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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Thrucomm, Inc. Model: DP1000

FCC ID:	MAWDP1000V18
GRANTEE:	Thrucomm, Inc. 1641 Commerce Ave. North St. Petersberg, FL 33716
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	May 7, 1998
FINAL TEST DATE:	March 27, 28 & 29, 1998
TEST ENGINEER:	Rudy Suy
AUTHORIZED SIGNATORY:	Mark Briggs Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Thrucomm direct sequence spread spectrum transceiver model DP1000 pursuant to Subpart C 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.

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 Thrucomm model DP1000 and therefore apply only to the tested sample. The sample was selected and prepared by Tom Dichiaro of Thrucomm Inc..

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C 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 which are subsequently manufactured.

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.).

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on March 27, March 28 and March 29, 1998 at the Elliott Laboratories Open Area Test Site located at 684 West Maude Avenue, Sunnyvale, California. 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, which is 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 CISPER 16 is used for emissions measurements. The ESH3 receiver 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 particular 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

A Rohde and Schwarz EZM Spectrum Monitor/Controller is utilized to convert the receiver measurements to the field strength at the antenna, 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.

The EZM provides a visual display of the signal being measured. In addition, the EZM Spectrum Monitor runs the automated data collection programs which control both 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 50 uH LISNs used were manufactured by Fischer Custom Communications, model LISN-3 in combination with a 250 uH Fischer Custom Communications LISN-3 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 output power measurements from transmitters as they provides a broadband indication of the power output. The power meter used was the Hewlett Packard model 432A, S/N 992-05509 and the thermister mount was the Hewlett Packard model 478A, S/N 46397.

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 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 appendix 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.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

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 to 1000 MHz. One or more of these is with the antenna polarized vertically while the one or more of these is 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.

DIRECT MEASUREMENTS OF EMISSIONS FROM THE 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:

CONDUCTED EMISSIONS SPECIFICATION LIMITS

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

RADIATED EMISSIONS SPECIFICATION LIMITS

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 - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

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

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Thrucomm model DP1000 is a 902-928 MHz direct sequence spread spectrum transceiver which is designed to serve as a wireless metropolitan area network. The electrical rating of EUT power supply is 120V/ 60Hz and 0.41 Amps. The sample was received on March 27, 1998 and tested on March 27, 28 and 29, 1998. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	FCC ID Number
ThruComm/ DP1000/ Wireless Modem	-	MAWDP1000V18
Decibel Products/ DB589-Y/ +9dB Omni Antenna	none	none
Antenex/ Y8966/ +9dB Yagi Antenna	none	none
K&L 6CB-915/T14-N/N Cavity Bandpass Filter	none	none

ENCLOSURE

The EUT enclosure is primarily constructed of extruded aluminum. It measures approximately 10.5 cm wide by 28.5 cm deep by 8.5 cm high.

INPUT POWER

The EUT was powered from an AC-to-AC adapter that connected directly to the AC outlet. The adapter used during testing was:

Description	Manufacturer	Model
120V - 18V ac Transformer	Ault	316-4018-000A

EMI SUPPRESSION DEVICES

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

Description	Manufacturer	Part Number
Shield, Synthesizer	Fotofob	3116-0110
Shield, RF Section	Fotofob	3116-0111
Partition, RF	Fotofob	3116-0112
Partition, IF	Fotofob	3116-0113
Gasket, TNC	Chomerics	3116-0114
18 VAC Line Filter	ThruComm	3018-3041

PRINTED WIRING BOARDS

The Thrucomm model DP1000 contained the following printed wiring boards during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
ThruComm/ RF	3116-0102	A	0002	39.3
ThruComm/ Digital	3011-0122	B	333	40, 7.3728

SUBASSEMBLIES

The Thrucomm model DP1000 contained the following subassembly modules during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial Number
ThruComm/ 18 VAC Line Filter	3018-3041	-	none

SUPPORT EQUIPMENT

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

Manufacturer/Model/Description	Serial #	FCC ID Number
Motorola/ Vanguard 100/ Multiplexer	006579925	FWDCAN-21726-DD-N

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
DB25 Shielded Multiplexer Cable	2	Vanguard 100/ #1	EUT/ Data I/O
RF IMR400 Coaxial	2	EUT/ Antenna RF	Cavity BPF/ RF
RF IMR400 Coaxial	10	Cavity BPF/ RF	Antenna RF
RF IMR400 Coaxial	50	EUT/ Antenna RF	Antenna RF
Line Cord	2	Vanguard 100/ AC	120 VAC

ANTENNA SYSTEM

The antenna port is a standard coaxial connector. This meets the requirements of FCC Part 15 for unlicensed transmitters because the system is always installed professionally under the control of ThruComm.

The system is supplied with either an Omni-Directional Antenna with gain of 9 dBd or a Yagi antenna with a gain of 9 dBd. These antennas are provided with a coaxial cable having a loss of 0.4 dB.

TEST MODES

The EUT was operating either in a receive-only mode or in transceiver mode. In transceiver mode the unit was constantly transmitting on either the low, center or high channel using BPSK modulation under mode 1, 2 or 3 into either the Omni or Yagi antenna. Refer to the individual test runs for operating mode and antenna configuration during each run.

TEST RESULTS

TEST DATA ANALYSIS - CONDUCTED

The following measurements were extracted from the data recorded during the conducted emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Conducted Emissions, 0.45-30.0 MHz,
Sorted by Margin, 120 V, 60 Hz

Frequency MHz	Level dBuV	Power Lead	EN55022B Limit	EN55022B Margin	Detector QP/Ave	Comments
0.6575	41.6	Line	48.0	-6.4	QP	
0.6575	41.3	Neutral	48.0	-6.7	QP	
0.6800	37.0	Neutral	48.0	-11.0	QP	Note 1
0.6800	36.6	Line	48.0	-11.4	QP	Note 1
1.3139	35.1	Neutral	48.0	-12.9	QP	
1.3139	26.8	Line	48.0	-21.2	QP	

Note 1: According to FCC part 15.207 (b) this emission is consider to be broadband. Therefore, this level measured with QP detector has been reduced by 13dB

TEST DATA ANALYSIS - RADIATED, RESTRICTED BANDS 30-1000 MHz

The following measurements were extracted from the data recorded during the radiated electric field emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Maximized Radiated Emissions Scan, Restricted Bands 30-1000 MHz.

A complete set of measurements were made with the system using spread-spectrum mode 2 and Omni-Directional antenna on low, center and high channels. The tests were then repeated on the high channel with the same antenna under spread-spectrum modes 1 and 3. No significant change in the level of the highest emissions was observed. A final test was performed on the high channel with the Yagi antenna under spread spectrum mode 2. No significant differences were observed in the highest emissions levels compared to the same operating mode with the Omni antenna. The results for the worst case configuration and mode are shown below:

High channel, Spread spectrum mode 1, Antenna A (Omni-Directional)

Frequency MHz	Level dBuV/m	Pol v/h	FCC Limit	FCC Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
279.995	40.0	h	46.0	-6.0	QP	240	1.2	
262.146	37.7	h	46.0	-8.3	QP	260	1.2	
960.000	37.7	h	46.0	-8.3	QP	210	1.0	Signal Sub.
275.100	37.4	h	46.0	-8.6	QP	240	1.2	
279.995	35.2	v	46.0	-10.8	QP	170	1.0	
275.100	35.0	v	46.0	-11.0	QP	160	1.0	
960.000	34.0	v	46.0	-12.0	QP	240	1.0	Signal Sub.
999.986	36.7	v	54.0	-17.3	QP	190	1.0	
979.984	36.5	h	54.0	-17.5	QP	220	1.0	
999.986	35.6	h	54.0	-18.4	QP	50	1.0	
979.984	35.3	v	54.0	-18.7	QP	220	1.0	

TEST DATA ANALYSIS - RADIATED, RESTRICTED BANDS 1-10 GHz

The following measurements were extracted from the data recorded during the radiated electric field emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Maximized Radiated Emissions Scan, Restricted Bands 1000-10000 MHz,

Complete set of measurements made with the system operating on the high channel under spread-spectrum mode 2 with both Yagi and Omni antennae. The highest emissions were observed with the Yagi antenna so the measurements were then repeated with the system operating on the center channel using mode 2 with Yagi antenna connected. Preliminary testing had shown that the peak level of the spurious emissions was independent of operating mode. The test plan agreed upon by Greg Czumak on a similar product (FCC ID: NMAEZCOMWL9D, designed and built by NOVA Engineering who also designed this radio) only required testing on center and high channels on the worst case antenna configuration. The results for the worst case configuration/mode were:

Center channel, Spread spectrum mode 2, Antenna B (Yagi)

Frequency MHz	Level dBuV/m	Pol v/h	FCC Limit	FCC Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
960.000	39.0	v	46.0	-7.0	QP	0	1.0	
960.000	37.8	h	46.0	-8.2	QP	130	1.0	
982.500	45.6	v	54.0	-8.4	QP	160	1.3	
279.995	37.2	h	46.0	-8.8	QP	320	1.2	
275.100	36.8	v	46.0	-9.2	QP	140	1.0	
275.100	36.6	h	46.0	-9.4	QP	20	1.2	

TEST DATA ANALYSIS - POWER AND BANDWIDTH

The maximum power output was 25.2 dBm (0.331 Watts) on the center channel using mode 3. Since the maximum gain of the antenna/cable combination used with this system is 9.6 dBi, the maximum permitted output power under 15.247 is 26.4 dBm (0.436 Watts).

The lowest 6 dB bandwidth was 2.983 Megahertz with the system operating under mode 3. The minimum bandwidth specified in 15.247 is 500 KHz.

The maximum power spectral density in a 3KHz band averaged over a 1 second period was 6.4 dBm (High channel, mode 1). The maximum permitted spectral density under 15.247 is 8.0 dBm.

The actual test data and any correction factors are contained in the appendices of this report.

TEST DATA ANALYSIS - ANTENNA CONDUCTED

The highest out-of-band emission recorded was more than 50 dB below the in-band level.

TEST DATA ANALYSIS - PROCESSING GAIN

The processing gain was measured by Nova Engineering to be 11.4 dB using the Jamming Margin Method. The actual test data and any correction factors are contained in the appendices of this report.

EXHIBIT A

Test Equipment Calibration

Test Equipment List - SVOATS#2

	Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☑	Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215, (F197)	12	1/16/98	1/16/99
☑	Rohde & Schwarz	T1 Conducted LISN	ESH3-Z4,	267			
☑	Rohde &Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	1/16/98	1/16/99
☑	Rohde& Schwarz	Pulse Limiter	ESH3Z2	811	12	2/5/98	2/5/99
☐	Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/22/97	4/22/98
☑	Narda-West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/22/97	4/22/98
☐	Hewlett Packard	Power Meter	432A	259, (F304)	12	3/10/98	3/10/99
☑	Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	24	1/14/98	1/14/2000
☑	Hewlett Packard	Microwave Preamplifier, 1-26.5	8449B	263, (F303)	12	6/6/97	6/6/98
☑	Hewlett Packard	Thermistor Mount	478A	652	12	3/10/98	3/10/99
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	24	10/24/97	10/24/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/10/97	11/10/98
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	10/27/97	10/27/98
☐	Fischer	LISN	FCC-LISN-50/2	810	12	1/29/98	1/29/99
☑	EMCO	Double Ridge Horn Antenna, 1-18	3115	487	12	6/3/97	6/3/98
☐	EMCO	Double Ridge Horn Antenna, 1-18	3115	786	12	11/13/97	5/13/99
☑	EMCO	Biconical Antenna	3110B	801		6/4/97	12/4/98
☑	EMCO	Log Periodic Antenna	3146A	802	12	6/13/97	12/13/98

File Number: T26354-TX & RX

Date: 4/27,28/98

Engr: RUDY

Test Equipment List - SVOATS#2

	Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☐	Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215, (F197)	12	1/16/98	1/16/99
☐	Rohde & Schwarz	T1 Conducted LISN	ESH3-Z4,	267			
☐	Rohde &Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	1/16/98	1/16/99
☐	Rohde& Schwarz	Pulse Limiter	ESH3Z2	811	12	2/5/98	2/5/99
☐	Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/22/97	4/22/98
☐	Narda-West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/22/97	4/22/98
☒	Hewlett Packard	Power Meter	432A	259, (F304)	12	3/10/98	3/10/99
☒	Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	24	1/14/98	1/14/2000
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5	8449B	263, (F303)	12	6/6/97	6/6/98
☒	Hewlett Packard	Thermistor Mount	478A	652	12	3/10/98	3/10/99
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	24	10/24/97	10/24/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/10/97	11/10/98
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	10/27/97	10/27/98
☐	Fischer	LISN	FCC-LISN-50/2	810	12	1/29/98	1/29/99
☐	EMCO	Double Ridge Horn Antenna, 1-18	3115	487	12	6/3/97	6/3/98
☐	EMCO	Double Ridge Horn Antenna, 1-18	3115	786	12	11/13/97	5/13/99
☐	EMCO	Biconical Antenna	3110B	801		6/4/97	12/4/98
☐	EMCO	Log Periodic Antenna	3146A	802	12	6/13/97	12/13/98

File Number: T26390

Date: 4/29/98

Engr: MRB

EXHIBIT B

Test Measurement Data

The following data includes conducted emission measurements of the Thrucomm model DP1000 and maximized radiated emissions measurements of the complete system.

Client:	ThruComm Inc.	Date:	4/27, 28/97	Test Engr:	Rudy Suy
Product:	DP 1000	File:	T26354-TX	Proj. Eng:	Mark Briggs
Objective:	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC Part 15.247	Page:	1 of 5	Approved:	

Test Objective

The objective of this test session is to perform final qualification testing on the transmitter circuits of the EUT defined below for certification against Part 15.247 of the FCC rules. The test procedure for the various combinations of operating modes and channels closely follows the procedure agreed upon by Greg Czumak for a similar product that was submitted in 1997 (FCC ID: NMAEZCOMWL9D)

Note: Metal EMI cover shown in detailed equipment photo as attached to configuration port was not used during testing.

Test Summary

Run #1 - Conducted Emissions Scan of EUT, 0.45-30.00 MHz, 120V, 60Hz.

PASS Results: FCC B -6.4 dB QP @ 0.6575 MHz Line

Run #2 - Unmaximized Preliminary Radiated Emissions Scan, 30-1000 MHz, Restricted Band, High channel, Spread spectrum mode 2, Antenna B

Results: FCC part 15 -7.0 dB QP @ 960.000 MHz Vertical

Run #3 - Maximized Radiated Emissions from Run #2

PASS Results: FCC part 15 -7.0 dB QP @ 960.000 MHz Vertical

Run #4 - Maximized Radiated Emissions Scan, 1000-10000 MHz, Restricted Band, High channel, Spread spectrum mode 2, Antenna B

PASS Results: FCC part 15 -6.7 dB Ave. @ 2771.900 MHz Vertical

Run #5 - Maximized Radiated Emissions Scan, 1000-10000 MHz, Restricted Band, Center channel, Spread spectrum mode 2, Antenna B

PASS Results: FCC part 15 -3.6 dB Ave. @ 2745.200 MHz Vertical

Run #7 - Maximized Radiated Emissions Scan, 1000-10000 MHz, Restricted Band, Center channel, Spread spectrum mode 2, Antenna A

PASS Results: FCC part 15 -9.6 dB Ave. @ 2745.200 MHz Vertical

Note: Center channel was the worst case with antenna B configuration. Therefore, only center channel was measured with antenna A configuration. Preliminary data showed that the emissions were independent of spreading mode.

Run #8 - Maximized Radiated Emissions Scan, 30-1000 MHz, Restricted Band, High channel, Spread spectrum mode 2, Antenna A

PASS Results: FCC part 15 -7.4 dB QP. @ 275.100 MHz Horizontal

Run #9 - Maximized Radiated Emissions Scan, 30-1000 MHz, Restricted Band, Middle channel, Spread spectrum mode 2, Antenna A

PASS Results: FCC part 15 -6.1 dB QP. @ 279.995 MHz Horizontal

Run #10 - Maximized Radiated Emissions Scan, 30-1000 MHz, Restricted Band, Low channel, Spread spectrum mode 2, Antenna A

PASS Results: FCC part 15 -6.1 dB QP. @ 279.995 MHz Horizontal

Run #11 - Maximized Radiated Emissions Scan, 30-1000 MHz, Restricted Band, High channel, Spread spectrum mode 1, Antenna A

PASS Results: FCC part 15 -6.0 dB QP. @ 279.995 MHz Horizontal

Run #12 - Maximized Radiated Emissions Scan, 30-1000 MHz, Restricted Band, High channel, Spread spectrum mode 3, Antenna A

PASS Results: FCC part 15 -6.2 dB QP. @ 279.995 MHz Horizontal

Equipment Under Test (EUT) General Description

The EUT is a 902-928 MHz direct sequence spread spectrum transceiver which is designed to serve as a wireless metropolitan area network. The electrical rating of EUT power supply is 120V/ 60Hz and 0.41 Amps. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, placed in this position during emissions testing to simulate the end user environment.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
ThruComm/ DP1000/ Wireless Modem	-	MAWDP1000V18
Decibel Products/ DB589-Y/ +9dB Omni Antenna	none	none
Antenex/ Y8966/ +9dB Yagi Antenna	none	none
K&L 6CB-915/T14-N/N Cavity Bandpass Filter	none	none

Local Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
Motorola/ Vanguard 100/ Multiplexer	006579925	FWDCAN-21726-DD-N

Remote Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
None	-	-

Power Supply and Line Filters

The EUT was powered from an AC-to-AC adapter that connected directly to the AC outlet. The adapter used during testing was:

Description	Manufacturer	Model
120V - 18V ac Transformer	Ault	316-4018-000A

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
DB25 Shielded Multiplexer Cable	2	Vanguard 100/ #1	EUT/ Data I/O
RF IMR400 Coaxial	2	EUT/ Antenna RF	Cavity BPF/ RF
RF IMR400 Coaxial	10	Cavity BPF/ RF	Antenna RF
RF IMR400 Coaxial	50	EUT/ Antenna RF	Antenna RF
Line Cord	2	Vanguard 100/ AC	120 VAC

Note: During testing the configuration port was not connected, nor was its cover attached. This port would not be connected during normal operation.

Antenna Port

The antenna port is a standard coaxial connector. This meets the requirements of FCC Part 15 for unlicensed transmitters because the system is always installed professionally under the control of ThruComm.

EUT Operating During Test

The EUT was operating either in a receive-only mode or in transceiver mode. In transceiver mode the unit was constantly transmitting on either the low, center or high channel using BPSK modulation under mode 1, 2 or 3. Refer to the individual test runs for operating mode during each run.

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
ThruComm/ RF	3116-0102	A	0002	39.3
ThruComm/ Digital	3011-0122	B	333	40, 7.3728

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
ThruComm/ 18 VAC Line Filter	3018-3041	-	none

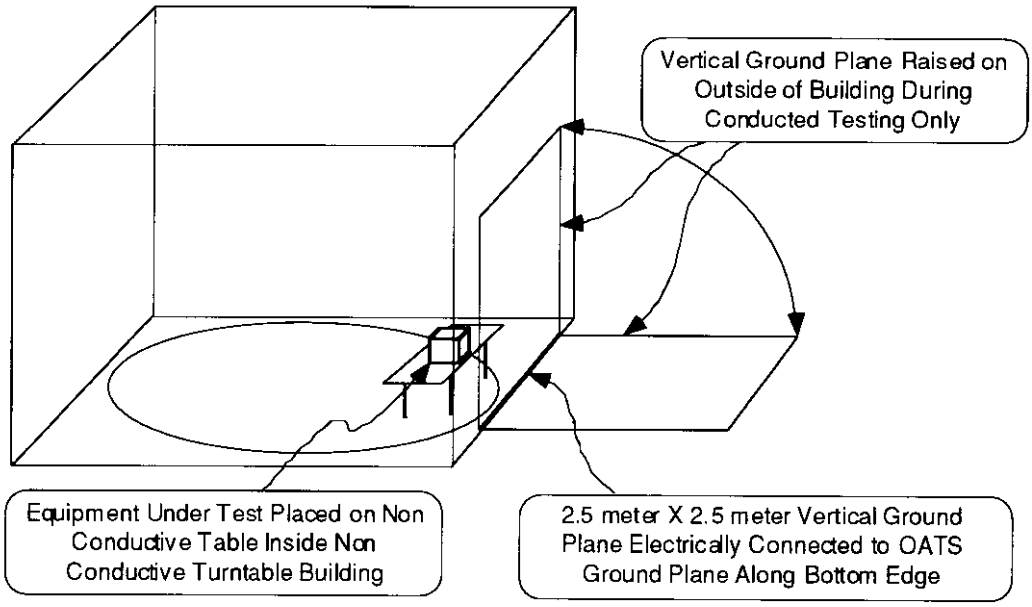
EUT Enclosure(s)

The EUT enclosure is primarily constructed of extruded aluminum. It measures approximately 10.5 cm wide by 28.5 cm deep by 8.5 cm high.

General Test Conditions

During radiated testing, the EUT was connected to 120V, 60Hz power input. The EUT and all local support equipment were located on the turntable for radiated testing and conducted testing.

During conducted emissions testing, the EUT was connected to 120V, 60Hz power input as noted. A 2.5 meter X 2.5 meter ground plane is raised to a vertical position 40 cm from the EUT as shown below:



EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
Shield, Synthesizer	Fotofob	3116-0110
Shield, RF Section	Fotofob	3116-0111
Partition, RF	Fotofob	3116-0112
Partition, IF	Fotofob	3116-0113
Gasket, TNC	Chomerics	3116-0114
18 VAC Line Filter	ThruComm	3018-3041

Test Data Tables

See the attached D-File

Elliott — Emissions Test Data

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #1: Conducted Emissions, 120V/60Hz
RF Channel = 915MHz, Spread Spectrum Mode = 2
Antenna Configuration = B [+9dBd Yagi plus 50' of LMR400]

Frequency	Level	Power	FCC B	FCC B	Detector	Comments
MHz	dBuV	Lead	Limit	Margin	QP/Ave	
0.6575	41.6	Line	48.0	**-6.4**	QP	
0.6575	41.3	Neutral	48.0	**-6.7**	QP	
0.6800	37.0	Neutral	48.0	**-11.0**	QP	Note 1
0.6800	36.6	Line	48.0	**-11.4**	QP	Note 1
1.3139	35.1	Neutral	48.0	**-12.9**	QP	
1.3139	26.8	Line	48.0	**-21.2**	QP	

Note 1	According to FCC part 15.207 (b) this emission is consider to be broadband. Therefore, this level measured with QP detector has been reduced by 13dB.

Run #2: Initial radiated scan, 30-1000 MHz, Restricted Ba
RF Channel = 924MHz (High), Spread Spectrum Mode = 2
Antenna Configuration = B [+9dBd Yagi plus 50' of LMR400]

Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
960.000	39.0	v	46.0	**-7.0**	QP	0	1.0	Signal Sub.
960.000	37.8	h	46.0	**-8.2**	QP	130	1.0	Signal Sub.
982.500	45.0	v	54.0	**-9.0**	QP	160	1.3	
275.100	36.8	v	46.0	**-9.2**	QP	140	1.0	
279.995	36.3	h	46.0	**-9.7**	QP	320	1.2	
275.100	36.2	h	46.0	**-9.8**	QP	20	1.2	
279.995	35.0	v	46.0	**-11.0**	QP	0	1.0	
262.146	34.2	h	46.0	**-11.8**	QP	70	1.3	
399.993	33.5	h	46.0	**-12.5**	QP	270	1.8	
399.993	33.4	v	46.0	**-12.6**	QP	0	1.0	
150.000	30.8	v	43.5	**-12.7**	QP	180	1.0	
990.000	41.2	v	54.0	**-12.8**	QP	160	1.3	B.B
240.000	33.1	h	46.0	**-12.9**	QP	260	1.4	
979.984	41.0	v	54.0	**-13.0**	QP	160	1.3	
998.900	41.0	v	54.0	**-13.0**	QP	170	1.3	B.B
999.986	40.8	v	54.0	**-13.2**	QP	160	1.3	B.B
999.986	40.5	h	54.0	**-13.5**	QP	320	1.3	
269.997	32.4	h	46.0	**-13.6**	QP	210	1.3	
967.800	40.4	v	54.0	**-13.6**	QP	170	1.4	B.B
982.500	40.2	h	54.0	**-13.8**	QP	80	1.0	
969.984	40.2	v	54.0	**-13.8**	QP	180	1.3	
974.800	40.2	v	54.0	**-13.8**	QP	100	1.3	B.B
269.997	31.7	v	46.0	**-14.3**	QP	160	1.0	
961.100	39.6	v	54.0	**-14.4**	QP	190	1.4	B.B
265.276	31.2	h	46.0	**-14.8**	QP	180	1.3	
989.986	39.0	h	54.0	**-15.0**	QP	330	1.3	
961.100	38.5	h	54.0	**-15.5**	QP	50	1.0	B.B
117.900	27.9	h	43.5	**-15.6**	QP	100	1.5	
265.276	29.8	v	46.0	**-16.2**	QP	160	1.0	
979.984	37.8	h	54.0	**-16.2**	QP	50	1.0	

Elliott

Emissions Test Data

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #3: Maximized radiated emissions from Run #2, Sorted by margin

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
960.000	39.0	v	46.0	**-7.0**	QP	0	1.0	
960.000	37.8	h	46.0	**-8.2**	QP	130	1.0	
982.500	45.6	v	54.0	**-8.4**	QP	160	1.3	
279.995	37.2	h	46.0	**-8.8**	QP	320	1.2	
275.100	36.8	v	46.0	**-9.2**	QP	140	1.0	
275.100	36.6	h	46.0	**-9.4**	QP	20	1.2	

Run #4: Maximized radiated scan, 1000-10000 MHz, Restricted Band
RF Channel = 924MHz, Spread Spectrum Mode = 2
Antenna Configuration = B [+9dBd Yagi plus 50' of LMR400]

8dB has been subtracted from Average reading for duty cycle correction factor
Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2771.900	47.3	v	54.0	**-6.7**	Ave.	210	2.1	
2718.000	46.3	h	54.0	**-7.7**	Ave.	170	1.0	
7392.600	44.5	h	54.0	**-9.5**	Ave.	170	1.1	
2771.900	61.9	v	74.0	**-12.1**	Peak	210	2.1	
2718.000	60.6	h	74.0	**-13.4**	Peak	170	1.0	
7392.600	53.1	h	74.0	**-20.9**	Peak	170	1.1	
7392.600	52.2	v	54.0	**-1.8**	Peak	100	1.5	Note 2
4621.500	49.0	h	54.0	**-5.0**	Peak	200	1.1	Note 2
4621.500	48.7	v	54.0	**-5.3**	Peak	240	1.5	Note 2

Note 2	Peak reading, average limit.

Run #5: Maximized radiated scan, 1000-10000 MHz, Restricted Band
RF Channel = 915MHz, Spread Spectrum Mode = 2
Antenna Configuration = B [+9dBd Yagi plus 50' of LMR400]

8dB has been subtracted from Average reading for duty cycle correction factor
Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2745.200	50.4	v	54.0	**-3.6**	Ave.	180	1.1	
2745.200	49.9	h	54.0	**-4.1**	Ave.	210	2.1	
2745.200	64.6	v	74.0	**-9.4**	Peak	180	1.1	
2745.200	63.6	h	74.0	**-10.4**	Peak	210	2.1	
4575.000	52.1	v	54.0	**-1.9**	Peak	210	1.0	Note 2
4575.000	51.4	h	54.0	**-2.6**	Peak	240	1.6	Note 2

Note 2	Peak reading, average limit.

Elliott

Emissions Test Data

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #6: Maximized radiated scan, 1000-10000 MHz, Restricted Band
RF Channel = 906MHz, Spread Spectrum Mode = 2
Antenna Configuration = B [+9dBd Yagi plus 50' of LMR400]

8dB has been subtracted from Average reading for duty cycle correction factor
Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2718.000	46.3	v	54.0	**-7.7**	Ave.	210	1.1	
2718.000	41.3	h	54.0	**-12.7**	Ave.	260	2.0	
2718.000	60.6	v	74.0	**-13.4**	Peak	210	1.1	
2718.000	55.2	h	74.0	**-18.8**	Peak	260	2.0	
7250.000	52.3	v	54.0	**-1.7**	Peak	180	1.0	Note 2
7250.000	51.5	h	54.0	**-2.5**	Peak	210	1.4	Note 2
4530.000	50.5	v	54.0	**-3.5**	Peak	200	1.2	Note 2
4530.000	49.0	h	54.0	**-5.0**	Peak	240	1.5	Note 2

Note 2	Peak reading, average limit.

Run #7: Maximized radiated scan, 1000-10000 MHz, Restricted Band
RF Channel = 915MHz, Spread Spectrum Mode = 2
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

8dB has been subtracted from Average reading for duty cycle correction factor
Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2745.200	64.4	v	74.0	**-9.6**	Peak	190	1.0	
2745.200	61.5	h	74.0	**-12.5**	Peak	160	1.0	
2745.200	39.5	v	54.0	**-14.5**	Ave.	190	1.0	
2745.200	35.7	h	54.0	**-18.3**	Ave.	160	1.0	
4575.000	50.1	h	54.0	**-3.9**	Peak	180	1.0	Note 2
4575.000	49.6	v	54.0	**-4.4**	Peak	180	1.0	Note 2

Note 2	Peak reading, average limit.

Elliott — Emissions Test Data

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #8: Maximized radiated scan, 30-1000 MHz, Restricted Band
RF Channel = 924MHz, Spread Spectrum Mode = 2
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
275.100	38.6	h	46.0	**-7.4**	QP	250	1.2	
279.995	38.3	h	46.0	**-7.7**	QP	240	1.2	
275.100	37.8	v	46.0	**-8.2**	QP	170	1.0	
960.000	37.8	h	46.0	**-8.2**	QP	180	1.1	Signal Sub.
960.000	37.7	v	46.0	**-8.3**	QP	160	1.0	Signal Sub.
262.146	37.6	h	46.0	**-8.4**	QP	250	1.2	
279.995	35.1	v	46.0	**-10.9**	QP	160	1.0	
979.984	37.6	h	54.0	**-16.4**	QP	190	1.1	
999.986	37.3	h	54.0	**-16.7**	QP	130	1.2	
999.986	36.6	v	54.0	**-17.4**	QP	200	1.0	
979.984	36.0	v	54.0	**-18.0**	QP	250	1.1	
970.000	34.1	h	54.0	**-19.9**	QP	190	1.1	
990.000	33.4	h	54.0	**-20.6**	QP	190	1.2	
990.000	33.2	v	54.0	**-20.8**	QP	120	1.0	

Run #9: Maximized radiated scan, 30-1000 MHz, Restricted Bands
RF Channel = 915MHz, Spread Spectrum Mode = 2
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
279.995	39.9	h	46.0	**-6.1**	QP	250	1.2	
960.000	37.7	h	46.0	**-8.3**	QP	210	1.1	Signal Sub.
275.100	37.2	h	46.0	**-8.8**	QP	240	1.2	
262.146	36.9	h	46.0	**-9.1**	QP	260	1.2	
279.995	35.0	v	46.0	**-11.0**	QP	170	1.0	
275.100	34.5	v	46.0	**-11.5**	QP	170	1.0	
960.000	33.5	v	46.0	**-12.5**	QP	240	1.0	Signal Sub.
979.984	37.4	h	54.0	**-16.6**	QP	210	1.1	
999.986	36.4	v	54.0	**-17.6**	QP	130	1.0	
999.986	35.6	h	54.0	**-18.4**	QP	40	1.0	
979.984	35.6	v	54.0	**-18.4**	QP	220	1.0	
970.000	34.4	h	54.0	**-19.6**	QP	160	1.1	

Elliott — Emissions Test Data

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #12: Maximized radiated scan, 30-1000 MHz, Restricted Band
RF Channel = 924MHz, Spread Spectrum Mode = 3
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
279.995	39.8	h	46.0	**-6.2**	QP	250	1.2	
960.000	38.0	h	46.0	**-8.0**	QP	210	1.0	Signal Sub.
275.100	37.9	h	46.0	**-8.1**	QP	240	1.2	
262.146	37.4	h	46.0	**-8.6**	QP	260	1.3	
279.995	35.3	v	46.0	**-10.7**	QP	170	1.0	
275.100	34.8	v	46.0	**-11.2**	QP	170	1.0	
960.000	34.0	v	46.0	**-12.0**	QP	240	1.0	Signal Sub.
979.984	36.6	h	54.0	**-17.4**	QP	220	1.0	
999.986	36.6	v	54.0	**-17.4**	QP	200	1.0	
979.984	35.7	v	54.0	**-18.3**	QP	220	1.0	
999.986	35.3	h	54.0	**-18.7**	QP	50	1.0	

Elliott **Emissions Test Data**

Client:	ThruComm Inc.	Date:	4/27, 28/1998	Test Engr:	Rudy Suy
Product:	DP 1000	File:	D26354 - TX	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #2	Contact:	Tom Dichiaro
Spec:	FCC part 15	Distance:	3 m	Approved:	

Run #10: Maximized radiated scan, 30-1000 MHz, Restricted Band
RF Channel = 906MHz, Spread Spectrum Mode = 2
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

Tested at 3M

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
279.995	39.9	h	46.0	**-6.1**	QP	250	1.2	
960.000	37.7	h	46.0	**-8.3**	QP	210	1.0	Signal Sub.
262.146	37.3	h	46.0	**-8.7**	QP	260	1.2	
275.100	37.0	h	46.0	**-9.0**	QP	250	1.2	
279.995	34.6	v	46.0	**-11.4**	QP	170	1.0	
275.100	34.5	v	46.0	**-11.5**	QP	120	1.0	
960.000	33.5	v	46.0	**-12.5**	QP	240	1.0	Signal Sub.
979.984	37.2	h	54.0	**-16.8**	QP	220	1.0	
999.986	36.5	v	54.0	**-17.5**	QP	130	1.0	
999.986	35.9	h	54.0	**-18.1**	QP	40	1.0	
979.984	35.9	v	54.0	**-18.1**	QP	230	1.0	
970.000	34.0	h	54.0	**-20.0**	QP	140	1.0	

Run #11: Maximized radiated scan, 30-1000 MHz, Restricted Band
RF Channel = 924MHz, Spread Spectrum Mode = 1
Antenna Configuration = A [+9dBd omni plus cavity BPF plus 10' of LMR400]

Tested at 3M

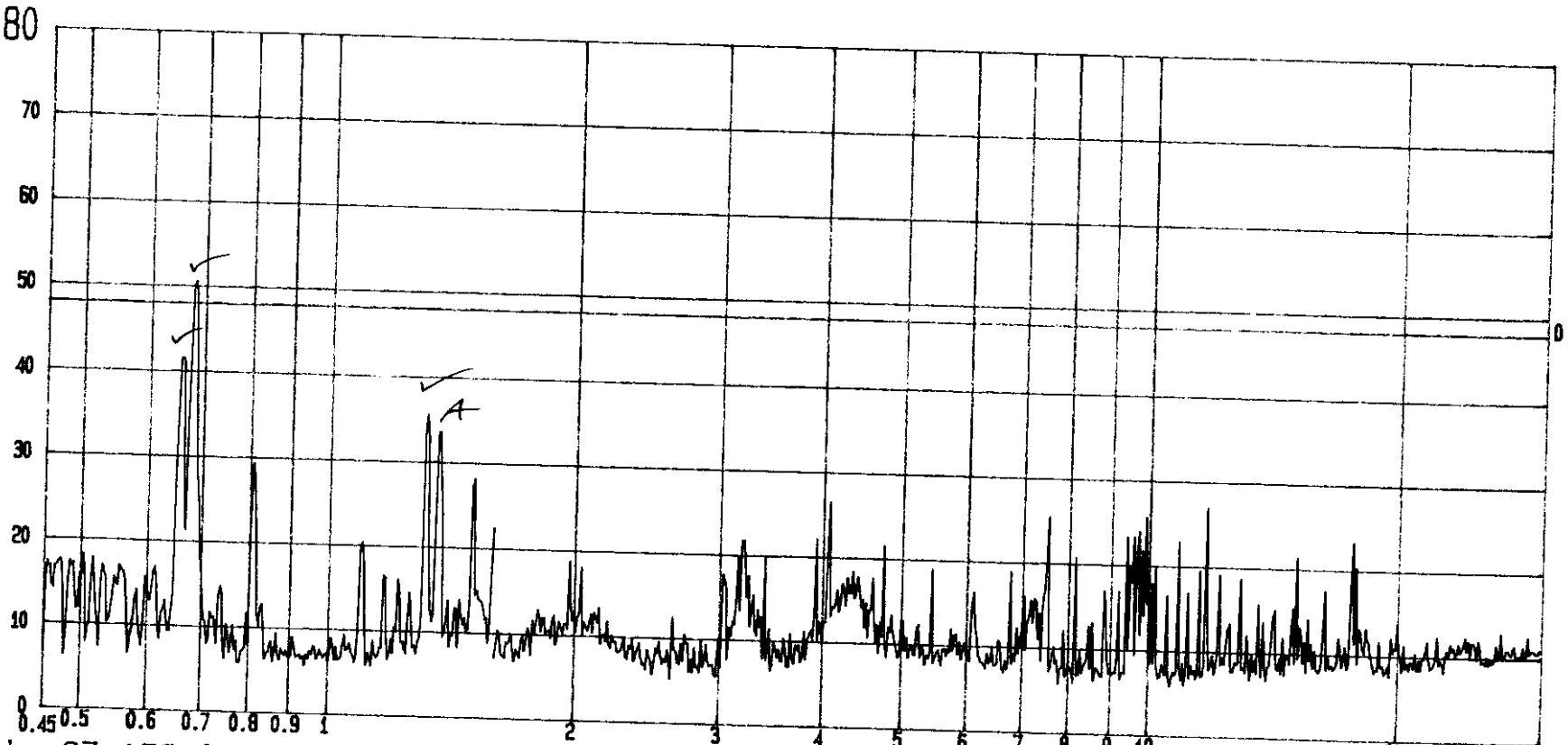
Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
279.995	40.0	h	46.0	**-6.0**	QP	240	1.2	
262.146	37.7	h	46.0	**-8.3**	QP	260	1.2	
960.000	37.7	h	46.0	**-8.3**	QP	210	1.0	Signal Sub.
275.100	37.4	h	46.0	**-8.6**	QP	240	1.2	
279.995	35.2	v	46.0	**-10.8**	QP	170	1.0	
275.100	35.0	v	46.0	**-11.0**	QP	160	1.0	
960.000	34.0	v	46.0	**-12.0**	QP	240	1.0	Signal Sub.
999.986	36.7	v	54.0	**-17.3**	QP	190	1.0	
979.984	36.5	h	54.0	**-17.5**	QP	220	1.0	
999.986	35.6	h	54.0	**-18.4**	QP	50	1.0	
979.984	35.3	v	54.0	**-18.7**	QP	220	1.0	

ELLIOTT LABORATORIES INC. (408) 245-7800
684 W. MAUDE AVE., SUNNYVALE, CA 94086
RFI Voltage Test

Customer:	ThruComm Inc.
E.U.T.:	DP 1000
Run #:	1 (T26354)
Test Engineer:	Rudy Suy
Test spec:	

FCC PART 15 GENERAL, SINGLE PHASE, 0.45..30 MHz

Final evaluation: Quasi Peak
* = QUASI PEAK on phase: NEUTRAL



Date 27.APR.'98 Time 19:39:06

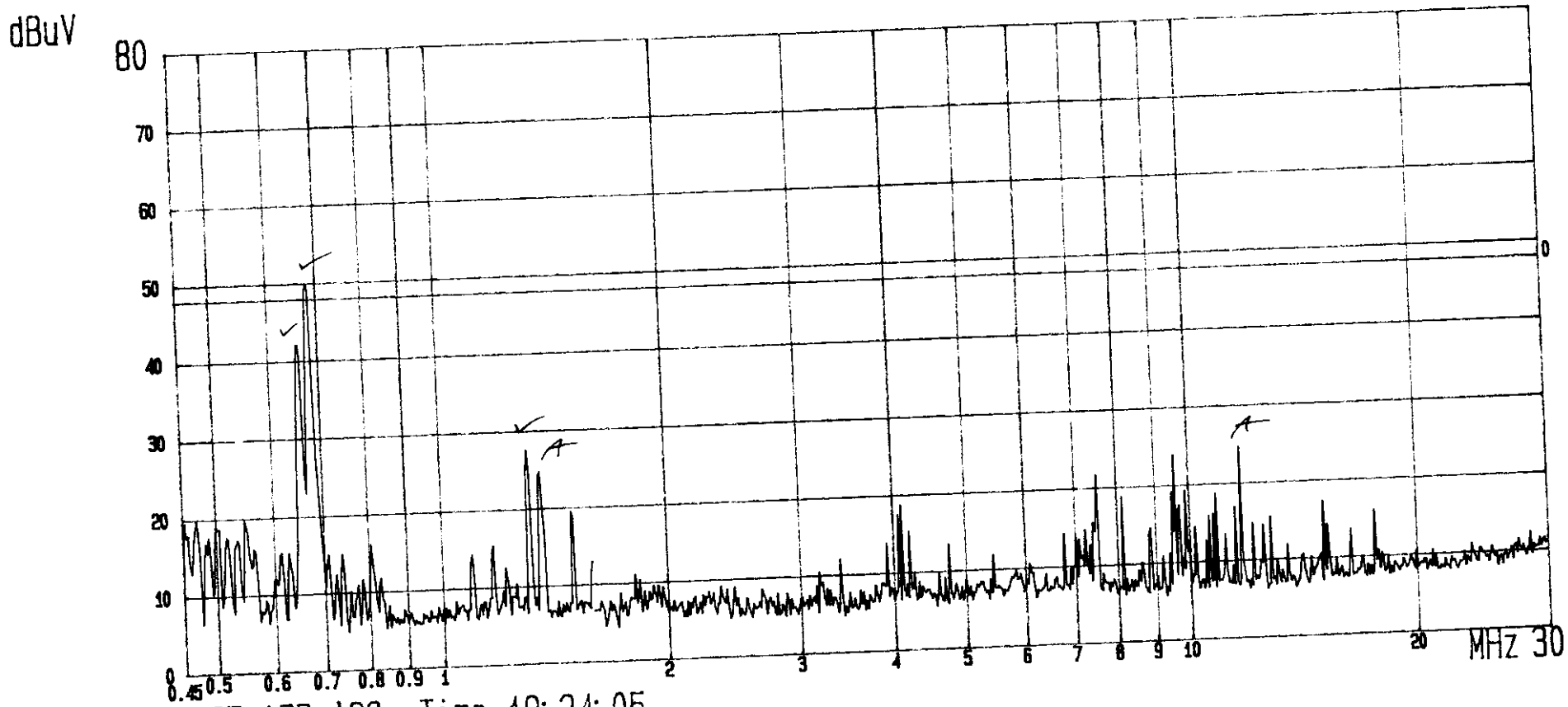
120V, 60 Hz.

✓ = EUT A = AMBIENT

ELLIOTT LABORATORIES INC. (408) 245-7800
684 W. MAUDE AVE., SUNNYVALE, CA 94086
RFI Voltage Test

Customer: ThruComm Inc.
E.u.T.: DP 1000
Run #: 1 (T26354)
Test Engineer: Rudy Suy
Test spec:
FCC PART 15 GENERAL, SINGLE PHASE, 0.45..30 MHz

Final evaluation: Quasi Peak
* = QUASI PEAK on phase: LINE



|--- Date 27.APR.'98 Time 19:24:05
120V, 60 Hz.

✓ = EUT A = AMBIENT

Client:	ThruComm Inc.	Date:	4/29/98	Test Engr:	Mark Briggs
Product:	DP 1000	File:	T26390	Proj. Eng:	Mark Briggs
Objective:	Final Qualification	Site:	N/A	Contact:	Tom Dichiaro
Spec:	FCC Part 15.247	Page:	1 of 5	Approved:	

Test Objective

The objective of this test session is to perform final qualification testing on the transmitter circuits of the EUT defined below for certification against Part 15.247 of the FCC rules. The test procedure for the various combinations of operating modes and channels closely follows the procedure agreed upon by Greg Czumak for a similar product that was submitted in 1997 (FCC ID: NMAEZCOMWL9D)

Test Summary

Run #1 - 6 dB Bandwidth Measurements §15.247 (a) (2)

PASS Minimum 6dB bandwidth was measured to be 2.983 MHz with the unit operating on mode 3.

Run #2 - Output Power Measurements §15.247 (b)

PASS Highest output power was measured to be 25.2dBm . Maximum permitted output power per FCC §15.247 is 26.4 dBm for an antenna/cable gain of 9.6 dBi.

Run #3 - Power Spectral Density Measurements §15.247 (d)

PASS Highest power spectral density in a 3KHz bandwidth and averaged over 1 second was measured to be 6.4 dBm on the high channel under mode 1. Maximum permitted is 8dBm.

Run #4 - Processing Gain Measurements

PASS These were performed by Nova Engineering (who designed the product) using the jamming margin method. Lowest Processing Gain was measured to be 11.4 with the unit operating under mode 2. The Nova test report is attached.

Run #5 - Out-Of-Band Conducted (Antenna Port) Measurements

PASS All out-of-band signals on the antenna port were more than 20dB below the highest in-band level when measured in a 100 KHz bandwidth..

Client:	ThruComm Inc.	Date:	4/29/98	Test Engr:	Mark Briggs
Product:	DP 1000	File:	T26390	Proj. Eng:	Mark Briggs
Objective:	Final Qualification	Site:	N/A	Contact:	Tom Dichiaro
Spec:	FCC Part 15.247	Page:	2 of 5	Approved:	

Equipment Under Test (EUT) General Description

The EUT is a 902-928 MHz direct sequence spread spectrum transceiver which is designed to serve as a wireless metropolitan area network. The electrical rating of EUT power supply is 120V/ 60Hz and 0.41 Amps. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, placed in this position during emissions testing to simulate the end user environment.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
ThruComm/ DP1000/ Wireless Modem	-	MAWDP1000V18
Decibel Products/ DB589-Y/ +9dB Omni Antenna	none	none
Antenex/ Y8966/ +9dB Yagi Antenna	none	none
K&L 6CB-915/T14-N/N Cavity Bandpass Filter	none	none

Support Equipment

None required for power, bandwidth and associated antenna conducted emissions tests.

Power Supply and Line Filters

The EUT was powered from an AC-to-AC adapter that connected directly to the AC outlet. The adapter used during testing was:

Description	Manufacturer	Model
120V - 18V ac Transformer	Ault	316-4018-000A

Interface Cabling

During antenna-port conducted tests the antenna port of the radio was connected directly to either a spectrum analyzer (via 30dB attenuator, which was accounted for using a reference level offset of 30dB) or power meter.

General Test Conditions

During radiated testing, the EUT was connected to 120V, 60Hz power input. The EUT was located on a wooden table-top during the antenna port emissions tests.

Client:	ThruComm Inc.	Date:	4/29/98	Test Engr:	Mark Briggs
Product:	DP 1000	File:	T26390	Proj. Eng:	Mark Briggs
Objective:	Final Qualification	Site:	N/A	Contact:	Tom Dichiaro
Spec:	FCC Part 15.247	Page:	3 of 5	Approved:	

EUT Operating During Test

The EUT was operating either in a receive-only mode or in transceiver mode. In transceiver mode the unit was constantly transmitting on either the low, center or high channel using BPSK modulation under mode 1, 2 or 3. Refer to the individual test runs for operating mode during each run.

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
ThruComm/ RF	3116-0102	A	0002	39.3
ThruComm/ Digital	3011-0122	B	333	40, 7.3728

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
ThruComm/ 18 VAC Line Filter	3018-3041	-	none

EUT Enclosure(s)

The EUT enclosure is primarily constructed of extruded aluminum. It measures approximately 10.5 cm wide by 28.5 cm deep by 8.5 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
Shield, Synthesizer	Fotofab	3116-0110
Shield, RF Section	Fotofab	3116-0111
Partition, RF	Fotofab	3116-0112
Partition, IF	Fotofab	3116-0113
Gasket, TNC	Chomerics	3116-0114
18 VAC Line Filter	ThruComm	3018-3041

Test Data Tables

Run #1 - 6 dB Bandwidth Measurements

Mode (1,2 or 3)	6dB Bandwidth MHz	Graph
1	3.733	T26390/101
2	3.967	T26390/102
3	2.983	T26390/103

Mode 1 is BPSK @ 52.0 kbps, mode 2 is BPSK @ 105.6 kbps and mode 3 is BPSK @ 218.3 kbps. Bandwidth plots are given for each mode on the center channel. Measurements on the low and high channel were the same as those on the center channel for a given mode.

Minimum 6dB bandwidth per FCC §15.247 is 500KHz.

Run #2 - Output Power Measurements

Channel	Mode (1,2 or 3)	Output Power (dBm)
Center	1	25.1
Center	2	25.2
Center	3	25.2
Low	1	24.7
Low	2	25.0
Low	3	25.0
High	1	25.2
High	2	25.2
High	3	25.2

Maximum permitted output power is 30dBm - X, where X is equal to 0 for an antenna gain of less than 6dBi and equal to G-6 for gains greater than 6dBi.
The gains of the Omni Directional and Yagi antennas with their appropriate cabling are:

Yagi Antenna Gain = +9dBd (11.1 dBi)
Omni Antenna Gain +9dBd (11.1 dBi)
LMR 400 cable loss @ 4dB/100', 10' length loss = 0.4dB
Helix Cable loss @1.3dB/100', 30' length loss = 0.4dB
Cavity Bandpass filter loss = 1dB.

Overall gain of any permitted combination = 11.1 - 0.4 - 1 = 9.6dBi
Maximum permitted output power per FCC §15.247 = 26.4 dBm.

Run #3 - Power Spectral Density Measurements

Channel	Mode (1,2 or 3)	Power Density (dBm)	Graph
Center	1	5.7	T26390/301
Center	2	3.7	T26390/302
Center	3	3.7	T26390/303
Low	1	6.0	T26390/304
High	1	6.4	T26390/305
Low	2	3.9	T26390/306
High	2	4.7	T26390/307

Power spectral density (power in a 3KHz bandwidth averaged over a 1 second period) measured on the center channel for all three modes. As mode 1 had the highest power spectral density the spectral density on the low and high channels was then measured with the EUT operating on mode 1. Additional measurements were made on the high and low channel with the system operating on mode 2.

Maximum permitted power spectral density per FCC §15.247 is 8dBm.

Run #4 - Processing Gain Measurements

These were performed by Nova Engineering (who designed the product) using the jamming margin method. The test results are attached to this test log. Lowest Processing Gain was measured to be 11.4 with the unit operating under mode 2.

Run #5 - Out-Of-Band Conducted (Antenna Port) Measurements

Channel	Mode (1,2 or 3)	Graph	Comments
Low	1,2 & 3	T26390/501 - 503	To show out-of-band emissions at band edges
High	1,2 & 3	T26390/504 - 506	To show out-of-band emissions at band edges
Center	1	T26390/507-509	Out-of-band emissions, 30 - 10,000 MHz
Center	2	T26390/510-512	Out-of-band emissions, 30 - 10,000 MHz
Center	3	T26390/513-515	Out-of-band emissions, 30 - 10,000 MHz
High	1	T26390/516-518	Out-of-band emissions, 30 - 10,000 MHz
Low	1	T26390/519-521	Out-of-band emissions, 30 - 10,000 MHz

Graphs T26390/501 - 506 show the frequency range 895 - 930 MHz for high and low channels under operating modes 1,2 and 3. The purpose of these is to show that, at the band edges, the output power is more than 20dB below the fundamental level.

Plots are also included for the frequency range 30 - 10,000 MHz for the system operating on center channel under operating modes 1,2 and 3 and then on high and low channels operating under mode 1 (worst case mode for previous runs).

All out-of-band emissions were more than 20dB below the highest in-band level when measured in a 100 KHz bandwidth.

EUT Processing Gain Measurement

The EUT processing gain was measured by means of the jamming margin method specified in Appendix C of the FCC Report and Order, FCC 97-114, released 10 April 1997. The test configuration is illustrated in the attached diagram. The test method consists of stepping a synthesized signal generator in 50kHz increments across the passband of the EUT. In this case, the bandwidth of the passband is 6.3MHz, which matches the EUT IF filter 3.0dB bandwidth. At each point, the generator level required to produce a bit error rate (BER) of $1x10^{-5}$ is recorded. The resulting RF power corresponds to the jammer level. The RF output power of the transmitting unit is measured at the same location. The jammer to signal ratio (M_j) is then calculated. After M_j values at all jammer frequencies have been measured, the worst 20% of the M_j data points are then discarded. The lowest remaining M_j ratio is used to calculate the EUT processing gain (G_p).

In a practical system, there are always implementation losses (L_{sys}) which degrade performance below that of an optimal theoretical system of the same type. Losses occur due to suboptimal filtering, intersymbol interference, clock recovery jitter, lack of equalization, LO phase noise, and truncation errors in digital processing. The measured cumulative effect of these factors exceeds 2.0dB for the EUT and therefore L_{sys} has been set to this value in the following calculations.

The EUT produces a DPSK waveform at one of 3 user selectable data rates, designated in the EUT Test Plan as Modes 1, 2, and 3. The BER (P_e) that can be achieved from a given signal to noise ratio $(S/N)_o$ for ideal non-coherent DPSK receivers are:[1],[2]

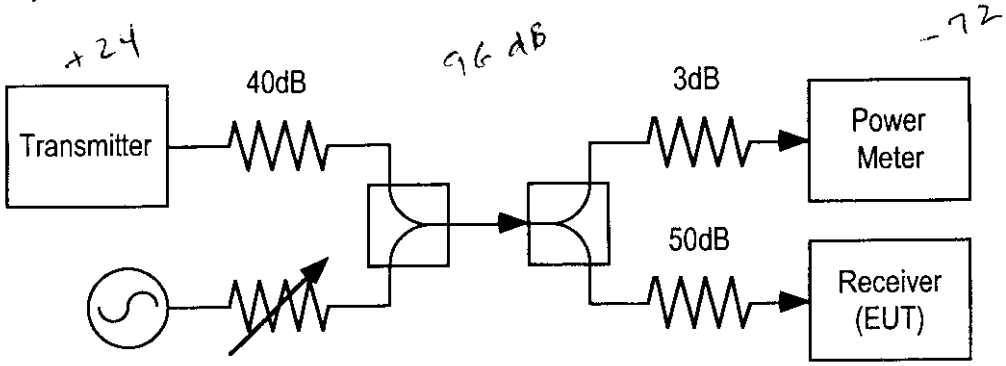
$$P_e = \frac{1}{2} e^{-(S/N)_o} \text{ for DPSK}$$

This equation reveals that the lowest value of $(S/N)_o$ that can deliver a BER of $1x10^{-5}$ for DPSK is 10.3dB.

The processing gain is related to other parameters quoted above through the equation:[3]

$$G_p = (S/N)_o + M_j + L_{sys}$$

The data on the following spreadsheet reveals that the value for M_j corresponds to +4.2, -0.9, and +0.9dB for the EUT when operated in Modes 1, 2, and 3, respectively. This indicates that the resulting processing gains, G_p, are 16.5, 11.4, and 13.2dB. This exceeds the 10.0dB minimum requirement established in §15.247(e) of the FCC regulations by 6.5, 1.4, and 3.2dB for EUT operating Modes 1, 2, and 3, respectively.



Processing Gain Test Setup

[1] Proakis, John G., Digital Communications, (New York: McGraw-Hill, 1983), pp. 171-175.
[2] Ha, Tri T., Digital Satellite Communications, (New York: McGraw-Hill, 1990), p. 421.
[3] Dixon, R., Spread Spectrum Systems, (New York: Wiley, 1984), Chapter 1.

ThruComm Processing Gain Measurement

Date: 20 Apr 98

52.0kbps BPSK

ThruComm #3 Length 63 PN Sequence

Transmit from SN0001 at +24dBm/915MHz, Receive at SN0004

System attenation equals 96dB, yielding -72dBm at Receiver

J/S Ratio at 0dBm from Sig Gen (dB) 15.2

Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)	Worst 20% Jammer/Signal Ratio	Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)
915.000	-19.0	-3.8	*	916.950	-8.0	7.2
914.050	-16.0	-0.8	*	917.100	-8.0	7.2
916.450	-16.0	-0.8	*	913.150	-7.0	8.2
913.550	-15.0	0.2	*	916.250	-7.0	8.2
913.850	-14.0	1.2	*	916.400	-7.0	8.2
914.650	-14.0	1.2	*	917.000	-7.0	8.2
914.800	-14.0	1.2	*	917.150	-7.0	8.2
915.550	-14.0	1.2	*	913.050	-6.0	9.2
915.950	-14.0	1.2	*	914.550	-6.0	9.2
913.400	-13.0	2.2	*	915.150	-6.0	9.2
913.450	-13.0	2.2	*	912.850	-5.0	10.2
913.900	-13.0	2.2	*	913.750	-5.0	10.2
914.950	-13.0	2.2	*	915.450	-5.0	10.2
915.350	-13.0	2.2	*	916.900	-5.0	10.2
915.600	-13.0	2.2	*	917.050	-5.0	10.2
916.150	-13.0	2.2	*	912.650	-4.0	11.2
913.950	-12.0	3.2	*	912.900	-4.0	11.2
914.200	-12.0	3.2	*	913.600	-4.0	11.2
914.600	-12.0	3.2	*	916.000	-4.0	11.2
915.200	-12.0	3.2	*	916.200	-4.0	11.2
915.400	-12.0	3.2	*	917.250	-4.0	11.2
916.550	-12.0	3.2	*	917.300	-4.0	11.2
916.750	-12.0	3.2	*	917.350	-4.0	11.2
913.300	-11.0	4.2	*	912.550	-3.0	12.2
914.150	-11.0	4.2	*	912.700	-3.0	12.2
914.350	-11.0	4.2		913.000	-3.0	12.2
914.400	-11.0	4.2		913.100	-3.0	12.2
914.450	-11.0	4.2		913.800	-3.0	12.2
914.750	-11.0	4.2		917.650	-3.0	12.2
914.900	-11.0	4.2		912.950	-2.0	13.2
915.650	-11.0	4.2		917.450	-2.0	13.2
916.100	-11.0	4.2		912.400	-1.0	14.2
916.350	-11.0	4.2		912.750	-1.0	14.2
916.600	-11.0	4.2		912.800	-1.0	14.2
913.250	-10.0	5.2		917.200	-1.0	14.2
913.350	-10.0	5.2		917.400	-1.0	14.2
914.100	-10.0	5.2		917.600	-1.0	14.2
914.300	-10.0	5.2		912.450	0.0	15.2
914.500	-10.0	5.2		912.500	0.0	15.2
914.700	-10.0	5.2		912.600	1.0	16.2
915.050	-10.0	5.2		917.500	1.0	16.2
915.250	-10.0	5.2		917.550	1.0	16.2
915.500	-10.0	5.2		912.300	3.0	18.2
915.700	-10.0	5.2		912.350	3.0	18.2
915.800	-10.0	5.2		917.700	3.0	18.2
915.850	-10.0	5.2		917.900	3.0	18.2
915.900	-10.0	5.2		912.100	5.0	20.2
916.050	-10.0	5.2		912.200	5.0	20.2
916.300	-10.0	5.2		912.250	5.0	20.2
916.700	-10.0	5.2		912.150	6.0	21.2
916.800	-10.0	5.2		917.750	6.0	21.2
913.500	-9.0	6.2		917.800	6.0	21.2
913.650	-9.0	6.2		917.850	6.0	21.2
914.850	-9.0	6.2		912.050	7.0	22.2
915.100	-9.0	6.2		917.950	7.0	22.2
915.300	-9.0	6.2		911.950	9.0	24.2
916.500	-9.0	6.2		912.000	9.0	24.2
916.650	-9.0	6.2		918.000	9.0	24.2
916.850	-9.0	6.2		911.900	10.0	25.2
913.200	-8.0	7.2		918.050	10.0	25.2
913.700	-8.0	7.2		911.850	11.0	26.2
914.000	-8.0	7.2		918.100	11.0	26.2
914.250	-8.0	7.2		918.150	12.0	27.2

65 1/2
126
7.2
25

ThruComm Processing Gain Measurement

Date: 20 Apr 98

105.6kbps BPSK

ThruComm #3 Length 31 PN Sequence

Transmit from SN0001 at +24dBm/915MHz, Receive at SN0004

System attenation equals 96dB, yielding -72dBm at Receiver

J/S Ratio at 0dBm from Sig Gen (dB) 15.1

Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)	Worst 20% Jammer/Signal Ratio	Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)
914.700	-20.0	-4.9	*	914.200	-12.0	3.1
914.850	-20.0	-4.9	*	914.400	-12.0	3.1
913.600	-19.0	-3.9	*	915.400	-12.0	3.1
914.050	-19.0	-3.9	*	916.000	-12.0	3.1
914.550	-19.0	-3.9	*	916.600	-12.0	3.1
915.650	-19.0	-3.9	*	912.750	-11.0	4.1
915.700	-19.0	-3.9	*	913.000	-11.0	4.1
916.050	-19.0	-3.9	*	913.300	-11.0	4.1
913.550	-18.0	-2.9	*	913.400	-11.0	4.1
914.100	-18.0	-2.9	*	915.050	-11.0	4.1
914.500	-18.0	-2.9	*	915.250	-11.0	4.1
914.800	-18.0	-2.9	*	916.500	-11.0	4.1
915.100	-18.0	-2.9	*	916.650	-11.0	4.1
915.200	-18.0	-2.9	*	916.900	-11.0	4.1
916.100	-18.0	-2.9	*	917.200	-11.0	4.1
914.650	-17.0	-1.9	*	912.600	-10.0	5.1
915.150	-17.0	-1.9	*	912.850	-10.0	5.1
915.500	-17.0	-1.9	*	912.950	-10.0	5.1
916.700	-17.0	-1.9	*	914.950	-10.0	5.1
913.100	-16.0	-0.9	*	915.800	-10.0	5.1
913.150	-16.0	-0.9	*	916.950	-10.0	5.1
914.150	-16.0	-0.9	*	917.000	-10.0	5.1
914.350	-16.0	-0.9	*	917.100	-10.0	5.1
914.600	-16.0	-0.9	*	912.800	-9.0	6.1
915.450	-16.0	-0.9	*	917.050	-9.0	6.1
915.550	-16.0	-0.9		917.250	-9.0	6.1
915.750	-16.0	-0.9		913.250	-8.0	7.1
915.900	-16.0	-0.9		912.500	-7.0	8.1
916.150	-16.0	-0.9		912.550	-7.0	8.1
916.200	-16.0	-0.9		916.750	-7.0	8.1
916.550	-16.0	-0.9		917.400	-7.0	8.1
913.650	-15.0	0.1		912.900	-6.0	9.1
913.750	-15.0	0.1		913.350	-6.0	9.1
913.950	-15.0	0.1		917.300	-6.0	9.1
914.900	-15.0	0.1		917.350	-6.0	9.1
915.000	-15.0	0.1		912.350	-5.0	10.1
915.350	-15.0	0.1		912.450	-5.0	10.1
915.950	-15.0	0.1		917.550	-5.0	10.1
916.400	-15.0	0.1		912.400	-4.0	11.1
916.450	-15.0	0.1		917.500	-4.0	11.1
913.700	-14.0	1.1		917.600	-4.0	11.1
914.000	-14.0	1.1		917.650	-4.0	11.1
914.450	-14.0	1.1		917.750	-4.0	11.1
915.300	-14.0	1.1		912.200	-3.0	12.1
915.850	-14.0	1.1		912.250	-3.0	12.1
912.650	-13.0	2.1		917.450	-3.0	12.1
913.050	-13.0	2.1		917.800	-2.0	13.1
913.200	-13.0	2.1		912.150	-1.0	14.1
913.800	-13.0	2.1		917.700	0.0	15.1
913.900	-13.0	2.1		917.850	0.0	15.1
914.250	-13.0	2.1		918.000	0.0	15.1
914.300	-13.0	2.1		912.050	1.0	16.1
914.750	-13.0	2.1		912.100	1.0	16.1
915.600	-13.0	2.1		912.300	1.0	16.1
916.250	-13.0	2.1		917.900	1.0	16.1
916.300	-13.0	2.1		911.950	2.0	17.1
916.350	-13.0	2.1		912.000	2.0	17.1
916.800	-13.0	2.1		917.950	2.0	17.1
916.850	-13.0	2.1		911.850	3.0	18.1
917.150	-13.0	2.1		911.900	3.0	18.1
912.700	-12.0	3.1		918.050	3.0	18.1
913.450	-12.0	3.1		918.100	3.0	18.1
913.500	-12.0	3.1		918.150	4.0	19.1

ThruComm Processing Gain Measurement

Date: 20 Apr 98

218.3kbps BPSK

ThruComm #3 Length 15 PN Sequence

Transmit from SN0001 at +24dBm/915MHz, Receive at SN0004

System attenation equals 96dB, yielding -72dBm at Receiver

J/S Ratio at 0dBm from Sig Gen (dB) 14.9

Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)	Worst 20% Jammer/Signal Ratio
914.900	-17.0	-2.1	*
915.050	-17.0	-2.1	*
915.100	-17.0	-2.1	*
915.150	-17.0	-2.1	*
914.850	-16.0	-1.1	*
914.950	-16.0	-1.1	*
915.000	-16.0	-1.1	*
915.350	-16.0	-1.1	*
915.400	-16.0	-1.1	*
914.550	-15.0	-0.1	*
914.600	-15.0	-0.1	*
914.650	-15.0	-0.1	*
914.800	-15.0	-0.1	*
915.200	-15.0	-0.1	*
915.450	-15.0	-0.1	*
915.750	-15.0	-0.1	*
915.800	-15.0	-0.1	*
916.000	-15.0	-0.1	*
916.050	-15.0	-0.1	*
913.950	-14.0	0.9	*
914.000	-14.0	0.9	*
914.050	-14.0	0.9	*
914.150	-14.0	0.9	*
914.200	-14.0	0.9	*
914.250	-14.0	0.9	*
914.500	-14.0	0.9	
914.700	-14.0	0.9	
915.300	-14.0	0.9	
915.500	-14.0	0.9	
915.650	-14.0	0.9	
915.700	-14.0	0.9	
915.850	-14.0	0.9	
915.900	-14.0	0.9	
915.950	-14.0	0.9	
916.100	-14.0	0.9	
913.900	-13.0	1.9	
914.100	-13.0	1.9	
914.300	-13.0	1.9	
914.350	-13.0	1.9	
914.400	-13.0	1.9	
914.450	-13.0	1.9	
914.750	-13.0	1.9	
915.250	-13.0	1.9	
915.550	-13.0	1.9	
915.600	-13.0	1.9	
916.250	-13.0	1.9	
916.300	-13.0	1.9	
916.350	-13.0	1.9	
916.400	-13.0	1.9	
916.450	-13.0	1.9	
916.500	-13.0	1.9	
916.550	-13.0	1.9	
913.450	-12.0	2.9	
913.500	-12.0	2.9	
913.550	-12.0	2.9	
913.600	-12.0	2.9	
913.650	-12.0	2.9	
913.700	-12.0	2.9	
913.750	-12.0	2.9	
916.150	-12.0	2.9	
916.200	-12.0	2.9	
916.600	-12.0	2.9	
916.650	-12.0	2.9	

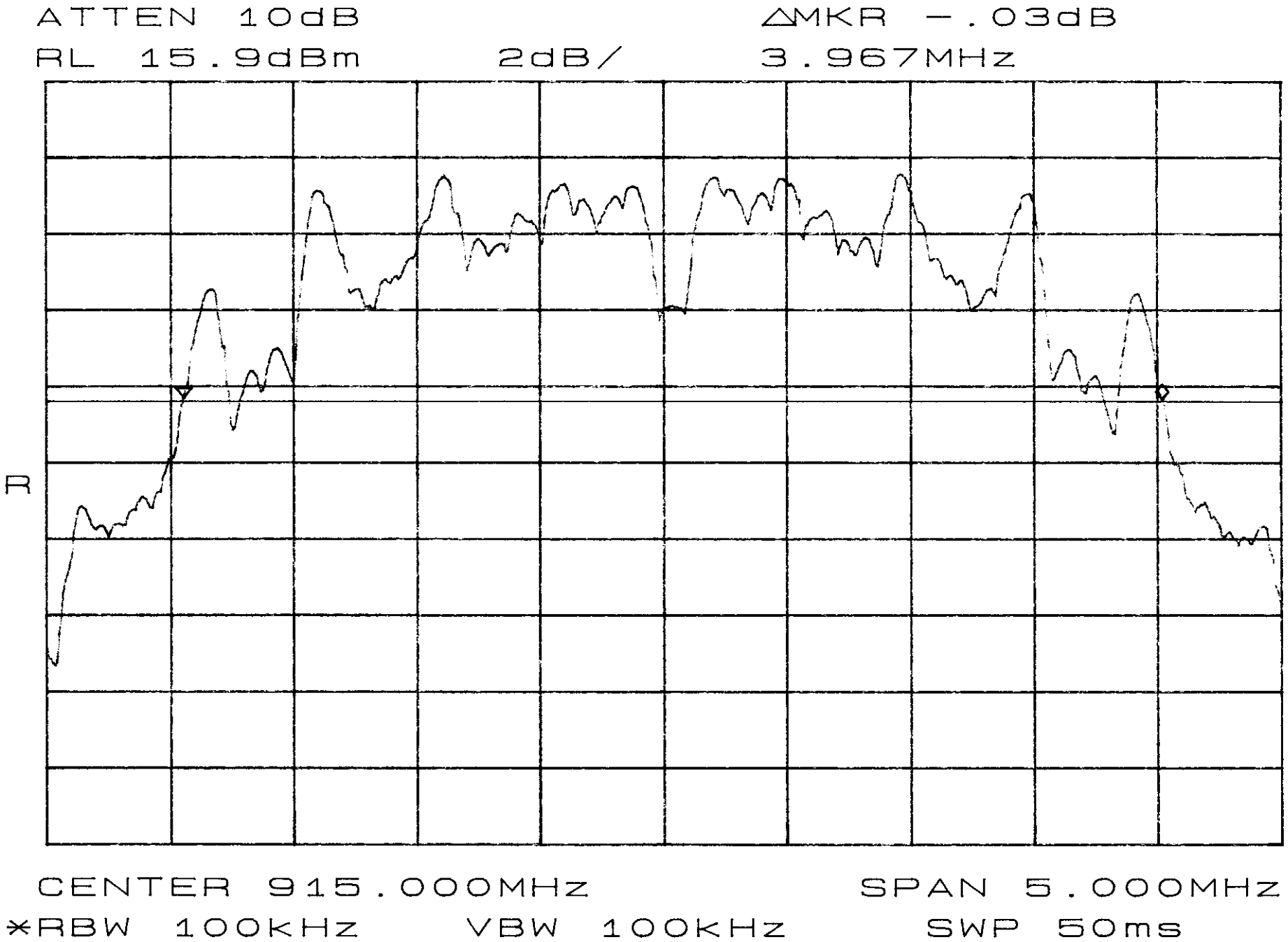
Jammer RF Frequency (MHz)	Sig Gen Level at 10^-5 BER (dBm)	Jammer/Signal Ratio (dB)
916.750	-12.0	2.9
916.800	-12.0	2.9
916.850	-12.0	2.9
913.250	-11.0	3.9
913.300	-11.0	3.9
913.350	-11.0	3.9
913.400	-11.0	3.9
913.800	-11.0	3.9
913.850	-11.0	3.9
916.900	-11.0	3.9
916.950	-11.0	3.9
917.000	-11.0	3.9
917.050	-11.0	3.9
917.200	-11.0	3.9
913.050	-10.0	4.9
913.100	-10.0	4.9
913.150	-10.0	4.9
913.200	-10.0	4.9
917.100	-10.0	4.9
917.150	-10.0	4.9
917.250	-10.0	4.9
917.300	-10.0	4.9
917.350	-10.0	4.9
917.400	-10.0	4.9
912.600	-9.0	5.9
912.650	-9.0	5.9
912.700	-9.0	5.9
912.750	-9.0	5.9
912.800	-9.0	5.9
912.850	-9.0	5.9
912.900	-9.0	5.9
912.950	-9.0	5.9
913.000	-9.0	5.9
917.450	-9.0	5.9
917.500	-9.0	5.9
917.550	-9.0	5.9
917.600	-9.0	5.9
917.650	-9.0	5.9
912.200	-8.0	6.9
912.300	-8.0	6.9
912.350	-8.0	6.9
912.400	-8.0	6.9
912.450	-8.0	6.9
912.500	-8.0	6.9
912.550	-8.0	6.9
917.700	-8.0	6.9
917.750	-8.0	6.9
917.800	-8.0	6.9
912.100	-7.0	7.9
912.150	-7.0	7.9
912.250	-7.0	7.9
917.850	-7.0	7.9
917.900	-7.0	7.9
911.950	-6.0	8.9
912.000	-6.0	8.9
912.050	-6.0	8.9
917.950	-6.0	8.9
918.000	-6.0	8.9
911.850	-5.0	9.9
911.900	-5.0	9.9
918.050	-5.0	9.9
918.100	-5.0	9.9
918.150	-4.0	10.9

EXHIBIT C

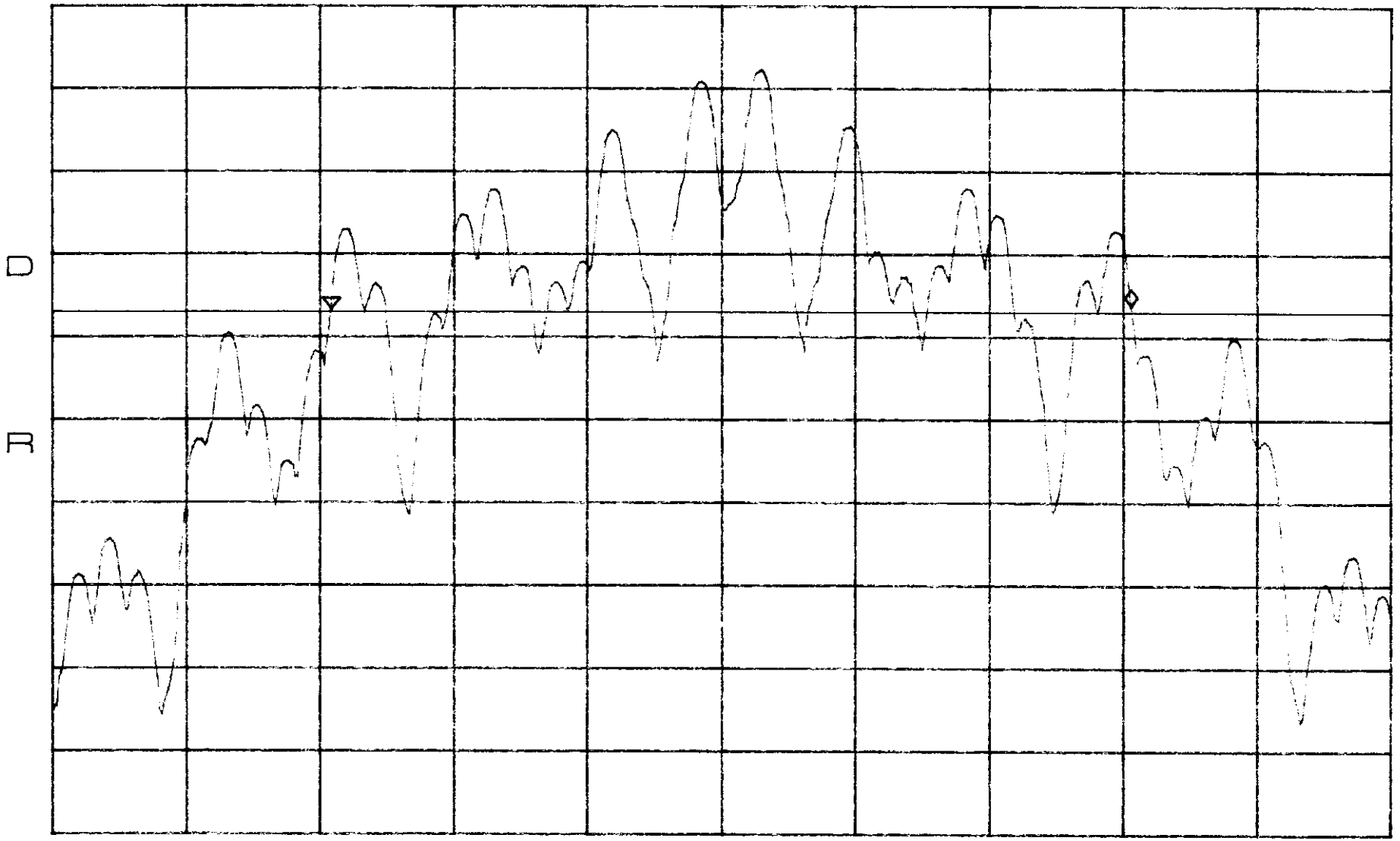
Photographs of Test Configurations

Mode 2

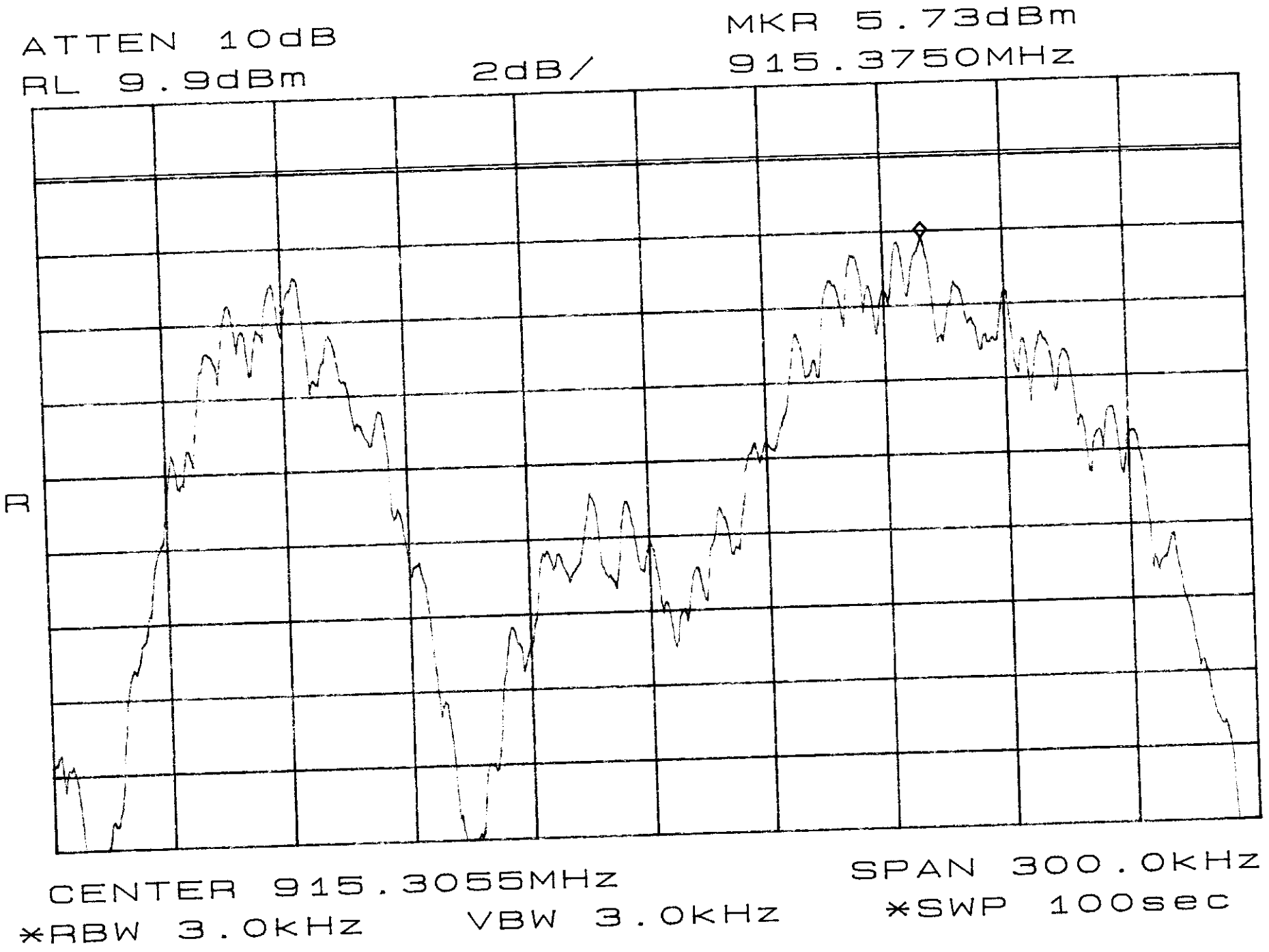
T26390/102
(Mode 2 6dB Bandwidth)



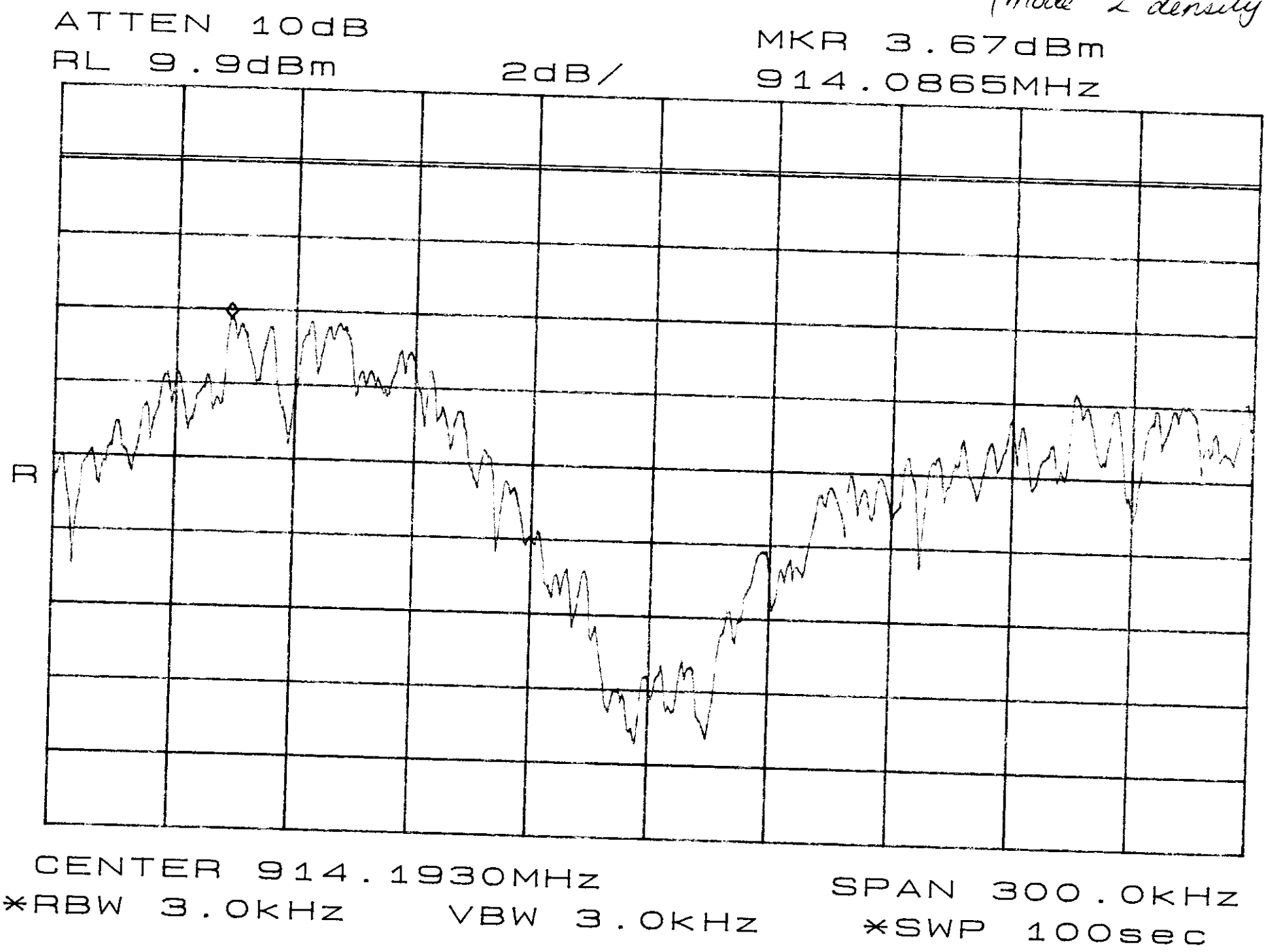
T26390/103
(Mode 3 6dB Bandwidth)



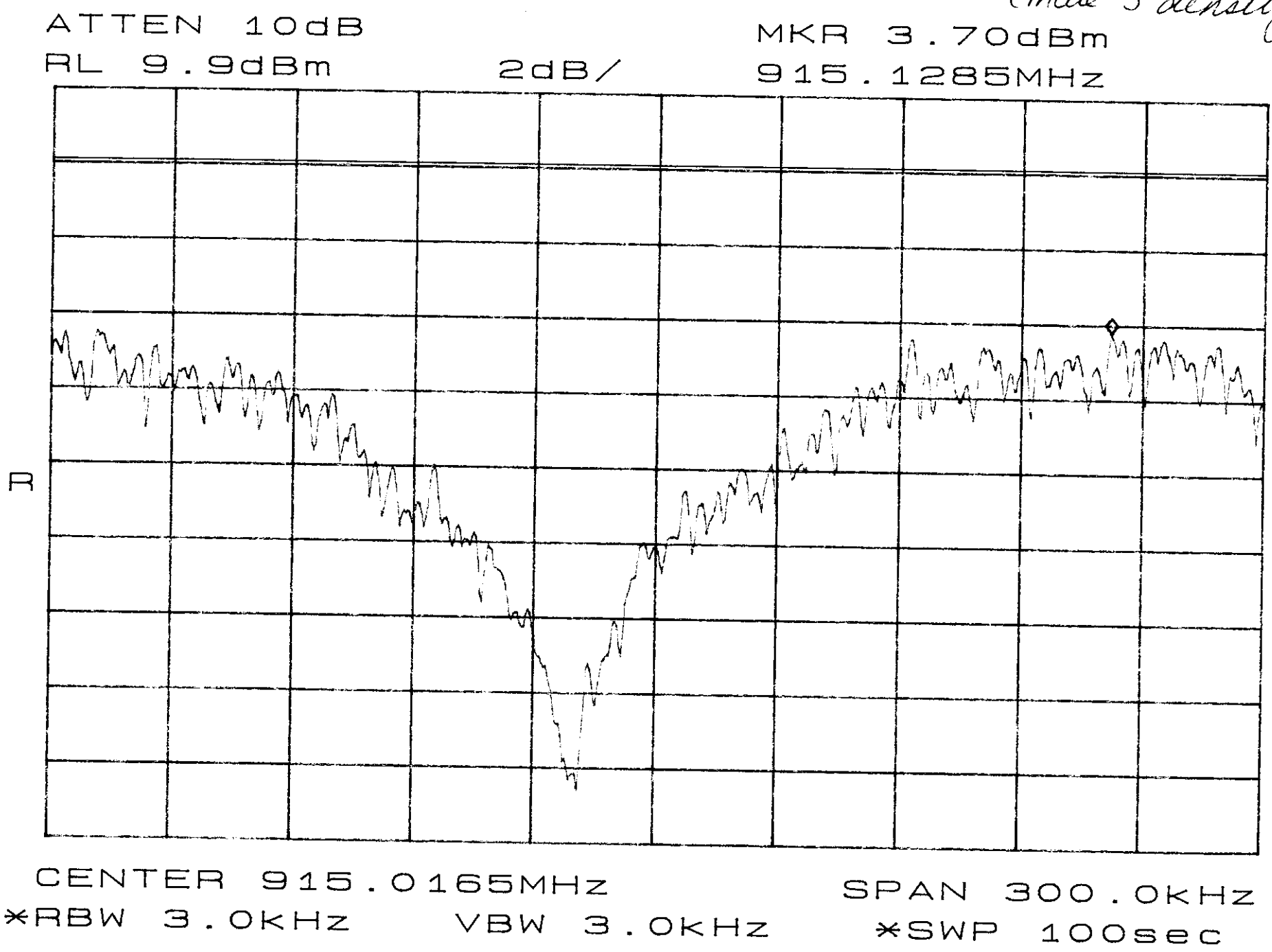
T26390/301
(Mode 1, Density)



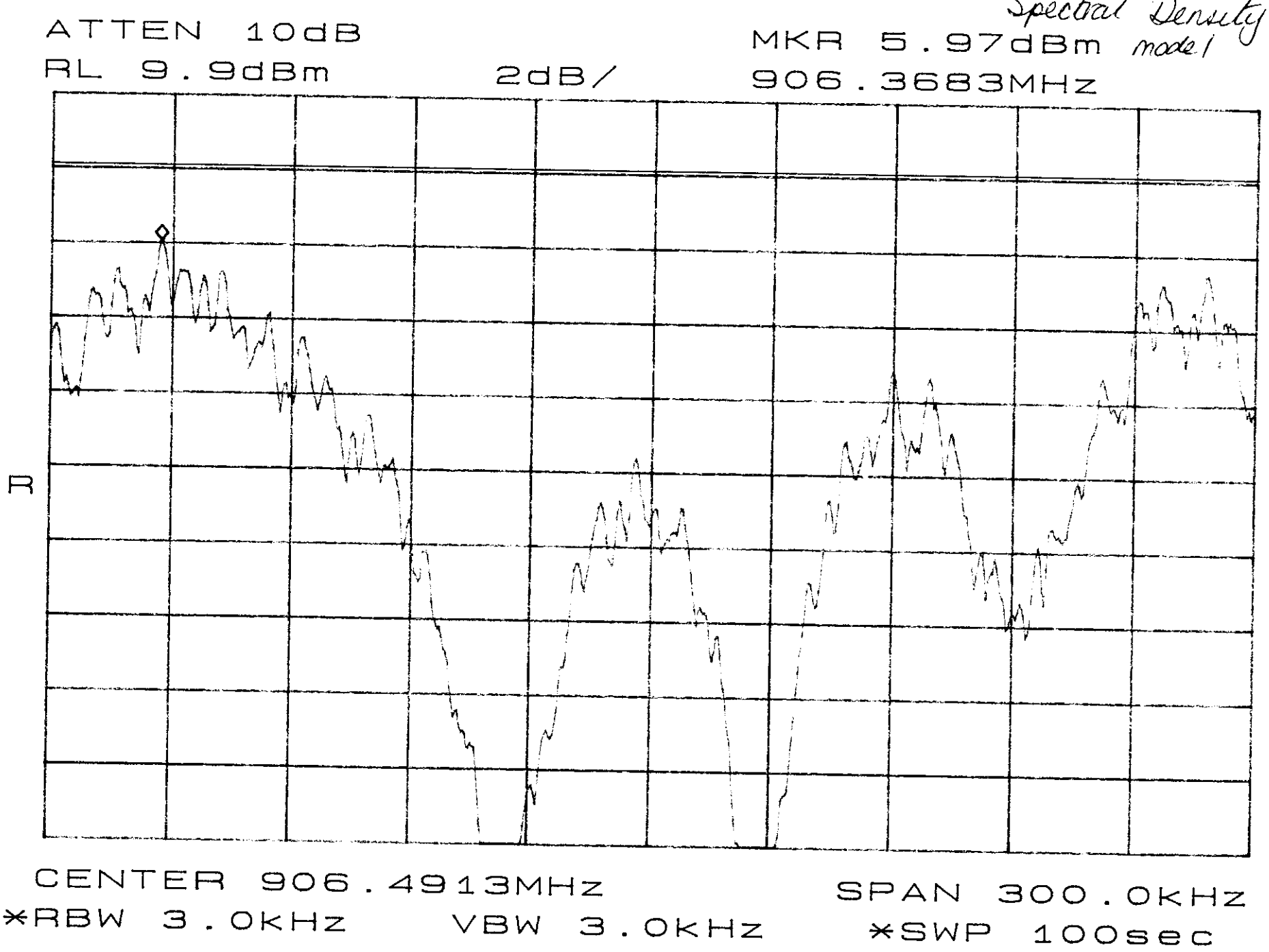
T28390/302
(mode 2 density)



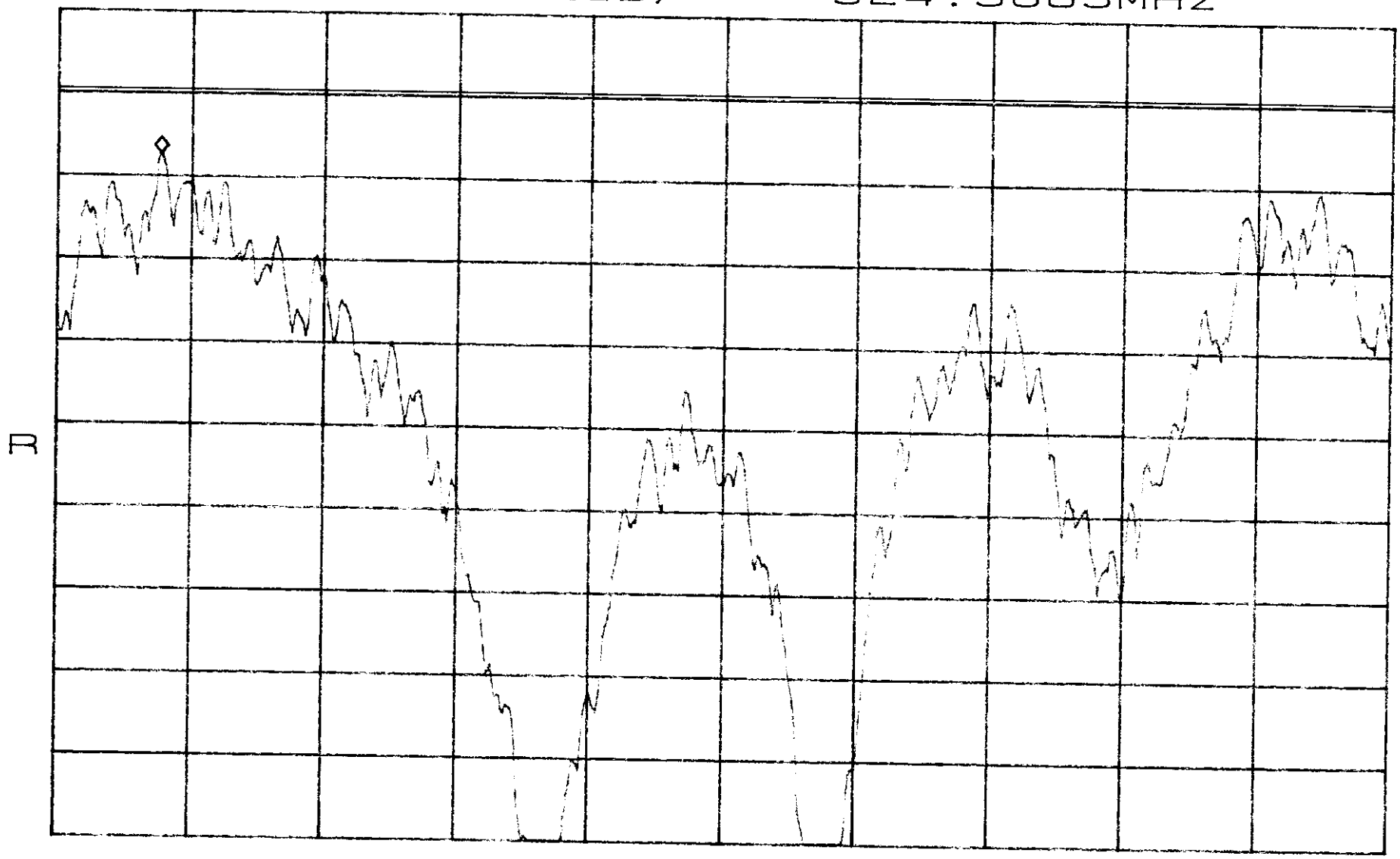
T26390/303
(mode 3 density)



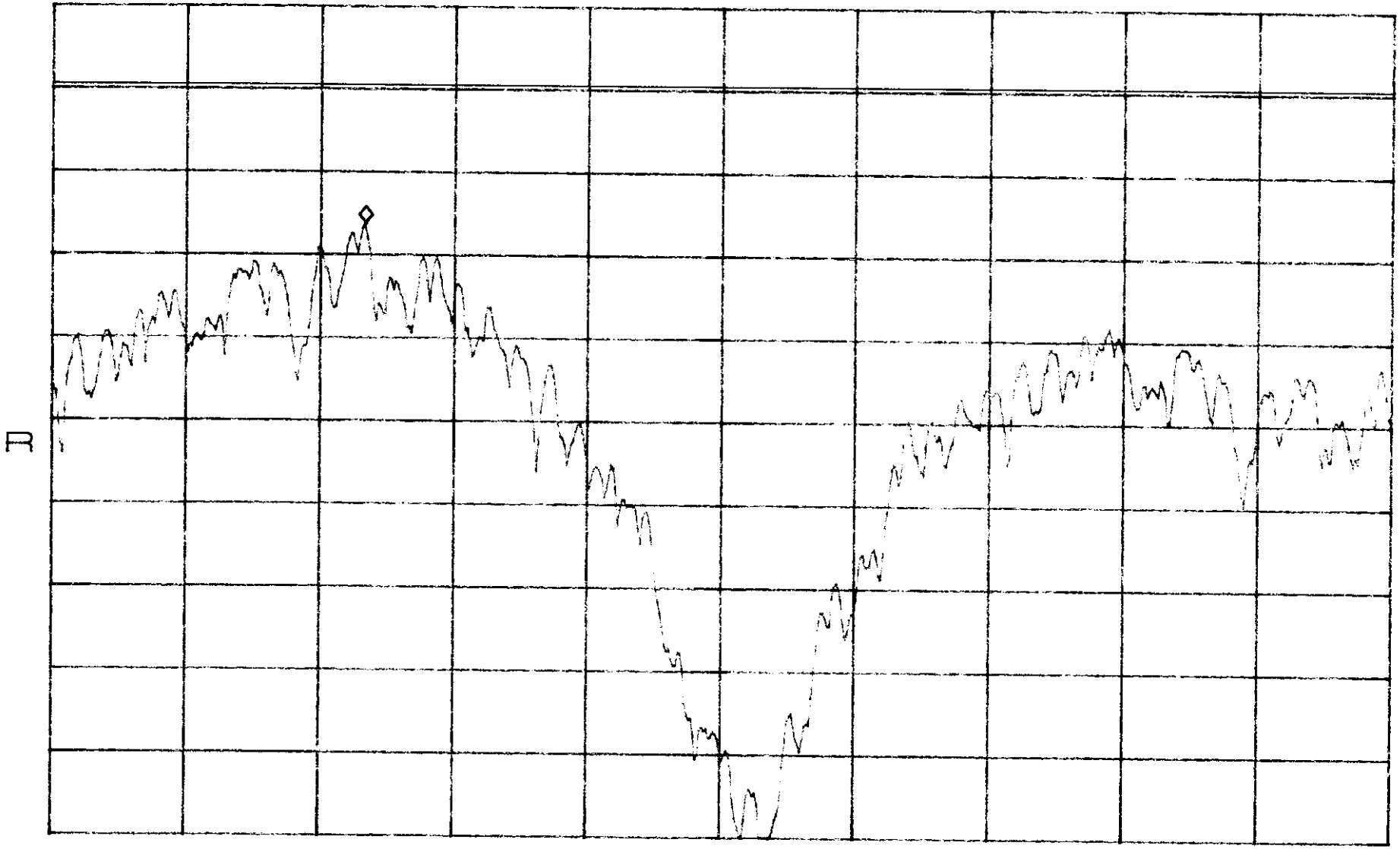
T26390/304
Spectral Density
model



T26390/305
Spectral Density
mode 1

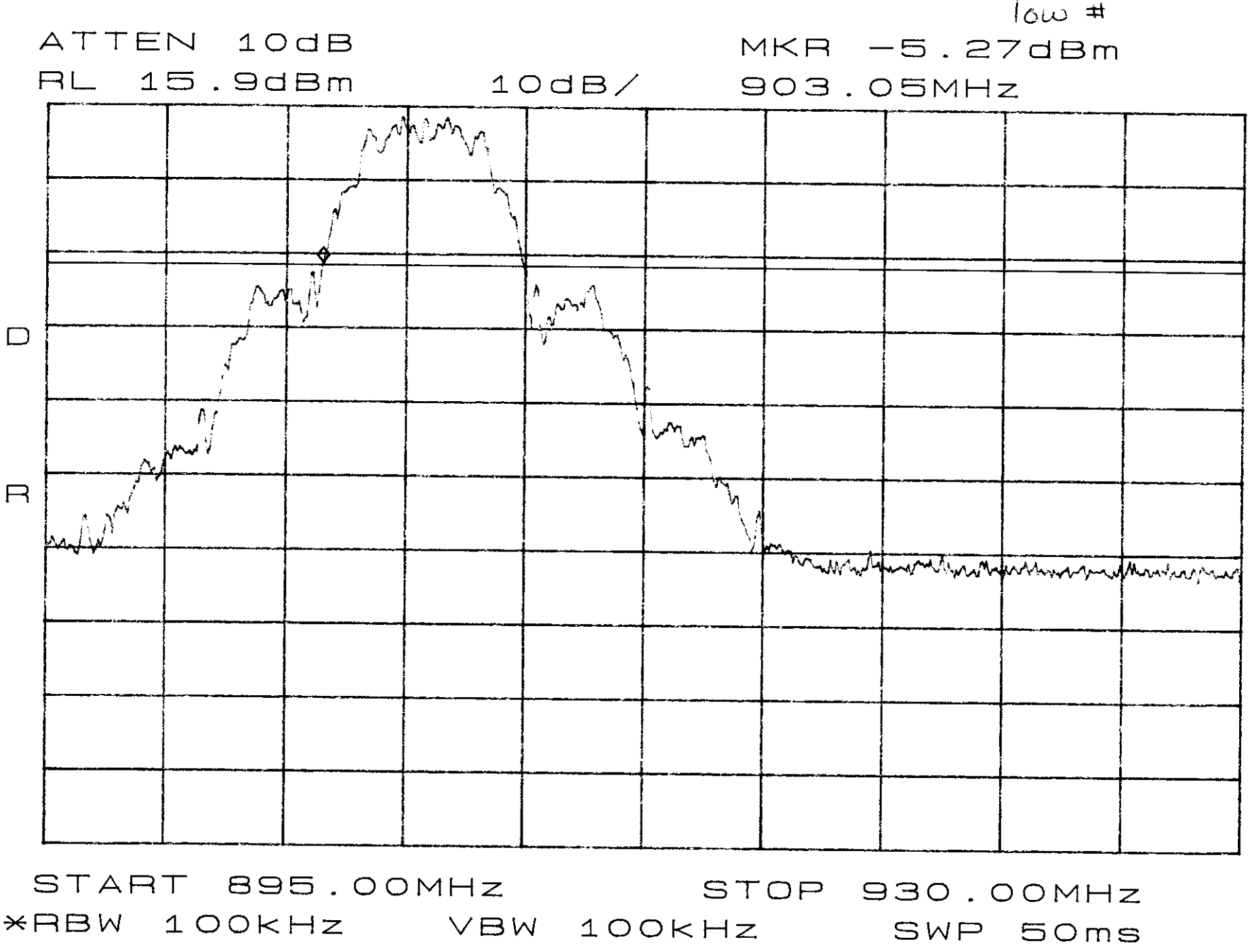


T26390/307
Spectral density
mode 2



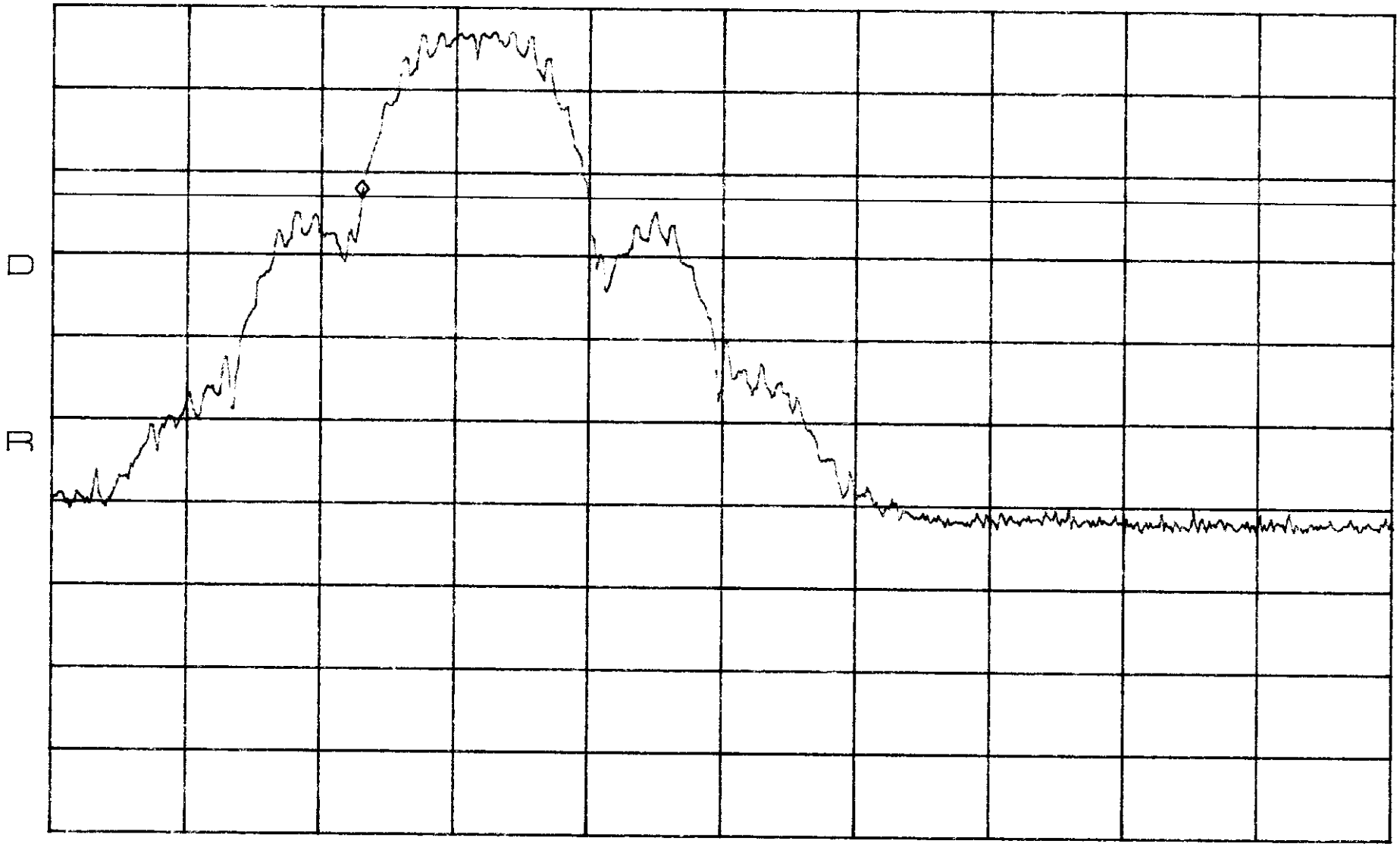
Mode 1

T26390/501
low #

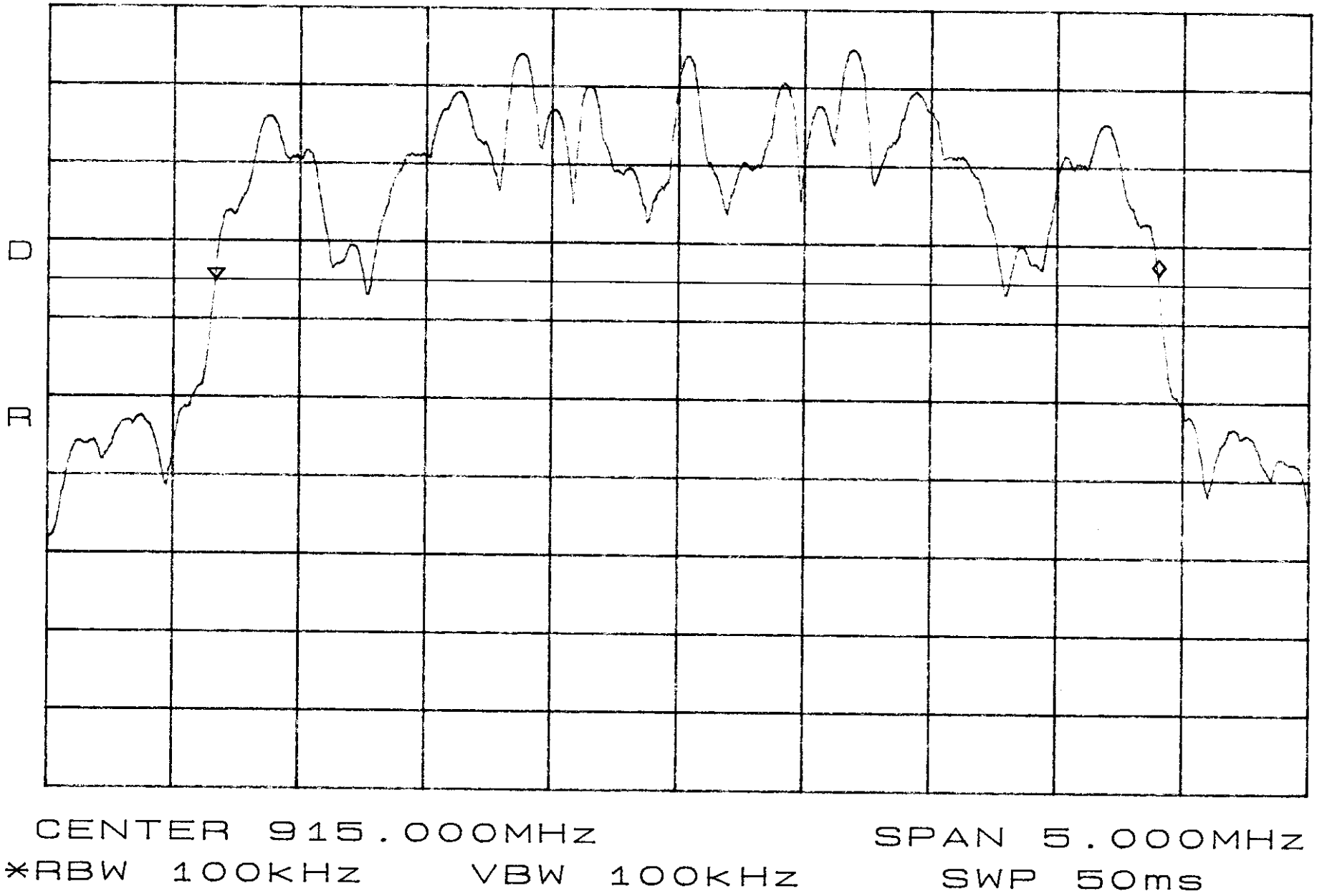


Mode 2

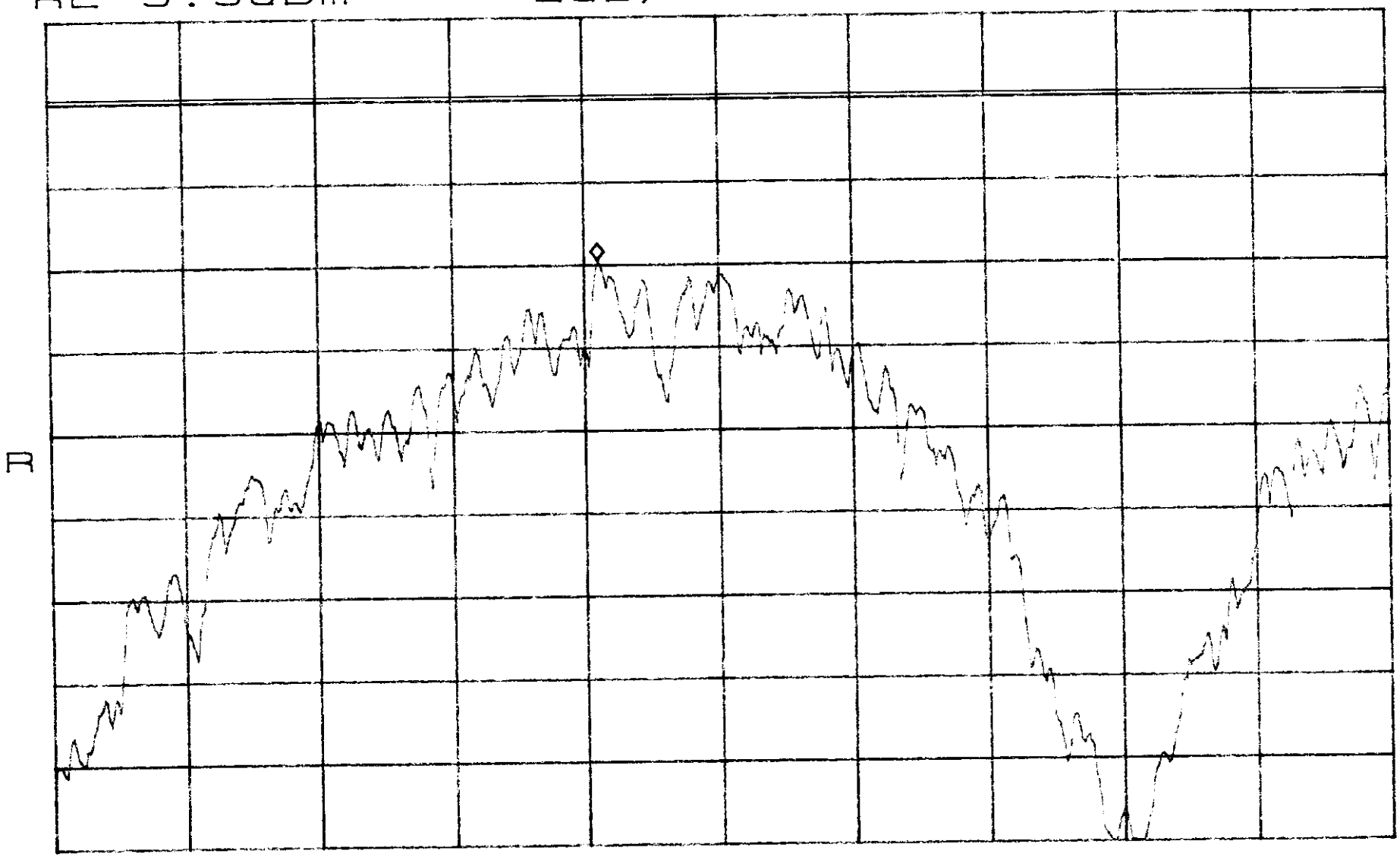
T26390/502
low #



T26390/101
(Mode 1 6dB Bandwidth)

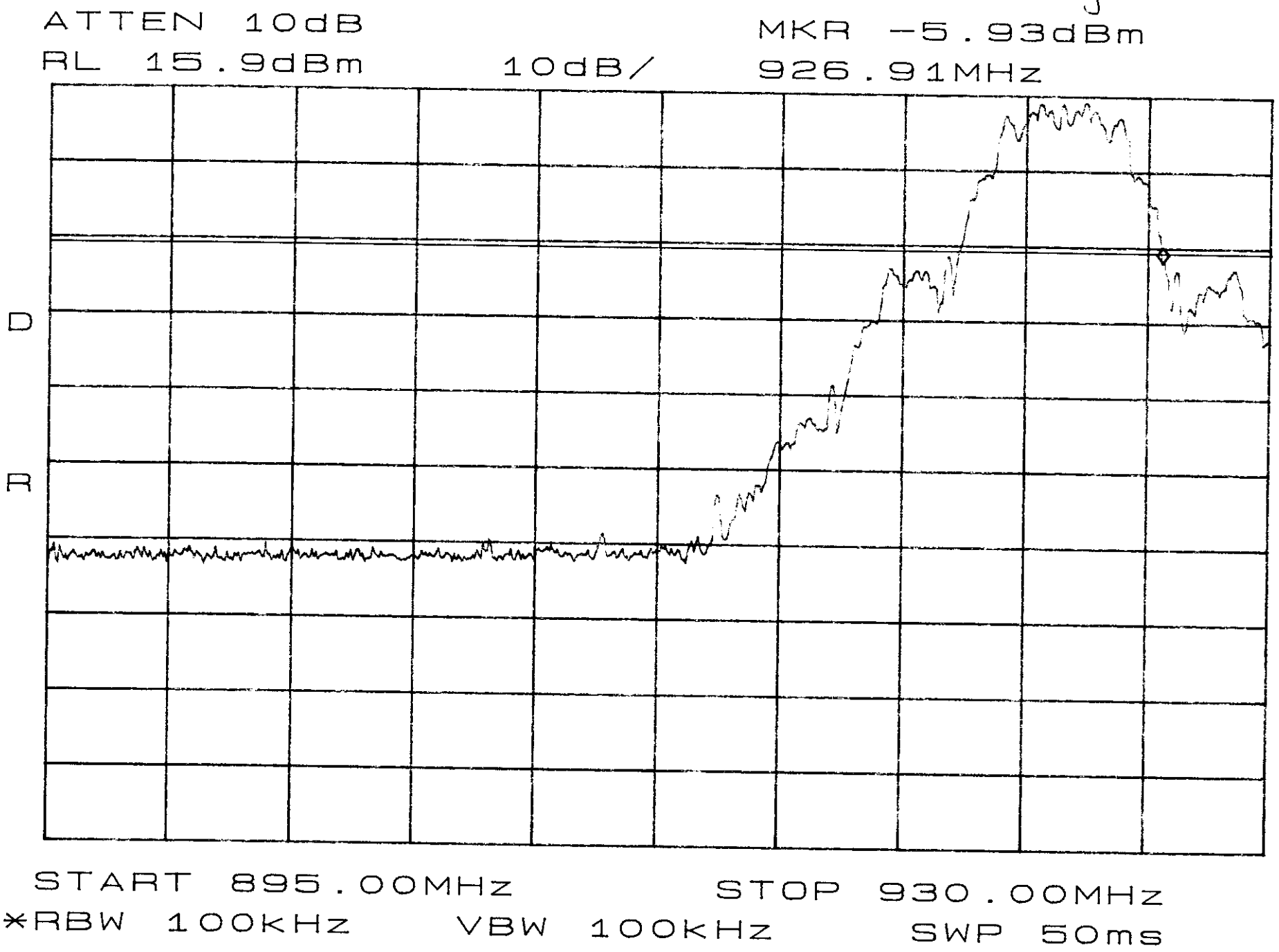


T26390/306
Spectral density
mode 2



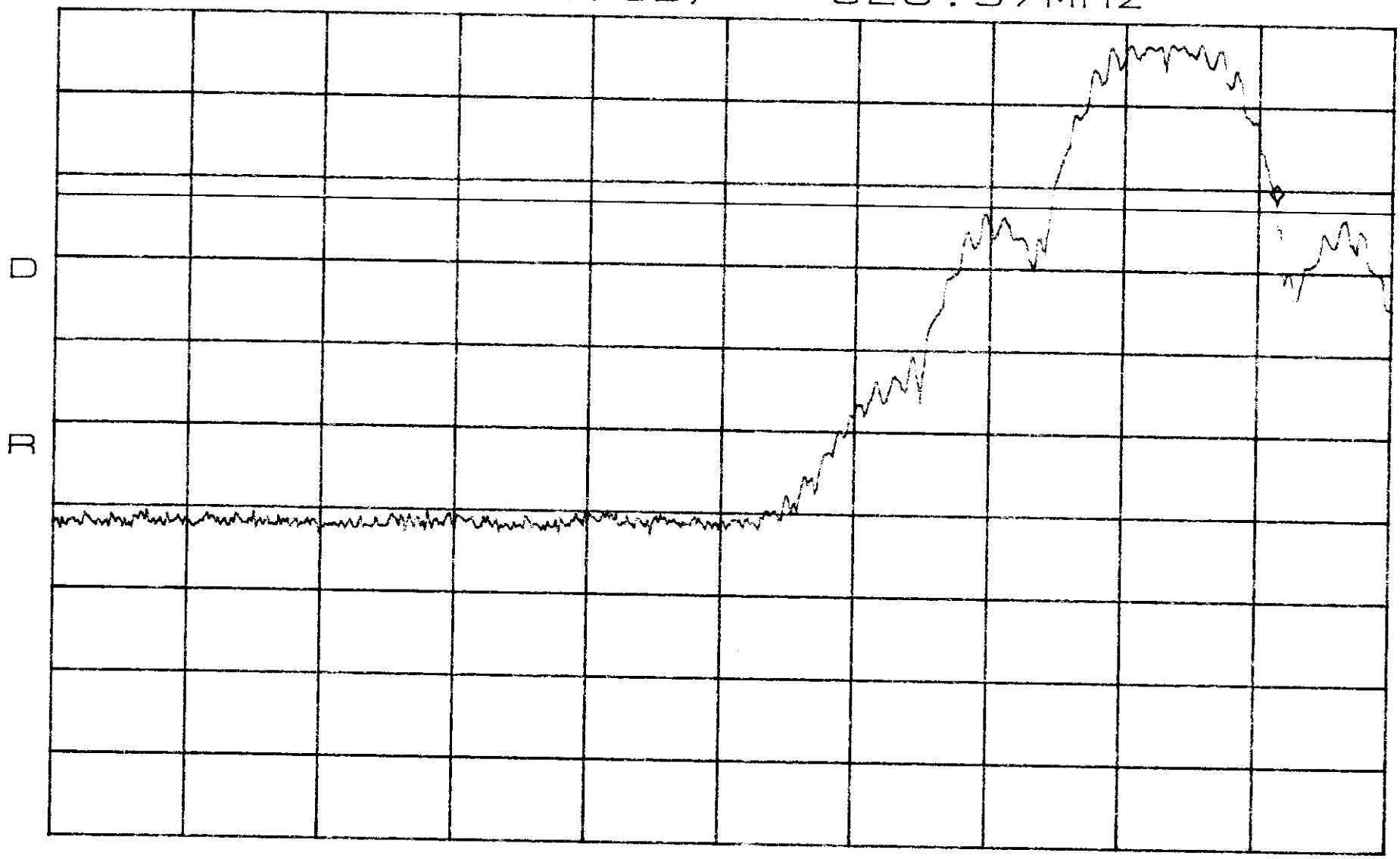
Mode 1

T26390/504
High #



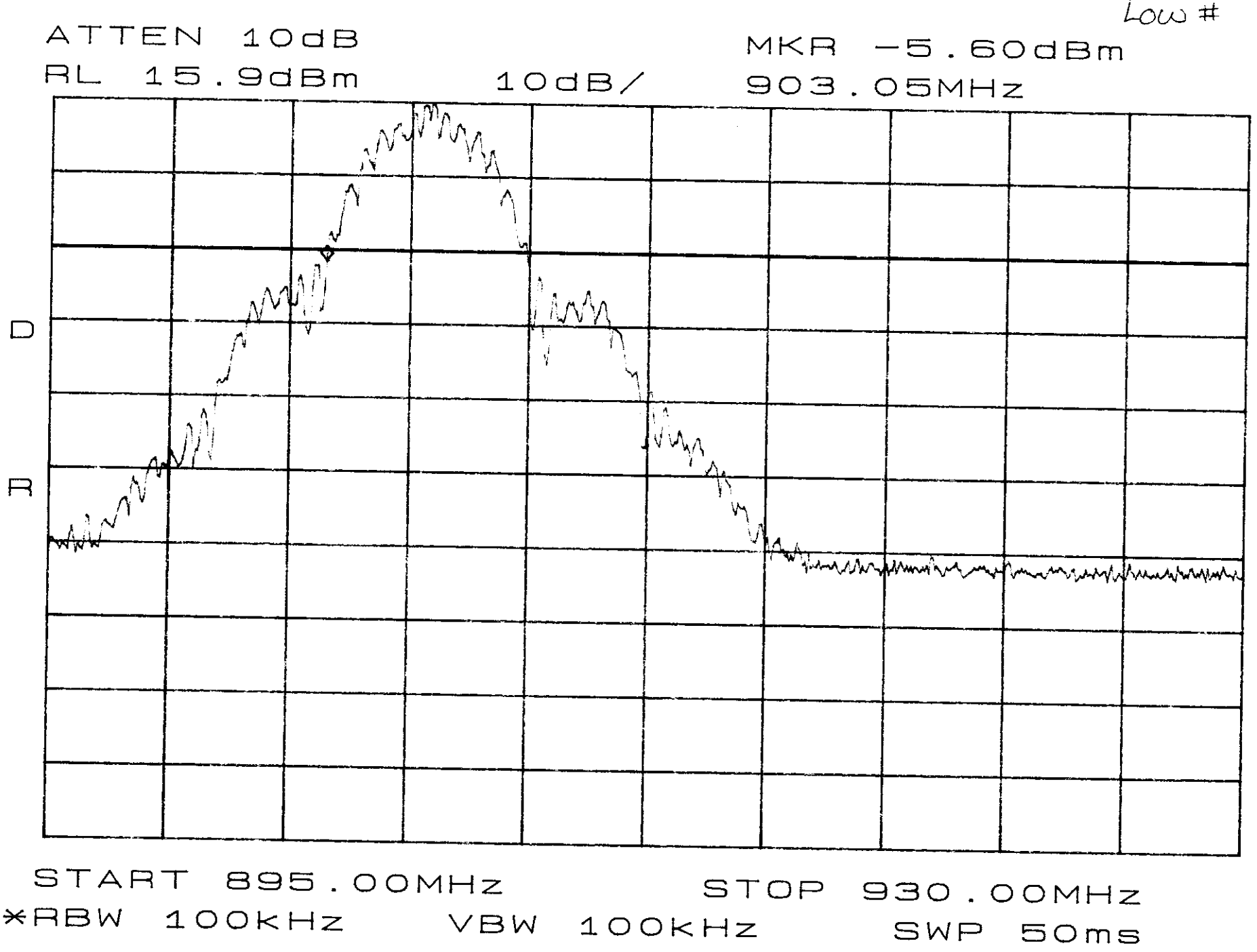
Mode 2

T26390/505
high #



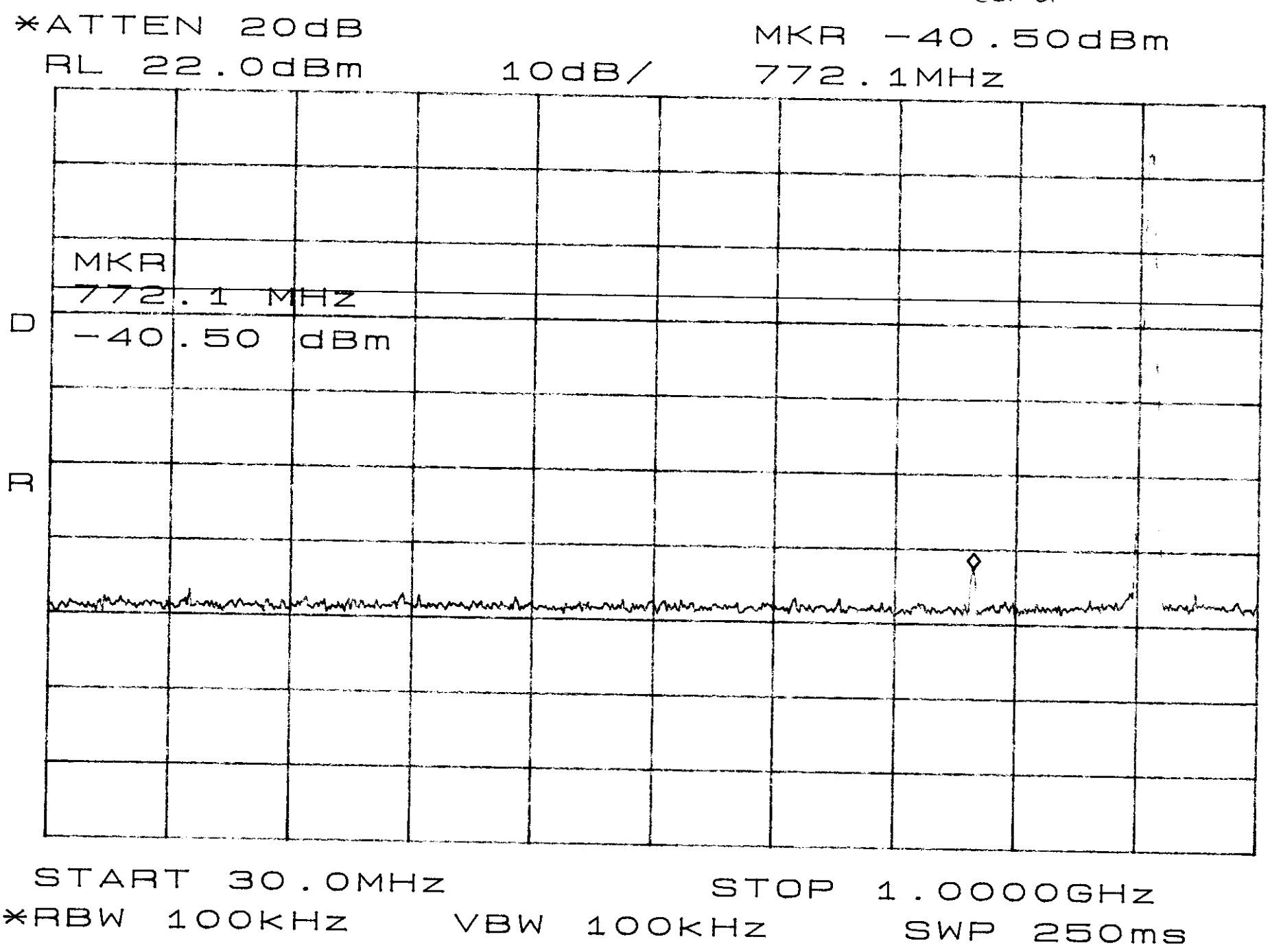
Mode 3

T26390/506
Low #



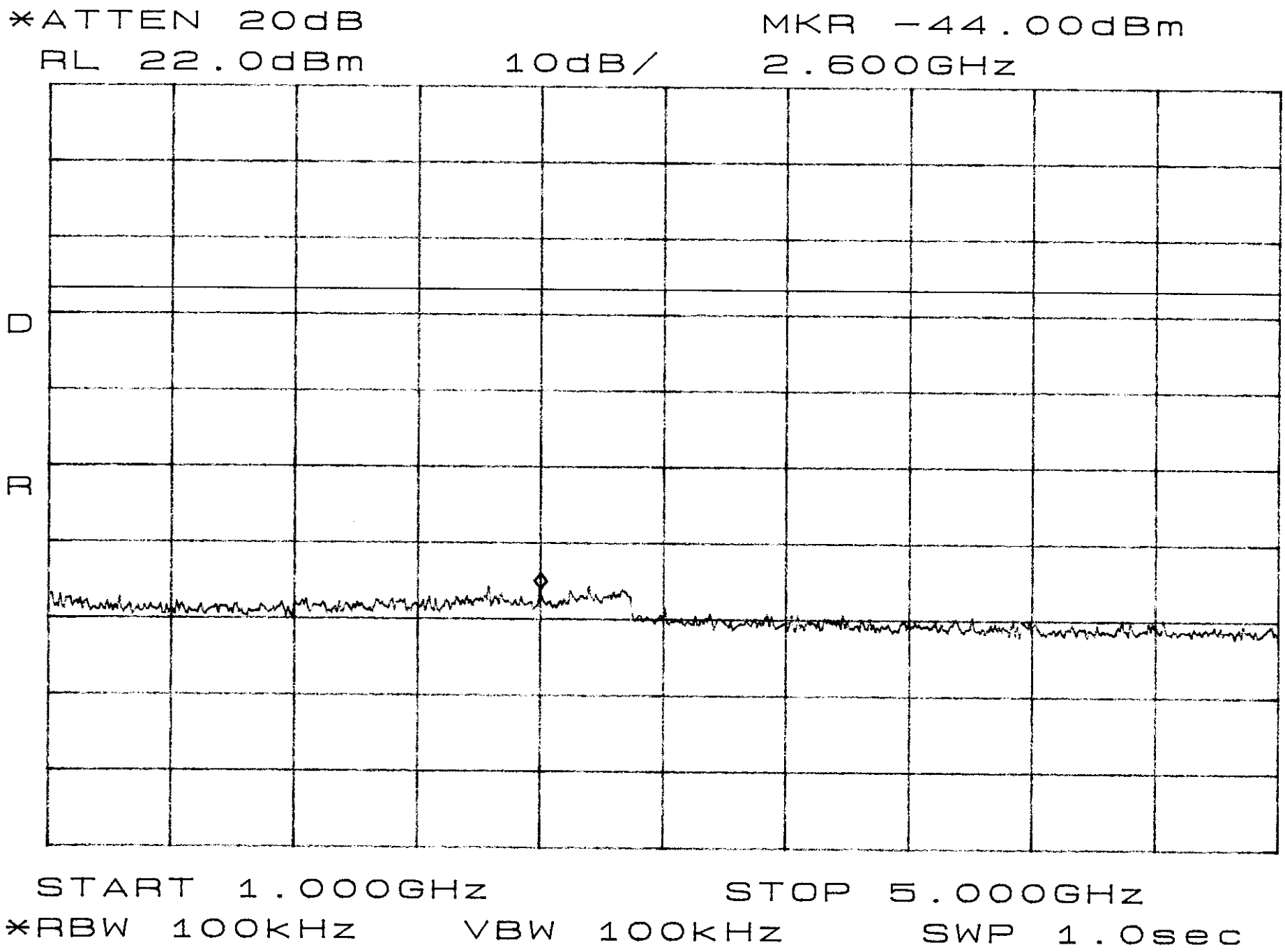
Mode 1

T26390/507
center #



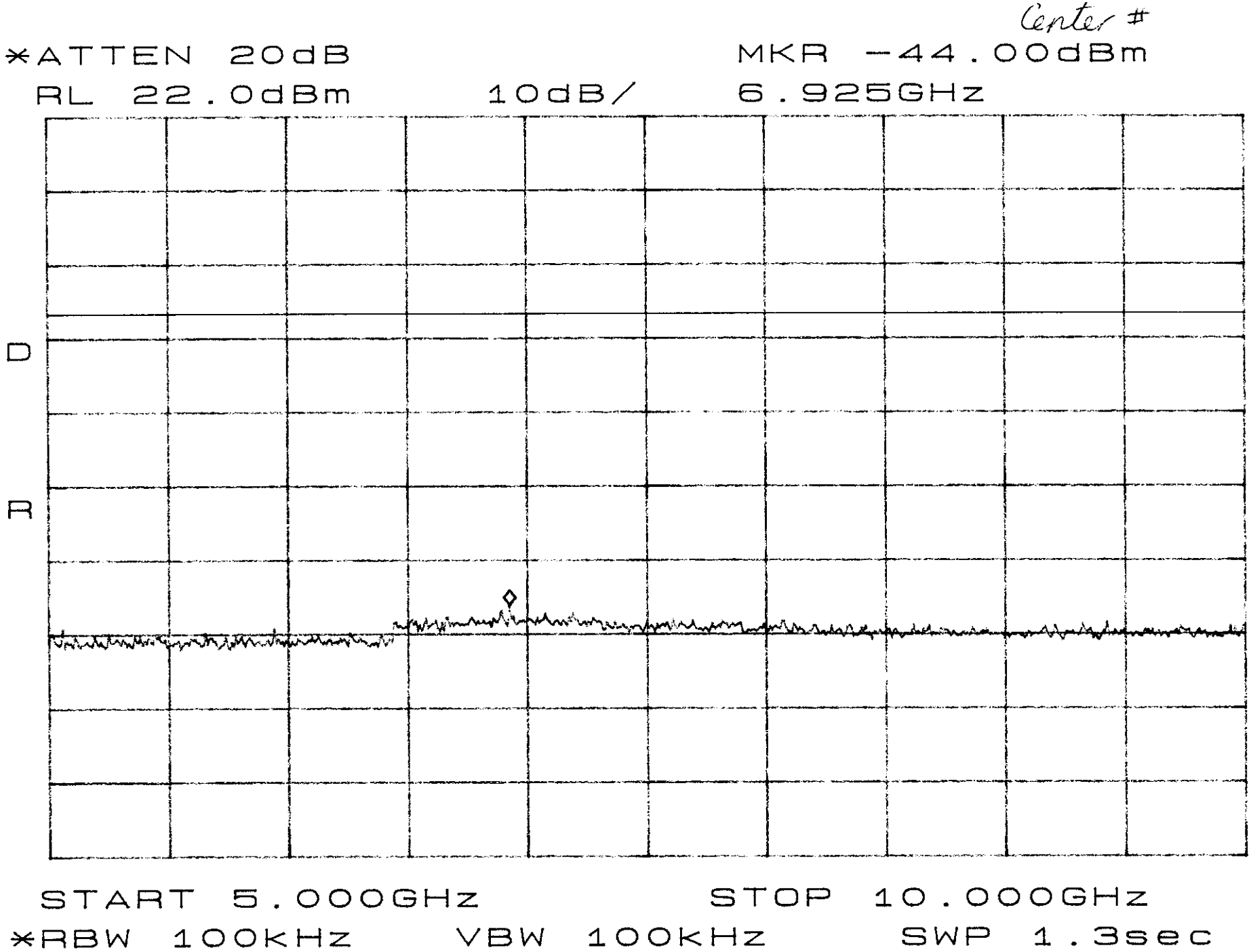
Mode 1

T26390/508
Center #1

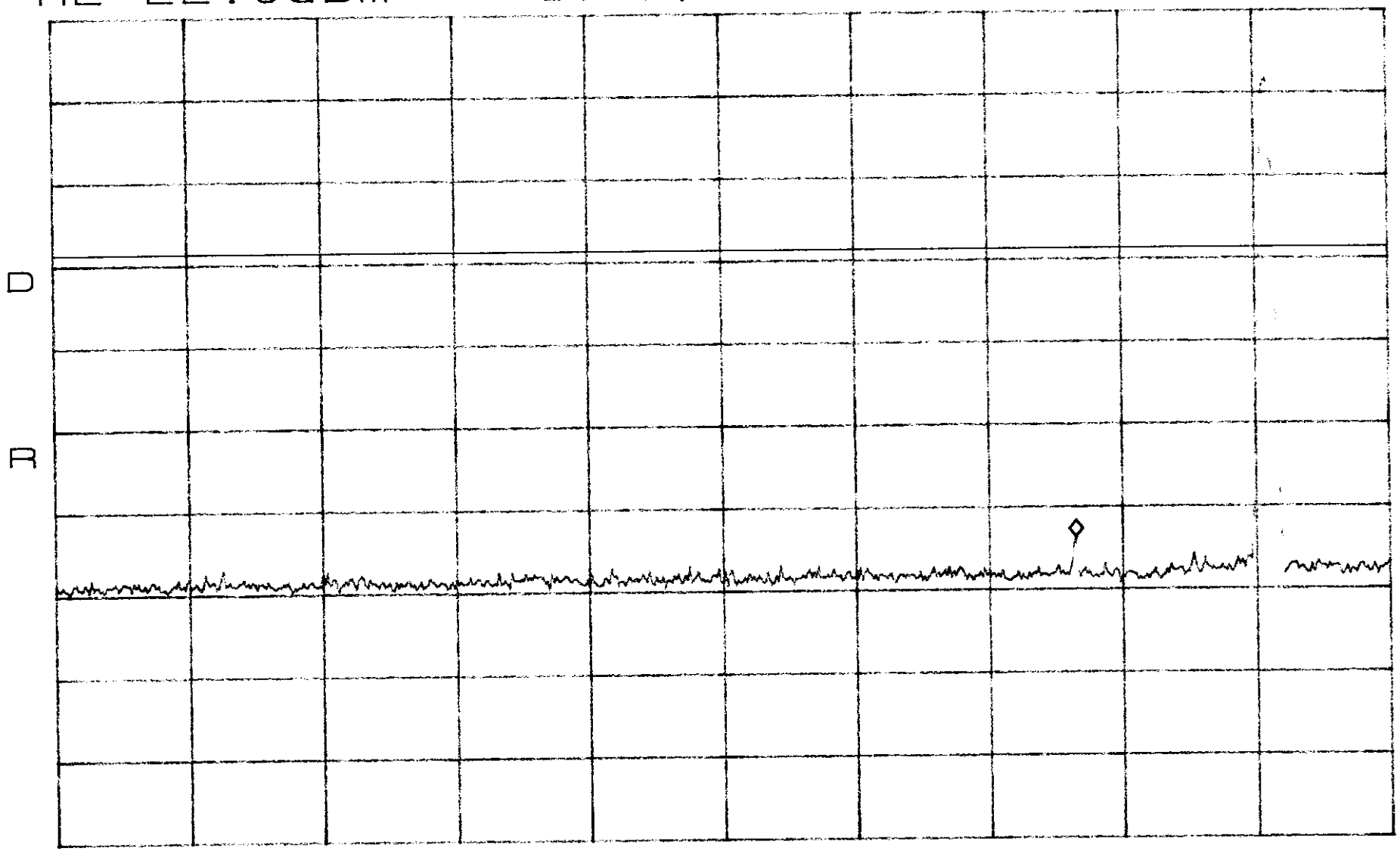


Mode 1

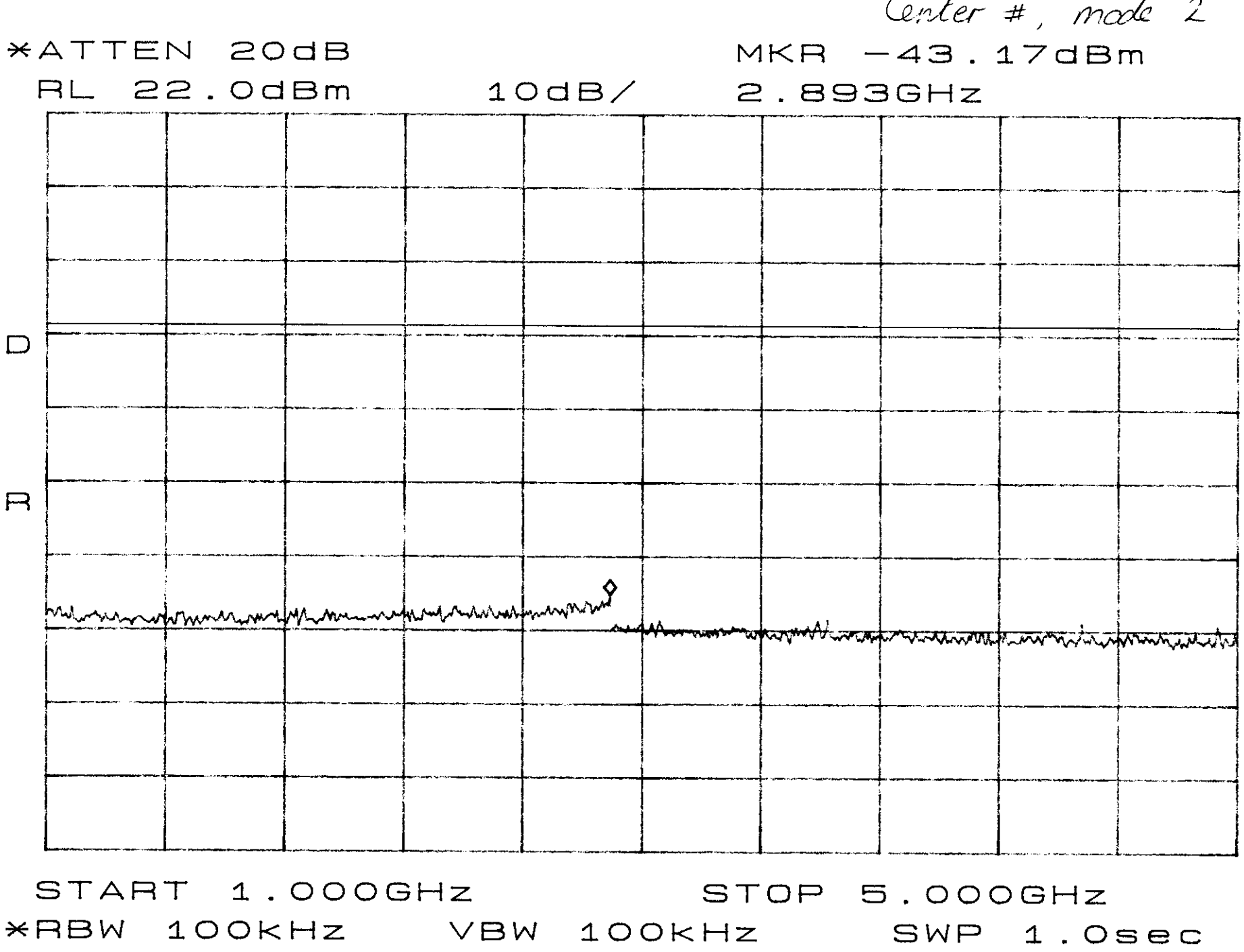
T26390/509
Center #



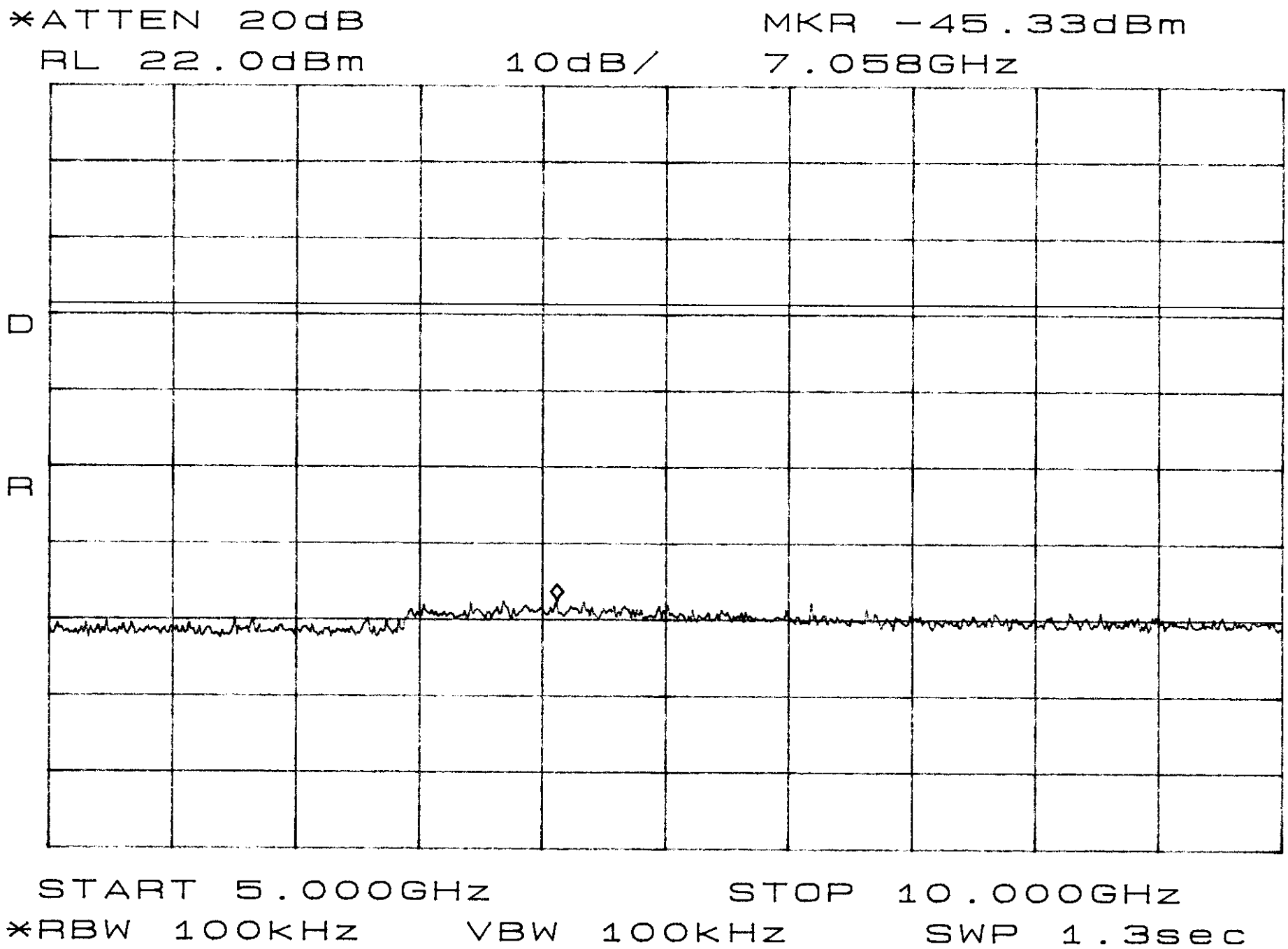
T26390/510
Center #, mode 2



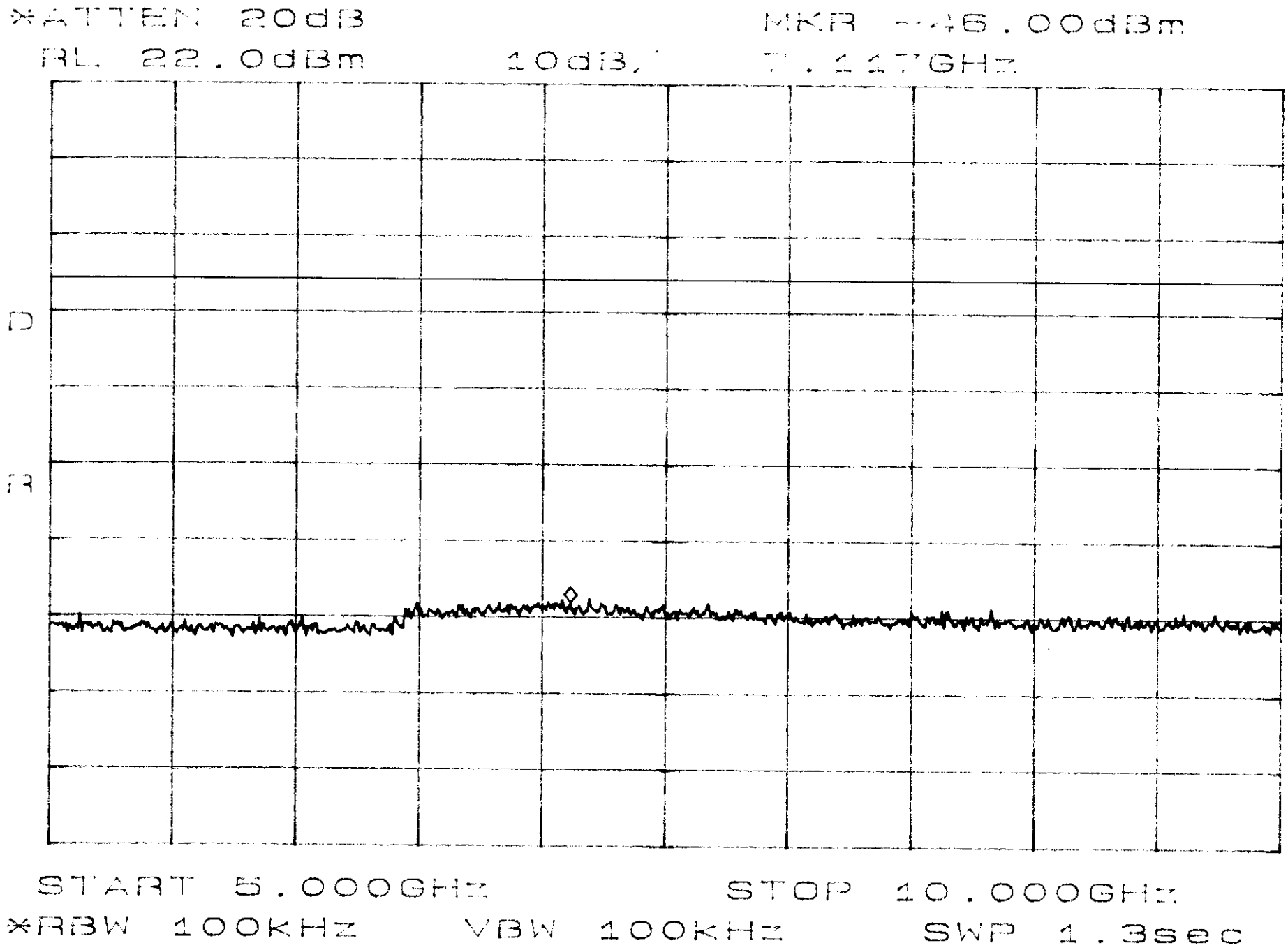
T26390/511
Center #, mode 2



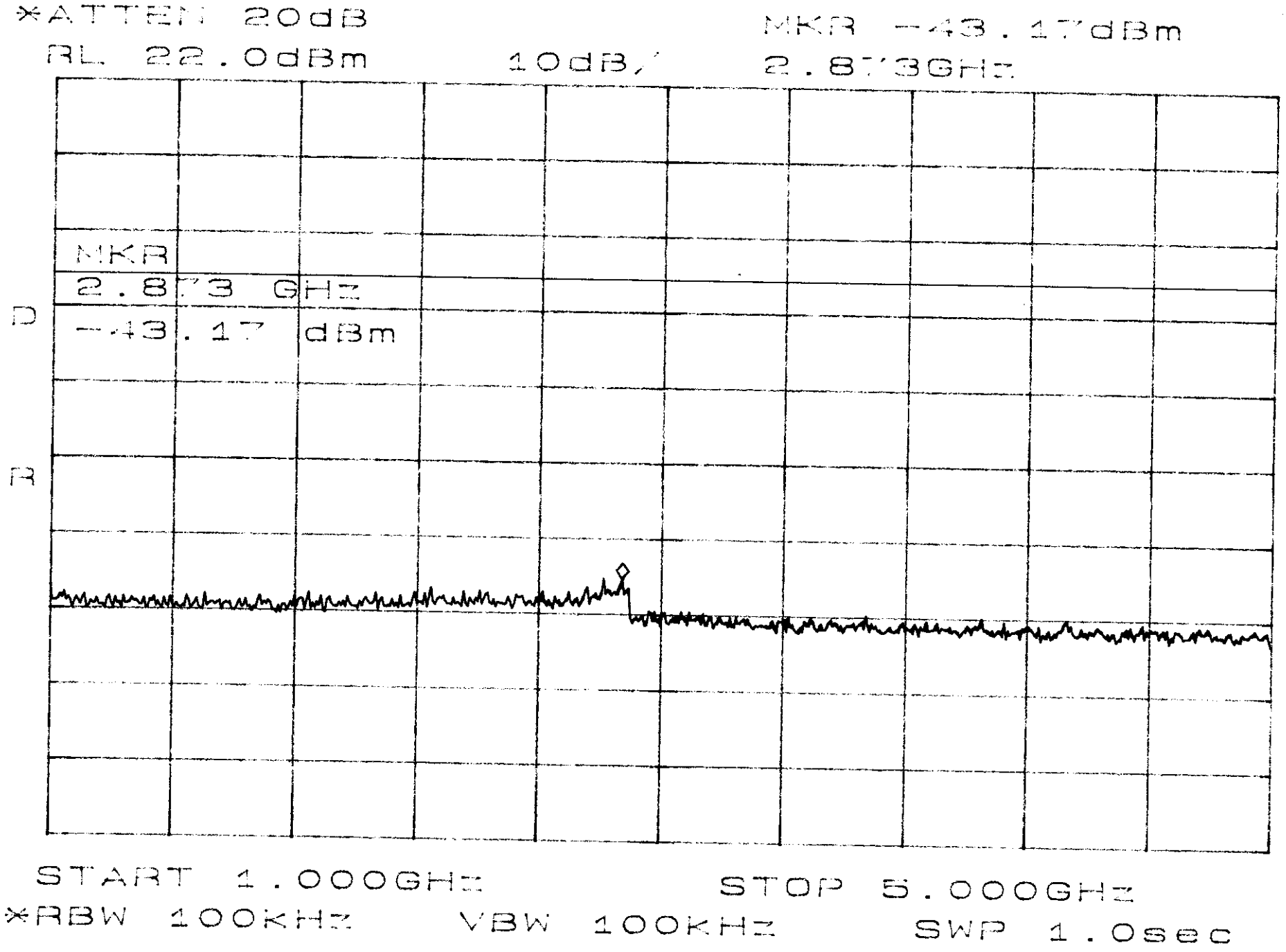
T26390/512
Center #, mode 2



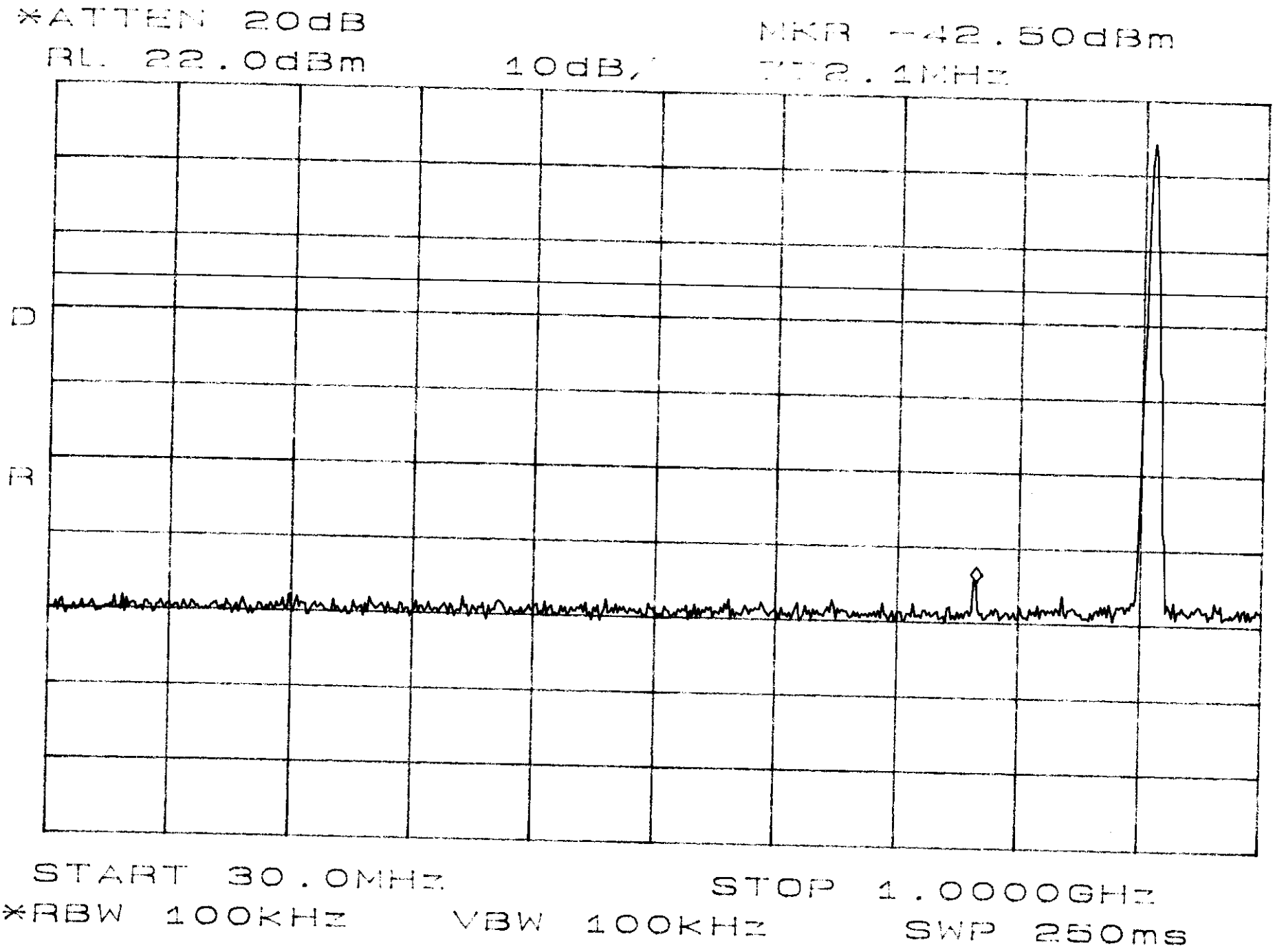
T26390/513
Center #, mode 3



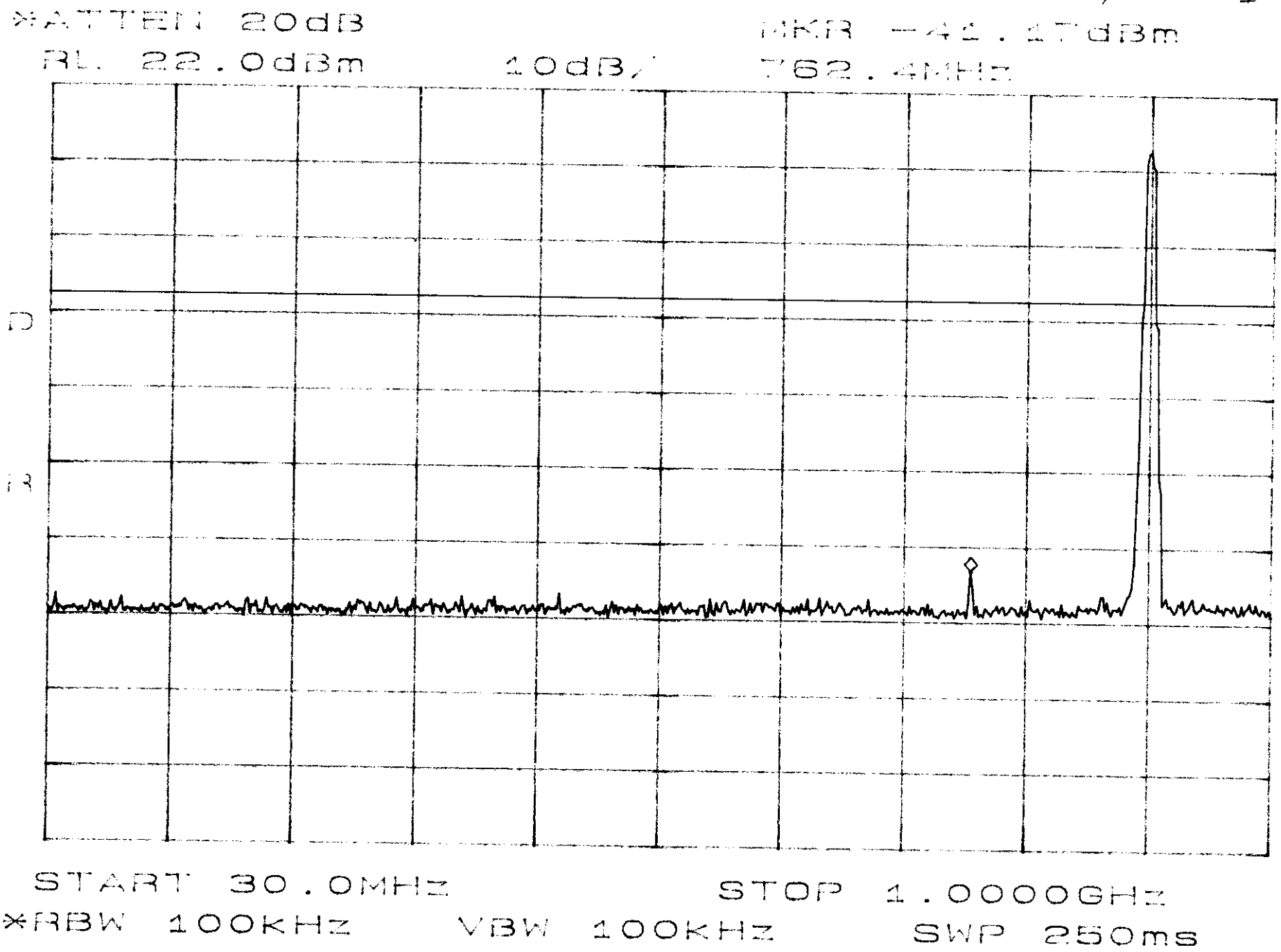
T26390/514
Center #, mode 3



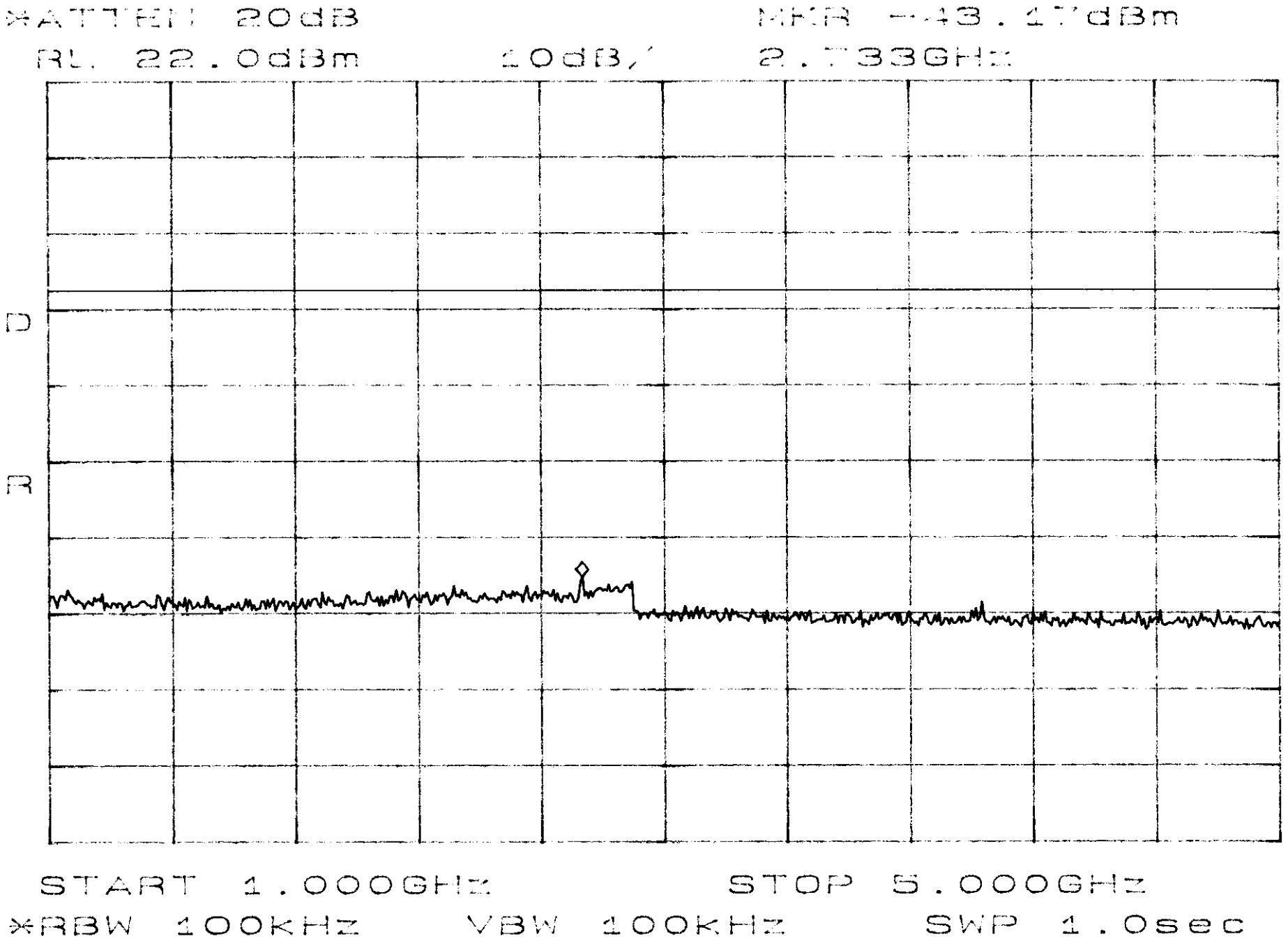
T26390/515
Center #, mode 3



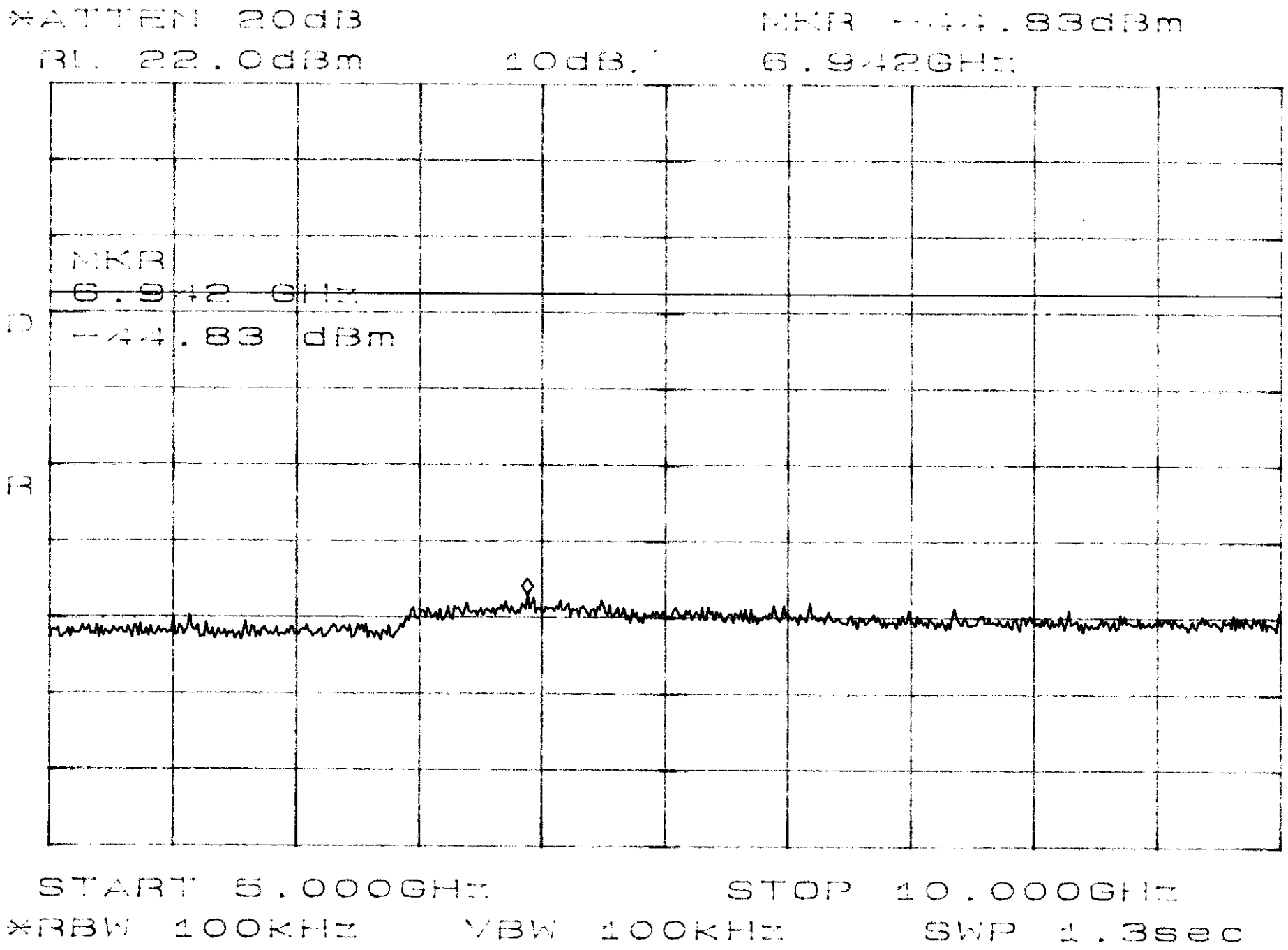
TD6390/516
low #, mode 1



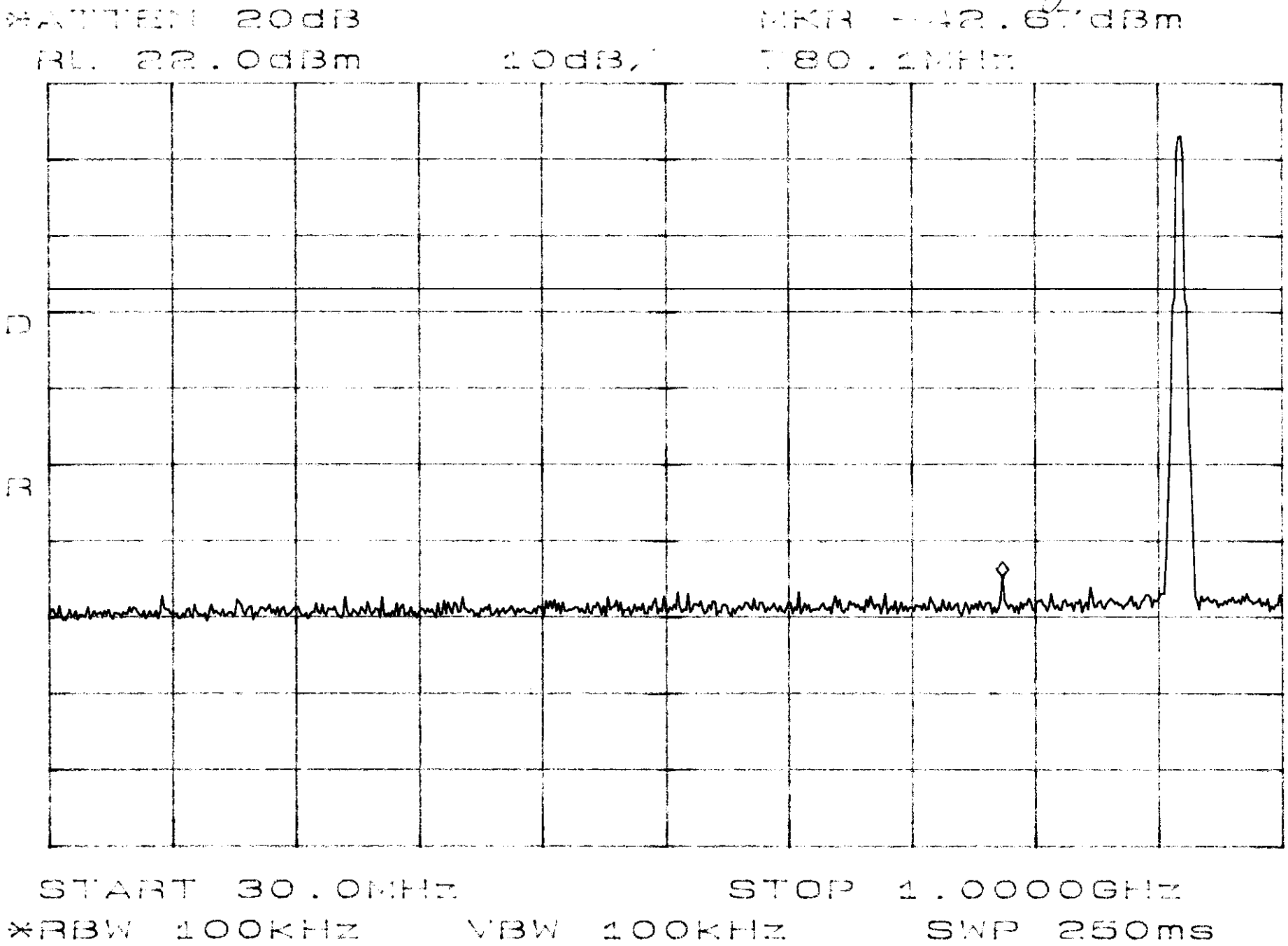
T26390/517
Low #, mode 1



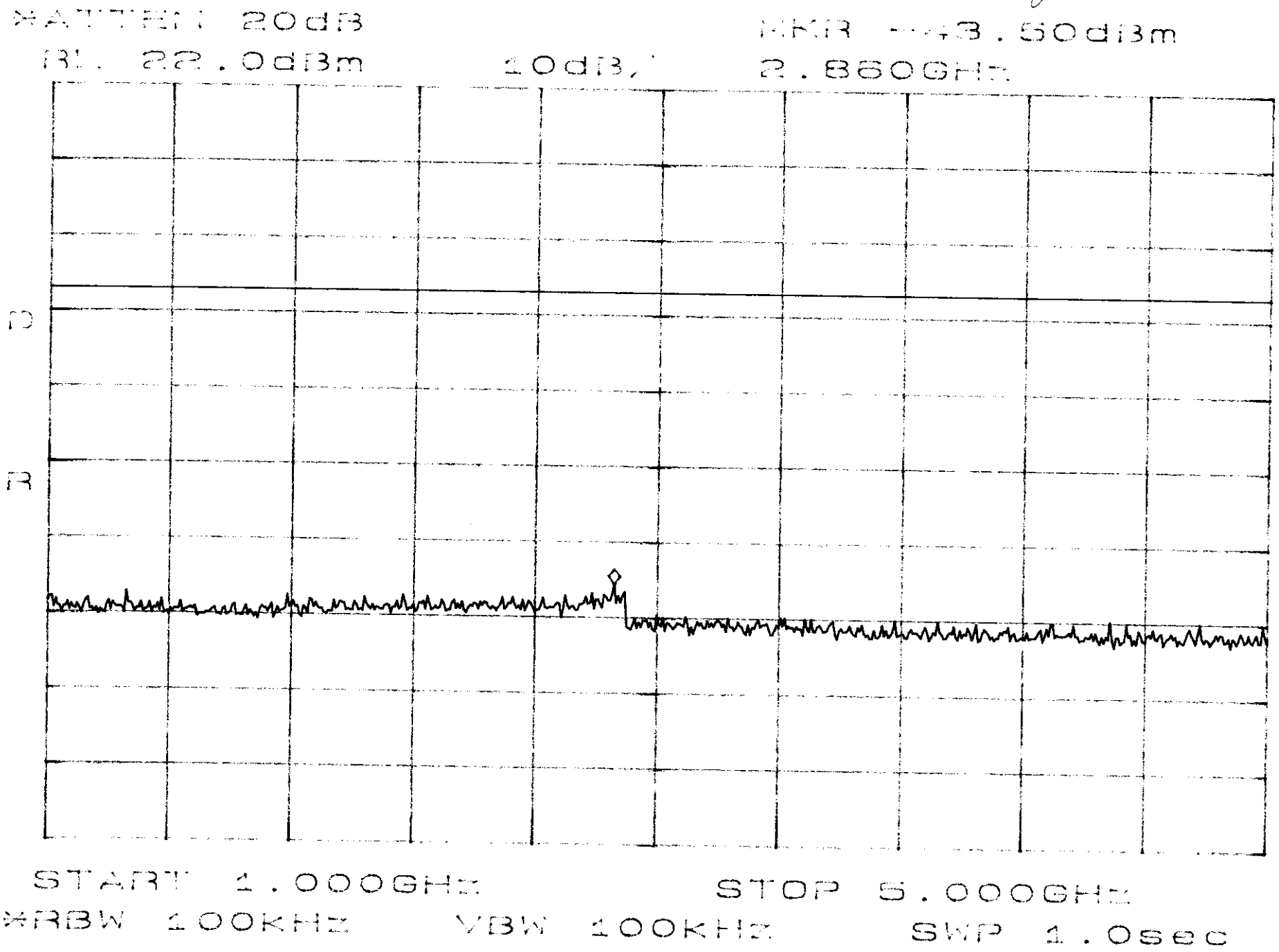
T26390/518
Low #, mode 1



T26390/519
High #, mode 1



T26390/520
High #, mode 1



R6390/521
High # mode 1