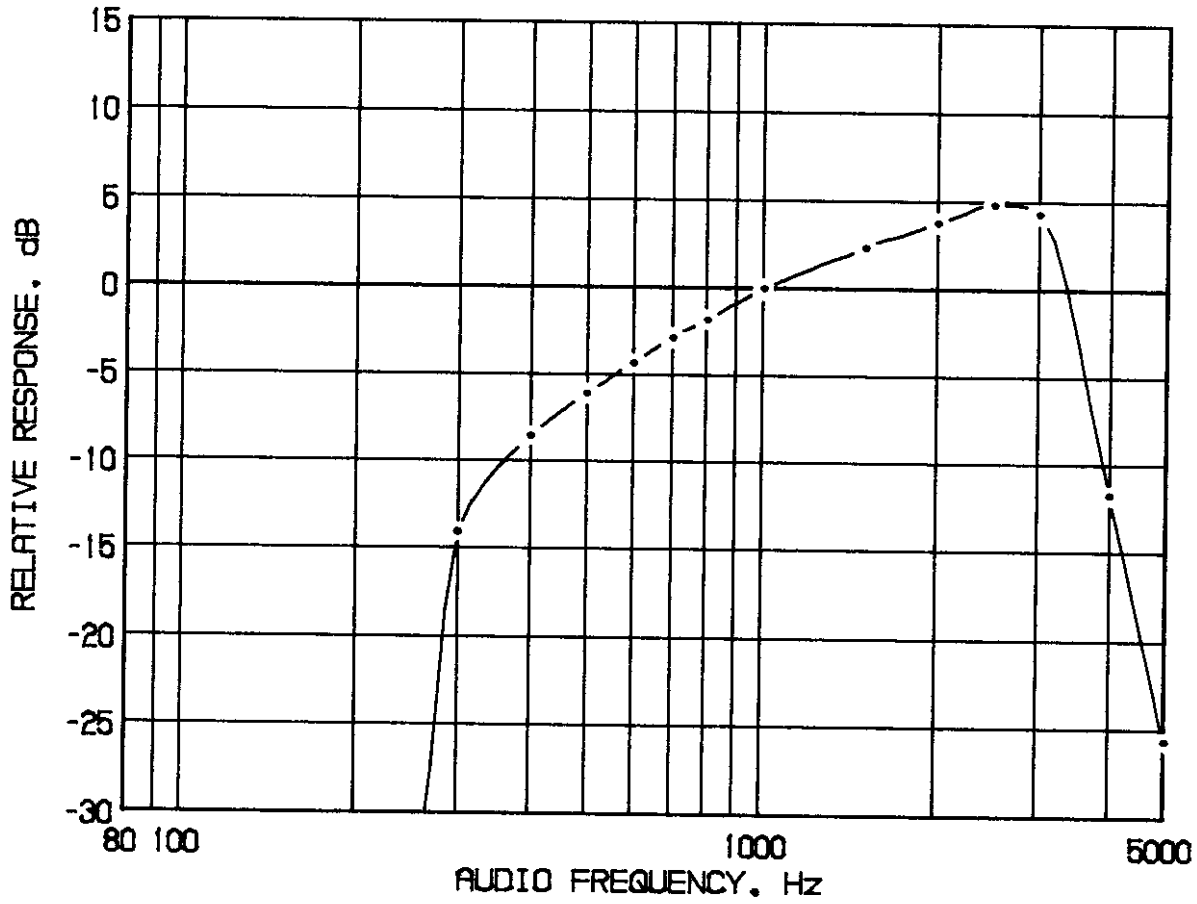
FIGURE 1

MODULATION FREQUENCY RESPONSE

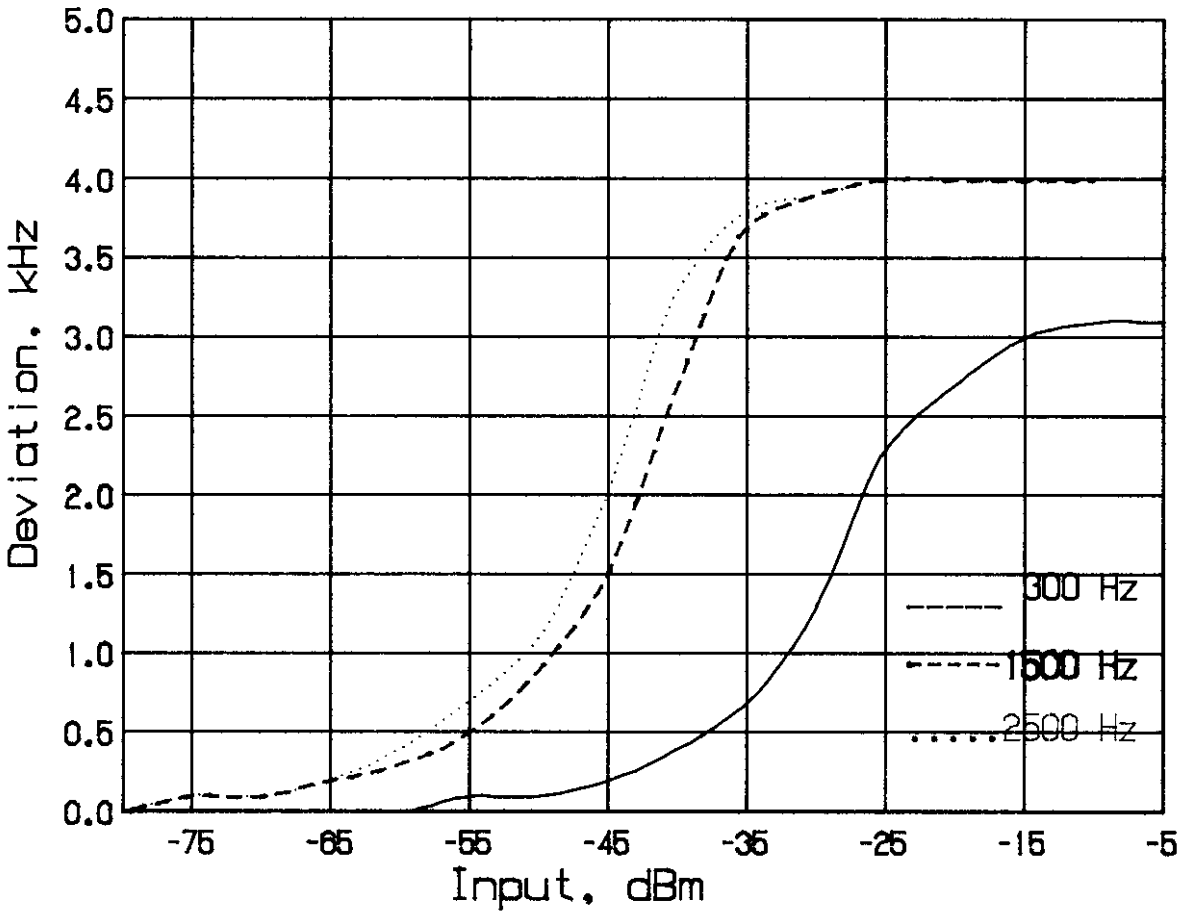


MODULATION FREQUENCY RESPONSE
FCC ID: F3JSP200V2

FIGURE 1

FIGURE 2a

AUDIO LIMITER CHARACTERISTICS

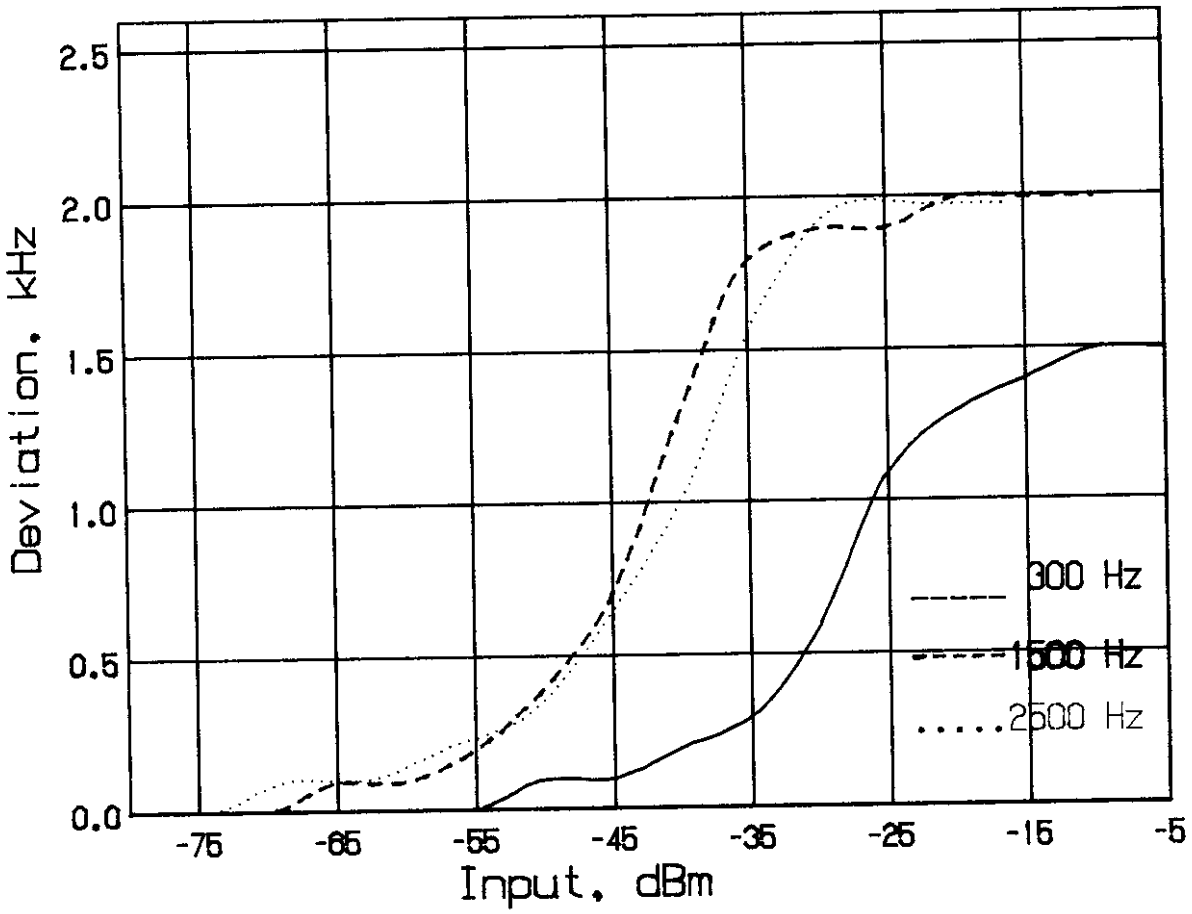


AUDIO LIMITER CHARACTERISTICS
FCC ID: F3JSP200V2

FIGURE 2a Wideband (5 kHz)

FIGURE 2b

AUDIO LIMITER CHARACTERISTICS

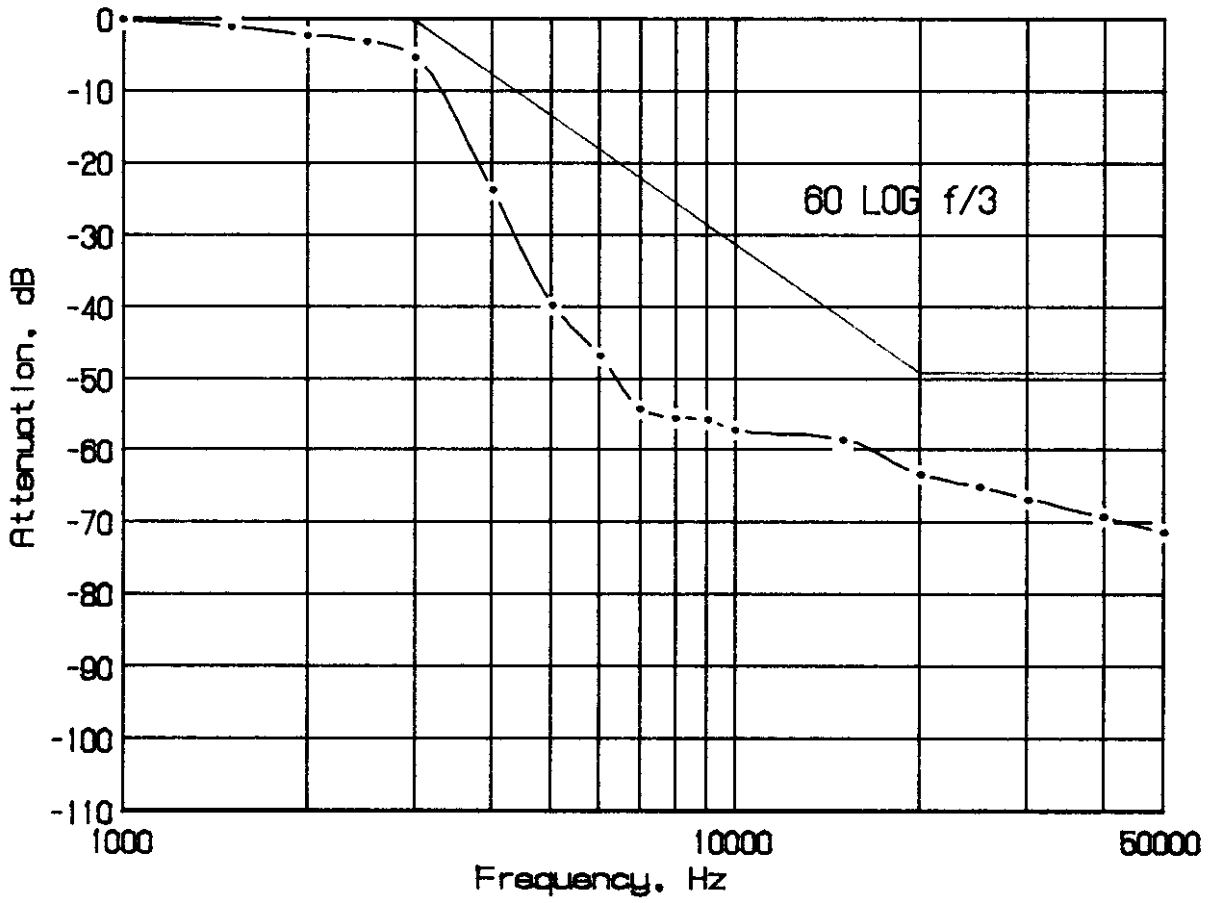


AUDIO LIMITER CHARACTERISTICS
FCC ID: F3JSP200V2

FIGURE 2b Narrow band (2.5 kHz)

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

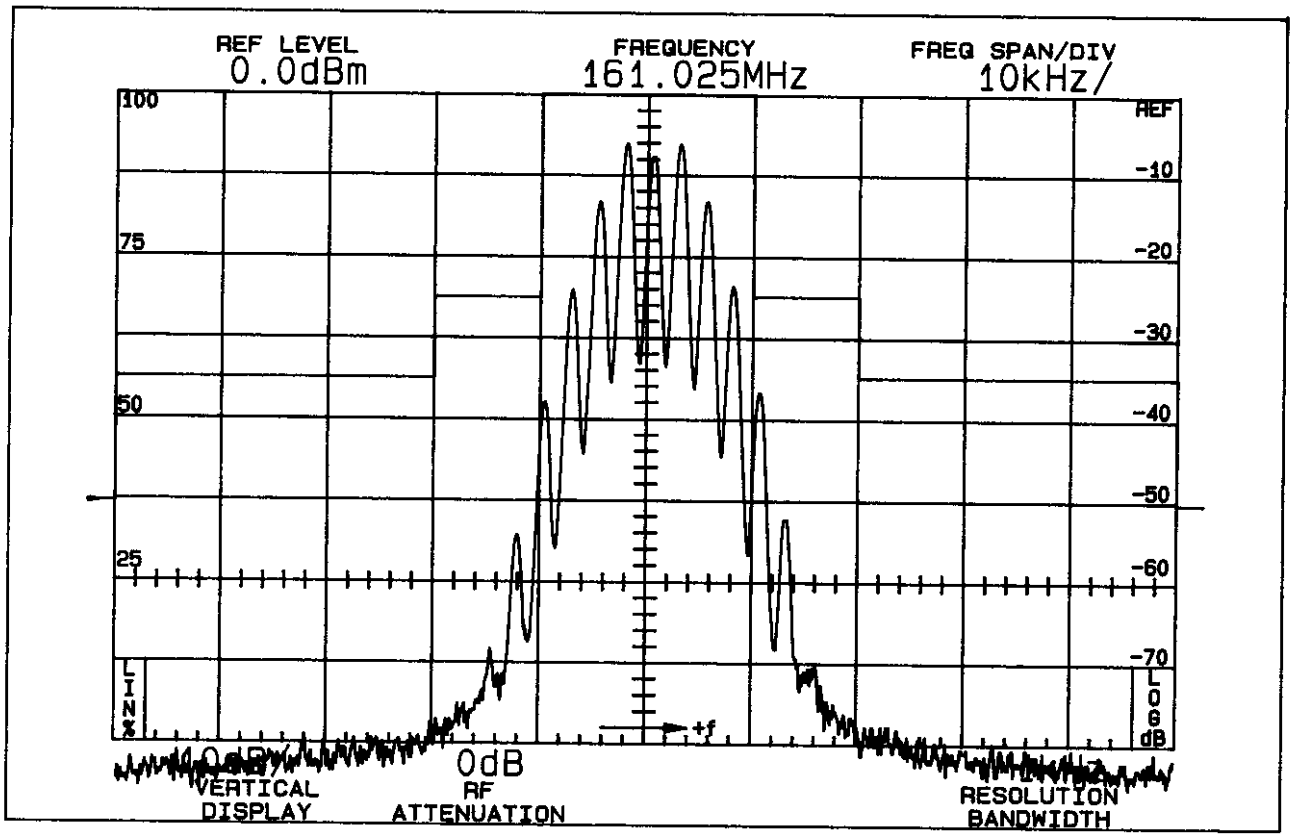


AUDIO LOW PASS FILTER RESPONSE
FCC ID: F3JSP200V2

FIGURE 3

FIGURE 4a

OCCUPIED BANDWIDTH



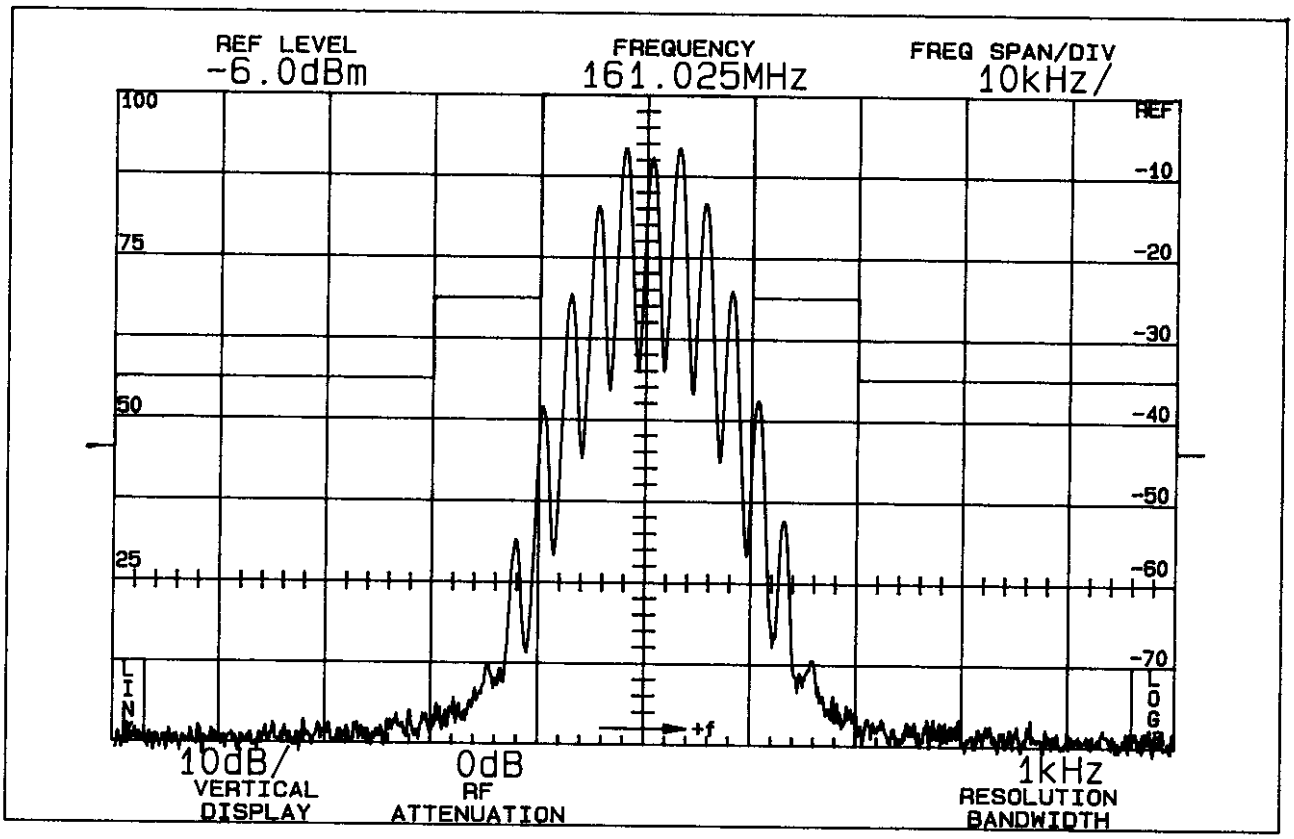
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 50 (P = 5.4 W)

OCCUPIED BANDWIDTH (5.4 W)
FCC ID: F3JSP200V2

FIGURE 4a (5 kHz)

FIGURE 4b

OCCUPIED BANDWIDTH



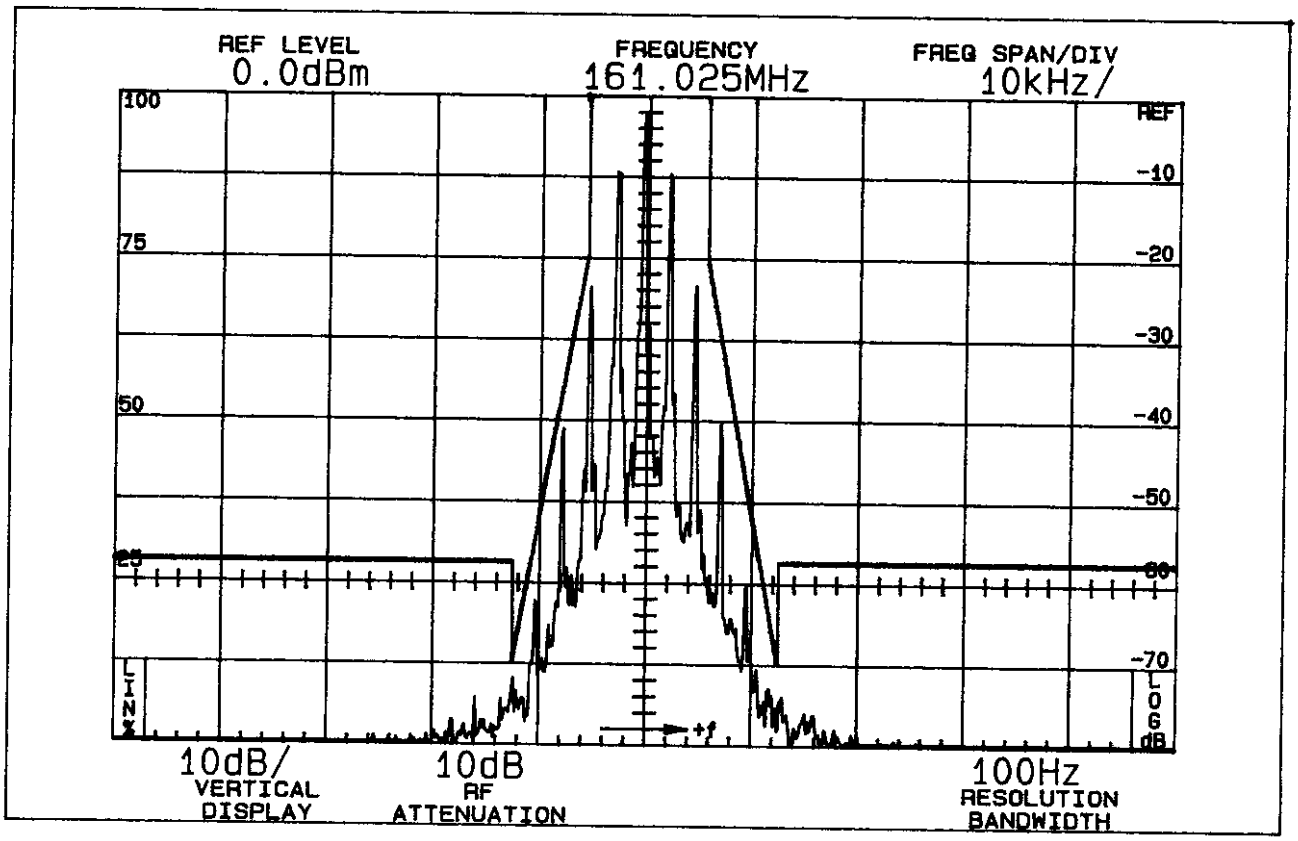
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 44 (P = 1.2 W)

OCCUPIED BANDWIDTH (1.2 W)
FCC ID: F3JSP200V2

FIGURE 4b (5 kHz)

FIGURE 4c

OCCUPIED BANDWIDTH



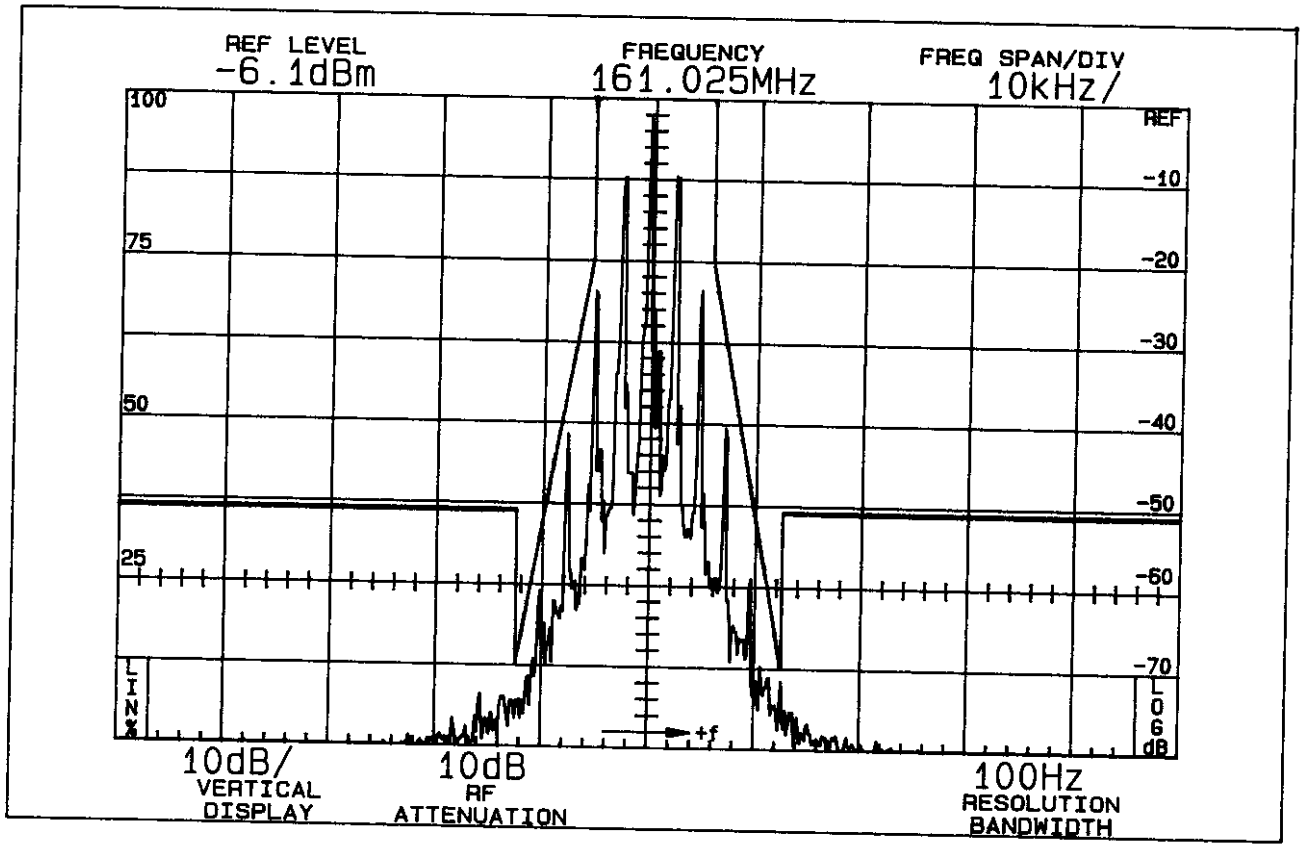
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o.	0 (>5.625 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: at least 7.27 (f_d - 2.88 kHz) dB.	70 (@ 12.5 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz.	50+10LogP = 57 (>12.5 kHz) (P = 5.4W)

OCCUPIED BANDWIDTH (F3E 5.4W)
FCC ID: F3JSP200V2

FIGURE 4c (2.5 kHz)

FIGURE 4d

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o.	0 (>5.625 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: at least 7.27 (f_d - 2.88 kHz) dB.	70 (@ 12.5 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz.	50+10LogP = 51 (>12.5 kHz) (P = 1.2W)

OCCUPIED BANDWIDTH (F3E 1.2W)
FCC ID: F3JSP200V2

FIGURE 4d (2.5 kHz)

D. MODULATION CHARACTERISTICS (Continued)

The plots are 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.

Resolution bandwidth was 100 Hz; video bandwidth 1 kHz; max store display; 20 second scan time.

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

The SP-200V2 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 2758 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through a Narda 765-20 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 7.5 volts throughout the tests.

Spurious emissions were measured at 5.4 and 1.2 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
161.025, 7.5 Vdc Input

	Spurious Frequency MHz	dB Below Carrier Reference	
5.4 W			
	322.050	92	
	483.075	81	
	644.100	86	
	805.125	99	
	966.150	>106	
	1127.175	>101	
	1288.200	>104	
	1449.225	>104	
	1610.250	>100	
	Required:	50	(57) 90.210(d)
1.2 W			
	322.050	80	
	483.075	76	
	644.100	100	
	805.125	97	
	966.150	>100	
	1127.175	>104	
	1288.200	>104	
	1449.225	>104	
	1610.250	97	
	Required:	44	(51) 90.210(d)

All other emissions from 12 MHz to the tenth harmonic were 20 dB or more below FCC limit.

*Reference data only, more than 20 dB 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 SP-200V2 were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated dipole antennas below 1 GHz, and Polarad CA-L, and CA-S or EMCO 3115 from 1-5.0 GHz.

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 7.5 Vdc.

Output power was 5.4 watts at 161.025 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 radiations was taken as an ideal dipole excited by 5.4 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 $E = \frac{(49.2 \times 5.4)^{1/2}}{3} = 5.3$ V/m

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

5.3 volts/meter = 5.4×10^6 uV/m

dBu/m = $20 \log_{10}(5.4 \times 10^6)$

= 135 dBu/m

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

135 - 107 = 28 dBm

*Reference Data for Radio Engineers, 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 95 dB or more 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

161.025 MHz, 7.5 Vdc, 5.4 watts

Spurious Frequency MHz	dB Below Carrier Reference[1]	
322.050	83V*	
483.075	76V*	
644.100	87H*	
805.125	91V*	
966.150	96H*	
1127.175	104V*	
1288.200	103V*	
1449.225	100H*	
1610.250	94H*	
Required:	50	(57) 90.210(d)

[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 4.6 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 supply was 7.5 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 161.025 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY vs. TEMPERATURE

161.025 MHz; 7.5 Vdc; 5.4 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-30.1	161.025158	1.0
-21.4	161.025052	0.3
-10.1	161.024993	0.0
- 0.5	161.025100	0.6
10.7	161.025185	1.1
20.9	161.025066	0.4
29.7	161.024971	-0.2
39.5	161.024935	-0.4
49.6	161.024939	-0.4
Maximum frequency error:	161.025185	
	161.025000	
	+ .000185 MHz	

FCC Rule 90.213(a) specifies .00025% or a maximum of ± .000403 MHz, which corresponds to:

High Limit	161.025403 MHz
Low Limit	161.024597 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 7.5 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

161.025 MHz, 7.5 Volts Nominal, 5.4 W

%	Supply Voltage	Output Frequency, MHz	p.p.m.
115	8.63	161.025143	0.9
110	8.25	161.025127	0.8
105	7.88	161.025099	0.6
100	7.50	161.025066	0.4
95	7.13	161.025033	0.2
90	6.75	161.025003	0.0
85	6.38	161.024978	-0.1
80	6.00*	161.024961	-0.2

Maximum frequency error: 161.025143
161.025000

\+ .000143 MHz

*MFR rated battery end-point

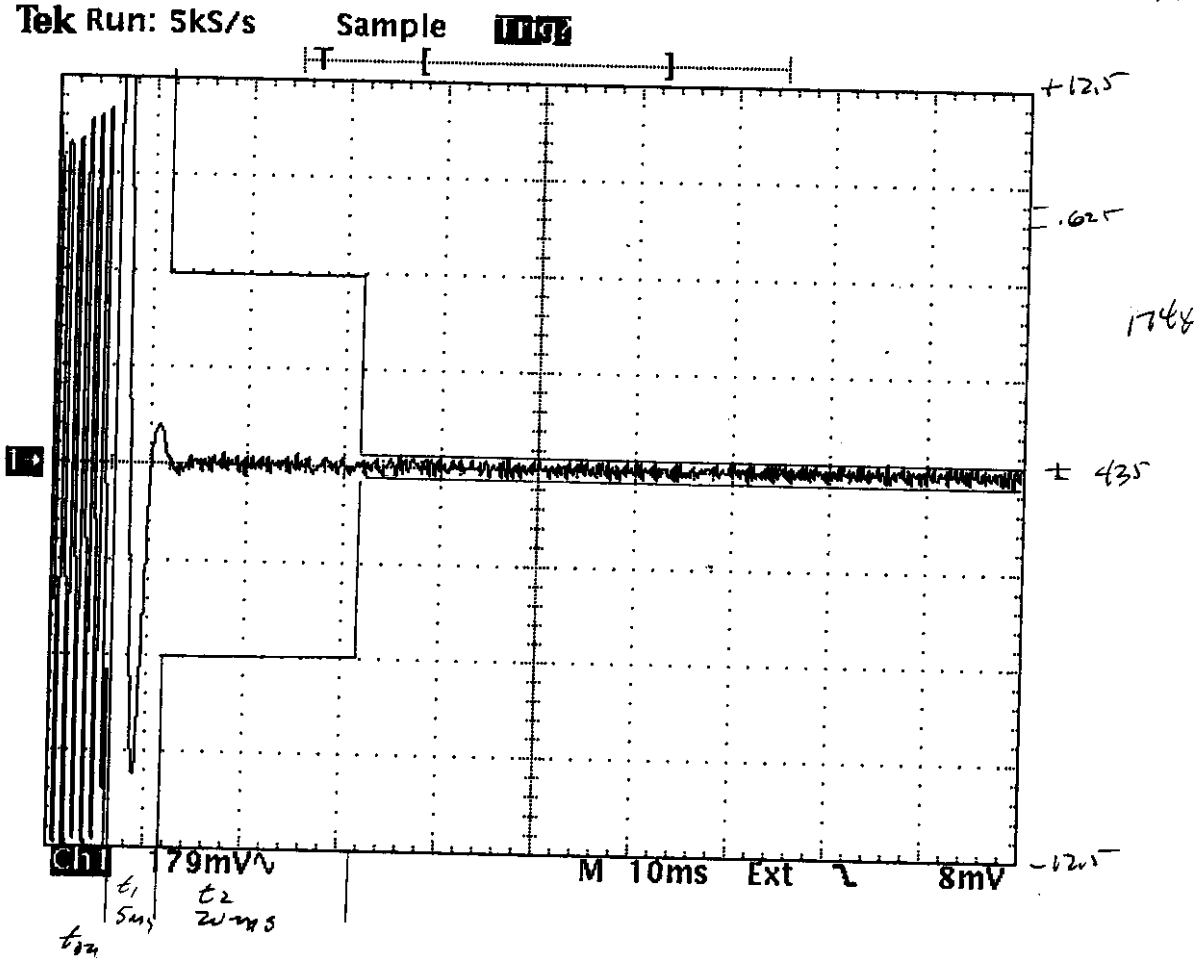
FCC Rule 90.213(a) specifies .00025% or a maximum of ± .001150 MHz, corresponding to:

High Limit 161.025403 MHz
Low Limit 161.024597 MHz

J. TRANSIENT FREQUENCY BEHAVIOR
(Paragraph 90.214 of the Rules)

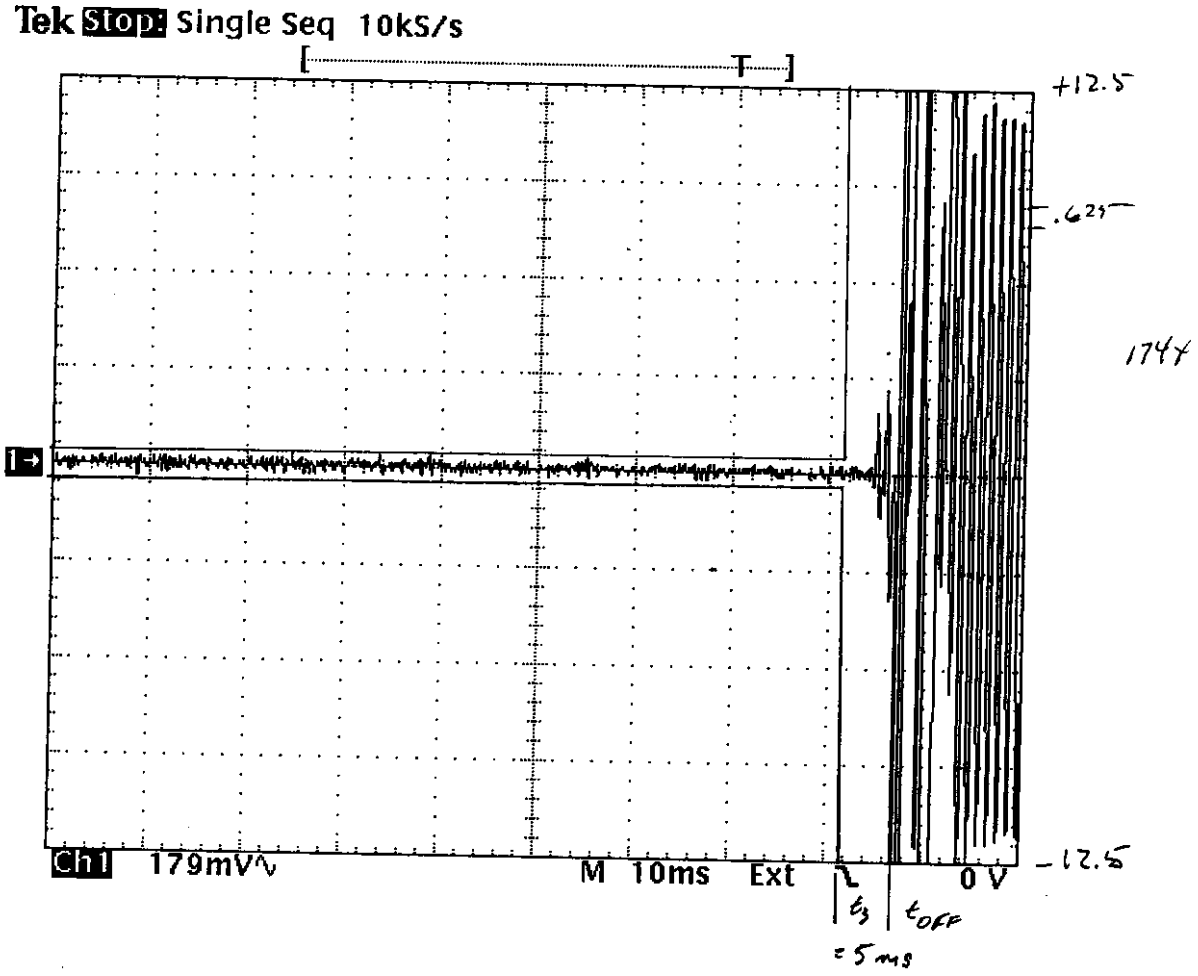
Plots identified as Figures 5 through 7 demonstrate TFB for 12.5 kHz or 25 kHz channel operation.

See Appendix 9 for test description.



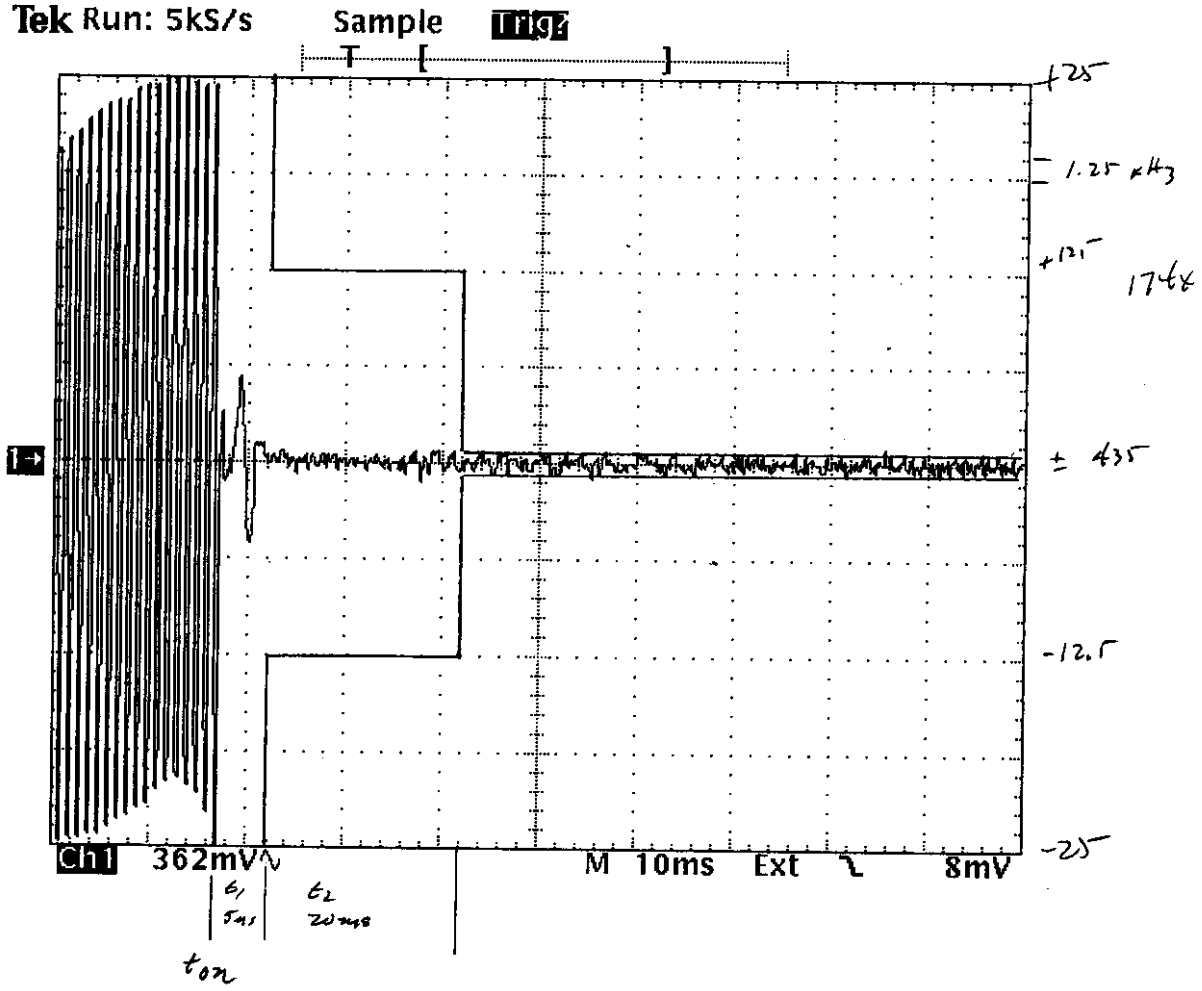
TRANSIENT FREQUENCY BEHAVIOR
FCC ID: F3JSP200V2

FIGURE 5 (12.5 kHz Turn-on)



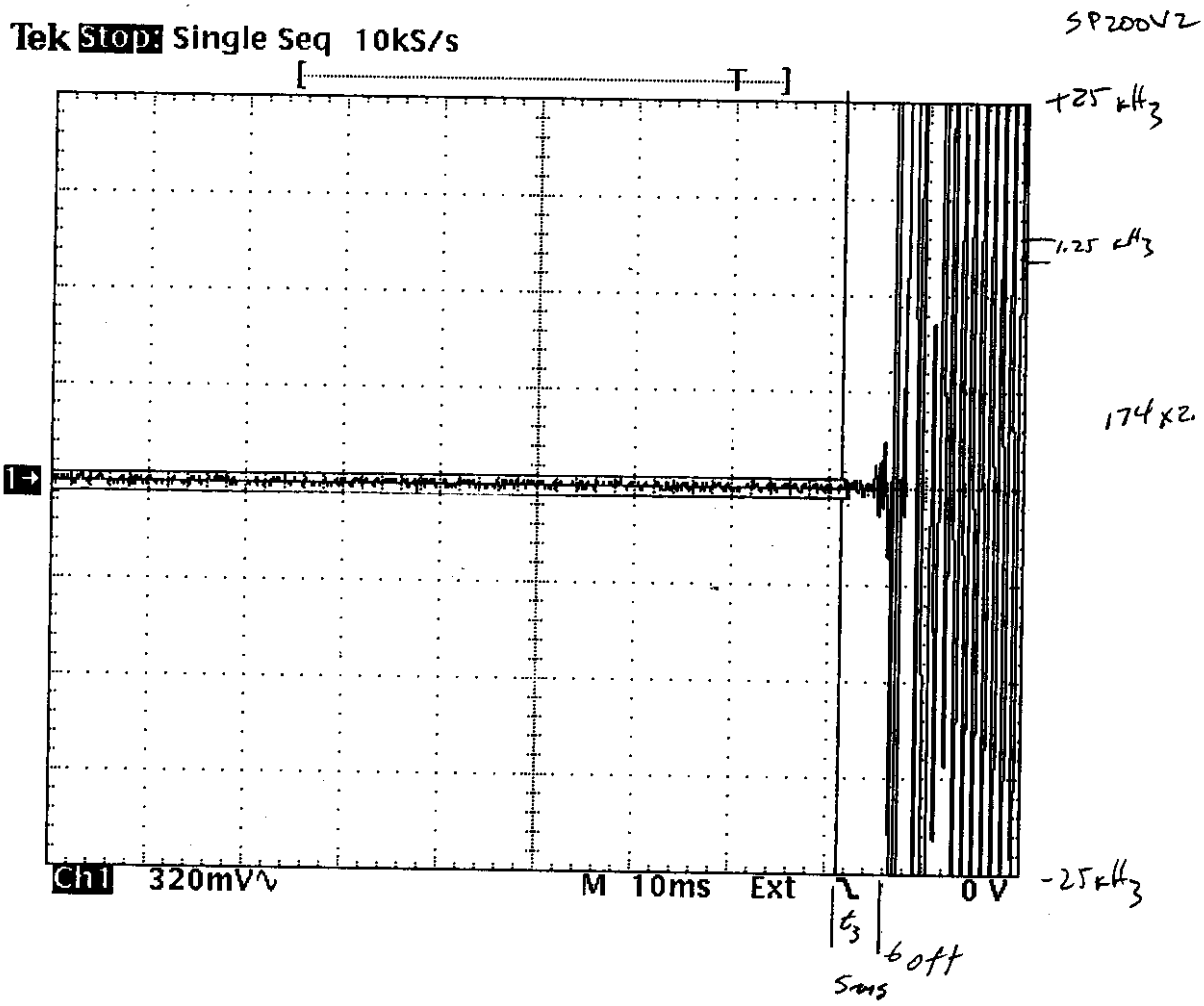
TRANSIENT FREQUENCY BEHAVIOR
FCC ID: F3JSP200V2

FIGURE 6 (12.5 kHz Turn-off)



TRANSIENT FREQUENCY BEHAVIOR
FCC ID: F3JSP200V2

FIGURE 7 (25 kHz Turn-on)



TRANSIENT FREQUENCY BEHAVIOR
FCC ID: F3JSP200V2

FIGURE 8 (25 kHz Turn-off)

APPENDIX 3

FUNCTION OF DEVICES
SP-200V2

REFERENCE NUMBER	DESCRIPTION	FUNCTION
TCXO1	KXN1355AA	TCXO, 12.8 MHz
Q16	MMBR951	RF Amp/Buffer
Q17	BFR951	Amplifier
Q3	MMBR951	Driver
IC9	M68776	Final RF Amplifier
IC2	MC145191F	PLL
IC406	XR56408-QFP	Audio Amp/Limiter/ Low Pass Filter

APPENDIX 9

TRANSIENT FREQUENCY BEHAVIOR (90.214) TEST PROCEDURE

FOLLOWS THIS SHEET

90.214 REQUIREMENTS: In the 150 - 174 MHz frequency band, transient frequencies must be within the maximum frequency difference limits during the time interval indicated below for 25, 12.5 and 6.25 kHz channels:

12.5 kHz:

Time Interval	Maximum Frequency	Mobile Radios 150 - 174 MHz
t_1	±12.5 kHz	5.0 ms
t_2	±6.25 kHz	10.0 ms
t_3	±12.5 kHz	5.0 ms

25.0 kHz

Time Interval	Maximum Frequency	Mobile Radios 150 - 174 MHz
t_1	±25.0 kHz	5.0 ms
t_2	±12.5 kHz	20.0 ms
t_3	±25.0 kHz	5.0 ms

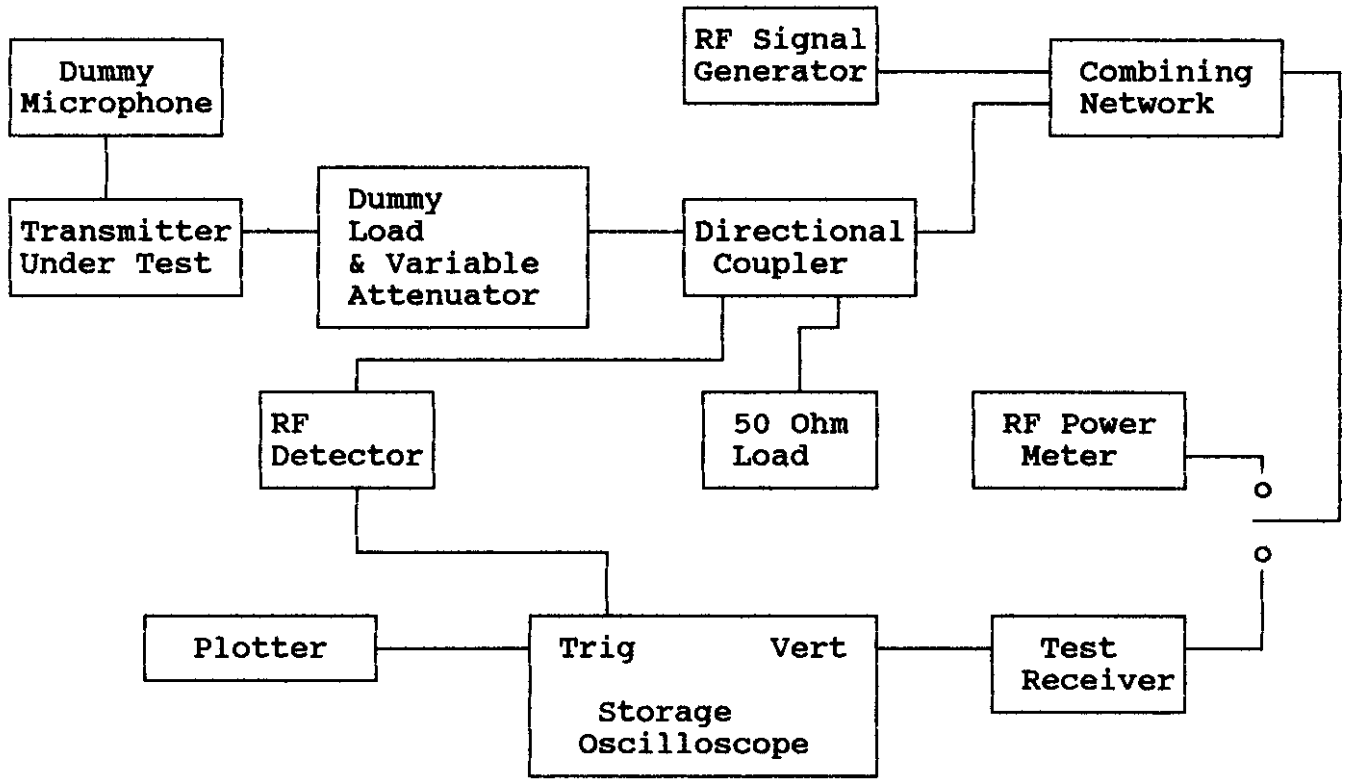
TEST PROCEDURE: TIA/EIA TS603, PARA. 2.219, the levels were set as follows:

1. Using the variable attenuator, the transmitter level was set to 40 dB below the test receivers maximum input level, then the transmitter was turned off.

2. With the transmitter off, the signal generator was set 20 dB below the level of the transmitter in the above step (this level was maintained with the signal generator throughout the test).

3. Attenuation between the transmitter and the RF detector was reduced by 30 dB.

4. The transient frequency behavior was observed and recorded using a TEK TDS360 DSO.

Para. 2.995(a)(b)(d) Frequency stability

90.214 Transient Frequency Behavior
(continued)