APPLICATION FOR FCC CERTIFICATION

LOW POWER TRANSMITTER

Applied Technology Solutions, Inc.

Direct Sequence Spread Spectrum Transmitter

MODEL: 1225 Transceiver

FCC ID: OHA1225TRNSCVR

February, 1999

This report concerns (check one): Equipment Type: **Transceiver**	**Original Grant:** X	**Class II Change:**
Deferred grant requested per 47 CFR 0.457 (d) (1) (ii)? **If yes, defer until:**	**Yes:** ____________ ***Date***	**No**: X
Company name agrees to notify the Commission by: ____________(date) of the intended date of announcement of the product so that the grant can be issued on that date.		
Transition Rules Request per 15.37? Yes: **If no, assumed Part 15, subpart B for unintentional radiators - the new 47 CFR [10-1-90 Edition] provision..**	**No:** X	

REPORT PREPARED BY:

EMI Technician: Daniel W. Baltzell

Administrative Writer: Melissa Fleming

Rhein Tech Laboratories, Inc.

Document Number: 990033 / QRTL98-167

TABLE OF CONTENTS

APPENDIX LISTING

FIGURE INDEX

TABLE INDEX

1.0 GENERAL INFORMATION

The following Application for FCC Certification of a low power transmitter is prepared on behalf of Applied Technology Solutions, Inc. in accordance with Part 15.247 of the Federal Communications Commissions rules and regulations. The Equipment Under Test (EUT) was the Applied Technology Solutions, Inc. DSSS 904 and 921 MHz Transmitter, Model: 1225 Transceiver, FCC ID: OHA1225TRNSCVR . The test results reported in this document relate only to the item that was tested.

All measurements contained in this Application were conducted in accordance with ANSI C63.4 Methods of Measurement of Radio Noise Emissions, 1992. The instrumentation utilized for the measurements conforms to the ANSI C63.4 standard for EMI and Field Strength Instrumentation. Some accessories are used to increase sensitivity and prevent overloading of the measuring instrument. These are explained in the appendix of this report. Calibration checks are performed regularly on the instruments, and all accessories including the high pass filter, preamplifier and cables.

All radiated and conducted emissions measurement were performed manually at Rhein Tech, Incorporated. The radiated emissions measurements required by the rules were performed on the three meter, open field, test range maintained by Rhein Tech Laboratories, Inc., 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. Complete description and site attenuation measurement data have been placed on file with the Federal Communications Commission. The power line conducted emission measurements were performed in a shielded enclosure also located at the Herndon, Virginia facility. Rhein Tech, Labs, Inc. is on the FCC accepted lab list as a Facility available to do measurement work for others on a contract basis.

1.1 TEST FACILITY

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report dated March 3, 1994, submitted to and approved by the Federal Communication Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 1992).

1.2 RELATED SUBMITTAL(S)/GRANT(S)

The receiver portion of the transmitter is compliant with part 15 subparts A and B an FCC class A Verification report was prepared on behalf of ATS. This report is an addendum to the application for certification..

TABLE 1 EMISSIONS EQUIPMENT LIST

Calibration certification is available upon request.

DESCRIPTION	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CAL. LAB
AMPLIFIER	HEWLETT PACKARD	11975A	2304A00348	TEST EQUITY
AMPLIFIER (S/A 1)	RHEIN TECH	PR-1040	00001	RTL
AMPLIFIER (S/A 2)	RHEIN TECH	RTL2	900723	RTL
AMPLIFIER (S/A 3)	RHEIN TECH	8447F	2944A03783	RTL
AMPLIFIER (S/A 4)	RHEIN TECH	8447D	2727A05397	RTL
BICONICAL/LOG ANTENNA 1	ANTENNA RESEARCH	LPB-2520	1037	LIBERTY LABS
BICONICAL/LOG ANTENNA 2	ANTENNA RESEARCH	LPB-2520	1036	LIBERTY LABS
FIELD SITE SOURCE	EMCO	4610	9604-1313	RTL
FILTER (ROOM 1)	SOLAR	8130	947305	RTL
FILTER (ROOM 2)	SOLAR	8130	947306	RTL
HARMONIC MIXER 1	HEWLETT PACKARD	11970K	2332A00563	TELOGY
HARMONIC MIXER 2	HEWLETT PACKARD	11970A	2332A01199	TELOGY
HORN ANTENNA 1	EMCO	3160-10	9606-1033	EMCO
HORN ANTENNA 2	EMCO	3160-9	9605-1051	EMCO
HORN ANTENNA 3	EMCO	3160-7	9605-1054	EMCO
HORN ANTENNA 4	EMCO	3160-8	9605-1044	EMCO
HORN ANTENNA 5	EMCO	3160-03	9508-1024	EMCO
LISN (ROOM 1/L1)	SOLAR	7225-1	900727	ACUCAL
LISN (ROOM 1/L2)	SOLAR	7225-1	900726	ACUCAL
LISN (ROOM 2/L1)	SOLAR	7225-1	900078	ACUCAL
LISN (ROOM 2/L2)	SOLAR	7225-1	900077	ACUCAL
PRE-AMPLIFIER	HEWLETT PACKARD	8449B OPT	3008A00505	TELOGY
QUASI-PEAK ADAPTER (S/A 1)	HEWLETT PACKARD	85650A	3145A01599	ACUCAL
QUASI-PEAK ADAPTER (S/A 2)	HEWLETT PACKARD	85650A	2811A01276	ACUCAL
QUASI-PEAK ADAPTER (S/A 3)	HEWLETT PACKARD	85650A	2521A00473	ACUCAL
QUASI-PEAK ADAPTER (S/A 4)	HEWLETT PACKARD	85650A	2521A01032	ACUCAL
RF PRESELECTOR (S/A 1)	HEWLETT PACKARD	85685A	3146A01309	ACUCAL
SIGNAL GENERATOR (HP)	HEWLETT PACKARD	8660C	1947A02956	ACUCAL
SIGNAL GENERATOR (WAVETEK)	WAVETEK	3510B	4952044	ACUCAL
SPECTRUM ANALYZER 1	HEWLETT PACKARD	8566B	3138A07771	ACUCAL
SPECTRUM ANALYZER 2	HEWLETT PACKARD	8567A	2841A00614	ACUCAL
SPECTRUM ANALYZER 4	HEWLETT PACKARD	8567A	2727A00535	ACUCAL
TUNABLE DIPOLE	EMCO	3121	274	LIBERTY LABS
ANTENNA	ATM	WR08	08443-6	ATM
MIXER	OLESON	M08HW	F80814-1	OLESON
MIXER	OLESON	M05HW	G80814-1	OLESON
DIPLEXER	OLESON	M05HW	G80814-1	OLESON
MIXER	HEWLETT PACKARD	11970U	2332A01110	ACUCAL
MIXER	HEWLETT PACKARD	11970V	2521A00512	TELOGY
MIXER	HEWLETT PACKARD	11970W	2521A00710	TELOGY
ANTENNA	ATM	WR15	15-443-6	ATM
ANTENNA	ATM	WR10	10-443-6	ATM
ANTENNA	ATM	WR05	05-443-6	ATM
SWEEP GENERATOR	HEWLETT PACKARD	83752A	3610A00866	HEWLETT PACKARD

2.0 CONFORMANCE STATEMENT

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. No modifications were made during testing to the equipment in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the ANSI C63.4 test methodology.

Signature: ______________________________ Date: April 1, 1999

Typed/Printed Name: Bruno Clavier Position: Quality Manager (NVLAP Signatory)

Accredited by the National Voluntary Accreditation Program for the specific scope of accreditation under Lab Code 20061-0.

Note: This report may not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

3.0 TEST DETAILS

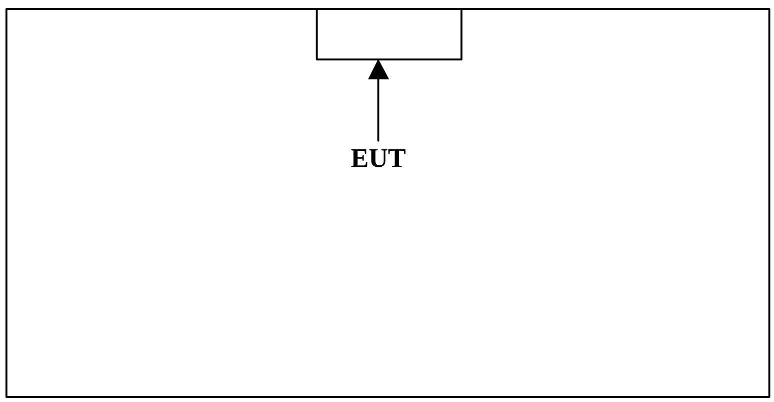
3.1 TEST SYSTEM DETAILS

The FCC Identifiers for all equipment, plus descriptions of all cables used in the tested system are:

External Components

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
TRANSCEIVER (EUT)	**APPLIED TECHNOLOGY**	**1225**	**N/A**	**N/A**	**N/A**	**010251**
ANTENNA	APPLIED TECHNOLOGY	N/A	N/A	N/A	N/A	010250
BATTERY 7.5 VDC NI-CAD	MULTIPLIER/CENTURION	M4326/SX4326	N/A	N/A	N/A	010254
REMOTE SPEAKER	ATS	1230-04	N/A	N/A	UNSHIELDED I/O	010255

FIGURE 1: CONFIGURATION OF TESTED SYSTEM



3.2 JUSTIFICATION

The EUT was tested in all three orthogonal planes in order to determine worst case emission. Channel A (904 MHz) and channel B (925 MHz) were tested and investigated from 9kHz to 10GHz. Both channels were found to exhibit the same signature.

To complete the configuration required by the FCC, the transmitter was tested with external microphone/speaker (m/n 1230-04), in order to cable and to terminate the transmitter ports.

3.3 EUT EXERCISE SOFTWARE

The EUT was enabled to continuously transmit, which was verified by a receiving unit during testing. The carrier was also checked to verify that the information was being transmitted.

3.4 SPECIAL ACCESSORIES

N/A

3.5 TEST METHODOLOGY

The radiated tests were performed according to the procedures in ANSI C63.4 1992. Radiated testing was performed at an antenna to EUT distance of 3 meters. Emissions above 1 GHz were video averaged. **Note:** Conducted emission was not performed because the EUT is not AC powered.

3.6 RADIATED MEASUREMENT

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one meter and three meter distances if necessary in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three-meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The spectrum was examined from 9 kHz to 10GHz MHz (10^{th} harmonic of carrier frequency) using a Hewlett Packard 8566B spectrum analyzer, a Hewlett Packard 85650A quasi-peak adapter, HP11790 mixers, and EMCO log periodic, EMCO horn antennas and biconical antenna. In order to gain sensitivity, a cougar preamplifier (from 30 to 2GHZ), and an HP preamplifier (from 1GHz to 26.5 GHz) was connected in series between the antenna and the input of the spectrum analyzer.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations. The spectrum analyzer's 6 dB resolution bandwidth was set to 120 kHz for measurements below 1GHz, and 1MHz for measurements above 1GHz. The analyzer was operated in peak detection mode below 1GHz and in the peak mode with 10Hz video averaging above 1 GHz. No video filter less than 10 times the resolution bandwidth was used when measuring below 1GHz. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

Note: Rhein Tech Laboratories, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the Rhein Tech quality manual, section 6.1. Rhein Tech implements the following procedures to minimize errors that may occur: yearly as daily calibration methods, technician training, and emphasis to employees on avoiding error.

3.7 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FI(dBuV/m) = SAR(dBuV) + SCF(dB/m)$$

FI = Field Intensity
SAR = Spectrum Analyzer Reading
SCF = Site Correction Factor

The Site Correction Factor (SCF) used in the above equation is determined empirically, and is expressed in the following equation:

$$SCF(dB/m) = -PG(dB) + AF(dB/m) + CL(dB)$$

SCF = Site Correction Factor
PG = Pre-amplifier Gain
AF = Antenna Factor
CL = Cable Loss

The field intensity in microvolts per meter can then be determined according to the following equation:

$$FI(uV/m) = 10^{FI(dBuV/m)/20}$$

For example, assume a signal at a frequency of 125 MHz has a received level measured as 49.3 dBuV. The total Site Correction Factor (antenna factor plus cable loss minus preamplifier gain) for 125 MHz is -11.5 dB/m. The actual radiated field strength is calculated as follows:

$$49.3 \text{ dBuV} - 11.5 \text{ dB/m} = 37.8 \text{ dBuV/m}$$

$$10^{37.8/20} = 10^{1.89} = 77.6 \text{ uV/m}$$

4.0 TEST RESULTS

4.1 MODULATED BANDWIDTH

The minimum 6 dB bandwidth per FCC 15.247(a)(2) was measured using a 50 ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 100 kHz. The Minimum 6 dB modulated bandwidth is 7.4 MHz for both channels. See 6 dB bandwidth plots. The antenna is a ½ wavelength flexible antenna. The directional gain is less than 6dBi.

TABLE 2: 6 dB BANDWIDTH: CHANNEL A

EMISSION FREQUENCY (MHz)	ANALYZER READING 20 dB ext. att. (dBuV)	Less 6 dB (dBuV)	Measured 6 dB down (MHz)	Bandwidth (MHz)
904.11	114.55	108.55	910.31/902.83	7.48

TABLE 3: 6 dB BANDWIDTH: CHANNEL B

EMISSION FREQUENCY (MHz)	ANALYZER READING 20 dB ext. att. (dBuV)	Less 6 dB (dBuV)	Measured 6 dB down (MHz)	Bandwidth (MHz)
923.18	114.38	108.38	926.73/919.39	7.34

4.2 POWER OUTPUT

The power output per FCC 15.247(b) was measured on the EUT using a 50 ohm spectrum analyzer with the resolution bandwidth set at 3 MHz, and the video bandwidth set at 3 MHz. The Peak power measured for modulated output power is 1.1W for channels A and B. See attached power output plot.

4.3 ANTENNA CONDUCTED SPURIOUS EMISSIONS

Antenna spurious emission per FCC 15.247(c) was measured from the EUT antenna port using a 50 ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 300 kHz. The modulated carrier was identified at 907.02 MHz with peak amplitude at 117.5 dBµV and 920.62MHz with a peak amplitude at 117.58dBµV with a 20 dB external attenuation. No other harmonics or spurs were found within 20 dB of the carrier level, and from 30 MHz to the carrier 10th harmonic. See antenna conducted spurious noise plots.

4.4 RADIATED SPURIOUS EMISSIONS

It applies to harmonics and spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. Outside the bands listed in part 15.205, and in any 100kHz outside the frequency band where the spread spectrum is operating, any radiated emissions must be 20dB below the carrier level. This level is based on a radiated measurement. The device under test was found compliant with the above requirement.

The following data lists the significant emission frequencies, measured levels, correction factor (includes cable and antenna corrections), the corrected reading, plus the limit. Explanation of the Correction Factor is given in paragraph 6.3.

TABLE 4 RADIATED EMISSIONS: CHANNEL A

EMISSION FREQUENCY (MHz)	Rx ANTENNA POLARITY (H/V)	EUT ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
904.39	V	V	114.5	-1.4	113.1	N/A	N/A
998.940	V	V	51.4	-1.4	50.0	54.0	-4.0
1003.380	V	V	51.0	-2.4	48.6	54.0	-5.4
1067.330	V	V	52.0	-1.4	50.6	54.0	-3.4
1151.390	V	V	44.1	-0.1	44.0	54.0	-10.0
1156.320	V	V	44.2	-0.1	44.1	54.0	-9.9
1161.420	V	V	42.1	0.2	41.9	54.0	-12.1
1209.370	V	V	43.8	0.7	43.1	54.0	-10.9
1214.980	V	V	48.6	0.9	47.7	54.0	-6.3
1219.960	V	V	46.3	1.0	45.3	54.0	-8.7
2496.94	H	V	48.3	1.2	49.5	54.0	-4.5
2721.99	V	V	47.4	2.3	49.7	54.0	-4.3
3626.87	V	V	44.1	5.4	49.5	54.0	-4.5
4535.43	V	V	45.0	-4.0	41.0	54.0	-13.0
5445.08	H	H	44.7	-2.5	42.2	54.0	-11.8
7253.84	H	H	46.7	-0.5	46.2	54.0	-7.8
8162.59	H	V	43.6	-0.9	42.7	54.0	-11.3
9067.26	V	V	40.1	4.9	45.0	54.0	-9.0
10885.51	H	H	39.5	5.0	44.5	54.0	-9.5
11794.31	V	H	35.1	4.0	39.1	54.0	-14.9

TEST PERSONNEL:

Signature: ________________________ Date: 1/22/99

Typed/Printed Name: Daniel W. Baltzell

TABLE 5: RADIATED EMISSIONS: CHANNEL B

EMISSION FREQUENCY (MHz)	Rx ANTENNA POLARITY (H/V)	EUT ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
920.840	V	V	115.3	-1.6	113.7	N/A	N/A
1011.350	V	V	50.5	-2.3	48.2	54.0	-5.8
1163.870	V	V	45.3	0.1	45.4	54.0	-8.6
1169.280	V	V	51.4	0.2	51.6	54.0	-2.4
1173.250	V	V	51.2	0.2	51.4	54.0	-2.6
1177.580	V	V	51.1	0.3	51.4	54.0	-2.6
1225.250	V	V	46.0	0.9	46.9	54.0	-7.1
2766.84	H	V	47.2	2.3	49.5	54.0	-4.5
3692.99	V	V	45.8	5.9	51.7	54.0	-2.3
4613.38	H	V	44.1	-3.8	40.3	54.0	-13.7
7381.37	H	V	46.8	-1.1	45.7	54.0	-8.3
8306.49	H	H	40.4	4.7	45.1	54.0	-8.9
11074.24	V	H	35.4	4.6	40.0	54.0	-14.0
11999.64	H	V	32.9	4.9	37.8	54.0	-16.2

TEST PERSONNEL:

Signature: ________________________ Date: 1/22/99

Typed/Printed Name: Daniel W. Baltzell

4.5 POWER SPECTRAL DENSITY

The Power spectral density per FCC 15.247(d) was measured from the antenna port of the EUT using a 50 ohm spectrum analyzer with the resolution bandwidth set at 100 Hz, the video bandwidth set at 10 kHz, and the sweep time set at 10 second. The spectral lines were resolved for the modulated carrier with amplitude below the +8 dBm limit. Plots are attached for the power spectral density measurements.

TABLE 6: POWER SPECTRAL DENSITY: CHANNEL A

EMISSION FREQUENCY (MHz)	ANALYZER READING (dBm)
904.2767	7.35

TABLE 7: POWER SPECTRAL DENSITY: CHANNEL B

EMISSION FREQUENCY (MHz)	ANALYZER READING (dBm)
921.0902	7.89

4.6 PROCESSING GAIN

Processing gain is a measure of the increase in signal-to-noise ration produced by the spread spectrum modulation. It must be at least 10dB. One method of measuring it, detailed in the FCC's notice, is the "CW jamming margin method." As shown in section 3.8.1, the test configuration consists of the EUT transmitter/receiver pair, a signal generator, an audio signal generator, signal-combining pad, and attenuators. The signal generator is used as an unmodulated (CW) jamming signal.

For this test, the signal generator is stepped in 50 kHz increments across the passband of the system. At each frequency, the generator level is adjusted to produce the BER desired for the system, that is 1/1000 for voice transmission. This is the jammer level (J). The output power (S) of the transmitting unit is measured at the same test point, and the jammer-to-signal ration (J/S) is calculated. The lowest 20% of J/S data points are discarded, and the lowest remaining J/S ration is used in calculating the processing gain.

(Processing gain (Gp) is thus defined by the following equation:

Gp=(S/N)o + Mj + Lsys

Where (S/N). = signal/noise ratio = -12.4 dB

Mj = J/S ration, selected as described = 22 dB for the following frequency:

Freq. (MHz)	S/G level (dBm)	J (dBm)	S (dBm)	J/S (dB)
906.082	-6.71	-11.64	-36.94	25.3

Lsys = system losses (dB) with Lsys = 2dB

The signal-to-noise ratio, (S/N)o, is related to the receivers bit error rate. Although thte precise relationship will vary with the demodulation scheme used, for an ideal noncoherent receiver, the probability of error (bit error rate) is related to (S/N)o by:

Probability of bit error = .5 x e(-5 x (S/N)o)

Conclusion: Processing gain = 14.9 dB

See processing gain plot at 906 MHz

4.6.1 TEST CONFIGURATION: PROCESSING GAIN