SMITH ELECTRONICS, INC.
ELECTROMAGNETIC COMPATIBILITY LABORATORIES

RADIO-FREQUENCY EMISSIONS TEST REPORT

FOR

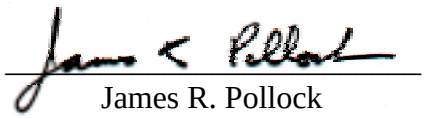
HEXAGRAM, INC.

"FLATPAC" TRANSMITTER
FCC ID: LLB6327

(MODIFICATION OF POWER AMPLIFIER AND SHIELD REMOVED)

June 17, 2002

Prepared by:



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TEST REPORT

INTRODUCTION

The Hexagram "FLATPAC" transmitter is a battery operated transmitter designed to be electrically attached to a utility meter. The transmitter would be wall mounted near the meter and provide a 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. Changes have been made to the RF circuitry, requiring that the transmitter be re-tested to assure that emissions are still within the limitations of the FCC Rules.

MEASUREMENTS PERFORMED

Due to changes in the RF power amplifier and the removal of an RF shield, measurements were made to determine the present equivalent output power and the level of harmonic emissions in relation to the fundamental frequency. The fundamental signal and its harmonics, as well as the occupied bandwidth, were investigated.

POWER OUTPUT AND SPURIOUS EMISSIONS

A series of measurements of the operating frequency and any harmonic emissions was made on the Smith Electronics, open field test site located at 8200 Snowville Road, Brecksville, OH. Data pertinent to this site is on file with the FCC.

Measurements below 1000 MHz were made at a three-meter test distance with frequencies above 1000 MHz being measured at one meter. A receiver and a tuned dipole were used below 1000 MHz and a spectrum analyzer and a wave guide antenna above 1000 MHz.

The transmitter was mounted vertically, as it would be on a wall, on a remotely rotatable test stand. The test stand is constructed of non-conducting material. The general set up is shown in Pictorial 1. Because of the intermittent nature of the normally operating transmitter, an external power supply was used and the transmitter was forced to continually transmit for the measurements. Ferrite beads were placed on the power supply wires to minimize their effect for emissions.

With the test receiver tuned to the unmodulated signal, the transmitter 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.

No differences were observed with different signal detectors, so a quasi-peak detector was used for the signals below 1000 MHz and peak detection above 1000 MHz. The frequencies measured are tabulated in Table 1 along with the test data, correction factors, field strength and relative strengths of the harmonic emissions compared to the fundamental.

The field strength is determined by taking the measured signal level in dBuV and adding the antenna factor and a coax loss factor. Power output is determined by relating the field strength generated by the transmitter to the field that would be generated by a tuned, half-wave dipole antenna by using the equation:

$$E = \frac{(49.2 \times P)^{1/2}}{R} \qquad \text{Eq. 1}$$

Where E is the field strength in V/m, P is power in Watts and R is the measurement distance in meters.

To determine the effective power from the measured field strength, Eq. 1 must be rearranged to the form:

$$P = \frac{(E \times R)^2}{49.2} \qquad \text{Eq. 2}$$

With the measured field strength of the fundamental from Table 1 of 1.641 V/m at a 3 meter distance, the effective power is 0.492 W or 492 mW.

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). Using P = 0.492 W, the required attenuation is 46.9 dB. An examination of Table 1 shows that all emissions are 46.9 dB or more below the carrier level.

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 "FLATPAC" 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 P was determined to be 0.492 W, 50 + 10 log(0.492) equals 46.9 dB.

The plot of Fig. 1 shows both the unmodulated carrier (in red), the modulated signal and the emissions mask. The plot indicates that the modulated emission does appear to comply with the requirement for occupied bandwidth as found in 90.210.

For purposes of this test, the transmitter 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.

TABLE 1
HEXAGRAM FLAT-PACK TRANSMITTER
NEW POWER AMPLIFIER AND SHIELD REMOVED

3 meter measurement

Frequency (MHz)	Value (dBuV)	Antenna Factor(dB)	Cable Loss (dB)	DBuV/m	uV/M	Difference (dB)
460	100.5	22.7	1.1	124.3	1,640,590	--
920	45.2	29.2	1.7	76.1	6,383	-48.2

1 meter measurement

Freq. (MHz)	**Value (dBuV)**	**Ant. Fact (dB)**	**Cable Loss (dB)**	**dBuV/m @1 m**	**dBuV/m @ 3 m***	**uV/m**	**Diff. (dB)**
1380	61.0	25	0.2	86.3	76.8	6,918	-47.5
1840	52.9	28	0.3	81.2	71.7	3,846	-52.6
2300	50.3	29	0.3	79.6	70.1	3,199	-54.2
2760	48.2	30	0.3	78.5	69.0	2,818	-55.3
3220	46.4	31	0.4	77.8	68.3	2,600	-56.0
3680	42.7	33	0.4	76.1	66.6	2,138	-57.7
4140	29.1	33	0.5.	62.6	53.1	452	-71.2
4600	35.2	33	0.5	68.7	59.2	912	-65.1

Required attenuation = 46.9 dB

*** = Three-meter value obtained by subtracting 9.5 dB (linear extrapolation)**

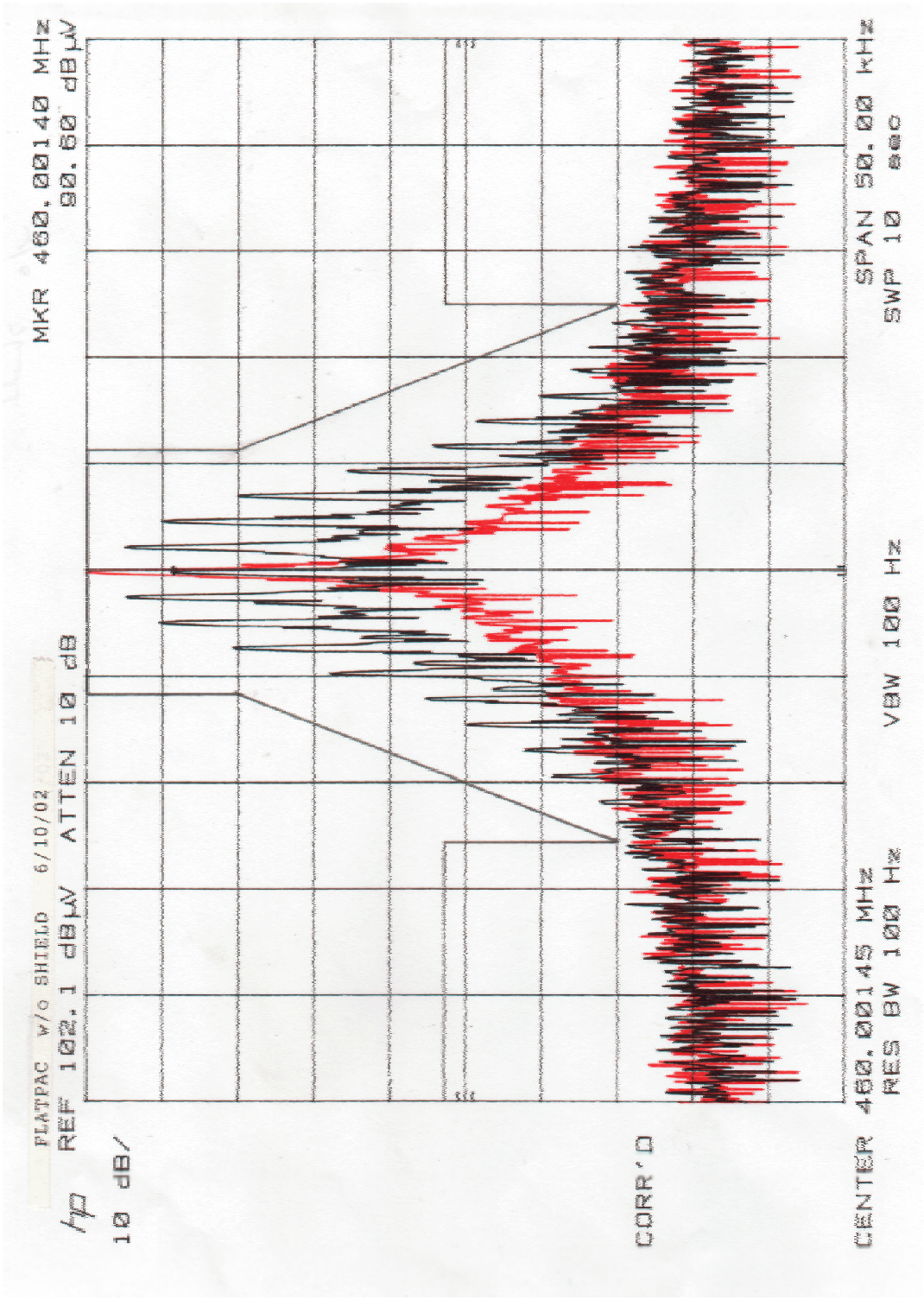

Fig. 1
EMISSIONS MASK
"FLATPAC" with NEW AMP and NO SHIELD

TEST INFORMATION

SUMMARY

The Hexagram "FLATPAC" transmitter, modified by changing the power amplifier and removing an RF shield, has been shown to be capable of complying with those requirements of the Federal Communications Commission for a Part 90 transmitter that are covered by this report.

EQUIPMENT UNDER TEST	"FLATPAC" Transmitter
MANUFACTURER	Hexagram, Inc. 23905 Mercantile Cleveland, OH 44122
TEST DATE	May 15 & June 10, 2002
TEST LABORATORY	Smith Electronics, Inc. 8200 Snowville Road Cleveland, OH 44141 (440)526-4386
MEASUREMENT EQUIPMENT	Hewlett-Packard Spectrum Analyzer Type 8568B with 8560A RF Section S/N 2216A02120 85662A Display Section S/N 2152A03686 85650A Quasi-Peak Adaptor S/N 2043A00350 Calibrated 6/01 Singer-Stoddart EMI Field Intensity Meter Model NM 37/57 S/N 0366-06168 Calibrated 6/01 Hewlett-Packard Spectrum Analyzer Model 8593EM S/N 3536A00147 Calibrated 6/01
ANTENNAS	Stoddart 91598-2 Tuned Dipole Frequency Range 400 – 1000 MHz EMCO 3115 Double Ridged Guide Horn Frequency Range 1 – 18 GHz
MISCELLANEOUS	12.2 m RG-214/U coaxial cable 0.6 m RG-214/U coaxial cable