

WHITEPAPER

# Radio Frequency Emissions

Analysis of Radio Frequency Exposure Associated  
with Silver Spring Networks' Advanced Metering Devices

## Executive Summary

This document provides information regarding radio frequency (RF) emissions and the spectrum of frequencies one is exposed to almost daily. Specifically, we address RF emissions from Silver Spring Networks' Advanced Metering Devices for smart meter communications.

With an eye toward resolving concerns about RF emissions, this document presents a framework for RF emissions and the critical role it plays in our daily communication systems, such as police and fire radio systems, pagers, radio and television broadcasts, and cellular telephones. In our homes, we have grown accustomed to cordless phones, wireless networks, garage door openers, baby monitors, microwave ovens, and our PCs – all of which utilize and emit RF energy.

Silver Spring-enabled smart grid devices have undergone extensive testing and validation during Federal Communications Commission (FCC) equipment authorization. That filing includes Maximum Permissible Exposure (MPE) testing, which can be found at <http://www.fcc.gov/oet/ea/fccid/>. The data indicate that all Silver Spring smart meters present an extremely low-level of RF exposure when compared to the regulatory limits established by the Federal Communications Commission (FCC) for safe operations.

Smart meters transmit for only a fraction of the day for short durations. They are installed in locations that are isolated from residents, which dramatically reduces exposure levels. In aggregate, actual RF emissions from smart meters are significantly lower than commonly used devices such as cell phones, laptop computers, microwave ovens and baby monitors.

**“Wireless smart meters, when installed and properly maintained, result in much smaller levels of radio frequency exposure than many existing common household electronic devices, particularly cell phones and microwave ovens.”**

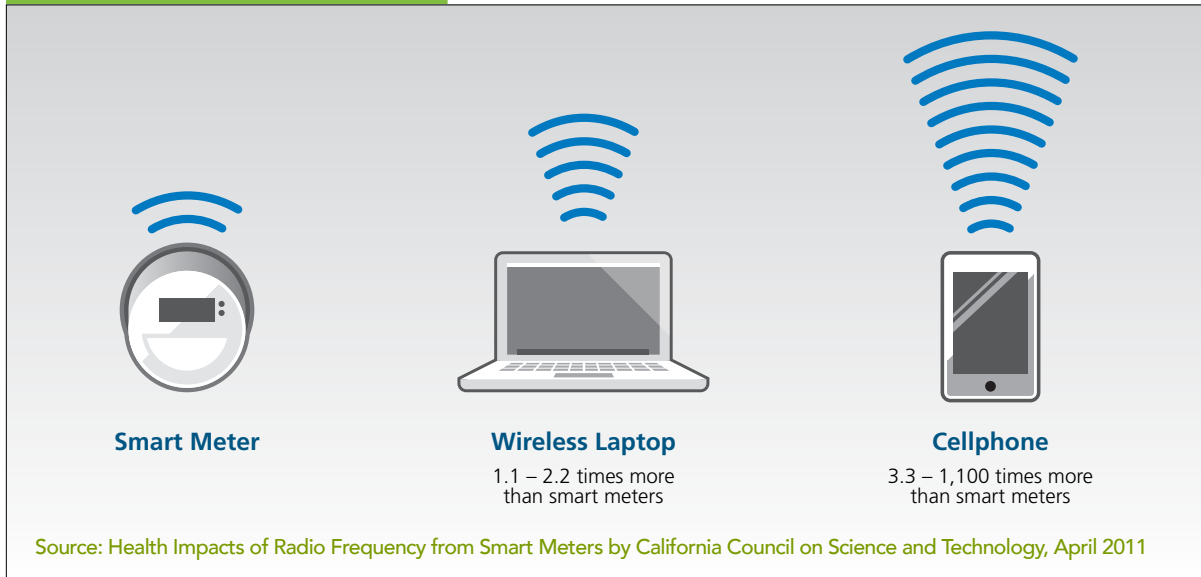
**“HEALTH IMPACTS OF RADIO FREQUENCY FROM SMART METERS”. PUBLISHED APRIL 2011 BY CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY**

### Examples of RF fields commonly found in the everyday environment in relation to Silver Spring-enabled Smart Grid Devices

Source	RF Output Compared to standing two feet from a Smart Meter
Standing in front of an active microwave oven, two feet from door	550 times more
Holding a walkie-talkie to your head	55 – 4,600 more times
Holding an active cell phone to your head	3.3 – 1,100 times more
Using a laptop computer	1.1 – 2.2 times more
Sitting in a Wi-Fi cyber café	1.1 – 2.2 times more

A comparison of the expected RF densities near Silver Spring-enabled smart grid devices versus a sampling of other common devices. Source: Health Impacts of Radio Frequency from Smart Meters by California Council on Science and Technology, April 2011

## Radio Frequency Comparison

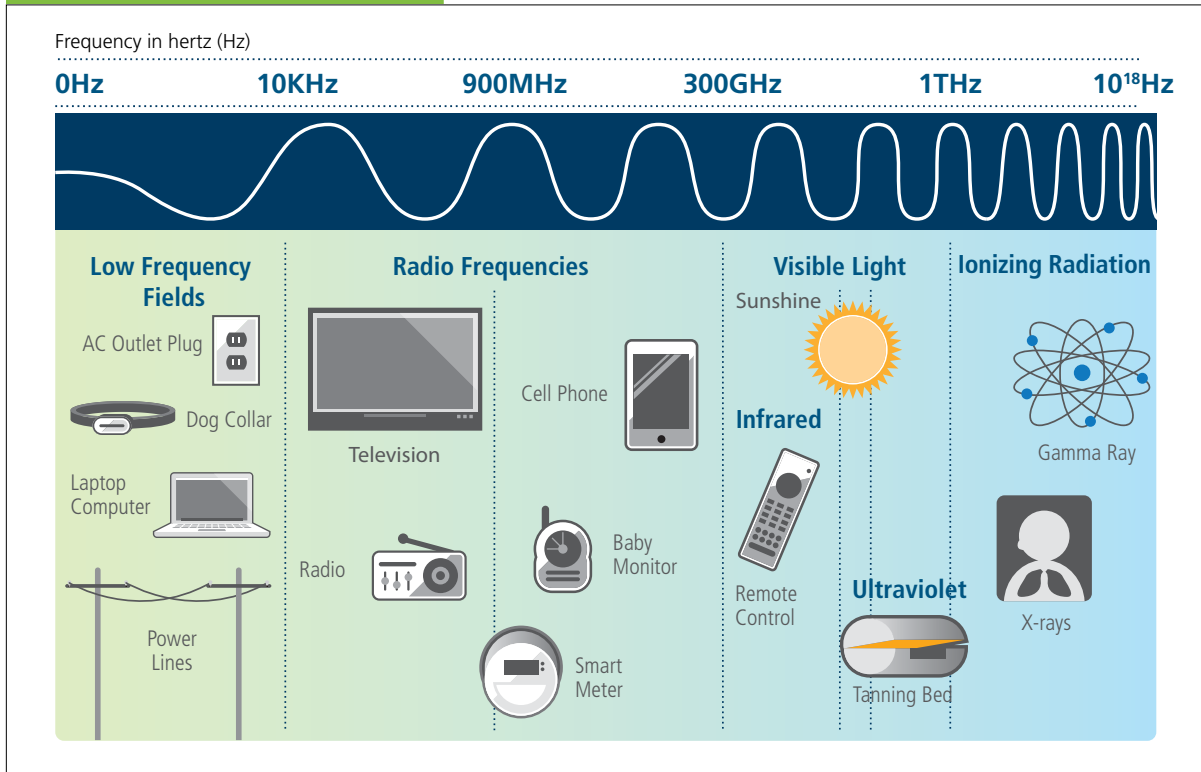


Silver Spring Networks continually monitors regulatory and scientific developments related to human exposure to RF emissions. Silver Spring Networks relies on expert scientific conclusions related to RF exposures and potential health effects. According to the Federal Communications Commission (FCC), the Electric Power Research Institute (EPRI) and the California Council on Science and Technology (CCST), no adverse short or long-term health effects have been shown to occur from the radio frequency signals produced by smart meters or other such wireless networks.

Our smart grid networking solution, utilizing radio frequency communications, fully complies with the United States Federal Communications Commission's Part 15 rules for safe use in publicly unlicensed spectrum. Pursuant to these rules, products are tested as if they are constantly transmitting. Many factors impact the total smart meter transmission schedule during a 24-hour period. The frequency of transmission varies widely depending on network usage, customer configured scheduled reads, and network maintenance activities. *Silver Spring-enabled smart grid devices not only meet the FCC rules but, in actual usage, transmit significantly less frequently.*

Based on actual field tests of 88,000 and 50,000 meters, the median transmission time is 45 seconds per day (half fall above, half below). The average transmission time is 60 seconds per day. The total per day transmission time includes meter read data, network management and time synchronization.

## Electromagnetic Spectrum



## Regulating Smart Meters vs. Consumer Products

In 1985, the FCC first established guidelines to limit human exposure and protect against thermal effects of absorbed RF emissions. The guidelines were based on those from the American National Standards Institute (ANSI) that were issued in 1982. In 1996, the FCC modified its guidelines, based on a rulemaking process that began in 1993 in response to a 1992 revision of the ANSI guidelines, as well as findings by the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). The 1996 guidelines are still in place today and have been updated as recently as 2001 to account for new classes of portable devices that communicate using radiofrequency.

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According to the FCC guidelines, consumer products such as cell phones and laptop computers—devices that are designed to be used in contact with or in close proximity to the human body—use specific absorption rate (SAR) as the primary metric for regulating exposure. This measures the rate of energy absorbed in units of watts per kilogram of body mass (W/kg). The FCC guidelines establish a safe limit of 1.6 W/kg for mobile phone devices.



Unlike consumer products, smart meters are typically sited on the sides of homes, inside of utility closets, and are often protected by walls separating the device from individuals inside of the residence. The locations of these devices inherently limit general population exposure. Consequently, the FCC created a separate set of guidelines for stationary devices that operate at least 8 inches away from human contact. These guidelines use Maximum Permissible Exposure (MPE), which is conservatively based on a SAR of 4 W/kg as the measure of exposure.

The FCC document detailing how to measure and/or calculate the levels of RF radiation titled “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields” can be found at [transition.fcc.gov](http://transition.fcc.gov).

## Smart Meters and the FCC Limits

Based on years of studying whether exposure to radio waves causes adverse health effects, the FCC adopted MPE limits for radio transmitters of all types, including smart meters. The FCC MPE limits for smart meters of 0.6 mW/cm<sup>2</sup> includes a prudent margin of safety just in case some health effects are too subtle to have been detected. Even so, smart meters operate far below the limit. Using a realistic high-end duty cycle (4%), the MPE level for a typical Silver Spring-enabled residential metering device operating in the unlicensed spectrum 902-928 MHz is 0.01 mW/cm<sup>2</sup>. The MPE level for this device configuration is equivalent to 1.6% of the FCC limit; however, actual results may vary depending on the specific meter integration.

Exposure is based on the transmitter’s power and the distance from the source. In general, doubling your distance cuts the power density by a factor of four. That’s a major reason why radio waves from a smart meter, at a distance of 10 feet, are only about one one-thousandth as much as a typical cell phone. That’s also why powerful but distant radio and TV transmitters are not seen as posing any danger.

## Types of Exposure and Exposure Limits

The FCC Rules and Guidelines define two types of exposures to RF energy:

1. Occupational / Controlled Exposure – persons who are exposed as a consequence of their employment and are fully aware of the potential for exposure and have the ability to exercise control over their exposure.
2. General Population/Uncontrolled Exposures – apply when one is exposed and may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

## FCC Limits for Maximum Permissible Exposure

Limits for Occupational/Controlled Exposure				
Frequency Range (MHz)	Electronic Field Strength (E)	Magnetic Field Strength (H)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time in Minutes
0.3 – 3.0	614	1.63	(100)*	6
3.0 – 30	1842/f	4.89/f	(900/f <sup>2</sup> )	6
30 – 300	61.4	0.163	1.0	6
300 – 1,500	–	–	f/300	6
1,500 – 100,000	–	–	5	6

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

Source: FCC OET Bulletin 56 – Fourth

Limits for General Population/Uncontrolled				
Frequency Range (MHz)	Electronic Field Strength (E)	Magnetic Field Strength (H)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time in Minutes
0.3 – 1.34	614	1.63	(100)*	30
1.34 – 30	842/f	2.19/f	(180/f <sup>2</sup> )	30
30 – 300	27.5	0.073	0.2	30
300 – 1,500	–	–	f/1500	30
1500 – 100,000	–	–	1.0	30

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

Source: FCC OET Bulletin 56 – Fourth

## Silver Spring NIC in a Residential Smart Meter per FCC Certification

FCC Rule:	15.247
Environment:	General Population/Uncontrolled Exposure
Exposure Conditions:	Minimum 20 centimeters (8 inches)
Frequency Bands:	RFLAN 902-928 MHz ZigBee 2.4-2.48 GHz
Transmit Power:	RFLAN 30 dBm (1000 mW) at 902 MHz ZigBee 22dBm (160mW) at 2.4 GHz
Antenna Gain:	RFLAN 1.2 dBi (1.3 times) at 902 MHz ZigBee 5.6 dBi (3.6 times) at 2.4 GHz
Duty Cycle (Estimate Max): (over 30 minute period)	RFLAN 4% ZigBee* 10%

\*The 2.4 GHz radio provides connectivity to in-home devices such as smart thermostats and in-home displays. Customers must opt-in to enable the 2.4 GHz radio functionality.

Calculation of RF emissions
<b>Power Density calculated with Reflection Factor</b> $\text{PowerDensity [mW/cm}^2\text{]} = \frac{\text{TransmitterPower [mW]} \times \text{Antenna Gain[times]} \times \text{Reflection Factor [times]}}{(4 \times \pi \times (\text{Distance[cm]})^2)}$

MPE limits for continuous exposure		
MPE Level		
RFLAN (902MHz)	3.0 mW/cm <sup>2</sup>	0.6 mW/cm <sup>2</sup>
ZigBee (2.4GHz)	8.0 mW/cm <sup>2</sup>	1.0 mW/cm <sup>2</sup>

Using realistic (high end) duty cycle*			
Transmitter	MPE Limit	MPE @ 20cm	Margin
RFLAN (902MHz)	0.6 mW/cm <sup>2</sup>	0.01 mW/cm <sup>2</sup>	1.6% of the limit
ZigBee (2.4GHz)	1.0 mW/cm <sup>2</sup>	0.01 mW/cm <sup>2</sup>	1.0% of the limit

\* This is a conservative estimate of MPE based on results from a typical residential metering device configuration. Actual results may vary depending on the specific meter integration.

## Summary

Pursuant to the FCC rules, products are tested in extreme conditions as if they are constantly transmitting. In actual usage, Silver Spring enabled devices transmit significantly less frequently than this. And, our solution meets the FCC testing standards even under these stringent testing parameters.

Silver Spring Networks will continue to monitor the regulatory standards and research related to RF exposure to verify that our products are in compliance with all applicable legal and regulations.

## Additional Information

Federal Communications Commission (FCC)

- » [Radio Frequency Safety](#)
- » [Radio Frequency Safety FAQs](#)
- » [Q&A about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields Evaluating](#)
- » [Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields](#)

Federal Drug Administration (FDA)

- » [Radiation Health](#)

Occupational Health & Safety Administration (OHSA)

- » [Radio Frequency and Microwave Radiation](#)

The National Institute for Occupational Safety and Health (NIOSH)

- » [EMF \(Electric and Magnetic Fields\)](#)

World Health Organization (WHO)

- » [Electromagnetic fields and public health](#)

California Council on Science and Technology (CCST)

- » [Health Impacts of Radio Frequency Exposure from Smart Meters](#)

### About Silver Spring Networks

Silver Spring Networks is a leading networking platform and solutions provider for smart energy networks. Silver Spring's pioneering IPv6 networking platform, with more than 23 million Silver Spring enabled devices delivered, is connecting utilities to homes and businesses throughout the world with the goal of achieving greater energy efficiency for the planet. Silver Spring's innovative solutions enable utilities to gain operational efficiencies, improve grid reliability, and empower consumers to monitor and manage energy consumption. Silver Spring Networks' customers include major utilities around the globe such as Baltimore Gas & Electric, CitiPower & Powercor, Commonwealth Edison, Consolidated Edison, CPS Energy, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric, Pepco Holdings, Progress Energy, and Singapore Power, among others. For more information please visit [www.silverspringnet.com](http://www.silverspringnet.com). Rev. 4/2018