Testing Tomorrow's Technology

Report of

Title 47 CFR Part 95 Subpart J, Multi User Radio Services (MURS) and TIA-603-C (2004) Land Mobile FM or PM- Communications Equipment Measurement and Performance Standard

For the
Radio Systems Corporation

Family Name: GPSC Mobile
Model: 300-2946
FCC ID: KE3-3002946

Issue Date: June 21, 2014
Test Dates: May 29 through June 10, 2014

UST Project No.: 14-0126

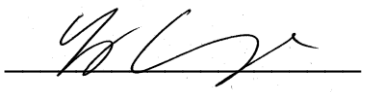
Total Number of Pages Contained in this Report: 15

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

Testing Tomorrow's Technology

I certify that I am authorized to sign for the test facility and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: 

Name: George Yang

Title: Laboratory Manager

Date: June 21, 2014

NVLAP LAB CODE 200162-0

This report shall not be reproduced except in full. This report may be copied in part only with the prior written approval of US Tech. The results contained in this report are subject to the adequacy and representative character of the sample provided. U.S. Technologies NVLAP accreditation does not allow product endorsement by NVLAP or any agency of the U.S. Government.

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

Table of Contents

Paragraph Title Page

1 General Information 5

1.1 Product Description 5
1.2 Related Submittal(s)/Grant(s) 5
1.3 Test Methodology 5
1.4 Test Facility 6
1.5 Test Equipment 6
1.6 Modifications to EUT 7

2 Output Power 9

2.1 Maximum Transmitter Power (FCC 2.1046 & 95.639(h)) 9
2.1.1 Maximum Power Allowed 9
2.1.2 Measured Fundamental Signal 9

3 Emission Bandwidth (Part 95.633(f)(1)) 10

3.1 Maximum Authorized Bandwidth, FCC requirement. 10

4 Unwanted Radiation Emission (CFR 95.635 (e)) 11

4.1 Test Method 11
4.2 FCC Limits 11
4.3 Test Results 12

5 Field Strength of Spurious Radiation, (FCC 2.1051 & 95.635(b)) 13

5.1 Test Method 13
5.2 FCC Limits 13

6 Frequency Stability (CFR 2.1055, 95.632(b)) 14

6.1 Test Method 14
6.2 FCC Limits 14
6.3 Test Results 14

List of Figures

Figure **Title** **Page**

Figure 1. Block Diagram 7
Figure 2. Measured Conducted Power 9
Figure 3. Bandwidth Measurement 10
Figure 4. Transmitter Spurious Emissions at Antenna Terminals 12

List of Tables

Table **Title** **Page**

Table 1. Test Instruments 6
Table 2. EUT and Peripherals 8
Table 3. Field Strength of Spurious Radiation 13
Table 4. Frequency Deviation/Stability 14
Table 5. Voltage Deviation/Stability 15

1 General Information

1.1 Product Description

The Equipment Under Test (EUT) is the Radio Systems Corporation GPSC Mobile, Model 300-2946 Invisible Fence brand pet collar. The product is a GPS pet containment collar unit that uses GPS coordinates to keep a pet within a desired area. The EUT also communicates via 151.82 MHz to a Base Reference Unit to receive GPS augmentation data and to relay battery levels and pet activity. See Figure.1 for the test setup.

1.2 Related Submittal(s)/Grant(s)

The EUT is subject to the following authorizations:

a) Certification as a 151.82 MHz, MURS transmitter per FCC Part 2, Subpart J and Part 95, Subpart J, MURS and Subpart E, Technical Requirements.

1.3 Test Methodology

These measurements were conducted in accordance with the requirements of Title 47 CFR Part 95, Subpart E and TIA-603-C (2004). All measurements are in terms of peak values unless stated otherwise. The measurement system video bandwidth was set to at least three times that of the resolution bandwidth to prevent the introduction of amplitude smoothing throughout the evaluation process. If interconnecting cables are part of the measurement setup then they were manipulated as necessary to maximize emissions. A block diagram of the tested system is shown in Figure 1.

1.4 Test Facility

The open area test site (OATS) used to collect the radiated data is located at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC under Site Registration number 186022.

1.5 Test Equipment

Table 1 describes test equipment used to evaluate this product.

Table 1. Test Instruments

Instrument Type	Manufacturer	Model	Serial Number	Last Calibration Date
Spectrum Analyzer	Hewlett-Packard	8566B	2410A00109	2/3/2014
Spectrum Analyzer	Agilent	E4407B	US41442935	11/8/2013
RF Preamp	Hewlett-Packard	8449B	3008A00480	2/06/2014
RF Preamp	Hewlett-Packard	8447D	2944A07436	2/6/2014
Loop Antenna	AH Systems	SAS-200/562	142	9/12/2013 2 year cal
Biconical Antenna	EMCO	3110B	9306-1708	2/11/2013 2 year cal
Log Periodic Antenna	EMCO	3146	9110-3236	6/5/2012 2 year cal 90 day extension
Environmental Chamber	Thermotron	SM16	17095	4/24/2013 2 year cal
Regulated Power Supply	TekPower	HY1803D	N/A	Not Required
LISN	Solar Electronics	9247-50-TS-50-N	955824 & 955825	3/20/2014
Spectrum Analyzer	Hewlett-Packard	3588A	3005A01195	5/17/2014
UST calculation software	UST	N/A	N/A	Not Required

All equipment is calibrated to NIST/USA traceable requirements and the calibration interval is 1-year unless otherwise noted.

1.6 Modifications to EUT

No modifications were necessary to bring the EUT into compliance with FCC Part 95.

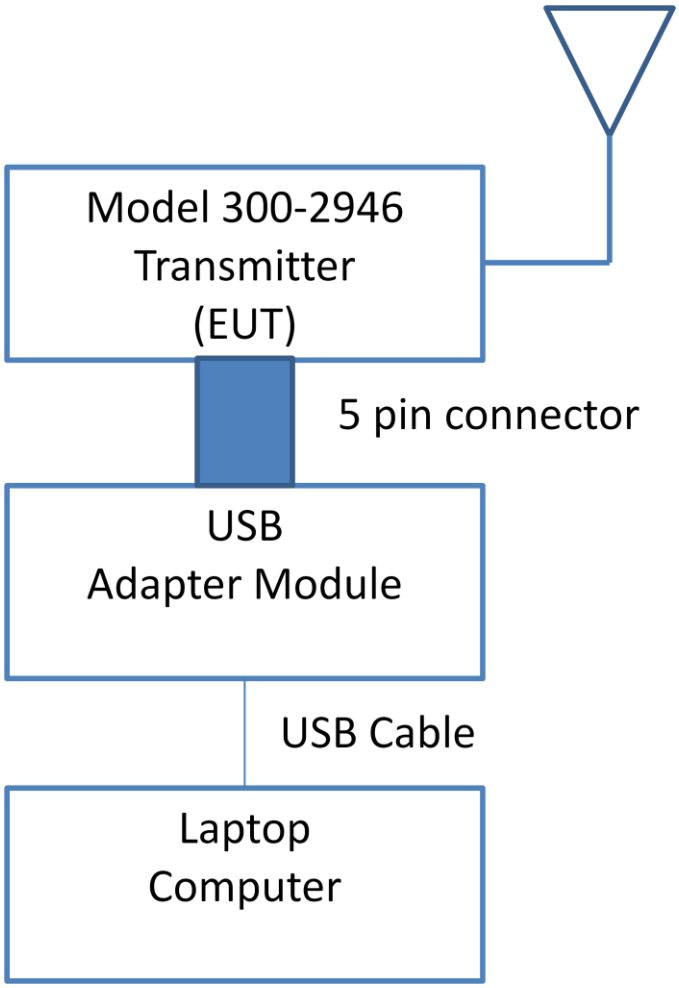


Figure 1. Block Diagram

Table 2. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/ IC ID:	CABLES P/D
GPSC Mobile (EUT) Radio Systems	300-2946	Engineering Sample	FCC: KE3-3002946 IC: N/A	NONE
USB Adapter Module	NA	NA	NA	USB
Laptop Dell	Various	Various	Various	USB 1.5m D

P = Power; D = Data U = Unshielded

2 Output Power

2.1 Maximum Transmitter Power (FCC 2.1046 & 95.639(h))

Maximum Transmitter Power was measured using the conducted method. The RF port where the antenna is terminated was connected to a short RF cable with an SMA connector on one end. The SMA connector was directly connected to a spectrum analyzer. The EUT was set up to transmit a signal with >98% duty cycle. The peak measurement of the signal was recorded.

2.1.1 Maximum Power Allowed

The maximum power allowed is 2 Watts (or 33 dBm) per FCC 95.639(h).

2.1.2 Measured Fundamental Signal

The maximum output power of the EUT as measured below is 0.0316 W.
15 dBm into 50 ohm = 31.63 mW <<2 Watts
Antenna gain = -19.7 dBi
EIRP = 15 – 19.7 = -4.7 dBm = 0.338 mW << 2 Watts

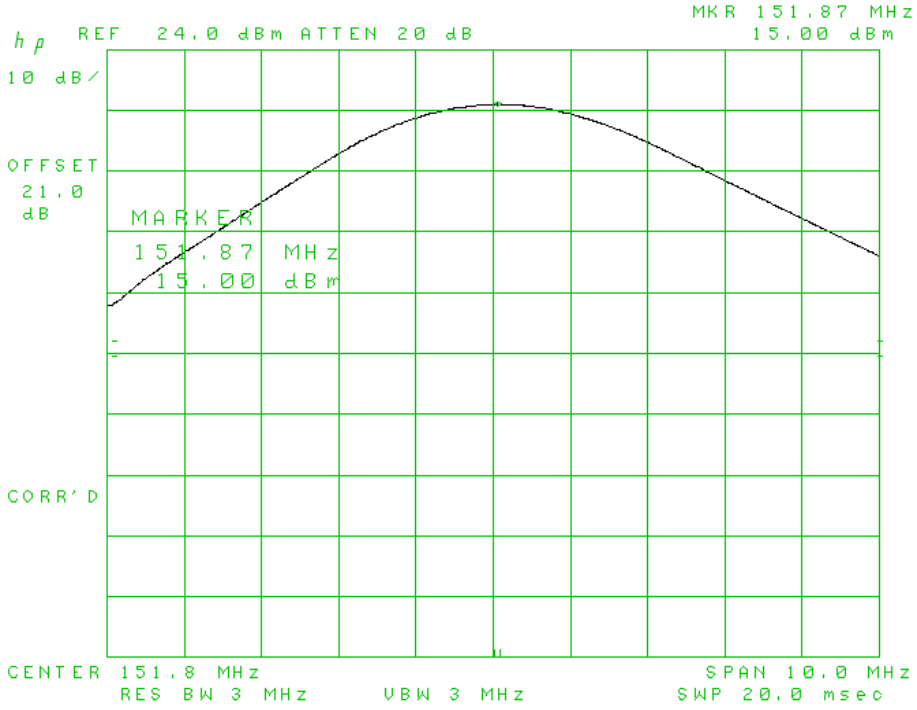


Figure 2. Measured Conducted Power

3 Emission Bandwidth (Part 95.633(f)(1))

The EUT was modulated by its own internal sources. The Bandwidth of the Fundamental was measured using a spectrum analyzer, as shown below. A RBW that was > 1% of the authorized bandwidth was used to measure the EUT's bandwidth.

Using the Emission Bandwidth measurement technique of ANSI C63.10-2009 as a guide, the measurement of the Emission Bandwidth is found to be 6.71 kHz.

3.1 Maximum Authorized Bandwidth, FCC requirement.

The maximum authorized Bandwidth per 95.633 (f)(1) = 11.25 kHz.

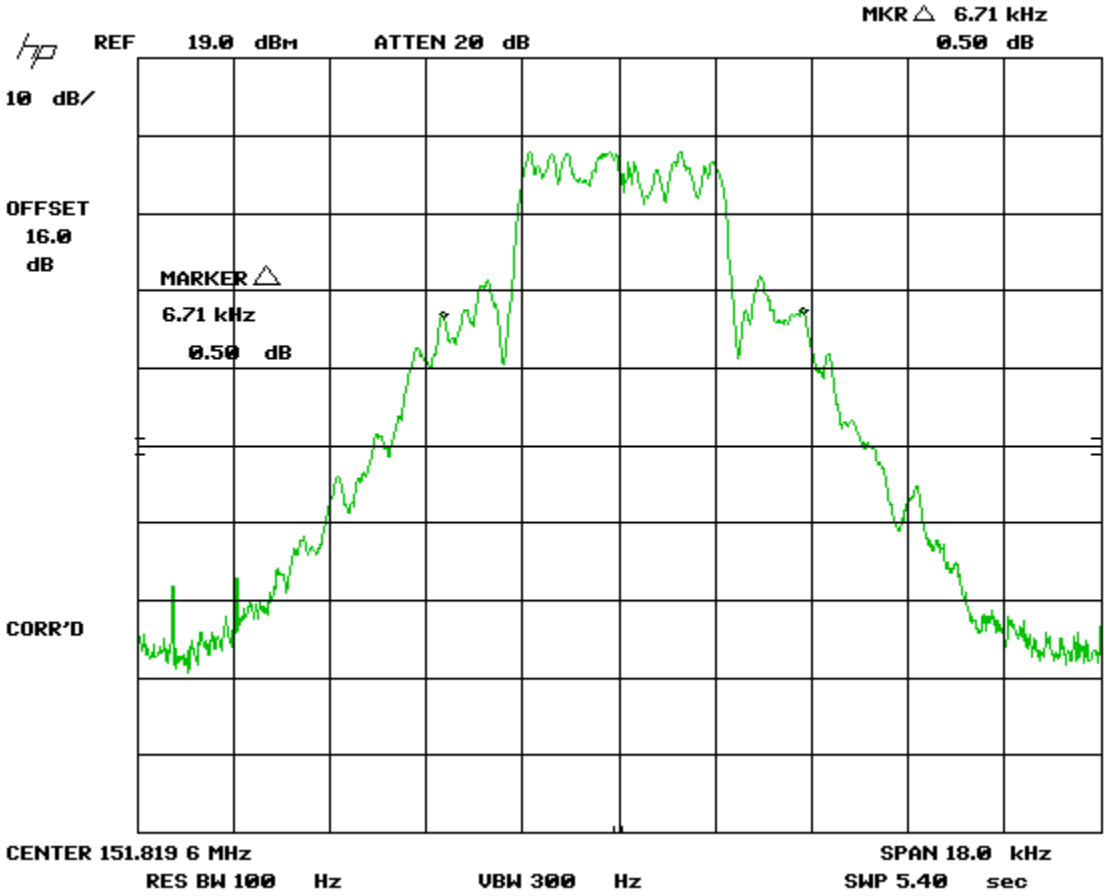


Figure 3. Bandwidth Measurement

4 Unwanted Radiation Emission (CFR 95.635 (e))

This requirement is from 47 CFR Part 2, Subpart J, Section 1053 and 95.635(e). The power of each unwanted emission shall be less than TP (Transmitter Power) as specified in paragraph 2.3.1 below.

4.1 Test Method

These emissions were measured on the Spectrum Analyzer via a short RF cable soldered to the RF output port of the transmitter circuit board.

4.2 FCC Limits

Per CFR Part 95.635(e) transmitters designed to operate in the MURS, transmitters shall comply with *"Emission Mask 1* : For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

"(i) On any frequency from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o: Zero dB.
(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: at least $7.27(f_d - 2.88$ kHz) dB.
(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation."

4.3 Test Results

The EUT is designed to operate in the 151.8200 MHz frequency and assumed not be using any audio low pass filter circuits, therefore only Emissions Mask 1 was applied.

The measured emissions comply with the specified mask as shown below.

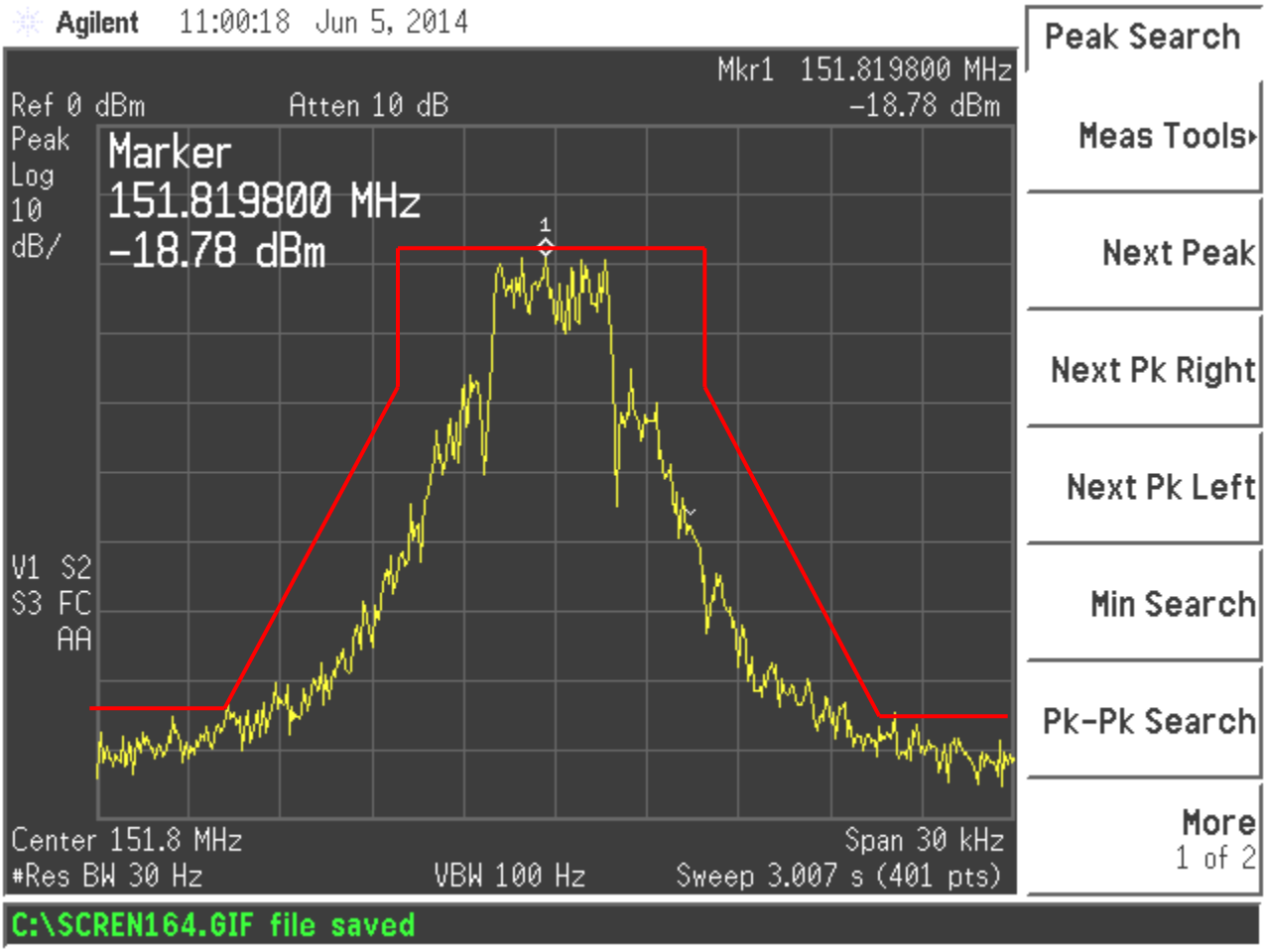


Figure 4. Transmitter Spurious Emissions at Antenna Terminals

Test Date: June 5, 2014
Tested By: _____ Name: John Wynn

5 Field Strength of Spurious Radiation, (FCC 2.1051 & 95.635(b))

5.1 Test Method

Spurious emissions were evaluated by the substitution method from 30 MHz to 1.0 GHz at a EUT to antenna distance of 3 meters. The EUT was tested in the far field. Measurements for 30 to 1000 MHz were made with the analyzer's bandwidth set to 120 kHz. Measurements above 1000 MHz were made with analyzer's bandwidth set to 1 MHz and 3 MHz. Since the EUT is part of a portable handheld configuration, the EUT was rotated through the three orthogonal planes to produce the highest emission relative to the limit. Results are shown in the Table below.

5.2 FCC Limits

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

Measured Conducted Output Power= 0.0316 Watts = 15 dBm
Attenuation Calculation = 50 + 10Log(0.0316) = 35
Power Limit = 15dBm – 35dB = -20 dBm

Table 3. Field Strength of Spurious Radiation

Frequency MHz	Maximum RX Reading (Units A)	Recreated Reading During Substitution (Using Same Units A) - Ideally 0	Difference Column A - B	TX Gain Relative to Dipole (dB)	RF Power into TX antenna (dBm) (SG Value-CL)	RF Power into substitution TX antenna (dBm)	Limit (dBm)	Margin Below Limit (dB)
303.64	52.40	52.00	0.40	1.86	-53.40	-51.14	-20.00	31.14
455.49	42.30	44.49	-2.19	3.86	-71.60	-69.93	-20.00	49.93
607.29	44.30	43.50	0.80	4.06	-65.50	-60.64	-20.00	40.64
759.11	40.60	44.67	-4.07	4.06	-65.64	-65.65	-20.00	45.65
910.96	37.70	40.05	-2.35	3.66	-65.85	-64.54	-20.00	44.54
1062.73	56.66	60.63	-3.97	2.66	-54.54	-55.85	-20.00	35.85
1214.57	56.07	58.83	-2.76	3.66	-54.64	-53.74	-20.00	33.74
1360.43	55.69	55.89	-0.20	4.86	-54.86	-50.20	-20.00	30.20
1518.26	49.99	52.77	-2.78	5.66	-65.68	-62.80	-20.00	42.80

Test Date: May 28, 2014
Tested By: John C Wynn Name: John Wynn

6 Frequency Stability (CFR 2.1055, 95.632(b))

6.1 Test Method

The EUT was tested in the Thermotron Environmental Chamber. The humidity was test to relative value of no more than 50%. The temperature was varied between -30°C to +50°C in 10° increments. All measurements were referenced back to the frequency measured at +20°C. At each set point the temperature was allowed to stabilize for no less than 30 minutes before measurements were recorded and the temperature changed.

The battery for the EUT was removed and the EUT was powered with a variable DC power supply. The voltage was varied between the nominal operating voltage and the end point of the battery (~85%). The fundamental frequency for each voltage setting was compared to the nominal voltage ambient temperature measurement and reported as compared to the limit.

6.2 FCC Limits

MURS transmitters must maintain a frequency stability of 5.0 ppm, or 2.0 ppm if designed to operate with a 6.25 kHz bandwidth.

6.3 Test Results

Table 4. Frequency Deviation/Stability

Temperature (degrees C)	Measured Frequency (MHz)	Allocated Frequency (MHz)	Deviation (ppm)	Limit (ppm)
-30	151.8197	151.82	2.00	5
-20	151.8198	151.82	1.10	5
-10	151.8202	151.82	1.00	5
0	151.8200	151.82	0.01	5
10	151.8197	151.82	2.00	5
20	151.8203	151.82	2.00	5
30	151.8202	151.82	1.00	5
40	151.8200	151.82	0.01	5
50	151.8200	151.82	0.01	5

Actual TX Frequency was: 151.8200 MHz

Maximum Deviation Calculation:

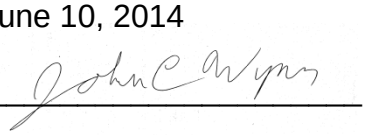
$$\text{Deviation} = \frac{|(151.820 - 151.8197)|}{151.8197} = 0.000002 = 2.00\text{ppm} < 5\text{ppm}$$

Table 5. Voltage Deviation/Stability

Voltage Variation	Measured Frequency (MHz)	Allocated Frequency (MHz)	Deviation (ppm)	Limit (ppm)
85%	151.820330	151.82	2.17	5
100%	151.820304	151.82	2.00	5

Maximum Deviation Calculation:

$$\text{Deviation} = \frac{|(151.820 - 151.820330)|}{151.820220} = 0.000002.17 = 0.000217\% = 2.17 \text{ ppm} < 5 \text{ ppm}$$

Test Date: June 10, 2014
Tested By
Signature:  Name: John C. Wynn