



FCC TEST REPORT

Prepared for

NARCO AVIONICS

on the

AT-155 AIR TRAFFIC CONTROL TRANSPONDER

Report No. 02_0790

June 28, 2002

20 Clipper Road — West Conshohocken, PA — 19428-2721
Phone: 610-825-1960 — Fax: 610-825-1684
emc@iitri.org — rb.iitri.org

**IIT Research Institute
R&B Laboratory
20 Clipper Road
West Conshohocken, PA 19428-2721
610-825-1960**



FCC TEST REPORT

Prepared for

Narco Avionics

on the

AT-155 Air Traffic Control Transponder

Report No. 02_0790

June 28, 2002

Customer:

Narco Avionics
Fort Washington, PA

P.O. Number: 22989-00

Job Number: 0790

Requirement:

FCC Part 87

This document shall not be reproduced, except in full, without the written approval of IIT Research Institute, R&B Laboratory.
This document cannot be used to claim a product endorsement by NVLAP or any agency of the U.S. Government.

TABLE OF CONTENTS

SECTION	TITLE	PAGE
	ADMINISTRATIVE DATA	4
	EXECUTIVE SUMMARY	5
1	GENERAL INFORMATION	6
1.1	DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)	6
1.2	MODE OF OPERATION	6
2	APPLICABLE DOCUMENTS	7
3	TEST FACILITIES	8
3.1	SCOPE	8
3.2	TEST SITE	8
3.3	OPEN-AREA RADIATED EMISSIONS TEST SITE	8
3.3	TEST EQUIPMENT	9
3.3.1	Calibration	9
3.3.2	Measurement-Receiver Characteristics	9
4	RF POWER OUTPUT	10
4.1	SCOPE	10
4.2	TEST PROCEDURE	10
4.3	TEST RESULTS	10
4.4	LIST OF TEST EQUIPMENT	10
5	MODULATION CHARACTERISTICS	12
5.1	SCOPE	12
5.2	TEST PROCEDURE	12
5.3	TEST RESULTS	12
5.4	LIST OF TEST EQUIPMENT	12
6	OCCUPIED BANDWIDTH	14
6.1	SCOPE	14
6.2	TEST PROCEDURE	14
6.3	TEST RESULTS	14
6.4	LIST OF TEST EQUIPMENT	14
7	SPURIOUS EMISSIONS	16
7.1	SCOPE	16
7.2	TEST PROCEDURE	16
7.3	TEST RESULTS	16
7.4	LIST OF TEST EQUIPMENT	16

	Report No. 02_0790
	Revision
	Page No. 2 of 29

FIELD STRENGTH OF SPURIOUS RADIATION	21
8.1 SCOPE	21
8.2 TEST PROCEDURE	21
8.3 TEST RESULTS	21
8.4 LIST OF TEST EQUIPMENT	21

APPENDIX A
DATA FOR MODULATION CHARACTERISTICS

APPENDIX B
DATA FOR OCCUPIED BANDWIDTH

APPENDIX C
DATA FOR SPURIOUS EMISSIONS

ADMINISTRATIVE DATA

Purpose of Test: To demonstrate completion of the Narco Avionics, Air Traffic Transponder, with FCC Part 87.

Equipment Tested: Model No: AT-155
S/N: E-01

Manufacturer: Narco Avionics

Test Specification: FCC Rules and Regulations, Part 2 and 87

Test Personnel: Scott Williamson
EMC Engineer

Customer Representative: M. Lockner
Narco Avionics

Date of Test: June 25, 2002

Test Location: IIT Research Institute
R&B Laboratory
20 Clipper Road
West Conshohocken, PA 19428

Disposition of Item Tested: Returned via Customer Representative

IITRI R&B Laboratory	Report No.	02_0790
	Revision	
	Page No.	4 of 29

EXECUTIVE SUMMARY

The Narco Avionics, Air Traffic Control Transponder, Model No. AT-155, Serial No. E-01 was tested in accordance with the procedures in FCC Part 2 for compliance with the requirements of the FCC Rules and Regulations, Part 87. The Equipment Under Test (EUT) completed all requirements as summarized below. The detailed test results can be found in the appropriate sections of this report.

Test Method	Section
RF Power Output 2.1046	4
Modulation Characteristics 2.1047	5 Appendix A
Occupied Bandwidth 2.1049	6 Appendix B
Spurious Emissions 2.1051	7 Appendix C
Field Strength of Spurious Radiation 2.1053	8

SECTION 1 GENERAL INFORMATION

1.1 DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Air Traffic Control Transponder has a receiver tuned to 1030 MHz, with a coded ground interrogator which requests replies of code switch settings or altitude. Response is .45 μ s pulses at 1090 MHz. A maximum of 1200 replies per second and a maximum of 15 pulses per reply is possible.

1.2 MODE OF OPERATION

ON

OFF

StandBy

Altitude

Test

(All Tests were performed in the Altitude Mode)

SECTION 2 APPLICABLE DOCUMENTS

ANSI C63.4-1992
17 July 1992

“American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”

ISO 10012-1:1992(3)
1 April 1996

“Quality Assurance Requirements for Measuring Equipment Part 1: Metrological Confirmation System for Measuring Equipment”

ANSI/NCSL Z540-1:1994
27 July 1994

“American National Standard for Calibration General Requirements - Calibration Laboratories and Measuring and Test Equipment”

Code of Federal Regulations
Title 47 Part 2

“Telecommunications, Federal Communications Commission Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

Code of Federal Regulations
Title 47 Part 87

“Telecommunications, Federal Communications Commission Aviation Services”

SECTION 3 TEST FACILITIES

3.1 SCOPE

Field strength testing was performed on the open-area test site according to the procedures in FCC Part 2.1053. Radiated emission testing was performed at an antenna-to-EUT distance of 3 meters. All other testing was performed in a shielded enclosure.

The open-area test site (OATS) and conducted measurement facility used to collect the radiated and conducted data are located at the IIT Research Institute/R&B Laboratory, 20 Clipper Road, West Conshohocken, PA 19428. This site has been fully described in a report submitted to the FCC dated June 30, 1997.

3.2 TEST SITE

The EUT was placed on an insulated surface and arranged in a normal operating configuration. The EUT was grounded only via its power cord.

3.3 OPEN-AREA RADIATED EMISSIONS TEST SITE

The radiated emissions test was performed on the open-area test site located adjacent to R&B Laboratory's EMI facility. The test site was constructed and tested to the recommendations/requirements of ANSI C63.4-1992. The following is a description of the test site.

The conducting ground plane measures 56 feet (17 meters) wide by 70 feet (21.3 meters) long and is made up of 1/4-inch square galvanized steel mesh. Copper ground rods are connected to the ground plane at key locations.

This size ground plane allows an extension of five meters beyond the antenna tower and is sufficiently wide to that it extends at least five meters beyond the widest horizontally polarized antenna (dipole or biconical).

The receive antennas were placed on a remotely controlled motorized fiberglass antenna positioner located three or ten meters from the EUT. The positioner was capable of positioning the center of the antenna at any height in the range of one to four meters above the ground plane. The positioner was also capable of maintaining the antenna in both horizontal and vertical polarizations.

The antenna signals were fed to the EMI receiver located within the building via a shielded cable. The EMI receiver was powered from a common wall socket through an isolation transformer.

The EUT was placed on a wooden table in the test site, which was located in a weather-protected structure 20 feet wide by 36 feet long and 16-1/2 feet high.

The power supplied to the EUT came from a separate power run from the main distribution box through underground PVC conduit. Receptacles were brought above ground via PVC conduit to the center of the turntable. The power was switchable

IITRI R&B Laboratory	Report No.	02_0790
	Revision	
	Page No.	8 of 29

remotely via a switch located at the building power-distribution panel.

3.3 TEST EQUIPMENT

3.3.1 Calibration

The calibration due date for each piece of test equipment used was specified on a sticker affixed to its case. All of the test equipment had been calibrated in accordance with the requirements of ISO 10012-1:1992(E) and ANSI/NSL Z54001:1994 using standards directly traceable to the National Institute of Standards and Technology.

3.3.2 Measurement-Receiver Characteristics

All emission measurements were made with the EMI analyzer in the peak detection mode. The bandwidths for the EMI analyzer were as follows:

Frequency Range	Bandwidth
9 kHz to 250 kHz	1 kHz
250 kHz to 30 MHz	10 kHz
30 MHz to 11 GHz	100 kHz

SECTION 4 RF POWER OUTPUT

4.1 SCOPE

The EUT was tested according to the procedures of FCC, Part 2.1046.

4.2 TEST PROCEDURE

The EUT was configured in a normal operating configuration. The test was performed inside a shielded room.

Measurements were taken using the "slide back" method. The transponder front panel code switches were set to "0 0 0 0". An oscilloscope was connected to the "Monitor Pwr" port on the customer-provided transmitter/receiver (see equipment list) to monitor the pulse output from the transponder. Then the "Power kW" dial on the transmitter/receiver was adjusted until the pulse output on the oscilloscope disappeared. This reading was then recorded. The process was then repeated with the transponder front panel code switches set to "7 7 7 7", to verify that there was no difference in the reading.

4.3 TEST RESULTS

FCC Part 87		RF Power Output		
Manufacturer:	Narco Avionics			
Model:	AT-155		S/N:	E-01
Setting		Results		
"0 0 0 0"		200 W		
"7 7 7 7"		200 W		

4.4 LIST OF TEST EQUIPMENT

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Digitizing Oscilloscope	250 MHz, 1Gsa/s	Hewlett Packard	54510A	3022A02224	8/31/02
XPDR/DME Simulator (customer supplied)		IFR	ATC-1200Y3	1616	5/25/01

IITRI R&B Laboratory	Report No.	02_0790
	Revision	
	Page No.	10 of 29

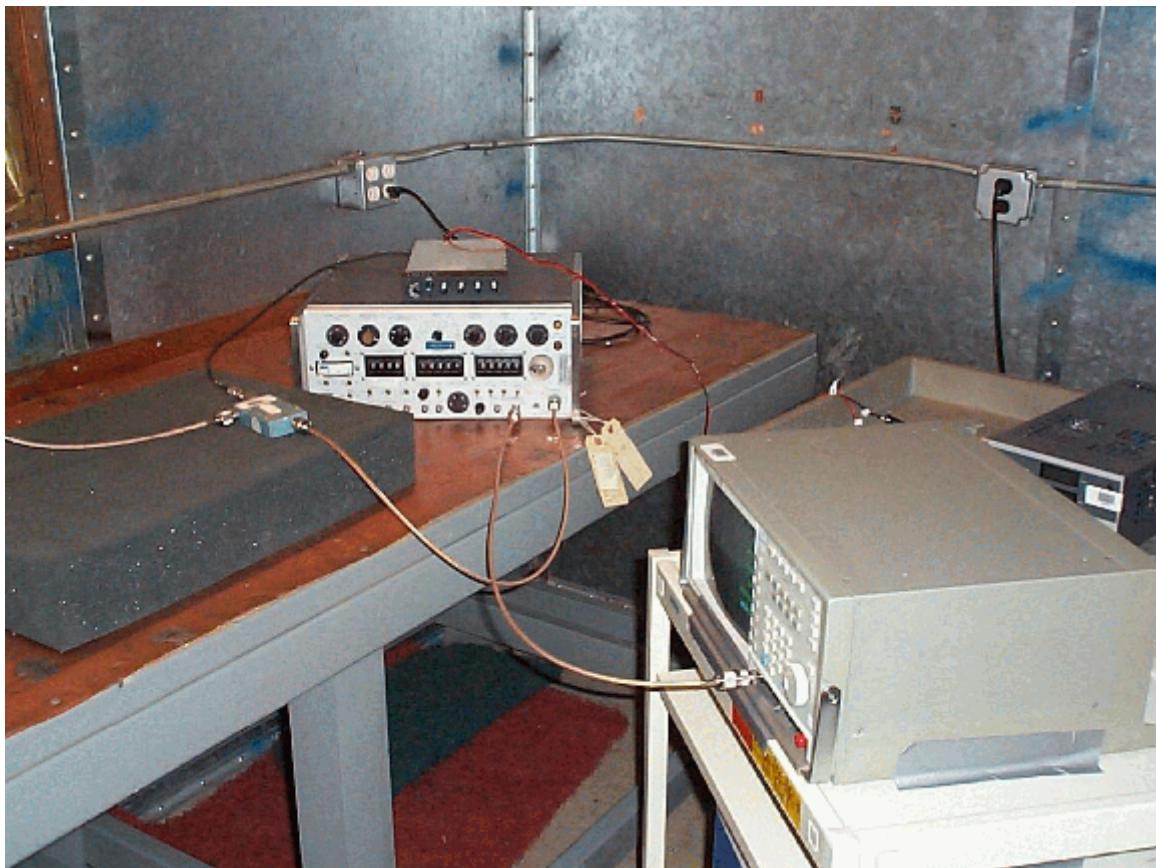


Figure 4-1
Photograph of RF Power Output Setup

SECTION 5 MODULATION CHARACTERISTICS

5.1 SCOPE

The EUT was tested according to the procedures of FCC, Part 2.1047.

5.2 TEST PROCEDURE

The EUT was configured in a normal operating configuration. The test was performed inside a shielded room.

A directional coupler was placed in-line between the EUT and its support equipment. An oscilloscope was connected to the forward power port of the directional coupler to monitor the pulses coming directly from the EUT. Print-outs were obtained of the time between responses, the number of pulses per response, and a close-up of the pulse itself.

5.3 TEST RESULTS

FCC Part 87		Modulation Characteristics		
Manufacturer:	Narco Avionics			
Model:	AT-155		S/N:	E-01
Plot		Results	Comments	
Time between responses		Completed	Appendix A	
Pulses per response		Completed	Appendix A	
Close-up of a single pulse		Completed	Appendix A	

5.4 LIST OF TEST EQUIPMENT

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Digitizing Oscilloscope	250 MHz, 1Gsa/s	Hewlett Packard	54510A	3022A02224	8/31/02
Directional Coupler	0.95 GHz to 2 GHz	Narda	3002-30	10093	1/24/03

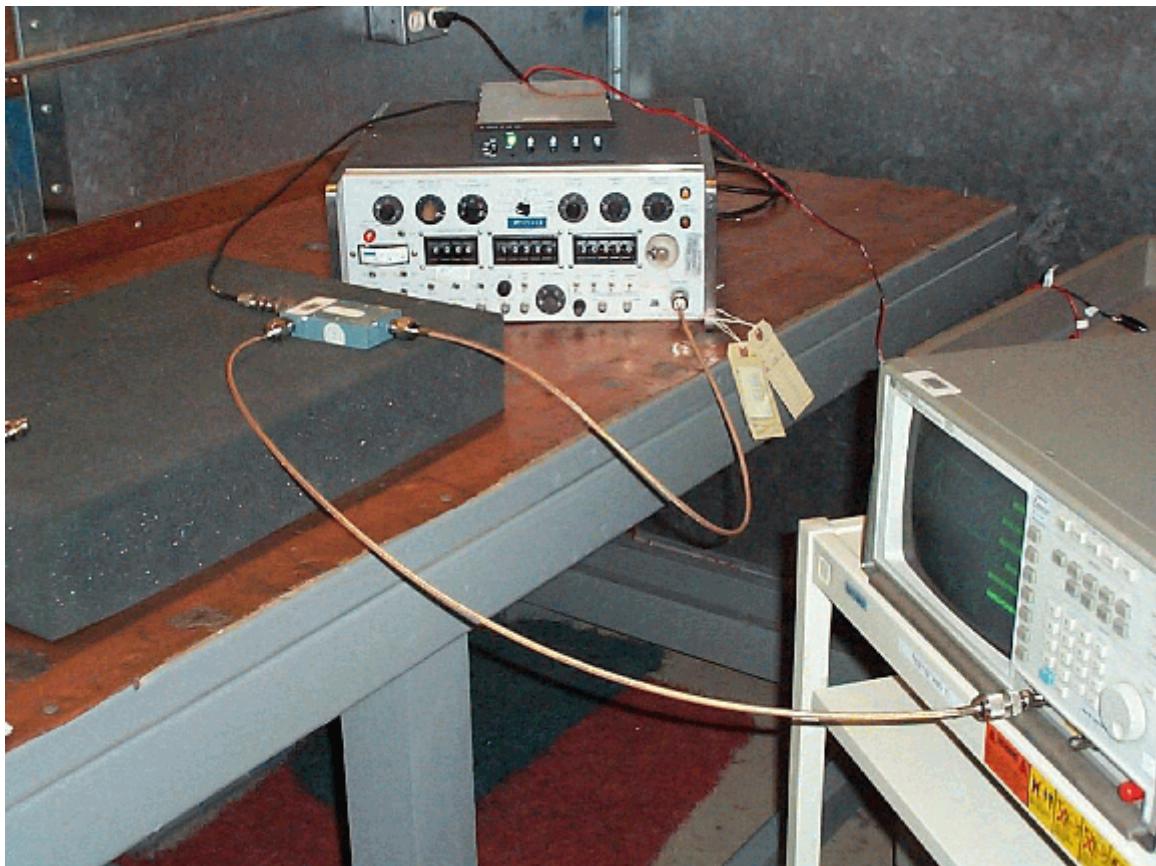


Figure 5-1
Photograph of Modulation Characteristics Setup

SECTION 6 OCCUPIED BANDWIDTH

6.1 SCOPE

The EUT was tested according to the procedures of FCC, Part 2.1049.

6.2 TEST PROCEDURE

The EUT was configured in a normal operating configuration. The test was performed inside a shielded room.

A directional coupler was placed in-line between the EUT and its support equipment. A spectrum analyzer was connected to the forward power port of the directional coupler to measure the bandwidth at which the mean power was 0.5 percent of the total mean power of the transponder. Print-outs were obtained of the upper and lower boundaries of this band. The occupied bandwidth was found to be 8.68 MHz.

6.3 TEST RESULTS

FCC Part 87		Occupied Bandwidth		
Manufacturer:		Narco Avionics		
Model:	AT-155	S/N: E-01		
Plot	Results	Comments		
Lower frequency boundary		1.0833 GHz		Appendix B
Upper frequency boundary		1.09198 GHz		Appendix B

6.4 LIST OF TEST EQUIPMENT

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Spectrum Analyzer	9 kHz to 1.5 GHz	Hewlett Packard	ESA-L1500A	US38292239	9/21/02
Directional Coupler	0.95 GHz to 2 GHz	Narda	3002-30	10093	1/24/03

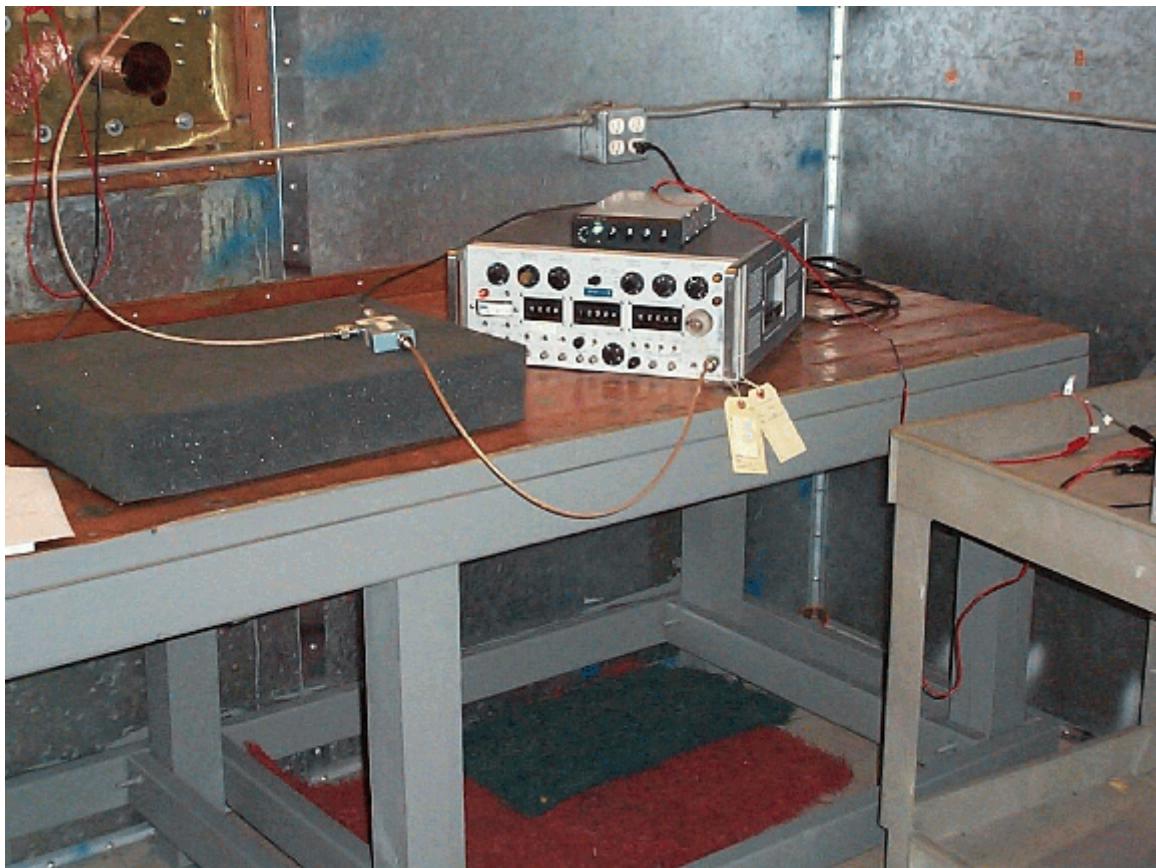


Figure 6-1
Photograph of Occupied Bandwidth Setup

SECTION 7 SPURIOUS EMISSIONS

7.1 SCOPE

The EUT was tested according to the procedures of FCC, Part 2.1051. The unit had to have no spurious emissions within 20 dB of the carrier signal power level within the frequency range from 9 kHz to 11 GHz.

7.2 TEST PROCEDURE

The EUT was configured in a normal operating configuration. The test was performed inside a shielded room.

Measurements were taken by placing a sampling tee (below 1 GHz) or directional coupler (above 1 GHz) in-line between the EUT and its support equipment. A spectrum analyzer was connected to the attenuated port of the coupling network to monitor the output from the transponder. Print-outs of the emissions in the frequency range from 9 kHz to 11 GHz were obtained, with the highest non-intentional signal in each frequency band denoted with a marker.

7.3 TEST RESULTS

FCC Part 87		Spurious Emissions		
Manufacturer:	Narco Avionics			
Model:	AT-155	S/N:	E-01	
Frequency Range	Results		Comments	
9 kHz to 30 MHz	Passed		Appendix C	
30 MHz to 1000 MHz	Passed		Appendix C	
1 GHz to 6.5 GHz	Passed		Appendix C	
6.5 GHz to 11 GHz	Passed		Appendix C	

7.4 LIST OF TEST EQUIPMENT

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Spectrum Analyzer	9 kHz to 1.5 GHz	Hewlett Packard	ESA-L1500A	US38292239	9/21/02
Spectrum Analyzer	9 kHz to 22 GHz	Hewlett Packard	8593EM	3639A00177	11/8/02
Sampling Tee	300 kHz to 3 GHz	Microlab/FXR	HM-30N	981119-2	2/1/03

IITRI R&B Laboratory	Report No.	02_0790
	Revision	
	Page No.	16 of 29

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Directional Coupler	0.8 GHz to 4 GHz	Amplifier Research	DC7144	24009	1/24/03
Directional Coupler	4 GHz to 10 GHz	Narda	3004-20	610	1/24/03



Figure 7-1
Photograph of Spurious Emissions Setup
9 kHz to 1 GHz

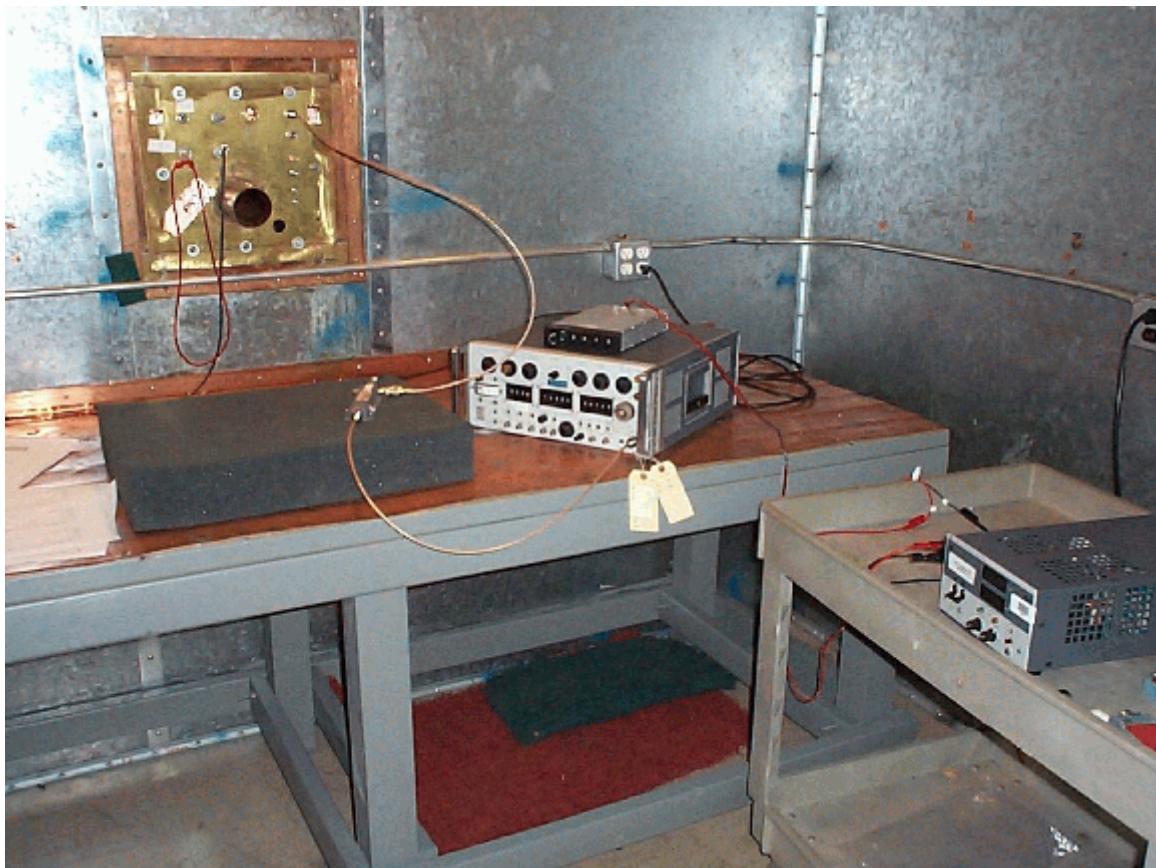


Figure 7-2
Photograph of Spurious Emissions Setup
1 GHz to 4 GHz



Figure 7-3
Photograph of Spurious Emissions Setup
4 GHz to 11 GHz

IITRI R&B Laboratory	Report No. 02_0790
	Revision
	Page No. 20 of 29

SECTION 8

FIELD STRENGTH OF SPURIOUS RADIATION

8.1 SCOPE

The EUT was tested according to the procedures of FCC, Part 2.1053.

8.2 TEST PROCEDURE

The EUT was configured in a normal operating configuration. The test was performed on the open-area test site. The measurements were taken with an EUT-to-antenna distance of three meters over the frequency range from 100 kHz to 11 GHz.

The emissions were taken in both the horizontal and vertical polarization of the receive antenna (above 30 MHz).

8.3 TEST RESULTS

FCC Part 87		Field Strength of Spurious Radiation					
Manufacturer:	Narco Avionics						
Model:	AT-155		S/N:	E-01			
Frequency Range		Results					
100 kHz to 11 GHz		Completed					

8.4 LIST OF TEST EQUIPMENT

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Spectrum Analyzer	9 kHz to 22 GHz	Hewlett Packard	8593EM	3639A00177	11/8/02
Sampling Tee	300 kHz to 3 GHz	Microlab/FXR	HM-30N	981119-2	2/1/03
Directional Coupler	0.8 GHz to 4 GHz	Amplifier Research	DC7144	24009	1/24/03
Directional Coupler	4 GHz to 10 GHz	Narda	3004-20	610	1/24/03
Loop Antenna	9 kHz to 30 MHz	Electro Metrics	ALR-25M	647	9/13/02
Biconical Antenna	20 MHz to 200 MHz	EMCO	3109	9101-2529	11/6/02

Item	Characteristics	Manufacturer	Model No.	Serial No.	Cal Due
Log Periodic Antenna	200 MHz to 1 GHz	Amplifier Research	AT1000	16186	3/1/03
Double Ridge Guide Antenna	1 GHz to 18 GHz	EMCO	4105	2052	No cal required

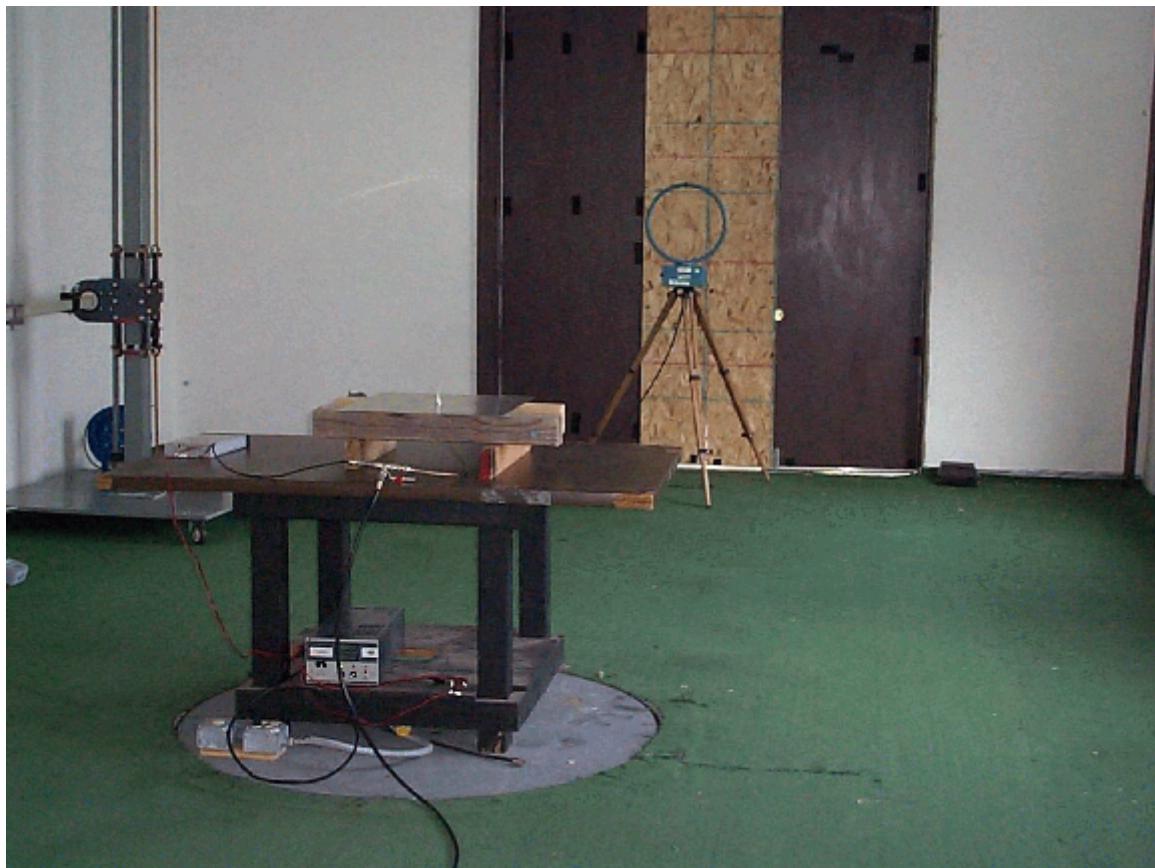


Figure 8-1
Photograph of Field Strength of Spurious Radiation Setup
100 kHz to 30 MHz



Figure 8-2
Photograph of Field Strength of Spurious Radiation Setup
30 MHz to 200 MHz
Vertical Polarization



Figure 8-3
Photograph of Field Strength of Spurious Radiation Setup
30 MHz to 200 MHz
Horizontal Polarization



Figure 8-4
Photograph of Field Strength of Spurious Radiation Setup
200 MHz to 1000 MHz
Vertical Polarization



Figure 8-5
Photograph of Field Strength of Spurious Radiation Setup
200 MHz to 1000 MHz
Horizontal Polarization



Figure 8-6
Photograph of Field Strength of Spurious Radiation Setup
1 GHz to 11 GHz
Vertical Polarization

IITRI R&B Laboratory	Report No. 02_0790
	Revision
	Page No. 28 of 29



Figure 8-7
Photograph of Field Strength of Spurious Radiation Setup
1 GHz to 11 GHz
Horizontal Polarization

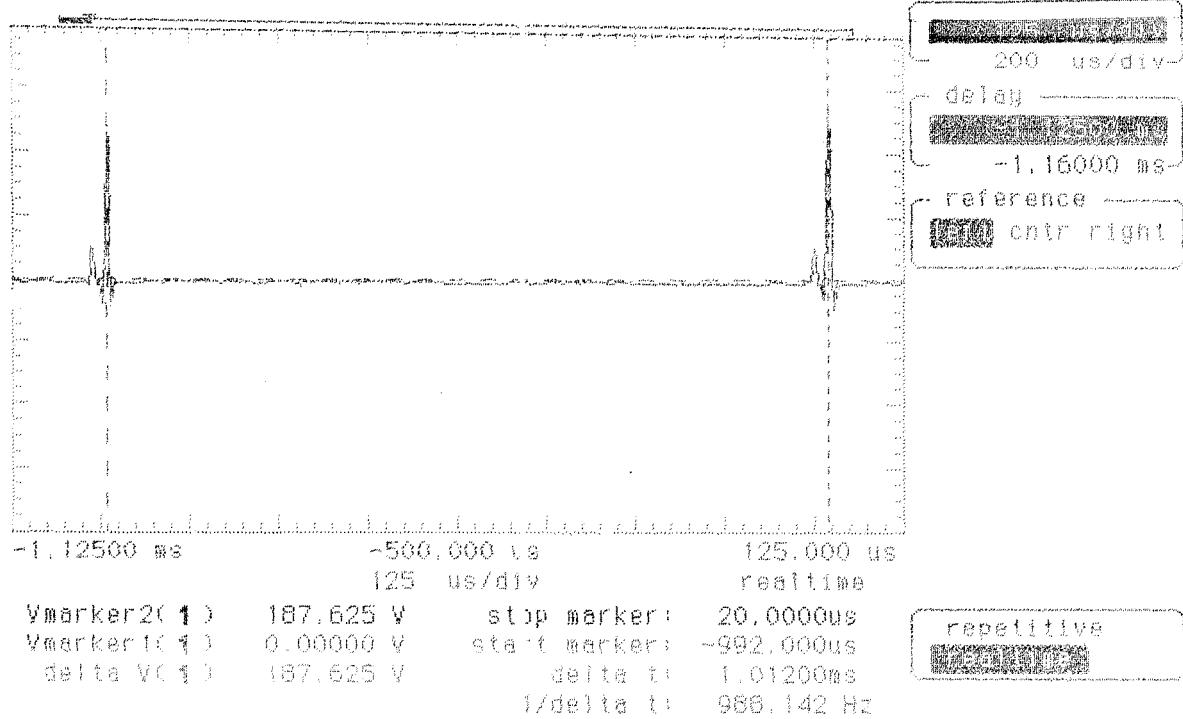
IITRI R&B Laboratory	Report No. 02_0790
	Revision
	Page No. 29 of 29

APPENDIX A
DATA FOR MODULATION CHARACTERISTICS

①

Date: 6/25/2002
Time: 1135

AP stopped



Channel 1	Sensitivity	Offset	Probe	Coupling	Impedance
1.58 V/div	0.00000 V	31.6:1	ac	1M ohm	

Trigger Mode: Edge
On the Positive Edge of Channel 1
Trigger Level(s):

Channel 1 = 198.996 mV (noise reject ON)

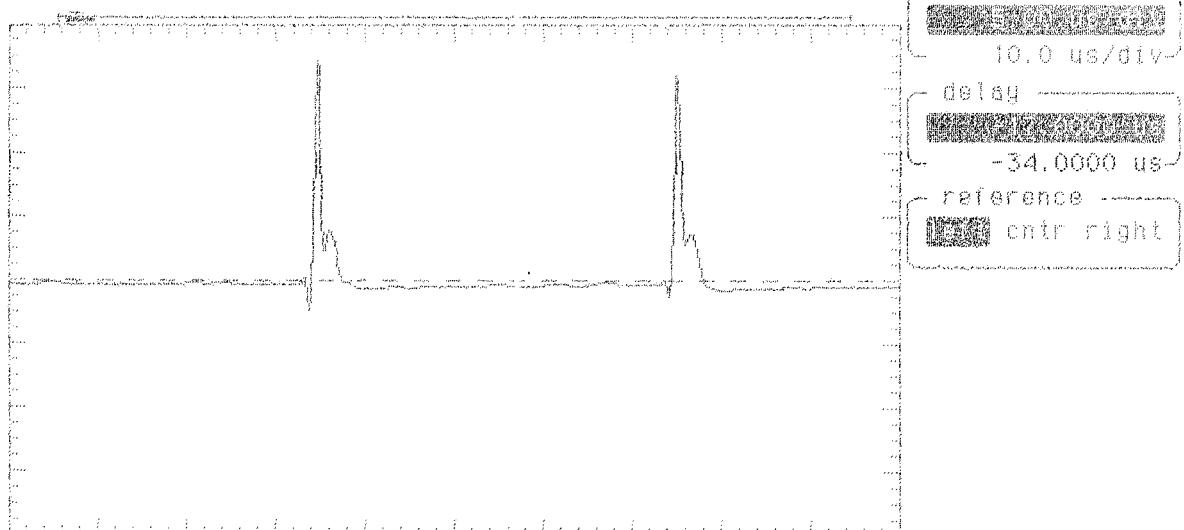
HoldOff = 40.000 ns

Two responses

(2)

D_{rec}: 6/25/2002T_{rec}: 1135

Ap stopped



-17.0000 us 8.00000 us 33.0000 us
 5.00 us/div realtime
 Vmarker2(1) 187.625 V stop marker: 74.4000us
 Vmarker1(1) 0.00000 V start marker: -65.4000us
 delta V(1) 187.625 V delta t: 139.600us
 1/delta t: 7.15308kHz



	Sensitivity	Offset	Probe	Coupling	Impedance
Channel 1	1.59 V/div	0.00000 V	31.6:1	ac	1M ohm

Trigger Mode: Edge
 On the Positive Edge of Channel 1
 Trigger Level(s):

Channel 1 = 100.000 mV (noise reject ON)
 HoldOff = 40.000 ns

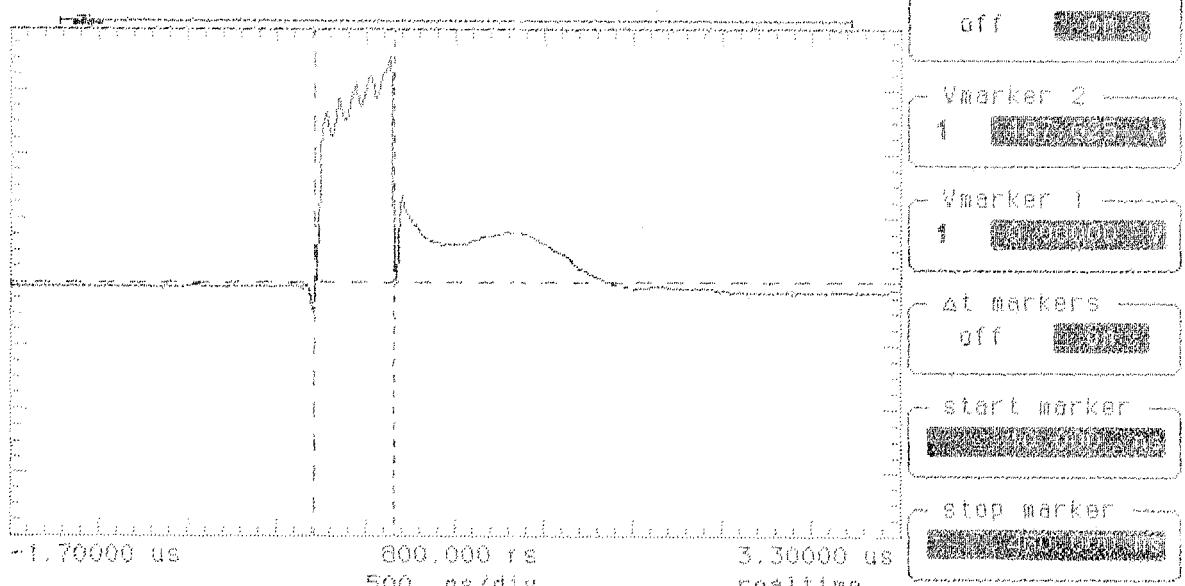
Close-up of a single response

(3)

Date: 6/25/2002

Time: 1136

Ap stopped



-1.70000 us 800,000 ns 3.30000 us
 500 ns/div realtime

Vmarker2(1) 187.625 V stop marker: 460.000ns
 Vmarker1(1) 0.00000 V start marker: 10.000 ns
 delta V(1) 187.625 V delta t: 450.000ns
 1/delta t: 2.22222MHz

Channel 1	Sensitivity	Offset	Probe	Coupling	Impedance
Channel 1	1.58 V/div	0.00000 V	31.6:1	ac	1M ohm

Trigger Mode: Edge
 On the Positive Edge of Channel 1

Trigger Level(s):

Channel1 = 100.000 mV (noise reject ON)
 HoldOff = 40.000 ns

Close-up of a single pulse

APPENDIX B
DATA FOR OCCUPIED BANDWIDTH

hp 10:48:11 JUN 25, 2002

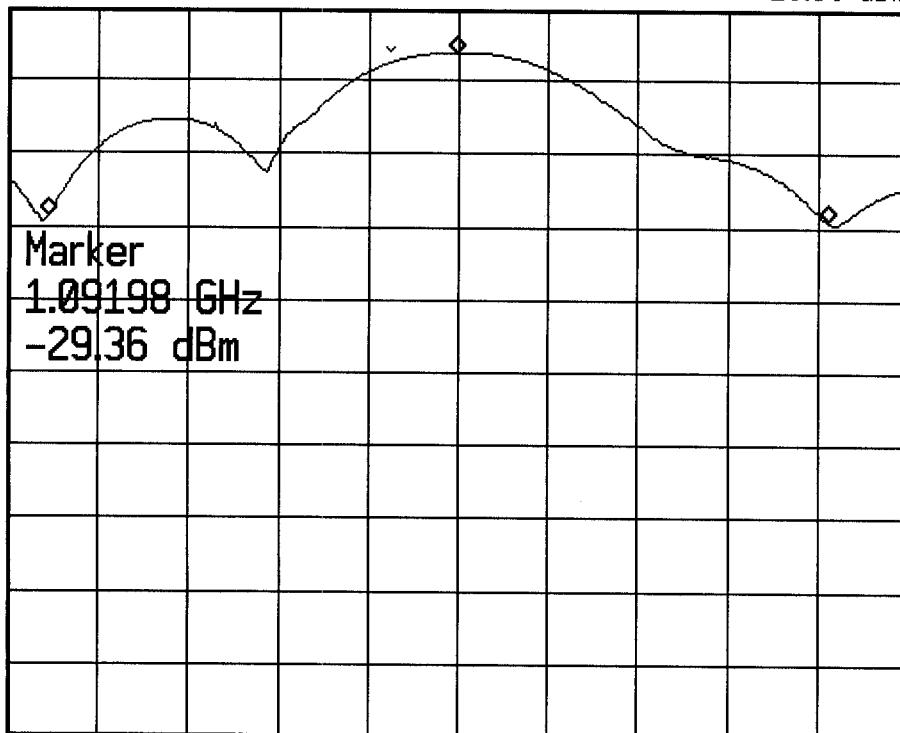
Mkr 1.09198 GHz

-29.36 dBm

Ref .0 dBm

Atten 10 dB

Peak
Log
10
dB/



Marker
1.09198 GHz
-29.36 dBm

MA SB
SC FC
AA

Center 1.08785 GHz

#Res BW 100 kHz

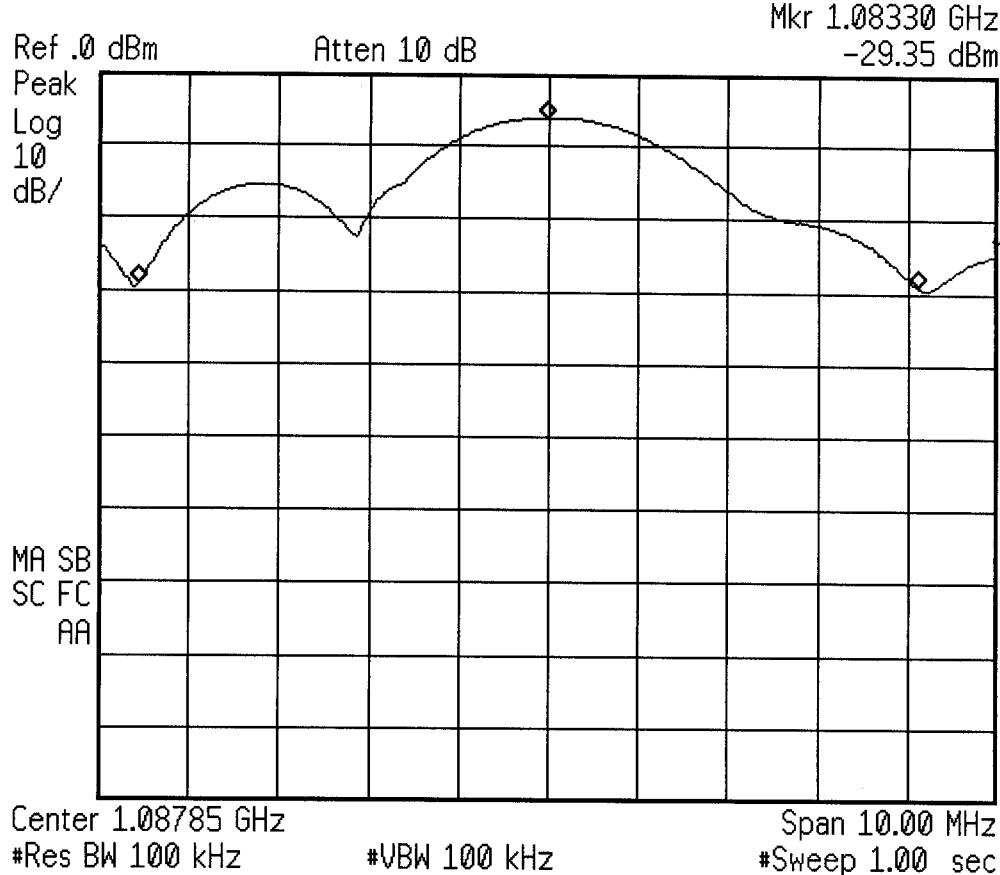
#VBW 100 kHz

Span 10.00 MHz

#Sweep 1.00 sec

hp 10:44:28 JUN 25, 2002

(2)



APPENDIX C
DATA FOR SPURIOUS EMISSIONS

hp 13:01:45 JUN 25, 2002

Ref .0 dBm
Peak
Log
10
dB/

Atten 10 dB

Mkr 129.5 kHz
-86.85 dBm

WA SB
SC FC
AA

Start 9.0 kHz
#Res BW 1.0 kHz VBW 1 kHz Stop 250.0 kHz
#Sweep 1.00 sec

hp 13:04:49 JUN 25, 2002

Ref .0 dBm
Peak
Log
10
dB/

Atten 10 dB

Mkr 12.37 MHz
-70.63 dBm

MA SB
SC FC
AA

Start 250 kHz
#Res BW 10 kHz VBW 10 kHz Stop 30.00 MHz
#Sweep 1.00 sec

hp 13:07:55 JUN 25, 2002

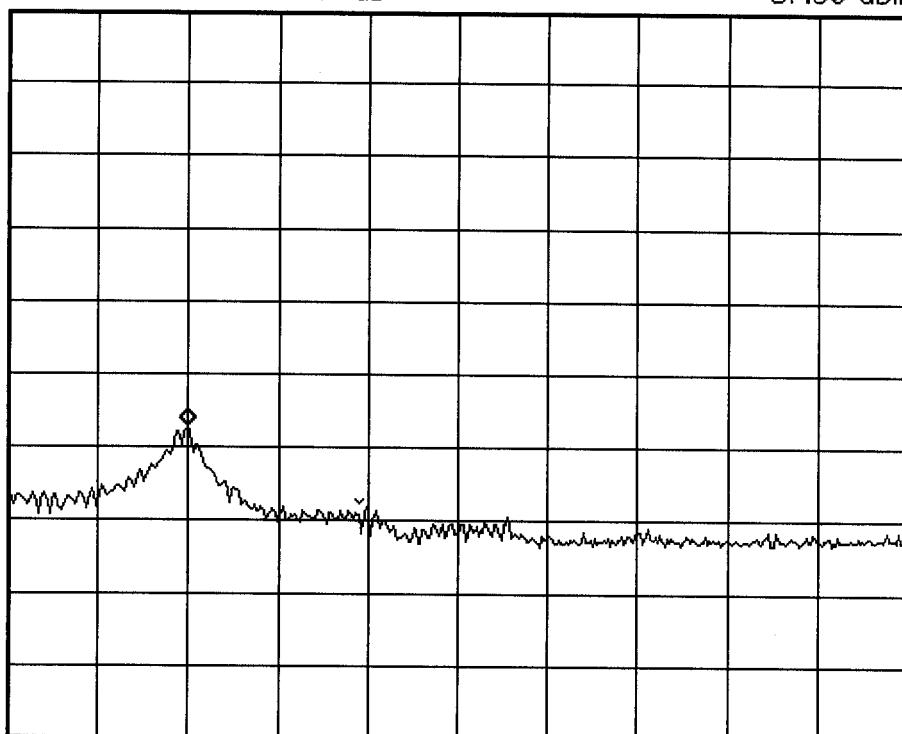
Ref .0 dBm

Atten 10 dB

Mkr 64.0 MHz

-57.30 dBm

Peak
Log
10
dB/



Start 30.0 MHz

#Res BW 100 kHz

VBW 30 kHz

Stop 200.0 MHz

#Sweep 1.00 sec

hp 13:09:10 JUN 25, 2002

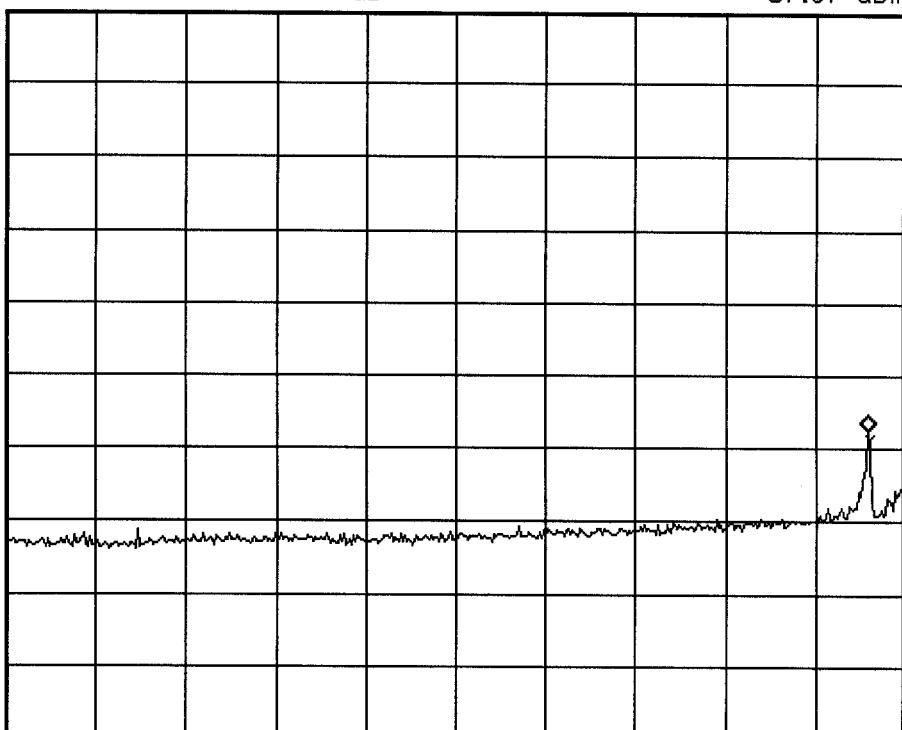
Ref .0 dBm

Atten 10 dB

Mkr 968.0 MHz

-57.87 dBm

Peak
Log
10
dB/



Start 200.0 MHz

#Res BW 100 kHz

VBW 30 kHz

Stop 1.0000 GHz

#Sweep 1.00 sec

13:50:10 JUN 25, 2002

REF .0 dBm

AT 10 dB

MKR 2.184 GHz
-56.00 dBm

PEAK

LOG

10

dB/

MARKER
2.184 GHz
-56.00 dBm

MA SB
SC FC
CORR

START 1.000 GHz
#RES BW 100 kHz

#VBW 100 kHz

STOP 2.679 GHz
#SWP 1.00 sec

MARKER
→ HIGH

MARKER
→ CF

NEXT
PEAK

NEXT PK
RIGHT

NEXT PK
LEFT

More
1 of 3

13:51:02 JUN 25, 2002

REF .0 dBm

AT 10 dB

MKR 2.864 GHz
-70.18 dBm

PEAK

LOG

10

dB/

STOP
4.000 GHz

MA SB
SC FC
CORR

START 2.679 GHz
#RES BW 100 kHz

#VBW 100 kHz

STOP 4.000 GHz
#SWP 1.00 sec

MARKER
→ HIGH

MARKER
→ CF

NEXT
PEAK

NEXT PK
RIGHT

NEXT PK
LEFT

More
1 of 3

13:59:53 JUN 25, 2002

REF .0 dBm

AT 10 dB

MKR 5.444 GHz
-67.93 dBm

PEAK

LOG

10

dB/

MARKER
5.444 GHz
-67.93 dBm

MA SB
SC FC
CORR

START 4.000 GHz
#RES BW 100 kHz

#VBW 100 kHz

STOP 6.500 GHz
#SWP 1.00 sec

MARKER
NORMAL

MARKER
Δ

MARKER
AMPTD

SELECT
1 2 3 4

MARKER 1
ON OFF

More
1 of 3

14:03:18 JUN 25, 2002

REF .0 dBm

AT 10 dB

MKR 10.764 GHz

-62.34 dBm

PEAK

LOG

10

dB/

MA SB

SC FC

CORR

MARKER
NORMAL

MARKER
4

MARKER
AMPTD

SELECT
1 2 3 4

MARKER 1
ON OFF

More
1 of 3

START 6.500 GHz
#RES BW 100 kHz

#VBW 100 kHz

STOP 11.000 GHz
SWP 1.37 sec

