Shenzhen CTA Testing Technology Co., Ltd.

Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao’an District, Shenzhen, China

FCC TEST REPORT

FCC Part 90

Report Reference No.	**CTA22021400204**
FCC ID	**O39V200**
Compiled by (position+printed name+signature)	File administrators Kevin Liu
Supervised by (position+printed name+signature)	Project Engineer Kevin Liu
Approved by (position+printed name+signature)	RF Manager Eric Wang
Date of issue	Mar. 03, 2022

Testing Laboratory Name	**Shenzhen CTA Testing Technology Co., Ltd.**
Address	Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao’an District, Shenzhen, China

Applicant’s name	**Hi-Target Surveying Instrument Co., Ltd**
Address	202, BLDG 13, Tian'An HQ Center, No.555 North Panyu RD. Donghuan Block, Panyu District, 511400 Guangzhou, China

Test specification	:
Standard	**FCC Part 90/FCC Part 2**

Equipment description	GNSS RTK Receiver
Trade Mark	Hi-Target
Manufacturer	**Hi-Target Surveying Instrument Co., Ltd**
Model/Type reference	V200
Listed Models	N/A
Modulation	4FSK,GMSK
Frequency	410-470MHz
Ratings	DC 7.2V From Battery and DC5.0V From external circuit
Result	**PASS**

TEST REPORT

Equipment under Test	:	GNSS RTK Receiver
Model /Type	:	V200
Listed Models	:	N/A
Applicant	:	**Hi-Target Surveying Instrument Co., Ltd**
Address	:	202, BLDG 13, Tian'An HQ Center, No.555 North Panyu RD. Donghuan Block, Panyu District, 511400 Guangzhou, China
Manufacturer	:	**Hi-Target Surveying Instrument Co., Ltd**
Address	:	202, BLDG 13, Tian'An HQ Center, No.555 North Panyu RD. Donghuan Block, Panyu District, 511400 Guangzhou, China

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 90 :2017: PRIVATE LAND MOBILE RADIO SERVICES.

ANSI C63.26:2015: American National Standard of procedures for compliance testing of transmitters used in licensed radio services.

FCC Part 2: FREQUENCY ALLOCA-TIONS AND RADIO TREATY MAT-TERS; GENERAL RULES AND REG-ULATIONS

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	Feb. 20, 2022
Testing commenced on	:	Feb. 21, 2022
Testing concluded on	:	Mar. 02, 2022

2.2 Product Description

Name of EUT:	GNSS RTK Receiver
Model Number	V200
Hardware version:	V1.0
Software version:	V1.0
Frequency Range:	From 410 MHz to 470 MHz
Modilation Type:	4FSK,GMSK
Channel Separation:	12.5KHz
Rated Output Power:	2 Watts(33dBm)/1.0 Watts(30dBm)/0.5Wattes(27dBm)
Support data rate:	9.6kbps
Antenna Type:	External antenna
Antenna Gain:	3dBi

2.3 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 7.2V From Battery and DC 5.0V From external circuit

2.4 Short description of the Equipment under Test (EUT)

This is a GNSS RTK Receiver.
For more details, refer to the user's manual of the EUT.

2.5 Description of Test Modes and Test Frequency

The EUT has been tested under typical operating condition. As, test modes selected as below by the technical parameters of the EUT:

Operation Mode No.	Modulation	Channel Separation	Condition		
	4FSK	12.5KHz	High Power	Middle power	Low Power
1	☒	☒	☒		
2	☒	☒		☒	
3	☒	☒			☒

Operation Mode No.	Modulation	Channel Separation	Condition		
	GMSK	12.5KHz	High Power	Middle power	Low Power
4	☒	☒	☒		
5	☒	☒		☒	
6	☒	☒			☒

Test Frequency list:

Modulation Type	Test Channel	Channel Separation	Test Frequency (MHz)
4FSK	Ch1	12.5KHz	410.125
	Ch2		440.000
	Ch3		469.875

Modulation Type	Test Channel	Channel Separation	Test Frequency (MHz)
GMSK	Ch1	12.5KHz	410.125
	Ch2		453.125
	Ch3		469.625

2.6 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with FCC Part 90 Rules.

2.7 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

Shenzhen CTA Testing Technology Co., Ltd.
Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao’an District, Shenzhen, China

3.2 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:
FCC-Registration No.: 517856 Designation Number: CN1318

Shenzhen CTA Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA-Lab Cert. No.: 6534.01

Shenzhen CTA Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

3.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:
Radiated Emission:

Temperature:	23 ° C
Humidity:	44 %
Atmospheric pressure:	950-1050mbar

AC Main Conducted testing：

Temperature:	24 ° C
Humidity:	47 %
Atmospheric pressure:	950-1050mbar

Conducted testing：

Temperature:	24 ° C
Humidity:	46 %
Atmospheric pressure:	950-1050mbar

3.4 Summary of measurement results

Description of Test Item	Standard clause	Verdict
Maximum Transmitter Power	FCC Part 90.205	PASS
Modulation Characteristic	FCC Part 90.207	N/A[note1]
Occupied Bandwidth	FCC Part 90.209	PASS
Emission Mask	FCC Part 90.210	PASS
Frequency Stability	FCC Part 90.213	PASS
Transmitter Frequency Behavior	FCC Part 90.214	PASS
Transmitter Radiated Spurious Emssion	FCC Part 90.210	PASS
Spurious Emssion On Antenna Port	FCC Part 90.210	PASS

Remark:
1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report

3.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the Shenzhen CTA Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen CTA Testing Technology Co., Ltd. :

Test Items	Measurement Uncertainty	Notes
Frequency error	25 Hz	(1)
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	2.20 dB	(1)
Adjacent and alternate channel power Conducted	1.20 dB	(1)
Conducted spurious emission 9KHz-12.75 GHz	1.60 dB	(1)
Radiated spurious emission 9KHz-12.75 GHz	2.20 dB	(1)
Intermodulation attenuation	1.00 dB	(1)
Maximum useable receiver sensitivity	2.80 dB	(1)
Co-channel rejection	2.80 dB	(1)
Adjacent channel selectivity	2.80 dB	(1)
Spurious response rejection	2.80 dB	(1)
Intermodulation response rejection	2.80 dB	(1)
Blocking or desensitization	2.80 dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3.6 Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Equipment No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	CTA-308	2021/08/06	2022/08/05
LISN	R&S	ENV216	CTA-314	2021/08/06	2022/08/05
EMI Test Receiver	R&S	ESPI	CTA-307	2021/08/06	2022/08/05
EMI Test Receiver	R&S	ESCI	CTA-306	2021/08/06	2022/08/05
Spectrum Analyzer	Agilent	N9020A	CTA-301	2021/08/06	2022/08/05
Spectrum Analyzer	R&S	FSP	CTA-337	2021/08/06	2022/08/05
Vector Signal generator	Agilent	N5182A	CTA-305	2021/08/06	2022/08/05
Analog Signal Generator	R&S	SML03	CTA-304	2021/08/06	2022/08/05
Universal Radio Communication	CMW500	R&S	CTA-302	2021/08/06	2022/08/05
Temperature and humidity meter	Chigo	ZG-7020	CTA-326	2021/08/06	2022/08/05
Ultra-Broadband Antenna	Schwarzbeck	VULB9163	CTA-310	2021/08/07	2022/08/06
Horn Antenna	Schwarzbeck	BBHA 9120D	CTA-309	2021/08/07	2022/08/06
Loop Antenna	Zhinan	ZN30900C	CTA-311	2021/08/07	2022/08/06
Horn Antenna	Beijing Hangwei Dayang	OBH100400	CTA-336	2021/08/06	2022/08/05
Amplifier	Schwarzbeck	BBV 9745	CTA-312	2021/08/06	2022/08/05
Amplifier	Taiwan chengyi	EMC051845B	CTA-313	2021/08/06	2022/08/05
Directional coupler	NARDA	4226-10	CTA-303	2021/08/06	2022/08/05
High-Pass Filter	XingBo	XBLBQ-GTA18	CTA-402	2021/08/06	2022/08/05
High-Pass Filter	XingBo	XBLBQ-GTA27	CTA-403	2021/08/06	2022/08/05
Automated filter bank	Tonscend	JS0806-F	CTA-404	2021/08/06	2022/08/05
Power Sensor	Agilent	U2021XA	CTA-405	2021/08/06	2022/08/05
Amplifier	Schwarzbeck	BBV9719	CTA-406	2021/08/06	2022/08/05

4 TEST CONDITIONS AND RESULTS

4.1 Maximum Transmitter Power

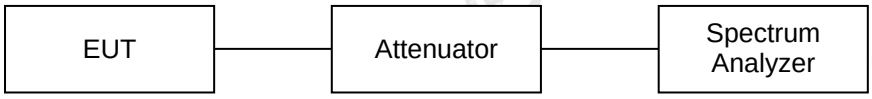
TEST APPLICABLE

Per FCC Part 2.1046 and Part 90.205: Maximum ERP is dependent upon the station's antenna HAAT and required service area.

TEST PROCEDURE

Measurements shall be made to establish the radio frequency power delivered by the transmitter the standard output termination. The power output shall be monitored and recorded and no adjustment shall be made to the transmitter after the test has begun, except as noted bellow:
If the power output is adjustable, measurements shall be made for the highest and lowest power levels.
The EUT connect to the Spectrum Analyzer through 20 dB attenuator.

TEST CONFIGURATION

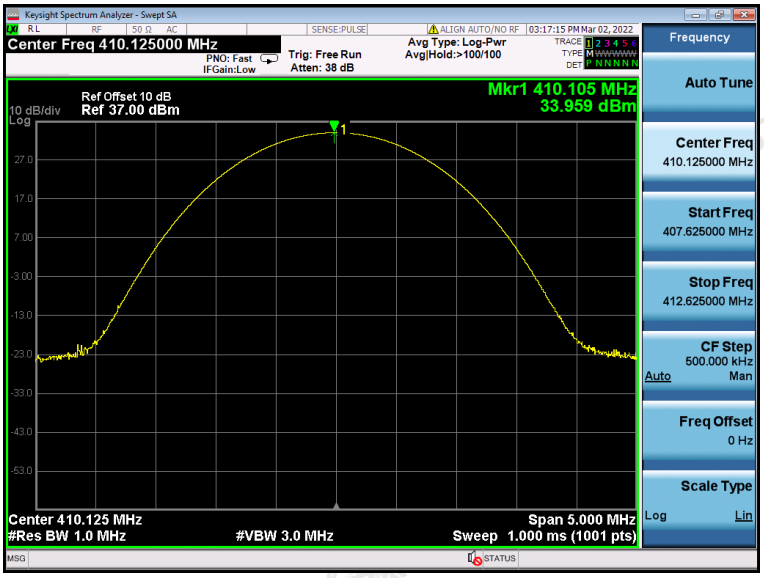


TEST RESULTS

Modulation Type	Channel Sparation	Power Level	Test Channel	Test Frequency (MHz)	Test Results (dBm)
4FSK	12.5KHz	High	Ch1	410.125	33.959
			Ch2	440.000	33.400
			Ch3	469.875	33.190
		Middle	Ch1	410.125	30.115
			Ch2	440.000	30.335
			Ch3	469.875	29.952
		Low	Ch1	410.125	26.765
			Ch2	440.000	26.653
			Ch3	469.875	26.673
Modulation Type	**Channel Sparation**	**Power Level**	**Test Channel**	**Test Frequency (MHz)**	**Test Results (dBm)**
GMSK	12.5KHz	High	Ch1	410.125	33.633
			Ch2	453.125	33.469
			Ch3	469.625	33.403
		Middle	Ch1	410.125	28.154
			Ch2	453.125	28.635
			Ch3	469.625	29.039
		Low	Ch1	410.125	26.821
			Ch2	453.125	26.713
			Ch3	469.625	26.679

Remark:By pre-scan,only worst result is reported.

Modulation Type:	4FSK	Operation Mode:	Mode 1

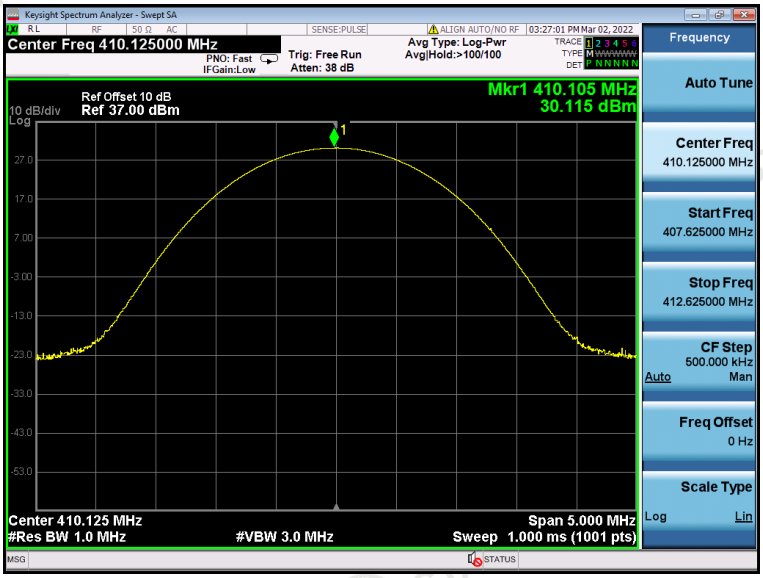


Ch1

Ch2

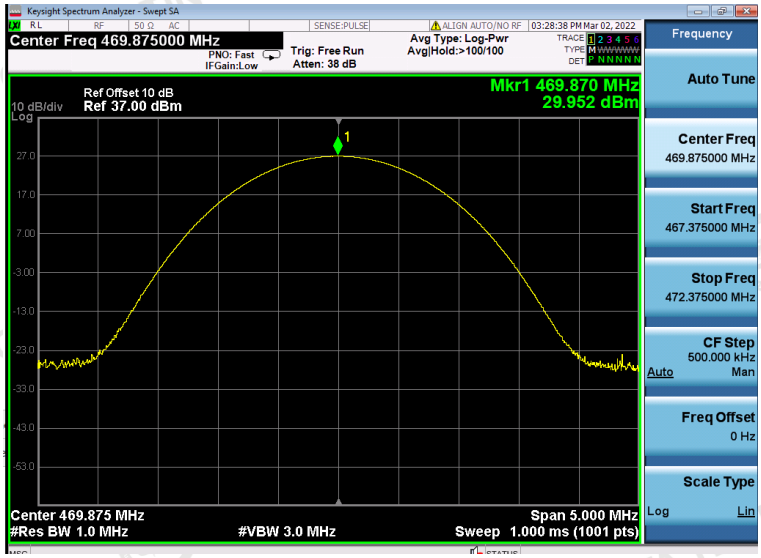
Ch3

Modulation Type:	4FSK	Operation Mode:	Mode 2



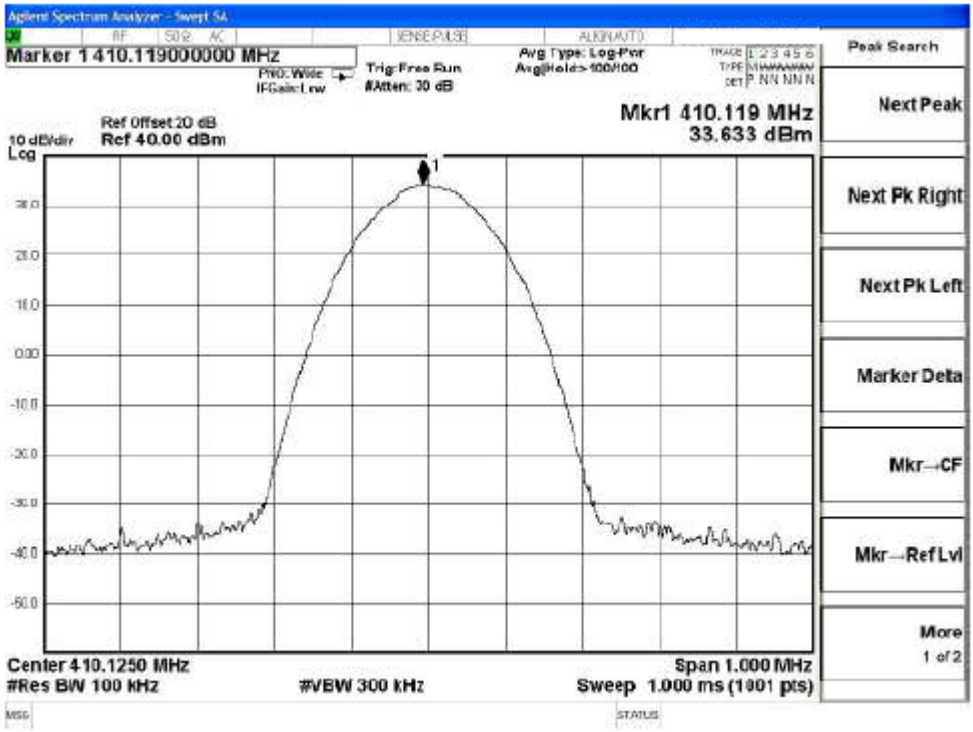
Ch1

Ch2

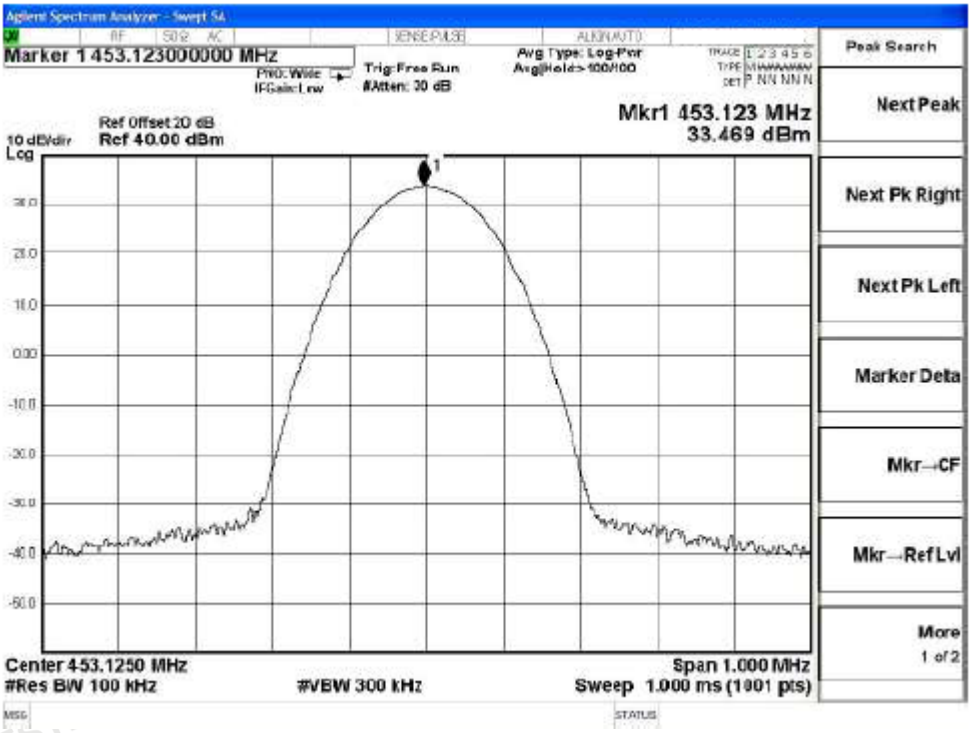


Ch3

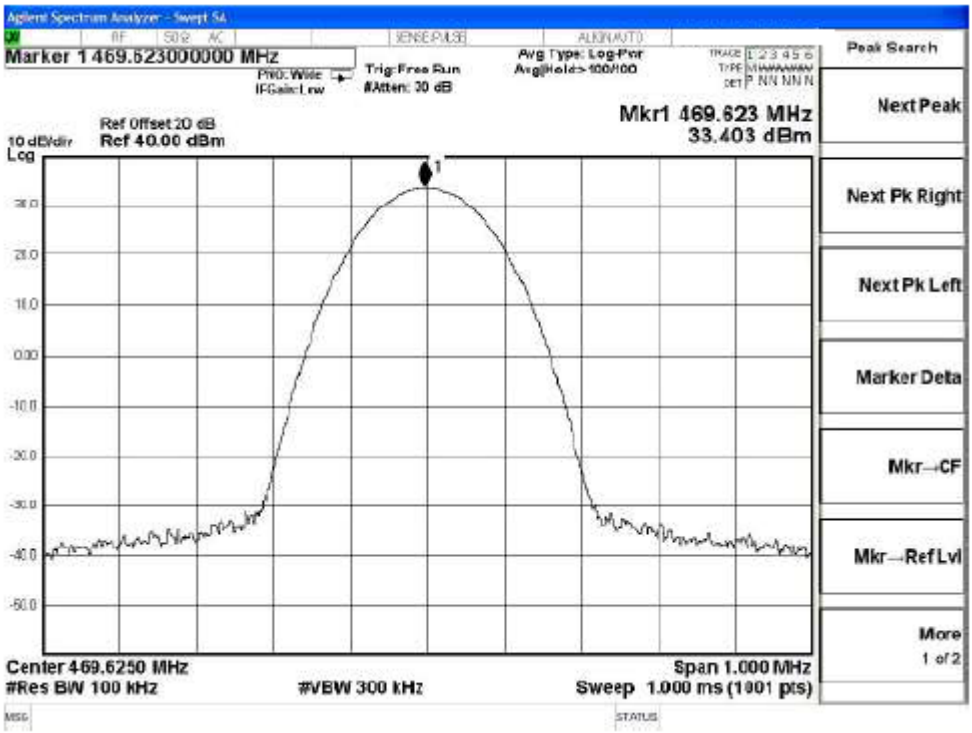
Modulation Type:	GMSK	Operation Mode:	Mode 3



Ch1

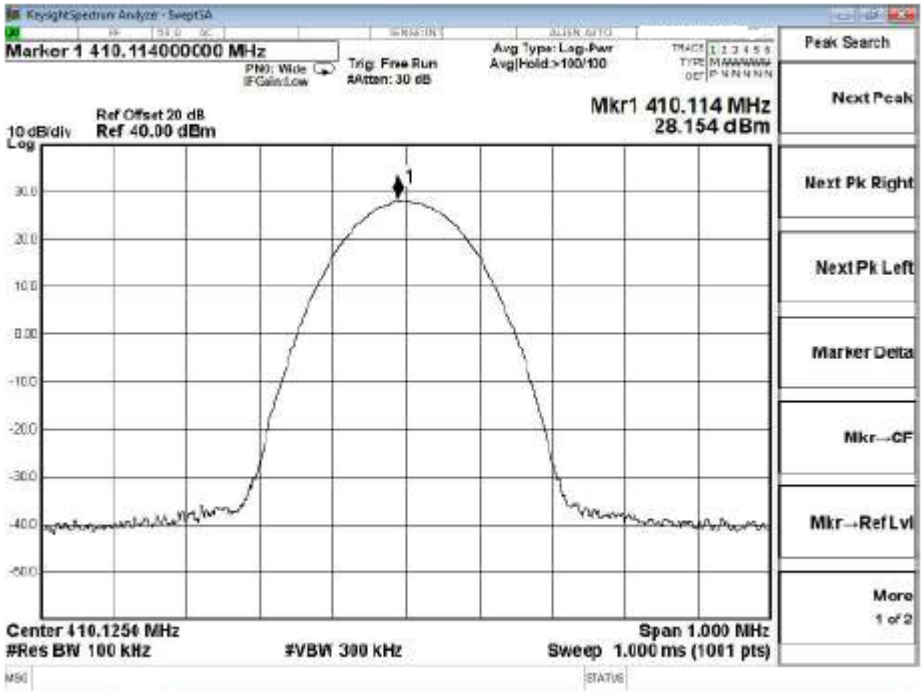


Ch2

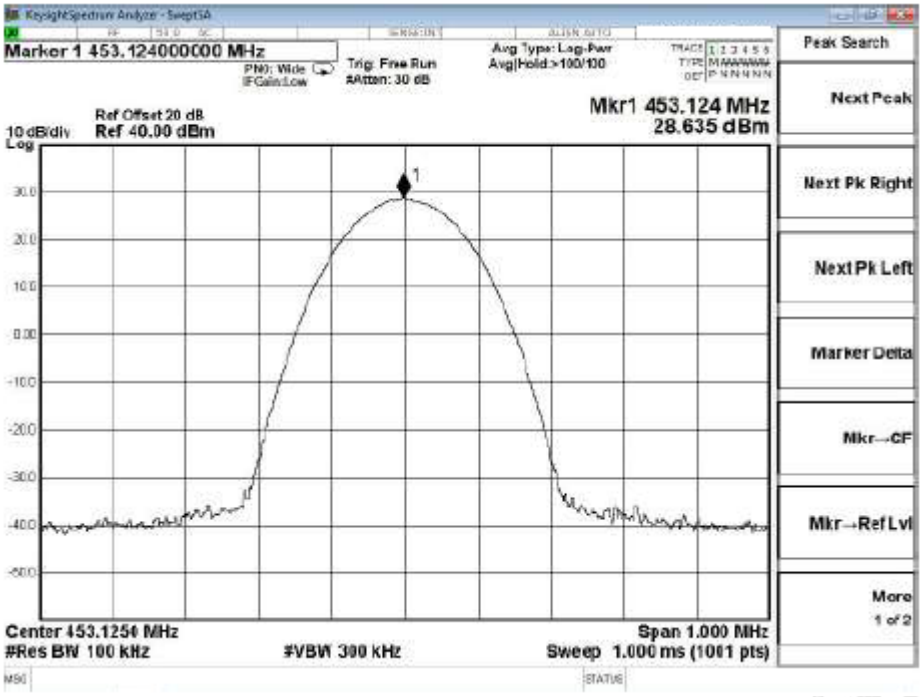


Ch3

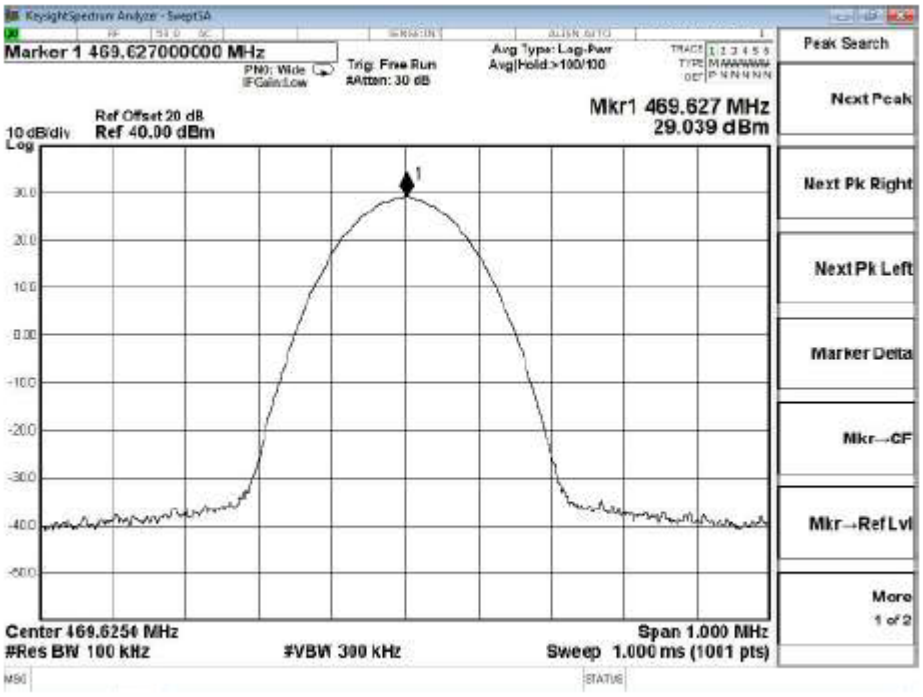
Modulation Type:	GMSK	Operation Mode:	Mode 4



Ch1


Agilent Spectrum Analyzer - Swept SA
Marker 1 453.124000000 MHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
Ref Offset 20 dB
10 dB/div
Log
Ref 40.00 dBm
Mkr1 453.124 MHz
28.635 dBm
Center 453.1250 MHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.000 MHz
Sweep 1.000 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Ch2


Agilent Spectrum Analyzer - Swept SA
Marker 1 469.627000000 MHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
Ref Offset 20 dB
10 dB/div
Log
Ref 40.00 dBm
Mkr1 469.627 MHz
29.039 dBm
Center 469.6250 MHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.000 MHz
Sweep 1.000 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Ch3

4.2 Occupied Bandwidth and Emission Mask Test

TEST APPLICABLE

(a). Occupied Bandwidth: The EUT was connected to the audio signal generator and the spectrum analyzer via the main RF connector, and through an appropriate attenuator. The EUT was controlled to transmit its maximum power. Then the bandwidth of 99% power can be measured by the spectrum analyzer.

(b). Emission Mask B: For transmitters that are equipped with an audio low-pass filter pursuant to §90.211(a), the power of any emission must be below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

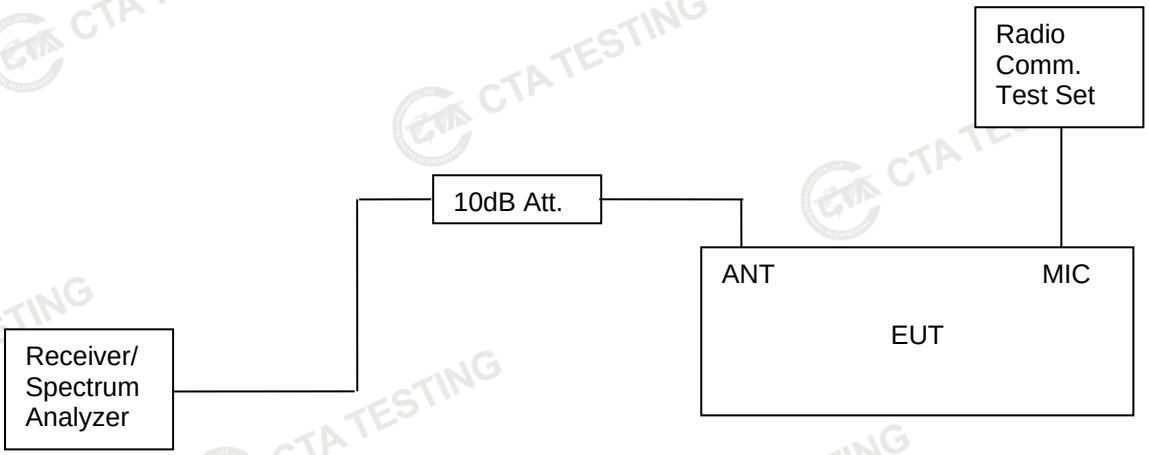
(c). Emission Mask D, 12.5 kHz channel bandwidth equipment: For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd -2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

TEST CONFIGURATION



TEST PROCEDURE

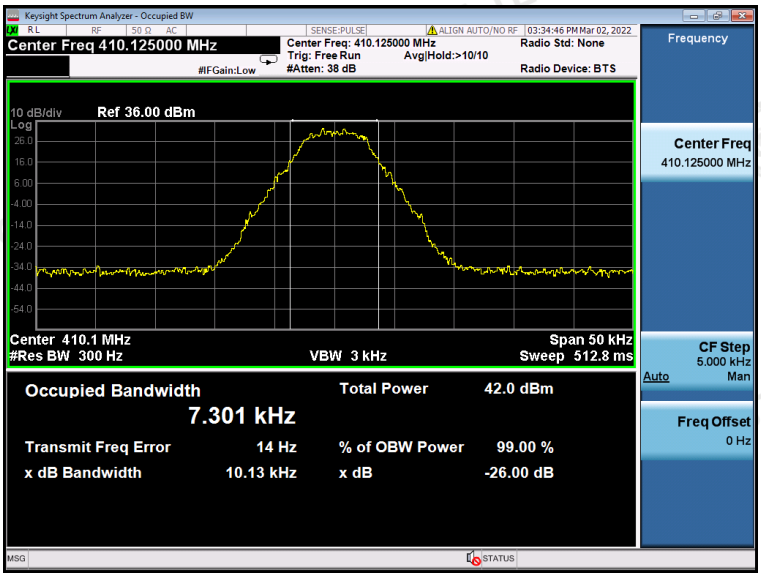
1 The EUT was placed on a turn table which is 0.8m above ground plane.
2 The EUT was modulated by 2.5 KHz Sine wave audio signal; the level of the audio signal employed is 16 dB greater than that necessary to produce 50% of rated system deviation. Rated system deviation is 2.5 kHz (12.5 kHz channel spacing) and 5 kHz (25 kHz channel spacing).
3 Set EUT as normal operation.
4 Set SPA Center Frequency = fundamental frequency, RBW=300Hz, VBW= 3 KHz, span =50 KHz.
5 Set SPA Max hold. Mark peak, Set 99% Occupied Bandwidth and 26dB Occupied Bandwidth.
6 Set SPA Center Frequency=fundamental frequency, set =300Hz, VBW=1 KHz, span=50 KHz for 12.5 channel spacing.

TEST RESULTS

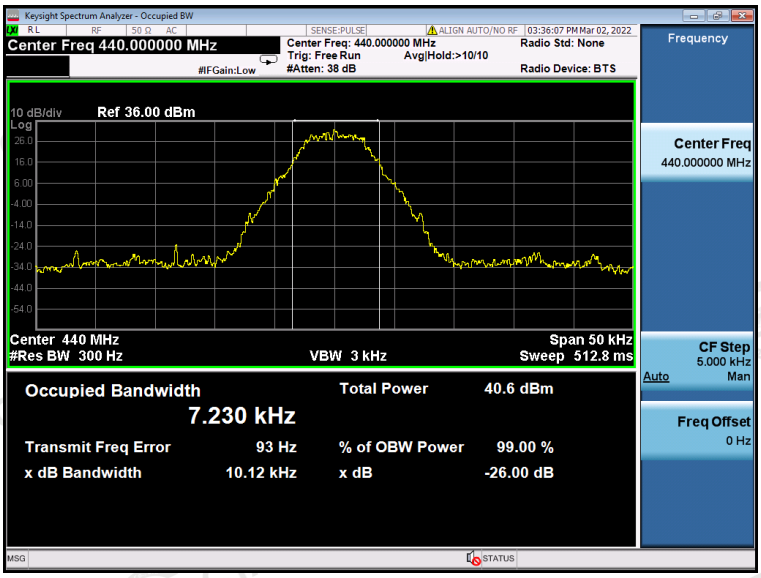
Occupied Bandwidth

Modulation Type	Channel Separation (kHz)	Power Level	Frequency (MHz)	99% OBW (kHz)	26dB bandwidth (kHz)	Limit (KHz)	Test result
Digital/4FSK	12.5KHz	High	410.125	7.301	10.13	11.25	Pass
			440.000	7.230	10.12		Pass
			469.875	7.317	10.20		Pass
		Low	410.125	7.358	9.636		Pass
			440.000	7.221	10.32		Pass
			469.875	7.326	10.56		Pass

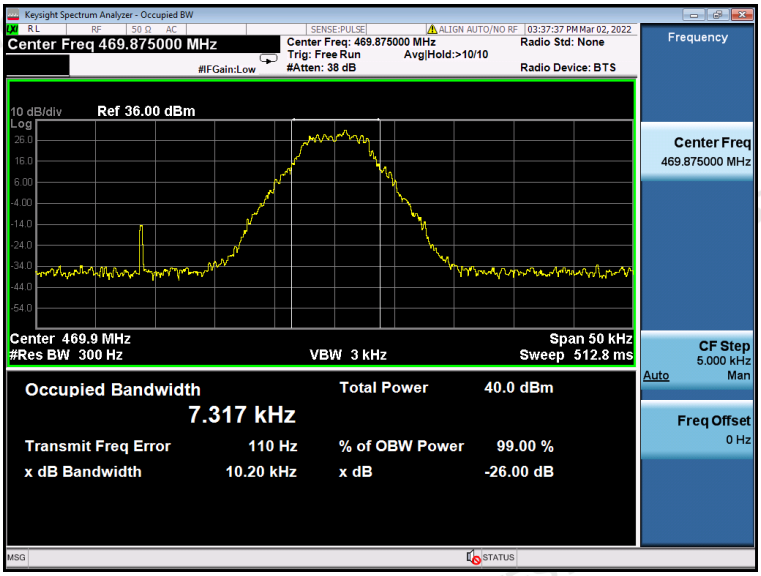
Modulation Type:	4FSK	Operation Mode:	Mode 1



Ch1

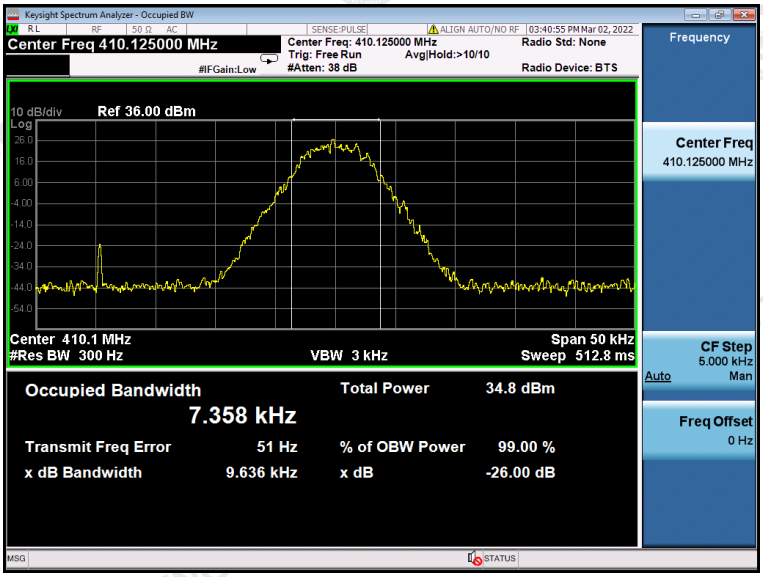


Ch2

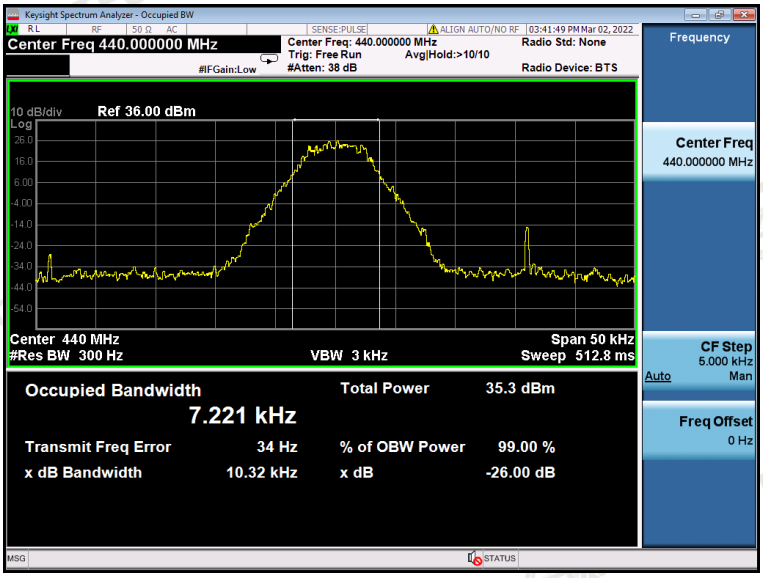


Ch3

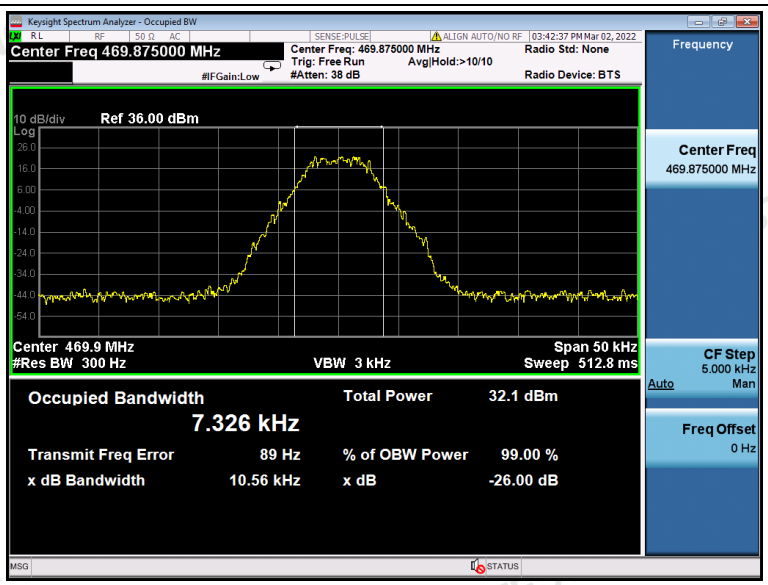
Modulation Type:	4FSK	Operation Mode:	Mode 2



Ch1



Ch2

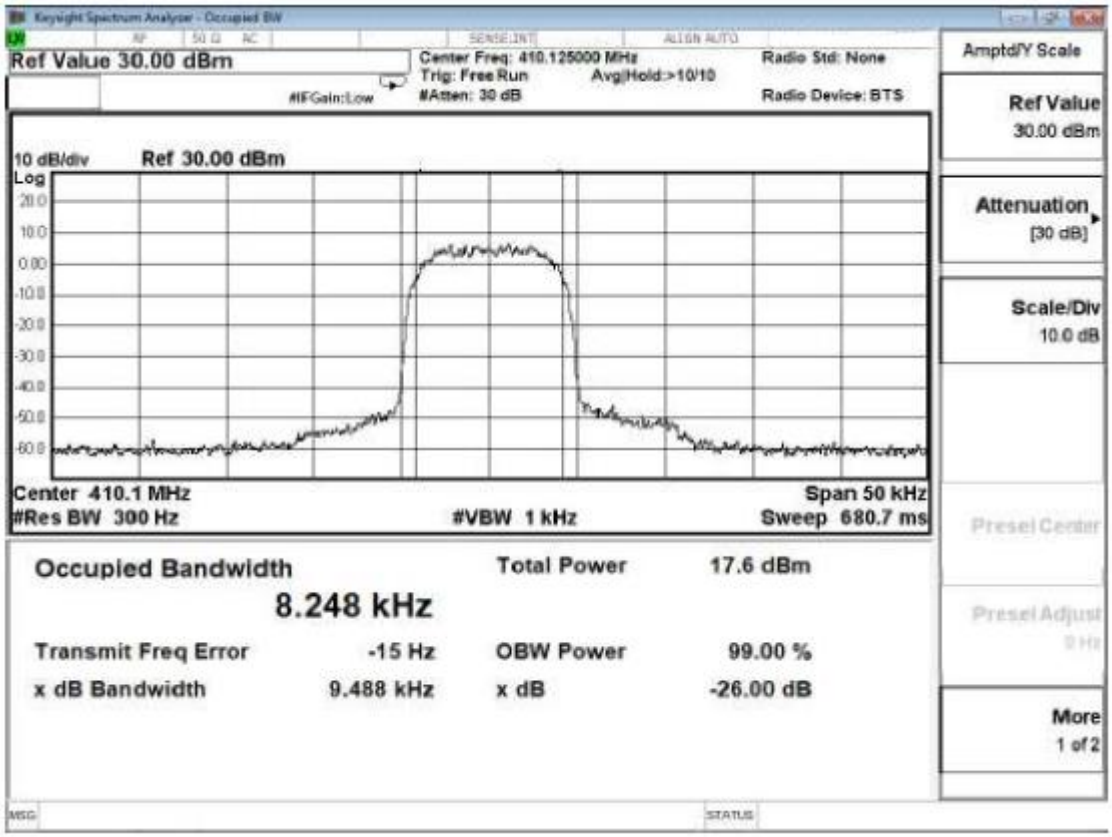


Ch3

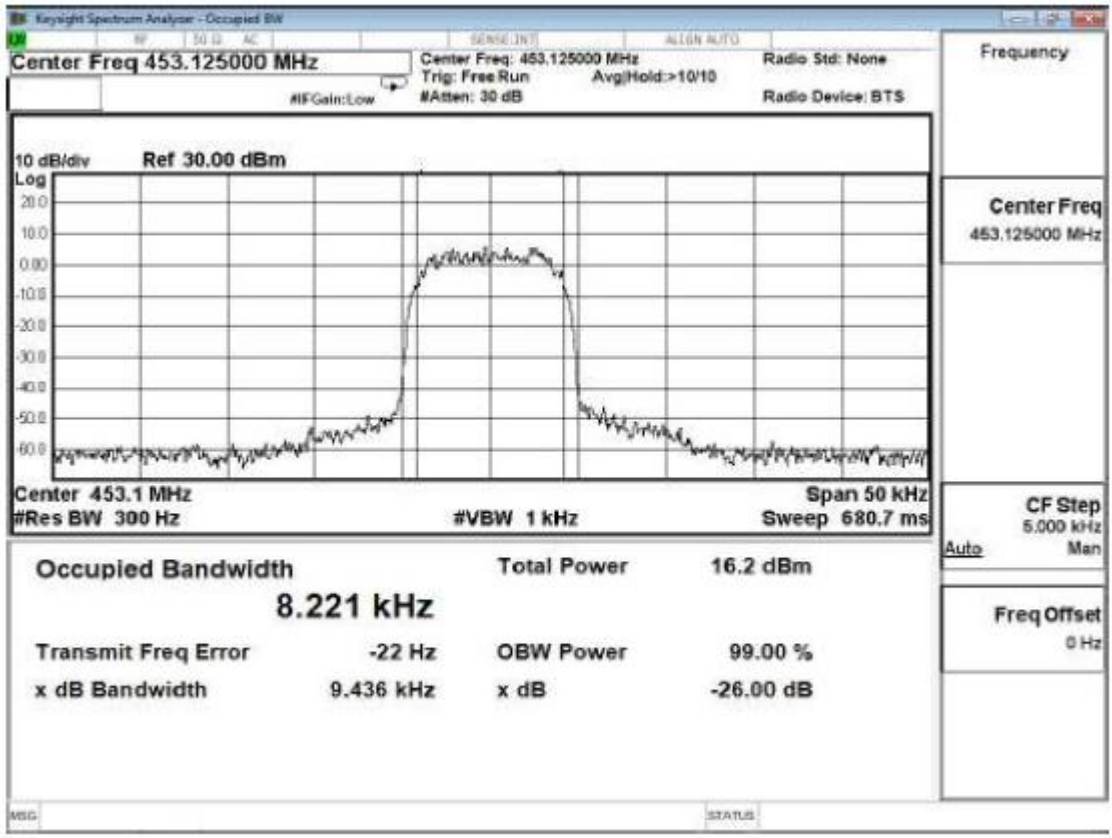
Modulation Type	Channel Separation (kHz)	Power Level	Frequency (MHz)	99% OBW (kHz)	26dB bandwidth (kHz)	Limit (KHz)	Test result
Digital/GMSK	12.5KHz	High	410.125	8.248	9.488	11.25	Pass
			453.125	8.221	9.436		Pass
			469.625	8.150	9.492		Pass
		Low	410.125	8.158	9.236		Pass
			453.125	8.021	9.321		Pass
			469.625	8.026	9.161		Pass

Remark: All models were tested,only worst case at Mode 4 was recorded.

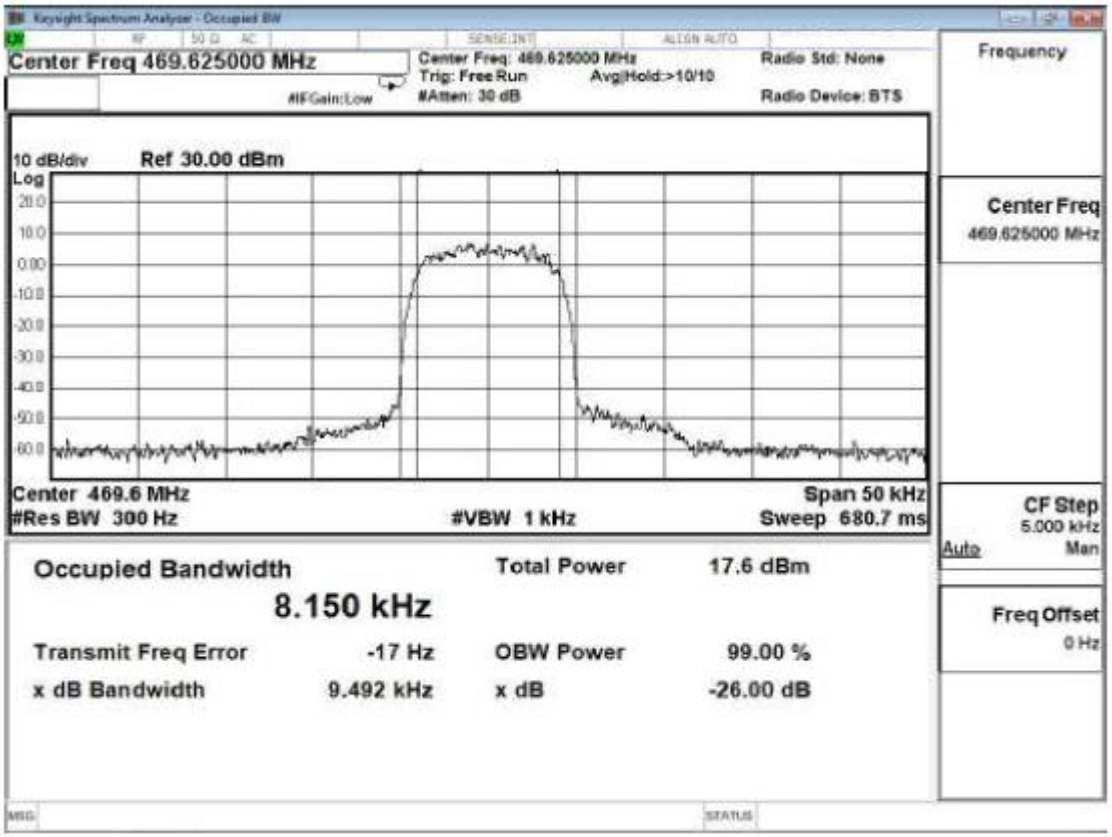
Modulation Type:	GMSK	Operation Mode:	Mode 4


Keysight Spectrum Analyzer - Occupied BW
Ref Value 30.00 dBm
Center Freq: 410.125000 MHz
Trig: Free Run
Avg|Hold:>10/10
#IFGain:Low
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Amptd/Y Scale
Ref Value
30.00 dBm
10 dB/div
Ref 30.00 dBm
Log
Attenuation
[30 dB]
Scale/Div
10.0 dB
Center 410.1 MHz
#Res BW 300 Hz
#VBW 1 kHz
Span 50 kHz
Sweep 680.7 ms
Occupied Bandwidth
8.248 kHz
Total Power
17.6 dBm
Transmit Freq Error
-15 Hz
OBW Power
99.00 %
x dB Bandwidth
9.488 kHz
x dB
-26.00 dB
More
1 of 2
MSG
STATUS

Ch1


Keysight Spectrum Analyzer - Occupied BW
Center Freq 453.125000 MHz
Center Freq: 453.125000 MHz
Trig: Free Run
Avg|Hold:>10/10
#IFGain:Low
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Frequency
10 dB/div
Ref 30.00 dBm
Log
Center Freq
453.125000 MHz
Center 453.1 MHz
#Res BW 300 Hz
#VBW 1 kHz
Span 50 kHz
Sweep 680.7 ms
CF Step
5.000 kHz
Auto
Man
Occupied Bandwidth
8.221 kHz
Total Power
16.2 dBm
Transmit Freq Error
-22 Hz
OBW Power
99.00 %
x dB Bandwidth
9.436 kHz
x dB
-26.00 dB
Freq Offset
0 Hz
MSG
STATUS

Ch2



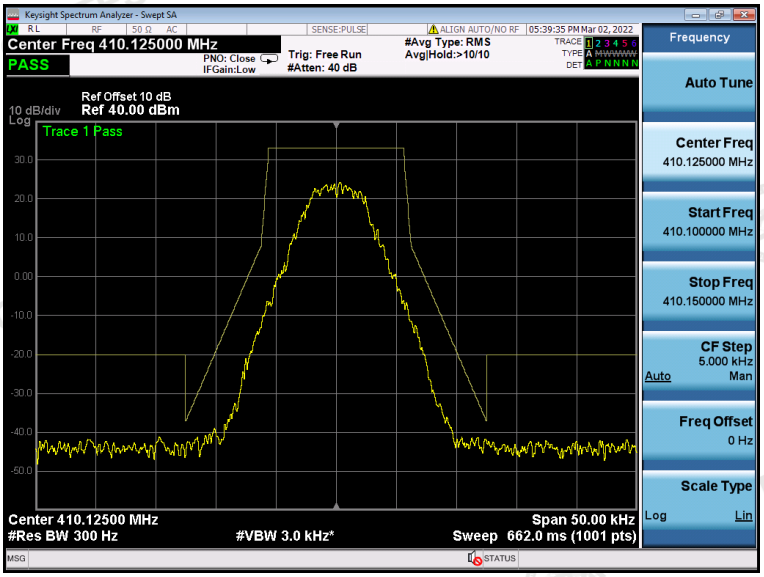
Ch3

Emission Mask

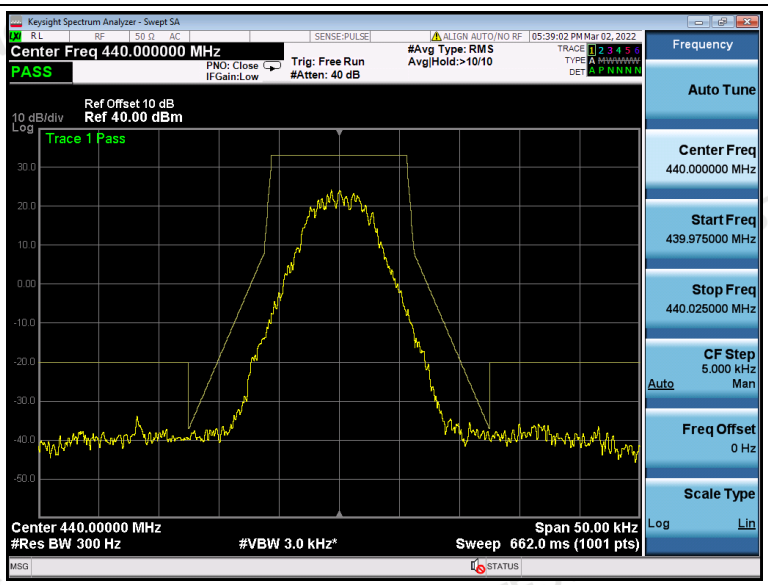
Remark:All models were tested,only worst case at Mode 1 was recorded.

Modulation Type	Channel Sparation	Operation Mode	Test Channel	Test Frequency (MHz)	Applicable Mask	RBW (Hz)
4FSK	12.5KHz	Mode1	Ch1	410.125	D	300
			Ch2	440.000	D	300
			Ch3	469.875	D	300
Test Results			**PASS**			

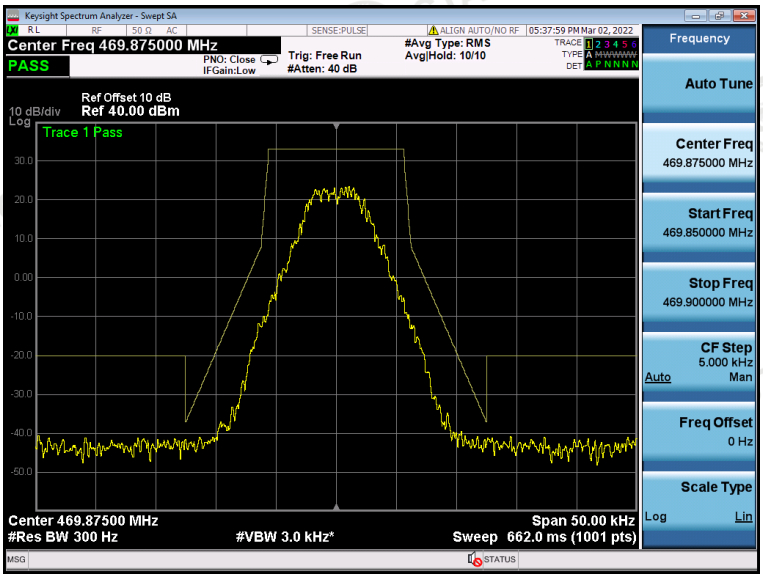
Modulation Type:	4FSK	Operation Mode:	Mode 1



Ch1



Ch2

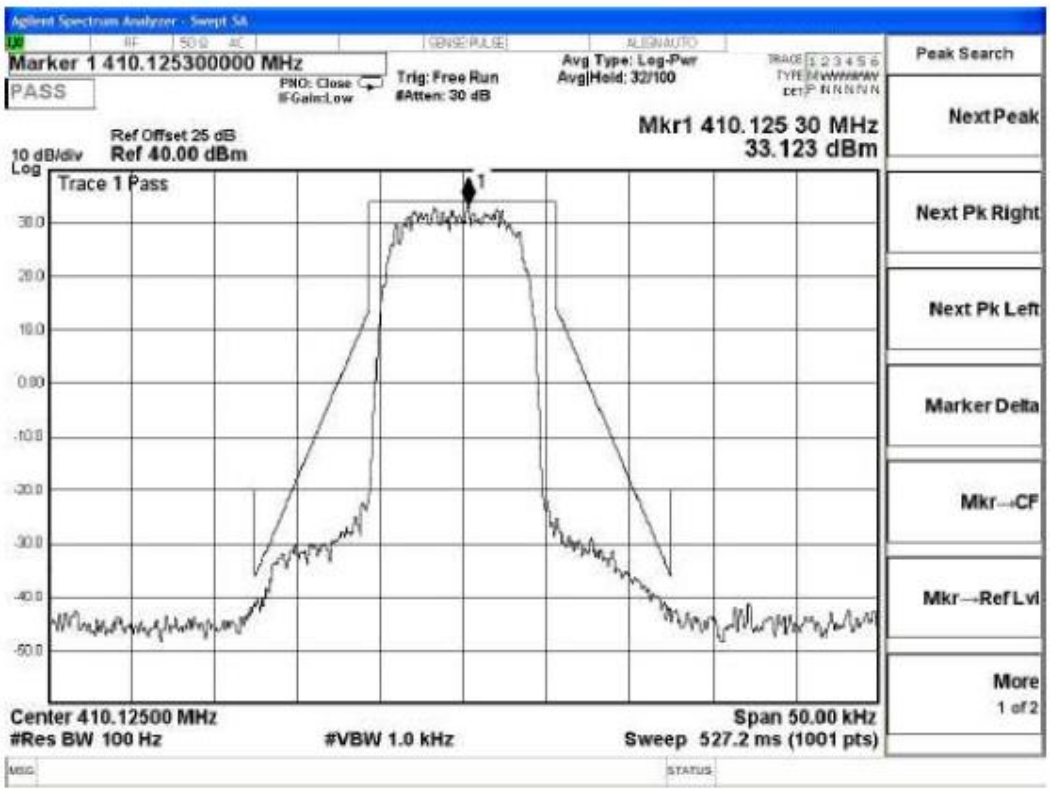


Ch3

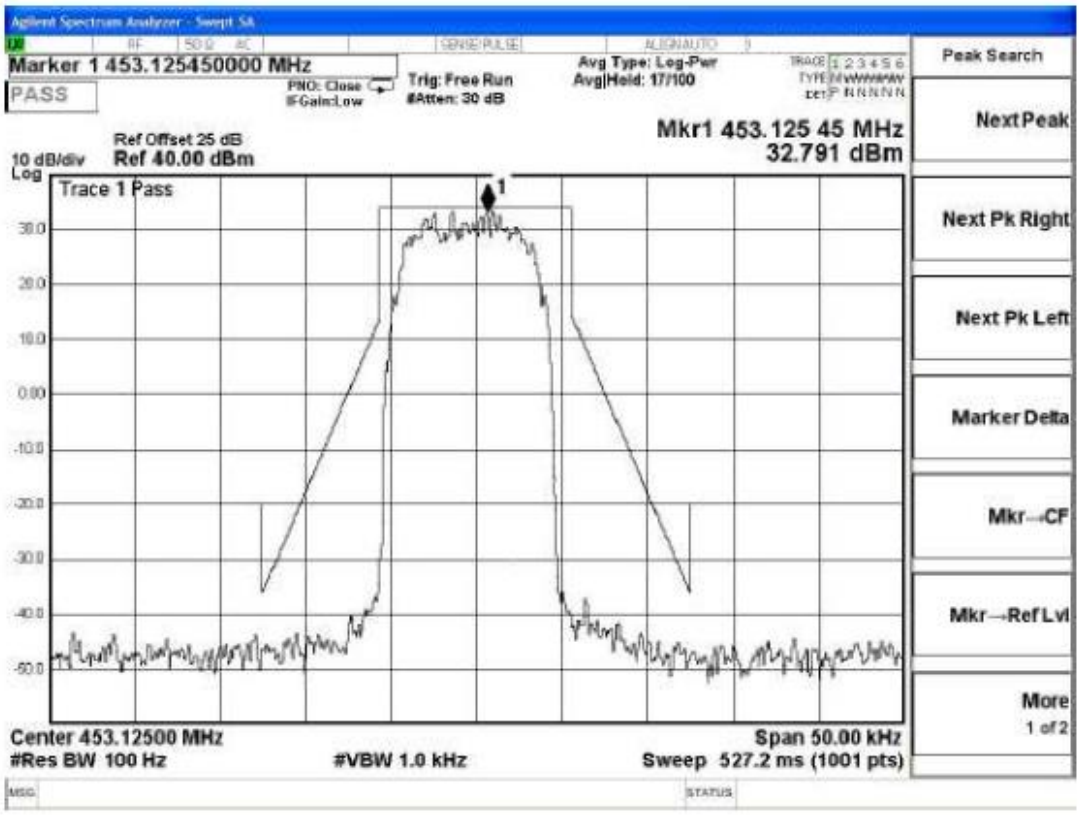
Remark:All models were tested,only worst case at Mode 4 was recorded.

Modulation Type	Channel Sparation	Operation Mode	Test Channel	Test Frequency (MHz)	Applicable Mask	RBW (Hz)
GMSK	12.5KHz	Mode1	Ch1	410.125	D	300
			Ch2	453.125	D	300
			Ch3	469.625	D	300
Test Results			**PASS**			

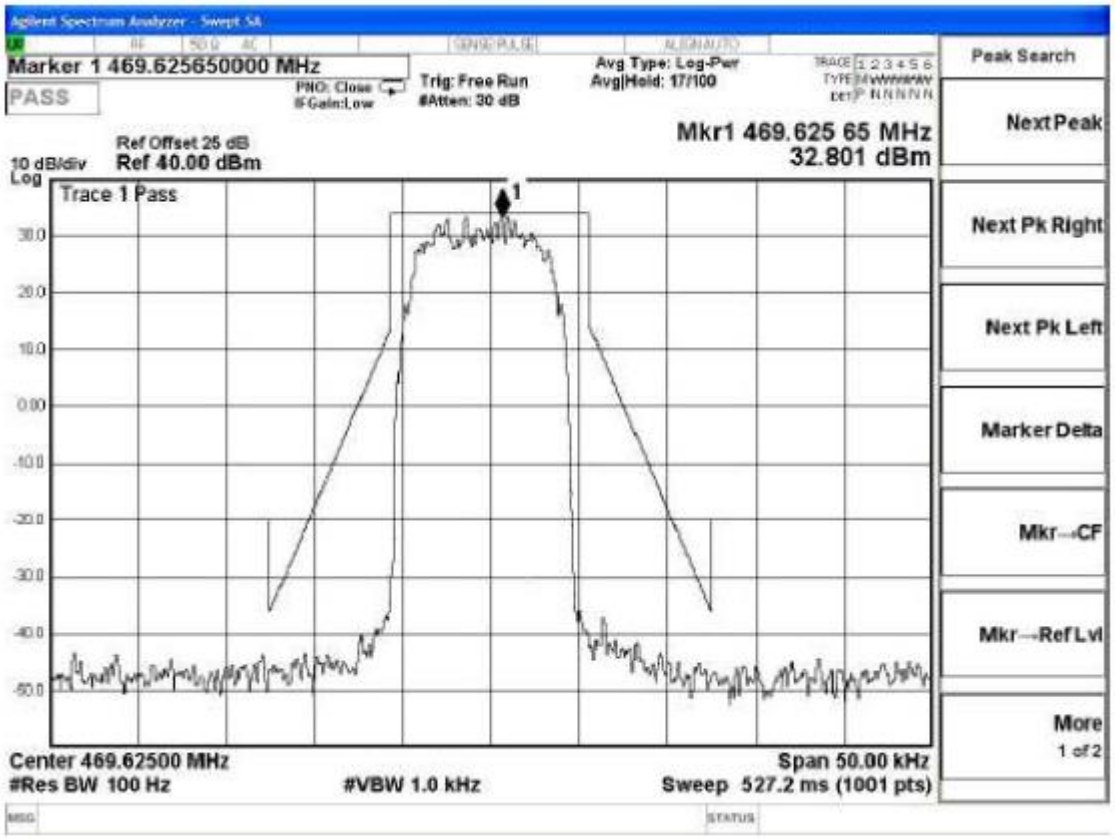
Modulation Type:	GMSK	Operation Mode:	Mode 4


Agilent Spectrum Analyzer - Swept SA
Marker 1 410.125300000 MHz
PASS
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 32/100
Ref Offset 25 dB
10 dB/div
Log
Ref 40.00 dBm
Trace 1 Pass
Mkr1 410.125 30 MHz
33.123 dBm
Center 410.12500 MHz
#Res BW 100 Hz
#VBW 1.0 kHz
Span 50.00 kHz
Sweep 527.2 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Ch1


Agilent Spectrum Analyzer - Swept SA
Marker 1 453.125450000 MHz
PASS
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 17/100
Ref Offset 25 dB
10 dB/div
Log
Ref 40.00 dBm
Trace 1 Pass
Mkr1 453.125 45 MHz
32.791 dBm
Center 453.12500 MHz
#Res BW 100 Hz
#VBW 1.0 kHz
Span 50.00 kHz
Sweep 527.2 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Ch2


Agilent Spectrum Analyzer - Swept SA
Marker 1 469.625650000 MHz
PASS
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 17/100
Ref Offset 25 dB
10 dB/div
Log
Ref 40.00 dBm
Mkr1 469.625 65 MHz
32.801 dBm
Trace 1 Pass
Center 469.62500 MHz
#Res BW 100 Hz
#VBW 1.0 kHz
Span 50.00 kHz
Sweep 527.2 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Ch3

4.3 Transmitter Radiated Spurious Emissions

TEST APPLICABLE

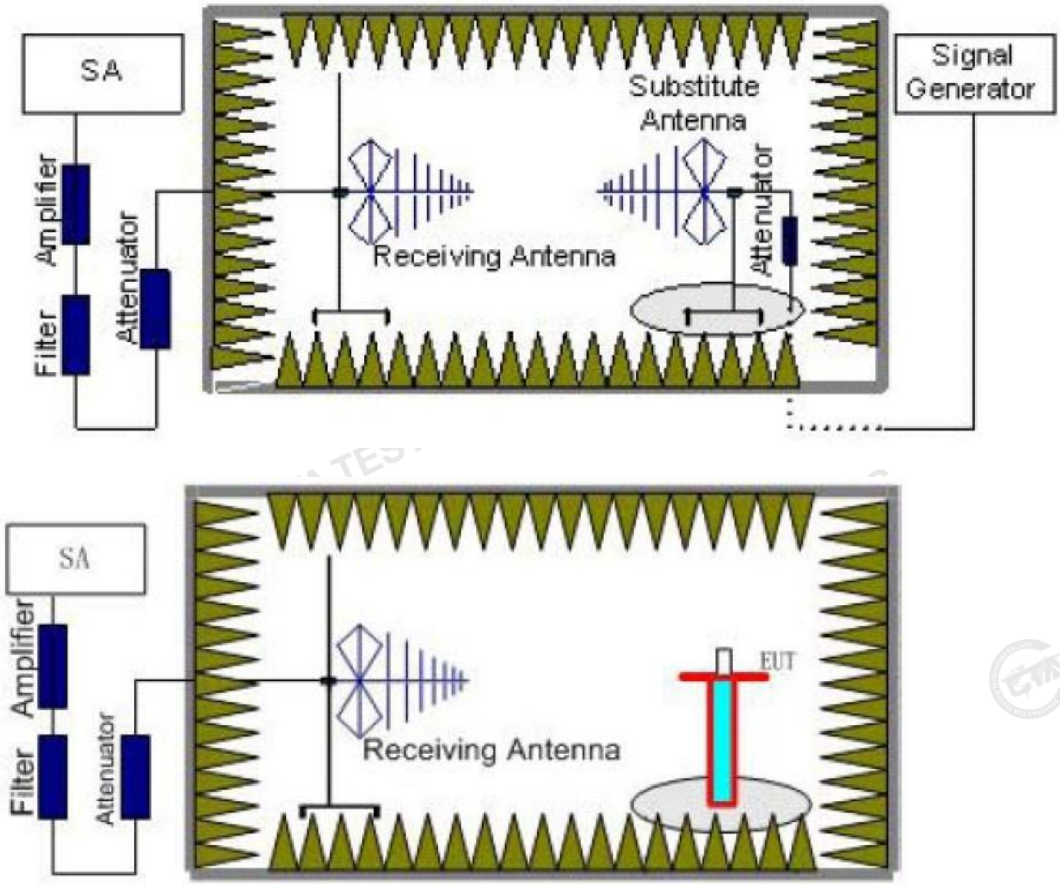
According to the ANSI C63.26 test method, and according to Section 90.210, the power of each unwanted emission shall be less than Transmitted Power as specified below for transmitters designed to operate with 12.5 KHz channel bandwidth:

1 On any frequency removed from the center of the authorized bandwidth fo to 5.625 KHz removed from fo: Zero dB
2 On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) fo of more than 5.625 KHz but no more than 12.5 KHz: At least 7.27dB
3 On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) fo of more than 12.5 KHz: At least 50+10 log (P) dB or 70 dB, which ever is lesser attenuation.

For transmitters designed to transmit with 25 KHz channel separation and equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as following:

1 On any frequency removed from the assigned frequency by more than 50 percent, but no more than 100 percent of the authorized bandwidth: At least 25 dB.
2 On any frequency removed from the assigned frequency by more than 100 percent, but no more than 250 percent of the authorized bandwidth: At least 35 dB.
3 On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43+10Log (P) dB.

TEST CONFIGURATION



TEST PROCEDURE

1. EUT was placed on a 1.50 meter high non-conductive stand at a 3 meter test distance from the receive antenna. A receiving antenna was placed on the antenna mast 3 meters from the EUT for emission measurements. The height of receiving antenna is 1.50 m. Detected emissions were maximized at each

frequency by rotating the EUT through 360° and adjusting the receiving antenna polarization. The radiated emission measurements of all transmit frequencies in six channels were measured with peak detector.

2. A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted in place of the EUT. The log-periodic antenna will be driven by a signal generator and the level will be adjusted till the same power value on the spectrum analyzer or receiver. The level of the spurious emissions can be calculated through the level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.
3. The EUT is then put into continuously transmitting mode at its maximum power level during the test.Set Test Receiver or Spectrum RBW=1MHz,VBW=3MHz for above 1GHz and RBW=100KHz,VBW=300KHz for 30MHz to 1GHz, And the maximum value of the receiver should be recorded as (P_r).
4. The EUT shall be replaced by a substitution antenna. In the chamber, an substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (P_{Mea}) is applied to the input of the substitution antenna, and adjust the level of the signal generator output until the value of the receiver reach the previously recorded (P_r). The power of signal source (P_{Mea}) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.
5. A amplifier should be connected to the Signal Source output port. And the cable should be connect between the Amplifier and the Substitution Antenna. The cable loss (P_{cl}) ,the Substitution Antenna Gain (G_a) and the Amplifier Gain (P_{Ag}) should be recorded after test.
   The measurement results are obtained as described below:
   Power(EIRP)=P_{Mea}- P_{Ag} - P_{cl} - G_a
   We used SMF100A micowave signal generator which signal level can up to 33dBm,so we not used power Amplifier for substituation test; The measurement results are amend as described below:
   Power(EIRP)=P_{Mea}- P_{cl} - G_a
6. This value is EIRP since the measurement is calibrated using an antenna of known gain (2.15 dBi) and known input power.
7. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP = EIRP-2.15dBi.

Limit

Modulation Type: FM

FCC Part 22.359, 74.462, 80.211 and 90.210 and RSS Gen, RSS 119 Issue 11 (12.5 kHz bandwidth only):
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least:
Low: 50 + 10 log (Pwatts) = 50 + 10 log (28.12) =64.49 dB
High: 50 + 10 log (Pwatts) = 50 + 10 log (29.85) =64.75 dB
Note: In general, the worse case attenuation requirement shown above was applied.
Calculation: Limit (dBm) =EL-50-10log10 (TP)

Notes: EL is the emission level of the Output Power expressed in dBm,
In this application, the EL is 43.98 dBm.
Limit (dBm) =43.98-50-10log10 (29.85) = -20 dBm

Modulation Type: 4FSK

FCC Part 22.359, 74.462, 80.211 and 90.210 and RSS Gen, RSS 119 Issue 11 (12.5 kHz Bandwidth only):
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least:
Low: 50 + 10 log (Pwatts) = 50 + 10 log (28.58) =54.56 dB
High: 50 + 10 log (Pwatts) = 50 + 10 log (29.85) =64.75 dB
Note: In general, the worse case attenuation requirement shown above was applied.
Calculation: Limit (dBm) =EL-50-10log10 (TP)

Notes: EL is the emission level of the Output Power expressed in dBm,
In this application, the EL is 43.98 dBm.
Limit (dBm) =43.98-50-10log10 (29.85) = -20 dBm

Note: 1. In general, the worse case attenuation requirement shown above was applied.
2. The measurement frequency range from 30 MHz to 5 GHz.
3. *** means that the emission level is too low to be measured or at least 20 dB down than the limit.

TEST RESULTS

Remark: All models were tested,only worst case at Mode 1 was recorded..

Test Frequency (MHz)	Frequency (MHz)	P_{Mea} (dBm)	P_{cl} (dB)	Distance (m)	G_a Antenna Gain (dBd/dBi)	Peak ERP (dBm)	Limit (dBm)	Margin (dB)	Pol.
410.125	820.25	-35.80	0.87	3.00	6.42	-30.25	-20	10.25	V
	1230.38	-34.58	1.02	3.00	10.24	-25.36	-20	5.36	V
	1640.50	-49.59	1.10	3.00	11.25	-39.44	-20	19.44	V
	--	--	--	--	--	--	--	--	--
	820.25	-37.20	0.87	3.00	6.42	-31.65	-20	11.65	H
	1230.38	-35.55	1.02	3.00	10.24	-26.33	-20	6.33	H
	1640.50	-51.01	1.10	3.00	11.25	-40.86	-20	20.86	H
	--	--	--	--	--	--	--	--	--
440.000	880.00	-36.80	0.92	3.00	6.47	-31.25	-20	11.25	V
	1320.00	-35.70	1.06	3.00	10.41	-26.35	-20	6.35	V
	1760.00	-48.70	1.12	3.00	11.38	-38.44	-20	18.44	V
	--	--	--	--	--	--	--	--	--
	880.00	-37.93	0.92	3.00	6.47	-32.38	-20	12.38	H
	1320.00	-37.23	1.06	3.00	10.41	-27.88	-20	7.88	H
	1760.00	-49.83	1.12	3.00	11.38	-39.57	-20	19.57	H
	--	--	--	--	--	--	--	--	--
469.875	939.75	-38.85	0.95	3.00	6.55	-33.25	-20	13.25	V
	1409.63	-37.47	1.10	3.00	10.89	-27.68	-20	7.68	V
	1879.50	-51.37	1.21	3.00	11.73	-40.85	-20	20.85	V
	--	--	--	--	--	--	--	--	--
	939.75	-39.92	0.95	3.00	6.55	-34.32	-20	14.32	H
	1409.63	-38.64	1.10	3.00	10.89	-28.85	-20	8.85	H
	1879.50	-52.50	1.21	3.00	11.73	-41.98	-20	21.98	H
	--	--	--	--	--	--	--	--	--

Remark:

1. *$EIRP=P_{Mea}(dBm)-P_{cl}(dB)+G_a(dBi)$*
2. *-- Means other points for values lower than limits and not recorded.*
3. *Margin = Limit – EIRP*

4.4 Spurious Emissions on Antenna Port

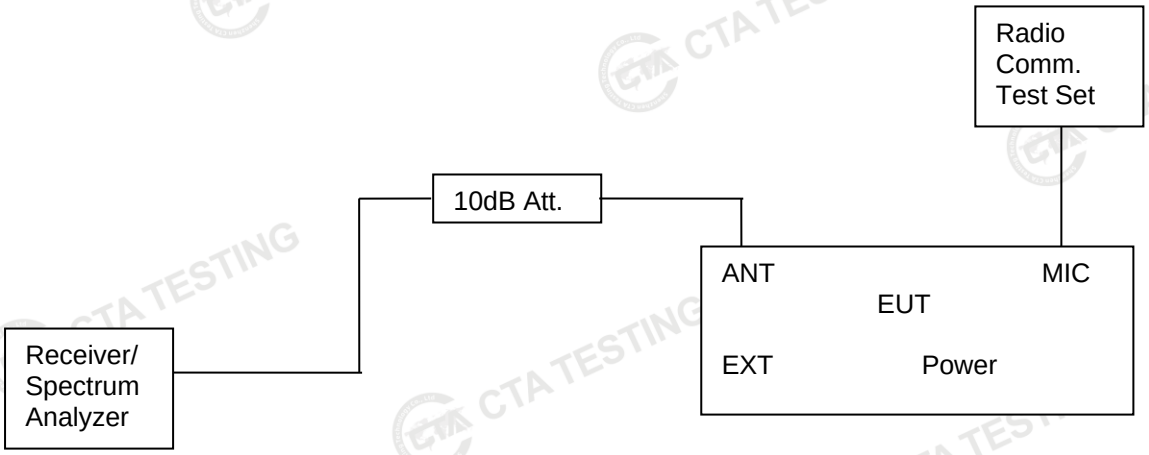
TEST APPLICABLE

The same as Section 4.3

TEST PROCEDURE

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set to 100 kHz. Sufficient scans were taken to show any out of band emission up to 10th. Harmonic for the lower and the highest frequency range. Set RBW 100 kHz, VBW 300 kHz in the frequency band 30MHz to 1GHz,while set RBW=1MHz.VBW=3MHz from the 1GHz to 10^{th} Harmonic.
The audio input was set to 0 to get the unmodulated carrier, the resulting picture is print out for each channel separation.

TEST CONFIGURATION



Limit

Modulation Type: FM
FCC Part 22.359, 74.462, 80.211 and 90.210 and RSS Gen, RSS 119 Issue 11 (12.5 kHz bandwidth only): On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least:
Low: 50 + 10 log (Pwatts) = 50 + 10 log (28.12) =64.49 dB
High: 50 + 10 log (Pwatts) = 50 + 10 log (29.85) =64.75 dB
Note: In general, the worse case attenuation requirement shown above was applied.
Calculation: Limit (dBm) =EL-50-10log10 (TP)
Notes: EL is the emission level of the Output Power expressed in dBm,
In this application, the EL is 43.98 dBm.
Limit (dBm) =43.98-50-10log10 (29.85) = -20 dBm

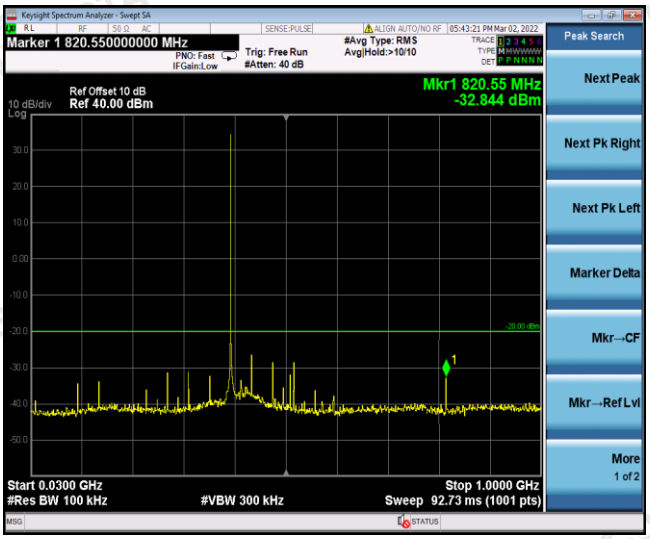
Modulation Type: 4FSK
FCC Part 22.359, 74.462, 80.211 and 90.210 and RSS Gen, RSS 119 Issue 11 (12.5 kHz Bandwidth only): On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least:
Low: 50 + 10 log (Pwatts) = 50 + 10 log (28.58) =54.56 dB
High: 50 + 10 log (Pwatts) = 50 + 10 log (29.85) =64.75 dB

Note: In general, the worse case attenuation requirement shown above was applied.
Calculation: Limit (dBm) =EL-50-10log10 (TP)
Notes: EL is the emission level of the Output Power expressed in dBm,
In this application, the EL is 43.98 dBm.
Limit (dBm) =43.98-50-10log10 (29.85) = -20 dBm
Note: 1. In general, the worse case attenuation requirement shown above was applied.
2.The measurement frequency range from 30 MHz to 5GHz.

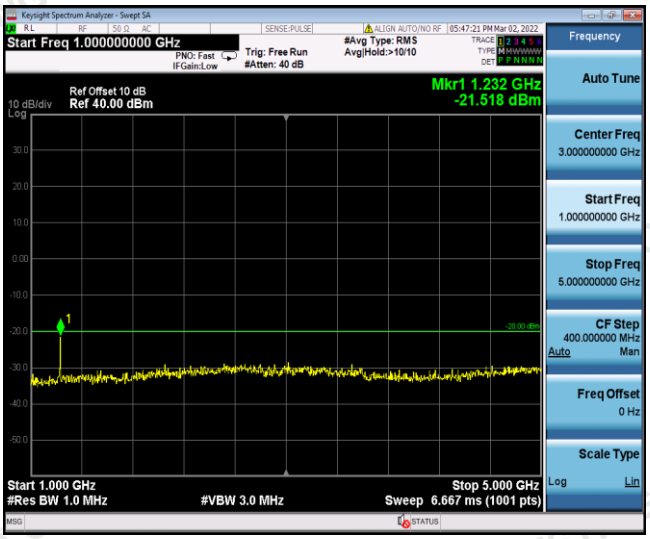
TEST RESULTS

Remark: All models were tested,only worst case at Mode 1 was recorded.

Modulation Type:	4FSK	Channel:	Ch1

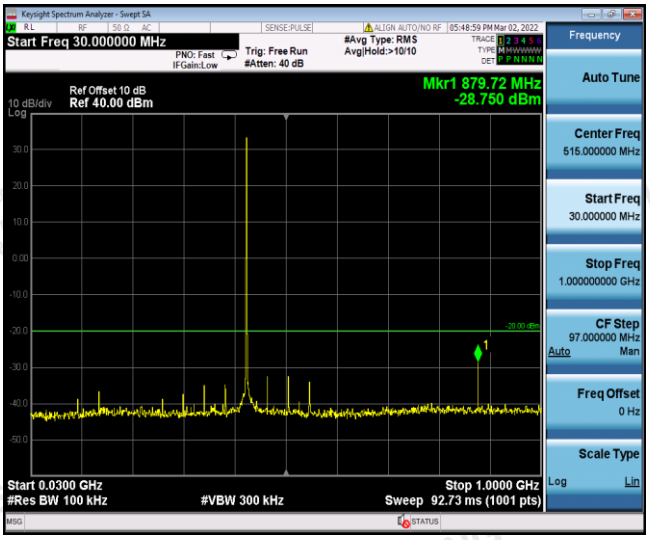


30MHz~1GHz

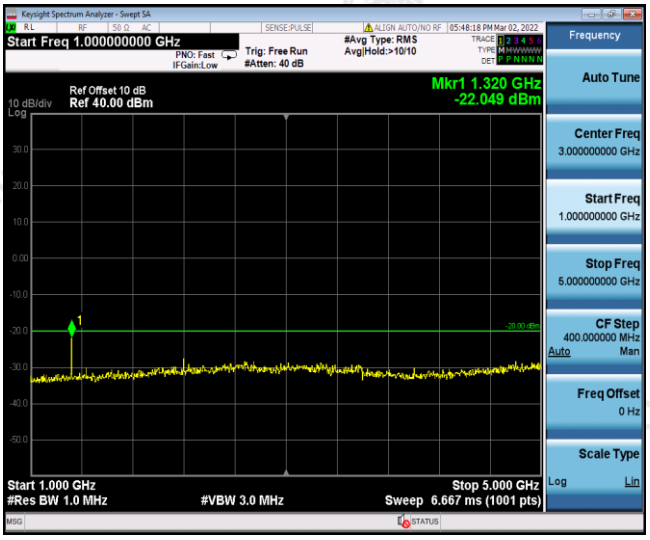


1GHz-5GHz

Modulation Type:	4FSK	Channel:	Ch2

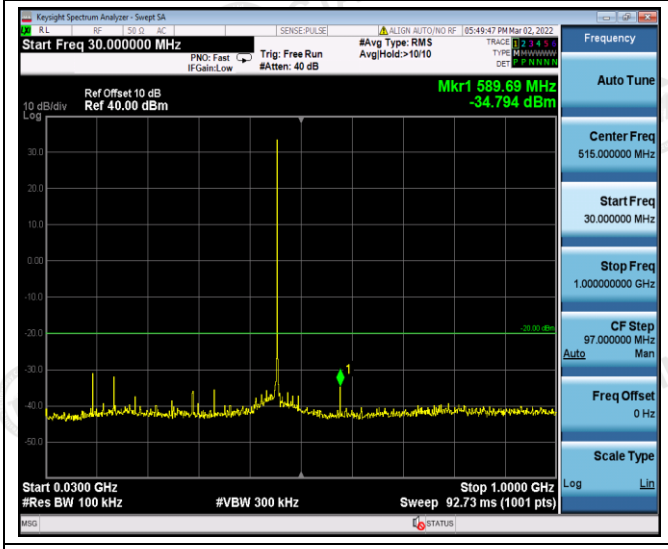


30MHz~1GHz

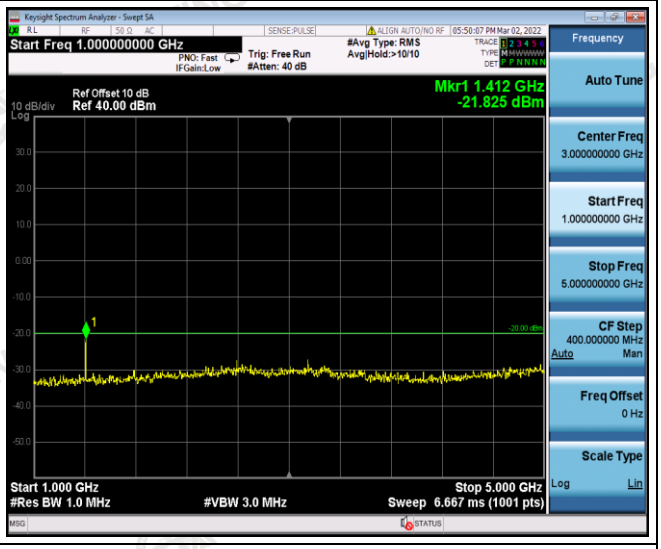


1GHz-5GHz

Modulation Type:	4FSK	Channel:	Ch3



30MHz~1GHz



1GHz-5GHz

4.5 Frequency Stability Test

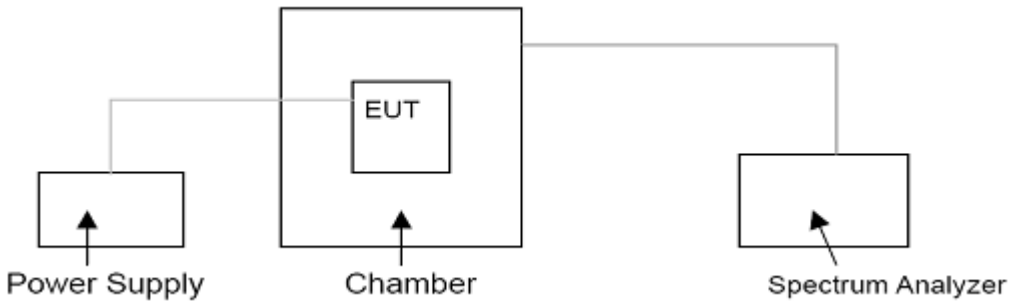
TEST APPLICABLE

1 According to FCC Part 2 Section 2.1055 (a)(1), the frequency stability shall be measured with variation of ambient temperature from -30℃ to +60℃ centigrade.
2 According to FCC Part 2 Section 2.1055 (a) (2), for battery powered equipment, the frequency stability shall be measured with reducing primary supply voltage to the battery operating end point, which is specified by the manufacture.
3 Vary primary supply voltage from 85 to 115 percent of the nominal value.
4 According to §90.213, the frequency stability limit is 1.5 ppm for 12.5KHz channel separation

TEST PROCEDURE

The EUT was set in the climate chamber and connected to an external DC power supply. The RF output was directly connected to Spectrum Analyzer ESI 26. The coupling loss of the additional cables was recorded and taken in account for all the measurements. After temperature stabilization (approx. 20 min for each stage), the frequency for the lower, the middle and the highest frequency range was recorded. For Frequency stability Vs. Voltage the EUT was connected to a DC power supply and the voltage was adjusted in the required ranges. The result was recorded.

TEST CONFIGURATION



TEST LIMITS

According to 90.213, Transmitters used must have minimum frequency stability as specified in the following table.

Frequency Range (MHz)	Channel Bandwidth (KHz)	Frequency Tolerance (ppm)		
		Fixed and Base Stations	Mobile Stations	
			> 2 W	≤ 2 W
150-174 MHz	6.25	1.0	2.0	2.0
	12.5	2.5	5.0	5.0
	25	5.0	5.0	50.0*
421-512 MHz	6.25	0.5	1.0	1.0
	12.5	1.5	2.5	2.5
	25	2.5	5.0	5.0

- Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.
- Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

TEST RESULTS

Remark:4FSK , All models were tested,only worst case at Mode 1 was recorded.

Operation Mode	Channel Separation	Test conditions		Frequency error (ppm)		
		Voltage(V)	Temp(℃)	410.125	440.000	469.875
Mode1	12.5KHz	7.2	-30	1.01	1.03	1.01
			-20	0.84	0.82	0.83
			-10	0.79	0.78	0.77
			0	0.76	0.75	0.75
			10	0.80	0.79	0.79
			20	0.54	0.55	0.53
			30	0.87	0.83	0.82
			40	0.91	0.90	0.90
			50	1.00	1.01	1.01
		3.15% Rated)	20	0.94	0.94	0.94
		4.26% Rated)	20	0.79	0.78	0.78
Limit				2.5 ppm		
Test Results				PASS		

Remark:GMSK , All models were tested,only worst case at Mode 4 was recorded.

Operation Mode	Channel Separation	Test conditions		Frequency error (ppm)		
		Voltage(V)	Temp(℃)	410.125	453.125	469.625
Mode1	12.5KHz	7.2	-30	1.00	1.01	1.01
			-20	0.82	0.83	0.86
			-10	0.72	0.72	0.78
			0	0.77	0.75	0.75
			10	0.80	0.79	0.72
			20	0.55	0.55	0.55
			30	0.87	0.82	0.84
			40	0.94	0.90	0.90
			50	1.02	1.01	1.03
		3.15% Rated)	20	0.92	0.94	0.94
		4.26% Rated)	20	0.80	0.79	0.75
Limit				2.5 ppm		
Test Results				PASS		

4.6 Transmitter Frequency Behaviour

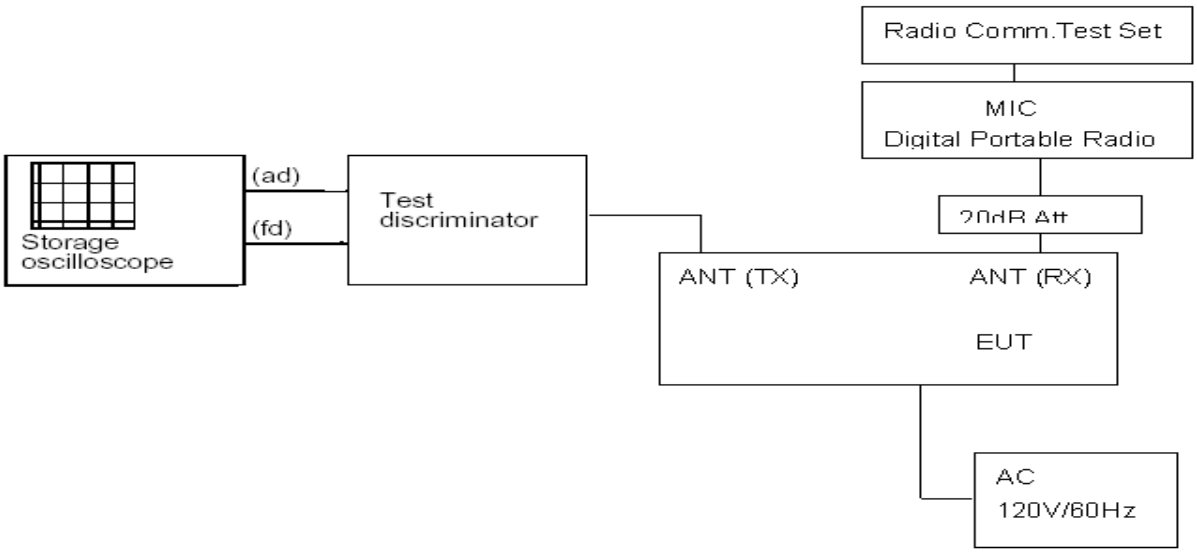
TEST APPLICABLE

Section 90.214
Transient frequencies must be within the maximum frequency difference limits during the time intervals indicated:

Time intervals [1, 2]	Maximum frequency difference [3]	All equipment	
		150 to 174 MHz	421 to 512MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 KHz Channels			
t_1 [4]	± 25.0 KHz	5.0 ms	10.0 ms
t_2	± 12.5 KHz	20.0 ms	25.0 ms
t_3 [4]	± 25.0 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 KHz Channels			
t_1 [4]	± 12.5 KHz	5.0 ms	10.0 ms
t_2	± 6.25 KHz	20.0 ms	25.0 ms
t_3 [4]	± 12.5 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 KHz Channels			
t_1 [4]	±6.25 KHz	5.0 ms	10.0 ms
t_2	±3.125 KHz	20.0 ms	25.0 ms
t_3 [4]	±6.25 KHz	5.0 ms	10.0 ms

1. t_{on} is the instant when a 1 KHz test signal is completely suppressed, including any capture time due to phasing.
   t_1 is the time period immediately following t_{on}.
   t_2 is the time period immediately following t_1.
   t_3 is the time period from the instant when the transmitter is turned off until t_{off}.
   t_{off} is the instant when the 1 KHz test signal starts to rise.
2. During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in § 90.213.
3. Difference between the actual transmitter frequency and the assigned transmitter frequency.
4. If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

TEST CONFIGURATION



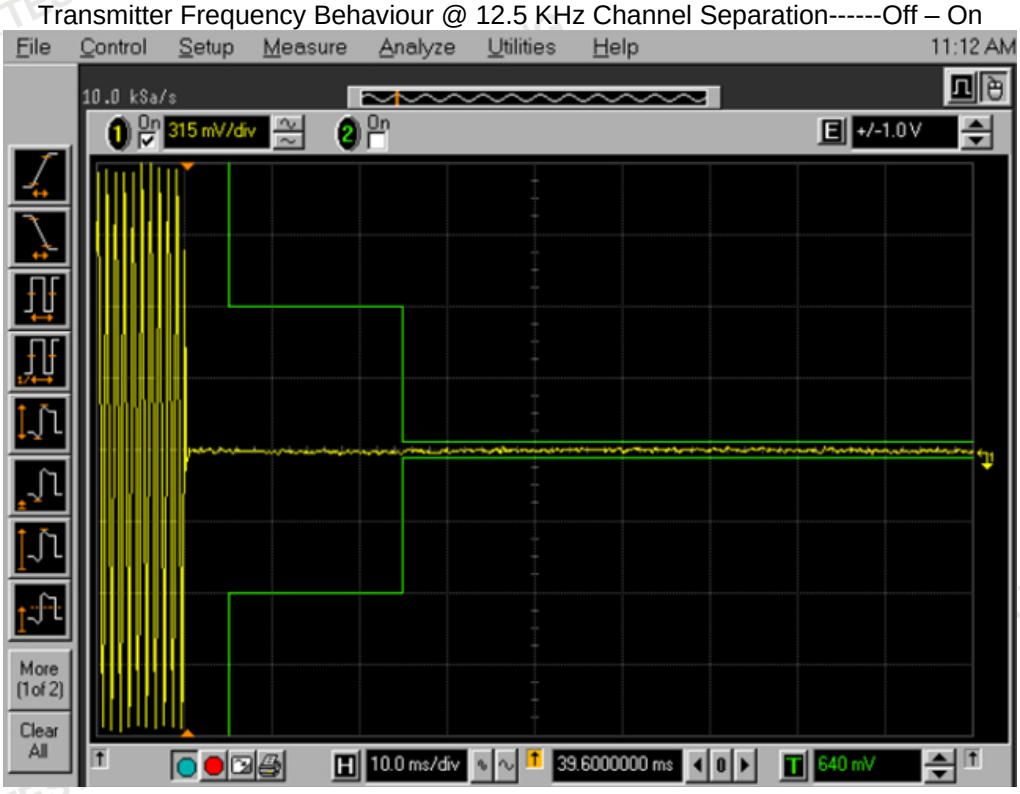
TEST PROCEDURE

1. Connect the EUT and test equipment as shown in the test configuration.
2. Set Spectrum Analyzer to measure FM deviation, and tune the RF frequency to transmitter assigned frequency.
3. Set the signal generator to the assigned transmitter frequency and modulate it with a 1KHz tone at ± 12.5Khz deviation and set its output level to -100dBm.
4. Turn on the transmitter.
5. Supply sufficient attenuation via RF attenuator to provide an input level to the Spectrum Analyzer that is 40dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on Spectrum Analyzer as P_0.
6. Turn off the transmitter.
7. Adjust the RF level of the signal generator to provide RF power equal to P_0. This signal generator RF level shall be maintained throughout the rest of the measurement.
8. Remove the attenuation 1, so the input power to the Spectrum Analyzer is increased by 30dB when the transmitter is turned on.
9. Adjust the vertical amplitude control of the spectrum analyzer to display the 1000Hz at ±4 divisions vertically centered on display. Set trigger mode of the Spectrum Analyzer to “Video”, and tune the “trigger level” on suitable level. Then set the “trigger offset” to -10ms for turn on and -15ms for turn off.
10. Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 KHz test signal is completely suppressed is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
11. Then turn off the transmitter, and another transient wave will be captured on the screen of Spectrum Analyzer. The trace should be maintained within the allowed divisions during the period t_3.

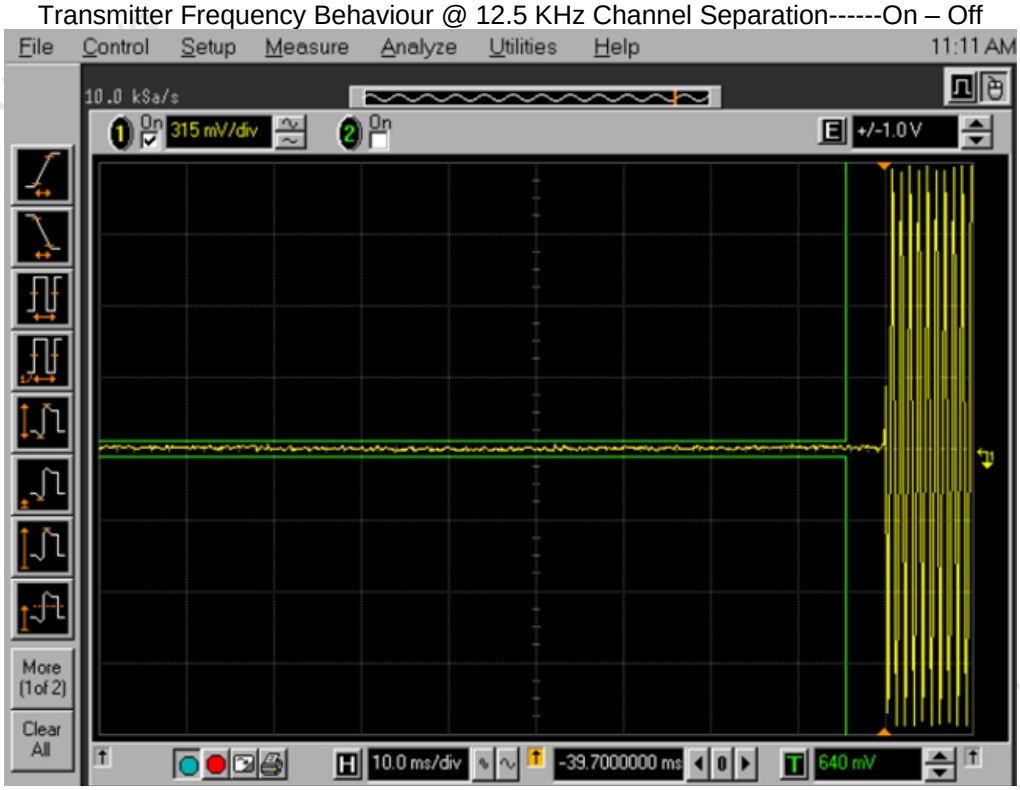
TEST RESULTS

Modulation Type: 4FSK

Transmitter Frequency Behaviour @ 12.5 KHz Channel Separation------Off – On

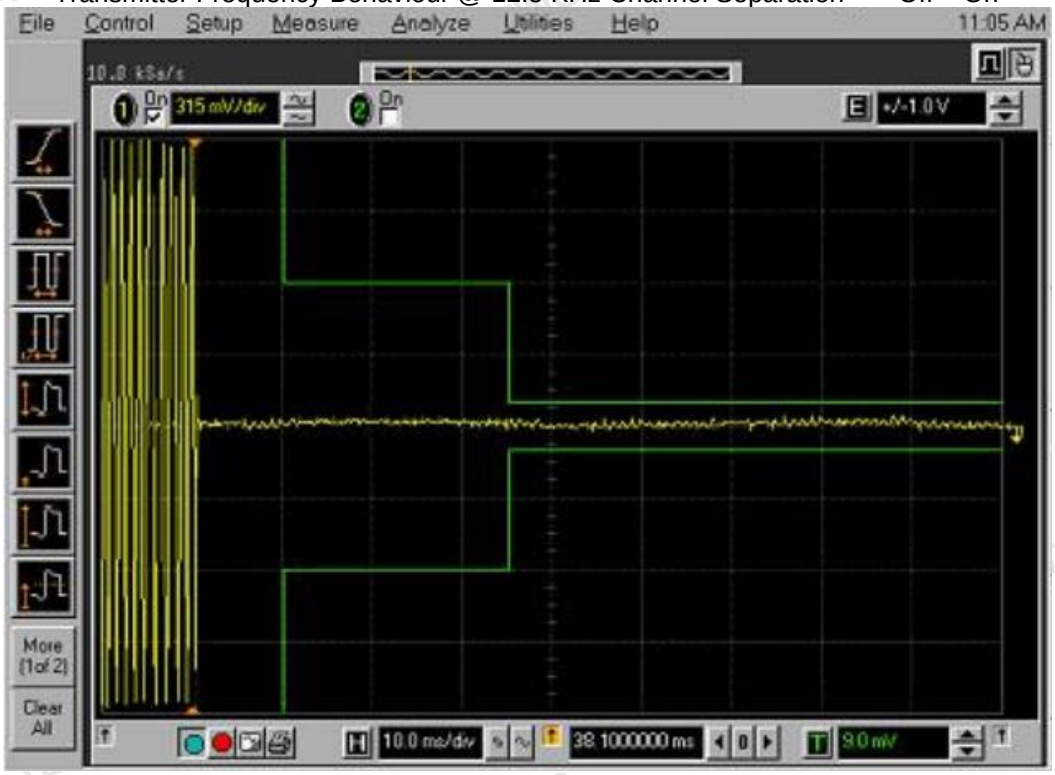


Transmitter Frequency Behaviour @ 12.5 KHz Channel Separation------On – Off

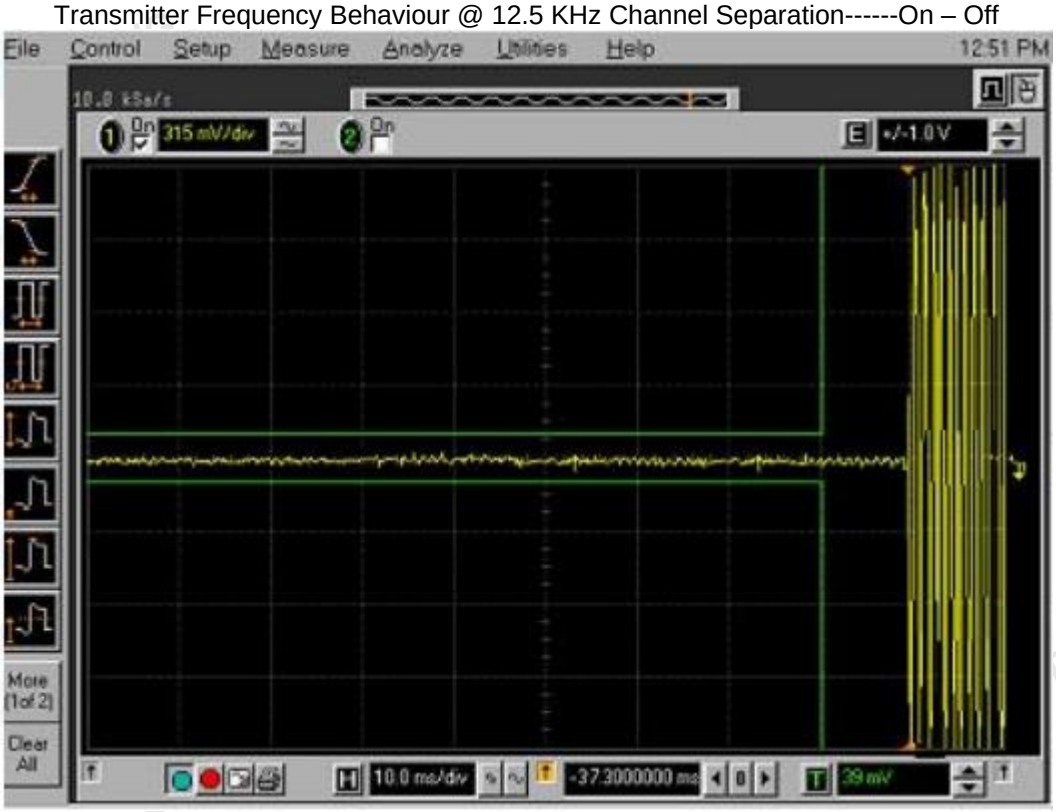


Modulation Type: GMSK

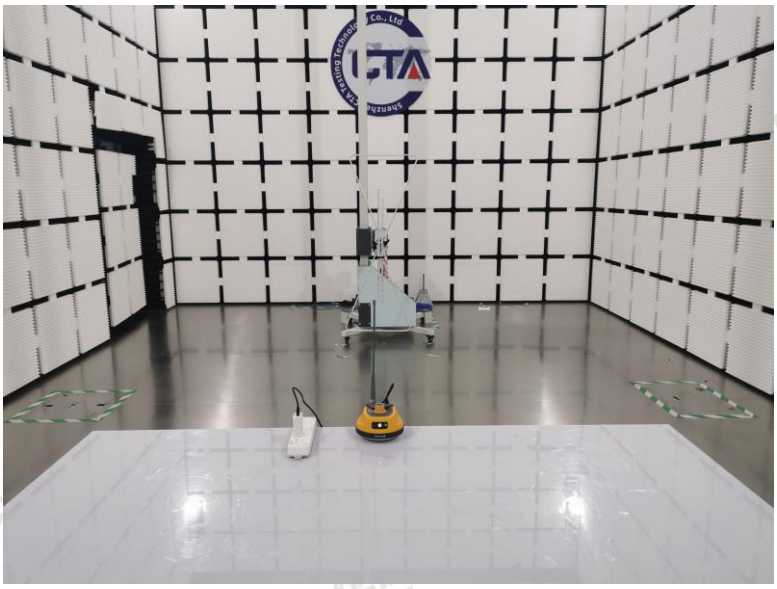
Transmitter Frequency Behaviour @ 12.5 KHz Channel Separation------Off – On

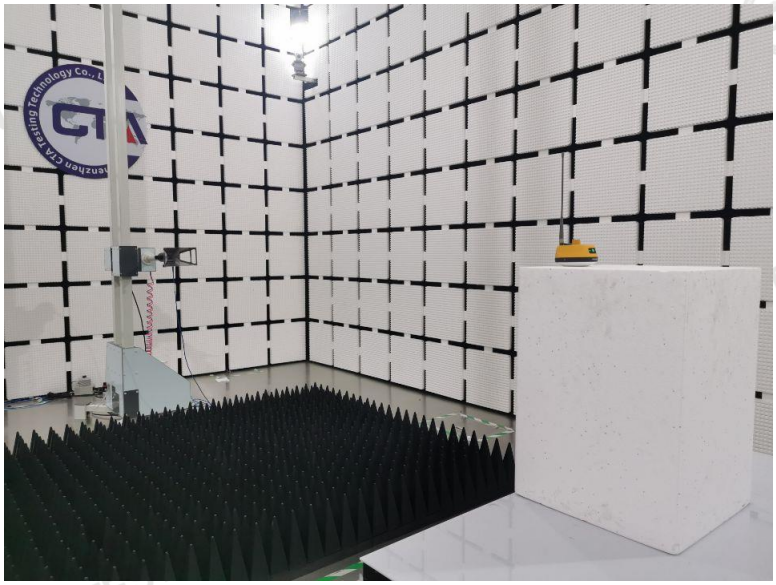


Transmitter Frequency Behaviour @ 12.5 KHz Channel Separation------On – Off



5 Test Setup Photos of the EUT





********** End of Report **********