

APPENDIX 3
FUNCTIONS OF ACTIVE SEMICONDUCTORS

<u>Reference</u>	<u>Type</u>	<u>Function</u>
Q4	2SC2223	Modulator Buffer
Q5	2SC2223	Buffer
Q6	2SC2223	Buffer/Driver
Q7	2SC2223	Driver
Q8	2SC4910	Final Amplifier
IC1	M65P512A	Encoder
IC2	16C54	uController
IC3	PLL2001S	PLL

FUNCTION OF ACTIVE
SEMICONDUCTORS
FCC ID: IFHSPEC75

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the Lynx 3D transmitter in accordance with Part 2, Subpart J of the FCC Rules.

The Lynx 3D is a low power, non-voice, transmitter intended for remote control of model vehicles in the 75 MHz band.

The equipment employs a vertical polarized antenna directly mounted on the unit and meets Paragraphs 95.645, 95.647, 95.649, and the technical requirements established in the Report & Order in PR Docket 90-222.

B. GENERAL INFORMATION REQUIRED FOR TYPE CERTIFICATION (Paragraph 2.983 of the Rules)

1. Name of applicant: Hitec RCD, Inc.
2. Identification of equipment: IFHSPEC75
 - a. The equipment identification label is shown in Appendix 1.
 - b. Photographs of the equipment are included in Appendix 2.
3. Quantity production is planned.
4. Technical description:
 - a. 6k00F1D emission
 - b. Frequency range: 75.41-75.99 MHz.
 - c. Operating power of transmitter is fixed at the factory at 0.35 Watt.
 - d. Maximum power permitted under Paragraph 95.635(b) of the FCC Rules is 750 milliwatts, and the Lynx 3D fully complied with those power limitations.
 - e. The dc voltage and dc currents at final amplifier:
Collector voltage: 11.3 Vdc
Collector current: 91 mA
 - f. Function of each active semiconductor device:
See Appendix 3.
 - g. Complete circuit diagram is included in Appendix 4
 - h. Draft instruction book is submitted as Appendix 5.
 - i. The transmitter tune-up procedure is included in Appendix 6.
 - j. A description of circuits for stabilizing frequency is included in Appendix 7.
 - k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
 - l. Not applicable.
5. Data for 2.985 through 2.997 follow this section.

B. GENERAL INFORMATION...(Continued)

6. RF Power Output (Paragraph 2.985(a) of the Rules)

Since the Lynx 3D has an immediately attached, integral antenna, no antenna port exists. Power was determined by calculation:

$$P = \frac{(E + D)^2}{30 G} \quad (1)$$

Where

P = Power input (same as power radiated assuming 100% efficient antenna)

E = Electric Field in V/M

D = Distance in meters

G = Gain of the antenna over isotropic. (For a 75 MHz monopole, gain = 0.8)

$$P = \frac{(0.996051 \times 3)^2}{30 \times 0.8} \quad (\text{from Table 1})$$

$$P = 0.35 \text{ watts}$$

C. MODULATION CHARACTERISTICS

1. Occupied Bandwidth
(Paragraphs 2.989(i), and 95.635(b) of the Rules)

Figure 1 is a plot of the sideband envelope of the transmitter taken with an Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(i) and consisted of the multiple pulses and synchronizing space normally used in radio control applications. Operator controls were adjusted for worst-case emission.

The plot is within the limits imposed by paragraph 95.635(c).

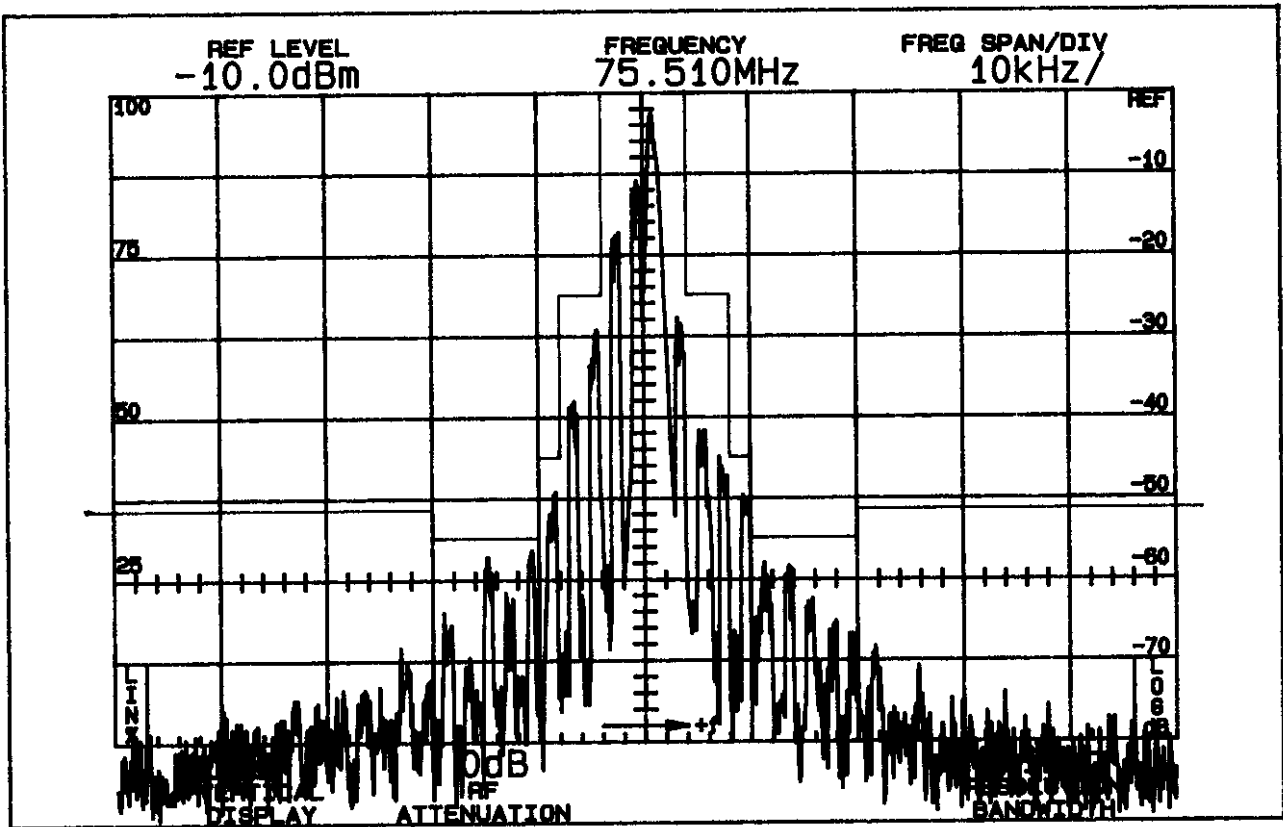
The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

Resolution bandwidth was 1 kHz; video bandwidth was 100 kHz.

Figure 2 is a plot from a Tektronix 494P spectrum analyzer with 5 mS/division sweep in the time domain of the modulated carrier. Modulation consisted of five bursts with a nominal 2 mS duration at a nominal 50 Hz repetition rate.

(1) Kraus, J.D., Antennas p.55.

FIGURE 1
OCCUPIED BANDWIDTH



95.635:

(3) At least 25 dB on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth (4 to 8 kHz).

(10) At least 45 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 125% of the authorized bandwidth. (8 to 10 kHz)

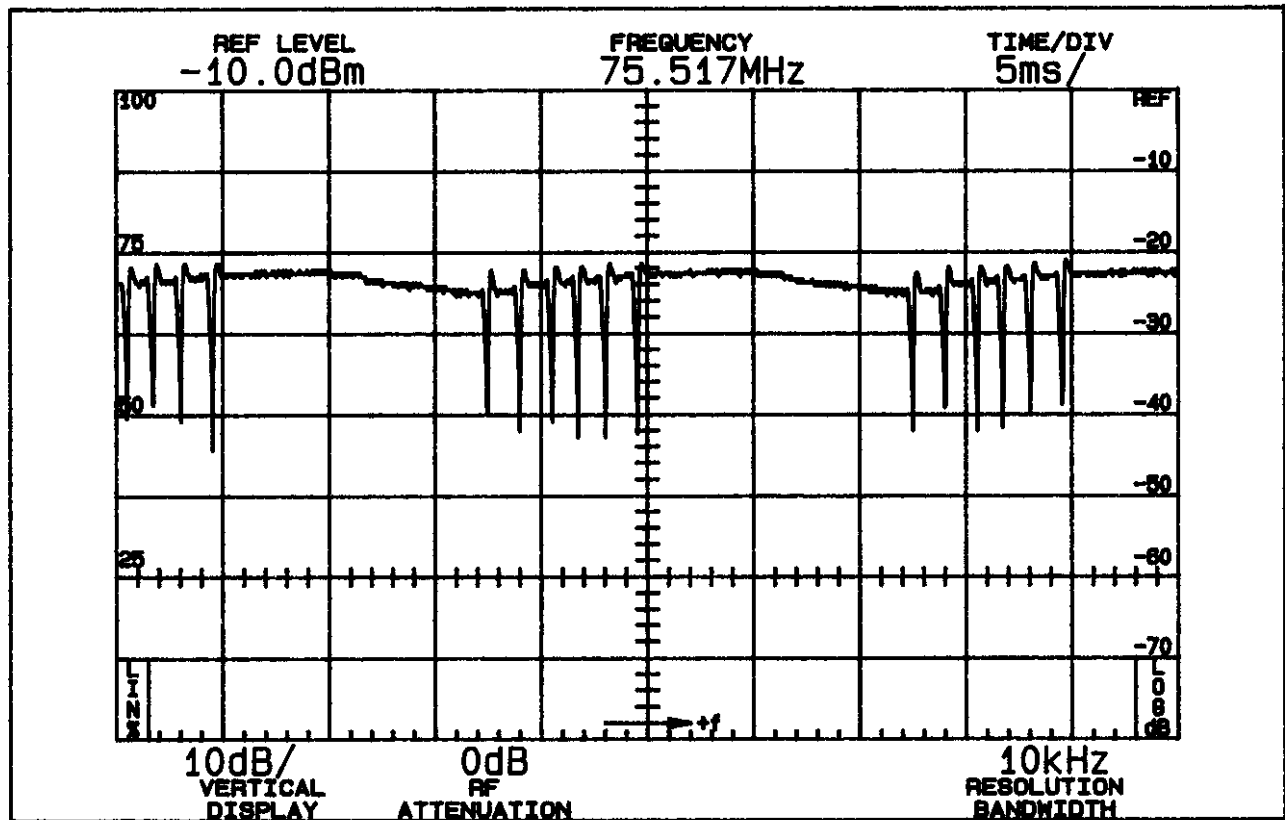
(11) At least 55 dB on any frequency removed from the center of the authorized bandwidth by more than 125% up to and including 250% of the authorized bandwidth. (10 to 20 kHz)

(12) At least $56 + 10 \log_{10} (TP)$ dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

OCCUPIED BANDWIDTH
FCC ID: IFHSPEC75

FIGURE 1

FIGURE 2
MODULATING WAVEFORM
TIME DOMAIN



5 millisecond/division sweep

OCCUPIED BANDWIDTH
(Modulating Waveform)
FCC ID: IFHSPEC75

FIGURE 2

D. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS
(Paragraph 2.991 of the Rules)

Since the Lynx 3D transmitter meets FCC Rules 95.645, there are no provisions for antenna terminal output measurements.

Substitution of a suitable matching network and retuning to permit observations at 50 ohms would not be representative of normal operation.

Accordingly data on radiated spurious emissions are included in lieu of antenna terminal conducted spurious emissions.

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION
(Paragraph 2.993(a) (b) (2) of the Rules)

Field intensity measurements of radiated spurious emissions from the Lynx 3D were made with a Tektronix 494P spectrum analyzer using EMCO 3121C calibrated test antennas.

The transmitter and its integral vertical antenna were located in an open field 3 meters from the test antenna. Supply voltage was from a fresh set of batteries with a terminal voltage under load of 9.6 Vdc. The transmitter and test antennas were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

Reference was measured emission at the carrier frequency, 75.510 MHz, expressed in $\mu\text{V/m}$ @ 3m.

The measurement system was capable of detecting signals 100 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit, 8 MHz, to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 1.

TABLE 1

TRANSMITTER RADIATED EMISSION
75.510 MHz; 9.6 Vdc; 0.35 watt ERP

<u>Emission Frequency</u> <u>MHz</u>	<u>Radiated</u> <u>Emission</u> <u>uV/m</u>	<u>dB Below</u> <u>Carrier Reference</u> ¹
75.510	966050.8	0.0
151.020	191	74.1
226.529	106	79.2
302.039	302	70.1
377.549	733	62.4
453.059	1035	59.4
528.568	562	64.7
604.078	248	71.8
679.588	327	69.4
755.098	484	66.0

Required: $56 + 10\log(0.35) =$ 51.4

1. Worst-case polarization, H-horizontal, V-vertical.

All other spurious from 8 - 756 MHz were 20 dB or more below FCC limit.

F. FREQUENCY STABILITY
(Paragraph 2.995(a) and 95.623(c) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to $+50^{\circ}\text{C}$. At each temperature, the unit was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within $\pm 2^{\circ}$ of the desired test temperature. Following the 1 hour soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 2, starting with -30°C .

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 177 DVM and Fluke 150-30 temperature probe. The transmitter output stage was terminated in a dummy load. Primary supply was 9.6 volts. Frequency was measured with a HP 5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made at 75.510 MHz. No transient keying effects were observed.

TABLE 2

FREQUENCY STABILITY vs. TEMPERATURE
75.510 MHz; 9.6 Vdc; 0.35 watt

<u>Temperature, $^{\circ}\text{C}$</u>	<u>Output Frequency, MHz</u>
-28.8	75.509270
-19.9	75.509568
- 9.9	75.509948
0.0	75.510385
10.4	75.510585
20.0	75.510191
30.1	72.510062
39.9	72.509943
49.7	72.509837

Maximum frequency error:	75.509270
	<u>75.510000</u>
	- .000730 MHz

Rule 95.623(c) specifies 0.002% or a maximum of ± 0.001510 MHz, which corresponds to:

High Limit	75.511510 MHz
Low Limit	75.508490 MHz

G. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE
(Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with an HP 5385A digital frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied $\pm 15\%$ from the nominal 9.6 volt rating. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 3

FREQUENCY STABILITY vs. SUPPLY VOLTAGE
75.51 MHz; 9.6 Vdc; 0.35 Watt

<u>Supply Voltage</u>	<u>Output Frequency, MHz</u>
11.04	75.510366
10.56	75.510285
10.08	75.510220
9.60	75.510191
9.12	75.510168
8.64	75.510152
8.16	75.510141
7.68*	75.510131

Maximum frequency error: 75.510131
75.510000

+ .000131 MHz

* Manufacturer's battery end point.

FCC Rule 95.623(c) specifies 0.002% or a maximum of ± 0.001510 MHz, corresponding to:

High Limit	75.511510 MHz
Low Limit	75.508490 MHz