Project 07441-10

SAT Corporation
SRM2-MC90XX

Certification
Electromagnetic Compatibility Test Report

Prepared for:

SAT Corporation

10111 Richmond Ave., Suite 650
Houston, TX 77042

By

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11 June 2007

Reviewed by
Jason Anderson
Director, Test Services

Written by
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FIGURES

Revision History

Rev 1 – Corrected emission limit for fundamental. Actual limit is higher than calculated. Pages 3 and 10 revised accordingly. EL

Certificate Of Compliance

Applicant: SAT Corporation

Applicant's Address: 10111 Richmond Ave., Suite 650
Houston, TX 77042

Project Number: 07441-10

Test Dates: 7 March 2007

I, Jason Anderson, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

The EUT, a **SAT Corporation, model SRM2-MC90XX** was tested to and found to be in compliance with FCC Part 15 Subpart C for an Intentional Radiator.

The highest emissions generated by the above equipment are listed below:

	Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Fundamental	0.134	90.4	130.1	-39.7
Harmonics	None measurable.	n/a	n/a	n/a
Spurious	347	34.0	37.0	-3.0

Occupied Bandwidth Not measured
Transmit Duty Cycle 100 % assumed

I, Jason Anderson, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

Jason Anderson
Regulatory Department Manager

This report has been reviewed and accepted by SAT Corporation. The undersigned is responsible for ensuring that this device will continue to comply with the FCC and IC rules.

1.0 EUT Description

The SRM2-MC90XX (EUT) is a short range RFID transmitter/interrogator that queries RFID transponders used as asset tags in industrial applications.

The EUT is a low-frequency RFID (Radio Frequency Identification) device for use with Texas Instruments TIRIS transponders. The EUT snaps on to the bottom end of a Symbol / Motorola handheld computer. The handheld computer provides 3.3V power and communicates with the module via a COM port.

The major components of the EUT are two PCAs (Printed Circuit Assemblies), a wire-wound antenna, a molded plastic shell, levers, and a neoprene boot. The two PCAs are designated the Controller and the Transceiver.

The EUT transmits at 134.2 kHz. Every read or write operation starts with a 50 ms burst to charge the transponder. Charge-only read operations send only the charge burst. Selective read operations follow the charge burst with 16 ms of On/Off modulation. Write operations follow the charge burst with 100 ms of On/Off modulation. The transponders are passive, with no internal battery. An internal capacitor gathers enough energy from the charge burst to allow a reply lasting about 20 milliseconds. The transponders reply using FSK modulation.

This EUT can only operate using battery power provided by the host handheld computer. The EUT, when attached for use, covers the charging connector of the handheld computer such that it cannot be charged while this device is attached.

The transmitter and receiver are integrated in the Texas Instruments TMS3705 IC. The power supply to the TMS3705 is 5V. The small loop antenna is tuned to resonance with a capacitor. An RC filter limits the high frequency content reaching the antenna.

The system tested consisted of the following:

Manufacturer	Description	FCC ID	IC Number
SAT Corporation	0.134 MHz Transmitter	OFZ90XX1	6984A-90XX1

1.1 Applicable Documents

Guidelines	FCC Rule Parts Part 15	IC Rules RSS-210 Issue 6
Transmitter Characteristics	15.209	RSS-210 2.6
Spurious Radiated Power	15.209	RSS-210 2.6
Occupied Bandwidth	Not measured.	Not measured.
Antenna Requirements	15.203	RSS-Gen 5.5
Averaging Calculations	Not applied.	RSS-Gen 4.3

1.2 EUT Operation

The EUT was operated in continuous transmit mode at a fixed and maximum power.

2.0 Electromagnetic Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. See Appendix B for details.

2.1 Radiated Emissions Measurements

Emission measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036A-2) in Austin, Texas, and radiated emissions below 30 MHz measured at the PTI open area test site designated Site 3 (FCC 459644, IC 3036-3), located in Round Rock, Texas. These sites are registered with the FCC under Section 2.948 and Industry Canada per RS-212 and are subsequently confirmed by laboratory accreditation (NVLAP).

The fundamental emissions of the equipment under test (EUT) were measured with the EUT placed in each of three orthogonal positions, then rotated for each measuring antenna orientation.

2.1.1 Test Procedure

The EUT was placed at the center of a non-conductive remotely-rotated table 0.8 meters above the ground plane. From 30 MHz to 1 GHz the measurement antenna was placed at a distance of 10 meters as measured from the closest point of the EUT. Below 30 MHz a loop antenna is placed at 3 meters distance on a 0.8 m high manually operated non-conductive turntable. The radiated emissions were maximized by rotating the EUT. A drawing showing the test setup is given as Figure 1.

2.1.2 Test Criteria

Relevant FCC/IC & CISPR emission limits are listed below. Transmitter harmonics are measured up to the 10^{th} harmonic. The lower limit shall apply at the transition frequency.

FCC/IC		
Frequency (MHz)	**Test Distance (Meters)**	**Field Strength Limit (dB µV/m)**
0.009 to 0.490	300	40 log (2400/F(kHz))
0.490 to 1.705	30	40 log (24000/F(kHz))
1.705 to 30	30	295
30 to 88	3	40.0
88 to 216	3	43.5
216 to 960	3	46.0
960 and above	3	54.0

CISPR		
Frequency (MHz)	**Test Distance (Meters)**	**Field Strength Limit (dB µV/m)**
30 to 230	3	40.5
230 to 1000	3	47.5

2.1.3 Test Results

The radiated test data is included in Appendix A. Peak detection was used during the test for the fundamental and harmonics. Quasi-Peak or peak detection was used for spurious emissions below 1 GHz. The measured radiated emissions are below the applicable limits.

2.1.4 Radiated Emissions Test Equipment < 30 MHz

Asset #	Manufacturer	Model #	Description	Calibration Due
1293	EMCO	6502	Loop Antenna	December 22, 2007
0586	HP	8447D	RF Preamplifier	January 1, 2007
0410	HP	8591EM	Spectrum Analyzer	December 27, 2007

2.1.5 Radiated Emissions Test Equipment 30 MHz to 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
0275	HP	85650A	Quasi-peak Adapter (high band)	June 5, 2007
1526	HP	85662A	Spectrum Analyzer Display (high band)	June 28, 2007
1525	HP	8566B	Spectrum Analyzer (high band)	July 10, 2007
0238	HP	85685A	RF Preselector (high band)	May 30, 2007
1280	HP	85650A	Quasi-peak Adapter (low band)	May 4, 2007
1273	HP	85662A	Spectrum Analyzer Display (low band)	NCR
1438	HP	8568B	Spectrum Analyzer (low band)	June 23, 2007
1035	HP	85685A	RF Preselector (low band)	December 8, 2007
1389	EMCO	3108	Antenna, Biconical (low band)	June 5, 2007
1486	EMCO	3147	Antenna, Log (high band)	May 13, 2007
1414	HP	8447D	Preamplifier, Dual	May 4, 2007
C026	-	-	Coaxial cable assembly (low band)	June 28, 2007
C027	-	-	Coaxial cable assembly (high band)	July 6, 2007

High band refers to equipment dedicated to measurements from 200 MHz to 1000 MHz. Low band refers to equipment dedicated to measurements from 30 MHz to 200 MHz.

3.0 Occupied Bandwidth Measurements

Measurements of the occupied bandwidth were not required since all emissions are limited to the general limits of FCC 15.209 and no regulatory bandwidth limitation exists.

4.0 Burst Length, Pulse Width, Pulse Repetition Rate and Duty Cycle

The EUT transmits in a pulsed fashion though max-hold quasi-peak or peak measurements were taken and these satisfied the limits without consideration of duty cycle.

5.0 Antenna Requirement

An analysis of the EUT was performed to determine compliance with FCC Section 15.203. This section requires specific handling and control of antennas used for devices subject to regulations.

5.1 Evaluation Procedure

The structure and application of the EUT was analyzed with respect to the rules.

5.2 Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

(a) Antenna must be permanently attached to the unit.

(b) Antenna must use a unique type of connector to attach to the EUT.

(c) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

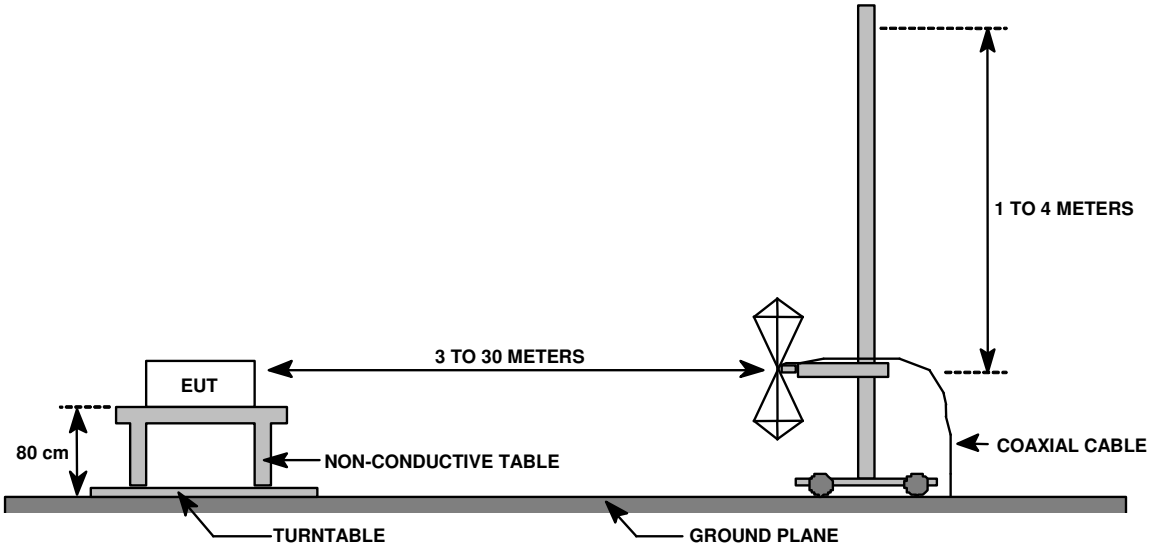
5.3 Evaluation Results

The EUT meets the criteria of this rule by virtue of having an internal antenna embedded into the printed circuit board. There is no external connector. The EUT is sealed in a small plastic assembly at the factory which protects against any user tampering. The EUT satisfies the criteria.

6.0 Modifications

To reduce 340 MHz harmonic emissions from the digital clocks the board layout was revised and the two offending digital clock sources were filtered with an RC network at the clock source. These modifications had no effect on the transmitter circuits. The worse-case emission mode above 30 MHz, transmit, was re-measured with the modification implemented as described.

FIGURE 1: Radiated Emissions Test Setup



Note: Site 45 is a semi-anechoic facility of 10 meters measurement distance and used for radiated emissions from 30 MHz to 1 GHz. Site 3, an open area test site, was used for 130 kHz to 30 MHz emission measurements at a distance of 3 meters.

APPENDIX A TEST DATA SHEETS

Radiated Emissions Data Sheet
Transmit Fundamental, Harmonics & Spurious
130 kHz ≤ f ≤ 30 MHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07441-10	7 March 2007	CISPR B	3 m	Loop	CISPR 9 kHz	30 kHz	QP

COMMENT	Transmit mode. Measurement for 0.134 MHz is highest of 3 orthogonal measurements.

ANTENNA POLARIZATION: Face On

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.134	90	1	106.9	27.4	9.6	1.4	90.4	130.1	-39.7	0.134
0.268	noise	floor	66	27.4	9.6	1.4	49.6	118.1	-68.5	0.268
0.402	noise	floor	64	27.4	9.6	1.4	47.6	111.0	-63.4	0.402
0.536	noise	floor	63	27.4	8.5	1.4	45.5	106.0	-60.5	0.536
0.670	noise	floor	63	27.4	8.6	1.4	45.6	102.2	-56.5	0.670
0.804	noise	floor	64	27.4	8.7	1.4	46.7	99.0	-52.3	0.804
0.938	noise	floor	65.2	27.3	8.7	1.4	48.0	96.3	-48.3	0.938
1.072	noise	floor	59.6	27.1	10.2	1.4	44.1	94.0	-49.9	1.072
1.206	noise	floor	66.4	27.1	10.2	1.4	50.9	92.0	-41.1	1.206
1.340	NF	B/C ambient	70.3	27.1	10.2	1.4	54.8	90.1	-35.3	1.340

ANTENNA POLARIZATION: Edge On

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
0.134	0	1	101.5	27.4	9.6	1.4	85.0	130.1	-45.1	0.134
0.268	noise	floor	66	27.4	9.6	1.4	49.6	118.1	-68.5	0.268
0.402	noise	floor	64	27.4	9.6	1.4	47.6	111.0	-63.4	0.402
0.536	noise	floor	63	27.4	8.5	1.4	45.5	106.0	-60.5	0.536
0.670	noise	floor	63	27.4	8.6	1.4	45.6	102.2	-56.5	0.670
0.804	noise	floor	64	27.4	8.7	1.4	46.7	99.0	-52.3	0.804
0.938	noise	floor	65.2	27.3	8.7	1.4	48.0	96.3	-48.3	0.938
1.072	noise	floor	59.6	27.1	10.2	1.4	44.1	94.0	-49.9	1.072
1.206	noise	floor	66.4	27.1	10.2	1.4	50.9	92.0	-41.1	1.206
1.340	NF	B/C ambient	70.3	27.1	10.2	1.4	54.8	90.1	-35.3	1.340

Test Engineer: Eric Lifsey

Radiated Emissions Data Sheet
Standby Mode, Harmonics & Spurious
130 kHz ≤ f ≤ 30 MHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07441-10	7 March 2007	CISPR B	3 m	Loop	CISPR 9 kHz	30 kHz	QP

COMMENT	Standby mode.

No emission from found from EUT in standby mode for 130 kHz to 30 MHz frequency range.

Test Engineer: Eric Lifsey

Spurious Radiated Emissions Data Sheet
30 MHz ≤ f ≤ 1 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07441-10	20 March 2007	CISPR B	10 m	Bicon | Log	CISPR 120 kHz	1 MHz	QP | Peak

COMMENT	Transmit mode. Measured with new digital clock design and permanent modification.

ANTENNA POLARIZATION: Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
129	max	4	28.9	25.6	11.5	1.4	16.2	30	-13.8	Peak
300	240	4	39.9	31.5	13.5	2.5	24.4	37	-12.6	QP
359	70	3.6	36.7	31.7	14.7	2.9	22.6	37	-14.4	QP
447.9	240	3	35.2	31.8	17.8	3.2	24.4	37	-12.6	QP
480	180	4	30.6	31.7	17.7	3.4	20.0	37	-17.0	QP
575	max	2.5	31.5	31.8	18.5	3.8	22.0	37	-15.0	Peak

ANTENNA POLARIZATION: Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
47.9	max	1	32.8	25.6	10.7	0.7	18.6	30	-11.4	Peak
125	max	1	34.6	25.6	11.3	1.2	21.5	30	-8.5	Peak
244.3	0	1	34.7	31.4	11.9	2.2	17.3	37	-19.7	QP
417.9	0	1	30.1	31.8	15.9	3.1	17.2	37	-19.8	QP
464	max	2	30.5	31.7	17.8	3.3	19.9	37	-17.1	QP
747	max	3.5	33.8	31.9	20.8	4.3	27.0	37	-10.0	QP

Test Technician: Jesse Banda

Spurious Radiated Emissions Data Sheet
30 MHz ≤ f ≤ 1 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
07441-10	7 March 2007	CISPR B	10 m	Bicon | Log	CISPR 120 kHz	1 MHz	QP | Peak

COMMENT	Standby mode. Measured with original digital clock design and temporary modification.

ANTENNA POLARIZATION: Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
347	300	2.9	48.4	31.7	14.5	2.9	34.0	37	-3.0	QP
392	220	2.2	45.7	31.8	15.4	2.9	32.2	37	-4.8	QP
476	230	1.9	41.7	31.7	17.7	3.4	31.1	37	-5.9	QP
500	200	1.6	39	31.8	17.6	3.4	28.2	37	-8.8	QP
610	240	1.6	35.8	31.7	18.6	3.8	26.5	37	-10.5	QP
777	90	1	39.6	31.9	20.5	4.4	32.6	37	-4.4	QP

ANTENNA POLARIZATION: Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector Function
47.9	max	1	32.8	25.6	10.7	0.7	18.6	30	-11.4	Peak
125	max	1	34.6	25.6	11.3	1.2	21.5	30	-8.5	Peak
244.3	0	1	34.7	31.4	11.9	2.2	17.3	37	-19.7	QP
417.9	0	1	30.1	31.8	15.9	3.1	17.2	37	-19.8	QP
464	max	2	30.5	31.7	17.8	3.3	19.9	37	-17.1	QP
747	max	3.5	33.8	31.9	20.8	4.3	27.0	37	-10.0	QP

Test Engineer: Eric Lifsey

APPENDIX B Policy, Rationale and Evaluation of EMC Measurement Uncertainty

Professional Testing (EMI) Inc. (PTI) Policy, Rationale and Evaluation of EMC Measurement Uncertainty

PTI operates in accordance with NIST (NVLAP) Handbook 150-11 [5], all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting state uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty discussed in TN 1297, NIS 81, and the ISO Guide to the Expression of Uncertainty in Measurement. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a-priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown in the table below. These are the worst-case uncertainties considering all operative influence factors.

Summary of PTI Measurement Uncertainties

Type of Measurement, Identification & Registrations	Frequency Range	Measurement Distance (m)	Expanded Uncertainty U, dB (k=2)
Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Radiated Emissions Site #45 Enclosed 10 meter site FCC 459644 IC 3036A-2	30 to 200 MHz	3	4.7
		10	4.4
	200 to 1000 MHz	3	4.6
		10	4.0
	1 to 2.5 GHz	1	2.5
	2.5 to 12.5 GHz	1	3.6
	12.5 to 18 GHz	1	4.0
Radiated Emissions Site #3 FCC 96692 IC 3036-3	30 to 200 MHz	3	3.9
	200 to 500 MHz	3	4.0
	500 to 1000 MHz	3	4.3
Radiated Emissions Site #1 FCC 90885	30 to 200 MHz	3	4.7
		10	4.4
	200 to 1000 MHz	3	4.6
		10	4.0
	1 to 2.5 GHz	1	2.5
	2.5 to 12.5 GHz	1	3.6
	12.5 to 18 GHz	1	4.0

Sites listed above are subjected to audit under scopes listed with NIST NVLAP file 200062-0.