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EMC Test Report

Application for Grant of Equipment Authorization

Industry Canada RSS-Gen Issue 3 / RSS 210 Issue 8
FCC Part 15 Subpart C

Model: QC250

IC CERTIFICATION #:	9849A-QC250A
FCC ID:	ZKSQC250A
APPLICANT:	Safemine Ltd. Lindenstrasse 4 Baar 6340, Switzerland
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-5 and 2845B-7
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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	September 11, 2014	First release	

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SCOPE

An electromagnetic emissions test has been performed on the Safemine Ltd. model QC250, pursuant to the following rules:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

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 - Silicon Valley test procedures:

ANSI C63.10-2009
FHSS test procedure DA 00-0705A1

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

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

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.

OBJECTIVE

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

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

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 Safemine Ltd. model QC250 complied with the requirements of the following regulations:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

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.

The test results recorded herein are based on a single type test of Safemine Ltd. model QC250 and therefore apply only to the tested sample. The sample was selected and prepared by Lukas Herzog of Safemine Ltd.

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS SUMMARY

FREQUENCY HOPPING SPREAD SPECTRUM (902 – 928 MHz, 50 channels or more)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247 (a) (1)	RSS 210 A8.1 (1) RSS-GEN	20dB Bandwidth	206 kHz	Channel spacing > 20dB bandwidth / 25kHz	Complies
		Channel Separation	400kHz		Complies
15.247 (a) (1) (i)	RSS 210 A8.1 (3)	Number of Channels	50	50 or more	Complies
15.247 (a) (1) (i)	RSS 210 A8.1 (3)	Channel Dwell Time	398.62ms within 20 seconds	<0.4 second within a 20 second period	Complies
15.247 (a) (1)	RSS 210 A8.1 (1)	Channel Utilization	All channels are used equally - refer to the operational description for full explanation	All channels shall, on average, be used equally	Complies
15.247 (b) (3)	RSS 210 A8.4 (1)	Output Power	13.0 dBm (0.020 Watts) EIRP = 0.040 W Note 1	1Watt, EIRP < 4 Watts	Complies
15.247 (c)	RSS 210 A8.5	Antenna Port Spurious Emissions 30MHz – 9.28 GHz	All spurious emissions < -20dBc	< -20dBc	Complies
15.247 (c) 15.209	RSS 210 A8.5 Table 2, 3	Radiated Spurious Emissions 30MHz – 9.28 GHz	51.2 dBµV/m @ 2745.0 MHz (-2.8 dB)	15.207 in restricted bands, all others < -20dBc	Complies
15.247 (a) (1)	RSS 210 A8.1(2)	Receiver bandwidth	Refer to operational description	Shall match the channel bandwidth	Complies
Note 1: EIRP calculated using antenna gain of 3 dBi for the highest EIRP system.					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Professionally installed, refer to user manual and attestation statements.	Unique connector or integral antenna or professional installation required	Complies
15.207	RSS GEN Table 4	AC Conducted Emissions	Testing was not performed as the EUT is battery powered.		
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	35.3 dBµV/m @ 72.01 MHz (-4.7 dB)	Refer to page 18	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP 100 RSS GEN 7.1.3	User Manual	Refer to user manual	Statement required regarding non-interference	Complies
-	RSP 100 RSS GEN 7.1.2	User Manual	Refer to user manual	Statement for products with detachable antenna	Complies

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 and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Safemine Ltd. model QC250 is a tracking device that is designed to be installed in a mine vehicle. It uses a GPS receiver, WiFi Modem module and ISM radio. Since the EUT would be placed in a vehicle during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is nominal 12-28 Volts DC.

The sample was received on March 31, 2014 and tested on March 31, April 2 and 16, 2014. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID IC ID
Safemine Ltd	QC250	Mine Vehicle tracking Device	70040110000	ZKSQC250A 9849A-QC250A

ANTENNA SYSTEM

The antenna system consists of custom MobileMark Antenna (Safemine model QF036 or QF037 connected to the QC250 via an integral coax cable.

ENCLOSURE

The EUT enclosure is primarily constructed of metal and plastic. It measures approximately 8.0 cm wide by 12.5 cm deep by 3.0 cm high.

MODIFICATIONS

The highest channel was lowered by 200 kHz form 927.8 to 927.6 MHz. The spurious emission test results at 927.8 MHz were considered the same as those that would be obtained at 927.6 MHz and are even worse with regard to band edge compliance so tests were not repeated at 927.6 MHz.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Safemine	QF037	WiFi/ISM/GPS Antenna	51314400246	-
Agilent	E3610A	DC Power Supply	MY40011740	-

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

Company	Model	Description	Serial Number	FCC ID
Acer	AS1410	Laptop	LXSA70X06493212A 702500	-

EUT INTERFACE PORTS

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

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
Antenna	GPS port	RF cable	Shielded	3.5
Antenna	RF port	RF cable	Shielded	3.5
Antenna	WIFI port	RF cable	Shielded	2.4
I/O	un-terminated	multiwire	Unshielded	1.8
Main	DC power supply and Laptop	multiwire	Unshielded	1.8 and 3.3

EUT OPERATION

During emissions testing the EUT was set to transmit continuously at the highest power setting either at fixed channels or in hopping mode as needed for the test performed.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 5	US0027	2845B-5	41039 Boyce Road Fremont, CA 94538-2435
Chamber 7	US0027	2845B-7	

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 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. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

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

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

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. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be 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 as specified in ANSI C63.4. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

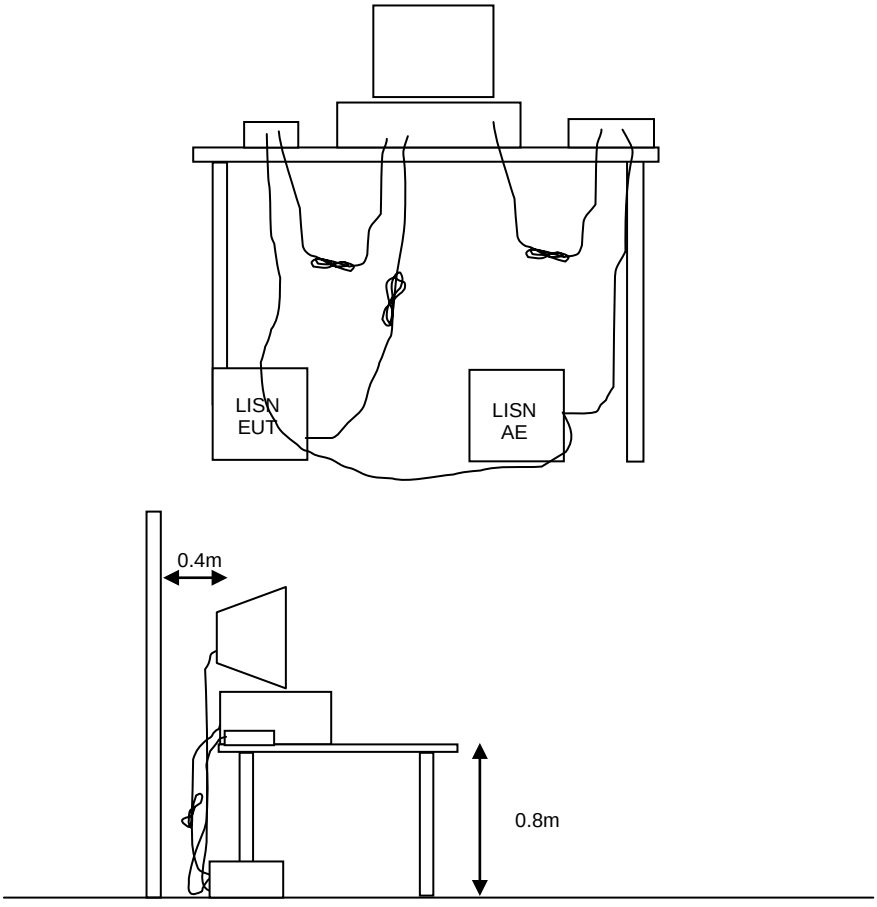


Figure 1 Typical Conducted Emissions Test Configuration

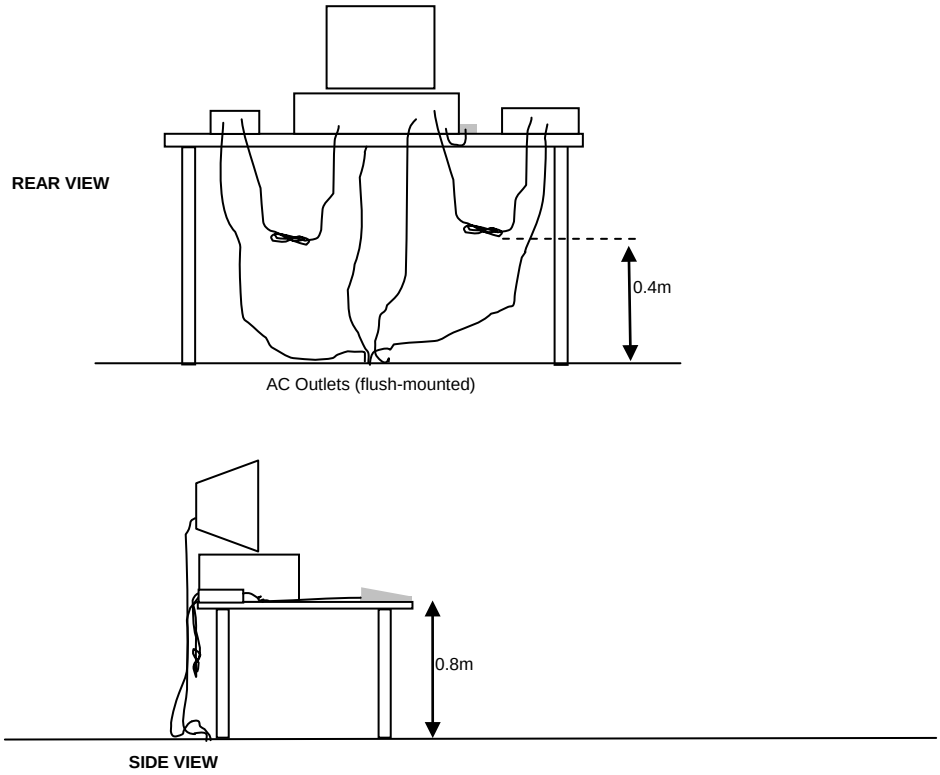
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

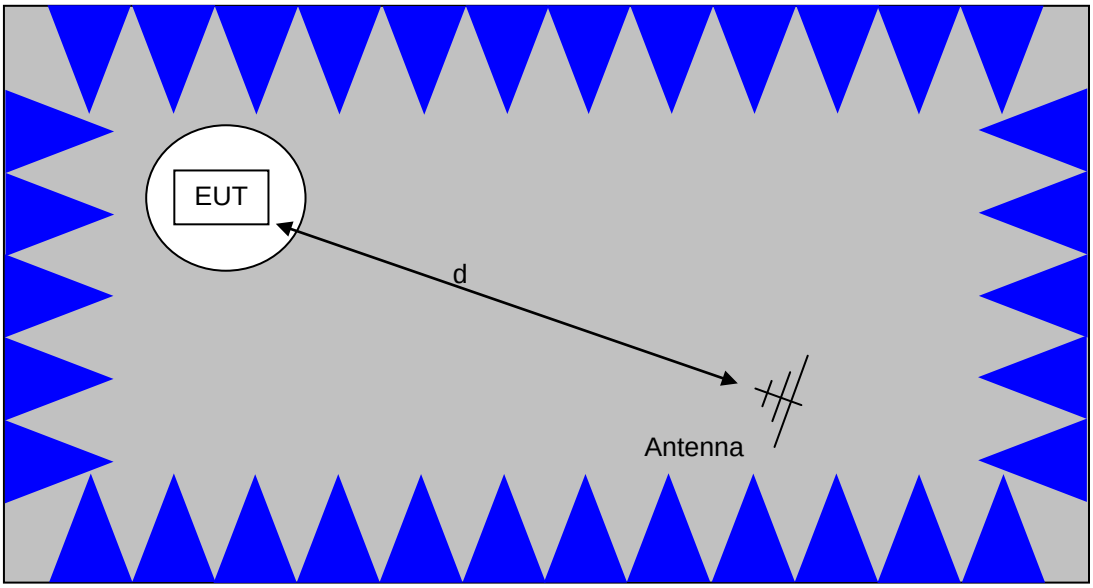
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

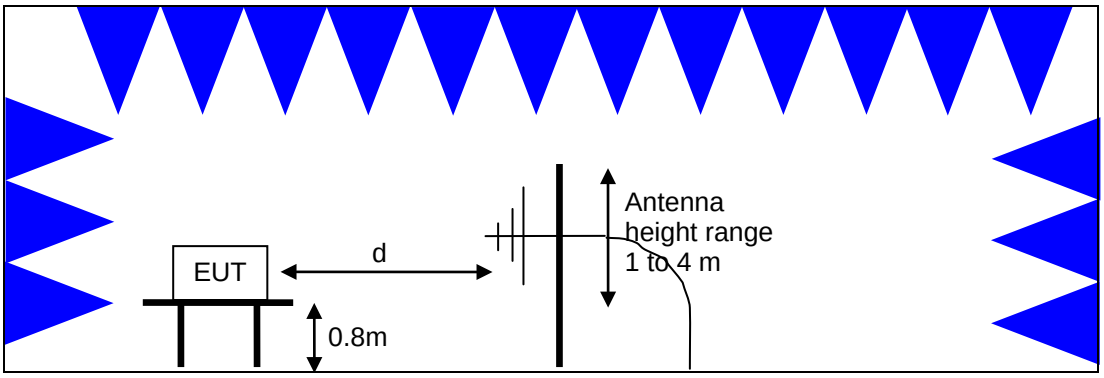


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

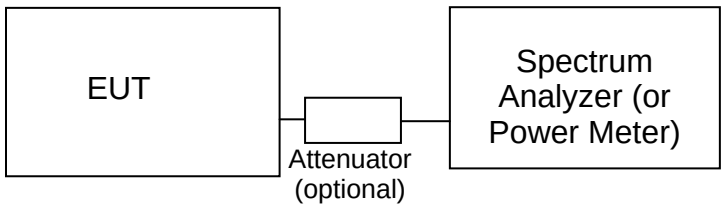
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1] (with the exception of transmitters operating under FCC Part 15 Subpart D and RSS 210 Annex 9), the limits for all emissions from a low power device operating under the general rules of RSS 310 (tables 3 and 4), RSS 210 (table 2) and FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

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

OUTPUT POWER LIMITS – FHSS SYSTEMS

The table below shows the limits for output power based on the number of channels available for the hopping system.

Operating Frequency (MHz)	Number of Channels	Output Power
902 – 928	≥ 50	1 Watt (30 dBm)
902 – 928	25 to 49	0.25 Watts (24 dBm)
2400 – 2483.5	≥ 75	1 Watt (30 dBm)
2400 – 2483.5	< 75	0.125 Watts (21 dBm)
5725 – 5850	75	1 Watt (30 dBm)

[1] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally 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, when used for electric field measurements above 30MHz, is calculated 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:

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

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

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 - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Cal Due
Radio Antenna Port Spurious Emissions, 31-Mar-14				
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/14/2014
Radiated Emissions, 1000 - 9,300 MHz, 31-Mar-14				
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/31/2014
EMCO	Antenna, Horn, 1-18GHz	3115	868	6/19/2014
Filtek	Filter, 1 GHz High Pass	HP12/1000-5BA	955	5/13/2014
Filtek	Filter, 1 GHz High Pass	HP12/1000-5BA	957	5/14/2014
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/14/2014
Radiated Emissions, 30 - 1,000 MHz, 31-Mar-14				
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/14/2014
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	6/4/2014
Radio Antenna Port Spurious Emissions, 02-Apr-14				
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/14/2014
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	2/6/2015
Radiated Emissions, 30 - 1,000 MHz, 16-Apr-14				
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/30/2015
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESIB40 (1088.7490.40)	2493	1/11/2015
Radiated Emissions, 1000 - 9300 MHz, 16-Apr-14				
Filtek	Filter, 1 GHz High Pass	HP12/1000-5BA	955	5/13/2014
Filtek	Filter, 1 GHz High Pass	HP12/1000-5BA	957	5/14/2014
Hewlett Packard	SpecAn 9 kHz - 40 GHz, FT (SA40) Blue	8564E (84125C)	1393	5/9/2014
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/12/2014
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	11/26/2014
RF Power, 16-Apr-14				
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1290	10-Dec-14
Rohde & Schwarz	Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	19-Dec-14

Appendix B Test Data

T94590 Pages 23 - 50

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Product	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Emissions Standard(s):	FCC Part 15	Class:	
Immunity Standard(s):	-	Environment:	Radio

EMC Test Data

For The

SAFEmine Technology, Inc.

Product

QC250

Date of Last Test: 4/17/2014

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

FCC 15.247 & RSS210 FHSS - Power, Bandwidth 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

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature:	20.6 °C
Rel. Humidity:	39 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	30 - 9300 MHz - Transmitter Radiated Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	51.2 dBµV/m @ 2745.0 MHz (-2.8 dB)
2	30 - 1900 MHz - Receiver Radiated Spurious Emissions	FCC Part 15.109 / RSS GEN	Pass	35.3 dBµV/m @ 72.01 MHz (-4.7 dB)
3	30 - 9300 MHz - Transmitter Conducted Spurious Emissions	FCC Part 15.247(c)	Pass	All emissions more than 20dB below the highest in-band signal level.
4	Output Power	15.247(b)	Pass	13.0 dBm
5	Maximum 20dB Bandwidth	15.247(a)	Pass	206 kHz
5	Channel Occupancy	15.247(a)	Pass	398.62ms
5	Number of Channels	15.247(a)	Pass	50 Channels

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Modifications Made During Testing:

The highest channel was lowered by 200 kHz form 927.8 to 927.6 MHz. The spurious emission test reuslts at 927.8 MHz were considered the same as those that would be obtained at 927.6 MHz and are even worse w.r.t. band edge compliance so tests were not repeated at 927.6 MHz.

Deviations From The Standard

No deviations were made from the requirements of the standard.

Test Notes

Power setting 3

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 9300 MHz.
Date of Test: 4/16/2014
Test Engineer: Rafael Varelas
Test Location: FT Chamber #5

Run #1a: Radiated Spurious Emissions, 30 - 9300 MHz. Channel 316 @ 908 MHz

Fundamental Signal Field Strength: Peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
907.934	112.9	V	-	-	PK	80	1.2	100 kHz; VB: 100 kHz
908.040	109.1	H	-	-	PK	133	1.0	100 kHz; VB: 100 kHz

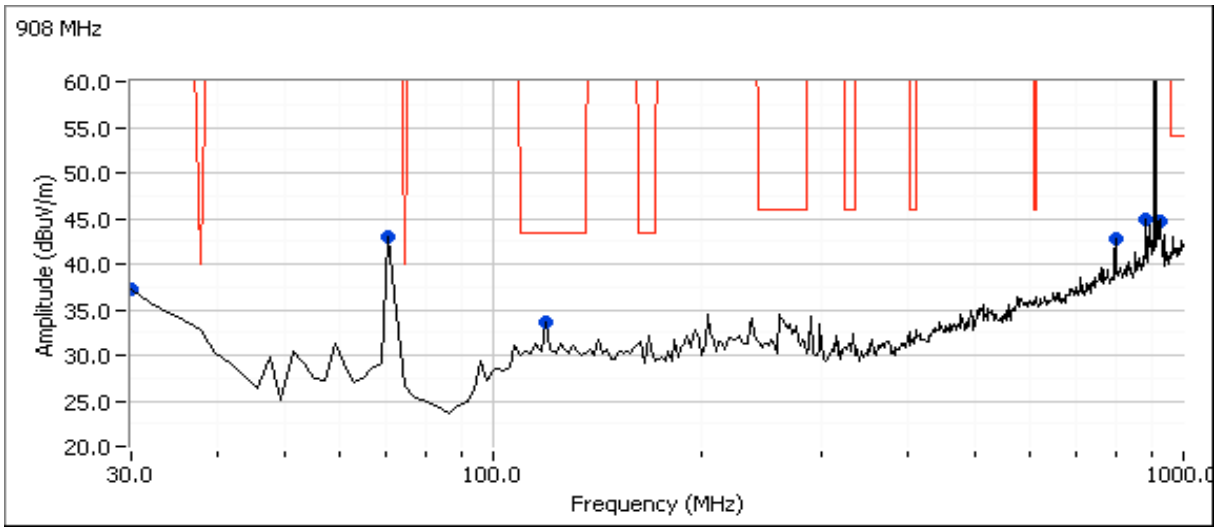
	H	V	
Fundamental emission level @ 3m in 100kHz RBW:	109.1	112.9	
Limit for emissions outside of restricted bands:	92.9 dBµV/m		Limit is -20dBc

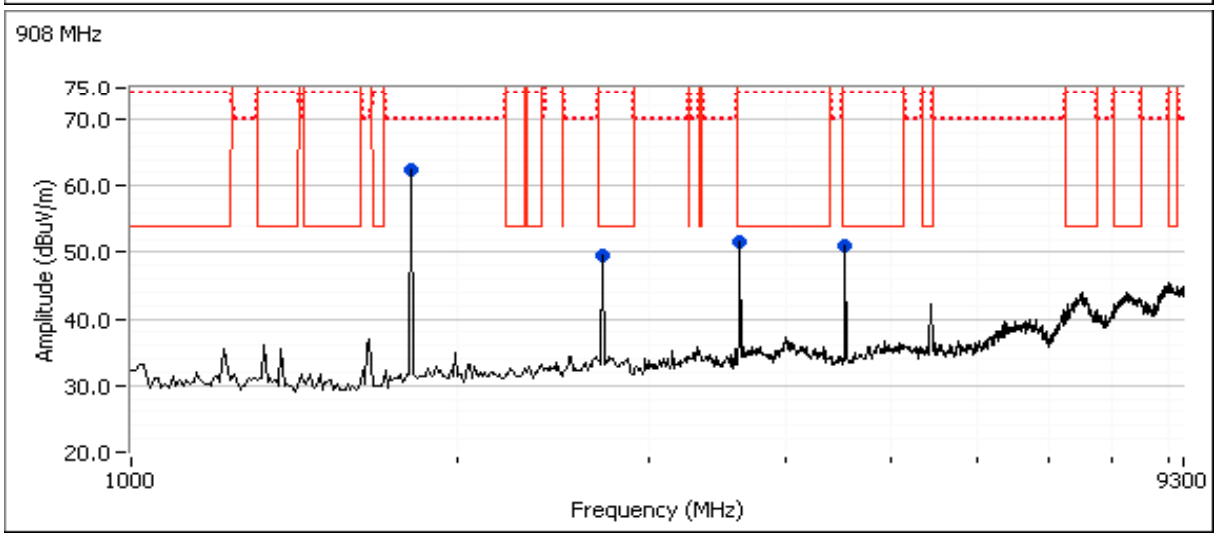
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2723.970	51.1	V	54.0	-2.9	AVG	21	1.3	RB 1 MHz;VB 10 Hz;Peak
2724.070	52.9	V	74.0	-21.1	PK	21	1.3	RB 1 MHz;VB 3 MHz;Peak
30.000	37.3	H	92.9	-55.6	Peak	85	3.0	
70.822	43.0	V	92.9	-49.9	Peak	144	1.0	
119.419	33.6	V	43.5	-9.9	Peak	152	1.0	
799.780	42.8	H	92.9	-50.1	Peak	157	1.0	
881.423	44.9	H	92.9	-48.0	Peak	145	1.5	
924.188	44.7	H	92.9	-48.2	Peak	150	1.5	
3631.960	50.7	V	54.0	-3.3	AVG	326	1.0	RB 1 MHz;VB 10 Hz;Peak
3632.180	53.2	V	74.0	-20.8	PK	326	1.0	RB 1 MHz;VB 3 MHz;Peak
4540.010	48.5	V	54.0	-5.5	AVG	54	1.0	RB 1 MHz;VB 10 Hz;Peak
4539.790	52.3	V	74.0	-21.7	PK	54	1.0	RB 1 MHz;VB 3 MHz;Peak
1815.890	62.8	V	92.9	-30.1	PK	14	1.0	RB 100 kHz;VB 100 kHz;Peak

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A





Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #1b: Radiated Spurious Emissions, 30 - 9300 MHz. Channel 351 @ 915 MHz

Fundamental Signal Field Strength: Peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
915.040	112.0	V	-	-	Pk	333	1.1	POS; RB 100 kHz; VB: 100 kHz
915.038	109.2	H	-	-	Pk	270	1.0	POS; RB 100 kHz; VB: 100 kHz

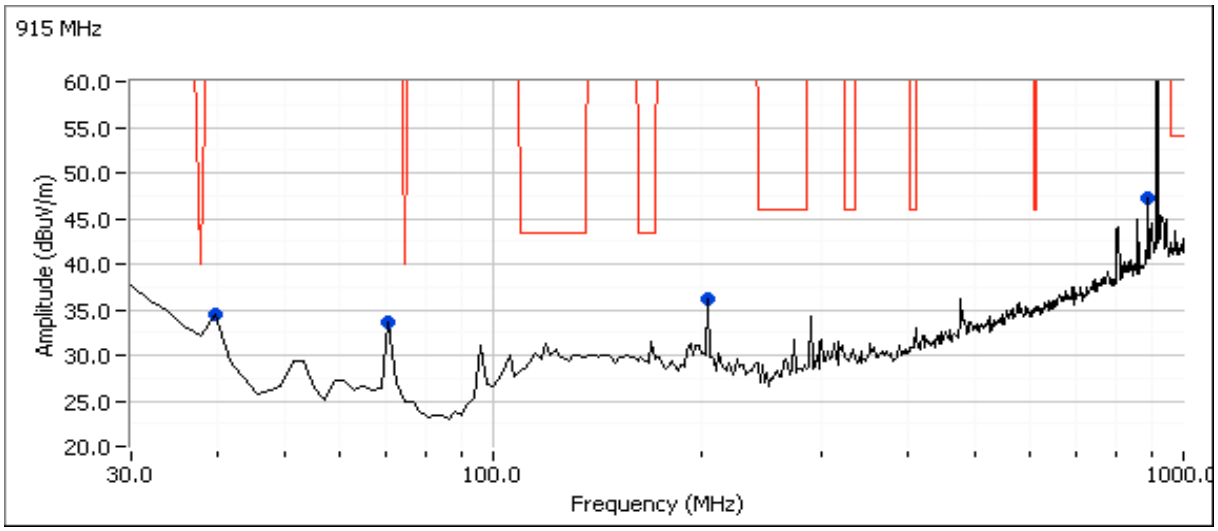
	H	V	
Fundamental emission level @ 3m in 100kHz RBW:	109.2	112	
Limit for emissions outside of restricted bands:	92.0 dBµV/m		Limit is -20dBc

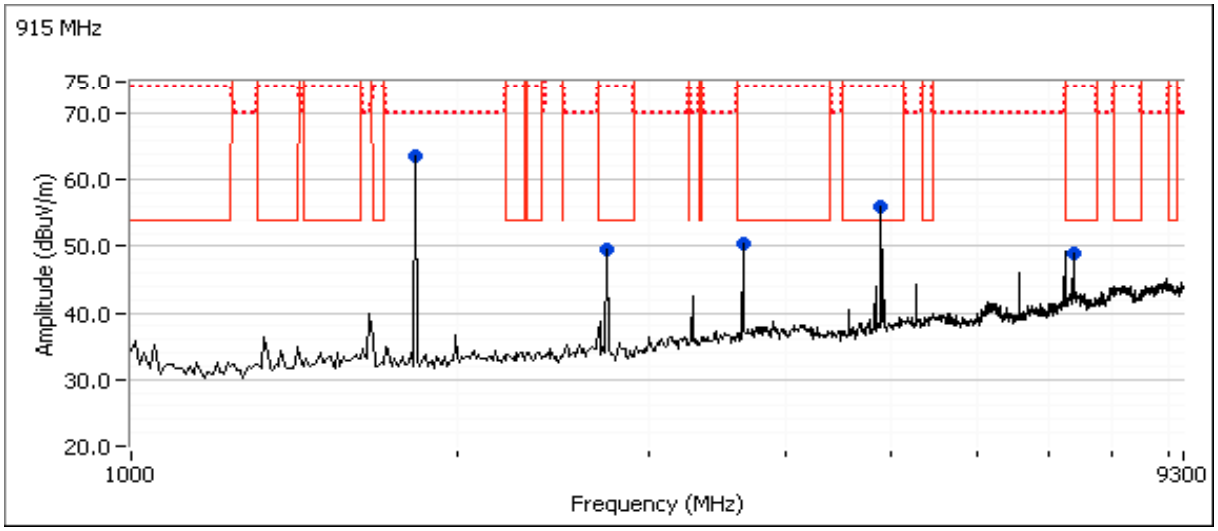
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2745.010	51.2	V	54.0	-2.8	AVG	0	1.1	RB 1 MHz;VB 10 Hz;Peak
2745.180	53.3	V	74.0	-20.7	PK	0	1.1	RB 1 MHz;VB 3 MHz;Peak
39.719	34.5	H	92.0	-57.5	Peak	62	2.0	
70.822	33.7	V	92.0	-58.3	Peak	103	1.0	
204.950	36.1	V	92.0	-55.9	Peak	98	1.0	
887.255	47.2	V	92.0	-44.8	Peak	197	1.5	
3659.960	50.3	V	54.0	-3.7	AVG	42	1.0	RB 1 MHz;VB 10 Hz;Peak
3660.220	53.4	V	74.0	-20.6	PK	42	1.0	RB 1 MHz;VB 3 MHz;Peak
1830.110	63.5	V	92.0	-28.5	PK	14	1.0	RB 100 kHz;VB 100 kHz;Peak
4894.730	34.4	H	54.0	-19.6	AVG	51	1.0	RB 1 MHz;VB 10 Hz;Peak
4890.000	45.1	H	74.0	-28.9	PK	51	1.0	RB 1 MHz;VB 3 MHz;Peak
7382.310	39.2	H	54.0	-14.8	AVG	251	1.3	RB 1 MHz;VB 10 Hz;Peak
7367.370	50.5	H	74.0	-23.5	PK	251	1.3	RB 1 MHz;VB 3 MHz;Peak

Note 1: For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A





Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #1c: Radiated Spurious Emissions, 30 - 9300 MHz. Channel 415 @ 927.8 MHz

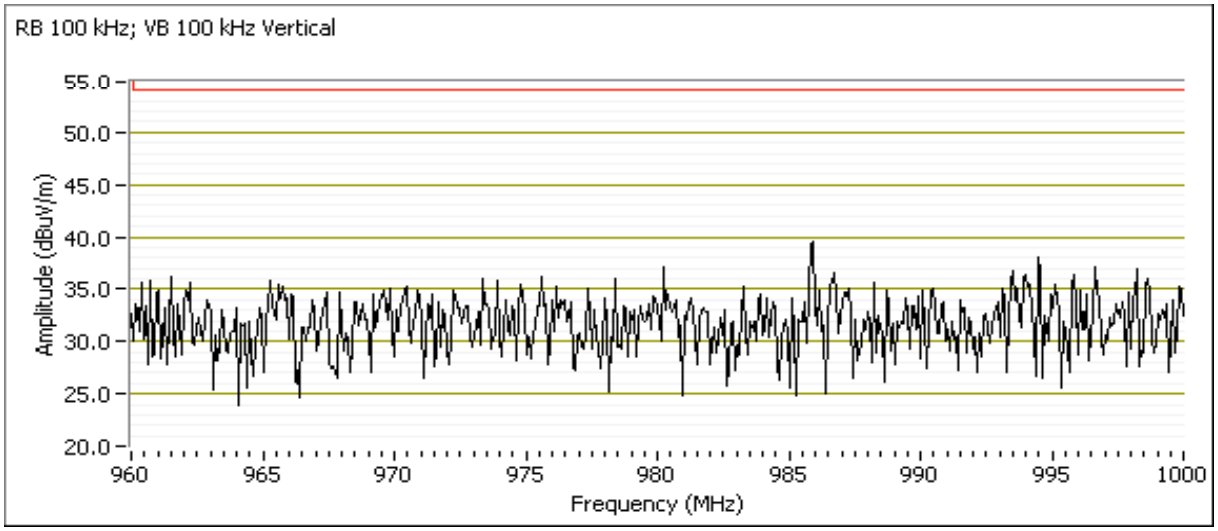
Fundamental Signal Field Strength: Peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
927.744	110.0	V	-	-	Pk	322	1.1	POS; RB 100 kHz; VB: 100 kHz
927.746	108.7	H	-	-	Pk	266	1.0	POS; RB 100 kHz; VB: 100 kHz

	H	V	
Fundamental emission level @ 3m in 100kHz RBW:	108.7	110	
Limit for emissions outside of restricted bands:	90.0 dBµV/m		Limit is -20dBc

Band Edge Signal Field Strength (960 MHz)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
985.800	45.9	V	54.0	-8.1	QP	308	1.0	QP (1.00s)
985.800	45.1	H	54.0	-8.9	QP	219	1.4	QP (1.00s)



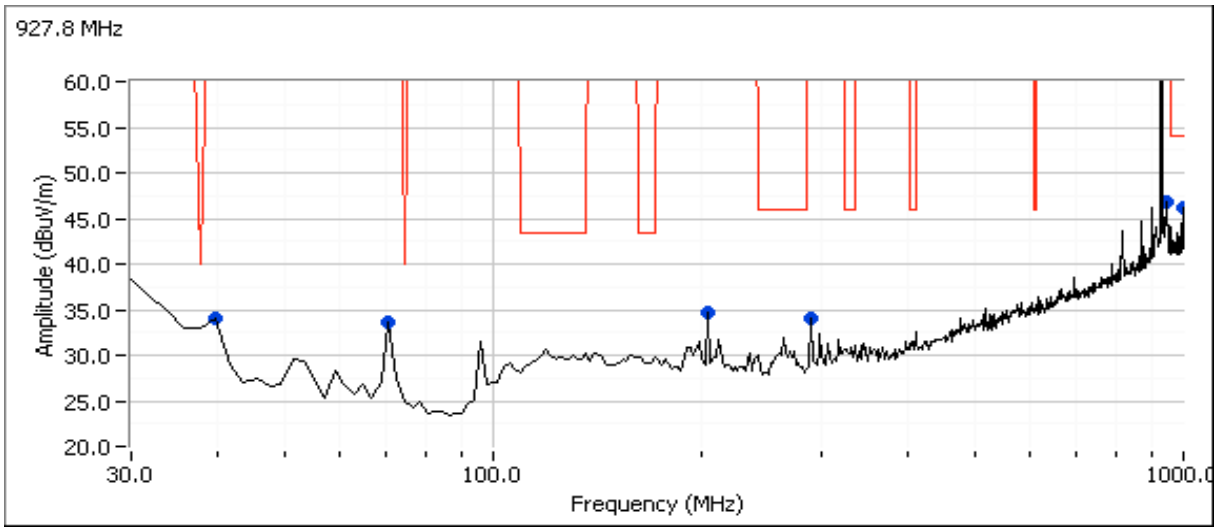
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

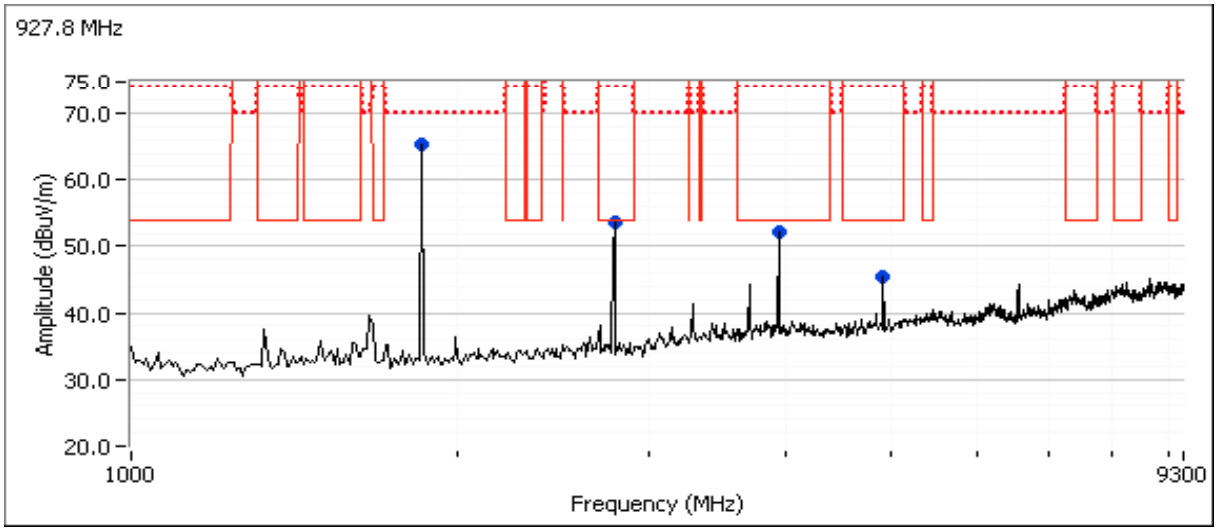
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
995.029	44.6	H	54.0	-9.4	QP	168	1.5	QP (1.00s)
39.719	34.1	V	90.0	-55.9	Peak	173	1.0	
70.822	33.6	V	90.0	-56.4	Peak	48	1.0	
204.950	34.6	V	90.0	-55.4	Peak	78	1.0	
288.537	34.1	H	90.0	-55.9	Peak	138	1.5	
943.627	46.9	V	90.0	-43.1	Peak	192	1.5	
4924.020	44.0	V	54.0	-10.0	AVG	102	1.0	RB 1 MHz;VB 10 Hz;Peak
4924.160	49.8	V	74.0	-24.2	PK	102	1.0	RB 1 MHz;VB 3 MHz;Peak
1855.510	65.4	V	90.0	-24.6	PK	360	1.0	RB 100 kHz;VB 100 kHz;Peak
2783.360	43.9	V	54.0	-10.1	AVG	343	1.0	RB 1 MHz;VB 10 Hz;Peak
2783.240	48.1	V	74.0	-25.9	PK	343	1.0	RB 1 MHz;VB 3 MHz;Peak
3939.140	33.9	V	54.0	-20.1	AVG	307	1.4	RB 1 MHz;VB 10 Hz;Peak
3939.150	44.9	V	74.0	-29.1	PK	307	1.4	RB 1 MHz;VB 3 MHz;Peak

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A





Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #2: Receiver Radiated Spurious Emissions, 30 - 1900 MHz.

Date of Test: 4/16/2014

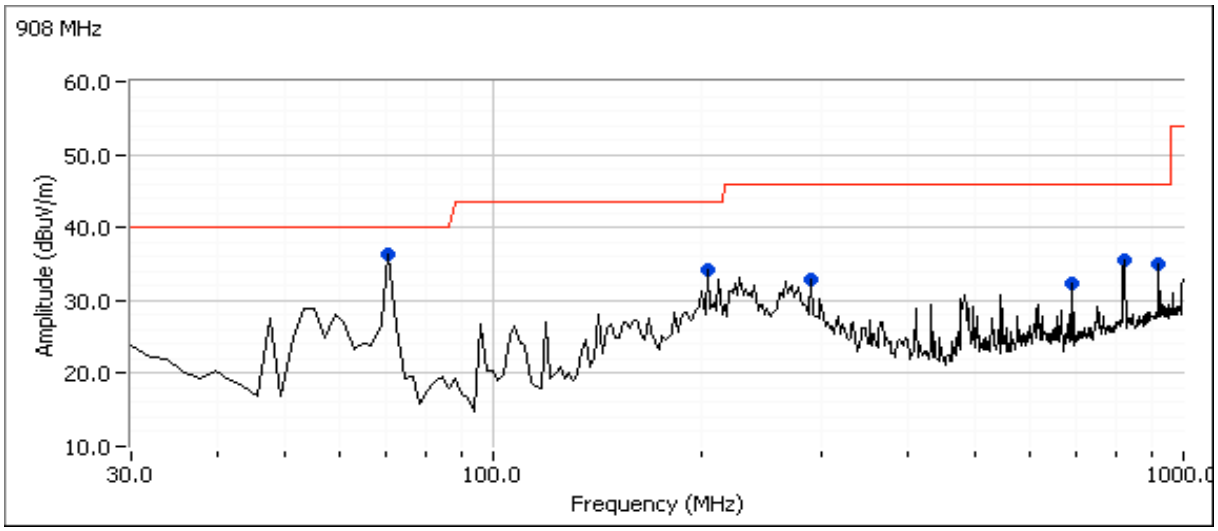
Test Engineer: Rafael Varelas

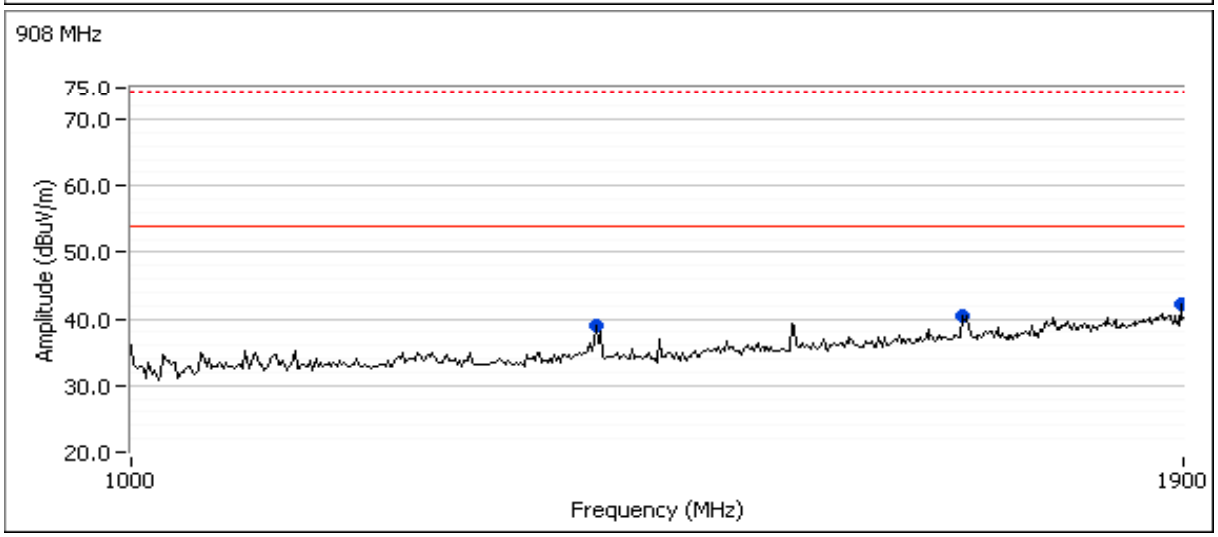
Test Location: FT Chamber #5

Run #2a: Receiver Radiated Spurious Emissions, 30 - 1900 MHz. Channel 316 @ 908 MHz

Frequency	Level	Pol	15.109 / RSS GEN		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
72.012	35.3	V	40.0	-4.7	QP	188	1.0	QP (1.00s)
689.973	34.6	V	46.0	-11.4	QP	7	1.0	QP (1.00s)
819.420	34.5	H	46.0	-11.5	QP	142	1.8	QP (1.00s)
204.686	32.4	V	43.5	-11.1	QP	157	1.0	QP (1.00s)
287.996	32.6	V	46.0	-13.4	QP	157	1.0	QP (1.00s)
922.229	32.9	V	46.0	-13.1	QP	292	1.0	QP (1.00s)
1886.150	34.3	V	54.0	-19.7	AVG	303	1.3	POS; RB 1 MHz; VB: 10 Hz
1893.210	45.7	V	74.0	-28.3	PK	303	1.3	POS; RB 1 MHz; VB: 3 MHz
1327.990	30.3	V	54.0	-23.7	AVG	114	1.0	POS; RB 1 MHz; VB: 10 Hz
1330.750	47.1	V	74.0	-26.9	PK	114	1.0	POS; RB 1 MHz; VB: 3 MHz
1664.420	32.6	H	54.0	-21.4	AVG	92	1.3	POS; RB 1 MHz; VB: 10 Hz
1659.890	49.5	H	74.0	-24.5	PK	92	1.3	POS; RB 1 MHz; VB: 3 MHz

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A



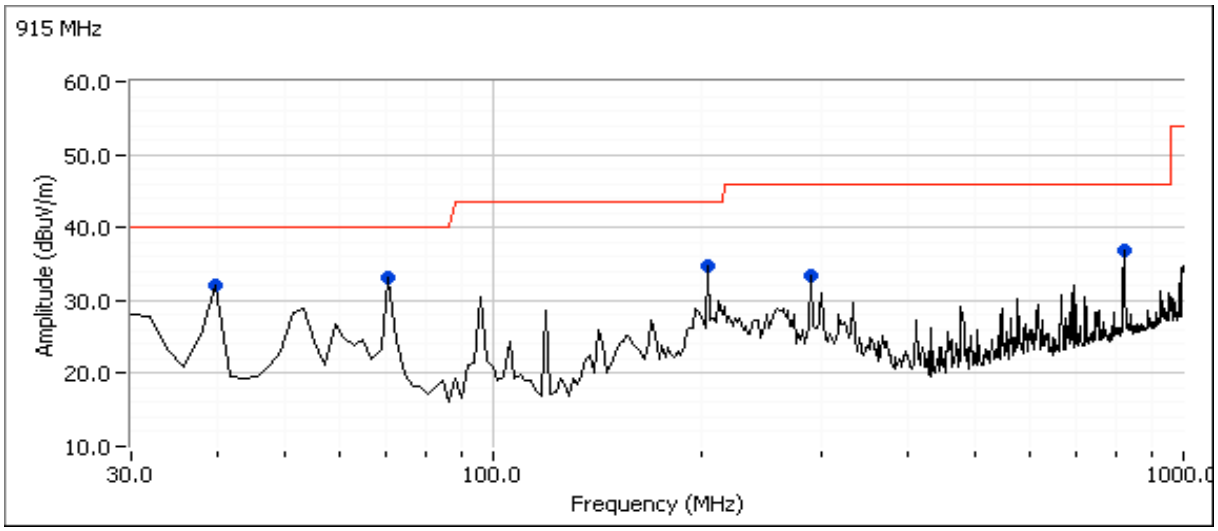


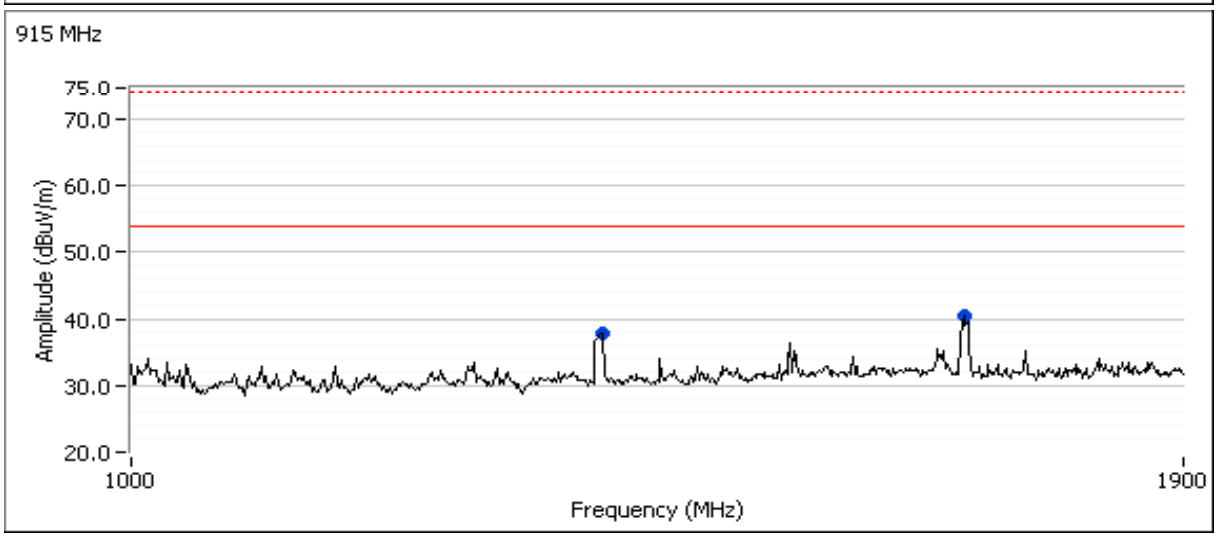
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #2b: Receiver Radiated Spurious Emissions, 30 - 1900 MHz. Channel 351 @ 915 MHz

Frequency	Level	Pol	15.109 / RSS GEN		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
72.023	32.0	V	40.0	-8.0	QP	150	1.4	QP (1.00s)
821.121	34.9	H	46.0	-11.1	QP	133	1.1	QP (1.00s)
204.552	31.7	V	43.5	-11.8	QP	120	1.0	QP (1.00s)
288.003	32.6	H	46.0	-13.4	QP	110	1.6	QP (1.00s)
39.632	21.7	V	40.0	-18.3	QP	106	1.0	QP (1.00s)
1331.440	31.0	V	54.0	-23.0	AVG	99	1.0	RB 1 MHz;VB 10 Hz;Peak
1332.860	47.9	V	74.0	-26.1	PK	99	1.0	RB 1 MHz;VB 3 MHz;Peak
1662.220	31.4	V	54.0	-22.6	AVG	157	1.0	RB 1 MHz;VB 10 Hz;Peak
1660.840	49.3	V	74.0	-24.7	PK	157	1.0	RB 1 MHz;VB 3 MHz;Peak

Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

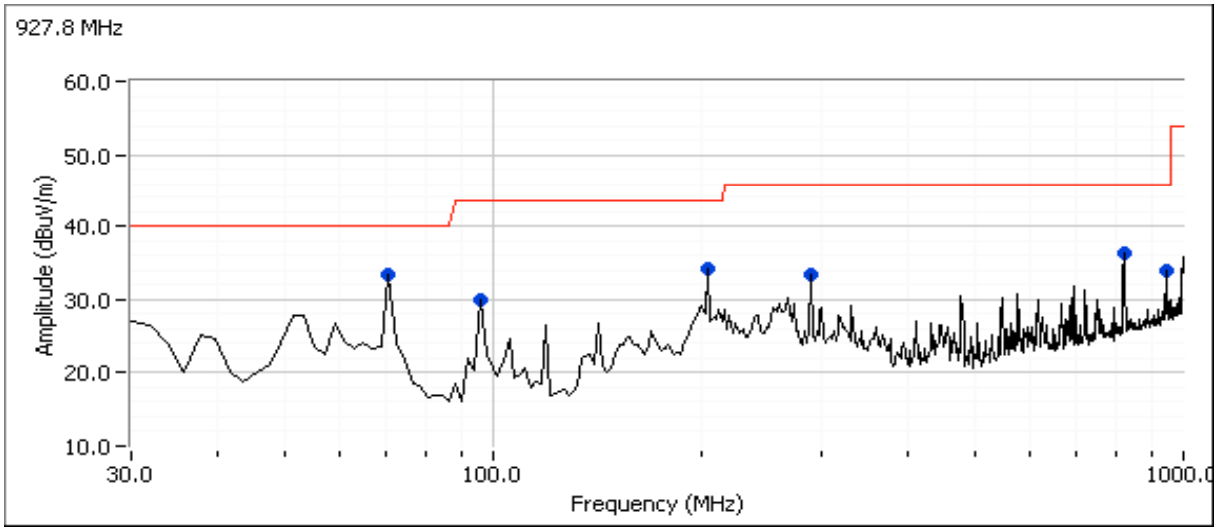




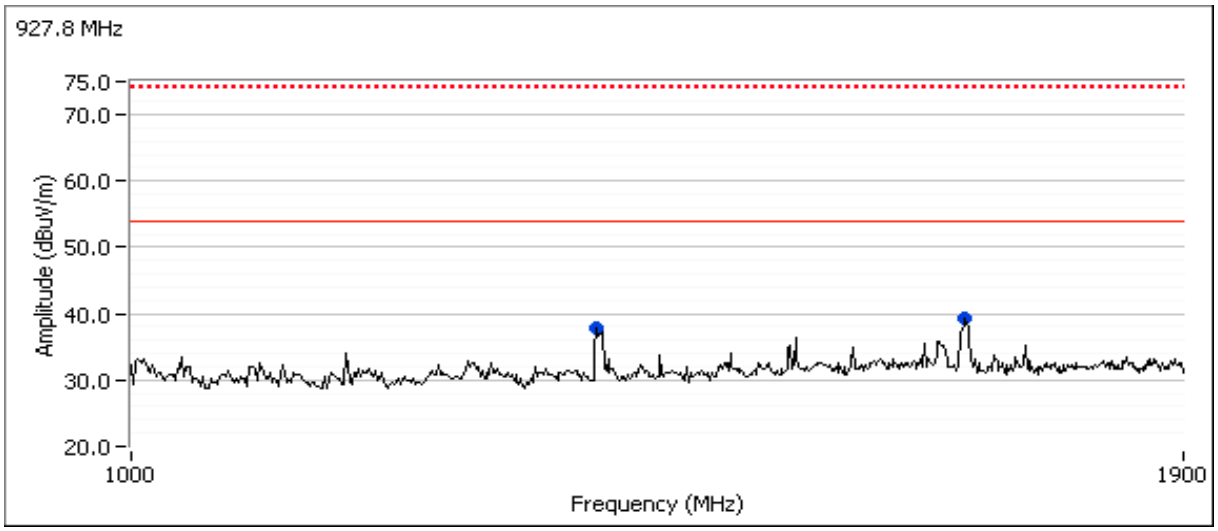
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #2c: Receiver Radiated Spurious Emissions, 30 - 1900 MHz. Channel 415 @ 927.8 MHz

Frequency	Level	Pol	15.109 / RSS GEN		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
72.015	32.1	V	40.0	-7.9	QP	66	1.2	QP (1.00s)
96.005	30.2	V	43.5	-13.3	QP	136	1.0	QP (1.00s)
287.995	33.8	H	46.0	-12.2	QP	146	1.6	QP (1.00s)
205.014	31.1	V	43.5	-12.4	QP	151	1.0	QP (1.00s)
819.667	32.9	V	46.0	-13.1	QP	160	1.0	QP (1.00s)
943.967	32.1	V	46.0	-13.9	QP	226	1.1	QP (1.00s)
1662.850	31.0	V	54.0	-23.0	AVG	24	1.2	RB 1 MHz;VB 10 Hz;Peak
1661.560	48.1	V	74.0	-25.9	PK	24	1.2	RB 1 MHz;VB 3 MHz;Peak
1330.900	31.9	V	54.0	-22.1	AVG	91	1.0	RB 1 MHz;VB 10 Hz;Peak
1332.010	48.5	V	74.0	-25.5	PK	91	1.0	RB 1 MHz;VB 3 MHz;Peak



Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A



Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #3: Antenna Conducted Spurious Emissions, 30 - 9300 MHz.

Date of Test: 3/31/14, 4/2/14

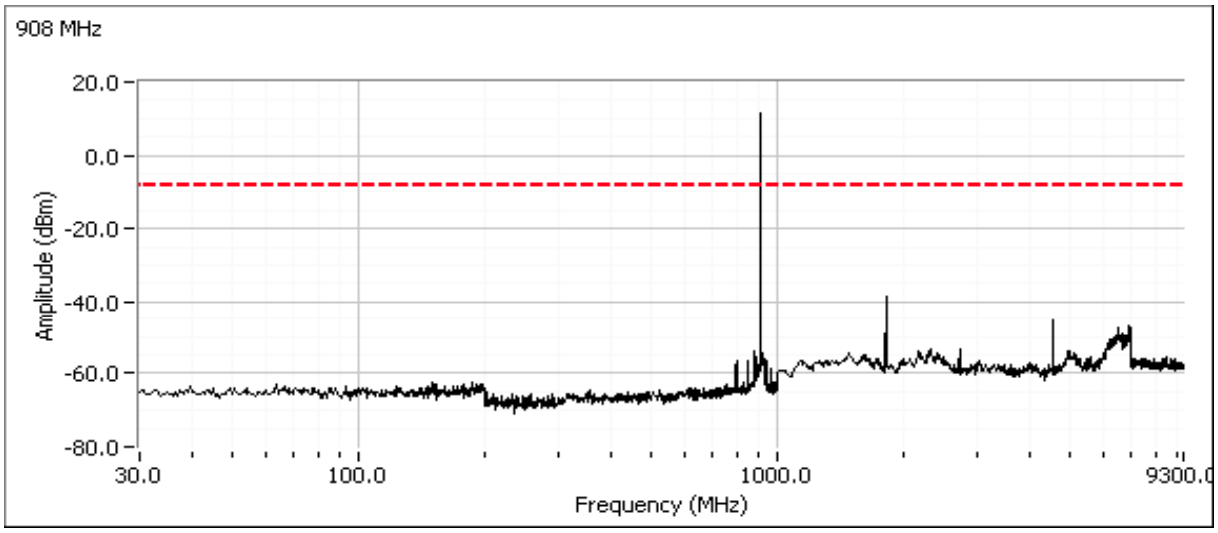
Test Engineer: Jack Liu

Test Location: FT Chamber# 7 , Lab# 6

Refer to plots below. Scans made using RBW=VB=100 KHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature disabled.

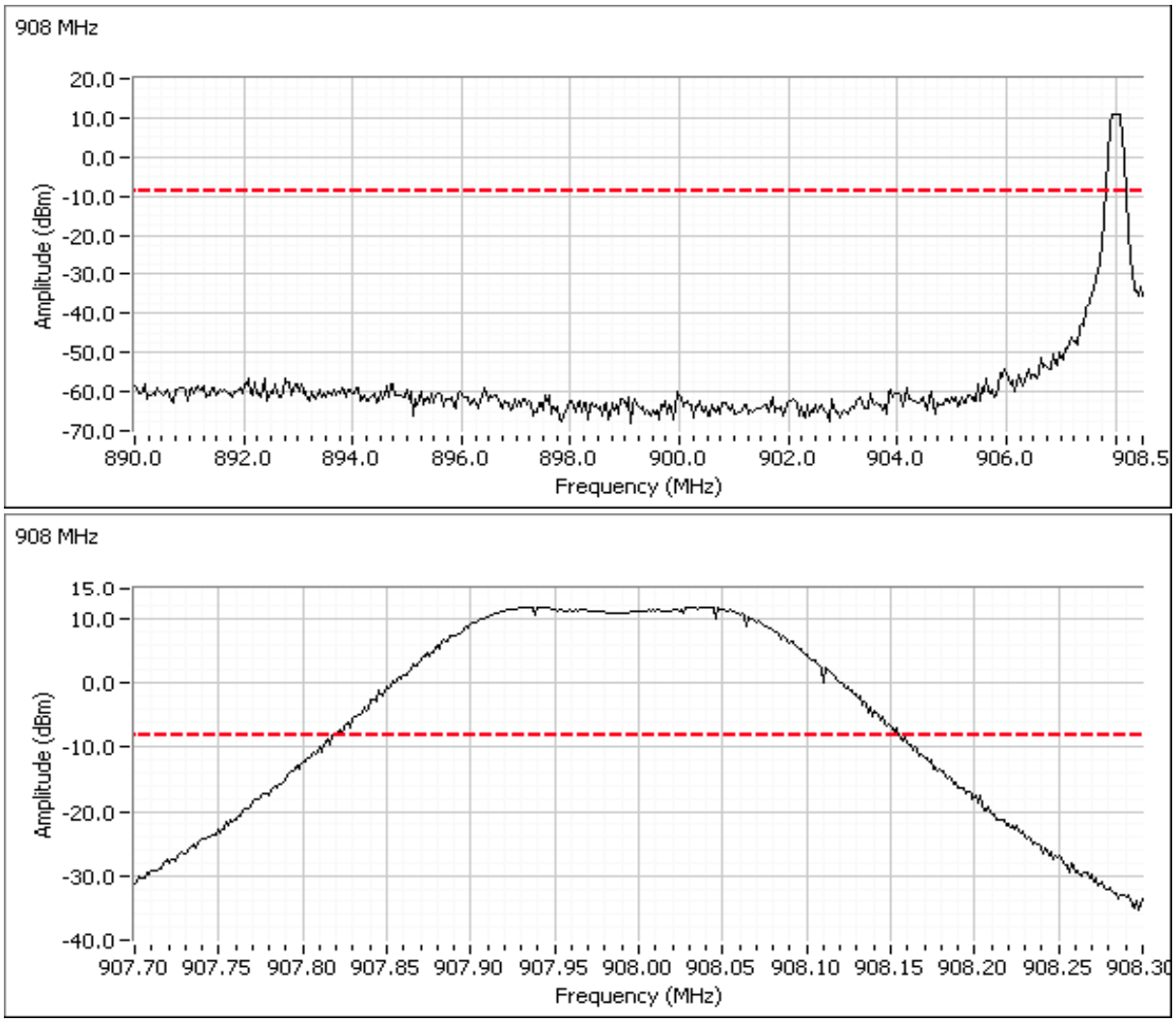
Channel 316 @ 908 MHz

Broadband plot



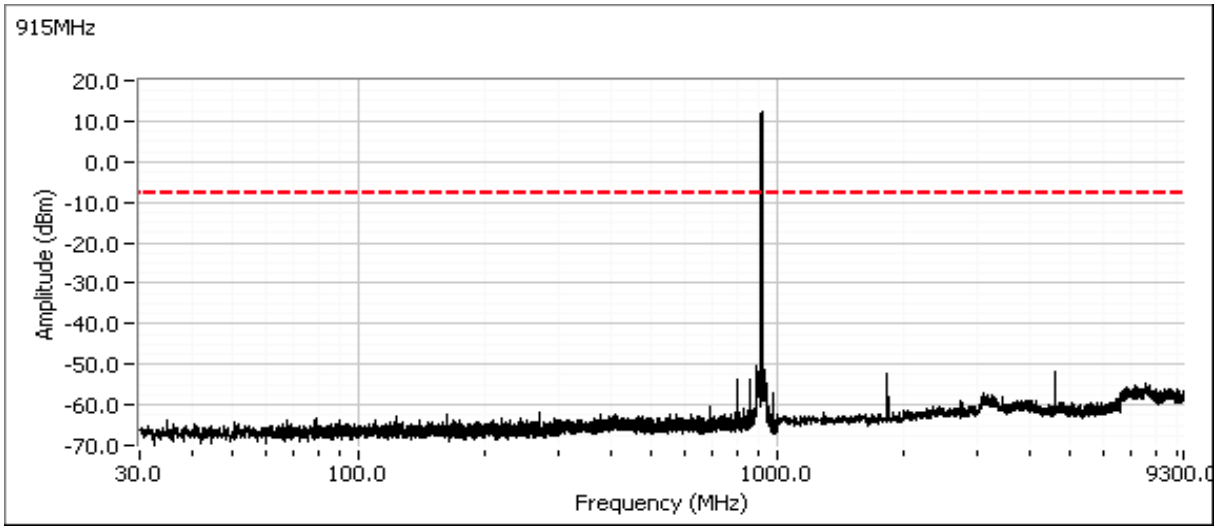
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Plot showing -20dBc at the lower band edge

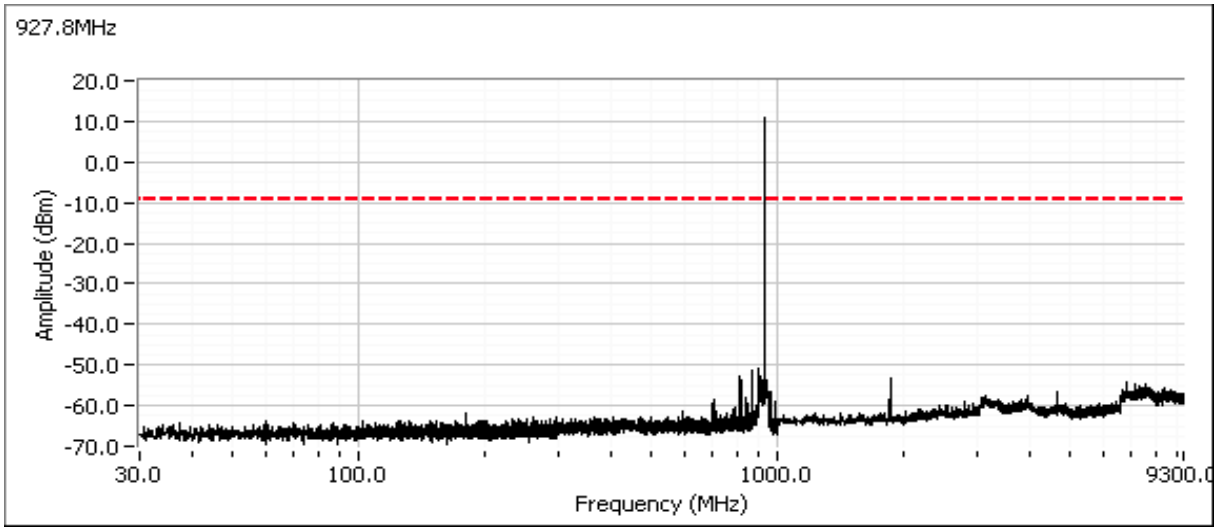


Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Channel 351 @ 915 MHz
Broadband plot

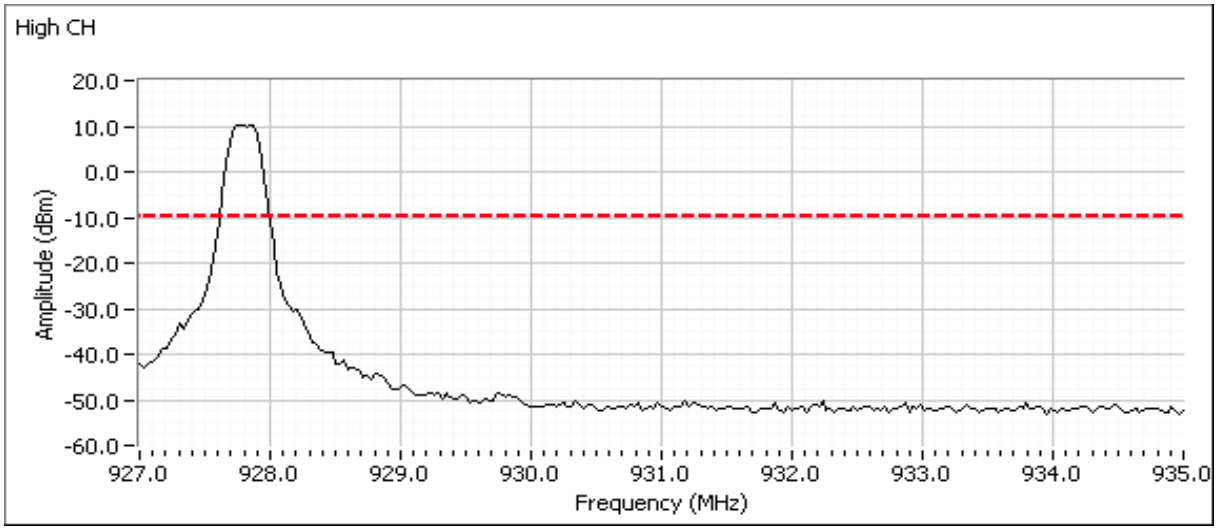


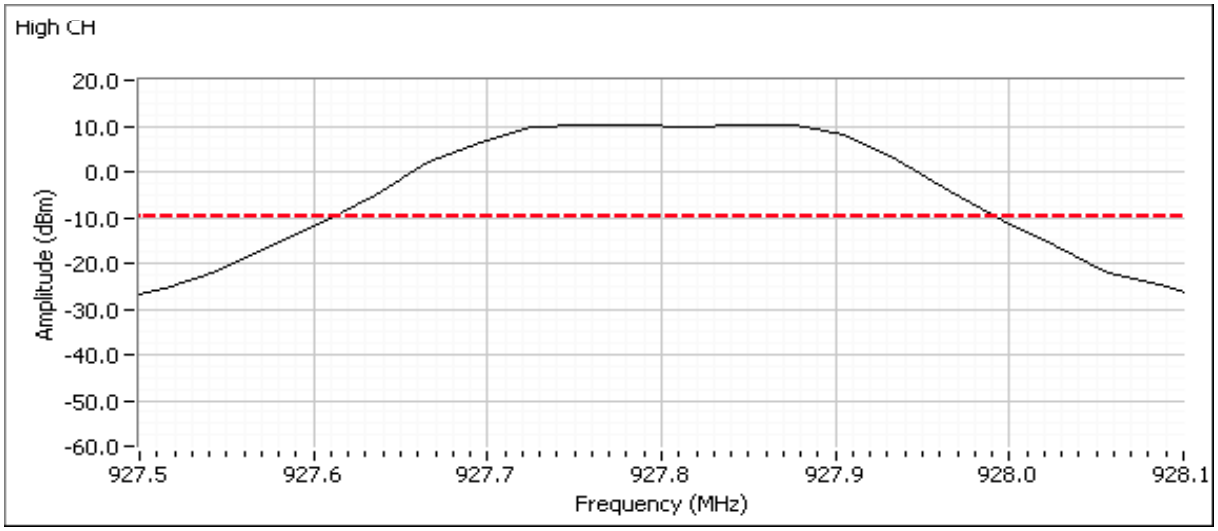
Channel 415 @ 927.8 MHz
Broadband plot



Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Plot showing -20dBc at the upper band edge



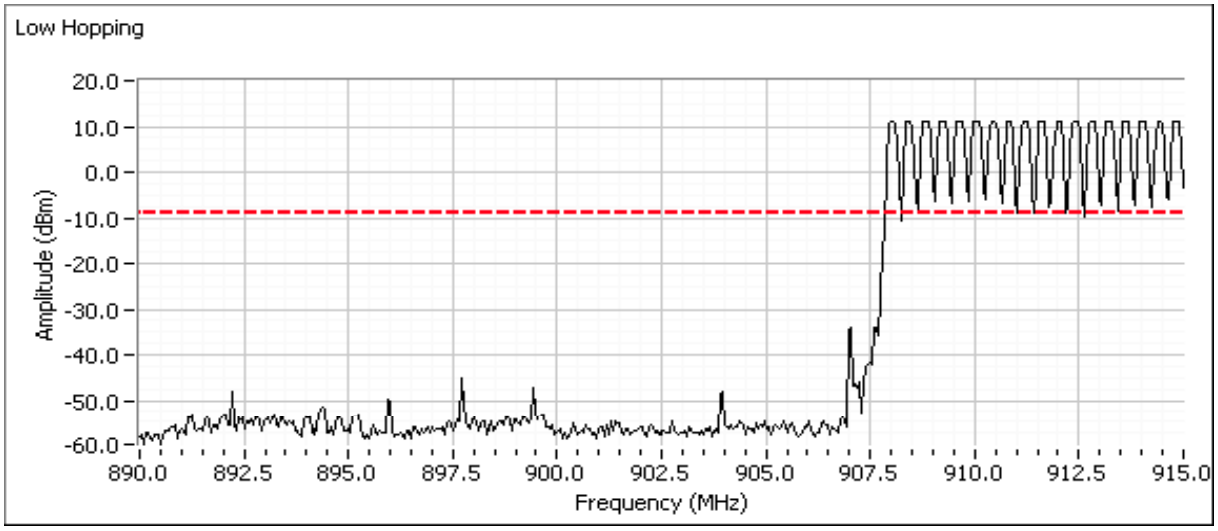


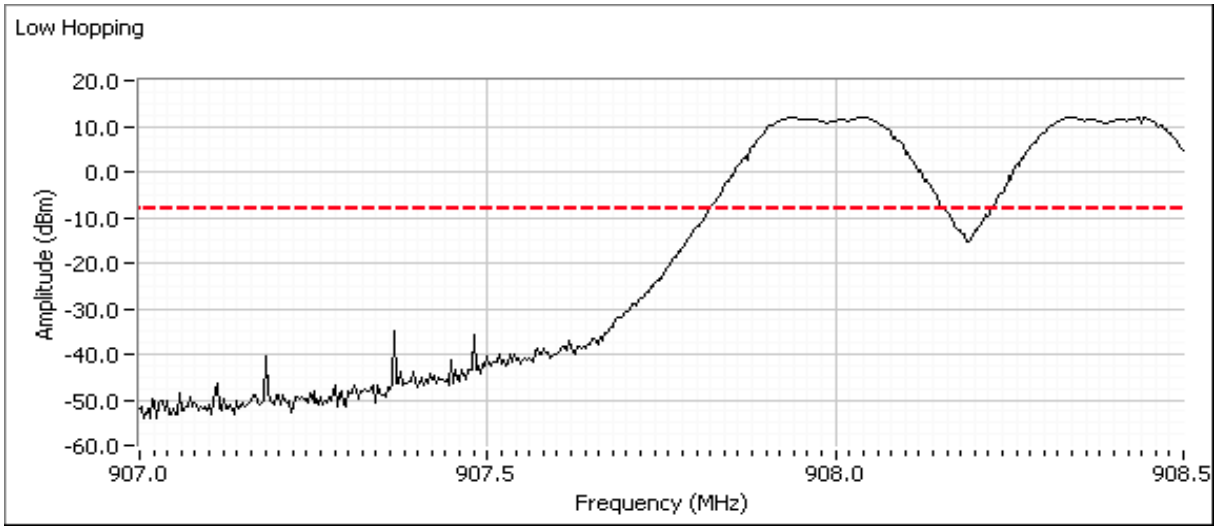
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Refer to plots below. Scans made using RBW=VB=100 KHz with the limit line set at 20dB below the highest in-band signal level with the hopping feature enabled to show compliance with the -20dBc requirement at the allocated band edge. The spectrum analyzer is left in max hold mode until the trace stabilizes.

Low channel, hopping enabled

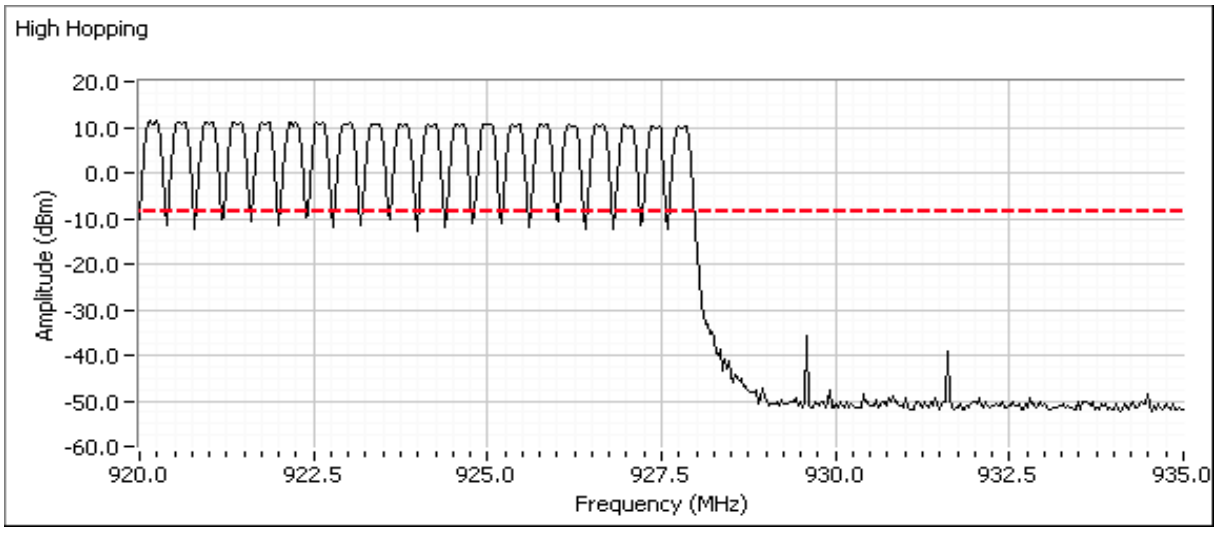
Plot showing -20dBc at the lower band edge

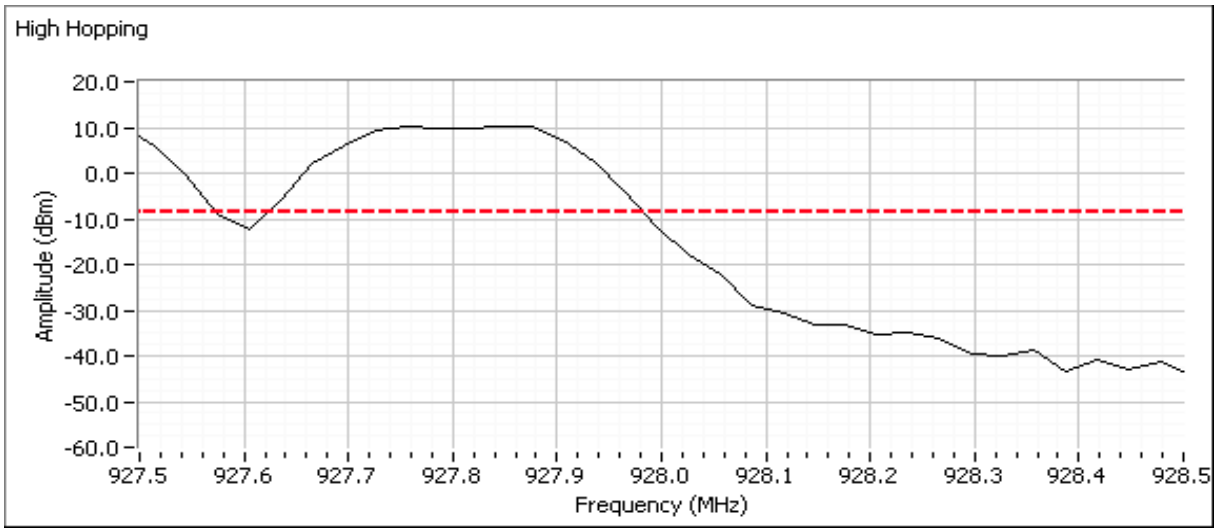




Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

High channel, hopping enabled
Plot showing -20dBc at the upper band edge





Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #4: Output Power Power setting 3

Date of Test: 4/16/2014
Test Engineer: Rafael Varelas
Test Location: FT Chamber #5

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels.

Maximum antenna gain: 3 dBi

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)	EIRP (W)
Low	908	-	13.0	0.020	0.040
Mid	915	-	12.4	0.017	0.035
High	927.6	-	10.9	0.012	0.025

Note 1:	Output power measured using a peak power meter, spurious limit is -20dBc.

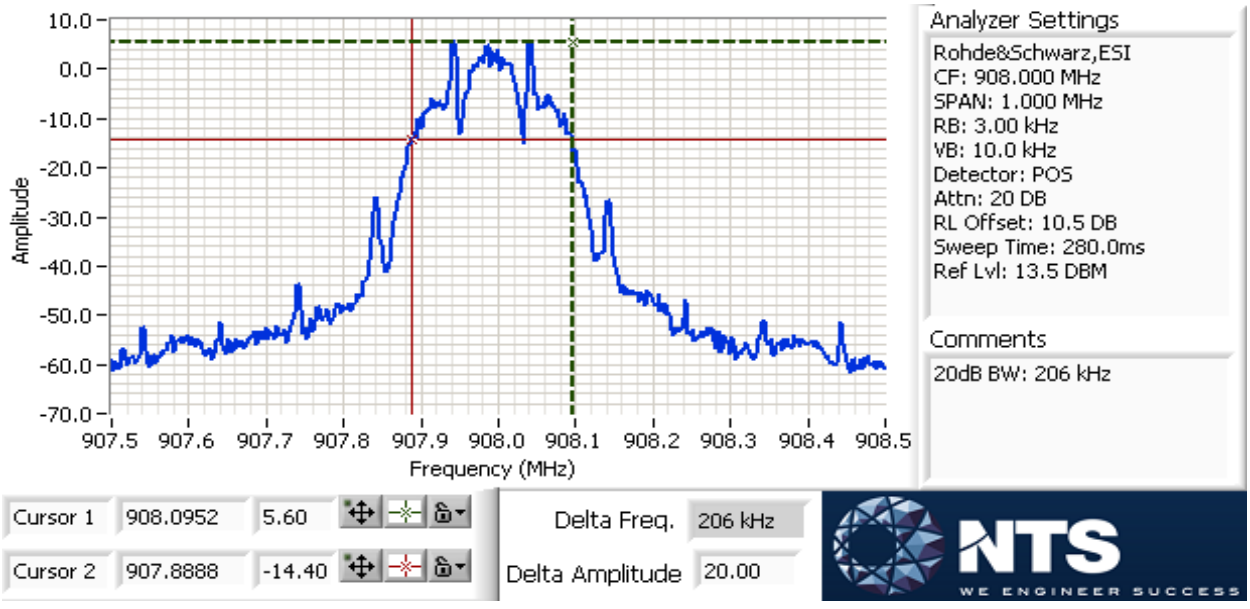
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

Run #5: Bandwidth, Channel Occupancy, Spacing and Number of Channels

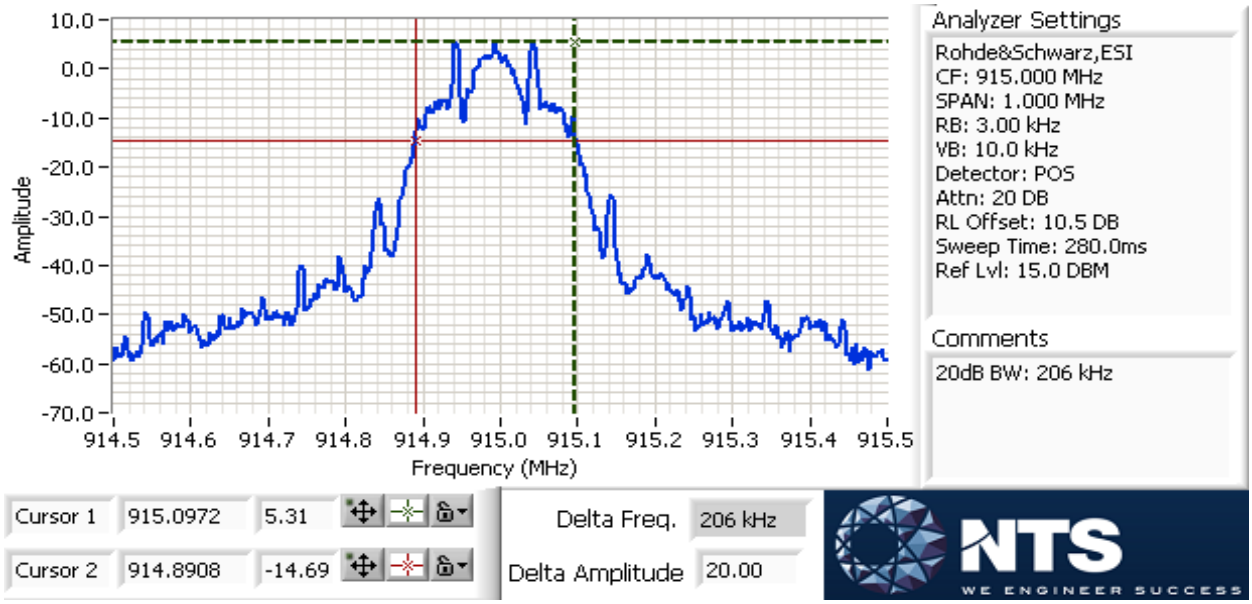
Date of Test: 3/31/14, 4/2/14
Test Engineer: Jack Liu
Test Location: FT Chamber# 7 , Lab# 6

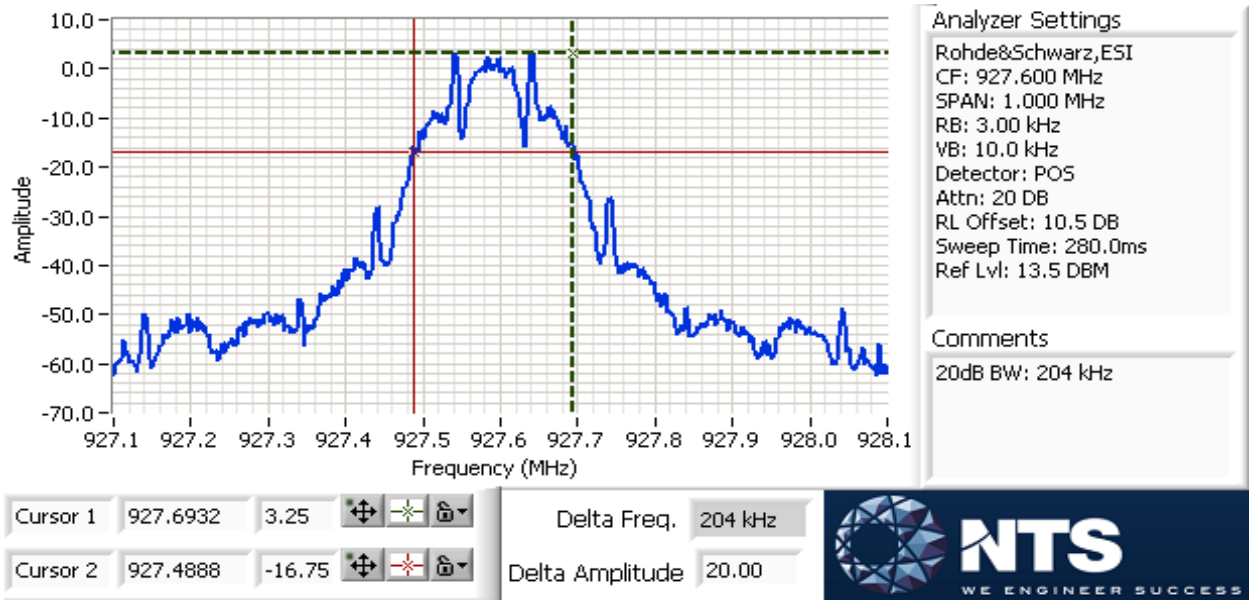
Channel	Frequency (MHz)	Resolution Bandwidth	20dB Bandwidth (kHz)
Low	908	3kHz	206
Mid	915.0	3kHz	206
High	927.6	3kHz	204

Note 1:	20dB bandwidth measured using RB = 3kHz, VB = 10kHz (VB > RB)



Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

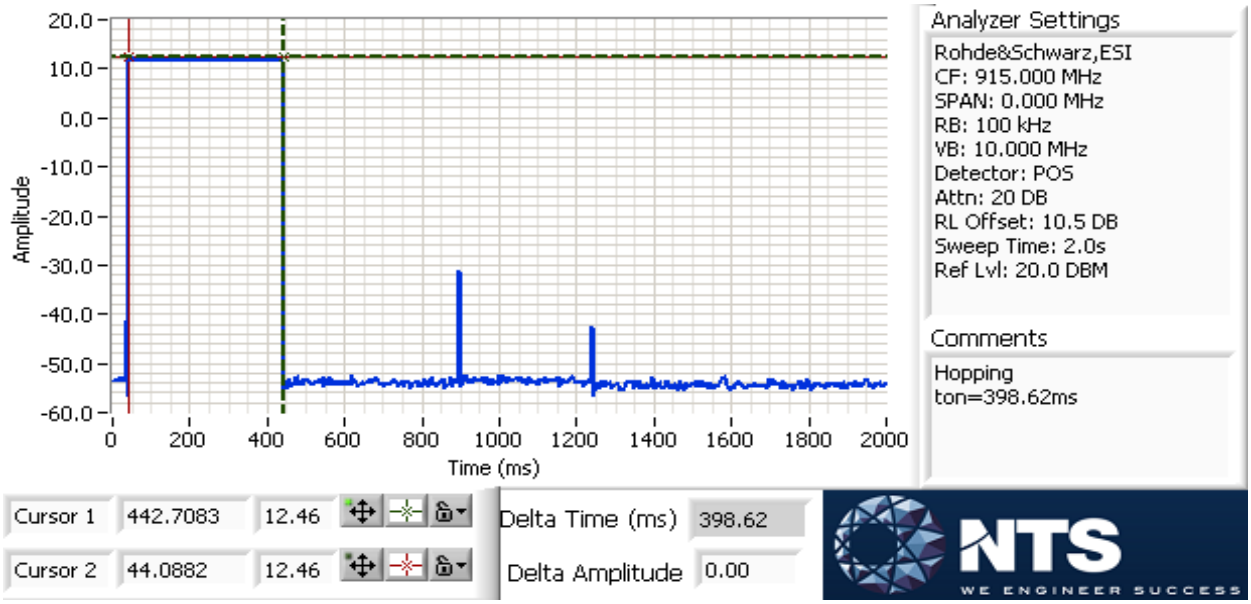




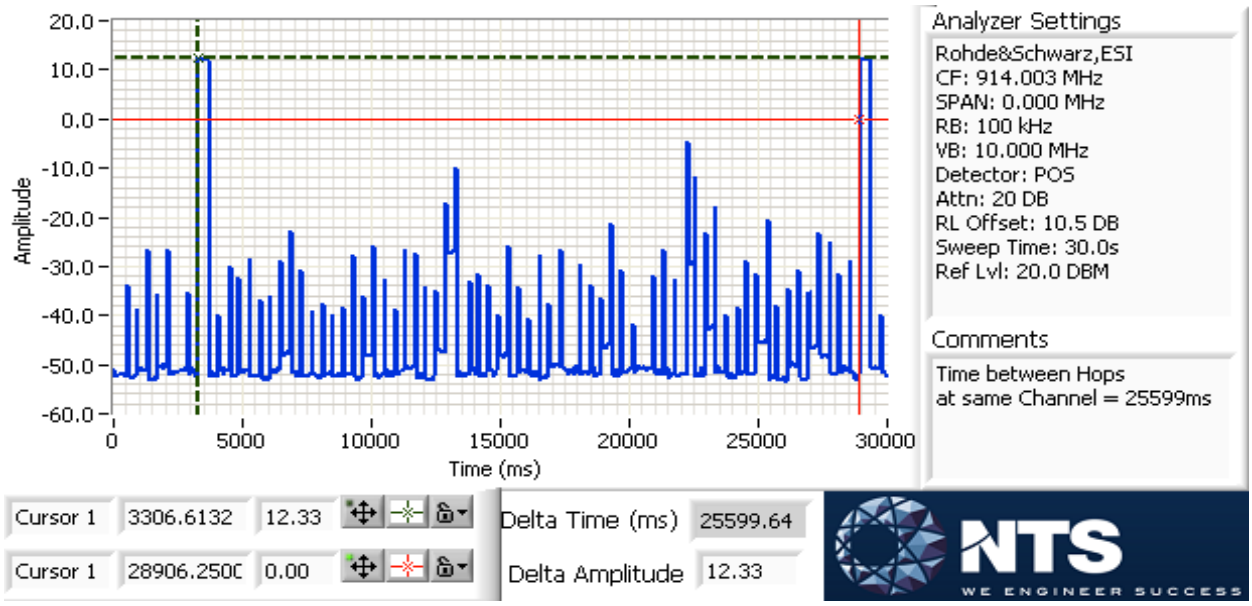
Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A

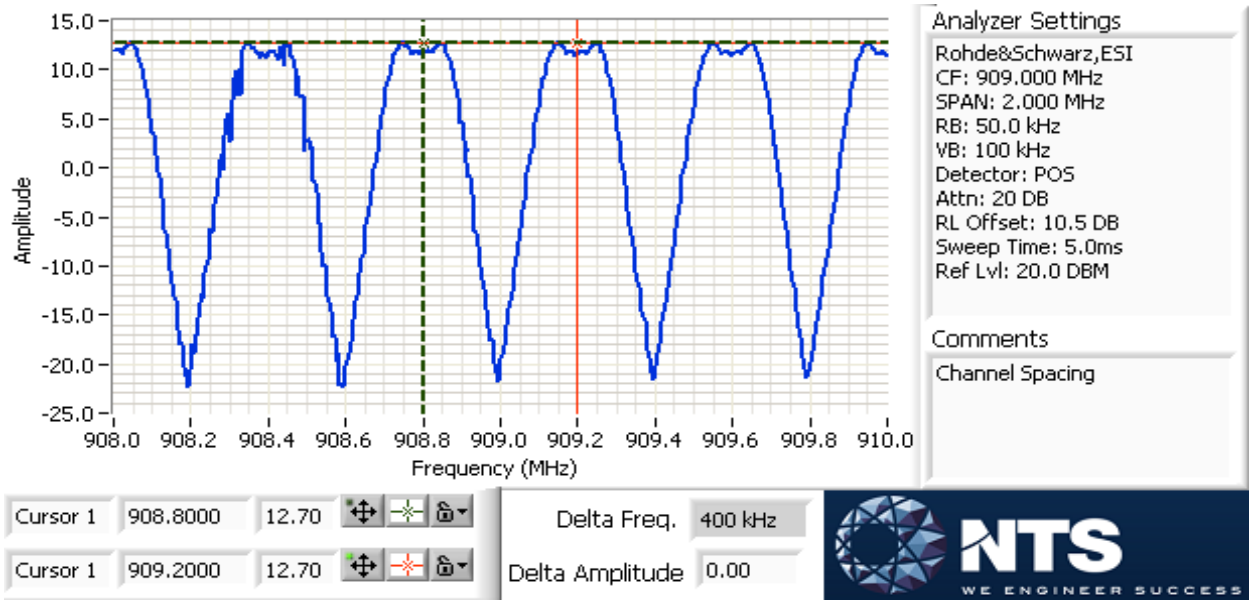
For frequency hopping systems operating in the 902-928 MHz band:
If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.
The channel dwell time is calculated from the transmit time on a channel multiplied by the number of times a channel could be used in the 20 second period (i.e. 20s divided by the time between successive hops, rounded up to the closest integer), unless the time between successive hops exceeds 20s in which case the channel dwell time is the transmit time on a channel.

Maximum 20dB bandwidth:	206	kHz	Pass
Channel spacing:	400	kHz	Pass
Transmission time per hop:	398.62	ms	
The time between successive hops on a channel:	25599	ms	
Number of channels (N):	50		Pass
Channel dwell time in 20 seconds:	398.62	ms	Pass

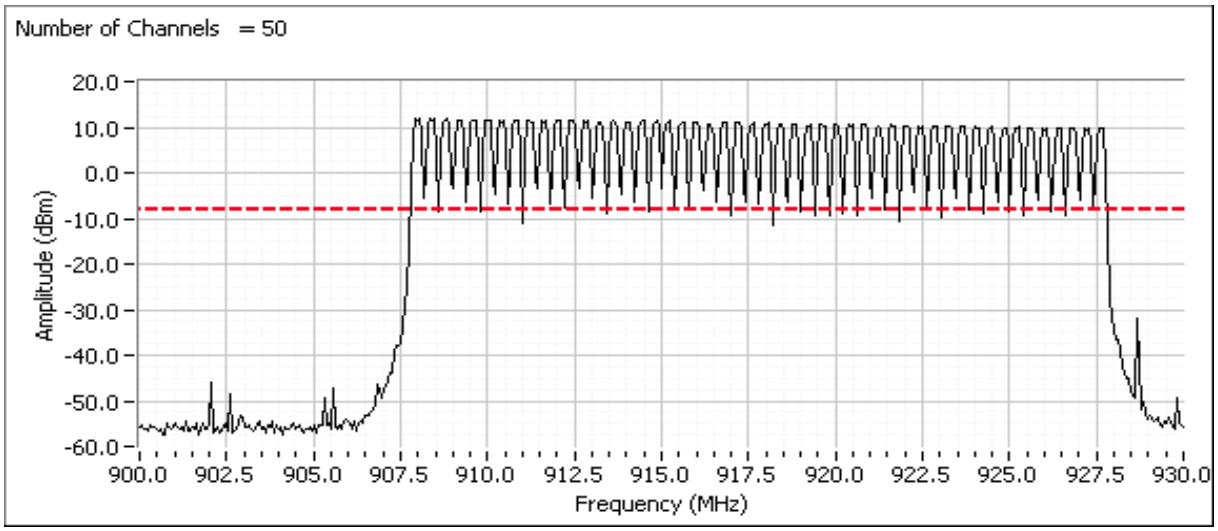


Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A





Client:	SAFEmine Technology, Inc.	Job Number:	J94480
Model:	QC250	T-Log Number:	T94590
		Project Manager:	Christine Krebill
Contact:	Lukas Herzog	Project Coordinator:	Irene Rademacher
Standard:	FCC Part 15	Class:	N/A



End of Report

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