ENGINEERING STATEMENT

For Type Certification of

MIDLAND CONSUMER RADIO

Model No: HP-425
FCC ID: MMAALHP425

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 type certification measurements on the HP-425 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: January 31, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for Type Certification of the HP-425 transceiver in

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

The HP-425 is a multi-bandwidth, UHF, frequency modulated transceiver intended for hand-held, portable applications in the 440 - 470 MHz band. It operates from a 7.5-volt battery pack. Manufacturer's rated output power is 1-5 watts. Both 25 kHz and 12.5 kHz channel operation is provided.

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

1. Name of applicant: Midland Consumer Radio

2. Identification of equipment: MMAALHP425

   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; 11k0F3E emission
   b. Frequency range: 440-470 MHz.
   c. Operating power of transmitter is fixed at the factory at 5 watts and can be reduced to 1 watt.
   d. Maximum power permitted under Part 90 of the FCC is 350 watts, and the HP-425 fully complied with those power limitations.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 7.4 Vdc
      Collector current: 1.3 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.

   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.

B. GENERAL INFORMATION...(Continued)

5. Data for 2.985 through 2.997 follow this section.

C. RF POWER OUTPUT (Paragraph 2.985(a) of the Rules)

a) Conducted

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 measured was 4.6 watts; and with internal adjustments minimum power was 1.0 watts.

b) ERP(d)

Using the supplied antenna, ERP(d) was determined, by substitution as 1.6 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 4a, 4b, 4c and 4d are plots of the sideband envelope of the transmitter for both 4.6 and 1.0 watt output taken with a Advantest R3361A 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 2462 Hz, the frequency of maximum response. Measured modulation under these conditions

was 2.9 kHz, or 1.4 kHz for 25 or 12.5 kHz channelization respectively.

For the 12.5 kHz channelization, RBW was 100 Hz, VBW 100 Hz, max hold, multiple scan per 90.210(d)(4).

All plots have unmodulated carrier as 0 dBm reference.

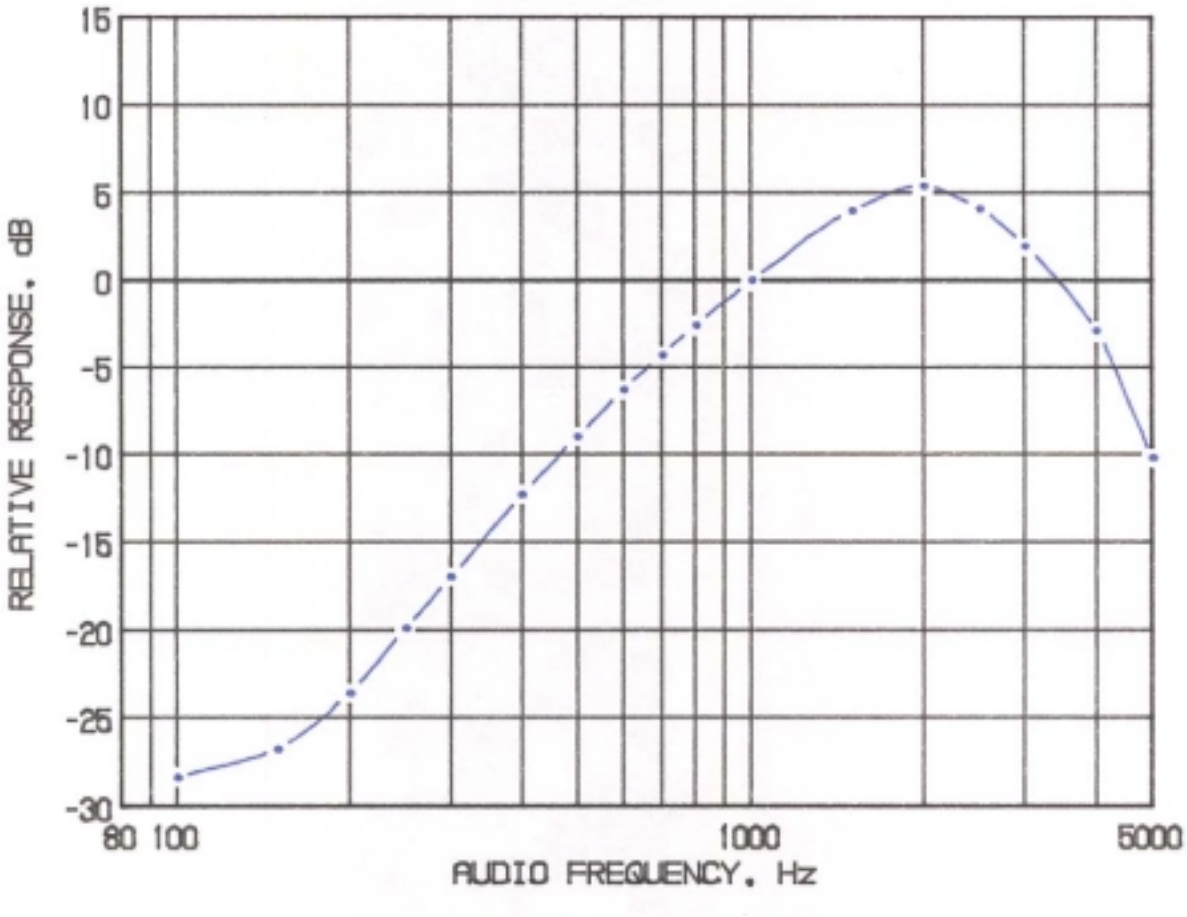
Emission designators: (2D + 2F)

25 kHz 2x5 + 2x3 = 16k0F3E
12.5 kHz 2x2.5 + 2x3 = 11k0F3E

D = rated system deviation, kHz.
F = maximum audio frequency, kHz.

FIGURE 1

MODULATION FREQUENCY RESPONSE

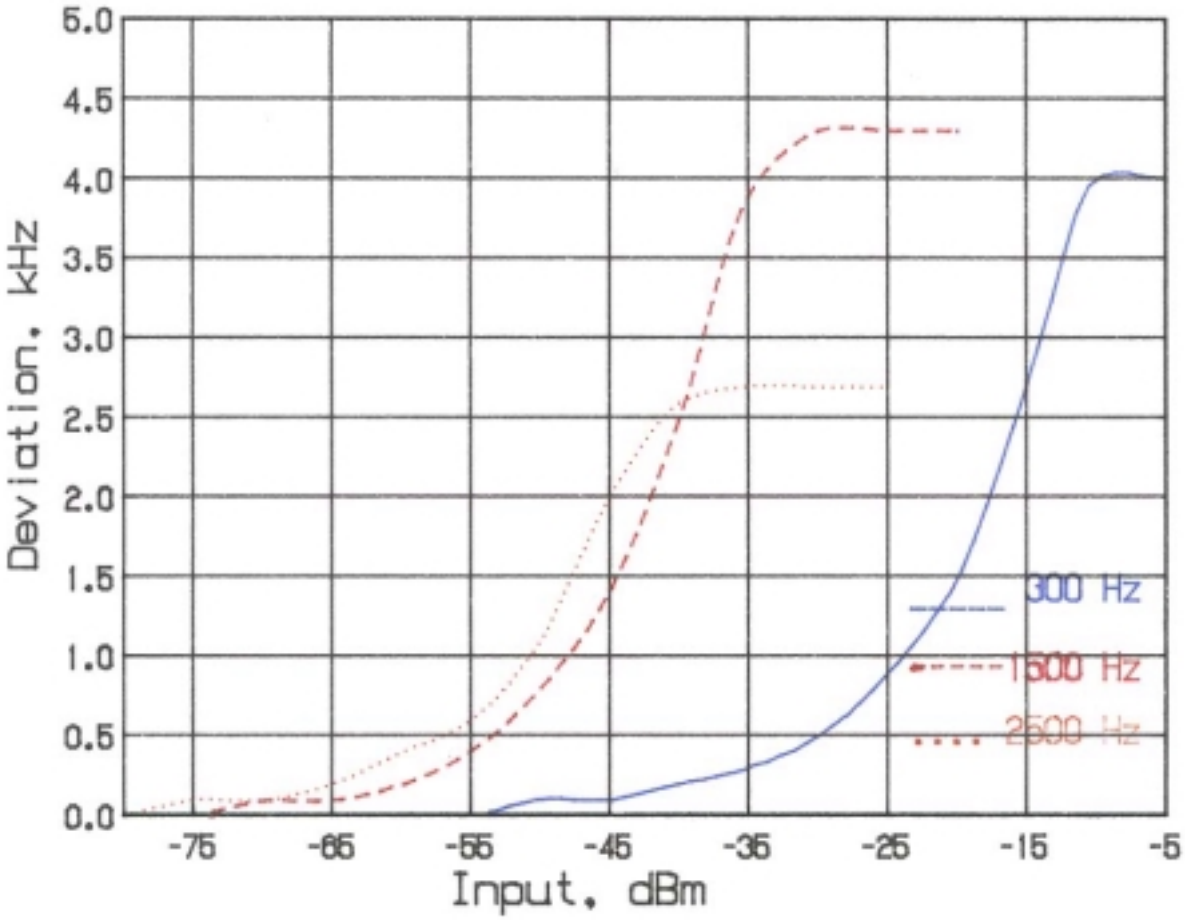


MODULATION FREQUENCY
RESPONSE
FCC ID: MMAALHP425

FIGURE 1

FIGURE 2a

AUDIO LIMITER CHARACTERISTICS

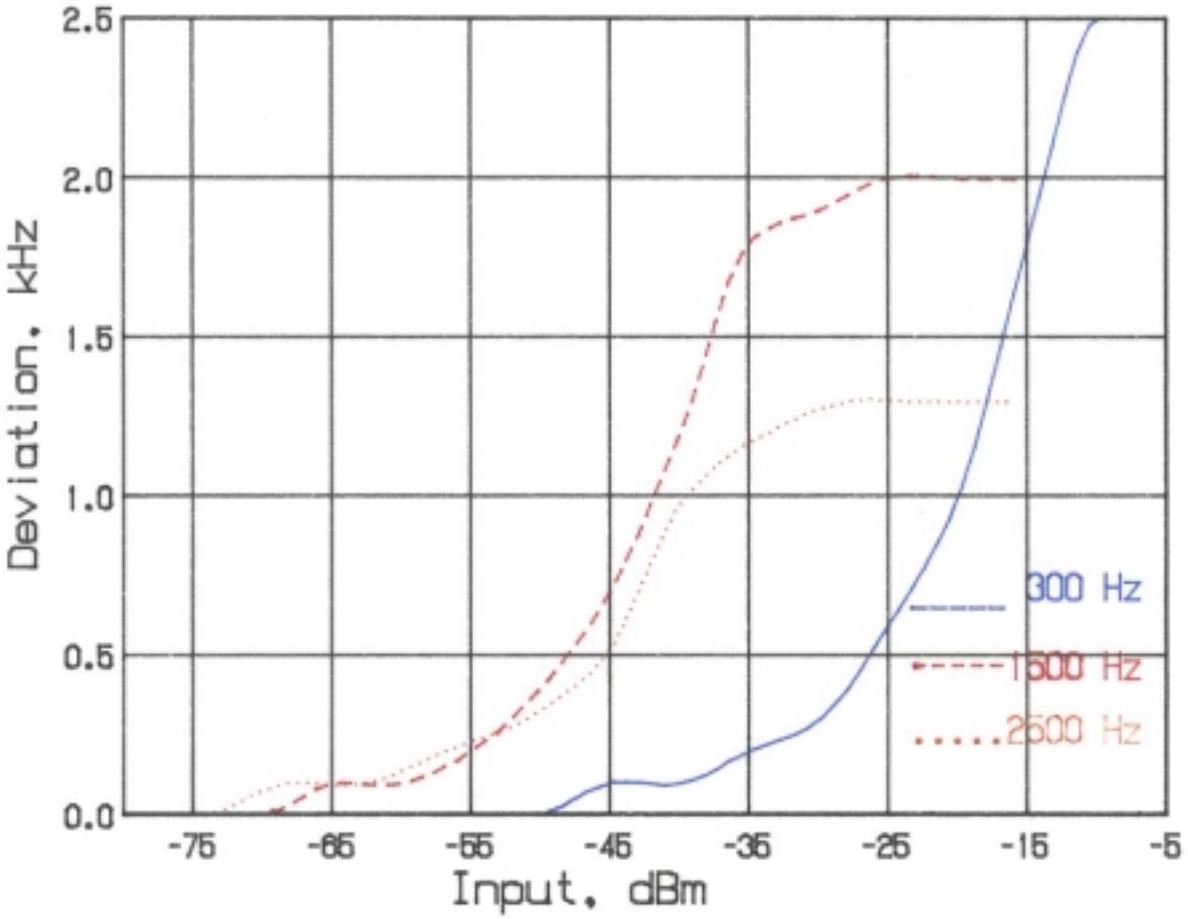


AUDIO LIMITER CHARACTERISTICS
FCC ID: MMAALHP425

FIGURE 2a Wideband (5 kHz)

FIGURE 2b

AUDIO LIMITER CHARACTERISTICS



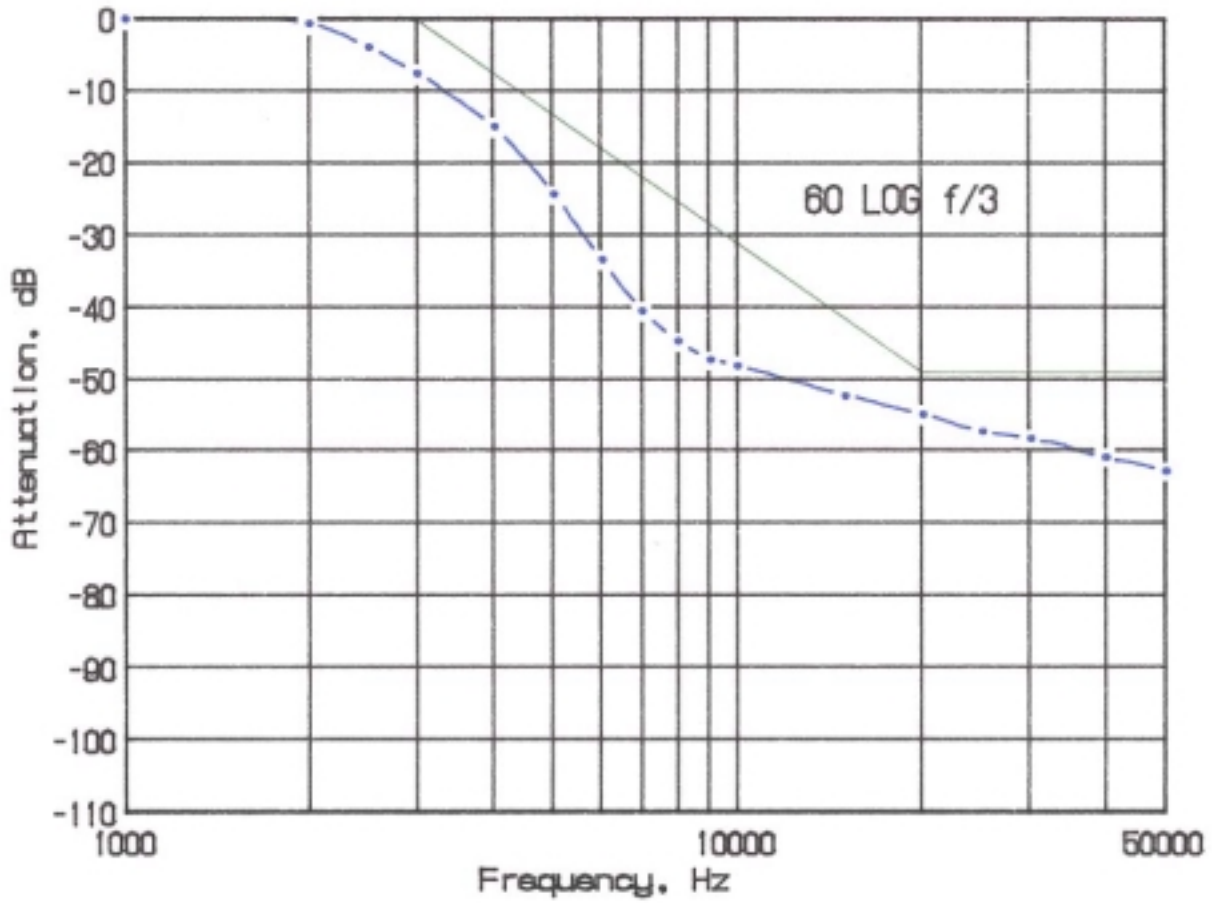
Note: Deviation @ 300 Hz did not exceed 2.5 kHz

AUDIO LIMITER CHARACTERISTICS
FCC ID: MMAALHP425

FIGURE 2b Narrow band (2.5kHz)

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

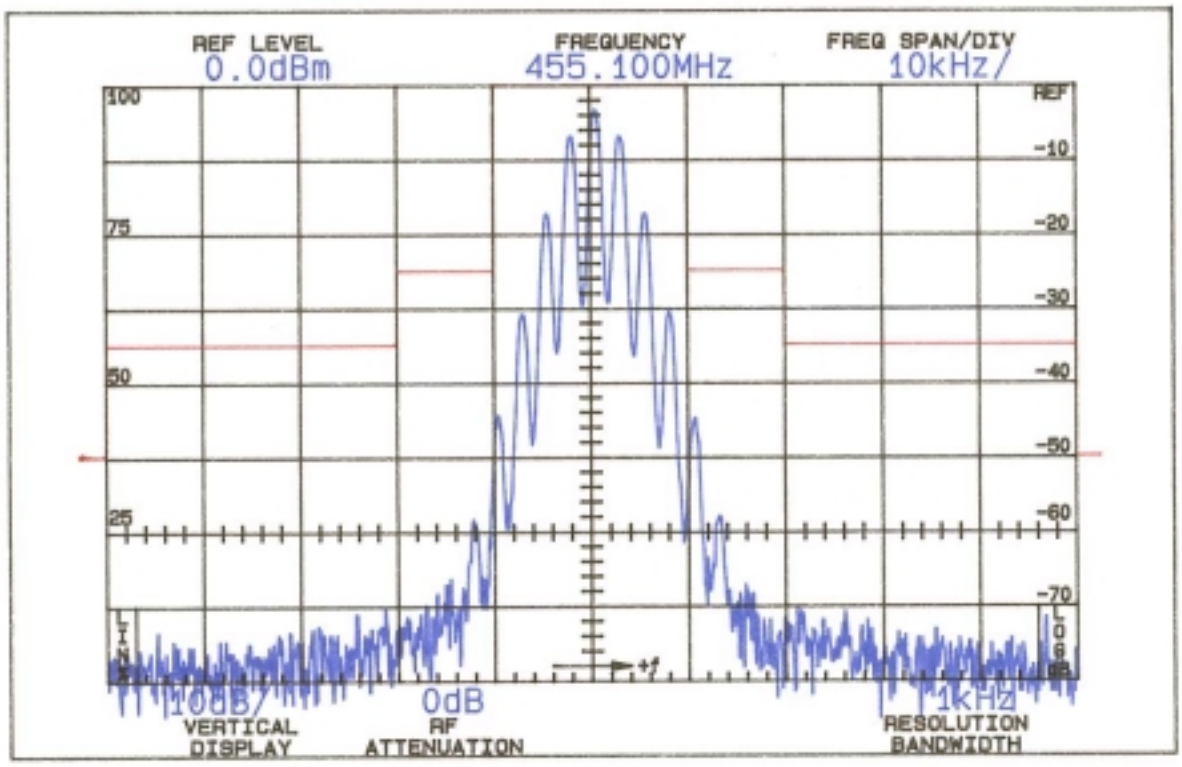


AUDIO LOW PASS FILTER RESPONSE
FCC ID: MMAALHP425

FIGURE 3

FIGURE 4a

OCCUPIED BANDWIDTH



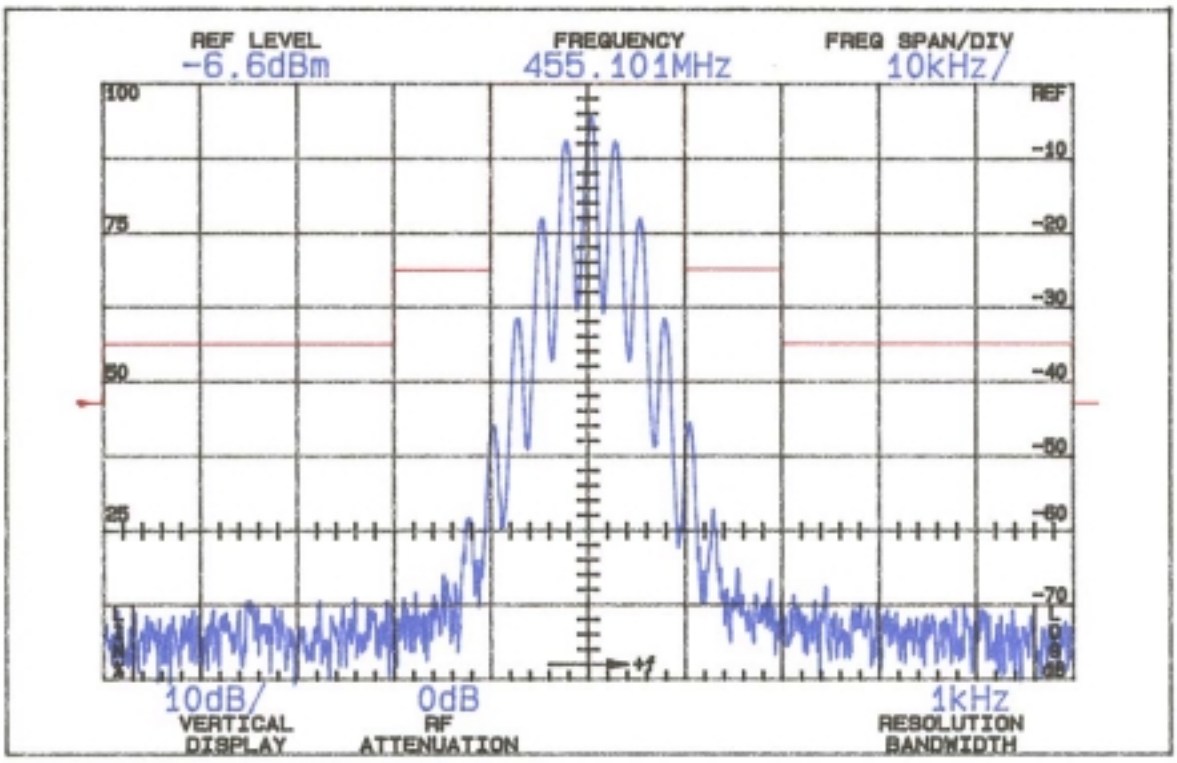
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 45 (P = 4.6 W)

OCCUPIED BANDWIDTH (4.6W)
FCC ID: MMAALHP425

FIGURE 4a (5 kHz)

FIGURE 4b

OCCUPIED BANDWIDTH



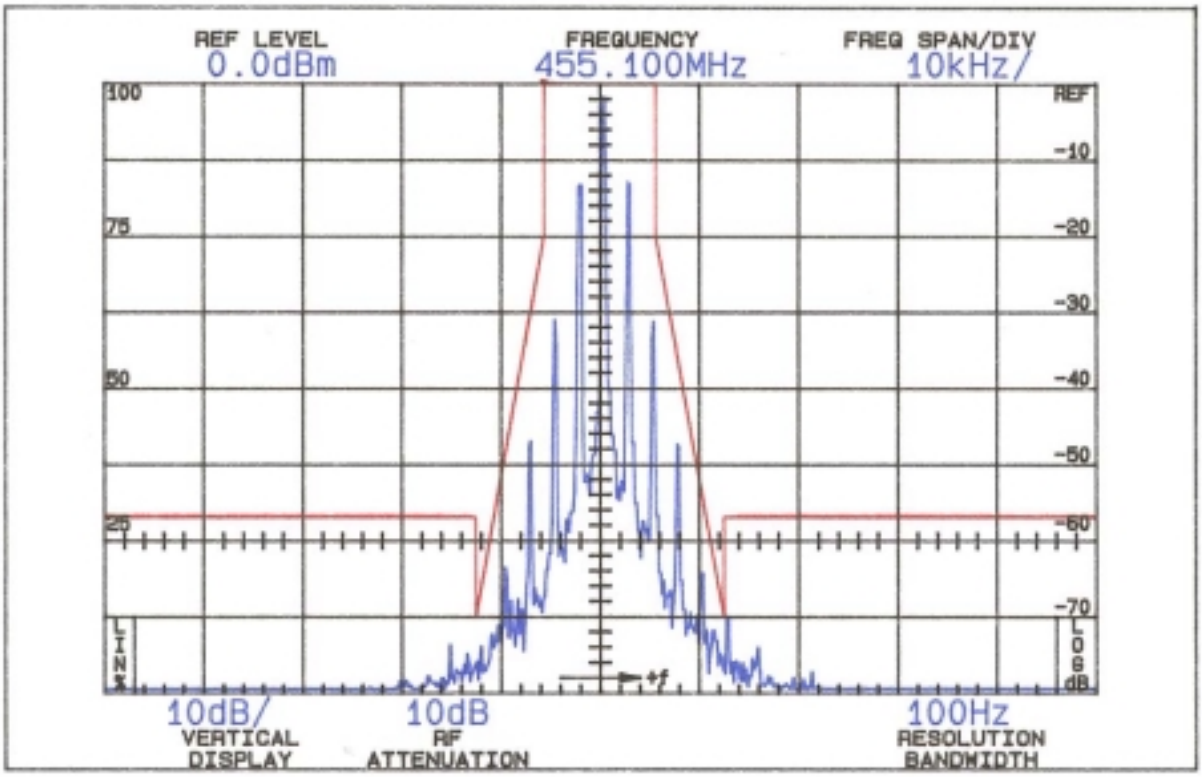
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 20 kHz (10-20 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (20-50 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 50 kHz)	43+10LogP = 43 (P = 1.0 W)

OCCUPIED BANDWIDTH (1.0W)
FCC ID: MMAALHP425

FIGURE 4b (5 kHz)

FIGURE 4c

OCCUPIED BANDWIDTH



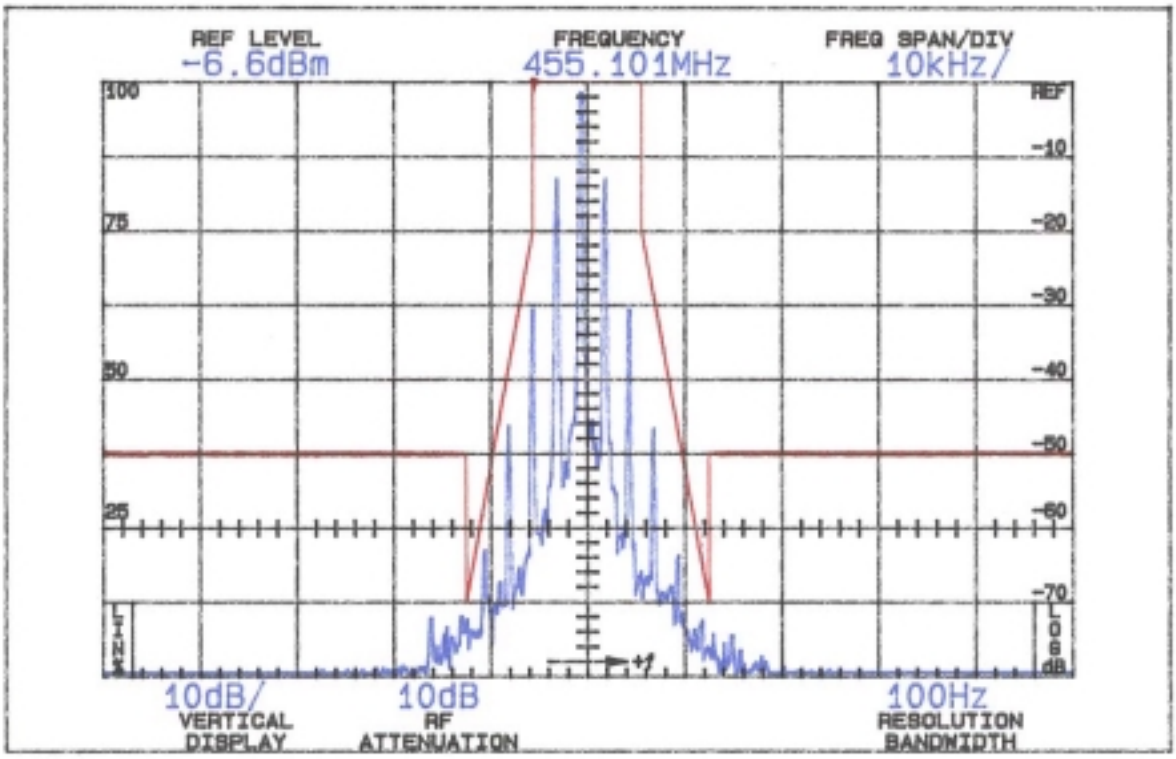
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o.	0 (>5.625 kHz)
On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no 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 = 4.6W)

OCCUPIED BANDWIDTH (F3E 4.6W)
FCC ID: MMAALHP425

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 = 50 (>12.5 kHz) (P = 1.0W)

OCCUPIED BANDWIDTH (F3E 1.0W)
FCC ID: MMAALHP425

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 HP-425 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 2462 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 4.6 and 1.0 watts output throughout the RF spectrum from 12.8 (lowest frequency generated in the transmitter) 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
455.100, 7.5 Vdc Input

Spurious Frequency MHz	dB Below Carrier Reference

4.6 W

910.204	90	
1365.306	>100	
1820.408	>100	
2275.510	95	
2730.612	>100	
3185.714	>100	
3640.816	>100	
4095.918	>100	
4551.020	>100	
Required:	50	(57) 90.210(d)

1.0 W

910.204	90	
1365.306	>100	
1820.408	99	
2275.510	99	
2730.612	>100	
3185.714	>100	
3640.816	>100	
4095.918	>100	
4551.020	>100	
Required:	43	(50) 90.210(d)

All other emissions from 12.8 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

Measurements of radiated spurious emissions from the HP-425 were by substitution, made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antenna for the measurements to 1 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 7.5 Vdc. The transmitter and test antenna were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

Conducted output power was measured as 4.6 watts.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

455.100 MHz, 7.5 Vdc

Spurious Frequency MHz	dB Below Carrier Reference[1]
455.102	1.6W ERP(d) Ref.
910.204	>76
1365.306	62H
1820.408	68V
2275.510	>76
2730.612	>76

3185.714	71V		
3640.816	>76		
4095.918	>76		
4551.020	>76		
Required:	49	(56)	90.210(d)

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

All other spurious from 12.8 MHz to 4.7 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 S1.0 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 455.100 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY vs. TEMPERATURE

455.100 MHz; 7.5 Vdc; 4.6 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-29.3	455.100212	0.5
-19.9	455.100122	0.3
-10.0	455.099804	-0.4
0.3	455.099692	-0.7
10.6	455.099775	-0.5
19.8	455.100097	0.2
30.4	455.100296	0.7
39.8	455.100452	1.0
50.5	455.100485	1.1
Maximum frequency error:	455.100485	
	455.100000	
	+ .000485 MHz	

FCC Rule 90.213(a) specifies .00025% or a maximum of ± .001138 MHz, which corresponds to:

High Limit	455.101138 MHz
Low Limit	455.098862 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
455.100 MHz, 7.5 Volts Nominal, 4.6 W

%	Supply Voltage	Output Frequency, MHz	p.p.m.
115	8.63	455.099960	-0.1
110	8.25	455.099985	0.0
105	7.88	455.100043	0.1
100	7.50	455.100097	0.2
95	7.13	455.100137	0.3
90	6.75	455.100169	0.4
85	6.38	455.100193	0.4
80	6.00*	455.100210	0.5

Maximum frequency error: 455.100210
455.100000
+ .000210 MHz

*MFR rated battery end-point

FCC Rule 90.213(a) specifies .00025% or a maximum of ± .001138 MHz, corresponding to:

High Limit	455.101138 MHz
Low Limit	455.098862 MHz

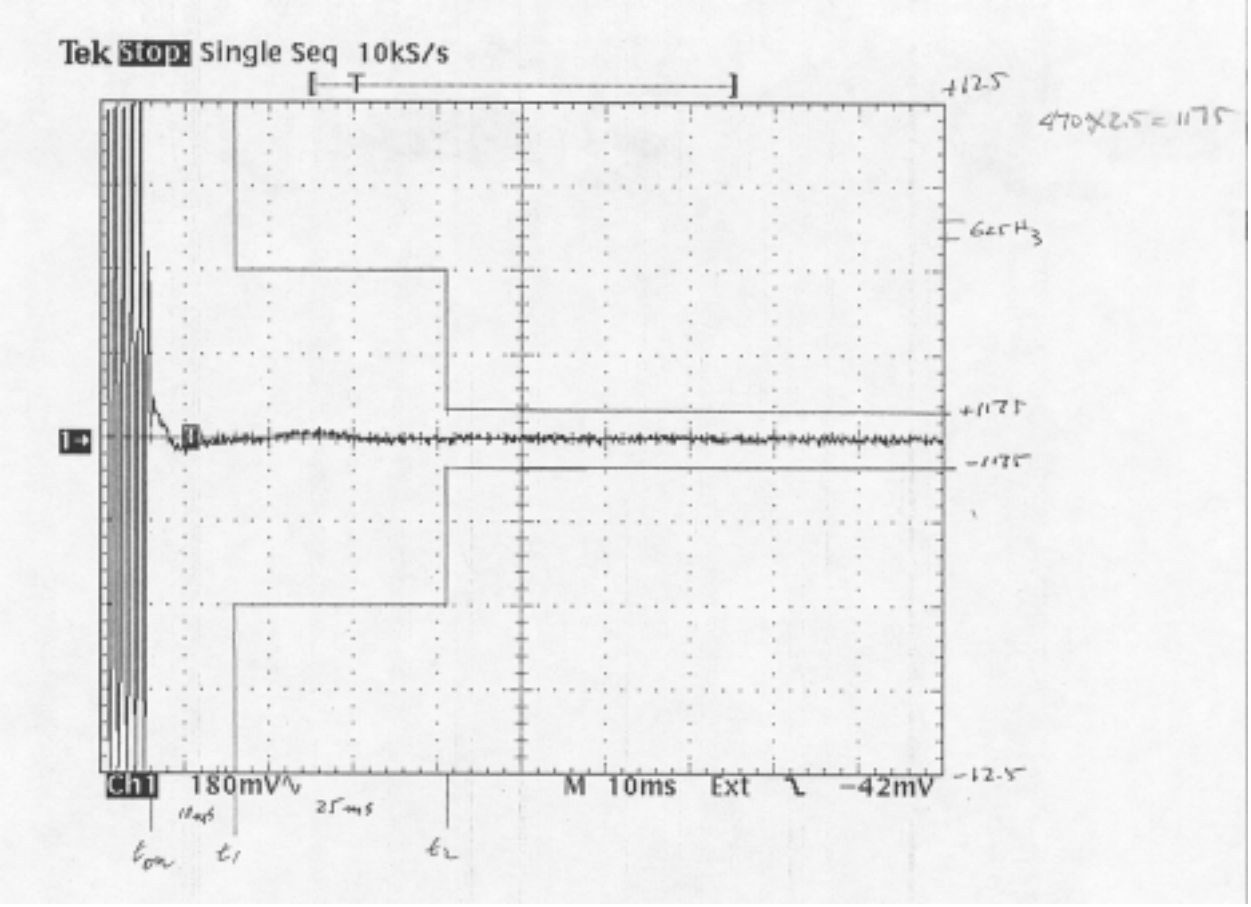
J. TRANSIENT FREQUENCY BEHAVIOR
(Paragraph 90.214 of the Rules)

Plots identified as Figure 5 and 6 demonstrate TFB for 12.5 kHz channel operation.

See Appendix 4 for test description.

FIGURE 5

TRANSIENT FREQUENCY BEHAVIOR

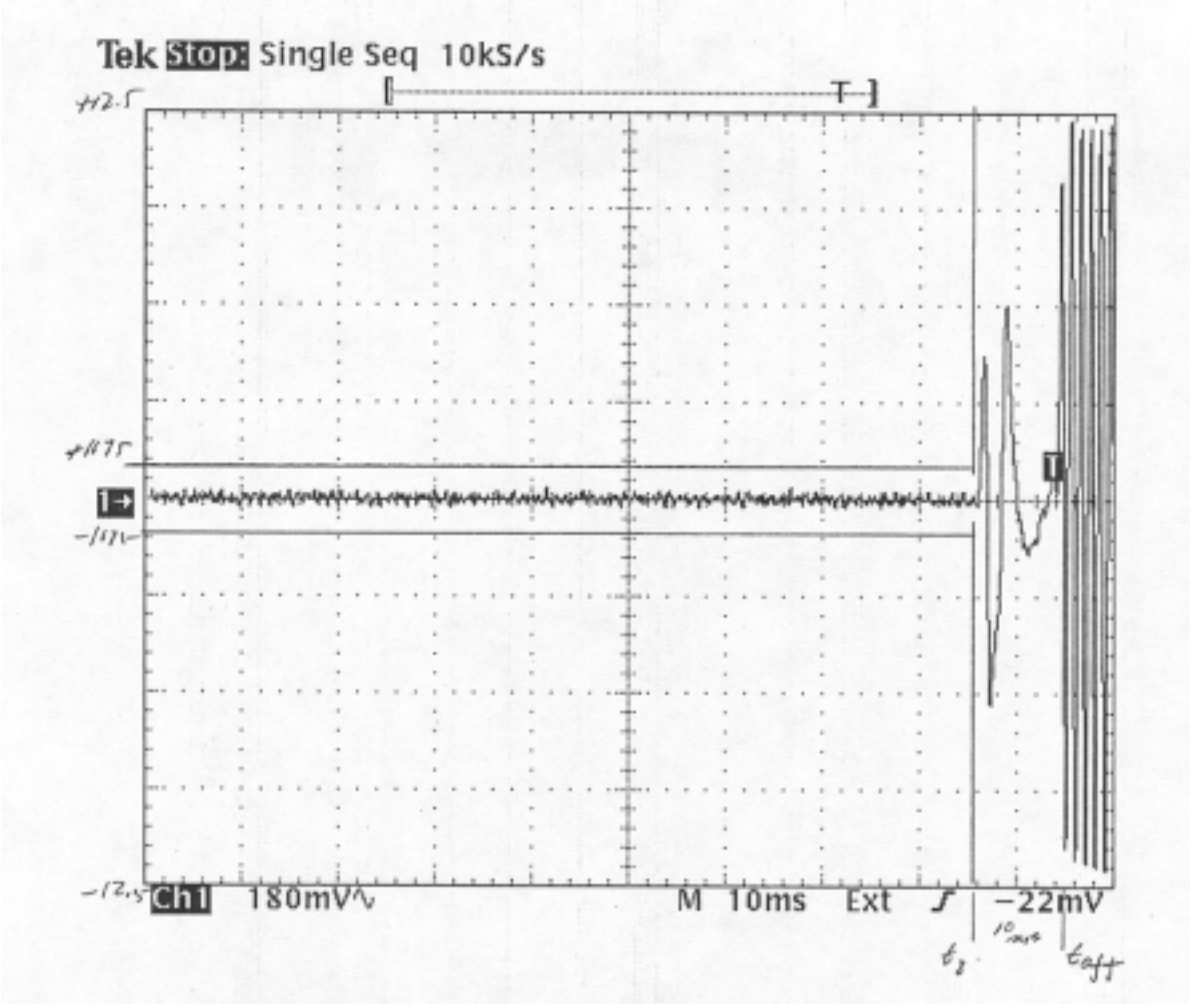


TRANSIENT FREQUENCY BEHAVIOR
FCC ID: MMAALHP425

FIGURE 5 (TURN-ON)

FIGURE 6

TRANSIENT FREQUENCY BEHAVIOR



TRANSIENT FREQUENCY BEHAVIOR
FCC ID: MMAALHP425

FIGURE 6 (TURN-OFF)

APPENDIX 1

FUNCTION OF DEVICES

Reference	Device	Function
IC 101	S80740SN	Voltage detector
IC 102	TC4SU69F	Audio mute
IC 103	TA7368F	Audio amp
IC104	S81250GUP	Regulator
IC105	TC4053B	Data multplexer
IC106	TK11250B	Regulator
IC107	TA75S558F	VOX Amp
IC108	H8/3644	MCU
IC110	FX829DS	FFSK Processor, DTMF
IC112	TC4S66F	MIC/Data switch
IC114	FX828DS	CTCSS/DCS Processor
IC115	LC7385M	DTMF Decoder
IC116	TC4S66F	12.5/25 Switch
IC117	TA31136FN	Integrated FM receiver
IC118	TK11806M	DC/DC converter
IC119	24LC65	EEprom
IC120	S81230GUP	Regulator
IC121	TA75S558F	OP amp
IC122	TA75S558F	OP amp
IC301	HD66727	Display driver
IC401	PFO350	TX PA
IC402	TK11250B	Regulator
IC403	LM358	APC
IC601	LMX1151TM	Frequency Synthesizer

Reference	Device	Function
Q102	2SK1588	Audio Mute
Q103	DTA123YE	Mic Switch
Q104	2SB1132Q	Audio Mute
Q105	2SK1588	Audio Mute
Q106	DTA123YE	Low volt inhibit
Q107	2SC4116	Audio Mute
Q108	DTA144EE	Clock Frequency Shift
Q109	DTA123YE	VOX Enable
Q110	RTIP434M	Voltage Gate
Q111	RTIP434M	Voltage Gate
Q112	RTIP434M	Voltage Gate
Q113	2SC4116	Ripple Filter
Q114	2SB1132Q	Led Switch
Q115	RTIN140M	Led Switch
Q116	2SC4116	Noise Filter
Q117	UMG2/TL	12.5/25 Switch
Q118	UMG2/TL	Dif Amp
Q120	RTIN441M	Digital Mod Limit switch
Q301	2SC4154	LCD Temp Compensation
Q401	RTIP434M	TX Power Switch
Q402	2SC4118	Power Control
Q403	2SC4118	TX Inhibit
Q404	2SC3356	TX amp
Q405	2SC4226	TX Amp
Q406	RTIN441M	TX Power Switch
Q501	2SC5085	RX RF Amp
Q502	2SK508	First IF
Q503	2SC4125Y	First IF
Q601	2SC4226	TX VCO
Q602	2SC4226	RX VCO
Q603	2SA1586GR	TX/RX Switch
Q604	DTA123YE	TX/RX Switch
Q605	2SC4118	Noise filter
Q606	3SK199	VCO Buffer
Q607	RT1N441M	TX INHIBIT
Q608	2SA1586GR	unlock Indicator
Q609	2SA1586GR	Charge Pump
Q610	2SC4116GR	Charge Pump
Q611	2SA1586GR	Charge Pump
Q612	2SC4116GR	Charge Pump

FUNCTION OF DEVICES
FCC ID: MMAALHP425

APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

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

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: MMAALHP425

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION,
LIMIT MODULATION AND CONTROL POWER

The transmitter is comprised of:

Power Amplifier
Harmonic Filter
Automatic Power Control

POWER AMPLIFIER

The power amplifier contains transistors Q13, Q9 and U3 and associated inductors, capacitors and resistors. When the radio is in transmit mode, the dual diode D4 enables the modulated RF signal from the VCO to pass to the buffer/preamplifier Q13 and Q9. Q8 enables Q9, so as to avoid unwanted transmission (i.e. Q8 does not enable Q9 in case of PLL Unlock). The output signal is passed from Q9 to U3 via a matching network consisting of L7 and C78. The signal is then amplified for transmission by U3 Hitachi PF0350.

HARMONIC FILTER

The amplified RF signal is passed to the harmonic low pass filter, comprising L10 to L8 and C31 to C69 and then to the antenna connector. Diode D6 is forward biased causing L11 to look like an open circuit to the transmitter inhibiting the TX signal through the receiver stage.

AUTOMATIC POWER CONTROL

The RF signal is rectified by D3 to produce a DC voltage. U4A is a differential amplifier. In transmit mode a reference level for U4A is supplied, depending on customer programming power output level, by micro-controller (PWM output pin 54). The reference level and the detected level are compared and a difference signal is produced. The difference signal controls the supply voltage to the first amplifier stage in U3. This control loop produces a constant power output at the antenna connector.

CIRCUITS TO SUPPRESS SPURIOUS RADIATION, LIMIT MODULATION- AND CONTROL POWER
FCC ID: MMAALHP425

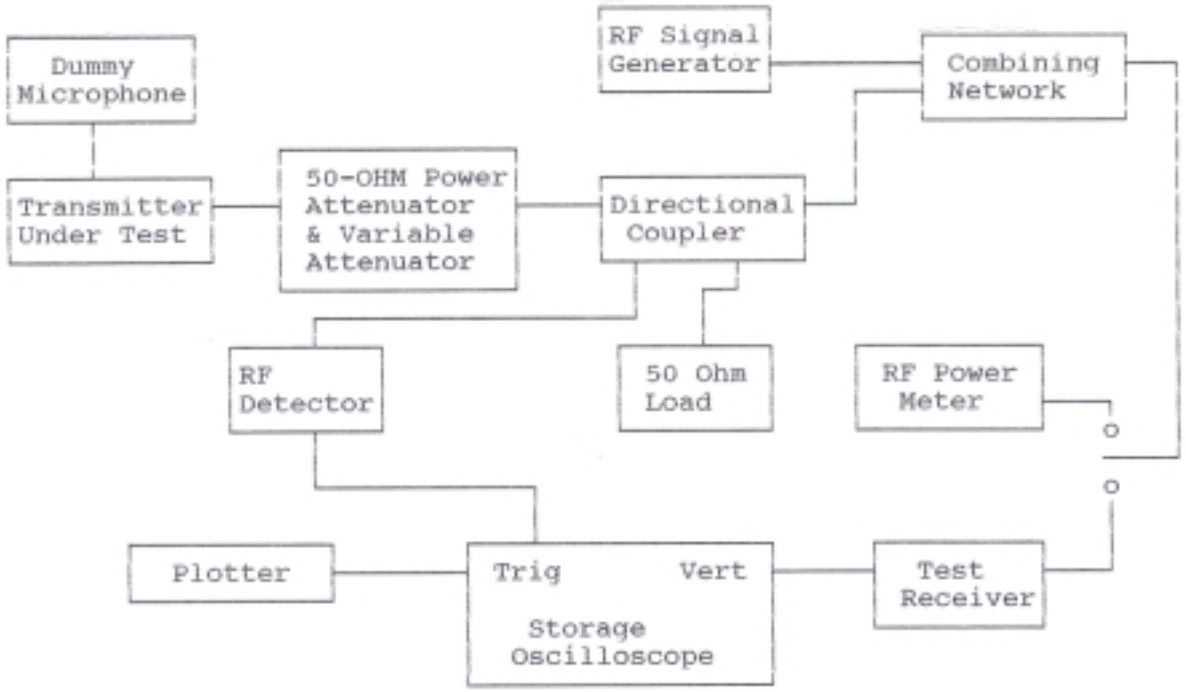
APPENDIX 3

APPENDIX 4

TRANSIENT FREQUENCY BEHAVIOR (90.214) TEST PROCEDURE

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

90.214 Transient Frequency Behavior
(continued)



90.214 TRANSIENT FREQUENCY BEHAVIOR

REQUIREMENTS: In the 300 - 500 MHz frequency band, transient frequencies must be within the maximum frequency difference limits during the time interval indicated below for 25 kHz channels:

Time Interval	Maximum Frequency	Radios 300 - 500 MHz
t_1	±25.0 kHz	10.0 ms
t_2	±12.5 kHz	25.0 ms
t_3	±25.0 kHz	10.0 ms

End of t_2 to beginning of t_3: 2.5 ppm.

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. Reduce the attenuation between the transmitter and the RF detector by 30 dB.

4. With the levels set as above the transient frequency behavior was observed & recorded.