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ENGINEERING STATEMENT

For Type Acceptance of

AUDIO-TECHNICA

Model No: ATW-T51B

FCC ID: JFZT51B

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 to make type acceptance measurements on the ATW-T51B transmitter. These tests made by me or under my supervision in our Springfield laboratory.

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

Rowland S. Johnson

Dated: April 28, 1998

89426

A. INTRODUCTION

The following data are submitted in connection with this request for type acceptance of the ATW-T51B transmitter in accordance with Part 2, Subpart J of the FCC Rules.

The ATW-T51B is a nominal 10 milliwatt, UHF, frequency modulated battery operated transmitter configured as a belt-pack for wireless guitar applications under Part 74.

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

1. Name of applicant: Audio-Technica

2. Identification of equipment: FCC ID: JFZT51B

   a. The equipment identification label is shown in Appendix 1.
   b. Photographs of the equipment are included in Appendix 2.

3. Quantity production is planned.

4. Technical description:

   a. Emission 80k0F3E
   b. Frequency range: 732 - 746 MHz.
   c. Operating power of transmitter is fixed at the factory at 10 mW and can be reduced to 3 dB.
   d. Maximum power permitted under Part 74.861(e)(1)(ii) of the rules is 250 milliwatts, and the ATW-T51B complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 8.6 Vdc
      Collector current: 0.7 mA

   f. Function of each active semiconductor device: See Appendix 3.
   g. Complete circuit diagram is included in Appendix 4.
   h. A draft instruction book is submitted as Appendix 5.
   i. The transmitter tune-up procedure is included in Appendix 6.
   j. A description of circuits for stabilizing frequency is included in Appendix 7.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
   l. Not applicable.

B. GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE (cont'd)

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 50 ohm coaxial port for service/alignment. Power at the coax port was measured as 10 dBm (10 milliwatts) using HP432A and HP478 power meter and sensor.

ERP was calculated (see Table 1) from measured field intensity as 8.3 mW.

C. MODULATION CHARACTERISTICS

NOTE: All audio measurements were made hard-wired.

1. A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was audio signal output from a Boonton 8220 modulation meter with 10 kHz deviation. Audio output was measured with a 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)

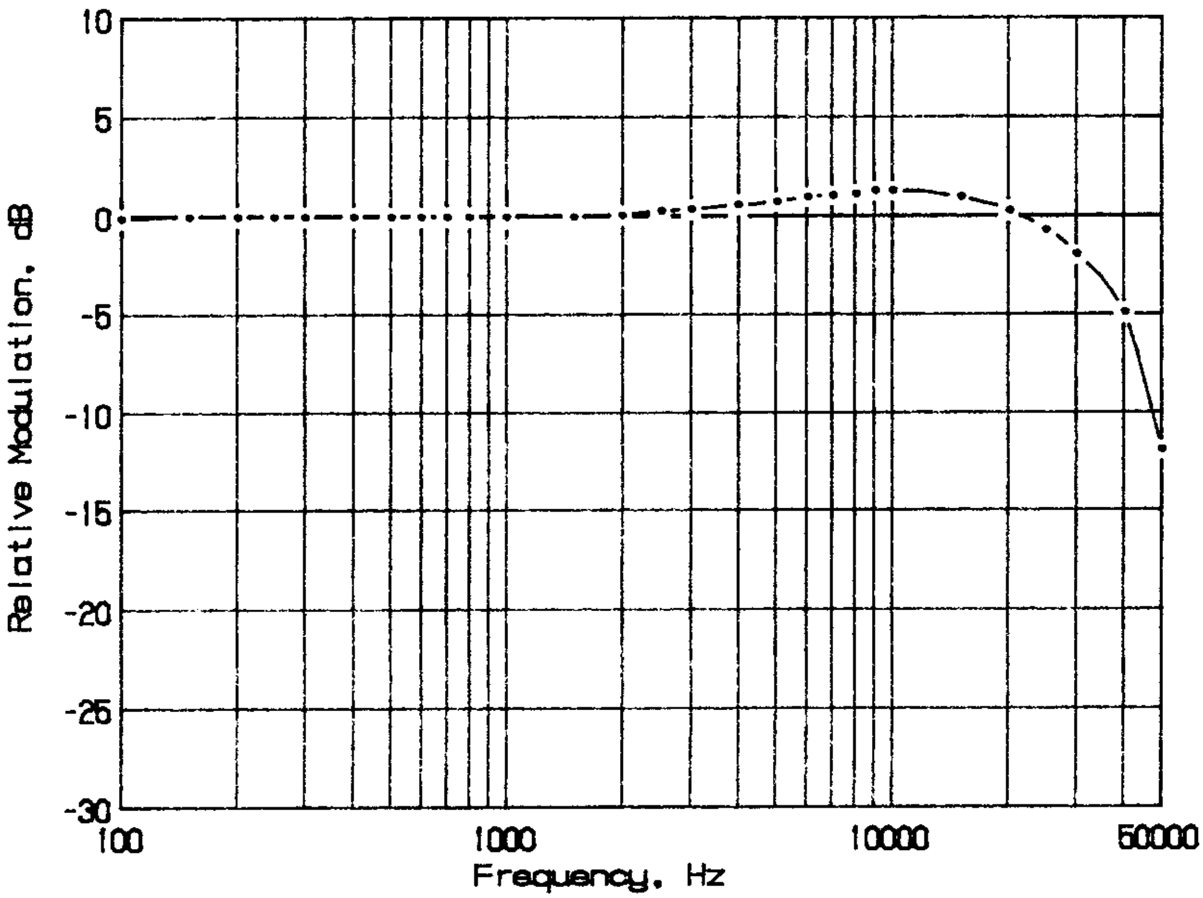
Figure 2 is a plot of the sideband envelope of the transmitter taken with a Tektronix 494P spectrum analyzer. Modulation consisted of a 9969 Hz tone, the frequency of maximum response, at an input level 16 dB greater than that necessary to produce 50% modulation.

Maximum measured modulation was 20 kHz.

NOTE: As a wireless microphone, audio bandwidth is 20 kHz, and maximum system deviation is 20 kHz. Using 2D+2F = modulation factor. Where "D" is rated system deviation, and "F" is maximum modulation frequency, an emission designator of 80K0F3E was computed.

FIGURE 1

MODULATION FREQUENCY RESPONSE



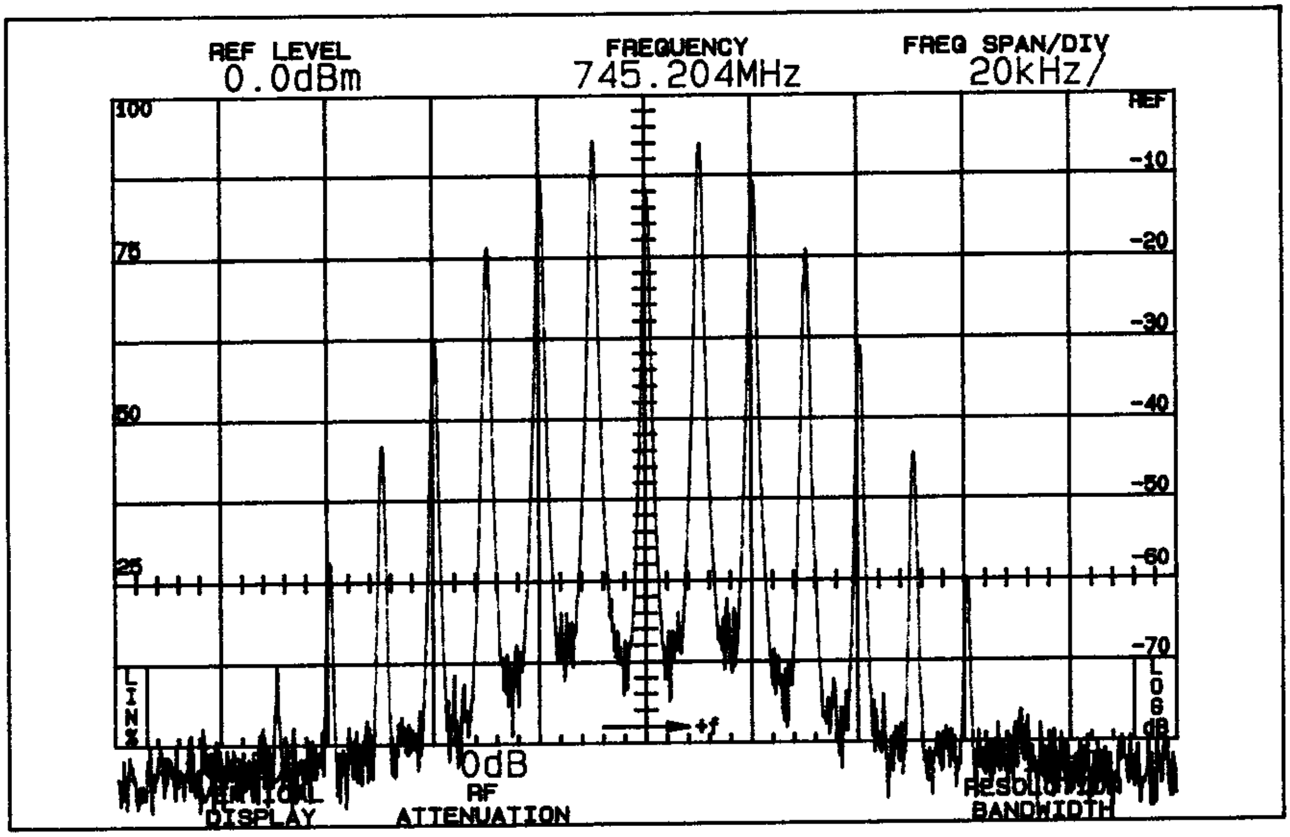
MODULATION FREQUENCY RESPONSE
FCC ID: JFZT51B

FIGURE 1

M:\ATKB&M.OBW

FIGURE 2

OCCUPIED BANDWIDTH



OCCUPIED BANDWIDTH
FCC ID: JFZT51B

FIGURE 2

C. MODULATION CHARACTERISTICS (Continued)

The plot is within the limits imposed by paragraph 74.861(6). The horizontal scale (frequency is 100 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 ATW-T51B transmitter is normally used with an integral antenna connections. Accordingly, only radiated emissions were measured.

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION (Paragraph 2.993(a) (b) (2) of the Rules)

Field intensity measurements of radiated spurious emissions from the ATW-T51B were made with a Tektronix 494P spectrum analyzer using Singer DM-105A dipoles or Polarad CA-L, CA-S and EMCO 3115 horn antennas. The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a fresh battery with a terminal voltage under load of 9.0 Vdc. The transmitter and test antennas were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed. (The radiation test range is currently listed as an accepted site.)

Since the transmitter is normally used with an integral antenna, reference level for spurious emissions was taken as maximum measured emission at the operational frequency.

The measurement system was capable of detecting signals 80 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit, (F_C/16) MHz, to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 1.

TABLE 1

TRANSMITTER RADIATED SPURIOUS
737.000 MHz; 9 Vdc; 8.3 mW

Emission Frequency MHz	Field Intensity uV/m@3m	dB Below Carrier Reference[1]
737.003 (Carrier)	212969	0
1474.006		27V
2211.008		35H
2948.011		53V
3685.013		39V
4422.016		48V
5159.018		50V
5896.021		56V
6633.023		60V
7370.028		54V

Required: 43+10Log(P) = 22

1. Worst-case polarization.

All other spurious from 46 MHz to the tenth harmonic were 20 dB or more below limit.

Power Computation:

$$E = \frac{(49.2P_t)^{1/2}}{3} \qquad (1)$$

$$P = \frac{(3E)^2}{49.2}$$

where P = Power in watts

E = electric-field intensity in volts/meter

$$0.0083 = (3*212969^{-6})^2/49.2$$

(1)

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

F. FREQUENCY STABILITY
(Paragraph 2.995(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 2, starting with -30°C.

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 9 volts. Frequency was measured with a HP5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made at 745.200 MHz.

TABLE 2

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE

745.200 MHz; 9 Vdc; 8.3 mW

Temperature, °C	Output Frequency, MHz	p.p.m.
-29.0	745.197218	-3.7
-19.7	745.203091	4.1
- 9.9	745.206453	8.7
- 0.4	745.207759	10.4
9.8	745.207165	9.6
20.5	745.205296	7.1
29.9	745.202671	3.6
40.4	745.200594	0.8
50.1	745.199091	-1.2

Maximum frequency error: 745.207759
745.200000

+ .007759 MHz

FCC Rule 74.861(e)(4) specifies .005% (50 p.p.m.) or a maximum of ±0.037260 MHz, corresponding to:

High Limit	745.237260 MHz
Low Limit	745.162740 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 a HP 5385A digital frequency counter as supply voltage provided by a HP 6264B variable dc power supply was varied ±15% from the nominal 9 volt 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

745.200 MHz; 9 Volt Nominal; 8.3 mW

Supply Voltage	Output Frequency, MHz
10.35	745.205348
9.90	745.205353
9.45	745.205334
9.00	745.205296
8.55	745.205290
8.10	745.205269
7.65	745.205226
7.20* rated battery end-point	745.205171
Maximum frequency error:	745.205334
	745.200000
	+ 0.005353

FCC Rule 74.861(e)(4) specified .005% (50 p.p.m.)or a maximum of ±0.037260 MHz, corresponding to:

High Limit	745.237260 MHz
Low Limit	745.162740 MHz

APPENDIX 6

TRANSMITTER ALIGNMENT

ONE (1) PAGE ALIGNMENT PROCEDURE FOLLOWS THIS SHEET

ATW-T51 Alignment Procedure

1. Audio/Oscillator/Modulator/Multiplier Stages.

VR3 serves as the deviation adjustment potentiometer. The system is a direct FM system and deviates on average +/- 10KHz with a 1KHz tone at 3.5 mV on the microphone input.

The oscillator is comprised of the crystal, X1, which operates at a fundamental frequency of Fc/16. Adjust L5 and T1 to put on the channel frequency.

The fundamental is passed through the first multiplier circuit which includes Q4. This circuit is tuned via T2. The signal is then fed to the circuit associated with Q5.

2. RF Amplifier/band pass Filter.

Connecting test point CN1 to a spectrum analyzer set to Fc, adjust VC1, L10, L11 & L12 for a carrier power not to exceed 50mW. Using the wide span setting of the spectrum analyzer, check that all spurious emissions and harmonics from 0-4GHz are at least -40dBc. If they are not, adjust FIL 1.

APPENDIX 7

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Operating frequency is determined and stabilized by a crystal-controlled oscillator operating at $F_C/16$.

APPENDIX 8

CIRCUITS TO SUPPRESS SPURIOUS RADIATION, ETC.

Circuits to Suppress Spurious Radiation

The last 3 transistors, all 2SC3606 types, comprise the amplifier chain culminating with a nominal transmitter output of 10 mW. BPF is a band pass filter which suppresses the output harmonics and matches the output to the antenna.

Circuits to Control Modulation

The audio signal is injected via the HRS connector into the circuit composed of a op amp and compandor, (IC1 & IC2). The signal is compressed via the compandor circuit at a 2:1 ratio and is pre-emphasized at 50 us. The level of the output signal is controlled by the pot, VR3.

Circuit Performing Frequency Modulation

The modulator circuit is a direct FM type built around the varactor diode, D3. the swing from the diode is presented to the crystal, XTAL 1 and is multiplied 16X to the carrier frequency through multiplier stages Q3 and Q4.

APPENDIX 3

ACTIVE SEMICONDUCTOR FUNCTIONS

Reference	Type	Function
Q7	2SC3606	Final RF Amplifier
Q6	2SC3606 (Type H)	Driver
Q5	2SC3606 (Type H)	Quadrupler
Q4	2SC3606 (Type H)	Quadrupler
Q3	2SC2714	XTAL Oscillator
IC1		Audio Amplifier/Processor
IC2		Compandor/Pre-emphasis