



41039 Boyce Road
Fremont, CA. 94538

510-578-3500 Phone
510-440-9525 Fax

EMC Test Report

Application for FCC Grant of Equipment Authorization Canada Certification Class II Permissive Change/Reassessment

Innovation, Science and Economic Development Canada RSS-Gen Issue 4 / RSS-247 Issue 2 FCC Part 15 Subpart C

Model: GR-5

IC CERTIFICATION #: 6050B-F90901
FCC ID: LCB-F90901

APPLICANT: Topcon Positioning Systems
7400 National Dr.
Livermore, CA 94550

TEST SITE(S): National Technical Systems
41039 Boyce Road.
Fremont, CA. 94538-2435

IC SITE REGISTRATION #: 2845B-4

PROJECT NUMBER: JD103485

REPORT DATE: March 2, 2018

FINAL TEST DATES: March 3, 15 and 16, 2017

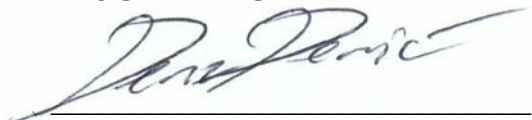
TOTAL NUMBER OF PAGES: 46



This report and the information contained herein represent the results of testing test articles identified and selected by the client performed to specifications and/or procedures selected by the client. National Technical Systems (NTS) makes no representations, expressed or implied, that such testing is adequate (or inadequate) to demonstrate efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it represent any statement whatsoever as to its merchantability or fitness of the test article, or similar products, for a particular purpose. This report shall not be reproduced except in full

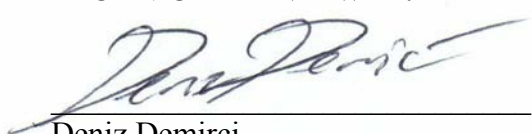
VALIDATING SIGNATORIES

PROGRAM MGR



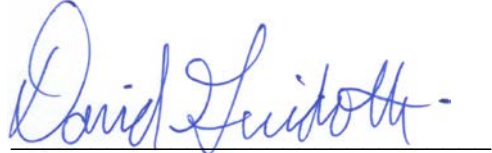
Deniz Demirci
Senior EMC/Wireless Engineer

TECHNICAL REVIEWER:



Deniz Demirci
Senior EMC/Wireless Engineer

FINAL REPORT PREPARER:



David Guidotti
Senior Technical Writer

QUALITY ASSURANCE DELEGATE



Gary Izard
Technical Writer



REVISION HISTORY

Rev#	Date	Comments	Modified By
-	March 2, 2018	First release	

TABLE OF CONTENTS

VALIDATING SIGNATORIES	2
REVISION HISTORY	3
TABLE OF CONTENTS	4
SCOPE.....	5
OBJECTIVE	5
STATEMENT OF COMPLIANCE	6
DEVIATIONS FROM THE STANDARDS.....	6
TEST RESULTS SUMMARY	7
FREQUENCY HOPPING SPREAD SPECTRUM (902 – 928 MHZ, 50 CHANNELS OR MORE)	7
MEASUREMENT UNCERTAINTIES	8
EQUIPMENT UNDER TEST (EUT) DETAILS.....	9
GENERAL.....	9
OTHER EUT DETAILS	9
ANTENNA SYSTEM	9
ENCLOSURE.....	9
MODIFICATIONS.....	9
SUPPORT EQUIPMENT	9
EUT INTERFACE PORTS	10
EUT OPERATION	10
TEST SITE.....	11
GENERAL INFORMATION	11
RADIATED EMISSIONS CONSIDERATIONS	11
MEASUREMENT INSTRUMENTATION	12
RECEIVER SYSTEM	12
INSTRUMENT CONTROL COMPUTER	12
FILTERS/ATTENUATORS	12
ANTENNAS.....	12
ANTENNA MAST AND EQUIPMENT TURNTABLE.....	13
INSTRUMENT CALIBRATION.....	13
TEST PROCEDURES	14
EUT AND CABLE PLACEMENT	14
RADIATED EMISSIONS	14
CONDUCTED EMISSIONS FROM ANTENNA PORT	17
SPECIFICATION LIMITS AND SAMPLE CALCULATIONS	18
CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(A), RSS GEN	18
GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS	19
RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS	19
OUTPUT POWER LIMITS – FHSS SYSTEMS	20
TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS AND DTS SYSTEMS.....	20
SAMPLE CALCULATIONS - RADIATED EMISSIONS.....	20
SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION.....	21
APPENDIX A TEST EQUIPMENT CALIBRATION DATA	22
APPENDIX B TEST DATA	24
END OF REPORT	46

SCOPE

An electromagnetic emissions test has been performed on the Topcon Positioning Systems model GR-5, pursuant to the following rules:

RSS-Gen Issue 4 “General Requirements for Compliance of Radio Apparatus”

RSS 247 Issue 2 “Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices”

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 test procedures:

ANSI C63.4: 2014

ANSI C63.10: 2013

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.

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

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.).

Testing was performed only on model GR-5.

STATEMENT OF COMPLIANCE

The tested sample of Topcon Positioning Systems model GR-5 complied with the requirements of the following regulations:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"

RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"

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) (i)	RSS 247 5.1 (1) & (3)	20dB Bandwidth	Same as original filing.	<= 500 kHz	Complies
15.247 (a) (1)	RSS 247 5.1 (2)	Channel Separation	Same as original filing.	Channel spacing > 20dB bandwidth (minimum 25kHz)	Complies
15.247 (a) (1) (i)	RSS 247 5.1 (3)	Number of Channels	Same as original filing.	50 or more	Complies
15.247 (a) (1) (i)	RSS 247 5.1 (3)	Channel Dwell Time	Same as original filing.	<0.4 second within a 20 second period	Complies
15.247 (a) (1)	RSS 247 5.1 (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 247 5.4 (1)	Output Power	29.1 dBm (0.813 W) EIRP = 2.57 W ^{Note 1}	1Watt, EIRP <= 4 Watts	Complies
15.247 (d)	RSS 247 5.5	Antenna Port Spurious Emissions 30MHz – 9.28 GHz	Same as original filing.	< -20dBc	Complies
15.247 (d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 30MHz – 9.28 GHz	32.7 dBμV/m @ 85.39 MHz (-7.3 dB)	Refer to the limits section (p19) for restricted bands, all others < -20dBc	Complies
15.247 (a) (1)	RSS 247 5.1(2)	Receiver bandwidth	Same as original filing.	Shall match the channel bandwidth	Complies
Note 1: EIRP calculated using antenna gain of 5.0 dBi for the highest EIRP system.					

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

Same as original filing.

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	900 MHz Reverse TNC BT Integral antenna.	Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 3	AC Conducted Emissions	Same as original filing.	Refer to page 18	Complies
15.109	RSS GEN Table 2	Receiver spurious emissions	35.8 dB μ V/m @ 500.00 MHz (-10.2 dB)	Refer to page 19	Complies
15.247 (i) 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
-	RSS-Gen 8.3	User Manual		Statement for products with detachable antenna	Complies
-	RSS-Gen 8.4	User Manual		Statement for all products	Complies
-	RSP-100 RSS-Gen 6.6	Occupied Bandwidth	Same as original filing	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
Radiated emission (field strength)	dB μ V/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS**GENERAL**

The Topcon Positioning Systems model GR-5 is a GNSS receiver with 900 MHz FHSS and Bluetooth 2.0/2.1 radio functions. Since the EUT would be placed on a pole in normal operation, for the purpose of testing the EUT was treated as tabletop equipment, 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 adapter is 100-240 Volts, 50-60 Hz, 0.8 Amps.

The sample was received on March 3, 2017 and tested on March 3, 15 and 16, 2017. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Topcon	GR5	GNSS receiver with 900 MHz FHSS and BT radios	800-21193	LCB-F90901 / IC: 6050B-F90901
Laird	5 dBi (900 MHz)	Antenna	-	N/A
PhiHong	PSC30U-120	AC/DC Adapter	P01702775C2	N/A

OTHER EUT DETAILS

C2PC to increase antenna gain (2.5 dBi) to 5 dBi for 900 MHz FHSS Radio. BT antenna remains the same.

ANTENNA SYSTEM

Monopole antenna with coaxial cable (Vehicle mount)

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

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

900 FHSS radio - unless otherwise stated, the EUT was configured to continuously transmit a modulated signal at the noted channel. All tests were performed at the high power state. The BT radio was configured to be active and transmitting.

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 4	US0027	2845B-4	41039 Boyce Road Fremont, CA 94538-2435

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.

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

Software is used to view and convert 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 software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

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 for testing below 1 GHz and 1.5m for testing above 1 GHz. 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.

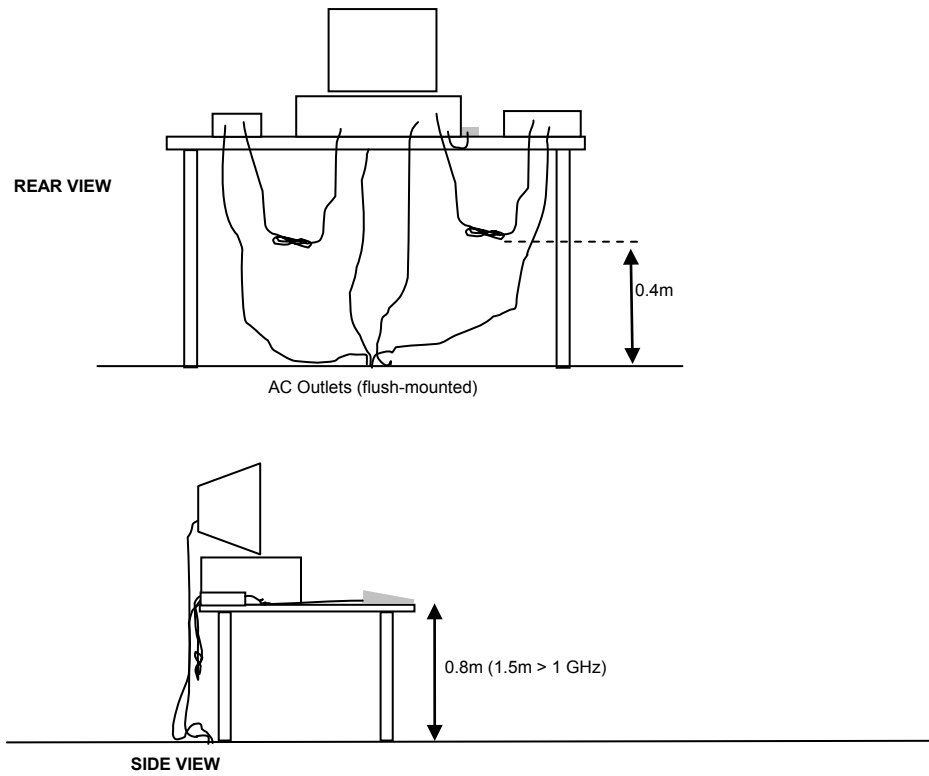
RADIATED EMISSIONS

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.

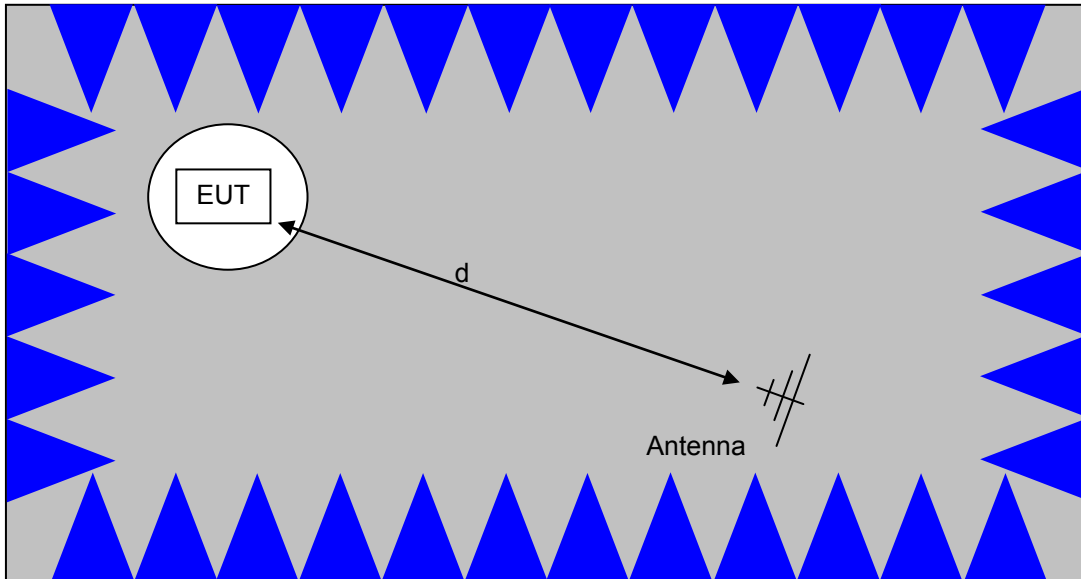
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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 1 meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

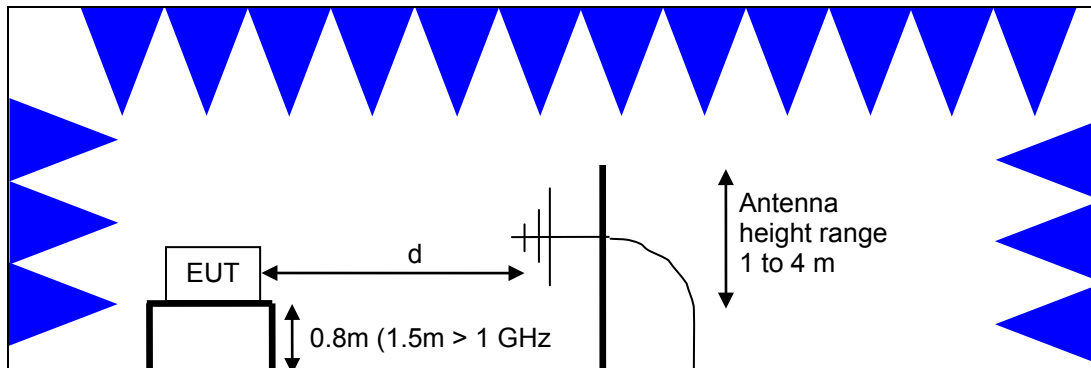


Typical Test Configuration for Radiated Field Strength Measurements



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.

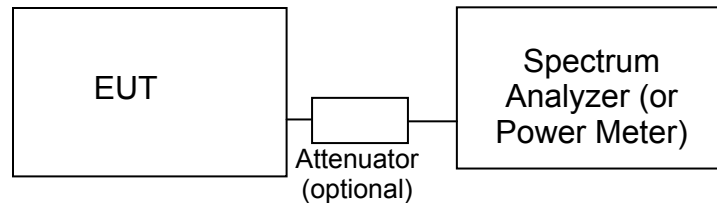
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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.

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 bands¹.

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 and RSS GEN Table 2. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109 and receivers that are not stand-alone are exempt from the ISED Canada requirements per RSS-GEN.

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 15.205 and RSS-Gen Table 6

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 - 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:

$$F_d = 20 * \text{LOG}_{10} (D_m/D_s)$$

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:

$$F_d = 40 * \text{LOG}_{10} (D_m/D_s)$$

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

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Radiated Spurious Emissions, 30 - 10,000 MHz, 03-Mar-17					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/8/2016	7/8/2018
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	7/27/2016	7/27/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESI 7	1756	6/29/2016	6/29/2017
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037	1769	9/9/2016	9/9/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	9/30/2016	9/30/2017
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/1/2017	3/1/2018
Com-Power	Preamplifier, 30-1000 MHz	PA-103	2465	9/16/2016	9/16/2017
Radio Antenna Port (Power and Spurious Emissions), 03-Mar-17					
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	1539	10/27/2016	10/27/2017
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts use with 20dB attenuator sn:1031.6959.00 only	NRV-Z32	3225	10/27/2016	10/27/2017
Rohde & Schwarz	20dB attenuator sn:1031.6959.00 only for Peak Power Sensor 100 uW - 2 Watts	NRV-Z32 atten	3226	10/27/2016	10/27/2017
Radiated Spurious Emissions, 15-Mar-17					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/5/2016	10/5/2017
Hewlett Packard	High Pass filter, 1.5 GHz (Blue System)	P/N 84300-80037 (84125C)	1389	9/9/2016	9/9/2017
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	3/28/2016	3/28/2017
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/31/2015	8/31/2017
Radiated Spurious Emissions, 16-Mar-17					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/5/2016	10/5/2017
Hewlett Packard	High Pass filter, 1.5 GHz (Blue System)	P/N 84300-80037 (84125C)	1389	9/9/2016	9/9/2017
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	3/28/2016	3/28/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz 18GHz	BRM50702-02	2238	10/14/2016	10/14/2017
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/31/2015	8/31/2017
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018



<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/16/2015	7/16/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	7/27/2016	7/27/2018
Com-Power	Preamplifier, 30-1000 MHz	PA-103	2465	9/16/2016	9/16/2017



Appendix B Test Data

T103567 Pages 25 - 45



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
		Account Manager:	Deepa Shetty
Contact:	Ferdinand Riodique		
Emissions Standard(s):	FCC Part 15.247, RSS-247	Class:	-
		Environment:	-

EMC Test Data

For The

Topcon Positioning Systems

Model

GR-5 GNSS Receiver with FH915

Date of Last Test: 3/16/2017



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (FHSS) Power

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, 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.

Ambient Conditions:

Temperature: 22 °C
Rel. Humidity: 40 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Output Power	15.247(b)	Pass	29.1 dBm (0.813 W)

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.

Sample Notes

Sample S/N: 800-21193
Driver: -
Antenna: Laird 5 dBi gain



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

Run #1: Output Power

Date of Test: 3/3/2017
Test Engineer: John Caizzi

Test Location: Chamber 4

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: 5 dBi

High power setting

Channel	Frequency (MHz)	Res BW	Output Power (dBm)	Output Power (W)	EIRP (W)
Low	902.2	300 kHz	28.8	0.759	2.399
Mid	915.0	300 kHz	29.1	0.813	2.570
High	927.6	300 kHz	28.8	0.759	2.399

Peak power measured with peak power meter.

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (FHSS) 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 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, unless otherwise noted.

Ambient Conditions:

Temperature: 20 °C
 Rel. Humidity: 38 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1a	Tx	Low 902.2 MHz	Max	28.8 dBm	Radiated Emissions, 30 MHz-10 GHz	FCC Part 15.209 / 15.247(c)	46.0 dBµV/m @ 2706.6 MHz (-8.0 dB)
1b		Center 915 MHz		29.1 dBm			31.2 dBµV/m @ 78.72 MHz (-8.8 dB)
1c		High 927.6 MHz		28.8 dBm			32.7 dBµV/m @ 85.39 MHz (-7.3 dB)
		28.8 dBm		Restricted Band at 960 MHz	44.1 dBµV/m @ 993.03 MHz (-9.9 dB)		
2a	Rx	Low 902.2 MHz	NA	-	Radiated Emissions, 30 MHz-3 GHz		35.1 dBµV/m @ 500.01 MHz (-10.9 dB)
2b		Center 915 MHz		-			34.5 dBµV/m @ 500.01 MHz (-11.5 dB)
2c		High 927.6 MHz		-			35.8 dBµV/m @ 500.00 MHz (-10.2 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.



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
FHSS	-	1.00	Yes	-	0	0	10

Hopping stopped.

Sample Notes

Sample S/N: 800-21193

Driver: -

Antenna: Laird 5 dBi gain

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

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

Date of Test: 3/3 & 3/15/17
 Test Engineer: John Caizzi
 Test Location: Chamber 4

Config. Used: 1
 Config Change: none
 EUT Voltage: 120V / 60Hz

Run #1a: Low Channel @ 902.2 MHz

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

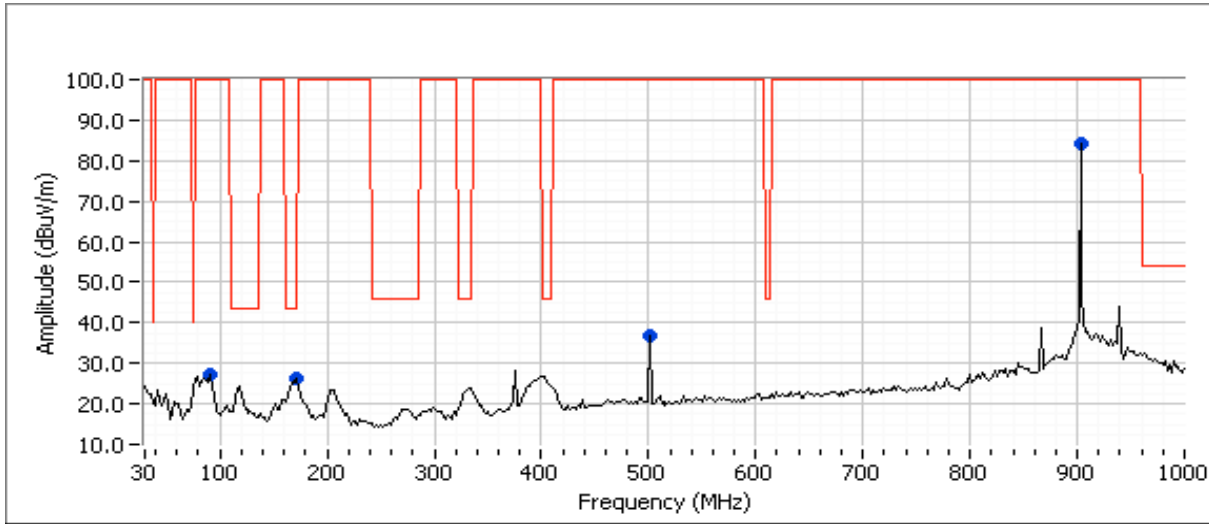
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
90.835	27.2	H	43.5	-16.3	Peak	137	2.0	Note 1
170.919	26.1	V	43.5	-17.4	Peak	182	1.0	
499.993	36.8	V	46.0	-9.2	Peak	256	1.0	Note 1
902.806	84.4	V	NA	NA	Peak	96	1.5	Fundamental
1800.000	45.6	V	54.0	-8.4	Peak	36	1.0	
2700.000	46.3	V	54.0	-7.7	Peak	254	1.5	
2440.000	60.9	V	NA	NA	Peak	231	1.0	BT advertising

Final readings

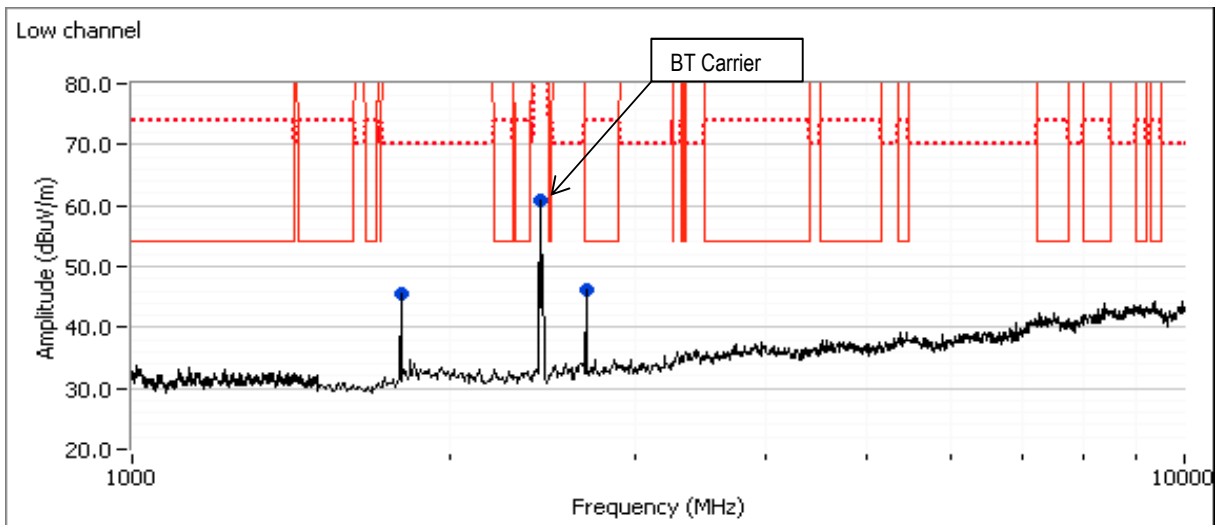
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
499.993	36.8	V	46.0	-9.2	QP	253	1.00	Note 1
170.919	24.9	V	43.5	-18.6	QP	198	1.00	
90.835	32.6	H	43.5	-10.9	QP	135	2.01	Note 1
1804.400	44.9	V	54.0	-9.1	AVG	32	1.00	Note 1
1804.480	47.3	V	74.0	-26.7	PK	32	1.00	Note 1
2706.630	46.0	V	54.0	-8.0	AVG	264	1.50	
2706.600	48.6	V	74.0	-25.4	PK	264	1.50	

Note: No spurious emissions observed between 10 GHz and 25 GHz during pre-scans.

Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Note: The narrow band tunable band reject filter K&L 3 TNF-800/1000 was used and tuned to suppress fundamental signal.





EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

Run #1b: Center Channel @ 915 MHz

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

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
78.716	27.6	V	40.0	-12.4	Peak	172	1.0	Note 1
170.815	25.8	V	43.5	-17.7	Peak	187	1.0	
332.196	25.6	V	46.0	-20.4	Peak	3	1.0	
499.997	34.5	V	46.0	-11.5	Peak	261	1.0	Note 1
916.413	81.9	V	NA	NA	Peak	277	1.0	Fundamental
1826.670	42.1	V	54.0	-11.9	Peak	320	1.0	Note 1
2740.000	39.2	V	54.0	-14.8	Peak	134	2.5	
2440.000	63.7	V	NA	NA	Peak	5	2.0	BT advertising

Final readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
499.997	36.5	V	46.0	-9.5	QP	250	1.02	Note 1
170.815	25.1	V	43.5	-18.4	QP	187	1.00	
78.716	31.2	V	40.0	-8.8	QP	131	1.00	Note 1
332.196	22.7	V	46.0	-23.3	QP	2	1.00	
1829.950	41.7	V	54.0	-12.3	AVG	321	1.28	Note 1
1830.050	45.5	V	74.0	-28.5	PK	321	1.28	Note 1
2745.050	35.8	V	54.0	-18.2	AVG	135	2.50	
2745.050	42.4	V	74.0	-31.6	PK	135	2.50	

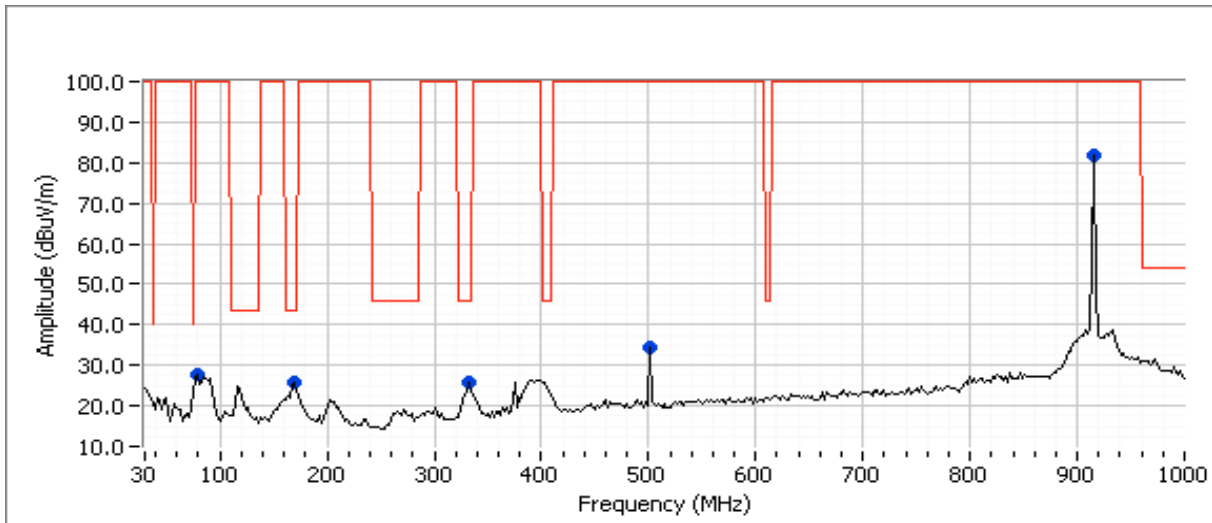
Note: No spurious emissions observed between 10 GHz and 25 GHz during pre-scans.

**NTS**

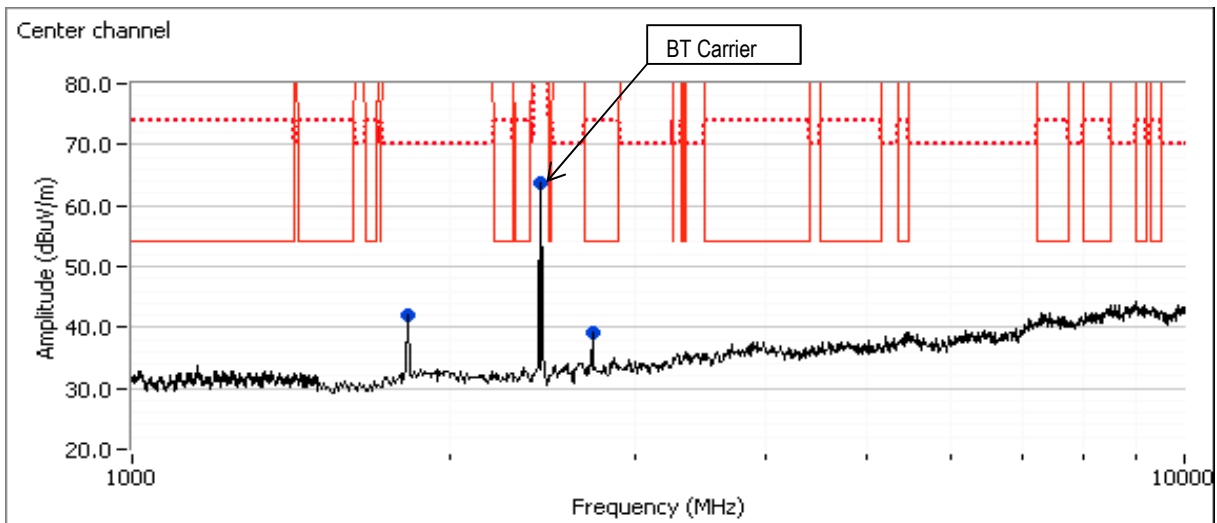
WE ENGINEER SUCCESS

EMC Test Data

Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Note: The narrow band tunable band reject filter K&L 3 TNF-800/1000 was used and tuned to suppress fundamental signal.



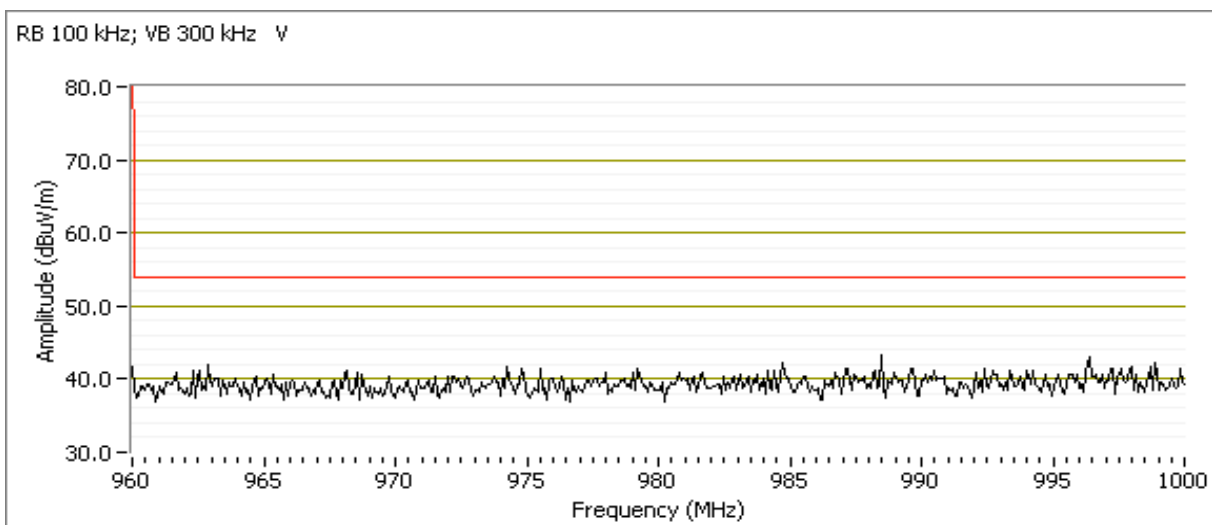
Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

Run #1c: High Channel @ 927.6 MHz

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
993.026	44.1	V	54.0	-9.9	Pk	359	3.01	RB 100 kHz, VB 300 kHz, note 2
975.471	43.0	H	54.0	-11.0	Pk	0	1.00	RB 100 kHz, VB 300 kHz, note 2

Note 2 | Peak reading vs QP limit.



Note: | No filter was used during the band edge test.



EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

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

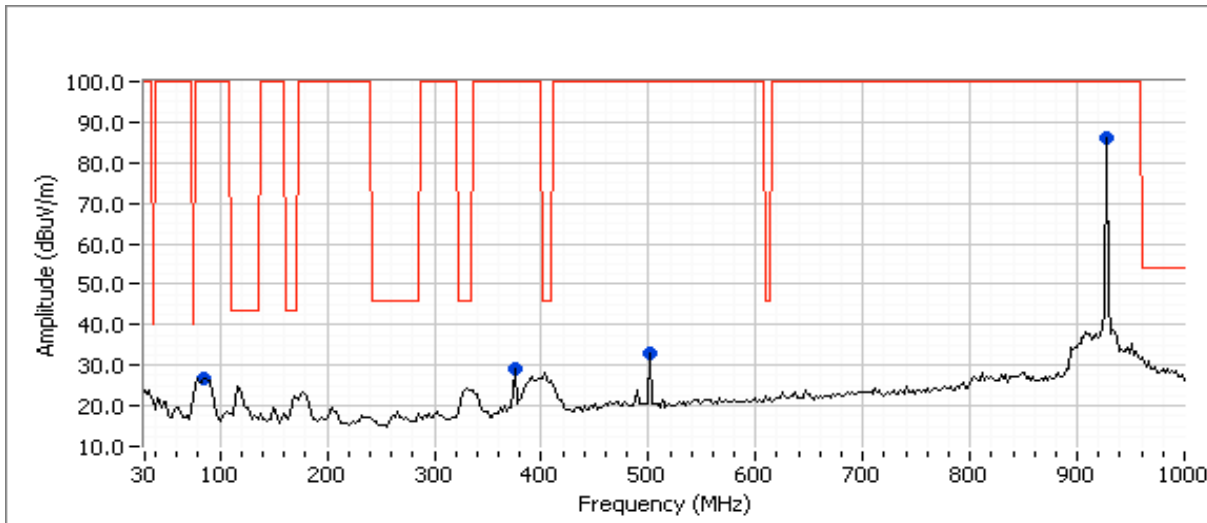
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
85.392	26.9	V	40.0	-13.1	Peak	86	1.0	Note 1
374.990	29.1	V	46.0	-16.9	Peak	60	1.0	Note 1
499.997	33.1	V	46.0	-12.9	Peak	264	1.0	Note 1
928.076	86.2	V	NA	NA	Peak	105	1.5	Fundamental
1853.330	44.7	V	54.0	-9.3	Peak	318	1.5	Note 1
2780.000	38.6	V	54.0	-15.4	Peak	280	1.5	
2440.000	63.9	V	NA	NA	Peak	359	2.5	BT advertising

Final readings

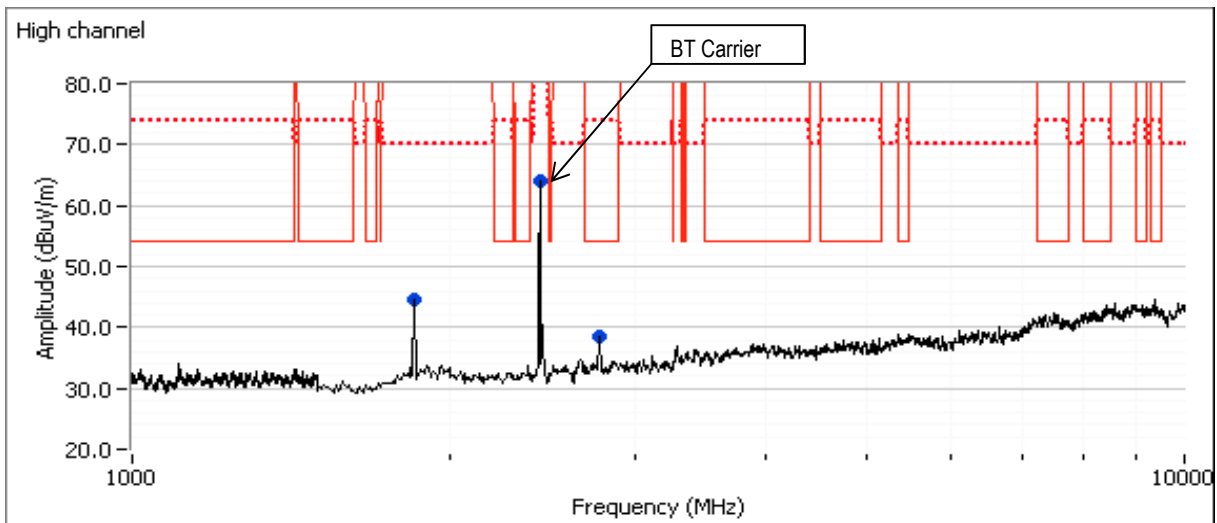
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
499.997	35.3	V	46.0	-10.7	QP	264	1.00	
85.392	32.7	V	40.0	-7.3	QP	124	1.00	
374.990	29.0	V	46.0	-17.0	QP	46	1.00	
2782.870	37.7	V	54.0	-16.3	AVG	257	1.51	
2782.750	43.3	V	74.0	-30.7	PK	257	1.51	
1855.180	44.6	V	54.0	-9.4	AVG	317	1.52	Note 1
1855.380	47.4	V	74.0	-26.6	PK	317	1.52	Note 1

Note: No spurious emissions observed between 10 GHz and 25 GHz during pre-scans.

Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Note: The narrow band tunable band reject filter K&L 3 TNF-800/1000 was used and tuned to suppress fundamental signal.



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A

Run #2: Radiated Spurious Emissions, 30 - 3000 MHz. Operating Mode: Rx

Date of Test: 3/3 & 3/16/17
 Test Engineer: John Caizzi
 Test Location: Chamber 4

Config. Used: 1
 Config Change: none
 EUT Voltage: 120V / 60Hz

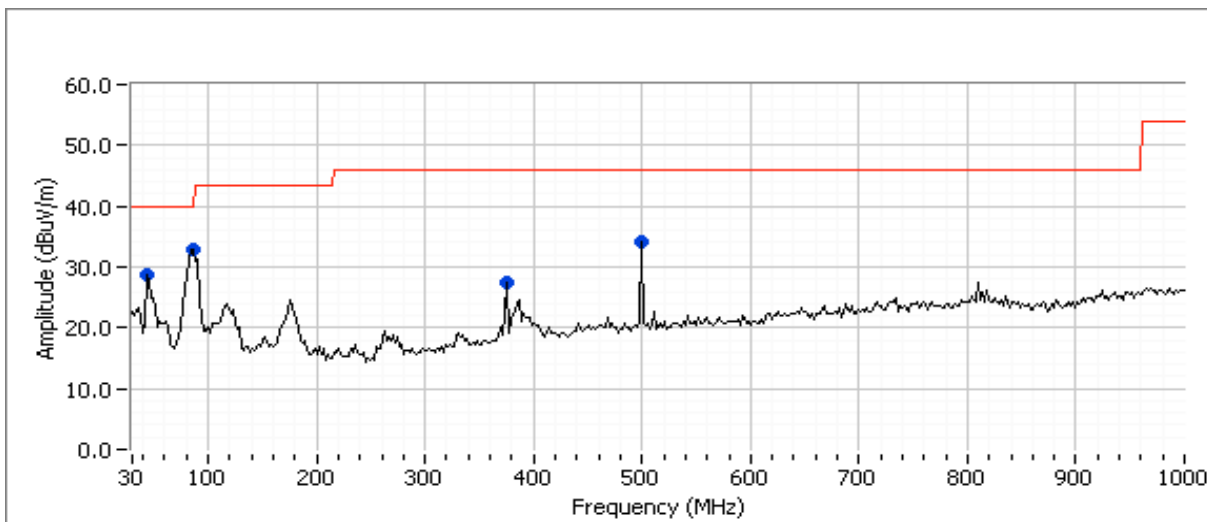
Run #2a: Low Channel @ 902.2 MHz

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

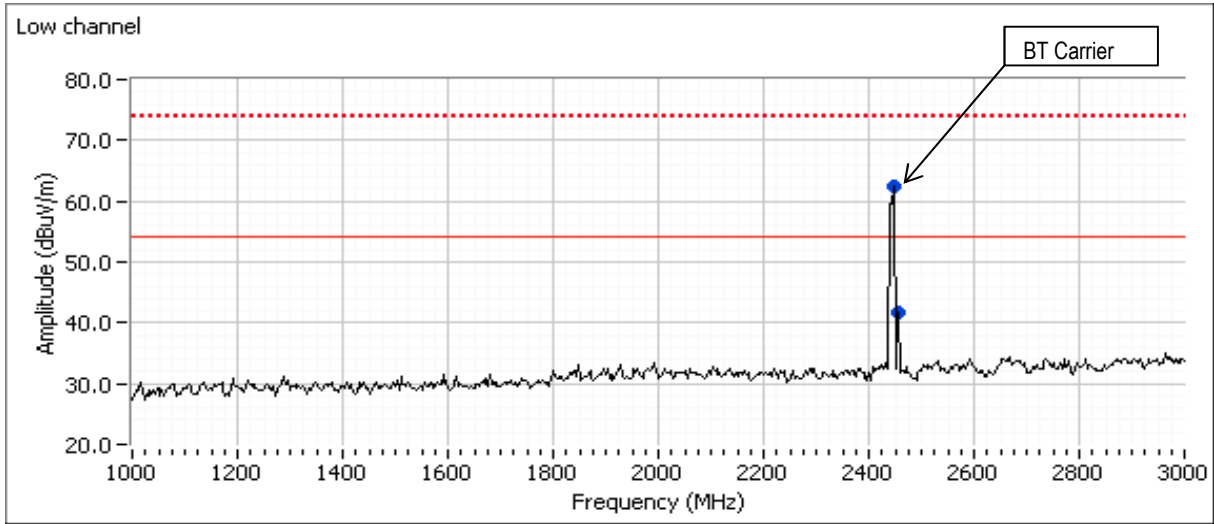
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
45.046	28.8	V	40.0	-11.2	Peak	32	1.0	
85.864	33.0	V	40.0	-7.0	Peak	116	1.0	
500.005	34.0	H	46.0	-12.0	Peak	77	2.0	
374.997	27.6	V	46.0	-18.4	Peak	82	1.0	
2446.670	62.3	V	54.0	8.3	Peak	290	2.0	BT advertising
2456.670	41.7	V	54.0	-12.3	Peak	112	1.5	BT advertising

Final readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
500.005	35.1	H	46.0	-10.9	QP	82	2.03	
85.860	20.7	V	40.0	-19.3	QP	182	1.00	
45.046	22.1	V	40.0	-17.9	QP	62	1.00	



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A

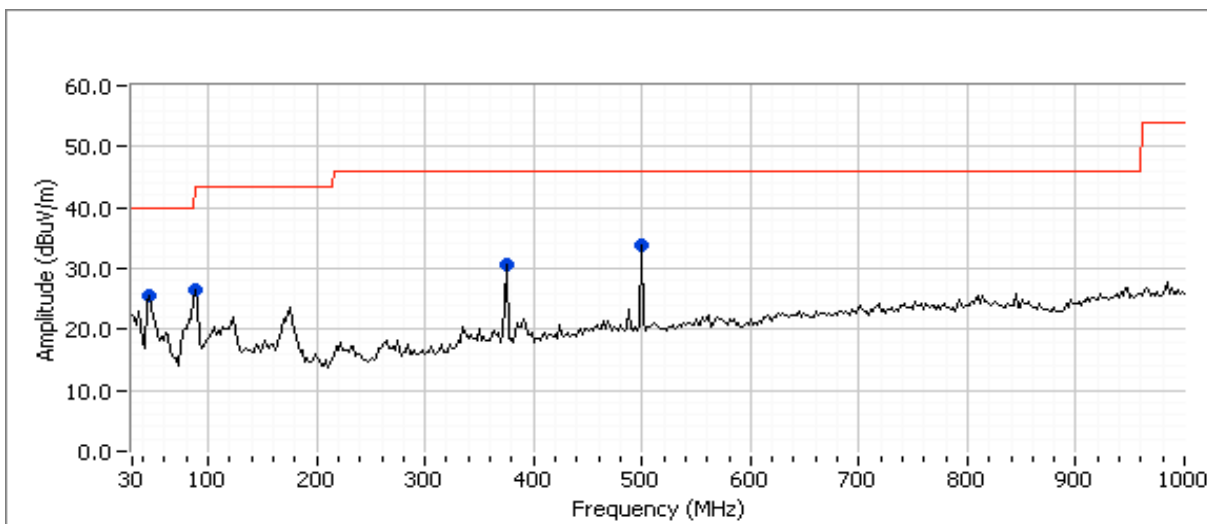
Run #2b: Center Channel @ 915 MHz

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

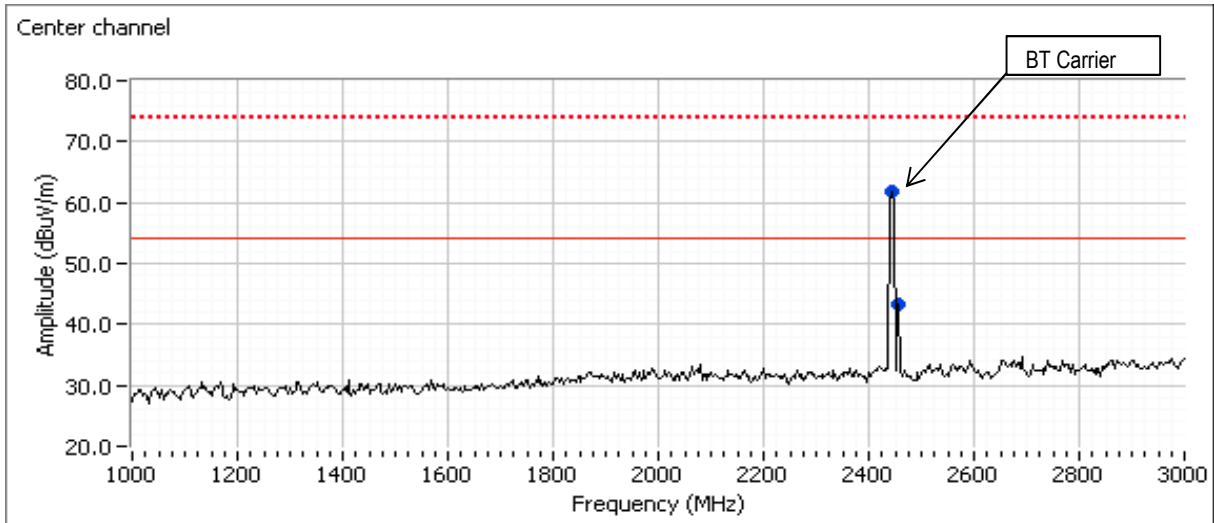
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
46.406	25.6	V	40.0	-14.4	Peak	57	1.0	
88.317	26.5	V	43.5	-17.0	Peak	186	1.0	
376.012	30.7	V	46.0	-15.3	Peak	241	1.0	
500.005	33.7	H	46.0	-12.3	Peak	106	2.0	
2443.330	61.7	V	54.0	7.7	Peak	17	1.0	BT advertising
2456.670	43.2	V	54.0	-10.8	Peak	37	1.0	BT advertising

Final readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
500.005	34.5	H	46.0	-11.5	QP	93	2.02	
46.406	23.2	V	40.0	-16.8	QP	96	1.00	



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A

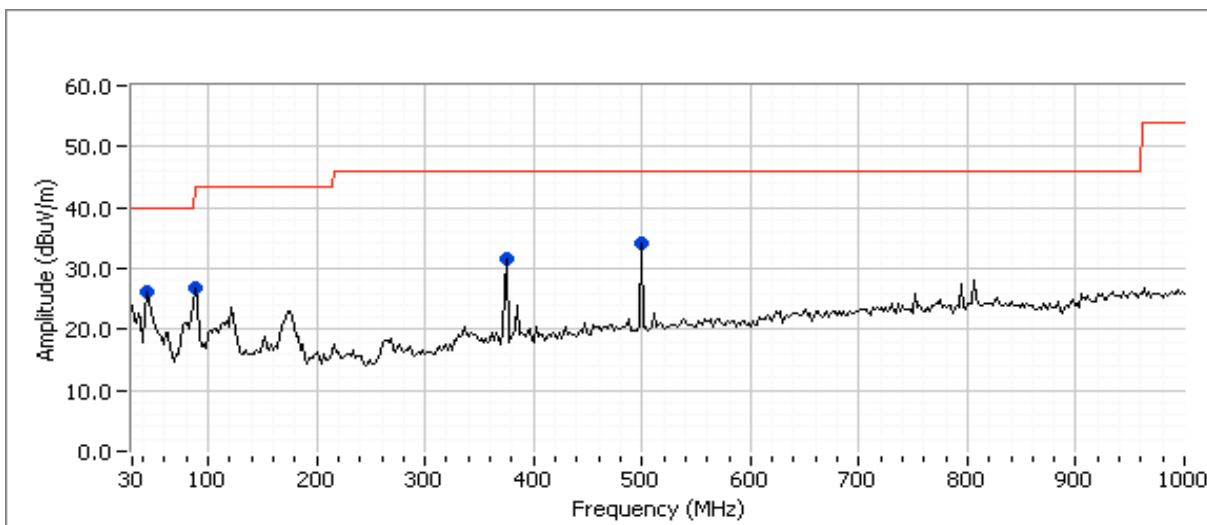
Run #2c: High Channel @ 927.6 MHz

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

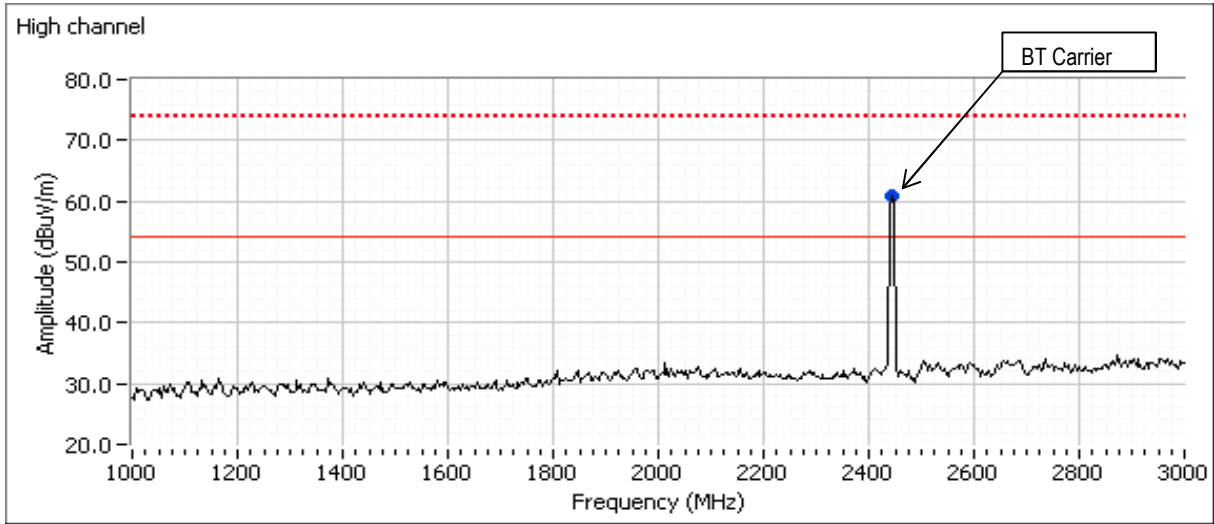
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
43.726	26.3	V	40.0	-13.7	Peak	47	1.0	
88.317	26.7	V	43.5	-16.8	Peak	211	1.0	
376.012	31.6	V	46.0	-14.4	Peak	27	1.0	
499.997	34.0	V	46.0	-12.0	Peak	92	1.0	
2443.330	61.0	V	54.0	7.0	Peak	9	1.5	BT advertising

Final readings

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
499.997	35.8	V	46.0	-10.2	QP	104	1.31	
43.726	22.7	V	40.0	-17.3	QP	38	1.00	



Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A



Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A

RSS 247 and FCC 15.247 (FHSS) 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.

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

Ambient Conditions:

Temperature: 22 °C

Rel. Humidity: 44 %

Summary of Results - Intermodulation

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1	Intermod check	BT @ 2441 Tx @ 915		-	Radiated Emissions 30 MHz - 25 GHz	FCC Part 15.209 / 15.247(c)	39.4 dBµV/m @ 499.99 MHz (-6.6 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.

Client: Topcon Positioning Systems	Job Number: JD103485
Model: GR-5 GNSS Receiver with FH915	T-Log Number: T103567
Contact: Ferdinand Riodique	Project Manager: Deepa Shetty
Standard: FCC Part 15.247, RSS-247	Project Coordinator: -
	Class: N/A

Run #1: Radiated Spurious Emissions, 30 MHz - 25 GHz.
BT - Basic mode 2441 MHz and UHF 30 dBm, modulated, 915 MHz

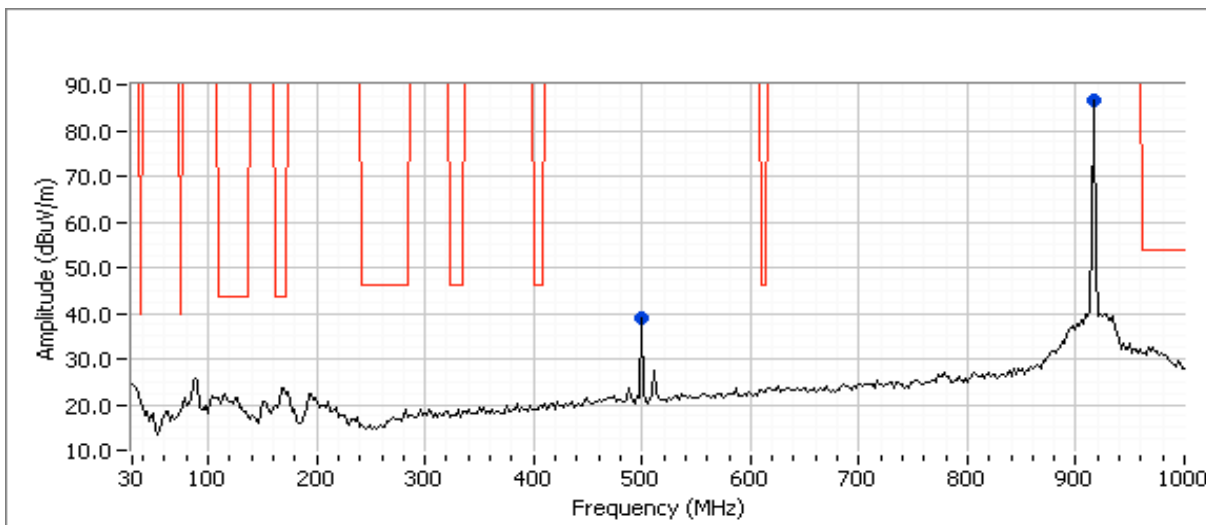
Date of Test: 3/16/2017
 Test Engineer: John Caizzi

Test Location: Chamber 4

Other Spurious Emissions

Frequency MHz	Level dBμV/m	Pol v/h	15.209 / 15.247 Limit Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
499.989	39.1	V	100.0 -60.9	Peak	348	1.5	
916.413	86.4	V	100.0 -13.6	Peak	286	1.0	UHF fundamental
1822.500	41.9	V	54.0 -12.1	Peak	273	1.0	Note 2
499.989	39.4	V	46.0 -6.6	QP	360	1.42	Note 2
1830.030	40.6	V	54.0 -13.4	AVG	267	1.00	
1830.020	44.4	V	74.0 -29.6	PK	267	1.00	

- 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: There was only one emission above the noise floor in the range 1.5-18 GHz. No plots for this frequency range.



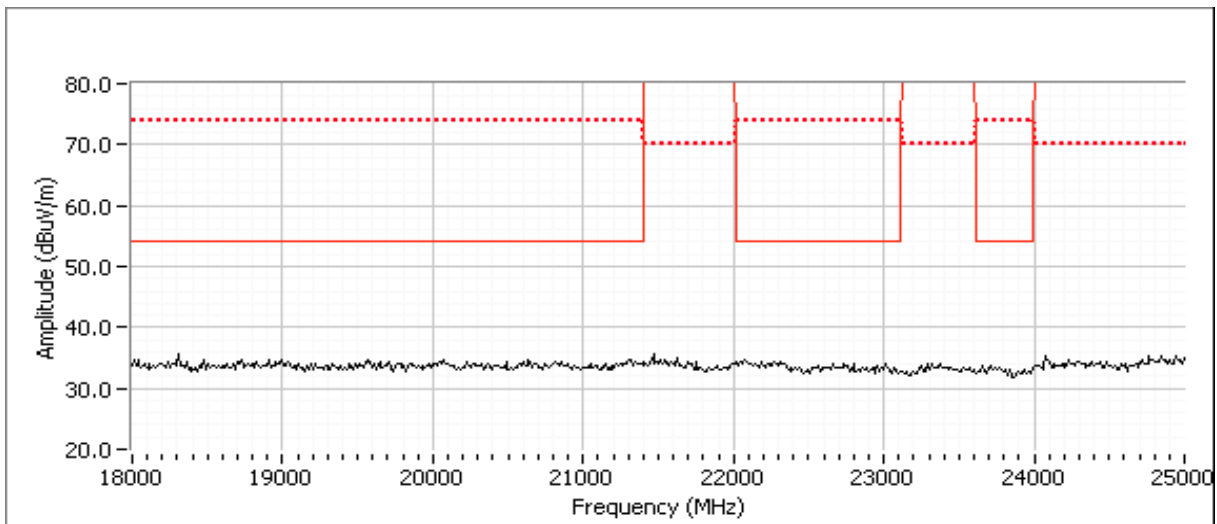
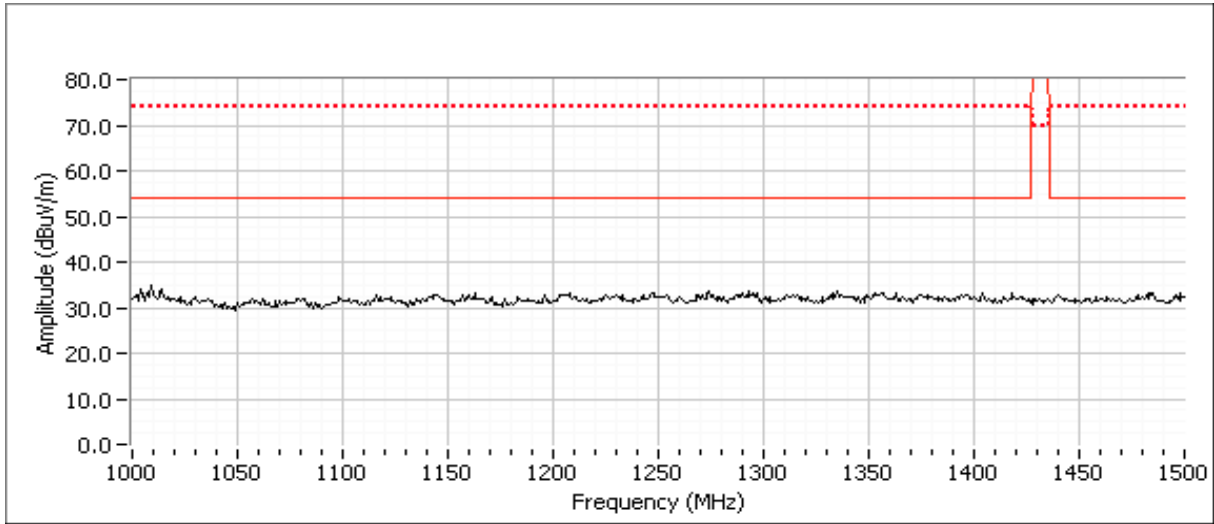
Note: The narrow band tunable band reject filter K&L 3 TNF-800/1000 was used and tuned to suppress fundamental signal.

**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client:	Topcon Positioning Systems	Job Number:	JD103485
Model:	GR-5 GNSS Receiver with FH915	T-Log Number:	T103567
Contact:	Ferdinand Riodique	Project Manager:	Deepa Shetty
Standard:	FCC Part 15.247, RSS-247	Project Coordinator:	-
		Class:	N/A



End of Report

This page is intentionally blank and marks the last page of this test report.