



**ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT
INTENTIONAL RADIATOR CERTIFICATION TO
FCC PART 15 SUBPART C REQUIREMENT**

OF

FCC ID: IMK-HRFPC2

PC CARD WIRELESS LAN ADAPTER

**MODEL NO: PROXIM 4440 SYMPHONY
HOME RF PC CARD**

REPORT NO: 01U0850-1

TEST DATE: JUNE 19, 2001

Prepared for
PROXIM, INC.
510 DEGUIGNE DRIVE
SUNNYVALE, CA 94085, U.S.A.

Prepared by
COMPLIANCE ENGINEERING SERVICES, INC.
561F MONTEREY ROAD,
MORGAN HILL, CA 95037, USA
TEL: (408) 463-0885

NVLAQ[®]
LAB CODE:200065-0

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1. VERIFICATION OF COMPLIANCE

COMPANY NAME: PROXIM, INC.
510 DEGUIGNE DRIVE
SUNNYVALE, CA 94085

TELEPHONE NO : (408) 731-2700

TECHNICAL PERSON: PETE GARCIA/SENIOR RF TECHNICIAN/(408) 731-2762
INFORMATION CONTACT: KEITH GLOVER/VP OF FINANCE/(408) 731-2706

EUT DESCRIPTION : PC CARD WIRELESS LAN ADAPTER

MODEL NAME : PROXIM 4440 SYMPHONY HOME RF PC CARD

DATE TESTED : JUNE 15, 2001

LIMITS APPLY TO: FCC PART 15 SECTION 15.247

TECHNICAL LIMITS	TEST RESULT
Radiated Emission/15.205 & 15.209	Complies
Radiated Emission/15.109	Complies
AC Line Conducted Emission	Complies
Minimum 20dB Bandwidth	Complies
RF Power Output	Complies
Minimum Number of Hopping Channels	Complies
Channel Separation	Complies
Average Time of Channel Occupancy	Complies

Compliance Engineering Services, Inc. tested the above equipment for compliance with the requirements set forth in CFR 47 PART 15, SUBPART C. This said equipment in the configuration described in this report shows the maximum emission levels emanating from equipment are within the compliance requirements.

STEVE CHENG/EMC ENG. MANAGER
COMPLIANCE CERTIFICATION SERVICES, INC.

DATE

Warning: This document reports conditions under which testing was conducted and results of tests performed. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revision section. Any alteration of this document not carried out by Compliance Certification Services will

2. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The product is a FHSS WLAN adapter operating in the 2.4-2.4835GHz bands with a nominal TX output power of 100mW. It is an enclosed circuit board assembly with a 68-pin data/power connector and a coaxial antenna connector.

3. ANTENNA CONNECTION

The PROXIM 4440 SYMPHONY HOME RF PC CARD is marketed with two specific antennas. Model "PROXIM 4440" is normally shipped with a 0 dBi snap-on antenna. An optional 1 dBi dipole antenna is also offered. Please refer to ATTACHMENT#7: ANTENNA REQUIREMENT.

To comply with 15.203, this product has an MMCX antenna connector to provide a unique coupling to the intentional radiator. The Manufacturer's control drawing is in Attachment 7.

4. PSEUDORANDOM HOPPING SEQUENCE

Please refer to ATTACHMENT#8: **CONFIDENTIALITY PACKAGE.**

5. CHANNEL USAGE

Please refer to ATTACHMENT#8: **CONFIDENTIALITY PACKAGE.**

6. THEORY OF OPERATION

Please refer to ATTACHMENT#8: **CONFIDENTIALITY PACKAGE.**

7. THE COORDINATION OF FREQUENCY HOPPING SYSTEM

Please refer to ATTACHMENT#8: **CONFIDENTIALITY PACKAGE.**

8. RECEIVER TECHNICAL INFORMATION

To describe system receiver input bandwidth and system receiver hopping capability
Please refer to ATTACHMENT#5: **EUT TECHNICAL DESCRIPTION** exhibit.

9. TEST LOCATION

All emissions tests were performed at:

Compliance Consulting Services
561F Monterey Road
Morgan Hill, CA 95087
Contact Person: Steve Cheng/EMC Engineering Manager

CCS has site descriptions on file with the FCC for 10 and 3 meter site configurations. CCS is a NVLAP accredited facility.

Radiated emissions from the digital portion of the EUT were performed on site A, one of the 10-meter sites.

10. SUPPORT EQUIPMENT

DEVICE TYPE	MANUFACTURER	MODEL NAME	SERIAL NO	FCC ID
LAPTOP PC	Compaq	Presario 1275	N/A	DOC
DC ADAPTER	Lap-Top	LE9702A	1V99CLR792YF	N/A

TEST EQUIPMENT

EQUIPMENT TYPE	MODEL NAME	SERIAL NO	CAL DUE:
SPECTRUM ANALYZER	HP8566B	3014A06685	06/16/01
PRE-AMP	HP8449B 1-26.5G	3008A00369	05/30/02
PRE-AMP	MITEQ 1-26G	646456	04/12/02
BILOG ANTENNA	SCHAFFNER- CHASE 30M-2G	CBL6112B	12/11/01
EMCO HORN ANTENNA	3115 1-18G	9001-2238	01/9/02
ARA HORN ANTENNA	MWH-1826 18-26G	1013	07/26/01
High Pass Filter	FYS Microwave	001	N/A
Band Pass Filter	NBP-1011	102	N/A

11. TEST PROCEDURES AND TEST RESULTS

Radiated Emissions (Restricted Bands of Operation)

Test Requirement: 15.205

Measurement Equipment Used:

HP 8593EM Spectrum Analyzer

HP8449B PRE-AMPLIFIER 1 –26.5 GHz

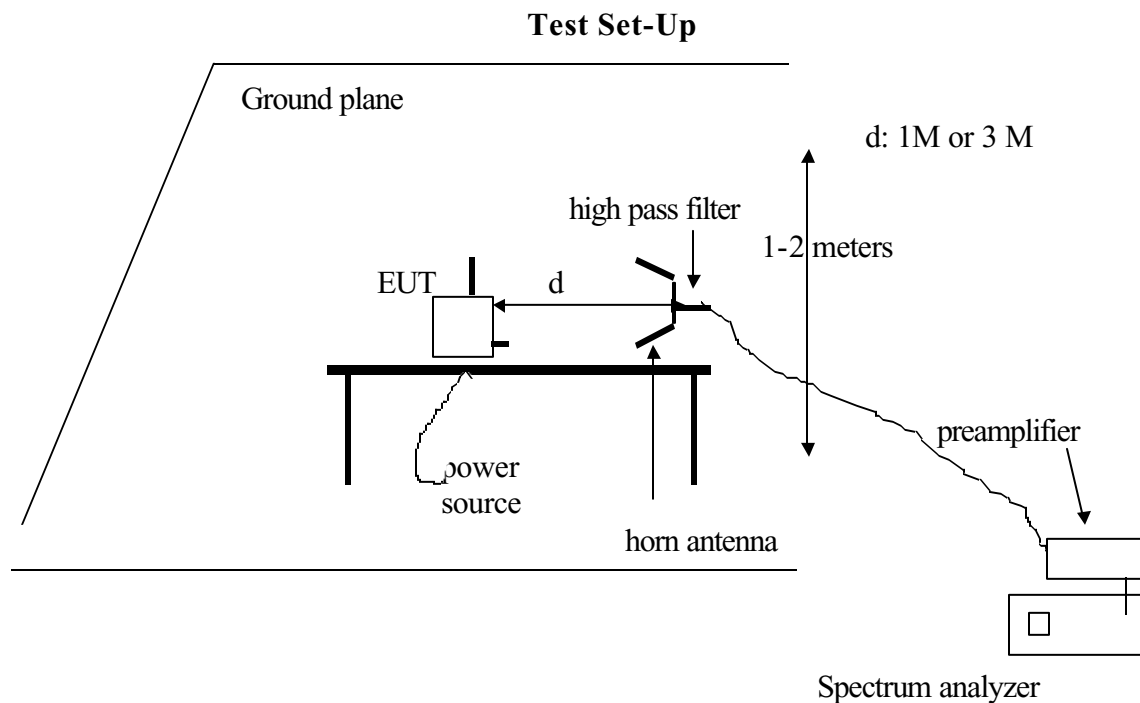
EMCO 3115 Horn Antenna, 1-18 GHz

ARA MWH1826/B Antenna, 18-26 GHz

FLEXCO Cables, 14ft (loss: 0.85 dB/ft@ 26 GHz)

FYS Microwave: High Pass Filter 4.305 GHz

NBP-1011: Band Pass Filter 4-8 GHz



Test Procedures

1. The EUT was placed on a wooden table on the outdoor ground plane. The search antenna was placed 3 M and 1 M from the EUT. Measurement distance is chosen so that the noise floor of the measurement system is at least 6dB below the specification limits. The EUT frequency hopping sequence disabled and set the EUT to transmit at its lowest channel first.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.
3. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.
4. Steps 1 to 3 were repeated for the middle and high channel
5. To ensure that the devices lowest and highest frequency of operation complies with 15.205, radiated peak and average measurements were made at the respective bandedge and plots are attached in pages 11 and 12.

Test Results:

Refer to attached spreadsheets.

PROXIM RADIATED EMISSION WITH 0dB GAIN ANT (data taken at 1m)

Frequency	SA Peak Reading (dBuV)	SA Ave Reading (dBuV)	cable loss (dB)	Filter Loss (dB)	Antenna Factor (dB)	Amp Gain (dB)	Distance Factor (dB)	Corrected 3m PK reading (dBuV)	Corrected 3m AV reading (dBuV)	Peak limit (dBuV)	Average limit (dBuV)	Peak Margin (dB)	Average Margin (dB)	
Low Channel (2402 MHz)														
4804	48.4	41.8	4.314	0.4	33.412	31.25	9.54	45.736	39.136	73.98	53.98	-28.244	-14.844	
7206	48.6	39.4	5.322	1	37.265	31.25	9.54	51.397	42.197	73.98	53.98	-22.583	-11.783	
9608	48.9	36.9	6.275	1	38.1	31.25	9.54	53.485	41.485	73.98	53.98	-20.495	-12.495	
12010	47.5	36.2	NF	7.004	1	39.49	31.25	9.54	54.204	42.904	73.98	53.98	-19.776	-11.076
14412	53	40.7	NF	8.042	1	41.212	31.25	9.54	62.464	50.164	73.98	53.98	-11.516	-3.816
Middle Channel (2440 MHz)														
4880	50.5	45.7	4.351	0.4	33.64	31.25	9.54	48.101	43.301	73.98	53.98	-25.879	-10.679	
7320	48.2	39.5	5.362	1	37.356	31.25	9.54	51.128	42.428	73.98	53.98	-22.852	-11.552	
9760	50.2	41.7	6.339	1	38.1	31.25	9.54	54.849	46.349	73.98	53.98	-19.131	-7.631	
12200	48.1	36.2	NF	7.084	1	39.3	31.25	9.54	54.694	42.794	73.98	53.98	-19.288	-11.188
14640	51.9	40.5	NF	8.154	1	40.88	31.25	9.54	61.144	49.744	73.98	53.98	-12.836	-4.236
High Channel (2480 MHz)														
4960	53.4	49.8	4.39	0.4	33.88	31.25	9.54	51.28	47.68	73.98	53.98	-22.7	-6.3	
7440	48.5	39.4	5.404	1	37.452	31.25	9.54	51.566	42.466	73.98	53.98	-22.414	-11.514	
9920	50.9	42	6.406	1	38.1	31.25	9.54	55.616	46.716	73.98	53.98	-18.364	-7.264	
12400	47.1	36.3	NF	7.168	1	39.1	31.25	9.54	53.578	42.778	73.98	53.98	-20.402	-11.202
14880	52.4	40.4	NF	8.271	1	40.16	31.25	9.54	61.041	49.041	73.98	53.98	-12.939	-4.939

NF: Measured noise floor

DISTANCE FACTOR: 1M to 3M measurement distance: -9.5dB
Correction to extrapolate reading to 3m specification distance

INSTRUMENT USED

ANTENNA: EMCO, 3115, S/N:2238 & ARA, MWH-1826/B, S/N:1013

SPECTRUM ANALYZER: HP8593EM, S/N:3710A00205

PRE-AMP: MITEQ, NSP2600-44, S/N:646456

PRE-AMP: HP8449B, S/N:3008A00369

CL: Cable loss (15ft)

HPP: High pass filter Insertion loss (4.6GHz) FSY (S/N: 001)

ANALYZER SETTINGS

Res. BW	Avg. BW
1MHz	1MHz
1MHz	10Hz

PEAK(Pk):
AVERAGE(Avg):

CORRECTED FIELD STRENGTH = SA reading +Cable Loss+ Filter Loss +Ant Factor - Amp Gain - (1 to 3 m conversion factor)
LIMIT: 500 uV = 20 x log 500 = 53.98 dBuV

NOTE: MEASURED HORIZONTAL (H) AND VERTICAL (V) (worse case vertical)

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COMPLIANCE CERTIFICATION SERVICES, INC. DOCUMENT NO:CCSUP4025B
561 F. Monterey, Rd. Route 2 Morgan Hill, CA. TEL: (408)463-0885 FAX:(408)463-0888

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PROXIM RADIATED EMISSION WITH 1dB GAIN ANT (data taken at 1m)

Frequency	SA Peak Reading (dBuV)	SA Avg Reading (dBuV)	cable Loss (dB)	Filter Loss (dB)	Antenna Factor (dB)	Amp Gain (dB)	Distance Factor (dB)	Corrected 3m Pk reading (dBuV)	Corrected 3m Avg reading (dBuV)	Peak limit (dBuV)	Average limit (dBuV)	Peak Margin (dB)	Average Margin (dB)
Low Channel (2402 MHz)													
4804	47.4	39.9	4.314	0.4	33.412	31.25	9.54	44.736	37.236	73.98	53.98	-29.244	-16.744
7206	48.3	39.6	5.322	1	37.265	31.25	9.54	51.097	42.397	73.98	53.98	-22.883	-11.583
9608	48.3	37.7	6.275	1	38.1	31.25	9.54	52.885	42.285	73.98	53.98	-21.095	-11.695
12010	47.7	36.5	NF 7.004	1	39.49	31.25	9.54	54.404	43.204	73.98	53.98	-19.576	-10.776
14412	51.4	40.6	NF 8.042	1	41.212	31.25	9.54	60.864	50.064	73.98	53.98	-13.116	-3.916
Middle Channel (2440 MHz)													
4880	50.7	45.9	4.351	0.4	33.64	31.25	9.54	48.901	43.501	73.98	53.98	-25.679	-10.479
7320	50.8	40.7	5.362	1	37.356	31.25	9.54	53.728	43.628	73.98	53.98	-20.252	-10.352
9760	51.4	42	6.339	1	38.1	31.25	9.54	56.049	46.649	73.98	53.98	-17.931	-7.331
12200	47.3	36	NF 7.084	1	39.3	31.25	9.54	53.894	42.594	73.98	53.98	-20.086	-11.386
14640	52.1	40.6	NF 8.154	1	40.88	31.25	9.54	61.344	49.844	73.98	53.98	-12.636	-4.136
High Channel (2480 MHz)													
4960	52.5	48.3	4.39	0.4	33.88	31.25	9.54	50.38	46.18	73.98	53.98	-23.6	-7.8
7440	50	41	5.404	1	37.452	31.25	9.54	53.066	44.066	73.98	53.98	-20.914	-9.914
9920	50.5	42	6.406	1	38.1	31.25	9.54	55.216	46.716	73.98	53.98	-18.764	-7.264
12400	47.4	36.1	NF 7.168	1	39.1	31.25	9.54	53.878	42.578	73.98	53.98	-20.102	-11.402
14880	52.8	40.8	NF 8.271	1	40.16	31.25	9.54	61.441	49.441	73.98	53.98	-12.539	-4.539

NF: Measured noise floor

DISTANCE FACTOR: 1M to 3M measurement distance: -9.5dB

Correction to extrapolate reading to 3m specification distance

INSTRUMENT USED

ANTENNA: EMCO, 3115, S/N:2238 & ARA, MWH-1828/B, S/N:1013

SPECTRUM ANALYZER: HP8593EM, S/N:3710A00205

PRE-AMP: MITEQ, NSP2600-44, S/N:646456

PRE-AMP: HP8449B, S/N:3008A00369

CL: Cable loss (15ft)

HPF: High pass filter insertion loss (4.6GHz) FSY (S/N: 001)

ANALYZER SETTINGS
 Res bw 1MHz Avg. bw 1MHz
 PEAK(Pk): 1MHz
 AVERAGE(Avg): 1MHz 10Hz

CORRECTED FIELD STRENGTH = SA reading +Cable Loss+ Filter Loss +Ant Factor - Amp Gain - (1 to 3 m conversion factor)

LIMIT: 500 uV = 20 x log 500 = 53.98 dBuV

NOTE: MEASURED HORIZONTAL (H) AND VERTICAL (V) (worse case vertical)

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Radiated Emissions

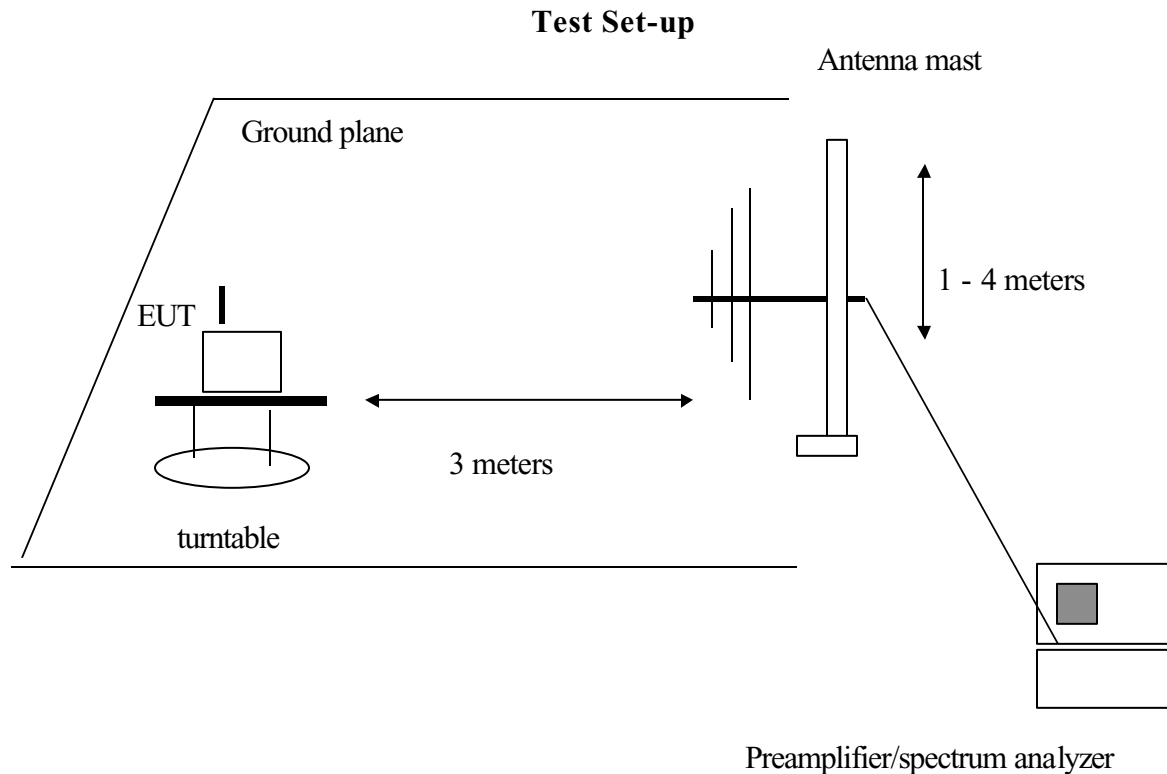
Test Requirement: 15.209

Measurement Equipment Used:

HP 8566B Spectrum Analyzer

SCHAFFNER-CHASE BILOG Antenna, 30 - 2 GHz

HP 8447D Amplifier




TEST PROCEDURE:

The EUT was placed on a turntable at a distance of 3 meters from a BILOG search antenna. The unit was set to transmit while hopping normally. The antenna was raised and lowered, the EUT rotated on the turntable, until the EUT azimuth, antenna elevation, and antenna polarity were found which yielded maximum received emission levels on the spectrum analyzer.

Test Result:

Refer to attached tabular data sheet.

		FCC, VCCI, CISPR, CE, AUSTEL, NZ UL, CSA, TUV, BSMI, DHHS, NVLAP		Project #: 01U0850-1 Report #: 010615B1							
		561F MONTEREY ROAD, SAN JOSE, CA 95037-9001 PHONE: (408) 463-0885 FAX: (408) 463-0888		Date & Time: 06/15/01 2:25 PM Test Engr: Jesse Saldivar							
Company: Proxim, Inc. EUT Description: Proxim 4442 Symphony Home RF PC Card Test Configuration: EUT/Notebook PC/Mouse/Modem/Printer Type of Test: FCC Class B Mode of Operation: EUT Continuously Send and Receive Data		<< Main Sheet									
Freq. (MHz)	Reading (dBuV)	AF (dB)	Cross (dB)	Pre-amp (dB)	Level (dBuV/m)	Limit FCC B	Margin (dB)	Pol (H/V)	Az (Deg)	Height (Meter)	Mark (P/Q/A)
48.00	52.00	10.62	1.56	29.48	34.70	40.00	-5.30	3mV	180.00	1.00	P
808.00	41.20	20.48	7.81	28.83	40.67	46.00	-5.33	3mH	180.00	1.00	P
808.00	41.20	20.48	7.81	28.83	40.67	46.00	-5.33	3mV	180.00	1.00	P
416.03	42.10	16.46	5.12	29.03	34.64	46.00	-11.36	3mH	180.00	1.00	P
376.00	42.90	15.55	4.80	28.86	34.39	46.00	-11.61	3mH	180.00	1.50	P
48.00	45.40	10.62	1.56	29.48	28.10	40.00	-11.90	3mH	270.00	1.00	P
6 Worst Data											

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AC Line Conducted Emissions

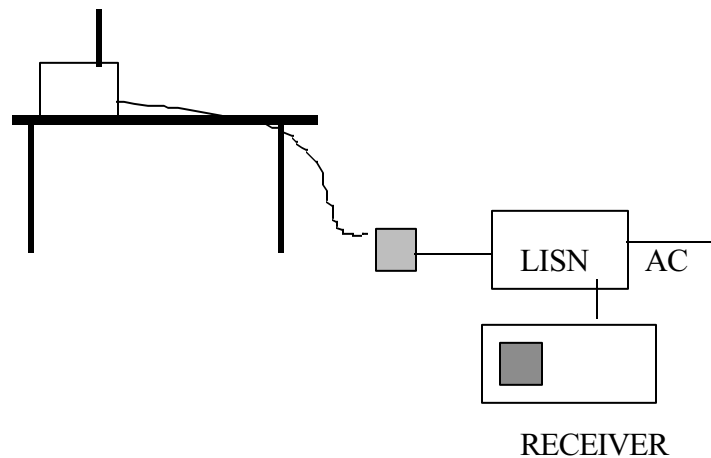
Test Requirement: 15.207

Measurement Equipment Used:

Rhode & Schwarz EMI Receiver ESHS-20

Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

Test Set-up



Test Procedure

1. The EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The unit was set to transmit while hopping normally.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

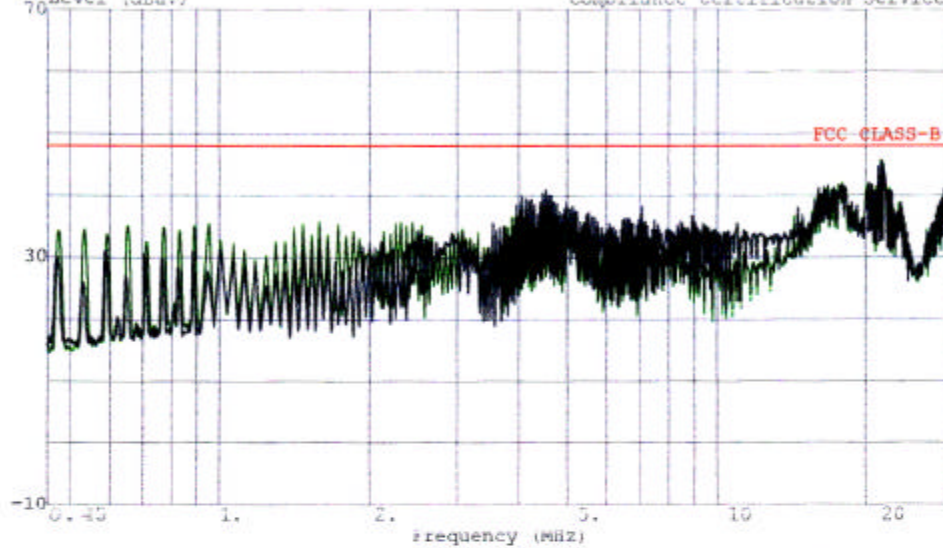
Test Results

Refer to attached graph.



561 F Monterey Road, Route 2
Morgan Hill, CA 95037-9001 USA
Tel: (408) 463-0885
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Data# 7 File# 01U0850.EMI Date: 06-15-2001 Time: 14:01:20
Level (dBuV) Compliance Certification Services



Tracer: 5 Ref Tracer:
Project No. : 01U0850-1
Report No. : 01061510
Test Eng: Jesse Saldiva
Company : Proxim, Inc.
EUT Description : Proxim 4442 Symphony Home RF PC Ca.
Model : 4442
EUT Config. : EUT/PC Host/Mouse/Printer/Mouse
Type of Test : FCC Class B
Mode of Operation: Frequency Hopping
: PEAK: L1(Green), L2 (Black)
: 120WAC 60H

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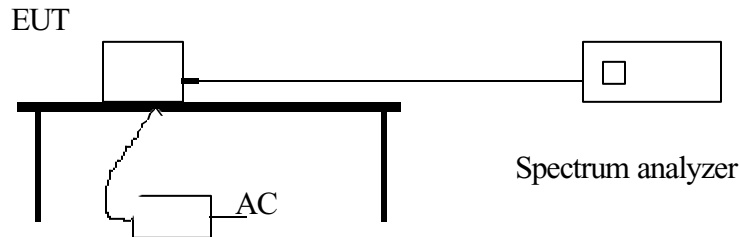
Conducted Emission

Test Requirement: 15.247(c)

Measurement Equipment Used:

HP 8566B Spectrum Analyzer

Test Set-up



Test Procedure:

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2 feet RG-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.

The EUT was configured on a test bench as shown above. The EUT was set to transmit while hopping normally. The spectrum analyzer was placed in MAX Hold mode, and individual sweeps were recorded with spectrum analyzer RES BW and VID BW set to 100KHz. The first plot shows spectrum analyzer START FREQUENCY set to 30 MHz and STOP FREQUENCY set to 2.5GHz. The second plot shows spectrum analyzer START FREQUENCY set to 2.0GHz and STOP FREQUENCY set to 2.68GHz. The third plot shows spectrum analyzer START FREQUENCY set to 2.6GHz and STOP FREQUENCY set to 22GHz. All emissions were compared to the 20-dB attenuation requirement.

Test Result:

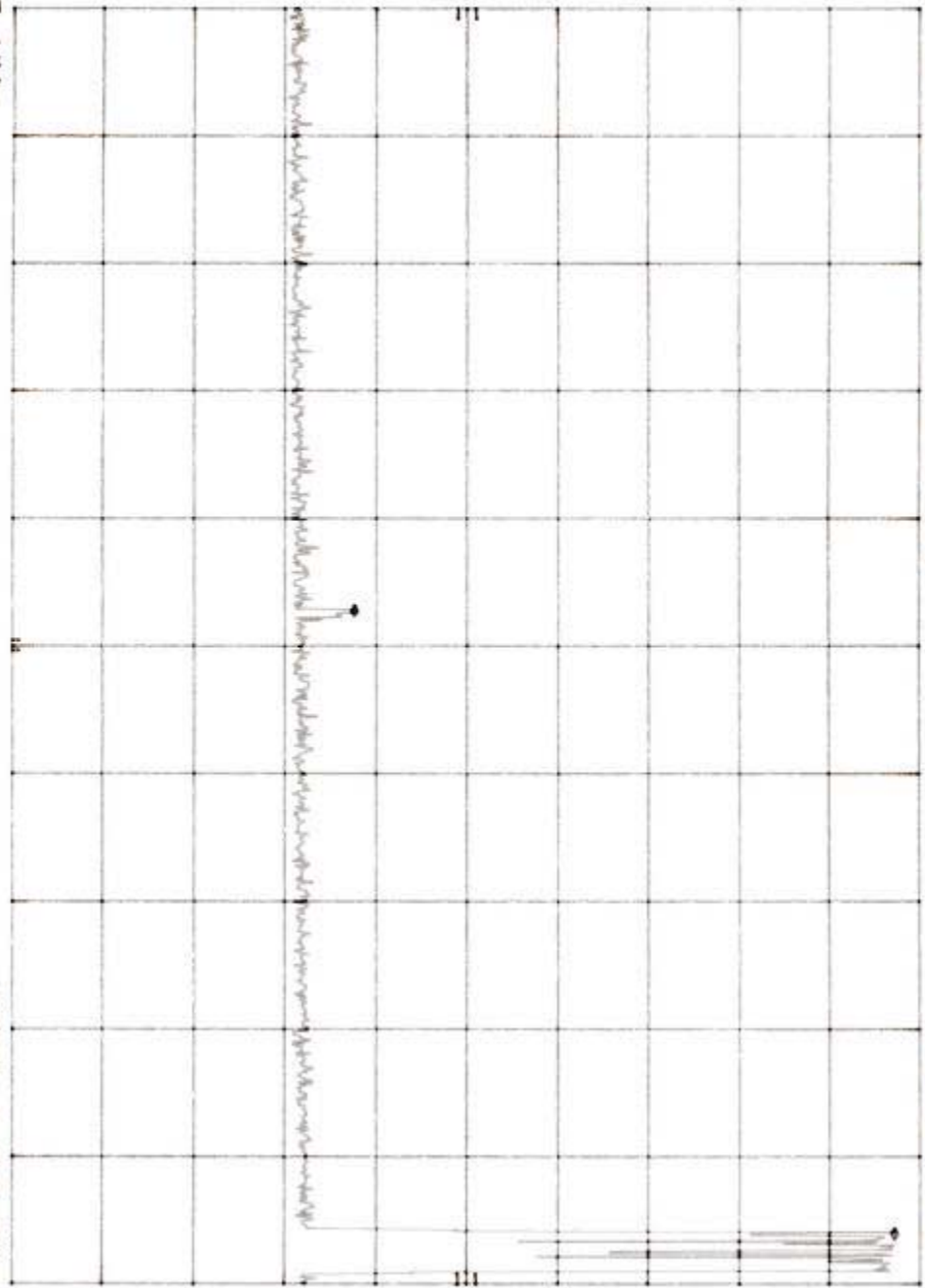
Please refer to attached plots.

SPURIOUS RF CONDUCTED EMISSIONS
MKR Δ -1.205 GHz
REF 21.5 dBm ATTEN 30 dB
-59.60 dB

HP
10 dB/

OFFSET
11.5
dB

START 30 MHz RES BW 100 KHZ VBW 100 KHZ STOP 2.50 GHz
SMP 741 msec



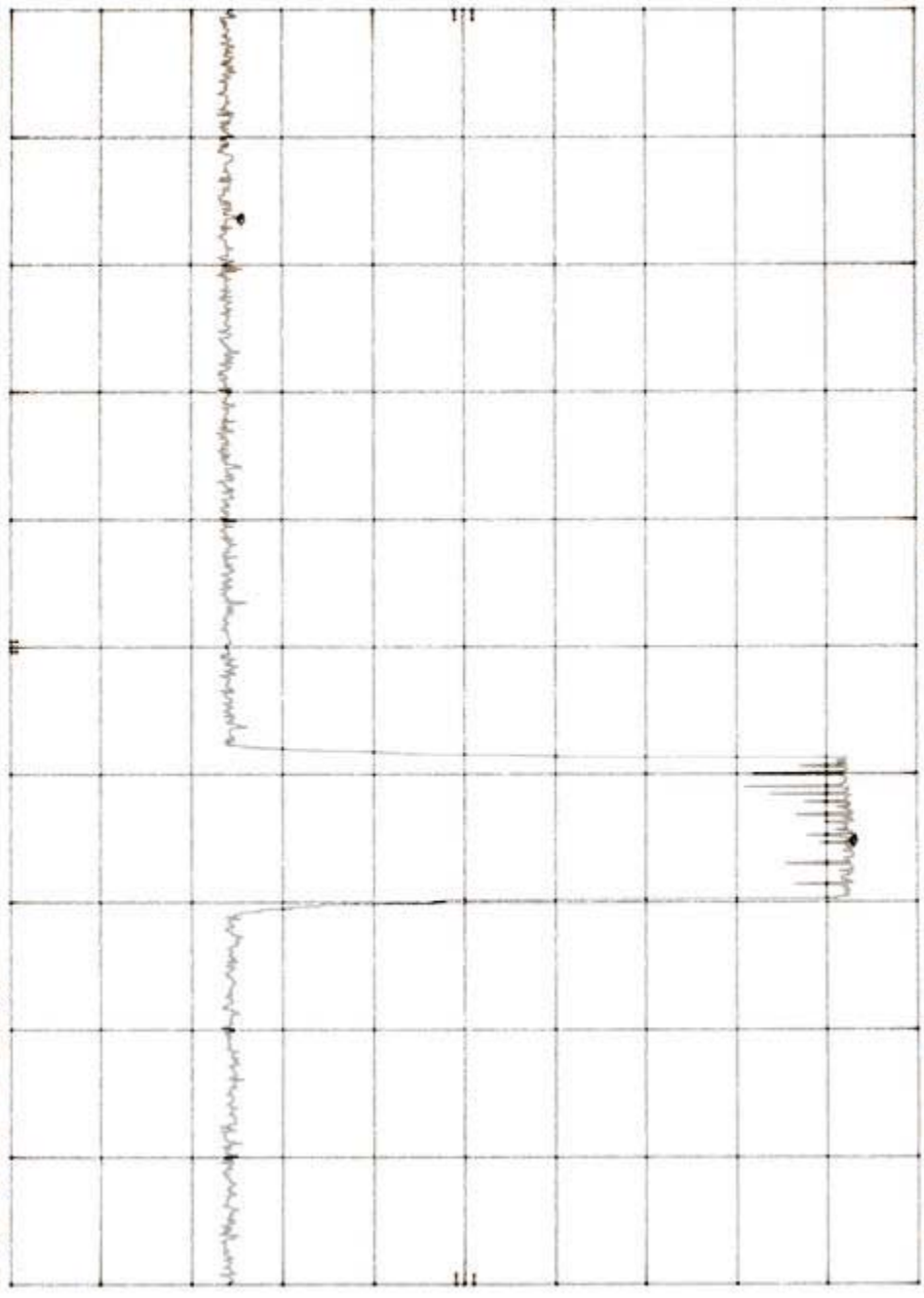
SPURIOUS RF CONDUCTED EMISSIONS
REF 21.5 DBM ATTEN 20 DB

MKR Δ-391.8 MHz
-67.50 DB

10 DB/

OFFSET
11.5
DB

START 2.000 GHz RES BW 100 KHZ VBW 100 KHZ STOP 2.680 GHz
SMP 204 msec

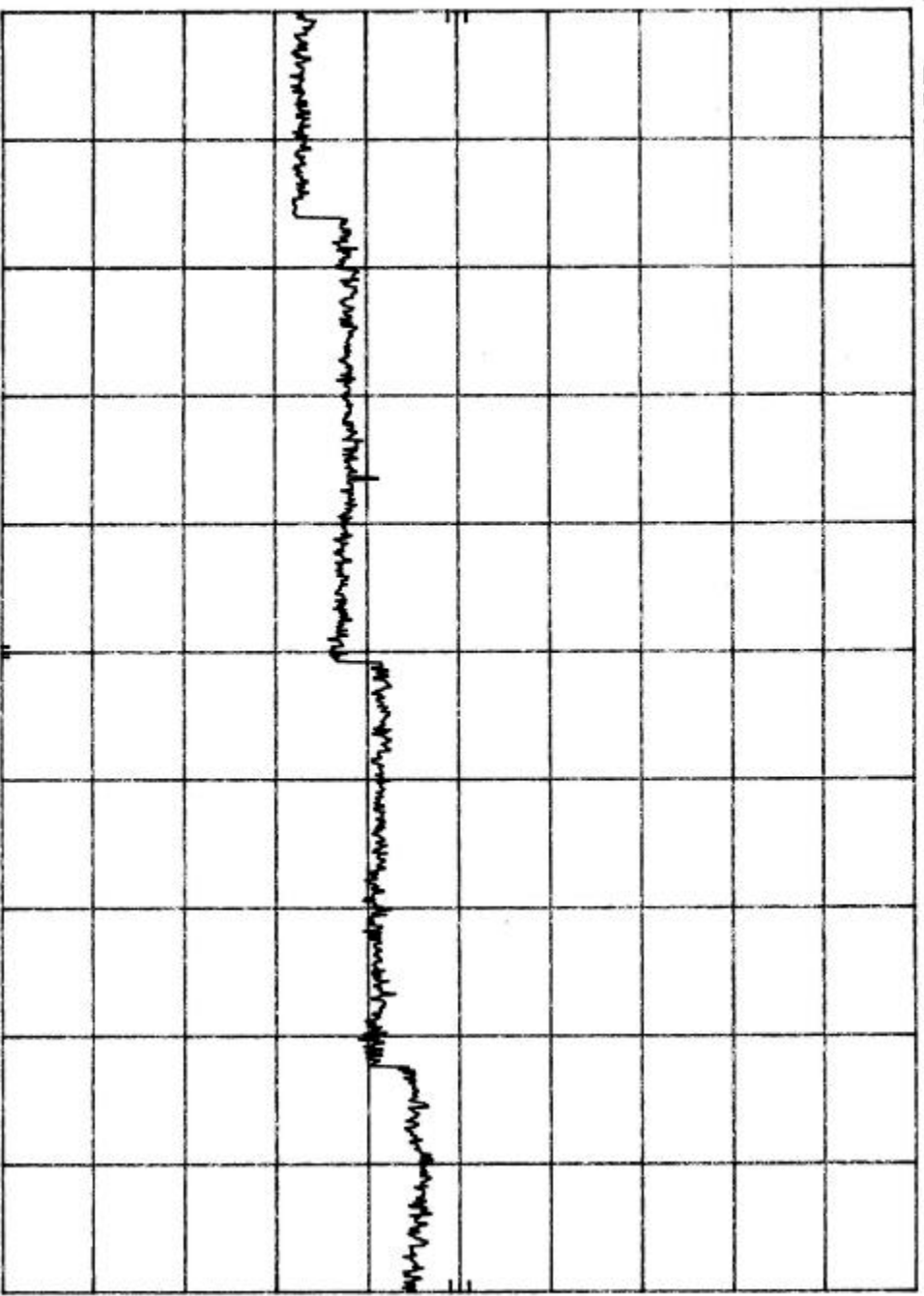


SPURIOUS RF CONDUCTED EMISSIONS

hp
10 dB/

OFFSET
11.5
dB

START 2.6 GHz RES BW 100 KHz VBW 100 KHz STOP 22.0 GHz
SMP 5.00 sec

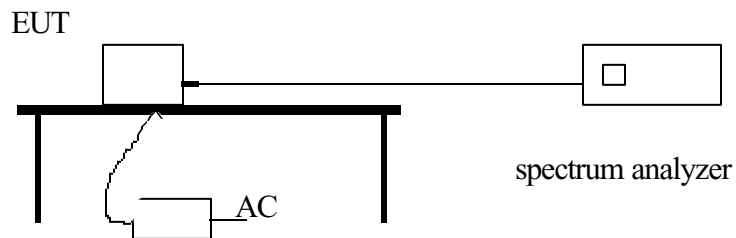


BAND-EDGE

Test Requirement: 15.247(c)

Measurement Equipment Used:

HP 8566B Spectrum Analyzer

Test Set-up**Test Procedure:**

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2 feet RG-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.

The EUT was configured on a test bench as shown above. The EUT was made to transmit uninterrupted random data on the low and high channel.

Spectrum analyzer CENTER FREQUENCY set to Low Channel (2402 MHz). SPAN set to 30MHz. RES BW and VIDEO BW both set to 300KHz. The spectrum analyzer was put into MAX HOLD mode. Using the delta marker function, the delta between the signal level at Low Channel and the signal level at 2400MHz was determined.

The above steps were repeated for HIGH Channel (2480 MHz) with delta markers set to High Channel (2480 MHz) and 2483.5 MHz.

To ensure that EUT will continue compliance with the Band-edge emission in normal hopping mode operation; the EUT was put back to the normal working condition (i.e. hopping mode enabled). And test repeated again.

Test Result:

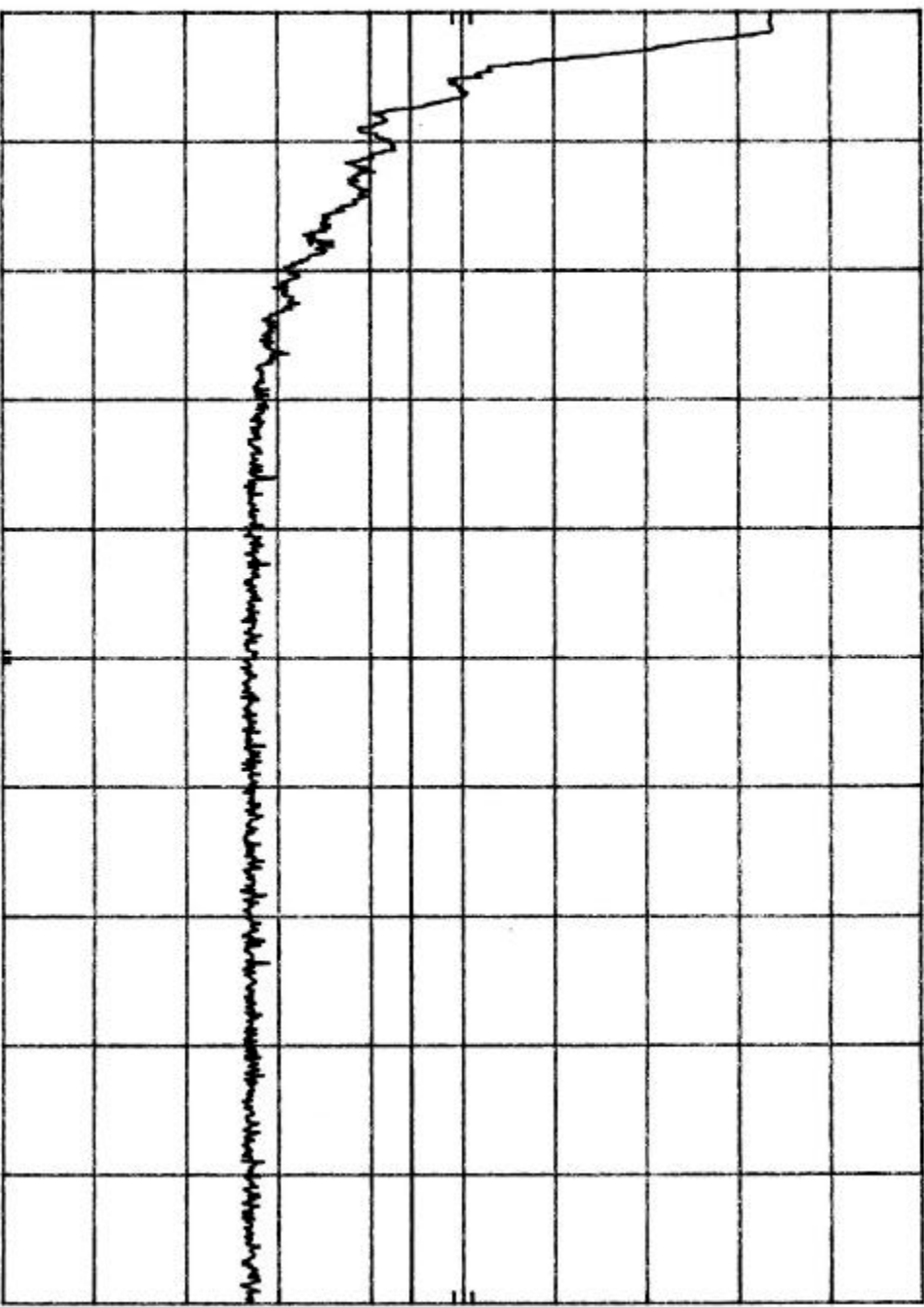
Please refer to attached plots.

HIGH CH BANDEGE
h_p REF 129.6 DB μ V ATTEN 10 DB

MKR 2.483 50 GHZ
69.20 DB μ V

10 DB/
POS PK
OFFSET 22.6 DB
DL 74.0 DB μ V

START 2.480 0 GHZ
RES BW 100 KHZ
VBW 1 MHZ
STOP 2.500 0 GHZ
SWP 20.0 msec

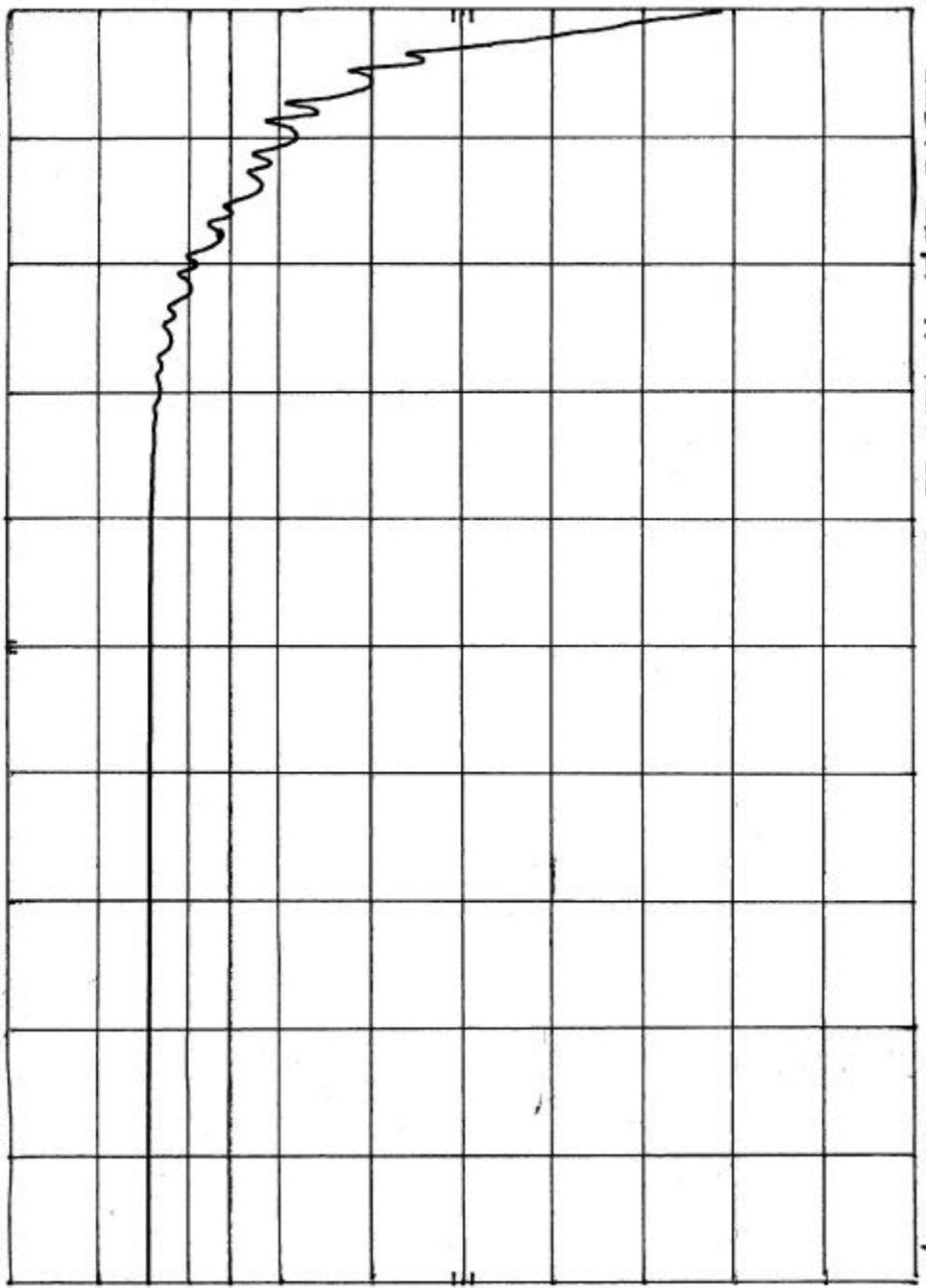


H
HIGH CH BANDEDGE
REF 129.6 dBµV ATTEN 10 dB

MKR 2.483 50 GHz
52.90 dBµV

10 dB/
POS PK
OFFSET 22.6 dB
DL
54.0 dBµV

START 2.480 0 GHz
RES BW 100 KHz
VBW 10 Hz
STOP 2.500 0 GHz
SWP 60.0 sec



hp

LOW CH BANDEDGE
REF 129.6 dBµV
ATTEN 10 DB

MKR 2.389 99 GHZ
58.50 DBµV

10 DB/

POS PK

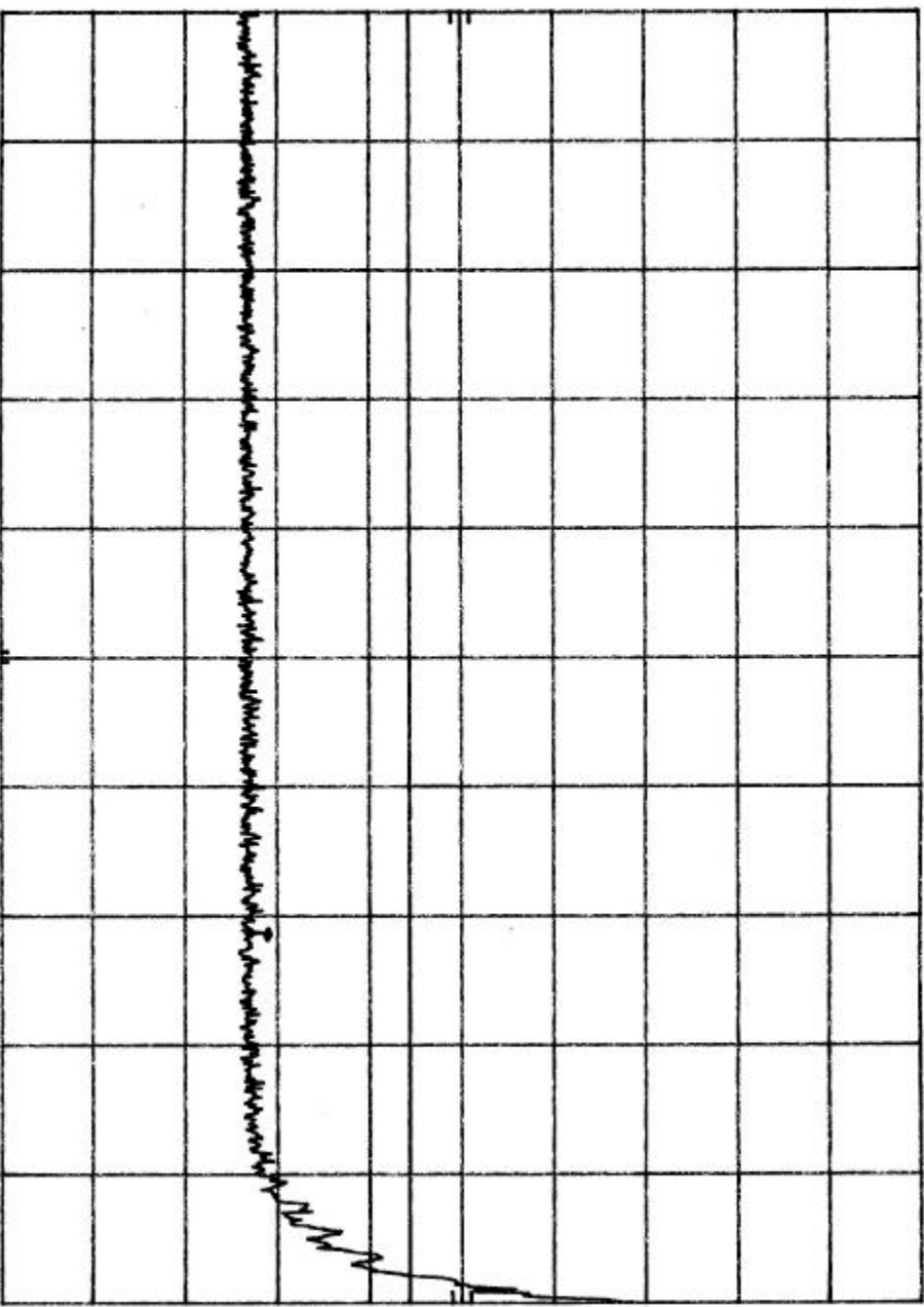
OFFSET
22.6

DB

DL

74.0
DBµV

START 2.360 0 GHZ
RES BW 100 KHZ
VBW 1 MHZ
STOP 2.402 0 GHZ
SWP 20.0 msec

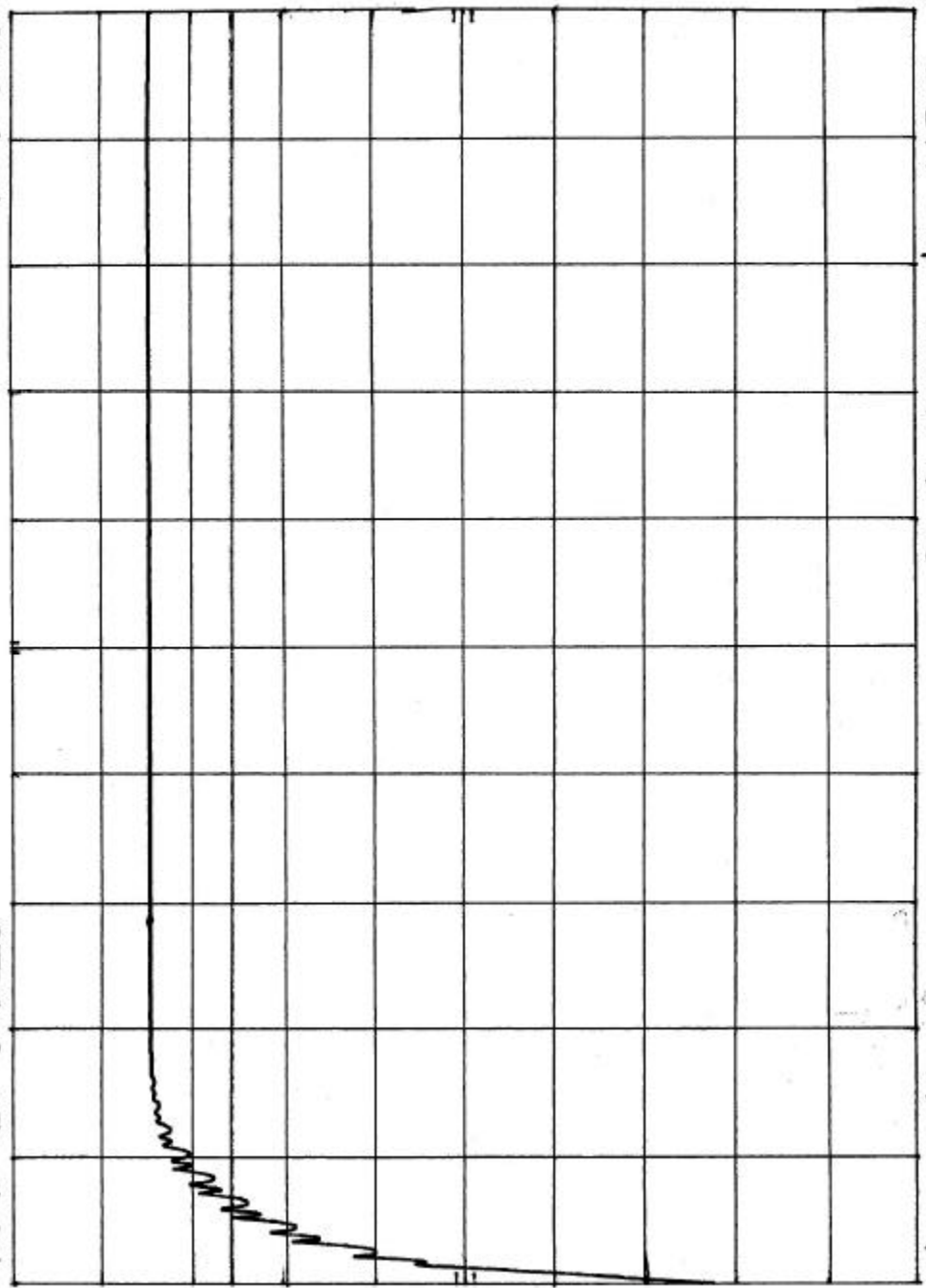


LOW CH BANDEDGE
REF 129.6 dBμV
ATTEN 10 dB

MKR 2.389 95 GHz
44.80 dBμV

10 dB/
POS PK
OFFSET 22.6 dB
DL 54.0 dBμV

START 2.360 0 GHz
RES BW 100 KHz
VBW 10 Hz
STOP 2.402 0 GHz
SMP 126 sec

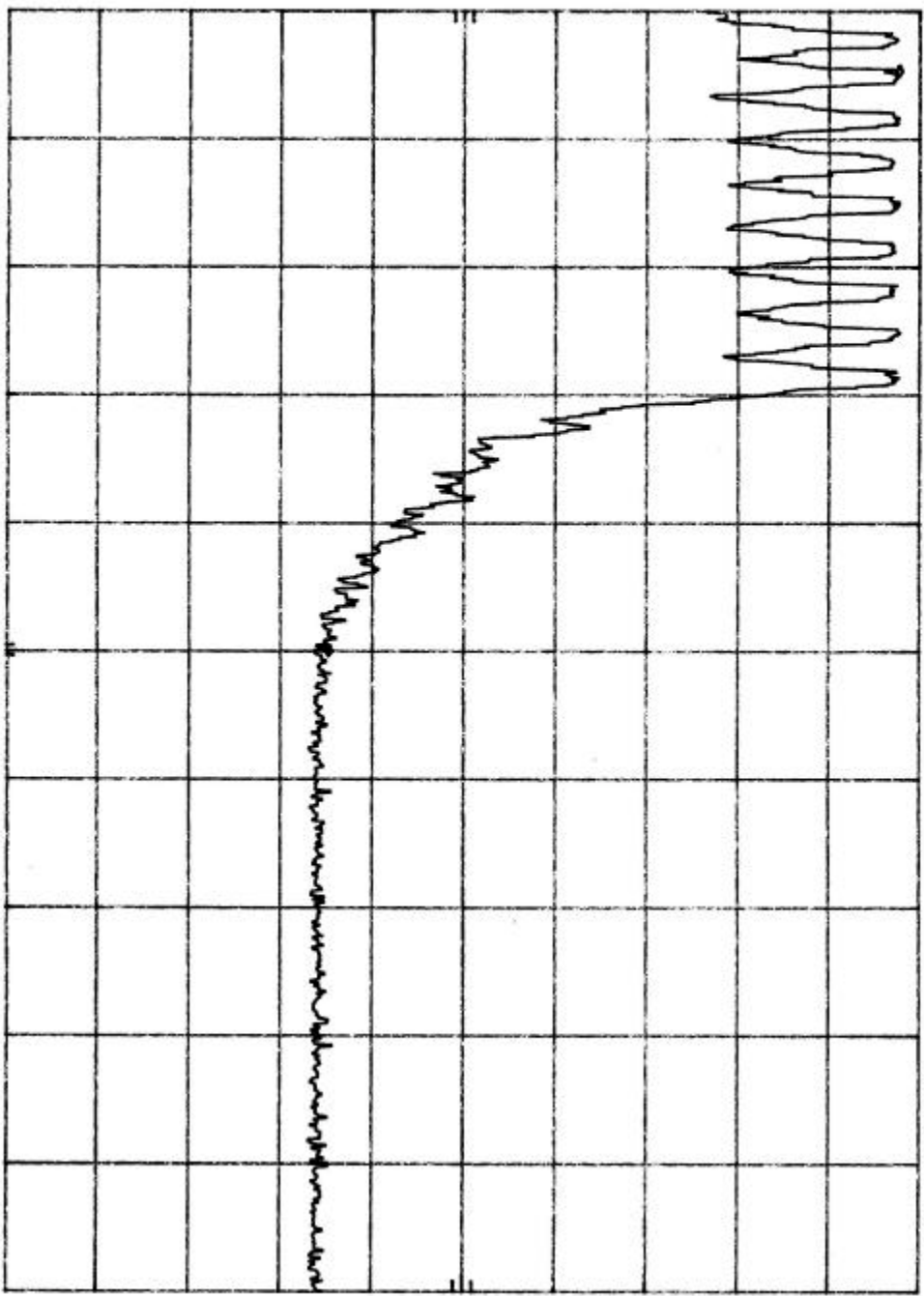


HIGH BANDEDGE WITH HOPPING ENABLED
REF 21.5 dBm ATTEN 30 DB

MKR Δ 13.59 MHz
-62.50 DB

10 DB/

OFFSET
11.5
DB



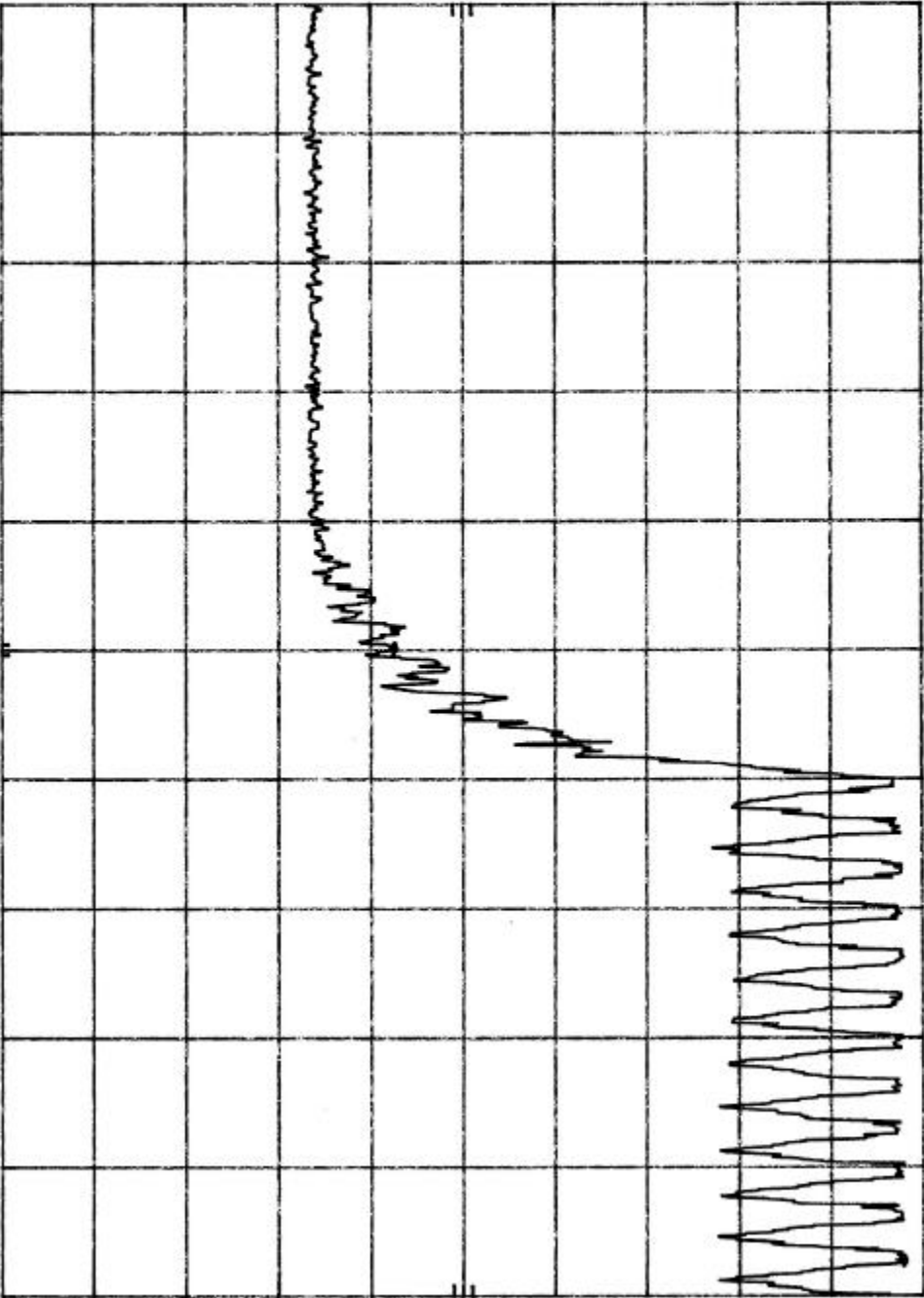
CENTER 2.483 5 GHz
RES BW 300 KHZ
VBW 300 KHZ
SPAN 30.0 MHz
SWP 20.0 msec

LOW BANDEDGE WITH HOPPING ENABLED
REF 21.5 dBm ATTEN 30 DB

MKR Δ -14.22 MHz
-55.40 DB

hp
10 dB/

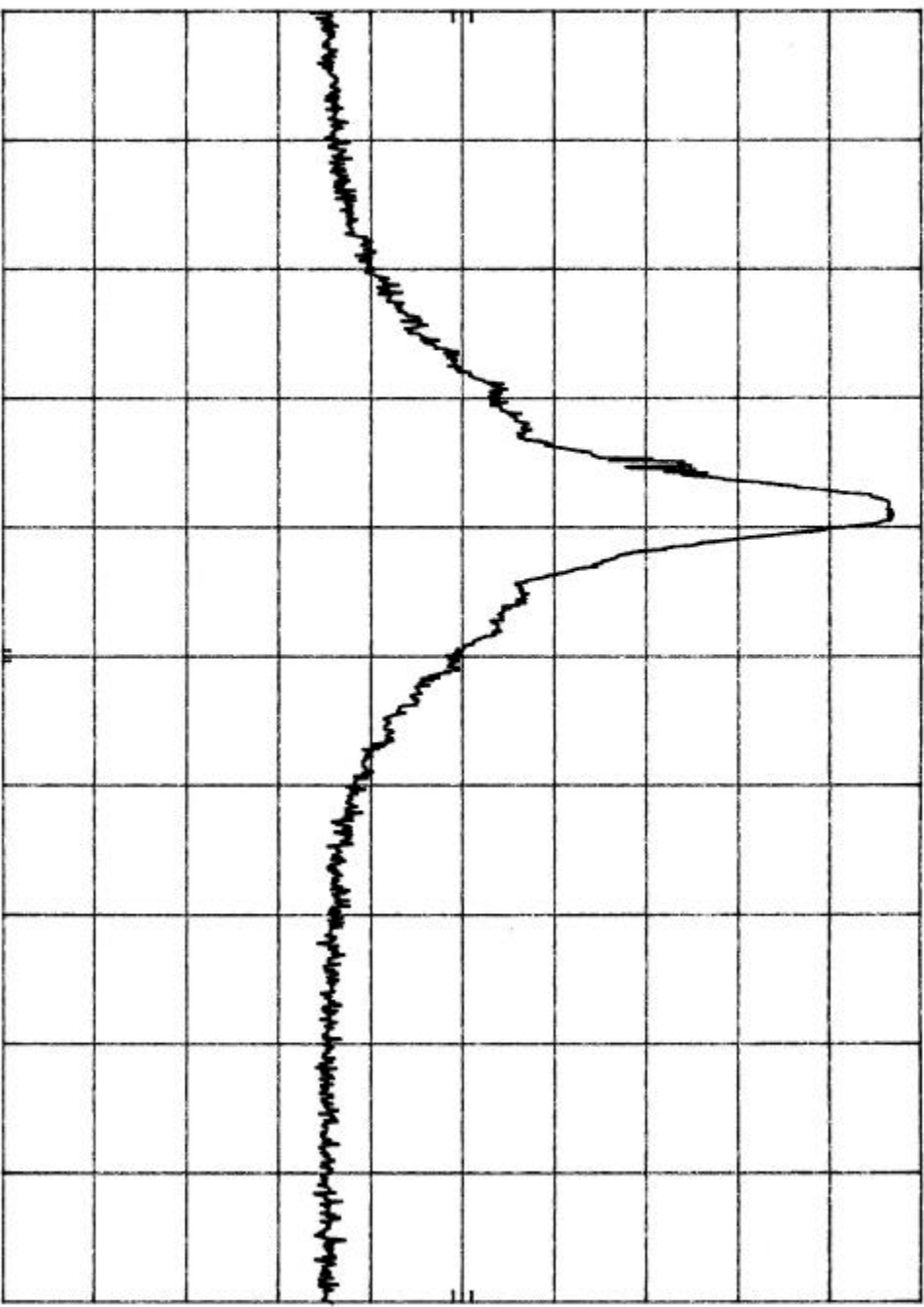
OFFSET
11.5
dB



CENTER 2.400 0 GHZ
RES BW 300 KHZ
VBW 300 KHZ
SPAN 30.0 MHZ
SMP 20.0 msec

HIGH BANDEDGE WITH HOPPING DISABLED
MKR Δ 3.24 MHz
REF 21.5 dBm ATTEN 30 DB
-47.20 DB

10 DB/
POS PK
OFFSET
11.5
DB

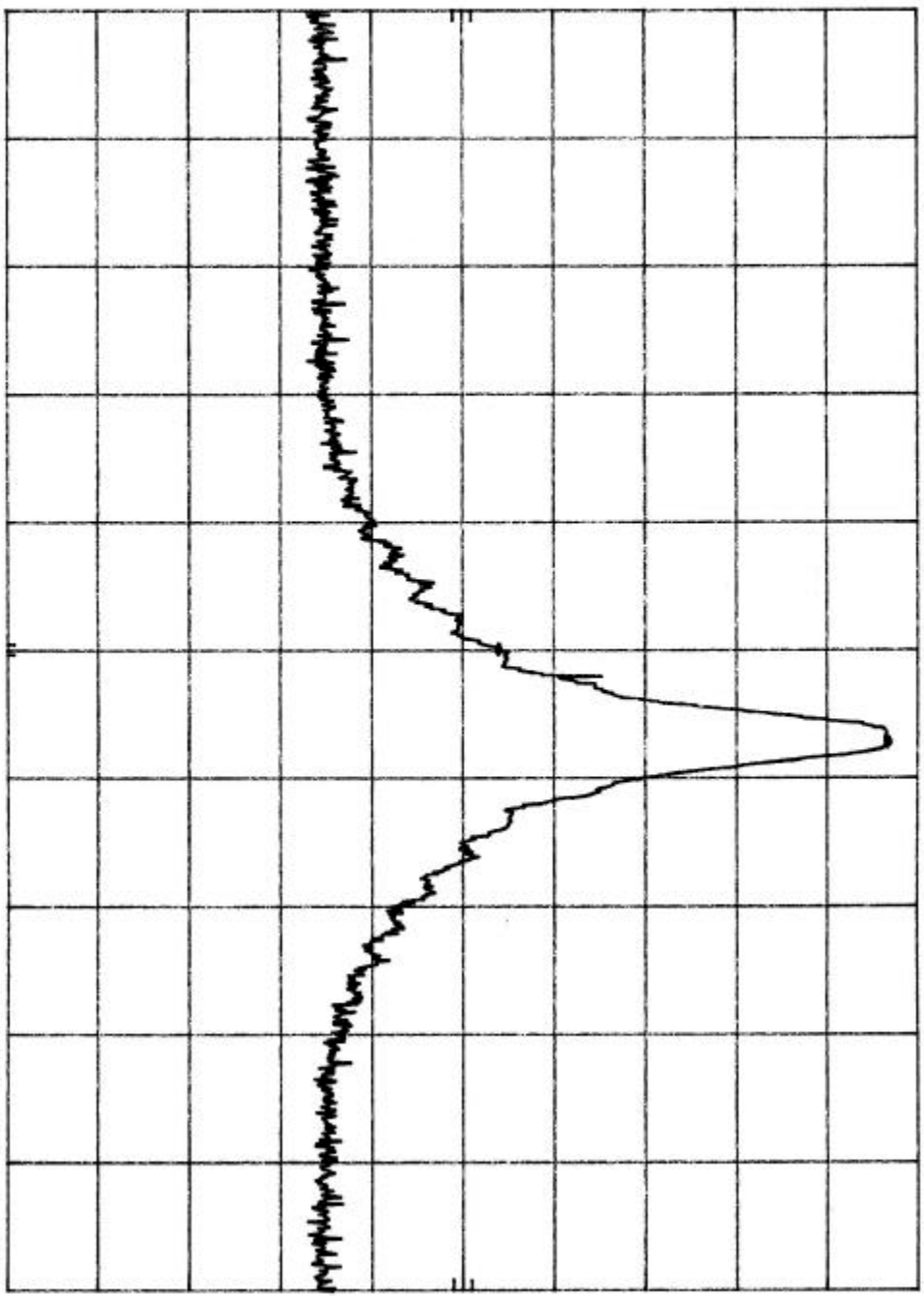


CENTER 2.483 5 GHz
RES BW 300 KHZ
VBW 300 KHZ
SPAN 30.0 MHz
SWP 20.0 msec

LOW BANDEDGE WITH HOPPING DISABLED MKR Δ -2.19 MHz
REF 21.5 dBm ATTN 30 dB -42.80 dB

10 dB/
POS PK
OFFSET 11.5 dB

CENTER 2.400 0 GHz RES BW 300 KHZ VBW 300 KHZ SWP 30.0 MHz
SMP 20.0 msec



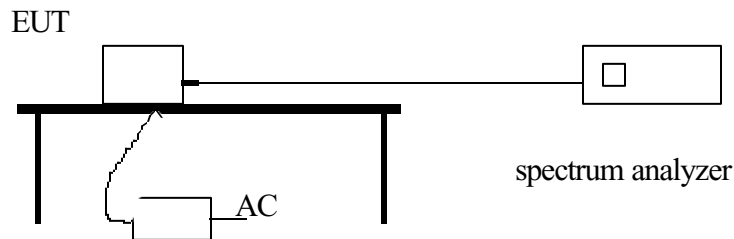
20dB Bandwidth for FHSS

Test Requirement: 15.247(a)(1)(ii)

Measurement Equipment Used:

HP 8566B Spectrum Analyzer

Test Set-up



Test Procedure:

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2 feet R-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.

The EUT was configured on a test bench as shown above. The EUT was made to transmit uninterrupted random data on each of the low/mid/high channels. Spectrum analyzer CENTER FREQUENCY set to Low Channel (2402MHz). SPAN set to 3 MHz. RES BW=30KHz. The above steps were repeated for MID Channel (2440 MHz) and HIGH Channel (2480 MHz).

The low/mid/high channels for high rate mode are 2405, 2440, and 2475MHz. Spectrum analyzer SPAN set to 20MHz, RES BW=VID BW=30kHz.

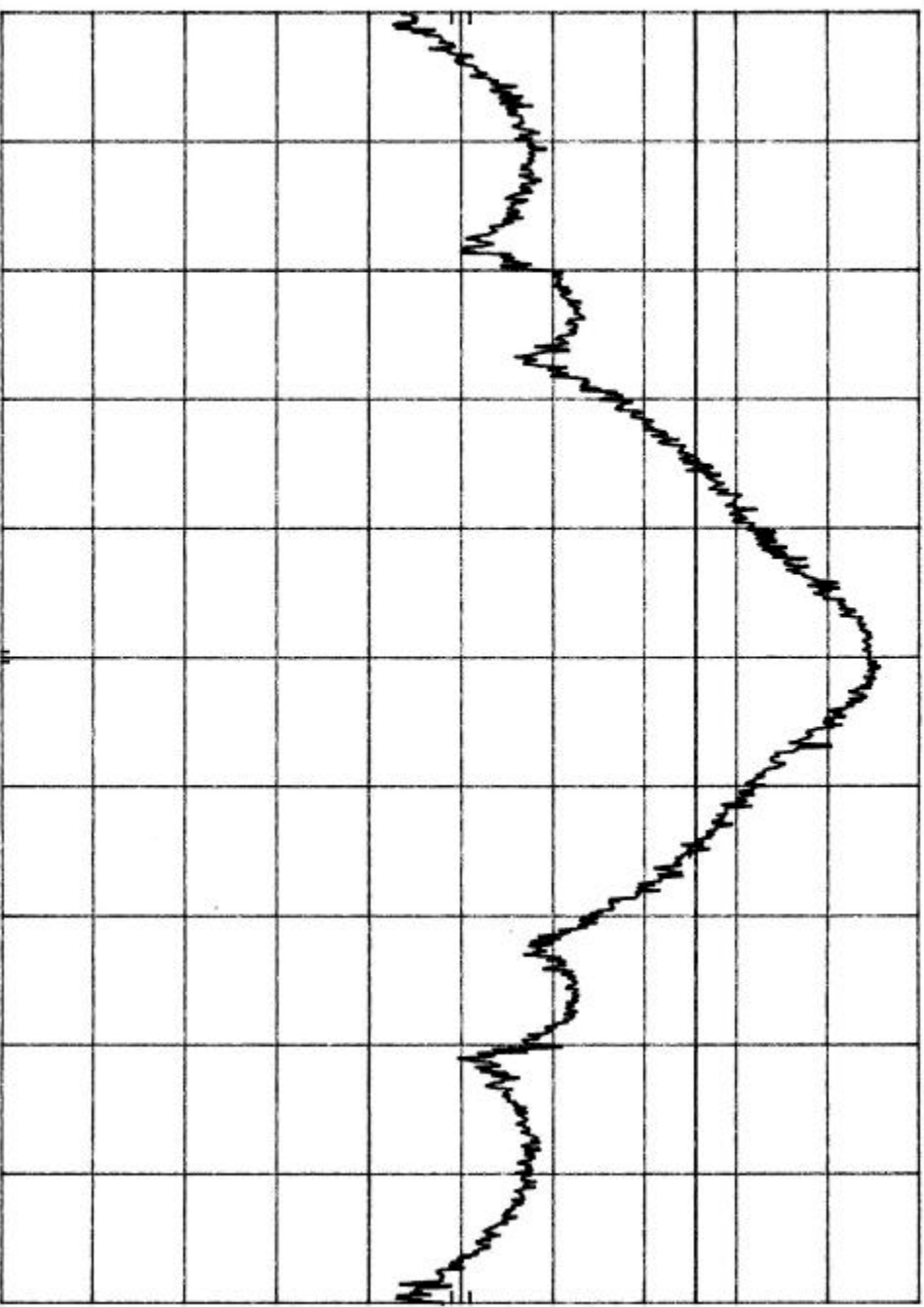
Test Results: Refer to attached spectrum analyzer data chart and plots.

20dB BW HIGH CH LOW RATE
REF 21.5 dBm ATTEN 30 DB

MKR Δ 900 KHZ
-0.80 DB

10 dB/
POS PK
OFFSET 11.5
DB
DL
-3.0
dBm

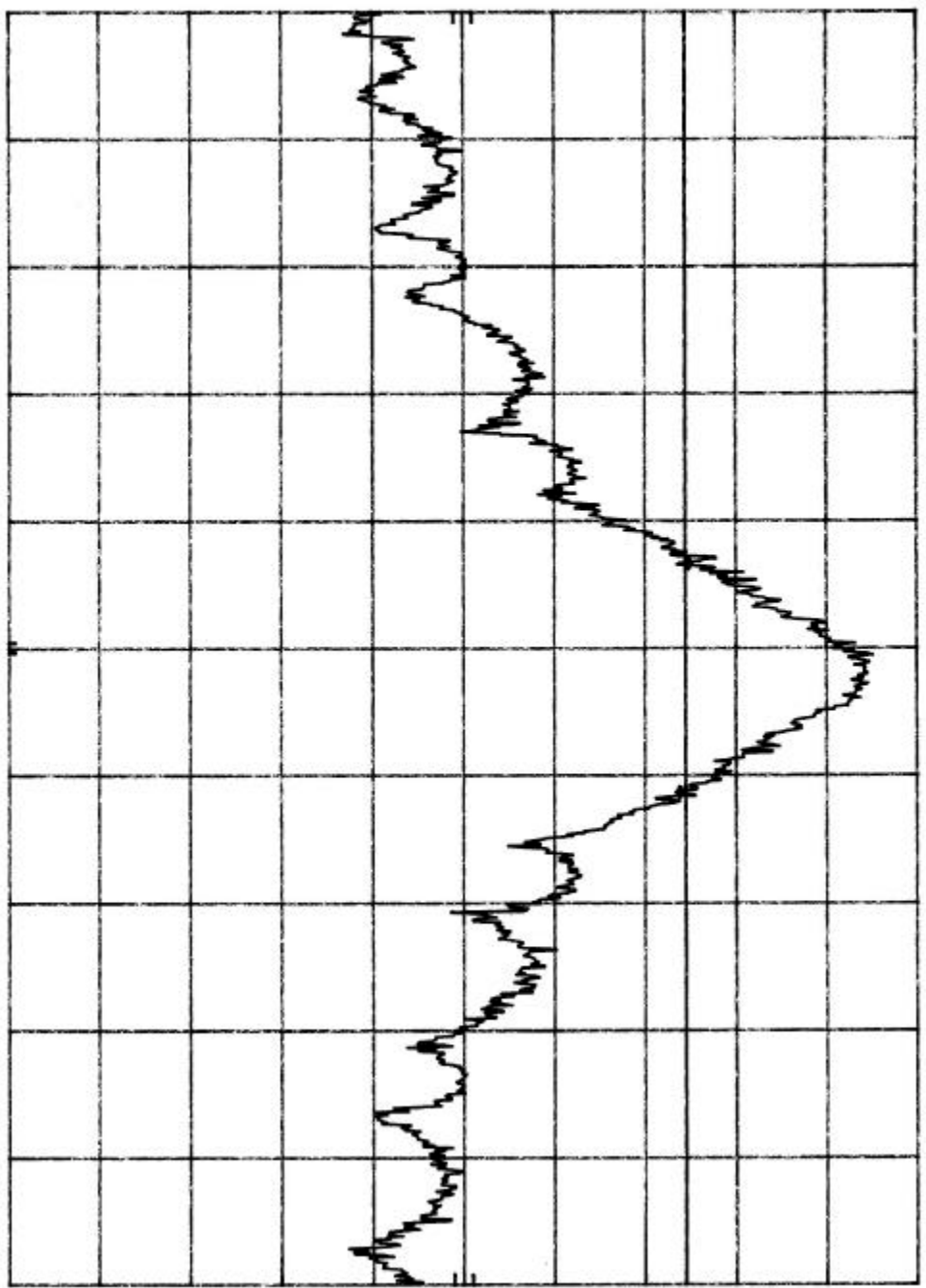
CENTER 2.480 00 GHZ
RES BW 30 KHZ
VBW 30 KHZ
SPAN 3.00 MHZ
SMP 20.0 msec



20dB BW MID CH LOW RATE
REF 21.5 dBm ATTEN 30 DB
10 dB/

MKR Δ 900 KHZ
-1.00 DB

h
OFFSET
11.5
DB
DL
-4.1
dBm

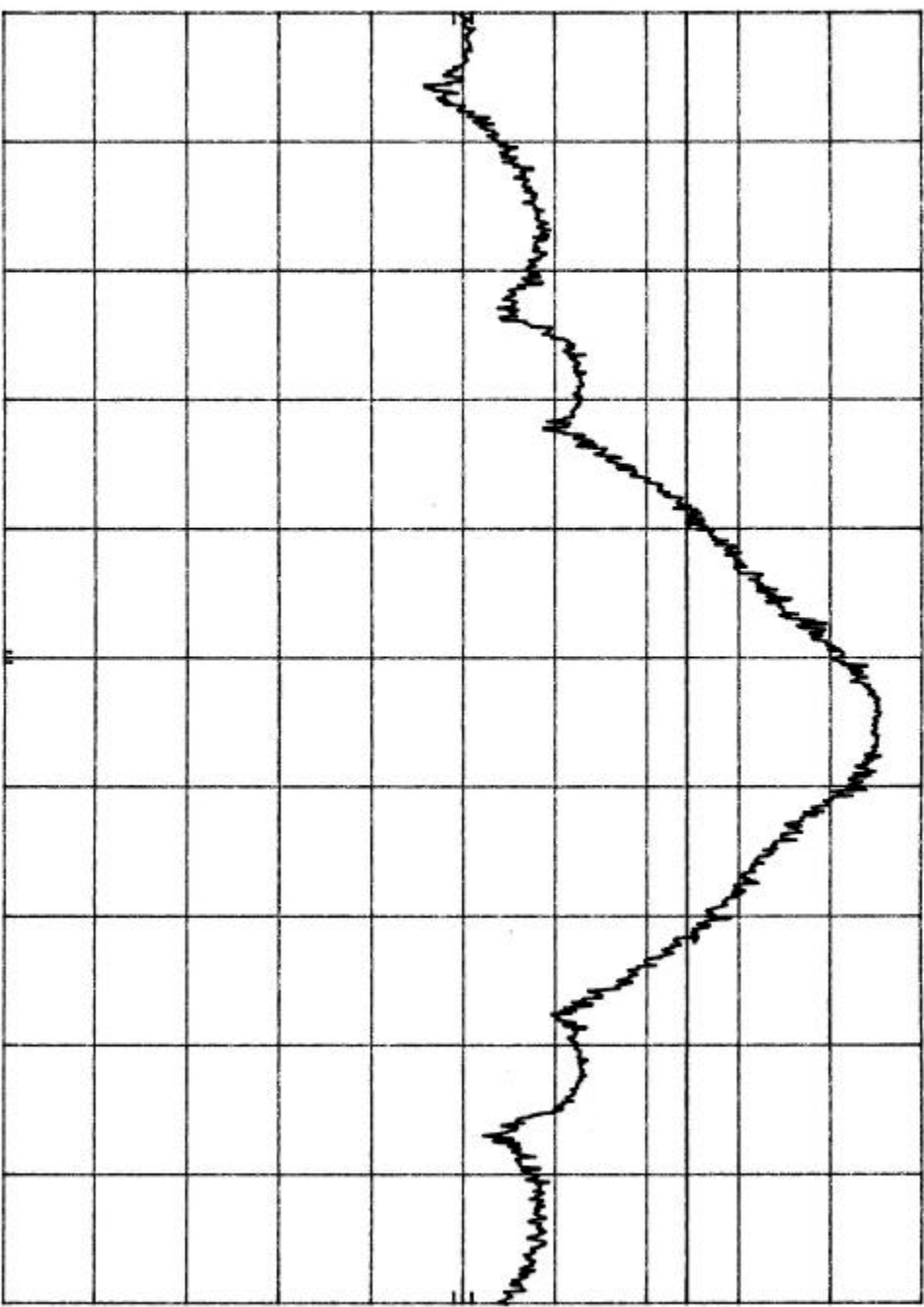


CENTER 2.440 00 GHZ
RES BW 30 KHZ
VBW 30 KHZ
SPAN 5.00 MHZ
SMP 20.0 msec

20dB BW LOW CH LOW RATE
REF 21.5 dBm ATTEN 30 DB

MKR Δ 963 KHZ
0.60 DB

10 dB/
POS PK
OFFSET 11.5
dB
DL
-4.2
dBm



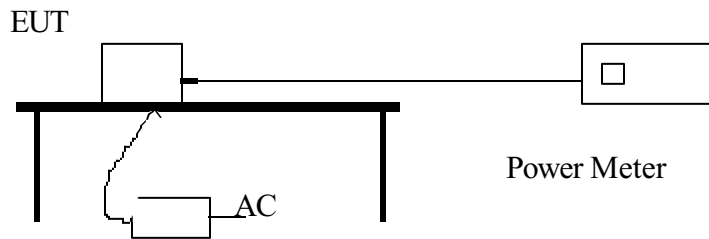
CENTER 2.402 00 GHZ
RES BW 30 KHZ
VBW 30 KHZ
SPAN 3.00 MHZ
SMP 20.0 msec

RF Power Output

Test Requirement: 15.247(b)(1)

Measurement Equipment Used:
 HP 8566B Spectrum Analyzer

Test Set-up



Test Procedure

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the Power Meter through a 2 feet RG-316 cable.

The EUT was configured on a test bench as shown above. The EUT was made to transmit uninterrupted random data on each of the low/mid/high channels.

Test Results:

CHANNEL	dBm	Watts	LIMIT (W)	LIMIT (dBm)	RESULT
2402MHz	18.60	0.072	1	30	COMPLIES
2440MHz	18.65	0.073	1	30	COMPLIES
2480MHz	18.59	0.072	1	30	COMPLIES

RF EXPOSURE REQUIREMENT

Test Requirement: 15.247(b)(4)

§ 1.1310 Radio frequency radiation exposure

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field Strength (V/m)	Magnetic field Strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

Test result:

TABLE 1 (B) LIMITS FOR GENERAL POPULATION/UNCONTROLLED EXPOSURE

F(MHz) **(POWER DENSITY (mW/cm²))**

1500 - 100,000 1

Transmitter Output power is **0.0724 Watts** and will be used with a **1 dBi (1.26 numerically)** antenna

Computation method:

$$P = E^2 / 3770$$

$$\sqrt{E^2} = \sqrt{1 \text{ mW/cm}^2 * 3770}$$

$$E = 61.4 \text{ V/m}$$

$$E = \frac{\sqrt{30 * P * G}}{D}$$

$$D = \frac{\sqrt{30 * 0.070 * 1.26}}{61.4 \text{ V/m}}$$

$$D = 2.7 \text{ cm}$$

$$2.64 / 2.54 = 1.06 \text{ inch}$$

MPE distance requirement is 1.06 inch. A warning statement with a MPE distance requirement of 20cm is placed in the manual.

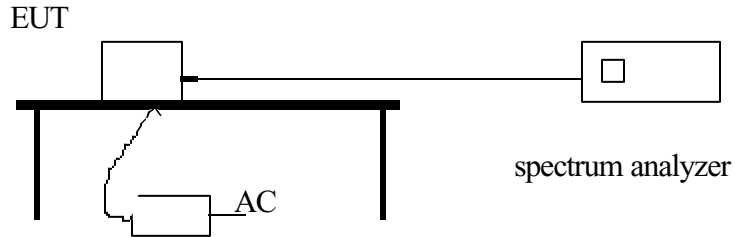
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Minimum Number of Hopping Channel

Test Requirement: 15.247(a)1(ii)

Measurement Equipment Used:
HP 8566B Spectrum Analyzer

Test Set-up



Test Procedure:

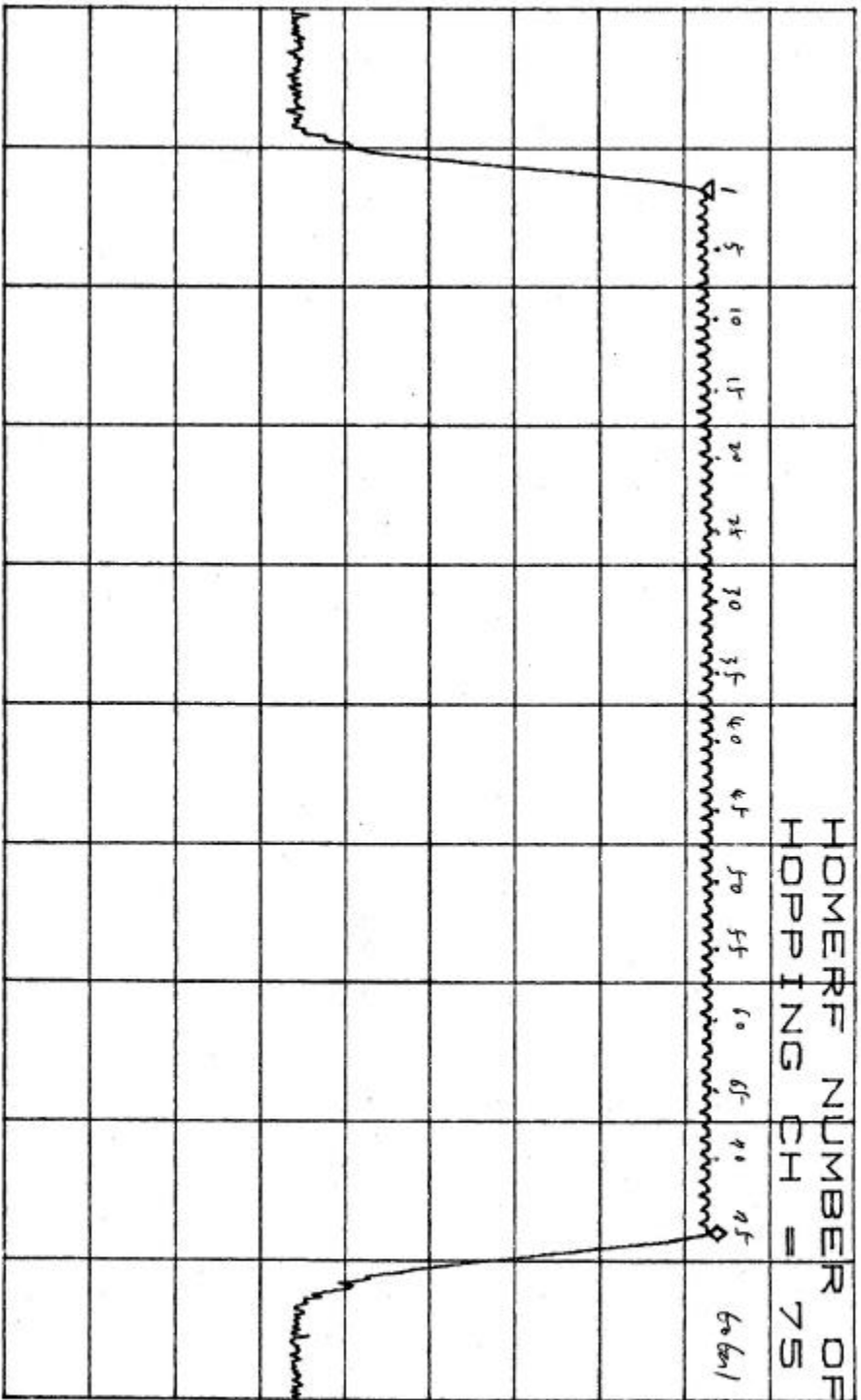
1. The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2 feet RF-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.
2. Turn on the transmitter in normal hopping mode. The emissions will “paint” the spectrum analyzer screen with individual traces from each transmit channel. Allow the transmitter to run for at least 3 minutes or until there are no more changes to the display.
3. Count the number of individual channel traces and compare to the design goal.

Test Results:

Frequency Range	Number of Hopping Channel
2.40000-2.4800GHz	75

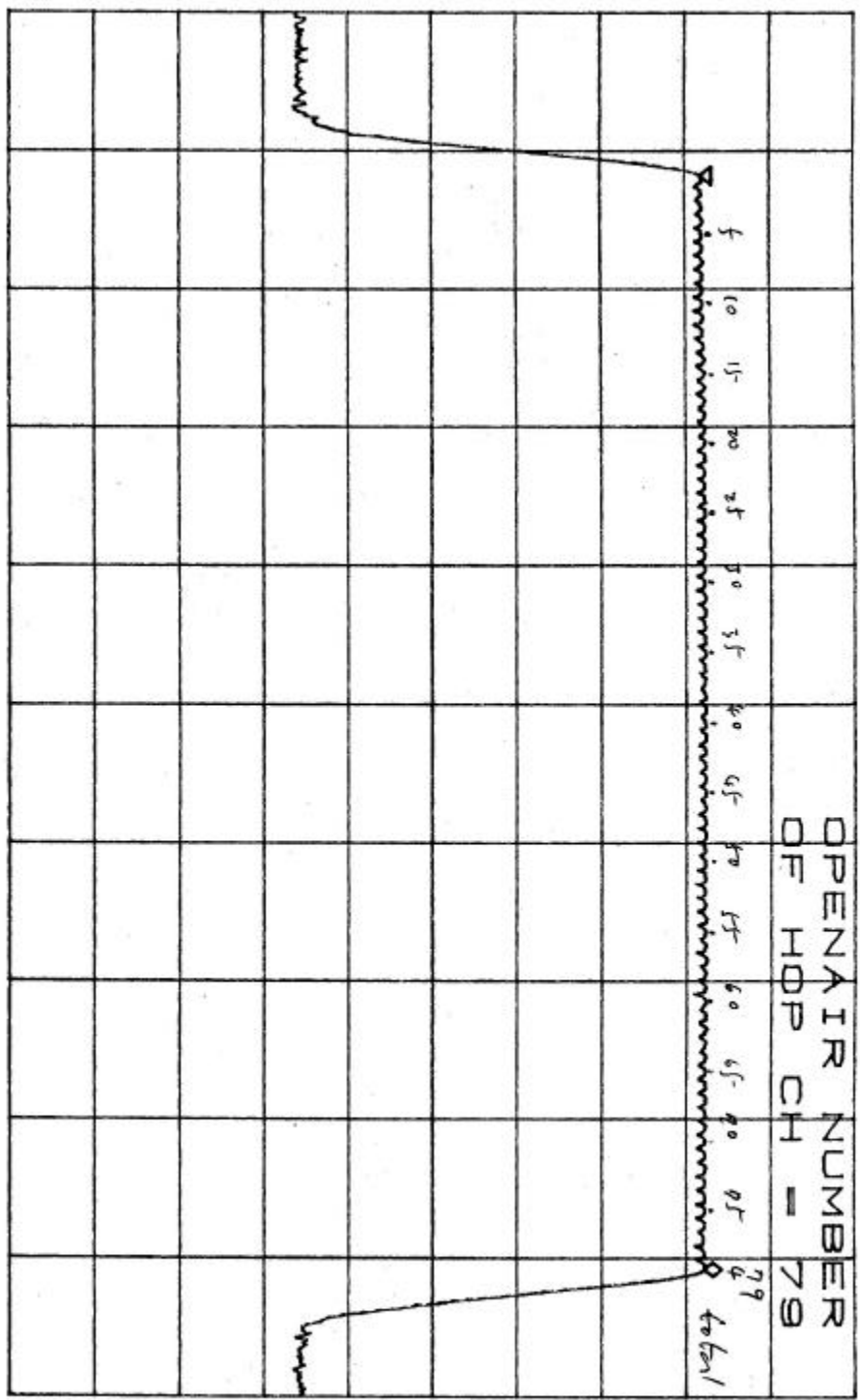
Please refer to attached spectrum plots.

CENTER 2.4400GHZ SPAN 100.0MHZ
 RBW 1.0MHZ VBW 1.0MHZ SWP 50.0ms



60 dbm
 9f dbm

CENTER 2.4400GHZ SPAN 100.0MHZ
 RBW 1.0MHZ VBW 1.0MHZ SWP 50.0ms



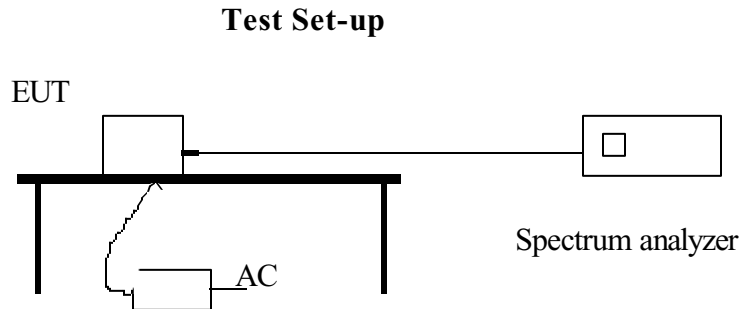
79
 channel
 ok

Hop Channel Separation

Test Requirement: 15.247(a)(1)(ii)

Measurement Equipment Used:

HP 8566B Spectrum Analyzer



Test Procedure:

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2-foot RG-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.

Turn on the transmitter in normal hopping mode. The emissions will “paint” the spectrum analyzer screen with individual traces from each transmit channel. Allow the transmitter to run for at least 3 minutes or until there are no more changes to the display. Move MARKER to the channel, which appears to have widest Channel separation and calculate the DELTA between two markers.

Test Result:

Please refer to attached spectrum plot.

Measured 996kHz > 25kHz (limit)

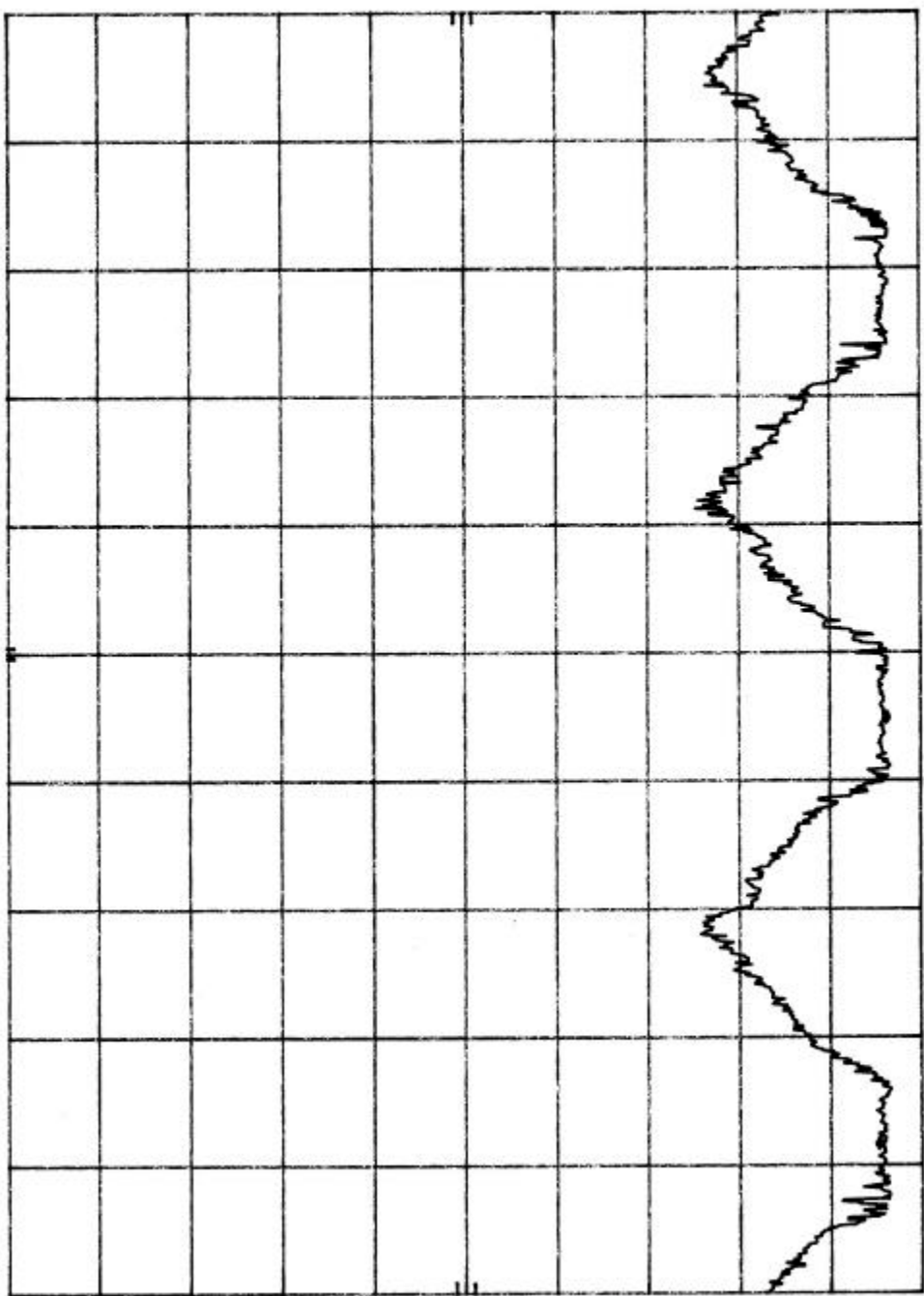
CARRIER FREQUENCY SEPARATION
REF 21.5 dBm ATTN 30 dB

hp
10 dB/

OFFSET
11.5
dB

MKR Δ-996 KHZ
0.90 dB

CENTER 2.440 00 GHZ
RES BW 100 KHZ
VBW 100 KHZ
SPAN 3.00 MHZ
SMP 20.0 msec

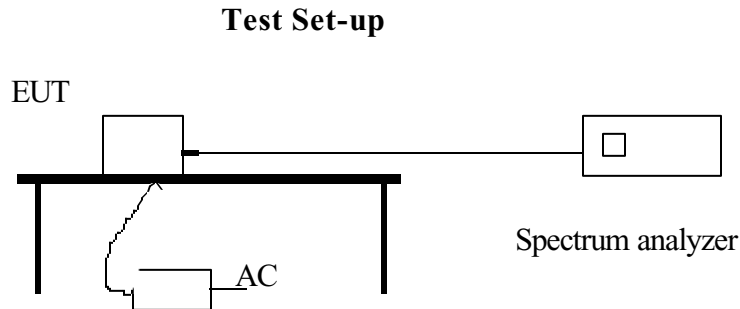


Average Time of Channel Occupancy

Test Requirement: 15.247(a)1 (ii)

Measurement Equipment Used:

HP 8566B Spectrum Analyzer



Test Procedure:

The RF output port of the EUT was attached to an MMCX to SMA adapter and connected to the spectrum analyzer through a 2 feet RG-316 cable. Total path loss including cable, adapter, and attenuator at 2.4 to 2.5GHz was 11.5dB.

Set the transmitter to operate in its normal frequency hopping mode. Set the spectrum analyzer Center Frequency at 2.440GHz. Set the Sweep Time to 30 seconds. Set Trace to Max Hold. Set the Amplitude function to Linear.

The maximum number of transmissions detected in any 30 Second periods determines the maximum time of channel occupancy.

The duration of each transmission is measured with RBW=VBW=300kHz. SPAN set to 0 Hz. SWP set to 50.0msec.

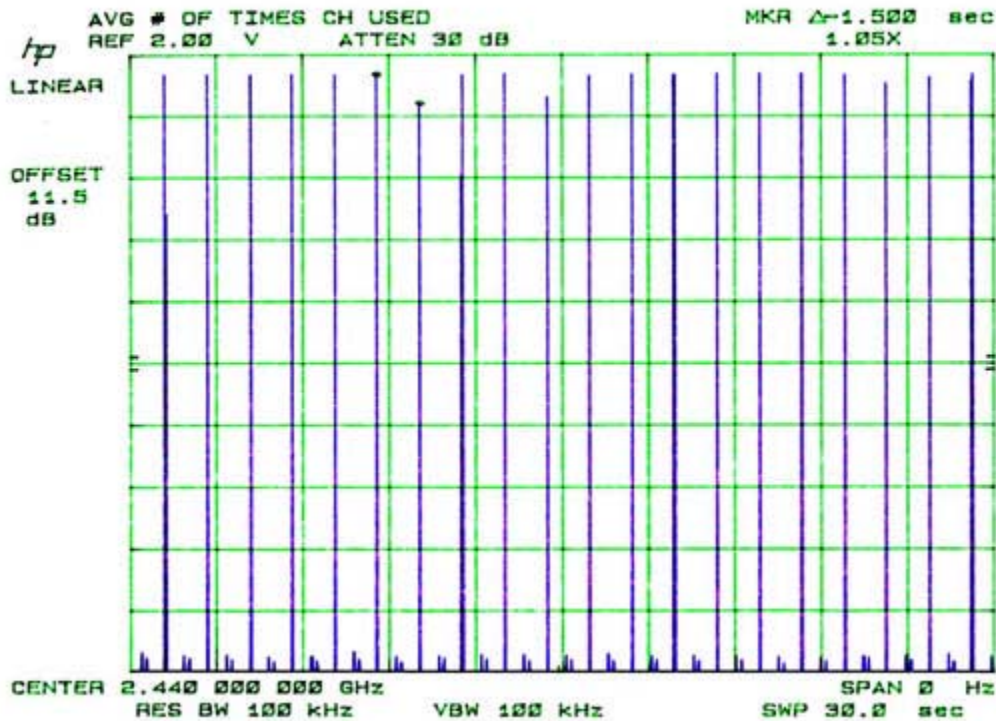
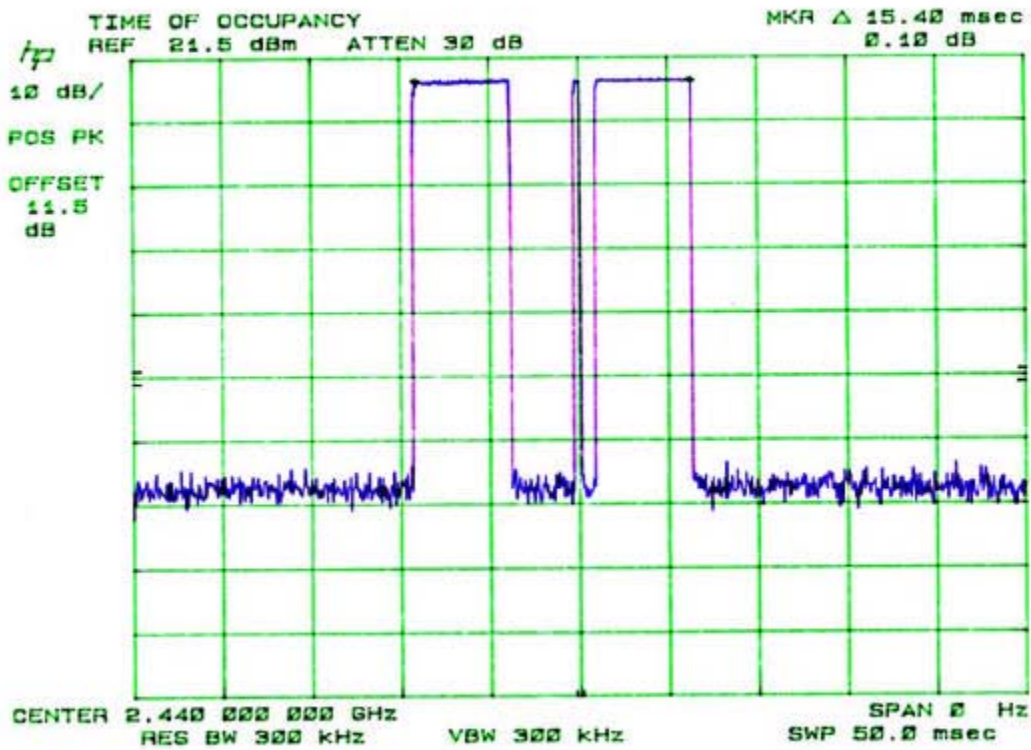
Test Results:

Average time of single channel occupancy: 0.0154 seconds

Average number of times any individual channel is used within any 30 seconds: 20

$20 \times 0.0154 = 0.308 \text{ second} < 0.4 \text{ second (limit)}$

Please refer to attached spectrum plots (two pages)



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