SensusRF Radio Safety

Electromagnetic radiation is a natural phenomenon that is vital to human existence. It is everywhere around us, be it the visible light illuminating all we see, and natural or man-made radio waves.

However, while it is an inherent part of the universe, some are concerned about potential detrimental effects, which has led to confusion and unsubstantiated claims, with little repeatable evidence or scientific rigour to support them.

It is beholden on any organisation to be guided by the best evidence available and to conform to the most rigorous limits set by scientists who have carried out extensive research subject to a rigorous peer review process. It is understandable that some people are apprehensive over what cannot be tangibly experienced or felt. The aim of this document is to show that as a responsible organisation Sensus takes these concerns seriously, and always ensures its products conform well below the permitted limits set throughout the world.

What is Radio?

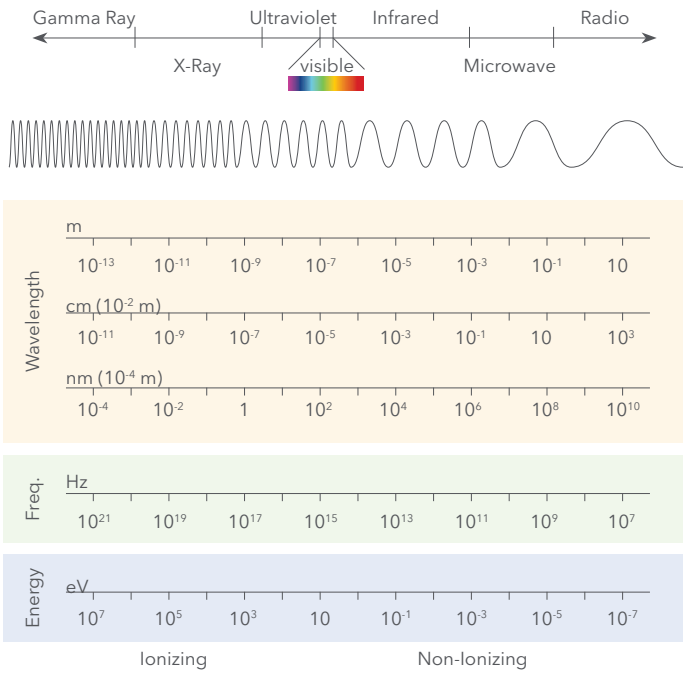
Radio is the wireless transmission of information by means of electromagnetic waves, often referred to as 'signals.' It is the same natural phenomena as light, and can be thought of as a stream of mass-less particles, called photons, each traveling in a wave-like pattern at the speed of light.

The frequency at which the signal oscillates can be used to partition the radio waves into various spectrum bands covering low, medium and high frequencies.

Band name	Abbreviation	ITU band number	Frequency / Wavelength
High Frequency	HF	7	3 – 30MHz / 100 – 10m
Very High Frequency	VHF	8	30 – 300MHz / 10 – 1m
Ultra High Frequency	UHF	9	300 – 3000MHz / 1 – 0,1m
Super High Frequency	SHF	10	3 – 30GHz / 100 – 10mm
Extremely High Frequency	EHF	11	30 – 300GHz / 10 – 1mm

High-frequency signals, in the HF, VHF, UHF, SHF and EHF bands, have a frequency between 3 megahertz and 300 gigahertz (where 1 hertz = 1 oscillation per second). Radio transmission is used extensively in a huge variety of applications, including radio, television, radar units, cell phones, WiFi and many others.

In the scheme of the electromagnetic spectrum, these photons are of relatively low frequency and low energy. To put this in perspective, even the lowest energy visible light (wavelength ~700nm) still carries roughly 1430 times the energy of the most energetic microwave photon (wavelength 0.1cm). Both radio and light are at energy levels are non-ionizing, meaning that they cannot break apart the chemical bonds such as those found in DNA.



Conversion between wavelength, frequency and energy for the electromagnetic spectrum. (Source : Nasa : Imagine the universe!)

Why SensusRF?

An efficient and economical reading of household water meters is not possible without radio transmission. Deploying meter readers to record a reading manually has become too costly and is extremely prone to error.

Reading meters using SensusRF technology, enables fast and effective processing of the meter information which can be used not only for billing purposes, but also to help detect leaking pipes and alleviate customer complaints due to misread readings.

Radio Emissions

A number of medical studies have stated that at extremely large power levels, high-frequency electromagnetic waves have a damaging effect on living things. However, this does not reflect the absorption levels and associated heat-energy, in modern wireless communications systems, such as those found in smart water meter automated meter reading or infrastructure networks.

The heat energy absorbed by tissue exposed to an electromagnetic field is quantified by the specific absorption rate (SAR). In the European Union, the maximum exposure to such fields

is set to a maximum of 2W per kilogram, averaged over the 10g volume receiving the most direct heating to circumvent thermal effects. Importantly, dielectric heating only increases tissue temperature and will not by itself cause any damage to DNA bonds, so SAR should not be considered a catalyst for increasing cancer risk. To date, there is no reputable evidence that wireless communications increases cancer risk.

SAR is quite a difficult to measure under field conditions, so in practical terms the primary variables that are directly proportional to the SAR figure – the surface power density (W/m2) or electric field potential (V/m) – are used as an alternative, to calculate a total dose level that can be directly related to the SAR.

Transmission power alone is not the sole determining factor on the amount of energy in an area away from the transmission source, the distance to the radio source and the duration of the transmission are also decisive factors. Consequently, high frequency radio should not automatically be considered dangerous – it depends on the dose received – where the dose is defined as the signal power where measured multiplied by the signals duration.

As the distance from a transmission source increases, the electromagnetic field strength decreases rapidly with the square of the distance. This means at a distance of just one metre from the transmitter, a SensusRF signal is approximately just one-twelfth the level of its original transmitted power.

A GSM mobile can have a peak output power of 2W, however, because GSM systems transmits for 1/8th of the time and every 26th pulse is omitted, the actual max. transmission output power is 240mW. For 3G phones where the transmission is continuous, the max. transmission output power from the mobile device is 250mW (24dBm), and for 4G systems it is 200mW (23dBm). Although adaptive power control in modern cellular systems are used to help increase battery life and can further reduce the actual transmission power by 50% or more, these techniques could not be utilised if the mobile is at the cell edge if a connection is to be maintained. Similarly using a mobile indoors or in built-up areas often requires the phone to maintain its maximum transmission power. In 3G and 4G cellular technologies, data streaming from the mobile to the network can actually increase output power by up to four times in comparison with a typical voice call.

Comparative Example:

Assuming a 1-minute call on a 3G cell phone with someone speaking on a voice call using a phone held to their ear (zero distance), made inside a building such that there is no active power control, would require a max. transmission power 250milliwatts (24dBm), leading to a total dose of radio energy in proximity to the head of 15W over the duration of the call.

By comparison, a water meter utilising SensusRF uses a radio band where the max. transmit power permitted is 25milliwatts. SensusRF transmits signals of just 0.0016-second duration every 15 seconds, i.e. 4 times per min). At 1m, using a free-space path loss model, the radio power would be ~12.57x less as it spreads away from the transmission antenna, equating to ~1.99mW and a total dose of just 0.0000127W.

Dose = transmission power x transmission duration.

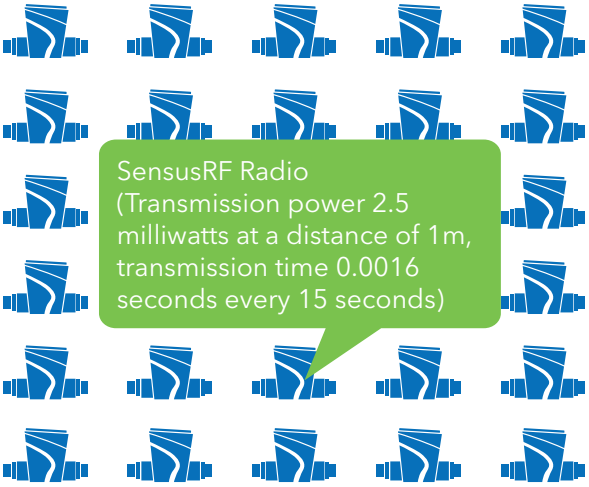
In this comparison the total dose of radio power received over a minute from a cell phone

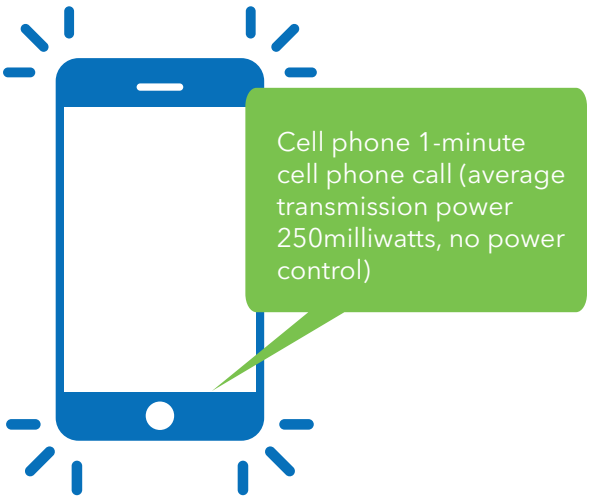
held to the ear is over 1.1 million times greater than that received 1metre away from a water meter using SensusRF radio technology, graphically illustrating just how small the electromagnetic radiation emitted by the SensusRF radio is in comparison.

In virtually all installations, a water meter is located much further than 1m away from people – typically behind walls, in outside pits or below reinforced concrete ceilings etc. All these physical barriers attenuate an electromagnetic field much more than free-space or air.

In other words, to achieve the same dose as just a single 1-minute cell phone voice call, SensusRF radio would need to transmit continuously for over 2 years with someone standing 1 meter away for the entire time (24 hours a day, 365 days per year).

The actual biological exposure dose for people in a real-world environment, where they move around and the water meters are sited in typical locations thus becomes miniscule, to a point where a dose equivalent to a 1-minute call on a cell phone held to the ear, cannot be achieved over the iPERL meters entire operational lifetime.





Typical Radio Applications

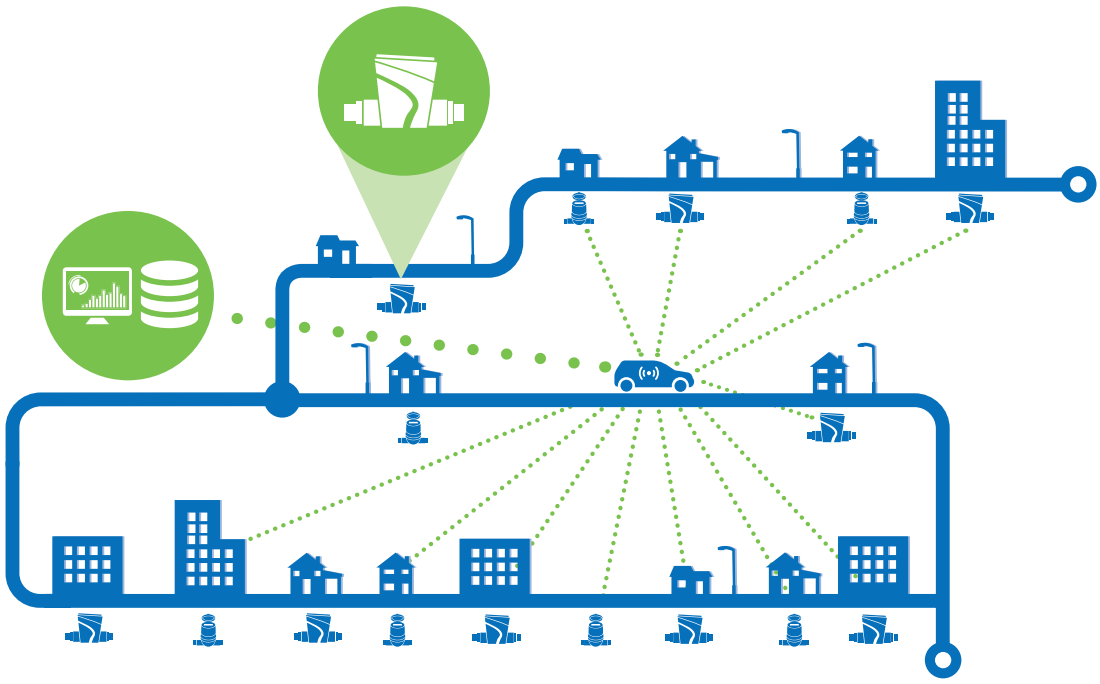
Applications	Frequency	Transmission power limits
SensusRF	868 MHz	25 mW
Bluetooth	2400 MHz	100 mW
Wi-Fi	2400 MHz	100 mW
DECT (cordless phone)	1900 MHz	250 mW
GSM (E-network)	1800 MHz	1000 mW
GSM (D-network)	900 MHz	2000 mW
DVB-TV station	470-790 MHz	5,000,000,000 mW
Radar station	1-3 GHz	100,000,000,000 mW directed

SensusRF does not transmit 99.99 per cent of the day.

SensusRF does not operate continuously, but rather it transmits very sparingly. Each transmission lasts approximately 0.0016 seconds, at a low power of a maximum of 25 milliwatts and a frequency of 868 MHz in Europe. Even if set to send a message every 15 seconds during the day, the Sensus RF radio would only transmit for a total of just 9.2 seconds over 24 hours - meaning each meter does not transmit for 99.99% of the day.

The low energy consumption required is illustrated by the fact that only a single 3.6 volt, 19 ampere-hour battery cell is required to meet all the metering and radio requirements of an iPERL meter over its complete operational lifetime, with no maintenance visits required to change the battery.

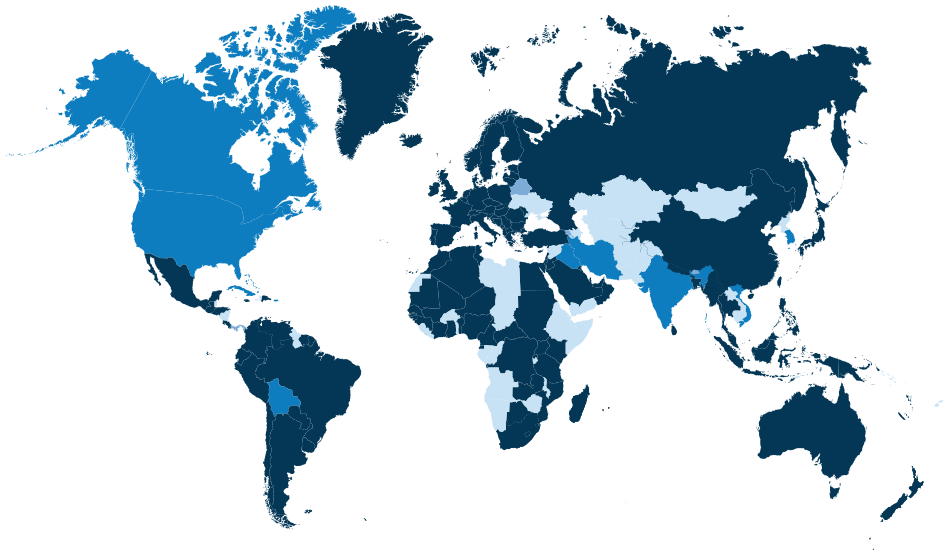
iPERL: the intelligent solution



Regulation and Legislation Limits

Concern regarding EMF exposure has led to legislation and specific regulations to ensure protection of the public. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998 Guidelines provide reference levels for public and occupational worker exposure that are used by regulators as the basis of their own limits. Some countries (and even regions) set different exposure levels e.g. at 1000MHz the allowed PD levels (W/m 2) are 6.7 in USA and Japan, 5 in ICNIRP 1998, Europe and the Republic of Korea, 2.94 in Canada and 0.4 in China.

The map below highlights the primary regulations that set the effective radio frequency exposure limits applicable radio device endpoints around the world. The map shows that 150 countries apply the ICNIRP limit and 19 use the FCC 1996 limits.



ICNIRP 1998 ■ FCC 1996 ■ Other ■ Unknown ■

Note: information from public sources except where indicated.

EU Directive 2014/53/EU applies within the European Union. This refers to limit values set by the recommendation of the Council of the European Union (1999/519/ EC) on "Limiting the exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)." These values are themselves based ICNIRP, which sets the field strength limit for frequencies between 400MHz – 2GHz at 1.375 x f½ and power densities (PD) equivalent to f/200 W/m2 (where f= freq. in MHz).

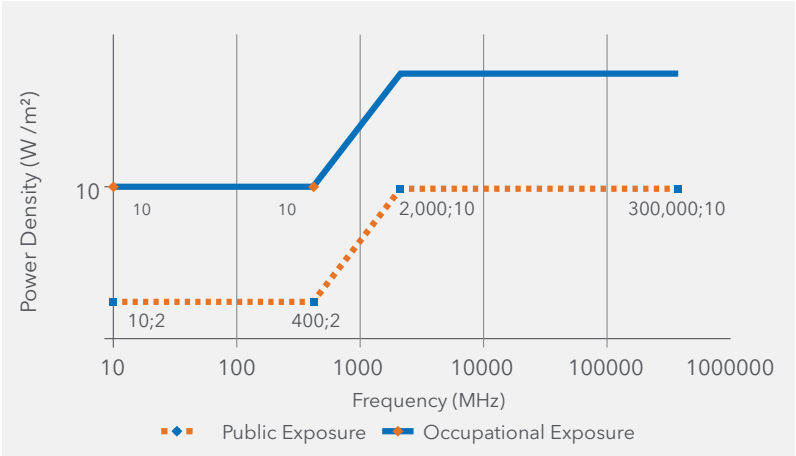


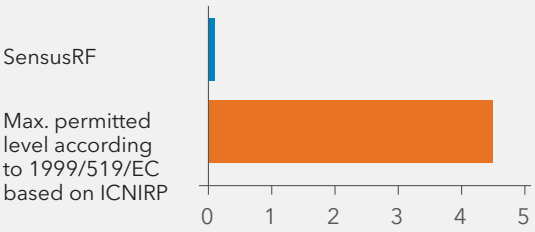
Figure 1: ICNIRP power-density reference levels for public and occupational workers

Most Europe countries follow these guidelines for example, the specification **"Verordnung über elektromagnetische Felder (26. BImSchV) des deutschen Bundesamtes für Strahlenschutz (BfS)"**, which defines radio emission levels across Germany, is based on ICNIRP values.

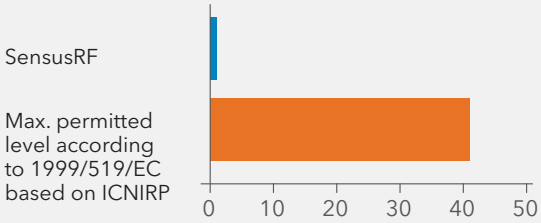
Some member states have defined their own lower limits for EMF exposure, with the lowest set at 6V/m. Even this limit is still 6 times greater than the absolute maximum transmit power possible from a SensusRF gateway or endpoint.

The radiated power of SensusRF is not only very low compared with other high frequency radio systems, but its maximum transmit power levels are substantially below the legal limits (see diagrams)

Radiation power density limits (W/m2)



Electrical field strength limits (V/m)



Source ICNIRP

Summary

SensusRF transmit power levels fall far below the limits set for all forms of radio communications.

The German Federal Office for Radiation Protection asserts that for wireless meters:

"It is therefore reasonable to assume that typical exposures are well below the maximum levels recommended for health protection."

Source: BfF Stand 22.03.2018