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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 Schlumberger Industries Inc. Model: Pit MIU1

FCC ID:	F9CTALWCNMIU1
GRANTEE:	Schlumberger Industries Inc. 1600 Alabama Highway 229 Tallassee, AL 36078
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	May 3, 1999
FINAL TEST DATE:	April 2, 1999
AUTHORIZED SIGNATORY:	Mark Hill EMC Staff Consultant

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SCOPE

An electromagnetic emissions test has been performed on the Schlumberger Industries Spread Spectrum Water Meter model Pit MIU1 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 Schlumberger Industries model Pit MIU1 and therefore apply only to the tested sample. The sample was selected and prepared by Mohammed S. Ali of Schlumberger Industries 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.

STATEMENT OF COMPLIANCE

The tested sample of Schlumberger Industries model Pit MIU1 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 Schlumberger Industries model Pit MIU1. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT does not connect to an AC power source and is powered from an internal battery. No conducted emissions tests were required.

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.

30 - 1000 MHz

Frequency MHz	Level dBuV/m	Pol v/h	§15.209 Limit	§15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
974.889	45.1	v	54.0	-8.9	QP	40	1.0	In restricted band

1 - 6 GHz

Frequency MHz	Level dBuV/m	Pol v/h	§15.209 Limit	§15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
3670.000	71.0	v	74.0	-3.0	Peak	182	1.2	In restricted band

6 - 10 GHz

Frequency MHz	Level dBuV/m	Pol v/h	§15.209 Limit	§15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
8257.000	56.6	v	74.0	-19.4	Peak	30	1.1	In restricted band

IMITS OF POWER AND BANDWIDTH

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

The output power output was 23.9 dBm (0.245 Watts). The power density was measured to be 6.5 dBm in a 3kHz bandwidth averaged over 1 second. The 6 dB bandwidth was 1.380 MHz.

Power measurements were calculated from a radiated field strength measurement made at a test distance of 3m. The formula used to calculate the Power (P, in Watts) from the radiated field strength (E, in V/m) at a distance d (3m) from the EUT was:

$$P = \frac{E^2 d^2}{30G}$$ (Note that the EUT antenna gain, G, was assumed to be unity)

The actual test data and any correction factors are contained in an exhibit of this report.

PROCESSING GAIN

The Processing Gain was measured by the manufacturer to be 14.8 dB. This measurement was made on a slightly different version of the device which was approved under FCC ID: F9CTALWCNMIU1 granted on 2/11/99. The difference between the approved device and the device being submitted is that the new device has a different transmit antenna. The transmit antenna is not used when making the processing gain measurements so the data for the original device is being submitted.

The actual test data and any correction factors are contained in an exhibit of this report.

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Schlumberger Industries model Pit MIU1 is a Water Meter Interface Unit (MIU), with an integrated CellNet RF transmitter. The sample was received on April 2, 1999 and tested on April 2, 1999. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	FCC ID Number
Schlumberger RMS/ Pit MIU1 / Water Meter Interface Unit	30327205	F9CTALPCNMIU1
Schlumberger RMS/ Pit Antenna	Preproduction	N/A

INPUT POWER

The EUT is powered by a 3.6 VDC battery.

PRINTED WIRING BOARDS

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

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Schlumberger/ Pit MIU1 PWB	442160-001	B	None	14.56 , 0.032768

SUBASSEMBLIES

The EUT contained the following subassembly modules during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial Number
Schlumberger/ Battery Pack	12213-000	B	None

ENCLOSURE

The EUT enclosure is primarily constructed of molded plastic. It measures approximately 11 cm deep by 14 cm wide and 6 cm high.

ANTENNA

The EUT assembly consists of the water meter, antenna and water pit enclosure. The antenna cable is soldered to the transmitter pcb, which is potted in the meter enclosure. The other end of the antenna connection is made via an SMA connector, which is also potted, into the antenna connector base. The completed assembly prevents the end user from access to the antenna connection, thereby meeting the requirements of §15.203.

EMI SUPPRESSION DEVICES

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

Description	Manufacturer	Part Number
None	-	-

SUPPORT EQUIPMENT

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

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

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
Shielded coaxial	0.25	EUT	Antenna

TEST SOFTWARE

The EUT was set to transmit once per second.

PROPOSED MODIFICATION DETAILS

GENERAL

This section details the modifications to the Schlumberger Industries model Pit MIU1 being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

Antenna

The difference between the approved device and the device being submitted, is that the new device has a different transmit antenna. The approved device utilized an internal antenna soldered to the transmitter printed wiring board. The new device replaces the antenna with a cable, soldered to the tranmitter pwb, connecting to an external antenna.

Installation Location

The approved device was designed to be wall mounted. The new device is designed to be located in a cement water meter pit.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on April 2, 1999 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

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

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, 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 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 measurments 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 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.

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

2 Pages

Test Equipment List - SVOATS#3

March 29, 1999

	Manufacturer/Description		Model	Asset_#	Interval	Last Cal	Cal Due
☒	Elliott Laboratories	300-1000 MHz Log Periodic	EL300.1000	55, (F130)	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	786	12	1/15/99	1/15/2000
☐	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	868	12	9/22/98	9/22/99
☐	Fischer	LISN	FCC-LISN-50/2	810	12	2/2/99	2/2/2000
☒	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	12	1/4/99	1/4/2000
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	11/23/98	11/23/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263, (F303)	12	6/8/98	6/8/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/25/98	11/25/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	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	85958-041-103-	Metric, 885	12	5/11/98	5/11/99
☐	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	4/27/98	4/27/99
☐	Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/27/98	4/27/99
☐	Rohde& Schwarz	Pulse Limiter	ESH3Z2	812	12	12/8/98	12/8/99
☐	Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	274	12	4/8/98	4/8/99
☒	Rohde &Schwarz	Test Receiver, 20-1300MHz	ESVP	213, (F196)	12	10/4/98	10/4/99

File Number: T31170

Date: 4/6/99

Engr: [signature]

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

Test Equipment List - SVOATS#1

March 29, 1999

	Manufacturer/Description		Model	Asset_#	Interval	Last Cal	Cal Due
☐	Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	304	12	6/24/98	6/24/99
☐	EMCO	Biconical Antenna, 30-300 MHz	3110B	363	12	4/8/98	4/8/99
☐	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
☐	EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	12	4/8/98	4/8/99
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	12	1/4/99	1/4/2000
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	11/23/98	11/23/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263, (F303)	12	6/8/98	6/8/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/25/98	11/25/99
☑	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	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	5/11/98	5/11/99
☐	Hewlett Packard	Thermistor Mount	478A	652	12	2/17/99	2/17/2000
☐	Narda West	High Pass Filter	HPF 180	821	12	8/10/98	8/10/99
☑	Narda-West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/27/98	4/27/99
☐	Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/27/98	4/27/99
☐	Rohde & Schwarz	10 dB Pad / Pulse Limiter	ESH322	372	12	6/22/98	6/22/99
☐	Rohde& Schwarz	Receiver 20 MHz - 1.3 GHz	ESVP	IR, 046	6	1/18/99	7/18/99
☐	Rohde& Schwarz	Receiver 9KHz - 30 MHz	ESH3	IR, 024	6	1/18/99	7/18/99
☑	HP	High Pass filter	161	833	12	8/10/98	8/10/99

File Number: T31174

Date: 4/2/99

Engr: Dan Richmond

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

T31174 12 Pages
Processing Gain Measurements 4 Pages
(Provided by Schlumberger)

Elliott

EMC Test Log

Client:	Schlumberger Industries Inc.	Date:	4/2/99	Test Engr:	Dan Anchondo
Product:	Pit MIU1	File:	T31174	Proj. Eng:	David Bare
Objective:	Final Qualification	Site:	SVOATS#1	Contact:	Mohammed S. Ali
Spec:	FCC Part 15	Page:	1 of 4	Approved:	
Revision	1.0				

Ambient Conditions	
Temperature:	7.8 ℃
Humidity:	65 %

Test Objective

The objective of this test session is to perform final qualification testing the EUT defined below relative to the specification(s) defined above. Run # 1-3 was performed on 4/1/99 as T31170 by Rudy Suy.

Test Summary

Run #1 - 6dB Bandwidth measurement @ 917.5 MHz In Accordance With §15.247 (a) (2) Test performed on 4/1/99, T31170

PASS Results: 6dB bandwidth was 1.380 MHz, meeting the minimum requirement of 500 kHz.

Run #2 - Transmitted Power Measurements @ 917.5 MHz In Accordance With 15.247 (b) Test performed on 4/1/99, T31170

PASS Results: Output power was calculated from the radiated field strength to be 23.9 dBm, -6.1 dBm below the maximum permitted output of 30 dBm (1 Watt).

Run #3 - Power Density Measurements @ 917.5 MHz In Accordance With 15.247 (d) Test performed on 4/1/99, T31170

PASS Results: Output power density in 3 kHz bandwidth was calculated from the radiated field strength to be 6.5 dBm, -1.5 dBm below the maximum permitted density of 8 dBm/kHz.

Run #4 - Maximized Emissions Scan, 30 - 902 MHz and 928 - 1000 MHz

PASS Results: §15.209 -8.9 dB QP @ 974.889 MHz Vertical

Note: Emissions lying in restricted bands were subject to the limits of §15.209. The limit at all other frequencies was 20dB below the fundamental emission of 112.7 dBµV/m.

Run #5 - Maximized Spurious Emissions Falling In Restricted bands Above 1 GHz

PASS* Results: §15.247c -3.0 dB Peak @ 3670.000 MHz Vertical

All other spurious emissions that were not in the restricted bands were more than 20dB below the fundamental emission level.

Note: * indicates that the difference between the level of one or more of the emissions from the system under test and the specification limit is within the measurement uncertainty.

Note: No AC conducted emission is required because the EUT is battery operated.

Equipment Under Test (EUT) General Description

The EUT is a Water Meter Interface Unit (MIU), with an integrated CellNet RF transmitter. Normally, the EUT would be mounted into a pit lid during operation. For the purpose of testing the EUT was treated as table top equipment.

The digital portion of this EUT was tested before on 11/16/98 (T29225) and approved under FCC ID: F9CTALWCNMIU1. The only difference between approved product and this product in this EUT is the antenna.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Schlumberger RMS/ Pit MIU1 / Water Meter Interface Unit	30327205	F9CTALPCNMIU1
Schlumberger RMS/ Pit Antenna	Preproduction	N/A

Power Supply and Line Filters

Description	Manufacturer	Model
None	-	-

The EUT is powered by a 3.6 VDC battery.

Client:	Schlumberger Industries Inc.	Date:	4/2/99	Test Engr:	Dan Anchondo
Product:	Pit MIU1	File:	T31174	Proj. Eng:	David Bare
Objective:	Final Qualification	Site:	SVOATS#1	Contact:	Mohammed S. Ali
Spec:	FCC Part 15	Page:	3 of 4	Approved:	
Revision	1.0				

Printed Wiring Boards in EUT

The following information was provided by the manufacturer:

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Schlumberger/ Pit MIU1 PWB	442160-001	B	None	14.56 , 0.032768

Subassemblies in EUT

The following information was provided by the manufacturer:

Manufacturer/Description	Assembly Number	Rev.	Serial Number
Schlumberger/ Battery Pack	12213-000	B	None

EUT Enclosure(s)

The EUT enclosure is primarily constructed of molded plastic. It measures approximately 11 cm deep by 14 cm wide and 6 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
None	-	-

Local Support Equipment

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

Remote Support Equipment

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

Client:	Schlumberger Industries Inc.	Date:	4/2/99	Test Engr:	Dan Anchondo
Product:	Pit MIU1	File:	T31174	Proj. Eng:	David Bare
Objective:	Final Qualification	Site:	SVOATS#1	Contact:	Mohammed S. Ali
Spec:	FCC Part 15	Page:	4 of 4	Approved:	
Revision	1.0				

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Shielded coaxial	0.25	EUT	Antenna

Test Software

The EUT was set to transmit once per second.

General Test Conditions

During radiated testing, the EUT was powered by a 3.6 VDC internal battery. The EUT and local support equipment were located on the turntable for radiated testing .

Test Data Tables

See attached data

Elliott — Emissions Test Data

Client:	Schlumberger Industries Inc.	Date:	4//2/1999	Test Engr:	Dan Anchondo
Product:	Pit MIU1	File:	D31174	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #1	Contact:	Muhammed Ali
Spec:	FCC Part 15	Distance:	3 m	Approved:	

Ambient Conditions
Temperature: 7.8 °C
Humidity: 65 %

Run #1 -3 was performed on 4/1/99 as D31170 by Rudy Suy.

Run #A: Measurement of the fundamental emissions (Reference only)

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
917.580	105.9	h	N/A	N/A	Peak	350	1.0	100 kHz Bandwidth, w/ Receiver
917.580	112.7	v	N/A	N/A	Peak	170	1.1	100 kHz Bandwidth, w/ Receiver
917.580	116.9	h	N/A	N/A	Peak	350	1.0	1MHz Bandwidth, w/ Analyzer
917.580	120.7	v	N/A	N/A	Peak	170	1.1	1MHz Bandwidth, w/ Analyzer

Run #1: 6dB Bandwidth Measurement, With 100kHz Bandwidth, 2M Span, 50ms Sweep time
6dB bandwidth was1.380 MHz (the minimum allowed in 6dB bandwidth is 500kHz).

Run #2 & 3: Measurement of fundamental emission, Power, and Power Density

	Level	Ant Gain	Calculation	FCC	dBu/m to			
	dBuV/m	dB	Factor	Limit	**dBm**	**Margin**		Comments
Power	119.1	v	-95.2	30.0	23.9	-6.1	dBm	P=E^2 * d^2 /30 * G
Pwr Density	101.7	v	-95.2	8.0	6.5	-1.5	dBm	P=E^2 * d^2 /30 * G
917.580	112.6	h	N/A	N/A		350	1.0	2 MHz BW, 2M Span, 50ms Swee
917.580	119.1	v	N/A	N/A		170	1.1	2 MHz BW, 2M Span, 50ms Sweep
917.580	95.0	h	N/A	N/A		350	1.0	3kHz BW, 300K Span, 100 sec
917.505	101.7	v	N/A	N/A		170	1.1	3kHz BW, 300K Span, 100 sec

Run #1: Maximized emissions scan, 30 - 1000 MHz.
Limits for signals not in the restricted bands is 20dB below the fundamental emission level of 112.7 dBuV/m

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
974.889	45.1	v	54.0	-8.9	QP	40	1.0	In restricted band
974.889	41.0	h	54.0	-13.0	QP	234	1.0	In restricted band
150.002	25.7	h	43.5	-17.8	QP	271	1.5	In restricted band
487.444	25.8	v	46.0	-20.2	QP	180	1.0	In restricted band
487.444	25.6	h	46.0	-20.4	QP	180	1.0	In restricted band
458.206	43.2	v	92.7	-49.5	QP	270	1.1	Not in restricted band.
895.230	40.7	v	92.7	-52.0	QP	61	1.2	Not in restricted band.
458.206	40.6	h	92.7	-52.1	QP	197	2.0	Not in restricted band.
895.230	37.2	h	92.7	-55.5	QP	225	1.0	Not in restricted band.
151.220	25.8	h	92.7	-66.9	QP	300	2.0	Not in restricted band.

Client:	Schlumberger Industries Inc.	Date:	4//2/1999	Test Engr:	Dan Anchondo
Product:	Pit MIU1	File:	D31174	Proj. Engr:	Mark Briggs
Objective	Final Qualification	Site:	SVOATS #1	Contact:	Muhammed Ali
Spec:	FCC Part 15	Distance:	3 m	Approved:	

Run #2a: Maximized radiated scan, 1-6 GHz

Frequencies that falls within the Restricted Band was compared to Class B.
Frequencies that does not falls within the Restricted Band must be -20dB below the fundamental emissions (112.7dBuV/m).
Measurements made at 3m per FCC requirements.
Note1: Used 1.4GHz High Pass Filter
Note2: -15.9dB was subtracted from Avg Reading for
Duty cycle correction factor (base on 16mS/100mS)
All readings have included AF, Cable Losses and Pre-Amp gain.

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
3670.000	71.0	v	74.0	-3.0	Peak	162	1.2	Restricted Band
2752.000	67.2	v	74.0	-6.8	Peak	301	1.2	Restricted Band
3670.000	65.4	h	74.0	-8.6	Peak	48	1.2	Restricted Band
3670.000	43.3	v	54.0	-10.7	Avg.	162	1.2	Restricted Band
3670.000	38.4	h	54.0	-15.6	Avg.	48	1.2	Restricted Band
2752.000	35.0	h	54.0	-19.0	Avg.	331	1.5	Restricted Band
2752.000	31.0	v	54.0	-23.0	Avg.	301	1.2	Restricted Band
2752.000	50.6	h	74.0	-23.4	Peak	331	1.5	Restricted Band
4587.000	25.6	h	54.0	-28.4	Avg.	211	1.5	Restricted Band
4587.000	45.5	v	74.0	-28.5	Peak	0	1.4	Restricted Band
4587.000	44.3	h	74.0	-29.7	Peak	211	1.5	Restricted Band
4587.000	21.4	v	54.0	-32.6	Avg.	0	1.4	Restricted Band
1835.000	52.1	v	92.7	-40.6	Peak	298	1.0	Not in Restricted Band
1835.000	27.1	v	92.7	-65.6	Avg.	298	1.0	Reference only

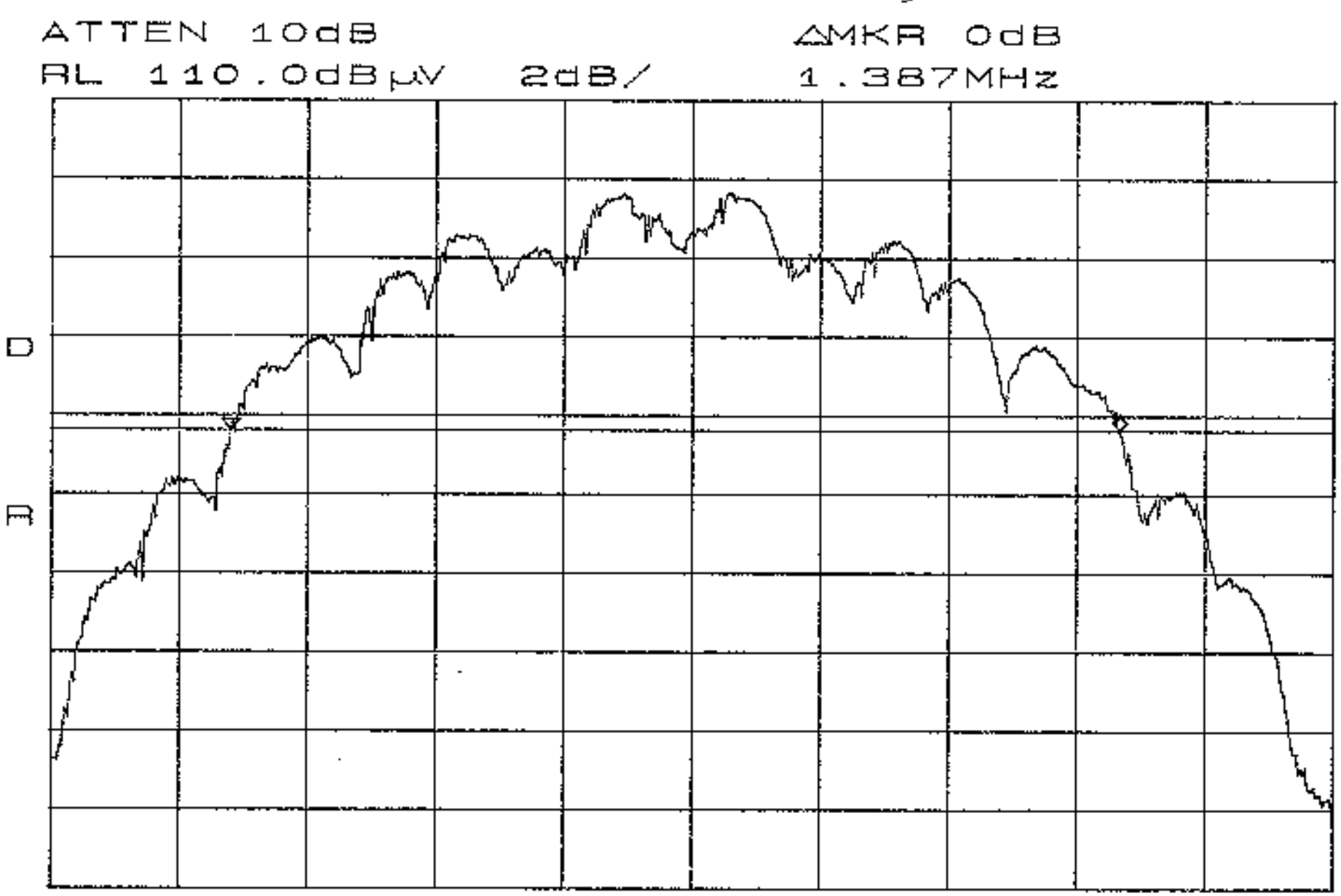
Run #2b: Maximized radiated scan, 6-10 GHz

Elliott equipment: 284 Analyzer, 868 Horn Antenna, 870 Pre-Amp, 833 High Pass Filter
All readings have included AF, Cable Losses and Pre-Amp gain.
Readings taken outside
Note1: Used 1.4GHz High Pass Filter
Note 2: -15.9dB was subtracted from Avg Reading for
Duty cycle correction factor (base on 16mS/100mS)
All readings have included AF, Cable Losses and Pre-Amp gain.

Frequency	Level	Pol	FCC	FCC	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
8257.000	54.6	v	74.0	-19.4	Peak	30	1.1	Restricted Band
7340.000	54.1	v	74.0	-19.9	Peak	320	1.2	Restricted Band
9175.000	51.8	v	74.0	-22.2	Peak	300	1.5	Restricted Band
8257.000	30.0	v	54.0	-24.0	Avg.	30	1.1	Restricted Band
7340.000	29.5	v	54.0	-24.5	Avg.	320	1.2	Restricted Band
7340.000	49.4	h	74.0	-24.6	Peak	180	1.5	Restricted Band
9175.000	27.6	v	54.0	-26.4	Avg.	300	1.5	Restricted Band
9175.000	46.1	h	74.0	-27.9	Peak	10	1.5	Restricted Band
8257.000	45.9	h	74.0	-28.1	Peak	360	1.5	Restricted Band
7340.000	24.1	h	54.0	-29.9	Avg.	180	1.5	Restricted Band
9175.000	24.0	h	54.0	-30.0	Avg.	10	1.1	Restricted Band
8257.000	23.6	h	54.0	-30.4	Avg.	360	1.5	Restricted Band

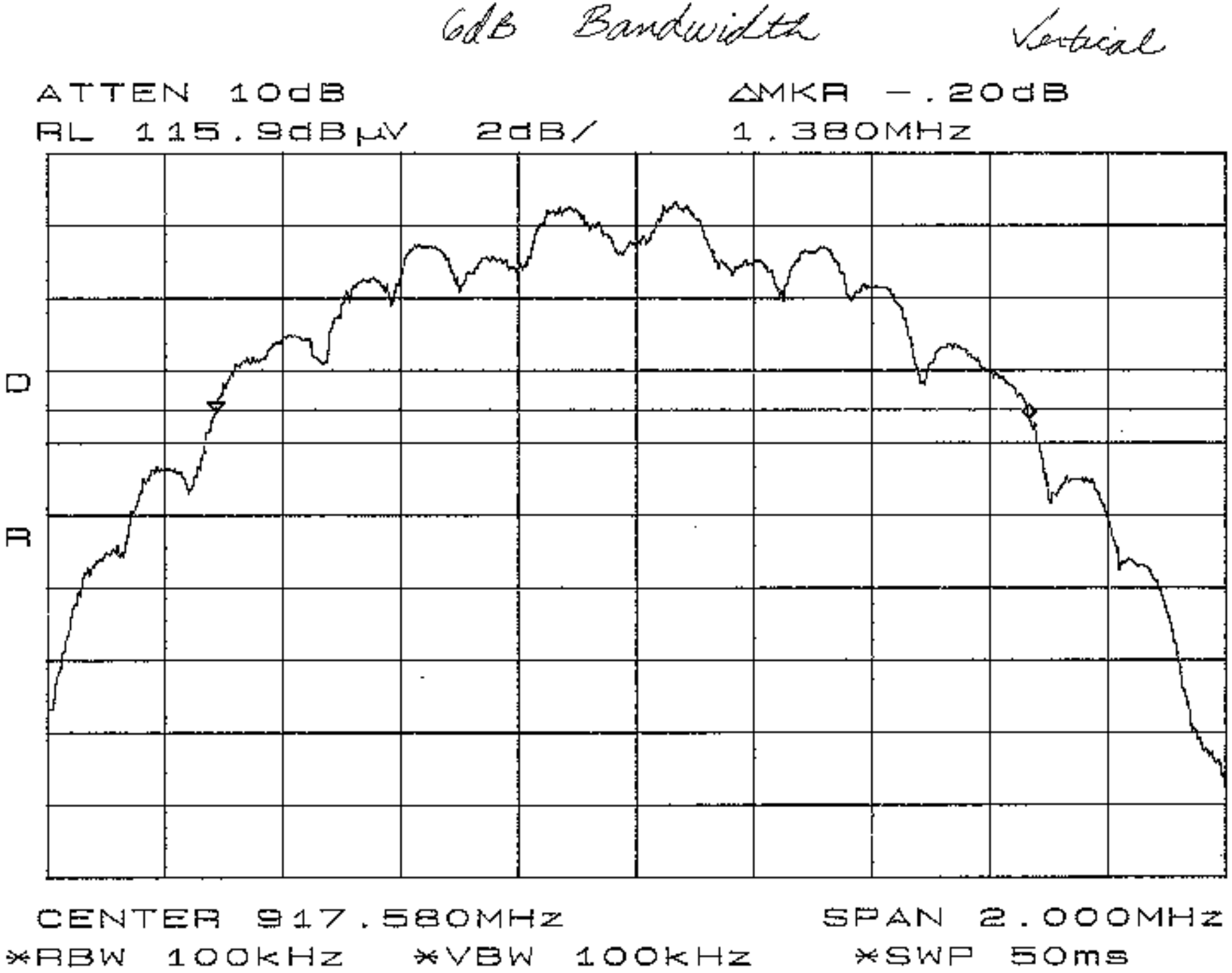
6dB Bandwidth

Horizontal



73170

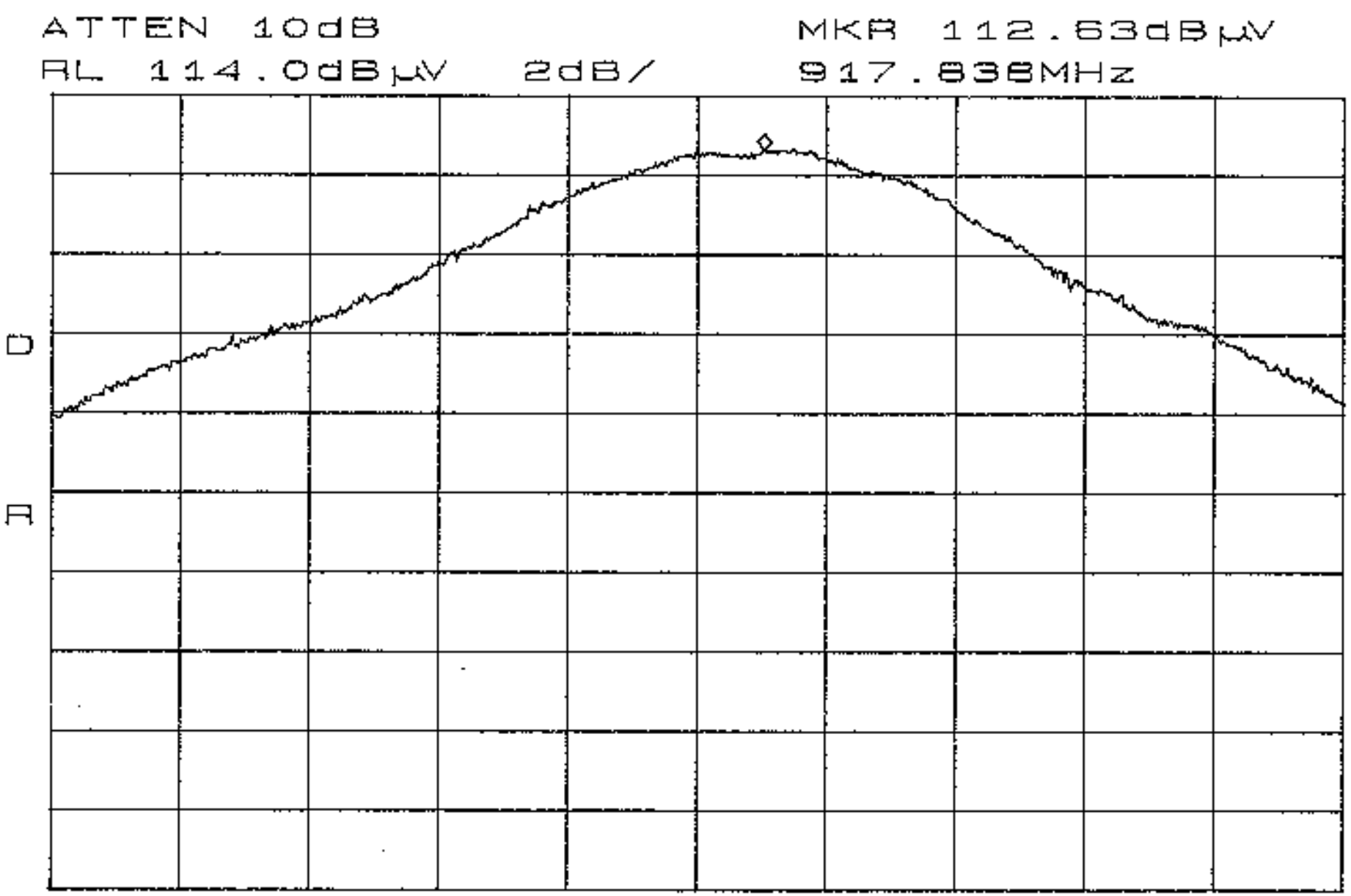
6dB Bandwidth Vertical



T31170

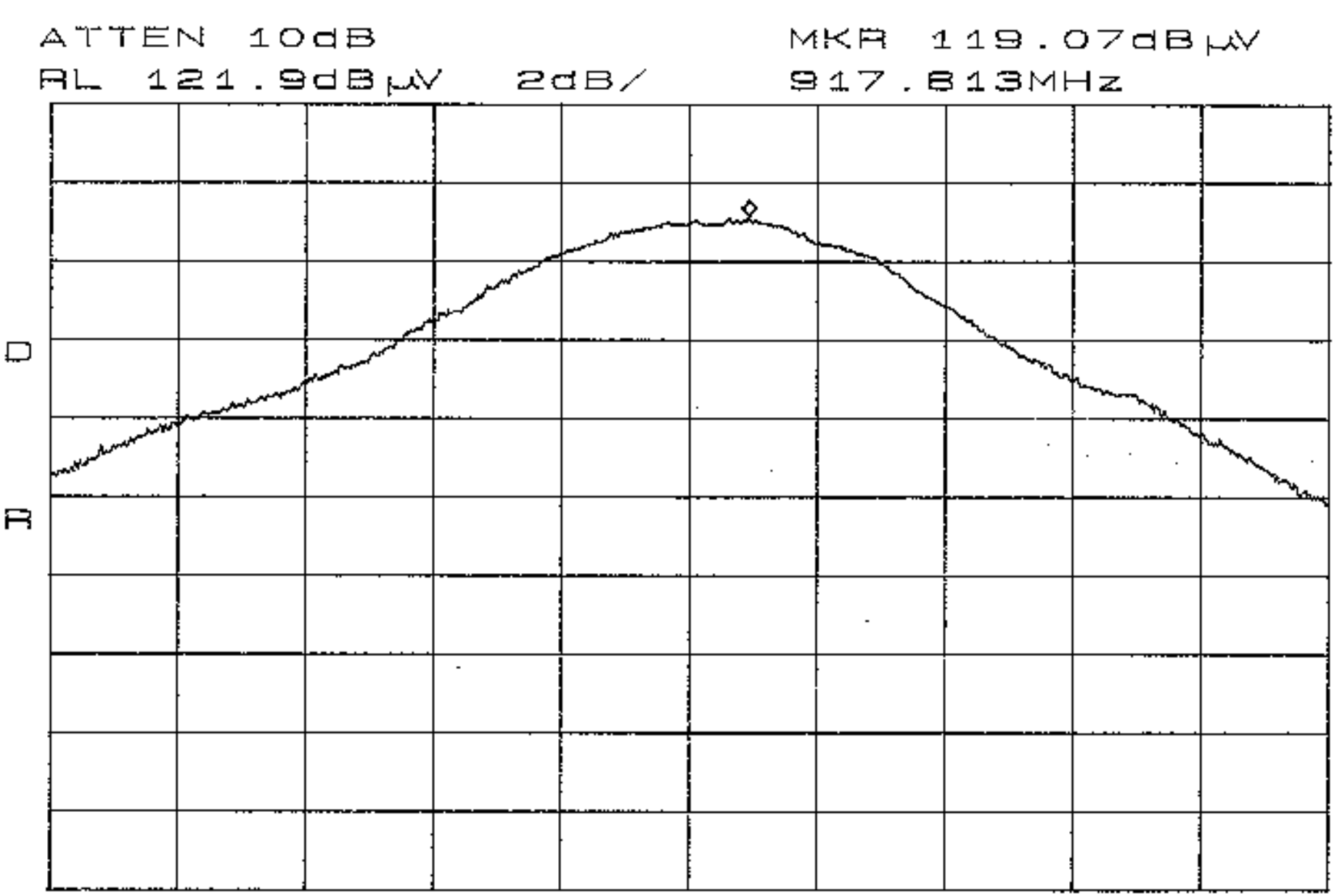
Transmit Power

Horizontal



73170

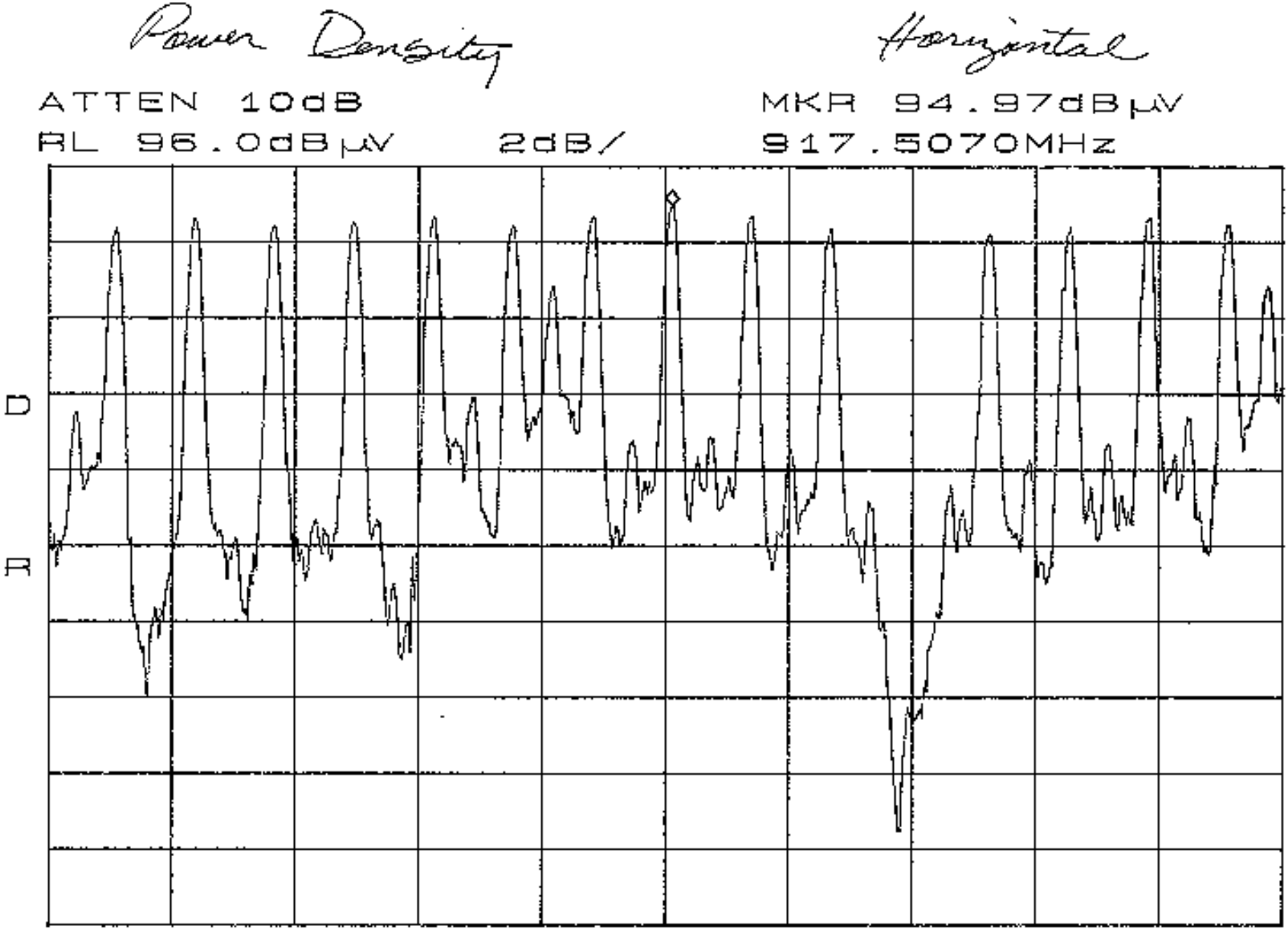
Transmit Power Vertical



T31170

Power Density

Horizontal



T31170

Power Density

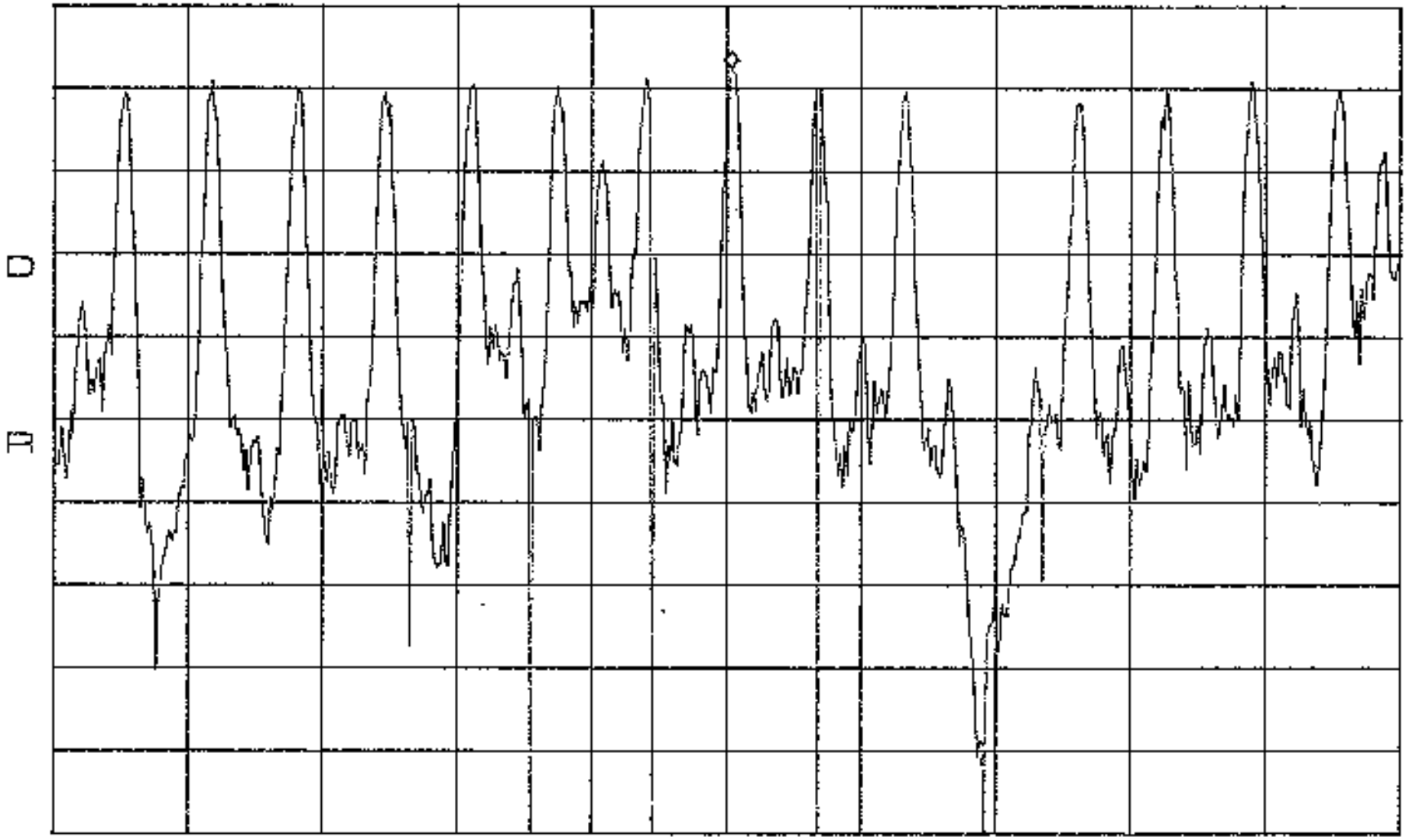
Vertical

ATTEN 10dB

RL 103.2dBμV 2dB/

MKR 101.70dBμV

917.5057MHz



CENTER 917.5047MHz

SPAN 300.0kHz

*RBW 3.0kHz *VBW 3.0kHz *SWP 100sec

T31170

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:
HP8664B 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. HP8664A Signal Generator:

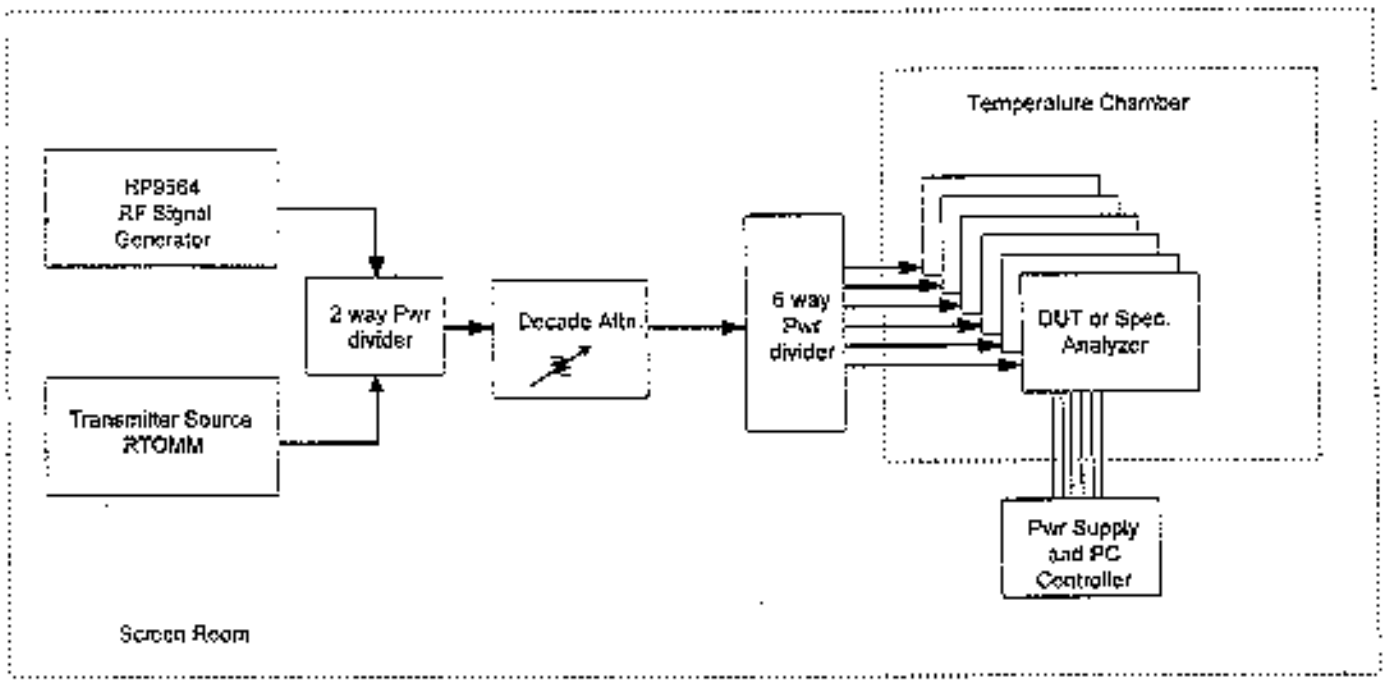
Center Frequency	=	917.38000 MHz
Signal Level	=	-30 dBm

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 -126 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 1997

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 4: Proposed FCC ID Label & Label Location

2 Pages

EXHIBIT 5:Detailed Photographs of Schlumberger Industries Model Pit MIU1 Construction

10 Pages

EXHIBIT 6:Operator's Manual for Schlumberger Industries Model Pit MIU1

17 Pages

EXHIBIT 7:Block Diagram of Schlumberger Industries Model Pit MIU1

1 Pages

EXHIBIT 8:Schematic Diagrams for Schlumberger Industries Model Pit MIU1

3 Pages

EXHIBIT 9:Theory of Operation for Schlumberger Industries Model Pit MIU1

5 Pages