ITS Intertek Testing Services

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Emissions Testing
Performed
on the
SAAR Associates, Inc.
Telemetry Transmitter
Model: SAI

Date of Test: October 1, 1999

JOB # J99023637
MJP/Rbt

DOT: 10/1/99
Contact: Mr. David Saar

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I – Introduction and Summary

TO: Mr. David Saar

FROM: Michael J. Peters, Senior Project Engineer
DATE: October 5, 1999
JOB #: J99023637

RE: Emissions Testing Performed On The Telemetry Transmitter, Model: SAI

On Friday, October 1, 1999 we tested the Telemetry Transmitter, Model: SAI to determine if it was in compliance with the FCC Part 15 , Subpart C, Section 15.249. A production version of the sample was received on October 1, 1999 in good condition. We found that the unit met the Part 15 requirements when tested as received.

The following Table summarizes the results of testing.

Test	Frequency (MHz)	Measurement	Requirement	Pass/Fail	Section of FCC Rules	Section of Test Report
Fundamental Field Strength	916.5	33.5 mV/m @ 3 meters	50 mV/m @ 3 meters	Pass	15.249	Table 1
Spurious & Harmonic Emission	9165.0	291.7 µV/m @ 3 meters	500 µV/m @ 3 meters	Pass	15.205 & 15.209	Table 1
Line-conducted Emissions	450 kHz to 30 Mhz	Not applicable. Device is Battery Powered.		N/a	15.207	Not Applicable
All emissions measured with an Average detector, the peak measurement was within 20 dB of the Average.						

In summary, this report confirms that the Model: SAI is compliant with the FCC Part 15, Subpart C requirements when production units conform with the initial sample. Please address all questions and comments concerning this report to Peter Boers, Senior Staff Engineer.

II – Technical Requirements

15.1 Scope

The device is an intentional radiator intended to operate in accordance with 15.249 of Part 15 of the FCC rules without a license.

15.15 General Technical Requirements

There are no controls accessible to the user that would cause the device to operate in violation of the FCC rules.

15.27 Special Accessories

No special accessories are necessary to meet compliance requirements.

15.31 Measurement Standards

The measurement procedures specified by ANSI C63.4:1992 were used to setup and test the device. See Section IV of this test report for detailed description of the test procedure.

A new battery was used during testing.

The device does not allow the connection of other devices other than a passive probe cable. The transmitter was tested standalone.

15.33 Frequency range of measurement

The device was scanned for spurious and harmonic emissions from 30 MHz to the 10^{th} harmonic of the fundamental emission.

15.35 Measurement detector functions and bandwidth

The following table illustrates the detector functions and bandwidth used to test the device. No deviations to the following were made.

Frequency Range	Measurement Detector	Measurement Bandwidth
450 kHz to 30 MHz	Quasi-Peak	9 kHz
30 MHz to 1000 MHz	Quasi-Peak	120 kHz
1000 MHz to 10^{th} harmonic	Average	1 MHz

The quasi-peak detector meets the requirements of CISPR 16.

An averaging factor was not used or determined for the device because it uses FSK modulation.

15.36 Transition Provisions

Transition provisions were not applied to the device. A receiver is not being certified with the device. The device does not operate in the band 902-905 MHz.

15.201 Certification

The device is required to be certified in accordance with Part 2 of the FCC rules, Subpart J.

15.203 Antenna Requirements

The antenna is soldered to the transmitter board. There is no convenient antenna connection jack that would make it possible for the end-user to attach an antenna other than that which is intended by the manufacturer.

15.204 External Radio Amplifier

The device is not an amplifier.

15.205 Restricted bands of operation

The requirements of this section are satisfied because all emissions but the fundamental are required to be below the general requirements of Section 15.209

Below 1000 MHz a quasi-peak detector was employed to measure emissions
Above 1000 MHz an average detector was employed to measure emissions. Peak measurements were also performed above 1000 MHz to insure that they were not greater than 20 dB of the average.

15.207 Conducted limits

Not applicable. The device is only battery powered.

15.209 Radiated emission limits; general requirements

Except for measurements within the transmiters band of operation all emission were compared to the general requirement. Measurements were performed at 3 meters except where indicated in the Data table.

No spurious emission measured exceeded the level of the fundamental emission.

15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz

The Field strength limit for the device was based on the operating frequency of 916.5 MHz:

Frequency (MHz)	Emission Limit (mV/m)	Emission Limit (dBμV/m)	Test Distance (meters)
916.5	50	94.0	3

The emission requirement for harmonic emission is identical to the general requirement of 15.209. Spurious emission measurements were compared to the general requirement of 15.209.

The fundamental emission was measured with a quasi-peak detector. For above 1000 MHz, measurements were made with both a peak and average detector to insure that peak measurements did not exceed the average by more than 20 dB.

Part 2

2.201 Emission Modulation and transmission characteristics

The emission designator is determined as follows

There is no bandwidth requirement for the transmitter. The manufacturere specifies the bandwidth is: 52.0 kHz

The main carrier modulation is FSK (frequency shift keying. Therefore the first symbol is "F".

There is no modulating signal. Therefore the second symbol is "0"

The type of information transmitted is telemetry. Therefore the third symbol is "D"

The emissions designator is:

52K0F0D

2.1041 Measurement Procedures

Only the measurement procedures of Part 15 are required for this device. The device was not evaluated to the requirements of 2.1046 through 2.1057.

2.1091 Radiofrequency radiation exposure evaluation: Mobile Devices

The device does not fall under any of the categories that require routine RF exposure measurements and is therefore exempt from the requirements of this section.

2.1093 Radiofrequency radiation exposure evaluation: Portable Devices

The device does not meet the definition of a portable device (That is it is not intended to operate within 20 cm of a persons body, it is used in a furnace and is magnetically activated inside the furnace) and is therefore exempt from the requirements of this section.

III - Attestation

LABORATORY MEASUREMENTS

Pursuant To
Part 15, Subpart C
For
Intentional Radiators

Company Name:	SAAR Associates, Inc.
Model:	SAI
Date of Test(s):	October 1, 1999
Test Site Location:	INTERTEK TESTING SERVICES NA INC. 70 Codman Hill Road Boxborough, MA 01719
Site:	2C

We attest to the accuracy of this report:

Signature

Michael J. Peters
Testing Performed By:

Senior Project Engineer
Title

Signature

Peter Boers
Reviewer

Senior Staff Engineer
Title

IV - Site Description

Introduction

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C, General Requirements.

A. **Test Set-Up**: The test set-up and procedures described below are designed to meet the requirements of ANSI C63.4 (1992).

1. The test site is a Plastic/Fiberglass structure with a groundplane. The site has attenuation characteristics which meet the requirements of ANSI C63.4 (1992). Information on the site has been filed with the FCC as required by Rule 2.948. The address of the site is 70 Codmand Hill Road, Boxborough, MA 01719.

2. Power to the site is nominal line voltage of 117 V_{AC} and 230 V_{AC}, 60 Hz.

3. The equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately one meter in height above the groundplane. During the radiated emissions test, the turntable is rotated 360 degrees and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The antenna height and polarization are also varied during the search for maximum signal levels. The height of the antenna is varied from one meter to four meters. Body-worn, hand-held and small portable devices are mounted on a non-conductive box and emissions are investigated on three orthogonal axis.

4. Detector function for radiated emissions is in peak or quasi-peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings according to the following formula:

Averaging Factor in dB = 20 LOG (duty cycle)

The time period over which the duty cycle is measured is 100 msec. The worst-case (highest percentage on) duty cycle is used and described specifically in the data section. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix 465 Oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities.

5. Antennas used below 1000 MHz were EMCO Model 3142 Biconolog Antennas and Compliance Designe Inc. Model A100 tuned Dipole Antennas. For measurements between 1000 MHz and 18000 MHz above 1 GHz, an EMCO Model: 3115 Horn Antenna is used. The Antennas used are listed in the Test Equipment Summary in Section 6

6. The field strength measuring equipment used included:

V - Measurement Equipment

EQUIPMENT LIST TABLE					
Abbr	Equipment	Manufacturer	Model	Serial	Cal Due
DIP3	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	3947	22Mar00
HORN1	HORN ANTENNA	EMCO	3115	4632	03Oct99
HP3	SPECTRUM ANALYZER	HEWLETT PACKARD	8593A	3009A00659	18May99
LOG4	BICONOLOG ANTENNA	EMCO	3142	1225	21Dec99
PRE8	PREAMPLIFIER	MITEQ	NSP4000-NF	507145	11Oct99
REC2	RECEIVER	HEWLETT PACKARD	85422	3625A00188	19Jan00
REC2	RF FILTER	HEWLETT PACKARD	8542	3427A00177	19Jan00

7. The frequency range to be scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency, or 40 GHz, whichever is lower. For line-conducted emissions, the range scanned is 450 kHz to 30 MHz.

8. The EUT is warmed up for 15 minutes prior to the test. AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new battery is used.

9. Conducted measurements were made as described in ANSI C63.4 (1992). An IF bandwidth of 9 kHz is used, and peak or quasi-peak detection is employed.

10. The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application No. 150-2. A discussion of whether pulse desensitivity is applicable to this unit is included in this report. Above 1000 MHz, a bandwidth of 1 MHz is generally used.

11. Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz (where no preamplifier is used), signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

12. For measurements made in the 9 kHz to 30 MHz range, a distance of 30 meters was used unless a good signal-to-noise ratio could not be obtained. In that case, a closer distance was used and that distance is so marked in the data table.

VI – Summary of Equipment Under Test

1	**Manufacturer**:	Heraeus Electo-nite Philadelphia, PA
2	**Grantee**:	SAAR Associates, Inc.
3	**Model No.**:	SAI
4	**Trade Name**:	SAI
5	**Serial No.**:	Not Labeled
6	**Date of Test**:	October 1, 1999
7	**Frequencies to which device can be tuned**:	916.5 MHz
8	**Can customer tune device?**	No
9	**Detailed description of operation pursuant to 15.209**:	See below Text
10	**Applicable emissions limits**:	15.209 & 15.249
11	**Additional Comments**:	Only Battery Operated

9. Detailed description of operation pursuant to 15.209

The transmitter was wired to transmit continuously. Under normal conditions the device would transmit every 100 milliseconds.

The transmitter operates at 915.6 MHz and employs FSK modulation (15 to 50 kHz deviation). The device is powered by a commercial 9 volt battery and consumes about 30 mA. A linear voltage regulator provides 5 volts to all the circuits.

The transmitter is encased in a ceramic fiber enclosure.

The transmitter was tested standalone and placed in the center of the turntable.

VII - Configuration Information

Equipment Under Test:	Telemetry Transmitter
Model:	SAI
Serial No.:	Not Labeled
FCC Identifier:	HEN011

Support Equipment:

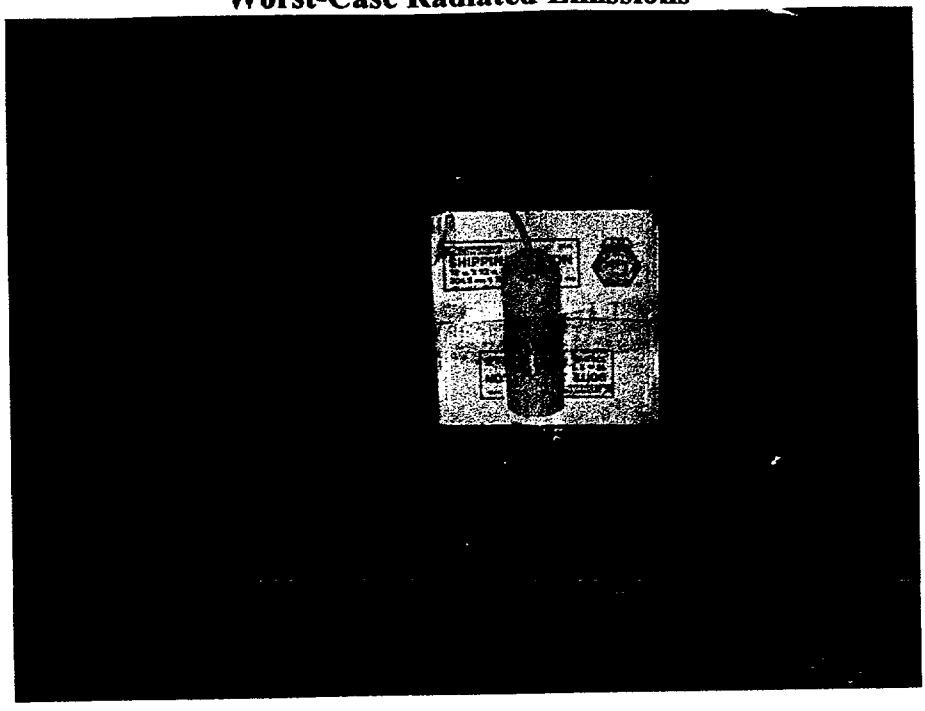
None

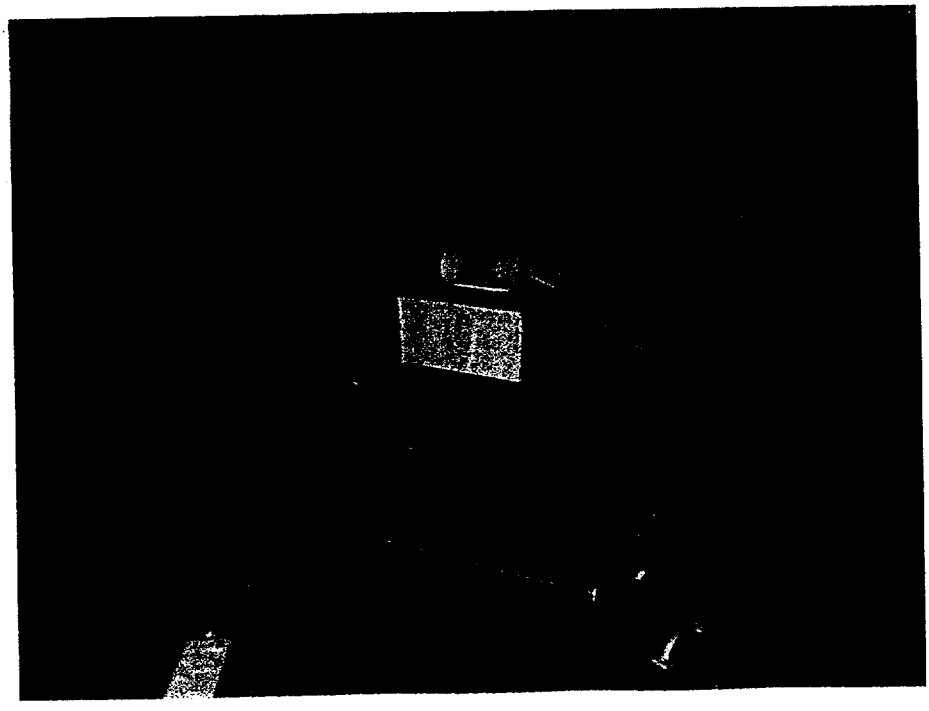
Cables:

1 Sensor Cable (Two wire), unshielded, 1 meter

VIII - Configuration Photographs

Worst-Case Radiated Emissions





IX Sample Calculation

The following is how net field strength readings were determined:

$NF = RF + AF + CF + PF + DF$

Where,

NF = Net Reading in dBμV/m
RF = Reading from receiver in dBμV/m
AF = Antenna Correction Factor in dB
CF = Cable Correction Factor in dB
PF = Preamplifier Correction Factor in dB
DF = Distance Factor in dB (using 20 dB/decade), from 3 to 1 meters 10.5 dB was added for measurements performed at 1 meter

To convert from dBμV/m to μV/m or mV/m the following was used:

$UF = 10^{(NF / 20)}$

Where,

UF = Net Reading in μV/m

$MF = UF / 1000$

Where,

MF = Net Reading in mV/m

For the fundamental field strength measurement at 916.5 MHz (distance = 3 meters) see table 1.

$NF = 56.8\ dB\mu V + 27.8\ dB + 5.9\ dB + 0.0\ dB + 0.0\ dB = 90.5\ dB\mu V/m$

$UF = 10^{(90.5\ dB\mu V / 20)} = 33{,}496.5\ \mu V/m$

$MF = 33{,}496.5\ \mu V / 1000 = 33.5\ mV/m$

X - Data Tables

Intertek Testing Services

Radiated Emissions / Interference

Table: 1

Company: Saar Associates
Model: SAI Telemetry Transmitter
Job No.: J99023637
Date: 10/01/99
Standard: FCC Part 15 Subpart C 15.249
Class: n/a Group: None
Notes: Scan from 30 to 9,165.0 MHz

Tested by: Michael Peters
Location: Site 2
Detector: HP 8542E
Antenna: EMCO HORN 4632
PreAmp: PRE8 MITEQ-50714
Cable(s): SM3 NS1
Distance: 3
Signature:

	Ant. Pol. (v h)	Frequency (MHz)	Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-amp Factor (dB)	Distance Factor (dB)	Net dBuV/m	Limit dBuV/m	Margin (dB)
	Measured with Quasi-Peak detector (120 kHz RBW)									
ame	h	916.50	56.8	27.8	5.9	0.0	0.0	90.5	94.0	- 3.5
	Measured with Average detector (1 MHz RBW)									
	v	1833.00	37.0	28.2	4.8	22.3	0.0	47.7	54.0	- 6.3
peak	h	2749.00	33.9	30.9	5.9	22.3	0.0	48.5	54.0	- 5.5
	v	3669.90	21.0	33.5	6.3	22.2	0.0	38.6	54.0	- 15.4
nf	h	4582.00	22.0	34.2	7.0	22.0	0.0	41.2	54.0	- 12.8
nf	v	5500.00	22.0	36.1	7.6	21.7	10.5	33.5	54.0	- 20.5
nf	v	6417.00	21.7	36.2	8.7	21.3	10.5	34.8	54.0	- 19.2
nf	v	7332.00	27.4	37.6	10.4	20.8	10.5	44.1	54.0	- 9.9
nf	v	8248.50	27.7	38.0	11.4	20.3	10.5	46.4	54.0	- 7.6
nf	v	9165.00	27.0	39.6	12.6	19.3	10.5	49.3	54.0	- 4.7
	Measured with Peak detector (1 MHz RBW)									< 20 dB?
	v	1833.00	40.6	28.2	4.8	22.3	0.0	51.3	67.7	Yes
	h	2749.00	33.9	30.9	5.9	22.3	0.0	48.5	-	Yes
	v	3669.90	35.9	33.5	6.3	22.2	0.0	53.5	58.6	Yes
nf	h	4582.00	32.2	34.2	7.0	22.0	0.0	51.4	61.2	Yes
nf	v	5500.00	36.0	36.1	7.6	21.7	10.5	47.5	53.5	Yes
nf	v	6417.00	36.0	36.2	8.7	21.3	10.5	49.1	54.8	Yes
nf	v	7332.00	35.8	37.6	10.4	20.8	10.5	52.5	64.1	Yes
nf	v	8248.50	36.0	38.0	11.4	20.3	10.5	54.7	66.4	Yes
nf	v	9165.00	36.0	39.6	12.6	19.3	10.5	58.3	69.3	Yes

nf - noise floor
RBW - Resolution Band Width