

TEST REPORT

Report Number: 30394451
Project Number: 3039445
Report Date: June 20, 2003

Testing performed on the

Hiper Lite
Model: 01-840802-03
FCC ID: LCB-840802
to
FCC Part 15.247

for
Topcon Positioning Systems

Test Performed by:
Intertek
1365 Adams Court
Menlo Park, CA 94025

Test Authorized by:
Topcon Positioning Systems
5758 West Las Positas Blvd.P
Pleasanton, CA 94588

Prepared by: David Chernomordik **Date:** 06/25/03
David Chernomordik, EMC Technical Manager

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1.0 Introduction

The Equipment under Test (EUT) is a composite device with two Spread Spectrum Transceivers operating in the 2.4 GHz and 900 MHz frequency bands.

This report is designed to show compliance of the 900 MHz transceiver with FCC Part 15.247 requirements.

1.1 Summary of Tests

TEST	REFERENCE	RESULTS
Max. Output power	15.247(b)	Complies
20 dB Bandwidth	15.247(a)(1)	Complies
Min. Channel Separation	15.247(a)(1)	Complies
Min. Hopping Channels	15.247(a)(1)	Complies
Average Channel Occupancy Time	15.47(a)(1)	Complies
Out-of-band Antenna Conducted Emission	15.247(c)	Complies
Out of Band Radiated Emission	15.247(c)	Not Applicable. The device passed Out-of-band Antenna Conducted Emission
Radiated Emission in Restricted Bands	15.247(c), 15.205	Complies
AC Conducted Emission	15.207	Complies
Radiated Emission from Digital Part	15.109	Complies
Radiated Emission from Receiver L.O.	15.109	Complies
Antenna Requirement	15.203	Complies

2.0 General Description

2.1 Product Description

The EUT is a Dual Frequency GNSS receiver with GPS, with 900 MHz Spread Spectrum modem and Bluetooth module. In normal operation the EUT is tracking satellite, get a reference data from Base station via radio modem, measure the position data.

Overview of the EUT

Applicant	Topcon Positioning Systems 5758 West Las Positas Blvd.P Pleasanton, CA 94588
Manufacturer name & address	Topcon Positioning Systems 5758 West Las Positas Blvd.P Pleasanton, CA 94588
Trade Name & Model No.	Hiper Lite, 01-840802-03
FCC Identifier	LCB-840802
Use of Product	GPS Survey Receiver
Type of Transmission	Spread Spectrum, Frequency Hopping
Rated RF Output	1 W
Frequency Range	902.2 – 927.6 MHz
Number of Channel(s)	128
Baude Rate/Link Rate	57600/9600 kb/s
Antenna(s) type & Gain	Model: DEXRN902RTN from Antenex, swivel, 1/2 wave, 2.5 dBi
Antenna Requirement	The antenna is affixed to the EUT using a reverse polarity TNC connector.
LO Frequencies	LO1: 1172.2 – 1197.6 MHz; LO2: 280.7 MHz

A production version of the sample was received on March 28, 2003 in good condition. As declared by the Applicant, it is identical to production units.

Test start date: March 28, 2003

Test end date: June 16, 2003

2.2 Related Submittal(s) Grants

The FCC Part 15.247 Application for FHSS transmitter, operating in the 2.4-2.4835 GHz band, is filed simultaneously with the same FCC ID.

2.3 Test Methodology

Radiated and AC Line conducted emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Data Sheet**" of this Application. All other measurements were made in accordance with the procedures described in DA 00-705.

2.4 Test Facility

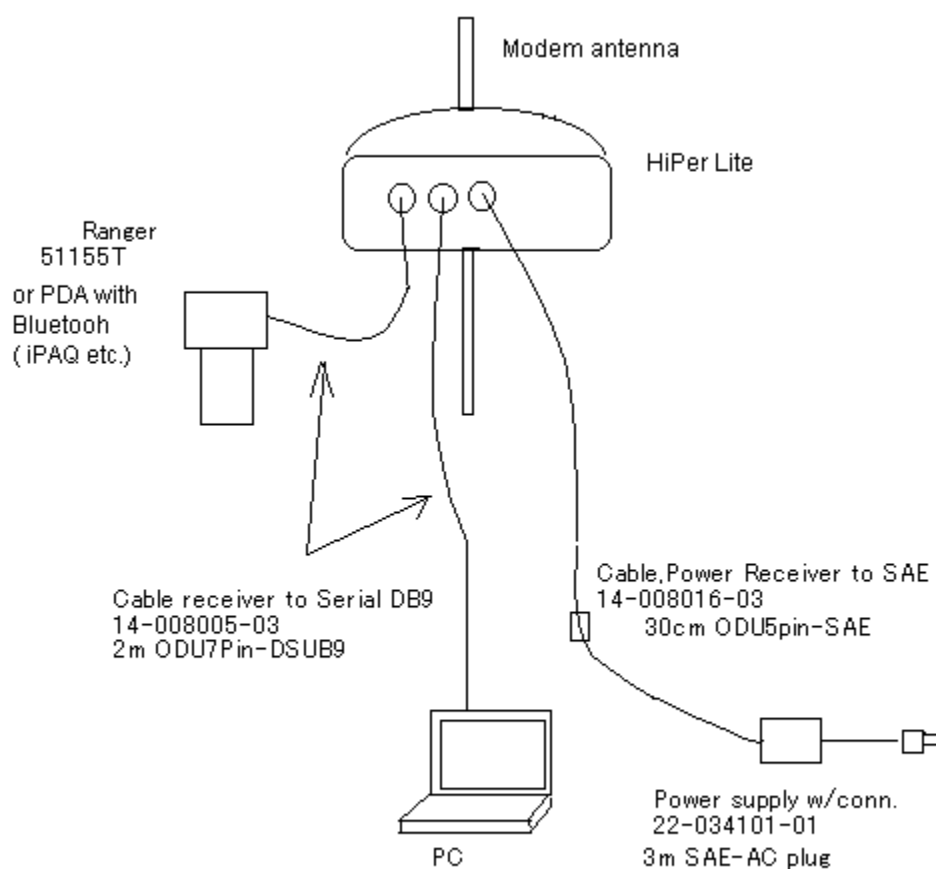
The open area test site and conducted measurement facility used to collect the radiated data is site 1 located in Menlo Park, California. This test facility and site measurement data have been fully placed on file with the FCC.

3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No.
1	Compaq Laptop	Armada E 500

3.2 Block Diagram of Test Setup



3.3 Justification

For radiated emission measurements the EUT is placed on the wooden turntable. The EUT is attached to peripherals and they are connected and operational (as typical as possible). The EUT is wired to transmit full power. During testing, all cables are manipulated to produce worst case emissions.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three-meter reading using inverse scaling with distance.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing is “Survey-Pro for Ranger” which is allowed to exercise the various system components in a manner similar to a typical use.

3.5 Mode of Operation During Test

The EUT was tested in test mode allowed to control the device from a computer (laptop). With hopping disable, the EUT was setup to transmit continuously at the lowest, middle, and highest channels (frequencies). Some tests were performed with hopping enabled.

3.6 Modifications Required for Compliance

The following modifications were installed during compliance testing in order to bring the product into compliance (Please note that this list does not include changes made specifically by Netopia Inc. prior to compliance testing):

Intertek installed no modifications.

4.0 Measurement Results

4.1 Conducted Output Power at Antenna Terminals FCC 15.247(b)(1)

Requirements

For systems operating in the 902 - 928 MHz band employing at least 50 hopping channels, the maximum peak output power is 1 watt (30 dBm), for systems employing less than 50 hopping channels – 0.25 W (24 dBm). If transmitting antennas of directional gain greater than 6 dBi are used the peak output power shall be reduced by the amount in dB that the directional gain of the antennas exceeds 6 dBi.

Procedure

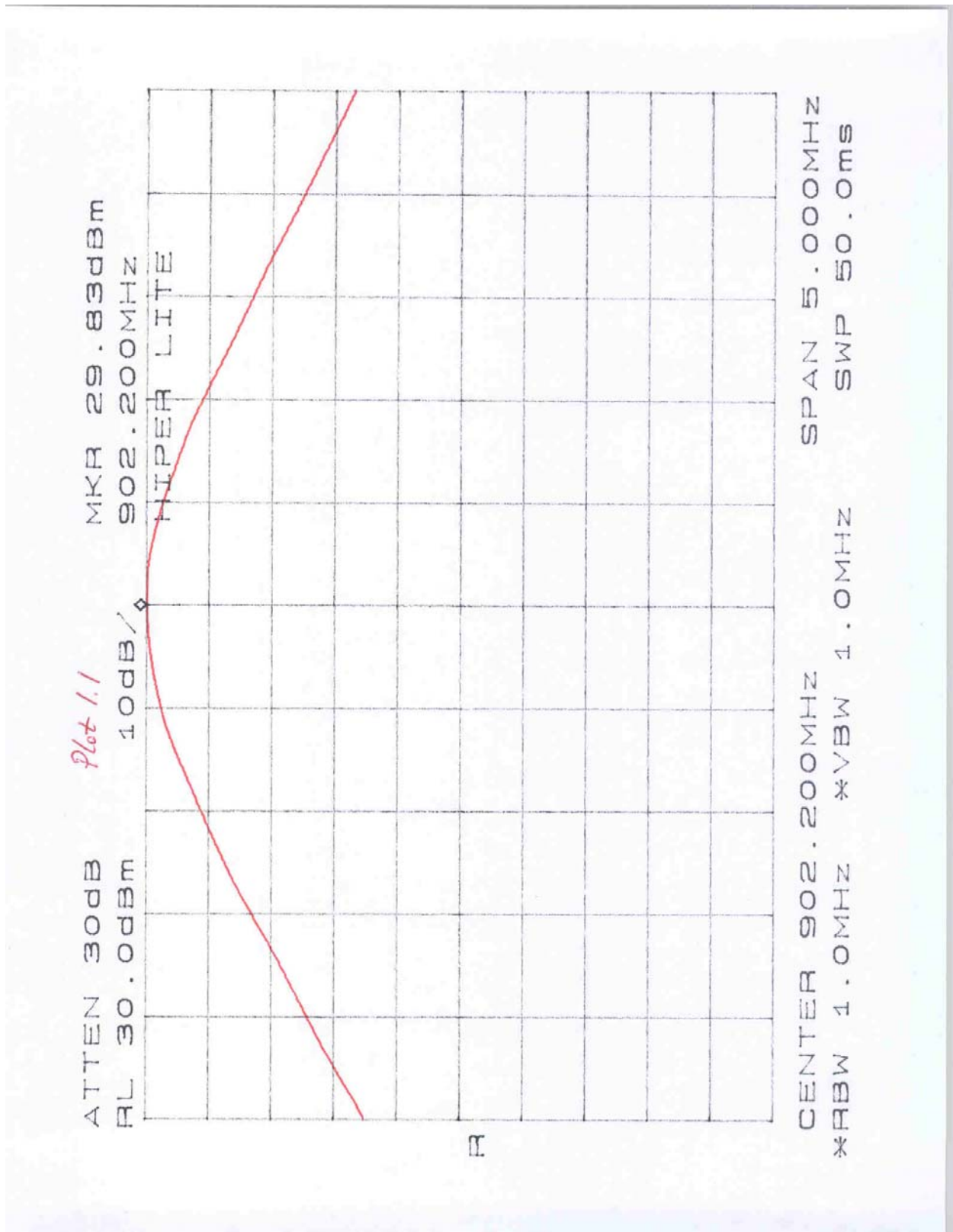
The antenna port of the EUT was connected to the input of a spectrum analyzer. The attenuation of the external attenuator and cable loss was added to the spectrum analyzer reading as Rev Lev OFFSET to obtain the power at the EUT antenna terminal.

Test Results

Frequency, MHz	Output, dBm	Output, W	Plot
902.2	29.83	0.961	1.1
915.6	29.83	0.961	1.2
927.6	29.83	0.961	1.3

Note: Hopping function was disabled during the test.

Refer to attached plots 1.1-1.3.







4.2 Hopping Channel 20-dB Bandwidth FCC 15.247(a)(ii)(iii)

Requirements

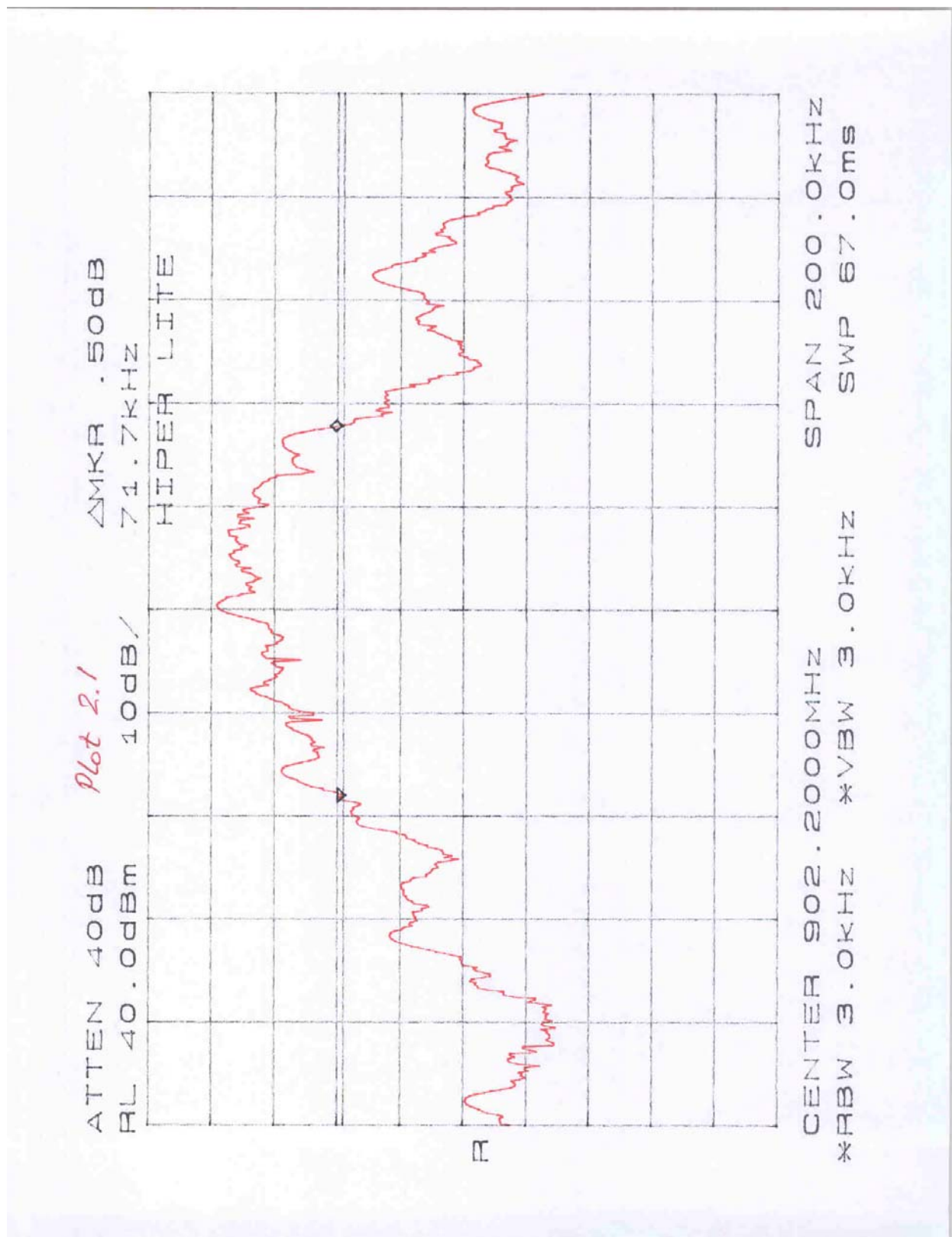
For systems operating in the 902 - 928 MHz band employing at least 50 hopping channels, the maximum 20 dB bandwidth of the hopping channel is 250 kHz. Systems may utilize hopping channels whose 20 dB bandwidth is greater than 250 kHz provided the system use at least 25 hopping channels.

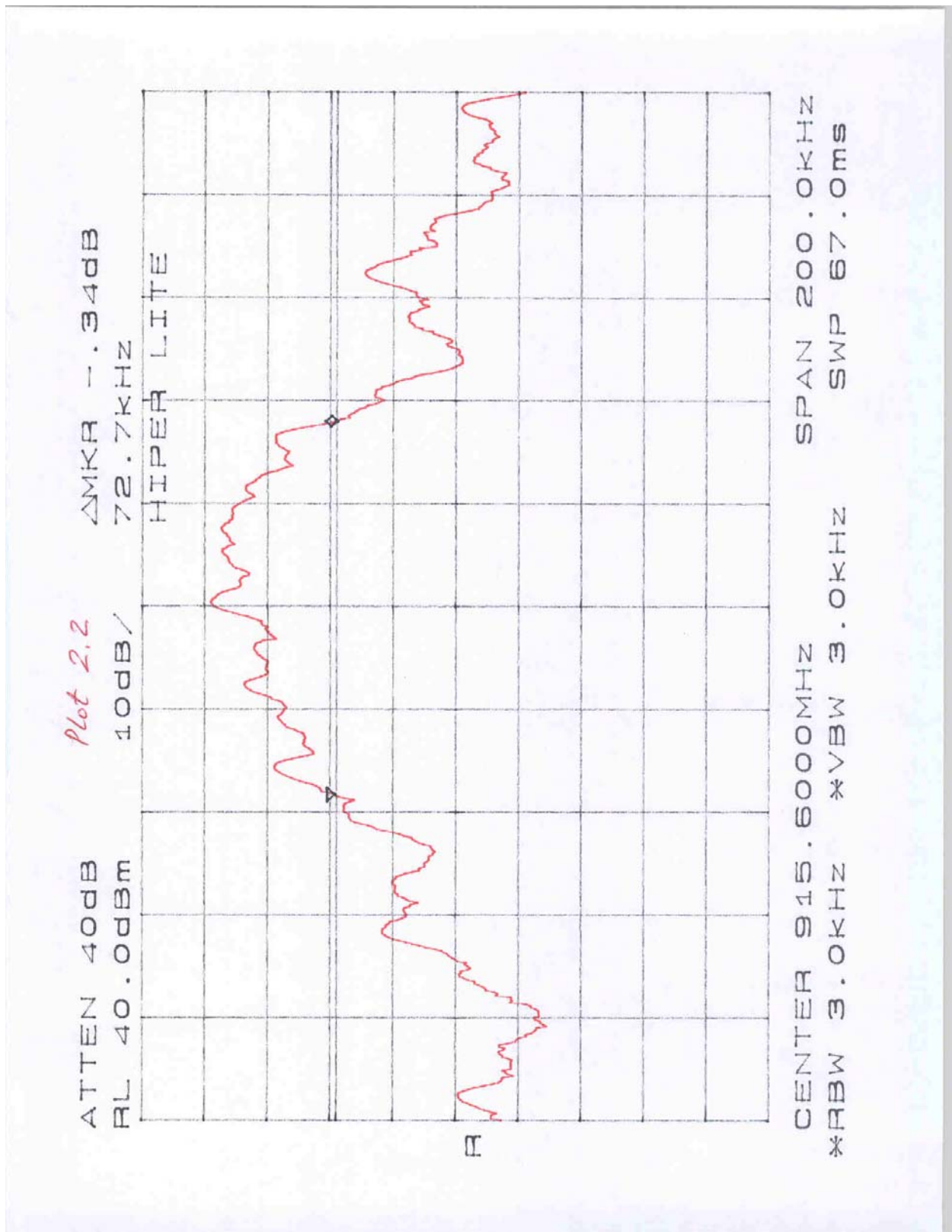
Test Results

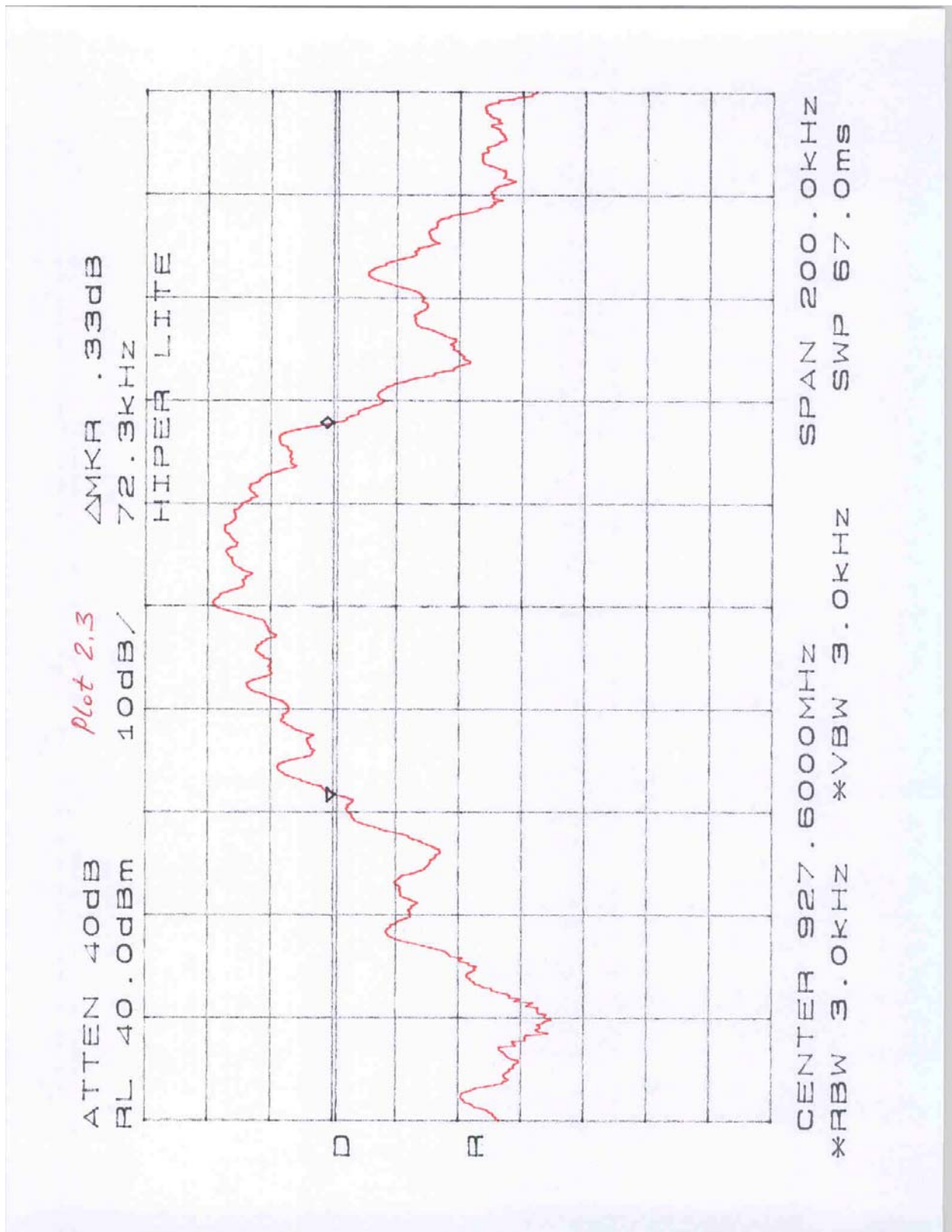
Frequency, MHz	20-dB channel bandwidth kHz	Plot
902.2	71.7	2.1
915.6	72.7	2.2
927.6	72.3	2.3

Note: Hopping function was disabled during the test.

Refer to attached plots 2.1-2.3.







4.3 Hopping Channel Carrier Frequency Separation FCC Ref: 15.247(a)(1)

Requirements

Systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth, whichever is greater.

Procedure

Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit.

Test Results

Refer to the attached spectrum analyzer plot # 4.1 in report section 4.4 for the test result. The channel separation is 200 kHz.

4.4 Number of Hopping Channels FCC Ref: 15.247(a)(1)(i&ii)

Requirements

Systems operating in the 902 – 928 MHz band shall use at least 50 hopping channels having the 20 dB bandwidth less than 250 kHz, and at least 25 hopping channels having the 20 dB bandwidth of 250 kHz or greater.

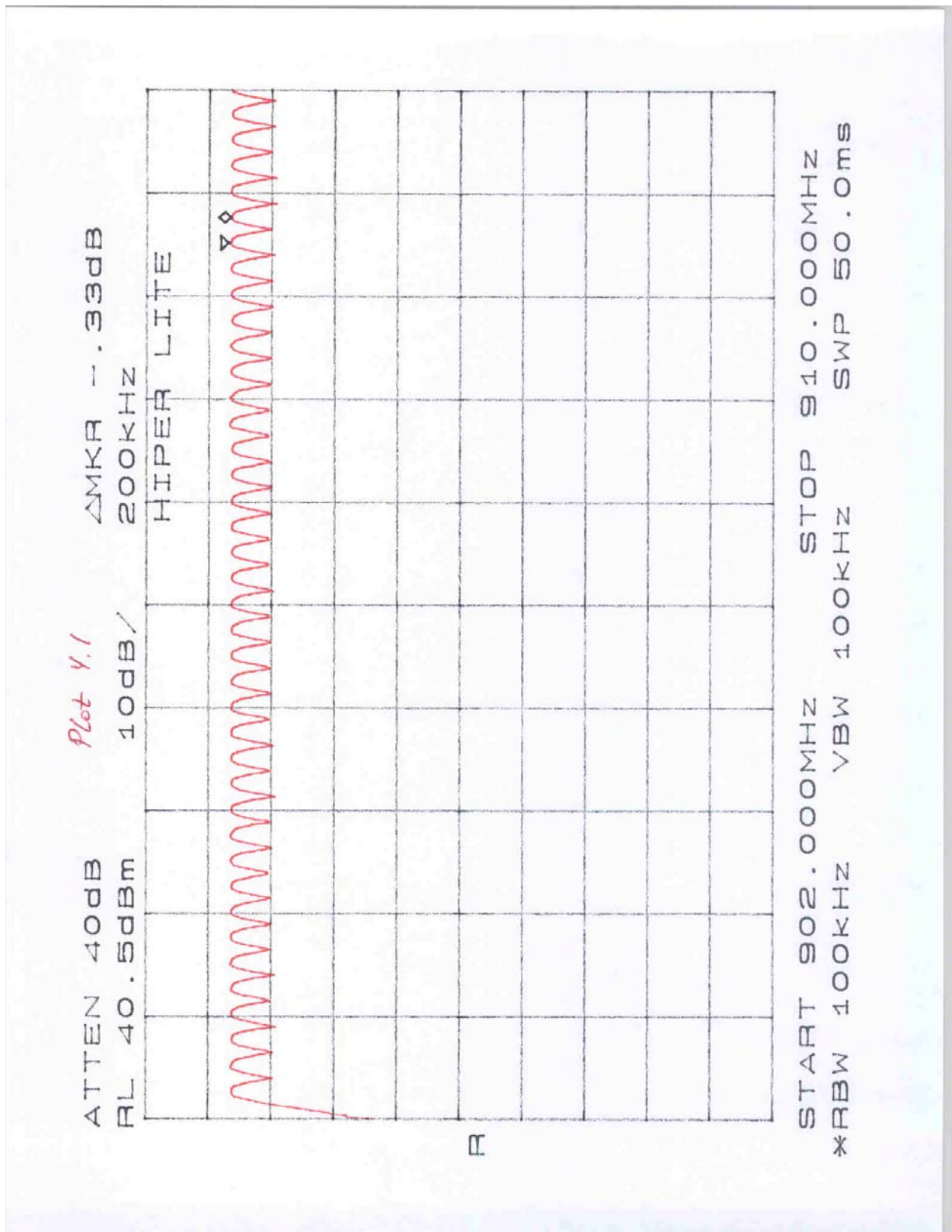
Procedure

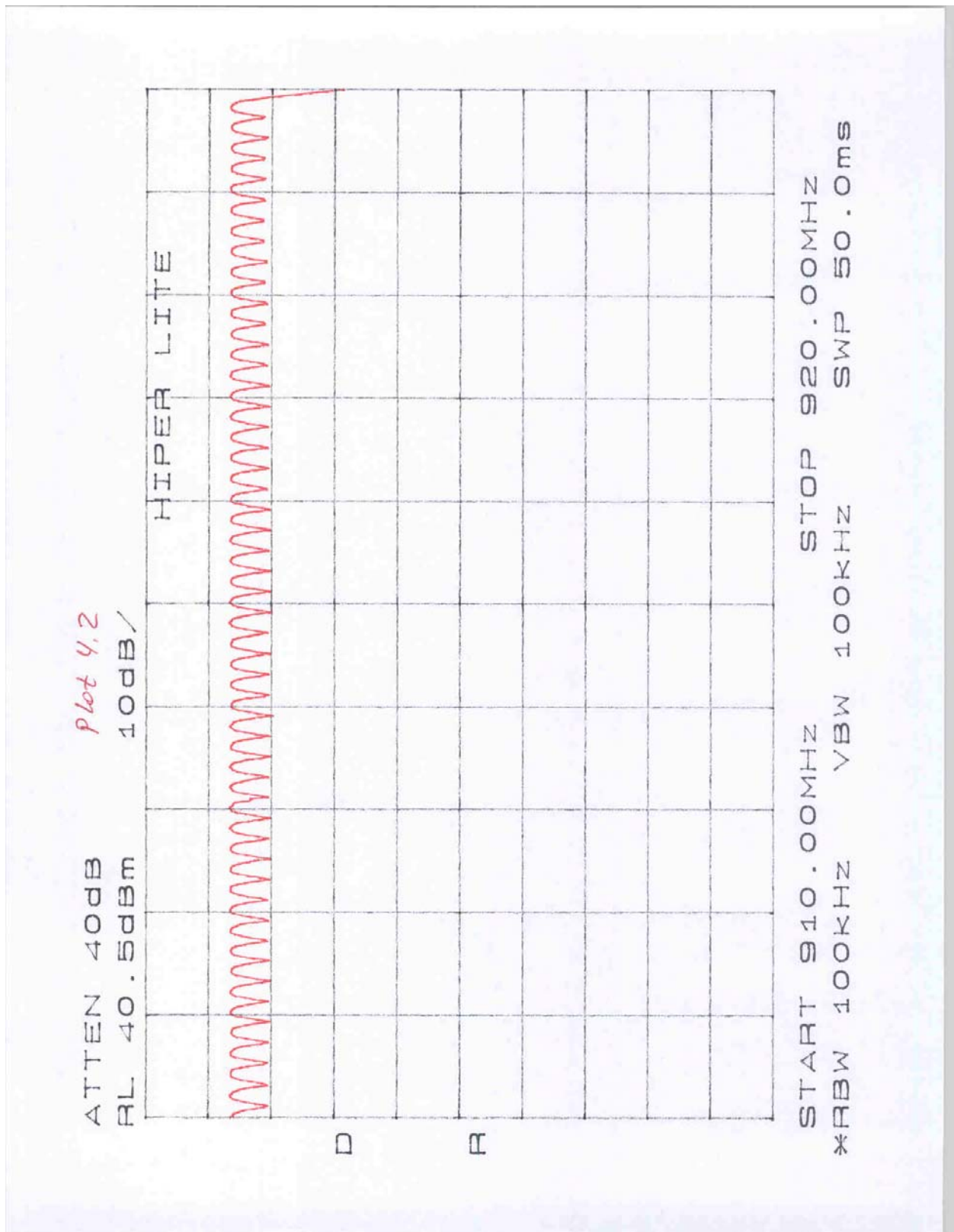
The RF passband of the EUT was divided into 3 approximately equal bands. With the analyzer set to MAX HOLD, readings were taken for 2 - 3 minutes in each band. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

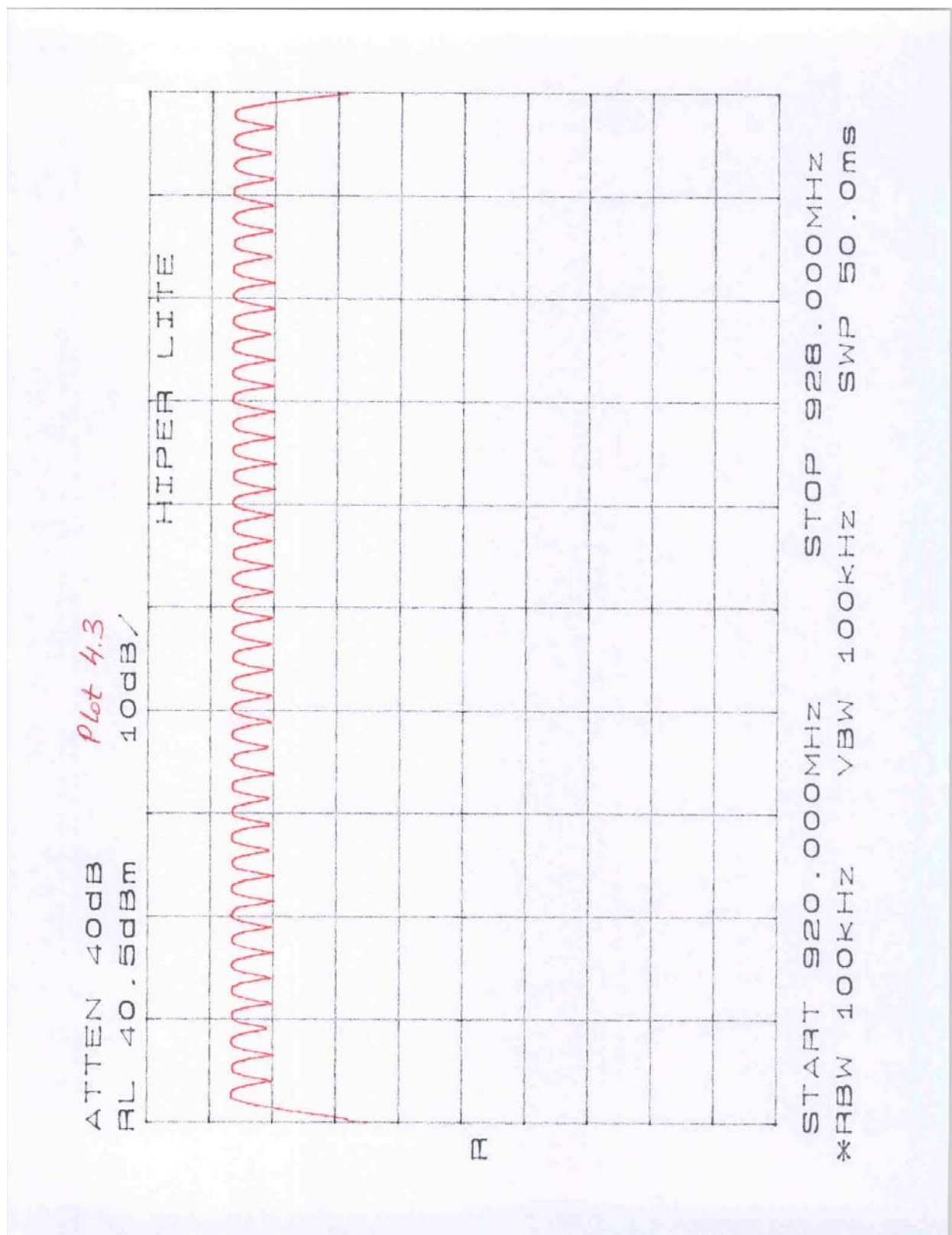
Test Results

Number of hopping channels with the bandwidth less than 250 kHz	128
---	-----

Refer to attached plots 4.1-4.3.







4.5 Average Channel Occupancy Time FCC 15.247(a)(1)(ii)(iii)

Requirements

For systems operating in the 902 - 928 MHz band and using at least 50 hopping channels with the 20-dB bandwidth of less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 20 second period.

For systems operating in the 902 - 928 MHz band and using at least 25 hopping channels with the 20-dB bandwidth of 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 10 second period.

Procedure

The spectrum analyzer center frequency was set to one of the known hopping channels. The SWEEP was set to 1 second, the SPAN was set to ZERO SPANS, and the TRIGGER was set to VIDEO. The time duration of the transmission so captured was measured with the MARKER DELTA function.

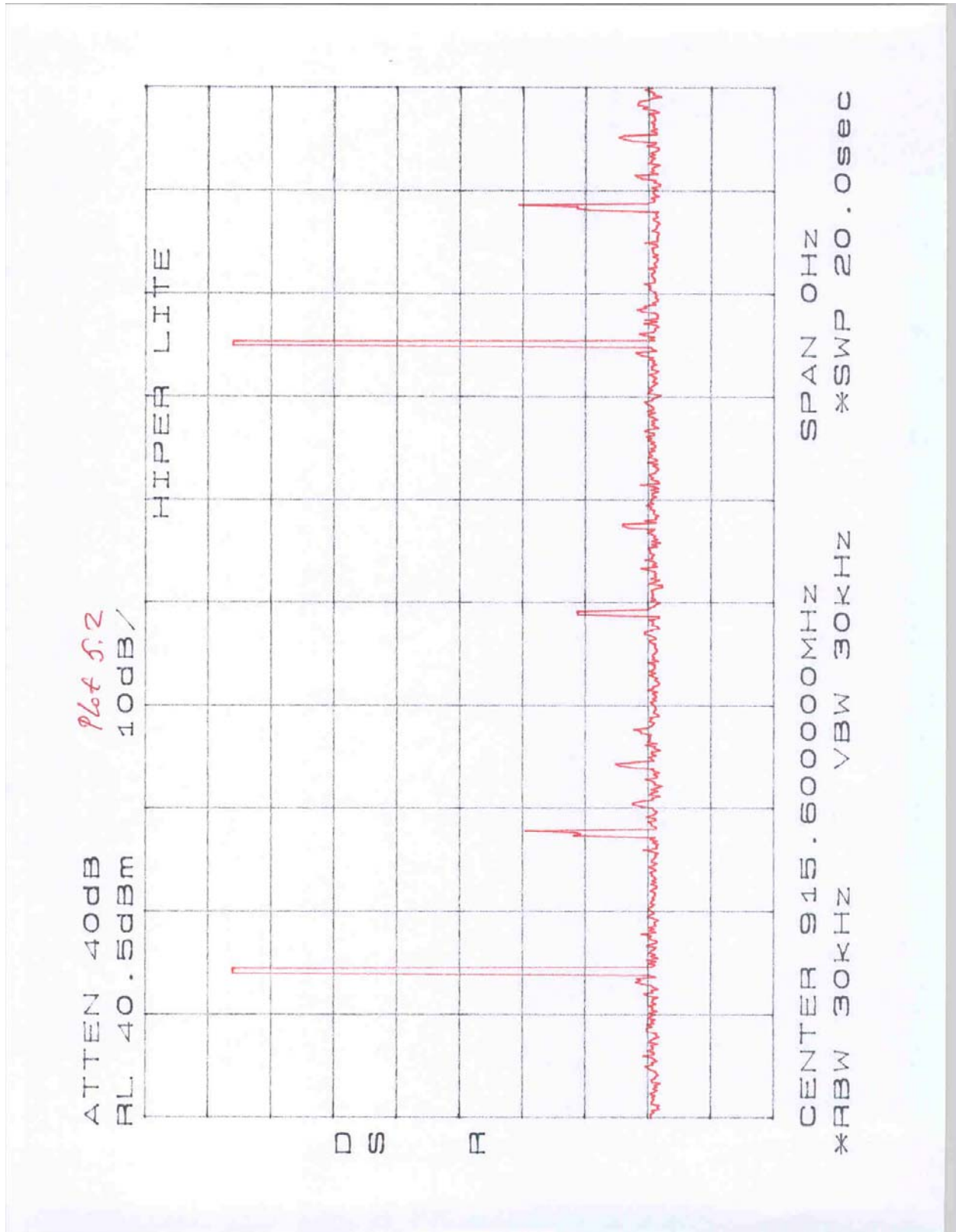
The SWEEP was then set to the time required by the regulation (20 seconds). The analyzer was set to SINGLE SWEEP, the total ON time was added and compared against the limit (0.4 seconds).

Test Results

The average time occupancy is: $88.3 \times 2 = 176.6$ ms.

Refer to attached plots 5.1-5.2.





4.6 Out of Band Conducted Emissions FCC 15.247(c)

Requirements

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be at least 20 dB below that of the maximum in-band 100 kHz emission.

Procedure

A spectrum analyzer was connected to the antenna port of the transmitter. Analyzer Resolution Bandwidth was set to 100 kHz. For each channel investigated, the in-band and out-of-band emission measurements were performed. The out-of-band emissions were measured from 10 MHz to 10 GHz. For this test hopping function was disabled during the test.

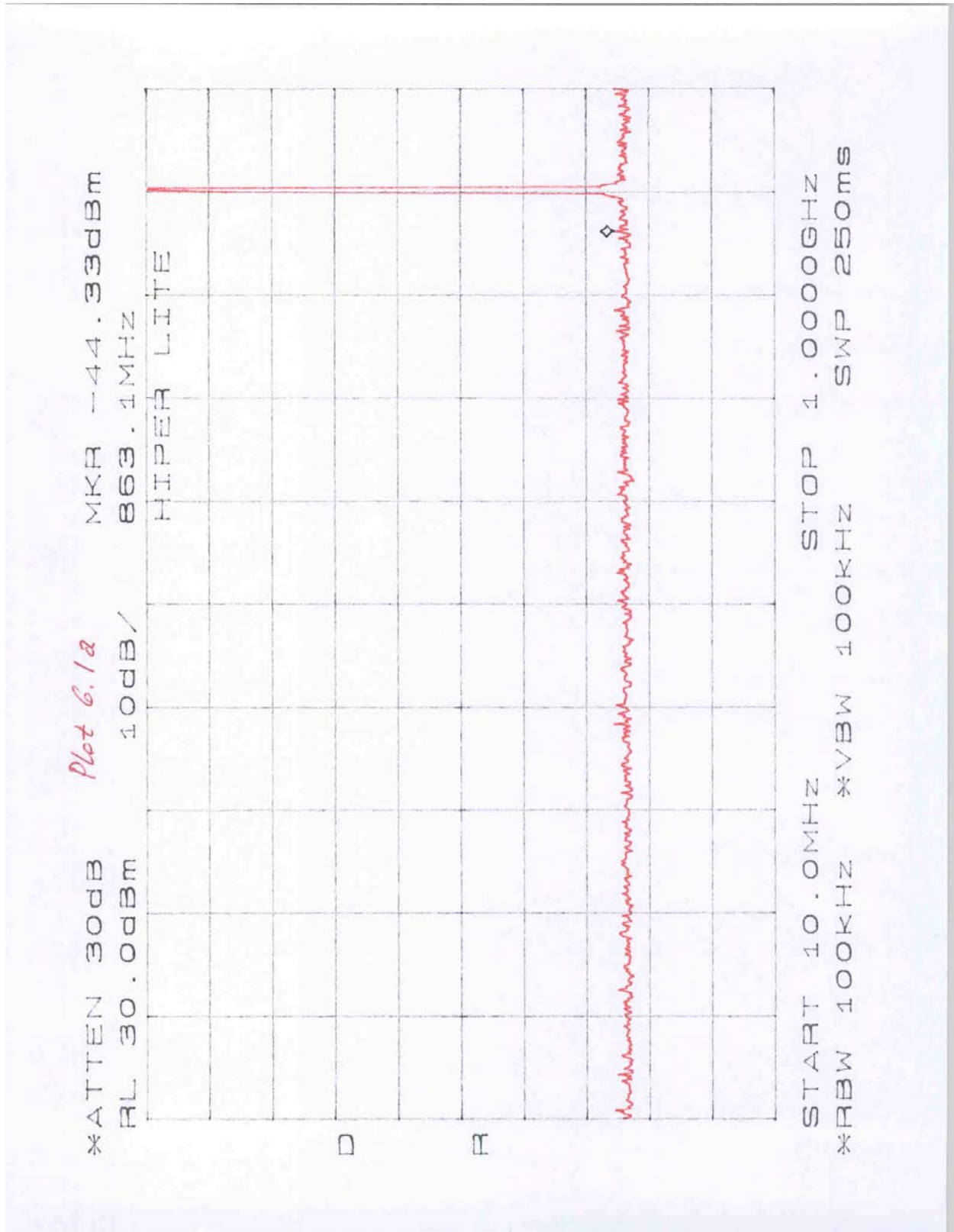
In addition, the emission attenuation on the band-edge frequencies was measured with hopping function disabled and enabled.

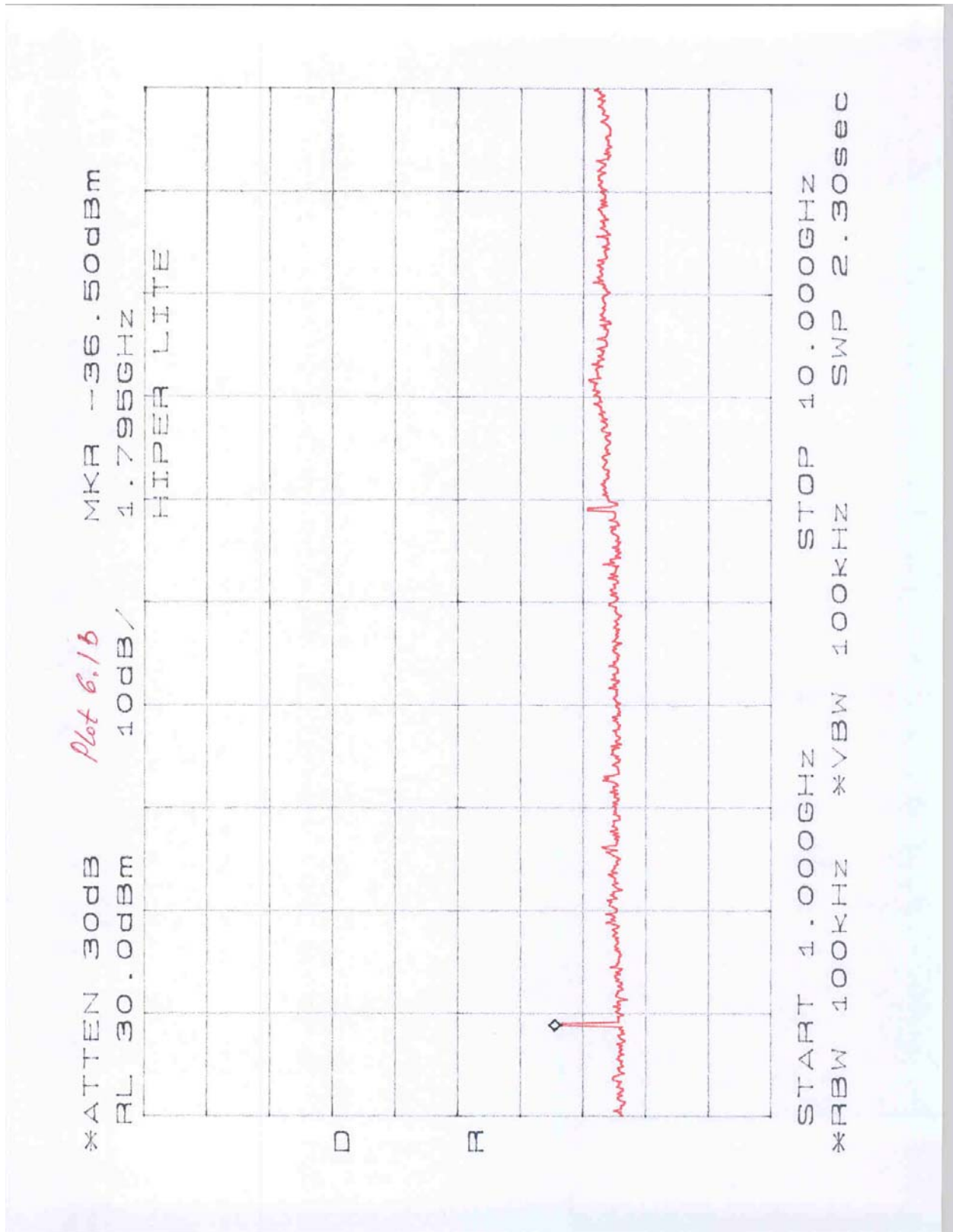
Test Result

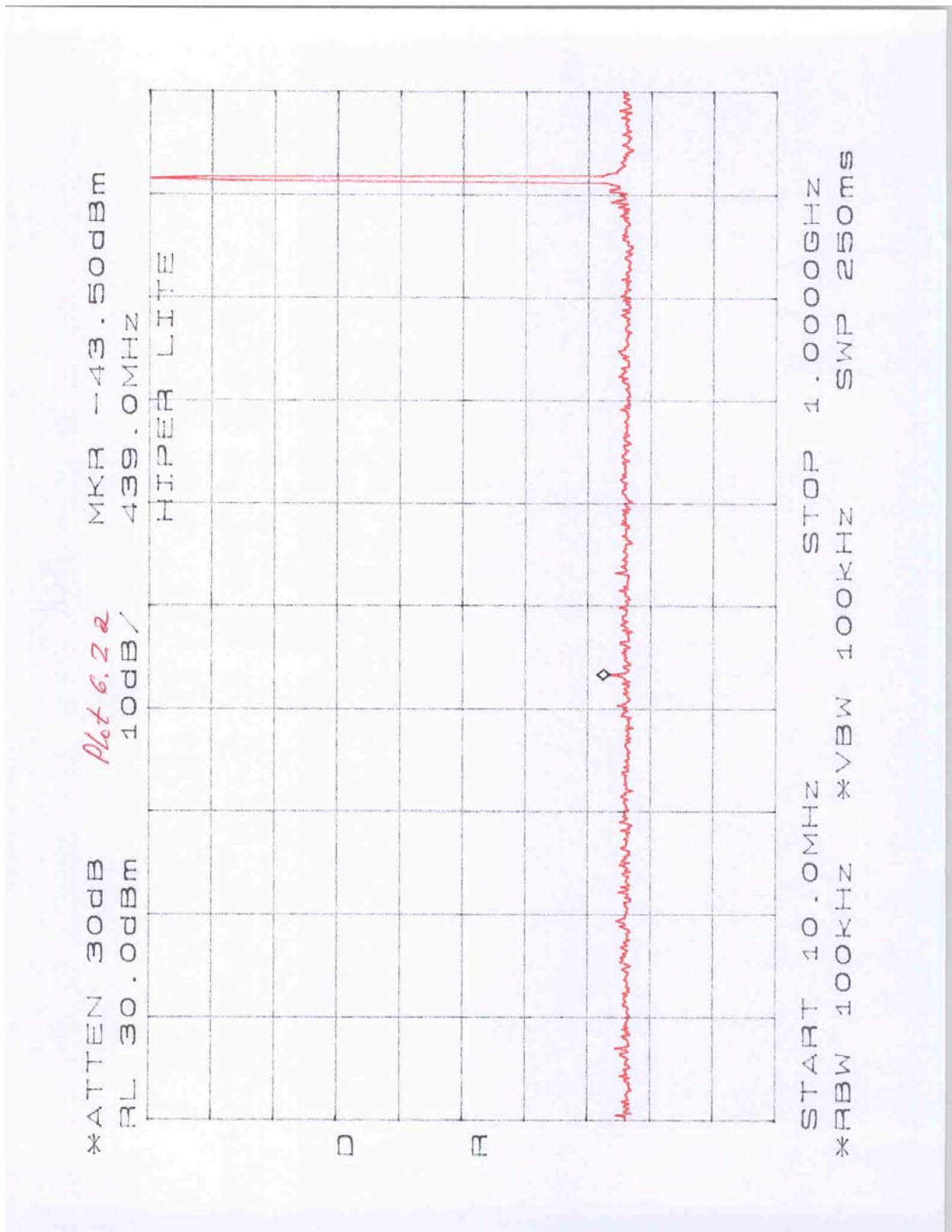
Refer to the following plots for the test result:

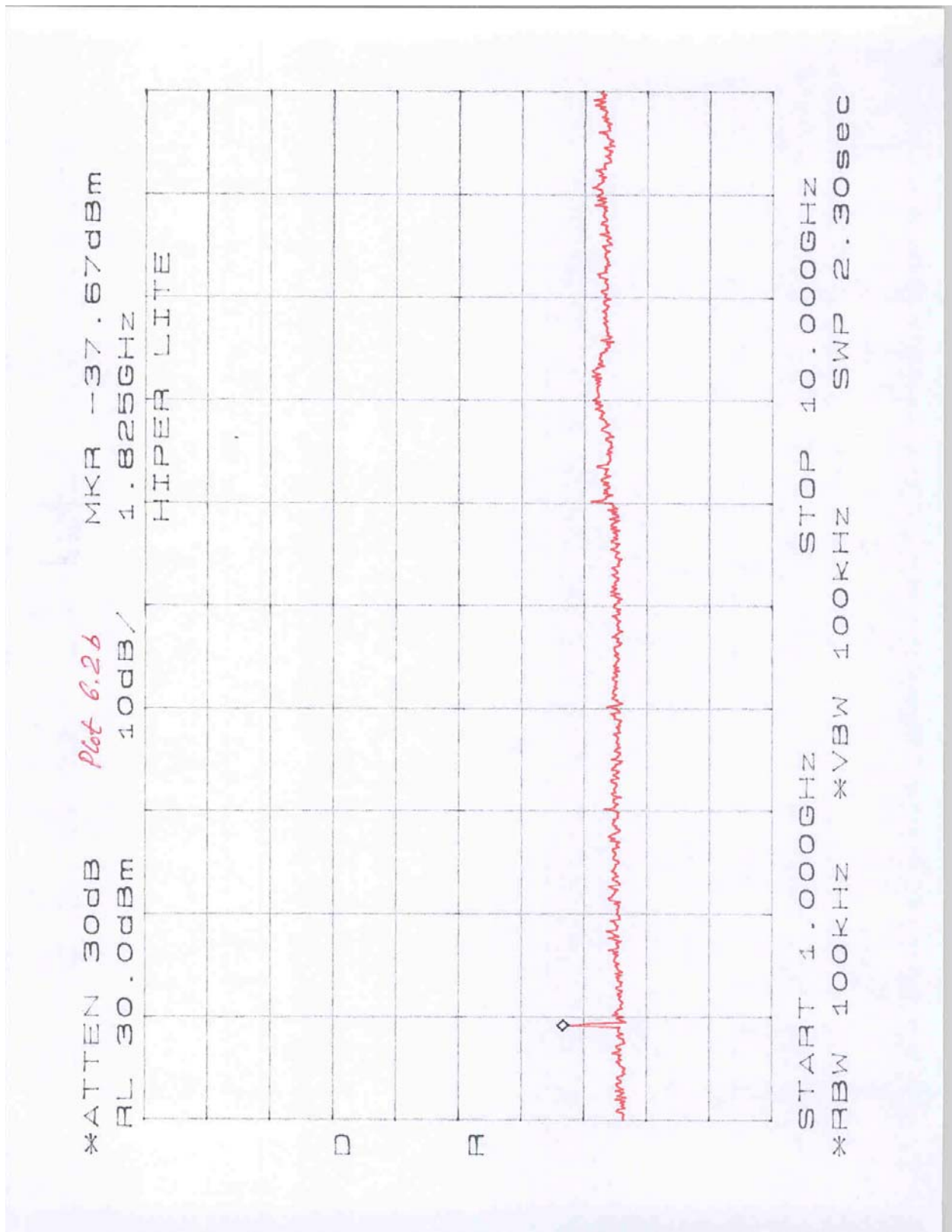
Out-of-Band conducted emissions	
Plots 6.1 a – 6.1 b	Out-of-band Emissions, low Channel, hopping disabled
Plots 6.2.a – 6.2.b	Out-of-band Emissions, middle Channel, hopping disabled
Plots 6.3.a – 6.3.b	Out-of-band Emissions, high Channel, hopping disabled
Plot 6.4.a	Band-edge Emissions, low Channel, hopping disabled
Plot 6.4.b	Band-edge Emissions, low Channel, hopping enabled
Plot 6.5.a	Band-edge Emissions, high Channel, hopping disabled
Plot 6.5.b	Band-edge Emissions, high Channel, hopping enabled

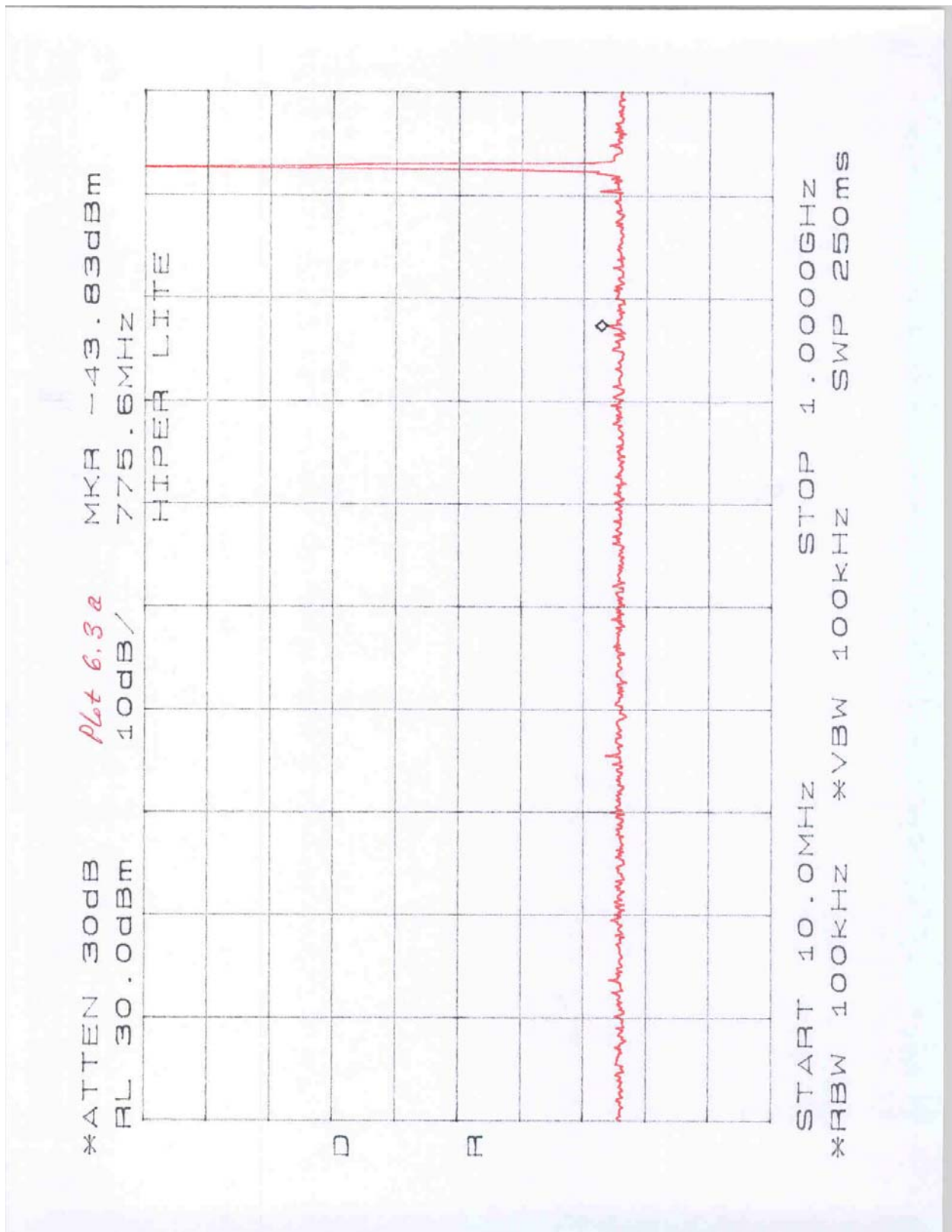
The attenuation is more than 60 dB.

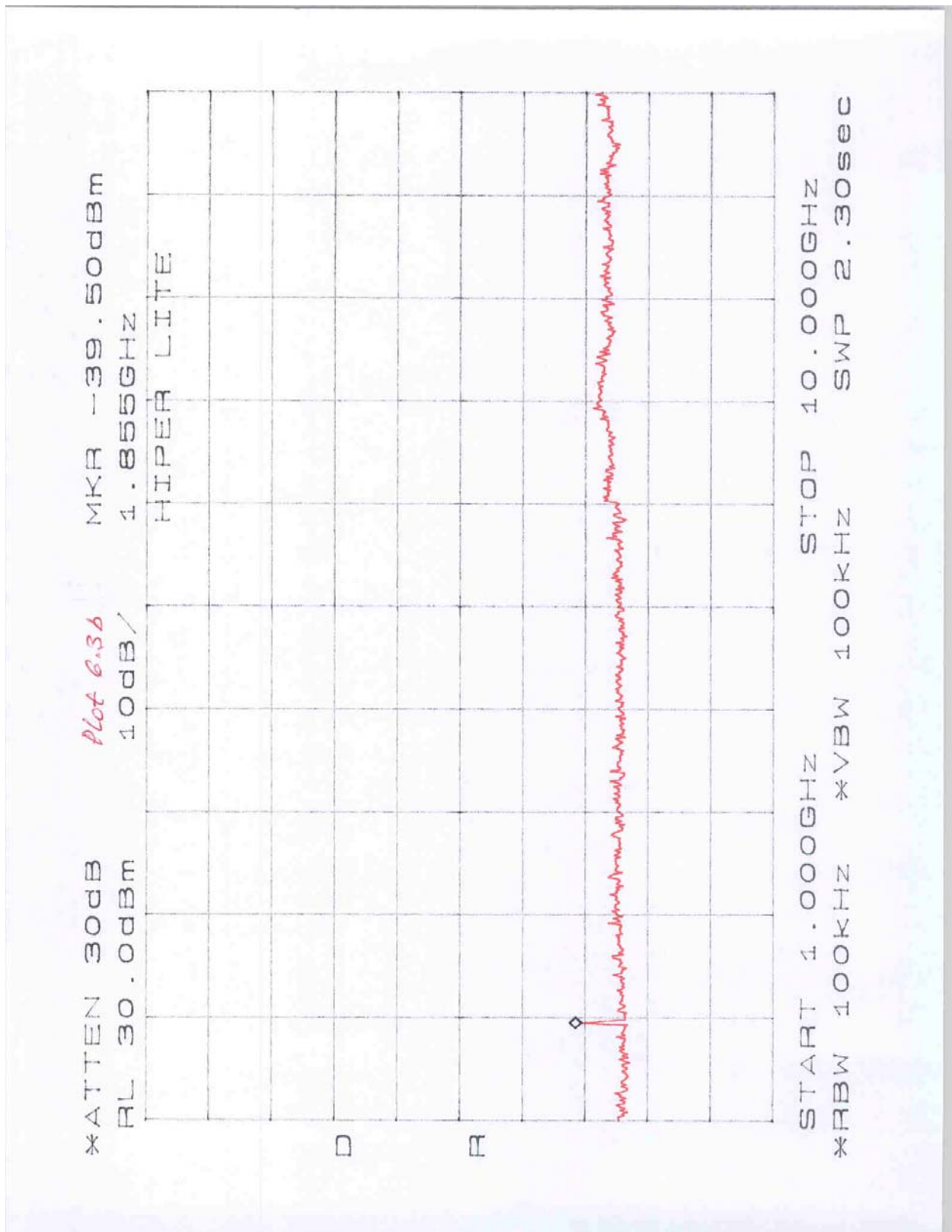


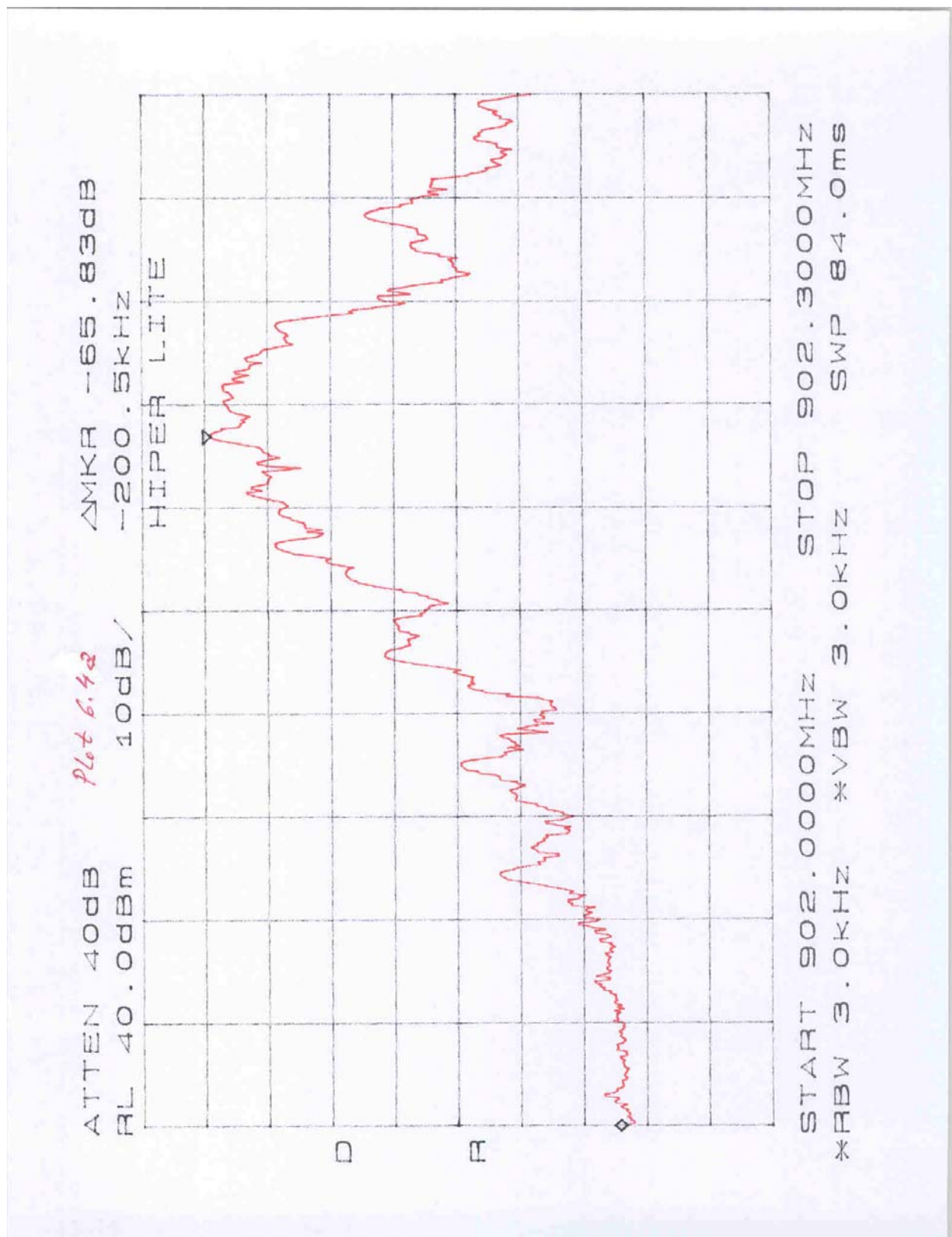


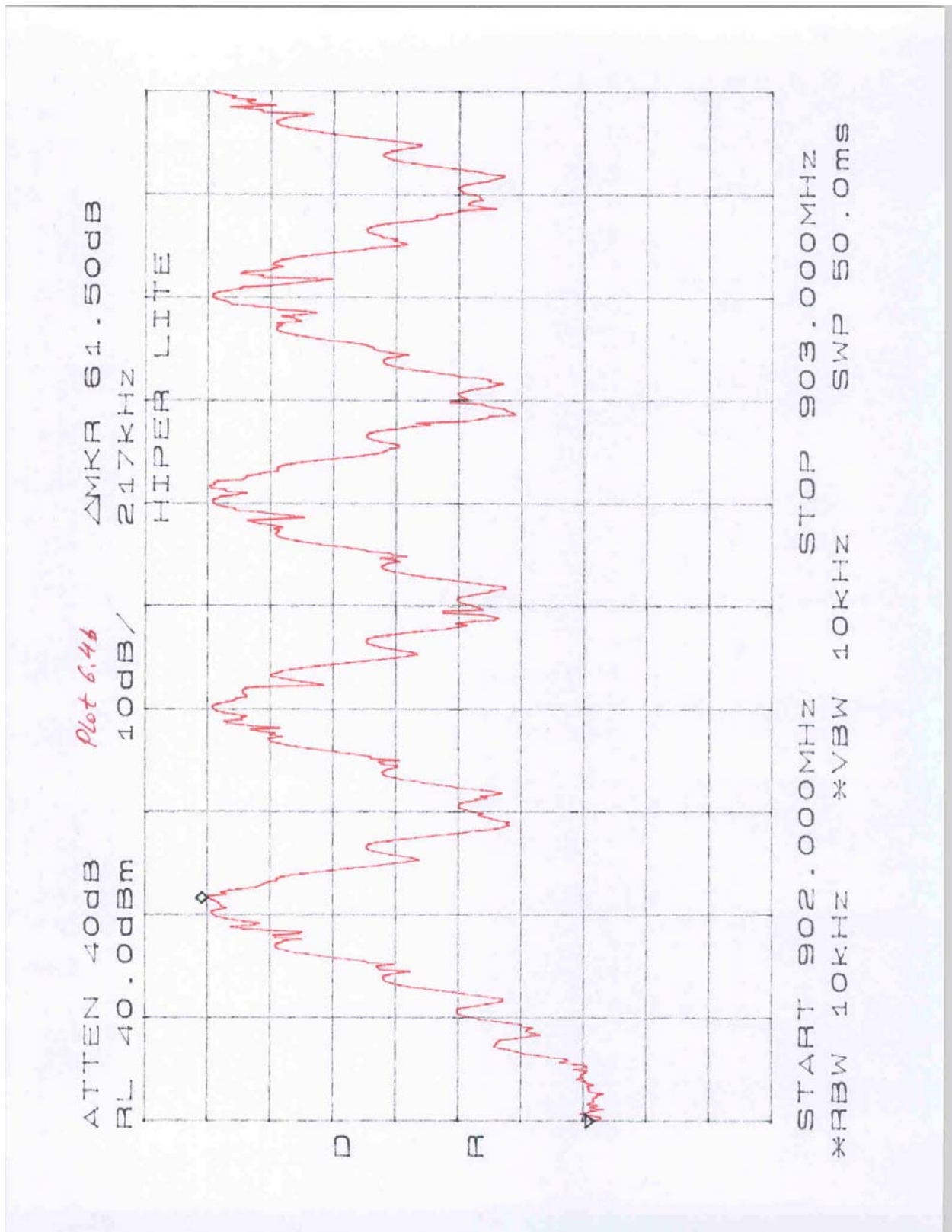


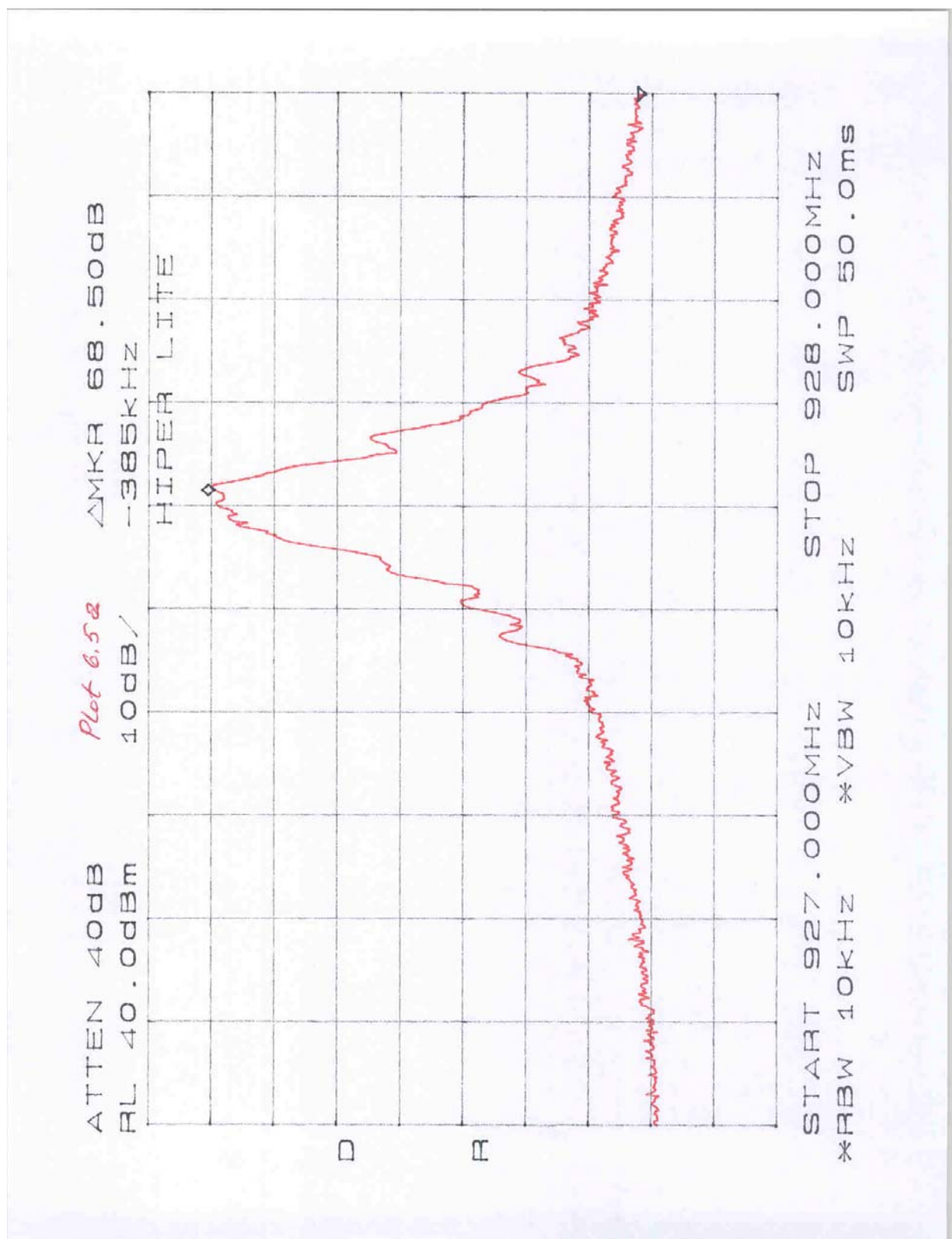


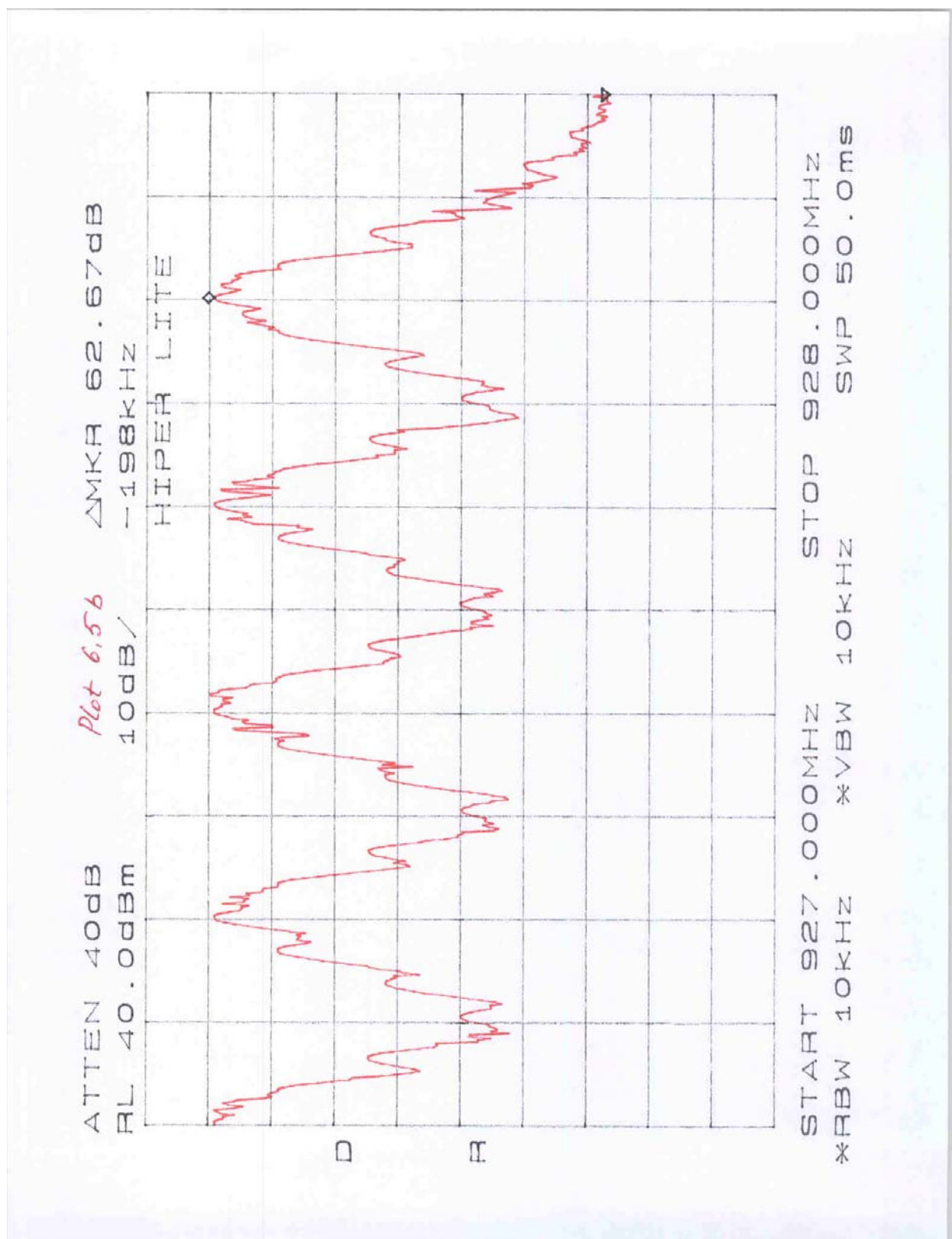












4.7 Out of Band Radiated Emissions (except emissions in restricted bands)
FCC 15.247(c)

For out of band radiated emissions (except for frequencies in restricted bands) that are close to or that exceed the 20 dB attenuation requirement described in the specification, radiated measurements were performed at a 3 m separation distance to determine whether these emissions complied with the general radiated emission requirement.

Test was not performed, as the EUT passed out-of-band antenna conducted emission test.

4.8 Transmitter Radiated Emissions in Restricted Bands FCC 15.247 (c), 15.205

Procedure

Radiated emission measurements were performed from 30 MHz to 10,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz - for frequencies above 1000 MHz.

The EUT is placed on the wooden turntable. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three-meter reading using inverse scaling with distance.

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included. All measurements were performed with peak detection unless otherwise specified.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V)

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}(\mu\text{V})$$

$$AF = 7.4 \text{ dB}(1/\text{m})$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 \text{ dB}(\mu\text{V}/\text{m})$$

$$\text{Level in } \mu\text{V}/\text{m} = \text{Common Antilogarithm } [(32 \text{ dB}\mu\text{V}/\text{m})/20] = 39.8 \mu\text{V}/\text{m}$$

Result

The data on the following page list the significant emission frequencies, the limit and the margin of compliance.

The EUT passed by 4.3 dB.

Test Result										
FCC Part 15.247 Radiated Emission in restricted bands										
Temperature: 21.0 C					Topcon Positioning Systems					
Humidity: 39.8 %					Model: Hiper Lite, 01-840802-03					
Test distance = 3 m					Engineer: A. Kaplan					
Test date: March 28, 2003										
Frequency MHz	Polarit y	Detector	SA reading dB(μV)	Cable loss dB	Pre- amp gain dB	Ant. factor dB(1/m)	Extern. attenuat. dB	Field Strength dB(μV /m)	Limit dB(μV /m)	Margin dB
Tx, @ 902.2 MHz										
2706.6	V	Average	38.3	5.5	36.4	31.3	3	41.7	54.0	-12.3
3608.8	V	Average	34.7	6.5	36.5	33.5	3	41.2	54.0	-12.8
4511.0	V	Average	38.4	7.7	36.0	34.7	3	47.8	54.0	-6.2
5413.2	V	Average	28.8	8.3	36.0	36.7	3	40.8	54.0	-13.2
8119.8	V/H	Average	23.4*	10.0	35.5	39.2	3	40.1	54.0	-13.9
9022.0	V/H	Average	22.7*	10.8	35.2	40.4	3	41.7	54.0	-12.3
Tx, @ 915.6 MHz										
2746.8	V	Average	38.0	5.6	36.5	31.6	3	41.7	54.0	-12.3
3662.4	V	Average	32.8	6.5	36.4	33.5	3	39.4	54.0	-14.6
4578.0	V	Average	40.3	7.7	36.0	34.7	3	49.7	54.0	-4.3
7324.8	V/H	Average	22.6*	9.5	35.9	38.5	3	38.2	54.0	-15.8
8240.4	V/H	Average	22.4*	10.2	35.4	39.2	3	39.4	54.0	-14.6
9156.0	V/H	Average	22.2*	11.4	35.4	40.4	3	41.6	54.0	-12.4
Tx, @ 927.6 MHz										
2782.8	V	Average	31.4	5.6	36.6	31.7	3	35.1	54.0	-18.9
3710.4	V	Average	34.8	6.5	36.5	33.5	3	41.3	54.0	-12.7
4638.0	V	Average	33.9	7.7	36.0	34.7	3	43.2	54.0	-10.8
7420.8	V/H	Average	22.7*	9.9	35.8	38.7	3	38.5	54.0	-15.5
8348.4	V/H	Average	22.4*	10.1	35.5	39.3	3	39.3	54.0	-14.7

Notes: Average value was measured with RBW = 1MHz, VBW = 1 KHz

Peak reading exceeded the average reading by no more than 10 dB

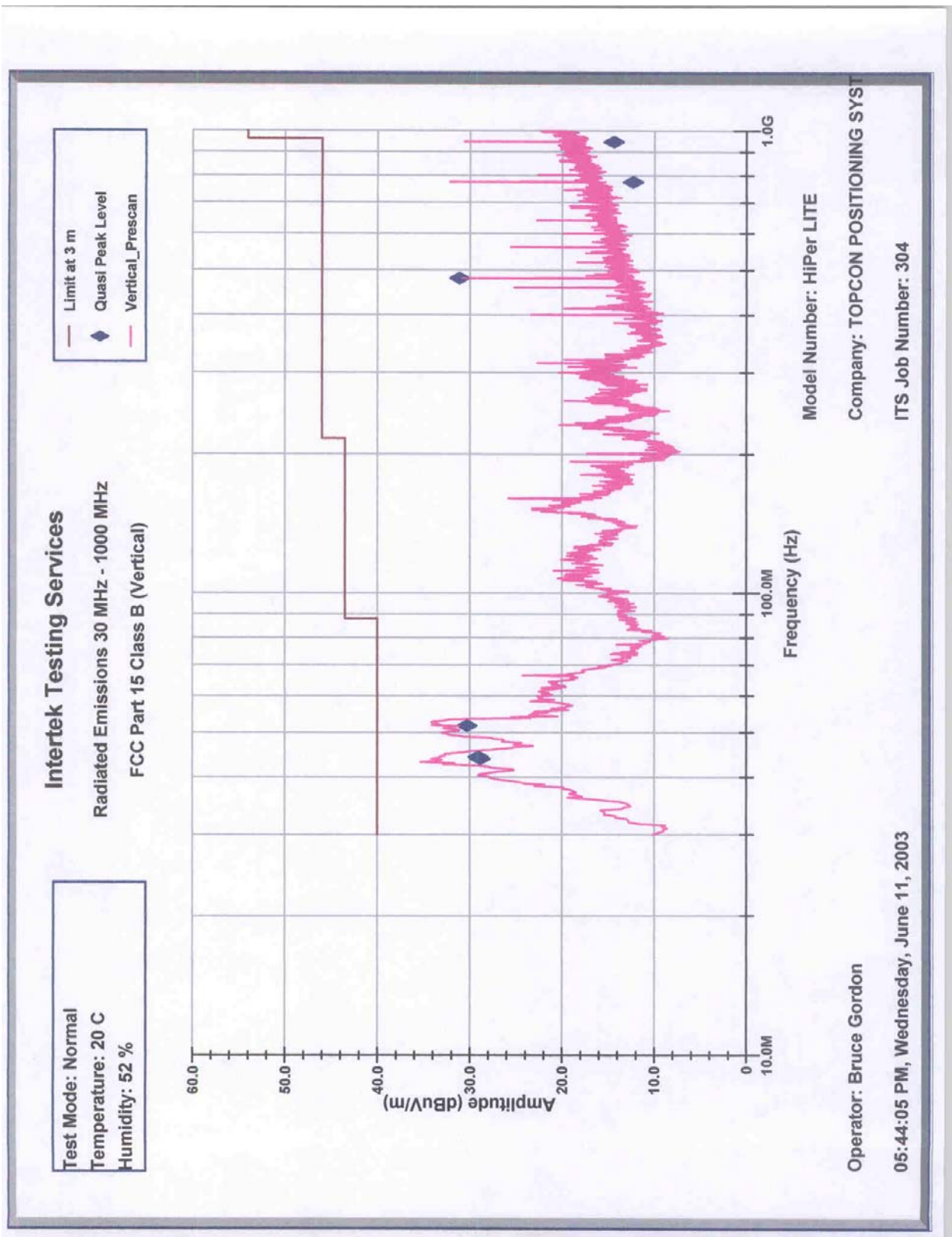
* Noise floor

4.9 Radiated Emissions from digital part of Transceiver (Transmitter)
FCC Ref: 15.109

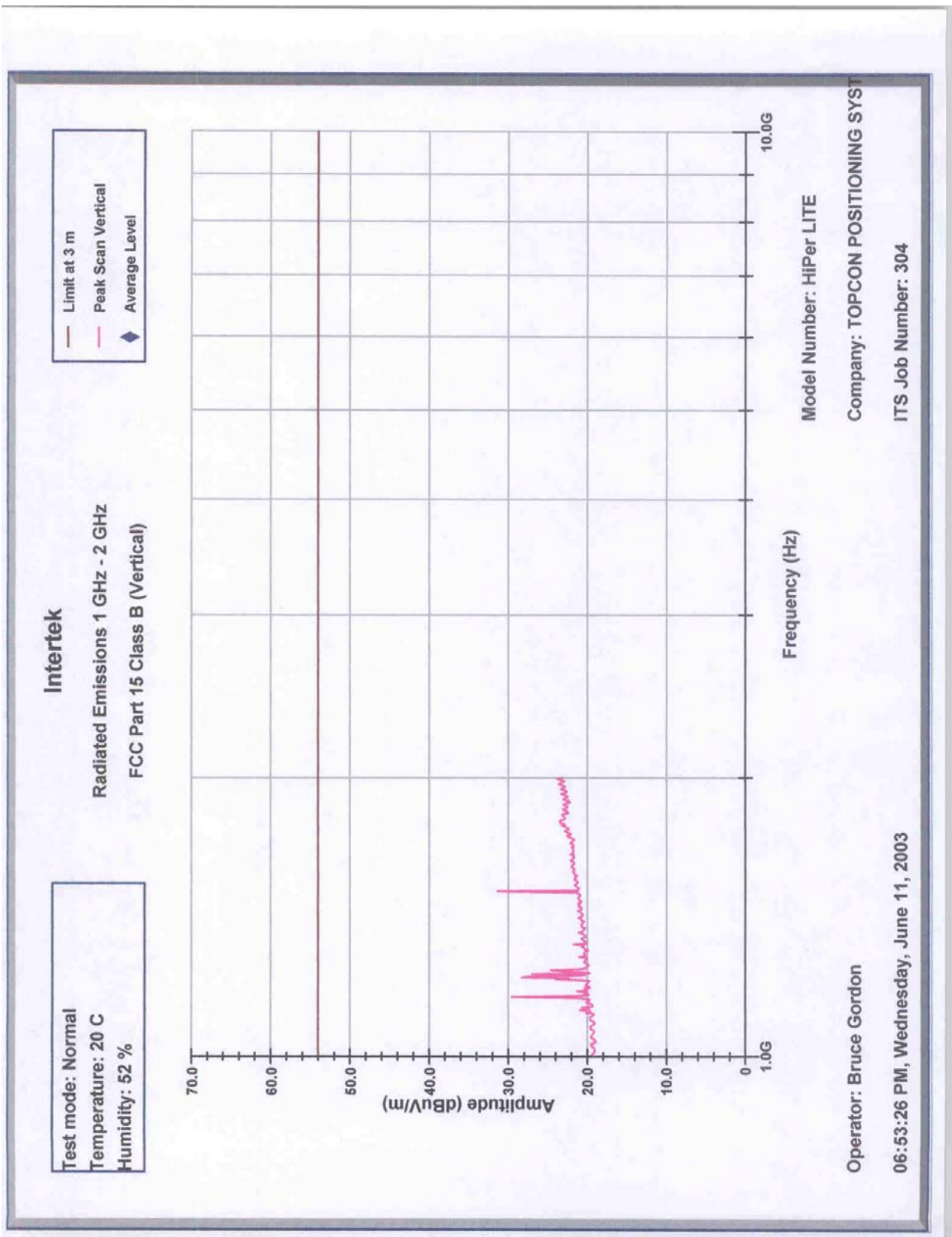
Radiated emission measurements were performed from 30 MHz to 2000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz for frequencies below 1 GHz, and 1 MHz for frequencies above 1 GHz. See also section 4.8.

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

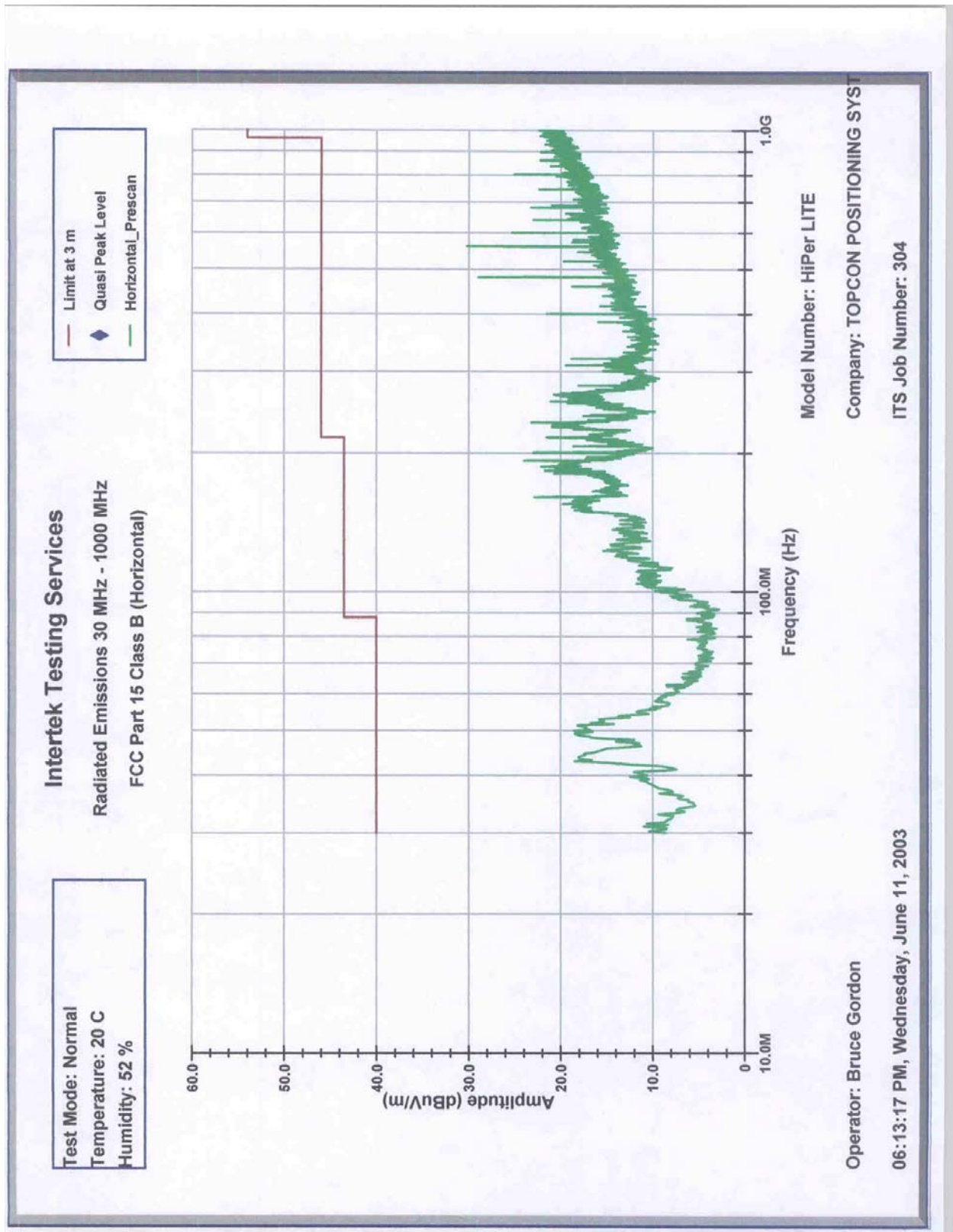
The EUT passed by 9.7 dB.



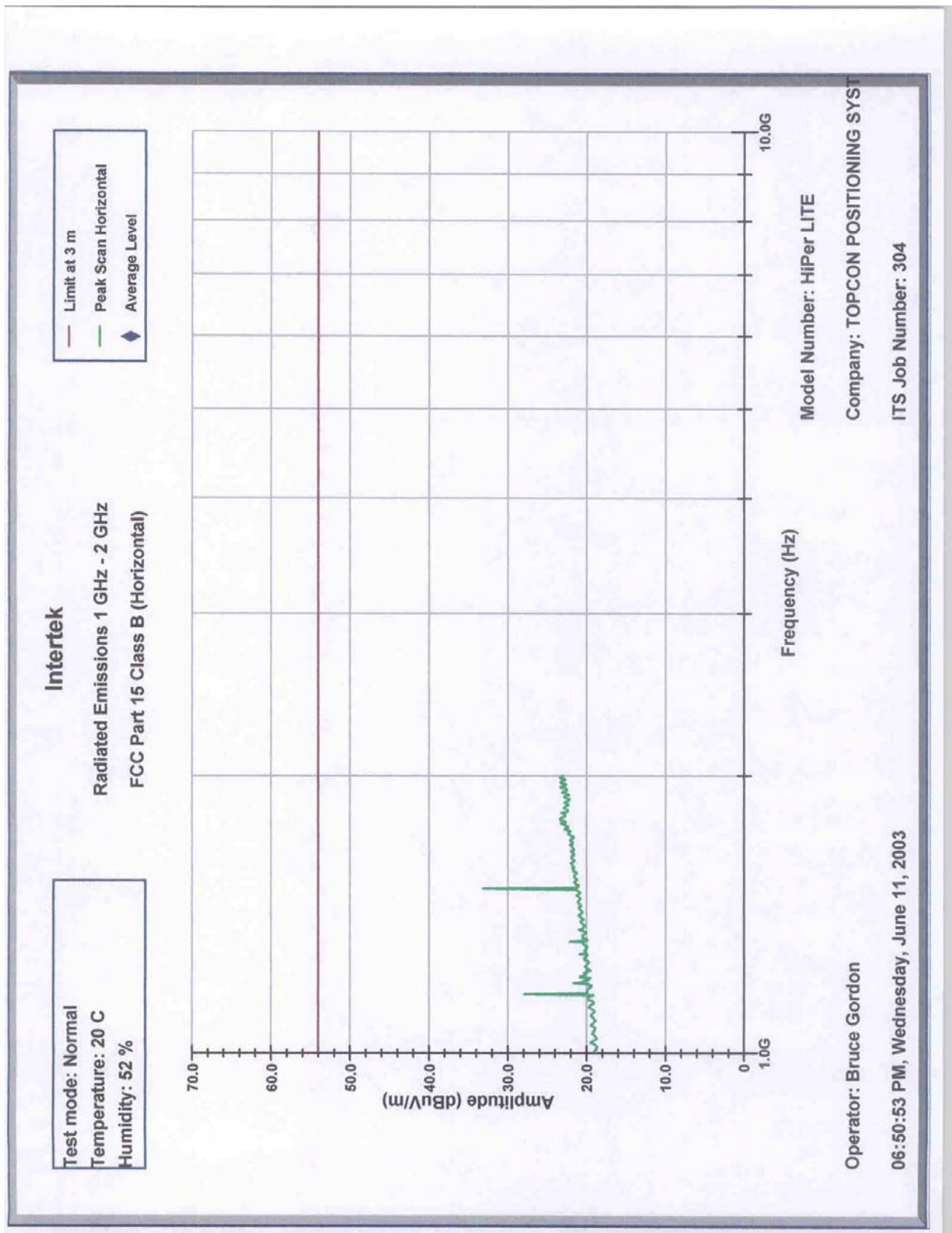
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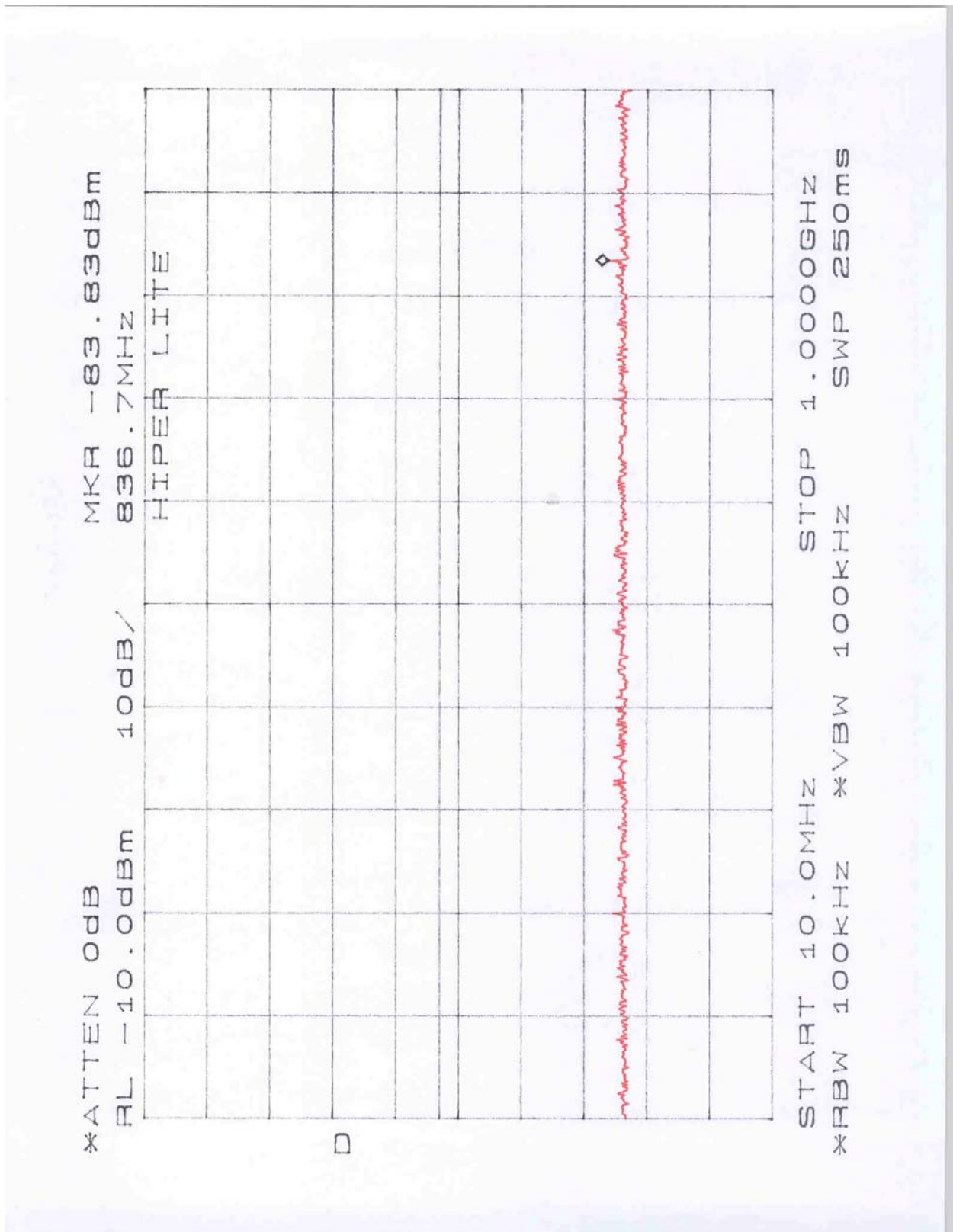
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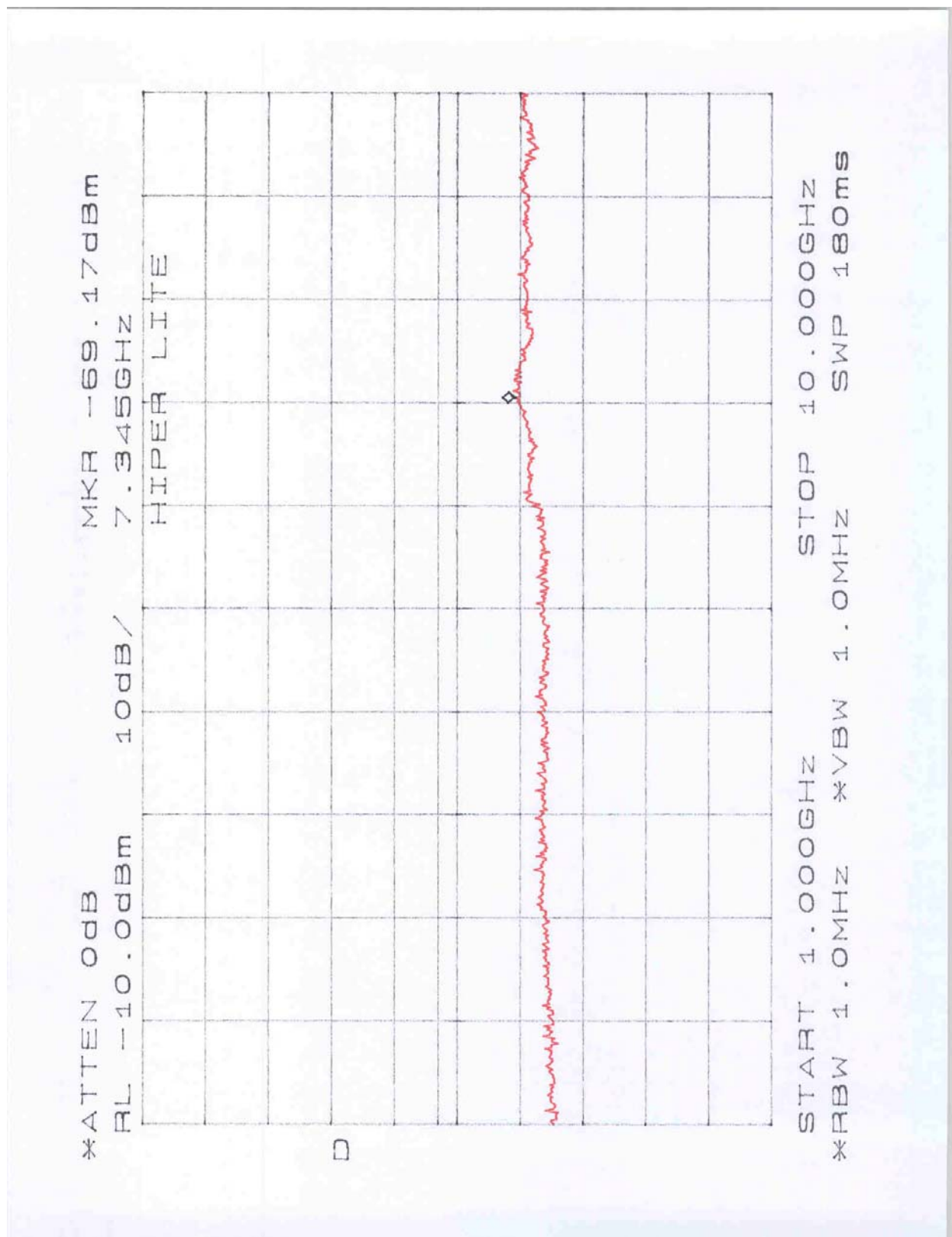


Page 1

4.10 Radiated Emissions from Receiver part of Transceiver (L.O. Radiation)
FCC 15.109, 15.111

Radiated emission measurements were performed simultaneously with the radiated emission measurements from digital part, and the result is included in section 4.9. In addition, antenna conducted emissions were measured. For the test result, see attached plots.

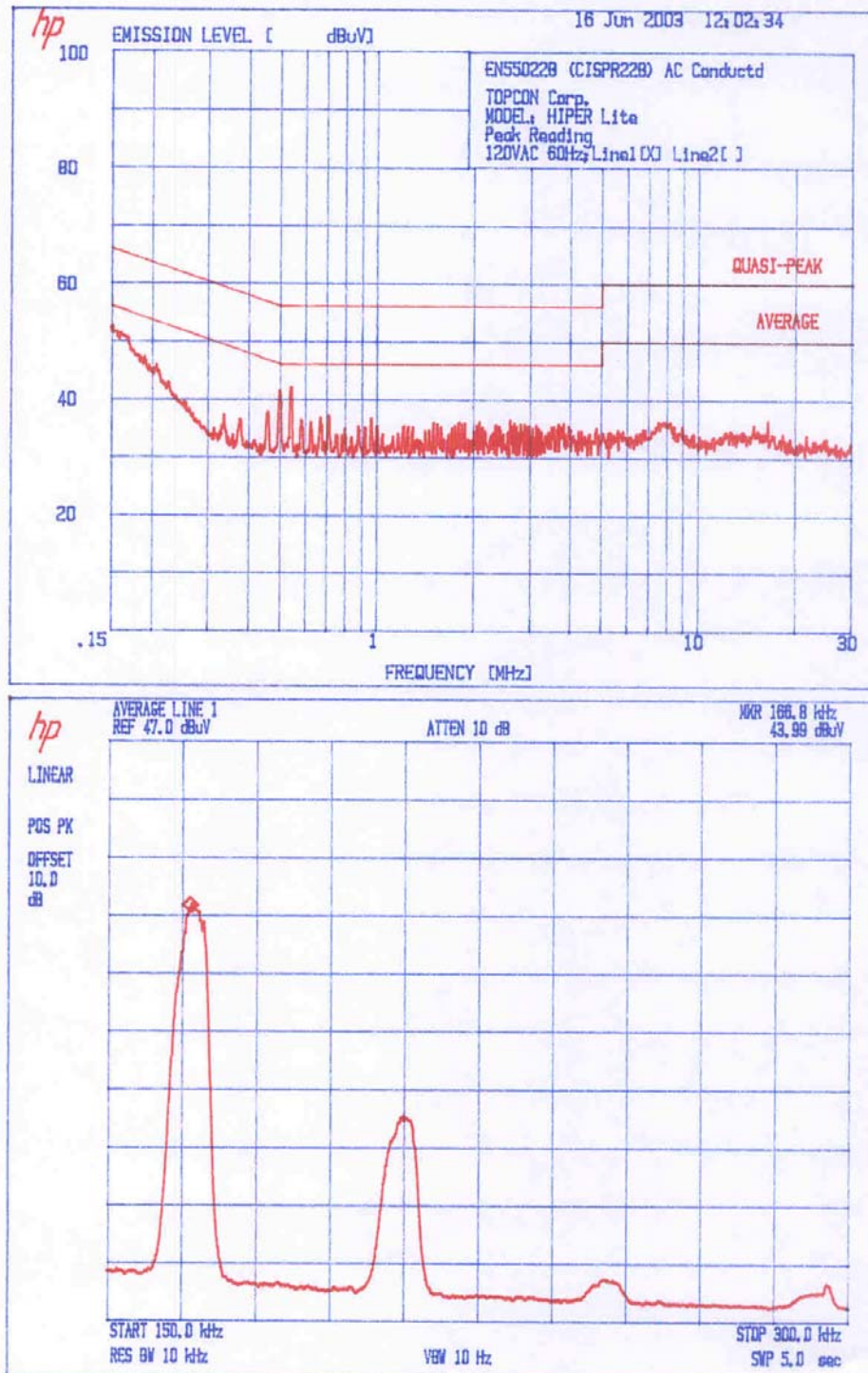


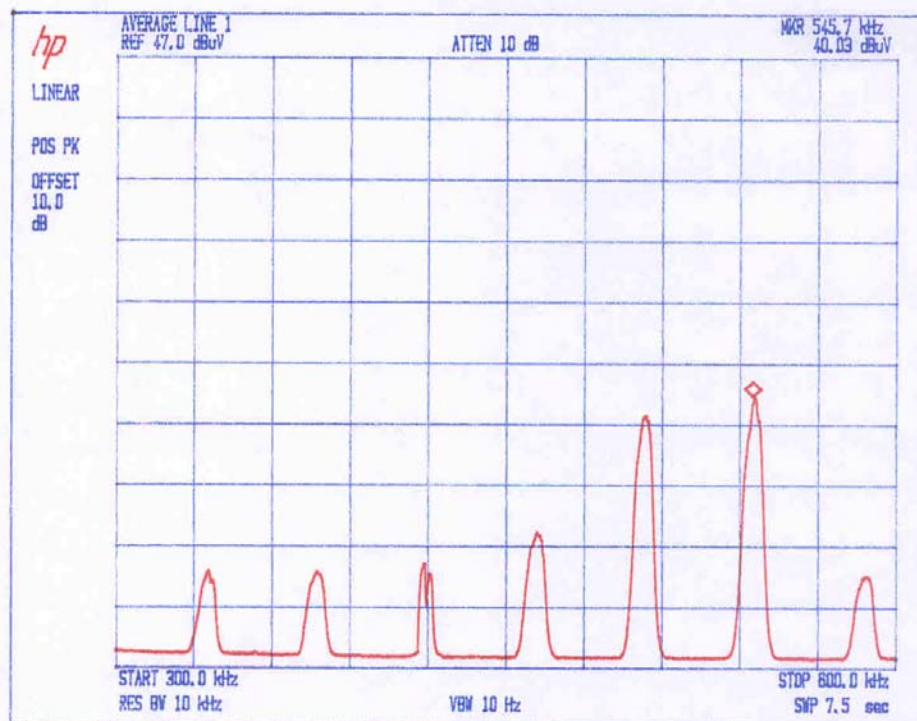


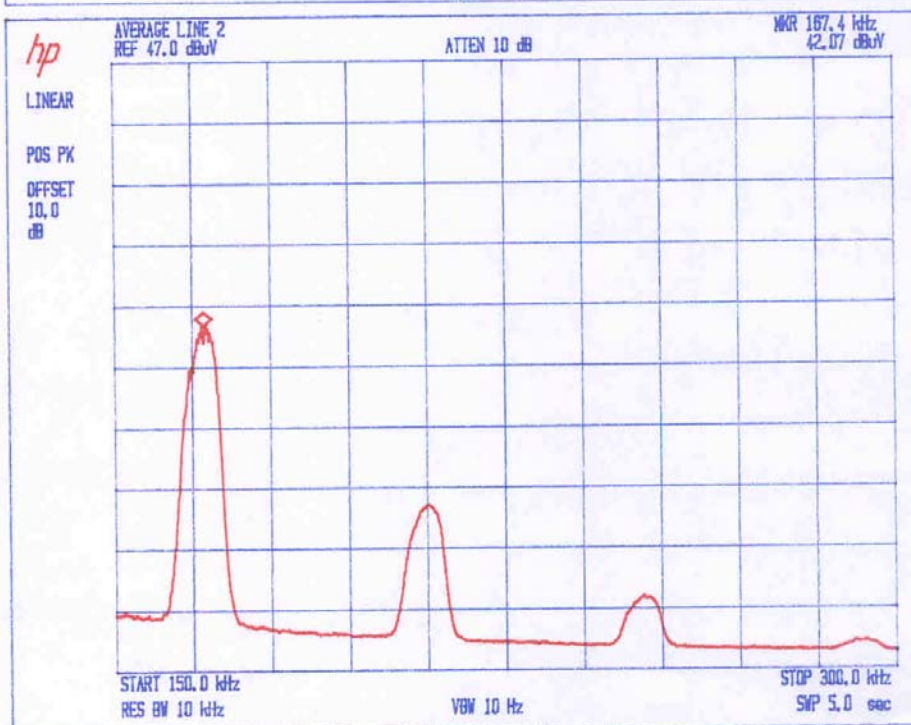
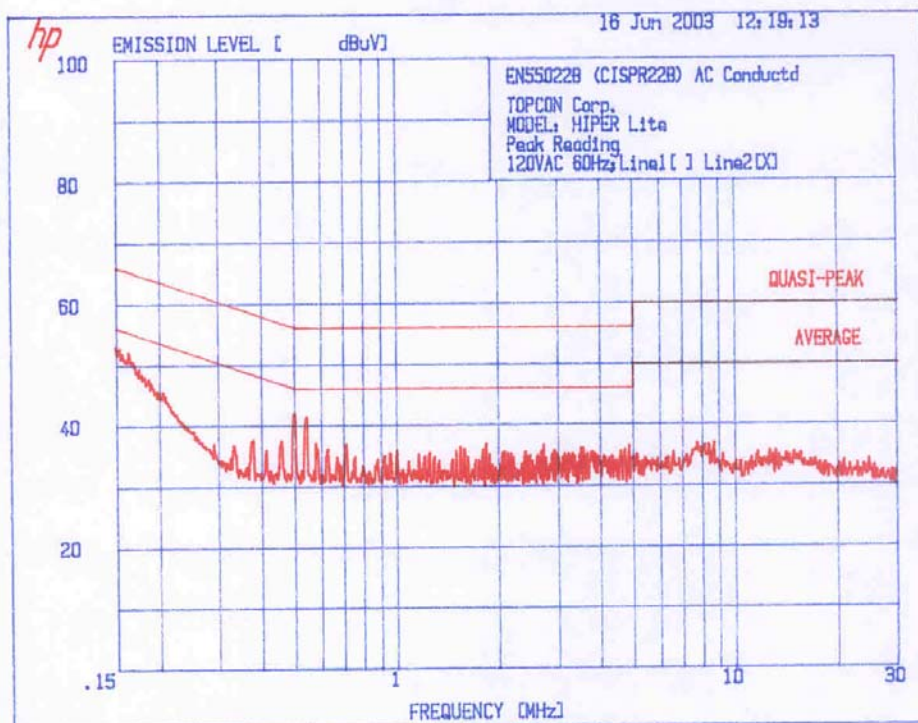
4.11 AC Line Conducted Emission
FCC 15.207:

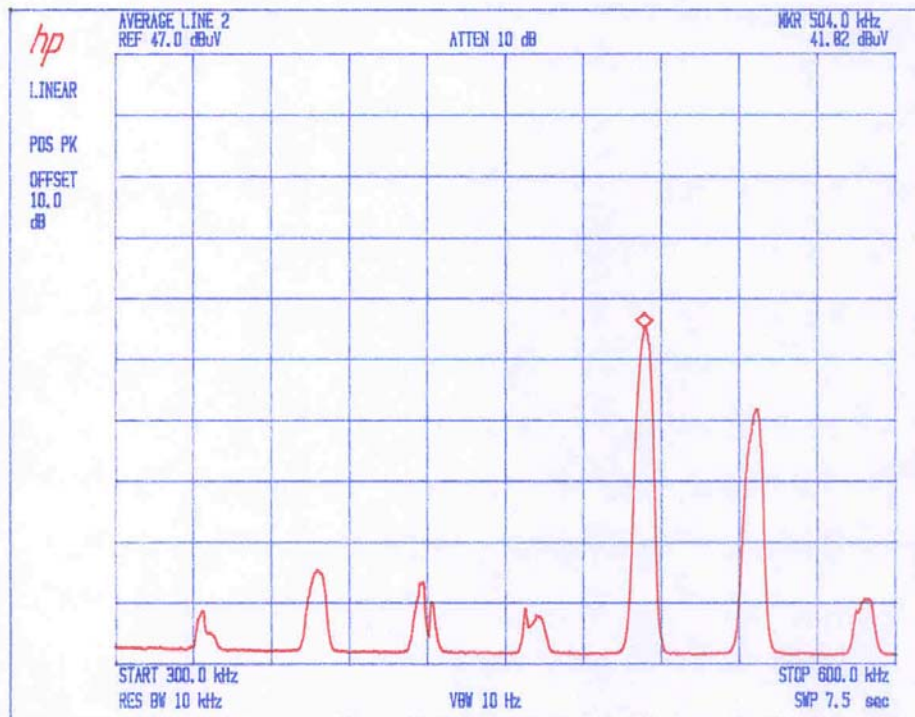
AC line conducted emission test was performed according the ANSI C63.4 standard. The EUT was connected to AC Line through the LISNs.

For the test result, see attached plots.
The EUT passed by 4.2 dB.









5.0 RF Exposure information

The EUT is a device used in mobile application, at least 20 cm from any body part of the user or near by persons.

The maximum conducted power is 1 W; antenna is fix-mounted, 2.5 dBi gain. Therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The maximum Peak EIRP calculated is 32.5 dBm or 1.78 W. The Power Density can be calculated using the formula

$$S = \text{EIRP} / 4\pi D^2$$

Where: S is Power Density in W/m^2
D is the distance from the antenna.

In the table below, the calculated Power Density at 20 cm distances and MPE Limit for general population/uncontrolled exposure are presented.

Distance, m	Power Density, W/m^2	MPE, W/m^2
0.10	14.2	10.0
0.15	6.30	10.0
0.20	3.54	10.0

As can be seen from the data, the MPE is well below the limit at 20 cm and greater.

6.0 List of test equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Serial #	Cal Int	Cal Due
BI-Log Antenna	EMCO	3143	9509-1160	12	9/19/03
Horn Antenna	EMCO	3115	8812-3049	12	4/08/04
Pre-Amplifier	ITS	ITSPA-1	44156	12	8/16/03
Pre-Amplifier	Avantek	AFT-18855	8723H705	12	10/5/03
Spectrum Analyzer w/85650 QP Adapter	Hewlett Packard	8566B	2416A00317 2043A00251	12	10/29/03
Spectrum Analyzer Display w/85650 QP Adapter	Hewlett Packard	85662B	2403A06796	12	10/29/03
RF Filter Section	Hewlett Packard	85460A	3448A00267	12	7/16/03
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	7/16/03
Spectrum Analyzer w/8650 QP Adapter	Hewlett Packard	8568B	1912A0053 2521A01021	12	11/20/03
LISN	FCC	FCC-LISN-50-50-M-H	2012	12	1/23/04
Pulse Limiter	Hewlett Packard	11947A	2820A00184	12	9/3/03

No Calibration required

7.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 3039445	DC	June 15, 2003	Original document