ENGINEERING STATEMENT

For Certification of

MIDLAND CONSUMER RADIO

Model No. G-15
FCC ID: MMAG15

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 Midland Consumer Radio to make certification measurements on the G-15 transceiver. These tests were made by me or under my supervision in our Springfield laboratory.

Test data and documentation required by the FCC for certification are included in this report. The data verifies that the above mentioned transceiver meets FCC requirements and certification is requested.

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Rowland S. Johnson

Dated: February 9, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type acceptance of the G-15 transceiver in accordance with Part 2,

Subpart J of the FCC Rules.

The G-15 is a hand-held, battery operated, UHF, frequency modulated, 1 W (conducted rating) transceiver intended for voice communications applications in the 462.5500 - 462.7250 MHz band under Part 95 in the GMRS service. (ERP (d) was 0.7 W.)

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

1. Name of applicant: Midland Consumer Radio

2. Identification of equipment: FCC ID: MMAG15

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

3. Quantity production is planned.

4. Technical description:

   a. 16k0F3E emission
   b. Frequency range: 462.5500-462.7250 MHz.
   c. Operating power of transmitter is fixed at the factory at 1 watts (conducted).
   d. Maximum power permitted under FCC Part 95 (interstitial) is 5 watts ERP. The G-15 fully complied with that power limitation.
   d. The dc voltage and dc currents at final amplifier:

      Collector voltage: 4.3 Vdc
      Collector current: 0.96 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.

   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 2.
   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 a Bird 4421 RF power meter and a Narda 765-20 attenuator as a 50 ohm dummy load. Maximum power was 1.12 watts with 4.5 V at the battery terminals. ERP (d), determined by substitution, was 0.7 W.

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 TRMS voltmeter and tracking generator.

2. Modulation limiting curves are shown in Figure 2, using a Boonton 8220 modulation meter. Signal level was established with an Audio Precision System One. The curves show compliance with paragraphs 2.987(b) and 95.633(b).

3. Figure 3 is a graph of the post-limiter low pass filter which meets the requirements of paragraph 95.633(b) in providing a roll-off of 60Logf/3 dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One on the Boonton 8220 modulation meter audio output.

4. <u>Occupied Bandwidth</u> (Paragraphs 2.989(c), 90.209(b)(4), and 95.629(a) 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 a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2996 Hz, the frequency of maximum response.

C. MODULATION CHARACTERISTICS (continued)

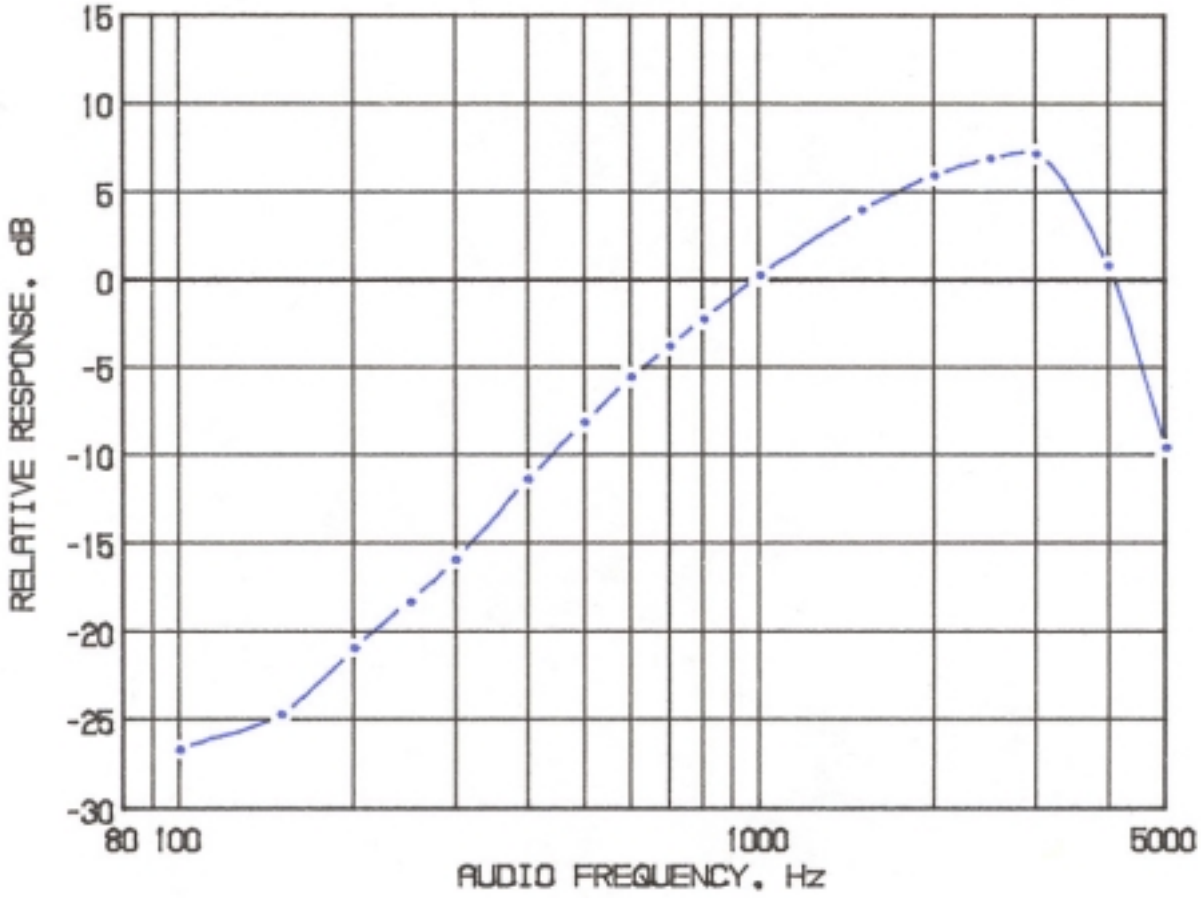
The plot is within the limits imposed by Paragraph 90.211(h) for frequency modulation. The horizontal scale (frequency) is 10 kHz per division and the vertical scale (amplitude) is a logarithmic presentation equal to 10 dB per division.

5. Emission Designator Calculation:

(2D + 2F) 2x5.0 + 2x3.0 = 16k0F3E

FIGURE 1

MODULATION FREQUENCY RESPONSE

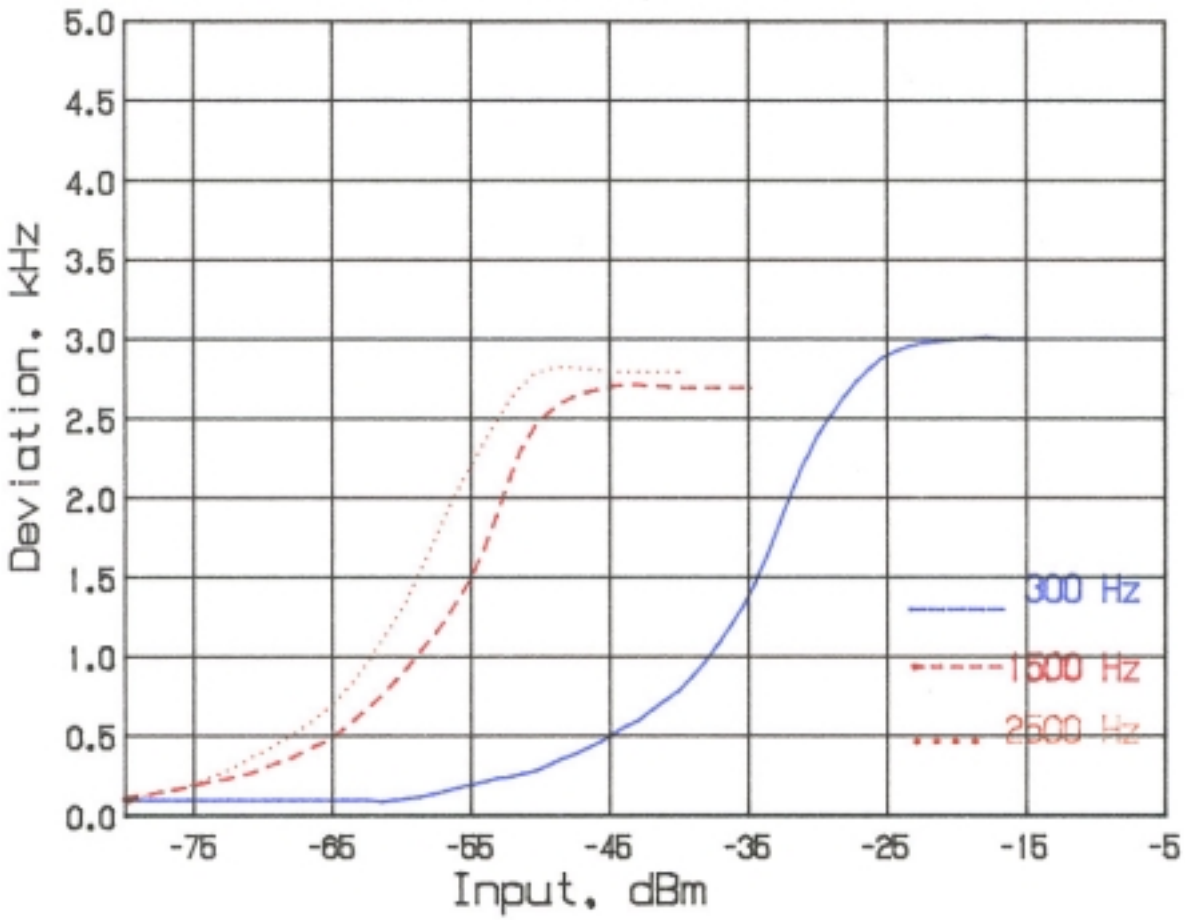


MODULATION FREQUENCY RESPONSE
FCC ID: MMAG15

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

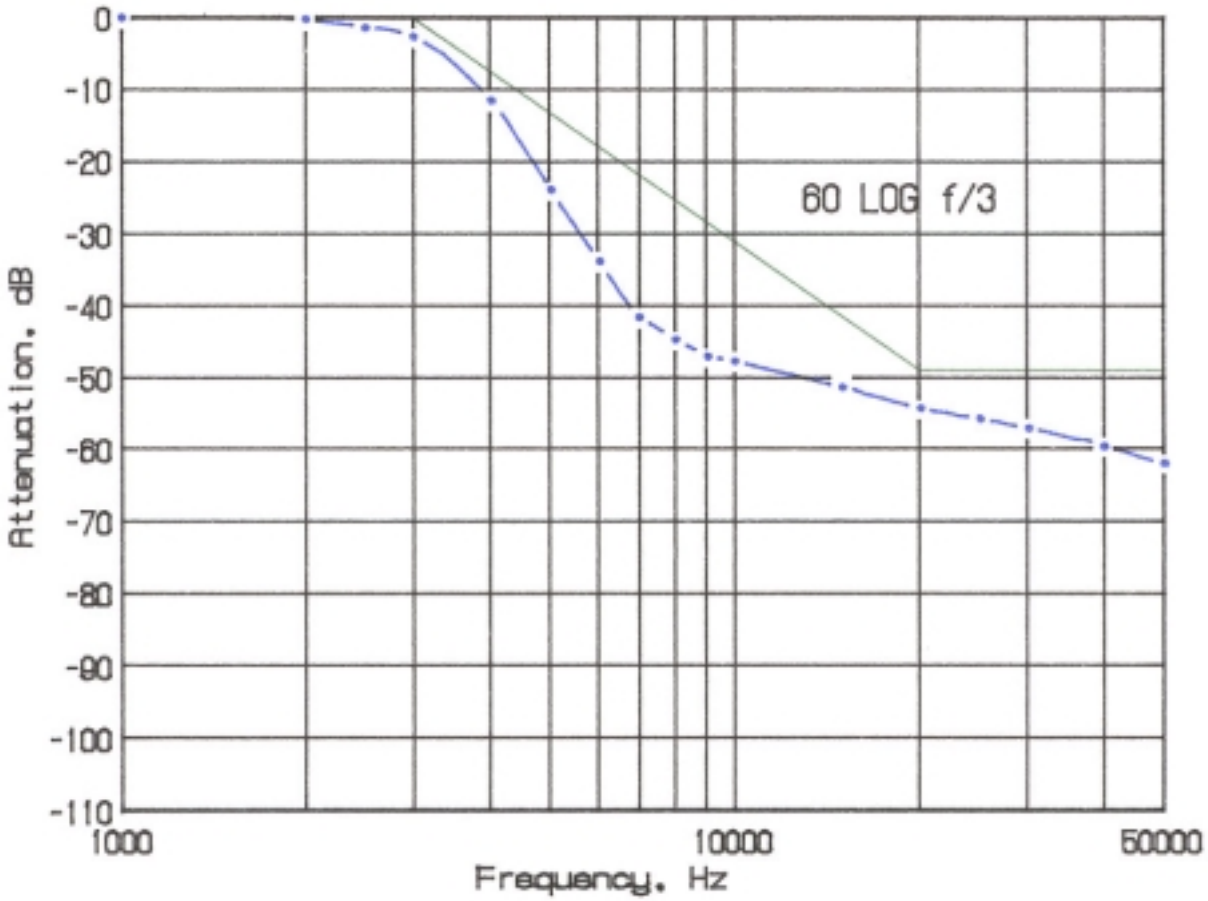


AUDIO LIMITER CHARACTERISTICS
FCC ID: MMAG15

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

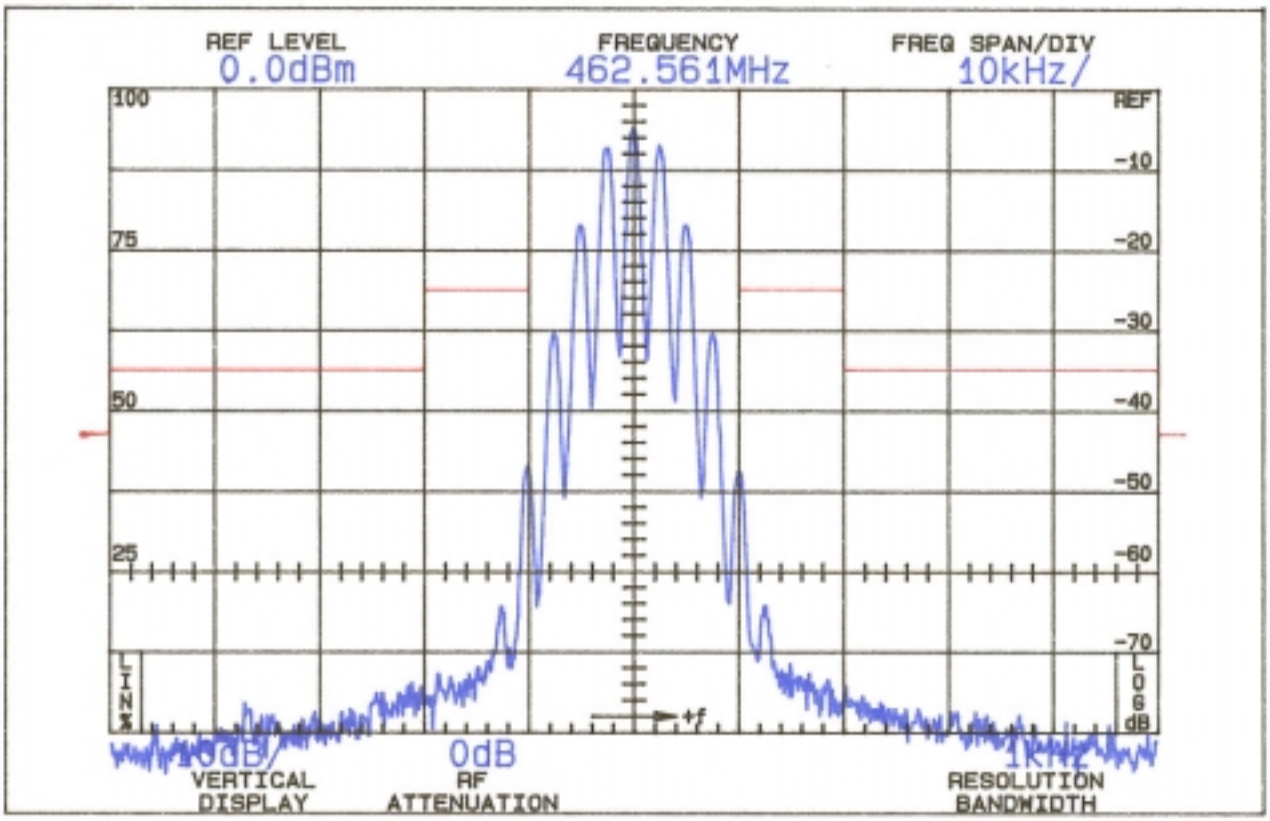


AUDIO LOW PASS FILTER RESPONSE
FCC ID: MMAG15

FIGURE 3

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 25
authorized bandwidth, 20 kHz
(10-20 kHz)

On any frequency more than 100%,
up to and including 250% of the 35
authorized bandwidth (20-50 kHz)

On any frequency removed from
the assigned frequency by more 43+10LogP = 43
than 250% of the authorized (P = 1.1W Conducted)
bandwidth (over 50 kHz)

OCCUPIED BANDWIDTH
FCC ID: MMAG15

FIGURE 4

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

The G-15 transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a 2500 Hz

signal, 16 dB above minimum input signal for 50% (2.5 kHz deviation) modulation at 2996 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through Narda 765-20 microwave power attenuator.

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 4.5 volts throughout the tests.

Spurious emissions were measured throughout the RF spectrum from 21.25 MHz (lowest frequency generated in the transmitter) to 4.7 GHz. Any emissions that were between the required attenuation and the noise floor of the spectrum analyzer were recorded. Data are shown in Table 1.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS
462.5625 MHz, 4.5 Vdc, 1.1 W (Conducted)

Spurious Frequency MHz	dB Below Carrier Reference
925.122	84
1387.683	>100
1850.244	96
2312.805	66
2775.366	>100
3237.927	>100
3700.488	>100
4163.049	>100
4625.610	>100
Required: 43+10Log(P)	43

All other emissions from 21.25 MHz to 5 GHz were 20 dB or more below FCC limit.

F. DESCRIPTION OF MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility was approved for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an acceptable site.

G. MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the G-15 were by substitution made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennae for the measurements to l GHz, and EMCO 3115 horn from 1 GHz to 5 GHz.

The transmitter with the normally supplied antenna 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. Output power was 1.1 watts (conducted) at the 462.5625 MHz operating frequency. The transmitter and test antenna were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS
462.5625 MHz, 4.5 Vdc, 0.7 W ERP(d)

Frequency MHz	dB Below Carrier Reference[1]
462.563	0
925.125	46V
1387.685	55V
1850.243	58H

3237.925	54H
4163.048	55V

Required: 43+10Log(0.7) = 42

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

All other spurious from 21.25 MHz to 5 GHz were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2) and 95.621(b) 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 temperature probe. The transmitter output stage was terminated in a dummy load. Primary supply was 4.5 volts. Frequency was measured with a HP 5385A

digital 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

462.5625 MHz, 4.5 V Nominal, 1.1 watts (Conducted)

Temperature, °C	Output_Frequency,_MHz	p.p.m.
-29.0	462.562309	-0.4
-19.4	462.562964	1.0
- 9.8	462.563602	2.4
0.2	462.563556	2.3
10.2	462.563219	1.6
20.3	462.562503	0.0
30.4	462.562317	-0.4
40.1	462.562305	-0.4
49.7	462.562807	0.7
Maximum frequency error:	462.563602	
	462.562500	
	+ .001102 MHz	

FCC Rule 95.621(b) specifies .0005% or a maximum of ± .002313 MHz, which corresponds to:

High Limit	462.564813 MHz
Low Limit	462.560187 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 digital frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 4.5 volt rating to below the battery end point. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20 o^C ambient.

TABLE 4

462.5625 MHz, 20°C, 4.5 V Nominal, 1.1 watts (Conducted)

%	Supply_Voltage	Output_Frequency,_MHz	p.p.m.
115	5.17	462.562213	-0.6
110	4.95	462.562334	-0.4
105	4.73	462.562446	-0.1
100	4.50	462.562503	0.0
95	4.28	462.562353	-0.3
90	4.05	462.562282	-0.5
85	3.83	462.562303	-0.4
80	3.60*	no 562438	-0.1

Maximum frequency error: 462.562213
462.562500

*Low battery limit - .000287 MHz

FCC Rule 95.621(b) specifies .0005% or a maximum of ±.002313 MHz, corresponding to:

High Limit 462.564813 MHz
Low Limit 462.560187 MHz

APPENDIX 1

ΣΕΜΙΧΟΝΔΥΧΤΟΡΣ ΑΝΔ ΦΥΝΧΤΙΟΝΣ

ΤΡΑΝΣΙΣΤΟΡ

ΘΡ1	2ΣΧ4226	Ν.Ε.Χ	ΡΞ ΡΦ ΑΜΠ.
ΘΡ2	2ΣΧ4226	Ν.Ε.Χ	1ΘΣΤ ΜΙΞΕΡ.
ΘΡ3	ΚΤΧ3880Σ	Κ.Ε.Χ	1ΘΣΤ ΙΦ ΑΜΠ.
ΘΡ4	ΚΤΑ1504Σ	Κ.Ε.Χ	ΣΘΥΕΛΧΗ ΜΥΤΕ.
ΘΤ1	2ΣΧ4226	Ν.Ε.Χ	ΤΞ ΒΥΦΦΕΡ.

ΘΤ2	2ΣΧ4226	Ν.Ε.Χ	ΤΞ ΠΟΩΕΡ ΔΡΙςΕ ΑΜΠ.
ΘΤ3	ΜΡΦ9482	ΜΟΤΟΛΟΡΑ	ΤΞ ΠΟΩΕΡ ΦΙΝΑΛ ΑΜΠ.
ΘΤ5	ΚΡΧ104Σ	Κ.Ε.Χ	ΡΞ Β+ ΣΩΙΤΧΗΙΝΓ ΑΤ ΤΞ.
ΘΤ7	ΚΡΧ110Σ	Κ.Ε.Χ	ΤΡΕΝΓΙΕΝΤ ΤΙΜΕ ΧΟΝΤΡΟΛ.
ΘΤ8	ΚΡΧ104Σ	Κ.Ε.Χ	ΤΡΕΝΓΙΕΝΤ ΤΙΜΕ ΧΟΝΤΡΟΛ
ΘΣ2	ΚΡΑ105Σ	Κ.Ε.Χ	ΠΟΩΕΡ ΣΑςΕ ΧΟΝΤΡΟΛ.
ΘΣ3	ΚΡΧ104Σ	Κ.Ε.Χ	ΤΞ Β+ ΣΩΙΤΧΗΙΝΓ.
ΘΣ4	ΚΡΑ105Σ	Κ.Ε.Χ	ΤΞ Β+ ΣΩΙΤΧΗΙΝΓ.
ΘΣ5	ΚΡΑ105Σ	Κ.Ε.Χ	ςΟΞ Β+ Σ/Ω.
ΘΣ6	ΚΡΑ101Σ	Κ.Ε.Χ	ΤΞ Β+ Σ/Ω.
ΘΣ7	ΚΡΧ110Σ	Κ.Ε.Χ	ΔΧΣ Σ/Ω.
ΘΣ8	ΚΤΧ3875Σ	Κ.Ε.Χ	ΤΟΝΕ ΔΕΤ.
Θ1	2ΣΧ4226	Ν.Ε.Χ	ΡΞ ΒΥΦΦΕΡ.
Θ31	ΚΡΧ104Σ	Κ.Ε.Χ	ΡΞ/ΤΞ ςΧΟ ΣΩΙΤΧΗΙΝΓ.
Θ32	2ΣΧ4226	Ν.Ε.Χ	Ο.Σ.Χ
Θ33	2ΣΧ4226	Ν.Ε.Χ	ΒΥΦΦΕΡ.
ΘΒ1	ΚΡΑ110Σ	Κ.Ε.Χ	ΒΑΧΚ ΛΙΓΗΤ ΛΕΔ ΣΩΙΤΧΗΙΝΓ.
ΘΧ1	ΚΡΧ104Σ	Κ.Ε.Χ	ΧΑΛΛ ΔΕΤ.

ΙΝΤΕΓΡΑΤΕΔ ΧΙΡΧΥΙΤ

ΙΧ1	ΔΒΛ5018ς	ΔΑΕΩΟΟ	2ɘΝΔ ΜΙΞΕΡ ΙΦ ΑΝΔ ΦΜ ΔΕΤΕΧΤ
ΙΧ2	ΛΜ324	ΝΑΤΙΟΝΑΛ	ΔΕ–ΕΜΠΑΣΙΣ ΤΟΝΕ ΦΙΛΤΕΡ
ΙΧ3	Νϑ Μ2070	ϑ.Ρ.Χ	ΑΥΔΙΟ ΠΟΩΕΡ Α
ΙΧ4	ΤΚ71330	ΤΟΚΟ	ΡΕΓΥΛΑΤΟΡ
ΙΧ5	ΛΜ358	ΝΑΤΙΟΝΑΛ	ΧΑΛΛ ΔΕΤ
ΙΧ7	ΤΜΠ87Χ21ΔΦ	ΤΟΣΙΒΑ	ΧΠΥ

IX8	ΜΣΕΛΠ	ΜΣΙ	TONE ΦΙΛΤΕΡ
IX9	24ΩX02ϑ	XTI	ΕΕΠΡΟΜ
IX10	MX14053BΔ	ΜΟΤΟΡΟΛΑ	ΑΝΑΛΟΓ Σ/Ω
IX11	ΛM324	NATIONAΛ	ΠΡΕ–ΕΜΠΑΣΙΣ ΛΙΜΙΤΤΕΡ ΑΝΔ ΜΙΧ ΑΜΠ
IC12	KB8825	SAMSUNG	PLL FREQUENCY SYN

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY, SUPPRESS SPURIOUS EMISSIONS AND LIMIT MODULATION

AUDIO

The voice signal input from the microphone is pre-emphasized at the IC11. The signal, which comes out of the IC11, is limited to a

certain amplitude for the voice signal not to exceed the allowable bandwidth assigned for transmission.

POWER

The transmitted signal of approximately 7 mW, combined at the PLL module is supplied to the base of the QT3 amplifier the transmitted signal amplified to 1 watt passes to the TX LPF of the 2nd characteristic of the LT4 and the LT5, and RX/TX switching takes place by the DT2. After this, the signal is provided to the antenna the TX LPF of the 1st characteristics, consisted of the LT7.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY, etc.
FCC ID: MMAG15

APPENDIX 2