FCC & IC Certification Test Report

FCC & Industry Canada Certification Test Report

for

Proton Control Systems, Inc.

FCC ID: R2R04HUSKY75

IC ID: 5382A-04HSKY75

October 5, 2004

Prepared for:

Proton Control Systems, Inc.
4905 Americana Drive Suite T-10
Annandale, VA 22003

Prepared By:

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FCC & Industry Canada Certification Test Report
for the
Proton Control Systems, Inc.
Husky Digital Control System
FCC ID: R2R04HUSKY75

October 5, 2004

WLL JOB# 8305/8354

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Abstract

This report has been prepared on behalf of Proton Control Systems, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 95 of the FCC Rules and Regulations and Spectrum Management and Standard RSS-210 of Industry Canada. This Certification Test Report documents the test configuration and test results for a Proton Control Systems, Inc. Husky Digital Control System.

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. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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 Proton Control Systems, Inc. Husky Digital Control System complies with the limits for an Intentional Radiator device under FCC Part 95 and Industry Canada RSS-210.

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1 Introduction

1.1 Compliance Statement

The Proton Control Systems, Inc. Husky Digital Control System complies with the limits for an Intentional Radiator device under FCC Part 95 and Industry Canada RSS-210.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 2001 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:	Proton Control Systems, Inc. 4905 Americana Drive Suite T-10 Annandale, VA 22003
Quotation Number:	61543-A

1.4 Test Dates

Testing was performed from April 26, 2004 to September 10, 2004.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Greg Snyder, James Ritter, Ken Gemmell
Client Representative	Chris Park

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 Proton Control Systems, Inc. Husky Digital Control System is a hand-held two-channel FM transmitter for use in radio control applications. It also contains a USB port for connecting to PCs, and a Direct Servo Control port for directly connecting to a Proton Control Systems "Ken" receiver via a cable. A battery charging AC adapter may be connected.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Proton Control Systems, Inc.
FCC ID Number	R2R04HUSKY75
IC ID Number:	5382A-04HSKY75
EUT Name:	Digital Control System
Model:	Husky
FCC Rule Parts:	§95
IC Rule Parts:	RSS-210
Frequency Range:	75.410 - 75.990 MHz
Maximum Output Power:	< 0.75W
Modulation:	FM
Necessary Bandwidth:	KHz
Keying:	Manual
Type of Information:	Control
Number of Channels:	2
Power Output Level	Fixed
Antenna Type	Integral
Frequency Tolerance:	< 0.0008%
Emission Type(s):	Control
Interface Cables:	Optional
Power Source & Voltage:	10.8Vdc from battery

2.2 Test Configuration

The Husky was tested in a stand-alone configuration.

2.3 Testing Algorithm

The Husky was tested with the transmitter in continuous operating mode.

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. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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. 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:

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

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 = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ 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

Site 1 List:

Equipment	WLL Asset #	Calibration Due
Sunol JB1 Biconilog Antenna	0382	10/21/04
ARA DRG118/A Microwave Horn Antenna	0425	4/17/05
Hewlett-Packard 8568B Spectrum Analyzer	0072	7/01/05
Hewlett-Packard 85650A Quasi-Peak Adapter	0069	7/08/05
Hewlett-Packard 85685A RF Preselector	0070	7/06/05
Hewlett-Packard 8593A Spectrum Analyzer	0074	8/17/05
Hewlett-Packard 8449B Microwave Preamp	0312	9/29/05
Solar Electronics 8012-50-R-24-BNC LISN	0124	9/30/04

Site 2 List:

Equipment	WLL Asset #	Calibration Due
Hewlett-Packard 8568B Spectrum Analyzer	0073	7/08/05
Hewlett-Packard 85650A Quasi-Peak Adapter	0069	7/08/05
Hewlett-Packard 8593A Spectrum Analyzer	0074	8/17/05
Hewlett-Packard 8449B Microwave Preamp	0312	9/29/05
Solar Electronics 8012-50-R-24BNC LISN	0124	9/30/04
ARA LPB-2520 BiconiLog Antenna	0007	9/14/05
ARA DRG118/A Microwave Horn Antenna	0425	4/17/05
Hewlett-Packard 85685A RF Preselector	0071	7/08/05
EMCO 3110B Biconical Antenna	0026	6/22/05
EMCO 3146A Log Periodic Antenna	0029	6/24/05

4 Test Results

4.1 RF Power Output

The antenna of the transmitter was connected to an attenuator and then to the input of an RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

The unmodulated power was measured per the requirements of 95.639(b)(3) and RSS-210, Section 6.1.3.

Table 3. RF Power Output

Frequency	Level	FCC Limit	RSS-210 Limit	Pass/Fail
75.64MHz	72.4mW	75mW	75mW	Pass

4.2 Occupied Bandwidth

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

FCC 95.633(b) and RSS-210, Section 6.1.3(4) states that the authorized bandwidth of the modulated carrier shall be less than 8kHz.

At full modulation, the occupied bandwidth was measured as shown:

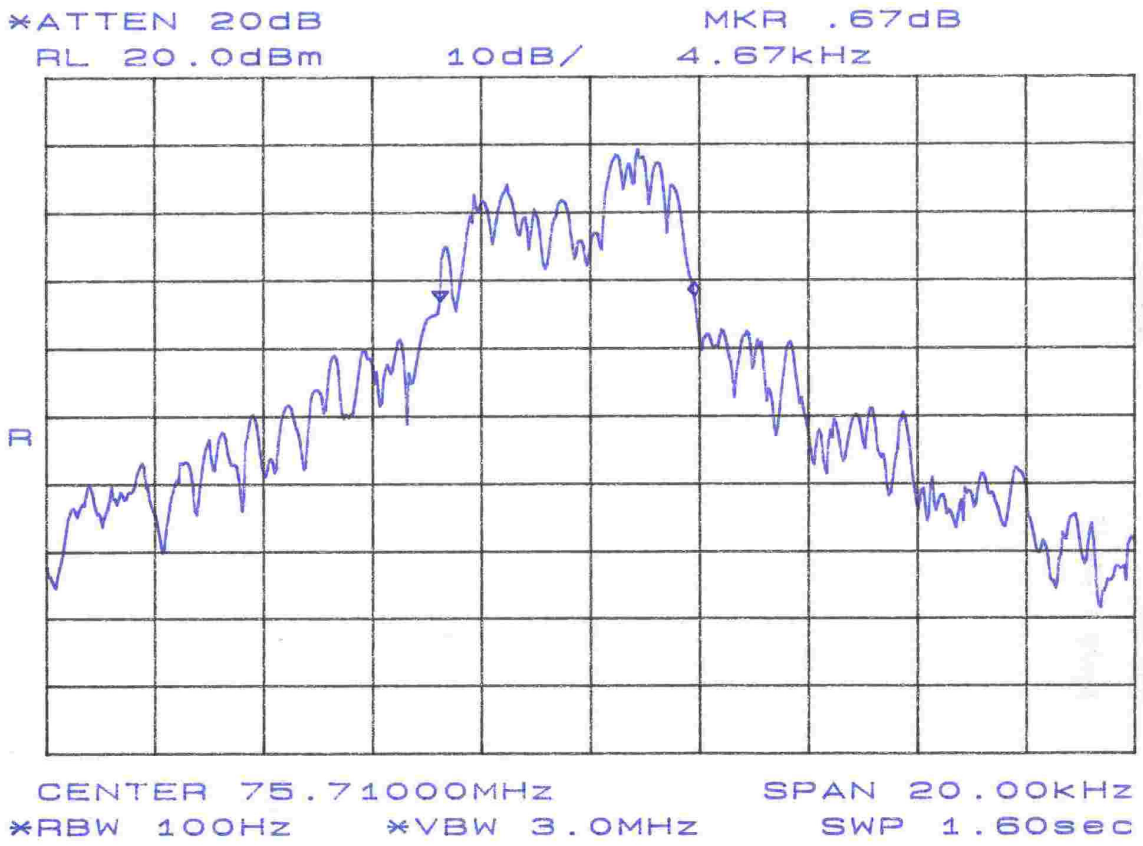

Figure 1. Occupied Bandwidth

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4. Occupied Bandwidth, FCC Part 95.633 and RSS-210, Section 6.1.3(4)

Frequency	Bandwidth	Limit	Pass/Fail
75.71MHz	4.67	8kHz	Pass

4.3 Emissions at Antenna Terminals: FCC Part 95.635 and RSS-210, Section 6.1.3(6)

The EUT must comply with requirements for spurious emissions at antenna terminals as listed in FCC Part 95.635 (a) with applicable sub-paragraphs 1, 10, 11 and 12 as follows (for transmitters imported or sold in the US after March 1, 1992) and RSS-210 Section 6.1.3(6). Emissions must be reduced from the carrier level by the following:

(1) At least 25 dB on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(10) At least 45 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 125% of the authorized bandwidth.

(11) At least 55 dB on any frequency removed from the center of the authorized bandwidth by more than 125% up to and including 250% of the authorized bandwidth.

(12) At least 56+10log(T) dB on any frequency removed from the center of the authorized bandwidth by 250%.

These levels are plotted in the conducted emissions charts of Figure 2 through Figure 5.

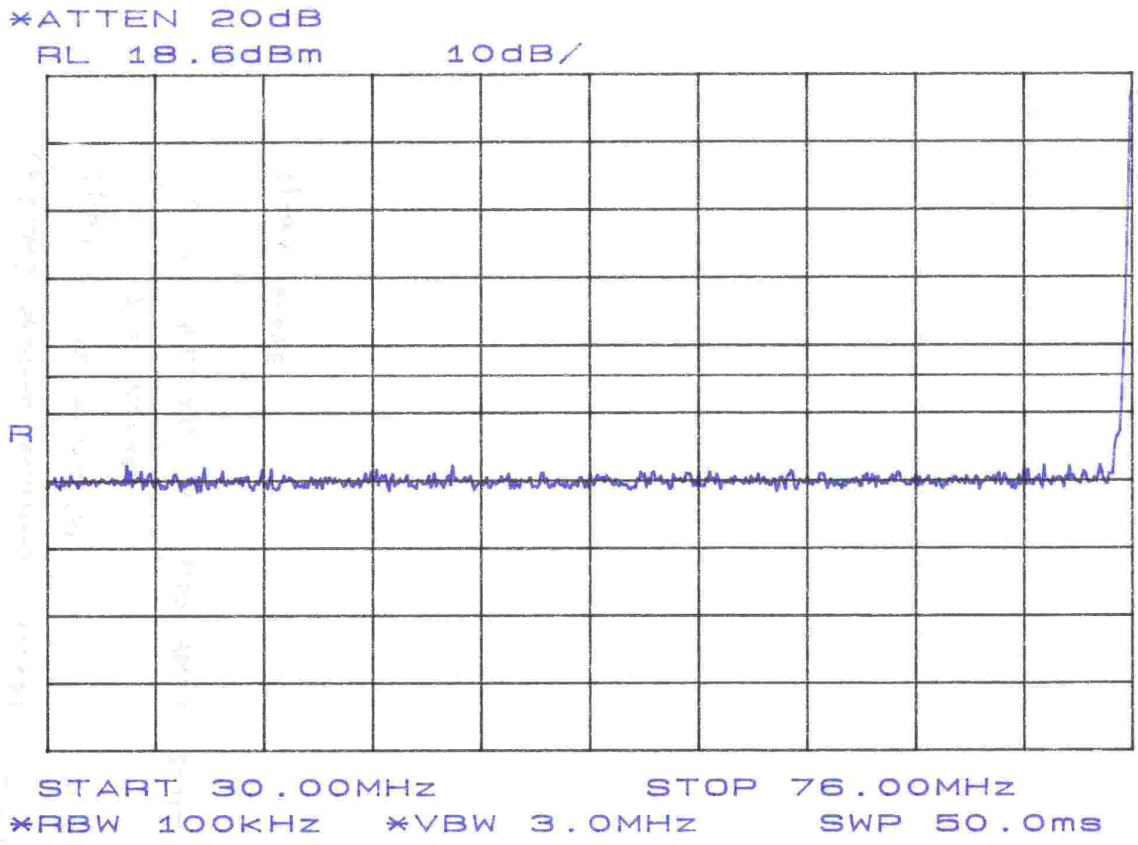

Figure 2. Conducted Spurious Emissions, 30 – 76 MHz. FCC Part 95.635

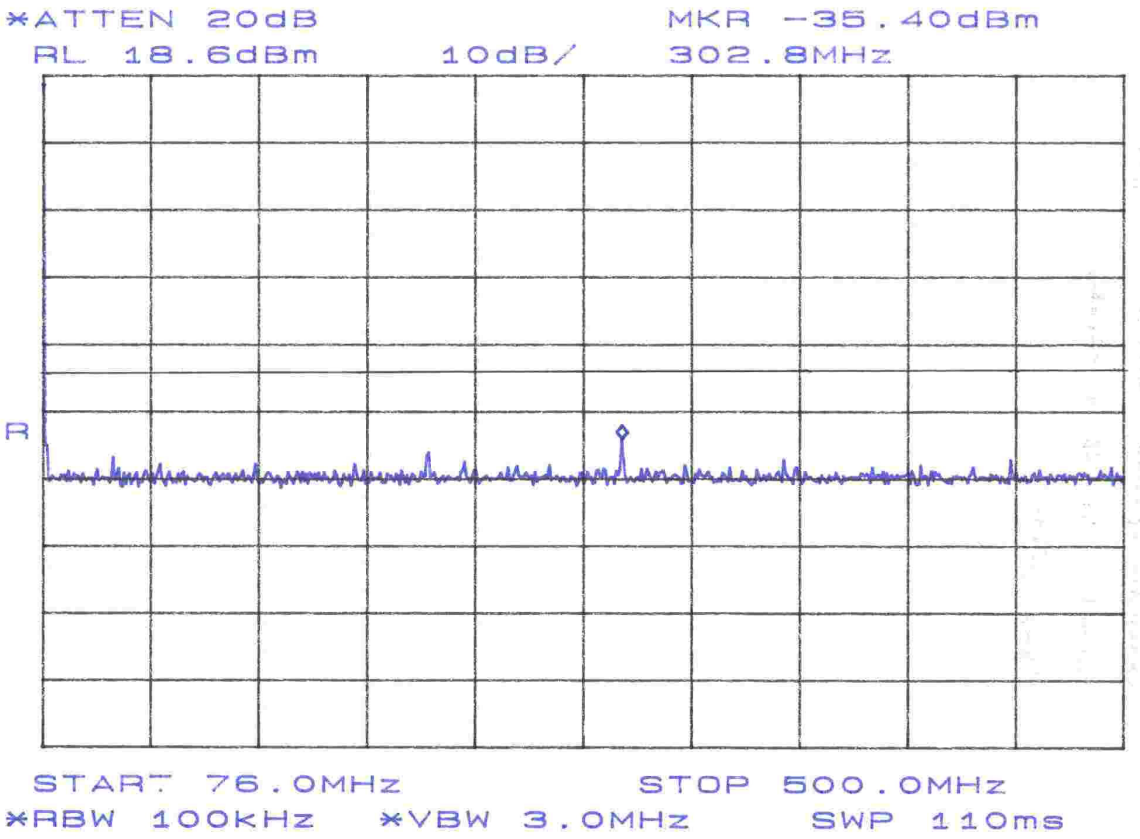

Figure 3. Conducted Spurious Emissions, 76 – 500 MHz. FCC Part 95.635

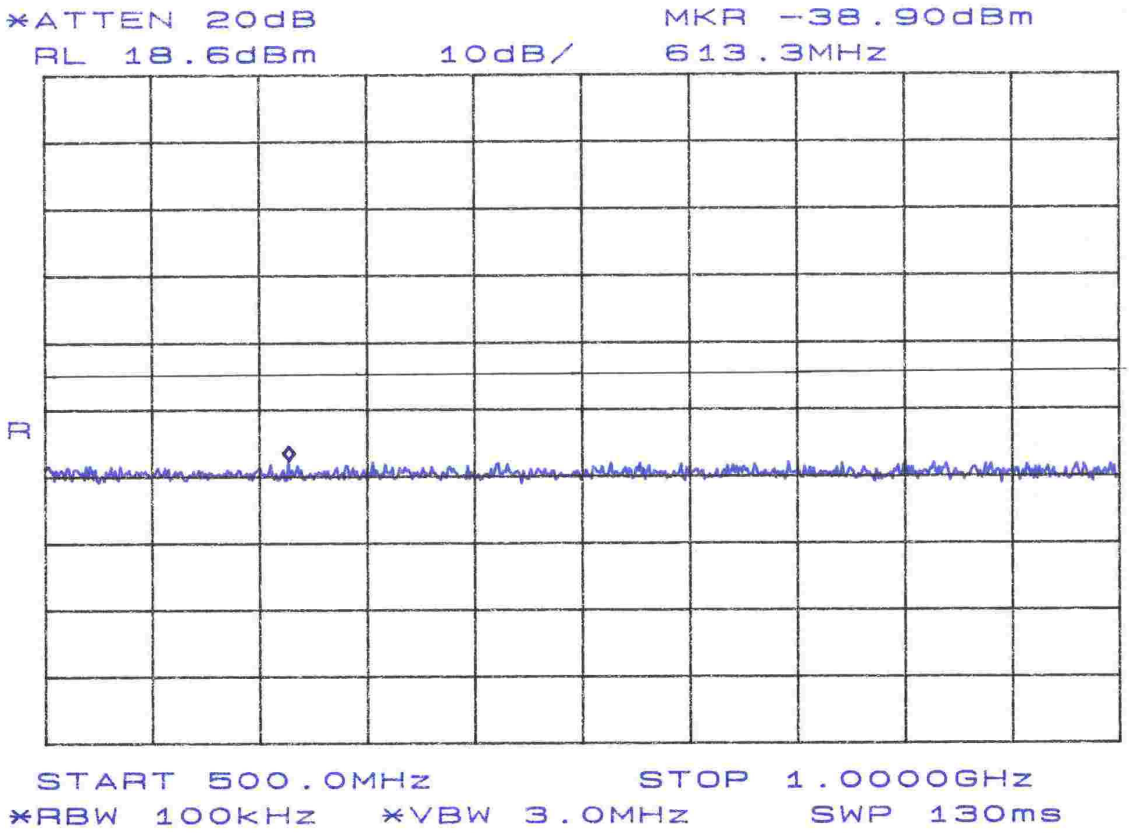

Figure 4. Conducted Spurious Emissions, 500MHz – 1GHz. FCC Part 95.635

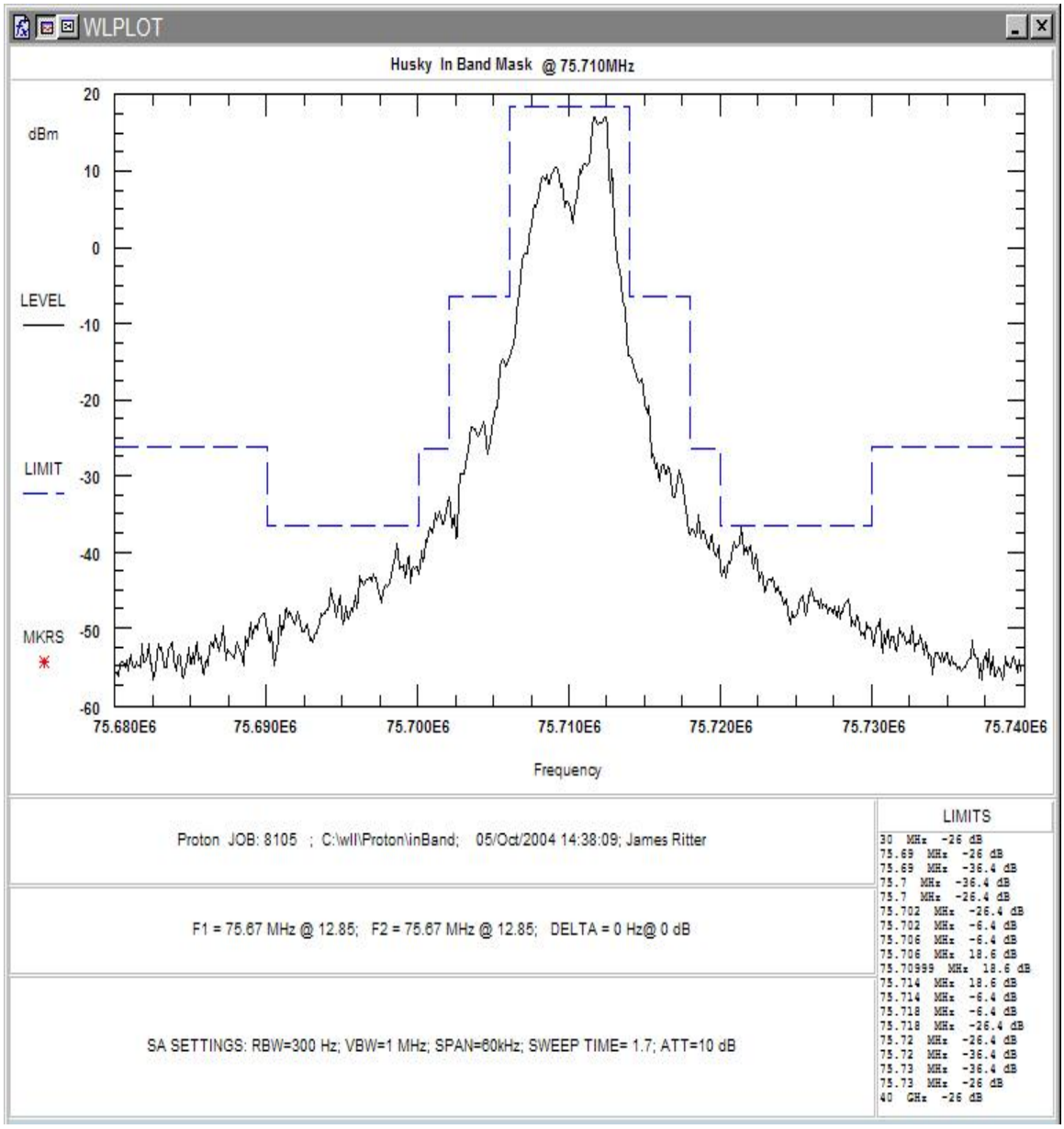

Figure 5. Conducted Spurious Emissions, FCC Part 95.635, RSS-210 Section 6.1.3(6)

4.4 Radiated Spurious Emissions: FCC Part 95.635 and RSS-210, Section 6.1.3(6)

The EUT must comply with requirements for spurious emissions at antenna terminals as listed in FCC Part 95.635 (a) with applicable sub-paragraphs 1, 10, 11 and 12 as follows (for transmitters imported or sold in the US after March 1, 1992). Emissions must be reduced from the carrier level by the following:

(1) At least 25 dB on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(10) At least 45 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 125% of the authorized bandwidth.

(11) At least 55 dB on any frequency removed from the center of the authorized bandwidth by more than 125% up to and including 250% of the authorized bandwidth.

(12) At least 56+10log(T) dB on any frequency removed from the center of the authorized bandwidth by 250%.

The measured EIRP of the fundamental is 10.8 dBm or T = 12mW. Emissions outside the band must be reduced below the carrier by:

$$56+10\log_{10}(T) = 56+10(\log 0.012W) = 36.8dB$$

The radiated EIRP limit is, then:

$$EIRPLimit = EIRP - 36.8$$

$$= 10.8 - 36.8$$

$$EIRPLimit = -26dBm$$

This is used in the "Limit" column of Table 5.

4.4.1 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.

EIRP Measurements

The EIRP levels were measured using the substitution method and the results shown in the following table.

Table 5: Radiated Emission Test Data

CLIENT:	Proton	DATE:	10/4/04
TESTER:	James Ritter	JOB #:	8105
EUT Information:		**Test Requirements:**	
EUT:	HuskyFM	TEST STANDARD:	FCC Part 95
CONFIGURATION:	Transmit at 75.71MHz	DISTANCE:	3m
	Unit upright, Antenna fully extended		
Test Equipment/Limit:			
ANTENNA:	A_00382	LIMIT:	EIRP
CABLE:	CSITE1_3m	AMPLIFIER (dB)	None

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Gain dBi	Sig. Gen. Level dBm	EIRP Level dBm	Limit dBm	Margin dB
75.710	V	45.0	1.0	94.7	0.5	10.3	10.8		
151.439	V	250.0	2.6	28.6	0.4	-40.9	-40.5	-26.0	-14.5
227.152	V	10.0	2.1	54.4	2.1	-36.0	-33.9	-26.0	-7.9
302.862	V	100.0	2.8	40.9	5.7	-43.7	-38.0	-26.0	-12.0
378.572	V	0.0	2.9	30.6	7.2	-57.4	-50.2	-26.0	-24.2
454.260	V	300.0	3.2	27.9	7.3	-58.2	-50.9	-26.0	-24.9
529.920	V	90.0	3.2	16.6	7.5	-66.2	-58.7	-26.0	-32.7
681.413	V	180.0	3.4	20.3	7.1	-55.6	-48.5	-26.0	-22.5
757.123	V	270.0	2.5	21.7	7.5	-53.5	-46.0	-26.0	-20.0
832.845	V	0.0	2.5	35.6	7.6	-41.7	-34.1	-26.0	-8.1
908.555	V	190.0	2.6	21.7	7.2	-53.1	-45.9	-26.0	-19.9
984.265	V	270.0	3.0	23.4	6.6	-51.0	-44.4	-26.0	-18.4

4.5 Frequency Stability:

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-and IC- 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 DC voltage supplied internally. The manufacturer's power requirements for the EUT include the following:

DC Voltage of 10.8 VDC (manufacturer's specification)

The frequency stability of the transmitter was examined at the voltage extremes 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 reference frequency at ambient was 75.43 MHz

Table 6. Frequency Deviation as a Function of Temperature

Temperature Degrees C	Frequency MHz	Difference Hz	Deviation (%)
Ambient	75.430750		
-30	no transmit		
-20	75.431317	567.0	0.000752
-10	75.431292	542.0	0.000719
0	75.431348	598.0	0.000793
10	75.431244	494.0	0.000655
20	75.431028	278.0	0.000369
30	75.430760	10.0	0.000013
40	75.430530	-220.0	0.000292
50	75.430416	-334.0	0.000443

Table 7. Frequency Deviation as a Function of Voltage

Voltage Volts	Frequency MHz	Difference Hz	Deviation (%)	Voltage Volts
At rated	75.430908	0	0.0	12VDC
8VDC	75.430783	125	0.000166	10.9VDC

Note: unit cuts off below 8VDC