FCC RF EXPOSURE EVALUATION REPORT

FOR

COUNTERBOMBER RADAR

MODEL NUMBER: CB3

FCC ID: 2AIY5CB3

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Prepared for

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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	11/08/2016	Initial Issue	M. Heckrotte

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: LOCKER, LLC
12525 CHARDON AVENUE
HAWTHORNE, CALIFORNIA 90250 U.S.A.

MODEL: CounterBomber 3 (CB3)

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC §1.1310	Pass

UL Verification Services Inc. performed an RF Exposure Evaluation of the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. The results show that the equipment is capable of demonstrating compliance with the requirements as documented in this report.

Note: This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL VS By:

MICHAEL HECKROTTE
PRINCIPAL ENGINEER
UL Verification Services Inc.

2. METHODOLOGY

The calculations documented in this report were performed in accordance with FCC OET Bulletin 65 Edition 97-01 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.”

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

4. RF EXPOSURE EVALUATION

4.1. LIMITS

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	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/f²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			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/f²)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

General Population / Uncontrolled Exposure conditions are applicable for this transmitter.
The MPE limit in the 33.4-36.0 GHz band is 1.0 mW/cm².

4.2. EQUATIONS AND CALCULATIONS

All RF Exposure calculations are based on the maximum conducted tune-up power of 17 dBm / 50 mW.

Equation numbers below are as given in OET Bulletin 65.

ANTENNA SURFACE

The maximum power density directly in front of an antenna (e.g., at the antenna surface) can be approximated by the following equation:

$S_{surface} = 4 * P / A$ (Eq. 11)

where:
$S_{surface}$ = maximum power density at the antenna surface
P = power fed to the antenna
A = physical area of the aperture antenna

Antenna Power (mW)	Antenna Diameter (m)	Antenna Radius (cm)	Antenna Area (cm^2)	Power Density (mW/cm^2)
50.00	0.419	21.0	1378.2	0.145

NEAR FIELD REGION

The extent of the near-field can be described by the following equation (D and λ in same units):

$R_{nf} = D^2 / (4 * \lambda)$ (Eq. 12)

where:
R_{nf} = extent of near field
D = maximum dimension of antenna (diameter if circular)
λ = wavelength

Channel	Frequency (GHz)	Wavelength (m)	Antenna Diameter (m)	Near-field Boundary (m)
Low	35.1	0.008547	0.419	5.14
High	35.9	0.008357	0.419	5.25

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The magnitude of the on-axis (main beam) power density varies according to location in the near-field. However, the maximum value of the near-field, on-axis, power density can be expressed by the following equation:

$S_{nf} = (16 * \eta * P) / (\pi * D^2)$ (Eq. 13)

where:
S_{nf} = maximum near-field power density
η = aperture efficiency, typically 0.5-0.75
P = power fed to the antenna
D = antenna diameter

Aperture efficiency can be estimated, or a reasonable approximation for circular apertures can be obtained from the ratio of the effective aperture area to the physical area as follows:

$\eta = ((G * \lambda^2)/(4 * \pi)) / ((\pi * D^2)/4)$ (Eq. 14)

where:
η = aperture efficiency for circular apertures
G = power gain in the direction of interest relative to an isotropic radiator
λ = wavelength
D = antenna diameter

Combining yields

$S_{nf} = (16 * ((G * \lambda^2)/(4 * \pi)) / ((\pi * D^2)/4) * P) / (\pi * D^2)$

which reduces to:
$S_{nf} = (16 * P * G * \lambda^2) / (\pi^3 * D^4)$

where:
S_{nf} = maximum near-field power density
P = power fed to the antenna
G = power gain in the direction of interest relative to an isotropic radiator
λ = wavelength
D = antenna diameter

Channel	Frequency (GHz)	Wavelength (m)	Antenna Power (mW)	Antenna Gain (dBi)	Antenna Gain (linear)	Antenna Diameter (m)	Power Density (mW/cm^2)
Low	35.1	0.008547	50.00	39.0	7943.3	0.419	0.049
High	35.9	0.008357	50.00	39.0	7943.3	0.419	0.047

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TRANSITION REGION

Power density in the transition region decreases inversely with distance from the antenna, while power density in the far-field (Fraunhofer region) of the antenna decreases inversely with the square of the distance. For purposes of evaluating RF exposure, the distance to the beginning of the far-field region (farthest extent of the transition region) can be approximated by the following equation:

$R_{ff} = (0.6 * D^2) / \lambda$ (Eq. 16)

where:
R_{ff} = distance to beginning of far field
D = antenna diameter
λ = wavelength

Channel	Frequency (GHz)	Wavelength (m)	Antenna Diameter (m)	Far-field Boundary (m)
Low	35.1	0.008547	0.419	12.32
High	35.9	0.008357	0.419	12.61

The transition region will then be the region extending from R_{nf}, calculated from Equation (12), to R_{ff}. If the location of interest falls within this transition region, the on-axis power density can be determined from the following equation:

$S_t = (S_{nf} * R_{nf}) / R$ (Eq. 17)

where:
S_t = power density in the transition region
S_{nf} = maximum power density for near-field calculated above
R_{nf} = extent of near-field calculated above
R = distance to point of interest

Channel	Near field Power Density (mW/cm^2)	Near field boundary (m)	Far Field Boundary (m)	Transition Region Power Density at Far Field Boundary (mW/cm^2)
Low	0.049	5.14	12.32	0.020
High	0.047	5.25	12.61	0.020

FAR-FIELD REGION

The power density in the far-field or Fraunhofer region of the antenna pattern decreases inversely as the square of the distance. The power density in the far-field region of the radiation pattern can be estimated by the general equation discussed earlier:

$S_{ff} = (P * G) / (4 * \pi * R^2)$ (Eq. 18)

where:
S_{ff} = power density (on axis)
P = power fed to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the point of interest

Channel	Far Field Boundary (m)	Antenna Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Power Density (mW/cm^2)
Low	12.32	17.00	39.0	56.0	398107	0.021
High	12.61	17.00	39.0	56.0	398107	0.020

In the far-field region, power is distributed in a series of maxima and minima as a function of the off-axis angle (defined by the antenna axis, the center of the antenna and the specific point of interest). For constant phase, or uniform illumination over the aperture, the main beam will be the location of the greatest of these maxima. The on-axis power densities calculated from the above formulas represent the maximum exposure levels that the system can produce. Off-axis power densities will be considerably less.

4.3. CONCLUSIONS

The power density in the reactive region at the surface of the antenna (0.159 mW/cm^2) is greater than the maximum power density in the radiating near-field region (0.059 mW/cm^2) and greater than the maximum power density in the far-field region (0.025 mW/cm^2). The maximum reactive-region near-field power density is less than the MPE limit (1.0 mW/cm^2).

For mobile transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

4.4. MINIMUM SEPARATION DISTANCE

As a mobile transmitter, the minimum separation distance is specified as 20 cm.

END OF REPORT

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