ENGINEERING STATEMENT

For Type Certification of

MIDLAND USA

Model No: 70-0671C
FCC ID: NCP700671C

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 USA to make type certification measurements on the 70-0671C 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: October 20, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for Type Certification of the 70-0671C transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The 70-0671C is VHF, frequency modulated transceiver intended for 25 kHz channel land mobile applications in the 42 - 50 MHz band. It operates from a 13.8 vehicle supply. Output power rating is 110 watts.

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

1. Name of applicant: Midland USA

2. Identification of equipment: NCP700671C

   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. 16k0F3E emission
   b. Frequency range: 42 - 50 MHz.
   c. Operating power of transmitter is fixed at the factory at 110 watts.
   d. Maximum power permitted under Part 90 of the FCC is 350 watts, and the 70-0671C fully complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 13.5 Vdc
      Collector current: 17.3 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.

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)

RF power output was measured with a Bird 4421 RF power meter and a Bird 8325-power attenuator as a 50 ohm dummy load. Maximum power measured was 110 watts.

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 a Audio Precision System One TRMS voltmeter and tracking generator.

2. Modulation limiting curves are shown in Figures 2a and 2b for wide or narrow channel operation respectively, using a Boonton 8220 modulation meter. Signal level was established with a Audio Precision System One TRMS voltmeter. The curves show compliance with paragraphs 2.987(b), and 90.211(c).

3. Figure 3 is a graph of the post-limiter low pass filter which meets the requirements of paragraph 90.211(d)(1) 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 selective voltmeter on the Boonton 8220 modulation meter audio output.

4. Occupied Bandwidth
(Paragraphs 2.989(c), 90.209(b)(4) and 90.210(d) of the Rules)

Figures 4 is a plot of the sideband envelope of the transmitter taken with a Advantest R3361A spectrum analyzer. Modulation corresponded to conditions

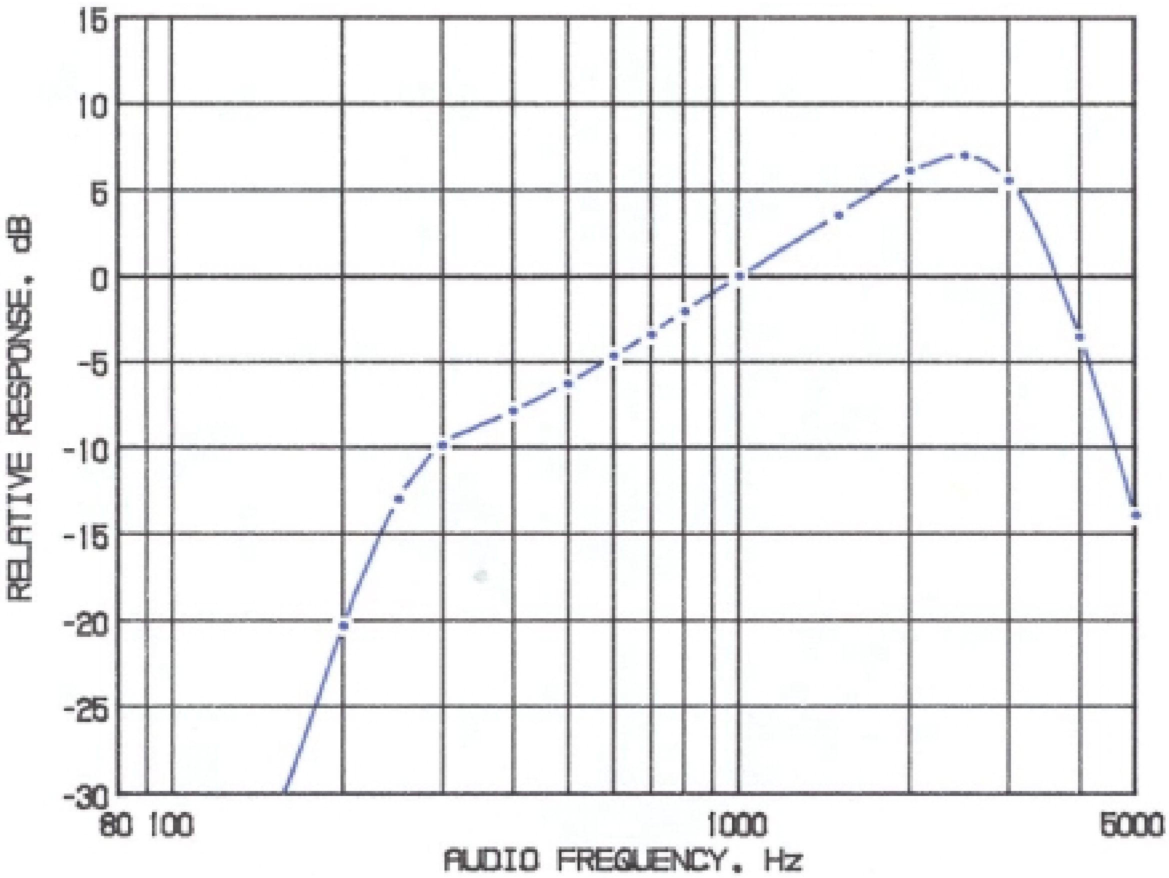
D. MODULATION CHARACTERISTICS (continued)

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 2769 Hz, the frequency of maximum response. Measured modulation under these conditions was 3.5.

The plot has unmodulated carrier as 0 dBm reference.

FIGURE 1

MODULATION FREQUENCY RESPONSE

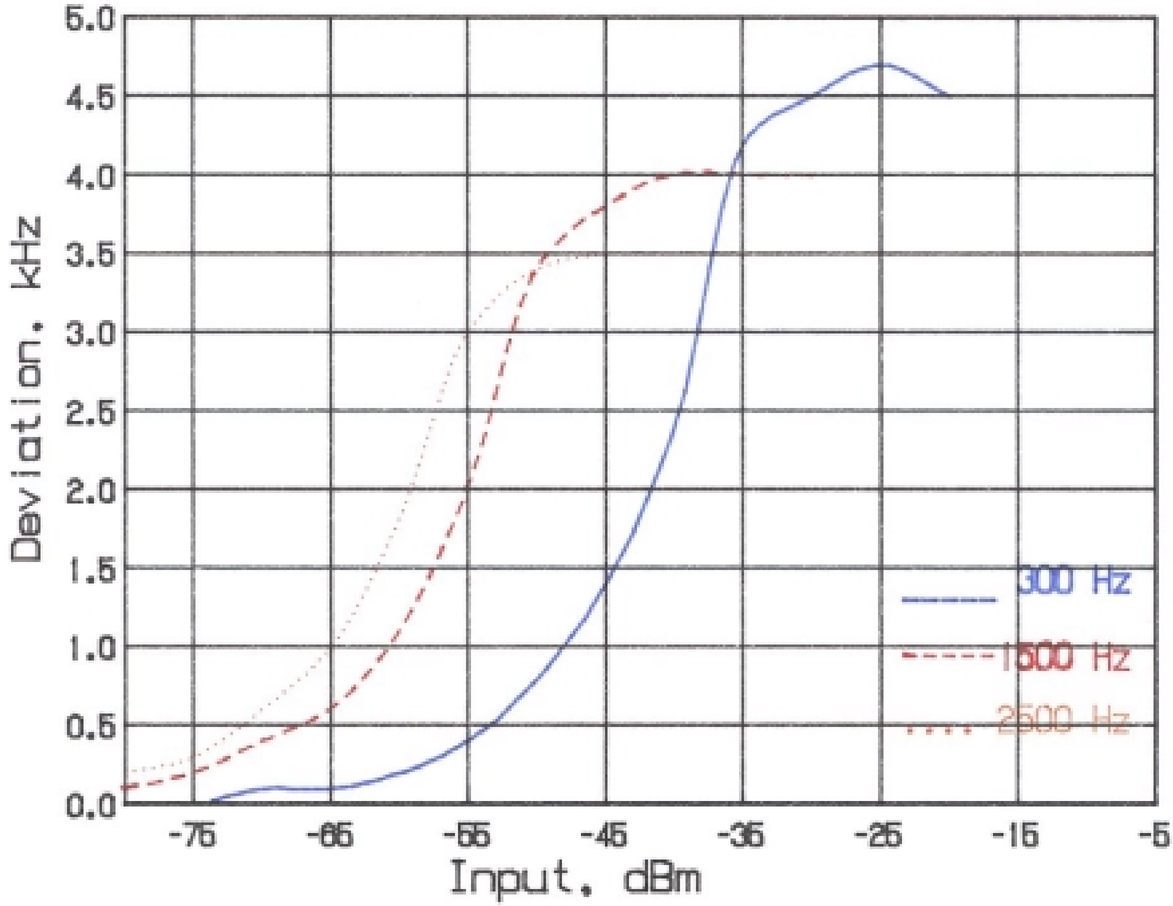


MODULATION FREQUENCY
RESPONSE
FCC ID: NCP700671C

FIGURE 1

FIGURE 2

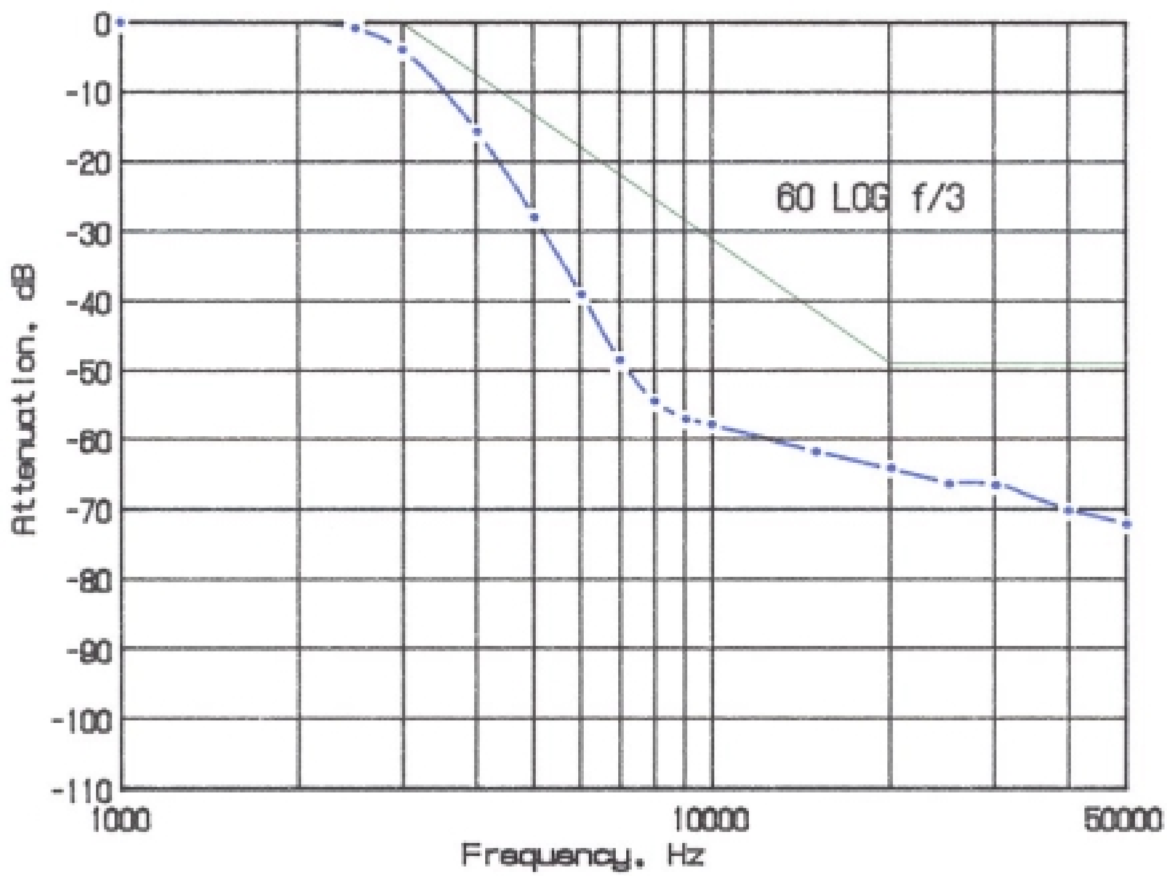
AUDIO LIMITER CHARACTERISTICS



AUDIO LIMITER CHARACTERISTICS
FCC ID: NCP700671C

FIGURE 2
FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

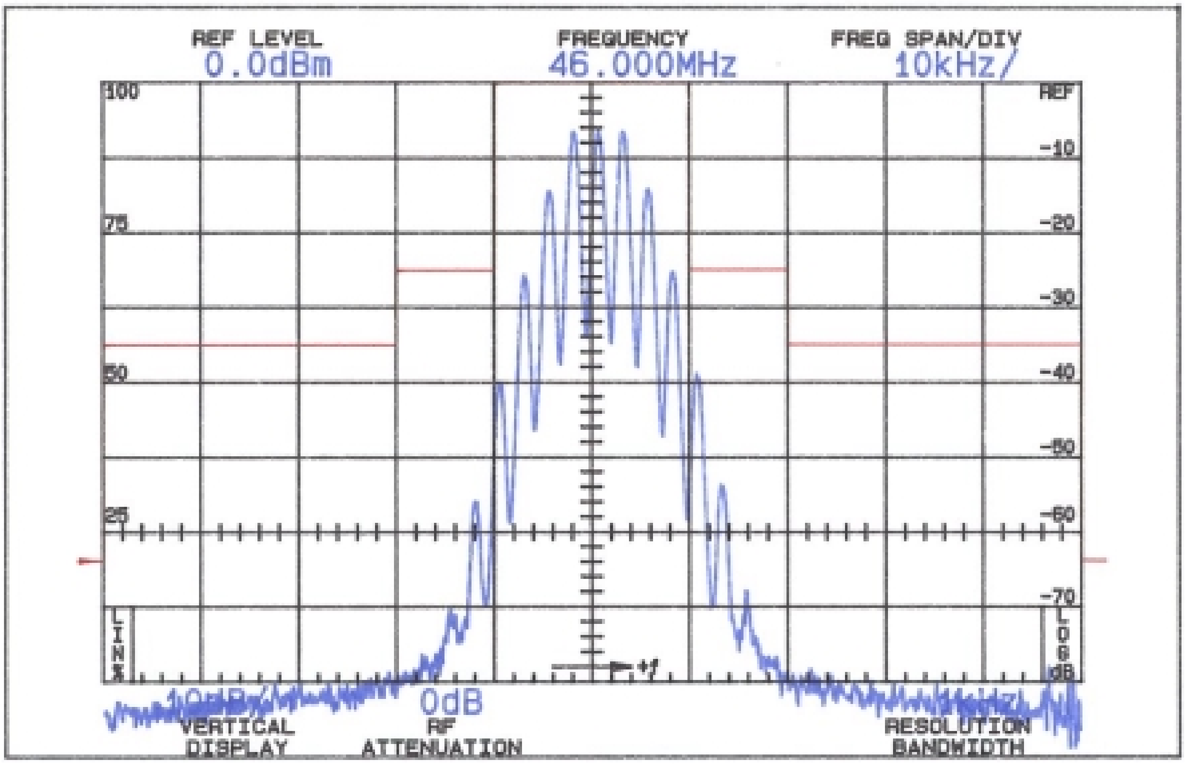


AUDIO LOW PASS FILTER RESPONSE
FCC ID: NCP700671C

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 authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 63 (P = 110 W)

OCCUPIED BANDWIDTH
FCC ID: NCP700671C

FIGURE 4

D. MODULATION CHARACTERISTICS (Continued)

The plot is within the limits imposed by Paragraph 90.211(c) 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.

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

The 70-0671C 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% modulation at 2769 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through a Bird 8325 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; dc supply was 13.8 volts throughout the tests.

Spurious emissions were measured at 110 watts output throughout the RF spectrum from 12 (lowest frequency generated in the transmitter is 12.8 MHz) 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.

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 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
46.000 MHz, 13.8 Vdc Input, 110 W

Spurious Frequency MHz	dB Below Carrier Reference
92.000	86
138.000	>100
184.000	86

230.000	78
276.000	86
322.000	96
368.000	96
414.000	90
460.010	96
Required: 43+10Log(P)	63

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.

G. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the Midland 70-0671C were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated dipole antennas.

The transmitter and dummy load were located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 13.8 Vdc.

Output power was 110 watts at 46.000 MHz 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 radiation was taken as an ideal dipole excited by 110 watts, 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 $$E = \frac{(49.2x110.0)^{1/2}}{3} = 24.5 \text{ V/m}$$

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

24.5 volts/meter = $24.5x10^6$ uV/m

dBu/m = 20 $Log_{10}(24.5x10^6)$

= 148 dBu/m

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

148 - 107 = 41 dBm

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

G. 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 100 dB below the reference level. Measurements were made from the lowest frequency generated within the unit (12 MHz), 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

46.000 MHz, 13.8 Vdc, 110 watts

Spurious Frequency MHz	dB Below Carrier Reference[1]
92.000	82*
138.000	71V
184.000	73V

230.000	76H
276.000	66V
322.000	95*
368.000	95*
414.000	91*
460.000	95*
Required:	63

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

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

All other spurious from 12 MHz to 460 GHz were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(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 3, starting with -30°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 was 13.8 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 46.000 MHz. No transient keying effects were observed.

TABLE 3
FREQUENCY STABILITY vs. TEMPERATURE
46.000 MHz; 13.8 Vdc; 110 W

Temperature, °C	Output Frequency, Hz	p.p.m.
-30.1	45.999944	-1.2
-21.5	45.999980	-0.4

-10.3	45.999990	-0.2
- 0.1	46.000001	0.0
10.3	46.000013	0.3
21.1	46.000006	0.1
30.8	45.999996	-0.1
41.2	45.999987	-0.3
50.3	45.999975	-0.5

Maximum frequency error: 45.999944
46.000000

- .000056 MHz

FCC Rule 90.213(a) specifies 0.002%.

The device met a stability of 0.002% (20 PPM) or a maximum of ± .000920 MHz

High Limit	46.000920 MHz
Low Limit	45.999080 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 ±15% above the nominal 13.8 volt rating. 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
46.000 MHz, 13.8 Volts Nominal, 110 W

%	Supply Voltage	Output Frequency, MHz	p.p.m.
115	15.87	46.000007	0.2
110	15.18	46.000007	0.2
105	14.49	46.000007	0.2
100	13.80	46.000006	0.1
95	13.11	46.000006	0.1
90	12.42	46.000005	0.1
85	11.73	46.000004	0.1

Maximum frequency error: 46.000007
46.000000

+ .000007 MHz

FCC Rule 90.213(a) specifies 0.002%

The device met a stability of 0.002% (20 PPM) or a maximum of ± .000405 MHz.

High Limit	46.000920 MHz
Low Limit	46.999080 MHz

APPENDIX 1

FUNCTION OF DEVICES

70-0671 ACTIVE SEMICONDUCTORS (1/3)

SYMBOL	TYPE	FUNCTION
Q201	2SC3357	RF Amp
Q203	2SK508K52	IF Amp
Q204	2SK360E	IF Amp
Q205	RT1N241C	Switch
Q206	RT1N241C	Switch
Q207	IMD3	Switch
IC201	TA31136FN	FM.I.F.
IC202	TDA1519A	Audio Amplifier
IC203	HA178L05UA	5V Regulator
Q301	RT1N241C	Switch
Q302	2SC2462C	Switch
Q303	2SD1421ED	Switch
Q304	RT1N241C	Switch
IC301	HA178L05UA	5V Regulator
IC302	M38203	Micro Computer
IC303	XC61AC4102	Reset Switch
IC305	HD14538	Switch
IC306	BU4066BCFV	Analog Switch
Q401	2SC2462C	Buffer Amplifier
Q402	2SC2462C	Switch

Q403	2SC2462C	Switch
Q404	RT1N241C	Switch
Q405	RT1N241C	Switch
Q406	UMH1N	Switch
Q407	UMH1N	Switch
Q408	RT1N241C	Switch
IC401	AK2368	Audio Processor
IC402	BA3308F	MIC Amplifier
IC403	MF6CWMX	Operational Amplifier
IC404	BA14741F	Operational Amplifier

70-0671 ACTIVE SEMICONDUCTORS (2/3)

SYMBOL	TYPE	FUNCTION
IC405	BA14741F	Operational Amplifier
IC406	HD14053BFP	Analog Switch
IC407	BU4066BCFV	Analog Switch
IC408	BA728F	Buffer Amplifier
IC409	BA728F	Buffer Amplifier
IC410	SC14S66F	Analog Switch
IC411	SC14S66F	Analog Switch
IC412	TC4W53FU	Analog Switch
IC413	TC4W53FU	Analog Switch
IC415	BA728F	Operational Amplifier
Q501	2SC2538	Power Amp
Q502	2SC1971	Power Amp
Q503	2SC2630	Power Amp
Q504	MRF492	Power Amp
Q505	MRF492	Power Amp
Q507	2SB945Q/P	APC
Q509	2SC2462C	APC
IC501	BA728F	Operational Amplifier
Q701	2SA1121C	Charge Pump
Q702	2SC2462C	Charge Pump
Q703	2SA1121C	Charge Pump
Q704	2SC2462C	Charge Pump
Q705	RT1N241C	Switch
Q706	2SK508K52	VCO
Q707	2SC3356	Pre Amp
Q708	2SC3357	Pre Amp
Q709	2SA1576A	Switch
Q710	UMH1N	Switch
Q712	DTB123YK	Switch
Q713	DTB123YK	Switch
Q714	UMH1N	Switch
Q715	2SB1197K	Switch
Q716	2SD596DV3	Filter
Q717	2SC3357	Local Amp

70-0671 ACTIVE SEMICONDUCTORS (3/3)

SYMBOL	TYPE	FUNCTION
IC701	MB1504PF	Synthesizer
IC702	BU4066BCFV	Analog Switch
IC703	μPC1675G	Operational Amplifier
IC704	μPC1675G	Operational Amplifier
IC705	μPC1675G	Operational Amplifier
Q801	2SK508K52	Switch
Q802	2SK508K52	Switch
Q803	3SK151GR	Buffer Amplifier
Q804	2SC2462C	Buffer Amplifier
Q805	2SA1121C	Multi Vibrator
Q806	2SA1121C	Multi Vibrator
Q807	2SC2462C	Buffer Amplifier
Q808	2SA1121C	Buffer Amplifier
Q809	2SA1121C	Rectifier Amplifier
Q810	2SA1121C	Rectifier Amplifier
Q811	2SC2462C	Rectifier Amplifier
Q812	DTC124EKA	Switch
IC801	MC1350DR2	AGC Amplifier
Q901	2SC2462C	Switch
Q902	RT1N241C	Switch
Q903	2SJ246S	Switch
Q904	RT1N241C	Switch
Q905	RT1N241C	Switch
IC901	M38079EFFP	Micro Computer
IC902	AT24C32N	E2PROM
IC904	NJM7808DLA	8V Regulator
IC905	HA178L05UA	5V Regulator
IC906	RH5VL45AA	5V Regulator
IC907	XC61AC4102MR	Reset Switch
IC910	RH5RL50AA	5V Regulator

FUNCTION OF DEVICES
FCC ID: NCP700671C

APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

A 12.8 MHz TCXO referenced PLL circuit establishes and stabilizes output frequency.

APPENDIX 3
CIRCUITS TO SUPPRESS SPURIOUS RADIATION, LIMIT MODULATION AND CONTROL POWER

RF Power Amplifier

A PC board stripline is used to match Q501 base terminal to the coax. RF impedance at collector of Q501 is transformed by PC board stripline to the base terminal of driver Q502 and the collector of Q502 is transformed to the base of Q503. Transformer T1 splits driver output to feed twin finals Q504 and Q505. Final stage outputs are combined by Transformer T2. In transmit mode, K501 connect this RF signal to the harmonic filter consisting of L520, L521 and L522 which purifies the signal before emission by the antenna connected to J502. R520 and R521 serve to drain static and other DC potentials from the antenna.

Automatic Power Control

T3, ahead of the harmonic filter, serves as a directional coupler. D502 rectifies a small RF sample that is developed across the thin runner, producing a DC voltage that increases with RF power traveling forward into the antenna. This power level sensing voltage is the inverting input of the comparator IC501 pin 6. The reference voltage applied to the comparator IC501 pin 5 is fed from IC901 pin 71, which is controlled by the programmer in alignment mode. Differential amplifier output drives Q507 which is a current source that feeds primary DC to the collector circuit of predriver Q501. The feedback loop, from the directional coupler to Q507, holds RF output power at a constant level that is determined by IC901.

Modulator

Voice signals from the hand microphone are applied to audio filter of IC401, where frequency response is pre-emphasized and splatter filtered. Gain is such that stronger signals bring IC401 into clipping, which limits modulation. Harmonics above the 3 kHz (wide) or 1.5 kHz (narrow) modulation pass band are removed in IC401. Modulation signals are then adjusted by IC401 so that modulation at limiting will produce transmitted carrier deviation of ±5 kHz (wide) or 2.5 kHz (narrow). Output of processed voice signals at IC405 pin 8 is fed to the gain control IC401.