

Intertek Testing Services

FCC Part 90 Test Report
for
Motorola Inc.
on the
UHF Two-Way Radio
Model: AAH38RDC9AA3AN

FCC ID: AZ489FT4844

Test Report: 00370025.doc
Date of Report: March 27, 2001

Report Prepared by:	Grace Lin	
Reviewer:	David Schramm	

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Table of Contents

1	JOB DESCRIPTION.....	4
1.1	Client Information	4
1.2	Equipment under test (EUT)	5
1.3	Test plan reference	5
1.4	System test configuration	6
1.4.1	System block diagram & Support equipment.....	6
1.4.2	Justification	6
1.4.3	Mode(s) of operation.....	6
1.5	Modifications required for compliance	7
2	TEST SUMMARY.....	8
3	RF POWER OUTPUT	9
3.1	Test Description	9
3.2	Test Procedure.....	9
3.3	Test Results	9
3.4	Modifications made during testing.....	9
3.5	Test Instrumentation.....	10
4	MODULATION CHARACTERISTICS	11
4.1	Test Description	11
4.2	Test Procedure.....	11
4.2.1	Audio Frequency Response.....	11
4.2.2	Audio Low-Pass Filter Response	11
4.2.3	Modulation Limiting	11
4.3	Test Results	12
4.4	Modifications made during testing.....	17
4.5	Test instrumentation.....	17
5	OCCUPIED BANDWIDTH	18
5.1	Test description	18
5.2	Test Procedure.....	18
5.3	Test Results	19
5.4	Modifications made during testing.....	21
5.5	Test instrumentation.....	21
6	TRANSMITTER CONDUCTED SPURIOUS EMISSIONS.....	22
6.1	Test description	22
6.2	Test Procedure.....	22
6.3	Test Results	22
6.4	Modifications made during testing.....	23
6.5	Test instrumentation.....	23
7	TRANSMITTER RADIATED SPURIOUS EMISSIONS	24
7.1	Test description	24
7.2	Test Procedure.....	24
7.3	Test Results	24
8	FREQUENCY STABILITY	26

Intertek Testing Services

8.1	Test description	26
8.2	Test Procedure.....	26
8.2.1	Frequency Stability vs. Temperature	26
8.2.2	Frequency Stability vs. Voltage	26
8.3	Test Results	27
8.4	Modifications made during testing.....	27
8.5	Test instrumentation.....	27
9	TRANSIENT FREQUENCY BEHAVIOR.....	28
9.1	Test description	28
9.2	Test Procedure.....	28
9.3	Test Results	28
9.4	Modifications made during testing.....	33
9.5	Test instrumentation.....	33
10	RECEIVER AC LINE CONDUCTED EMISSIONS.....	34
10.1	Test description	34
10.2	Test Procedure.....	34
10.3	Test Results	34
10.4	Modifications made during testing.....	34
10.5	Test instrumentation.....	34
11	RECEIVER RADIATED EMISSION.....	35
11.1	Test description	35
11.2	Test Procedure.....	35
11.3	Test Results	35
11.4	Modifications made during testing.....	37
11.5	Test instrumentation.....	37

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

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1.2 Equipment under test (EUT)

Equipment type: UHF Two-Way Radio

FCC ID: AZ489FT4844

Model number(s): AAH38RDC9AA3AN

Serial number: 004TAU2495

Manufacturer: Motorola Inc.

Use of Product : Voice communications

Production is planned: ☒ 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 - 4 W
Means for variation of operating power	None
The dc voltage applied to and current into the several elements of the final RF amplifying device	<i>Voltage:</i> 7.5 Vdc <i>Current:</i> 1.8 A
Frequency Range	403 to 470 MHz
Max. number of Channels	16
Antenna	Helical
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: 3/27/2001

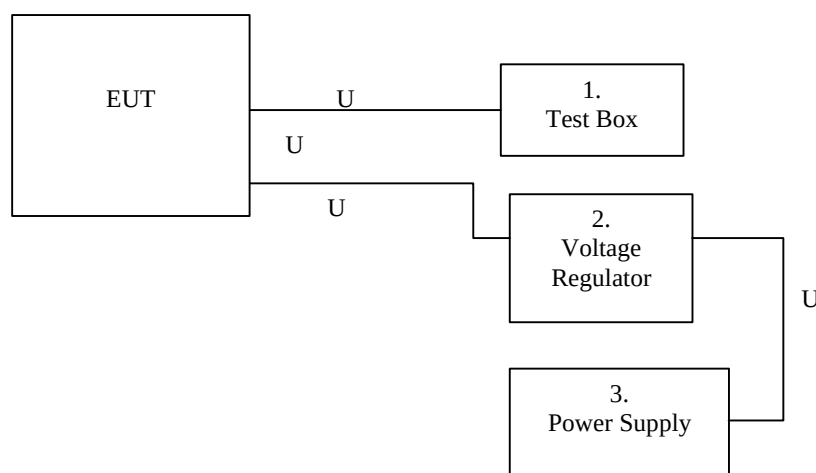
1.3 Test plan reference

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
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Support equipment					
Equip. #	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.

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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	< 4.4 Watts (Conducted) <4.6 Watts ERP	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	Complies	18
2.1051 90.210	Transmitter Conducted Spurious Emission	>72 dBc	22
2.1053 90.210	Transmitter Radiated Spurious Emission	>58 dBc	24
2.1055 90.213	Frequency Stability Vs. Temperature Vs. Voltage	1.48 ppm -0.84 ppm	26
90.214	Transient Frequency Behavior	Complies	28
Receiver Section			
15.107(a)	Receiver Line Conducted Emissions	Worst-case: -9.9 dB at 0.45 MHz	34
15.109(a)	Receiver 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):	< 4.54 Watts ERP
Power Output (Conducted):	1.2 watt (minimum), 4.4 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 spectrum analyzer. During the measurement, the resolution and video bandwidth of the spectrum analyzer were set at 120 kHz. To maximize emissions, the system was rotated through 360degrees, 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, in addition to the signal substitution method, conducted method was used.

3.3 Test Results

Effective Radiated Power (4W):

Location of range of operation	Frequency (MHz)	Channel	ERP (Watts)
Low	403.025	8	2.11
Middle	436.025	11	4.54
High	469.975	14	3.51

Power Output (Conducted, 4W):

Location of range of operation	Frequency (MHz)	Channel	Power Meter Reading Watts
Low	403.025	8	4.23
Middle	436.025	11	4.35
High	469.975	14	4.40

Power Output (Conducted, 1W):

Location of range of operation	Frequency (MHz)	Channel	Power Meter Reading Watts
Low	403.025	1	1.22
Middle	436.025	4	1.30
High	469.975	7	1.35

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 attenuator
- [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, or alternatively, the microphone element was removed and the generator output was connected to the microphone connectors.

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, set the generator frequency between 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 signal generator frequency was set between 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

With the same setup as section 4.2.1 above, at three different modulating frequencies, the output level of the audio generator was varied and the FM deviation level was recorded.

4.3 Test Results

Audio Frequency Response:

Test Condition	
Frequency (MHz)	mid channel

Manufacturer: Motorola
 Model: JMUE1021A, UHF Radio
 FCC ID: AZ489FT4844
 Frequency: 436.025 MHz
 Channel Spacing: 12.5 kHz

Transmitter Audio Response Characteristic Modulation Level vs. Audio Frequency

Data Taken by: Grace Lin
 Approved by: David Schramm
 Date: 2/13/2001



4.3 Test Results (Continued)

Audio Frequency Response:

Test Condition	
Frequency (MHz)	mid channel

Manufacturer: Motorola, Inc.
 Model: JMUE1021A, UHF Radio
 FCC ID: AZ489FT4844
 Frequency: 436.025 MHz
 Channel Spacing: 25 kHz

Transmitter Audio Response Characteristic Modulation Level vs. Audio Frequency

Data Taken by: David Schramm
 Approved by: Grace Lin
 Date: 2/13/2001

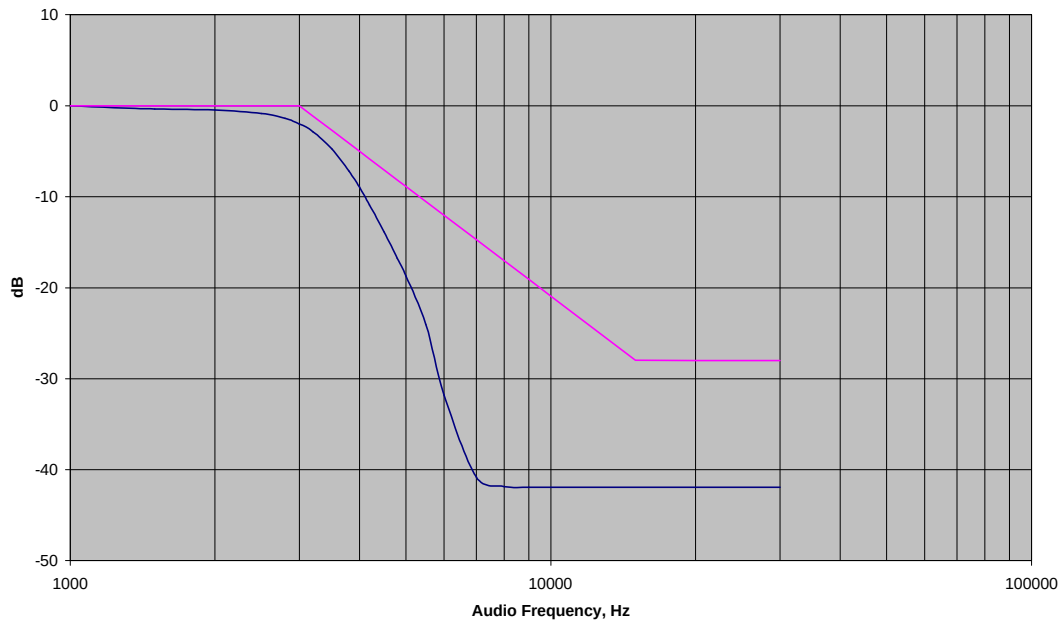


4.3 Test Results (Continued)

Audio Low-Pass Filter Response:

Test Condition	
Frequency (MHz)	mid channel

Audio Low Pass Filter Response (12.5kHz Channel Spacing)
FCC ID: AZ489FT4844

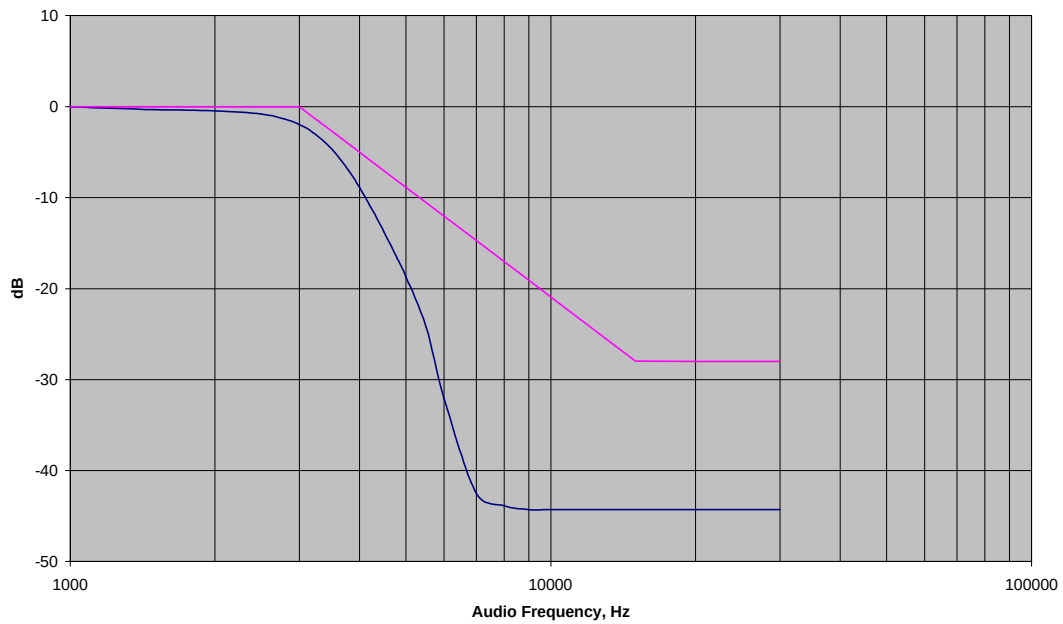


4.3 Test Results (Continued)

Audio Low-Pass Filter Response:

Test Condition	
Frequency (MHz)	mid channel

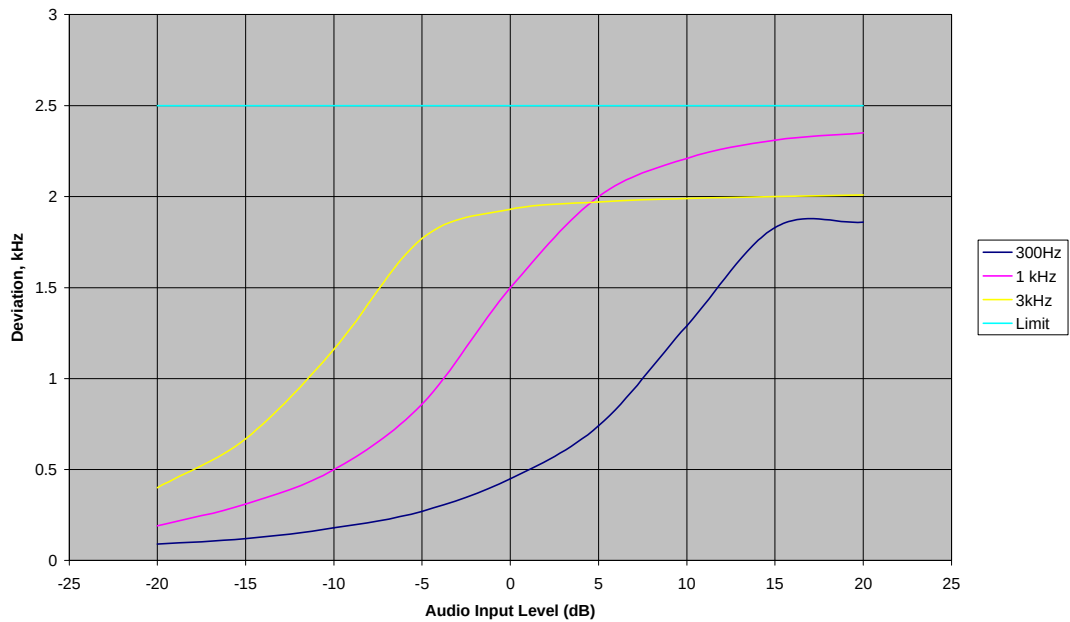
Audio Low Pass Filter Response (25kHz Channel Spacing)
FCC ID: AZ489FT4844

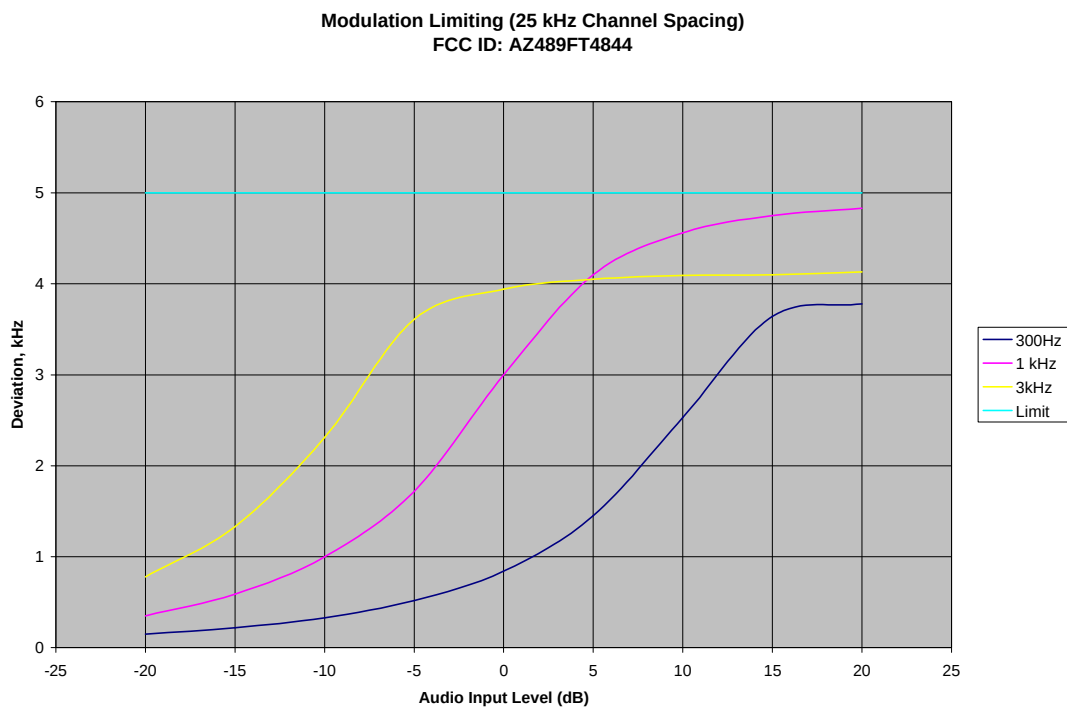


4.3 Test Results (Continued)

Modulation Limiting Test Condition	
Frequency (MHz)	436.025 MHz
V _{inp} (mV)	408mV, 400mV
Reference Deviation	1.5 kHz, 3 kHz at 1 kHz modulating frequency

Modulation Limiting (12.5kHz Channel Spacing)
FCC ID: AZ489FT4844





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.

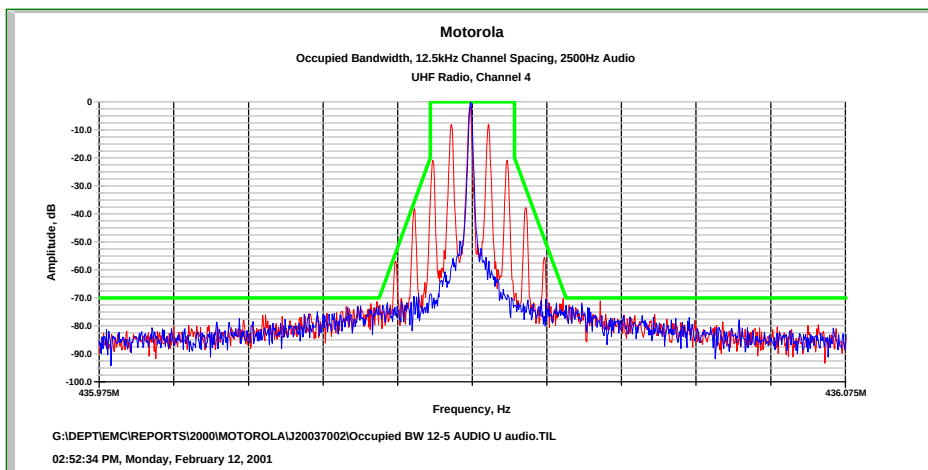
The transmitter was then modulated with a 2500 Hz tone at an input level 16 dB greater than the necessary to produce 50% of rated system deviation. The resolution bandwidth of the spectrum analyzer was set to 300 Hz and the spectrum of the transmitting signal was recorded. This spectrum was compared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

5.3 Test Results

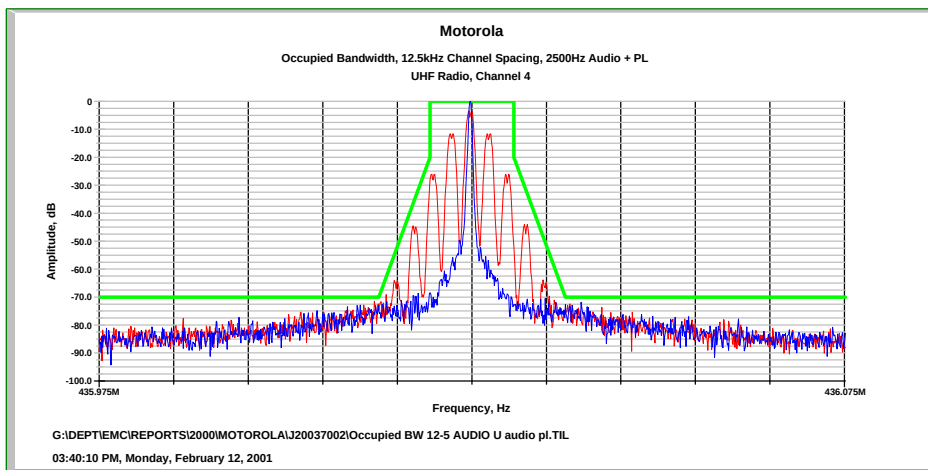
Spectrum analyzer settings for the following Occupied Bandwidth plots:

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

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

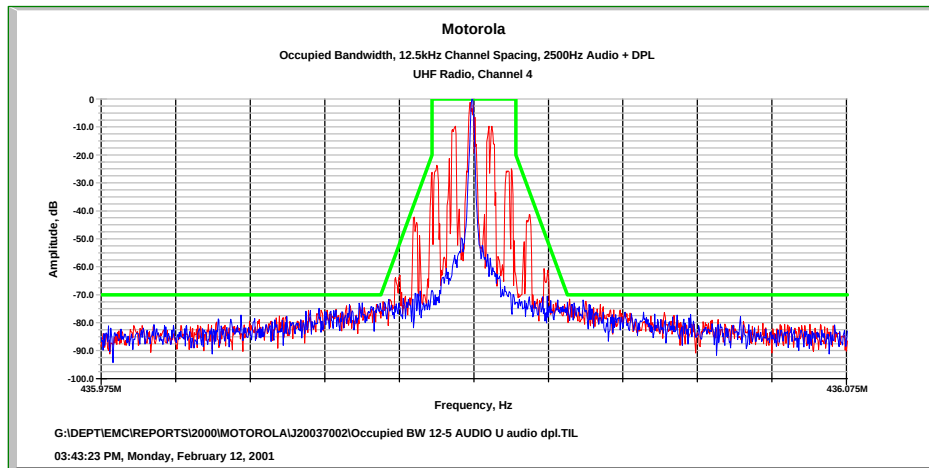


12.5 kHz Channel Spacing, 2500 Hz Audio + PL:
Emissions Mask D

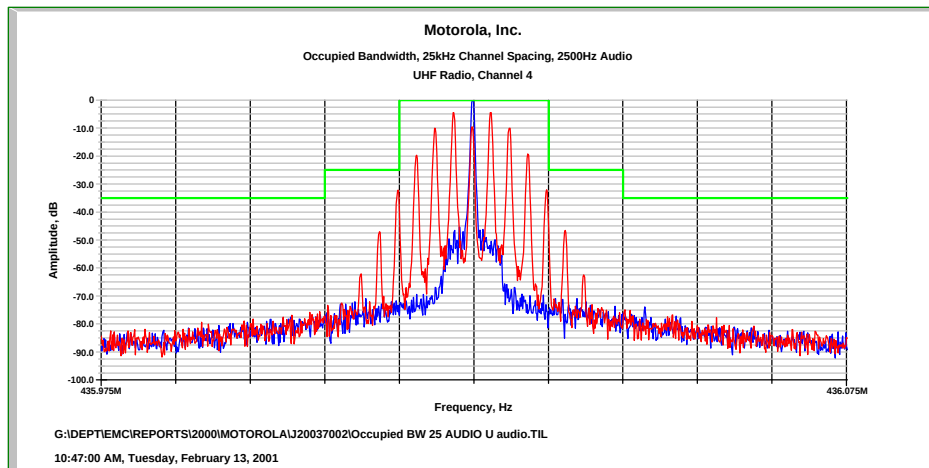


5.3 Test Results (Continued)

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



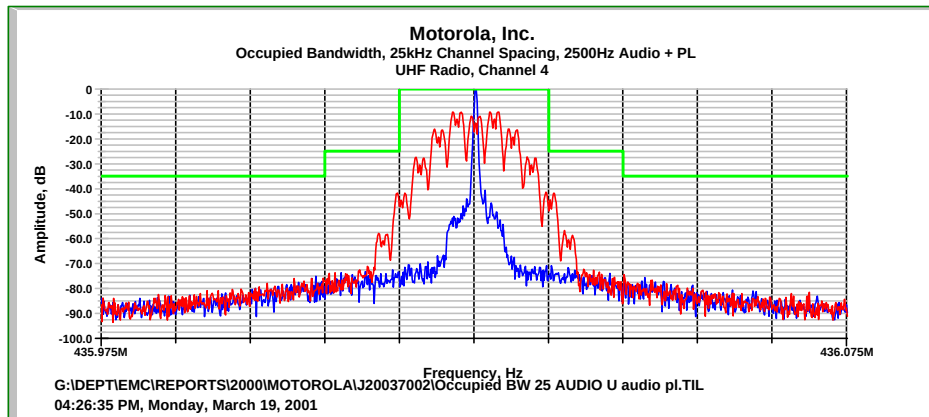
25 kHz Channel Spacing, 2500 Hz Audio:
Emission Mask B



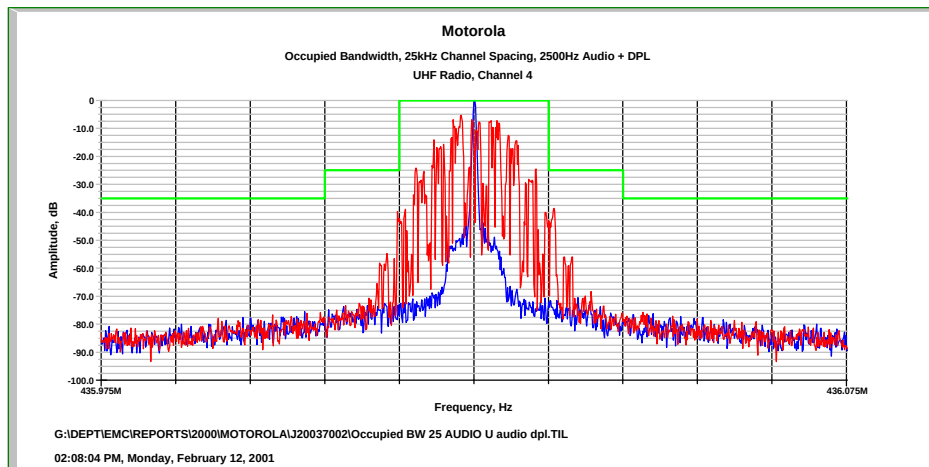
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5.3 Test Results (Continued)

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, 403.025MHz):

Spurious	Frequency MHz	Measured Data dBm	Cable Loss + Attenuation dB	Net dBm	Results dBc	Limit dBc	Margin dB
Fundamental	403.025	10.66	26.26	36.92	--	--	--
2	806.050	-61.98	26.46	-35.52	72.44	50	-22.44
3	1209.075	-69.52	26.67	-42.85	79.77	50	-29.77
4	1612.100	-84.79	26.93	-57.86	94.78	50	-44.78
5	2015.125	-84.35	29.07	-55.28	92.2	50	-42.2
6	2418.150	-90.75	27.33	-63.42	100.34	50	-50.34
7	2821.175	-81.88	27.53	-54.35	91.27	50	-41.27
8	3224.200	-72.53	27.74	-44.79	81.71	50	-31.71
9	3627.225	-87.77	27.66	-60.11	97.03	50	-47.03
10	4030.250	-92.37	27.93	-64.44	101.36	50	-51.36

*: Noise Floor

High Channel (Channel 14, 469.975MHz):

Spurious	Frequency MHz	Measured Data dBm	Cable Loss + Attenuation dB	Net dBm	Results dBc	Limit dBc	Margin dB
Fundamental	403.025	10.43	26.26	36.69			
2	806.050	-61.59	26.46	-35.13	72.05	50	-22.05
3	1209.075	-68.70	26.67	-42.03	78.95	50	-28.95
4	1612.100	-81.89	26.93	-54.96	91.88	50	-41.88
5	2015.125	-82.73	29.07	-53.66	90.58	50	-40.58
6	2418.150	-68.26	27.33	-40.93	77.85	50	-27.85
7	2821.175	-67.34	27.53	-39.81	76.73	50	-26.73
8	3224.200	-78.70	27.74	-50.96	87.88	50	-37.88
9	3627.225	-84.75	27.66	-57.09	94.01	50	-44.01
10	4030.250	-86.38	27.93	-58.45	95.37	50	-45.37

*: Noise Floor

6.4 Modifications made during testing

None

6.5 Test instrumentation

- ☒ HP 8546A EMI Receiver
- ☒ Pasternack 6 dB Attenuator, PE7014-6
- ☒ Hewlett-Packard 8491B, 20 dB Attenuator
- ☒ 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 test was performed by placing the EUT on 3 orthogonal axis.

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 = $43 + 10\log_{10}(\text{power out in Watts})$

7.3 Test Results

Please see the following page.

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RADIATED SPURIOUS EMISSIONS

Company: Motorola Inc.
Project #: J20037002
Model: AAH38RDC9AA3AN
Engineer: Grace Lin
Date of test: March 15, 2001

Test Condition: continuous transmitting at 4 Watt, channel 11 (436.025 MHz)

Frequency MHz	Measured dB(μ V)		Substitution Method dBm		Results dBc		Limit dBc		Margin dB	
	V	H	V	H	V	H	V	H	V	H
436.025	110.52	111.95	33.59	34.62	--	--	--	--	--	--
1308.075	50.87	51.27	-25.24	-24.25	59.86	58.87	50	50	-9.86	-8.87

There were no other emissions detected within 20 dB of the limit

Note: 1. All measurement were made at 3 meters

8 FREQUENCY STABILITY

8.1 Test description

Parameter:	FCC §2.1055
Requirement:	FCC § 90.213
Frequency Tolerance:	Within 0.0005% (2 ppm)

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° 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.

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8.3. Test Results

Frequency Stability vs. Temperature		
ACF (MHz): 436.025 MHz		Limit: 2 ppm
Temperature, C	MCF (MHz)	PPM
-30	436.025621	1.42
-20	436.025645	1.48
-10	436.025476	1.09
0	436.025074	0.17
10	436.024835	-0.38
20	436.024633	-0.84
30	436.024741	-0.59
40	436.024709	-0.67
50	436.025135	0.31

Frequency Stability vs. Voltage				
ACF (MHz): 436.025 MHz				Limit: 2 ppm
%		Voltage (Vdc)	MCF (MHz)	PPM
115		8.625	436.024711	-0.66
100		7.5	436.024633	-0.84
85		6.375	436.024718	-0.65
Battery Endpoint	120	9.0	436.024860	-0.32
	80*	6.0	436.024682	-0.73

* NOTE: Battery went into continuous reset at XXX volts DC.

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:	TIA/EIA 603-1
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 & 4W at 436.025 MHz
 Channel Spacing: 25 kHz
 Switch – On condition

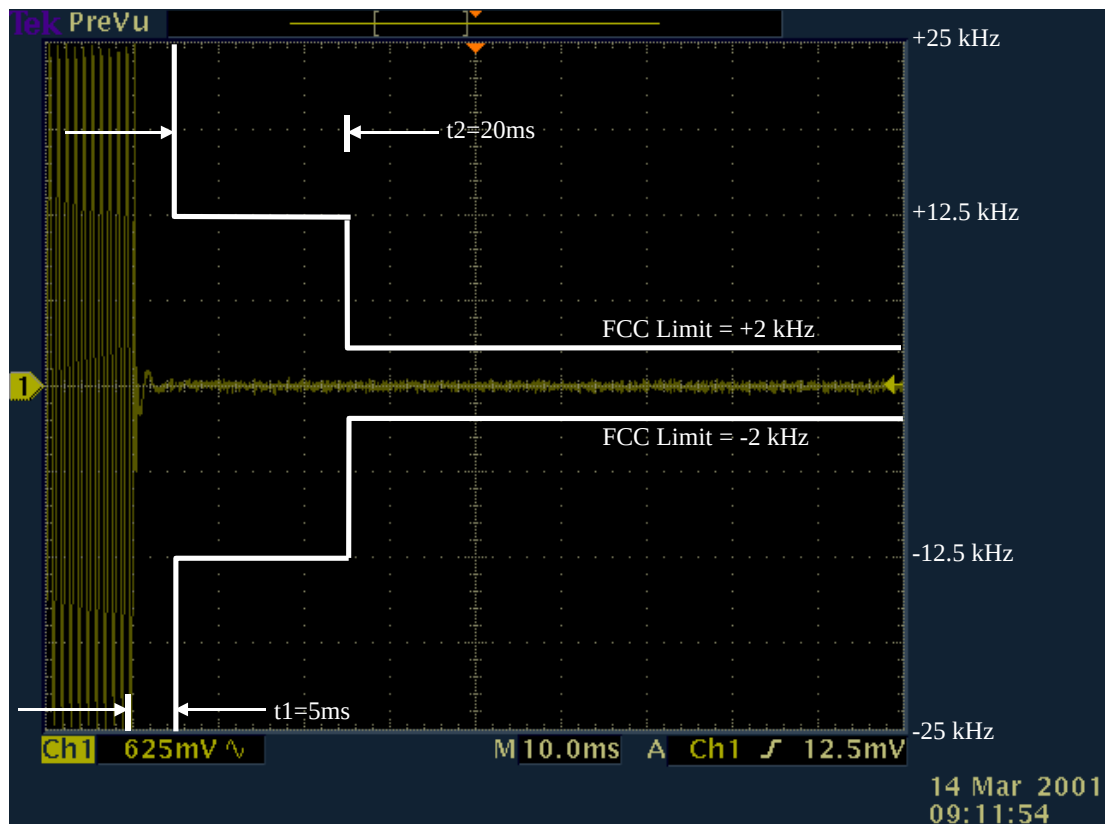


Figure 9.3-2: Transient Frequency Behavior

Power: 1W & 4W at 436.025 MHz
Channel Spacing: 25 kHz
Switch – Off condition

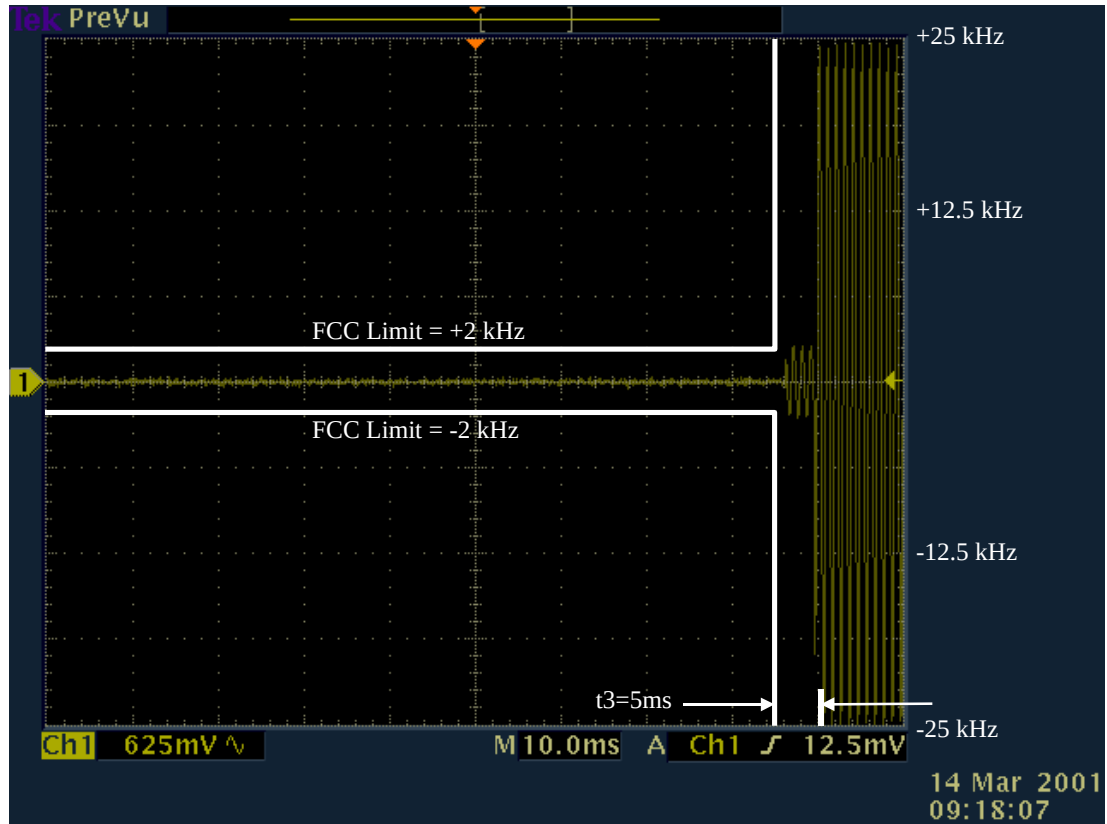


Figure 9.3-3: Transient Frequency Behavior

Power: 1W & 4W at 436.025 MHz
Channel Spacing: 12.5 kHz
Switch – On condition

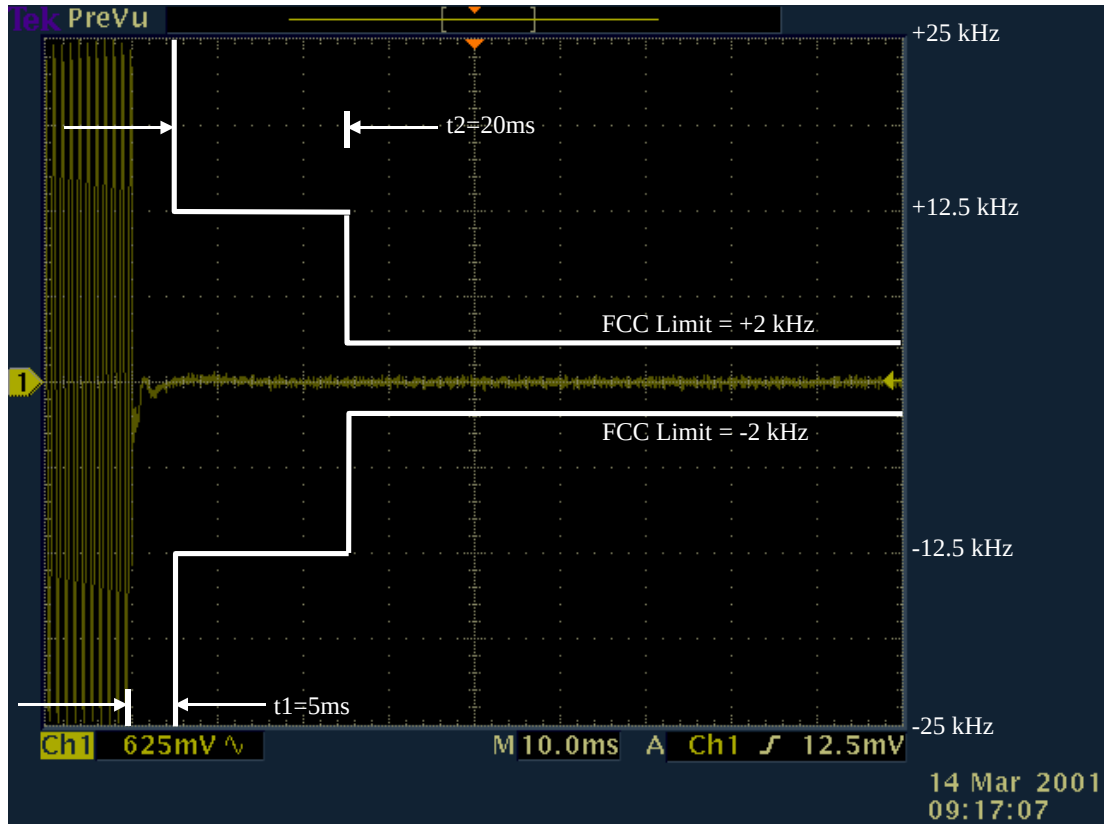
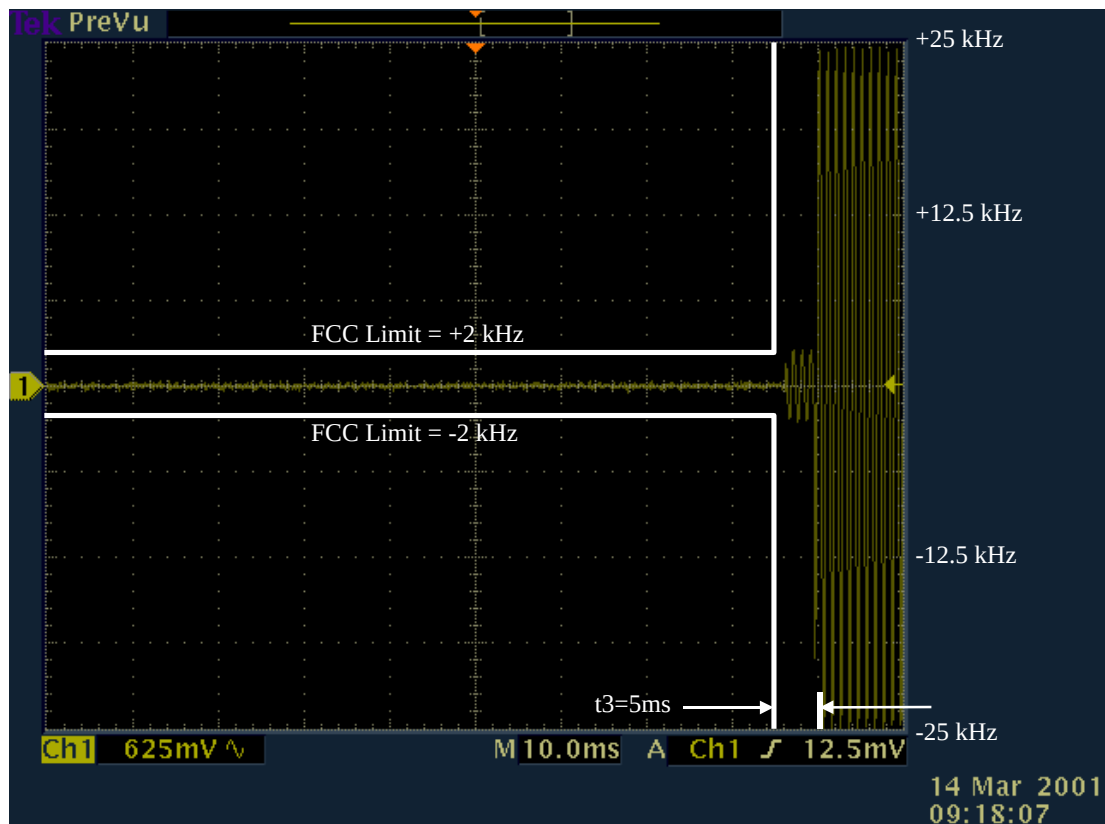


Figure 9.3-4: Transient Frequency Behavior

Power: 1W & 4W at 436.025 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

10 RECEIVER AC LINE CONDUCTED EMISSIONS

10.1 Test description

Parameter:	ANSI C63.4
Requirement:	FCC § 15.107(a)

10.2 Test Procedure

The EUT was connected to the DC battery pack, which was connected to the battery charger with AC line through the LISNs.

Both HOT and NEUTRAL leads were tested.

10.3 Test Results

Frequency MHz	Reading Hot dB	Reading Neutral dB	Attenuator Factor dB	System Loss dB	Qausi-Peak		Margin dB	
					Net	Limit		
					dB(uV)	dB(uV)		
0.450	35.8	37.4	0.0	0.7	38.1	48.0	-9.9	*
0.460	35.3	37.1	0.0	0.7	37.8	48.0	-10.2	*
0.470	34.9	36.8	0.0	0.7	37.5	48.0	-10.5	*
0.475	34.7	36.6	0.0	0.7	37.3	48.0	-10.7	*
0.500	33.6	35.5	0.0	0.6	36.1	48.0	-11.9	*
0.750	24.0	27.6	0.0	0.6	28.2	48.0	-19.8	*
*13 dB reduction applied per FCC 15.107(d).								

10.4 Modifications made during testing

None

10.5 Test instrumentation

[X] HP 8593 Spectrum Analyzer
[X] Solar LISN

11 RECEIVER RADIATED EMISSION

11.1 Test description

Parameter:	ANSI C63.4
Requirement:	FCC §15.109(a)

11.2 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 test was performed by placing the EUT on 3 orthogonal axis.

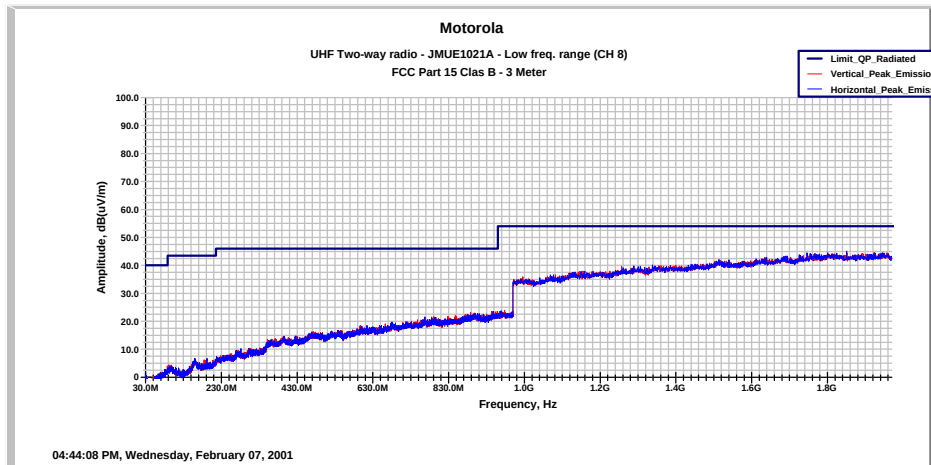
11.3 Test Results

No radiated emission was detected, or the radiated emission was at least 20 dB below the applicable limit. Please see the following plots.

Test Condition: Receiving mode

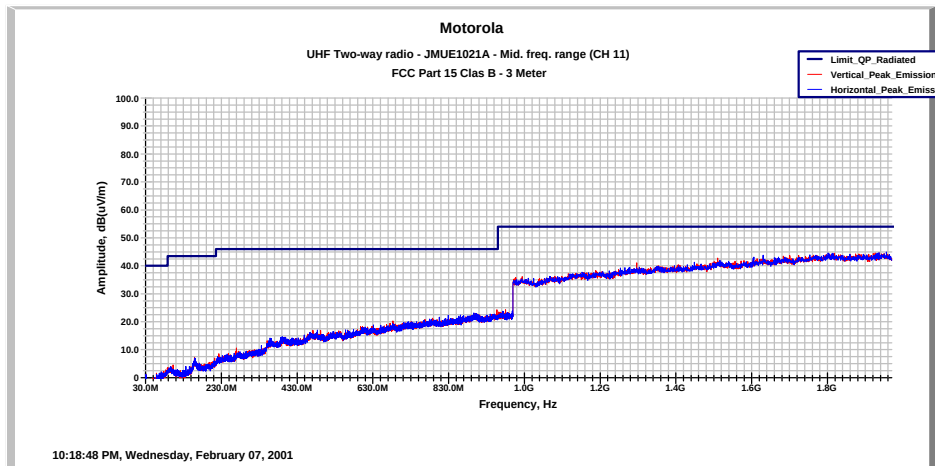
Frequency range investigated: 30 to 1000 MHz.

Low Channel:

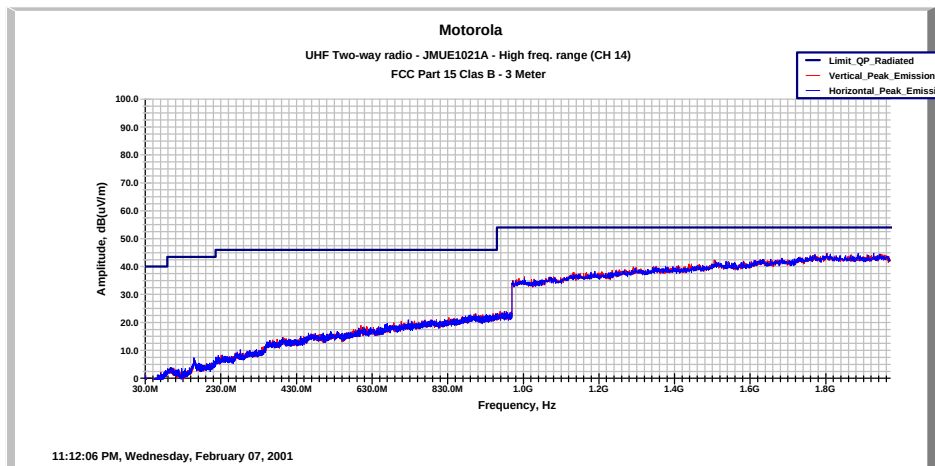


11.3 Test Results (Continued)

Middle Channel:



High Channel:



11.4 Modifications made during testing

None

11.5 Test instrumentation

[X] EMCO 3141 Bi-logcon Antenna
[X] HP 8546A EMI Receiver