FCC Part 90 Test Report
for
Motorola Inc.
on the
VHF Two-Way Radio
Model: AAH38KDC9AA3AN

FCC ID: AZ489FT3801

Test Report: 0037002u.doc
Date of Report: March 16, 2001

Report Prepared by:	Grace Lin	
Reviewer:	David Schramm	

Table of Contents

1 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of

Company: Motorola Inc.
8000 West Sunrise Boulevard
Fort Lauderdale, Florida 33323

Name of contact: Mike Ramnath
Telephone: (954) 723-5793
Fax: (954) 723-4794
Email: emr003@email.mot.com

1.2 Equipment under test (EUT)

Equipment type: VHF Two-Way Radio

FCC ID: AZ489FT3801

Model number(s): AAH38KDC9AA3AN

Serial number: 004TAU1118

Manufacturer: Motorola Inc.

Use of Product : Voice communications

Production is planned: [X] Yes, [ ] No

Technical Specifications:

Type of Emission	11K0F3E, 16K0F3E
Max. Allowed modulation (M)	3.0 kHz
Max. Allowed deviation (D)	5 kHz, 2.5 kHz
Range of RF Output	1 W – 5 W Variable Power
Means for variation of operating power	None
The dc voltage applied to and current into the several elements of the final RF amplifying device	*Voltage:* 7.5 Vdc *Current:* 1680 mA
Frequency Range	136 to 174 MHz
Max. number of Channels	16
Antenna	Helix
Detachable antenna	Yes
External input	Audio

EUT receive date: 1/17/2001

EUT received condition: Good condition prototype

Test start date: 2/7/2001

Test end date: 3/16/2001

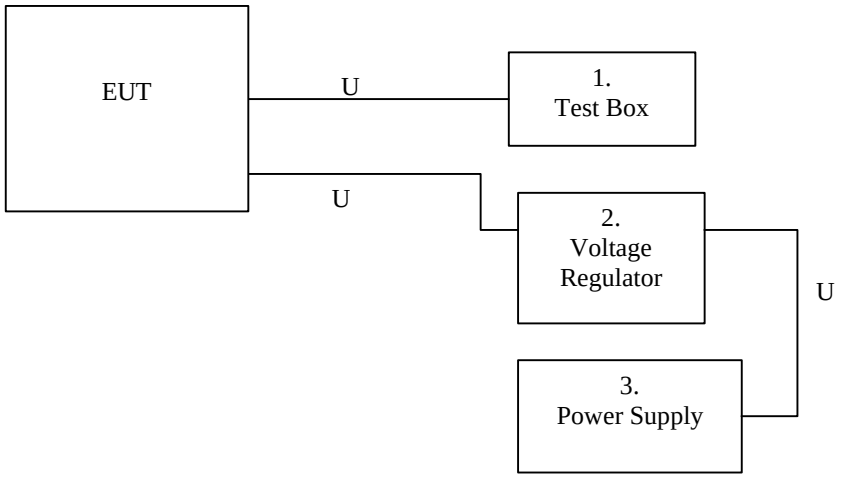
1.3 Test plan reference

FCC Part 2.1033, FCC Part 90

1.4 System test configuration

1.4.1 System block diagram & Support equipment

The diagram shown below details the placement of the equipment under test on the turntable. Please note that the equipment on the rear of the table was centered along the back edge. Equipment on the front of the turntable was centered along the front edge. All peripherals were separated by 10 cm.



S:	Shielded	**U:**	Unshielded	**F:**	With Ferrite Core

Support equipment					
Equp. #	**Equipment**	**Manufacturer**	**Model #**	**S/N #**	**FCC ID**
1	Test Box	Motorola Inc.	RLN4460B	Not labeled	N/A
2	Voltage Regulator	Motorola Inc.	RLN4510A	Not labeled	N/A
3.	DC Power Supply	Topward	TPS 4302	925281	N/A

1.4.2 Justification

The system was configured for testing in a typical manner in accordance with ANSI C63.4 and TIA/EIA 603-1: 1998 standards.

1.4.3 Mode(s) of operation

The EUT was powered and fully operational with option test box (speaker/microphone) connected. The unit was powered from a fully charged lithium iron battery or the external dc power supply.

1.5 Modifications required for compliance

No modifications were implemented by the Intertek Testing Services during compliance testing.

2 TEST SUMMARY

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
Transmitter Section			
2.1046 90.205	RF Power Output	<5.75 Watts ERP <5.47 Watts Conducted	9
2.1047 90.205	Modulation Characteristics F3E analogy voice Peak frequency deviation Audio frequency response Audio Low Pass Filter Response Modulation Limiting	 5 kHz, 2.5 kHz Complies Complies Complies	11
2.1049 90.210	Occupied Bandwidth	11 kHz, 16kHz	18
2.1051 90.210	Transmitter Conducted Spurious Emission	< dBc	22
2.1053 90.210	Transmitter Radiated Spurious Emission	< dBc	26
2.1055 90.213	Frequency Stability Vs. Temperature Vs. Voltage	 3.41 ppm 1.33 ppm	28
90.214	Transient Frequency Behavior		30
Receiver Section			
15.107(a)	Line Conducted Emissions	Worst-case: -9.9 dB at 0.45 MHz	35
15.109(a)	Radiated Emissions	No radiated emission was detected.	35

3 RF POWER OUTPUT

3.1 Test Description

Parameter:	FCC § 2.1046
Requirement:	FCC § 90.205
Effective Radiated Power (ERP):	< 5.75 watts
Power Output (Conducted):	1.13 Watts (minimum) to 5.47 Watts (maximum)

3.2 Test Procedure

The EUT was positioned on a non-conductive turntable, 0.8m above the ground plane on an open test site.

The radiated emission at the fundamental frequency was measured at 3m distance with a test antenna and EMI receiver. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set at 120 kHz and 300 kHz, respectively. To maximize emissions, the system was rotated through 360 degrees , the antenna height was varied from 1m to 4m, and the antenna polarization was changed (horizontal and vertical).

Signal substitution method was used to measure the effective radiated power (ERP). For reference, conducted measurements were also made.

3.3 Test Results

Effective Radiated Power (1W setting on SN: 004TAU1118)

Location of range of operation	Frequency (MHz)	Channel	EMI Receiver Reading (dBuV)	Power Meter Reading (dBm)	Cable Loss & Attenuation (dB)	ERP (dBm)	ERP (Watts)
Low	136.025	8	106.9	6.05	25.91	31.96	1.57
Middle	154.925	11	103.2	5.48	25.98	31.46	1.40
High	173.825	14	101.9	3.51	25.92	29.43	0.88

Power Output (Conducted, 1W setting on SN: 004TAU1148)

Location of range of operation	Frequency (MHz)	Channel	Power Meter Reading (dBm)	Cable Loss & Attenuation (dB)	Power Output (dBm)	Power Output (Watt)
Low	136.025	1	4.6	26.2	30.8	1.20
Middle	154.925	4	4.4	26.2	30.6	1.14
High	173.825	7	4.3	26.2	30.5	1.13

3.3 Test Results (*Continued*)

Effective Radiated Power (5W setting on SN: 004TAU1118):

Location of range of operation	Frequency (MHz)	Channel	EMI Receiver Reading (dBuV)	Power Meter Reading (dBm)	Cable Loss & Attenuation (dB)	ERP (dBm)	ERP (Watts)
Low	136.025	8	108.3	7.66	25.91	33.57	2.28
Middle	154.925	11	108.8	11.62	25.98	37.60	5.75
High	173.825	14	108.2	9.92	25.92	35.84	3.84

Power Output (Conducted, 5W setting on SN: 004TAU1148):

Location of range of operation	Frequency (MHz)	Channel	Power Meter Reading (dBm)	Cable Loss & Attenuation (dB)	Power Output (dBm)	Power Output (Watt)
Low	136.025	8	11.2	26.2	37.4	5.44
Middle	154.925	11	12.27	26.2	37.3	5.40
High	173.825	14	12.10	26.2	37.4	5.47

3.4 Modifications made during testing

None

3.5 Test Instrumentation

[x] Hewlett Packard HP8546A EMI Receiver
[x] Hewlett Packard HP8566B Spectrum Analyzer (S.A.)
[x] EMCO 3141 Bi-Log Antenna
[x] Fluke 6082A Signal Generator
[x] Robert Dipole Antenna
[x] Hewlett Packard 436A Power Meter with Hewlett Packard 8481A Power Sensor
[x] Hewlett Packard 8491B 10 dB and 20 dB attenuators
[x] Pasternack 6 dB attenuator, PE7019-6
[x] Kalmus 737LC RF Amplifier

4 MODULATION CHARACTERISTICS

4.1 Test Description

Parameter:	FCC § 2.1047
Requirement:	FCC § 90.205

4.2 Test Procedure

4.2.1 Audio Frequency Response

The RF output of the transceiver was connected to the input of a modulation analyzer through sufficient attenuation so as not to overload the analyzer or distort the readings. An audio signal generator was coupled into the external microphone jack of the transceiver, which is located on the Motorola Test Box.

The audio signal input level was adjusted to obtain 20% of the maximum rated system deviation at 1 kHz, and recorded as DEV_{REF}. With the audio signal generator level unchanged, the generator frequency between is swept from 300 Hz to 5000 Hz. The transmitter deviations (DEV_{FREQ}) were measured and the audio frequency response was calculated as

$$20 \log_{10} \frac{DEV_{FREQ}}{DEV_{REF}}$$

4.2.2 Audio Low-Pass Filter Response

An audio signal generator and an audio spectrum analyzer were connected to the input and output of the post limiter low pass filter respectively. The audio input frequency was set to 1000 Hz and the input level set to 20 dB greater than that required to produce standard test modulation. This input level was recorded as LEV_{FREQ} and held constant throughout this test. The audio signal generator frequency was swept from 1000 Hz and the upper low pass filter limit. The audio frequency response at test frequency was calculated as

$$LEV_{FREQ} - LEV_{REF}$$

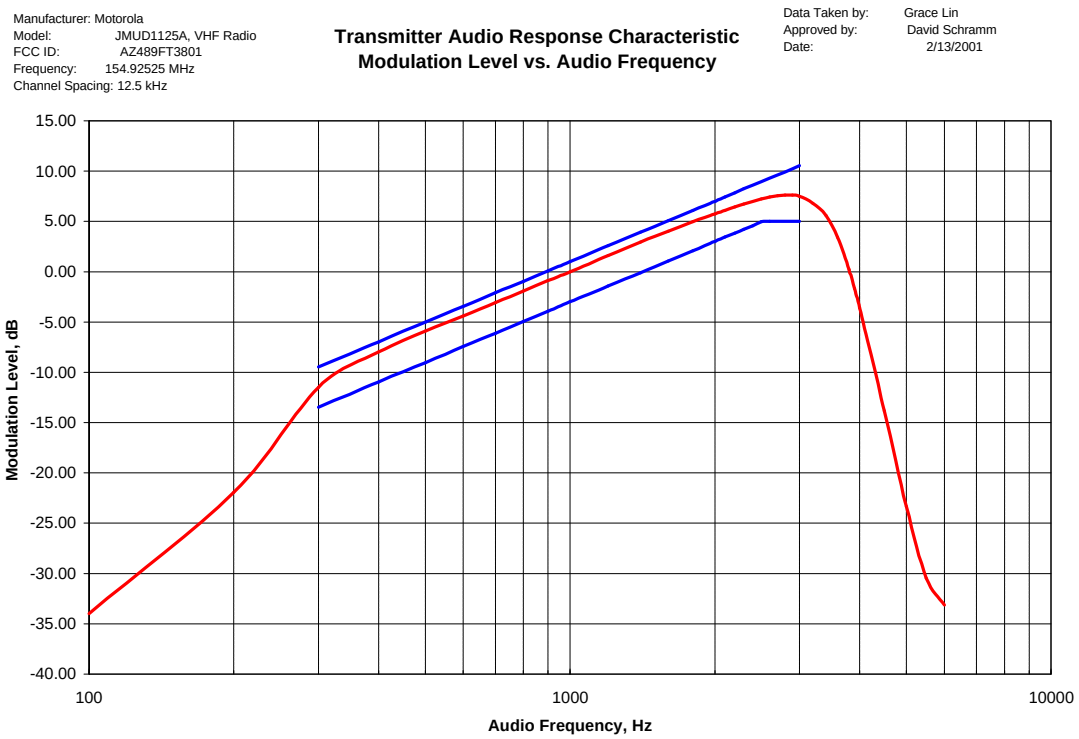
4.2.3 Modulation Limiting

An audio oscillator is connected to the microphone audio input. The transmitter output is monitored with a modulation analyzer. The oscillator is adjusted, at 1 kHz, to obtain 60% of full system deviation. The oscillator level is then varied over a range of +/- 25 dB and the resulting deviation is plotted. This measurement is repeated at 300 Hz and 3 kHz.

4.3 Test Results

Audio Frequency Response:

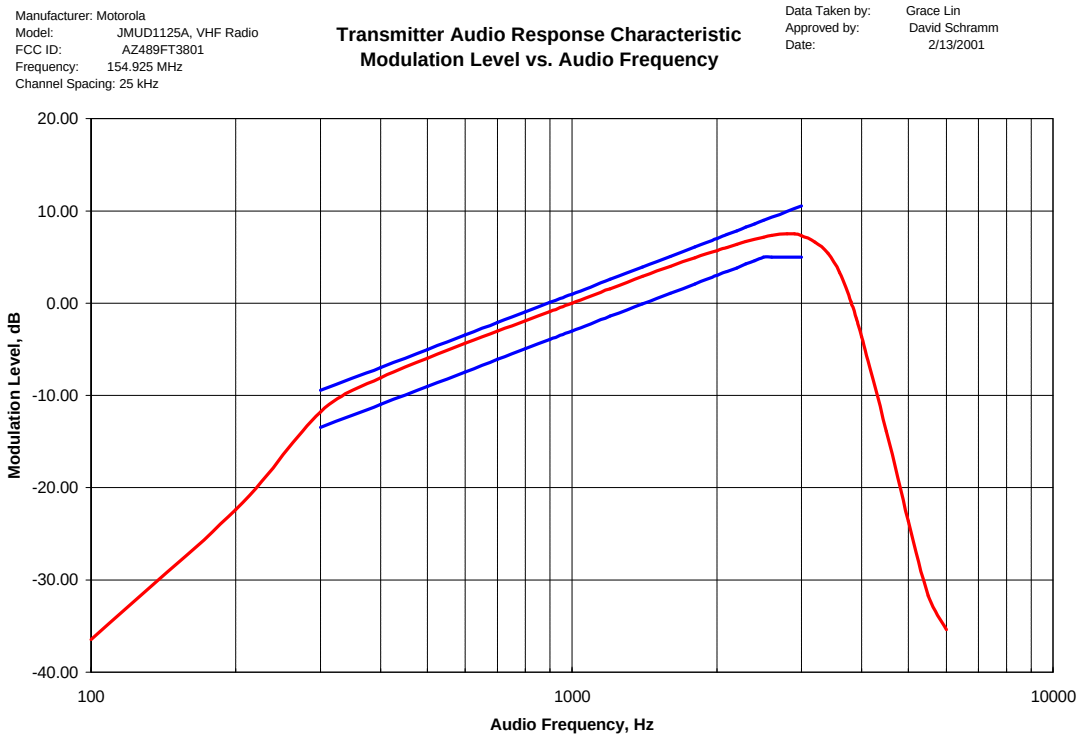
Test Condition	
Frequency (MHz)	Mid-channel



4.3 Test Results (*Continued*)

Audio Frequency Response:

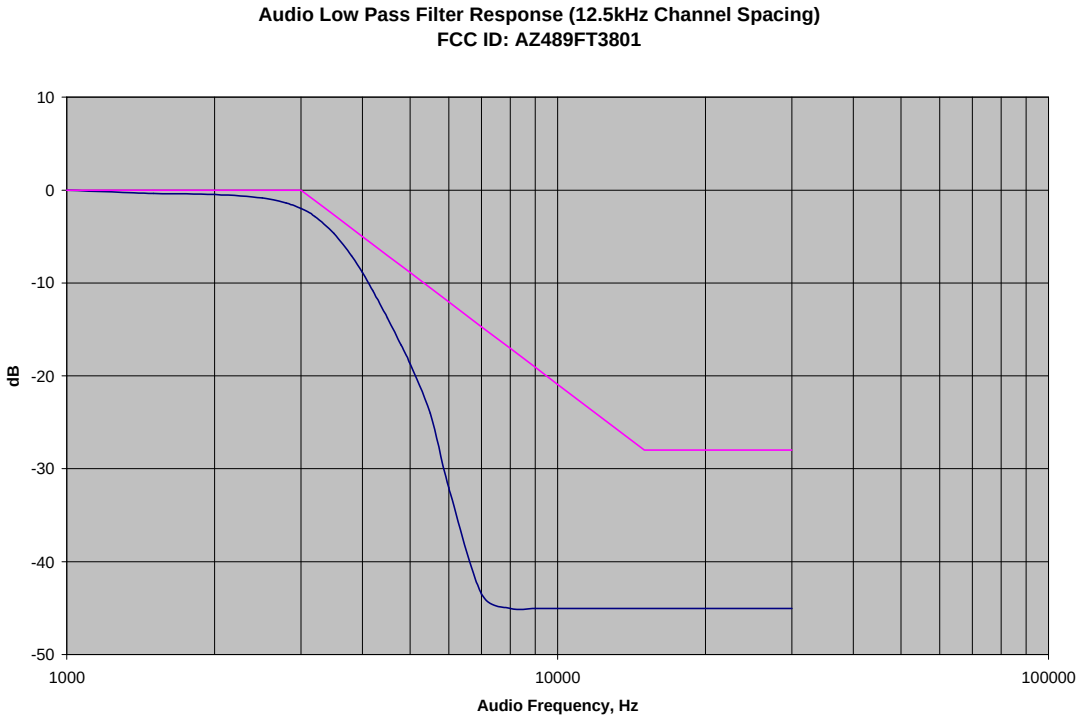
Test Condition	
Frequency (MHz)	Mid-channel



4.3 Test Results (*Continued*)

Audio Low-Pass Filter Response:

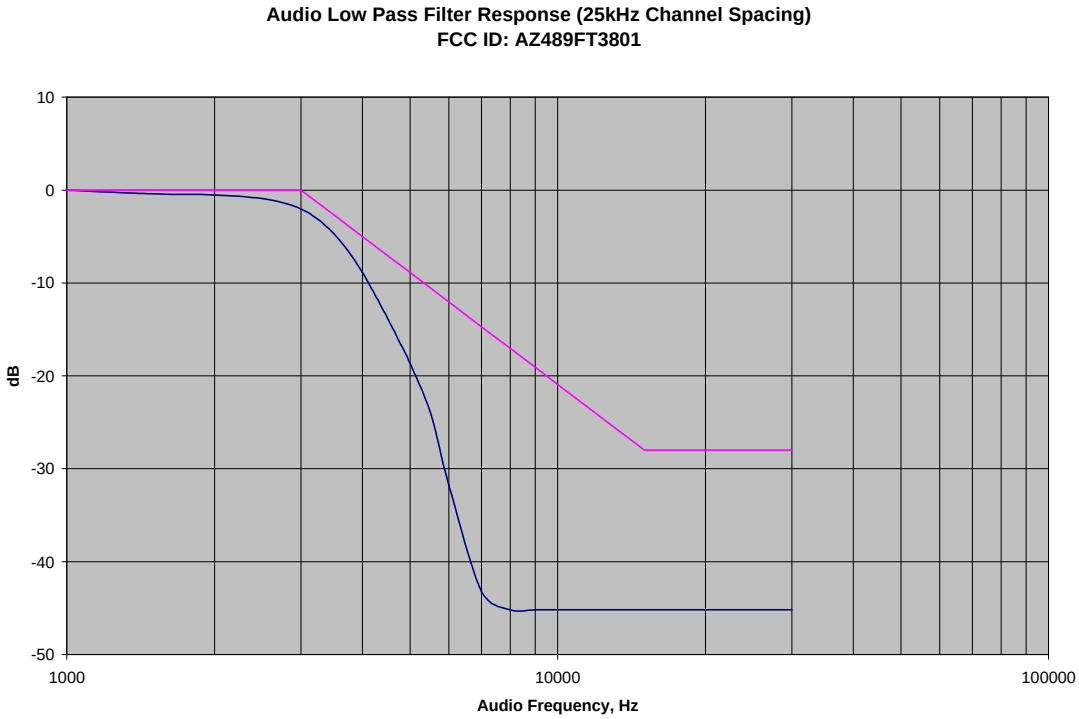
Test Condition	
Frequency (MHz)	Mid-channel



4.3 Test Results (*Continued*)

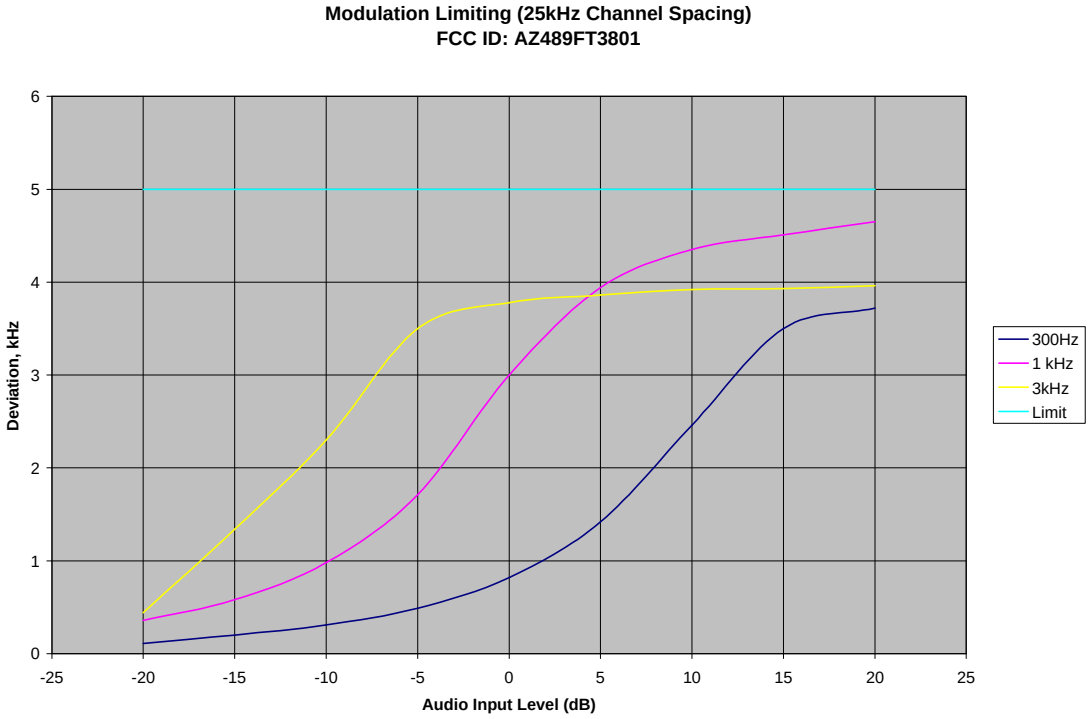
Audio Low-Pass Filter Response:

Test Condition	
Frequency (MHz)	Mid-channel

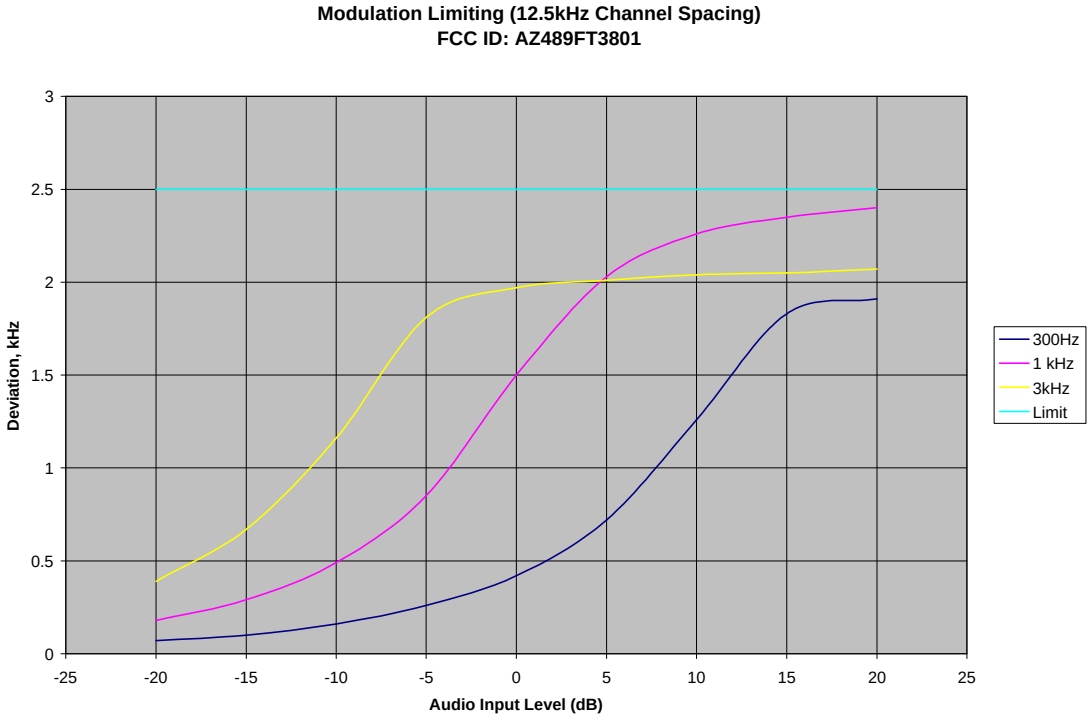


4.3 Test Results (*Continued*)

Modulation Limiting Test Condition	
Frequency (MHz)	Mid-Channel
Reference Deviation	3 kHz



Modulation Limiting Test Condition	
Frequency (MHz)	Mid-Channel
Reference Deviation	3 kHz



4.4 Modifications made during testing

None

4.5 Test instrumentation

[X] Hewlett-Packard 8901 Modulation Analyzer
[X] Hewlett-Packard 8904A Multifunction Synthesizer
[X] Leader LFG-1300S Function Generator
[X] Fluke 8060A True RMS Millimeter

5 OCCUPIED BANDWIDTH

5.1 Test description

Parameter:	FCC §2.1049
Requirement:	FCC § 90.210
Emission Bandwidth:	12.5 kHz, 25 kHz

5.2 Test Procedure

The antenna was disconnected from the transmitter and the short cable was connected to the transmitter RF output.

The RF output was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth and video bandwidth of the spectrum analyzer was set at 300 Hz. With the transmitter keyed, the level of the unmodulated carrier was set to the full scale reference line of the spectrum analyzer. This is used as a 0dB reference for emission mask measurements.

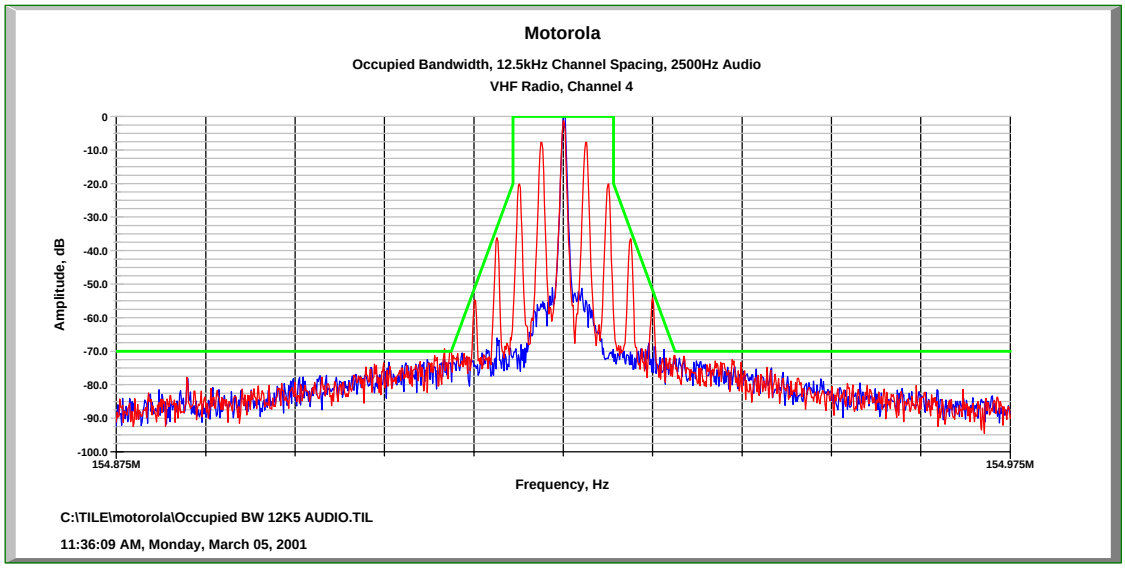
The transmitter was then modulated with a 2500 Hz tone at an input level 16 dB greater than the necessary to produce 50% of rated system deviation. The resolution bandwidth of the spectrum analyzer was set to 300 Hz and the spectrum of the transmitting signal was recorded. This spectrum was compared to the required emission mask.

5.3 Test Results

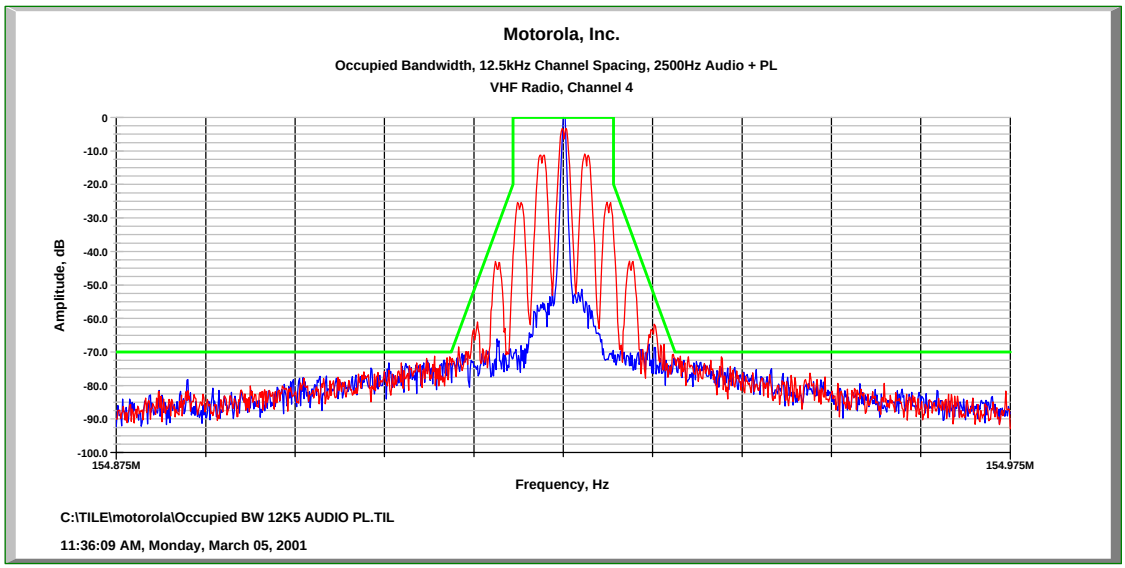
Spectrum analyzer settings for the following Occupied Bandwidth plots:

RBW = 300 Hz, VBW = 300 Hz, SPAN = 100 kHz

12.5 kHz Channel Spacing, 2500 Hz Audio:
Emission Mask D

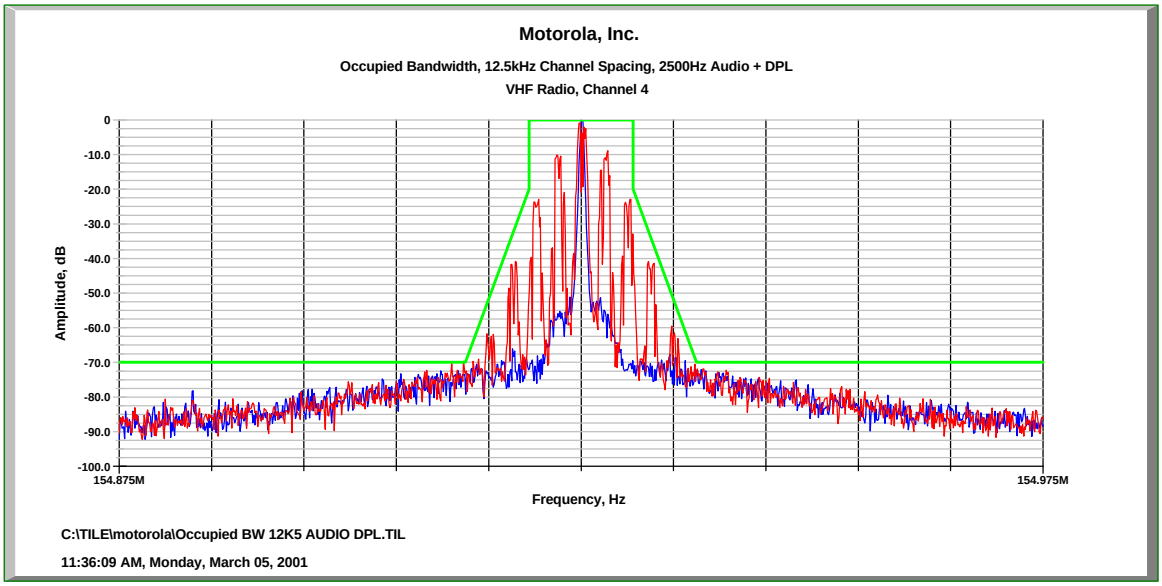


12.5 kHz Channel Spacing, 2500 Hz Audio + PL:
Emission Mask D

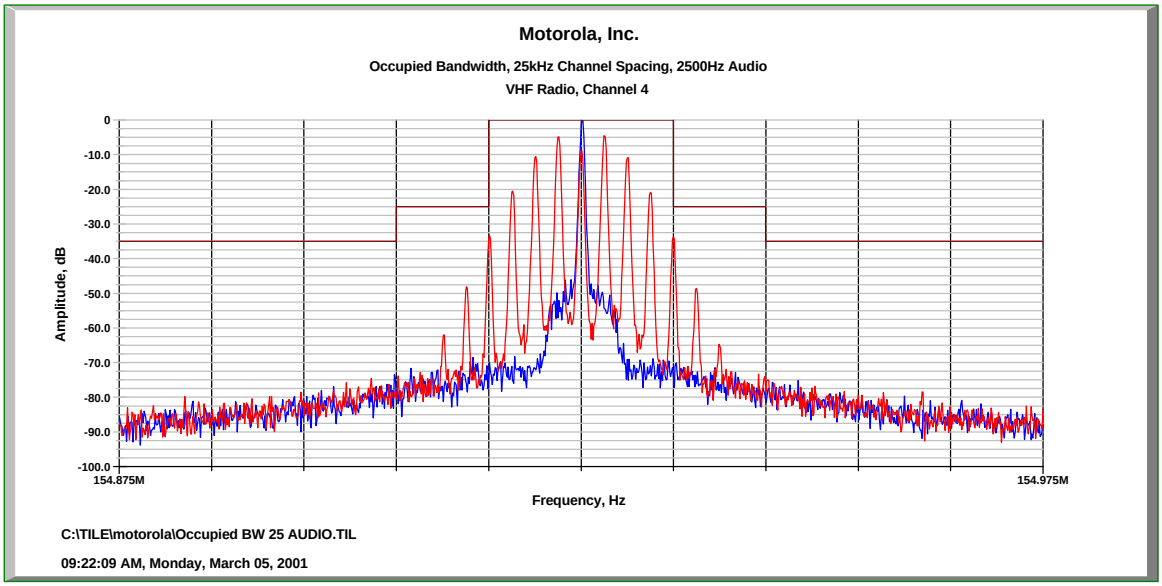


5.3 Test Results (Continued)

12.5 kHz Channel Spacing, 2500 Hz Audio + DPL:
Emission Mask D

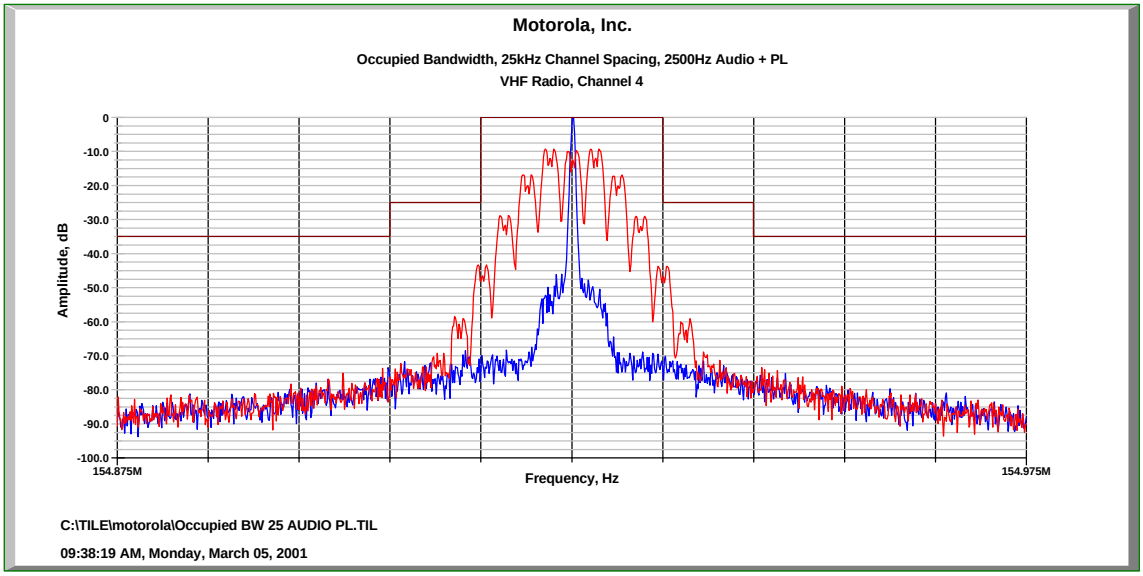


25 kHz Channel Spacing, 2500 Hz Audio:
Emission Mask B

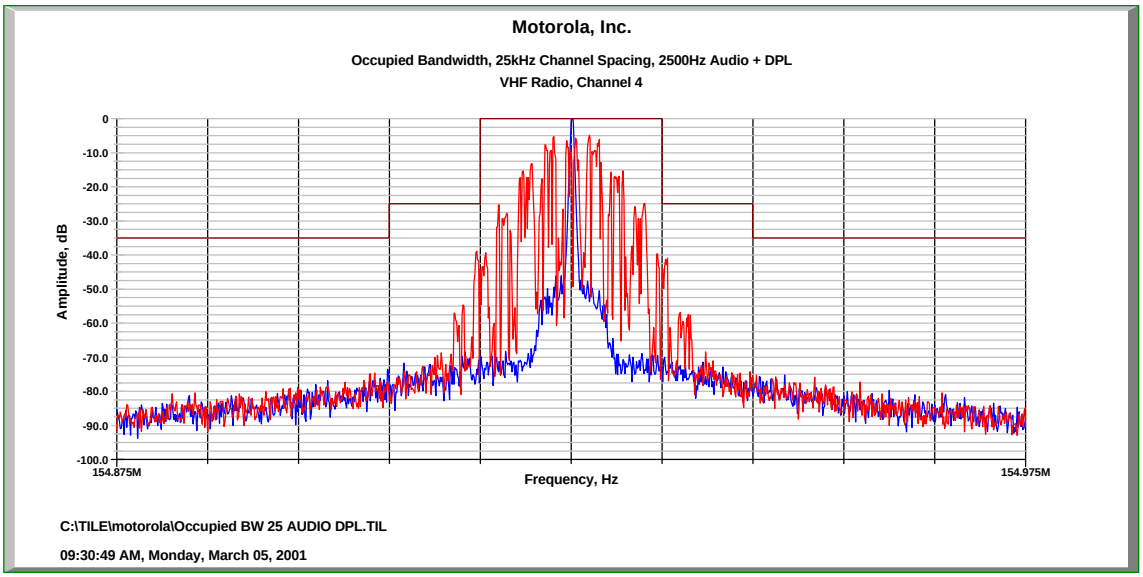


5.3 Test Results (Continued)

25 kHz Channel Spacing, 2500 Hz Audio + PL:
Emission Mask B



25 kHz Channel Spacing, 2500 Hz Audio + DPL:
Emission Mask B



5.4 Modifications made during testing

None

5.5 Test instrumentation

[X] Leader LFG-1300S Function Generator
[X] HP 8566B Spectrum Analyzer
[X] Computer

6 TRANSMITTER CONDUCTED SPURIOUS EMISSIONS

6.1 Test description

Parameter:	FCC § 2.1051
Requirement:	FCC § 90.210

6.2 Test Procedure

The antenna port of the EUT was connected to the spectrum analyzer through a 20 dB attenuator. The EUT was powered by a DC power supply through a Motorola supplied test fixture.

6.3 Test Results

Low Channel (Channel 8, 136.025MHz):

Conducted Spurious	Frequency MHz	Reading dBm	Attenuation dB	Net dB	dBc	Limit dBc	Margin dB
Fundamental	136.025	11.9	26.1	38.1	--	--	
2	272.050	-59.6	26.2	-33.4	70.3	50.0	-20.3
3	408.075	-70.2	26.3	-43.9	80.9	50.0	-30.9
4	544.100	-90.1	26.3	-63.8	100.7	50.0	-50.7
5	680.125	-78.1	26.4	-51.7	88.6	50.0	-38.6
6	816.150	-89.5	26.5	-63.0	100.0	50.0	-50.0
7	952.175	-90.5	26.5	-64.0	100.9	50.0	-50.9
8	1088.200	-97.0	26.7	-70.3	107.2	50.0	-57.2
9	1224.225	-98.3	26.7	-71.7	108.6	50.0	-58.6
10	1360.250	-97.6	26.7	-70.9	107.8	50.0	-57.8

6.3 Test Results (*Continued*)

High Channel (Channel 14, 173.825MHz):

Conducted Spurious	Frequency MHz	Reading dBm	Attenuation dB	Net dB	dBc	Limit dBc	Margin dB
Fundamental	173.825	11.8	26.2	38.0	--	--	
2	347.650	-65.5	26.2	-39.3	76.2	50.0	-26.2
3	521.475	-69.6	26.3	-43.3	80.2	50.0	-30.2
4	695.300	-94.5	26.4	-68.2	105.1	50.0	-55.1
5	869.125	-88.1	26.5	-61.7	98.6	50.0	-48.6
6	1042.950	-93.1	26.5	-66.6	103.5	50.0	-53.5
7	1216.775	-90.6	26.7	-63.9	100.9	50.0	-50.9
8	1390.600	-100.0	26.7	-73.3	110.2	50.0	-60.2
9	1564.425	-95.1	26.9	-68.2	105.1	50.0	-55.1
10	1738.250	-90.6	27.2	-63.4	100.3	50.0	-50.3

6.4 Modifications made during testing

None

6.5 Test instrumentation

[X] HP 8546A EMI Receiver
[X] Pasternack 6 dB Attenuator, PE7014-6
[X] Hewlett-Packard 8491B, 20 dB Attenuator
[X] Topward Power Supply

7 TRANSMITTER RADIATED SPURIOUS EMISSIONS

7.1 Test description

Parameter:	FCC §2.1053
Requirement:	FCC § 90.210
--	--

7.2 Test Procedure

The transmitter was placed on a wooden turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

The spurious harmonic attenuation was measured as the difference between ERP in dBm at the fundamental frequency and at the spurious emission frequency.

Spurious attenuation in dB = 43 +10Log_{10}(power out in Watts)

7.3 Test Results

Please see the following page.

RADIATED SPURIOUS EMISSIONS

Company: Motorola Inc.
Project #: J20037002
Model: AAH38KDC9AA3AN
Engineer: Grace Lin
Date of test: February 19, 2001

Test Condition: continue transmitting

Ant. Pol.	Frequency (MHz)	Receiver Reading (dBuV)	Signal Generator (dBm)	Power Meter (dBm)	C. F. (dB)	Power (dBm)	Results (dBc)	Limit (dBc)	Margin (dB)
V	154.925	108.8		11.62	25.98	37.60			
V	929.550	33.9	-29.6	-30.17	0	-30.17	67.77	50	-17.77
V	1084.475	35.6	-31.8	-32.35	-0.02	-32.37	69.97	50	-19.97
H	154.925	103.2		5.48	25.98	31.46			
H	309.850	41.9	-32.8	-33.5	0	-33.50	64.96	50	-14.96
H	774.625	35.4	-29.9	-30.43	0	-30.43	61.89	50	-11.89
H	929.550	32.8	-31.4	-31.96	0	-31.96	63.42	50	-13.42

*: EIRP-Antenna Gain (dBi)

Note: 1. All measurement were made at 3 meters
Note: 2. There were no other emissions detected within 20 dB of the limit.

8 FREQUENCY STABILITY

8.1 Test description

Parameter:	FCC §2.1055
Requirement:	FCC § 90.213
Frequency Tolerance:	Within 0.0005% (5ppm)

8.2 Test Procedure

The ppm frequency error of the transmitter was calculated by:

$$ppm\ error = \frac{MCF}{ACF} \cdot 106$$

Where MCF is the Measured Carrier Frequency in MHz
ACF is the Assigned Carrier Frequency in MHz

8.2.1 Frequency Stability vs. Temperature

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feedthrough attenuators. The EUT was placed inside the temperature chamber. After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the counter.

8.2.2 Frequency Stability vs. Voltage

At room temperature (25 +/- 5^{o}C), an external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115%, 100% and 85% of the nominal operating input voltage.

8.3. Test Results

Frequency Stability vs. Temperature		
ACF (MHz): 154.925 MHz		Limit: 5 ppm
Temperature, C	MCF (MHz)	PPM
-30	154.925522	3.37
-20	154.925528	3.41
-10	154.925464	2.99
0	154.925381	2.46
10	154.925252	1.63
20	154.925174	1.12
30	154.925162	1.05
40	154.925207	1.34
50	154.925275	1.78

Frequency Stability vs. Voltage				
ACF (MHz): 154.925 MHz				Limit: 5 ppm
%		Voltage (Vdc)	MCF (MHz)	PPM
115		8.625	154.925183	1.18
100		7.5	154.925174	1.12
85		6.375	154.925170	1.10
Battery	120	9.0	154.925206	1.33
Endpoint*	80	6.0	154.925143	0.92

*Reset Voltage is 4.5 Volts.

8.4 Modifications made during testing

None

8.5 Test instrumentation

[X] Envirotronics Temperature Chamber
[X] Leader LDC-825 Frequency Counter
[X] Hewlett-Packard 8566B Spectrum Analyzer
[X] Topward TPS-4000 DC Power Supply

9 TRANSIENT FREQUENCY BEHAVIOR

9.1 Test description

Parameter:	--
Requirement:	FCC § 90.214
:	

9.2 Test Procedure

Test setup was configured according to the paragraph 2.2.19 of the TIA/EIA 603-1. A digital oscilloscope was used to capture the transient response.

9.3 Test Results

Please see the following plots.

Figure 9.3-1: Transient Frequency Behavior

Power: 1W & 5W at 154.925 MHz
Channel Spacing: 25 kHz
Switch – On condition

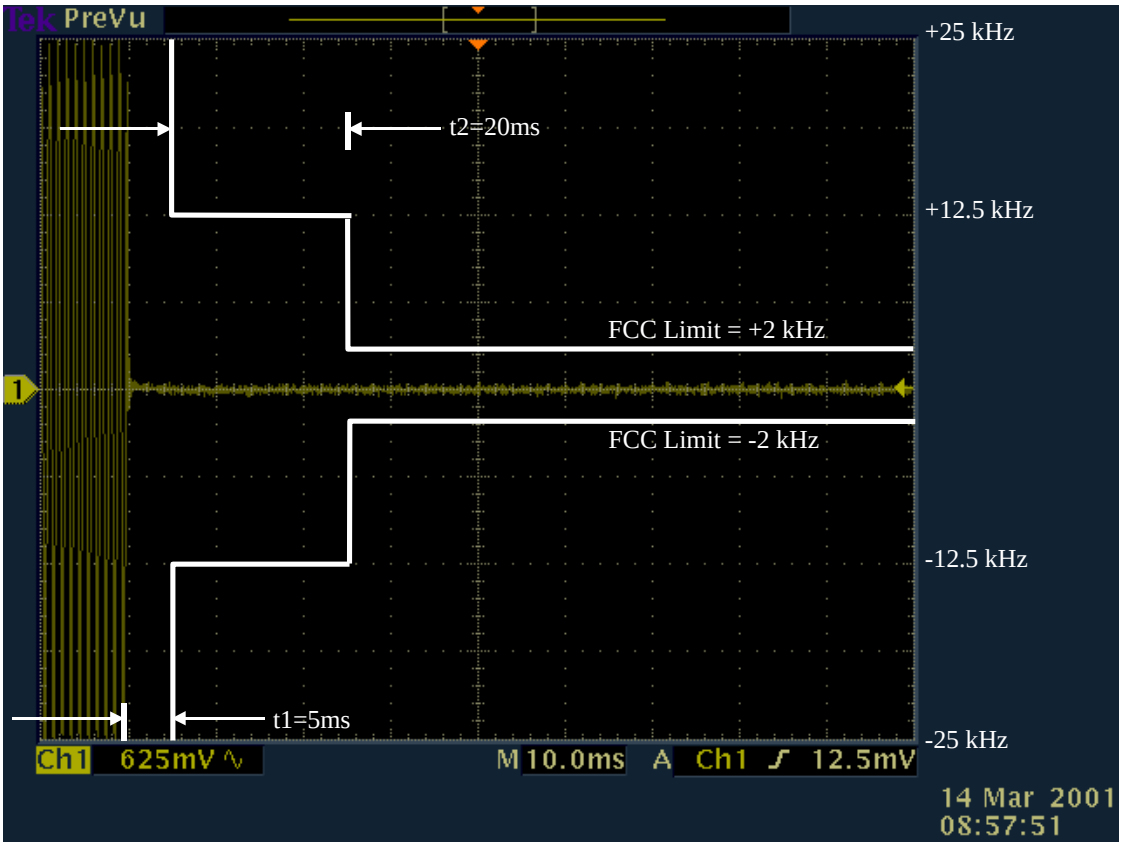


Figure 9.3-2: Transient Frequency Behavior

Power: 1W & 5W at 154.925 MHz
Channel Spacing: 25 kHz
Switch – Off condition

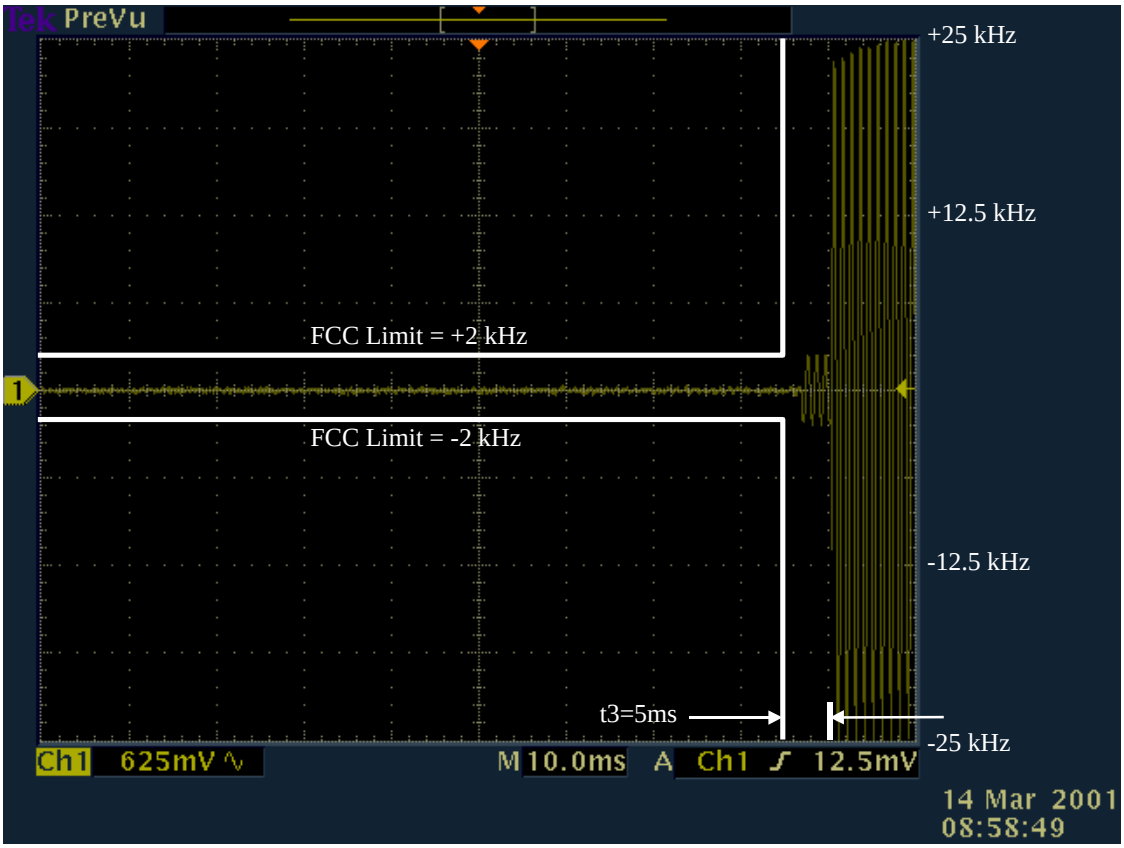


Figure 9.3-3: Transient Frequency Behavior

Power: 1W & 5W at 154.925 MHz
Channel Spacing: 12.5 kHz
Switch – On condition

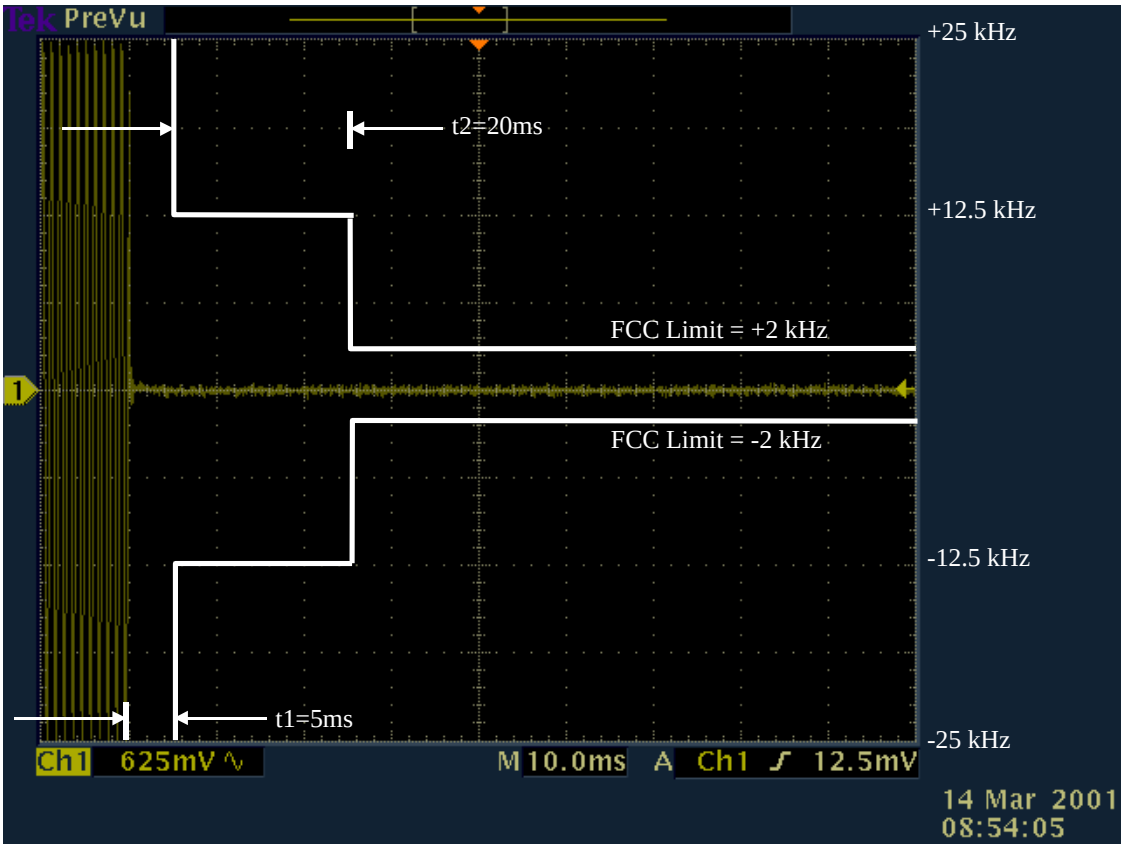
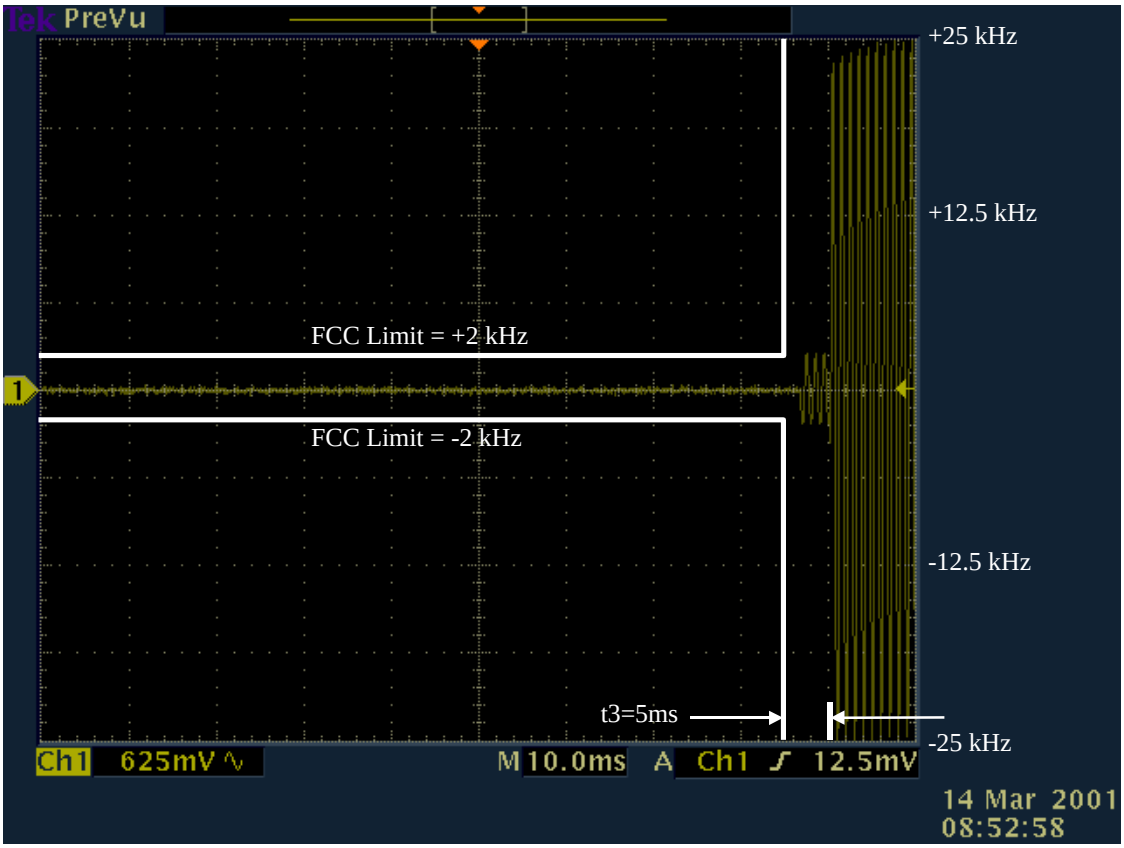


Figure 9.3-4: Transient Frequency Behavior

Power: 1W & 5W at 154.925 MHz
Channel Spacing: 12.5 kHz
Switch – Off condition



9.4 Modifications made during testing

None

9.5 Test instrumentation

[X] Tektronix TDS3012 Two Channel Color digital Phosphor Oscilloscope
[X] Hewlett-Packard 436A Power Meter with Hewlett-Packard 8481A Power Sensor
[X] Hewlett-Packard 8901 Modulation Analyzer
[X] Hewlett-Packard 8491B, 20 dB Attenuator
[X] Hewlett-Packard 8491B, 10 dB Attenuator
[X] Fluke 6071A Signal Generator
[X] Pasternack 3 dB Attenuator, PE7000-3
[X] Pasternack 6 dB Attenuator, PE7000-6
[X] Pasternack 6 dB Attenuator, PE7019-6
[X] Pasternack RF Detector, PE8000-50
[X] Narda Bi-directional Coaxial Coupler, Model: 3020A
[X] Mini-circuits ZFRSC-2050 Power Splitter