
Project Number: 00209-10

Prepared for:

LONG RANGE SYSTEM
10840 Switzer Ave., Suite 107
Dallas Texas 75238

By

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October 1999

CERTIFICATION
Electromagnetic Interference
Test Report

LONG RANGE SYSTEM
T2-500 Transmitter
(Intentional Radiator Portion)

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THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF PROFESSIONAL TESTING (EMI), INC.



Certificate of Compliance

Applicant: Long Range System
 Applicant's Address: 10840 Switzer Ave., Suite 107
 Dallas Texas 75238
 Model: T2-500 Transmitter
 Serial Number: N/A
 Project Number: 00209-10
 Test Dates: September 17 and 21, 1999

I, Jeffrey A. Lenk, 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 **Long Range System T2-500 Transmitter** 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:

	<u>Frequency (MHz)</u>	<u>Level (dBμV/m)</u>	<u>Limit (dBμV/m)</u>	<u>Margin (dB)</u>
Fundamental	467.75	80.7	81.9	-1.2
Spurious	935.5	45.0	46.0	-1.0

Occupied Bandwidth

Record Only Per 47 CFR 15 - Widest OCBW: 11.8 kHz

Jeffrey A. Lenk
 President

This report has been reviewed and accepted by Long Range System. The undersigned is responsible for ensuring that the **T2-500 Transmitter** will continue to comply with the FCC rules.

1.0 EUT Description

The Equipment Under Test (EUT) is the **Long Range System T2-500 Transmitter**. The **T2-500 Transmitter** is used to control the operation of a remote receiver. The **T2-500 Transmitter** has four pushbuttons which, when pressed, wake the microprocessor from an inactive state. In the sleep state, all functions are powered off including the processor clock. The EUT operates at 467.75 MHz and is designed for compliance with 47 CFR 15.231 of the FCC rules. Specific test requirements for this device include the following:

47 CFR 15.231	Fundamental Transmit Power
47 CFR 15.231 & 15.205	Spurious Radiated Power
47 CFR 15.231 & 2.1049	Occupied Bandwidth (2.989 used as Procedural Reference)
47 CFR 15.203	Antenna Requirement

The system tested consisted of the following:

<u>Manufacturer & Model</u>	<u>Serial #</u>	<u>FCC ID #</u>	<u>Description</u>
Long Range System T2-500 Transmitter	N/A	M74T2500	Low Power Transmitter

A separate verification report pursuant to Part 15, Subpart B has been prepared for the **Long Range System, T2-500 Transmitter** as a Digital Device.

1.1 EUT Operation

The **T2-500 Transmitter** was tested with the wireless link active and fully modulated. Setup and operational modes cover worst case configuration and operational modes for the device. The frequency of the transmitting signal is 467.75 MHz.

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.

Radiated emission measurements were made of the Fundamental and Spurious Emission levels for the **T2-500 Transmitter**. Measurements of the occupied bandwidth were also made for the equipment.

Measurements of the maximum emission levels for the fundamental and the spurious/harmonic emissions of the **T2-500 Transmitter** were made at the Professional Testing "Open Field" Site 1, located in Marble Falls, Texas to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

Tests of the fundamental for the device were performed to determine the worst case polarization of the devices. The fundamental emissions of the device were measured with the antennas of the devices vertical and horizontal to the ground plane.

2.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a motorized turntable which allows 360 degree rotation. For measurements of the fundamental signal, a measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. For spurious/harmonic measurements above 1 GHz, the measurement antenna was placed 1 meter from the EUT. The radiated emissions were maximized by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

A Spectrum Analyzer with peak detection was used to find the maximums of the radiated emissions during the variability testing. A drawing showing the test setup is given as Figure 1.

2.2 Test Criteria

The table below shows FCC Part 15.231 radiated limits for an intentional radiator operating at 467.75 MHz band. In addition to these requirements, the EUT must meet the restricted emission band requirements of §15.205. For this frequency range, the unintentional radiated emission limits of §15.249 for 467.75 MHz radiator is higher than the restricted band limits of §15.205. The limit of §15.205 was used for the spurious emission test. The spurious measurements of the harmonic were performed to the 10th harmonic of the fundamental. The reference distance for each limit is also shown in this table.

<u>Signal Type</u>	<u>Test Distance (Meters)</u>	<u>Field Strength</u>	
		<u>(μV/m)</u>	<u>(dBμV/m)</u>
Fundamental (467.75 MHz)	3	12406.25	81.9
2nd Harmonics (935.5 MHz)	3	500	46.0
Harmonics (3rd and above)	1	1500	63.5

2.3 Test Results

The radiated test data for the fundamental is included in Appendix A. Quasi-Peak detector has been used during the test. The radiated emission test data for the harmonics is included in Appendix B. The emissions were maximized at each frequency and the highest emissions identified were measured using peak detection. The radiated emissions generated by the **T2-500 Transmitter** are below the FCC Part 15.231 and FCC Part 15.205 maximum emission criteria.

3.0 Occupied Bandwidth Measurements

Measurements of the occupied bandwidth for the fundamental signals of the of the FCC Part 15.231 were made at the Professional Testing's Round Rock, Texas laboratory. All measurements were made in a controlled indoor environment in a configuration which did not present measurement distortion or ambient interference.

3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. The table was rotated to an angle which presented the highest signal level. The occupied bandwidth was also measured on the device. Peak detection was used for all tests. The occupied bandwidth was based on a 26 dB criteria (26 dB down either side of the emission from the nominal center of the emission). A drawing showing the test setup is given as Figure 1.

3.2 Test Criteria

According to FCC Part 15.231, the bandwidth of the emission shall not be wider than 0.25 % of the center frequency for the devices operating above 70 MHz and below 900 MHz. The limit is 1.17 MHz for the transmitter working at 467.75 MHz.

Measurement of the occupied bandwidth was performed to verify that the emission bandwidth from the EUT did not exceed 1.17 MHz. The typical occupied bandwidth for **Long Range System T2-500 Transmitter** is 12 kHz.

3.3 Test Results

The occupied bandwidth test data is included in Appendix C. The occupied bandwidth for the fundamental frequency (467.75 MHz) is 11.8 kHz. The figure is typical for the **T2-500 Transmitter**.

The intended center frequency for the EUT was centered at 467.75 MHz. The center frequency is within the allowed band. The fundamental signal generated by the **T2-500 Transmitter** is within the band allowed under FCC Part 15.231 emission band criteria.

4.0 Antenna Requirement

An analysis of the **T2-500 Transmitter** was performed to determine compliance with Section 15.203 of the Rules. This section requires specific handling and control of antennas used for devices subject to regulations under the Intentional Radiator portions of Part 15.

4.1 Evaluation Procedure

The structure and application of the **T2-500 Transmitter** were analyzed with respect to the rules. The antenna for this unit is an external antenna which is soldered onto the main board and is not accessible by the user. An auxiliary antenna port is not present.

4.2 Evaluation Criteria

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

- (a) Antenna 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.

4.3 Evaluation Results

The **T2-500 Transmitter** meets the criteria of this rule by virtue of having an external antenna permanently attached to the unit. The EUT is therefore compliant with §15.203.

5.0 Modifications to Equipment

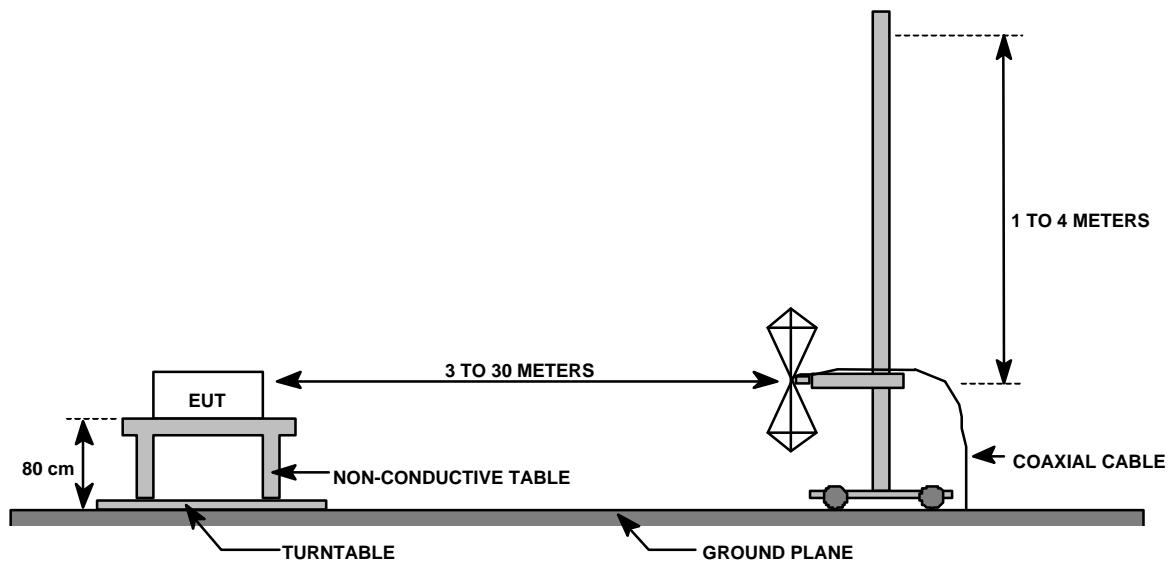
There were no modifications made on the **T2-500 Transmitter** during the performance of the test program in order to meet the FCC criteria.

6.0 List of Test Equipment

A list of the test equipment utilized to perform the testing is given below. The date of calibration is given for each.

Electromagnetic Emissions Test Equipment

<u>Device</u>	<u>Description</u>	<u>Date Last Calibrated</u>	<u>Calibration Due</u>
HP 8568B	Spectrum Analyzer	10/08/98	10/08/99
HP 85650A	Quasi Peak Adapter	10/08/98	10/08/99
HP 8566B	Spectrum Analyzer	10/30/98	10/30/99
HP 85650A	Quasi Peak Adapter	10/30/98	10/30/99
HP 8447F	Preamp	10/28/98	10/28/99
EMCO 3104C	Biconical Antenna	07/10/99	07/10/00
EMCO 3146	Log Antenna	07/10/99	07/10/00
EMCO 3115	Microwave Antenna	05/21/99	05/21/00
MITEQ	Preamp	05/16/99	05/16/00
AFS4-00101800-40-10P-N			

FIGURE 1: Radiated Emissions Test Setup

Appendix A

Radiated Emissions Data Sheets

Fundamental Radiated Data Sheet

Long Range System T2-500 Transmitter

SERIAL #: N/A
DATE: 09/17/99
PROJECT #: 00209-10

MEASUREMENT DISTANCE (m): 3
DETECTOR FUNCTION: Quasi-Peak

EUT Horizontal, Antenna Horizontal

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.75	82.0	1.0	59.4	17.2	4.1	80.7	81.9	-1.2

EUT Vertical, Antenna Horizontal

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.75	19.0	1.1	43.6	17.2	4.1	64.9	81.9	-17.0

EUT Horizontal, Antenna Vertical

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.75	0.0	2.6	45.1	17.2	4.1	66.4	81.9	-15.5

EUT Vertical, Antenna Vertical

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Height (Meter)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.75	228.0	1.5	59.1	17.2	4.1	80.4	81.9	-1.5

$$\text{Corrected Level} = \text{Recorded Level} + \text{Antenna Factor} + \text{Cable Loss}$$

COMMENT #1:

COMMENT #2:

TEST ENGINEER: _____ APPROVED BY: _____
Larry Zhou Jeffrey Lenk

Appendix B

Spurious Radiated Emissions Data Sheets

Spurious Radiated Data Sheet**Long Range System
T2-500 Transmitter**

SERIAL #: N/A

DATE: 09/17/99 and 09/21/99

PROJECT #: 00209-10

MEASUREMENT DISTANCE (m): 1

ANTENNA POLARIZATION: Horizontal

DETECTOR FUNCTION: Peak

Freq. (MHz)	EUT Dir. (Deg.)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
935.50	228	15.3	22.8	6.9	45.0	46.0	-1.0
1403.25	130	9.9	25.0	2.1	37.0	63.5	-26.5
1871.00	180	13.5	27.0	2.0	42.5	63.5	-21.0
2338.75	30	21.6	29.0	3.1	53.7	63.5	-9.8
2806.50	250	16.3	30.0	2.1	48.4	63.5	-15.1
3274.25	190	-7.0	30.5	3.0	26.5	63.5	-37.0
3742.00	80	-0.1	32.0	4.8	36.7	63.5	-26.8
4209.75	130	-10.5	32.5	3.2	25.2	63.5	-38.3
4677.50	0	-5.1	33.0	3.8	31.7	63.5	-31.8

Corrected Level = Recorded Level + Antenna Factor + Cable Loss

COMMENT #1: EUT Horizontal.

COMMENT #2: Antenna Elevation optimized at 1 meter.

COMMENT #4: EUT at 3 meter for the measurement at 935.50 MHz.

TEST ENGINEER: _____ APPROVED BY: _____

Larry Zhou**Jeffrey Lenk****Spurious Radiated Data Sheet**

Long Range System T2-500 Transmitter

SERIAL #: N/A
 DATE: 09/17/99 and 09/21/99
 PROJECT #: 00209-10

MEASUREMENT DISTANCE (m): 1
 ANTENNA POLARIZATION: Vertical
 DETECTOR FUNCTION: Peak

Freq. (MHz)	EUT Dir. (Deg.)	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
935.50	0	9.9	22.8	6.9	39.6	46.0	-6.4
1403.25	0	17.6	25.0	2.1	44.7	63.5	-18.8
1871.00	270	19.9	27.0	2.0	48.9	63.5	-14.6
2338.75	70	28.6	29.0	3.1	60.7	63.5	-2.8
2806.50	90	28.5	30.0	2.1	60.6	63.5	-2.9
3274.25	90	2.3	30.5	3.0	35.8	63.5	-27.7
3742.00	90	6.7	32.0	4.8	43.5	63.5	-20.0
4209.75	150	-8.5	32.5	3.2	27.2	63.5	-36.3
4677.50	90	-2.8	33.0	3.8	34.0	63.5	-29.5

Corrected Level = Recorded Level + Antenna Factor + Cable Loss

COMMENT #1: EUT Horizontal.

COMMENT #2: Antenna Elevation optimized at 1 meter.

COMMENT #3: EUT at 3 meter for the measurement at 935.50 MHz.

TEST ENGINEER: _____ APPROVED BY: _____
 Larry Zhou Jeffrey Lenk

Occupied

Appendix C

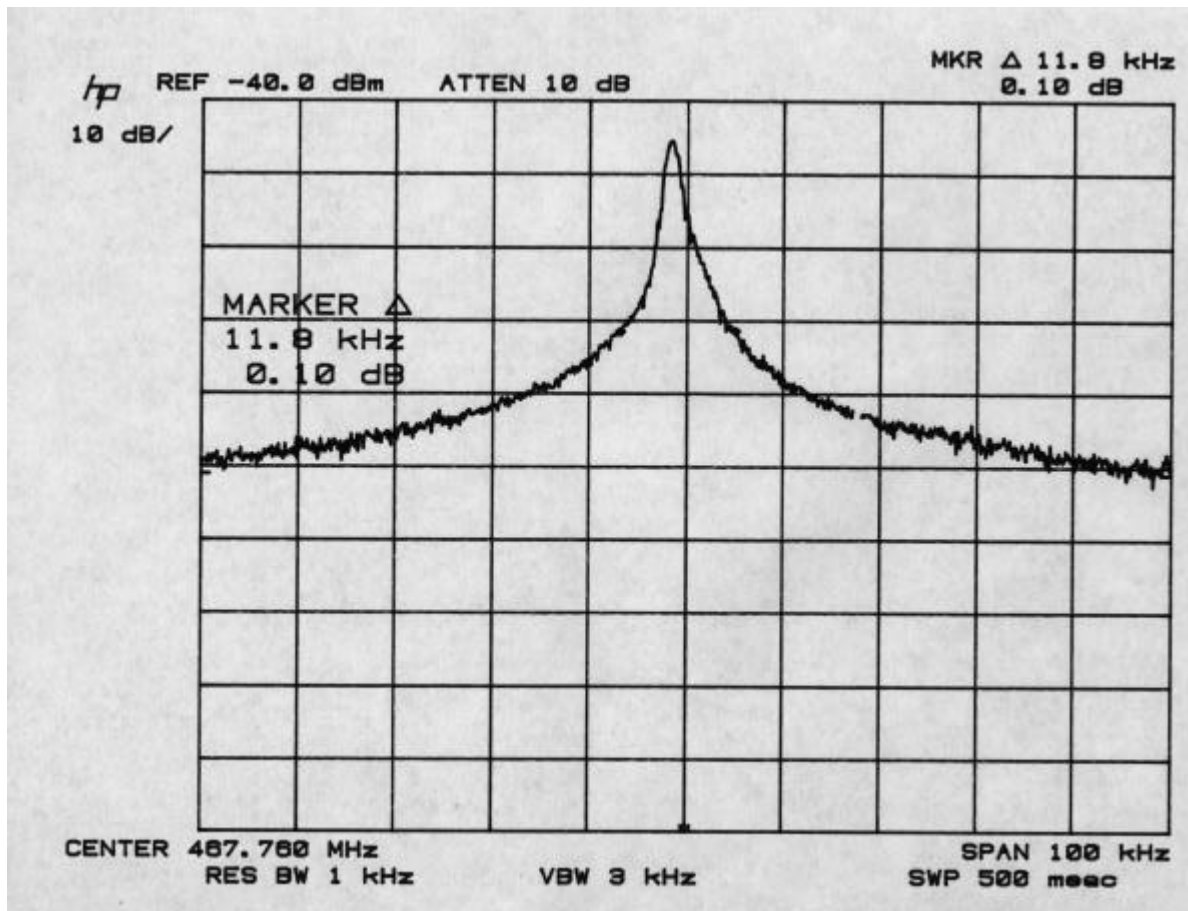
Bandwidth Data Sheets

Occupied Bandwidth Datasheet

Long Range System
T2-500 Transmitter

SERIAL #: N/A
 DATE: 09/21/99
 PROJECT #: 00209-10

MEASUREMENT DISTANCE (m): 1.0
 ANTENNA POLARIZATION: Horizontal
 DETECTOR FUNCTION: Peak



COMMENT #1: 26dB Bandwidth = 11.8 kHz

COMMENT #2:

TEST ENGINEER: _____ APPROVED BY: _____
 Larry Zhou Jeffrey Lenk