SMITH ELECTRONICS, INC.
ELECTROMAGNETIC COMPATIBILITY LABORATORIES

RADIO-FREQUENCY EMISSIONS TEST REPORT

FOR

HEXAGRAM, INC.

MODIFIED S-4
METER TRANSMITTING UNIT (MTU)
with RECEIVER

Model 9845
FCC ID: LLB9845

October 19, 2006

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TEST REPORT

INTRODUCTION

As a result of operational difficulties when used with certain meter configurations, the Model 9845 transceiver antenna shape and positioning was modified. The following measurements support an application for a recertification.

The Hexagram Model 9845 transceiver is a designed to provide remote meter reading capability with the Landis & Gyr "S-4" family of electric meters. The transceiver is connected to the meter circuitry and mounts within the meter enclosure. An on-board battery provides power when AC power is not available. The transmitter provides a very short, intermittent radio frequency transmission to provide 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 to request a meter reading or other options available in the system. One transmitter was tested and this report presents the data obtained in support of an application for certification.

MEASUREMENTS PERFORMED

POWER OUTPUT AND SPURIOUS EMISSIONS

Within the tuning range of 450 – 470 MHz, the transmitter portion 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 (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.

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 signal recorded.

Peak detection was used for the CW 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:

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

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 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 + 10log(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 9845 MTU
OUTPUT POWER AND SPURIOUS EMISSIONS
TYPICAL TEST SETUP

TABLE 1a
HEXAGRAM MODEL 9845 TRANSMITTER
SUBSTITUTION METHOD

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	27.0	1.1	0	25.9	
900	-23.3	1.7	0	-25.0	-50.9

Output = 25.9 dBm
= 0.389 W
Req. Att.= 45.9 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	-41.4	0.4	3.1	-38.7	-64.6
1800	-52.0	0.5	4.9	-47.6	-73.5
2250	-48.7	0.6	5.6	-43.7	-69.6
2700	-47.5	0.7	6.2	-42.0	-67.9
3150	-46.9	0.8	6.7	-41.0	-66.9
3600	-40.4	0.9	6.6	-34.7	-60.6
4050	-38.2	0.9	6.5	-32.6	-58.5
4500	-36.69	1.0	7.2	-30.7	-56.6

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	25.8	1.1	0	24.7	
900	-36.8	1.7	0	-38.5	-63.2

Output = 24.7 dBm
= 0.295 W
Req. Att.= 44.6 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	-39.1	0.4	3.1	-36.4	-61.1
1800	-50.8	0.5	4.9	-46.4	-71.1
2250	-51.0	0.6	5.6	-46.0	-70.7
2700	-47.8	0.7	6.2	-42.3	-67.0
3150	-47.0	0.8	6.7	-41.1	-65.8
3600	-46.2	0.9	6.6	-40.5	-65.2
4050	-43.1	0.9	6.5	-37.5	-62.2
4500	-45.2	1.0	7.2	-39.0	-63.7

TABLE 1b
HEXAGRAM MODEL 9845 TRANSMITTER
SUBSTITUTION METHOD

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	27.7	1.1	0	26.6	
920	-25.5	1.7	0	-27.2	-53.8

Output = 26.6 dBm
= 0.457 W
Req. Att.= 46.6 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	-45.7	0.4	3.1	-43.0	-69.6
1840	-45.2	0.5	4.9	-40.8	-67.4
2300	-41.8	0.6	5.6	-36.8	-63.4
2760	-46.0	0.7	6.2	-40.5	-67.1
3220	-39.6	0.8	6.7	-33.7	-60.3
3680	-36.0	0.9	6.6	-30.3	-56.9
4140	-36.3	0.9	6.5	-30.7	-57.3
4600	-40.3	1.0	7.2	-34.1	-60.7

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	23.4	1.1	0	22.3	
920	-28.5	1.7	0	-30.2	-52.5

Output = 22.3 dBm
= 0.170 W
Req. Att.= 42.3 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	-41.7	0.4	3.1	-39.0	-61.3
1840	-46.0	0.5	4.9	-41.6	-63.9
2300	-46.4	0.6	5.6	-41.4	-63.7
2760	-48.3	0.7	6.2	-42.8	-65.1
3220	-49.5	0.8	6.7	-43.6	-65.9
3680-	-44.9	0.9	6.6	-39.2	-61.5
4140	-41.0	0.9	6.5	-35.4	-57.7
4600	-39.6	1.0	7.2	-33.4	-55.7

TABLE 1c
HEXAGRAM MODEL 9845 TRANSMITTER
SUBSTITUTION METHOD

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)
469	26.8	1.1	0	25.7	
938	-26.2	1.7	0	-27.9	-53.6

Output = 25.7 dBm
= 0.3724 W
Req. Att.= 45.7 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)
1407	-41.6	0.5	3.1	-39.0	-64.7
1876	-47.8	0.6	4.9	-43.5	-69.2
2345	-36.0	0.6	5.6	-31.0	-56.7
2814	-47.0	0.7	6.2	-41.5	-67.2
3283	-36.2	0.8	6.7	-30.3	-56.0
3752	-40.0	0.9	6.6	-34.3	-60.0
4221	-32.0	1.0	6.5	-26.5	-52.2
4690	-41.4	1.0	7.2	-35.2	-60.9

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)
469	20.6	1.1	0	19.5	
938	-27.2	1.7	0	-28.9	-48.4

Output = 19.5 dBm
= 0.089 W
Req. Att.= 39.5 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)
1407	-37.3	0.5	3.1	-34.7	-54.2
1876	-41.7	0.6	4.9	-37.4	-56.9
2345	-42.7	0.6	5.6	-37.7	-57.2
2814	-47.4	0.7	6.2	-41.9	-61.4
3283	-44.6	0.8	6.7	-38.7	-58.2
3752	-43.4	0.9	6.6	-37.7	-57.2
4221	-34.7	1.0	6.5	-29.2	-48.7
4690	-39.4	1.0	7.2	-33.2	-52.7

TEST EQUIPMENT USED

Spectrum Analyzer	Hewlett-Packard Spectrum Analyzer Model 8593EM S/N 3536A00147 Calibrated 7/06
Antennas	(2x) Stoddart 91598-2 Tuned Dipole Frequency Range 400 – 1000 MHz
	EMCO 3115 Double Ridged Guide Horn Frequency Range 1 – 18 GHz (Rcv)
	Eaton Model 96001 Double Ridged Guide Horn Frequency Range 1 – 18 GHz (Xmt)
Signal Generator	Hewlett-Packard Model 8340B, S/N 3010A01889 Calibrated 12/05
Miscellaneous	12.2 m RG-214/U coaxial cable
	6.1 m RG-214/U coaxial cable
	2.4 m RG-8/U coaxial cable
	1.2 m RG-214/U coaxial cable

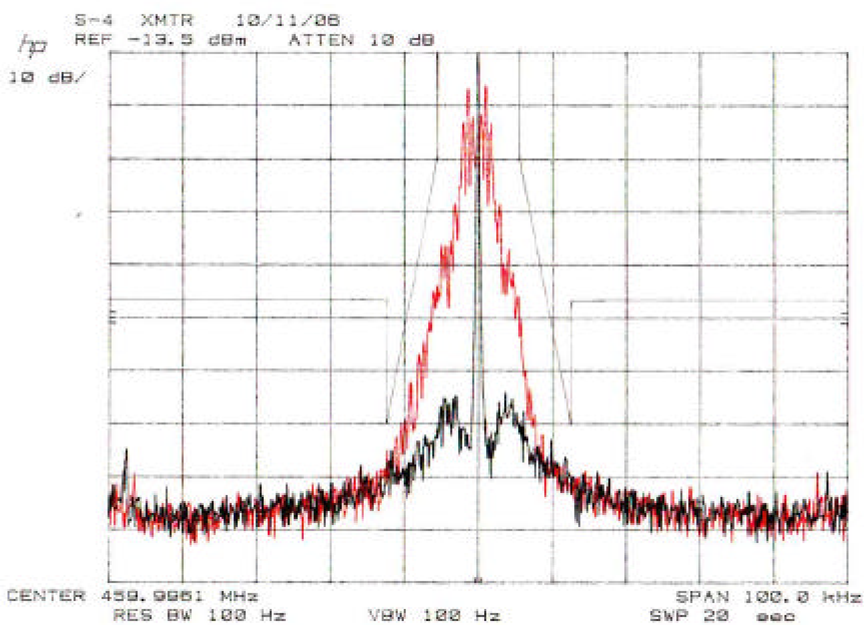
OCCUPIED BANDWIDTH

The emissions close to the center of the specified channel are limited by the emissions masks described in 90.210. For the frequency range of the 9845 transmitter, Mask D is specified. From the center frequency of the band ±5.625 kHz, 0 dB of attenuation is required. From 5.625 kHz to 12.5 kHz from the center frequency, attenuation must be at least $7.27(f_d - 2.88 \text{ kHz})$ dB, where f_d is the displacement frequency from the center of the band in kHz.

At more than 12.5 kHz from the band center, the attenuation must be 70 dB or 50 + 10 log(P), whichever is less. Since the maximum P was determined to be 0.575 W, 50 + 10 log(0.575) equals 47.6 dB.

Both modulated and unmodulated transmissions were stored on the spectrum analyzer display. The plot of Fig. 1 shows both signals with Mask D superimposed on the plot. The plot indicates that the modulated emission does comply with the requirement for occupied bandwidth as found in 90.210.

For purposes of this test, the modulated signal was FSK modulated with a continuous sequence of Manchester encoded 1's at the specified 1200 bits per second data rate. The Manchester encoding scheme forces a mid-bit transition for an encoded "1". Therefore, the sequence of continuous 1's sends the highest frequency waveform to the modulator circuit.



-46.6 dB

Fig. 1
Hexagram Model 9845 MTU
Emissions Mask

TEST EQUIPMENT USED

Spectrum Analyzer	Hewlett-Packard 8568B with 85680A RF Section S/N: 2216A02120 85662A Display Section SN: 2152A03683 Calibration 11/05
Antenna	EMCO Model 3146 Log Periodic Frequency Range 200 MHz – 1000 MHz