ENGINEERING TEST REPORT

ISP DIRECT INDOOR & OUTDOOR UNITS
Model No: 2401-01 (indoor) and 2401-02 (outdoor)

FCC ID: NUX-ISP2401

FCC PART 15, SUBPART C, PARA. 15.247
DIRECT SEQUENCE SPREAD SPECTRUM (DSSS) TRANSMITTERS
OPERATING IN THE FREQUENCY BAND FROM 2408.625 - 2464.875 MHz

UltraTech's FILE NO.: IAW-004FTX

TESTED FOR:

INTERAIR WIRELESS
485 Cayuga Road. P.O. Box 222
Buffalo, New York
USA, 14225-0222

TESTED BY:

UltraTech Engineering Labs Inc.
4181 Sladeview Crescent, Unit 33
Mississauga, Ontario
Canada L5L 5R2

PREPARED BY: Tri M. Luu, P.Eng.

DATE: Apr. 12, 1998

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15.247(a)(2)	Spectrum Bandwidth of a Direct Sequence Spread Spectrum System	Yes
15.247(b) & 1.1310	Maximum Peak Power and RF Exposure Limits	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
15.247(d)	Transmitted Power Density of a Direct Sequence Spread Spectrum System	Yes
15.247(e)	Processing Gain of Direct Sequence Spread Spectrum System	Yes
15.107, 15.109	AC Power Conducted Emissions & Radiated Emissions for Digital Circuit Portions	Yes (Note 1)

Note 1: The digital circuits and receiver portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices. The engineering test report can be provided upon FCC requests.

TESTIMONIAL AND STATEMENT OF CERTIFICATION

THIS IS TO CERTIFY:

1) *THAT the application was prepared either by, or under the direct supervision of the undersigned.*

2) *THAT the measurement data supplied with the application was taken under my direction and supervision.*

3) *THAT the data was obtained on representative production units, representative.*

4) *THAT, to the best of my knowledge and belief, the facts set forth in the application and accompanying technical data are true and correct.*

Certified by:

Tri Minh Luu, P. Eng.
V.P., Engineering

DATE: Apr. 12, 1998

2. EXHIBIT 2 - GENERAL INFORMATION

2.1 Applicant

INTERAIR WIRELESS
485 Cayuga Road. P.O. Box 222
Buffalo, New York
USA, 14225-0222

Applicant's Representative: Mr. Dave Chauncey, Director RF Engineering

2.2 Manufacturer

INTERAIR WIRELESS
485 Cayuga Road. P.O. Box 222
Buffalo, New York
USA, 14225-0222

Applicant's Representative: Mr. Dave Chauncey, Director RF Engineering

2.3 Description of Equipment under Test

PRODUCT NAME:	ISP DIRECT INDOOR & OUTDOOR UNITS
SERIAL NUMBER:	Preproduction
TYPE OF EQUIPMENT:	DSSS Transmitters
POWER RATING:	160 mWatts
EMISSION DESIGNATION:	Direct sequence spread spectrum
DUTY CYCLE:	45% maximum
OSC. FREQUENCY(IES):	35 MHz (Rx IF), 70 MHz (Rx LO), 915 MHz (Tx IF), Tx Lo. Osc. = Tx Freq- 915 MHz.
INPUT SUPPLY:	AC 120 V 60Hz from Elpac external switching power supply, model WRI4232
OPERATING FREQ./ 6dB BANDWIDTH	2408.625 - 2464.875 MHz

The following table shows the characteristics of each channel frequency of the transmitter:

Channel No.	Channel Frequency	Modulation Bandwidth	Maximum 6dB Bandwidth (MHz)	Chips per Symbol	Data Rate (Mb/s)	Max. RF Output Power (miliWatts)	Highest gain Antenna Used (dBi)
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	2408.625	Narrow	4.2	11	4.5	190	17
4	2411.4375	Medium	5.3	11	5.625	190	17
5	2417.0625	Medium	5.3	11	5.625	190	17
6	2419.875	Wide	10	11	11.25	190	17
7	2422.6875	Medium	5.3.0	11	5.625	190	17
8	2428.3125	Medium	5.3	11	5.625	190	17
9	2431.125	Wide	10	11	11.25	190	17
10	2433.9375	Medium	5.3	11	5.625	190	17
11	2439.5625	Medium	5.3	11	5.625	190	17
12	2442.3750	Wide	10.0	11	11.25	190	17
13	2445.1875	Medium	5.3	11	5.625	190	17
14	2450.8125	Medium	5.3	11	5.625	190	17
15	2453.625	Wide	10.0	11	11.25	190	17
16	2456.4375	Medium	5.3	11	5.625	190	17
17	2462.0625	Medium	5.3	11	5.625	190	17
18	2464.875	Narrow	4 .2	11	4.5	190	17

For worst case of measurements the following channels were chosen to be tested: Narrow BW: 3 & 17, Medium BW: 4, 10 & 17, Wide BW: 6, 9 & 15.

ASSOCIATED DEVICES:

(1) Elpac external switching power supply, model WRI4232, AC IN: AC 95 250 V, 47-63 Hz, 1.2A, DC OUT: +5V, +12V, -12 Vdc

(2) One of the following antenna may be supplied with the InterAir ISP Direct System, the antenna is permanently secured to the ISP Direct Outdoor Unit using TNC connectors and heat shrink:

Selection Number	Description	Vendor	P/N	Gain (dBi)
1	1x1 Patch	Huber Suhner	64958022	8.5
2	~~3x3 Patch~~	~~Huber Suhber~~	65119522	16.5
3	1x10 Patch	Huber Suhner	65247322	16.5
4	Omni	Andrew	RT1N0F-024V-013A	13
5	Reflector	Conifer	18T-2400	17

Removed see 6/22/98 amend.

The Conifer Reflector with the highest antenna gain from the above list is chosen to be tested with the InterAir ISP Direct System for the worst case.

(3) The RF interconnecting cable between the InterAir ISP Direct Indoor and the Outdoor Units can be selected with one of the following:

Selection No.	Description	Vendor	Part No.	Length (ft)	Loss (dB)
1	0.4" Cable – WP	Times	LMR-400-DB	150	10.2
2	0.3" Cable	Times	LMR-300	100	10.4
3	0.24" Cable	Times	LMR-240	80	10.3
4	0.2" cable	Times	LMR-200	60	10.1
5	0.5" Cable – WP	Times	LMR-500-DB	200	11
6	0.6" Cable – WP	Times	LMR-600-DB	250	11
7	0.9" Cable – WP	Times	LMR-900-DB	400	12
8	0.25" Flex	MISC	RG-223/U	30	10.5

The above item # 8, 0.25" Flex, RG-223/U cable with shortest available length (30 ft) and lowest loss (10.5 dB), was used for testing and represents the worst case.

FCC ID: NUX-ISP2401

INTERFACE PORTS:

INDOOR UNIT:

(1) LAN Port - RJ-45
(2) Event In/Out (Sync) - BNC
(3) Serial Port – DB9 (for factory uses only)
(4) RF OUT - TNC. The RF OUT will not deliver any rf power if the indoor unit is not connected to the outdoor unit.

OUTDOOR UNIT:

(1) RF-IN (TNC) (1) LAN Port - RJ-45
(2) RF-OUT (TNC). Permanently attached to the antenna as one unique assembly. Heat shrink is used to secured the Outdoor Box's RF –OUT terminal to the Antenna, and the Outdoor Box is mounted on the antenna.

2.4 Related Submittal(s)/Grant

No applicable.

2.5 Test Methodology

These tests were conducted on a sample of the equipment for the purpose of certification compliance with Code of Federal Regulations (CFR47-1991), Part 15, Subpart C, Para. 15.247, Direct Sequence Spread Spectrum Transmitters operating in the Frequency Band 2408.625 - 2464.875 MHz.

Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4-1992 - 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.

2.6 Test Facility

AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

Radiated Emissions were performed at the UltraTech's 3-10 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: July 16, 1997.

The above test site is also filed with Interference Technology International Ltd (ITI - An EC Directive on EMC).

2.7 Units of Measurements

Measurements of conducted emissions are reported in units of dB referenced to one microvolt [dB(μV)].

Measurements of radiated emissions are reported in units of dB referenced to one microvolt per meter [dB(μV)/m] at the distance specified in the report, wherever it is applicable.

3. EXHIBIT 3 - SYSTEM TEST CONFIGURATION

3.1 Test System Details

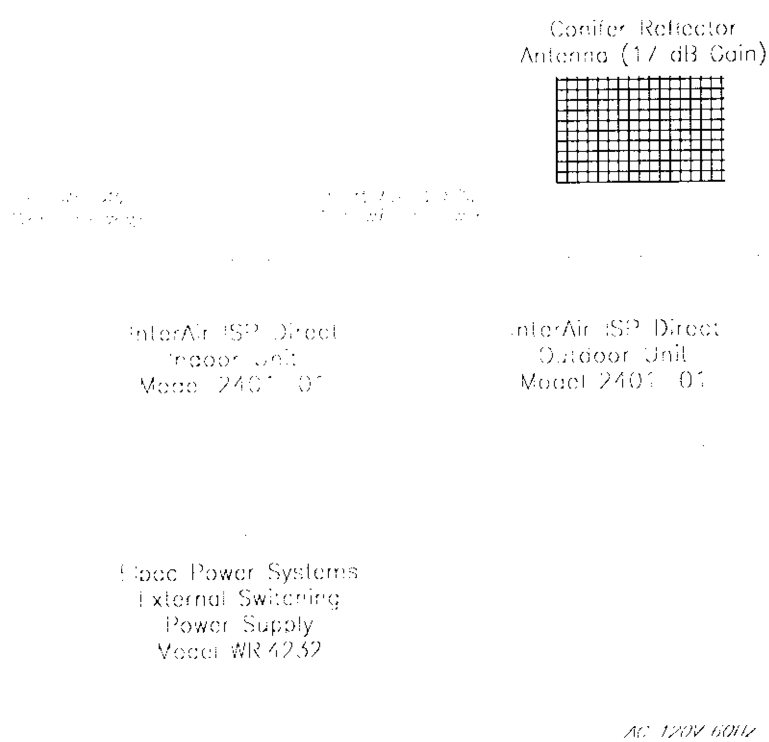
The following peripherals, FCC identifiers and types interconnecting cables were used with the EUT for testing:

(1) **EUT**: INTERAIR WIRELESS, ISP DIRECT INDOOR & OUTDOOR UNITS, Model : 2401-01 (indoor) and 2401-02 (outdoor), S/N: Preproduction.
I/O Cable: All I/O cables were shielded except for the RJ-45 LAN cable
Power Supply Cable: Non-shielded AC cord and shielded DC out cable.

(2) **ASSOCIATED MAXIMUM GAIN ANTENNA**: Conifer Reflector Antenna , P/N: 18T-2400, Gain: 17 dB.
I/O Cable: All I/O Cables were shielded

(3) **ASSOCIATED SHORTEST & MINIMUM LOSS RF CABLE**: RG-223/U shielded cable, 0.25" flex, 30ft long minimum, 10.5 dB loss @ 2.45 GHz.

3.2 Block Diagrams for Conducted & Radiated Emission Measurements



3.4 Justification

No deviation, in both configuration and operation manners, different from normal operation were required.

3.5 EUT Operating Condition

Software provided by INTERAIR WIRELESS to set the EUT to transmit or receive at various channel frequencies.

3.6 Special Accessories

No special accessories were required.

3.7 Equipment Modifications

To achieve compliance with FCC 15.205 and 15.209 at the Transmitter local oscillator frequency (Tx Freq – 915 MHz), the following modifications were made by InterAir Wireless:

a. The front and back plastic bezel with the Ni EMI coated edges were clued to the front and back metal plates using Conductive EMI adhesive.
b. Metal shield boxes were installed at both sides (RF board and Digital Board) of the internal 40-Pin connector.
c. EMI gasket/washer was installed between the RF and Digital printed circuit boards at the 40-Pin Connector.
d. 2 mounting screws were added to secure the DC IN power jack to the back metal plate.

4. EXHIBIT 4 - TEST DATA

4.1 6 dB Bandwidth @ FCC 15.247(a)(2)

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

For a direct sequence spread spectrum system, the minimum 6 dB bandwidth shall be at least 500 KHz.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

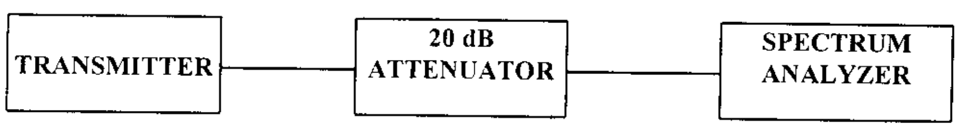
TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

The transmitter output was connected to the spectrum analyzer through an attenuator. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using 100 KHz RBW, VBW = 100 KHz,. The 6 dB bandwidth was measured and recorded.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Feb. 26 & Mar. 04, 1998

MEASUREMENT DATA:

Channel No.	Channel Frequency	Modulation Bandwidth	Data Rate (Mb/s)	Chips per Symbol	Measured 6dB Bandwidth (MHz)	FCC Limit (MHz)
3	2408.625	Narrow	4.5	11	4 .2	0.5
4	2411.4375	Medium	5.625	11	5.0	0.5
6	2419.875	Wide	11.25	11	8.4	0.5
9	2431.125	Wide	11.25	11	10.0	0.5
10	2433.9375	Medium	5.625	11	5.2	0.5
15	2453.625	Wide	11.25	11	8.1	0.5
17	2462.0625	Medium	5.625	11	5.3	0.5
18	2464.875	Narrow	4.5	11	4.0	0.5

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ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #3

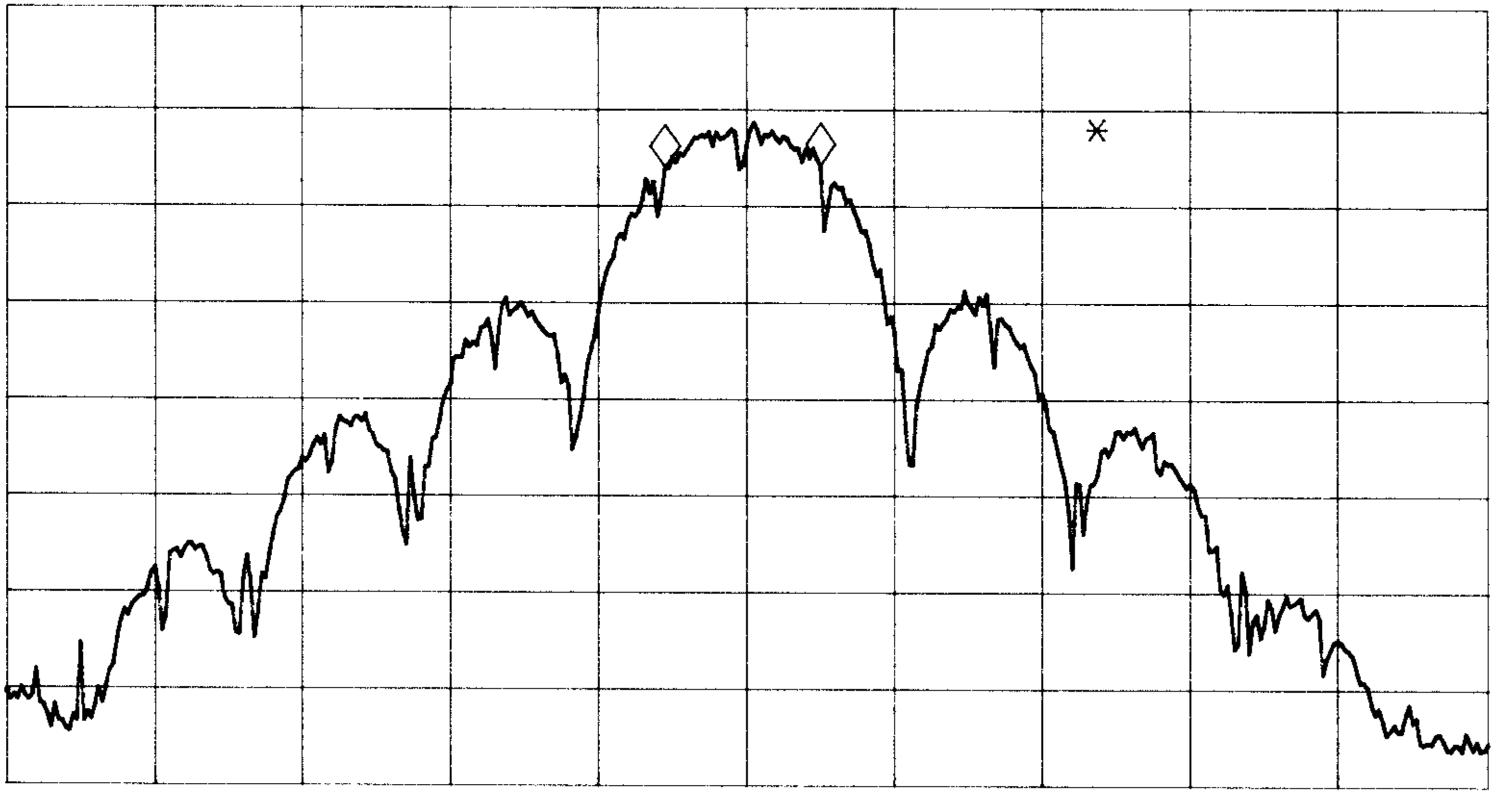
MARKER △
4.2Ø MHz
.23 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 4.2Ø MHz
.23 dB

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
#ATN
1Ø dB

VA SB
SC FC
CORR



CENTER 2.4Ø863 GHz
#IF BW 3Ø kHz
#AVG BW 3ØØ kHz
SPAN 4Ø.ØØ MHz
#SWP 5Ø.Ø sec

UltraTech Engineering Labs Inc.

hp

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #4

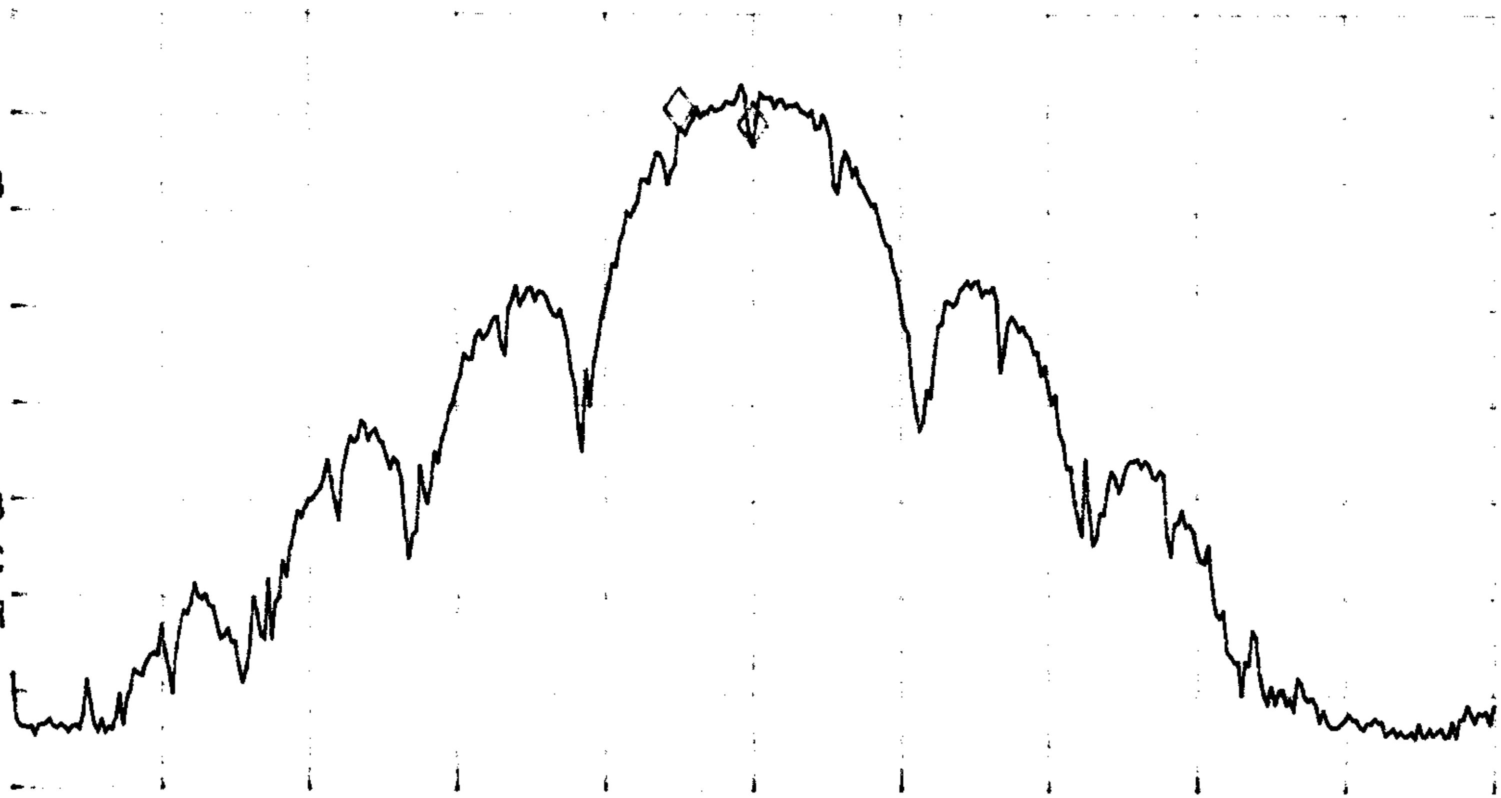
MARKER Δ
2.50 MHz
-1.67 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.50 MHz
-1.67 dB

No user Menu

REF OFFST 20.0 dB
LOG REF 15.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



CENTER 2.41144 GHz
#IF BW 30 kHz
#AVG BW 300 kHz
SPAN 50.00 MHz
#SWP 20.0 sec

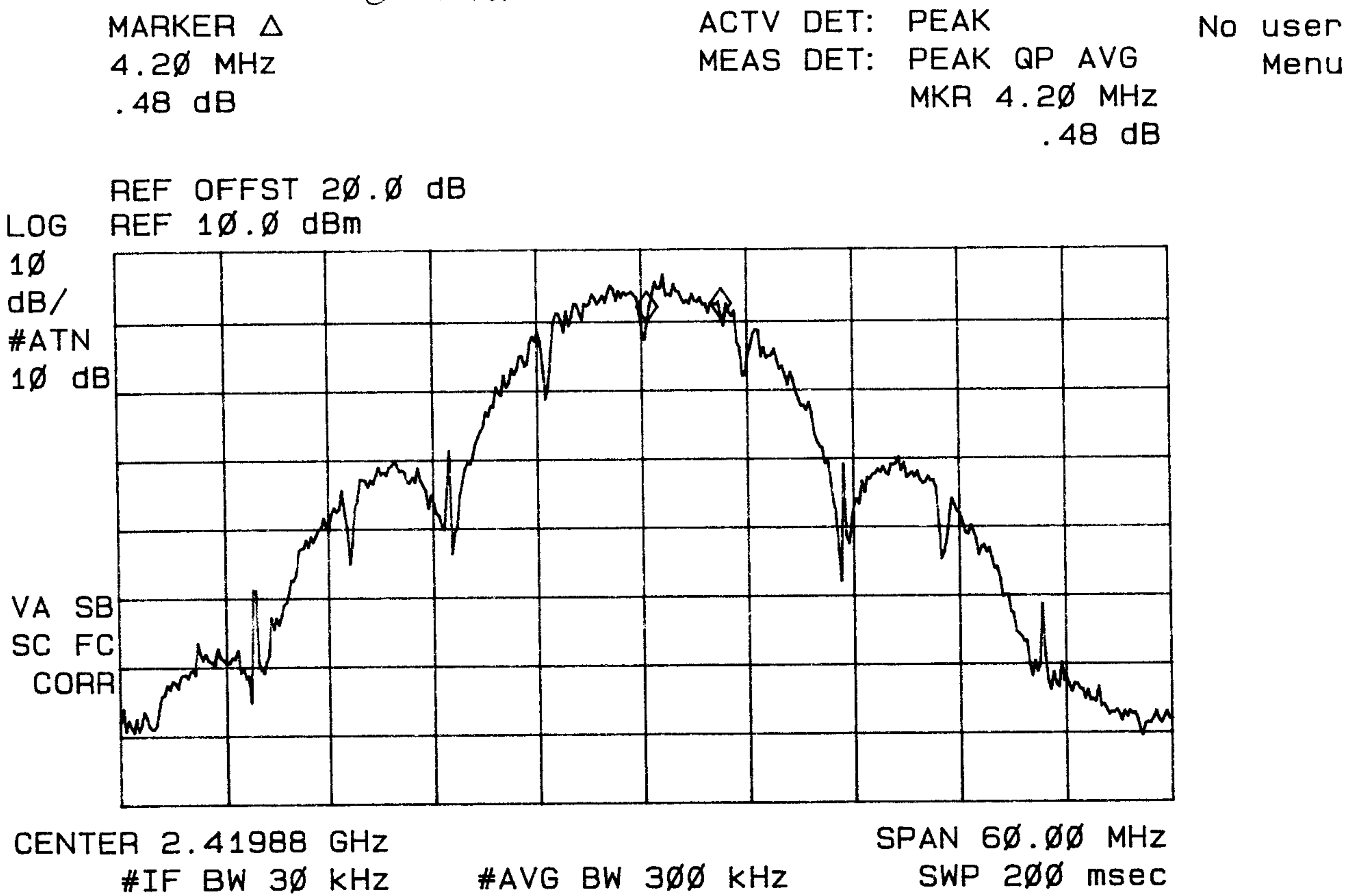
UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 1, Tx Frequency: 2419.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

hp

Channel #6.



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 2, Tx Frequency: 2431.125 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 1? /98
Tested by: Tri Luu

hp

Channel # 6

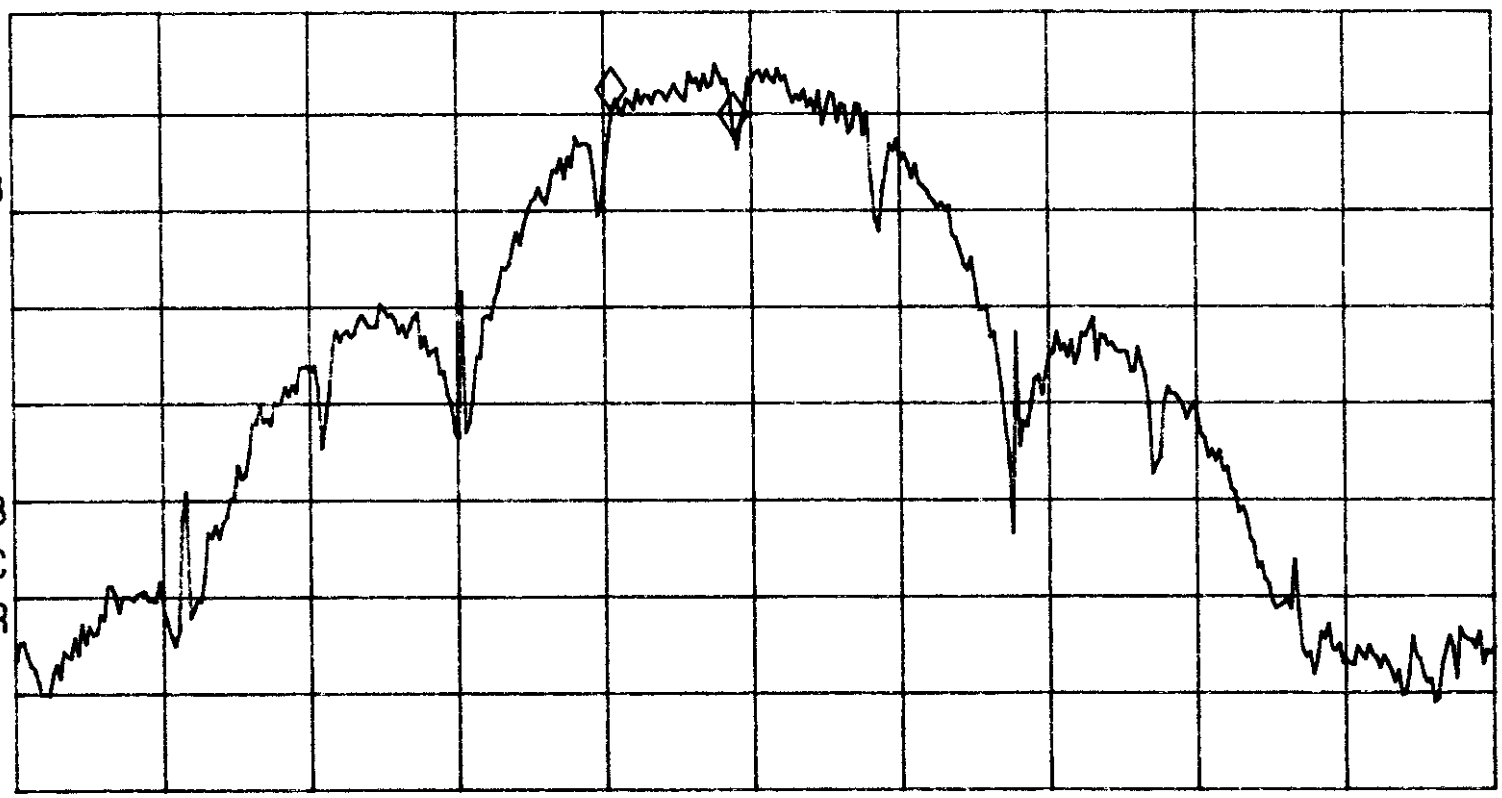
MARKER Δ
4.95 MHz
-2.55 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 4.95 MHz
-2.55 dB

No user Menu

REF OFFST 20.0 dB
LOG REF 10.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



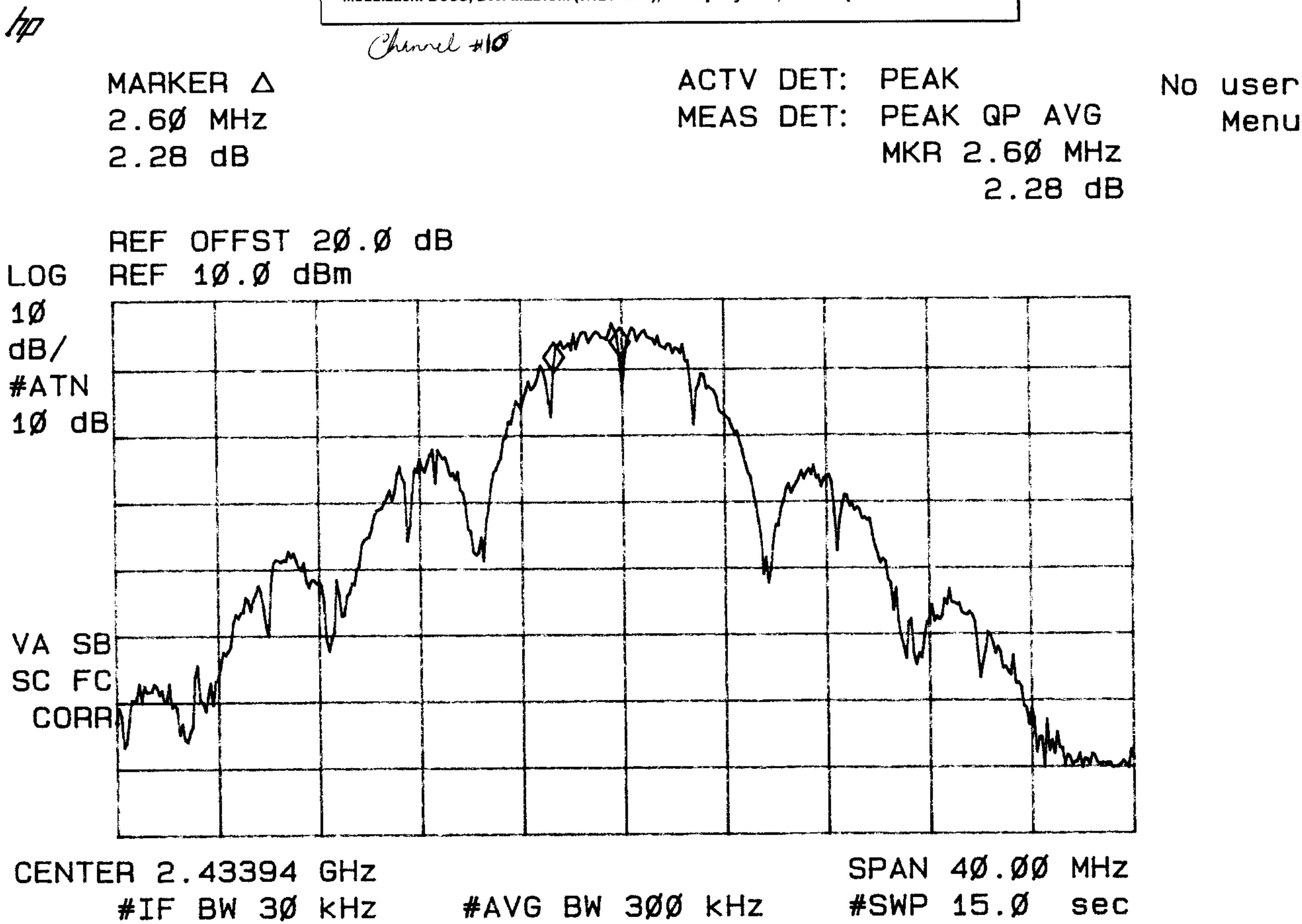
CENTER 2.43188 GHz
#IF BW 30 kHz
#AVG BW 300 kHz
SPAN 60.00 MHz
SWP 200 msec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 5, Tx Frequency: 2433.9375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #10



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 3, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #15

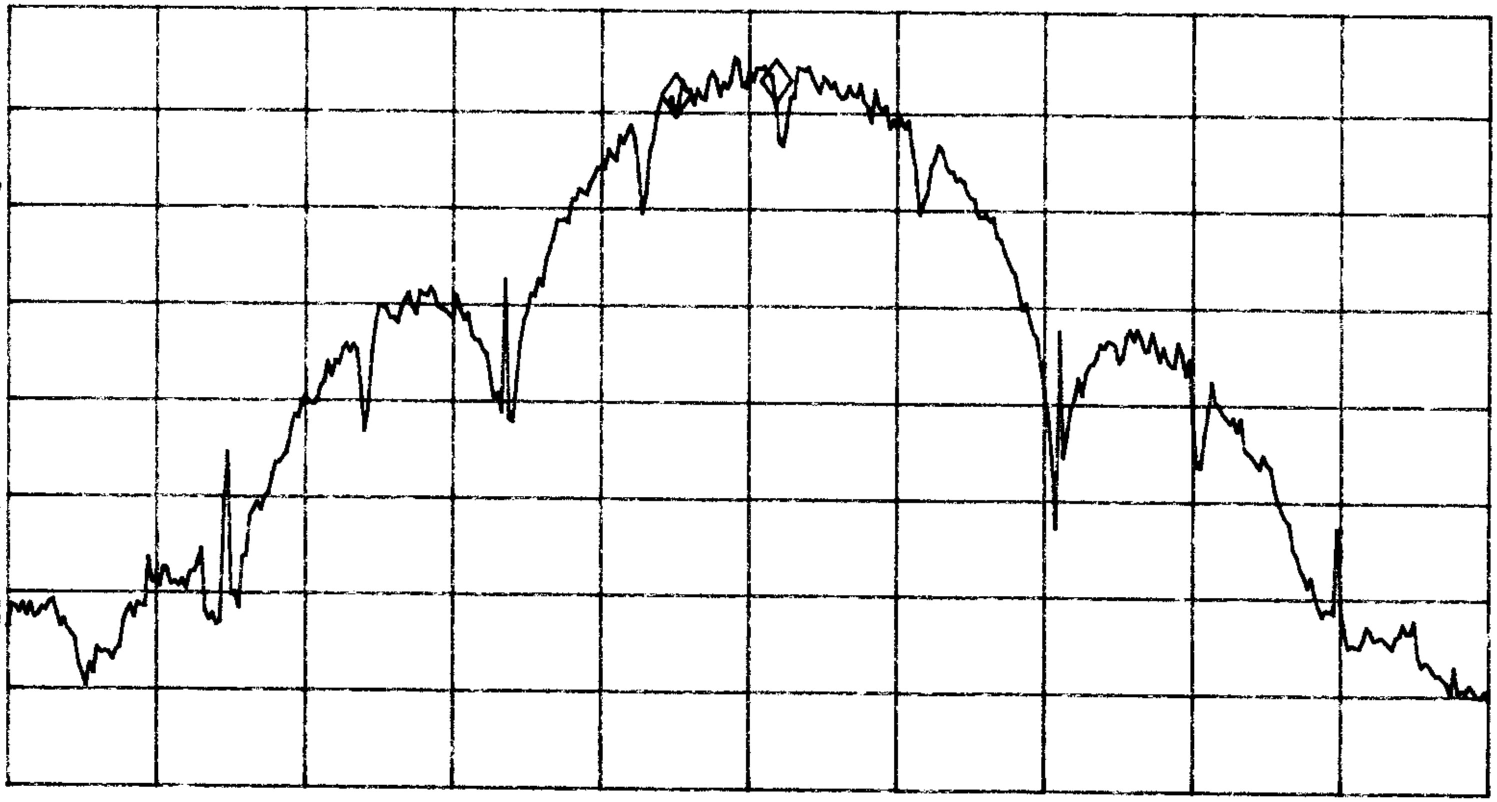
MARKER Δ
4.Ø5 MHz
1.49 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 4.Ø5 MHz
1.49 dB

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 1Ø.Ø dBm
1Ø
dB/
#ATN
1Ø dB

VA SB
SC FC
CORR



CENTER 2.4525Ø GHz
#IF BW 3Ø kHz
#AVG BW 3ØØ kHz
SPAN 6Ø.ØØ MHz
SWP 2ØØ msec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu

hp

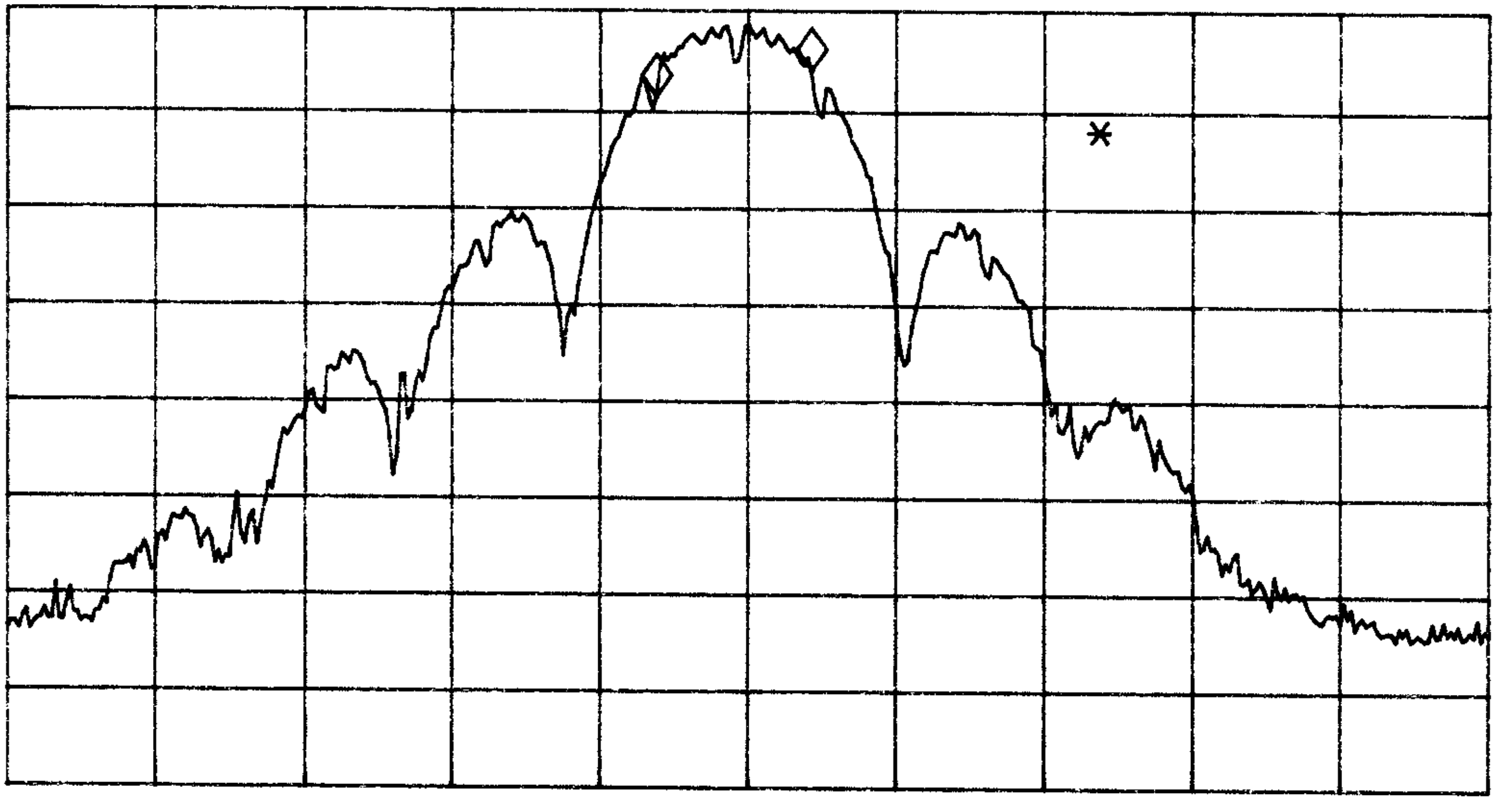
MARKER Δ
5.25 MHz
2.74 dB

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 5.25 MHz
2.74 dB

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 1Ø.Ø dBm
1Ø
dB/
ATN
1Ø dB

VA SB
SC FC
CORR



CENTER 2.4625Ø GHz
#IF BW 1ØØ kHz #AVG BW 3ØØ kHz
SPAN 5Ø.ØØ MHz
#SWP 7.5Ø sec

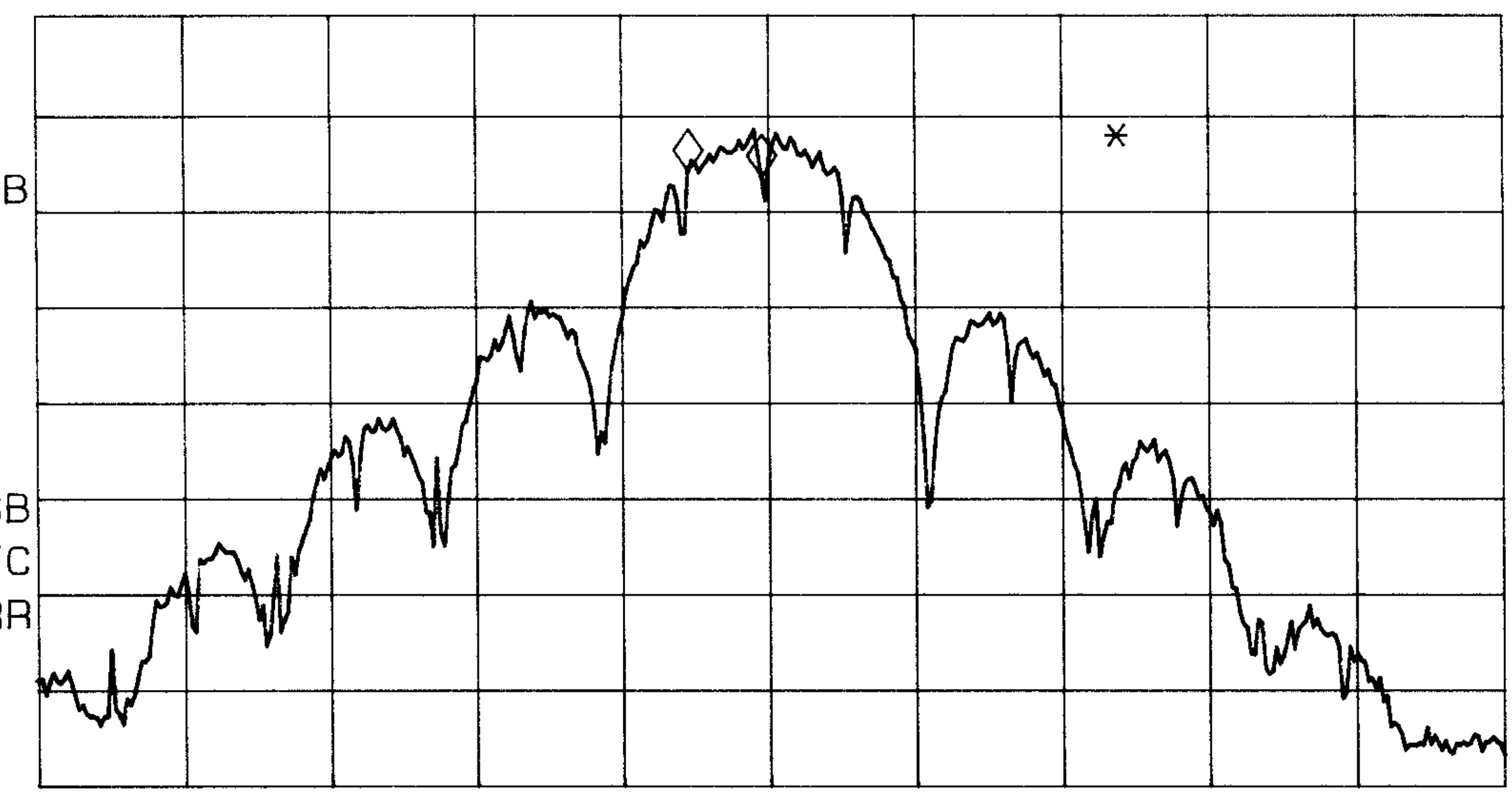
UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 8, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #18



4.2 Maximum Peak Output Power @ FCC 15.247(b) and RF Exposure Limit FCC 1.1310

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

FCC 15.247(b):- Maximum peak output power of the transmitter shall not exceed 1 Watt.

(i) Systems operating in the 2400-2483.5 MHz band that used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduce by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

FCC 1.1310:- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
(B) Limits for General Population/Uncontrolled Exposure				
300-1500	...	...	F/1500	6
1500-100,000	...	...	1.0	30

F = Frequency in MHz
* = Plane-wave equivalent power density

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- HP RF Peak Power Meter, Model 8900, S/N: 2131A00124, Measuring Freq. Range: 01 - 18 GHz, 50 Ohm IN.
- HP RF Peak Power Sensor, Model 8481A, S/N: 2551A01965, Measuring Freq. Range: 0.1 - 18 GHz, 50 Ohm IN/OUT

METHOD OF MEASUREMENTS:

FCC @ 1.1310 & OST Bulletin No. 65-October 1985

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

Where:
- P: power input to the antenna in mW
- EIRP: Equivalent (effective) isotropic radiated power.
- S: power density mW/cm^2
- G: numeric gain of antenna relative to isotropic radiator
- r: distance to centre of radiation in cm

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

$r = \sqrt{PG/4\Pi S}$

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

TEST ARRANGEMENT

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Feb. 26, 1998

MEASUREMENT DATA:

PEAK POWER MEASUREMENT

Maximum Antenna Gain provided: 17 dBi
FCC Power Output Limit = 30 dBm – (17 dBi - 6 dBi)/3 = 29.3 dBm or 851 mWatts

Channel No.	Channel Frequency	Modulation Bandwidth	Data Rate (Mb/s)	Chips per Symbol	Measured Peak Power (mWatts)	FCC Limit (mWatts)
3	2408.625	Narrow	4.5	11	190	851
4	2411.4375	Medium	5.625	11	190	851
6	2419.875	Wide	11.25	11	190	851
9	2431.125	Wide	11.25	11	190	851
10	2433.9375	Medium	5.625	11	190	851
15	2453.625	Wide	11.25	11	190	851
17	2462.0625	Medium	5.625	11	190	851
18	2464.875	Narrow	4.5	11	190	851

Note: The power density or SAR tests were not applicable to this type of equipment. Since the transmitting antenna is located outdoor far away from the user (at least 30 ft away).

4.3 RF Conducted Emissions at the Transmitter Antenna Terminal, FCC CFR 47, Para. 15.247(c)

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT
- Microphase Highpass Filter, P/N: CR220HIB, S/N: 1301, Cut-off Freq. 1.8 GHz. (Optional)

METHOD OF MEASUREMENT:

A scan was made by using a spectrum analyzer with the detector function set to PEAK mode.

Set RBW = 100 KHz, VBW = 100 KHz.

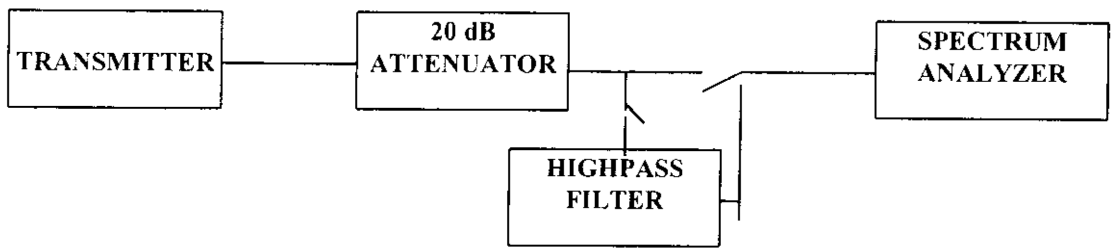
FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10^{th} harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.991 - Spurious Emissions at Antenna Terminal

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.989 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

TEST ARRANGEMENT



TEST RESULTS:

Conforms.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Feb. 26, 1998

MEASUREMENT DATA

SPURIOUS & HARMONIC EMISSIONS AT THE TRANSMITTER ANTENNA TERMINAL

TEST CONFIGURATION

- *The transmitter was coupled to the Spectrum Analyzer through a 20 dB attenuator.*
- *The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 20 dB*
- *The channel frequencies were established on the extreme edges (both upper and lower) and middle of the 2408.625 - 2464.875 MHz band at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 15.247(c)*

Channel #: 3, Frequency: 2408.625 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, narrow, 11 chips/symbol, Data Rate: 4.5 Mb/s, 2 bits/symbol			**Power Level in 100 KHz BW: 9.7 dBm Limit = 9.7 dBm - 20 dB = -10.3 dBm**		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2408.6	9.7	Peak	--	--	PASS
451.0	-46.7	Peak	-10.3	-36.4	PASS
1498.0	-44.5	Peak	-10.3	-34.2	PASS
2374.0	-43.0	Peak	-10.3	-32.7	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 4, Frequency: 2411.4375 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, medium , 11 chips/symbol, Data Rate: 5.625 Mb/s, 2 bits/symbol			**Power Level in 100 KHz BW: 9.1 dBm Limit = 9.1 dBm - 20 dB = -10.9 dBm**		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2411.4	9.1	Peak	--	--	PASS
451.0	-45.6	Peak	-10.9	-34.7	PASS
1496.4	-39.9	Peak	-10.9	-29.0	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 6, Frequency: 2419.875 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, wide, 11 chips/symbol, Data Rate: 11.25 Mb/s, 2 bits/symbol			Power Level in 100 KHz BW: 9.1 dBm Limit = 9.1 dBm - 20 dB = -10.9 dBm		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2419.9	9.1	Peak	--	--	PASS
1504.9	-38.6	Peak	-10.9	-27.7	PASS
2382.3	-38.7	Peak	-10.9	-27.8	PASS
2386.0	-41.8	Peak	-10.9	-30.9	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 9, Frequency: 2431.125 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, wide, 11 chips/symbol, Data Rate: 11.25 Mb/s, 2 bits/symbol			Power Level in 100 KHz BW: 8.7 dBm Limit = 8.7 dBm - 20 dB = -11.3 dBm		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2431.1	8.7	Peak	--	--	PASS
1516.1	-41.3	Peak	-11.3	-30.0	PASS
2396.5	-40.5	Peak	-11.3	-29.2	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 10, Frequency: 2433.9375 Full Rated Peak Power: 190 mW Modulation: DQPSK, medium, 11 chips/symbol, Data Rate: 5.625 Mb/s, 2 bits/symbol			Power Level in 100 KHz BW: 8.7 dBm Limit = 8.7 dBm - 20 dB = -11.3 dBm		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2433.9	8.7	Peak	--	--	PASS
2398.5	-45.4	Peak	-11.3	-34.1	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 15, Frequency: 2453.625 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, wide, 11 chips/symbol, Data Rate: 11.25 Mb/s, 2 bits/symbol			**Power Level in 100 KHz BW: 8.9 dBm Limit = 8.9 dBm - 20 dB = -11.1 dBm**		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2453.6	8.9	Peak	--	--	PASS
1538.6	-38.3	Peak	-11.1	-27.2	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 17, Frequency: 2462.0625 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, medium, 11 chips/symbol, Data Rate: 5.625 Mb/s, 2 bits/symbol			**Power Level in 100 KHz BW: 8.6 dBm Limit = 8.6 dBm - 20 dB = -11.4 dBm**		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2462.1	8.6	Peak	--	--	PASS
494.0	-48.7	Peak	-11.4	-37.3	PASS
1547.1	-45.5	Peak	-11.4	-34.1	PASS
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

Channel #: 18, Frequency: 2464.875 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, narrow, 11 chips/symbol, Data Rate: 4.5 Mb/s, 2 bits/symbol			**Power Level in 100 KHz BW: 8.6 dBm Limit = 8.6 dBm - 20 dB = -11.4 dBm**		
FREQUENCY (MHz)	RF LEVEL (dBm)	EMI DETECTOR (dBm)	LIMIT (dBm)	MARGIN (dB)	PASS/ FAIL
2464.875	9.5	Peak	--	--	PASS
No significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details					

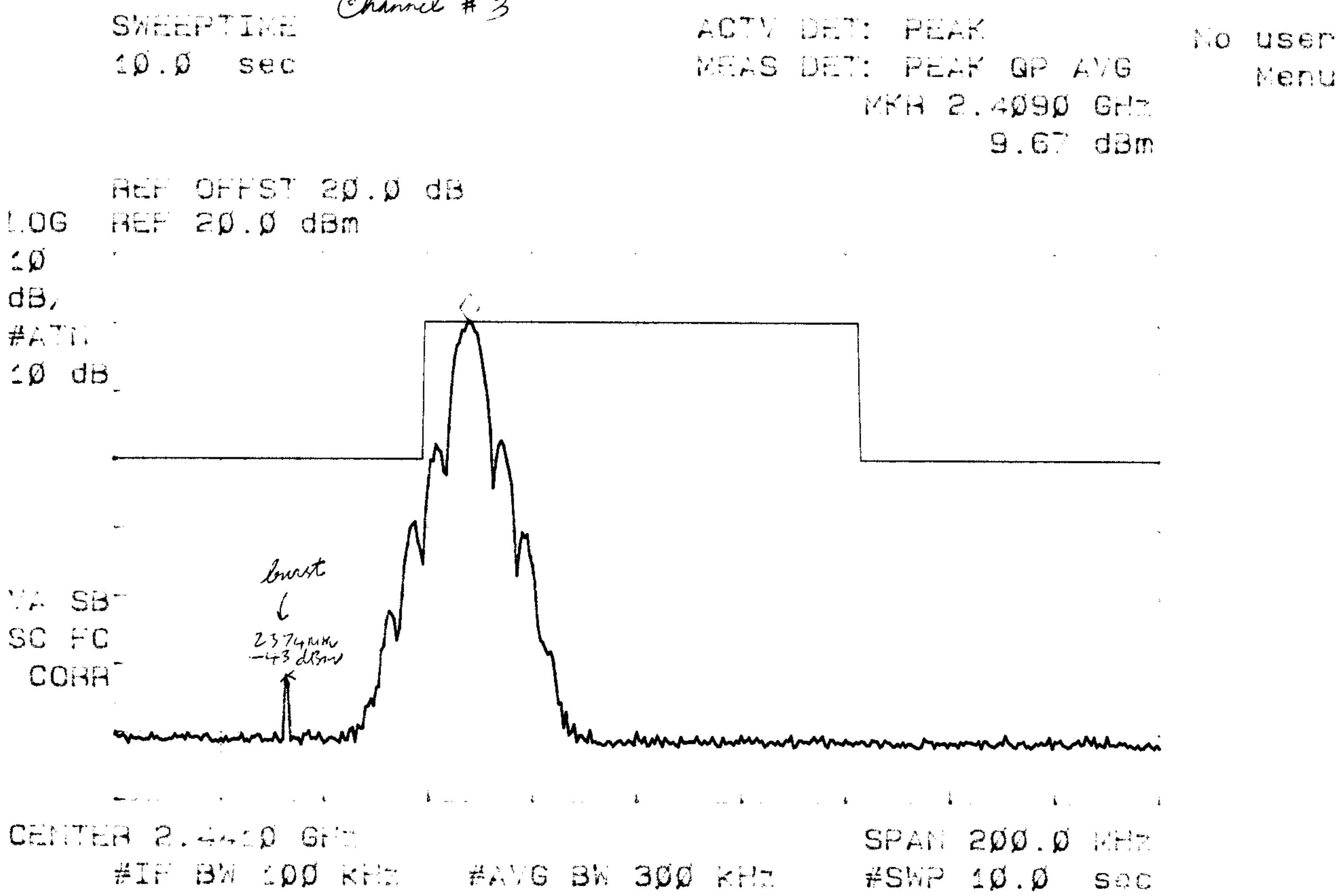
UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel # 3

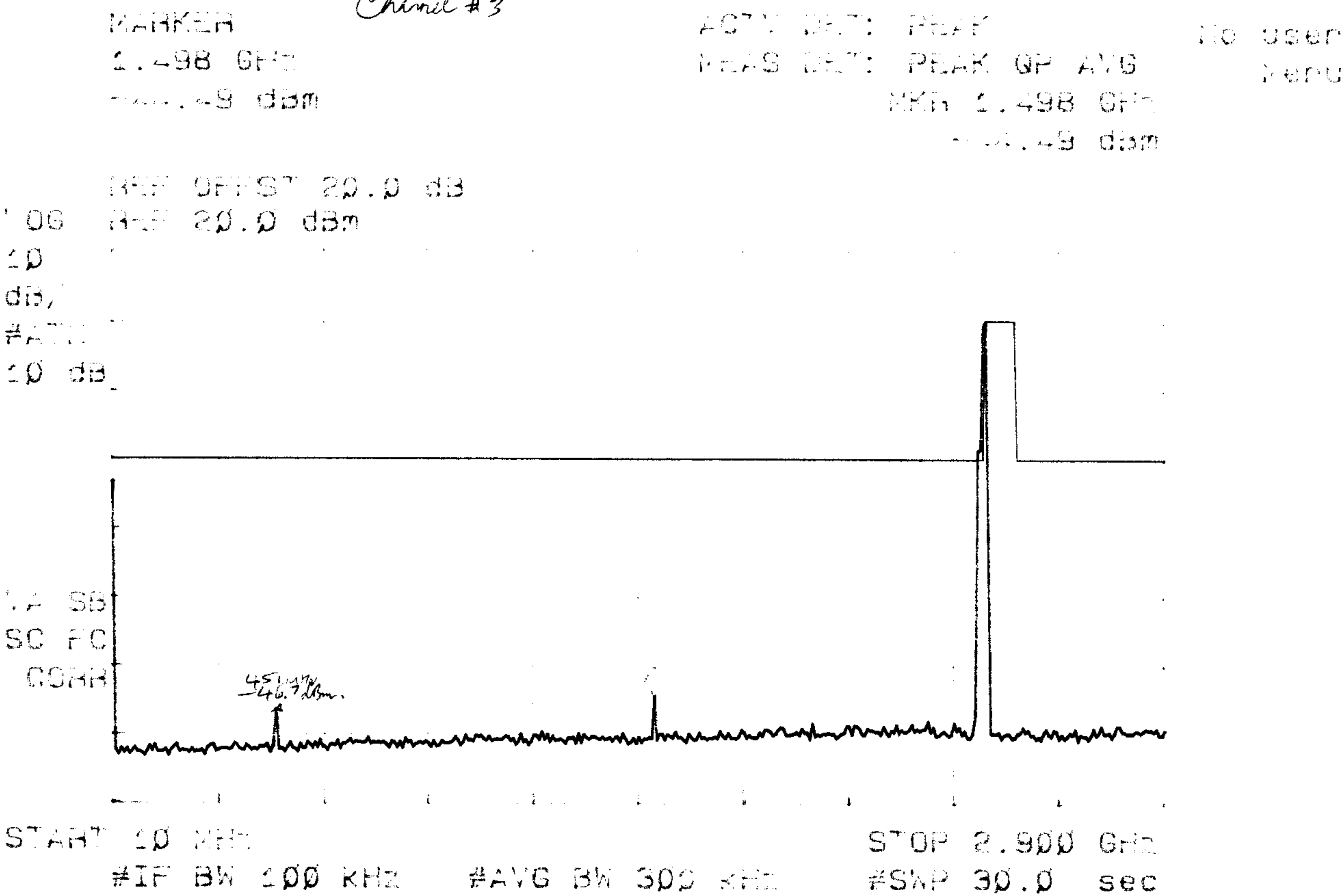


![UltraTech Engineering Labs Inc.]

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Chnnl #3

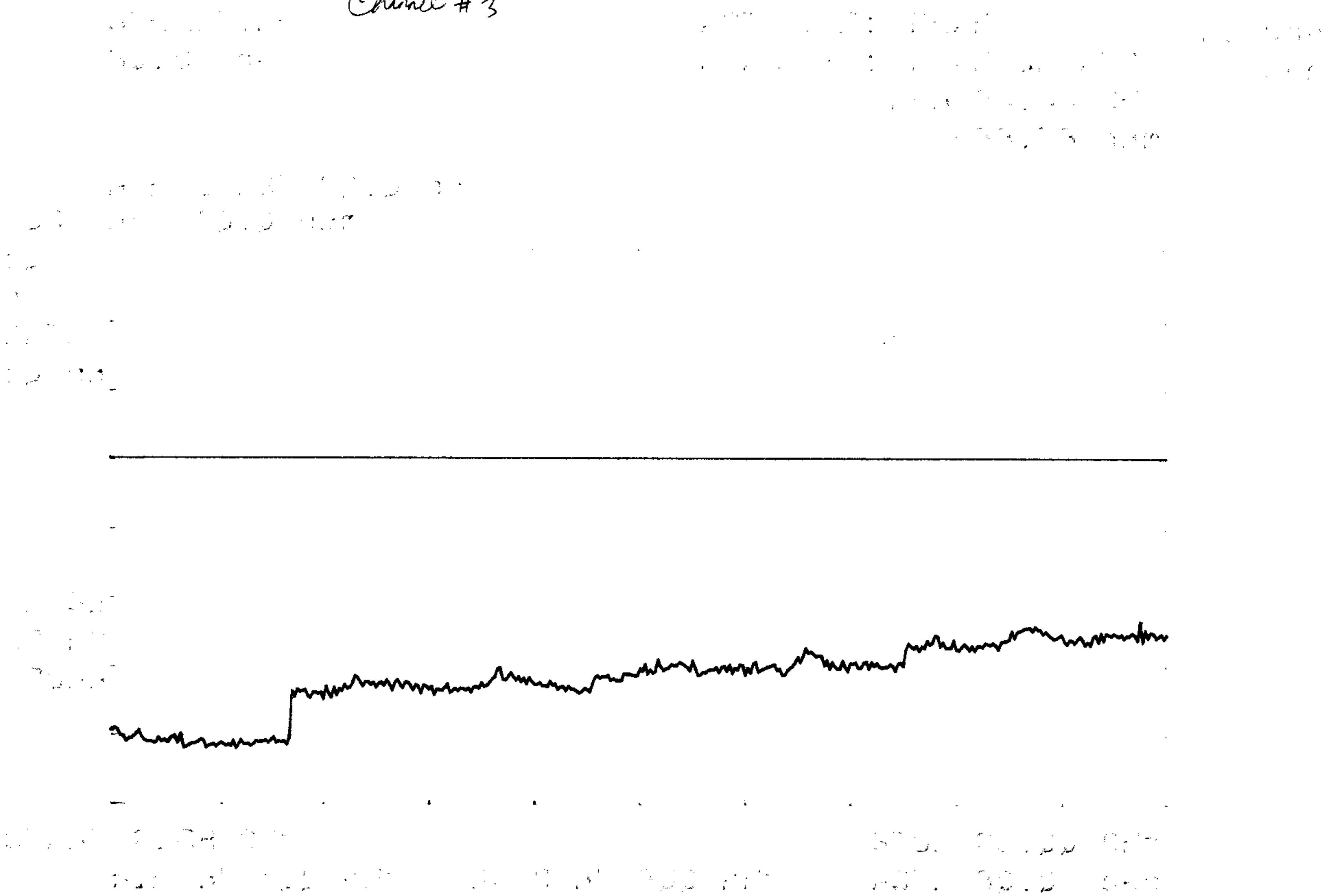


UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #3



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #4

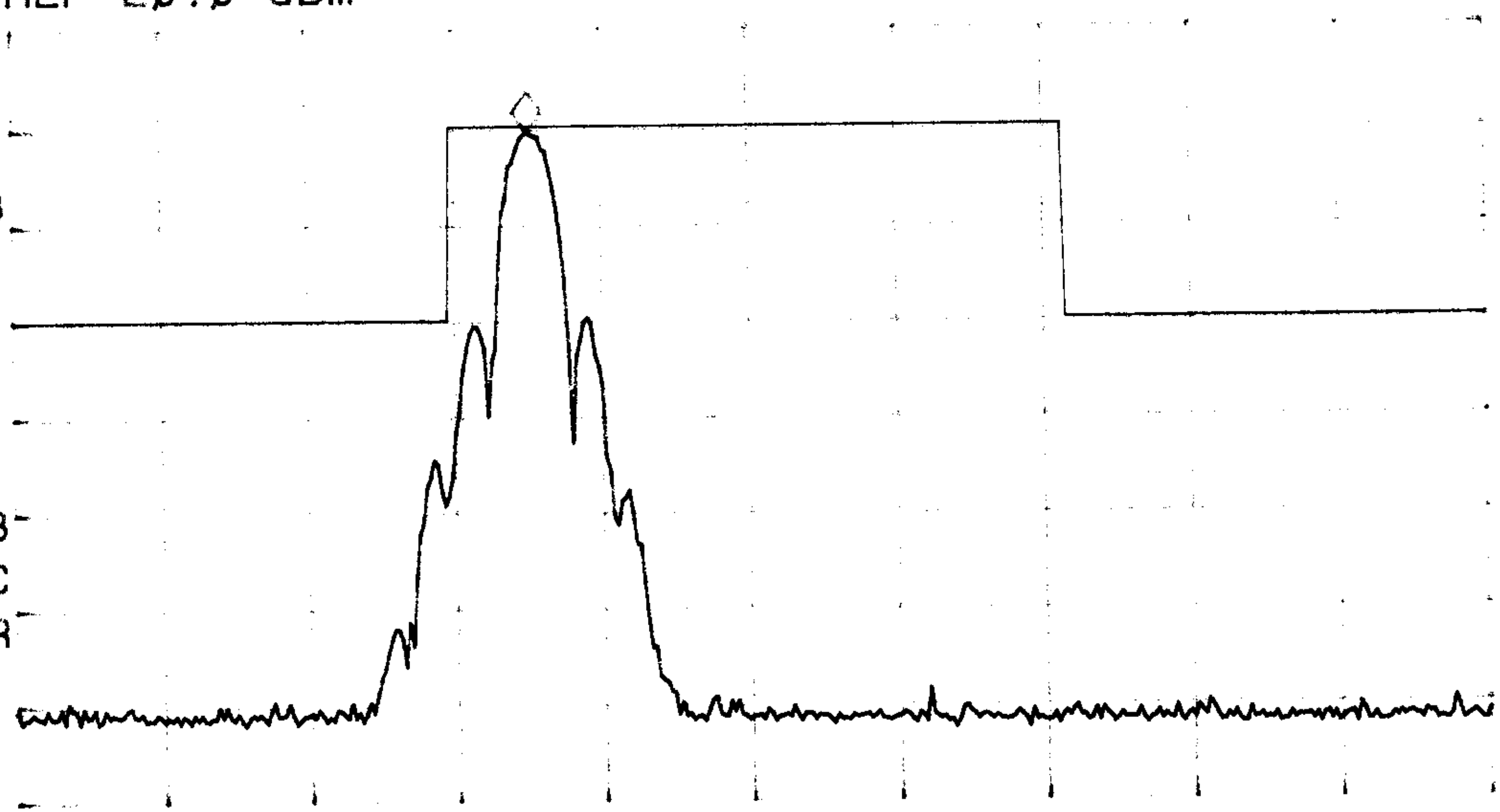
MARKER
2.4110 GHz
9.07 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4110 GHz
9.07 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



CENTER 2.4410 GHz
#IF BW 100 kHz #AVG BW 300 kHz
SPAN 200.0 MHz
#SWP 20.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #4

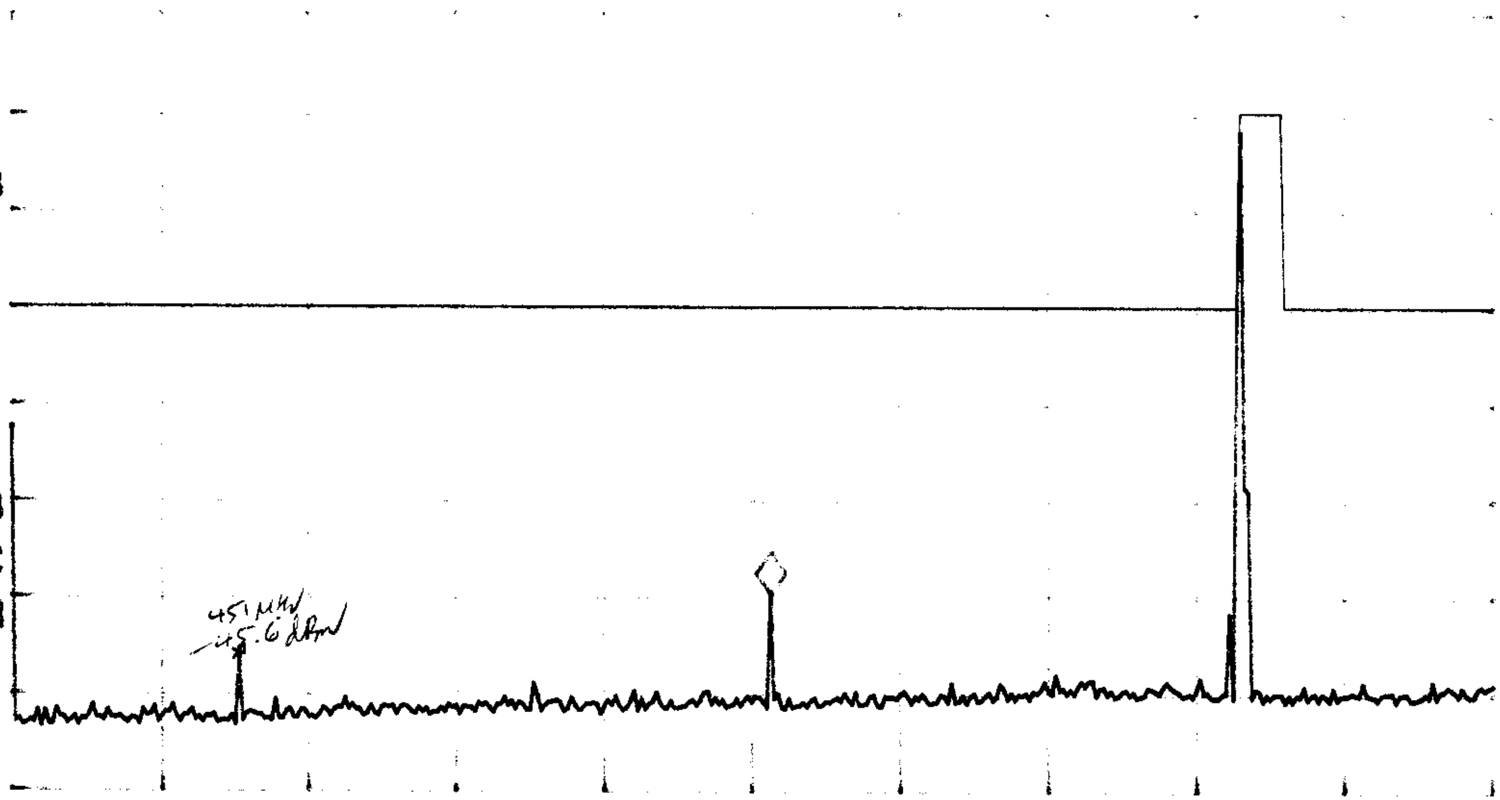
MARKER
1.491 GHz
-39.86 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.491 GHz
-39.86 dBm

No user Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



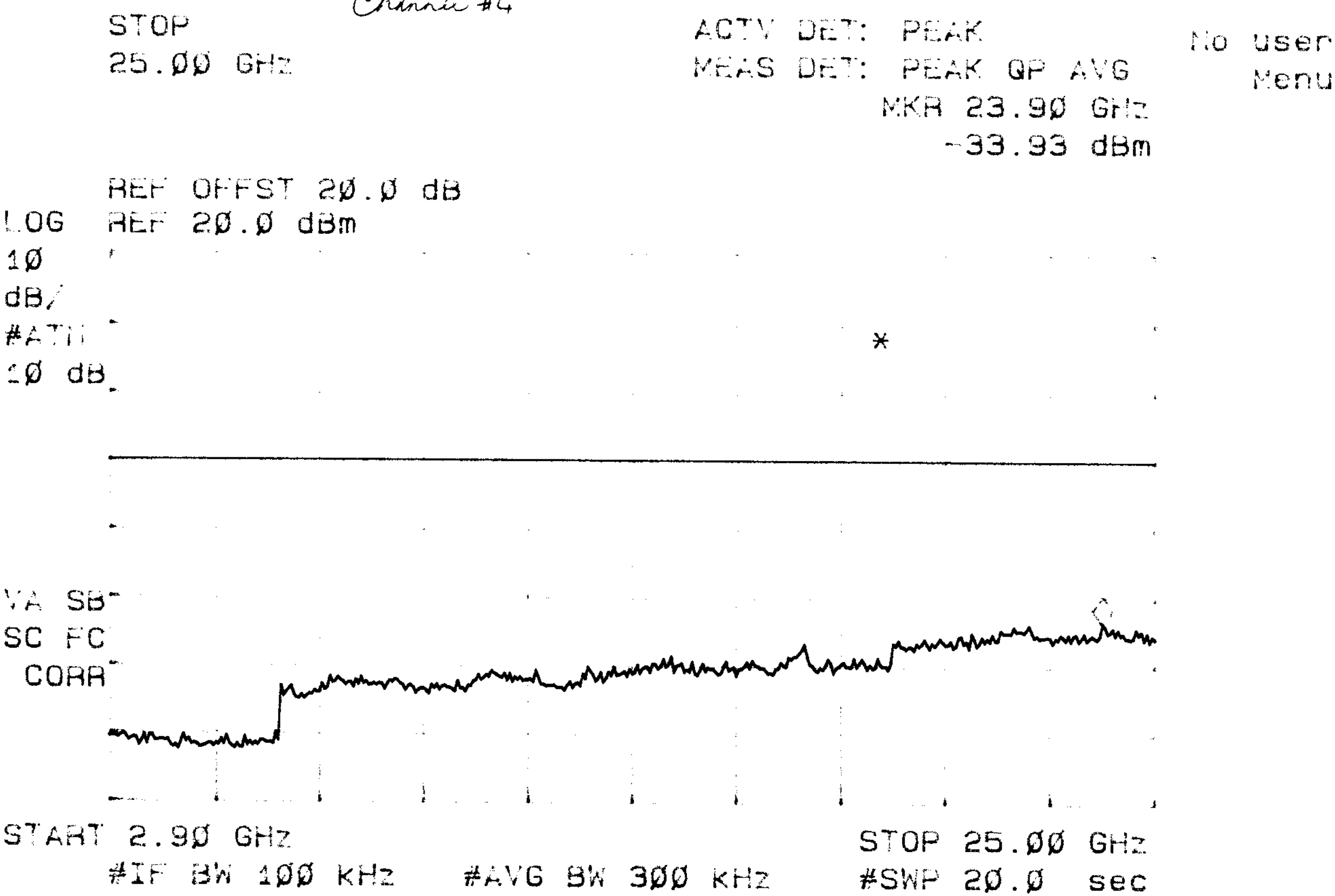
START 10 MHz
#IF BW 100 kHz #AVG BW 300 kHz
STOP 2.900 GHz
#SWP 20.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #4



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 1, Tx Frequency: 2419.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

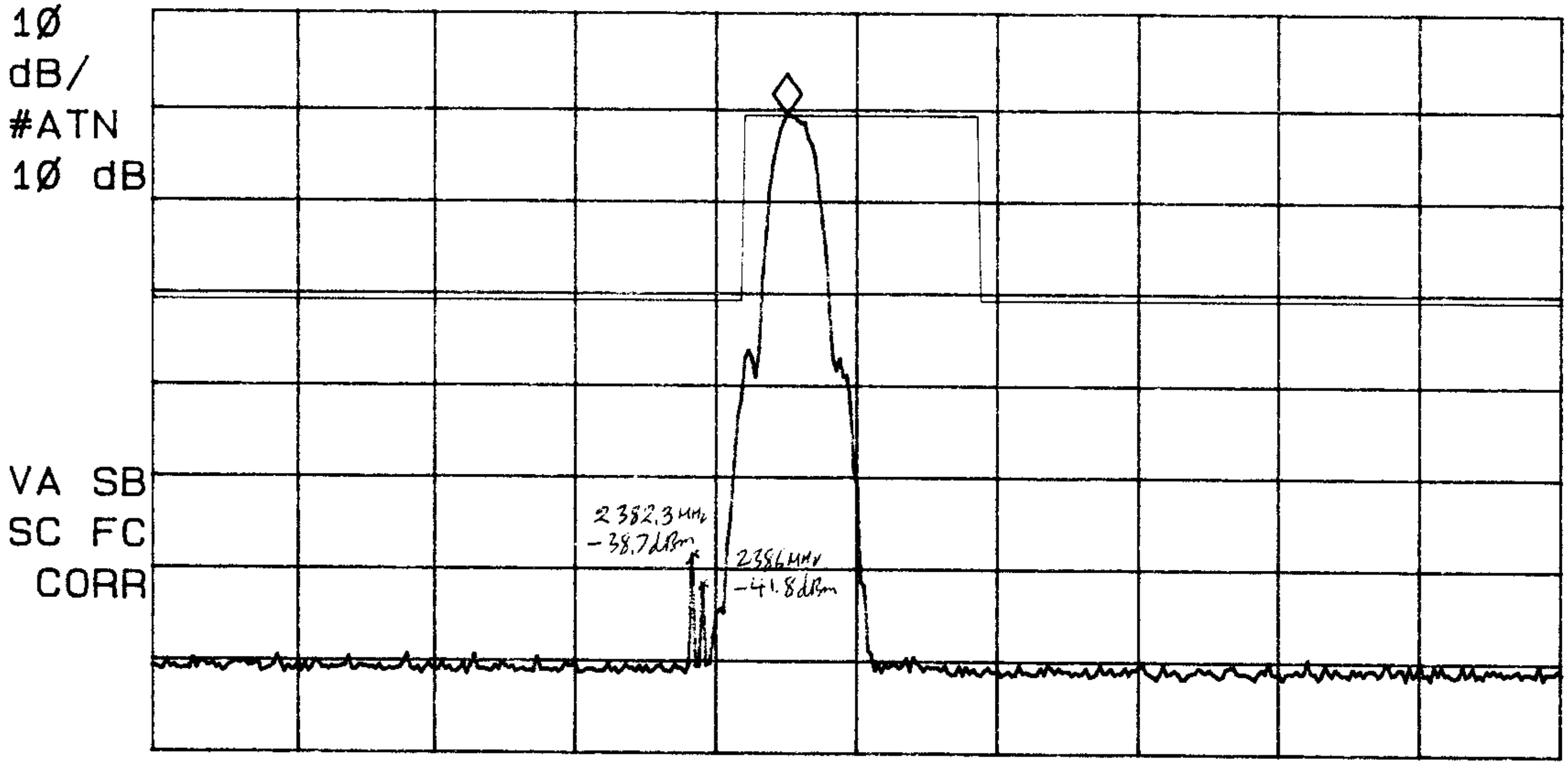
hp

Channel #6

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4160 GHz
9.07 dBm

No user Menu

REF OFFST 20.0 dB
REF 20.0 dBm



CENTER 2.4410 GHz
#IF BW 100 kHz #AVG BW 300 kHz
SPAN 500.0 MHz
#SWP 100 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 1, Tx Frequency: 2419.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

Channel #6

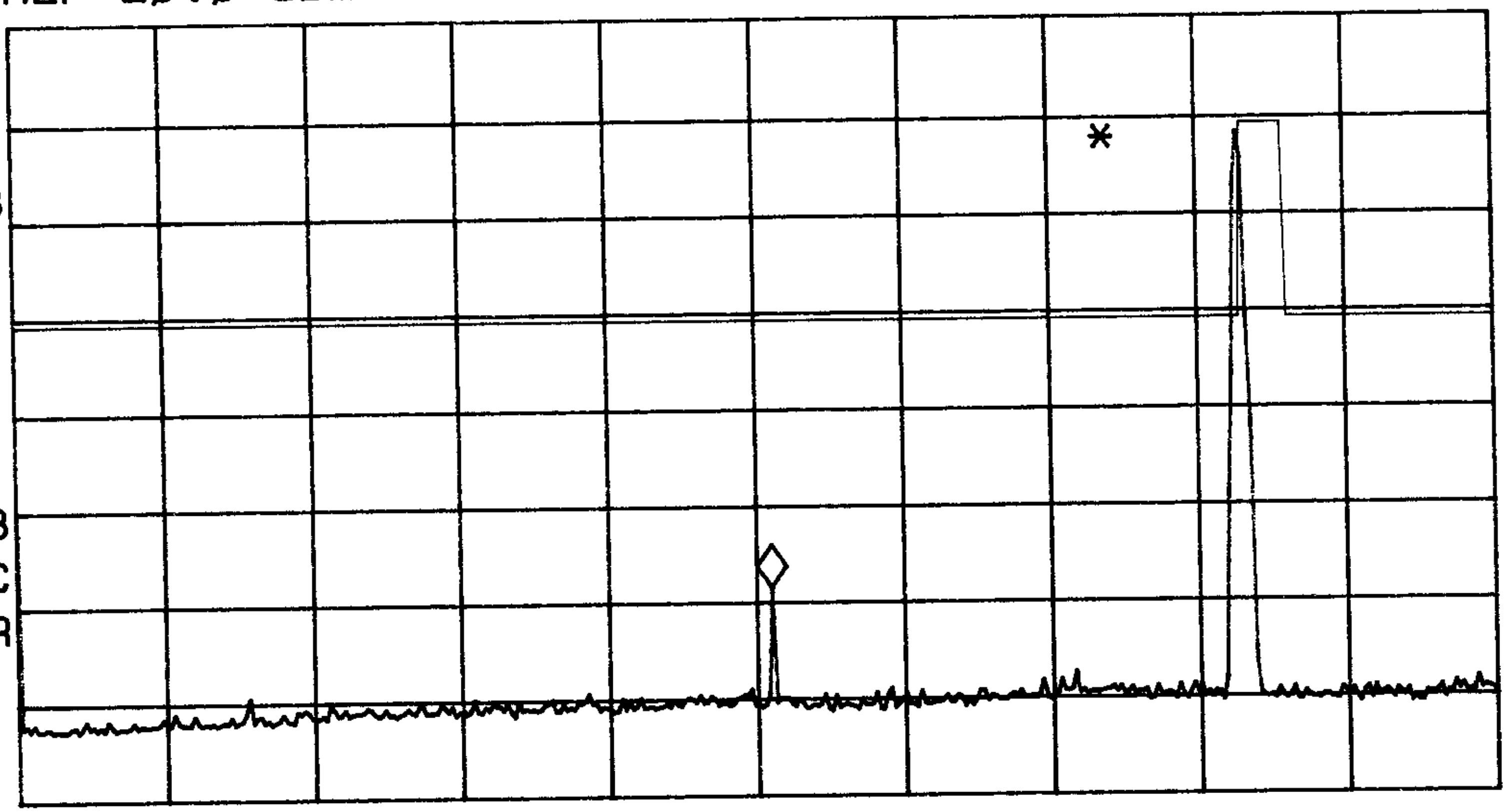
hp

MARKER
1.484 GHz
-38.55 dBm

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.484 GHz
-38.55 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB



VA SB
SC FC
CORR

START 10 MHz
#IF BW 100 kHz #AVG BW 300 kHz

STOP 2.900 GHz
#SWP 100 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 1, **Tx Frequency:** 2419.875 **MHz, RF Power: 0.19 W**
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

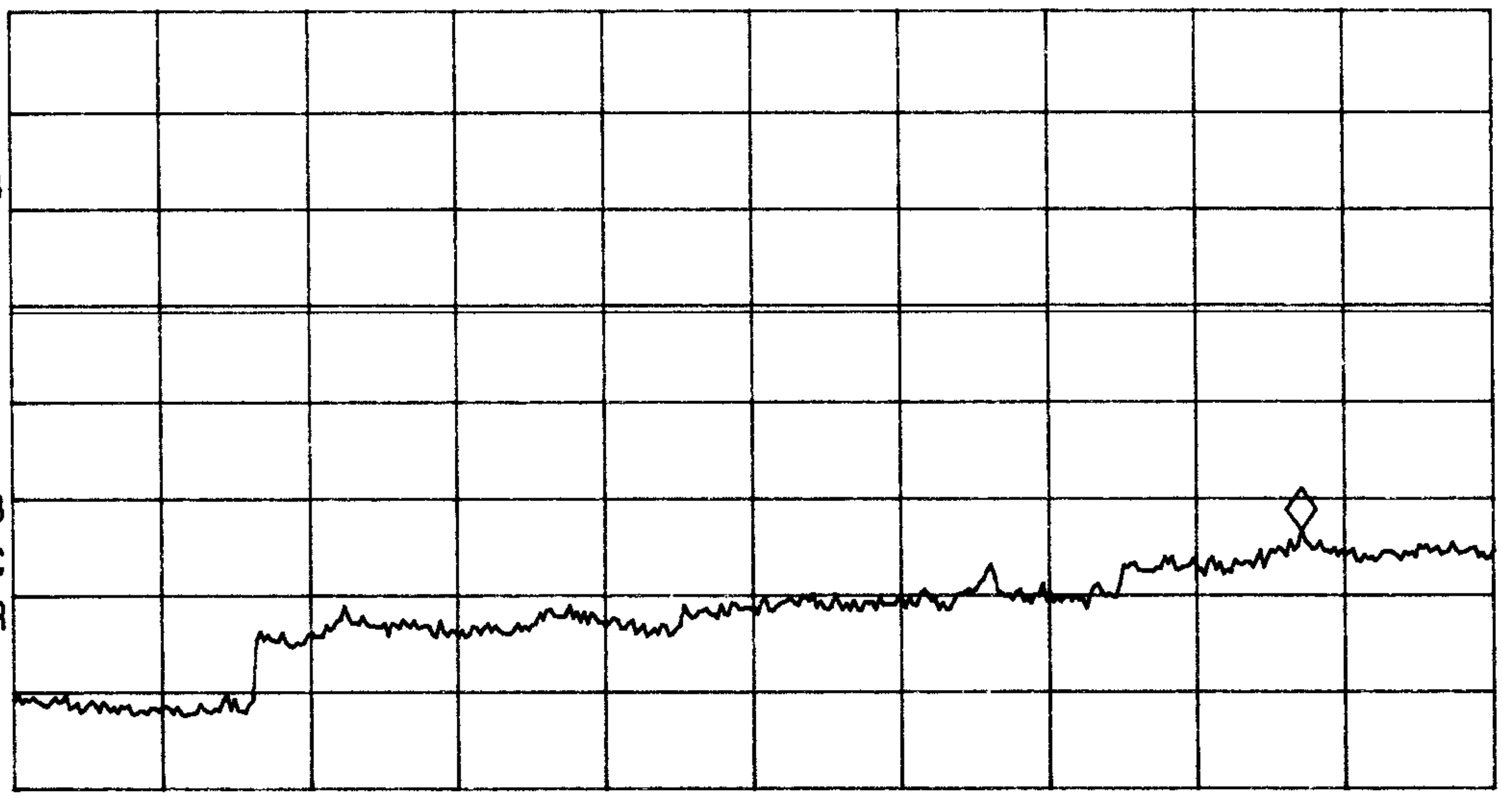
hp

Channel #6.

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 22.13 GHz
-33.51 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm



START 2.90 GHz
STOP 25.00 GHz
#IF BW 100 kHz
#AVG BW 300 kHz
SWP 6.63 sec

UltraTech Engineering Labs Inc.

hp

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 2, Tx Frequency: 2431.125 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

Channel #9

REF LEVEL
20.0 dBm

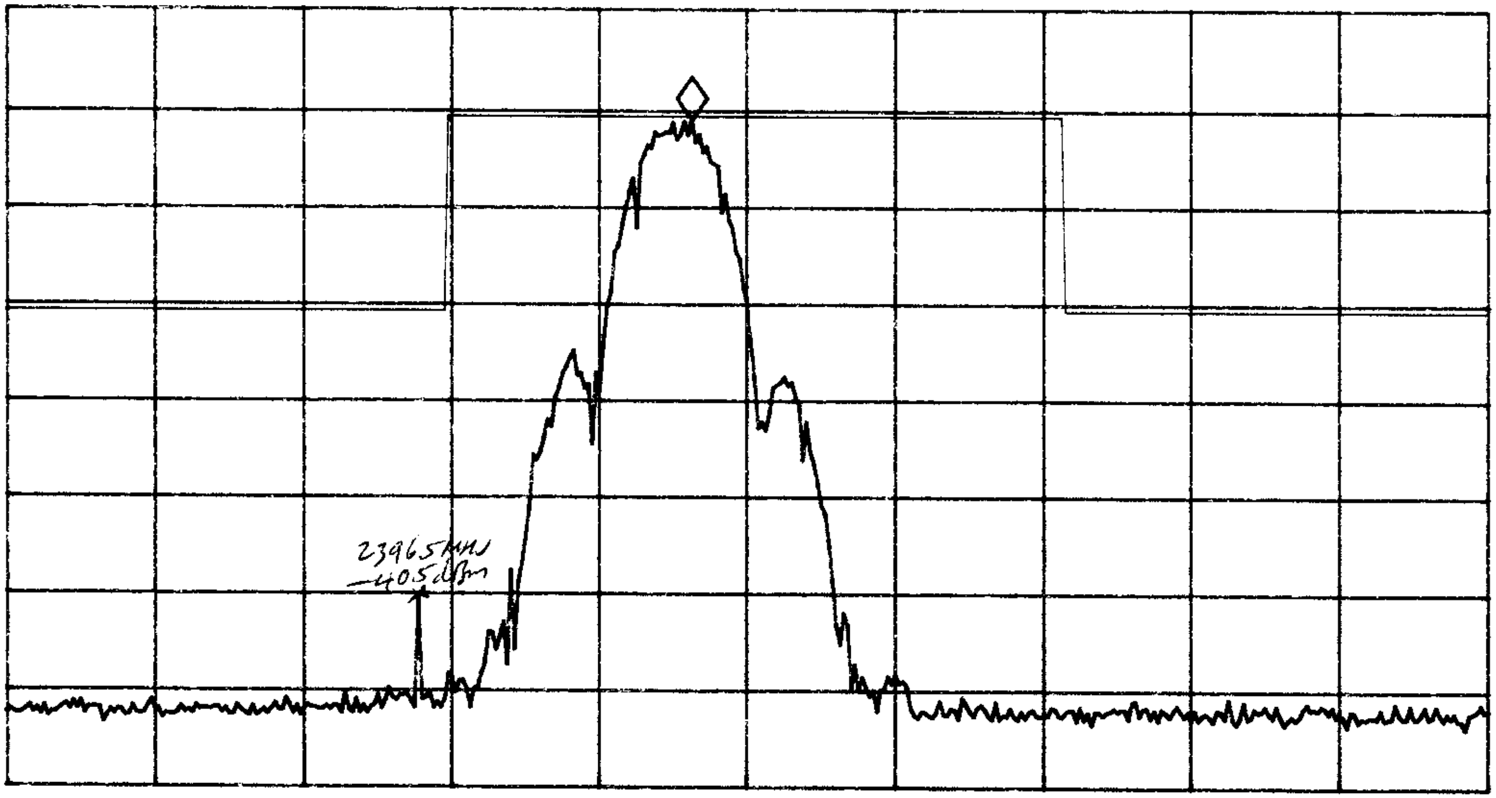
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4335 GHz
8.65 dBm

No user
Menu

REF OFFST 20.0 dB
REF 20.0 dBm

LOG
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



CENTER 2.4410 GHz
#IF BW 100 kHz
#AVG BW 300 kHz
SPAN 200.0 MHz
SWP 60.0 msec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 21, Tx Frequency: 2431.125 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

hp

Channel #A

MARKER
1.513 GHz
-41.31 dBm

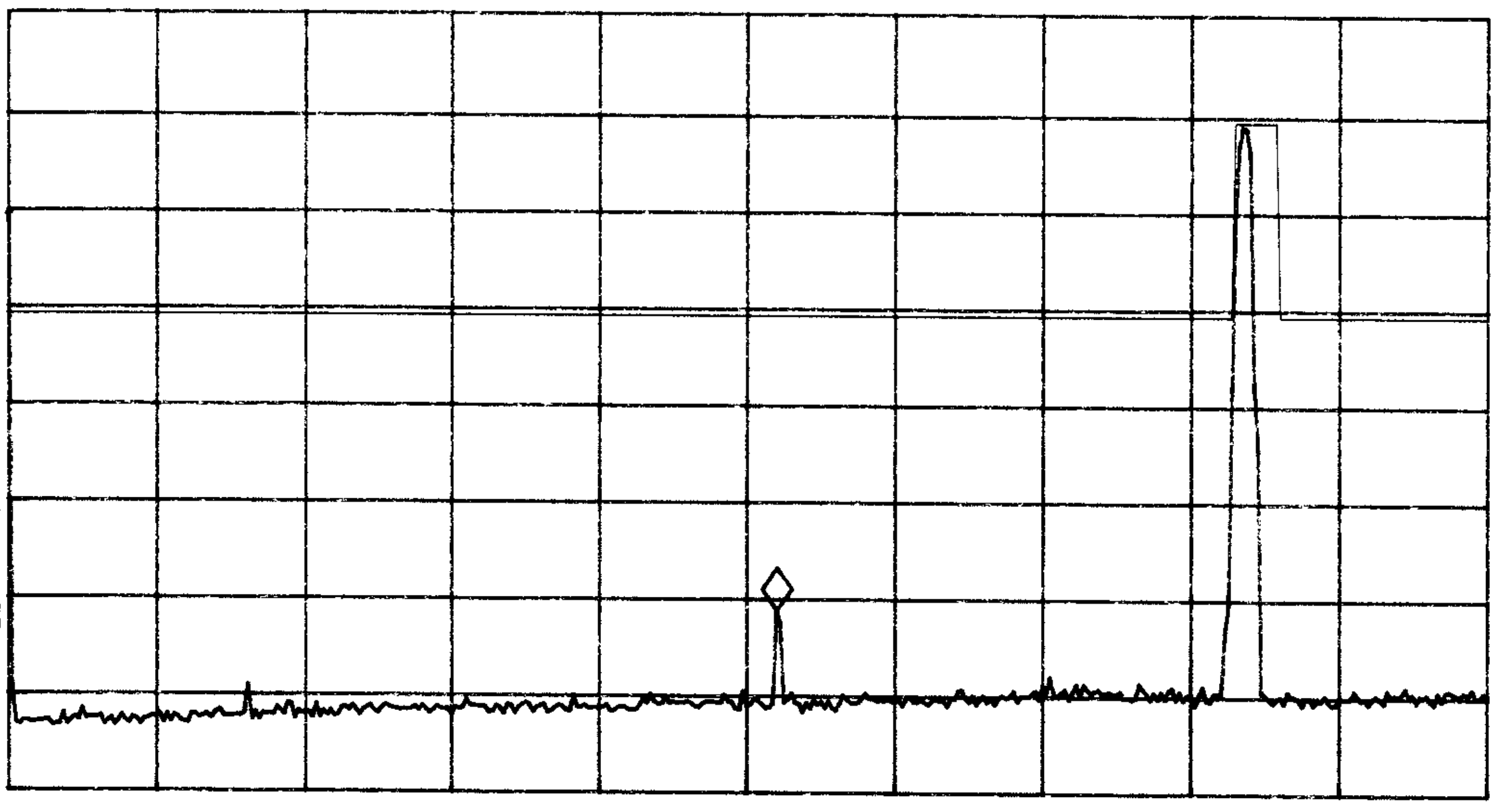
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.513 GHz
-41.31 dBm

No user Menu

REF OFFST 20.0 dB
REF 20.0 dBm

LOG
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



START 10 MHz
#IF BW 100 kHz
#AVG BW 300 kHz
STOP 2.900 GHz
#SWP 10.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 2, Tx Frequency: 2431.125 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

Channel #9

hp

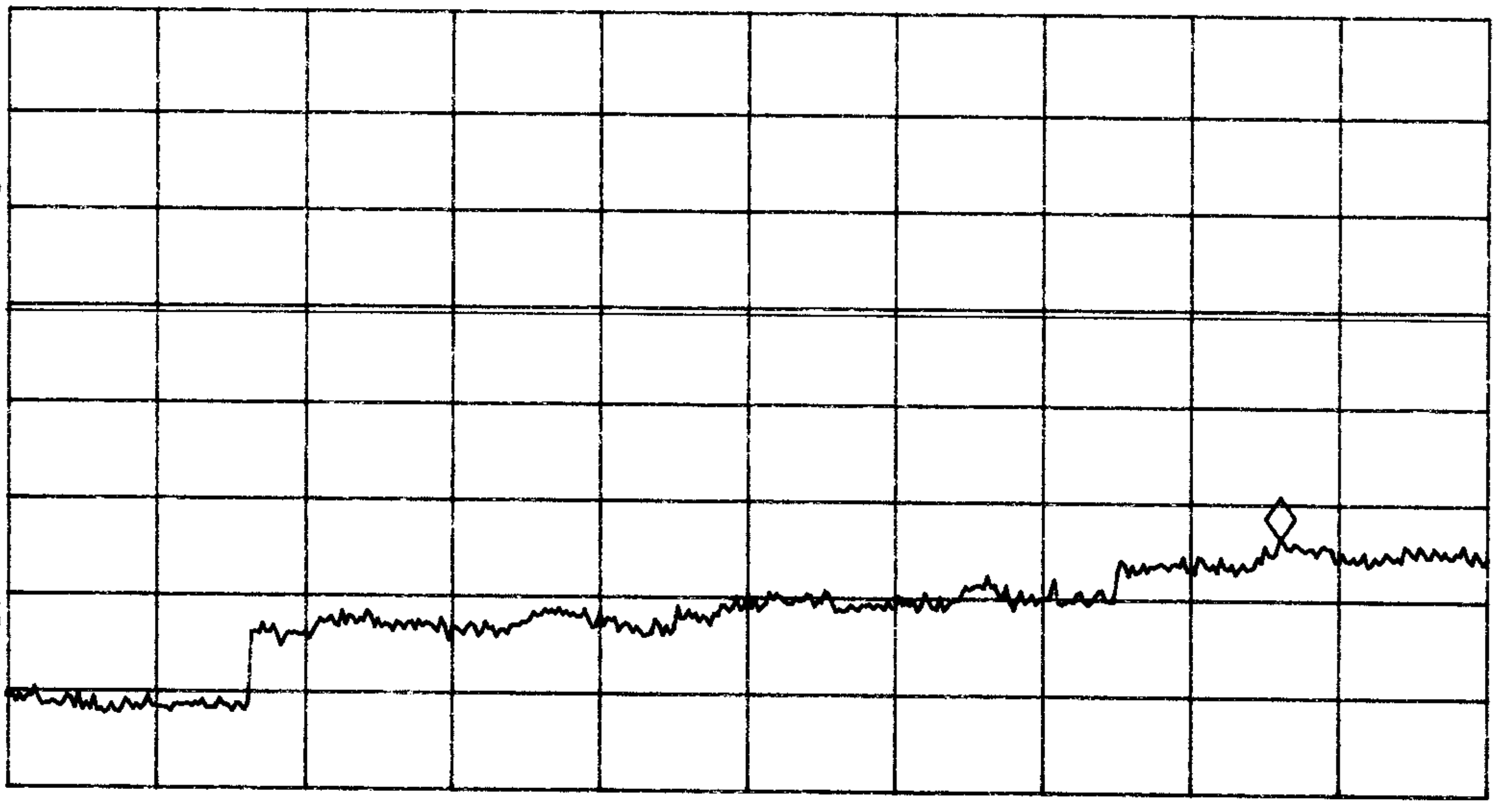
START
2.90 GHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 21.91 GHz
-33.81 dBm

No user
Menu

REF OFFST 20.0 dB
REF 20.0 dBm

LOG
10
dB/
#ATN
10 dB



VA SB
SC FC
CORR

START 2.90 GHz
#IF BW 100 kHz
#AVG BW 300 kHz
STOP 25.00 GHz
#SWP 10.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 5, Tx Frequency: 2433.9375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #10

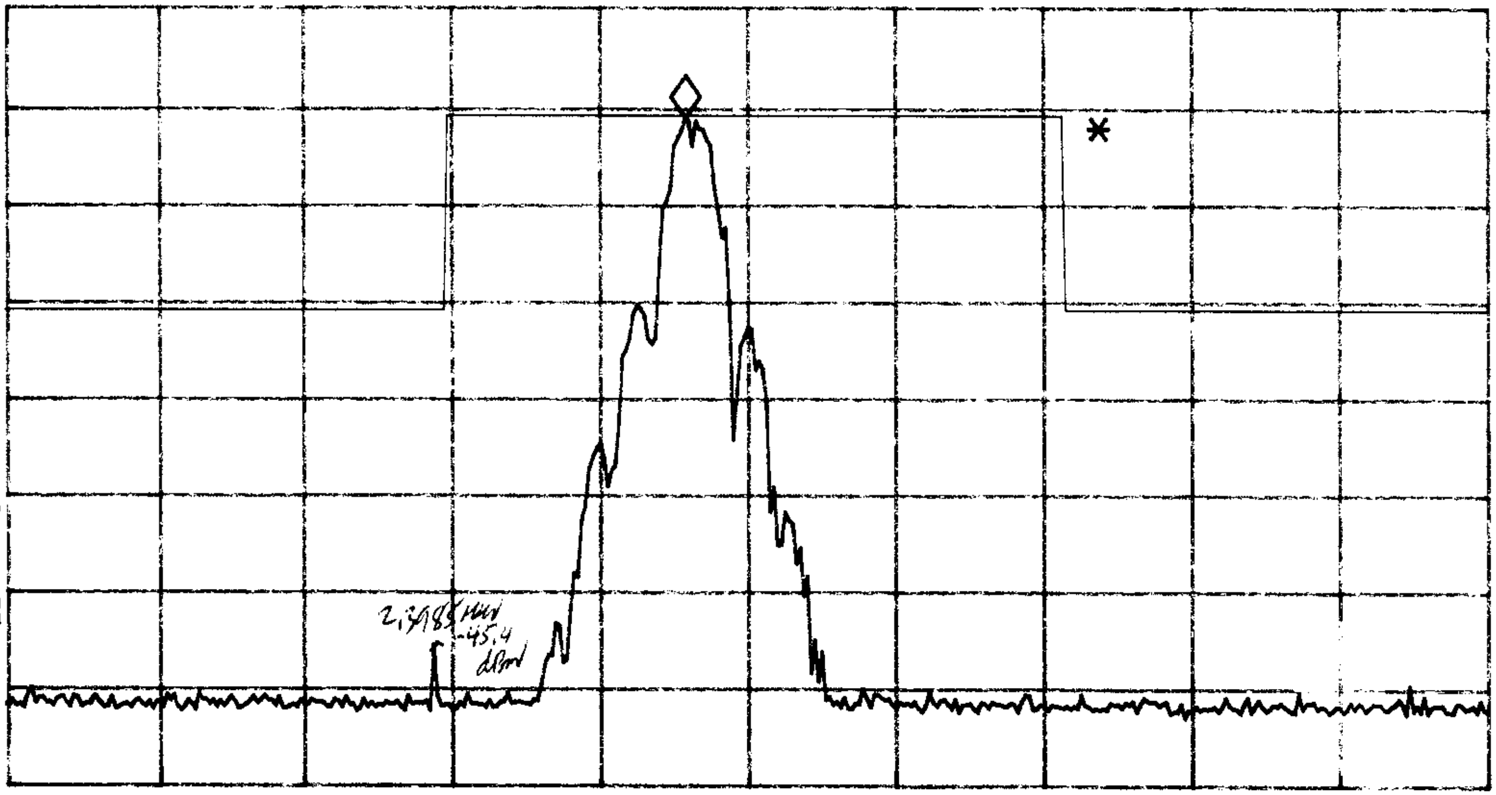
SWEEPTIME
30.0 sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4325 GHz
8.65 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



CENTER 2.4410 GHz
IF BW 120 kHz #AVG BW 300 kHz

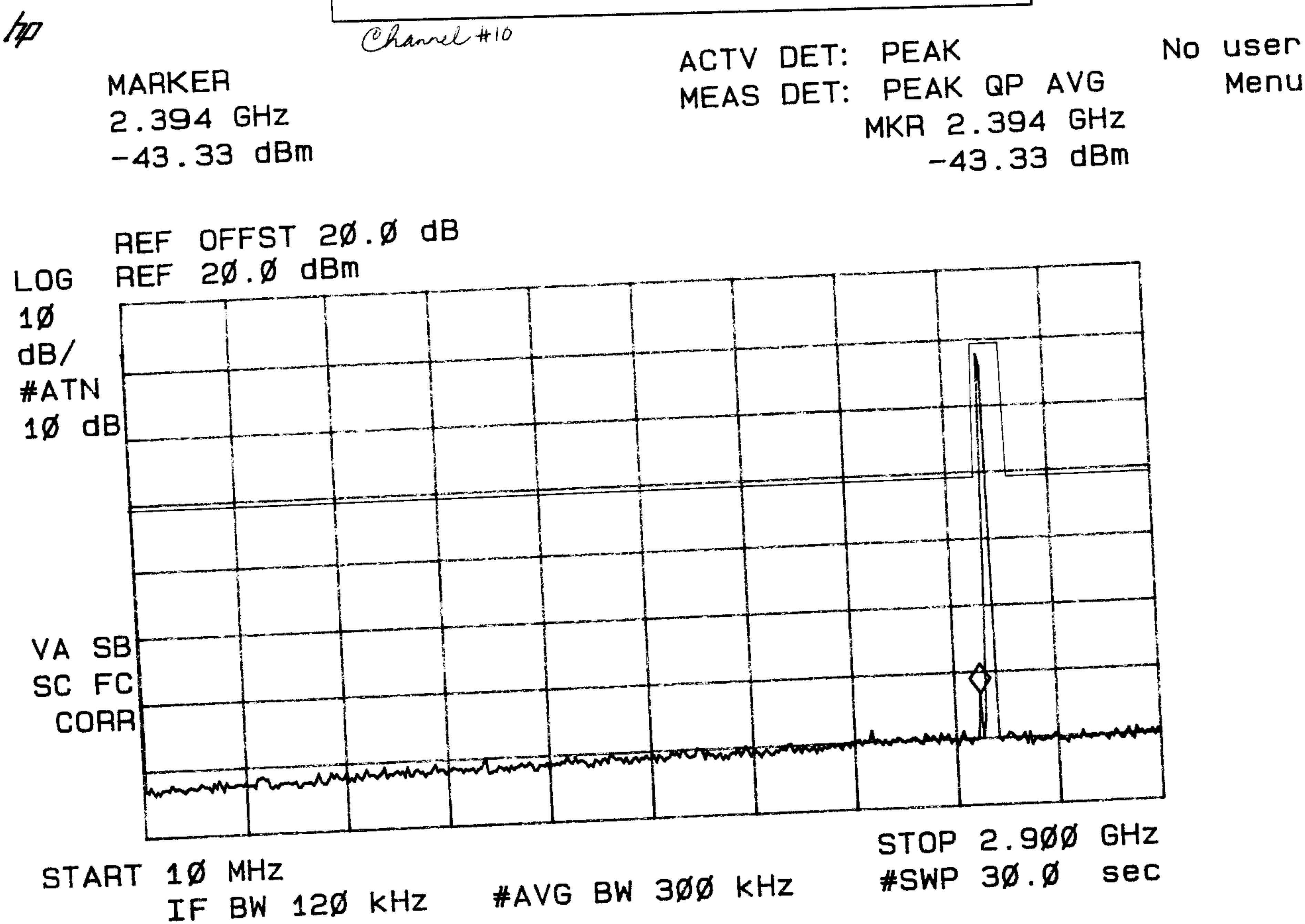
SPAN 200.0 MHz
#SWP 30.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 5, Tx Frequency: 2433.9375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #10



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 5, Tx Frequency: 2433.9375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

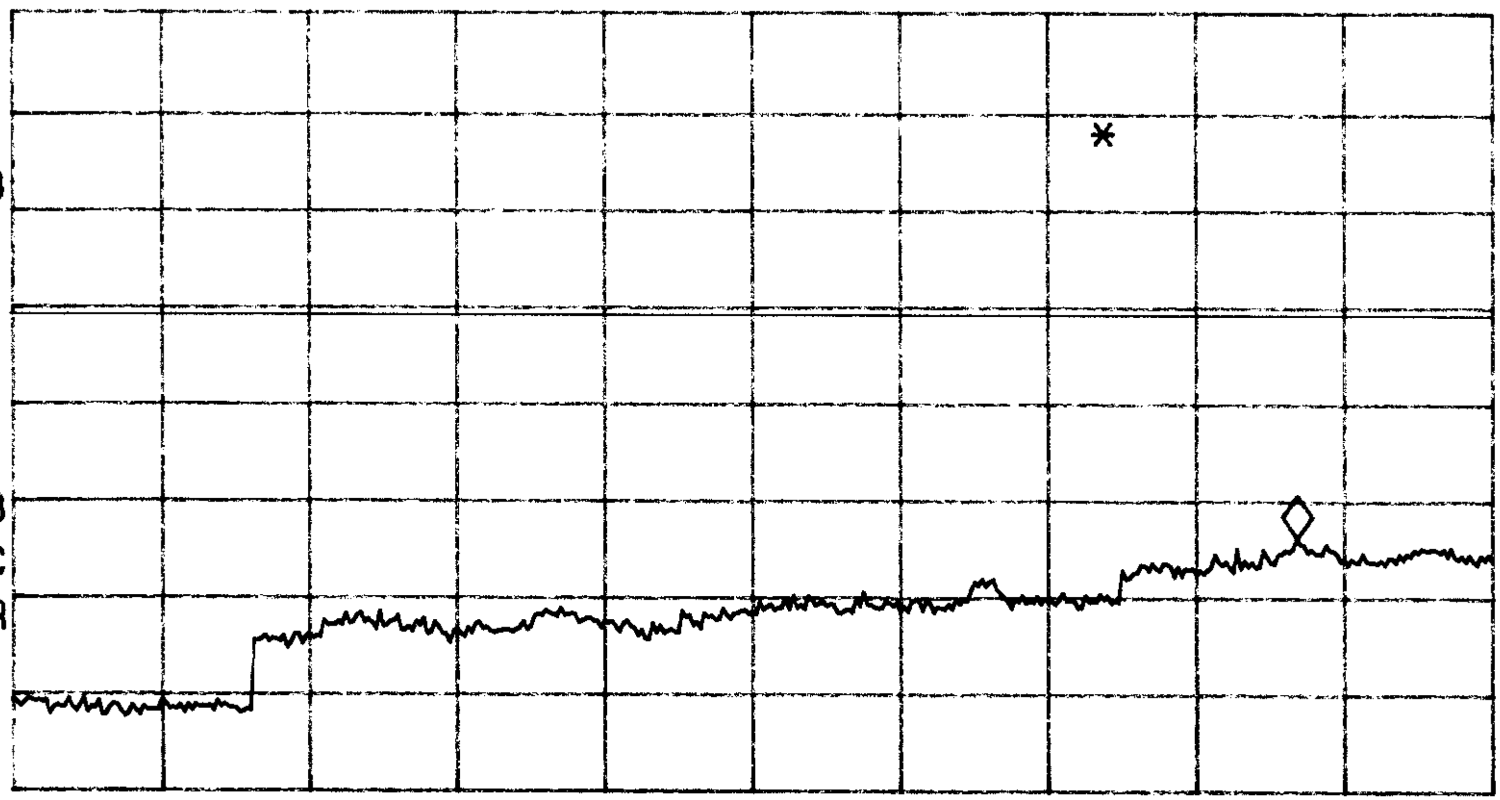
Channel #10

STOP
25.ØØ GHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 22.Ø7 GHz
-33.94 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
#ATN
1Ø dB



VA SB
SC FC
CORR

START 2.9Ø GHz
IF BW 12Ø kHz #AVG BW 3ØØ kHz

STOP 25.ØØ GHz
#SWP 3Ø.Ø sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 3, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel # 15

SPAN
2ØØ.Ø MHz

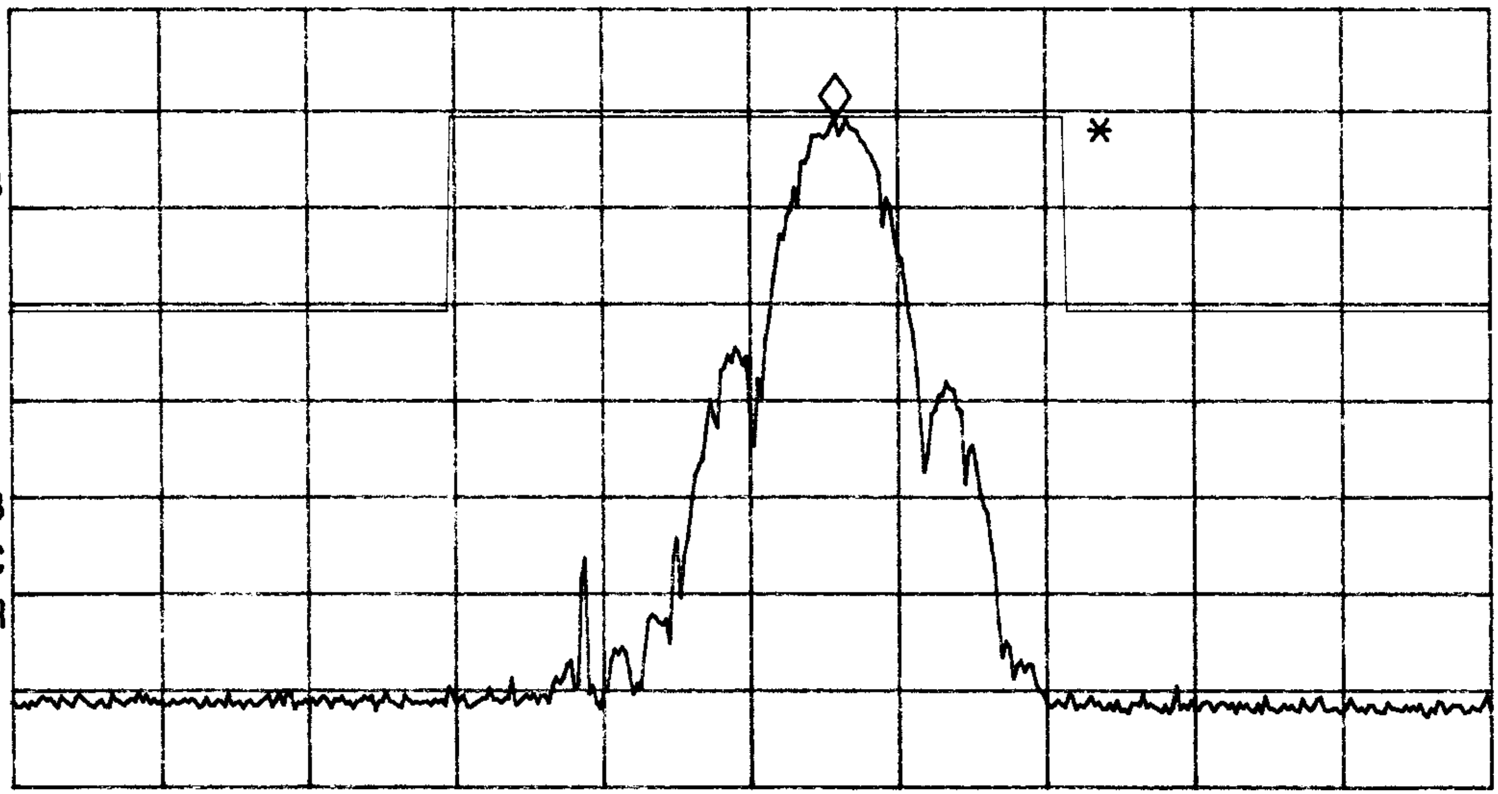
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4525 GHz
8.86 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
REF 2Ø.Ø dBm

LOG
1Ø
dB/
#ATN
1Ø dB

VA SB
SC FC
CORR



CENTER 2.441Ø GHz
#IF BW 1ØØ kHz #AVG BW 3ØØ kHz

SPAN 2ØØ.Ø MHz
#SWP 3Ø.Ø sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 3, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #15

MARKER
1.542 GHz
-38.33 dBm

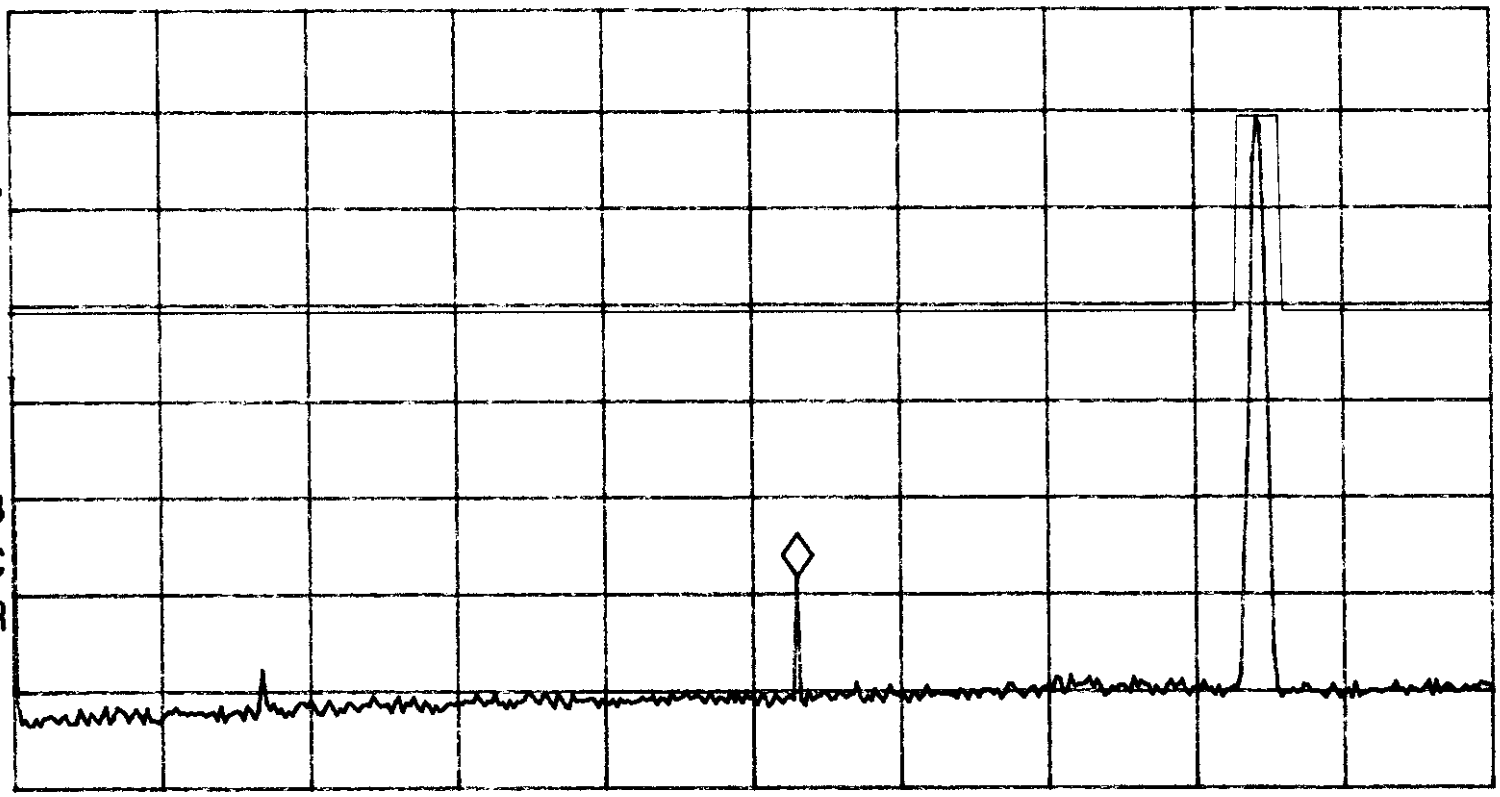
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.542 GHz
-38.33 dBm

No user
Menu

REF OFFST 20.0 dB
REF 20.0 dBm

LOG
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



START 10 MHz
#IF BW 100 kHz
#AVG BW 300 kHz
STOP 2.900 GHz
#SWP 30.0 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 3, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #15

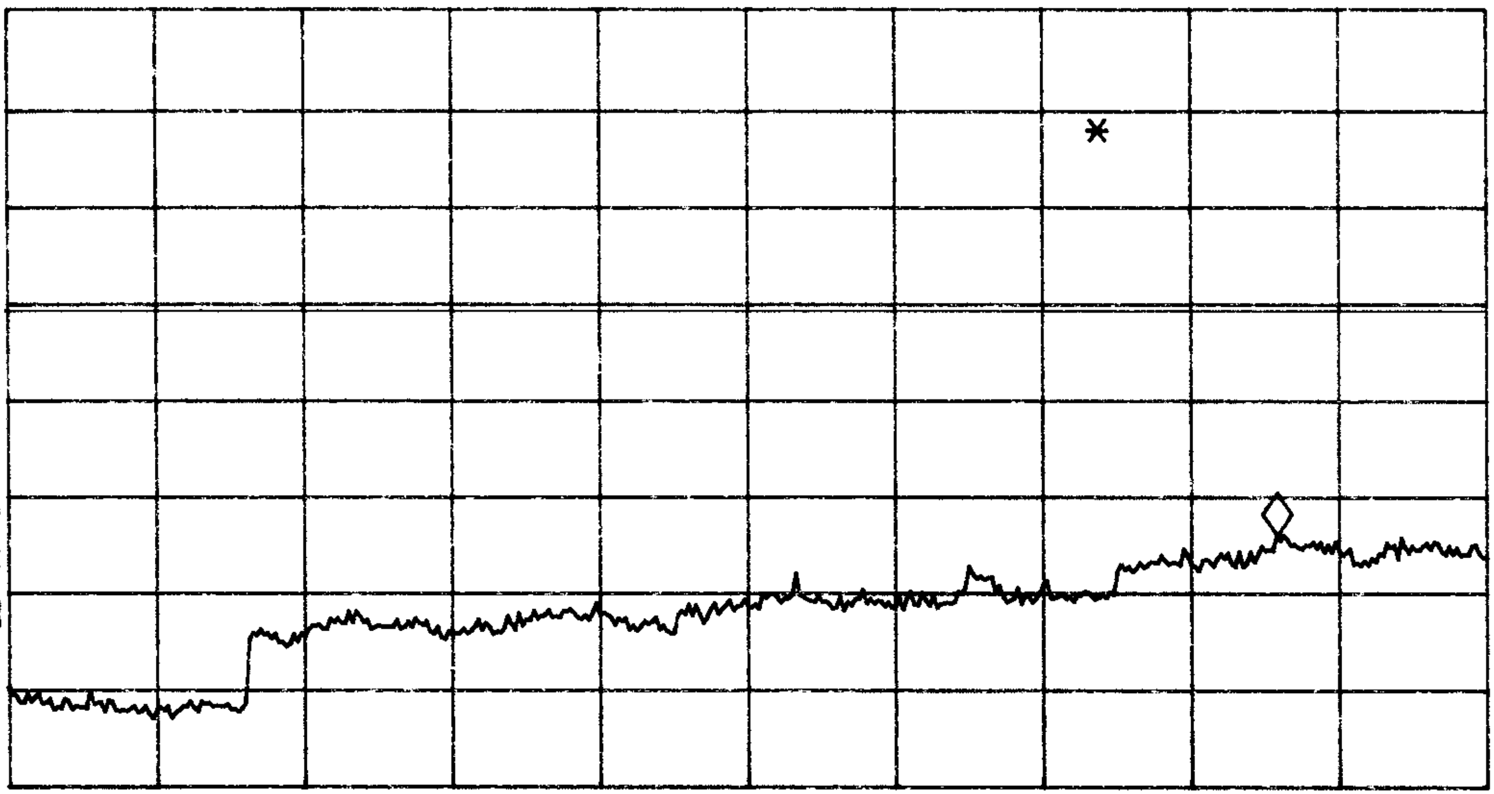
START
2.90 GHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 21.85 GHz
-34.14 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR

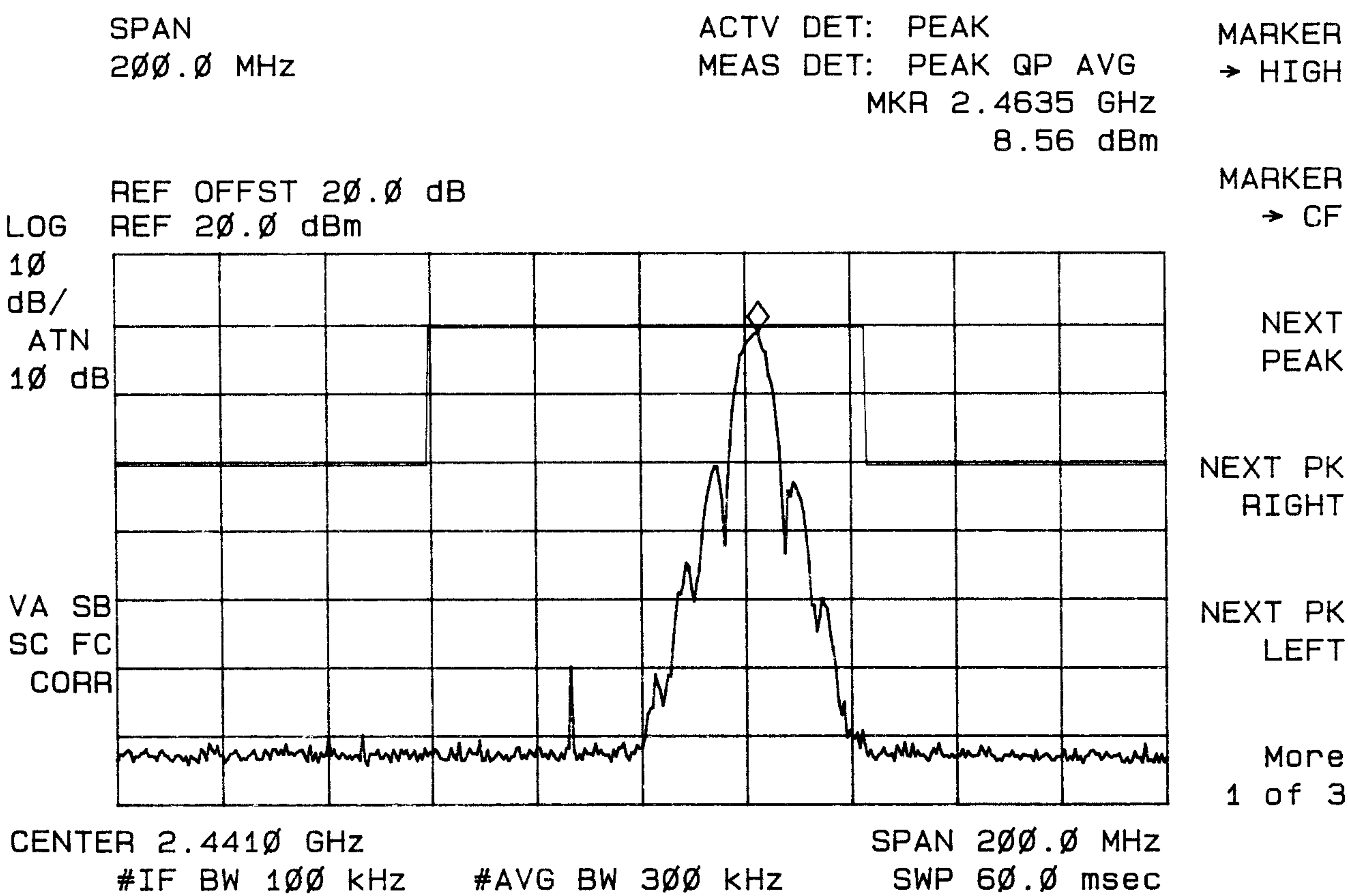


START 2.90 GHz
#IF BW 100 kHz #AVG BW 300 kHz

STOP 25.00 GHz
#SWP 10.0 sec

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu

hp

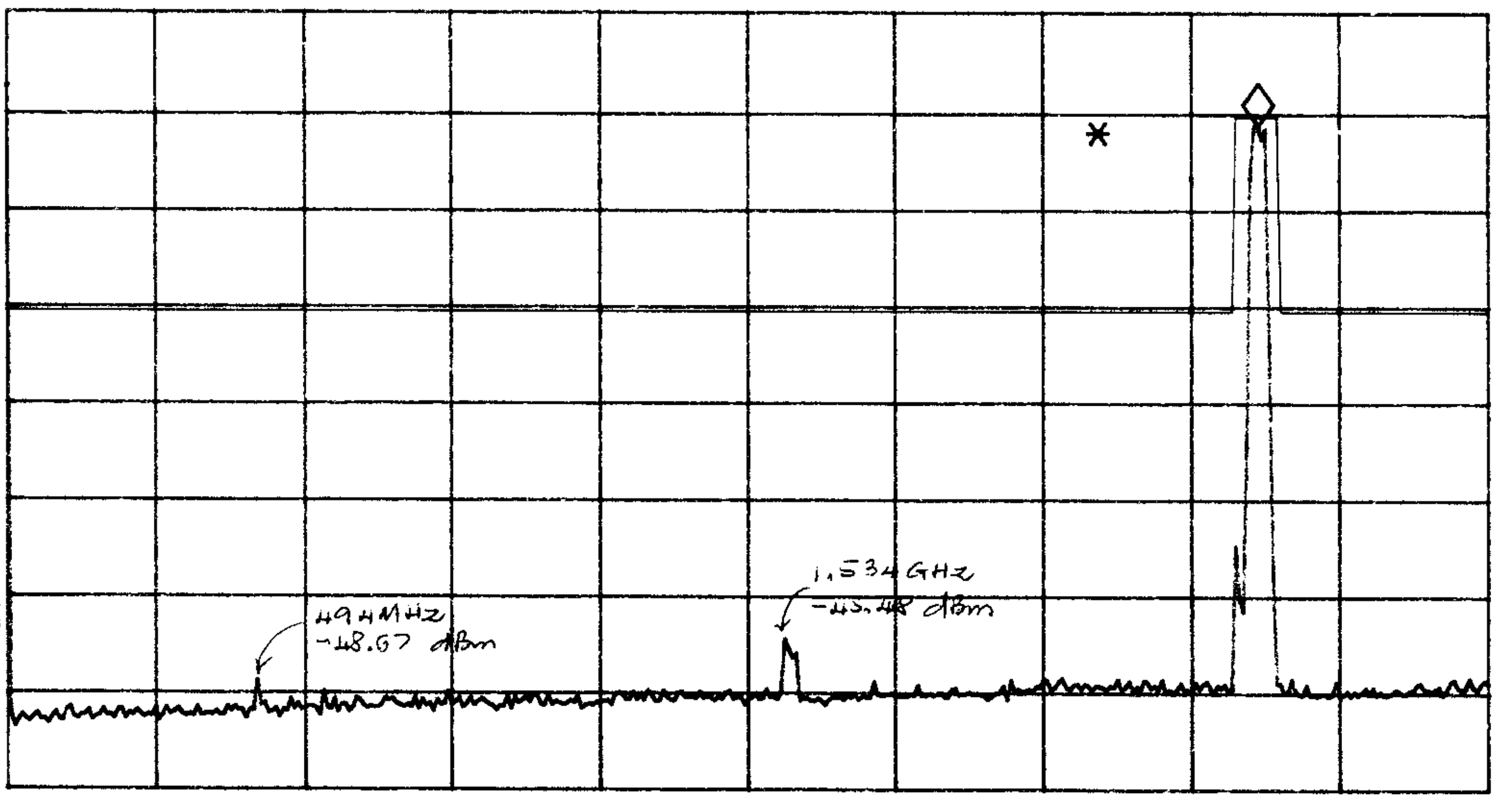
SWEEPTIME
1ØØ sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.452 GHz
8.37 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
ATN
1Ø dB

VA SB
SC FC
CORR

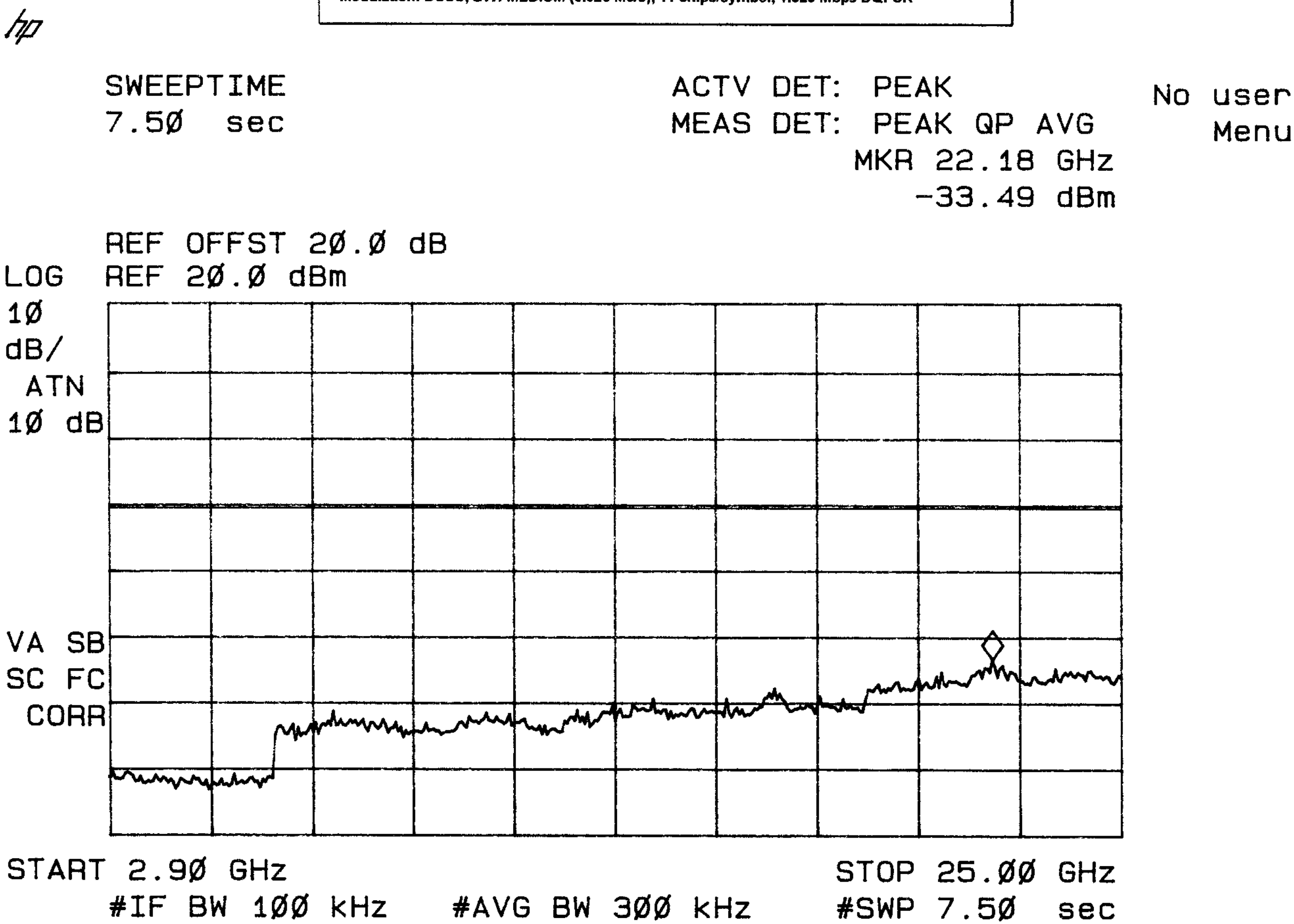


START 1Ø MHz
STOP 2.9ØØ GHz
#IF BW 1ØØ kHz #AVG BW 3ØØ kHz #SWP 1ØØ sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu



UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 8, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

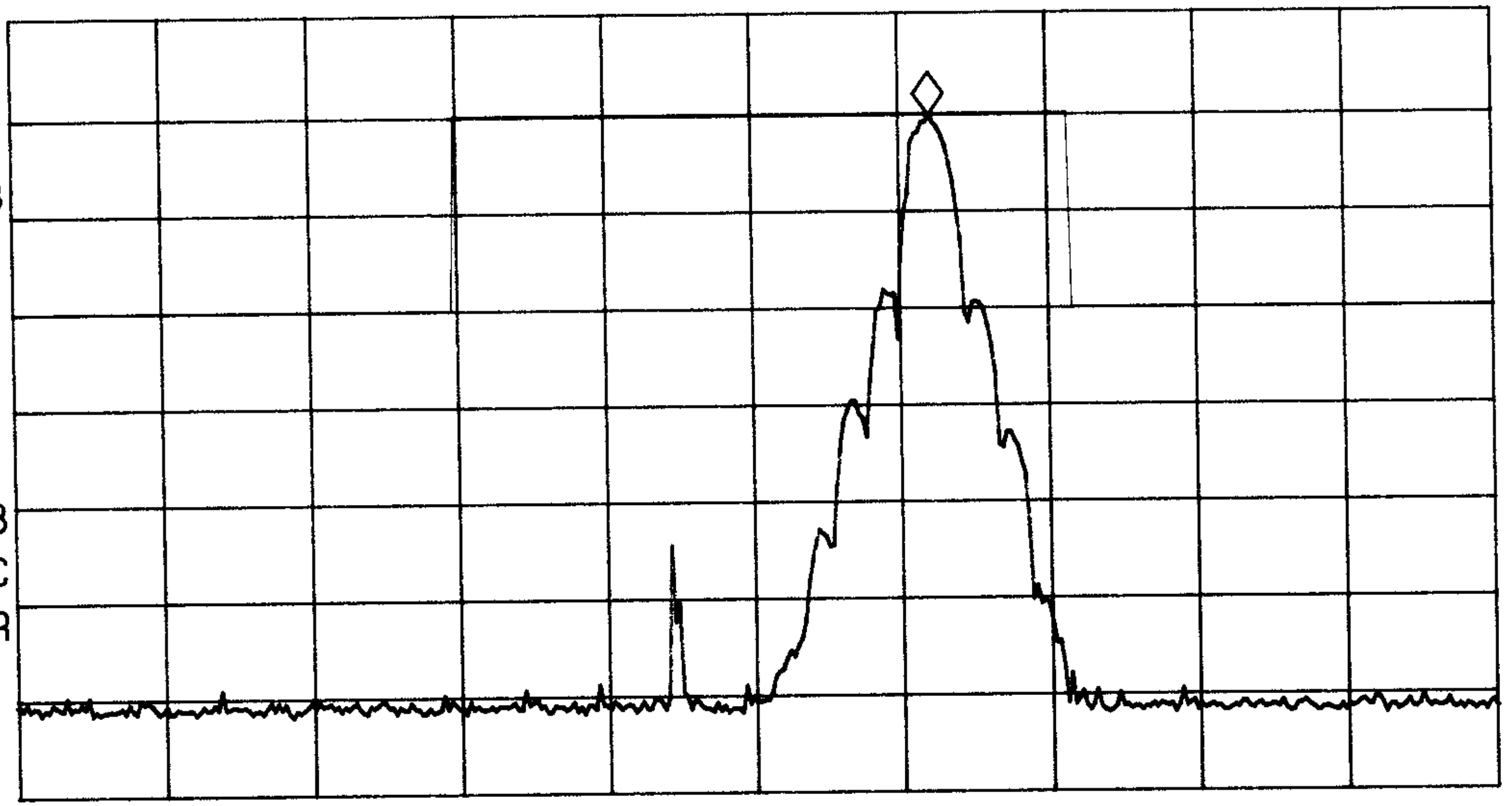
Channel #18

SWEEPTIME
2Ø.Ø sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.465Ø GHz
9.51 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
#ATN
1Ø dB



VA SB
SC FC
CORR

CENTER 2.441Ø GHz
#IF BW 1ØØ kHz
#AVG BW 3ØØ kHz
SPAN 2ØØ.Ø MHz
#SWP 2Ø.Ø sec

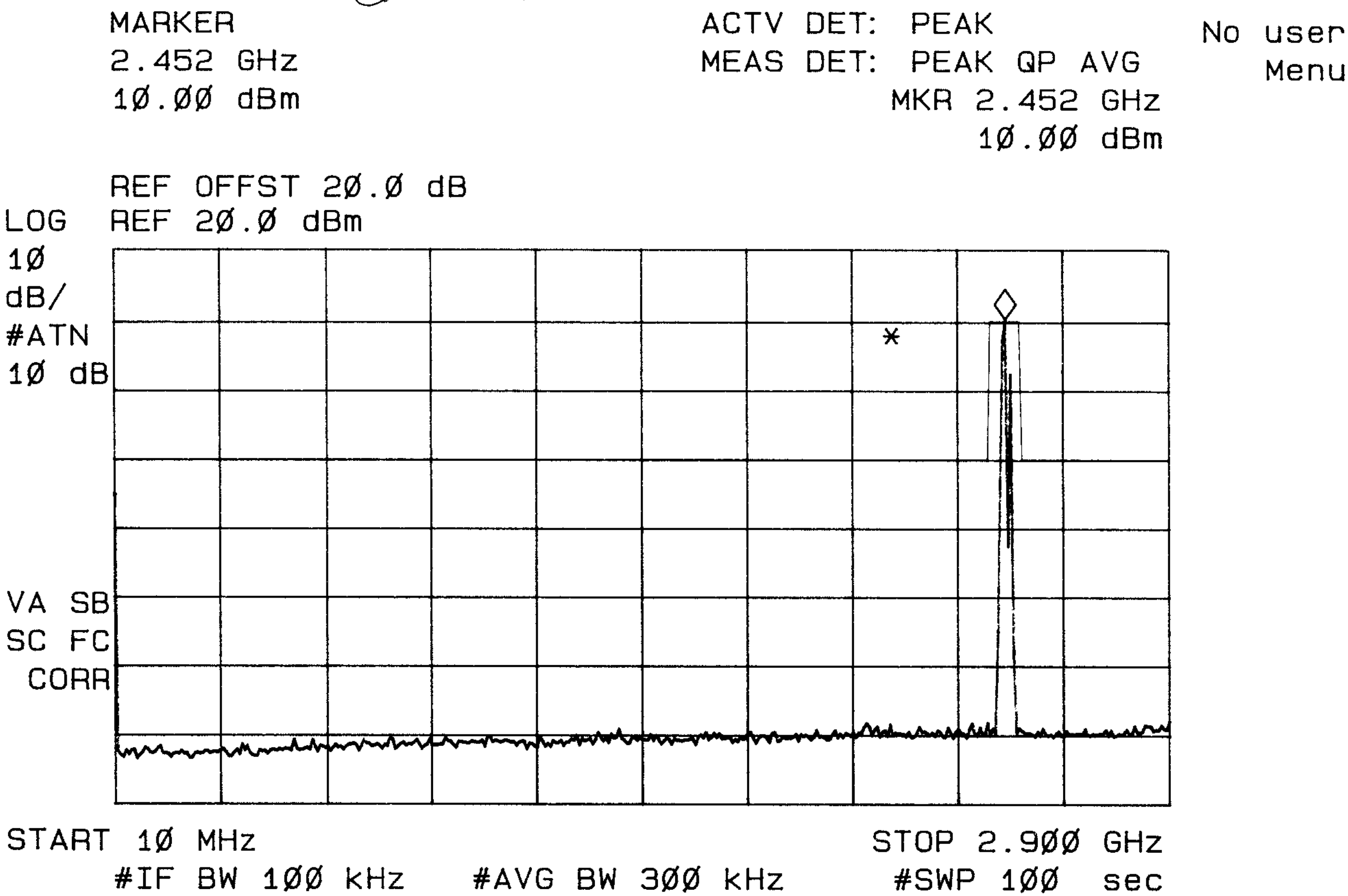
UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 8, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #18

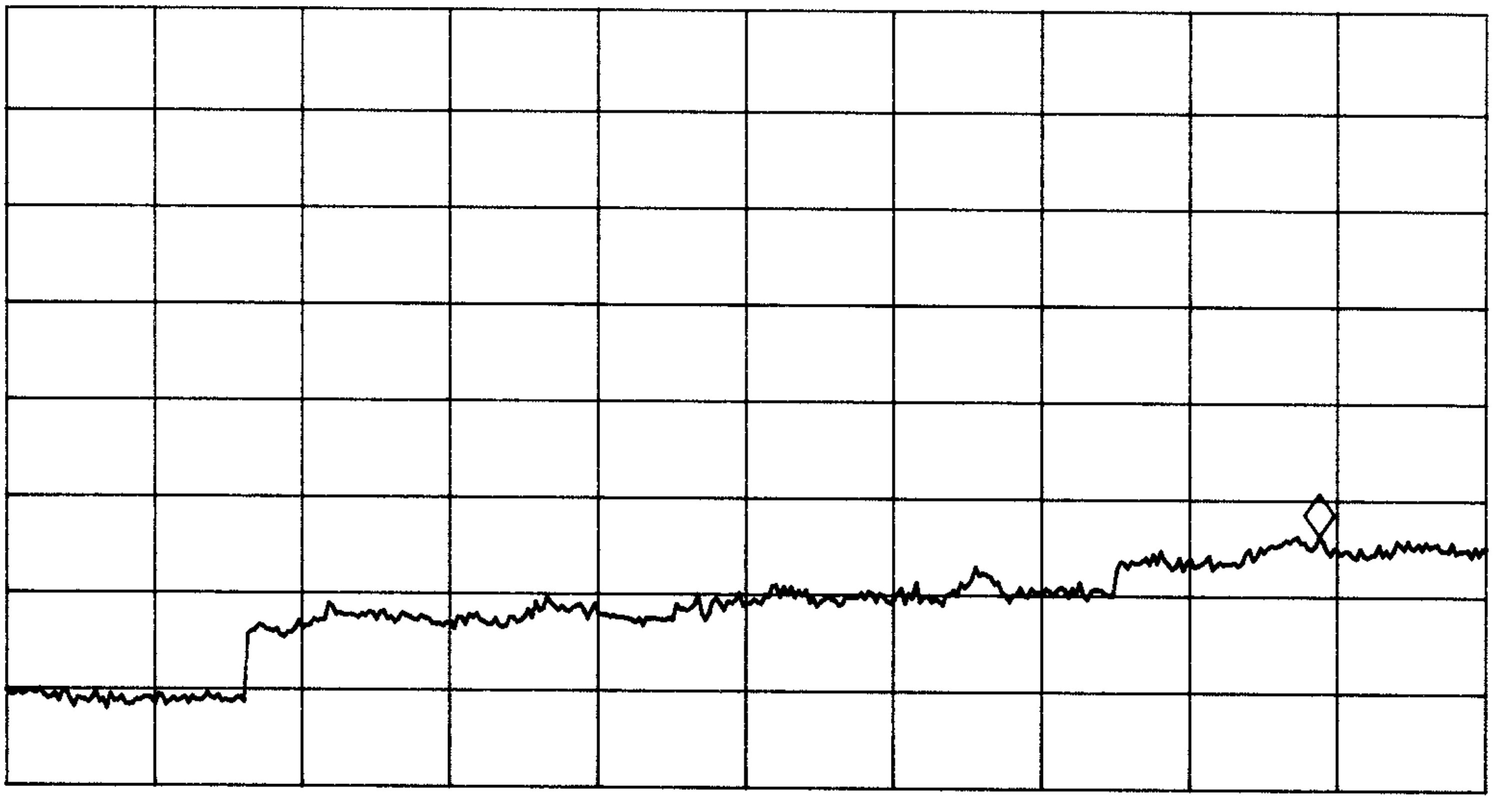


UltraTech
Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 8, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

Channel #18



4.4 Transmitter Radiated Emissions @ 3 Meters, FCC CFR 47, Para. 15.247(c), 15.209 & 15.205

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

In any 100 KHz bandwidth outside the operating frequency band, the radio frequency power that is produced by modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 KHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in @ 15.209(a), which lesser attenuation.

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- @ **FCC CFR 47, Para. 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in @**15.35** for limiting peak emissions apply.

FCC CFR 47, Part 15, Subpart C, Para. 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	162.0125 - 167.17	2310 - 2390	9.3 - 9.5
0.49 - 0.51	167.72 - 173.2	2483.5 - 2500	10.6 - 12.7
2.1735 - 2.1905	240 - 285	2655 - 2900	13.25 - 13.4
8.362 - 8.366	322 - 335.4	3260 - 3267	14.47 - 14.5
13.36 - 13.41	399.9 - 410	3332 - 3339	14.35 - 16.2
25.5 - 25.67	608 - 614	3345.8 - 3358	17.7 - 21.4
37.5 - 38.25	960 - 1240	3600 - 4400	22.01 - 23.12
73 - 75.4	1300 - 1427	4500 - 5250	23.6 - 24.0
108 - 121.94	1435 - 1626.5	5350 - 5460	31.2 - 31.8
123 - 138	1660 - 1710	7250 - 7750	36.43 - 36.5
149.9 - 150.05	1718.8 - 1722.2	8025 - 8500	Above 38.6
156.7 - 156.9	2200 - 2300	9000 - 9200	

FCC CFR 47, Part 15, Subpart C, Para. 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

FREQUENCY (MHz)	FIELD STRENGTH LIMITS (microvolts/m)	DISTANCE (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- **Spectrum Analyzer**, Advantest, Model R3271, S/N: 15050203, 100 Hz to 32 GHz)
- **Spectrum Analyzer**, Advantest, Model 3261A, SN 91720151, Input +25dBm max., 9KHz-2.6GHz, 50 Ohms, built-in Quasi-Peak Detector.
- **RF Preselector,** Advantest Model R3551, SN 92970002, 9KHz-1GHz, 50 Ohms input/output, input +25 dBm max, 30 dB gain.
- **Microwave Amplifier**, HP, Model 83017A, Frequency Range 1 to 22 GHz, 30dB gain nominal.
- **Active Loop Antenna**, Emco, Model 6507, SN 8906-1167, Frequency Range 1 KHz - 30 MHz, @ 50 Ohms
- **Log Periodic/Bow-Tie Antenna**, Emco, Model 3143, SN 1029, 20 - 1000 MHz, @ 50 ohms.
- **Log Periodic Antenna**, A.H. Systems, Model SAS-200/518, SN 343, Frequency Range: 1 - 18 GHz, @ 50 Ohms.
- **Horn Antenna**, Emco, Model 3160-09, 18-26.5GHz
- **Horn Antenna**, Emco, Model 3160-10, 26.5-40GHz
- **Mixer**, Tektronix, P/N 118-0098-00, 18-26.5GHz
- **Mixer**, Tektronix, P/N 119-0098-00, 26.5-40GHz

METHOD OF MEASUREMENTS:

Refer to **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

For measurement below 1 GHz, set RBW = 100 KHz, VBW ≥ 100 KHz, SWEEP=AUTO.

For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

FCC CFR 47, Para. 2.997 - Frequency spectrum to be investigated

The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10th harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC CFR 47, Para. 2.993 - Field Strength Spurious Emissions

(a) Measurements was made to detect spurious emissions radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data were supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph 2.989(c) as appropriate. For equipment operating on frequencies below 1 GHz, an Open Field Test is normally required, with the measuring instrument antenna located in the far field at all test frequencies. In event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurement will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with the reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

(b) Measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Mar. 04-05, 1998

MEASUREMENT DATA

RADIATED EMISSIONS MEASUREMENTS @ 3 METERS

TEST CONFIGURATION

- *This lowest, middle and highest channels were established at its full rated output power. The emissions were investigated from the lowest frequency generated by the transmitter up to the 10th harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Parts 15.247(c) or 15.209(a) whichever was applicable.*
- *For measuring radiated emissions at frequencies below 1 GHz, the Spectrum Analyzer was set as 100 KHz RBW, VBW ≥ RBW, SWEEP TIME: AUTO, PEAK DETECTOR.*
- *For measuring radiated emissions at frequencies above 1 GHz, the Spectrum Analyzer was set as 1 MHz RBW, 1 MHz VBW, SWEEP TIME: AUTO for PEAK measurements and 1 MHz RBW, 10 Hz VBW, SWEEP TIME: AUTO for AVERAGE measurements.*
- *The following measurements were the worst cases when the radiating antenna was placed in both horizontal and vertical polarization.*
- *The following **AVERAGE** rf levels were obtained from either Peak or Average readings added by the duty cycle correction factor. **DUTY CYCLE FACTOR = 20LOG$_{10}$(0.45) = -6.9 dB***

Channel #: 3, Frequency: 2408.625 MHz
Full Rated Peak Power: 190 mW
Modulation: DQPSK, narrow, 11 chips/symbol, Data Rate: 4.5 Mb/s, 2 bits/symbol

Power Level in 1 MHz BW: 116.2 dBuV/m
Limit = 116.2dBuV/m - 20dB = 96.2 dBuV/m

FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2408.63	116.2	109.3	V	--	--	--	--
2408.63	109.1	102.2	H	--	--	--	--
1493.00	53.2	45.4	V	54.0	96.2	-8.6	PASS
1493.00	52.8	43.9	H	54.0	96.2	-10.1	PASS
2384.50	66.4	45.2	V	54.0	96.2	-8.8	PASS
2986.00	37.9	25.4	V	54.0	96.2	-70.8	PASS
2986.00	33.2	26.3	H	54.0	96.2	-69.9	PASS
4816.00	56.5	34.5	V	54.0	96.2	-19.5	PASS
4816.00	56.1	34.3	H	54.0	96.2	-19.7	PASS

No other significant emissions were found in the frequency range from 10 MHz to 25 GHz.
Refer to attached plots for details

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

Channel #: 4, Frequency: 2411.4375 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, medium , 11 chips/symbol, Data Rate: 5.625 Mb/s, 2 bits/symbol				Power Level in 1 MHz BW: 118.9 dBuV/m Limit = 118.9dBuV/m - 20dB = 98.9 dBuV/m			
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2411.44	118.9	112.0	V	--	--	--	PASS
2411.44	110.9	104.0	H	--	--	--	PASS
1496.00	54.4	44.7	V	54.0	98.9	-9.3	PASS *
1496.00	54.7	44.8	H	54.0	98.9	-9.2	PASS *
2992.00	34.7	22.5	V	54.0	98.9	-76.4	PASS
2992.00	35.5	24.0	H	54.0	98.9	-74.9	PASS
4488.00	44.4	33.8	V	54.0	98.9	-20.2	PASS *
4488.00	43.2	32.1	H	54.0	98.9	-21.9	PASS *
4822.00	55.4	34.8	V	54.0	98.9	-19.2	PASS *
4822.00	53.5	33.0	H	54.0	98.9	-21.0	PASS *
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details							

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

Channel #: 6, Frequency: 2419.875 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, wide, 11 chips/symbol, Data Rate: 11.25 Mb/s, 2 bits/symbol				Power Level in 1 MHz BW: 116.4 dBuV/m Limit = 116.4dBuV/m - 20dB = 96.4 dBuV/m			
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2419.88	116.4	109.5	V	--	--	--	--
2419.88	108.8	101.9	H	--	--	--	--
1504.00	55.6	46.4	V	54.0	96.4	-7.6	PASS *
1504.00	48.7	40.4	H	54.0	96.4	-13.6	PASS *
3008.00	38.0	28.3	V	54.0	96.4	-68.1	PASS
3008.00	36.1	24.1	H	54.0	96.4	-72.3	PASS
4512.00	43.3	34.4	V	54.0	96.4	-19.6	PASS *
4512.00	41.8	30.2	H	54.0	96.4	-23.8	PASS *
4838.00	55.2	34.6	V	54.0	96.4	-19.4	PASS *
4838.00	50.1	30.7	H	54.0	96.4	-23.3	PASS *
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details							

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

Channel #: 15, Frequency: 2453.625 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, wide, 11 chips/symbol, Data Rate: 11.25 Mb/s, 2 bits/symbol				Power Level in 1 MHz BW: 117.3 dBuV/m Limit = 117.3dBuV/m - 20dB = 97.3 dBuV/m			
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2453.63	117.3	110.4	V	--	--	--	--
2453.63	106.9	100.0	H	--	--	--	--
1538.00	54.8	44.2	V	54.0	97.3	-9.8	PASS *
1538.00	35.6	27.8	H	54.0	97.3	-26.2	PASS *
3076.00	47.8	40.2	V	54.0	97.3	-57.1	PASS
3076.00	44.1	36.3	H	54.0	97.3	-61.0	PASS
4614.00	39.3	28.3	V	54.0	97.3	-25.7	PASS *
4614.00	41.8	33.5	H	54.0	97.3	-20.5	PASS *
4906.00	55.4	32.9	V	54.0	97.3	-21.1	PASS *
4906.00	59.1	33.7	H	54.0	97.3	-20.3	PASS *
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details							

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

Channel #: 17, Frequency: 2462.0625 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, medium, 11 chips/symbol, Data Rate: 5.625 Mb/s, 2 bits/symbol				Power Level in 1 MHz BW: 117.8 dBuV/m Limit = 117.8dBuV/m - 20dB = 97.8 dBuV/m			
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
2462.06	117.8	110.9	V	--	--	--	--
2462.06	110.8	103.9	H	--	--	--	--
1547.00	54.4	45.3	V	54.0	97.8	-8.7	PASS *
1547.00	52.9	43.6	H	54.0	97.8	-10.4	PASS *
3094.00	45.0	37.1	V	54.0	97.8	-60.7	PASS
3094.00	39.3	30.8	H	54.0	97.8	-67.0	PASS
4924.00	55.9	35.7	V	54.0	97.8	-18.3	PASS *
4924.00	42.6	40.9	H	54.0	97.8	-13.1	PASS *
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details							

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

Channel #: 18, Frequency: 2464.875 MHz Full Rated Peak Power: 190 mW Modulation: DQPSK, narrow, 11 chips/symbol, Data Rate: 4.5 Mb/s, 2 bits/symbol				Power Level in 1 MHz BW: 117.1 dBuV/m Limit = 117.1dBuV/m - 20dB = 97.1 dBuV/m			
FREQUENCY (MHz)	RF PEAK LEVEL (dBuV/m)	RF AVG LEVEL (dBuV/m)	ANTENNA PLANE (H/V)	LIMIT 15.209 (dBuV/m)	LIMIT 15.247 (dBuV/m)	MARGIN (dB)	PASS/ FAIL
1549.00	52.1	43.1	V	54.0	97.1	-10.9	PASS *
1549.00	52.7	44.6	H	54.0	97.1	-9.4	PASS *
2464.88	117.1	110.2	V	54.0	97.1	--	--
2464.88	110.8	103.9	H	54.0	97.1	--	--
3098.00	44.0	36.2	V	54.0	97.1	-60.9	PASS
3098.00	41.9	34.1	H	54.0	97.1	-63.0	PASS
4647.00	40.1	30.4	V	54.0	97.1	-23.6	PASS *
4647.00	41.4	32.5	H	54.0	97.1	-21.5	PASS *
4928.00	47.1	40.2	V	54.0	97.1	-13.8	PASS *
4928.00	39.3	27.4	H	54.0	97.1	-26.6	PASS *
No other significant emissions were found in the frequency range from 10 MHz to 25 GHz. Refer to attached plots for details							

** FCC Limit @ 15.209 was applied for frequency fell within restricted band @ 15.205*

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 3, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

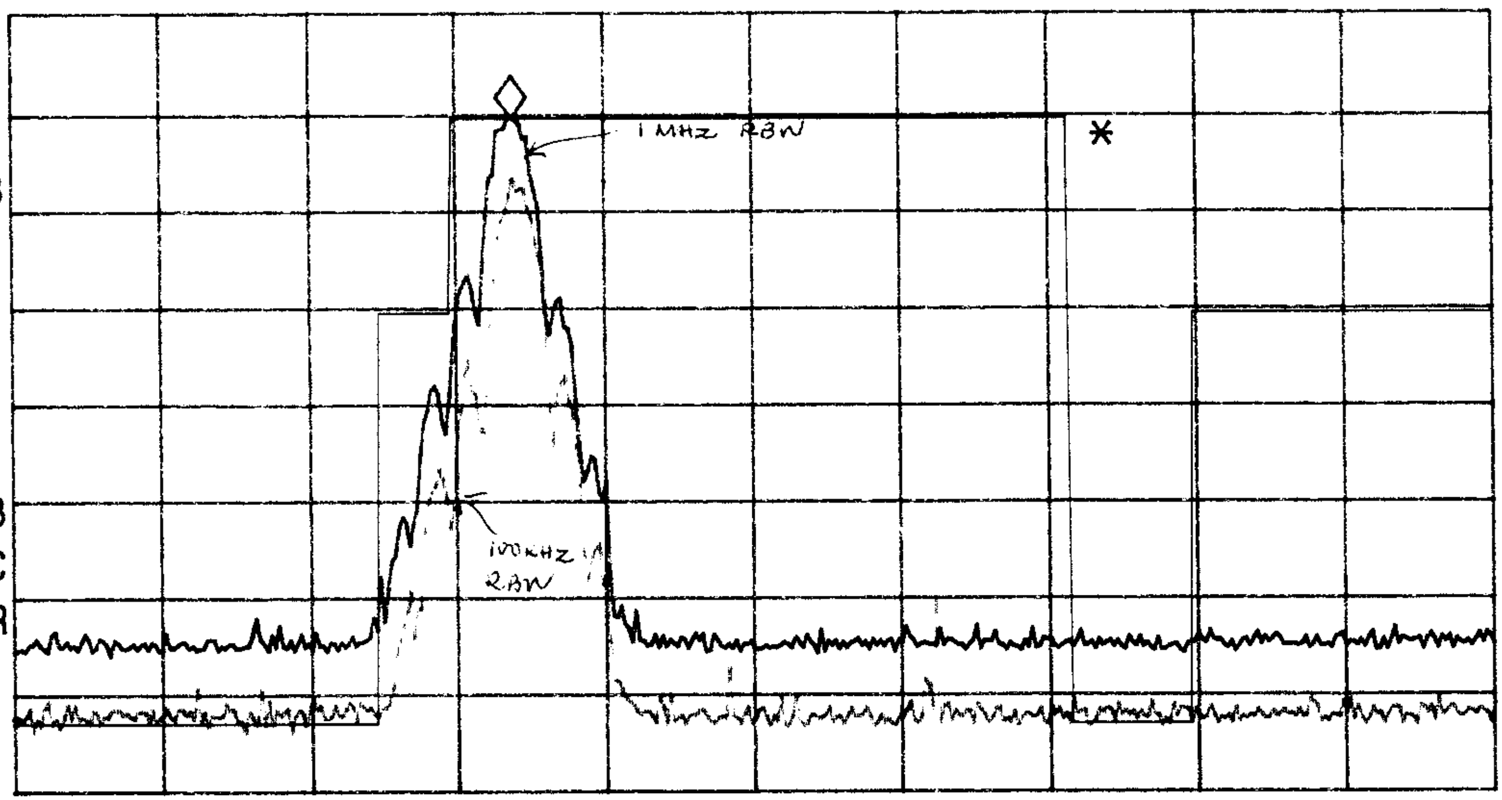
IF BANDWIDTH
1.Ø MHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4Ø85 GHz
116.19 dBμV

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz

SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 3, Tx Frequency: 2408.125 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

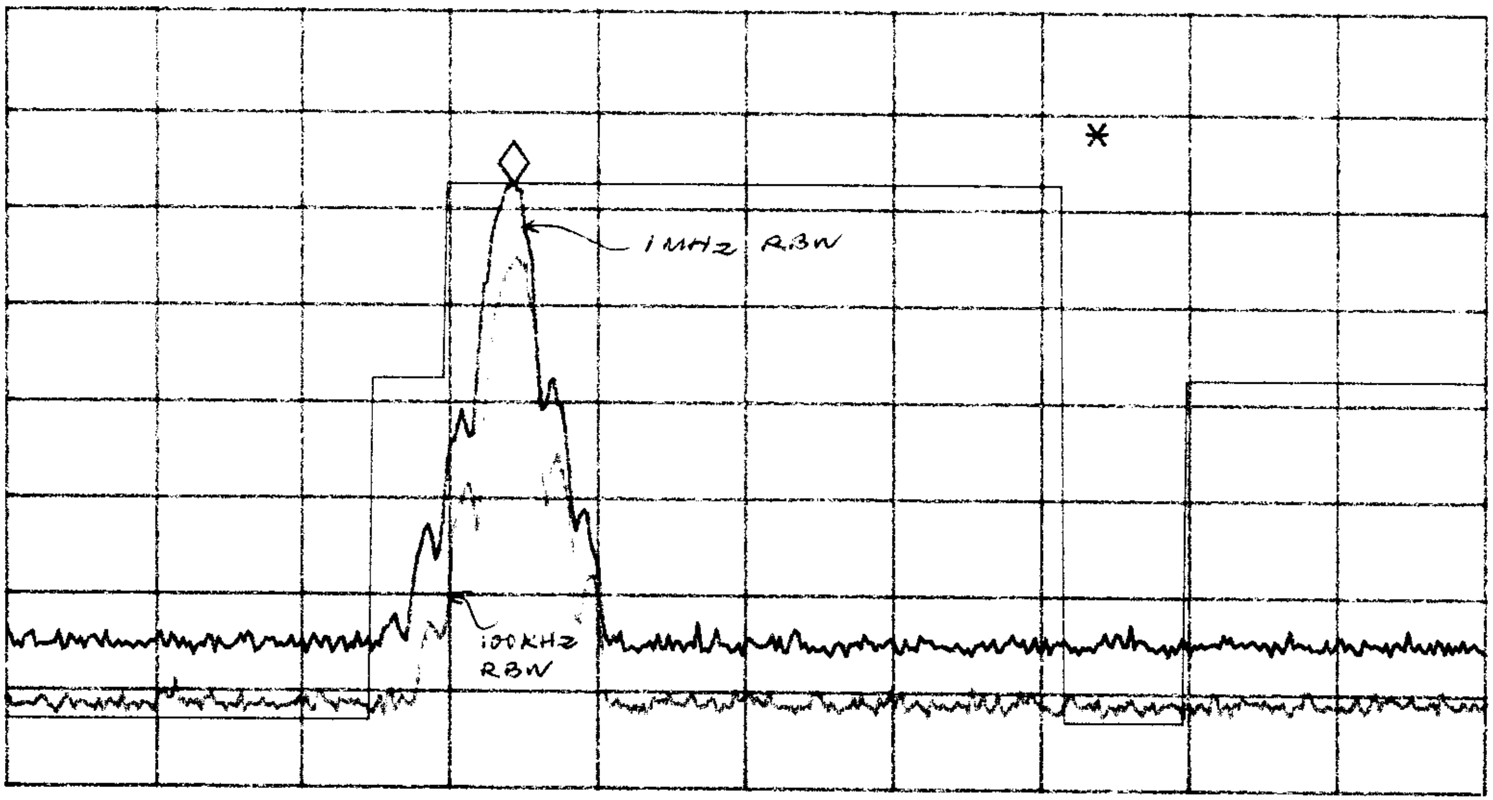
Antenna Polarization: HORIZONTAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4Ø95 GHz
1Ø9.12 dBμV

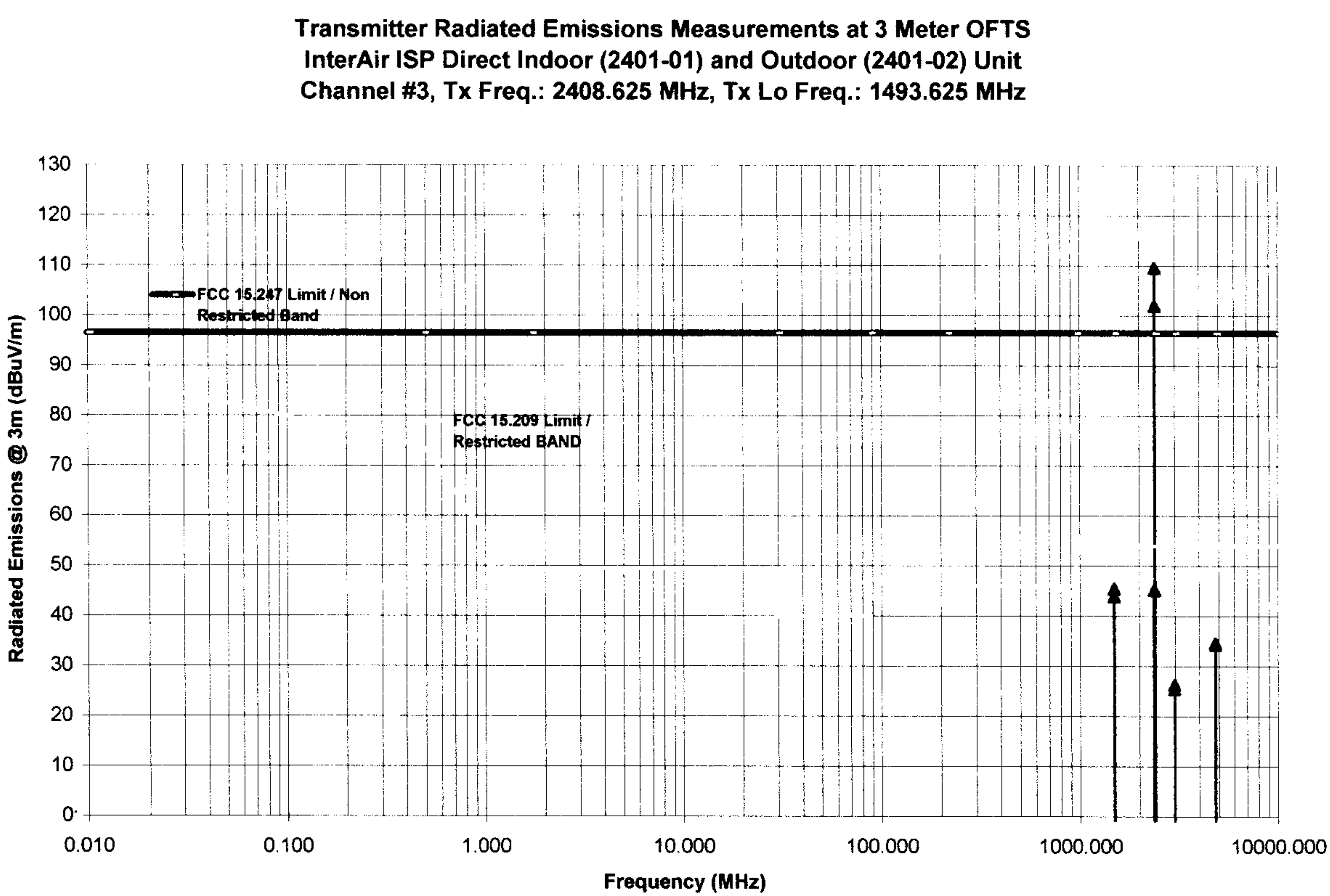
No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB



VA VB
SC FC
ACORR

CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec



Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #3, Tx Freq.: 2408.625 MHz, Tx Lo Freq.: 1493.625 MHz
Radiated Emissions @ 3m (dBuV/m)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FCC 15.247 Limit / Non Restricted Band
FCC 15.209 Limit / Restricted BAND
0.010
0.100
1.000
10.000
100.000
1000.000
10000.000
Frequency (MHz)

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

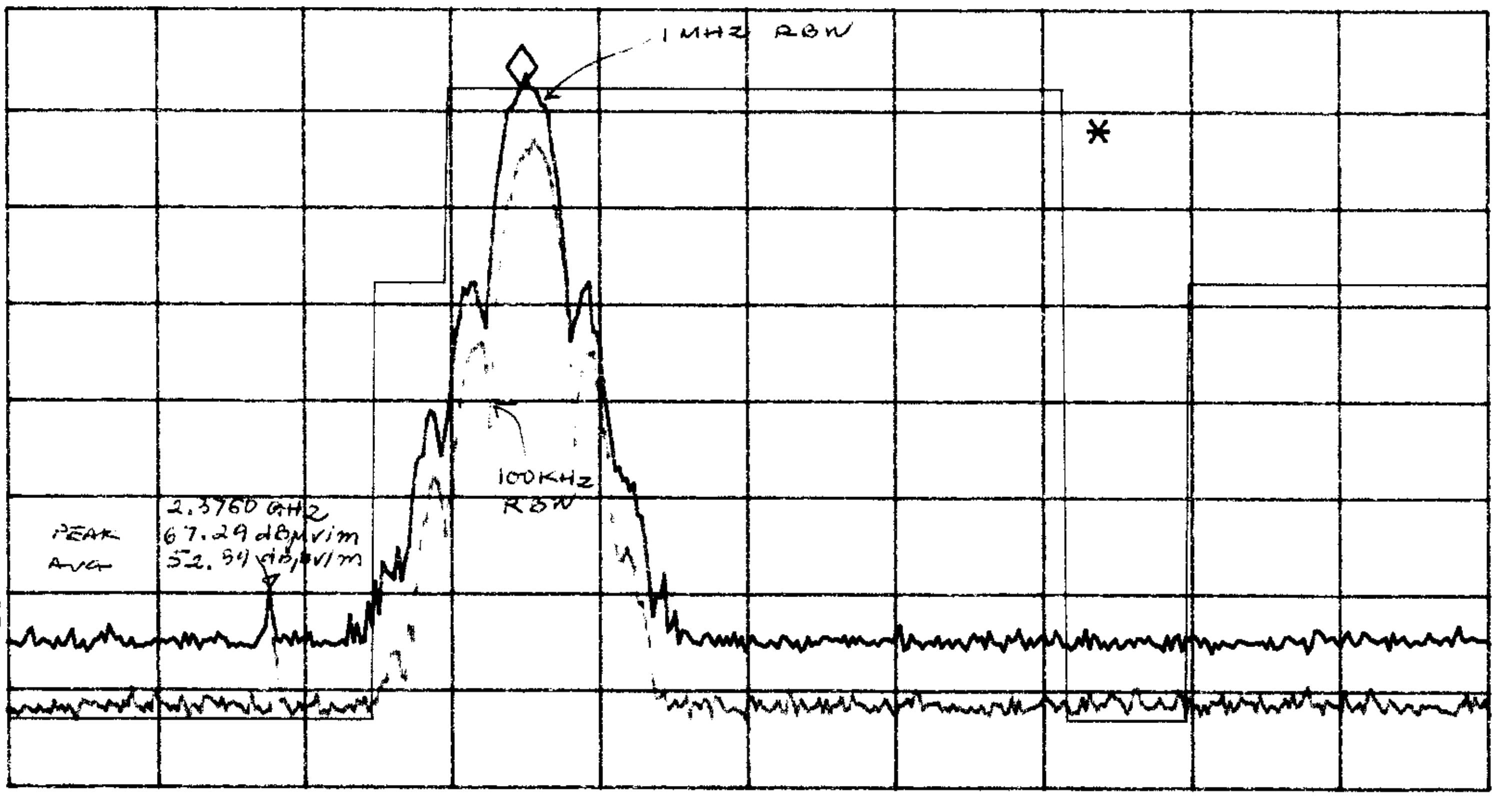
hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.41Ø5 GHz
118.87 dBμV

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 4, Tx Frequency: 2411.4375 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

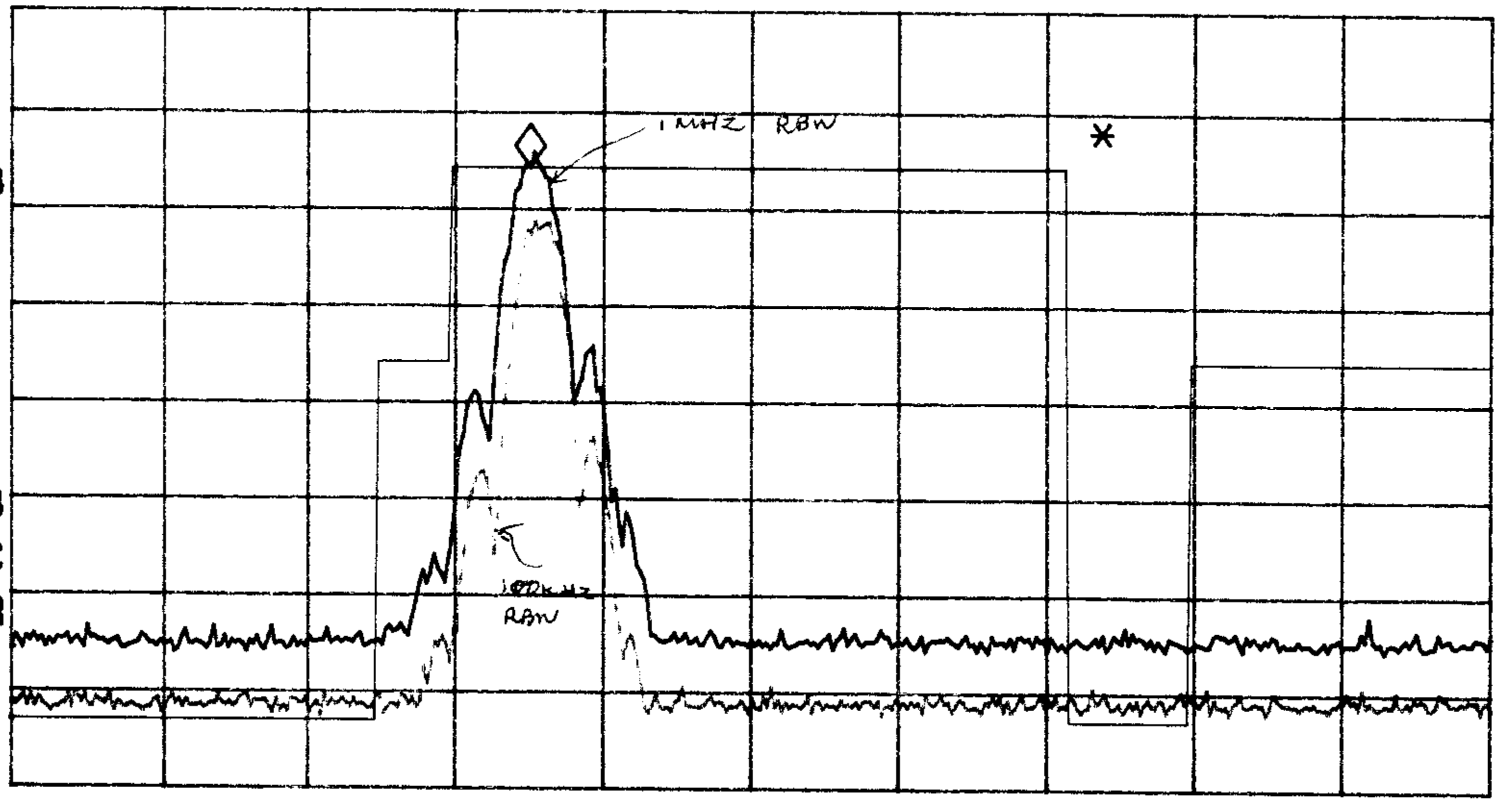
Antenna Polarization: HORIZONTAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.411Ø GHz
11Ø.92 dBµV

No user Menu

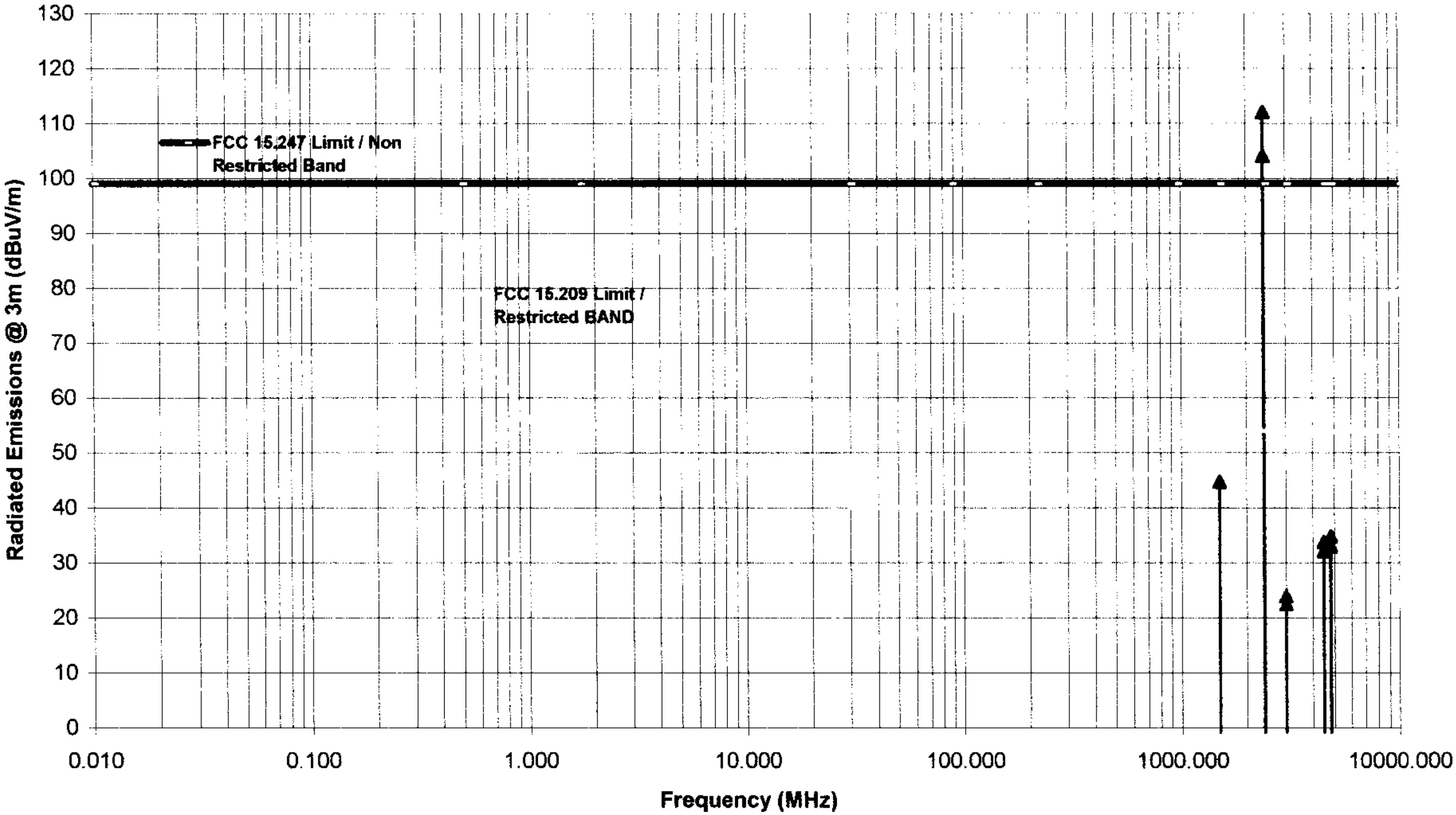
REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBµV
1Ø
dB/
#ATN
1Ø dB



VA VB
SC FC
ACORR

CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #4, Tx Freq.: 2411.4375 MHz, Tx Lo Freq.: 1496.4375 MHz



UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 6, Tx Frequency: 2419.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

hp

Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

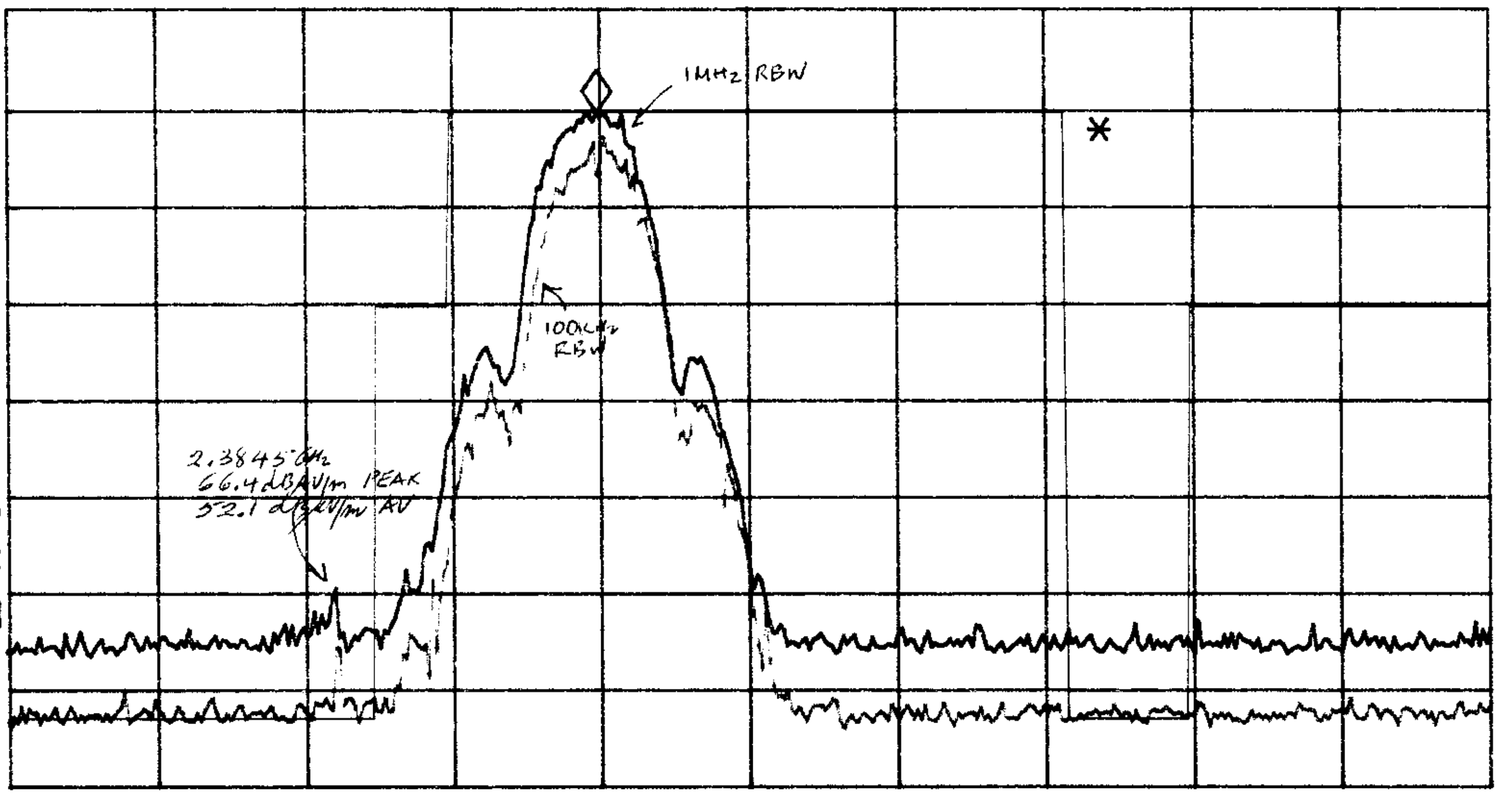
AVERAGE BANDWIDTH
1 MHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.42Ø5 GHz
116.36 dBµV

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBµV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 6, Tx Frequency: 2419.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: HORIZONTAL

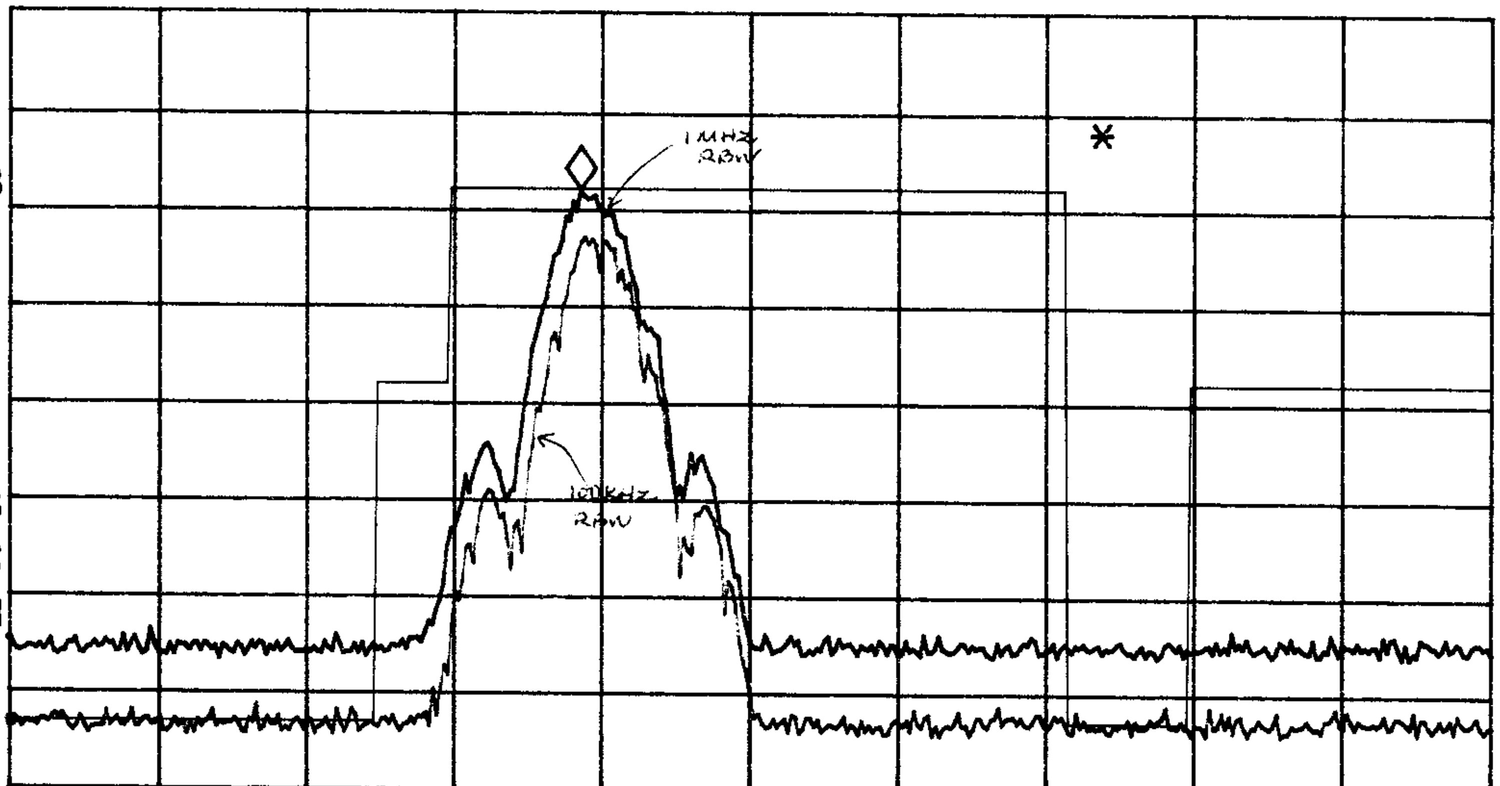
hp 09: 39: 31 OCT 24, 1997 10: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4180 GHz
108.75 dBµV

No user Menu

REF OFFST 20.0 dB
LOG REF 127.0 dBµV
10
dB/
#ATN
10 dB

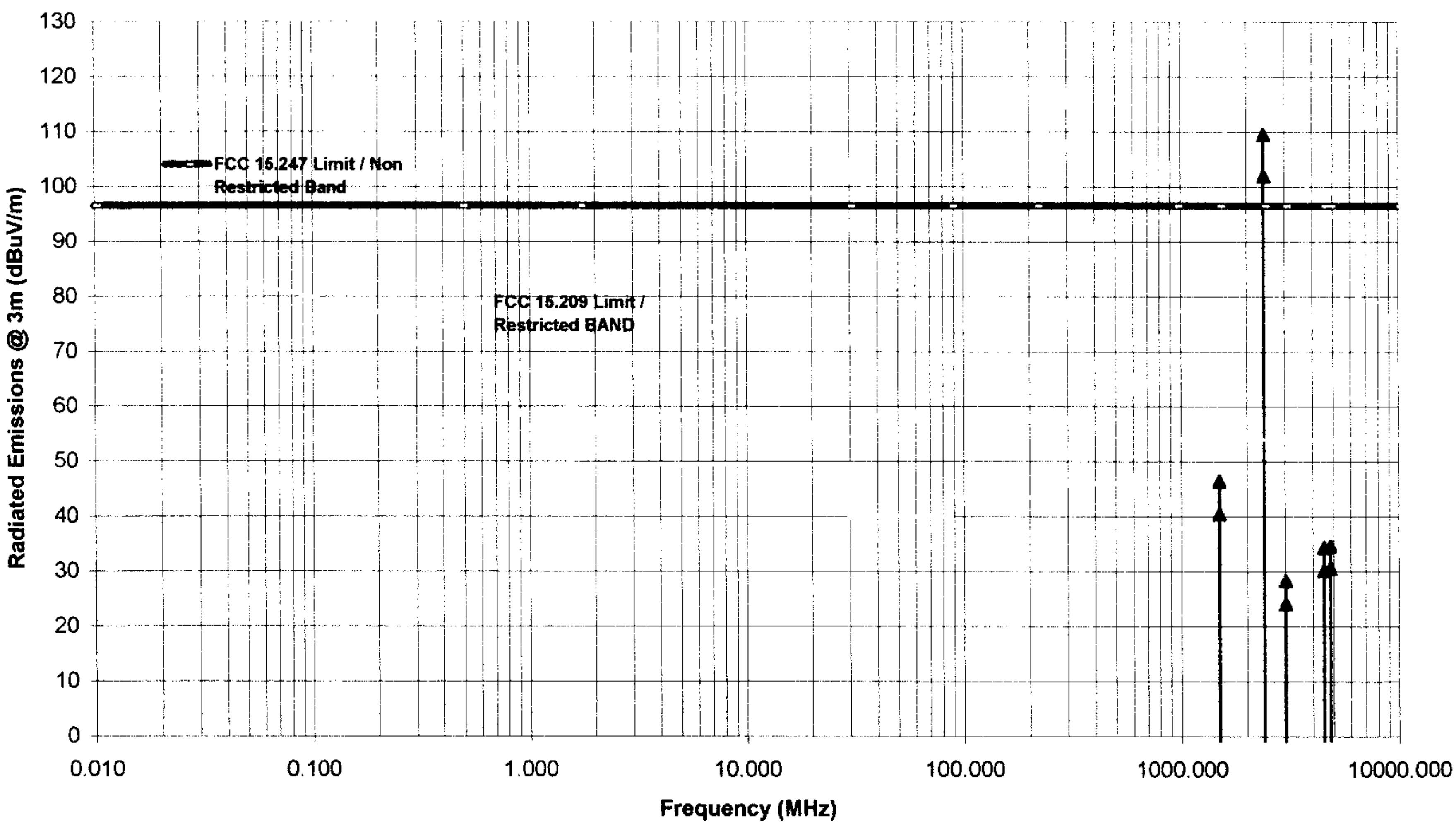
VA VB
SC FC
ACORR



CENTER 2.4410 GHz
#IF BW 1.0 MHz #AVG BW 1 MHz

SPAN 200.0 MHz
SWP 20.0 msec

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #6, Tx Freq.: 2419.875 MHz, Tx Lo Freq.: 1504.875 MHz



UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 15, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

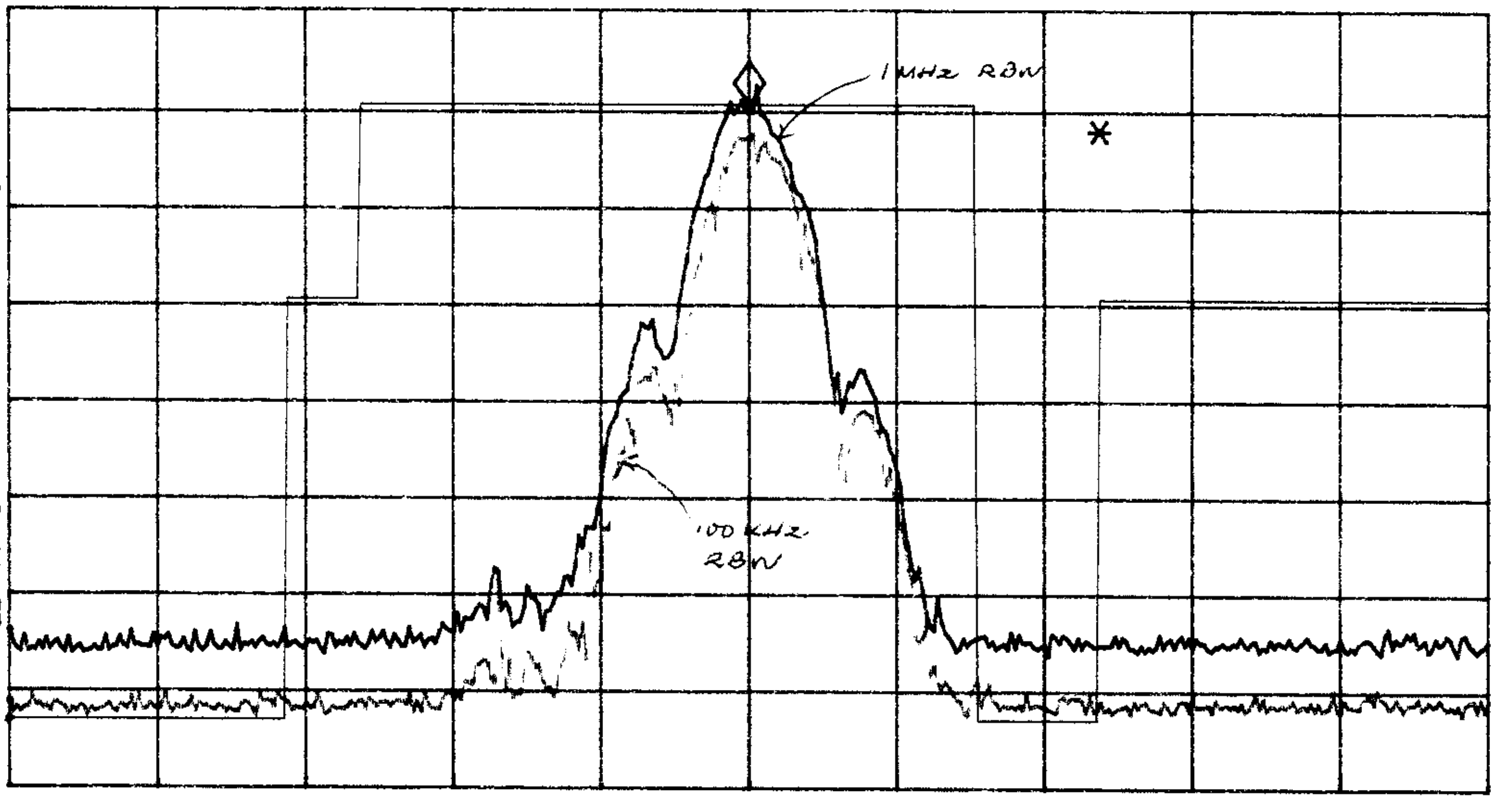
hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.453Ø GHz
117.32 dBμV

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.453Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz

SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 15, Tx Frequency: 2453.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

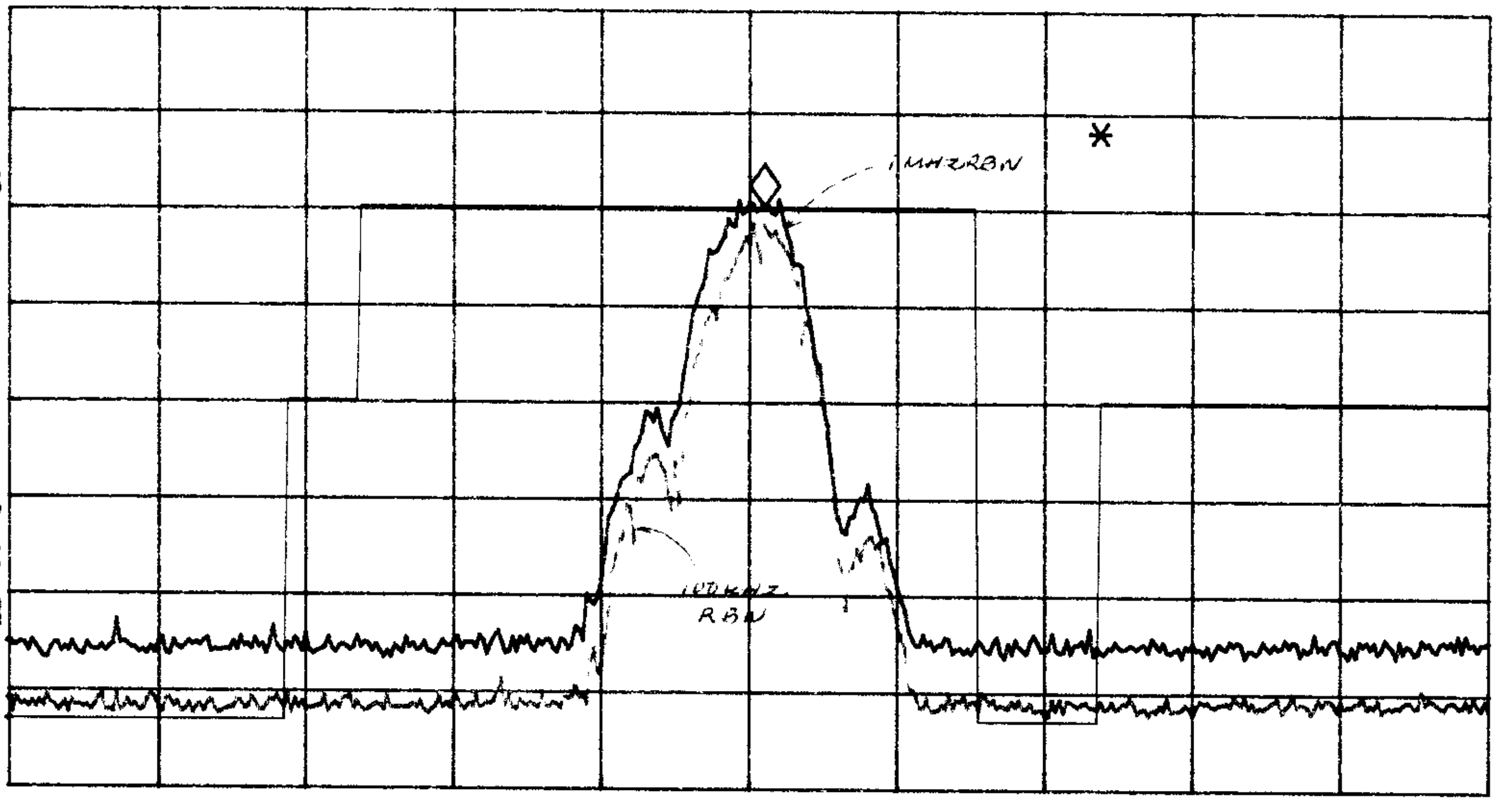
Antenna Polarization: HORIZONTAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.455Ø GHz
1Ø6.94 dBµV

No user
Menu

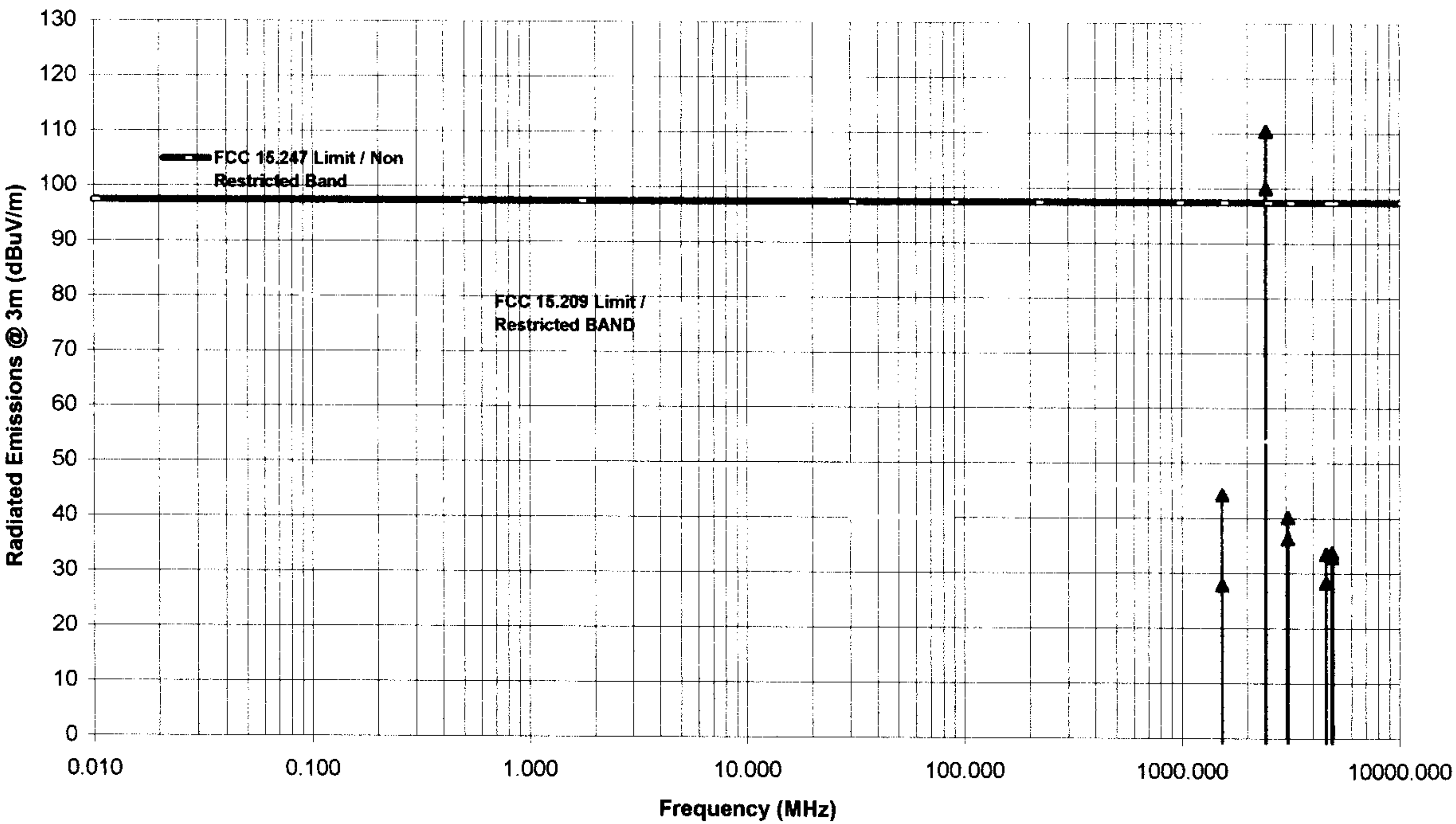
REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBµV
1Ø
dB/
#ATN
1Ø dB



VA VB
SC FC
ACORR

CENTER 2.453Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #15, Tx Freq.: 2453.625 MHz, Tx Lo Freq.: 1538.625 MHz



UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2462.025 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

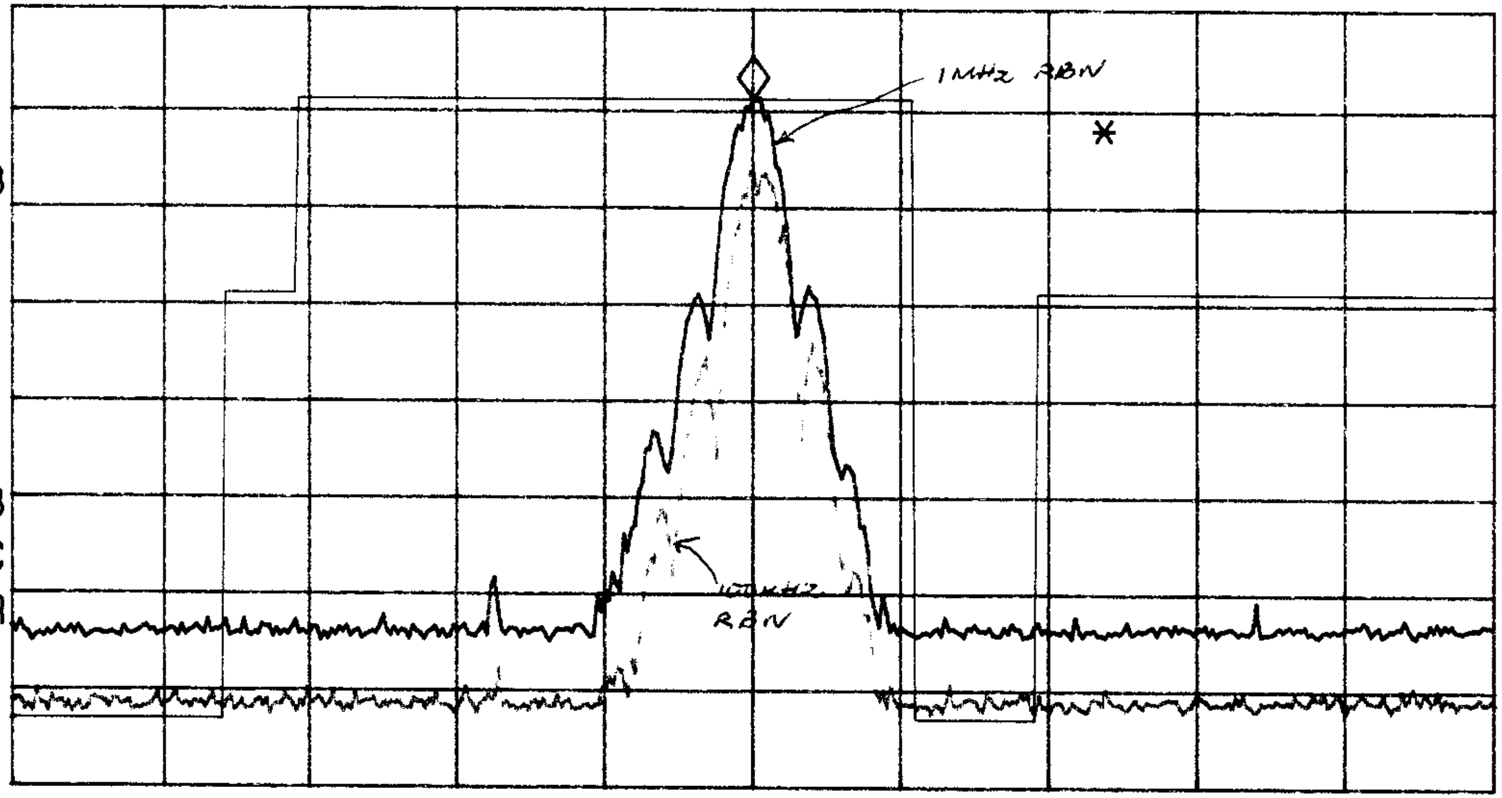
hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.462Ø GHz
117.79 dBµV

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBµV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.462Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2462.025 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

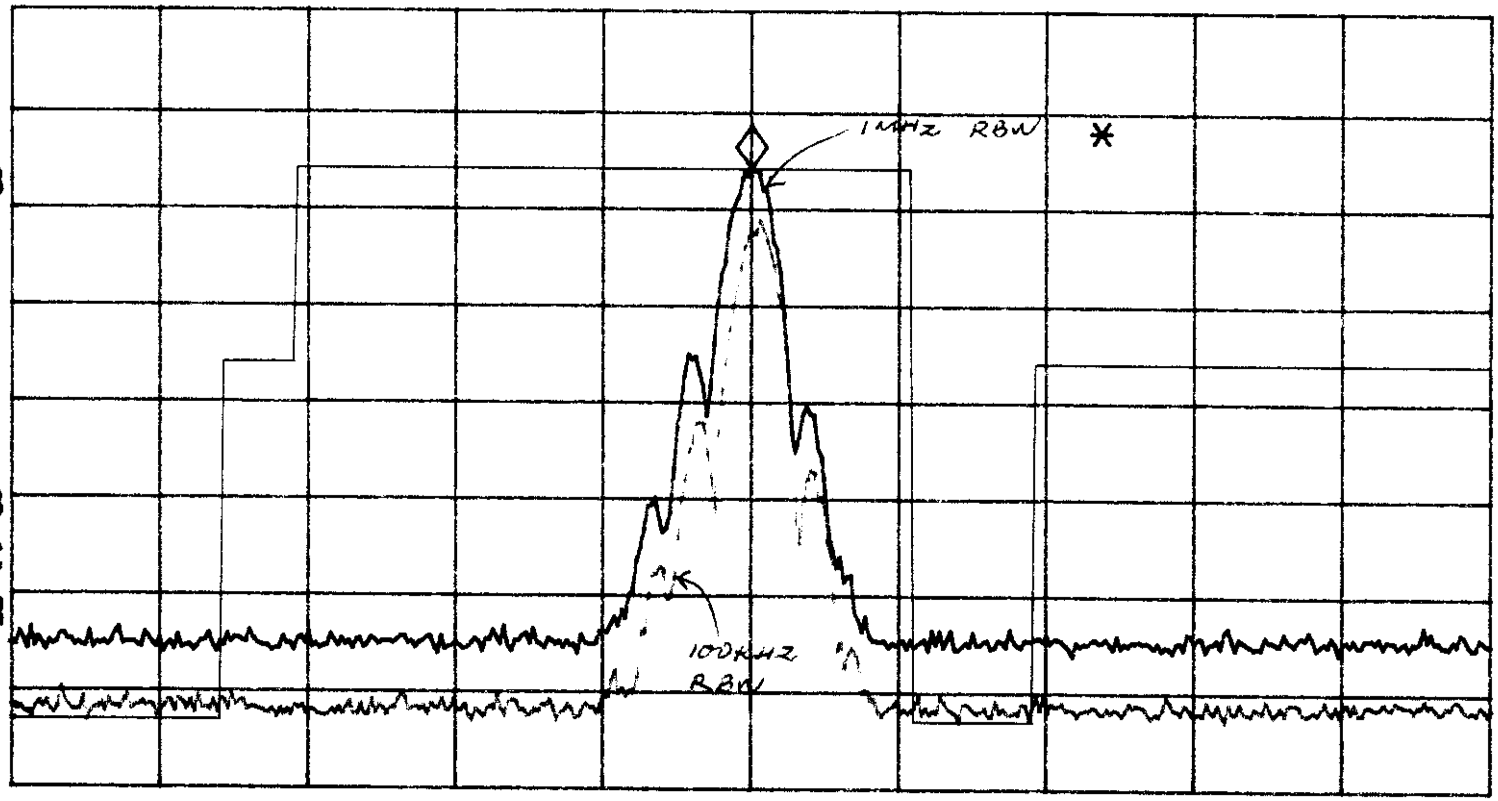
Antenna Polarization: HORIZONTAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.462Ø GHz
11Ø.83 dBµV

No user Menu

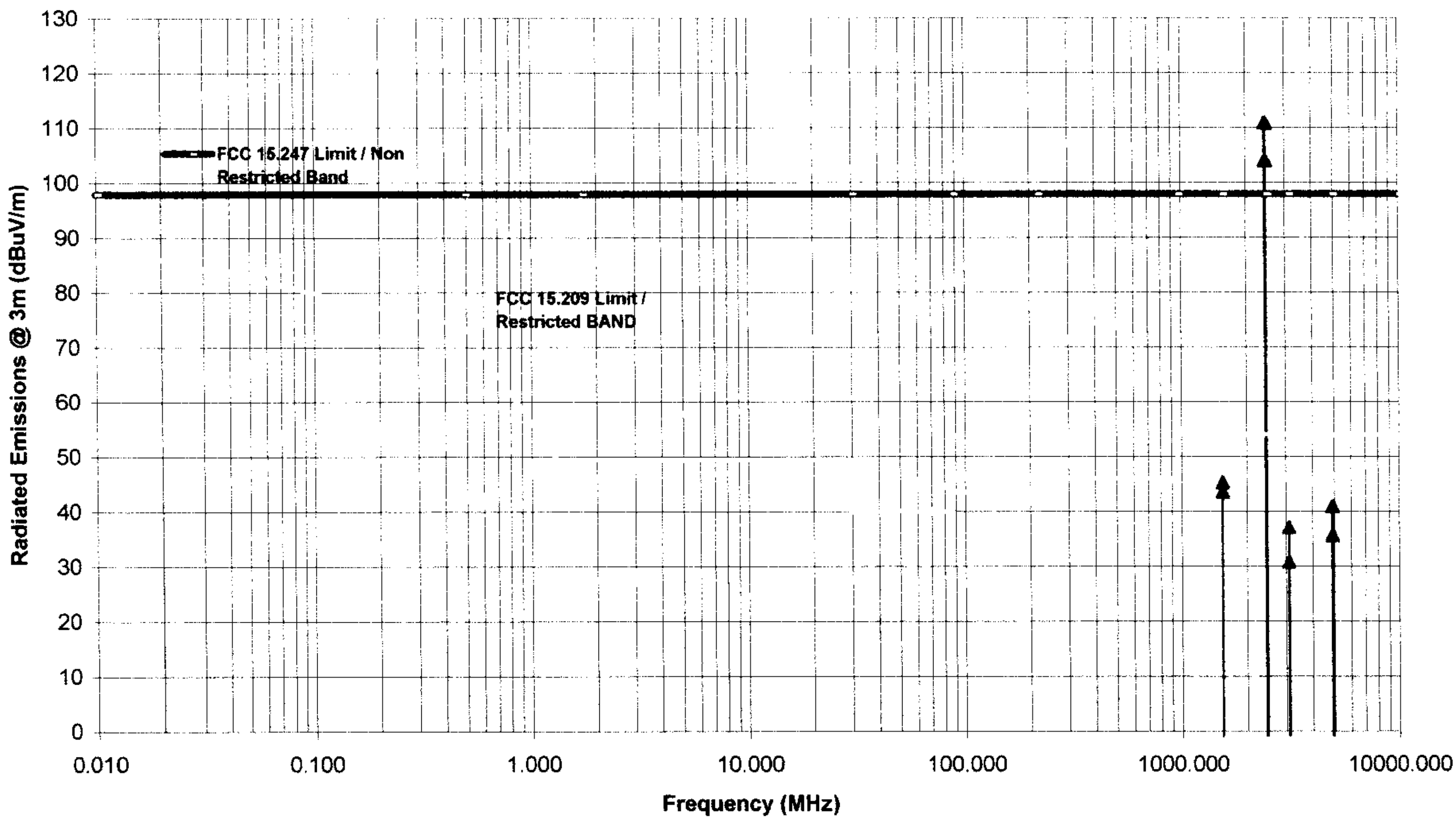
REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBµV
1Ø dB/
#ATN 1Ø dB



VA VB
SC FC
ACORR

CENTER 2.462Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #17, Tx Freq.: 2462.0625 MHz, Tx Lo Freq.: 1547.0625 MHz



UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 18, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

Antenna Polarization: VERTICAL

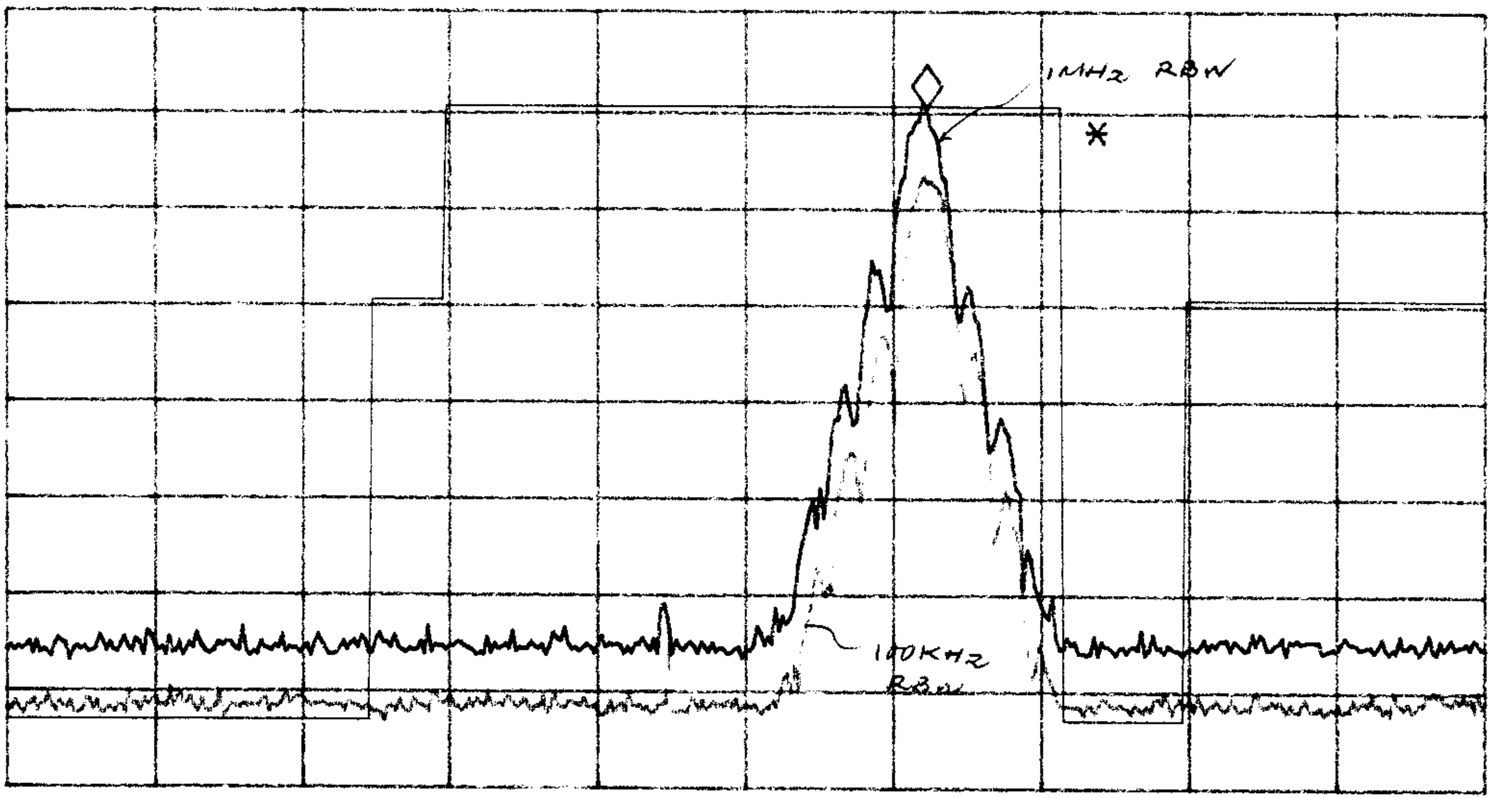
hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4655 GHz
117.12 dBμV

No user Menu

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

UltraTech Engineering Labs Inc.

Date: Mar. 04/98
Tested by: Tri Luu

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 18, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Transmitter Radiated Emissions @ 3m

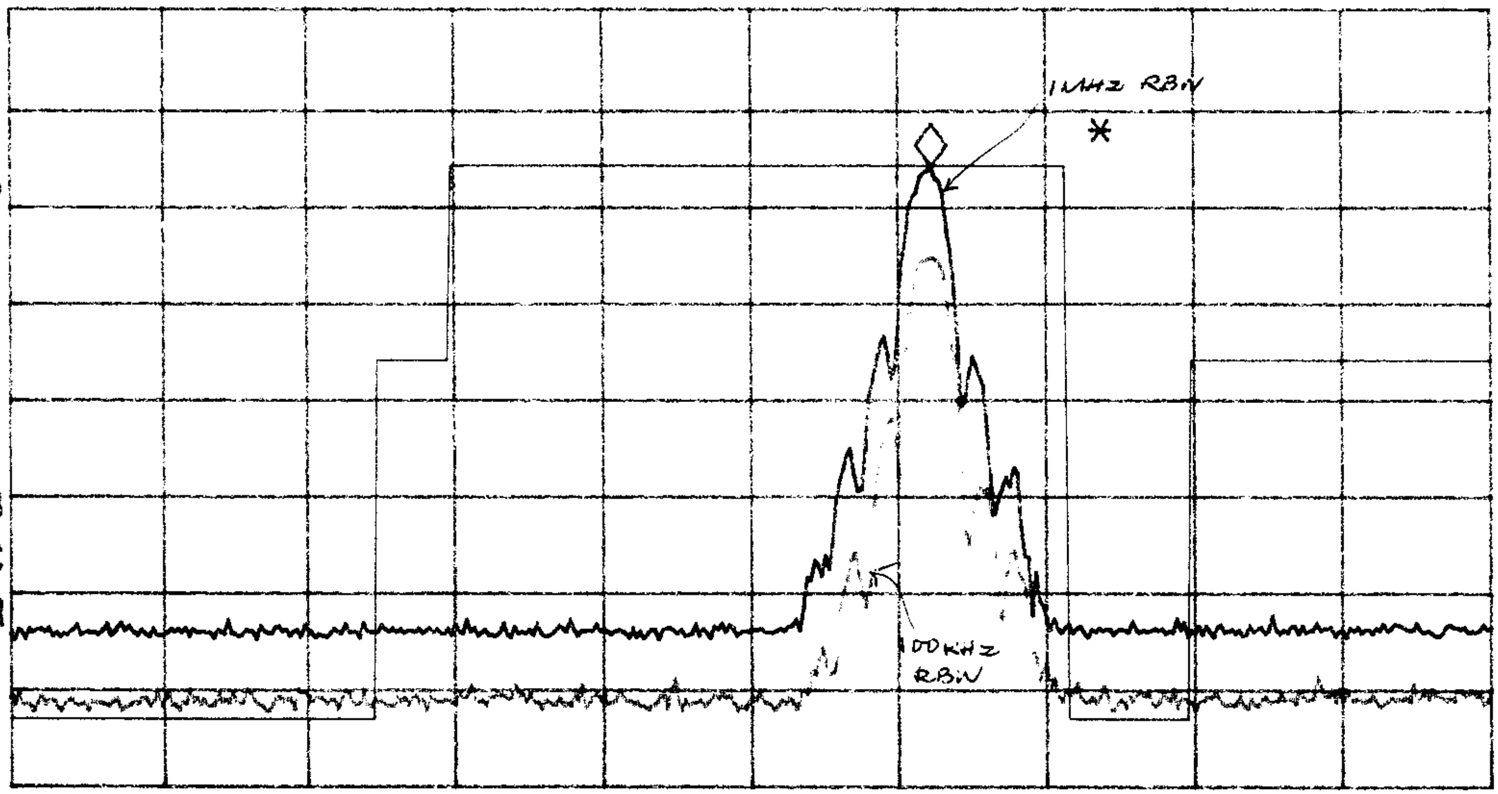
Antenna Polarization: HORIZONTAL

hp Ø9: 39: 31 OCT 24, 1997 1Ø: 53: 46 OCT 24, 1997

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4655 GHz
11Ø.83 dBμV

REF OFFST 2Ø.Ø dB
LOG REF 127.Ø dBμV
1Ø
dB/
#ATN
1Ø dB

VA VB
SC FC
ACORR



LIMIT 1
ON OFF

MARGIN 1
ON OFF

LMT TEST
ON OFF

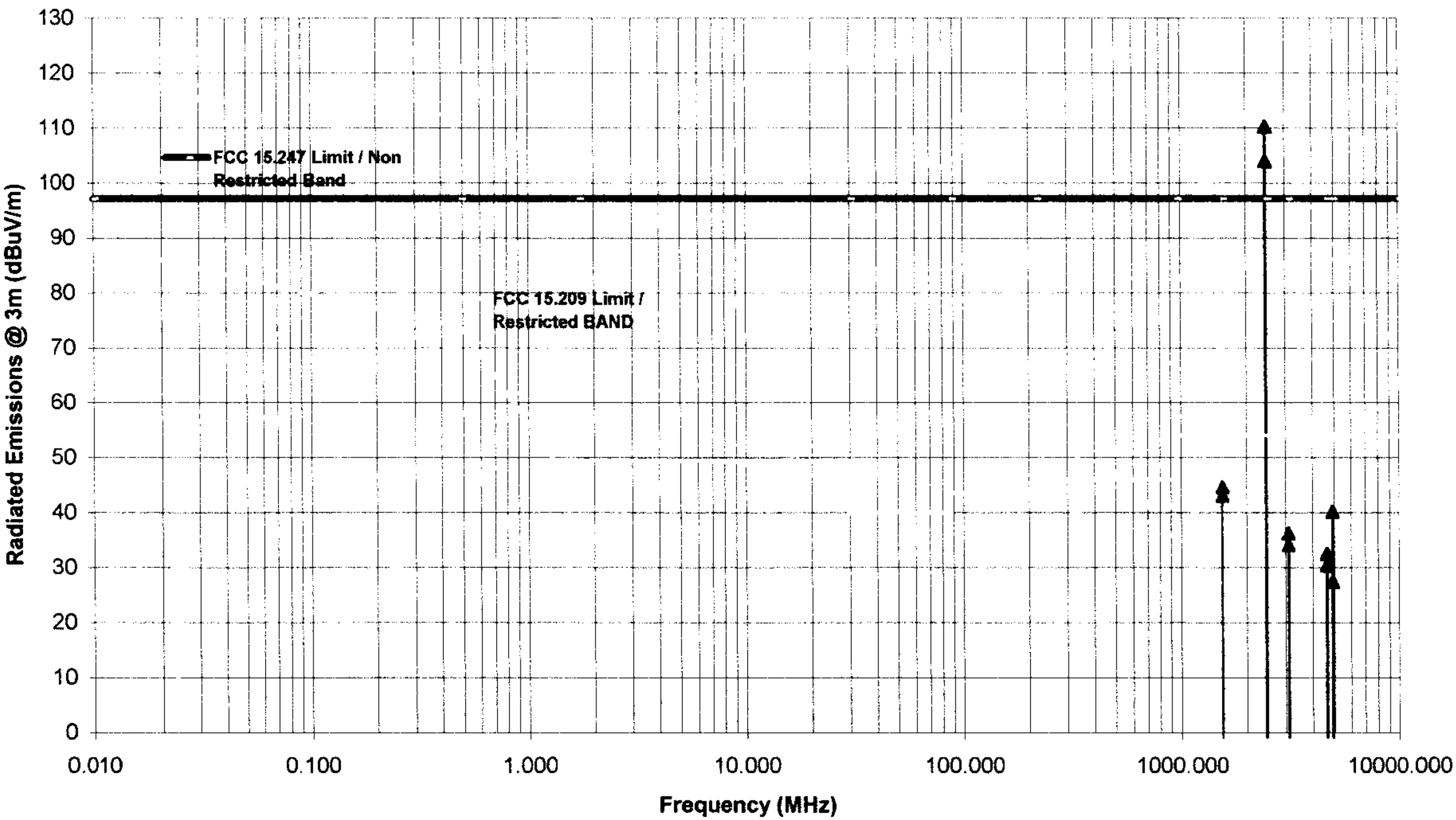
DELETE
LIMIT

EDIT
LIMIT

Previous
Menu

CENTER 2.441Ø GHz
#IF BW 1.Ø MHz #AVG BW 1 MHz
SPAN 2ØØ.Ø MHz
SWP 2Ø.Ø msec

Transmitter Radiated Emissions Measurements at 3 Meter OFTS
InterAir ISP Direct Indoor (2401-01) and Outdoor (2401-02) Unit
Channel #18, Tx Freq.: 2464.875 MHz, Tx Lo Freq.: 1549.875 MHz



4.5 Transmitted Power Density of a Direct Sequence Spread Spectrum System, FCC CFR 47, Para. 15.247(d)

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

For a direct sequence system, the transmitted power density average over any 1 second interval shall not be greater than 8 dBm in any 3 KHz bandwidth within this band.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT

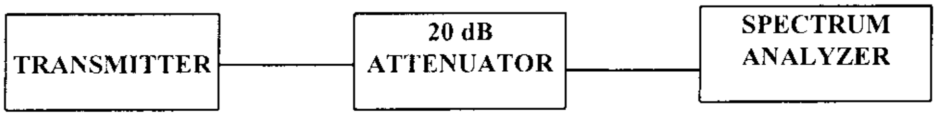
METHOD OF MEASUREMENT:

A scan was made by using a spectrum analyzer with the detector function set to NORMAL mode.

Locate and zoom in on emission peak(s) within the passband. Set RBW = 3 KHz, VBW ≥ RBW, Sweep = SPAN/3 KHz. For example, a span of 1.5 MHz, the sweep should be $1.6x10^6/3.0x10^3$= 500 seconds. The measured peak level must be no greater than +8 dBm.

- For devices with spectrum line spacing greater than 3 KHz no change is required.
- For devices with spectrum line spacing equal to or less than 3 KHz, the resolution bandwidth must be reduced below 3 KHz until the individual lines in the spectrum are resolved. The measurement data must then be normalized to 3 KHz by summing the power of all the individual spectral lines within 3 KHz band (in linear power units) to determine compliance.
- If the spectrum line spacing cannot be resolved on the available spectrum analyzer, the noise density function on most modern conventional spectrum analyzer will directly measure the noise power density normalized to 1 Hz noise power bandwidth. Add 30 dB for correction to 3 KHz.
- Should all the above fail or any controversy develop regarding accuracy of measurement, the Laboratory will use HP 89440A Vector Signal Analyzer for final measurement unless a clear showing can be made for a further alternate.

TEST ARRANGEMENT



TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Feb. 26 & Mar. 04, 1998

MEASUREMENT DATA:

TEST CONFIGURATION

- *The transmitter was coupled to the Spectrum Analyzer through a 20 dB attenuator.*
- *The insertion loss between the transmitter output terminal and the spectrum analyzer was measured to be 20 dB*
- *The channel frequencies were established on the extreme edges (both upper and lower) and middle of the 2408.625 - 2464.875 MHz band at its full rated output power. The emissions was investigated up to the tenth harmonic of the fundamental emissions in each case. the measured level of the carrier was recorded and compared to the level of the emissions as required in Part 15.247(d)*

Channel No.	Channel Frequency	Modulation Bandwidth	Data Rate (Mb/s)	Chips per Symbol	Measured Power Density in 3 kHz BW (dBm)	FCC Limit (dBm)
3	2408.625	Narrow	4.5	11	-1.0	8.0
9	2431.125	Wide	11.25	11	1.8	8.0
17	2462.0625	Medium	5.625	11	-3.2	8.0

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Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #3

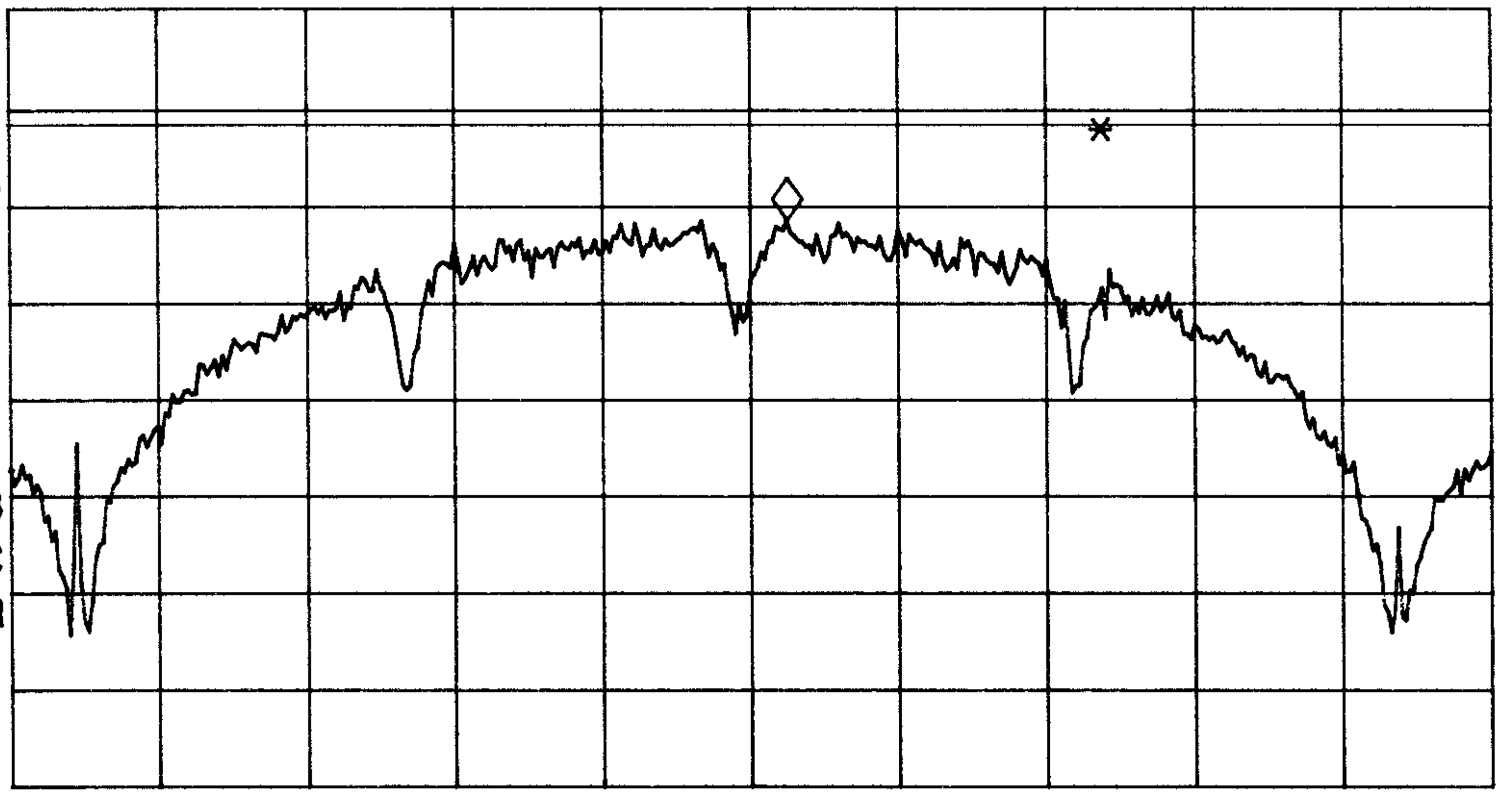
SWEEPTIME
1ØØ sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4Ø438 GHz
-1.82 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
#ATN
1Ø dB

VA SB
SC FC
CORR



CENTER 2.4Ø413 GHz
#IF BW 3.Ø kHz #AVG BW 3ØØ kHz
SPAN 1Ø.ØØ MHz
#SWP 1ØØ sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 7, Tx Frequency: 2408.625 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: NARROW (4.5 Mc/s), 11 chips/symbol, 0.818 Mbps DQPSK

Date: Feb. 26/98
Tested by: Tri Luu

hp

Channel #3

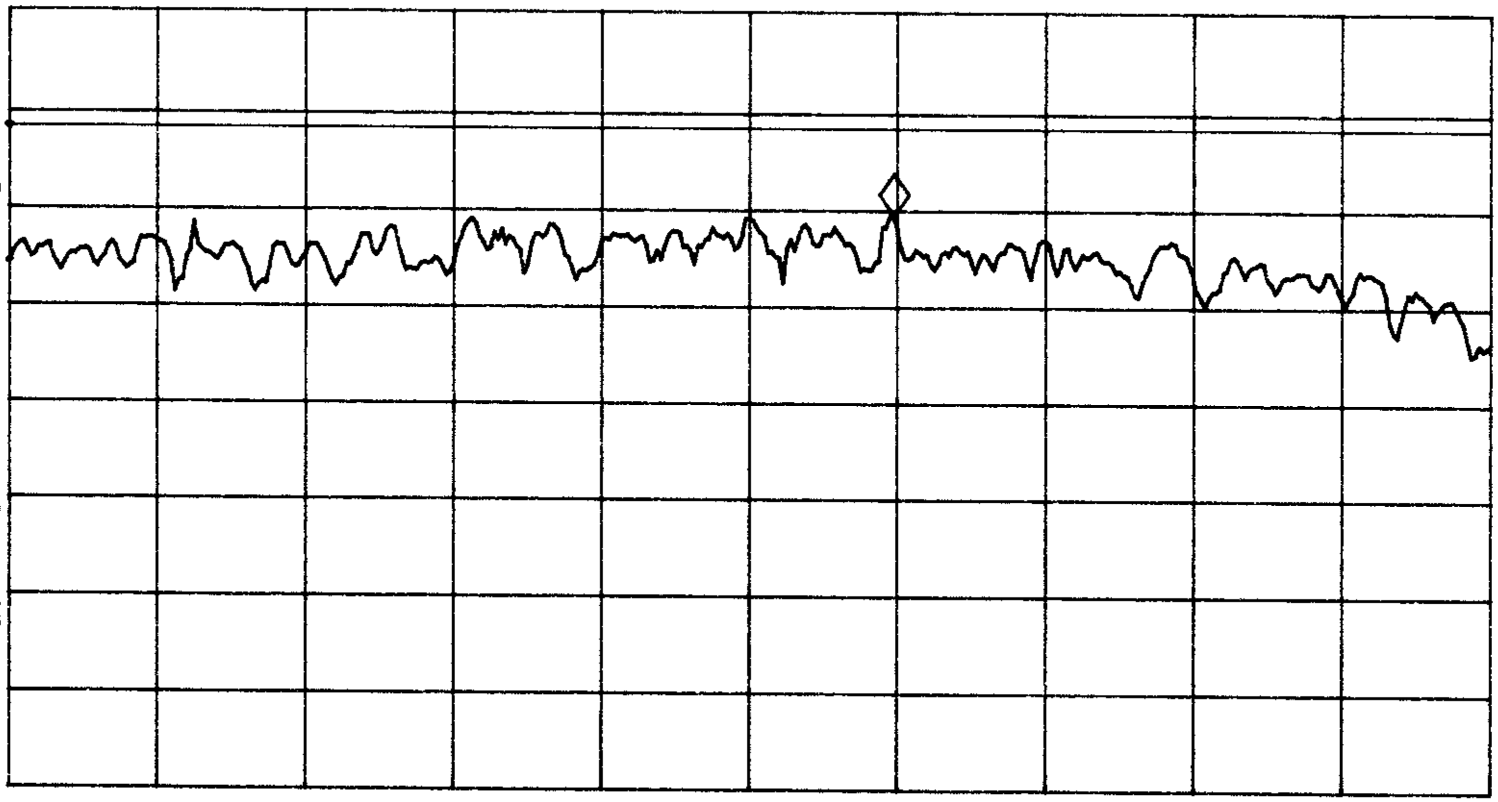
SWEEPTIME
100 sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4038738 GHz
-.95 dBm

No user
Menu

REF OFFST 20.0 dB
LOG REF 20.0 dBm
10
dB/
#ATN
10 dB

VA SB
SC FC
CORR



CENTER 2.4038250 GHz
#IF BW 3.0 kHz #AVG BW 300 kHz
SPAN 500.0 kHz
#SWP 100 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 2 **, Tx Frequency:** 2431.125 **MHz, RF Power: 0.19 W**
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

hp

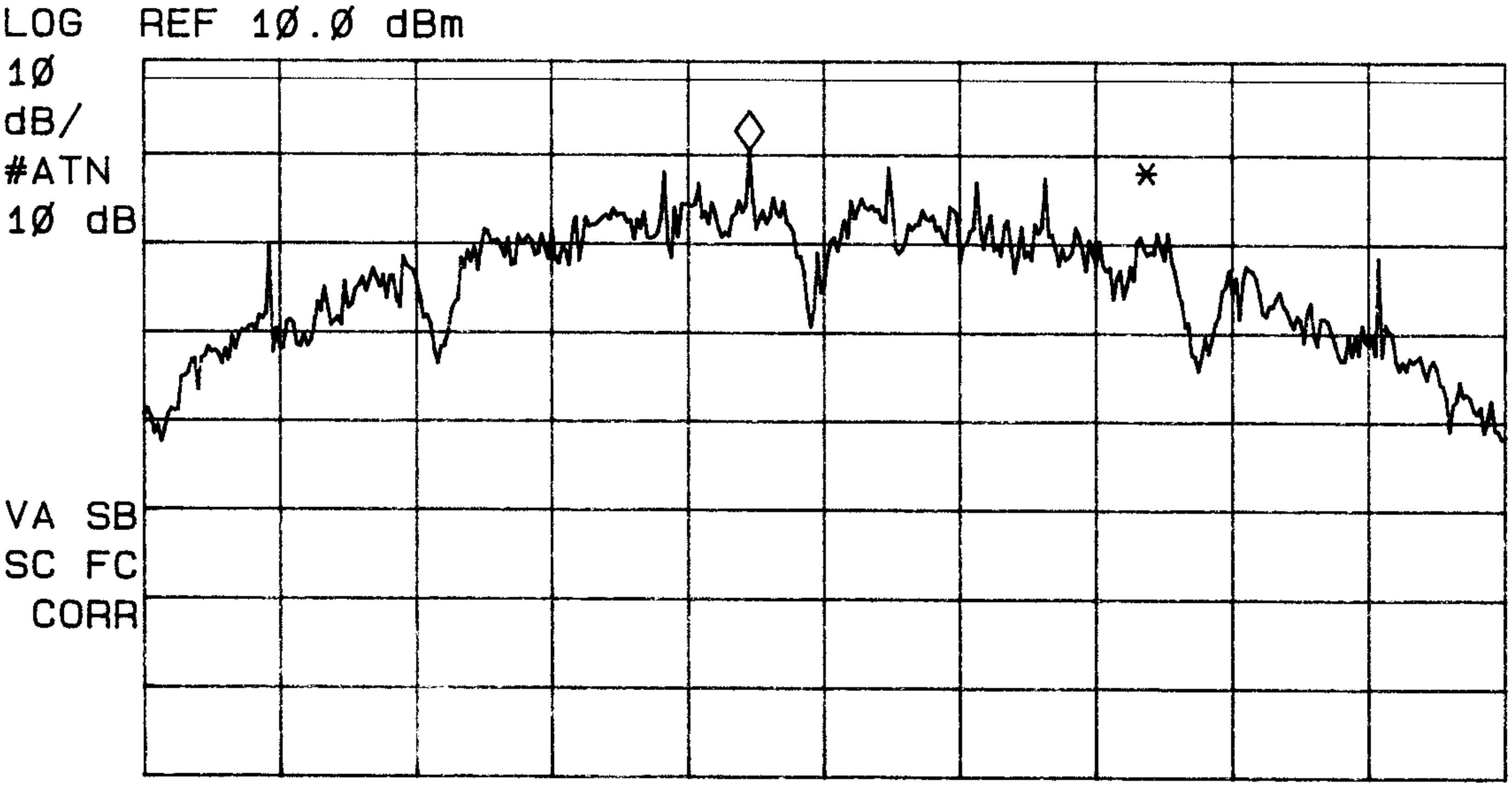
Channel #9

SPAN
20.ØØ MHz

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.43ØØ3 GHz
.Ø3 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
REF 1Ø.Ø dBm



CENTER 2.43113 GHz
#IF BW 3.Ø kHz
#AVG BW 3Ø kHz
SPAN 2Ø.ØØ MHz
#SWP 1ØØ sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Test Configuration #: 21 **, Tx Frequency:** 2431.125 **MHz, RF Power: 0.19 W**
Modulation: DSSS, BW: WIDE (11.25 Mc/s), 11 chips/symbol, 2.045 Mbps DQPSK

Date: Feb. 26 /98
Tested by: Tri Luu

hp

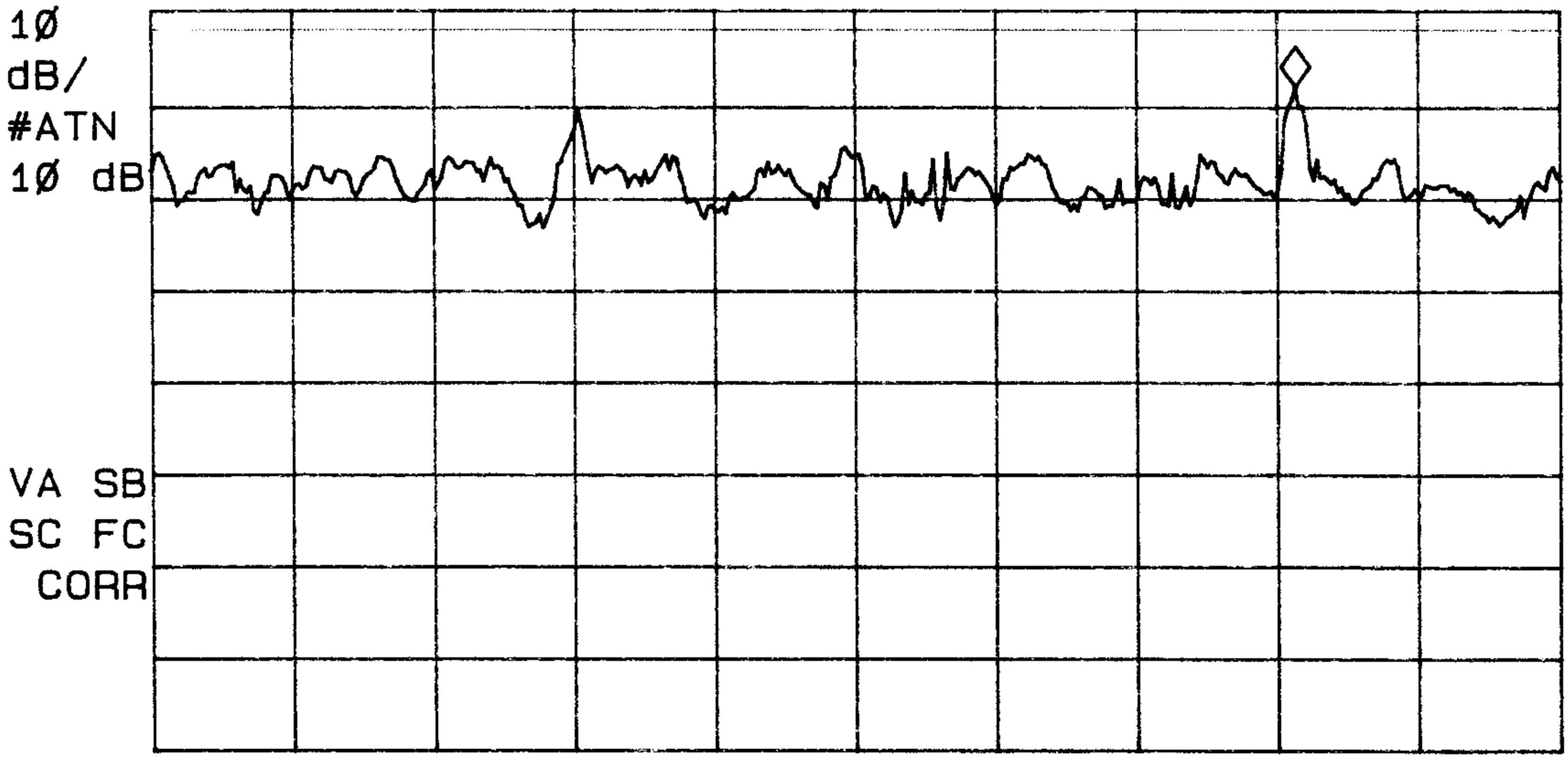
Channel #9

SWEEPTIME
100 sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.4332338 GHz
1.77 dBm

No user
Menu

REF OFFST 20.0 dB
REF 10.0 dBm



CENTER 2.4330775 GHz
#IF BW 3.0 kHz #AVG BW 30 kHz

SPAN 500.0 kHz
#SWP 100 sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu

hp

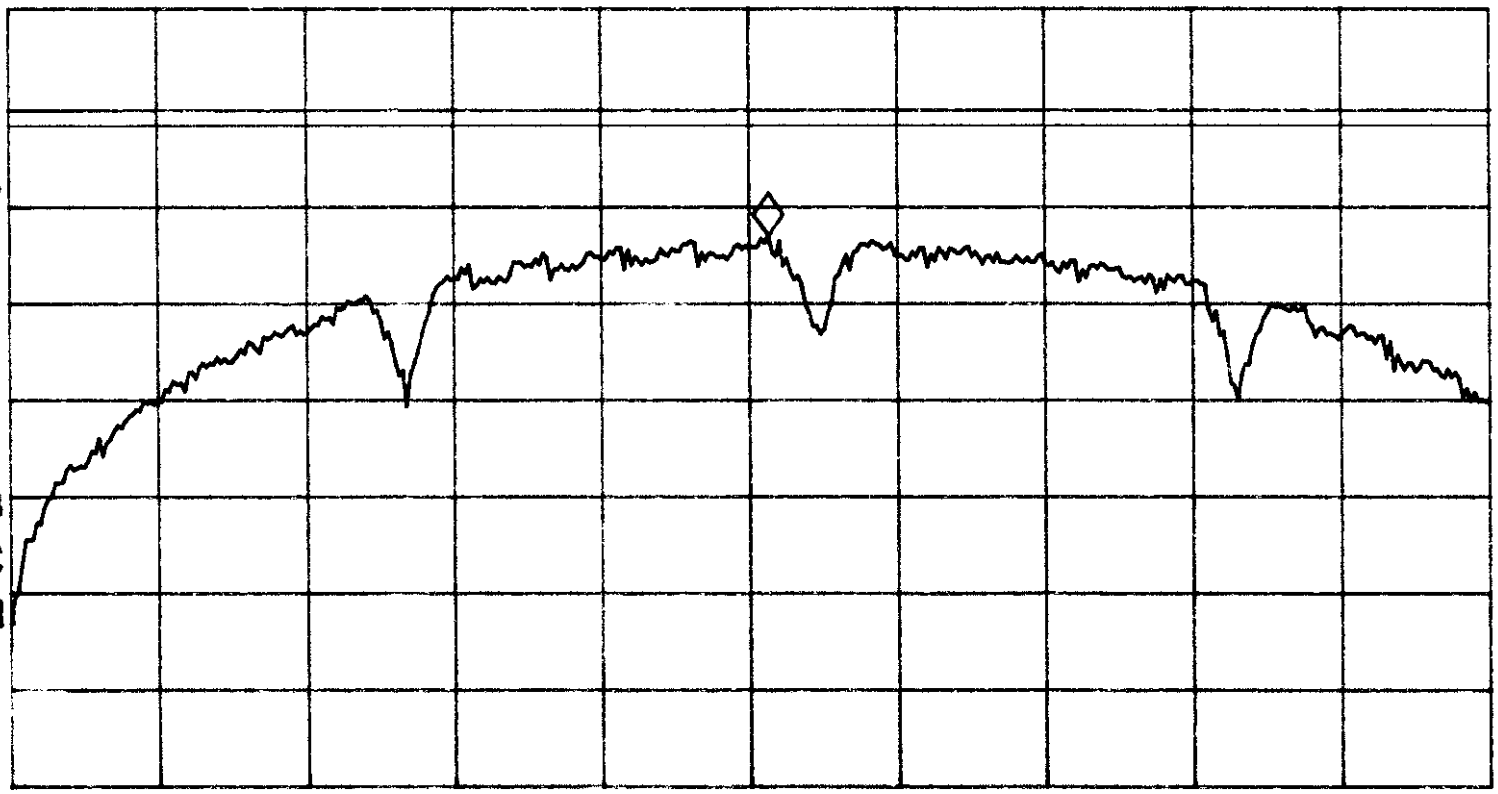
SWEEPTIME
1ØØ sec

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.46168 GHz
-3.37 dBm

No user
Menu

REF OFFST 2Ø.Ø dB
LOG REF 2Ø.Ø dBm
1Ø
dB/
ATN
1Ø dB

VA SB
SC FC
CORR

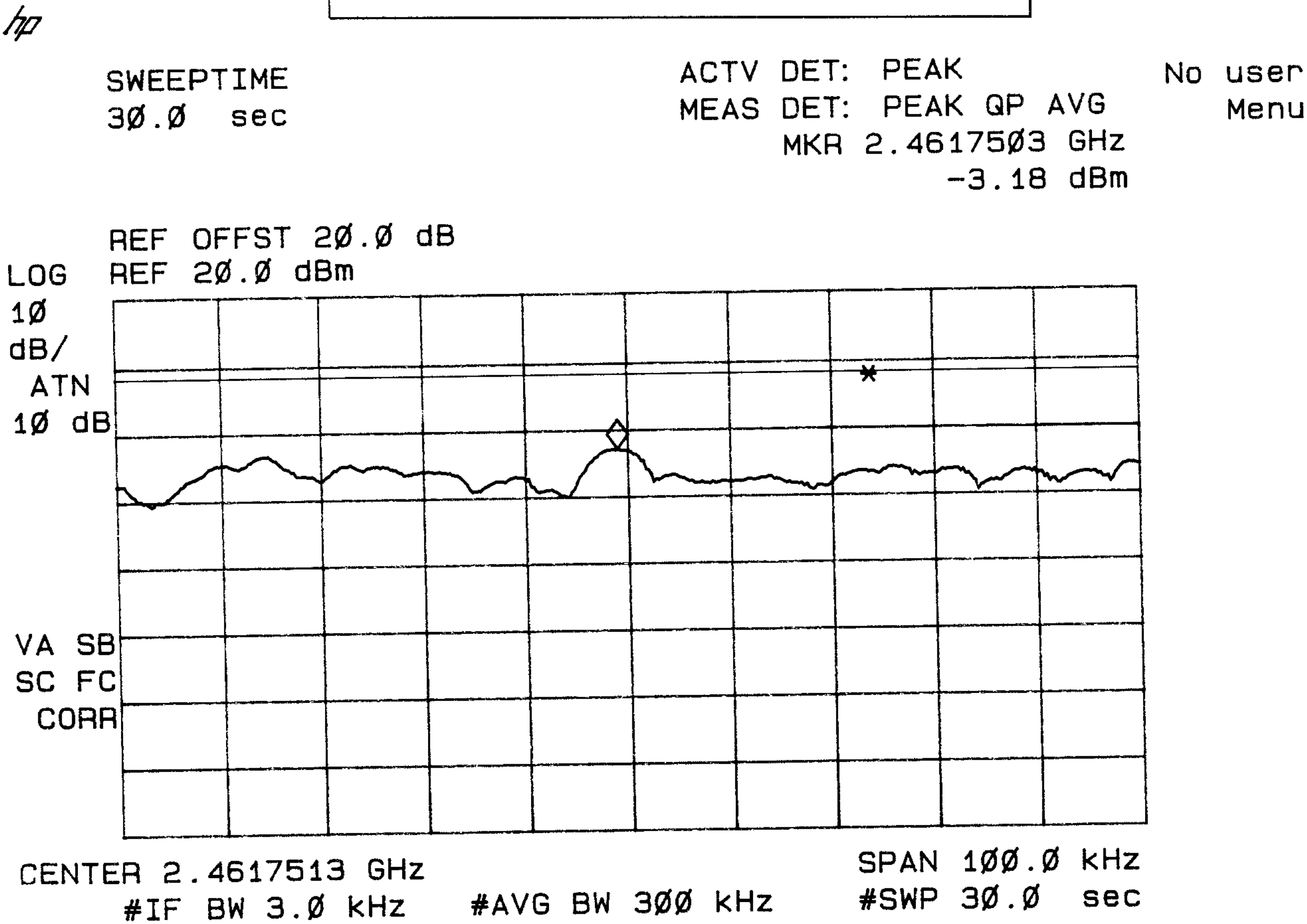


CENTER 2.46155 GHz SPAN 1Ø.ØØ MHz
#IF BW 3.Ø kHz #AVG BW 3ØØ kHz #SWP 1ØØ sec

UltraTech Engineering Labs Inc.

ISP DIRECT, MODEL 2401-01 (INDOOR) & 2401-02 (OUTDOOR)
Channel #: 17, Tx Frequency: 2464.875 MHz, RF Power: 0.19 W
Modulation: DSSS, BW: MEDIUM (5.625 Mc/s), 11 chips/symbol, 1.023 Mbps DQPSK

Date: Mar. 04/98
Tested by: Tri Luu



4.6 Processing Gain of A Direct Sequence Spread Spectrum, FCC CFR 47, Para. 15.247(e)

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

FCC REQUIREMENTS:

The processing gain of a direct sequence system shall be at least 10 dB. The processing gain shall be determined from the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on, as measured at the demodulated output of the receiver.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- Advantest Spectrum Analyzer, Model R3271, S/N: 15050203
- Bird 20 dB Attenuator, 50 Ohm IN/OUT
- IBM PS/1 & IBM 350 ThinkPad Host Computer(s)
- Fluke RF Signal Generator, Model 6061A, Freq. range: 10 KHz - 1050 MHz.
- HP 8900 RF Peak Power Meter, Measuring Frequency Range: 100 MHz - 18 GHz.

METHOD OF MEASUREMENT:

METHOD #1:- Jamming Margin Method

The processing gain may be measured using the CW jamming margin method. Figure 1 shows the test configuration. The test consists of stepping a signal generator in 50 KHz increments across the passband of the system. At each point, the generator level required to produce the recommended Bit Error Rate (BER) is recorded. This level is jammer level. The output power of the transmitting unit is measured at the same point. The Jammer to Signal (J/S) ratio is then calculated. Discard the worst 20% of the J/S data points. The lowest remaining J/S ratio is used when calculating the Process Gain.

The signal to noise ratio for an ideal non-coherent receiver is calculated from:

$$\boxed{Pe = 1/2e^{(-1/2(S/N)o)}} \quad (1)$$

where: Pe = probability of error (BER)
(S/N)o = the required signal to noise ratio at the receiver output for a given received signal quality

Ref.: Viterbi, A.J. Principles of Coherent Communications (New York: McGraw-HILL 1966), Pg. 207

Using equation (1) shown above, calculate the signal to noise ratio required for your chosen BER. This value and the measured J/S ratio are used in the following equation to calculate the Process Gain (Gp) of the system.

Gp = (S/N)o+Mj+Lsys

Where:

(S/N)o: Theoretical signal to noise ratio required to maintain the normal operation just before the BERappears. In real measurements the maximum error of 0.001 is allowed in an ideal system using their modulation scheme with all codes turned off (i.e. no spreading or processing gain).

Mj: Maximum jammer to Signal Ratio that recorded at the detected BER.

Lsys: System losses such as non-ideal synchronization, tracking circuitry, non-optimal baseband receiver filtering and etc... These losses can be in excess of 2 dB for each transmitter and receiver pair. For the purpose of this processing gain calculation we assume a Lsys at its minimum value of 2 dB.

Ref.: Dixon, R, Spread Spectrum Systems. (New York: Wiley, 1984)

The Signal-to-Noise Ratio (S/N) with respect to the probability of bit error for a differentially QPSK (DQPSK) receiver in the presence of additive white Gaussian noise (AWGN) is given by Figure 4.5.1 as attached.

Ref.: Marvin Simon, Spread Spectrum Communication Handbook, page 695.

Since the CW jamming is a tone jamming, the (S/N)o for a AWGN jamming obtained from Figure 4.5.1 can be converted to the CW jamming or tone jamming using the formula (3.97) of the Marvin Simon Spread Spectrum Communication Handbook as follows:

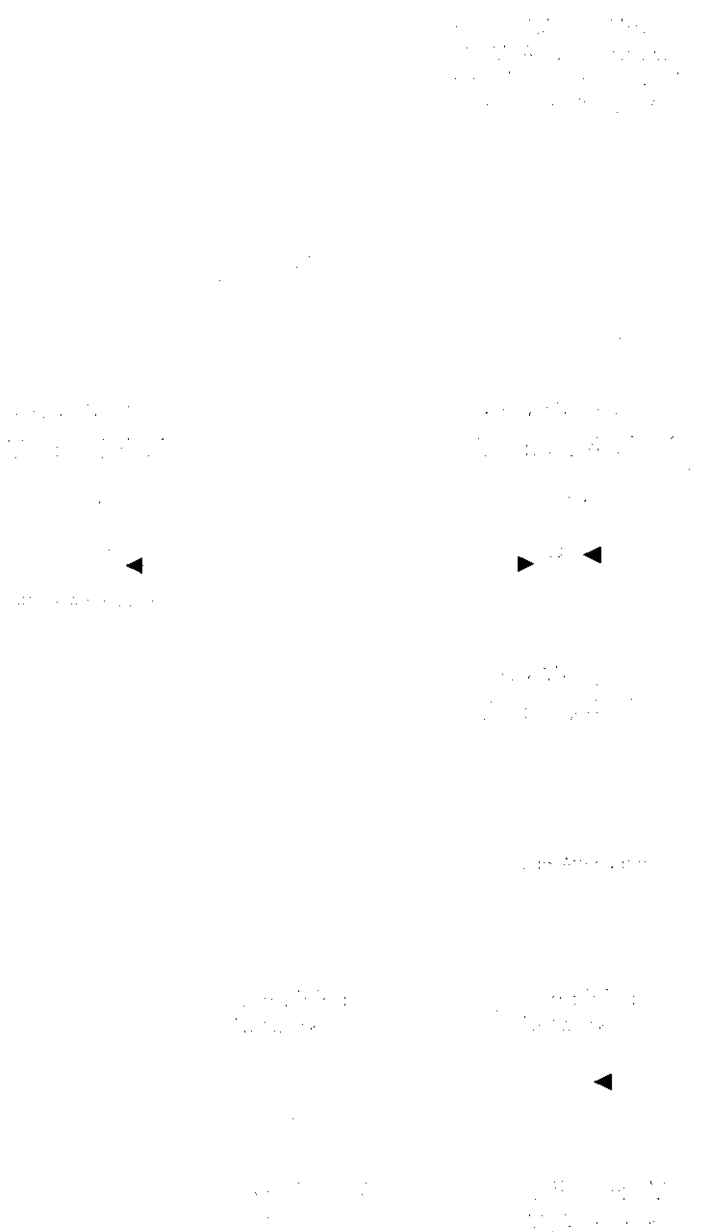
$(S/N)_o^{t}$ in dB = $(S/N)_o^{AWGN} / 0.8$

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Mar. 31 & Apr. 01, 1998

Figure 1:- SETUP FOR PROCESSING GAIN MEASUREMENT - JAMMING MARGIN METHOD



MEASUREMENT DATA:

Channel #4, Fc = 2411.4375 MHz	Data Rate = 1.023 Mbps (DQPSK), Medium
Chip Rate = 5.625 MHz	PN Code Length = 11 chips/symbol
6 dB BW = 5 MHz	

(S/N)o = 12 dB / 0.8 = 15 dB per attached Figure 4.5.1 and formula 3.97

Measured Processing Gain Gp = (S/N)o + Lsys + Mj = 15 + 2 + Mj = 17 + Mj (dB)

Theoretical Calculated Processing Gain = Chip Rate/Data rate = $\frac{\text{5.625 MHz}}{\text{(1.023 Mb/s)/(2 bits/symbol)}}$ = 11.0 or 10.4 dB

Note:

- Total Peak Power from the EUT's Tx measured at the EUT's Rx Input: P_t = -46.7 dBm
- Jamming signal level at measured at the EUT's receiver input: J
- $Mj = J - P_t$
- The following shaded boxes are discarded worst measurements (17.7% of total measurement points)

SUMMARY OF TEST RESULTS	
Theoretical Process Gain	10.4 dB
Minimum Measured Process Gain with discard of 17.7% of the worst measurements	12.5 dB

Test Point	Jammer Signal Freq. + /- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
1	-3.50	0.00001	15.0	2.0	1.7	18.7
2	-3.45	0.00001	15.0	2.0	2.0	19.0
3	-3.40	0.00001	15.0	2.0	1.6	18.6
4	-3.35	0.00001	15.0	2.0	1.7	18.7
5	-3.30	0.00001	15.0	2.0	0.6	17.6
6	-3.25	0.00001	15.0	2.0	-0.4	16.6
7	-3.20	0.00001	15.0	2.0	-0.4	16.6
8	-3.15	0.00001	15.0	2.0	-0.4	16.6
9	-3.10	0.00001	15.0	2.0	0.0	17.0
10	-3.05	0.00001	15.0	2.0	0.8	17.8
11	-3.00	0.00001	15.0	2.0	0.8	17.8
12	-2.95	0.00001	15.0	2.0	1.6	18.6
13	-2.90	0.00001	15.0	2.0	1.6	18.6
14	-2.85	0.00001	15.0	2.0	1.7	18.7
15	-2.80	0.00001	15.0	2.0	1.5	18.5
16	-2.75	0.00001	15.0	2.0	1.1	18.1
17	-2.70	0.00001	15.0	2.0	0.8	17.8
18	-2.65	0.00001	15.0	2.0	0.7	17.7
19	-2.60	0.00001	15.0	2.0	-0.4	16.6
20	-2.55	0.00001	15.0	2.0	-2.4	14.6
21	-2.50	0.00001	15.0	2.0	-2.7	14.3
22	-2.45	0.00001	15.0	2.0	-2.8	14.2

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
23	-2.40	0.00001	15.0	2.0	-2.9	14.1
24	-2.35	0.00001	15.0	2.0	-2.9	14.1
25	-2.30	0.00001	15.0	2.0	-2.6	14.4
26	-2.25	0.00001	15.0	2.0	-2.6	14.4
27	-2.20	0.00001	15.0	2.0	-2.5	14.5
28	-2.15	0.00001	15.0	2.0	-2.9	14.1
29	-2.10	0.00001	15.0	2.0	-3.6	13.4
30	-2.05	0.00001	15.0	2.0	-4.4	12.6
31	-2.00	0.00001	15.0	2.0	-4.5	12.5
32	-1.95	0.00001	15.0	2.0	-4.6	12.4
33	-1.90	0.00001	15.0	2.0	-4.5	12.5
34	-1.85	0.00001	15.0	2.0	-4.8	12.2
35	-1.80	0.00001	15.0	2.0	-4.4	12.6
36	-1.75	0.00001	15.0	2.0	-3.8	13.2
37	-1.70	0.00001	15.0	2.0	-3.2	13.8
38	-1.65	0.00001	15.0	2.0	-3.1	13.9
39	-1.60	0.00001	15.0	2.0	-3.3	13.7
40	-1.55	0.00001	15.0	2.0	-4.0	13.0
41	-1.50	0.00001	15.0	2.0	-6.3	10.7
42	-1.45	0.00001	15.0	2.0	-5.4	11.6
43	-1.40	0.00001	15.0	2.0	-5.8	11.2
44	-1.35	0.00001	15.0	2.0	-5.0	12.0
45	-1.30	0.00001	15.0	2.0	-4.8	12.2
46	-1.25	0.00001	15.0	2.0	-4.3	12.7
47	-1.20	0.00001	15.0	2.0	-3.9	13.1
48	-1.15	0.00001	15.0	2.0	-3.8	13.2
49	-1.10	0.00001	15.0	2.0	-3.3	13.7
50	-1.05	0.00001	15.0	2.0	-3.8	13.2
51	-1.00	0.00001	15.0	2.0	-3.8	13.2
52	-0.95	0.00001	15.0	2.0	-4.6	12.4
53	-0.90	0.00001	15.0	2.0	-4.9	12.1
54	-0.85	0.00001	15.0	2.0	-5.1	11.9
55	-0.80	0.00001	15.0	2.0	-5.3	11.7
56	-0.75	0.00001	15.0	2.0	-5.3	11.7
57	-0.70	0.00001	15.0	2.0	-4.8	12.2
58	-0.65	0.00001	15.0	2.0	-4.0	13.0
59	-0.60	0.00001	15.0	2.0	-3.3	13.7
60	-0.55	0.00001	15.0	2.0	-2.7	14.3
61	-0.50	0.00001	15.0	2.0	-3.8	13.2
62	-0.45	0.00001	15.0	2.0	-4.2	12.8
63	-0.40	0.00001	15.0	2.0	-4.1	12.9
64	-0.35	0.00001	15.0	2.0	-4.0	13.0

65	-0.30	0.00001	15.0	2.0	-4.8	12.2
66	-0.25	0.00001	15.0	2.0	-3.3	13.7
67	-0.20	0.00001	15.0	2.0	-3.8	13.2
68	-0.15	0.00001	15.0	2.0	-3.6	13.4
69	-0.10	0.00001	15.0	2.0	-2.7	14.3
70	-0.05	0.00001	15.0	2.0	-3.0	14.0
71	0.00	0.00001	15.0	2.0	-3.3	13.7
72	0.05	0.00001	15.0	2.0	-5.0	12.0
73	0.10	0.00001	15.0	2.0	-4.6	12.4
74	0.15	0.00001	15.0	2.0	-4.6	12.4
75	**0.20**	**0.00001**	**15.0**	**2.0**	**-4.5**	**12.5**
76	0.25	0.00001	15.0	2.0	-4.7	12.3
77	**0.30**	**0.00001**	**15.0**	**2.0**	**-4.5**	**12.5**
78	0.35	0.00001	15.0	2.0	-5.0	12.0
79	0.40	0.00001	15.0	2.0	-5.0	12.0
80	0.45	0.00001	15.0	2.0	-4.6	12.4
81	0.50	0.00001	15.0	2.0	-4.6	12.4
82	0.55	0.00001	15.0	2.0	-4.2	12.8
83	0.60	0.00001	15.0	2.0	-5.0	12.0
84	0.65	0.00001	15.0	2.0	-4.6	12.4
85	0.70	0.00001	15.0	2.0	-4.2	12.8
86	0.75	0.00001	15.0	2.0	-4.4	12.6
87	0.80	0.00001	15.0	2.0	-4.3	12.7
88	0.85	0.00001	15.0	2.0	-4.2	12.8
89	**0.90**	**0.00001**	**15.0**	**2.0**	**-4.5**	**12.5**
90	**0.95**	**0.00001**	**15.0**	**2.0**	**-4.5**	**12.5**
91	1.00	0.00001	15.0	2.0	-4.1	12.9
92	1.05	0.00001	15.0	2.0	-3.7	13.3
93	1.10	0.00001	15.0	2.0	-3.9	13.1
94	1.15	0.00001	15.0	2.0	-4.0	13.0
95	1.20	0.00001	15.0	2.0	-3.8	13.2
96	1.25	0.00001	15.0	2.0	-4.1	12.9
97	1.30	0.00001	15.0	2.0	-4.4	12.6
98	1.35	0.00001	15.0	2.0	-4.7	12.3
99	1.40	0.00001	15.0	2.0	-4.2	12.8
100	1.45	0.00001	15.0	2.0	-4.7	12.3
101	1.50	0.00001	15.0	2.0	-4.6	12.4
102	1.55	0.00001	15.0	2.0	-2.5	14.5
103	1.60	0.00001	15.0	2.0	-2.2	14.8
104	1.65	0.00001	15.0	2.0	-2.2	14.8
105	1.70	0.00001	15.0	2.0	-3.8	13.2
106	1.75	0.00001	15.0	2.0	-2.6	14.4
107	1.80	0.00001	15.0	2.0	-2.8	14.2
108	1.85	0.00001	15.0	2.0	-2.8	14.2

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
109	1.90	0.00001	15.0	2.0	-2.4	14.6
110	1.95	0.00001	15.0	2.0	-2.4	14.6
111	2.00	0.00001	15.0	2.0	-2.2	14.8
112	2.05	0.00001	15.0	2.0	-1.9	15.1
113	2.10	0.00001	15.0	2.0	-2.7	14.3
114	2.15	0.00001	15.0	2.0	-2.2	14.8
115	2.20	0.00001	15.0	2.0	-2.0	15.0
116	2.25	0.00001	15.0	2.0	-1.8	15.2
117	2.30	0.00001	15.0	2.0	-2.2	14.8
118	2.35	0.00001	15.0	2.0	-2.2	14.8
119	2.40	0.00001	15.0	2.0	-2.4	14.6
120	2.45	0.00001	15.0	2.0	-2.4	14.6
121	2.50	0.00001	15.0	2.0	-2.4	14.6
122	2.55	0.00001	15.0	2.0	-2.3	14.7
123	2.60	0.00001	15.0	2.0	-2.2	14.8
124	2.65	0.00001	15.0	2.0	-1.9	15.1
125	2.70	0.00001	15.0	2.0	0.9	17.9
126	2.75	0.00001	15.0	2.0	1.2	18.2
127	2.80	0.00001	15.0	2.0	1.0	18.0
128	2.85	0.00001	15.0	2.0	1.2	18.2
129	2.90	0.00001	15.0	2.0	1.0	18.0
130	2.95	0.00001	15.0	2.0	1.2	18.2
131	3.00	0.00001	15.0	2.0	0.8	17.8
132	3.05	0.00001	15.0	2.0	0.0	17.0
133	3.10	0.00001	15.0	2.0	-0.7	16.3
134	3.15	0.00001	15.0	2.0	-1.4	15.6
135	3.20	0.00001	15.0	2.0	-1.6	15.4
136	3.25	0.00001	15.0	2.0	-1.6	15.4
137	3.30	0.00001	15.0	2.0	-0.5	16.5
138	3.35	0.00001	15.0	2.0	0.0	17.0
139	3.40	0.00001	15.0	2.0	0.4	17.4
140	3.45	0.00001	15.0	2.0	0.7	17.7
141	3.50	0.00001	15.0	2.0	-0.1	16.9

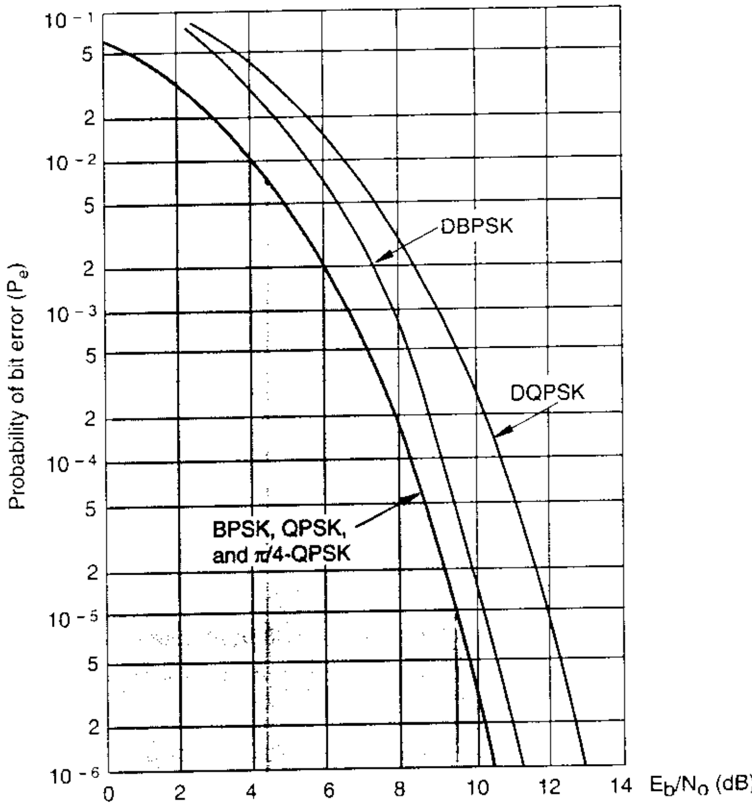


Figure 4.5.1 Theoretical $P_e = f(E_b/N_o)$ performance in a stationary additive white Gaussian noise (AWGN) environment. Ideal, linearly amplified coherent BPSK, QPSK, and differentially demodulated DBPSK systems are illustrated. The performance of nonlinearly amplified FQPSK and GMSK is compared to ideal linearly amplified QPSK in Figures 4.3.33 and 4.3.34. (From Proakis, 1989.) See Appendix A.3.

tically equivalent term bit-error rate (BER) is used in applied references and specifications.

Power efficiency of modulated systems is defined as being inversely proportional to the

$$\mathrm{BER} = f(C/N)$$

and/or

$$\mathrm{BER} = f(E_b/N_o)$$

equations and performance curves, where E_b is the average energy of a modulated bit and N_o is the noise power spectral density (the noise power in a normalized 1-Hz bandwidth) at the demodulator input. The higher the probability of error, the lower the power efficiency, since transmitted power is "wasted" on more bad data.

symbol rate and R_c/R_s represent the *processing gain associated with the* *spreading*, herein taken to be a larger integer I. It follows from assumption of a large processing gain that the spread tone jammer posses a fairly flat power spectral density within the data modulation bandwid and is now caused to behave like a white noise jammer of spectral dens

$$N_J' = J_0/R_c = J_0 T_c. \quad (3.87)$$

Using (3.4) and (3.5), we can rewrite (3.87) as

$$N_J' = J/\rho N R_c. \quad (3.88)$$

Since the hop frequency slots (assumed to be *contiguous*) must now be wide to accommodate the PN modulation, in terms of the total h frequency band W_{ss} and the number of hop slots N in that band, we th have

$$N = W_{ss}/R_c. \quad (3.89)$$

Combining (3.88) and (3.89) gives

$$N_J' = \frac{J/W_{ss}}{\rho} = \frac{N_J}{\rho}, \quad (3.90)$$

which is identical to (3.63) (the case of FH/QPSK in the presence partial-band noise jamming) *independent of the chip rate* R_c.

The above discussion concerns the spectral characteristics of the spre tone jammer which, as concluded, resembles a white noise jammer wit identical spectral density. We shall now discuss the assumptions and the retical adjustments under which the spread tone jammer can also be treate as a *Gaussian* noise interference.

Consider an FH/PN/QPSK demodulator, similar to the one in Figu 3.2, where the despreading process now also includes a PN code correlato following the frequency dehopper. Let p represent the PN code length (i number of chips). Accounting for the effects of the spread jammer only (i.e neglecting thermal noise), it follows that the decision variable z_I for th in-phase channel (see (3.11)) becomes

$$z_I = a_i\sqrt{\frac{S}{2}}\,T_s - \sqrt{J_0}\,\sin\theta_J C_{\mathrm{PN}} \quad (3.91)$$

where

$$C_{\mathrm{PN}} = \int_{(i-1)T_s}^{iT_s} c(t)\,dt \quad (3.92)$$

and $c(t)$ is the ± 1-valued PN waveform. In deriving (3.91), ideal PN code synchronization at the receiver has been assumed. Recalling that the processing gain is the ratio of the PN chip rate to the data symbol rate, or equivalently $T_s/T_c = I$, then it follows that the integral in (3.92) amounts to a partial correlation of the PN code, starting from some random phase,

ovided that the number I of integrat
gth p. Phrased differently, the conclusi
or in a weaker sense when $1 \ll I$ moc
ll known, the full-period integration
p, in which case, no randomness abo
en p is very large, successive code
dependent, identically distributed ± 1-
se the condition $I \ll p$ would provide
on for the random variable C_{PN}. The
uses this binomial distribution to beha
Arguments similar to the above were
ith the evaluation of the performanc
read-spectrum systems. A more rigor
aussian assumption for C_{PN} has been
nd Gold codes, with sufficient eviden
mately, for a wide class of such codes.
Let us now return to (3.91). Conditior
ted phase θ_J, z_I is, according to the
hose conditional variance is

$$\mathrm{var}\{z_I|\theta_J\} = T$$

Hence, when the jammer is present, the
channel (identically for the Q channel

$$P_{b_J}' = \frac{1}{2\pi}\int_0^{2\pi} Q\left(\sqrt{\frac{ST_s}{2T_cJ_0}}\,\frac{1}{|\sin\theta_J|}\right) dt$$

where (3.18), (3.87), (3.90), and (3.93)
result. Finally, multiplying (3.94) by ρ
of FH/PN/QPSK in the presence
namely,

$$P_b' = \frac{2\rho}{\pi}\int_0^{\pi/2} Q\Bigg(\sqrt{}$$

Although (3.95) can be used in as
jammer on system performance, we sh
of evaluating the tone interference effe
tone jammer to an *equivalent* AWGN
understood *in terms of its effect on bit e*
one-sided power spectral density of
characteristics remain the same after
error probability in this case is given

$$P_{b_J}'' = Q\Bigg($$

provided that the number I of integrated chips does not equal the code length p. Phrased differently, the conclusions to follow hold when $1 \ll I \ll p$ (or in a weaker sense when $1 \ll I$ modulo $p \ll p$). This is because, as is well known, the full-period integration of a PN code equals the constant $1/p$, in which case, no randomness about C_{PN} exists. On the other hand, when p is very large, successive code chips can be considered almost independent, identically distributed ± 1-valued random variables, in which case the condition $I \ll p$ would provide an approximate binomial distribution for the random variable C_{PN}. The additional constraint $I \gg 1$ then causes this binomial distribution to behave like a Gaussian distribution.

Arguments similar to the above were made in Chapter 1 in connection with the evaluation of the performance of pulse-jammed direct-sequence spread-spectrum systems. A more rigorous treatment of the validity of the Gaussian assumption for C_{PN} has been examined in [6] for a variety of PN and Gold codes, with sufficient evidence that it holds, at least approximately, for a wide class of such codes.

Let us now return to (3.91). Conditioned on the $(0, 2\pi)$-uniformly distributed phase θ_J, z_I is, according to the above, a Gaussian random variable whose conditional variance is

$$\operatorname{var}\{z_I|\theta_J\} = T_s T_c J_0 \sin^2\theta_J. \tag{3.93}$$

Hence, when the jammer is present, the average bit error probability for the I channel (identically for the Q channel) is given by

$$P_{b_J}^I = \frac{1}{2\pi}\int_0^{2\pi} Q\left(\sqrt{\frac{ST_s}{2T_cJ_0}}\,\frac{1}{|\sin\theta_J|}\right)d\theta_J = \frac{2}{\pi}\int_0^{\pi/2} Q\left(\sqrt{\frac{\rho E_b}{N_J}}\,\frac{1}{\sin\theta_J}\right)d\theta_J \tag{3.94}$$

where (3.18), (3.87), (3.90), and (3.93) have been used in arriving at this result. Finally, multiplying (3.94) by ρ gives the average bit error probability of FH/PN/QPSK in the presence of partial-band multitone jamming, namely,

$$P_b^I = \frac{2\rho}{\pi}\int_0^{\pi/2} Q\left(\sqrt{\frac{\rho E_b}{N_J}}\,\frac{1}{\sin\theta_J}\right)d\theta_J. \tag{3.95}$$

Although (3.95) can be used in assessing the effect of a spread tone jammer on system performance, we shall now indicate an even simpler way of evaluating the tone interference effect by means of converting the spread tone jammer to an *equivalent* AWGN interference, where the equivalence is understood *in terms of its effect on bit error probability*. Let N_{0_J} represent the one-sided power spectral density of AWGN interference whose statistical characteristics remain the same after the PN despreader. Clearly, the bit error probability in this case is given by

$$P_{b_J}^n = Q\left(\sqrt{\frac{2E_b}{N_{0_J}}}\right). \tag{3.96}$$

Equations (3.94) and (3.96) have been plotted in Figure 3.16. The abscissa is the signal-to-jammer power ratio SJR in decibels where, for the spread tone case $(\mathrm{SJR})' = E_b/N_J$ while, for the noise case, $(\mathrm{SJR})'' = E_b/N_{0_J}$. A careful examination of Figure 3.16 reveals that, for values of $(\mathrm{SJR})'$ up to approximately 12 dB, the difference $(\mathrm{SJR})'_{(\mathrm{dB})} - (\mathrm{SJR})''_{(\mathrm{dB})}$ between the signal-to-jammer ratios which achieve the same performance is, to a high degree of accuracy, linearly increasing with $(\mathrm{SJR})'_{(\mathrm{dB})}$, the slope of the line being 0.2. It is therefore concluded that, given a spread tone jammer of $(\mathrm{SJR})'_{(\mathrm{dB})}$, an

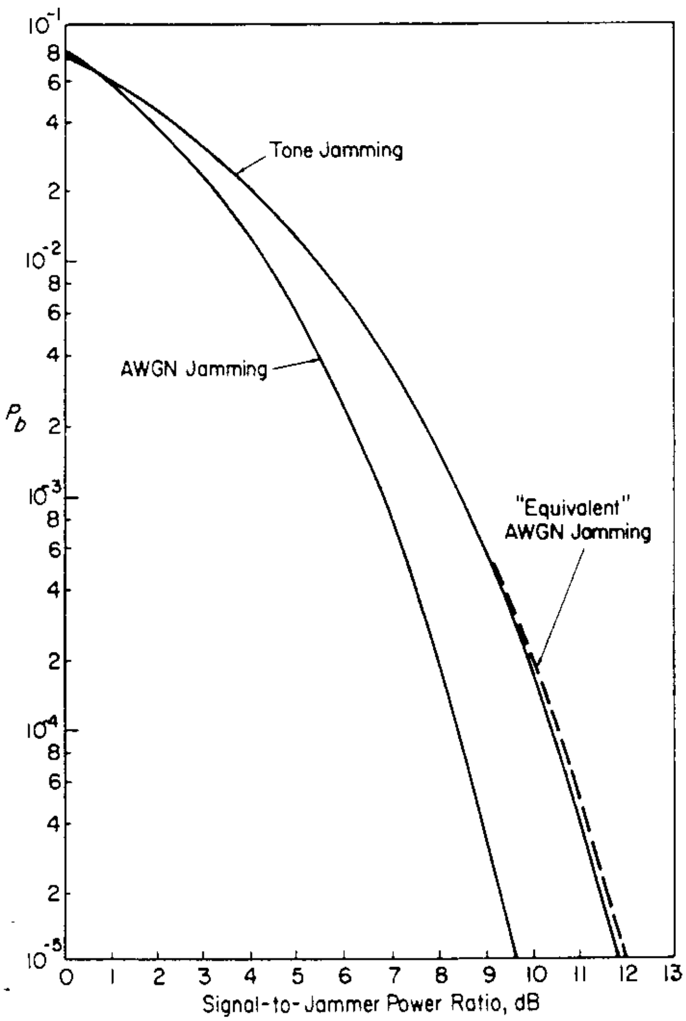


Figure 3.16. QPSK bit error probability versus $\mathrm{SJR}_{(\mathrm{dB})}$ for AWGN and tone jamming and spread tone "equivalent" AWGN jamming.

"*equivalent*" AWGN jammer can

$$(\mathrm{SJR})''_{\mathrm{equiv(dB)}}$$

If the SJR's are measured in or
(3.97) implies that

$$(\mathrm{SJR})''_{\mathrm{equ}}$$

From (3.96) and (3.98), it then fol
conveniently thought of as an "
sponding bit error probability

$$P'_{b_J} = Q\Big($$

Equation (3.99) has been plotted
the high degree of agreement w
witnessed. The range of applicabi
more than adequate since, in th
present, the system is forced to op
especially true when the jamme
optimized). From (3.99), it follow
ability (accounting for partial-ban

$$P'_b = \rho Q\Big($$

The worst case jammer can be f

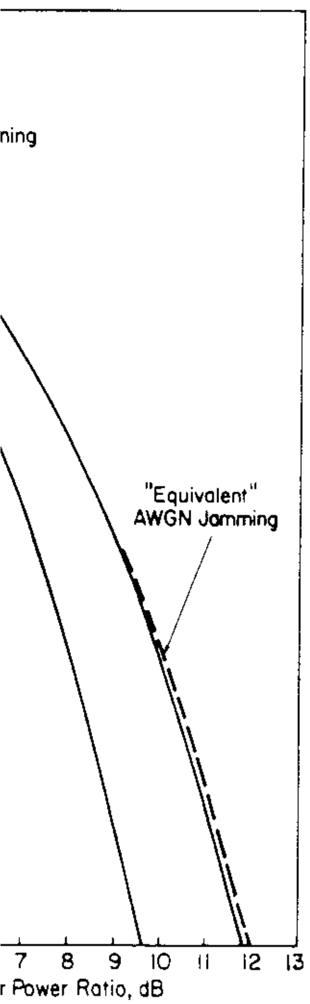
$$\rho_{\mathrm{wc}} = \begin{cases} \dfrac{0.9220}{E_b/N_J} \\ 1; \end{cases}$$

with corresponding

$$P'_{b_{\max}} = \begin{cases} \dfrac{0.0789}{E_b/N_J}; \\ Q\left(\sqrt{2\left(\dfrac{E_b}{N_J}\right.}\right. \end{cases}$$

A comparison of (3.102) with (3.73
FH/PN/QPSK is slightly less ef
FH/QPSK.

otted in Figure 3.16. The abscissa is
decibels where, for the spread tone
e case, $(\mathrm{SJR})^n = E_b/N_{0_J}$. A careful
it, for values of $(\mathrm{SJR})^t$ up to ap-
$_{(\mathrm{dB})} - (\mathrm{SJR})^n_{(\mathrm{dB})}$ between the signal-
performance is, to a high degree of
$_{(\mathrm{dB})}$, the slope of the line being 0.2.
pread tone jammer of $(\mathrm{SJR})^t_{(\mathrm{dB})}$, an



ersus $\mathrm{SJR}_{(\mathrm{dB})}$ for AWGN and tone
N jamming.

"*equivalent*" AWGN jammer can be devised for which

$$(\mathrm{SJR})^n_{\mathrm{equiv(dB)}} = (0.8) \times (\mathrm{SJR})^t_{(\mathrm{dB})}. \tag{3.97}$$

If the SJR's are measured in ordinary numbers rather than decibels, then (3.97) implies that

$$(\mathrm{SJR})^n_{\mathrm{equiv}} = \left((\mathrm{SJR})^t\right)^{0.8}. \tag{3.98}$$

From (3.96) and (3.98), it then follows that the spread tone jammer can be conveniently thought of as an "*equivalent*" AWGN jammer with corresponding bit error probability

$$P^t_{b_J} = Q\left(\sqrt{2\left(\frac{\rho E_b}{N_J}\right)^{0.8}}\right). \tag{3.99}$$

Equation (3.99) has been plotted in Figure 3.16 (dashed lines), from which the high degree of agreement with the exact expression for $P^t_{b_J}$ can be witnessed. The range of applicability of (3.99) is, for the current purposes, more than adequate since, in the frequency bands where the jammer is present, the system is forced to operate at high bit error probabilities (this is especially true when the jammer strategy, i.e., choice of ρ, has been optimized). From (3.99), it follows that the overall average bit error probability (accounting for partial-band jamming) is given by

$$P^t_b = \rho Q\left(\sqrt{2\left(\frac{\rho E_b}{N_J}\right)^{0.8}}\right). \tag{3.100}$$

The worst case jammer can be found from (3.100), with the result

$$\rho_{\mathrm{wc}} = \begin{cases} \dfrac{0.9220}{E_b/N_J}; & E_b/N_J \geq 0.9220 \\ 1; & E_b/N_J < 0.9220 \end{cases} \tag{3.101}$$

with corresponding

$$P^t_{b_{\max}} = \begin{cases} \dfrac{0.0789}{E_b/N_J}; & E_b/N_J \geq 0.9220 \\ Q\left(\sqrt{2\left(\dfrac{E_b}{N_J}\right)^{0.8}}\right); & E_b/N_J < 0.9220. \end{cases} \tag{3.102}$$

A comparison of (3.102) with (3.73) indicates that the worst tone jammer for FH/PN/QPSK is slightly less effective than the worst noise jammer for FH/QPSK.

Channel #6, Fc = 2419.8750 MHz	**Data Rate = 2.045 Mbps (DQPSK), Wide**
Chip Rate = 11.25 MHz	**PN Code Length = 11 chips/symbol**
6 dB BW = 8.4 MHz	

(S/N)o = 12 dB / 0.8 = 15 dB per attached Figure 4.5.1 and formula 3.97

Measured Processing Gain Gp = (S/N)o + Lsys + Mj = 15 + 2 + Mj = 17 + Mj (dB)

Theoretical Calculated Processing Gain = Chip Rate/Data rate = $\frac{\text{11.25 MHz}}{\text{(2.045 Mb/s)/(2 bits/symbol)}}$ = 11.0 or 10.4 dB

Note:

- Total Peak Power from the EUT's Tx measured at the EUT's Rx Input: P_t = -46.7 dBm
- Jamming signal level at measured at the EUT's receiver input: J
- $Mj = J - P_t$
- The following shaded boxes are discarded worst measurements (19.9% of total measurement points)

SUMMARY OF TEST RESULTS	
Theoretical Process Gain	**10.4 dB**
Minimum Measured Process Gain with discard of 19.9% of the worst measurements	**11.1 dB**

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
1	-5.00	0.00001	15.0	2.0	-3.7	13.3
2	-4.95	0.00001	15.0	2.0	-4.2	12.8
3	-4.90	0.00001	15.0	2.0	-4.2	12.8
4	-4.85	0.00001	15.0	2.0	-4.6	12.4
5	-4.80	0.00001	15.0	2.0	-4.6	12.4
6	-4.75	0.00001	15.0	2.0	-4.1	12.9
7	-4.70	0.00001	15.0	2.0	-3.6	13.4
8	-4.65	0.00001	15.0	2.0	-3.6	13.4
9	-4.60	0.00001	15.0	2.0	-3.6	13.4
10	-4.55	0.00001	15.0	2.0	-3.5	13.5
11	-4.50	0.00001	15.0	2.0	-3.5	13.5
12	-4.45	0.00001	15.0	2.0	-3.4	13.6
13	-4.40	0.00001	15.0	2.0	-3.5	13.5
14	-4.35	0.00001	15.0	2.0	-3.6	13.4
15	-4.30	0.00001	15.0	2.0	-4.3	12.7
16	-4.25	0.00001	15.0	2.0	-4.9	12.1
17	-4.20	0.00001	15.0	2.0	-5.6	11.4
18	-4.15	0.00001	15.0	2.0	-5.7	11.3
19	-4.10	0.00001	15.0	2.0	-5.8	11.2
20	-4.05	0.00001	15.0	2.0	-5.8	11.2

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
21	-4.00	0.00001	15.0	2.0	-6.2	10.8
22	-3.95	0.00001	15.0	2.0	-6.2	10.8
23	-3.90	0.00001	15.0	2.0	-6.2	10.8
24	-3.85	0.00001	15.0	2.0	-6.0	11.0
25	-3.80	0.00001	15.0	2.0	-6.0	11.0
26	-3.75	0.00001	15.0	2.0	-6.0	11.0
27	-3.70	0.00001	15.0	2.0	-6.0	11.0
28	-3.65	0.00001	15.0	2.0	-6.0	11.0
29	-3.60	0.00001	15.0	2.0	-6.0	11.0
30	-3.55	0.00001	15.0	2.0	-5.0	12.0
31	-3.50	0.00001	15.0	2.0	-5.2	11.8
32	-3.45	0.00001	15.0	2.0	-5.0	12.0
33	-3.40	0.00001	15.0	2.0	-4.8	12.2
34	-3.35	0.00001	15.0	2.0	-5.0	12.0
35	-3.30	0.00001	15.0	2.0	-5.4	11.6
36	-3.25	0.00001	15.0	2.0	-7.2	9.8
37	-3.20	0.00001	15.0	2.0	-8.0	9.0
38	-3.15	0.00001	15.0	2.0	-8.0	9.0
39	-3.10	0.00001	15.0	2.0	-8.0	9.0
40	-3.05	0.00001	15.0	2.0	-8.0	9.0
41	-3.00	0.00001	15.0	2.0	-7.9	9.1
42	-2.95	0.00001	15.0	2.0	-7.2	9.8
43	-2.90	0.00001	15.0	2.0	-7.2	9.8
44	-2.85	0.00001	15.0	2.0	-6.7	10.3
45	-2.80	0.00001	15.0	2.0	-6.2	10.8
46	-2.75	0.00001	15.0	2.0	-6.0	11.0
47	-2.70	0.00001	15.0	2.0	-6.0	11.0
48	-2.65	0.00001	15.0	2.0	-5.8	11.2
49	-2.60	0.00001	15.0	2.0	-5.8	11.2
50	-2.55	0.00001	15.0	2.0	-5.8	11.2
51	-2.50	0.00001	15.0	2.0	-5.4	11.6
52	-2.45	0.00001	15.0	2.0	-5.0	12.0
53	-2.40	0.00001	15.0	2.0	-5.0	12.0
54	-2.35	0.00001	15.0	2.0	-5.0	12.0
55	-2.30	0.00001	15.0	2.0	-4.6	12.4
56	-2.25	0.00001	15.0	2.0	-4.8	12.2
57	-2.20	0.00001	15.0	2.0	-5.1	11.9
58	-2.15	0.00001	15.0	2.0	-5.2	11.8
59	-2.10	0.00001	15.0	2.0	-5.4	11.6
60	-2.05	0.00001	15.0	2.0	-5.8	11.2

Continued...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
61	-2.00	0.00001	15.0	2.0	-5.8	11.2
62	-1.95	0.00001	15.0	2.0	-6.4	10.6
63	-1.90	0.00001	15.0	2.0	-6.1	10.9
64	-1.85	0.00001	15.0	2.0	-5.4	11.6
65	-1.80	0.00001	15.0	2.0	-5.3	11.7
66	-1.75	0.00001	15.0	2.0	-5.5	11.5
67	-1.70	0.00001	15.0	2.0	-5.6	11.4
68	-1.65	0.00001	15.0	2.0	-5.5	11.5
69	-1.60	0.00001	15.0	2.0	-5.4	11.6
70	-1.55	0.00001	15.0	2.0	-4.5	12.5
71	-1.50	0.00001	15.0	2.0	-5.8	11.2
72	-1.45	0.00001	15.0	2.0	-4.4	12.6
73	-1.40	0.00001	15.0	2.0	-4.9	12.1
74	-1.35	0.00001	15.0	2.0	-4.9	12.1
75	-1.30	0.00001	15.0	2.0	-5.1	11.9
76	-1.25	0.00001	15.0	2.0	-5.2	11.8
77	-1.20	0.00001	15.0	2.0	-5.1	11.9
78	-1.15	0.00001	15.0	2.0	-5.4	11.6
79	-1.10	0.00001	15.0	2.0	-5.6	11.4
80	-1.05	0.00001	15.0	2.0	-5.6	11.4
81	-1.00	0.00001	15.0	2.0	-5.6	11.4
82	-0.95	0.00001	15.0	2.0	-5.9	11.1
83	-0.90	0.00001	15.0	2.0	-6.5	10.5
84	-0.85	0.00001	15.0	2.0	-6.8	10.2
85	-0.80	0.00001	15.0	2.0	-6.9	10.1
86	-0.75	0.00001	15.0	2.0	-6.6	10.4
87	-0.70	0.00001	15.0	2.0	-6.9	10.1
88	-0.65	0.00001	15.0	2.0	-6.9	10.1
89	-0.60	0.00001	15.0	2.0	-6.9	10.1
90	-0.55	0.00001	15.0	2.0	-6.7	10.3
91	-0.50	0.00001	15.0	2.0	-6.7	10.3
92	-0.45	0.00001	15.0	2.0	-5.8	11.2
93	-0.40	0.00001	15.0	2.0	-5.1	11.9
94	-0.35	0.00001	15.0	2.0	-5.1	11.9
95	-0.30	0.00001	15.0	2.0	-5.1	11.9
96	-0.25	0.00001	15.0	2.0	-5.1	11.9
97	-0.20	0.00001	15.0	2.0	-5.1	11.9
98	-0.15	0.00001	15.0	2.0	-5.5	11.5

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
99	-0.10	0.00001	15.0	2.0	-6.3	10.7
100	-0.05	0.00001	15.0	2.0	-6.7	10.3
101	0.00	0.00001	15.0	2.0	-6.5	10.5
102	0.05	0.00001	15.0	2.0	-6.6	10.4
103	0.10	0.00001	15.0	2.0	-6.5	10.5
104	0.15	0.00001	15.0	2.0	-5.7	11.3
105	0.20	0.00001	15.0	2.0	-5.2	11.8
106	0.25	0.00001	15.0	2.0	-5.0	12.0
107	0.30	0.00001	15.0	2.0	-5.1	11.9
108	0.35	0.00001	15.0	2.0	-5.3	11.7
109	0.40	0.00001	15.0	2.0	-5.5	11.5
110	0.45	0.00001	15.0	2.0	-5.5	11.5
111	0.50	0.00001	15.0	2.0	-5.7	11.3
112	0.55	0.00001	15.0	2.0	-5.7	11.3
113	0.60	0.00001	15.0	2.0	-5.7	11.3
114	0.65	0.00001	15.0	2.0	-5.7	11.3
115	0.70	0.00001	15.0	2.0	-5.6	11.4
116	0.75	0.00001	15.0	2.0	-6.1	10.9
117	0.80	0.00001	15.0	2.0	-6.1	10.9
118	0.85	0.00001	15.0	2.0	-6.1	10.9
119	0.90	0.00001	15.0	2.0	-6.1	10.9
120	0.95	0.00001	15.0	2.0	-5.5	11.5
121	1.00	0.00001	15.0	2.0	-5.5	11.5
122	1.05	0.00001	15.0	2.0	-5.3	11.7
123	1.10	0.00001	15.0	2.0	-5.3	11.7
124	1.15	0.00001	15.0	2.0	-4.8	12.2
125	1.20	0.00001	15.0	2.0	-5.3	11.7
126	1.25	0.00001	15.0	2.0	-5.3	11.7
127	1.30	0.00001	15.0	2.0	-4.8	12.2
128	1.35	0.00001	15.0	2.0	-4.7	12.3
129	1.40	0.00001	15.0	2.0	-4.6	12.4
130	1.45	0.00001	15.0	2.0	-4.9	12.1
131	1.50	0.00001	15.0	2.0	-4.9	12.1
132	1.55	0.00001	15.0	2.0	-5.5	11.5
133	1.60	0.00001	15.0	2.0	-6.0	11.0
134	1.65	0.00001	15.0	2.0	-5.8	11.2
135	1.70	0.00001	15.0	2.0	-5.5	11.5
136	1.75	0.00001	15.0	2.0	-5.4	11.6
137	1.80	0.00001	15.0	2.0	-5.7	11.3
138	1.85	0.00001	15.0	2.0	-5.7	11.3

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
139	1.90	0.00001	15.0	2.0	-5.5	11.5
140	1.95	0.00001	15.0	2.0	-5.7	11.3
141	2.00	0.00001	15.0	2.0	-5.2	11.8
142	2.05	0.00001	15.0	2.0	-4.7	12.3
143	2.10	0.00001	15.0	2.0	-4.3	12.7
144	2.15	0.00001	15.0	2.0	-4.2	12.8
145	2.20	0.00001	15.0	2.0	-4.4	12.6
146	2.25	0.00001	15.0	2.0	-4.9	12.1
147	2.30	0.00001	15.0	2.0	-5.1	11.9
148	2.35	0.00001	15.0	2.0	-5.1	11.9
149	2.40	0.00001	15.0	2.0	-5.1	11.9
150	2.45	0.00001	15.0	2.0	-5.1	11.9
151	2.50	0.00001	15.0	2.0	-5.2	11.8
152	2.55	0.00001	15.0	2.0	-5.3	11.7
153	2.60	0.00001	15.0	2.0	-5.3	11.7
154	2.65	0.00001	15.0	2.0	-5.4	11.6
155	2.70	0.00001	15.0	2.0	-5.3	11.7
156	2.75	0.00001	15.0	2.0	-5.4	11.6
157	2.80	0.00001	15.0	2.0	-5.4	11.6
158	2.85	0.00001	15.0	2.0	-5.5	11.5
159	2.90	0.00001	15.0	2.0	-5.8	11.2
160	**2.95**	**0.00001**	**15.0**	**2.0**	**-5.9**	**11.1**
161	**3.00**	**0.00001**	**15.0**	**2.0**	**-5.9**	**11.1**
162	**3.05**	**0.00001**	**15.0**	**2.0**	**-5.9**	**11.1**
163	3.10	0.00001	15.0	2.0	-5.5	11.5
164	3.15	0.00001	15.0	2.0	-5.5	11.5
165	3.20	0.00001	15.0	2.0	-5.5	11.5
166	3.25	0.00001	15.0	2.0	-5.7	11.3
167	3.30	0.00001	15.0	2.0	-5.7	11.3
168	3.35	0.00001	15.0	2.0	-5.7	11.3
169	3.40	0.00001	15.0	2.0	-5.6	11.4
170	**3.45**	**0.00001**	**15.0**	**2.0**	**-5.9**	**11.1**
171	**3.50**	**0.00001**	**15.0**	**2.0**	**-5.9**	**11.1**
172	3.55	0.00001	15.0	2.0	-5.5	11.5
173	3.60	0.00001	15.0	2.0	-5.5	11.5
174	3.65	0.00001	15.0	2.0	-5.5	11.5
175	3.70	0.00001	15.0	2.0	-5.5	11.5
176	3.75	0.00001	15.0	2.0	-5.5	11.5
177	3.80	0.00001	15.0	2.0	-4.8	12.2
178	3.85	0.00001	15.0	2.0	-4.9	12.1

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
179	3.90	0.00001	15.0	2.0	-4.9	12.1
180	3.95	0.00001	15.0	2.0	-4.9	12.1
181	4.00	0.00001	15.0	2.0	-4.9	12.1
182	4.05	0.00001	15.0	2.0	-4.9	12.1
183	4.10	0.00001	15.0	2.0	-4.5	12.5
184	4.15	0.00001	15.0	2.0	-4.5	12.5
185	4.20	0.00001	15.0	2.0	-4.1	12.9
186	4.25	0.00001	15.0	2.0	-4.1	12.9
187	4.30	0.00001	15.0	2.0	-3.9	13.1
188	4.35	0.00001	15.0	2.0	-3.9	13.1
189	4.40	0.00001	15.0	2.0	-3.9	13.1
190	4.45	0.00001	15.0	2.0	-3.9	13.1
191	4.50	0.00001	15.0	2.0	-3.7	13.3
192	4.55	0.00001	15.0	2.0	-3.7	13.3
193	4.60	0.00001	15.0	2.0	-3.7	13.3
194	4.65	0.00001	15.0	2.0	-3.7	13.3
195	4.70	0.00001	15.0	2.0	-3.7	13.3
196	4.75	0.00001	15.0	2.0	-3.7	13.3
197	4.80	0.00001	15.0	2.0	-3.7	13.3
198	4.85	0.00001	15.0	2.0	-3.7	13.3
199	4.90	0.00001	15.0	2.0	-3.7	13.3
200	4.95	0.00001	15.0	2.0	-3.7	13.3
201	5.00	0.00001	15.0	2.0	-3.3	13.7

Channel #18, Fc = 2464.8750 MHz	**Data Rate = 0.818 Mbps (DQPSK), Narrow**
Chip Rate = 4.5 MHz	**PN Code Length = 11 chips/symbol**
6 dB BW = 4 MHz	

(S/N)o = 12 dB / 0.8 = 15 dB per attached Figure 4.5.1 and formula 3.97

Measured Processing Gain Gp = (S/N)o + Lsys + Mj = 15 + 2 + Mj = 17 + Mj (dB)

Theoretical Calculated Processing Gain = Chip Rate/Data rate = 4.5 MHz / (0.818 Mb/s)/(2 bits/symbol) = 11 or 10.4 dB

Note:

- Total Peak Power from the EUT's Tx measured at the EUT's Rx Input: P_t = -49.9 dBm
- Jamming signal level at measured at the EUT's receiver input: J
- Mj = J-P_t
- The following shaded boxes are discarded worst measurements (18.8% of total measurement points)

SUMMARY OF TEST RESULTS	
Theoretical Process Gain	10.4 dB
Minimum Measured Process Gain with discard of 18.8% of the worst measurements	11.2 dB

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
1	-2.50	0.00001	15.0	2.0	-1.0	16.0
2	-2.45	0.00001	15.0	2.0	-1.1	15.9
3	-2.40	0.00001	15.0	2.0	-0.1	16.9
4	-2.35	0.00001	15.0	2.0	0.0	17.0
5	-2.30	0.00001	15.0	2.0	0.8	17.8
6	-2.25	0.00001	15.0	2.0	1.3	18.3
7	-2.20	0.00001	15.0	2.0	2.1	19.1
8	-2.15	0.00001	15.0	2.0	1.6	18.6
9	-2.10	0.00001	15.0	2.0	1.0	18.0
10	-2.05	0.00001	15.0	2.0	0.2	17.2
11	-2.00	0.00001	15.0	2.0	-0.4	16.6
12	-1.95	0.00001	15.0	2.0	-1.7	15.3
13	-1.90	0.00001	15.0	2.0	-1.6	15.4
14	-1.85	0.00001	15.0	2.0	-1.3	15.7
15	-1.80	0.00001	15.0	2.0	0.4	17.4
16	-1.75	0.00001	15.0	2.0	0.6	17.6
17	-1.70	0.00001	15.0	2.0	0.6	17.6
18	-1.65	0.00001	15.0	2.0	0.1	17.1
19	-1.60	0.00001	15.0	2.0	0.1	17.1
20	-1.55	0.00001	15.0	2.0	0.5	17.5
21	-1.50	0.00001	15.0	2.0	0.6	17.6
22	-1.45	0.00001	15.0	2.0	0.6	17.6

Continued ...

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
23	-1.40	0.00001	15.0	2.0	2.0	19.0
24	-1.35	0.00001	15.0	2.0	1.9	18.9
25	-1.30	0.00001	15.0	2.0	2.1	19.1
26	-1.25	0.00001	15.0	2.0	2.0	19.0
27	-1.20	0.00001	15.0	2.0	2.4	19.4
28	-1.15	0.00001	15.0	2.0	2.4	19.4
29	-1.10	0.00001	15.0	2.0	2.4	19.4
30	-1.05	0.00001	15.0	2.0	3.0	20.0
31	-1.00	0.00001	15.0	2.0	-4.1	12.9
32	-0.95	0.00001	15.0	2.0	-5.7	11.3
33	-0.90	0.00001	15.0	2.0	-5.6	11.4
34	-0.85	0.00001	15.0	2.0	-5.2	11.8
35	-0.80	0.00001	15.0	2.0	-5.6	11.4
36	-0.75	0.00001	15.0	2.0	-5.5	11.5
37	-0.70	0.00001	15.0	2.0	-6.4	10.6
38	-0.65	0.00001	15.0	2.0	-5.9	11.1
39	-0.60	0.00001	15.0	2.0	-5.2	11.8
40	-0.55	0.00001	15.0	2.0	-4.5	12.5
41	-0.50	0.00001	15.0	2.0	-5.0	12.0
42	**-0.45**	**0.00001**	**15.0**	**2.0**	**-5.8**	**11.2**
43	-0.40	0.00001	15.0	2.0	-6.3	10.7
44	-0.35	0.00001	15.0	2.0	-5.6	11.4
45	-0.30	0.00001	15.0	2.0	-6.1	10.9
46	-0.25	0.00001	15.0	2.0	-6.8	10.2
47	-0.20	0.00001	15.0	2.0	-5.5	11.5
48	-0.15	0.00001	15.0	2.0	-4.9	12.1
49	-0.10	0.00001	15.0	2.0	-4.7	12.3
50	-0.05	0.00001	15.0	2.0	-4.4	12.6
51	0.00	0.00001	15.0	2.0	-6.6	10.4
52	0.05	0.00001	15.0	2.0	-4.8	12.2
53	0.10	0.00001	15.0	2.0	-4.5	12.5
54	0.15	0.00001	15.0	2.0	-3.9	13.1
55	0.20	0.00001	15.0	2.0	-4.4	12.6
56	0.25	0.00001	15.0	2.0	-5.1	11.9
57	0.30	0.00001	15.0	2.0	-6.5	10.5
58	0.35	0.00001	15.0	2.0	-4.9	12.1
59	0.40	0.00001	15.0	2.0	-4.5	12.5
60	0.45	0.00001	15.0	2.0	-5.3	11.7
61	0.50	0.00001	15.0	2.0	-4.5	12.5
62	0.55	0.00001	15.0	2.0	-6.3	10.7
63	0.60	0.00001	15.0	2.0	-6.5	10.5

Continued ..

Test Point	Jammer Signal Freq. +/- Fc (MHz)	(BER) (DQPSK)	(S/N)o (dB)	System Loss Lsys (dB)	Jammer to Signal Ratio Mj (dB)	Measured Processing Gain (dB)
64	0.65	0.00001	15.0	2.0	-5.7	11.3
65	0.70	0.00001	15.0	2.0	-5.6	11.4
66	0.75	0.00001	15.0	2.0	-6.1	10.9
67	0.80	0.00001	15.0	2.0	-5.2	11.8
68	0.85	0.00001	15.0	2.0	-5.2	11.8
69	0.90	0.00001	15.0	2.0	-5.2	11.8
70	0.95	0.00001	15.0	2.0	-4.6	12.4
71	1.00	0.00001	15.0	2.0	-4.6	12.4
72	1.05	0.00001	15.0	2.0	-6.5	10.5
73	1.10	0.00001	15.0	2.0	-6.7	10.3
74	1.15	0.00001	15.0	2.0	-5.8	11.2
75	1.20	0.00001	15.0	2.0	-6.6	10.4
76	1.25	0.00001	15.0	2.0	-7.0	10.0
77	1.30	0.00001	15.0	2.0	-6.3	10.7
78	1.35	0.00001	15.0	2.0	-5.9	11.1
79	1.40	0.00001	15.0	2.0	-5.9	11.1
80	1.45	0.00001	15.0	2.0	-5.9	11.1
81	1.50	0.00001	15.0	2.0	-5.8	11.2
82	1.55	0.00001	15.0	2.0	-5.9	11.1
83	1.60	0.00001	15.0	2.0	-5.8	11.2
84	1.65	0.00001	15.0	2.0	-5.7	11.3
85	1.70	0.00001	15.0	2.0	-4.8	12.2
86	1.75	0.00001	15.0	2.0	-4.4	12.6
87	1.80	0.00001	15.0	2.0	-4.4	12.6
88	1.85	0.00001	15.0	2.0	-4.4	12.6
89	1.90	0.00001	15.0	2.0	-4.4	12.6
90	1.95	0.00001	15.0	2.0	-4.3	12.7
91	2.00	0.00001	15.0	2.0	-5.2	11.8
92	2.05	0.00001	15.0	2.0	-3.3	13.7
93	2.10	0.00001	15.0	2.0	-0.8	16.2
94	2.15	0.00001	15.0	2.0	0.7	17.7
95	2.20	0.00001	15.0	2.0	0.9	17.9
96	2.25	0.00001	15.0	2.0	0.9	17.9
97	2.30	0.00001	15.0	2.0	1.2	18.2
98	2.35	0.00001	15.0	2.0	1.0	18.0
99	2.40	0.00001	15.0	2.0	0.6	17.6
100	2.45	0.00001	15.0	2.0	1.0	18.0
101	2.50	0.00001	15.0	2.0	1.0	18.0

4.7 AC Powerline Conducted Emissions, FCC CFR 47, Para. 15.107(a)

PRODUCT NAME: **ISP DIRECT INDOOR & OUTDOOR UNITS, Model No.: 2401-01 (indoor) and 2401-02 (outdoor)**

NAME OF TEST: **AC Powerline Conducted Emissions.**

FCC LIMIT:

The RF voltage conducted back onto the public utility lines shall not exceed 250 μV or 48.0 dBμV measured from 450 KHz to 30 MHz.

CLIMATE CONDITION:

Standard Temperature and Humidity:

- Ambient temperature: 23 °C
- Relative humidity: 43 %

POWER INPUT:

AC 120 V 60Hz from Elpac external switching power supply, model WRI4232.

TEST EQUIPMENT:

- Advantest R3271 Spectrum Analyzer, Frequency Range: 100Hz-26.5GHz, with built-in Peak, Quasi-Peak and Average Detectors.
- HP 11947A Transient Limiter, HP, Model 11947A, Frequency Range: 9KHz-200MHz, Attenuation: 10dB HP.
- HP 7475 Plotter
- EMCO 3825/2 LISN, Frequency Range: 9KHz-200MHz
- RF Shielded Enclosure (12x16x12 feet)

METHOD OF MEASUREMENTS:

Refer to ANSI C63.4-1992.

TEST RESULTS: Conforms.

TEST PERSONNEL: Mr. Tri M. Luu, P.Eng.

DATE: Mar. 04, 1998

MEASUREMENT DATA

AC POWER-LINE CONDUCTED EMISSIONS

REMARKS

- *All rf emissions from 450 KHz to 30 MHz were scanned, and eight highest emission levels were recorded. See attached plots.*
- *P: Peak Detector, 10 KHz RBW, VBW ≥ RBW*
- *Q: CISPR QUASI-PEAK, 9 KHz RBW, VBW ≥ RBW*
- *QP/BB: for broadband emission (QP level - AVG level > 6 dB); the recorded level was QP level less 13 dB.*

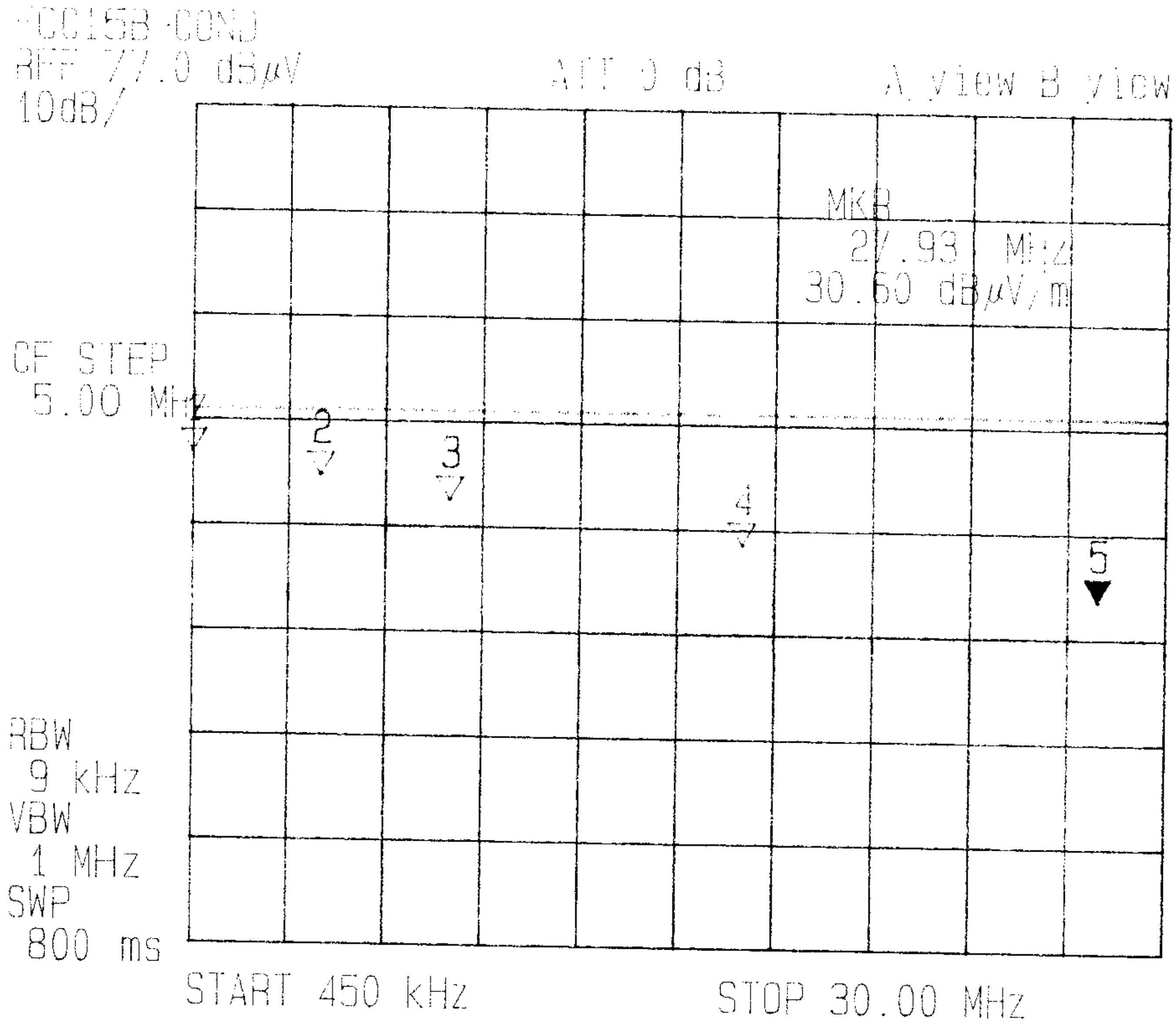
FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP/NB LIMIT (dBuV)	QP/BB LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.450	43.9	Peak	48.0	61.0	-4.1	PASS	L1
4.380	42.0	Peak	48.0	61.0	-6.0	PASS	L1
8.300	39.7	Peak	48.0	61.0	-8.3	PASS	L1
17.170	35.7	Peak	48.0	61.0	-25.3	PASS	L1
27.930	30.6	Peak	48.0	61.0	-17.4	PASS	L1
0.790	37.1	Peak	48.0	61.0	-23.9	PASS	L2
4.420	39.8	Peak	48.0	61.0	-8.2	PASS	L2
8.600	37.7	Peak	48.0	61.0	-23.3	PASS	L2
16.580	33.6	Peak	48.0	61.0	-14.4	PASS	L2
27.890	29.7	Peak	48.0	61.0	-31.3	PASS	L2

UltraTech
Engineering Labs Inc.

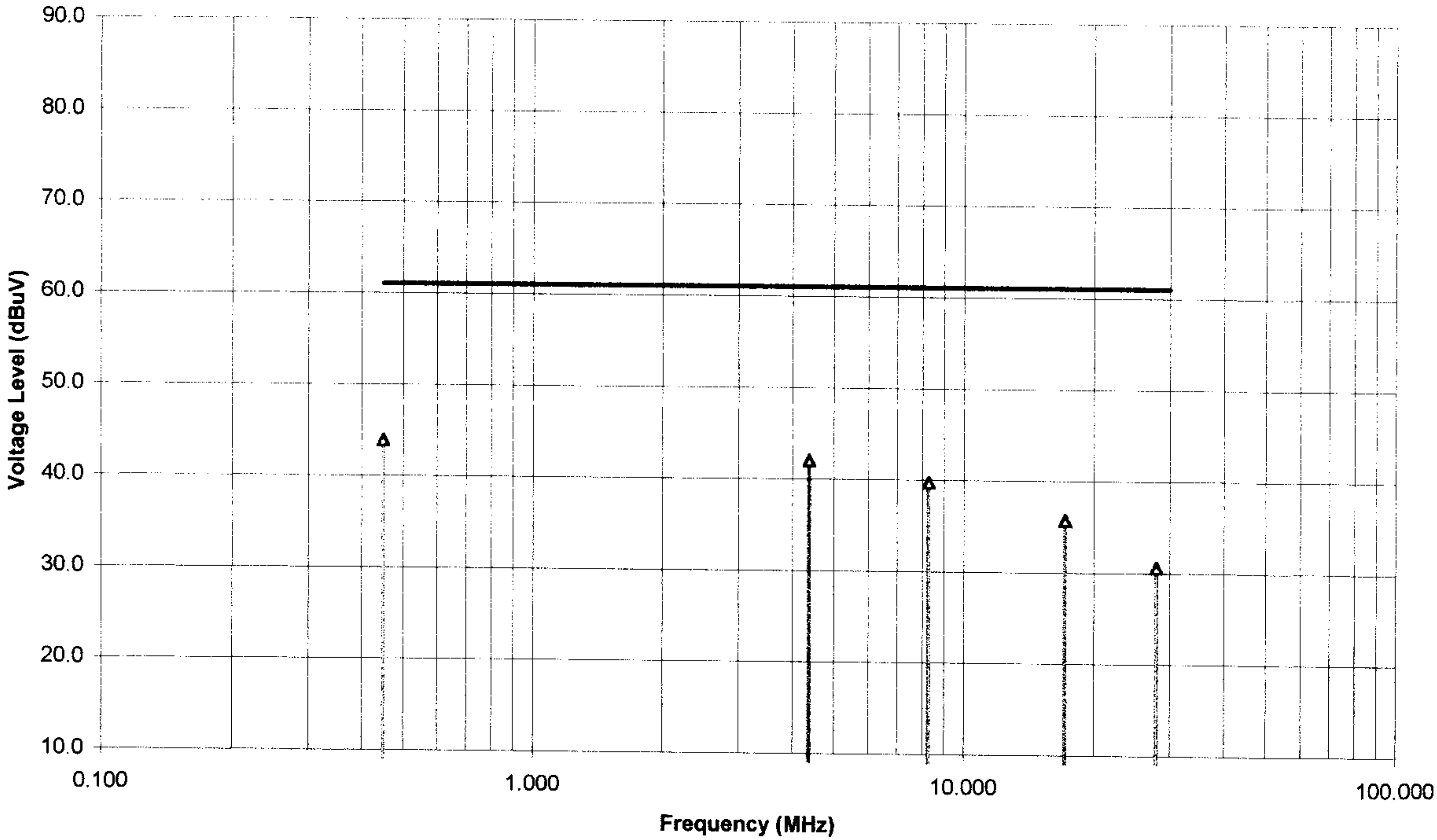
POWER-LINE CONDUCTED EMISSIONS MEASUREMENTS

APPLICANT: INTERAIR WIRELESS
PRODUCT: SPREAD SPECTRUM DEVICE
MODEL:

EMI Detector: [✓] Peak [ ] Quasi Peak [ ] Average Temp.: 22 °C, Humidity: 27%
Line Tested: 1, Input Voltage: 120, Tested by: HUNG Test Date: 04 MAR 98
Comments: FCC 15 B



AC Conducted Emissions - Line #1 (Hot)
InterAir ISP Direct Indoor (2401-01) & Outdoor (2401-02) Units
Operating Modes: Transmit & receive

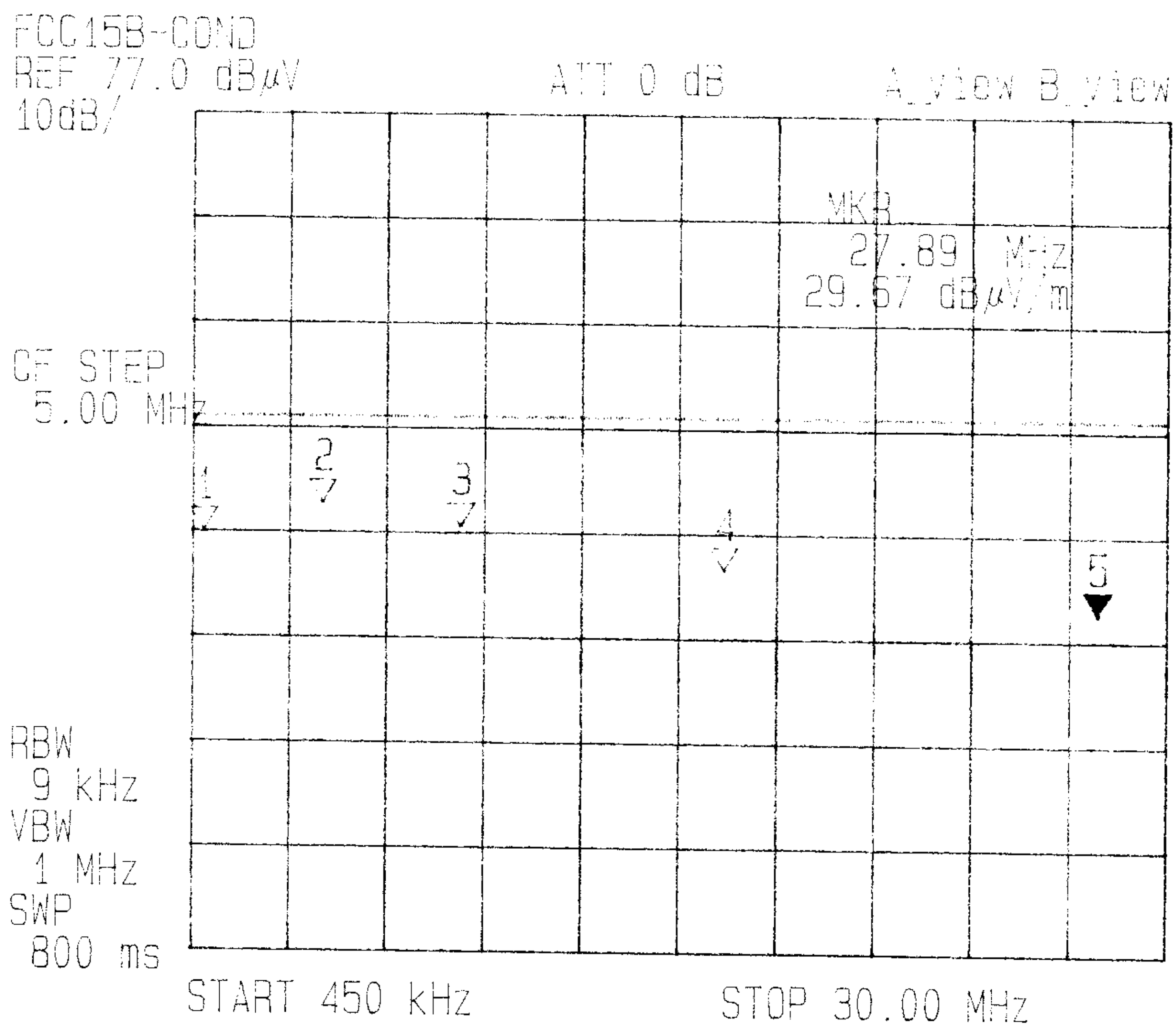


UltraTech Engineering Labs Inc.

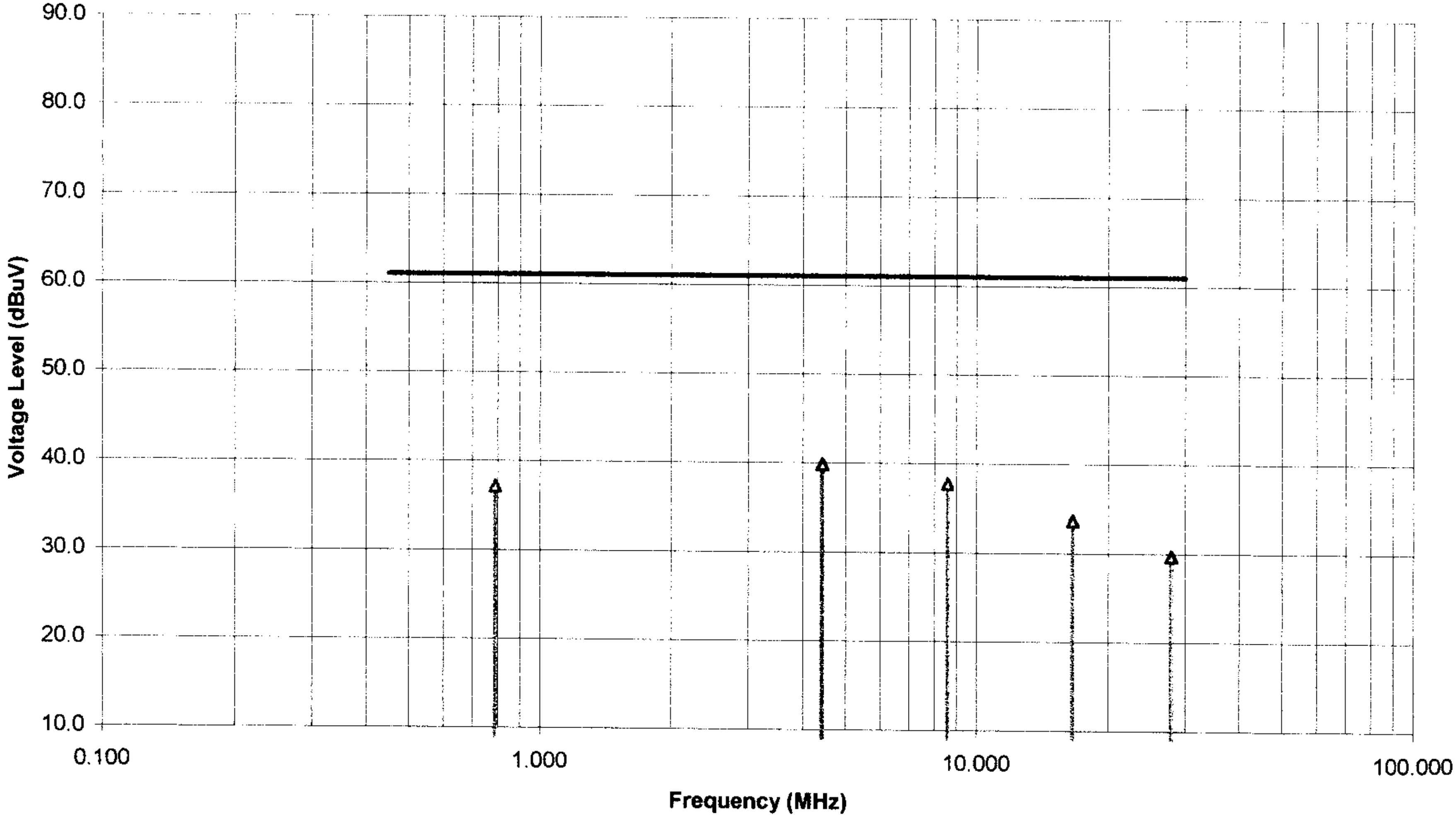
POWER-LINE CONDUCTED EMISSIONS MEASUREMENTS

APPLICANT: INTERAIR WIRELESS
PRODUCT: SPREAD SPECTRUM DEVICE
MODEL:

EMI Detector: [✓] Peak [ ] Quasi Peak [ ] Average Temp.: 22 °C, Humidity: 27 %
Line Tested: 2, Input Voltage: 120, Tested by: HUNG Test Date: 02 MAR 03
Comments: FCC 15 B



AC Conducted Emissions - Line #2 (Neutral)
InterAir ISP Direct Indoor (2401-01) & Outdoor (2401-02) Units
Operating Modes: Transmit & receive



5. EXHIBIT 5 - GENERAL TEST PROCEDURES

5.1 AC Powerline Conducted Emissions Measurements - General Test Method

- AC Powerline Conducted Emissions were performed in the shielded room, 16'(L) by 12'(W) by 12'(H).
- Conducted power-line measurements were made over the frequency range from 450 KHz to 30 MHz to determine the line-to-ground radio noise voltage which was conducted from the EUT power-input terminals that were directly connected to a public power network.
- The EUT normally received power from another device that connects to the public utility ac power lines, measurements would be made on that device with the EUT in operation to ensure that the device continues to comply with the appropriate limits while providing the EUT with power.
- If the EUT was operates only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines, ac power-line conducted measurements are not required.
- Table-top devices were placed on a platform of nominal size 1 m by 1.5m raised 80 cm above the conducting ground plane.
- The EUT current-carrying power lead, except the ground (safety) lead, was individually connected through a LISN to the power source. All unused 50-Ohm connectors of the LISN was terminated in 50-ohm when not connected to the measuring instruments.
- The line cord of the EUT connected to one LISN which was connected to the measuring instrument. Those power cords for the units of devices not under measurement were connected to a separate multiple ac outlets. Drawings and photographs of typically conducted emission test setups were shown in the Test Report. Each current-carrying conductor of the EUT shall be individually tested.
- The EUT was normally operated with a ground (safety) connection, the EUT was connected to the ground at the LISN through a conductor provided in the lead from the ac power mains to the LISN.
- The excess length of the power cord was folded back and forth in an 8-shape on a wooden strip with a vertical prong located on the top of the LISN case.
- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.
- A preliminary scan was made by using spectrum analyzer system with the detector function set to PEAK mode (10 KHz RBW, VBW $\geq$ RBW), frequency span 450KHz-30MHz.
- The maximum conducted emission for a given mode of operation was found by using the following step-by-step procedure:

  Step1. Monitor the frequency range of interest at a fixed EUT azimuth.

  Step2. Manipulate the system cables and peripheral devices to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3. The effects of various modes of operation is examined. This is done by varying equipment operation modes as step 2 is being performed.

  Step4. After completing step 1 through 3, record EUT and peripheral device configuration, mode of operation, cable configuration, signal levels and frequencies for final test.

- Each highest signal level at the maximized test configuration was zoomed in a small frequency span on the spectrum analyzer's display (the manipulation of cables and peripheral devices and EUT operation modes might have to be repeated to obtain the highest signal level with the spectrum analyzer set to PEAK detector mode 10 KHz RBW and VBW ≥ RBW). The spectrum analyzer was then set to CISPR QUASI-PEAK detector mode (9 KHz RBW, 1 MHz VBW) and the final highest RF signal level and frequency was record.

- ***Broad-band ac Powerline conducted emissions***:- If the EUT exhibits ac Powerline conducted emissions that exceed the limit with the instrument set to the quasi-peak mode, then measurements should be made in the average mode. If the amplitude measured in the quasi-peak mode is at least 6 dB higher than the amplitude measured in the average mode, the level measured in quasi peak mode may be reduced by 13 dB before comparing it to the limit.

5.2 Electrical Field Radiated Emissions Measurements - General Test Method

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC.

- Radiated emissions measurements were made using the following test instruments:

    1) Calibrated EMCO active loop antenna in the frequency range from 10 KHz to 1 MHz
    2) Calibrated EMCO biconilog antenna in the frequency range from 30 MHz to 2000 MHz.
    3) Calibrated A.H. Systems log periodic antenna in the frequency range 1GHz - 18 GHz.
    4) Horn Antennas:
        a) Horn Antenna, Emco, Model 3160-09, 18-26.5GHz
        b) Horn Antenna, Emco, Model 3160-10, 26.5-40GHz
        c) Mixer, Tektronix, P/N 118-0098-00, 18-26.5GHz
        d) Mixer, Tektronix, P/N 119-0098-00, 26.5-40GHz
    5) Calibrated Advantest spectrum analyzer and pre-selector/pre-amplifier. In general, the spectrum analyzer would be used as follows:

        – The rf electric field levels were measured with the spectrum analyzer set to PEAK detector (1 KHz RBW and 1 KHz VBW for frequency below 30 MHz, 100 KHz RBW and VBW ≥ RBW for Frequency below 1 GHz and 1 MHz RBW and 1 MHz VBW for frequency greater than 1 GHz).

        – If any rf emission was observed to be a broadband noise, the spectrum analyzer's CISPR QUASI-PEAK detector (120 KHz RBW and 1MHz VBW) was then set to measure the signal level.

        – If the signal being measured was narrowband and the ambient field was broadband, the bandwidth of the spectrum analyzer was reduced.

- The EUT was set-up in its typical configuration and operated in its various modes as described in 3.2 of the test report.

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.

- During this process, cables and peripheral devices were manipulated within the range of likely configuration.

- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement (each variable within bounds specified elsewhere) were explored to produce the highest amplitude signal relative to the limit.

The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

Step4: Move the antenna over its full allowed range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

Step7: After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.

Calculation of Field Strength:

The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$\boxed{\mathbf{FS = RA + AF + CF - AG}}$$

Where	FS	=	Field Strength
	RA	=	Receiver/Analyzer Reading
	AF	=	Antenna Factor
	CF	=	Cable Attenuation Factor
	AG	=	Amplifier Gain

Example: If a receiver reading of 60.0 dBμV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:.

Field Level in dBμV/m = 60 + 7.0 + 1.0 - 30 = 38.0 dBμV/m.

Field Level in μV/m = $10^{(38/20)}$ = 79.43 μV/m.

Notes: The frequency and amplitude of at least six highest conducted emissions relative to the limit are recorded unless such emissions are more than 20 dB below the limit. If less than six emissions are within 20dB of the limit, the background or receiver noise level shall be reported at representative frequencies.

6. EXHIBIT 6 - INFORMATION RELATED TO EQUIPMENT UNDER TESTS

6.1 FCC ID Labeling and Sketch of FCC Label Location

Refer to the attached sheets

6.2 Photographs of Equipment under Test

Refer to the attached photographs

6.3 System Block Diagram(s)

Refer to the attached sheets

6.4 Schematic Diagrams

Refer to the attached sheets

6.5 User's Manual with "FCC Information to User Statements"

Refer to the attached Users' manual