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Radio Test Report

FCC Parts 24, 90 and 101 and RSS-119 (896 MHz to 960 MHz)

Model: SD9

IC CERTIFICATION #:	101D-SD9
FCC ID:	E5MDS-SD9-1
COMPANY:	GE Digital Energy - MDS 175 Science Parkway Rochester, NY 14620
TEST SITE(S):	National Technical Systems 41039 Boyce Road. Fremont, CA. 94538-2435
PROJECT NUMBER:	PR082346
REPORT DATE:	August 2, 2018
RE-ISSUED DATE:	August 10, 2018
FINAL TEST DATES:	July 23, 24, 25 and 26, 2018
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A2LA ACCREDITED
Testing Cert #0214.26

VALIDATING SIGNATORIES

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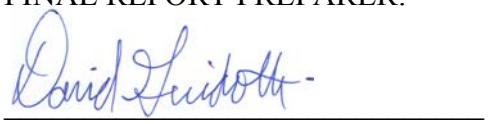

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REVISION HISTORY

Rev#	Date	Comments	Modified By
0	August 2, 2018	First release	
1	August 10, 2018	Reissued with added comment on EIRP on page 23	dwb

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SCOPE

Tests have been performed on the GE Digital Energy - MDS model SD9, pursuant to the relevant requirements of the following standard(s) in order to obtain a permissive change against the regulatory requirements of the Federal Communications Commission and Innovation Science and Economic Development Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- RSS-Gen Issue 5, April 2018
- CFR 47 Part 24 Subpart E (Narrowband PCS)
- CFR 47 Part 90 (Private Land Mobile Radio Service) Subpart S
- CFR 47 Part 101 (Fixed Microwave Service) Subpart C
- RSS-119, Issue 12, May 2015 (Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 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 National Technical Systems test procedures:

ANSI C63.26:2015
FCC KDB 971168 Licensed Digital Transmitters

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Innovation Science and Economic Development 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.

National Technical Systems is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

The test results recorded herein are based on a single type test of the GE Digital Energy - MDS model SD9 and therefore apply only to the tested samples. The samples were selected and prepared by Dennis McCarthy of GE Digital Energy - MDS.

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. Permissive change is a procedure where the manufacturer submits test data and technical information to a certification body and receives a new certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents related to the changes made to the product.

STATEMENT OF COMPLIANCE

The tested samples of GE Digital Energy - MDS model SD9 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 (e.g., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.)..

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS

FCC Parts 24, 90, 101 and RSS-119

FCC	Canada	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) § 24.129		Frequency range(s)	Same as original certification	901-902 MHz 930-941 MHz	-
§2.1033 (c) (5) § 90.613		Frequency range(s)		928-930 MHz 896-901/935-940 MHz	-
§2.1033 (c) (5) § 101.101		Frequency range(s)		928-960 MHz	-
	RSS-119	Frequency range(s)		896-901 MHz 928-953 MHz	-
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 90.205	RSS-119	RF power output at the antenna terminals	20 dBm to 37 dBm	44.8 or 50 dBm	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 101.113	RSS-119	RF power output at the antenna terminals		47 dBm	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 24.131		RF power output at the antenna terminals		38.5 dBm	Pass
§2.1033 (c) (4) § 2.1047 § 90.210	RSS-119	Emission types	Same as original filing	-	-
		Emission mask	Same as original filing	J	-
§2.1033 (c) (4) §2.1047 §101.111	RSS-119	Emission types	Same as original filing	-	-
		Emission mask	Same as original filing	101.111(a)(6) RSS-119 G	-
§2.1033 (c) (4) §2.1047 §24.133		Emission types	Same as original filing	-	-
		Emission mask	Same as original filing	24.133	-
§ 2.1049 § 24.131		Occupied Bandwidth	Same as original filing	10, 20 and 45 kHz	-
§ 2.1049 § 90.209		Occupied Bandwidth	Same as original filing	11 kHz	-
§ 2.1049 § 101.109		Occupied Bandwidth	Same as original filing	200 kHz	-
	RSS-GEN 6.7 RSS-119	Occupied Bandwidth	Same as original filing	50 kHz	-
Transmitter spurious emissions					
§ 2.1051 § 2.1057	RSS-119	At the antenna terminals	All > 20dB below the limit	-20 dBm	Pass
§ 2.1053 § 2.1057	RSS-119	Field strength	All > 20dB below the limit	-20 dBm	Pass
Other details					
§ 2.1055 § 90.213	RSS-119	Frequency stability	0.3 ppm	1 ppm	Pass

FCC	Canada	Description	Measured	Limit	Result
§ 2.1093	RSS-102	RF Exposure	Same as original filing	-	-
§2.1033 (c) (8)		Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	Same as original filing	-	-
-	-	Antenna Gain	Same as original filing	-	-
Notes Based on the changes made to the device, only spurious emissions and frequency stability were considered necessary to assess the device for a permissive change.					

EXTREME CONDITIONS

Frequency stability is determined over extremes of temperature and voltage. The extremes of voltage were 10 to 30 volts.

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 Digital Energy - MDS model SD9 is an industrial radio that is designed to in multiple bands in from 896-960 MHz (see other EUT details for bands of operation). 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, 2.5 Amps.

The samples were received on July 23, 2018 and tested on July 23, 24, 25 and 26, 2018. The following samples of the EUT were used for testing:

Company	Model	Description	Serial Number	FCC ID
GE MDS LLC	SD9	Industrial Radio	02941053	E5MDS-SD9-1
GE MDS LLC	SD9	Industrial Radio	02941055	E5MDS-SD9-1
GE MDS LLC	SD9	Industrial Radio	02941059	E5MDS-SD9-1

OTHER EUT DETAILS

The following EUT details should be noted: Sample serial # 02941053 operates from 896-901 MHz; sample serial # 022941055 operates from 928-941 MHz; sample serial # 02941059 operates from 928-960 MHz

ENCLOSURE

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

MODIFICATIONS

No modifications were made to the EUT during the time the product was at National Technical Systems.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Antenna Conducted

Company	Model	Description	Serial Number	FCC ID
hp	Probook 6570b	Laptop	5CB2480TRQ	-

Radiated

Company	Model	Description	Serial Number	FCC ID
hp	Probook 6570b	Laptop	5CB2480TRQ	-
hp	6024A	Power Supply	2430A-03013	-
Cisco	SD2005	Ethernet Switch	7ED00J906382	-

EUT INTERFACE PORTS

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

Antenna Conducted

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
COM 1	Laptop	Multiwire	Shielded	1.8

Radiated

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
COM 2 (EUT #1)	Unterminated	Multiwire	Shielded	1.8
COM 2 (EUT #2)	Unterminated	Multiwire	Shielded	1.0
Ethernet (EUT #1)	Switch	Cat 6	Shielded	7.5
Ethernet (EUT #2)	Switch	Cat 6	Shielded	7.5

EUT OPERATION

During emissions testing the EUT(s) were set to transmit continuously on the selected frequency and power level.

TESTING

GENERAL INFORMATION

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

Radiated spurious emissions measurements were taken at the National Technical Systems Anechoic Chambers and/or Open Area Test Site(s) listed below. The sites conform to the requirements of ANSI C63.4 *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 Innovation Science and Economic Development Canada.

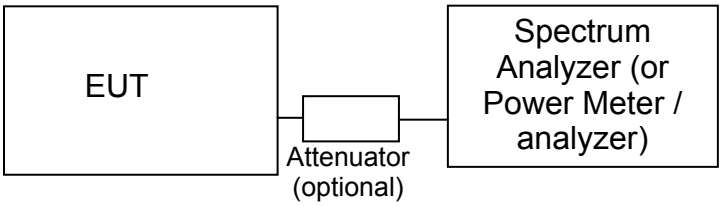
Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 4	US0027	IC 2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 5	US0027	IC 2845B-5	

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.

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.

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 C63.26 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 30 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.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radio Antenna Port (Power and Spurious Emissions), 23-Jul-18					
Rohde & Schwarz	Signal Analyzer 20 Hz - 26.5 GHz	FSQ26	2327	6/25/2018	6/25/2019
Frequency Stability, 23-Jul-18					
Watlow	Temp Chamber (w/ F4 watlow Controller)	96A0	2171	7/19/2018	7/19/2019
Rohde & Schwarz	Signal Analyzer 20 Hz - 26.5 GHz	FSQ26	2327	6/25/2018	6/25/2019
Radiated Emissions, 30 - 1,000 MHz, 24, 25-Jul-18					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/30/2017	5/30/2019
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	8/30/2017	8/30/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	9482	10/28/2016	10/28/2018
Radiated Emissions, 1,000 - 10,000 MHz, 24, 25-Jul-18					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/29/2016	9/29/2018
Hewlett Packard	Spectrum Analyzer (SA40) Red 30 Hz -40 GHz	8564E (84125C)	1148	10/14/2017	10/14/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/31/2017	8/31/2018
Substitutions, 26-Jul-18					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	786	11/29/2017	12/6/2019
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/29/2016	9/29/2018
Hewlett Packard	Spectrum Analyzer (SA40) Red 30 Hz -40 GHz	8564E (84125C)	1148	10/14/2017	10/14/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/31/2017	8/31/2018
Rohde & Schwarz	Power Meter, Dual Channel, DC to 40 GHz, 100 pW to 30 W, 9 kHz to 3 GHz, 200µV to 1000V	NRVD	1787	2/6/2018	2/6/2019
Rohde & Schwarz	Power Sensor, 1 nW-20 mW, 10 MHz-18 GHz, 50ohms	NRV-Z1	2114	11/5/2017	11/5/2018
Agilent Technologies	PSG, Vector Signal Generator, (250kHz - 20GHz)	E8267D	3011	2/26/2018	2/26/2019

Appendix B Test Data

TL082346-RA Pages 21 – 40

Client:	GE MDS LLC	PR Number:	PR082346
Product	SD9	T-Log Number:	TL082346-RA
System Configuration:	-	Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Engineer:	David Bare
Emissions Standard(s):	FCC parts 15, 24, 90 and 101, RSS-119	Class:	-
Immunity Standard(s):		Environment:	Radio

EMC Test Data

For The

GE MDS LLC

Product

SD9

Date of Last Test: 7/25/2018

Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

RSS 119 and FCC Parts 24, 90 and 101

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: 23 °C

Rel. Humidity: 42 %

Summary of Results

Run #			Test Performed	Limit	Pass / Fail	Result / Margin
1			Output Power		Pass	See below
2			Spurious Emissions (conducted)	-20 dBm	Pass	All emiusisons < -20 dBm
3			Spurious emissions (radiated)	-20 dBm	Pass	-34.7 dBm @ 7624.0 MHz (-14.7 dB)
4			Frequency Stability	1.0 ppm	Pass	0.3 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:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Run #1: Output Power

Date of Test: 7/23/2018 Config. Used: 1

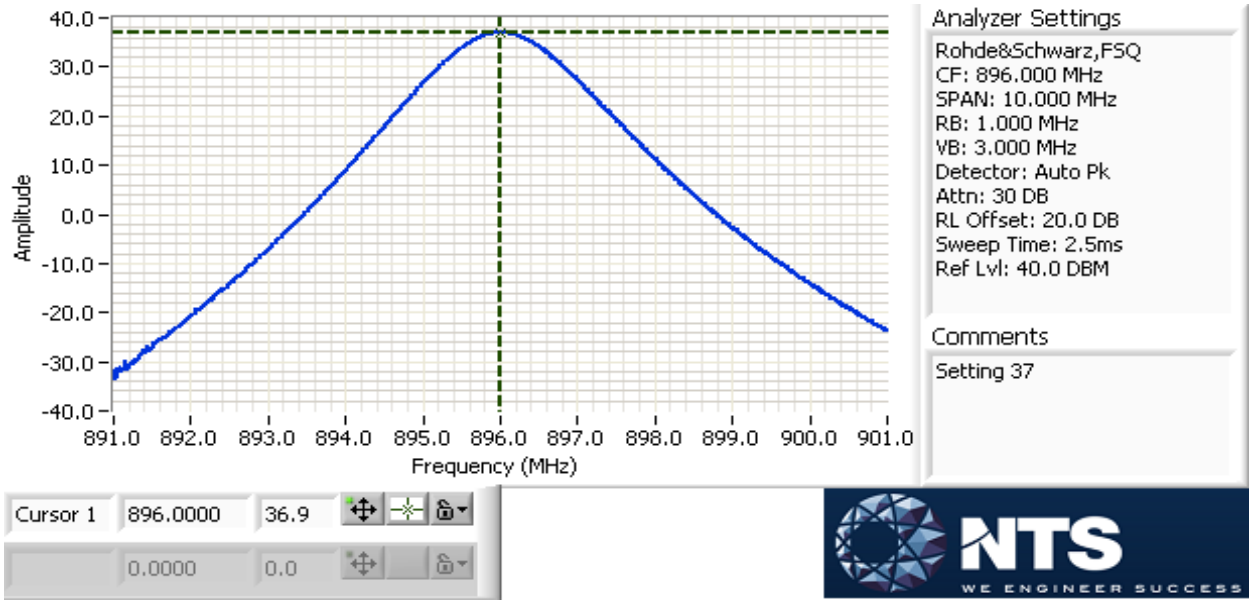
Test Engineer: David W. Bare Config Change: None

Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power W	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W
37	896	36.9	4.9	16.5	Pass	53.4	218.776
37	901	36.9	4.9	16.5	Pass	53.4	218.776
37	901.5	37.3	5.4	16.5	Pass	53.8	239.883
37	928	37.3	5.4	16.5	Pass	53.8	239.883
37	930	37.2	5.2	16.5	Pass	53.7	234.423
37	935	36.9	4.9	16.5	Pass	53.4	218.776
37	940	37.0	5.0	16.5	Pass	53.5	223.872
37	941	37.3	5.4	16.5	Pass	53.8	239.883
37	953	37.3	5.4	16.5	Pass	53.8	239.883
37	960	37.2	5.2	16.5	Pass	53.7	234.423

Note 1:	Output power measured using a spectrum analyzer (see plots below) with RBW=1MHz, VB=3MHz, Peak detector
Note 2:	Power setting - the software power setting used during testing, included for reference only.
Note 3:	Device operates on multiple bandwidths in the 901-902 MHz and 930-941 MHz bands under part 24, 896-901 MHz, 928-930 MHz and 935-940 MHz bands under part 90 and 928-960 MHz band under part 101 at 5.4W except for 896-901 is 4.9W and 935-940 is 5.0W. RSS-119 Bands 896-901 and 928-953 MHz.
Note 4:	Power and antenna selection are set by licensee and power is reduced as necessary to meet the limits for the rule part for which the device is used.

Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A



Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

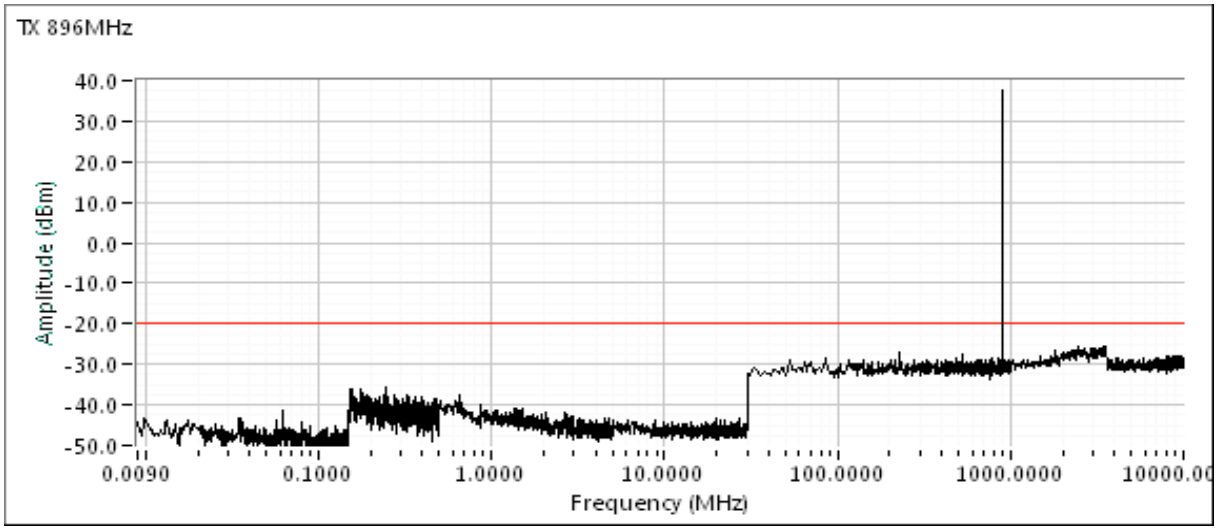
Run #2: Out of Band Spurious Emissions, Conducted

Date of Test: 7/23/2018 Config. Used: 1
Test Engineer: David W. Bare Config Change: None
Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

Frequency (MHz)	Limit	Result
896	-20 dBm	Pass
901	-20 dBm	Pass
901.5	-20 dBm	Pass
928	-20 dBm	Pass
930	-20 dBm	Pass
935	-20 dBm	Pass
940	-20 dBm	Pass
941	-20 dBm	Pass
953	-20 dBm	Pass
960	-20 dBm	Pass

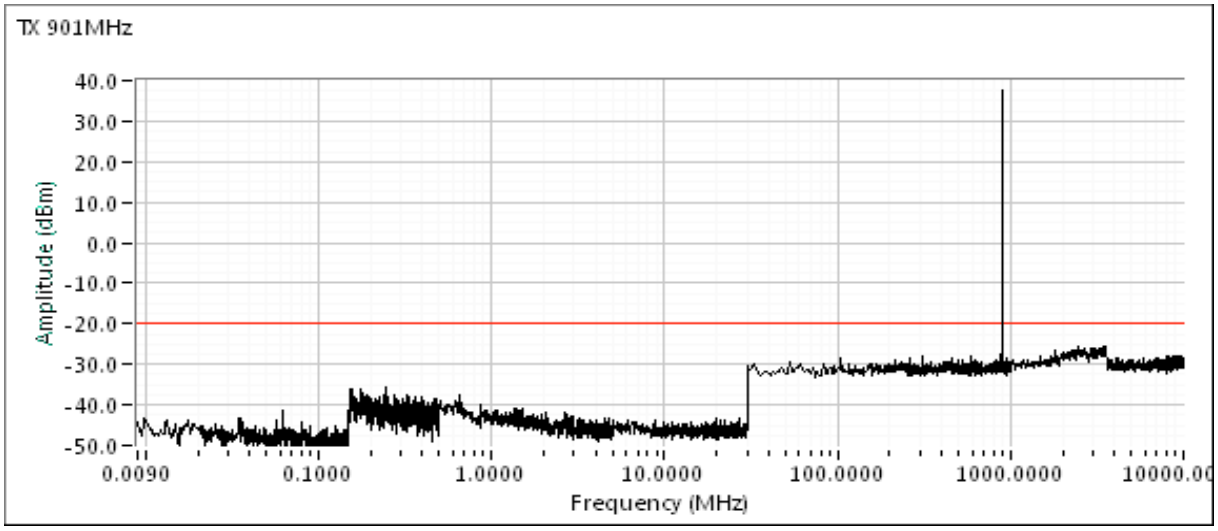
The limit is taken from FCC Part 24.133 and Part 90 Mask J.
No emisisons observed above the test system noise floor.
SA settings: Peak detector, RBW = 1 kHz belw 150 kHz, 9 kHz below 30 MHz and 100 kHz above 30 MHz with video bandwidth 3x the resolution BW. Any emisisons observed above 1 GHz were measured using a 1 MHz RBW.

Plots for 896 MHz, power setting(s) = 37

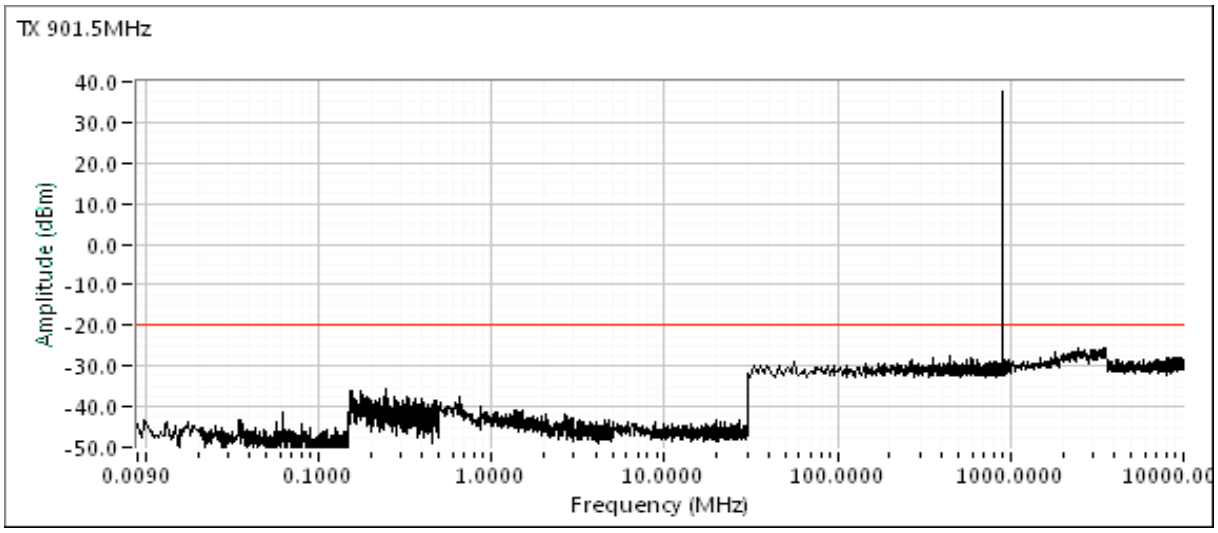


Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 901 MHz, power setting(s) = 37

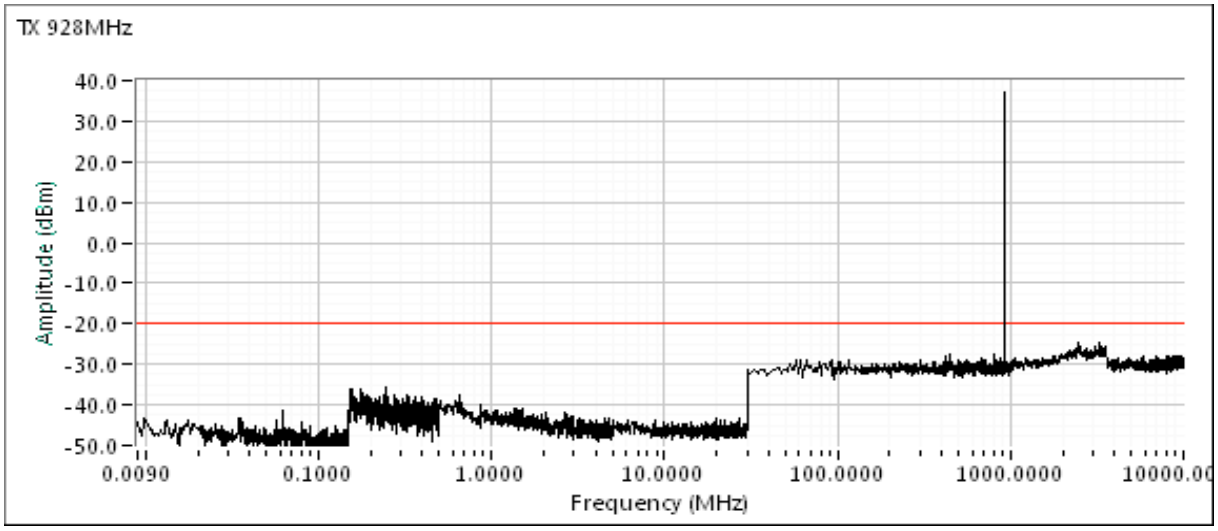


Plots for 901.5 MHz, power setting(s) = 37

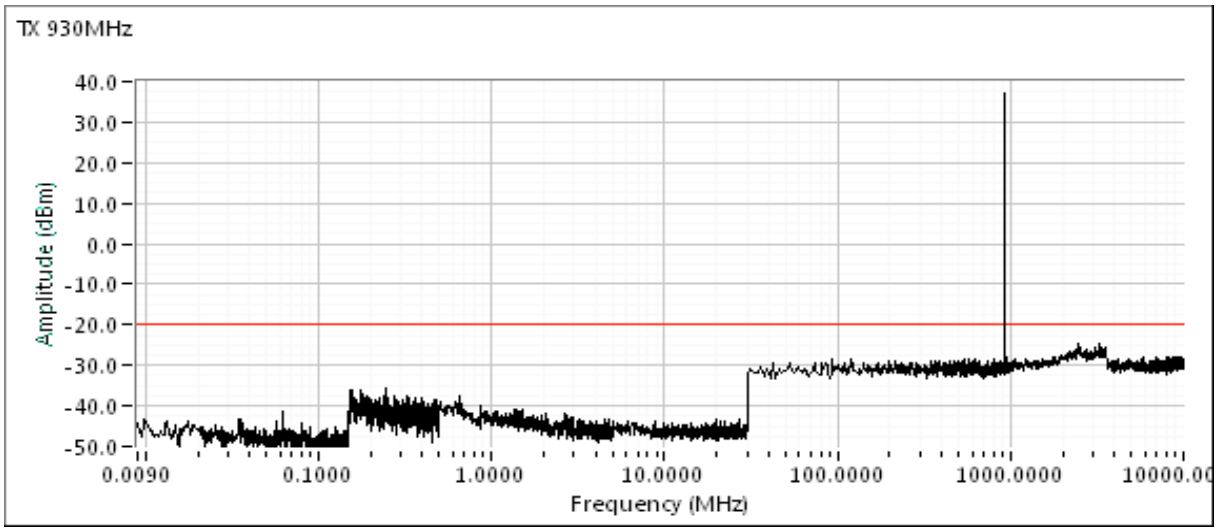


Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 928 MHz, power setting(s) = 37

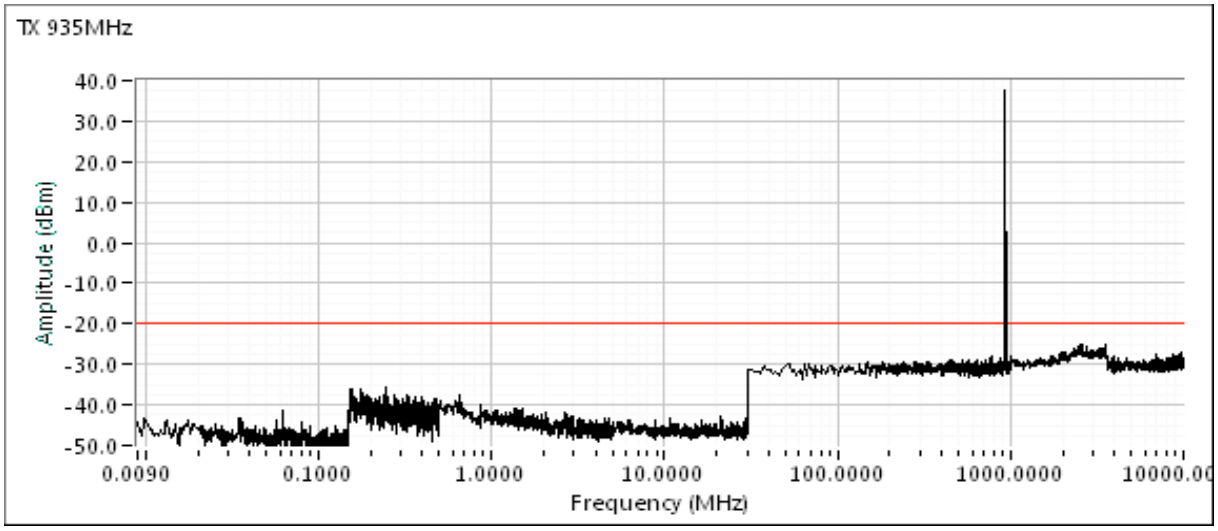


Plots for 930 MHz, power setting(s) = 37

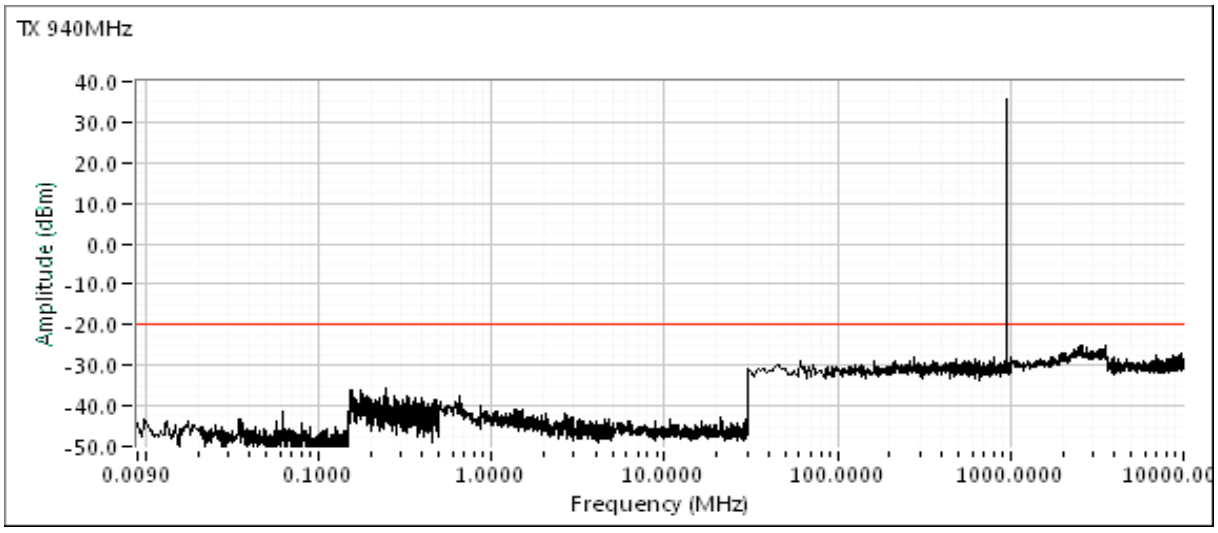


Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 935 MHz, power setting(s) = 37

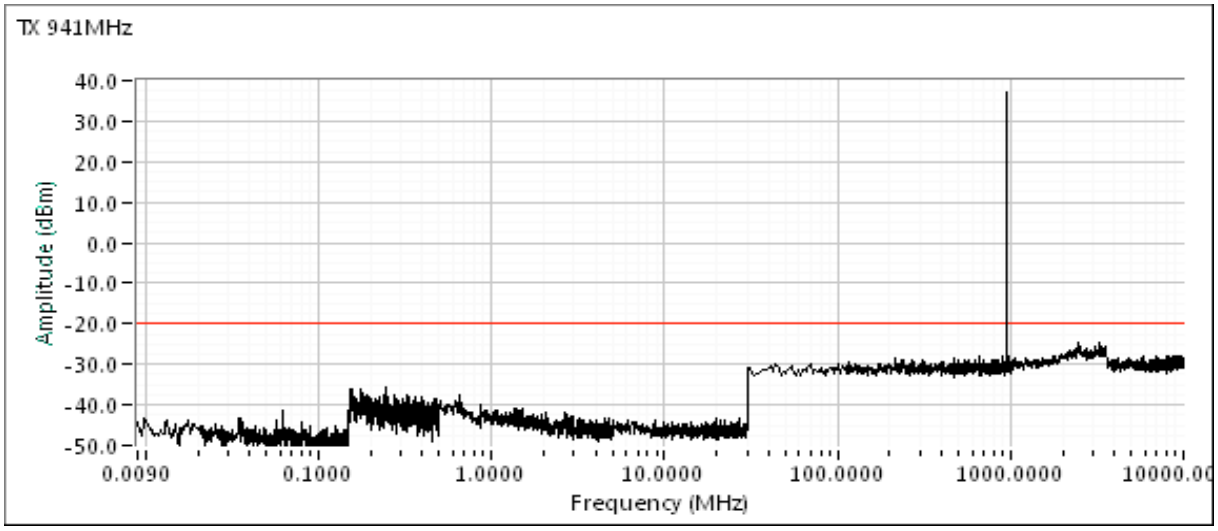


Plots for 940 MHz, power setting(s) = 37

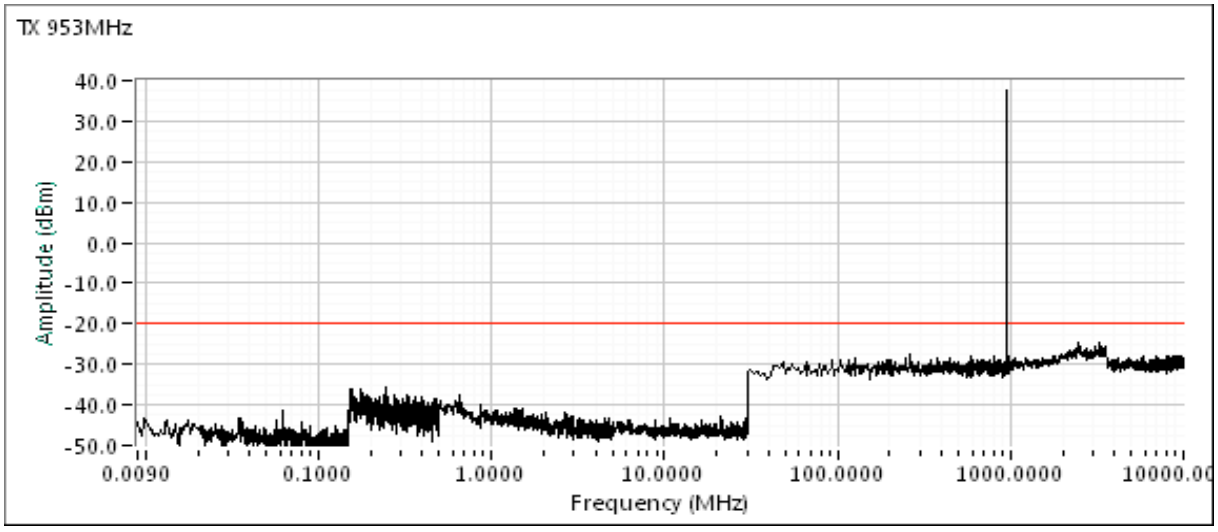


Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 941 MHz, power setting(s) = 37

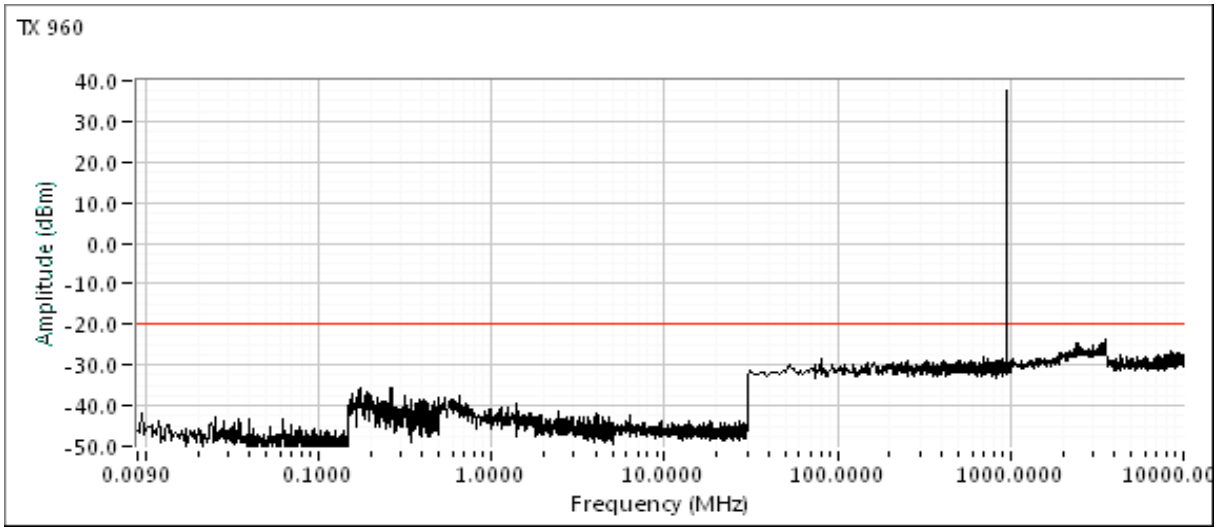


Plots for 953 MHz, power setting(s) = 37



Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 960 MHz, power setting(s) = 37



Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Run #3: Out of Band Spurious Emissions, Radiated

Conducted limit (dBm): -20
Approximate field strength limit @ 3m: 75.3
The limit is taken from FCC Part 24.133 and Part 90 Mask J.

Run #3a - Preliminary measurements

Date of Test: 7/24 & 7/25/2018 Config. Used: 2
Test Engineer: David W. Bare & Mehran Birgani Config Change: None
Test Location: Fremeont Chamber #5 EUT Voltage: 13.8 VDC

Frequency	Level	Pol	FCC Part 90		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
159.402	46.6	V	75.3	-28.7	Peak	264	2.0	Transient Signal (Outside source)	
450.000	66.2	V	75.3	-9.1	Peak	295	2.0	Transient Signal (Outside source)	
750.000	38.2	V	75.3	-37.1	Peak	190	1.0		896 & 930
875.000	37.3	H	75.3	-38.0	Peak	125	1.0		896 & 930
1000.000	42.0	V	75.3	-33.3	Peak	82	1.5		896 & 930
1792.000	50.9	H	75.3	-24.4	Peak	264	1.6		896 & 930
1875.000	48.1	V	75.3	-27.2	Peak	161	1.0		896 & 930
4480.000	52.9	V	75.3	-22.4	Peak	196	1.3		896 & 930
4650.000	49.0	V	75.3	-26.3	Peak	208	1.6		896 & 930
8064.070	58.8	H	75.3	-16.5	Peak	196	1.3		896 & 930
250.000	39.6	V	75.3	-35.7	Peak	76	1.0		901 & 941
375.000	39.0	V	75.3	-36.3	Peak	40	1.0		901 & 941
750.000	39.1	V	75.3	-36.2	Peak	224	1.5		901 & 941
875.000	42.3	V	75.3	-33.0	Peak	20	1.0		901 & 941
1000.000	47.1	H	75.3	-28.2	Peak	199	2.0		901 & 941
1802.000	51.1	H	75.3	-24.2	Peak	223	1.6		901 & 941
4505.000	52.8	V	75.3	-22.5	Peak	183	1.0		901 & 941
8109.000	57.7	H	75.3	-17.6	Peak	189	1.3		901 & 941
250.000	38.9	V	75.3	-36.4	Peak	188	1.0		901.5 & 940
375.000	40.5	H	75.3	-34.8	Peak	71	1.5		901.5 & 940
540.276	37.3	V	75.3	-38.0	Peak	344	1.0		901.5 & 940
750.000	41.3	V	75.3	-34.0	Peak	360	1.5		901.5 & 940
875.000	42.5	H	75.3	-32.8	Peak	139	2.0		901.5 & 940
1000.000	51.5	H	75.3	-23.8	Peak	109	1.5		901.5 & 940
1803.000	51.9	H	75.3	-23.4	Peak	229	1.6		901.5 & 940
4507.500	52.4	H	75.3	-22.9	Peak	141	1.6		901.5 & 940
8113.500	56.4	H	75.3	-18.9	Peak	194	1.3		901.5 & 940

Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

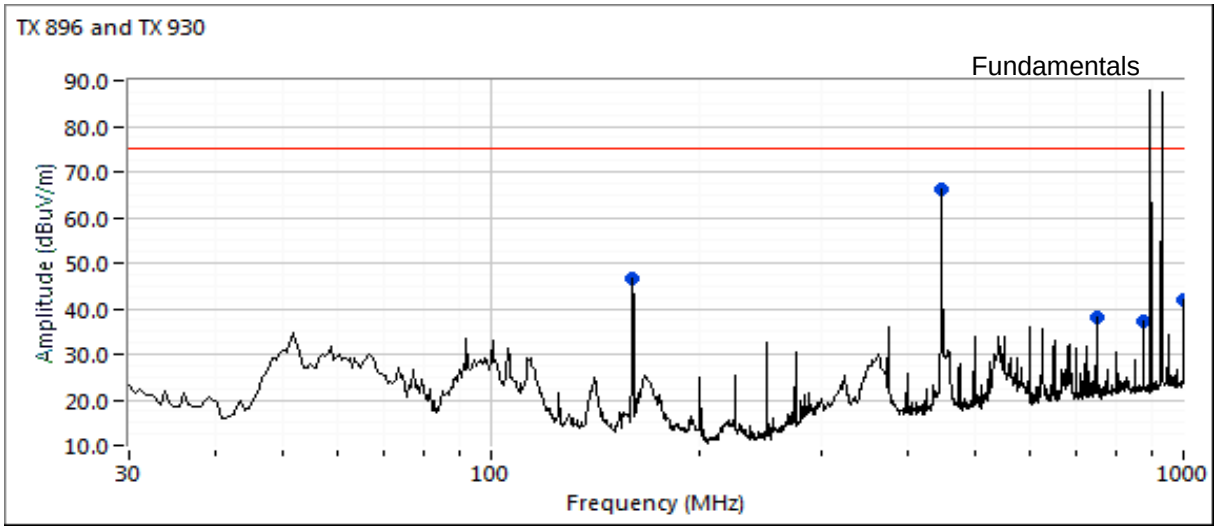
Run #3a continued

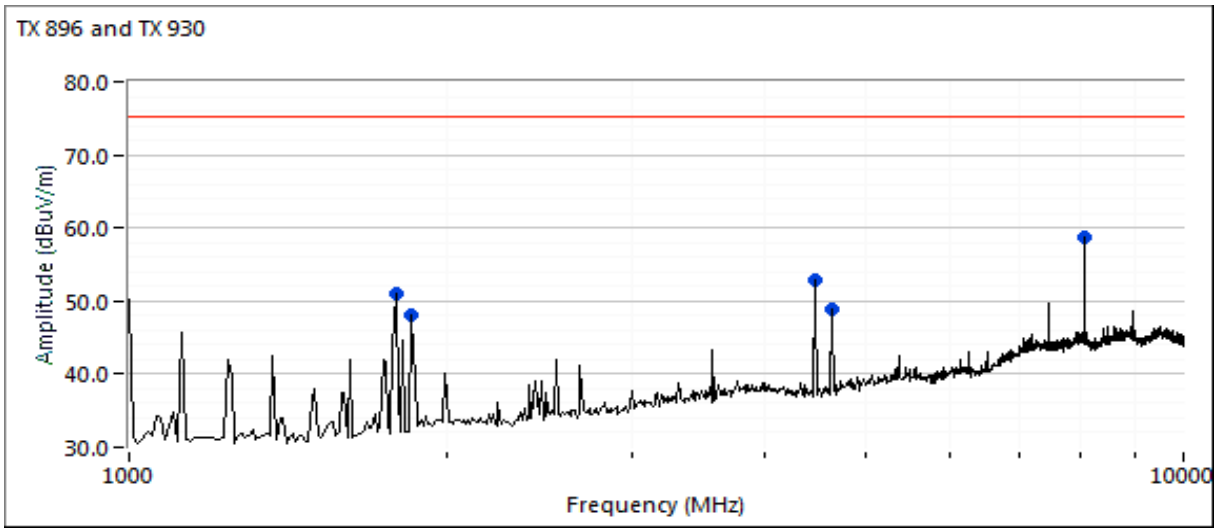
Frequency	Level	Pol	FCC Part 90		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
250.000	34.5	V	75.3	-40.8	Peak	302	1.0		928 & 953
375.000	33.5	H	75.3	-41.8	Peak	161	1.5		928 & 953
540.742	35.5	V	75.3	-39.8	Peak	31	1.0		928 & 953
875.000	36.3	H	75.3	-39.0	Peak	161	1.5		928 & 953
1000.000	44.2	V	75.3	-31.1	Peak	351	1.5		928 & 953
1850.000	49.8	H	75.3	-25.5	Peak	226	2.2		928 & 953
1900.000	53.2	H	75.3	-22.1	Peak	244	2.5		928 & 953
4640.000	51.2	H	75.3	-24.1	Peak	183	1.0		928 & 953
7625.000	59.0	V	75.3	-16.3	Peak	194	1.0		928 & 953
7425.000	60.7	V	75.3	-14.6	Peak	187	1.6		928 & 953
250.000	31.6	H	75.3	-43.7	Peak	55	2.0		935 & 960
540.287	35.4	V	75.3	-39.9	Peak	23	1.0		935 & 960
725.000	37.4	H	75.3	-37.9	Peak	205	1.0		935 & 960
875.000	43.0	V	75.3	-32.3	Peak	224	1.0		935 & 960
1000.000	45.0	V	75.3	-30.3	Peak	209	1.0		935 & 960
1870.000	50.6	V	75.3	-24.7	Peak	197	1.0		935 & 960
1920.000	50.1	V	75.3	-25.2	Peak	181	1.9		935 & 960
4800.000	53.4	H	75.3	-21.9	Peak	172	1.6		935 & 960
7680.000	62.1	V	75.3	-13.2	Peak	174	1.6		935 & 960

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:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

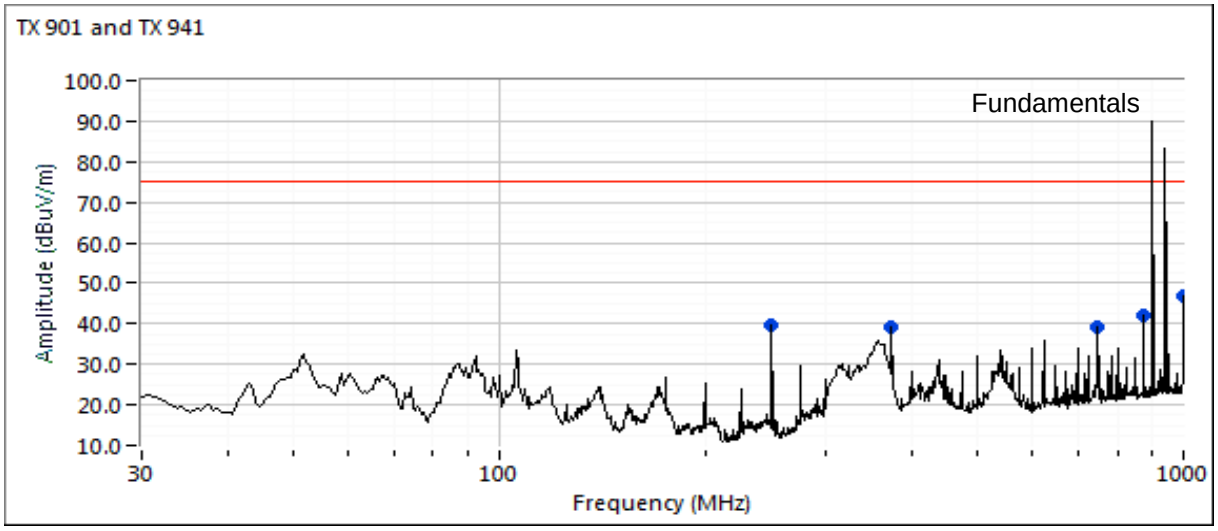
Plots for 896 and 930 MHz, power setting(s) = 37

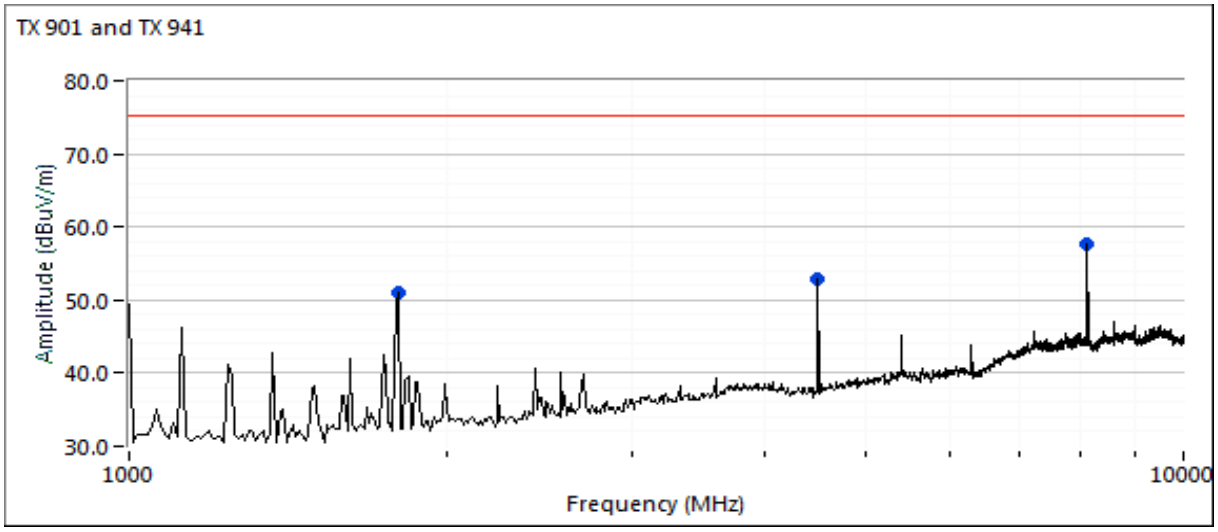




Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

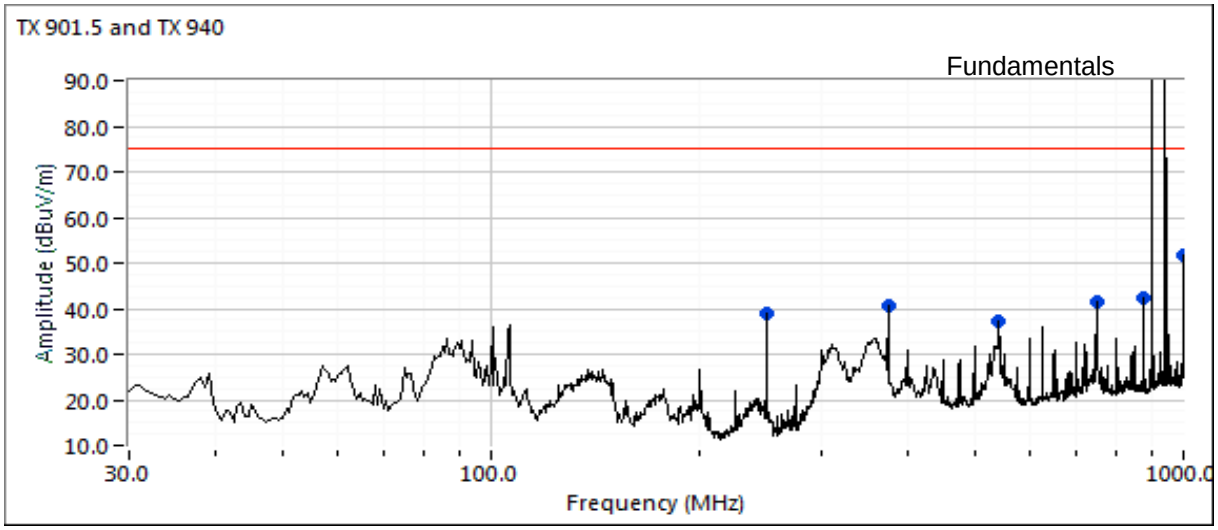
Plots for 901 and 941 MHz, power setting(s) = 37

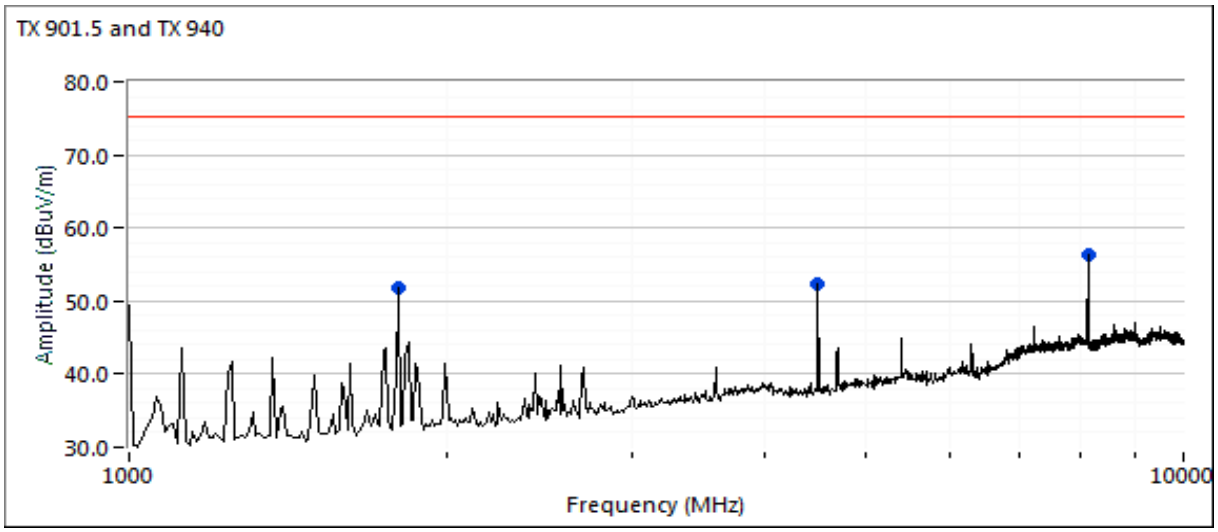




Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

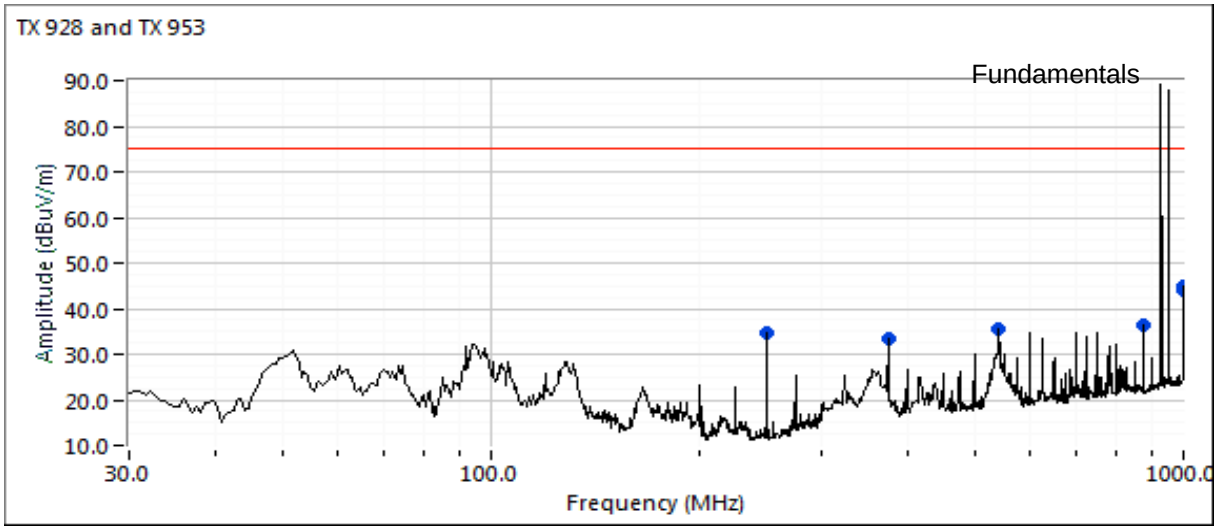
Plots for 901.5 and 940 MHz, power setting(s) = 37

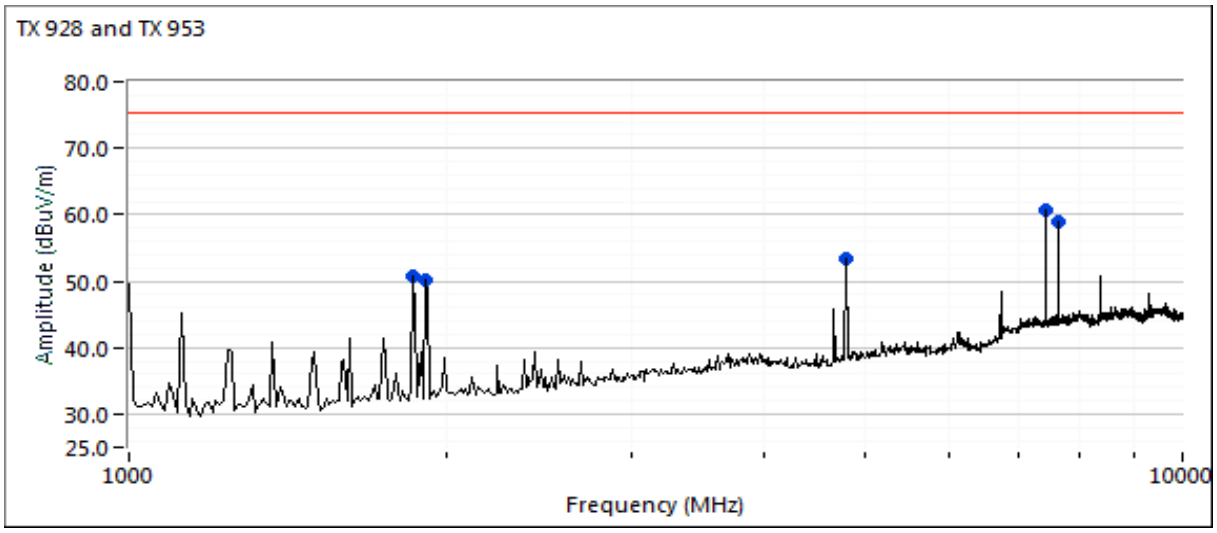




Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

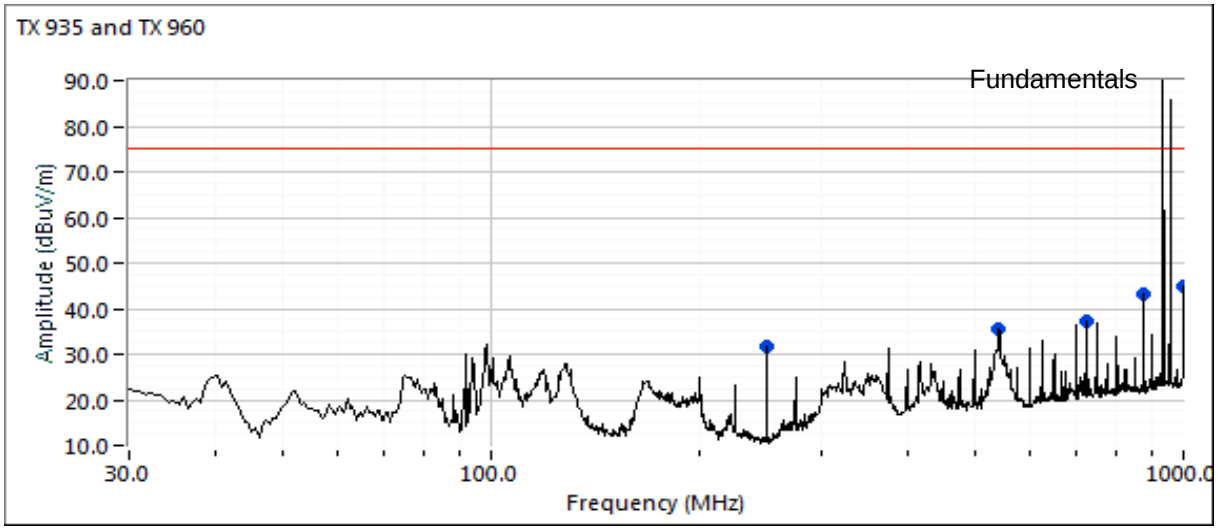
Plots for 928 and 953 MHz, power setting(s) = 37

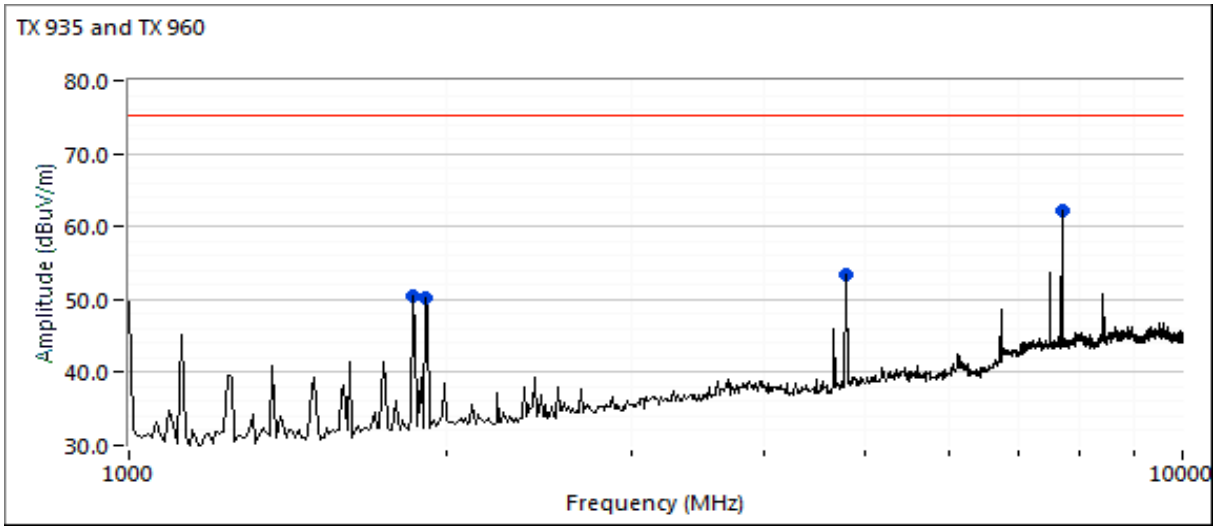




Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Plots for 935 and 960 MHz, power setting(s) = 37





Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Run #3b: - Final Field Strength and Substitution Measurements

Date of Test: 7/25/2018 Config. Used: 2

Test Engineer: David W. Bare Config Change: None

Test Location: Fremont Chamber #5 EUT Voltage: 13.8VDC

EUT Field Strength

Frequency	Level	Pol	FCC Part 90		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
7624.00	64.6	V	75.3	-10.7	Pk	194	1.0		928 & 953
7680.00	62.8	V	75.3	-12.5	Pk	174	1.6		935 & 960
8064.07	58.6	H	75.3	-16.7	Pk	196	1.3		896 & 930
8109.27	57.9	H	75.3	-17.4	Pk	189	1.3		901 & 941
8113.24	56.7	H	75.3	-18.6	Pk	194	1.3		901.5 & 940
4800.00	55.1	H	75.3	-20.2	Pk	172	1.6		935 & 960
1000.00	54.5	H	75.3	-20.8	Pk	97	1.5		901.5 & 940
4507.50	53.6	H	75.3	-21.7	Pk	141	1.6		901.5 & 940
4479.55	53.4	V	75.3	-21.9	Pk	196	1.3		896 & 930
4505.00	53.4	V	75.3	-21.9	Pk	183	1.0		901 & 941
7424.10	52.4	V	75.3	-22.9	Pk	187	1.6		928 & 953
1803.79	51.8	H	75.3	-23.5	Pk	229	1.6		901.5 & 940
1856.05	51.2	H	75.3	-24.1	Pk	226	2.2		928 & 953
1920.00	51.0	V	75.3	-24.3	Pk	181	1.9		935 & 960
1801.92	50.9	H	75.3	-24.4	Pk	223	1.6		901 & 941
1874.97	49.4	V	75.3	-25.9	Pk	161	1.0		896 & 930
4649.21	49.2	V	75.3	-26.1	Pk	208	1.6		896 & 930
1870.00	47.1	V	75.3	-28.2	Pk	197	1.0		935 & 960
1906.09	46.0	H	75.3	-29.3	Pk	244	2.5		928 & 953
4640.00	45.3	H	75.3	-30.0	Pk	183	1.0		928 & 953
875.00	45.0	H	75.3	-30.3	Pk	138	2.0		935 & 960
375.00	42.5	H	75.3	-32.8	Pk	80	1.3		901.5 & 940
750.00	41.3	V	75.3	-34.0	Pk	360	1.4		901.5 & 940
250.00	38.9	V	75.3	-36.4	Pk	241	1.0		935 & 960
540.29	37.3	V	75.3	-38.0	Pk	340	1.0		901.5 & 940

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:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Substitution measurements

Date of Test: 7/26/2018
Test Engineer: David W. Bare
Test Location: Fremont Chamber #5

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
8064.07	-42.3	11.4	66.4	97.3	58.6	-38.7	-40.9		-20.0	-20.9
8109.27	-42.3	11.5	66.5	97.3	57.9	-39.4	-41.6		-20.0	-21.6
8113.24	-42.3	11.5	66.2	97.0	56.7	-40.3	-42.5		-20.0	-22.5

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
7624.00	-41.9	11.6	66.8	97.1	64.6	-32.5	-34.7		-20.0	-14.7
7680.00	-41.9	11.6	66.9	97.2	62.8	-34.4	-36.6		-20.0	-16.6

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.

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Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Run #4: Frequency Stability

Date of Test: 7/23/2018 Config. Used: 1

Test Engineer: David W. Bare & Mehran Birgani Config Change: None

Test Location: Fremont EMC Lab #4B EUT Voltage: 10-30 VDC

Nominal Frequency: 930 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	930.000000	0	0.0
-20	930.000080	80	0.1
-10	930.000064	64	0.1
0	930.000032	32	0.0
10	930.000096	96	0.1
20	929.999840	-160	-0.2
30	929.999936	-64	-0.1
40	929.999765	-235	-0.3
50	929.999784	-216	-0.2
	Worst case:	-235	-0.3

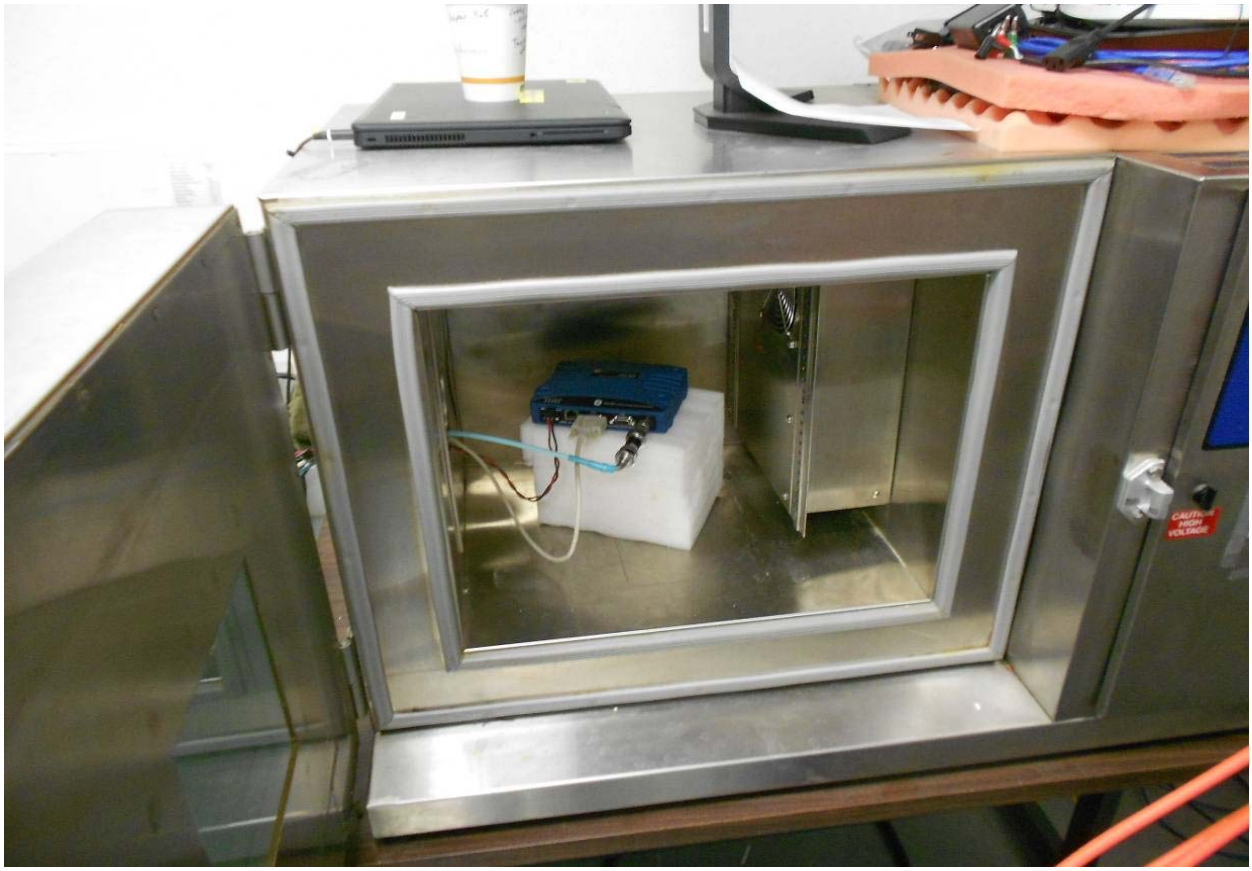
Frequency Stability Over Input Voltage

Nominal Voltage is 13.8Vdc.

Voltage	Frequency Measured	Drift	
(Dc)	(MHz)	(Hz)	(ppm)
10.0	929.999958	-42	0.0
13.8	929.999966	-34	0.0
30.0	929.999936	-64	-0.1
	Worst case:	-64	-0.1

Client:	GE MDS LLC	Job Number:	PR082346
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A

Test Configuration Photographs



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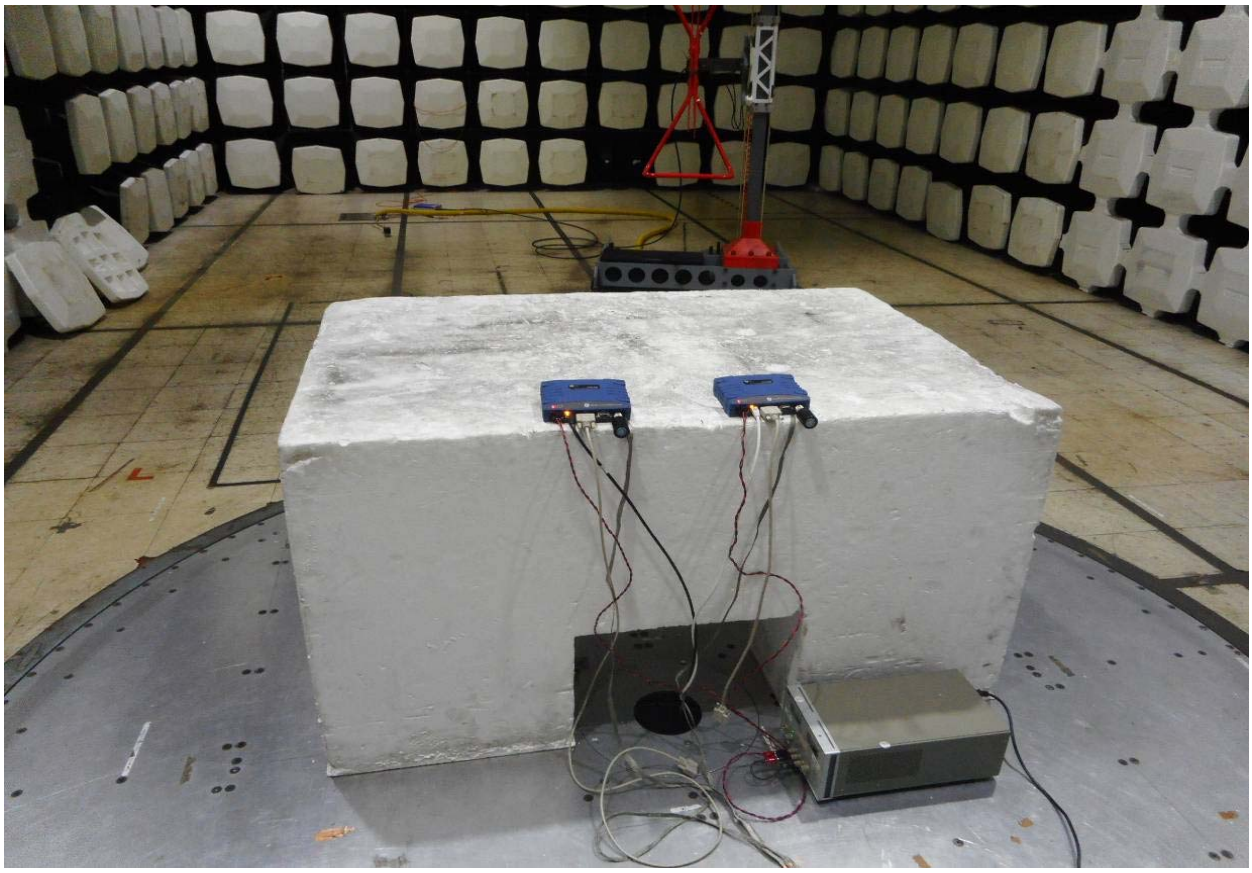
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A



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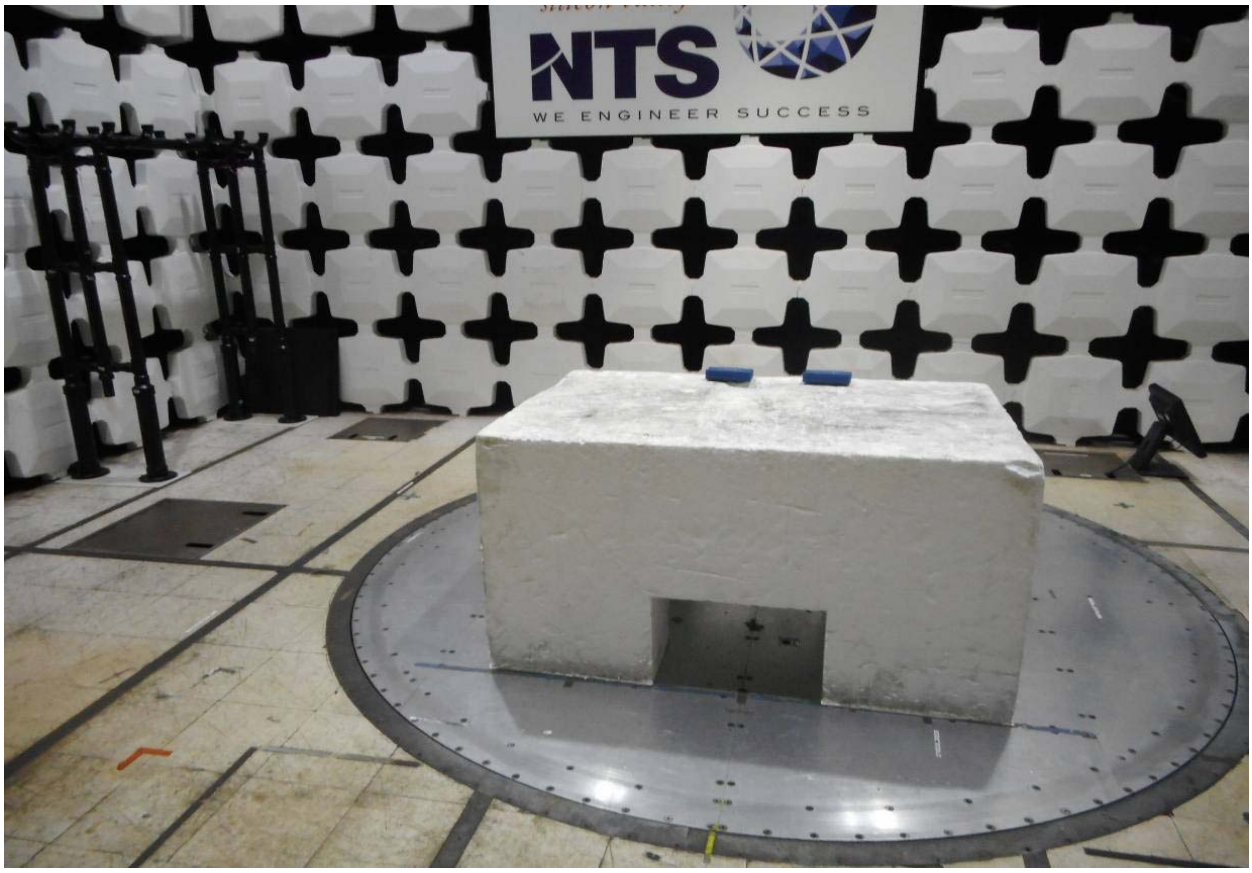
Model:	SD9	T-Log Number:	TL082346-RA
		Project Manager:	Christine Krebill
Contact:	Dennis McCarthy	Project Coordinator:	David Bare
Standard:	FCC parts 15, 24, 90 and 101, RSS-119	Class:	N/A



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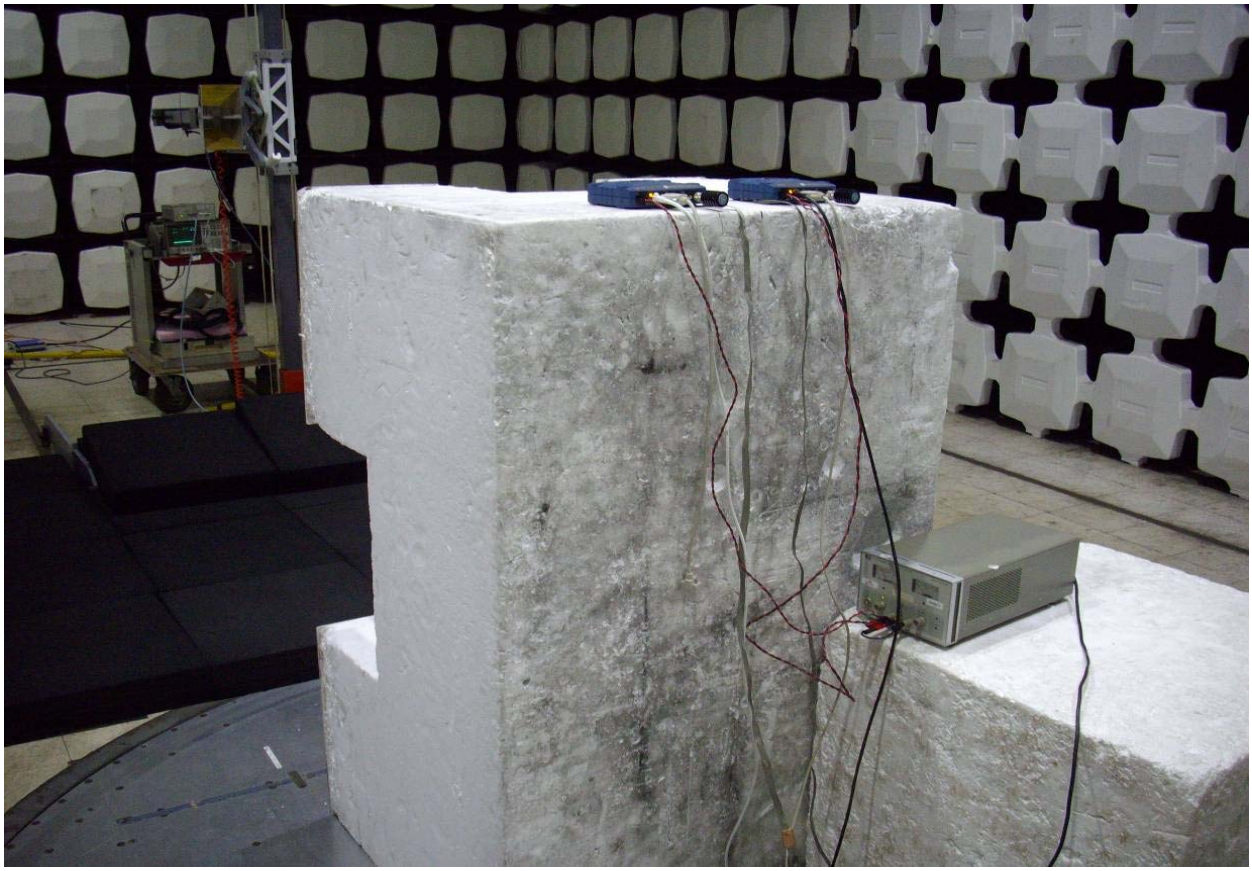

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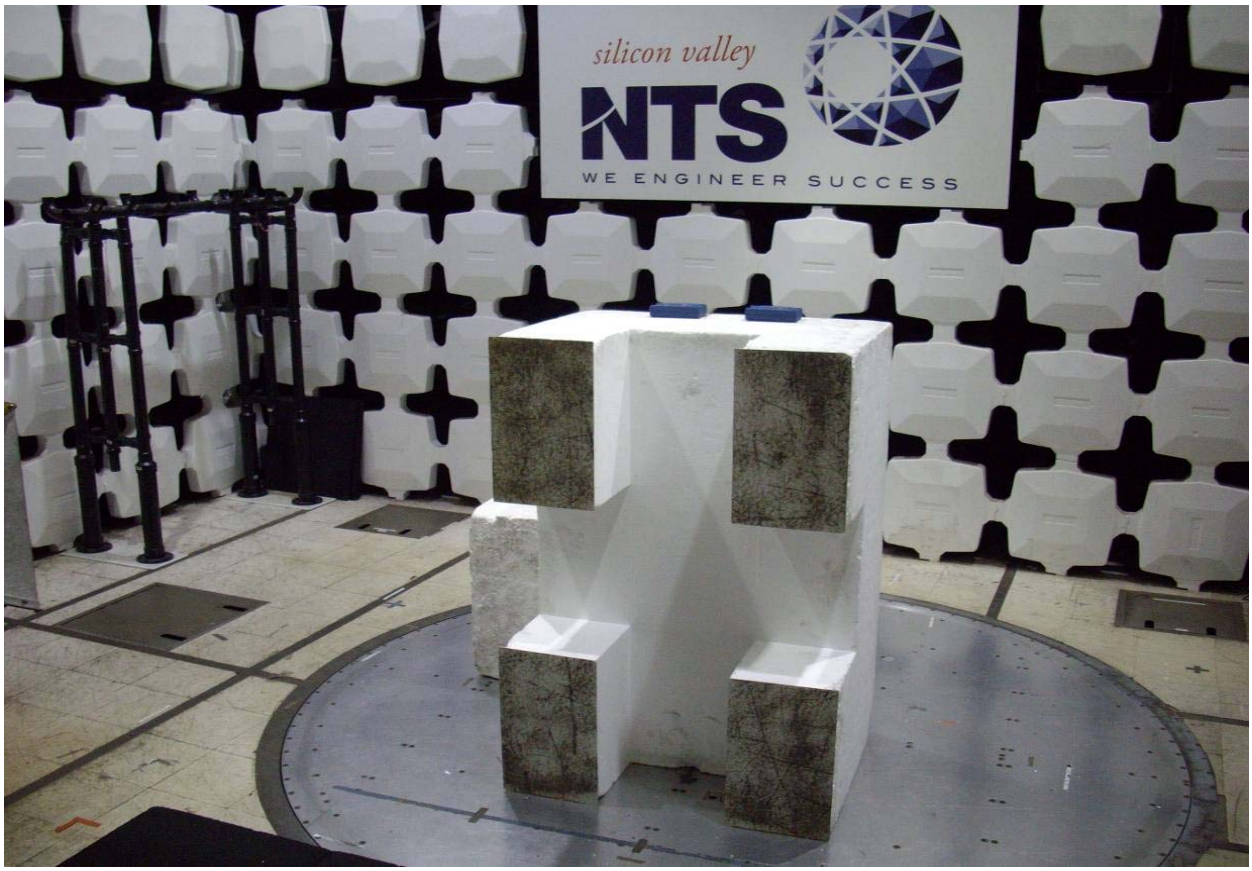

End of Report

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