ENGINEERING STATEMENT

For Type Certification of

CATTRON INCORPORATED

Model No: M840P-90HP
FCC ID: CN2M840-90HP

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 M840P-90HP 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: November 9, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for Type Certification of the M840P-90HP transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The M840P-90HP is a UHF, non-voice, frequency modulated transceiver intended for hand-held, industrial remote control applications in the 447 - 473 MHz band. It operates from a 15.0 volt battery pack. Output power rating is 0.450 watts. Narrow band, 12.5 kHz channel, operation is provided.

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

1. Name of applicant: Cattron Inc.

2. Identification of equipment: CN2M840-90HP

   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. 14k4F1D emission
   b. Frequency range: 447-473 MHz.
   c. Operating power of transmitter is fixed at the factory at 0.450 watts.
   d. Maximum power permitted under Part 90 of the FCC is 350 watts, and the M840P-90HP fully complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 14.3 Vdc
      Collector current: 0.070 A

   f. Function of each active semiconductor device: See Appendix 1.
   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 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.

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

RF power output was measured with an HP 432A power meter with HP 478A sensor and a Narda 765-20 attenuator as a 50 ohm dummy load. Maximum power measured was 0.450 watts. (The transmitter was tuned by the factory.)

D. MODULATION CHARACTERISTICS

Occupied Bandwidth (Paragraphs 2.989(c), 90.209(b)(4) and 90.210(d) of the Rules)

Figure 1 is a plot of the sideband envelope of the transmitter output taken with a Advantest R3361A spectrum analyzer. Modulation consisted of a 4000 baud test pattern. Measured modulation under these conditions was 3.2 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 90.210(d). 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).

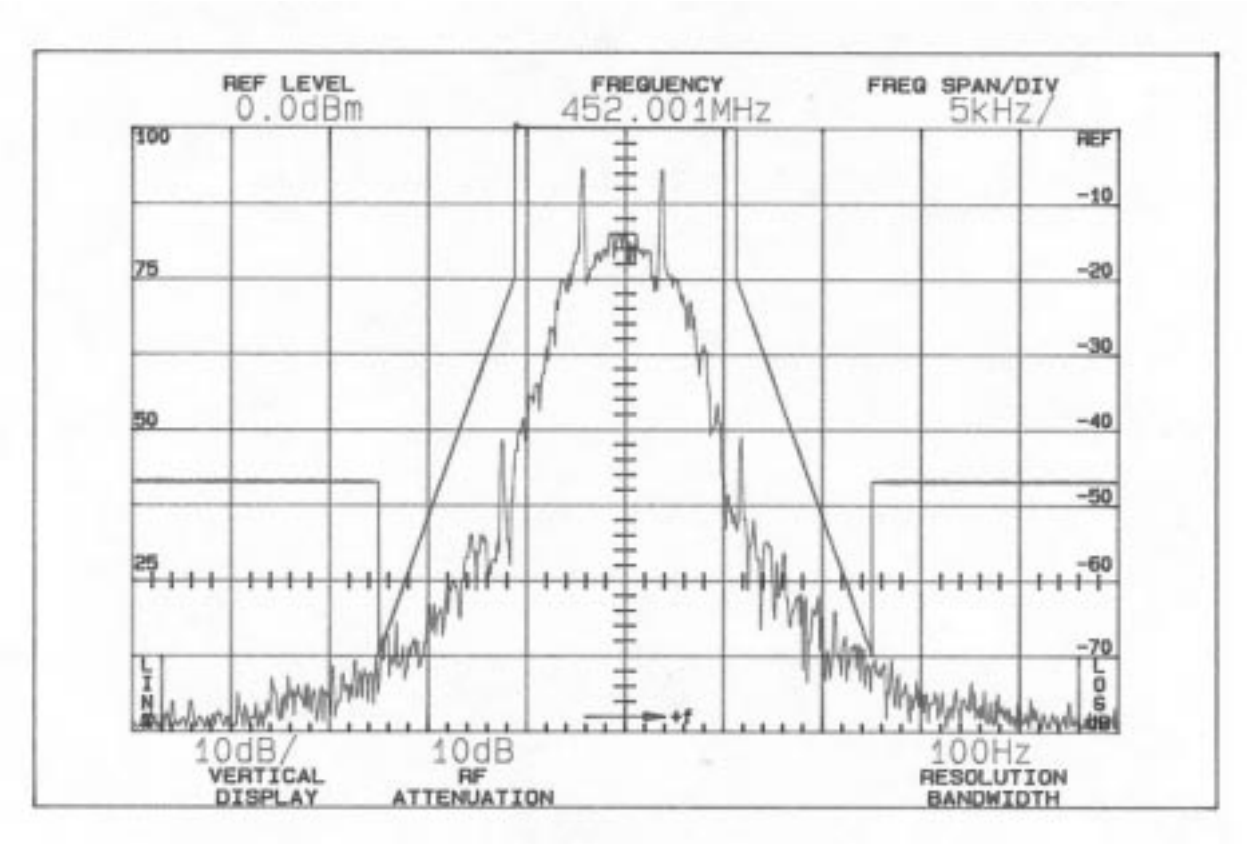
Bandwidth computation: @ 4000 bits per second

2D + 2F = 6.4 + 8

= 14k4F1D

FIGURE 1

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o.	0 (>5.625 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: at least 7.27 (f_d - 2.88 kHz) dB.	70 (@ 12.5 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz.	50+10LogP = 47 (>12.5 kHz) (P = 0.45W)

OCCUPIED BANDWIDTH
FCC ID: CN2M840-90HP

FIGURE 1

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

The M840P-90HP transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a random 4 kbs signal.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through a Narda 765-20 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 15.0 volts throughout the tests.

Spurious emissions were measured throughout the RF spectrum from 9 (lowest frequency generated in the transmitter is 9.6 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.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS
452.000, 15.0 Vdc Input, 0.450 W

Spurious Frequency MHz	dB Below Carrier Reference

904.000	103*
1356.000	101*
1808.000	100*
2260.000	99*
2712.000	102*
3164.000	102*
3616.000	101*
4068.000	100*
4520.000	101*

Required: 50+10Log(P) = 47 90.210(d)

All other emissions from 9 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 M840P-90HP 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 15.0 Vdc.

Output power was 0.450 watts at 452.000 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 0.450 watts, 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 $E = \frac{(49.2 \times 0.45)^{1/2}}{3} = 1.6$ V/m

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

1.6 volts/meter = 1.6×10^6 uV/m

dBu/m = $20 \log_{10}(1.2 \times 10^6)$

= 124 dBu/m

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

124 - 107 = 17 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 (9 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

452.000 MHz, 15.0 Vdc, 0.450 watts

Spurious	dB Below

Frequency MHz	Carrier Reference[1]
904.000	79V*
1356.000	96V*
1808.000	>100H*
2260.000	91V*
2712.000	90H*
3164.000	92H*
3616.000	>100H*
4068.000	>100V*
4520.000	80V*

Required: 50+10Log(P) = 47 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 9 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 15.0 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 452.000 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY vs. TEMPERATURE

452.000 MHz; 15.0 Vdc; 0.450 W

Temperature, °C	Output Frequency, MHz	ppm
-29.7	451.999476	-1.2
-19.6	451.999412	-1.3
- 9.8	451.999451	-1.2
0.1	451.999658	-0.8
10.4	451.999954	-0.1
19.9	452.000312	0.7
30.1	452.000511	1.1
39.9	452.000432	1.0
49.7	452.000001	0.0

Maximum frequency error: 452.999412
452.000000

- .000588 MHz

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

High Limit	452.001130 MHz
Low Limit	451.998870 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 15.0 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
452.000 MHz, 15.0 Volts Nominal, 0.450 W

%	Supply_Voltage	Output_Frequency,_MHz	ppm
115	17.25	452.000264	0.6
110	16.50	452.000271	0.6
105	15.75	452.000290	0.6
100	15.00	452.000312	0.7
95	14.25	452.000329	0.7
90	13.50	452.000340	0.8

85	12.75	452.000344	0.8
80*	12.00	452.000340	0.8

Maximum frequency error:

452.000344	
452.000000	
+ .000344	MHz

*MFR rated battery end-point

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

High Limit	452.001130 MHz
Low Limit	451.998870 MHz

J. TRANSIENT FREQUENCY BEHAVIOR
(Paragraph 90.214 of the Rules)

Plot identified as Figure 2 demonstrates TFB for 12.5 kHz channel operation.

Appendix 4 has Block Diagram and measurement description for TFB.

FIGURE 2

TRANSIENT FREQUENCY BEHAVIOR

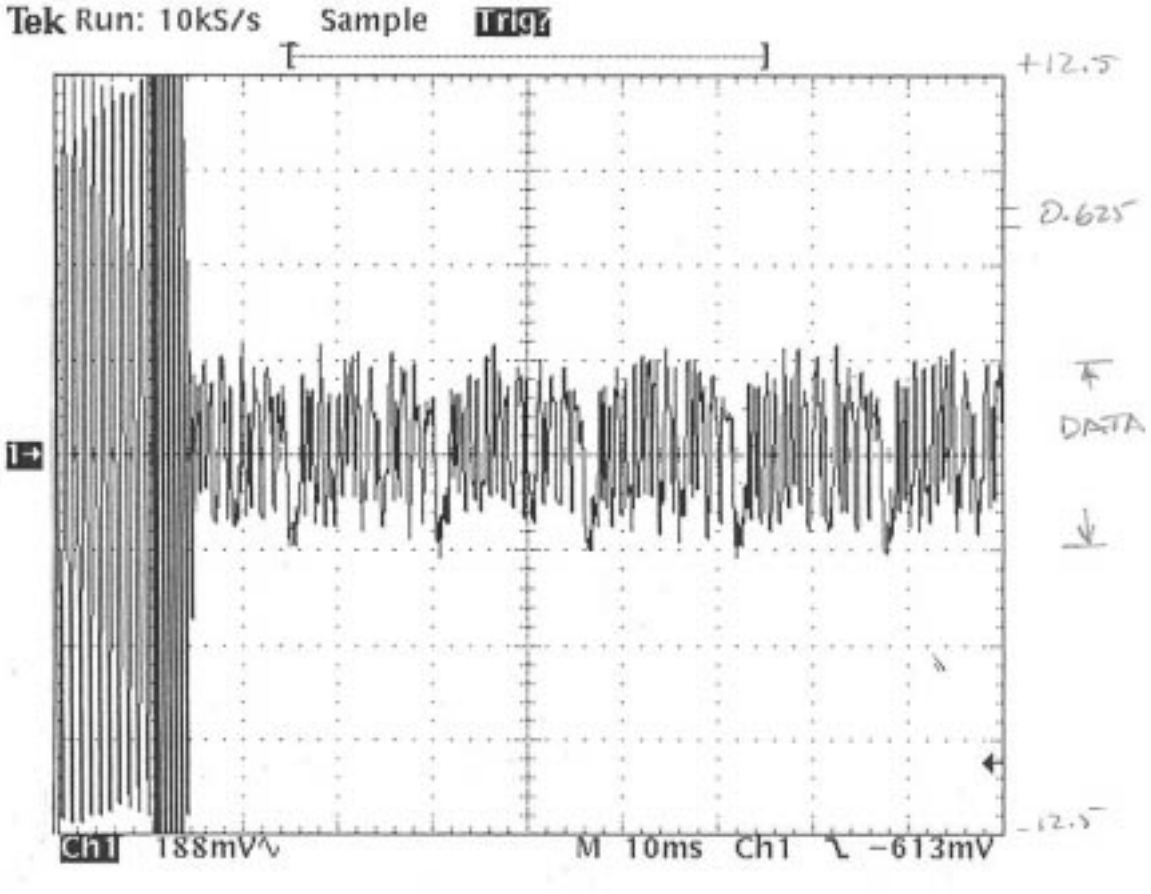
(PLOTS FOLLOW THIS SHEET)
a) Turn-on

b) Turn-off

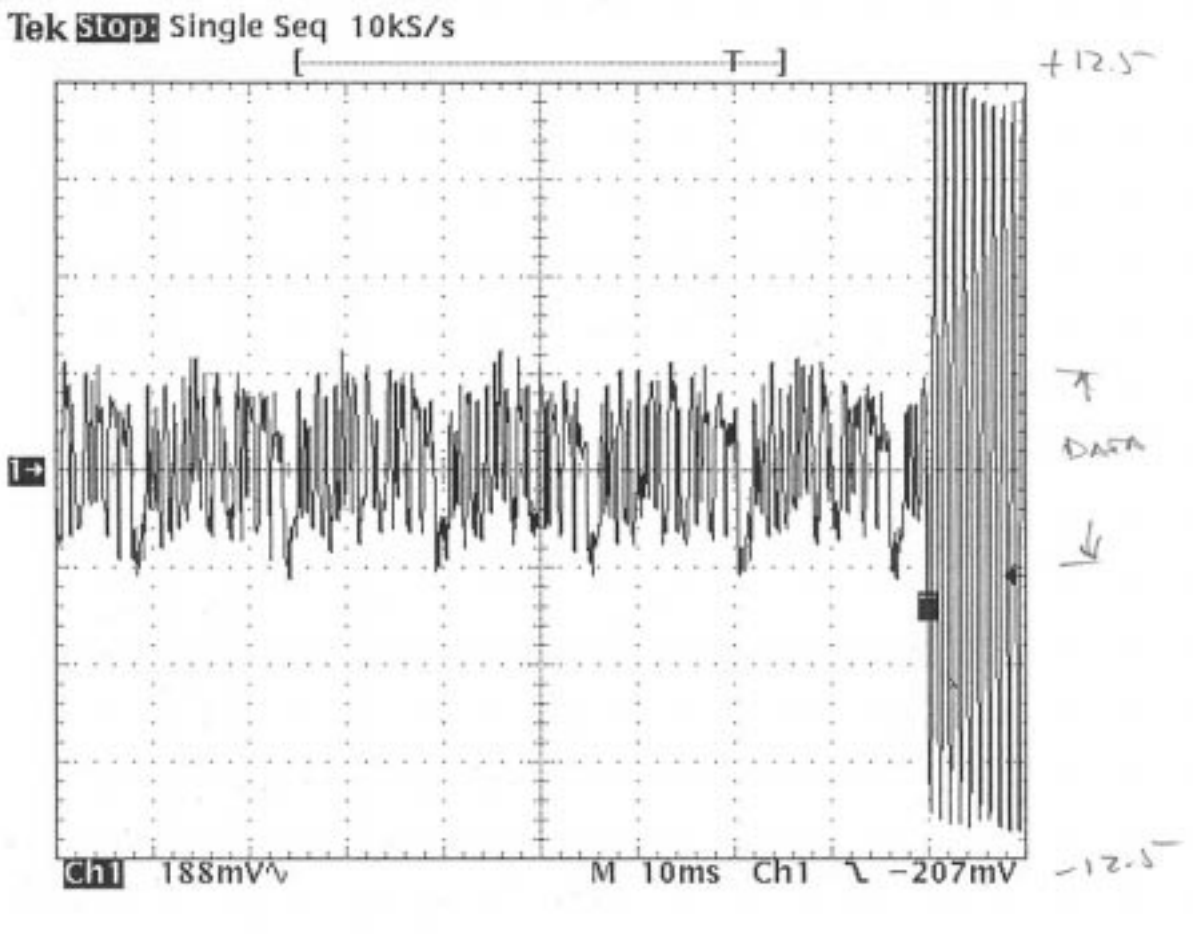
Tests performed with 4 kBs test pattern.

TRANSIENT FREQUENCY BEHAVIOR
FCC ID: F3J130-142U2

FIGURE 2


Tek Run: 10kS/s Sample Trig?
+12.5
0.625
DATA
-12.5
Ch1 188mV
M 10ms Ch1 -613mV

TURN-ON



TURN-OFF

APPENDIX 1

FUNCTION OF DEVICES

A 9.6 MHz reference TCXO and a PLL circuit establishes and stabilizes output frequency.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: CN2M840-90HP

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION,
LIMIT MODULATION AND CONTROL POWER

TWO (2) PAGES FOLLOW THIS SHEET

TFB BLOCK DIAGRAM & PROCEDURE
FCC ID: CN2M840-90HP

APPENDIX 4

90.214 REQUIREMENTS: In the 420 - 500 MHz frequency band, transient frequencies must be within the maximum frequency difference limits during the time interval indicated below for 12.5 and 6.25 kHz channels:

12.5 kHz:

Time Interval	Maximum Frequency	Mobile Radios 420 - 500 MHz
t1	±12.5 kHz	10.0 ms
t2	±6.25 kHz	25.0 ms
t3	±12.5 kHz	10.0 ms

TEST PROCEDURE: TIA/EIA TS603, PARA. 2.219, the levels were set as follows:

1. Using the variable attenuator, the transmitter level was set to 40 dB below the test receivers maximum input level,then the transmitter was turned off.

2. With the transmitter off, the signal generator was set 20 dB below the level of the transmitter in the above step(this level was maintained with the signal generator throughout the test).

3. Attenuation between the transmitter and the RF detector was reduced by 30 dB.

4. The transient frequency behavior was observed and recorded using a TEK TDS360 DSO.

5. The transmitter was modulated with its normal digital signal.

Para. 2.995(a)(b)(d) Frequency stability

90.214 Transient Frequency Behavior
(continued)