FCC Part 90 Test Report
for
M/A-Com, Inc.
on the
OpenSky M-803 Mobile Radio Systems
Model: MAMROS0003, MAMROS0004, MAMROS0005, MAMROS0006, MAMROS0012, MAMROS0013, MAMROS0014, MAMROS0015

FCC ID: BV8M803M

Test Report #: 3004358
Date of Report: August 15, 2001

Job #: 3004358
Dates of Test: July 18-25, August 13, August 15, 2001

Total No of Pages Contained in this Report: 22 + Data Sheets

NVLAP Laboratory Code: 100270-0

8/21/01	Nicholas Abbondante, Test Engineer
8/21/01	Robert Martin, Senior Technical Manager

Table of Contents

1.0 Summary of Tests

FCC ID: BV8M803M
Model No.: MAMROS0003, MAMROS0004, MAMROS0005, MAMROS0006, MAMROS0012, MAMROS0013, MAMROS0014, MAMROS0015

FCC RULE	DESCRIPTION OF TEST	RESULTS	REPORT PAGE
2.1046	RF Power Output	Passed	8
2.1049, 90.209(b)(5), 90.210	Occupied Bandwidth, Bandwidth Limitation, Emission Masks	Passed	9
2.1051	Out-of-Band Emissions at Antenna Terminals	Passed	10
2.1053, 90.205, 90.635	Field Strength of Spurious Radiation	Passed	12
2.1047	Modulation Characteristics	N/A	--
2.1055	Frequency Stability vs. Temperature	Passed	13
2.1055	Frequency Stability vs. Voltage	Passed	14
2.914	Transient Frequency Behavior	N/A	15
2.1091, 2.1093	RF Exposure	Passed	19

Test Engineer: Nicholas Abbondante Date: 8/21/01

Senior Technical Manager: Robert Martin Date: 8/21/01

2.0 General Description

2.1 Product Description

The OpenSky M-803 Mobile Radio is a versatile voice and data radio designed for the mobile environment. The M-803 Mobile Radio operates in the 800 MHz SMR and NPSPAC frequency bands.

Two production versions of the sample were received on July 18, 2001 in good condition. Only the OpenSky digital modulation (OTP which employs a GSFK modulation) software was provided and tested. The OpenSky M-803 configurations were:

1. Trunk Mount Mobile Radio Unit, Half Duplex Configuration with GPS (M/A-Com Model MAMROS0015, Serial A40070000020)
2. Dash Mount Mobile Radio Unit, Half Duplex Configuration with GPS (M/A-Com Model MAMROS0004, Serial A40060000020)

The Trunk Mount version is electronically the same as the Dash Mount, except that the internal circuitry is located in 2 chassis instead of one, requiring several additional cables to communicate between them.

The EUT has been tested at the request of

Company: M/A-Com
1011 Pawtucket Blvd.
Lowell, MA, 01853-2395
Name of contact: Andy Moysenko
Telephone: (978) 442-4762
Fax: (978) 442-5442

Overview of M-803 Mobile Radio Unit

Applicant	M/A-Com
Trade Name	OpenSky M-803 Mobile Radio
FCC Identifier	BV8M803M
Use of Product	Voice and Data Communication
Type of Modulation	GFSK and FM
Bit Rate	19200 bps
Max. Allowed Deviation	10 kHz
RF Output	32 Watts Maximum
The dc voltage applied to and current into the several elements of the final RF amplifying device	Voltage: 12VDC Current: 9A
Frequency Range	806 – 824 MHz and 851 – 869 MHz
Max. Number of Channels	830
Antenna(e) & Gain	0 dBi and 3 dBi
Detachable Antenna?	[X] Yes [ ] No
Receiver L.O. Frequency	921 – 939 MHz
External Input	[X] Audio [X] Digital Data

Model Numbers in the OpenSky M-803 Mobile Radio Series

Dash Mount Mobile Radio Unit Half Duplex	MAMROS0003
Dash Mount Mobile Radio Unit Half Duplex with GPS*	MAMROS0004
Dash Mount Mobile Radio Unit Full Duplex	MAMROS0012
Dash Mount Mobile Radio Unit Full Duplex with GPS	MAMROS0013
Trunk Mount Mobile Radio Unit Half Duplex	MAMROS0014
Trunk Mount Mobile Radio Unit Half Duplex with GPS*	MAMROS0015
Trunk Mount Mobile Radio Unit Full Duplex	MAMROS0005
Trunk Mount Mobile Radio Unit Full Duplex with GPS	MAMROS0006

* - Unit provided for testing

The Dash Mount Mobile Radio Unit Half Duplex with GPS (MAMROS0004) and Trunk Mount Mobile Radio Unit Half Duplex with GPS (MAMROS0015) were selected for testing for the following reasons:

- Half-duplex selected over full-duplex due to the full-duplex radio requiring an external RF Combiner. The RF Combiner consists of RF switches and a duplex filter that provides additional transmit signal filtering. There are no amplifiers within the RF Combiner. There is no other difference between the half-duplex and full-duplex RF transmit circuitry. Therefore, the half-duplex RF transmissions should be the worst case for the M-803 Mobile Radio.
- The GPS option was selected since it requires an additional OEM circuit board within the M-803 Mobile Radio. The GPS circuit board does not transmit any energy but it does require an external antenna. There are no differences in the M-803 800 MHz RF circuitry with or without the GPS option. Therefore, there should be no difference with or without the GPS option, the GPS option was used to determine any variations during Part 15 testing (no variations were detected). The GPS antenna is not the transmit antenna.
- A trunk mount and dash mount was selected to determine any variations during Part 15 testing (no variations were detected). There are no differences in the M-803 RF circuitry in either the dash mount or trunk mount configuration.

2.2 Related Submittal(s) Grants

None.

2.3 Test Facility

Radiated Testing:
Site 2C (Middle Site) is a 3m and 10m sheltered EMI measurement range located in a light commercial environment in Boxborough, Massachusetts. It meets the technical requirements of ANSI C63.4-1992 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal ground plane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets of metal are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid. The copper straps are directly connected to the ground plane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical ground plane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical ground plane is electrically connected to the reference ground plane.

RF Exposure Testing:
RF exposure testing was performed in the parking lot to simulate a typical environment.

2.4 Test Equipment and Support Equipment

Test Equipment

Description	Manufacturer	Model Number	Serial Number	Cal Due Date
Average Power Meter	Boonton	4232A	55601	12/20/01
EMI Receiver Set W/RF Filter	Hewlett Packard	85422E	3520A00125	11/21/01
Cable, SMA – SMA <18 GHz	Sucoflex	104PE	CBLSHF203	8/21/01
Cable, SMA – SMA <18 GHz	Sucoflex	104PE	CBLSHF201	8/21/01
Generator, Synthesized Sweep	Hewlett Packard	83620A	3213A01244	9/21/01
Horn Antenna	EMCO	3115	9512-4632	10/9/01
Cable, SMA – SMA <18 GHz	Sucoflex	104PE	CBLSHF103	8/21/01
Cable BNC – BNC 10m long	Pasternack	RG-58C/U	CBL10MS1	9/17/01
Low to High Temperature Chamber	Bryant Manufacturing Associates	TH-5S	1207	7/17/02
Chart Recorder (TH-5S)	Honeywell	DR45AT	0028Y047153900001	6/25/02
Broadband Antenna	Compliance Design	B300	00674	5/10/02
Antenna	EMCO	3142	9711-1225	1/11/02
Horn Antenna	EMCO	3115	9610-4980	11/01/01
Spectrum Analyzer	Agilent	E7405A	US40240205	11/28/01
Test Vehicle	Toyota	1988 Camry	JT2SV21E8 J3285636	No Cal
30 dB Attenuator	Weinschel Corporation	47-30-34	BD4327	8/14/01*
30 dB Attenuator	Weinschel Corporation	23-30-34	AR6008	8/14/01
10 dB Attenuator	Weinschel Corporation	47-10-34	BD8309	8/14/01

* Used after calibration expired. Equipment was verified to have the correct attenuation using a signal generator outputting through the attenuator to a spectrum analyzer.

Support Equipment			
Description	**Manufacturer**	**Model Number**	**Serial Number**
40 dBAttenuator (Qty. 2)	Pasternack	PE7021-40	N/L
Laptop Computer Compaq Armada	Compaq	1456VQL10H(INT)	3J99CX55G662
Fan	Electrix	N619	N/L
Standard 3 dB Gain Antenna	Allen Telecom	ASPA1850M	N/L
Standard 3 dB Gain Elevated Feed Antenna	Allen Telecom	ASPSA912M	N/L
Standard Unity Gain Antenna	Maxrad	Z322	N/L
Microphone	M/A-Com	CTC000247	N/L
GPS Antenna	M/A-Com	ANPC-135B-H-240-BR	N/L
Speaker (Qty. 2)	Kenwood	KES-4	N/L
DC Power Supply	Hewlett Packard	6652A	3541A-02405

Cables					
Quantity	**Type**	**Length (m)**	**Shielding**	**Ferrite**	**Connector Type**
1	Serial Cable*	6	Foil	No	Metal w/360
1	Serial Cable	4	No	No	Metal w/360
1	Microphone Cable	1	No	No	Plastic
2	DC Power Cable	4	No	No	Plastic
1	AC Power Cable	2	No	No	Plastic
1	GPS Antenna Cable	4	No	No	Plastic
2	Speaker Cable	2	No	No	Plastic
1	Can Cable*	10	No	No	Plastic

* - Present only in the Dash Mount Mobile Radio Unit, Models: MAMROS0003, MAMROS0004, MAMROS0005, MAMROS0006

3.0 RF Power Output

FCC § 2.1046, § 90.205(i), § 90.635(d)

3.1 Test Procedure

The transmitter output was connected to a calibrated coaxial attenuator, the other end of which was connected to an average power meter. The readings were taken from the power meter in dBm.

Requirement: The RF Power Output must be below 20 dBW.

3.2 Test Results

Results: Passed

Conducted RF Output Power

Frequency (MHz)	Description	Value (dBm)	Value (dBW)	Limit (dBW)
807.2375	Low Channel	43.89	13.89	20
816.3625	Middle Channel	43.59	13.59	20
823.9875	High Channel	43.36	13.36	20

4.0 Occupied Bandwidth, Bandwidth Limitation, Emission Masks
FCC §2.1049, 90.209(b)(5), 90.210

4.1 Test Procedure

The antenna was disconnected from the transmitter and a spectrum analyzer was connected to the transmitter RF output through sufficient attenuation to prevent overloading of the analyzer. The resolution bandwidth of the spectrum analyzer was set up to 300 Hz in the 100 kHz span around the transmit frequency, and the spectrum of the transmitting signal was recorded. This spectrum was compared to the required emission mask. Readings were taken of the unmodulated carrier power at low, middle, and high values of the transmit frequency using an average power meter. These readings are used to determine the upper limit for the applicable emissions masks.

Occupied bandwidth was measured using the 99% power function on the spectrum analyzer.

The emission designator was defined as 11K8F1E, where 11.8 kHz is the Necessary Bandwidth, determined using the maximum Occupied Bandwidth. The EUT implements a digital data stream through software GFSK modulation which shapes and constrains the Necessary Bandwidth and therefore the equations for Necessary Bandwidth are not appropriate.

Requirement: To determine compliance with the emissions mask, place the appropriate overlay over the mask plot, lining up the top of the overlay grid with the horizontal graticule that corresponds to 111 dBuV. 111 dBuV is equivalent to 4 dBm, the measured unmodulated continuous wave power through identical attenuation to that used to take the mask data.

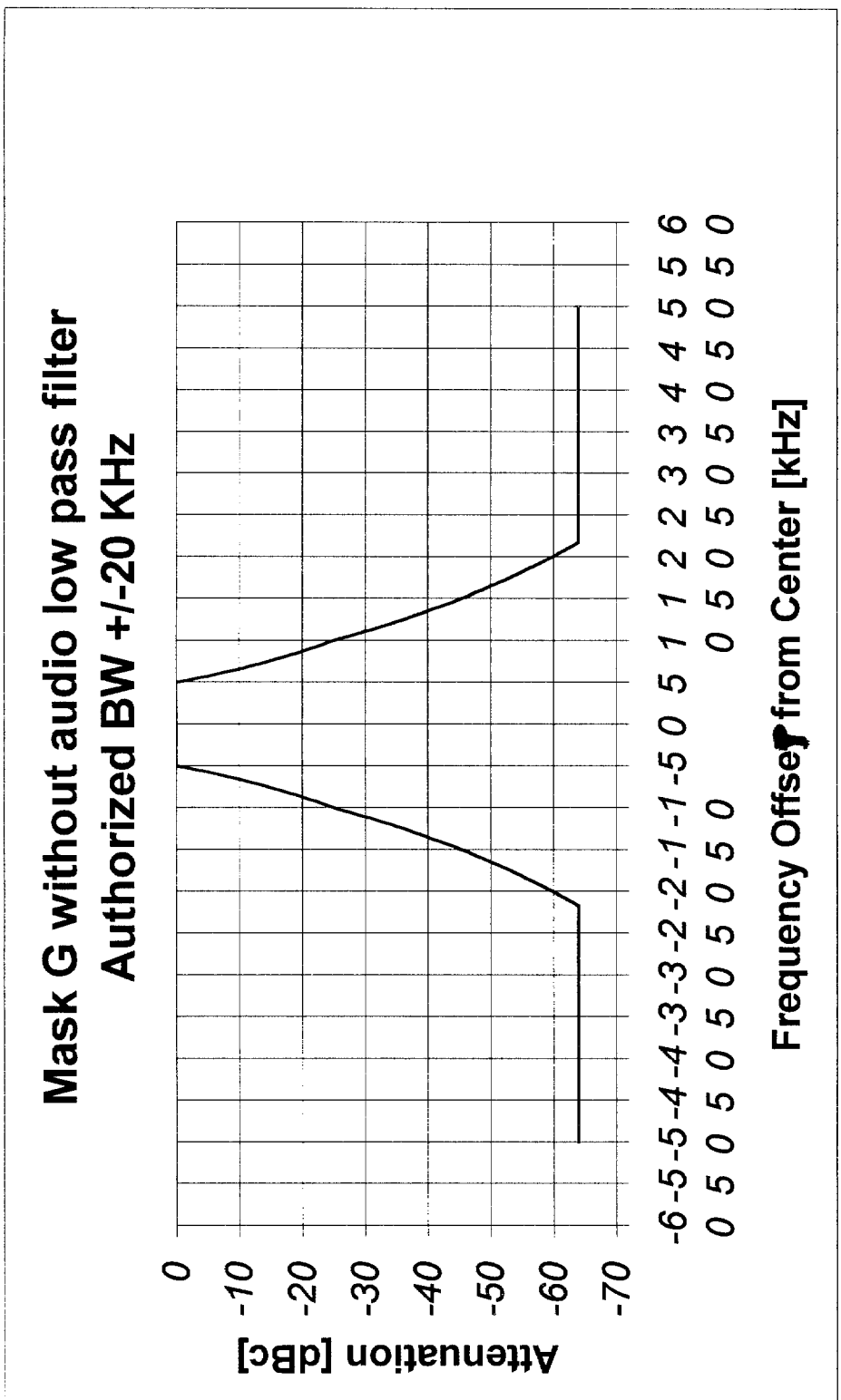
4.2 Test Results

Plot Number	Description
4-1	Overlay, Mask G
4-2	Overlay, Mask H
4-a	Low Channel, Mask G
4-b	Mid Channel, Mask G
4-c	High Channel, Mask G
4-d	Low Channel, Mask H
4-e	High Channel, Mask H

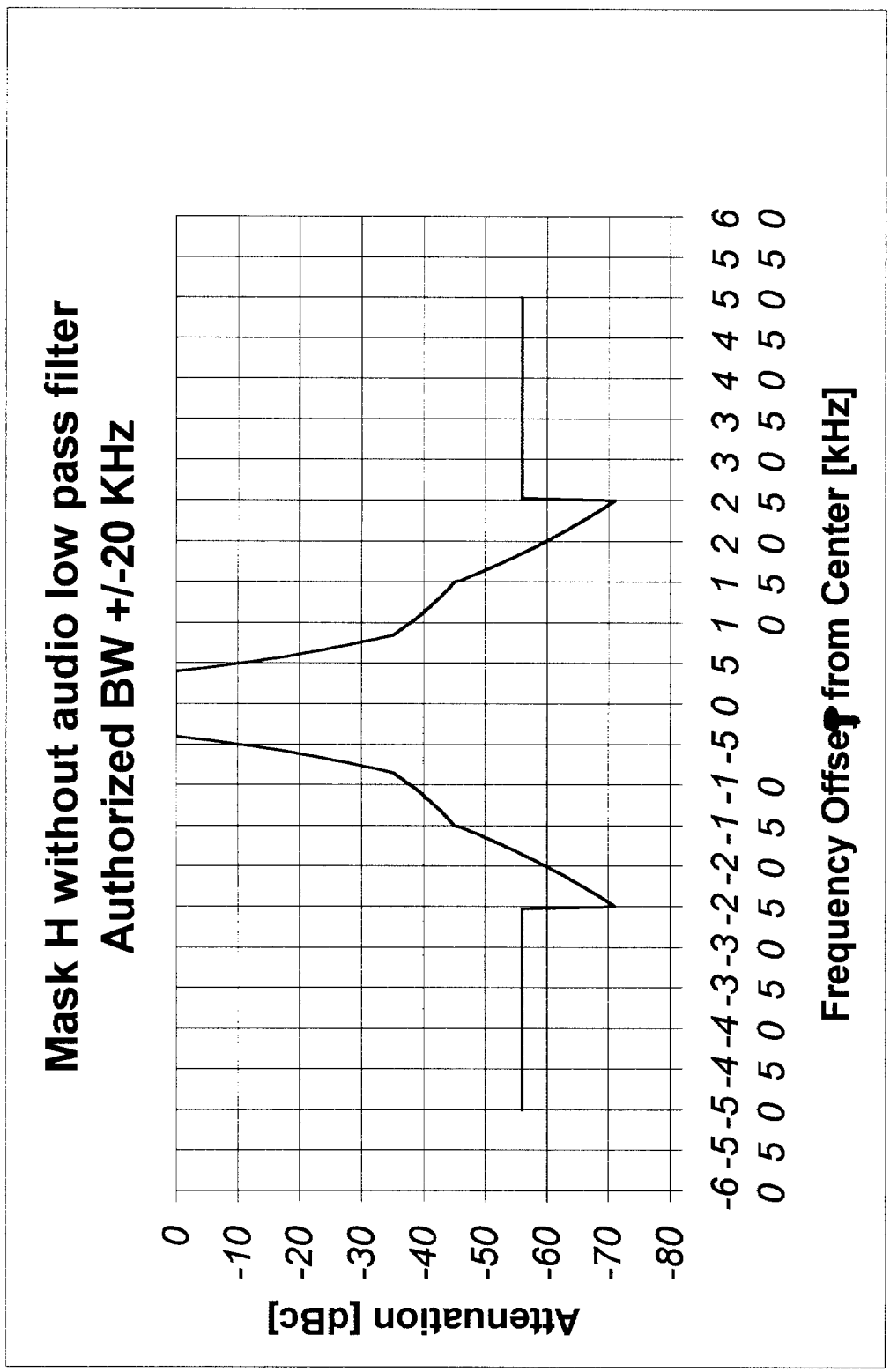
Frequency (MHz)	Occupied Bandwidth (kHz)	Authorized Bandwidth (kHz)
807.2375 (Low Channel)	11.8	20
816.3625 (Middle Channel)	11.8	20
823.9875 (High Channel)	11.8	20

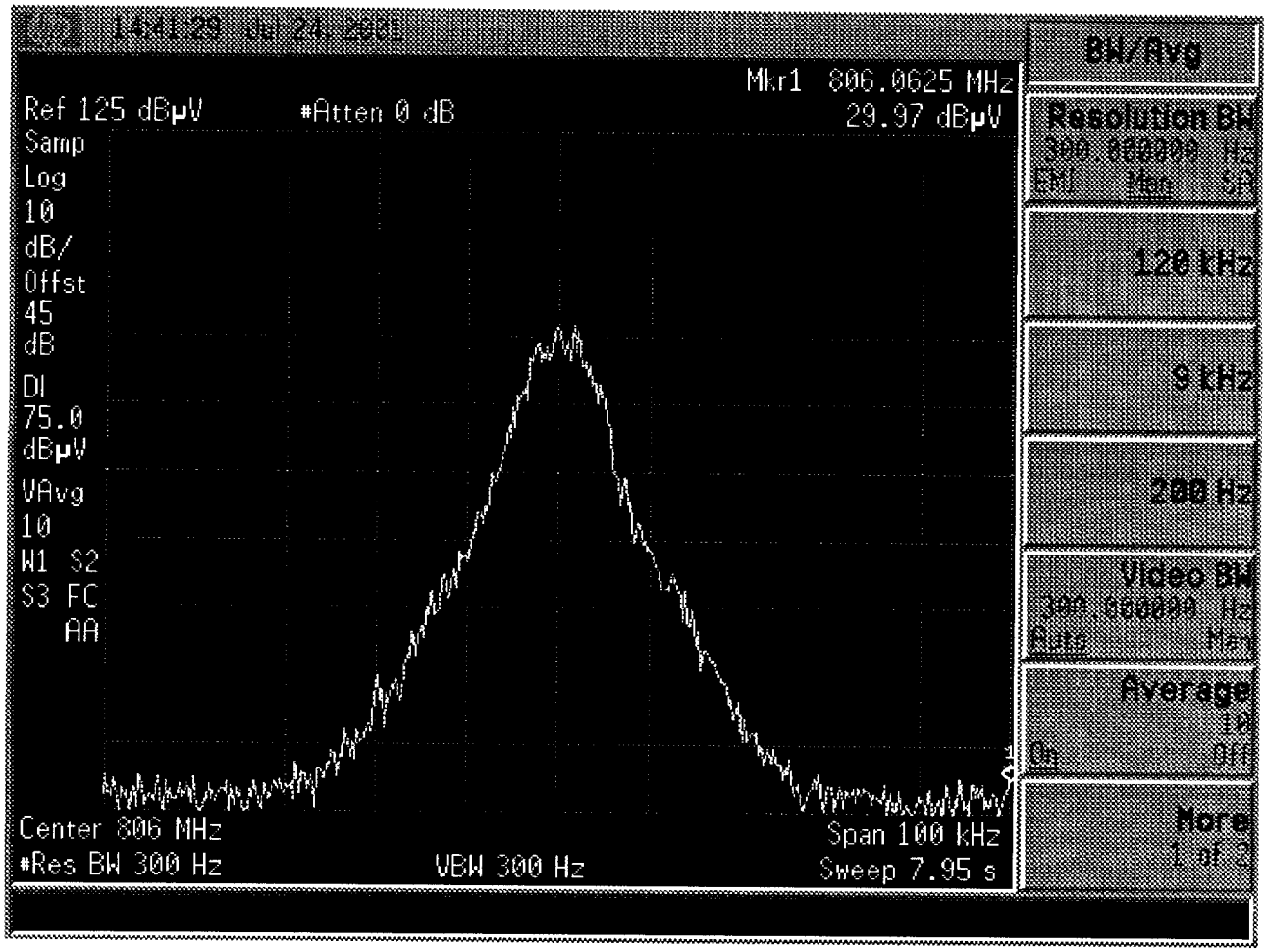
Results: Passed

Plot 4-1

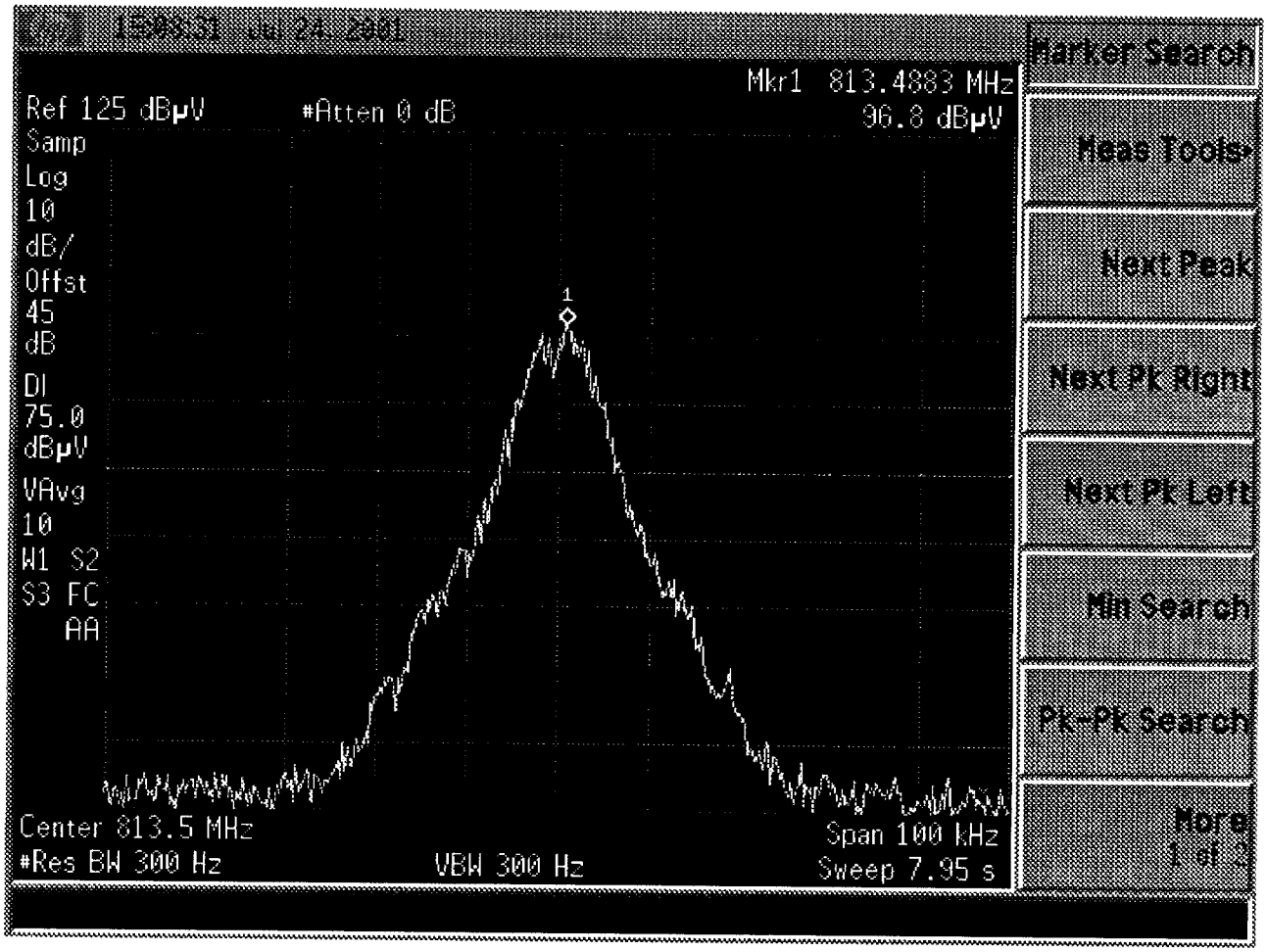

Mask G without audio low pass filter
Authorized BW +/-20 KHz
Attenuation [dBc]
0
-10
-20
-30
-40
-50
-60
-70
-6 -5 -5 -4 -4 -3 -3 -2 -2 -1 -1 -5 0 5 1 1 2 2 3 3 4 4 5 5 6
0 5 0 5 0 5 0 5 0 5 0 5 0 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0
Frequency Offset from Center [kHz]

Plot 4-2

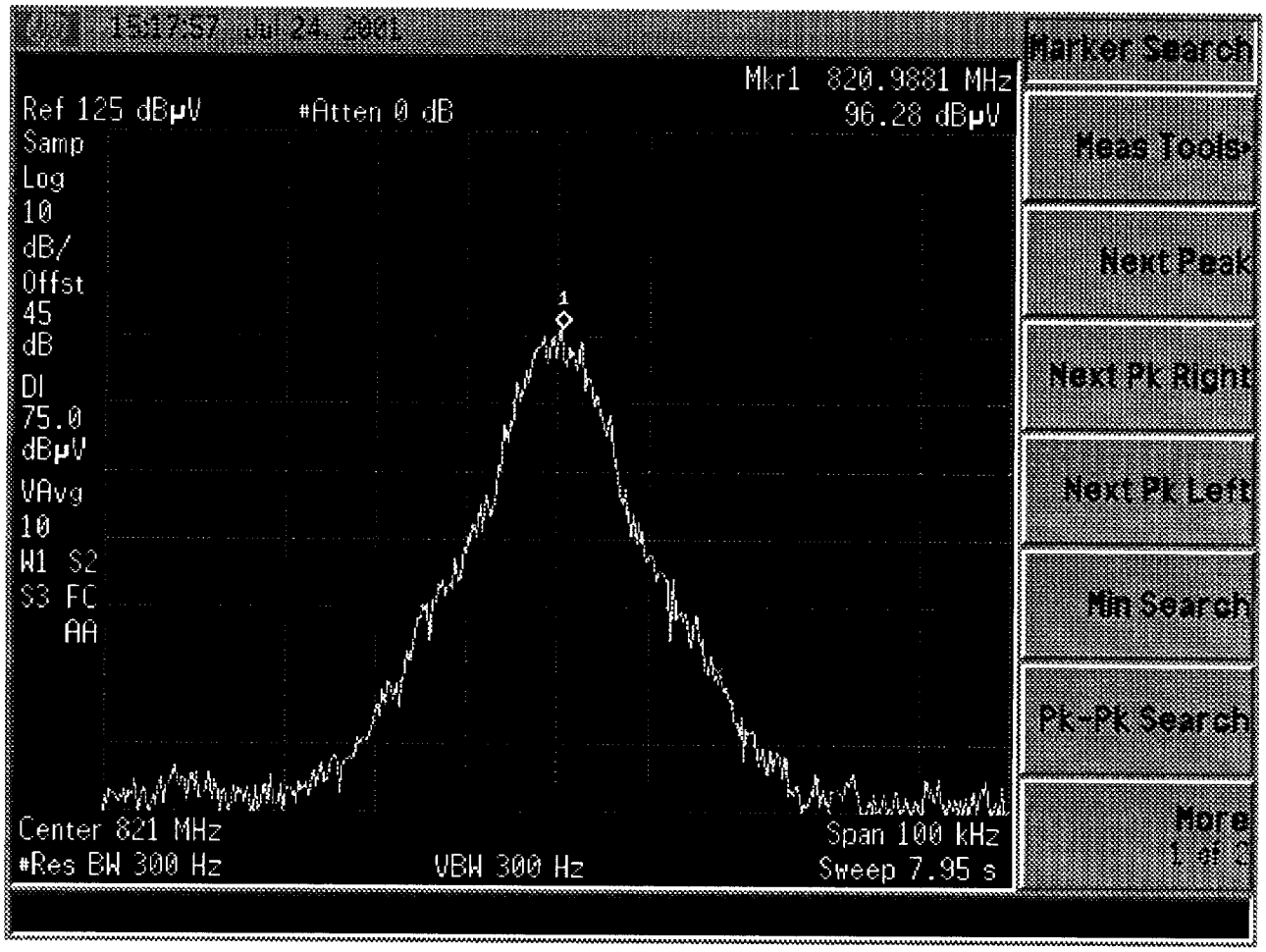

Mask H without audio low pass filter
Authorized BW +/-20 KHz
Attenuation [dBc]
0
-10
-20
-30
-40
-50
-60
-70
-80
-6 -5 -5 -4 -4 -3 -3 -2 -2 -1 -1 -5 0 5 1 1 2 2 3 3 4 4 5 5 6
0 5 0 5 0 5 0 5 0 5 0 5 0 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0
Frequency Offset from Center [kHz]


Mkr1 806.0625 MHz
29.97 dBµV
Ref 125 dBµV
#Atten 0 dB
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Center 806 MHz
#Res BW 300 Hz
VBW 300 Hz
Span 100 kHz
Sweep 7.95 s
BW/Avg
Resolution BW
120 kHz
9 kHz
200 Hz
Video BW
Average
More

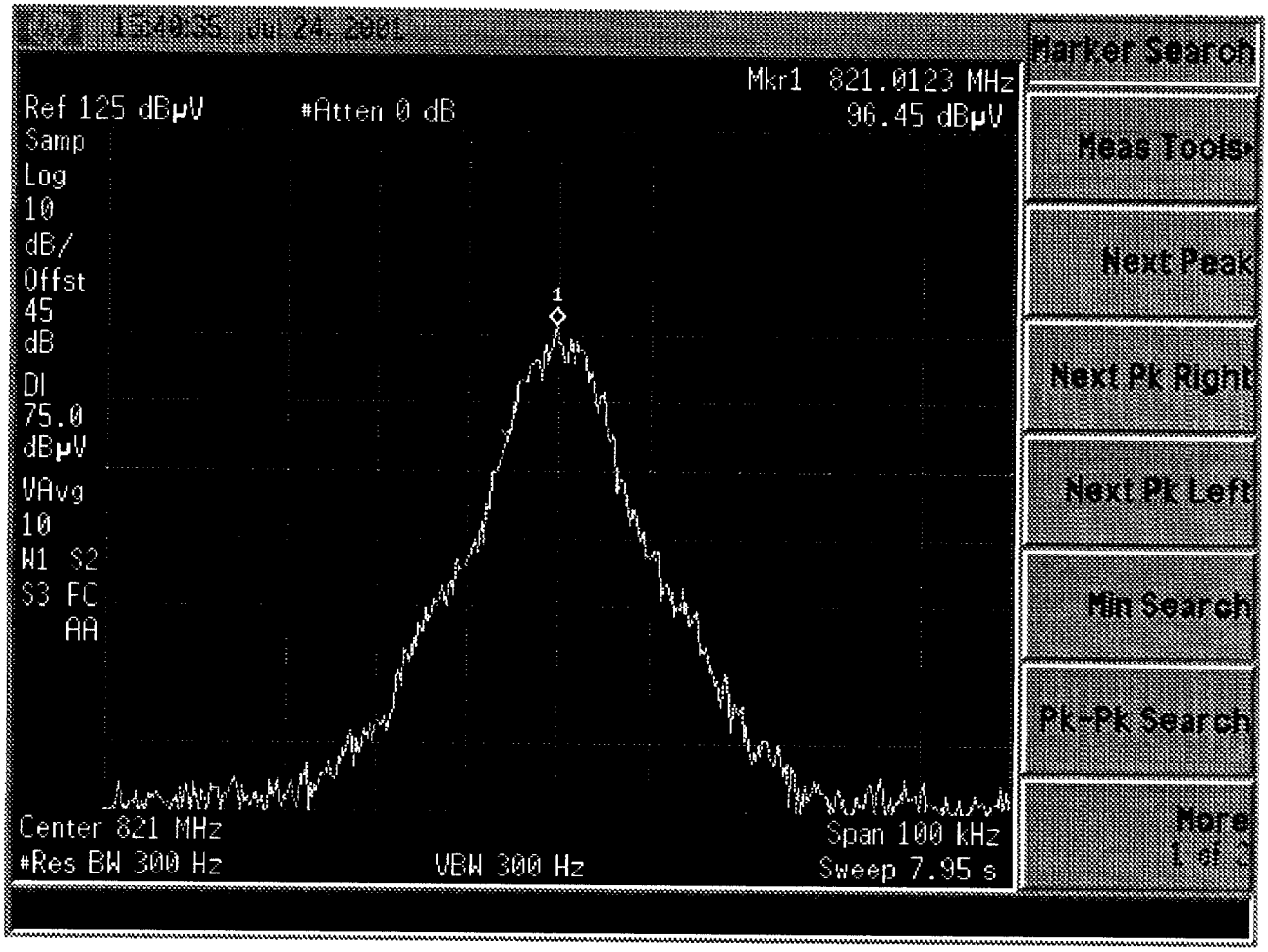
Plot 4-a


Ref 125 dBµV
#Atten 0 dB
Mkr1 813.4883 MHz
96.8 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Center 813.5 MHz
#Res BW 300 Hz
VBW 300 Hz
Span 100 kHz
Sweep 7.95 s
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Mkr Search
Pk-Pk Search
More
1 of 2

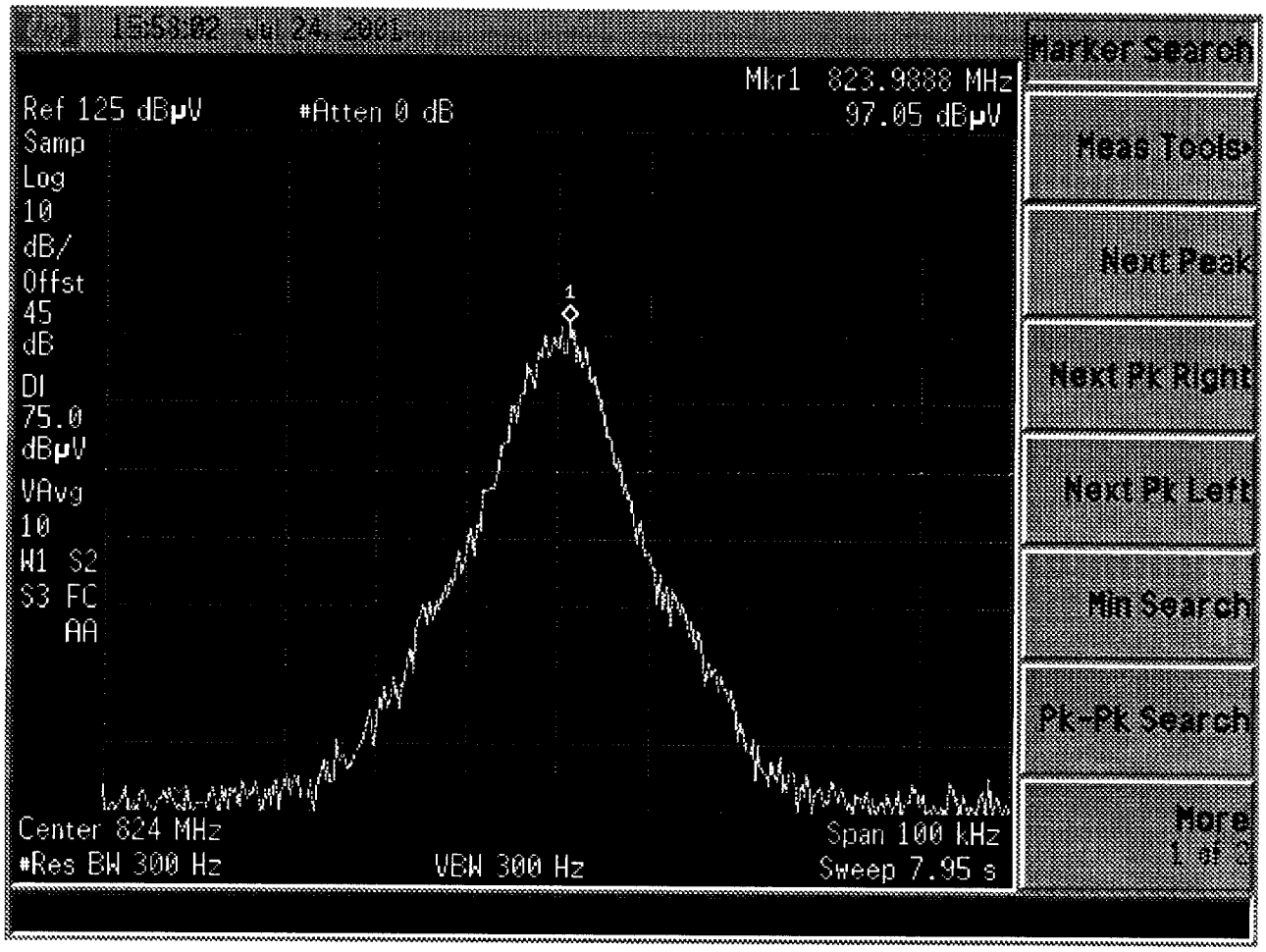
Plot 4-b


15:17:52 Jul 24, 2001
Mkr1 820.9881 MHz
96.28 dBµV
Ref 125 dBµV
#Atten 0 dB
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
1
Center 821 MHz
#Res BW 300 Hz
VBW 300 Hz
Span 100 kHz
Sweep 7.95 s
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

Plot 4-c


15:49:35 Jul 24 2001
Mkr1 821.0123 MHz
96.45 dBµV
Ref 125 dBµV
#Atten 0 dB
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
1
Center 821 MHz
#Res BW 300 Hz
VBW 300 Hz
Span 100 kHz
Sweep 7.95 s
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

Plot 4-d


Mkr1 823.9888 MHz
97.05 dBµV
Ref 125 dBµV
#Atten 0 dB
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Center 824 MHz
#Res BW 300 Hz
VBW 300 Hz
Span 100 kHz
Sweep 7.95 s
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Mkr Search
Pk-Pk Search
More

Plot 4-e

5.0 Out-of-Band Emissions at Antenna Terminals
FCC §2.1051, FCC §90.210

5.1 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through sufficient attenuation to prevent overloading the analyzer; a high-pass or band stop filter is used where necessary to prevent the fundamental emission from overloading the analyzer. The resolution bandwidth of the spectrum analyzer was set at 100 kHz below 1 GHz. Above 1 GHz the bandwidth was set to 10 kHz, since the noise floor exceeded the spectral mask limits using a 1 MHz resolution bandwidth. Sufficient scans were taken to show the out-of-band emissions, if any, up to 10th harmonic.

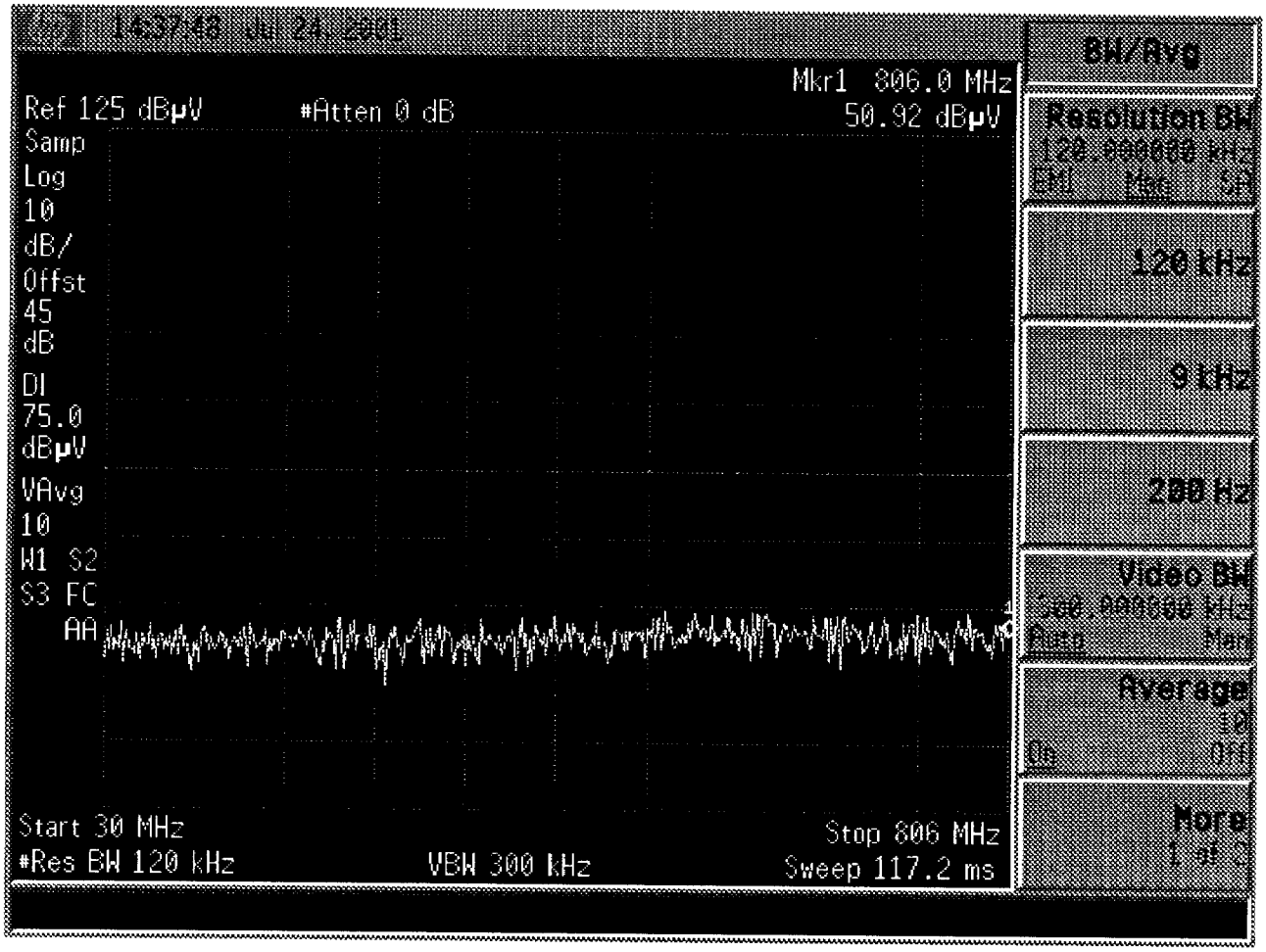
Requirement: The power of emissions must be attenuated below the power of the unmodulated carrier (P) on any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth at least (43 + 10 log P) dB. P is the rated RF output power of 25 Watts. The measured unmodulated carrier power was 4 dBm. Therefore all emissions should be attenuated below -53 dBm, or 54 dBuV.

5.2 Test Results

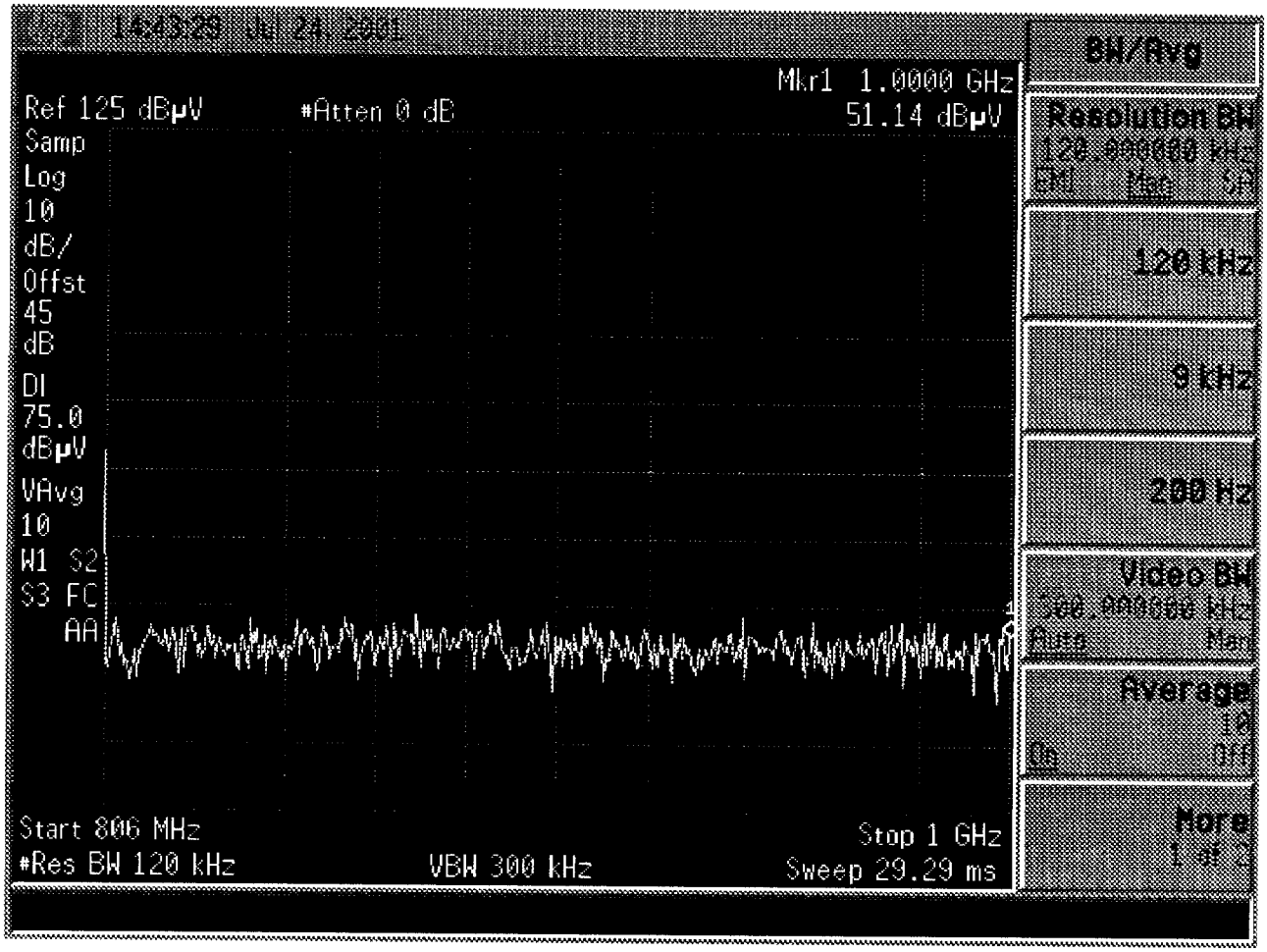
Refer to the attached plots.

Plot Number	Description
5-a-1	Low Channel , 30 MHz - Tx Frequency, Mask G
5-a-2	Low Channel, Tx Frequency - 1 GHz, Mask G
5-a-3	Low Channel, 1 GHz - 10 GHz, Mask G
5-b-1	Mid Channel , 30 MHz - Tx Frequency, Mask G
5-b-2	Mid Channel, Tx Frequency - 1 GHz, Mask G
5-b-3	Mid Channel, 1 GHz - 10 GHz, Mask G
5-c-1	High Channel , 30 MHz - Tx Frequency, Mask G
5-c-2	High Channel, Tx Frequency - 1 GHz, Mask G
5-c-3	High Channel, 1 GHz - 10 GHz, Mask G
5-d-1	Low Channel , 30 MHz - Tx Frequency, Mask H
5-d-2	Low Channel, Tx Frequency - 1 GHz, Mask H
5-d-3	Low Channel, 1 GHz - 10 GHz, Mask H
5-e-1	High Channel , 30 MHz - Tx Frequency, Mask H
5-e-2	High Channel, Tx Frequency - 1 GHz, Mask H
5-e-3	High Channel, 1 GHz - 10 GHz, Mask H

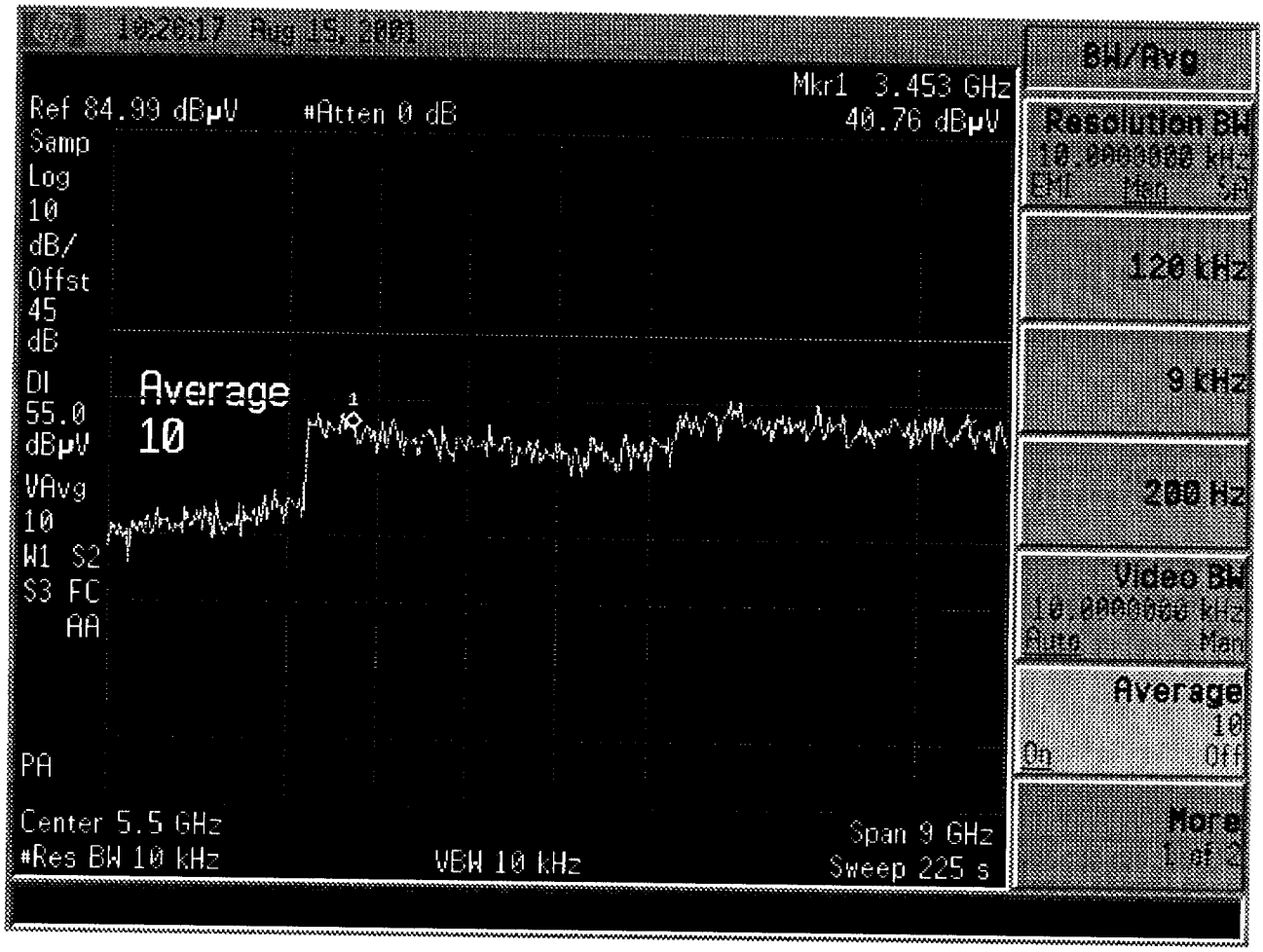
Results: Passed


14:37:48 Jul 24, 2001
Mkr1 806.0 MHz
Ref 125 dBµV
#Atten 0 dB
50.92 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 30 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 806 MHz
Sweep 117.2 ms
BW/Avg
Resolution BW
120.000000 kHz
EMI Mag SA
120 kHz
9 kHz
200 Hz
Video BW
300.000000 kHz
Auto Man
Average
On Off
More
1 of 2

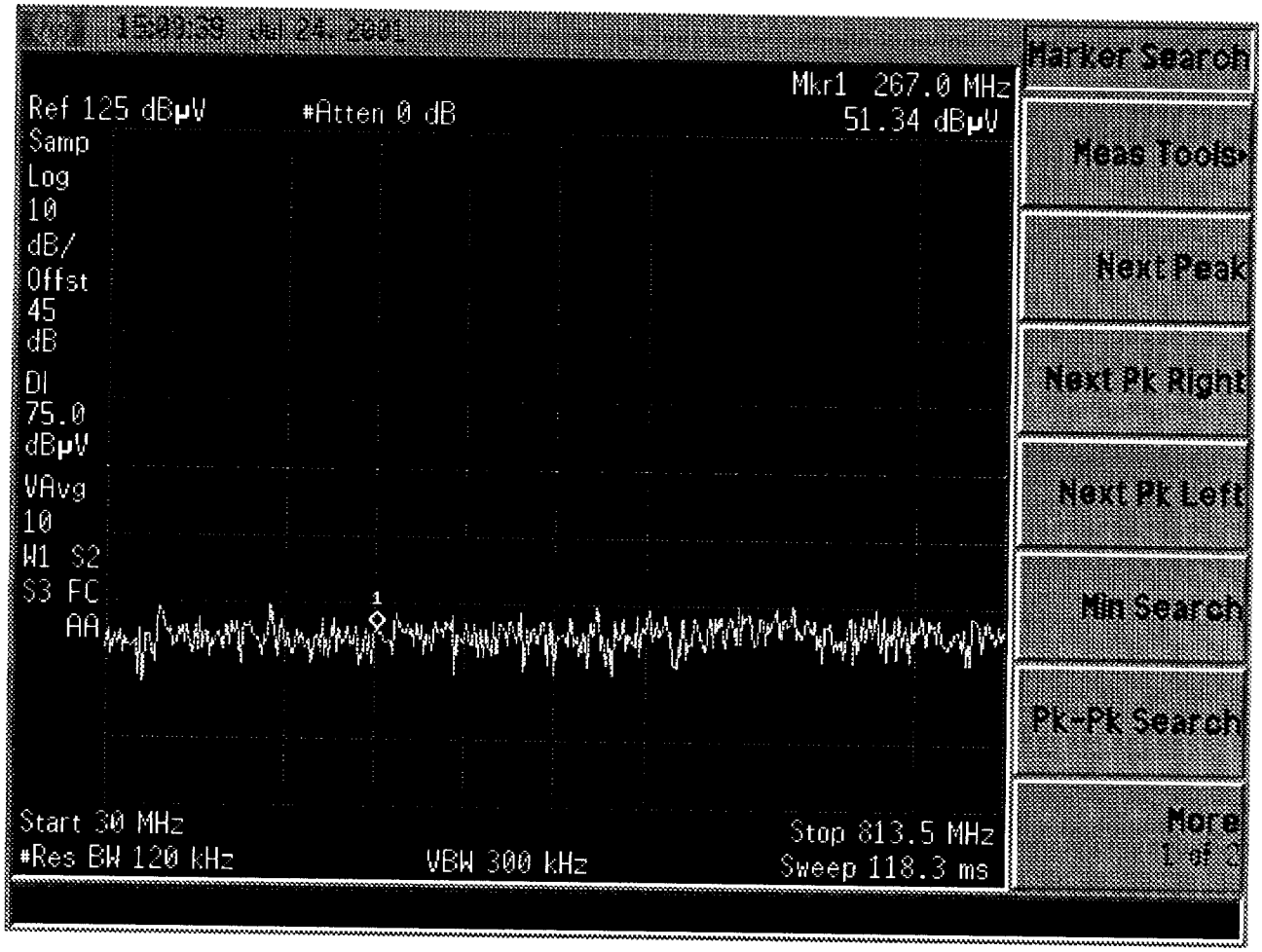
Plot 5-a-1


14:43:29 Jul 24, 2001
Mkr1 1.0000 GHz
Ref 125 dBµV
#Atten 0 dB
51.14 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 806 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 1 GHz
Sweep 29.29 ms
BW/Avg
Resolution BW
120.000000 kHz
EMI Mag Sa
120 kHz
9 kHz
200 Hz
Video BW
300.000000 kHz
Auto Man
Average
On Off
More
1 of 2

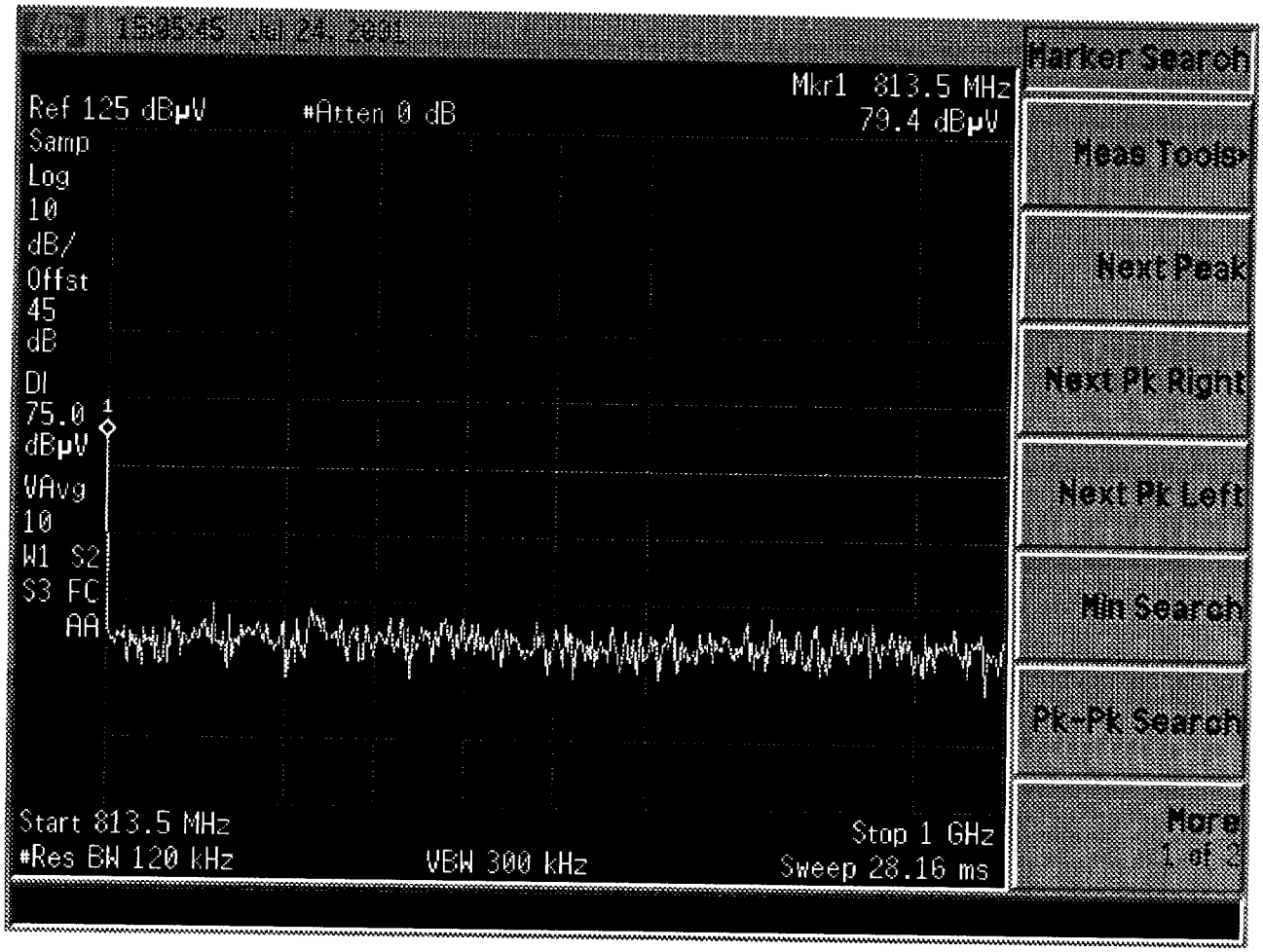
Plot 5-a-2


10:26:17 Aug 15, 2001
Ref 84.99 dBµV
#Atten 0 dB
Mkr1 3.453 GHz
40.76 dBµV
Samp
Log
10
dB/
Offst
45
dB
Average
10
DI
55.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
PA
Center 5.5 GHz
#Res BW 10 kHz
VBW 10 kHz
Span 9 GHz
Sweep 225 s
BW/Avg
Resolution BW
10.0000000 kHz
EMI Man Sel
120 kHz
9 kHz
200 Hz
Video BW
10.0000000 kHz
Auto Man
Average
10
On Off
More
1 of 2

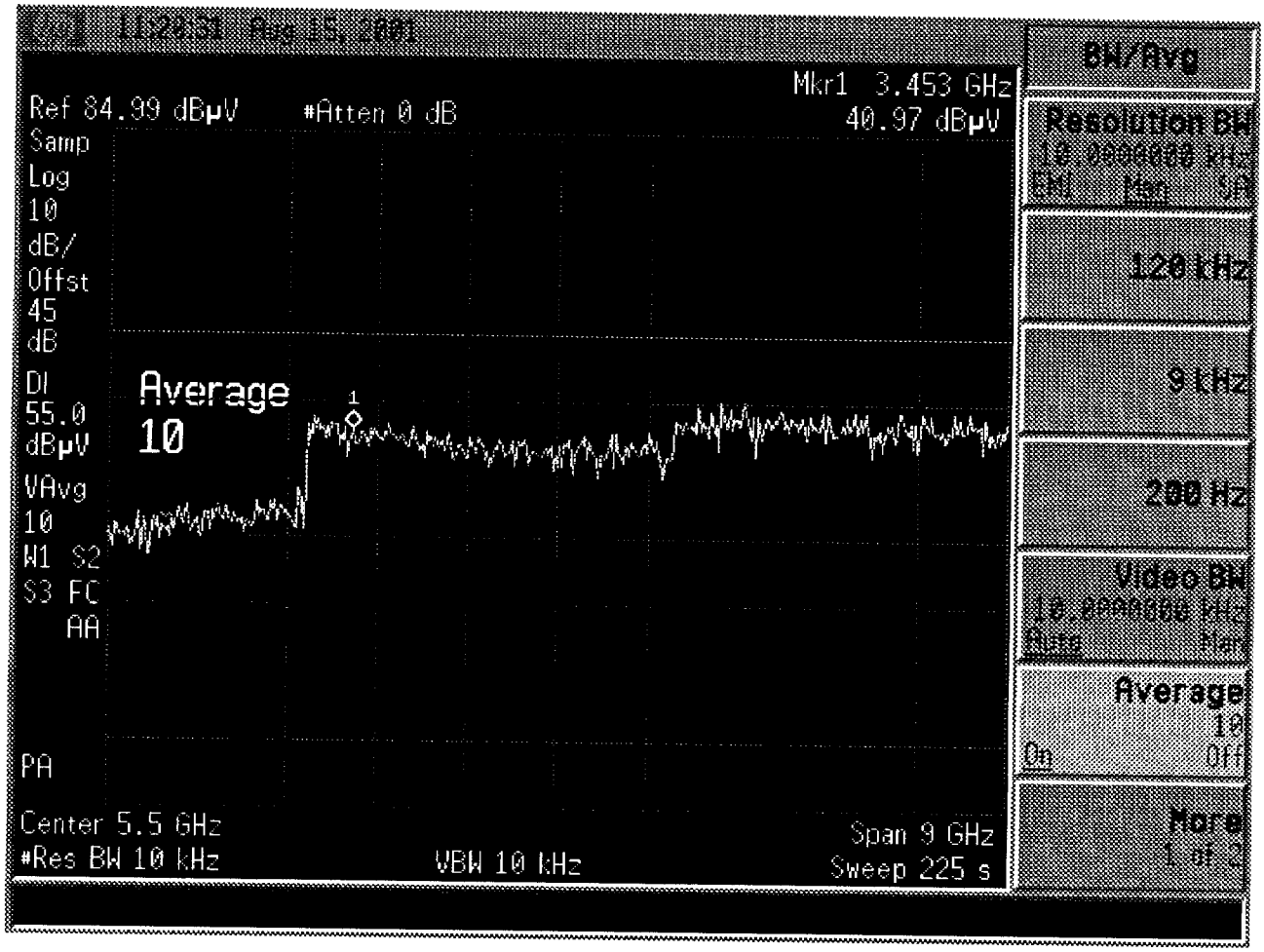
Plot 5-a-3


Ref 125 dBµV
#Atten 0 dB
Mkr1 267.0 MHz
51.34 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 30 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 813.5 MHz
Sweep 118.3 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

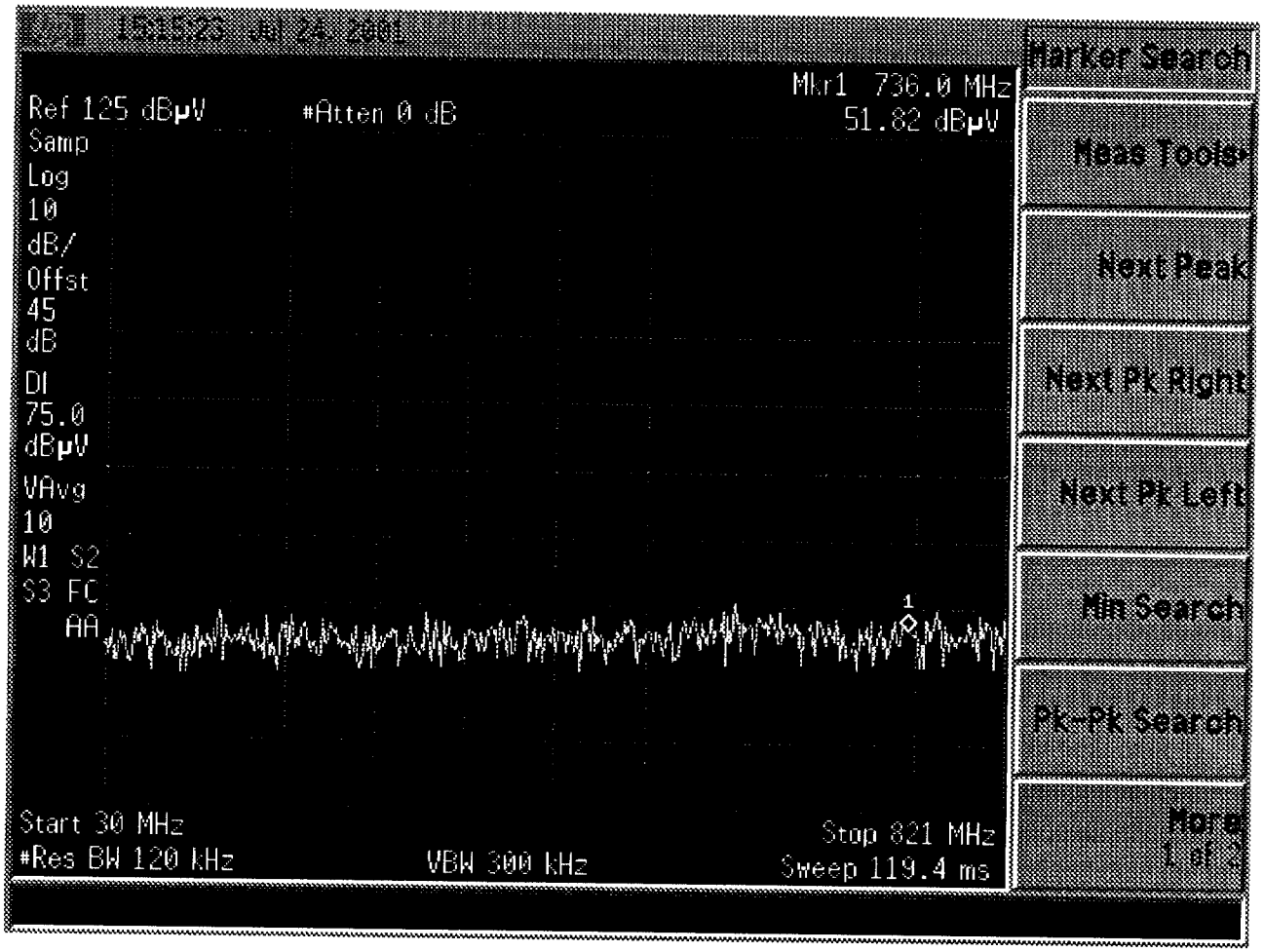
Plot 5-b-1


Ref 125 dBµV
#Atten 0 dB
Mkr1 813.5 MHz
79.4 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 813.5 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 1 GHz
Sweep 28.16 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

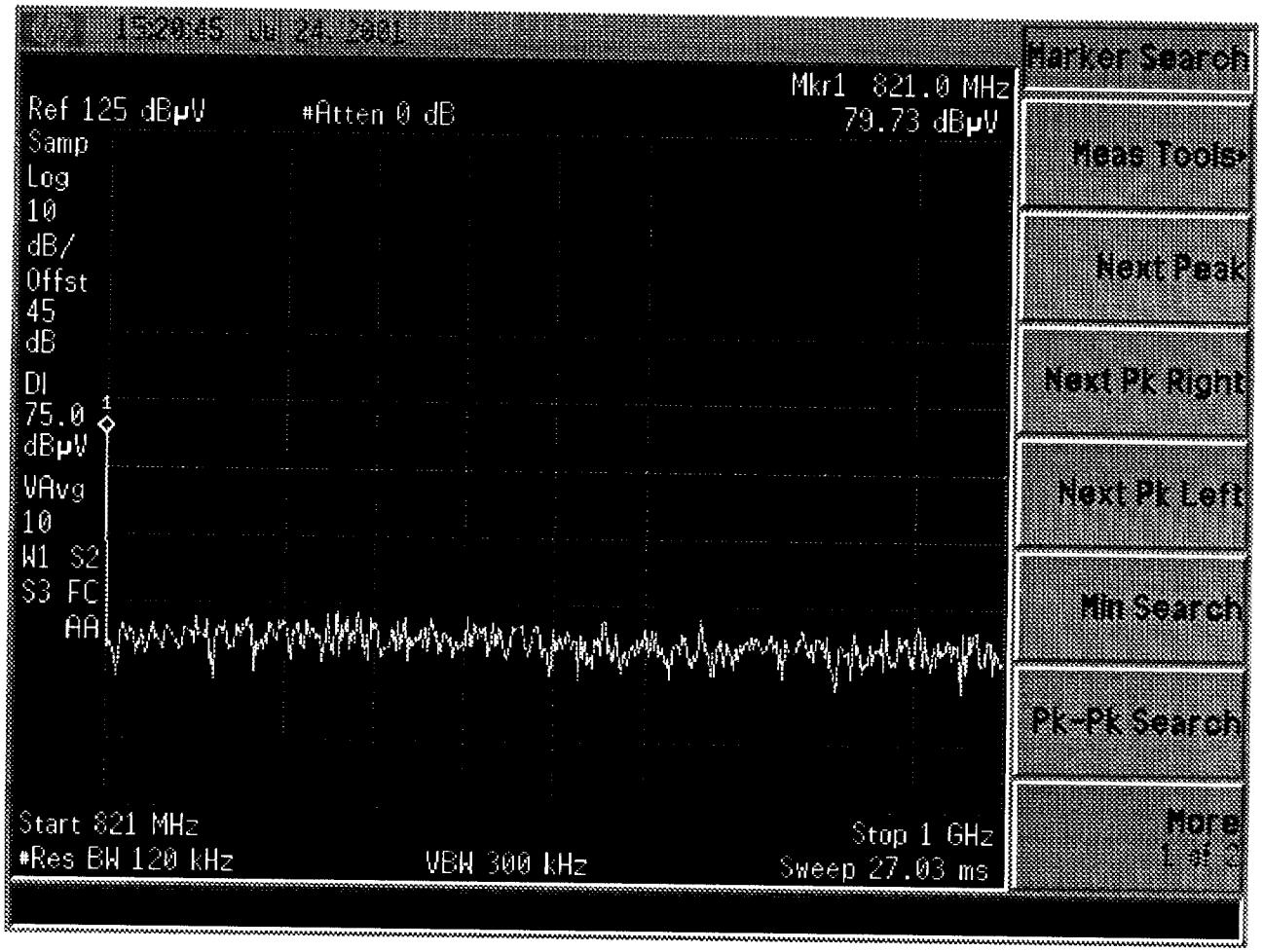
Plot 5-b-2


Ref 84.99 dBµV
#Atten 0 dB
Mkr1 3.453 GHz
40.97 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
55.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Average
10
PA
Center 5.5 GHz
#Res BW 10 kHz
VBW 10 kHz
Span 9 GHz
Sweep 225 s
BW/Avg
Resolution BW
Auto Man
120 kHz
9 kHz
200 Hz
Video BW
Auto Man
Average
On Off
More
1 of 2

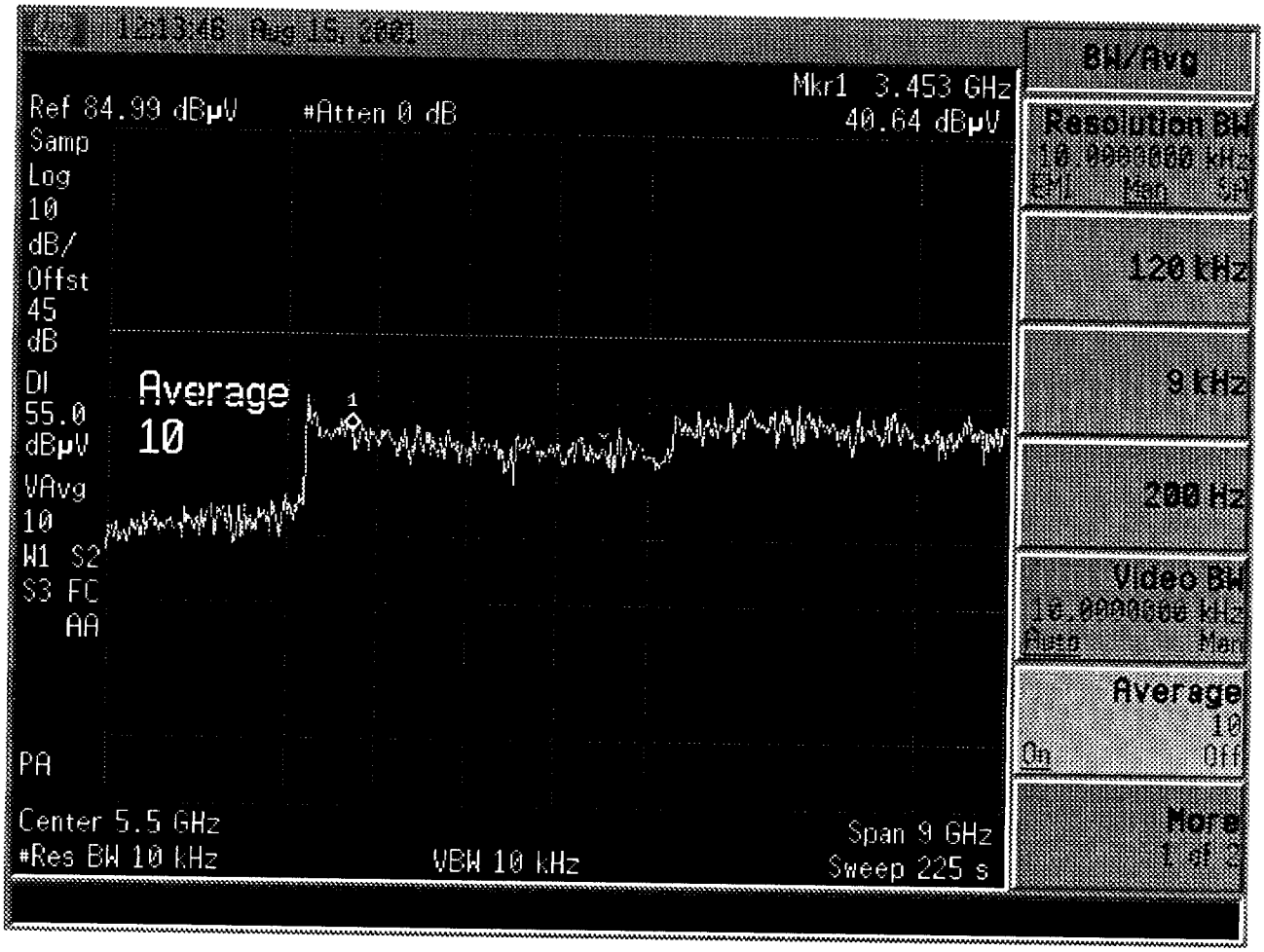
Plot 5-b-3


Ref 125 dBµV
#Atten 0 dB
Mkr1 736.0 MHz
51.82 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 30 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 821 MHz
Sweep 119.4 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

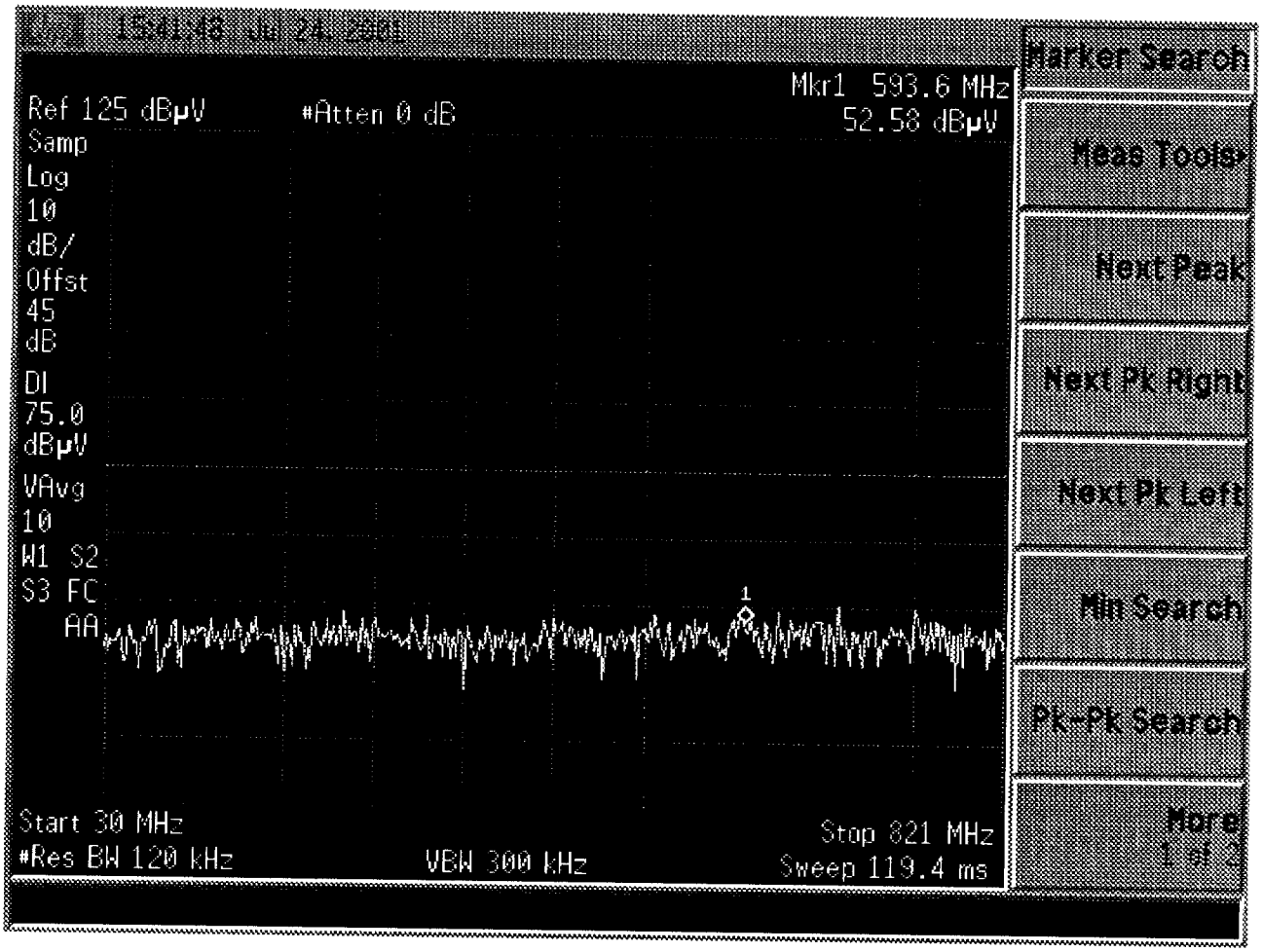
Plot 5-c-1


15:20:45 Jul 24 2001
Ref 125 dBµV
#Atten 0 dB
Mkr1 821.0 MHz
79.73 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 821 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 1 GHz
Sweep 27.03 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

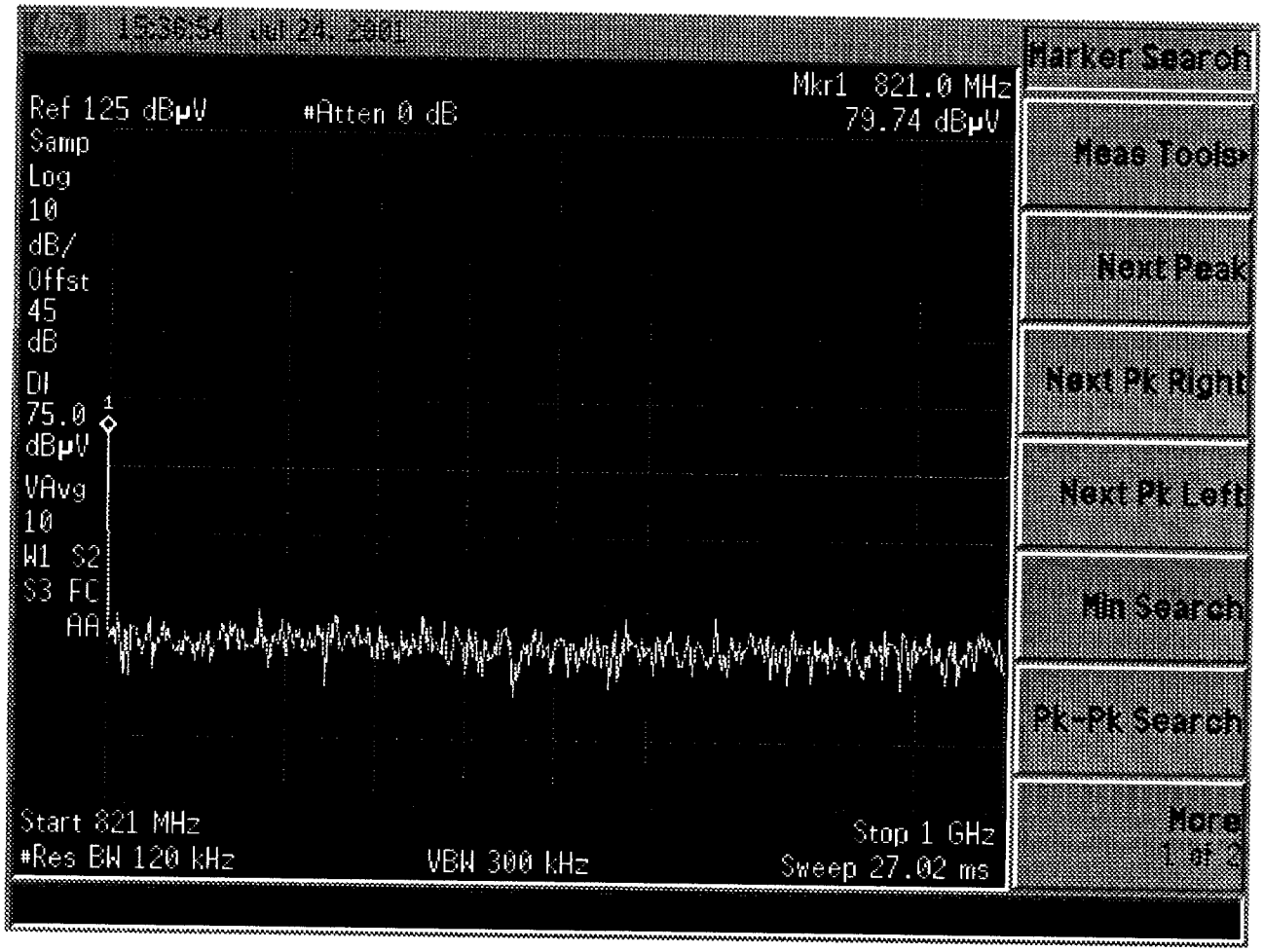
Plot 5-c-2


12:13:46 Aug 15, 2001
Ref 84.99 dBµV
#Atten 0 dB
Mkr1 3.453 GHz
40.64 dBµV
Samp
Log
10
dB/
Offst
45
dB
Average
10
VAvg
10
W1 S2
S3 FC
AA
PA
Center 5.5 GHz
#Res BW 10 kHz
VBW 10 kHz
Span 9 GHz
Sweep 225 s
BW/Avg
Resolution BW
120 kHz
9 kHz
200 Hz
Video BW
Average
10
On
Off
More

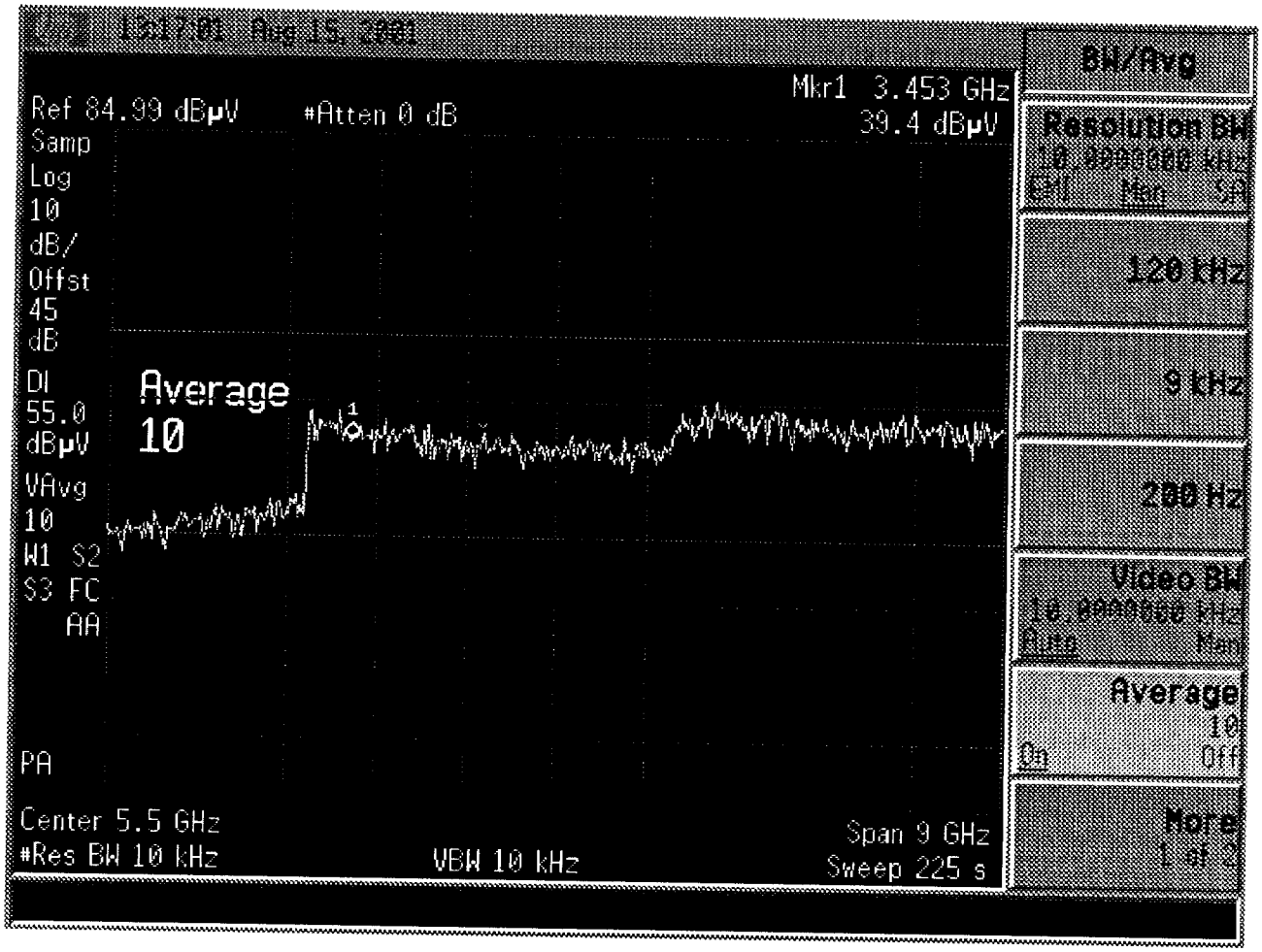
Plot 5-c-3


Ref 125 dBµV
#Atten 0 dB
Mkr1 593.6 MHz
52.58 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 30 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 821 MHz
Sweep 119.4 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

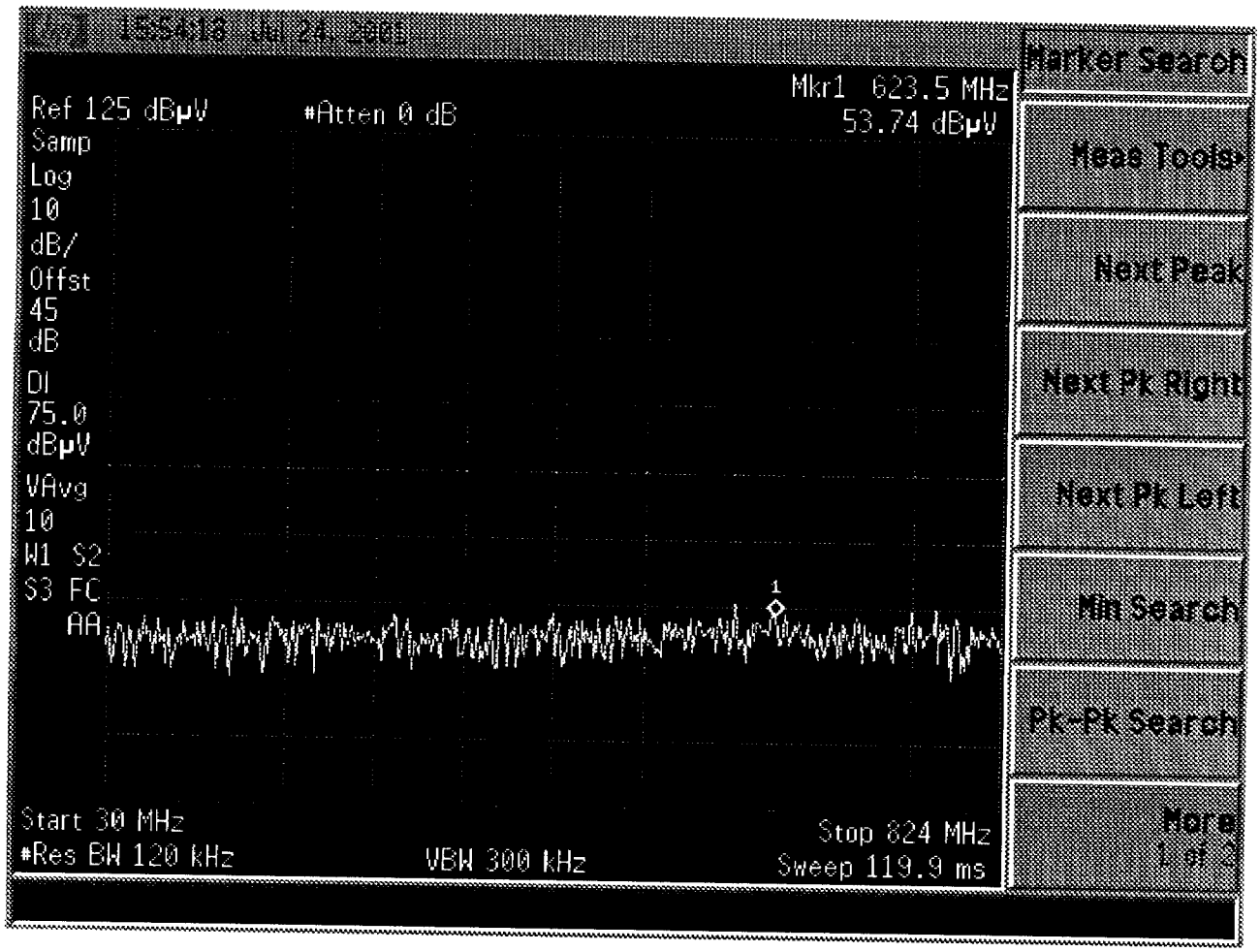
Plot 5-d-1


Ref 125 dBµV
#Atten 0 dB
Mkr1 821.0 MHz
79.74 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 821 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 1 GHz
Sweep 27.02 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

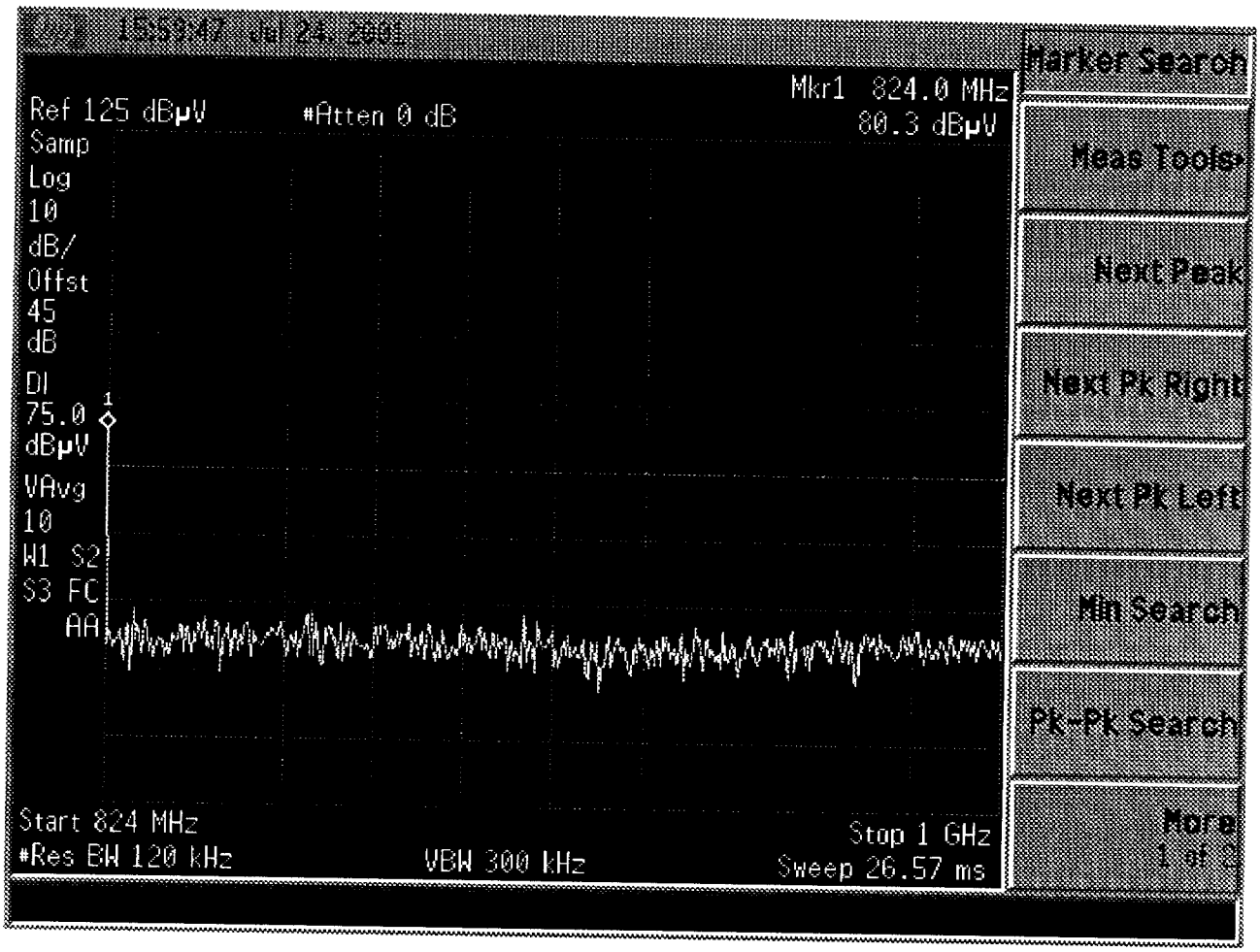
Plot 5-d-2


12:17:01 Aug 15, 2001
Ref 84.99 dBµV
#Atten 0 dB
Mkr1 3.453 GHz
39.4 dBµV
Samp
Log
10
dB/
Offst
45
dB
Average
10
Center 5.5 GHz
#Res BW 10 kHz
VBW 10 kHz
Span 9 GHz
Sweep 225 s
BW/Avg
Resolution BW
120 kHz
9 kHz
200 Hz
Video BW
Average
10
Off
More
1 of 2

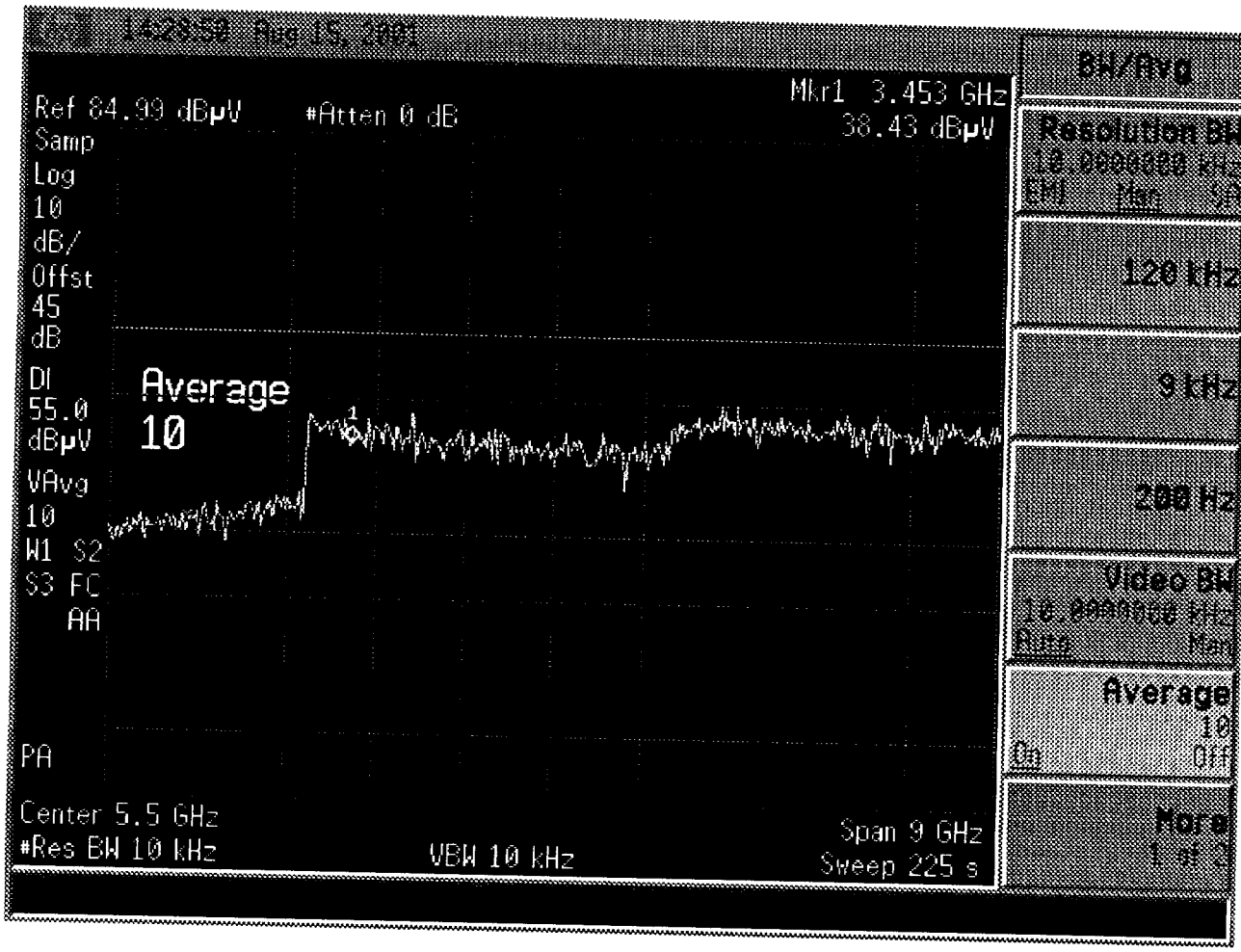
Plot 5-d-3


Ref 125 dBµV
#Atten 0 dB
Mkr1 623.5 MHz
53.74 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 30 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 824 MHz
Sweep 119.9 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

Plot 5-e-1


15:59:47 Jul 24, 2001
Ref 125 dBµV
#Atten 0 dB
Mkr1 824.0 MHz
80.3 dBµV
Samp
Log
10
dB/
Offst
45
dB
Dl
75.0
dBµV
VAvg
10
W1 S2
S3 FC
AA
Start 824 MHz
#Res BW 120 kHz
VBW 300 kHz
Stop 1 GHz
Sweep 26.57 ms
Marker Search
Meas Tools
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
More
1 of 2

Plot 5-e-2


Ref 84.99 dBµV
#Atten 0 dB
Mkr1 3.453 GHz
38.43 dBµV
Samp
Log
10
dB/
Offst
45
dB
Average
10
VAvg
10
PA
Center 5.5 GHz
#Res BW 10 kHz
VBW 10 kHz
Span 9 GHz
Sweep 225 s
BW/Avg
Resolution BW
120 kHz
9 kHz
200 Hz
Video BW
Average
10
Off
More
1 of 2

Plot 5-e-3

6.0 Field Strength of Spurious Radiation

FCC §2.1053, §90.210

6.1 Test Procedure

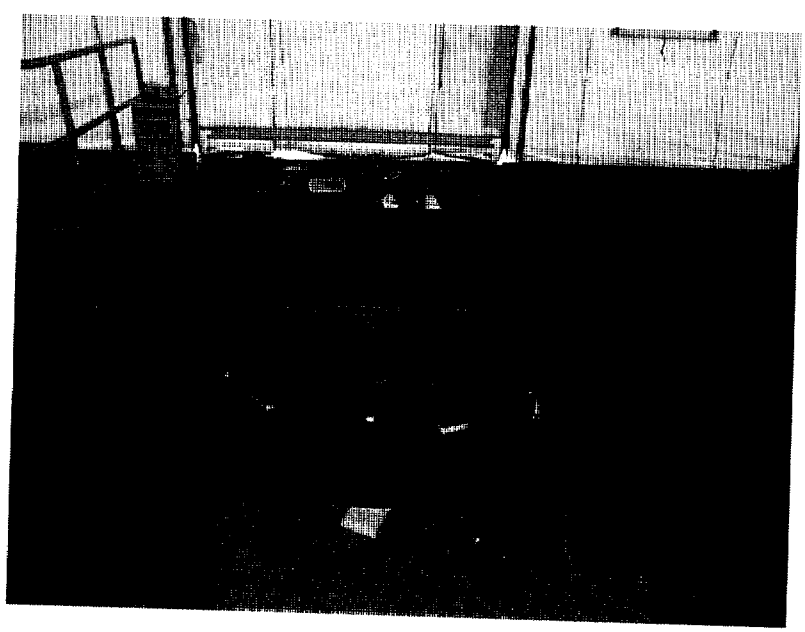
The transmitter was placed on a wooden turntable. The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The Field Strength (FS) in the frequency range up to tenth harmonic of the fundamental frequency was measured. At the frequencies where the FS exceed 62.3 dBuV/m, the EIRP of spurious emissions was measured by the substitution method using the double-ridged horn antenna. The FS=62.3 dBuV/m corresponds to the EIRP equal -33 dBm which is 20 less than the limit (-13 dBm), adjusted by 9.5 dB to account for the test distance of 3 meters, adjusted by the gain of a typical dipole antenna, 2.14 dBi. The Radiated Power was measured by the substitution method using horn antenna connected to a generator. Power P (in dBm) was calculated as follows:

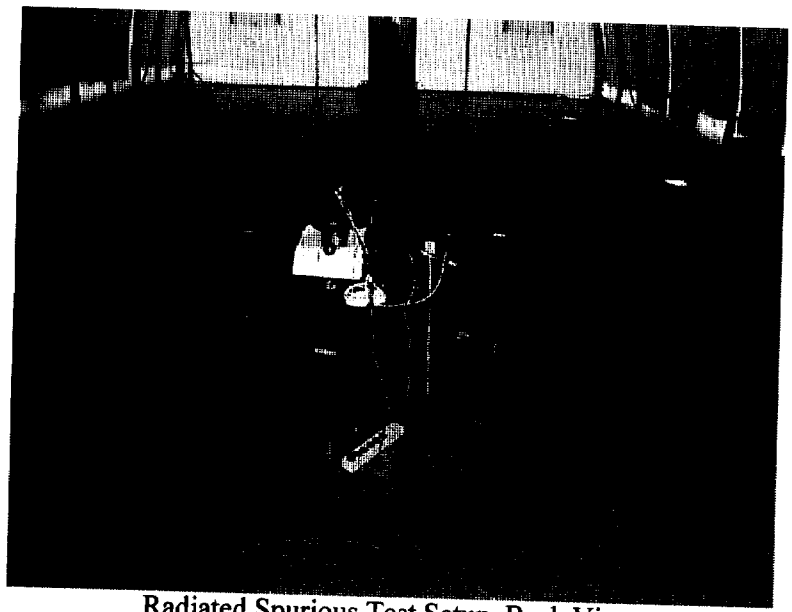
$$P = P_{sg} - L + G_H - G_d$$

Where G_H is the gain of the transmit horn antenna attached to the signal generator
L is the loss in the cable between the signal generator and the transmit antenna
P_{sg} is the generator output power (on the end of the cable connected to an antenna)
G_d is 2.14 dBi – the gain of the half-wave dipole.

Photographs of the test setup used to test for radiated emissions from the EUT chassis are below. Requirement: The power into a dipole required to duplicate the chassis emission must be below –13 dBm.



Radiated Spurious Test Setup, Front View



Radiated Spurious Test Setup, Back View

6.2 Test Results

Frequency (MHz)	Power (dBm)	Power Limit (dBm)
1633	-34.4	-13
2449	-32.7	-13
3266	-29.8	-13
4898	-34.5	-13
5715	-31.8	-13
6531	-26.3	-13
7347	-45.4	-13
8164	-40.7	-13

Results: Pass

7.0 Frequency Stability vs Temperature

FCC § 2.1055, § 90.213

7.1 Test Procedure

The equipment under test was connected to an external DC power supply and the RF output was connected to a spectrum analyzer through an attenuator pad. The EUT was placed inside the temperature chamber. The DC power cable, RF output cable, exited the chamber through an opening insulated to minimize heat flow. After the temperature stabilized for approximately 20 minutes, the frequency of the output signal was recorded from the analyzer.

Requirement: The frequency must not deviate by more than 1.5 parts-per-million (ppm) in the frequency band 806-821 MHz, and 2.5 ppm in the frequency band 821-824 MHz. The tighter limit of 1.5 ppm will be applied from 806-824 MHz in order to show compliance, with the lowest frequency 806 MHz selected to provide the lowest possible limit.

7.2 Test Results

Refer to the test data below.

Temperature, C	Reading (Hz)	Difference (Hz)	Limit (Hz)
+50	807.238	0	1209
+40	807.238	0	1209
+30	807.238	0	1209
+20	807.238	0 (Nominal Value)	1209
+10	807.237	1000	1209
0	807.238	0	1209
-10	807.238	0	1209
-20	807.238	0	1209
-30	807.238	0	1209

Results: Passed

8.0 Frequency Stability vs Voltage

FCC §2.995(d)(2)

8.1 Test Procedure

An external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115% of the DC nominal value and for 85% of the nominal value.

Requirement: The frequency must not deviate by more than 1.5 parts-per-million (ppm) in the frequency band 806-821 MHz, and 2.5 ppm in the frequency band 821-824 MHz. The tighter limit of 1.5 ppm will be applied from 806-824 MHz in order to show compliance, with the lowest frequency 806 MHz selected to provide the lowest possible limit.

8.2 Test Results

Refer to the test data below.

Voltage, VDC	Reading (Hz)	Difference (Hz)	Limit (Hz)
11.73 (85%)	820.988	0	1209
12.42 (90%)	820.988	0	1209
13.11 (95%)	820.988	0	1209
13.8 (100%)	820.988	0 (Nominal Voltage)	1209
14.49 (105%)	820.988	0	1209
15.18 (110%)	820.988	0	1209
15.87 (115%)	820.987	1000	1209

Results: Passed

9.0 Transient Frequency Behavior

FCC §90.214

9.1 Test Procedure

This test is required for transmitters operating the frequency bands 150-174 MHz and 421-512 MHz. The EUT does not transmit in these bands.

9.2 Test Results

Results: Not Applicable

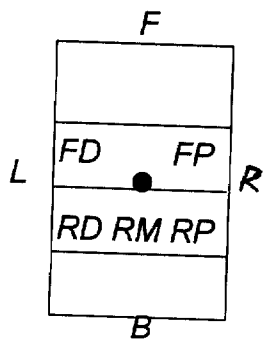
10.0 RF Exposure

FCC §2.1091, §2.1093

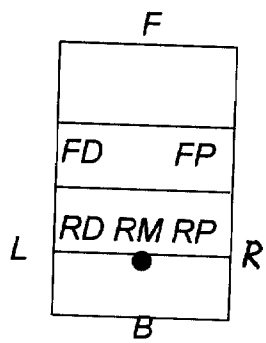
10.1 Test Procedure

The EUT was activated at full power, and connected to the three antennas that will be provided for use with it. Each antenna was placed at three different positions on a test vehicle, the center of the roof, the center of the trunk, and centered on the trunk at the back window. These are typical mounting points. A measurement antenna was connected to a spectrum analyzer, and peak readings of the field strength were taken at various test points outside and inside of the vehicle. Measurement antenna height and polarization were varied at each point to produce the worst-case value. Below are diagrams showing the transmit antenna mounting point and the corresponding test point locations and designations.

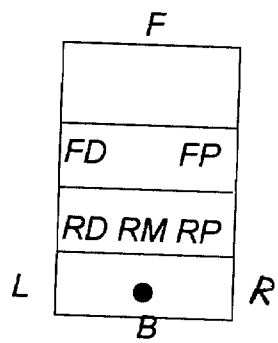
Roof Mount



Trunk @ Window Mount



Trunk @ Center Mount



F = Front
L = Left
R = Right
B = Back

FD = Front Driver Side
FP = Front Passenger Side
RD = Rear Driver Side
RM = Rear Middle

RP = Rear Passenger Side
● = Transmit Antenna

The readings at the spectrum analyzer are in dBuV/m. The limits are expressed in mW/cm^2. An equation that relates these two values is

$$E = 20 \text{ LOG } (1x10^6 (377*10*P)^{1/2})$$

where E is the measured voltage in dBuV/m, and P is the power density in mW/cm^2. The factor 377 is the impedance of free space, a constant. The obtained power density can then be compared to the limits. The power density limit for uncontrolled exposure is f/1500, where f is the transmit frequency. The worst case limits are at the lowest transmit frequency, and the measured RF output power of the EUT at the antenna port was maximum at the lowest transmit frequency. Therefore the lowest transmit frequency of 806.0125 MHz was selected as the worst case frequency and the limit for Maximum Permissible Exposure (MPE) was determined to be 0.537 mW/cm^2.

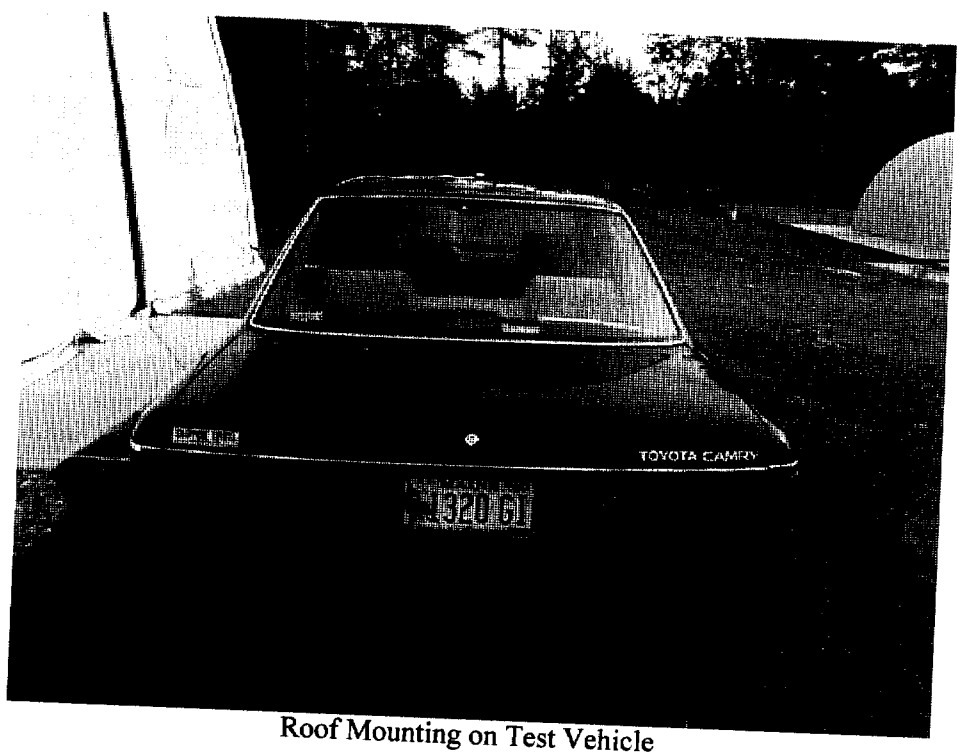
The distance between the transmit antenna and the test points is measured, and compared to a calculated Minimum Safe Distance (MSD). The MSD is determined by taking the maximum power output at the antenna terminals and adding the gain of the transmit antenna to determine the Effective Isotropic Radiated Power (EIRP). The EIRP assumed to radiate spherically from the transmit antenna and the Minimum Safe Distance is the radius of a sphere large enough that the radiated power density at the surface is equal to the limits for Maximum Permissible Exposure (MPE). The following equation relates the EIRP (mW) of the transmitter and P (mW/cm^2), the power density at radius r (cm):

$EIRP = P*4*Pi*r^2$

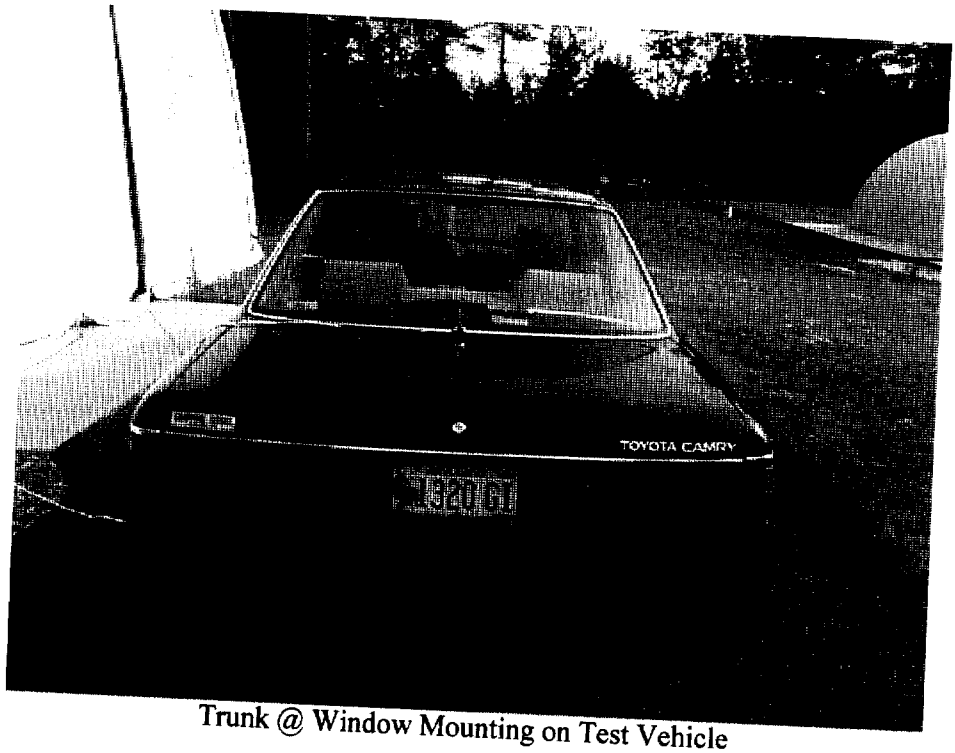
$EIRP_{3dB}$ = maximum radio output (45 dBm) + maximum antenna gain (3 dB) = 48 dBm
$EIRP_{0dB}$ = maximum radio output (45 dBm) + maximum antenna gain (0 dB) = 45 dBm

Therefore,

$MSD_{3dB} = [EIRP/(4*Pi*P)]^{1/2} = 96.7$ cm
$MSD_{0dB} = [EIRP/(4*Pi*P)]^{1/2} = 68.5$ cm



Roof Mounting on Test Vehicle



Trunk @ Window Mounting on Test Vehicle

Trunk @ Center Mounting on Test Vehicle

10.2 Test Results

Allen Telecom ASPSA912M 3dB Gain Roof Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	144.2	0.069	0.537	261.2	96.7
Back	145.8	0.101	0.537	195.6	96.7
Left	151.5	0.375	0.537	81.3	96.7
Right	152.1	0.430	0.537	76.2	96.7
Front Driver	139.5	0.024	0.537	45.7	96.7
Front Passenger	137.1	0.014	0.537	38.1	96.7
Rear Driver	139.6	0.024	0.537	35.4	96.7
Rear Middle	139.5	0.024	0.537	28.0	96.7
Rear Passenger	138.7	0.020	0.537	33.0	96.7

Allen Telecom ASPSA912M 3dB Gain Trunk @ Window Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	141.6	0.038	0.537	388.6	96.7
Back	152.7	0.494	0.537	66.0	96.7
Left	151.2	0.350	0.537	86.4	96.7
Right	151.8	0.401	0.537	86.4	96.7
Front Driver	149.0	0.211	0.537	165.1	96.7
Front Passenger	145.6	0.096	0.537	155.0	96.7
Rear Driver	152.4	0.461	0.537	73.7	96.7
Rear Middle	153.2	***0.554***	0.537	68.6	96.7
Rear Passenger	151.5	0.375	0.537	78.7	96.7

Allen Telecom ASPSA912M 3dB Gain Trunk @ Center Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	143.1	0.054	0.537	419.1	96.7
Back	156.7	***1.241***	0.537	48.3	96.7
Left	152.0	0.420	0.537	88.9	96.7
Right	153.0	0.529	0.537	86.4	96.7
Front Driver	146.0	0.106	0.537	188.0	96.7
Front Passenger	147.0	0.133	0.537	182.9	96.7
Rear Driver	152.1	0.430	0.537	94.0	96.7
Rear Middle	153.8	***0.636***	0.537	86.4	96.7
Rear Passenger	151.6	0.383	0.537	94.0	96.7

Allen Telecom ASPA1850M 3dB Gain Roof Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	144.0	0.067	0.537	261.2	96.7
Back	147.6	0.153	0.537	195.6	96.7
Left	153.4	***0.580***	0.537	81.3	96.7
Right	153.5	***0.594***	0.537	76.2	96.7
Front Driver	140.9	0.033	0.537	45.7	96.7
Front Passenger	140.6	0.030	0.537	38.1	96.7
Rear Driver	141.9	0.041	0.537	35.4	96.7
Rear Middle	140.3	0.028	0.537	28.0	96.7
Rear Passenger	142.7	0.049	0.537	33.0	96.7

Allen Telecom ASPA1850M 3dB Gain Trunk @ Window Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	141.4	0.037	0.537	388.6	96.7
Back	155.1	***0.858***	0.537	66.0	96.7
Left	150.9	0.326	0.537	86.4	96.7
Right	152.6	0.483	0.537	86.4	96.7
Front Driver	145.7	0.099	0.537	165.1	96.7
Front Passenger	148	0.167	0.537	155.0	96.7
Rear Driver	151.9	0.411	0.537	73.7	96.7
Rear Middle	155.0	***0.839***	0.537	68.6	96.7
Rear Passenger	152.1	0.430	0.537	78.7	96.7

Allen Telecom ASPA1850M 3dB Gain Trunk @ Center Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	140.6	0.030	0.537	419.1	96.7
Back	156.0	***1.056***	0.537	48.3	96.7
Left	153.8	***0.636***	0.537	88.9	96.7
Right	152.9	0.517	0.537	86.4	96.7
Front Driver	147.5	0.149	0.537	188.0	96.7
Front Passenger	146.8	0.127	0.537	182.9	96.7
Rear Driver	153.7	***0.622***	0.537	94.0	96.7
Rear Middle	152.7	0.494	0.537	86.4	96.7
Rear Passenger	151.9	0.411	0.537	94.0	96.7

Maxrad Z322 0dB Gain Roof Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	142.9	0.052	0.537	261.2	68.5
Back	146.2	0.111	0.537	195.6	68.5
Left	150.7	0.312	0.537	81.3	68.5
Right	148.6	0.192	0.537	76.2	68.5
Front Driver	143.9	0.065	0.537	45.7	68.5
Front Passenger	139.6	0.024	0.537	38.1	68.5
Rear Driver	142.6	0.048	0.537	35.4	68.5
Rear Middle	139.6	0.024	0.537	28.0	68.5
Rear Passenger	137.7	0.016	0.537	33.0	68.5

Maxrad Z322 0dB Gain Trunk @ Window Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	135.3	0.009	0.537	388.6	68.5
Back	144.7	0.078	0.537	66.0	68.5
Left	151.2	0.350	0.537	86.4	68.5
Right	145.8	0.101	0.537	86.4	68.5
Front Driver	140.6	0.030	0.537	165.1	68.5
Front Passenger	143.2	0.055	0.537	155.0	68.5
Rear Driver	148.0	0.167	0.537	73.7	68.5
Rear Middle	151.0	0.334	0.537	68.6	68.5
Rear Passenger	148.1	0.171	0.537	78.7	68.5

Maxrad Z322 0dB Gain Trunk @ Center Mount

Test Point	Field Strength Reading (dBuV/m)	Field Strength Reading (mW/cm²)	MPE Limit (mW/cm²)	Test Point Distance (cm)	MSD Limit (cm)
Front	135.6	0.010	0.537	419.1	68.5
Back	154.3	*0.714*	0.537	48.3	68.5
Left	148.0	0.167	0.537	88.9	68.5
Right	148.2	0.175	0.537	86.4	68.5
Front Driver	142.9	0.052	0.537	188.0	68.5
Front Passenger	147.4	0.146	0.537	182.9	68.5
Rear Driver	150.5	0.298	0.537	94.0	68.5
Rear Middle	151.6	0.383	0.537	86.4	68.5
Rear Passenger	149.3	0.226	0.537	94.0	68.5

It can be seen from the above tables that all of the field strength readings (bolded italicized readings) that exceeded the MPE limit are well within the MSD. Additionally, those readings that exceeded the MPE limit all had a direct line-of-sight between the EUT transmit antenna and the field strength measurement antenna. Therefore, the test confirms that the calculated MSD provides an accurate representation safe distance from the transmit antenna.

The EUT's transmitter is activated by bursty data transmissions and the operator keying a microphone which classifies the device as a Push-To-Talk (PTT) device. PTT allows a 50% averaging power factor reduction that corresponds to a 3 dB reduction in the measured field strength reading. The table below applies the power factor reduction for those test points that exceeded the MPE limit.

Over limit reading adjustment for Push to Talk 50% averaging factor

Test Point	Field Strength Reading – 3 dB PTT AVG Factor (dBuV/m)	Field Strength Reading – 3 dB PTT AVG Factor (mW/cm²)	Test Point Distance (cm)	Limit (mW/cm²)	Antenna	Mounting
Rear Middle	150.2	0.278	68.6	0.537	Allen Telecom ASPSA912M	Trunk @ Window
Back	153.7	*0.622*	48.3	0.537	Allen Telecom ASPSA912M	Trunk @ Center
Rear Middle	150.8	0.319	86.4	0.537	Allen Telecom ASPSA912M	Trunk @ Center
Left	150.4	0.291	81.3	0.537	Allen Telecom ASPA1850M	Roof
Right	150.5	0.298	76.2	0.537	Allen Telecom ASPA1850M	Roof
Back	152.1	0.430	66.0	0.537	Allen Telecom ASPA1850M	Trunk @ Window
Rear Middle	152.0	0.420	68.6	0.537	Allen Telecom ASPA1850M	Trunk @ Window
Back	153.0	0.529	48.3	0.537	Allen Telecom ASPA1850M	Trunk @ Center
Left	150.8	0.319	88.9	0.537	Allen Telecom ASPA1850M	Trunk @ Center
Rear Driver	150.7	0.312	94.0	0.537	Allen Telecom ASPA1850M	Trunk @ Center
Back	151.3	0.358	48.3	0.537	Maxrad Z322	Trunk @ Center

Having adjusted the over limit values for the Push to Talk average factor, it can be seen that the Allen Telecom ASPSA912M antenna mounted on the Trunk @ Center and measured at the Back test point still exceeds the MPE limit, but it is well within the MSD. Additionally, the Allen Telecom ASPA1850M antenna mounted on the Trunk @ Center and measured at the Back test point is very close to the limit.

This radio has been tested and complies with the FCC RF exposure limits for Uncontrolled Exposure and

Occupational exposure. The difference is in the minimum safe distance that people must be away from the antenna when transmitting RF energy. To assure optimal radio performance and that human exposure to RF electromagnetic energy is within the guidelines, transmit only when people are at least the minimum distance away from a properly installed antenna. The following table lists the minimal distances.

Rated Power of OpenSky Mobile Radio	Antenna Gain	MSD from Transmitting Antenna, General Population / Uncontrolled Exposure	MSD from Transmitting Antenna, Occupational / Controlled Exposure
45 dBm max, 43 dBm nominal	0 dB	70 cm (27.5 inches)	30.6 cm (12 inches)
45 dBm max, 43 dBm nominal	3 dB	1 meter (39.4 inches)	43.2 cm (17 inches)

Results: Passed