ENGINEERING STATEMENT

For Type Certification of

CATTRON INCORPORATED

Model No: MK
FCC ID: CN2MK

I am an Electronics Engineer, a principal in 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 Cattron Inc. to make type certification measurements on the MK transceiver. These tests made by me or under my supervision in our Springfield laboratory.

Test data and documentation required by the FCC for Type Certification are included in this report. The data verifies that the above mentioned transceiver meets FCC requirements and Type Certification is requested.

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Rowland S. Johnson

Dated: March 17, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for Type Certification of the MK transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The MK is a UHF, 12.5 kHz channel, non-voice, frequency modulated transceiver intended for hand-held, industrial remote control applications in the 447 - 473 MHz band. It operates from a 3 volt battery pack. Output power rating is 14 milliwatts, (90.217 applies).

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

1. Name of applicant: Cattron Inc.

2. Identification of equipment: CN2MK

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

3. Quantity production is planned.

4. Technical description:

   a. 9k0F1D emission
   b. Frequency range: 447-473 MHz.
   c. Operating power of transmitter is fixed at the factory at 0.014 watts.
   d. Maximum power permitted under Part 90 of the FCC is 350 watts, and the MK fully complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 2.9 Vdc
      Collector current: 0.015 A

   f. Function of each active semiconductor device is submitted as a separate exhibit.
   g. Complete circuit diagram is submitted as a separate exhibit.
   h. A draft instruction book is submitted as a separate exhibit.
   i. The transmitter tune-up procedure is submitted as a separate exhibit

B. GENERAL INFORMATION . . .(Continued)

   j. A description of circuits for stabilizing frequency is included in Appendix 1
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is submitted as a separate

exhibit.

l. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

C. RF POWER OUTPUT (Paragraph 2.985(a) of the Rules)

RF power output was measured with a HP 432A power meter with HP 478A sensor and a HP8491B (6 dB) attenuator as a 50 ohm dummy load. Maximum power measured was 0.0138 watts. (The transmitter was tuned by the factory.)

D. MODULATION CHARACTERISTICS

1. Occupied Bandwidth (Paragraphs 2.989(c), 90.209(b)(4) and 90.217(b) of the Rules)

Figure 1 is a plot of the sideband envelope of the transmitter output taken with an Advantest R3361A spectrum analyzer. Modulation consisted of a 4000 baud test pattern. Measured modulation under these conditions was 2.5 kHz for 12.5 kHz channelization.

For the 12.5 kHz channelization, RBW was 100 Hz, VBW 100 Hz, max hold, multiple scan per 90.210(d)(4).

The plot has unmodulated carrier as 0 dBm reference.

The plot is within the limits imposed by Paragraph 90.217(b). The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

NOTE: The transmitter has a power output of under 500 milliwatts and is not required to meet the spectrum efficiency provisions of Para 90.203(j)(3).

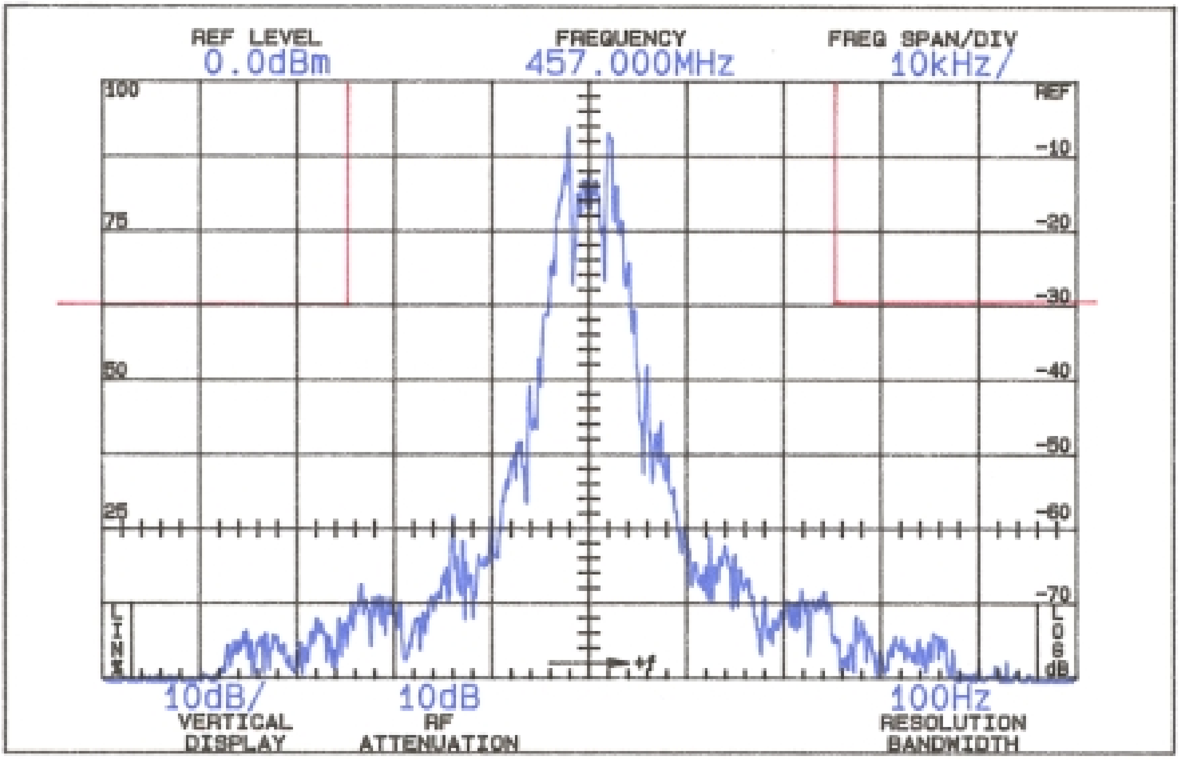
2. Digital Signal Description (Submitted as a separate exhibit for Confidentiality purposes.)

Bandwidth computation:

2D + 2F = 5.0 + 4
= 9k0F1D

FIGURE 1

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
For equipment designed to operate with a 12.5 kHz channel band width, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 25 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.	0 (>5.625 kHz) 70 (@ 12.5 kHz) 50+10LogP = 31 (>12.5 kHz) (P = 0.0138W)

OCCUPIED BANDWIDTH
FCC ID: CN2MK

FIGURE 1

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

The MK transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a random 4000 baud signal.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through a HP 8491B (6 dB) power attenuator. A notch filter was used to attenuate the carrier.

During the tests, the transmitter was terminated in the 50 ohm attenuator. Power was monitored on a Bird 43 Thru-Line wattmeter; dc supply was 3.0 volts throughout the tests.

Spurious emissions were measured throughout the RF spectrum from 14 (lowest frequency generated in the transmitter is 14.4 MHz) to the tenth harmonic of the carrier.

Any emissions that were between the required attenuation and the noise floor of the spectrum analyzer were recorded. Data are shown in Table 1.

F. DESCRIPTION OF RADIATED SPURIOUS MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility meets ANSI 63.4-1992 and was accepted for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an accepted site.

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TABLE 1

TRANSMITTER CONDUCTED SPURIOUS
457.000, 3.0 Vdc Input, 0.0138 mW

Spurious Frequency	dB Below Carrier

MHz	Reference
904.000	82*
1356.000	103*
1808.000	93*
2260.000	103*
2712.000	101*
3164.000	100*
3616.000	104*
4068.000	102*
4520.000	103*

Required: 50+10Log(P) = 31 90.210(d)

All other emissions from 14 MHz to the tenth harmonic were 20 dB or more below FCC limit.

*Reference data only, more than 20 dB below FCC limit.

NOTE: Carrier notch filter used to increase dynamic range.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the MK were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated dipole antennas below 1 GHz, and Polarad CA-L, and CA-S or EMCO 3115 from 1-5.0 GHz.

The transmitter and dummy load were located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 3.0 Vdc.

Output power was 13.8 mW at 457.000 MHz operating frequency. The transmitter and test antennas were arranged to maximize pickup. Both vertical and horizontal test antennae polarization were employed.

Reference level for the spurious radiation was taken as an ideal dipole excited by 13.8 mW, the output power of the transmitter according to the following relationship:*

$$E = \frac{(49.2P_t)^{1/2}}{R}$$

where E = electric-field intensity in volts/meter

P_t = transmitter power in watts

R = distance in meters

for this case $$E = \frac{(49.2\text{x}0.014)^{1/2}}{3} = 0.28 \text{ V/m}$$

Since the spectrum analyzer is calibrated in decibels above one milliwatt (dBm), a conversion, for convenience, was made from dBu to dBm.

0.28 volts/meter = $0.28\text{x}10^6$ uV/m

dBu/m = $20 \text{ Log}_{10}(1.2\text{x}10^6)$

= 109 dBu/m

Since 1 uV/m = -107 dBm, the reference becomes

109 - 107 = 2 dBm

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*Reference Data for Radio Engineers, Fourth Edition, International Telephone and Telegraph Corp., p. 676.

G. FIELD STRENGTH MEASUREMENTS (Continued)

The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

The measurement system was capable of detecting signals 95 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit (14 MHz), to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 2.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

457.000 MHz, 3.0 Vdc, 13.8 mW

Spurious Frequency MHz	dB Below Carrier Reference[1]
914.000	52V*
1371.000	66V*
1828.000	70V*
2285.000	72H*
2742.000	71V*
3199.000	71V*
3656.000	70V*
4113.000	68V*
4570.000	69V*

Required: 50+10Log(P) = 31 90.210(d)

[1]Worst-case polarization, H-Horizontal, V-Vertical.

* Reference data only, more than 20 dB below FCC limit.

All other spurious from 14 MHz to 4.6 GHz were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2) and 90.213 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 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 3, starting with -30°C.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital thermometer. The transmitter output stage was terminated in a dummy load. Primary supply was 3.0 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 457.000 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY vs. TEMPERATURE

457.000 MHz; 3.0 Vdc; 13.8 mW

Temperature, °C	Output Frequency, MHz	ppm
-29.4	no output	N/A
-20.3	456.999637	-0.8
-10.1	456.999702	-0.7
- 0.1	456.999500	-1.1
10.8	456.999702	-0.7
20.2	456.999972	-0.1
30.1	457.000324	0.7
40.0	457.000556	1.2
50.3	457.000428	0.9

Maximum frequency error: 457.000556
457.000000

\+ .000556 MHz

FCC Rule 90.213(a) specifies .00025% or a maximum of ±.001143 MHz, which corresponds to:

High Limit	457.001143 MHz
Low Limit	456.998858 MHz

I. 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 a HP 5385A frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 3.0 volt rating. A Fluke 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE
457.000 MHz, 3.0 Volts Nominal, 13.8 mW

%	Supply_Voltage	Output_Frequency,_MHz	ppm
115	3.45	456.999987	0.0
110	3.30	456.999979	0.0
105	3.15	456.999966	-0.1
100	3.00	456.999972	-0.1

95	2.85	456.999969	-0.1
90	2.70	456.999955	-0.1
85	2.55	456.999957	-0.1
80*	1.90	456.999947	-0.1

Maximum frequency error: 457.000053
457.000000
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\+ .000053 MHz

*MFR rated battery end-point

FCC Rule 90.213(a) specifies .00025% or a maximum of ± .001130 MHz, corresponding to:

High Limit	457.001143 MHz
Low Limit	456.998858 MHz

J. TRANSIENT FREQUENCY BEHAVIOR

Operation under 90.217 does not require TFB compliance.

APPENDIX 1

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

A 14.4 MHz reference TCXO and a PLL circuit establishes and stabilizes output frequency.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: CN2MK

APPENDIX 1