Exposure induced by smart meters

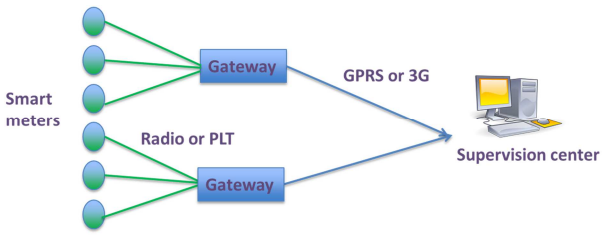
Emmanuelle Conil[(1)], Jean-Benoît Agnani [(1)],
(1) ANFR, Maisons-Alfort, France

Abstract

Smart metering consists in sending automatically meter readings. Transmission of the meter readings are either based on radio solution or on PLT (power line transmission) solution. This study is focused on the levels of electromagnetic fields emitted by different smart meters.

1. Introduction

Smart meters are the new generation of gas, water and electricity meters being rolled out across a number of countries including France. Smart meters are based on modules integrated in meters that allow the automatic sending of meter readings to gateways serving as relay points to the supervision service of power companies. A gateway manages a cluster of meters.
The data exchanged between the meters and the gateway are sent either by a radio transmission or by a power line transmission (PLT). Between the gateways and the supervision center, information is sent on existing wireless communication network (GPRS or 3G).



In this paper, we are interested in the level of electromagnetic fields (EMF) emitted by both types of smart meters based on radio modules or on PLC.

2. Smart meters based on radio modules

2.1 Generalities and exposure limits

In France, smart metering based on radio modules are using dedicated unlicensed frequency bands, either 169.4-169.475 MHz or 868 MHz band. In this paper we are focusing on smart meters using 169 MHz band. Regulation is requiring power and duty cycle limitations. The maximum equivalent radiated power (ERP) is 500 mW and the duty cycle shall not exceed 10 %.

The limit value is 87 V/m in the French regulation for the public based on ICNIRP 98 [1].

For the measurements a Narda SRM3006 has been used associated with a three axis electric field 3501/03 antenna.

2.2 Measurement methodology

The distance measurement is 50 cm above 300 MHz and 1 meter under 300 MHz according to standard EN 50492 9.1 [2].
Because of the frequencies are above 100 kHz, a spatial average is made at 3 heights (1.1m; 1.5m; 1.7m) and the measurement is time-averaged over 6 minutes.

2.3 Results

Test frames in lab are composed of 3 pulses of 120 ms. Measurement is carried out at 1 m of the smart meter.
A minimized exposure is assessed due to time averaging (over 6 minutes) when a pulse is transmitted.

Height	Electric field averaged over 6 minutes	Max electric field
1,7 m	0.04 V/m	1.12 V/m
1,5 m	0.05 V/m	1.10 V/m
1,1 m	0.04 V/m	1.22 V/m
Spatial average	< sensitivity threshold	1.15 V/m

Exposure levels at 1 meter are extremely low in comparison with limit values (less than 0.2 % in electric field)

In practice, the water meter does not emit the large majority of the time. The majority of the modules deployed in the field are programmed to transmit the meter readings every 6 hours. These frames are composed of one to three pulses of 120 ms.

Two types of measurements in real situations have been carried out:

- An in-situ measurement at a distance of one meter from the smart meter: the average exposure level over 6 minutes (according to the standard) is about 0.04 V/m. The maximum values, that is to say those measured only during the 120 ms emissions, are around 1.15 V/m.

- In situ measurements over a period of 24 hours, to check the cyclic behavior of the emissions of the smart meter:

  - At a meter of the smart meter, in a laundry room, similar measured levels are found: between 0.03 and 0.04 V/m on average over a period of 6 minutes, and maximum levels during the pulse of about 1.2 V/m;

  - At 4 meters from the meter, in a dwelling: the level of maximum electric field during the pulse is strongly attenuated, around 0.3 V/m. This attenuation is mainly due to distance.

3. Smart meters based on PLC

Index is sent once a day by PLT (Power Line Transmission) to a gateway.
Gateway monitors periodically a cluster of meters by periodically sending them requests and sends information to a control center's computer by GPRS or 3G.

3.1 Generalities and exposure limits

The limit values in the PLT band (35.9-90.6 kHz) are 6.25 µT (5 A/m) and 87 V/m in the French regulation for the public based on ICNIRP 98 [1].

There are two generations of smart meters called Linky: one (G1) uses a S-FSK modulation and the other (G3) an OFDM modulation (36 carriers). The S-FSK modulation has the property to be able to work with only one carrier (amplitude detection) when the other carrier is too noisy.

For the measurements a Narda SRM 3006 has been used associated with a three axis magnetic field 3581-02 and single axis electric field 3531-04 antenna.
A PMM field meter 8053 associated with a triaxial probe EHP 50A has also been used for the electric field measurement.

3.2 Measurement methodology

To assess conformity, measurements are carried out at 20 cm of the meter in the PLT band (35.9-90.6 kHz) according to IEC 61786-2 standard [3].

Because of the near field condition, electric and magnetic field intensities are both assessed.

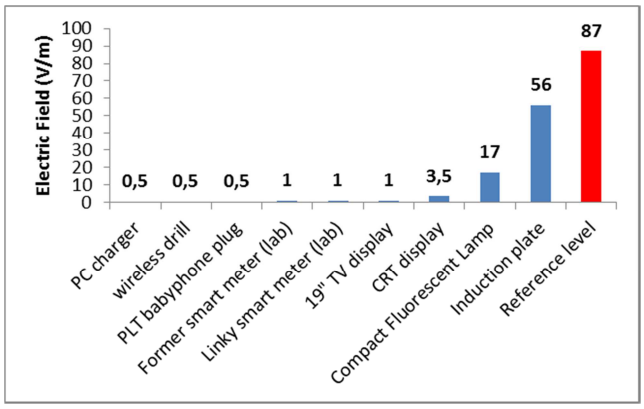
3.3 Results

First generation of smart meters (G1) has been characterized in real conditions with private households.

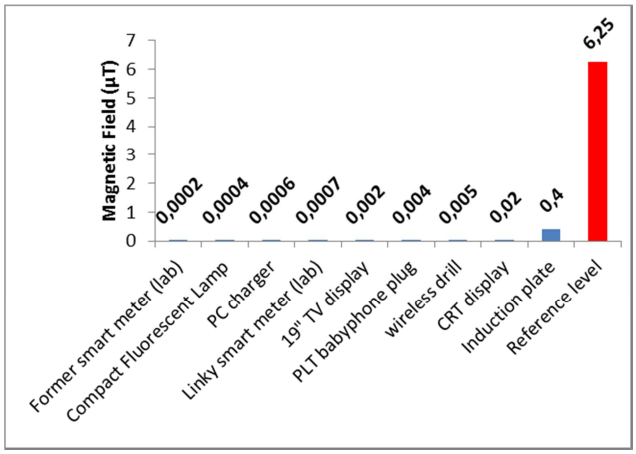
Magnetic field levels at 20 cm are between 0.01 µT and 0.06 µT (limit value: 6.25 µT).

Electric field levels at 20 cm are between 0.25 V/m and 2 V/m (limit value: 87 V/m)

Tests have been carried out also in laboratory where comparison have been made with exposure generated by household appliances in the PLT band at 30 cm from the equipment under test.



30 - 95 kHz band electric field measurement



1.2 - 100 kHz band magnetic field measurement

We can notice in particular that the previous electric meter created an electric field close to those generated by Linky.

The levels of the maximum magnetic fields measured in situ are higher than those measured in the laboratory which were particularly low.
For private individuals, electrical appliances were connected to the power and some were in operation.

Differences of impedances in the different cases of measurements could explain the differences.

4. Conclusion

Gas and water smart meters are operating on battery power provided for more than 10 years and they are using low power communication whereas electricity smart meters have limitations due to electromagnetic compatibility requirements. Therefore the exposure levels are very weak in comparison with the limits.

One of the difficulties of these results is the difference of methodology according to frequency to assess the exposure. It appears interesting to work on the harmonization of measurement protocols to obtain comparable results between the different frequency bands, especially around 100 kHz.

5. References

[1] ICNIRP guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz) (1998)

[2] EN 50492: the Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations

[3] IEC 61786-2 standard: Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings.
Part 2: Basic standard for measurements