ENGINEERING STATEMENT

For Type Certification of

AUDIO-TECHNICA CORPORATION

Model: ESW-T211

FCC ID: JFZT211

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 Audio-Technica US, Inc., to make type certification measurements on the ESW-T211 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: September 6, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the ESW-T211 transmitter in

accordance with Part 2, Subpart J of the FCC Rules.

The ESW-T211 is a 6 milliwatt (ERP(d), UHF, frequency modulated, synthesized, transmitter configured as a portable belt-pack for wireless microphone applications under Part 74. Power supply consists of two 1.5V AA cells.

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

1. Name of applicant: Audio Technica Corporation

2. Identification of equipment: FCC ID: JFZT211

   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 81k6F3E
   b. Frequency range: 728 - 741 MHz.
   c. Operating power of transmitter is fixed at the factory at 6 mW.
   d. Maximum power permitted under Part 74.861(e)(1)(ii) of the rules is 250 milliwatts, and the ESW-T211 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 an integral antenna. Effective radiated power (assuming an ideal dipole) was calculated, using the data of Table 1, as 6 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.

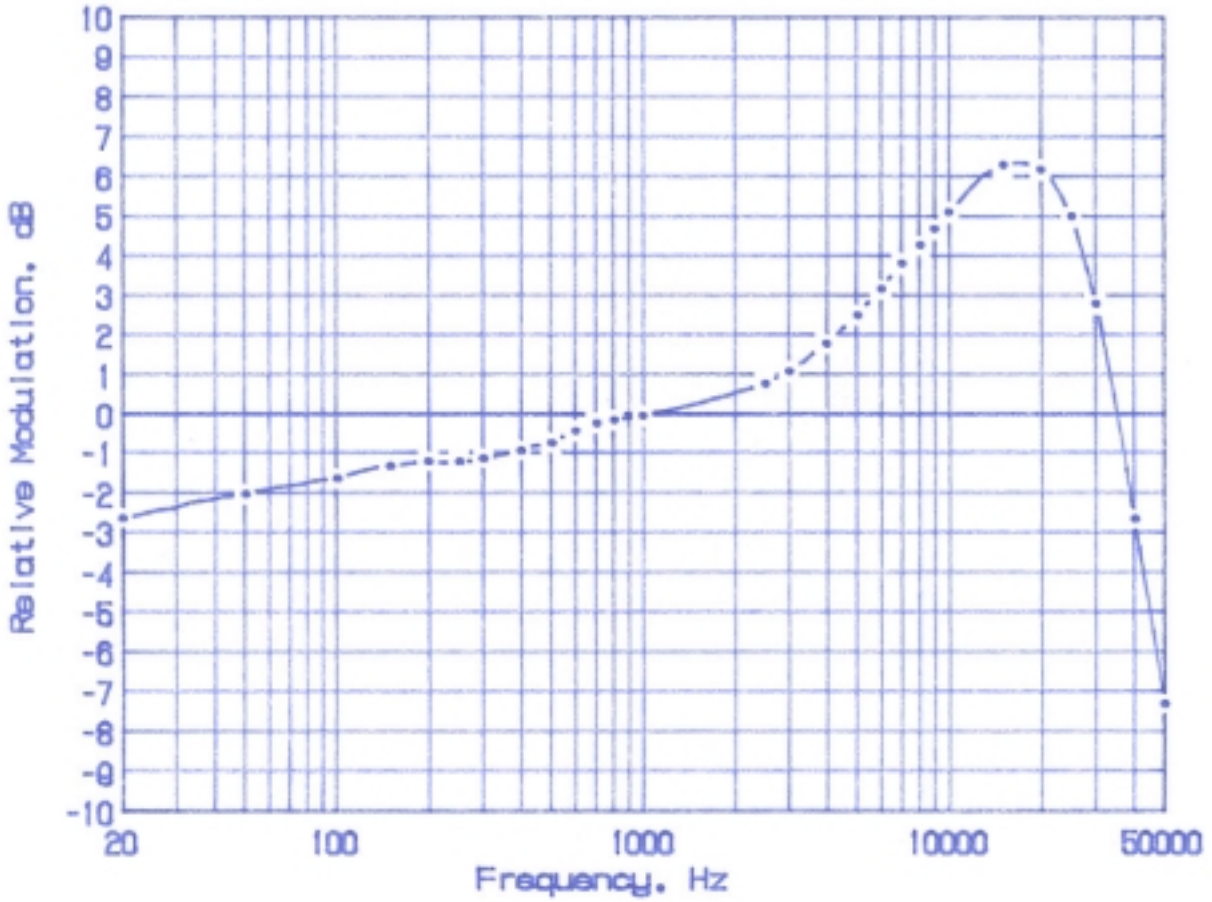
3. Occupied Bandwidth
(Paragraphs 2.989(c), and 74.861(6) of the Rules)

Figure 2 is a plot of the sideband envelope of the transmitter taken with a Tektronix 494P spectrum analyzer. Modulation consisted of a 16.8 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 16.8 kHz, and maximum system deviation (0dBm input) is 24 kHz. Using 2D+2F = modulation factor. Where "D" is rated system deviation, and "F" is maximum modulation frequency, an emission designator of 81k6F3E was computed.

FIGURE 1

MODULATION FREQUENCY RESPONSE

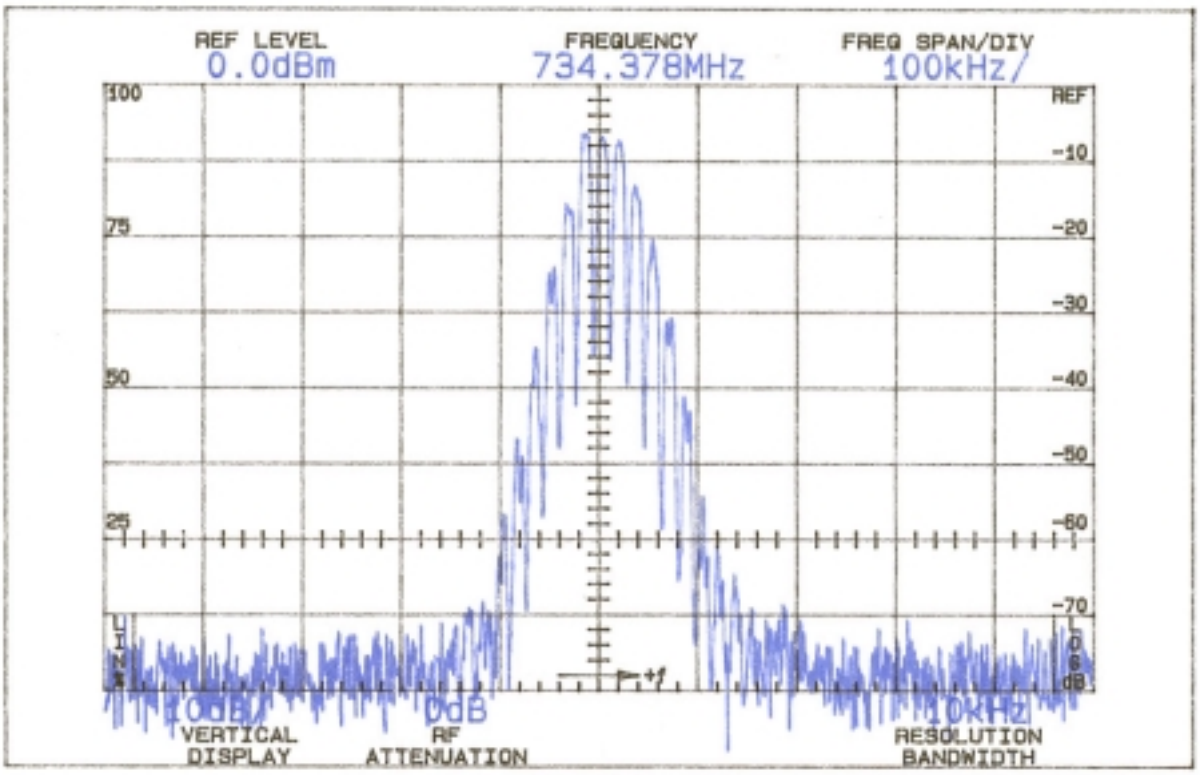


MODULATION FREQUENCY RESPONSE
FCC ID: JFZT211

FIGURE 1

FIGURE 2

OCCUPIED BANDWIDTH



OCCUPIED BANDWIDTH
FCC ID: JFZT211

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)

NOT APPLICABLE, INTEGRAL ANTENNA.

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.

F. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the ESW-T211 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 1-8.0 GHz.

The transmitter was located in an open field 3 meters from the test antenna. Supply was a set of fresh batteries.

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 the carrier level.

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 1.

TABLE 1

TRANSMITTER CABINET RADIATED SPURIOUS

734.375 MHz, 3 Vdc, 6 mW

Spurious Frequency MHz	F.I.@3m uV/m	dB Below Carrier Reference[1]
734.377	186209	0
1468.750	234	58V*

2203.131	224	58V*
2937.508	168	61H*
3671.885	65	69V*
4406.262	48	72H*
5140.639	71	68H*
5875.016	62	70V*
6609.393	97	66V*
7343.770	135	63H*
Required:	43+10Log(P)	21

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

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

All other spurious to 8.0 GHz were 20 dB or more below FCC limit.

Power Calculation =

$ERP(d) = (F.I.xd)^2/49.2$

$= (0.186209x3)^2/49.2$

$= 0.006W$

G. FREQUENCY STABILITY
(Paragraph 2.995(2) and 74.861 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 2, 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 3 Vdc. 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
734.375 MHz; 3 Vdc; 6 mW

Temperature, °C	Output Frequency, MHz
- 0.2	734.372965
9.8	734.374245
19.9	734.374686
29.9	734.374657
39.8	734.374621
50.6	734.375214
Maximum frequency error:	734.372965
	734.375000
	- 0.002035 MHz

FCC Rule 74.861(e)(4) specifies .005% or a maximum of 0.036719 MHz, corresponding to:

High Limit	734.411719 MHz
Low Limit	734.338281 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 3

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE
734.375 MHz; 3 Vdc; 6 mW

Supply Voltage	Output Frequency, MHz
3.5	734.374678

3.3	734.374682
3.2	734.374684
3.0	734.374686
2.9	734.374688
2.7	734.374687
2.6	734.374687
2.4*	734.374733
Maximum frequency error:	734.374678
	733.375000
	- 0.000322

FCC Rule 74.861(e)(4) specifies .005% or a maximum of 0.036719 MHz, corresponding to:

High Limit	734.411719
Low Limit	734.338281

*Rated mfg. battery end-point.

APPENDIX 1

ACTIVE SEMICONDUCTIOR FUNCTIONS

Reference	Type	Function
AF Circuit Board		
IC101	MJM2115	Audio preamplifier
IC103	NE575	Compandor IC
RF Circuit Board		
Q602,Q603	2SC5226	Driver
Q604	2SC5226	Final RF Amplifier
IC401	PIC16C72	PLL/ 6MHz Ref. Oscillator

ACTIVE SEMICONDUCTORS
FCCID: JFZT211

APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Operating frequency is determined and stabilized by a PLL circuit using a 6MHz crystal-Controlled reference oscillator.

CIRCUIT AND DEVICES TO STABILZE FREQUENCY
FCCID: JFZ T214

APPENDIX 2

APPENDIX 3

CIRCUIT TO SUPPRESS SPURIOUS RADIATION AND CONTROL MODULATION

AUDIO CIRCUIT

The audio signal is injected via the HRS connector into the audio circuit composed of the op amp IC101, NJM2115 & compandor IC103, NE575. The signal is compressed via the compandor circuit at a 2:1 ratio and is pre-emphasized. The level of the output signal is controlled by the pot VR302 which is injected into the VCO, VCO501.

MODULATOR CIRCUIT

The modulator circuit is a direct FM type built around the VCO, VCO501. The modulated output from the VCO is sent to the RF pre-amp and RF final amplifier which boosts the output to a nominal level of 10mW.

RF PRE-AMPLIFIER & FINAL AMPLIFIER

The 3 transistor amplifier stages, using 2SC5226 type transistors, culminating with a normal transmitter output of 10mW. The output filter comprised of L605, L606, C610,C611, & C612 suppresses the output harmonics and matches the output to the antenna.

CIRCUIT TO SUPPRESS SPURIOUS
RADIATION & CONTROL MODULATION
FCC ID: JFZT211

APPENDIX 3