
FCC ID: M74T74REP

Prepared for:

LONG RANGE SYSTEM
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By:

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Submitted to:

Federal Communications Commission
Equipment Approval Services
P.O. Box 358315
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October 1999

**FCC Application for Certification
of an Intentional Radiator**

LONG RANGE SYSTEM
T74 Repeater

Table of Contents

Title Page	1
Table of Contents.....	2
Certificate of Compliance	3
1.0 Equipment Under Test (EUT) Description	5
2.0 Occupied Bandwidth Measurements.....	5
2.1 Test Procedure	5
2.2 Test Criteria.....	6
2.3 Test Results	6
3.0 Effective Radiated Power (ERP) Measurements.....	6
3.1 Test Procedure	6
3.2 Test Criteria.....	6
3.3 Test Results	7
4.0 Out of Band Emissions - Radiated.....	7
4.1 Test Procedure	7
4.2 Test Criteria.....	8
4.3 Test Results	8
5.0 Out of Band Emissions - Conducted.....	8
5.1 Test Procedure	9
5.2 Test Criteria.....	9
5.3 Test Results	10
6.0 Radiofrequency Radiation Exposure Evaluation	9
6.1 Evaluation Procedure.....	10
6.2 Evaluation Results	10
7.0 Frequency Stability vs. Temperature Test.....	10
7.1 Test Procedure	100
7.2 Test Criteria.....	11
7.3 Test Results	11
8.0 Frequency Stability vs. AC Voltage Test.....	11
8.1 Test Procedure	11
8.2 Test Criteria.....	11
8.3 Test Result	11
9.0 Form 731 Information.....	11
9.1 Emission Designator	12
9.2 Output Power	12
9.3 Frequency Band of Operation	12
10.0 Modification	12
11.0 List of Test Equipment.....	12

Appendices

Appendix A - Occupied Bandwidth Test Data	14
Appendix B - Effective Radiated Power (ERP) Test Data	16
Appendix C – Low-Pass Filter Test Data	18

Appendix D - Out of Band Emissions - Radiated Test Data.....	21
Appendix E - Out of Band Emissions - Conducted Test Data.....	24
Appendix F – Frequency Stability vs. Temperature Test Data.....	26
Appendix G – Frequency Stability vs. AC Voltage Test Data	28



Certificate of Compliance

Applicant: Long Range System

Applicant's Address: 10840 Switzer Avenue, Suite 107
Dallas, Texas 75238

Model: T74 Repeater

Serial Number: N/A

Project Number: 00211-10

Test Dates: September 14,15,16, 1999

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measurement data and this report. I believe them to be true and accurate. The **Long Range System, T74 Repeater** was tested and found to be in compliance with FCC Part 90 for Intentional Radiators.



Jeffrey A. Lenk
President

This report has been reviewed and accepted by **Long Range System**. The undersigned is responsible for ensuring that the **Long Range System, T74 Repeater** will continue to comply with the FCC rules.

1.0 Equipment Under Test (EUT) Description

The **Long Range System, T74 Repeater** is a microprocessor controlled RF transmitter used in on-site paging system. The **Long Range System, T74 Repeater** is capable of AM operation. The receiver is of a super-heterodyne configuration, with a single L.O. 455 kHz below the carrier frequency. The transmitter final amplifier makes use of a IC amplifier with a maximum out of 0.25 W.

The **Long Range System, T74 Repeater** is intended for operation under the requirements of Part 90 (Subpart I). Specific test requirements include the following:

47 CFR 2.1049	Occupied Bandwidth
47 CFR 90.205	Effective Radiated Power (ERP)
47 CFR 90.210 (b)	Out of Band Emissions - Radiated
47 CFR 90.210 (b)	Out of Band Emissions - Conducted
47 CFR 1.1310	Radiofrequency Radiation Exposure Limits
47 CFR 2.1055(a) & 47 CFR 90.213 (a)	Frequency Stability vs. Temperature
47 CFR 2.1055(d) & 47 CFR 90.213 (a)	Frequency Stability vs. AC Power

This unit does not re-modulate or re-key the signal. Based on the lack of re-keying/re-modulation circuitry, the following tests were not performed:

47 CFR 90.209	Bandwidth Limitations
47 CFR 90.211	Modulation Requirements
47 CFR 90.214	Transient Frequency Behavior

The system tested consisted of the following:

<u>Manufacturer & Model</u>	<u>Serial #</u>	<u>FCC ID #</u>	<u>Description</u>
Long Range System	N/A	M74T74REP	T74 Repeater

The equipment within this report was tested to verify its compliance with FCC Rule Parts 2, and 90, for Intentional Radiators. A separate verification report pursuant to Part 15, Subpart B has been prepared for the **Long Range System, T74 Repeater** as a Digital Device and a receiver.

2.0 Occupied Bandwidth Measurements

Measurements were made on the **Long Range System, T74 Repeater** to determine the occupied bandwidth in accordance with Part 2.1049.

2.1 Test Procedure

All measurements were performed in a controlled laboratory environment. The occupied bandwidth of the **Long Range System, T74 Repeater** was measured using a Hewlett Packard HP 8566 Spectrum.

The occupied bandwidth was measured based on the emission width 26 dB below the peak emission level.

2.2 Test Criteria

Section 2.989 requires that the occupied bandwidth for Type Certification units be measured and reported as part of the device filing.

2.3 Test Results

Data for occupied bandwidth testing is located in Appendix A of this report. The widest bandwidths for each of the modulation types used by the **Long Range System, T74 Repeater** are listed below.

Service Type	Reference Frequency	Occupied Bandwidth
AM	467.75 MHz	7.68 kHz

3.0 Effective Radiated Power (ERP) Measurements

Measurements were made on the **Long Range System, T74 Repeater** to verify compliance with the maximum effective radiated power (ERP) requirements of §90.205.

ERP measurements 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.

3.1 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. A measurement antenna was positioned at a distance of 3 meters as measured from the closest point of 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. All final measurements were taken using a Quasi-Peak Adapter with a measurement bandwidth of 120 kHz.

ERP testing of the **Long Range System, T74 Repeater** was performed at AM transmission mode.

3.2 Test Criteria

Section 90.205 lists various levels for the maximum effective radiated power of Part 90 transmitters. Based on this specification, the lowest allowed ERP is 2 watts. Since the EUT does not include an antenna, a typical antenna (a whip type antenna) was attached to the EUT and used for the ERP measurements. This process was also used for the spurious emission measurements. ERP testing was

performed by measuring the maximum electric field from the **Long Range System, T74 Repeater** and translating this level to ERP using the following formula:

$$\text{ERP} = \{(E \cdot r)^2\} / (30)$$

Where:

E = Electric Field in v/m

r = distance from the measurement antenna to the EUT in meters

This formula was obtained from the Industry Canada document, 'Guidelines for Measurement of Radio Frequency Fields at Frequencies from 10 kHz to 300 GHz, Document Reference NIR-E, dated January 1994'.

3.3 Test Results

Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 3 kHz/10 kHz. For final measurements, the frequency span was set for 3 MHz and was centered on the peak of the output signal.

Data for ERP testing is located in Appendix B of this report. **Long Range System, T74 Repeater** met the §90.205 ERP requirements.

4.0 Out of Band Emissions - Radiated

Radiated emissions measurements were made to determine out of band radiated noise produced by the **Long Range System, T74 Repeater** in accordance with Section 90.210 (b). Evaluation of the spurious emissions for this device was based primarily on Mask B criteria using representative traffic signals. A schematic of the low pass filter as well as SPICE data describing the design evaluation is provided in Appendix C.

Radiated emissions measurements were made at the Professional Testing "Open Field" Site 2, 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.

4.1 Test Procedure

The spurious emissions for the device were measured using test signals for AM. These signals were selected for use for this test based on the criteria described in 47 CFR 2.989 (h).

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. A measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. For measurements above 1 GHz, the antenna distance was decreased to 1 meter. 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.

The Spectrum Analyzer was used to find the maximums of the radiated emissions during the testing. All final measurements were made using a peak measurement method. The final measurements provided were determined by using the following formula:

$$\text{Corrected Level} = \text{Recorded Level} - \text{Pre-Amp Gain} + \text{Antenna Factor} + \text{Cable Loss}$$

Measurement of the fundamental signal and spurious radiated emissions was performed with a sample whip antenna attached to the EUT. The whip antenna as part of the **Long Range System, T74 Repeater**.

4.2 Test Criteria

In order to evaluate the EUT versus the out of band emission criteria of §90.210, a representative emission mask suitable for this band (Emission mask B) was selected. For emissions beyond the immediate area of the intended emission, the attenuation required by §90.210 does not vary ($43 + 10 \log(P)$) versus emission type. Based on this criteria, transmitter related emissions for the **Long Range System, T74 Repeater** shall be reduced by the following amount with respect to the level of the fundamental:

Frequency offset versus the fundamental (% of BW)	Attenuation versus the fundamental (dB)
50 to 100	25
100 to 250	35
250 to $10f_c$	$43 + 10 \log(P)$

Based on manual of the EUT, the maximum power of this unit is 0.25 watts, which translates the $43 + 10 \log(P)$ term to a minimum attenuation of 37 dB.

4.3 Test Results

The **Long Range System, T74 Repeater** was tested for radiated spurious emissions at AM transmission modes. The signals were fully modulated for all tests. The test frequency is listed below.

Service Type	Test Frequency (MHz)
AM	467.75

Radiated emission data sheets are contained in Appendix D of this report. The **Long Range System, T74 Repeater** met the §90.210(b) radiated emission requirements. Documentation of the immediate area surrounding the intended emission is shown as part of the occupied bandwidth plots.

5.0 Out of Band Emissions - Conducted

Radiated emissions measurements were made to determine out of band radiated noise produced by the **Long Range System, T74 Repeater** in accordance with Section 90.210 (b). Evaluation of the

spurious emissions for this device was based primarily on Mask B criteria using representative traffic signals.

Conducted emissions measurements were made at Professional Testing's Round Rock, Texas laboratory. All measurements were made in an environmentally controlled setting.

5.1 Test Procedure

The spurious emissions for the device were measured using test signals for AM. These signals were selected for use for this test based on the criteria described in 47 CFR 2.989 (h).

The conducted spurious emissions of the **Long Range System, T74 Repeater** was measured by a Hewlett Packard HP 8566 Spectrum Analyzer. The Spectrum Analyzer was used to find the maximums of the conducted emissions during the testing. All final measurements were made using a peak measurement method. The final measurements provided were determined by using the following formula:

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

5.2 Test Criteria

In order to evaluate the EUT versus the out of band emission criteria of §90.210, a representative emission mask suitable for this band (Emission mask B) was selected. For emissions beyond the immediate area of the intended emission, the attenuation required by §90.210 does not vary ($43 + 10 \log(P)$) versus emission type. Based on this criteria, transmitter related emissions for the **Long Range System, T74 Repeater** shall be reduced by the following amount with respect to the level of the fundamental:

<u>Frequency offset versus the fundamental (% of BW)</u>	<u>Attenuation versus the fundamental (dB)</u>
50 to 100	25
100 to 250	35
250 to $10f_c$	$43 + 10 \log(P)$

Based on the figures obtained from the occupied bandwidth tests, the peak power of this unit is 0.25 watts, which translates the $43 + 10 \log(P)$ term to a minimum attenuation of 37 dB.

5.3 Test Results

The **Long Range System, T74 Repeater** was tested for radiated spurious emissions at AM transmission modes. The signals were fully modulated for all tests. The test frequencies used for each modulation type are listed below.

Service Type	Test Frequency (MHz)
AM	467.75

Radiated emission data sheets are contained in Appendix E of this report. The **Long Range System, T74 Repeater** met the §90.210(b) radiated emission requirements. Documentation of the immediate area surrounding the intended emission is shown as part of the occupied bandwidth plots.

6.0 Radiofrequency Radiation Exposure Evaluation

An evaluation was performed to provide data regarding the **Long Range System, T74 Repeater** with respect to the Radiofrequency Radiation Exposure requirements of 47 CFR 1.1310.

6.1 Evaluation Procedure

The primary method of controlling radio frequency radiation exposure from the **Long Range System, T74 Repeater** will be the responsibility of the installer of the equipment. The device is to be professionally installed by personnel trained and familiar with installation and configuration of wireless systems. The installer is responsible for antenna selection, site selection and final site configuration. Final compliance with Commission RF exposure regulations for this type of site is the responsibility of the installer and is addressed under separate OET documents.

This device is not marketed outside the wireless communications community. In order to install this system properly, the maximum output power versus the frequency range should be reported in the User's Manual for the device such that this issue can be addressed when the installation site of this device is designed.

6.2 Evaluation Results

The output power level for the **Long Range System, T74 Repeater** is reported in the User's Manual as being 0.25 watts. In addition, the transmitting frequency for this device is reported as 467.75 MHz.

Based on this information, the **Long Range System, T74 Repeater** met the necessary requirements regarding RF exposure.

7.0 Frequency Stability vs. Temperature Test

Measurements were made on the **Long Range System, T74 Repeater** to verify compliance with the frequency stability requirements of §2.1055(a) and 90.213(a). Under these specifications, the EUT is tested to verify satisfactory frequency stability versus changes of temperature.

7.1 Test Procedure

The EUT was placed in an environmental test chamber and powered such that the frequency control element received normal voltage and the transmitter provided nominal RF output. The chamber was programmed to cool from room temperature to -30 degrees C and then step in 10-degree increments, each step held for 20 minutes, to 50 degrees C. A HP 8591E Spectrum Analyzer was used to measure the transmitting frequency.

7.2 Test Criteria

When combined, Sections 2.1055(a) and 90.213(a) indicate that the paging transmitters operating on paging-only frequencies must operate with frequency stability of 2.5 ppm in the 421-512 MHz band with the temperature varied from -30 to 50 degree C.

7.3 Test Results

Data for this test is located in the Appendix F of this report. **Long Range System, T74 Repeater** meets the frequency stability requirements for frequency stability versus temperature variation based on the criteria listed above.

8.0 Frequency Stability vs. AC Voltage Test

Measurements were made on the **Long Range System, T74 Repeater** to verify compliance with the frequency stability requirements of §2.1055(d) and 90.213(a). Under these specifications, the EUT is tested to verify satisfactory frequency stability versus changes of AC Voltage.

8.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. AC Power to the input terminals was varied from 100VAC to 140VAC. The normal AC mains power for this system is 115 VAC. The center frequency and center frequency power level was recorded at 5 volt intervals over this range.

8.2 Test Criteria

When combined, Sections 2.1055(d) and 90.213(a) indicate that the paging transmitters operating on paging-only frequencies must operate with frequency stability of 2.5 ppm in the 421-512 MHz band with the AC power varied from 100VAC to 140VAC.

8.3 Test Results

Data for this test is located in the Appendix G of this report. **Long Range System, T74 Repeater** meets the frequency stability requirements for frequency stability versus temperature variation based on the criteria listed above.

9.0 Form 731 Information

The following information is provided for inclusion in the FCC Form 731 for the **Long Range System, T74 Repeater**.

9.1 Emission Designator

As with the emission bandwidth, the emission type emitted by the **Long Range System, T74 Repeater** are depended on the service that it operates with. Due to the intended installation of the system, the RF output signals of the **Long Range System, T74 Repeater** are complaint with the AM and NBFM protocol requirements. This output emission designators (based on Party 2.201) for these services are:

Service Type	Emission Description	Emission Designator
AM	(1) Modulation Type: Amplitude Modulation (2) Nature of Modulating Signal: A single channel containing quantized or digital information without the use of a modulating sub-carrier, excluding time-division mutiplex. (3) Telecommand	K1D

9.2 Output Power

In the conducted power tests, the highest power attained was 14.3 dBm (0.027 watts). Since the system automatically controls the maximum output power, this level should be constant for all single carrier operations.

Due to the operating features of the EUT, 0.25 watt is the maximum composite power available from the device. The data in the this report showed the power from the EUT is below this power level. Therefore, the power rating requested for the grant for the **Long Range System, T74 Repeater** is:

0.25 watts

9.3 Frequency Band of Operation

The transmission frequency of the **Long Range System, T74 Repeater** is:

467.75 MHz

10.0 Modifications

No modification was made on the **Long Range System, T74 Repeater** during the test.

11.0 List of Test Equipment

A list of the test equipment utilized to perform the conducted and radiated emission measurements is given below. The date of calibration is given for each.

<u>Device</u>	<u>Description</u>	<u>Date Last Calibrated</u>	<u>Calibration Due</u>
----------------------	---------------------------	------------------------------------	-------------------------------

HP 8566B	Spectrum Analyzer	10/30/98	10/30/99
HP 85650A	Quasi Peak Adapter	10/30/98	10/30/99
MITEQ AFS4- 00101800-40-10P-N	Preamplifier	05/10/99	05/10/00
EMCO 3108	Biconical Antenna	07/10/99	07/10/00
EMCO 3146	Log Periodic Antenna	07/10/99	07/10/00
EMCO 3115	Double Ridged Horn Antenna	05/10/99	05/10/00
HP8591E	Spectrum Analyzer	01/25/99	01/25/00
Thermonthron SM-32	Temperature Chamber	10/05/98	10/05/99

Appendix A

Occupied Bandwidth Test Data

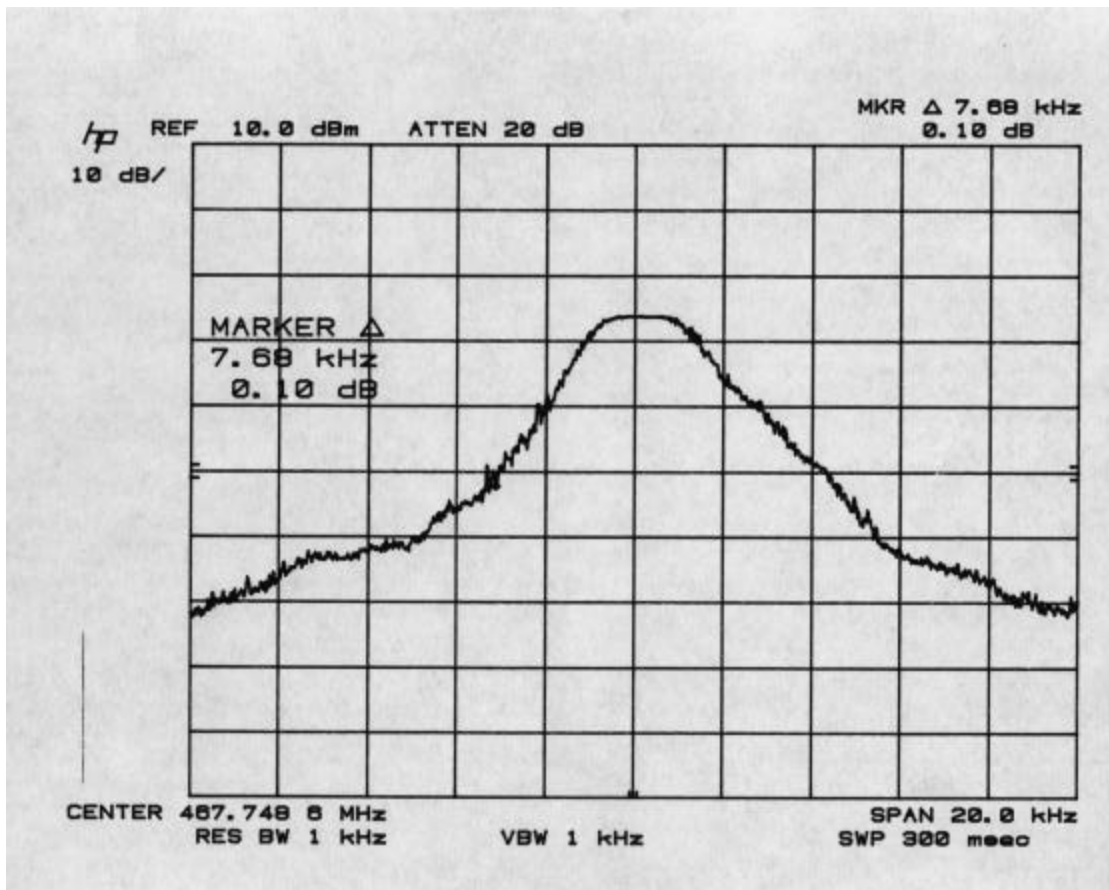
Occupied Bandwidth Data Sheet**Long Range System
T74 Repeater**

SERIAL #: N/A

PROJECT #: 00211-10

DATE: September 15, 1999

MODE: AM



COMMENT #1: 26 dB Bandwidth = 7.68 kHz

COMMENT #2:

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

Appendix B

Effective Radiated Power Test Data

Effective Radiated Power Data Sheet**Long Range System
T74 Repeater**

SERIAL #: N/A

PROJECT #: 00211-10

DATE: September 15, 1999

Antenna Horizontal

Freq.	EUT	Antenna	Recorded	Antenna	Cable	Corrected	Level	Limit	Margin
(MHz)	Direction	Height	Level	Factor	Loss	Level	ERP	(watts)	(watts)
(MHz)	(Deg.)	(Meter)	(dBuV)	(dB/m)	(dB)	(dBuV/m)	(watts)	(watts)	(watts)
467.75	94.00	1.00	84.20	17.20	4.10	105.50	0.011	2.00	-1.99

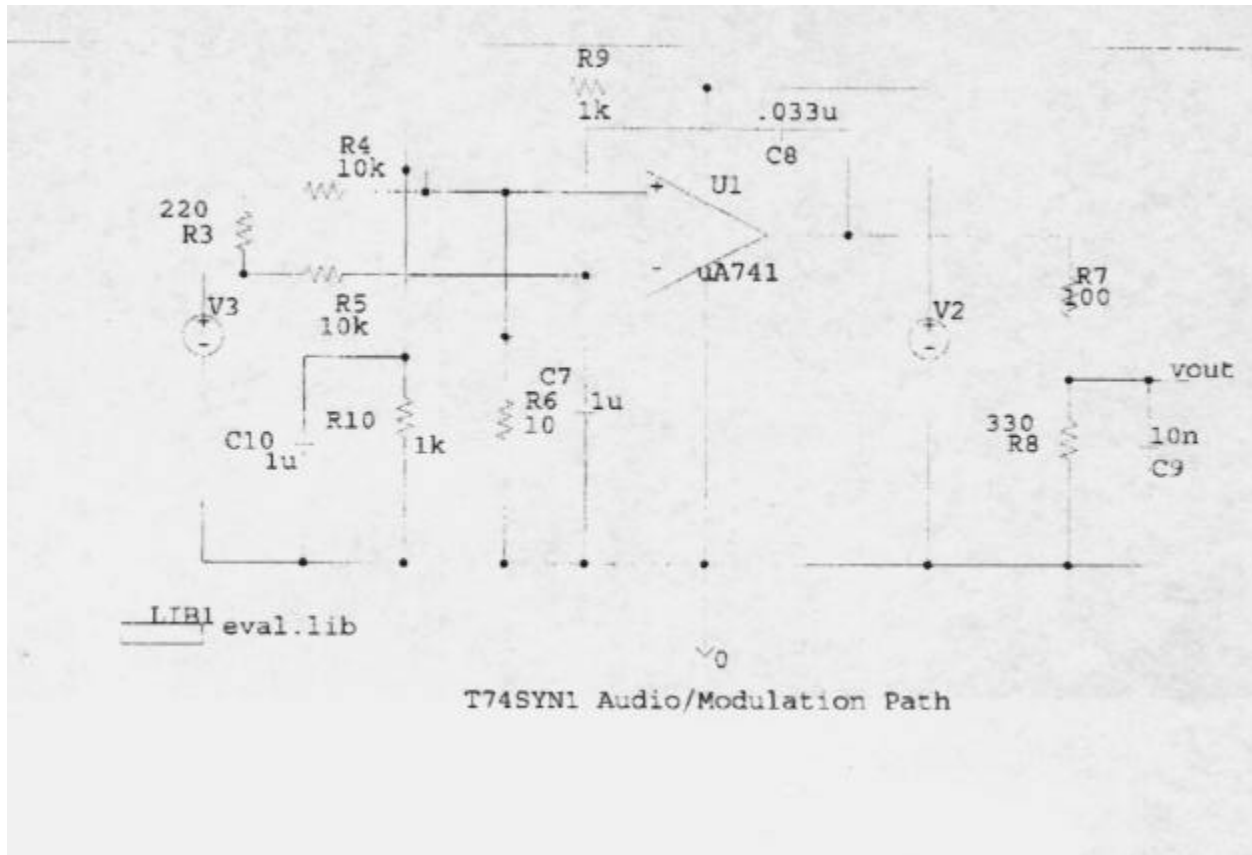
Antenna Vertical

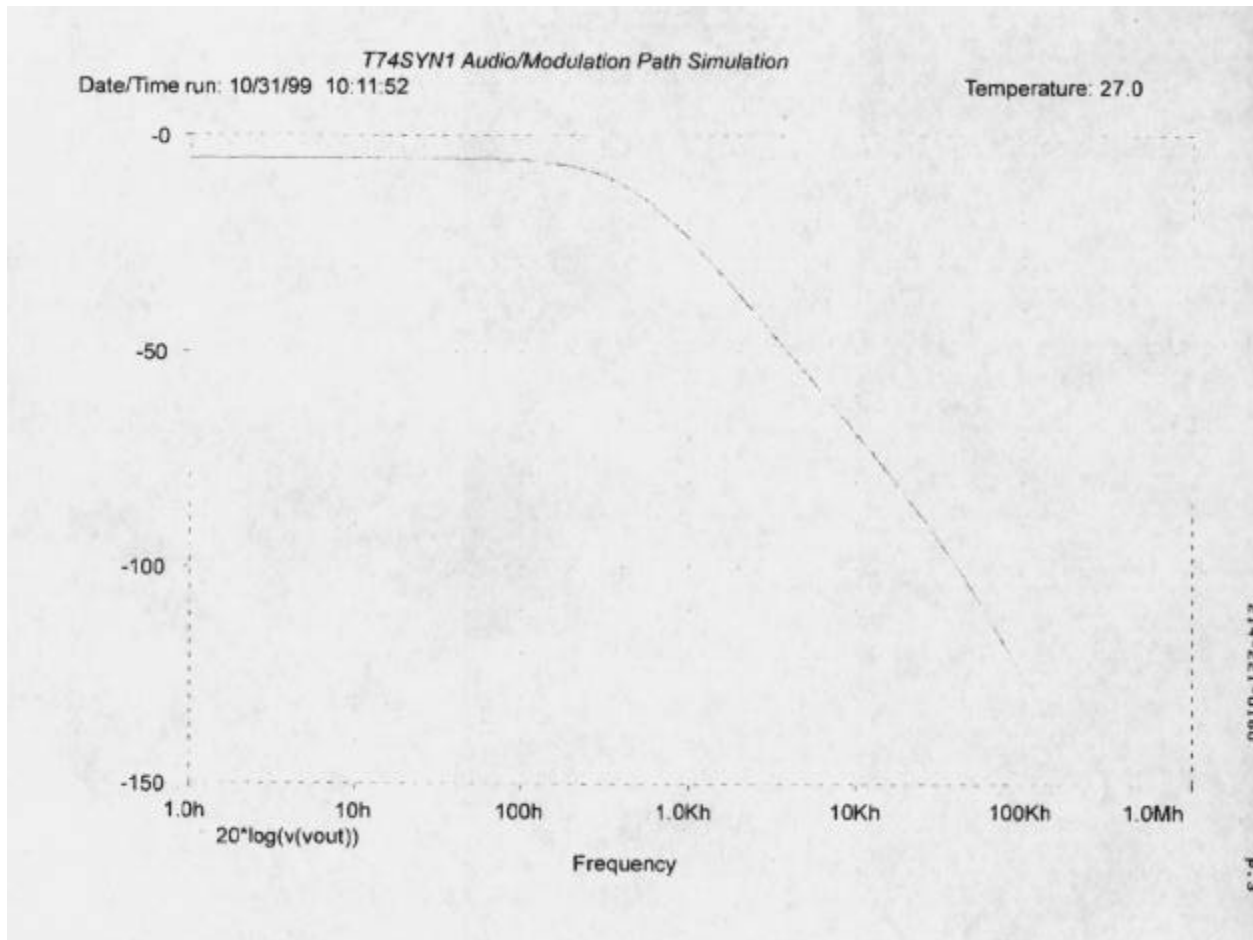
Freq.	EUT	Antenna	Recorded	Antenna	Cable	Corrected	Level	Limit	Margin
(MHz)	Direction	Height	Level	Factor	Loss	Level	ERP	(watts)	(watts)
(MHz)	(Deg.)	(Meter)	(dBuV)	(dB/m)	(dB)	(dBuV/m)	(watts)	(watts)	(watts)
467.75	87.00	1.40	84.50	17.20	4.10	105.80	0.011	2.00	-1.99

TEST ENGINEER: _____ APPROVED BY: _____
Larry Zhou **Jeffrey A. Lenk**

Low-Pass Filter Test Data

Appendix C

Low-Pass Filter Data Sheet**Long Range System
T74 Repeater****Schematics, Audio Filter, LPF**

Low-Pass Filter Data Sheet**Long Range System
T74 Repeater****SPICE Generated LPF Performance**

Appendix D

Out of Band Emissions (Radiated) Test Data

Out of Band Emission - Radiated Data Sheet**Long Range System
T74 Repeater**

SERIAL #: N/A

PROJECT #: 00211-10

DATE: September 17, 1999

POLARIZATION: Horizontal

Freq. (MHz)	EUT Direction (Deg)	Recorded Level (dBuV)	Cable Loss (dB)	Antenna Factor (dBuV/m)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.750	94.0	84.20	4.1	17.2	105.5	Ref	Ref
467.754	94.0	55.30	4.1	17.2	76.6	80.5	-3.9
467.758	94.0	44.70	4.1	17.2	66.0	70.5	-4.5
467.770	94.0	33.60	4.1	17.2	54.9	68.5	-13.6
935.500	295.0	37.00	6.9	22.8	66.7	68.5	-1.8
1403.25	10.0	47.30	2.1	25.0	74.4	78.0	-3.6
1871.00	300.0	37.20	2.1	27.0	66.3	78.0	-11.7
2338.75	300.0	29.20	3.1	29.0	61.3	78.0	-16.7
2806.50	300.0	28.60	2.0	30.0	60.6	78.0	-17.4
3274.25	0.0	25.00	3.0	30.5	58.5	78.0	-19.5
3742.00	0.0	24.40	4.8	32.0	61.2	78.0	-16.8
4209.75	0.0	17.40	3.2	32.5	53.1	78.0	-24.9
4677.50	0.0	19.80	3.8	33.0	56.6	78.0	-21.4

COMMENT #1: EUT Height: 1 Meter.

COMMENT #2: Measurements < 1 GHz made at 3 meters. Measurements made > 1 GHz made at 1 meter. No EUT emissions detected between the fundamental and the 2nd Harmonics.

COMMENT #3: Authorized Bandwidth = 8 kHz.

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

Out of Band Emission - Radiated Data Sheet**Long Range System
T74 Repeater**

SERIAL #: N/A

PROJECT #: 00211-10

DATE: September 17, 1999

POLARIZATION: Vertical

Freq. (MHz)	EUT Direction (Deg)	Recorded Level (dBuV)	Cable Loss (dB)	Antenna Factor (dBuV/m)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
467.750	87.0	84.50	4.1	17.2	105.8	Ref	Ref
467.754	87.0	55.50	4.1	17.2	76.8	80.8	-4.0
467.758	87.0	44.90	4.1	17.2	66.2	70.8	-4.6
467.770	87.0	33.20	4.1	17.2	54.5	68.8	-14.3
935.500	196.0	36.60	6.9	22.8	66.3	68.5	-2.2
1403.25	90.0	49.10	2.1	25.0	76.2	78.0	-1.8
1871.00	270.0	41.40	2.1	27.0	70.5	78.0	-7.5
2338.75	270.0	36.20	3.1	29.0	68.3	78.0	-9.7
2806.50	0.0	37.70	2.0	30.0	69.7	78.0	-8.3
3274.25	0.0	33.60	3.0	30.5	67.1	78.0	-10.9
3742.00	0.0	10.50	4.8	32.0	47.3	78.0	-30.7
4209.75	0.0	4.90	3.2	32.5	40.6	78.0	-37.4
4677.50	180.0	8.10	3.8	33.0	44.9	78.0	-33.1

COMMENT #1: EUT Height: 1 Meter.

COMMENT #2: Measurements < 1 GHz made at 3 meters. Measurements made > 1 GHz made at 1 meter. No EUT emissions detected between the fundamental and the 2nd Harmonics.

COMMENT #3: Authorized Bandwidth = 8 kHz.

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

Appendix E

Out of Band Emissions (Conducted) Test Data

Out of Band Emission - Conducted Data Sheet**Long Range System
T74 Repeater**

SERIAL #: N/A

PROJECT #: 00211-10

DATE: September 20, 1999

Mode: AM

Freq. (MHz)	Recorded Level (dBm)	Cable Loss (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
467.750	-16.20	30.5	14.3	Ref	Ref
467.754	-46.70	30.5	-16.2	-10.7	-5.5
467.758	-61.20	30.5	-30.7	-20.7	-10.0
467.770	-70.60	30.5	-40.1	-22.7	-17.4
935.500	-64.50	30.5	-34.0	-22.7	-11.3
1403.25	-66.40	30.5	-35.9	-22.7	-13.2
1871.00	-68.30	30.5	-37.8	-22.7	-15.1
2338.75	-75.40	30.5	-44.9	-22.7	-22.2
2806.50	-66.70	30.8	-35.9	-22.7	-13.2
3274.25	-74.20	31.0	-43.2	-22.7	-20.5
3742.00	-75.00	31.0	-44.0	-22.7	-21.3
4209.75	-76.20	31.0	-45.2	-22.7	-22.5
4677.50	-76.60	31.0	-45.6	-22.7	-22.9

COMMENT #1: Cable Loss adjusted to compensate for 30 dB attenuator installed in signal path prior to taking reading.

COMMENT #2: Authorized Bandwidth = 8 kHz.

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

Appendix F

Frequency Stability vs. Temperature Test Data

Appendix G

Frequency Stability vs. AC Voltage Test Data
