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Maximum Permissible Exposure Evaluation

For the

Cooper Power Systems

RFN420FL

FCC ID: P9X-RFN420FL
IC: 6766A-RFN420FL

December 8, 2010

WLL Report: 11668-MPE

Prepared for:

COOPER POWER SYSTEMS

20201 CENTURY BLVD. SUITE 250

GERMANTOWN, MD 20874

Prepared by:

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ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

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Abstract

This report has been prepared on behalf of Cooper Power Systems RFN420FL to document the findings of the maximum permissible exposure evaluation on the Cooper Power Systems RFN420FL. The purpose of this evaluation is to establish a minimum safe distance as per the RF exposure requirements as defined in FCC §1.1307 & §1.1310.

This report documents the results of testing to the requirements of:

- CFR Title 47 Volume 1 Practice and Procedure; (1.1307) Environmental Assessments

The Evaluation was performed by Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. is accredited by ACLASS under Testing Certificate AT-1448.

Revision History	Reason	Date
Rev 0	Initial Release	December 8, 2010

Table of Contents

List of Tables

1 Introduction

This report has been prepared on behalf of Cooper Power Systems RFN420FL Transmitter to show compliance with the RF exposure requirements as defined in FCC §1.1307.

Testing supporting this evaluation was performed at Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. is accredited with ACLASS under Testing Certificate AT-1448.

2 Requirements

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable. Additionally, the FCC categorizes the use of the devices based on the user's awareness and the ability to exercise control over his or her exposure. The two categories are defined as Occupational/Controlled Exposure and General Population/Uncontrolled Exposure.

2.1 Transmitter Categories

2.1.1 Fixed Installations

A fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.

2.1.2 Mobile Devices

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.

2.1.3 Portable Devices

A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

2.2 Exposure Categories

The limits for exposure are determined by the type of situation the individual is exposed to. Table 1 lists the limits for the particular environment.

2.2.1 Occupational/Controlled Exposure

In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.

2.2.2 General Population/Uncontrolled Exposure

The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category and the general population/uncontrolled exposure limits apply to these devices.

Table 1: MPE Limits

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm2)
(A) Limits for Occupational/Controlled Exposures			
0.3–3.0	614	1.63	*(100)
3.0–30	1842/f	4.89/f	*(900/f2)
30–300	61.4	0.163	1
300–1500	N/A	N/A	f/300
1500–100,000	N/A	N/A	5
(B) Limits for General Population/Uncontrolled Exposure			
0.3–1.34	614	1.63	*(100)
1.34–30	824/f	2.19/f	*(180/f2)
30–300	27.5	0.073	0.2
300–1500	N/A	N/A	f/1500
1500–100,000	N/A	N/A	1

3 Device Summary

Table 1 below summarizes the criteria used to evaluate the RFN420FL.

Table 2: Device Summary of the RFN420FL

Model Evaluated:	RFN420FL
Transmitter Category:	Mobile
Exposure Category:	General Population/Uncontrolled Exposure
Antenna Gain:	902-928 Radio portion =8dBi; Zigbee Radio Portion= 0dBi
Power Output (dBm):	902-928 Radio portion =27.90dBm; Zigbee Radio Portion= 20.84dBm
Evaluation Distance:	20cm
Frequency Range:	902.75-927.25MHz & 2405-2475MHz
Minimum Required Separation Distance	18cm
Maximum power Density (combined)	0.65mW/m^2 (6.5W/m^2)

4 Radio Frequency Radiation Exposure Evaluation

4.1 Duty Cycle Corrections

4.1.1 Zigbee Transceiver Power Corrections

This Zigbee transceiver operates with a 42% transmit duty cycle. This data was provided by the transceiver manufacturer and is shown in appendix A with the permission of Ember Corporation (transceiver manufacturer).

According to OET bulletin 65 Supplement B the signal could be reduced by:

The peak power in Watts * "the Duty factor" * "the transmit on time per 6 minutes"

For this unit 42% will be considered the Duty factor with a transmit time of 6 minutes. Thus reduction for this unit will be:

0.121W (20.84dBm) * 0.42 (42% duty factor) * 1(TX- 6 minutes of 6 minutes) =

0.051W (17.06dBm)

4.1.2 902-928MHz Band Transceiver Power Corrections

The unit operates under the following conditions according to the theory of operation:

"*The communications channel is divided into time slots. Each slot is 20 ms in length and corresponds to a single hop frequency. A time division duplexing (TDD) scheme is used where master and slave alternatively transmit and receive. The packet start is aligned with the slot start.*"

Since the master and slave units alternately transmit a 20ms signal the maximum transmit time per 6 minutes would be 3 minutes.

According to OET bulletin 65 Supplement B the signal could be reduced by:

The peak power in Watts * "the Duty factor" * "the transmit on time per 6 minutes"

For this unit 100% will be considered the Duty factor. Thus reduction for this unit will be:

0.616W (27.90dBm) * 1 (100% duty factor) * 0.5 (TX- 3 minutes of 6 minutes) =

0.308W (24.88dBm)

In light of this 24.88dBm is entered in Table 1 below as the EUT transmit power

4.2 RF Exposure Results

The highest RF output power of the unit was measured and recorded. According to §1.1310 of the FCC rules, the power density limit for General Population/Uncontrolled Exposure is 1mW/cm^2 for the 2400MHz band and 0.602mW/cm^2 (freq/1500).

The MPE shall be calculated at 20cm to show compliance with the power density limit. The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:
S = Power Density
P = Output Power at the Antenna Terminals
G = Gain of Transmit Antenna (linear gain-isotropic)
R = Distance from Transmitting Antenna

Table 3: Transmitter MPE Calculation Summary

One Transmitter			
Frequency	902.75	MHz	
Limit	0.602	mW/cm^2	
Distance (cm), R =	20	cm	
Power (dBm), P =	24.88	dBm	
TX Ant Gain (dBi), G =	8	dB	
Power Density:	0.39	mW/cm^2	**Separation<20 cm**
Minimum Distance:	**16.0**	cm	
Second Transmitter			
Frequency	2475	MHz	
Limit	1.000	mW/cm^2	
Distance (cm), R =	20	cm	
Power (dBm), P =	17.06	dBm	
TX Ant Gain (dB), G =	0	dB	
Power Density:	0.01	mW/cm^2	**Separation<20 cm**
Minimum Distance:	**2.0**	cm	
Multiple Transmitter Summary			
Power Density:	0.65	mW/cm^2	**Separation<20 cm**
Minimum Distance:	**18.0**	cm	**Sum of the Distances**

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Transmitter	Power Density (mW/cm^2)	Limit (mW/cm^2)	Percent of MPE used (%)
#1 – 902-928 Band	**0.39**	**0.602**	**64.78**
#2- Zigbee	**0.01**	**1.000**	**1.00**
Total			**65.78**

From the above table the RFN420FL meets the MPE requirements at a minimum of 18cm separation from the user for a mobile device. The user manual for this device must contain a statement requiring at least this separation distance

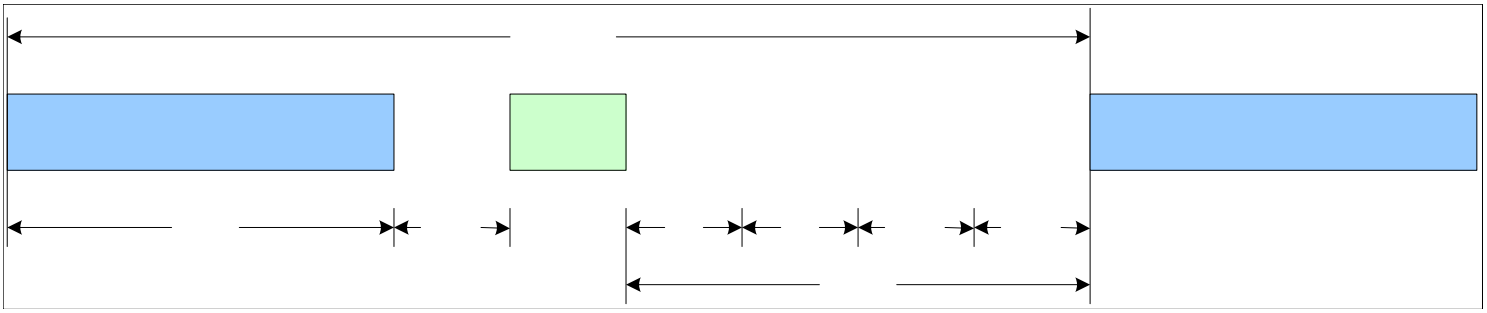
5 Appendix A

Table 4: Zigbee Duty Cycle Calculations

Per information supplied by Ember Corporation

IEEE 802.15.4-2003 2.4 GHz PHY
Constants

Data Rate	250000	bits / sec	
	31250	bytes / sec	
Symbols/byte	2	sym / bytes	
Symbol Timing	62500	sym / sec	
	0.000016	sec / sym	
Byte Timing	0.000032	sec / byte	
PHY PSDU	6	bytes	4 Pramble, SPD, Length
Max Length	127	bytes	
Total Packet Length	133	bytes	
Maximum Time TX PKT	0.004256	sec	



Long Frame Scenario:

1) TX Frame — Assume Frame is Data Frame
2) Wait for ACK
3) RX ACK
4) CPU Processing of ACK
5) Wait for Backoff
6) Repeat 1)

MAC-Level Calculation (LIFS)

Long InterFrame Spacing (Slotted w/ ACK)			
Long Frame	127	bytes	
Data Frame Payload	102	bytes	
ACK Frame	5	bytes	
tack	12	sym	
LIFS	40	sym	
Backoff Period	20	sym	
Maximum Backoff	31		Random between 0 and 31
Backoff Required	2		
Backoff Time	300	sym	Average at 15

Transmit Time	
TX Time (Packet)	0.004256
Total TX Time (sec)	0.004256

NOT Transmit time (RX or Idle)		
Wait for ACK (tack)	0.000192	
RX Time (ACK)	0.000352	
Backoff Time (tbo)	0.0048	(Backoff Time * Backoff Period)
CPU Processing (tcpu)	0.0002	(0.2ms average on EM2xx running EmberZNet)
CCA Assessment (tcca)	0.000128	(averaged over 8 symbols in RX Mode)
Turn Around Time (RX to TX)	0.000192	(After CCA, Radio turns over to TX in 12 symbols)
Total Off Time (sec)	0.005864	

Total Time (ttotal)	0.01012
	9.8814229
Number of RX / TX cycles in 100ms	2

Worse Case (100ms window)

TX Frame 10 times	0.04256
RX or IDLE 10 Times	0.05864
Sum	0.1012

MAC TX Duty Cycle (On /total)	42.06%		Represents theoretical ZigBee / MAC performance (This number should be used for FCC compliance testing.)

