

TechNote

LT-3130 Radiation Safe Distance Report

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1 Summary

The human safe distances of the LT-3130 Antenna Unit are given in the table below.

Occupational / controlled zone	5 cm
General public / uncontrolled zone	10 cm

Regional Requirement	Occupational / controlled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	40.400	120.599	0.322
FCC	50.000		
RSS	25.949	98.909	0.262
ARPANSA	40.400	123.412	0.327
LT-3130 @ 5 cm	4.525	58.065	0.156

Regional Requirement	General public / uncontrolled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	8.080	55.274	0.149
FCC	10.000		
RSS	4.081	39.222	0.104
ARPANSA	8.080	55.073	0.146
LT-3130 @ 10 cm	1.393	32.357	0.089

2 Introduction

Local and regional regulations define the maximum level of radiation towards the general public and occupational zones. The limits are defined for the radiated power flux density, the electric field strength and the magnetic field strength. To determine these limits for the LT-3130 Antenna Unit, formulas describing the radiated field magnitudes are given below.

The power flux density of an antenna is given by

$$S = \frac{P_T G(\theta, \phi)}{4 \pi r^2}$$

The electric field strength is determined by

$$|E| = \sqrt{\eta S} = \frac{1}{r} \sqrt{\frac{\eta}{4 \pi} P_T G(\theta, \phi)}$$

The magnetic field strength is determined by

$$|H| = \sqrt{\frac{S}{\eta}} = \frac{1}{r} \sqrt{\frac{P_T G(\theta, \phi)}{4 \pi \eta}}$$

The time average transmit power from the Iridium 9523N LBT is 0.6W, see the table below.

Parameter	Value
Iridium 9523N Average Power during a transmit slot (max)	7.0 W
Iridium 9523N Average Power during a frame (typical)	0.6 W
LT-3130 Antenna Element Maximum Gain	2.6 dBi
LT-3130 GNSS Splitter and Feed Loss	4.2 dB

3 Requirements

3.1 Formulas

Most of the specifications on radiated field magnitudes are proportional to the operating frequency. Thus, the field magnitudes to comply to are given by the lowest frequency in the operating band, 1,616 MHz.

The radiation limitations are determined by formulas given in the tables below.

Regional Requirement	Occupational / controlled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	$f/40$	$3 \cdot f^{0.5}$	$0.008 \cdot f^{0.5}$
FCC	50		
RSS	$0.6455 \cdot f^{0.5}$	$15.6 \cdot f^{0.25}$	$0.04138 \cdot f^{0.25}$
ARPANSA	$f/40$	$3.07 \cdot f^{0.5}$	$0.00814 \cdot f^{0.5}$

Regional Requirement	General public / uncontrolled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	$f/200$	$1.375 \cdot f^{0.5}$	$0.0037 \cdot f^{0.5}$
FCC	10		
RSS	$0.02619 \cdot f^{0.6834}$	$3.142 \cdot f^{0.3417}$	$0.008335 \cdot f^{0.3417}$
ARPANSA	$f/200$	$1.37 \cdot f^{0.5}$	$0.00364 \cdot f^{0.5}$

3.2 Limits

The compliance levels are shown in the tables below.

Regional Requirement	Occupational / controlled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	40.400	120.599	0.322
FCC	50.000		
RSS	25.949	98.909	0.262
ARPANSA	40.400	123.412	0.327

Regional Requirement	General public / uncontrolled zone		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	8.080	55.274	0.149
FCC	10.000		
RSS	4.081	39.222	0.104

ARPANSA	8.080	55.073	0.146
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4 Results

Combining the formulas of Chapter 2, and the compliance levels in Chapter 3, yields the minimum safe distances in the tables below. The maximum distances for occupational and general public are highlighted.

Regional Requirement	Occupational / controlled zone – safe distance [cm]		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	2.807	2.872	2.857
FCC	2.523		
RSS	3.502	3.502	3.502
ARPANSA	2.807	2.807	2.808

Regional Requirement	General public / uncontrolled zone – safe distance [cm]		
	S field (W/m ²)	E field (V/m)	H field (A/m)
ICNIRP	6.277	6.267	6.178
FCC	5.642		
RSS	8.831	8.832	8.831
ARPANSA	6.277	6.290	6.280

To include some margin, the human safe distances are chosen as:

Occupational / controlled zone	5 cm
General public / uncontrolled zone	10 cm

At the chosen safe distances, the resulting field strengths are:

	S field (W/m ²)	E field (V/m)	H field (A/m)
Occupational	4.525 (25.9)	58.065 (98.9)	0.156 (0.262)
General Public	1.393 (4.08)	32.357 (39.2)	0.089 (0.104)

5 Simulated Results

To verify the determined safe distances, the radiated field magnitudes have been inspected in numerical software.

The power level at each helix wire port is in the order of 0.6 W - 3.5 dB - 6.7 dB = 57 mW ([time average power] – [power divider loss] – [feed network “loss”]).

The simulated results are summarized in the table below.

	S field (W/m ²)	E field (V/m)	H field (A/m)
Occupational	4.52 (25.9)	58.1 (98.9)	0.16 (0.262)
General Public	1.39 (4.08)	32.4 (39.2)	0.0886 (0.104)

5.1 Simulation at 5 cm distance

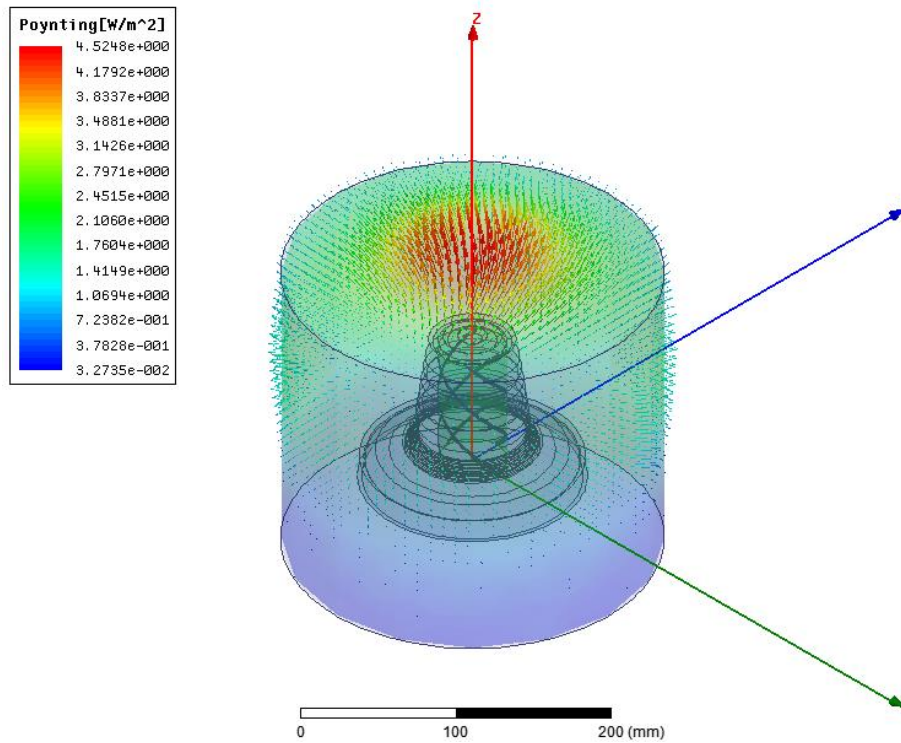


Figure 5-1. Simulated power flux density at 5 cm distance.

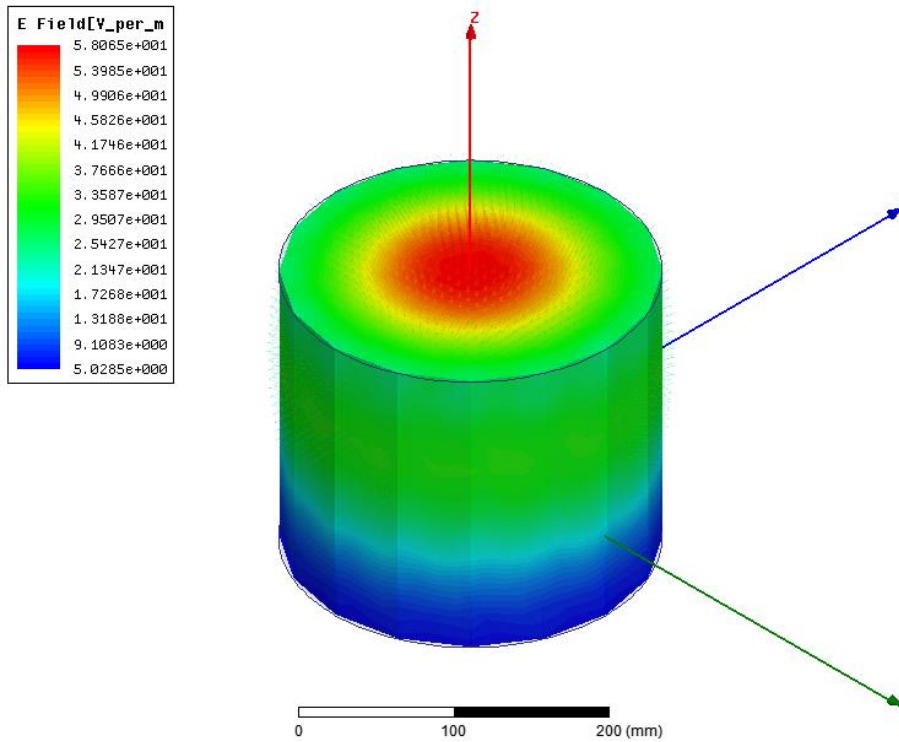


Figure 5-2. Simulated electric field strength at 5 cm distance.

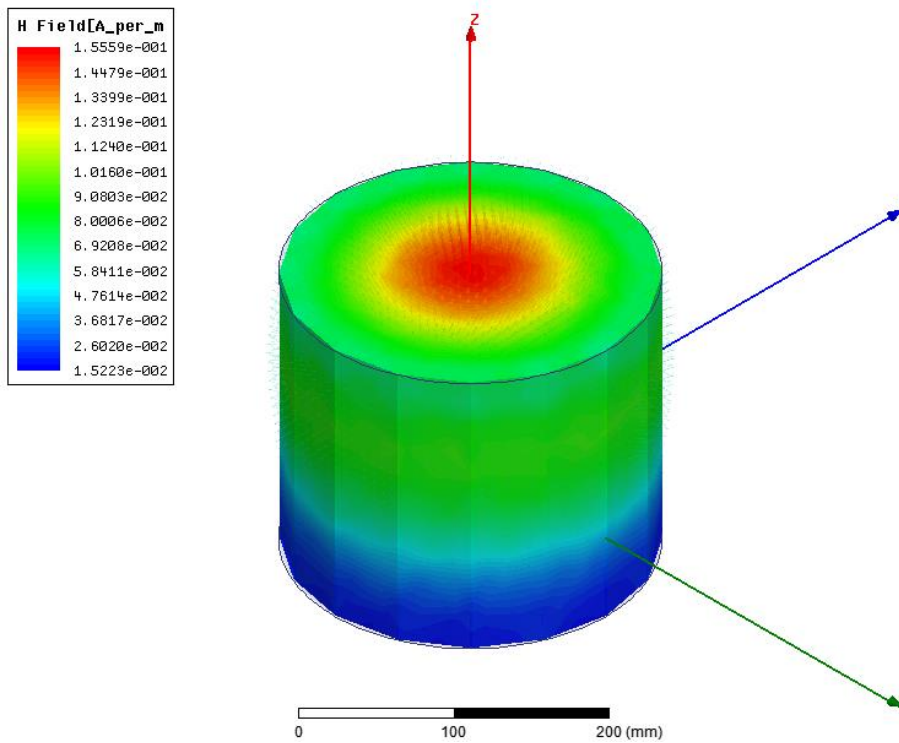


Figure 5-3. Simulated magnetic field strength at 5 cm distance.

5.2 Simulation at 10 cm distance

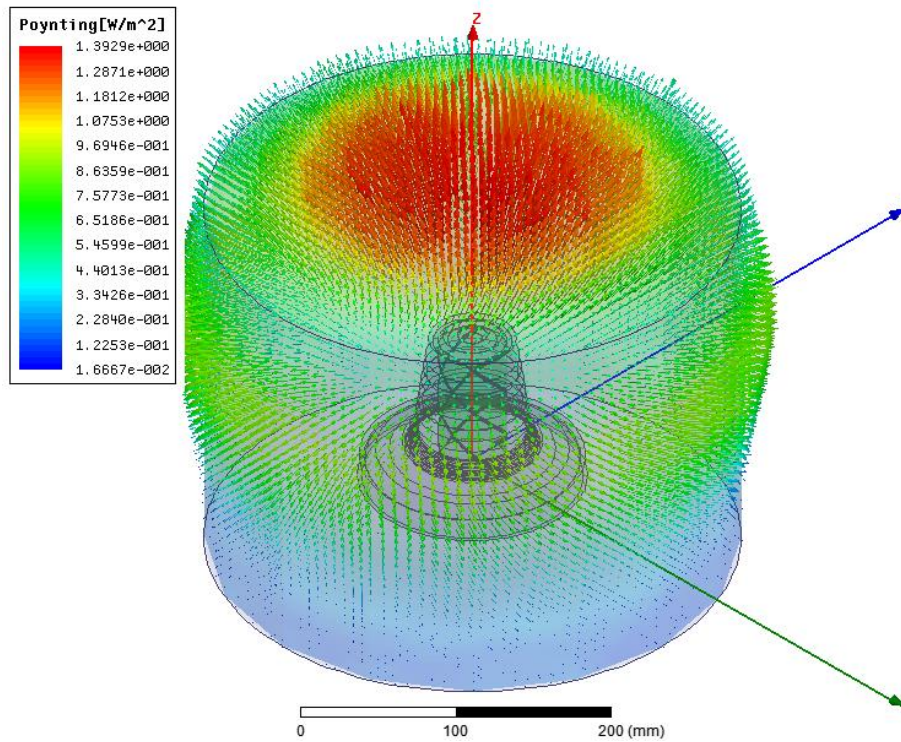


Figure 5-4. Simulated power flux density at 10 cm distance.

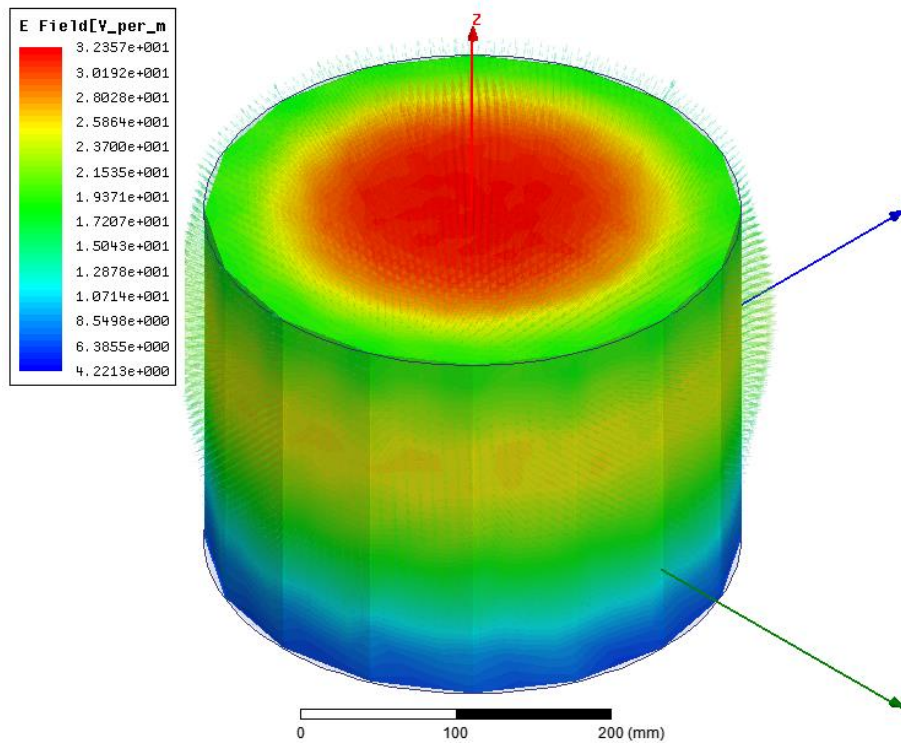


Figure 5-5. Simulated electric field strength at 10 cm distance.

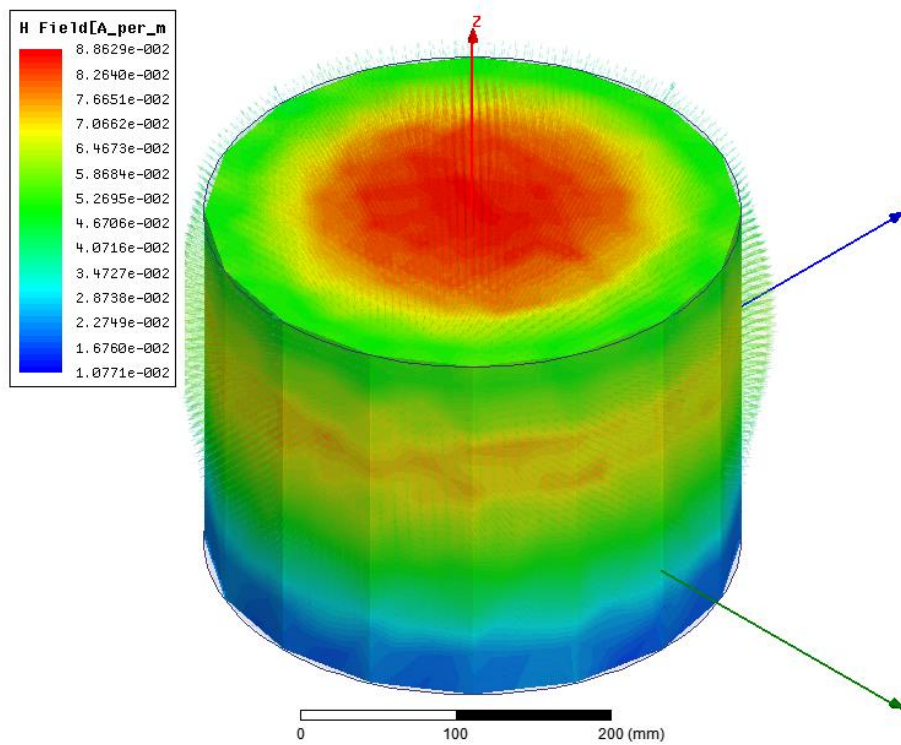


Figure 5-6. Simulated magnetic field strength at 10 cm distance.

6 Relevant documents

- Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, Safety Code 6 (2015), Consumer and Clinical Radiation Protection Bureau, Health Canada
- IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, IEEE Std C95.1™-2005
- ICNIRP Guidelines for Limiting Exposure To Time-Varying Electric, Magnetic and Electromagnetic Fields (Up To 300 GHz), <http://www.icnirp.org/en/frequencies/high-frequency/index.html>
- FCC OET Bulletin 65 Edition 97-01 (1997), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, <https://transition.fcc.gov/bureaus/oet/info/documents/bulletins/oet65/oet65.pdf>
- Radiation Protection Standard, Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz, Radiation Protection Series Publication No. 3 (2002), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)