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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: GR-5

IC CERTIFICATION #:	6050B-F90901
FCC ID:	LCB-F90901
APPLICANT:	Topcon Positioning Systems 7400 National Drive Livermore, CA 94550
TEST SITE(S):	NTS Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-4, 2845B-7
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ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	04-10-2013	First release	
1	04-16-2013	Reissued to revise model name from GR5 to GR-5	Dave Guidotti
2	04-25-2013	Updated references to test procedures	Mark Hill

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SCOPE

An electromagnetic emissions test has been performed on the Topcon Positioning Systems model GR-5, 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 NTS Silicon Valley test procedures:

ANSI C63.4:2003
ANSI C63.10:2009
FHSS test procedure DA 00-0705A1, March 2000

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 Topcon Positioning Systems model GR-5 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 Topcon Positioning Systems model GR-5 and therefore apply only to the tested sample. The sample was selected and prepared by Ferdinand Riodique of Topcon Positioning Systems.

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)	20dB Bandwidth	139 kHz	Channel spacing > 20dB bandwidth / 25kHz	Complies
		Channel Separation	200 kHz		Complies
15.247 (a) (1) (i)	RSS 210 A8.1 (3)	Number of Channels	127	50 or more	Complies
15.247 (a) (1) (i)	RSS 210 A8.1 (3)	Channel Dwell Time	169.8ms per 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	29.1 dBm (0.813 Watts) EIRP = 1.45 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	35.7 dBµV/m @ 37.78 MHz (-4.3 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 2.5 dBi for the highest EIRP system.					

FREQUENCY HOPPING SPREAD SPECTRUM (2400 – 2483.5 MHz, less than 75 channels)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247 (a) (1)	RSS 210 A8.1 (1)	20dB Bandwidth	Basic: 850kHz EDR: 1255 kHz	Channel spacing > 2/3rds 20dB BW	Complies
		Channel Separation	1000 kHz		Complies
15.247 (a) (1) (iii)	RSS 210 A8.1 (4)	Channel Dwell Time (*average time of occupancy)*	128ms	<0.4 second within a period of 0.4 x number of channels	Complies
15.247 (a) (1) (iii)	RSS 210 A8.1 (4)	Number of Channels	Max: 79 Min: 20	15 or more	Complies
15.247 (a) (1)	RSS 210 A8.1 (1)	Channel Utilization	The system uses the BlueTooth algorithm and, therefore, meets all requirements for channel utilization.	All channels shall, on average, be used equally	Complies
15.247 (b) (3)	RSS 210 A8.4 (2)	Output Power (multipoint systems)	1.9 dBm (1.5 mW) EIRP = 0.61 mW Note 1	0.125W	Complies
15.247(c)	RSS 210 A8.5	Spurious Emissions – 30MHz – 25GHz	All spurious emissions < -20dBc	< -20dBc	Complies
15.247(c) / 15.209	RSS 210 A8.5 Table 2, 3	Radiated Spurious Emissions 30MHz – 25GHz	50.5 dBµV/m @ 2484.4 MHz (-3.5 dB)	15.207 in restricted bands, all others < -20dBc	Complies (- ?.? dB)
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 -4.0 dBi

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	BT – uses internal/integral antenna 900MHz – Reverse TNC	Unique or integral antenna required	Complies
15.207	RSS GEN Table 2	AC Conducted Emissions	36.5dBµV @ 2.86MHz (-9.5dB)	Refer to page 19	Complies
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	41.2 dBµV/m @ 297.00 MHz (-4.8 dB)	Refer to page 20	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in Exhibit 11, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual		Statement required regarding non-interference	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual		Statement for products with detachable antenna	Complies
-	RSP 100 RSS GEN 4.4.1	99% Bandwidth	BT – Basic: 844kHz BT – EDR: 1163kHz 900MHz: 186kHz	Information only	N/A

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 Topcon Positioning Systems model GR-5 is a GPSS receiver with 900MHz FHSS and Bluetooth 2.0/2.1 radio functions. Since the EUT would be placed on a pole for the purpose of testing the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The EUT is typically battery powered but is provided with an optional AC/DC adapter. The electrical rating of the AC/DC adapter is 100-240 Volts, 50-60 Hz, 0.8 Amps.

The sample was received on January 25, 2013 and tested on January 25, 2013. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Topcon	GR5	GNS receiver with 900MHz FHSS and BT radios	800-10212	LCB-F90901 IC: 6050B-F90901
PhiHong	PSC30U-120	AC/DC Adapter	P01702775C2	N/A

OTHER EUT DETAILS

The EUT has a 900MHz FHSS radio
The EUT has a BT 2.0/2.1 radio (Basic/EDR modes supported)
The 900MHz FHSS radio and BT radio can transmit simultaneously.

ANTENNA SYSTEM

900MHz radio: 2.5dBi dipole antenna. Attached via a reverse TNC connector.
Bluetooth radio: -4.0dBi. Internal antenna.

ENCLOSURE

The EUT enclosure is primarily constructed of magnesium extrusion and a Xenoy Radome. It measures approximately 158.1 mm wide by 158.1 mm deep by 253.0 mm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

No local support equipment was used during testing.

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

Company	Model	Description	Serial Number	FCC ID
IBM Laptop	T42	Laptop Computer	2373R32	-

EUT INTERFACE PORTS

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

Port		Cable(s)		
From	To	Description	Shielded/Unshielded	Length(m)
EUT - Serial	Remote Laptop	multiconductor	shielded	5.0m
EUT - Power	AC/DC Adapter	multiconductor	shielded	2.0m
EUT - USB	Not connected	-	-	-
AC/DC Adapter	AC Mains	3wire	unshielded	1.5m

Note: The USB port was not connected during testing. The manufacturer stated that this port is not supported and therefore would not normally be connected.

EUT OPERATION

Digital Device / Radio testing - Conducted Emissions: The BT radio was configured to be active, transmitting and hopping across all channels, but not paired. The 900MHz radio was configured to transmit at 915MHz, at the high power setting. All other functions of the EUT was in a normal operating condition.

900MHz FHSS radio - unless otherwise stated, the EUT was configured to continuously transmit a modulated signal at the noted channel. The EUT has two output power states. Unless otherwise noted, all tests were performed at the high power state.

Bluetooth radio - unless otherwise stated, the EUT was configured to continuously transmit a modulated signal at the noted channel. The EUT supports both basic and EDR modes. The 8PSK mode was tested as representative of the QPSK mode, as they have the same frequency envelope and same output power.

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	Registration Numbers		Location
	FCC	Canada	
Chamber 4	211948	2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 7	A2LA accreditation	2845B-7	

ANSI C63.4:2003 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 C63.4:2003.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4:2003. 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 C63.4:2003 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4:2003.

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 C63.4:2003 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. 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 C63.4:2003, 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.

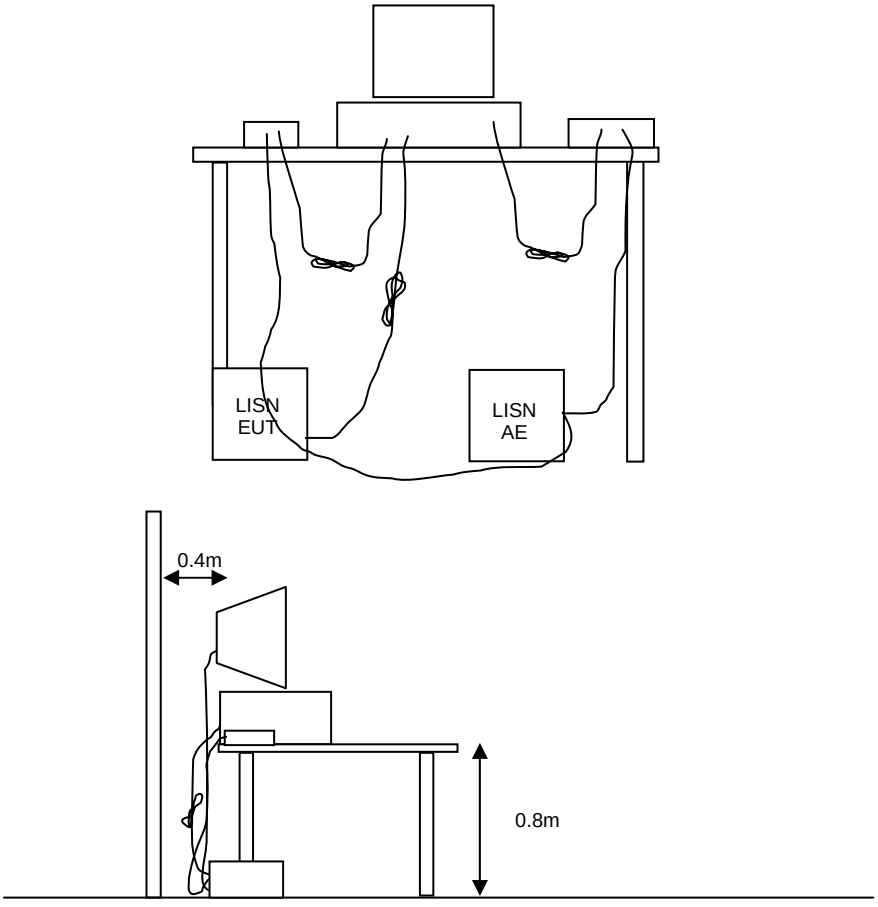


Figure 1 Typical Conducted Emissions Test Configuration

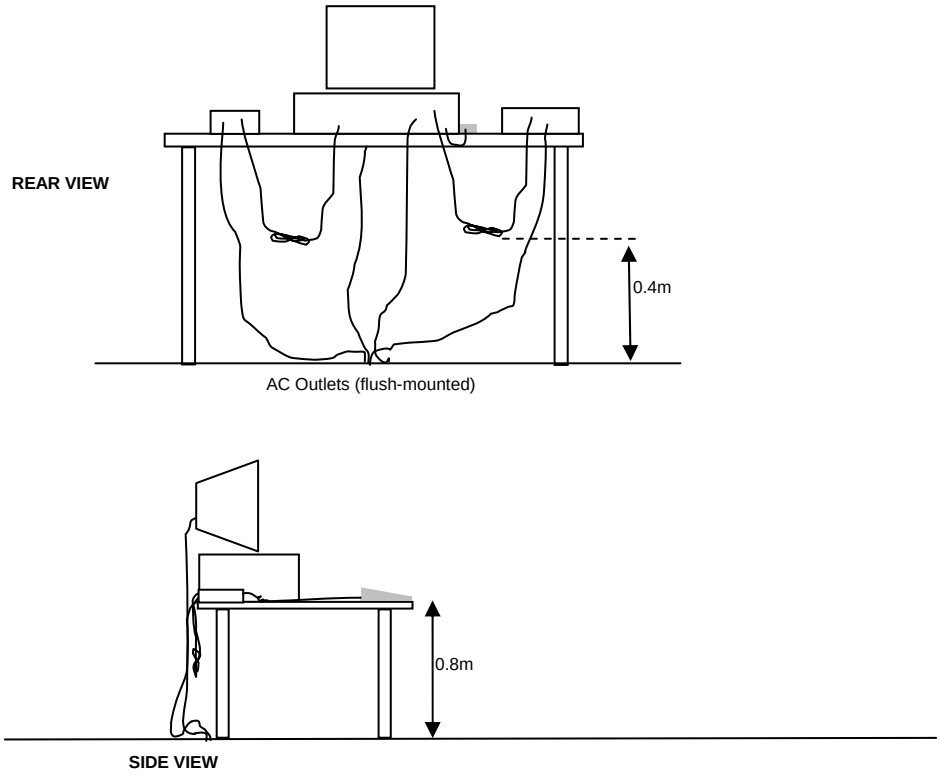
RADIATED EMISSIONS

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.

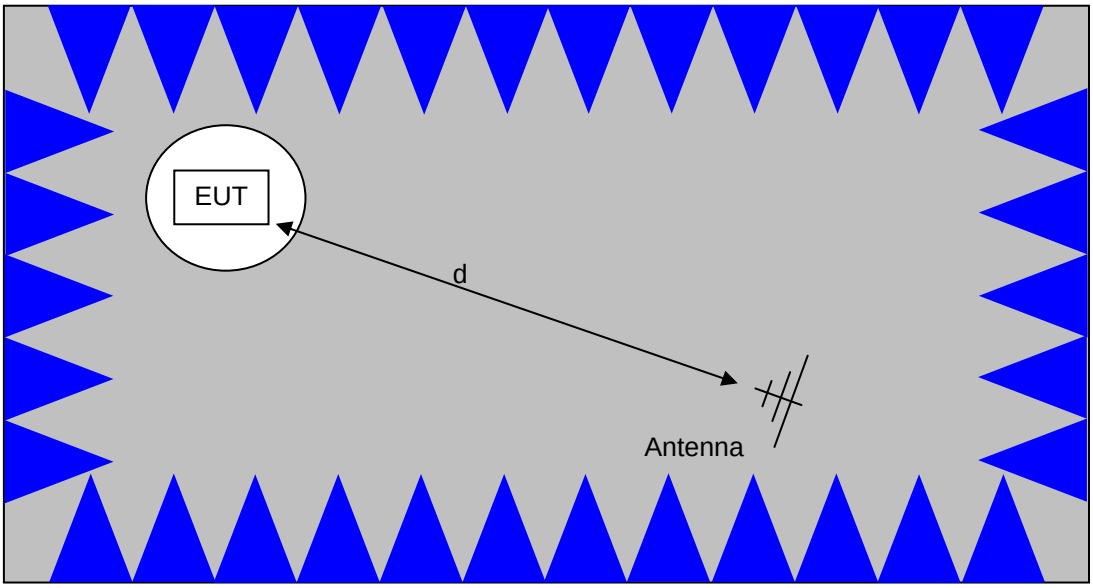
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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.

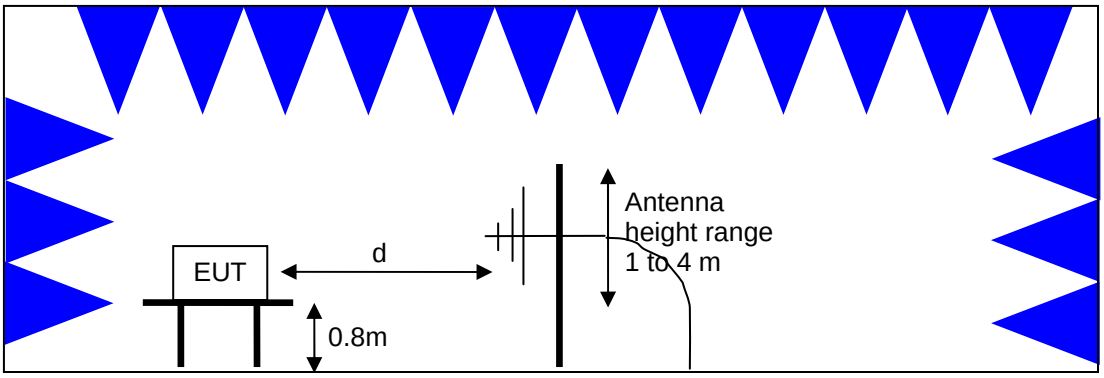


Typical Test Configuration for Radiated Field Strength Measurements



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.

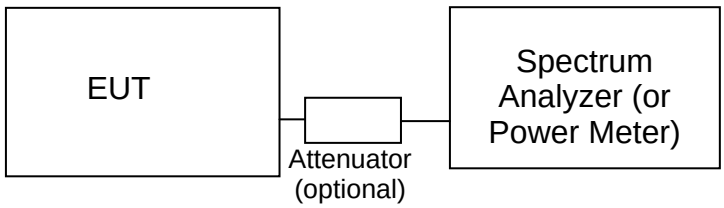
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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 and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.10. When required, the 99% bandwidth is measured using the methods detailed in 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:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

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

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

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)

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:

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

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
Radiated Emissions, 30 - 6,000 MHz, 25-Jan-13				
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	8/23/2014
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/12/2013
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/25/2013
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/23/2013
Com-Power Corp.	Preamplifier, 30-1000 MHz	PA-103A	2359	2/25/2013
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	8/10/2013
Conducted Emissions - AC Power Ports, 25-Jan-13				
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	5/15/2013
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/12/2013
Com-Power	9KHz-30MHz, 50uH, 15Aac, 10Adc, max	LI-215A	2671	5/25/2013
Radiated Emissions, 30 - 26,500 MHz, 28-Jan-13				
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	11/9/2013
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	8/23/2014
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/14/2013
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	6/4/2014
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/2/2013
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	5/21/2013
Radiated Spurious Emissions, 1000 - 25,000 MHz, 29-Jan-13				
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	11/9/2013
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	8/23/2014
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/14/2013
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	6/4/2014
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/2/2013
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	5/21/2013
Com-Power Corp.	Preamplifier, 30-1000 MHz	PAM-103	2380	11/9/2013
Radio Antenna Port (Power and Spurious Emissions), 30-Jan-13				
Agilent	50GHz PSA Spectrum Analyzer	E4448A-M27	199979	11/15/2013
Radio Antenna Port (Power and Spurious Emissions), 07-Feb-13				
Agilent	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	2/23/2013
Rx Radiated Spurious Emissions, 30 - 1,000 MHz, 07-Feb-13				
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/12/2013
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/25/2013
Com-Power Corp.	Preamplifier, 30-1000 MHz	PA-103A	2359	2/25/2013

Appendix B Test Data

T90831 Pages 25 – 75

Client:	Topcon Positioning Systems	Job Number:	J90335
Product	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Emissions Standard(s):	FCC 15.247	Class:	-
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Topcon Positioning Systems

Product

GR-5

Date of Last Test: 2/7/2013

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	-

Conducted Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

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

Date of Test: 1/25/2013
Test Engineer: M. Birgani
Test Location: Fremont Chamber #4
Config. Used: 1
Config Change: -
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 15-18 °C
Rel. Humidity: 30-40 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	Class B	PASS	36.5dBµV @ 2.86MHz (-9.5dB)

Modifications Made During Testing

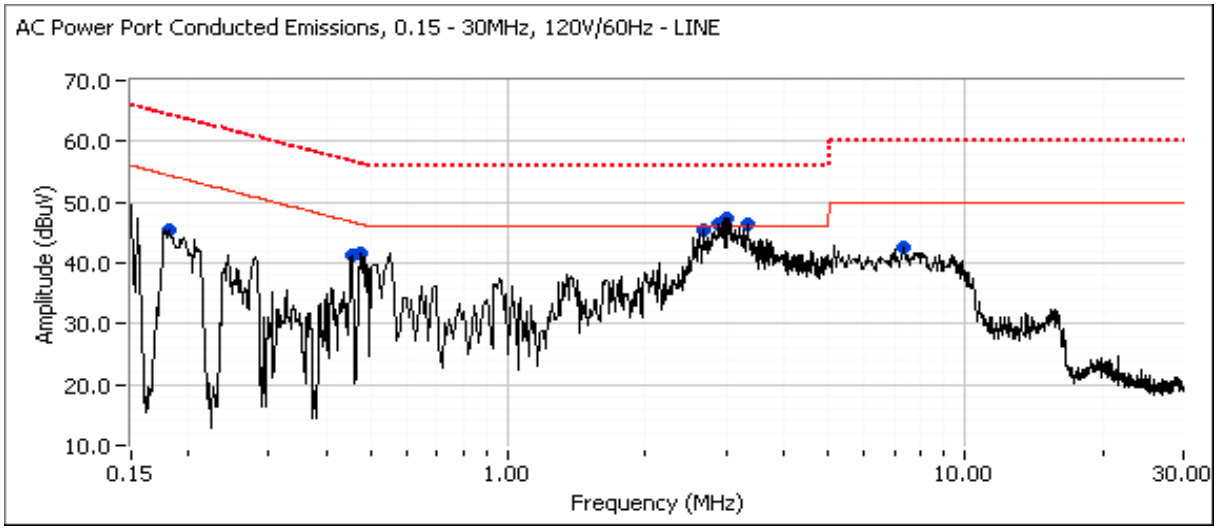
No modifications were made to the EUT during testing

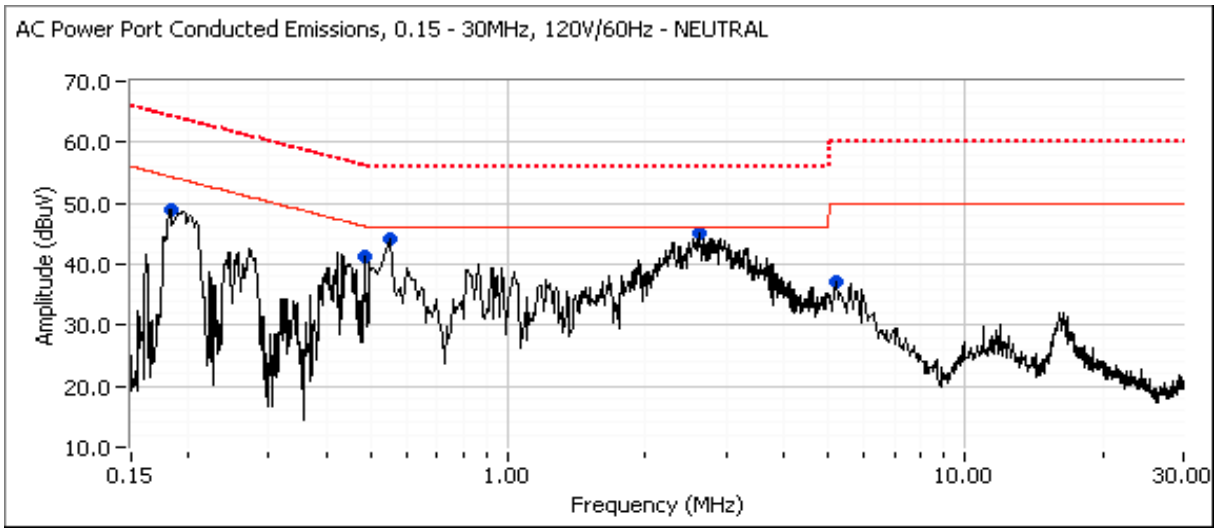
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	-

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	-

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	Class A		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
2.993	47.5	Line	46.0	1.5	Peak	
2.860	46.5	Line	46.0	0.5	Peak	
3.343	46.3	Line	46.0	0.3	Peak	
2.678	45.4	Line	46.0	-0.6	Peak	
2.599	45.1	Neutral	46.0	-0.9	Peak	
0.558	44.1	Neutral	46.0	-1.9	Peak	
0.484	41.4	Neutral	46.2	-4.8	Peak	
0.476	41.5	Line	46.4	-4.9	Peak	
0.185	48.8	Neutral	54.3	-5.5	Peak	
0.459	41.2	Line	46.8	-5.6	Peak	
7.312	42.5	Line	50.0	-7.5	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	Class A		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
2.860	36.5	Line	46.0	-9.5	AVG	AVG (0.10s)
2.993	45.0	Line	56.0	-11.0	QP	QP (1.00s)
2.993	33.7	Line	46.0	-12.3	AVG	AVG (0.10s)
2.678	33.4	Line	46.0	-12.6	AVG	AVG (0.10s)
3.343	43.4	Line	56.0	-12.6	QP	QP (1.00s)
3.343	31.9	Line	46.0	-14.1	AVG	AVG (0.10s)
2.860	41.4	Line	56.0	-14.6	QP	QP (1.00s)
2.678	41.1	Line	56.0	-14.9	QP	QP (1.00s)
0.558	40.8	Neutral	56.0	-15.2	QP	QP (1.00s)
2.599	40.3	Neutral	56.0	-15.7	QP	QP (1.00s)
2.599	30.2	Neutral	46.0	-15.8	AVG	AVG (0.10s)
0.476	39.8	Line	56.4	-16.6	QP	QP (1.00s)
0.459	39.8	Line	56.7	-16.9	QP	QP (1.00s)
0.484	38.9	Neutral	56.3	-17.4	QP	QP (1.00s)
0.185	44.6	Neutral	64.3	-19.7	QP	QP (1.00s)
0.558	25.4	Neutral	46.0	-20.6	AVG	AVG (0.10s)
0.484	25.2	Neutral	46.3	-21.1	AVG	AVG (0.10s)
7.312	28.6	Line	50.0	-21.4	AVG	AVG (0.10s)
0.476	23.6	Line	46.4	-22.8	AVG	AVG (0.10s)
7.312	37.1	Line	60.0	-22.9	QP	QP (1.00s)
0.185	30.3	Neutral	54.3	-24.0	AVG	AVG (0.10s)
0.459	21.3	Line	46.7	-25.4	AVG	AVG (0.10s)

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

RSS 210 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

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

General Test Configuration

The EUT was located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

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

Ambient Conditions:

Temperature: 17-20 °C

Rel. Humidity: 30-40 %

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.

Notes:

During the spurious emissions testing, near field scans were performed 18-26GHz. No emissions were observed.

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1	Basic	2402	Max		Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	42.5 dBµV/m @ 2352.2 MHz (-11.5 dB)
			Max		Band Edge (2400 MHz)	FCC Part 15.209 / 15.247(c)	-43.9 dBc @ 2400.006 MHz
			Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit
	Basic	2441	Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit
	Basic	2480	Max		Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	50.5 dBµV/m @ 2484.4 MHz (-3.5 dB)
			Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit
2	EDR	2402	Max		Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	42.8 dBµV/m @ 2361.3 MHz (-11.2 dB)
			Max		Band Edge (2400 MHz)	FCC Part 15.209 / 15.247(c)	-47.6 dBc @ 2400 MHz
			Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit
	EDR	2441	Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit
	EDR	2480	Max		Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	50.0 dBµV/m @ 2484.3 MHz (-4.0 dB)
			Max		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	more than 10dB below the limit

Mode	on time	cycle time	off time	duty cycle	correction
	(ms)	(ms)	(ms)		(dB)
Basic	2.94	3.75	0.81	78.4%	-2.1
EDR	0.42	1.25	0.83	33.6%	-9.5

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

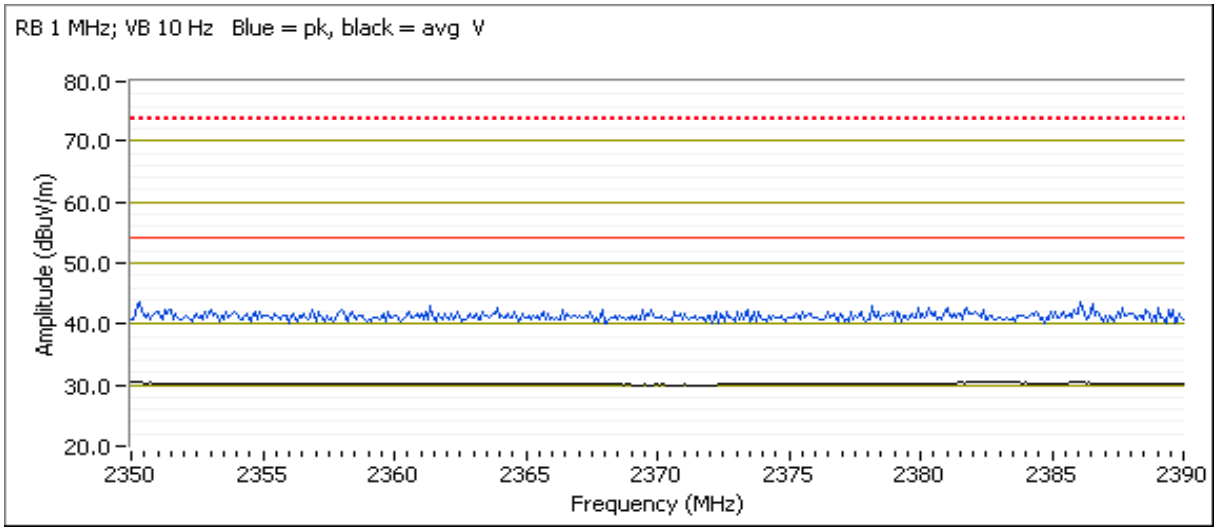
Run #1: Radiated Spurious Emissions, 30 - 25000 MHz. Operating Mode: Basic

Date of Test: 1/28-29/2013 Test Location: Chamber #7
Test Engineer: M. Birgani, J. Caizzi

Run #1a: Low Channel @ 2402 MHz

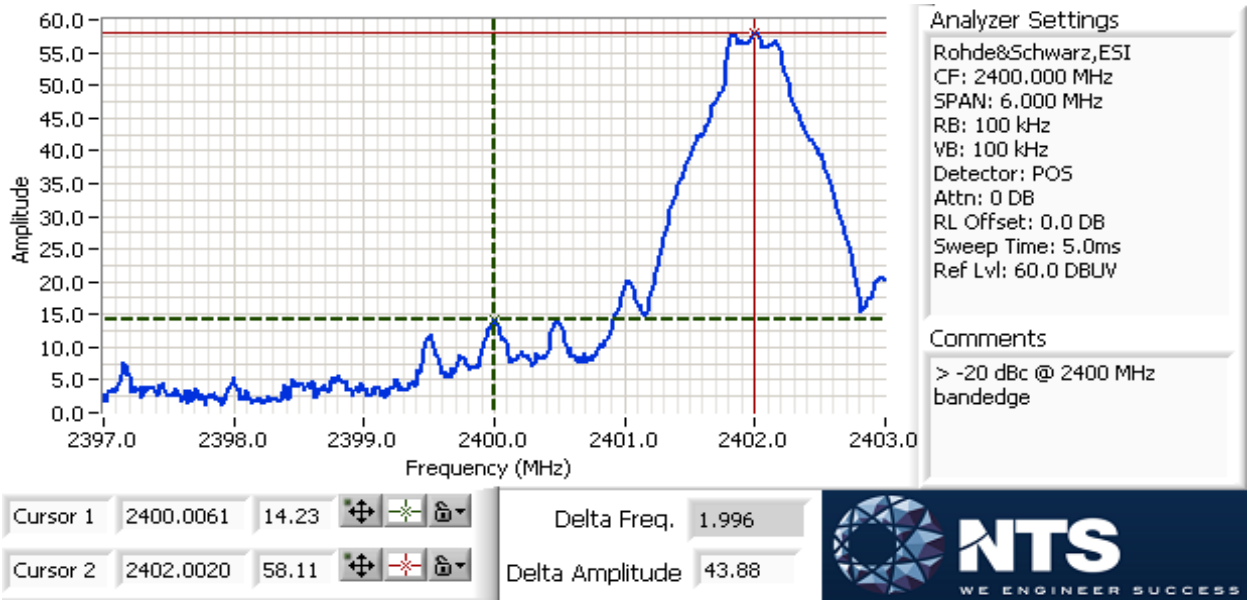
Band Edge Signal Field Strength - Direct measurement of field strength
Restricted Bandedge at 2390MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2352.160	42.5	V	54.0	-11.5	PK	360	1.61	Below noise floor. Note 2.
2352.160	42.5	V	74.0	-31.5	PK	360	1.61	Below noise floor.
2350.320	42.2	H	54.0	-11.8	PK	0	1.00	Below noise floor. Note 2.
2350.320	42.2	H	74.0	-31.8	PK	0	1.00	Below noise floor.



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Bandedge at 2400MHz (-20dBc using 100k/100k)



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	
Note 3								

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 and measured in 100kHz.
Note 2:	Peak reading vs average limit. No duty cycle correction applied.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor.

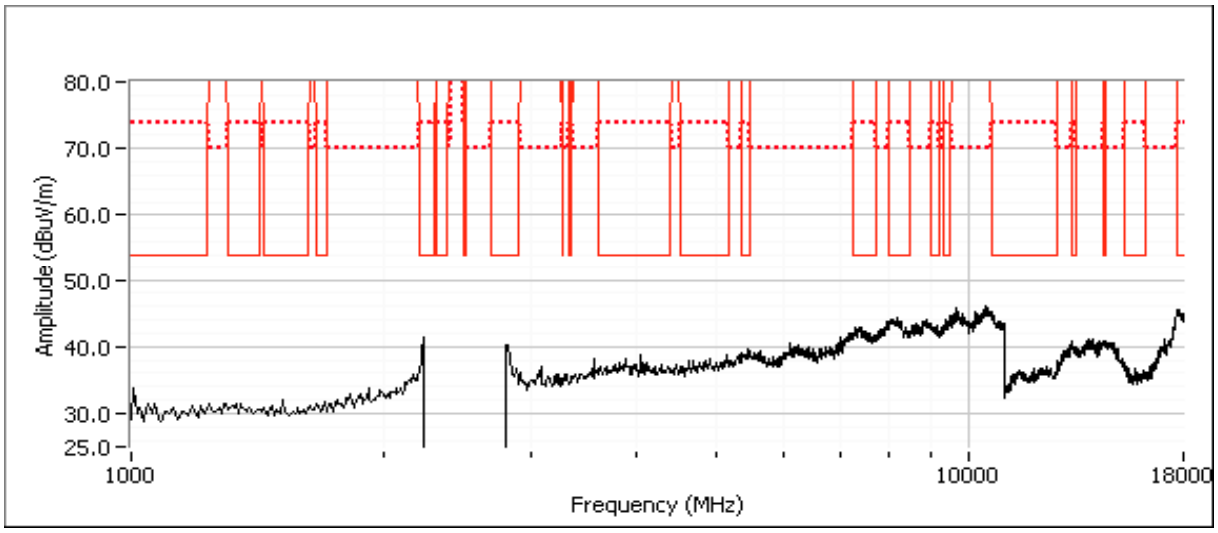
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1b: Center Channel @ 2441 MHz

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	
No signal was found from transmitter.								

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 and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor, 18-25 GHz.

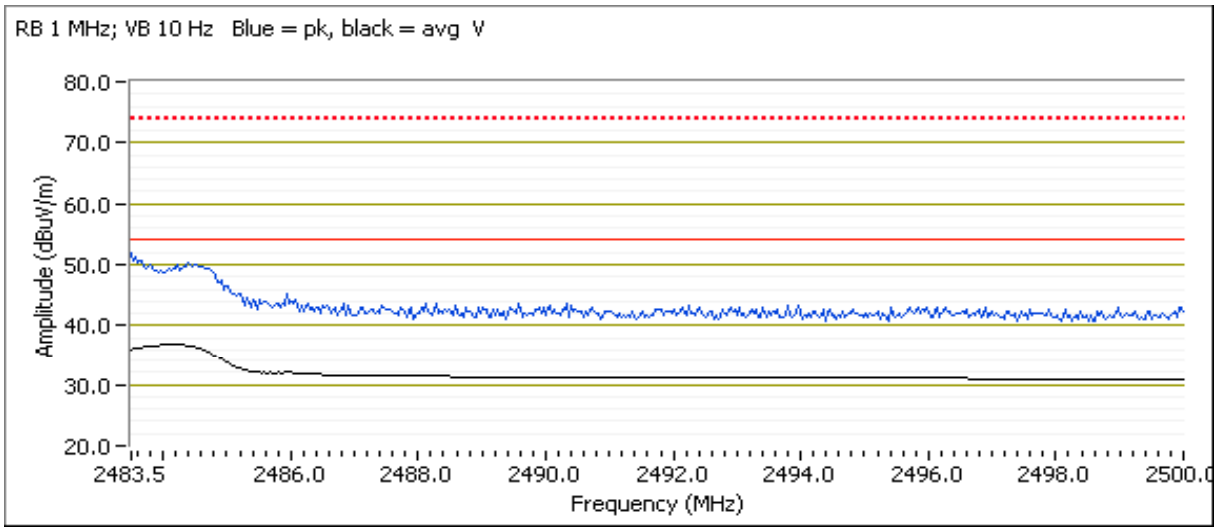


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1c: High Channel @ 2480 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.390	50.5	V	54.0	-3.5	PK	355	1.04	Note 2
2484.390	50.5	V	74.0	-23.5	PK	355	1.04	
2483.800	45.5	H	54.0	-8.5	PK	250	1.16	Note 2
2483.800	45.5	H	74.0	-28.5	PK	250	1.16	



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	
Note 3								

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 and measured in 100kHz.
Note 2:	Peak reading vs average limit. No duty cycle correction applied.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor.

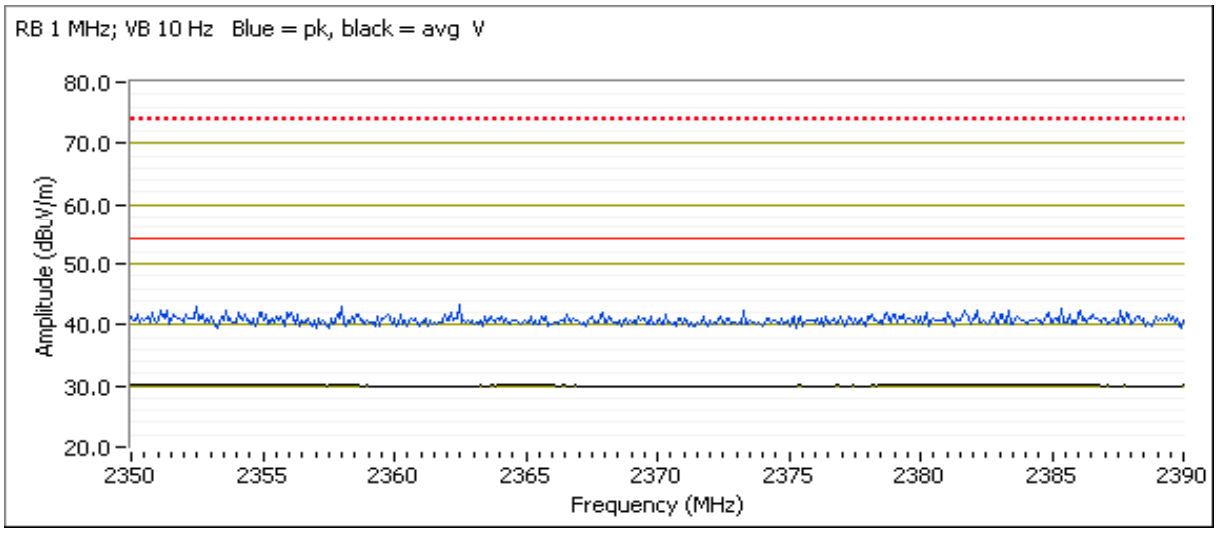
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #2: Radiated Spurious Emissions, 30 - 25000 MHz. Operating Mode: EDR

Date of Test: 1/28-29/2013 Test Location: Chamber #7
Test Engineer: M. Birgani, J. Caizzi

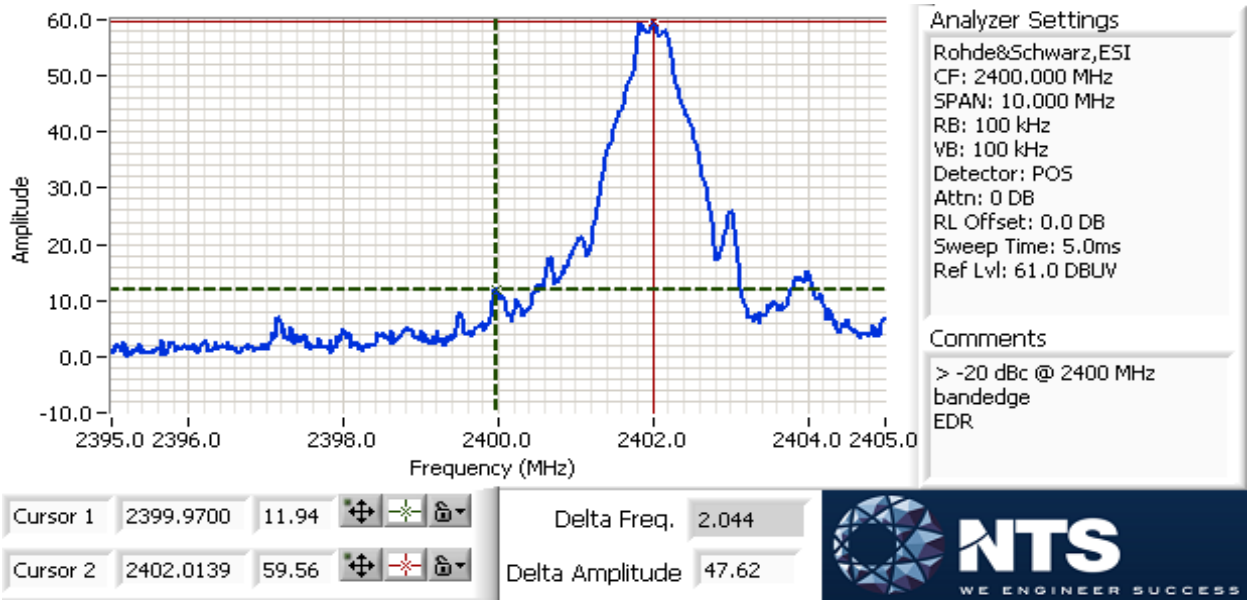
Run #2a: Low Channel @ 2402 MHz
Band Edge Signal Field Strength - Direct measurement of field strength
Restricted Bandedge at 2390MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2361.300	42.8	V	54.0	-11.2	PK	0	2.01	Below noise floor. Note 2.
2361.300	42.8	V	74.0	-31.2	PK	0	2.01	Below noise floor.



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Bandedge at 2400MHz (-20dBc using 100k/100k)



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	
Note 3								

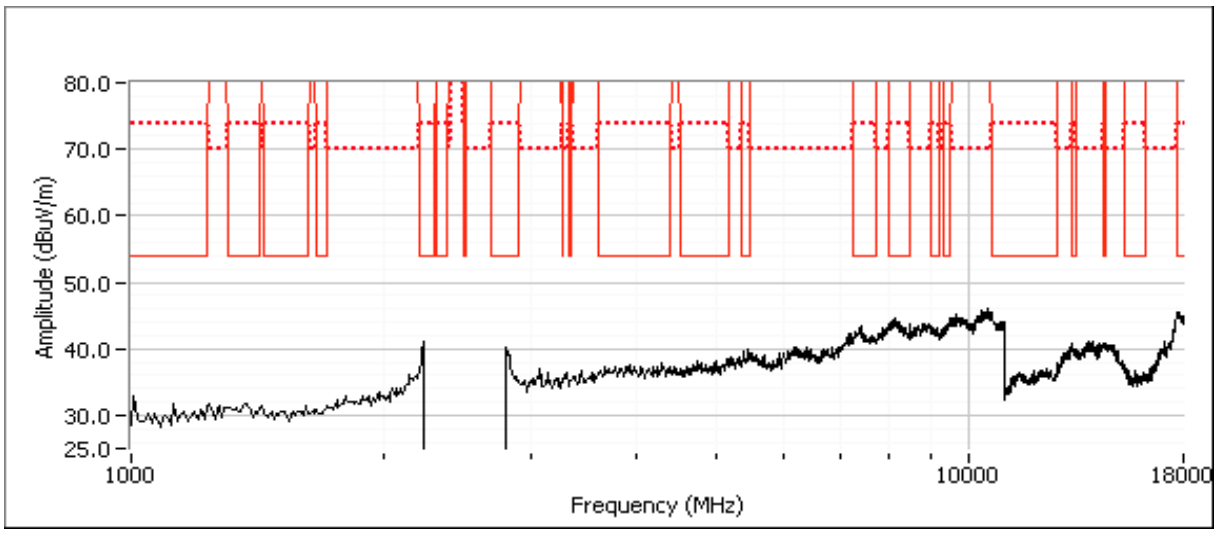
Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental and measured in 100kHz.
Note 2:	Peak reading vs average limit. No duty cycle correction applied.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor.

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #2b: Center Channel @ 2441 MHz

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	
No signal was found from transmitter.								



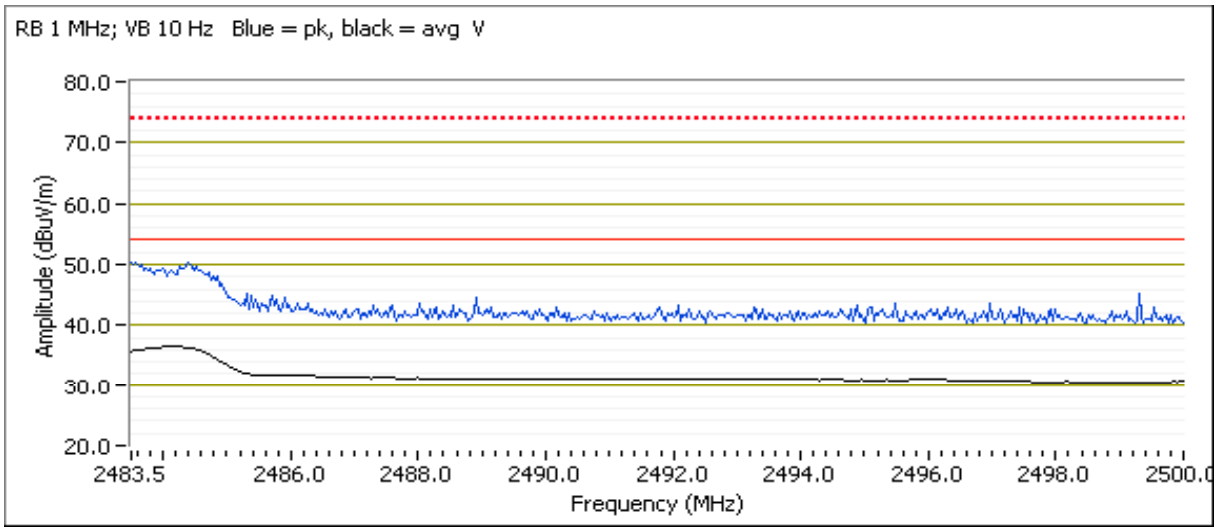
Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor, 18-25 GHz.

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #2c: High Channel @ 2480 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.290	50.0	V	54.0	-4.0	PK	350	1.04	Note 2
2484.290	50.0	V	74.0	-24.0	PK	350	1.04	

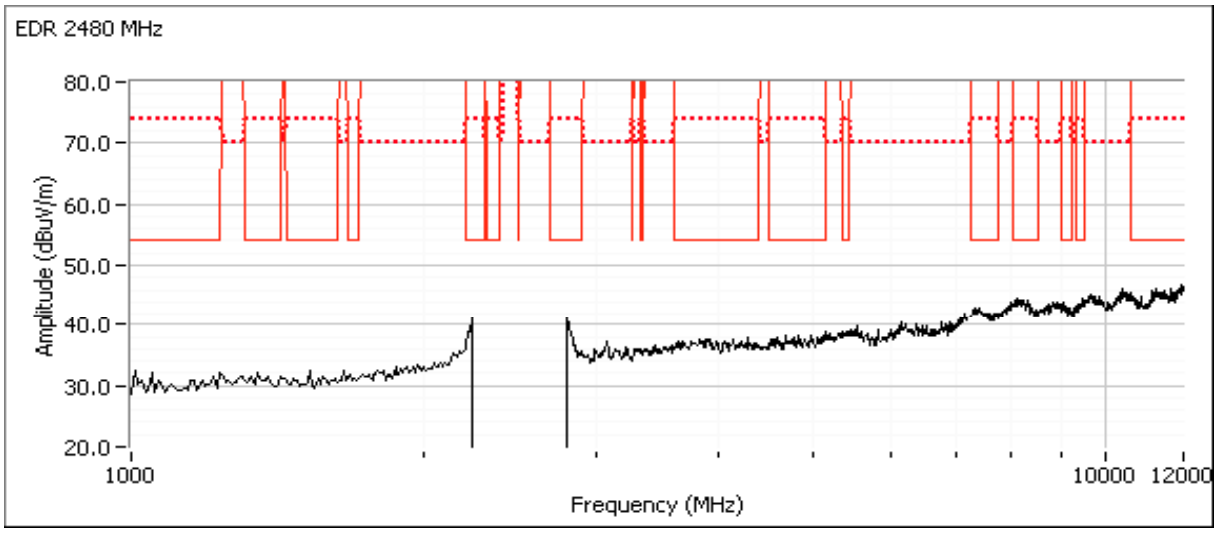


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

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	
No signal was found from transmitter.								

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 and measured in 100kHz.
Note 2:	Peak reading vs average limit. No duty cycle correction applied.
Note 3:	Near field scan (about 30 cm distance) showed no emissions above the measurement noise floor, 12-18 GHz.



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

FCC 15.247 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

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 °C

Rel. Humidity: 35 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
3	30 - 10000 MHz - Transmitter Conducted Spurious Emissions	FCC Part 15.247(c)	Pass	All emissions < -20 dBc.
4	Output Power	15.247(b)	Pass	1.9 dBm (.00154 W)
5	20dB Bandwidth	15.247(a)	Pass	1255 kHz
5	99% bandwidth	15.247(a)	-	1163 kHz
5	Channel Occupancy	15.247(a)	Pass	128 ms
5	Number of Channels	15.247(a)	Pass	79

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.

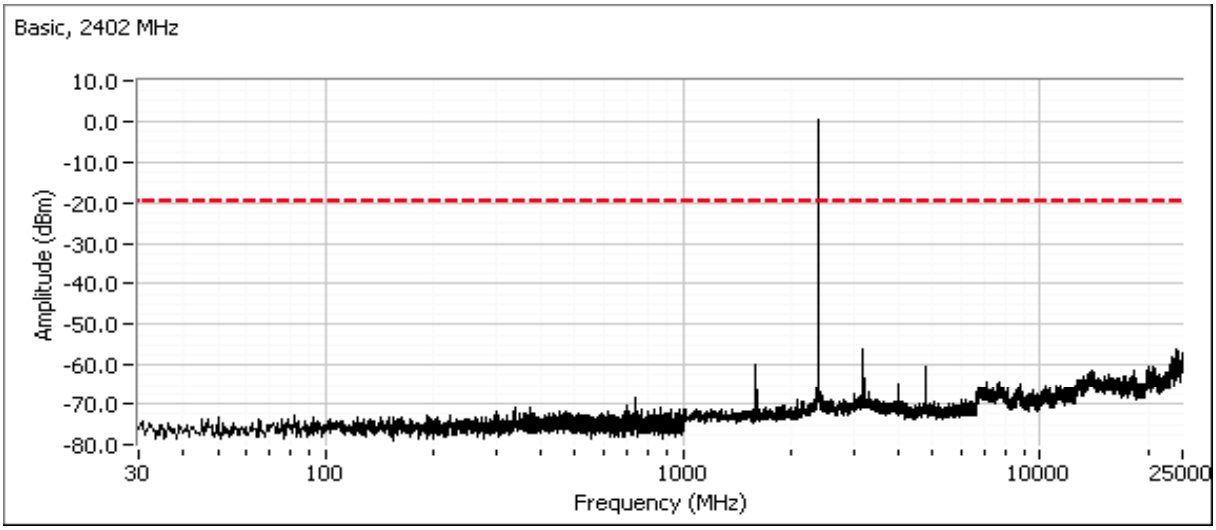
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

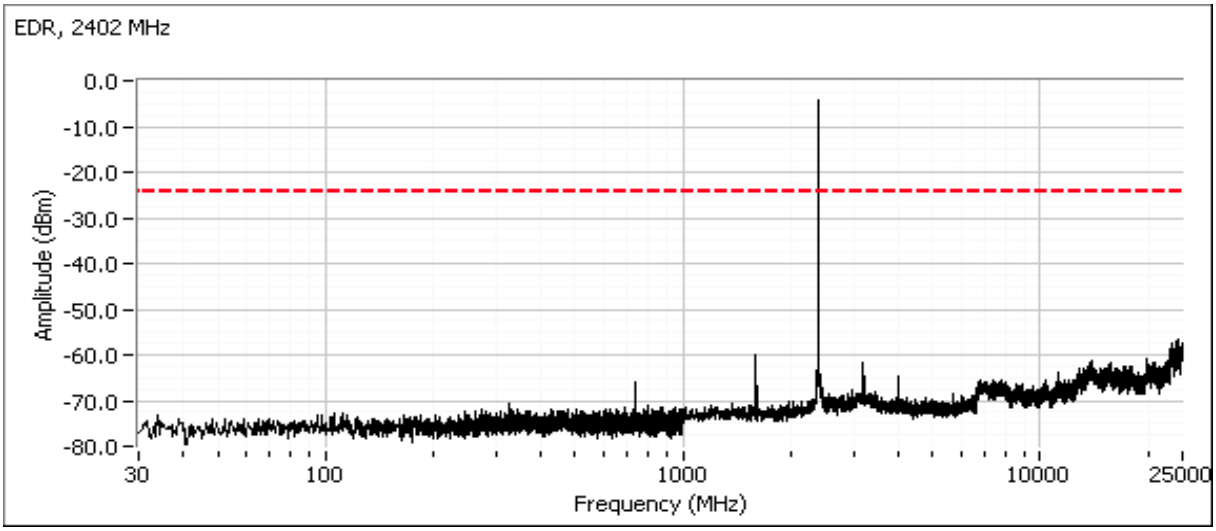
Run #3: Antenna Conducted Spurious Emissions, 30 - 25,000 MHz..

Date of Test: 2/7/2013 Test Location: Lab 4A
Test Engineer: John Caizzi

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.

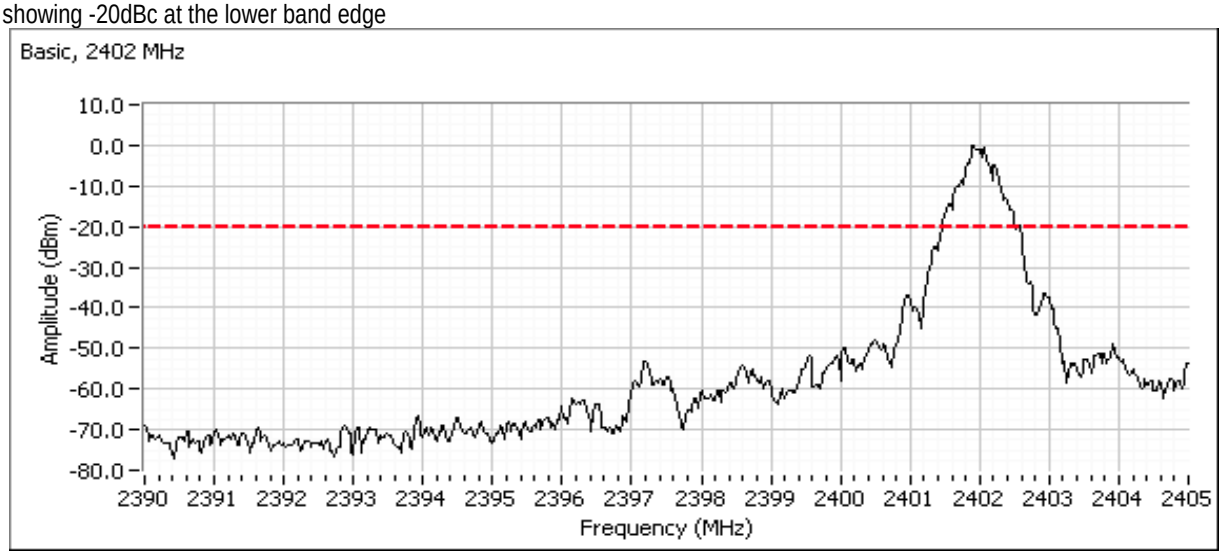
Low channel

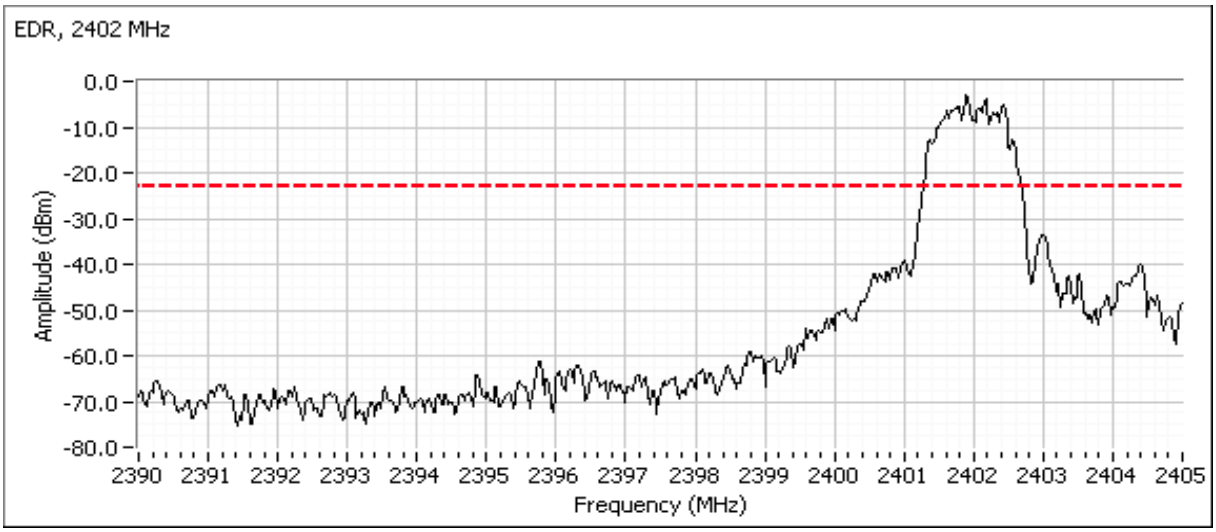




Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

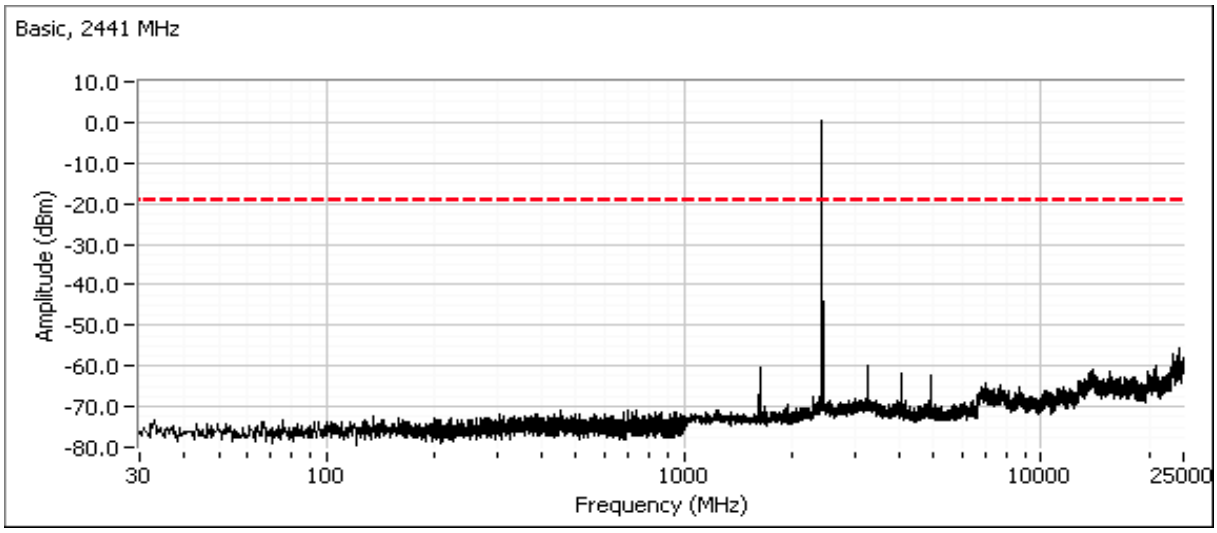
Plot showing -20dBc at the lower band edge

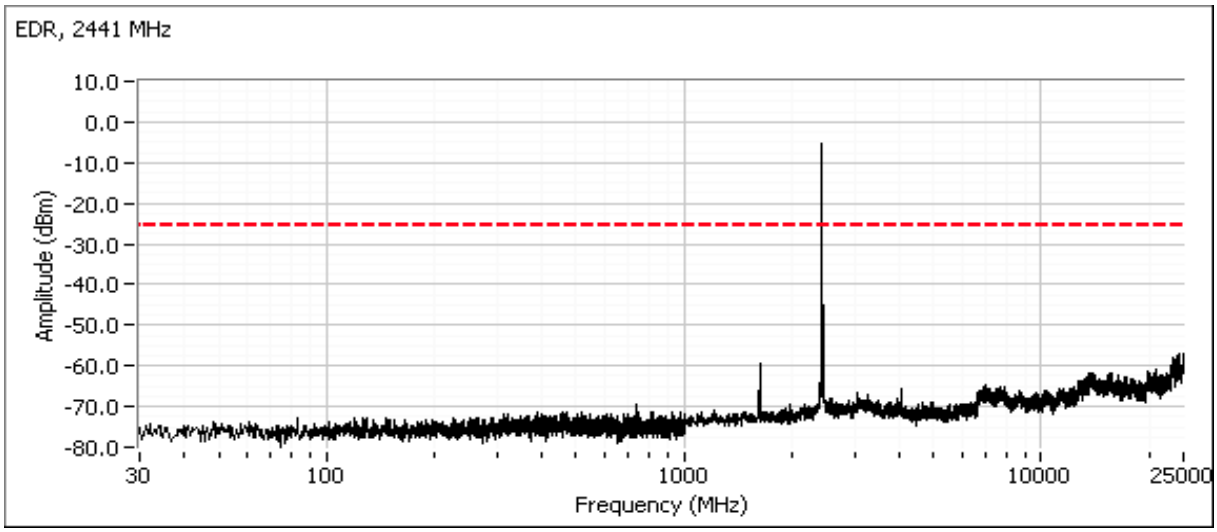




Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

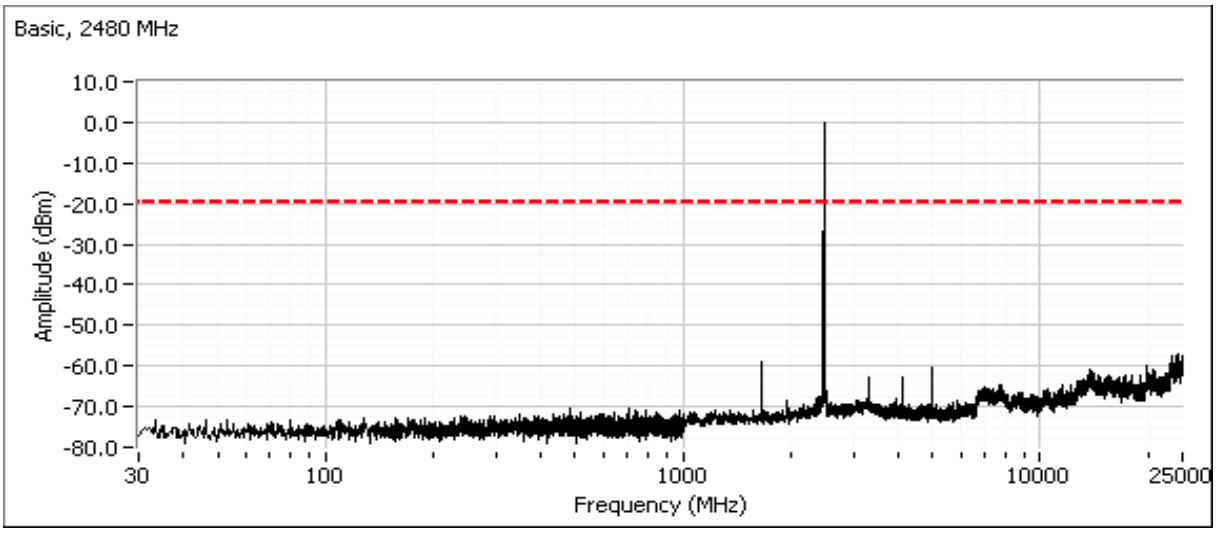
Center channel

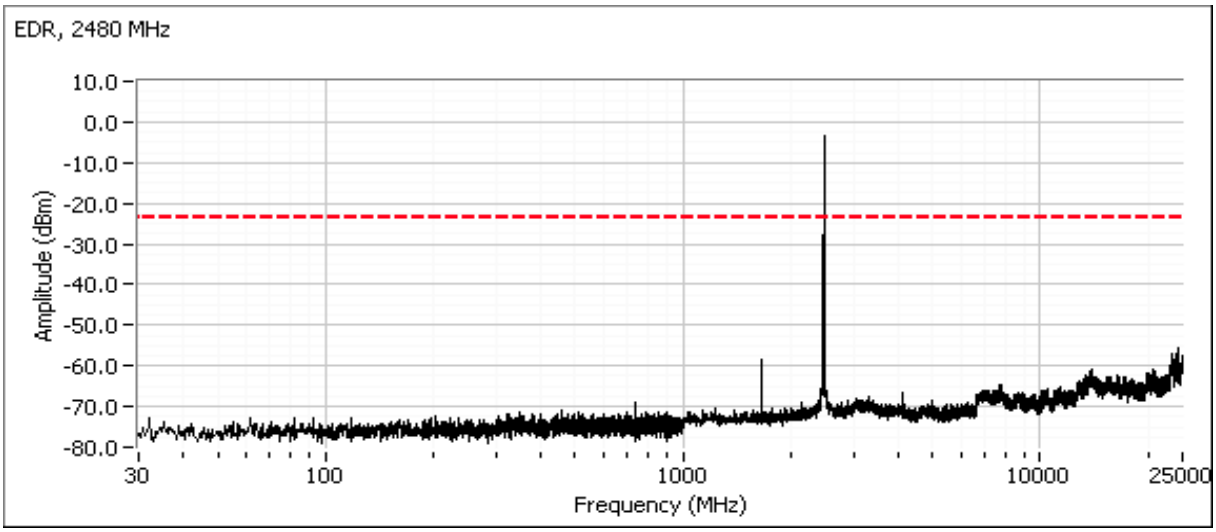




Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

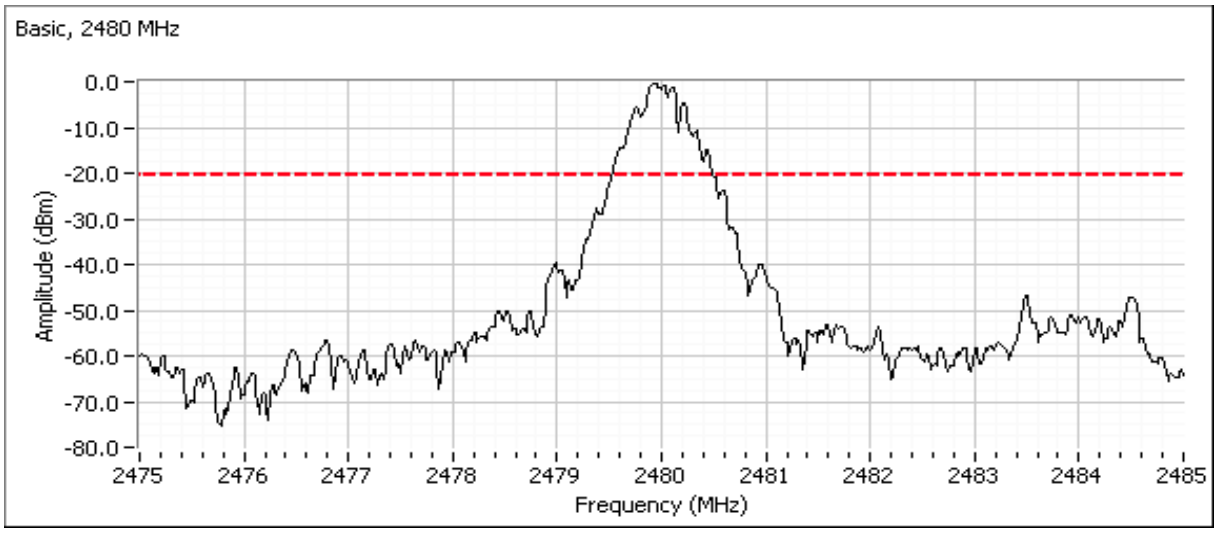
High channel

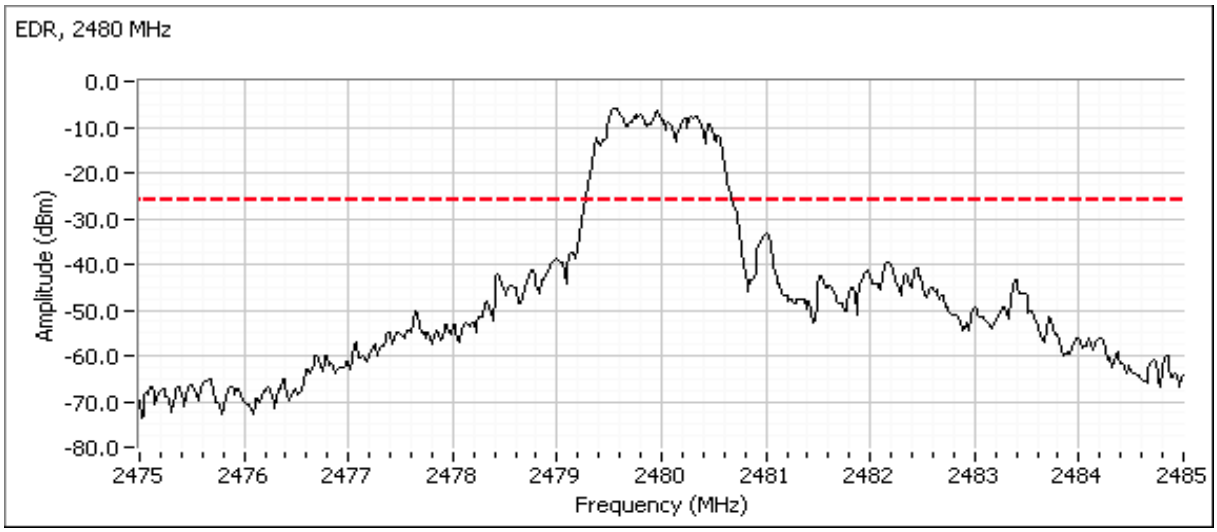




Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Plot showing -20dBc at the upper band edge



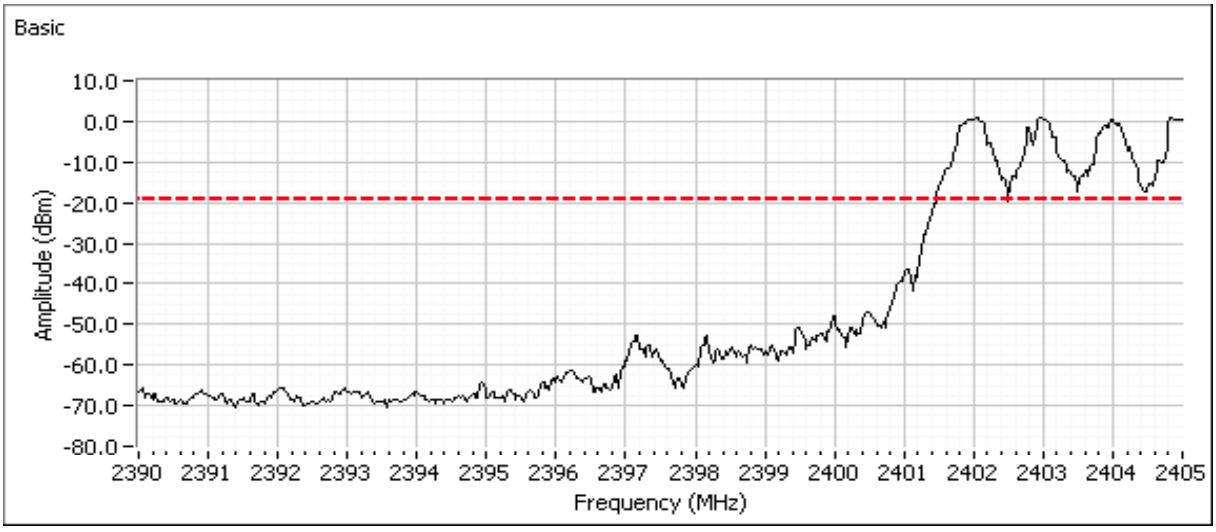


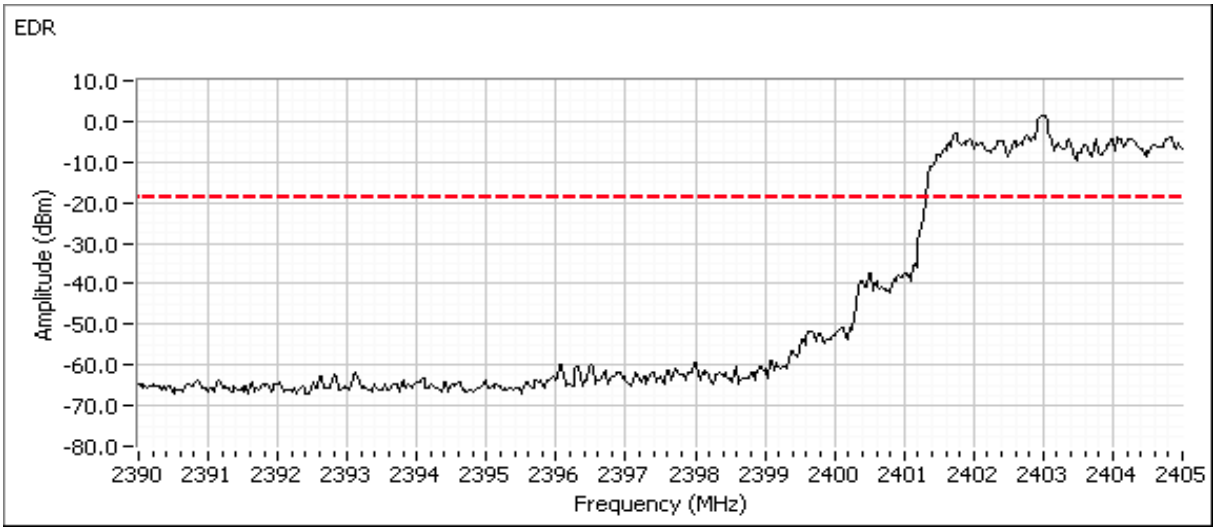
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

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

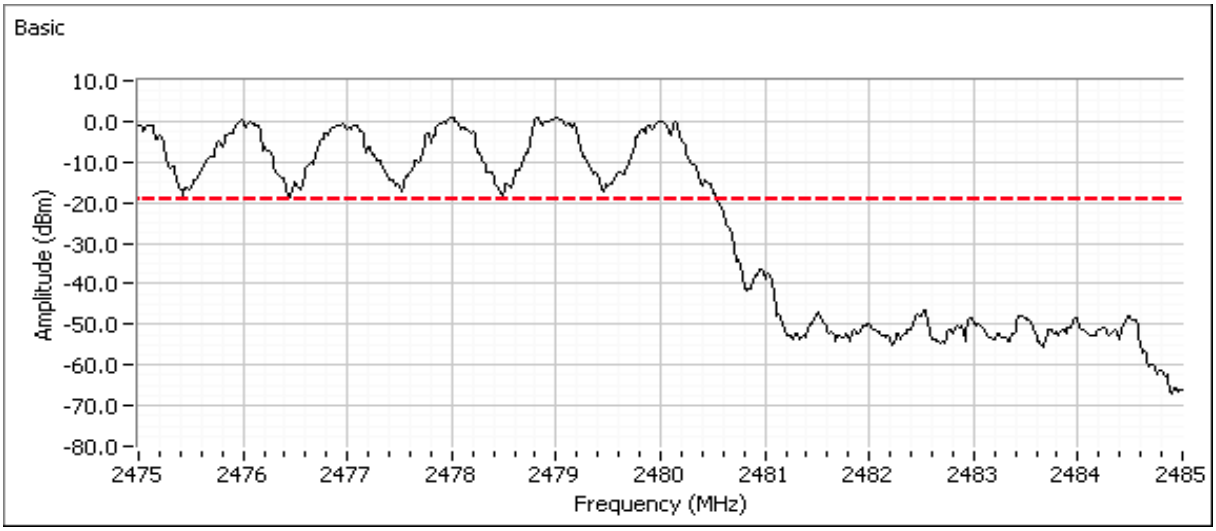


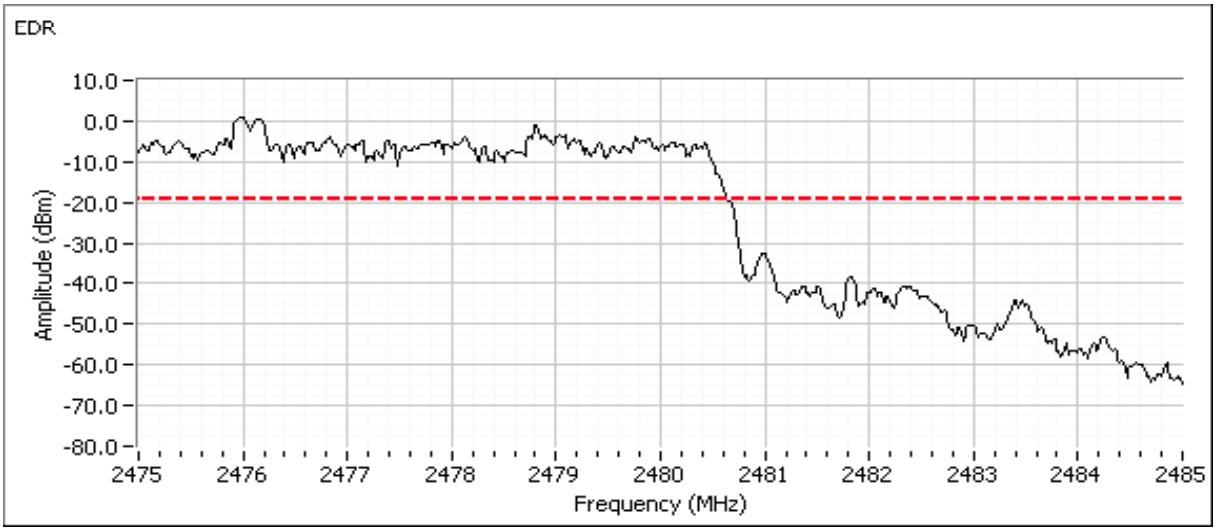


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

High channel, hopping enabled

Plot showing -20dBc at the upper band edge





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #4: Output Power

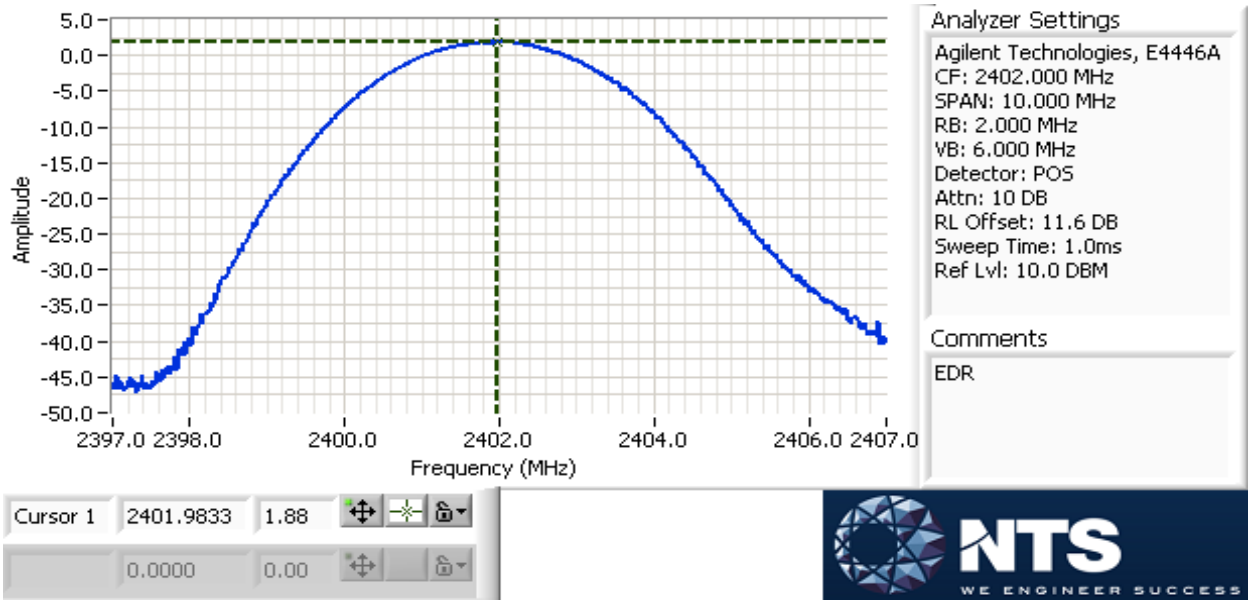
Date of Test: 2/7/2013
Test Engineer: John Caizzi
Test Location: Lab 4A

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Maximum antenna gain: -4.0 dBi

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)	EIRP (mW)
Basic	2402	2MHz	1.6	0.00144	0.57
Basic	2441	2MHz	1.2	0.00131	0.52
Basic	2480	2MHz	1.1	0.00129	0.51
EDR	2402	2MHz	1.9	0.00154	0.61
EDR	2441	2MHz	1.4	0.00139	0.55
EDR	2480	2MHz	1.3	0.00134	0.53

Peak power measured with RBW > EBW, VBW=3xRBW, Peak detector, max hold



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

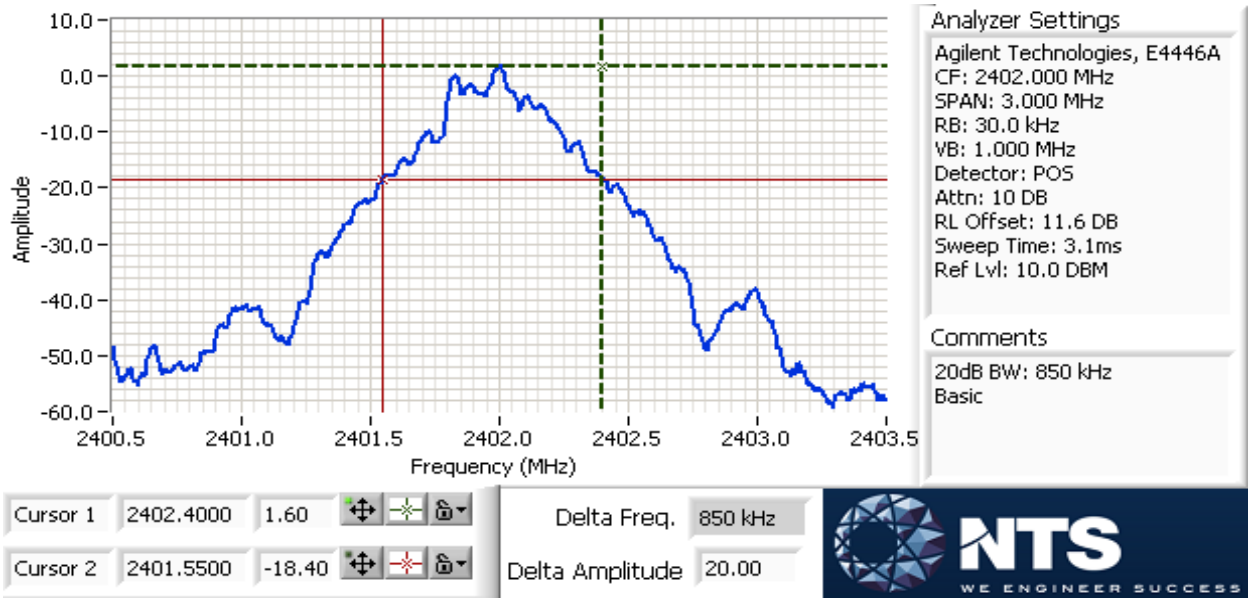
Run #5: Bandwidth, Channel Occupancy, Spacing and Number of Channels

Date of Test: 2/7/2013 Test Location: Lab 4A

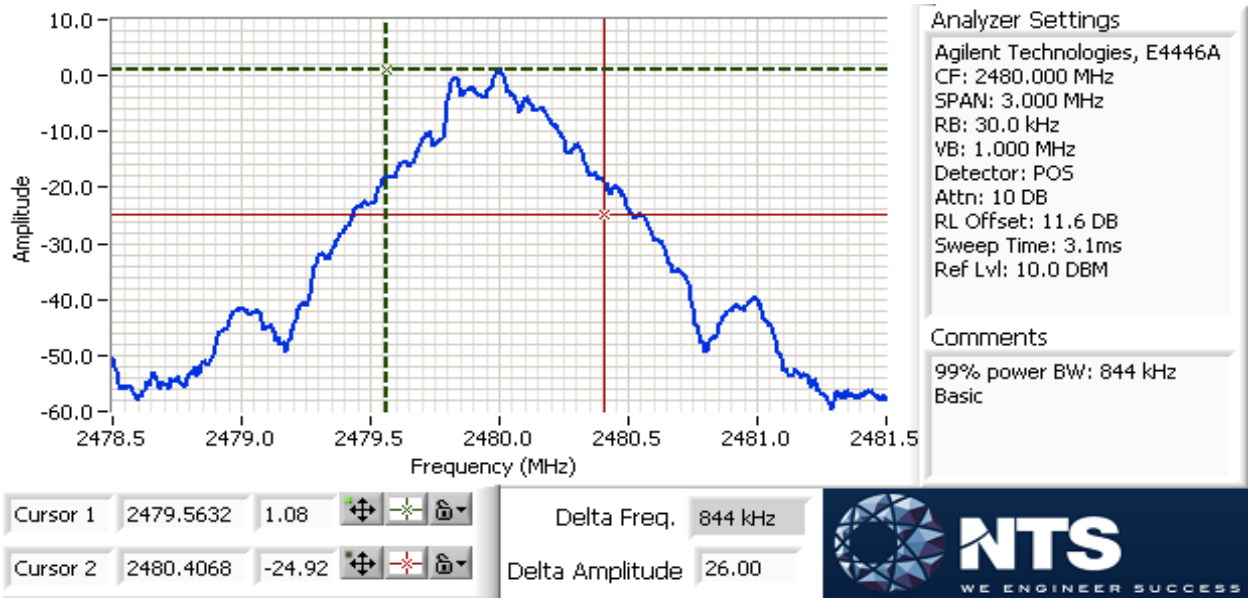
Test Engineer: John Caizzi

Channel	Frequency (MHz)	Resolution Bandwidth	20dB Bandwidth (kHz)	Resolution Bandwidth	99% Bandwidth (kHz)
Low - Basic	2402	30kHz	850	30kHz	839
Mid - Basic	2441	30kHz	860	30kHz	839
High - Basic	2480	30kHz	860	30kHz	844
Low - EDR	2402	30kHz	1255	30kHz	1163
Mid - EDR	2441	30kHz	1255	30kHz	1158
High - EDR	2480	30kHz	1255	30kHz	1158

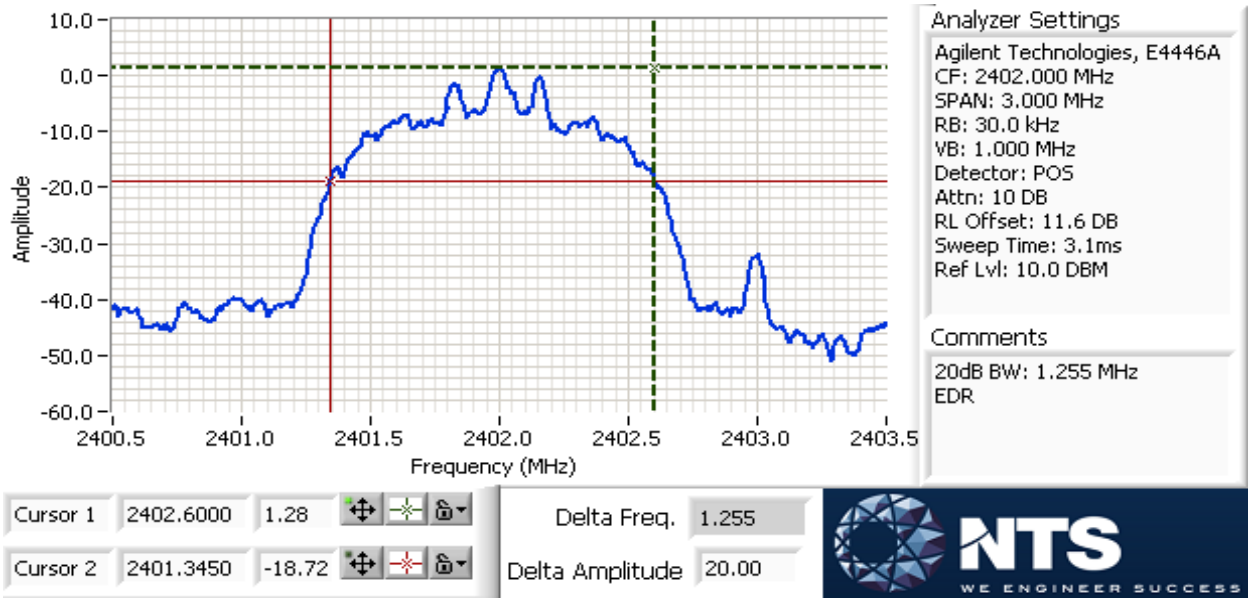
Note 1:	20dB bandwidth measured using RB = 30kHz, VB = 1MHz (VB > RB)
Note 2:	99% bandwidth measured using RB = 30kHz, VB = 1 MHz (VB >=3RB)

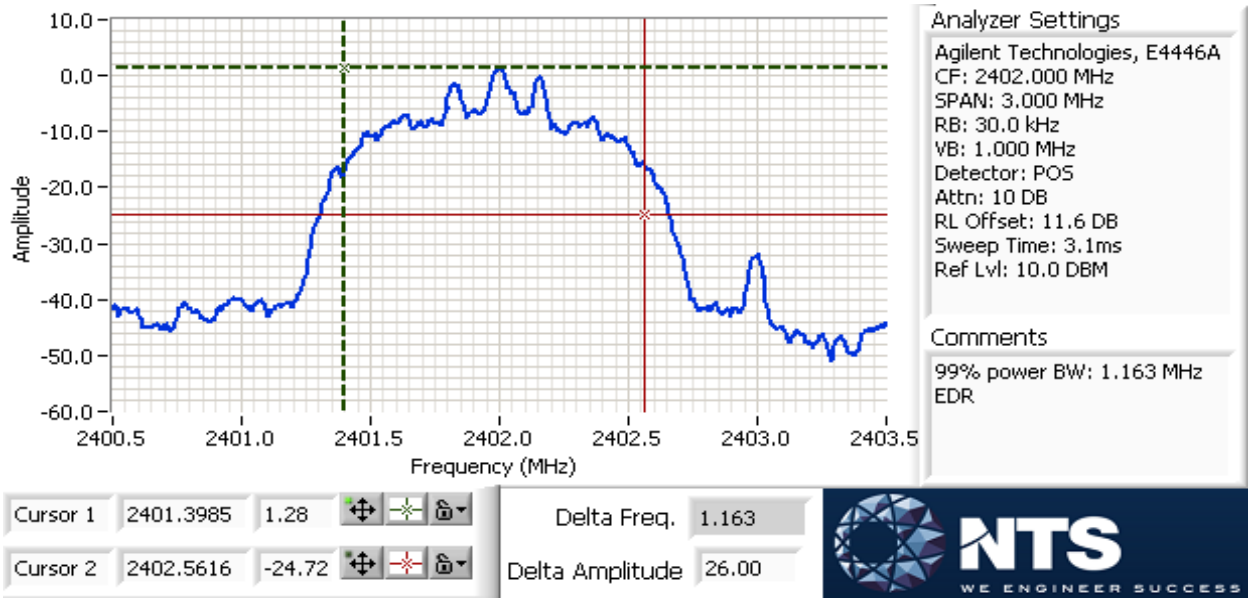


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



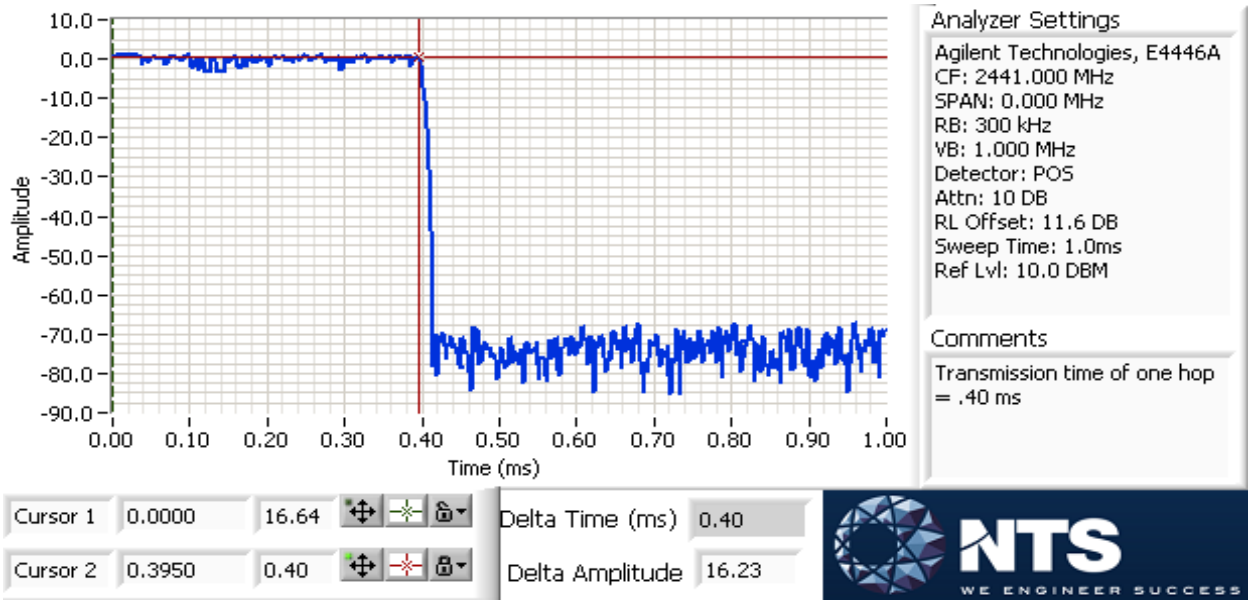


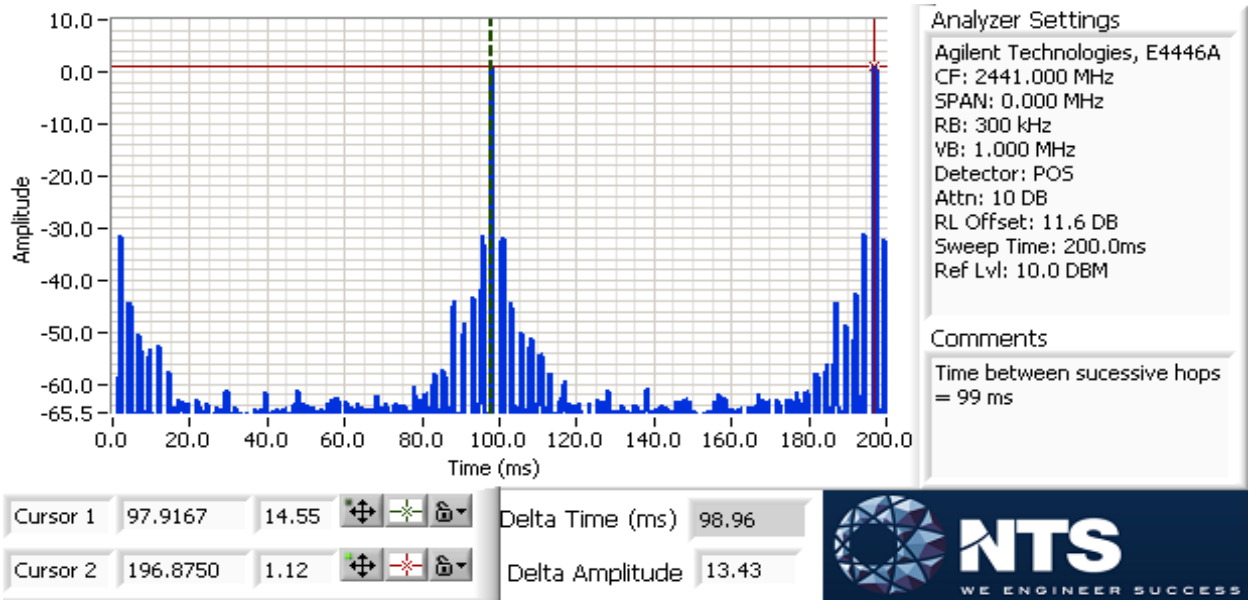
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. (Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.)
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 a period of 0.4 times the number of channels, N (i.e. 0.4N divided by the time between successive hops, rounded up to the closest integer), unless the time between successive hops exceeds 0.4N, in which case the channel dwell time is the transmit time on a channel.

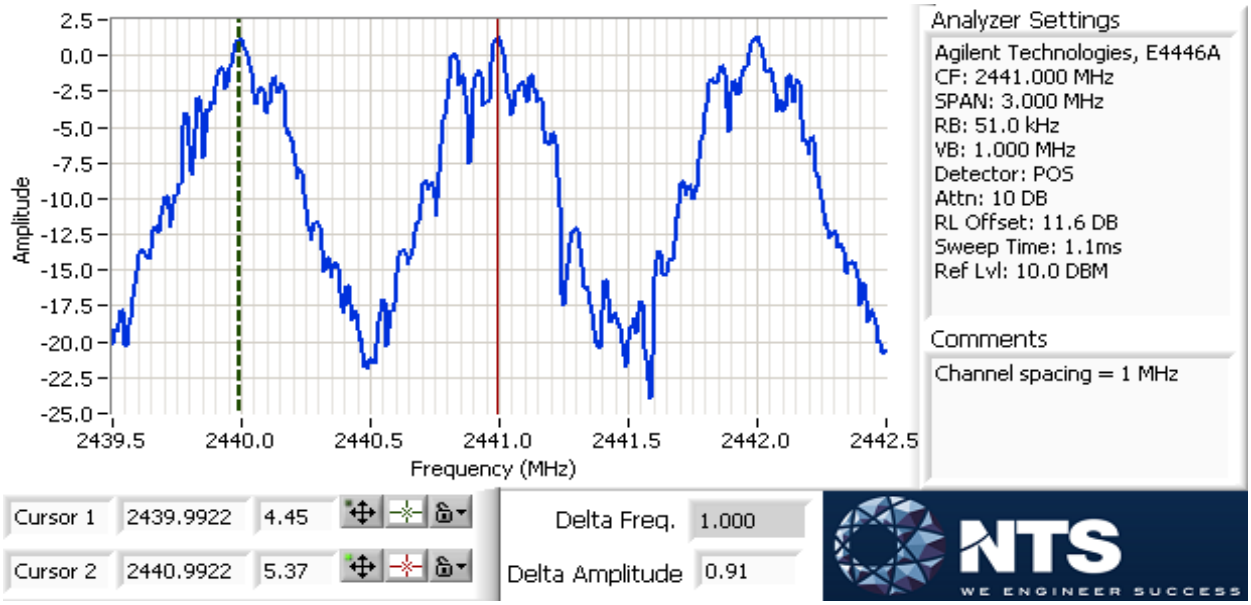
Maximum 20dB bandwidth:	1255	kHz	Pass
Channel spacing:	1000	kHz	Pass
Transmission time per hop:	0.4	ms	
The time between successive hops on a channel:	99	ms	
Number of channels (N):	79		Pass
Channel dwell time in 31.6 seconds:	128	ms	Pass

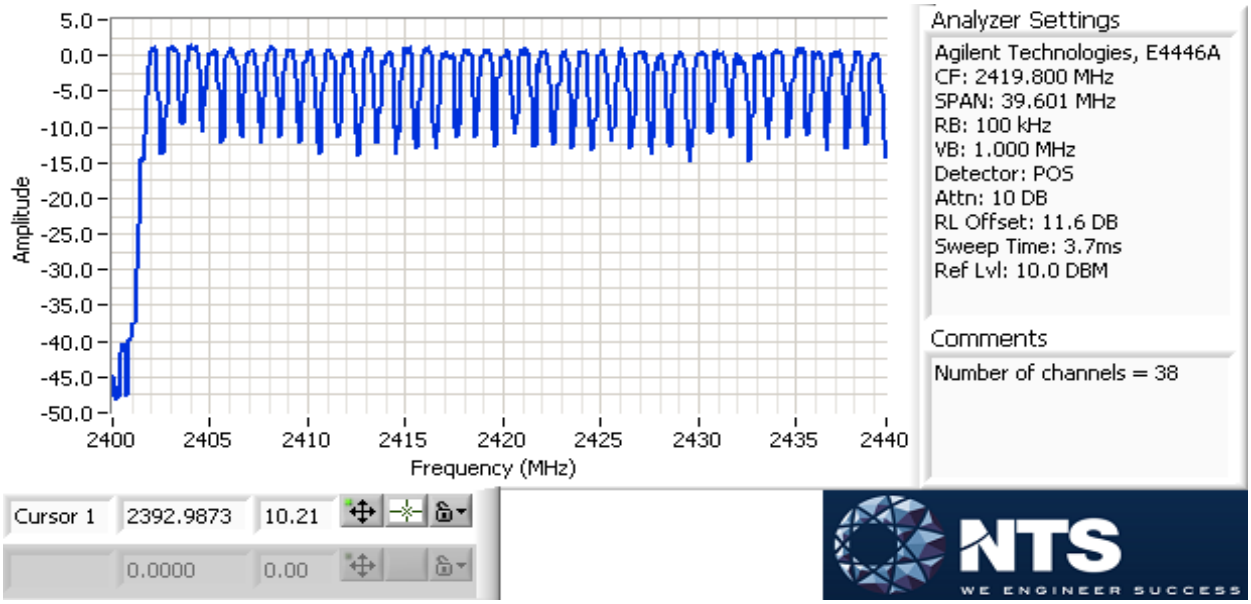
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



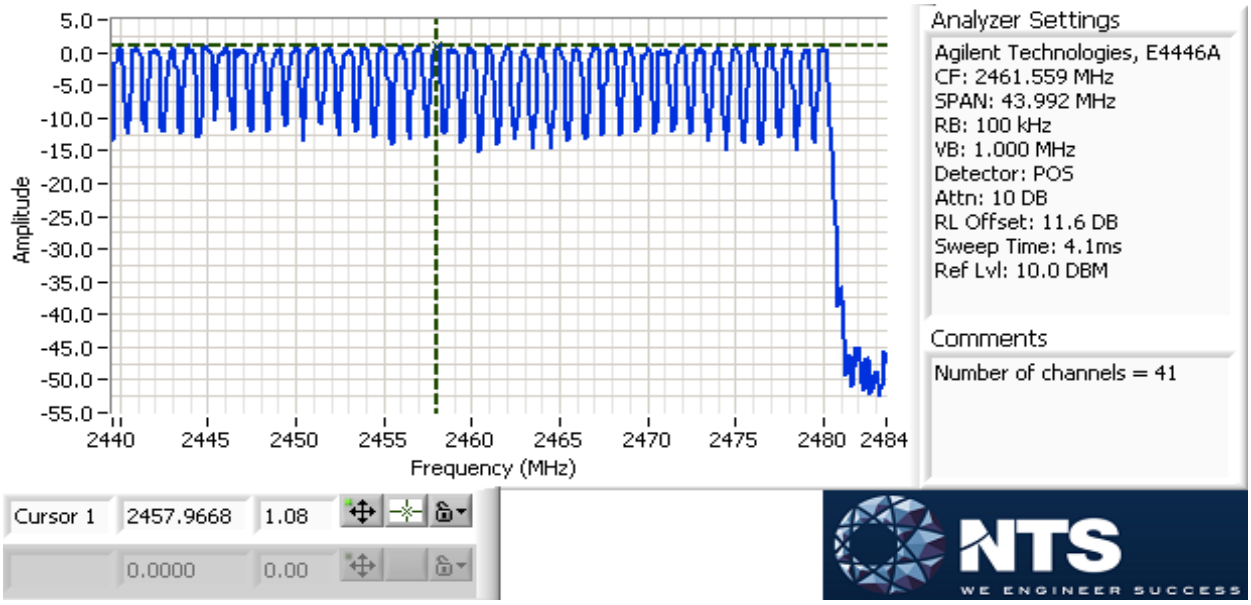


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

FCC 15.247 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 was located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

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: 13-17 °C

Rel. Humidity: 30-40 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	30 - 10000 MHz - Transmitter Radiated Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	35.7 dBµV/m @ 37.78 MHz (-4.3 dB)
2	30 - 3000 MHz - Receiver Radiated Spurious Emissions	FCC Part 15.109 / RSS GEN	Pass	41.2 dBµV/m @ 297.00 MHz (-4.8 dB)

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.

Notes

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:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 10,000 MHz.

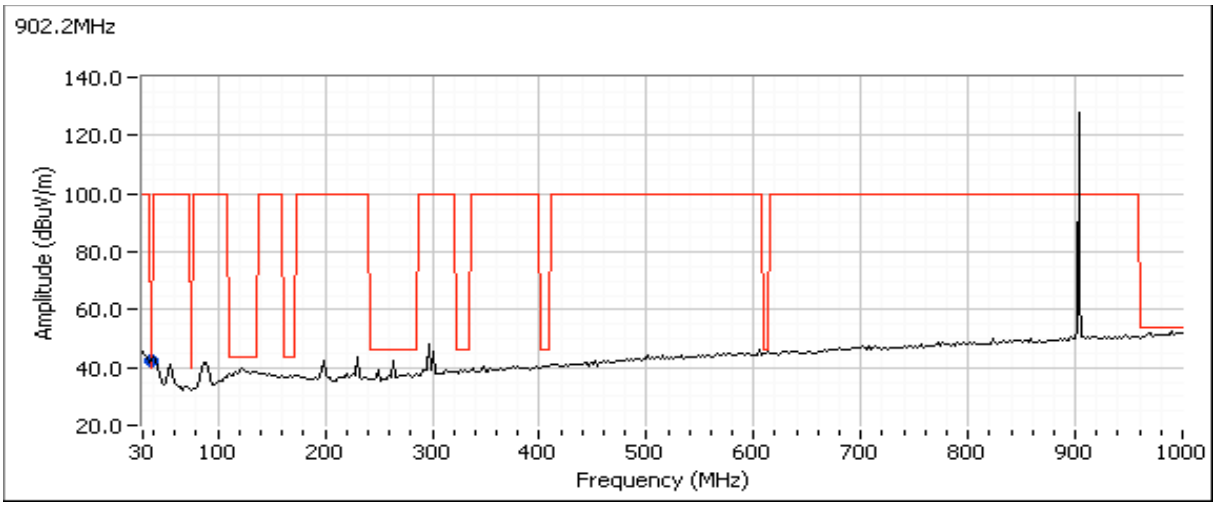
Date of Test: 1/28/2013 Test Location: Chamber #7

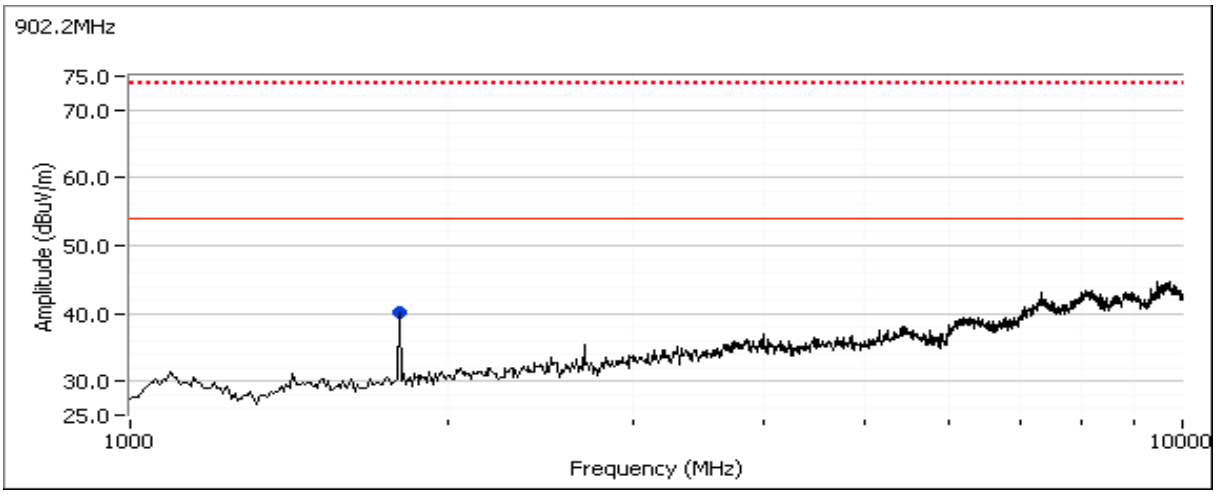
Test Engineer: M. Birgani

Run #1a: Low Channel @ 902.2 MHz

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	
37.776	35.7	V	40.0	-4.3	QP	320	1.0	QP (1.00s)
1804.390	39.7	V	54.0	-14.3	AVG	257	1.9	RB 1 MHz;VB 10 Hz;Peak
1804.260	43.9	V	74.0	-30.1	PK	257	1.9	RB 1 MHz;VB 3 MHz;Peak

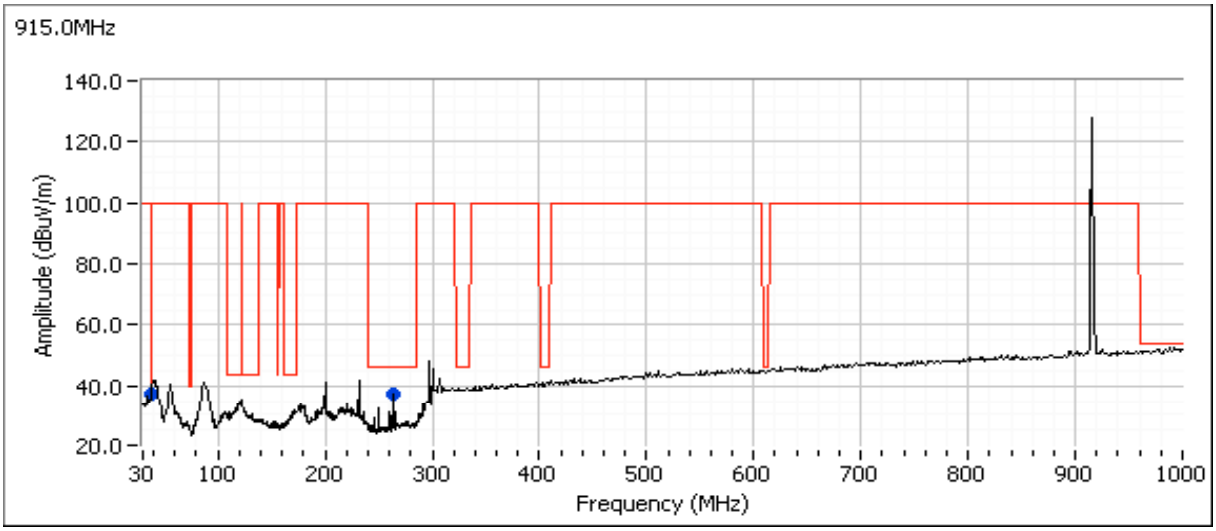


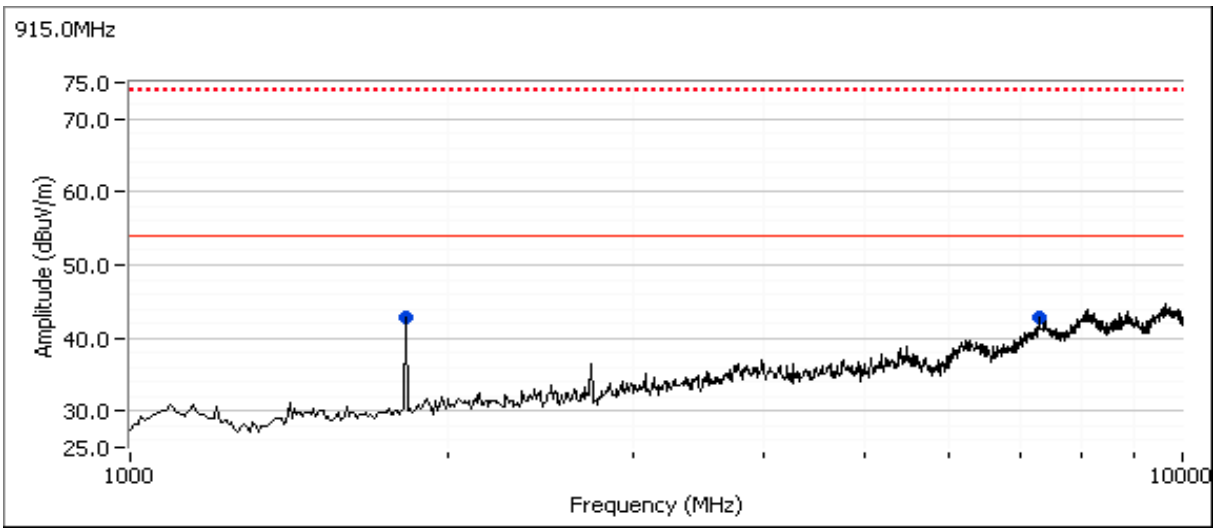


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1b: Center Channel @ 915 MHz
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	
7320.000	42.8	H	54.0	-11.2	Peak	64	1.9	Peak reading with average limit
1830.020	42.6	V	54.0	-11.4	AVG	226	1.0	RB 1 MHz;VB 10 Hz;Peak
1830.110	46.4	V	74.0	-27.6	PK	226	1.0	RB 1 MHz;VB 3 MHz;Peak



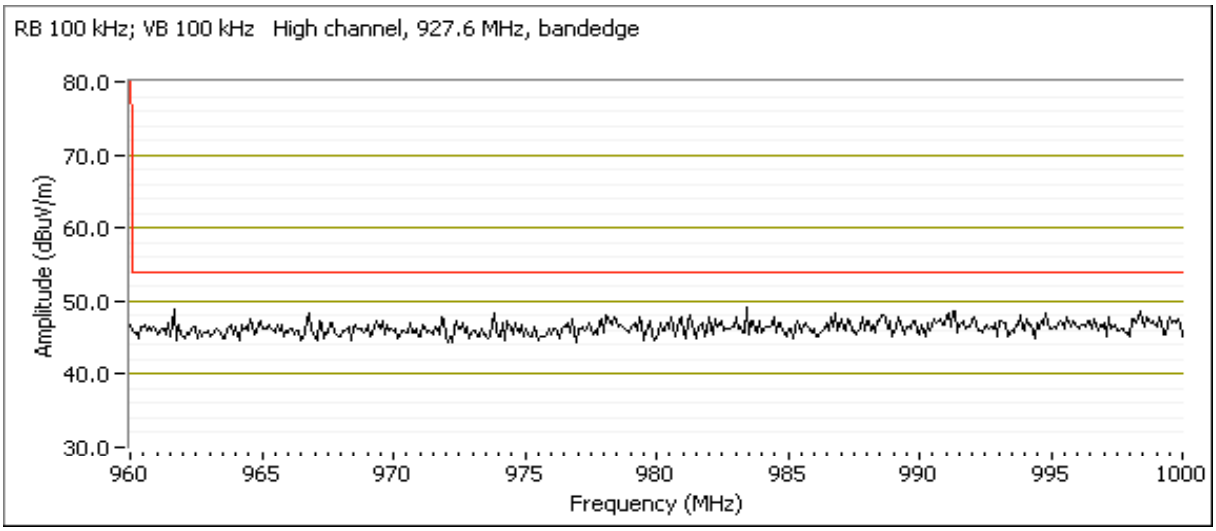


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1c: High Channel @ 927.6 MHz

Band Edge Signal Field Strength @ 960MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
987.255	48.4	V	54.0	-5.6	QP	0	1.00	Pk reading vs QP limit

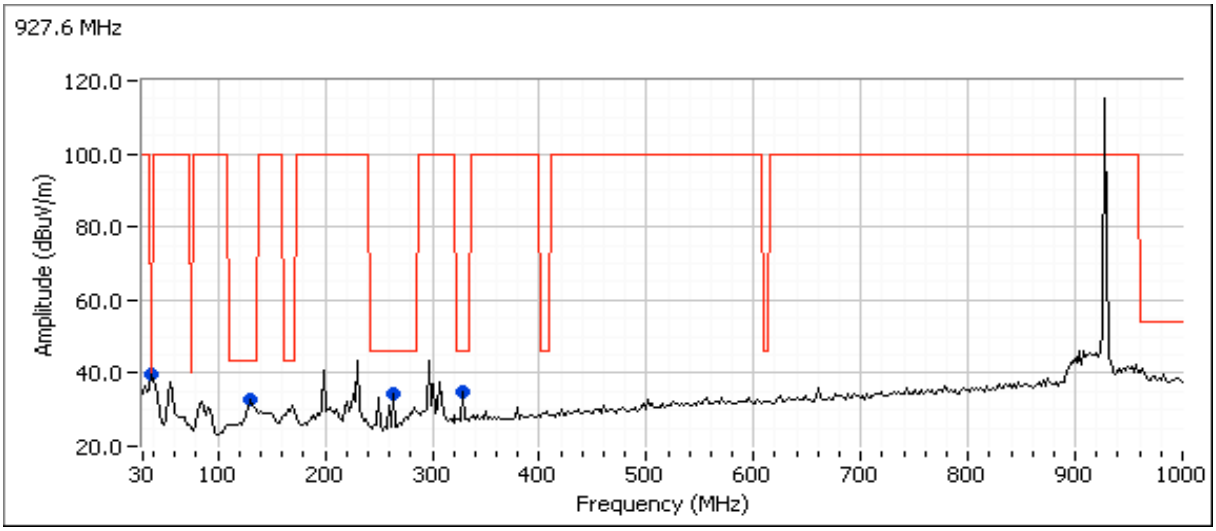


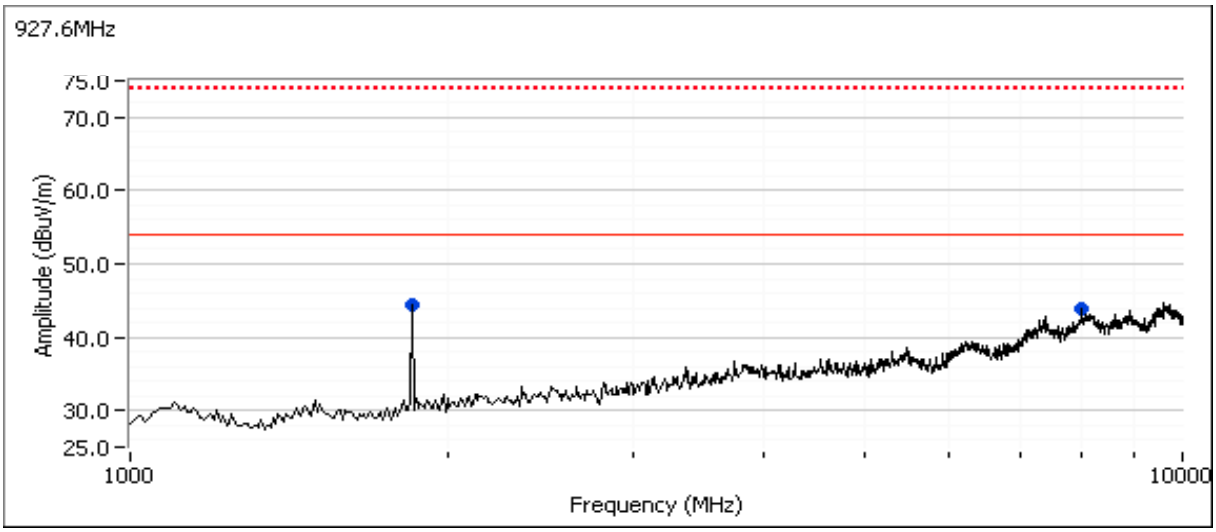
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
38.068	39.6	V	40.0	-0.4	Peak	334	1.0	Pk reading vs QP limit
38.068	35.3	V	40.0	-4.7	QP	349	1.0	
131.082	32.9	H	43.5	-10.6	Peak	269	2.0	Pk reading vs QP limit
263.267	34.3	H	46.0	-11.7	Peak	106	1.0	Pk reading vs QP limit
329.359	34.7	V	46.0	-11.3	Peak	140	1.5	Pk reading vs QP limit
8006.670	43.9	V	54.0	-10.1	Peak	302	1.9	Peak reading with average limit
1855.310	46.0	V	54.0	-8.0	AVG	169	2.5	RB 1 MHz;VB 10 Hz;Peak
1855.110	48.5	V	74.0	-25.5	PK	169	2.5	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:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #2: Receiver Radiated Spurious Emissions, 30 - 3000 MHz.

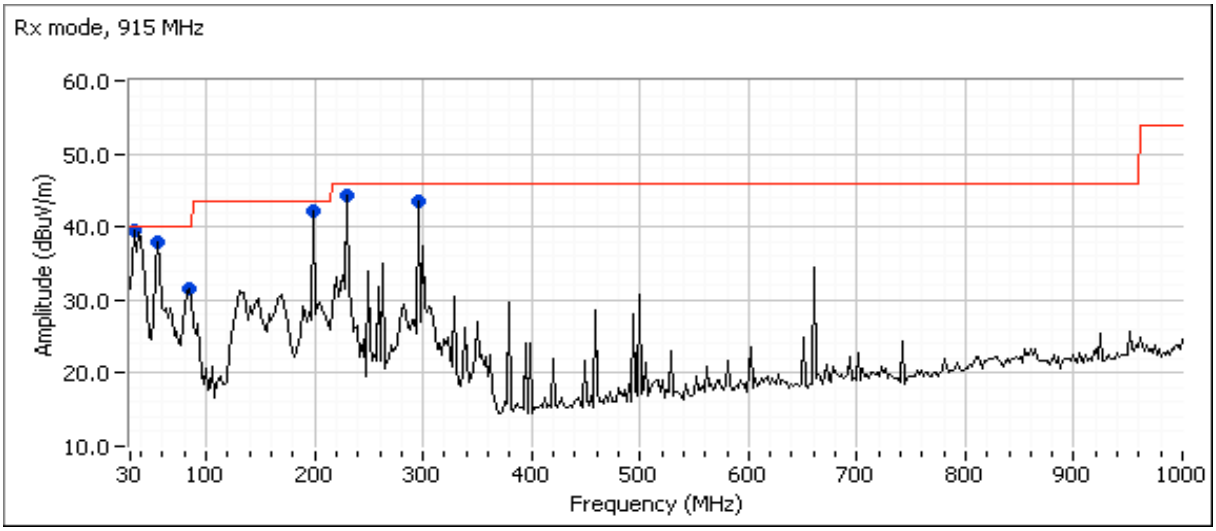
Date of Test: 1/28/2013 & 2/7/13 Test Location: Chamber #7

Test Engineer: M. Birgani & John Caizzi

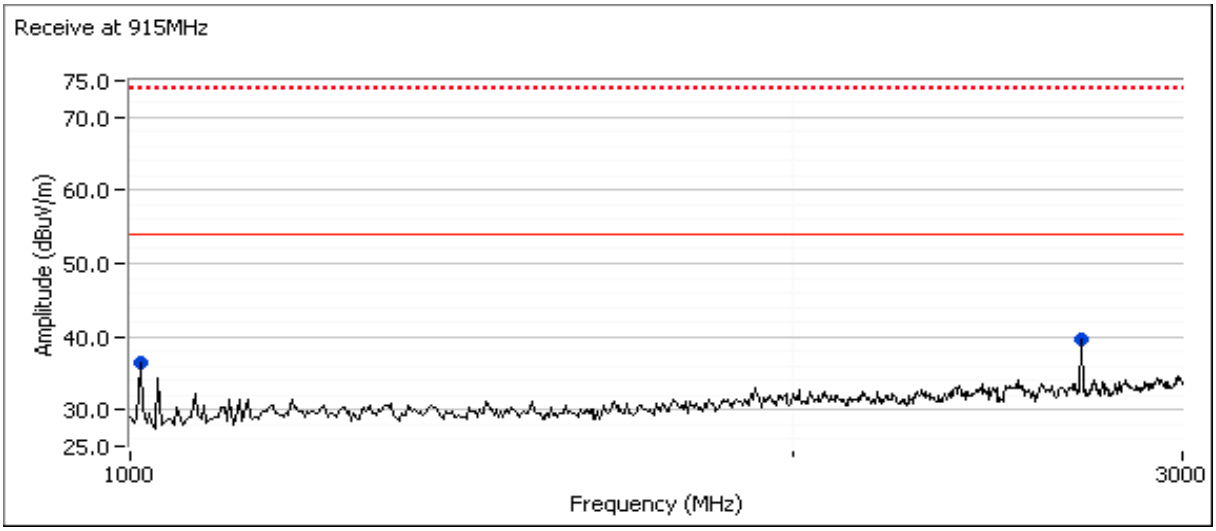
Run #2a: Receiver Radiated Spurious Emissions, 30 - 3000 MHz. Center Channel @ 915 MHz

Frequency	Level	Pol	15.109 / RSS GEN		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
39.083	39.5	V	40.0	-0.5	Peak	107	1.0	
39.478	32.7	V	40.0	-7.3	QP	280	1.0	
199.998	42.3	V	43.5	-1.2	Peak	107	1.0	
200.003	36.0	V	43.5	-7.5	QP	81	1.0	
230.989	44.2	H	46.0	-1.8	Peak	112	1.5	
230.992	31.6	H	46.0	-14.4	QP	69	1.5	
55.785	38.0	V	40.0	-2.0	Peak	267	1.0	
56.465	22.9	V	40.0	-17.1	QP	49	1.0	
66.190	26.6	V	40.0	-13.4	QP	229	1.0	
296.992	43.5	V	46.0	-2.5	Peak	167	2.0	
296.995	41.2	V	46.0	-4.8	QP	93	1.5	
82.876	31.5	V	40.0	-8.5	Peak	198	1.5	
86.306	25.1	V	40.0	-14.9	QP	104	1.0	
2700.000	39.5	V	54.0	-14.5	Peak	324	1.6	Peak reading with average limit
1010.000	36.4	V	54.0	-17.6	Peak	347	1.3	Peak reading with average limit

Note 1:



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

FCC 15.247 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

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: 21 °C

Rel. Humidity: 33 %

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
3	30 - 10000 MHz - Transmitter Conducted Spurious Emissions	FCC Part 15.247(c)	Pass	All emissions below limit.
4	Output Power	15.247(b)	Pass	29.1 dBm (0.813 W)
5	20dB Bandwidth	15.247(a)	Pass	139 kHz
5	99% bandwidth	15.247(a)	-	186 kHz
5	Channel Occupancy	15.247(a)	Pass	169.8 ms
5	Number of Channels	15.247(a)	Pass	127

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.

Notes

Refer to V:\t\Topcon Positioning Systems\J89363 (HiPer V and GRX2)\04 - NTS Test Logs\T89589_config_2.xls (radio the same)

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

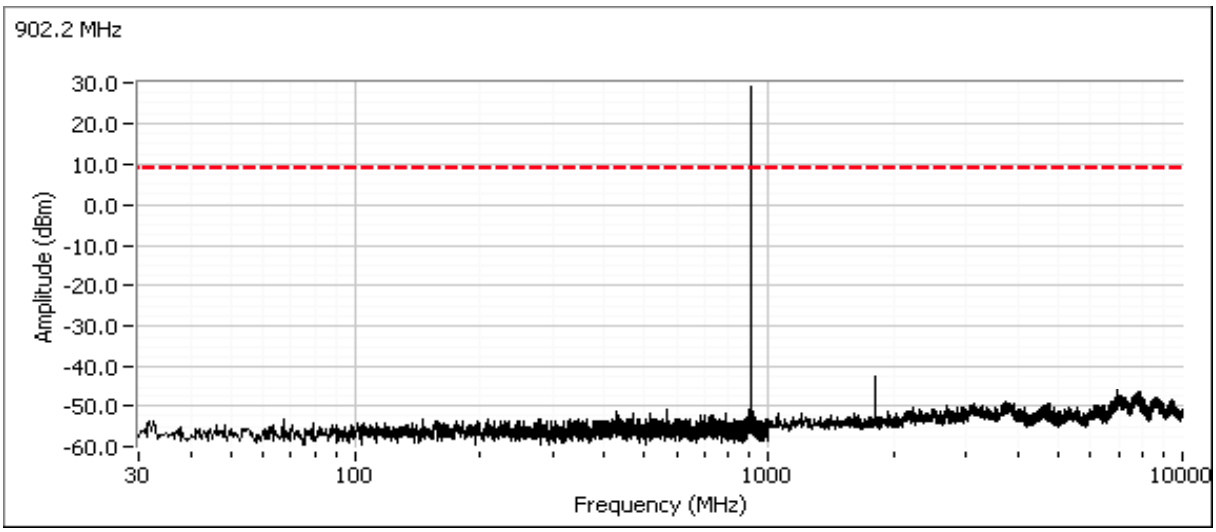
Run #3: Antenna Conducted Spurious Emissions, 30 - 10,000 MHz.

Date of Test: 1/30/2013 Test Location: Lab 4A

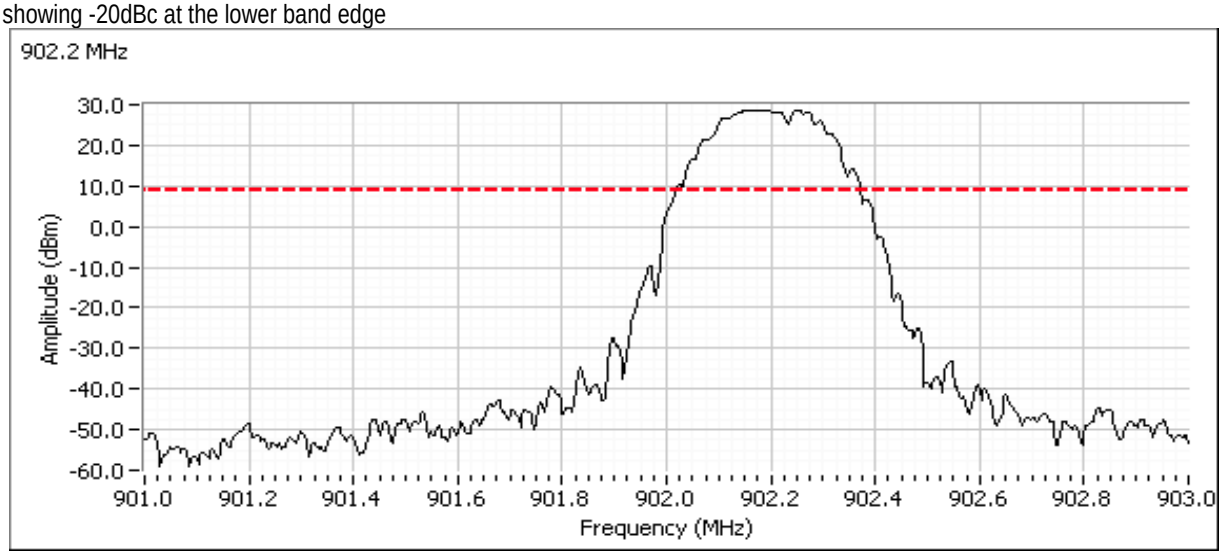
Test Engineer: John Caizzi

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.

Low channel

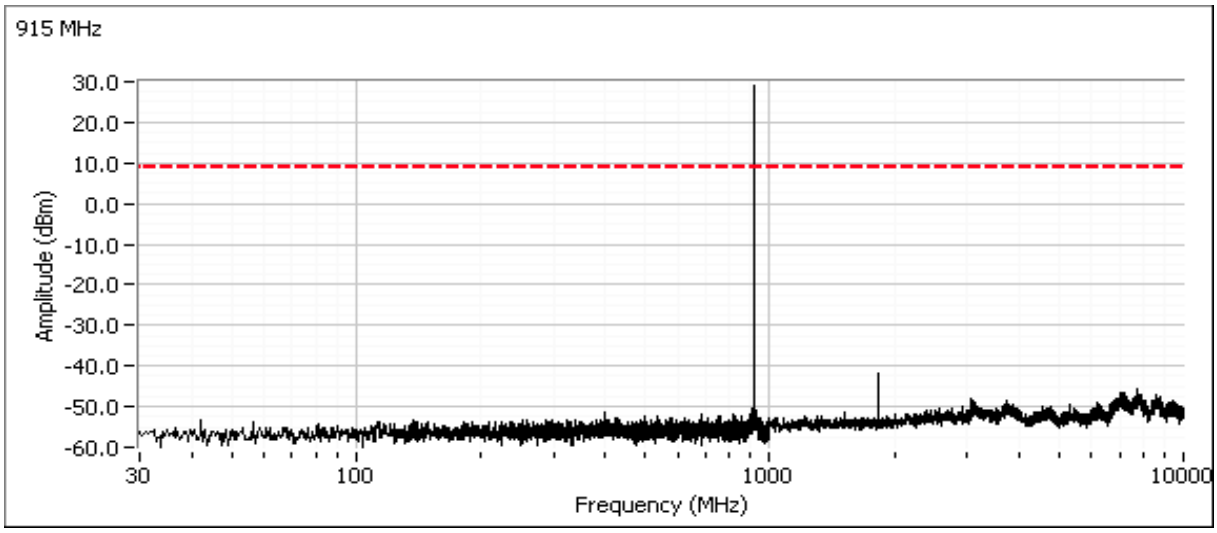


Plot showing -20dBc at the lower band edge

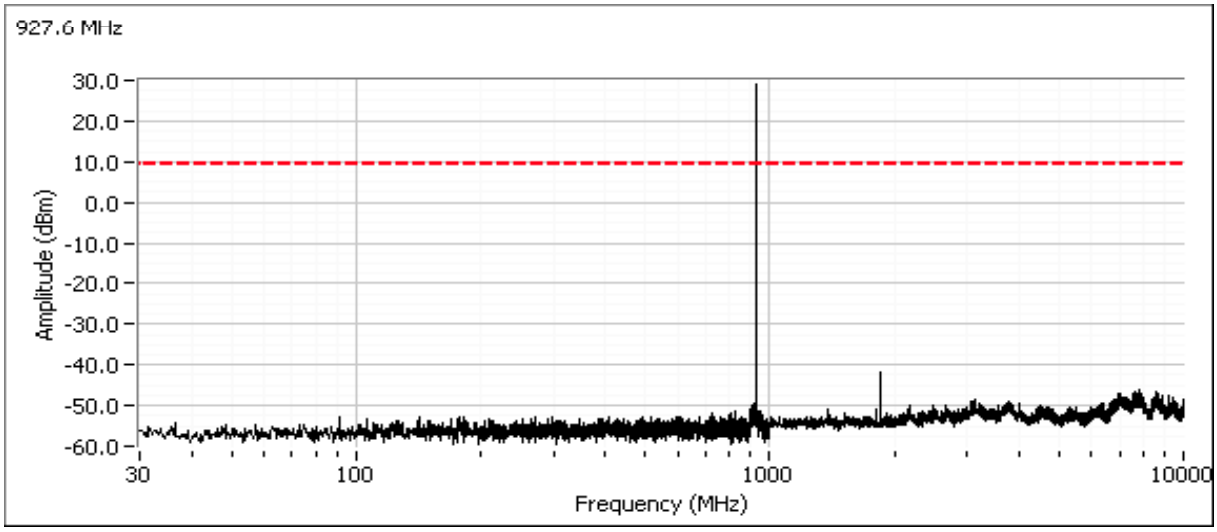


Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Center channel

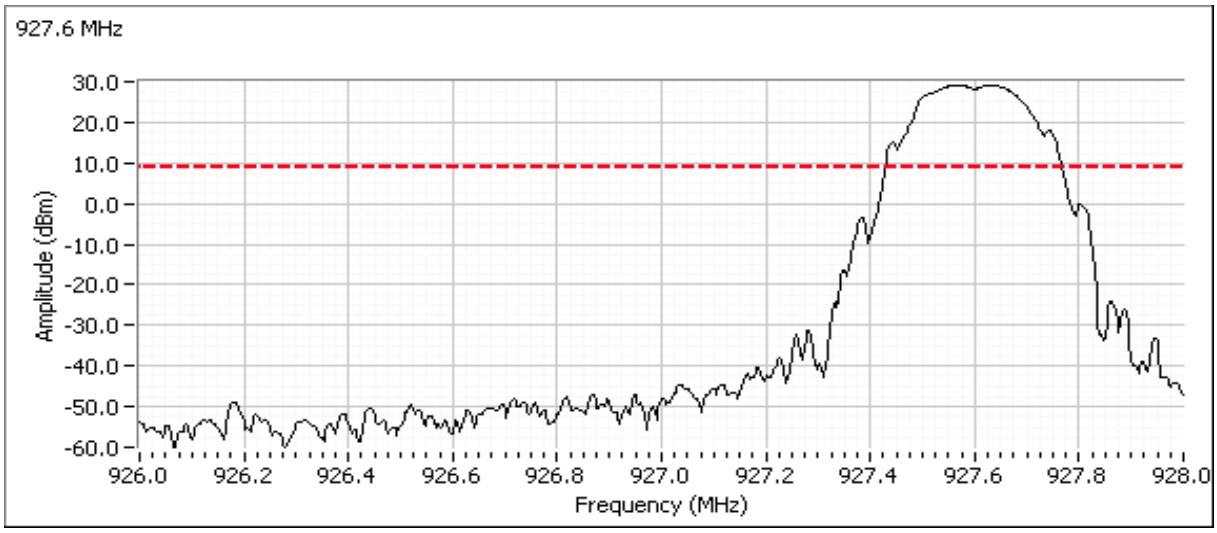


High channel



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

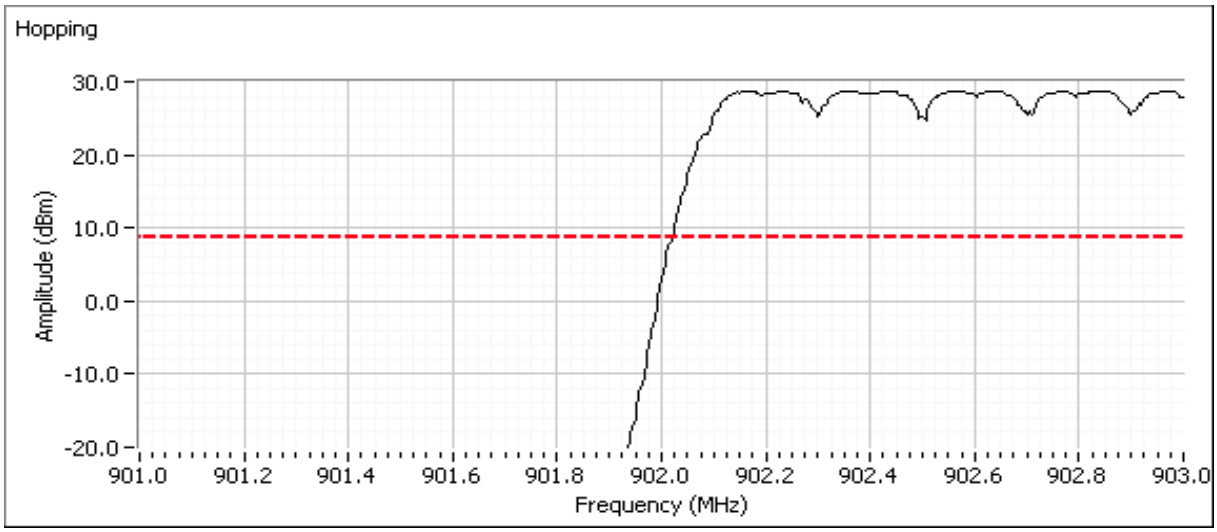
Plot showing -20dBc at the upper band edge



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

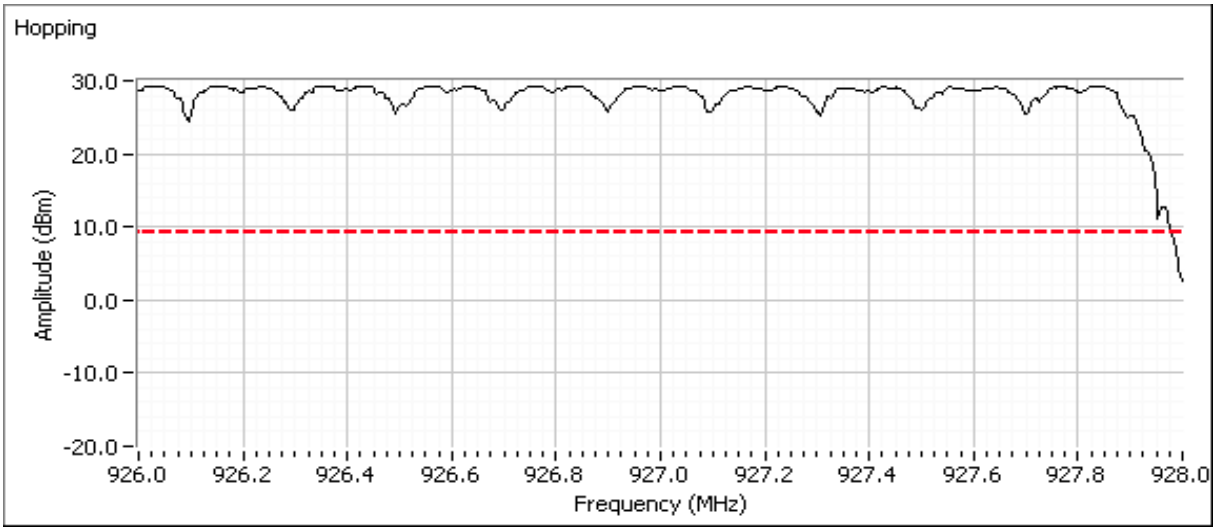
Plot showing -20dBc at the lower band edge



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

High channel, hopping enabled

Plot showing -20dBc at the upper band edge



Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #4: Output Power

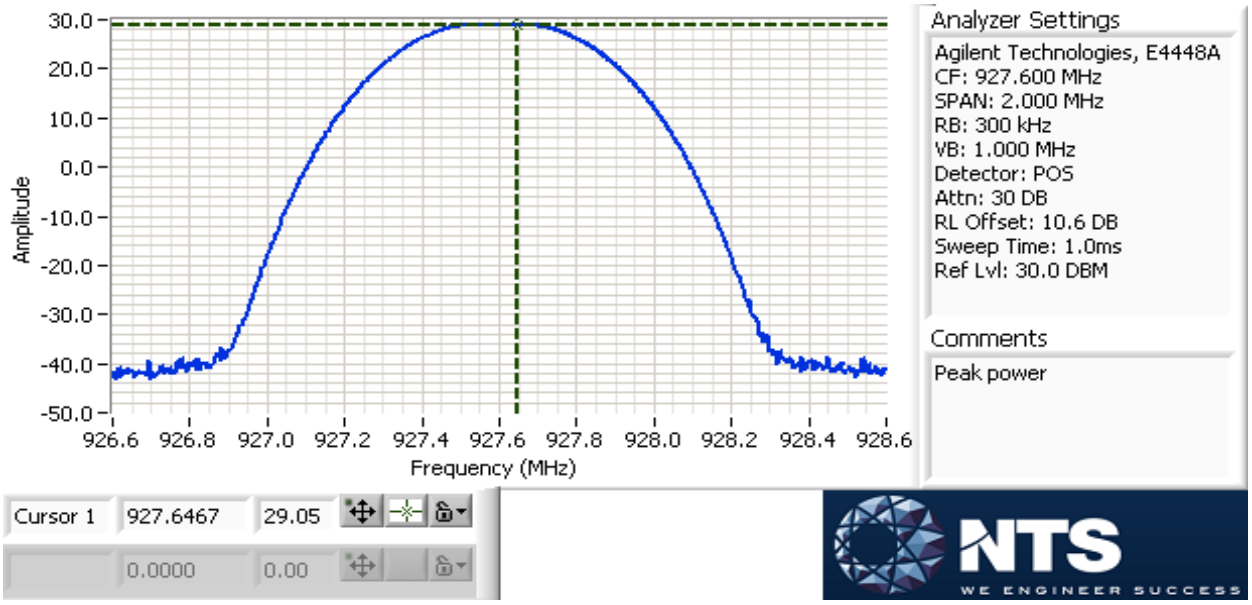
Date of Test: 1/30/2013 Test Location: Lab 4A
Test Engineer: John Caizzi

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: 2.5 dBi

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)	EIRP (W)
Low	902.2	300 kHz	28.8	0.759	1.3489629
Mid	915.0	300 kHz	29.0	0.794	1.4125375
High	927.6	300 kHz	29.1	0.813	1.4454398
Low	902.2	300 kHz	22.7	0.186	0.3311311
Mid	915.0	300 kHz	23.0	0.200	0.3548134
High	927.6	300 kHz	23.1	0.204	0.3630781

Peak power measured with RBW > EBW, VBW=3xRBW, Peak detector, max hold



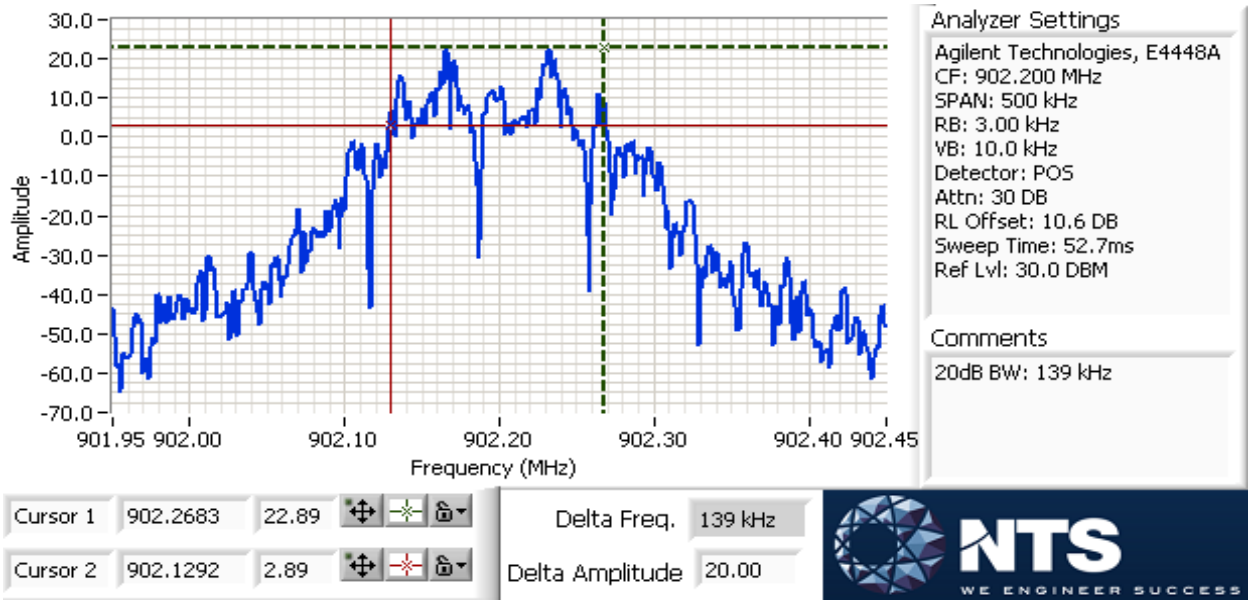
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

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

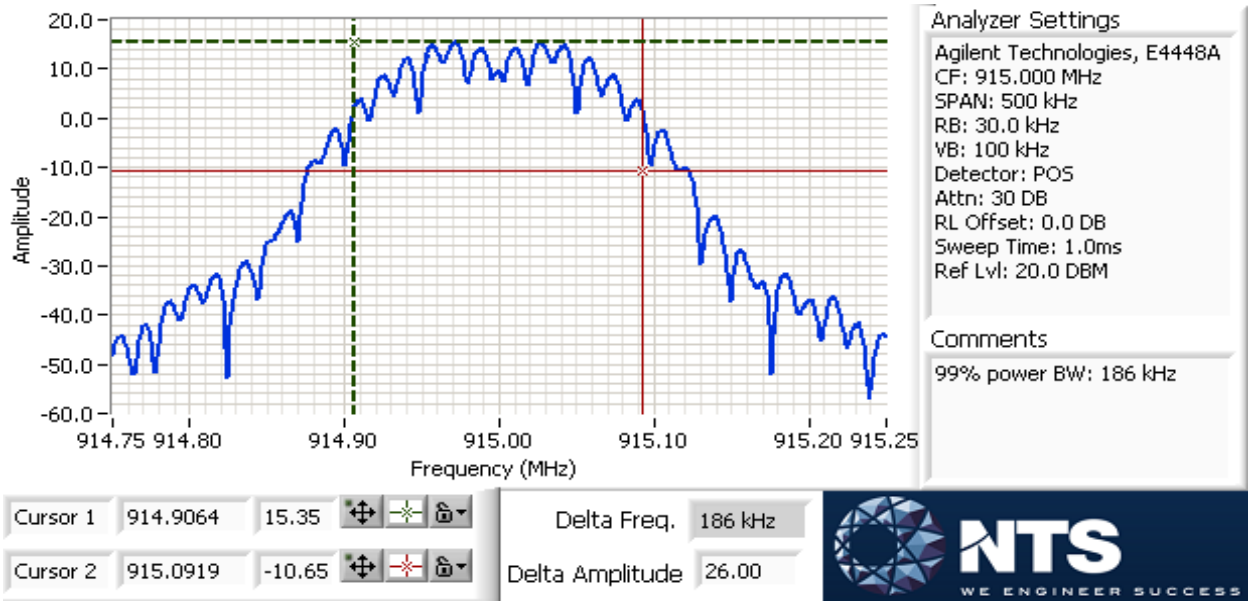
Date of Test: 1/30/2013
Test Engineer: John Caizzi
Test Location: Lab 4A

Channel	Frequency (MHz)	Resolution Bandwidth	20dB Bandwidth (kHz)	Resolution Bandwidth	99% Bandwidth (kHz)
Low	902.2	3 kHz	139	30 kHz	185
Mid	915.0	3 kHz	133	30 kHz	186
High	927.6	3 kHz	133	30 kHz	185

Note 1:	20dB bandwidth measured using RB = 3kHz, VB = 10kHz (VB > RB)
Note 2:	99% bandwidth measured using RB = 30kHz, VB = 100kHz (VB >=3RB)



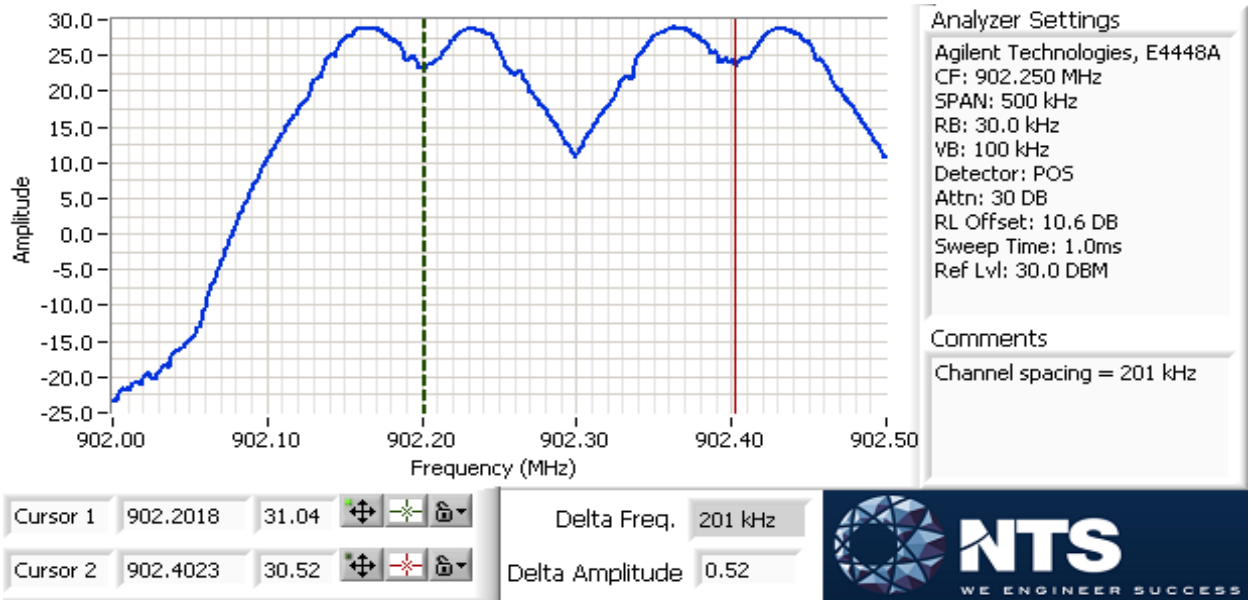
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

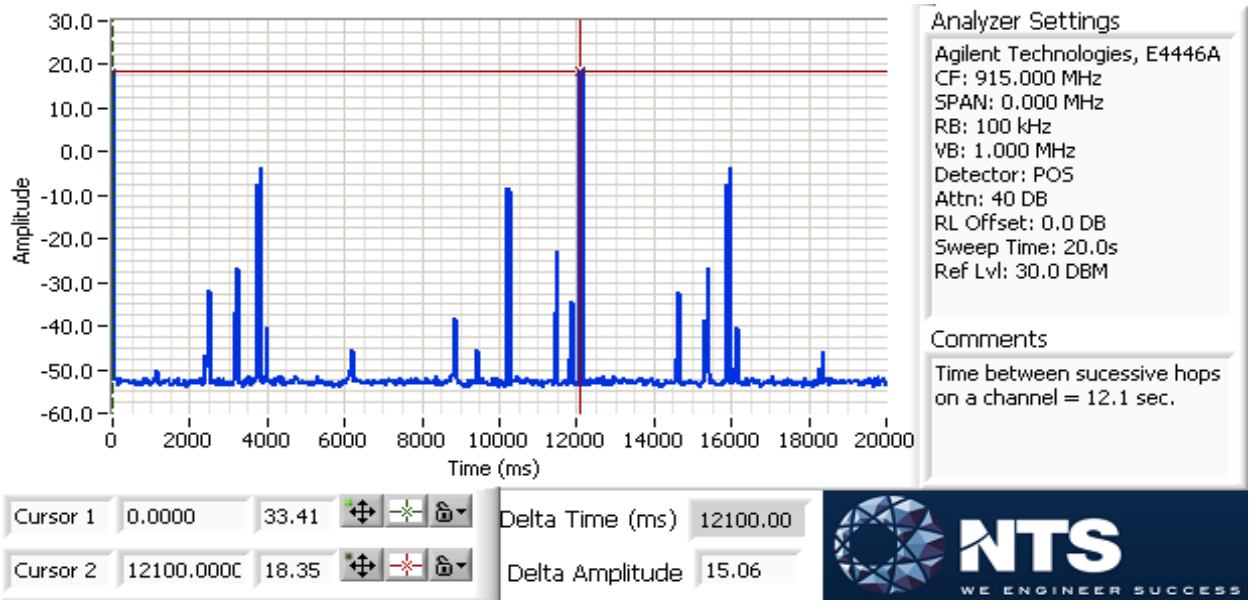


For frequency hopping systems operating in the 902-928 MHz band:
If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.
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.

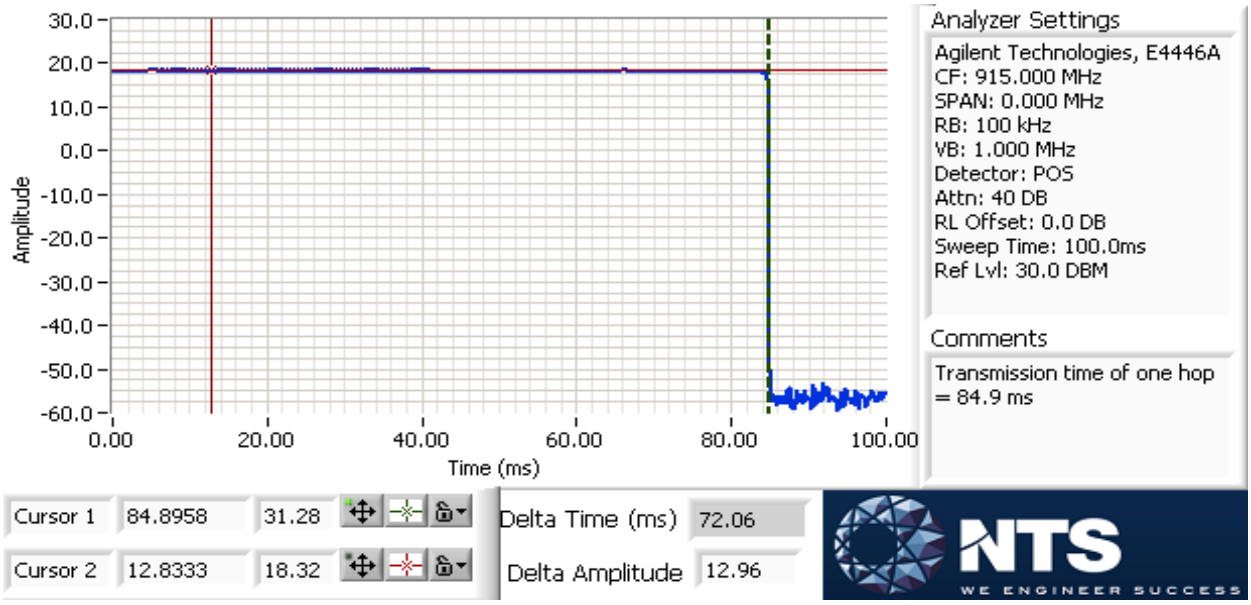
Maximum 20dB bandwidth:	139	kHz	Pass
Channel spacing:	200	kHz	Pass
Transmission time per hop:	84.9	ms	
The time between successive hops on a channel:	12100	ms	
Number of channels (N):	127		Pass
Channel dwell time in 20 seconds:	169.8	ms	Pass

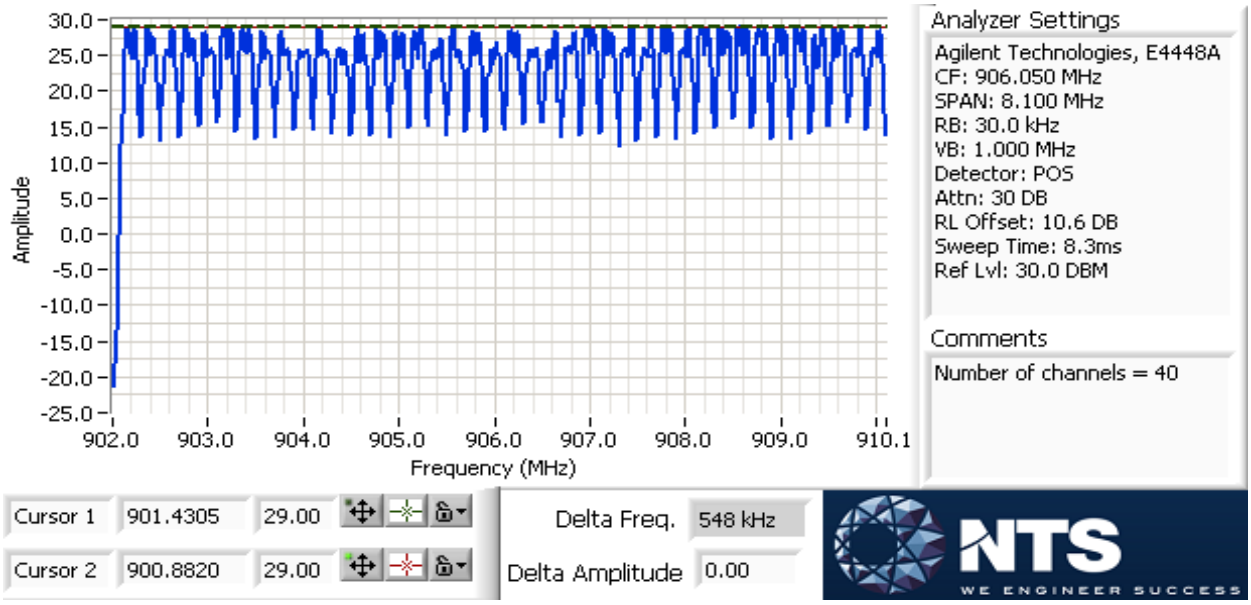
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A



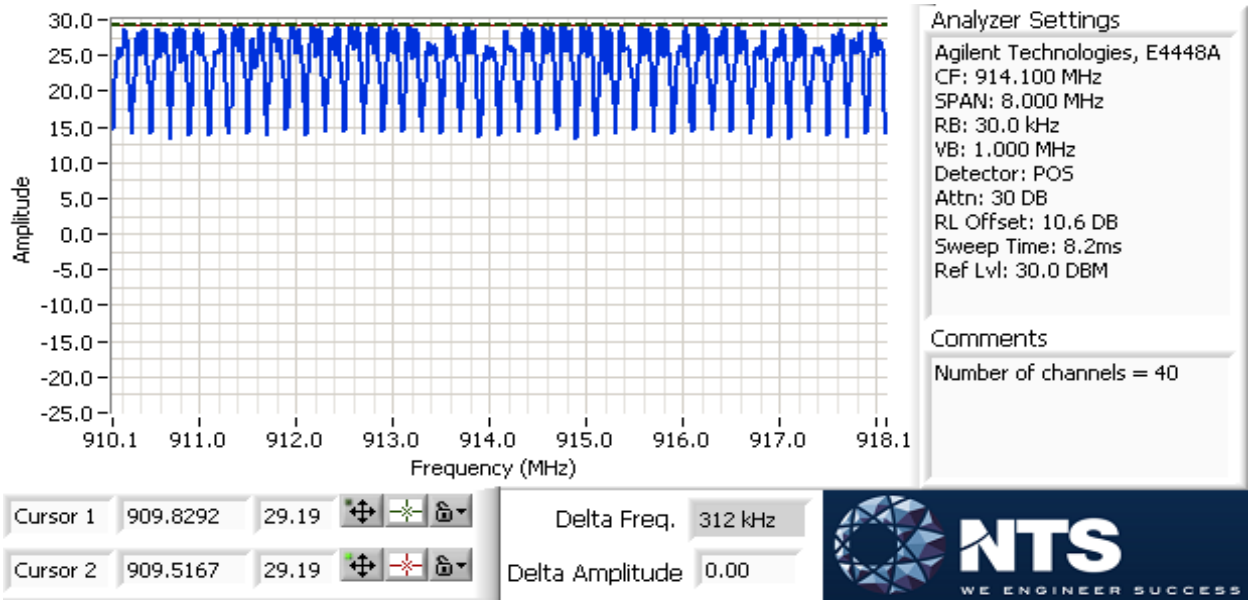


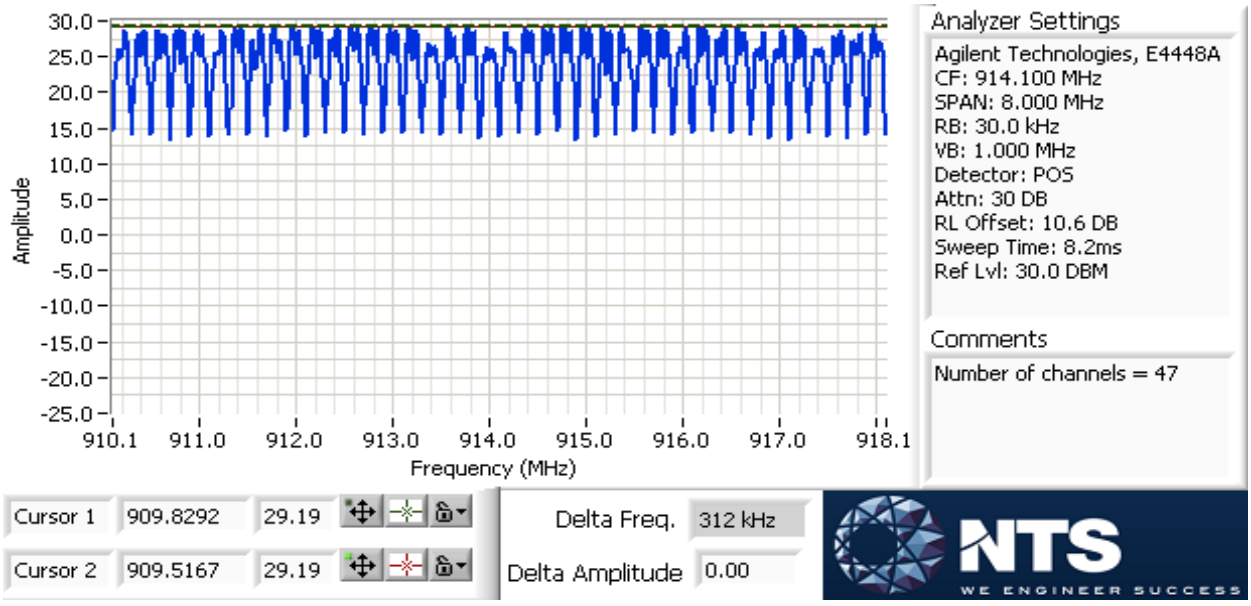
Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A





Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

RSS 210 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

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

General Test Configuration

The EUT was located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

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

Ambient Conditions:

Temperature: 13-17 °C

Rel. Humidity: 30-40 %

Summary of Results - Intermodulation

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1	Intermod check	BT @ 2441 Tx @ 915	default 30dBm	-	Radiated Emissions 1 - 12 GHz	FCC Part 15.209 / 15.247(c)	PASS (No signal was found)

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.

Notes:

Initial test to be perfomed with the EUT configured for BT Tx @ 2441 basic mode and TX at 915MHz @ 30dBm. Depending on results, additional intermodulation checks will need to be performed with other channel combinations.

Client:	Topcon Positioning Systems	Job Number:	J90335
Model:	GR-5	T-Log Number:	T90831
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Standard:	FCC 15.247	Class:	N/A

Run #1: Radiated Spurious Emissions, 1000-12000 MHz.

BT - Basic mode (2441MHz) and 900MHz - 30dBm, modulated, 915MHz

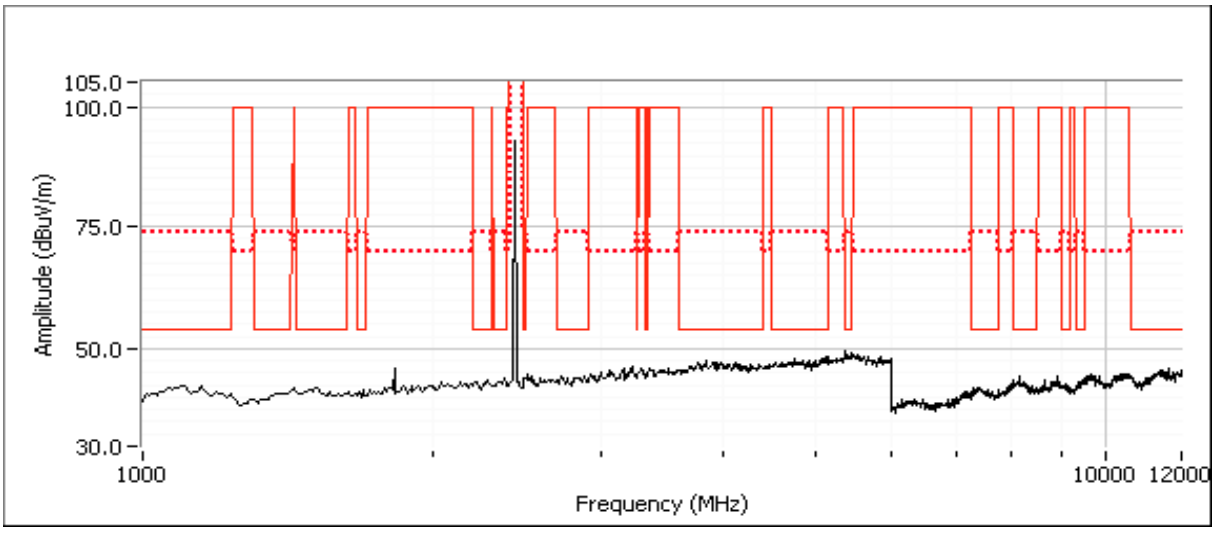
Date of Test: 1/28/2013 Test Location: Chamber #7

Test Engineer: M. Birgani

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	
No signal were found during intermodulation test.								

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Signal is not in a restricted band but the more stringent restricted band limit was used.
Note 3:	From 1-6GHz, a 10dB pad and 1GHz high pass filter was used. From 6-12GHz, a 3.5GHz high pass filter was used only.



End of Report

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