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Office of Engineering and Technology
Federal Communications Commission
7435 Oakland Mills Road
Columbia, MD 21046

Subject: Neuropace, Inc.
 Application for Grant Certification
 FCC ID: WBW5200
 MPE Calculation

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The following equation uses the Biot Savart law for a circular current loop to obtain the magnetic induction, B, at a distance away from the center of the loop.

$$B = \frac{\mu_0 i r^2}{2(r^2 + x^2)^{3/2}}$$

Where

μ_0 is the permeability constant (1.26×10^{-6} H/m)

i is the current flowing in the loop (in amps)

r is the radius of the loop (in meters)

x is the distance, on axis, from the center of the current loop (in meters)

The following equation converts the magnetic induction to magnetic field.

$$H = \frac{B}{\mu_0} = \frac{i r^2}{2(r^2 + x^2)^{3/2}}$$

Neuropace Wand Calculation:

The maximum magnetic field that the patient is exposed to for a single transmit pulse is 954 A/m.

Source Based Time Averaging:

Per 47 CFR part 2.1093 (d)(5), it is allowable to use source based time averaging based on an inherent property of the device to calculate magnetic field strength in an uncontrolled environment.

The following equation was used to calculate the source based magnetic field using the maximum continuous magnetic field strength at the worst case operating distance for magnetic field exposure:

Wand transmit pulses have an on-time ranging from 0.7 μ s (PW=3 counts) up to 4.9 μ s (PW=24 counts) depending on communication distance. Positioning the Wand coil in a misaligned orientation can cause the Wand to switch to the higher pulse width to maintain communication, so both cases are valid for the 10mm spacing listed above (x=0.01m). For Wand transmit pulses a '1' is the presence of energy and a '0' is no energy, so use cases where the data contains a larger number of '1' bits results in more exposure.

This results in the following duty cycle:

Register Setting	PW=3	PW=24
On-time	0.7 μ s	4.9 μ s

Overall Duty Cycle while sending data frames only (All 0's, 60% 1's, 100% 1's)	0.34%, 0.8%, 0.8%	1.1%, 1.1%, 1.1%
H-field with continuous usage	7.63 A/m	10.5 A/m

Note 1: Neuropace assumes a 60% 1's use case as a worst case for programming operations.

Communication with the neurostimulator is not solely composed of data frames with 100% of the bits at a '1' value, but this represents a simplified worst case.

Exposure Duration:

RF exposure to the patient by the Wand is limited by the duration of the exposure. Interrogation and programming by the Wand are comprised of several communication sub-steps (as described in the operational description). Due to the inclusion or exclusion of an optional communication sub-step during programming as prescribed by the physician, the duration of the field can change. Similarly, the duration from interrogation can change depending on the number of physiological records stored in the patient's neurostimulator. The following table shows the maximum duration of each type of communication interaction.

	Maximum Duration (minutes)
Wand Test Signal	10
Interrogation	4.2
Programming	9.6

Daily Average Exposure:

The following table shows the daily average magnetic field strength for the Wand used in daily home use and in the semiannual worst case physician's office use.

Usage	# of Interactions	Recurrence	Resulting daily average magnetic field (A/m)
Patient in the home -Wand Test & Clinical Interrogation Only	Wand Test + 1 interrogation	daily	0.103 A/m
Physician prescribed	Wand Test + 8 programmings + 5 interrogations	semiannual	0.79 A/m

MPE Limit:

The Neuropace PDP_0170 Wand W-02 transmits at a frequency of 22.2kHz. The lowest frequency listed in FCC 47 CFR part 1.1310 Table 1 limits for maximum permissible exposure is 300kHz. The magnetic field strength limit at 300kHz in uncontrolled environments list in part 1.1310 Table 1 is 1.63 A/m.

Using a conservative theoretical approach to determine the source based duty cycle for the maximum expected duration of exposure and at the distance between Wand and patient which exposes the patient to the greatest level of exposure, the daily average magnetic field for the patient in the home and for the patient during physician prescribed exposure is below the limit of 1.63 A/m.