EXHIBITS

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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

20 July 2000

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: Watkins Johnson.

FCC ID: NTTSX1124

To whom it may concern,

Request is hereby submitted, on behalf of my client Watkins Johnson., 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:

Watkins Johnson 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,

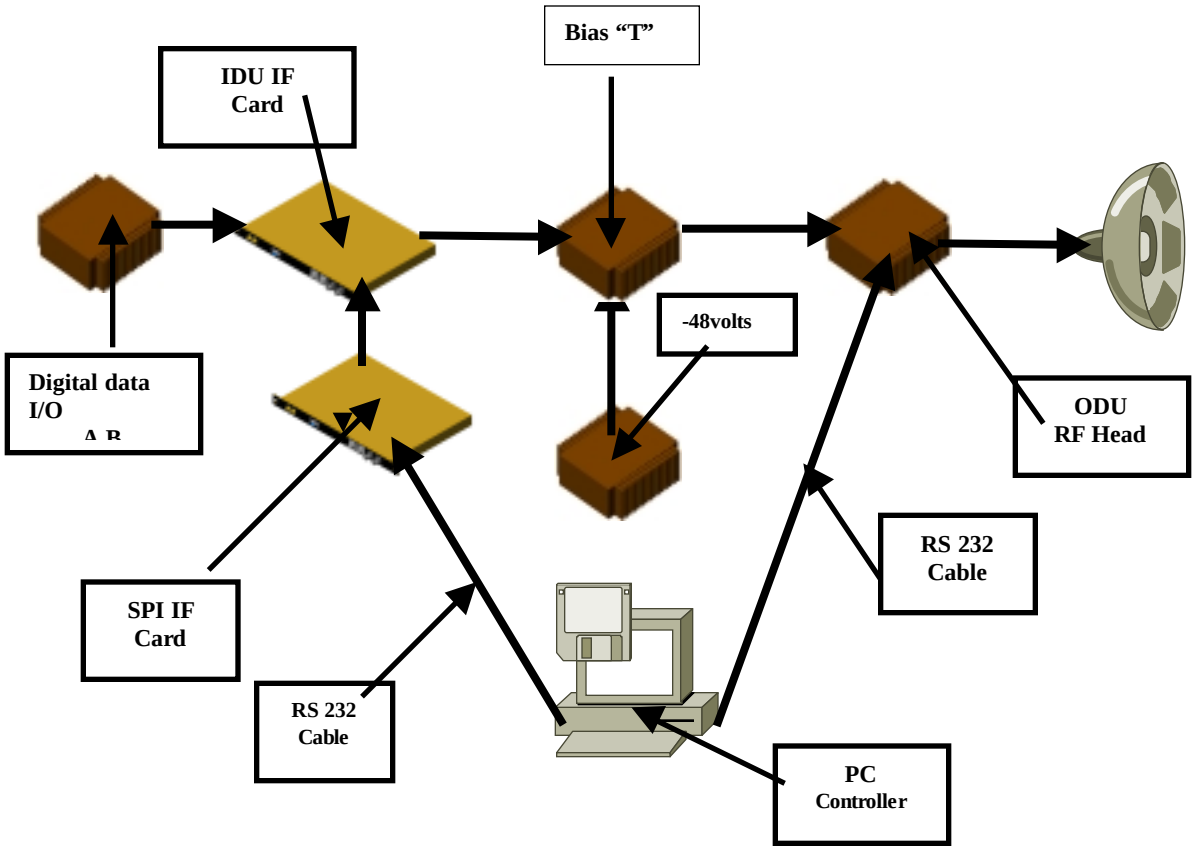
THOMAS N. COKENIAS
EMC Consultant/Agent for Watkins Johnson.

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

EXHIBIT 2: Product Description and Operation Overview

The Watkins Johnson FCC ID: NTTSX1124 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 **IDU** IF card up-link performs the modulation functions of the system. A 330 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 1.5, 3.0, and 6.0 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 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 IF output RF spectrum is in Exhibit 11.

The **bias "T"** provides DC and the 330 MHz IF signal on a single coaxial cable for routing to the RF head.

The **ODU** RF head produces the RF transmit link at 2150 – 2162 MHz , 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 Watkins Johnson. The –48 VDC supply shown in the diagram is telephone central office (CO) power or a customer provided supply.

SPECIFICATIONS

ODU RF Head

Frequency range:	2150 - 2162 MHz
Power output:	30 - 36 dBm maximum, depending on channel bandwidth
Channel Bandwidth:	1.5 MHz, 3.0 MHz, and 6 MHz configurable

IDU IF Head

Frequency range:	330 MHz	
	24 MHz clock	
Power output:	330 MHz:	-13 dBm nominal (programmable)
	24 MHz:	-12 dBm nominal

Data transfer rate, air link: 22 Mbs/sec (6 MHz channel)

A detailed description of the theory of operation and product configuration is found in the attached document, rfhea~1.doc..

System Interconnection

** Provided by Cisco

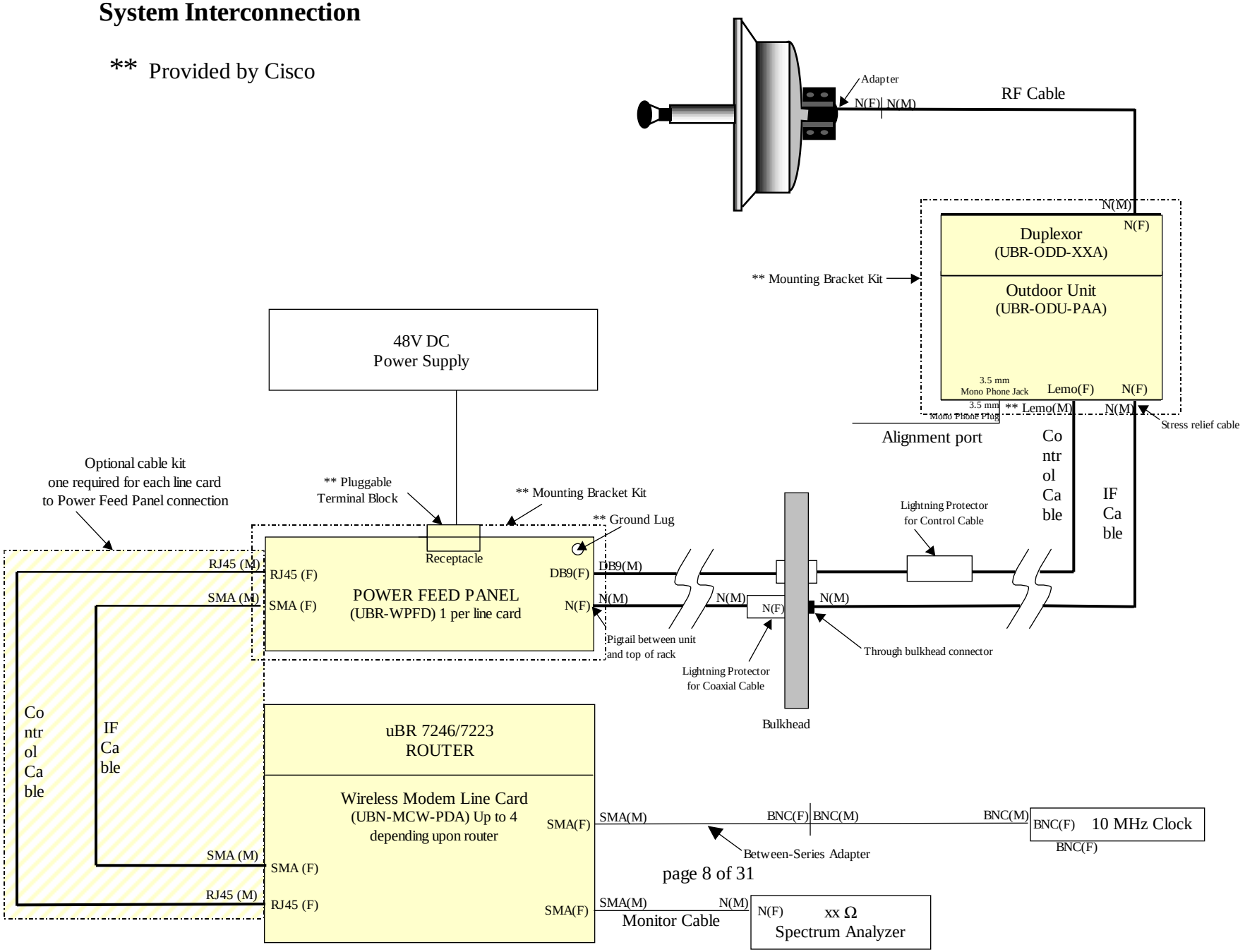


EXHIBIT 3: Information for which Confidentiality is Requested

Schematics

Block Diagrams

Theory of Operations

EXHIBIT 4: Product Photographs

- refer to separate attachment

EXHIBIT 5: Bill of Materials (BOM)

- refer to separate attachment

EXHIBIT 6: User Manual and FCC ID Label

- refer to separate attachment

EXHIBIT 7: RF Hazard Information Per Sec. 1.1307

For transmitters operating in the 2150 - 2162 MHz 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

Watkins Johnson 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: Watkins Johnson.
3333 Hillview Ave
Palo Alto, CA 94303

2.1033(c)2 FCC ID: NTTSX1124

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

2.1033(c)4 Emission type is OFDM in 1.5/3/6 MHz channel configuration

1M50D1D, 3M00D1D, 6M00D1D

2.1033(c)5 Frequency range: 2150-2162 MHz

2.1033(c)6 Range of Operating Power

0 – 36 dBm, TX attenuation settings via software

2.1033(c)7 Maximum Power Rating

Maximum allowed per 21.904: 33 dBw

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 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 are attached as electronic (PDF) files.
Circuit description and theory of operation are found in the attached electronic file named rfhea~1.doc.

2.1033(c)11 FCC ID Label

Attached electronic file

2.1033(c)12 Product Photographs

Attached electronic files

2.1033(c)13 Description of Modulation System

Refer to appropriate chapters in attached electronic file rhea~1.doc

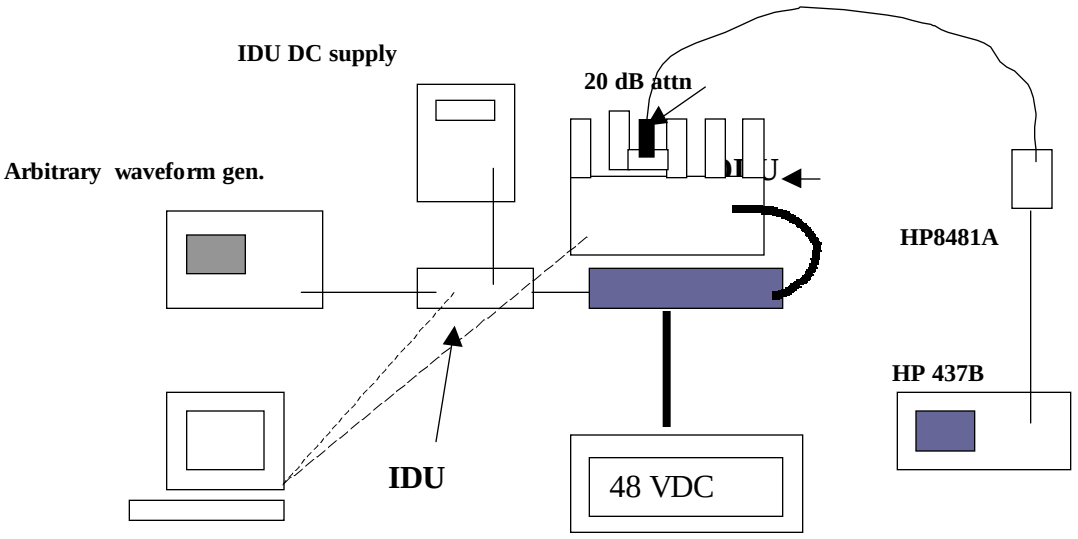
2.1033(c)14 Test Data per 2.1046 – 2.1057

(2) RF Output Power Measurements

Measurement equipment used:

HP 437B Power meter
HP 8381A power sensor

Test set-up:



Test Procedures

1. Set the IDU channel bandwidth parameters and output level to desired values. Output level is chosen to maximize RF output level from ODU while keeping spectral re-growth and spurious emissions from ODU at acceptably low levels.
2. Set ODU 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)	1.5 MHz	1.5 MHz	3 MHz	3MHz	6 MHz	6 MHz

	P, requested	**P,measured**	**P,requested**	**P,measured**	**P,requested**	**P,measured**
2506	36 dBm	36.0 dBm	35 dBm	35.0 dBm	33 dBm	33.0 dBm

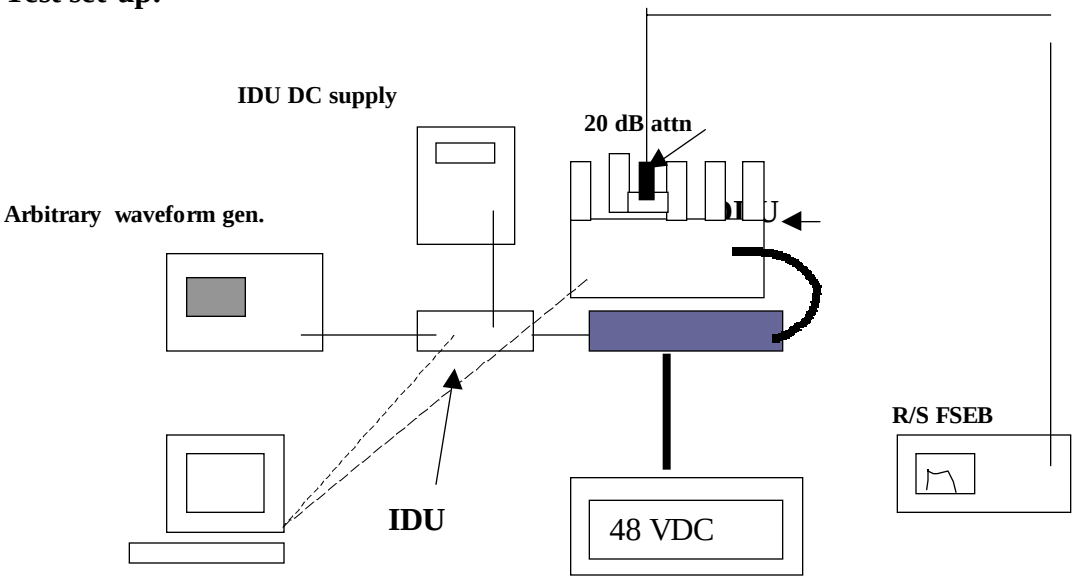
NOTE: Power leveling is within 1 dB accuracy.

Section 2.1047 Modulation Characteristics

Measurement equipment used:

Rohde&Schwarz FSEB spectrum analyzer
Arbitrary waveform generator
20 dB attenuator, low loss cable, directional coupler

Test set-up:



Test Procedures

The R/S FSEB RES bandwidth, VID bandwidth, and span settings were chosen to best display the emissions mask for this complex waveform. Various combinations of external and internal attenuator settings were tried to minimize spectral regrowth in the analyzer and to maintain maximum dynamic range.

It became apparent during the course of testing that different span and filter bandwidth settings were required to show –25 dBc, -40 dBc, and –60 dBc requirements. A total of 15 spectrum analyzer graphs are presented, 3 each for each of the following channels:

1.5 MHz HI, 1.5 MHz LOW, 3 MHz HI, 3 MHz LOW, 6 MHz – all referenced to 6 MHz channel center frequency of 2153 MHz

Video bandwidths were chosen to produce average power readings. Refer to attached document named analys~1.com for a description of the equivalency of measurements taken

using the Video Averaging function of the spectrum analyzer and using narrow bandwidth filtering to obtain average power readings.

Test Results

PASS. Refer to attached spectrum analyzer charts.

Section 2.1049 Occupied Bandwidth

Measurement Equipment Used:

Rohde&Schwarz FSEB spectrum analyzer
Arbitrary waveform generator
20 dB attenuator, low loss cable, directional coupler

Test Set-up

- Same as for 2.1047 above

Test Procedures and Results:

Using MKR DELTA function of the analyzer:

-26 dB Occupied Bandwidth: 1.5 MHz, 3 MHz, 6 MHz

Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals

Measurement Equipment Used:

Rohde&Schwarz FSEB spectrum analyzer
Arbitrary waveform generator
20 dB attenuator, low loss cable, directional coupler

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

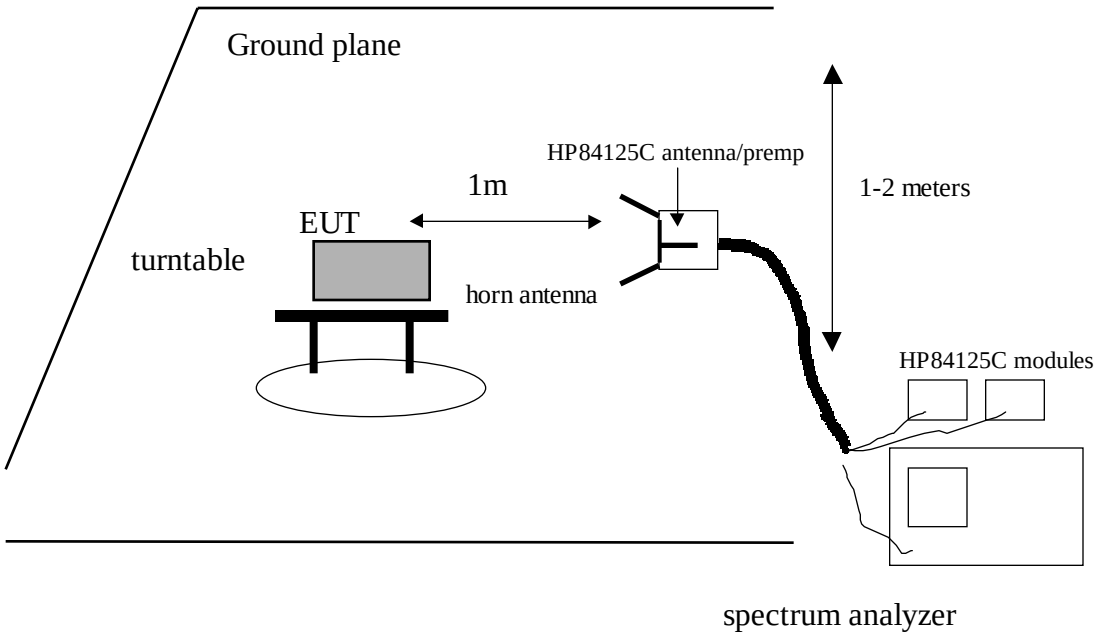
PASS. Refer to data plots in separate electronic attachment

Section 2.1053 Field Strength of Spurious and Harmonic Radiation

Measurement Equipment Used:

HP 8565E Spectrum Analyzer
HP 84125C Microwave EMI Measurement System (with 3.5 GHz HPF)

Test Set-Up (Cisco EMC anechoic chamber, Building 7)



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 when measured in a 1MHz bandwidth:

Power Out, 1.5 MHz bandwidth: 36 dBm max – 10log(1.5/1) = 34.3 dBm in 1 MHz

34.3 dBm – 60 dB = -25.7 dBm

Resultant radiated field at 1 m from –24.7 dBm source feeding isotropic antenna:

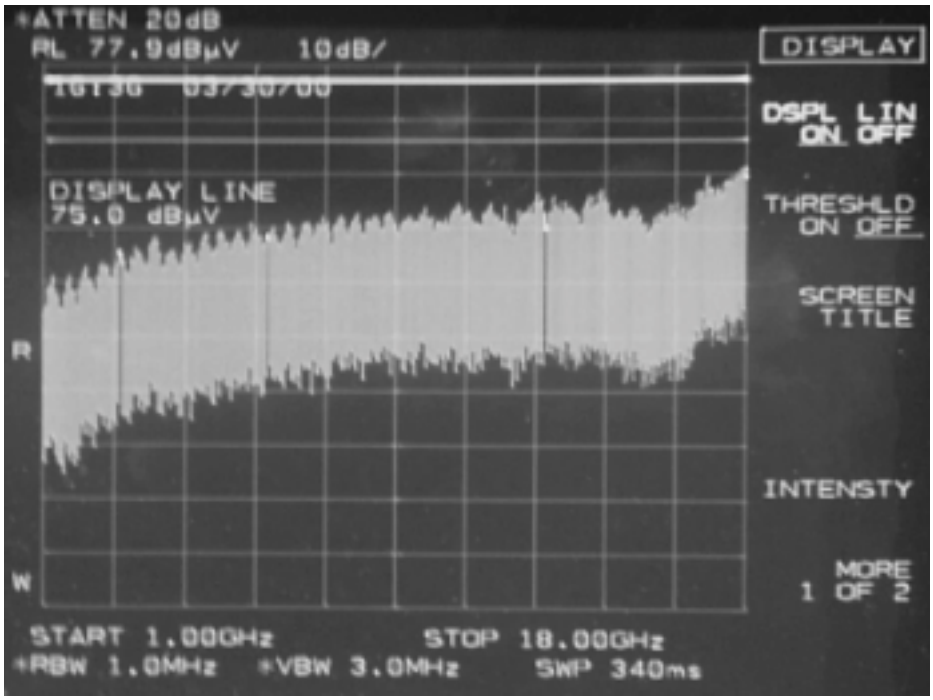
E@1m, dBuV/m = (105.24 + PdBm + GdBi) dBuV/m = (105.24 - 25.7+0) = 79.5 dBuV/m

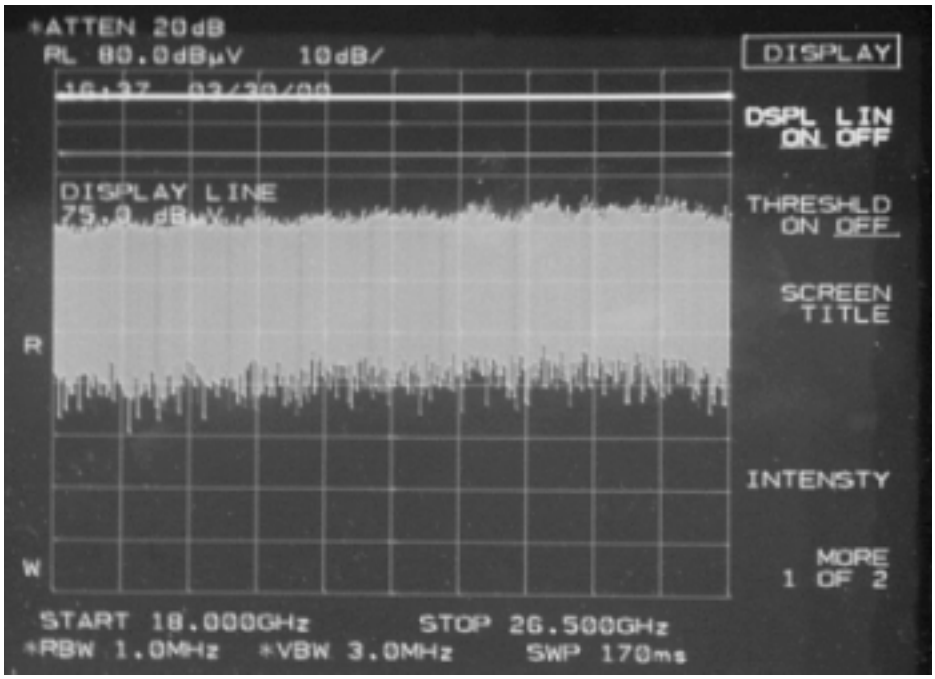
Test Method

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.

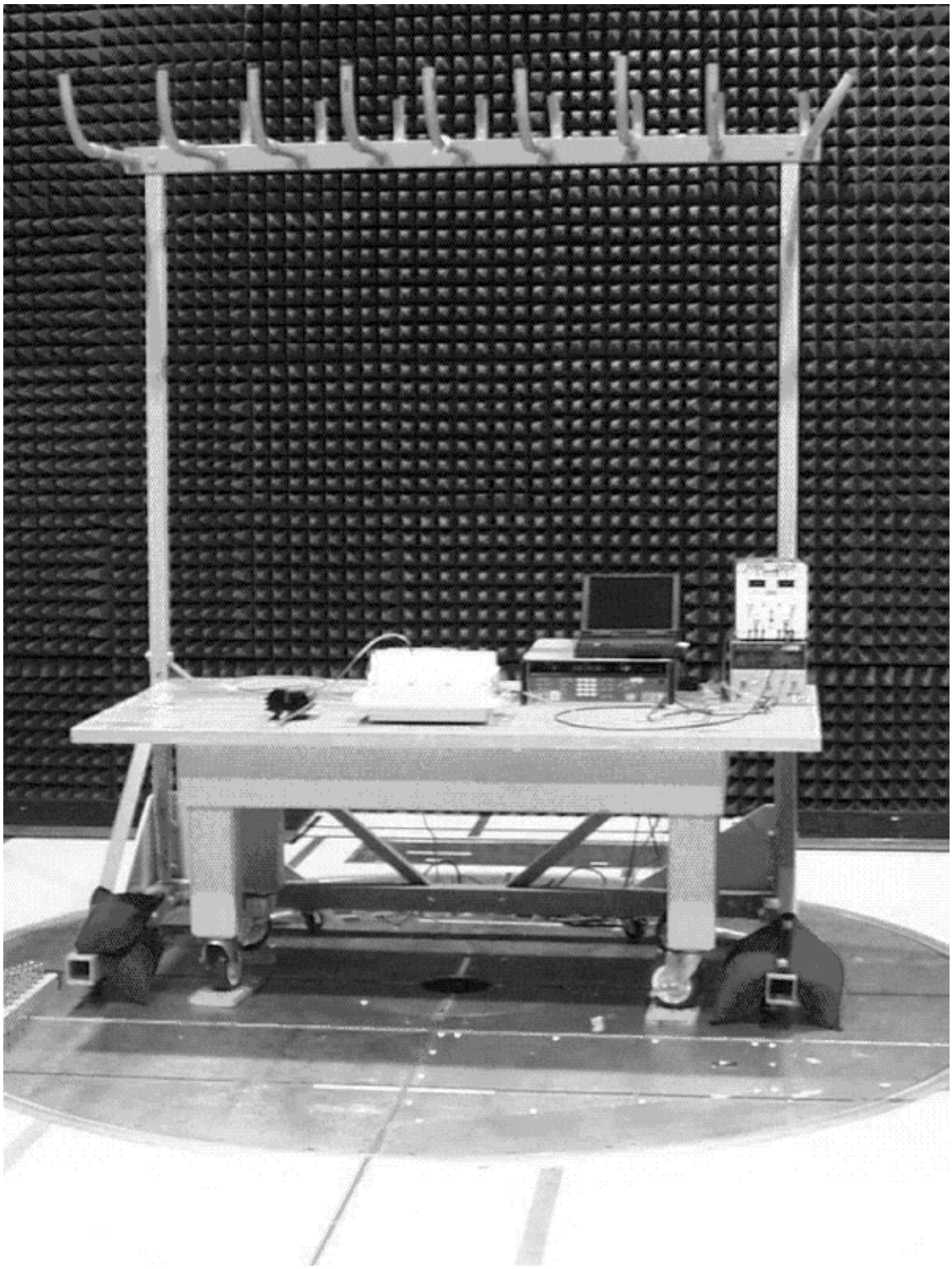
Test Results

No emissions detected to 26 GHz. Noise floor approximately 20 dB below limits.

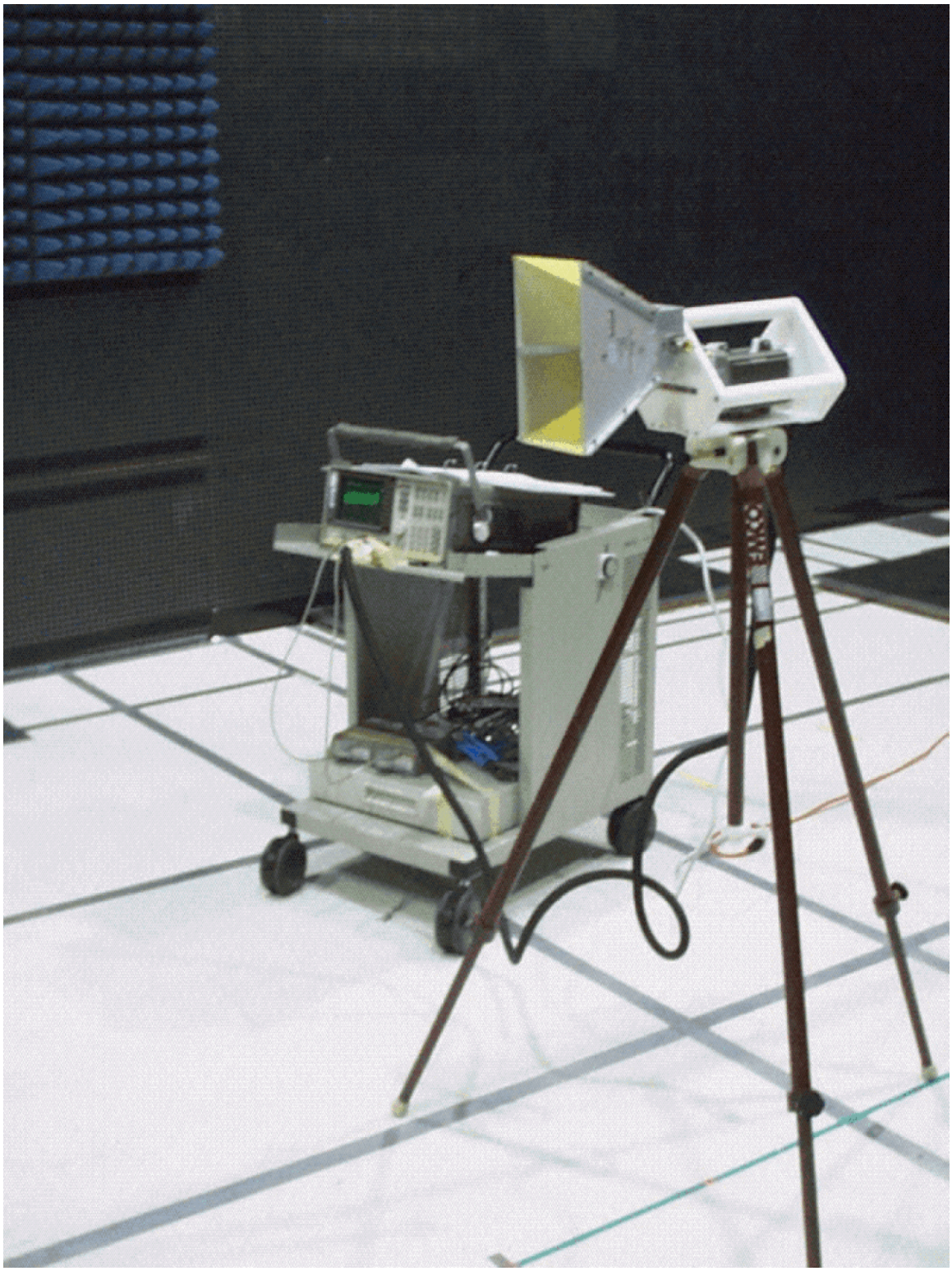



*ATTEN 20dB
RL 80.0dBµV 10dB/
DISPLAY
DSPL LIN
ON OFF
DISPLAY LINE
75.0 dBµV
THRESHLD
ON OFF
SCREEN
TITLE
R
INTENSTY
W
MORE
1 OF 2
START 18.000GHz
STOP 26.500GHz
*RBW 1.0MHz
*VBW 3.0MHz
SWP 170ms

Case Radiated Test Set-up (Cisco Building 7)



Case Radiated Test Equipment



(3) Frequency Stability

Refer to separate electronic attachment

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 Watkins Johnson.

Test Site

All testing was performed at Watkins and 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

- see separate attachment "4/24/2000 Masks SX1124"

Case Radiated Emissions, 1 meter Separation

- see separate attachment-

EXHIBIT 11 IF Card TX Signals to RF Module

- see separate attachment-