TEST REPORT

of

FCC Part 15 Subpart B&C §15.247
FCC ID : ROYCCR24R

Equipment Under Test	:	Wireless Transmitter System
Model Name	:	CCR24R
Serial No.	:	N/A
Applicant	:	Trinus Systems Inc.
Manufacturer	:	Trinus Systems Inc.
Date of Test(s)	:	2009.03.05 ~ 2009.03.17
Date of Issue	:	2009.03.20

In the configuration tested, the EUT complied with the standards specified above.

Tested By: **Date** **2009.03.20**

Duke Ko

Approved By **Date** **2009.03.20**

Charles Kim

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1. General information

1.1 Testing laboratory

SGS Testing Korea Co., Ltd.
Wireless Div. 2FL, 18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, Korea 435-040
www.electrolab.kr.sgs.com
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1.2 Details of applicant

Applicant : Trinus Systems Inc.
Address : Unitech-Ville 8F 801, #1141-2 Beakseok-Dong, Ilsan-Gu, Goyang-City, Gyeonggi-Do, Korea
Contact Person : KiGin Jang
Phone No. : +82 +31 904 5588

1.3 Description of EUT

Kind of Product	Wireless Transmitter System
Model Name	CCR24R
Serial Number	N/A
Power Supply	DC 12 V (Use DC 12 V Battery for the vehicle or DVR's DC 12 V power source only)
Frequency Range	2401.056 ~ 2478.816 MHz
Modulation Technique	GFSK
Number of Channels	91
Operating Conditions	0 ~ 50 ℃
Antenna Type	Special SMA connector Type (Whip Antenna)
Antenna Gain	1.35 dBi

* DVR : Digital Video Recorder

1.4 Details of modification

-N/A

1.5. Information about the FHSS characteristics:

1.5.1. Pseudorandom Frequency Hopping Sequence

Use 91 RF channels. Re-map though hopping table. Part of RFPI/RPN defines which hopping sequence to use. Bearer hand-over: change of slot-position and hopping index. Different connection/bearer should use different hopping index. The frame format is based on DECT half bit rate and modified from 24 timeslots to 8 timeslots and 91 possible RF carriers. Frequency hopping is implemented on a frame by frame basis. The system is implemented with encryption based on DECT.

1.5.2. Equal Hopping Frequency Use

All channels, 91 RF carrier, are included in 2401.056 to 2478.816 MHz. There are same channel spacing 0.864 MHz for all of channels.

1.5.3. System Receiver Input Bandwidth

Each channel bandwidth is 0.864 MHz

1.6 Test equipment list

Equipment	Manufacturer	Model	Cal Due.
Signal Generator	Agilent	E4438C	May 09, 2009
Spectrum Analyzer	H.P	8565E	Oct. 01, 2009
Attenuator	Wein cshel	58-30-34	Oct. 01, 2009
Preamplifier	H.P	8447F	Jul. 03, 2009
Preamplifier	Agilent	8449B	May 09, 2009
Band Rejection Filter	Wainwright Instrument GmbH	WRCT2402/2480-2400/ 2483.5/20SS	Oct. 01, 2009
High Pass Filter	Wainwright Instrument GmbH	WHK3.0/18G-11SS	Oct. 01, 2009
DC Power Supply	Agilent	E3631A	May 09, 2009
Test Receiver	Rohde & Schwarz	ESHS10	Jul. 21, 2009
Ultra-Broadband Antenna	Rohde & Schwarz	HL562	Oct. 02, 2009
Horn Antenna	Electro-Metrics	HF906	Nov. 13, 2009
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	Jan. 31, 2010

1.7. Summary of test results

The EUT has been tested according to the following specifications:

Applied standard : FCC Part15 subpart C		
Standard section	**Test item**	**Result**
15.205(a) 15.209 15.247(d)	Transmitter radiated spurious emissions and Conducted spurious emission	Complied
15.247(a)(1)	20 dB bandwidth	Complied
15.247(b)(1)	Maximum peak output power	Complied
15.247(a)(1)	Frequency separation	Complied
15.247(b)(1)	Number of hopping frequency	Complied
15.247(a)(1)(iii)	Time of occupancy (Dwell time)	Complied
15.247(i) 1.1307(b)(1)	RF exposure evaluation	Complied

1.8. Test report revision

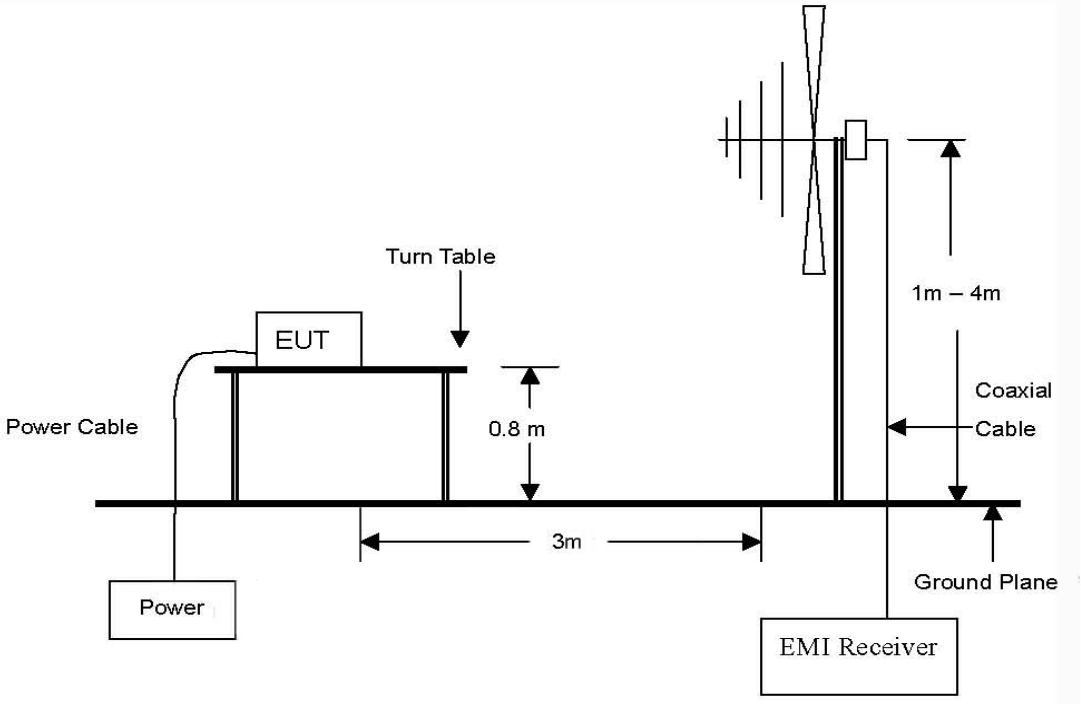
Revision	Report number	Description
0	F690501/RF-RTL002973	Initial

2. Transmitter radiated spurious emissions and conducted spurious emission

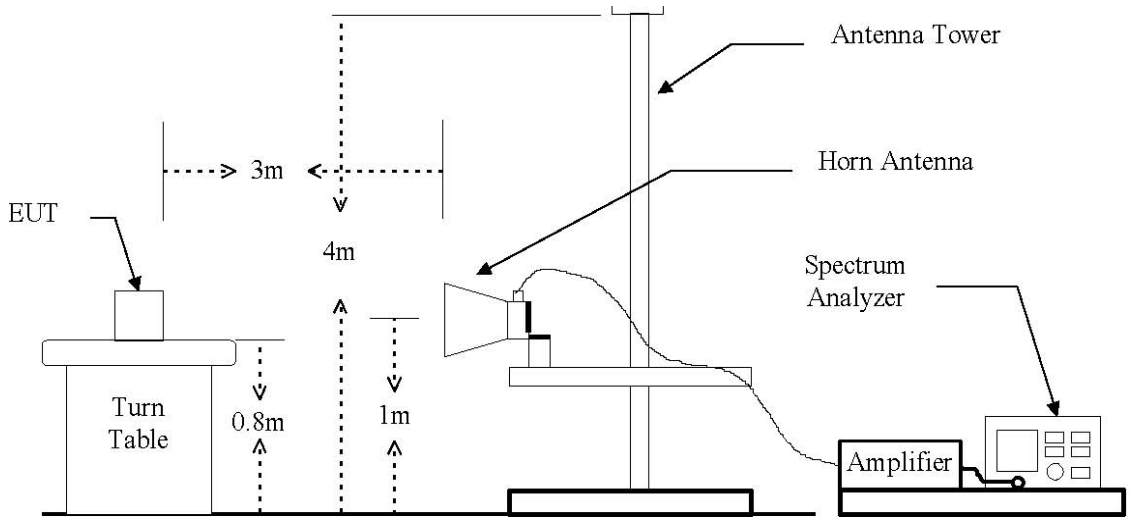
2.1. Test setup

2.1.1. Transmitter radiated spurious emissions

The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to 24 GHz Emissions.



2.1.2. Conducted spurious emissions

2.2. Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement , provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))
According to § 15.109(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

2.3. Test procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

2.3.1. Test procedures for radiated spurious emissions

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

▣ Note

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1MHz for Peak detection and frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz for Average detection (AV) at frequency above 1 GHz.

2.3.2. Test procedures for conducted spurious emissions

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW=100 kHz, VBW=100 kHz.

2.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

2.4.1. Spurious radiated emission

The frequency spectrum from 30 MHz to 1000 MHz was investigated. Emission levels are not reported much lower than the limits by over 30 dB.

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
136.700	27.6	Q.P.	V	8.52	1.32	37.44	43.50	6.06
199.750	22.9	Q.P.	V	7.41	1.56	31.87	43.50	11.63
364.650	9.5	Q.P.	H	12.66	2.20	24.36	46.00	21.64
Above 400.000	Not detected	-	-	-	-	-	-	-

▣ Remark:

1. All spurious emission at low, middle and high channel are almost the same below 1 GHz, so the spurious emission test result of the low channel was chosen as representative in finial test.
2. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes
3. The emission levels above 400 MHz are very lower than the limit by over 30 dB.

2.4.2. Spurious radiated emission

The frequency spectrum above 1000 MHz was investigated. Emission levels are not reported much lower than the limits by over 30 dB. All reading values are peak values.

A. Low Channel (2401.056 MHz)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*2390.00	15.27	Peak	V	28.05	5.32	48.64	74.00	25.36

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4802.21	54.50	Peak	V	32.95	-36.70	50.75	74.00	23.25
7202.88	49.19	Peak	V	35.74	-36.31	48.62	74.00	25.38
Above 7300.00	Not detected	-	-	-	-	-	-	-

B. Middle Channel (2441.664 MHz)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4882.79	52.64	Peak	V	33.17	-36.69	49.12	74.00	24.88
Above 4900.00	Not detected	-	-	-	-	-	-	-

C. High Channel (2478.816 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*2483.50	25.13	Peak	V	28.18	5.34	58.65	74.00	15.35
*2483.50	10.09	Average	V	28.18	5.34	43.61	54.00	10.39

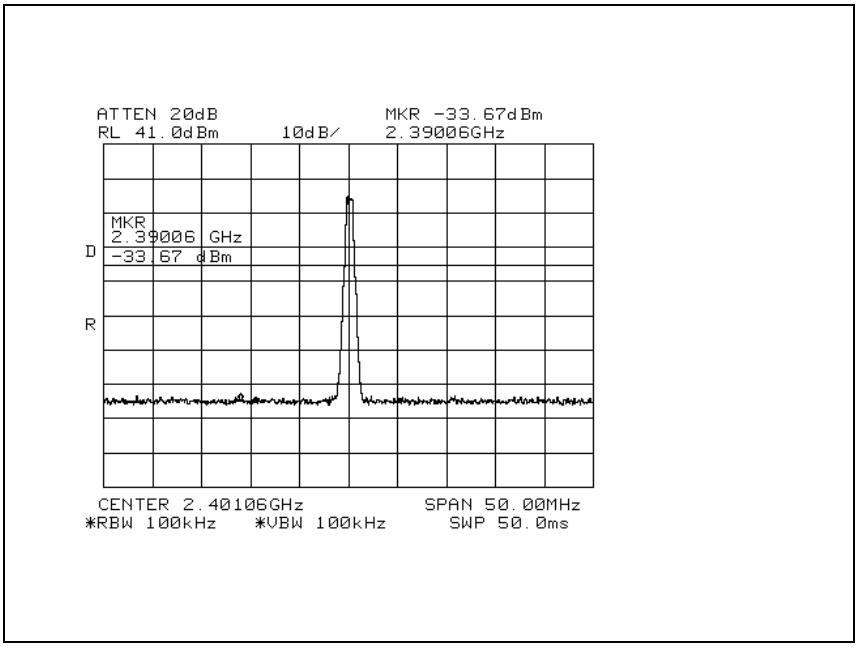
Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4957.84	48.35	Peak	V	33.38	-36.68	45.05	74.00	28.95
Above 5000.00	Not detected	-	-	-	-	-	-	-

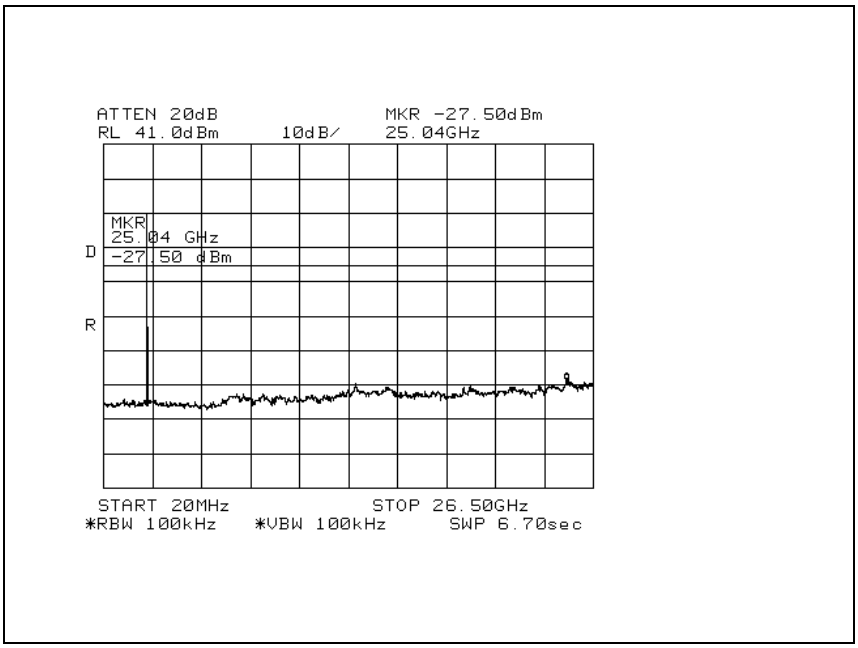
Remarks ;

1. "*" means the restricted band and were measured without pre-amp.
2. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental Frequency.
3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using peak/average detector mode.
4. Average test would be performed if the peak result were greater than the average limit.
5. Actual = Reading + AF + Amp Gain + CL

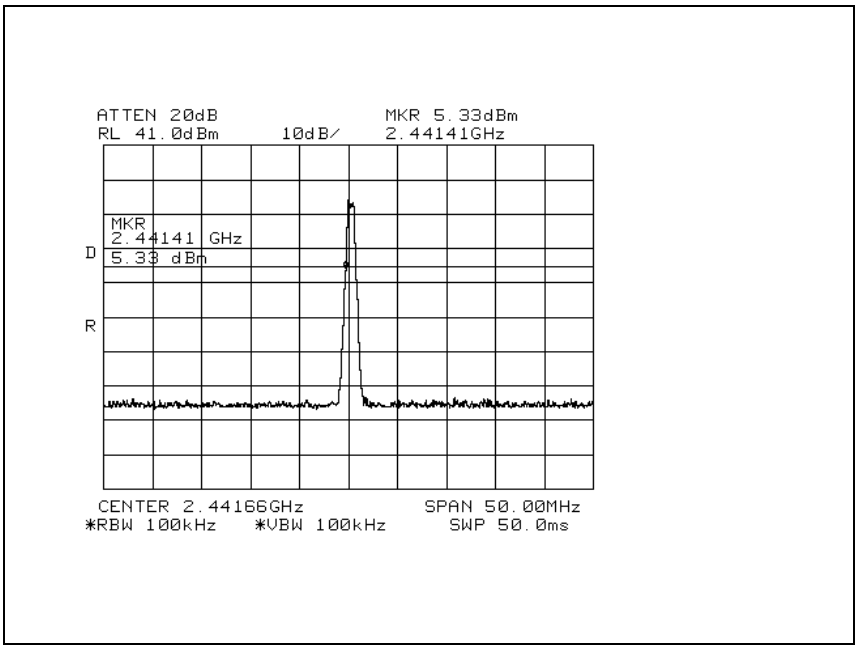
2.4.3. Spurious RF Conducted Emissions: Plot of Spurious RF Conducted Emission

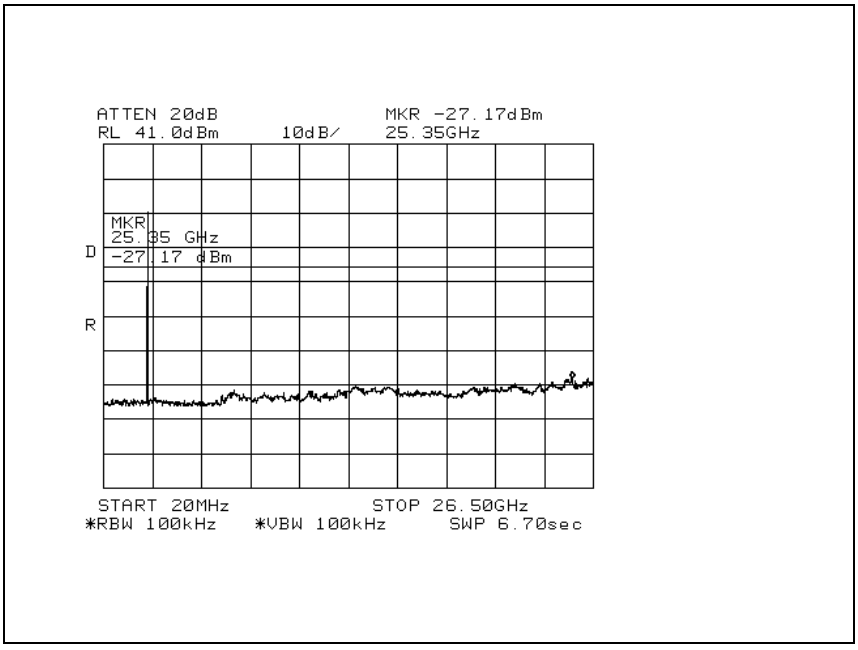
Low Channel



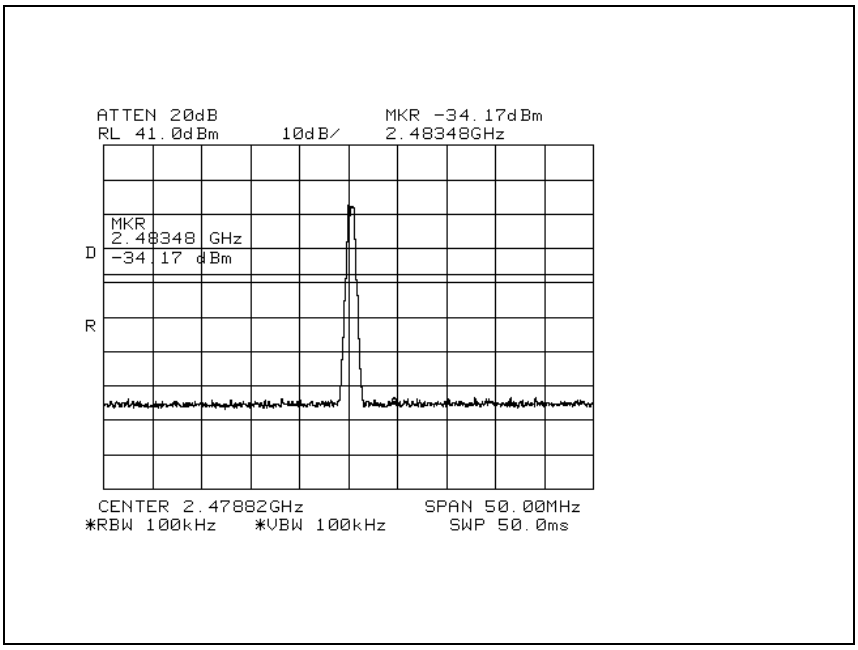


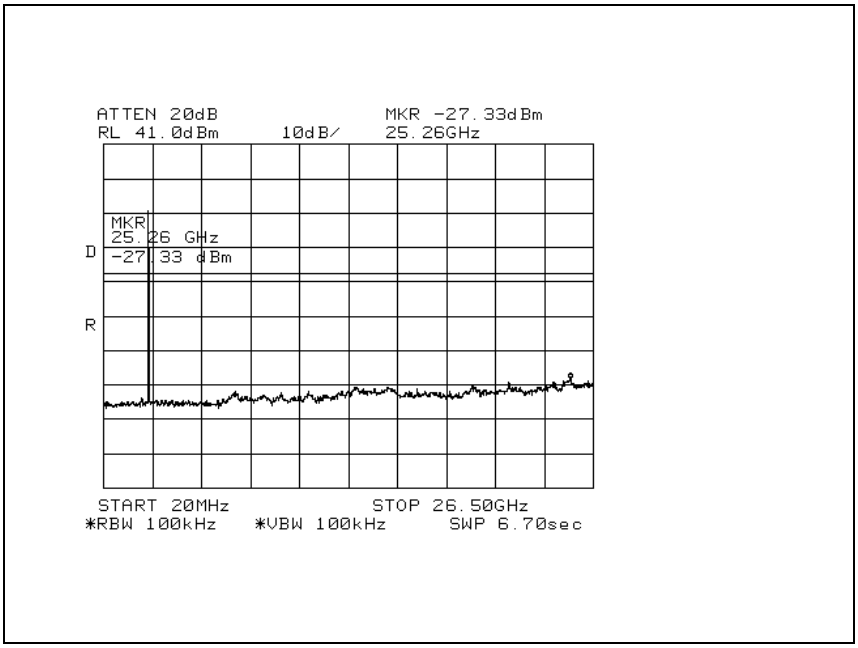
Middle Channel





High Channel





3. 20 dB bandwidth

3.1. Test setup

3.2. Limit

Limit: Not Applicable

3.3. Test procedure

1. The 20dB band width was measured with a spectrum analyzer connected to RF antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 20dB band width of the emission was determined.

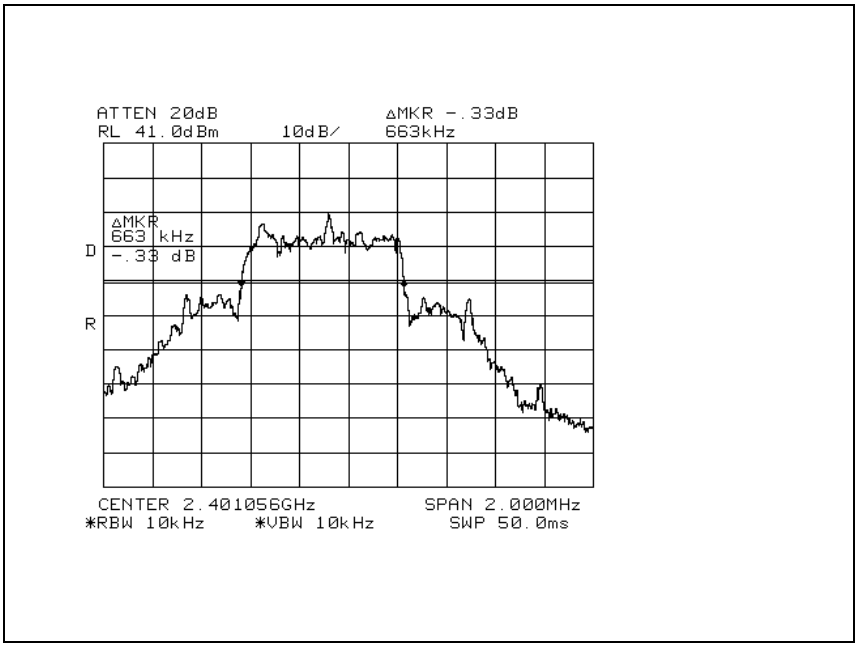
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW=10 kHz, VBW=10 kHz, Span=2 MHz.

3.4. Test result

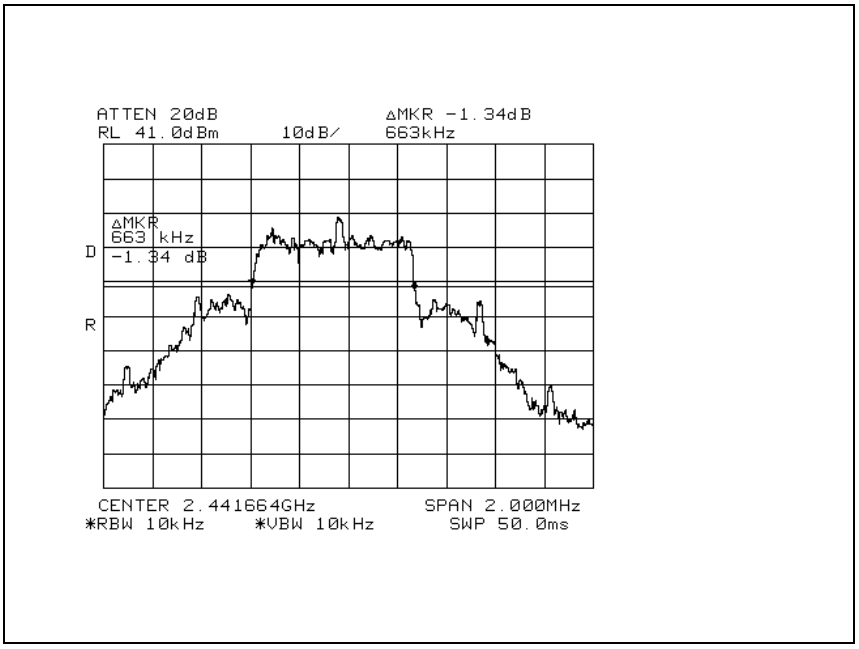
Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Channel Frequency (MHz)	20 dB Bandwidth (MHz)
GFSK	Low	2401.056	0.663
	Middle	2441.664	0.663
	High	2478.816	0.670

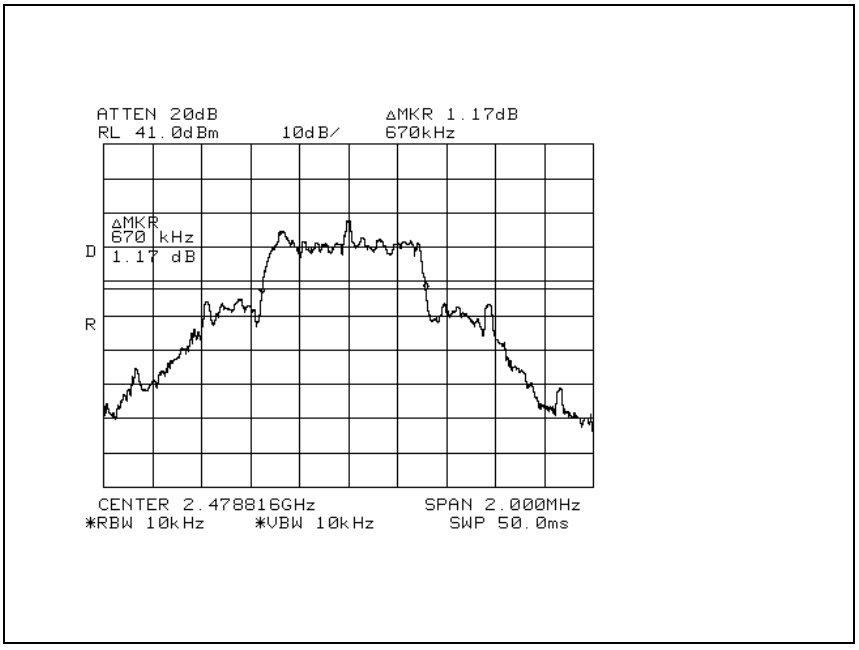
Low channel



Middle channel



High channel



4. Maximum peak output power

4.1. Test setup

4.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §15.247(a)(1), 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.
2. §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5805 MHz band: 1 Watt.

4.3. Test procedure

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.

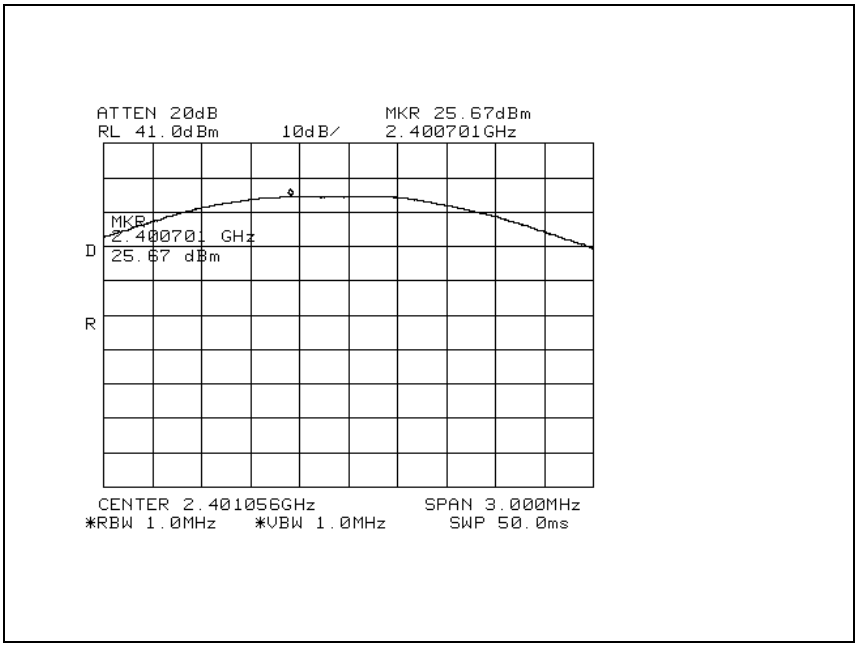
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;
   Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
   RBW ≥ 20dB BW
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

4.4. Test result

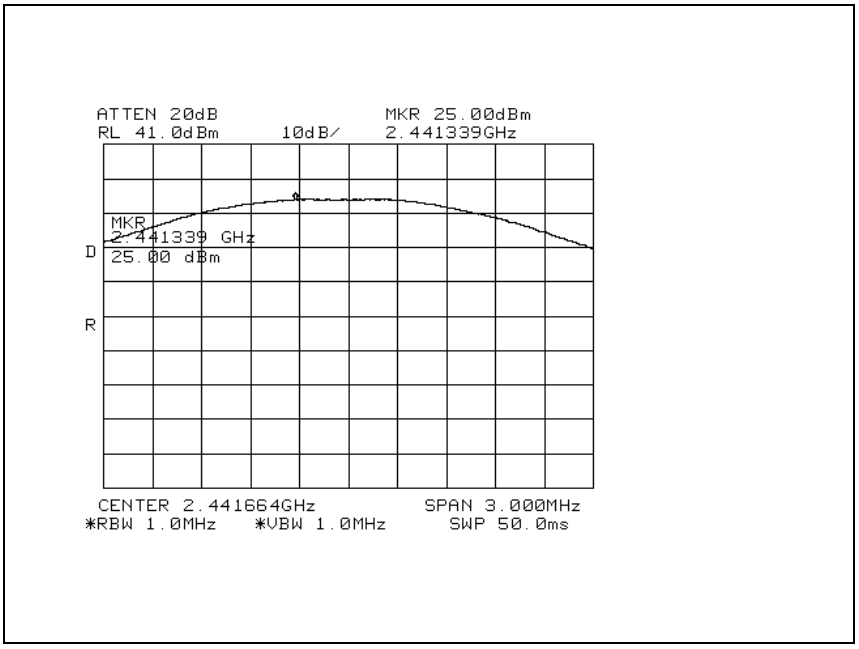
Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

Operation mode	Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)
GFSK	Low	2401.056	25.67	30.00
	Middle	2441.664	25.00	30.00
	High	2478.816	24.00	30.00

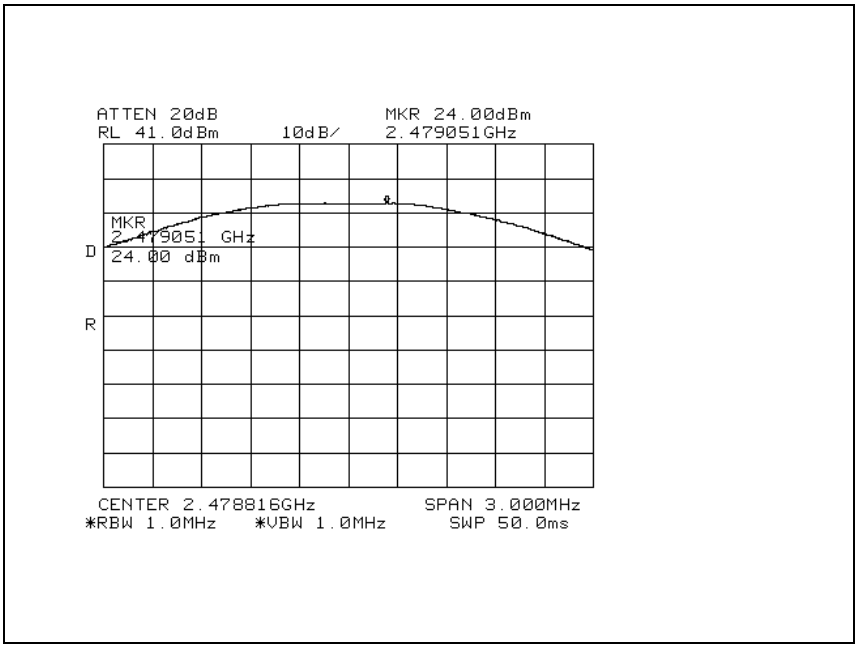
Low channel



Middle channel

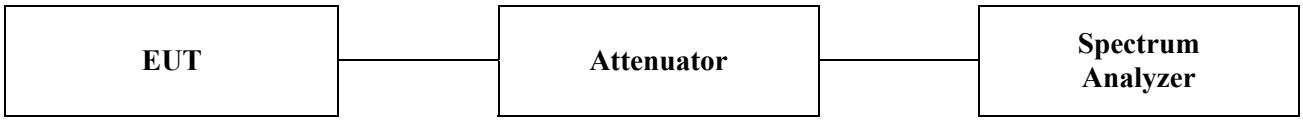


High channel



5. Hopping Channel Separation

5.1. Test setup



5.2. Limit

§15.247(a)(1) Frequency hopping system operating in 2400-2483.5MHz. Band may have hopping channel carrier frequencies that are separated by 25kHz or two-third of 20dB bandwidth of the hopping channel, whichever is is greater.

5.3. Test procedure

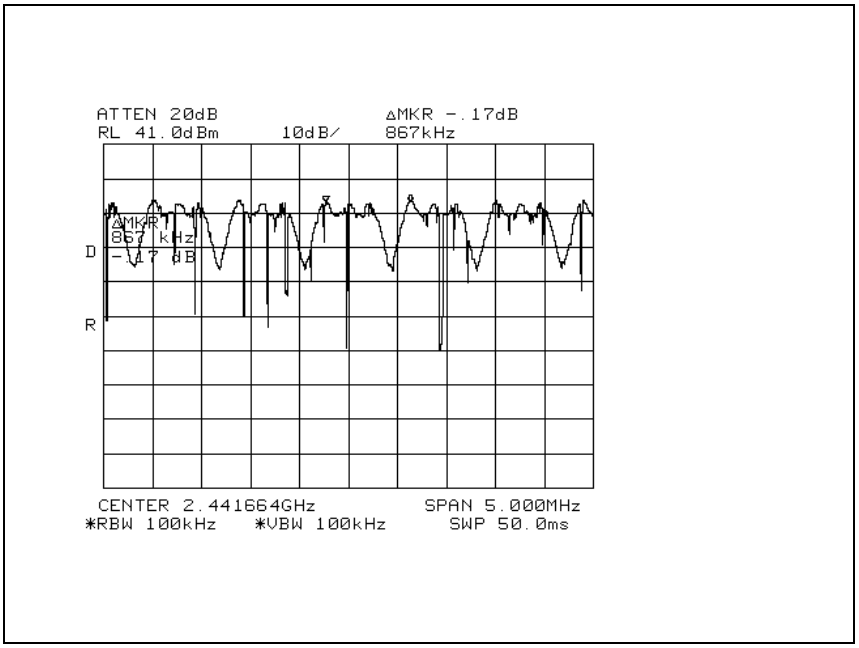
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the MaxHold function record the separation of adjacent channels.
4. Measure the frequency difference of these two adjacent channels by spectrum analyzer MARK function. And then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.
6. Set center frequency of spectrum analyzer = middle of hopping channel.
7. Set the spectrum analyzer as RBW=100 kHz, VBW=100 kHz, Span=5 MHz and Sweep = auto.

5.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel (Middle)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20 dB Bandwidth (kHz)	Minimum Bandwidth (kHz)
GFSK	2441.664 MHz	867	422	25

▣ Note
20 dB bandwidth measurement, the measured channel separation should be greater than two-third of 20dB bandwidth or Minimum bandwidth.



6. Number of hopping frequency

6.1. Test setup

6.2. Limit

§15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5805 MHz band: 1 Watt.

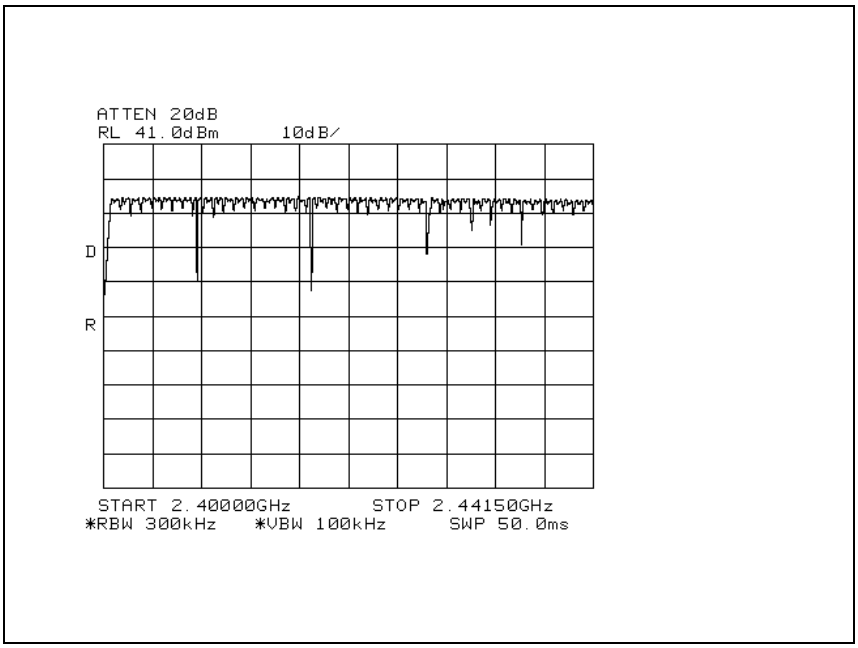
6.3. Test procedure

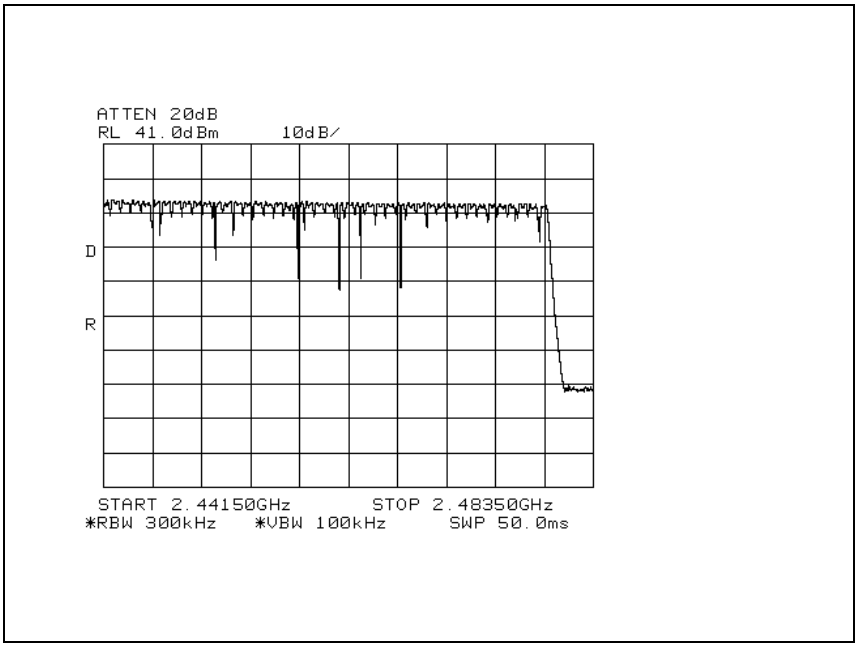
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer
3. Set spectrum analyzer Start=2400 MHz, Stop=2441.5 MHz, Sweep=auto and Start=2441.5 MHz, Stop= 2483.5 MHz, Sweep=auto.
4. Set the spectrum analyzer as RBW=300 kHz, VBW=100 kHz.
5. Max hold, view and count how many channel in the band.

6.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

Operation mode	Number of hopping frequency	Limit
GFSK	91	>=75





7. Time of occupancy (Dwell time)

7.1. Test setup

7.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2400-2483.5MHz band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 36.4 second period.

A period time=0.4(s) ×91 = 36.4(s)

7.3. Test procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.
3. Adjust the center frequency of spectrum analyzer on any frequency be measured and set spectrum analyzer to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.
6. The hopping rate is 100 per second.

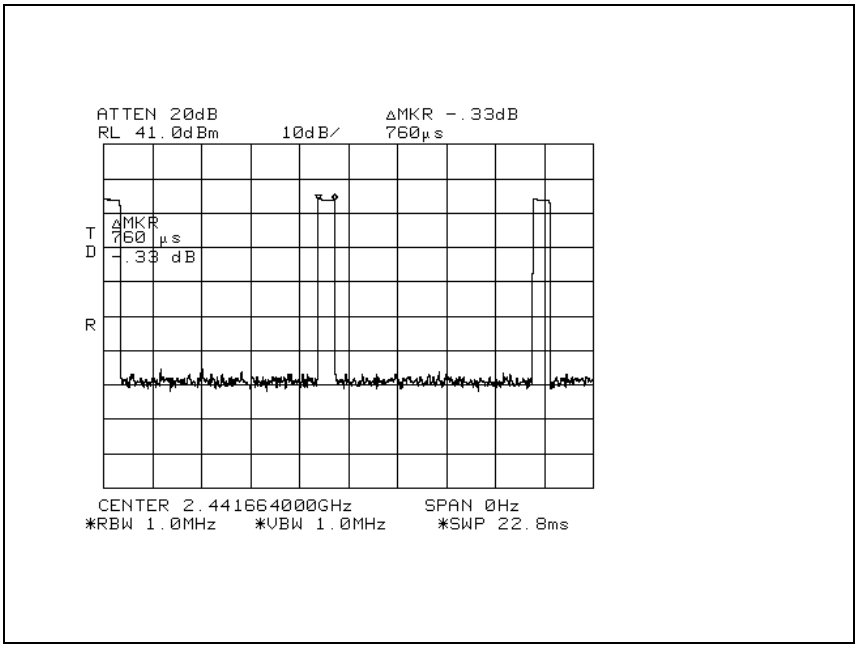
7.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

Time of occupancy on the TX channel in 36.4sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 36.4

Frequency	Dwell time (ms)	Time of occupancy on the Tx channel in 36.4 sec (ms)	Limit for time of occupancy on the Tx channel in 36.4 sec (ms)
2441.664 MHz	0.76	15.20	400

Dwell time : 0.76 (ms) × [(100÷2) ÷91] ×36.4(s) = 15.20 (ms)



8. Antenna requirement

8.1. Standard applicable

For intentional device, according to FCC 47 CFR Section §15.203, 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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6dBi.

8.2. Antenna connected construction

The antenna used of this product is Whip antenna and connected with special SMA connector type that pin is converted.
The peak max gain of this antenna is 1.35 dBi

9. RF exposure evaluation

According to FCC 1.1310 : The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in § 1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Average time
(A) Limits for Occupational /Control Exposures				
300 – 1500	--	--	F/300	6
1500 - 100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300 – 1500	--	--	F/1500	6
1500 - 100000	--	--	1	30

9.1 Friis transmission formula : Pd = (Pout*G)/(4*pi*R^2)

Where
Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 3.1416
R = distance between observation point and center of the radiator in cm
Pd the limit of MPE, 1 mW/cm^2. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

9.2 Test result of RF exposure evaluation

Test Item : RF Exposure evaluation data
Test Mode : Normal operation

9.2.1 Output power into antenna & RF exposure evaluation distance

Operating mode	Channel	Frequency (MHz)	Peak output power (dBm)	Antenna gain (dBi)	Power density at 20cm (mW/cm^2)	Limit (mW/cm^2)
GFSK	Low	2401.056	25.67	1.35	0.100	1
	Middle	2441.664	25.00	1.35	0.086	
	High	2478.816	24.00	1.35	0.068	

▣Note
The power density Pd (4th column) at a distance of 20cm calculated from the friis transmission formula is far below the limit of 1 mW/ cm^2.