FCC Part 15.249
Transmitter Certification

Direct Sequence Spread Spectrum Transmitter

Test Report

FCC ID: SJS-380100HP

FCC Rule Part: 15.249

ACS Report Number: 04-0311-15C

Manufacturer: MARS Company
Model: 100-HP

Test Begin Date: September 30, 2004
Test End Date: October 1, 2004

Report Issue Date: November 10, 2004

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612

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This report contains 11 pages

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1.0 GENERAL

1.1 Purpose
The purpose of this report is to demonstrate compliance with Part 15, Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

1.2.1 Intended Use
The unit is intended to be used to transmit meter reading data from a utility meter to a mobile data collecting device. The device operates in a 'regular transmit' mode. The utility meter is interrogated every 30 minutes to 1 hour, and the reading taken is transmitted every 4 seconds (maximum, in some instances the unit will transmit less often). The unit is intended to be fitted in a metal bodied mete pit fitted with a metal lid.

1.2.2 Antennas
The Antenna used in this application is a 'quarter-wave' whip design and is constructed from self-supporting wire. The associate gain is 5.15 dBi.

The wire length is cut to 85mm in length and is formed to bend at right angles near the PCB mounting pad. With the complete Transmitter module in its normal upright mounting position the RF radiation pattern is predominately vertically polarized.

2.0 LOCATION OF TEST FACILTY
All testing was performed by qualified ACS personnel located at the following address:

ACS, Inc.
5015 B.U. Bowman Drive
Buford, GA 30518

2.1 DESCRIPTION OF TEST FACILITY
Both the Open Area Test Site (OATS) and Conducted Emissions site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450
Industry Canada Lab Code: IC 4175
VCCI Member Number: 1831
- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

2.1.1 Open Area Test Site

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 3.2-1 below:

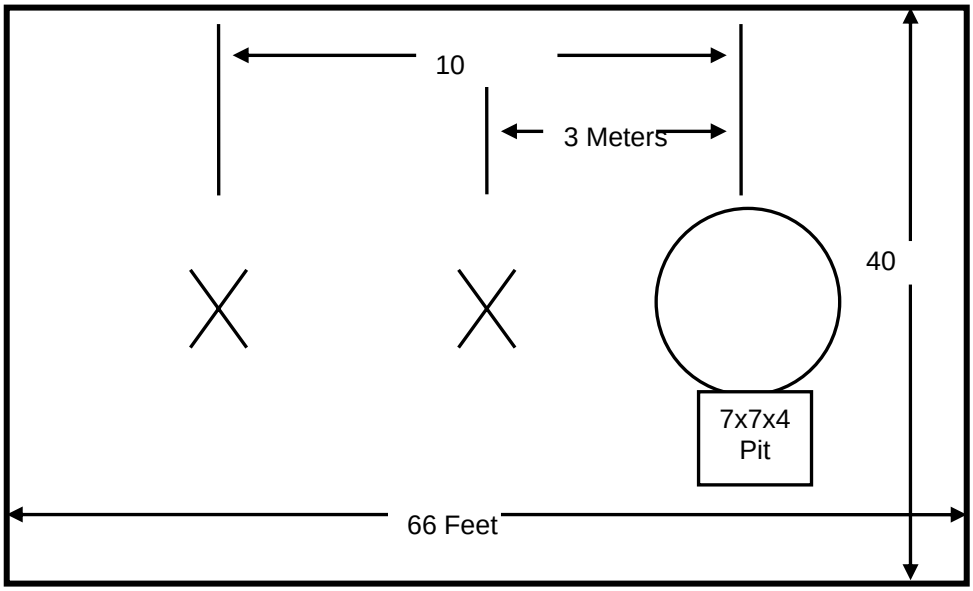

Figure 2.1.1-1: Open Area Test Site

2.1.2 Conducted Emissions Test Site Description

The AC mains conducted EMI site is a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.1.2-1:

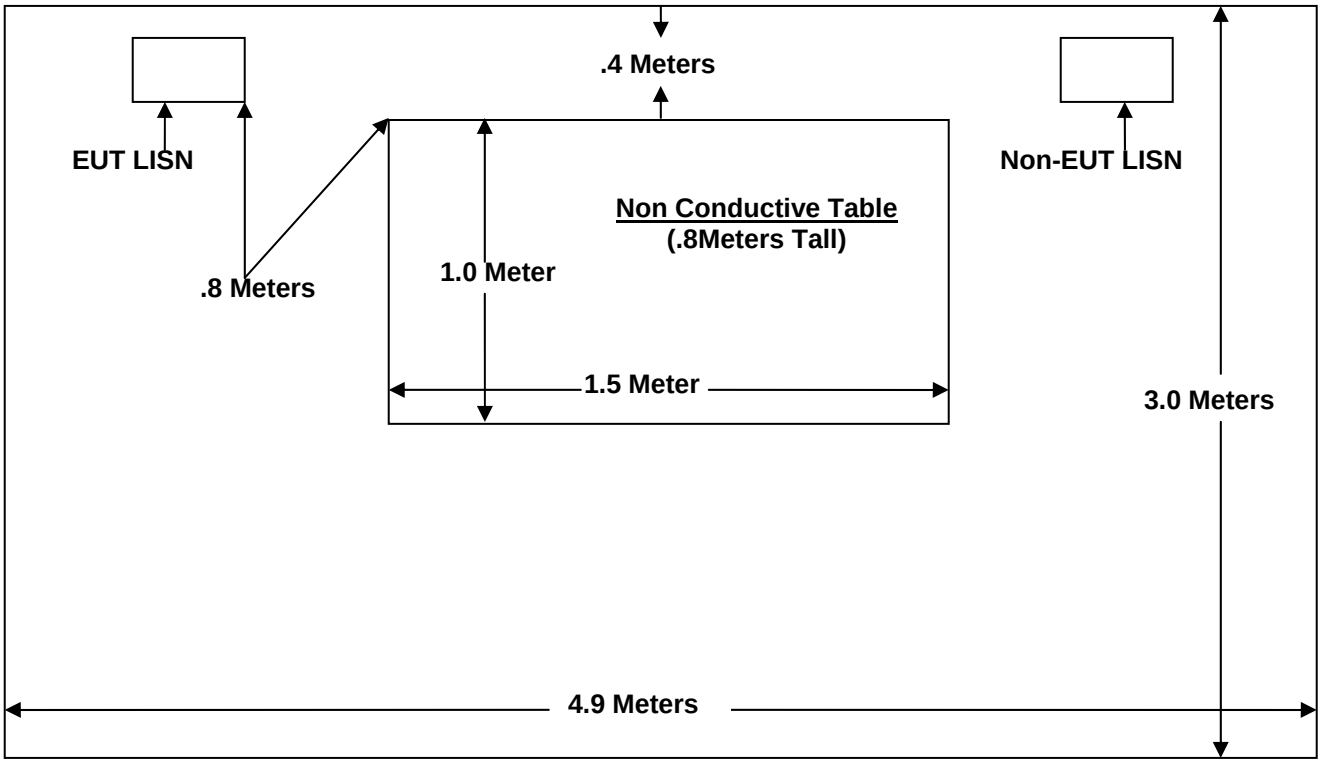

Figure 2.1.2-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

1 - ANSI C63.4-1992: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the 9 KHz to 40GHz

2 - US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators (October 2002)

3 - FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4.0-1: Test Equipment

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
---	Agilent	Spectrum Analyzer	E7402A	US40240259	02/26/05
26	Chase	Bi-Log Antenna	CBL6111	1044	10/11/05
152	EMCO	LISN	3825/2	9111-1905	01/08/05
153	EMCO	LISN	3825/2	9411-2268	12/11/04
193	ACS	OATS Cable Set	RG8	193	01/09/05
167	ACS	Conducted EMI Cable Set	RG8	167	01/09/05
22	Agilent	Pre-Amplifier	8449B	3008A00526	05/12/05
73	Agilent	Pre-Amplifier	8447D	272A05624	04/30/05
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	05/08/05
105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	06/09/05
209	Microwave Circuits	High Pass Filters	H3G020G2	4382-01 DC0421	06/09/05
1	Rohde & Schwarz	Receiver	804.8932.52	833771/007	02/26/05
2	Rohde & Schwarz	Receiver	1032.5640.53	839587/003	02/26/05
3	Rohde & Schwarz	ESMI Receiver	804.8932.52	839379/011	*
4	Rohde & Schwarz	ESMI Receiver	1032.5640.53	833827/003	*
213	Test Equipment Corp.	Pre-Amplifier	PA-102	44927	06/28/05
211	Eagle	Band Reject Filter	C7RFM3NFNM	n/a	06/28/05
168	Hewlett Packard	Pulse Limiter	11947A	3107A02268	04/30/05
93	Chase	EM Clamp	CIC 8101	65	01/12/05
184	ACS	Cable	RG8	184	01/09/05
169	Solar Electronics	LISN	9117-5-TS-50-N	031032	04/12/05
6	Harbour Industries	HF RF Cable	LL-335	00006	03/15/05
7	Harbour Industries	HF RF Cable	LL-335	00007	03/15/05
208	n/a	HF RF Cable	n/a	00208	06/14/05
5	ChaseRF Current Probe	Current Probe	CSP-8441	19	01/23/05

* Note: No calibration required – used for pre-scan data only

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number	FCC ID
The EUT was tested in a Stand Alone Configuration with Support Equipment					

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

The EUT was tested in a stand alone configuration which utilized an internal battery for operation. Consistent with the typical installation, all measurements were made in a cast iron meter box cover buried in a 4'x4'x44", measured from the outer dimensions, wooden fixture surrounded by soil. The meter box cover consists of a solid cast iron frame and lid. The meter box cover lid was installed flush with the top of the soil grade. The specific meter box cover used for this test is Model W3F-000, manufactured by Ford Meter Box Company. The top of the meter box cover was measured to be approximately 80 cm from the ground plane of the test site.

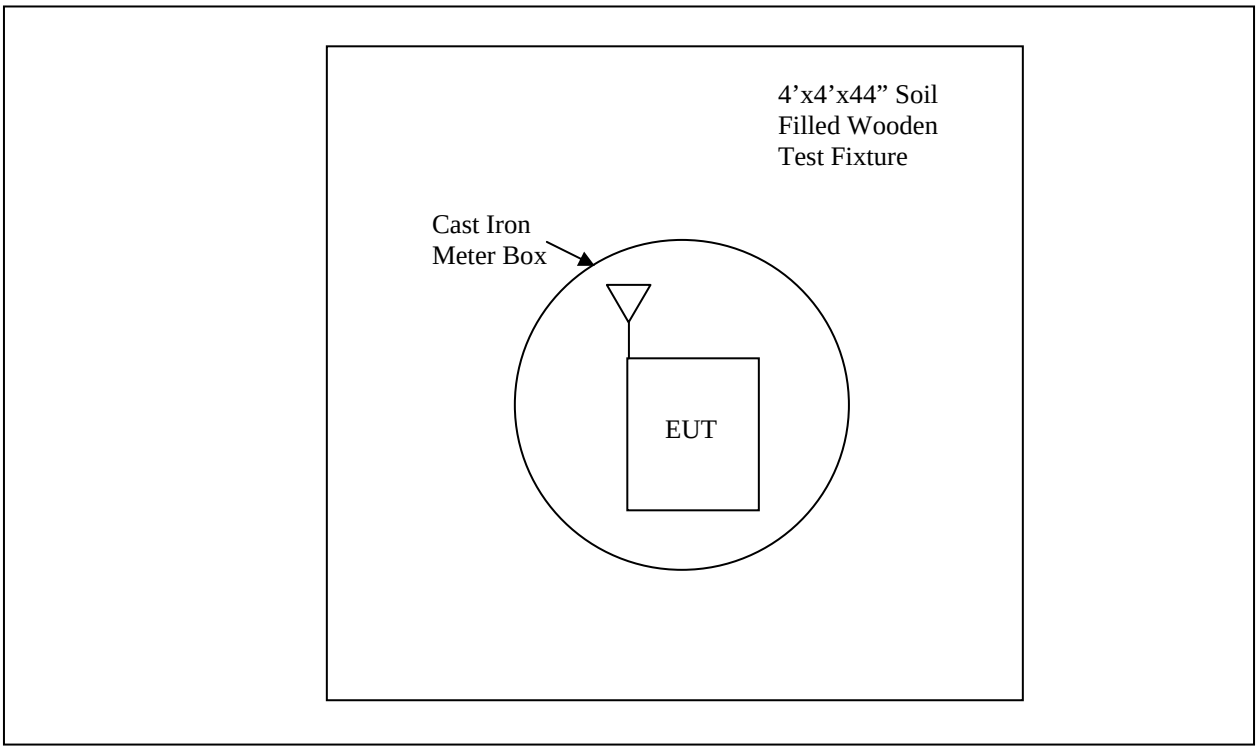

Figure 6.0-1: EUT Test Setup

7.0 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 Antenna Requirement - FCC Section 15.203

The EUT employs a permanently attached internal integral antenna which can not be modified.

7.2 Power Line Conducted Emissions - FCC Section 15.207

The EUT is power by an internal battery and is therefore not design to be connected to the public utility (AC) power line. No Power line conducted emissions testing was performed.

7.3 Radiated Emissions - FCC Section 15.109(Unintentional Radiation)

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 1000 MHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. A Quasi-peak detector was enabled and measurements were taken with the Spectrum Analyzer's resolution bandwidth set to 120 KHz.

7.3.2 Test Results

Results of the test are given in Table 7.3-1 below:

Table 7.3-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Uncorrected Reading (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (°)	Total Correction Factor (dB)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Results
30	23.65	H	100	0	-5.21	18.44	40	21.6	**Pass**
86.04	23.3	H	100	0	9.37	32.67	40	7.3	**Pass**
172.26	23.27	H	100	0	-12.93	10.34	43.5	33.2	**Pass**
267.11	24.49	H	100	0	-8.62	15.87	46	30.1	**Pass**
296.211	29.6	H	100	0	-8.12	21.48	46	24.5	**Pass**
305.911	24.29	H	100	0	-8.11	16.18	46	29.8	**Pass**
315.611	23.04	H	100	0	-7.98	15.06	46	30.9	**Pass**
486.977	24.74	H	100	0	-2.13	22.61	46	23.4	**Pass**
703.611	23.83	H	100	0	2.73	26.56	46	19.4	**Pass**
946.11	24.74	H	100	0	5.34	30.08	46	15.9	**Pass**

* Note: All emissions above 946.11 MHz were attenuated at least 20 dB below the permissible limit.

7.4 Fundamental Field Strength – FCC Section 15.249(a)

7.4.1 Test Methodology

Radiated emissions tests were made on the 3 channels in the 902MHz to 928MHz frequency range, the low channel being 905 MHz, the middle channel being 915 MHz, and the high channel being 925 MHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz.

The EUT was caused to generate a constant carrier signal for the test.

7.4.2 Test Results

Results are shown below in table 6.4.2-1 below:

Table 7.4.2-1: Fundamental Field Strength

Frequency [MHz]	Uncorrected Level [dBuV/m]	Correction Factors [dB]	Corrected Level [dBuV/m]	Limit [dBuV/m]	Margin [dB]
905	82.18	4.50	86.68	94.00	7.3
915	83.44	5.11	88.55	94.00	5.5
925	84.59	5.15	89.74	94.00	4.3

7.5 Radiated Spurious Emissions 15.249(a)

7.5.1 Test Methodology

Radiated emissions tests were made over the frequency range of 30MHz to 10 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For frequencies above 1000MHz, average measurements were made using an RBW of 1 MHz and a VBW of 10 Hz and peak measurements were made with RBW of 1 MHz and a VBW of 1 MHz.

7.5.2 Duty Cycle Correction

Under normal operation the unit will transmit its data every 4 seconds. The Radio transmitter is only turned on during this transmission, and is in power down state at all other times. The maximum duration of the RF transmission is 4ms (Nominally 3.5ms, but have added 0.5ms to allow for any tolerances, power up / power down delays).

For average radiated measurements, the measured level was reduced by a factor 28dB to account for the duty cycle of the EUT. The EUT transmits for 4mS on a channel followed by a 4 second rest period before the next transmission. Therefore the duty cycle is 4%. The duty cycle correction factor is determined using the formula: 20log (.04)=-27.95 dB.

7.5.3 Test Results

Results are shown below in Table 7.5.2-1.

Table 7.5.2-1: Radiated Spurious Emissions

Frequency (MHz)	Level (dBuV/m)	Detector (P/A)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Low Channel							
2.71	56.54	P	V	1.25	57.79	74.00	16.21
2.71	55.57	A	V	-26.75	28.82	54.00	25.18
3.62	44.78	P	V	4.99	49.77	74.00	24.23
3.62	40.06	A	V	-23.01	17.05	54.00	36.95
4.52	41.56	P	V	6.95	48.51	74.00	25.49
4.52	35.46	A	V	-21.05	14.41	54.00	39.59
5.43	47.22	P	V	10.73	57.95	74.00	16.05
5.43	43.49	A	V	-17.27	26.22	54.00	27.78
6.33	44.83	P	V	12.78	57.61	74.00	16.39
6.33	39.24	A	V	-15.22	24.02	54.00	29.98
7.24	38.71	P	V	13.65	52.36	74.00	21.64
7.24	26.98	A	V	-14.35	12.63	54.00	41.37
Middle Channel							
2.74	55.29	P	V	1.41	56.70	74.00	17.30
2.74	54.33	A	V	-26.59	27.74	54.00	26.26
3.65	47.57	P	V	5.12	52.69	74.00	21.31
3.65	44.02	A	V	-22.88	21.14	54.00	32.86
4.57	39.93	P	V	7.18	47.11	74.00	26.89
4.57	29.34	A	V	-20.82	8.52	54.00	45.48
5.49	52.32	P	V	10.95	63.27	74.00	10.73
5.49	50.09	A	V	-17.05	33.04	54.00	20.96
6.4	42.39	P	V	12.82	55.21	74.00	18.79
6.4	37.14	A	V	-15.18	21.96	54.00	32.04
7.32	37.44	P	V	13.39	50.83	74.00	23.17
7.32	26.98	A	V	-14.61	12.37	54.00	41.63
High Channel							
2.77	56.61	P	V	1.57	58.18	74.00	15.82
2.77	55.7	A	V	-26.43	29.27	54.00	24.73
3.7	42.29	P	V	5.33	47.62	74.00	26.38
3.7	37.09	A	V	-22.67	14.42	54.00	39.58
4.625	45.16	P	V	7.43	52.59	74.00	21.41
4.625	38.94	A	V	-20.57	18.37	54.00	35.63
5.55	49.43	P	V	11.15	60.58	74.00	13.42
5.55	46.63	A	V	-16.85	29.78	54.00	24.22
6.47	40.03	p	V	12.86	52.89	74.00	21.11
6.47	33.33	A	V	-15.14	18.19	54.00	35.81
7.401	37.44	P	V	13.12	50.56	74.00	23.44
7.401	26.73	A	V	-14.88	11.85	54.00	42.15

7.5.3 Sample Calculation:

$R_C = R_U + CF_T$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation:

Corrected Level: 56.54 + 1.25 = 57.79 dBuV

Margin: 74dBuV – 57.79 dBuV = 16.21 dB

8.0 CONCLUSION

In the opinion of ACS, Inc. the 100-HP, manufactured by Mars Company., meets the requirements of FCC Part 15 subpart C.