Elliott

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November 10, 1999

Chief, Equipment Authorization Branch,
Authorization and Evaluation Division,
Office of Engineering and Technology
FEDERAL COMMUNICATIONS COMMISSION
P.O. Box 358315
Pittsburgh, PA 15251-5315

Gentlemen:

The enclosed documents constitute a formal submittal and request for a Class II Permissive Change pursuant to Subpart E of Part 15 of FCC Rules (CFR 47) regarding changes to intentional radiators. A change is being proposed to the Wavespan Corporation model Stratum 100 ODUA and B, which would result in changes to the performance characteristics originally reported to the Commission. Since the Stratum 100 is presently certified, an emissions test has been performed to demonstrate that it continues to comply with FCC Part 15 limits for intentional radiators.

Elliott Laboratories, as duly authorized agent prepared this submittal. A copy of the letter of our appointment as agent is enclosed. Please also find enclosed a check in the amount of $45.00 for the application fee.

If there are any questions or if further information is needed, please contact Elliott Laboratories for assistance.

Sincerely,

Mark Briggs

Mark R. Briggs
Manager, EMC Consulting Services

MRB/dmg
Enclosures: Application Fee
FC Form 159
FCC Form 731
Agent Authorization Letter
Emissions Test Report with Exhibits

File: R34555

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Electromagnetic Emissions Test Report and Request for Class II Permissive Change pursuant to FCC Part 15, Subpart E Specifications for an Intentional Radiator on the Wavespan Corporation Model: Stratum 100 ODUA and B

FCC ID:	NGP7020010
GRANTEE:	Wavespan Corporation 500 N. Bernardo Avenue Mountain View, CA. 94043
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	November 10, 1999
FINAL TEST DATE:	October 18 and 19, 1999
AUTHORIZED SIGNATORY:	Mark Briggs Mark R. Briggs Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Wavespan Corporation model Stratum 100 pursuant to Subpart E of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Wavespan Corporation model Stratum 100 and therefore apply only to the tested sample. The sample was selected and prepared by Keith Brombergof Wavespan Corporation

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart E of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Wavespan Corporation model Stratum 100 complied with the requirements of Subpart E of Part 15 of the FCC Rules for low power intentional radiators operating under the rules for UNII devices.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the Wavespan Corporation model Stratum 100 ODU A and B. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE – ODU A and B

The EUT was not tested as the changes proposed will not affect the data for conducted emissions already reported to the FCC. Both the ODU A and ODU B take power from an Indoor Unit (IDU). The IDU has not been changed since the original submittal.

REQUIREMENTS OF 15.407 (c),(f) AND (g) – ODU A and B

The requirements for these sections of Subpart E of Part 15 of the FCC's rules were addressed in the original submittal. The proposed changes will not affect the details submitted to the FCC.

LIMITS OF OUTPUT POWER– ODU A

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (a)(2).

The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 23.3 dB bandwidth was measured to be 73.3 MHz. The power spectral density was measured to be -9.0 dBm/MHz.

The maximum permitted output power and PSD, based on an emission bandwidth of 73.3 MHz and the maximum antenna gain of 26 dBi, are 4 dBm (250 mW – 20 dB) and -9 dBm/MHz (11 dBm – 20 dB) respectively.

LIMITS OF SPURIOUS ANTENNA CONDUCTED EMISSIONS – ODU A

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (b) (2).

All emissions outside of the operational band of 5.25 – 5.35 GHz were at a level that would result in an EIRP of less than –27 dBm/MHz based on an operational antenna gain of 26 dBi.

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH – ODU A

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (b) (5) for the frequency range 30 – 1000 MHz and 15.407 (b)(6) in the case of emissions falling within the frequency bands specified in Section 15.205 in the frequency range 1 – 40 GHz.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Radiated Spurious Emissions, 30 – 1000 MHz

Frequency MHz	Level dBuV/m	Pol v/h	15.209 Limit	15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
778.175	43.9	H	46.0	-2.1	QP	42	2.8	Signal Substitution

Radiated Spurious Emissions In restricted Bands, 1 – 40 GHz

Frequency MHz	Level dBuV/m	Pol v/h	15.209 Limit	15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
10.750	46.4	H	54.0	-7.6	Avg	70	1.1	

LIMITS OF OUTPUT POWER– ODU B

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (a)(3).

The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 26 dB bandwidth was measured to be 76.0 MHz. The power spectral density was measured to be -6.4 dBm.

The maximum permitted output power and PSD, based on an emission bandwidth of 76.0 MHz and a maximum antenna gain for fixed, point-to-point operation of 43 dBi, are 10 dBm (1W – 20 dB) and –3 dBm (17 dBm – 20 dB) respectively.

LIMITS OF SPURIOUS ANTENNA CONDUCTED EMISSIONS – ODU B

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (b)(3)

All emissions within the frequency range from the band edge to 10 MHz above or below the band edge did not exceed an EIRP of –17 dBm/MHz. Emissions at frequencies 10 MHz or greater above or below the band edge did not exceed an EIRP of –27 dBm/MHz. Measurements were based on a maximum antenna gain of 43 dBi.

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH – ODU B

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.407 (b) (5) for the frequency range 30 – 1000 MHz and 15.407 (b)(6) in the case of emissions falling within the frequency bands specified in Section 15.205 in the frequency range 1 – 40 GHz.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Radiated Spurious Emissions, 30 – 1000 MHz

Frequency MHz	Level dBuV/m	Pol v/h	15.209 Limit	15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
778.175	43.5	H	46.0	-2.5	QP	35	2.5	Signal Substitution

Radiated Spurious Emissions In restricted Bands, 1 – 40 GHz
Flat Panel Antenna

Frequency MHz	Level dBuV/m	Pol v/h	15.209 Limit	15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
4.260	52.6	H	54.0	-1.4	Avg	-	1.1	Note 2, Noise Floor

Radiated Spurious Emissions In restricted Bands, 1 – 40 GHz
Dish Antenna

Frequency MHz	Level dBuV/m	Pol v/h	15.209 Limit	15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
18.840	44.0	H	54.0	-10.0	Avg	65	1.1	

MEASUREMENT UNCERTAINTIES

ISO Guide 25 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.2

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Wavespan Corporation model Stratum 100 ODUA and B is an intentional radiator that uses the UNII band and is designed for outdoor operation. The Stratum 100 system consists of two separate radios, one operating in the 5.25–5.35 MHz band and the other in the 5.725-5.825 GHz band. Each radio is comprised of an IDU (indoor unit) located within the building and an ODU (outdoor unit) that is typically located on an antenna tower. The ODU contains all of the RF circuitry; the IDU is a digital device that provides the ODU with power (via shielded cable) and data signals (via fibre optic cables).

The sample was received on October 18, 1999 and tested on October 18 and 19, 1999. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	FCC ID Number
Wavespan Stratum 100 ODU A (Outdoor unit)	AA3396	NGP7020010
Wavespan Stratum 100 ODU B (Outdoor unit)	AA5205	NGP7020010

INPUT POWER

The EUT input is rated at 120/240, 50/60 Hz. The EUT contained the following input power components during emissions testing:

The ODU power was derived from the remote IDU.

PRINTED WIRING BOARDS

The EUT contained the following printed wiring boards during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Wavespan / ODU Radio A	500055704	X4	AA5218	120.0
Wavespan / Tuner Assembly	500056301	X8	None	10.0
Wavespan / ODU Control Board	500056101	15	None	32.424

SUBASSEMBLIES

The EUT did not contain subassembly modules during emissions testing:

ANTENNA

The ODU A is designed to use the Wavespan flat panel antenna that has a gain of 26 dBi. This antenna was previously reported to the FCC as having a gain of 28 dBi. Since the original submittal Wavespan has had measurements made on the antenna by TRW which showed that the antenna gain was 26 dBi in the 5.25 – 5.35 GHz band.:

The flat panel antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203.

The ODU B is designed to use either the Wavespan flat panel antenna (gain of 26 dBi) or a parabolic dish antenna. The dish antennas that can be used with the device may have a gain of up to 43 dBi

The flat panel antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203. When using a parabolic dish antenna, a new faceplate is placed on the ODU with an N-type connector that is used to connect to the dish via LMR-400 coaxial cable. The high gain dish antennas require that the device be professionally installed. The professional installation issues with respect to FCC Part 15.203 were addressed in the original application..

ENCLOSURE

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 310 cm wide by 5 cm deep by 40 cm high.

EMI SUPPRESSION DEVICES

The EUT contained the following EMI suppression devices during emissions testing:

Description	Manufacturer	Part Number
Feedthru Filter	Corry Micronics, Inc.	FTF3-15
RF Gasket	Vanguard Products, Corp.	12125-03-075-PSA
RF Gasket	Vanguard Products, Corp.	14125-05-050-ORA-NPS

MODIFICATIONS

The EUT required the following modifications in order to comply with the emission specifications:

During the 30–1000 MHz radiated emissions test it was noticed that the dc power cable was not wired correctly (cable shield and ground wires had been reversed). The fault was noticed after the preliminary run (run #4). Prior to maximizing the levels, the wiring fault was corrected, resulting in a lower level of emissions at 259.395 MHz than was previously observed.

SUPPORT EQUIPMENT

No local support equipment was used during emissions testing.

The following equipment was used as remote support equipment for emissions testing:

Manufacturer/Model/Description	Serial Number	FCC ID Number
Wavespan Stratum 100 IDU Indoor Unit	15154	N/A

EXTERNAL I/O CABLING

The I/O cabling configuration during emissions testing was as follows:

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Duplex fibre optic	30	ODU Tx/Rx	IDU Rx/Tx
Shielded	30	IDU Power	ODU Power
RG214/U coaxial cable (Used for run #8 – ODU B connected to dish antenna only)	1.5	ODU B Antenna	4’ Dish antenna

EUT OPERATION DURING TESTING

The EUT was set to operate transmitting continuously at the nominal operational frequency.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Wavespan Corporation model Stratum 100 ODUA and B being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed.

OUTPUT POWER

The changes made to the device since the original submittal was made were:

Output power for the ODU A was increased from –0.9 dBm to 1.0 dBm.
Output power for the ODU B was increased from –3.5 dBm to 1.0 dBm.
Parabolic dish antenna for use with ODU B may have a gain of up to 43 dBi (previously the maximum antenna gain was 40 dBi) for a Class II Permissive Change.

The increase in output power was made by adjusting variable pots in the ODU. No circuit modifications were made to the ODUs. The adjustable pots are used during manufacturing to set the output power of the device. They are not accessible to the end user.

Correspondence with the FCC was made prior to making to this submittal to ensure that the above changes would constitute a Class II permissive change.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on October 18 and 19, 1999 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal standardized RF impedance, provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde and Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and thermister mount are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors, which are programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these are with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

Test Equipment List - SVOATS#1

October 20, 1999

Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☑ EMCO	Biconical Antenna, 30-300 MHz	3110B	363	12	4/19/99	4/19/2000
☑ EMCO	Double Ridged Horn antenna	3115	1097	12	10/27/98	10/27/99
☑ EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	12	6/25/99	6/25/2000
☑ EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	788	12	1/16/99	1/16/2000
☑ Hewlett Packard	EMC Spectrum Analyzer	8593EM	1106			
☑ Hewlett Packard	HF amplifier, 45 MHZ -50 GHz	83051A	1107	12	11/12/98	11/12/99
☑ Hewlett Packard	High Pass filter, 8.2GHz	84300-80039	1102	12		
☑ Hewlett Packard	Microwave EMI test system,	84125B, (Amp.	1108	12	9/15/99	9/15/99
☑ Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	12	1/18/99	1/18/2000
☑ Rohde & Schwarz	Dual Channel Power Meter, 25VA,	NRVD	1071	12	5/4/99	5/4/2000
☑ Rohde & Schwarz	Thermal Power Sensor,	NRV-Z51	1069	12	4/27/99	4/27/2000
☑ Hewlett Packard	Spectrum Analyzer	8565E	3442A00235	12	9/29/99	9/29/2000

File Number: T34224

Date: 10·18·99; 10·19·99

Engr: MRB

All calibration of equipment is traceable to a national standard of measurement such as NIST.

EXHIBIT 2:Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T 34224 41 Pages

Test Objective

The objective of this test session is to perform final qualification testing the EUT defined below relative to the specification defined above in order to support an application for a Class II Permissive change to the product.

Test Summary

Run #1 - Antenna Conducted Measurements **ODU A** (Test performed 10/18/99, Chris Byleckie/David Bare)

Fundamental Signal (5.25 – 5.35 GHz Band)

PASS Results: FCC 15.407(a)(2)

The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 23.3 dB bandwidth was measured to be 73.3 MHz. The power spectral density was measured to be -9.0 dBm/MHz.

The maximum permitted output power and PSD, based on an emission bandwidth of 73.3 MHz and the maximum antenna gain of 26 dBi, are 4 dBm (250 mW – 20 dB) and -9 dBm/MHz (11 dBm – 20 dB) respectively.

Spurious Emissions, 1 – 40 GHz

PASS Results: FCC 15.407(b)(2)

All emissions outside of the operational band of 5.25 – 5.35 GHz were at a level that would result in an EIRP of less than –27 dBm/MHz based on an operational antenna gain of 26 dBi.

The requirements of 15.407 (c), (f) and (g) for ODU A were addressed in the original submittal. The changes to the previously authorized device do not affect the details reported to the FCC.

Run #2 - Antenna Conducted Measurements **ODU B** (Test performed 10/18/99, Chris Byleckie/David Bare)

Fundamental Signal (5.725 – 5.825 GHz Band)

PASS Results: FCC 15.407(a)(3)

The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 26 dB bandwidth was measured to be 76.0 MHz. The power spectral density was measured to be -6.4 dBm.

The maximum permitted output power and PSD, based on an emission bandwidth of 76.0 MHz and a maximum antenna gain for fixed, point-to-point operation of 43 dBi, are 10 dBm (1W – 20 dB) and –3 dBm (17 dBm – 20 dB) respectively.

Spurious Emissions, 1 – 40 GHz

PASS Results: FCC 15.407(b)(3)

All emissions within the frequency range from the band edge to 10 MHz above or below the band edge did not exceed an EIRP of –17 dBm/MHz. Emissions at frequencies 10 MHz or greater above or below the band edge did not exceed an EIRP of –27 dBm/MHz. Measurements were based on a maximum antenna gain of 43 dBi.

The requirements of 15.407 (c), (f) and (g) For ODU B were addressed in the original submittal. The changes to the previously authorized device do not affect the details reported to the FCC.

Run #3 - Preliminary radiated emissions, 30-1000 MHz as per 15.407 (b)(5), **ODU B**

Results: FCC 15.209 -2.4 dB QP @ 259.395 MHz Horizontal

The frequencies measured were based on a preliminary scan performed in an anechoic chamber (T34196)

Run #4 - Maximized radiated emissions, 30–1000 MHz as per 15.407 (b)(5), **ODU B**

PASS* Results: FCC 15.209 -2.5 dB QP @ 778.175 MHz Horizontal

* The margin between the recorded signal level and the specification limit is less than the measurement uncertainty.

Run #5 - Maximized radiated emissions, 30–1000 MHz as per 15.407 (b)(5), **ODU A**

PASS* Results: FCC 15.209 -2.1 dB QP @ 778.175 MHz Horizontal

* The margin between the recorded signal level and the specification limit is less than the measurement uncertainty.

The signals maximized were the same signals that were maximized during run #4. Previous testing had shown that the radiated emissions below 1 GHz from ODU A and ODU B were not significantly different. All signals generated within the ODU that are related to the fundamental transmission signal are above 1GHz.

Run #6 - Maximized radiated emissions in restricted bands, 1 – 40 GHz as per 15.407 (b)(6), **ODU A w/Flat Panel**

PASS Results: FCC 15.209 -7.6 dB Avg @ 10.750 GHz Horizontal

Run #7 - Maximized radiated emissions in restricted bands, 1 – 40 GHz as per 15.407 (b)(6), **ODU B w/Flat Panel**

PASS Results: FCC 15.209 -1.4 dB Avg @ 4.260 GHz Horizontal

Highest emission with respect to the limit was actually the noise floor of the measurement instrumentation used.

Run #8 - Maximized radiated emissions in restricted bands, 1 – 40 GHz as per 15.407 (b)(6), **ODU B w/4'Dish Antenna**

PASS Results: FCC 15.209 -10.0 dB Avg @ 18.840 GHz Horizontal

Emissions were not radiated from the antenna (with the signal maximized, the level did not change as the orientation of the antenna was altered but did move as the orientation of the ODU was altered). No corrections were made to the data to convert from a 4 foot dish antenna to a dish antenna with a gain of 43 dBi.

Conducted Emissions Scan of EUT as per 15.407 (b)(5).

The ODU A and ODU B are both dc powered devices that take power from an Indoor Unit (IDU). No modifications have been made to the IDU since the original grant of authorization for the UNII system was issued. The increase in output power for the ODUs would not affect the conducted emissions data already submitted to the FCC. No new conducted emissions data was taken.

Equipment under Test (EUT) General Description

The EUT is an intentional radiator that uses the UNII band and is designed for outdoor operation. The Stratum 100 system consists of two separate radios, one operating in the 5.25–5.35 MHz band and the other in the 5.725-5.825 GHz band. Each radio is comprised of an IDU (indoor unit) located within the building and an ODU (outdoor unit) that is typically located on an antenna tower. The ODU contains all of the RF circuitry; the IDU is a digital device that provides the ODU with power (via shielded cable) and data signals (via fibre optic cables).

Normally, the EUT would be placed on an antenna tower during operation. The EUT was treated as tabletop equipment during emissions testing.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Wavespan Stratum 100 ODU A (Outdoor unit)	AA3396	NGP7020010
Wavespan Stratum 100 ODU B (Outdoor unit)	AA5205	NGP7020010

Power Supply and Line Filters

The ODU power was derived from the remote IDU.

Printed Wiring Boards in ODU A

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Wavespan / ODU Radio A	500055704	X4	AA5218	120.0
Wavespan / Tuner Assembly	500056301	X8	None	10.0
Wavespan / ODU Control Board	500056101	15	None	32.424

Printed Wiring Boards in ODU B

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Wavespan / ODU Radio B	500055804	X4	AA5203	120.0
Wavespan / Tuner Assembly	500056301	X8	None	10.0
Wavespan / ODU Control Board	500056101	15	None	32.424

Subassemblies in EUT

No subassemblies were used in the EUT.

EUT Antenna

The ODU A is designed to use the Wavespan flat panel antenna that has a gain of 26 dBi. This antenna was previously reported to the FCC as having a gain of 28 dBi. Since the original submittal Wavespan has had measurements made on the antenna by TRW which showed that the antenna gain was 26 dBi in the 5.25 – 5.35 GHz band.:

The flat panel antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203.

The ODU B is designed to use either the Wavespan flat panel antenna (gain of 26 dBi) or a parabolic dish antenna. The dish antennas that can be used with the device may have a gain of up to 43 dBi

The flat panel antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203. When using a parabolic dish antenna, a new faceplate is placed on the ODU with an N-type connector that is used to connect to the dish via LMR-400 coaxial cable. The high gain dish antennas require that the device be professionally installed. The professional installation issues with respect to FCC Part 15.203 were addressed in the original application.

Permissive Changes to the EUT

The changes made to the device since the original submittal was made were:

Output power for the ODU A was increased from –0.9 dBm to 1.0 dBm.
Output power for the ODU B was increased from –3.5 dBm to 1.0 dBm.
Parabolic dish antenna for use with ODU B may have a gain of up to 43 dBi (previously the maximum antenna gain was 40 dBi) for a Class II Permissive Change.

The increase in output power was made by adjusting variable pots in the ODU. No circuit modifications were made to the ODUs. The adjustable pots are used during manufacturing to set the output power of the device. They are not accessible to the end user.

EUT Enclosure(s)

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 310 cm wide by 5 cm deep by 40 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

The manufacturer provided the following information:

Description	Manufacturer	Part Number
Feedthru Filter	Corry Micronics, Inc.	FTF3-15
RF Gasket	Vanguard Products, Corp.	12125-03-075-PSA
RF Gasket	Vanguard Products, Corp.	14125-05-050-ORA-NPS

Modifications

The following modifications were made to the EUT during testing in order to comply with the requirements:

During the 30–1000 MHz radiated emissions test it was noticed that the dc power cable was not wired correctly (cable shield and ground wires had been reversed). The fault was noticed after the preliminary run (run #4). Prior to maximizing the levels, the wiring fault was corrected, resulting in a lower level of emissions at 259.395 MHz than was previously observed.

Local Support Equipment

None required. All support equipment was located remotely from the EUT.

Remote Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
Wavespan Stratum 100 IDU Indoor Unit	15154	N/A

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Duplex fibre optic	30	ODU Tx/Rx	IDU Rx/Tx
Shielded	30	IDU Power	ODU Power
RG214/U coaxial cable (Used for run #8 – ODU B connected to dish antenna only)	1.5	ODU B Antenna	4' Dish antenna

EUT Operation During Testing

The EUT was set to operate transmitting continuously at the nominal operational frequency.

General Test Conditions

During radiated testing, the EUT was connected to the dc output from the IDU. The EUT was located on the turntable for radiated testing. The remote support equipment was located approximately 30 meters from the EUT with the fibre interface routed above the turntable and the dc power interface running beneath the ground plane. A three meter length of the dc interface cabling was exposed above the ground plane at the turntable.

Test Data Tables

See attached data

Emissions Test Data

Client:	Wavespan	Date:	10/18 & 10/19/99	Test Engr:	MB, DB, CB
Product:	Stratum 100 ODU A and ODU B	File:	T34224	Proj. Engr:	Mark Briggs
Objective	Final Qualification (Permissive Change)	Site:	SV #1 / Chamber 2	Contact:	Mark Byington
Spec:	FCC Part 15 Subpart E	Distance:	3 m (where applicable)	Approved:	

Run #1: Antenna Conducted Emissions - Fundamental and Spurious, ODU A (5.25 - 5.35 GHz Band UNII)

Intentional Signal as per 15.407 (a) (2):

The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 23.3dB bandwidth was measured to be 73.3 MHz (refer to graph 101). The power spectral density was measured to be -9.0dBm/MHz (refer to graph 102).

The maximum permitted output power and PSD, based on an emission bandwidth of 73.3 MHz and the device's antenna gain of 26dBi, are 4dBm (250mW - 20dB) and -9dBm (11dBm - 20dB) respectively.

Spurious Emissions as per 15.407 (b) (2):

The out-of-band emissions were measured as shown in the table below:

Frequency Range (GHZ)	Graph	Highest Signal Level (dBm)	Antenna* Gain (dBi)	EIRP (dBm)	Status
1 - 2.75	103	-55.7 dBm @ 2.67 GHz	26	-29.7	Complied - limit for conducted spurious emissions is EIRP of -27dBm or less.
2.75 - 5.23	104	-56.9 dBm @ 5.23 GHz	26	-30.9	
5.23 - 5.25	105	Highest emission is at the band edge (-54.9 dBm @ 5.25 GHz). Measurement made in reduced bandwidth (3kHz) by summing individual peaks in a 1MHz band.	26	-28.9	
	106				
	107				
5.25 - 5.35	108	Permitted band of operation			
5.35 - 5.60	109	-55.5dBm @ 5.35 GHz	26	-29.5	
5.60 - 10.00	110	-55.2dBm @ 6.93 GHz	26	-29.2	
10.00 - 15.00	111	-53.3 @ 14.233 GHz	26	-29.3	
15.00 - 26.50	112	-77.2 @ 17.17 GHz (Note 1)	26	-51.2	
26.5 - 40.0	113	-70.33 @ 37.32 GHz (Note 1)	26	-44.3	

Note 1 Measured with filter and preamplifier between antenna port and analyzer.

* Antenna gain assumed to be flat across the complete frequency range.

Spurious Emissions as per 15.407 (b) (5) and (6):

Refer to runs 5 and 6 below.

Requirements of 15.407 (c), (f) and (g)

These were addressed in the original application for a grant of authorization for the Stratum 100 Radio.

Emissions Test Data

Client:	Wavespan	Date:	10/18 & 10/19/99	Test Engr:	MB, DB, CB
Product:	Stratum 100 ODU A and ODU B	File:	T34224	Proj. Engr:	Mark Briggs
Objective	Final Qualification (Permissive Change)	Site:	SV #1 / Chamber 2	Contact:	Mark Byington
Spec:	FCC Part 15 Subpart E	Distance:	3 m (where applicable)	Approved:	

Run #2: Antenna Conducted Emissions - Fundamental and Spurious, ODU B (5.725 - 5.825 GHz Band UNII)

Intentional Signal as per 15.407 (a) (3):
The output power from the device was measured to be +1 dBm, as measured directly on the antenna port using a power meter. The 26dB bandwidth was measured to be 76.0 MHz (refer to graph 201). The power spectral density was measured to be -6.4dBm/MHz (refer to graph 202).

The maximum permitted output power and PSD, based on an emission bandwidth of 76.0 MHz and a maximum antenna gain for fixed, point-to-point operation of 43 dBi, are 10 dBm (1W - 20dB) and -3dBm (17dBm - 20dB) respectively.

Spurious Emissions as per 15.407 (b) (3):

The out-of-band emissions were measured as shown in the table below:

Frequency Range (GHZ)	Graph	Highest Signal Level (dBm)	Antenna* Gain (dBi)	EIRP (dBm)	Status
1.0 - 2.7	203	-75.8 dBm @ 2.425 GHz	43	-35.8	Complied - limit for conducted spurious emissions is EIRP of -17dBm or less in the bands 5.715 - 5.725 GHz and 5.825 - 5.835 GHz, -27dBm elsewhere.
2.7 - 5.51	204	-70.3 dBm @ 5.504 GHz	43	-27.3	
5.51 - 5.715	205	Highest emission is at the band edge (-73.0 dBm @ 5.715 GHz). Measurement made in reduced bandwidth (3kHz) by summing individual peaks in a 1MHz band.	43	-30	
	206				
5.715 - 5.725	207	Highest emission is at the band edge (-74.8 dBm @ 5.725 GHz). Measurement made in reduced bandwidth (3kHz) by summing individual peaks in a 1MHz band.	43	-31.8	
	208				
5.725 - 5.825	209	Permitted Band of Operation			
5.825 - 5.835	210	Highest emission is at the band edge (-74.5 dBm @ 5.725 GHz). Measurement made in reduced bandwidth (3kHz) by summing individual peaks in a 1MHz band.	43	-31.5	
	211				
5.835 - 6.0	212	Highest emission near the band edge (-77.1 dBm @ 5.8395 GHz). Measurement made in reduced bandwidth (3kHz) by summing individual peaks in a 1MHz band.	43	-34.1	
	213				
6.0 - 26.5	214	-66.4 @ 25.03 GHz (note 2)	39	-27.4	
26.5 - 40.0	215	-70.7 @ 39.62 GHz (Note 1)	43	-27.7	

Note 1 Measured with filter and preamplifier between antenna port and analyzer.

Note 2 Assumed a minimum of 4dB cable loss for LMR 400 as specified in installation instructions - typical figure would be much higher.

***** Antenna gain assumed to be flat across the complete frequency range, with no account for cable loss, except as noted above

Spurious Emissions as per 15.407 (b) (5) and (6):

Refer to runs 4,7 and 8 below.

Requirements of 15.407 (c), (f) and (g)

These were addressed in the original application for a grant of authorization for the Stratum 100 Radio.

Elliott — Emissions Test Data

Client:	Wavespan	Date:	10/18 & 10/19/99	Test Engr:	MB, DB, CB
Product:	Stratum 100 ODU A and ODU B	File:	T34224	Proj. Engr:	Mark Briggs
Objective	Final Qualification (Permissive Change)	Site:	SV #1 / Chamber 2	Contact:	Mark Byington
Spec:	FCC Part 15 Subpart E	Distance:	3 m (where applicable)	Approved:	

Run #3: Preliminary radiated emissions, 30-1000 MHz. ODU B

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
259.395	43.6	H	46.0	-2.4	QP	210	1.2	
778.175	43.5	H	46.0	-2.5	QP	35	2.5	Signal Substitution
259.395	42.5	V	46.0	-3.5	QP	80	1.0	
778.182	40.3	V	46.0	-5.7	QP	13	1.0	Signal Substitution
437.730	40.0	V	46.0	-6.0	QP	175	1.1	
405.302	39.6	H	46.0	-6.4	QP	310	2.2	
194.545	36.5	H	43.5	-7.0	QP	170	1.7	
405.298	38.0	V	46.0	-8.0	QP	340	2.1	
360.015	37.5	V	46.0	-8.5	QP	151	1.0	
145.913	34.4	V	43.5	-9.1	QP	170	1.0	
194.547	33.9	V	43.5	-9.6	QP	0	1.0	
291.817	36.3	V	46.0	-9.7	QP	300	1.6	
291.817	36.0	H	46.0	-10.0	QP	180	1.1	
145.913	33.2	H	43.5	-10.3	QP	150	1.2	
360.015	35.4	H	46.0	-10.6	QP	129	1.0	
178.335	31.5	H	43.5	-12.0	QP	180	1.0	
437.730	33.5	H	46.0	-12.5	QP	332	1.0	
713.338	33.0	V	46.0	-13.0	QP	350	2.0	
178.338	28.2	V	43.5	-15.3	QP	40	1.0	
69.500	18.8	V	40.0	-21.2	QP	0	1.0	Broadband
40.605	18.0	V	40.0	-22.0	QP	0	1.0	Broadband

Run #4: Maximized readings from run #0 (ODU B), 30-1000 MHz

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
778.175	43.5	H	46.0	-2.5	QP	35	2.5	Signal Substitution
778.182	41.0	V	46.0	-5.0	QP	16	1.8	Signal Substitution
437.730	40.9	V	46.0	-5.1	QP	174	1.0	
405.302	39.7	H	46.0	-6.3	QP	304	1.8	
259.395	37.9	H	46.0	-8.1	QP	170	1.2	Note 1
259.395	34.4	V	46.0	-11.6	QP	150	1.0	Note 1

Note 1: Shield on dc power cable was incorrectly wired during preliminary run. Re-wired correctly for this run.

Elliott — Emissions Test Data

Client:	Wavespan	Date:	10/18 & 10/19/99	Test Engr:	MB, DB, CB
Product:	Stratum 100 ODU A and ODU B	File:	T34224	Proj. Engr:	Mark Briggs
Objective	Final Qualification (Permissive Change)	Site:	SV #1 / Chamber 2	Contact:	Mark Byington
Spec:	FCC Part 15 Subpart E	Distance:	3 m (where applicable)	Approved:	

Run #5: Maximized Rdaiated Emissions, 30 - 1000 MHz from run #0 (ODU A), 30-1000 MHz

Re-measured at the frequencies for the highest emissions from ODU B - preliminary testing had shown there to be no signifcant differences between the radiated emissions in the frequency range 30 - 1000 MHz from either ODU.

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
778.175	43.9	H	46.0	-2.1	QP	42	2.8	Signal Substitution
437.730	43.8	V	46.0	-2.2	QP	177	1.0	
778.182	43.4	V	46.0	-2.6	QP	52	1.1	Signal Substitution
259.395	40.8	H	46.0	-5.2	QP	110	1.3	
405.302	36.7	H	46.0	-9.3	QP	66	1.8	
259.395	31.8	V	46.0	-14.2	QP	165	1.0	

Run #6: Maximized Radiated Emissions 1,000 - 40,000 MHz - Spurious Emissions In Restricted Bands as per 15.407 (b)(6), ODU A w/flat panel antenna

Measurements made at 3m test distance.

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
GHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
10.750	46.4	H	54.0	-7.6	Avg	70	1.1	
4.789	42.7	H	54.0	-11.3	Pk	90	1.0	Note 1,2,3
19.159	39.9	H	54.0	-14.1	Avg	70	1.1	
10.750	52.1	H	74.0	-21.9	Pk	70	1.1	
19.159	50.0	H	74.0	-24.0	Pk	70	1.1	

Note 1:	Measurement made at distance of 1.0m, extrapolated to 3m using 20Log(1.0/3) correction factor
Note 2:	Unable to use a pre-amplifier as signal too close to fundamental emission.
Note 3:	Peak reading compared to average limit

Elliott — Emissions Test Data

Client:	Wavespan	Date:	10/18 & 10/19/99	Test Engr:	MB, DB, CB
Product:	Stratum 100 ODU A and ODU B	File:	T34224	Proj. Engr:	Mark Briggs
Objective	Final Qualification (Permissive Change)	Site:	SV #1 / Chamber 2	Contact:	Mark Byington
Spec:	FCC Part 15 Subpart E	Distance:	3 m (where applicable)	Approved:	

Run #7: Maximized Radiated Emissions 1,000 - 40,000 MHz - Spurious Emissions In Restricted Bands as per 15.407 (b)(6), ODU B w/flat panel antenna

Measurements made at 3m test distance.

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
GHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4.260	52.6	H	54.0	-1.4	Avg	-	1.1	Note 2, Noise Floor
12.560	46.3	H	54.0	-7.7	Avg	190	1.0	
9.366	45.7	H	54.0	-8.3	Avg	240	1.0	
9.420	44.8	H	54.0	-9.2	Avg	240	1.0	
4.260	63.7	H	74.0	-10.3	Pk	-	1.1	Note 2, Noise Floor
18.840	43.4	H	54.0	-10.6	Avg	230	1.1	
18.732	43.4	H	54.0	-10.6	Avg	110	1.1	Pk Reading average limit
6.280	37.8	H	54.0	-16.2	Avg	Note 3		Note 1,2
6.280	53.8	H	74.0	-20.2	Pk	Note 3		Note 1,2
12.560	52.1	H	74.0	-21.9	Pk	190	1.0	
18.840	51.2	H	74.0	-22.8	Pk	230	1.1	
9.420	50.7	H	74.0	-23.3	Pk	240	1.0	
18.732	50.6	H	74.0	-23.4	Pk	110	1.1	
9.366	49.8	H	74.0	-24.2	Pk	240	1.0	

Note 1:	Measurement made at distance of 0.5m, extrapolated to 3m using 20Log(0.5/3) correction factor
Note 2:	Unable to use a pre-amplifier as signal too close to fundamental emission.
Note 3:	Signla at maximum level with horn directly in-line with the input power port.

Run #8: Maximized Radiated Emissions 1,000 - 40,000 MHz - Spurious Emissions In Restricted Bands as per 15.407 (b)(6), ODU B w/4' dish antenna

Measurements made at 3m test distance.

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
GHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
18.840	44.0	H	54.0	-10.0	Avg	65	1.1	
9.420	41.0	H	54.0	-13.0	Avg	40	1.0	
18.732	40.9	H	54.0	-13.1	Avg	70	1.1	
9.366	39.4	H	54.0	-14.6	Avg	30	1.0	
6.280	39.2	H	54.0	-14.8	Avg	Note 3		Note 1,2
12.560	37.5	H	54.0	-16.5	Avg	60	1.0	
6.280	51.8	H	74.0	-22.2	Pk	Note 3		Note 1,2
18.840	51.2	H	74.0	-22.8	Pk	65	1.1	
18.732	50.4	H	74.0	-23.6	Pk	70	1.1	
9.420	49.3	H	74.0	-24.7	Pk	40	1.0	
9.366	49.0	H	74.0	-25.0	Pk	30	1.0	
12.560	48.8	H	74.0	-25.2	Pk	60	1.0	

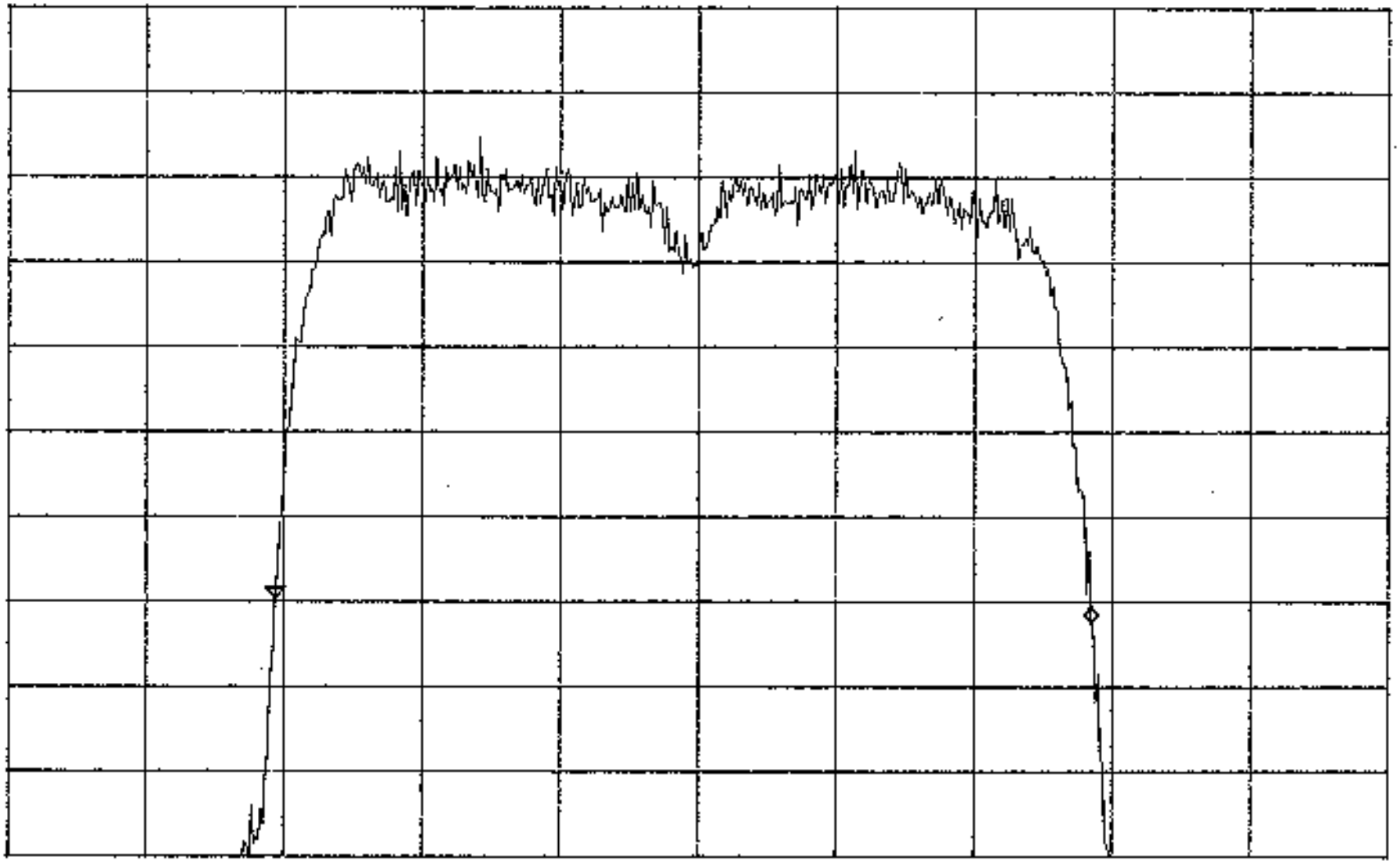
Note 1:	Measurement made at distance of 0.5m, extrapolated to 3m using 20Log(0.5/3) correction factor
Note 2:	Unable to use a pre-amplifier as signal too close to fundamental emission.
Note 3:	Signla at maximum level with horn directly in-line with the input power port.

WAVESPAN ODU A 5.25 - 5.35MHz

10-18-99
CM

*ATTEN 20dB 26 dB BANDWIDTH ΔMKR -1.42dB

RL 0dBm 5dB/ 73.3MHz



START 5.2261GHz STOP 5.3500GHz

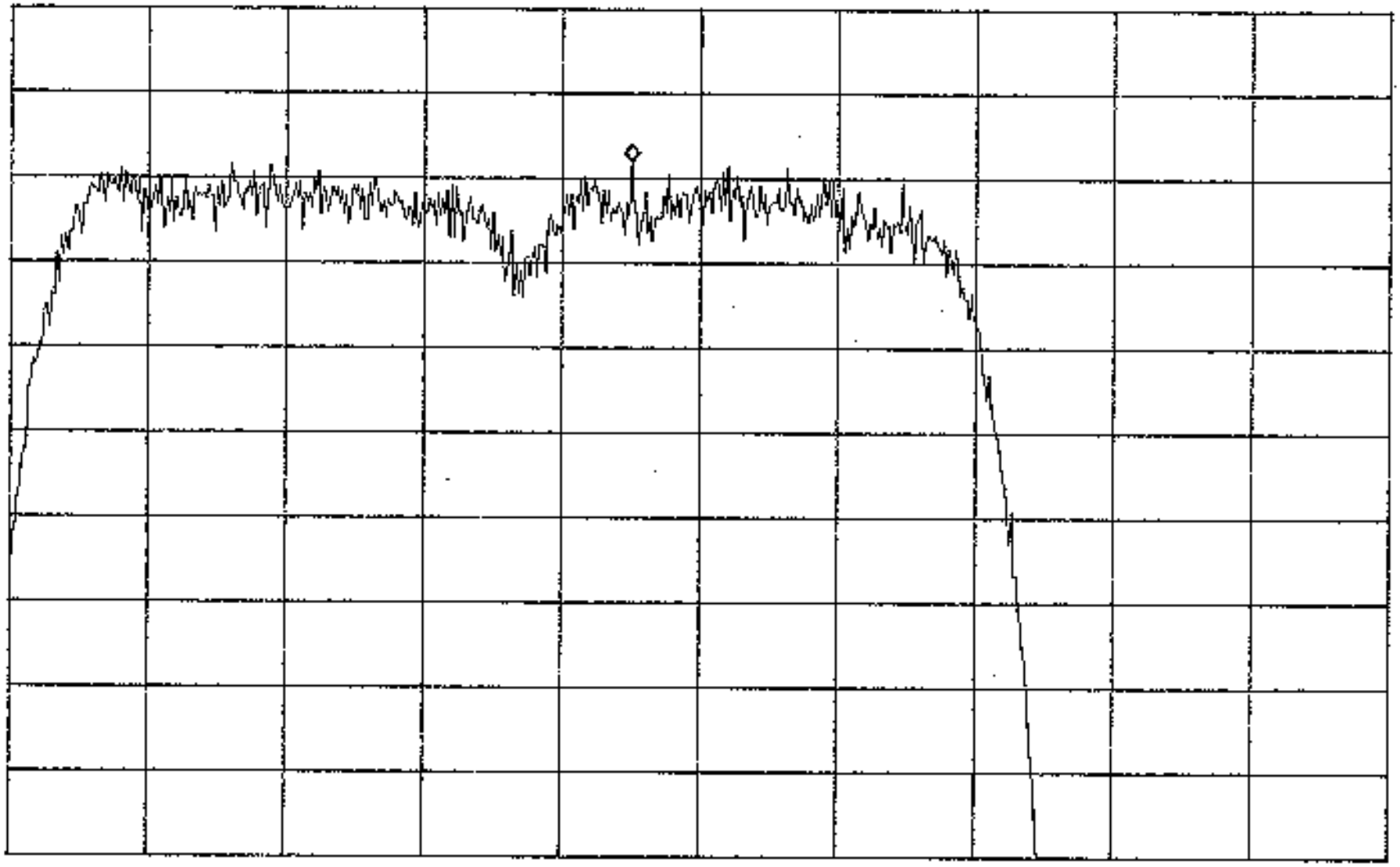
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

D34224-GPH 101

WAVESAM ODU A 5.25 - 5.35 MHz

10-18-99
CAJ

*ATTEN 20dB Peak Power Spectral Density MKR -9.00dBm
RL 0dBm 5dB/ 5.2950GHz



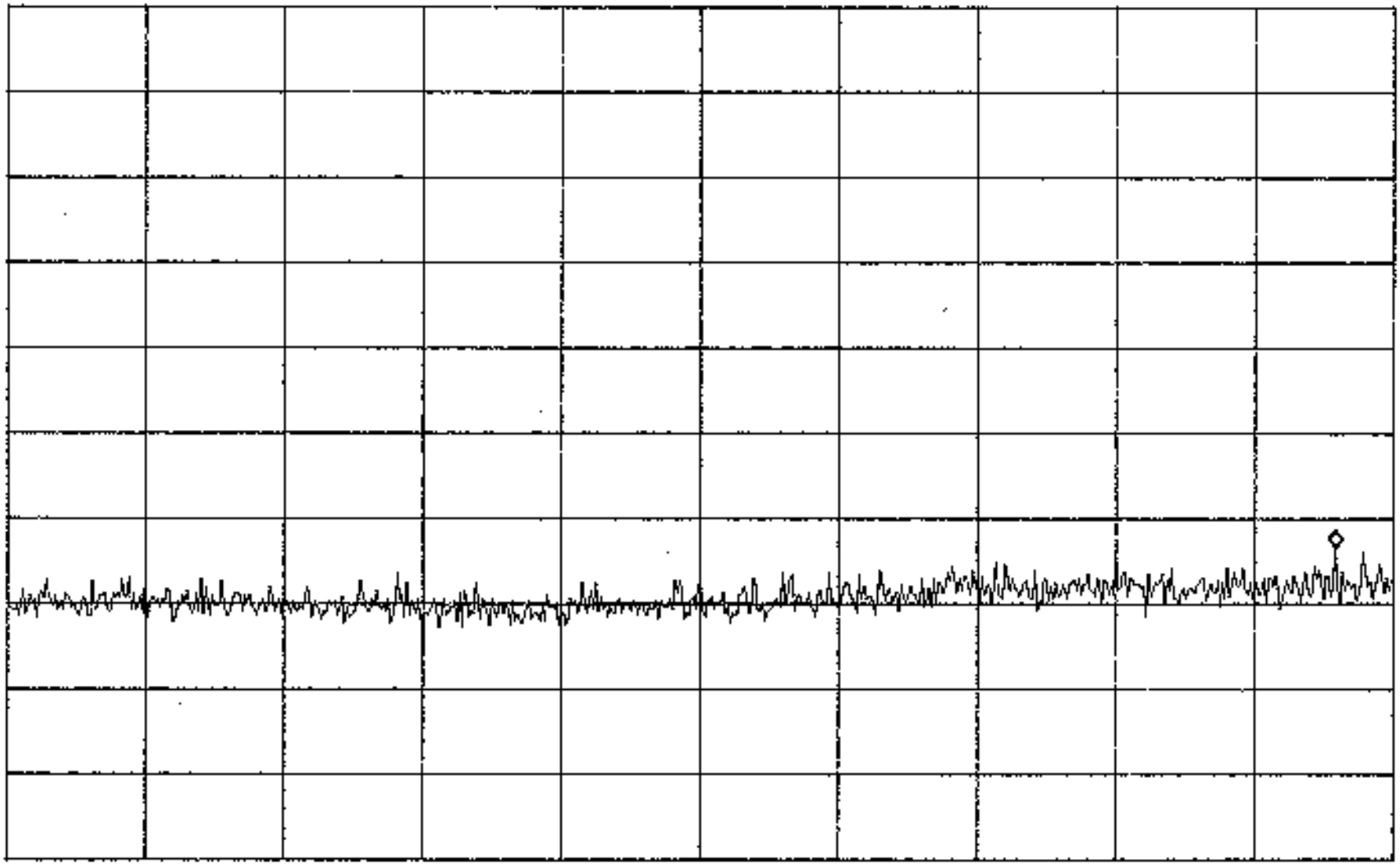
START 5.2500GHz STOP 5.3500GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

D34224-GPH 102

WAVESPAN 00L A 5.25-5.35 GHz

10-18-99
CD

*ATTEN 20dB OUT OF BAND MKR -55.67dBm
RL -24.0dBm 5dB/ 2.677GHz



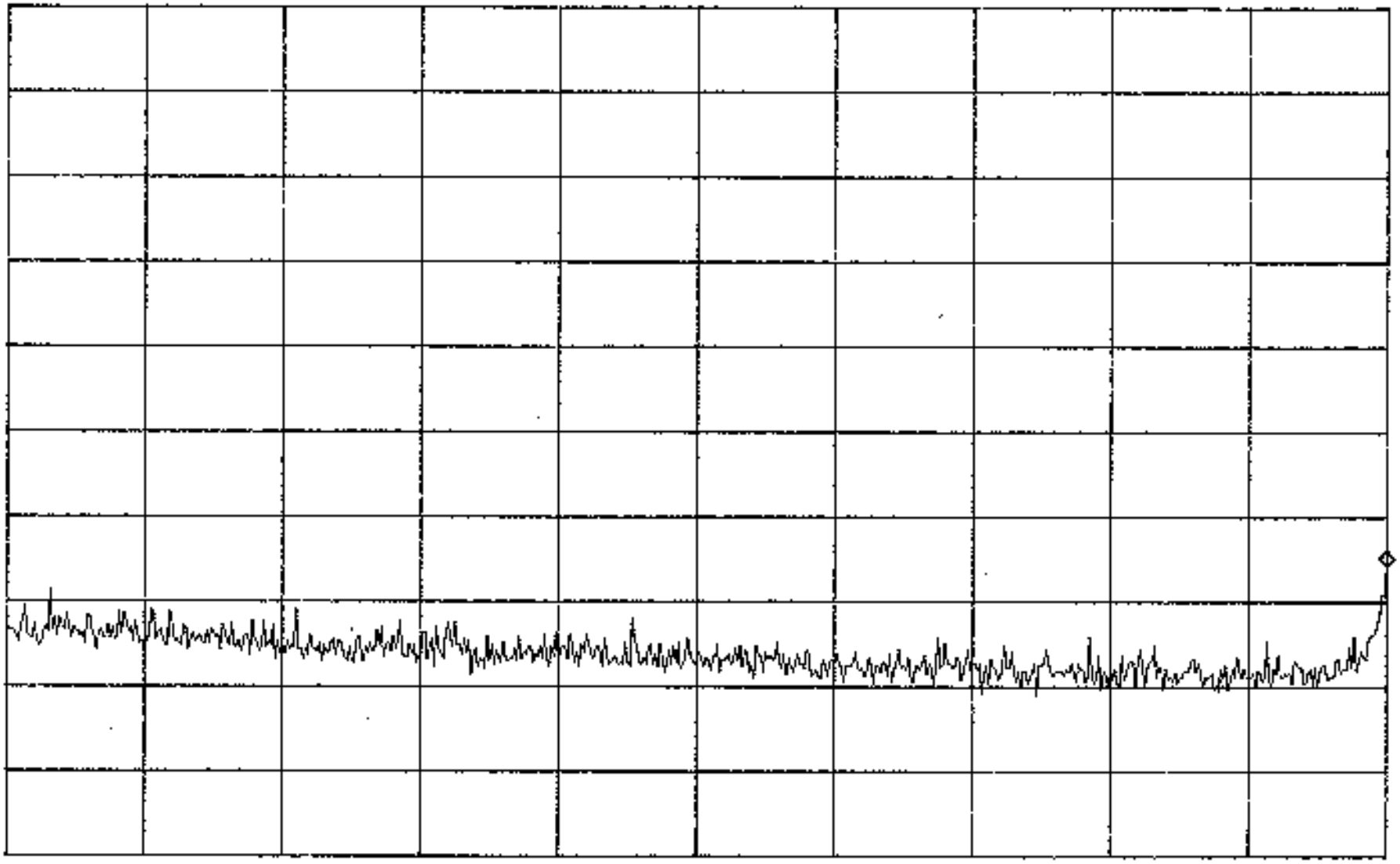
START 1.000GHz STOP 2.750GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

D34224 GPH 103

WAVESPAN ODU A 5.25-5.35 GHz

10-18-99
CJD

*ATTEN 20dB OUT OF BAND MKR -56.92dBm
RL -24.0dBm 5dB/ 5.230GHz



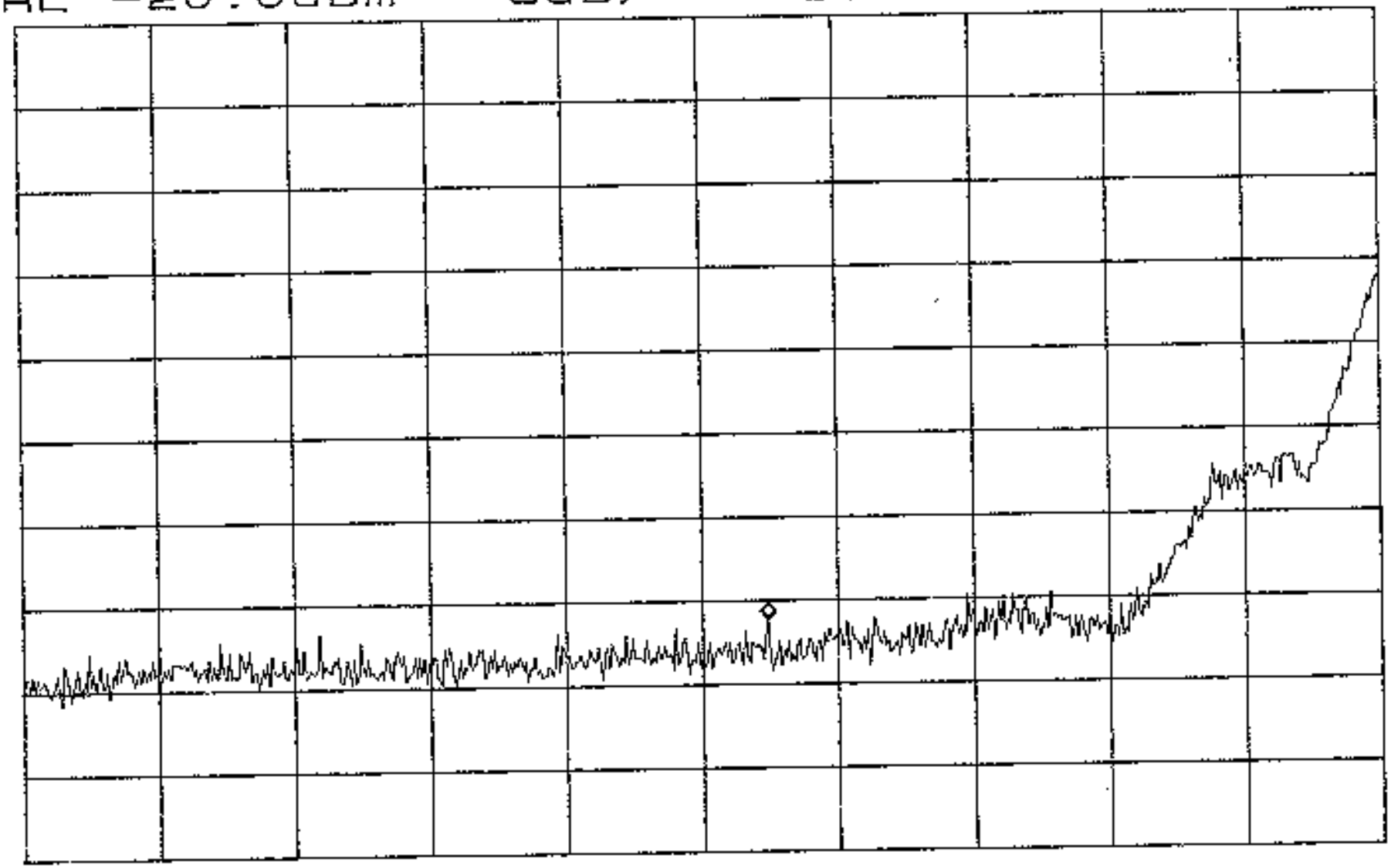
START 2.750GHz STOP 5.230GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

D34224 GPH 104

WAVESPAN ODU A 5.25-5.35 GHz

10-18-99
CDS

*ATTEN 10dB OUT OF BAND . BAND EDGE MKR -56.08dBm
RL -20.0dBm 5dB/ 5.24097GHz



START 5.23000GHz STOP 5.25000GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

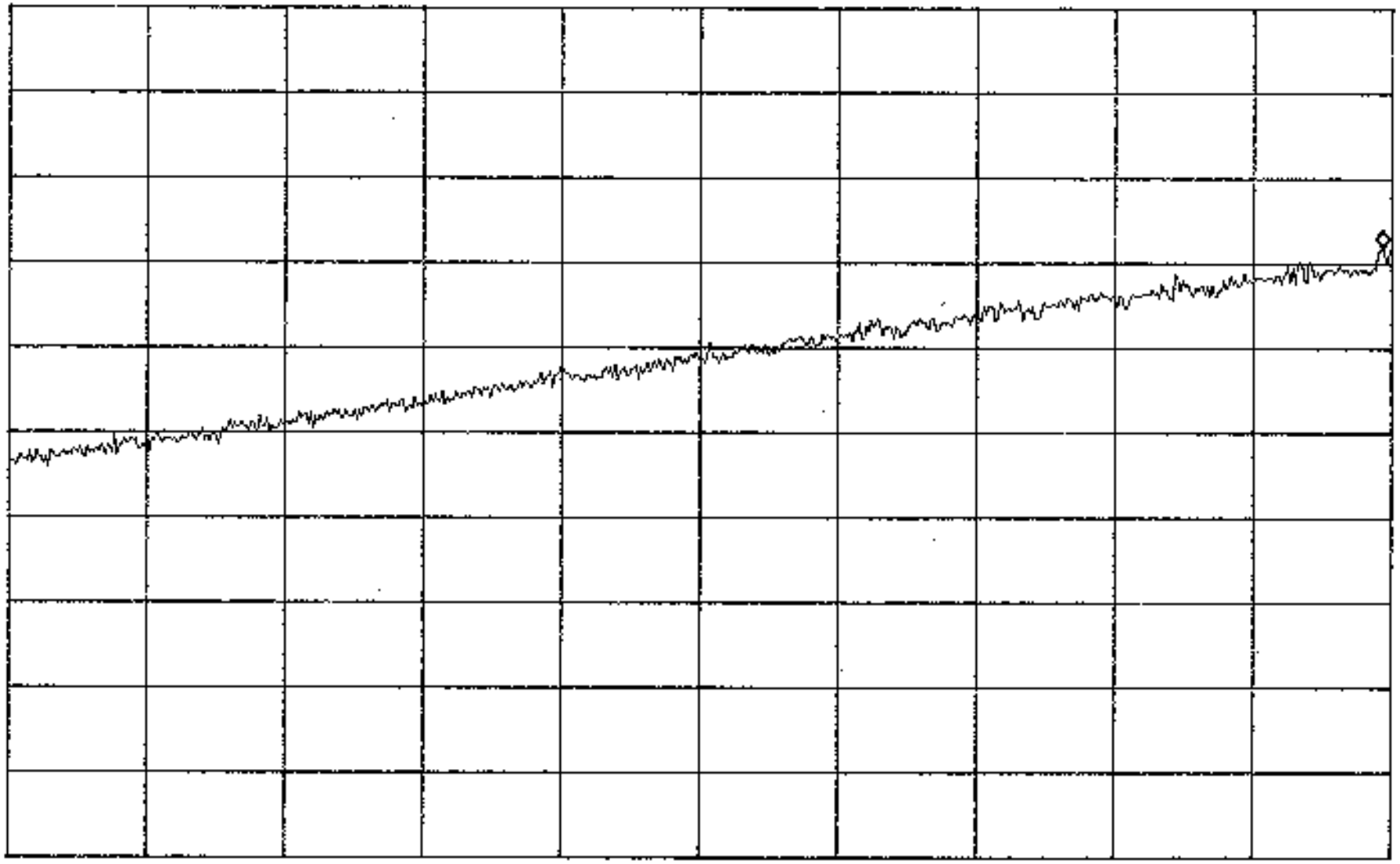
GPH 105

WAVESPAN ODU A 5.25 - 5.35 GHz

10-18-99
CMB

*ATTEN 10dB OUT OF BAND - BAND EDGE MKR 398.1nW = -34.0dB

RL 10.00µW 5dB/ 5.249993GHz



START 5.249000GHz STOP 5.250000GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

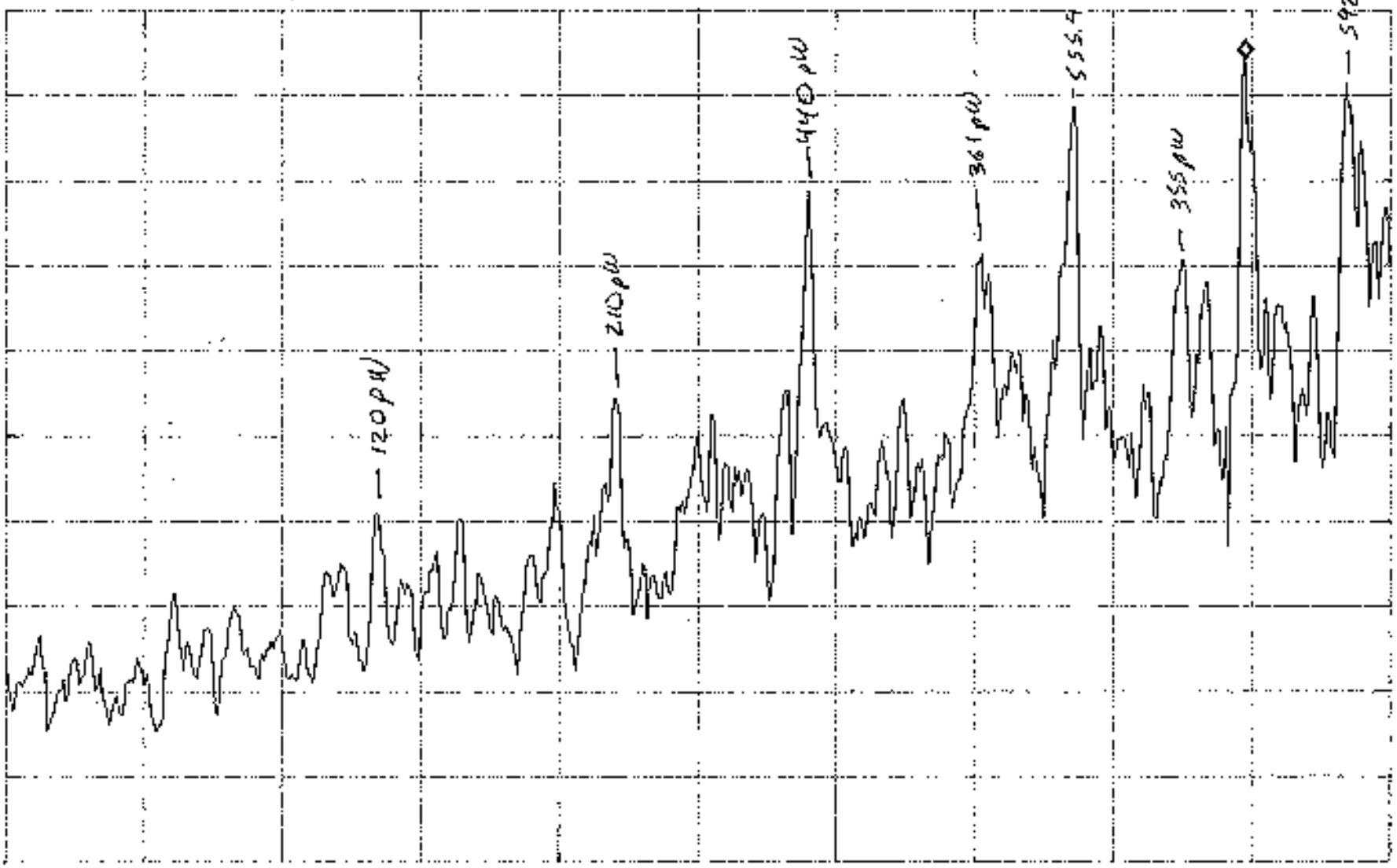
GPH 106

WAVESPAN ODU A 5.25-5.35 GHz

10-19-99
CTB

OUT OF BAND - BAND EDGE

*ATTEN 10dB MKR 629.5pW
RL 707.9pW LIN 5.2499475GHz



START 5.2495000GHz STOP 5.2500000GHz
*RBW 3.0kHz *VBW 3.0kHz SWP 140ms

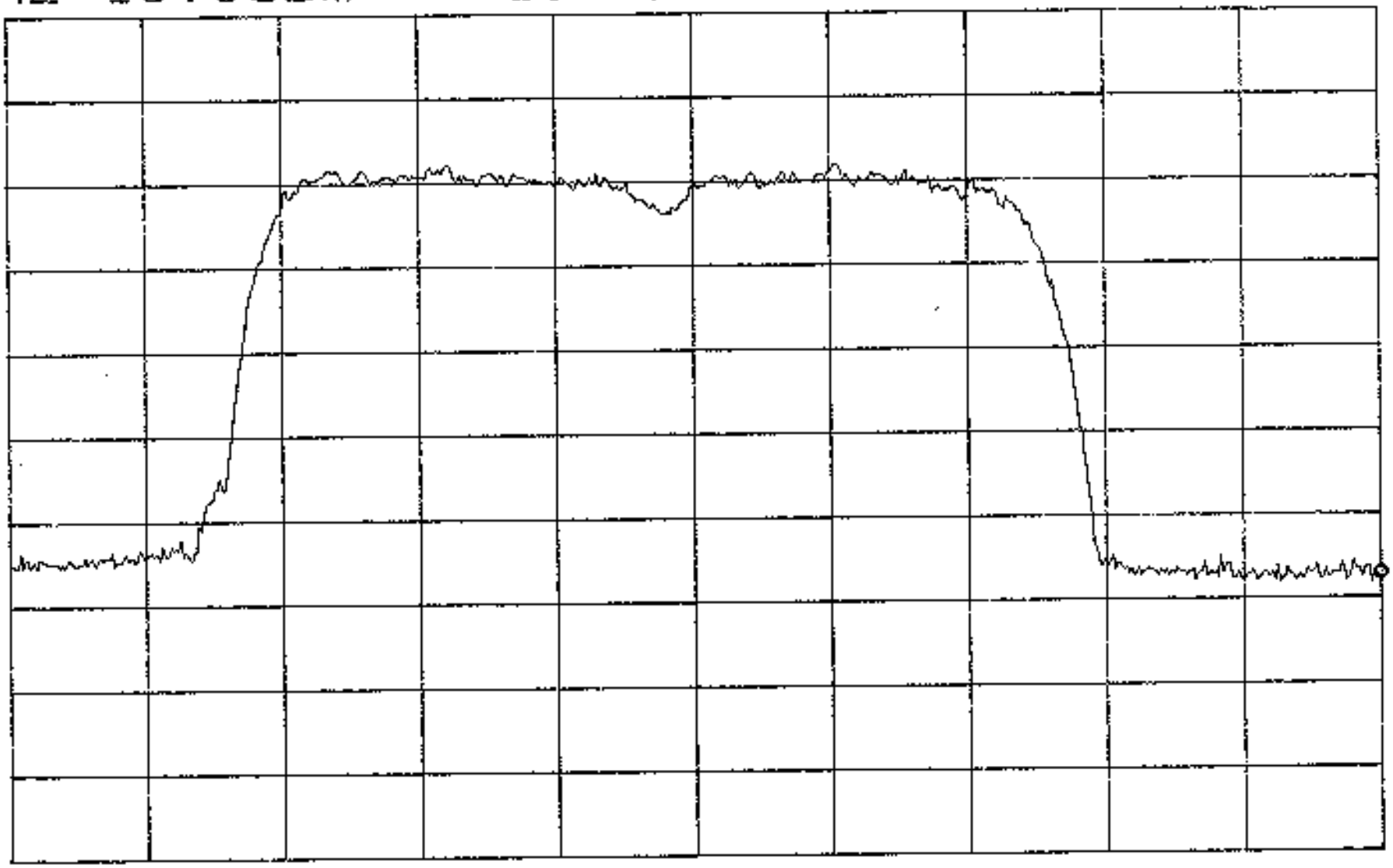
TOTAL POWER = 3.26nW = -54.9 dBm

GPH 107

WAVESPAN ODU A 5.25 - 5.35 GHz

10-18-99
CB

*ATTEN 20dB MKR -58.00dBm
RL 10.0dBm 10dB/ 5.3500GHz



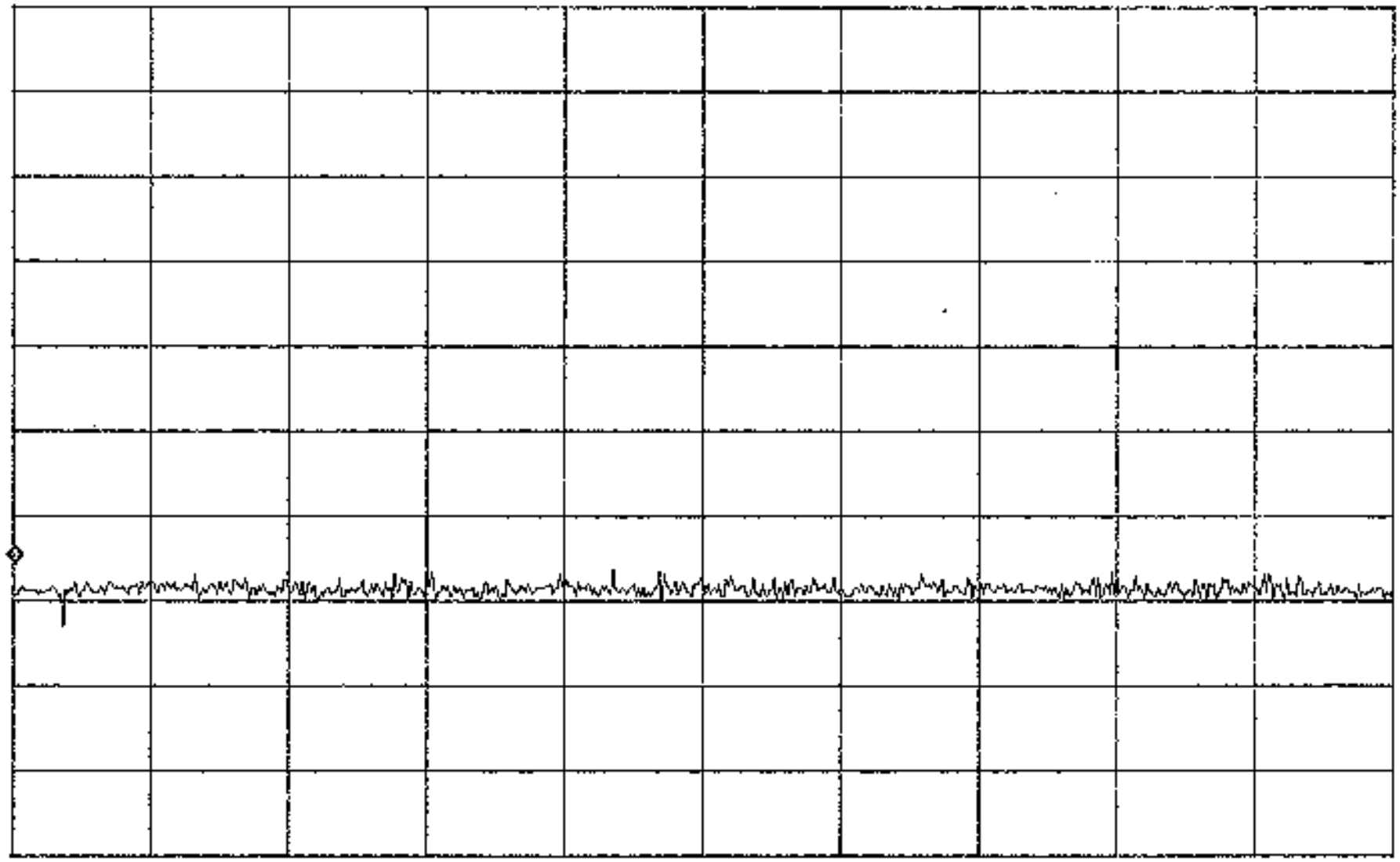
START 5.2300GHz STOP 5.3500GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

GPH 108 mA

WAVESPAN ODU A 5.25 - 5.35 GHz

10-18-99
073

*ATTEN 20dB OUT OF BAND MKR -55.50dBm
RL 10.0dBm 10dB/ 5.3504GHz



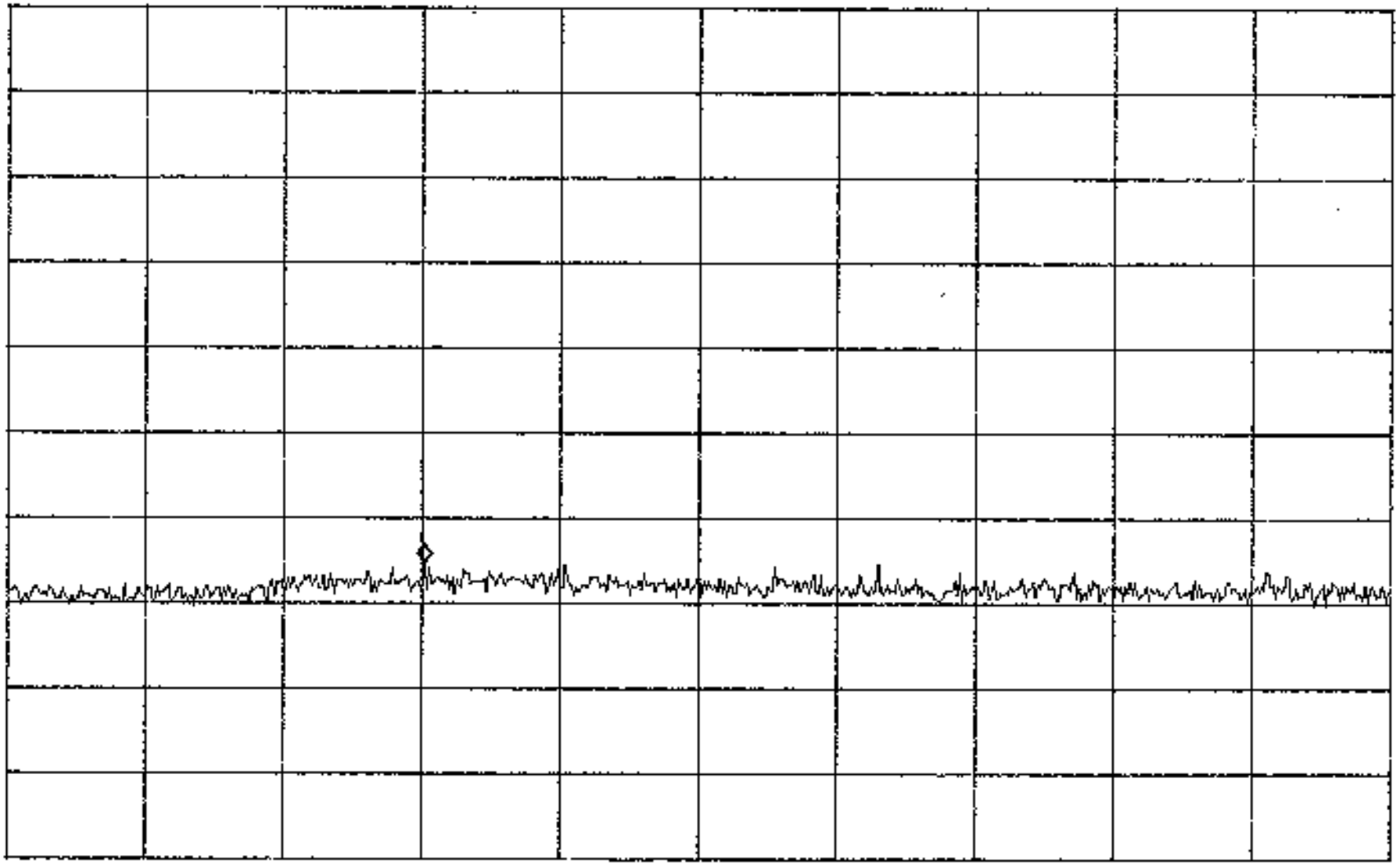
START 5.3500GHz STOP 5.6000GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

GPH 109

WAVESPAN 00U A 5.25-5.35GHZ

10-18-99
CJS

*ATTEN 20dB OUT OF BAND MKR -55.17dBm
RL 10.0dBm 10dB/ 6.927GHz



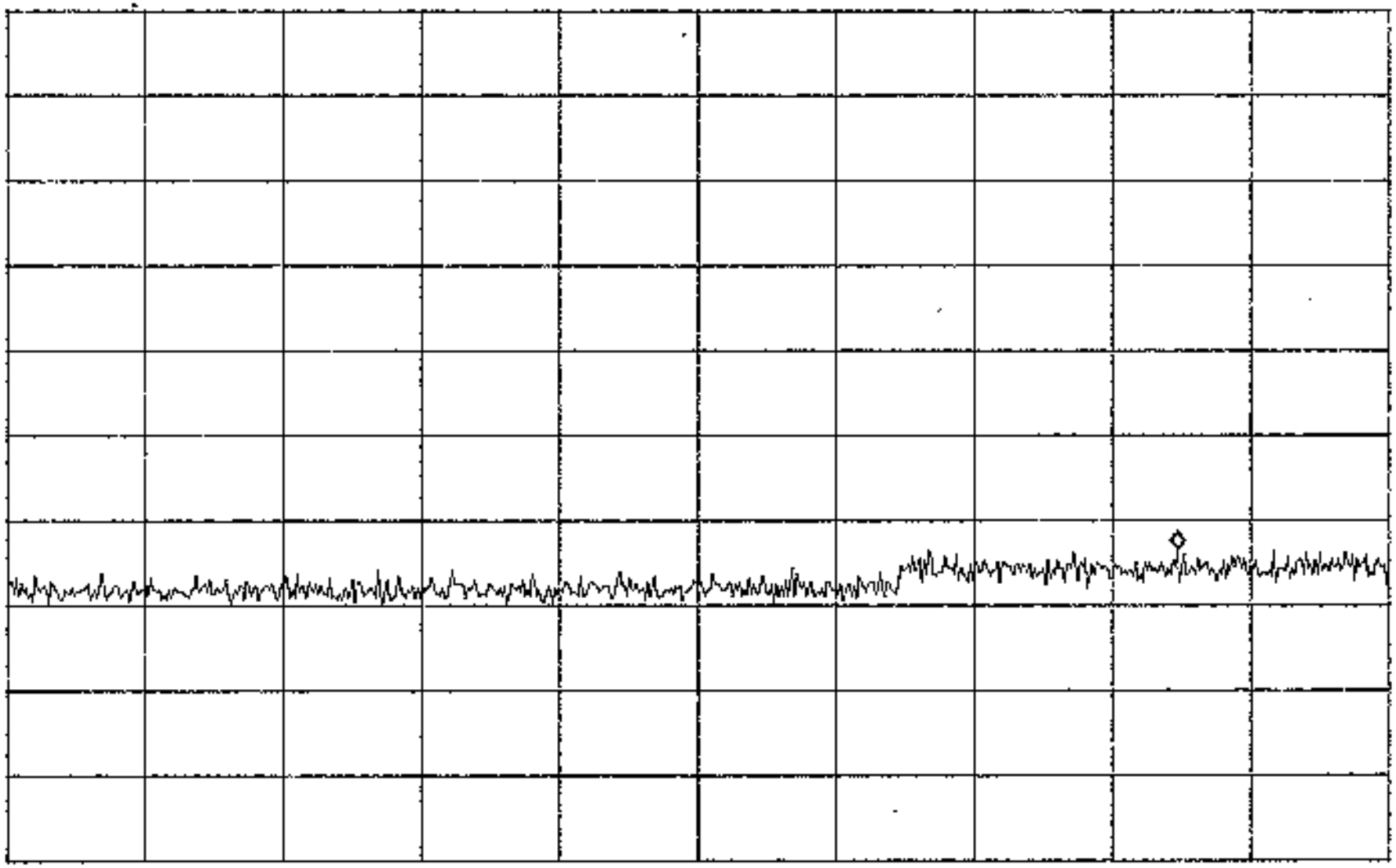
START 5.600GHz STOP 10.000GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 88ms

GPH 110

WAVESPAN ODU A 5.25-5.35GHz

10-18-99
CB

*ATTEN 20dB OUT OF BAND MKR -53.33dBm
RL 10.0dBm 10dB/ 14.233GHz



START 10.000GHz STOP 15.000GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 100ms

GPH 111

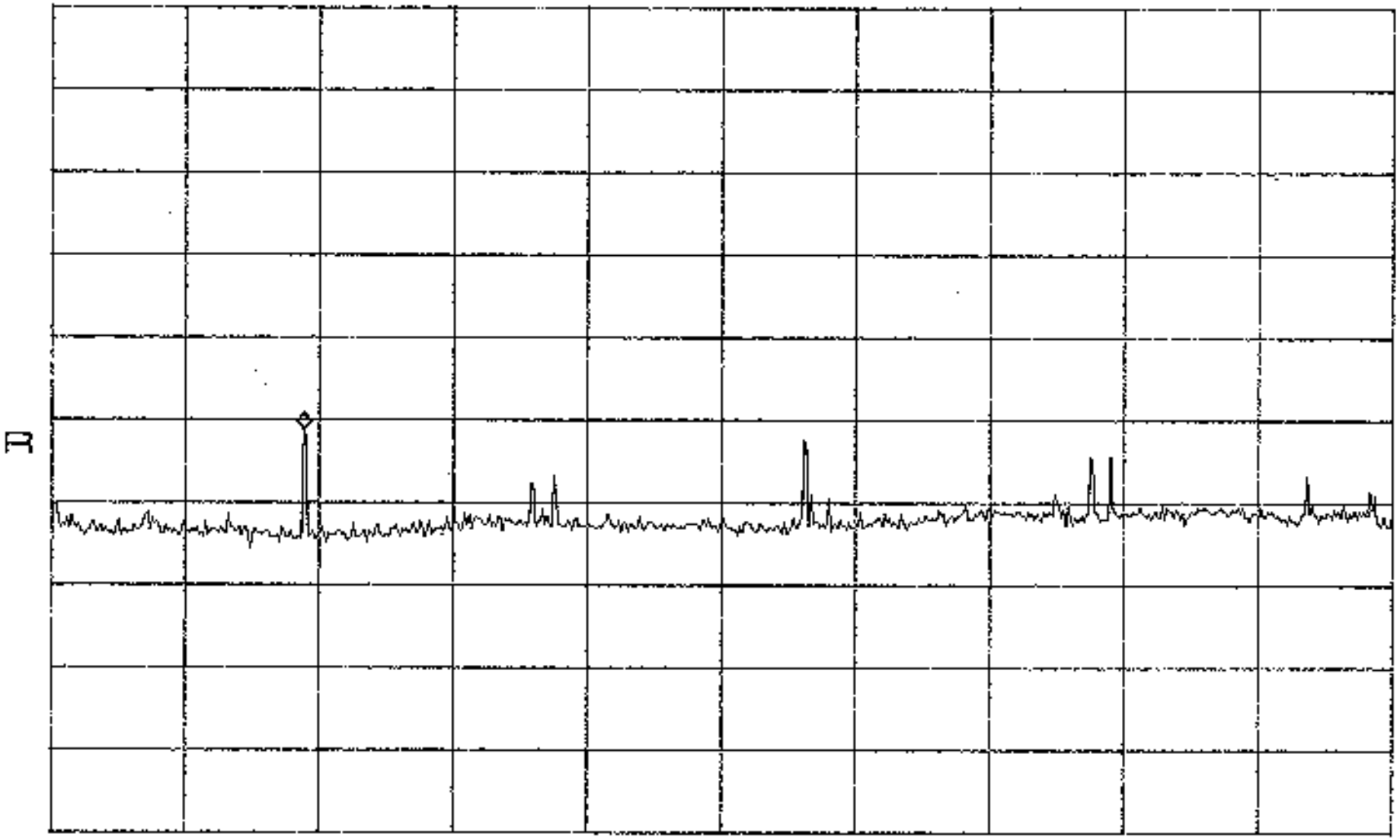
WAVESPAN 00U A 5.25–5.35 GHz

10-19-99
CB

w/ HP 8449B Pre-Amp +36dB GAIN

*ATTEN 20dB Out of Band MKR −77.17dBm

RL −26.0dBm 10dB/ 17.17GHz



START 15.00GHz STOP 26.50GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 230ms

GPH 112

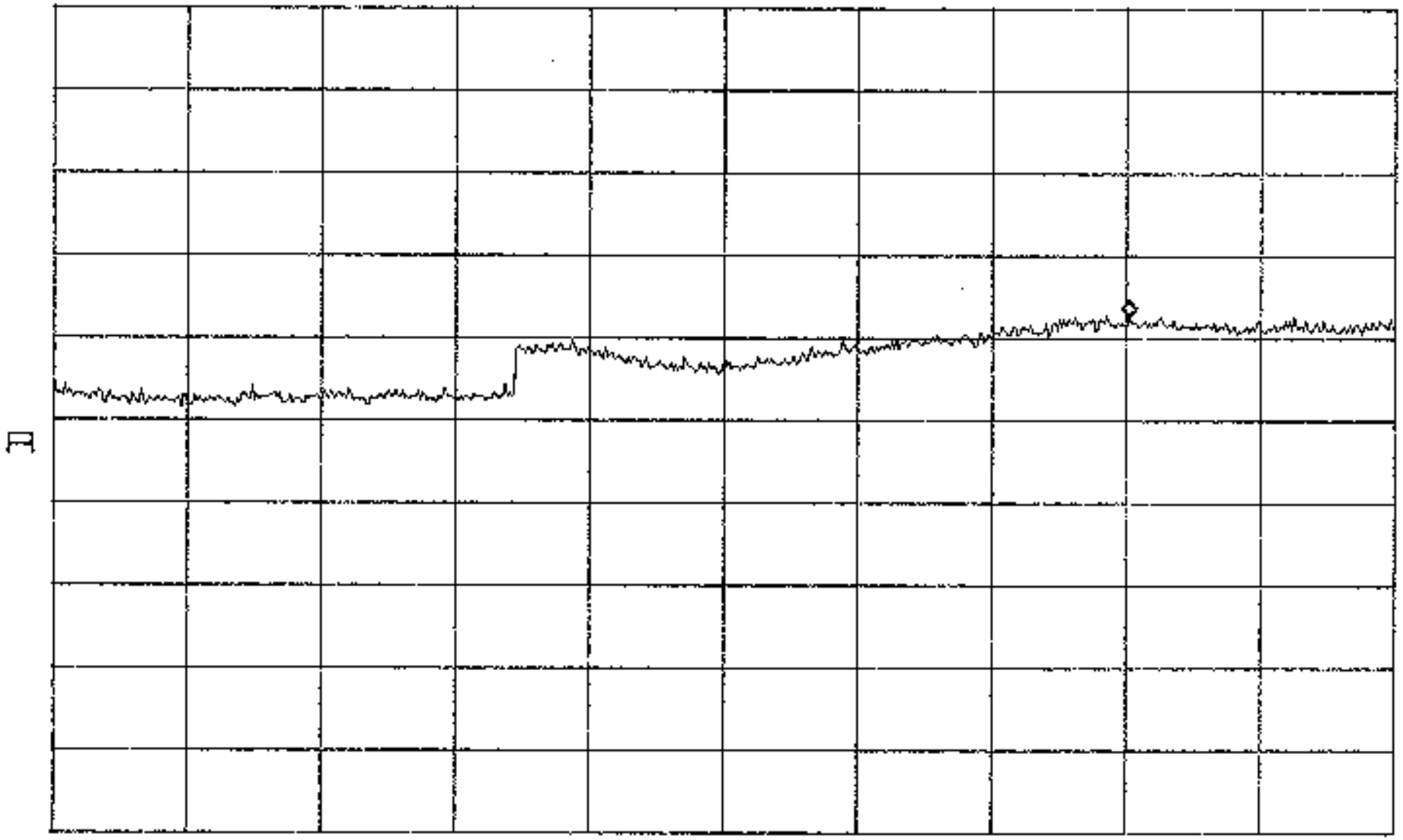
WAVESPAN ODU A 5.25 GHz – 5.35 GHz

10-18-99
CW

w/ 83051A Pre-Amp +23dB Gain

ATTEN 10dB OUT OF BAND MKR −70.33dBm

RL −33.0dBm 10dB/ 37.32GHz



START 26.50GHz STOP 40.00GHz

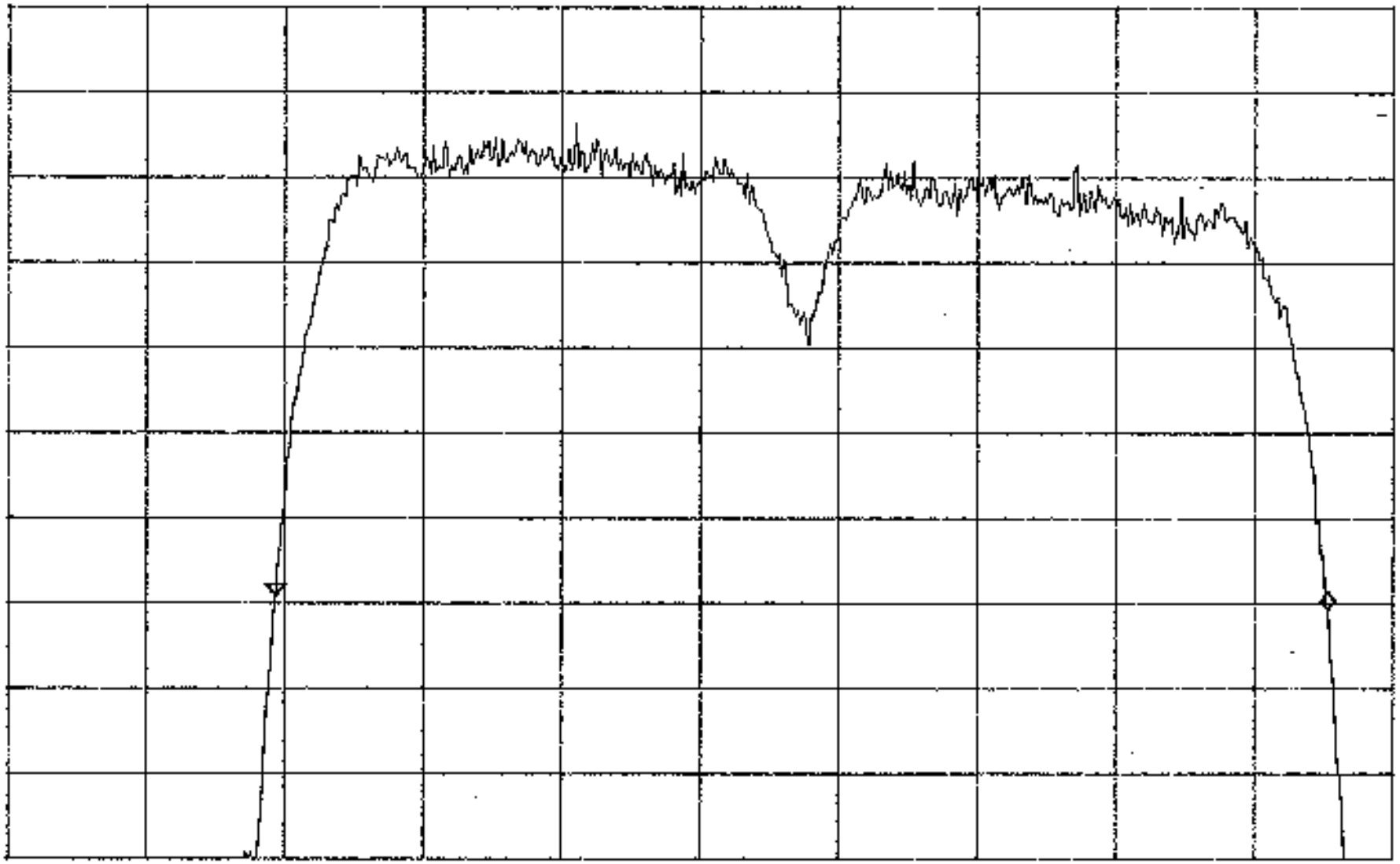
RBW 1.0MHz VBW 1.0MHz SWP 270ms

GPH 113

WAVESPAN 204 B 5.725 - 5.925 GHz

10-18-99
CB

*ATTEN 20dB 26 dB BANDWIDTH ΔMKR -.75dB
RL 0dBm 5dB/ 76.0MHz



START 5.7250GHz STOP 5.8250GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

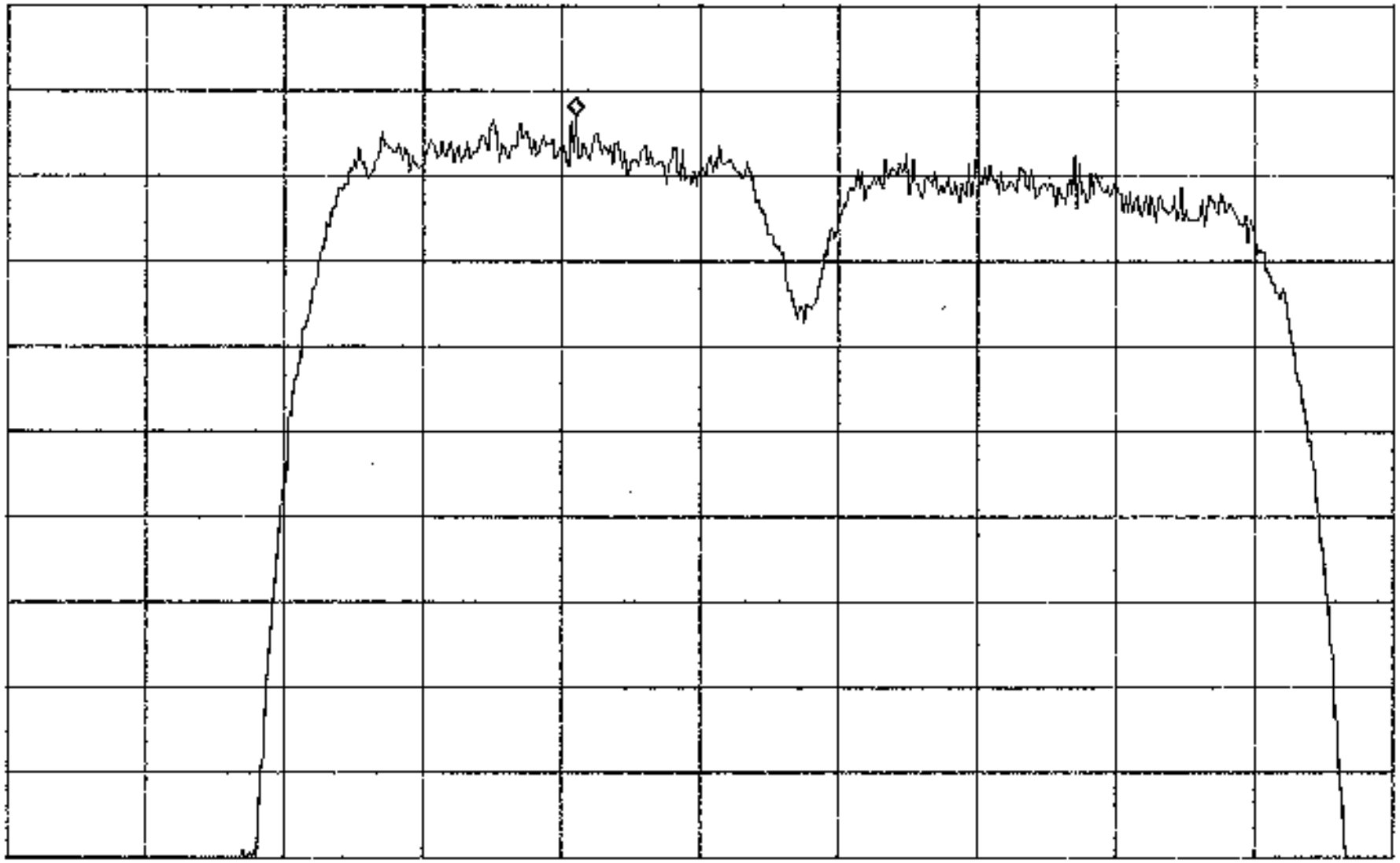
GPH 201

WAVESPAN 00U B 5.725 - 5.825 GHz

10-18-99
CB

*ATTEN 20dB Peak Power Spectral Density MKR -6.42dBm

RL 0dBm 5dB/ 5.7660GHz



START 5.7250GHz STOP 5.8250GHz

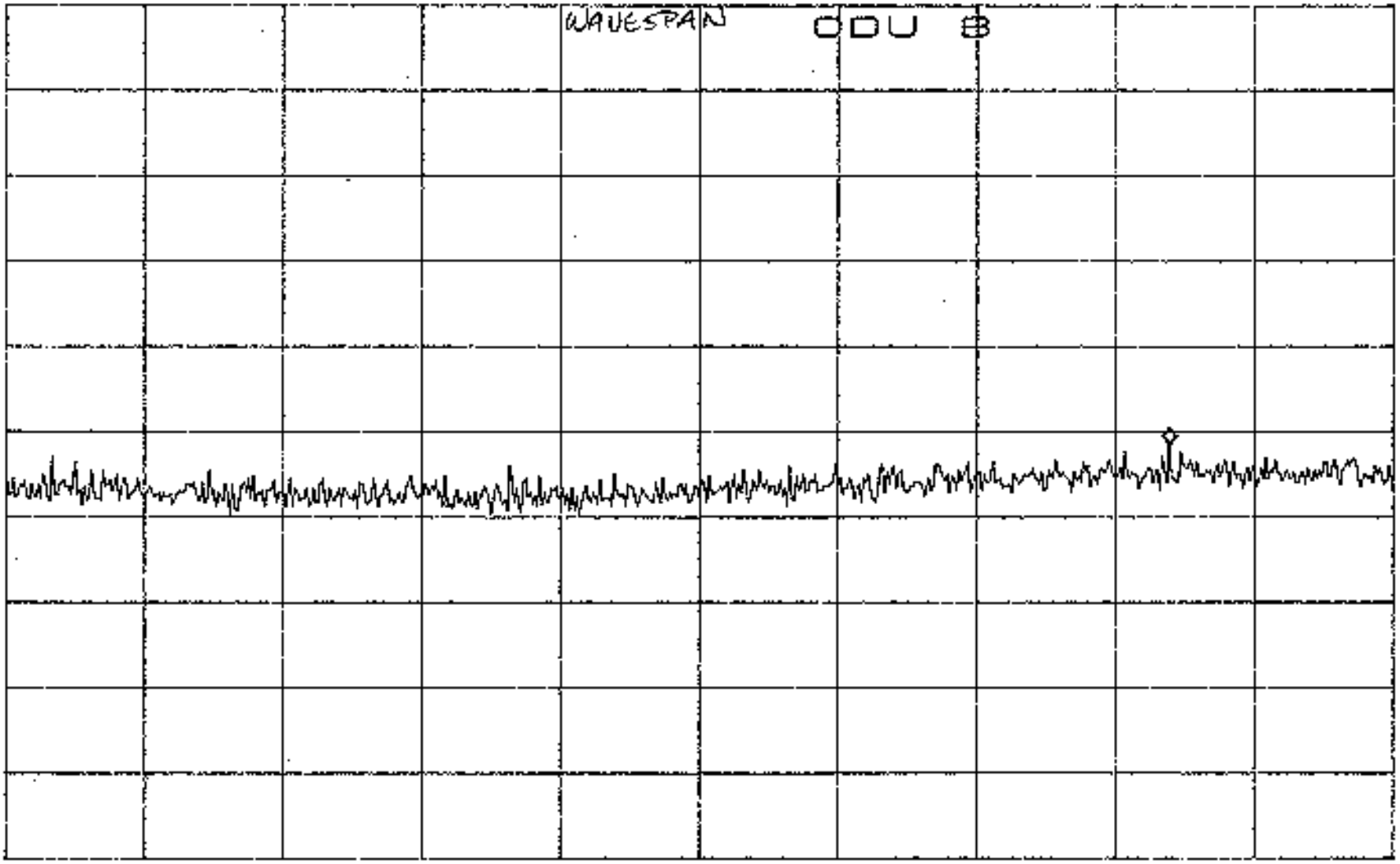
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

GPH 202

10-18-99 DWB

*ATTEN 0dB MKR -75.75dBm

RL -50.0dBm 5dB/ 2.425GHz



START 1.000GHz STOP 2.700GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

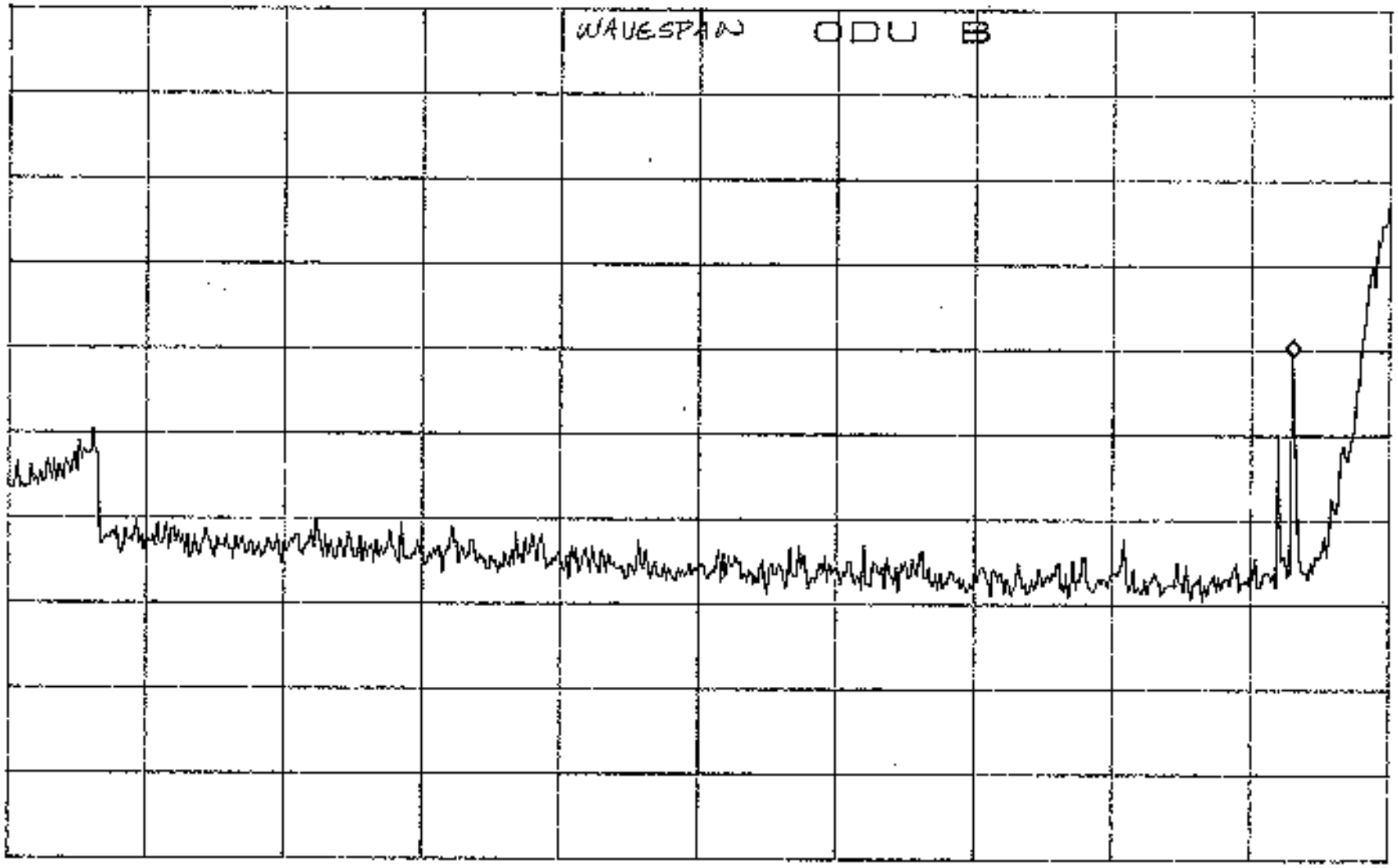
GPH 203

10-18-99 DWB

*ATTEN 0dB MKR -70.33dBm

RL -50.0dBm 5dB/ 5.504GHz

WAVESPAN ODU B



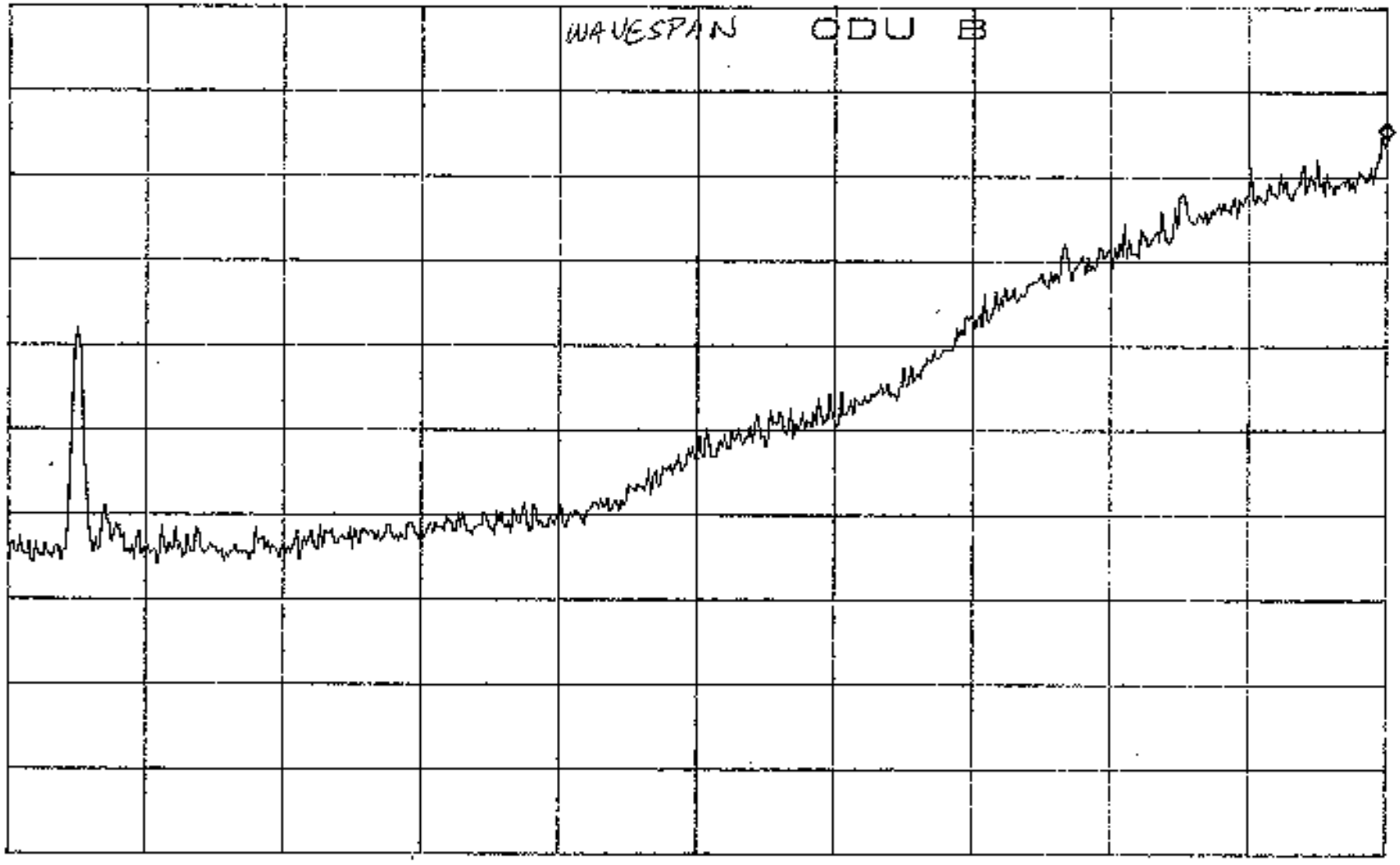
START 2.700GHz STOP 5.715GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 61ms

10-18-99 [illegible]

*ATTEN 0dB MKR -57.75dBm

RL -50.0dBm 5dB/ 5.7150GHz



START 5.4833GHz STOP 5.7150GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

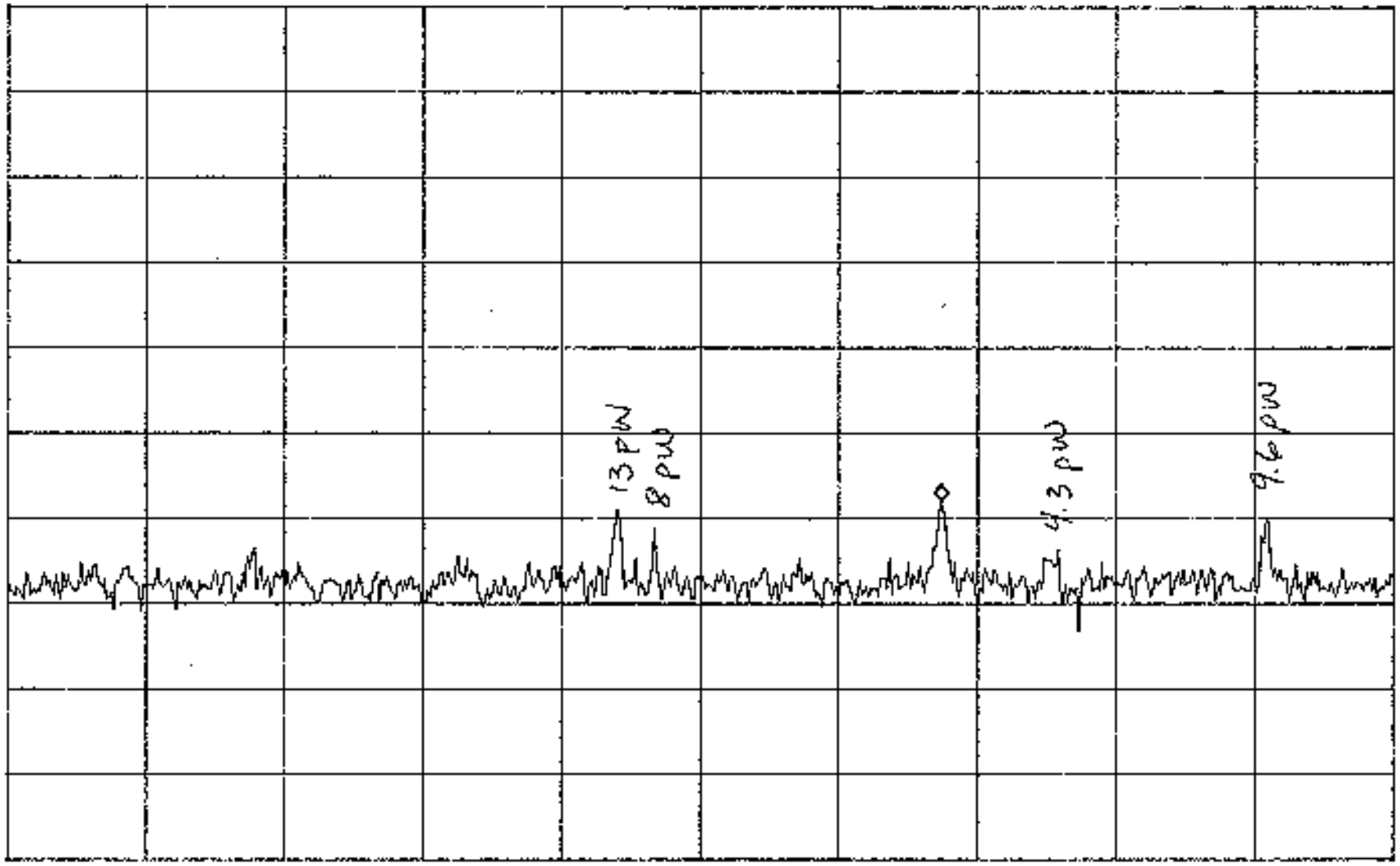
GPH205

WAVESPAN ODU B

10-18-99 AWB

ATTEN 10dB MKR 15.85pW

RL 10.00μW 10dB/ 5.714673GHz



START 5.714000GHz STOP 5.715000GHz

*RBW 3.0kHz *VBW 3.0kHz SWP 280ms

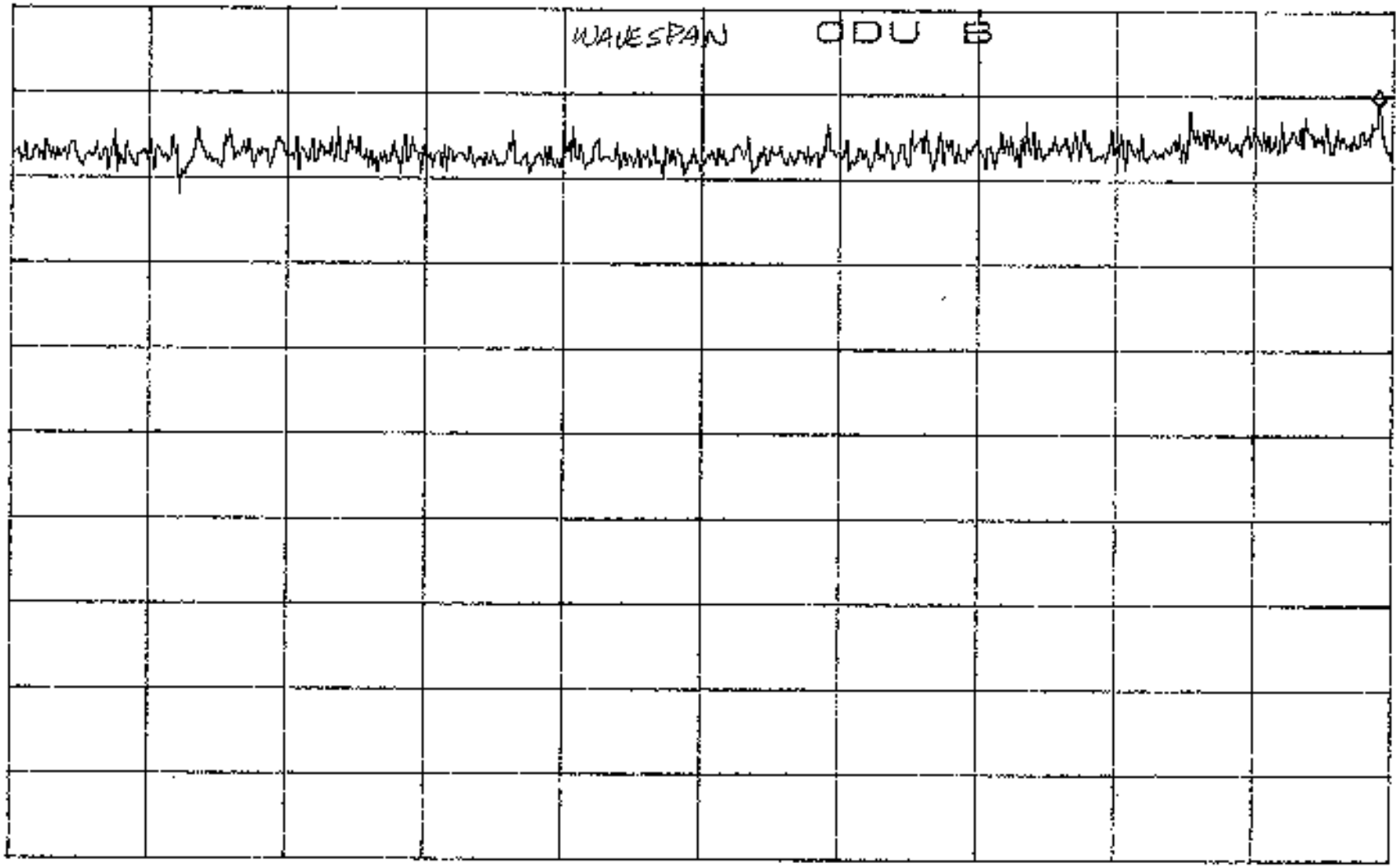
Total Power = 50.8 pW = -73 dBm

GPH 206

10-18-99 DWB

ATTEN 10dB MKR -55.58dBm

RL -50.0dBm 5dB/ 5.72490GHz



START 5.71500GHz STOP 5.72500GHz

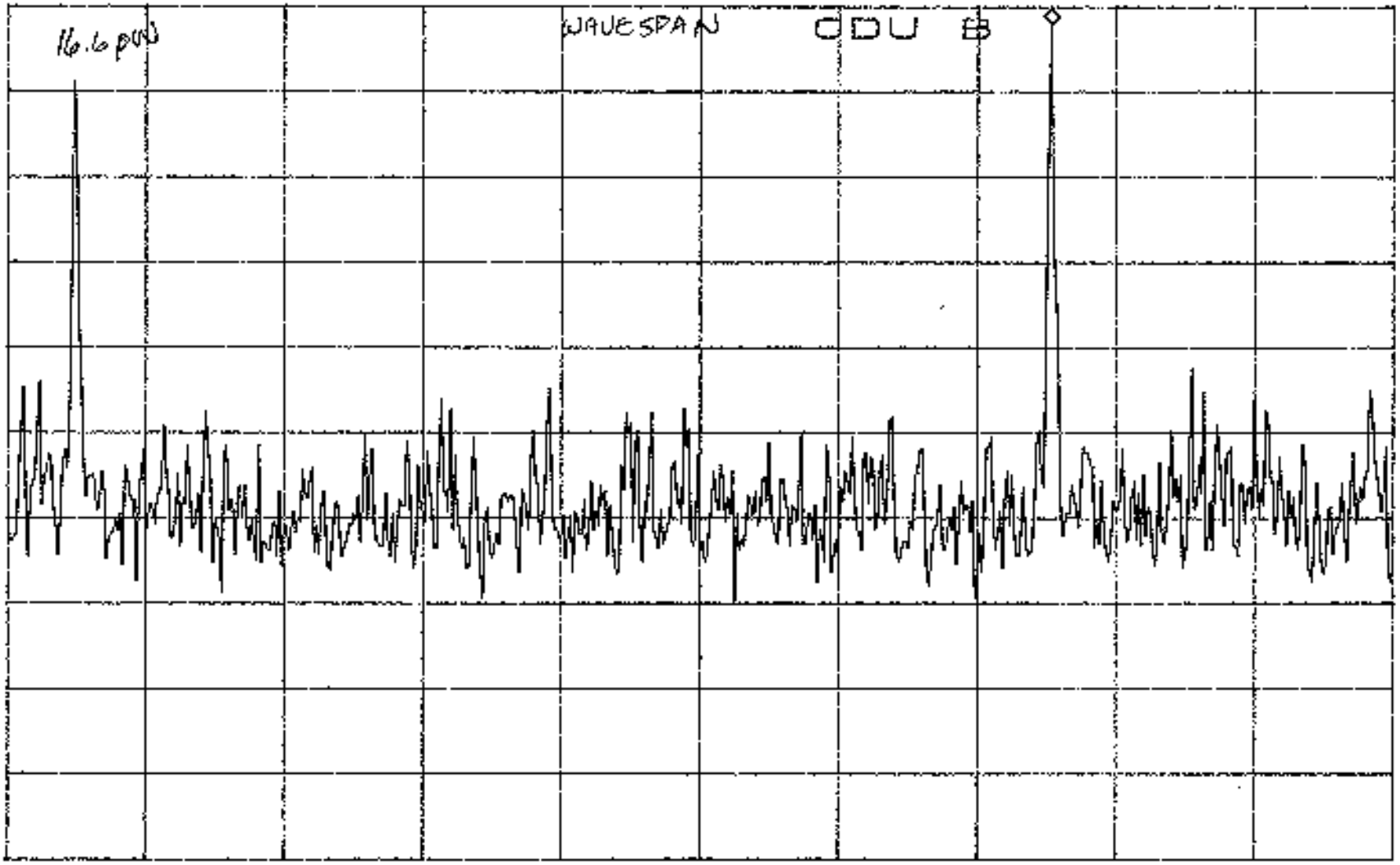
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

GPH 207

10-18-99 DWB

ATTEN 10dB MKR 19.10pW

RL 19.95pW LIN 5.724753GHz



CENTER 5.724500GHz SPAN 1.000MHz

*RBW 3.0kHz *VBW 3.0kHz SWP 280ms

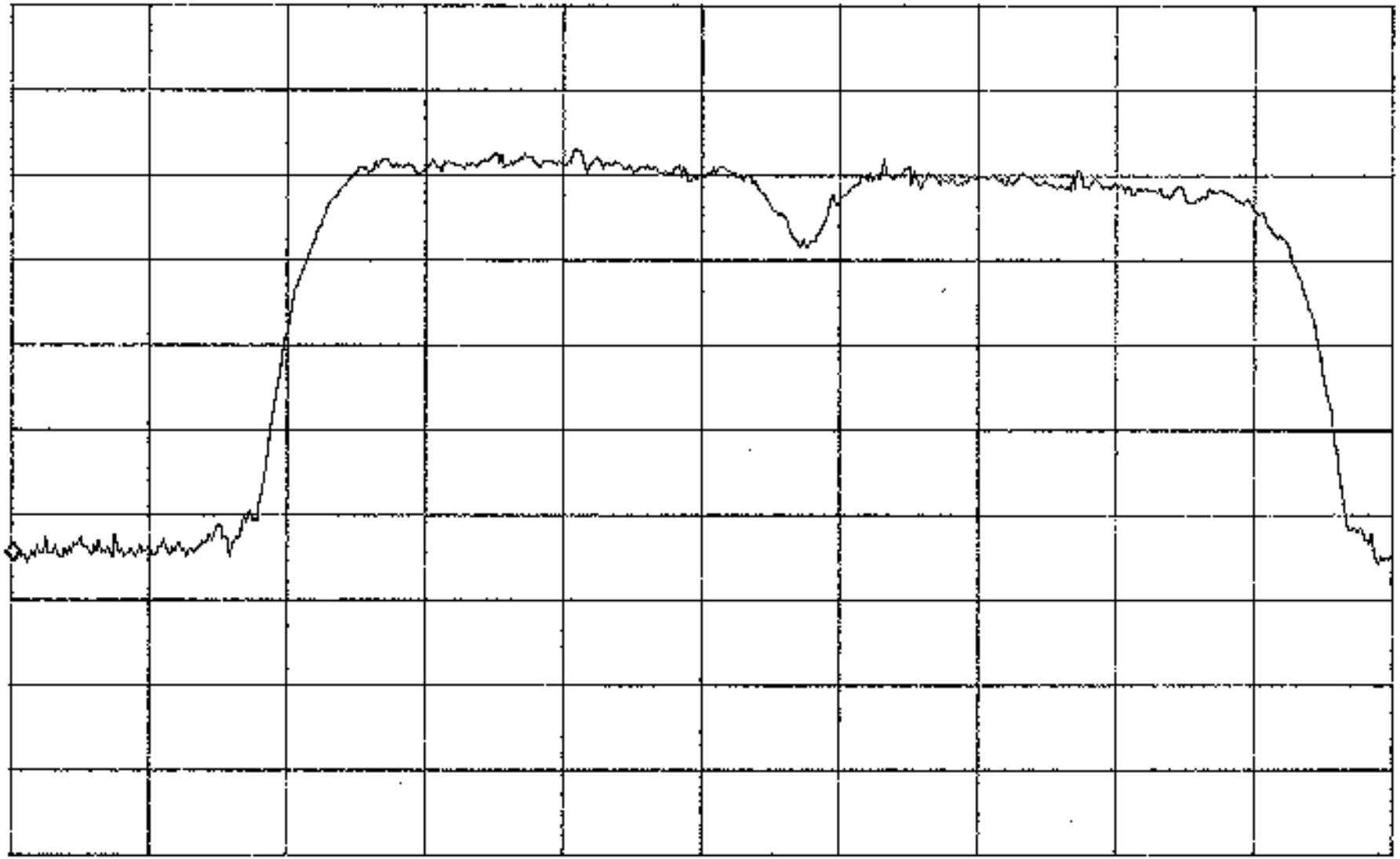
Total power = 35.7pW = -74.8dBm

GPH 208

WAVESPAN ODU B 5.725 - 5.825 GHz

10-18-99
CD

*ATTEN 20dB MKR -55.33dBm
RL 10.0dBm 10dB/ 5.7252GHz



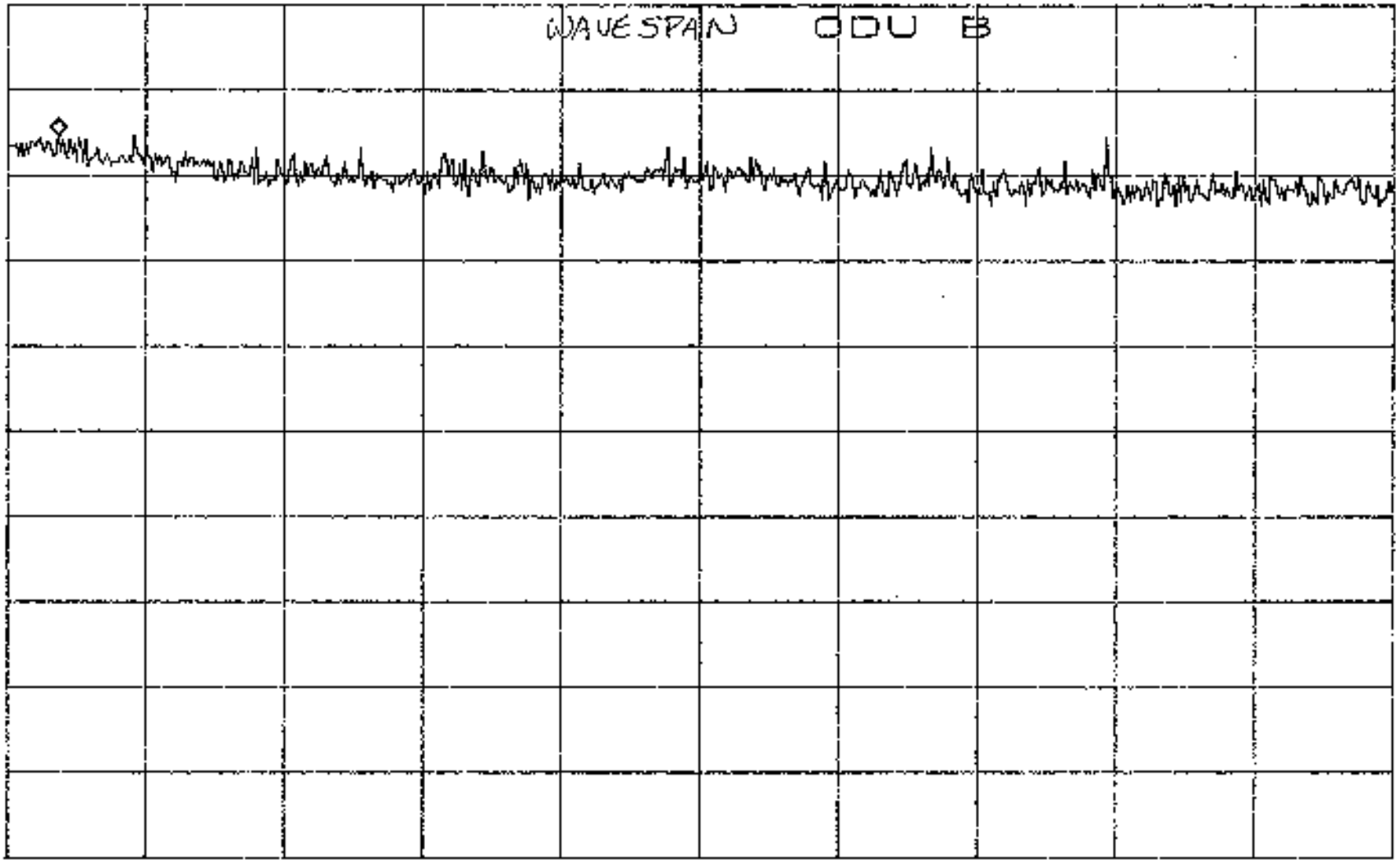
START 5.7250GHz STOP 5.8250GHz
*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

GPH 209

10-18-99 DWB

ATTEN 10dB MKR -57.67dBm

RL -50.0dBm 5dB/ 5.82537GHz



START 5.82500GHz STOP 5.83500GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 50ms

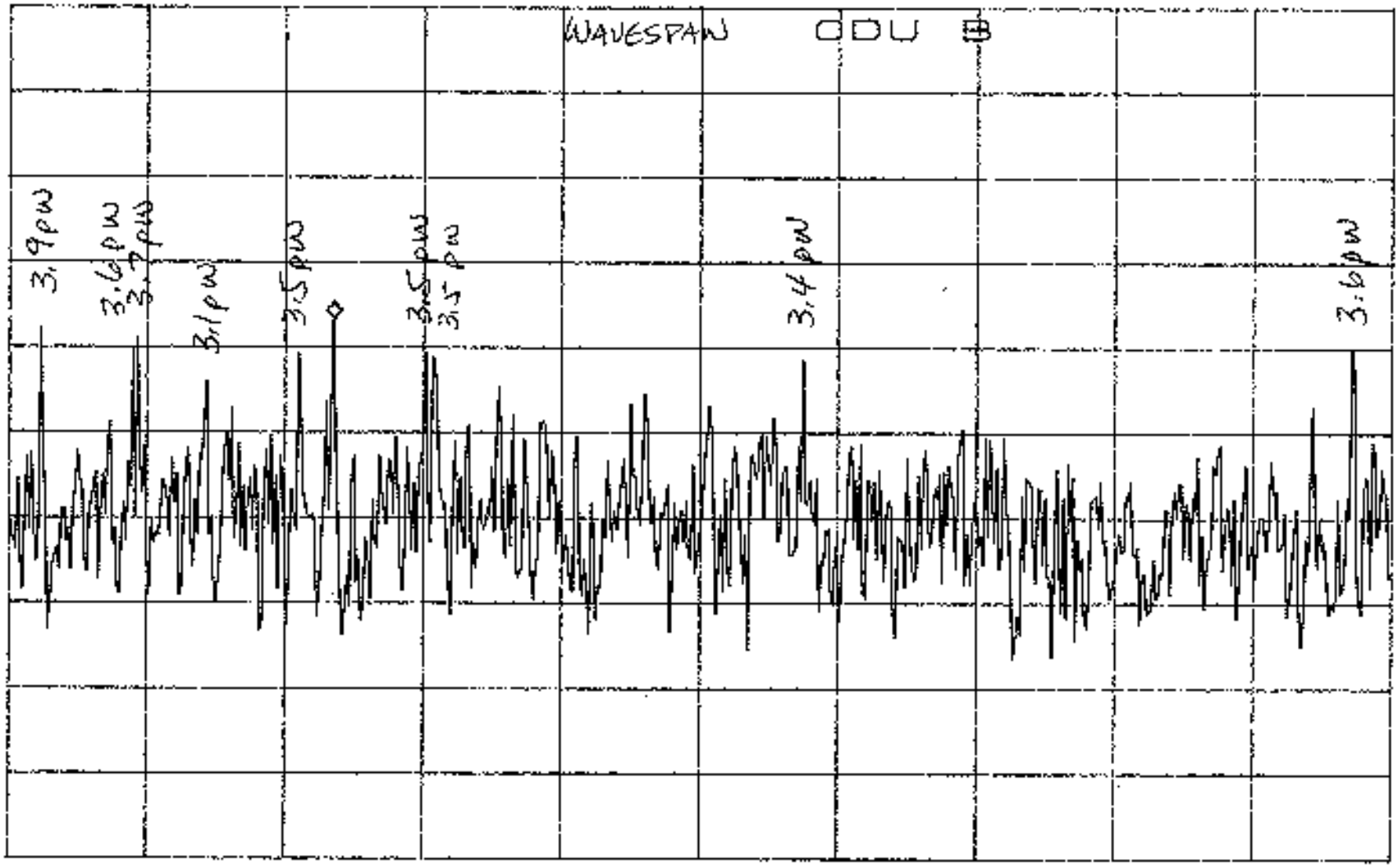
GPH 210

10-18-99 AWB

*ATTEN 0dB MKR 4.009pW

RL 10.00pW LIN 5.825235GHz

WAVESPAN ODU B



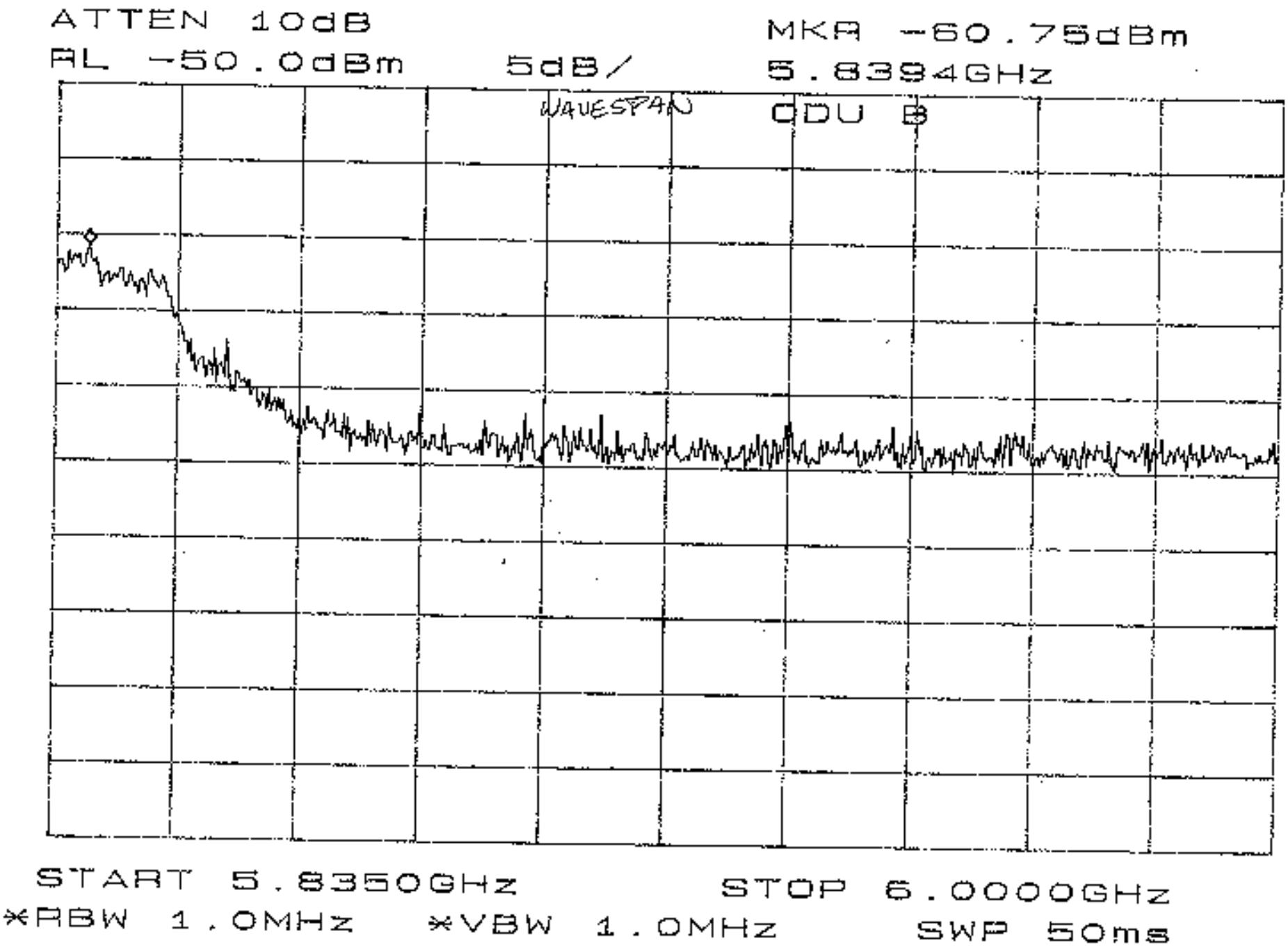
START 5.825000GHz STOP 5.826000GHz

*RBW 3.0kHz *VBW 3.0kHz SWP 280ms

Total power = 35.8 pW = -74.5 dBm

GPH211

10-18-99 DWF

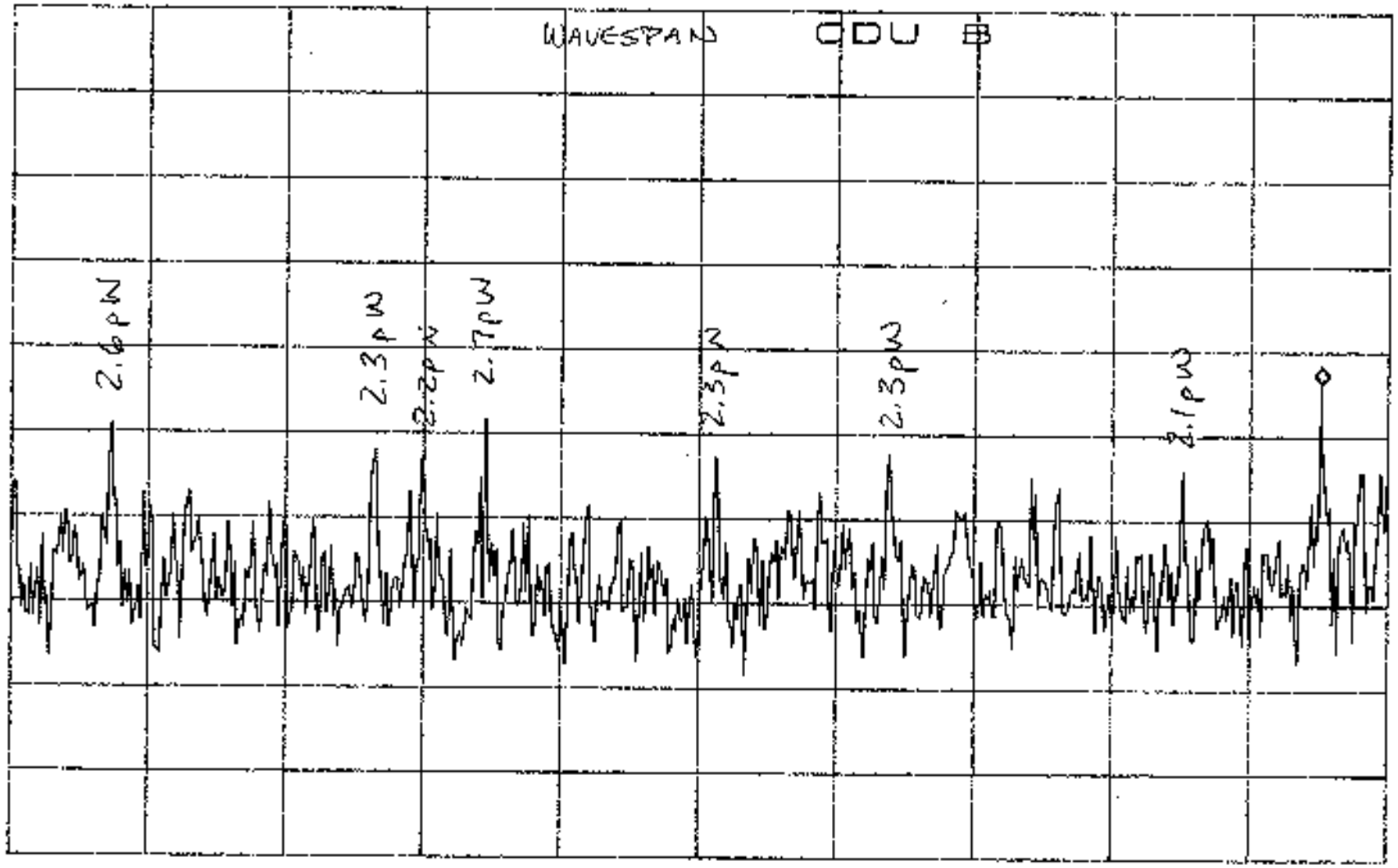


GPH 212

10-18-99 DWB

*ATTEN 0dB
RL 10.00pW LIN

MKR 3.170pW
5.839952GHz



CENTER 5.839500GHz
*RBW 3.0kHz *VBW 3.0kHz

SPAN 1.000MHz
SWP 280ms

Total Power = 19.7pW = -77.1 dBm

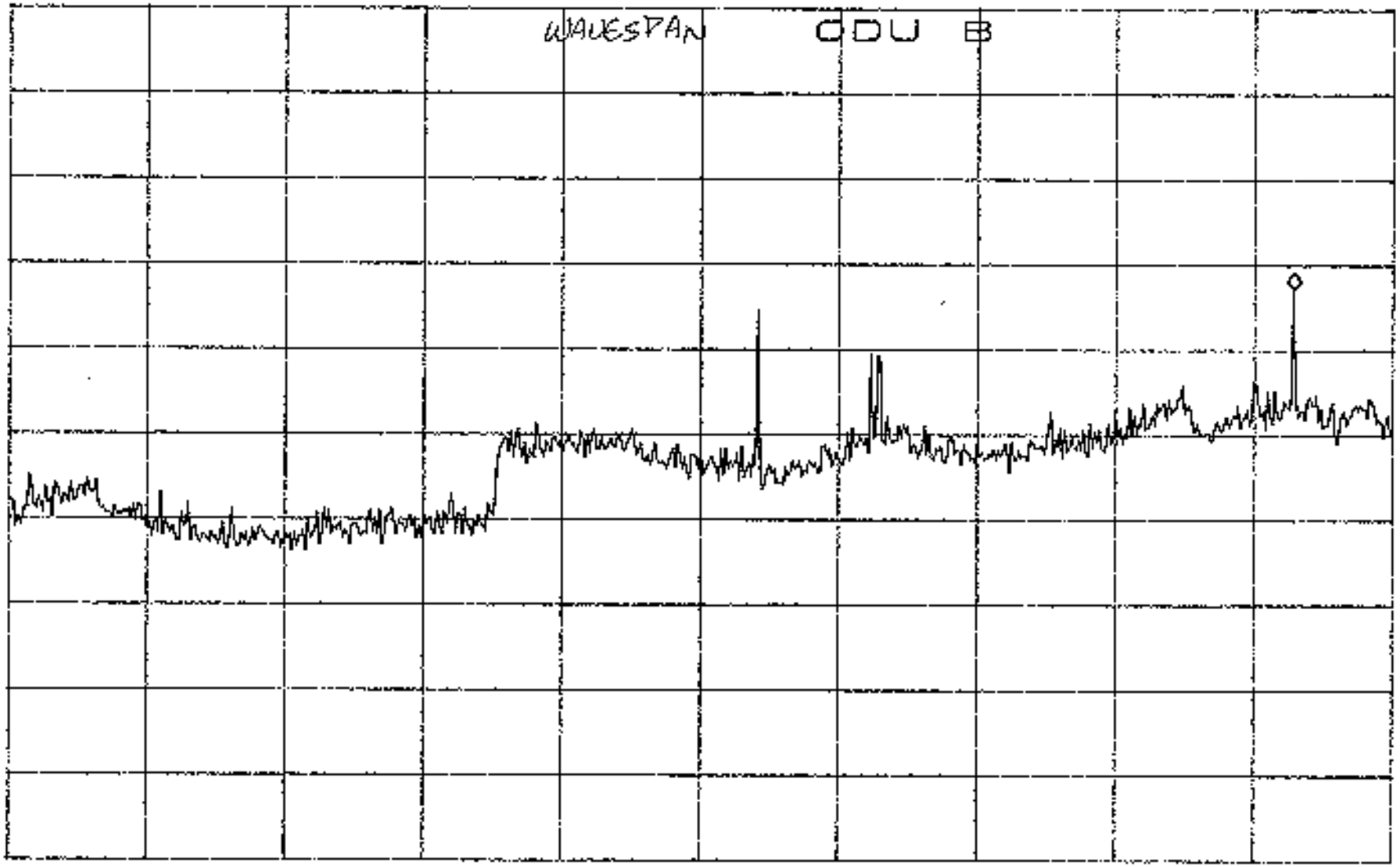
GPH213

10-18-89 [illegible]

*ATTEN 0dB MKR -66.42dBm

RL -50.0dBm 5dB/ 25.03GHz

WAVESPAN ODU B



START 6.00GHz STOP 26.50GHz

*RBW 1.0MHz *VBW 1.0MHz SWP 410ms

GPH 214

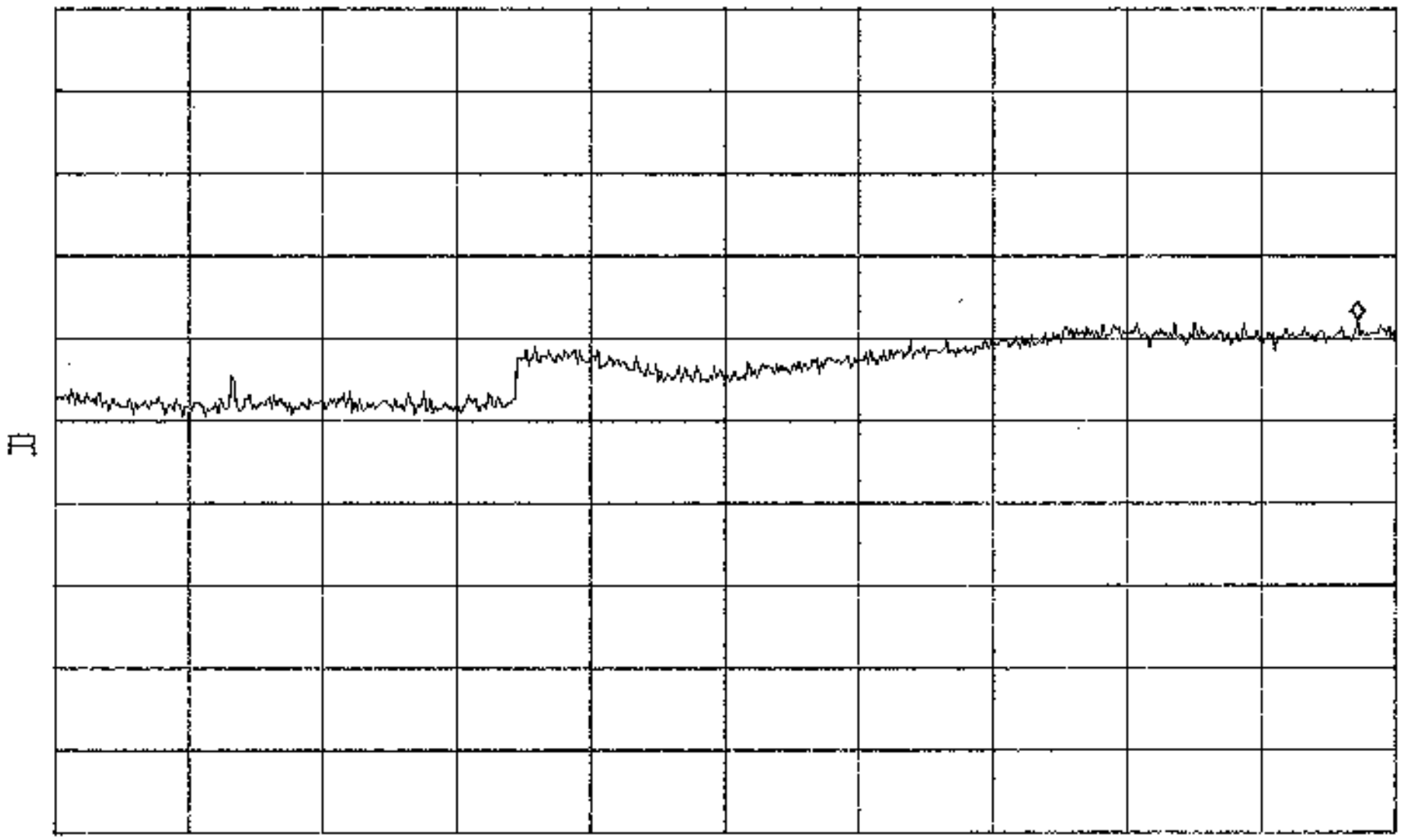
WAVESPAN ODU B 5.725 - 5.825 GHz

10-18-99
CB

w/ 8305A PRE-AMP +23 dB GAIN

ATTEN 10dB OUT OF BAND MKR -70.67dBm

RL -33.0dBm 10dB/ 39.62GHz



START 26.50GHz STOP 40.00GHz

RBW 1.0MHz VBW 1.0MHz SWP 270ms

GPH 215

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

ODU with Flat Panel Antenna

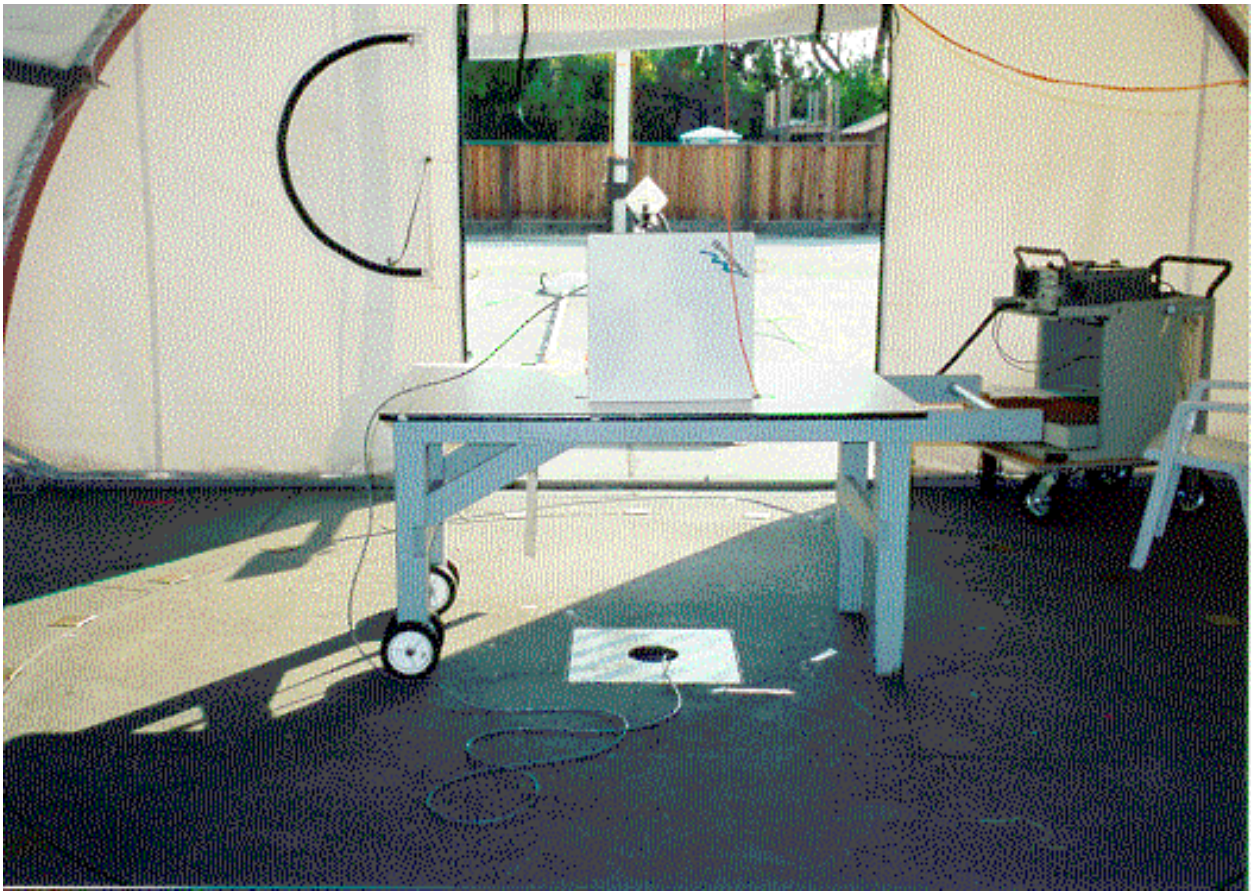


EXHIBIT 3: Radiated Emissions Test Configuration Photographs

ODU with Flat Panel Antenna

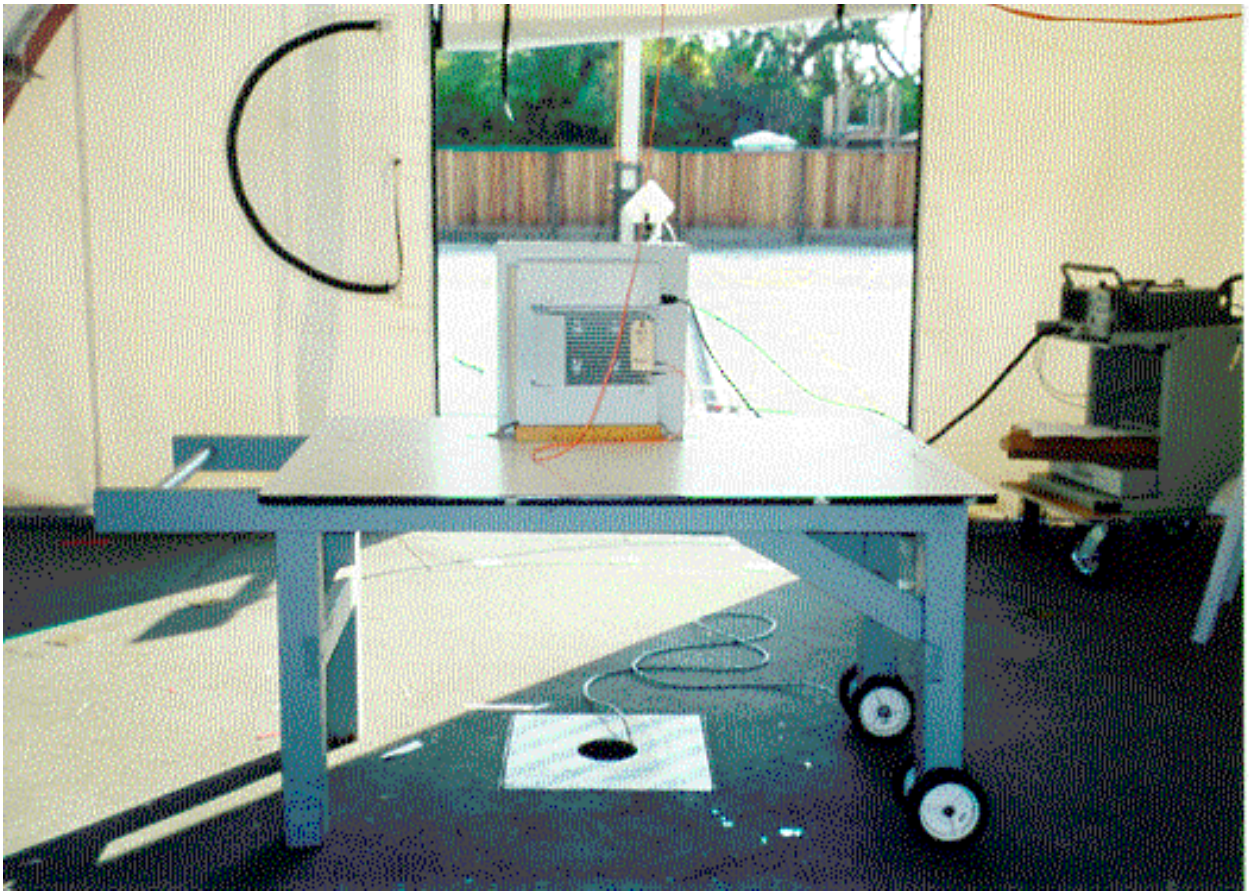


EXHIBIT 3: Radiated Emissions Test Configuration Photographs

ODU with Dish Antenna

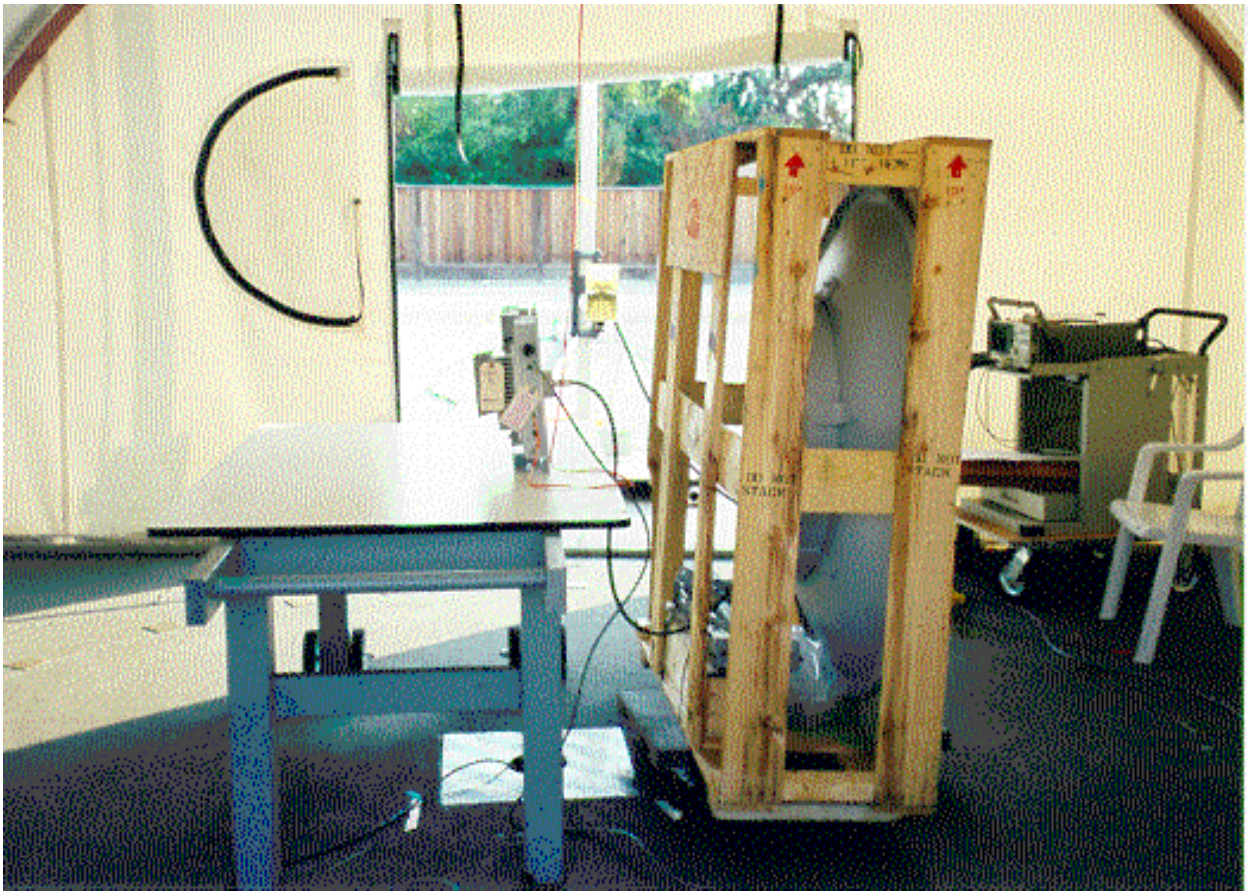


EXHIBIT 3: Radiated Emissions Test Configuration Photographs

ODU with Dish Antenna

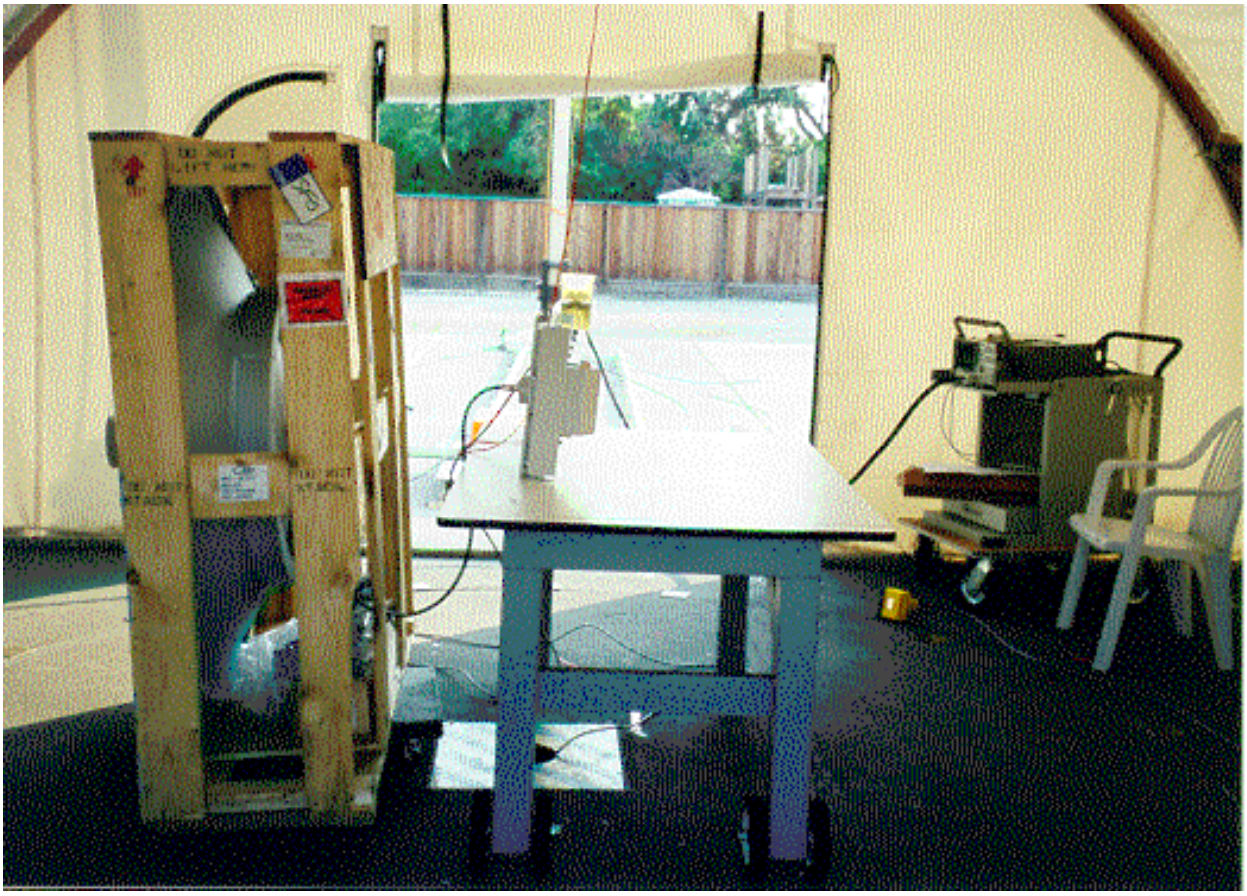


EXHIBIT 4: Proposed FCC ID Label & Label Location

Not changed since previous submittal

EXHIBIT 5:Detailed Photographs of Wavespan Corporation Model Stratum 100 Construction

Not changed since previous submittal

EXHIBIT 6: Operator's Manual for Wavespan Corporation Model Stratum 100

Not changed since previous submittal

EXHIBIT 7: Block Diagram of Wavespan Corporation Model Stratum 100

Not changed since previous submittal

EXHIBIT 8: Schematic Diagrams for Wavespan Corporation Model Stratum 100

Not changed since previous submittal

EXHIBIT 9: Theory of Operation for Wavespan Corporation Model Stratum 100

Not changed since previous submittal