FCC Part 15C
Measurement and Test Report

For

LM Technologies Ltd.

Unit19, Spectrum House, 32-34, Gordon House Road, London, NW5 1LP,

United Kingdom

FCC ID: VVXLM410

FCC Rules:	FCC Part 15.247
Product Description:	LM410 Bluetooth Class 1 Module with SMA Antenna
Tested Model:	410-0200
Report No.:	SEM13108151I
Tested Date:	2013-10-24 to 2013-11-12
Issued Date:	2013-11-12
Tested By:	Susan Su / Engineer
Reviewed By:	Lahm Peng / EMC Manager
Approved & Authorized By:	Jandy so / PSQ Manager

Prepared By:

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TABLE OF CONTENTS

1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant:	LM Technologies Ltd.
Address of applicant:	Unit19, Spectrum House, 32-34, Gordon House Road, London, NW5 1LP, United Kingdom
Manufacturer:	LM Technologies Ltd.
Address of manufacturer:	Unit19, Spectrum House, 32-34, Gordon House Road, London, NW5 1LP, United Kingdom

General Description of EUT	
Product Name:	LM410 Bluetooth Class 1 Module with SMA Antenna
Trade Name:	LM410 Bluetooth Module
Model No.:	410-0200
Adding Models:	/
Rated Voltage:	DC 3.0V
Note: The test data is gathered from a production sample, provided by the manufacturer.	

Technical Characteristics of EUT	
Support Standards:	V2.0+EDR
Frequency Range:	2402-2480MHz
RF Output Power:	17.16dBm(Conducted)
Data Rate:	1Mbps, 2Mbps, 3Mbps
Modulation:	GFSK, Pi/4 QDPSK, 8DPSK
Quantity of Channels:	79
Channel Separation:	1MHz
Antenna Type:	External Antenna
Antenna Gain:	2dBi
Lowest Internal Frequency	26MHz

1.2 Test Standards

The following report is prepared on behalf of the LM Technologies Ltd. in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

The objective is to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz. The public notice DA 00-705 for frequency hopping spread spectrum systems shall be performed also.

1.4 Test Facility

- **FCC – Registration No.: 934118**
  Shenzhen SEM.Test Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files and the Registration is 934118.

- **Industry Canada (IC) Registration No.: 11464A**
  The 3m Semi-anechoic chamber of Shenzhen SEM.Test Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 11464A.

1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List		
Test Mode	Description	Remark
TM1	Low Channel	2402MHz
TM2	Middle Channel	2441MHz
TM3	High Channel	2480MHz
TM4	Hopping	2402-2480MHz

Modulation Configure			
Modulation	Packet	Packet Type	Packet Size
GFSK	DH1	4	27
	DH3	11	183
	DH5	15	339
Pi/4 DQPSK	2DH1	20	54
	2DH3	26	367
	2DH5	30	679
8DPSK	3DH1	24	83
	3DH3	27	552
	3DH5	31	1021
Note: The Bluetooth has been tested on the modulation of GFSK, (Pi/4) DQPSK and 8DPSK, compliance test and record the worst case.			

Special Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
Notebook	Lenovo	E23	EB12648265

Auxiliary Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

2. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test Item	Result
§ 15.203; § 15.247(b)(4)(i)	Antenna Requirement	Compliant
§15.205	Restricted Band of Operation	Compliant
§ 15.207(a)	Conducted Emission	N/A
§ 15.209(a)(f)	Radiated Spurious Emissions	Compliant
§ 15.247(a)(1)(iii)	Quantity of Hopping Channel	Compliant
§ 15.247(a)(1)	Channel Separation	Compliant
§ 15.247(a)(1)(iii)	Time of Occupancy (Dwell time)	Compliant
§ 15.247(a)	20dB Bandwidth	Compliant
§ 15.247(b)(1)	Power Output	Compliant
§ 15.247(d)	Band Edge (Out of Band Emissions)	Compliant
§ 15.247(a)(1)	Frequency Hopping Sequence	Compliant
§ 15.247(g), (h)	Frequency Hopping System	Compliant

N/A: not applicable

3. RF Exposure

3.1 Standard Applicable

According to § 1.1307 and § 2.1091, the portable transmitter must comply the RF exposure requirements.

3.2 Test Result

This product complied with the requirement of the RF exposure, please see the RF Exposure report.

4. Antenna Requirement

4.1 Standard Applicable

According to FCC Part 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. 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.

4.2 Evaluation Information

This product has a detachable and unique antenna, fulfill the requirement of this section,

5. Frequency Hopping System Requirements

5.1 Standard Applicable

According to FCC Part 15.247(a)(1), The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

5.2 Frequency Hopping System

This transmitter device is frequency hopping device, and complies with FCC part 15.247 rule.

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centred from 2402 to 2480 MHz) in the range 2,400-2,483.5 MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

This device was tested with an bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for DA 00-705 and FCC Part 15.247 rule.

5.3 EUT Pseudorandom Frequency Hopping Sequence

Pseudorandom Frequency Hopping Sequence Table as below:
Channel: 08, 24, 40, 56, 40, 56, 72, 09, 01, 09, 33, 41, 33, 41, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 42, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 55, 71, 08, 24, 08, 24, 40, 56, 40, 48, 72, 01, 72, 01, 25, 33, 12, 28, 44, 60, 42, 58, 74, 11, 05, 13, 37, 45 etc.

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

6. Quantity of Hopping Channels and Channel Separation

6.1 Standard Applicable

According to FCC 15.247(a)(1), frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, and frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

6.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	Agilent	E4402B	US41192821	2013-05-07	2014-05-06
Attenuator	ATTEN	ATS100-4-20	/	2013-05-07	2014-05-06

6.3 Test Procedure

According to the DA 00-705, the number of hopping frequencies test method as follows.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set span = the frequency band of operation (2400MHz to 2483.5MHz)
RBW = 100kHz, VBW = 100kHz
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize, observed the band of 2400MHz to 2483.5MHz, than count it out the number of channels for comparing with the FCC rules.

The channel spacing test method as follows:

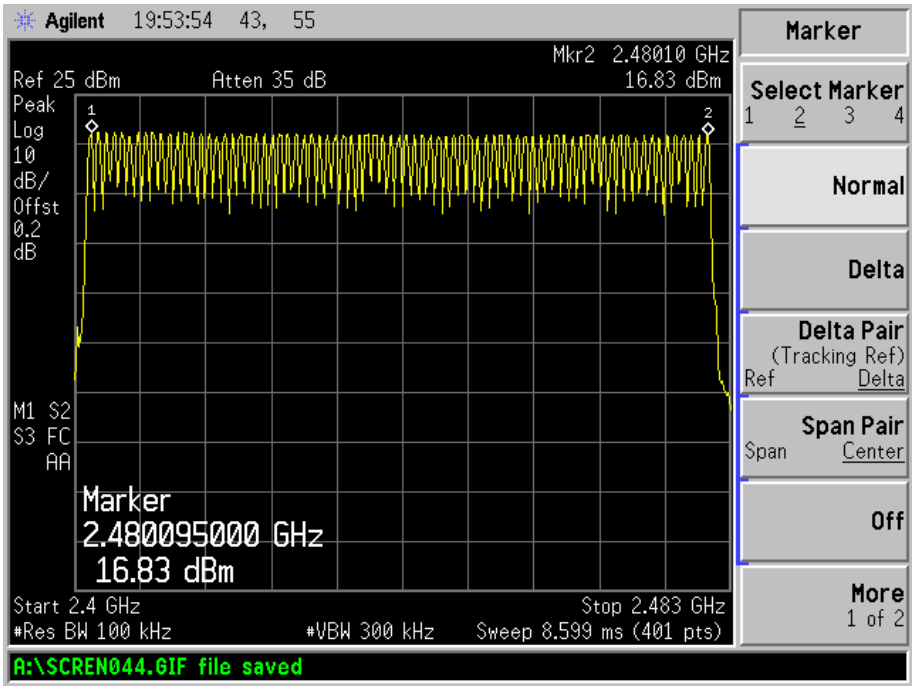
Set span = wide enough to capture the peaks of two adjacent channels
Other setting as above
Allow the trace to stabilize, Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

6.4 Environmental Conditions

Temperature:	24 °C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

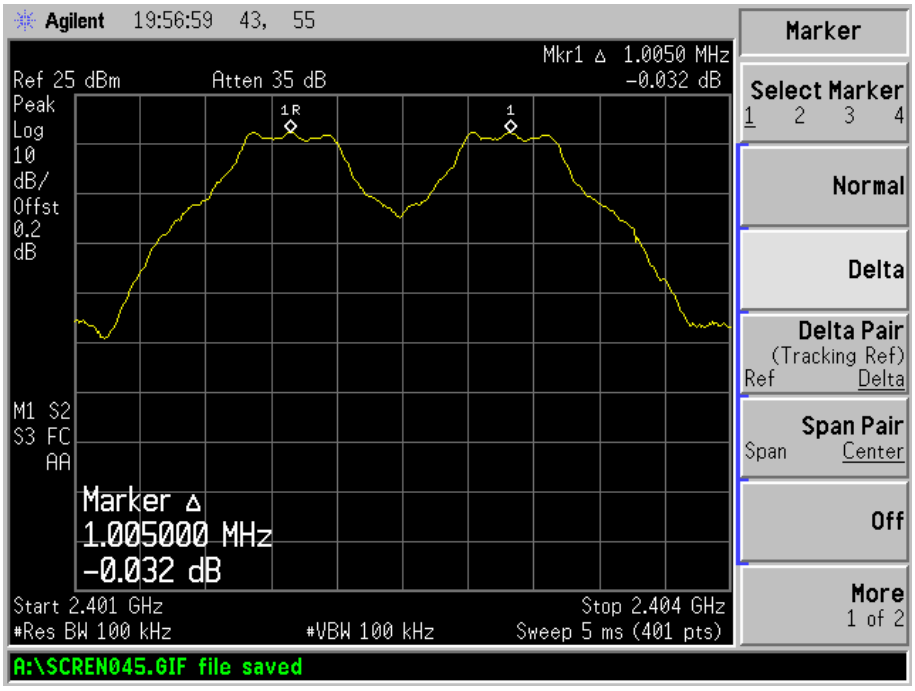
6.5 Summary of Test Results/Plots

Test mode: GFSK DH1 No. of Channel = 79

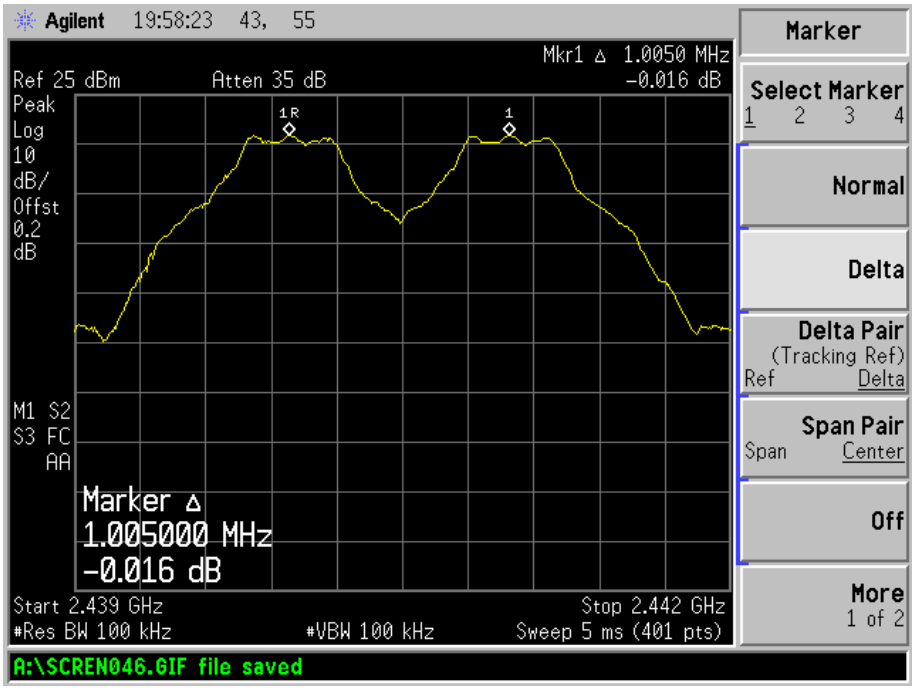


For GFSK

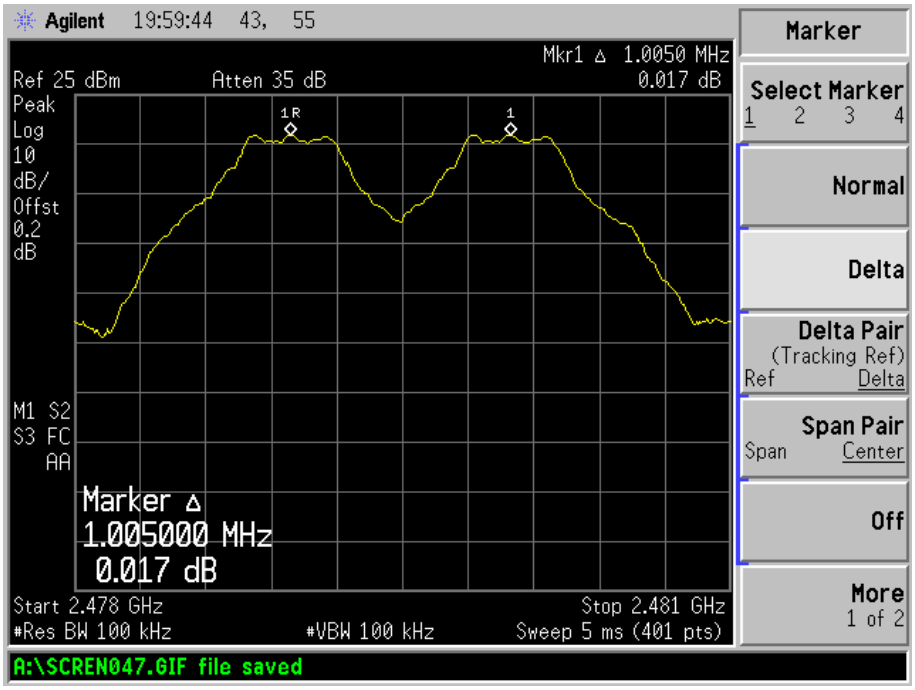
Channel Spacing (Low CH=1MHz)



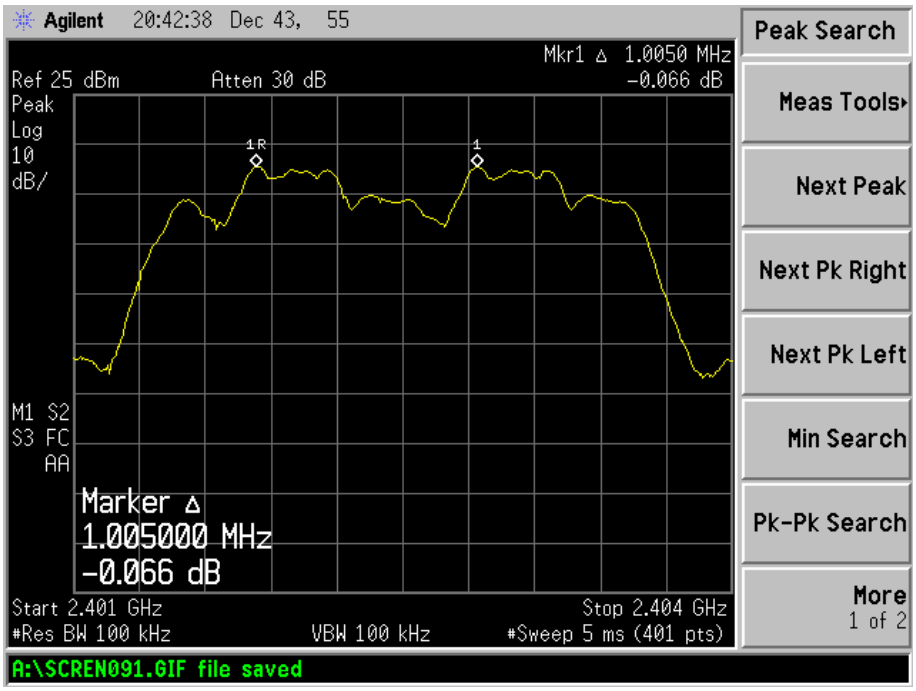
Channel Spacing (Middle CH=1MHz)



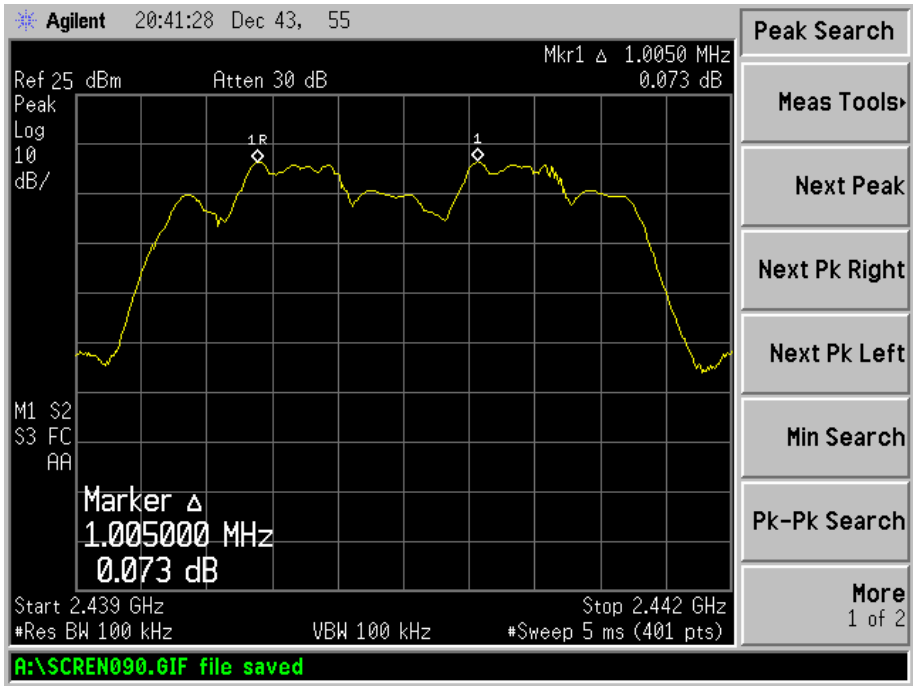
Channel Spacing (High CH=1MHz)



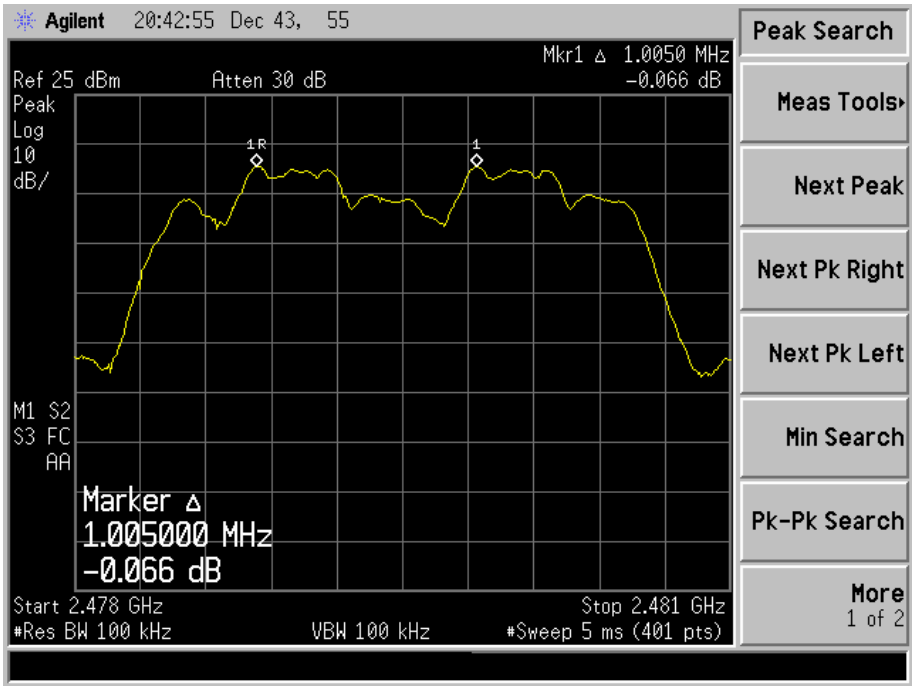
For 8DPSK
Channel Spacing (Low CH=1MHz)



Channel Spacing (Middle CH=1MHz)



Channel Spacing (High CH=1MHz)



7. Dwell Time of Hopping Channel

7.1 Standard Applicable

According to 15.247(a)(1)(iii), Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

7.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	Agilent	E4402B	US41192821	2013-05-07	2014-05-06
Attenuator	ATTEN	ATS100-4-20	/	2013-05-07	2014-05-06

7.3 Test Procedure

According to the DA 00-705, the dwell time of a hopping channel test method as follows.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set span = zero span, centered on a hopping channel
RBW = 1MHz, VBW = 1MHz
Sweep = auto
Detector function = peak
Trace = max hold
Use the marker-delta function to determine the dwell time

7.4 Environmental Conditions

Temperature:	24 °C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

7.5 Summary of Test Results/Plots

The dwell time within a period in data mode is independent from the packet type (packet length).
Test data is corrected with the worse case, which the packet length is DH1, DH3, and DH5.

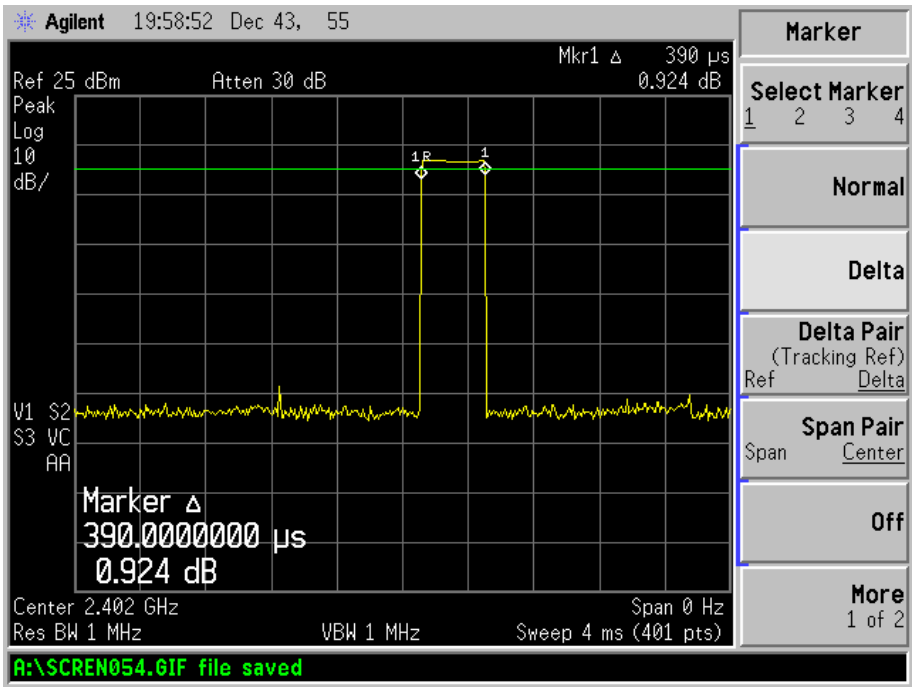
The test period: T = 0.4 Second * 79 Channel = 31.6 s
Dwell time = time slot length * (Hopping rate / Number of hopping channels) * Period

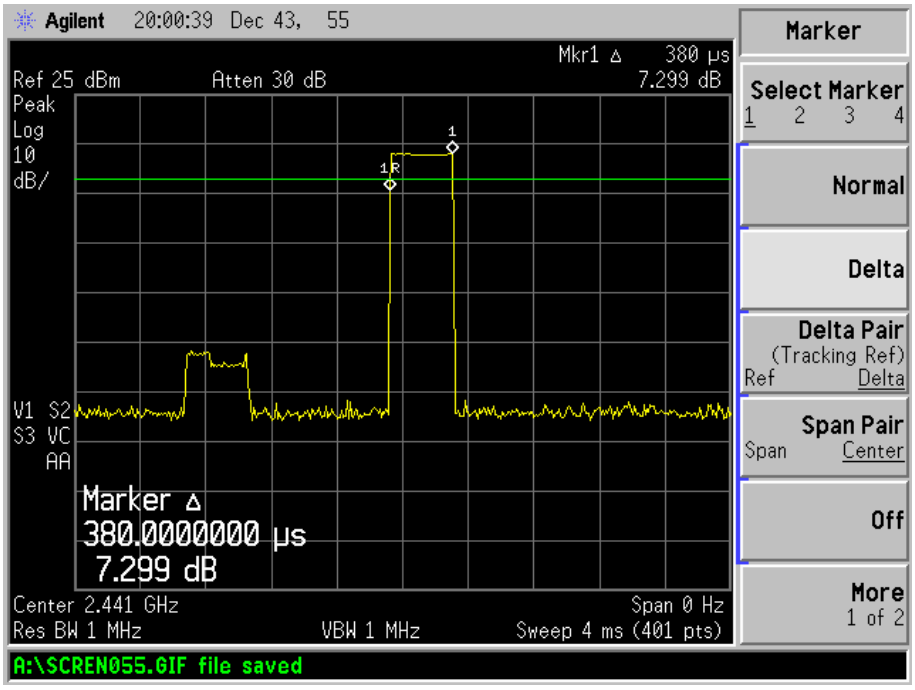
Modulation	Test Channel	Packet	Time Slot Length	Dwell Time	Limit
			ms	ms	ms
GFSK	2402MHz	DH1	0.390	124.80	400
		DH3	1.630	260.80	400
		DH5	2.880	307.20	400
	2441MHz	DH1	0.380	121.60	400
		DH3	1.630	260.80	400
		DH5	2.880	307.20	400
	2480MHz	DH1	0.380	121.60	400
		DH3	1.630	260.80	400
		DH5	2.890	308.27	400
8DPSK	2402MHz	3DH1	0.390	124.80	400
		3DH3	1.630	260.80	400
		3DH5	2.880	307.20	400
	2441MHz	3DH1	0.380	121.60	400
		3DH3	1.630	260.80	400
		3DH5	2.890	308.27	400
	2480MHz	3DH1	0.380	121.60	400
		3DH3	1.630	260.80	400
		3DH5	2.890	308.27	400

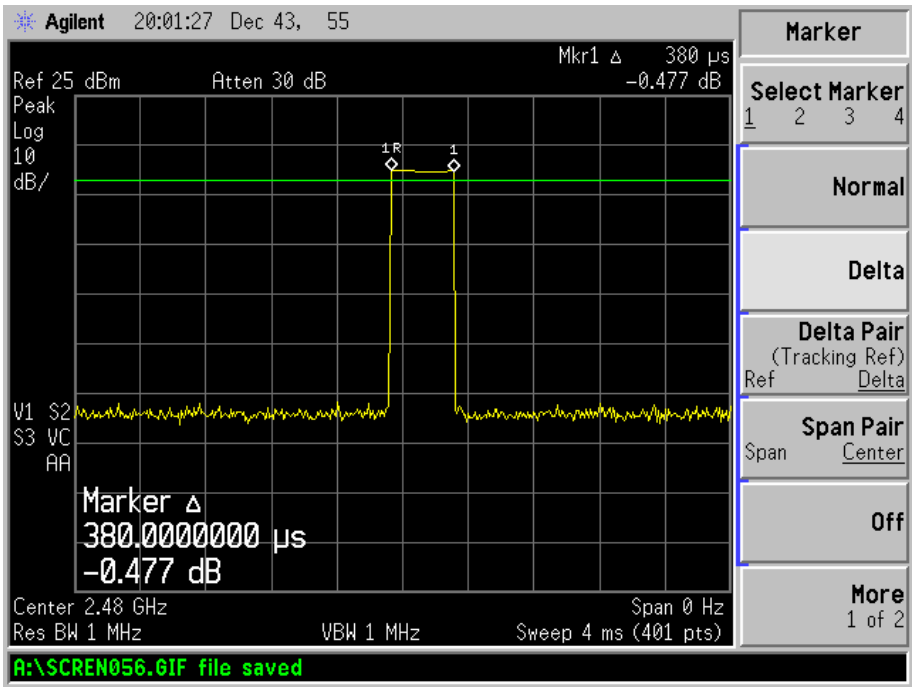
Please refer to the test plots as below:

GFSK:

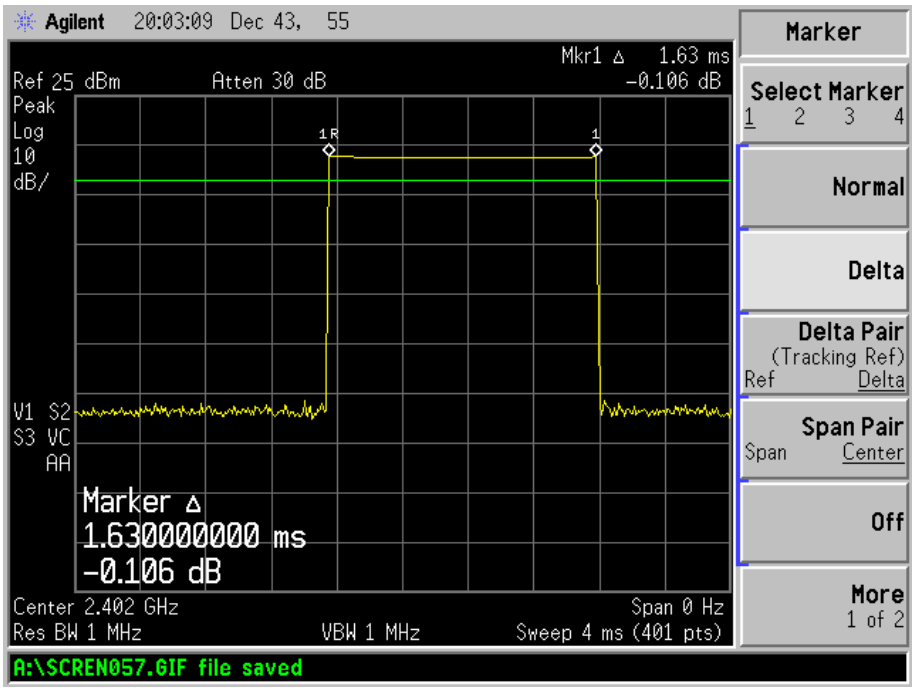
DH1 time slot (Low, Middle, High Channels)

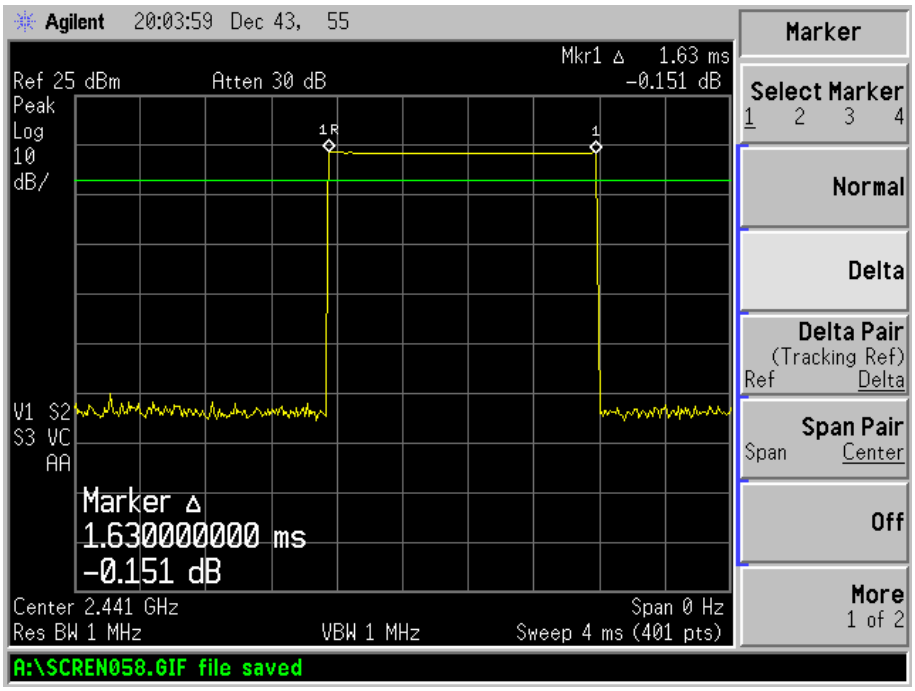


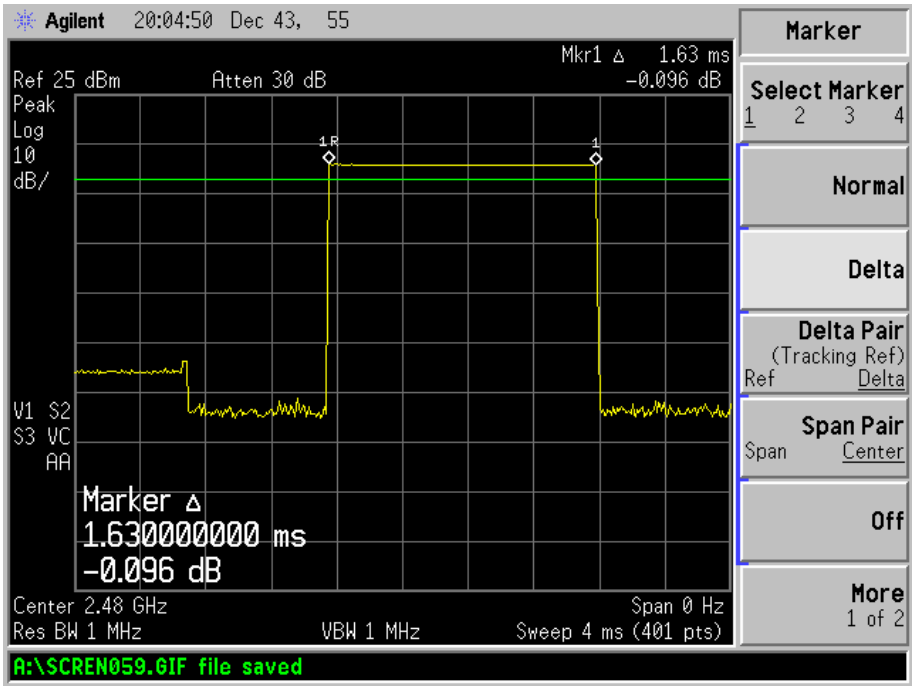




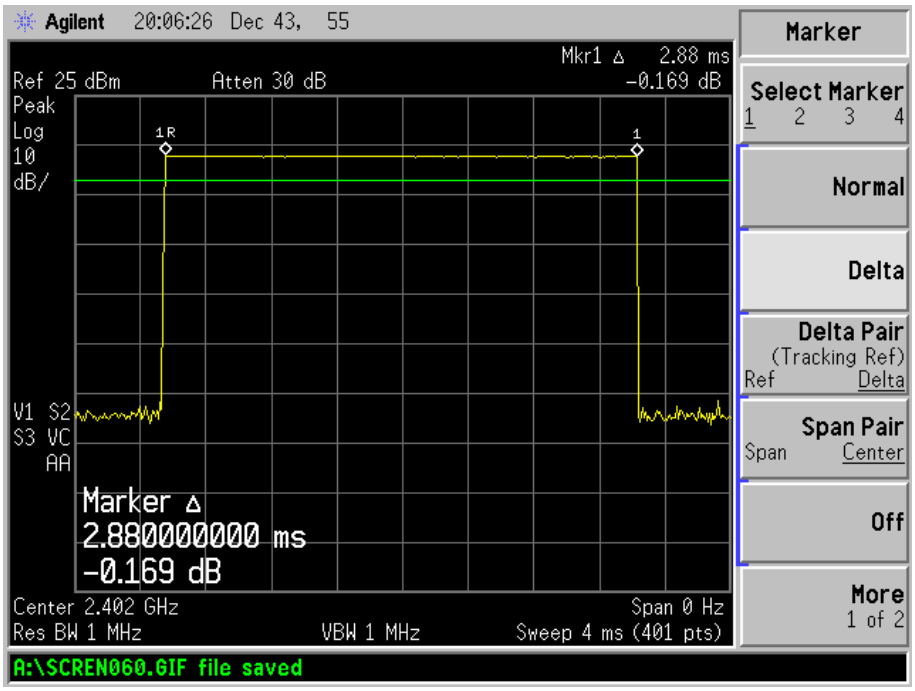
DH3 time slot (Low, Middle, High Channels)

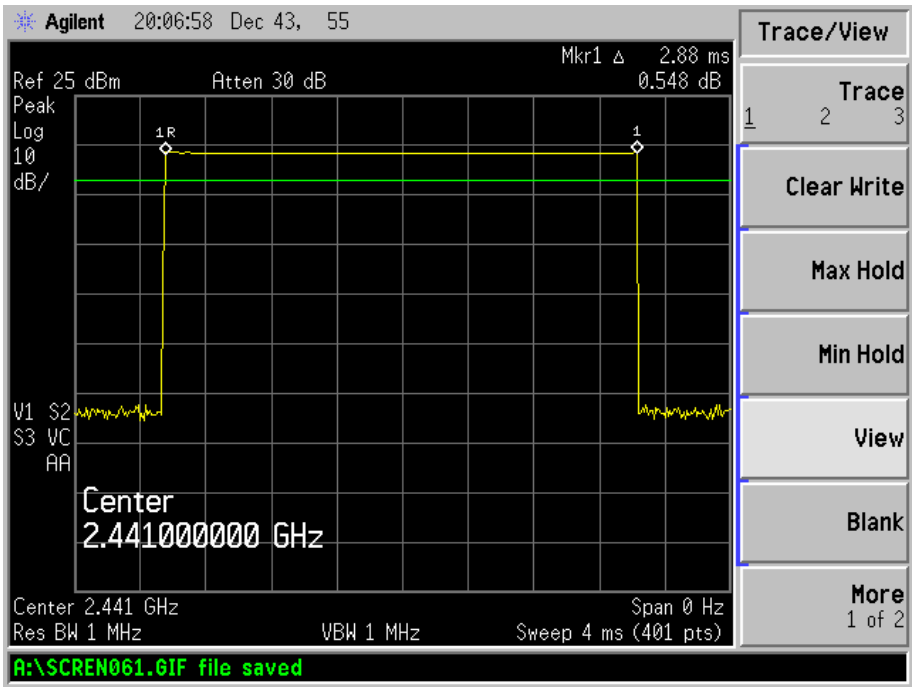


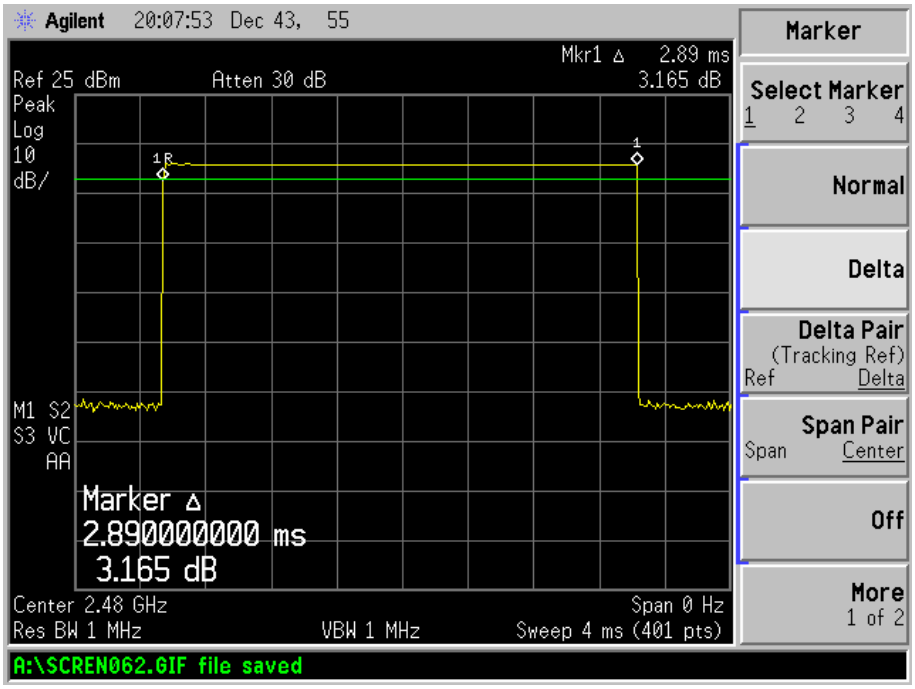

Agilent 20:03:59 Dec 43, 55
Mkr1 Δ 1.63 ms
Ref 25 dBm
Atten 30 dB
-0.151 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
1.630000000 ms
-0.151 dB
Center 2.441 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 4 ms (401 pts)
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2
A:\SCREN058.GIF file saved


Agilent 20:04:50 Dec 43, 55
Mkr1 Δ 1.63 ms
Ref 25 dBm
Atten 30 dB
-0.096 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
1.630000000 ms
-0.096 dB
Center 2.48 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 4 ms (401 pts)
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2
A:\SCREN059.GIF file saved

DH5 time slot (Low, Middle, High Channels)

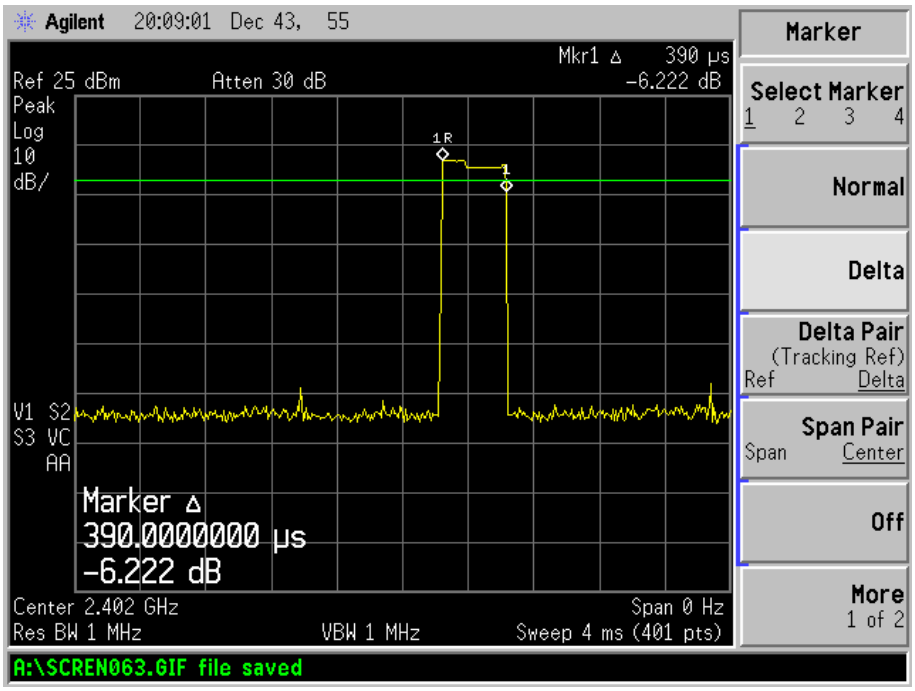


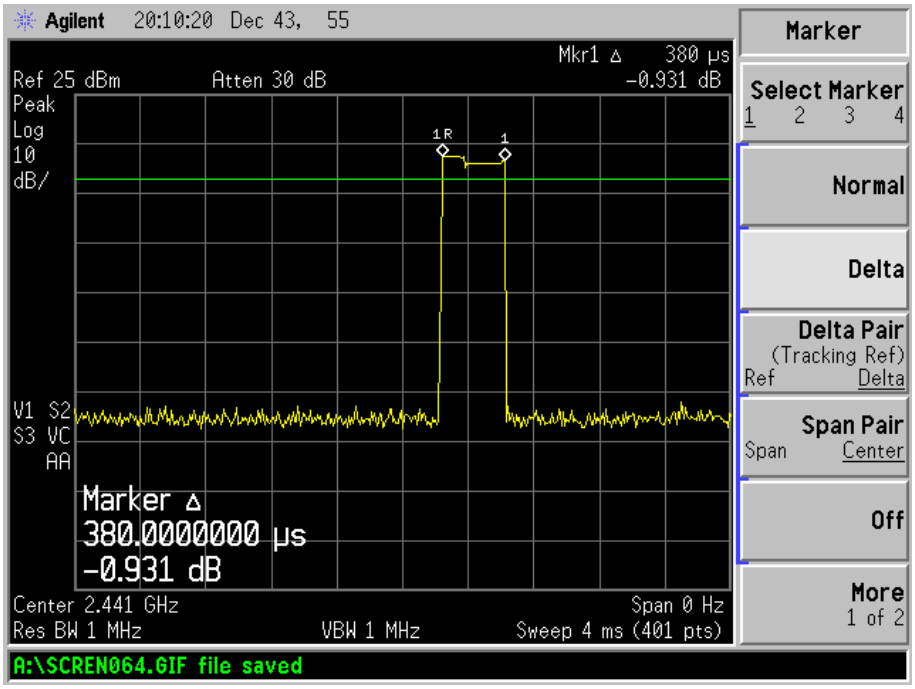


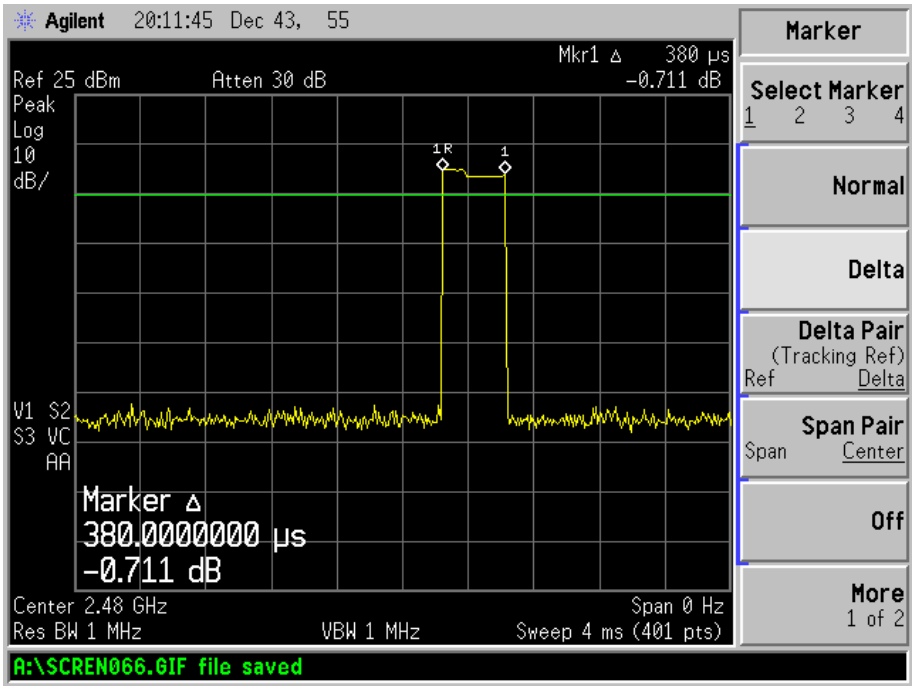


8DPSK:

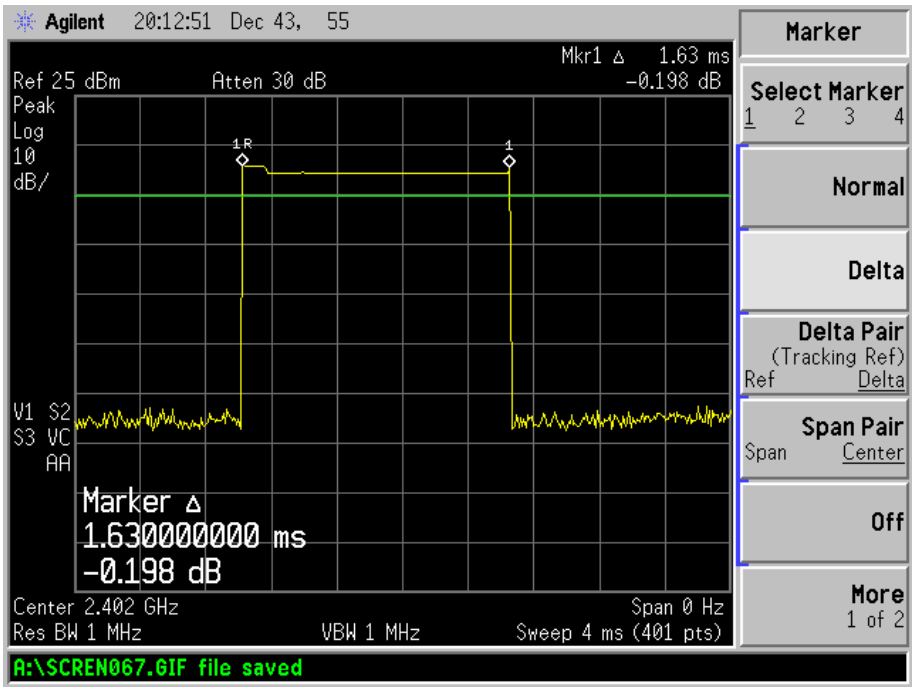
3DH1 time slot (Low, Middle, High Channels)

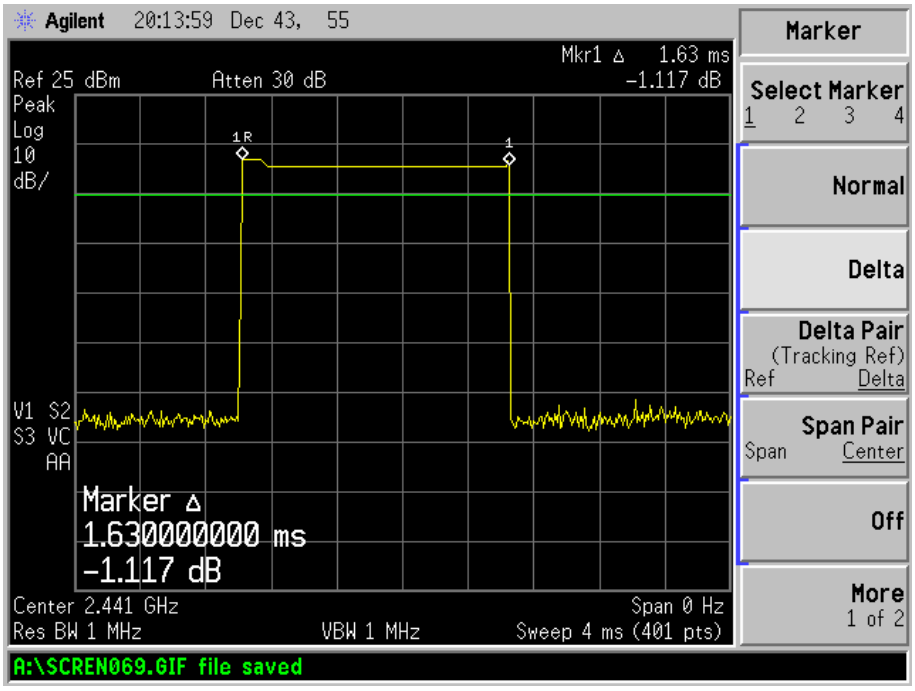


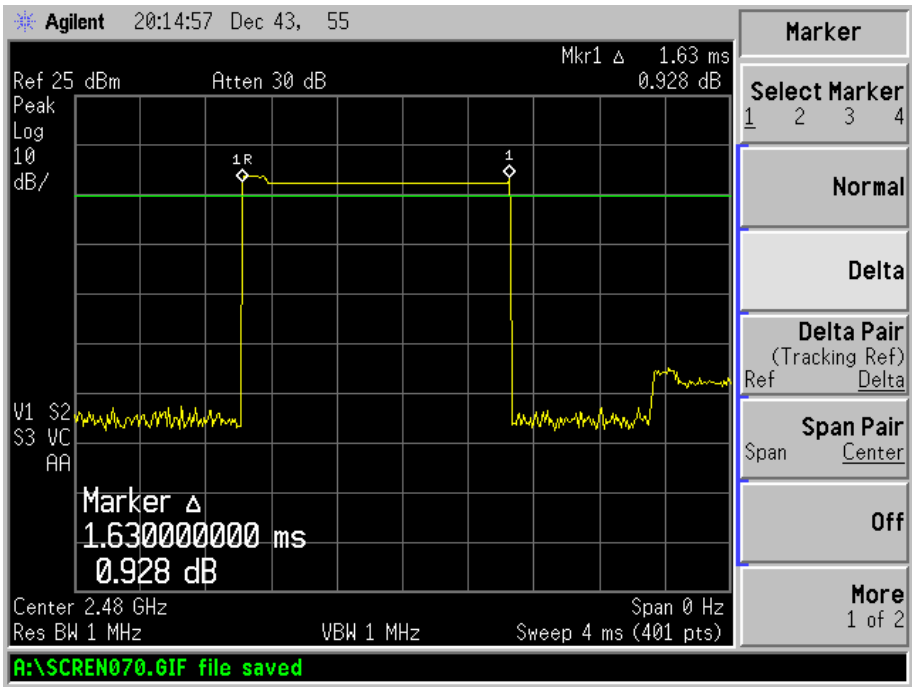

Agilent 20:10:20 Dec 43, 55
Mkr1 Δ 380 µs
Ref 25 dBm Atten 30 dB -0.931 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
380.0000000 µs
-0.931 dB
Center 2.441 GHz Span 0 Hz
Res BW 1 MHz VBW 1 MHz Sweep 4 ms (401 pts)
A:\SCREN064.GIF file saved
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2


Agilent 20:11:45 Dec 43, 55
Mkr1 Δ 380 µs
Ref 25 dBm Atten 30 dB -0.711 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
380.0000000 µs
-0.711 dB
Center 2.48 GHz Span 0 Hz
Res BW 1 MHz VBW 1 MHz Sweep 4 ms (401 pts)
A:\SCREN066.GIF file saved
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2

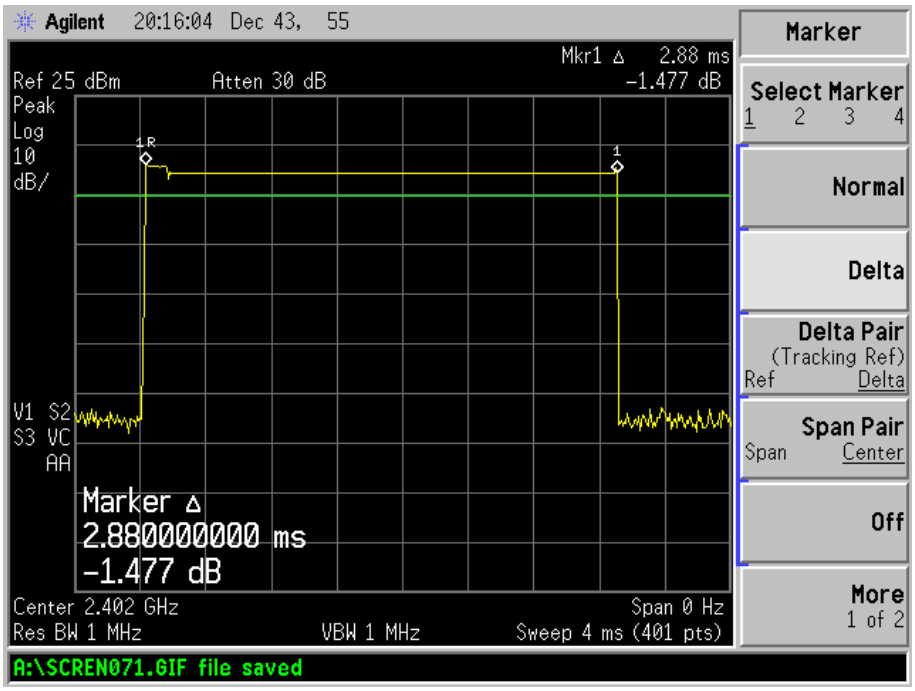
3DH3 time slot (Low, Middle, High Channels)

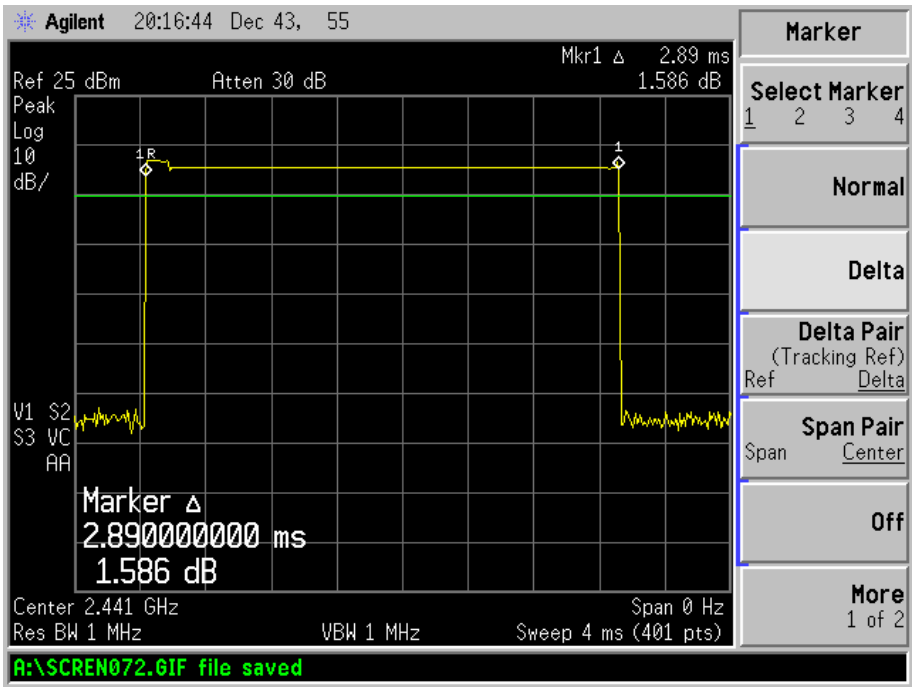


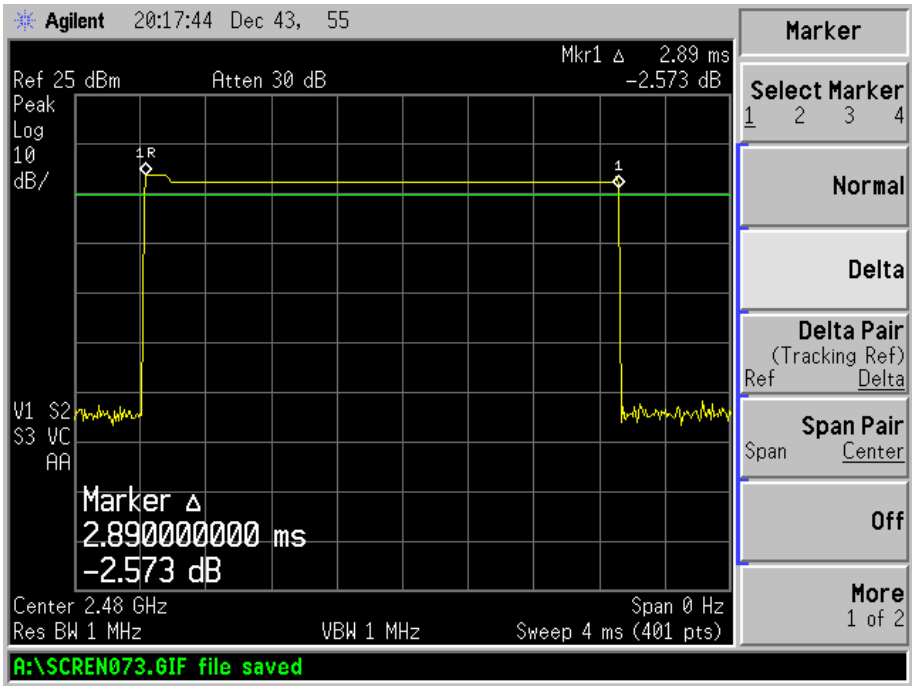




3DH5 time slot (Low, Middle, High Channels)




Agilent 20:16:44 Dec 43, 55
Mkr1 Δ 2.89 ms
Ref 25 dBm
Atten 30 dB
1.586 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
2.890000000 ms
1.586 dB
Center 2.441 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 4 ms (401 pts)
A:\SCREN072.GIF file saved
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2


Agilent 20:17:44 Dec 43, 55
Mkr1 Δ 2.89 ms
Ref 25 dBm
Atten 30 dB
-2.573 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 VC
AA
Marker Δ
2.890000000 ms
-2.573 dB
Center 2.48 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 4 ms (401 pts)
A:\SCREN073.GIF file saved
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2

8. 20dB Bandwidth

8.1 Standard Applicable

According to 15.247(a)(1)(iii). For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

8.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	Agilent	E4402B	US41192821	2013-05-07	2014-05-06
Attenuator	ATTEN	ATS100-4-20	/	2013-05-07	2014-05-06

8.3 Test Procedure

According to the DA 00-705, the 20dB bandwidth test method as follows.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set span = 3MHz, centered on a hopping channel
RBW ≥1% 20dB Bandwidth, VBW ≥RBW
Sweep = auto
Detector function = peak
Trace = max hold
All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.

8.4 Environmental Conditions

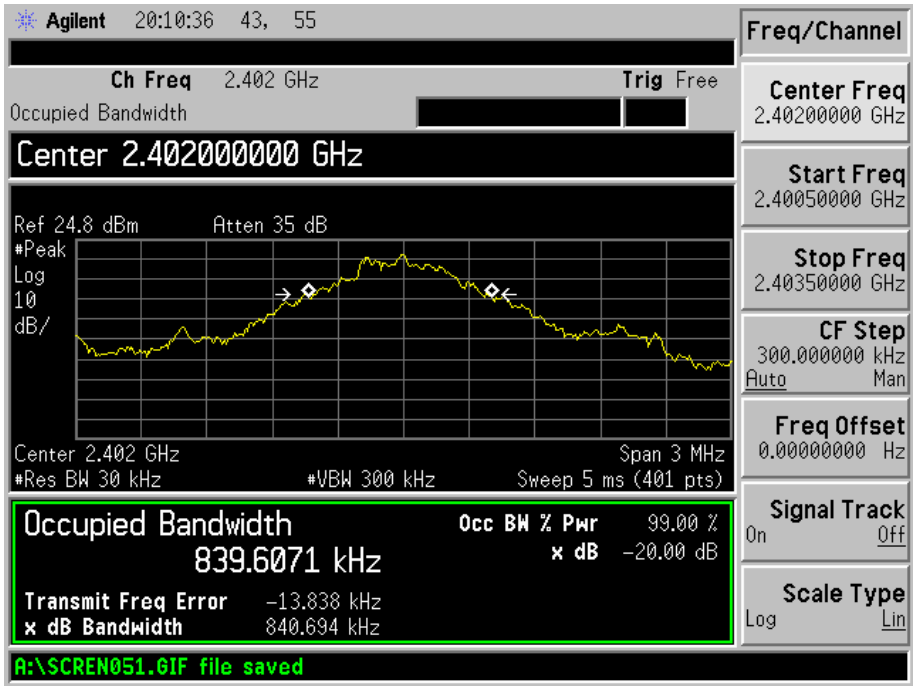
Temperature:	25 °C
Relative Humidity:	53%
ATM Pressure:	1018 mbar

8.5 Summary of Test Results/Plots

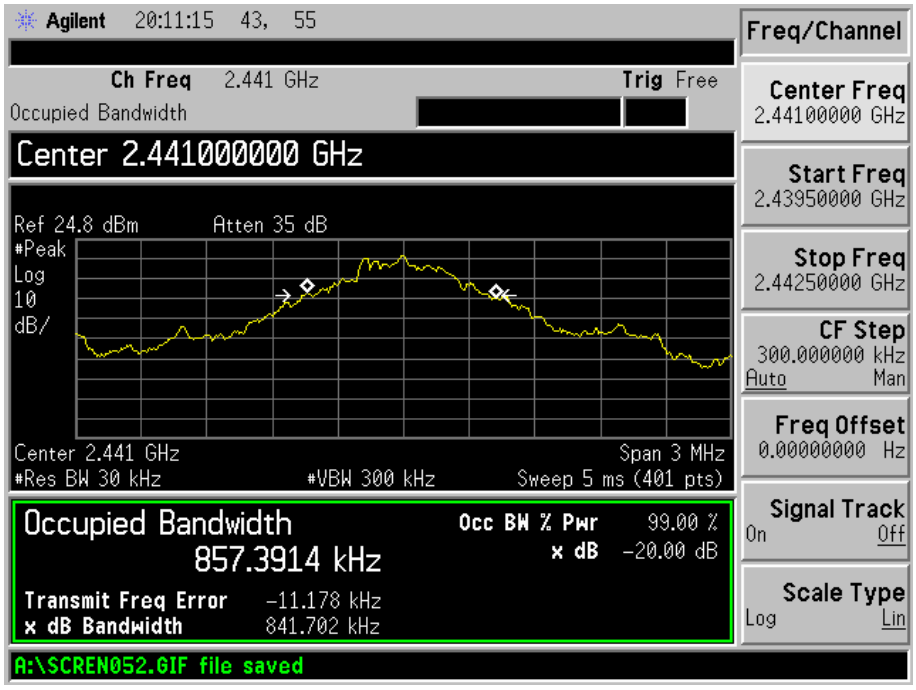
Channel	Frequency MHz	20dB Bandwidth (GFSK) kHz	20dB Bandwidth (8DPSK) kHz
Low Channel	2402	841	1171
Middle Channel	2441	842	1155
High Channel	2480	847	1167

GFSK Mode

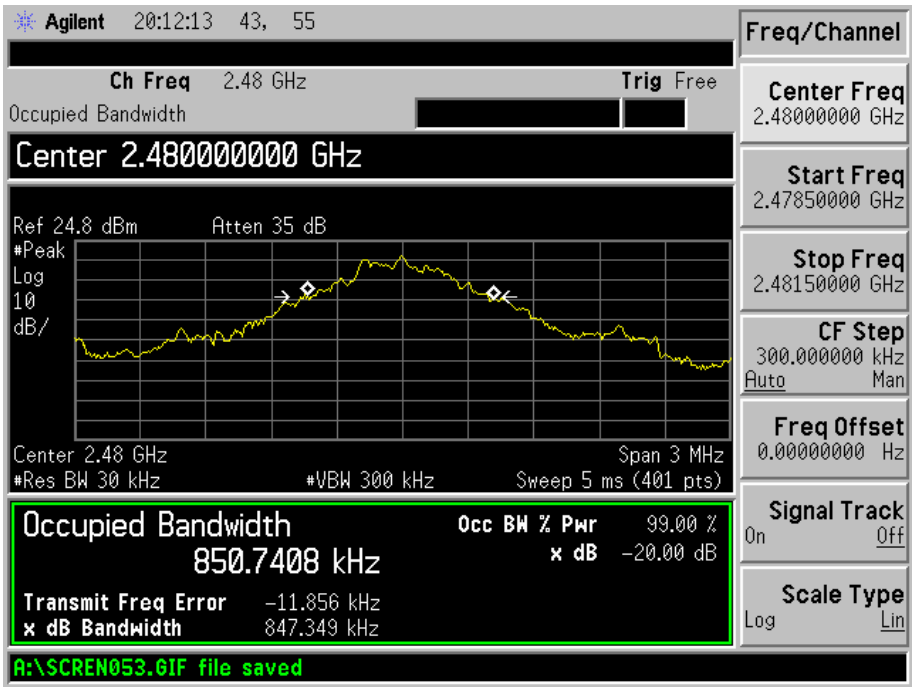
Low Channel:



Middle Channel:

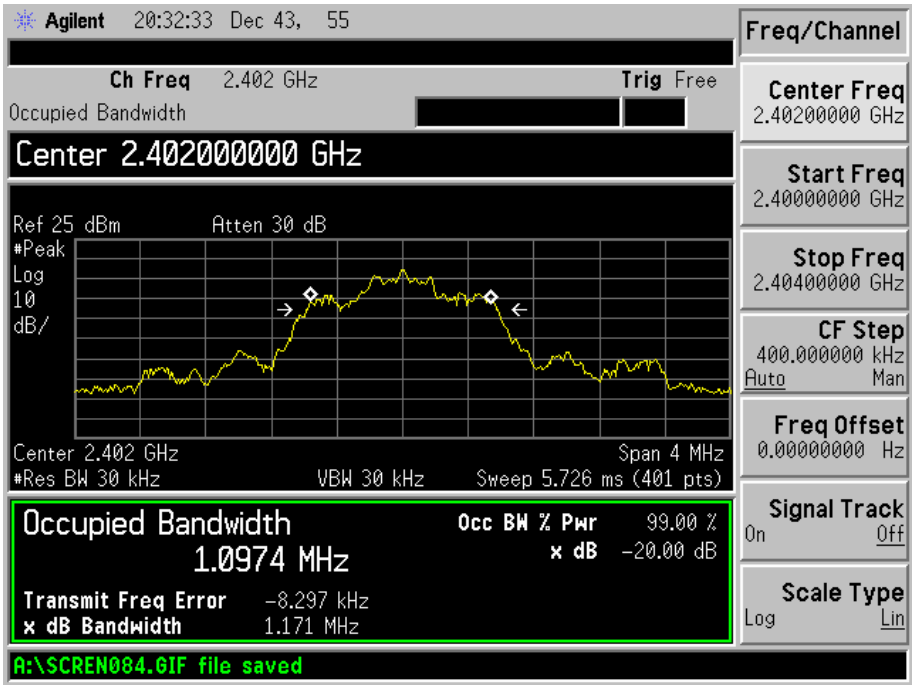


High Channel:

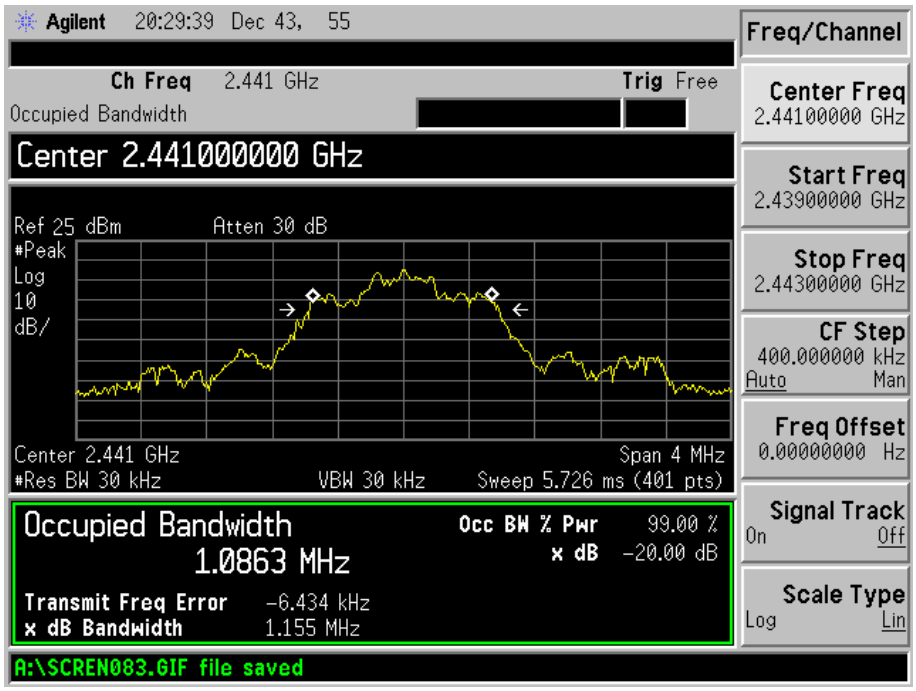


8DPSK Mode

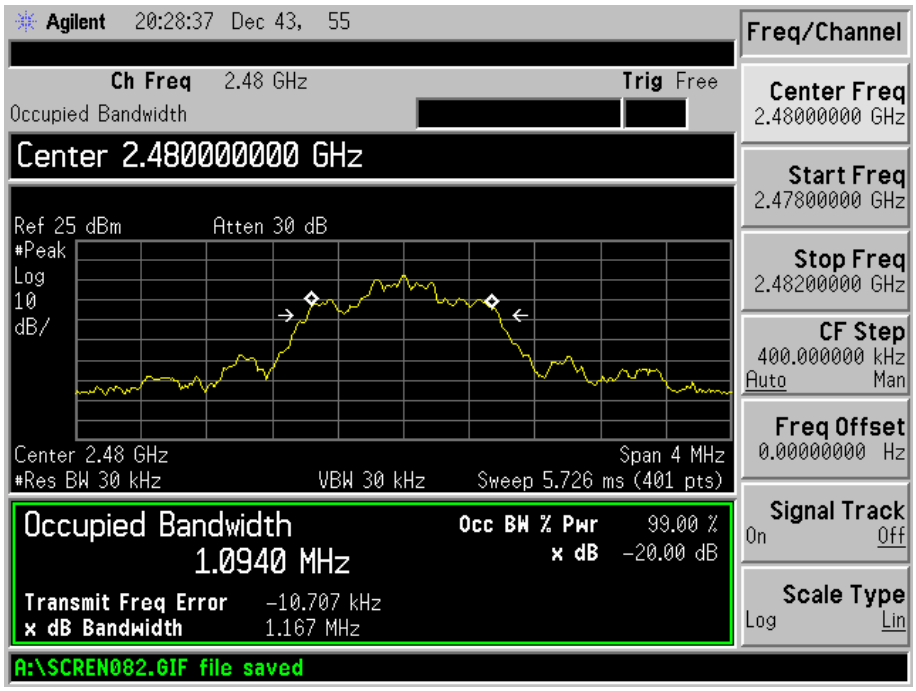
Low Channel:



Middle Channel:



High Channel:



9. RF Output Power

9.1 Standard Applicable

According to 15.247(b)(1). For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

9.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	Agilent	E4402B	US41192821	2013-05-07	2014-05-06
Attenuator	ATTEN	ATS100-4-20	/	2013-05-07	2014-05-06

9.3 Test Procedure

According to the DA 00-705, the peak output power test method as follows.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set span = 5MHz, centered on a hopping channel
RBW = 1MHz, VBW = 1MHz
Sweep = auto
Detector function = peak
Trace = max hold

All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, the indicated level is the peak output power (the external attenuation and cable loss shall be considered).

8.4 Environmental Conditions

Temperature:	24 °C
Relative Humidity:	55%
ATM Pressure:	1011 mbar

9.5 Summary of Test Results/Plots

Maximum Output Power:

Channel	Frequency MHz	Measured Value dBm	Output Power mW	Limit mW
GFSK (1Mbps)				
Low Channel	2402	17.16	52.00	1000
Middle Channel	2441	16.53	44.98	1000
High Channel	2480	16.68	46.56	1000
Pi/4 DQPSK (2Mbps)				
Low Channel	2402	15.32	34.04	1000
Middle Channel	2441	14.98	31.48	1000
High Channel	2480	14.91	30.97	1000
8DPSK (3Mbps)				
Low Channel	2402	14.62	28.97	1000
Middle Channel	2441	14.08	25.59	1000
High Channel	2480	14.33	27.10	1000

Note: the antenna gain of 2dBi less than 6dBi maximum permission antenna gain value based on 1 watt peak output power limit.

10. Field Strength of Spurious Emissions

10.1 Measurement Uncertainty

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of a radiation emissions measurement is ±5.10 dB.

10.2 Standard Applicable

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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

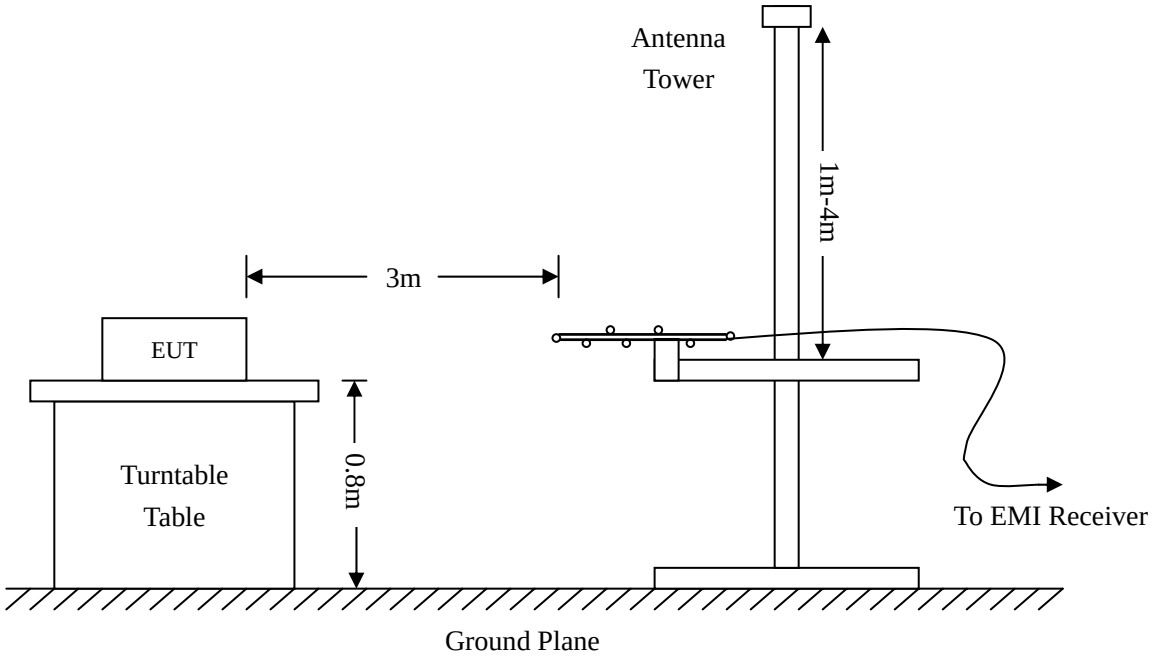
The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

10.3 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	R&S	FSP	836079/035	2013-05-07	2014-05-06
EMI Test Receiver	R&S	ESVB	825471/005	2013-05-07	2014-05-06
Pre-amplifier	Agilent	8447F	3113A06717	2013-05-07	2014-05-06
Pre-amplifier	Compliance Direction	PAP-0118	24002	2013-05-07	2014-05-06
Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	2013-04-20	2014-04-19
Horn Antenna	ETS	3117	00086197	2013-04-20	2014-04-19
Horn Antenna	ETS	3116B	00088203	2013-04-20	2014-04-19
Loop Antenna	SCHWARZECK	HFRA 5165	9365	2013-04-20	2014-04-19

10.4 Test Procedure

The setup of EUT is according with per ANSI C63.4-2003 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.



Frequency :9kHz-30MHz	Frequency :30MHz-1GHz	Frequency :Above 1GHz
RBW=10KHz,	RBW=120KHz,	RBW=1MHz,
VBW =30KHz	VBW=300KHz	VBW=3MHz(Peak), 10Hz(AV)
Sweep time= Auto	Sweep time= Auto	Sweep time= Auto
Detector function = peak	Detector function = peak	Detector function = peak, AV

10.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Ant. Factor + Cable Loss – Ampl. Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dBμV means the emission is 6dBμV below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – FCC Part 15 Limit

10.6 Environmental Conditions

Temperature:	25 °C
Relative Humidity:	52%
ATM Pressure:	1012 mbar

10.7 Summary of Test Results/Plots

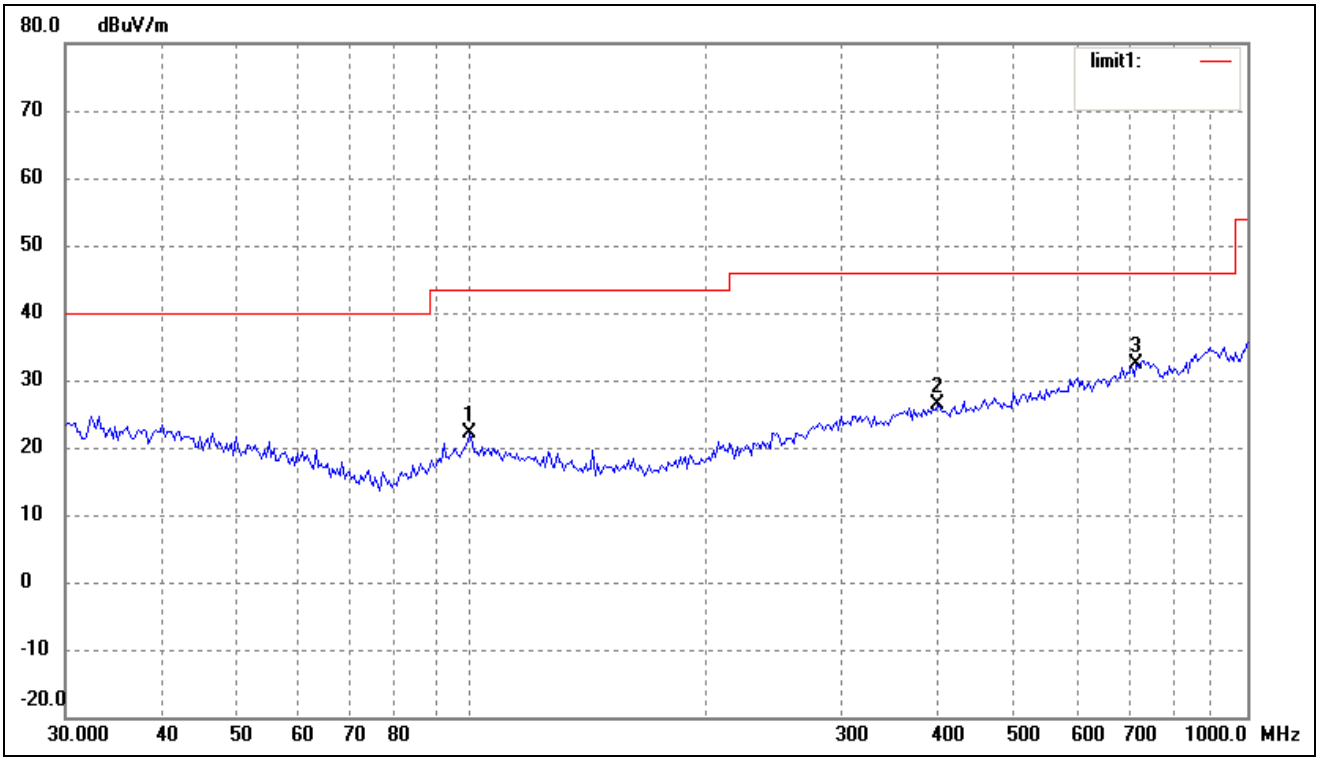
According to the data below, the FCC Part 15.205, 15.209 and 15.247 standards, and had the worst margin of:

-8.27 dB at **4804 MHz** in the **Horizontal** polarization for **Low Channel**, **9kHz** to **25 GHz**, **3 Meters**

Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.

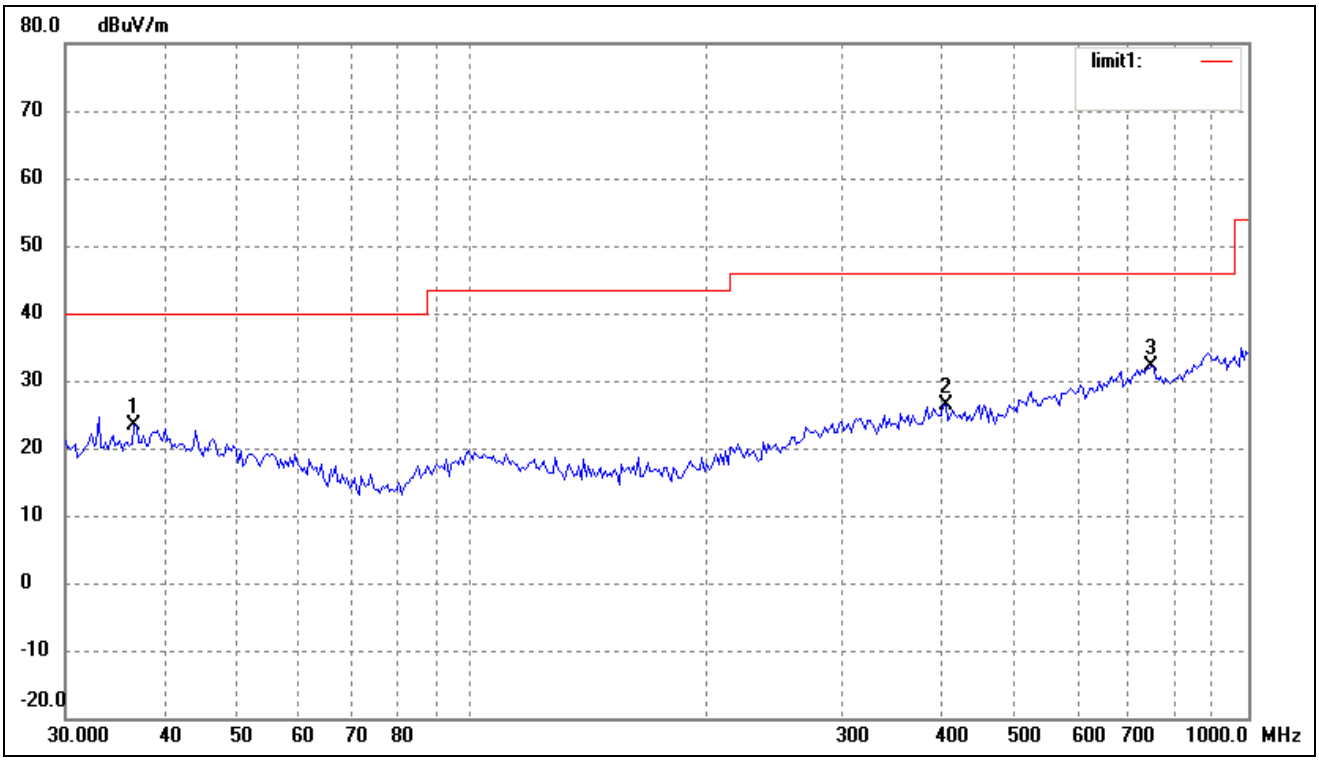
Plot of Radiated Emissions Test Data (30MHz to 1GHz)

EUT: *LM410 Bluetooth Class 1 Module with SMA Antenna*
Tested Model: *410-0200*
Operating Condition: *Transmitting Low Channel (2402MHz)*
Comment: *AC 120V/60Hz PC; DC 3.0V*
Test Specification: *Horizontal*



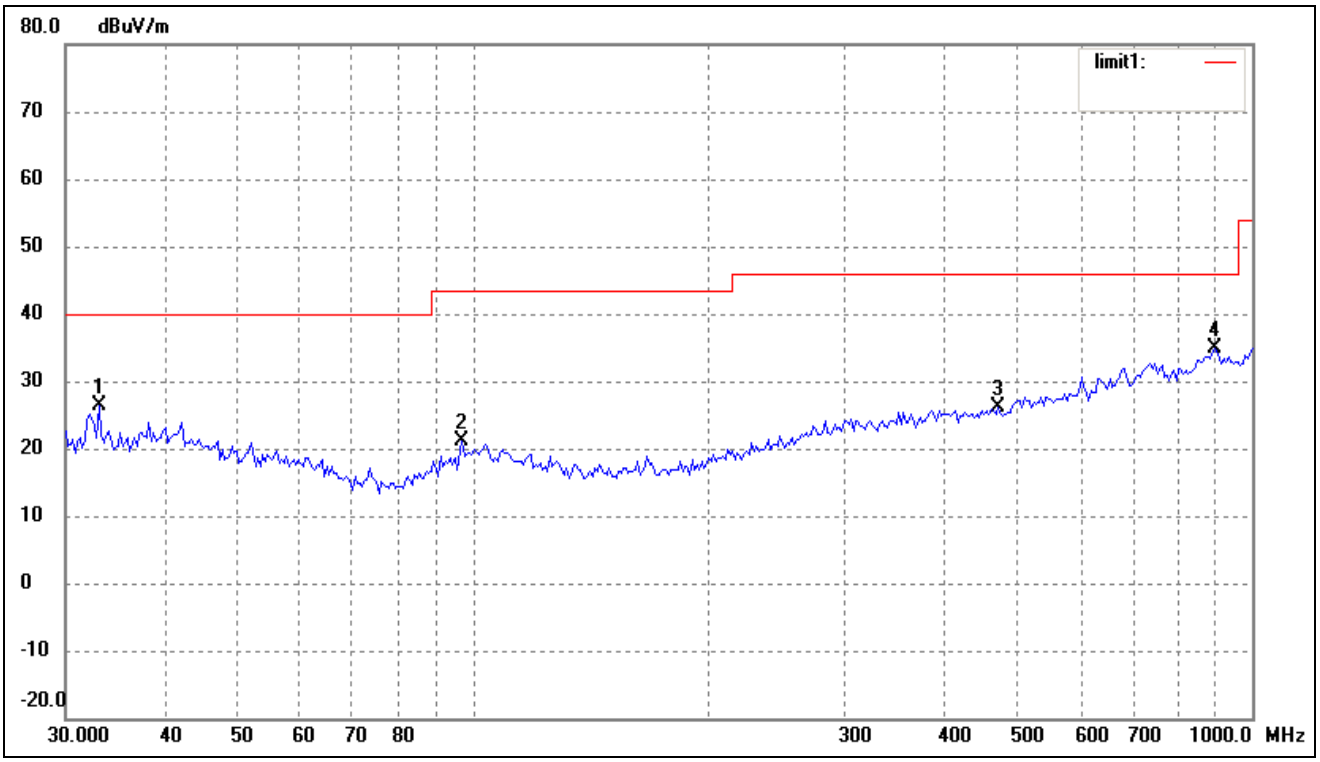
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	99.5281	15.35	6.72	22.07	43.50	-21.43	12	100	peak
2	399.0302	14.90	11.50	26.40	46.00	-19.60	12	100	peak
3	719.1995	15.81	16.59	32.40	46.00	-13.60	12	100	peak

Test Specification: *Vertical*



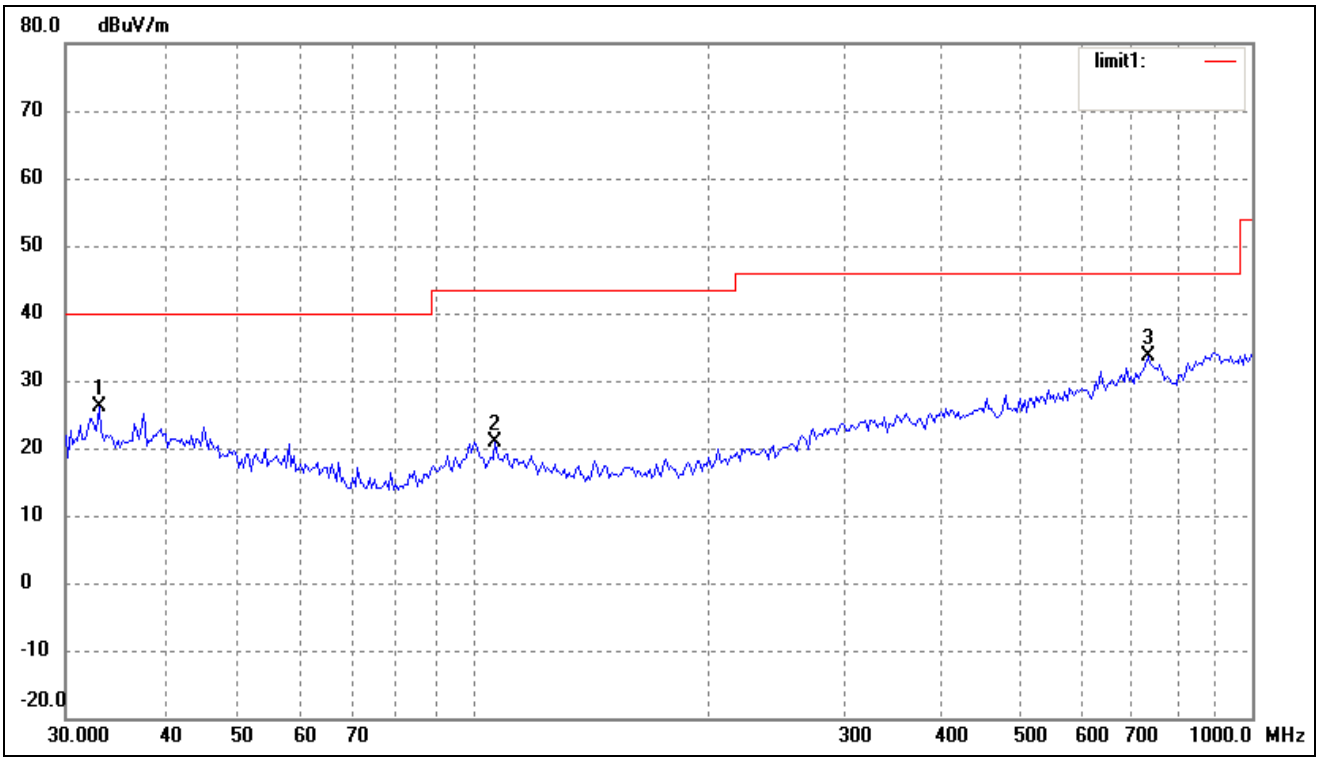
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	36.7662	14.28	9.16	23.44	40.00	-16.56	0	100	peak
2	407.5145	15.19	11.22	26.41	46.00	-19.59	0	100	peak
3	750.1083	14.37	17.78	32.15	46.00	-13.85	0	100	peak

Operating Condition: *Transmitting Middle Channel (2441MHz)*
Comment: *AC 120V/60Hz PC; DC 3.0V*
Test Specification: *Horizontal*



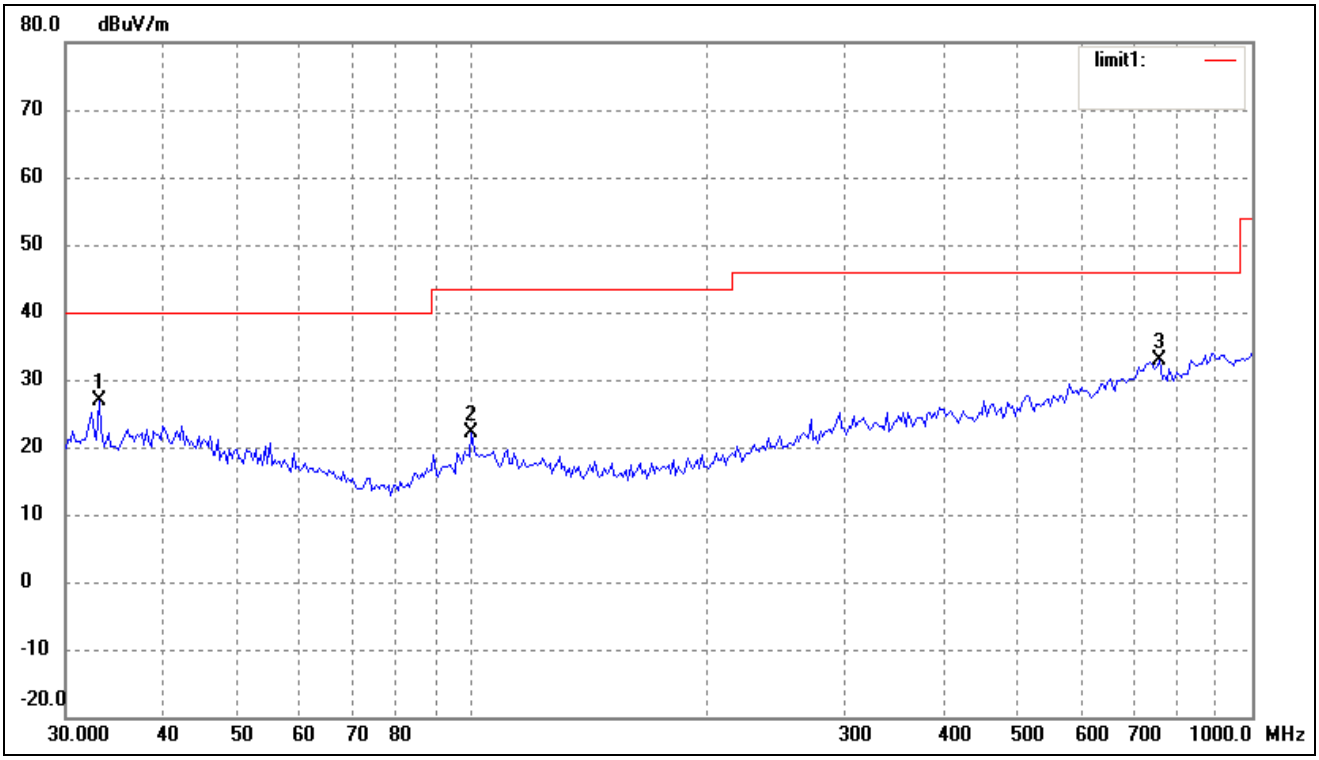
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	33.0950	17.92	8.56	26.48	40.00	-13.52	12	100	peak
2	96.7749	14.97	6.04	21.01	43.50	-22.49	12	100	peak
3	472.1760	14.50	11.55	26.05	46.00	-19.95	12	100	peak
4	893.8567	15.72	19.27	34.99	46.00	-11.01	12	100	peak

Test Specification: *Vertical*



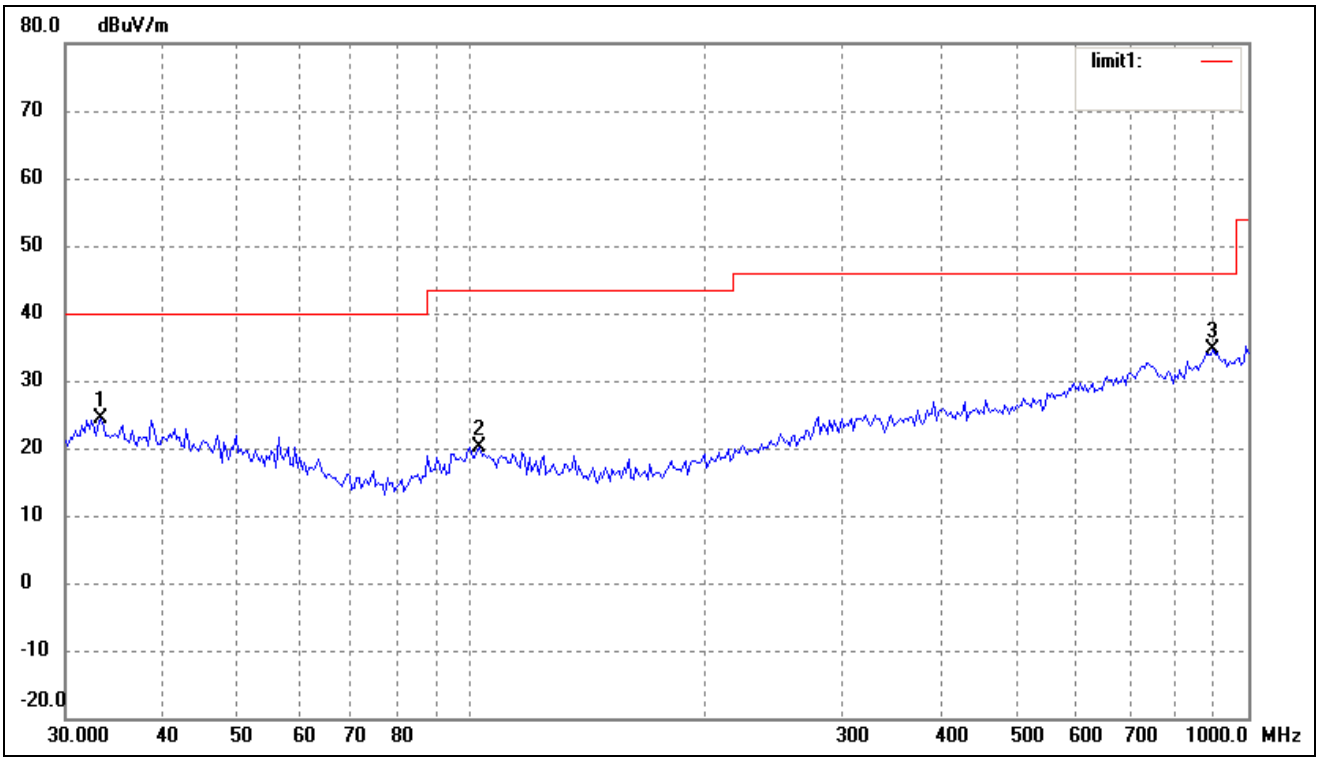
No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	33.0950	17.53	8.56	26.09	40.00	-13.91	0	100	peak
2	106.7587	14.79	6.18	20.97	43.50	-22.53	0	100	peak
3	734.4913	15.85	17.68	33.53	46.00	-12.47	0	100	peak
1	33.0950	17.53	8.56	26.09	40.00	-13.91	0	100	peak

Operating Condition: *Transmitting High Channel (2480MHz)*
Comment: *AC 120V/60Hz PC; DC 3.0V*
Test Specification: *Horizontal*



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	33.0950	18.33	8.56	26.89	40.00	-13.11	0	100	peak
2	99.5281	15.30	6.72	22.02	43.50	-21.48	0	100	peak
3	760.7036	15.64	17.15	32.79	46.00	-13.21	0	100	peak

Test Specification: *Vertical*



No.	Frequency	Reading	Correct	Result	Limit	Margin	Degree	Height	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	(•)	(cm)	
1	33.3279	15.88	8.60	24.48	40.00	-15.52	12	100	peak
2	102.3597	13.62	6.61	20.23	43.50	-23.27	12	100	peak
3	900.1474	15.29	19.38	34.67	46.00	-11.33	12	100	peak

Spurious Emissions Above 1GHz

Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Polar H/V	Detector
Low Channel-2402MHz							
4804	69.32	-3.59	65.73	74	-8.27	H	PK
4804	45.12	-3.59	41.53	54	-12.47	H	AV
7206	56.38	-0.52	55.86	74	-18.14	H	PK
7206	45.27	-0.52	44.75	54	-9.25	H	AV
4804	57.66	-3.59	54.07	74	-19.93	V	PK
4804	38.94	-3.59	35.35	54	-18.65	V	AV
7206	46.31	-0.52	45.79	74	-28.21	V	PK
7206	33.15	-0.52	32.63	54	-21.37	V	AV
Middle Channel-2441MHz							
4882	66.58	-3.49	63.09	74	-10.91	H	PK
4882	46.32	-3.49	42.83	54	-11.17	H	AV
7323	58.36	-0.47	57.89	74	-16.11	H	PK
7323	44.59	-0.47	44.12	54	-9.88	H	AV
4882	47.26	-3.49	43.77	74	-30.23	V	PK
4882	36.47	-3.49	32.98	54	-21.02	V	AV
7323	50.31	-0.47	49.84	74	-24.16	V	PK
7323	33.27	-0.47	32.8	54	-21.20	V	AV
High Channel-2480MHz							
4960	66.31	-3.41	62.9	74	-11.10	H	PK
4960	45.88	-3.41	42.47	54	-11.53	H	AV
7440	54.09	-0.42	53.67	74	-20.33	H	PK
7440	42.37	-0.42	41.95	54	-12.05	H	AV
4960	55.12	-3.41	51.71	74	-22.29	V	PK
4960	36.94	-3.41	33.53	54	-20.47	V	AV
7440	53.33	-0.42	52.91	74	-21.09	V	PK
7440	33.18	-0.42	32.76	54	-21.24	V	AV

Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, which above 3th Harmonics are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
The measurements greater than 20dB below the limit from 9kHz to 30MHz..

11. Out of Band Emissions

11.1 Standard Applicable

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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

11.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Spectrum Analyzer	R&S	FSP	836079/035	2013-05-07	2014-05-06
EMI Test Receiver	R&S	ESVB	825471/005	2013-05-07	2014-05-06
Pre-amplifier	Agilent	8447F	3113A06717	2013-05-07	2014-05-06
Pre-amplifier	Compliance Direction	PAP-0118	24002	2013-05-07	2014-05-06
Trilog Broadband Antenna	SCHWARZBECK	VULB9163	9163-333	2013-04-20	2014-04-19
Horn Antenna	ETS	3117	00086197	2013-04-20	2014-04-19
Spectrum Analyzer	Agilent	E4402B	US41192821	2013-05-07	2014-05-06
Attenuator	ATTEN	ATS100-4-20	/	2013-05-07	2014-05-06

11.3 Test Procedure

According to the DA 00-705, the band-edge radiated test method as follows.

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2410MHz for low bandedge, 2470MHz to 2500MHz for the high bandedge)
RBW = 1MHz, VBW = 1MHz for peak value measured
RBW = 1MHz, VBW = 10Hz for average value measured
Sweep = auto; Detector function = peak; Trace = max hold

All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation porduct outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement KDB publication number: 913591 may be used for the radiated bandedge measurements.

According to the DA 00-705, the band-edge conducted test method as follows:

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2380MHz to 2410MHz for low bandedge, 2470MHz to 2500MHz for the high bandedge)
RBW = 100kHz, VBW = 300kHz
Sweep = auto; Detector function = peak; Trace = max hold

All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation porduct outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the limit specified in this section (at least 20dB attenuation).

11.4 Environmental Conditions

Temperature:	23°C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

11.5 Summary of Test Results/Plots

Test mode	Frequency	Limit	Result
	MHz	dBuV / dBc	
Lowest	2310.00	<54 dBuV	Pass
	2390.00	<54 dBuV	Pass
	2400.00	> 20dBc	Pass
Highest	2483.50	<54 dBuV	Pass
	2500.00	<54 dBuV	Pass

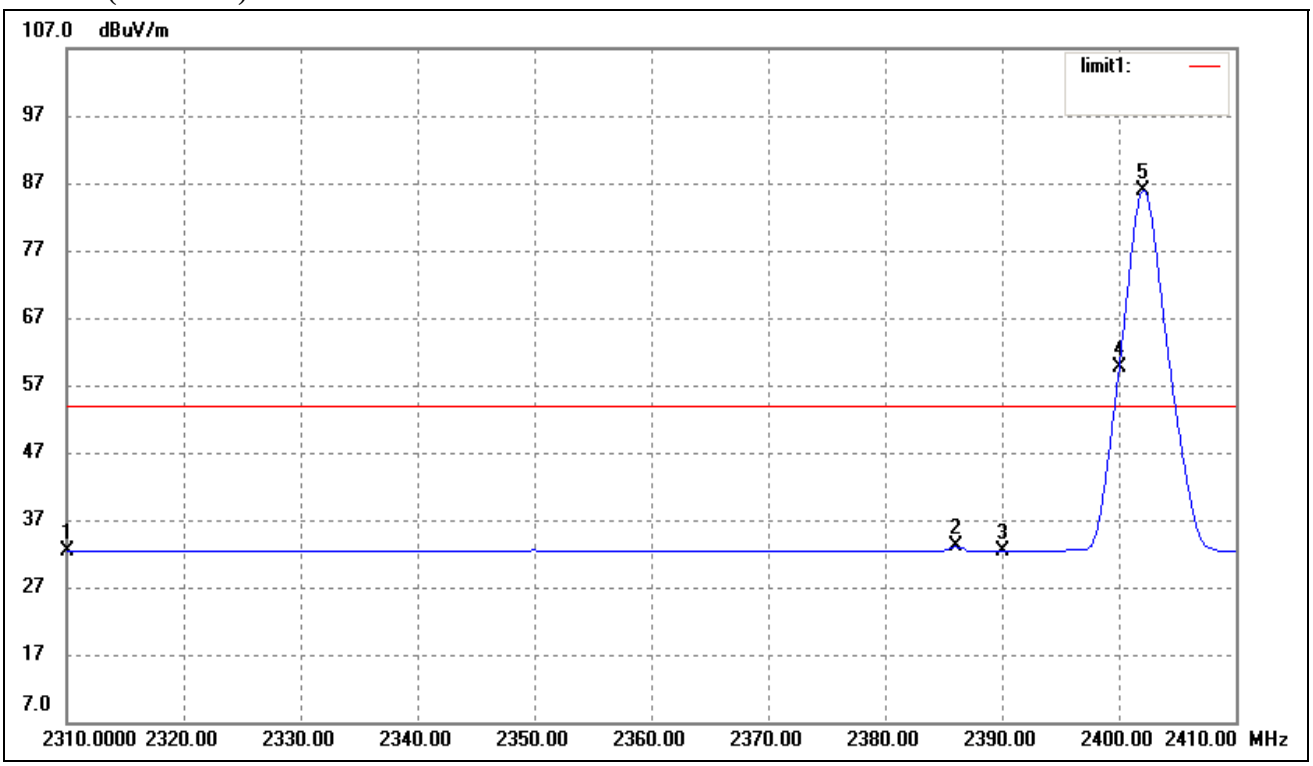
The edge emissions are below the FCC 15.209 Limits or complies with the 15.247(d) requirements.

Please refer to the test plots as below.

Bandedge (Radiated)

Lowest Bandedge

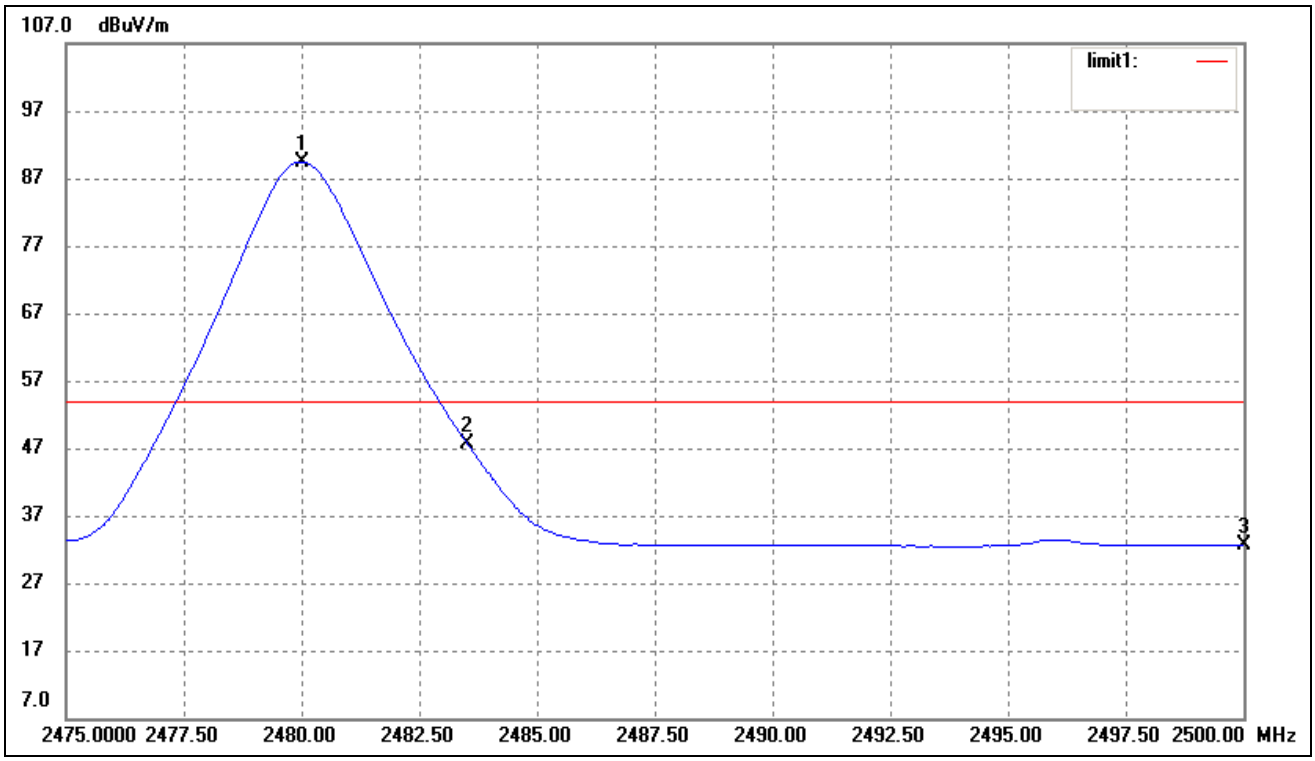
Vertical (Worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	Factor(dB)	(dBuV/m)	(dBuV/m)	(dB)	
1	2310.000	36.08	-3.71	32.37	54.00	-21.63	Average Detector
	2310.000	49.55	-3.71	45.84	74.00	-28.16	Peak Detector
2	2386.000	36.56	-3.54	33.02	54.00	-20.98	Average Detector
	2386.000	49.89	-3.57	45.32	74.00	-28.68	Peak Detector
3	2390.000	35.93	-3.54	32.39	54.00	-21.61	Average Detector
	2390.000	49.43	-3.54	45.89	74.00	-28.11	Peak Detector
4	2400.000	63.26	-3.51	59.75	Delta=26.03		Average Detector
5	2402.000	89.29	-3.51	85.78			Average Detector

Highest Bandedge

Vertical (Worst case)



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	Factor(dB)	(dBuV/m)	(dBuV/m)	(dB)	
1	2480.000	92.77	-3.33	89.44	/	/	Average Detector
	2480.000	102.42	-3.33	99.09	/	/	Peak Detector
2	2483.500	Delta=63.49		25.95	54.00	-28.05	Average Detector
	2483.500			35.60	74.00	-38.40	Peak Detector
3	2500.000	35.92	-3.28	32.64	54.00	-21.36	Average Detector
	2500.000	49.87	-3.28	46.59	74.00	-27.41	Peak Detector

12. Conducted Emissions

12.1 Measurement Uncertainty

Base on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any conducted emissions measurement is ± 2.88 dB.

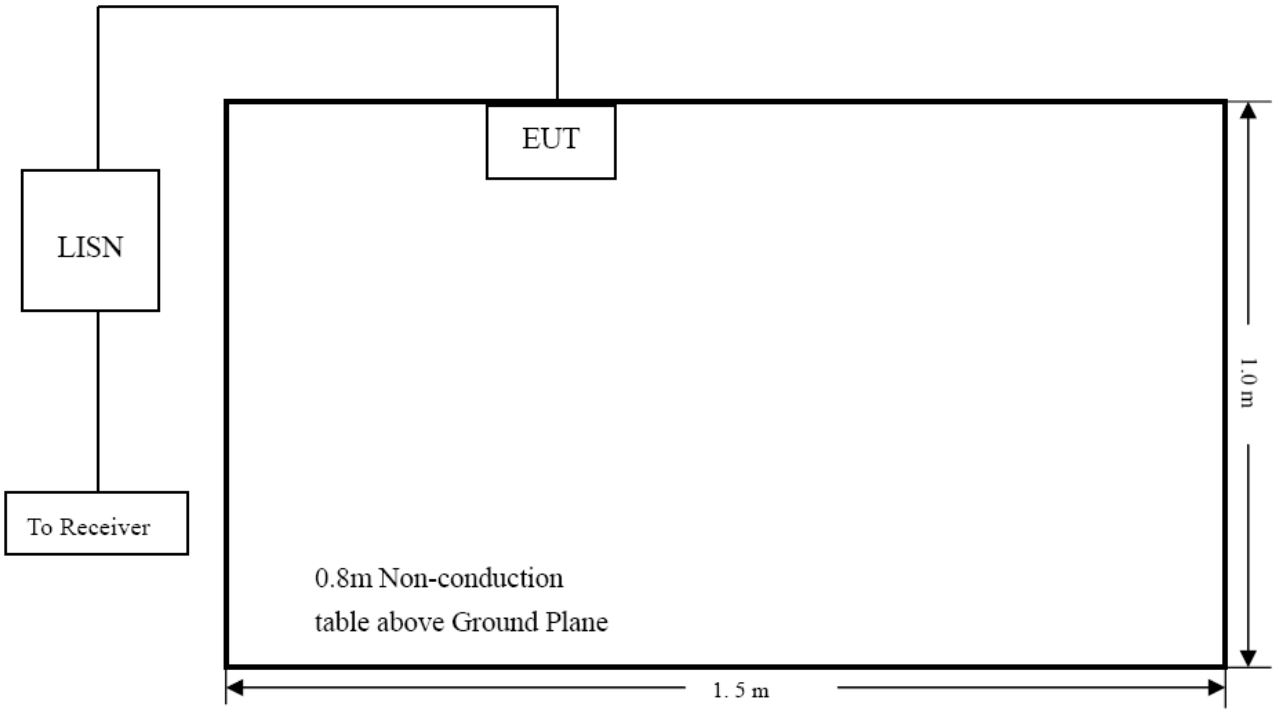
12.2 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
EMI Test Receiver	Rohde & Schwarz	ESPI	101611	2013-05-07	2014-05-06
L.I.S.N	Schwarz beck	NSLK8126	8126-224	2013-05-07	2014-05-06
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100911	2013-05-07	2014-05-06

12.3 Test Procedure

The setup of EUT is according with per ANSI C63.4-2003 measurement procedure. The specification used was with the FCC Part 15.207 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.
The spacing between the peripherals was 10 cm.

12.4 Basic Test Setup Block Diagram



12.5 Environmental Conditions

Temperature:	25 °C
Relative Humidity:	52%
ATM Pressure:	1012 mbar

12.6 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency ..... 150 kHz
Stop Frequency..... 30 MHz
Sweep Speed ..... Auto
IF Bandwidth..... 10 kHz
Quasi-Peak Adapter Bandwidth ..... 9 kHz
Quasi-Peak Adapter Mode ..... Normal

12.7 Summary of Test Results/Plots

According to the data in section 12.8, the EUT complied with the FCC Part 15.207 Conducted margin for a Class B device, with the *worst* margin reading of:

-8.30 dB at 0.206 MHz in the **Line** mode**, Ave** detector, **0.15-30MHz**

12.8 Conducted Emissions Test Data

Plot of Conducted Emissions Test Data

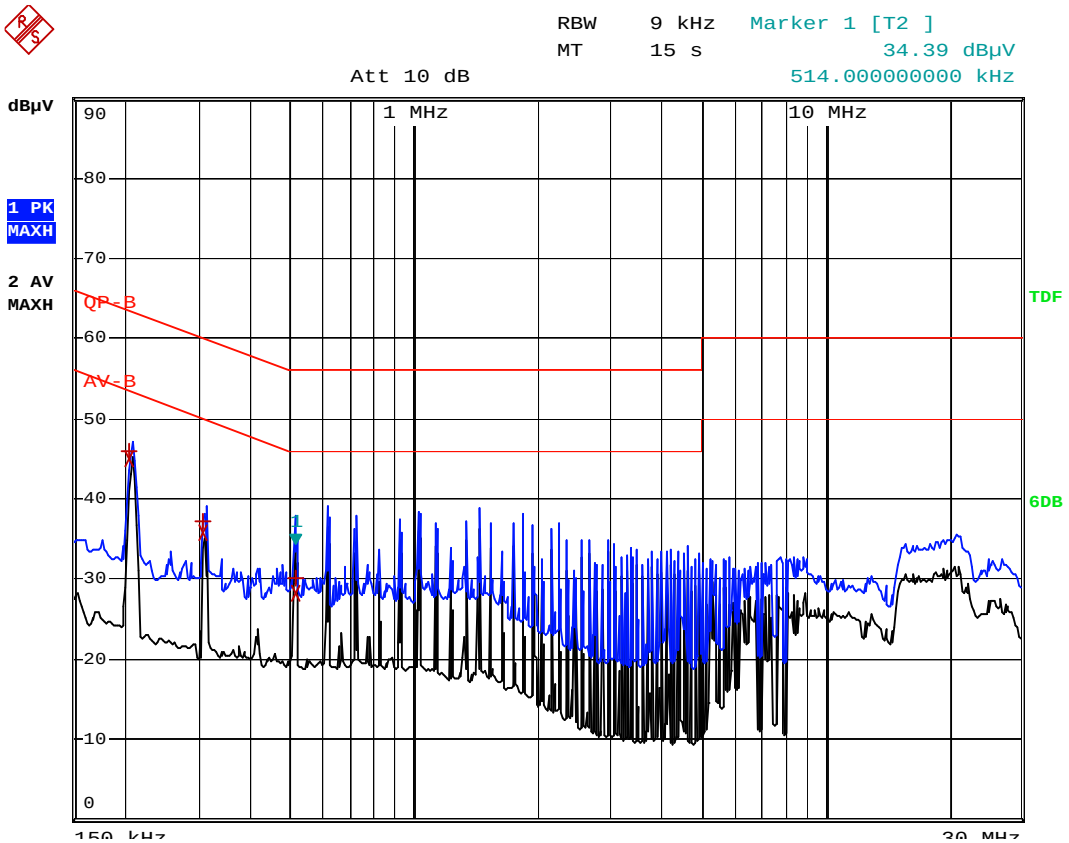
EUT: *LM410 Bluetooth Class 1 Module with SMA Antenna*

Tested Model: *410-0200*

Operating Condition: *Transmitting*

Comment: *AC 120V/60Hz PC; DC 3.0V*

Test Specification: *Line*

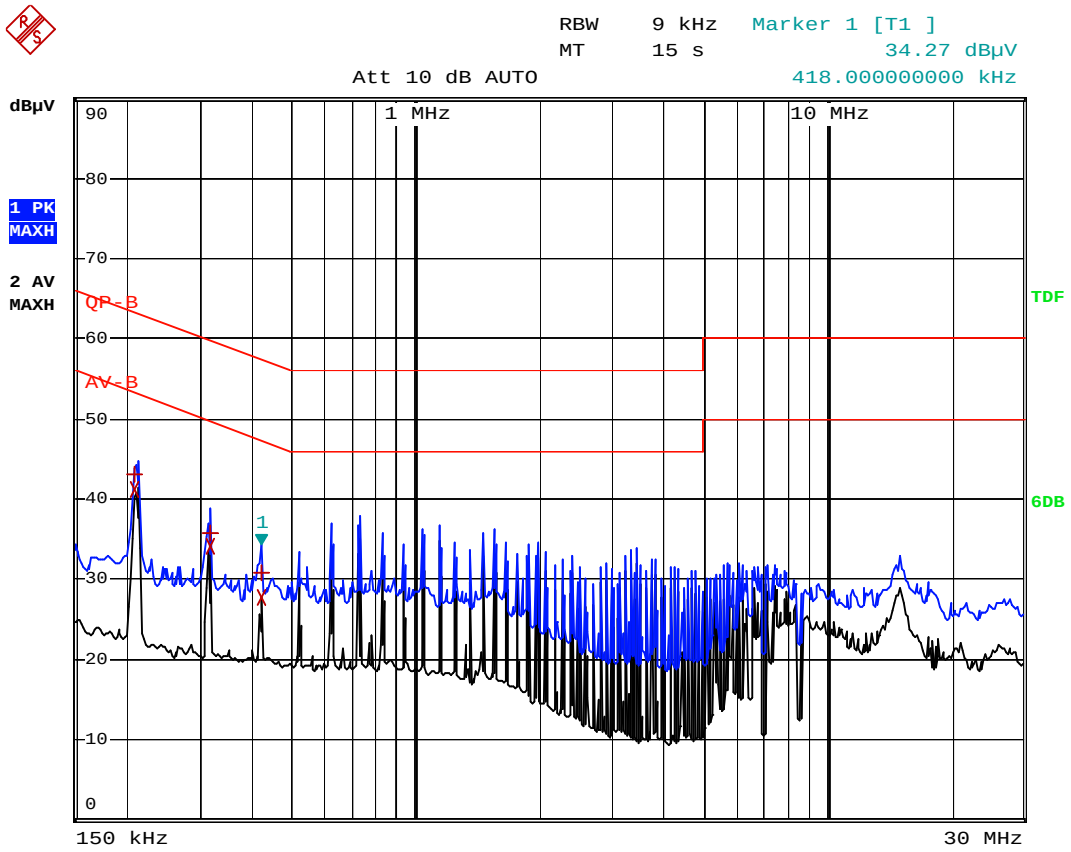


EDIT PEAK LIST (Final Measurement Results)

Trace1: QP-B
Trace2: AV-B
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
2	Average	206 kHz	45.06	-8.30
1	Quasi Peak	206 kHz	45.82	-17.53
1	Quasi Peak	310 kHz	37.23	-22.73
2	Average	310 kHz	35.85	-14.11
2	Average	514 kHz	28.33	-17.66
1	Quasi Peak	514 kHz	30.06	-25.93

Test Specification: *Neutral*



EDIT PEAK LIST (Final Measurement Results)

Trace1:	QP-B
Trace2:	AV-B
Trace3:	---

TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1 Quasi Peak	210 kHz	43.22	-19.97
2 Average	210 kHz	41.12	-12.08
2 Average	314 kHz	34.04	-15.82
1 Quasi Peak	314 kHz	35.87	-23.99
1 Quasi Peak	418 kHz	30.76	-26.72
2 Average	418 kHz	27.86	-19.62

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