

ENGINEERING STATEMENT

For Type Certification of
Maxon Electronics Co., Ltd

Model No: TC0002
FCC ID: AWWTC0002

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 Maxon Electronics Co., Ltd to make type certification measurements on the Model TC0002 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.

Rowland S. Johnson

Dated: August 30, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the Model TC0002 transceiver in

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

The Model TC0002 is a portable, battery operated, UHF, frequency modulated transceiver intended for 12.5 kHz channel family radio service applications in the 462.5625-467.7125 MHz band. It operates from a nominal 4.5 Vdc battery supply. MFR rated output power is 0.2 watts ERP.

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

1. Name of applicant: Maxon Electronics Co., Ltd
2. Identification of equipment: FCC ID: AWWTC0002
 - 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. 11k0F3E emission
 - b. Frequency range: 462.5625 - 467.7125 MHz.
 - c. Operating power of transmitter is fixed at the factory at less than 0.2 W ERP.
 - d. Maximum power permitted is 0.5 watts, and the TC0002 fully complied with that power limitation.
 - e. The dc voltage and dc currents at final amplifier:

Collector voltage: 4.3 Vdc
Collector current: 0.39 A
 - f. Function of each active semiconductor device:
See Appendix 1.
 - g. Complete schematic diagram is submitted as a separate exhibit.
 - h. A draft instruction manual is submitted as a separate exhibit.
 - i. The transmitter tune-up procedure is submitted as a separate exhibit.

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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)

The Model TC0002 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power output was calculated, see Table 1.
The transmitter was tuned by the factory.

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.192

D. MODULATION CHARACTERISTICS

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 one kHz deviation. Audio output was measured with an Audio Precision System One integrated test system.
2. Modulation limiting curves are shown in Figure 2, using a Boonton 8220 modulation meter. Signal level was established with a Audio Precision System One integrated test system. The curves show compliance with paragraphs 2.987(b).
3. Figure 3 is a graph of the post-limiter low pass filter which provides a roll-off of $60\log f/3$ dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One integrated test system on the Boonton 8220 modulation meter audio output.

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4. Occupied Bandwidth
(Paragraphs 2.989(c) of the Rules)

Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2029 Hz, the frequency of maximum response. Measured modulation under these conditions was 2.1 kHz. Maximum deviation was 2.5 kHz @ 1500 Hz.

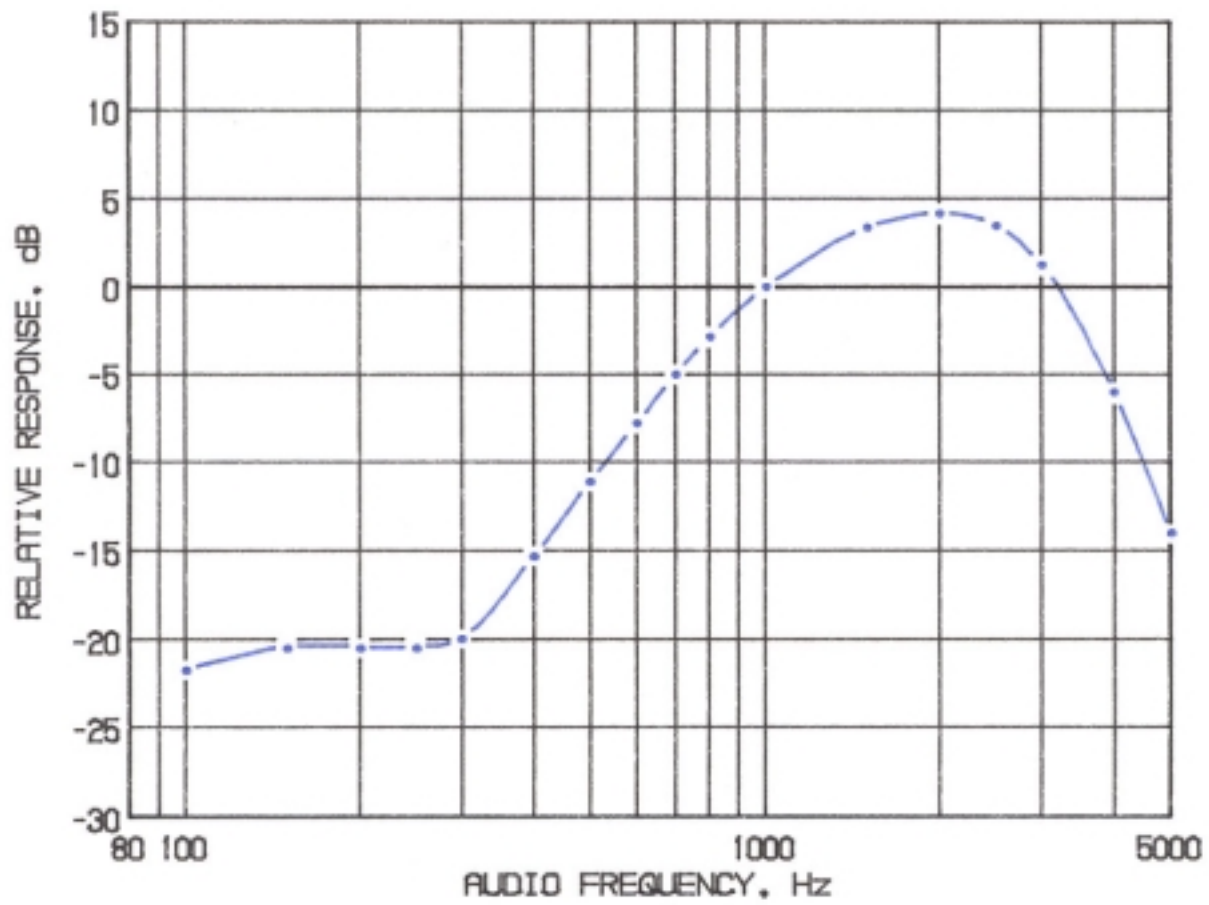
Emission designator:

$$(2M + 2D) (2 \times 3 \text{ kHz}) + (2 \times 2.5 \text{ kHz}) = 11k0F3E$$

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FIGURE 1

MODULATION FREQUENCY RESPONSE



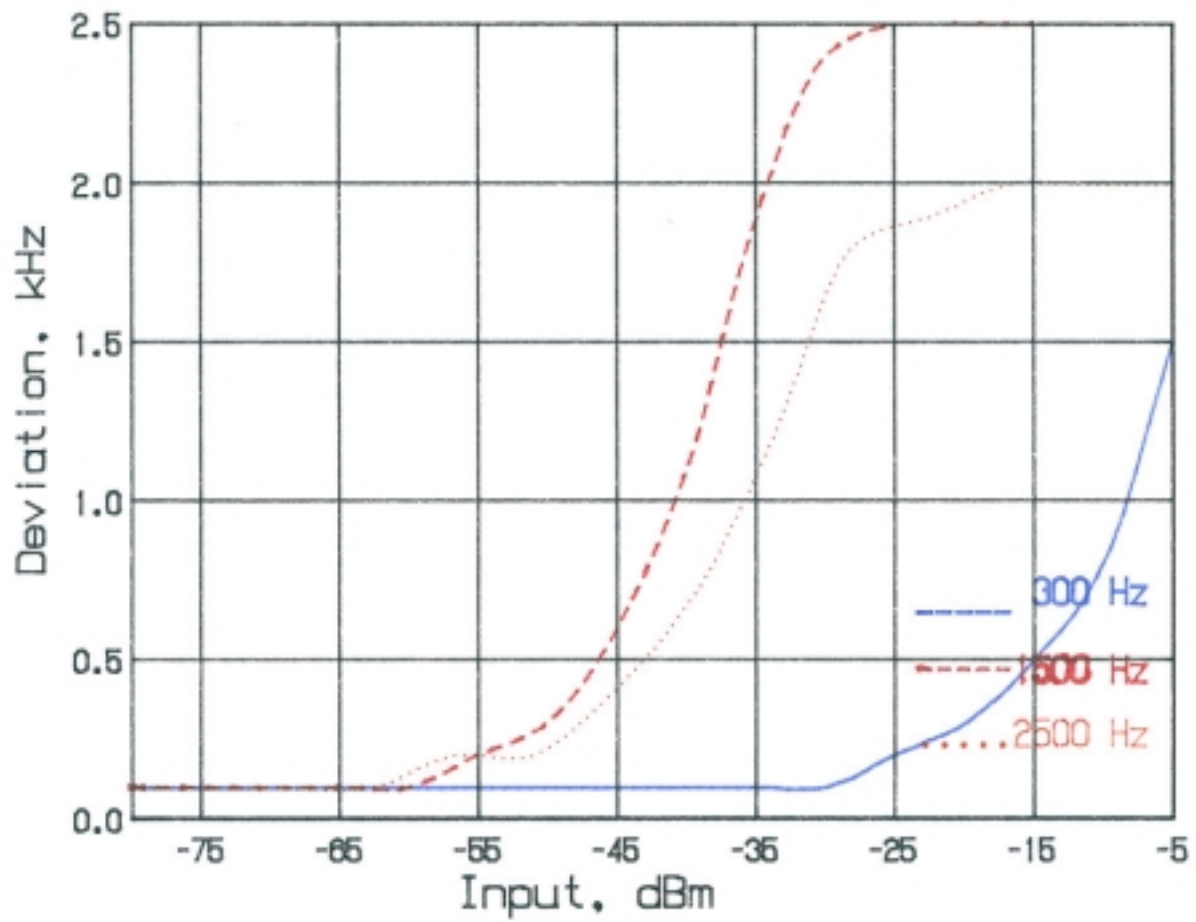
MODULATION FREQUENCY RESPONSE
FCC ID: AWWTC0002

FIGURE 1

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FIGURE 2

AUDIO LIMITER CHARACTERISTICS



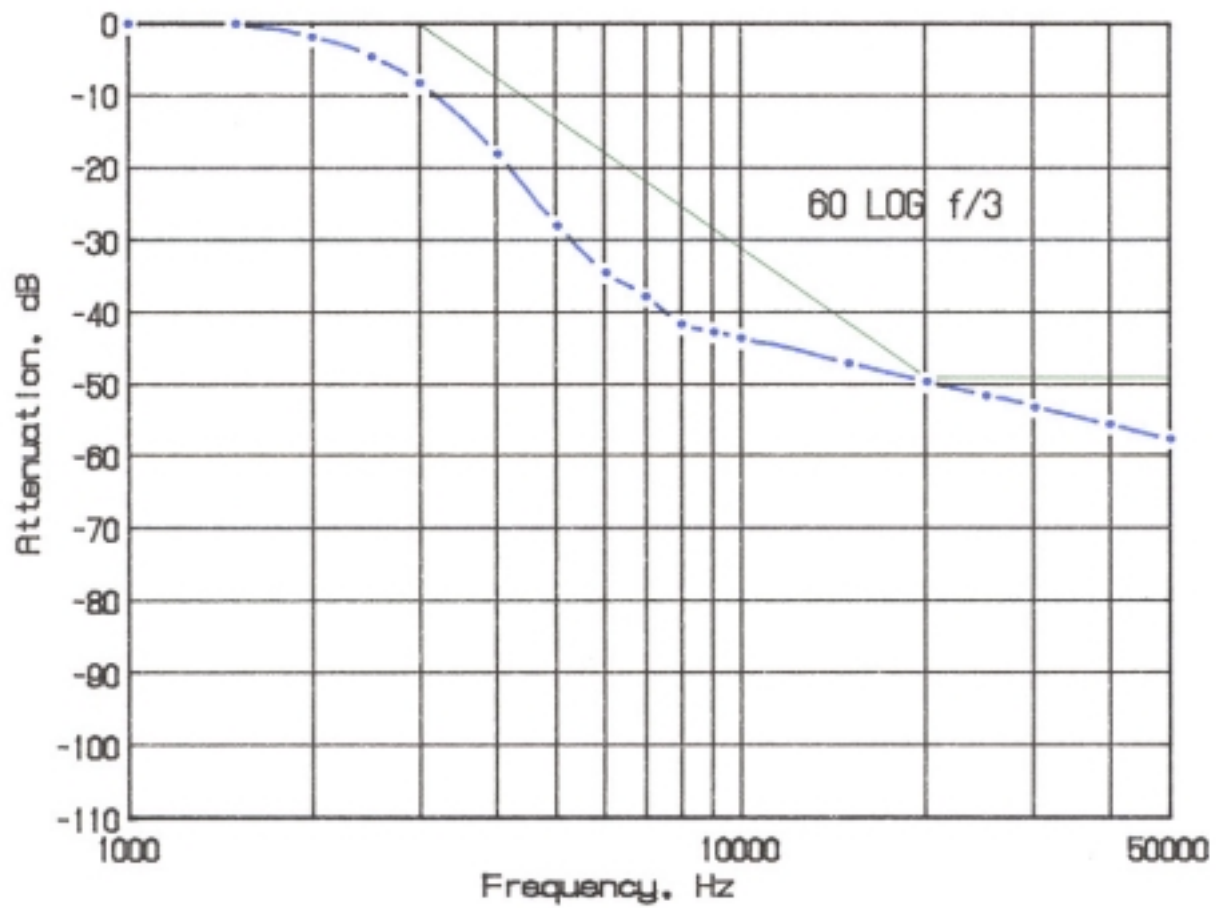
Note, deviation did not exceed 2.5 kHz @1500 Hz.

AUDIO LIMITER CHARACTERISTICS
FCC ID: AWWTC0002

FIGURE 2
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FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



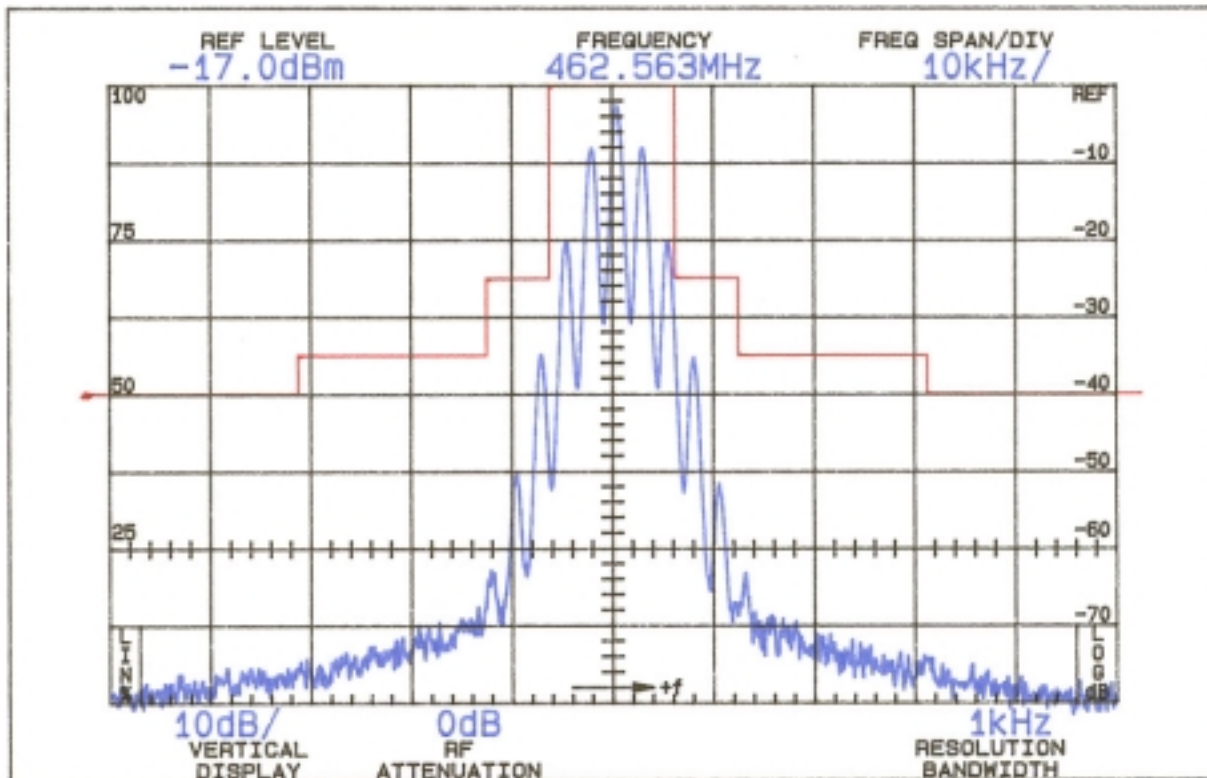
AUDIO LOW PASS FILTER
RESPONSE
FCC ID: AWWTC0002

FIGURE 3

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FIGURE 4

OCCUPIED BANDWIDTH



ATTENUATION IN dB BELOW
MEAN OUTPUT POWER
Required

On any frequency more than 50%
up to and including 100% of the
authorized bandwidth, 12.5 kHz
(6.25-12.5 kHz)

25

On any frequency more than 100%,
up to and including 250% of the
authorized bandwidth (12.5-31.25
kHz)

35

On any frequency removed from
the assigned frequency by more
than 250% of the authorized
bandwidth (over 31.25 kHz)

$$43 + 10 \log P = 36$$

$$(P = 0.192)$$

OCCUPIED BANDWIDTH
FCC ID: AWWTC0002

FIGURE 4

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D. MODULATION CHARACTERISTICS (Continued)

The plots are within FCC limits. The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

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

The Model TC0002 has a permanently attached antenna. There is no connector for an external antenna. Therefore, no antenna terminal conducted measurements were made.

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 was accepted for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an accepted site.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the Model TC0002 were made with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMCO 3115 horn to 4.8 GHz.

The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 4.5 Vdc.

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 100 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

462.5625 MHz, 4.5 Vdc, 0.192 watts

Spurious Frequency	Radiated Field	dB Below Carrier
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<u>MHz</u>	<u>uV/m @ 3M</u>	<u>Reference</u> ¹
462.563	1035142	0
925.125	2130	54V
1387.688	5864	45V
1850.250	142	77V
2312.813	139	77H
2775.375	200	74V
3237.938	161	76V
3700.500	261	72H
4163.063	322	70H
4625.625	324	70H

Required: $43 + 10 \log(P) = 36$

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

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

All other spurious from lowest frequency generated in unit to the tenth harmonic were 20 dB or more below FCC limit.

Power:

$$\begin{aligned}
 P &= (F.I.x3)^2 / 49.2 \\
 &= (1.035142)^2 / 49.2 \\
 &= 0.192 \text{ W}
 \end{aligned}$$

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H. FREQUENCY STABILITY (Paragraph 2.995(a)(2))

Measurement of frequency stability versus temperature was made at temperatures from -20°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 -20°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 4.5 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 462.5625 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
462.5625 MHz, 4.5 Vdc, 0.192 W

<u>Temperature, °C</u>	<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
-20.1	462.561866	-1.4
- 9.7	462.562583	0.2
- 0.8	462.562525	0.1
10.2	462.562886	0.8
20.8	462.562810	0.7
30.2	462.562623	0.3
40.1	462.562603	0.2
50.1	462.563047	1.2
Maximum frequency error:	462.561866 <u>462.562500</u>	
	- .000634 MHz	

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of ± 0.001156 MHz, which corresponds to:

High Limit	462.563656 MHz
Low Limit	462.561344 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 $\pm 15\%$ above the nominal 4.5 volt rating to below the battery end point. 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

462.5625 MHz, 4.5 Vdc Nominal; 0.192 W

<u>Supply_Voltage</u>		<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
5.17	115%	462.562858	0.8
4.95	110%	462.562847	0.8
4.73	105%	462.562818	0.7
4.5	100%	462.562810	0.7
4.28	95%	462.562800	0.6
4.05	90%	462.562795	0.6
3.83	85%	462.562770	0.6
3.6	80%	462.562785	-0.3
Maximum frequency error:		462.562858	
		<u>462.562500</u>	
		+ .000358 MHz	

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m. or a maximum of ± 0.001156 MHz, corresponding to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

*Battery end point.

1) TRANSISTER

REF NO	TYPE	MANUFATURER	FUNCTION
Q1	2SC5084	TOSHIBA	RX RF AMP.
Q2	2SC5084	TOSHIBA	1'ST MIXER
Q7	KTC3880S	K. E. C	1'ST IF AMP.
Q27	KTA1504ST1(G)	K. E. C	AUDIO PATH
Q24	KTA1504ST1(G)	K. E. C	PTT DETECTOR
Q21	KRC104S	K. E. C	RX B+ SWITCHING
Q20	KRC104S	K. E. C	TX B+ SWITCHING 1
Q22	KRC104S	K. E. C	TX B+ SWITCHING 2
Q26	KRC104S	K. E. C	AUDIO B+ SW1
Q25	KTA1504ST1(G)	K. E. C	AUDIO B+ SW2
Q23	KRA104S	K. E. C	ROGER BEEP SWITCHING
Q32	KRC112S	K. E. C	BACK LIGHT SWITCHING
Q11	BFG135A	SIEMENS	TX POWER FINAL AMP.
Q12	MMBR951	MOTOLOLA	TX POWER DRIVER AMP.
Q36	2SC5084	TOSHIBA	TX POWER PRE DRIVER AMP.
Q13	2SC5084	TOSHIBA	BUFFER
Q15	2SC5084	TOSHIBA	O. S. C
Q17	KRC104S	K. E. C	V. C. O RX SWITCHING
Q16	KTC3875S	K. E. C	V. C. O NOISE FILTER
Q18	KRA105S	K. E. C	RX POWER SAVING SWITCHING
Q19	KRA105S	K. E. C	RX B+ SWITCHING

2) INTERGRATED CIRCUIT

REF NO	TYPE	MANUFATURER	FUNCTION
IC1	MC3361CD	MOTOLOLA	2'ND MIXER, IF, AND FM DETECTOR
IC4	NJM2070M	JRC	AUDIO POWER AMP.
IC6	K1A324F	K. E. C	PRE-EMPHASIS AND 300Hz HFP, REGULATOR
IC9	TK11130	TOKO	CTCSS TONE GENERATOR & FILTER
IC3	CMX808A	CML	RX AUDIO BPF FILTER
IC3	CMX808A	CML	EEPROM
IC8	KS24C010	SAMSUNG	CPU
IC10	KS88C2426	SAMSUNG	PLL FREQUENCY SYNTHESIZER
IC2	TB31202FN	TOSHIBA	

FUNCTION OF DEVICES
FCC ID: AWWTC0002

APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

SYNTHESIZER

A phase locked loop (PLL) circuit establishes and stabilizes operating frequency.

The data for producing necessary frequencies is established by the CPU on the digital board.

The frequency stability of the TX/RX is maintained by the TCXO, which generates a stable frequency of 12.8 MHz.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

The transmitted signal of approximately 16 dBm, combined at the PLL circuit, is supplied to the base of amplifier Q11. The transmitted signal amplified to 28 dBm passes the TX LPF of the 2nd order characteristic of the L19, L18, C53, C52 and RX/TX switching takes place by the D5. After this, the signal is provided to the antenna.

Circuitry to Limit Modulation and Audio Low Pass Filter

Voice signal input from the microphone is pre-emphasized at IC6D, and at the same time, the components below 300 Hz are reduced to minimize the influence to the CTCSS tone. The signal out of IC6D, go to 15 pin of the Ic3, and comes out 16 pin of the IC3. The signal limited to a certain amplitude at the IC6C for the voice

signal not to exceed the allowable band width assigned for transmission.

3 KHz LPF (IC6B)

VOL1A adjusts the assigned frequency bandwidth not to exceed the allowable range. The signal passes the VOL1A and is supplied to the 3KHz LPF has the 3rd characteristic (=IC6B). After passing the IC6B, the signal is combined with the CTCSS tone at the digital circuits.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION
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APPENDIX 3