



Maximum Permissible Exposure Evaluation

**For the
EATON'S Cooper Power Systems
RFN NS200
FCC ID: P9X-NS200
IC: 6766A-NS200**

**WLL Report: 15136-02-MPE Rev 3
July 26, 2017
Re-Issued
December 12, 2017**

**PREPARED FOR:
EATON'S COOPER POWER SYSTEMS
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Abstract

This report has been prepared on behalf of EATON'S Cooper Power Systems to document the findings of the maximum permissible exposure evaluation on the RFN NS200. 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 & Industry Canada RSS-102 Issue 5.

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

- CFR Title 47 Volume 1 Practice and Procedure; (1.1307) Environmental Assessments
- RSS-102 Issue 5 March 2015 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

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 ANAB under Testing Certificate AT-1448.

| Revision History | Reason | Date |
|------------------|-------------------------------------------------------------------------------------------------------|-------------------|
| Rev 0 | Initial Release | July 26, 2017 |
| Rev 1 | Correct the name in table 2 and the headers | August 2, 2017 |
| Rev 2 | Correct the test report to address the ISED requirements, and address max power via tune-up procedure | November 2, 2017 |
| Rev 3 | Updated to reflect additional duty cycle measurements | December 12, 2017 |

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1 Introduction

This report has been prepared on behalf of EATON'S Cooper Power Systems RFN NS200 Transmitter to show compliance with the RF exposure requirements as defined in FCC §1.1307 and RSS-102 Issue 5.

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 ANAB 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: FCC MPE Limits

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm ²) | Averaging time (minutes) |
|---------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| (A) Limits for Occupational/Controlled Exposures | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0–30 | 1842/f | 4.89/f | *(900/f ²) | 6 |
| 30–300 | 61.4 | 0.163 | 1 | 6 |
| 300–1500 | N/A | N/A | f/300 | 6 |
| 1500–100,000 | N/A | N/A | 5 | 6 |
| (B) Limits for General Population/Uncontrolled Exposure | | | | |
| 0.3–1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34–30 | 824/f | 2.19/f | *(180/f ²) | 30 |
| 30–300 | 27.5 | 0.073 | 0.2 | 30 |
| 300–1500 | N/A | N/A | f/1500 | 30 |
| 1500–100,000 | N/A | N/A | 1 | 30 |

Table 2: ISED MPE Limits (General Population/Uncontrolled Exposure)

| Frequency Range (MHz) | Electric Field (V/m rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | Reference Period (minutes) |
|-------------------------------------------------------------------------------|--------------------------|-------------------------------|-----------------------------------|----------------------------|
| 0.003-10 ²¹ | 83 | 90 | - | Instantaneous* |
| 0.1-10 | - | $0.73/f$ | - | 6** |
| 1.1-10 | $87/f^{0.5}$ | - | - | 6** |
| 10-20 | 27.46 | 0.0728 | 2 | 6 |
| 20-48 | $58.07/f^{0.25}$ | $0.1540/f^{0.25}$ | $8.944/f^{0.5}$ | 6 |
| 48-300 | 22.06 | 0.05852 | 1.291 | 6 |
| 300-6000 | $3.142 f^{0.3417}$ | $0.008335 f^{0.3417}$ | $0.02619 f^{0.6834}$ | 6 |
| 6000-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | $616000/f^{1.2}$ |
| 150000-300000 | $0.158 f^{0.5}$ | $4.21 \times 10^{-4} f^{0.5}$ | $6.67 \times 10^{-5} f$ | $616000/f^{1.2}$ |
| Note: f is frequency in MHz. | | | | |
| *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR). | | | | |

3 Device Summary

Table 1 below summarizes the criteria used to evaluate the RFN NS200.

Table 3: Device Summary of the RFN NS200

| | |
|----------------------------------------------------|---------------------------------------------------|
| Model Evaluated: | RFN NS200 |
| Transmitter Category: | Mobile |
| Exposure Category: | General Population/Uncontrolled Exposure |
| Maximum Antenna Gain: | 5dBi |
| Maximum Power Output (dBm): | 30.0dBm (Duty Cycle Corrected 26.044dBm) |
| Evaluation Distance: | 20cm |
| Frequency Range: | 902.75-927.25MHz |
| Minimum Required Separation Distance (FCC) | 12.89cm |
| Minimum Required Separation Distance (ISED) | 19.13cm |
| Duty Cycle Correction: | 3.956dB |
| FCC Limit: | 0.610mW/cm ² |
| ISED Limit: | 2.766W/m ² (0.2766mW/cm ²) |

4 Radio Frequency Radiation Exposure Evaluation

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 Power Density (mW/cm²) = f/1500.

Where f = frequency in MHz of the maximum power measurement

Therefore:

$$\begin{aligned}\text{Power Density (mW/cm}^2\text{)} &= 914.75/1500 \\ &= 0.6098\text{mW/cm}^2\end{aligned}$$

According to ISSED RSS-102 Issue 5, the power density limit for General Population/Uncontrolled Exposure for the frequency range 300-6000MHz is $0.02619f^{0.6834}$.

Therefore:

$$\begin{aligned}\text{Power Density (W/m}^2\text{)} &= 0.02619f^{0.6834} \\ &= 0.02619*(914.75)^{0.6834} \\ &= 2.766 \text{ or } (0.2766\text{mW/cm}^2)\end{aligned}$$

4.1 Exposure Calculations

As stated in the manufacturer's tune-up procedure, the max power is set at 29dBm + 1dB for the radio. With consideration to the above tolerances the data in Table 4 will be used in the calculations below:

RFN NS200: Max Power of 30.0dBm as per the Manufacturer's tune-up procedure

Table 4: Duty Cycle Summary (All Data Rates)

| Data Rate (kbps) | Medium Utilization (%) | Duty Cycle (%) | Min. Gap Time (ms) | Max. Sequence Time (ms) | Max. Sequence Time (100ms) | RMS (dBm) |
|------------------|------------------------|----------------|--------------------|-------------------------|----------------------------|-----------|
| 9.6 | 4.101 | 49.988 | 48.148 | 154.325 | N/A | 26.129 |
| 19.2 | 4.141 | 47.809 | 21.948 | 20.142 | 40.241 | 26.171 |
| 38.4 | 4.136 | 46.778 | 22.398 | 19.687 | 39.373 | 26.166 |
| 76.8 | 3.978 | 46.094 | 21.715 | 18.366 | 38.801 | 25.996 |
| 153.6 | 3.761 | 41.803 | 12.825 | 9.215 | 37.759 | 25.752 |

The duty cycle correction factor is calculated by:

$$10 \times \log^*(\text{dwell time}/100\text{ms})$$

The on time per hop is 20.142ms. The unit hops on 2 channels every 100ms and the maximum total on time per 100ms is 40.241ms. This corresponds to a duty cycle correction/reduction of 3.956dB for the power measurements.

The radio power used for the exposure calculation will be 30dBm – (3.956) dB or 26.044dBm.

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 5: Transmitter FCC MPE Calculation Summary

| One Transmitter | | |
|--------------------------|--------|-------------------------------------|
| Frequency | 914.75 | MHz |
| Limit | 0.610 | mW/cm ² |
| Distance (cm), R = | 20 | cm |
| Power (dBm), P = | 26.044 | dBm |
| TX Ant Gain (dBi), G = | 5 | dB |
| Power Density: | 0.25 | mW/cm ² Separation<20 cm |
| Minimum Distance: | 12.89 | cm |

Table 6: Transmitter ISED MPE Calculation Summary

| One Transmitter | | |
|--------------------------|--------|-------------------------------------|
| Frequency | 914.75 | MHz |
| Limit | 0.277 | mW/cm ² |
| Distance (cm), R = | 20 | cm |
| Power (dBm), P = | 26.044 | dBm |
| TX Ant Gain (dBi), G = | 5 | dB |
| Power Density: | 0.25 | mW/cm ² Separation<20 cm |
| Minimum Distance: | 19.13 | cm |