ENGINEERING STATEMENT

For Type Certification of

Hitec RCD, Inc.

Model: Laser4/6
FCC ID: IFHLAS46

I am an Electronics Engineer, a principal the firm of Hyak Laboratories, Inc., Springfield, Virginia. My education and experience are a matter of record with the Federal Communications Commission.

Hyak Laboratories, Inc. has been authorized by Hitec RCD, Inc., to make type certification measurements on the Laser4/6 transmitter. These tests were made by me or under my supervision in our Springfield laboratory.

Test data and other documentation required by the FCC for type certification are included in this report. It is submitted that the above mentioned transmitter meets FCC requirements and type certification is requested.

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Rowland S. Johnson

Dated: April 30, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the Laser4/6 transmitter in accordance with Part 2, Subpart J of the FCC Rules.

The Laser4/6 is a low power, non-voice, transmitter intended for remote control of model aircraft in the 72 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: IFHLAS46

   a. The equipment identification label is submitted as a separate exhibit.
   b. Photographs of the equipment are submitted as separate exhibits.

3. Quantity production is planned.

4. Technical description:

   a. 6k00F1D emission
   b. Frequency range: 72.010 – 72.99 MHz.
   c. Operating power of transmitter is fixed at the factory at 0.43 Watt – ERP(d).
   d. Maximum power permitted under Paragraph 95.635(b) of the FCC Rules is 750 milliwatts, and the Laser4/6 fully complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:
      Collector voltage: 9.6 Vdc
      Collector current: 150 mA
   f. Function of each active semiconductor device: See Appendix 1.
   g. Complete schematic diagram is submitted as a separate exhibit.
   h. Draft instruction book is submitted as a separate exhibit.

B. GENERAL INFORMATION (continued)

i. The transmitter tune-up procedure is submitted as a separate exhibit.
j. A description of circuits for stabilizing frequency is included in Appendix 2.
k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 3.
l. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

6. RF_Power_Output (Paragraph 2.985(a) of the Rules)

Since the Laser4/6 has an immediately attached, integral antenna, no antenna port exists. Power was determined by substitution comparison.

Assuming an ideal dipole (not the actual monopole)

ERP(d) = 0.43 Watts.

C. MODULATION CHARACTERISTICS

Occupied_Bandwidth
(Paragraphs 2.989(i), and 95.635(b) of the Rules)

Figure 1 is a plot, with unmodulated carrier at 0 dB Ref., of the sideband envelope of the transmitter taken with a 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).

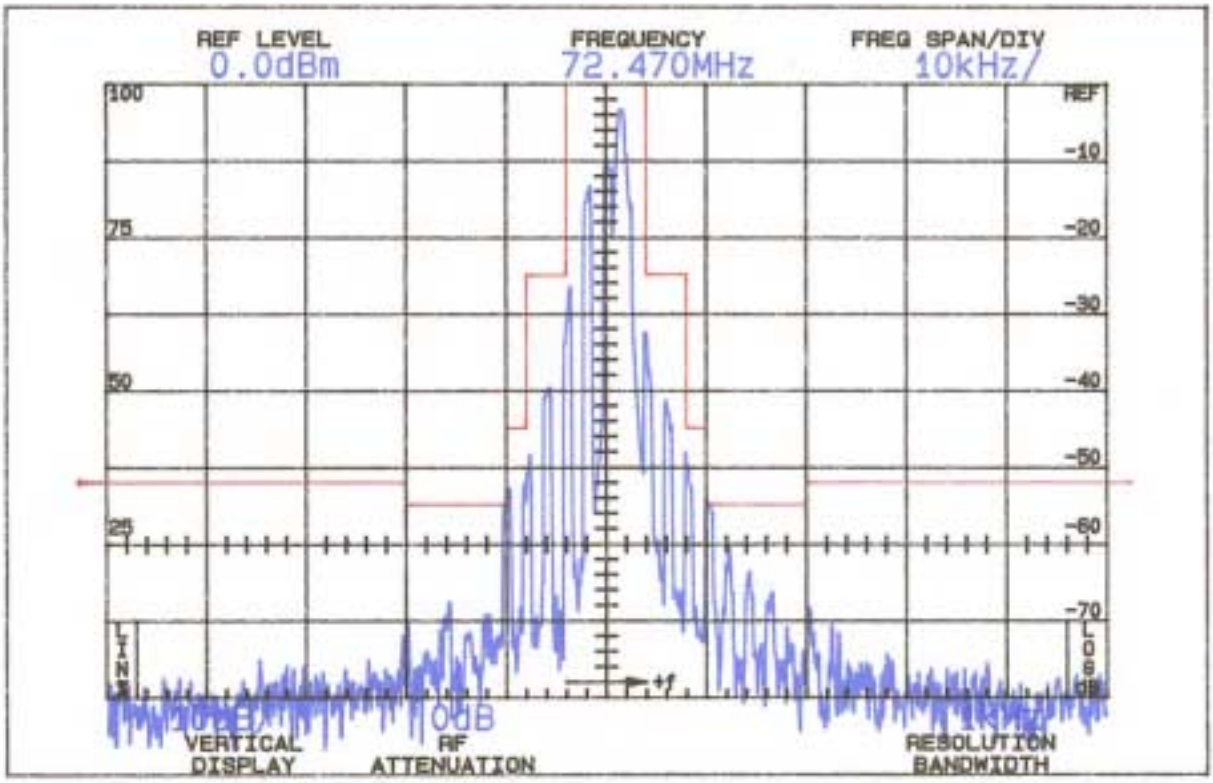
The horizontal scale (frequency) is **10** kHz per division and the vertical scale (Amplitude) is a logarithmic presentation equal to 10 dB per division.

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

Figure 2 is a plot from a Tektronix 494P spectrum analyzer with 2 mS/division sweep in the time domain of the modulated carrier. Modulation consisted of six bursts with a nominal 0.8 mS duration at a nominal 50 Hz repetition rate.

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)

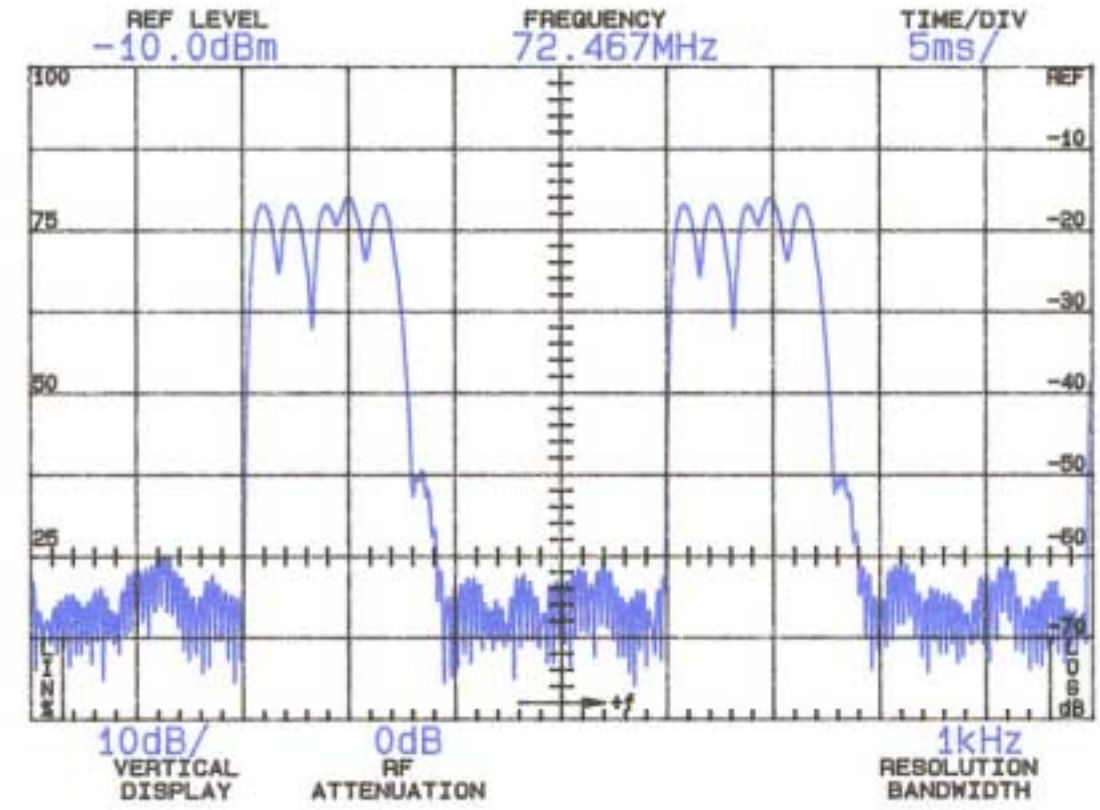
(12) At least $56+10 \log_{10}$ (TP) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

OCCUPIED BANDWIDTH
FCC ID: IFHLAS46

FIGURE 1

FIGURE 2

MODULATING WAVEFORM
TIME DOMAIN



2 millisecond/division sweep

OCCUPIED BANDWIDTH
(Modulating Waveform)
FCC ID: IFHLAS46

FIGURE 2

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

Since the Laser4/6 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. MEASUREMENTS OF SPURIOUS RADIATION
(Paragraph 2.993(a) (b) (2) of the Rules)

Measurements of radiated spurious emissions from the Laser4/6 were made with a Tektronix 494P spectrum analyzer using EMCO 3121C calibrated test antennas using substitution comparison.

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 power at the carrier frequency.

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.

TABLE 1

TRANSMITTER RADIATED EMISSION

72.47 MHz; 9.6 Vdc; 0.43 watt ERP(d)

Emission Frequency MHz	dB Below Carrier_Reference[1]
72.472	0
144.944	57V
217.416	67V
362.360	69H
434.832	64H
507.298	58V
652.242	70V
724.710	70V
Required: **56**+10Log(0.43) =	52

All other spurious from 8 - 728 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°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 ±2° of the desired test temperature. Following the 1 our 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 72.47 MHz. No transient keying effects were observed.

TABLE 2

FREQUENCY STABILITY vs. TEMPERATURE
72.47 MHz; 9.6 Vdc; 0.43 watt ERP(d)

Temperature, °C	Output Frequency, MHz	ppm
-29.7	72.470504	7.0
-20.0	72.470707	9.8
- 9.3	72.470753	10.4
- 0.1	72.470646	8.9
10.0	72.470408	5.6
20.2	72.470209	2.9
30.5	72.469971	-0.4
40.5	72.469784	-3.0
50.5	72.469616	-5.3

Maximum frequency error: 72.470753
72.470000

+ .000753 MHz

Rule 95.623(c) specifies **0.002%** or a maximum of ±0.001449 MHz, which corresponds to:

High Limit	72.471449 MHz
Low Limit	72.468551 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 ±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
72.47 MHz; 9.6 Vdc; 0.43 watt

Supply_Voltage	Output_Frequency,_MHz	ppm
11.04	72.470301	4.2
10.56	72.470263	3.6
10.08	72.470234	3.2
9.60	72.470209	2.9
9.12	72.470185	2.6
8.64	72.470166	2.3
8.16	72.470146	2.0
7.68*	72.470142	2.0

Maximum frequency error: 72.470301
72.470000

\+ .000301 MHz

* Manufacturer's battery end point.

FCC Rule 95.623(c) specifies **0.002%** or a maximum of ±0.001449 MHz, corresponding to:

High Limit	72.471449 MHz
Low Limit	72.468551 MHz

APPENDIX 1

FUNCTIONS OF ACTIVE SEMICONDUCTORS/PARTS LIST

Main Board Parts List

ITEM	QTY	COMP. NAM	REF. DESIGNATOR	DESCRIPTION
1	1	DIP IC	IC1	GMS87C1202
2	1		IC2	LM324
3	1		IC3	78LO5
4	1	SMD IC	IC4	GD4066
5	2	CHIP TR	Q1 Q2	R1102
6	5		Q3 Q4 Q5 Q7 Q8	C1623
7	2		Q9 Q10	C2223
8	1	DIP TR	Q6	A928
9	1		Q11	C4910
10	1	RFT COIL	T1	HDR01S
11	1		T2	HDR01S
12	1		T3	HDR05S
13	2		T4 T5	HDR04S
14	4	CHIP RES	R18 R15 R12 R21	27K
15	4		R19 R13 R22 R16	82K
16	9		R14 R17 R42 R4 R46 R48 R50 R2 R23	47K
17	12		R5 R6 R32 R1 R29 R30 R33 R3 R41 R61 R73 R28	470
18	3		R1 R79 R4	100
19	2		R24 R49	100K
20	10		R27 R35 R36 R4 R52 R77 R9 R R10 R8	4.7K
21	4		R34 R44 R47 R74	10K
22	1		R26	1K

Main Board Continued

ITEM	QTY	COMP. NAM	REF. DESIGNATOR	DESCRIPTION
23	3	CHIP RES	R51 R76 R81	820
24	1		R66	150
25	1		R67	0
26	1		R62	18K
27	3		R63 R65 R78	1.2K
28	3		R64 R72 R25	8.2K
29	1		R68	2.7K
30	1		R69	22
31	1		R75	220K
32	1		R80	220
33	2		R83 R82	2.2
34	2		R2 R3	1.5K
35	1		R70	2.2K
36	1	THERMISTO	R71	3.3K
37	4	VOL. POT	VR1 VR2 VR3 VR4	TR133N18.5F B5K
38	2	SEMI VOL.	VR5 VR6	GF06P 203
39	1		VR7	RVM637A0 B1K
40	1		VR8	RVM637A0 B2K
41	50	CHIP CA (1608)	C2 C3 C6~C29 C31~C33 C39 C4 C42 C44~C4 C51~C53 C62 C6 C67 C77 C80 C8 C86	103
42	2		C5 C30	104
43	5		C34 C48 C49 C6 C68	102
44	3		C43 C35 C63	470P
45	2		C71 C69	68P

Main Board Continued

ITEM	QTY	COMP. NAM	REF. DESIGNATO	DESCRIPTION
46	1	CHIP CAP	C74	0.5P
47	2		C72 C76	5P
48	3		C78 C83 C87	27P
49	2		C79 C91	10P
50	1		C85	91P
51	2		C89 C90	36P
52	1		C88	180P
53	1	MYLAR CAP	C64	0.01
54	3	ELEC CAP	C1 C4 C54	SRA 16V 100µF
55	1		C50	SRA 16V 10µF
56	1	DIP DIODE	D1	1N4001
57	3	CHIP DIOD	D2 D5 D6	MA152K
58	1	CHIP ZENNER	D4	MA3051N
59	1	CHIP VDIODE	D7	BB535G
60	1	LED	LED1	KR05RC
61	1		LED2	KR05YC
62	3		LED3~4	HR05GC
63	1	CHIP COIL	L1	LK2125 1R2K
64	1	INDUCTOR	L2	HDQ02 10µH
65	1	CHIP RES	L3	0
66	1	SLIDE SW	SW1	KSK2202B075T
67	1		SW2	SSSS923CNSL4
68	4		SW3~SW6	SSSS922CNSL4
69	1	TOGGLE	SW7	AS550BL
70	1	RESONATOR	X1	ZTT4.00MG

Main Board Continued

ITEM	QTY	COMP. NAM	REF. DESIGNATO	DESCRIPTION
71	1	XTAL	X-2	HTF72MHZ
72	1	PIEZO	PIEZO	CB13PAX5
73	1	CHG JACK	DC JACK	DCP20 2P
74	1	TR JACK	TA JACK	D6733A11
75	1	ANTENNA	ANT	HT4N
76	1	BATTERY	BATT	

FUNCTION OF ACTIVE
SEMICONDUCTORS
FCC ID: IFHLAS46

APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Transmitter output frequency is determined and stabilized by crystal controlled oscillator.

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION,

Final RF amplifier spurious emissions are attenuated by a matching network consisting of L3, C27, C28, C29, T4, C30, T5, C31, C32 and C37.

CIRCUITS TO SUPPRESS SPURIOUS RADIATION, LIMIT MODULATION AND CONTROL POWER
FCC ID: IFHLAS46

APPENDIX 3