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Radio Test Report

FCC Part 90 and RSS 119
(150 MHz to 174 MHz)

Model: SD1

COMPANY:	GE MDS LLC 175 Science Parkway Rochester, NY 14620
TEST SITE(S):	Elliott Laboratories 41039 Boyce Road. Fremont, CA. 94538-2435
REPORT DATE:	February 3, 2011
FINAL TEST DATES:	January 5, 6, 7 and 12, 2011

AUTHORIZED SIGNATORY:

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Chief Engineer
Elliott Laboratories LLC

A2LA ACCREDITED
Testing Cert #2016.01

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	2-3-2011	First release	

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SCOPE

Tests have been performed on the GE MDS LLC model SD1, 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 3
- CFR 47 Part 90 (Private Land Mobile Radio Service)
- RSS-119, Issue 10, April 2010 (Land Mobile and Fixed Radio Transmitters and Receivers Operating the Frequency Range 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 SD1 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 SD1 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 90 and RSS-119

FCC	Canada	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) § 90.205	RSP 100 7.2 (a) SRSP-500	Frequency range(s)	150 – 174 MHz	150 – 174 MHz	Complied
§2.1033 (c) (6) §2.1033 (c) (7) §2.1046 § 90.205		RF power output at the antenna terminals	20 dBm to 37 dBm Conducted	54 dBm ERP	Complied
	RSP 100 7.2 (a) RSS 119 5.4.1	RF power output at the antenna terminals	20 dBm to 37 dBm Conducted	44.8 dBm Conducted (Mobile)	Complied
§2.1033 (c) (4) §2.1047 § 90.210	RSP 100 7.2 (b) (iii) RSS 119 5.8	Emission types	F1D, F2D, F3D	-	Complied
		Emission mask	All emissions with mask	D and E	Complied
§2.1049 § 90.209	RSS GEN 4.4.1 RSS 119 5.5	99% / Occupied Bandwidth	3.53, 9.33 kHz	6, 11.25 kHz	Complied
§ 90.214	RSS 119 5.9	Transient Frequency Behavior	Within times required. Refer to plots.	t_1, 5ms t_2, 20ms t_3, 5ms	Complied
Transmitter spurious emissions					
§2.1051 §2.1057		At the antenna terminals	-29.7 dBm	-25 dBm	Complied
§2.1053 §2.1057		Power	-42.9 dBm erp	-25 dBm	Complied
Receiver spurious emissions					
15.111	RSS GEN 7.2.3	At the antenna terminals	-75.0 dBm	2nW / 100kHz (-57dBm)	Complied
15.109	RSS GEN 7.2.3 Table 1	Field strength	44.6 dBuV/m	See limit table on page 20	
Other details					
§2.1055 § 90.213	RSS-119 5.3	Frequency stability	1 ppm	1 ppm	Complied
§2.1093	RS 102	RF Exposure	To be considered at time of licensing	-	Complied
§2.1033 (c) (8)	RSP 100 7.2 (a)	Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	13.8V, 2.2 A	-	Complied
-	-	Antenna Gain	Up to 7 dBd	-	Complied
Notes					

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 SD1 is a licensed, half-duplex, narrow band data transceiver which operates in the VHF band. The EUT was treated as table-top equipment during testing to most closely simulate the end-user environment. The electrical rating of the EUT is 10-30 VDC (13.8V nominal), 2.2 Amps.

The sample was received on January 5, 2011 and tested on January 5, 6, 7 and 12, 2011. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
GE MDS	SD1	Data transceiver	FCC #1	E5MDS-SD1

OTHER EUT DETAILS

The GE MDS LLC Model SD1 is a professionally installed licensed radio and may use up to 7 dBd gain antennas.

ENCLOSURE

The EUT enclosure is primarily constructed of cast aluminum. It measures approximately 16 cm wide by 12 cm deep by 3.5 cm 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
Power Designs	6150D	DC power supply	902012	-
db Products	15W Type N	50 ohm load	NA	-

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

Company	Model	Description	Serial Number	FCC ID
HP	Pavilion dv6000	Laptop	-	-
AirLink	ASW108/A4	Hub	-	-
-	-	Serial - USB adaptor	-	-

EUT INTERFACE PORTS

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

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
COM2	Serial - USB adaptor	Multiwire	Shielded	10
Serial - USB adaptor	Laptop	Multiwire	Shielded	0.3
LAN	Hub	Cat 7	Shielded	10
Antenna	50 ohm load	Coax	Shielded	2
DC Power	DC supply	2 wire	Unshielded	3
AC Power (DC supply)	AC mains	3 wire	Unshielded	2

Note: COM1 was not connected during testing. The manufacturer stated that this is for configuration purposes and therefore would not normally be connected.

EUT OPERATION

During emissions testing the EUT was set to transmit continuously or in receive mode as required for the test performed.

TESTING

GENERAL INFORMATION

Antenna port measurements were taken at the Elliott Laboratories test site located at 41039 Boyce Road, Fremont, CA 94538-2435.

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.

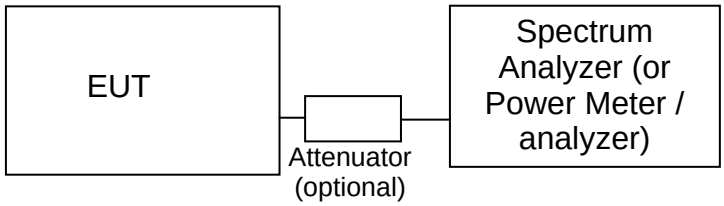
Site	Registration Numbers		Location
	FCC	Canada	
Chamber 7	A2LA Accredited	IC 2845B-7	41039 Boyce Road Fremont, CA 94538-2435

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 RADIATED EMISSIONS MEASUREMENTS). 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.

TRANSIENT FREQUENCY BEHAVIOR:

The TIA/EIA 603 procedure is used to determine compliance with transient frequency timing requirements as the radio is keyed on and off.

The EUTs rf output is connected via a combiner/splitter to the test receiver/spectrum analyzer and to a diode detector. The test receiver or spectrum analyzer video output is connected to an oscilloscope, which is triggered by the output from the diode detector.

Plots showing Ton, T1, and T2 are made when turning on the transmitter and showing T3 when turning off the transmitter.

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

Radio Antenna Port (Power and Spurious Emissions), 05-Jan-11

Manufacturer	Description	Model	Asset #	Cal Due
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	7/12/2011
Tektronix	1 GHz, 4 CH, 5GS/s Oscilloscope	TDS5104	1435	4/26/2011

Conducted Emissions - AC Power Ports, 05-Jan-11

Manufacturer	Description	Model	Asset #	Cal Due
EMCO	LISN, 10 kHz-100 MHz	3825/2	1292	3/12/2011
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	3/12/2011
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz - 22 GHz	8593EM	1319	11/22/2011
Rohde & Schwarz	Test Receiver, 9 kHz-2750 MHz	ESCS 30	1337	11/24/2011
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	4/20/2011

Radiated Emissions, 30 - 2,000 MHz, 06-Jan-11

Manufacturer	Description	Model	Asset #	Cal Due
Fluke Mfg Co	Signal Generator, 100KHz - 2100MHz	6062A	852	N/A
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz - 22 GHz	8593EM	1319	11/22/2011
Hewlett Packard	SpecAn 9 kHz - 40 GHz, FT (SA40) Blue	8564E (84125C)	1393	4/14/2011
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1422	12/1/2011
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1548	6/24/2012
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/22/2012
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	11/23/2011
Compliance Design	Tuned Dipole Antenna	Roberts (400-1000MHz)	1896	12/16/2011
Rohde & Schwarz	Power Sensor, 1 uW-100 mW, DC-18 GHz, 50ohms	NRV-Z51	2152	11/6/2011
Com-Power Corp.	Preamplifier, 30-1000 MHz	PAM-103	2234	5/19/2011

Appendix B Test Data

T81609 23 Pages

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		-
Emissions Standard(s):	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	A
Immunity Standard(s):	-	Environment:	Radio

EMC Test Data

For The

GE MDS LLC

Model

SD1

Date of Last Test: 1/12/2011

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

RSS 119 and FCC Part 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

With the exception of the radiated spurious emissions tests, 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: 18 °C

Rel. Humidity: 33 %

Summary of Results

Run #	Spacing	Test Performed	Limit	Pass / Fail	Result / Margin
1	6.25 & 12.5 kHz	Output Power	500 W ERP	Pass	151 W ERP
2	6.25 & 12.5 kHz	Spectral Mask	See plots below	Pass	-
3	6.25 & 12.5 kHz	99% or Occupied Bandwidth	6, 11.25 and 20 kHz	Pass	3.53, 9.33 & 16.5 kHz
4	6.25 & 12.5 kHz	Tx Spurious Emissions (conducted)	-25 dBm	Pass	-29.7 dBm @ 300 MHz (-4.7 dB)
5	6.25 & 12.5 kHz	Tx Spurious emissions (radiated)	-25 dBm	Pass	-40.7 dBm @ 1000.100 MHz (-15.7 dB)
6	6.25 & 12.5 kHz	Transient Frequency Behaviour	5 and 20 ms	Pass	Less than 5 and 20 ms
7	6.25 & 12.5 kHz	Frequency Stability		Pass	1.0 ppm

Modifications Made During Testing

Modifications are detailed under each run description.

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #1: Output Power

Date: 1/5/2011 Engineer: John Caizzi Location: FT7

Cable Loss: 0.0 dB Attenuator: 30.0 dB Total Loss: 30.0 dB

Cable ID(s): EL 535 Attenuator IDs: 1878 & 2102

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Antenna Gain (dBi)	Result	ERP dBm	ERP W
37	150	37.0	5011.9	9.15	Pass	44.0	24.831
37	162	37.0	5011.9	9.15	Pass	44.0	24.831
37	174	37.0	5011.9	9.15	Pass	44.0	24.831
20	150	20.6	114.8	9.15	Pass	27.6	0.569
20	162	20.3	107.2	9.15	Pass	27.3	0.531
20	174	20.7	117.5	9.15	Pass	27.7	0.582

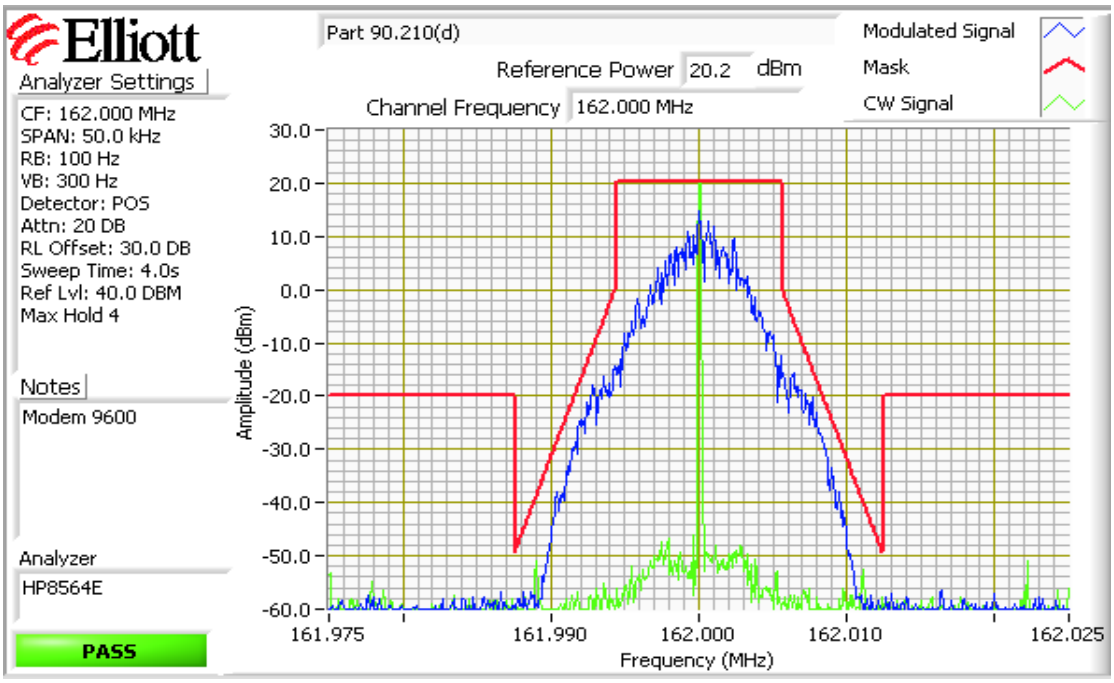
Note 1:	Output power measured using an average power meter.
Note 2:	Power setting - the software power setting used during testing, included for reference only.

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

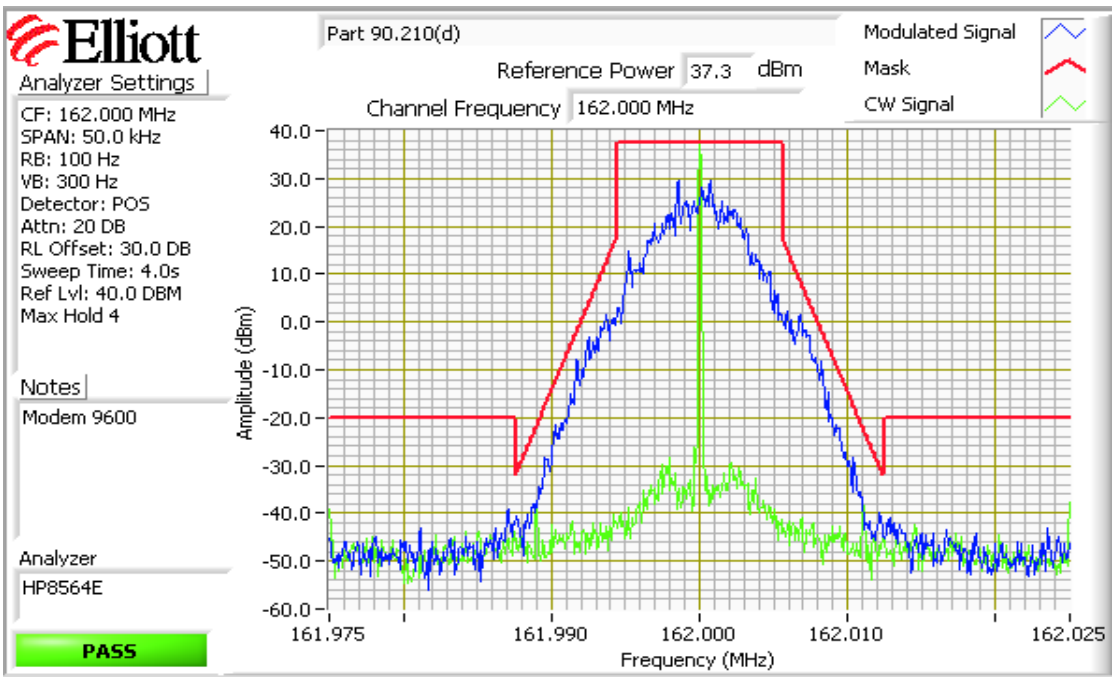
Run #2: Spectral Mask, FCC Part 90 and RSS-119 Masks D and E

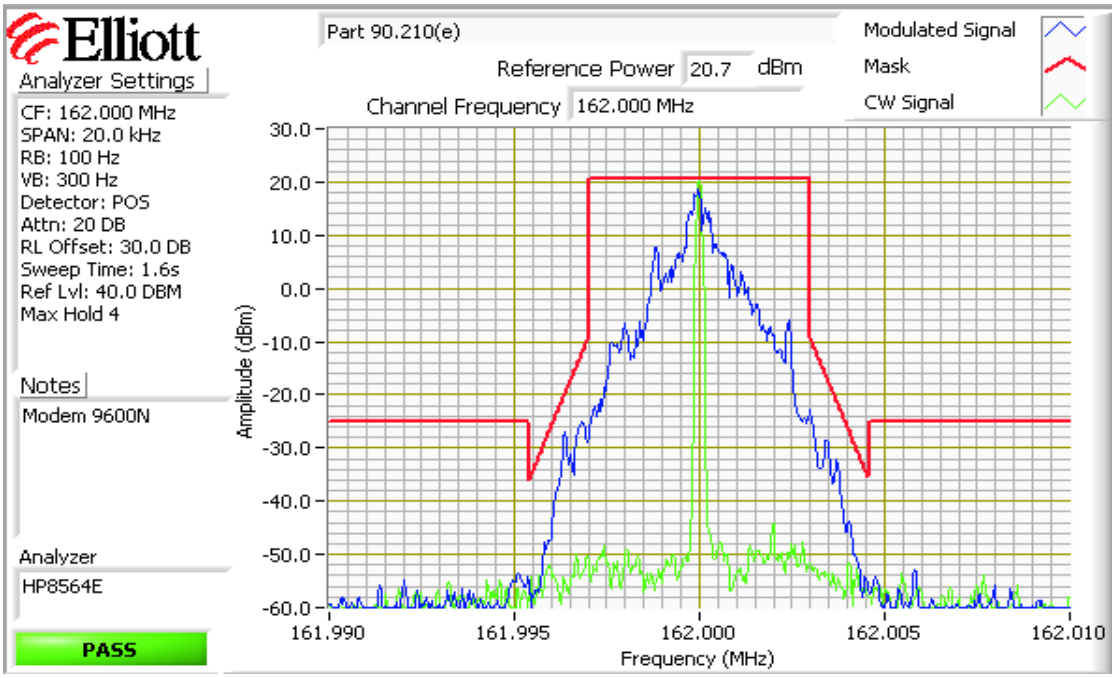
Date: 1/5/2011 Engineer: John Caizzi FT7

Note 1:	For Mask C, RB=300 Hz and VB=1KHz. For Mask D and E, RB=100Hz and VB=300Hz. The mask reference was established using the peak amplitude of the unmodulted transmitter output.
Note 2	For Mask C, use Modem 19200; for Mask D, use Modem 9600; for Mask E, use Modem 9600N.

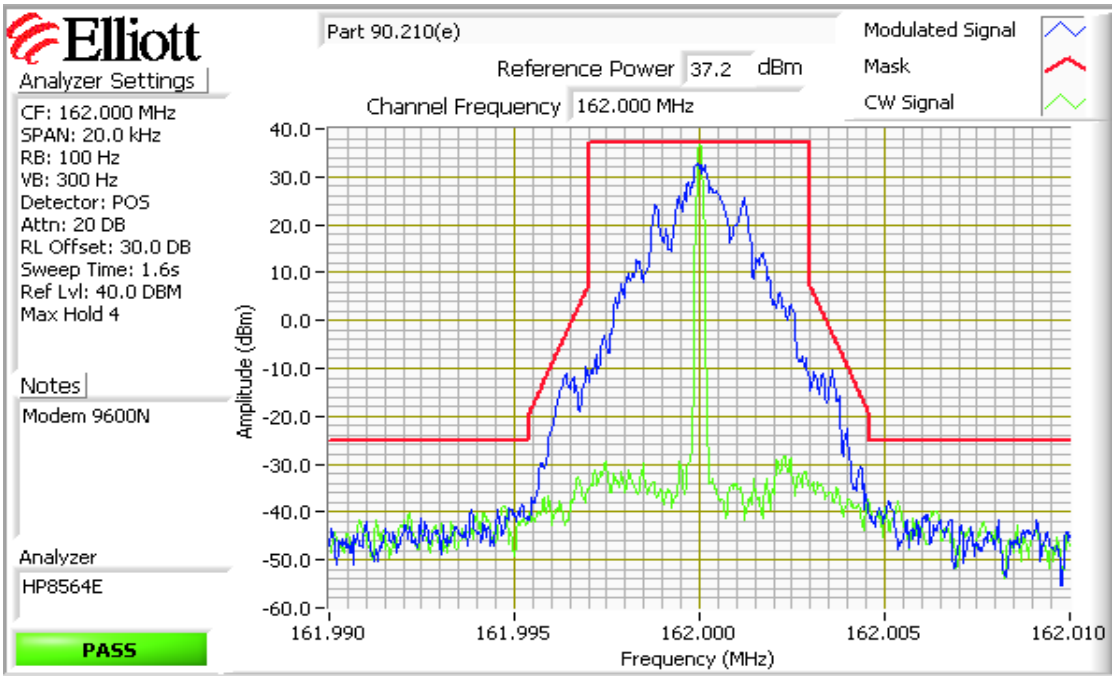


Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A





Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A



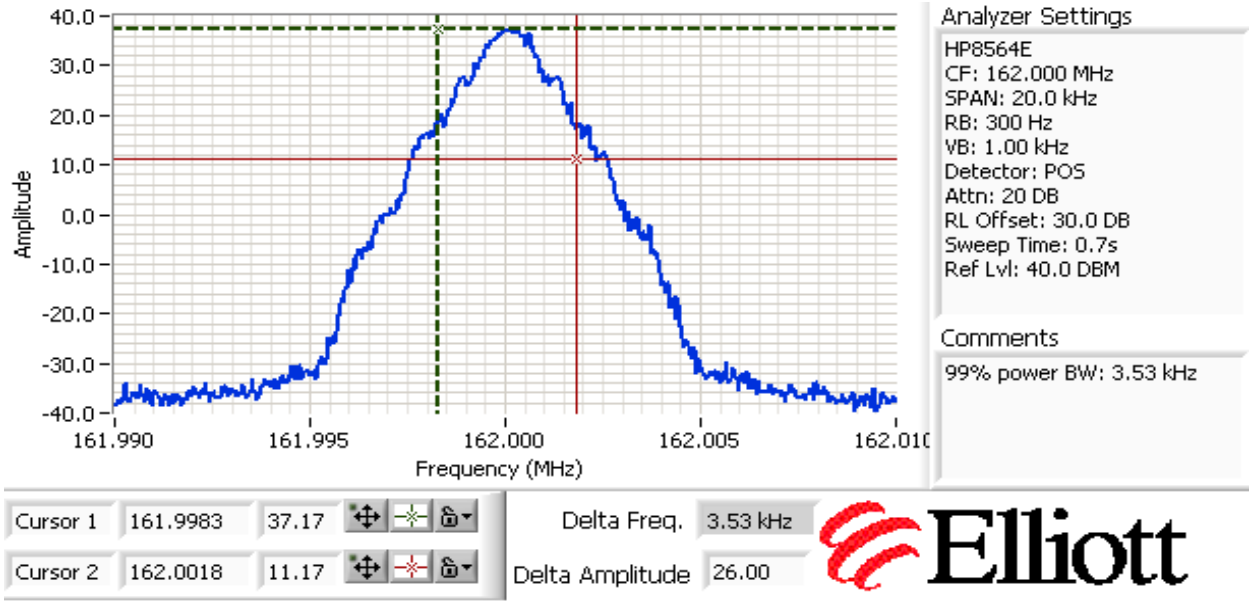
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #3: Signal Bandwidth

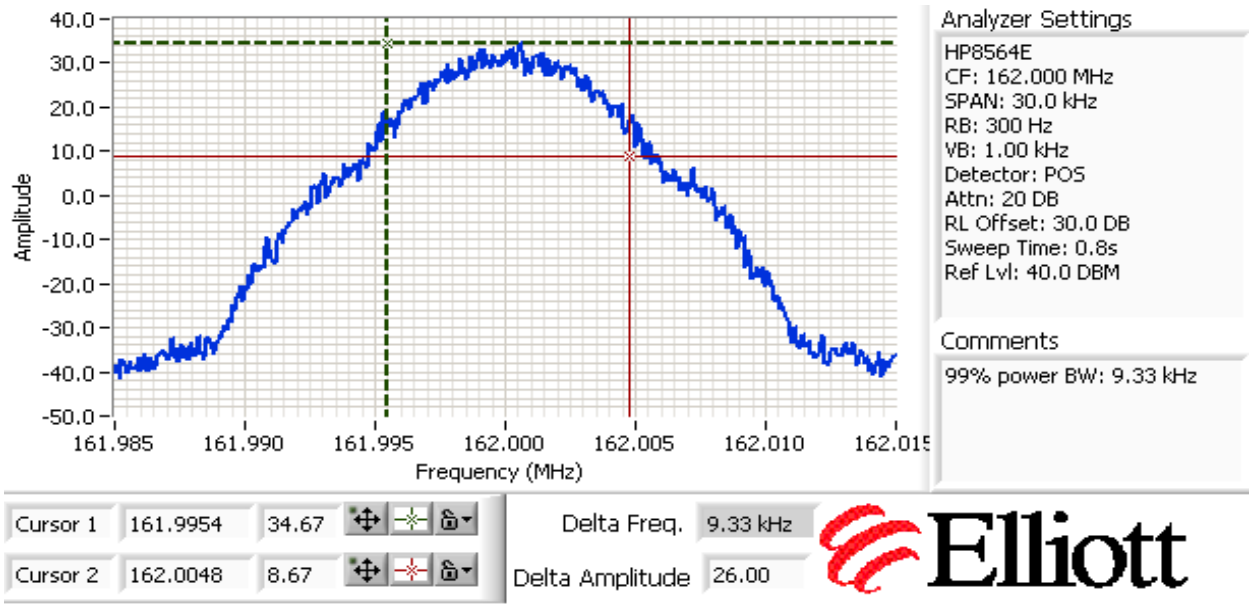
Date: 1/5/2011 Engineer: John Caizzi Location: FT7

Power Setting	Frequency (MHz)	Resolution Bandwidth	Bandwidth (kHz)		Limit (kHz)
				99%	
37	162	300 Hz	9600N	3.53	6
37	162	300 Hz	9600	9.33	11.25
37	162	1 kHz	19200	16.5	20

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:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A



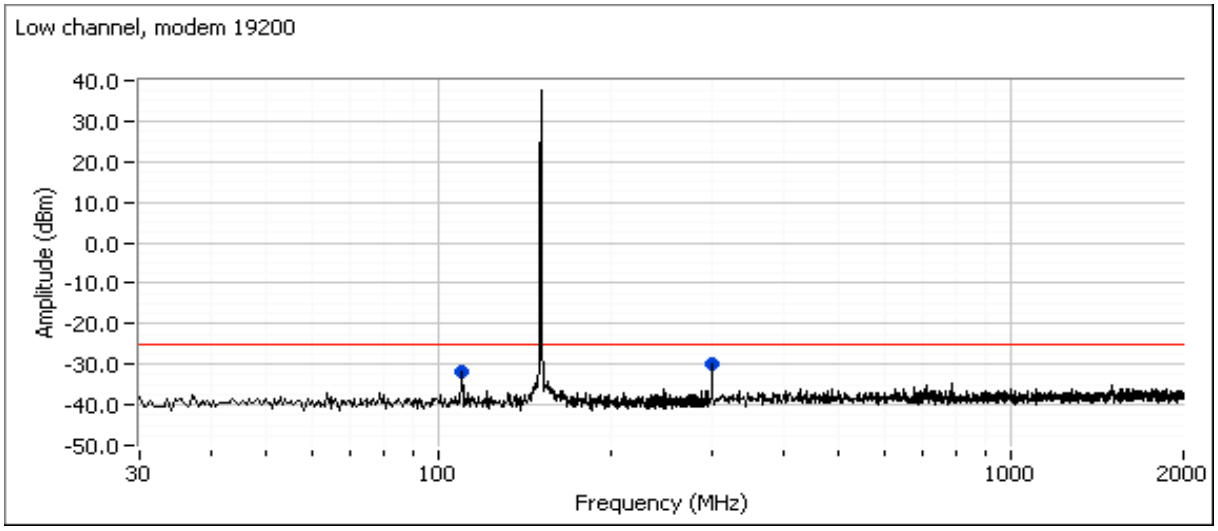
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #4: Out of Band Spurious Emissions, Conducted

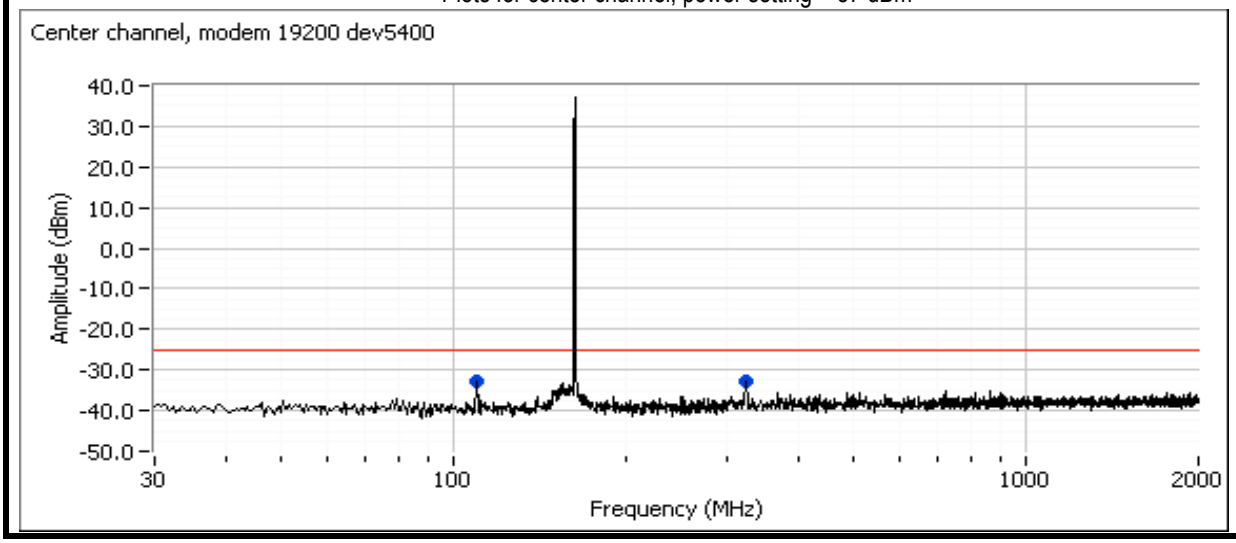
Date: 1/5/2011 Engineer: John Caizzi Location: FT7

Frequency (MHz)	Limit	Result
150.0125	-25 dBm	Pass
162.0125	-25 dBm	Pass
173.9875	-25 dBm	Pass

Plots for low channel, power setting = 37 dBm

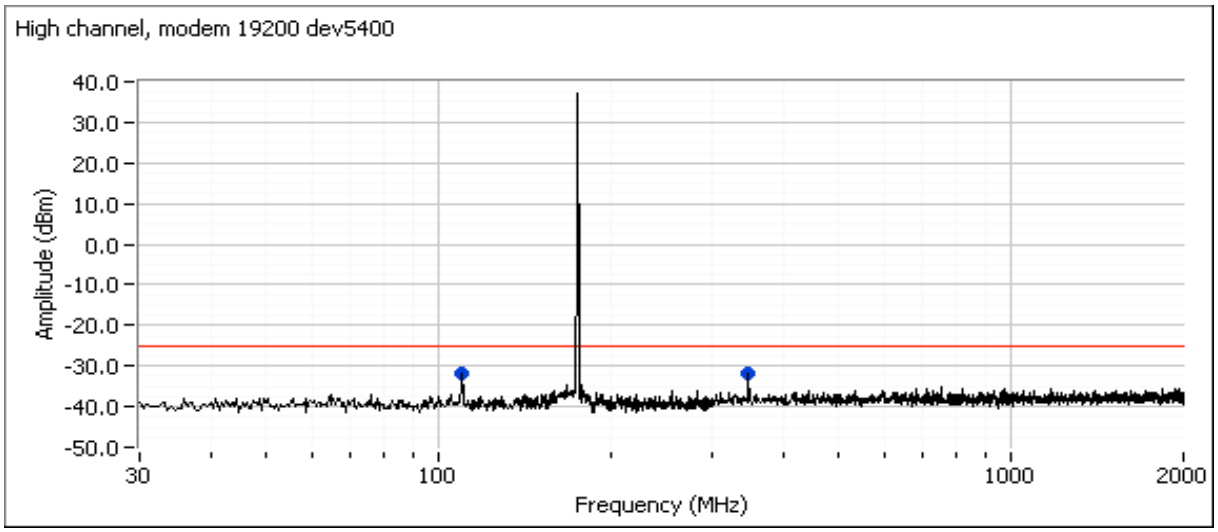


Plots for center channel, power setting = 37 dBm



Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Plots for high channel, power setting = 37 dBm



Frequency	Level	Port	FCC 90.210(e)		Detector			Comments	Channel
MHz	dBm		Limit	Margin	Pk/QP/Avg				
109.650	*-31.6*	*Antenna*	*-25.0*	*-6.6*	*Peak*				*Low*
300.000	*-29.7*	*Antenna*	*-25.0*	*-4.7*	*Peak*				*Low*
109.650	*-32.6*	*Antenna*	*-25.0*	*-7.6*	*Peak*				*Center*
324.500	*-33.0*	*Antenna*	*-25.0*	*-8.0*	*Peak*				*Center*
109.650	*-31.6*	*Antenna*	*-25.0*	*-6.6*	*Peak*				*High*
347.833	*-31.9*	*Antenna*	*-25.0*	*-6.9*	*Peak*				*High*

The limit is taken from FCC Part 90 Mask E

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #5: Out of Band Spurious Emissions, Radiated

Conducted limit (dBm): -25
Approximate field strength limit @ 3m: 70.3

Run #5a - Preliminary measurements
Date: 1/6/2011 Engineer: John Caizzi Location: FT7

Frequency	Level	Pol	FCC 90.210(e)		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		Low
1000.000	51.3	V	70.2	-18.9	Peak	155	1.6		Low
1125.000	48.1	V	70.2	-22.1	Peak	162	1.9		Low
1375.000	48.0	V	70.2	-22.2	Peak	165	1.0		Low
1625.000	46.8	V	70.2	-23.4	Peak	145	1.3		Low
877.500	45.6	H	70.2	-24.6	Peak	126	1.0		Low
375.250	39.7	H	70.2	-30.5	Peak	248	1.0		Low
301.750	39.3	H	70.2	-30.9	Peak	238	1.0		Low
252.075	38.5	H	70.2	-31.7	Peak	258	1.0		Low
627.250	37.7	H	70.2	-32.5	Peak	231	1.5		Low
751.500	35.8	H	70.2	-34.4	Peak	126	1.0		Low
106.950	35.0	V	70.2	-35.2	Peak	154	1.0		Low
101.550	34.8	V	70.2	-35.4	Peak	194	1.0		Low
1000.000	51.3	V	70.2	-18.9	Peak	152	1.6		Center
1685.000	47.7	V	70.2	-22.5	Peak	156	1.6		Center
1625.000	47.6	V	70.2	-22.6	Peak	164	1.3		Center
1375.000	47.5	V	70.2	-22.7	Peak	170	1.0		Center
1125.000	46.7	H	70.2	-23.5	Peak	132	1.3		Center
877.500	45.1	H	70.2	-25.1	Peak	130	1.0		Center
375.250	41.7	H	70.2	-28.5	Peak	252	1.0		Center
324.500	40.8	H	70.2	-29.4	Peak	255	1.0		Center
751.500	39.8	H	70.2	-30.4	Peak	220	1.0		Center
543.250	39.6	V	70.2	-30.6	Peak	321	1.0		Center
251.400	37.2	H	70.2	-33.0	Peak	247	1.0		Center
100.875	33.4	V	70.2	-36.8	Peak	212	1.5		Center
106.275	32.1	V	70.2	-38.1	Peak	158	1.0		Center

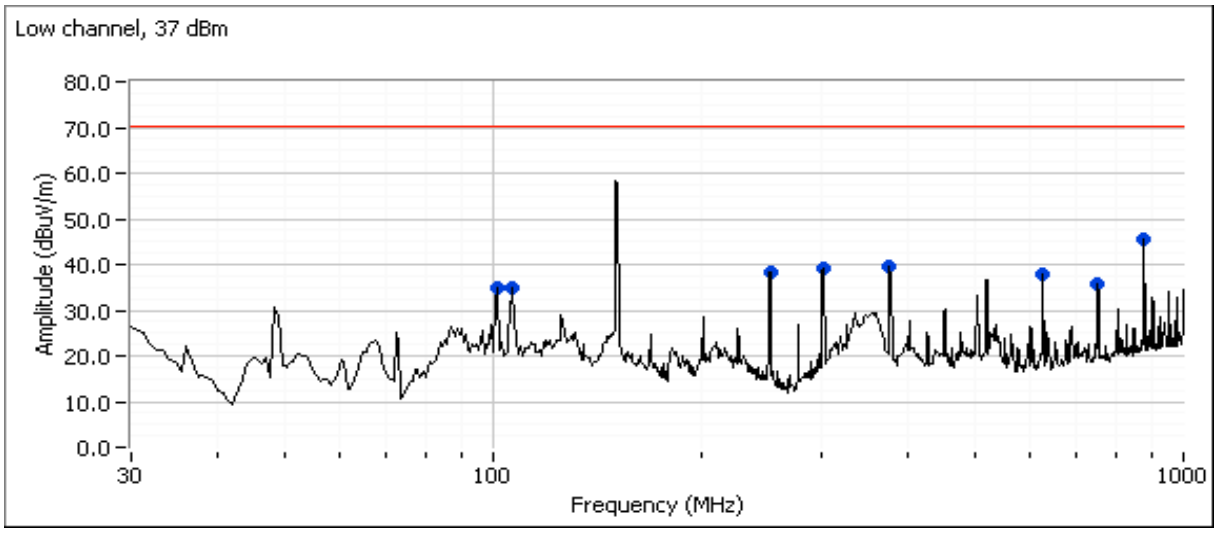
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

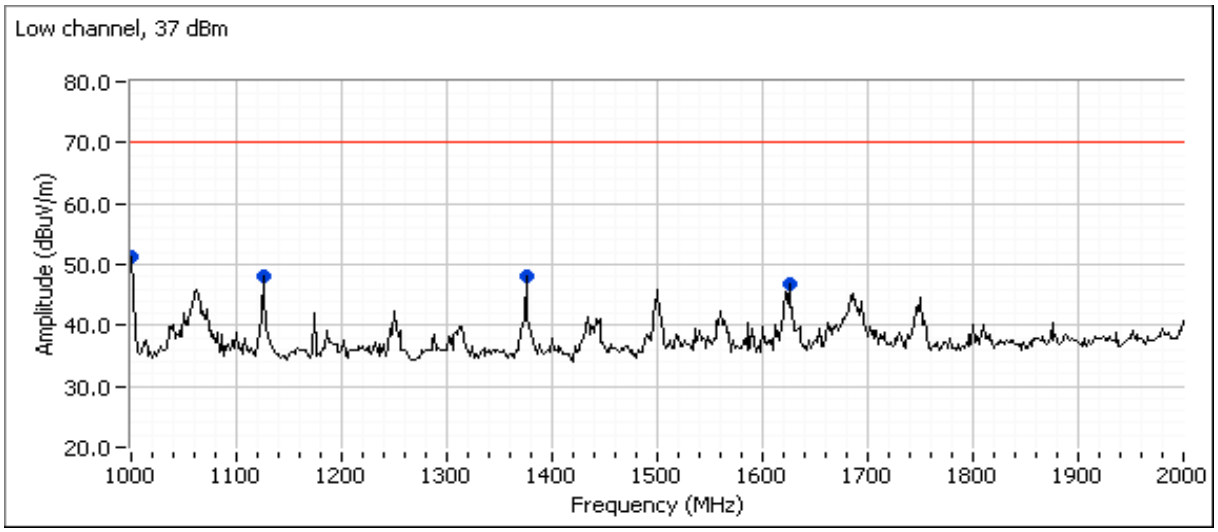
Frequency	Level	Pol	FCC 90.210(e)		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		Low
1000.000	*51.2*	*V*	*70.2*	*-19.0*	*Peak*	*174*	*2.2*		High
1625.000	*47.6*	*V*	*70.2*	*-22.6*	*Peak*	*151*	*1.3*		High
1375.000	*47.1*	*V*	*70.2*	*-23.1*	*Peak*	*162*	*1.0*		High
877.500	*44.8*	*H*	*70.2*	*-25.4*	*Peak*	*133*	*1.0*		High
375.250	*41.5*	*H*	*70.2*	*-28.7*	*Peak*	*252*	*1.0*		High
349.000	*41.0*	*H*	*70.2*	*-29.2*	*Peak*	*262*	*1.0*		High
251.400	*40.1*	*V*	*70.2*	*-30.1*	*Peak*	*134*	*1.5*		High
100.875	*33.0*	*V*	*70.2*	*-37.2*	*Peak*	*216*	*1.5*		High
106.275	*32.7*	*V*	*70.2*	*-37.5*	*Peak*	*185*	*1.0*		High
48.225	*30.5*	*V*	*70.2*	*-39.7*	*Peak*	*294*	*1.0*		High

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.
Note 3:	The limit is taken from FCC Part 90 Mask E.

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

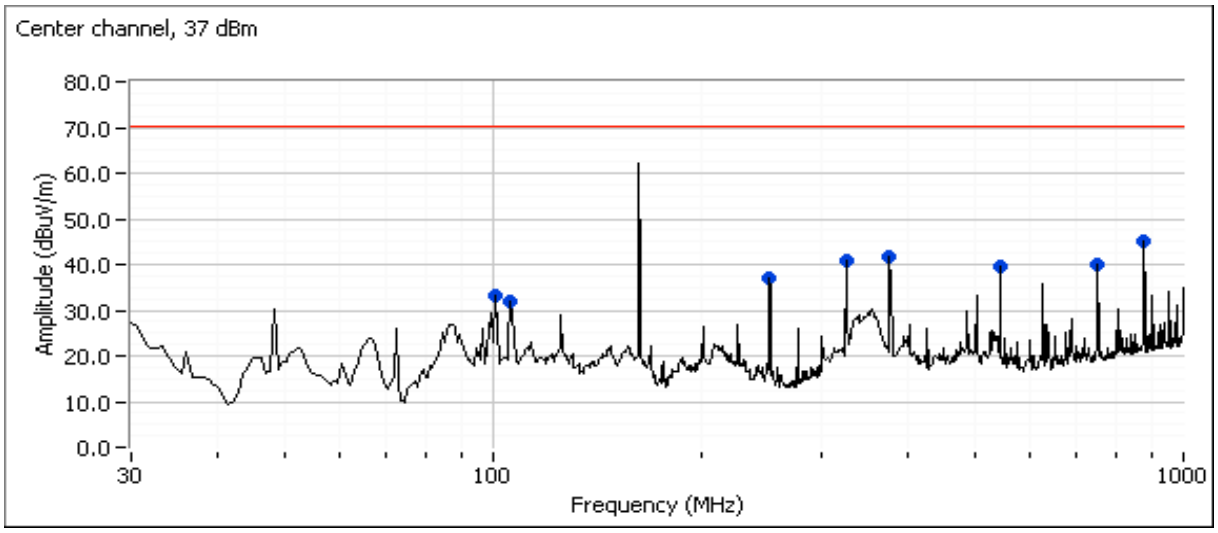
Plots for low channel, power setting = 37 dBm

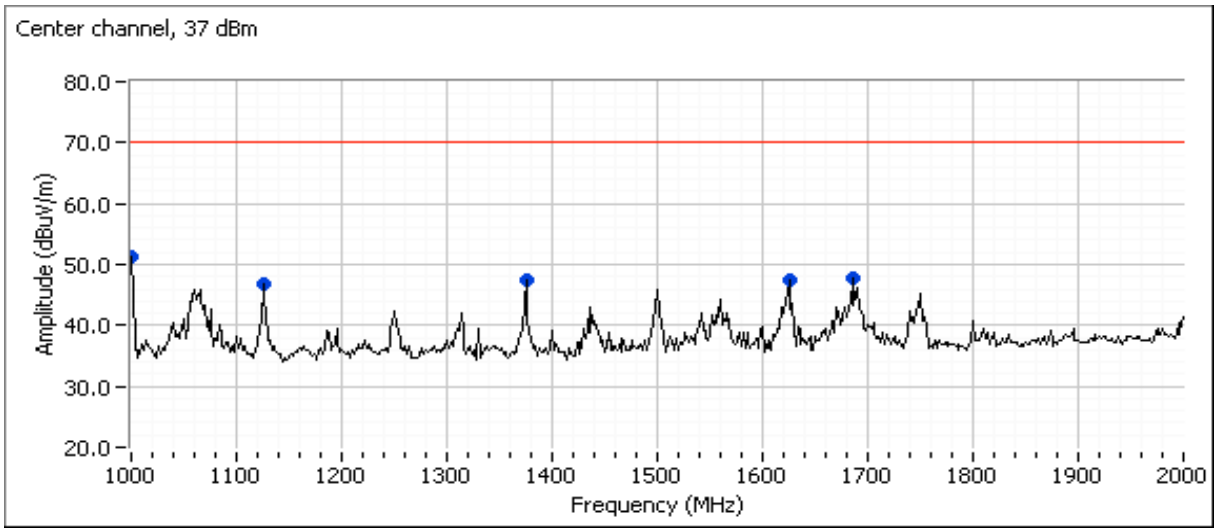




Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

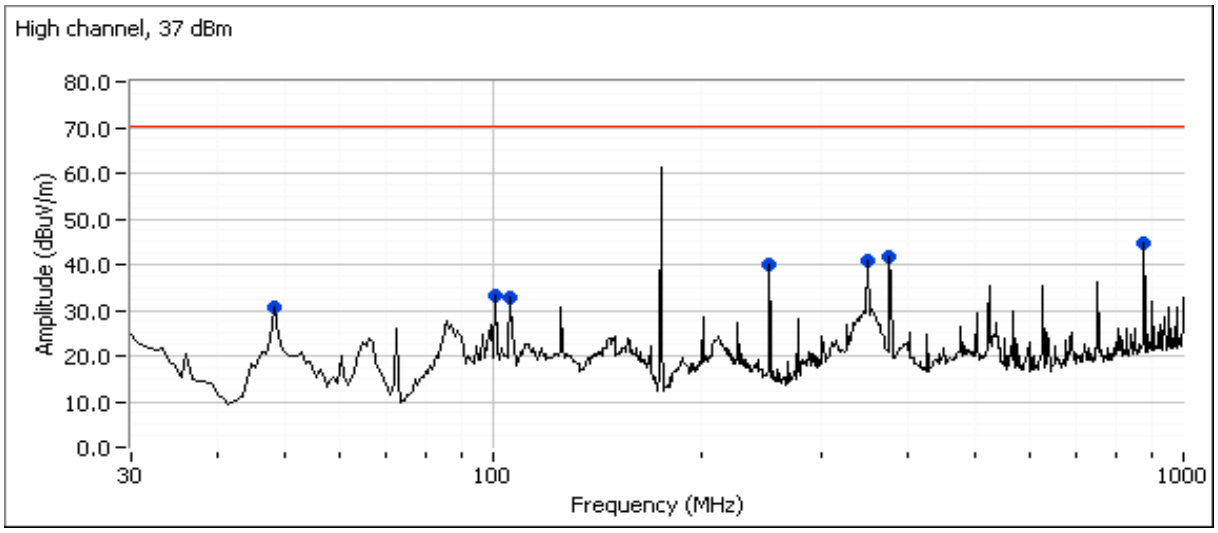
Plots for center channel, power setting = 37 dBm

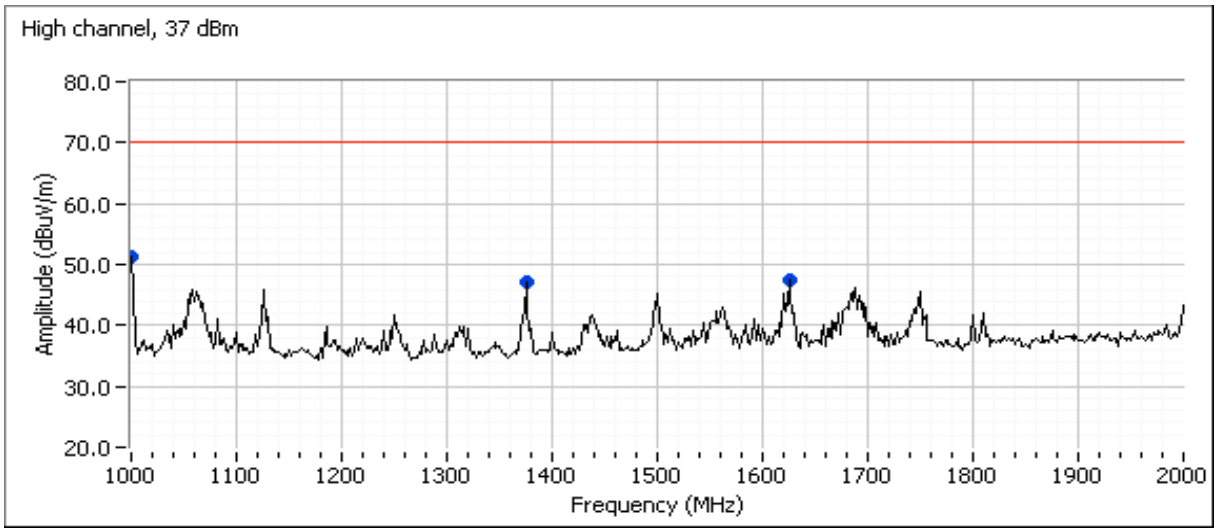




Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Plots for high channel, power setting = 37 dBm





Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #5b: - Final Field Strength Measurements and Substitution Measurements

Date: 1/6/2011 Engineer: John Caizzi Location: FT7

EUT Field Strength

Frequency	Level	Pol	FCC 90.210(e)		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
999.850	53.6	V	70.2	-16.6	PK	156	1.49		Low
1000.100	54.0	V	70.2	-16.2	PK	160	2.40		Center
1000.070	53.7	V	70.2	-16.5	PK	151	2.37		High

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.

Substitution measurements

Horizontal

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
999.850	-21.5	1.95	75.0	94.6	53.6	-41.0	-43.2	-25.0		-16.0
1000.100	-21.5	1.95	75.1	94.7	54.0	-40.7	-42.9	-25.0		-15.7
1000.070	-21.5	1.95	75.1	94.7	53.7	-41.0	-43.2	-25.0		-16.0

Vertical

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
999.850	-21.5	1.95	76.4	96.0	53.6	-42.4	-44.6	-25.0		-17.4
1000.100	-21.5	1.95	76.3	95.9	54.0	-41.9	-44.1	-25.0		-16.9
1000.070	-21.5	1.95	76.3	95.9	53.7	-42.2	-44.4	-25.0		-17.2

Note 1:	Pin is the input power (dBm) to the substitution antenna
Note 2:	Gain is the gain (dBi) for the substitution antenna.
Note 3:	FS is the field strength (dBuV/m) measured from the substitution antenna.
Note 4:	Site Factor - this is the site factor to convert from a field strength in dBuV/m to an eirp in dBm.
Note 5:	EUT field strength as measured during initial run.

Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6: Transient Frequency Behavior

Date: 1//5/11 Engineer: John Caizzi Location: FT7

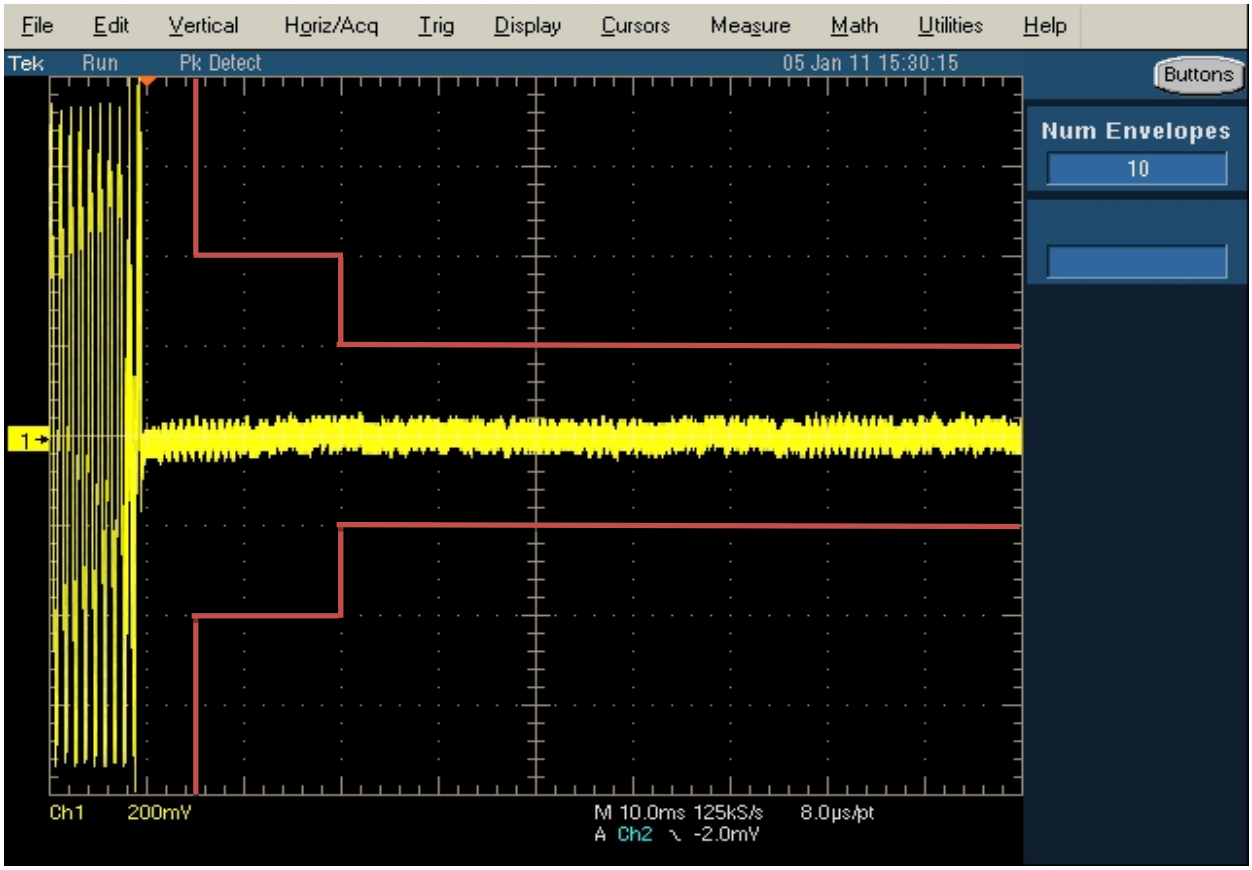
Run #6a

Carrier Frequency: 162.003125 MHz

Channel Spacing: 6.25 kHz

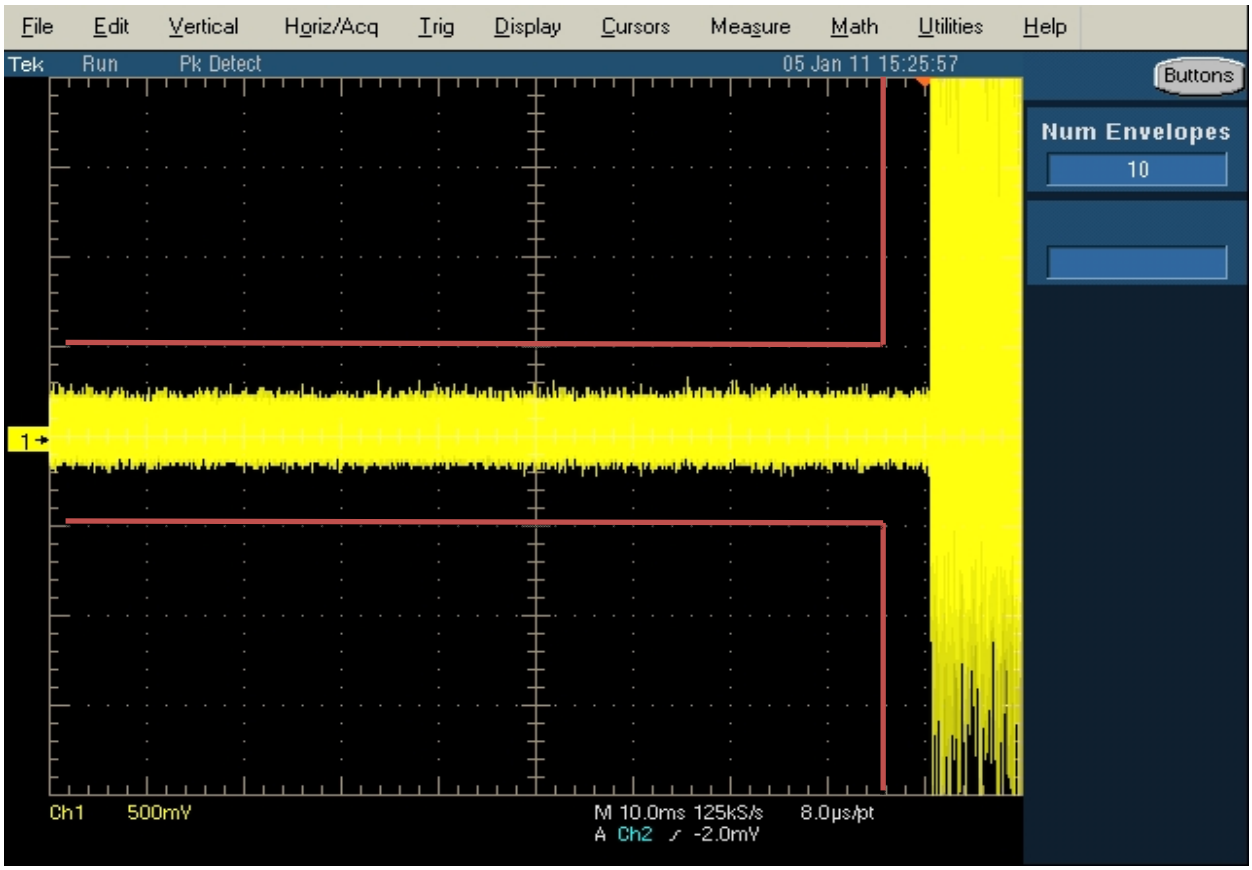
Modulation: Modem 9600N

Description: Switch on condition ton, t1, and t2



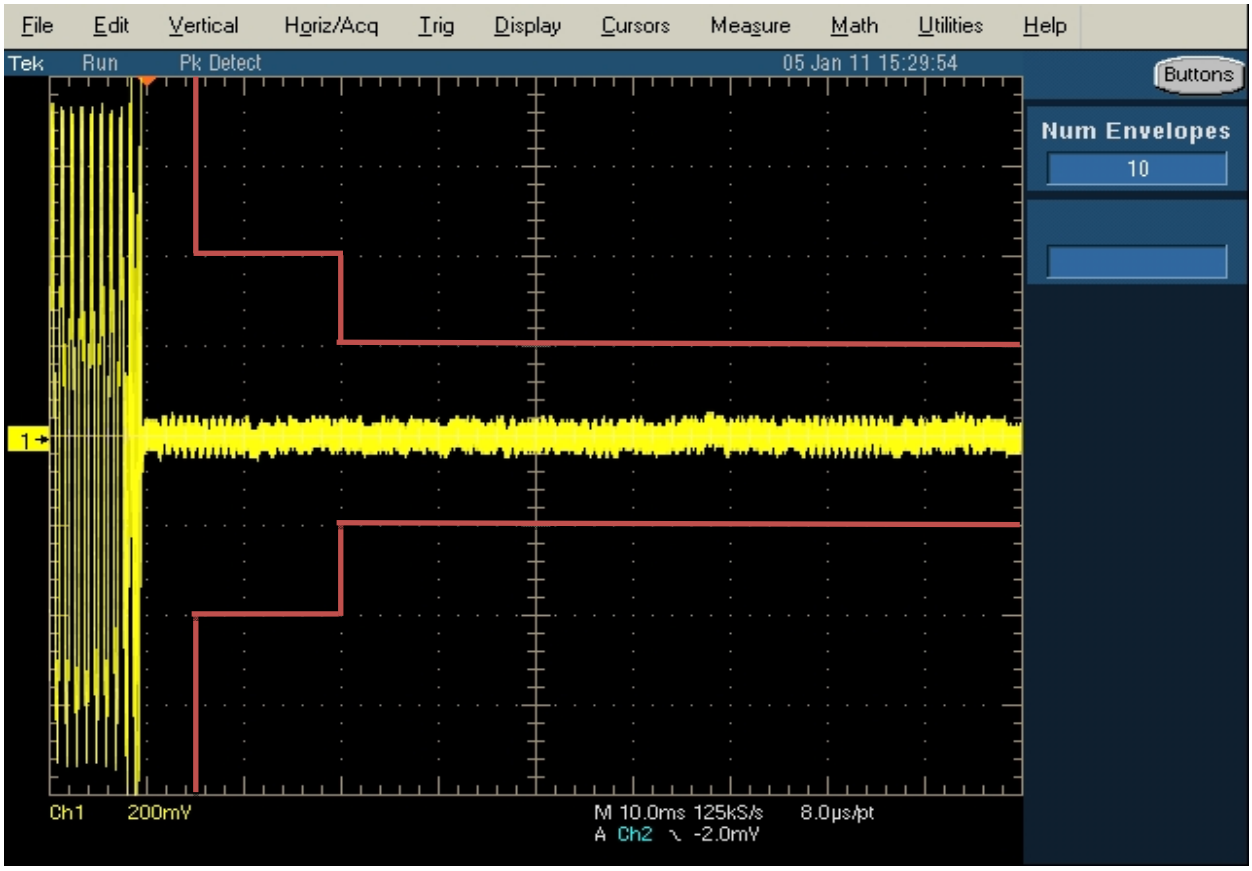
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6b
Carrier Frequency: 162.003125 MHz
Channel Spacing: 6.25 kHz
Modulation: Modem 9600N
Description: Switch off condition t3 and toff



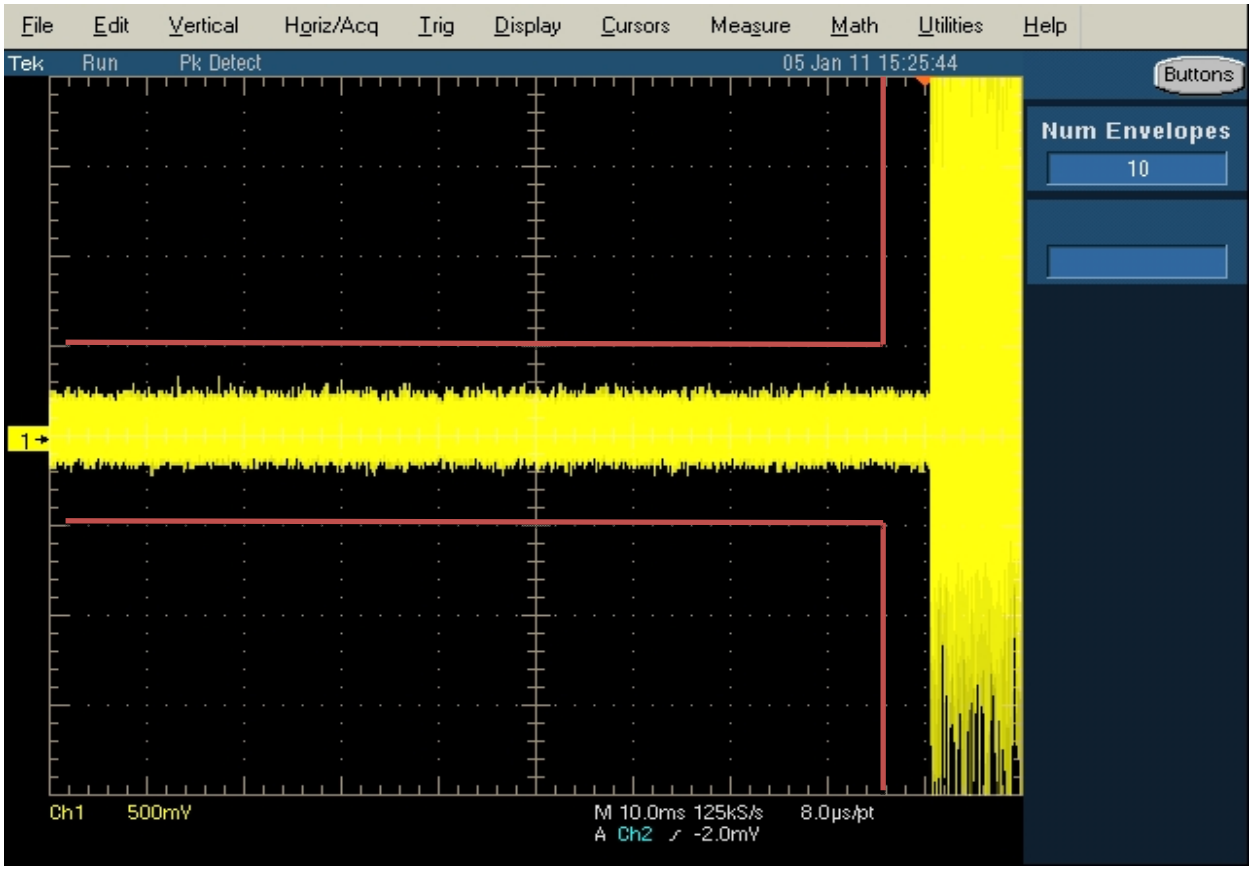
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6c
Carrier Frequency: 162.00625 MHz
Channel Spacing: 12.5 kHz
Modulation: Modem 9600
Description: Switch on condition ton, t1, and t2



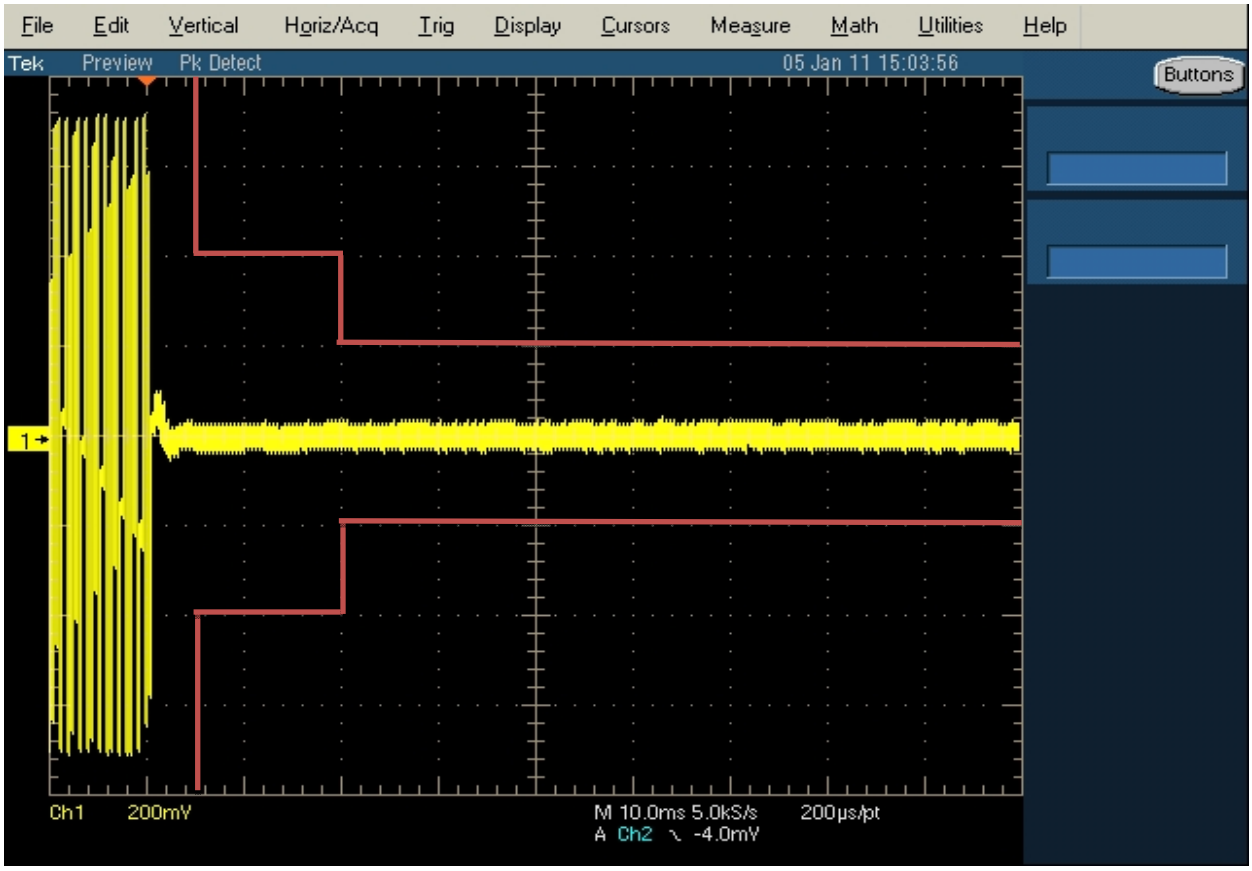
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6d
Carrier Frequency: 162.00625 MHz
Channel Spacing: 12.5 kHz
Modulation: Modem 9600
Description: Switch off condition t3 and toff



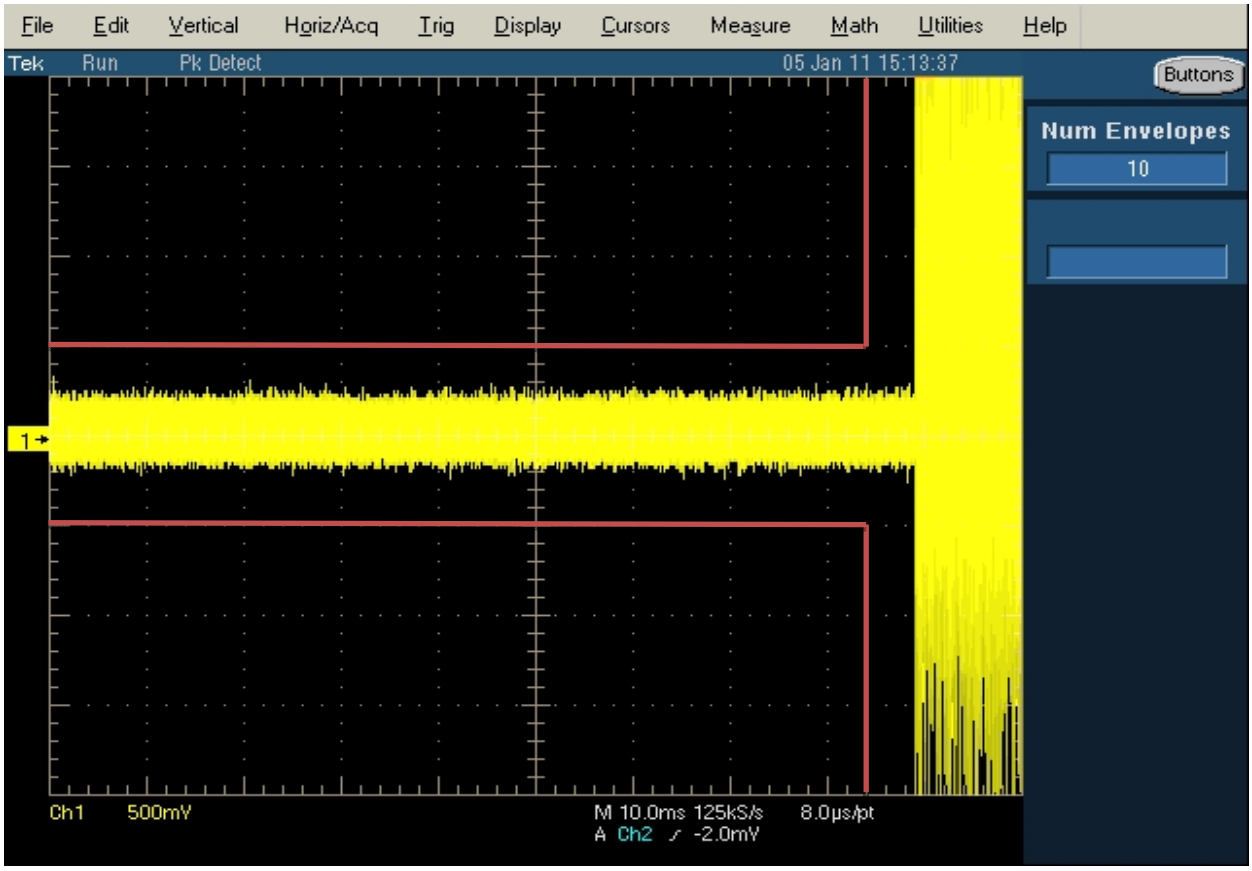
Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6e
Carrier Frequency: 162.0125 MHz
Channel Spacing: 25 kHz
Modulation: Modem 19200, dev 5400
Description: Switch on condition ton, t1, and t2



Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #6f
Carrier Frequency: 162.0125 MHz
Channel Spacing: 25 kHz
Modulation: Modem 192600, dev 5400
Description: Switch off condition t3 and toff



Client:	GE MDS LLC	Job Number:	J81584
Model:	SD1	T-Log Number:	T81609
		Account Manager:	Susan Pelzl
Contact:	Dennis McCarthy		
Standard:	FCC Parts 15 & 90, RSS-GEN and RSS-119	Class:	N/A

Run #7: Frequency Stability

Date: 1/12/2011 Engineer: Rafael Varelas Location: FT Lab #4

Nominal Frequency: 162 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	Frequency Measured	Drift	
(Celsius)	(MHz)	(Hz)	(ppm)
-30	162.000130	130	0.8
-20	162.000145	145	0.9
-10	162.000145	145	0.9
0	162.000143	143	0.9
10	162.000153	153	0.9
20	162.000100	100	0.6
30	162.000168	168	1.0
40	162.000160	160	1.0
50	162.000170	170	1.0
	Worst case:	170	1.0

Frequency Stability Over Input Voltage

Nominal Voltage is 13.8Vdc, done at room temperature.

Voltage	Frequency Measured	Drift	
(Dc)	(MHz)	(Hz)	(ppm)
85%	162.000100	100	0.6
115%	162.000105	105	0.6
	Worst case:	105	0.6

Note 1:	Maximum drift of fundamental frequency before it shut down at 9.0Vdc was 105 Hz.