ELECTROMAGNETIC INTERFERENCE TEST REPORT

FOR

LOVETT'S ELECTRONICS

CONTROL TRANSMITTER
MODEL NO. TX99

April 16, 1999

Prepared for: Lovett's Electronics
840 E. Pinckley St.
Brazil, IN 47834

Measurements made
and report prepared by:

James R. Pollock

SMITH ELECTRONICS, INC.
8200 SNOWVILLE RD.
CLEVELAND, OH 44141
440/526-4386

CERTIFICATE OF COMPLIANCE

1.	Applicant:	Lovett's Electronics 840 E. Pinckley St. Brazil, IN 47834
2.	Manufacturer:	Above
3.	Contact:	Henry Lovett Lovett's Electronics Tel. 812/446-10933 Fax 812/448-8742
4.	Regulation:	CFR47-Part 15C 15.231
5.	Measurement Method:	ANSI C63.4-1992
6.	Type:	Model TX99 Radio Control Transmitter
7.	Frequency:	418 MHz
8.	Date of Test:	April 9 & 12, 1999
9.	Place of Test:	Smith Electronics, Inc. Test Lab, 8200 Snowville Rd., Brecksville, OH. Open Field Site at 8200 Snowville Rd., Brecksville, OH

10. Statement of Compliance:

I hereby certify that measurements of radio frequency emissions from the Lovett's Electronics Model TX99 RF control transmitter were performed by me on April 9 & 12, 1999, and that the results of the measurements confirmed that the unit tested is capable of compliance with the above regulations.

4-16-99
Date

James K. Pollock, Pres.
Signature, Title

INTRODUCTION:

The device tested is a battery powered RF control transmitter designed to be used with a companion receiver in a dog training application under Part 15.231 of the FCC Rules. One sample of the transmitter was tested.

RADIATED EMISSIONS BELOW 1000 MHZ:

An initial scan of the emissions profile of the transmitter was made in a shielded room and verified that between 30 MHz and 1500 MHz no significant emissions other than the fundamental frequency and its harmonics were present.

Measurements of the emissions below 1000 MHz were made on the Smith Electronics 3 m open field test site located at 8200 Snowville Road, Brecksville, OH. Data on this test site is on file with the FCC.

The transmitter, with its coding set for maximum duty cycle and the switch held on, was placed upright on rotatable, non-conductive platform at a 3 m test distance. The NM 37/57 receiver was tuned to the fundamental frequency and the transmitter was then rotated and the vertical polarized test antenna varied in height between 1 & 4 meters to obtain the maximum reading. The maximum level, using peak detection, was recorded. The transmitter was also examined in two other orthogonal positions and with the antenna horizontally polarized. All measured values were recorded. The same procedure was used to obtain the maximum level of the second harmonic. The maximum values at each frequency are recorded in Table 1.

RADIATED EMISSIONS ABOVE 1000 MHZ:

The measurement of radiated emissions above 1000 MHz was performed in an open area at a distance of 1 meter. The same rotating platform described above was used and the same procedure followed except for the variation in antenna height. Peak readings were made using a HP 8593EM spectrum analyzer. Maximum measured levels are also recorded in Table 1.

AVERAGE DETERMINATION:

To determine the average value of the emissions from the peak values, the pulse information shown in Figs. 1 & 2 was used. Figure 1 shows a complete pulse train as well as the timing between trains. Figure 2 is an expanded view of the train so that more accurate calculations can be made. Using distance measurements from the plots, it was determined that each pulse train is about 48.8 mS long and the interval between trains is about 14.0 mS for a period of 62.8 mS. This leaves 37.2 mS of a second train to complete the 100 mS interval for determining the average value. The pulse trains comprise 86 mS of the 100 mS interval. Each pulse train consists of 15 narrow pulses of about 0.42 mS and 26 wide pulses of about 0.8 mS. Therefore, within the train of 48.8 mS, the pulses are "on" for 27.1 mS or 55%. Using this ratio for the train, 55% of the 86 mS "on time" during the 100 mS interval results in the pulses being on for 47.3 mS of the 100 mS. This is 47.3% of the interval or a ratio of -6.5 dB.

As a result, each peak value measured is reduced by 6.5 dB to give the average value desired by 15.231.

OCCUPIED BANDWIDTH:

Paragraph 15.231(c) restricts the occupied bandwidth of these transmitters to 0.25% of the fundamental frequency. With a fundamental of 418 MHz, this allows an occupied bandwidth of 1.04 MHz. The approximate 20 dB down points as shown in Fig. 3 indicate a bandwidth of about 43 kHz. This is well below the requirement.

CALCULATIONS:

A.) Field Strength.

Peak readings were made at all frequencies in dBuV. The 6.5 dB peak to average factor was subtracted from the peak reading to produce an average value. To these values were added the antenna factor and a coax loss factor in dB to arrive at field strength in dBuV/m. This value was then converted to microvolts per meter by dividing dBuV/m by 20 and finding the anti-log of the quotient.

For the measurements above 1000 MHz which were made at a 1 m distance, the field strength in uV/m was divided by 3 to allow for an inverse distance correction.

B.) Occupied Bandwidth.

With the transmitter operating, a scan was made as shown in Fig. 3. The marker was set to the peak level, and using the "delta" capability moved to the left until it was at least 20 dB below the peak. The marker was reset, the "delta" engaged and the marker relocated to the right of the peak to approximately the same level as the left marker. The distance between the markers, indicated on the analyzer display was read directly.

CONCLUSIONS:

The Lovett's Electronics Model TX99 transmitter, when tested as described, has been shown to be capable of compliance with the FCC Rules and Regulations under Part 15.231 for control transmitters.

EQUATIONS USED IN CALCULATIONS

$$E = R + A + C \qquad \text{EQ. 1}$$

Where: E = Field strength in dBuV/m

R = Meter reading in dBuV

A = Antenna factor in dB

C = Coax loss in dB

$$FS = 10^{(E/20)} \qquad \text{EQ. 2}$$

Where: FS = Field strength in uV/m

E = Field strength in dBuV/m

$$E_{Avg.} = E_{Pk} - 6.5$$

Where: $E_{Avg.}$ = Average field strength in dBuV/m

E_{Pk} = Peak field strength in dBuV/m

6.5 = Peak to average ratio in dB

Sample Calculation:

At 1254 MHz, using EQ. 3 and data from Table 1,

$$E_{Avg.} = 33.1 - 6.5$$

$$= 26.6 \text{ dBuV/m (Pk)}$$

Using EQ. 1,

$$E = 26.6 + 25.0 + 0.2 = 51.8 \text{ dBuV/m}$$

Using EQ. 2, $FS = 10^{(51.8/20)}$

$$= 10^{2.59}$$

FS = 389 uV/m (Avg. at 1 m)

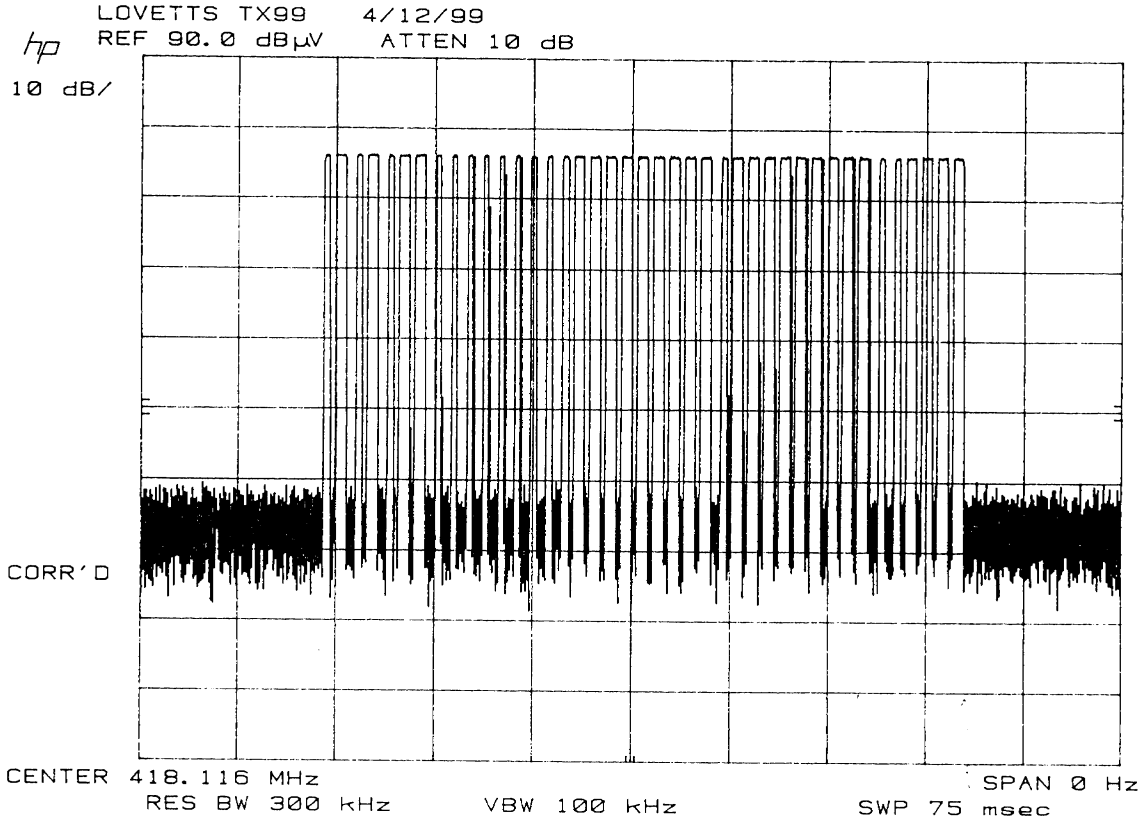
389/3 = 130 uV/m (Avg. at 3 m)

TABLE 1

LOVETT'S ELECTRONICS
TX99 CONTROL TRANSMITTER
EMISSIONS

Freq. (MHz)	Meter dBuV	AF dB	Coax dB	Field Strength @ Dist. dBuV/m	Field Strength @ Dist. uV/m	@3m uV/m	Limit uV/m	Diff. dB
@ 3 m								
418	59.0 pk 52.5 av	21.6	1.0	75.1	5688	5688	10,333	- 5.2
836	28.5 pk 22.0 av	25.5	1.6	49.1	285	285	1,033	-11.2
@ 1 m								
1254	33.1 pk 26.6 av	25.0	0.2	51.8	389	130	1,033	-18.0
1672	32.7 pk 26.2.av	26.0	0.3	52.5	432	141	500	-11.0
2090	33.8 pk 27.3 av	29.0	0.3	56.6	676	225	1,033	-13.2
2508	34.6 pk 28.1 av	29.5	0.3	57.9	785	262	1,033	-11.9
2926	32.8 pk 26.3 av	30.5	0.4	57.2	724	241	1,033	-12.6
3344	32.6 pk 26.1 av	32.0	0.4	58.5	841	280	1,033	-11.3
3762	32.6 pk 26.1 av	33.0	0.4	59.5	944	315	500	- 4.0
4180	31.7 pk 25.2 av	33.5	0.5	59.2	912	301	500	- 4.3

Average values are calculated by subtracting 6.5 dB from the peak value.



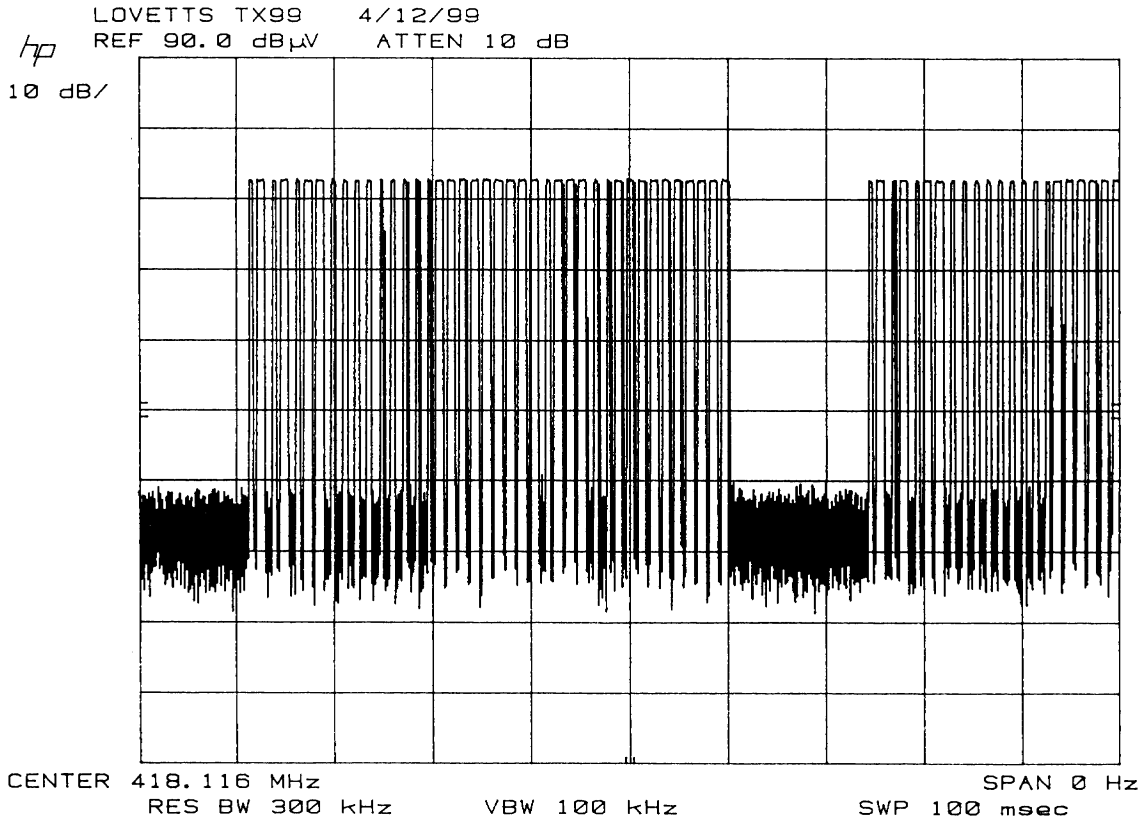
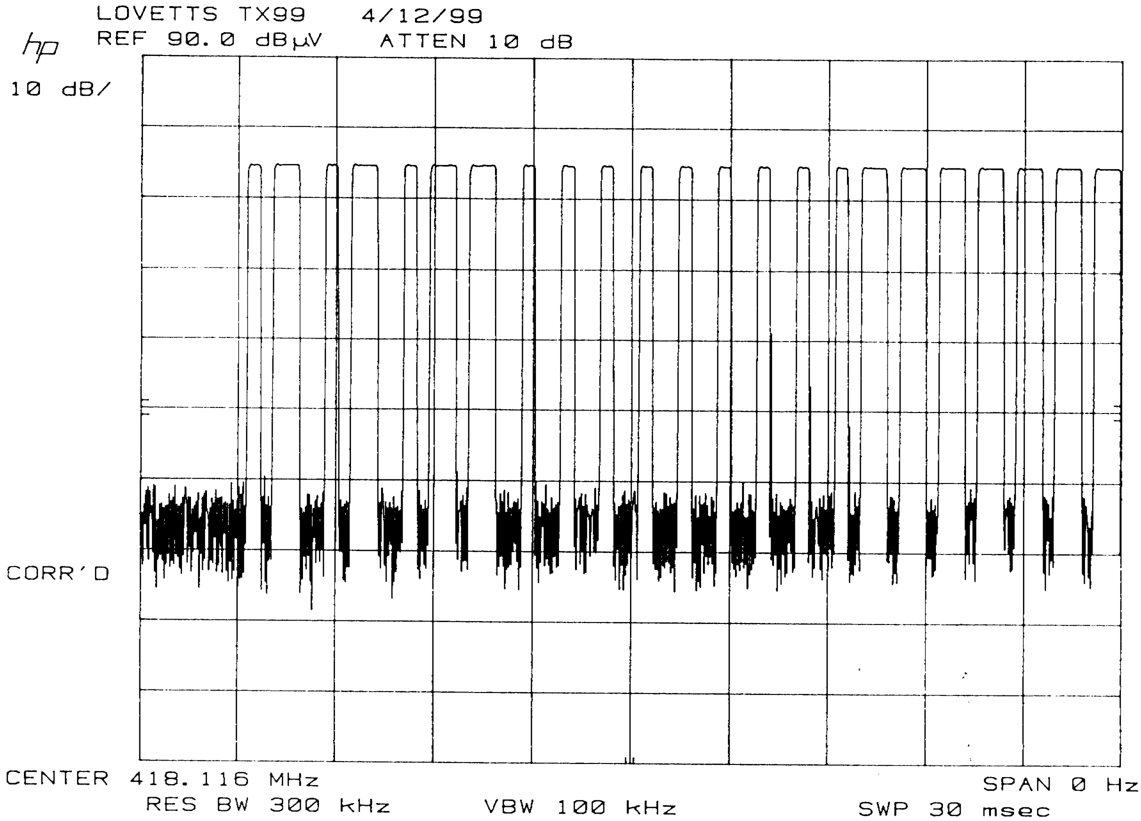


Fig. 1
LOVETT'S ELECTRONICS
TX99 REMOTE TRANSMITTER
TYPICAL PULSE TRAIN



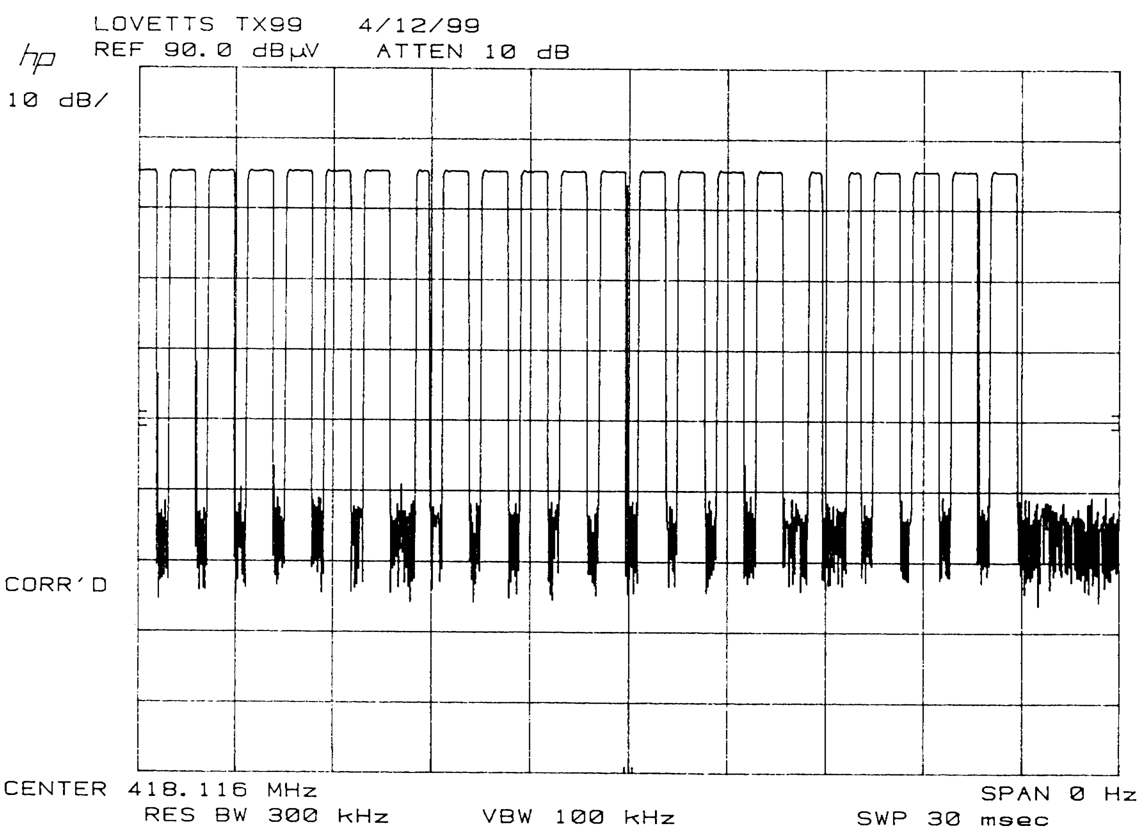


Fig. 2
LOVETT'S ELECTRONICS
TX99 REMOTE TRANSMITTER
EXPANDED PULSE TRAIN

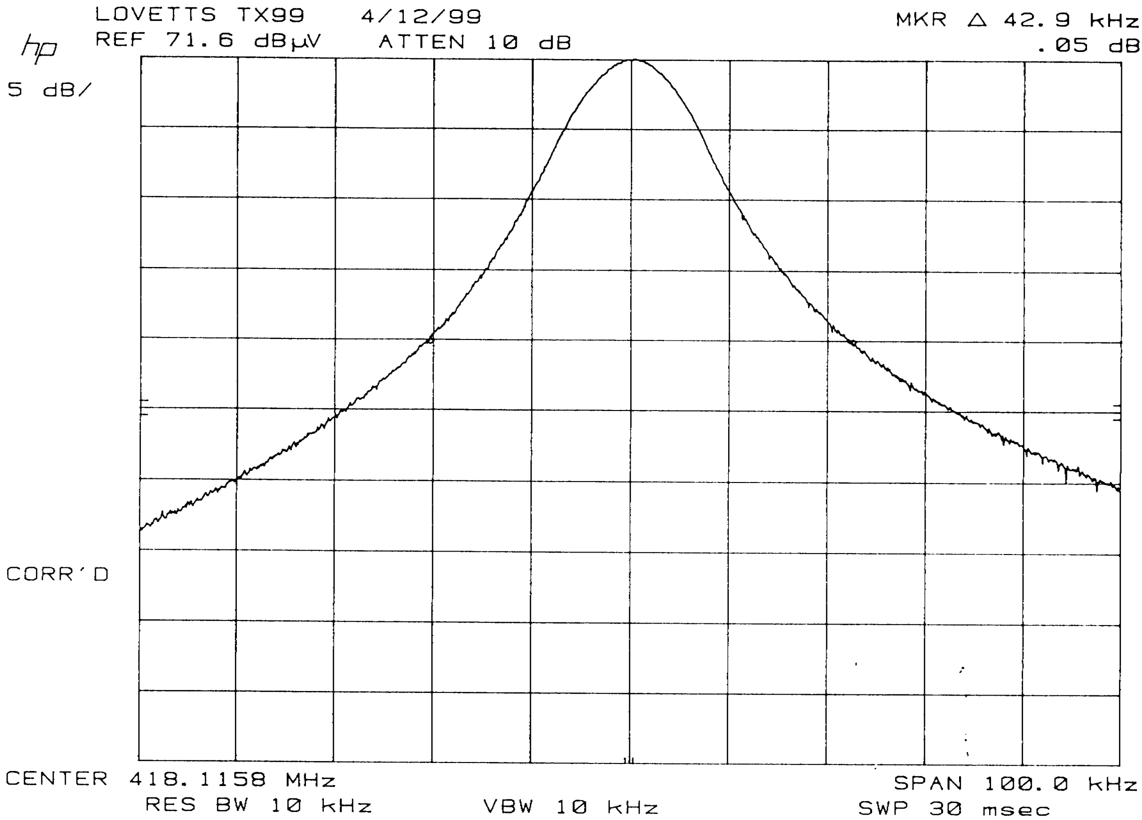


Fig. 3
LOVETT'S ELECTRONICS
TX99 REMOTE TRANSMITTER
OCCUPIED BANDWIDTH

LIST OF TEST EQUIPMENT

RECEIVERS:	Hewlett-Packard Spectrum Analyzer Type 8568B with 8560A RF Section S/N 2216A02120 85662A Display Section S/N 2152A03686 85650A Quasi-Peak Adapter S/N 2043A00350 Calibrated 5/98
	Singer Stoddart EMI Field Intensity Meter Model NM 37/57 S/N 0234-04233 Calibrated 5/98
	Hewlett-Packard Spectrum Analyzer Model 8593EM, S/N 3536A00147 Calibrated 5/97
ANTENNAS;	EMCO Biconical Antenna Model 3104 Freq. Range 20 - 200 MHz
	EMCO Log-Periodic Antenna Model 3146 Freq. Range 200 - 1000 MHz
	Stoddart Tuned Dipole Antenna Model 90832-2 Freq. Range 88 - 400 MHz
	Stoddart Tuned Dipole Antenna Model 91598-2 Freq. Range 400 - 1000 MHz
	EMCO Double Ridged Guide Horn Model 3115 Freq. Range 1 - 18 GHz
MISCELLANEOUS:	Hewlett-Packard Preamplifier Model 8447D S/N 1725A01282
	12.2 m RG-214/U coaxial cable
	0.6 m RG-214/U coaxial cable