RF safety and the EnergyAxis® System

Introduction

There is a growing concern in the industry, especially on the part of energy consumers, over the potential health impact of smart meter radio communications. This paper is to assist Elster's EnergyAxis users in understanding matters related to radio frequency (RF) safety with regard to the EnergyAxis mesh local area network (LAN) radio used in EnergyAxis smart meter endpoints, specifically REX2™ and A3 ALPHA® meters.

Overview

The use of RF in consumer facing products has increased considerably over the past decade, and continues to increase. Prominent examples of this are the prolific use of cellular phones, wireless routers, and even microwave ovens.

A lack of education on smart metering technology has led to rising public concern over their use and associated health risks. Although smart meters utilize RF technology, they represent significantly lower RF exposure for consumers than nearly all other products, such as cellular phones, that are used daily without concern.

The bottom line is that smart meters represent no known health hazard and have, as noted above, significantly lower exposure levels than most other typical devices that emit radio waves. Two additional contributing factors to the negligible RF exposure from EnergyAxis smart meters are:

- the distance consumers are typically from smart meters and the minimal amount of time smart meter radios are actually transmitting
- the EnergyAxis smart meter radio achieves equivalent performance with a much lower power than most other smart meter designs. This is an intentional characteristic of the Elster design to avoid potential equipment interference and to lower the technical losses on utility distribution grids, while also lowering RF emissions.

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For example, a typical EnergyAxis *smart meter transmits (that is, emits power) with an approximate duty cycle of only 1%*. In addition, these meters are typically placed outdoors, with a wall and a metal socket separating the meter from the living space thereby attenuating the signal from the occupants of the living space.

Power levels and density

All electronic devices have some RF emissions. The measure of the strength of these signals is called the power density, which is the amount of RF power (measured in milliwatts) hitting a particular surface area (measured in square centimeters). The power density of a signal can be calculated using the output power level (for example 0.25 watts), and the distance from the transmitter. Higher power density numbers equate to stronger signals, a closer proximity to the signal, or a combination of these two factors.

Power density is calculated using the following formula:

Power density = TxPwr × AntGain ÷ (4 × π × Distance²) mW/cm²

Where:

- TxPwr = The radio frequency power input to the antenna in milliwatts
- AntGain = The power gain of the antenna (unitless)
- π = Constant: Pi (3.14)
- Distance = Distance from the transmitter, in cm

EnergyAxis LAN radios operate in the 900 MHz ISM band using FHSS (Frequency Hopping Spread Spectrum) and have a maximum transmit power (TxPwr) of 250 mW. The radiation pattern of a device depends on the antenna and on surrounding objects. When installed in an electrical socket, the energy radiated backwards through the socket into the home would be significantly reduced due to the metal socket. The metal socket reduces the energy transmitted into the residence but redirects the energy out the front of the meter. As measured as part of the FCC certification process, the maximum antenna gain for a meter in a metal socket was 5.64 dBi, which equates to a gain of 3.66. For calculation purposes, a distance of 2 feet (61 cm) will be used, but typically the distance between an electricity meter and a person would be significantly greater than 2 feet.

The numbers in the previous paragraph can be used to calculate a *worst case theoretical* power density for an EnergyAxis smart meter:

Power density = 250 × 3.66 ÷ (4 × π × (61)²) = 0.02 mW/cm²

More typical numbers, especially for someone in the residence of the meter in question, would be an antenna gain of 0.5 and a distance of more than 10 feet. Using these numbers, a more realistic power density value would be:

Power density = 250 × 0.5 ÷ (4 × π × (305)²) = 0.0001 mW/cm²

It is helpful to compare this typical power density of a smart electricity meter to other types of devices that are commonly found in a residence:

	Transmitter power*	Antenna gain	Typical distance	Power density	Typical exposure times
Cellular phone	600 mW	1	1 cm	48 mW/cm²	Continuously when in use
Cordless phone (handset)	20 mW	1	1 cm	1.6 mW/cm²	Continuously when in use
EnergyAxis meters (close proximity)	250 mW	1	61 cm (2 ft)	0.02 mW/cm²	1.5 seconds every 4 hours
WiFi access point or NIC	100 mW	1	30.5 cm (1 ft)	0.008 mW/cm²	Nearly continuously when in use
EnergyAxis meters (typical proximity)	250 mW	0.5	305 cm (10 ft)	0.0001 mW/cm²	1.5 seconds every 4 hours

*May be higher depending on the specific device

FCC permissible exposure limits

A substantial number of studies have been performed by various organizations to evaluate the impact of RF emissions on the human body. Taking input from these studies, the FCC set exposure limits that "incorporate prudent margins of safety" (according to the FCC's RF Safety FAQ sheet[1]).

Devices which emit radio energy must be certified by the FCC to meet maximum permissible exposure (MPE) requirements, as specified in FCC 1.1310. The limits specified by the FCC vary based on frequency and the power density limits are specified as an average value over a 6 minute time period. The power density limit for the 915 MHz band is 0.6 mW/cm^2. The FCC validates a device using a calculation distance of 20 cm.

In the MPE report submitted to the FCC for the communications device used on the REX2 meter, the transmitter power was measured as 232 mW, with an antenna gain of 3.66 and at a distance of 20 cm. This results in a calculated power density of 0.169 mW/cm^2 which is 0.431 mW/cm^2 below the limit. It is important to note these calculations assumed the device was transmitting 100% of the time during the 6 minute averaging period, whereas there is no possible scenario existing where an EnergyAxis device can transmit at a 100% duty cycle for even a short period of time, let alone for six minutes.

As highlighted above, raw power density calculations do not take into account how often a device is transmitting. The consumer electronic devices listed above are transmitting nearly continuously when they are in use. In comparison, an electricity meter typically transmits very infrequently. A typical EnergyAxis smart meter has a transmit duty cycle of less than 1%. The average power density would therefore be 1/100 of the maximum calculated power density.

1 Viewed at http://www.fcc.gov/oet/rfsafety/rf-faqs.html

Conclusion

In summary, EnergyAxis smart meters:

- Pose no known health risks to humans through RF emissions
- Are proven to have lower RF emissions than other readily accepted consumer devices in use today
- Comply with all applicable FCC exposure limits by a wide margin
- Emit much lower RF energy than most competing smart meters, many of which use radios with 1W or 2W of transmit power

Elster
208 S Rogers Lane
Raleigh, NC 27610-2144
United States

T +1 800 257 9754 (Elster sales information)
T +1 800 338 5251 (Elster product support)
T +1 905 634 4895 (Canada)

www.elster.com

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