RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

FCC Certification Report

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MODEL: ELUSIV Hummingbird GPS Tracking System
452 MHz FSK Beacon

FCC ID: 2ADCL-EL2715C001

July 12, 2015

Standards Referenced for this Report	
Part 2: 2014	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 15: 2014	Radio Frequency Devices
Part 90: 2014	Private Land Mobile Radio Services
TIA-EIA-603-C August 2004	Land Mobile FM or PM Communications Equipment – Measurement and Performance Standards

Frequency Range (MHz)	Rated Transmit Power (W) (Conducted)	Frequency Tolerance (ppm)	Emission Designator
452	0.01	3.4	20K2F1D

Report Prepared By: Daniel Baltzell

Document Number: 2014122

These test(s) are accredited under Rhein Tech Laboratories, Inc. ISO/IEC 17025 accreditation issued by the ANSI-ASQ National Accreditation Board. Refer to certificate and scope of accreditation AT-1445.

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1 Test Result Summary

Test	FCC & IC References	Result
RF Power Output	2.1046(a), 90.205	Compliant
Spurious Emissions at Antenna Terminals	2.1051, 90.210	Compliant
Field Strength of Spurious Radiation	2.1053(a), 90.210	Compliant
Occupied Bandwidth/Emission Masks	2.1049(c)(1), 90.210	Compliant
Frequency Stability vs. Temperature and Voltage	2.1055, 90.213,	Compliant
Modulation Characteristics	2.1047(a)(b)	N/A
Transient Frequency Response	90.214	N/A
Unintentional Digital/Receive Emissions	15B	Compliant

2 General Information

The following Certification Report is prepared on behalf of **Ntrepid Corporation** in accordance with the Federal Communications Commission Rules and Regulations. The Equipment Under Test (EUT) was the **ELUSIV Hummingbird GPS Tracking System; FCC ID: 2ADCL-EL2715C001.**

The radio is also subject to FCC verification. Verification testing was performed and the data is contained in a separate report.

All measurements contained in this application were conducted in accordance with the applicable sections of FCC Rules and Regulations CFR 47 Parts 2, 15, and 90. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, preamplifier and cables.

2.1 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to, and approved by, the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

2.2 Related Submittal(s)/Grant(s)

This is original submission for FCC certification.

2.3 Grant Notes

Requested grant notes: This device may be collocated with the following module: FCC ID: RI7GE865

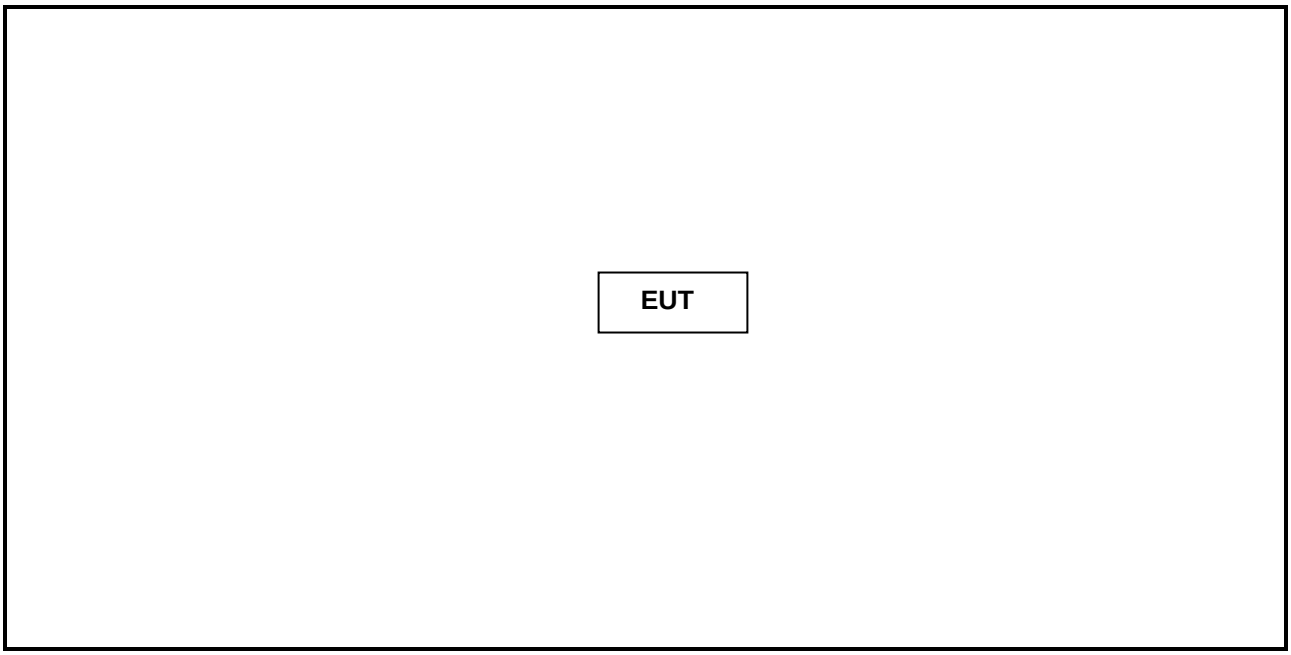
2.4 Tested System Details

The test sample was received on June 23, 2015. Listed below are the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this test, as applicable.

Table 2-1: Equipment Under Test (EUT)

Part	Manufacturer	Model	PN/SN	FCC ID	RTL Bar Code
Beacon	Ntrepid Corporation	ELUSIV Hummingbird GPS Tracking System	N/A	2ADCL-EL2715C001	21683
Conducted Antenna Beacon	Ntrepid Corporation	ELUSIV Hummingbird GPS Tracking System	N/A	2ADCL-EL2715C001	21681

Figure 2-1: Configuration of Tested System



3 FCC Rules and Regulations Part 2.1033(C)(8): Voltages and Currents Through The Final Amplifying Stage

VHF: 3.7 V / .003 A

4 FCC Rules and Regulations Part 2.1046(a): RF Power Output: Conducted, Part 90.205: Power and Antenna Height Limits

4.1 Test Procedure

ANSI/TIA/EIA-603-2004, section 2.2.1

The EUT was connected to a coaxial attenuator having a 50 Ω load impedance.

Manufacturer's Rated Power: 10 mW

4.2 Test Data

Table 4-1: RF Conducted Output Power - Measured

Frequency (MHz)	Power (dBm)	Power (W)
452	10	0.01

Table 4-2: Test Equipment Used For Testing RF Power Output - Conducted

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	11/13/15

Test Personnel:

Daniel Baltzell		June 25, 2015
EMC Test Engineer	Signature	Date of Test

5 FCC Rules and Regulations Part 2.1051: Spurious Emissions at Antenna Terminals; Part 90.210: Emission Limitations

5.1 Test Procedure

ANSI/TIA/EIA-603-2004, Section 2.2.13

The transmitter is terminated with a 50 Ω load and interfaced with a spectrum analyzer.

5.2 Test Data

Frequency range of measurement per Part 2.1057: 9 kHz to 10 x Fc

Limit: 43 + 10 LOG(P(W))

452 MHz was investigated and compared to the limit.

Plot 5-1: Spurious Emissions at Antenna Terminals – 452.0 MHz; Narrowband

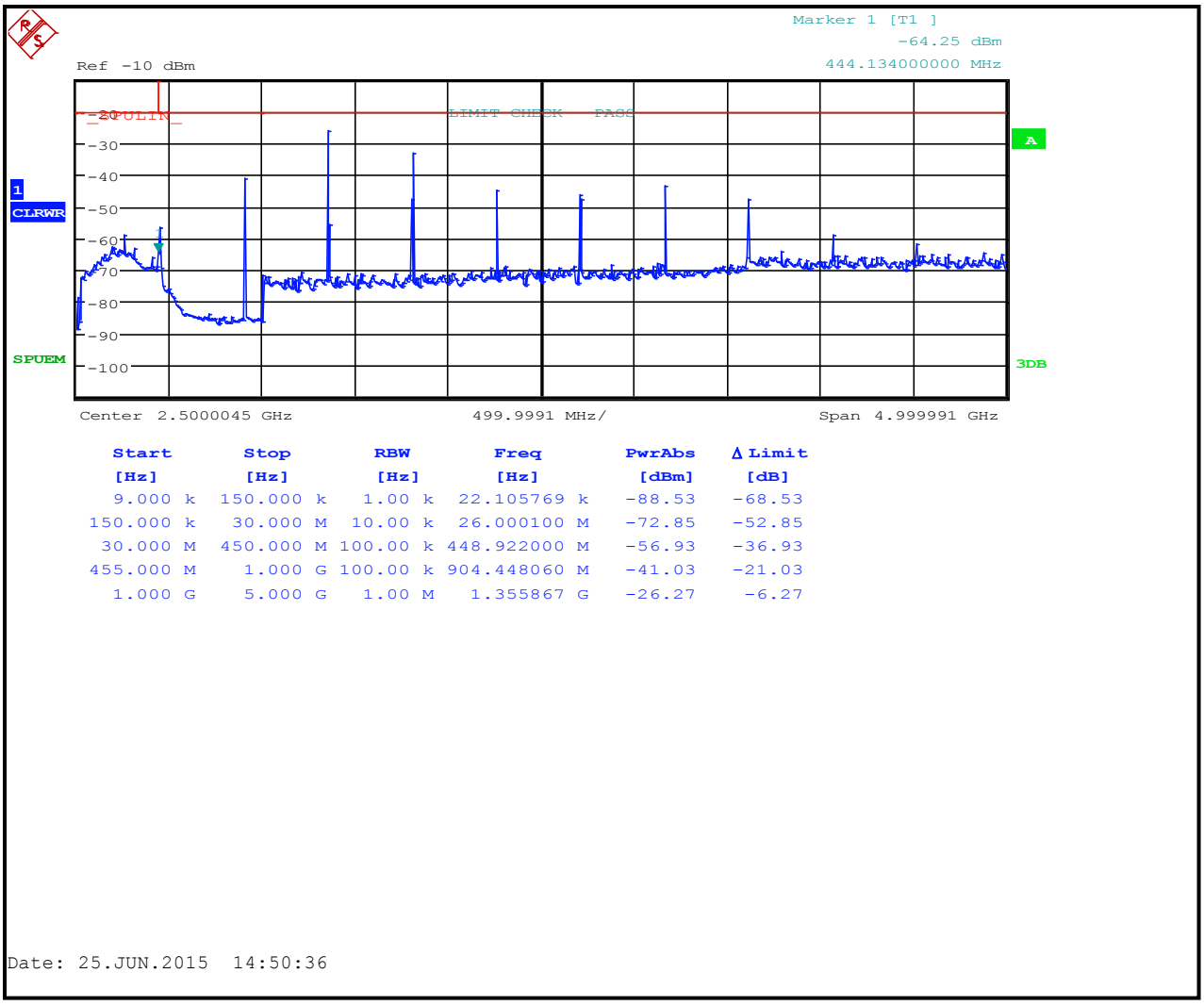


Table 5-1: Test Equipment Used For Testing Spurious Emissions

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	11/13/15

Test Personnel:

Daniel Baltzell		June 25, 2015
EMC Test Engineer	Signature	Date of Test

6 FCC Rules and Regulations Part 90.210(g) and Part 2.1053(a): Field Strength of Spurious Radiation, RSS-119 5.8 Transmitter Unwanted Emissions

6.1 Test Procedure

ANSI/TIA/EIA-603-2004, section 2.2.12

The spurious emissions levels were measured, and the device under test was replaced by a substitution antenna connected to a signal generator. This signal generator level was then corrected by subtracting the cable loss from the substitution antenna to the signal generator, and the gain of the antenna (dBi) was added to achieve the EIRP level.

6.2 Test Data

6.2.1 CFR 47 Part 90.210 Requirements

The magnitude of emissions attenuated more than 20 dB below the FCC limit need not be recorded.

Table 6-1: Field Strength of Spurious Radiation – 452 MHz

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
904.0	19.8	-54.3	0.3	0.9	63.6	-40.6
1356.0	11.0	-62.3	0.4	7.5	65.1	-42.1
1808.0	8.6	-63.4	0.4	8.5	65.4	-42.4
2260.0	15.1	-61.7	0.5	9.0	63.2	-40.2
2712.0	23.3	-52.7	0.6	9.6	53.7	-30.7
3164.0	22.3	-52.8	0.7	8.9	54.6	-31.6
3616.0	7.9	-66.3	0.8	9.2	67.8	-44.8
4068.0	2.4	-68.8	0.8	9.7	70.0	-47.0
4520.0	1.1	-70.2	0.9	10.6	70.5	-47.5

Note: radiated emissions were investigated with the module collocated and transmitting simultaneously with the following modularly approved device: FCC ID: RI7GE865

No non-compliant emissions were found; per FCC guidance, no data is being reported.

Table 6-2: Test Equipment Used For Testing Field Strength of Spurious Radiation

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900878	Rhein Tech Laboratories	AM3-1197-0005	3 meter antenna mast, polarizing	OATS1	N/A
901592	Insulated Wire Inc.	KPS-1503-3600-KPR	SMK RF Cables 20’	NA	9/3/15
901594	Insulated Wire Inc.	KPS-1503-360-KPR	SMK RF Cables 36”	NA	9/3/15
901242	Rhein Tech Laboratories	WRT-000-0003	Wood rotating table	N/A	N/A
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	11/13/15
901582	Rohde & Schwarz	1167.0000.02	Signal Generator	101903	11/14/15
900791	Chase	CBL6111B	Bilog Antenna (30 MHz – 2000 MHz)	N/A	6/11/17
900321	EMCO	3161-03	Horn Antennas (4 – 8 GHz)	9508-1020	4/9/18
900772	EMCO	3161-02	Horn Antenna (2 - 4 GHz)	9804-1044	4/9/18

Test Personnel:

Daniel Baltzell		June 25, 2015
Test Engineer	Signature	Date of Test

7 FCC Rules and Regulations Part 2.1049(c)(1): Occupied Bandwidth; Part 90.210: Authorized Bandwidth

Occupied Bandwidth - Compliance with the Emission Masks

7.1 Test Procedure

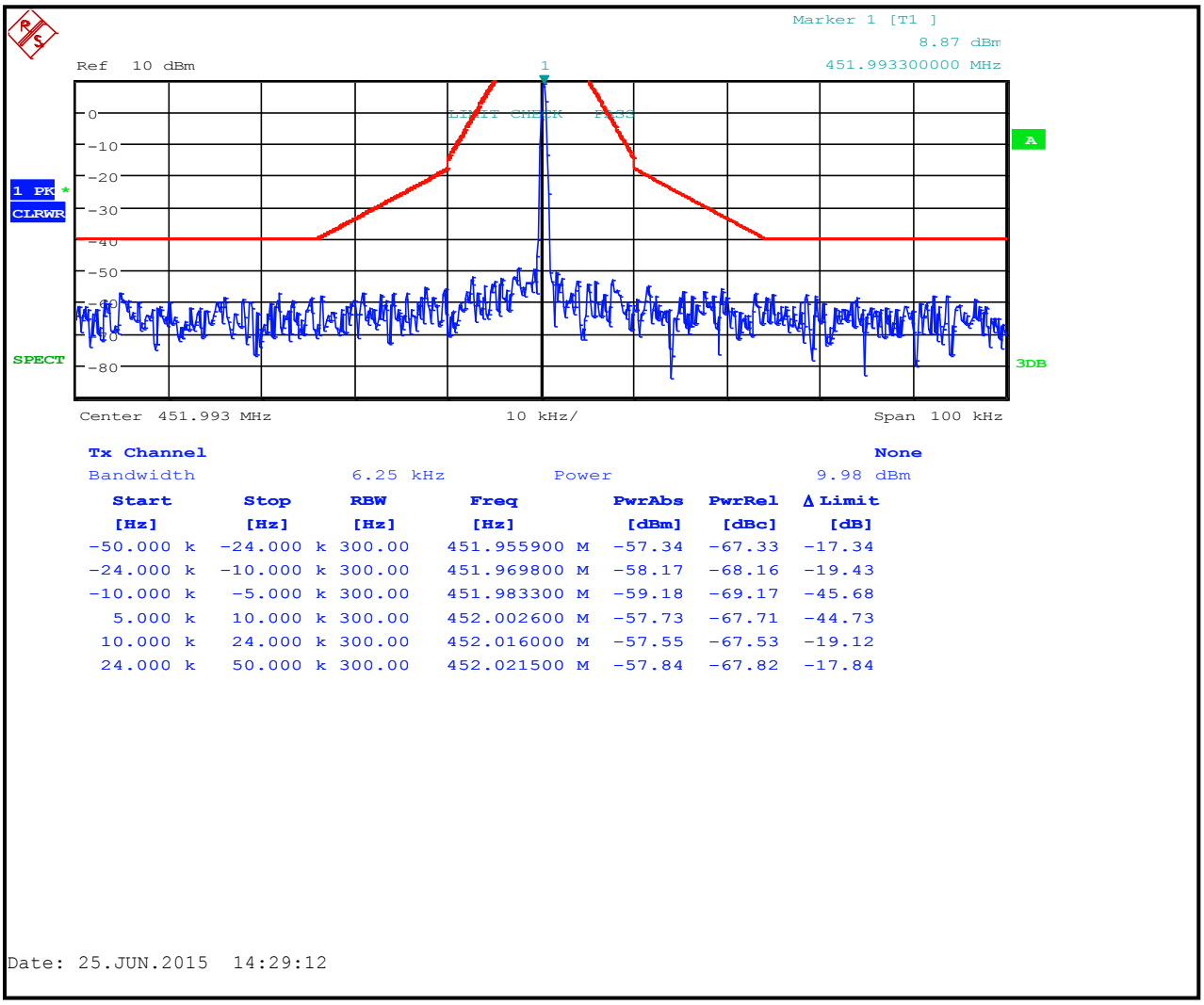
ANSI/TIA/EIA-603-2004, section 2.2.11 and TIA/EIA-102.CAAA-2002 section 2.2.5

Applicable Emission Masks		
Frequency Band (MHz)	**Mask for Equipment with Audio Low Pass Filter**	**Mask for Equipment Without Audio Low Pass Filter**
Below 25 [1]	A or B	A or C
25–50.....	B	C
72–76.....	B	C
150–174 [2]	B, D, or E	C, D, or E
150 Paging-only	B	C
220–222	F	F
421–512 [2]	B, D, or E	C, D, or E
450 Paging-only	B	G
806–809/851–854	B	H
809–824/854–869 [3]	B	G
896–901/935–940	I	J
902–928	K	K
929–930	B	G
4940–4990 MHz …….	L or M	L or M
5850–5925 [4]		
All other bands	B	C

1 Equipment using single sideband J3E emission must meet the requirements of Emission Mask A. Equipment using other emissions must meet the requirements of Emission Mask B or C, as applicable.
2 Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.
3 Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of §90.691.
4 DSRCS Roadside Units equipment in the 5850–5925 MHz band is governed under subpart M of this part.

7.2 Test Data

Plot 7-1: Occupied Bandwidth; Narrowband FSK; Mask C; 452 MHz



Tx Channel None

Bandwidth 6.25 kHz Power 9.98 dBm

Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	PwrRel [dBc]	Δ Limit [dB]
-50.000 k	-24.000 k	300.00	451.955900 M	-57.34	-67.33	-17.34
-24.000 k	-10.000 k	300.00	451.969800 M	-58.17	-68.16	-19.43
-10.000 k	-5.000 k	300.00	451.983300 M	-59.18	-69.17	-45.68
5.000 k	10.000 k	300.00	452.002600 M	-57.73	-67.71	-44.73
10.000 k	24.000 k	300.00	452.016000 M	-57.55	-67.53	-19.12
24.000 k	50.000 k	300.00	452.021500 M	-57.84	-67.82	-17.84

Date: 25.JUN.2015 14:29:12

Plot 7-2: 99% Occupied Bandwidth; 452 MHz

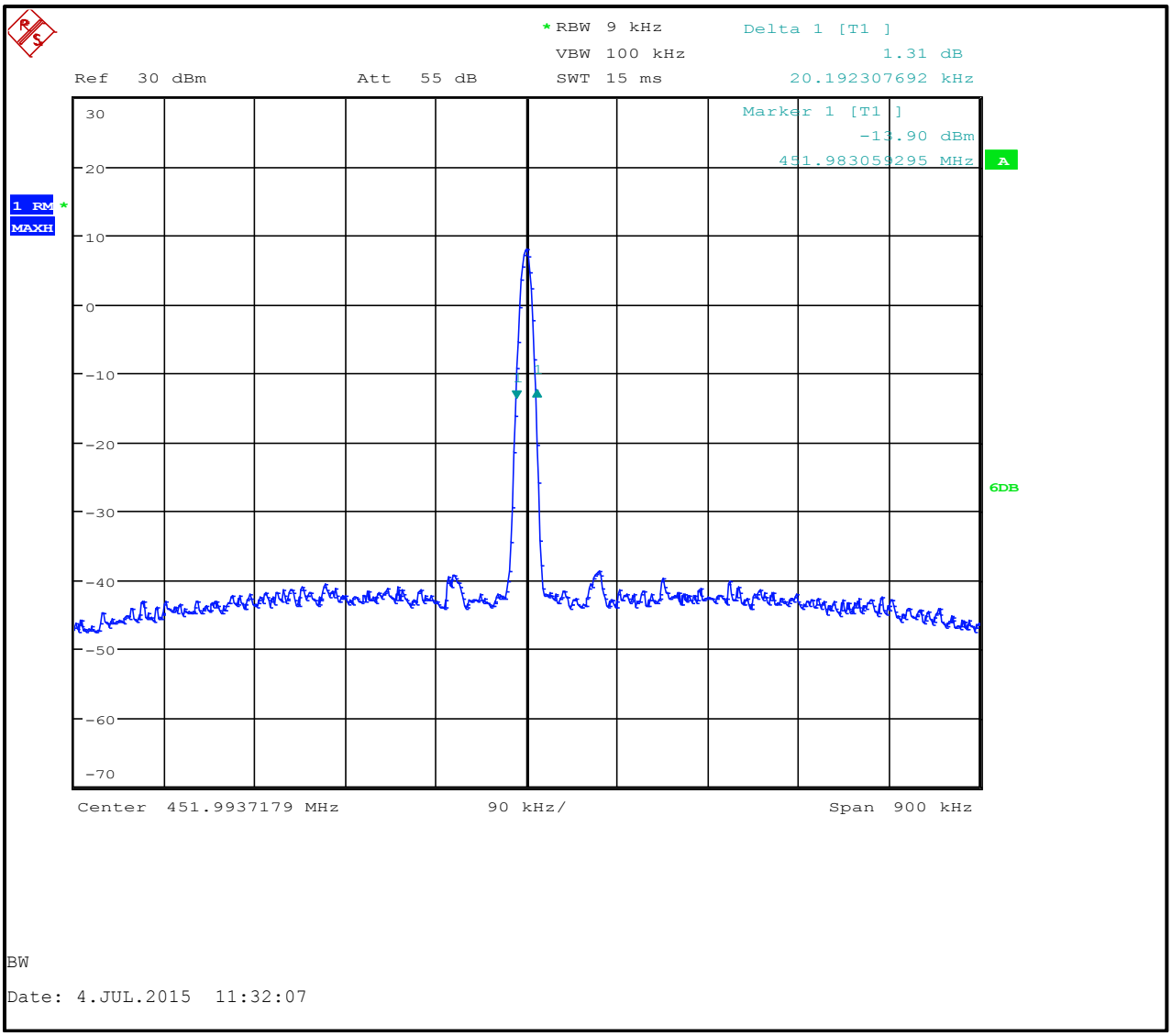


Table 7-1: Test Equipment Used For Testing Occupied Bandwidth

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	11/13/15
900957	Weinschel Corp	68-20-43	100W Attenuator 20 dB	LT394	3/25/16

Test Personnel:

Daniel Baltzell		June 25 and July 4, 2015
Test Engineer	Signature	Dates of Test

8 FCC Rules and Regulation Part 2.1055: Frequency Stability; Part 90.213

8.1 Test Procedure

ANSI/TIA/EIA-603-2004, section 2.2.2

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

The EUT was evaluated over the temperature range -30°C to +55°C.

The temperature was initially set to -30°C and a 1-hour period was observed for stabilization of the EUT. The frequency stability was measured within one minute after application of primary power to the transmitter. The temperature was raised at intervals of 10 degrees centigrade through the range. A ½-hour period was observed to stabilize the EUT at each measurement step and the frequency stability was measured within one minute after application of primary power to the transmitter. Additionally, the power supply voltage of the EUT was varied +/-15% nominal input voltage.

§90.217 Exemption from the Technical Standards

90.217(c) For equipment designed to operate with a 6.25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 12.5 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

8.2 Test Data

Table 8-1: Temperature Frequency Stability – 452 MHz

Temperature (°C)	Measured Frequency (Hz)	ppm
-30	451.998873	-2.49
-20	451.999909	-0.20
-10	452.000275	0.61
0	452.000708	1.57
10	452.000736	1.63
20 (reference)	452.000000	0.00
30	451.999979	-0.05
40	451.999484	-1.14
50	451.999333	-1.48
60	451.999182	-1.81

Result: The EUT is compliant.

8.2.1 Frequency Stability/Voltage Variation

Table 8-2: Frequency Stability/Voltage Variation – 452 MHz

Voltage (VDC)	Measured Frequency (MHz)	ppm
1.8 (Battery End Point)	451.999949	-0.11
3.145	452.000094	0.21
3.7 (reference)	452.000000	0.00
4.255	451.999210	-1.75

Table 8-3: Test Equipment Used For Testing Frequency Stability

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	1/13/16
901581	Rohde & Schwarz	FSU	Spectrum Analyzer	1166.1660.50	11/13/15
901635	Hewlett Packard	6024A	DC Power Supply	1912A00331	N/A
901350	Meterman	33XR	Multimeter	040402802	4/14/17

Test Personnel:

Daniel Baltzell		June 26, 2015
EMC Test Engineer	Signature	Date of Test

9 FCC Part 2.1047: Modulation Characteristics

Device is digital; no audio filtering present therefore testing not required.

10 FCC Part 90.214: Transient Frequency Response

Device is digital; no audio filtering present therefore testing not required.

11 FCC Rules and Regulations Part 2.202: Necessary Bandwidth and Emission Bandwidth

Calculation 2-FSK:
Data rate in bps (R) =1199
Deviation Peak deviation of carrier (D) = 5157
Constant factor (K): 1 (default)
Bn = 3.86D+0.27RK = 3.86(5157) + 0.27(1199)(1) =20.23 kHz
Emission designator: 20K2F1D

12 Conclusion

The data in this report shows that the Ntrepid Corporation Model ELUSIV Hummingbird GPS Tracking System, FCC ID: 2ADCL-EL2715C001 complies with the applicable requirements of FCC Parts 90, 15 and 2.