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Radio Test Report

FCC Part 80
RSS 119
216 - 220 MHz

Model: SD2

COMPANY:	GE MDS LLC 175 Science Parkway Rochester, NY 14620
TEST SITE(S):	Elliott Laboratories 684 W. Maude Avenue Sunnyvale, CA 94085
REPORT DATE:	November 11, 2009
FINAL TEST DATES:	October 28, October 29, November 1, November 5, November 6 and November 9, 2009

AUTHORIZED SIGNATORY:

David W Bare

David W. Bare
Chief Engineer
Elliott Laboratories

A2LA ACCREDITED

Testing Cert #2016-01

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	November 16, 2009	First release	

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SCOPE

Tests have been performed on the GE MDS LLC model SD2, pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission and Industry Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- Industry Canada RSS-Gen Issue 2
- CFR 47 Part 80 (Stations in the Maritime Services) Subpart E
- RSS-119, Issue 9 (Land Mobile and Fixed Radio Transmitters and Receivers, 27.41 to 960 MHz)

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in Elliott Laboratories test procedures:

ANSI C63.4-2003
ANSI TIA-603-C August 17, 2004

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the GE MDS LLC model SD2 and therefore apply only to the tested sample. The sample was selected and prepared by Dennis McCarthy of GE MDS LLC.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification. Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of GE MDS LLC model SD2 complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS

FCC Part 80 – 216 – 222 MHz

FCC	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics				
§2.1033 (c) (5) § 80.	Frequency ranges (Listed for each channel spacing)	25 kHz 216-220 MHz 12.5 kHz 216-220 MHz 6.25 kHz 216-220 MHz	216-220 MHz	Complies
§2.1033 (c) (6) §2.1033 (c) (7) §2.1046 § 80.215(h)(5)	Total power (216-220 MHz) (Maximum for each channel spacing)	25 kHz 2.0 W 12.5 kHz 2.0 W 6.25 kHz 1.9 W	50 Watts	Complies
§2.1033 (c) (4)	Emission types	F1D, F2D, F3D[3]	Information only	-
§2.1047 § 80.211(f)	Emission mask	Device complies with spectral masks – refer to test data	Mask B	Complies
§2.1049	Occupied (99%) Bandwidth	16.8 kHz 216-220 MHz 9.32 kHz – 216-220 MHz 3.24 kHz – 216-220 MHz	Information only	-
Transmitter spurious emissions				
§2.1051 §2.1057 §80.211(f)	At antenna terminal	-29.7 dBm	-13 dBm	Complies
	Radiated (erp)	-48.0 dBm[2]		Complies
Receiver spurious emissions				
15.111	At antenna terminal	-69.0 dBm	-57 dBm	Complies
15.109	Field strength	33.4 dBuV/m	Refer to RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS	Complies
Other details				
§2.1055 §80.209	Frequency stability	0.2 ppm	216-220 MHz 5.0 ppm	Complies
§1.1307(b) §2.1093 §80.227	RF Exposure	Although RF exposure compliance is addressed at the time of licensing an MPE calculation has been provided to demonstrate compliance with limits at distances of 1.5m or more from the antennas.		
§2.1033 (c) (8)	Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	13.8V, 2.2A	Information only	-
-	Antenna Gain	This application is submitted for antennas of 7.0 dBd (9.15 dBi) gain.		

Notes
1) Aggregate 3 channels.
2) Calculated from measured field strength using free space propagation equation
3) Operation in AMTS allowed for use with Part 90 transmitters, see GE MDS letter and FCC R&O 07-87 (WT Docket No. 04-257).

EXTREME CONDITIONS

Frequency stability is determined over extremes of temperature and voltage. The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2) and were calculated in accordance with NAMAS document NIS 81 and M3003.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF frequency	Hz	25 to 7,000 MHz	1.7×10^{-7}
RF power, conducted	dBm	25 to 7,000 MHz	± 0.52 dB
Conducted emission of transmitter	dBm	25 to 40,000 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 40,000 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 40,000 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1,000 MHz 1 to 40 GHz	± 3.6 dB ± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The GE MDS LLC model SD2 is a industrial radio operating in the 216-222 MHz band for FCC Part 90 and Part 80. Since the EUT could be placed anywhere in use, it was placed on a table top during testing to simulate the end-user environment. The electrical rating of the EUT is 10 - 30 Volts DC, 2.2 Amps.

The sample was received on October 28, 2009 and tested on October 28, October 29, November 1, November 5, November 6 and November 9, 2009. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
GE MDS LLC	SD2 Transceiver	Industrial Radio	999999	E5MDS-SD2

OTHER EUT DETAILS

The radio can operate on 5, 12.5 and 25KHz channels (F1D, F2D and F3D modulations).

ENCLOSURE

The EUT enclosure is primarily constructed of aluminum. It measures approximately 16cm wide by 12cm deep by 4cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at Elliott.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Winbook	Winbook XL	Computer	H1106677	-
Agilent	E3610A	Power Source	MY40011740	-

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
Netgear	GS108	Ethernet Switch	GS16152CB035447	-

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
Ethernet	Switch	Cat 5	Shielded	10.0
COM1	Computer	Serial	Shielded	2.0
DC Power	Power Source	two wire	Unshielded	2.0

Note: The COM2 port was not connected during testing except as needed for configuration of the radio. This port is for diagnostic purposes and therefore would not normally be connected.

EUT OPERATION

During radio performance emissions testing the EUT was set to transmit at 37dBm with modulation on or off as needed for testing. During receiver and unintentional emissions testing, the radio was set for receive mode.

EMISSIONS TESTING

GENERAL INFORMATION

Antenna port measurements were taken at the Elliott Laboratories test site located at 684 West Maude Ave, Sunnyvale, CA 94085-3518 Radiated spurious emissions measurements were taken at the Elliott Laboratories Anechoic Chambers and/or Open Area Test Site(s) listed below. The sites conform to the requirements of 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* and CISPR 16-1-4:2007 - *Specification for radio disturbance and immunity measuring apparatus and methods Part 1-4: Radio disturbance and immunity measuring apparatus Ancillary equipment Radiated disturbances*. They are on file with the FCC and industry Canada.

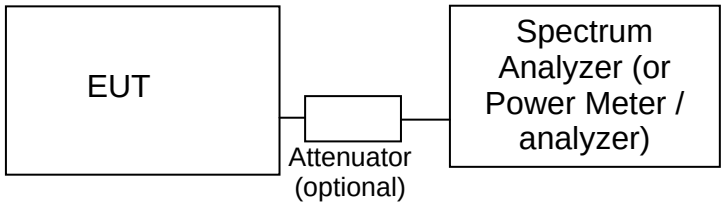
Site	Registration Numbers		Location
	FCC	Canada	
SVOATS #2	90593	2845A-2	684 West Maude Ave, Sunnyvale CA 94085-3518

In the case of Open Area Test Sites, ambient levels are at least 6 dB below the specification limits with the exception of predictable local TV, radio, and mobile communications traffic.

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's rf input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the rf port of the EUT and the measurement equipment.



Test Configuration for Antenna Port Measurements

For devices with an integral antenna the output power and spurious emissions are measured as a field strength at a test distance of (typically) 3m and then converted to an eirp using a substitution measurement (refer to **Error! Reference source not found.**). All other measurements are made as detailed below but with the test equipment connected to a measurement antenna directed at the EUT.

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

CONDUCTED SPURIOUS EMISSIONS

Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode measurements). Where the limits are expressed as an average power the spectrum analyzer is tunes to that frequency with a narrow span (wide enough to capture the emission and its sidebands) and the resolution and video bandwidths are adjusted as required by the reference measurement standards. For transmitter measurements the appropriate detector (average, peak, normal ,sample, quasi-peak) is used when making measurements for licensed devices. For receiver conducted spurious measurements the detector is set to peak.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

FREQUENCY STABILITY

The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The temperature is varied across the specified frequency range in 10 degree increments with frequency measurements made at each temperature step. The EUT is allowed enough time to stabilize at each temperature variation.

The spectrum analyzer is configured to give a 5- or 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature. Where possible the device is set to transmit an unmodulated signal. Where this is not possible the frequency drift is determined by finding a stable point on the signal (e.g. the null at the centre of an OFDM signal) or by calculating a centre frequency based on the upper and lower XdB points (where X is typically 6dB or 10dB) on the signal’s skirts.

RADIATED EMISSIONS MEASUREMENTS

Receiver radiated spurious emissions measurements are made in accordance with ANSI ANSI C63.4:2003 by measuring the field strength of the emissions from the device at a specific test distance and comparing them to a field strength limit. Where the field strength limit is specified at a longer distance than the measurement distance the measurement is extrapolated to the limit distance.

Transmitter radiated spurious emissions are initially measured as a field strength. The eirp or erp limit as specified in the relevant rule part(s) is converted to a field strength at the test distance and the emissions from the EUT are then compared to that limit. Emissions within 20dB of this limit are the subjected to a substitution measurement.

All radiated emissions measurements are performed in two phases. A preliminary scan of emissions is conducted in either an anechoic chamber or on an OATS during which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed across the complete frequency range of interest and at each operating frequency identified in the reference standard. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode).

During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit. For transmitter spurious emissions, where the limit is expressed as an effective radiated power, the eirp or erp is converted to a field strength limit.

Final measurements are made on an OATS or in a semi-anechoic chamber at the significant frequencies observed during the preliminary scan(s) using the same process of rotating the EUT and raising/lowering the measurement antenna to find the highest level of the emission. The field strength is recorded and, for receiver spurious emissions, compared to the field strength limit. For the final measurement the appropriate detectors (average, peak, normal, sample, quasi-peak) are used. For receiver measurements below 1GHz the detector is a Quasi-Peak detector, above 1GHz a peak detector is used and the peak value (RB=VB=1MHz) and average value (RB=1MHz, VB=10Hz) are recorded.

For transmitter spurious emissions, the radiated power of all emissions within 20dB of the calculated field strength limit are determined using a substitution measurement. The substitution measurement is made by replacing the EUT with an antenna of known gain (typically a dipole antenna or a double-ridged horn antenna), connected to a signal source. The output power of the signal generator is adjusted until the maximum field strength from the substitution antenna is similar to the field strength recorded from the EUT. The erp of the EUT is then calculated.

INSTRUMENTATION

An EMI receiver as specified in CISPR 16-1-1 is used for radiated emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 7000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary.

For measurements above the frequency range of the receivers and for all conducted measurements a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis.

Measurement bandwidths for the test instruments are set in accordance with the requirements of the standards referenced in this document.

Software control is used to correct the measurements for transducer factors (e.g. antenna) and the insertion loss of cables, attenuators and other series elements to obtain the final measurement value. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are exported in a graphic and/or tabular format, as appropriate.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the EUT antenna port or receiving antenna and the test receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A combination of biconical, log periodic or bi-log antennas are used to cover the range from 30 MHz to 1000 MHz. Broadband antennas or tuned dipole antennas are used over the entire 25 to 1000 MHz frequency range as the reference antenna for substitution measurements.

Above 1000 MHz, a dual-ridge guide horn antenna or octave horn antenna are used as reference and measurement antennas.

The antenna calibration factors are included in site factors that are programmed into the test receivers and instrument control software when measuring the radiated field strength.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.
Table mounted devices are placed on a non-conductive table at a height of 80 centimeters above the floor. Floor mounted equipment is placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. The EUT is positioned on a motorized turntable to allow it to be rotated during testing to determine the angel with the highest level of emissions.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH

Measurements of radiated field strength are compared directly to the specification limit (decibel form). The receiver and/or control software corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor is sued when measurements are made at a test distance that is different to the specified limit distance by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_S = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS –RADIATED POWER

The erp/eirp limits for transmitter spurious measurements are converted to a field strength in free space using the following formula:

$$E = \frac{\sqrt{30\ P\ G}}{d}$$

where:

E = Field Strength in V/m
P = Power in Watts
G = Gain of isotropic antenna (numeric gain) = 1
D = measurement distance in meters

The field strength limit is then converted to decibel form (dBuV/m) and the margin of a given emission peak relative to the limit is calculated (refer to *SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH*).

When substitution measurements are required (all signals with less than 20dB of margin relative to the calculated field strength limit) the eirp of the spurious emission is calculated using:

$$P_{EUT} = P_S - (E_S - E_{EUT})$$

and

$$P_S = G + P_{in}$$

where:

P_S = effective isotropic radiated power of the substitution antenna (dBm)
P_{in} = power input to the substitution antenna (dBm)
G = gain of the substitution antenna (dBi)
E_S = field strength the substitution antenna (dBm) at eirp P_S
E_{EUT} = field strength measured from the EUT

Where necessary the effective isotropic radiated power is converted to effective radiated power by subtracting the gain of a dipole (2.2dBi) from the eirp value.

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109, RSS 210 Table 2, RSS GEN Table 1 and RSS 310 Table 3. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

Appendix A Test Equipment Calibration Data

Conducted Emissions - AC Power Ports, 28-Oct-09				
Engineer: Mehran Birgani				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Elliott Laboratories	LISN, FCC / CISPR	LISN-3, OATS	304	15-Jul-10
Hewlett Packard	EMC Spectrum Analyzer, 9 kHz - 6.5 GHz	8595EM	780	30-Dec-09
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	812	23-Feb-10
Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	1316	06-Nov-09
Radio Antenna Port (Power and Spurious Emissions), 29-Oct-09				
Engineer: John Caizzi				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1290	22-Oct-10
Rohde & Schwarz	Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	02-Sep-10
Agilent	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	30-Dec-09
Radiated Emissions, 30 - 2,500 MHz Chamber Prescan, 02-Nov-09				
Engineer: John Caizzi				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	19-Aug-10
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz-26.5 GHz	8593EM	1141	29-Dec-09
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1404	24-Feb-10
EMCO	Biconical Antenna, 30-300 MHz	3110B	1497	15-Sep-10
EMCO	Antenna, Horn, 1-18 GHz	3117	1662	11-Apr-10
Hewlett Packard	Preamplifier, 100 kHz - 1.3 GHz	8447D OPT 010	1826	26-May-10
Radiated Emissions, 30 - 2,500 MHz, Final Data, 02-Nov-09				
Engineer: John Caizzi				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	213	02-Apr-10
EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	23-Dec-09
Radiated Emissions, 30 - 2,300 MHz, 05-Nov-09				
Engineer: Mehran Birgani				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	54	03-Apr-11
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	213	02-Apr-10
EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	23-Dec-09
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	08-Sep-11
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	19-Aug-10
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	12-Mar-10
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1404	24-Feb-10
Hewlett Packard	Preamplifier, 100 kHz - 1.3 GHz	8447D OPT 010	1826	26-May-10

Radiated Emissions, 30 - 2,300 MHz, 06-Nov-09				
Engineer: Mehran Birgani				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	54	03-Apr-11
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	213	02-Apr-10
EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	23-Dec-09
EMCO	Antenna, Horn, 1-18 GHz	3115	487	15-Jul-10
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	19-Aug-10
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	12-Mar-10

Frequency Stability, 09-Nov-09				
Engineer: Mehran Birgani				
Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Agilent	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	30-Dec-09
Thermotron	Temp Chamber (w/ F4 Watlow Controller)	S1.2	2170	29-Jun-10

Appendix B Test Data

T77262 19 Pages

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy	Project Engineer:	David Bare
Emissions Standard(s):	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	A
Immunity Standard(s):	-	Environment:	Radio

EMC Test Data

For The

GE MDS LLC

Model

SD2 Transceiver

Date of Last Test: 11/9/2009

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

RSS 119 and FCC Part 80 & 90

Power, Occupied Bandwidth, Frequency Stability and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

All measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

Temperature: 19 °C
Rel. Humidity: 52 %

Summary of Results, serial #9999999

Run #	Spacing		Test Performed	Limit	Pass / Fail	Result / Margin
1	25, 15, 12.5, 6.25 and 5 kHz		Output Power	Determined at time of Licensing	-	
2	25, 15, 12.5, 6.25 and 5 kHz		Spectral Mask	Within Mask 90.210(b)/80.211(f) or 90.210(f)	Pass	See Plots
3	25, 15, 12.5, 6.25 and 5 kHz		99% or Occupied Bandwidth	20, 11.25 6 or 4 KHz	Pass	See Plots
4	25 and 15 kHz		Spurious Emissions (conducted)	-13dBm or -25dBm	Pass	-29.7dBm @ 216.90MHz (-4.7dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Run #1: Output Power

Date of Test: 10/29/2009
Test Engineer: John Caizzi
Test Location: Environmental Lab

Power settings from 20 to 37 are available corresponding to 0.1 to 5 Watts for 220 - 222 MHz.
Power settings from 20 to 33 are available corresponding to 0.1 to 2 Watts for 216 - 220 MHz.

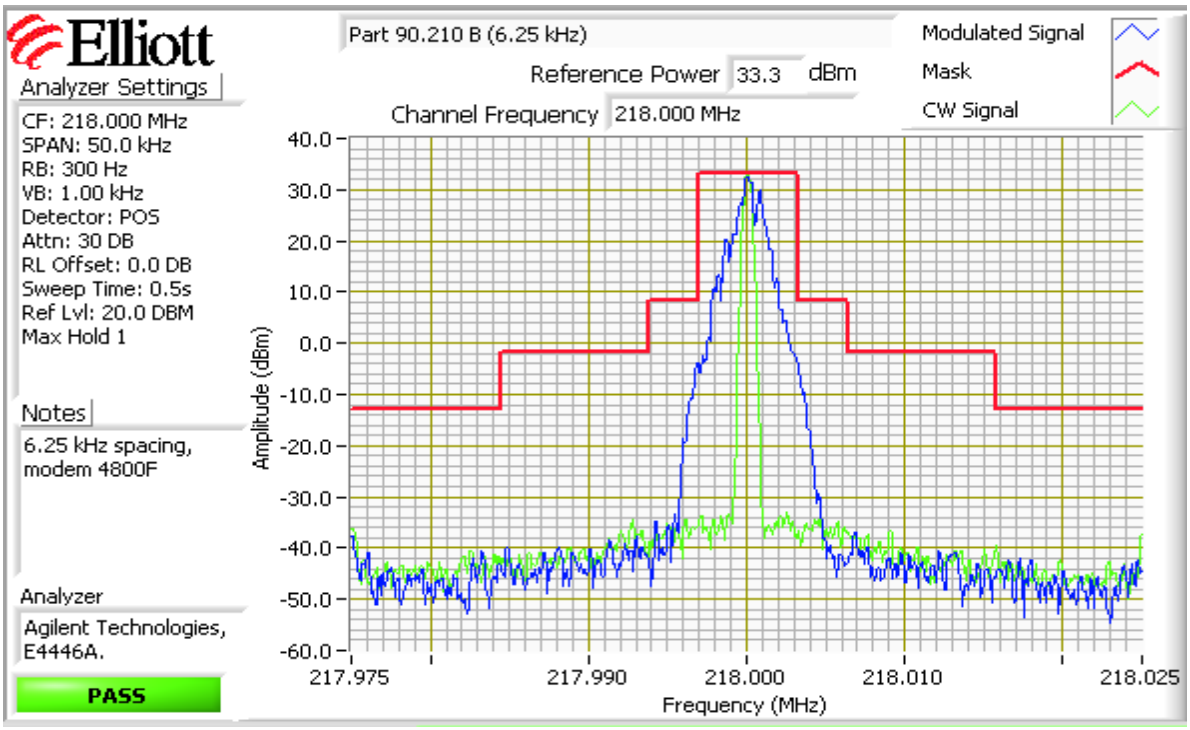
Power Setting[2]	Frequency (MHz)	Output Power (dBm)[1]	Output Power W	Antenna Gain(dBd)	Result	ERP dBm	ERP W	Modem
33	216	33.0	2.0	7.0	Pass	40.0	10.000	19200
33	220	32.8	1.9	7.0	Pass	39.8	9.550	19200
33	216	33.0	2.0	7.0	Pass	40.0	10.000	9600
33	220	32.6	1.8	7.0	Pass	39.6	9.120	9600
33	216	32.9	1.9	7.0	Pass	39.9	9.772	19200N
33	220	32.7	1.9	7.0	Pass	39.7	9.333	19200N
33	216	32.9	1.9	7.0	Pass	39.9	9.772	4800F
33	220	32.5	1.8	7.0	Pass	39.5	8.913	4800F
37	220	37.0	5.0	7.0	Pass	44.0	25.119	19200E
37	222	36.6	4.6	7.0	Pass	43.6	22.909	19200E
37	220	36.5	4.5	7.0	Pass	43.5	22.387	9600M
37	222	37.0	5.0	7.0	Pass	44.0	25.119	9600M
37	220	36.6	4.6	7.0	Pass	43.6	22.909	3200
37	222	36.6	4.6	7.0	Pass	43.6	22.909	3200

Note 1:	Output power measured using a peak power meter
Note 2:	Power setting - the software power setting used during testing, included for reference only.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

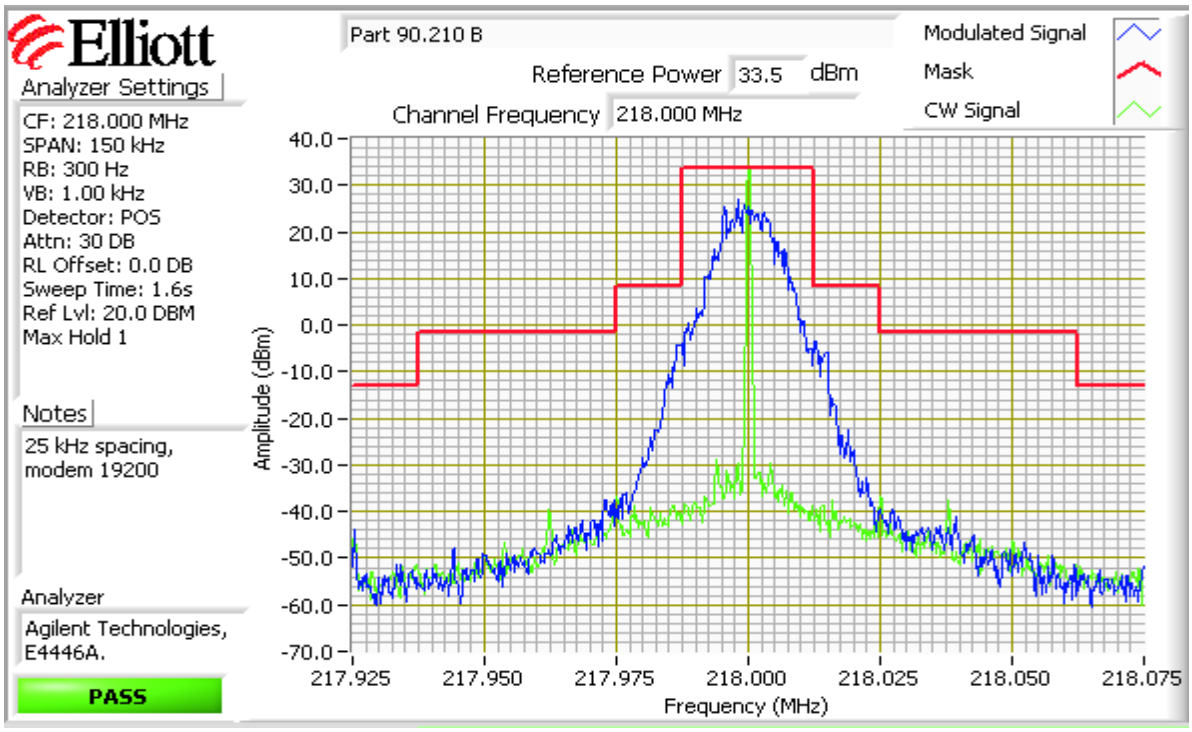
Run #2: Spectral Mask, FCC Part 90 Mask E, 6.25KHz channel spacing

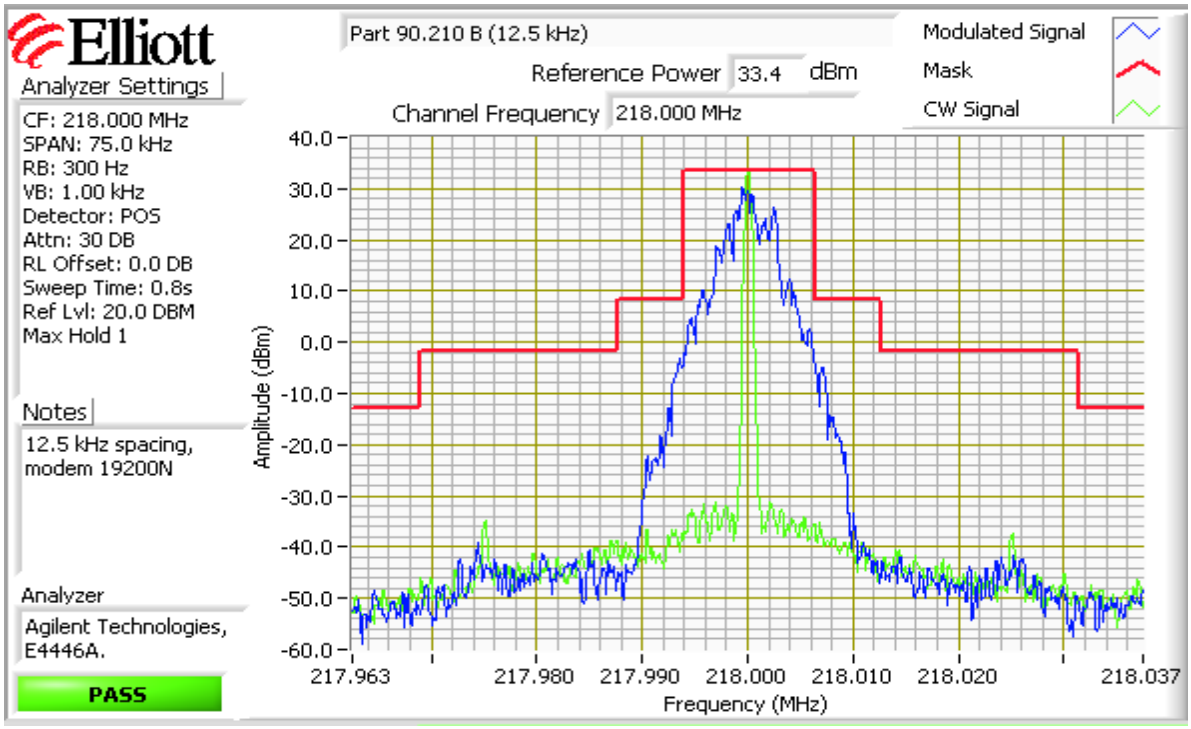
Date of Test: 10/29/2009
Test Engineer: John Caizzi
Test Location: Environmental Lab



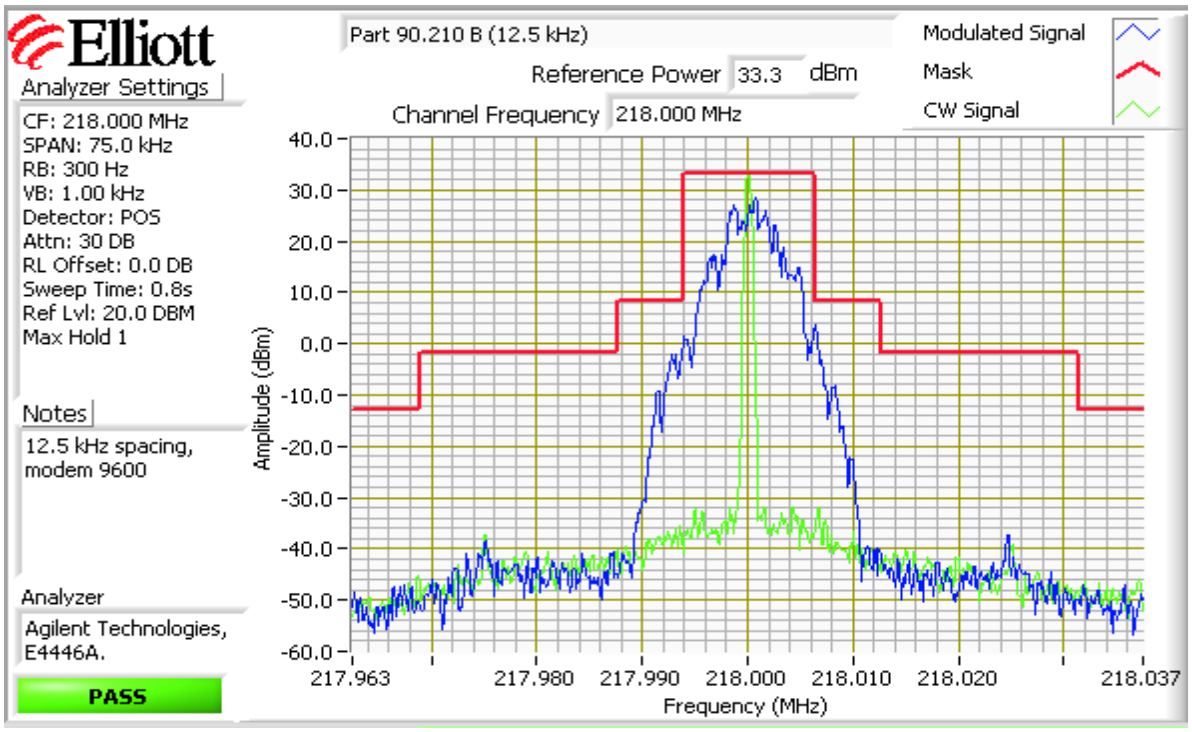
Note 1:	Mask reference level based on CW level.

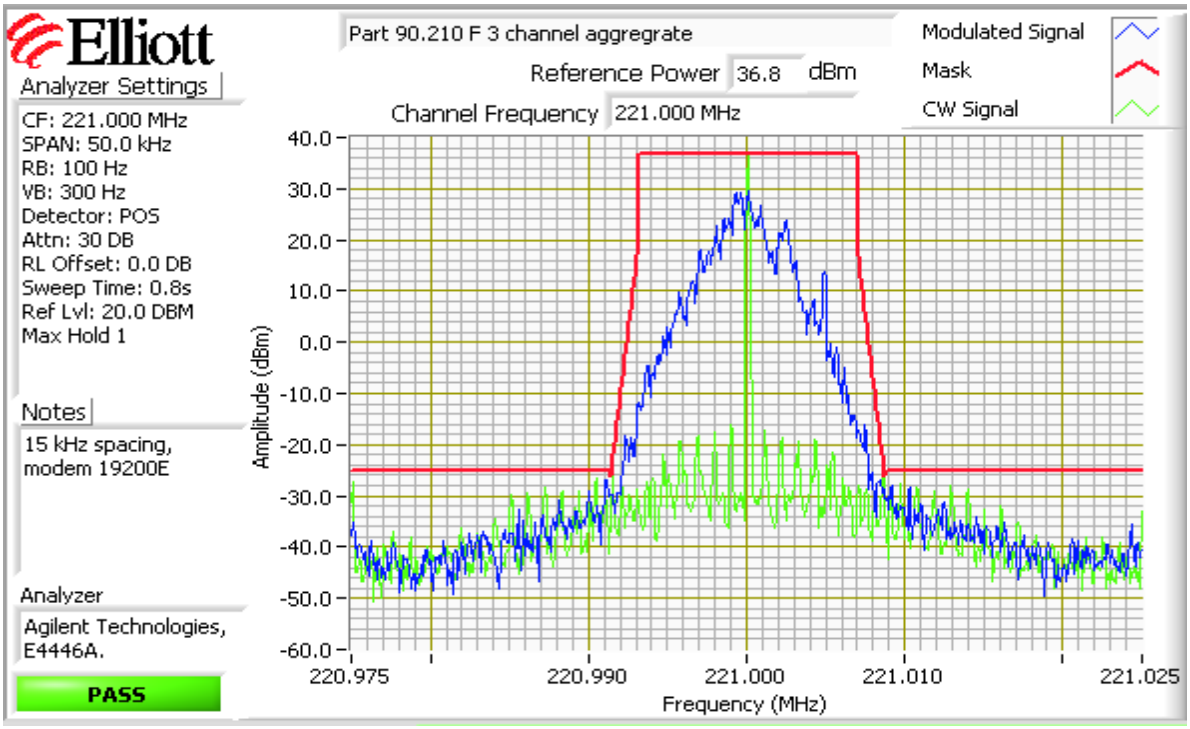
Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A



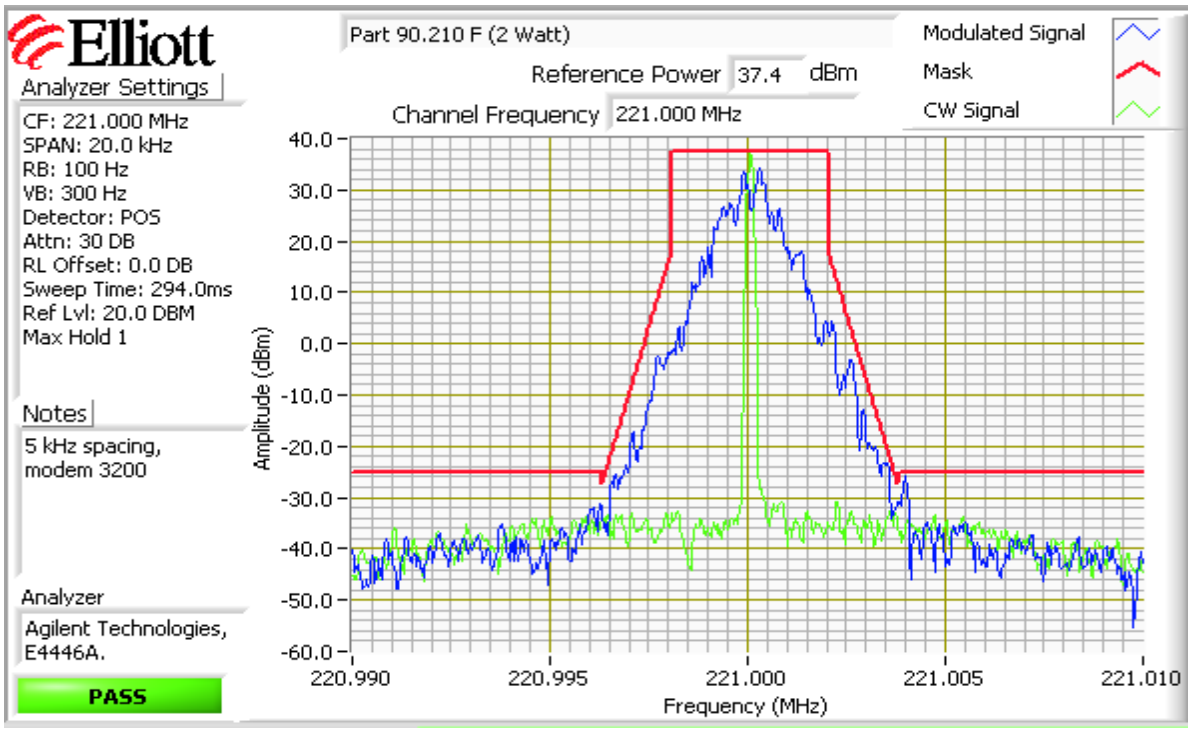


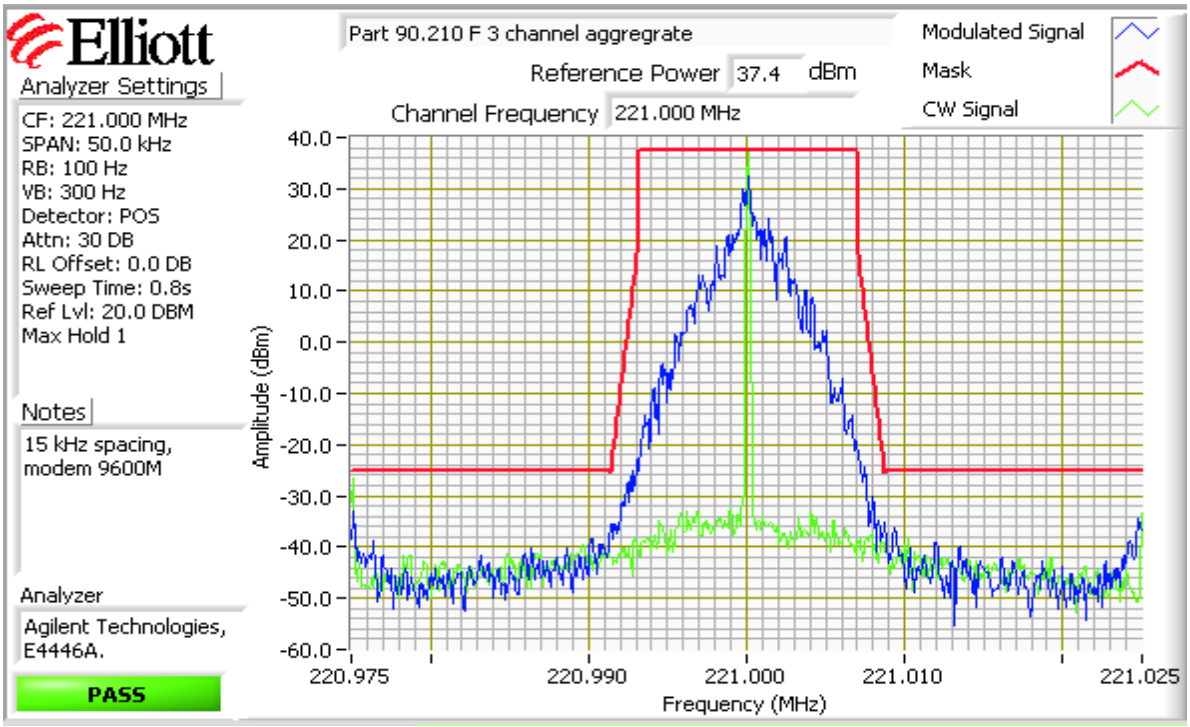
Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A





Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A





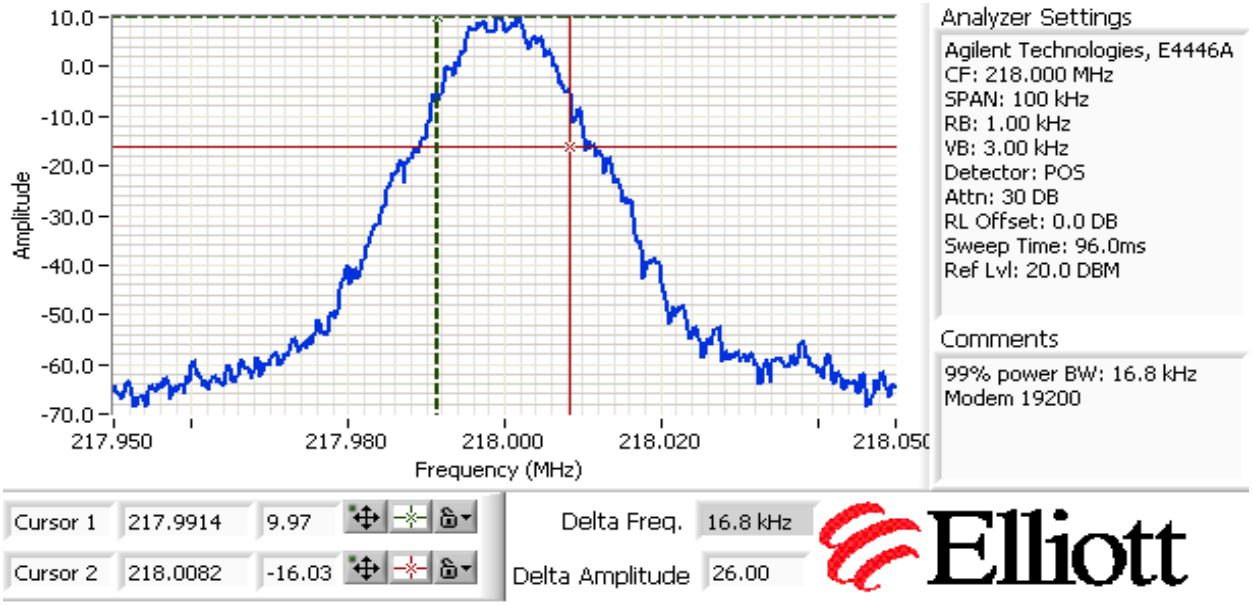
Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Run #3: Signal Bandwidth

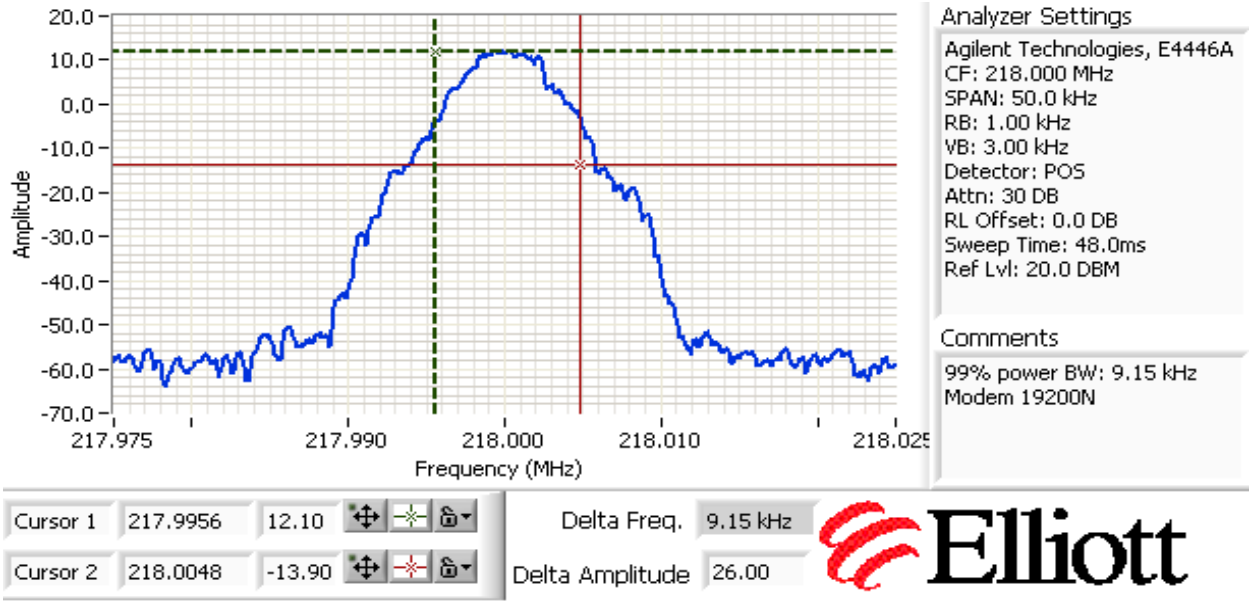
Date of Test: 10/29/2009
Test Engineer: John Caizzi
Test Location: Environmental Lab

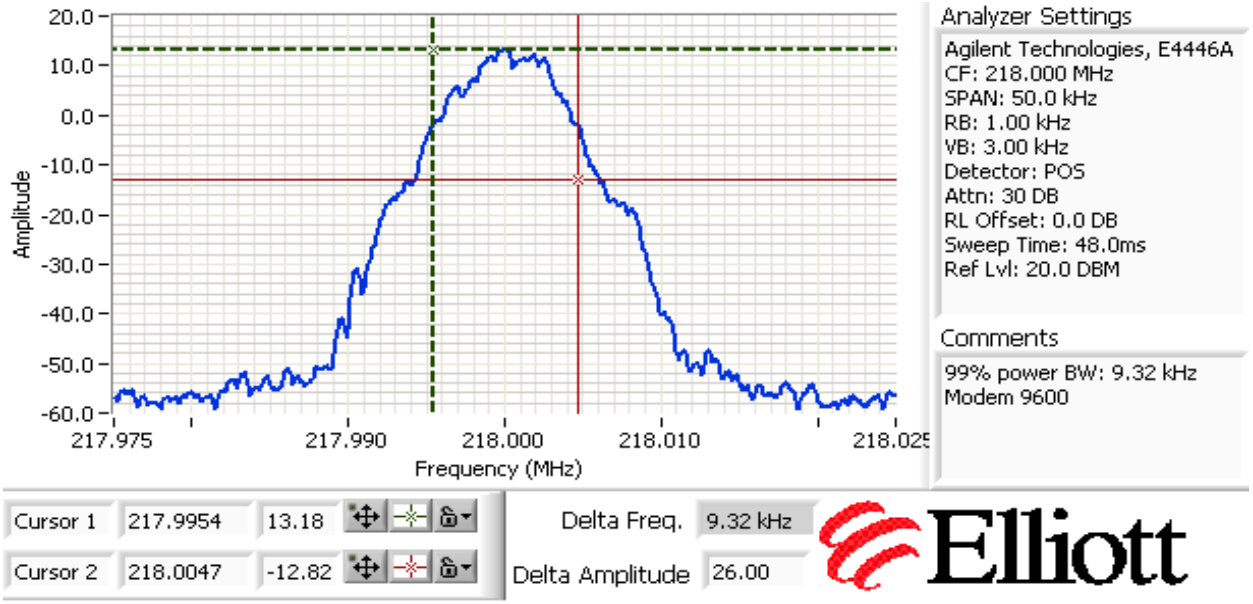
Power Setting	Frequency (MHz)	Span (kHz)	Resolution Bandwidth	Bandwidth (kHz) 26dB	Bandwidth (kHz) 99%	Modem	Channel Spacing
33 dBm	218	100	1 kHz		16.80	19200	25 kHz
33 dBm	218	50	1 kHz		9.15	9600	12.5 kHz
33 dBm	218	50	1 kHz		9.32	19200N	12.5 kHz
33 dBm	218	30	300 Hz		3.24	4800F	6.25 kHz
37 dBm	221	50	1 kHz		8.15	19200E	15 kHz
37 dBm	221	50	1 kHz		6.91	9600M	15 kHz
37 dBm	221	30	300 Hz		2.80	3200	5 kHz

Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > 3xRB

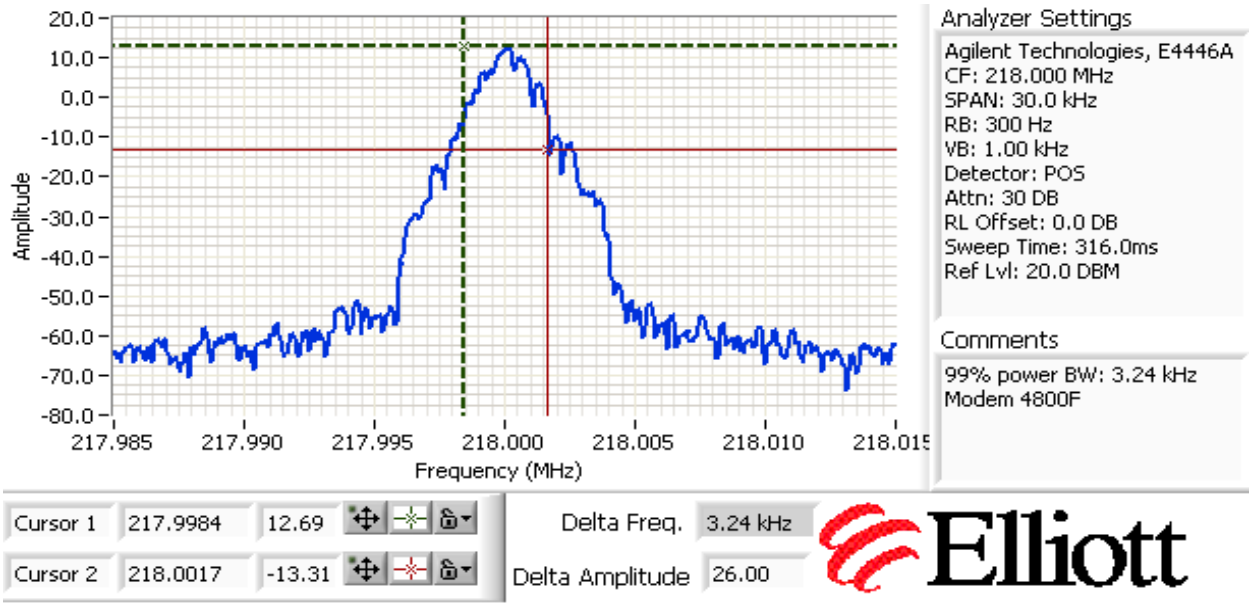


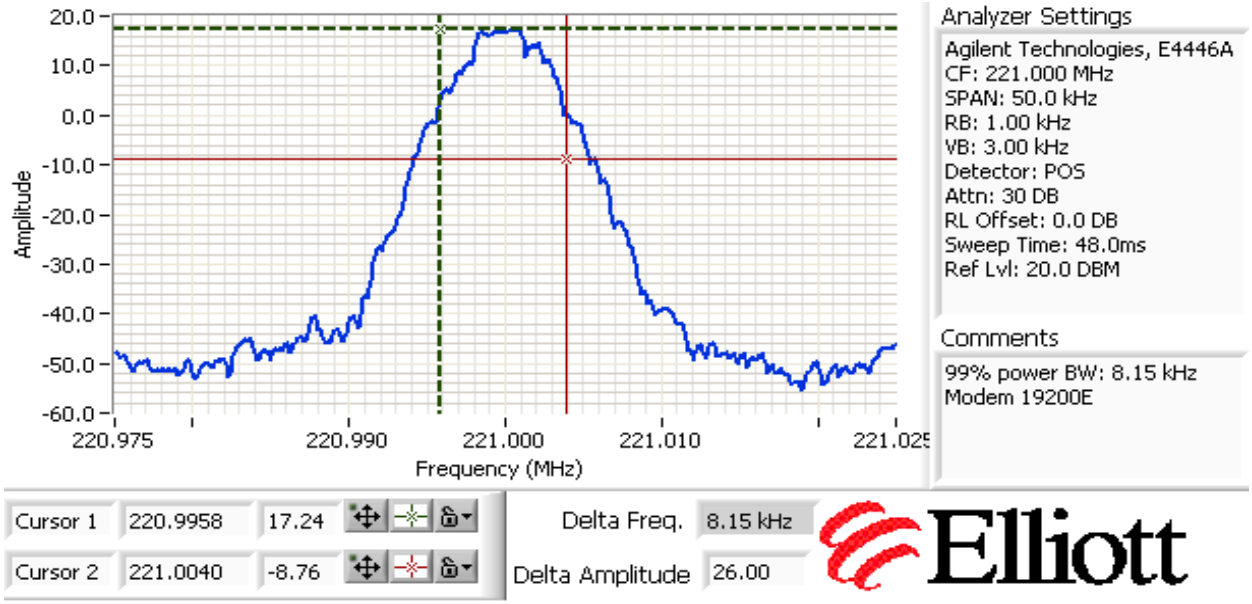
Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A



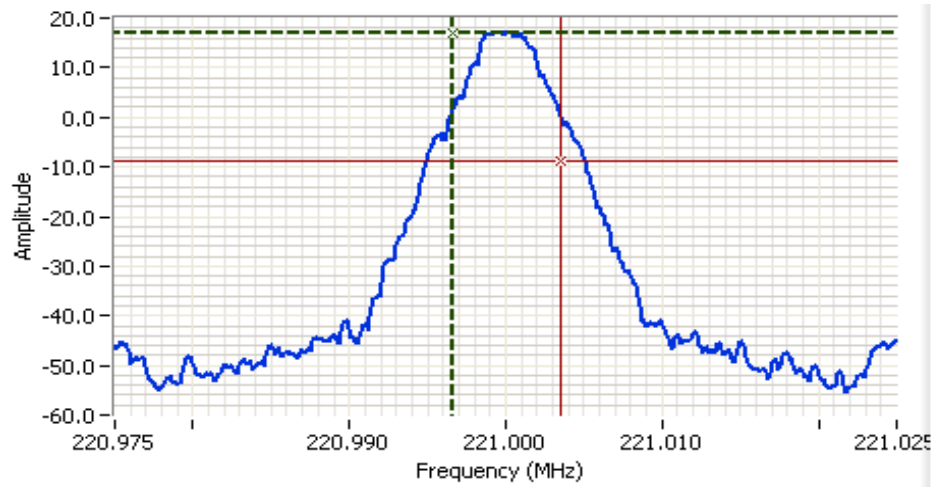


Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A





Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A



Analyzer Settings

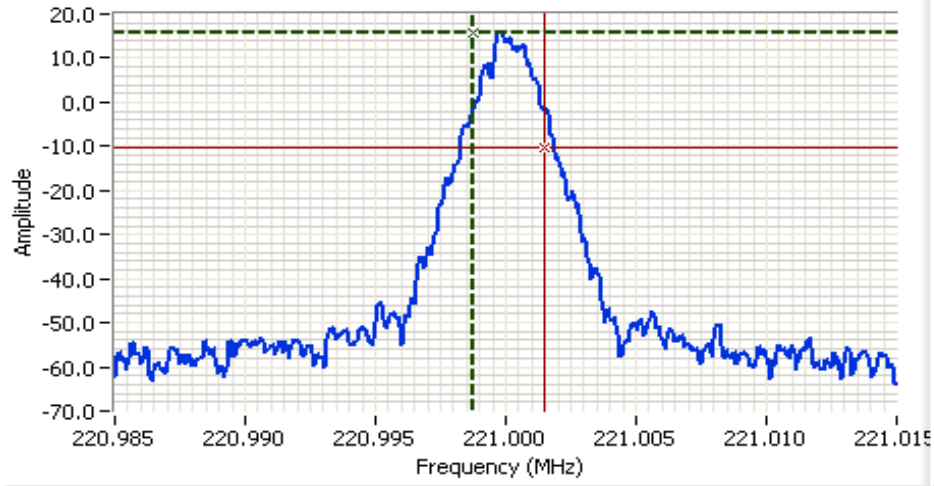
Agilent Technologies, E4446A
CF: 221.000 MHz
SPAN: 50.0 kHz
RB: 1.00 kHz
VB: 3.00 kHz
Detector: POS
Attn: 30 DB
RL Offset: 0.0 DB
Sweep Time: 48.0ms
Ref Lvl: 20.0 DBM

Comments

99% power BW: 6.91 kHz
Modem 9600M

Cursor 1	220.9966	17.14	Delta Freq.	6.91 kHz	
Cursor 2	221.0035	-8.86	Delta Amplitude	26.00	

Elliott



Analyzer Settings

Agilent Technologies, E4446A
CF: 221.000 MHz
SPAN: 30.0 kHz
RB: 300 Hz
VB: 1.00 kHz
Detector: POS
Attn: 30 DB
RL Offset: 0.0 DB
Sweep Time: 316.0ms
Ref Lvl: 20.0 DBM

Comments

99% power BW: 2.80 kHz
Modem 3200

Cursor 1	220.9987	15.81	Delta Freq.	2.80 kHz	
Cursor 2	221.0015	-10.19	Delta Amplitude	26.00	

Elliott

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Run #4: Out of Band Spurious Emissions, Conducted

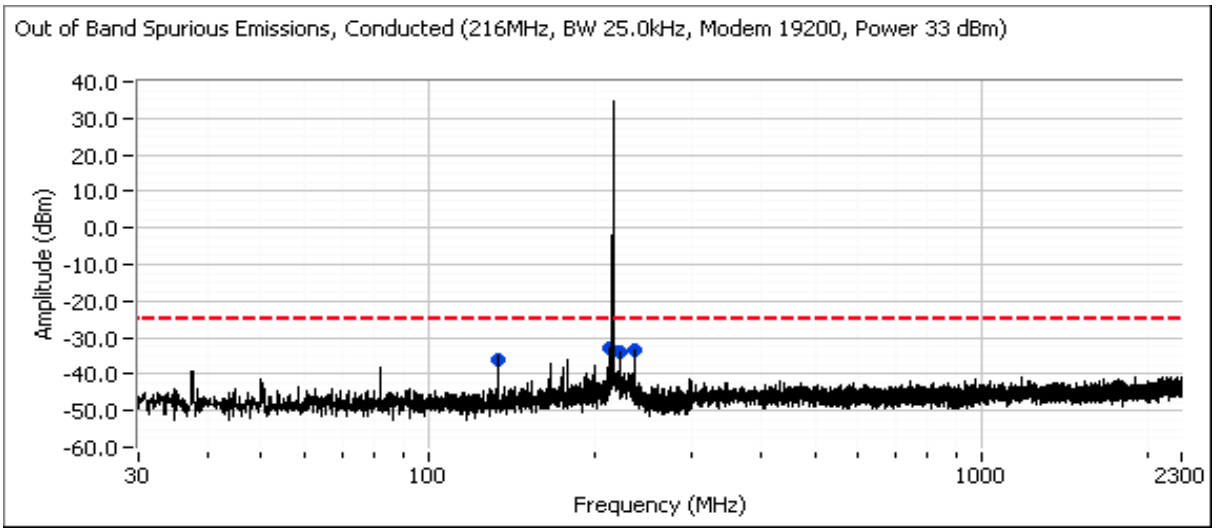
Date of Test: 10/29/2009
Test Engineer: John Caizzi
Test Location: Environmental Lab

The limit is taken from FCC Part 90 Mask B for 216-220 MHz operation and Mask F for 220-222 MHz operation

Frequency MHz	Level dBm	Port -	FCC Part 90 (Mask F) Limit	Margin	Detector	Tx Freq.	Mode	Comments	
133.715	-36.3	RF Port	-25.0	-11.3	Peak	216	19200.0	Power= 33dBm	Note 1
182.511	-34.6	RF Port	-25.0	-9.6	Peak	220	9600M	Power= 37dBm	
184.492	-34.6	RF Port	-25.0	-9.6	Peak	222	9600M	Power= 37dBm	
212.851	-32.7	RF Port	-25.0	-7.7	Peak	216	19200.0	Power= 33dBm	Note 1
216.902	-29.7	RF Port	-25.0	-4.7	Peak	220	9600M	Power= 37dBm	
218.883	-29.9	RF Port	-25.0	-4.9	Peak	222	9600M	Power= 37dBm	
223.204	-34.1	RF Port	-25.0	-9.1	Peak	216	19200.0	Power= 33dBm	Note 1
235.719	-33.5	RF Port	-25.0	-8.5	Peak	216	19200.0	Power= 33dBm	Note 1

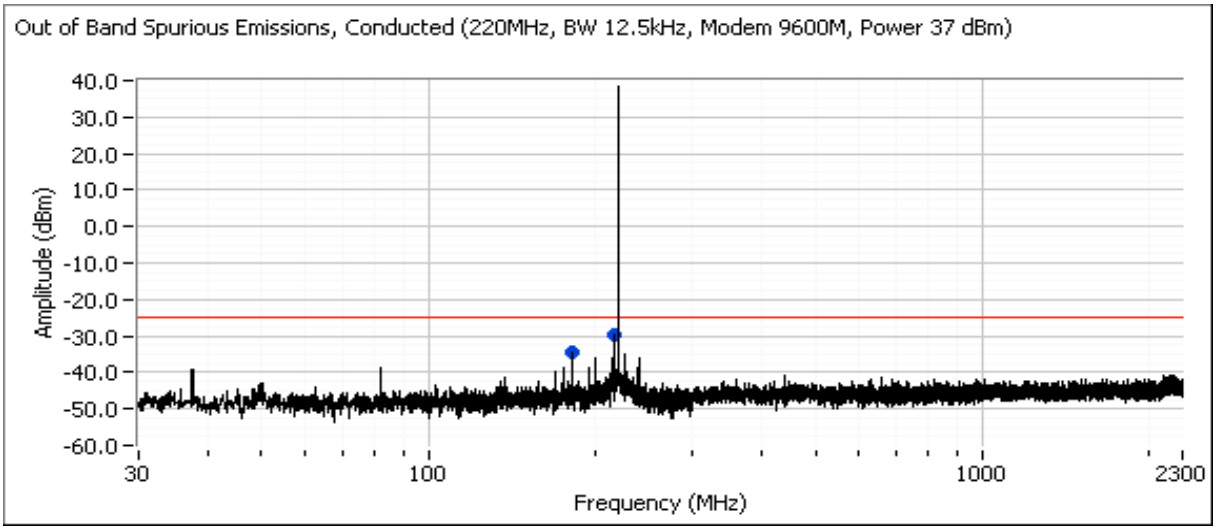
Note 1:	The limit for this band was -13dBm but more restrictive limit (-25dBm) was used

Plot for 216 MHz channel, power setting(s) = 33

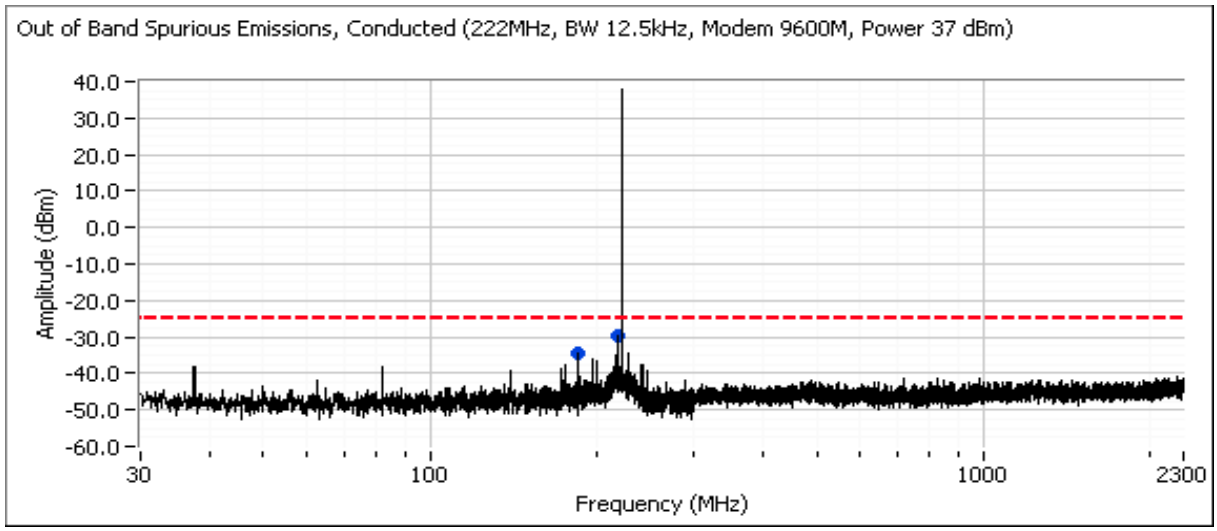


Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Plot for 220 MHz channel, power setting(s) = 37



Plot for 222 MHz channel, power setting(s) = 37



Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

RSS 119 and FCC Part 80 & 90
Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 11/5/2009
Test Engineer: Mehran Birgani
Test Location: Refer to each run

Config. Used: 1
Config Change: no laptop
EUT Voltage: 13.8VDC

General Test Configuration

All measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

Temperature: 13-18 °C
Rel. Humidity: 30-40 %

Summary of Results

Run #	Spacing	Data Rate	Test Performed	Limit	Pass / Fail	Result / Margin
1	-	-	Spurious emissions (radiated)	FCC 90.210	Pass	47.2dBµV/m @ 1125.0MHz (-23.0dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Run #1: Out of Band Spurious Emissions, Radiated

Date: 11/5/2009 Engineer: Mehran Birgani Location: Chamber #2

Conducted limit (dBm): -25

Approximate field strength limit @ 3m: 70.2

The limit is taken from FCC Part 90 Mask B for 216-220 MHz operation and Mask F for 220-222 MHz operation

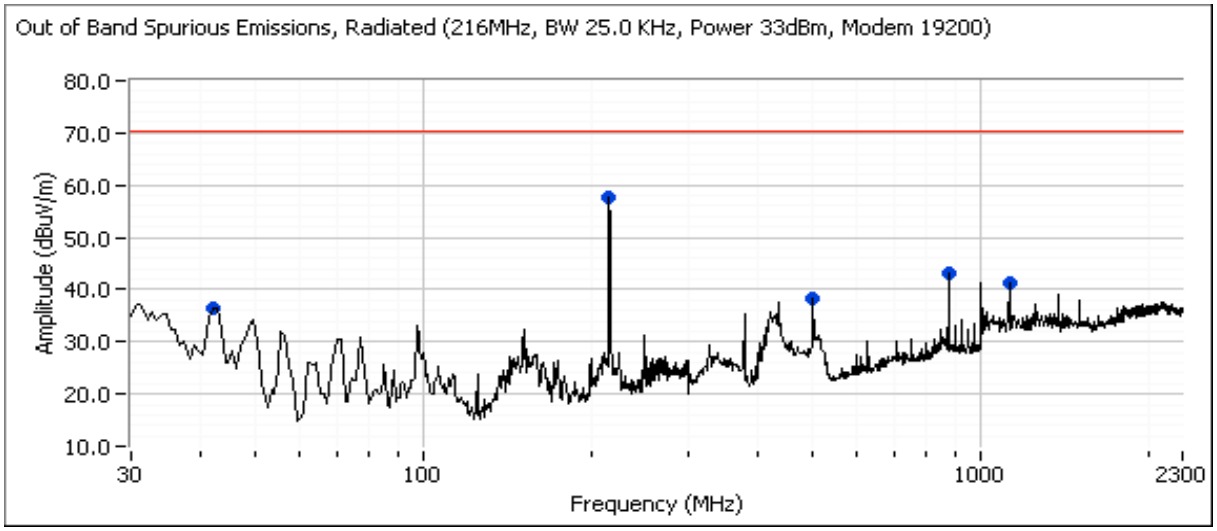
Run #1a - Preliminary measurements - chamber scans

Frequency	Level	Pol	FCC 90.210		Detector	Azimuth	Height	Comments	Tx Freq
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		MHz
42.981	36.5	V	70.2	-33.7	Peak	121	1.7	Modem 19200, PWR 33	216
42.983	35.7	V	70.2	-34.5	Peak	239	1.7	Modem 9600M, PWR 37	220
42.983	36.1	V	70.2	-34.1	Peak	121	1.7	Modem 9600M, PWR 37	222
440.022	38.4	H	70.2	-31.8	Peak	320	1.7	Modem 9600M, PWR 37	220
444.006	39.2	H	70.2	-31.0	Peak	315	1.7	Modem 9600M, PWR 37	222
499.993	38.2	V	70.2	-32.0	Peak	132	1.7	Modem 19200, PWR 33	216
874.991	43.2	H	70.2	-27.0	Peak	118	1.7	Modem 19200, PWR 33	216
875.004	42.8	H	70.2	-27.4	Peak	116	1.7	Modem 9600M, PWR 37	222
875.017	38.6	H	70.2	-31.6	Peak	112	1.7	Modem 9600M, PWR 37	220
1000.060	43.3	H	70.2	-26.9	Peak	163	1.7	Modem 9600M, PWR 37	220
1000.060	40.5	V	70.2	-29.7	Peak	38	1.7	Modem 9600M, PWR 37	222
1125.000	41.1	H	70.2	-29.1	Peak	156	1.7	Modem 19200, PWR 33	216
216.001	57.5	V	-	-	Peak	271	1.7	Modem 19200, PWR 33	216
220.003	56.9	V	-	-	Peak	269	1.7	Modem 9600M, PWR 37	220
222.003	57.1	H	-	-	Peak	119	1.7	Modem 9600M, PWR 37	222

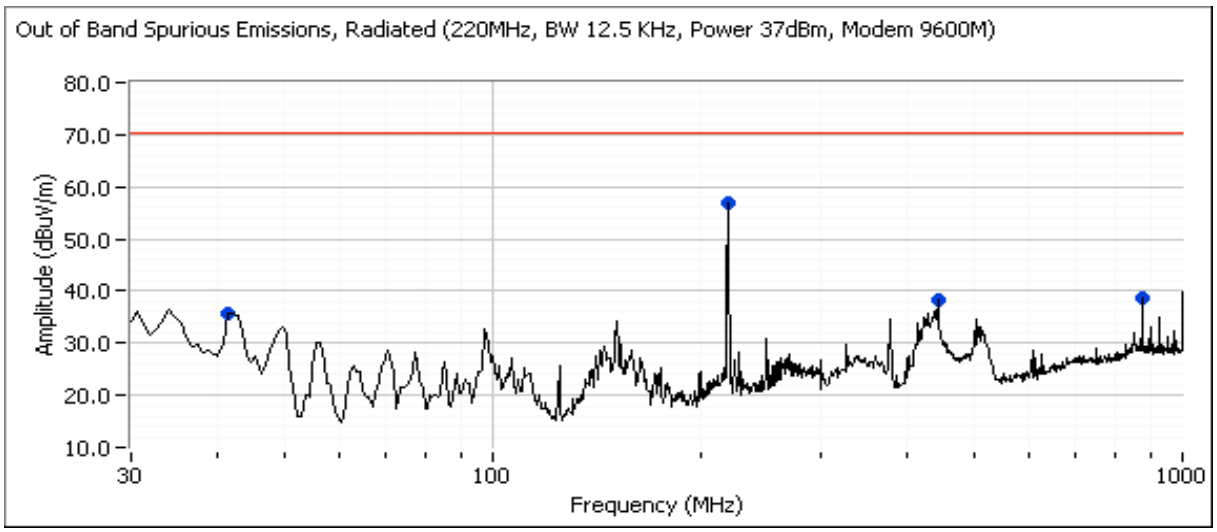
Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: $E=\sqrt{(30PG)}/d$. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Plots for 216 MHz channel, power setting(s) = 33

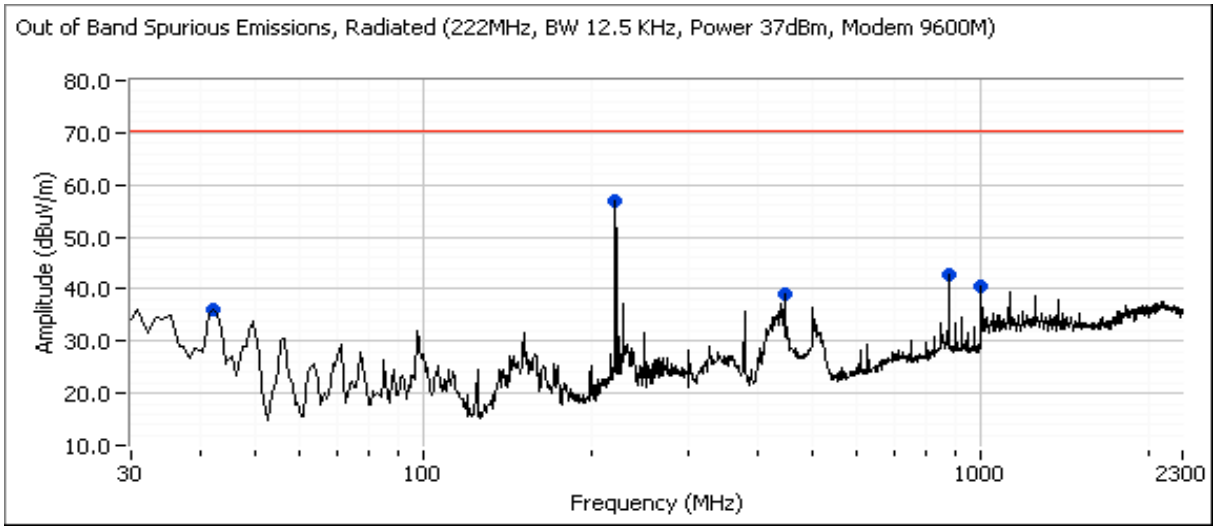


Plots for 220MHz channel, power setting(s) = 37



Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Plots for 222 MHz channel, power setting(s) = 37



Run #1b: - OATS EUT Field Strength Measurements and Substitution Measurements

Date: 11/5/2009 Engineer: Mehran Birgani Location: SVOATS #2

EUT Field Strength

Frequency	Level	Pol	FCC 90.210		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
42.981	30.2	V	70.2	-40.0	PK	10	1.2	Modem 19200, PWR 33	216
440.022	35.2	H	70.2	-35.0	PK	200	1.0	Modem 9600M, PWR 37	220
443.998	34.5	H	70.2	-35.7	PK	298	1.0	Modem 9600M, PWR 37	222
499.993	40.1	V	70.2	-30.1	PK	5	1.0	Modem 19200, PWR 33	216
874.991	39.7	H	70.2	-30.5	PK	360	1.0	Modem 19200, PWR 33	216
875.004	41.7	H	70.2	-28.5	PK	309	1.0	Modem 9600M, PWR 37	222
875.017	40.4	H	70.2	-29.8	PK	350	1.0	Modem 9600M, PWR 37	220
1000.060	46.7	H	70.2	-23.5	PK	15	1.1	Modem 9600M, PWR 37	220
1125.000	47.2	H	70.2	-23.0	PK	40	1.0	Modem 19200, PWR 33	216

Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

RSS 119 and FCC Part 80 & 90
Frequency Stability

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 11/9/2009
Test Engineer: J. Caizzu, M. Birgani
Test Location: Radio Lab
Config. Used: 1
Config Change: None
EUT Voltage: 13.8VDC

General Test Configuration

All measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was placed inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

Temperature: 17-22 °C
Rel. Humidity: 30-40 %

Summary of Results

Run #	Spacing	Data Rate	Test Performed	Limit	Pass / Fail	Result / Margin
1	12.5	9600M	Frequency Stability	Part 90 - 1.5ppm	Pass	0.17 ppm

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	GE MDS LLC	Job Number:	J77138
Model:	SD2 Transceiver	T-Log Number:	T77262
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Part 80 & 90, RSS-119, FCC Part 15	Class:	N/A

Run #8: Frequency Stability

Nominal Frequency: 220 MHz

Frequency Stability Over Temperature

The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements to ensure the EUT and chamber had stabilized at that temperature.

Temperature	requency Measure	Drift	
(Celsius)	(MHz)	(Hz)	(ppm)
-30	219.999971	-29	0.13
-20	219.999968	-32	0.15
-10	219.999981	-19	0.09
0	219.999963	-37	0.17
10	219.999981	-19	0.09
20	219.999988	-12	0.05
30	219.999990	-10	0.05
40	220.000003	3	0.01
50	220.000035	35	0.16
	Worst case:	-37	0.17

Frequency Stability Over Input Voltage

Nominal Voltage: 13.8 Vdc

Voltage	requency Measure	Drift	
(DC)	(MHz)	(Hz)	(ppm)
11.7	219.999984	-16	0.07
15.9	219.999985	-15	0.07
	Worst case:	-16	0.07

Note 1:	Maximum drift of fundamental frequency before it shut down at 9.6 Vdc was 2.0 Hz.

Appendix C Photographs

Uploaded as a separate exhibit

Appendix D Proposed FCC ID Label & Label Location

Uploaded as a separate exhibit

Appendix E Detailed Photographs

Uploaded as a separate exhibit

Appendix F Operator's Manual

Uploaded as a separate exhibit

Appendix G Block Diagram

Uploaded as a separate exhibit

Appendix H Schematic Diagrams

Uploaded as a separate exhibit

Appendix I Theory of Operation

Uploaded as a separate exhibit

Appendix J Tune-up Procedure

Uploaded as a separate exhibit

Appendix K Parts List

Uploaded as a separate exhibit