FCC Certification Test Report

FCC Certification Test Report
for
Scope Marketing, Ltd.
JRNMOBILINK

November 26, 2001

Prepared for:

Scope Marketing, Ltd.
Wills Road, Totnes Industrial Estate
Totnes Devon TQ95XN England

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

FCC Certification Test Report
for the
Scope Marketing, Ltd.
HHTXU1 Paging Transmitter
JRNMOBILINK

November 26, 2001

WLL JOB# 6670

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Documentation Specialist

Reviewed by: Gregory M. Snyder
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Abstract

This report has been prepared on behalf of Scope Marketing, Ltd. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Paging Transmitter under Part 90 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Scope Marketing, Ltd. HHTXU1 Paging Transmitter.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Scope Marketing, Ltd. HHTXU1 Paging Transmitter complies with the limits for a Paging Transmitter device under Part 90 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Scope Marketing, Ltd. HHTXU1 Paging Transmitter complies with the limits for a Paging Transmitter device under Part 90 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted emissions at the antenna terminals were performed. All measurements were performed according to the 1992 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Scope Marketing, Ltd. Wills Road, Totnes Industrial Estate Totnes Devon TQ95XN England
Quotation Number:	59299

1.4 Test Dates

Testing was performed from 8/23/01 to 9/20/01.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Santo Lavorata
	Steve Koster
	Greg Snyder

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test

FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Scope Marketing, Ltd. Model: HHTXU1 transmitter is a hand-held digital transmitter designed to cover various applications across industry from simplistic press button calling to advanced automated monitoring of individuals who could be overcome by physical or other means and acquire to have calls sent to provide automated assistance. The unit is battery powered.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Scope Marketing, Ltd.
FCC ID Number	JRNMOBILINK
EUT Name:	Paging Transmitter
Model:	HHTXU1
FCC Rule Parts:	§90
Frequency Range:	450 MHz to 470 MHz
Maximum Output Power:	86.5mW ERP, 26.3 dBm (Conducted)
Modulation:	FFSK
Necessary Bandwidth:	12kHz
Keying:	Manual
Type of Information:	Data
Number of Channels:	Single
Power Output Level	Fixed
Antenna Type	Shortened Helical Aerial
Frequency Tolerance:	2.5 ppm
Emission Type(s):	F1D
Interface Cables:	None

Power Source & Voltage:	Battery operated

2.2 Emissions Designator Calculation

Referencing Part 2.201 and 2.202 of the FCC Rules and Regulations and using the following formula the Emissions Designator(s) and Necessary Bandwidths were calculated.

Necessary Bandwidth:

$B = 2M + 2DK$

Frequency deviation (D) = 2.5 kHz to 4.5 kHz

Baud rate = 1200 baud

$M = Baud/2 = 1200/2 = 600$

D = 2.5kHz or 4.5kHz and using $K = 1$

For the 2.5kHz deviation:

$$B = 2(600) + (2)(2500)(1) = 6200$$

For the 4.5kHz deviation:

$$B = 2(600) + (2)(4500)(1) = 10200$$

Emission Designator:

The EUT is an FM device containing digital information for data transmission therefore the emission designator is F1D.

Final emission designators: 6K20F1D and 10K2F1D

2.3 Test Configuration and Testing Algorithm

The HHTXU1 was configured to continuously transmit, with or without modulation depending on the test being performed.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The measurement uncertainty of the data contained herein is ±2.3 dB.

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

Total Uncertainty = $(A^2 + B^2 + C^2)^{1/2}/(n-1)$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, total uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2}$ = ±2.3 dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Manufacturer & Model	Description	Serial Number	Property Number	Date Calibrated	Calibration Due Date
A.H. Systems SAS-200/518	Log Periodic Antenna	117	00001	3/1/01	3/1/02
Antenna Research Associates DRG-118/A	Horn Antenna	1010	00004	10/20/01	10/20/02
Antenna Research Associates LPB-2520	Biconilog Antenna Site 2	1118		5/15/01	5/15/02
EMCO 3146	Log Periodic Antenna	1709	00028	7/12/01	7/12/02

Manufacturer & Model	Description	Serial Number	Property Number	Date Calibrated	Calibration Due Date
Hewlett Packard 8449B	Pre-Amplifier	3008A00729	00066	12/7/00	12/7/01
Hewlett Packard 8564E	Spectrum Analyzer	3643A00657	00067	4/11/01	4/11/02
Hewlett Packard 85650A	Q.P. Adapter	2811A01283	00068	6/29/01	6/29/02
Hewlett Packard 85685A	RF Preselector	3146A01296	00070	6/29/01	6/29/02
Hewlett Packard 8568B	Spectrum Analyzer	2928A04750	00072	6/29/01	6/29/02
Hewlett Packard 8593A	Spectrum Analyzer	3009A00739	00074	5/10/01	5/10/02
Hewlett Packard 8648C	Signal Generator	3347A00242	00075	5/7/01	5/7/02
Hewlett-Packard 8672A	Synth. Signal Generator	2311A03131	00080	11/16/00	11/16/01
Hewlett Packard 8672A-K22	Frequency Extension unit	2311A00221	00257	11/16/00	11/16/01
Racal-Dana 1992	Frequency Counter	2806		2/07/01	2/07/02
Solar Electronics 8012-50-R-24-BNC	LISN	8379493	00124	8/15/01	8/15/02

4 Test Results

4.1 RF Power Output: (FCC Part §2.1046)

The antenna was replaced with a short coax connector and the output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

Bandreject and/or high pass filters were installed to suppress the carrier to assure that measuring instrumentation would remain linear, and that the dynamic range requirements were met.

Table 3. RF Power Output

Frequency	Measured Conducted	Measured Conducted Output	Measured Effective	Measured Effective

	Output Power (dBm)	**Power (Watts)**	**Radiated Power (dBm)**	**Radiated Power (Watts)**
458.725 MHz	26.3	0.4266	19.4	0.086

4.2 Modulation Characteristics: (FCC Part §2.1047);

The EUT is shipped with the frequency modulation set to 4.5kHz deviation. However, there is the capability of adjusting the modulation down to a 2.5kHz deviation present on the board. This adjustment is not made by the end user nor are instructions provided for adjusting the deviation. For this report, however, the modulation was adjusted to 2.5kHz and then to 4.5kHz deviation. The following frequency deviations were measured via connecting the RF output to a modulation analyzer.

Table 4. Modulation Parameters

Deviation Setting	Measured Value
2.5kHz	2.7kHz
4.5kHz	4.61kHz

4.3 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

The occupied bandwidth was measured as shown:

OBW = 5.43 kHz for 4.5 kHz deviation

OBW = 4.5 kHz for 2.5 kHz deviation

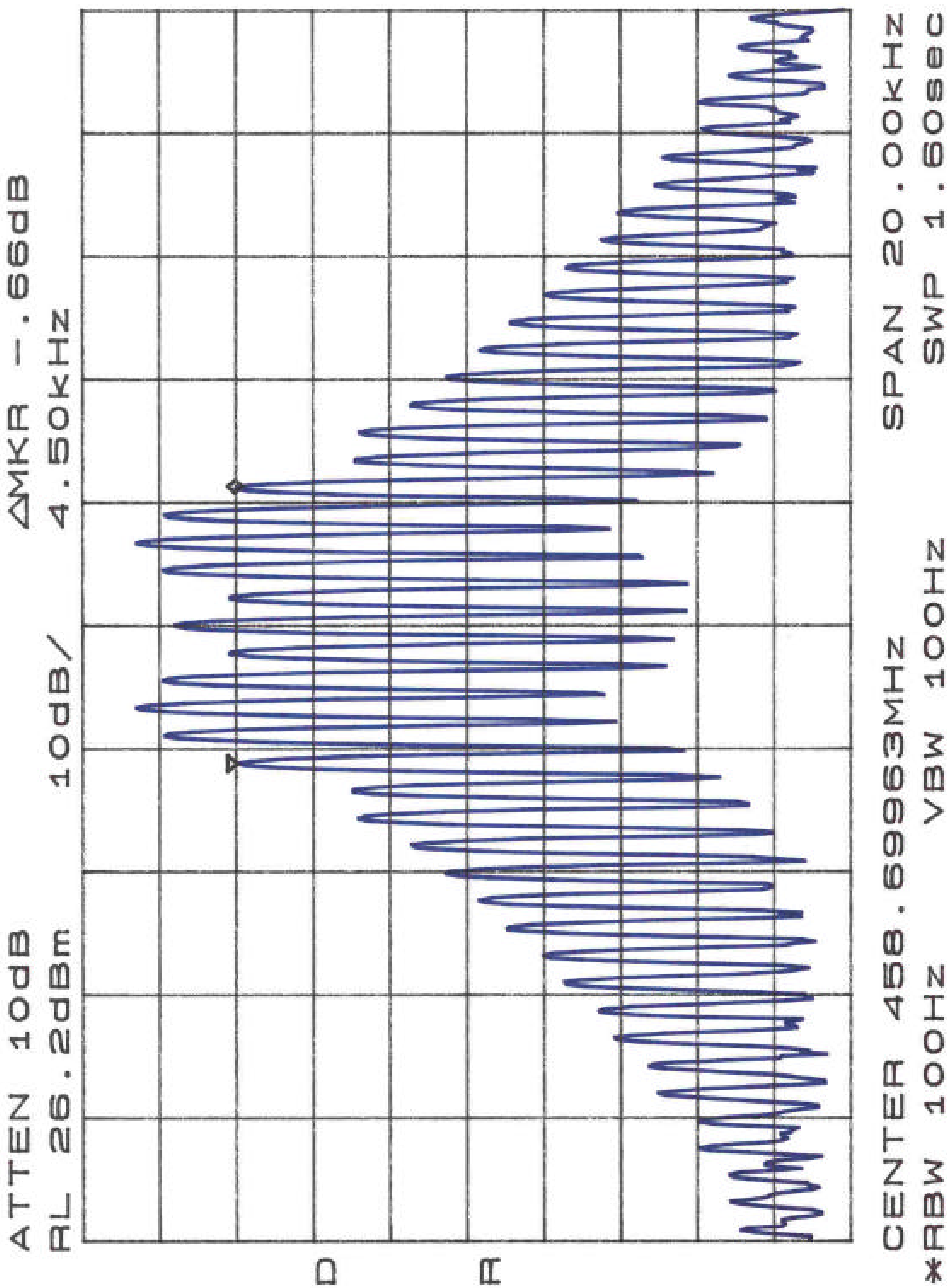

Figure 1. Occupied Bandwidth, 2.5 kHz Deviation

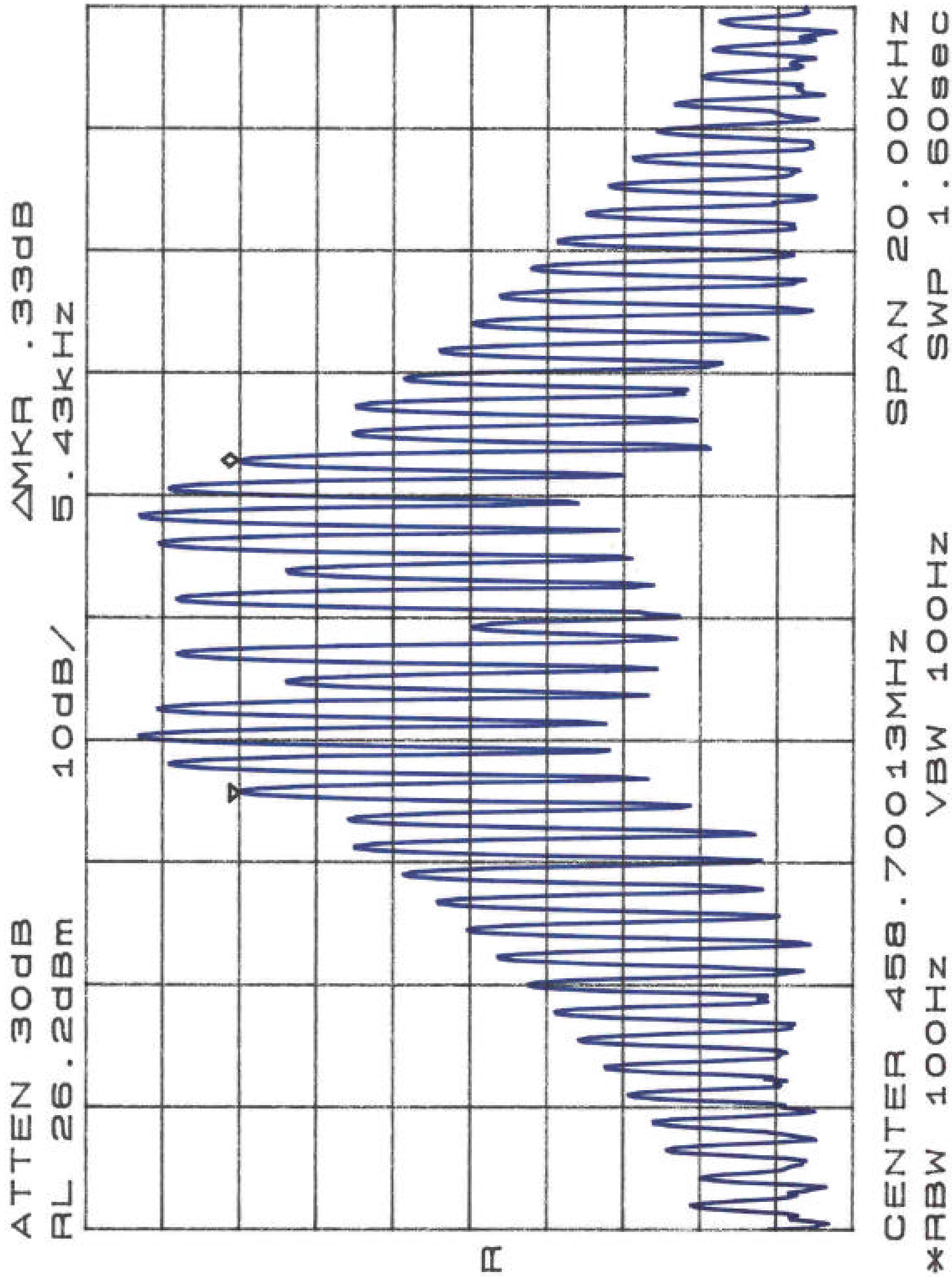

Figure 2. Occupied Bandwidth, 4.5 kHz Deviation

4.4 Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. The limits are based on §90.210(b) Emissions Mask C (25 kHz channel) and Emissions Mask D (12.5 kHz channel). The plots of the conducted spurious emissions are shown in the following plots.

The plots for the conducted spurious emissions from 30MHz to 4.6GHz include limits for both Emission Mask C (-13dBm, Red line) and Emission Mask D (-20dBm, Black line).

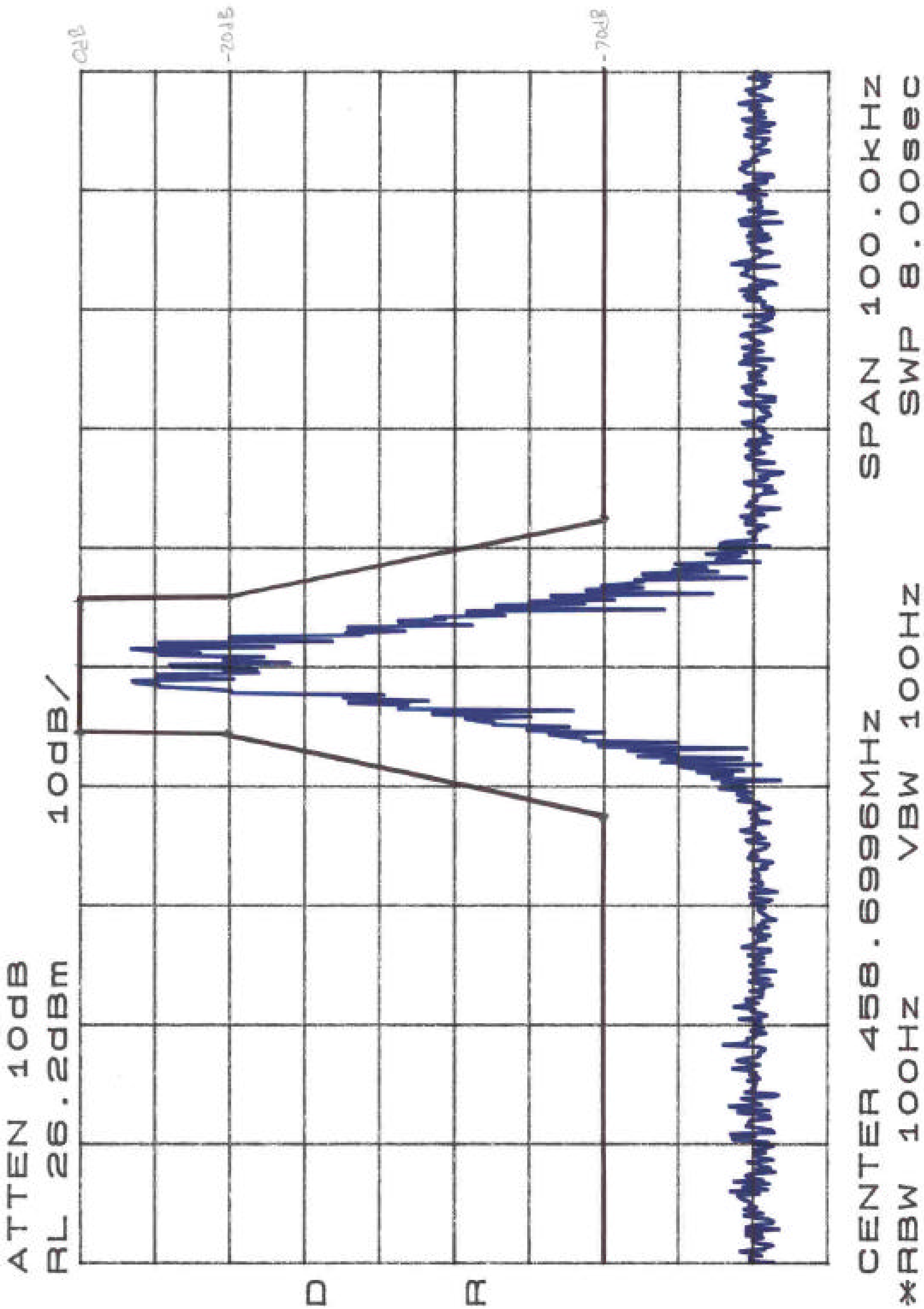

Figure 3. Conducted Spurious Emissions, Emission Mask D, 2.5 kHz Deviation

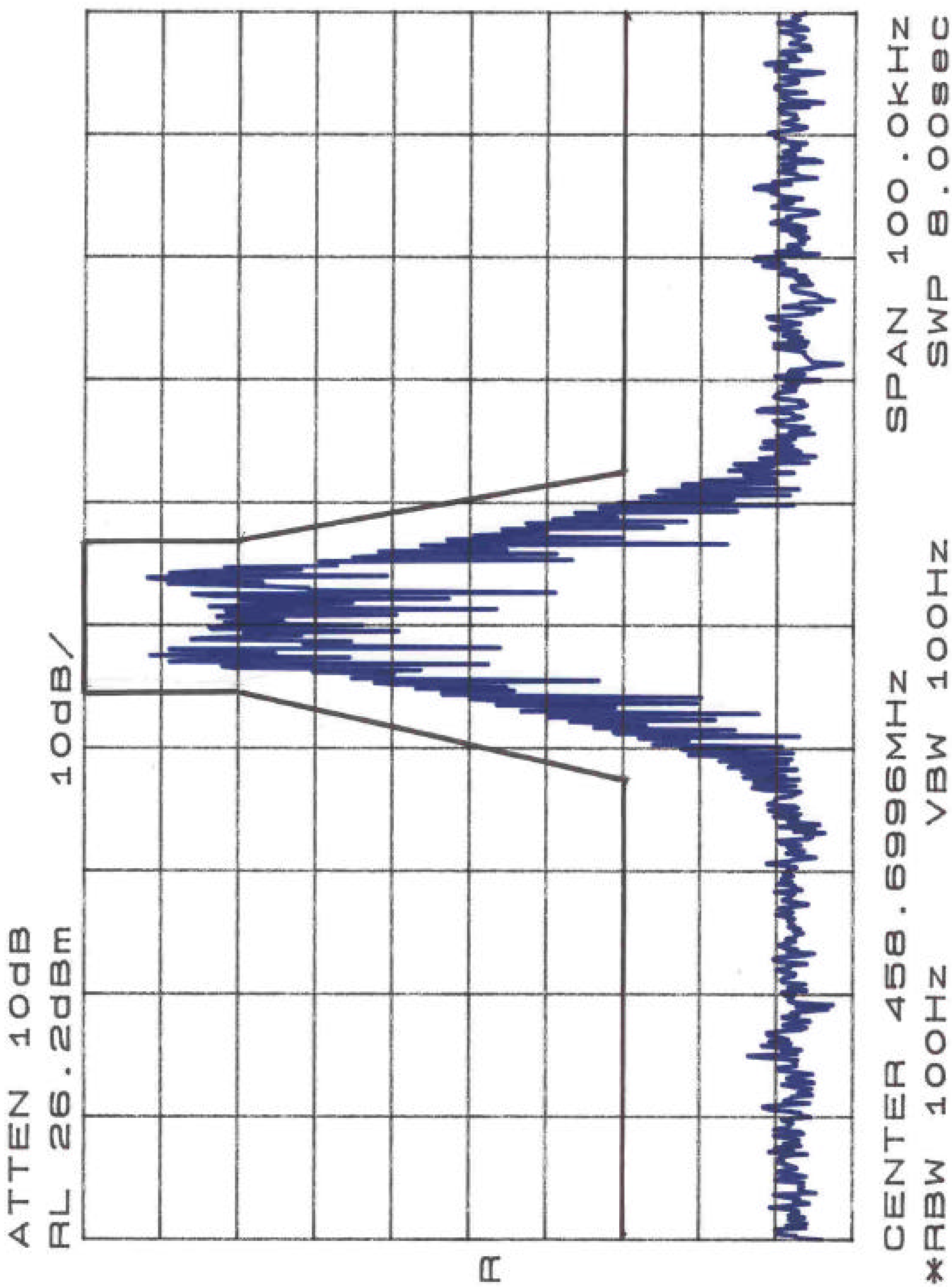

Figure 4. Conducted Spurious Emissions, Emission Mask D, 4.5 kHz Deviation

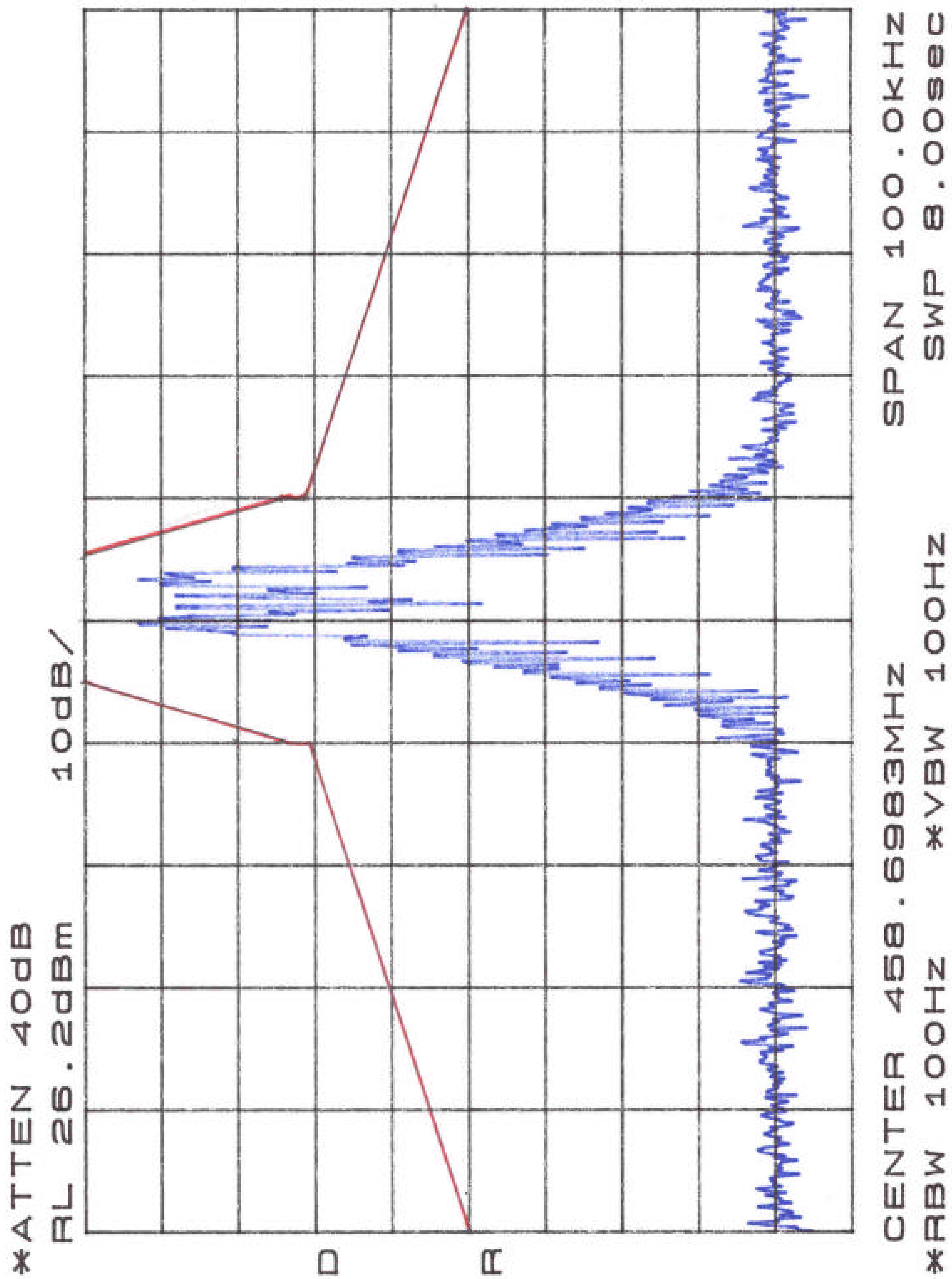

Figure 5. Conducted Spurious Emissions, Emission Mask C

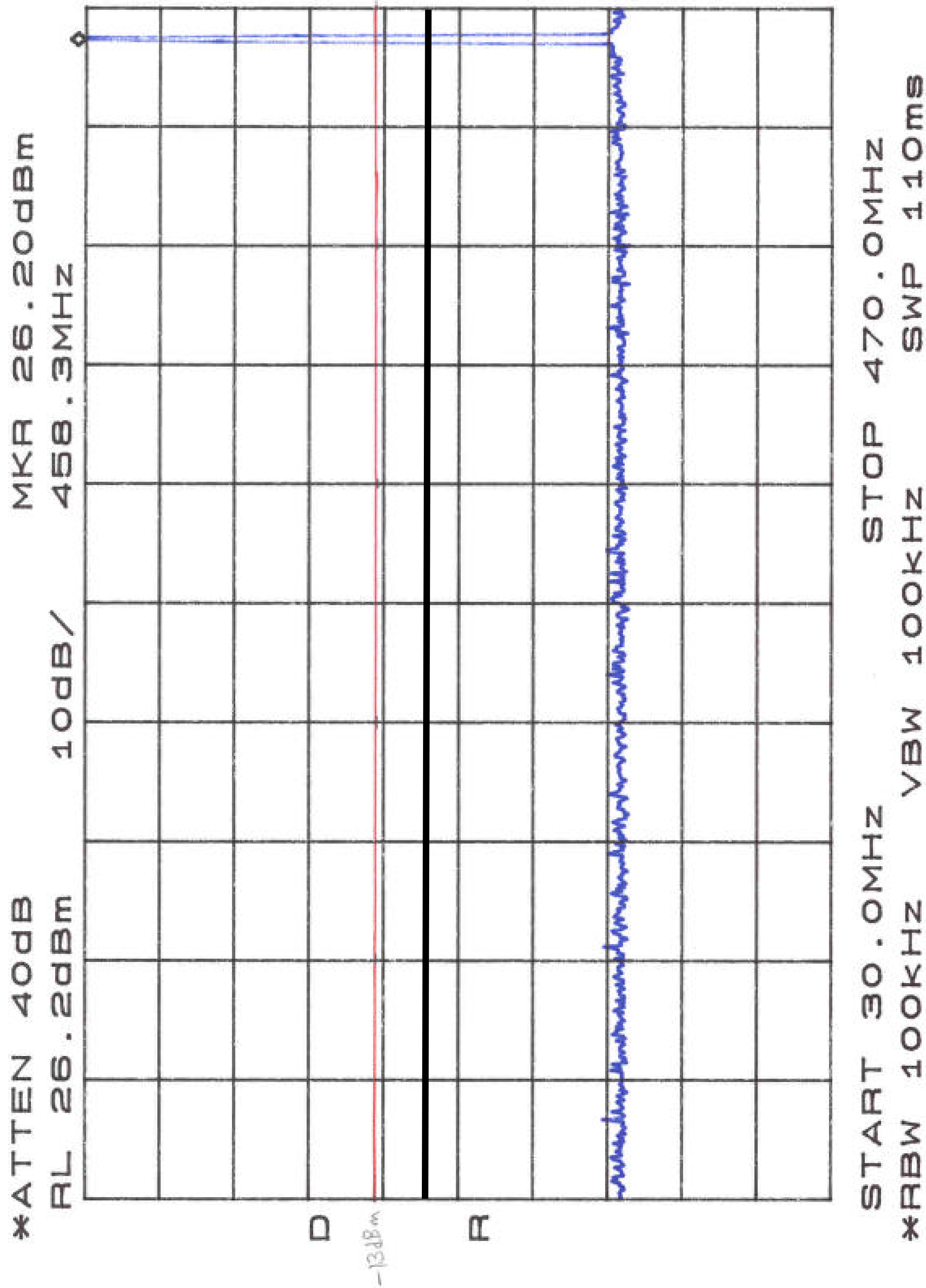

Figure 6. Conducted Spurious Emissions, 30MHz to 470MHz

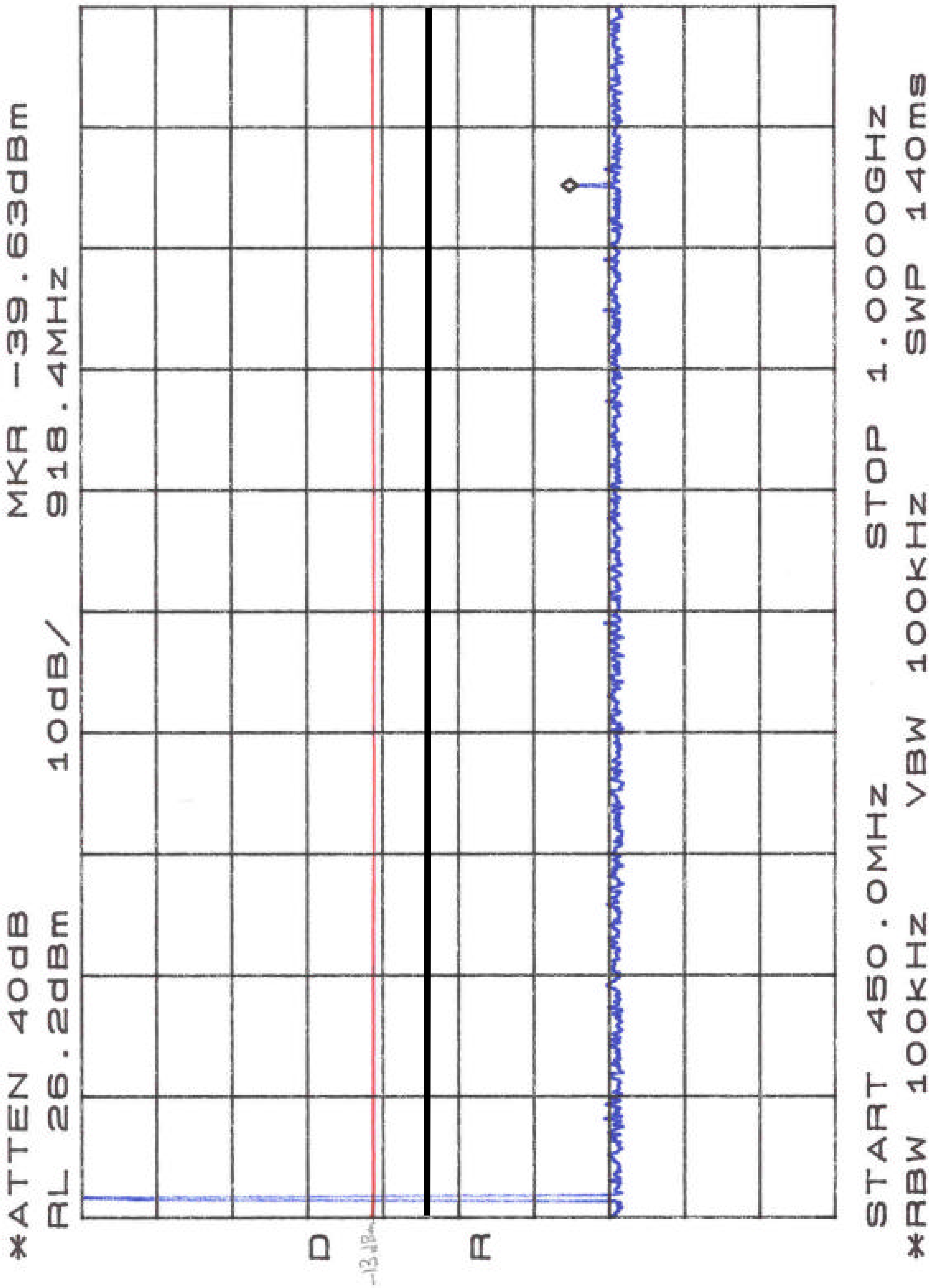

Figure 7. Conducted Spurious Emissions, 450MHz to 1GHz

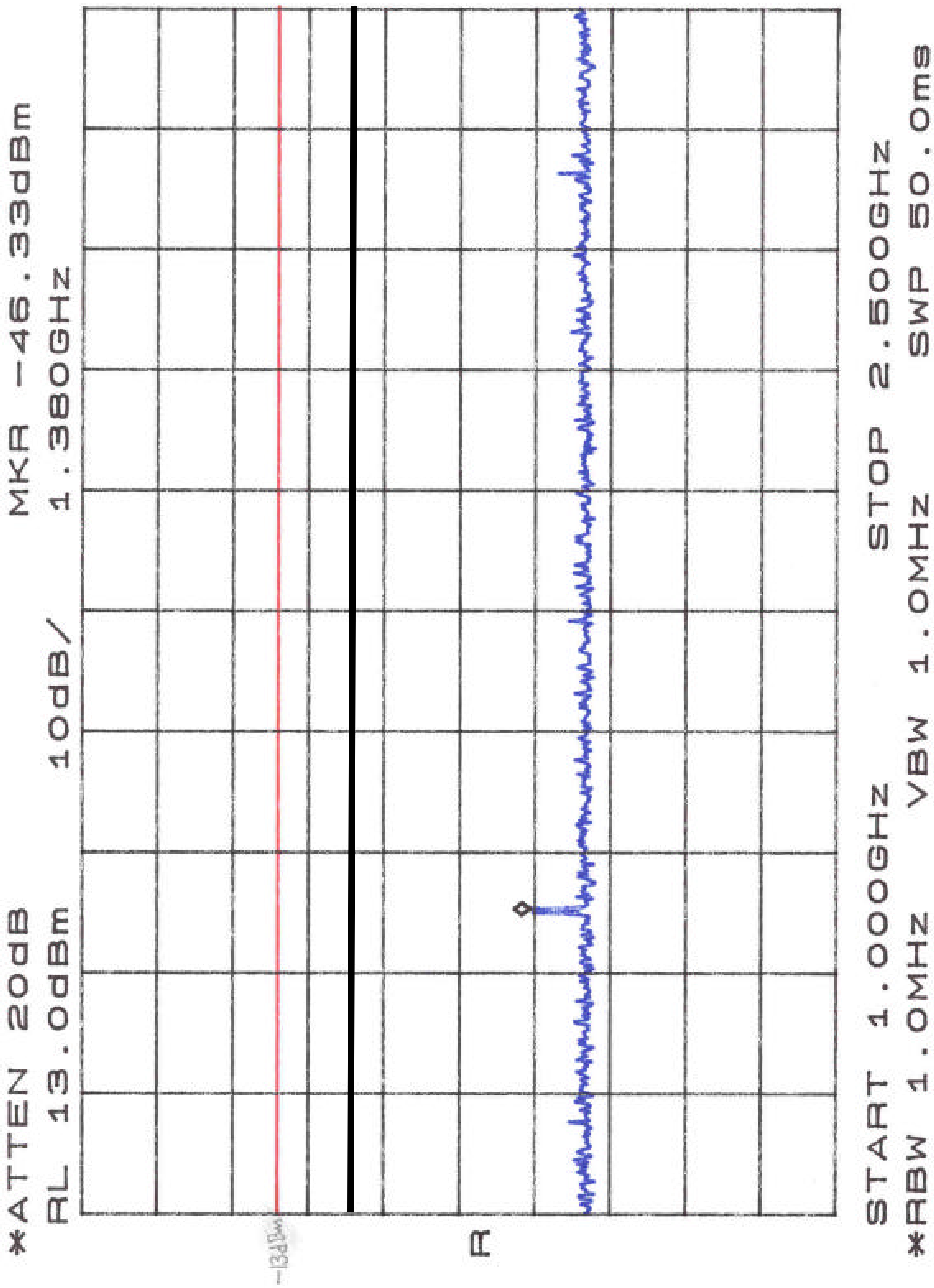

Figure 8. Conducted Spurious Emissions, 1GHz to 2.5GHz

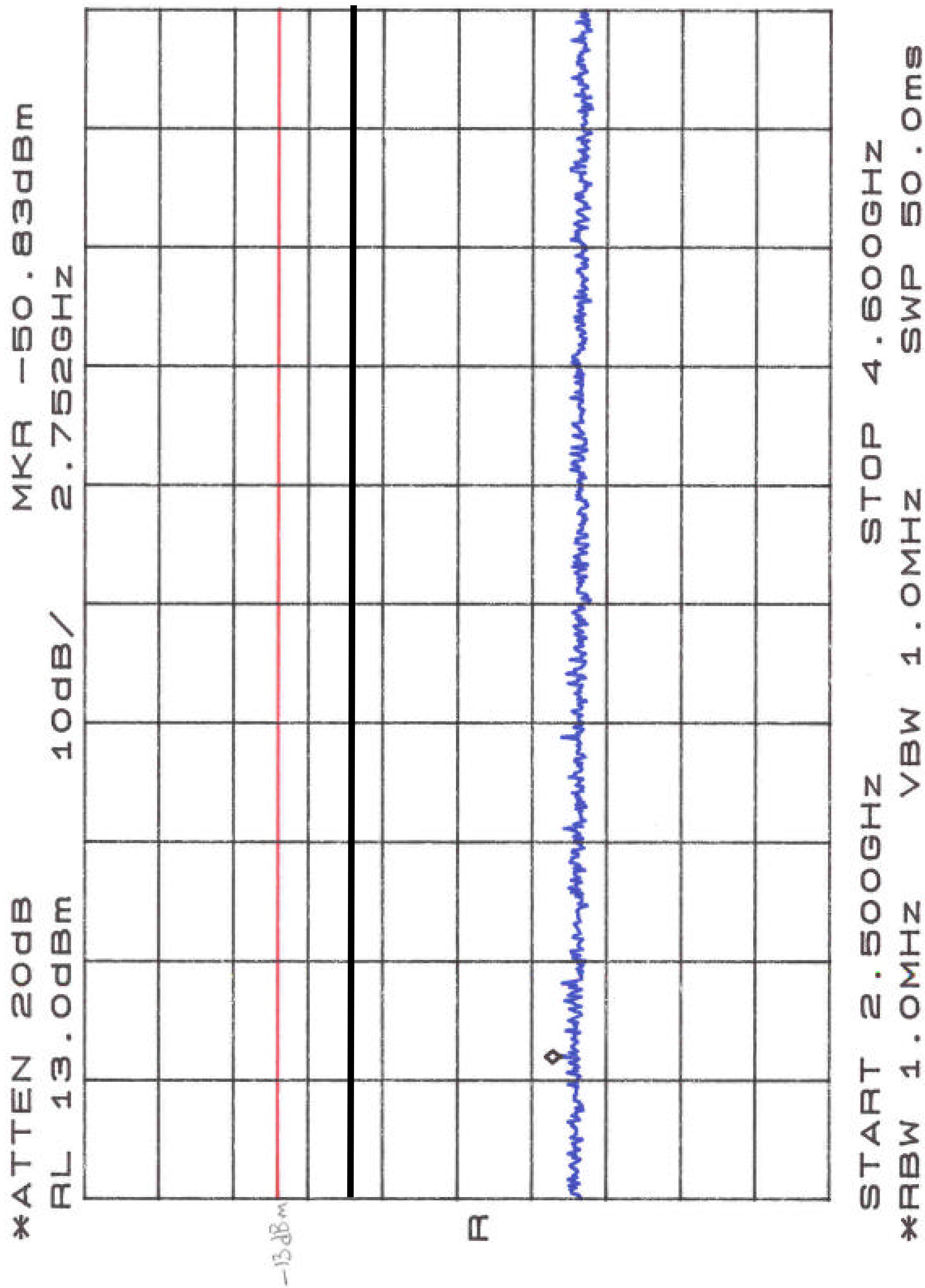

Figure 9. Conducted Spurious Emissions, 2.5GHz to 4.6GHz

4.5 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with requirements for radiated spurious emissions. The limits are as shown in the following table.

Table 5. Radiated Spurious Emissions Limits

Frequency	Fundamental Level	Harmonic Level (-dBc)
FCC Mask	C (426.6mW)	C 39.3dBc (-13dBm)

4.5.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. Both the horizontal and vertical field components were measured.

After measuring the spurious emissions, the transmitter was replaced with a substitution transmit antenna and emission level was determined using the substitution method as described in ANSI/TIA/EIA-603, Section 2.2.12.

During the emissions testing the EUT antenna was in place and the unit was tested in all 3 orthogonal planes. The worst case emissions are listed in the data table.

Table 6: Radiated Emission Test Data (Substitution Method)

CLIENT: Scope
MODEL NO: HHTXU
TYPE/PART: 90
DATE: 8/23/2001
BY: S. Lavorata
JOB #: 6670X

Frequency MHz	Signal Gen. Level dBm	Tx Antenna Gain (Ref. to 1/2 wave dipole)	Emission Level (dBm)	Limit Mask C (dBm)	Margin (dB)
917.40	-44.3	4.9	-39.4	-13.0	-26.4
1376.09	-60.3	4.9	-55.4	-13.0	-42.4
1834.78	-63.5	4.3	-59.2	-13.0	-46.2
2293.80	-62.2	4.3	-57.9	-13.0	-44.9
2752.21	-57.8	3.7	-54.1	-13.0	-41.1
3210.98	-47.7	4.0	-43.7	-13.0	-30.7
3669.77	-52.5	4.5	-48.0	-13.0	-35.0
4128.36	-53.0	5.1	-47.9	-13.0	-34.9
4587.20	-55.0	5.8	-49.2	-13.0	-36.2

4.6 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The EUT is powered by an internal, rechargeable, battery. The operating endpoint of the battery is: 1.8VDC

The frequency stability of the transmitter was examined at the battery endpoint and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter. The following is the reference frequency at ambient.

Reference Ambient Frequency: 458.69825 MHz

Table 7. Frequency Deviation as a Function of Temperature

Client: Scope
Model: HHTXU
Date: 9/19/01; 9/20/01
Steve Koster

Temperature C°	Frequency Measured (MHz)	Frequency Change (Hz)	Limit 2.5 PPM (Hz)	Change PPM	Pass/Fail
-30	NO TX	N/A	1147	N/A	Pass
-20	NO TX	N/A	1147	N/A	Pass
-10	NO TX	N/A	1147	N/A	Pass
0	458.698623	373.0	1147	0.8	Pass
10	458.698889	639.0	1147	1.4	Pass
20	458.698606	356.0	1147	0.8	Pass
30	458.698131	119.0	1147	0.3	Pass
40	458.697672	578.0	1147	1.3	Pass
50	458.697373	877.0	1147	1.9	Pass

Table 8. Frequency Deviation as a Function of Voltage

Voltage (Volts DC)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)
2.5	458.698250	0.0	1147
1.8	458.698188	62.0	1147

4.7 Transient Frequency Behavior (Part 90.214)

The transient frequency behavior of the transmitter was tested using the procedure described in TIA/EIA 603, Section 1.2.19.

The following equipment was used to perform the measurement:

- Spectrum Analyzer: HP 8564E
- Oscilloscope: Tektronix TDS 540
- RF Detector: HP 8471D
- Signal Generator: HP 8648C
- Combiner: Minicircuits: ZFSC-2-4
- Directional Coupler: Minicircuits: ZDC-10-2
- Step Attenuator: Kay Elemetrics Corporation M/N: 839

The equipment listed above was setup in accordance with the procedure of TIA/EIA 603, Section 1.2.19. The spectrum analyzer was tuned to the carrier frequency of the transmitter. The demodulated AUX Video Output of the spectrum analyzer was connected to the Channel 1 of the oscilloscope to provide a signal that is proportional to the frequency deviation of the input from the RF combiner.

The transmitter was keyed on and the waveform was captured on the oscilloscope. This procedure was repeated while turning off the transmitter and capturing the turn-off waveform.

The following plots depict the "turn-off" and "turn-on" time intervals for the unit under test. The transmitter meets the requirements for transient frequency behavior.

Figure 7 shows the "turn-on" time of the transmitter depicting the transmitter behavior during t_1, t_2 and t_3. The frequency deviation for the time following t_2 to the beginning of t_3 must meet the requirements of Part 90.213. Figure 8 shows the "turn-off" response of the transmitter.

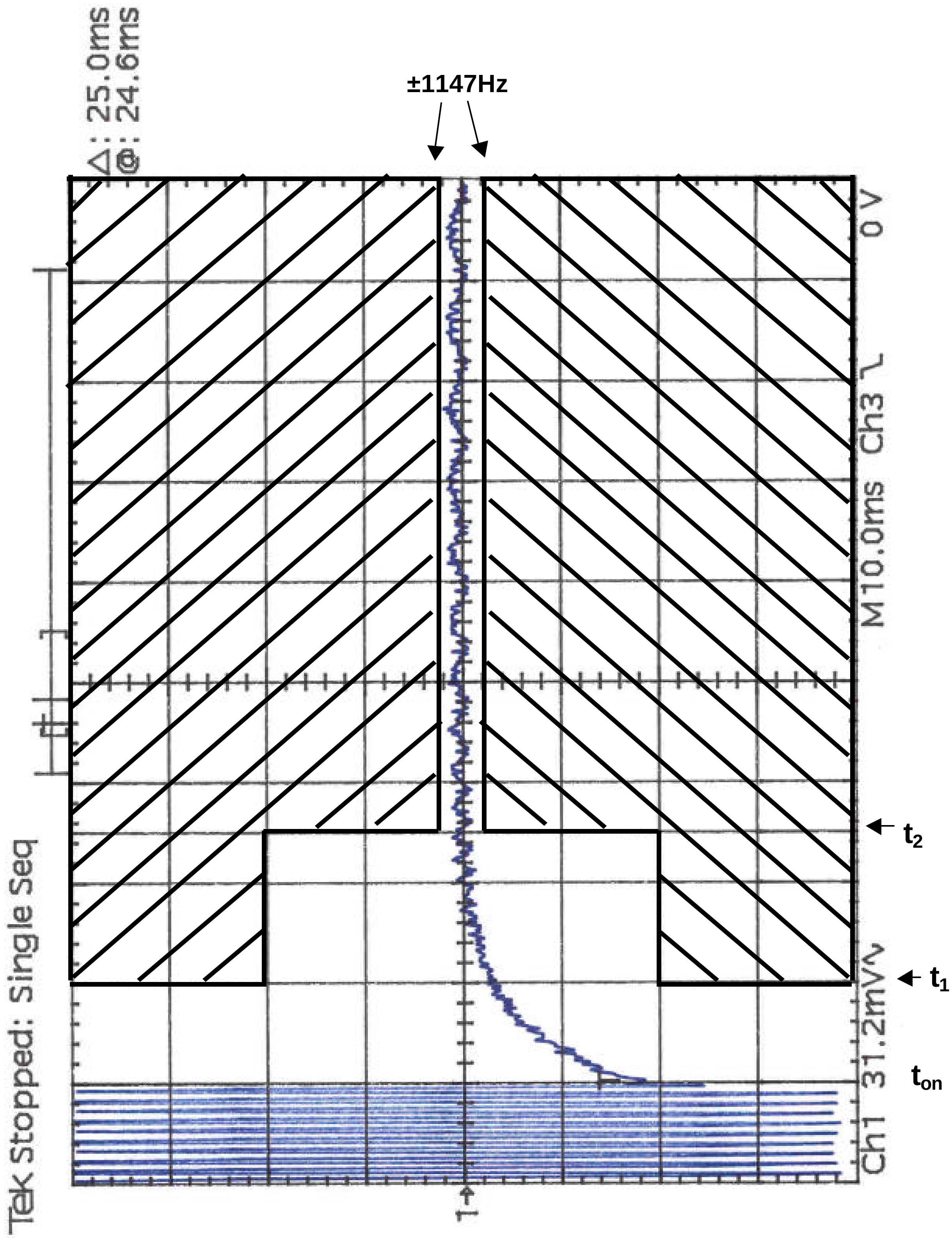

Figure 10. Transient Frequency Behavior, Turn-On

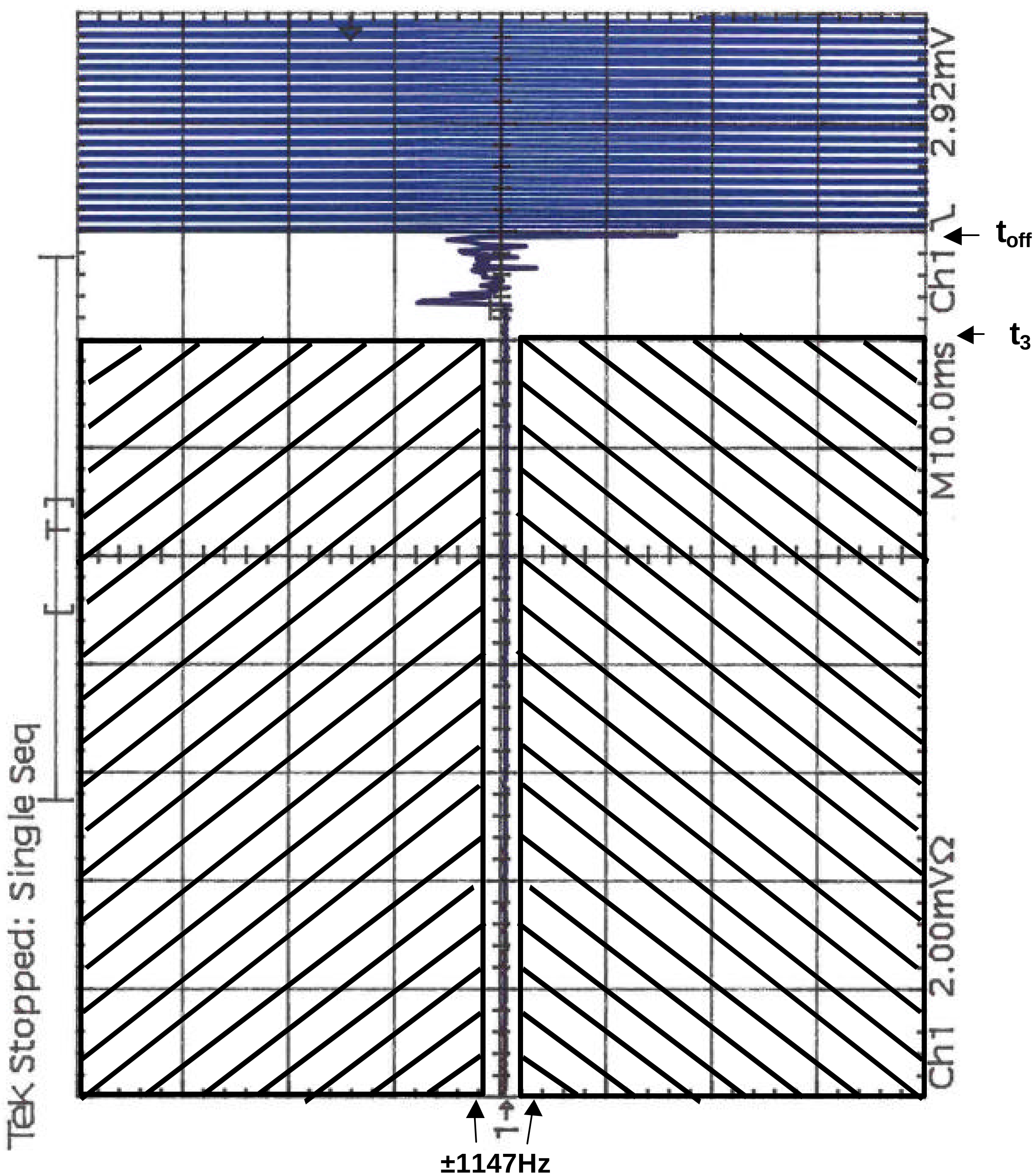

Figure 11. Transient Frequency Behavior, Turn-Off

5 Transmitter Environmental Assessment, Maximum Permissible Exposure (MPE)

5.1 Scope

This testing applies to RF transmitters used more than 20 cm of a human body. FCC §1.1307 calls out the criteria for evaluation of radio frequency exposure.

The highest RF output power of the unit was measured at 26.2 dBm at 458.7 MHz. According to §1.1310 of the FCC rules, the limit for occupational/controlled RF exposure is defined as S = f/300. For the frequency of 458.7 MHz, the Power Density limit is calculated to be 1.529 mW/cm^2. The gain of the antenna is –6 dBi. To comply with the exposure limits for this section, humans must maintain a safe distance from the transmit antenna. The following formula was used to calculate the minimum distance:

$$S = \frac{PG}{4pR^2}$$

Where:

S = Power Density

P = Output Power at the Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna

For this device, the calculation is as follows:

S = FCC Limit = 1.529 mW/cm^2

P = Output Power = 426.6 mW

G = Worst Case Gain = -6 dBi = INVLOG(-6/10) = 0.251

1.529mW/ cm^2 = (426.6mW)(0.251)/(4π R^2)

Solving for the required minimum safe distance using the following formula:

$$R = \sqrt{\frac{PG}{4pS}}$$

$$R = \sqrt{\frac{426.6 \times 0.251}{4 \times \boldsymbol{p} \times 1.529}}$$ = 2.36 cm (Based on continuous transmission)

However, based on the usage of the device, and taking the duty cycle into account, the EUT will transmit a maximum of 600mS in a 6 minute period. Therefore, averaging the power over a 6 minute period gives:

426.6mW x 0.00167 = 0.711mW

$$R = \sqrt{\frac{0.711 \times 0.251}{4 \times \boldsymbol{p} \times 1.529}}$$ = 0.096 cm (Averaging over 6 minutes)

Based on the calculation above, the device complies with the minimal permissible exposure requirements using the current antenna-housing configuration.