ENGINEERING STATEMENT

For Type Certification of

SAM ASH MUSIC CORPORATION

Model: Ear Amp T600

FCC ID: CRRT600

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 retained by Sam Ash Music Corporation to make type certification measurements on the T600 transmitter. These tests made by me or under my supervision in our Springfield laboratory.

Test data 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: August 28, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the T600 transmitter in accordance with Part 2, Subpart J of the FCC Rules.

The T600 is a 50 milliwatt, UHF, frequency modulated, synthesized, ac-line operated transmitter configured as a rack-mount chassis for wireless ear monitor applications under Part 74.

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

1. Name of applicant: Sam Ash Music Corporation

2. Identification of equipment: FCC ID: CRRT600

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

3. Quantity production is planned.

4. Technical description:

   a. Emission 87k0F3E
   b. Frequency range: 614 - 662 MHz.
   c. Operating power of transmitter is fixed at the factory at 50 mW.
   d. Maximum power permitted under Part 74.861(e) (1)(ii) of the rules is 250 milliwatts, and the T600 complied with those power limitations.

   e. Function of each active semiconductor device: See Appendix 1.
   f. Complete circuit diagram is included as a separate exhibit.
   g. A draft instruction book is included as a separate exhibit.
   h. The transmitter tune-up procedure is included as a separate exhibit.

   i. A description of circuits for stabilizing frequency is included in Appendix 2.
   j. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 3.
   k. Not applicable.

5. Data for 2.985 through 2.997 follow this section.

6. RF Power Output (Paragraph 2.987(a) of the Rules)

   The device has a BNC RF output connector. RF output power, was measured using an HP 432 power meter as 54 mW.

   NOTE: All audio measurements were made hard-wired using the normal input connector.

C. MODULATION CHARACTERISTICS

1. A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was a 1 kHz audio signal at 10 kHz deviation. A Boonton 8220 modulation meter was used to measure deviation. Audio output was measured from an Audio Precision System One integrated measurement system.

2. Under Section 74.861 no modulation limiting is required.

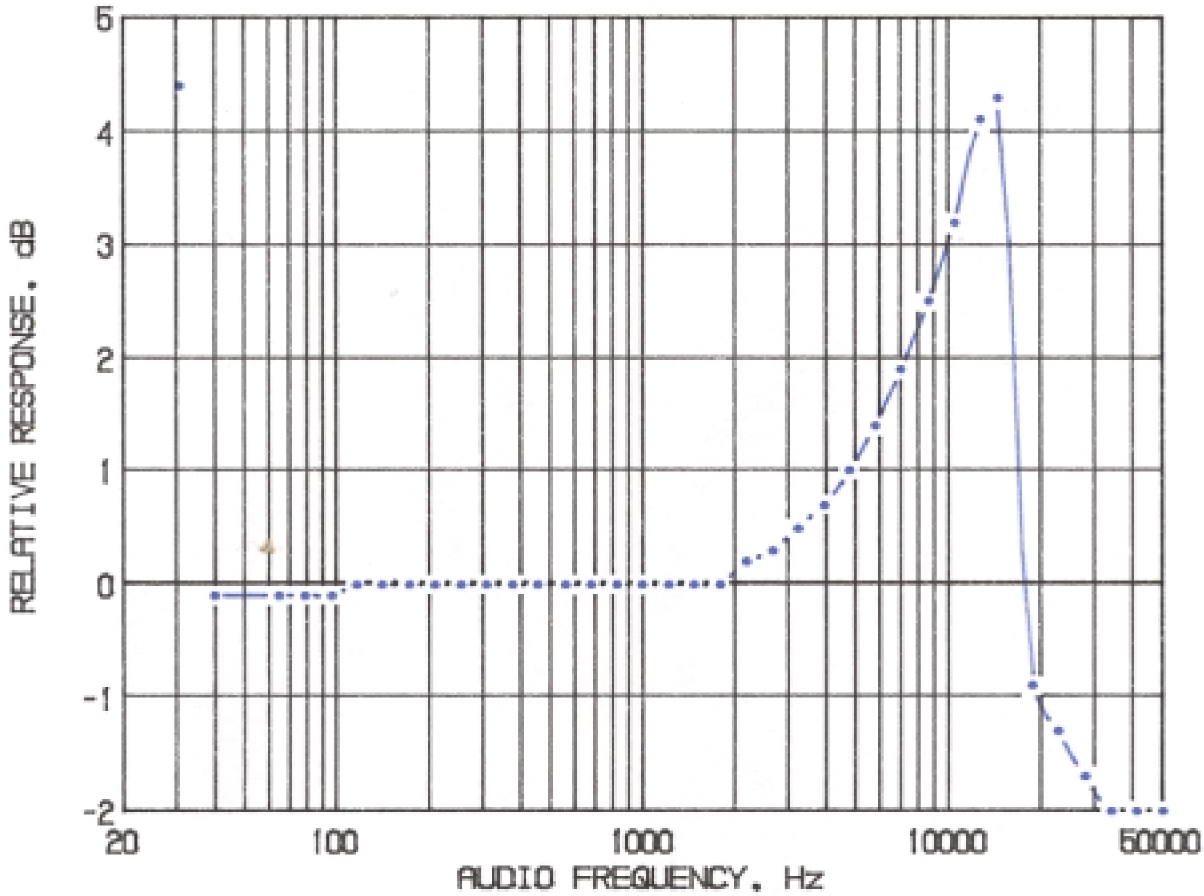
3. Occupied Bandwidth
   (Paragraphs 2.989(c), and 74.861(6) of the Rules)

   Figure 2 is a plot of the sideband envelope of the transmitter taken with a Tektronix 494P spectrum analyzer. Modulation consisted of a 14.5 kHz tone, the frequency of maximum response, at an input level 16 dB greater than that necessary to produce 50% modulation.

   NOTE: Audio bandwidth is 15 kHz, and maximum system deviation (0dBm input) is 29 kHz. Using 2D+2F = modulation factor. Where "D" is rated system deviation, and "F" is maximum modulation frequency, an emission designator of 87k0F3E was computed.

FIGURE 1

MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
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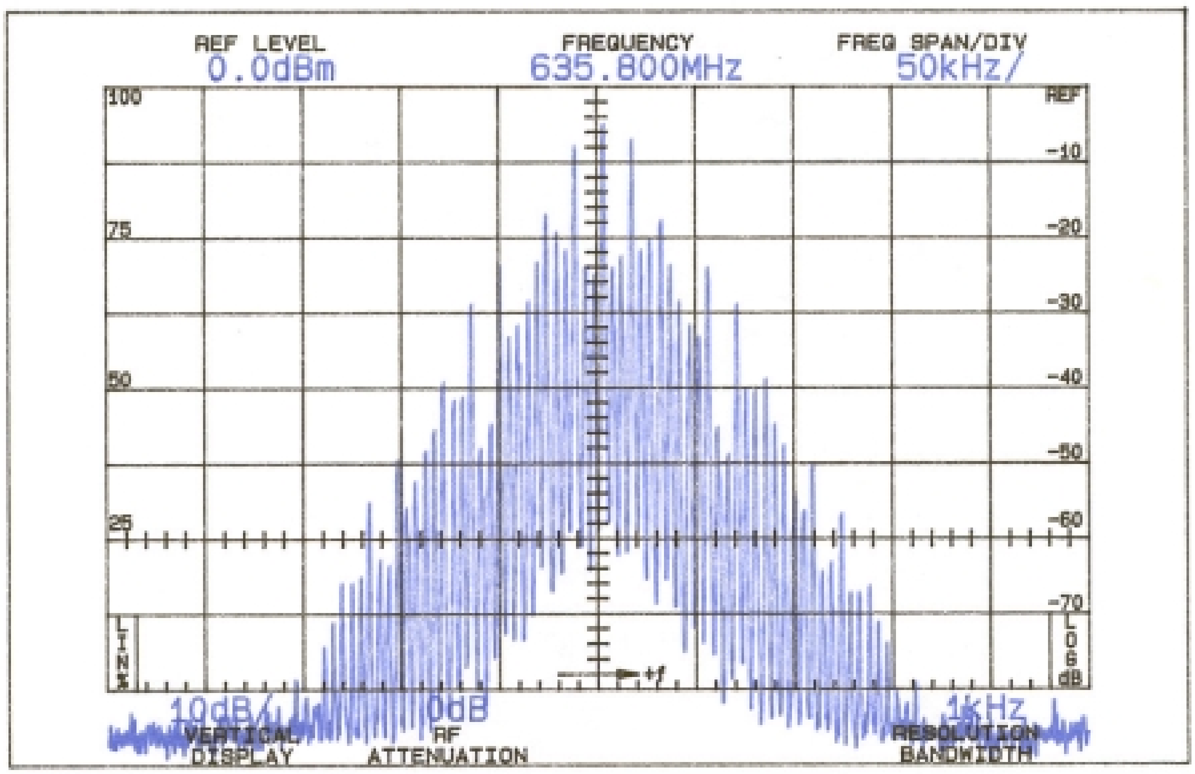
FIGURE 1

FIGURE 2

OCCUPIED BANDWIDTH



OCCUPIED BANDWIDTH
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FIGURE 2

C. MODULATION CHARACTERISTICS (Continued)

The plots are within the limits imposed by paragraph 74.861(6). The horizontal scale (frequency is 50 kHz per division) and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

D. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS

(Paragraph 2.991 of the Rules)

The T600 transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a 15 kHz signal, 16 dB above minimum input signal for 50% modulation.

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; ac supply was 117 volts throughout the tests.

Spurious emissions were measured throughout the RF spectrum from lowest frequency generated in the transmitter 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.

E. 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
635.8, 117 Vac, 53.7 mW

Spurious Frequency MHz	dB Below Carrier Reference
1271.602	81

1907.402		96
2543.208		>100
3179.010		>100
3814.812		>100
4450.614		>100
5086.416		>100
5722.218		>100
6358.020		>100
6993.822		100
Required:	43+10Log(P)	30

All other emissions from 12 MHz to the tenth harmonic were 20 dB or more below FCC limit.

NOTE: Carrier notch filter used to increase dynamic range.

F. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the T600 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 117 Vac.

Output power was 53.7 mW at the 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 radiations was taken as an ideal dipole excited by 53.7 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 $$E = \frac{(49.2 \times 0.0537)^{1/2}}{3} = 0.54 \text{ V/m}$$

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

0.54 volts/meter = 0.54×10^6 uV/m

dBu/m = 20 $\mathrm{Log}_{10}(0.54 \times 10^6)$

= 115 dBu/m

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

115 - 107 = 8 dBm

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*Reference_Data_for_Radio_Engineers, Fourth Edition, International Telephone and Telegraph Corp., p. 676.

F. 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 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

633.05 MHz, 117 Vac, 53.7 mW

Spurious Frequency MHz		dB Below Carrier Reference[1]
1266.102		69V*
1899.156		84V*
2532.208		81V*
3165.260		83H*
3798.312		80H*
4431.364		80H*
5064.416		78H*
5697.468		78H*
6330.520		77H*
Required:	43+10Log(P)	30

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

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

All other spurious to 7.0 GHz were 20 dB or more below FCC limit.

G. FREQUENCY STABILITY
(Paragraph 2.995(2) and 90.213 of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -0°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 stabi- lized 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 -0oC.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital temperature probe. The transmitter output stage was terminated in a 50 ohm dummy load. Primary supply was 117 Vac. Frequency was measured with a HP5385A digital frequency counter connected to the transmitter through a power attenuator.

TABLE 3

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
640.000 MHz; 117 Vac; 53.7 mW

Temperature, °C	Output Frequency, MHz
0	639.999811
10.1	640.000264
19.9	640.000149
29.9	639.999751
39.7	639.999545
49.7	640.000065

Maximum frequency error: 639.999545
640.000000

- 0.000455 MHz

FCC Rule 74.861(e)(4) specifies .005% or a maximum of 0.032000 MHz, corresponding to:

High Limit	640.032000 MHz
Low Limit	639.968000 MHz

H. 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 digital frequency counter as supply voltage provided by a variable ac power supply was varied ±15% from the nominal 117 Vac rating. A Keithley 177 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
640.000 MHz; 117 Vac; 53.7 mW

Supply Voltage	Output Frequency, MHz
134.55	640.000147
128.70	640.000147
122.85	640.000149
117.00	640.000149
111.15	640.000148

105.30	640.000149
99.45	640.000147

Maximum frequency error:	640.000149
	640.000000
	+ 0.000149

FCC Rule 74.861(e)(4) specifies .005% or a maximum of 0.032000 MHz, corresponding to:

High Limit	640.032000
Low Limit	639.968000

APPENDIX 1

ACTIVE SEMICONDUCTOR FUNCTIONS

Reference	Type	Function
U50	MC1452200T	PLL
U4	BA3853BFS	Audio Processing
U5,U6	NJM2073N	Audio Processing
U41,40		Low Pass Filter
Q316	2SC3356	Driver/Buffer
Q315	2SC3356	Driver
Q324	MRF571	Final RF Amp

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Both oscillators are frequency locked by a phase-locked-loop composed of U50 to a reference derived from a 4 MHz crystal (Y1).

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION

Description of Circuits to Suppress Emissions

A fixed frequency L.O. operating on 220 MHz is mixed up to the desired output frequency by a doubly balanced mixer made up of L322, U301, and L321. The 220 MHz signal is passed through a low pass filter before being applied to the mixer to prevent any harmonics from leading to any undesired products that could lie within the pass band. The pass band for the U.S. version (Band A) is 614-662 MHz and for the export version (Band B) it is 774-865 N4hz. The 21 L.O. operates 220 MHz above the output frequency. The output of the mixer is amplified by Q317, then fed through a pass band filter which is tuned to pass only the low side product of the conversion. Any undesired products are to be greater than 60 dBc below the desired signal at this point. The desired signal is then fed to an amplifier chain composed of Q316, Q315, and Q324. After amplification, the signal is passed through a low pass filter to remove any harmonics generated by the amplifiers. In addition, the processor monitors the PLL for an out of lock condition of either synthesizer. The processor, with the aid of Q12 and Q321, provides power for the last two stages of final amplification only if both loops have been locked for a predetermined amount of time. This reduces the possibility of transmitting off frequency and also prevents transmitting upon power up while the synthesizers acquire lock.

Description of Circuits to Limit Modulation

Each channel is limited independently by both a hard limiter and a dynamic limiter. The dynamic limiter functions as an AGC once full modulation is reached. If additional audio is applied, the limiter will reduce the gain of the audio path by overriding the compressor. This maintains legal modulation with little if any noticeable distortion. There is an optional jumper that will cause both limiters to be activated whenever either one is triggered. This feature is designed to maintain a specific balance between the two channels regardless of which channel has excessive audio apllied. Since each dynamic limiter is designed to ignore transients, the hard limiters are present only to limit anything the dynamic limiters allow to pass.

Audio is fed through the compressor (U5), then pre-emphasized by U40(left channel) or U41 (right channel). Q200 and Q20 I (left channel) or Q203 and Q204 (right channel) provide the hard limiting. At this point the audio is amplified byUI4 (left channel) or UI3(right channel) and rectified by CR7 and CR8(left channel) or CR5 and CR6(right channel). The resulting DC voltage is applied to a comparator formed by Q9, Ql 5, and Ql 6(left channel) or Q8, Ql 3, and Q 14(right channel). Once a preset voltage is exceeded at the input of the comparator, the output of the comparator overrides the feedback loop in the compressor and reduces the audio path gain as needed to maintain legal modulation. The top bar graph LED indicates whenever any dynamic limiting is being employed.

CIRCUITS TO SUPPRESS
SPURIOUS RADIATION &
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APPENDIX 3