

TEST REPORT

FCC Part 90

FCC Part 15 Subpart B

Industry Canada RSS-119, Issue 11: 2011

Industry Canada RSS-Gen, Issue 3: 2009

MANUFACTURER	Meteorcomm LLC 1201 SW 7 th Street Renton WA 98057
MODEL NUMBER(S)	63020
EUT DESCRIPTION	Locomotive Radio 220-222 MHz
SERIAL NUMBER(S) TESTED	FCC #2
TEST REPORT NUMBER	WC1104224.4B Rev A

TÜV SÜD America Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the applicable requirements of FCC Part 90, FCC Part 15 Subpart B and RSS-119, Issue 11: 2011 – “Land Mobile and Fixed Radio Transmitters and Receivers Operating in the Frequency Range 27.41-960 MHz”, and RSS-Gen, Issue 3: 2010 – “General Requirements and Information for the Certification of Radio Apparatus.”

TÜV SÜD America, Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NARTE, and VCCI.

Not Transferable

1.0 TEST RESULT SUMMARY

Tables 1 and 2 summarize the results for the tested EUT with respect to the essential requirements defined in FCC Parts 90, 15 and RSS-119, Issue 11 and RSS-Gen, Issue 3.

1.1. Transmitter

Table 1: Transmitter results summary - mobile

FCC Section	Test	Measured	Limit	Result
§2.1033(c)(5) §90.35	Frequency ranges		217-220 MHz – N/A 220-222 MHz	Complies
§2.1033(c)(6), (7) §2.1046, §90.205 §90.259, §90.729	Power		2 W 217-220 MHz – N/A 250 W 220-221 MHz 50 W 221-222 MHz	Complies
§2.1033(c)(4) §2.1047, §90.210	Emission types		Information only	
§2.1033(c)(4) §2.1047, §90.210	Emission mask		F – 220-222 MHz B – 217-220 MHz – N/A	Complies
§2.1049, §90.209 §90.259, 90.733(d)	Bandwidth		50/25/12.5/6.25 kHz – 217-220 MHz – N/A 4 kHz – 220-222 MHz ⁴	Complies
§2.1051, §2.1057 §90.210	Spurious emissions Case radiation		Mask B - -13 dBm – N/A Mask F - -25 dBm	Complies
§2.1055, §90.213	Frequency stability		1 ppm – 217-220 MHz – N/A 1.5 ppm – 220-222 MHz	Complies
§15.109	Receiver emissions			Complies

RSS-119 Clause	Test	Measured	Limit	Result
RSS-119	Frequency ranges		217-220 MHz – N/A 220-222 MHz ¹	Complies
5.4.3 SRSP-512	Power		5 W 217-218 MHz – N/A 5 W 219-220 MHz – N/A 125 W 220-221 MHz ² 50 W 221-222 MHz	Complies
5.5 Table 3	Emission mask		D or J – 217-218 MHz ³ – N/A D or J – 219-220 MHz ³ – N/A F – 220-222 MHz	Complies
5.5 Table 3	Emission types		Information only	
5.5 Table 3	Bandwidth		11.25 kHz – 217-218 MHz – N/A 11.25 kHz – 219-220 MHz – N/A 4 kHz – 220-222 MHz	Complies
5.8	Spurious emissions		Mask D/J - -20 dBm – N/A Mask F - -25 dBm	Complies
5.3	Frequency stability		5 ppm – 217-218 MHz – N/A 5 ppm – 219-220 MHz – N/A 1.5 ppm – 220-222 MHz	Complies
RSS-Gen Issue 3	Receiver emissions			Complies

¹ RSS-119 limits operation to 217-218 MHz and 219-222 MHz.

² See SRSP-512

³ D or I if device has audio filter

⁴ Licensees, except for licensees authorized on Channels 161 through 170 and 181 through 185, may combine any number of their authorized, contiguous channels (including channels derived from multiple authorizations) to form channels wider than 5 kHz.

NOTE: Antenna gain = per license.

REVISION RECORD

REVISION	TOTAL NUMBER OF PAGES	DATE	DESCRIPTION
	126	12 July 2011	Initial Release
A	128	28 October 2011	Page 8: added traceability statement. Page 15-16: Added modulation mask information.



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2. Introduction

This testing is intended to verify the Meteorcomm 63020 Locomotive Radio is performing in accordance with the requirements of FCC Part 90, RSS-Gen and RSS-119.

This test report consists of:

- Test result summary
- List of contents
- Introduction and further information
- Equipment application data
- Detailed test information
- List of measurement equipment with calibration validity
- Photographs and further test results (plots, graphs, etc.)

All pages have been numbered consecutively and bear TÜV SÜD America, the test report number, the date, the test specification in its current version as well as the type designation of the EUT. The total number of pages in this report is 128.

The tests were carried out on a representative assembly and in accordance with the test methods stated in:

ANSI C63.4-2003; ANSI TIA-603-C, 2004.

The sample(s) of the product was received on:

09 May 2011

The tests were carried out in the following period of time:

09 - 27 May 2011

3. Testing laboratory

The tests were carried out at TÜV SÜD America:

Wild River Lab
19333 Wild Mountain Road
Taylors Falls MN 55084
Large Test Site Open Area Test Site ☐
Small Test Site Open Area Test Site ☐

Accredited by:

NVLAP

Accreditation number 200696-0

Oakwood Lab
Oakwood Town Road
Millville MN 55957-0255

Accredited by:

NVLAP

Accreditation number 200695-0

New Brighton Environmental Testing Lab ☐
1775 Old Highway 8 NW
New Brighton MN 55112

The conducted measurements were provided by:

NextGen RF Design, Inc.
299 Johnson Ave. Suite 170
Waseca, MN 56093

4. Applicant

Company name : Meteorcomm LLC
Address : 1201 SW 7th Street, Renton WA 98057
Country : USA
Contact : Fred Cleveland
Telephone : 253-872-2521 x128
Fax : 253-872-7662
Email : fcleveland@meteorcomm.com

5. Product and product documentation

Samples of the following apparatus were submitted for testing:

Manufacturer : CalAmp Corp
Trademark : Locomotive Radio
Type designation : 63020
Hardware version : N/A
Serial number : FCC#2
Software release : Sprint v16.01
Type of equipment : 220-222 MHz Locomotive Radio

For issuing this report the following product documentation was used:

Test Plan-CDF Locomotive-r1

6. Conclusions, observations and comments

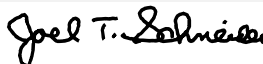
The test report will be filed at TÜV SÜD America for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval from TÜV SÜD America.

TÜV SÜD America Inc reports apply only to the specific samples tested under stated test conditions. TÜV SÜD America Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America Inc issued reports.

TÜV SÜD America assumes the sample to comply with the requirements of FCC Section 1.1307 (b)(1) and IC RSS-102 for the respective test sector, if the test results turn out positive.

Comments: ---

Reviewed By



Joel T Schneider
Senior EMC Engineer

Tested By



Robert J Behringer
EMC Engineer



7.0 ENVIRONMENTAL CONDITIONS IN THE LAB

Temperature: Actual
 : 20-21°C
 Relative Humidity : 32-40%
 Atmospheric pressure : 98-99 kPa

POWER SUPPLY UTILIZED

Power supply system : 74 VDC

MEASUREMENT UNCERTAINTY

Table 3: Measurement uncertainties

Parameter	Maximum Measurement Uncertainty	Actual
Radio Frequency	$\pm 1 \times 10^{-7}$	$\pm 3 \times 10^{-9}$
Radiated emission of transmitter	valid up to 4 GHz ± 6 dB	± 4.8 dB
Radiated emission of receiver	valid up to 4 GHz ± 6 dB	± 4.8 dB
Temperature	± 1 °C	± 0.8 °C
Humidity	± 5 %	± 4.6 %

The equipment comprising the test systems is calibrated on an annual basis. All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated according to internal procedure.

SIGN EXPLANATIONS

- ☐ - not applicable
- ☒ - applicable

8. Transmitter parameters

8.1 Frequency ranges

Test summary

The requirements are: ☒ - MET ☐ - NOT MET

The transmitter is designed to operate in the 220-222 MHz band. The low channel was measured to be 220.0125 MHz. The high channel was measured to be 221.9875 MHz.

Test location

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☒ - NextGen RF Design

Test equipment

	Vendor	Model	Serial Number	Cal Date / Cal Due Date
Spectrum Analyzer	Agilent	PSA N9030A	US4S230321	03-03-2011 / 04-21-2012
Power Supply	HP/Agilent	6030A	2934A-01826	12-16-2010 / 07-07-2011
Computer	Dell	XPS M170	36134745733	N/A
30 dB power attenuator	Weinschel	5009	MA907	Cal by user
Multimeter	Fluke	87V	86670404	04/21/2011 – 04/21/2012
Rx1 Load	Weinschel	2-40	T1328	Cal by user
Rx2 Load	Systron Doner	108328	N/A	Cal by ser
DC Block	PE8210		N/A	Cal by user
50 ohm load	Inmet 3016		N/A	Cal by user
Temperature Chamber	Thermotron	S1.2 MiniMax	NGRF16	N/A

Frequency ranges allowed

FCC 90.35 – 217 - 220 MHz – N/A

220 - 222 MHz

RSS-119 – 217-218 – N/A

219-220 MHz – N/A

220 - 222 MHz

8.2 Power

Test summary

The requirements are: ■ - MET □ - NOT MET

Test location

- - Wild River Lab Large Test Site (Open Area Test Site)
- - Wild River Lab Small Test Site (Open Area Test Site)
- - NextGen RF Design

Test equipment

	Vendor	Model	Serial Number	Cal Date / Cal Due Date
Spectrum Analyzer	Agilent	PSA N9030A	US4S230321	03-03-2011 / 04-21-2012
Power Supply	HP/Agilent	6030A	2934A-01826	12-16-2010 / 07-07-2011
Computer	Dell	XPS M170	36134745733	N/A
30 dB power attenuator	Weinschel	5009	MA907	Cal by user
Multimeter	Fluke	87V	86670404	04/21/2011 / 04/21/2012
Rx1 Load	Weinschel	2-40	T1328	Cal by user
Rx2 Load	Systron Doner	108328	N/A	Cal by ser
DC Block	PE8210		N/A	Cal by user
50 ohm load	Inmet 3016		N/A	Cal by user

Test limits, 220-221 MHz

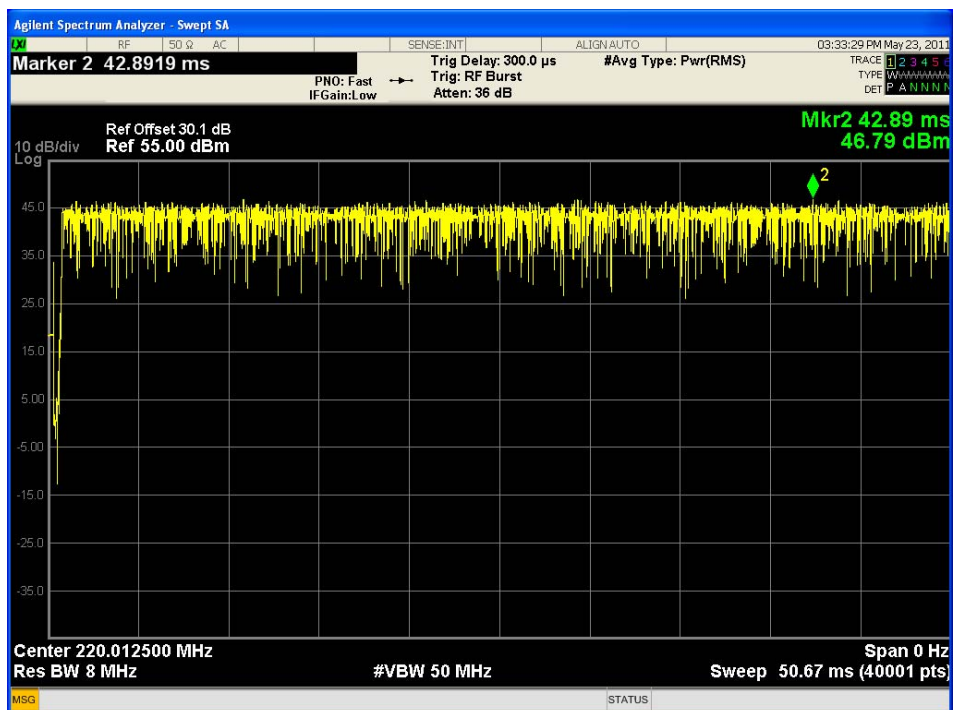
Antenna height above average terrain (HAAT) (meters)	FCC 90.729(a) ERP (Watts)	SRSP-512 6.3.1.1 ERP (Watts)
Up to 150	500	125
150-225	250	125
225-300	125	125
300-450	60	60
450-600	30	30
600-750	20	20
750-900	15	15
900-1050	10	10
Above 1050	5	5

Test limits, 221-222 MHz

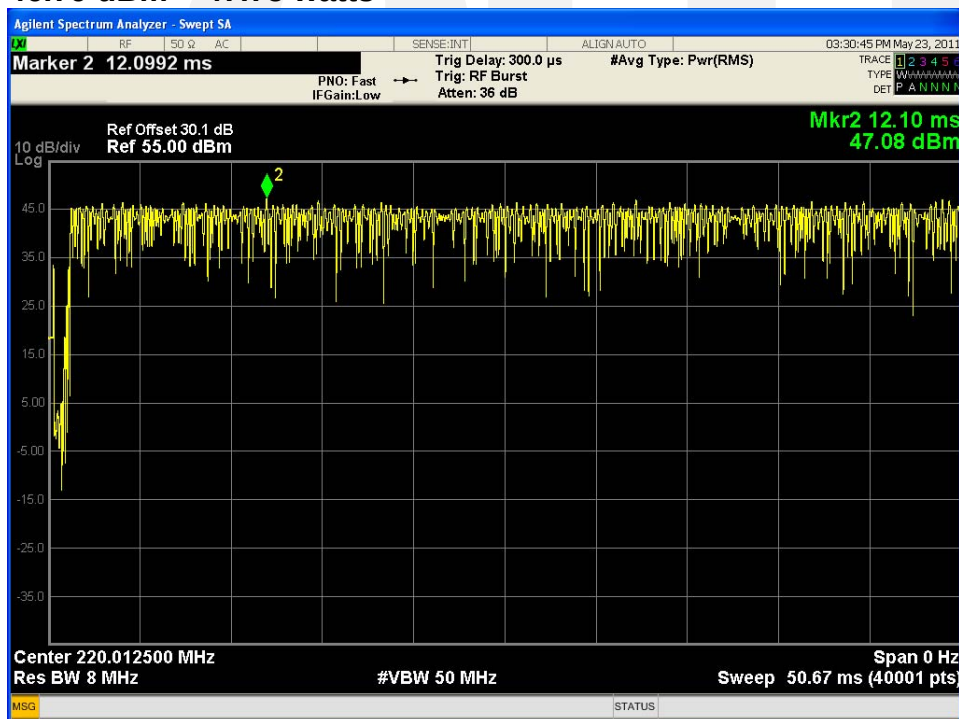
FCC 90.729(b) & SRSP-512 6.3.1.4
50 Watts ERP

Test data

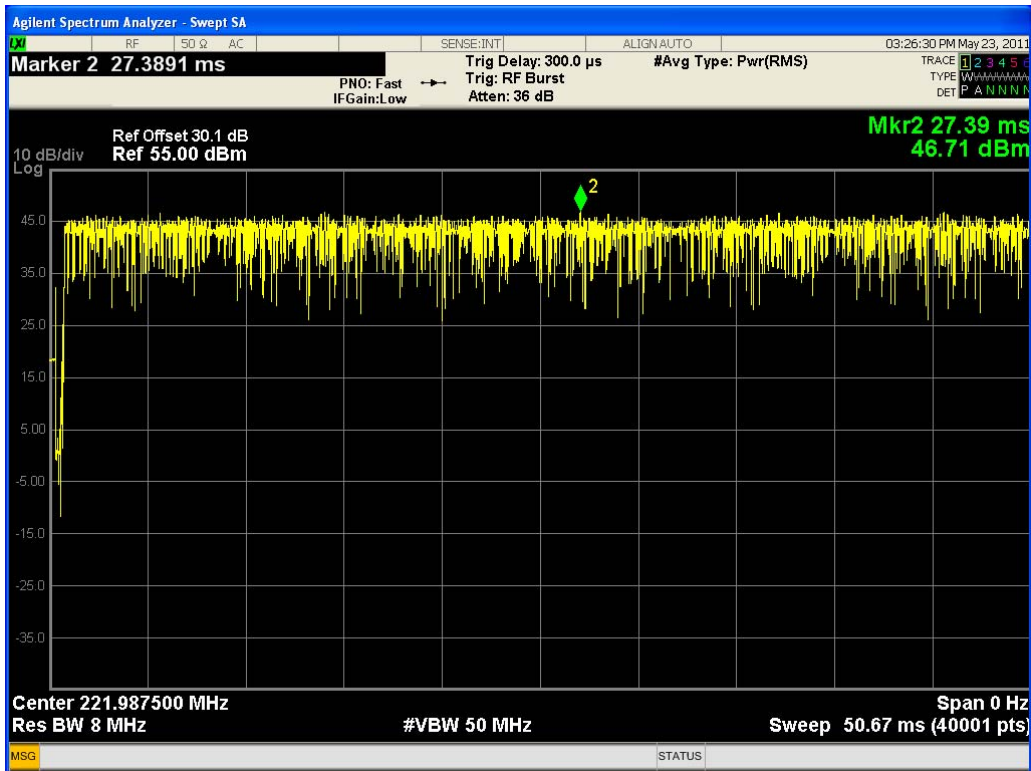
Frequency (MHz)	Modulation	High power		Low power	
		dBm	Watts	dBm	Watts
220.0125	DQPSK	46.79	47.75	41.53	14.22
221.9875	DQPSK	46.71	46.88	41.47	14.03
220.0125	DQPSK Half	47.08	51.05	41.78	15.07
221.9875	DQPSK Half	47.00	50	41.70	14.79



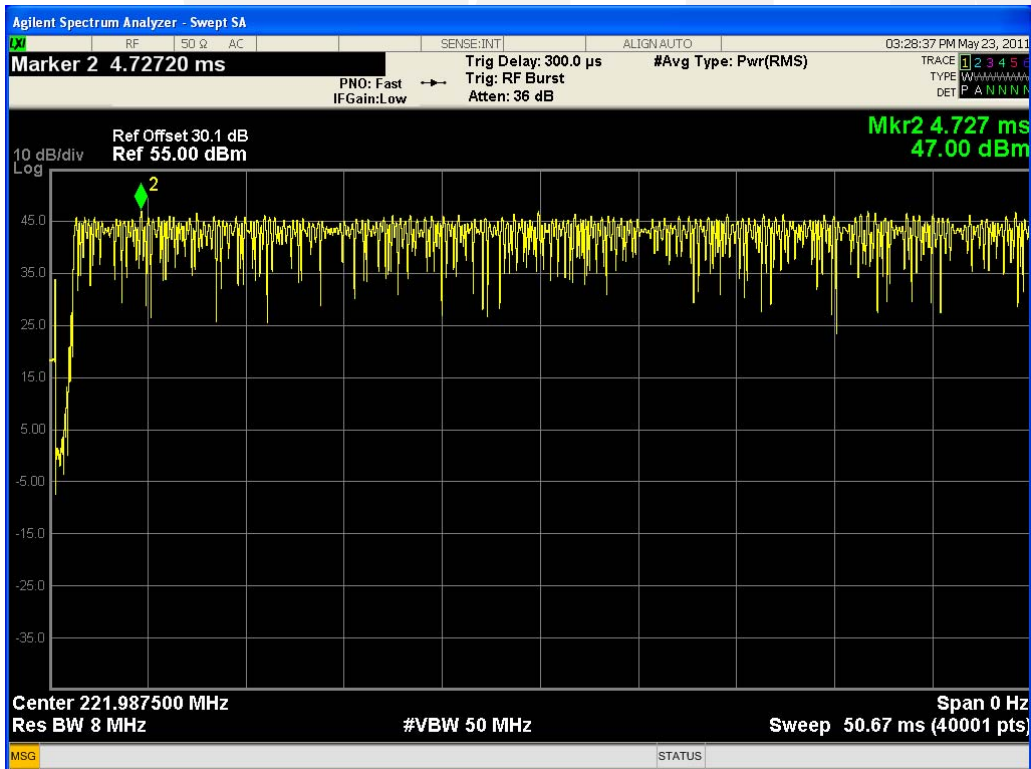
Tx port-Transmit mode-Low Channel: 220.0125 MHz-Modulation: DQPSK
46.79 dBm = 47.75 watts



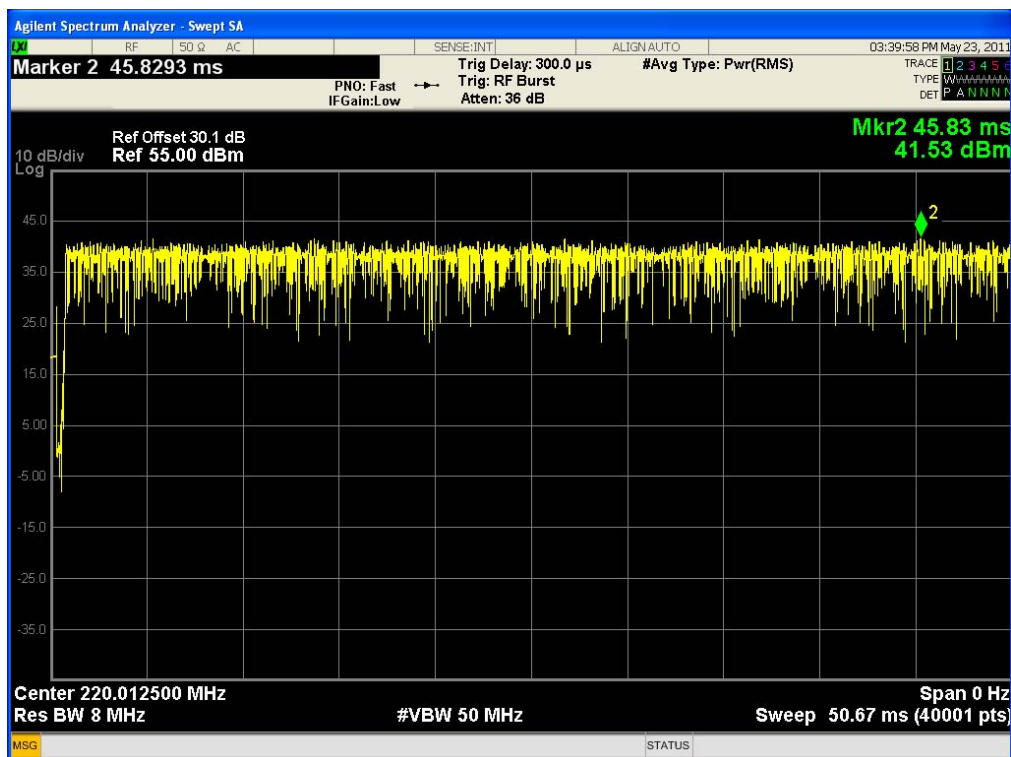
Tx port-Transmit mode-Low Channel: 220.0125 MHz-Modulation: DQPSK_HALF
47.08 dBm = 51.05 watts



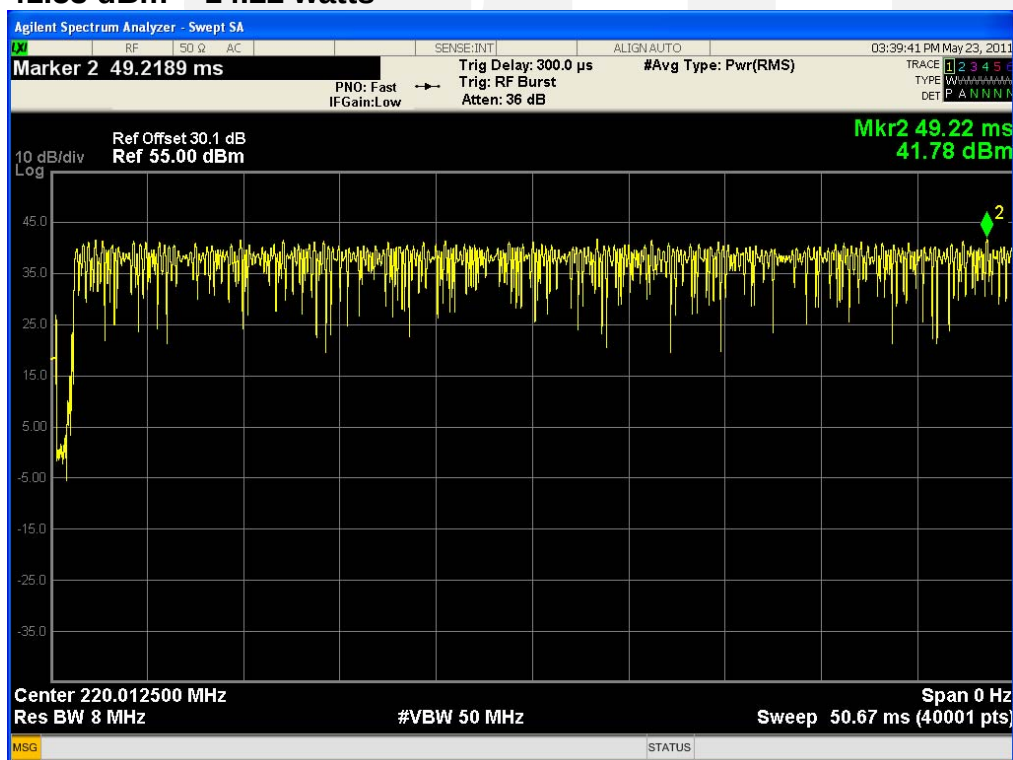
Tx port-Transmit mode-High Channel: 221.9875 MHz-Modulation: DQPSK
46.71 dBm = 46.88 watts



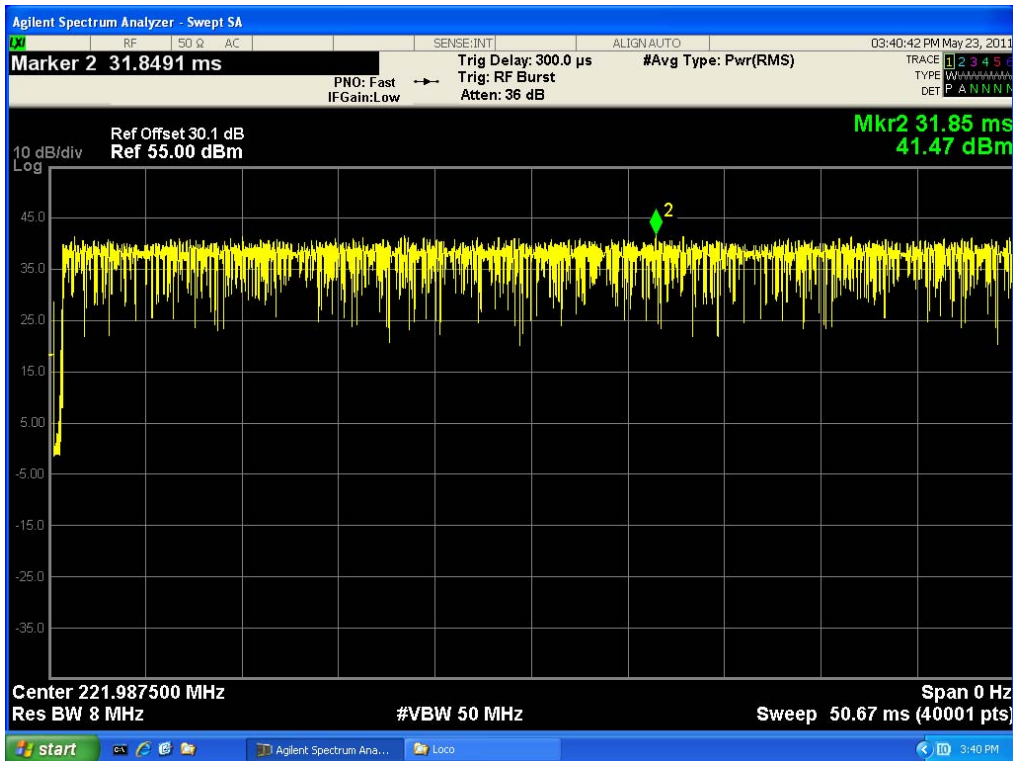
Tx port-Transmit mode-High Channel: 221.9875 MHz-Modulation: DQPSK_HALF
47.00 dBm = 50 watts



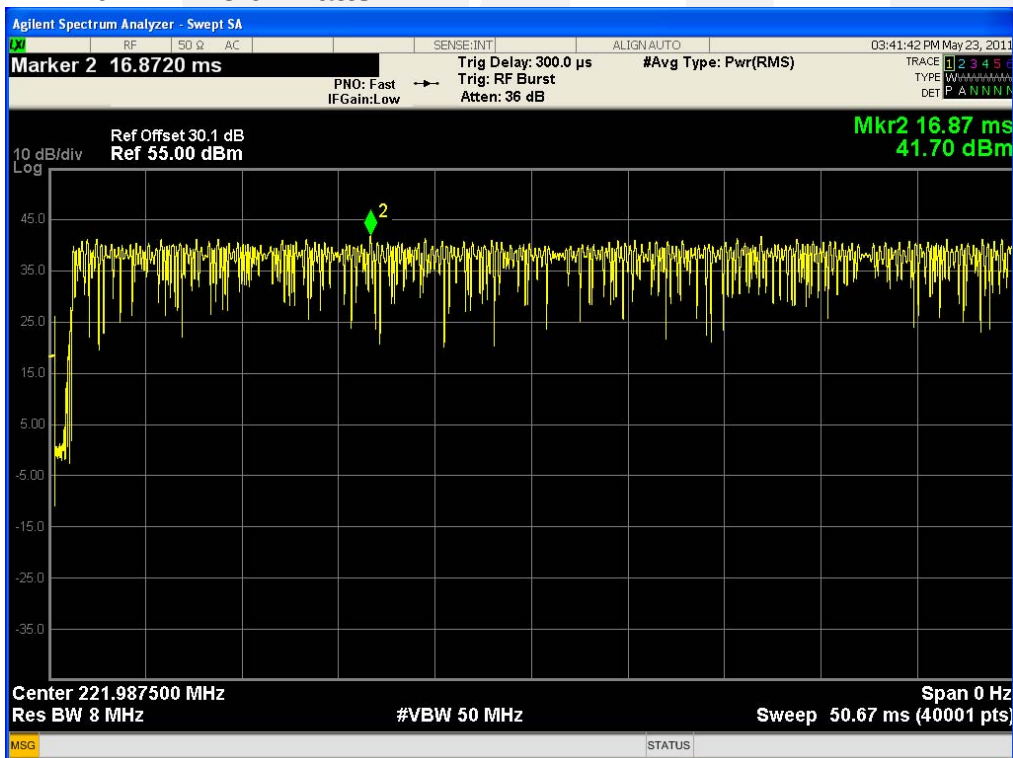
Tx port-Transmit mode-Low Channel: 220.0125 MHz-Modulation: DQPSK
41.53 dBm = 14.22 watts



Tx port-Transmit mode-Low Channel: 220.0125 MHz-Modulation: DQPSK_HALF
41.78 dBm = 15.07 watts



Tx port-Transmit mode-High Channel: 221.9875 MHz-Modulation: DQPSK
41.47 dBm = 15.07 watts



Tx port-Transmit mode-High Channel: 221.9875 MHz-Modulation: DQPSK_HALF
41.70 dBm = 14.79 watts

8.3 Emission mask

Test summary

The requirements are: ■ - MET □ - NOT MET

Test location

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
☐ - Wild River Lab Small Test Site (Open Area Test Site)
☒ - NextGen RF Design

Test equipment

	Vendor	Model	Serial Number	Cal Date / Cal Due Date
Spectrum Analyzer	Agilent	PSA N9030A	US4S230321	03-03-2011 / 04-21-2012
Power Supply	HP/Agilent	6030A	2934A-01826	12-16-2010 / 07-07-2011
Computer	Dell	XPS M170	36134745733	N/A
30 dB power attenuator	Weinschel	5009	MA907	Cal by user
Multimeter	Fluke	87V	86670404	04/21/2011 – 04/21/2012
Rx1 Load	Weinschel	2-40	T1328	Cal by user
Rx2 Load	Systron Doner	108328	N/A	Cal by ser
DC Block	PE8210		N/A	Cal by user
50 ohm load	Inmet 3016		N/A	Cal by user

Test limits

FCC 90.210

F – 220-222 MHz

B – 217-220 MHz - N/A

RSS-119 5.5

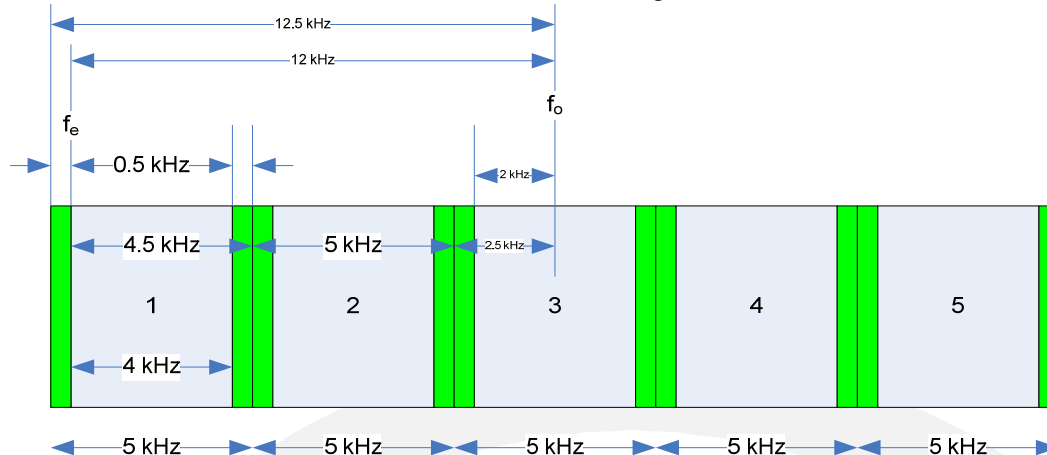
F – 220-222 MHz

D or J – 217-218 MHz and 219-220 MHz³ – N/A

Test data

See following pages

The emission mask for five contiguous channels is created by adjusting the frequency offsets described in 90.210(f) to match the bandwidth of the new channel. The diagram below visually describes the composition of a 25 kHz channel that has been created from five contiguous 5 kHz channels.



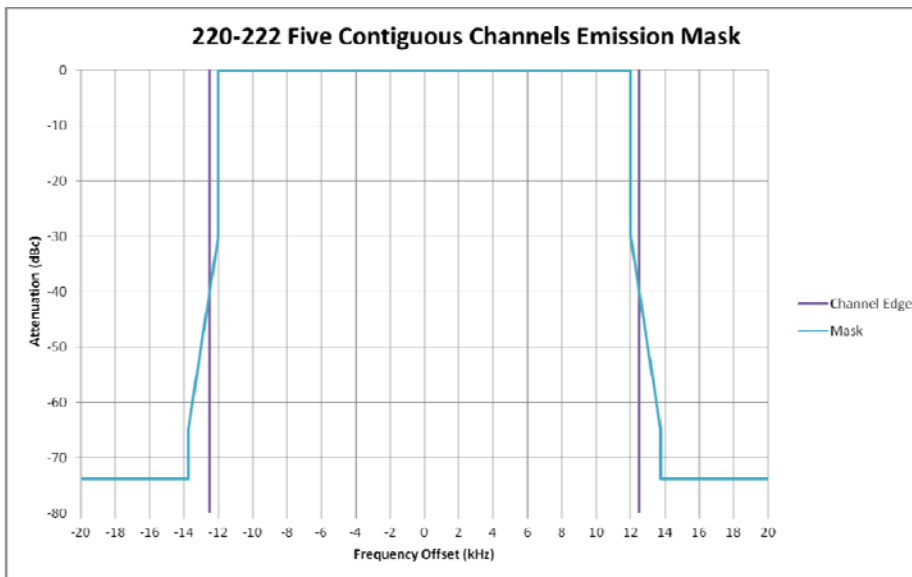
For a single 5 kHz channel, the authorized bandwidth is 4 kHz. For five contiguous channels, the authorized bandwidth is comprised of the five 4 kHz bandwidths plus the eight shared guard bands between the adjacent channels which produces an authorized bandwidth of $5 \times 4 + 8 \times 0.5 = 24$ kHz.

A 25 kHz channel emissions mask based on the band edge requirements defined in 90.210(f) would be described by the following.

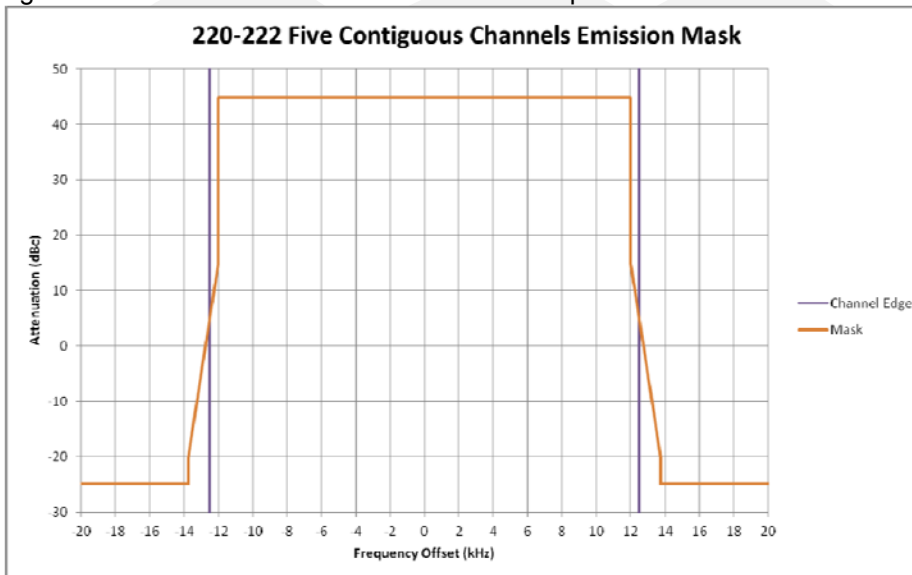
90.210(f) *Emission Mask F boundary conditions (for 5 contiguous channels)*. For transmitters operating in the 220–222 MHz frequency band, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- (1) On any frequency from the center of the authorized bandwidth f_o to the edge of the authorized bandwidth f_e : Zero dB. ($f_e = 12$ kHz)
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12 kHz up to and including 13.75 kHz: $30 + 20(f_d - 12)$ dB or $55 + 10 \log(P)$, or 65 dB, whichever is the lesser attenuation.
- (3) On any frequency beyond 13.75 kHz removed from the center of the authorized bandwidth f_d : At least $55 + 10 \log(P)$ dB.

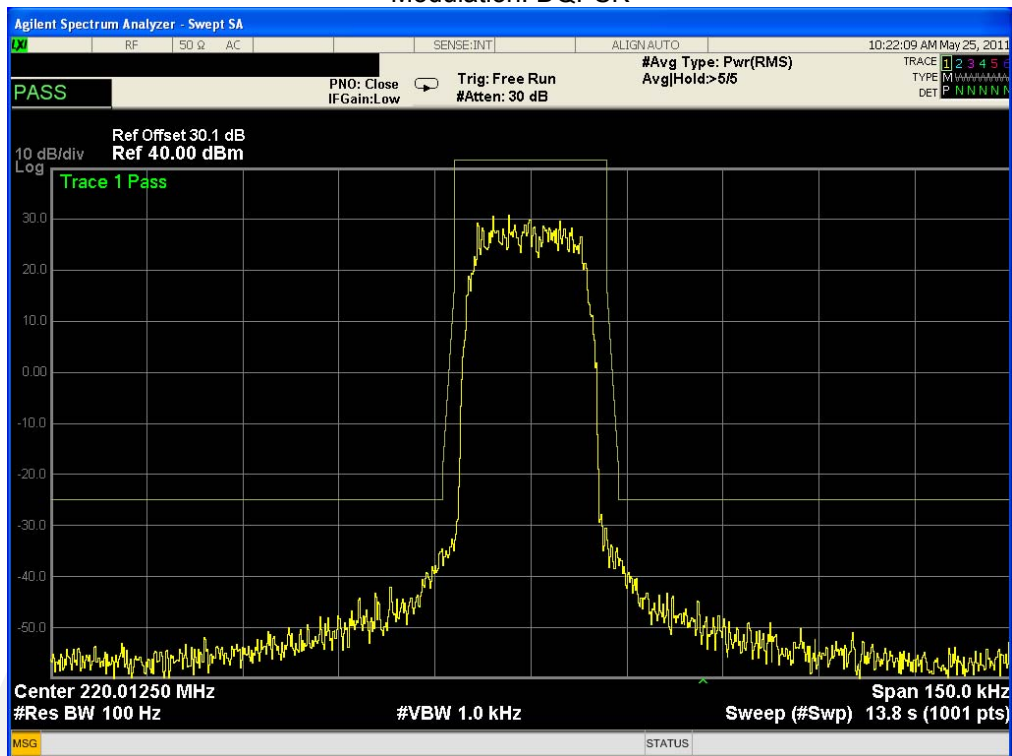
The emissions mask as described in RSS-119 is very similar to the FCC mask with the exception that frequencies beyond 13.75 kHz removed from the center of the authorized bandwidth shall be attenuated 65 or $55 + 10 \log_{10}(p)$ dB whichever is the lesser attenuation. Since the FCC mask has a greater attenuation requirement for a displacement frequency beyond 13.75 kHz, the FCC attenuation requirement is used for all transmitter mask and emissions measurements as shown in the plot below.



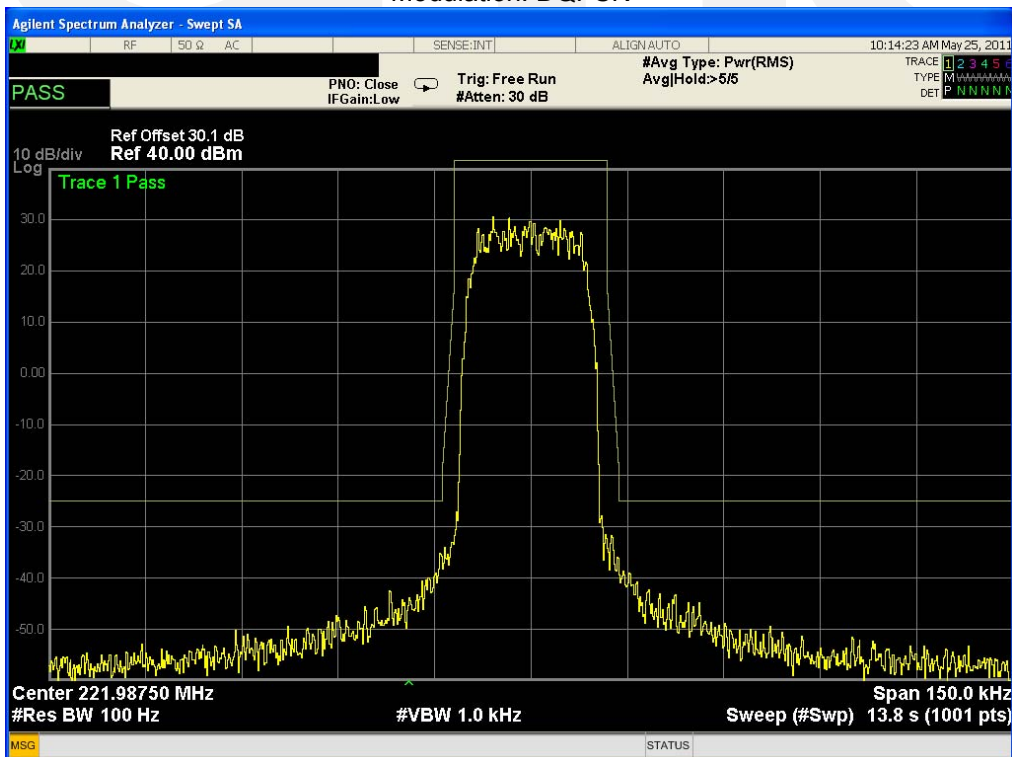
The mask shown in the test report has been adjusted for the absolute power level of the transmitter. The FCC limit for emissions beyond the displacement frequency is $55 + 10\log_{10}(P)$. This value, when applied to the transmitter power shall always equal -25 dBm. All transmitter emissions measurements have been verified against the -25 dBm limit as shown in the mask plot below.



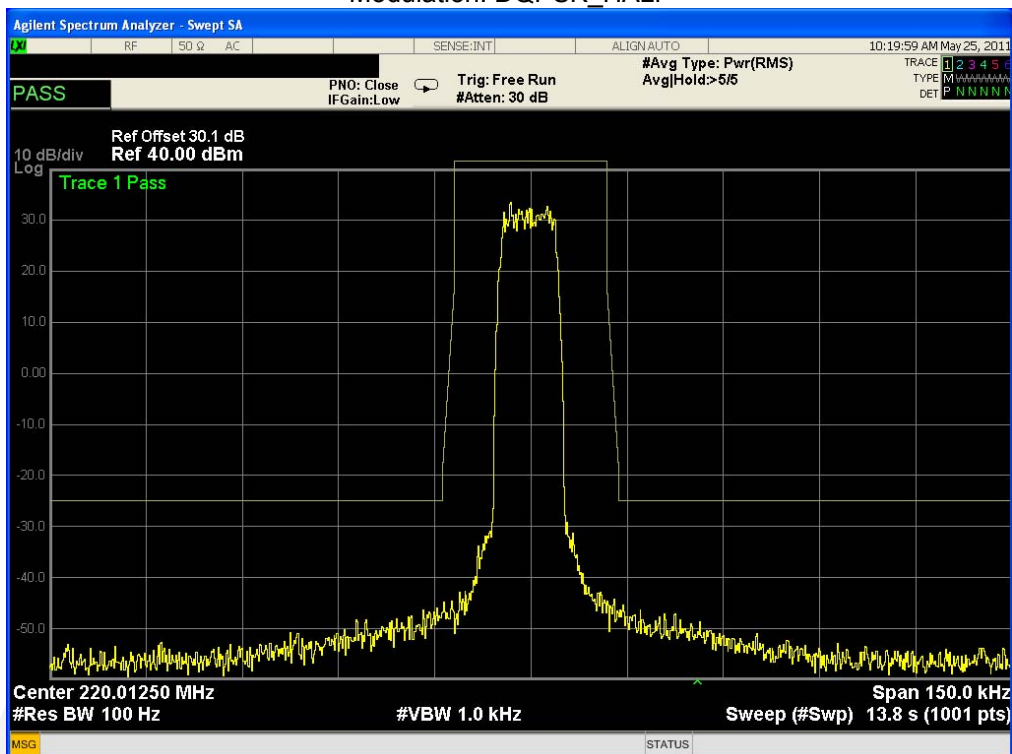
Low Channel: 220.0125 MHz
Modulation: DQPSK



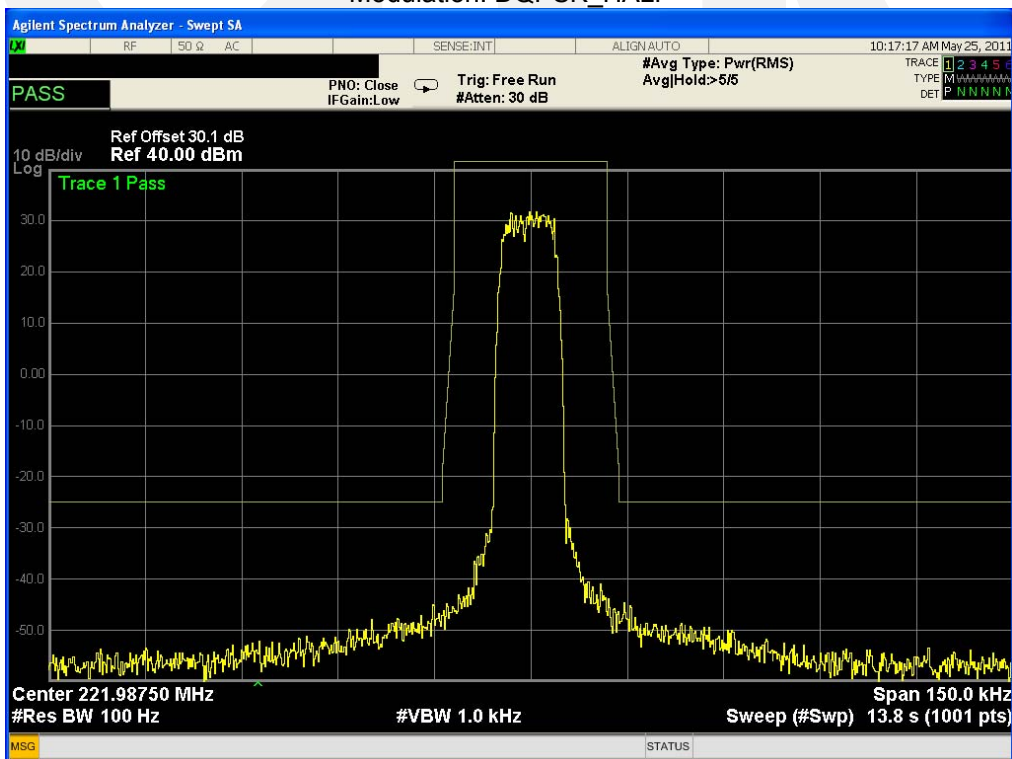
High Channel: 221.9875 MHz
Modulation: DQPSK



Low Channel: 220.0125 MHz
Modulation: DQPSK_HALF



High Channel: 221.9875 MHz
Modulation: DQPSK_HALF



8.4 Bandwidth

Test summary

The requirements are: ■ - MET □ - NOT MET

Test location

- - Wild River Lab Large Test Site (Open Area Test Site)
 ■ - NextGen RF Design

Test equipment

	Vendor	Model	Serial Number	Cal Date / Cal Due Date
Spectrum Analyzer	Agilent	PSA N9030A	US4S230321	03-03-2011 / 04-21-2012
Power Supply	HP/Agilent	6030A	2934A-01826	12-16-2010 / 07-07-2011
Computer	Dell	XPS M170	36134745733	N/A
30 dB power attenuator	Weinschel	5009	MA907	Cal by user
Multimeter	Fluke	87V	86670404	04/21/2011 – 04/21/2012
Rx1 Load	Weinschel	2-40	T1328	Cal by user
Rx2 Load	Systron Doner	108328	N/A	Cal by ser
DC Block	PE8210		N/A	Cal by user
50 ohm load	Inmet 3016		N/A	Cal by user

Test limits

FCC 90.209 / 90.733(d)

50/25/12.5/6.25 kHz – 217-220 MHz – N/A
 20 kHz – 220-222 MHz

RSS-119 5.5 / SRSP-512 (4.1.5)

11.25 kHz – 217-218 MHz – N/A
 11.25 kHz – 219-220 MHz – N/A
 20 kHz – 220-222 MHz

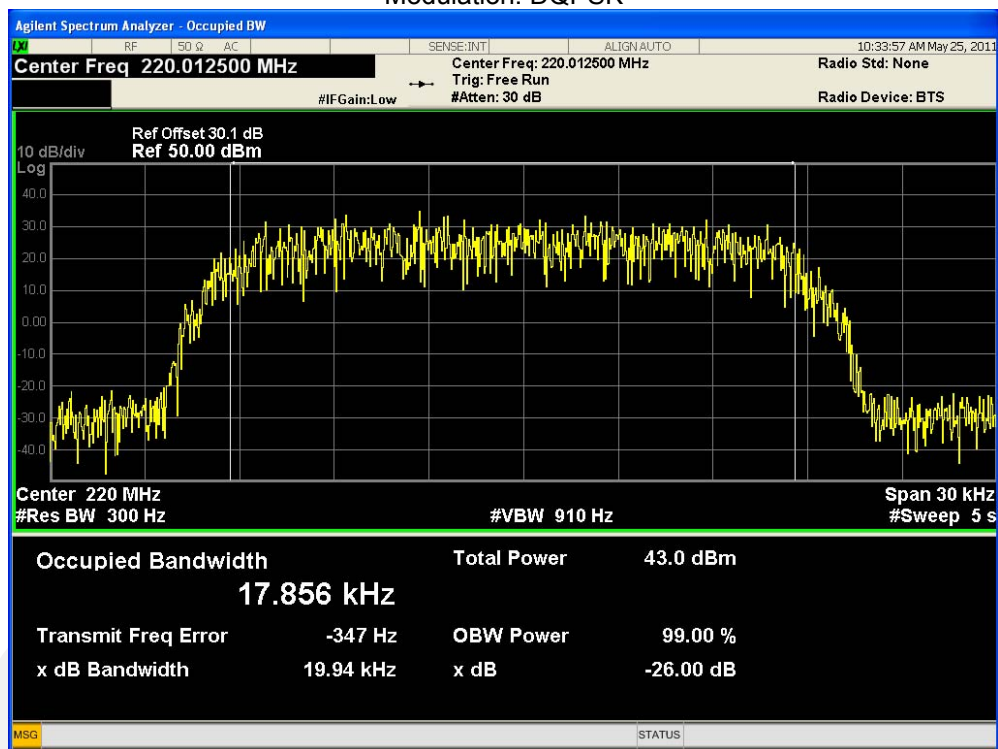
Test Data

Measurement Summary: Occupied Bandwidth

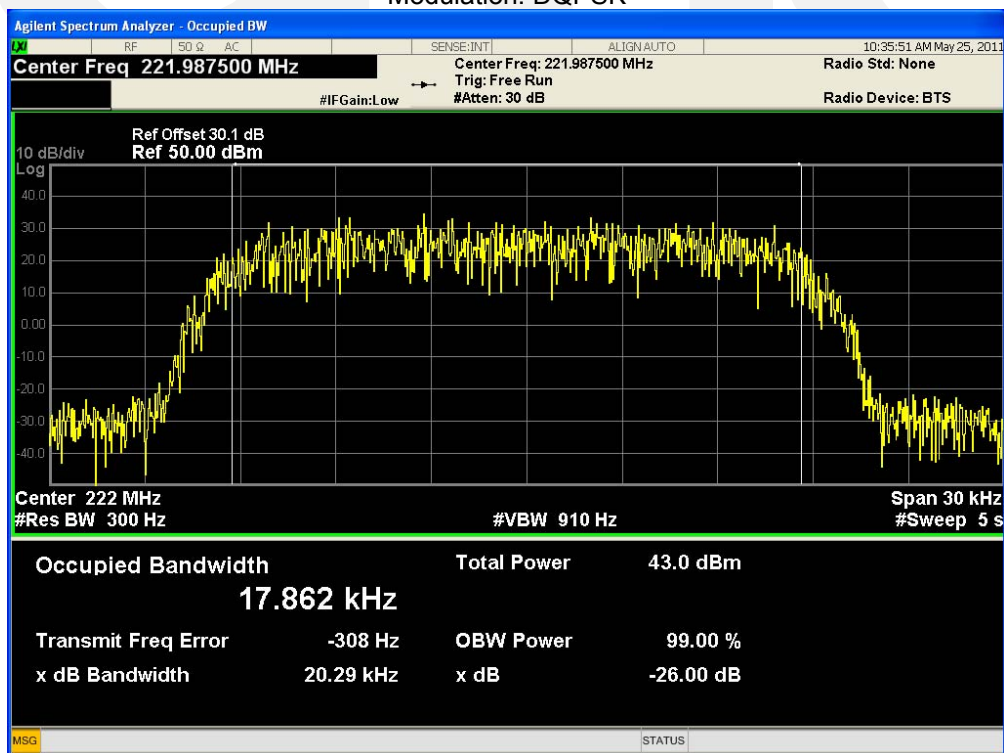
Frequency (MHz)	DQPSK (kHz)	DQPSK_HALF (kHz)
220.0125	17.856	8.891
221.9875	17.862	8.865

See following pages

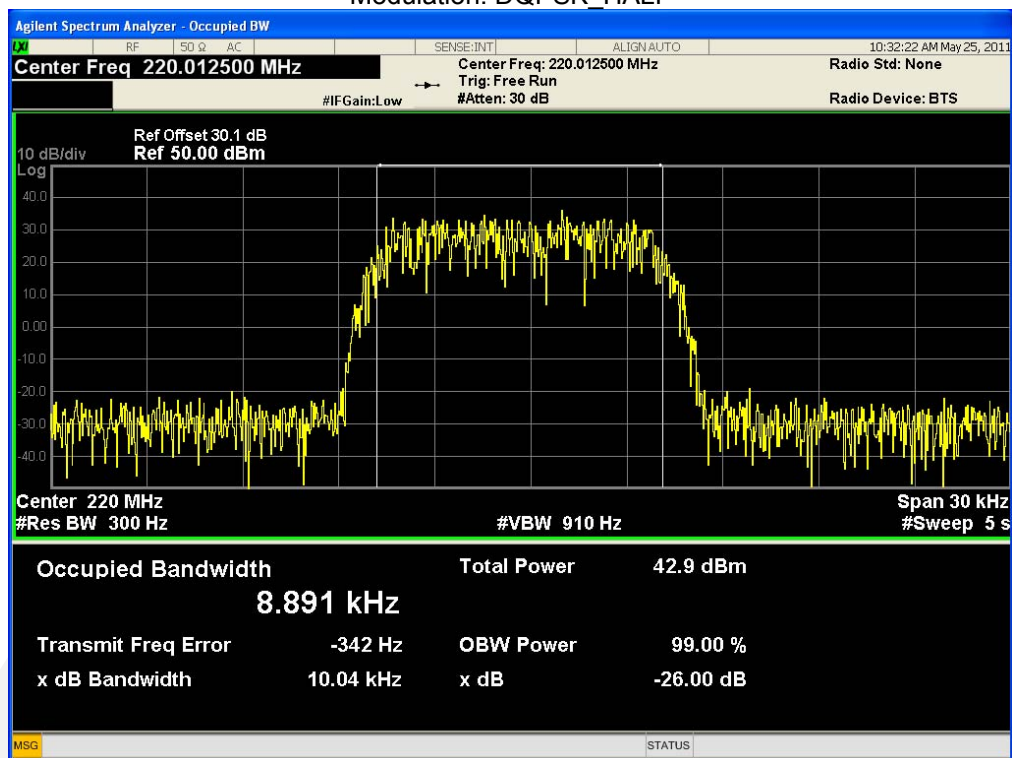
Low Channel: 220.0125 MHz
Modulation: DQPSK



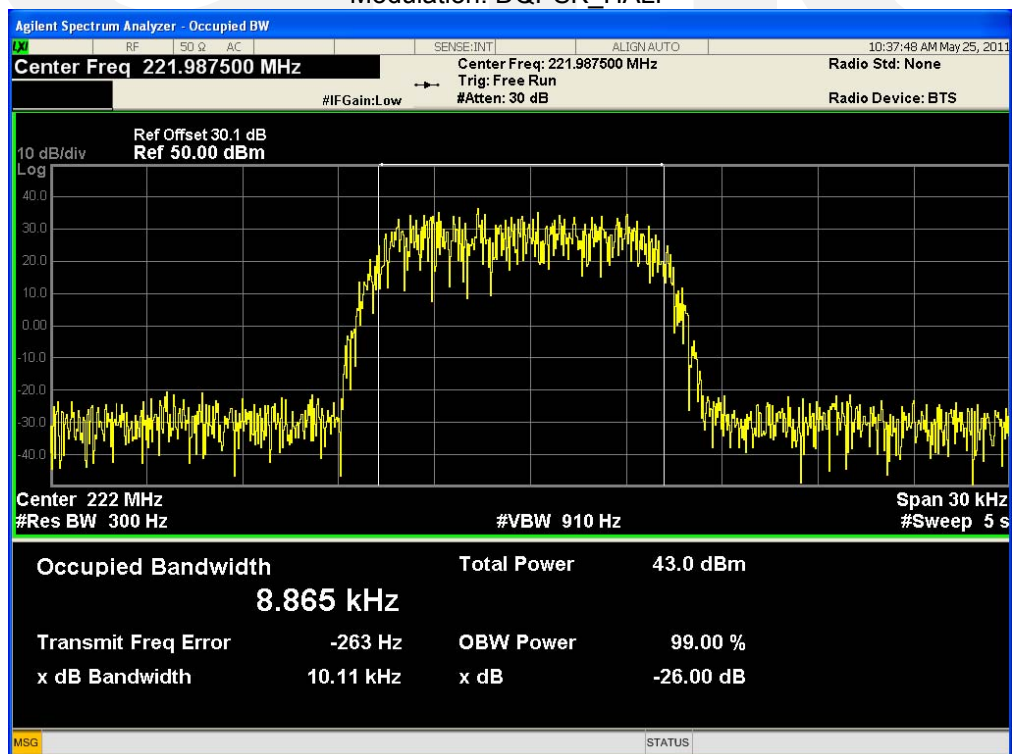
High Channel: 221.9875 MHz
Modulation: DQPSK



Low Channel: 220.0125 MHz
Modulation: DQPSK_HALF



High Channel: 221.9875 MHz
Modulation: DQPSK_HALF



8.5 Spurious emissions

Test summary

The requirements are: ■ - MET □ - NOT MET

Test location

- - Wild River Lab Large Test Site (Open Area Test Site)
- - Oakwood Lab (Open Area Test Site) (radiated)
- - NextGen RF Design (conducted)

Test equipment (radiated)

TUV ID	Model	Manufacturer	Description	Serial	Cal Due
OWLE02074	3115	Electro-Mechanics	Ridge Guide Antenna	2504	24-Feb-12
WRLE02075	3115	Electro-Mechanics	Ridge Guide Antenna	9001-3275	14-Jan-12
WRLE02674	85662A	Hewlett-Packard	Analyzer Display	2050A02007	05-Nov-11
WRLE02690	8568B	Hewlett-Packard	Spectrum Analyzer	2430A00930	05-Nov-11
WRLE02680	85650A	Hewlett-Packard	Quasi-Peak Adapter	2043A00343	15-Jun-11
OWLE02671	8447D	Hewlett-Packard	Preamplifier	2648A04942	Code B 05-Jan-12
WRLE03958	SL18B4020	Phase One Microwave	Preamplifier 1 – 18 GHz	0002	Code B 05-Jan-12
WRLE03204	EM-6917B	Electro-Metrics	Biconicalog Periodic	102	21-Apr-12
WRLE03333	SME03	Rohde & Schwarz	Signal Generator	100003	18-Oct-11
Schwarzbeck VHAP/UHAP precision dipoles					

Test equipment (conducted)

	Vendor	Model	Serial Number	Cal Date / Cal Due Date
Spectrum Analyzer	Agilent	PSA N9030A	US4S230321	03-03-2011 / 04-21-2012
Power Supply	HP/Agilent	6030A	2934A-01826	12-16-2010 / 07-07-2011
Computer	Dell	XPS M170	36134745733	N/A
30 dB power attenuator	Weinschel	5009	MA907	Cal by user
Multimeter	Fluke	87V	86670404	04/21/2011 – 04/21/2012
Rx1 Load	Weinschel	2-40	T1328	Cal by user
Rx2 Load	Systron Doner	108328	N/A	Cal by ser
DC Block	PE8210		N/A	Cal by user
50 ohm load	Inmet 3016		N/A	Cal by user
100 MHz Lowpass Filter	Microlab	LC-01N 100 Mc	NGRF-F01	Cal by user

Test limits

FCC 90.210

Mask B - -13 dBm – N/A
Mask F - -25 dBm

RSS-119 5.8

Mask D/J - -20 dBm – N/A
Mask F - -25 dBm

Test Data

See following pages

Radiated – case radiation per 2.1053

Below 1 GHz

Measurement summary for limit2 (Pk)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	FINAL (dBm)
599.939 MHz	53.56	2.81 / 19.01 / 24.89 / 0.0	50.49	V / 1.00 / 215	-46
443.905 MHz	54.85 Pk	2.25 / 16.47 / 24.79 / 0.0	48.78	V / 1.00 / 0	-48
435.174 MHz	51.7 Pk	2.23 / 16.45 / 24.87 / 0.0	45.5	V / 1.30 / 185	-51
499.93 MHz	47.2	2.37 / 17.46 / 24.75 / 0.0	42.28	V / 1.00 / 180	-55
474.95 MHz	45.5	2.32 / 17.02 / 24.5 / 0.0	40.34	V / 1.00 / 180	-57

≥ 1 GHz

Measurement summary for limit2: (Pk)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	FINAL (dBm)
2.557 GHz	74.8 Pk	6.89 / 28.72 / 48.25 / 0.0	62.16	V / 1.00 / 90	-35
1.615 GHz	75.7 Pk	4.61 / 26.45 / 51.12 / 0.0	55.64	V / 1.00 / 90	-41
1.23 GHz	76.95 Pk	3.95 / 25.6 / 51.1 / 0.0	55.39	V / 1.00 / 90	-41
1.0 GHz	76.55 Pk	3.61 / 24.6 / 50.6 / 0.0	54.16	H / 1.00 / 0	-43
1.5 GHz	72.35 Pk	4.36 / 26.05 / 51.23 / 0.0	51.54	V / 1.00 / 180	-45

Testing was performed in accordance with the test procedure of ANSI TIA-603-C, clause 2.2.13 and 2.2.17

The radiated case spurious emissions were measured using a substitution method. A sample calculation is given below:

62.16 dBuV/m @ 3 m @ 2.557 GHz= -35 dBm erp (signal generator+ cable loss = -41.75 dBm + antenna gain of 6.75 dBd)

The spectrum analyzer uses a peak detector. Bandwidths used are equal to or greater than 100 Hz from 9 kHz to 150 kHz, 9 kHz from 150 kHz to 30 MHz, 100 kHz from 30 MHz to 1000 MHz, and 1 MHz from 1 GHz to 40 GHz. Video bandwidths are at least three times greater than the IF bandwidth.

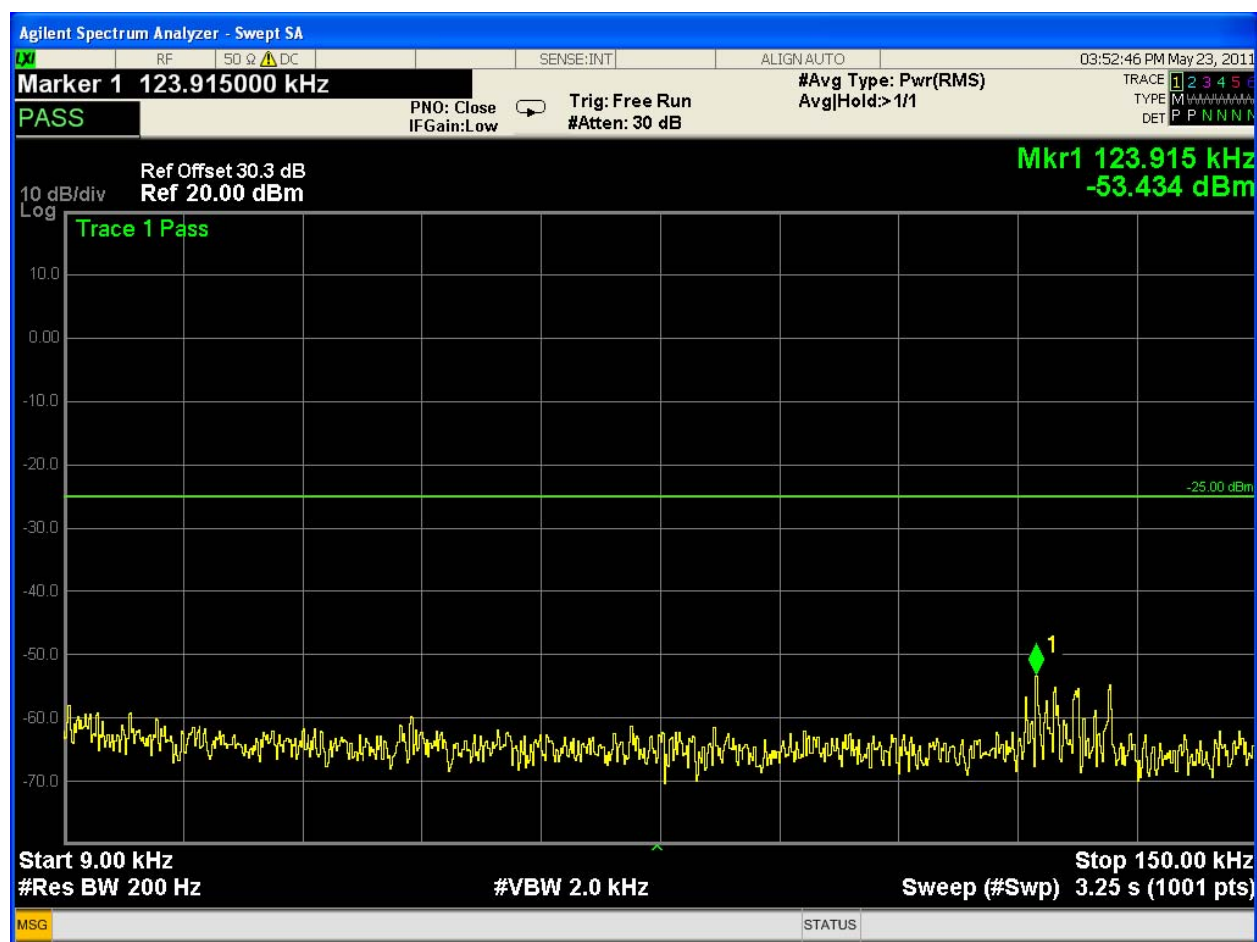
Conducted

Industry Canada Transmitter Conducted Emissions below 1 GHz

Tx port

Transmit mode

50 watt peak power



Modulation: DQPSK

Low channel: 220.0125 MHz