Excellence in Compliance Testing

Certification Test Report

FCC ID: AZ489FT4903
IC: 109U-89FT4903

FCC Rule Part: 15.247
IC Radio Standards Specification: RSS-210

ACS Report Number: 11-2043.W06.11.A

Manufacturer: **Motorola Solutions, Inc.**
Model: **APX 6000 UHF RANGE 2**

Test Begin Date: **July 2, 2011**
Test End Date: **July 11, 2011**

Report Issue Date: **July 15, 2011**

ACCREDITED TESTING

FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

This report must not be used by the client to claim product certification, approval, or endorsement by ACLASS, ANSI, or any agency of the Federal Government.

Project Manager:

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Reviewed by:

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This report contains 60 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210.

1.2 Manufacturer Information

Motorola Solutions, Inc.
8000 West Sunrise Blvd.
Plantation, FL 33322

1.3 Product description

APX 6000 UHF RANGE 2 is a portable push-to-talk radio with Bluetooth 2.0 + EDR. Additional features consist of GPS, accelerometer, & secure audio. The EUT operates at a nominal power of 7.5VDC, 2A with a 50-ohm antenna load on UHF TX. The available modulation formats and operation characteristics of the Bluetooth radio are provided below.

Table 1.3-1: Bluetooth Radio Properties

Mode of Operation	Frequency Range (MHz)	Number of Channels	Channel Separation (kHz)	Data Rates Supported (kbps)
GFSK	2402 - 2480	79	1000	1000
π/4-DQPSK	2402 - 2480	79	1000	2000
8DPSK	2402 - 2480	79	1000	3000

Model Number: UHF R2 Model 3.5: H98SDH9PW7AN

Test Sample Serial Number(s): CAI110CKTGS, CAI110KTKG

Test Sample Condition: Good

Table 1.3-2: APX 6000 UHF RANGE 2 Model Variants

Model Name	Model Number	Description	Tested
APX 6000 UHF RANGE 2 Model 3.5	H98SDH9PW7AN	Front display, all front buttons	Yes
APX 6000 UHF RANGE 2 Model 2.5	H98SDF9PW6AN	Front display, few front buttons	------
APX 6000 UHF RANGE 2 Model 1.5	H98SDD9PW5AN	No front display, no front buttons	------

1.4 Test Methodology and Considerations

The APX 6000 UHF RANGE 2, Model No. H98SDH9PW7AN, was tested to the applied test standards for the GFSK, π/4-DQPSK and 8DPSK modulation formats.

Conducted power line emissions were performed on the EUT Hopping for all the available modulation formats and for the EUT in the receive mode. Results are provided for the configuration leading to the worst case emissions.

For the radiated emissions, preliminary evaluations were performed for the EUT setup in three orthogonal orientations, corresponding to the X, Y, Z planes. Final measurements were performed using the EUT orientation leading to the worst case emissions.

Additionally, inter-modulation evaluation was performed between the Bluetooth and the collocated UHF radio operating at 450 MHz. All inter-modulation product emissions were attenuated below the noise floor of the measurement equipment.

Table 1.4-1: Test Configuration

Mode of Operation	Channel (MHz)	Data Rates (kbps)
GFSK	2402	1000
	2441	1000
	2480	1000
π/4-DQPSK	2402	2000
	2441	2000
	2480	2000
8DPSK	2402	3000
	2441	3000
	2480	3000

1.5 Emission Designators

The Bluetooth transmitter produces 3 distinct modulation formats. The emissions designators for the modulation types used by the Bluetooth transmitter are as follows:

EMISSIONS DESIGNATORS:

GFSK: 1M13F1D
Π/4 DQPSK: 1M40G1D
8DPSK: 1M38G1D

2 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

FCC Test Firm Registration #: 587595
Industry Canada Lab Code: 4175C

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ACLASS program and has been issued certificate number AT-1533 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with metallic loaded springs. An EMCO Model 1050 Multi-device Controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

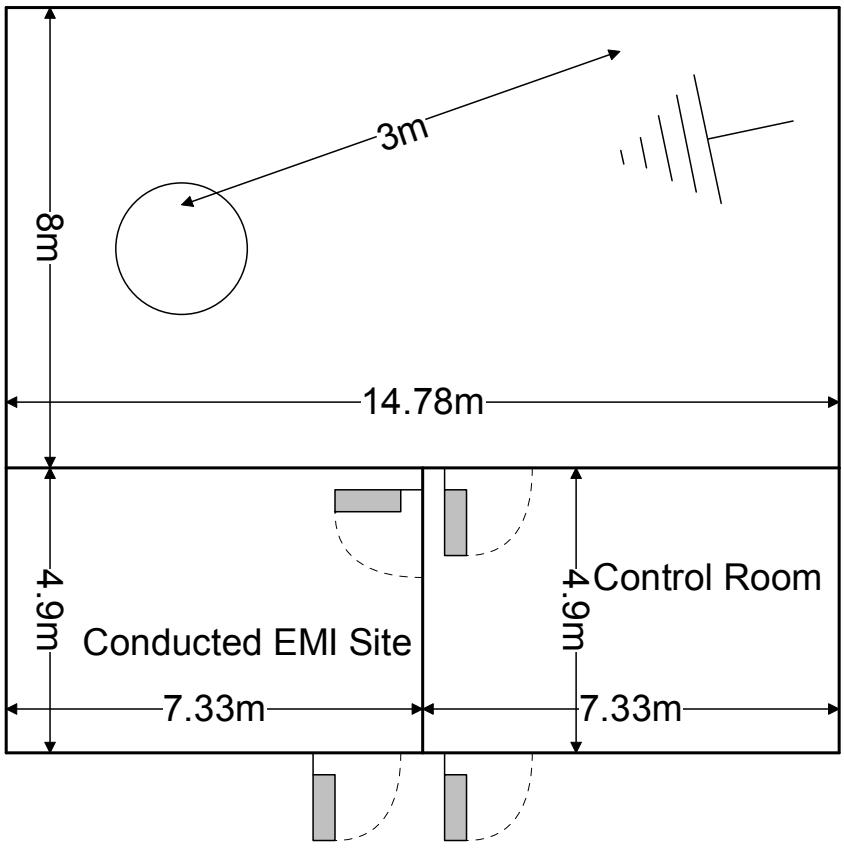

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. As per ANSI C63.4 2003 requirements, the data were taken using two LISNs; a Solar Model 8028-50 50 Ω/50 µH and an EMCO Model 3825, which are installed as shown in Photograph 3. For 220 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B, to filter conducted noise from the generator.

A diagram of the room is shown below in figure 2.3.2-1:

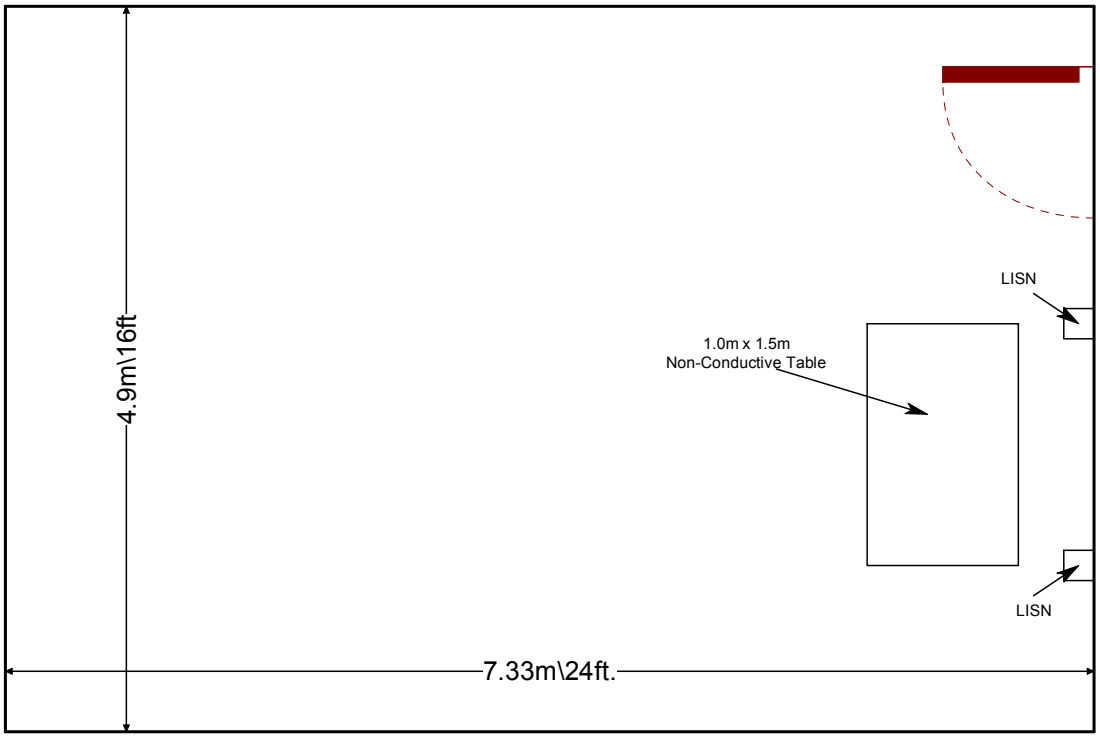

Figure 2.3.2-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2010
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2010
- FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, March 30, 2000
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8, December 2010
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue3, December 2010.

4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/5/2011	1/5/2013
524	Chase	CBL6111	Antennas	1138	1/7/2011	1/7/2013
2006	EMCO	3115	Antennas	2573	3/2/2011	3/2/2013
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	1/3/2011	1/3/2012
2012	Hewlett-Packard	HP83017A	Amplifiers	3123A00324	2/25/2011	2/25/2012
2013	Hewlett Packard	HP8566B	Spectrum Analyzers	2407A03233	8/5/2010	8/5/2012
2014	Hewlett Packard	HP 85650A	Quasi Peak Adapter	2430A00559	8/5/2010	8/5/2012
2022	EMCO	LISN3825/2R	LISN	1095	8/10/2009	8/10/2011
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	1/7/2011	1/7/2012
2044	QMI	N/A	Cables	2044	1/7/2011	1/7/2012
2045	ACS Boca	Conducted Cable Set	Cable Set	2045	1/6/2011	1/6/2012
2064	CIR Q-TEL	FHT/22-10K-13/50-3A/3A	Filter	9	1/15/2011	1/15/2012
2070	Mini Circuits	VHF-8400+	Filter	2070	2/3/2011	2/3/2012
2072	Mini Circuits	VHF-3100+	Filter	30737	2/3/2011	2/3/2012
2076	Hewlett Packard	HP5061-5458	Cables	2076	2/2/2011	2/2/2012
2082	Teledyne Storm Products	90-010-048	Cables	2082	6/6/2011	6/6/2012

NCR = No Calibration Required

*Note:
The asset 2008 is a standard gain horn antenna. Hence, recurring calibration beyond initial calibration per the manufacturer is not required only in case of damage, suspected deterioration or use at distance closer than $2xa^2/\lambda$, as per ANSI C63.4 requirements.

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Charger	Motorola	NNTN7079A	0320MTI05
2	Power Supply	Motorola	NU20-C140150-13	N/A

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

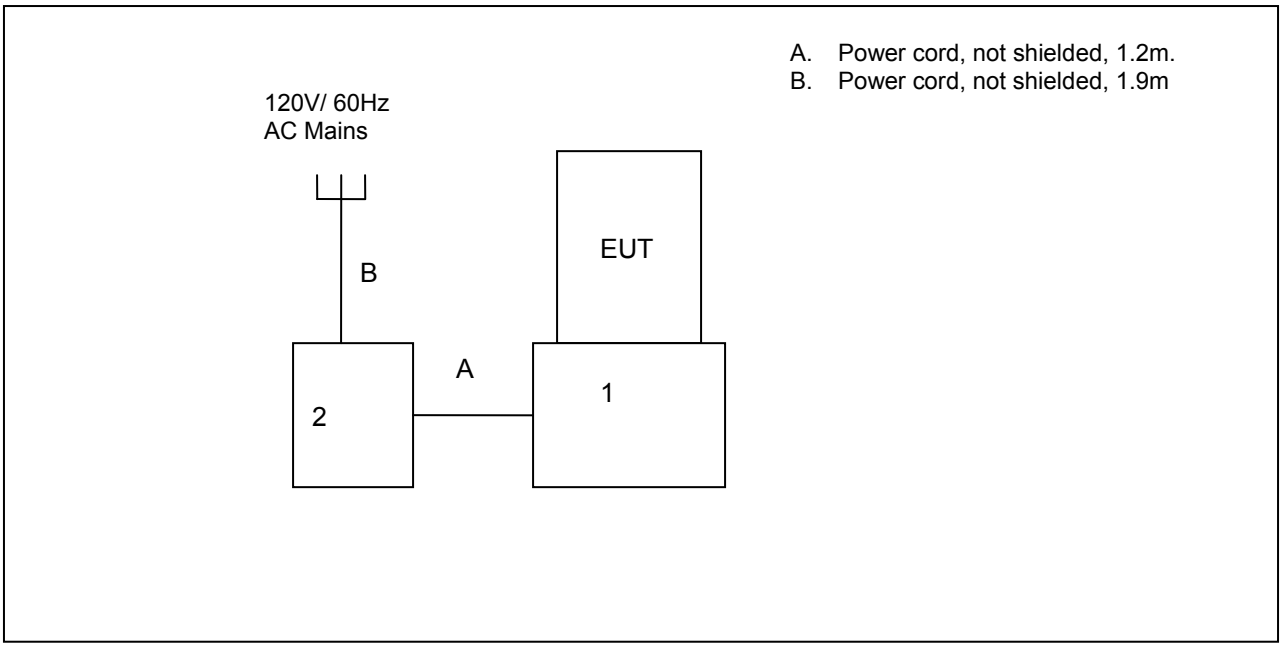

Figure 6-1: Support Equipment – EUT with Charger

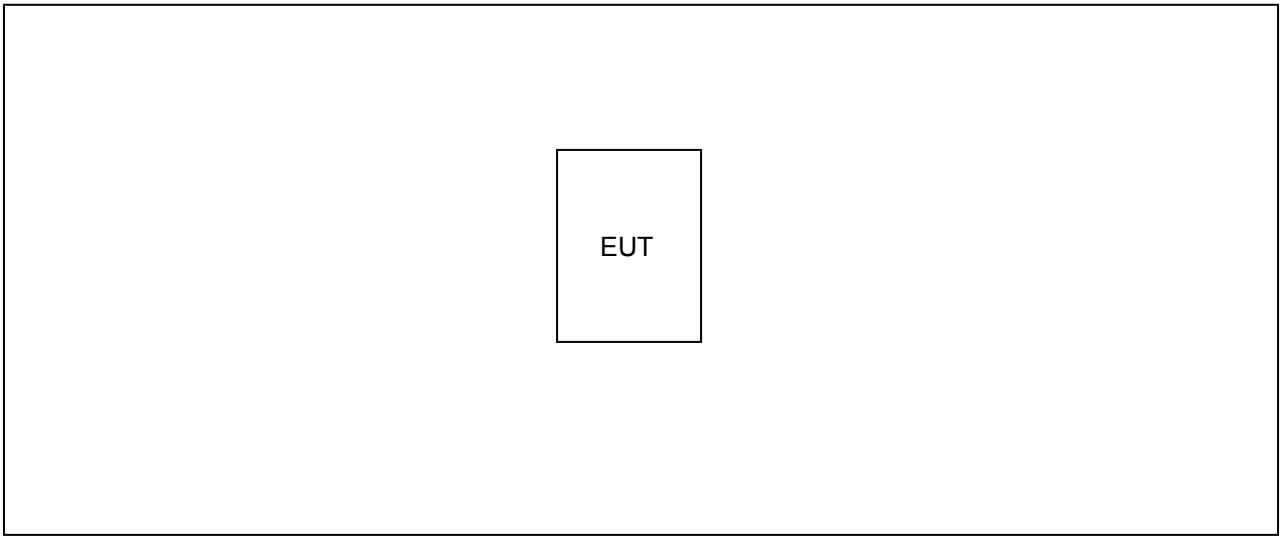

Figure 6-2: Support Equipment – Standalone

7 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement – FCC: Section 15.203

The Bluetooth radio of the APX 6000 UHF RANGE 2 uses a 2.5 dBi internal PIFA.

7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.4

7.2.1 Measurement Procedure

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150 kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Measurement Results

Results of the test corresponding to the EUT configuration leading to the worse case emissions are shown below in Table 7.2.2-1 and Figure 7.2.2-1 to Figure 7.2.2-2 .

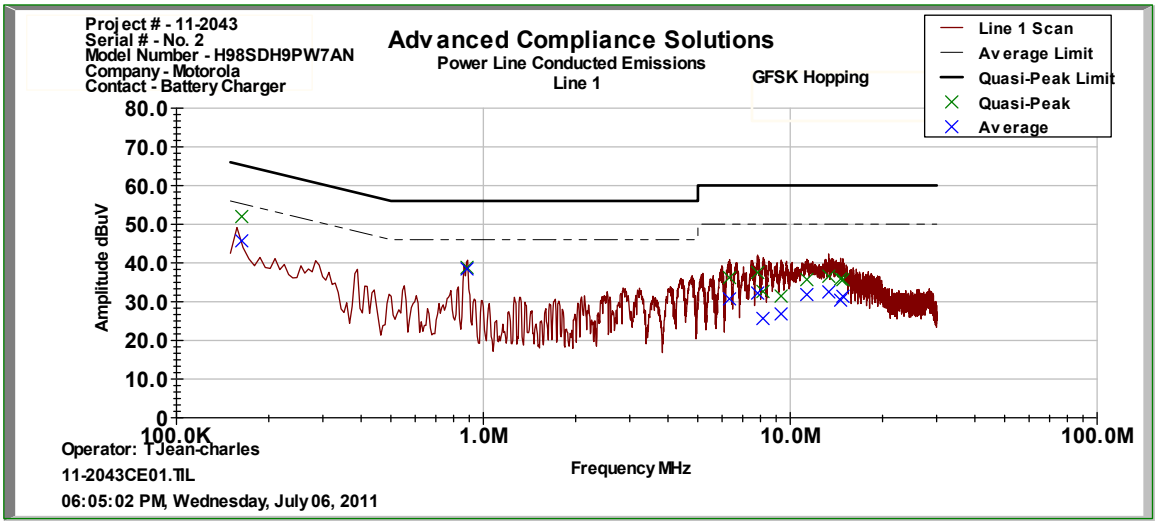

Figure 7.2.2-1: Conducted Emissions Results – Line 1

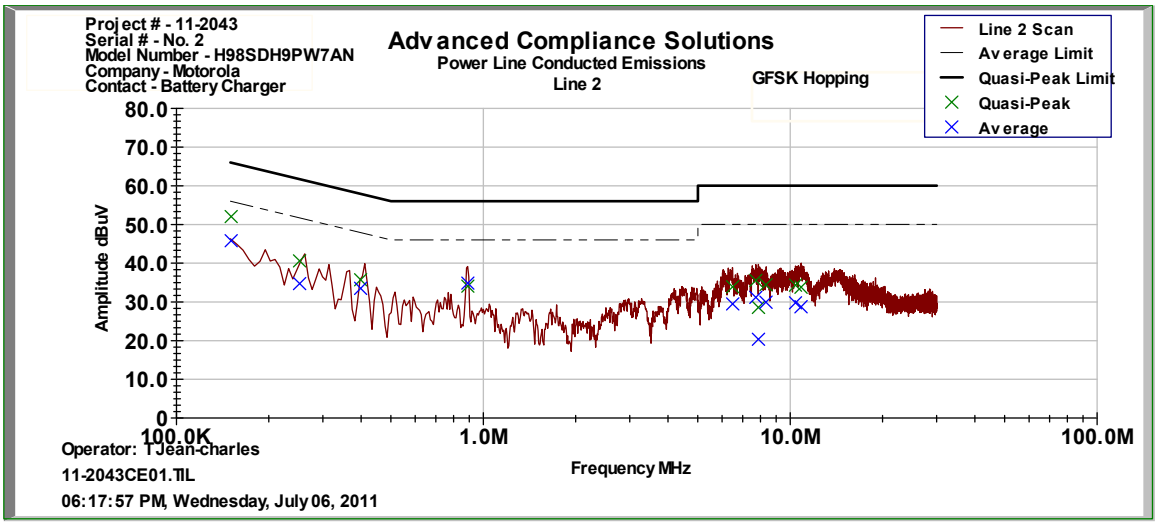

Figure 7.2.2-2: Conducted Emissions Results – Line 2

Table 7.2.2-1: Conducted EMI Results

☒ Line 1 ☒ Line 2 ☐ Line 3
☐ Line 4
☒ To Ground ☐ Floating
☐ Telecom Port _____
☒ dBµV ☐ dBµA

Plot Number: 11-2043CE01
Power Supply Description: 14 VDC

Frequency (MHz)	Uncorrected Reading		Total Correction Factor (dB)	Corrected Level		Limit		Margin (dB)	
	Quasi-Peak	Average		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
Line 1									
0.163315	51.587	45.32	0.46	52.05	45.78	65.29	55.29	13.2	9.5
0.884587	38.501	38.129	0.34	38.84	38.47	56.00	46.00	17.2	7.5
6.33777	35.689	30.173	0.56	36.25	30.73	60.00	50.00	23.8	19.3
7.82711	36.811	31.523	0.72	37.53	32.24	60.00	50.00	22.5	17.8
8.14513	31.842	24.867	0.74	32.59	25.61	60.00	50.00	27.4	24.4
9.3362	29.732	25.097	1.21	30.94	26.31	60.00	50.00	29.1	23.7
11.3138	33.029	29.177	2.79	35.81	31.96	60.00	50.00	24.2	18.0
13.3444	34.086	30.031	2.82	36.91	32.85	60.00	50.00	23.1	17.1
14.5893	33.486	28.018	2.84	36.33	30.86	60.00	50.00	23.7	19.1
14.8341	33.314	29.015	2.84	36.16	31.86	60.00	50.00	23.8	18.1
Line 2									
0.150899	51.534	45.294	0.57	52.10	45.86	65.95	55.95	13.9	10.1
0.252037	40.148	34.308	0.45	40.59	34.75	61.69	51.69	21.1	16.9
0.398287	35.293	33.08	0.41	35.71	33.49	57.89	47.89	22.2	14.4
0.889887	33.659	34.441	0.40	34.06	34.84	56.00	46.00	21.9	11.2
6.49025	33.233	28.819	0.69	33.93	29.51	60.00	50.00	26.1	20.5
7.72409	34.758	30.369	0.82	35.58	31.19	60.00	50.00	24.4	18.8
7.87439	27.742	19.508	0.85	28.59	20.36	60.00	50.00	31.4	29.6
8.33202	33.461	28.922	0.88	34.34	29.80	60.00	50.00	25.7	20.2
10.4004	31.481	26.94	2.86	34.34	29.80	60.00	50.00	25.7	20.2
10.841	30.992	25.942	2.85	33.84	28.79	60.00	50.00	26.2	21.2

* Note: Results are reported for the EUT configuration leading to the worst case emissions.

7.3 Radiated Emissions – FCC: Section 15.109 (Unintentional Radiation) IC: RSS-Gen 6

7.3.1 Measurement Procedure

Radiated emissions tests were performed over the frequency range of 30 MHz to 12.5 GHz. Measurements of the radiated field strength were made at a distance of 3 m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements above 30MHz and below 1 GHz were made with the Spectrum Analyzer's resolution bandwidth set to 120 kHz using a Quasi-peak detector. Above 1GHz, measurements are taken with the RBW set to 1MHz and the VBW set to 3 MHz and 10 Hz for peak and average measurements, respectively.

7.3.2 Measurement Results

Results of the test are given Table 7.3.2-1 below:

Table 7.3.2-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
31.2321	30.50	25.90	H	-8.61	---------	17.29	--------	40.0	---------	22.70
133.253	30.10	25.93	H	-14.38	---------	11.55	--------	43.5	---------	31.90
969.443	29.60	25.21	H	2.00	---------	27.21	--------	54.0	---------	26.80
30.636	32.90	28.77	V	-8.30	---------	20.47	--------	40.0	---------	19.50
52.041	42.00	39.61	V	-19.04	---------	20.57	--------	40.0	---------	19.40
815.151	30.90	25.03	V	0.20	---------	25.23	--------	46.0	---------	20.80
990.481	29.20	25.15	V	2.27	---------	27.42	--------	54.0	---------	26.60

* Note: All emissions above 1000 MHz were attenuated below the permissible limit.

7.4 Peak Output Power - FCC Section 15.247(b) (2) IC: RSS-210 A8.4 (1)

7.4.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The measurements were performed with RBW and VBW greater than the measured bandwidth of the signal.

7.4.2 Measurement Results

Results are shown below in Table 7.4.2-1 to Table 7.4.2-3 below:

Table 7.4.2-1: RF Output Power (GFSK)

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Power (dBm)
2402.00	8.60	0.59	9.19
2441.00	8.50	0.59	9.09
2480.00	7.30	0.59	7.89

Table 7.4.2-2: RF Output Power (π/4 DQPSK)

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Power (dBm)
2402.00	8.40	0.59	8.99
2441.00	8.50	0.59	9.09
2480.00	7.30	0.59	7.89

Table 7.4.2-3: RF Output Power (8DPSK)

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Power (dBm)
2402.00	9.10	0.59	9.69
2441.00	9.00	0.59	9.59
2480.00	7.70	0.59	8.29

7.5 Channel Usage Requirements

7.5.1 Carrier Frequency Separation – FCC: Section 15.247(a) (1) IC: RSS-210 A8.1 (b)

7.5.1.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to ≥ 1% of the span.

7.5.1.2 Measurement Results

Results are shown below in Figure 7.5.1.2-1:

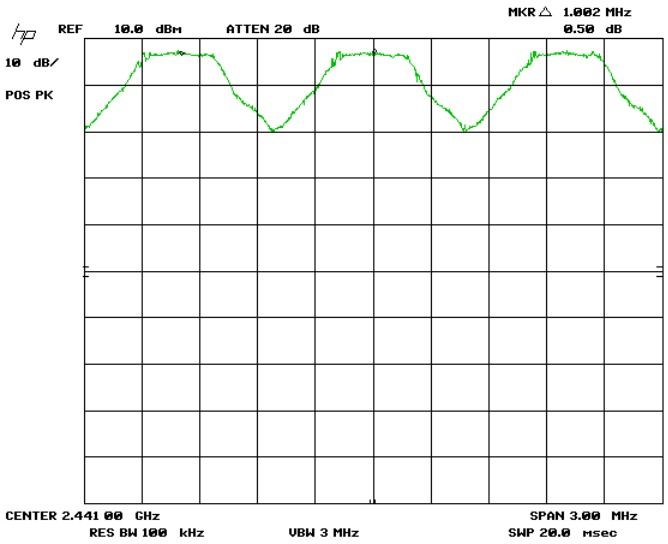

Figure 7.5.1.2-1: Carrier Frequency Separation

7.5.2 Number of Hopping Channels – FCC: Section 15.247(a) (1) (i) IC: RSS-210 A8.1(c)

7.5.2.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The span of the spectrum analyzer was set wide enough to capture the number of hopping channels.

7.5.2.2 Measurement Results

Results are shown below in Figure 7.5.2.2-1 to 7.5.2.2-3.

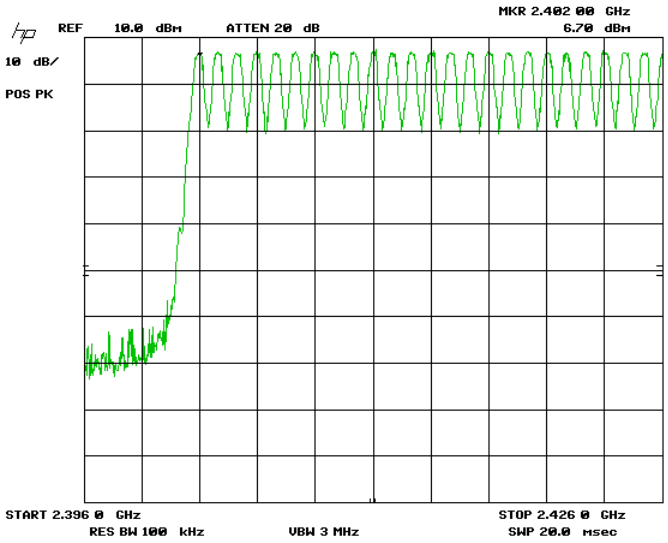

Figure 7.5.2.2-1: Number of Hopping Channels (1 – 25)

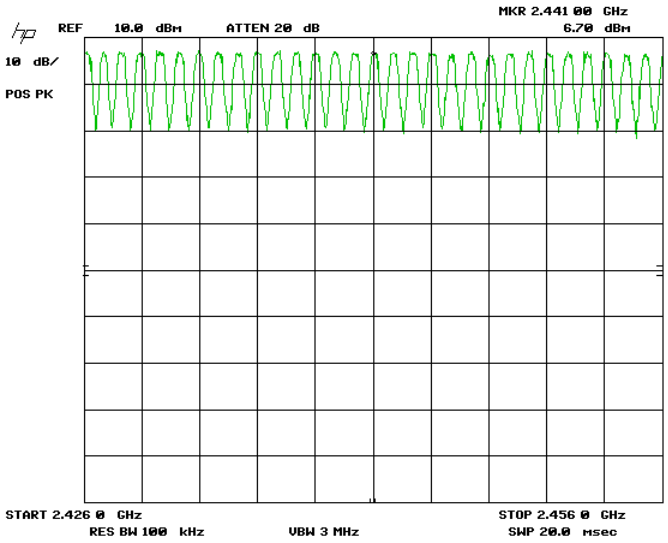

Figure 7.5.2.2-2: Number of Hopping Channels (25 – 55)

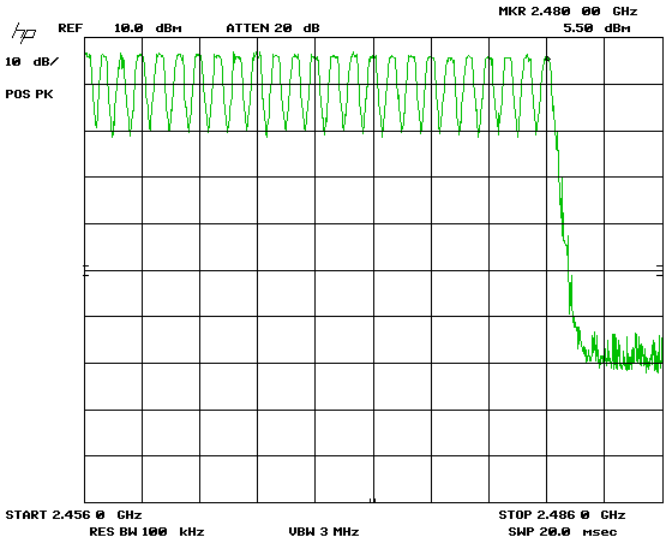

Figure 7.5.2.2-3: Number of Hopping Channels (55 -79)

7.5.3 Channel Dwell Time – FCC: Section 15.247(a) (1) (i) IC: RSS-210 A8.1(c)

7.5.3.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The span of the spectrum analyzer was set 0 Hz centered on a hopping channel. The RBW was set to 1 MHz and the sweep time adjusted to capture the entire dwell time per channel with peak detector max hold function.

7.5.3.2 Measurement Results

Results are shown below in Table 7.5.3.2-1 and Figure 7.5.3.2-1 to Figure 7.5.3.2-3

Table 7.5.3.2-1: Dwell Time on a 31.6 Second Cycle

Packet Format	Number of Hops Per Sec. (NHPS)	Number of Hops per Channel Per Sec. (NHPCPS)	Number of hops on a 31.6 s Cycle (NHPC)	Measured Dwell Times (ms)	Dwell Times on a 31.6 s Cycle	Limit (ms)	Status
DH1	800.00	10.13	320.00	0.38	120.00	400.00	PASS
DH3	400.00	5.06	160.00	1.65	264.00	400.00	PASS
DH5	266.67	3.38	106.67	2.88	306.67	400.00	PASS

*Notes:

NHPS = (1600 /sec)/ (NT+NR) (where NT and NR are the number of transmit and receive packets, respectively)
NHPCPS = NHPS/79
NHPC = NHPCPS * 31.6s
Dwell Time per Cycle = NHPC* Measured Dwell Time

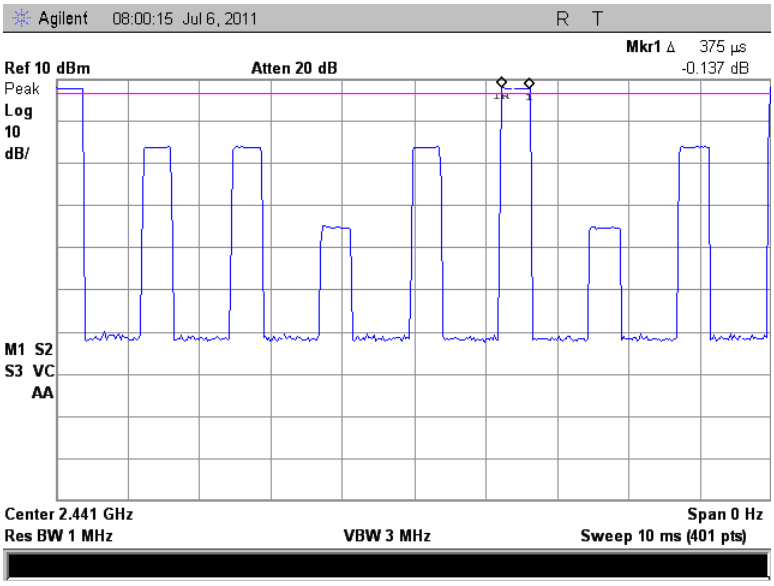

Figure 7.5.3.2-1: Channel Dwell Time – DH1

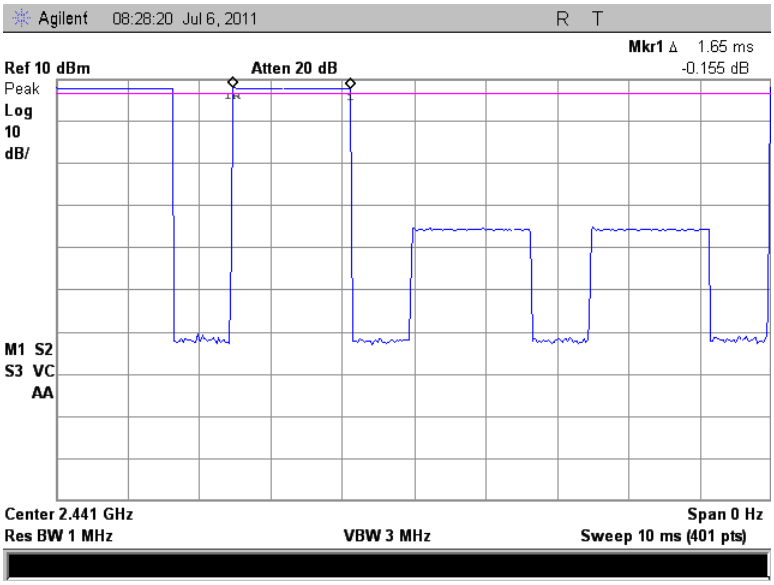

Figure 7.5.3.2-2: Channel Dwell Time – DH3

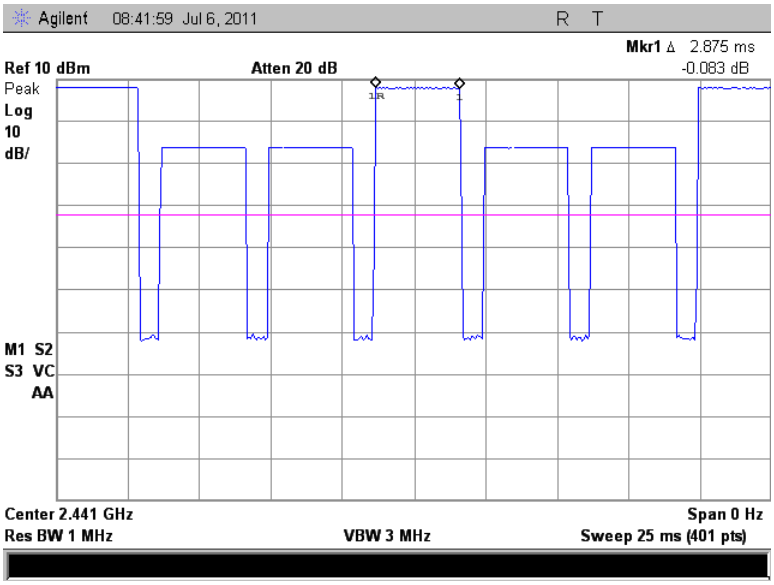

Figure 7.5.3.2-3: Channel Dwell Time – DH5

7.5.4 20dB / 99% Bandwidth - FCC: Section 15.247(a) (1) (i) IC: RSS-210 A8.1(c)

7.5.4.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The spectrum analyzer span was set to 2 to 3 times the estimated bandwidth of the emission. The RBW was to ≥ 1% of the estimated emission bandwidth. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission.

The 99% occupied bandwidth was measured by setting the reference level at measured peak power level with RBW > than the approximate emission bandwidth. Then, the RBW was set to 1% to 3% of the approximate emission width. The trace was set to max hold with a peak detector active. The 99 % occupied bandwidth was measured 26 dB down from the reference level.

7.5.4.2 Measurement Results

Results are shown below in Table 7.5.4.2-1 to Table 7.5.4.2-3 and Figure 7.5.4.2-1 to Figure 7.5.4.2-18.

Table 7.5.4.2-1: 20dB / 99% Bandwidth (GFSK)

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
2402	975	1120
2442	965	1125
2480	1020	1130

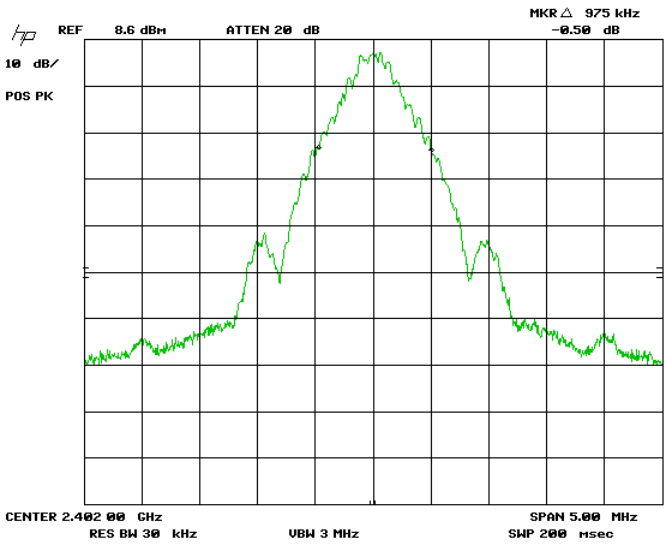

Figure 7.5.4.2-1: 20dB BW Low Channel (GFSK)

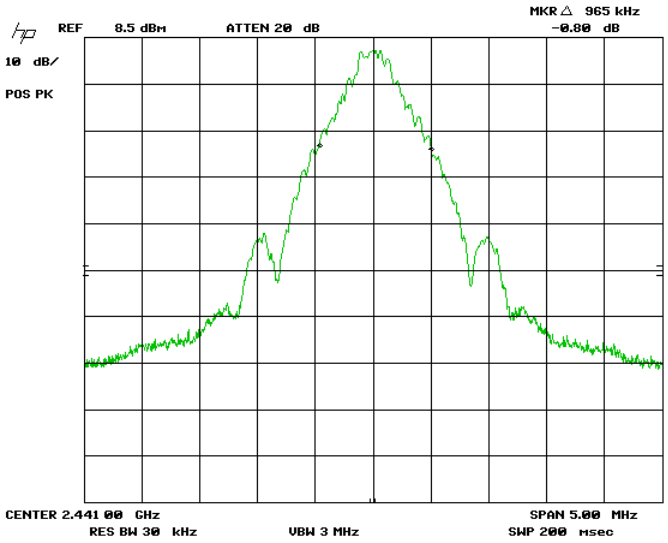

Figure 7.5.4.2-2: 20dB BW Middle Channel (GFSK)

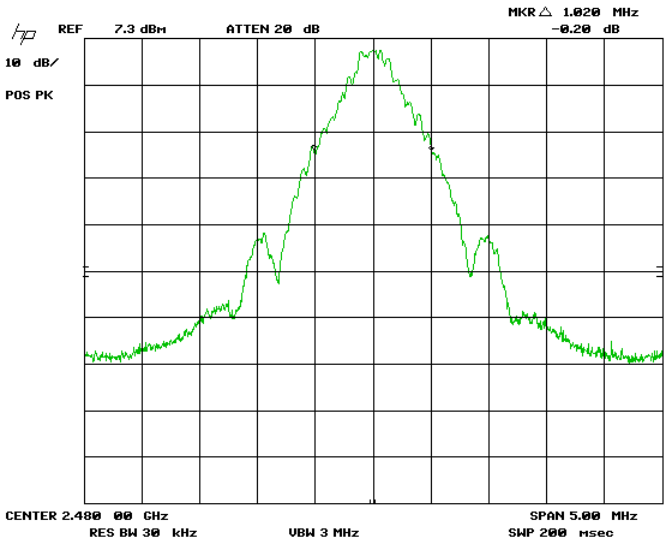

Figure 7.5.4.2-3: 20dB BW High Channel (GFSK)

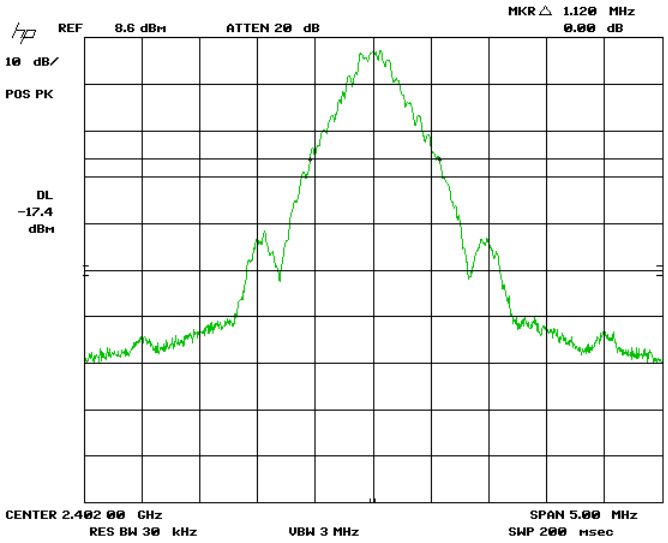

Figure 7.5.4.2-4: 99% OBW Low Channel (GFSK)

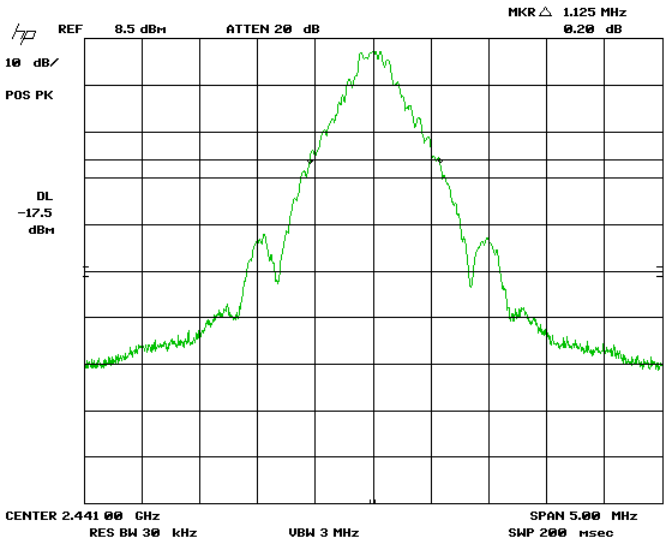

Figure 7.5.4.2-5: 99% OBW Middle Channel (GFSK)

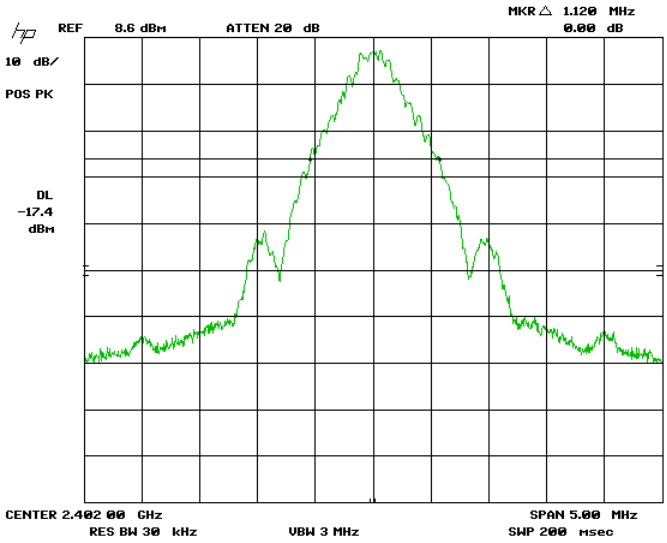

Figure 7.5.4.2-6: 99% OBW High Channel (GFSK)

Table 7.5.4.2-2: 20dB / 99% Bandwidth (π/4 DQPSK)

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
2402	1390	1370
2441	1390	1370
2480	1400	1375

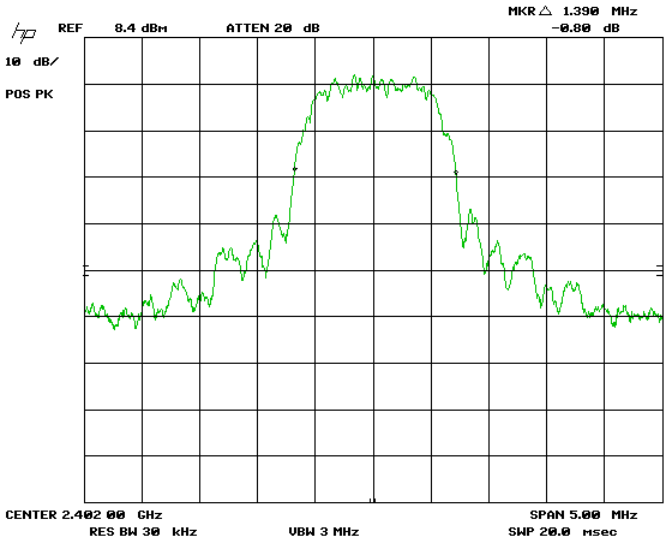

Figure 7.5.4.2-7: 20dB BW Low Channel (π/4 DQPSK)

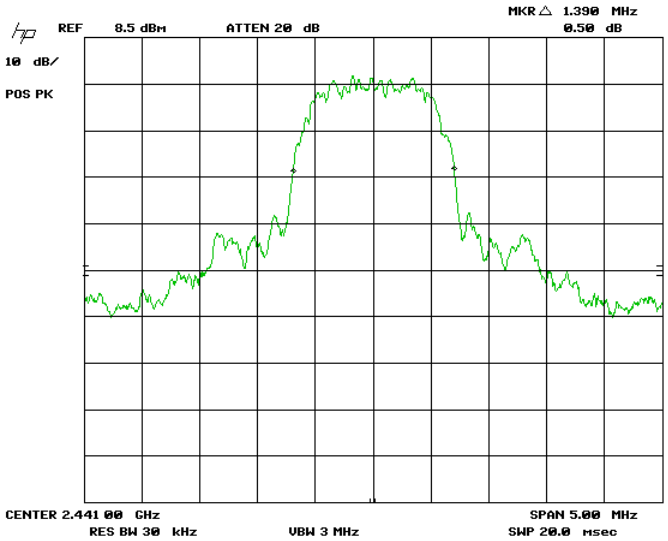

Figure 7.5.4.2-8: 20dB BW Middle Channel (π/4 DQPSK)

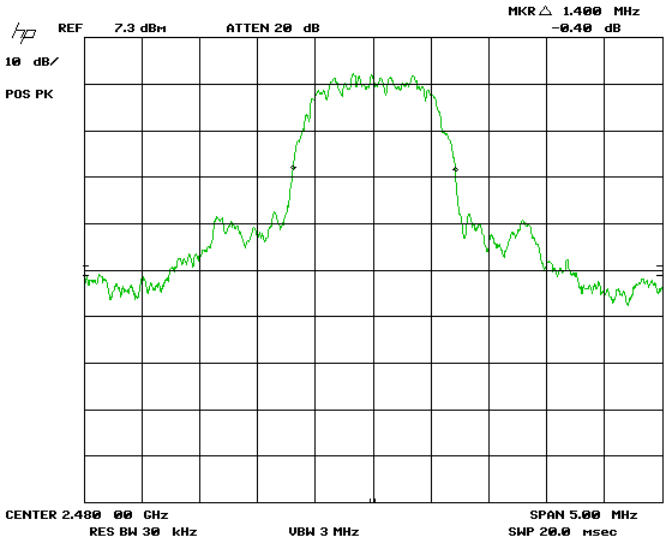

Figure 7.5.4.2-9: 20dB BW High Channel (π/4 DQPSK)

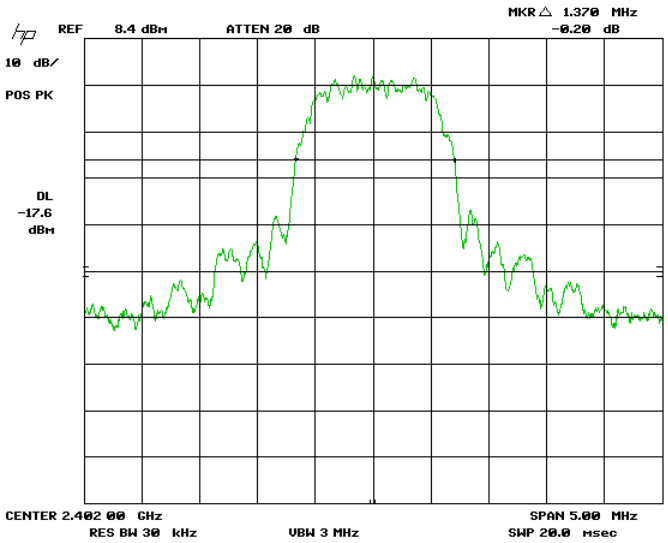

Figure 7.5.4.2-10: 99% OBW Low Channel (π/4 DQPSK)

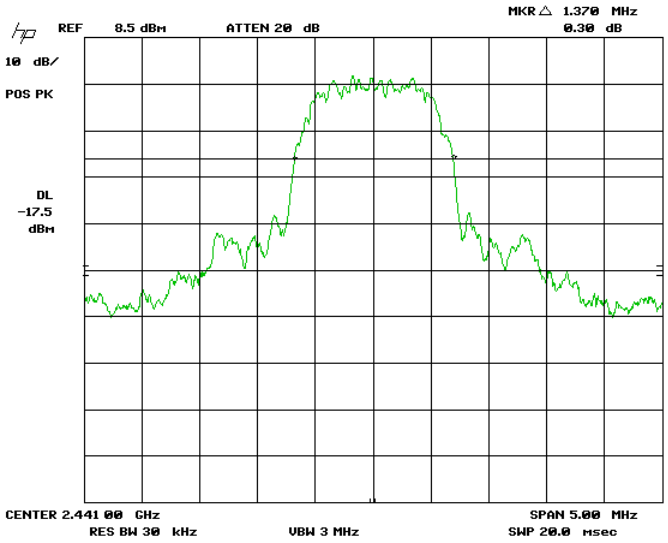

Figure 7.5.4.2-11: 99% OBW Middle Channel (π/4 DQPSK)

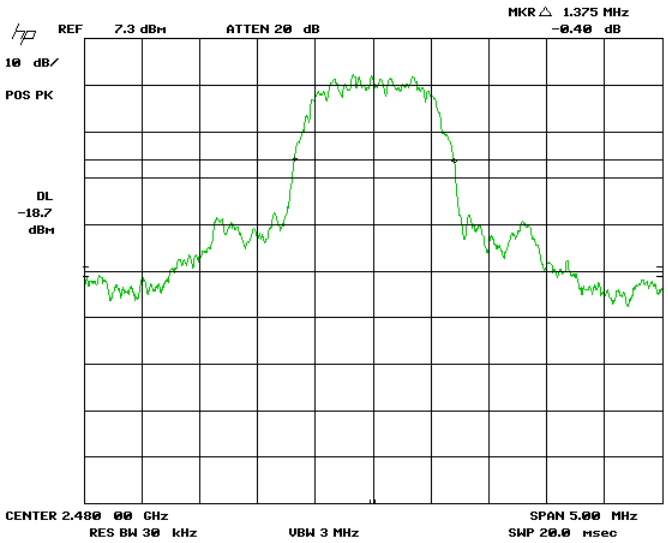

Figure 7.5.4.2-12: 99% OBW High Channel (π/4 DQPSK)

Table 7.5.4.2-3: 20dB / 99% Bandwidth (8DPSK)

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
2402	1380	1345
2441	1380	1345
2480	1385	1355

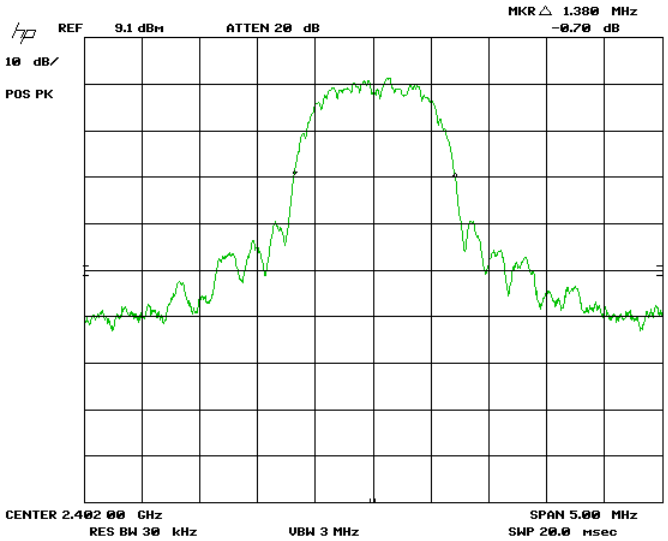

Figure 7.5.4.2-13: 20dB BW Low Channel (8DPSK)

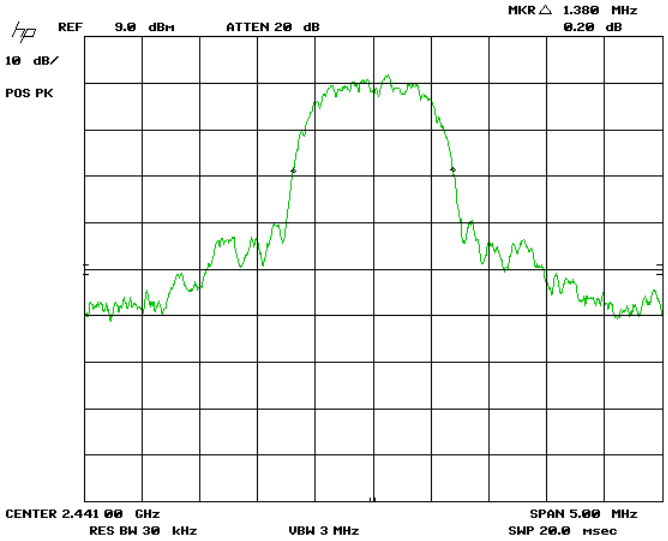

Figure 7.5.4.2-14: 20dB BW Middle Channel (8DPSK)

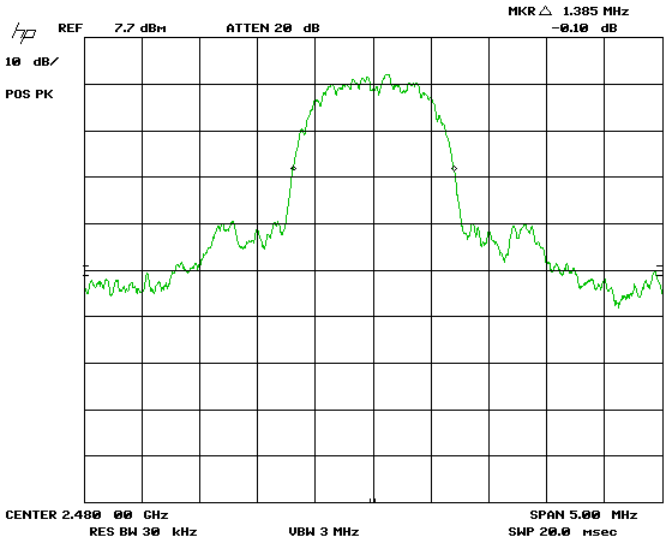

Figure 7.5.4.2-15: 20dB BW High Channel (8DPSK)

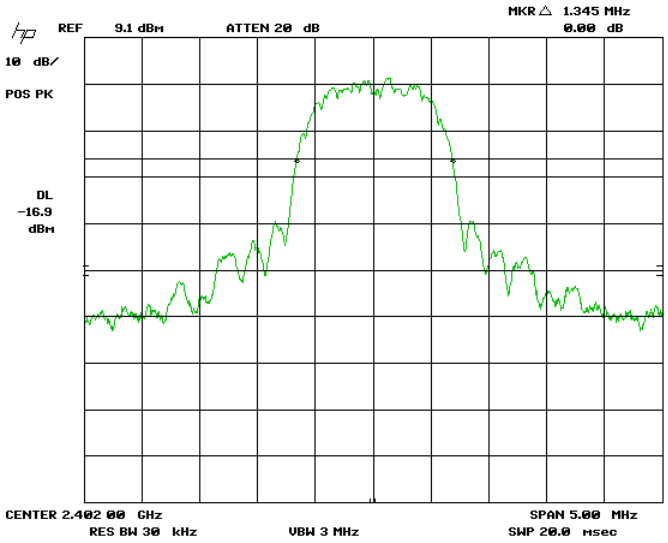

Figure 7.5.4.2-16: 99% OBW Low Channel (8DPSK)

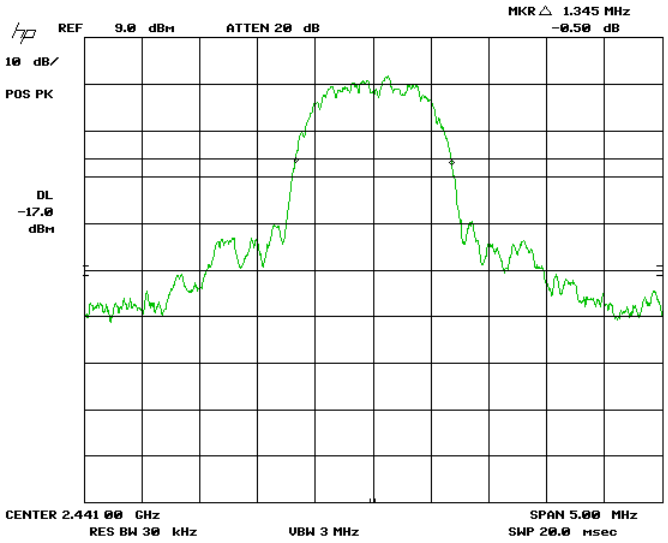

Figure 7.5.4.2-17: 99% OBW Middle Channel (8DPSK)

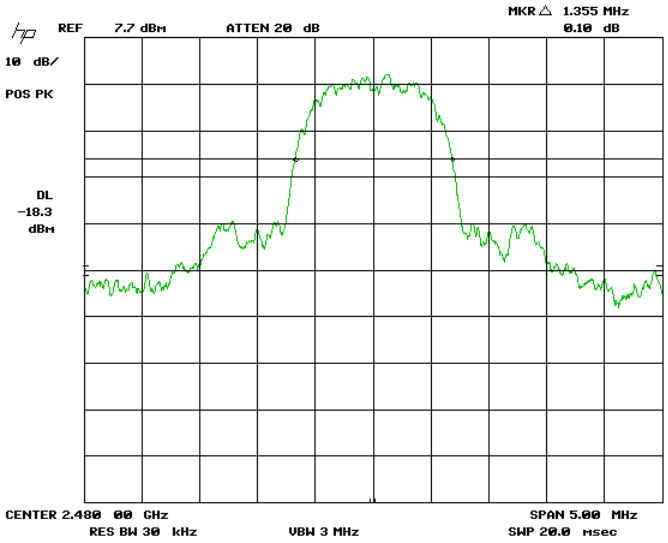

Figure 7.5.4.2-18: 99% OBW High Channel (8DPSK)

7.6 Band-Edge Compliance and Spurious Emissions-FCC 15.247d IC: RSS-210 2.6, A8.5

7.6.1 Band-Edge Compliance of RF Conducted Emissions

7.6.1.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, which is ≥ 1% of the span, and the VBW was set to 3000 kHz.

7.6.1.2 Measurement Results

Results are shown in Table 7.6.1.2-1 to Table 7.6.1.2-3 and Figure 7.6.1.2-1 to Figure 7.6.1.2-12 below.

Table 7.6.1.2-1: Conducted Band Edge - GFSK

	Measured Delta (dB)		Requirements	Band Edge	
	Single TX	Hopping Mode		Single TX	Hopping Mode
Lower Band-Edge	57.9	58.9	>20 dB	Passed	Passed
Upper Band-Edge	64.5	59.3	>20 dB	Passed	Passed

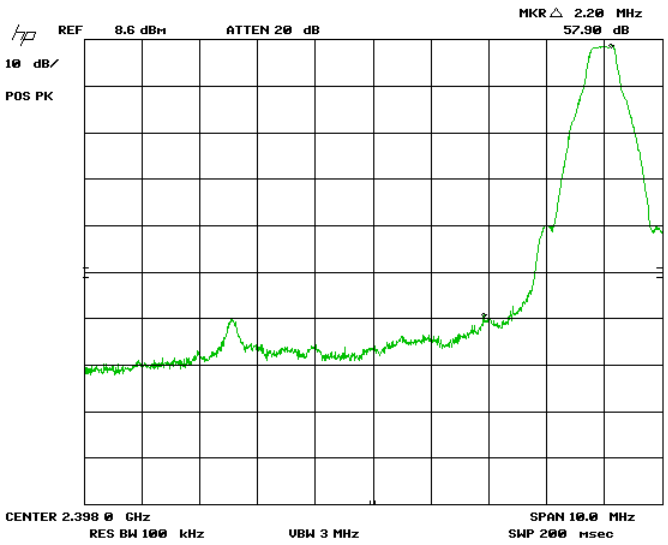

Figure 7.6.1.2-1: Lower Band-edge (GFSK)

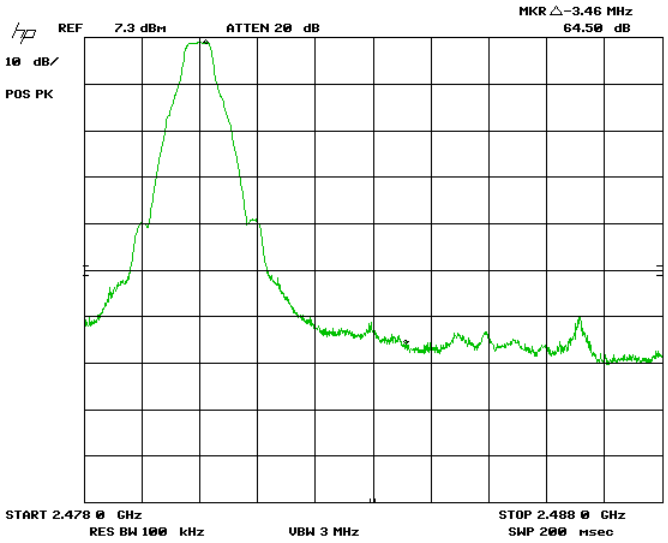

Figure 7.6.1.2-2: Upper Band-edge (GFSK)

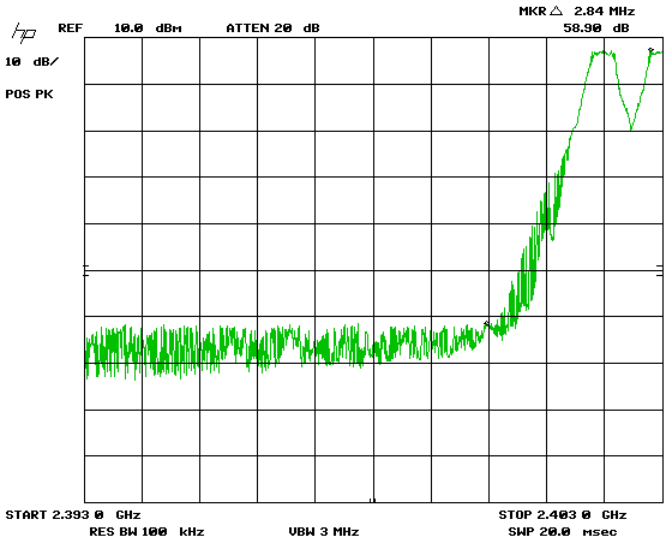

Figure 7.6.1.2-3: Lower Band-edge – Hopping Mode (GFSK)

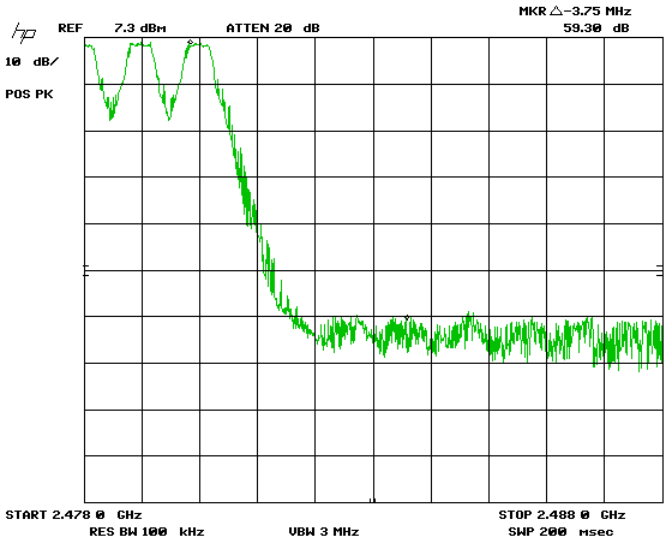

Figure 7.6.1.2-4: Upper Band-edge – Hopping Mode (GFSK)

Table 7.6.1.2-2: Conducted Band Edge - π/4 DQPSK

	Measured Delta (dB)		Requirements	Band Edge	
	Single TX	Hopping Mode		Single TX	Hopping Mode
Lower Band-Edge	48.1	50.2	> 20 dB	Passed	Passed
Upper Band-Edge	54.1	57.3	> 20 dB	Passed	Passed

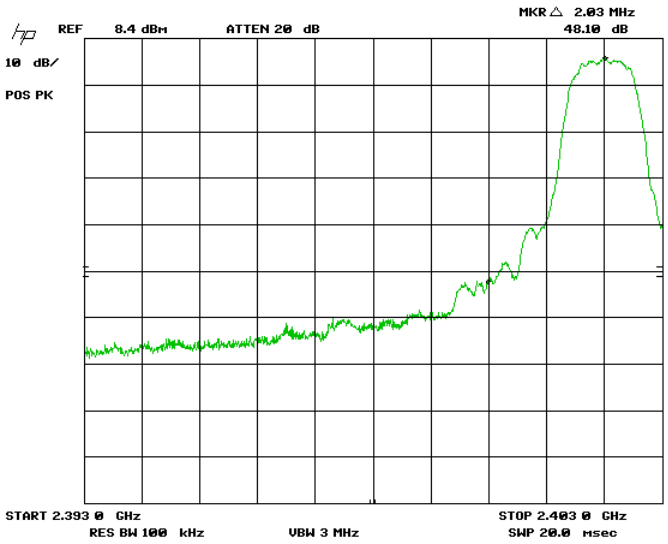

Figure 7.6.1.2-5: Lower Band-edge (π/4 DQPSK)

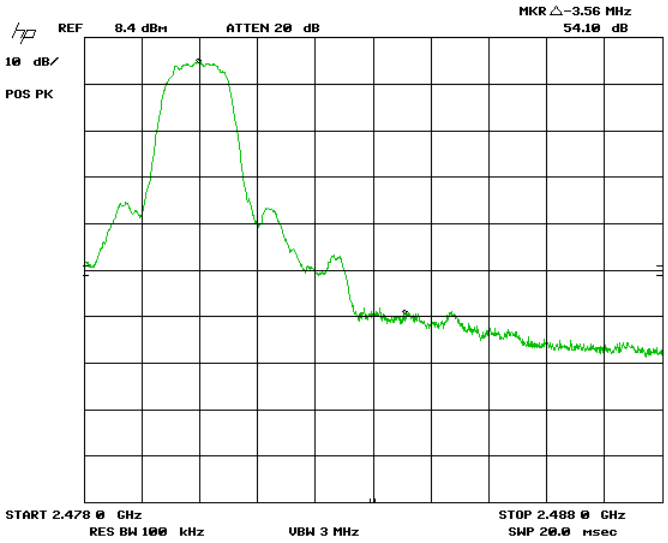

Figure 7.6.1.2-6: Upper Band-edge (π/4 DQPSK)

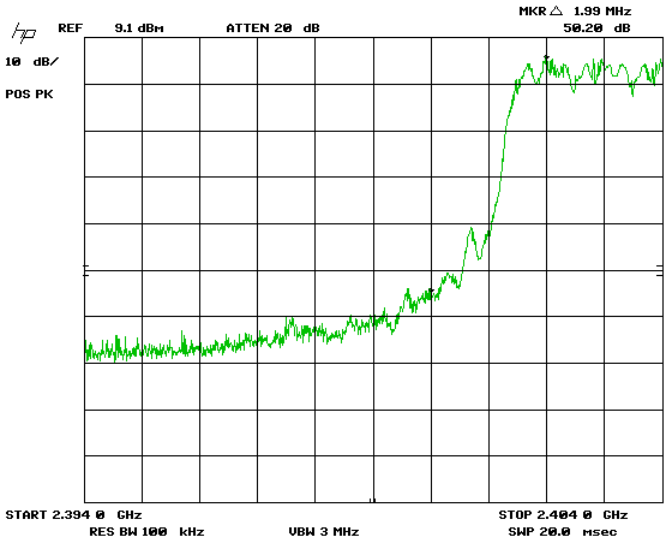

Figure 7.6.1.2-7: Lower Band-edge – Hopping Mode (π/4 DQPSK)

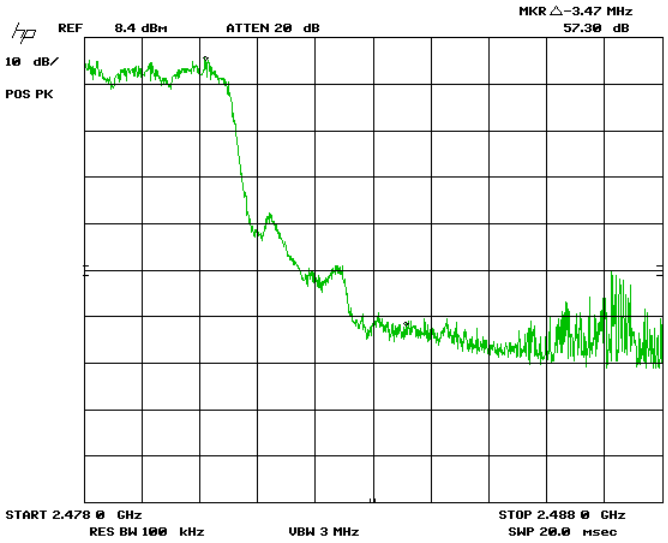

Figure 7.6.1.2-8: Upper Band-edge – Hopping Mode (π/4 DQPSK)

Table 7.6.1.2-3: Conducted Band Edge – 8DPSK

	Measured Delta (dB)		Requirements	Band Edge	
	Single TX	Hopping Mode		Single TX	Hopping Mode
Lower Band-Edge	48.6	50.2	> 20 dB	Passed	Passed
Upper Band-Edge	54.4	55.2	> 20 dB	Passed	Passed

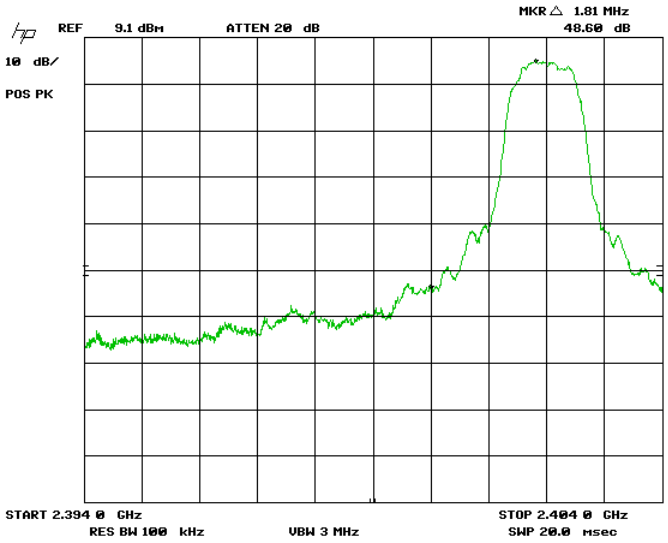

Figure 7.6.1.2-9: Lower Band-edge (8DPSK)

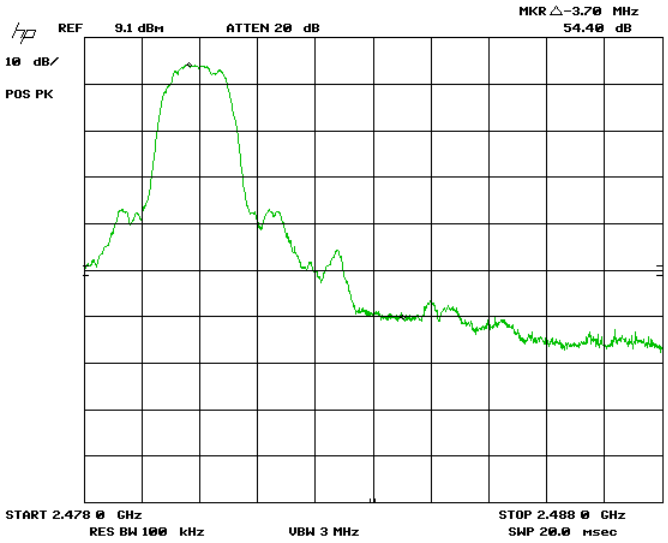

Figure 7.6.1.2-10: Upper Band-edge (8DPSK)

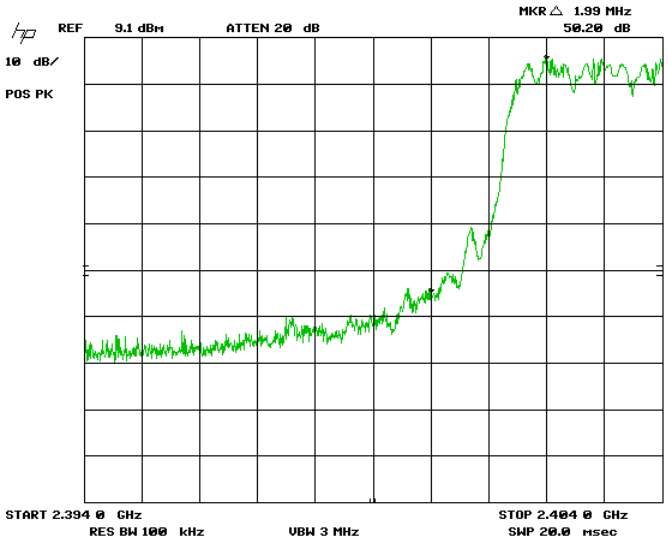

Figure 7.6.1.2-11: Lower Band-edge – Hopping Mode (8DPSK)

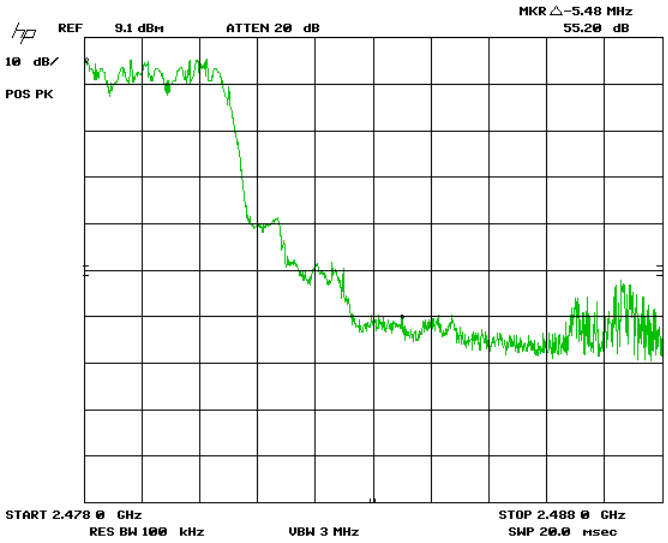

Figure 7.6.1.2-12: Upper Band-edge – Hopping Mode (8DPSK)

7.6.2 Band-Edge Compliance of Radiated Spurious Emissions

7.6.2.1 Measurement Procedure

The EUT was investigated at the low and high channels of operation to determine band-edge compliance. All antenna types were evaluated. Because the upper band-edge coincides with a restricted band, band-edge compliance for the upper band-edge was determined using the radiated mark-delta method. The radiated field strength of the fundamental emission was first determined and then the mark-delta method was used to determine the field strength of the band-edge emission

7.6.2.2 Measurement Results

Band-edge compliance is displayed in Table 7.6.2.2-1 to Table 7.6.2.2-3 and Figure 7.6.2.2-1 to Figure 7.6.2.2-6.

Table 7.6.2.2-1: Upper Band-edge -GFSK

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Margin to Limits (dB)	
										74	54
	pk	Qpk/Avg			pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg
2480	106.90	105.70	H	-3.39	103.51	102.31	60.27	43.24	42.04	30.76	11.96
2480	103.00	101.90	V	-3.39	99.61	98.51	57.70	41.91	40.81	32.09	13.19

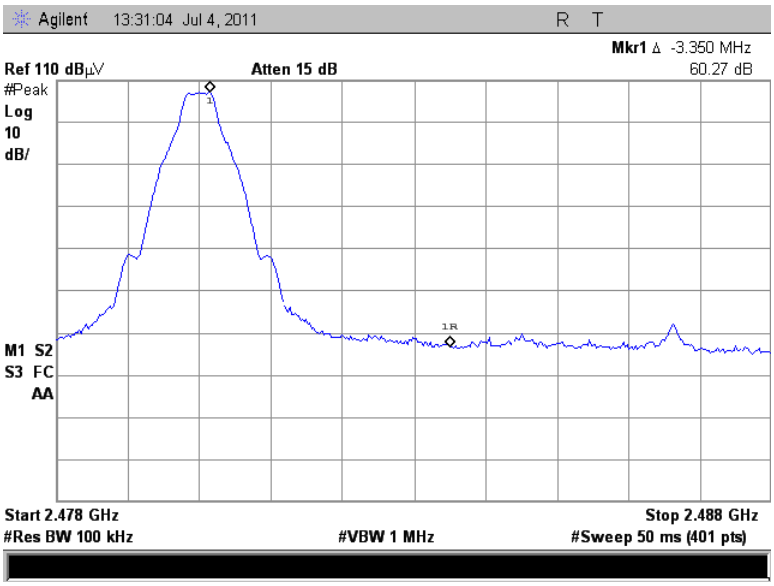

Figure 7.6.2.2-1: Upper Band-edge (GFSK - Horizontal)

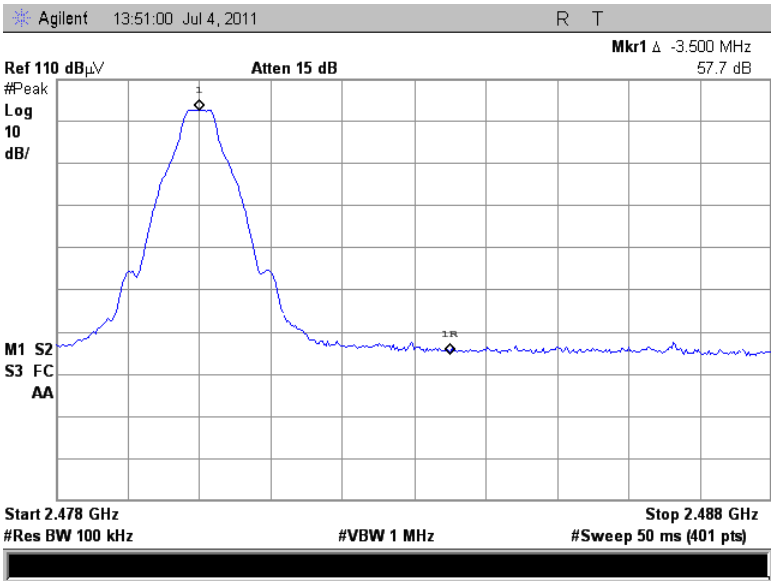

Figure 7.6.2.2-2: Upper Band-edge (GFSK - Vertical)

Table 7.6.2.2-2: Upper Band-edge - π/4 DQPSK

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Margin to Limits (dB)	
										74	54
	pk	Qpk/Avg			pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg
2480	106.60	102.80	H	-3.39	103.21	99.41	53.62	49.59	45.79	24.41	8.21
2480	101.30	97.39	V	-3.39	97.91	94.00	51.14	46.77	42.86	27.23	11.14

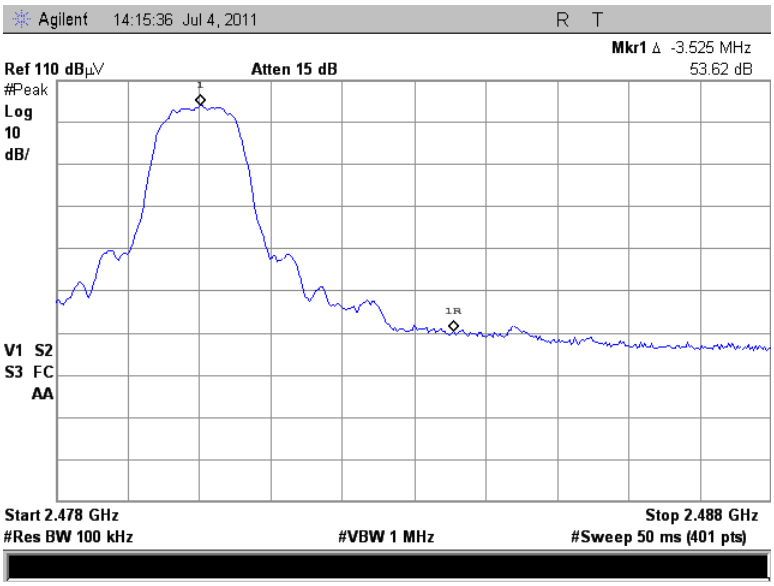

Figure 7.6.2.2-3: Upper Band-edge (π/4 DQPSK - Horizontal)

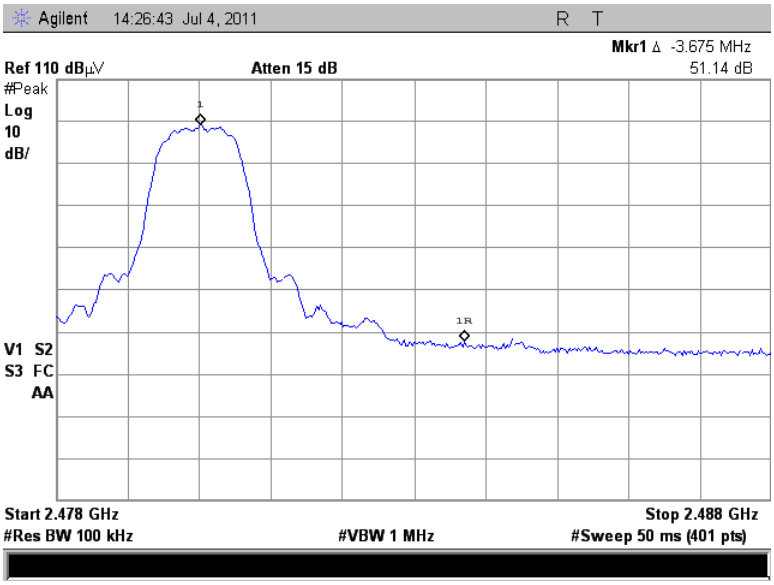

Figure 7.6.2.2-4: Upper Band-edge (π/4 DQPSK - Vertical)

Table 7.6.2.2-3: Upper Band-edge – 8DPSK

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Margin to Limits (dB)	
										74	54
	pk	Qpk/Avg			pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg
2480	106.20	102.20	H	-3.39	102.81	98.81	53.07	49.74	45.74	24.26	8.26
2480	101.80	97.97	V	-3.39	98.41	94.58	52.07	46.34	42.51	27.66	11.49

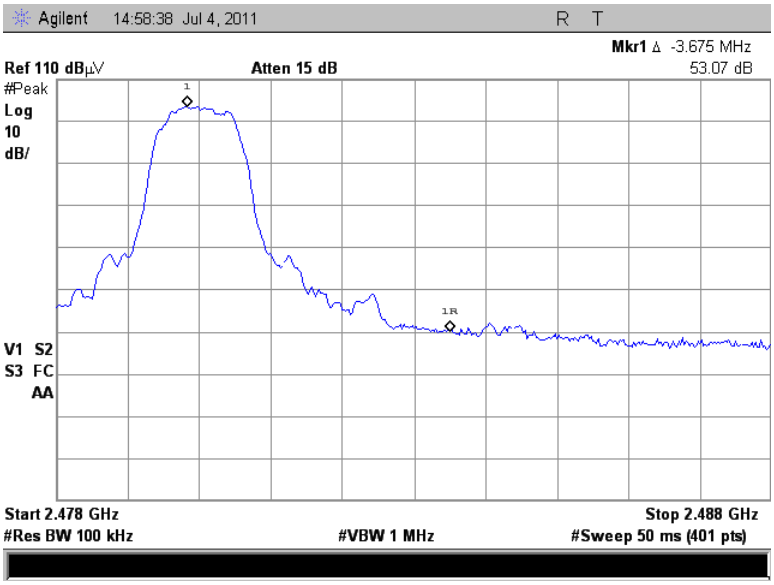

Figure 7.6.2.2-5: Upper Band-edge (8DPSK - Horizontal)

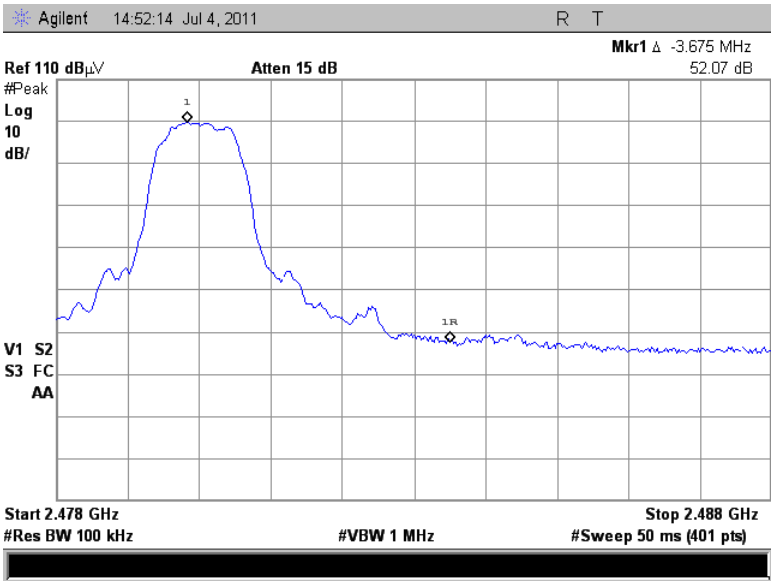

Figure 7.6.2.2-6: Upper Band-edge (8DPSK - Vertical)

7.6.3 RF Conducted Spurious Emissions

7.6.3.1 Measurement Procedure

The RF output port of the EUT was connected to the input of the spectrum analyzer through a temporary SMA connector. The EUT was investigated for conducted spurious emissions from 30MHz to 26.5 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz. A peak detector function was used with the trace set to max hold.

7.6.3.2 Measurement Results

Results are shown below in Table 7.6.3.2-1 to Table 7.6.3.2-3 and Figure 7.6.3.2-1 to Figure 7.6.3.2-18:

Table 7.6.3.2-1: RF Spurious Emissions GFSK

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Spurious Level (dBm)	Limit (dBm)	Margin to Limit (dB)
Low Channel (2402 MHz)					
4804.00	-45.55	0.78	-44.77	-11.81	32.96
9608.00	-52.21	1.09	-51.12	-11.81	39.31
14412.00	-49.78	2.23	-47.55	-11.81	35.74
19216.00	-49.60	1.82	-47.79	-11.81	35.98
Low Channel (2441 MHz)					
4882.00	-44.70	0.78	-43.92	-10.91	33.01
9764.00	-46.61	1.40	-45.21	-10.91	34.31
14646.00	-49.54	1.92	-47.62	-10.91	36.72
19528.00	-48.34	1.62	-46.72	-10.91	35.81
High Channel (2480 MHz)					
4960.00	-46.91	0.78	-46.13	-13.01	33.12
9920.00	-51.42	1.40	-50.02	-13.01	37.02
14880.00	-47.69	2.17	-45.53	-13.01	32.52
19840.00	-48.37	2.05	-46.32	-13.01	33.31

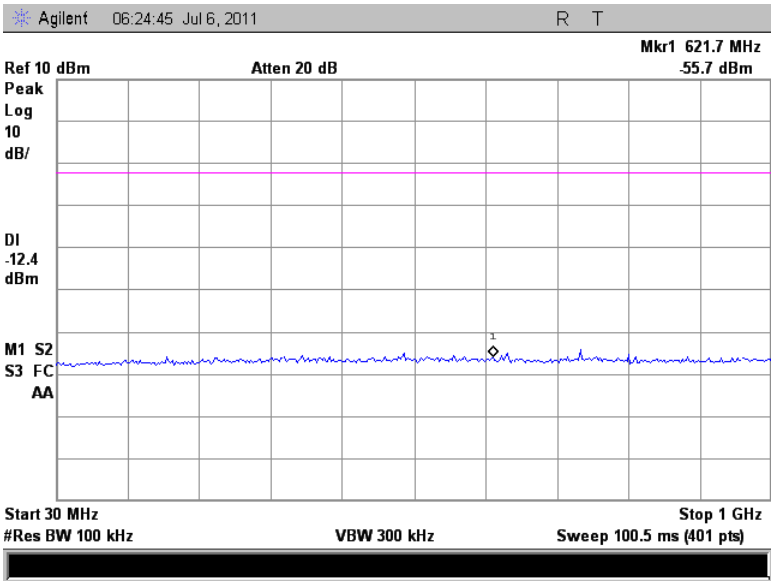

Figure 7.6.3.2-1: 30 MHz – 1 GHz – Low Channel (GFSK)

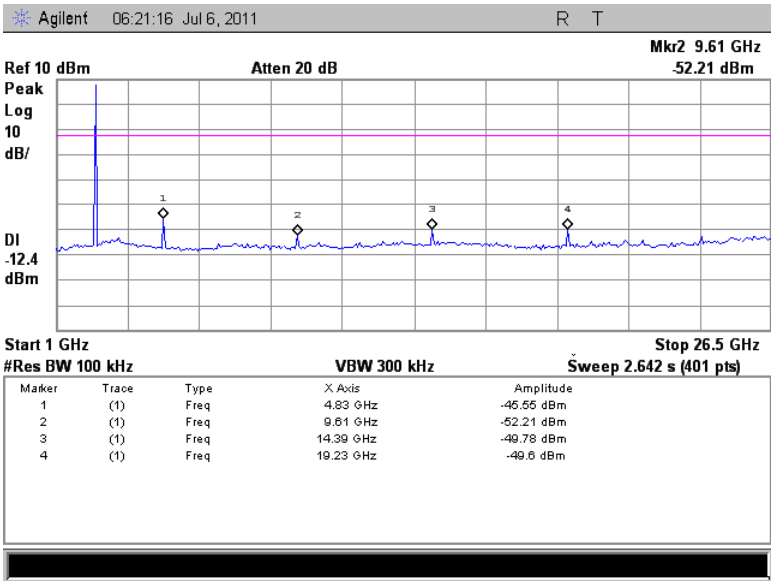

Figure 7.6.3.2-2: 1 GHz – 26.5 GHz – Low Channel (GFSK)

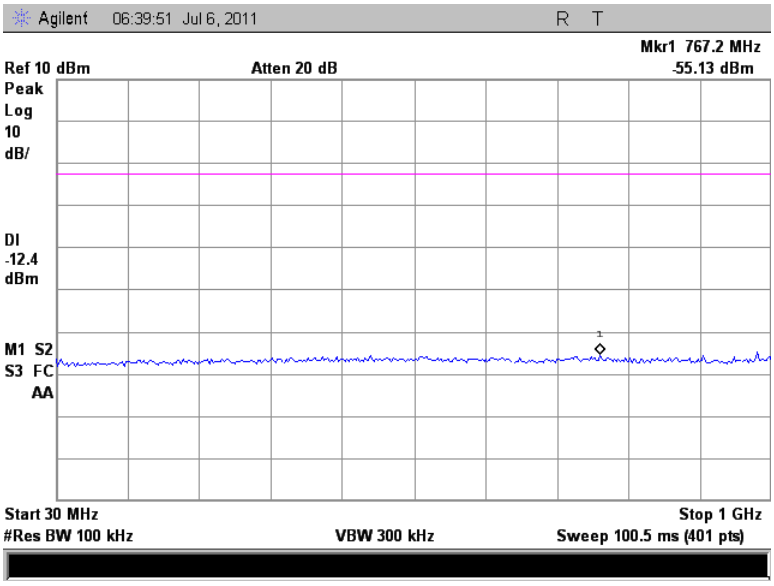

Figure 7.6.3.2-3: 30 MHz – 1 GHz –Mid Channel (GFSK)

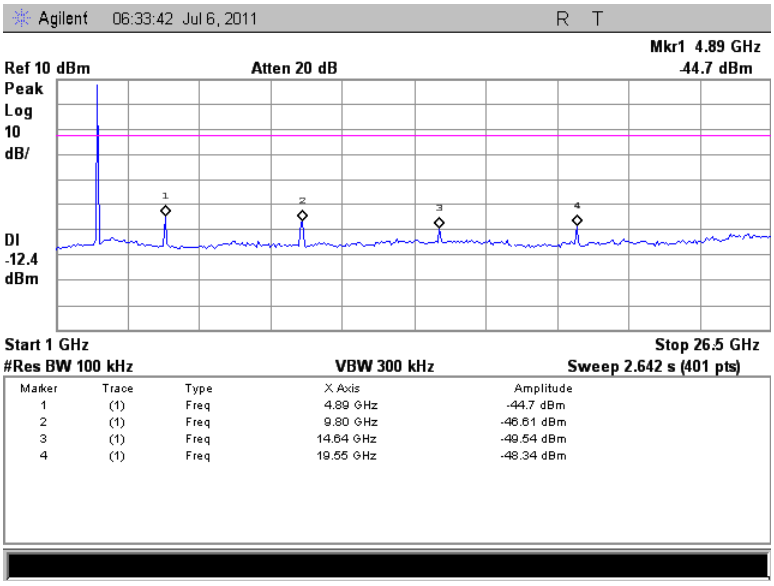

Figure 7.6.3.2-4: 1 GHz – 26.5 GHz – Mid Channel (GFSK)

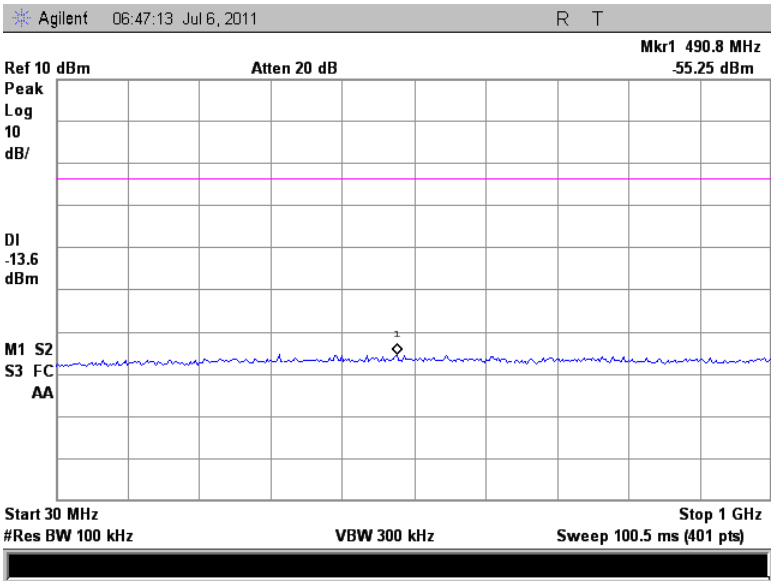

Figure 7.6.3.2-5: 30 MHz – 1 GHz – High Channel (GFSK)

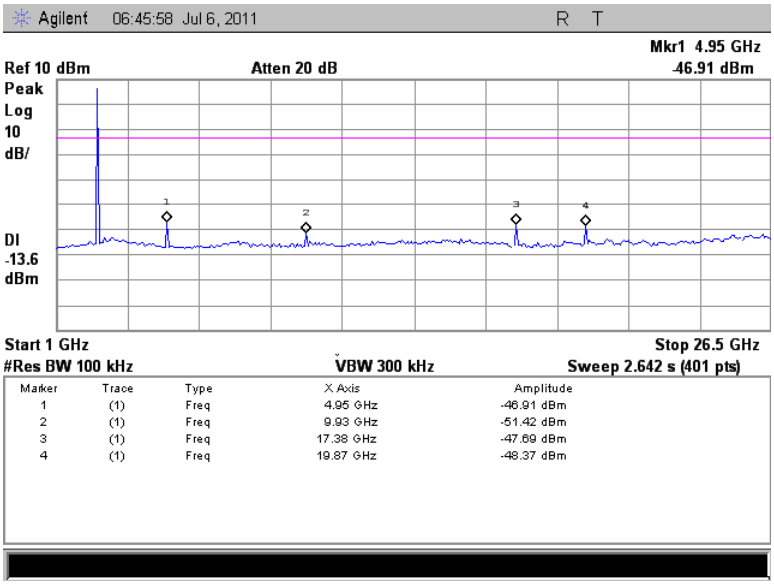

Figure 7.6.3.2-6: 1 GHz – 26.5 GHz –High Channel (GFSK)

Table 7.6.3.2-2: RF Spurious Emissions π/4 DQPSK

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Spurious Level (dBm)	Limit (dBm)	Margin to Limit (dB)
Low Channel (2402 MHz)					
4804.00	-51.55	0.78	-50.77	-15.61	35.16
9608.00	-53.44	1.09	-52.35	-15.61	36.74
14412.00	-48.42	2.23	-46.19	-15.61	30.58
19216.00	-49.21	1.82	-47.40	-15.61	31.79
Low Channel (2441 MHz)					
9764.00	-48.85	1.40	-47.45	-15.81	31.65
14646.00	-48.22	1.92	-46.30	-15.81	30.50
19528.00	-50.42	1.62	-48.80	-15.81	32.99
High Channel (2480 MHz)					
9920.00	-49.90	1.40	-48.50	-16.21	32.30
14880.00	-52.11	2.17	-49.95	-16.21	33.74
19840.00	-49.20	2.05	-47.15	-16.21	30.94

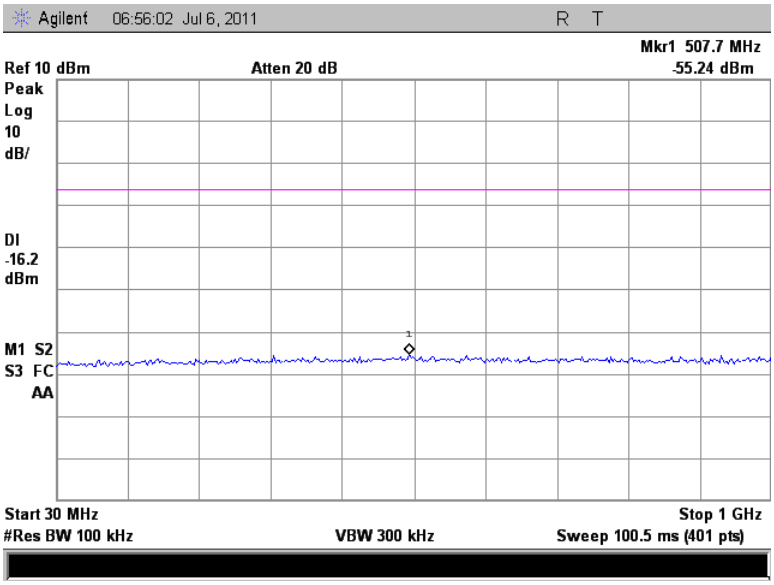

Figure 7.6.3.2-7: 30 MHz – 1 GHz – Low Channel (π/4 DQPSK)

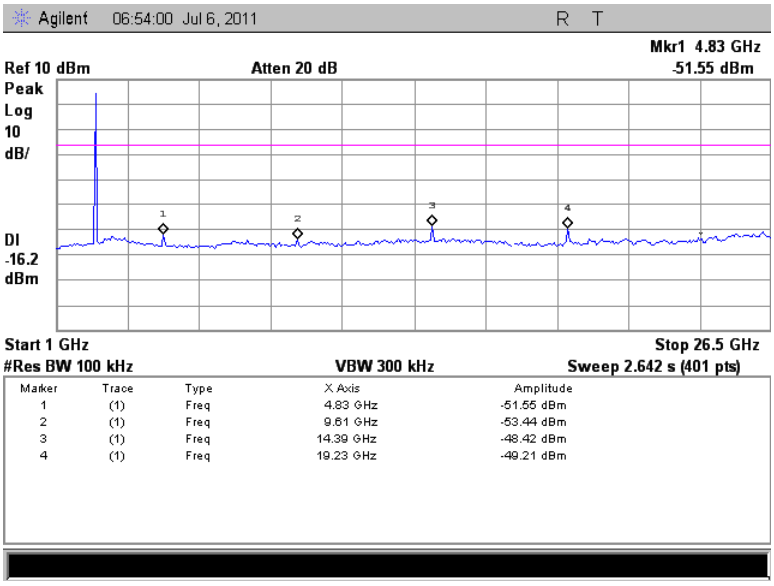

Figure 7.6.3.2-8: 1 GHz – 26.5 GHz – Low Channel (π/4 DQPSK)

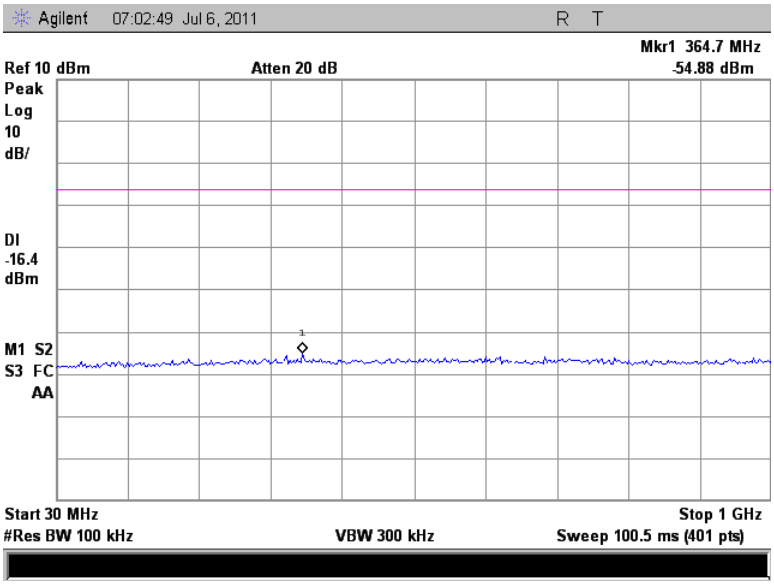

Figure 7.6.3.2-9: 30 MHz – 1 GHz –Mid Channel (π/4 DQPSK)

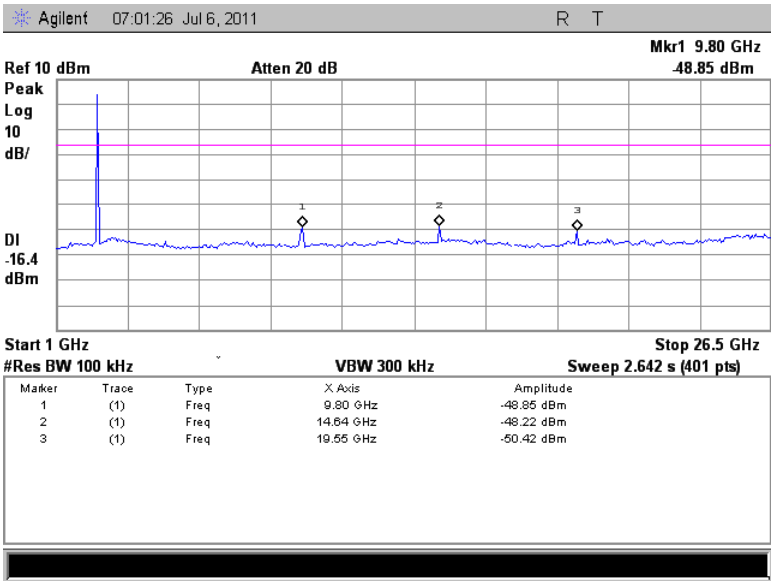

Figure 7.6.3.2-10: 1 GHz – 26.5 GHz – Mid Channel (π/4 DQPSK)

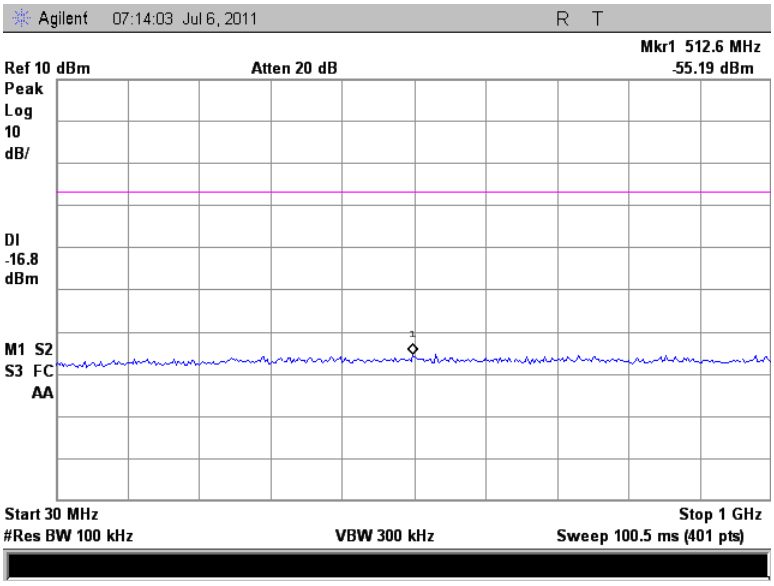

Figure 7.6.3.2-11: 30 MHz – 1 GHz – High Channel (π/4 DQPSK)

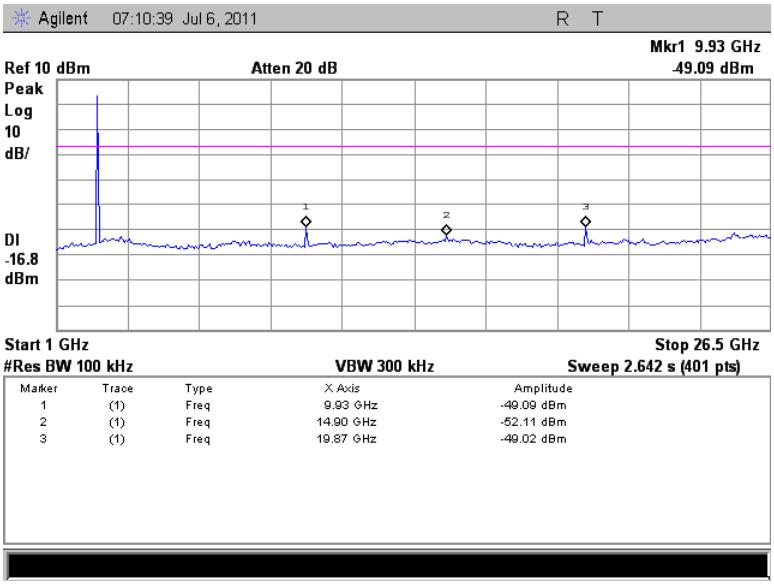

Figure 7.6.3.2-12: 1 GHz – 26.5 GHz –High Channel (π/4 DQPSK)

Table 7.6.3.2-3: RF Spurious Emissions 8DPSK

Frequency (MHz)	Reading (dBm)	Insertion Loss (dB)	Spurious Level (dBm)	Limit (dBm)	Margin to Limit (dB)
Low Channel (2402 MHz)					
4804.00	-51.72	0.78	-50.94	-15.41	35.53
14412.00	-49.96	2.23	-47.73	-15.41	32.32
19216.00	-50.68	1.82	-48.87	-15.41	33.46
Low Channel (2441 MHz)					
9764.00	-51.02	1.40	-49.62	-15.81	33.82
14646.00	-48.53	1.92	-46.61	-15.81	30.81
19528.00	-51.08	1.62	-49.46	-15.81	33.65
High Channel (2480 MHz)					
9920.00	-52.09	1.40	-50.69	-16.41	34.29
14880.00	-52.32	2.17	-50.16	-16.41	33.75
19840.00	-49.53	2.05	-47.48	-16.41	31.07

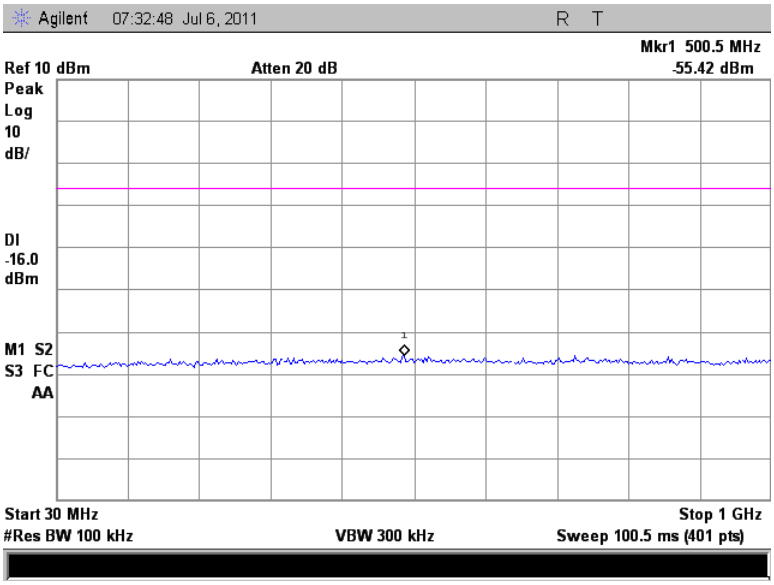

Figure 7.6.3.2-13: 30 MHz – 1 GHz – Low Channel (8DPSK)

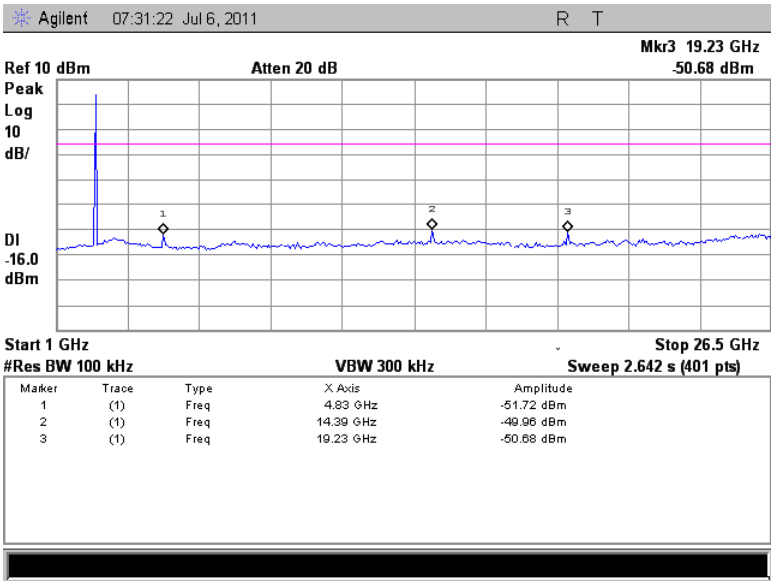

Figure 7.6.3.2-14: 1 GHz – 26.5 GHz – Low Channel (8DPSK)

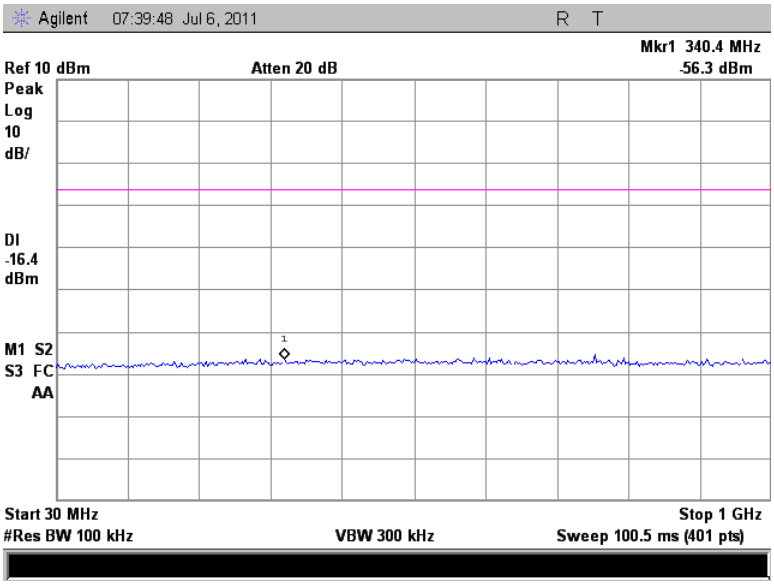

Figure 7.6.3.2-15: 30 MHz – 1 GHz –Mid Channel (8DPSK)

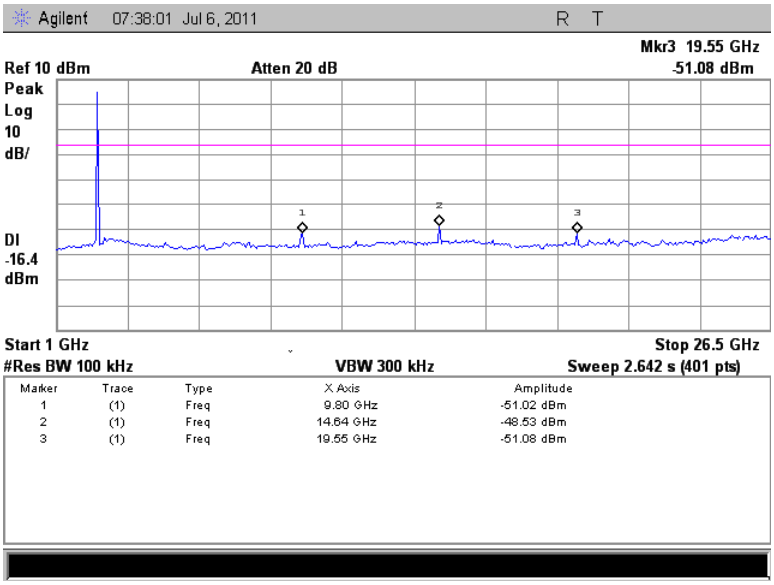

Figure 7.6.3.2-16: 1 GHz – 26.5 GHz – Mid Channel (8DPSK)

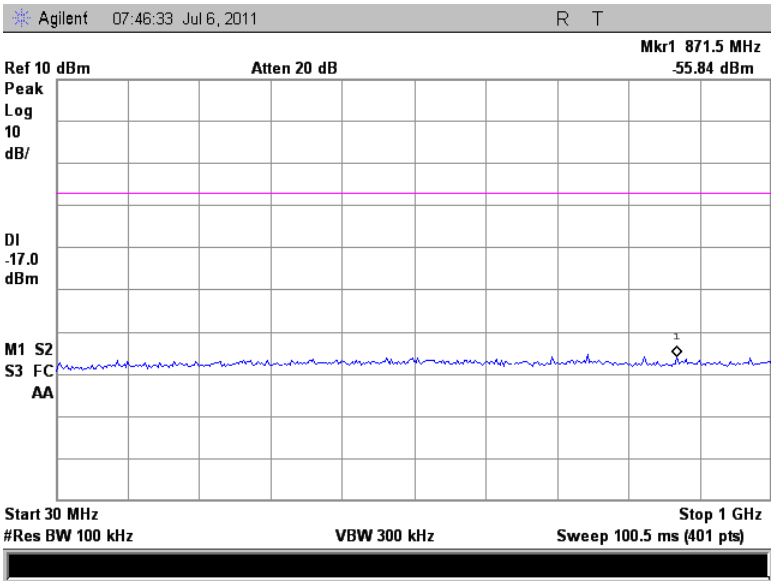

Figure 7.6.3.2-17: 30 MHz – 1 GHz – High Channel (8DPSK)

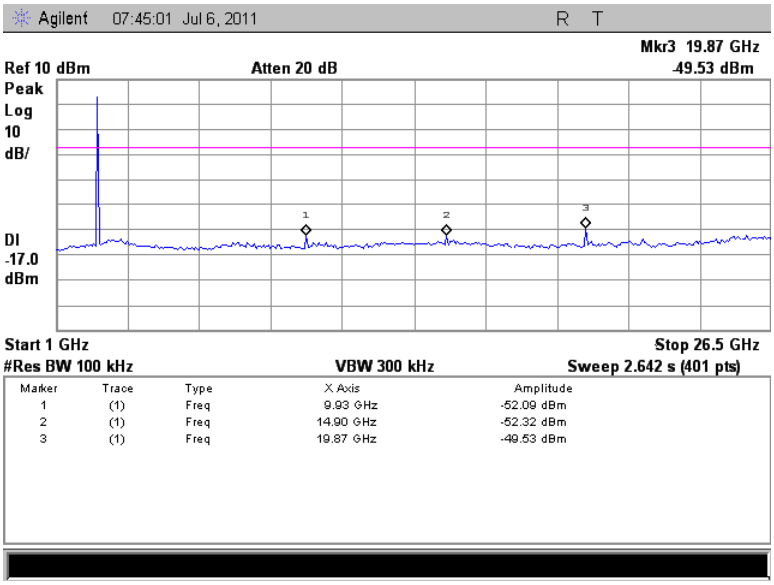

Figure 7.6.3.2-18: 1 GHz – 26.5 GHz –High Channel (8DPSK)

7.6.4 Radiated Spurious Emissions - FCC Section 15.205 IC: RSS-210 2.6

7.6.4.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 26.5 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements made with RBW and VBW of 1 MHz and 3 MHz respectively.

The EUT was caused to generate a continuous carrier signal on the hopping channel.

7.6.4.2 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 26.5 GHz are reported in Table 7.6.4.2-1 to Table 7.6.4.2-3 below. The measurements were performed using the EUT configuration leading to the worst case emissions.

Table 7.6.4.2-1: Radiated Spurious Emissions Tabulated Data (GFSK)

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel (2402 MHz)										
19216	46.92	36.53	H	9.24	56.16	45.77	83.5	63.5	27.30	17.70
19216	53.68	45.14	V	9.24	62.92	54.38	83.5	63.5	20.60	9.10
Middle Channel (2441 MHz)										
19528	48.04	38.76	H	10.10	58.14	48.85	83.5	63.5	25.40	14.60
19528	54.72	46.38	V	10.10	64.82	56.48	83.5	63.5	18.70	7.00
High Channel (2480 MHz)										
2484	55.69	52.29	H	-3.38	52.31	48.91	74.0	54.0	21.70	5.10
19840	46.06	36.46	H	11.46	57.52	47.92	83.5	63.5	26.00	15.60
19840	53.61	45.10	V	11.46	65.07	56.56	83.5	63.5	18.40	6.90

* Note:

1. All emissions above 19840 MHz were attenuated below the permissible limit and the noise floor of the measurement equipment.
2. The measurements above 10 GHz were performed at 1m. The limits were corrected using the distance factor of 20*log(3/1) dB ≈ 9.5 dB.

Table 7.6.4.2-2: Radiated Spurious Emissions Tabulated Data (π/4 DQPSK)

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel (2402 MHz)										
19216	47.45	36.23	H	9.24	56.68	45.47	83.5	63.5	26.80	18.00
19216	55.73	44.63	V	9.24	64.97	53.86	83.5	63.5	18.50	9.60
Middle Channel (2441 MHz)										
19528	46.99	35.78	H	10.10	57.09	45.88	83.5	63.5	26.40	17.60
19528	53.67	43.81	V	10.10	63.77	53.91	83.5	63.5	19.70	9.60
High Channel (2480 MHz)										
2484	59.69	53.65	H	-3.38	56.31	50.27	74.0	54.0	17.70	3.70
19840	46.13	34.74	H	11.46	57.59	46.20	83.5	63.5	25.90	17.30
19840	53.51	43.73	V	11.46	64.97	55.19	83.5	63.5	18.50	8.30

* Note:

1. All emissions above 19840 MHz were attenuated below the permissible limit and the noise floor of the measurement equipment.
2. The measurements above 10 GHz were performed at 1m. The limits were corrected using the distance factor of 20*log(3/1) dB ≈ 9.5 dB.

Table 7.6.4.2-3: Radiated Spurious Emissions Tabulated Data (8DPSK)

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel (2402 MHz)										
19216	48.26	36.65	H	9.24	57.49	45.88	83.5	63.5	26.0	17.6
19216	57.76	46.28	V	9.24	67.00	55.51	83.5	63.5	16.5	8.0
Middle Channel (2441 MHz)										
19528	47.65	37.12	H	10.10	57.74	47.22	83.5	63.5	25.80	16.30
19528	53.70	44.47	102	10.10	63.80	54.56	83.5	63.5	19.70	8.90
High Channel (2480 MHz)										
2485	59.72	46.06	H	-3.37	56.35	42.69	74.0	54.0	17.70	11.30
19840	46.05	34.91	H	11.46	57.51	46.37	83.5	63.5	26.00	17.10
19840	53.32	43.62	V	11.46	64.77	55.07	83.5	63.5	18.70	8.40

* Note:

1. All emissions above 19840 MHz were attenuated below the permissible limit and the noise floor of the measurement equipment.
2. The measurements above 10 GHz were performed at 1m. The limits were corrected using the distance factor of 20*log(3/1) dB ≈ 9.5 dB.

7.6.4.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak
Corrected Level: 48.26 + 9.24 = 57.5dBµV/m
Margin: 83.5 dBuV/m – 57.5dBµV/m = 26.0dB

Example Calculation: Average
Corrected Level: 36.65 + 9.24 = 45.89dBµV
Margin: 63.5 dBuV – 45.89dBµV = 17.61dB

Note: the limits are corrected using a distance factor of 20*log(3/1) dB.

8 CONCLUSION

In the opinion of ACS, Inc. the APX 6000 UHF RANGE 2, manufactured by Motorola Solutions, Inc meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT