Electro-Magnetic Compatibility
Test Report

for the

Radio Frequency Systems (RFS)
12 Channel Digital SMR BDA,
Model C-BDA-SMR800

Tested Under

FCC Part 90, Subpart J
Title 47 of the CFR
for Private Land Mobile Radio Services

MET REPORT: **EMCS13538-FCC90**

April 29, 2003

PREPARED FOR:

Radio Frequency Systems, Inc.
29 Research Parkway
Wallingford, CT 06492

PREPARED BY:

MET Laboratories, Inc.
33439 Western Avenue
Union City, California 94587

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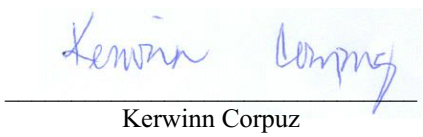
Alvin Ilarina, Manager
Electromagnetic Compatibility Testing

Cheryl Anicete
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 90, Subpart J, of the FCC Rules under normal use and maintenance.



Kerwinn Corpuz
Project Engineer

REPORT STATUS SHEET

Revision	Report/Revision Date	Reason for Revision
⌀	April 29, 2003	Initial Issue.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PHOTOGRAPHS

LIST OF FIGURES

LIST OF TERMS AND ABBREVIATIONS

AC	**A**lternating **C**urrent
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBm	**d**ecibels **B**elow 1 **m**illiwatt
dBμA	**D**eci**b**els above one **micro**amp
dBμV	**D**eci**b**els above one **micro**volt
dBμA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBμV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
μH	**micro**henry
μF	**micro**farad
μs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane
W	**W**atts

Summary of Test Results

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 90, Subpart J. All tests were conducted using measurement procedure ANSI TIA/EIA-603-A-2001.

Type of Submission/ Rule Part:	Certification / Part 90 Subpart J
EUT:	RFS, 12 Channel Digital SMR BDA (Repeater), Model C-BDA-SMR800
FCC ID:	IWDC-BDA-SMR800
Equipment Code:	IWD
Type of Emissions:	17K6D7W
RF Power Output:	Conducted Output Power in PEP (Peak Envelope Power) for two channels: 35.5 dBm (3.55 Watts)
Frequency Range (MHz):	UPLINK: 806 - 821 DOWNLINK: 851 - 866
Frequency Stability:	within 2.5 ppm

Table 1. Summary of Test Results

Name of Test	FCC Rule Part/Section	Results
RF Power Output	2.1046; 90.219(b)	Complies
Modulation Characteristics	2.1047(a)	N/A - EUT is non-analog voice.
Occupied Bandwidth	2.1049; 90.209	Complies
Spurious Emissions at Antenna Terminals	2.1051; 90.210	Complies
Radiated Spurious Emissions	2.1053; 90.210	Complies
Frequency Stability over Temperature Variations	2.1055(a) (1); 90.213	Complies
Frequency Stability over Voltage Variations	2.1055(d) (2)	Complies
Transient Frequency Behavior	90.214	N/A - EUT operates at 800 MHz

Table 2. Summary of Test Results

I. Executive Summary

I. Executive Summary

A. Purpose of Test

An EMC evaluation to determine compliance of the 12 Channel Digital SMR BDA, Model C-BDA-SMR800 (referred to as EUT hereafter) with the requirements of Part 90, Subpart J, was conducted. (All references are to the most current version of Title 47 of the Code of Federal Regulations in effect). In accordance with §2.1033, the following data is presented in support of the Certification of the EUT. Radio Frequency Systems should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been **permanently** discontinued.

B. Executive Summary

The EUT, as supplied to MET Laboratories, complied with the requirements stated in this test report.

References	Description
Purchase Order #P172392	RFS Purchase Order for 12 Channel Digital SMR BDA (Repeater), Model C-BDA-SMR800 testing
ANSI-C63.4: 2001	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
TIA/EIA-603-A-2001	Land Mobile HM or PM Communications Equipment Measurement and Performance Standards
FCC 47CFR, Chapter 1, Part 2	Title 47 Code of Federal Regulations Part 2 - Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
FCC 47CFR, Chapter 1, Part 15	Title 47 Code of Federal Regulations Part 15 - Digital Devices
FCC 47CFR, Chapter 1, Part 90	Title 47 Code of Federal Regulations Part 90 - J

Table 3. References

II. General

II. General

A. Test Site

All testing was conducted at MET Laboratories, Inc., 4855 Patrick Henry Drive, Building 6, Santa Clara, California 95054. Radiated Emissions measurements were performed inside a 10 meter semi-anechoic chamber. In accordance with §2.948(a)(2), a complete site description is filed with the Commission's Laboratory in Columbia, Maryland. MET Laboratories has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0).

B. Description of Test Sample

The EUT is a Class A narrowband Repeater used for boosting the signal strength of Cellular (iDEN) signals. The band of operation is 806 - 821 MHz for the uplink and 851 - 866 MHz for the downlink. In each band, the user can select up to 12 specific channels (each with a bandwidth of 25 kHz) to be amplified.

C. General Test Setup

The EUT was configured with an AC voltage of 120 and PC (HOST) interface to program the EUT controlling the Channel Allocation. The EUT was operated in a manner representative of the typical usage of the equipment. During all testing, system components were manipulated with the confines of typical usage to maximize each emission.

D. Mode of Operation

The EUT was configured in accordance with the manufacturer's instructions and was operated as follows for all testing contained in this report unless stated otherwise:

Basic operation involves an iDEN Signal Generators, 25-watt 30 dB pad, and a connection with transmit/receive lines to a host microprocessor. The iDEN Signal Generators will be connected to the "service area" port and a Spectrum Analyzer to the "base station" port. This will test the Uplink operation. The equipment is swapped to test the Downlink operation.

The unit will be monitored by a local computer or remotely of the frequency gain and output power levels. Alarms will be displayed on the screen indicating failures of frequency and power levels.

II. General

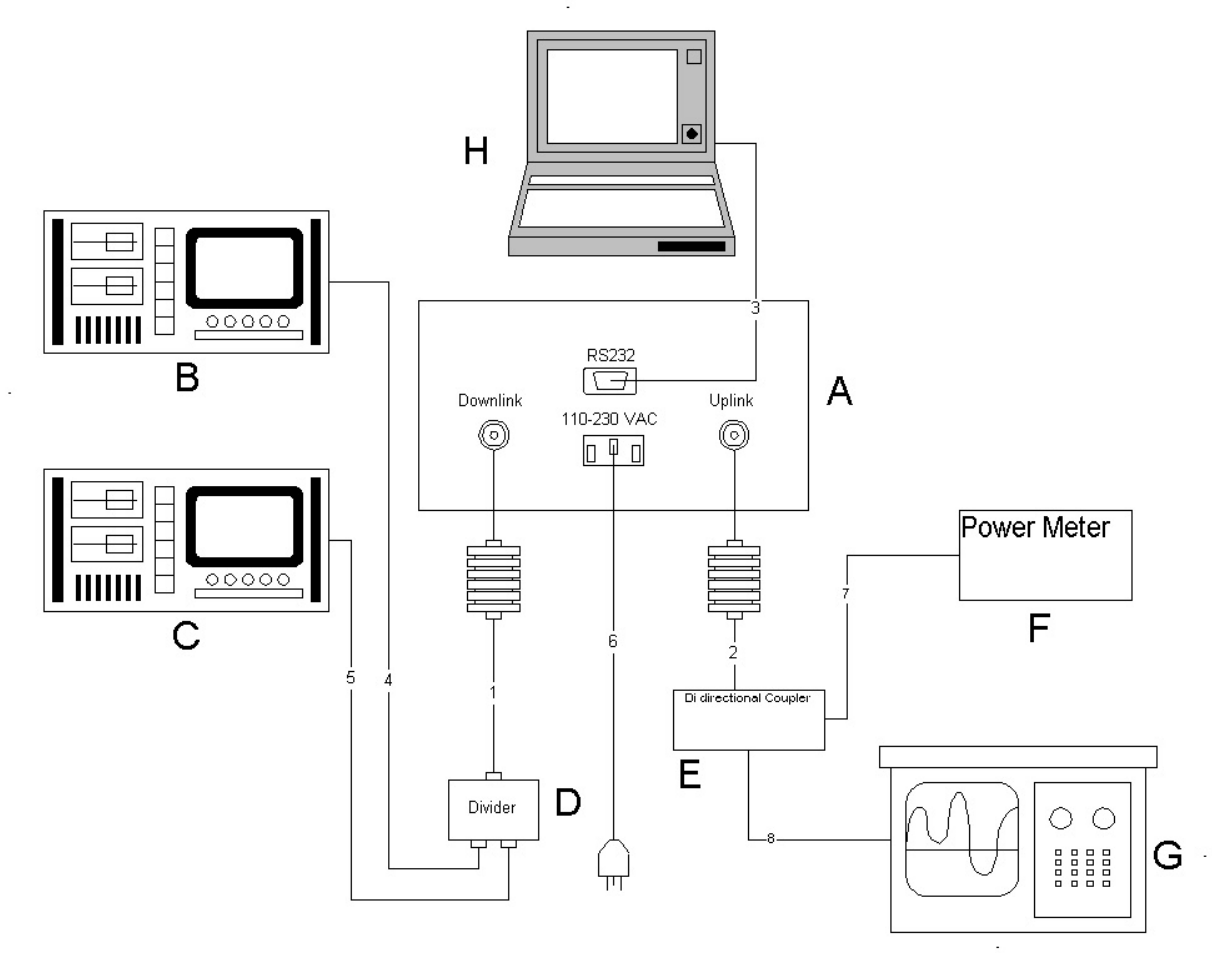


Figure 1. Test Configuration 1 (Conducted Measurement)

II. General

TEST CONFIGURATION 1

EUT and Support Equipment

Ref. ID	Description	Manufacturer	Model Number	Customer Supplied Calibration Data*	Additional Information
A	Repeater - EUT	RFS	C-BDA-SMR800	N/A	N/A
B	iDEN Generator	Motorola	R-2660	N/A	Functional Verification
C	iDEN Generator	Motorola	R-2660	N/A	
D	Power Divider	Mini Circuit	15542	N/A	
E	BI-Directional Coupler	Narda	3020A	N/A	
F	Power Meter	Agilent Corp.	E4418B	08/28/03	N/A
G	Spectrum Analyzer	Hewlett Packard	8564E	08/27/03	N/A
H	PC Laptop	DELL Corp.	Latitude CPt	N/A	N/A

Ports and Cabling Information

Ref. ID	Port Name	Port Location (Ref. ID + Slot)	Connector Type	Cable Type	Qty.	Length (m)	Shielded ?		Cable Termination (Ref. ID + Slot + Port ID)
							Y	N	
1	To Downlink	A	N Type to SMA	Coax	1	1	X		D with 30 dB Attenuator
2	To Uplink	A	N Type	Coax	1	1	X		E with 30 dB Attenuator
3	RS232	A	DB9	Serial	1	1.5	X		H
4	None	D	N type to SMA	Coax	1	1	X		B
5	None	D	N type to SMA	Coax	1	1	X		C
6	120 Vac	A	Single Phase	Standard	1	1.2		X	AC outlet
7	Power Meter	E	SMA	Power Sensor	1	1.5	X		F
8	None	E	SMA	Coax	1	1	X		G

II. General

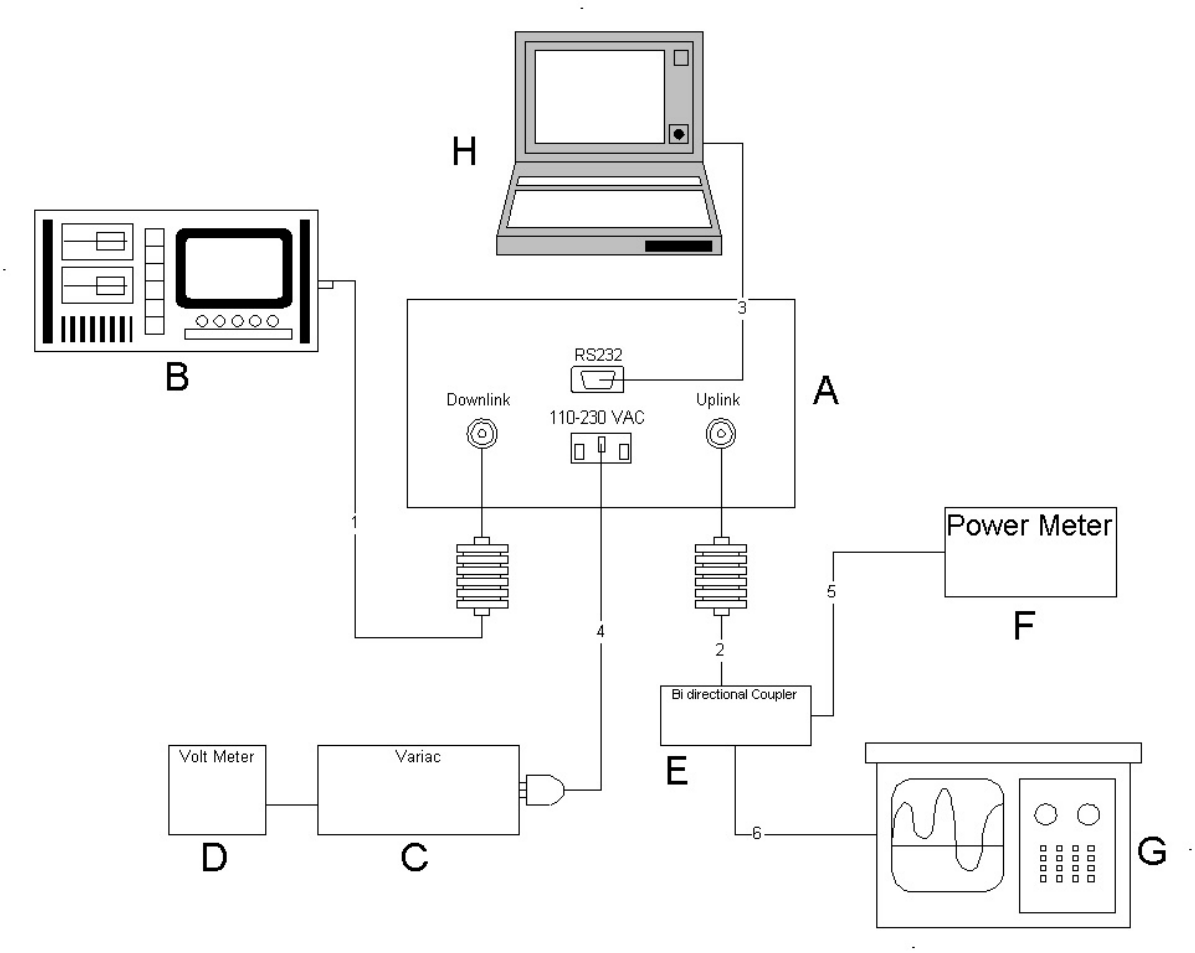


Figure 2. Test Configuration 2 (Frequency Stability)

II. General

TEST CONFIGURATION 2

EUT and Support Equipment

Ref. ID	Description	Manufacturer	Model Number	Customer Supplied Calibration Data*	Additional Information
A	Repeater - EUT	RFS	C-BDA-SMR800	N/A	N/A
B	Signal Generator	Hewlett Packard	83650B	08/27/03	N/A
C	Variac	STACO Energy	3PN2210	N/A	Functional Verification
D	Volt Meter	Fluke	77 Series II	09/18/03	N/A
E	BI-Directional Coupler	Narda	3020A	N/A	Functional Verification
F	Power Meter	Agilent Corp.	E4418B	08/28/03	N/A
G	Spectrum Analyzer	Hewlett Packard	8564E	08/27/03	N/A
H	PC Laptop	DELL Corp.	Latitude CPt	N/A	N/A

Ports and Cabling Information

Ref. ID	Port Name	Port Location (Ref. ID + Slot)	Connector Type	Cable Type	Qty.	Length (m)	Shielded ?		Cable Termination (Ref. ID + Slot + Port ID)
							Y	N	
1	To Downlink	A	N Type to SMA	Coax	1	1	X		D with 30 dB Attenuator
2	To Uplink	A	N Type	Coax	1	1	X		E with 30 dB Attenuator
3	RS232	A	DB9	Serial	1	1.5	X		H
4	120 Vac	A	Single Phase	Standard	1	1.2		X	C
5	Power Meter	E	SMA	Power Sensor	1	1.5	X		F
6	None	E	SMA	Coax	1	1	X		G

II. General

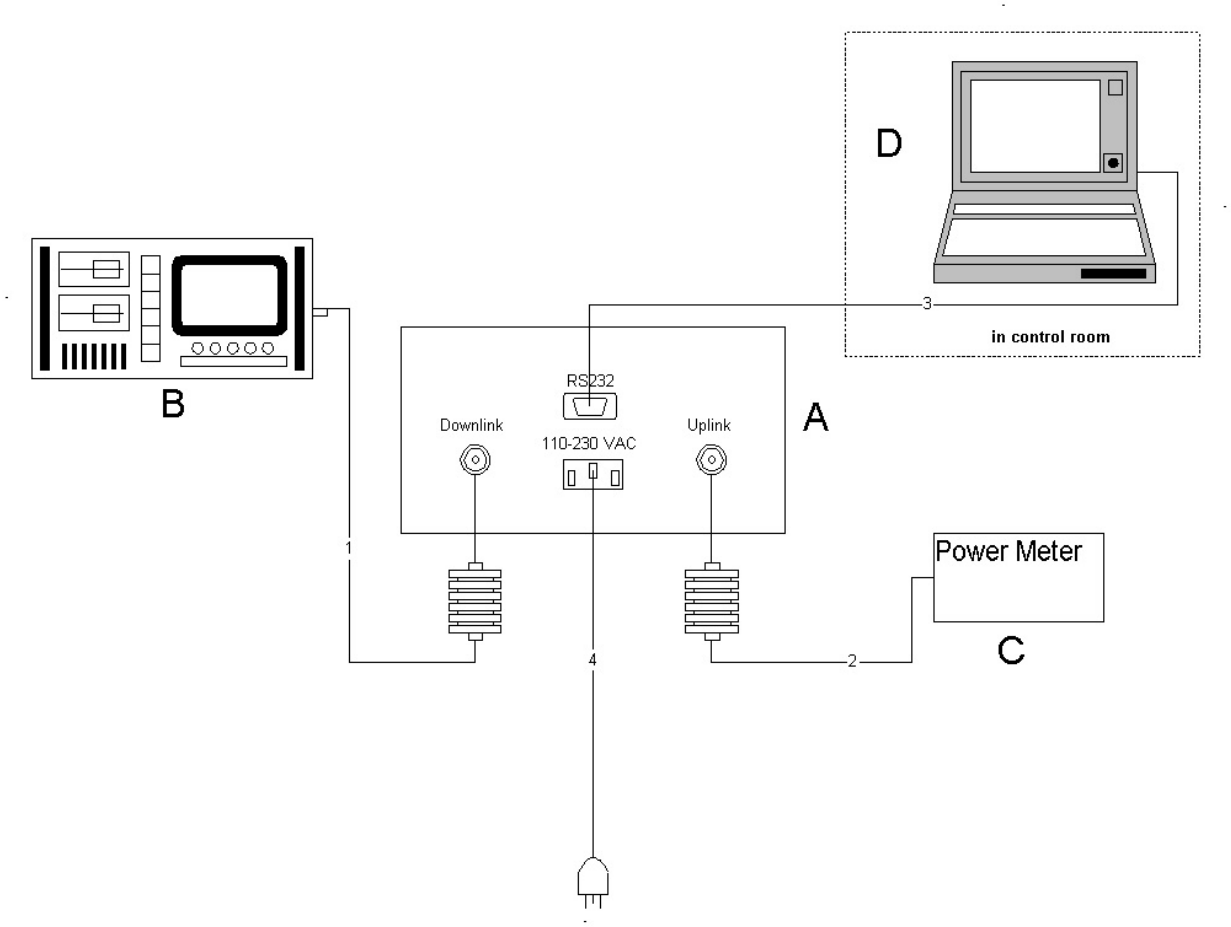


Figure 3. Test Configuration 3 (Radiated Emissions, Tx Mode)

II. General

TEST CONFIGURATION 3

EUT and Support Equipment

Ref. ID	Description	Manufacturer	Model Number	Customer Supplied Calibration Data*	Additional Information
A	Repeater - EUT	RFS	C-BDA-SMR800	N/A	N/A
B	iDEN Generator	Motorola	R-2660	N/A	Functional Verification
C	Power Meter	Agilent Corp.	E4418B	08/28/03	N/A
D	PC Laptop	DELL Corp.	Latitude CPt	N/A	N/A

Ports and Cabling Information

Ref. ID	Port Name	Port Location (Ref. ID + Slot)	Connector Type	Cable Type	Qty.	Length (m)	Shielded ?		Cable Termination (Ref. ID + Slot + Port ID)
							Y	N	
1	To Downlink	A	N Type to SMA	Coax	1	1	X		B with 30 dB Attenuator
2	To Uplink	A	N Type	Coax	1	1	X		C with 30 dB Attenuator
3	RS232	A	DB9	Serial	1	10	X		H
4	120 Vac	A	Single Phase	Standard	1	1.2		X	AC outlet

II. General

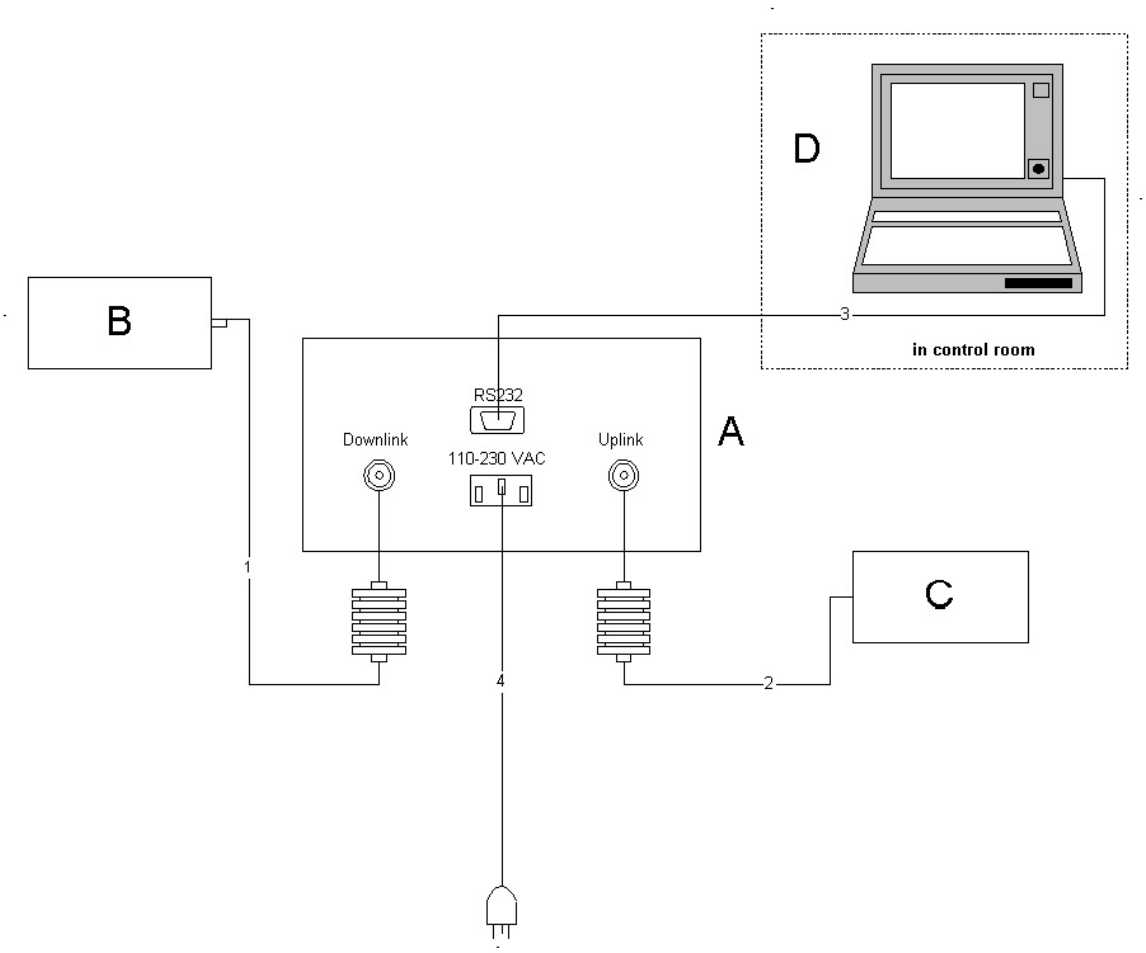


Figure 4. Test Configuration 4 (Radiated Emissions, Standby Mode)

II. General

TEST CONFIGURATION 4

EUT and Support Equipment

Ref. ID	Description	Manufacturer	Model Number	Customer Supplied Calibration Data*	Additional Information
A	Repeater - EUT	RFS	C-BDA-SMR800	N/A	N/A
B	50Ω Terminator	Narda	378 NM	N/A	Functional Verification
C	50Ω Terminator	Narda	375 BNM	N/A	
D	PC Laptop	DELL Corp.	Latitude CPt	N/A	N/A

Ports and Cabling Information

Ref. ID	Port Name	Port Location (Ref. ID + Slot)	Connector Type	Cable Type	Qty.	Length (m)	Shielded ?		Cable Termination (Ref. ID + Slot + Port ID)
							Y	N	
1	To Downlink	A	N Type to SMA	Coax	1	1	X		B with 30 dB Attenuator
2	To Uplink	A	N Type	Coax	1	1	X		C with 30 dB Attenuator
3	RS232	A	DB9	Serial	1	10	X		H
4	120 Vac	A	Single Phase	Standard	1	1.2		X	AC outlet

II. General

F. Modification

No modifications were made during testing.

G. Disposition of Test Sample

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Radio Frequency Systems upon completion of testing.

III. Electromagnetic Compatibility RF Power Output Requirements

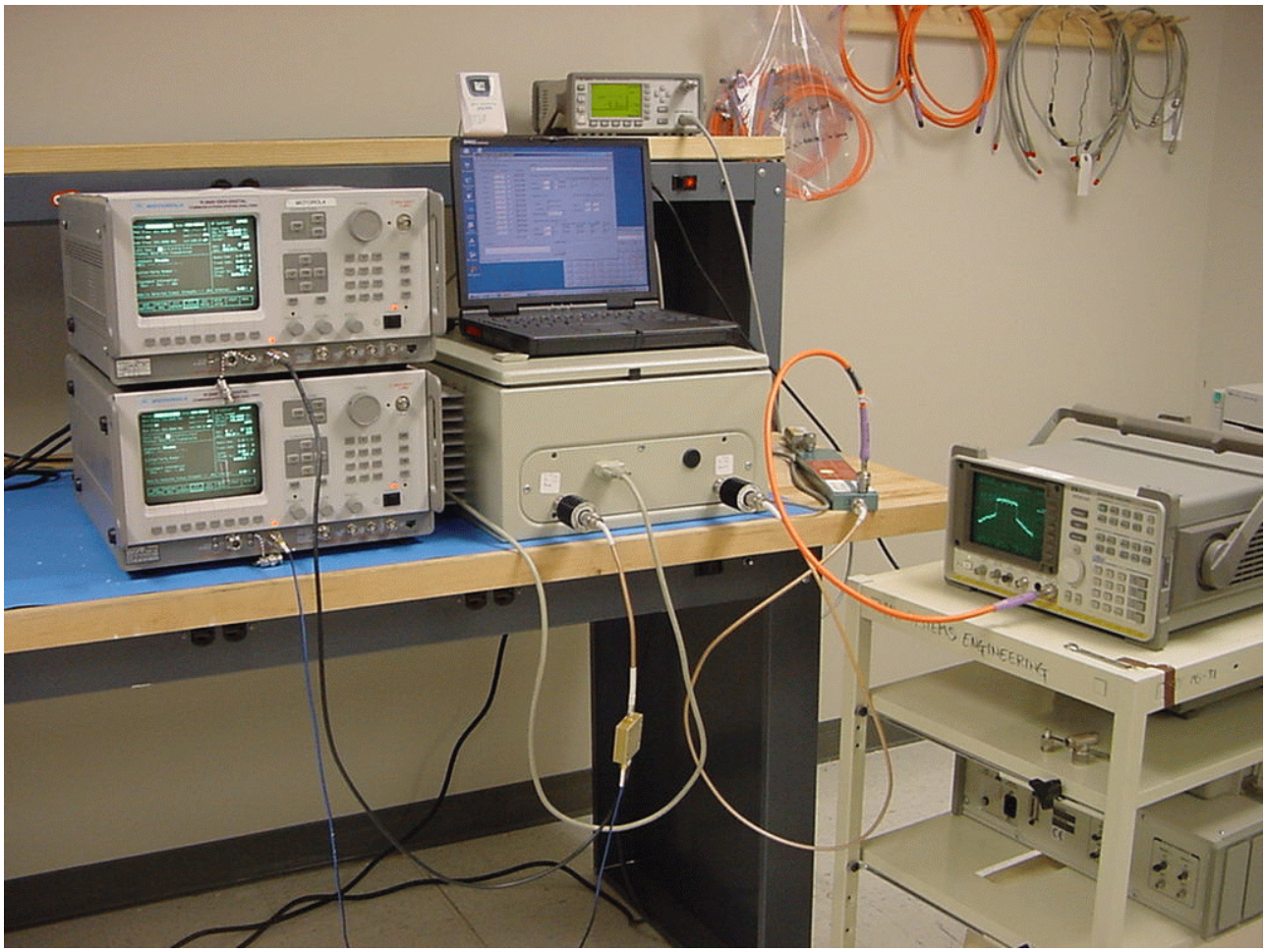
III. Electromagnetic Compatibility RF Power Output Requirements

A. RF Power Output

Technical Specifications: §2.1046 and 90.219(b)

Test equipment: Test equipment for RF Power Output is listed in Section X of this report.

Photograph:



Photograph 1. RF Power Output Test Setup Photo

III. Electromagnetic Compatibility RF Power Output Requirements

Measurement Procedures: As required by 47 CFR 2.1046, *RF power output measurements* were made at the RF output terminals using a 25-watt 30 dB attenuator and a Spectrum Analyzer measuring PEP (Peak Envelope Power).

Connect iDEN signal generators to the input of EUT. Set a 50.7 dB Reference level Offset and the RBW = VBW = 100kHz to Spectrum Analyzer. The EUT was set to transmit two tones in the lowest of the operating frequency range. The iDEN signal generators was adjusted enough to produce maximum output power as specified in the owner's manual. The max hold button from the Spectrum Analyzer was activated capturing the PEP of the EUT. Peak Search the highest amplitude and plot the graph. This process was repeatedly done with middle and highest channels for Uplink and Downlink.

Results: Equipment complies with 47CFR 2.1046 and 90.219(b). The EUT does not exceed 5 W (37 dBm) at the carrier frequency.

Important note: Limit shows in Effective Radiated Power (ERP), the maximum antenna gain that can be applied is 1.5 dBi with the EUT maximum power output of 3.5 watts. Therefore, antenna gain should not be greater than 1.5 dBi.

All RF Power output measurements were direct connection to RF output Terminal of EUT.

The following page show measurements of RF Power output which is recorded below:

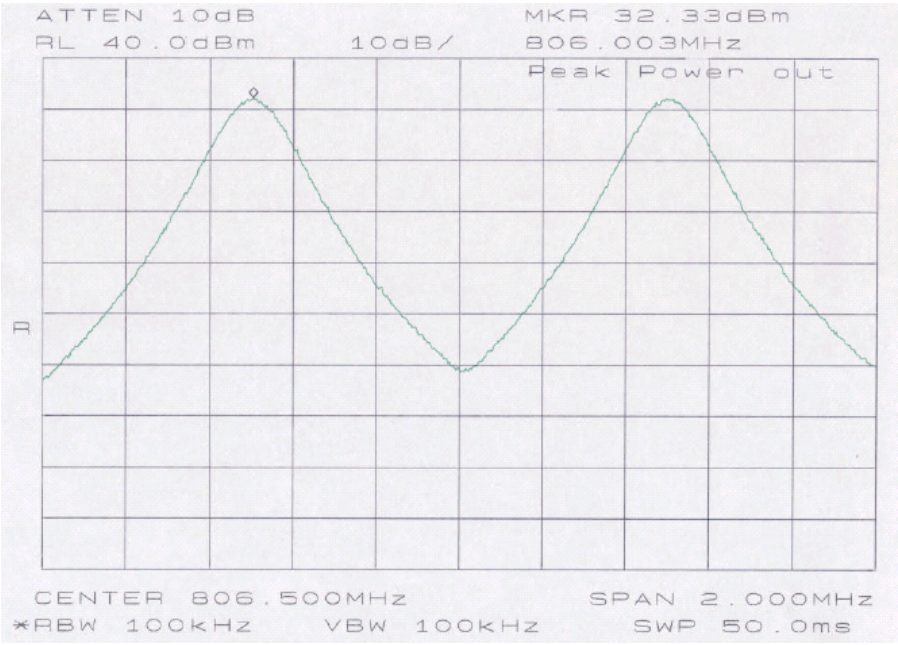
PEP; Peak Envelope Power = measured output power + 3 dB

Plot #	Comments	PEP (dBm / Watt)
1	Uplink: two tones @ 806 and 807 MHz	35.33 / 3.41
2	Uplink: two tones @ 813.5 and 816 MHz	35.00 / 3.16
3	Uplink: two tones @ 820 and 821 MHz	35.33 / 3.41
4	Downlink: two tones @ 851 and 852 MHz	35.50 / 3.55
5	Downlink: two tones @ 858.5 and 861 MHz	35.17 / 3.29
6	Downlink: two tones @ 865 and 866 MHz	35.33 / 3.41

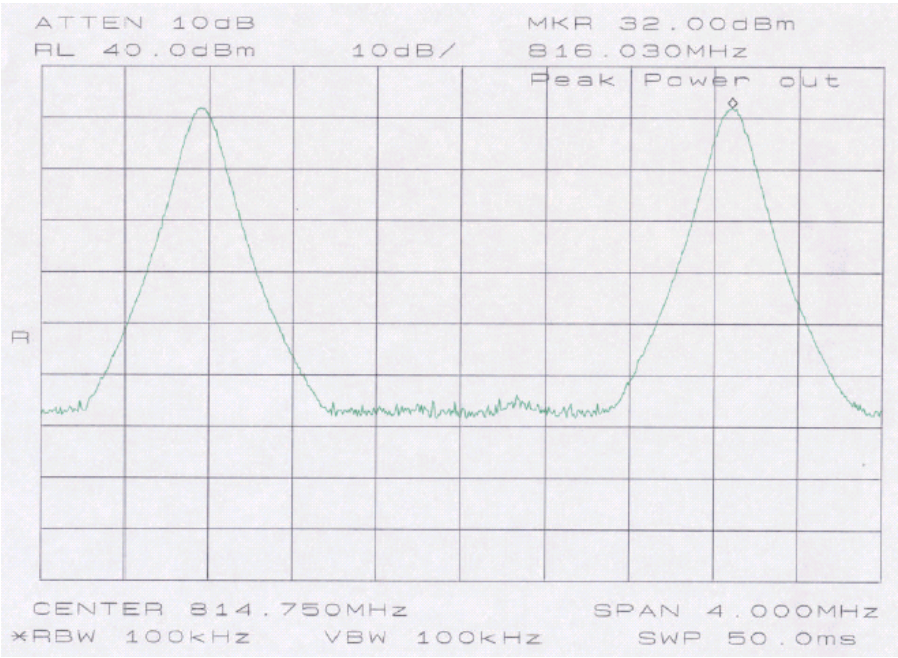
Test Engineer: Kerwinn Corpuz

Test Date: 04/16/03

III. Electromagnetic Compatibility RF Power Output Requirements

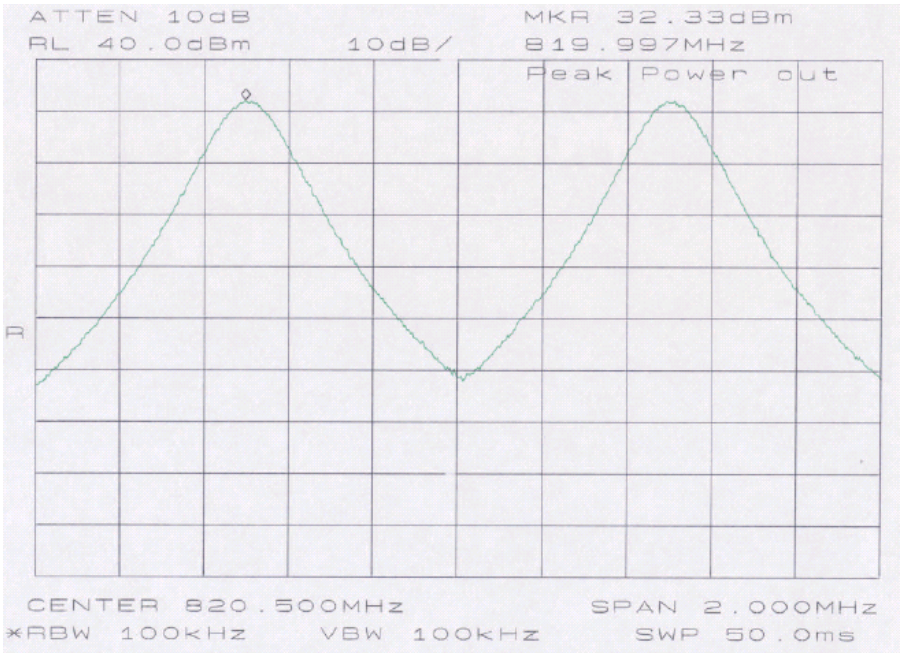


Plot #1: UL Power Output at CH1 and CH2

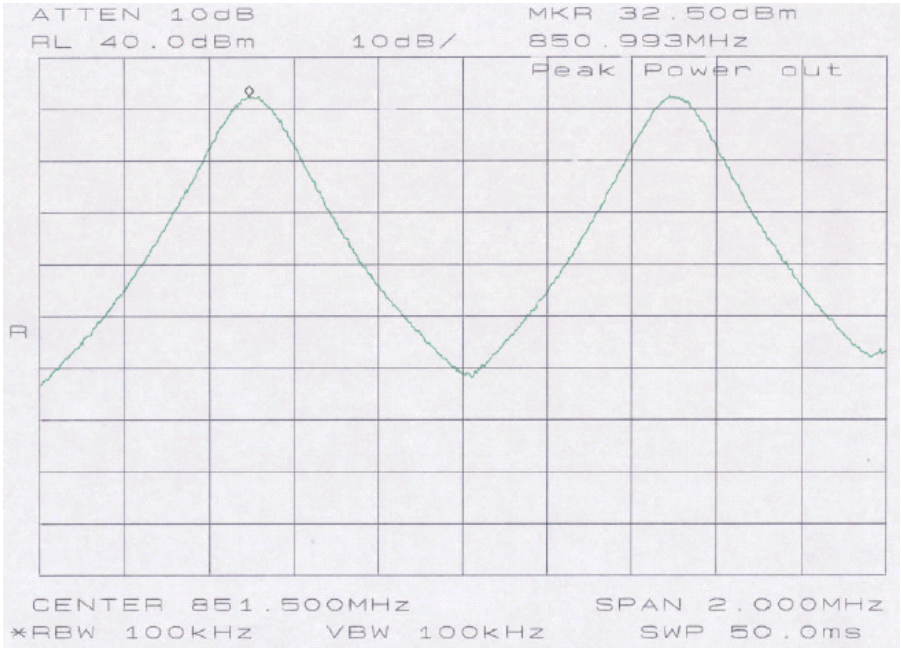


Plot #2: UL Power Output at CH6 and CH7

III. Electromagnetic Compatibility RF Power Output Requirements

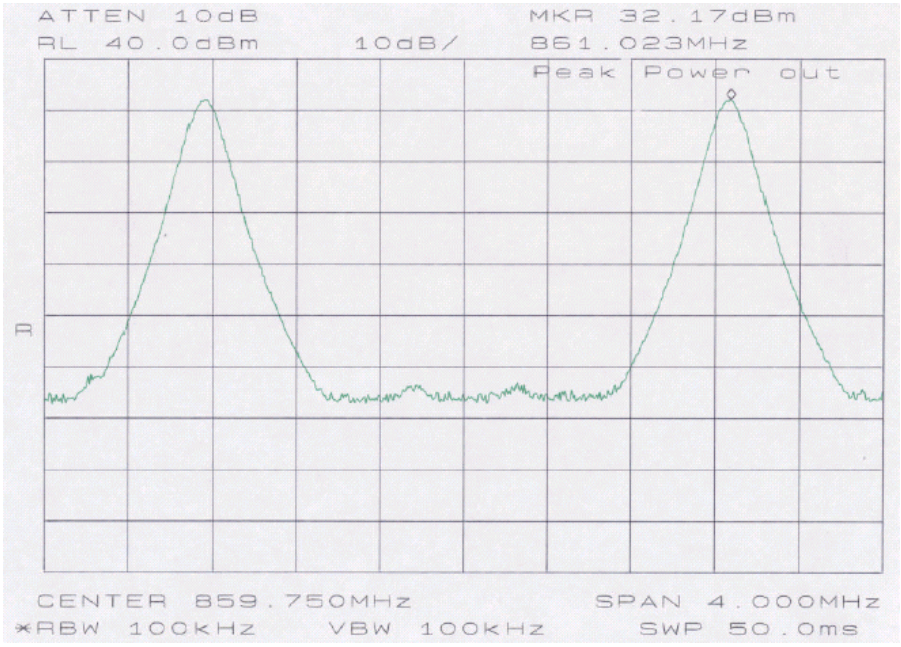


Plot #3: UL Power Output at CH11 and CH12

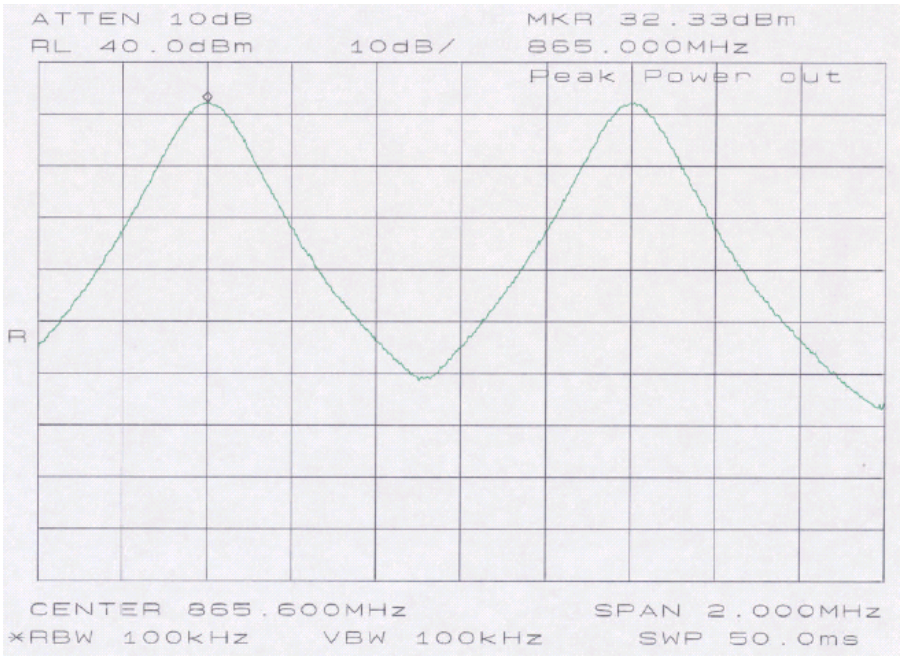


Plot #4: DL Power Output at CH1 and CH2

III. Electromagnetic Compatibility RF Power Output Requirements



Plot #5: DL Power Output at CH6 and CH7



Plot #6: DL Power Output at CH11 and CH12

IV. Electromagnetic Compatibility Modulation Characteristics Requirements

IV. Electromagnetic Compatibility Modulation Characteristics Requirements

A. Modulation Characteristics

Technical Specifications: §2.1047

Test equipment: Test equipment for Modulation Characteristics is listed in Section X of this report.

Measurement Procedures: As required by 47 CFR 2.1047, *Modulation Characteristics measurements* were made at the RF output terminals.

Results: EUT is not required for this test.
The EUT contain no analog voice circuitry.

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

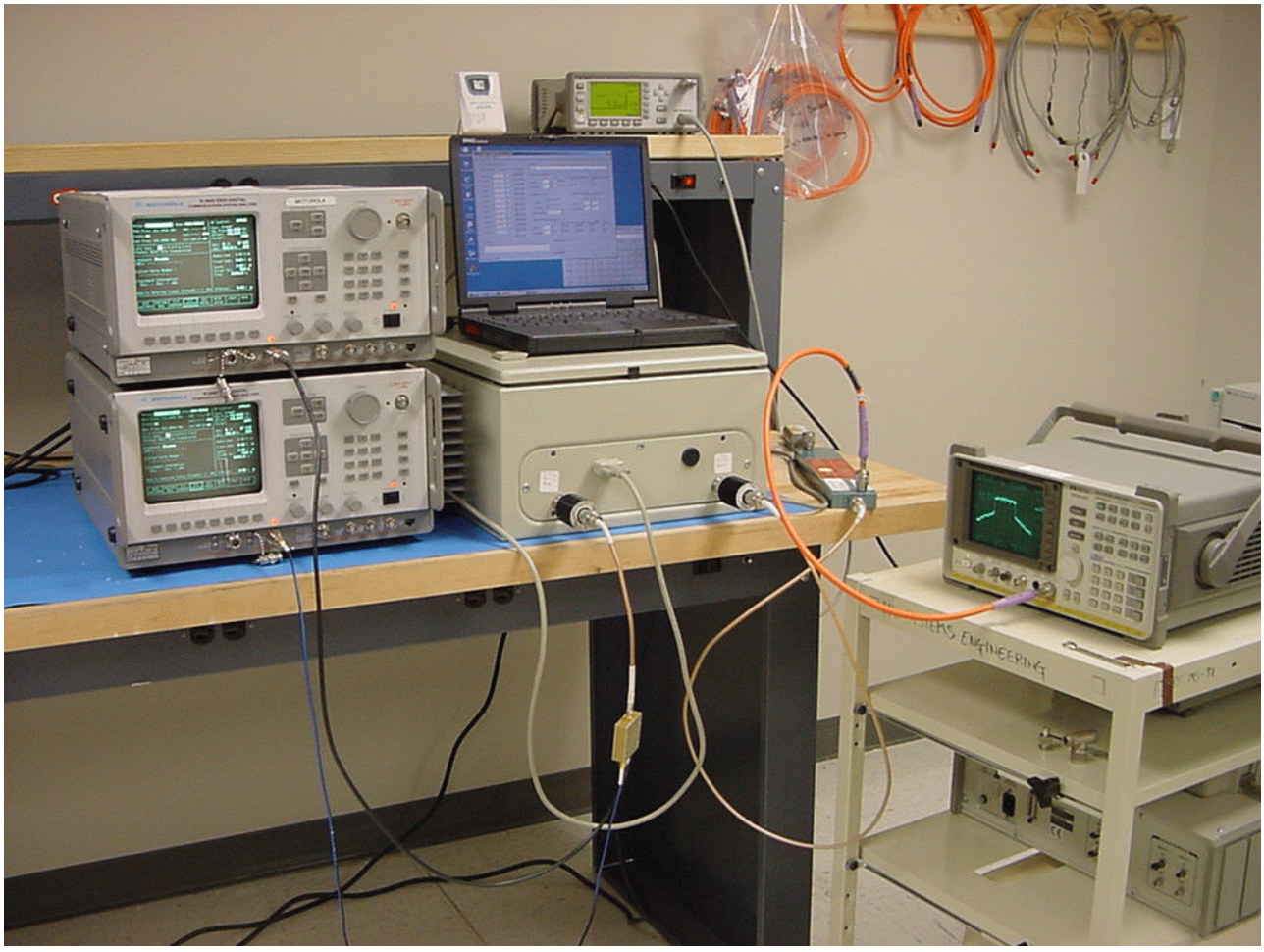
V. Electromagnetic Compatibility Occupied Bandwidth Requirements

A. Occupied Bandwidth

Technical Specifications: §2.1049 and §90.209

Test equipment: Test equipment for Occupied Bandwidth is listed in Section X of this report.

Photograph:



Photograph 2. Occupied Bandwidth Test Setup Photo

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

Measurement Procedures: As required by 47 CFR 2.1049, *occupied bandwidth measurements* were made at the RF output terminals using a 25-watt 30 dB attenuator and a Spectrum Analyzer.

Set a 50.7 dB Reference level Offset and RBW = VBW = 300 Hz to Spectrum Analyzer. The EUT was set to transmit two tones in the lowest of the operating frequency range. The iDEN signal generators was adjusted enough to produce maximum output power as specified in the owner's manual. The max hold button from the Spectrum Analyzer was activated capturing the modulated envelope of the EUT. Peak Search the highest amplitude and activated the 99% BW of the Spectrum Analyzer. Plot the graph. This process was repeatedly done with middle and highest channels for Uplink and Downlink.

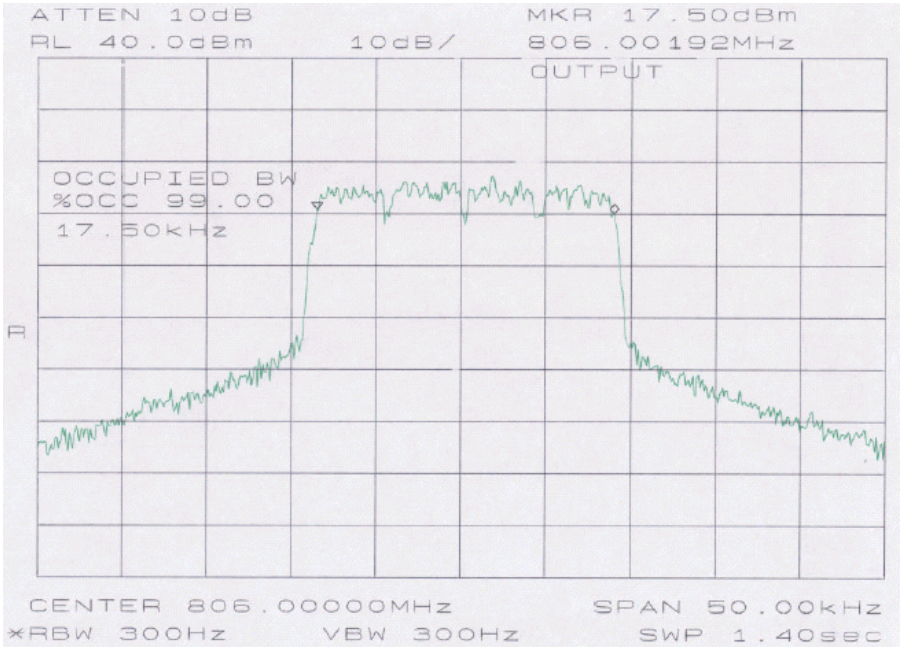
Input signals was also plotted to compare for any distortion between input and output signals.

Results: Equipment complies with Section 2.1049 and 90.209. The EUT does not exceed 20 kHz bandwidth.

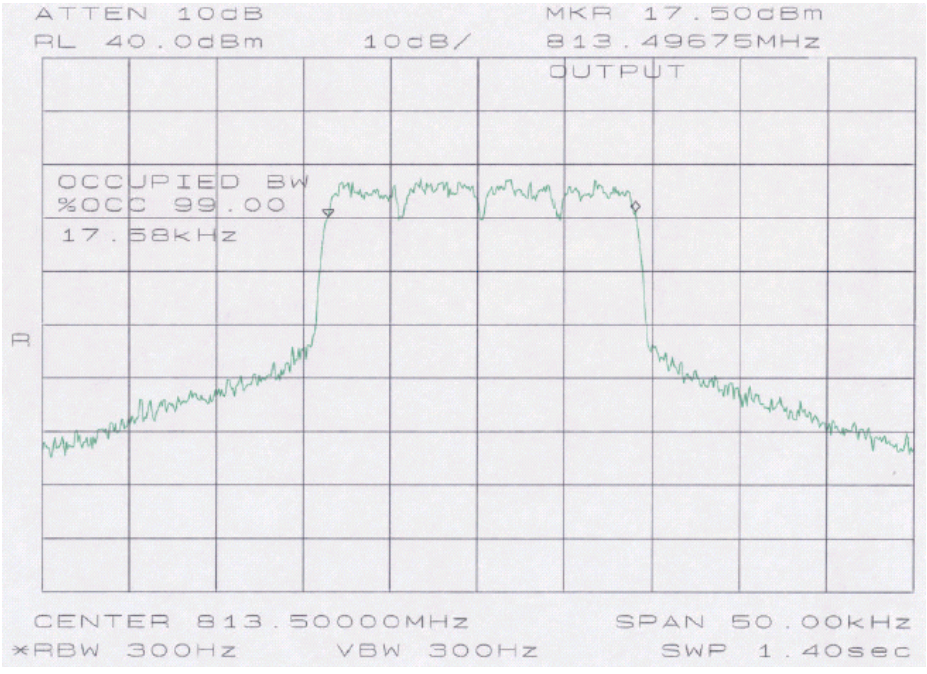
The following pages show measurements of Bandwidth Limitations plots which is recorded below:

OUTPUT SIGNALS		
Plot #	**Comment**	**Measured BW (kHz)**
7	Uplink Lowest Channel (806 MHz) 99% Occupied Bandwidth	17.5
8	Uplink Middle Channel (813.5 MHz) 99% Occupied Bandwidth	17.58
9	Uplink Highest Channel (821 MHz) 99% Occupied Bandwidth	17.5
10	Downlink Lowest Channel (851 MHz) 99% Occupied Bandwidth	17.5
11	Downlink Middle Channel (858.5 MHz) 99% Occupied Bandwidth	17.58
12	Downlink Highest Channel (866 MHz) 99% Occupied Bandwidth	17.5
INPUT SIGNALS		
Plot #	**Comment**	**Measured BW (kHz)**
13	Uplink Lowest Channel (806 MHz) 99% Occupied Bandwidth	17.5
14	Uplink Middle Channel (813.5 MHz) 99% Occupied Bandwidth	17.58
15	Uplink Highest Channel (821 MHz) 99% Occupied Bandwidth	17.5
16	Downlink Lowest Channel (851 MHz) 99% Occupied Bandwidth	17.5
17	Downlink Middle Channel (858.5 MHz) 99% Occupied Bandwidth	17.58
18	Downlink Highest Channel (866 MHz) 99% Occupied Bandwidth	17.5

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

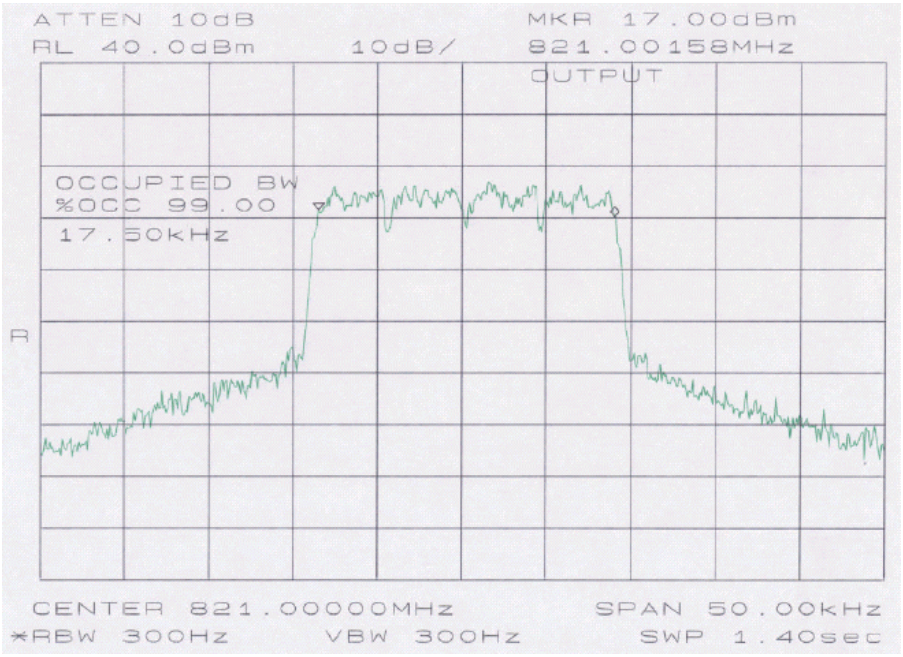


Plot #7: Uplink Lowest Channel (806 MHz) 99% Occupied Bandwidth

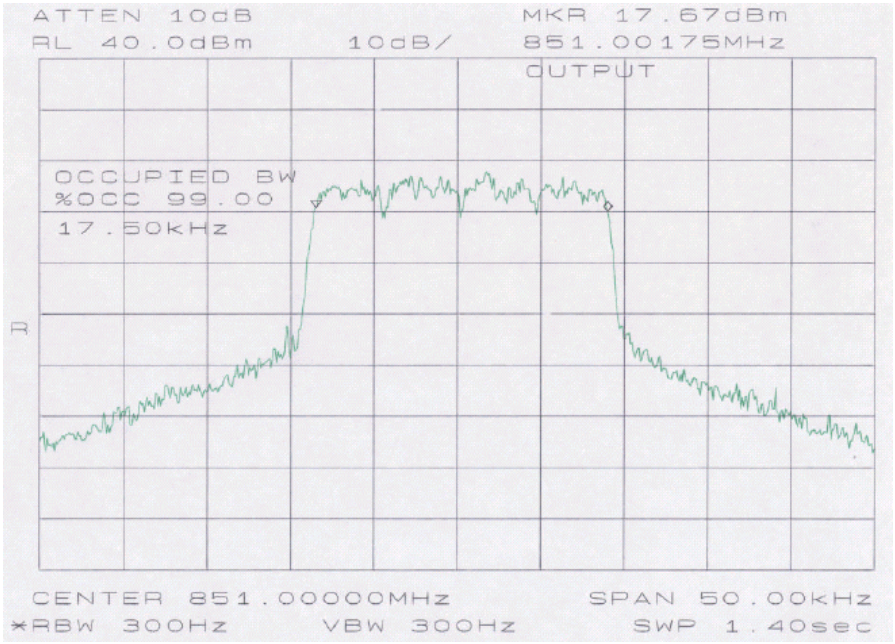


Plot #8: Uplink Middle Channel (813.5 MHz) 99% Occupied Bandwidth

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

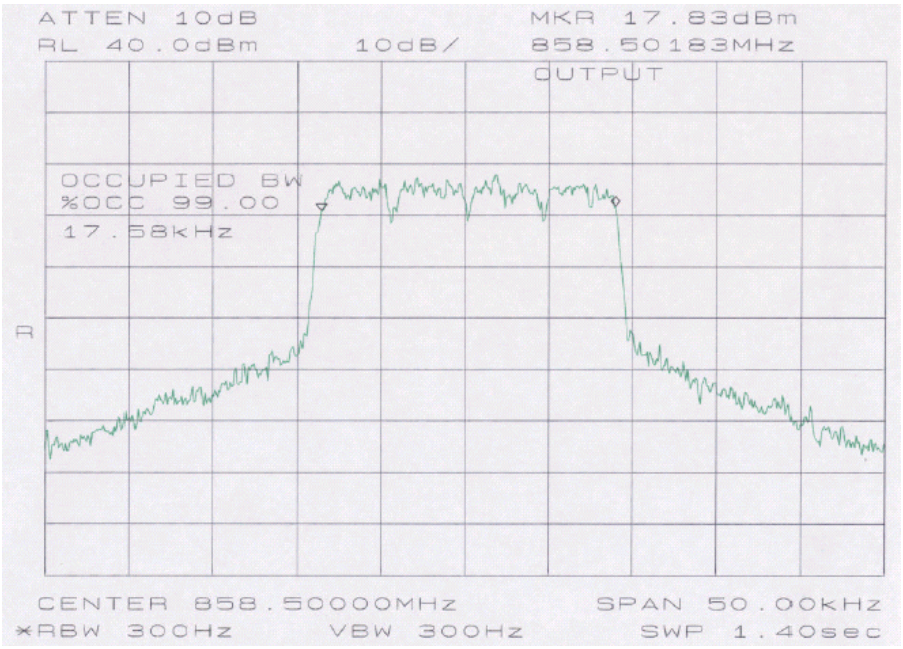


Plot #9: Uplink Highest Channel (821 MHz) 99% Occupied Bandwidth

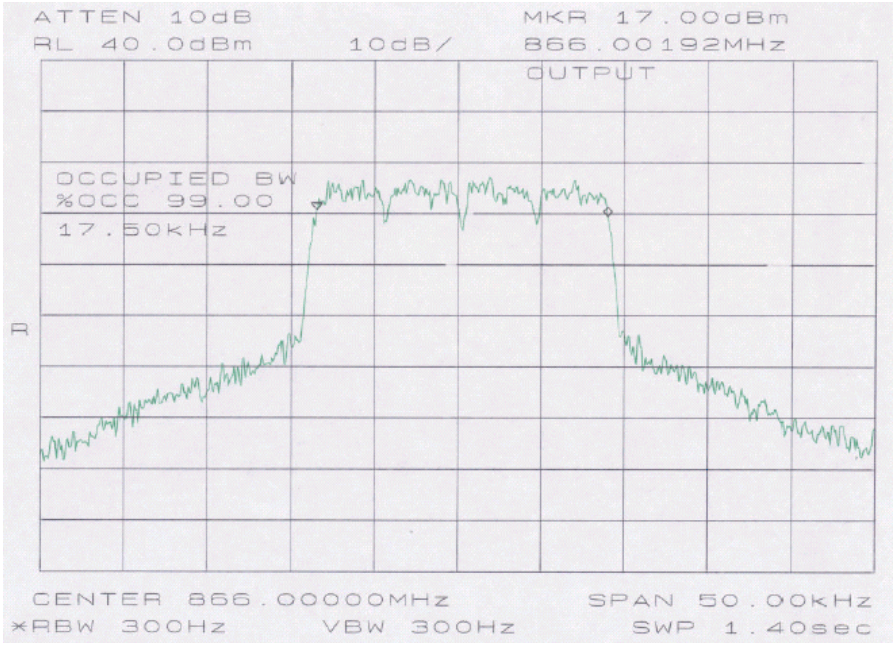


Plot #10: Downlink Lowest Channel (851 MHz) 99% Occupied Bandwidth

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

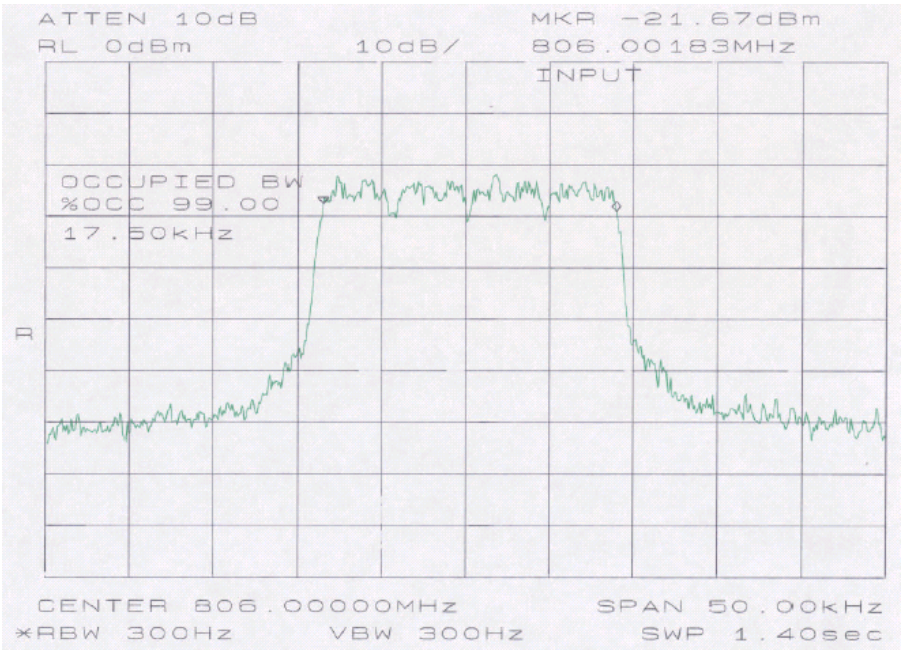


Plot #11: Downlink Middle Channel (858.5 MHz) 99% Occupied Bandwidth

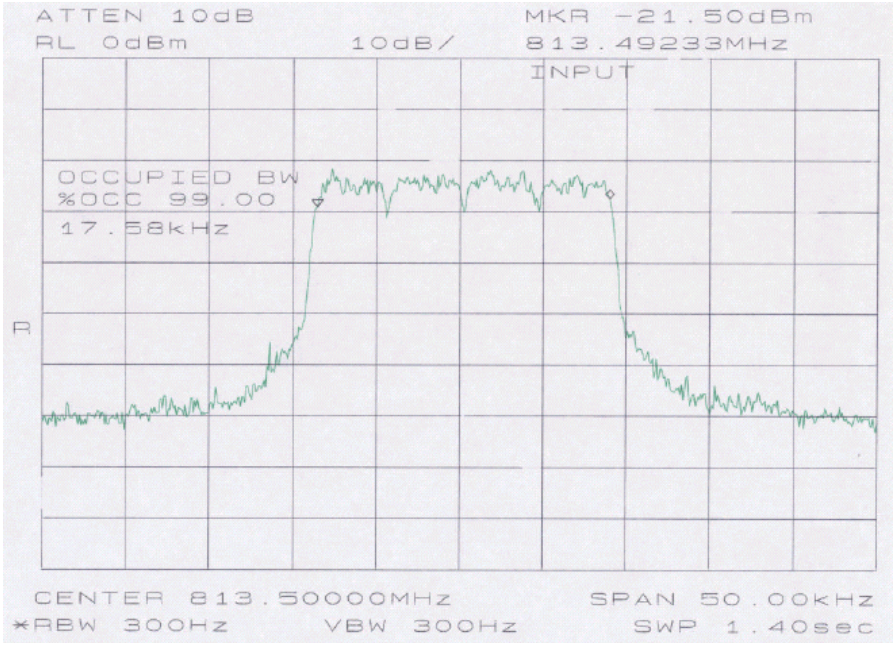


Plot #12: Downlink Highest Channel (866 MHz) 99% Occupied Bandwidth

V. Electromagnetic Compatibility Occupied Bandwidth Requirements

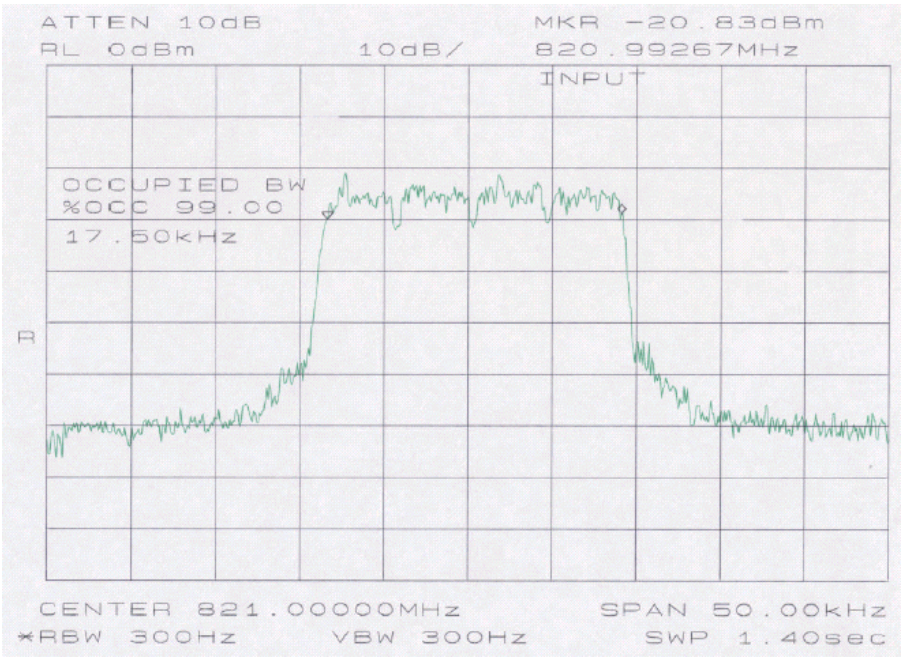


Plot #13: Uplink Lowest Channel (806 MHz) 99% Occupied Bandwidth

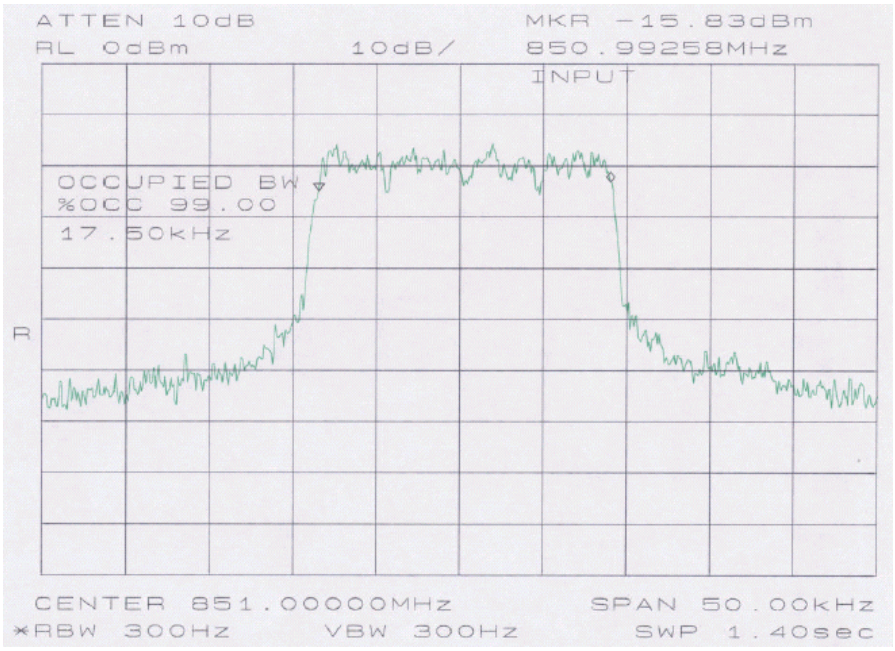


Plot #14: Uplink Middle Channel (813.5 MHz) 99% Occupied Bandwidth

V. Electromagnetic Compatibility Occupied Bandwidth Requirements



Plot #15: Uplink Highest Channel (821 MHz) 99% Occupied Bandwidth



Plot #16: Downlink Lowest Channel (851 MHz) 99% Occupied Bandwidth

