Elliott

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September 15, 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 C of Part 15 of FCC Rules (CFR 47) regarding changes to intentional radiators. A change is being proposed to the Cellnet Data Systems model DCOM, which would result in changes to the performance characteristics originally reported to the Commission. Since the DCOM 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 E. Hill
EMC Staff Consultant

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

File: R33720

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Electromagnetic Emissions Test Report and Request for Class II Permissive Change pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Cellnet Data Systems Model: DCOM

FCC ID:	H6NCMM2200
GRANTEE:	Cellnet Data Systems 125 Shorway Road San Carlos, CA 94070
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	September 15, 1999
FINAL TEST DATE:	September 3, 1999
AUTHORIZED SIGNATORY:	Mark E. Hill EMC Staff Consultant

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SCOPE

An electromagnetic emissions test has been performed on the Cellnet Data Systems Spread Spectrum Radio model DCOM 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 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 Cellnet Data Systems model DCOM and therefore apply only to the tested sample. The sample was selected and prepared by Doug Gronberg of Cellnet Data Systems

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 subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Cellnet Data Systems model DCOM complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

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 Cellnet Data Systems model DCOM. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.207.

The following measurement was extracted from the data recorded during the conducted 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.

120V, 60Hz

Frequency MHz	Level dBuV	Power Lead	Class B Limit	Class B Margin	Detector QP/Ave	Comments
0.488	18.2	Neutral	-29.8	QP		

LIMITS OF ANTENNA CONDUCTED POWER

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The highest out-of-band (Un-restricted) emission recorded in any 100 kHz band was more than 20 dB below the in-band level at 917.720 MHz. The actual test data and any correction factors are contained an exhibit of this report.

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247 and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

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.

Frequency MHz	Level dBuV/m	Pol v/h	Class B Limit	Class B Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
4587.900	68.7	V	-5.3	Pk	147	1.3		

LIMITS OF POWER AND BANDWIDTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The maximum power output was 25.22 dBm. The minimum 6 dB bandwidth was 1.373 Megahertz. The actual test data and any correction factors are contained in an exhibit of this report. The power spectral density was measured to be 7.2 dBm at 917.673 MHz.

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 Cellnet Data Systems model DCOM is a spread spectrum radio designed to transmit machine quantity usage readings to a local base-station. The sample was received on September 3, 1999 and tested on September 3, 1999. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Cellnet DCOM Spread Spectrum Radio	102

INPUT POWER

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

Description	Manufacturer	Model
120VAC to 12VDC external Adapter	AMC	UA12300

PRINTED WIRING BOARDS

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

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Cellnet Data Main Board	25-1221	5.0	None	14.564762

ENCLOSURE

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 11.7 cm wide by 12 cm deep by 2.5 cm high.

SUPPORT EQUIPMENT

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

Manufacturer/Model/Description	Serial Number	FCC ID Number
DB Product DB784SM5N-SY Antenna	217426-4	-

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
Coaxial	0.5	Antenna, N Connector	EUT, SMA connector

TEST SOFTWARE

The EUT contained test software running during testing which exercised the transmitter by sending administration message once every second.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Cellnet Data Systems model DCOM being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

PRINTED WIRING BOARD LAYOUT

The printing wiring board during emissions testing was as follows:

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Cellnet Data Main Board	25-1221	5.0	None	14.564762

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on September 3, 1999 at the Elliott Laboratories Open Area Test Site #3 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.

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 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:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

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

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 - 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

EXHIBIT 1: Test Equipment Calibration Data

Test Equipment List - SVOATS#3

August 24, 1999

	Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☑	Elliott Laboratories	300-1000 MHz Log Periodic	EL300.1000	55	12	9/26/98	9/26/99
☐	Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	773	12	11/3/98	11/3/99
☐	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	487	12	3/24/99	3/24/2000
☑	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	786	12	1/15/99	1/15/2000
☐	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	868	12	9/22/98	9/22/99
☐	Filtek	High Pass Filter	HP12/1000-5B	955	12	4/17/99	4/17/2000
☐	Filtek	High Pass Filter	HP12/1000-5B	956	12	4/17/99	4/17/2000
☐	Filtek	High Pass Filter	HP12/1000-5B	957	12	4/17/99	4/17/2000
☑	Fischer	LISN	FCC-LISN-50/2	810	12	2/2/99	2/2/2000
☐	Fluke Mfg Co	Signal Generator.	6062A	852	N/A		
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	12	1/4/99	1/4/2000
☐	Hewlett Packard	EMC Recever /Analyzer	8595EM	787	12	11/23/98	11/23/99
☐	Hewlett Packard	Microwave Preamplifier,	8449B	263, (F303)	12	8/3/99	8/3/2000
☑	Hewlett Packard	Microwave Preamplifier,	8449B	785	12	11/25/98	11/25/99
☐	Hewlett Packard	Microwave Preamplifier,	8449B	870	12	11/12/98	11/12/99
☐	Hewlett Packard	Power Meter	432A	259, (F304)	12	2/17/99	2/17/2000
☑	Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	12	1/18/99	1/18/2000
☐	Hewlett Packard	Spectrum Analyzer, 9 KHz-6.5 GHz	8595E-041-103-	Metric, 885	12	5/11/99	5/11/2000
☐	Hewlett Packard	Thermistor Mount	478A	652	12	2/17/99	2/17/2000
☑	Narda West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/23/99	4/23/2000
☐	Narda West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/29/99	4/29/2000
☐	Narda West	High Pass Filter	HPF 180	821	12	8/10/99	8/10/2000
☑	Rohde& Schwarz	Pulse Limiter	ESH3 Z2	812	12	12/8/98	12/8/99
☑	Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215, (F197)	12	2/17/99	2/17/2000
☑	Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP			1/11/99	1/11/2000
☑	Narda	10dB attenuator	774-10	641	12	10/12/98	10/12/99
☑	Narda	20dB attenuator	757C-20	258	12	6/17/99	6/17/2000

File Number: D33573

Date: 9.2.99

Engr: Jerry Hill

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 33573	17 Pages
Processing Gain Measurement	5 Pages

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EMC Test Log

Client:	Cellnet Data Systems	Date:	9/3/99	Test Engr:	Jerry Hill
Product:	DCOM	File:	T33573	Proj. Eng:	Mark Briggs
Objective:	Permissive Change	Site:	SVOATS #3	Contact:	Doug Gronberg
Spec:	FCC	Page:	1 of 5	Approved:	
Revision	1.0				

Ambient Conditions	
Temperature:	20 °C
Humidity:	90 % RH

Test Objective

The objective of this test session is to perform Permissive Change testing the EUT defined below relative to the specification(s) defined above.

Test Summary

Run #1 - Maximized Preliminary Radiated Emissions Scan, Selected Frequencies from T24938 30-1000 MHz

PASS Results: FCC B -10.7 dB QP @ 611.725 MHz Horizontal

Run #2 - Maximized Radiated Spurious Emissions 1-10GHz falling in restricted bands. Ref. T24938

PASS Results: FCC -5.3 dB Pk @ 4587.900 MHz Vertical

Run #3 - Conducted Emissions Scan of EUT, 0.45-30.00 MHz, 120V/60Hz

PASS Results: FCC B -29.8 dB QP @ 0.488 MHz Neutral

Run #4a-c - Antenna Conducted Emissions Scan of EUT, 30 – 10,000 MHz

PASS Results: All signals more than 20dB below the Fundamental.

The antenna port of the EUT was connected directly to the Spectrum Analyzer. All signals were more than 20dB below the highest in-band signal level when measured with a resolution bandwidth of 100kHz.
Refer to attached plots.

Client:	Cellnet Data Systems	Date:	9/3/99	Test Engr:	Jerry Hill
Product:	DCOM	File:	T33573	Proj. Eng:	Mark Briggs
Objective:	Permissive Change	Site:	SVOATS #3	Contact:	Doug Gronberg
Spec:	FCC	Page:	2 of 5	Approved:	
Revision	1.0				

Run #5 - 6dB Bandwidth measurement @ 917.670 MHz in accordance with para. 15.247 (a) (2)

PASS The 6dB bandwidth was 1.373MHz, meeting the required minimum of 500kHz. See plot D33573-5

Run #6 - Transmitted Power @ 917.720 MHz was measured in Accordance with para. 15.247 (b).

PASS See plot D33573-6 which shows Output power was measured to be 25.22dBm, 4.78 dB below the maximum permitted output of 30 dBm (1 Watt).

Run #7 - Power Density Measurements @ 917.720 MHz was measured in Accordance with para. 15.247 (d)

See plot D33573-7a

PASS Plot D33573-7a Power Density Measurements was made at 917.673MHz using a resolution bandwidth of 3kHz and gives a power spectral density of 7.2dBm in a 3kHz band averaged over 1 sec.

Run #8a - Sidelobe Emissions Lower sidelobes of fundamental.

PASS Measurements, plot D33573-8a were made between 900MHz – 930MHz and found that the lower sidelobe was down greater than 20dB from the peak measurement. See plot D33573-8a

Run #8b - Sidelobe Emissions Upper sidelobes of fundamental.

PASS Measurements, plot D33573-8b were made between 900MHz – 930MHz and found that the lower sidelobe was down greater than 20dB from the peak measurement. See plot D33573-8b

Equipment Under Test (EUT) General Description

The EUT is a spread spectrum radio which is designed to transmit machine quantity usage readings to a local base-station. When installed the EUT could be placed in a variety of locations. For the purposes of testing the unit was treated as a table-top unit.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Cellnet DCOM Spread Spectrum Radio	102	H6NCMM2200

Power Supply and Line Filters

The EUT used the following external AC-DC adapter:

Description	Manufacturer	Model
120VAC to 12VDC external Adapter	AMC	UA12300

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Cellnet Data Main Board	25-1221	5.0	None	14.564762

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
None	-	-	-

EUT Enclosure(s)

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 11.7 cm wide by 12 cm deep by 2.5 cm high.

Elliott

EMC Test Log

Client:	Cellnet Data Systems	Date:	9/3/99	Test Engr:	Jerry Hill
Product:	DCOM	File:	T33573	Proj. Eng:	Mark Briggs
Objective:	Permissive Change	Site:	SVOATS #3	Contact:	Doug Gronberg
Spec:	FCC	Page:	4 of 5	Approved:	
Revision	1.0				

EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
None	-	-

Modifications

No modifications were made to the EUT in order to comply with the requirements.

Local Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
DB Product DB784SM5N-SY Antenna	217426-4	None

Remote Support Equipment

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

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Coaxial	0.5	Antenna, N Connector	EUT, SMA connector

Test Software

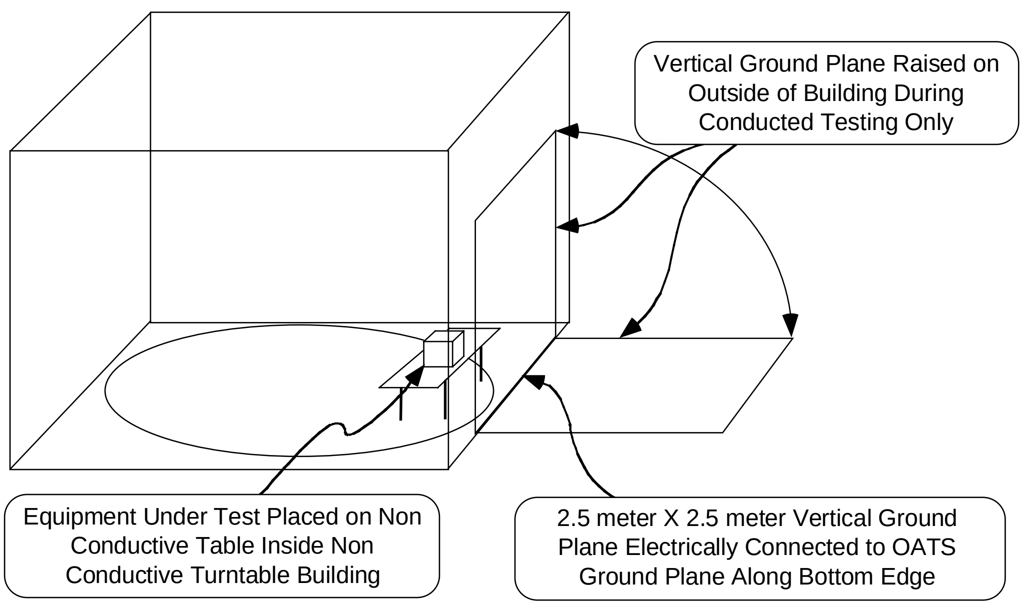
The EUT contained test software running during testing which exercised the transmitter by sending administration message once every second.

EMC Test Log

Client:	Cellnet Data Systems	Date:	9/3/99	Test Engr:	Jerry Hill
Product:	DCOM	File:	T33573	Proj. Eng:	Mark Briggs
Objective:	Permissive Change	Site:	SVOATS #3	Contact:	Doug Gronberg
Spec:	FCC	Page:	5 of 5	Approved:	
Revision	1.0				

General Test Conditions

During testing, the power adapter was connected to 120V/60Hz power input which provided 12VDC to the EUT. The EUT was located on the non-conductive bench on the turntable for radiated and conducted testing.



Test Data Tables

See attached data

Elliott

Emissions Test Data

Client:	Cellnet Data Systems	Date:	09/02/1999	Test Engr:	Jerry Hill
Product:	DCOM	File:	D33573	Proj. Engr:	Doug Gronberg
Objective	Permissive Change	Site:	SVOATS #3	Contact:	Mark Briggs
Spec:	FCC	Distance:	3 m	Approved:	

Ambient Conditions
Temperature: 20 °C
Humidity: 90 % RH

Run #a: Site consistency Check.
Site Check.

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
407.555	48.2	v	-	-	QP	0	1.4	
960.000	52.3	v	-	-	QP	0	1.4	
609.998	64.7	v	-	-	QP	0	1.4	

Run #1: Preliminary radiated emissions, 30-1000 MHz. Sorted by Margin.
Site Check.

Frequency	Level	Pol	FCC B	FCC B	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
611.725	35.3	h	46.0	-10.7	QP	48	1.0	
611.725	33.2	v	46.0	-12.8	QP	239	1.0	
407.812	29.9	v	46.0	-16.1	QP	311	1.0	
407.812	24.9	h	46.0	-21.1	QP	7	1.0	
961.300	29.1	v	54.0	-24.9	QP	45	1.0	
961.648	29.0	v	54.0	-25.0	QP	0	1.0	
960.812	29.0	v	54.0	-25.0	QP	355	1.0	
961.300	26.4	h	54.0	-27.6	QP	0	1.5	noise floor
964.916	26.3	v	54.0	-27.7	QP	0	1.0	noise floor
960.812	26.3	h	54.0	-27.7	QP	0	1.0	noise floor
961.648	26.3	h	54.0	-27.7	QP	0	1.0	noise floor
964.916	26.2	h	54.0	-27.8	QP	0	1.0	noise floor

Emissions Test Data

Client:	Cellnet Data Systems	Date:	09/02/1999	Test Engr:	Jerry Hill
Product:	DCOM	File:	D33573	Proj. Engr:	Doug Gronberg
Objective	Permissive Change	Site:	SVOATS #3	Contact:	Mark Briggs
Spec:	FCC	Distance:	3 m	Approved:	

Run #2: Maximized readings 1-10GHz falling in restricted bands. Ref. T24938
Sorted by Margin.

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4587.900	68.7	v	74.0	-5.3	Pk	147	1.3	
2752.833	66.9	v	74.0	-7.1	PK	8	1.4	
2752.833	66.0	h	74.0	-8.0	Pk	237	1.4	
4587.900	63.9	h	74.0	-10.1	Pk	295	1.2	
3670.300	58.2	v	74.0	-15.8	Pk	0	1.0	
3670.300	56.9	h	74.0	-17.2	Pk	43	1.2	
4587.900	21.9	h	54.0	-32.1	Avg	295	1.2	Note 1
4587.900	20.6	v	54.0	-33.4	Avg	0	1.3	Note 1
3670.300	20.4	h	54.0	-33.6	Avg	43	1.1	Note 1
3670.300	20.1	v	54.0	-33.9	Avg	311	1.0	Note 1
2752.833	19.1	h	54.0	-34.9	Avg	237	1.4	Note 1
2752.833	17.7	v	54.0	-36.3	Avg	310	1.0	Note 1

Note 1:	15.9dB was subtracted from Average Reading for Duty Cycle Correction.

Run #3: Conducted Emissions 0.45-30.0 MHz, Sorted by Margin. 120V/60Hz
Sorted by Margin.

Frequency	Level	Power	FCC B	FCC B	Detector	Comments
MHz	dBuV	Lead	Limit	Margin	QP/Ave	
0.488	18.2	Neutral	48.0	-29.8	QP	
0.613	14.3	Neutral	48.0	-33.7	QP	
0.589	13.9	Neutral	48.0	-34.1	QP	
0.552	13.0	Line 1	48.0	-35.0	QP	
1.096	12.3	Line 1	48.0	-35.7	QP	
1.245	11.7	Line 1	48.0	-36.3	QP	

Run #4: Antenna Conducted Emissions, 30 - 10000MHz.
The antenna port of the EUT was connected directly to the Spectrum Analyzer. All signals were more than 20dB below the highest in-band signal level when measured with a resulution bandwidth of 100kHz.
refer to attached plots D33573 for data points.

Run #5: 6dB Bandwidth Measurement @ 917.670MHz in Accordance with para. 15.247 (a) (2)

Run #6: Transmitted Power Measurements @ 917.670MHz in Accordance with 15.247 (b)

Run #7: Power Density Measurements @ 917.670MHz in Accordance with 15.247 (d).

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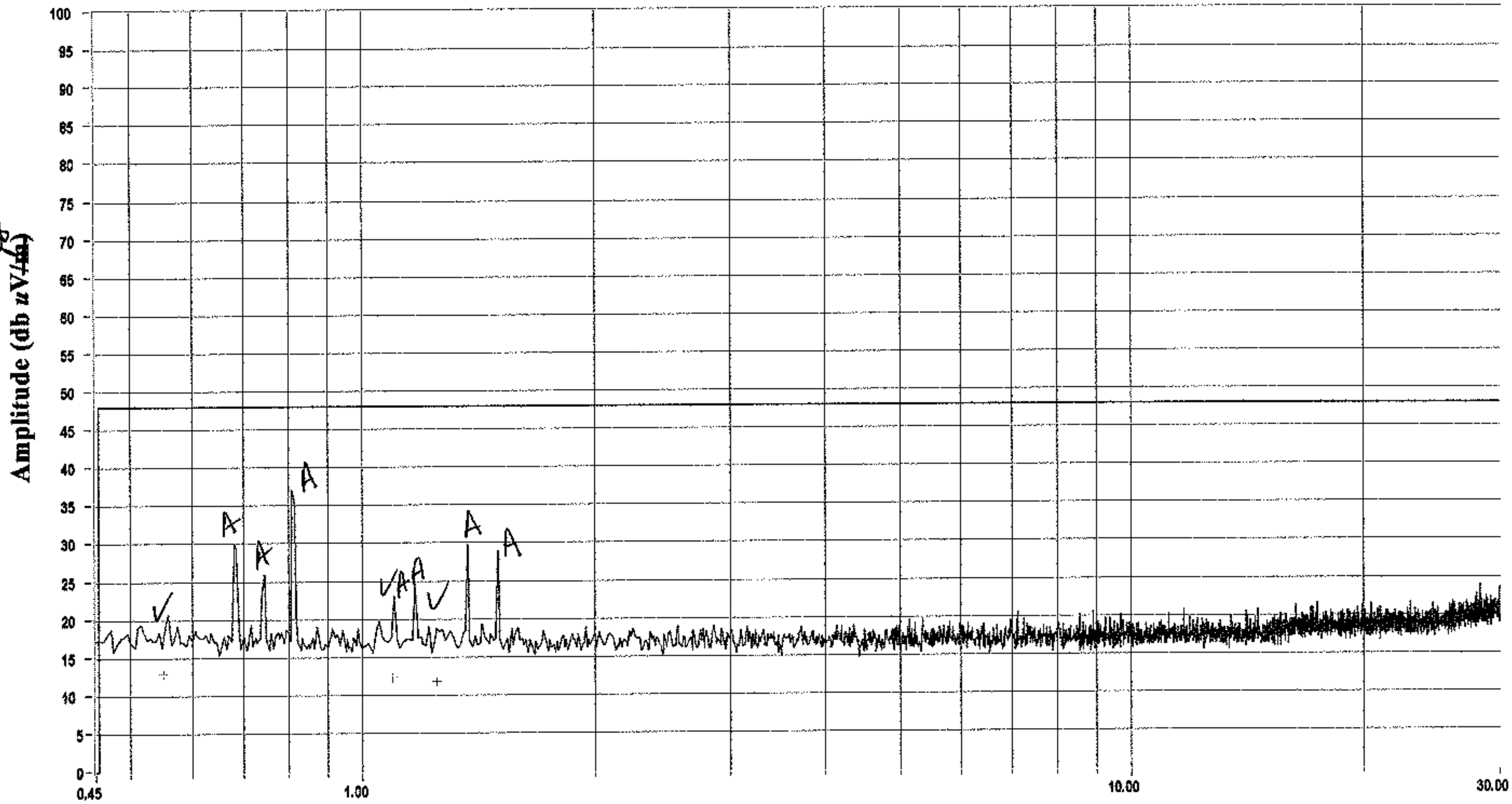
SVOATS #3: Cellnet DCOMM Run 3

Permissive Change

Spec:
FCC-B

Mains Lead
Line 1



D33573 (ref. D24938) 120V/60Hz <x> Line < > Neutral / = EUT A = Ambient

Scan
Peak
Quasi-peak
Average
QuasiPeak Limit
QuasiPeak Limit

9/3/99
Jerry Hill

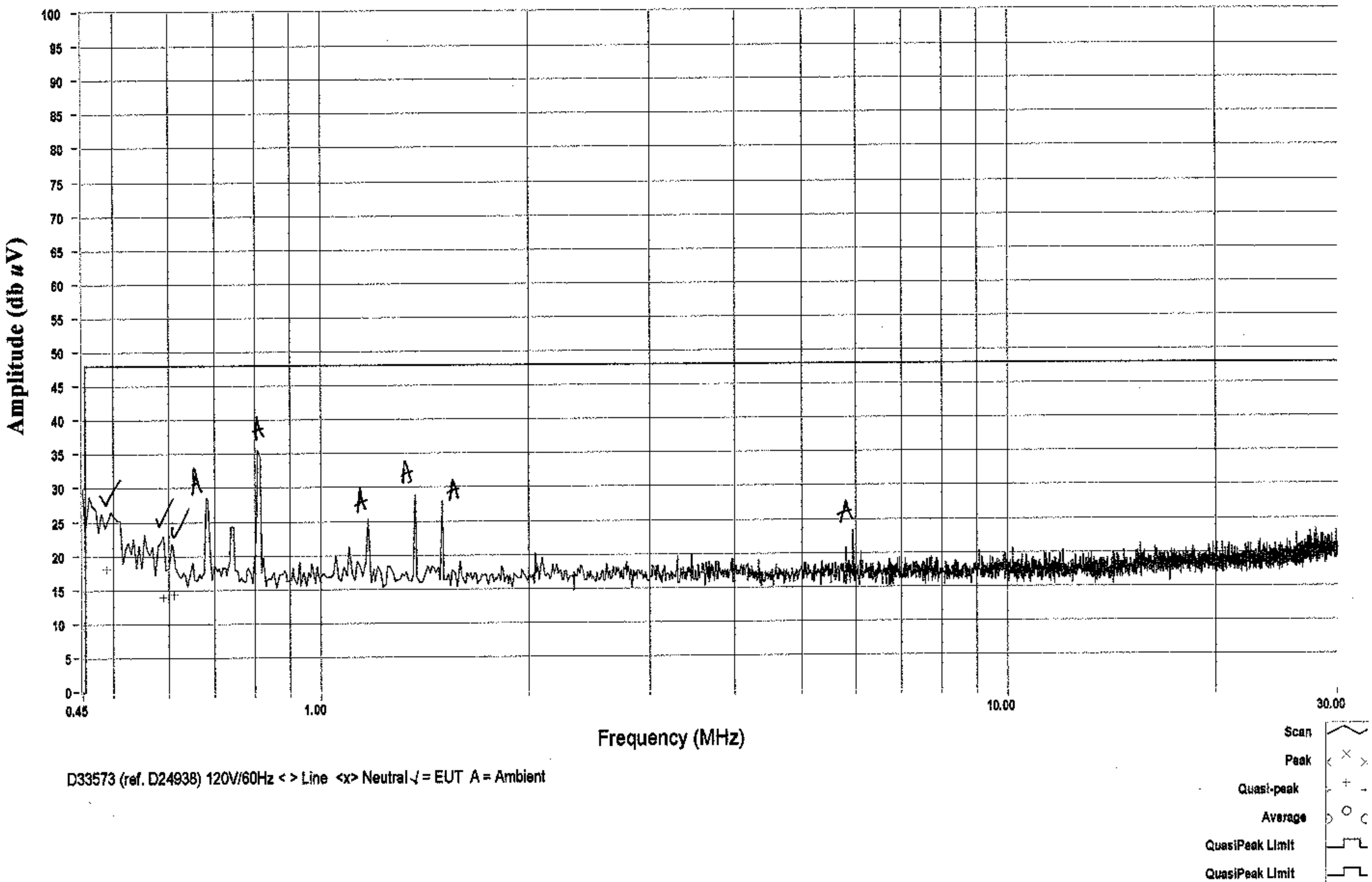
Elliott

SVOATS #3: Cellnet DCOMM Run 3

Permissive Change

Spec:
FCC-B

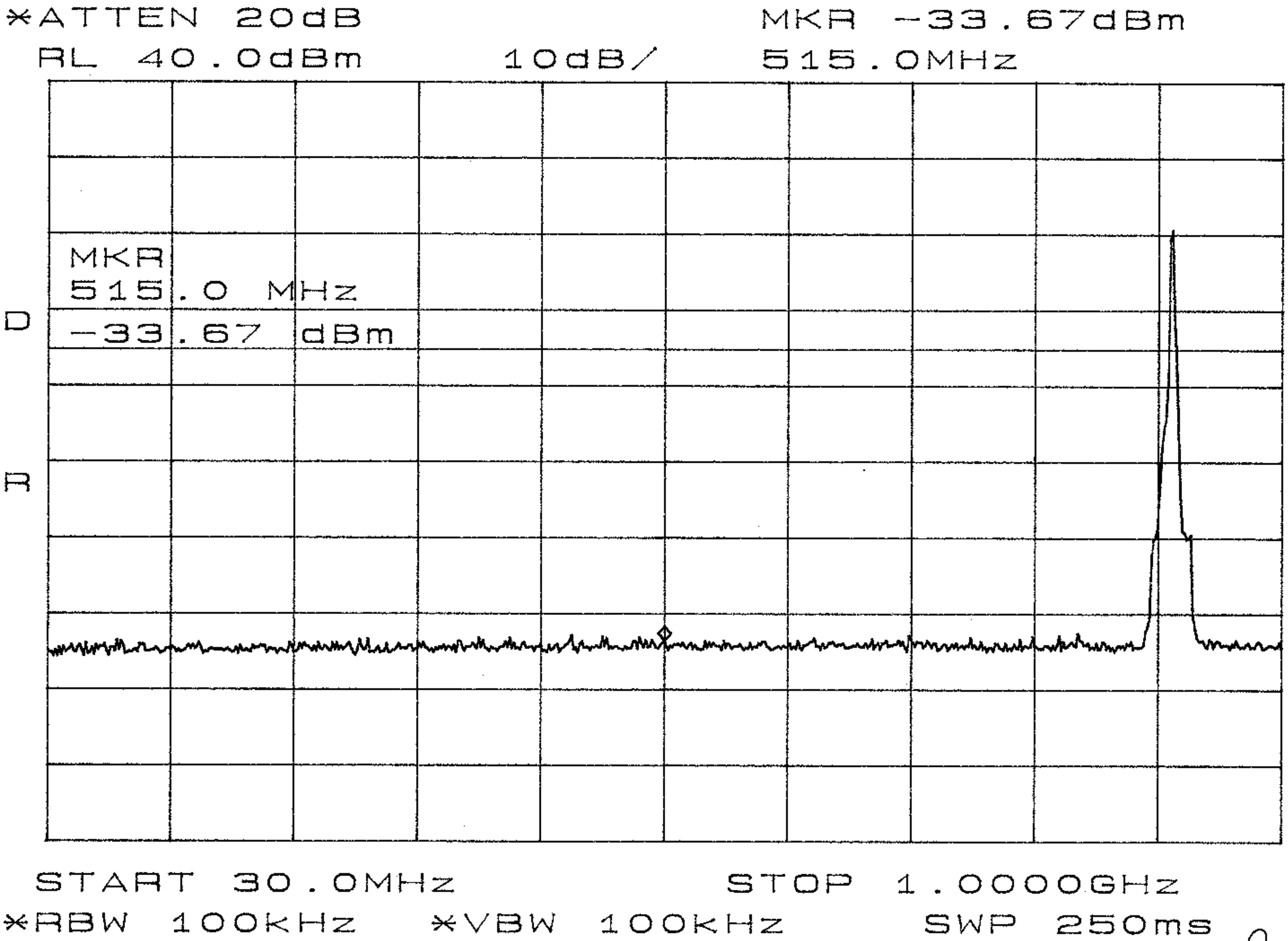
Mains Lead
Neutral



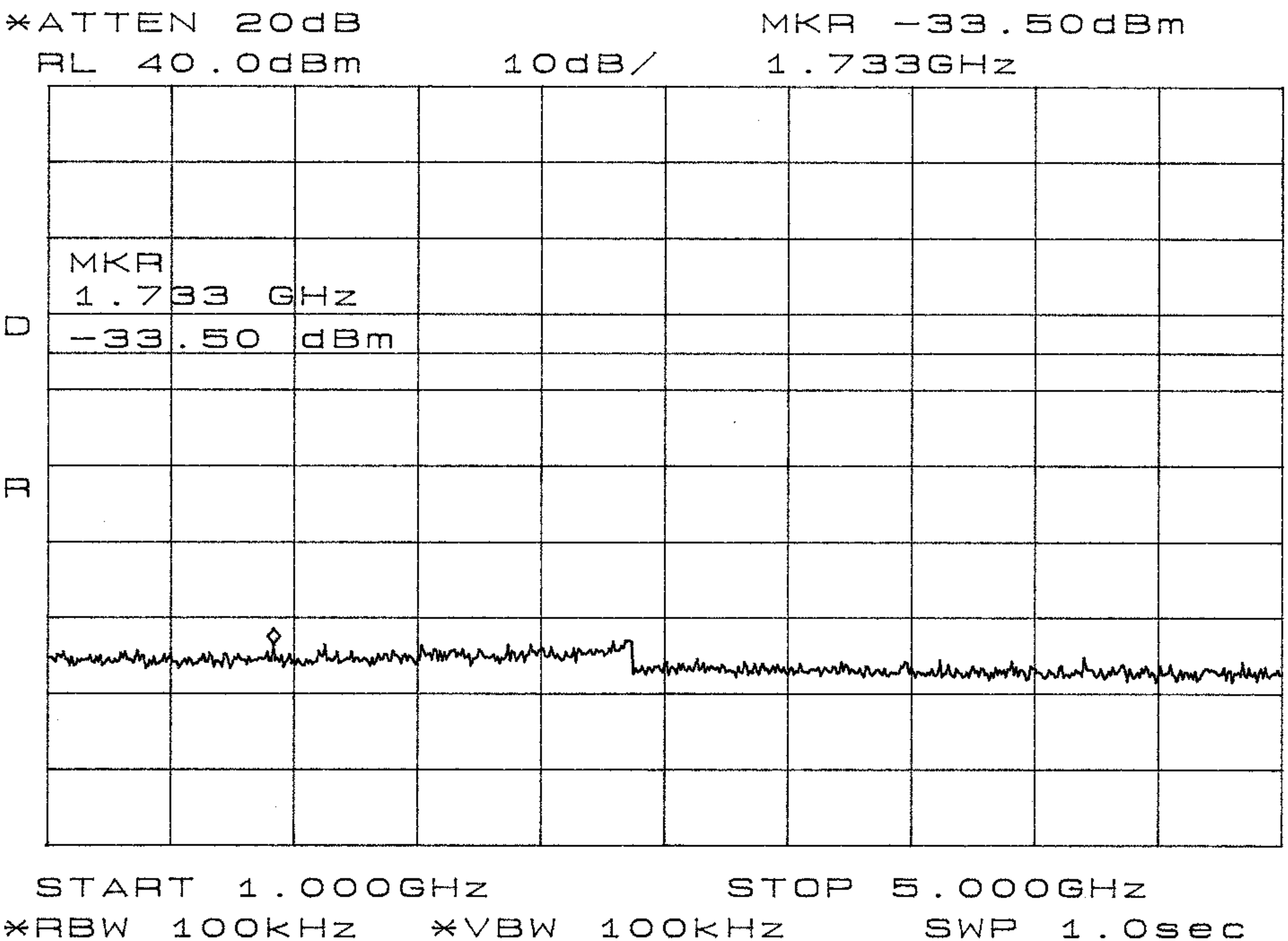
D33573 (ref. D24938) 120V/60Hz < > Line <x> Neutral √ = EUT A = Ambient

9/3/99

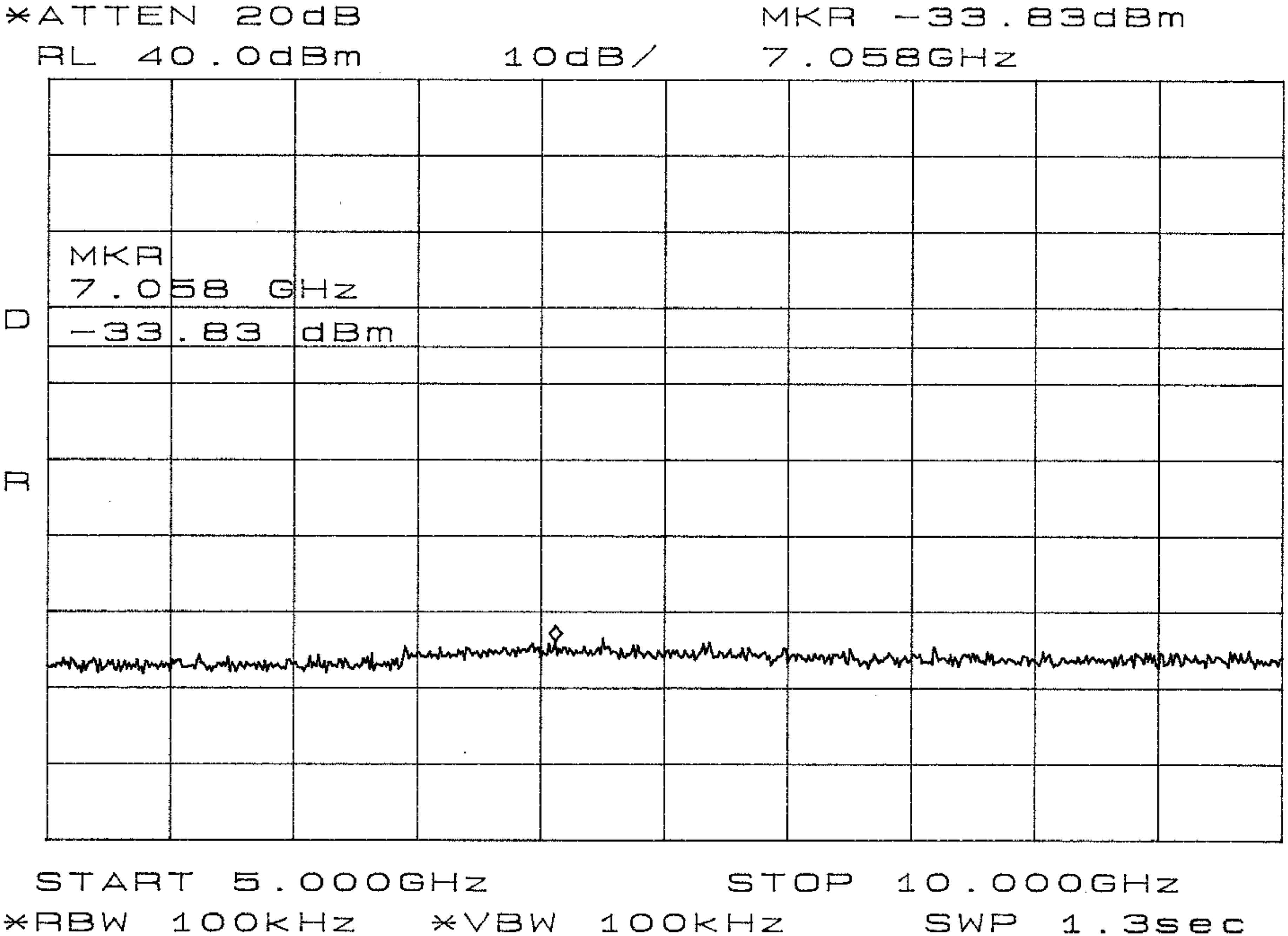
Jerry Hill



D33573-4a ANT PORT MEASUREMENT 30-1000 MHz



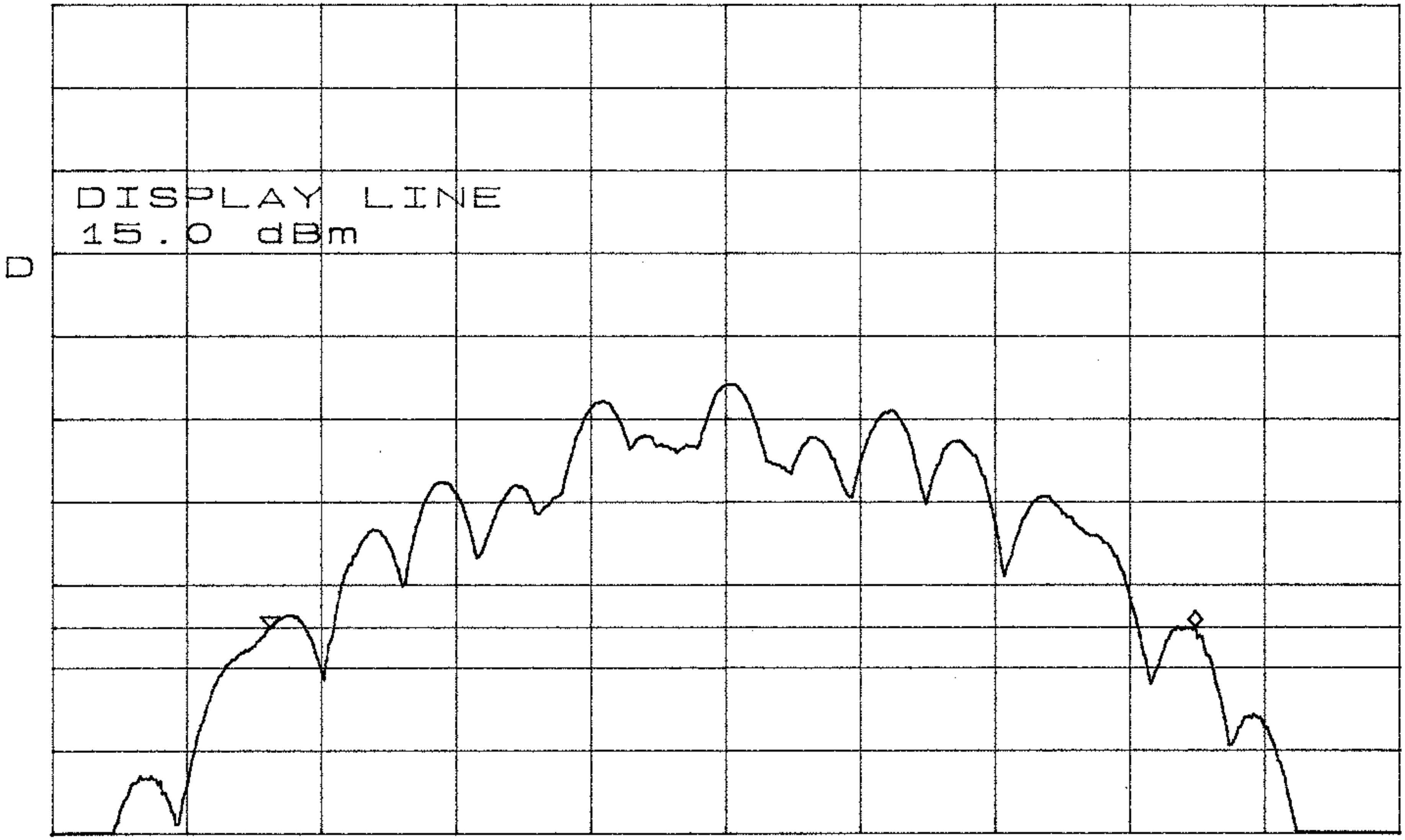
D33573-4b ANT PORT MEASUREMENT 1-5GHz



D33573-4/C ANT. PORT EMISSIONS 5-10 GHz

*ATTEN 40dB
RL 30.0dBm 2dB/

ΔMKR 0dB
1.373MHz



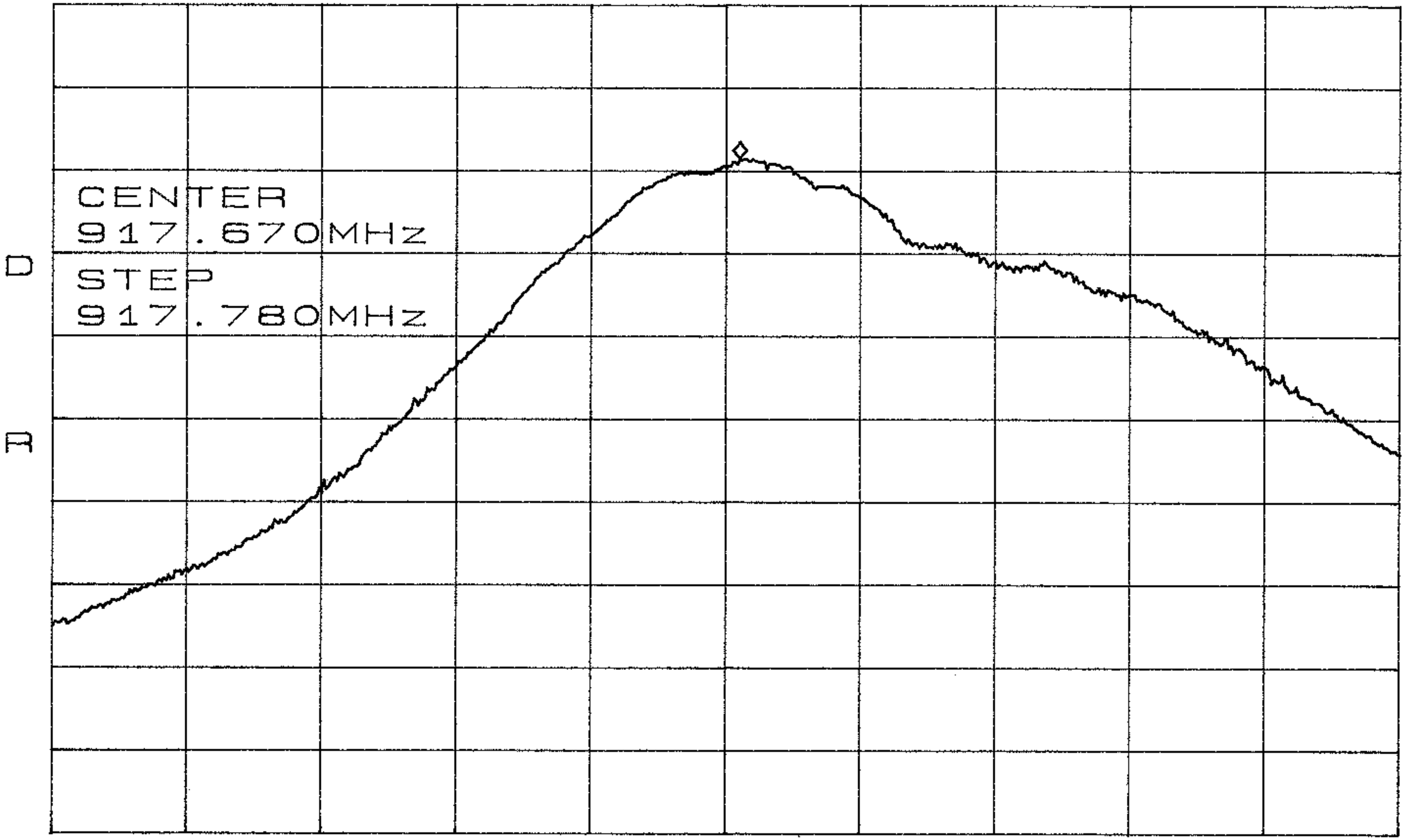
CENTER 917.670MHz SPAN 2.000MHz
*RBW 100kHz *VBW 100kHz *SWP 50ms

D33573-5

6dB BANDWIDTH

NO EXT. ATTN USED.

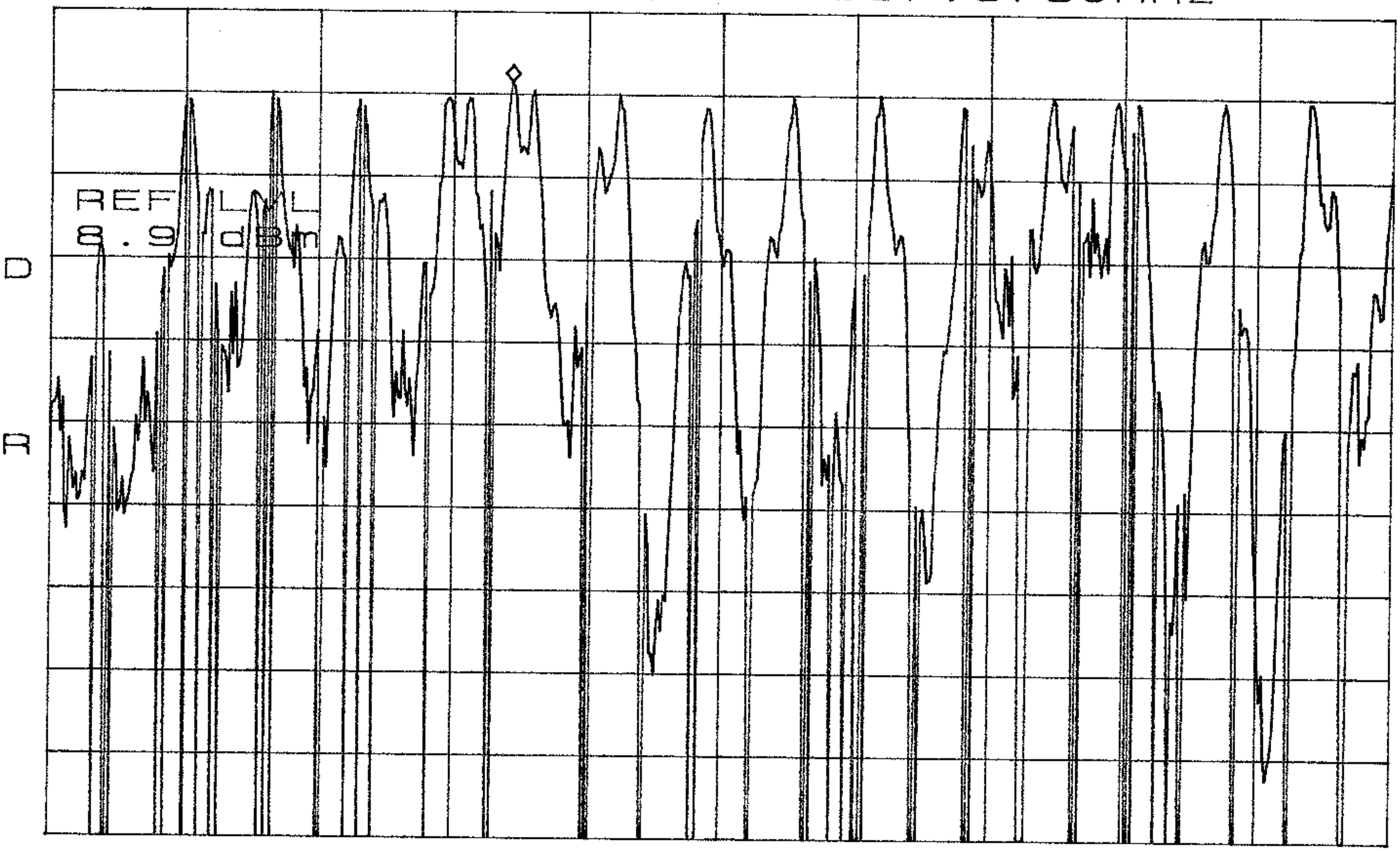
*ATTEN 20dB MKR 25.22dBm
RL 27.0dBm LIN 917.720MHz



CENTER 917.670MHz SPAN 5.000MHz
*RBW 2.0MHz *VBW 3.0MHz SWP 50ms

D33573-6 TRANSMIT POWER

*ATTEN 20dB RL 8.9dBm 2dB/ MKR 7.20dBm 917.6730MHz

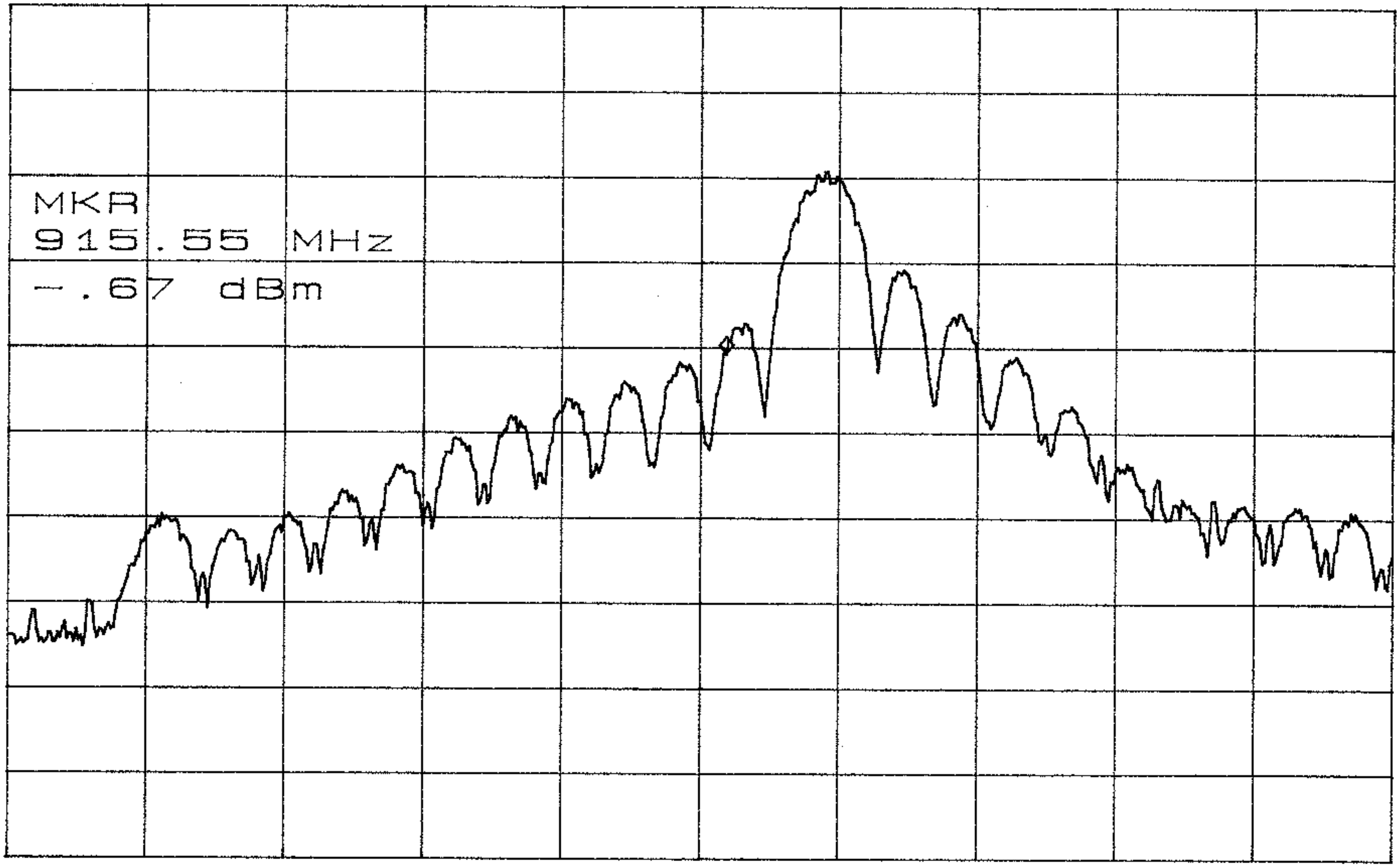


CENTER 917.7200MHz SPAN 300.0KHz
*RBW 3.0KHz *VBW 3.0KHz *SWP 100sec

D33573-7a Power Density

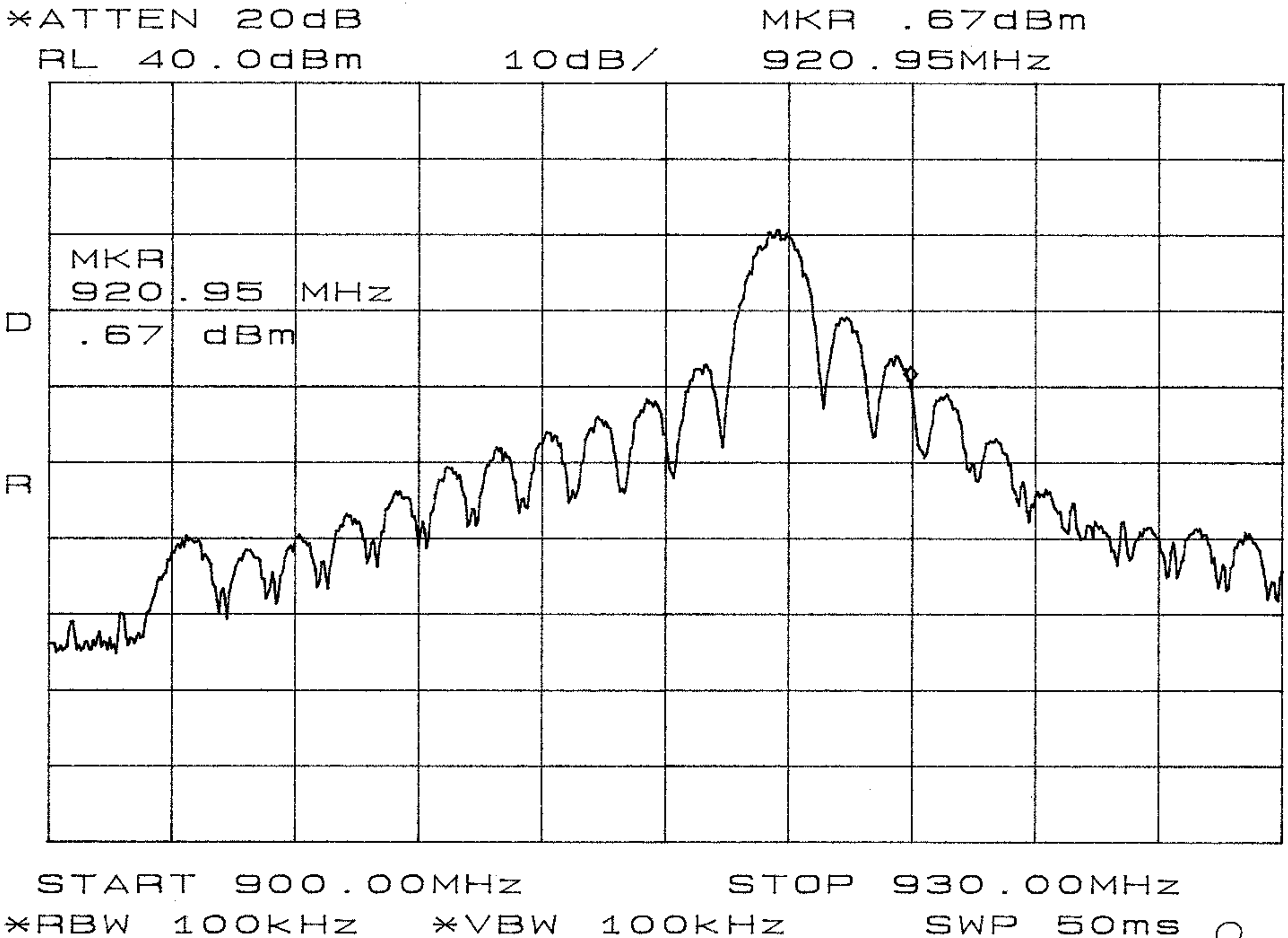
*ATTEN 20dB MKR -.67dBm
RL 40.0dBm 10dB/ 915.55MHz

D
R



START 900.00MHz STOP 930.00MHz
*RBW 100kHz *VBW 100kHz SWP 50ms

D33573-8a SPURIOUS



D33573-8b SPURIOUS

Test Name: **Processing Gain** **Test #: 3.B.1**
Test Summary: Verifies compliance to receiver processing gain specification at +25°C with an input signal level of -104 dBm.
Applies to Specification 3.2.2.7

Pass / Fail Criteria:
Every point must exhibit => 12 dB process gain. (FCC Requirement ≥ 10 dB)

Required Test Equipment:
HP9664B Signal Generator
Variable attenuator(s)
Power supply
Boonton Power Meter
HP8594E Spectrum Analyzer
IBM PC compatible computer with serial interface
Transceiver power cable, twisted pair, extended length
Transceiver serial cable, RJ45, extended length

Equipment Set Up:
The processing gain of the DSP receiver is measured by the spread signal to unspread signal method whereby a CW signal is injected in 50 KHz intervals from 917.3800 to 917.7800 MHz. The difference (in dB) of the correlated spread signal level applied separately, is the system process gain.

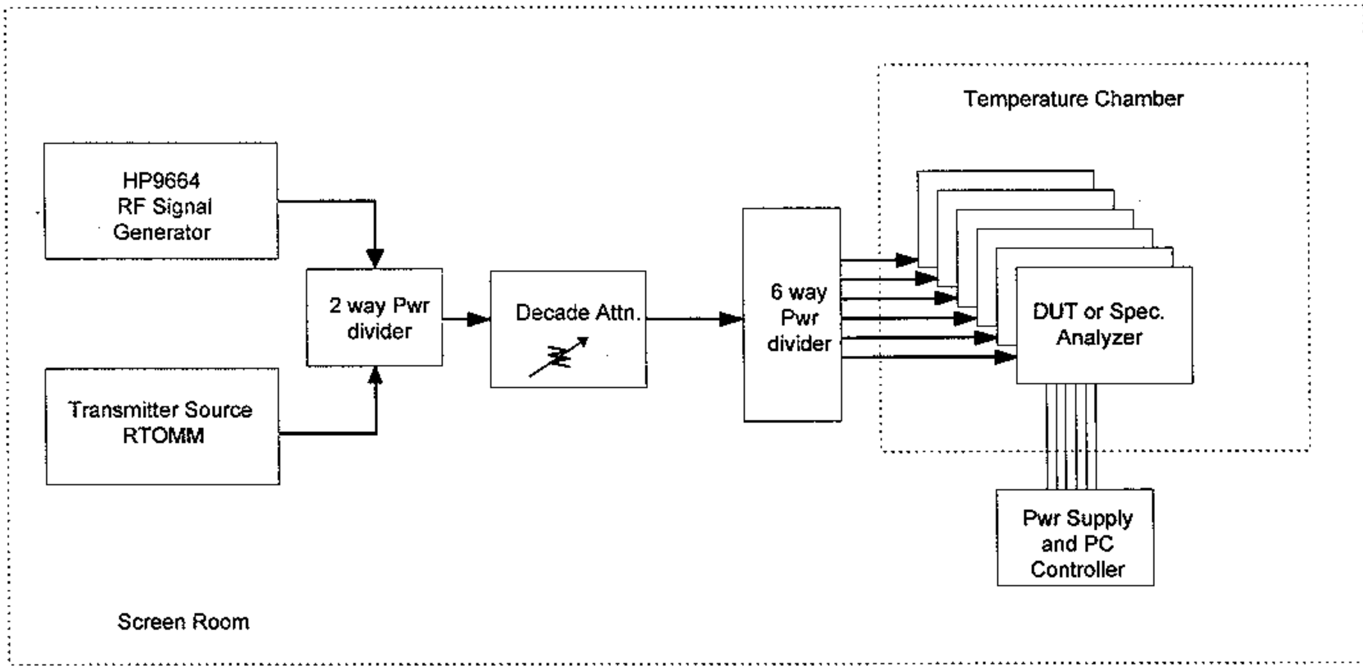
1. Each transceiver receive section will be programmed with default parameters using appropriate software/firmware. Select a receive frequency of 917.58 MHz for all tests.

2. HP9664A Signal Generator:
   - Center Frequency = 917.38000 MHz
   - Signal Level = -30 dBm

3. HP8594E Spectrum Analyzer
   - Resolution Bandwidth = 3 MHz
   - Video Bandwidth = 1 MHz
   - Sweep = 50 msec
   - Span = 0 MHz
   - Attenuation = 10 dB

4. Variable Attenuator = as required to achieve a -95 dBm spread signal.

Note: Ensure that all test equipment has been warmed up for 30 minutes and calibrated before measurements are taken.



3.B.1 Test Configuration for Process Gain

Procedure:

1. Place the transceiver(s) to be tested in the temperature chamber.
2. Label and route each wire and cable described below outside the temperature chamber.
3. Use the transceiver power cable to connect the device under test to the DC supply. Set the DC supply to provide 13.5 VDC to the device under test.
4. Determine the amount of power difference between the injected spread signal at 917.58 MHz and the injected CW signal at 917.58 MHz that produced the same signal level on the spectrum analyzer.
   a. Measure and record the power of the spread signal present at the input to any one of the DUTs by connecting it to the spectrum analyzer. Measure power during preamble portion of the message packet.
   b. Then, after turning the Spread signal OFF and switching ON the CW signal, measure and record the power of the CW signal present at the input of the same DUT by routing again the spectrum analyzer.
   c. Determine a calibration factor based on the difference between the measurements made in steps a. and b. This amount of attenuation shall be added or removed (as appropriate) from the circuit when configured for CW input measurements.
5. Apply a spread signal to the receiver. Record the indicated level of this signal after correlation.
6. Reconfigure the set-up to apply a CW signal at 917.58 MHz to the DSP input.
7. Apply (or remove) the appropriate amount of attenuation, as determined in step 4 above, such that the CW signal is at the same indicated input power level as the spread signal from step 5.
8. Input a spread signal level at - 80 dBm at 917.58 MHz, and then, input a CW signal beginning at 917.3800 MHz, and increment up in 50 KHz steps to 917.7800, record the delta (change in attenuator settings) that produces the same indicated output for the CW signal as the - 80 dBm spread signal. The indicated output is first of the last three bites in the reported packet as is a number between 0 and 255 which roughly corresponds to -128 and -30 dBm respectively.
9. Determine average process gain by averaging the linear equivalent in Watts of the values in the table below and then converting back to dB's.

PROCESS CAIN TEST

+25 C (only)	Frequency Offset (KHz)								
UNIT #	**-200**	**-150**	**-100**	**-50**	**0**	**+50**	**+100**	**+150**	**+200**
1	*14.8*	*14.5*	*14.5*	*14.0*	*15.0*	*14.4*	*15.0*	*15.7*	*15.1*
2	*16.3*	*16.0*	*15.7*	*15.0*	*15.0*	*15.7*	*16.1*	*17.0*	*16.2*
3	*16.2*	*15.8*	*15.7*	*15.2*	*16.0*	*15.8*	*16.4*	*16.6*	*16.6*
4	*16.0*	*16.0*	*15.0*	*14.4*	*15.0*	*14.5*	*15.3*	*15.6*	*15.5*
Pass/Fail (dB)	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12**	**≥ 12 dB**

DUT # 1 Average Process Gain = *14.8* dB

DUT # 2 Average Process Gain = *16.0* dB

DUT # 3 Average Process Gain = *16.1* dB

DUT # 4 Average Process Gain = *15.3* dB

Acceptance Block:	**A signature below denotes that this test has met all pass criteria.**
Signature:	*Gordon Furze* Gordon Furze
Date:	*July 30, 1997* July 30, 97

Dear Greg Czumack:

Please excuse the lack of introduction, but I was asked to look at the correspondence between you and Elliott Labs/ CellNet about the H6NCMM2200 device. My summary of the problem is that our people have been too close to the details and haven't conveyed the big picture you have been asking for, (as I read between the lines of your questions).

The missing picture is that our system uses on-off keying as the data modulation. Data zeros are "sent" as zero amplitude of the spread signal, and data ones are sent as full amplitude of the spread signal. Thus the data is demodulated by the amplitude detector, which also supplies the signal level indication.

Consequently, in the processing gain measurement, the spread signal is correlated, by being mixed against the identically-spread local oscillator and narrow-bandwidth-filtered, then demodulated by the amplitude level detector. The amplitude measurement is actually made during the all-ones synchronization burst. Then the spread signal source is turned off, and the CW signal from the signal generator is substituted for the spread signal. This CW signal represents a nonspread signal that is a data modulated signal with the "data" being all-ones. This CW signal is "correlated, " then demodulated at the level detector. The processing gain is the number of dBs that have to be removed from an attenuator preceding the receiver to bring the indicated level of this nonspread signal, at the receiver demodulating amplitude detector, up to the level indicated for the spread signal, when they each enter the attenuator at the same power level.

If this communication resolves the questions, I will try to get our people to buy me a beer.

Sincerely

Forrest Fulton

Forrest Fulton
Chief Scientist, Radio Systems

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

EXHIBIT 5: Proposed FCC ID Label & Label Location

EXHIBIT 6: Detailed Photographs of Cellnet Data Systems Model DCOM Construction

2 Pages

EXHIBIT 7: Operator's Manual for Cellnet Data Systems Model DCOM

1 Page

EXHIBIT 8: Block Diagram of Cellnet Data Systems Model DCOM

Did not change from original application.

EXHIBIT 9: Schematic Diagrams for Cellnet Data Systems Model DCOM

4 Pages

EXHIBIT 10: Theory of Operation for Cellnet Data Systems Model DCOM

8 Pages