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# ENGINEERING TEST REPORT

RADIO-FREQUENCY EMISSIONS TEST REPORT

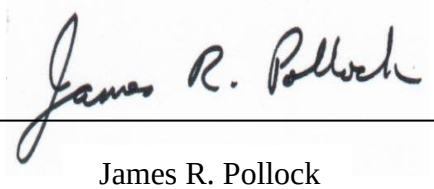
FOR

HIGH READ-RATE
METER TRANSMITTING UNIT

Model 2009-010B, Rev. G
FCC ID: LLB09010B

September 22, 2010

Report Prepared by



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# TEST REPORT

## INTRODUCTION

The Hexagram Model 2009-010B, Rev. G transceiver is a "Meter Transmitting Unit" (MTU) designed to provide remote meter reading capability for utility meters that provide a pulsed or encoded output. The transceiver is self-powered and connects to a meter output with an electrical cable. An on-board battery provides power. The transmitter provides a very short, intermittent radio frequency transmission to send a remote reading of the meter. A microprocessor provides timing, control and data processing functions. The built in antenna is inaccessible to the user and no provision is made for an external antenna. The receiver can be used for upgrading firmware, requests for meter reads or other options available in the system. This report presents the data obtained in support of an application for a Class II permissive change.

Based on the measurements made and presented in this report, the Rev. G transceiver is still in compliance with the FCC Part 90.210 rules for spurious emissions. As no component changes were made in the RF section, there should be no change to the emissions mask, the frequency stability with temperature or voltage, or the transient behavior.

## CHANGES MADE:

The following changes were made from the previously certified LLB09010B:

Removed multiple capacitors and resistors
C79,90,93,94,95,96,98,99,100,101,102,103,104,105,106,109,110,111
R60,61,64
Removed test points in RF section
Removed IDC's
Added 10 uH (L18) inductor and changed L17 from 22 uH to 10 uH
Added dual switching diode for +5 V application
Added 100 ohm resistors (R70), (R71)
Added TS1 and TS2 for ESD suppression
Changed R59 from 10 ohm to 0 ohm
Decreased length of antenna arms
Changed to low-profile, two-piece shield
Slightly shifted RF section on board

## MEASUREMENTS PERFORMED

## POWER OUTPUT AND SPURIOUS EMISSIONS

Within the tuning range of 450 – 470 MHz, the transmitter portion of the Model 2009-010B Rev. G was examined at three fundamental frequencies and their harmonics. All measurements below 1 GHz were made at a 3-meter distance on the Smith Electronics open area test site located at 8200 Snowville Road, Brecksville, OH. Data pertinent to this site is on file with the FCC (Reg. #90938) and Industry Canada (File #4541A-1). The harmonic measurements above 1 GHz were made at a distance of 1 meter over a suitable ground plane. The measurements were made using the substitution method described in TIA/EIA-603-A.

Tuned dipoles were used for measurements below 1000 MHz and a wave-guide antenna was used above 1000 MHz. A spectrum analyzer was used as a receiver.

The transmitter was placed on a remotely rotatable, non-conducting test stand. This general set up is shown in Pictorial 1. Because of the intermittent nature of the normally operating transmitter a larger, external battery pack was connected directly to the transmitter and the transmitter was forced to continually transmit for these measurements. A ferrite bead was placed on the battery leads to minimize emissions that might come from the leads.

With the test receiver tuned to the unmodulated signal, the transmitter under test was rotated to the position of maximum signal. The receiving antenna was then varied between 1 and 4 meters in height to again maximize the signal. Measurements were made with the antennas positioned both vertically and horizontally and the maximum signals recorded.

Peak detection was used for the signals below 1000 MHz and average detection above 1000 MHz.

After the maximum received meter readings were obtained for each frequency and polarity, the transmitter under test was removed from the area and replaced by a signal generator and transmitting antenna. With the transmit antenna placed as close as possible to the position of the test unit, the signal generator was activated at a test frequency. With the signal detected, the receiving antenna was positioned for maximum reception. The signal generator output was then adjusted until the received signal was equal to the previously received signal from the unit under test. These measurements were repeated for each frequency and antenna orientation and the maximum values obtained are noted in Tables 1a – 1c.

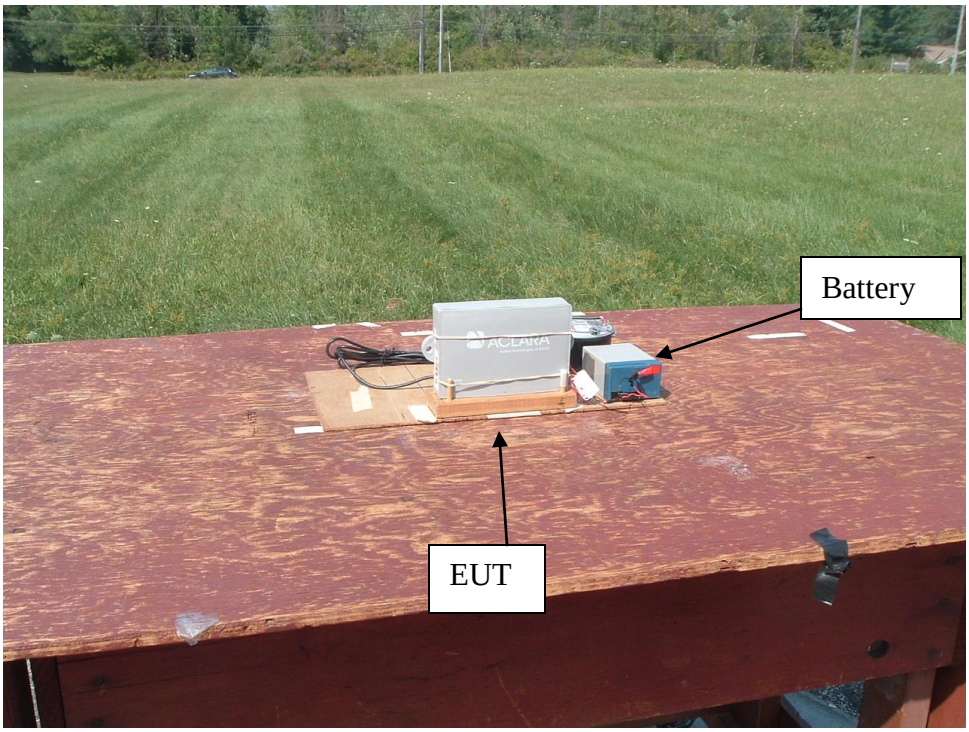
In order to convert the signal generator output value to equivalent radiated power from a dipole, the following equation is used:

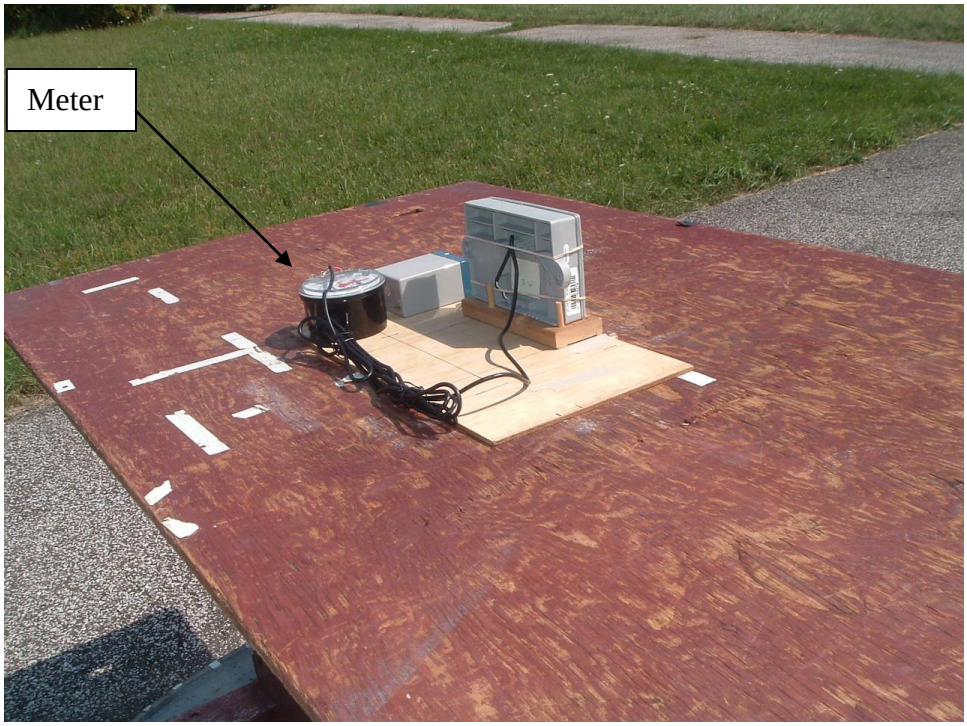
$$P_d = P_g - \text{cable loss(dB)} + \text{antenna gain(dB}_d\text{)}$$

where:

$P_d$ is the dipole equivalent power in dBm, $P_g$ is the generator output into the substitution antenna, also in dBm, and "antenna gain" is the gain of the substitution antenna with respect to a theoretical dipole.

According to 90.210(d)(3) all emissions greater than 12.5 kHz from the center of the authorized band shall be attenuated below the unmodulated carrier by $50 + 10\log(P)$.
The determined power outputs, the required harmonic attenuation as well as the attenuation for each harmonic are found in Tables 1a – 1c.




PICTORIAL 1
HEXAGRAM MODEL 2009-010B, Rev G MTU
OUTPUT POWER AND SPURIOUS EMISSIONS
TYPICAL TEST SETUP

**TABLE 1a**
**HEXAGRAM MODEL 2009-010B Rev. G TRANSMITTER**
**SUBSTITUTION METHOD**
**450 MHz**

**Horizontal** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 450 | 18.3 | 2.0 | -0.2 | 16.1 | |
| 900 | -23.4 | 2.9 | -0.5 | -26.8 | -42.9 |

**Output = 16.1 dBm**
**= 0.041 W**
**Req. Att.= 36.1 dBm**

**Horizontal** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1350 | -40.2 | 0.8 | 5.5 | -35.5 | -51.6 |
| 1800 | -51.0 | 1.0 | 5.9 | -46.1 | -62.2 |
| 2250 | -39.1 | 1.2 | 6.8 | -33.5 | -49.6 |
| 2700 | -47.0 | 1.3 | 7.6 | -40.7 | -56.8 |
| 3150 | -51.9 | 1.4 | 7.7 | -45.6 | -61.7 |
| 3600 | -49.6 | 1.6 | 7.7 | -43.5 | -59.6 |
| 4050 | -27.3 | 1.7 | 7.6 | -29.5 | -45.6 |
| 4500 | -43.5 | 1.8 | 8.3 | -37.0 | -53.1 |

**Vertical** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 450 | 29.3 | 2.0 | -0.2 | 27.1 | |
| 900 | -18.5 | 2.9 | -0.5 | -21.9 | -49.0 |

**Output = 27.1 dBm**
**= 0.513 W**
**Req. Att.= 47.1 dBm**

**Vertical** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1350 | -45.1 | 0.8 | 5.5 | -40.4 | -67.5 |
| 1800 | -45.7 | 1.0 | 5.9 | -40.8 | -67.9 |
| 2250 | -36.2 | 1.2 | 6.8 | -30.6 | -57.7 |
| 2700 | -43.9 | 1.3 | 7.6 | -37.6 | -64.7 |
| 3150 | -50.9 | 1.4 | 7.7 | -44.6 | -71.7 |
| 3600 | -50.6 | 1.6 | 7.7 | -44.5 | -71.6 |
| 4050 | -38.3 | 1.7 | 7.6 | -32.4 | -59.5 |
| 4500 | -44.8 | 1.8 | 8.3 | -38.3 | -65.4 |

**TABLE 1b**
**HEXAGRAM MODEL 2009-010B Rev. G TRANSMITTER**
**SUBSTITUTION METHOD**
**460 MHz**

**Horizontal** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 460 | 18.5 | 2.1 | -0.2 | 16.2 | |
| 920 | -27.0 | 3.0 | -0.4 | -30.4 | -46.6 |

**Output = 16.2 dBm**
**= 0.042 W**
**Req. Att.= 36.2 dBm**

**Horizontal** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1380 | -40.8 | 0.9 | 5.6 | -36.1 | -52.3 |
| 1840 | -48.9 | 1.0 | 5.9 | -44.0 | -60.2 |
| 2300 | -43.7 | 1.2 | 6.9 | -38.0 | -54.2 |
| 2760 | -45.9 | 1.3 | 7.6 | -39.6 | -55.8 |
| 3220 | -47.2 | 1.4 | 7.8 | -40.8 | -57.0 |
| 3680 | -40.7 | 1.6 | 7.7 | -34.6 | -50.8 |
| 4140 | -37.1 | 1.7 | 7.7 | -31.1 | -47.3 |
| 4600 | -50.0 | 1.8 | 8.3 | -43.5 | -59.7 |

**Vertical** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 460 | 29.8 | 2.1 | -0.2 | 27.5 | |
| 920 | -21.1 | 3.0 | -0.4 | -24.5 | -52.0 |

**Output = 27.5 dBm**
**= 0.562 W**
**Req. Att.= 47.5 dBm**

**Vertical** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1380 | -46.4 | 0.9 | 5.6 | -41.7 | -69.2 |
| 1840 | -45.8 | 1.0 | 5.9 | -40.9 | -68.4 |
| 2300 | -38.1 | 1.2 | 6.9 | -32.4 | -59.9 |
| 2760 | -47.2 | 1.3 | 7.6 | -40.9 | -68.4 |
| 3220 | -50.9 | 1.4 | 7.8 | -44.5 | -72.0 |
| 3680 | -42.4 | 1.6 | 7.7 | -36.3 | -63.8 |
| 4140 | -41.5 | 1.7 | 7.7 | -35.5 | -63.0 |
| 4600 | -53.2 | 1.8 | 8.3 | -46.7 | -74.2 |

**TABLE 1c**
**HEXAGRAM MODEL 2009-010B Rev. G TRANSMITTER**
**SUBSTITUTION METHOD**
**470 MHz**

**Horizontal** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 470 | 18.4 | 2.1 | -0.2 | 16.1 | |
| 940 | -24.2 | 3.0 | -0.4 | -27.6 | -43.7 |

**Output = 16.1 dBm**
**= 0.407 W**
**Req. Att.= 36.1 dBm**

**Horizontal** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1410 | -54.4 | 0.9 | 5.7 | -49.6 | -65.7 |
| 1880 | -58.2 | 1.0 | 5.9 | -53.3 | -69.4 |
| 2350 | -47.1 | 1.2 | 7.1 | -41.2 | -57.3 |
| 2820 | -50.1 | 1.3 | 7.7 | -43.7 | -59.8 |
| 3290 | -50.3 | 1.5 | 7.8 | -44.0 | -60.1 |
| 3760 | -36.7 | 1.6 | 7.6 | -30.7 | -46.8 |
| 4230 | -39.2 | 1.7 | 7.9 | -33.0 | -49.1 |
| 4700 | -47.7 | 1.8 | 8.4 | -41.1 | -57.2 |

**Vertical** 3 meter measurement using tuned dipole antenna

| Freq. (MHz) | Gen. Output (dB) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (dBm) | Difference (dB) |
|---|---|---|---|---|---|
| 470 | 28.8 | 2.1 | -0.2 | 26.5 | |
| 940 | 22.1 | 3.0 | -0.4 | -25.5 | -52.0 |

**Output = 26.5 dBm**
**= 0.447W**
**Req. Att.= 46.5 dBm**

**Vertical** 1 meter measurement using horn antenna

| Freq. (MHz) | Gen. Output (dBm) | Coax Loss (dB) | Ant. Gain (dBd) | Dipole Eq. Power (Dbm) | Difference (dB) |
|---|---|---|---|---|---|
| 1410 | -53.5 | 0.9 | 5.7 | -48.7 | -75.2 |
| 1880 | -48.5 | 1.0 | 5.9 | -43.6 | -70.1 |
| 2350 | -41.3 | 1.2 | 7.1 | -35.4 | -61.9 |
| 2820 | -48.8 | 1.3 | 7.7 | -42.4 | -68.9 |
| 3290 | -50.5 | 1.5 | 7.8 | -44.2 | -70.7 |
| 3760 | -39.9 | 1.6 | 7.6 | -33.9 | -60.4 |
| 4230 | -44.1 | 1.7 | 7.9 | -37.9 | -64.4 |
| 4700 | -50.9 | 1.8 | 8.4 | -44.3 | -70.8 |

**TEST EQUIPMENT USED**

| | |
|---|---|
| **Spectrum Analyzer** | Hewlett-Packard Model 8563A Spectrum Analyzer<br>SN: 3020AO0522 Cal Due: 8-2011 |
| **Antennas** | (1) ETS-Lindgren Model DB-4 Tuned Dipole<br>Frequency Range 400 – 1000 MHz |
| | (1) Stoddart Model 91598-2 Tuned Dipole<br>Frequency Range 350 – 1000 MHz |
| | (2x) ETS-Lindgren Model 3115 Double Ridged Guide Horn<br>Frequency Range 0.75 – 18 GHz |
| **Signal Generator** | Hewlett-Packard Model 8340B,<br>S/N 3010A01889 Cal Due: 6/2011 |
| **Miscellaneous** | 12.2 m RG-213/U coaxial cable |
| | 22.5 m LMR-400 coaxial cable |
| | 3.0 m RG-213/U coaxial cable |
| | 3.0 m RG-213/U coaxial cable |
| **Tests Performed** | September 15-16, 2010 |

Unit Tested: 2009-010B Rev G SN—0003