



FCC Certification Test Report
for
Capricorn Electronics, Inc.
FCC ID: CNAPI460

September 20, 2002

Prepared for:

Capricorn Electronics, Inc.
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Maiden, NC 28650

Prepared By:

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FCC Certification Test Report
for the
Capricorn Electronics, Inc.
PI460 Alarm Sensor Transmit Module
FCC ID: CNAPI460

September 20, 2002

WLL JOB# 7091

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Abstract

This report has been prepared on behalf of Capricorn Electronics, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Periodic Intentional Radiator under Part 15.231 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Capricorn Electronics, Inc. PI460 Alarm Sensor Transmit Module.

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 Capricorn Electronics, Inc. PI460 Alarm Sensor Transmit Module complies with the limits for a Periodic Intentional Radiator device under Part 15.231 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Capricorn Electronics, Inc. PI460 Alarm Sensor Transmit Module complies with the limits for a Periodic Intentional Radiator device under Part 15.231 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated emissions 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:	Capricorn Electronics, Inc. 48 Capricorn Drive Maiden, NC 28650
Purchase Order Number:	0775
Quotation Number:	59994

1.4 Test Dates

Testing was performed on July 24, 2002.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Ken Gemmell, Thuan Ta
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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 Capricorn Electronics, Inc. PI460 Alarm Sensor Transmitter is part of a security system and is intended for use in homes and small businesses. The RF section operates at 313.5 MHz and sends phase encoded, pulsed (ON/OFF) codes to Capricorn Electronics' receivers such as the SPI-648 security system (FCC ID: CNASPI-648) or the PL-1 single channel receiver (FCC ID: CNAPL-1).

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Capricorn Electronics, Inc.
FCC ID Number	CNAPI460
EUT Name:	Alarm Sensor Transmitter
Model:	PI460
FCC Rule Parts:	§15.231
Frequency Range:	313.5 MHz
Maximum Output Power:	<1mW
Modulation:	Pulsed
Occupied Bandwidth:	200 kHz
Keying:	Automatic
Type of Information:	Code data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Internal etched PCB
Interface Cables:	None
Power Source & Voltage:	Battery powered 3.6Vdc

2.2 Test Configuration

The PI460 was configured for normal use along with the PI-2600 infrared detector.

2.3 Testing Algorithm

The PI460 was preset by the manufacturer for continuous transmission. The EUT was oriented on the test fixture in the x, y, and z axis.

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. 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

Equipment	Serial Number	Date Calibrated	Calibration Due
Sunol Science JB1 Biconilog Antenna	A090501	9/21/01	9/21/02
Hewlett-Packard Spectrum Analyzer: HP 8568B (Site 1)	2928A04750	7/02/02	7/02/03
Hewlett-Packard Quasi-Peak Adapter: HP 85650A (Site 1)	3303A01786	7/05/02	7/05/03
Hewlett-Packard RF Preselector: HP 85685A (Site 1)	3146A01296	7/02/02	7/02/03

4 Test Results

4.1 Duty Cycle Correction

Measurements may be adjusted where pulsed RF is utilized to find the average level associated with a quantity. This calculation is applied to limits for pulsed licensed and unlicensed devices.

On time = $N_1L_1 + N_2L_2 + \dots + N_{N-1}L_{N-1} + N_NL_N$, where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.

- For Licensed Transmitters basic formula can be stated as $20\log[\text{Duty Cycle}]$
- For Unlicensed Intentional Radiators under 47CFR Part 15, all duty cycle measurements compared to a 100 millisecond period
- i.e. duty cycle = on time/100 milliseconds or period, whichever is less
- Restating the basic formula:
 - o Duty cycle = $(N_1L_1 + N_2L_2 + \dots + N_{N-1}L_{N-1} + N_NL_N)/100$ or T, whichever is less

Where T is the period of the pulse train.

The following Figures show the plots of the modulated carrier. The spectrum analyzer was set to Zero Span and the video triggered to collect the pulse train of the modulation. Calculations of the duty cycle correction factor were obtained from time data provided by the plots.

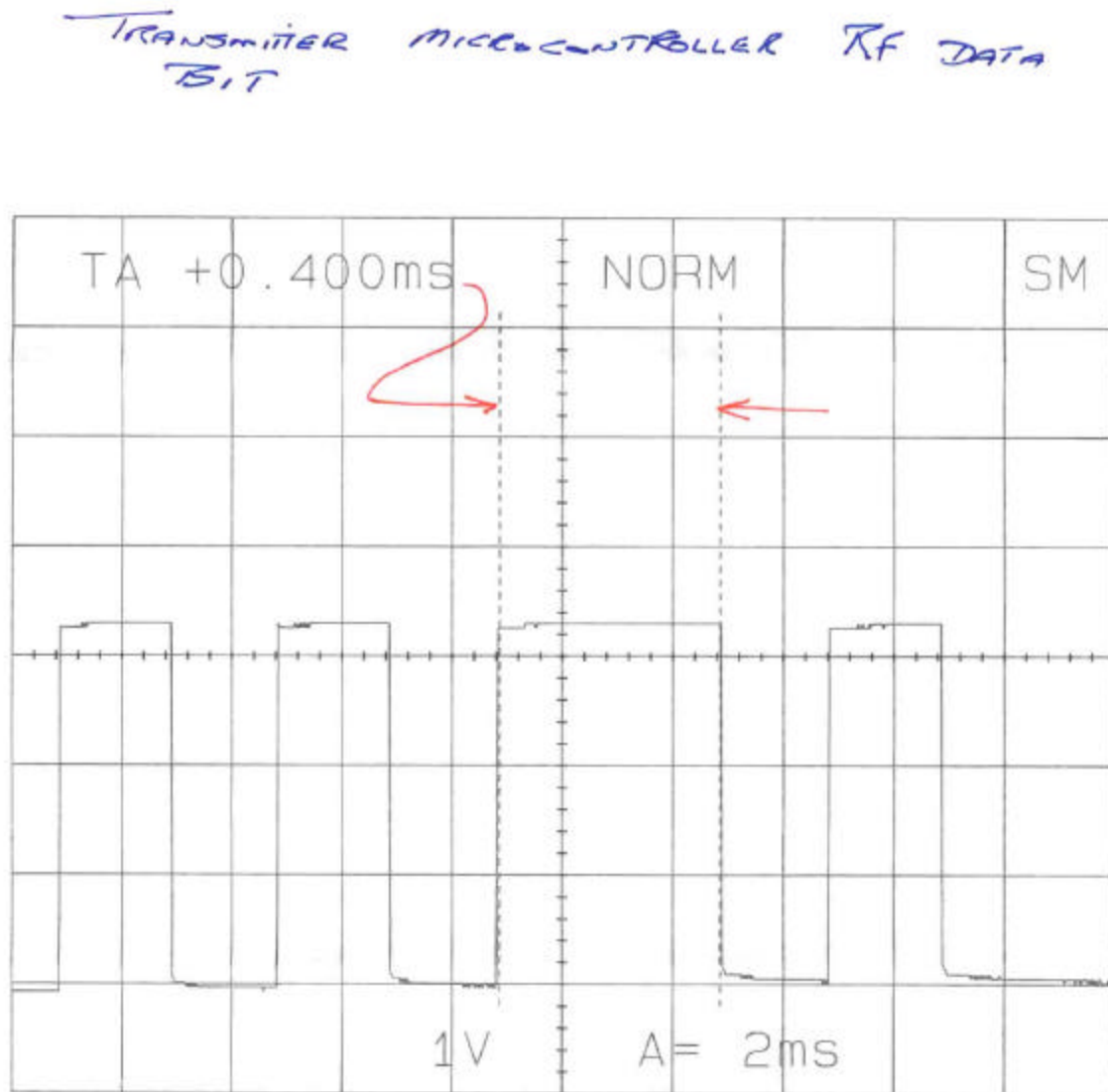


Figure 1. Duty Cycle Plots, Pulse Width

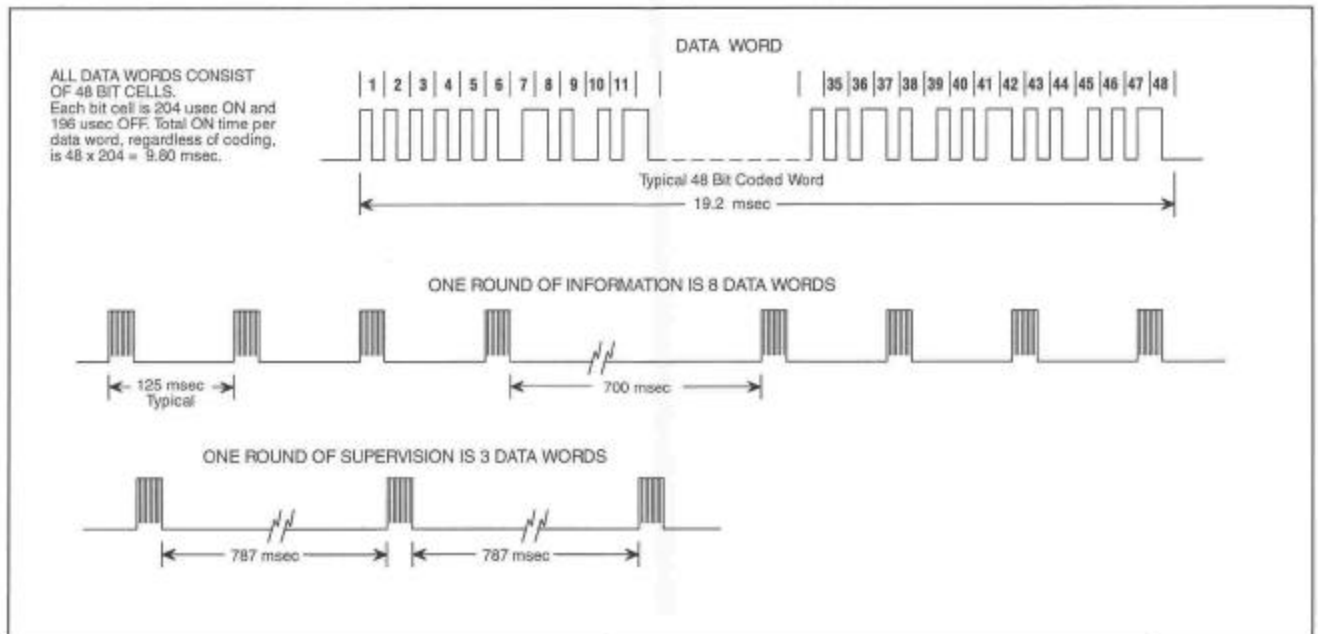


Figure 2. Duty Cycle Plot "On Time"

From the data in Figure 1 and Figure 2, the following calculations are made.

On Time Per Code Group:

$$204 \text{ usec} \times 48 = 9.8 \text{ msec}$$

Code Groups per 100 msec:

1

Total On Time Per 100 msec:

$$\text{On Time} = 1 \times 9.8 \text{ msec} = 9.8 \text{ msec}$$

The data are summarized in the following table.

Table 3. Duty Cycle Correction

Measurement Time	Total ON Time	Duty Cycle (%)	Duty Cycle (dB)
100 msec	9.8 msec	9.8	20

4.2 RF Power Output: (FCC Part §2.1046)

N/A

4.3 Modulation Characteristics: (FCC Part §2.1047); Audio Frequency Response

N/A

4.4 Occupied Bandwidth: (FCC Part §2.1049)

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

FCC Part 15.231 states that the 20 dB bandwidth of the modulated carrier shall be as follows:

Frequency Range (MHz)	Occupied Bandwidth Limit
70-900 MHz	0.25%
> 900 MHz	0.5%

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

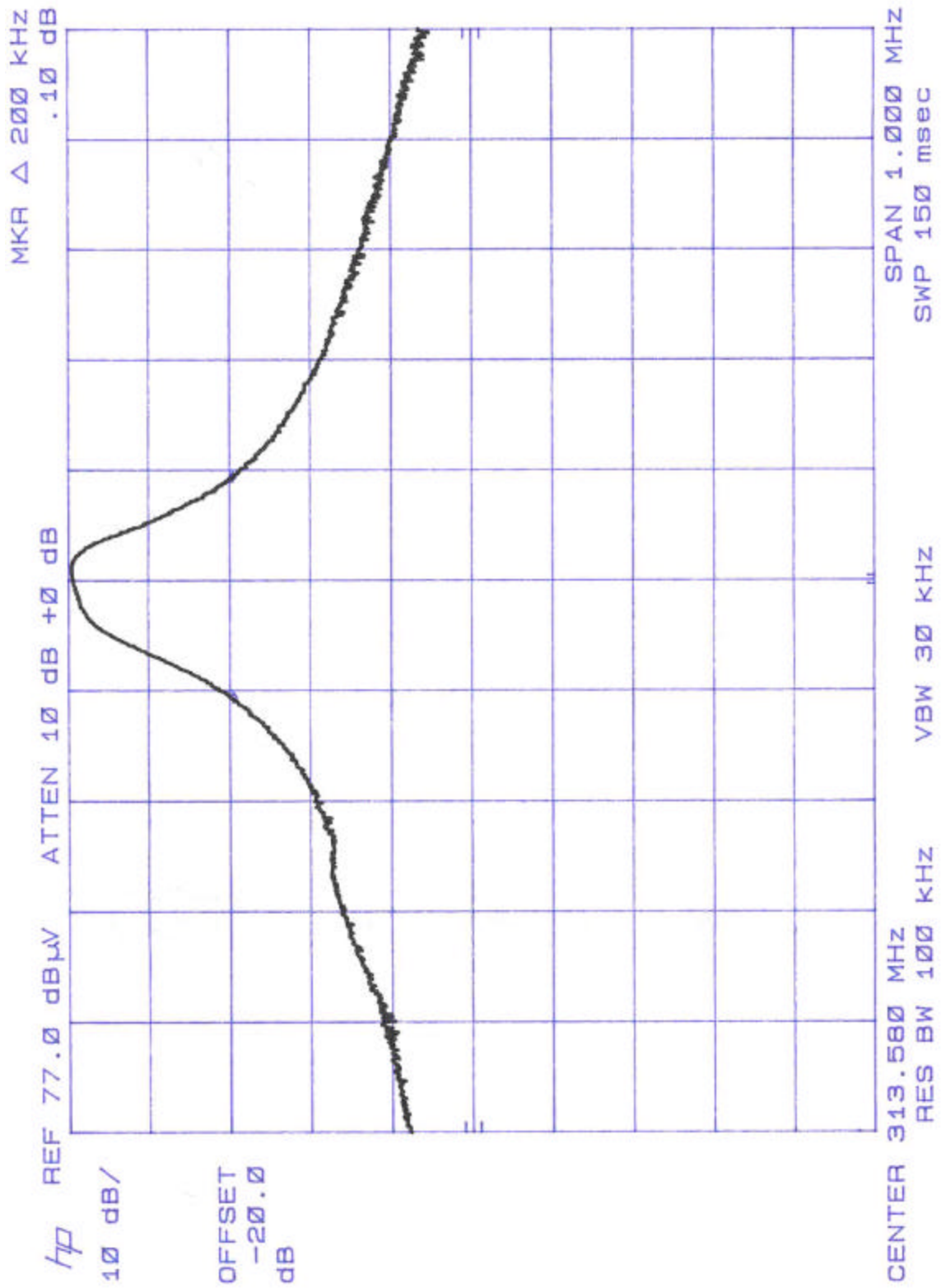


Figure 3. Occupied Bandwidth

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4. Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
313.58 MHz	200 kHz	783.95 kHz	Pass

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

N/A

4.6 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	Harmonic Level (-dBc or E-Field)
Fundamental	5982 uV/m	
Harmonics		
FCC Restricted Bands		500 uV/m

4.6.1 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. The peripherals were placed on the table in accordance with ANSI C63.4-1992. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Measurements were taken on three axis. Tables 10 through 13 contain the emissions data.

Table 6: Radiated Emission Test Data, X-axis

CLIENT:	Capricorn Electronics	DATE:	07.24.02
TESTER:	Chad Beattie/Thuan Ta	JOB #:	7091x
EUT:	PI-460		
Test Requirements:			
CONFIGURATION:	continuous transmit	TEST STANDARD:	FCC Part 15.231
DISTANCE:	3m	CLASS:	B
Low Frequency Test Equipment/Limit:		High Frequency Test Equipment/Limit:	
ANTENNA:	A_00382	ANTENNA:	A_00004
CABLE:	CSITE1_3m	CABLE:	CSITE1_HF
LIMIT:	LFCC_3m_Class_B	TX Frequency:	313.58MHz
Low Frequency (30 MHz to 1 GHz)		High Frequency Amp (1GHz to 18 GHz)	
AMPLIFIER (dB)	0	AMPLIFIER (dB)	34
Peak Data – Harmonics			

Frequency	Polarity	Azimuth	Ant. Hght	SA Level (QP)	Ant. Corr.	Amp Corr.	Cable Corr.	Duty Cycle Corr.	Corr. Level	Corr. Level	Limit	Margin	Notes
(MHz)	H/V	Degree	(m)	(dBuV)	(dB/m)	(dB)	(dB)	(dB)	(dBuV/m)	(uV/m)	(uV/m)	dB	
313.58	V	180.0	2.0	54.8	13.5	0	4.2	-20.0	52.5	422.2	5982.5	-23.0	
313.58	H	180.0	1.0	61.8	13.5	0	4.2	-20.0	59.5	945.1	5982.5	-16.0	
627.16	V	15.0	2.5	3.1	18.6	0	6.1	-20.0	7.8	2.5	598.3	-47.7	
627.16	H	180.0	3.0	33.5	18.6	0	6.1	-20.0	38.2	81.6	598.3	-17.3	
940.74	V	0.0	1.0	-2.5	22.7	0	8.0	-20.0	8.2	2.6	598.3	-47.3	
940.74	H	0.0	3.0	19.8	22.7	0	8.0	-20.0	30.5	33.7	598.3	-25.0	
1070.00	H	248.0	1.0	68.4	25.1	34	2.2	-20.0	41.7	122.1	500.0	-12.2	
1090.38	V	180.0	1.0	51.9	25.2	34	2.2	-20.0	25.3	18.5	500.0	-28.6	
1254.32	V	270.0	1.0	68.1	26.1	34	2.3	-20.0	42.5	133.2	598.3	-13.0	
1254.32	H	180.0	1.0	69.6	26.1	34	2.3	-20.0	43.9	157.0	598.3	-11.6	
1429.63	V	180.0	1.0	58.6	26.9	34	2.3	-20.0	33.8	48.9	500.0	-20.2	
1430.08	H	270.0	1.0	58.3	26.9	34	2.3	-20.0	33.5	47.2	500.0	-20.5	
1567.90	V	180.0	1.0	62.8	27.4	34	2.4	-20.0	38.6	85.2	500.0	-15.4	
1567.90	H	180.0	1.0	66.2	27.4	34	2.4	-20.0	42.0	125.5	500.0	-12.0	
1784.70	H	270.0	1.0	63.1	28.2	34	2.4	-20.0	39.7	97.1	500.0	-14.2	
1785.88	V	180.0	1.0	58.6	28.2	34	2.4	-20.0	35.2	57.6	500.0	-18.8	
1881.48	V	135.0	1.0	58.3	28.5	34	2.5	-20.0	35.2	57.8	598.3	-20.3	
1881.48	H	315.0	1.0	48.6	28.5	34	2.5	-20.0	25.5	18.9	598.3	-30.0	
2195.06	V	180.0	1.0	54.9	29.3	34	2.8	-20.0	33.0	44.5	598.3	-22.6	
2195.06	H	200.0	1.0	48.7	29.3	34	2.8	-20.0	26.8	21.8	598.3	-28.8	
2508.64	V	135.0	1.0	52.9	29.9	34	3.0	-20.0	31.8	38.9	598.3	-23.7	
2508.64	H	0.0	1.0	49.2	29.9	34	3.0	-20.0	28.1	25.3	598.3	-27.5	
2822.22	V	225.0	1.0	49.0	30.4	34	3.2	-20.0	28.7	27.1	500.0	-25.3	
2822.22	H	0.0	1.0	46.0	30.4	34	3.2	-20.0	25.7	19.2	500.0	-28.3	AMB
3135.80	V	0.0	1.0	46.9	30.9	34	3.4	-20.0	27.2	23.0	598.3	-28.3	AMB
3135.80	H	0.0	1.0	46.5	30.9	34	3.4	-20.0	26.7	21.7	598.3	-28.8	AMB

Table 7: Radiated Emission Test Data, Y-axis

CLIENT: Capricorn Electronics
TESTER: Chad Beattie/Thuan Ta
EUT: PI-4610

DATE: 07.24.02
JOB #: 7091x

Test Requirements:

CONFIGURATION: continuous transmit
DISTANCE: 3m

TEST STANDARD: FCC Part 15.231
CLASS: B

Low Frequency Test Equipment/Limit:

ANTENNA: A_00382
CABLE: CSITE1_3m
LIMIT: LFCC_3m_Class_B
Low Frequency (30 MHz to 1 GHz)
AMPLIFIER (dB) 0

High Frequency Test Equipment/Limit:

ANTENNA: A_00004
CABLE: CSITE1_HF
TX Frequency: 313.58MHz
High Frequency Amp (1GHz to 18 GHz)
AMPLIFIER (dB) 34

Peak Data – Harmonics

Frequency	Polarity	Azimuth	Ant. Hght	SA Level (QP)	Ant. Corr.	Amp Corr.	Cable Corr.	Duty Cycle Corr.	Corr. Level	Corr. Level	Limit	Margin	Notes
(MHz)	H/V	Degree	(m)	(dBuV)	(dB/m)	(dB)	(dB)	(dB)	(dBuV/m)	(uV/m)	(uV/m)	dB	
313.58	V	90.0	2.5	65.4	13.5	0	4.2	-20.0	63.1	1430.5	5982.5	-12.4	
313.58	H	0.0	1.5	59.7	13.5	0	4.2	-20.0	57.4	745.6	5982.5	-18.1	
627.16	V	112.0	2.5	13.1	18.6	0	6.1	-20.0	17.8	7.8	598.3	-37.7	
627.16	H	0.0	1.5	4.4	18.6	0	6.1	-20.0	9.1	2.9	598.3	-46.4	
940.74	V	0.0	1.0	-3.0	22.7	0	8.0	-20.0	7.7	2.4	598.3	-47.8	
940.74	H	0.0	1.0	-2.9	22.7	0	8.0	-20.0	7.8	2.5	598.3	-47.7	
1070.00	H	248.0	1.0	62.1	25.1	34	2.2	-20.0	35.4	59.1	500.0	-18.5	
1070.10	V	180.0	1.0	68.0	25.1	34	2.2	-20.0	41.3	116.6	500.0	-12.6	
1254.32	V	225.0	1.0	74.5	26.1	34	2.3	-20.0	48.9	277.3	598.3	-6.7	
1254.32	H	270.0	1.0	60.3	26.1	34	2.3	-20.0	34.6	54.0	598.3	-20.9	
1430.00	H	180.0	1.0	59.6	26.9	34	2.3	-20.0	34.8	54.9	500.0	-19.2	
1430.08	V	180.0	1.0	63.1	26.9	34	2.3	-20.0	38.3	82.1	500.0	-15.7	
1567.90	V	200.0	1.0	69.2	27.4	34	2.4	-20.0	45.0	177.9	500.0	-9.0	
1567.90	H	225.0	1.0	61.2	27.4	34	2.4	-20.0	37.0	70.7	500.0	-17.0	
1785.10	H	180.0	1.0	61.4	28.2	34	2.4	-20.0	38.0	79.5	500.0	-16.0	
1786.80	V	180.0	1.0	66.5	28.2	34	2.4	-20.0	43.1	143.1	500.0	-10.9	
1881.48	V	225.0	1.0	53.9	28.5	34	2.5	-20.0	30.9	35.0	598.3	-24.6	
1881.48	H	225.0	1.0	51.0	28.5	34	2.5	-20.0	27.9	25.0	598.3	-27.6	
2195.06	V	200.0	1.0	53.2	29.3	34	2.8	-20.0	31.3	36.6	598.3	-24.3	
2195.06	H	180.0	1.0	48.2	29.3	34	2.8	-20.0	26.2	20.5	598.3	-29.3	
2508.64	V	180.0	1.0	47.8	29.9	34	3.0	-20.0	26.7	21.7	598.3	-28.8	
2508.64	H	180.0	1.0	51.1	29.9	34	3.0	-20.0	30.0	31.6	598.3	-25.5	
2822.22	V	180.0	1.0	48.4	30.4	34	3.2	-20.0	28.1	25.3	500.0	-25.9	
2822.22	H	180.0	1.0	47.1	30.4	34	3.2	-20.0	26.8	21.8	500.0	-27.2	AMB
3135.80	V	180.0	1.0	46.1	30.9	34	3.4	-20.0	26.4	20.9	598.3	-29.1	AMB
3135.80	H	180.0	1.0	46.7	30.9	34	3.4	-20.0	27.0	22.4	598.3	-28.5	AMB

Table 8: Radiated Emission Test Data, Z-axis

CLIENT: Capricorn Electronics
TESTER: Chad Beattie/Thuan Ta
EUT: PI-4610

DATE: 07.24.02
JOB #: 7091x

Test Requirements:

CONFIGURATION: continuous transmit
DISTANCE: 3m

TEST STANDARD: FCC Part 15.231
CLASS: B

Low Frequency Test Equipment/Limit:

ANTENNA: A_00382
CABLE: CSITE1_3m
LIMIT: LFCC_3m_Class_B
Low Frequency (30 MHz to 1 GHz)
AMPLIFIER (dB) 0

High Frequency Test Equipment/Limit:

ANTENNA: A_00004
CABLE: CSITE1_HF
TX Frequency: 313.58 MHz
High Frequency Amp (1GHz to 18 GHz)
AMPLIFIER (dB) 34

Frequency	Polarity	Azimuth	Ant. Hght	SA Level (QP)	Ant. Corr.	Amp Corr.	Cable Corr.	Duty Cycle Corr.	Corr. Level	Corr. Level	Limit	Margin	Notes
(MHz)	H/V	Degree	(m)	(dBuV)	(dB/m)	(dB)	(dB)	(dB)	(dBuV/m)	(uV/m)	(uV/m)	dB	
313.58	V	180.0	1.5	55.1	13.5	0	4.2	-20.0	52.8	437.0	5982.5	-22.7	
313.58	H	90.0	1.0	66.6	13.5	0	4.2	-20.0	64.3	1642.4	5982.5	-11.2	
627.16	V	0.0	1.0	-3.7	18.6	0	6.1	-20.0	1.0	1.1	598.3	-54.5	
627.16	H	112.0	1.0	16.9	18.6	0	6.1	-20.0	21.6	12.1	598.3	-33.9	
940.74	V	0.0	1.0	-2.2	22.7	0	8.0	-20.0	8.5	2.7	598.3	-47.0	
940.74	H	90.0	1.0	1.2	22.7	0	8.0	-20.0	11.9	4.0	598.3	-43.6	
1070.40	V	180.0	1.0	55.3	25.1	34	2.2	-20.0	28.7	27.1	500.0	-25.3	
1070.40	H	248.0	1.0	64.0	25.1	34	2.2	-20.0	37.3	73.6	500.0	-16.6	
1254.32	V	270.0	1.0	68.1	26.1	34	2.3	-20.0	42.5	133.2	598.3	-13.0	
1254.32	H	180.0	1.0	69.6	26.1	34	2.3	-20.0	43.9	157.0	598.3	-11.6	
1430.08	V	270.0	1.0	60.6	26.9	34	2.3	-20.0	35.8	61.6	500.0	-18.2	
1430.40	H	180.0	1.0	62.4	26.9	34	2.3	-20.0	37.6	75.8	500.0	-16.4	
1567.90	V	180.0	1.0	62.8	27.4	34	2.4	-20.0	38.6	85.2	500.0	-15.4	
1567.90	H	180.0	1.0	66.2	27.4	34	2.4	-20.0	42.0	125.5	500.0	-12.0	
1785.50	H	180.0	1.0	58.4	28.2	34	2.4	-20.0	35.0	56.3	500.0	-19.0	
1786.80	V	180.0	1.0	54.8	28.2	34	2.4	-20.0	31.4	37.2	500.0	-22.6	
1881.48	V	135.0	1.0	58.3	28.5	34	2.5	-20.0	35.2	57.8	598.3	-20.3	
1881.48	H	315.0	1.0	48.6	28.5	34	2.5	-20.0	25.5	18.9	598.3	-30.0	
2195.06	V	180.0	1.0	54.9	29.3	34	2.8	-20.0	33.0	44.5	598.3	-22.6	
2195.06	H	200.0	1.0	48.7	29.3	34	2.8	-20.0	26.8	21.8	598.3	-28.8	
2508.64	V	135.0	1.0	52.9	29.9	34	3.0	-20.0	31.8	38.9	598.3	-23.7	
2508.64	H	0.0	1.0	49.2	29.9	34	3.0	-20.0	28.1	25.3	598.3	-27.5	
2822.22	V	225.0	1.0	49.0	30.4	34	3.2	-20.0	28.7	27.1	500.0	-25.3	
2822.22	H	0.0	1.0	46.0	30.4	34	3.2	-20.0	25.7	19.2	500.0	-28.3	AMB
3135.80	V	0.0	1.0	46.9	30.9	34	3.4	-20.0	27.2	23.0	598.3	-28.3	AMB
3135.80	H	0.0	1.0	46.5	30.9	34	3.4	-20.0	26.7	21.7	598.3	-28.8	AMB

4.7 Frequency Stability: (FCC Part §2.1055)

N/A

4.8 Transient Frequency Response (Part 90.214)

N/A

5 Transmitter Environmental Assessment, Maximum Permissible Exposure (MPE)

N/A