ENGINEERING STATEMENT

For Type Certification of

Trisquare Communications

Model No: FRS420
FCC ID: O9GFRS440

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 Trisquare Communications to make type certification measurements on the model FRS420 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.

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Rowland S. Johnson

Dated: March 2, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the model FRS420 transceiver in

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

The model FRS420 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 4.8 Vdc battery supply. MFR rated output power is 0.5 watts ERP(d)

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

1. Name of applicant: Trisquare Communications

2. Identification of equipment: FCC ID: O9GFRS440

   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 0.5 W ERP(d)
   d. Maximum power permitted is 0.5 watts, and the model FRS420 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 4.4 Vdc
      Collector current: 0.57 A

   f. Function of each active semiconductor device: See Semiconductors exhibit.
   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.

   j. A description of circuits for stabilizing frequency is included in Technical Description exhibit.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Technical Description exhibit.
   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 FRS420 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power was determined by substitution.

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.49

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 60Logf/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.

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

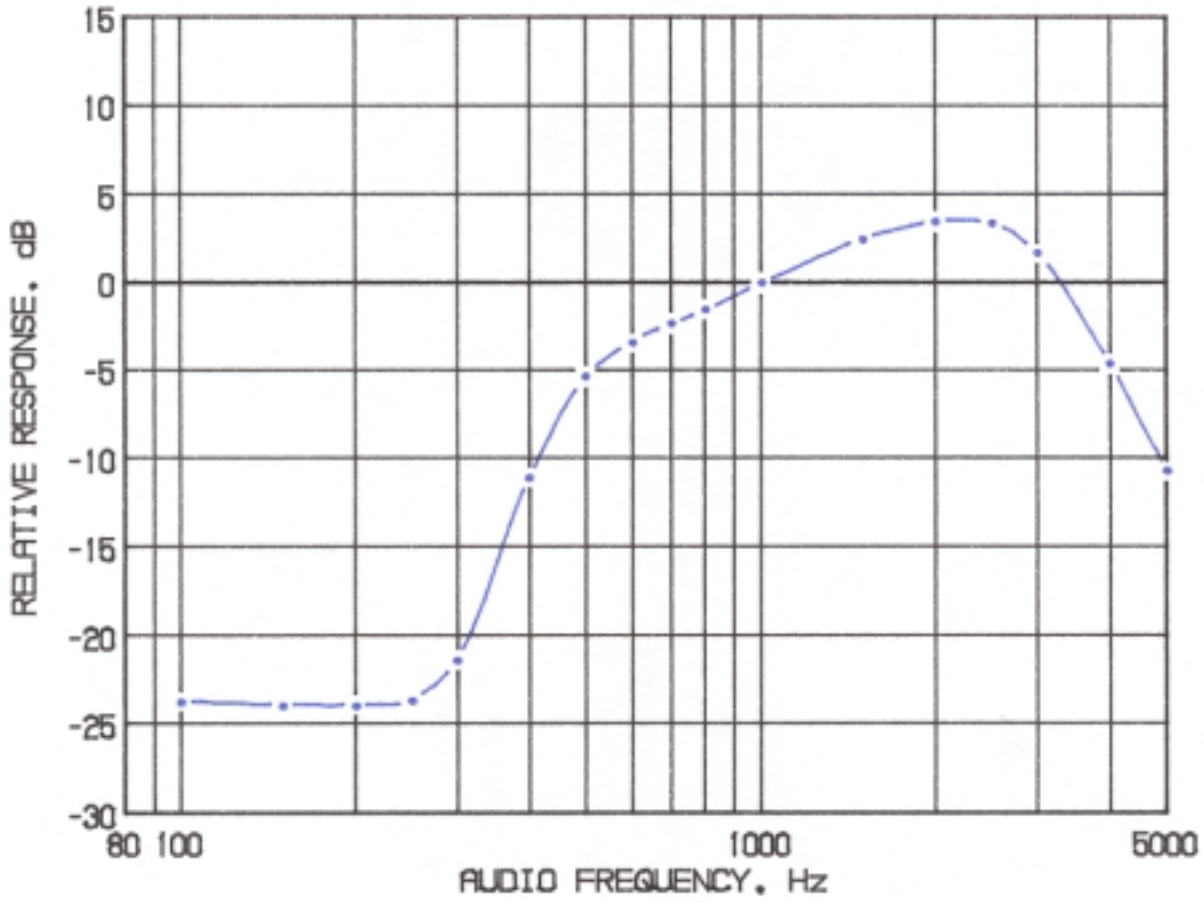
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2469 Hz, the frequency of maximum response.

Emission designator:

(2M + 2D) (2 x 3 kHz) + (2 x 2.5 kHz) = 11k0F3E

FIGURE 1

MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
FCC ID: O9GFRS440

FIGURE 1

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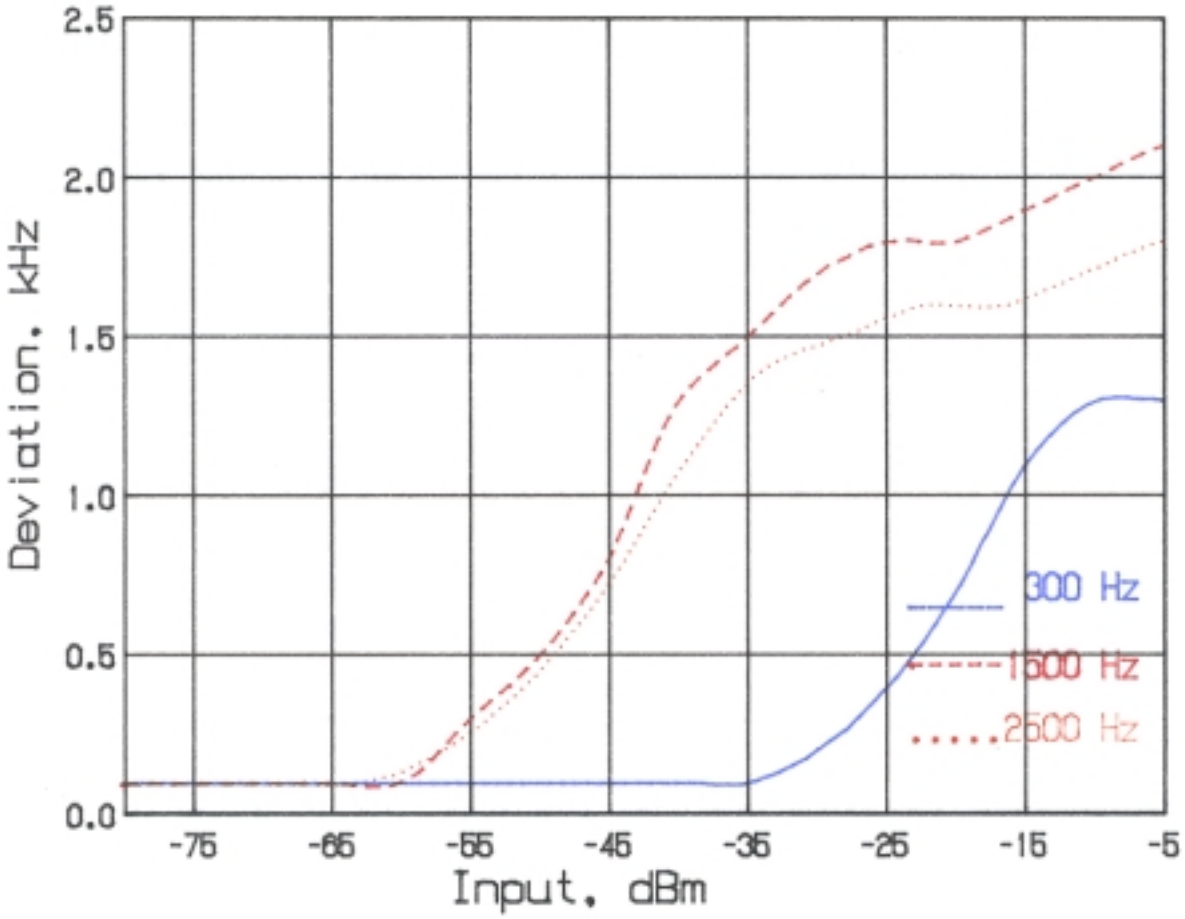
FIGURE 2

AUDIO LIMITER CHARACTERISTICS

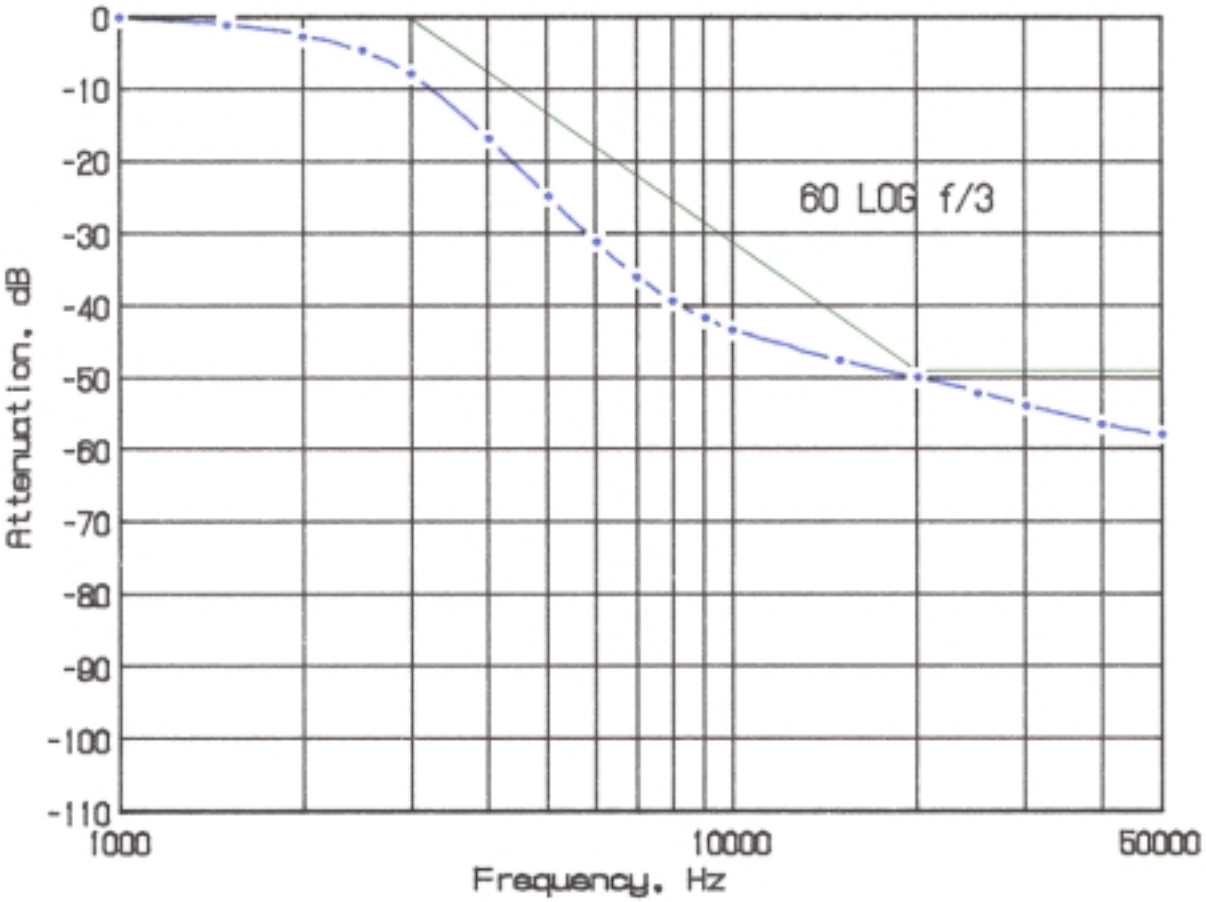


AUDIO LIMITER CHARACTERISTICS
FCC ID: O9GFRS440

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

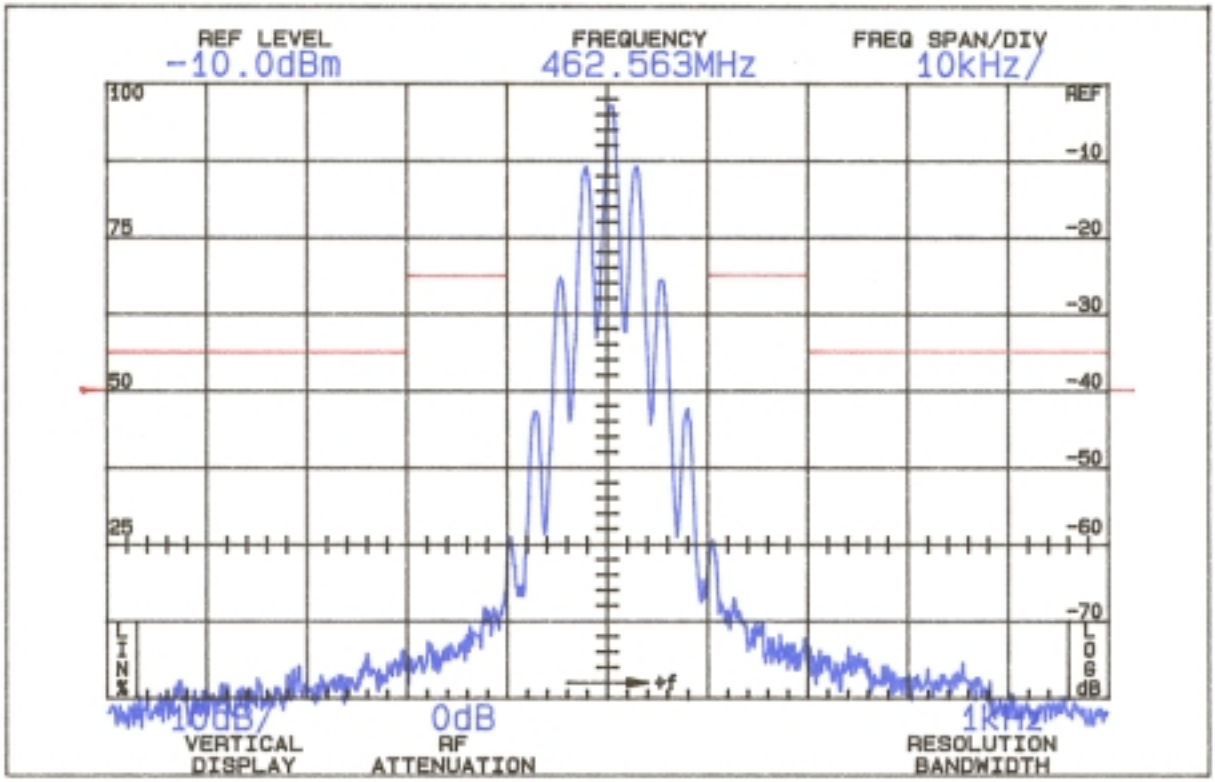


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: O9GFRS440

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, 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+10LogP = 40 (P = 0.49)

OCCUPIED BANDWIDTH
FCC ID: O9GFRS440

FIGURE 4

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 FRS420 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. MEASUREMENTS OF SPURIOUS RADIATION

Spurious emissions from the model FRS420 were made by substitution 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.

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, 0.49 watts

Spurious Frequency	dB Below Carrier

MHz	Reference[1]
462.563	0
925.126	43V
2312.815	54H
2775.378	56V
3237.941	50V
3700.504	57H
Required: 43+10 Log(P) =	40

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

All other spurious from 12.8 MHz to the tenth harmonic were 20 dB or more below FCC limit.

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, 0.49 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-20.3	462.563596	2.4
-10.6	462.563128	1.4
- 0.5	462.562443	-0.1
10.4	462.562334	-0.4
20.1	462.562357	-0.3
31.8	462.562426	-0.2
41.2	462.562399	-0.2
49.8	462.562081	-0.9

Maximum frequency error: 462.563596
462.562500

+ .001096 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 ±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; 0.49W

Supply Voltage		Output Frequency, MHz	p.p.m.
5.17	115%	462.562375	-0.3
4.95	110%	462.562353	-0.3
4.73	105%	462.562360	-0.3
4.50	100%	462.562357	-0.3
4.28	95%	462.562349	-0.3
4.05	90%	462.562336	-0.4
3.83	85%	462.562322	-0.4
3.60	80%	462.562306	-0.4

Maximum frequency error: 462.562306
462.562500

\- .000194 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.

APPENDIX 1

FUNCTION OF DEVICES
Model FRS420

SEE SEMICONDUCTORS EXHIBIT

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

SEE TECHNICAL DESCRIPTION EXHIBIT

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: O9GFRS440

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

SEE TECHNICAL DESCRIPTION EXHIBIT

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION

FCC ID: O9GFRS440
APPENDIX 3