FCC Certification Test Report

FCC Certification Test Report
for
Innovative Technology of America
FCC ID: PTOITATRAN

August 29, 2001

Prepared for:

Innovative Technology of America
2702 North Mattis Avenue
Champaign, IL 61822

Prepared By:

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FCC Certification Test Program

FCC Certification Test Report
for the
Innovative Technology of America
ST2000 SWS Safety Transmitter
FCC ID: PTOITATRAN

August 29, 2001

WLL JOB# 6415

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Reviewed by: Michael Violette
President

Abstract

This report has been prepared on behalf of Innovative Technology of America to support the attached Application for Equipment Authorization. The test report and application are submitted for a Safety Warning Transmitter under Part 90.103 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Innovative Technology of America ST2000 SWS Safety Transmitter.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Innovative Technology of America ST2000 SWS Safety Transmitter complies with the limits for a Safety Warning System device under Part 90.103 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Innovative Technology of America ST2000 SWS Safety Transmitter complies with the limits for a Safety Warning System device under Part 90.103 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 1992 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Innovative Technology of America 2702 North Mattis Avenue Champaign, IL 61822
Purchase Order Number:	154
Quotation Number:	59103

1.4 Test Dates

Testing was performed during the month of April, 2001.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Michael Violette
	Chad Beattie
Customer	Jay Schreiber

1.6 Abbreviations

Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference

EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
Rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Innovative Technology of America
FCC ID Number	PTOITATRAN
EUT Name:	SWS Safety Transmitter
Model:	ST2000
FCC Rule Parts:	§90.103
Frequency Range:	24.1 GHz
Maximum Output Power:	10dBm
Modulation:	FM
Deviation:	2.5 MHz
Necessary Bandwidth:	6 MHz
Data Rate	2 kHz
Keying:	Constant Transmit
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral Horn Antenna
Frequency Tolerance:	2000 ppm
Emission Designator	6M00F1D
Interface Cables:	None
Power Source & Voltage:	12VDC from vehicle or power supply

The Innovative Technology of America Safety Warning System (SWS) Transmitter is used to provide short messages to alert drivers of hazardous conditions on highways. It is designed for fixed and mobile operation.

2.2 Test Configuration

The ST2000 was configured with a bench source power supply providing 12VDC to the EUT.

2.3 Testing Algorithm

The ST2000 was operated continuously by streaming a message to the modulation circuit that fed the oscillator.

Worst-case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The measurement uncertainty of the data contained herein is ±2.3 dB.

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ± dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

Total Uncertainty $= (A^2 + B^2 + C^2)^{1/2}/(n-1)$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, total uncertainty $= 0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Equipment	Serial/Asset Number	Calibration Due
HP 8564E Spectrum Analyzer	67	4/12/02
Narda 638 Standard Gain Horn (18-26.5GHz)	210	N/A
Narda V637 Standard Gain Horn (26.5-40GHz)	209	N/A
Millitech SGH-19-RP00 w/HP 11970U mixer	83	8/27/01
Millitech SGH-15-RP00 w/HP 11970V mixer	54	8/27/01
Millitech SGH-10-RP00 w/HP 11970W mixer	55	8/27/01
Fluke 87 DVM	41	6/28/02
Global Specialties 1337 DC power supply	None	N/A
Fluke Type K T/C and module	40	6/26/02
Tenney Engineering TR64 Chamber	254	5/7/02

4 Test Results

4.1 Output Power (§2.1046)

Output power was measured by connecting the output flange of the EUT via a waveguide coupler to the input of the HP 8564E Spectrum Analyzer.

The following settings were used on the spectrum analyzer:

Resolution Bandwidth 1 MHz

VBW: 1. 0 MHz

Span 20 MHz

Sweep 50 ms

The output power was measured to be +10 dBm.

4.2 Spurious Emissions at antenna terminals (§2.1051)

Waveguides were not available for coupling to the output terminal of the transmitter above the carrier frequency. As the antenna is integral with the unit, the spurious emissions at the antenna terminals were not measured. Instead, spurious emissions were measured using a radiated method.

4.3 Frequency Stability (§2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

4.3.1 Frequency as a Function of Applied Voltage.

The EUT is powered by an external DC voltage source. The EUT was connected to a variable DC supply and the input power varied over the following range:

Low DC Voltage of 10.8 VDC (85% nominal)

High DC Voltage of 13.2 VDC (115% nomina)

Table 3. Frequency Deviation as a Function of Applied Voltage

Voltage	Frequency (GHz)	Deviation (MHz)	Limit (MHz)	Result
10.2	24.10087	0.3	+/-48.2	Pass
12	24.1009	0	-	-
13.8	24.1004	0.5	+/-48.2	Pass

4.3.2 Frequency as a Function of Temperature

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

Tested by: Son Ngyuen

Date: July 19, 2001

Table 4. Frequency Deviation as a Function of Temperature

Temperature (Celsius)	Frequency (GHz)	Deviation (MHz)	Limit (MHz)	Result
-30	24.10207	6.1	+/-48.2	Pass
-20	24.10042	7.8	+/-48.2	Pass
-10	24.10275	5.4	+/-48.2	Pass
0	24.10625	1.9	+/-48.2	Pass
10	24.10783	0.3	+/-48.2	Pass
20	24.10667	1.5	+/-48.2	Pass
30	24.1050	3.2	+/-48.2	Pass
40	24.10358	4.6	+/-48.2	Pass
50	24.10217	6.0	+/-48.2	Pass

4.4 Spurious Emissions (§2.1053)

The EUT is provided with an integral antenna attached via waveguide to a horn antenna. The spurious emissions measurements were performed by radiated method.

Spurious emissions are required to be less than –23dBc, according to FCC 90.103. Measurements were performed up to the 5th harmonic of the fundamental per §2.1057(a)(2).

Tested by: Michael Violette

Date: June 19, 2001.

Table 5. Field Strength Measurements

Frequency (GHz)	Level dBuV	Antenna Factor	Ref Level Offset	Test Distance (m)	Distance Correction (dB)	E-Field dBuV/m @1m	Limit dBuV/m	Result
24.1	87	37.5	0	1	0	124.5	-	-
48.2	41.8	43.3	-8	1	0	77.1	101.5	Pass
72.3	41.8	46.7	6	0.5	6	88.5	101.5	Pass
96.4	28	46.3	10	1	0	84.3	101.5	Pass

4.5 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. At full modulation, the occupied bandwidth was measured as shown.

Tested by: Michael Violette

Date: June 19, 2001.

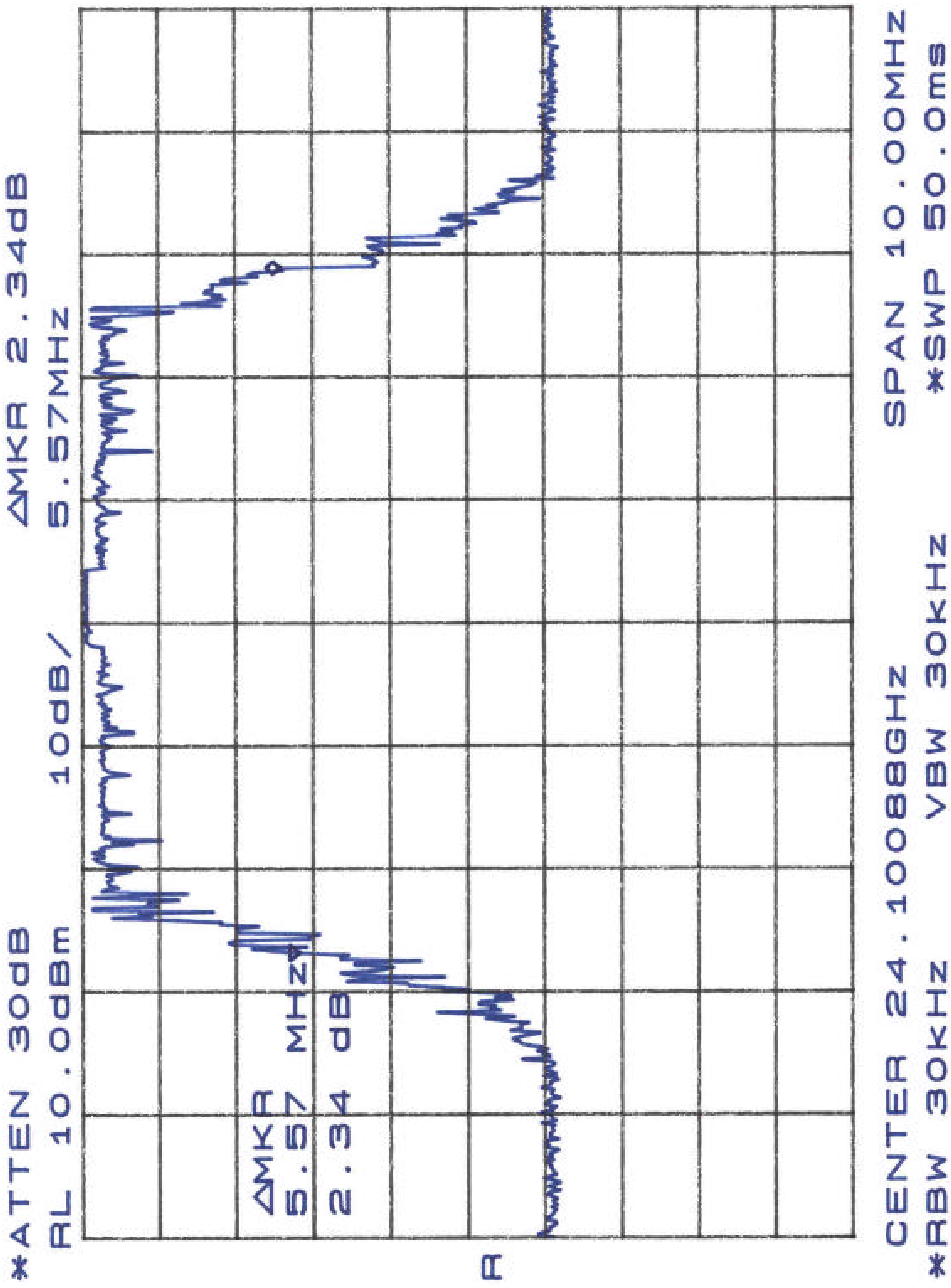

Figure 1. Occupied Bandwidth

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6. Occupied Bandwidth Results

Frequency	Bandwidth
24.1 GHz	5.57 MHz

4.6 Necessary Bandwidth (§2.202)

The necessary bandwidth is calculated from §2.202(g) for an FM signal without error-correction, where the necessary bandwidth is calculated from:

$$Bn = 2M + 2DK$$

Where,

M = maximum modulation frequency in Hz = 2000

D = Deviation (2.5MHz)

K = 1.2

Solving for the necessary bandwith yields:

$$Bn = (4000) + 2(2.8E6)*1.2$$

$$Bn = 6.004MHz \sim 6 MHz$$

5 Radiofrequency radiation evaluation exposure (§2.1091)

FCC §2.1091 calls out the criteria for evaluation of radiofrequency exposure. Per 2.1091©, mobile devices that operate at frequencies in excess of 1.5 GHz and whose ERP is less than 3 watts are excluded from routine environmental evaluation.

The ERP for the ITA SWS transmitter is calculated as follows:

Effective Radiated Power, $ERP = PtGt$ (1)

Power Density, $S = E^2/Zo$ (2)

$S = (PtGt)/4\pi r^2$ (3)

$PtGt = S \times 4\pi r^2$ (4)

From measurement, the Electric field at a distance of 1 m was found to be 124.5 dBuV/m, or 4.5 dBV/m or 1.68 V/m.

The equivalent power density is:

From (2) $S = (1.68^2)/Zo$

$S = 2.822/377$

$S = 0.00748\ W/m^2$

From (4) $PtGt = S\ X\ 4\pi r^2$

$PtGt = 0.00748\ X\ 4\ X\ 3.1515\ X\ 1^2$

Thus, solving for ERP:

$PtGt = 0.09$ Watts

This is below the 3 Watt limit set by the FCC in 2.1091(c).