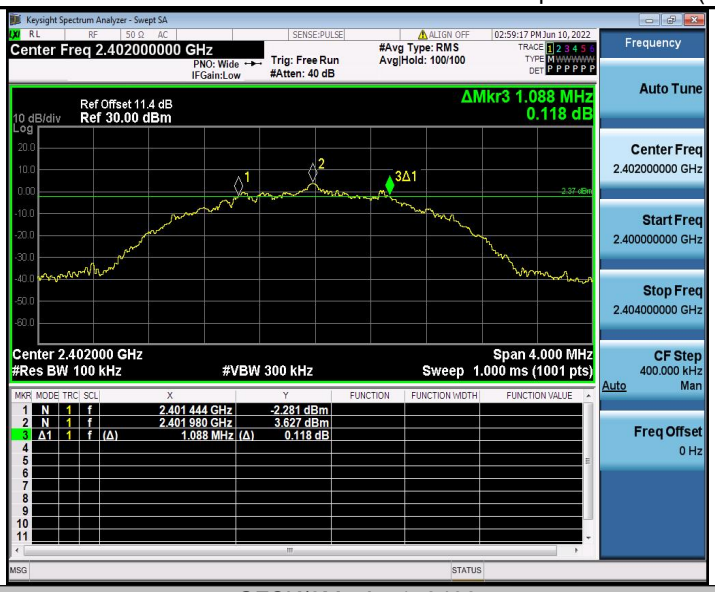
GFSK/1M _Ant1_2402



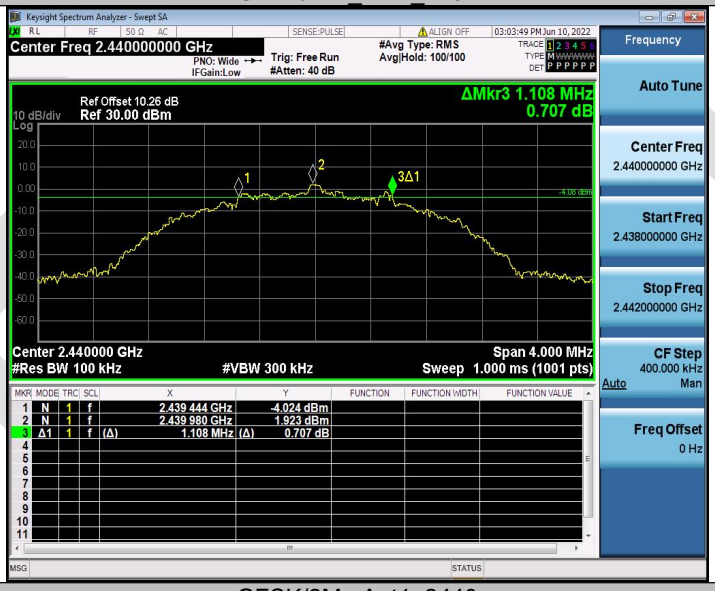
GFSK/1M _Ant1_2440



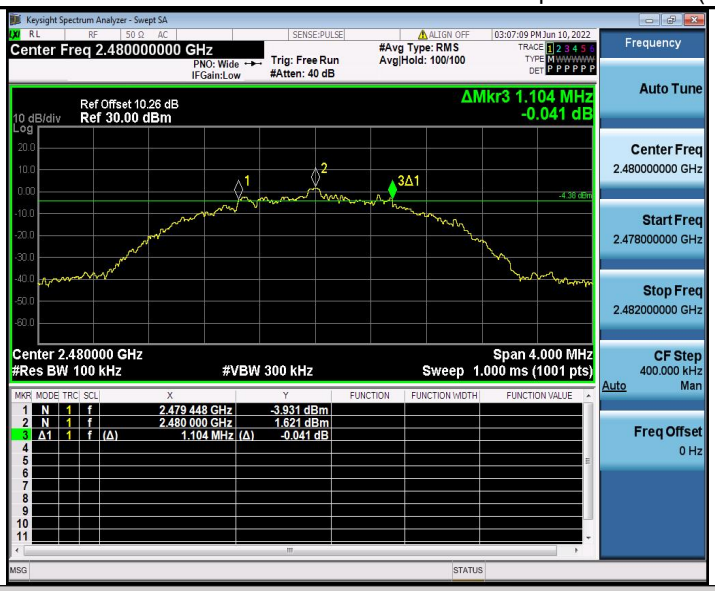
GFSK/1M _Ant1_2480



GFSK/2M _Ant1_2402



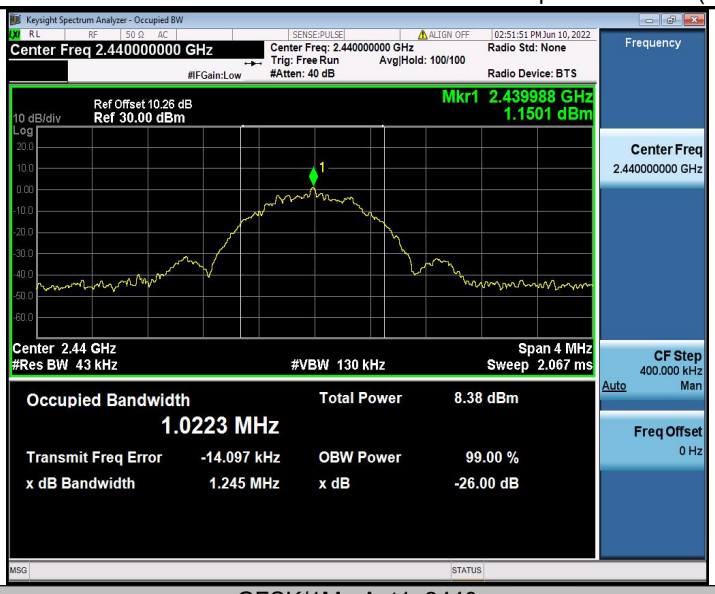
GFSK/2M _Ant1_2440



GFSK/2M _Ant1_2480

Test Graphs(OCB)

GFSK/1M _Ant1_2402



GFSK/1M _Ant1_2440

GFSK/1M _Ant1_2480

GFSK/2M _Ant1_2402

GFSK/2M _Ant1_2440

GFSK/2M _Ant1_2480

A.3 Conducted Spurious Emission

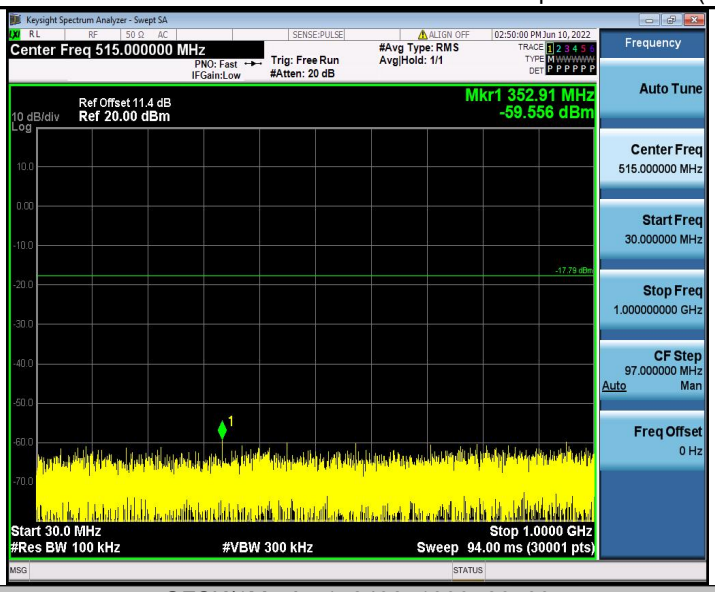
Test Result:

TestMode	Antenna	Channel	FreqRange [Mhz]	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
GFSK/1M	Ant1	2402	Reference	2.21	2.21	---	PASS
			30~1000	2.21	-59.56	≤-17.79	PASS
			1000~26500	2.21	-40.97	≤-17.79	PASS
		2440	Reference	0.29	0.29	---	PASS
			30~1000	0.29	-60.97	≤-19.71	PASS
			1000~26500	0.29	-41.81	≤-19.71	PASS
		2480	Reference	0.39	0.39	---	PASS
			30~1000	0.39	-60.79	≤-19.61	PASS
			1000~26500	0.39	-42.34	≤-19.61	PASS
GFSK/2M	Ant1	2402	Reference	1.08	1.08	---	PASS
			30~1000	1.08	-59.4	≤-18.92	PASS
			1000~26500	1.08	-41.67	≤-18.92	PASS
		2440	Reference	-1.37	-1.37	---	PASS
			30~1000	-1.37	-60.99	≤-21.37	PASS
			1000~26500	-1.37	-42.03	≤-21.37	PASS
		2480	Reference	-1.40	-1.40	---	PASS
			30~1000	-1.40	-59.06	≤-21.4	PASS
			1000~26500	-1.40	-43.3	≤-21.4	PASS

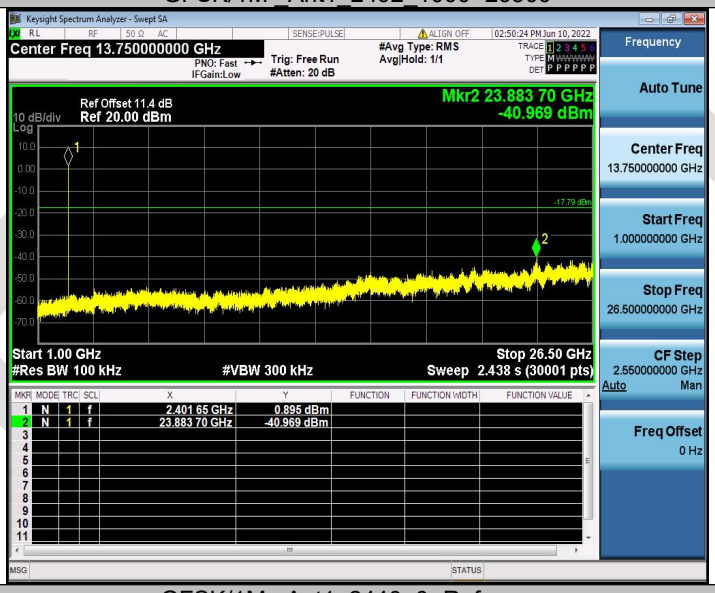
Test Graphs:

GFSK/1M _Ant1_2402_0~Reference

GFSK/1M _Ant1_2402_30~1000

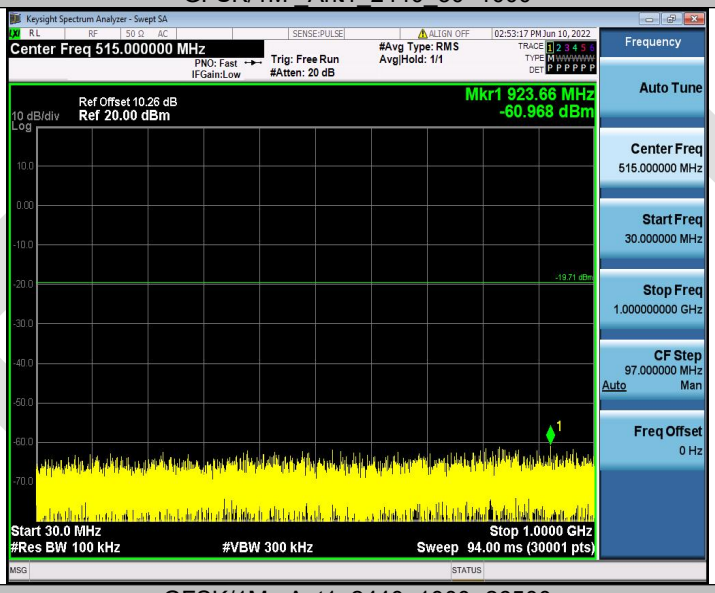


GFSK/1M _Ant1_2402_1000~26500

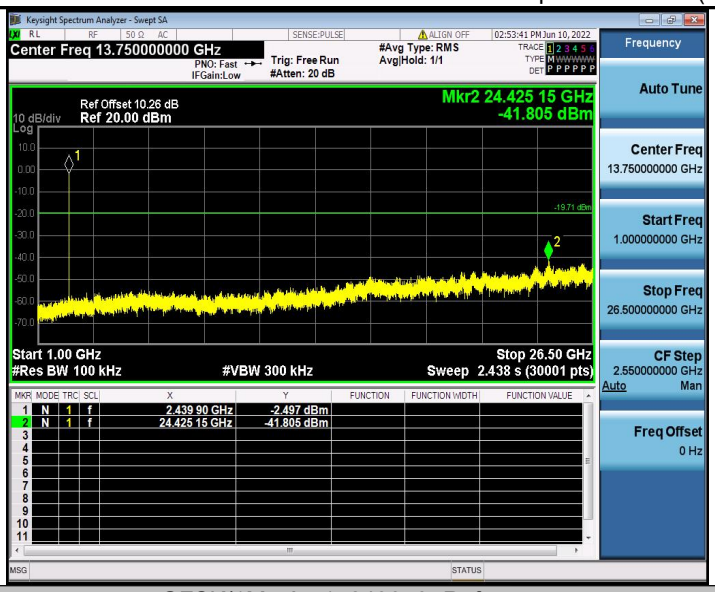


GFSK/1M _Ant1_2440_0~Reference

GFSK/1M _Ant1_2440_30~1000

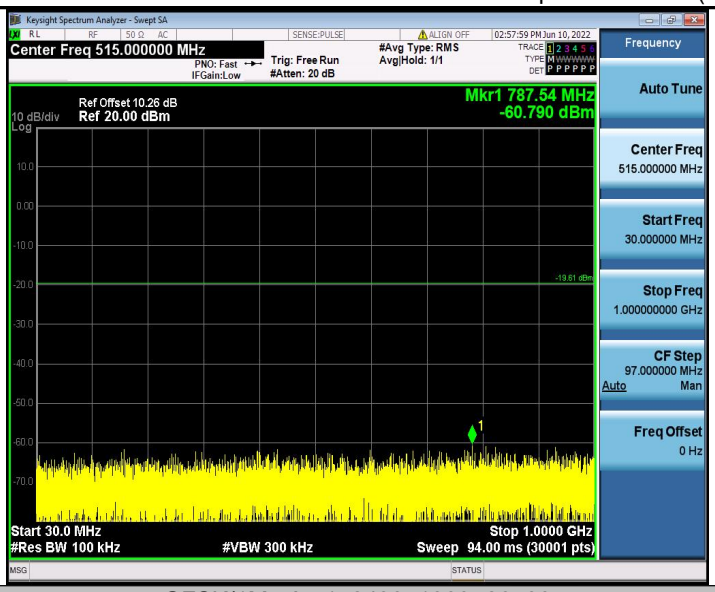


GFSK/1M _Ant1_2440_1000~26500

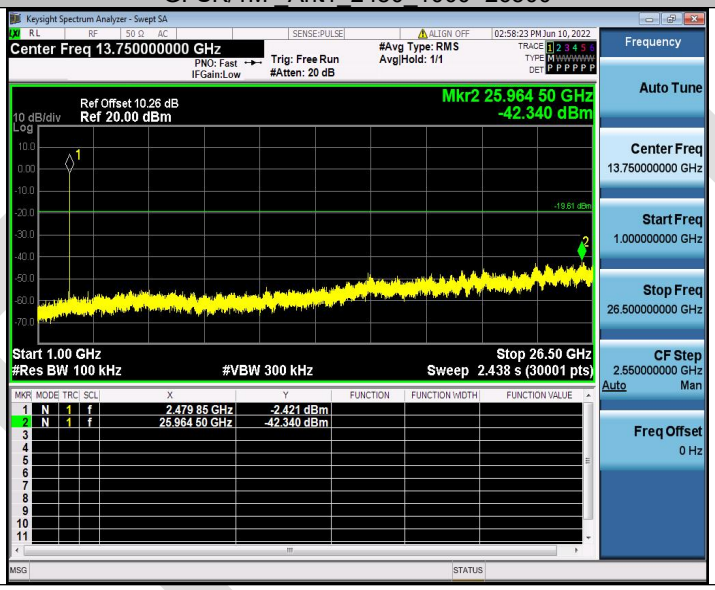


GFSK/1M _Ant1_2480_0~Reference

GFSK/1M _Ant1_2480_30~1000



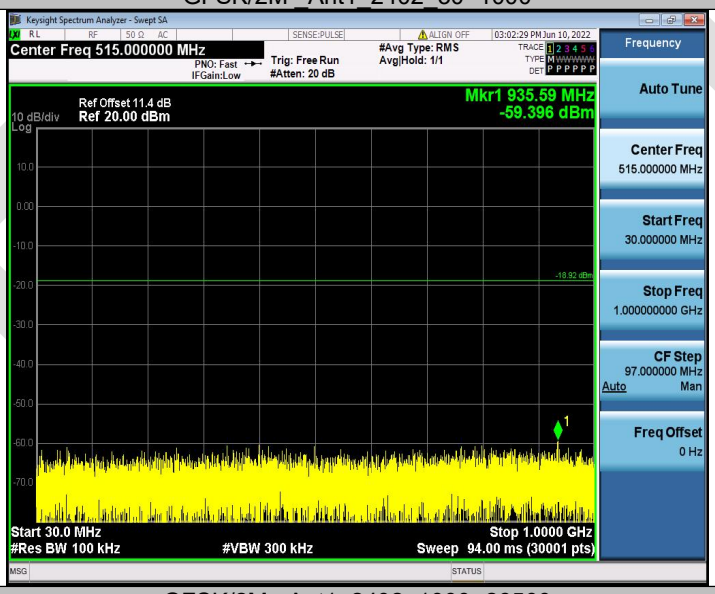
GFSK/1M_Ant1_2480_1000~26500



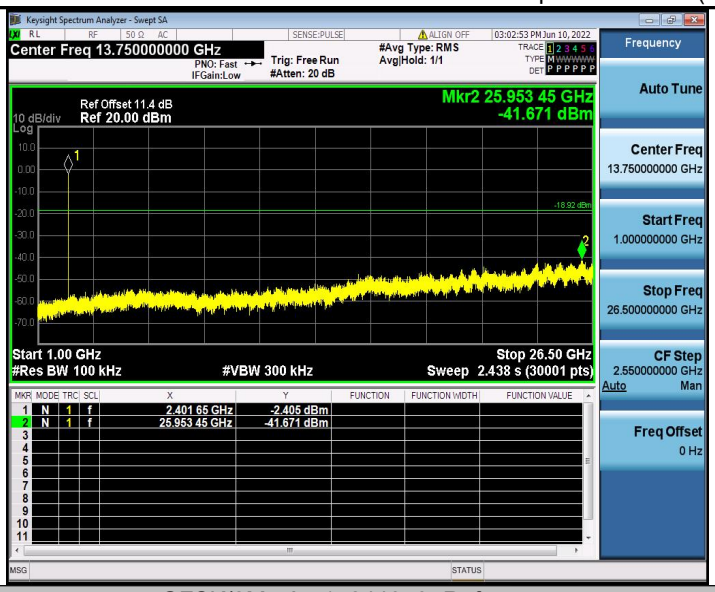
Test Graphs:

GFSK/2M _Ant1_2402_0~Reference

GFSK/2M _Ant1_2402_30~1000

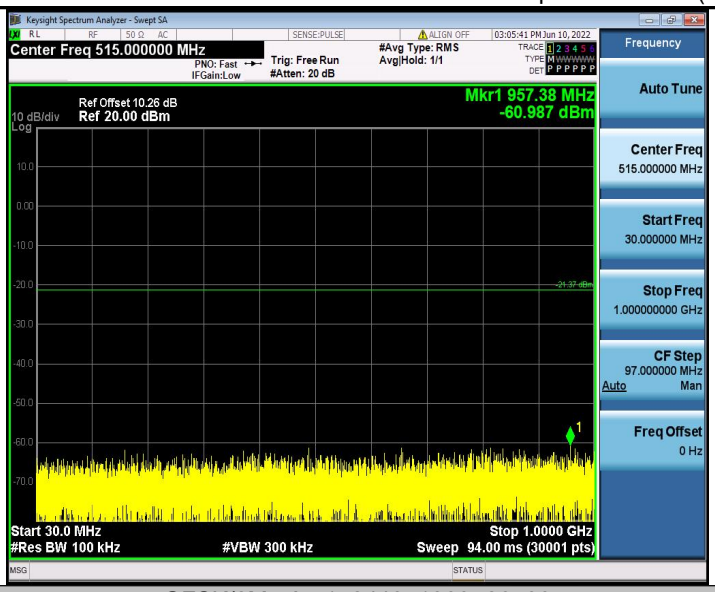


GFSK/2M _Ant1_2402_1000~26500

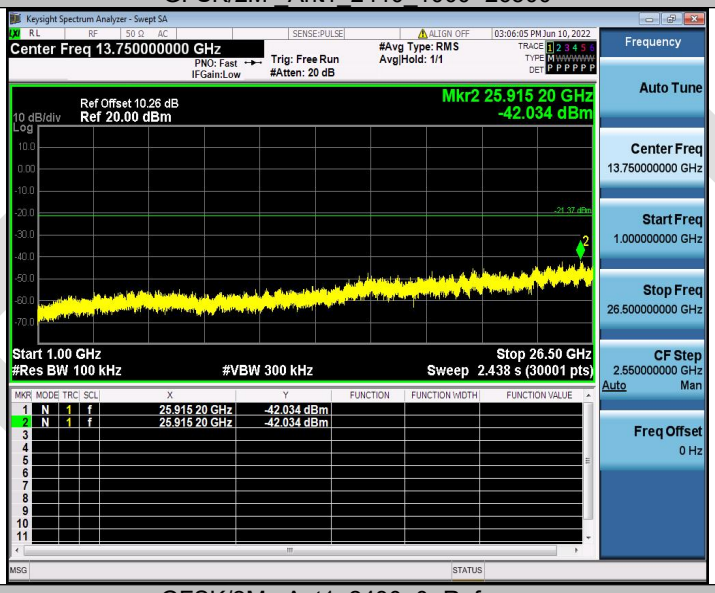


GFSK/2M _Ant1_2440_0~Reference

GFSK/2M _Ant1_2440_30~1000

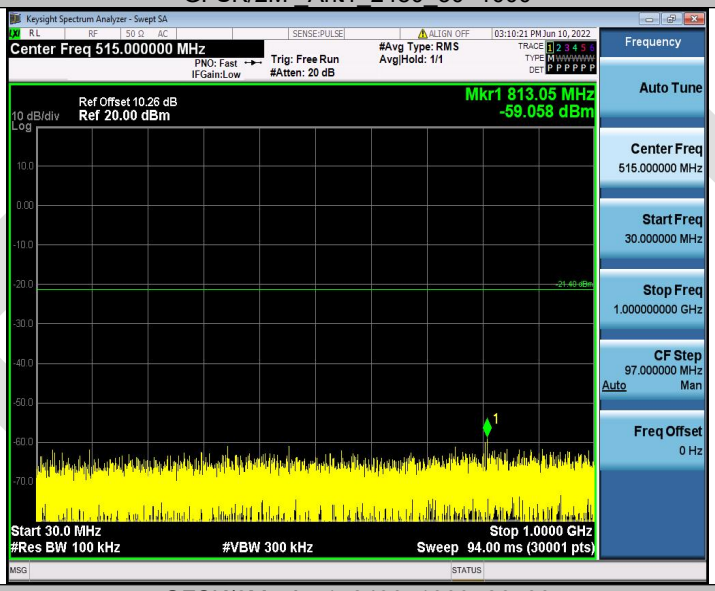


GFSK/2M _Ant1_2440_1000~26500



GFSK/2M _Ant1_2480_0~Reference

GFSK/2M _Ant1_2480_30~1000



GFSK/2M _Ant1_2480_1000~26500