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Radio Test Report

FCC Part 90, Subpart M
919.75 MHz to 927.75 MHz

Model: MBS Beacon - Tiger (100-0004-05)

COMPANY:	NextNav LLC 484 Oakmead Pkwy Sunnyvale, CA 94085
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
REPORT DATE:	September 17, 2014
FINAL TEST DATES:	August 28, 2014
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ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	September 17, 2014	First release	

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SCOPE

Tests have been performed on the NextNav LLC model MBS Beacon - Tiger (100-0004-05), pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission and Industry Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- CFR 47 Part 90 (Private Land Mobile Radio Service) Subpart M

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.4:2003
ANSI TIA-603-C August 17, 2004

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

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the NextNav LLC model MBS Beacon - Tiger (100-0004-05) and therefore apply only to the tested sample. The sample was selected and prepared by Waldemar Kunysz of NextNav LLC.

OBJECTIVE

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

Prior to marketing in the USA, the device requires certification. Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of NextNav LLC model MBS Beacon - Tiger (100-0004-05) complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS

FCC Part 90

FCC	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics				
§2.1033 (c) (5) § 90.357(a)	Frequency range(s)	922.308 – 924.692 MHz[1]	919.75 -927.75 MHz	Pass
§2.1033 (c) (6) §2.1033 (c) (7) §2.1046 § 90.205	EIRP / ERP	25.1 Watts ERP[2]	30 Watts ERP (44.8 dBm)	Pass
§2.1033 (c) (4)	Emission types	G1D	-	-
§2.1047 § 90.207 § 90.210 (k)(1)	Emission mask	Within Mask	Within Mask	Pass
§2.1049 § 90.209(b)(5)	Occupied Bandwidth	3.877 MHz	8 MHz	Pass
Transmitter spurious emissions				
§2.1051 §2.1057	At the antenna terminals	Proposed new bandwidth would not affect spurious emissions	66dBc (-25dBm for 41 dBm output)	N/A
§2.1053 §2.1057	Field strength		-25 dBm	N/A
Receiver spurious emissions				
15.109	Field strength	Proposed new bandwidth would not affect receiver emissions	See limit table on page 14	N/A
Other details				
§2.1055 § 90.213	Frequency stability	Proposed new bandwidth would not affect stability	2.5 ppm	N/A
§2.1093	RF Exposure	Proposed new bandwidth would not affect RF Exposure	-	-
§2.1033 (c) (8)	Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	28VDC, 10amps, max 280 Watts	-	-
-	Antenna Gain	Maximum 8 dBi	-	-

Notes:
1. Minimum and maximum channel frequencies for this new bandwidth. Grant frequency range is 919.75-927.75.
2. Within 0.2 dB of grant power of 26.3 W.

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2) and were calculated in accordance with NAMAS document NIS 81 and M3003.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF frequency	Hz	25 to 7,000 MHz	1.7×10^{-7}
RF power, conducted	dBm	25 to 7,000 MHz	± 0.52 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The NextNav LLC model MBS Beacon - Tiger (100-0004-05) is a dedicated terrestrial navigation network transmitter that is designed to provide location services where traditional GPS receivers do not work. Since the EUT would be placed at a cell tower location during operation, the EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 120 Volts, 60 Hz, 5 Amps.

The sample was received on August 28, 2014 and tested on August 28, 2014. The EUT consisted of the following:

Company	Model	Description	Serial Number	FCC ID
NextNav, LLC	100-0004-05	Terrestrial Navigation Network Transmitter	905	A4P-100-0004-05

OTHER EUT DETAILS

The EUT antenna is provided at the installation site. The combination of antenna gain and cable loss will not exceed 3 dBd. The EUT unit has a capability to reduce the transmitted power in 0.5 dB steps in order to ensure that ERP of 30 Watts is not exceeded.

ENCLOSURE

The EUT enclosure is primarily constructed of steel. It measures approximately 66 cm wide by 51.5 cm deep by 76 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

No equipment was used as local support equipment for testing:

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

Company	Model	Description	Serial Number	FCC ID
Dell	Vostro	Laptop	42915093157	DoC

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Ethernet	Laptop	Cat 5	Unshielded	5

EUT OPERATION

During emissions testing the EUT was set to transmit on either the low or high channel at full power.

TESTING

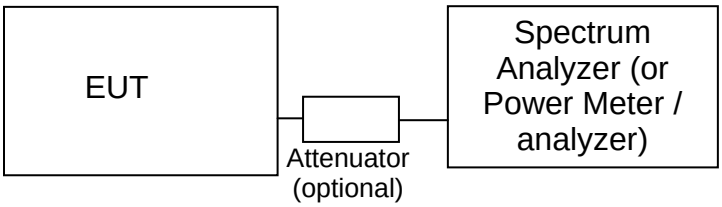
GENERAL INFORMATION

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

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's rf input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the rf port of the EUT and the measurement equipment.



Test Configuration for Antenna Port Measurements

For devices with an integral antenna the output power and spurious emissions are measured as a field strength at a test distance of (typically) 3m and then converted to an eirp using a substitution measurement. All other measurements are made as detailed below but with the test equipment connected to a measurement antenna directed at the EUT.

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH

Measurements of radiated field strength are compared directly to the specification limit (decibel form). The receiver and/or control software corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor is sued when measurements are made at a test distance that is different to the specified limit distance by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

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

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS –RADIATED POWER

The erp/eirp limits for transmitter spurious measurements are converted to a field strength in free space using the following formula:

$$E = \frac{\sqrt{30\ P\ G}}{d}$$

where:

E = Field Strength in V/m
P = Power in Watts
G = Gain of isotropic antenna (numeric gain) = 1
D = measurement distance in meters

The field strength limit is then converted to decibel form (dBuV/m) and the margin of a given emission peak relative to the limit is calculated (refer to *SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH*).

When substitution measurements are required (all signals with less than 20dB of margin relative to the calculated field strength limit) the eirp of the spurious emission is calculated using:

$$P_{EUT} = P_S - (E_S - E_{EUT})$$

and

$$P_S = G + P_{in}$$

where:

P_S = effective isotropic radiated power of the substitution antenna (dBm)
P_{in} = power input to the substitution antenna (dBm)
G = gain of the substitution antenna (dBi)
E_S = field strength the substitution antenna (dBm) at eirp P_S
E_{EUT} = field strength measured from the EUT

Where necessary the effective isotropic radiated power is converted to effective radiated power by subtracting the gain of a dipole (2.2dBi) from the eirp value.

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109, RSS 210 Table 2, RSS GEN Table 1 and RSS 310 Table 3. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

Appendix A Test Equipment Calibration Data

Radio Antenna Port (Power Mask and Bandwidth), 28-Aug-14

Manufacturer	Description	Model	Asset #	Cal Due
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1422	1/24/2015
Rohde & Schwarz	Power Sensor 100 uW - 2 Watts use with 20dB attenuator sn:1031.6959.00 only	NRV-Z32	1423	9/17/2014
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	4/8/2015

Appendix B Test Data

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Client:	NextNav LLC	Job Number:	J96114
Product	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	
Emissions Standard(s):	FCC Part 90	Class:	-
Immunity Standard(s):	-	Environment:	Radio

EMC Test Data

For The

NextNav LLC

Product

100-0004-05

Date of Last Test: 8/28/2014

Client:	NextNav LLC	Job Number:	J96114
Model:	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	-
Standard:	FCC Part 90	Class:	N/A

FCC Part 90

Power, Mask and Occupied Bandwidth

Test Specific Details

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

General Test Configuration

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Ambient Conditions:

Temperature: 21 °C

Rel. Humidity: 40 %

Summary of Results

Run #			Test Performed	Limit	Pass / Fail	Result / Margin
1			Output Power	30 Watts ERP (44.8 dBm)	Pass	44.0 dBm ERP
2			Spectral Mask	Within mask	Pass	Within Mask
3			99% or Occupied Bandwidth	-	-	3.877 MHz

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:	NextNav LLC	Job Number:	J96114
Model:	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	-
Standard:	FCC Part 90	Class:	N/A

Run #1: Output Power

Date of Test: 8/28/2014 Config. Used: 1

Test Engineer: David Bare Config Change: None

Test Location: Fremont Lab #4A EUT Voltage: 120V, 60 Hz

Cable Loss: 0.5 dB Attenuator: 20.0 dB Total Loss: 20.5 dB

Cable ID(s): EL525 Attenuator IDs: 1878.0

Attn Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Antenna Gain (dBi)	Result	ERP dBm	ERP W
2.5	922.308	41.2	13182.6	5.0	Pass	44.0	25.119
3	924.692	41.1	12882.5	5.0	Pass	43.9	24.547

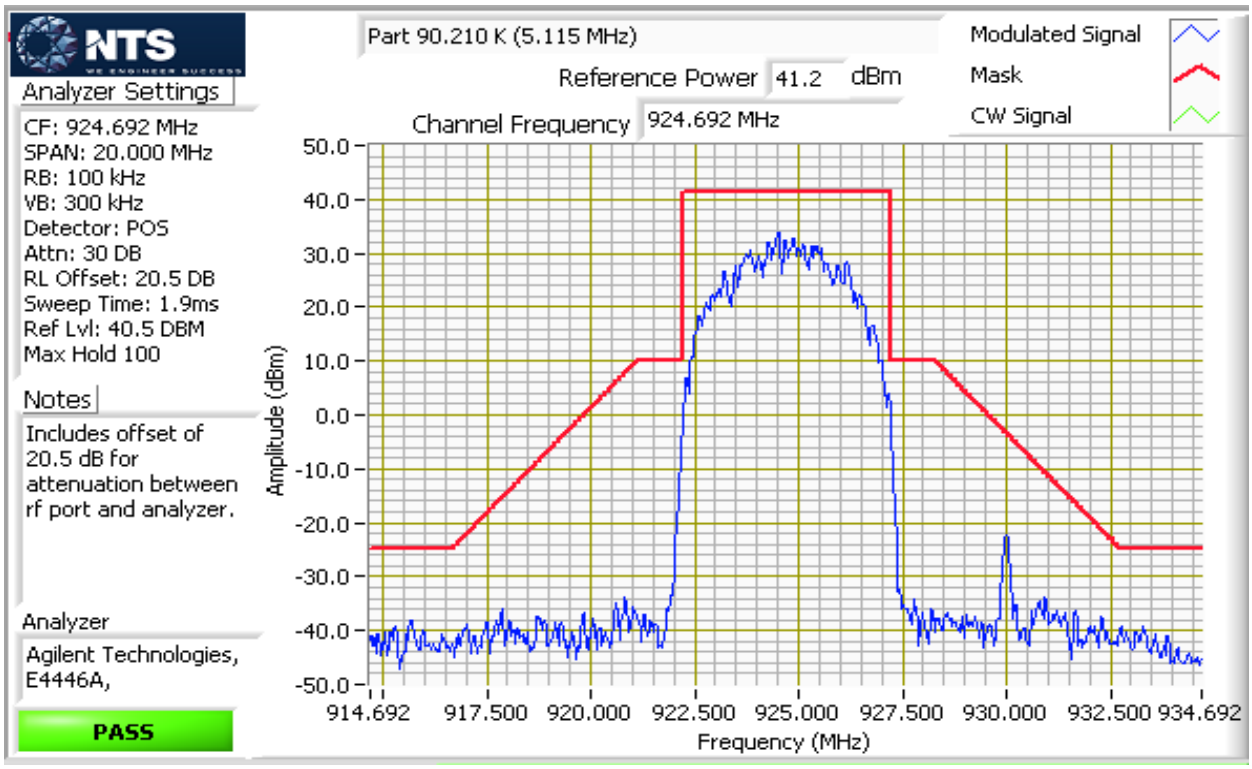
Note 1:	Output power measured using a peak power meter
Note 2:	Attenuator setting - the software attenuator setting used during testing, included for reference only.

Client:	NextNav LLC	Job Number:	J96114
Model:	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	-
Standard:	FCC Part 90	Class:	N/A

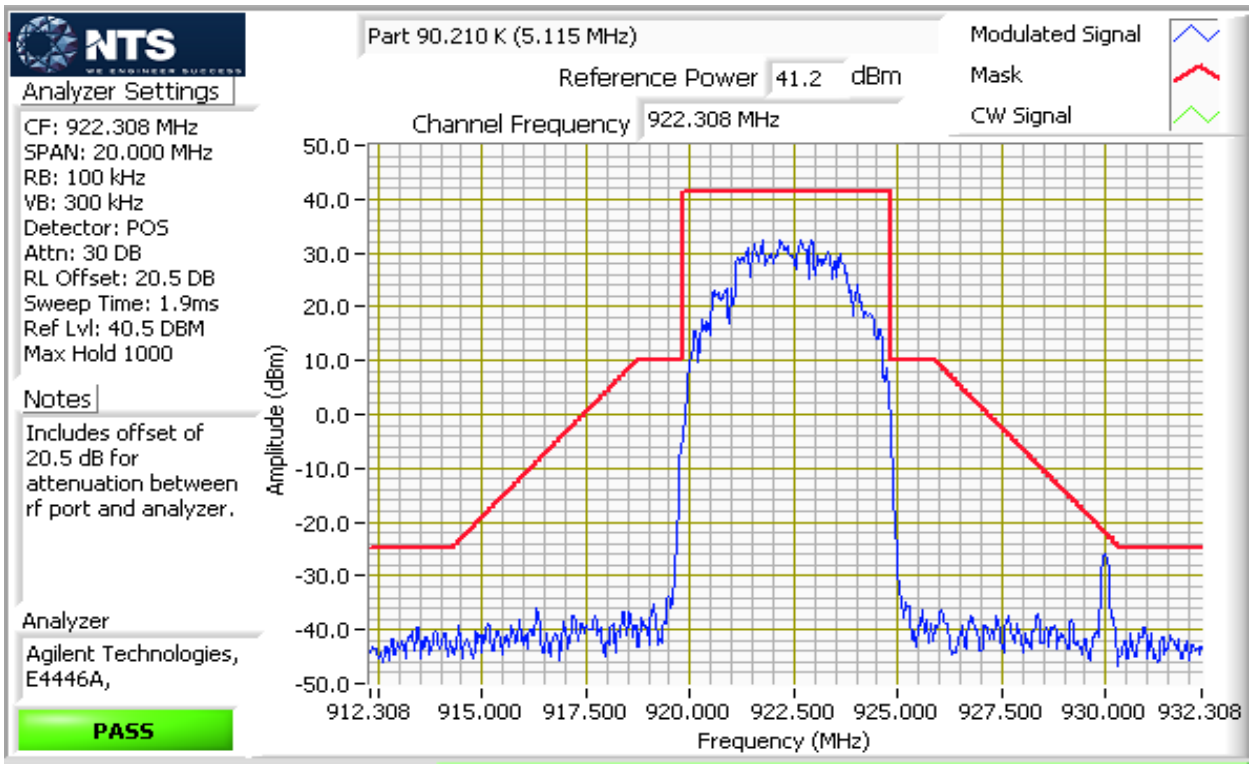
Run #2: Spectral Mask, FCC Part 90 Mask K 1 for 5.115 MHz necessary bandwidth

Date of Test: 8/28/2014 Config. Used: 1
Test Engineer: David Bare Config Change: None
Test Location: Fremont Lab #4A EUT Voltage: 120V, 60 Hz

Note 1:	Top of the mask was set to total peak power from Run #1.



Client:	NextNav LLC	Job Number:	J96114
Model:	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	-
Standard:	FCC Part 90	Class:	N/A



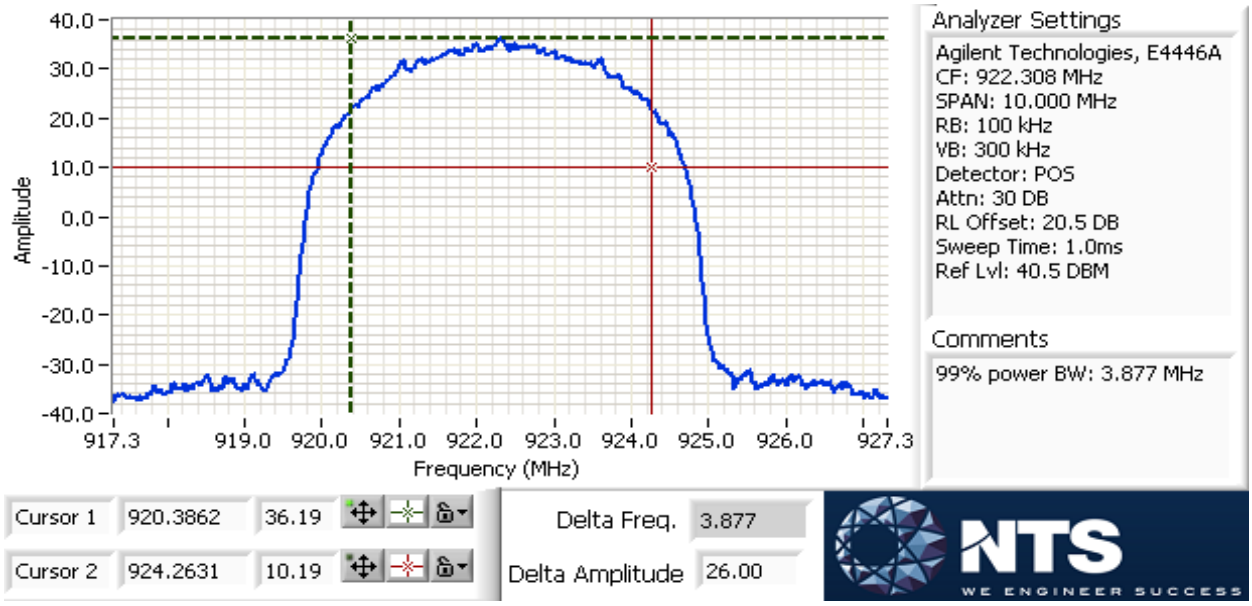
Client:	NextNav LLC	Job Number:	J96114
Model:	100-0004-05	T-Log Number:	T96183
		Project Manager:	Christine Krebill
Contact:	Waldemar Kunysz	Project Coordinator:	-
Standard:	FCC Part 90	Class:	N/A

Run #3: Signal Bandwidth

Date of Test: 8/28/2014 Config. Used: 1
Test Engineer: David Bare Config Change: None
Test Location: Fremont Lab #4A EUT Voltage: 120V, 60 Hz

Attn Setting	Frequency (MHz)	Resolution Bandwidth	Bandwidth (MHz)	
				99%
2.5	922.308	100 kHz		3.877

Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > 3xRB



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