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Theory of Operation

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EXHIBIT 1: Letter Requesting Confidentiality under Sec. 0.457(d)

Thomas N. Cokenias *EMC &Radio Approvals*
Test & Consulting Services for Commercial, Military, International Compliance
P.O. Box 1086
El Granada, CA 94018

22 May 1999

FCC Laboratory
7435 Oakland Mills Road
Columbia, MD 21046

Attention: Application Examiner
Reviewing Engineer

Re: Request for confidentiality per Section 0.459 of FCC Rules

Applicant: Cisco Systems Inc.

FCC ID: LDK-OFDM-MMDS2

To whom it may concern,

Request is hereby submitted, on behalf of my client Cisco Systems Inc., to withhold from public review certain portions of the application for equipment certification for the referenced FCC identifier. In particular, the following sections of the application and report are requested to be kept confidential:

Schematics
Block diagrams
Theory of operation (P2P Architecture)

Rationale for request for confidentiality:

Cisco Systems has invested considerable time and materials in research and development to produce the referenced product. Disclosure of the confidential portions of this application to competitors would give them competitive advantage in developing similar products.

The $135 fee for confidentiality has been submitted along with the fee for certification. If you have questions or need further information, please contact the undersigned.

Sincerely,

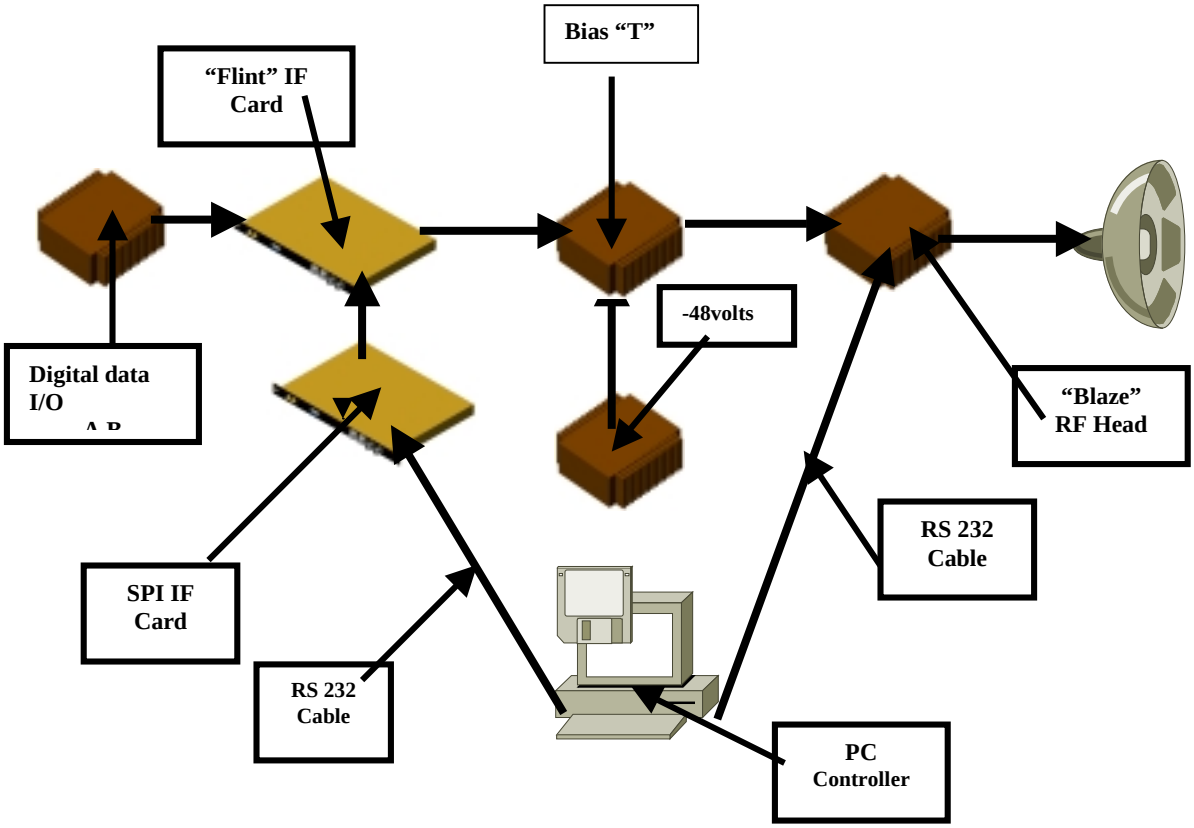
THOMAS N. COKENIAS
EMC Consultant/Agent for Cisco Systems Inc.

Tel 650 726 1263 *fax 650 726 1252* *trephonc@macconnect.com*

EXHIBIT 2: Product Description and Operation Overview

The Cisco FCC ID: LDKOFDMMMDSU is a MMDS transceiver operating under the provisions of Part 21 of the Rules. The product functions as a point to point (P2P) wireless router.

Refer to the system module diagram below:



Product development strategy is to follow a modular approach.

Digital data I/O for the initial version of the system will be a line card that will fit into a standard Cisco uBR7246 or 7223 router chassis. For test purposes, a Tektronix arbitrary waveform generator will simulate the signal output of the router/line card combination.

The **"Flint" IF card** up-link performs the modulation functions of the system. A 324 MHz signal is modulated with the digital data stream using Orthogonal Frequency Division Multiplexing (OFDM) techniques. The system is capable of producing channel bandwidths in 6 MHz multiples. The system will be configurable for use with 6 MHz and 12 MHz channel bandwidths.

For the down-link signal, the IF card demodulates the receiver IF signal from the RF head and routes the demodulated digital information to the digital I/O card.

It is anticipated that the Flint IF card will be used with a number of different RF heads, but will provide the same kind of OFDM modulation, the same IF signals, and at the same channel spacing as will be provided for the present application. The Flint output RF spectrum is shown for 6 MHz channel spacings and 12 MHz channel spacings in Exhibit 11.

The **bias "T"** provides DC and the 324 MHz IF signal on a single coaxial cable for routing to the RF head.

The **"Blaze" RF head** produces the RF transmit link at 2.5 – 2.7 GHz , and houses the receiver LNAs, receiver local oscillator, and the 139 MHz receiver IF bandpass filters and IF amplifiers. The RF head also houses the TX-RF diplexer.

The **PC controller** and **RS 232 cables** are for system control and set-up for testing purposes.

The antenna shown in the diagram is specified but not supplied by Cisco. The –48 VDC supply shown in the diagram is telephone central office (CO) power or a customer provided supply.

SPECIFICATIONS

RF Head

Frequency range:	2.5 – 2.7 GHz
Power output:	30 dBm
Channel Bandwidth:	6 MHz and 12 MHz, configurable

IF Head

Frequency range:	324 MHz	
	24 MHz clock	
Power output:	324 MHz:	-13 dBm nominal (programmable)
	24 MHz:	-12 dBm nominal

Data transfer rate, air link: 44 Mbs/sec (12 MHz channels)

A detailed description of the theory of operation and product configuration is found in the attached document, "P2P OEM Product Architecture" (P2P-Architecture.doc, Microsoft Word file). Page 46 of this document is the system signal path block diagram.

System Interconnection

** Provided by Cisco

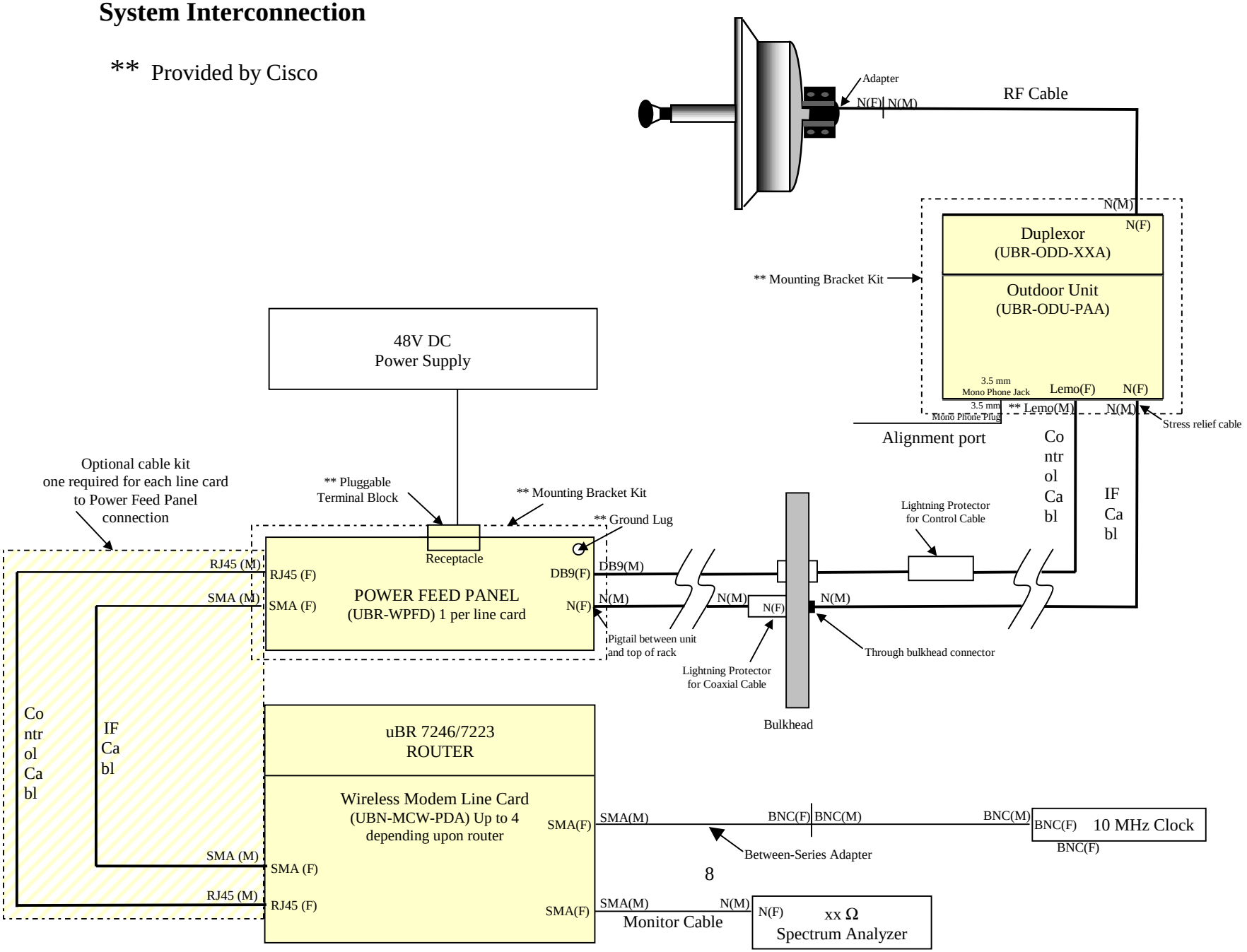


EXHIBIT 3: Information for which Confidentiality is Requested

Schematics

Block Diagrams (p. 46, P2P Architecture)

Theory of Operations (P2P Architecture)

EXHIBIT 4: Product Photographs

EXHIBIT 5: Bill of Materials (BOM)

EXHIBIT 6: User Manual and FCC ID Label

EXHIBIT 7: RF Hazard Information Per Sec. 1.1307

For transmitters operating in the 2.5-2.7 GHz frequency range, paragraph 1.1310 limits maximum permissible exposure (MPE) to 1 mW/cm2 for uncontrolled environments, and 5 mW/cm2 for controlled environments.

The maximum distance from the antenna at which MPE is met or exceeded is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain, and separation distance in meters:

E,V/m = $(\sqrt{(30*P*G)})/d$

Power density, mW/m2 = $E^2/3770$

E for MPE 1mW/m2 = 61.4 V/m E for MPE 5 mW/m2 = 136 V/m

Cisco does not provide an antenna with their MMDS radio system. The licensee is responsible for placing a label on the antenna providing adequate information regarding hazardous RF exposure
(such as the maximum distance at which MPE is achieved) and including reference to the applicable FCC regulations.

EXHIBIT 8: Report of Measurements

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2.

2.1033(c)1 Applicant: Cisco Systems Inc.
170 W. Tasman Drive
San Jose. CA 95134

2.1033(c)2 FCC ID: LDK-OFDM-MMDSU

2.1033(c)3 Installation instructions are found in attached document.

2.1033(c)4 Emission type is OFDM in 6MHz or 12 MHz channel configuration

6M0D1D and 12M0D1D

2.1033(c)5 Frequency range: 2500-2700 MHz

2.1033(c)6 Range of Operating Power

0 – 30 dBm, TX attenuation settings via software

2.1033(c)7 Maximum Power Rating

Maximum allowed per 21.904: 33 dBw

Maximum rated output power of EUT: 30 dBm into customer-supplied antenna with gain less than 33 dBi

2.1033(c)8 Applied voltages and currents into the final transistor elements

Refer to electronic format (PDF) schematics accompanying this application

2.1033(c)9 Tune-up procedure

Refer to electronic format file installation.pdf for hardware configuration instructions. RF channel selection and RF power output of the “Blaze” outdoor unit are selected via control and set-up PC software via GUI.

2.1033(c)10 Circuit and Functional Block Diagram, Description of Circuitry

Complete product schematics (17 total) are attached as electronic (PDF) files. Circuit description and theory of operation are found in the attached electronic file

named P2P-Architecture.doc.

2.1033(c)11 FCC ID Label

Attached as JPEG electronic file

2.1033(c)12 Product Photographs

Attached as JPEG electronic files

2.1033(c)13 Description of Modulation System

Refer to appropriate chapters in attached electronic file P2P-Architecture.doc

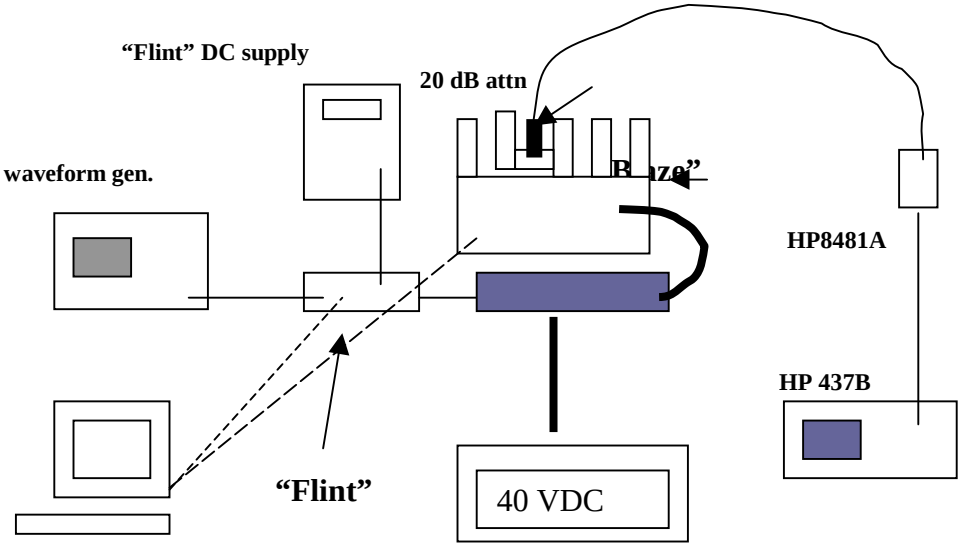
2.1033(c)14 Test Data per 2.1046 – 2.1057

2.1055 RF Output Power Measurements

Measurement equipment used:

HP 437B Power meter
HP 8381A power sensor

Test set-up:



Test Procedures

1. Set the "Flint" channel bandwidth parameters and output level to desired values. Output level is chosen to maximize RF output level from "Blaze" while keeping spectral re-growth and spurious emissions from "Blaze" at acceptably low levels.
2. Set "Blaze" output power and channel bandwidth parameters as required.
3. Zero HP 437/HP8481A and enter HP8481A cal factors.
4. Connect HP8481A to 20 dB attenuator and record value.

Test Results

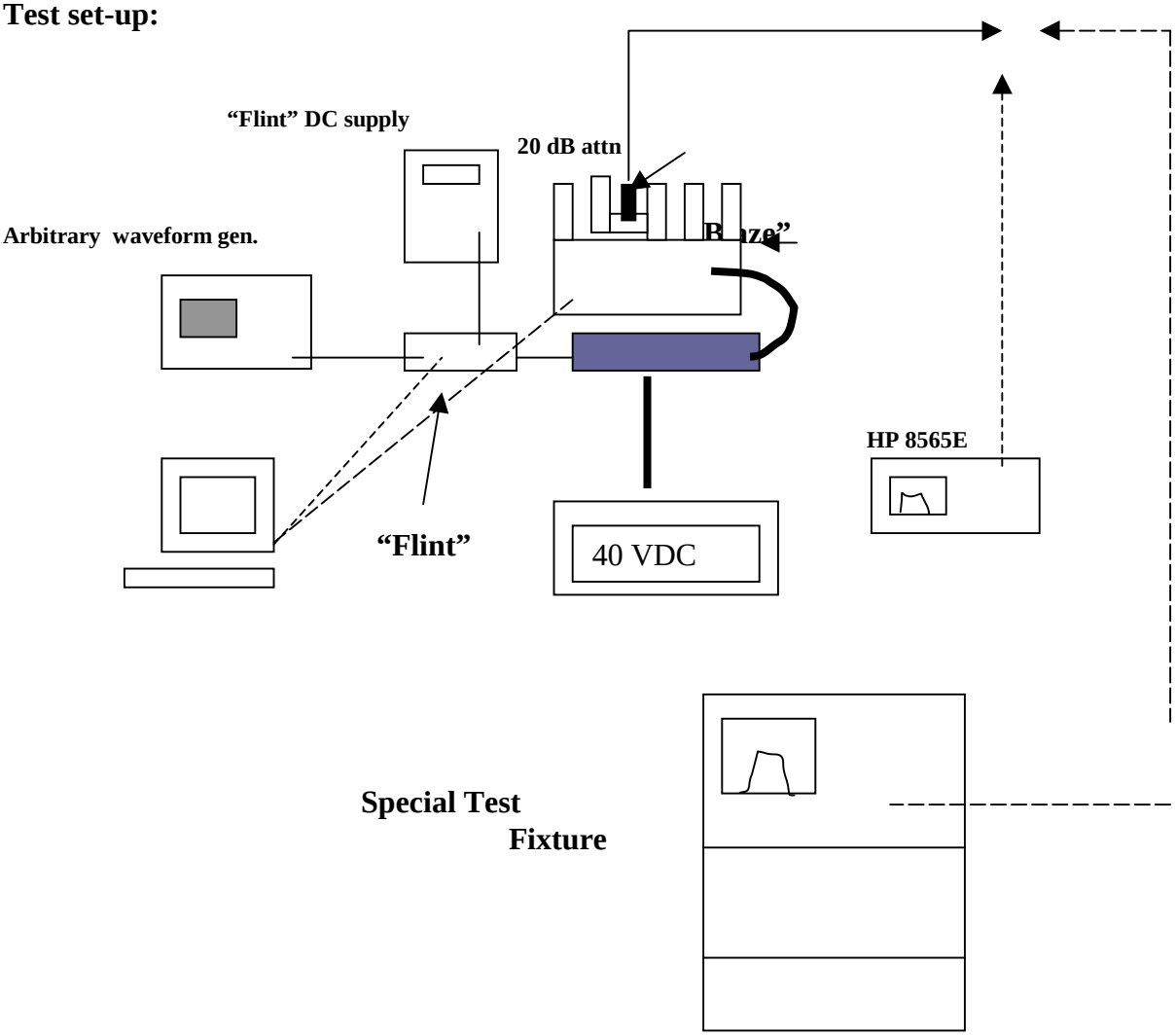
F(MHz)	**Pout, 6 MHz Ch. BW**	**Pout, 12 MHz Ch BW**
2506	(20)+8.54 = **28.54 dBm**	(20)+6.5 = **26.5 dBm**

Section 2.1047 Modulation Characteristics

Measurement equipment used:

HP 8565E spectrum analyzer
Cisco Special Test Fixture

Test set-up:



Test Procedures

1. The output of the "Blaze" unit is first coupled to the input of the Special Test Fixture. This test equipment is described in a document entitled Special Test Fixture. This

equipment extends the measurement system dynamic range to meet the attenuation requirements of paragraph 21.908(e):

> At more than 3 MHz removed from channel edge: 60 dB down from flat top, measured
> with 100 kHz bandwidth

The dynamic range of commercially available spectrum analyzers is limited to 50-55 dB.

2. Set transmitter output power and channel bandwidth parameters as required to meet the 60 dB attenuation requirement.
3. Record the output power level settings. This is the maximum permitted operating power level for each channel.
4. Connect the transmitter to the spectrum analyzer. Use the Digital Radio Personality utility to compare the transmitter output to a peak power relative mask.
5. Plot/photograph resultant spectrum analyzer trace.

Test Results

PASS. The Special Test Fixture yielded the following results:

TX Output Frequency: 2506 MHz

Channel BW/ Output power	Reading, fc	Reading, fL	Reading, fH	ATTN, fL	ATTN, fH
6 MHz/ 28.54 dBm	-12.7 dBm	-73.7 dBm	-73.0 dBm	61 dB	60.3 dB
12 MHz/ 26.5 dBm	-13.4 dBm	-73.7 dBm	-73.7 dBm	60.3 dB	60.3 dB

Refer to spectrum analyzer graphs in Exhibit 9.

Section 2.1049 Occupied Bandwidth

Measurement Equipment Used:

HP 856EE Spectrum Analyzer

Test Set-up

- Same as for 2.1047 above, but without the Special Test Fixture

Test Procedures and Results:

Using MKR DELTA function of the analyzer:

-26 dB Occupied Bandwidth: 6 MHz and 12 MHz

Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals

Measurement Equipment Used:

HP 856EE Spectrum Analyzer

Test Set-up

- Same as for 2.1049 above

Test Procedures

Section 21.908(e) requires that for a 100 kHz measurement bandwidth, all emissions removed from the channel edge by more than 3 MHz must be attenuated at least 60 dB below the channel emission flat top.

1. Set spectrum analyzer to TX output center frequency, RES BW = 100 kHz, VID BW = 100 Hz.
2. Use analyzer PEAK SEARCH to find flat top peak.
3. Set DISPLAY LINE to a level 60 dB below flat top peak
4. Record transmitter output spectrum from 1 MHz to 10^{th} harmonic of TX output frequency
5. Plot/photograph spectrum analyzer data

Test Results

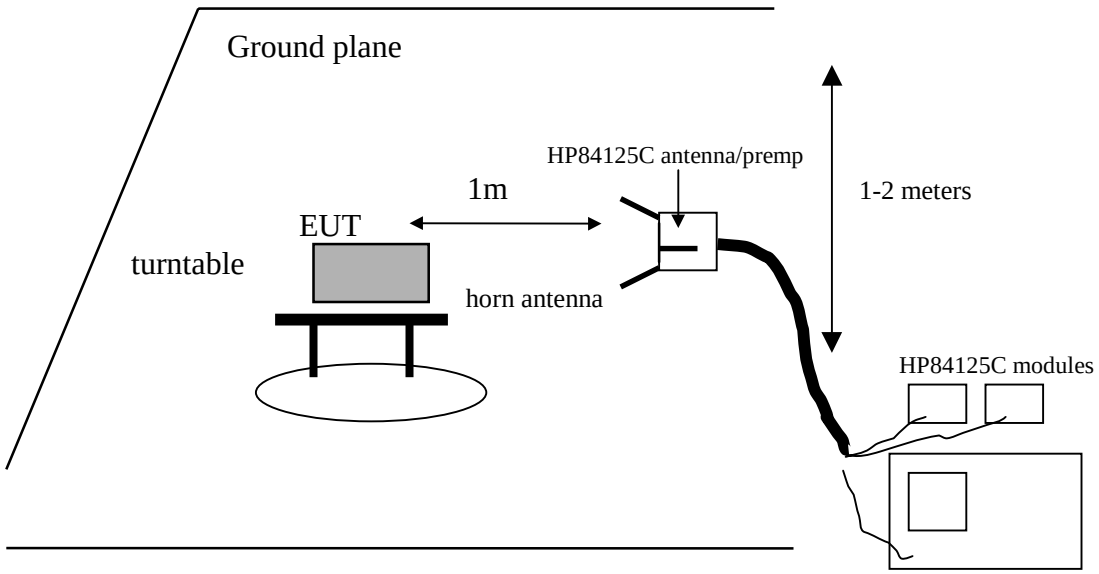
PASS. Refer to 14 spectrum analyzer photographs labeled "Antenna Conducted Emissions", Exhibit 10. Output emissions data is presented from 1 MHz to the 10th harmonic of the carrier frequency.

Section 2.1053 Field Strength of Spurious and Harmonic Radiation

Measurement Equipment Used:

HP 8565E Spectrum Analyzer
HP 84125C Microwave EMI Measurement System

Test Set-Up



spectrum analyzer

Minimum Requirement

The magnitude of each spurious and harmonic emission detected as being radiated from the EUT must be at a level more than 60 dB below the emission flat top = -44.4 dBm

Resultant radiated field at 1 m from –44.4 dBm source feeding isotropic antenna:

61 dBuV/m

Test Method

The antenna output port of the EUT was terminated with a 50 ohm load. With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was raised and lowered in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 10 fo.

Test Results

Refer to spectrum analyzer photographs labeled Case Radiated Emissions in Exhibit 10. The HP 84125C system stores antenna factors, cable losses, and other correction factors in software, and the spectrum analyzer displays corrected field strength levels. Spurious and harmonic radiated emissions from the transmitter were below the 61 dBuV/m limit at 1 m separation.

2.1056 Frequency Stability

NOT APPLICABLE. Frequency stability tests are not meaningful for OFDM modulation systems.

Part 15 Digital Device Emissions

Tests were performed to measure radiated emissions per 15.109 of the Rules. A separate verification report is being held on file at Cisco Systems.

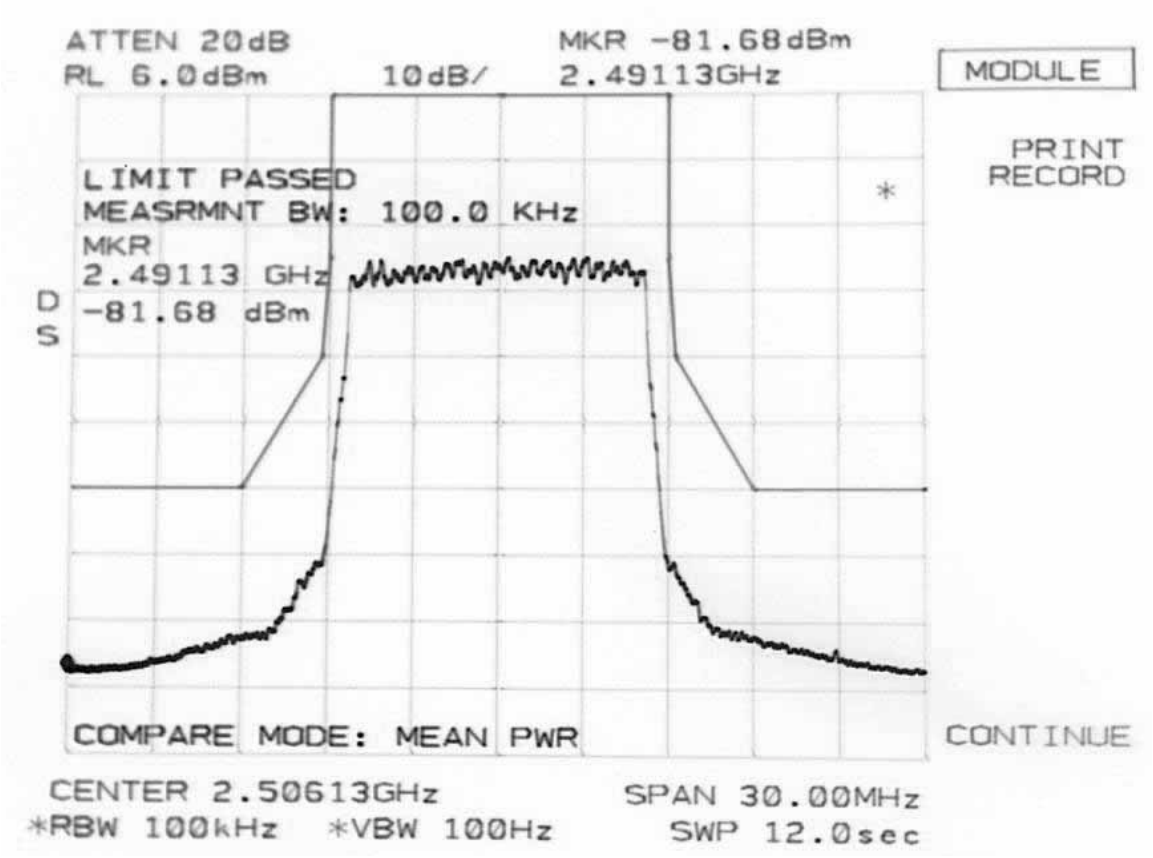
Test Site

All testing was performed at Cisco Systems by me or under my supervision. Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.

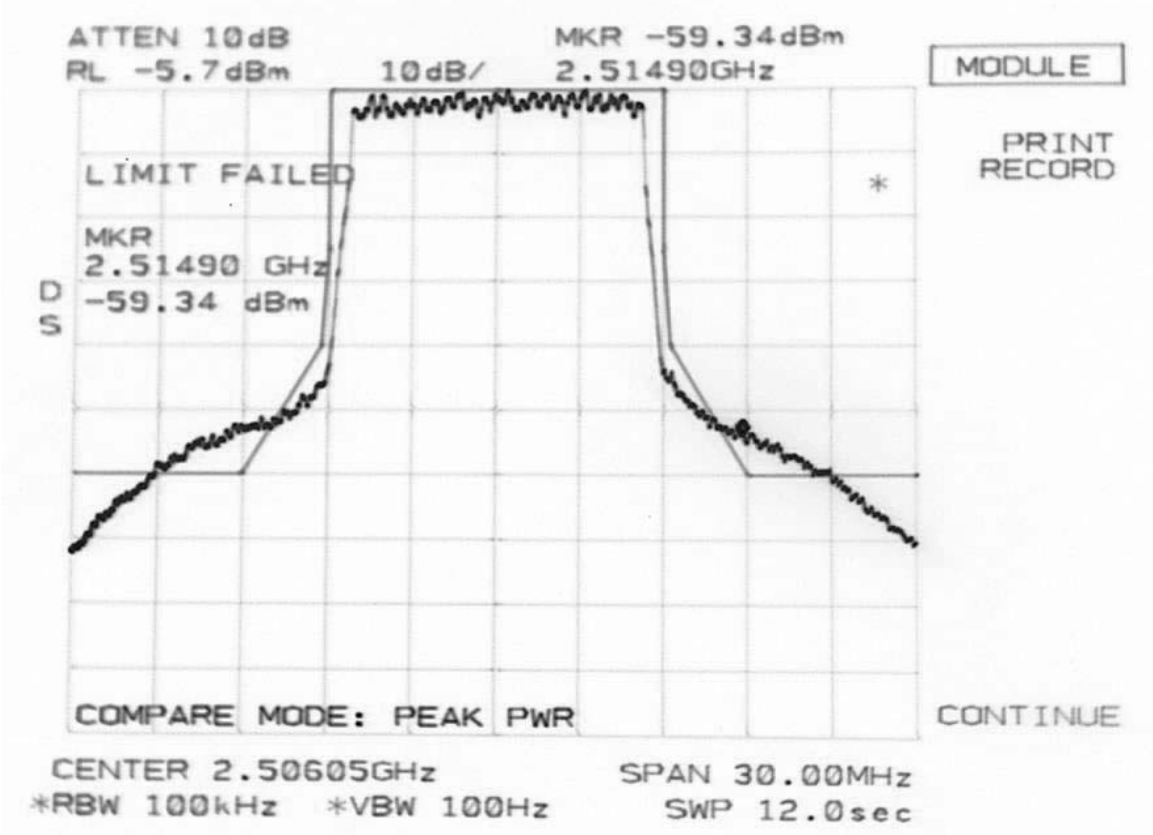
THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals

EXHIBIT 9: Data Graphs: Emissions Masks

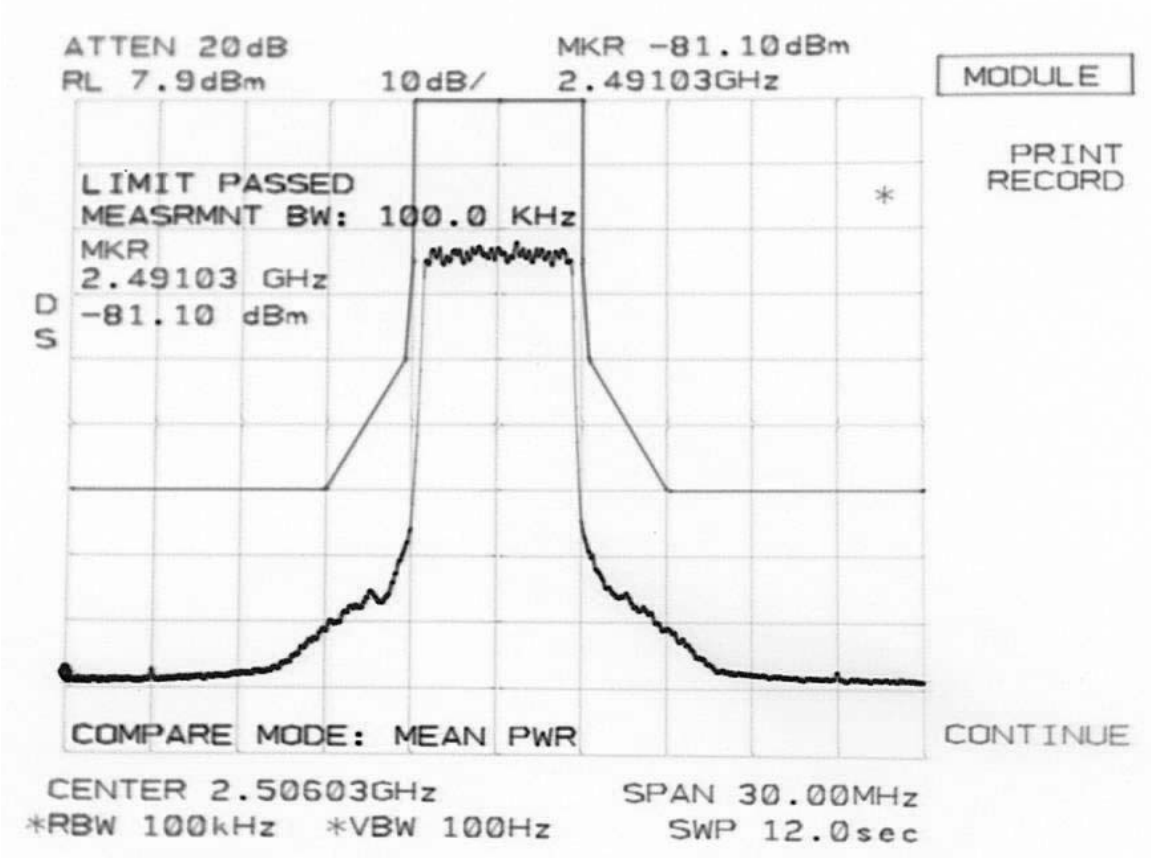
12 MHz Channel Mask, 100 kHz Mean Power Comparison



12 MHz Channel Mask, 100 kHz Peak Power Comparison



6 MHz Channel Mask, 100 kHz Mean Power Comparison



6 MHz Channel Mask, 100 kHz Peak Power Comparison

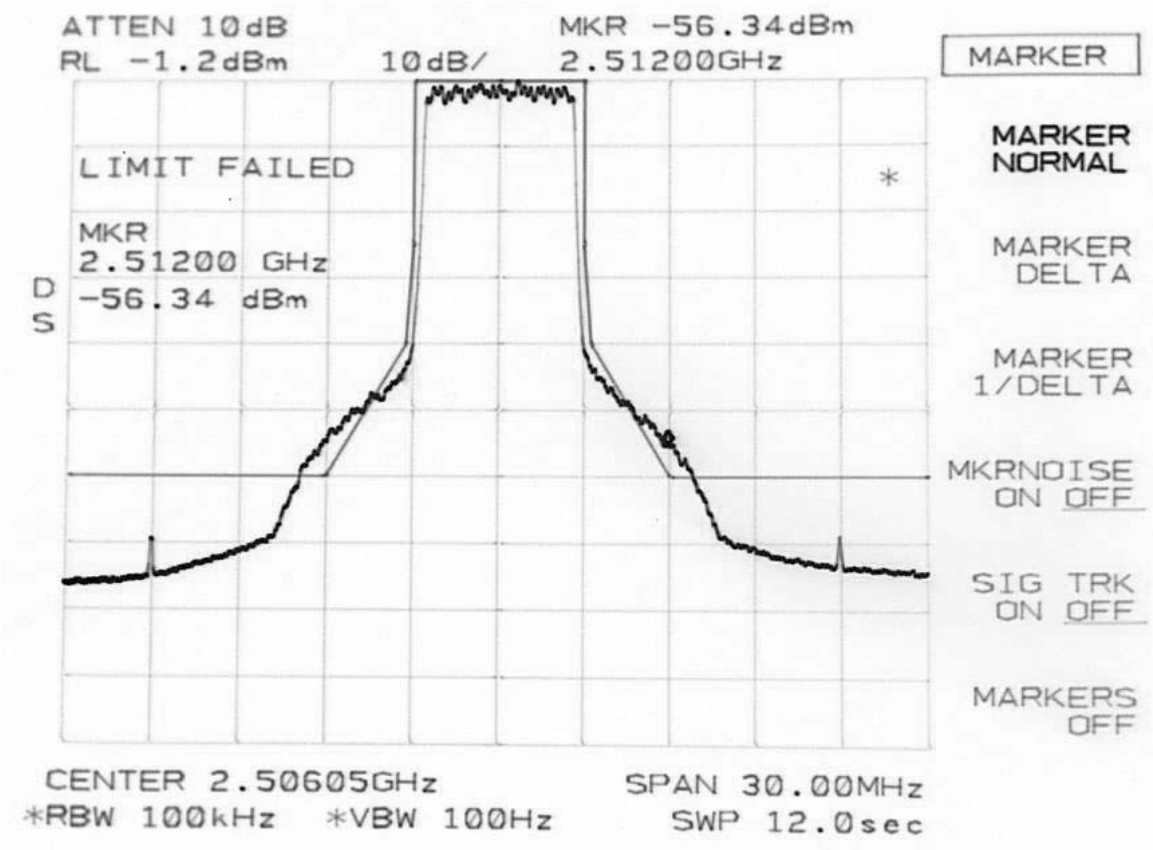
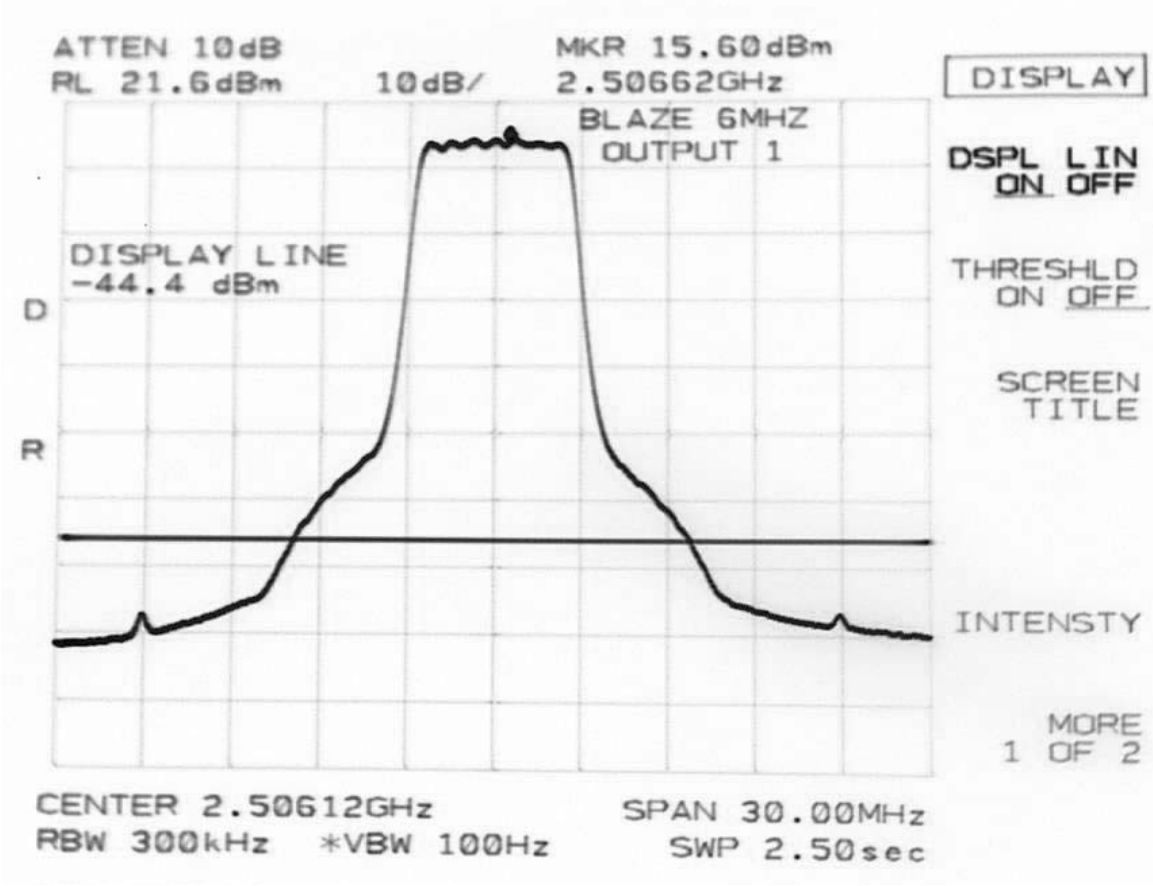


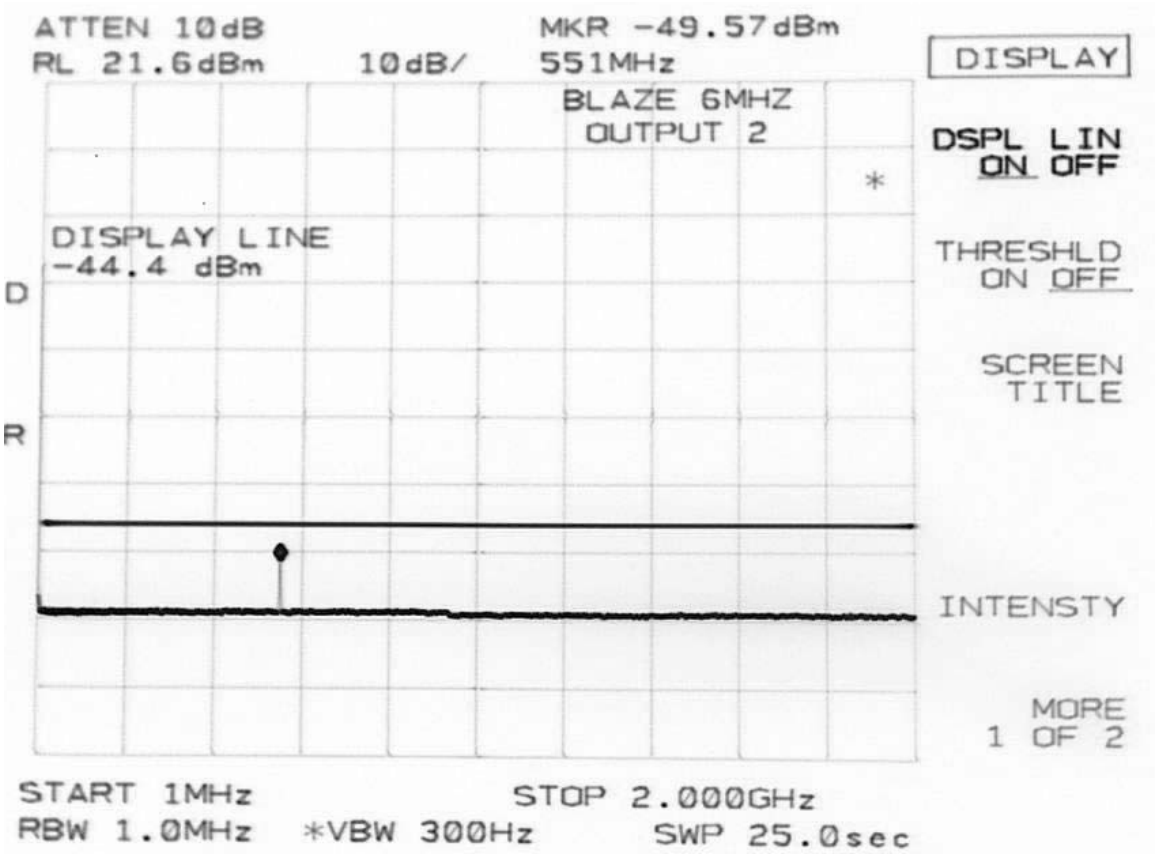
EXHIBIT 10: Data Graphs: Antenna Conducted Emissions

Case Radiated Emissions

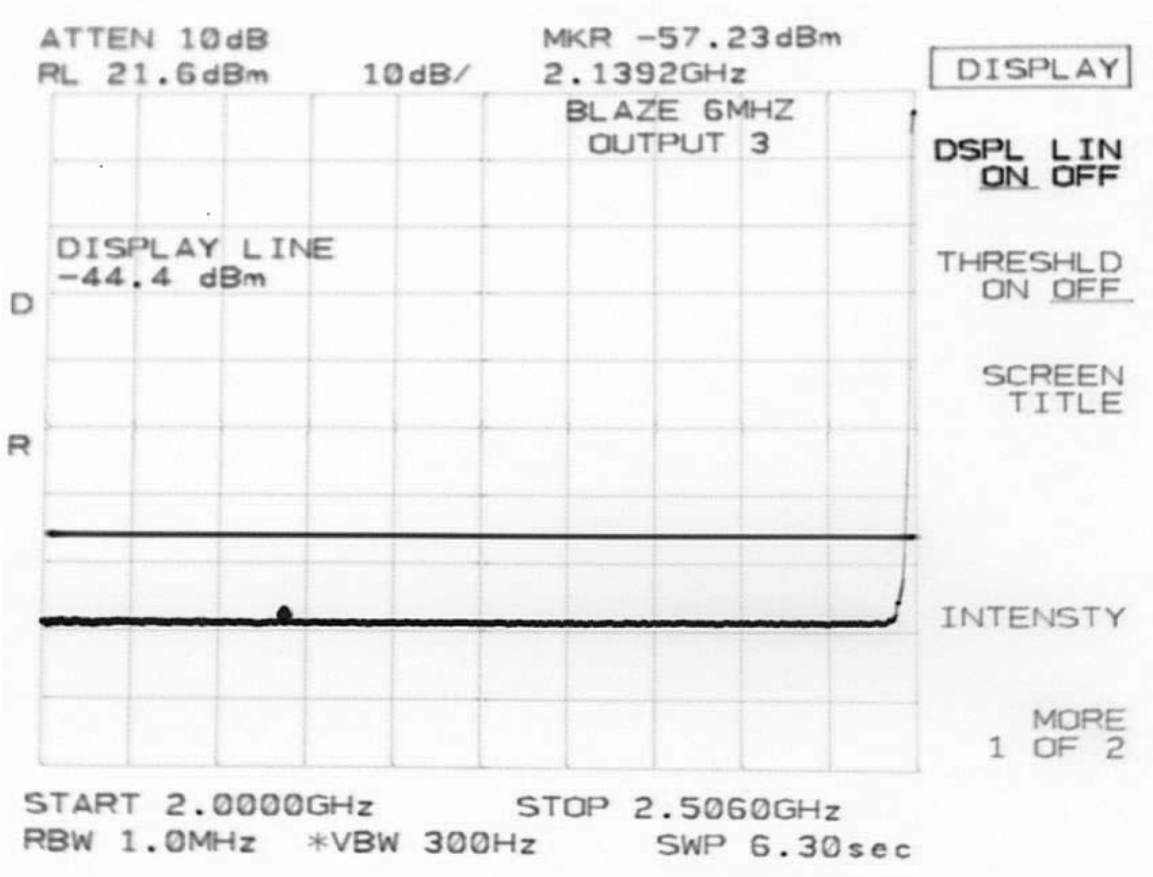
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (1 of 7)



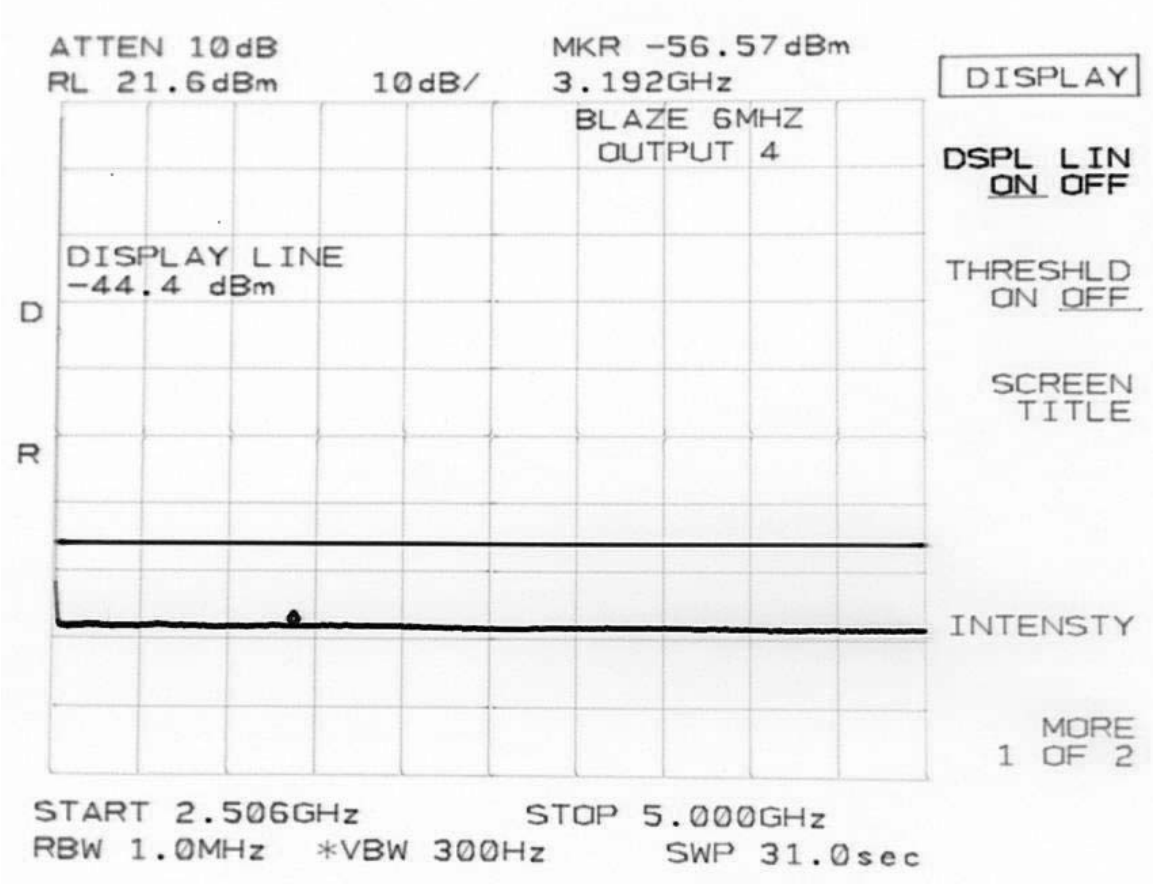
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (2 of 7)



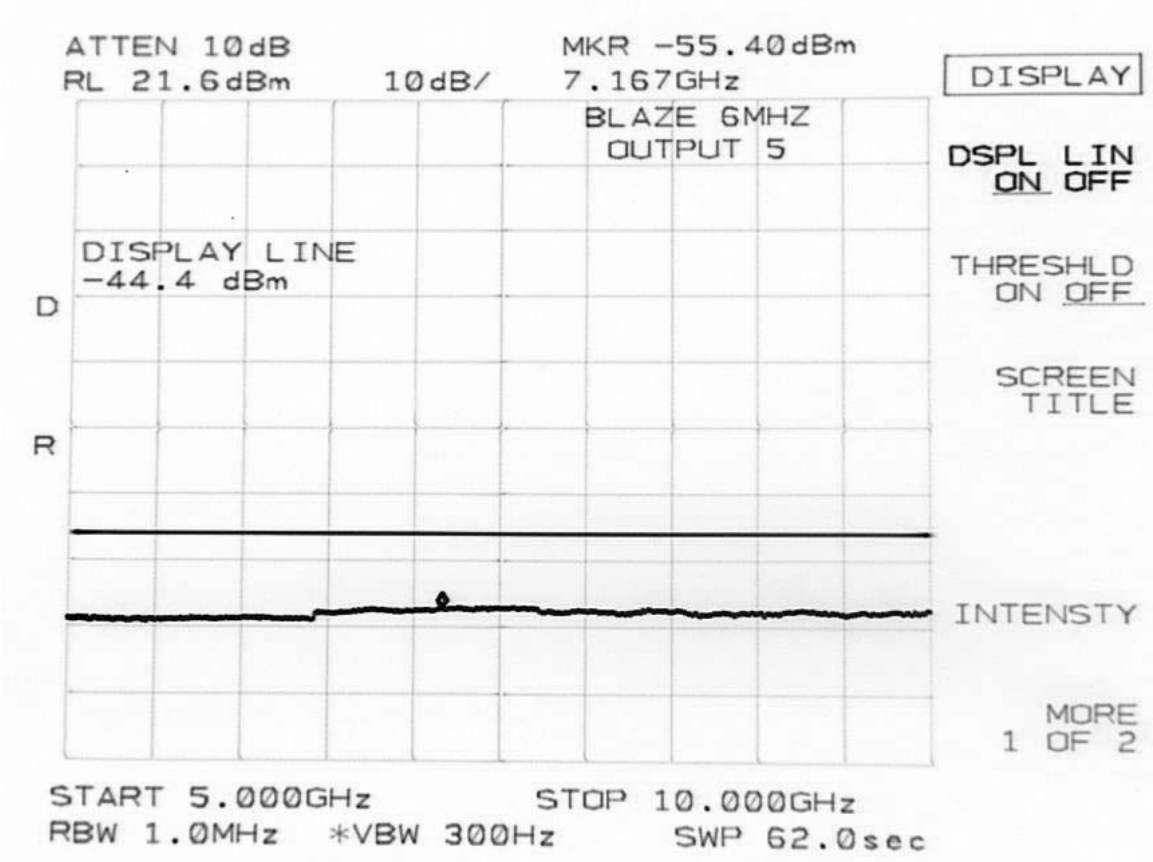
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (3 of 7)



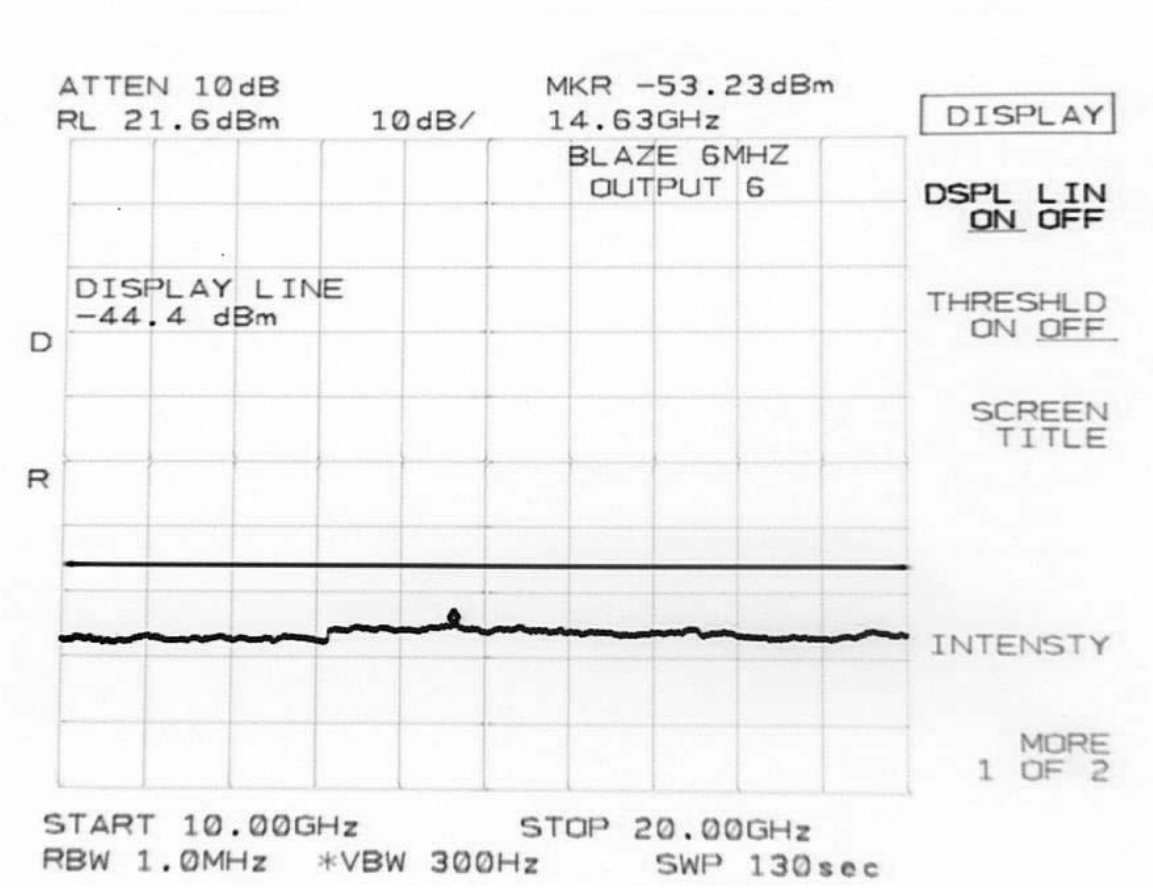
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (4 of 7)



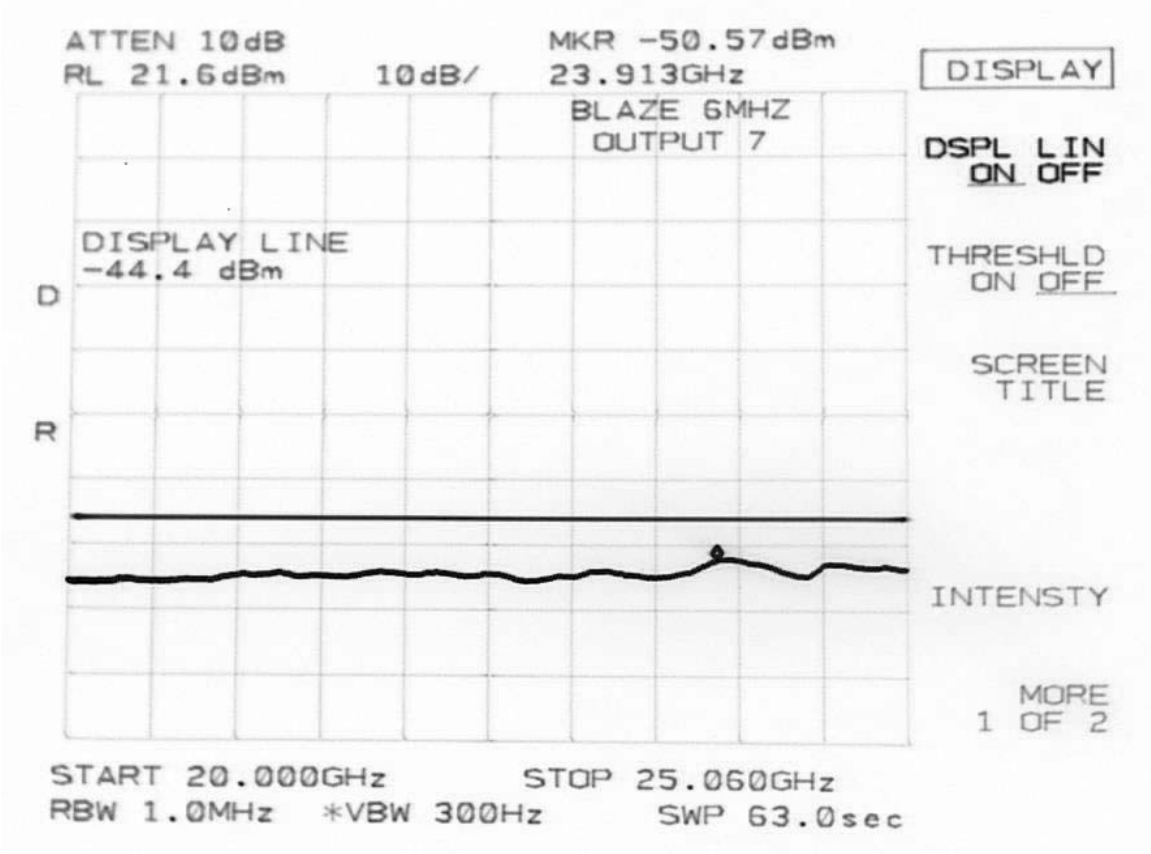
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (5 of 7)



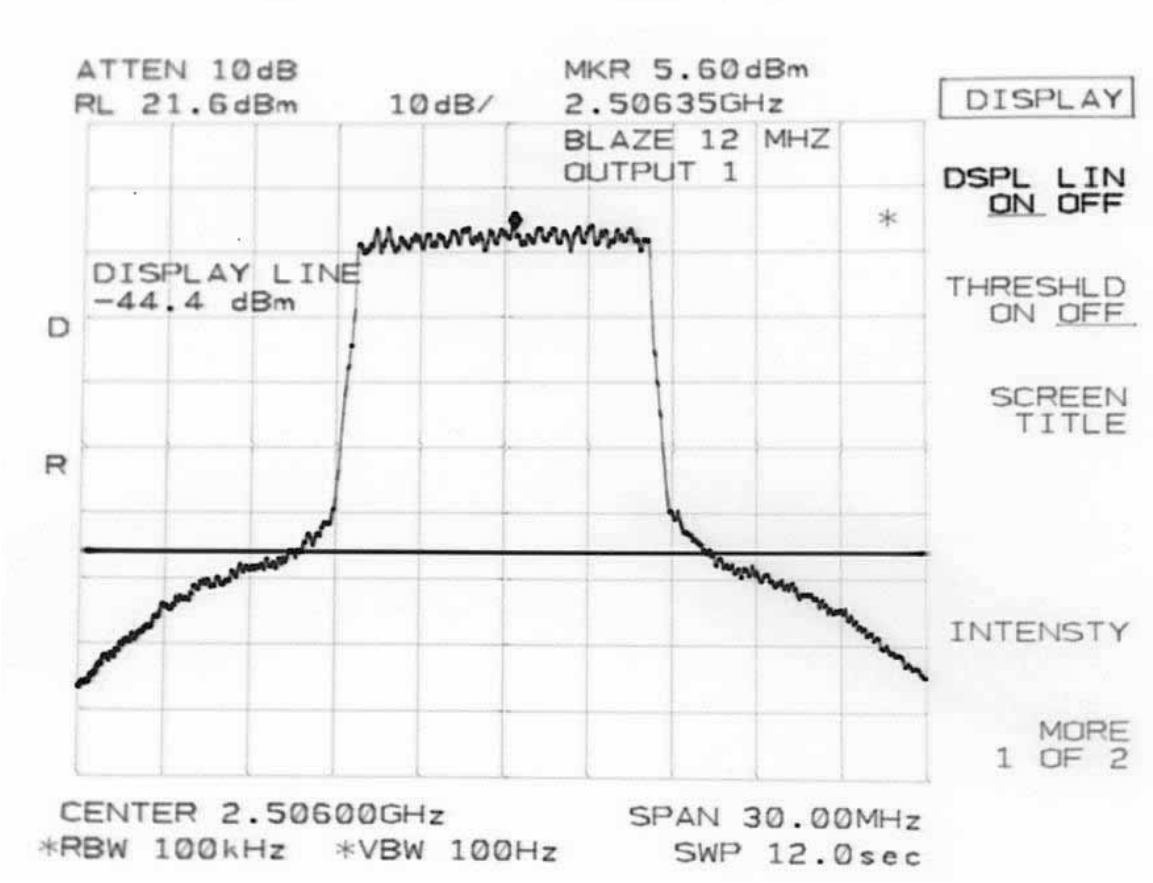
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (6 of 7)



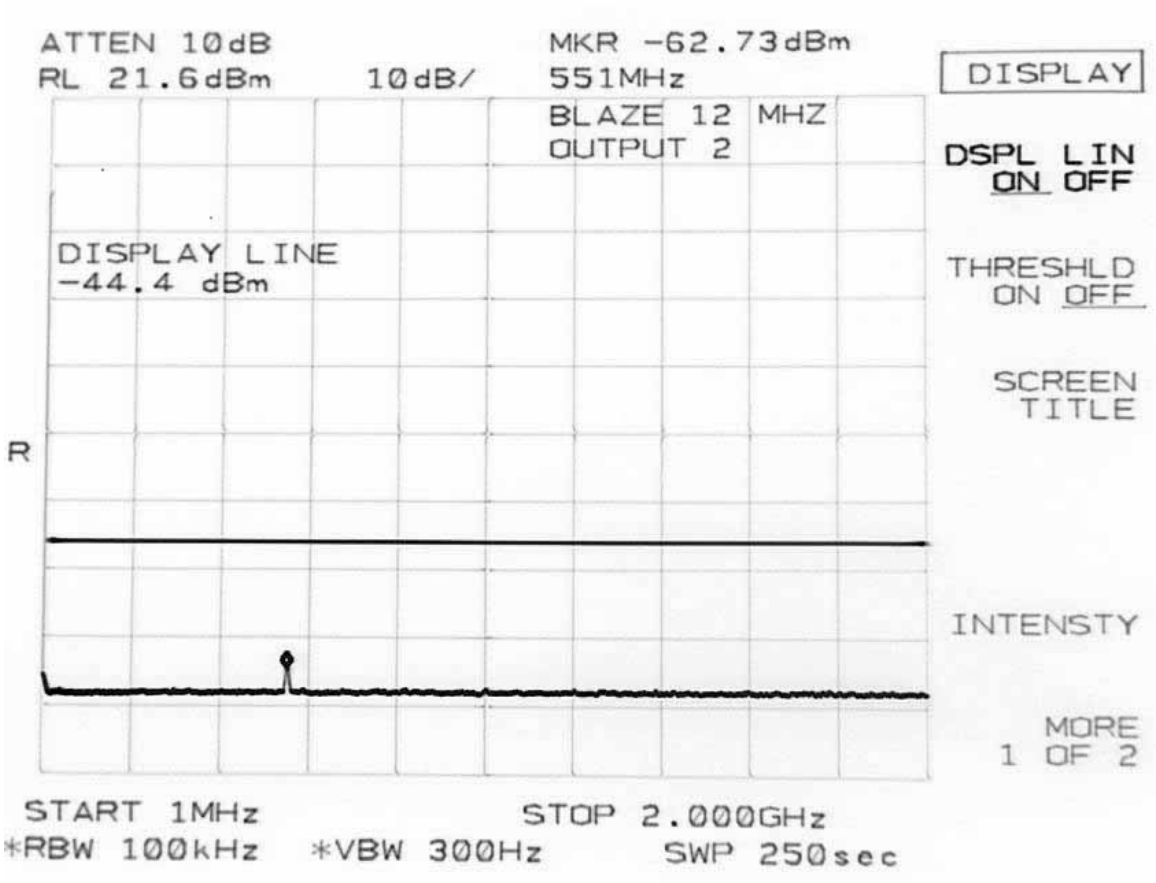
Antenna Conducted Emissions, 6 MHz Channel Bandwidth (7 of 7)



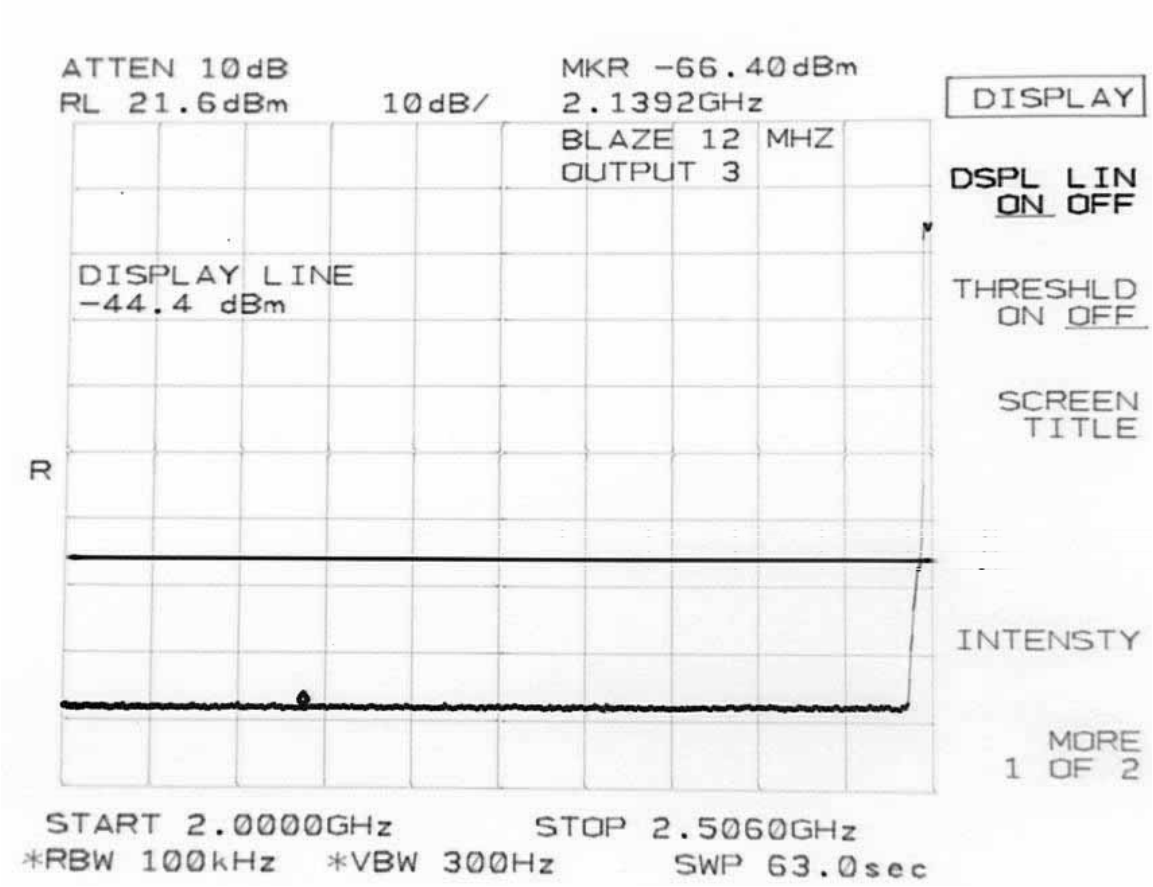
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (1 of 7)



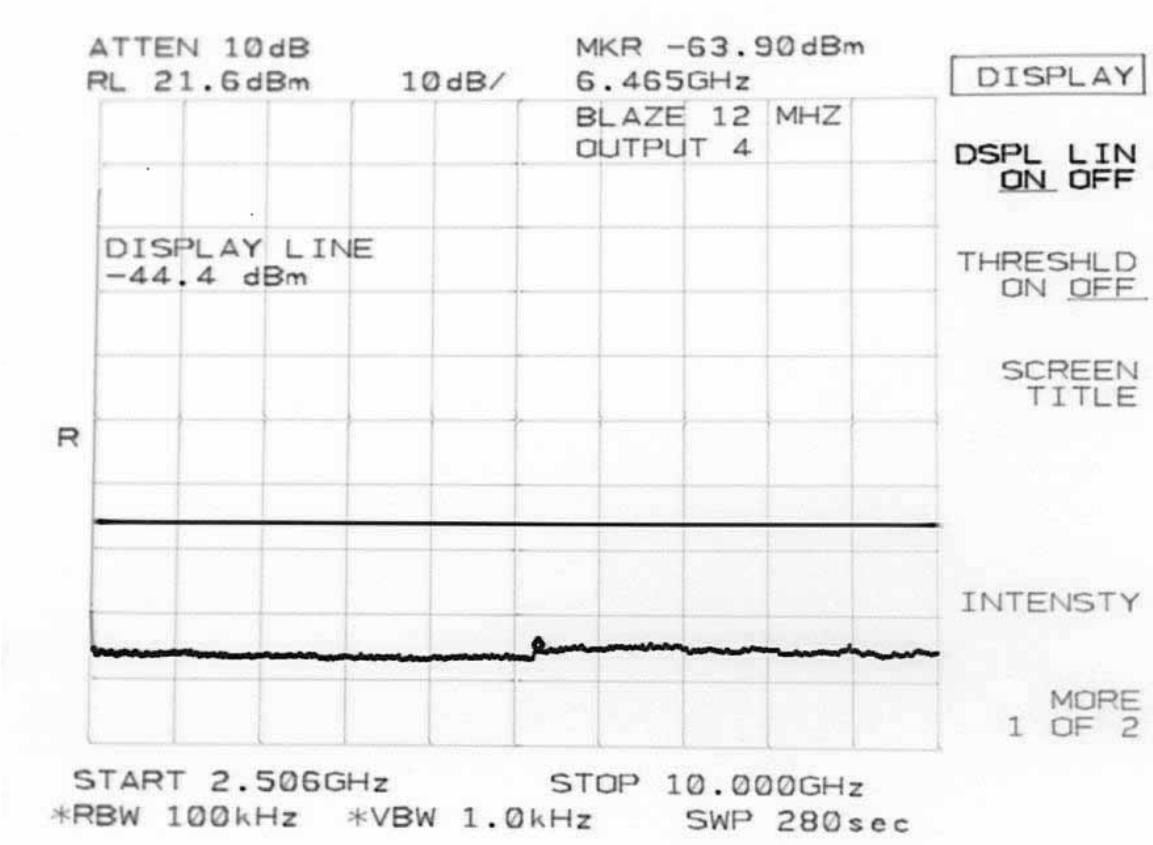
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (2 of 7)



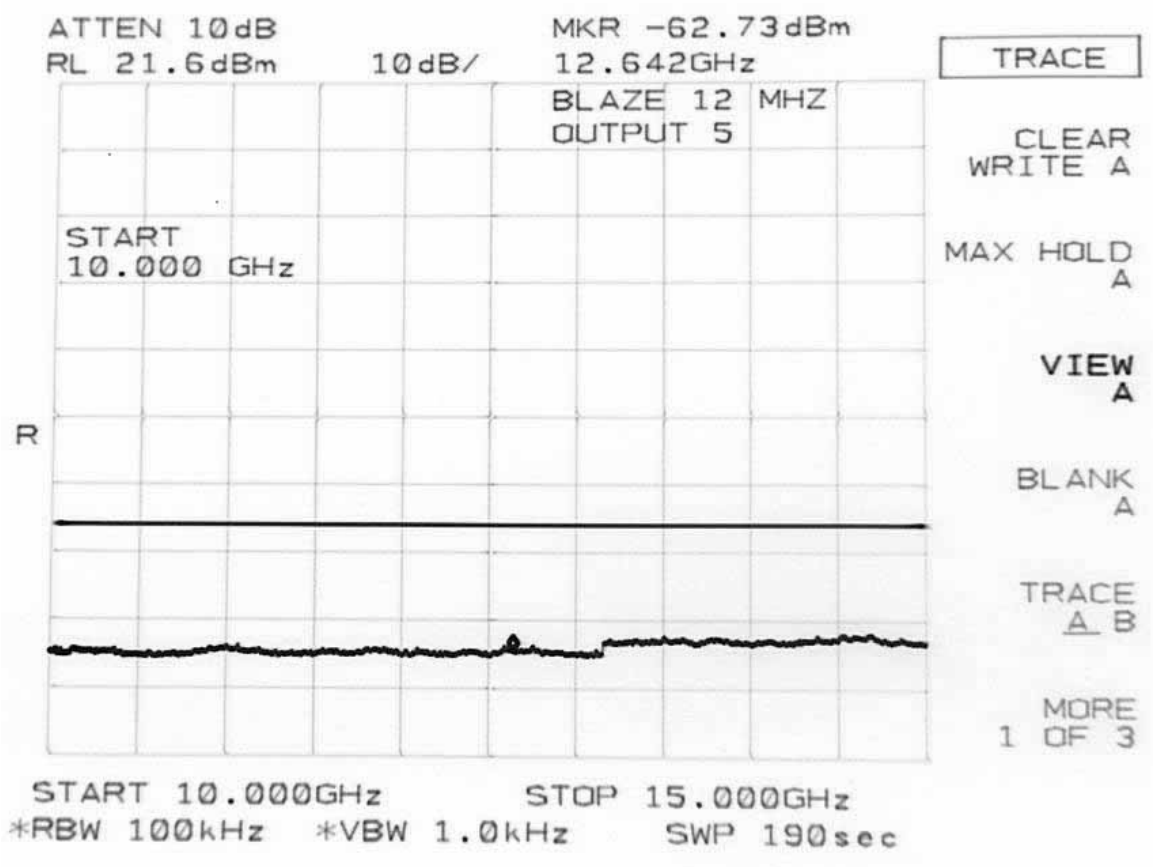
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (3 of 7)



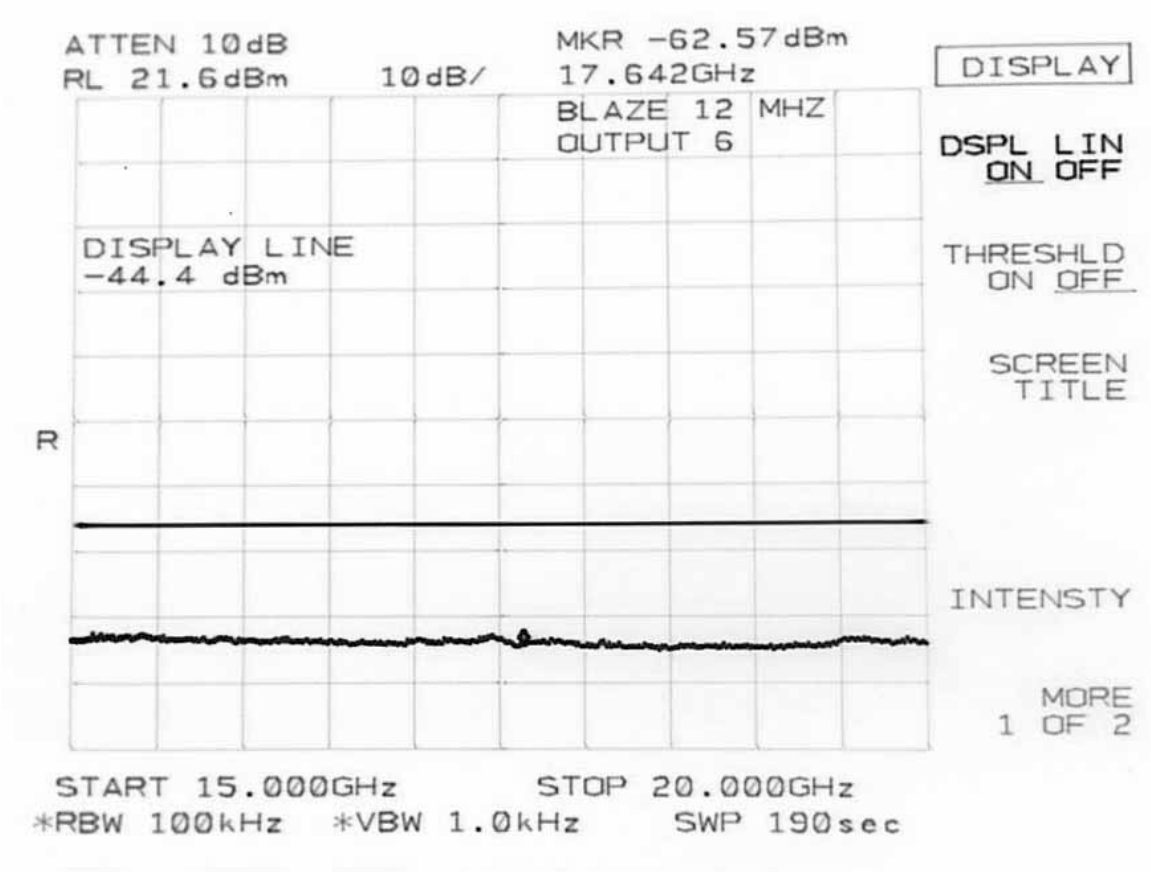
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (4 of 7)



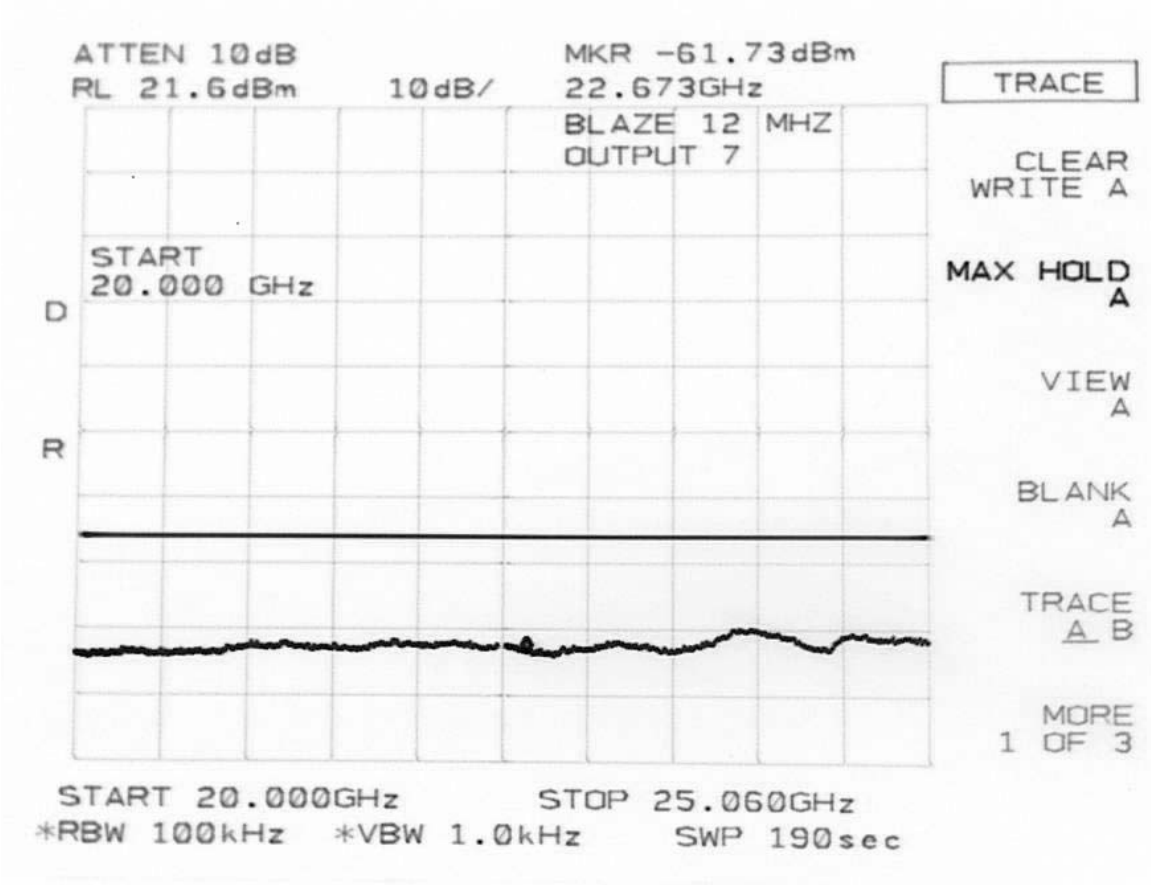
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (5 of 7)



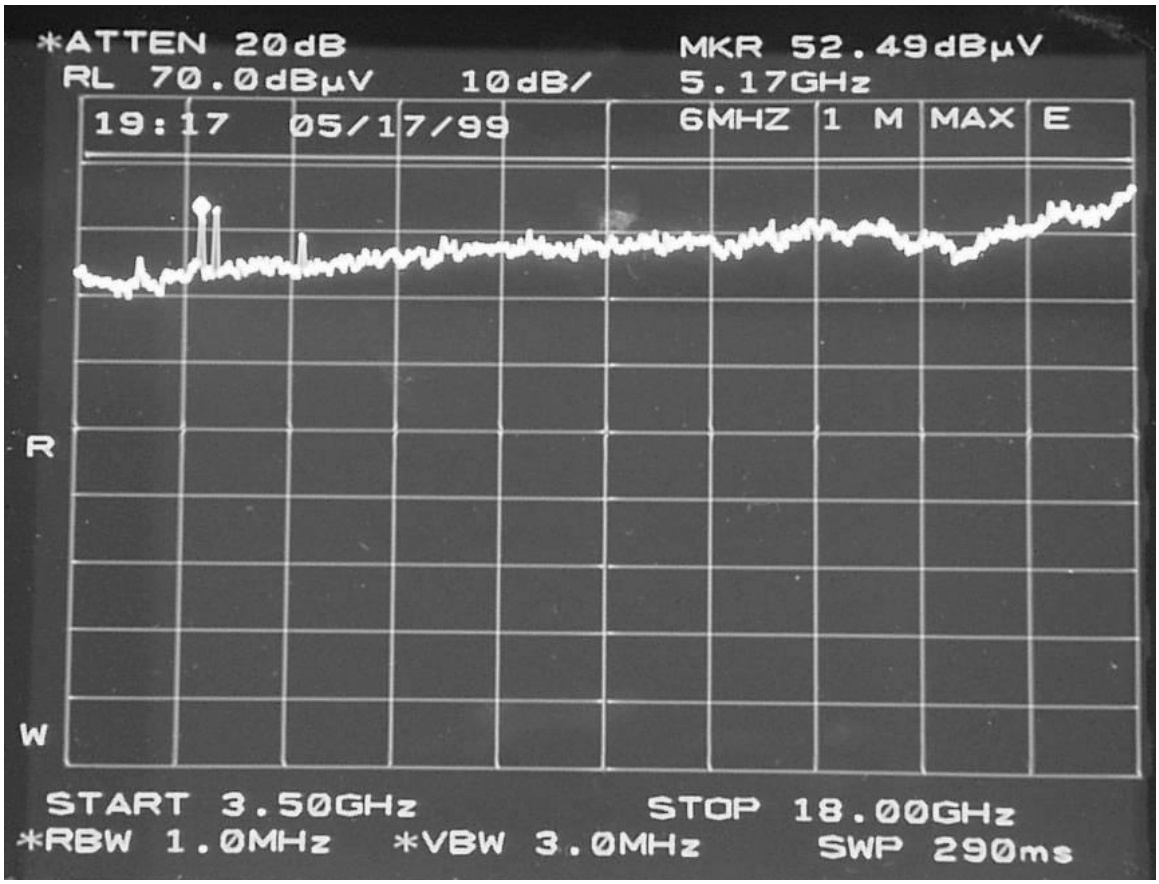
Antenna Conducted Emissions, 12 MHz Channel Bandwidth (6 of 7)



Antenna Conducted Emissions, 12 MHz Channel Bandwidth (7 of 7)



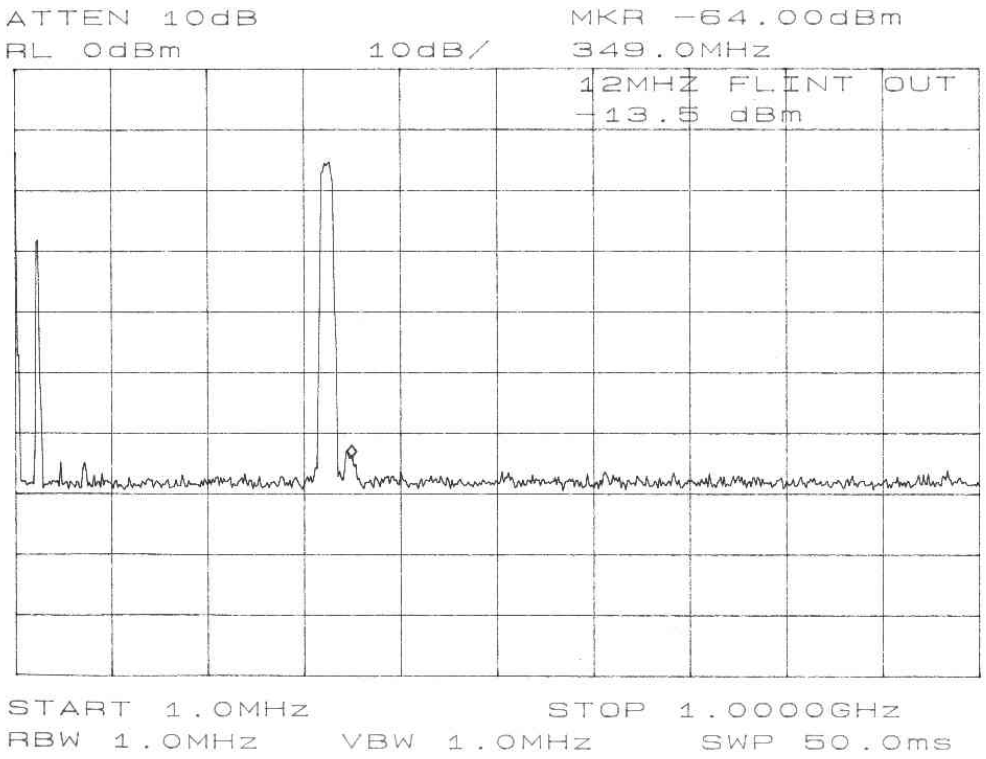
Case Radiated Emissions, 1 meter Separation



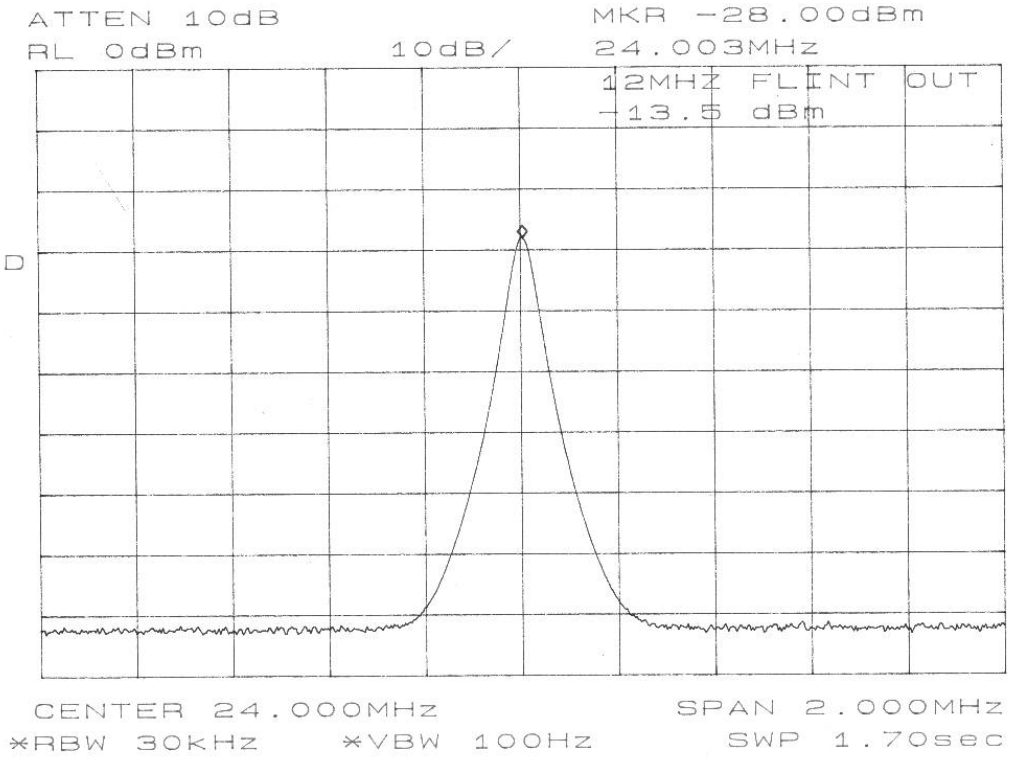
Case Radiated Emissions, 1 meter Separation

EXHIBIT 11 IF Card TX Signals to RF Module

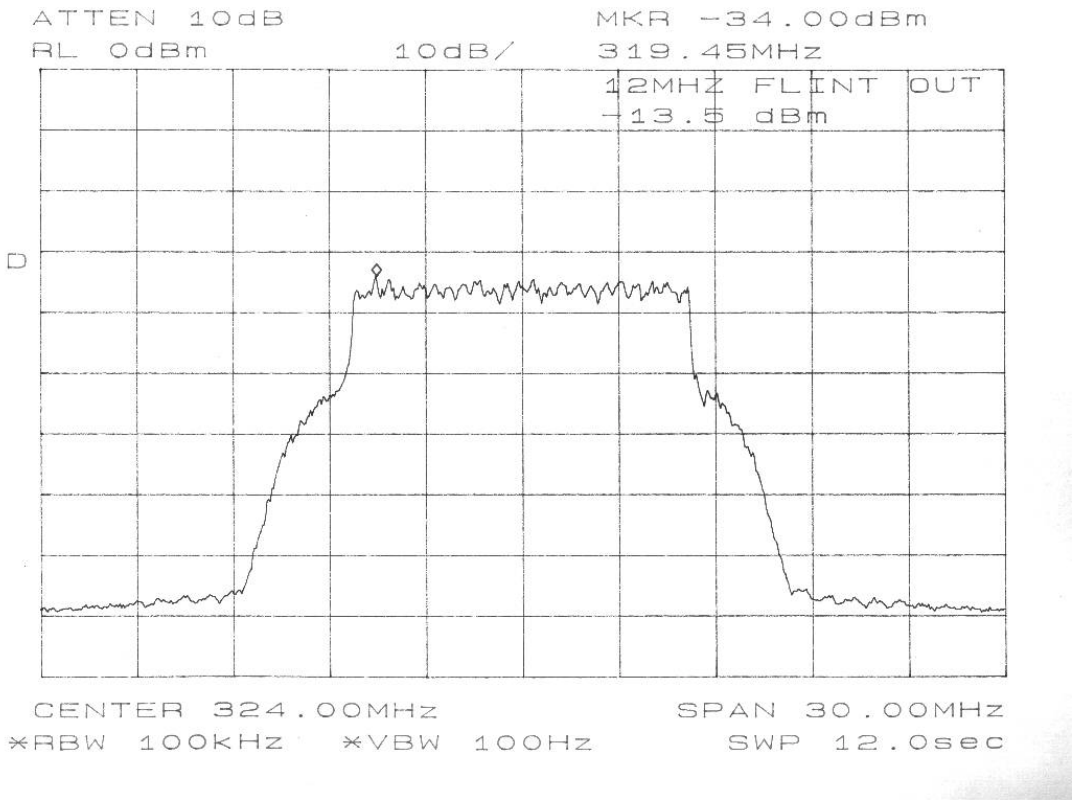
12 MHz output, 1 of 3



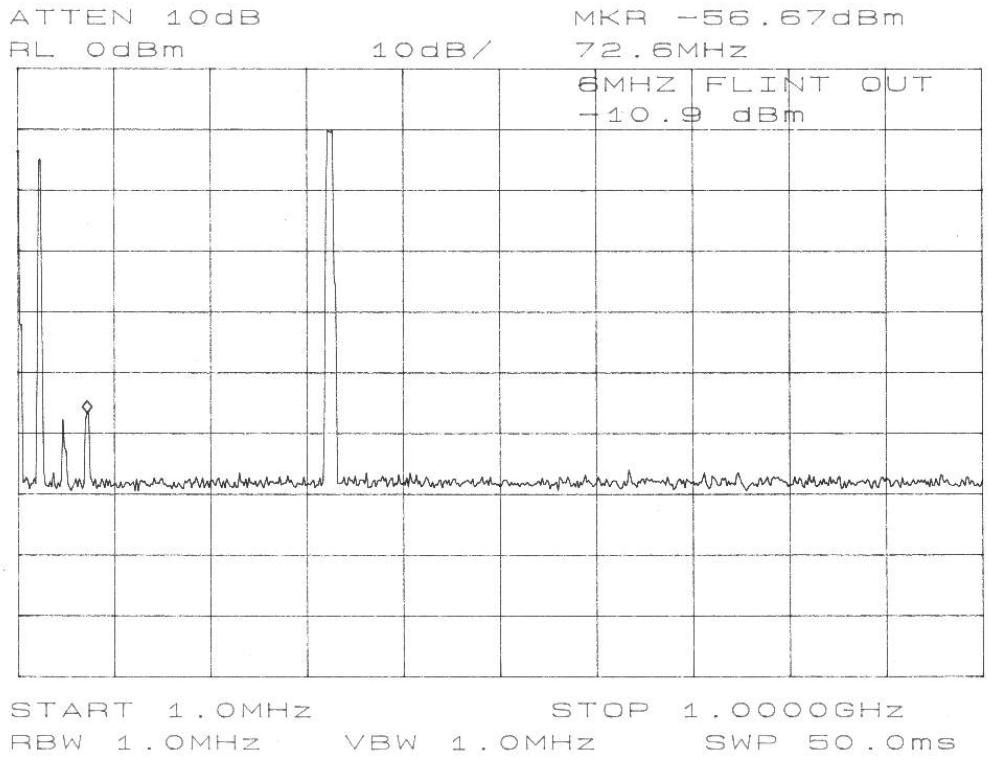
12 MHz output, 2 of 3



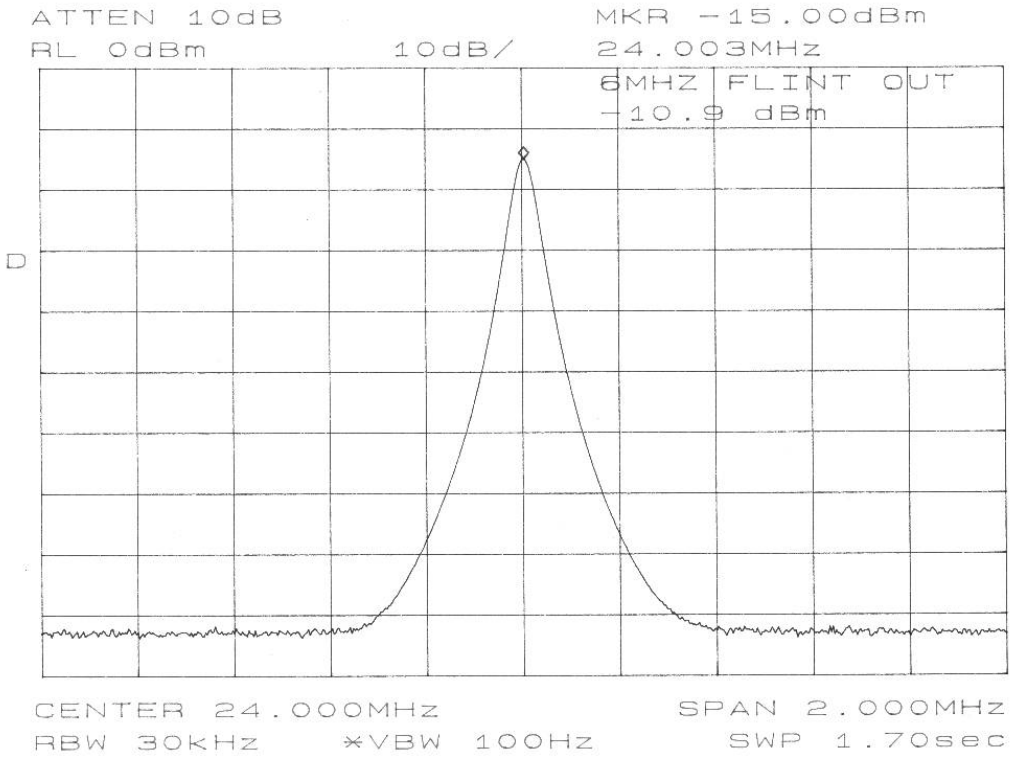
12 MHz output, 3 of 3



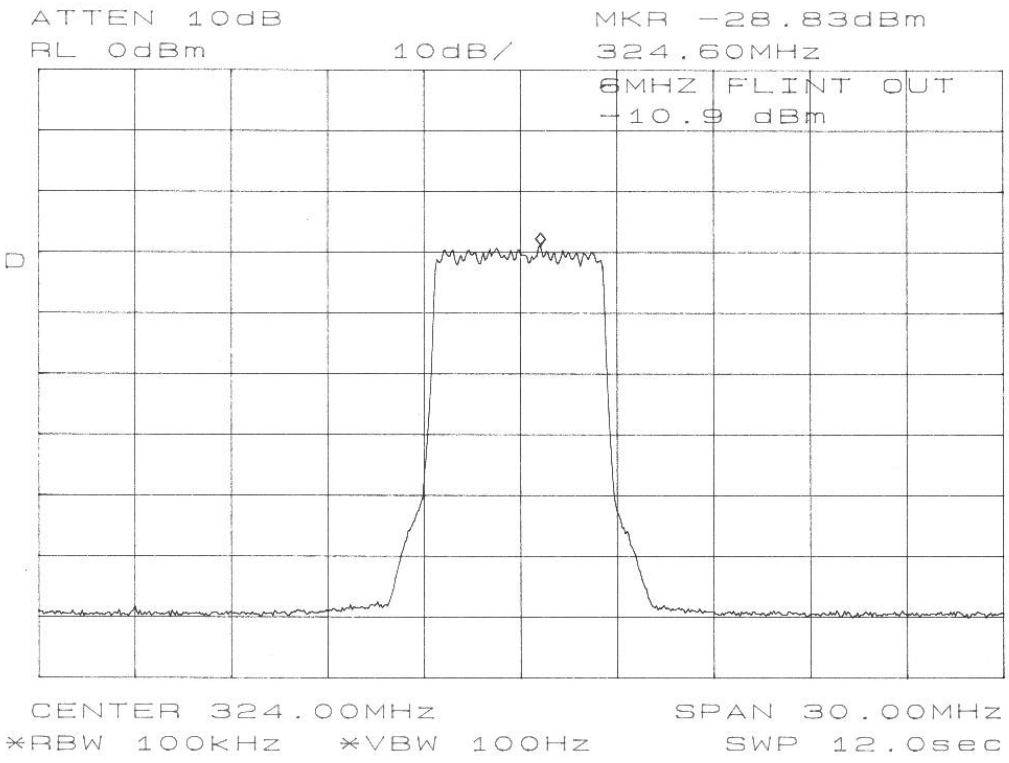
6 MHz output, 1 of 3

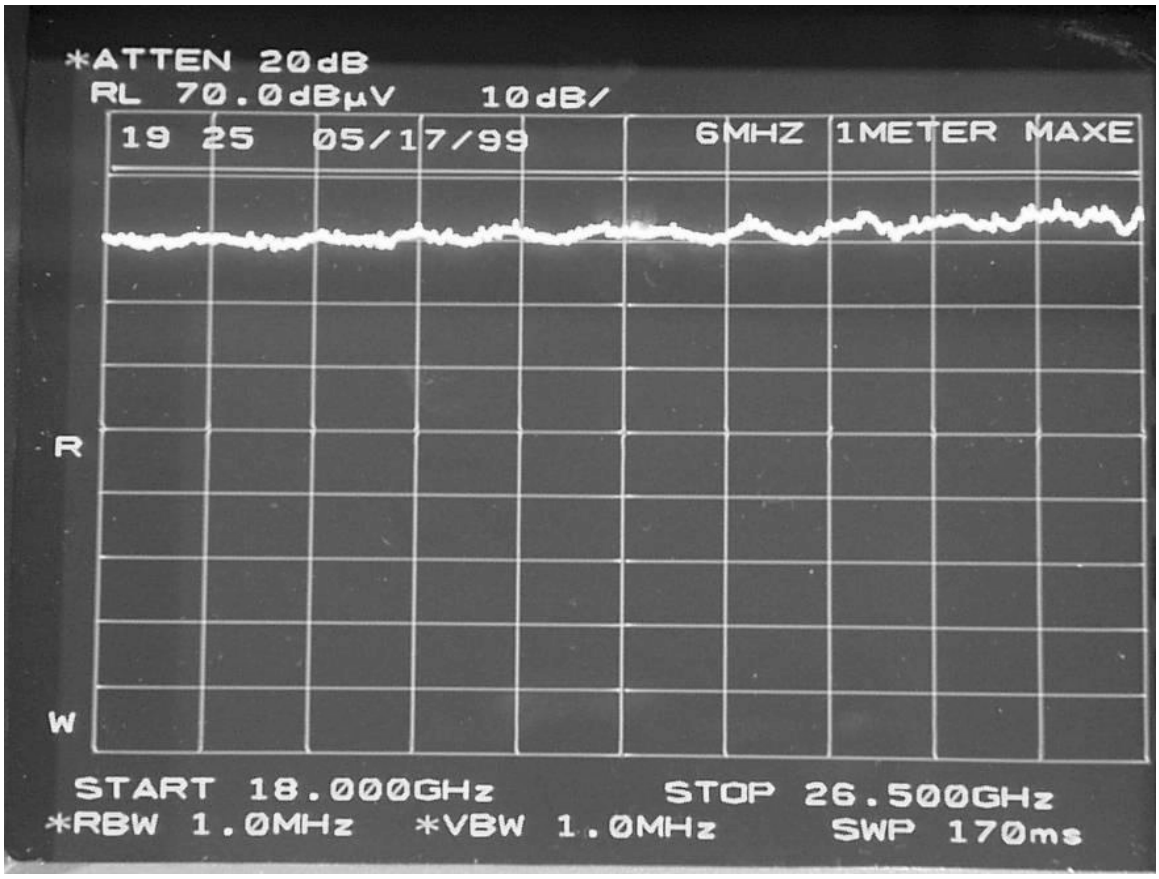


6 MHz output, 2 of 3



6 MHz output, 3 of 3




*ATTEN 20dB
RL 70.0dBµV 10dB/
19 25 05/17/99 6MHZ 1METER MAXE
R
W
START 18.000GHz STOP 26.500GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 170ms