Small Cell RF Study
City of San Clemente

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Life Member, IEEE
Life Member, ARRL
Radio Frequency (RF)

Radio Frequency Energy is Electromagnetic Energy

Forms of Electromagnetic Energy

- Visible Light
- Infrared Radiation (Heat)
- Ultraviolet Radiation (UV)
- Microwave Oven
- FM/AM Broadcast
- Cellular Radio
The Electromagnetic Spectrum

4G Cellular/Mobile Phone Frequencies

Proposed 5G Frequencies

Non-Ionizing Radiation

Ionizing Radiation
What Matters for RF Safety?

- Power of the RF Source, Cell Base Station Transmitter, Measured in Watts (W)
- Distance from the RF Source, Measured in Feet or Meters (ft. or m)
- Resulting RF Power Density, Measured in Watts per Area (W/m²)
- FCC and IEEE Guideline for Consumer Safety = 580 microwatts/square cm

Maximum Permissible Exposure (MPE) ≈ 580 µW/cm²

Operating Conditions

Fixed facilities: §1.1307 (MPE)
- antennas on outdoor permanent structures
  - whole body exposure in far-field conditions
  - broadcast towers, basestations etc.

Mobile installations: §2.1091 (MPE @ ≥ 20 cm)
- antennas on non-permanent objects & structures
  - partial body exposure between near to far field conditions
  - vehicle-mounted antennas, desktop configurations etc.

Portable operations: §2.1093 (SAR @ < 20 cm)
- devices at close proximity to persons
  - localized exposure in near-field conditions
  - wireless handsets, Wi-Fi products etc.
Radio Power Decreases with Distance

Intensity = \frac{1}{d^2}
Comparison of Safety Guideline with the Sun

**FCC/IEEE Safety Guideline:**

580 $\mu$W/cm$^2$

**Sunny Day, Solar Energy Hitting the Ground:**

100,000 $\mu$W/cm$^2$
Radio Base Stations / Antennas

Radio 2203

The radio 2203 is part of the Ericsson Radio System portfolio. Radio 2203 has been proven to offer superior performance and cost efficiency when it comes to medium range 3GPP radio products.

Radio 2203 has, by use of its small and smart design, support for a wide range of mounting scenarios and ease of deployment. It is a product in the Ericsson portfolio that can be used for a wide range of use cases, from small cell deployments to larger scale enterprises.

The Radio 2200 support installations with integrated or external antenna systems and can be used in a variety of radio and optical CFP8 interfaces. It can be connected to any of the efficient Ericsson Baseband VDCMA or LTE modules by use of star or cascade configurations. This supports both single and multi-band configurations.

Radio 2203 support VDCMA and LTE with two separate TX/RX branches. The Radio 2200 support up to 4 VDCMA carriers or 40 MHz LTE, as well as VDCMA and LTE mixed mode configurations.

Out Door Small Cell: Radio 2205 FOR UNLICENSED BANDS

Operator Challenge:

- Boost user experience and data speeds with limited spectrum available. Deploy fully integrated micro solution on unlicensed spectrum.

Operate Micro Cells on Unlicensed Spectrum

- Outdoor micro for Licensed Assisted Access
- Uses same baseband and network management

Radio 2205 Unlicensed

- 4 liter, 4 kg micro 2T2R with 2*500mW output power
- For unlicensed 5GHz band and up to 3 LTE carriers
# Analysis of Power Densities

**San Clemente AT&T Small Cell Power Density Calculations**

M. Pettus

**Given Data/Acornptions:**

- **FCC Guideline for Maximum Power Density** = 580 $\mu$W/cm$^2$ (FCC/IEEE C95.1-2005)
- **Ericsson Radio 2203, Power Output** = 10 W (2 x 5-W transmitters)
- **Ericsson Radio 2205, Power Output** = 1 W (2 x 0.5-W transmitters)
- **Base Antenna**: Galronics GQ2410-06621

**Power Density** = \( \frac{P \times G}{4 \times \pi \times D^2} \)

<table>
<thead>
<tr>
<th>Site</th>
<th>Site 1</th>
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<th>Site 3</th>
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<td>62</td>
<td>86</td>
<td>145</td>
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<td>(m)</td>
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LTE Bands | Frequency (MHz) | Ant Gain (dBi) | Site 1 (\(\mu\)W/cm$^2$) | Site 2 (\(\mu\)W/cm$^2$) | Site 3 (\(\mu\)W/cm$^2$) | Site 4 (\(\mu\)W/cm$^2$) | Site 5 (\(\mu\)W/cm$^2$) |
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Thank You