ENGINEERING STATEMENT

For Type Certification of

Radio Shack, a Div. of Tandy Corporation

Model No: TRC-241

FCC ID: AAO2101679

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 Radio Shack, a Division of Tandy Corporation, to make type certification measurements on the TRC-241 transceiver. These tests were 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. It is submitted that the above-mentioned transceiver meets all applicable FCC requirements.

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Rowland S. Johnson

Dated: September 25, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the TRC-241 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The TRC-241 is a double sideband amplitude modulated transmitter/receiver combination intended for portable operation in the citizens radio service. The transmitter has 40-channel capability in the 26.965 - 27.405 MHz band utilizing phase locked loop (PLL) technology.

ERP (d) at 27 MHz is 6 mW.

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

1. Name of applicant: Radio Shack, a Div. of Tandy Corp.

2. Identification of equipment: FCC ID: AAO2101679

   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. 6k00A3E emission
   b. Frequency range: 26.965 - 27.405 MHz
   c. Operating power of transmitter is fixed at the factory at less than 4 watts and can be reduced 6 dB.
   d. Maximum power rating under 95.635(c) of the Rules is 4 watts.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 11.9 V
      Collector current: 0.56 mA @ 12.0 Vdc input.

   f. Function of each active semiconductor device: Submitted as a separate exhibit.
   g. Complete ciruit 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 1.
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.

6. RF_Power_Output (Paragraph 2.985(a),(b)(1) of the Rules)

RF power output in the AM mode was measured with a Bird 4421 RF power meter and a Narda 765-20 50 ohm dummy load. (The transmitter was tuned by the factory.) Power was measured with a supply voltage of 12.0 volts, and indicated:

| Channel | Power, W | |
|---|---|---|
| | High | Low |
| 1 | 3.8 | 0.96 |
| 21 | 3.6 | 0.95 |
| 40 | 3.5 | 0.95 |

C. MODULATION CHARACTERISTICS

1. AF_Frequency_Response

A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was taken as a 1 kHz tone with 50% modulation, as measured on a Data Tech 209 modulation meter, using Audio Precision System One digital voltmeter and tracking generator.

2. Modulation_Limiting

Curves of AM modulation limiting for both positive and negative peaks are shown in Figures 2a and 2b, respectively. Characteristics at 300, 1320, and 2500 Hz are shown using a Data Tech 209 modulation meter. Signal level was established with a Audio Precision System One digital voltmeter. The curves show compliance with Paragraph 95.633(d) of the Rules.

C. MODULATION REQUIREMENTS…(Continued)

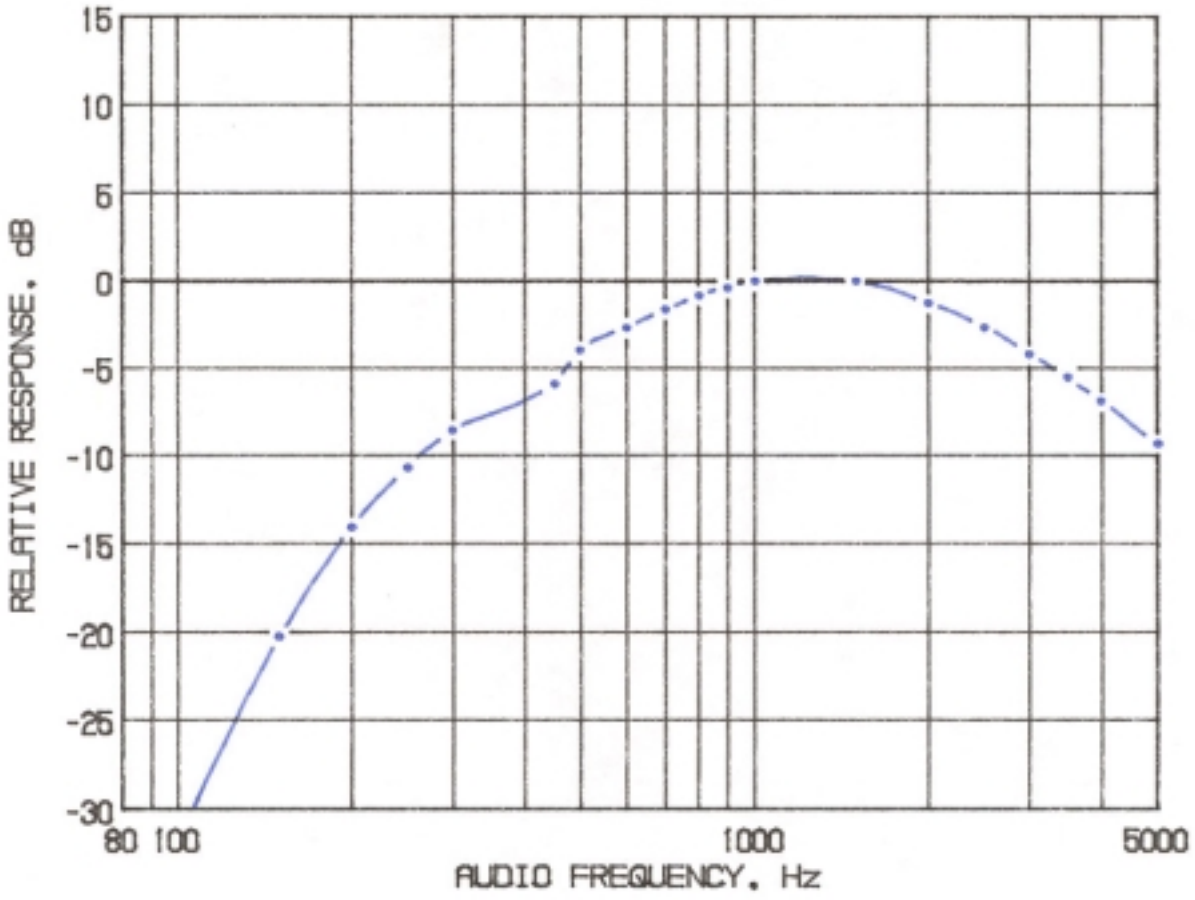
3. Modulation_Limiter_Attack_Time

Modulation limiter attack time was measured by applying to the microphone input terminals a pulsed tone at 2500 Hz, 16 dB above the level required for 50% modulation at the frequency of maximum response, 1320 Hz. The spectrum analyzer was tuned to upper and lower fourth-order sidebands in the time domain. Horizontal sweep of the analyzer was triggered in synchronism with the tone turn-on. Sweep speed was 100 milliseconds per division.

Plots are included as Figures 3a and 3b. Any transients observed in excess of 33 dB attenuation as referenced to the carrier were less than 20 ms in duration.

FIGURE 1

TRANSMITTER FREQUENCY RESPONSE



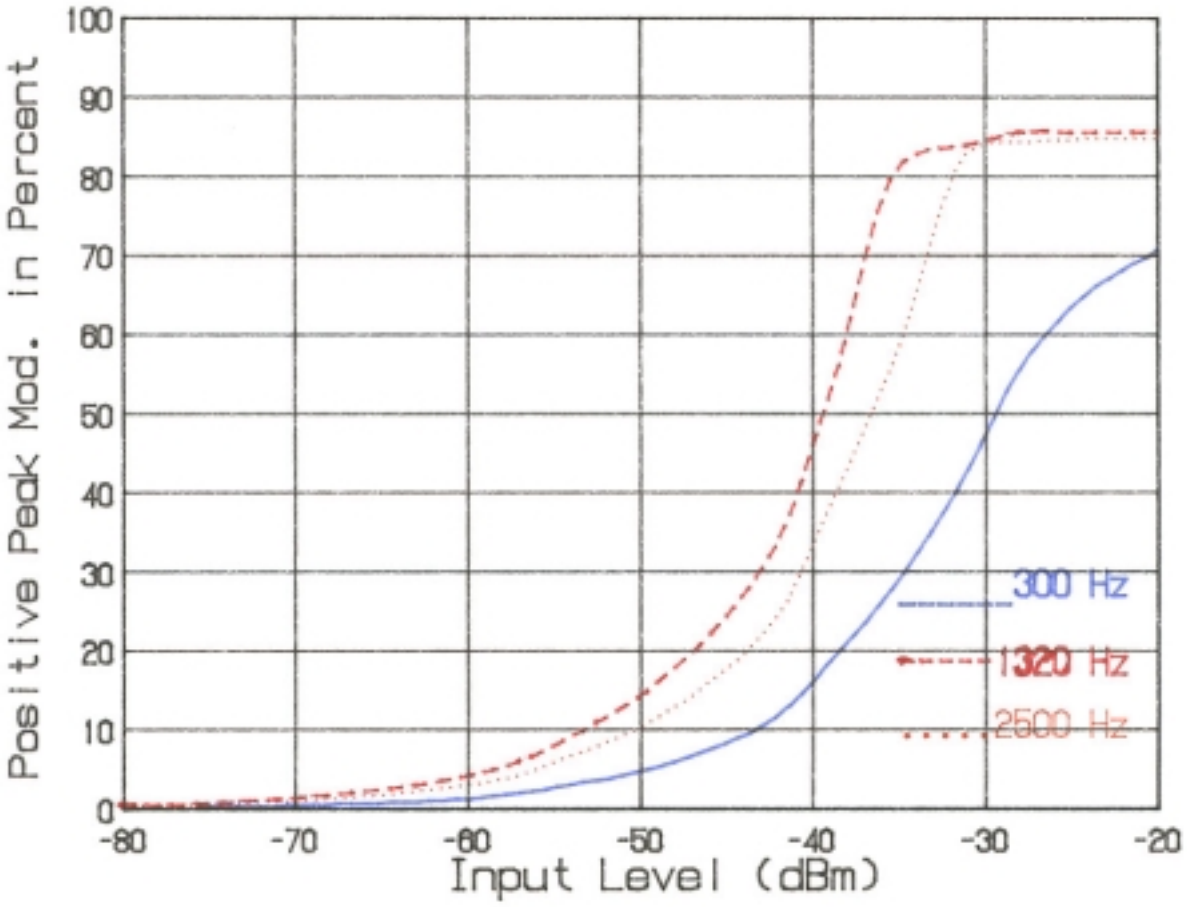
TRANSMITTER FREQUENCY RESPONSE
FCC ID: AAO2101679

FIGURE 1

5

FIGURE 2a

AM MODULATION LIMITING - POSITIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1320 Hz, and 2500 Hz tones.

MODULATION LIMITING POSITIVE PEAKS
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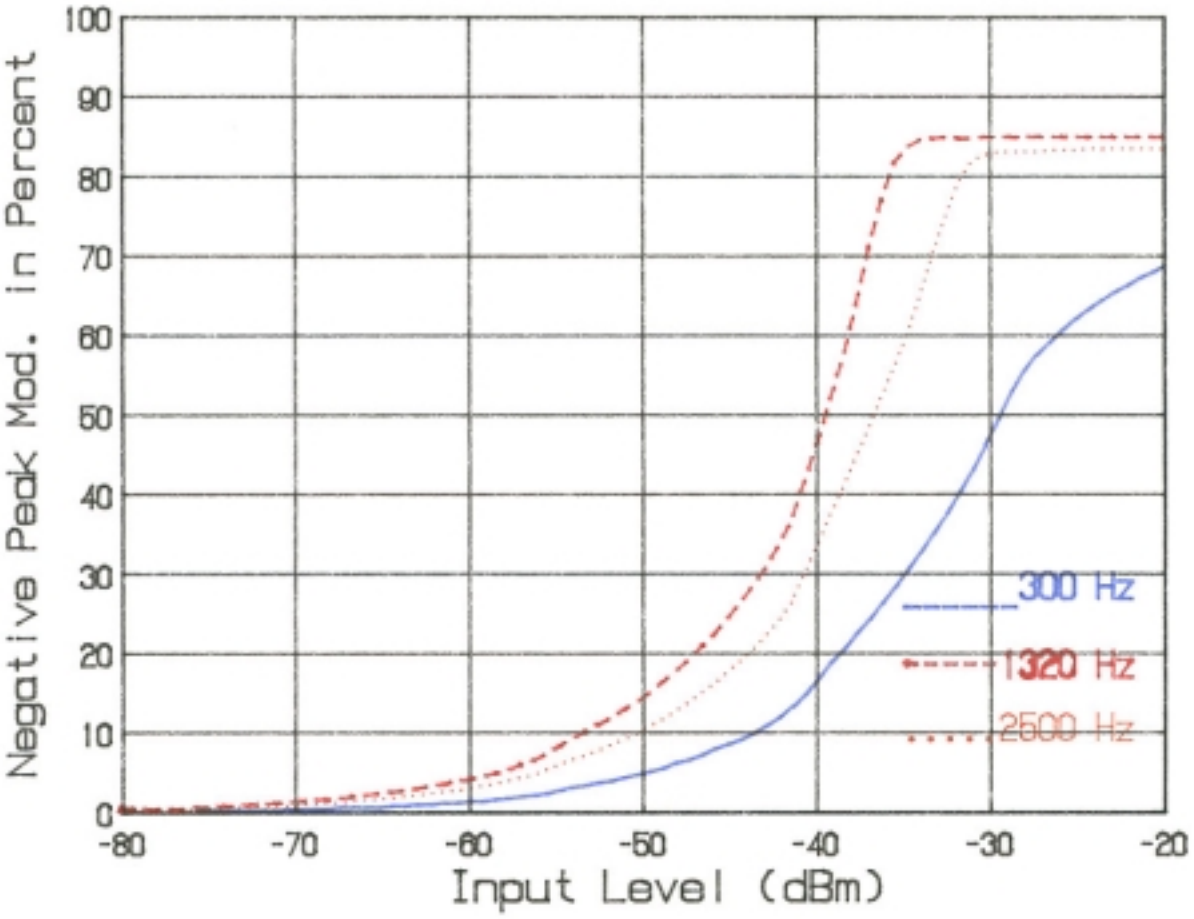
FIGURE 2a



FIGURE 2b

AM MODULATION LIMITING - NEGATIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1320 Hz, and 2500 Hz tones.

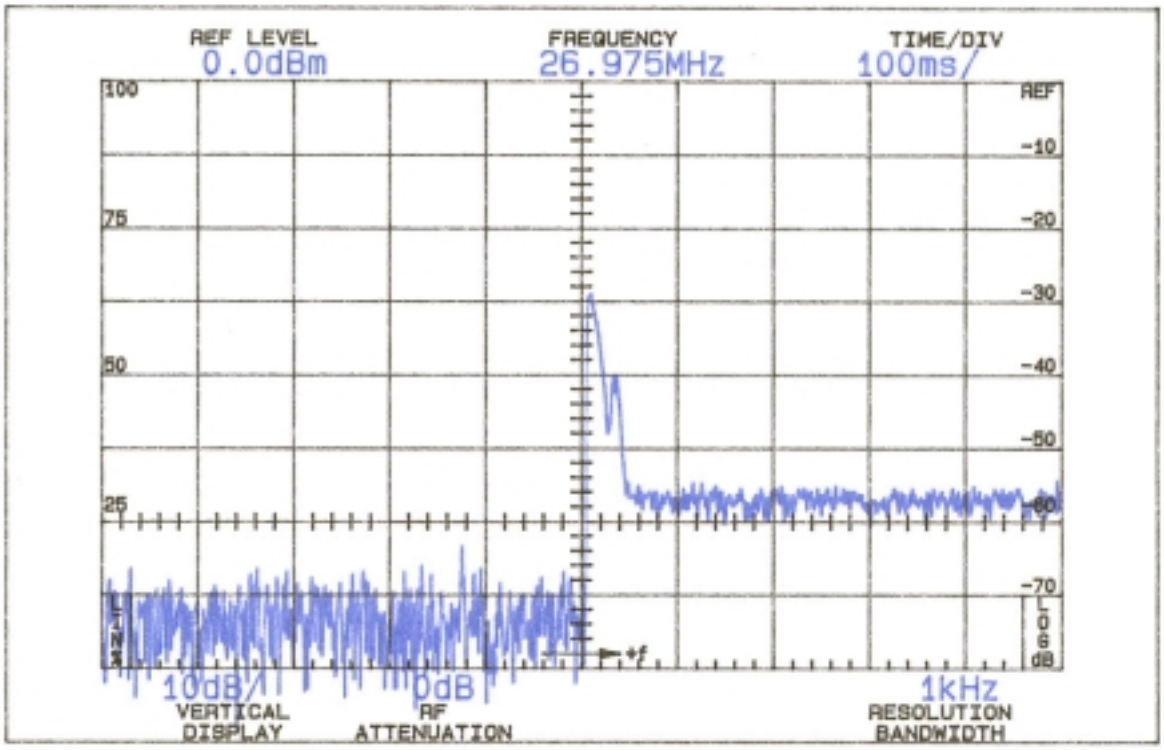
MODULATION LIMITING NEGATIVE PEAKS
FCC ID: AAO2101679

FIGURE 2b



FIGURE 3a

MODULATION LIMITER ATTACK TIME



Measurement_Conditions: 16 dB over 50% modulation level at 1320 Hz with 2500 Hz tone, upper fourth order sideband; horizontal scale 100 ms/div.

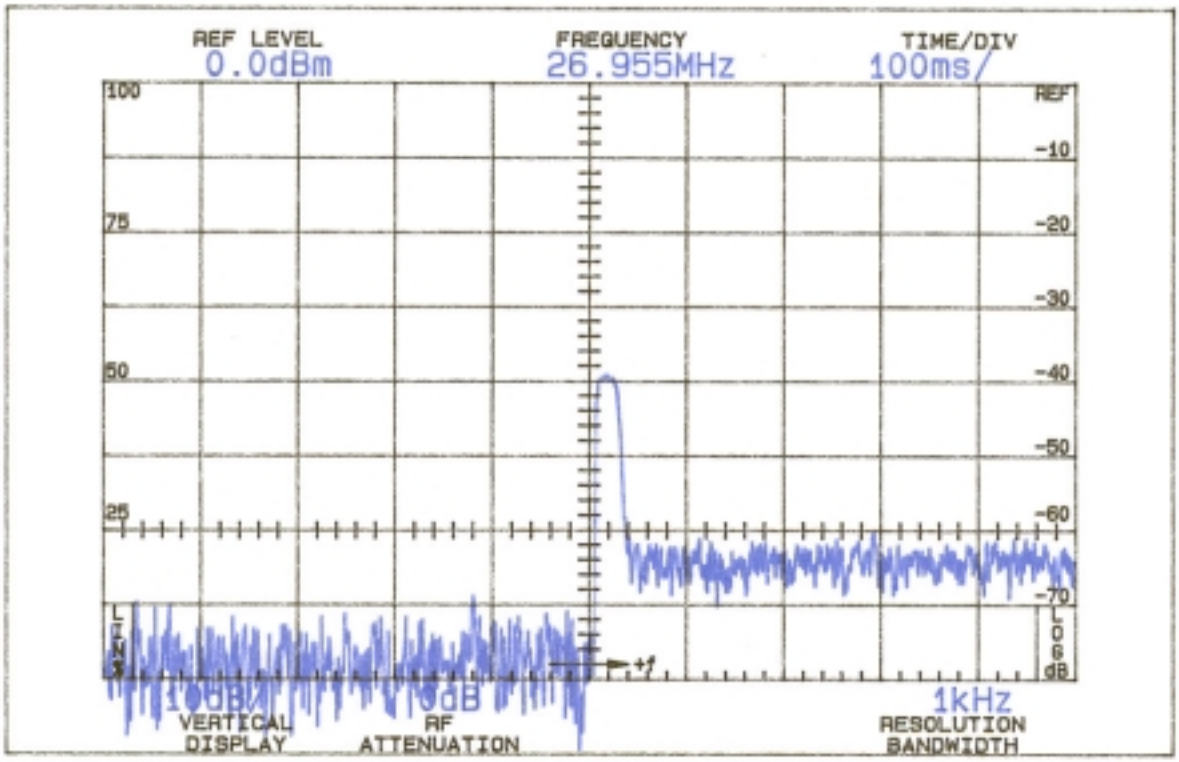
UPPER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: AAO2101679

FIGURE 3a



FIGURE 3b

MODULATION LIMITER ATTACK TIME



Measurement_Conditions: 16 dB over 50% modulation level at 1320 Hz with 2500 Hz tone, lower fourth order sideband; horizontal scale 100 ms/div.

LOWER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: AAO2101679

FIGURE 3b



C. MODULATION CHARACTERISTICS (Continued)

4. Occupied_Bandwidth_-_AM
(Paragraph 2.989(c) of the Rules)

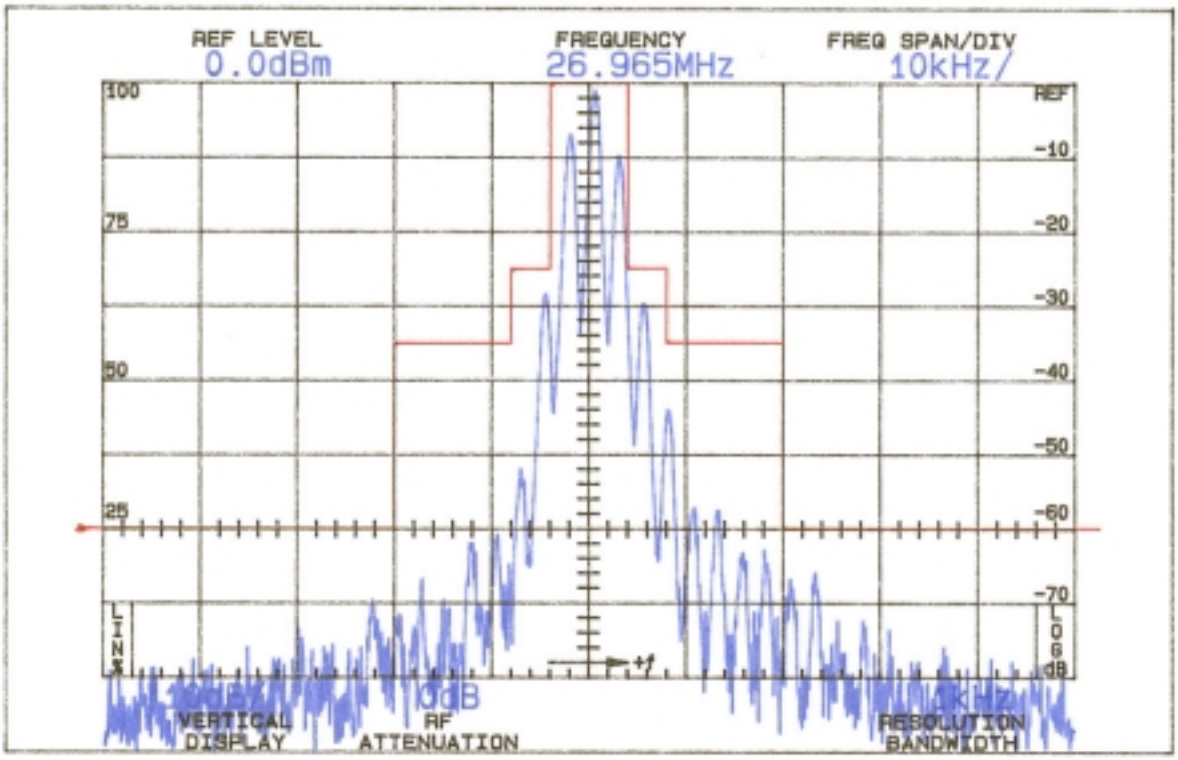
Figures 4a and 4b are plots of the sideband envelope of the transmitter taken from a Tektronix 494P spectrum analyzer for both nominal 4 watt and 1 W power. Modulation corresponded to conditions of 2.989(a) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 1320 Hz, the frequency of maximum response. Measured modulation was 85% positive, 86% negative.

The plots are @ 1320 Hz within the limits imposed by Paragraph 95.631(b)(1,3) for double sideband AM 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.

**NOTE: CW carrier reference was 0 dBm, top of analyzer screen.**

FIGURE 4a

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, 8kHz (4-8kHz) | 25 |
| On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz) | 35 |
| On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth | 60 |

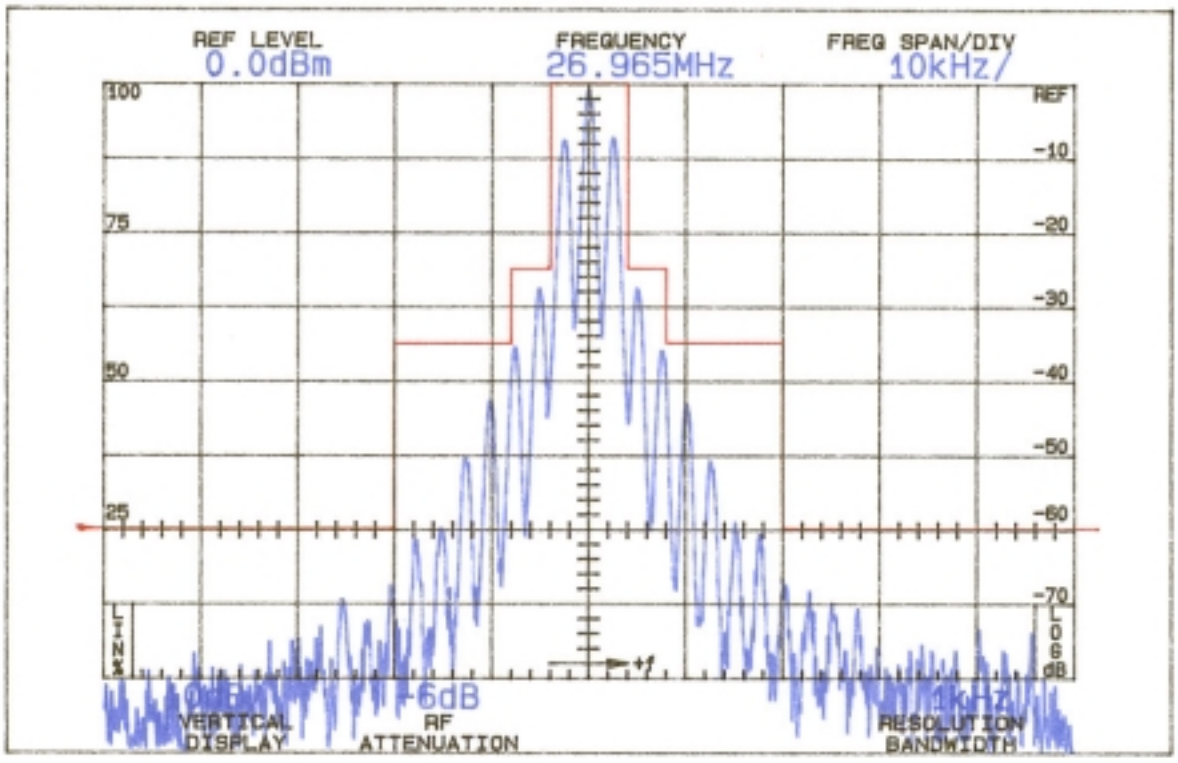
OCCUPIED BANDWIDTH
FCC ID: AAO2101679

FIGURE 4a (High Power)



Figure 4b

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, 8kHz (4-8kHz) | 25 |
| On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz) | 35 |
| On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth | 60 |

OCCUPIED BANDWIDTH
FCC ID: AAO2101679

FIGURE 4b (Low Power)



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

The TRC-241 transmitter was tested in the AM mode for spurious emissions at the antenna terminals while the equipnment was modulated with a 2500 Hz signal, 16 dB above minimum input signal for 50% modulation at 1320 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through Narda 765-20 50 ohm power attenuation.

In order to improve measurement system dynamic range, a series trap tuned to the carrier frequency was used on the Narda attenuator output. The trap, which had negligible attenuation at the second harmonic and higher frequencies, provided 26 dB attenuation of the fundamental. The trap was not used during close-in (within 10 MHz of the carrier) spurious measurements.

During the tests, the transmitter was terminated in the Narda 765-20 dummy load. Power was monitored on a Bird 43 Thru-Line wattmeter; dc supply was 12.0 volts throughout the tests.

Spurious emission was measured at both power settings on Channels 1, 21, and 40 throughout the RF spectrum from 10.24 to 300 MHz. Any emissions that were between the 60 dB attenuation required and the 100 dB noise floor of the spectrum analyzer were recorded. Data are shown in Table.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS

12.0 Vdc Input

| Channel | Spurious Frequency MHz | dB Below Unmod Carrier Ref. "High" | dB Below Unmod Carrier Ref. "Low" |
|---|---|---|---|
| 1 | 53.930 | 63 | 64 |
| 1 | 80.895 | 70 | 66 |
| 1 | 107.860 | 72 | 72 |
| 1 | 134.825 | 80 | 78 |
| 1 | 161.790 | 82 | 94 |
| 1 | 188.755 | 96 | 90 |
| 1 | 215.720 | 102 | >100 |
| 1 | 242.685 | 98 | 87 |
| 1 | 269.650 | 90 | 85 |
| 21 | 54.430 | 63 | 64 |
| 21 | 81.645 | 70 | 66 |
| 21 | 108.860 | 75 | 72 |
| 21 | 136.075 | 78 | 79 |
| 21 | 163.290 | 82 | 90 |
| 21 | 190.505 | 95 | 89 |
| 21 | 217.720 | 94 | >100 |
| 21 | 244.935 | 102 | 90 |
| 21 | 272.150 | 84 | 91 |
| 40 | 54.810 | 63 | 64 |
| 40 | 82.215 | 70 | 66 |
| 40 | 109.620 | 77 | 72 |
| 40 | 137.025 | 76 | 79 |
| 40 | 164.430 | 82 | 88 |
| 40 | 191.835 | 91 | 88 |
| 40 | 219.240 | 92 | >100 |
| 40 | 246.645 | 92 | 95 |
| 40 | 274.050 | 82 | 98 |
| | Required: | 60 | 60 |

All other spurious were more than 20 dB below required 60 dB suppression.

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 TRC-241 transmitter were made with a Tektronix 494P spectrum analyzer open field 3 meters from the test antenna. Output power was 3.8 watts into the short flexible antenna. The supply voltage was 12.0 volts. The transmitter and test antennae were arranged according to OCE 42 to maximize pickup. The device has accessory ports. Both vertical and horizontal test antenna polarization were employed.

Measurements were made from 10.24 MHz to 10 times the maximum operating frequency of 26.965 or 269.65 MHz.

Reference level for the spurious radiations was taken as the operating channel carrier.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS
Channel 1, 26.965 MHz; 3.8 watts RF output

| Frequency, MHz | Field uV/m @ 3M | dB Below Carrier Reference |
|---|---|---|
| 26.965 | 186209 | 0 |
| 53.930 | 108 | 65V |
| 80.895 | 38 | 74V |
| 107.860 | 54 | 71H |
| 134.825 | 130 | 63V |
| 161.790 | 119 | 64V |
| 188.755 | 24 | 78V |
| 215.720 | 9 | 86V |
| 242.685 | 9 | 87H |
| 269.650 | 73 | 68V |
| Required: | | 60 |

V/H: Worst-case test ant. polarization.

ERP (dipole):

$$P = \frac{(F.I. \times 3)^2}{49.2}$$

$$= \frac{(0.186 \times 3)}{}$$

49.2

= 0.006 W

Any unlisted spurious were more than 80 below carrier reference from 10.24 to 269.650 MHz.

15

F. FREQUENCY STABILITY
(Paragraph 2.995(a)(1) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to +50°C in 10° increments. At each temperature, the unit was exposed to the test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following a 30 minute 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. The transmitter output stage was terminated in a dummy load. Primary supply was 12.0 volts. Frequency was measured with a HP 5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made on Channel 9, 27.065 MHz. No transient keying effects were observed.

TABLE 3

| Temperature | Output_Frequency,_MHz |
|---|---|
| -29.5 | 27.065241 |
| -19.8 | 27.065247 |
| - 9.5 | 27.065279 |
| 0.6 | 27.065279 |
| 9.8 | 27.065252 |
| 19.7 | 27.065174 |
| 30.7 | 27.065132 |
| 40.3 | 27.065098 |
| 49.7 | 27.065094 |
| Maximum frequency error: | 27.065279 |
| | 27.065000 |
| | + .000279 MHz |

FCC Rule 95.625(b) specifies .005% or a maximum of ± .001353 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 an HP 6264B variable dc power supply was varied ±15% from the nominal 12.0 volt rating. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

| Supply Voltage | Output Frequency, MHz |
|---|---|
| 13.80 | 27.065215 |
| 13.20 | 27.065203 |
| 12.60 | 27.065189 |
| 12.00 | 27.065174 |
| 11.40 | 27.065161 |
| 10.80 | 27.065151 |
| 10.20 | 27.065143 |
| 9.60* | 27.065131 |
| Maximum frequency error: | 27.065215 |
| | 27.065000 |
| | + .000215 MHz |

*Mfg. rated battery end-point.

FCC Rule 95.625(b) specifies .005% or a maximum of ± .0001353 MHz. No effects on frequency related to keying the unit were observed.

H. ADDITIONAL REQUIREMENTS FOR TYPE CERTIFICATION
(Paragraph 95.665 of the Rules)

The TRC-241 meets the applicable provision of 95.665(a).

External controls are limited to the following per 95.665(a):

1. Primary power connection
2. Internal Microphone
3. RF output power connection
4. N/A
5. On-off switch (combined with receiver volume control)
6. Not applicable, AM only
7. Not applicable, AM only
8. Transmitting frequency selector
9. Transmit-receive switch
10. See #1
11. Not applicable

The serial number of each unit will be implemented in accordance with 95.667.

A copy of Part 5, Subpart D, of the FCC rules for the Citizens Band Radio Service, current at the time of packing of the transmitter, must be furnished with each CB transmitter marketed per 95.669.

I. PLL RESTRICTIONS
(Per Public Notice of April 27, 1978)

The TRC-241 meets the following conditions specified in the April 27, 1978 notice:

1. All frequency-determining elements, including crystals, PLL integrated circuits and channel selector switches are permanently wired and soldered in place.

2. The PLL integrated circuit has no more than six active leads and is BCD encoded.

3. The channel selection mechanism has only 40 positions.

4. The PLL integrated circuit has no "spare" or undedicated leads.

5. A copy of the PLL data sheet is submitted as a separate exhibit.



## APPENDIX 1

## CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

All 40 channels of transmitting, and receiving, frequencies are provided by PLL (Phase Locked Loop) circuitry.

The purpose of the PLL is to provide a multiple number of frequencies from VCO (Voltage Controlled Oscillator) with quartz crystal accuracy and stability from on crystal oscillator reference frequency.

The reference crystal oscillator frequency is 10.24 MHz.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: AAO2101679

APPENDIX 1

APPENDIX 2

Description of Circuits Follows This Page

DEVICES AND CIRCUITS TO SUPPRESS SPURIOUS RADIATION AND LIMIT MODULATION

FCC ID: AAO2101679

APPENDIX 2

## 5. DESCRIPTION OF OTHER CIRCUITS

### TRANSMITTER

#### a. RF AMPLIFICATION

THE OUTPUT OF DOUBLER AMP Q305 IS FED THROUGH TUNING LFT L301 AND L302 TO THE BASE OF PRE DRIVER AMP Q306.
THE OUTPUT IS THEN SUPPLIED THROUGH TUNING CIRCUIT L303 TO RF DRIVER AMP Q307.
THE OUTPUT OF Q307 IS SPLITTED WITH TUNING CIRCUIT L304 AND C321 , C322 AND GOES TO THE BASE OF FINAL RF AMP Q308.
THE OUTPUT OF Q308 IS SUPPLIED TO THE ANTENNA THROUGH LOW PASS FILTER.

#### b. CIRCUIT FOR SUPPRESSION OF SPURIOUS RADIATION

THE TUNING CIRCUIT BETWEEN THE OUTPUT OF FINAL AMP Q308 AND ANTENNA , 4-STAGE "PHI" NETWORK C327, L312, C333, L313, C335, C337, C338, L314, C336, C341, L315, C342.
SERVES AS A SPURIOUS RADIATION SUPPRESSOR.
THIS NETWORK ALSO SERVES TO MATCH THE IMPEDANCE BETWEEN TX POWER AMP Q308 AND THE ANTENNA.

#### c. CIRCUITS FOR LIMITING POWER

AFTER FINISHED ALL ALIGNMENT, THE CONSTANT VOLTAGE SUPPLY CIRCUIT LIMITS THE AVAILABLE POWER 4 [W] OR SLIGHTLY LESS.
RV801 AND CORRESPONDING THREE TRANSISTORS Q817, Q816, Q815, AND Q814 CONTROL SUPPLY VOLTAGE OF RF AMPLIFIER.

TUNE ALL THE TRIMMING PARTS FOR MAXIMUM INDICATION OF RF POWER METER AND ADJUST RV1 TO MAKE 4 [W] INDICATION OF RF POWER METER.
THE TUNING IS ADJUSTED SO THAT THE ACTUAL POWER IS FROM 3.8 TO 4.0 [W].
THERE ARE NO OTHER ADDITIONAL CONTROLS FOR ADJUSTING THE TX OUTPUT POWER.

#### d. MODULATION CONTROL.

THE MIC INPUT IS FED TO AUDIO POWER AMPLIFIER IC IC7 WHICH DRIVES MODULATION TRANSFORMER T1.
THE AUDIO OUTPUT AT THE SECONDARY OF T1 IS FED THE MODULATION AUDIO SIGNAL SERIES WITH THE B+ VOLTAGE TO THE COLLECTORS OF DRIVER Q307 AND TX POWER AMP Q308 TO MODULATE BOTH STAGES.

#### e. CIRCUIT FOR LIMITING THE MODULATION

SOME OF THE MODULATING SIGNAL IS RECTIFIED WITH D9 WHICH CONTROLS Q26 AND Q19 TO ATTENUATE THE MIC INPUT SIGNAL
THE RESULTING FEEDBACK LOOP KEEPS THE MODULATION SHALL NOT EXCEED 100 PERCENT FOR THE INPUT SIGNAL APPROXIMATELY 40[dB] GREATER THEN THE SIGNAL LEVEL REQUIRED TO PRODUCE 50% MODULATION.

ADJUST RV3 SHALL NOT EXCEED +/- 90 [%] MODULATION UNDER 1.0 [KHz] /50[%] MODULATION INPUT LEVEL