Testing Tomorrow's Technology

August 4, 2015

Ms. Cindy Allen
Radio Systems Corporation
10427 Electric Avenue
Knoxville, TN 37932

Dear Ms. Allen:

Enclosed herewith, please find Radio Systems Corporation's file copy of the FCC Part 95 Certification Report Update for the Radio Systems Corporation TEK G.

Please keep the report in your files as proof that the product has been successfully tested.

If you have any questions, please don't hesitate to call. Thank you very much for your business.

Sincerely,

Alan Ghasiani
Consulting Engineer - President

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

Testing Tomorrow's Technology

# Permissive Change Report

**for**

**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**

**Model: TEK G**

**FCC ID: KE3-3001112**

**Issue Date: September 2, 2015**
**Test Dates: August 3, September 1, 2015**

**UST Project No.: 15-0165**

Total Number of Pages Contained in this Report: 14

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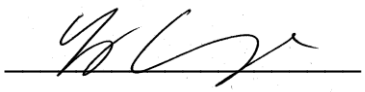
I certify that I am authorized to sign for the test facility and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: 

Name: George Yang

Title: Laboratory Manager

Date: September 2, 2015

NVLAP LAB CODE 200162-0



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# Table of Contents

## List of Figures

**Figure** **Title** **Page**



## List of Tables

**Table** **Title** **Page**

# 1 General Information

## 1.1 Test Report Purpose

The purpose of this report is to demonstrate compliance with FCC Part 95 of the FCC's Code of Federal Regulations for a Class II Permissive Change. The following changes have been made to the radio:

- The charge IC, U9, has been updated from MCP73853 to MCP73871
- The GPS receiver, U11, has been updated from IT500 to IT530
- A current limiting switch was added to the power amplifier. This is identified by reference designator U19A in the schematic.

No other changes were made. The RF path remains identical to the originally tested product. The functionality will remain unchanged, and the output power levels will remain unchanged. Complete testing was deemed inapplicable due to the changes made. Based on the changes listed above, only the digital emissions and a simple verification of the radio functions were reexamined. Please see the data presented in this test report.

## 1.2 Product Description

This device is a GPS-based tracking system for locating dogs. The system uses MURS band to send small amounts of data between the collar and handheld unit. This location data enables the handheld unit to display relative location of the dog to the handheld unit, including vector information, thereby allowing the user to track the dog.

## 1.3 Related Submittal(s)/Grant(s)

The EUT is subject to the following authorizations:

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

b) Verification under 15.101 as a digital device and receiver.

## 1.4 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.

## 1.5 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 | Agilent | E4407B | US41442935 | 1/28/2015 |
| RF Preamp | Hewlett-Packard | 8449B | 3008A00480 | 12/5/2014 |
| RF Preamp | Hewlett-Packard | 8447D | 1937A02980 | 12/4/2014 |
| Biconical Antenna | EMCO | 3110B | 9306-1708 | 11/24/2014<br>2 year cal |
| Log Periodic Antenna | EMCO | 3146 | 9305-3600 | 7/1/2014<br>2 year cal |
| Log Periodic Antenna | EMCO | 3146 | 9110-3236 | 11/19/2014<br>2 year cal |
| Horn Antenna | EMCO | 3115 | 3107-3723 | 7/8/2014<br>2 year Cal |
| Signal Generator | Hewlett-Packard | 8648B | 364U01679 | Verified with Agilent Spectrum Analyzer |

**Note: The calibration interval of the above test instruments is 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.**

## 1.6 Modifications to EUT

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

## 1.7 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.

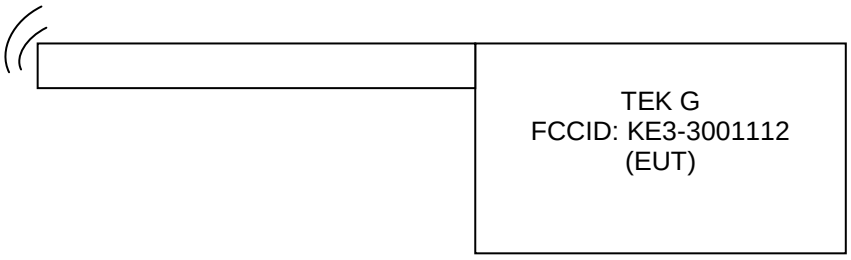



**Figure 1. Test Configuration Block Diagram**

## Table 2. EUT and Peripherals

| PERIPHERAL MANUFACTURER | MODEL NUMBER | SERIAL NUMBER | FCC/ IC ID: | CABLES P/D |
|---|---|---|---|---|
| TEK G (EUT) Radio Systems | TEK G | Engineering Sample | FCC: KE3-3001112 IC: N/A | None |
| Antenna (See Antenna Table) | - | - | - | - |

P = Power; D = Data U = Unshielded

## Table 3. Antennas

| REPORT REFERENCE | MANUFACTURER | TYPE OF ANTENNA | PART NUMBER | GAIN $dB_i$ | TYPE OF CONNECTOR |
|---|---|---|---|---|---|
| Antenna 1 | Radio Systems | Coil Antenna | ASM Antenna TEK-100E/TEK100G | 0 | SMA |

# 2 Output Power

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

No MURS unit, under any condition of modulation, shall exceed 2 Watts transmitter power output. In Order to calculate the output power at the transmitter connector, the emissions substitution method was used (see table below).

**Table 4. Peak Radiated Harmonic & Spurious Emissions**

| Frequency MHz | Maximum RX Reading (Units A) | Recreated Reading During Substitution (Using Same Units A) - Ideally 0 | Difference Column A - B | TX Gain (dBi) | TX Gain Relative to Dipole (dB) | RF Power into TX antenna (Corrected for any CL and Pads to antenna Feed Point) (dBm) (SG Value-CL) | RF Power into substitution TX antenna corrected by TX Gain Relative to Dipole (dBm) | Limit (dBm) | Margin Below Limit (dB) |
|---|---|---|---|---|---|---|---|---|---|
| The following applies information from test as performed | | | | | | | | | |
| 151.88 | 99.63 | 70.61 | 29.02 | 1.6 | -0.54 | -13.5 | 12.41 | 33 | 20.59 |
| | | | | | | | | | |

SAMPLE CALCULATION:
Results = Power into TX antenna – Cable loss + substitution antenna gain + Difference Column A –B
Results at 151.88 MHz: -13.5 + (-3.11) + (29.02) = 12.41 dBm [17.4 mW]

Test Date: September 1, 2015

Tested By
Signature:  Name: **Carrie Ingram**

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

## 3.1 Test Method

Spurious emissions were evaluated by the substitution method from 30 MHz up to tenth harmonic of the fundamental 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 emissions relative to the limits. Results are shown in the Table below.

## 3.2 FCC Limits

The limit is determined using the following information: 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, the limit will be at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

Output Power= 12.4 dBm = 17.4 mW
Attenuation Calculation = 50 + 10Log(0.0174) = 32.4 dB
Power Limit = 12.4 dBm – 32.4 dB = -20.0 dBm

## 3.3 Test Results

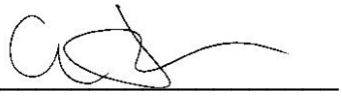
**Table 5. Field Strength of Spurious Radiation Up to 10th Harmonic**

| Frequency (MHz) | Maximum RX Reading (Units A) | Recreated Reading During Substitution (Using Same Units A) - Ideally 0 | Difference Column A - B | TX Cable Loss (dB) | 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) |
|---|---|---|---|---|---|---|---|---|---|
| 303.76 | 32.83 | 33.84 | -1.01 | 4.9 | 2.76 | -54.12 | -53.83 | -20 | 33.83 |
| 455.64 | 35.45 | 35.25 | 0.2 | 6.4 | 4.26 | -47.69 | -44.97 | -20 | 24.97 |
| 607.52 | 38.8 | 37.75 | 1.05 | 6.5 | 4.36 | -45.04 | -41.61 | -20 | 21.61 |
| 759.39 | 27.55 | 31.17 | -3.62 | 6.4 | 4.26 | -50.18 | -51.72 | -20 | 31.72 |
| 911.28 | 25.06 | 25.15 | -0.09 | 5.9 | 3.76 | -53.02 | -51.72 | -20 | 31.72 |
| No other emissions within 20 dB of limit were detected. | | | | | | | | | |

Sample Calculation at 303.76 MHz:

| | |
|---|---|
| SG Power Into TX Antenna | -54.12 (dBm) |
| + TX Gain | 2.76 (dB) |
| +Difference between recreated and Actual | -1.01 (dB) |
| +TX Cable Loss | -1.46 (dB) |
| RF Power Into TX Antenna | -53.83 (dBm) |
| | |
| Limit | -20.00 (dBm) |
| RF Power into TX Antenna | -53.83 (dBm) |
| Margin | 33.83 (dB) |

Test Date: August 3, 2015

Tested By
Signature:  Name: Carrie Ingram

# 4 Digital Radiated Emissions (CFR 15.101)

The data included in the test report is for the Digital Emission verification of the EUT.

## 4.1 Test Method

The EUT was configured as shown in the above block diagram. The EUT was tested per ANSI C63.4-2009, *American National Standard for Methods of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz(2009)* paragraph 8 for radiated emissions. Radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter on the spectrum analyzer was OFF throughout the evaluation process. The EUT and Peripherals Table describe other instruments and accessories used to evaluate this product.

## 4.2 Test Results

The worst-case radiated emission for the EUT in the range of 30 MHz to 1000 MHz was 13.7 dB below the limit at 165.68 MHz. All other radiated emissions were at least 14.6 dB below the FCC Part 15, Class B limit. This data can be found in Table 6.

All emissions in the Frequency range from 1 GHz to 16 GHz were 20 dB or more from the limit.

## Table 6. Radiated Emissions Test Data Below 1 GHz

| 30 MHz to 1000 MHz with Class B Limits | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test:** Radiated Emissions | | | | **Client:** Radio Systems Corporation | | | |
| **Project:** 15-0165 | | | | **Model:** TEK G | | | |
| **Frequency (MHz)** | **Test Data (dBuv)** | **AF+CA-AMP (dB/m)** | **Results (dBuV/m)** | **QP Limits (dBuV/m)** | **Antenna Distance/ Polarization** | **Margin (dB)** | **Detector PK, or QP** |
| 137.26 | 35.43 | -13.26 | 22.17 | 43.5 | 3m./HORZ | 21.3 | QP |
| 188.97 | 37.97 | -10.91 | 27.06 | 46.0 | 3m./HORZ | 16.4 | QP |
| 110.50 | 38.46 | -15.03 | 23.43 | 43.5 | 3m./VERT | 20.1 | QP |
| 165.68 | 40.25 | -11.35 | 28.9 | 46.0 | 3m./VERT | 14.6 | QP |
| 386.55 | 39.28 | -8.17 | 31.11 | 46.0 | 3m./HORZ | 14.9 | QP |
| 386.56 | 40.62 | -8.37 | 32.25 | 46.0 | 3m./VERT | 13.7 | QP |
| All other emissions seen were 20 dB or more from the limit. | | | | | | | |

Sample Calculation at 188.97 MHz:

| | | |
|---|---|---|
| Magnitude of Measured Frequency | 37.97 | dBuV |
| +Antenna Factor + Cable Loss+ Amplifier Gain | -10.91 | dB/m |
| Corrected Result | 27.06 | dBuV/m |

Test Date: August 3, 2015
Tested by
Signature: _____ Name: Carrie Ingram

## Table 7. Radiated Emissions Test Data Above 1 GHz

| 30 MHz to 1000 MHz with Class B Limits | | | | | | | |
|---|---|---|---|---|---|---|---|
| Test: Radiated Emissions | | | | Client: Radio Systems Corporation | | | |
| Project: 15-0165 | | | | Model: TEK G | | | |
| **Frequency (MHz)** | **Test Data (dBuv)** | **AF+CA-AMP (dB/m)** | **Results (dBuV/m)** | **AVG Limits (dBuV/m)** | **Antenna Distance/ Polarization** | **Margin (dB)** | **Detector PK, or AVG** |
| All emissions seen were 20 dB or more from the limit. | | | | | | | |

Sample Calculation: N/A

Test Date: August 3, 2015
Tested by
Signature: _____ Name: Carrie Ingram

### 4.2.1 Measurement Uncertainty

#### 4.2.1.1 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21 dB (3 m distance).

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. The EUT unconditionally passes this requirement.

### 4.3 Test Outcome

The EUT unconditionally passed Technical Requirements of Title 47 of the US Code, Part 15 Subpart B, Unintentional Radiators, per paragraph 15.109 for a Class B Digital Device.