EXPOSURE TO ELECTROMAGNETIC FIELDS EMITTED BY SMART METERS USING POWER LINE COMMUNICATION TECHNOLOGY

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ABSTRACT

This paper deals with the public exposure to electromagnetic fields emitted by smart meters which use Power Line Communication (PLC) technology, such as Linky smart meter. Electromagnetic fields levels at PLC frequencies are measured and compared to the reference levels given in the European recommendation 1999/519/EC. It turns out that the electromagnetic field emission from PLC of the new Linky smart meter fully respects the reference levels.

INTRODUCTION

The public concern in France about exposure to power line communication (PLC) frequencies from smart meters recently raised the issue of the electromagnetic emissions of the new Linky smart meters.

The objective of this paper is to characterize the electromagnetic field levels emitted by Linky smart meters. We have compared measured levels to the European recommendation of 1999 [1] and checked the compliance with reference levels.

To do this, several measurements have been carried out. First, we characterized experimentally the exposure to electromagnetic fields emitted by different smart meters at PLC frequencies in our laboratory. Then we characterized the exposure to electromagnetic fields emitted by a domestic network equipped with a smart meter. Finally, we compared the electromagnetic fields emitted by the Linky smart meter to other kinds of domestic emission sources in the same frequency band.

CONTEXT

The PLC technology

PLC technology uses a 50 Hz low voltage network as a transmission channel to transmit low power high frequency signals. The PLC technology used for the Linky project allows communication between a concentrator installed in the MV/LV transformer station and the Linky meters [2]. Two generation PLC protocols are being used:

- The G1-PLC signal is coded using two carriers at 63.3 and 74 kHz and SFSK modulation
- The G3-PLC involves 36 spaced carriers between 35.9 and 90.6 kHz and OFDM modulation.

The meters considered in this study are only based on G1 PLC.

The European recommendation

The European recommendation aims at protecting the health of the public against known effects of electromagnetic fields. It defines limitations in terms of exposure to electromagnetic fields between 0 and 300 GHz. Reference levels are given in Table 1 at 50 Hz and in the frequency band [30-90] kHz.

Table 1 : European recommendation reference levels [1]

	B (µT)	E (V/m)
50 Hz	100	5000
[30- 90] kHz	6.25	87

The recommendation also deals with the case of simultaneous exposure to fields of different frequencies. In that case, the following criteria should be satisfied [1]:

$$\sum_{i=1Hz}^{1MHz} \frac{E_i}{E_{L,i}} + \sum_{i>1MHz}^{10MHz} \frac{E_i}{a} \leq 1 \qquad (1)$$

$$\sum_{i=1Hz}^{150kHz} \frac{B_i}{B_{L,i}} + \sum_{i>150kHz}^{10MHz} \frac{B_i}{b} \leq 1 \qquad (2)$$

where E_i and B_i are the electric and magnetic field intensity at the i^{th} frequency and $E_{L,i}$ and $B_{L,i}$ are the reference levels at the same frequency. They respectively equal to 87V/m and 6.25µT at PLC frequencies and 5000V/m and 100µT at 50 Hz.

Concerning our measurements, if we want to take into

account the 50 Hz signal, we need to check that the following criteria is satisfied:

$$\frac{E_{50Hz}}{5000} + \frac{E_{63.3kHz}}{87} + \frac{E_{74kHz}}{87} \leq 1 \quad (3)$$

$$\frac{B_{50Hz}}{100} + \frac{B_{63.3kHz}}{6.25} + \frac{B_{74kHz}}{6.25} \leq 1 \quad (4)$$

MEASUREMENT IN LABORATORY

Materials and methods

First, measurements have been carried out in our laboratory considering five different Linky smart meters (single-phase or tri-phase and Itron, Landis & Gyr, Iskra). Each smart meter has been connected to a load and communicates with an emulated concentrator.

To take into account a worse case, we realize our measurements in close proximity to the cables to determine electromagnetic fields. Besides, as the PLC is a low power signal, significant levels of electromagnetic fields will be measured only in the close vicinity of cables. Measurements are carried out in near-field area where electric and magnetic fields are independent. To do these measurements we used EMCO near-field probes, illustrated in Figure 1, associated to the Anritsu 2127B Rhode & Schwarz network analyzer (9 kHz – 790 MHz frequency bandwidth). The small size of these probes is well adapted to local characterization of near-fields. Indeed, using a larger probe in that case could lead to important mean effect influence and under-estimation of field intensity. Note that both these probes are single axis probes so we investigated different measurement directions to be sure to measure the maximum field.

Figure 1 : Near-field probes EMCO n°901 for magnetic field measurement and n°904 for electric field measurement

We also used NARDA EFA 300 with appropriate electric and magnetic field probes (5 Hz – 32 kHz frequency bandwidth) to measure electric and magnetic fields at 50Hz.

Measurements are carried out considering different distances between the meter and the probe: from 5cm to 1m. We remind that the electric field measurement is very sensitive in close proximity of objects that disturb the field lines. Thus the minimum distance considered for electric field measurement is 20cm away from the meter. This distance is a good compromise between the disturbance of electric field lines and the possibility to detect electric field levels.

Results

For greater distances than 20cm, the measured levels are equivalent to ambient noise level. Maximum measured values are given in Table 2. The cumulative effect of the 50 Hz and PLC frequencies is also calculated as described in *(3)* and *(4)*, and given in Table 3. We observed that the obtained results are much lower than the reference levels no matter which model of Linky smart meter is considered. The radiation due to PLC signal is negligible compared to 50 Hz signal. Thus, the cumulative effect criterion is also completely satisfied. These first measurements show that the Linky smart meter does not emit significant levels of electromagnetic fields.

Table 2 : Electromagnetic fields measured in laboratory close to smart meters at PLC frequencies

	Smart meter	A	B	C	D	E
63.3 kHz	E (V/m) (20 cm)	0.37	0.16	0.17	0.18	0.14
	B (µT) (5 cm)	0.02	0.1	0.06	0.05	0.01
74 kHz	E (V/m) (20 cm)	0.54	0.47	0.46	0.59	0.33
	B (µT) (5 cm)	0.18	0.33	0.10	0.12	0.02
50 Hz	E (V/m) (20 cm)	56	38	230.3	227	70.2
	B (µT) (5 cm)	18	12	7.4	15	6.5

Table 3 : Frequencies cumulative effect

Smart meter	A	B	C	D	E
E (20 cm)	0.02	0.02	0.05	0.05	0.02
B (5 cm)	0.21	0.19	0.1	0.18	0.07

MEASUREMENT IN A DOMESTIC NETWORK

Materials and methods

We also measured the in-situ electromagnetic field considering a whole domestic network of an apartment equipped with the first generation of Linky smart meter. The aim of these measurements is to compare PLC signal levels to those obtained in laboratory. Thus, we will not consider frequencies cumulative effects in this part.

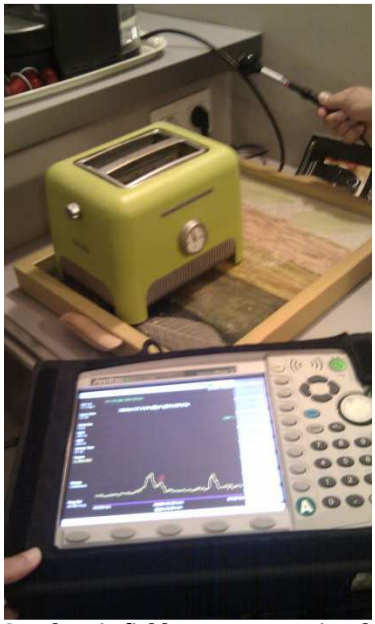

Figure 2 : Electric field measurement in a kitchen

For PLC frequencies measurements, we used the same probes than the ones used in the laboratory. We also investigated an ambient electromagnetic field meter: the Narda PMM 8053A field meter associated to EHP-50C probe (5 Hz – 100 kHz). We measured the electromagnetic fields in close proximity of the Linky meter and near cables feeding various domestic equipments located in different rooms of the apartment. The apartment is constituted by 9 main rooms.

Results

The PMM 8053A with EHP-50C is well adapted to ambient field measurement however as its sensor is larger than the EMCO probes, it turns out that the effects of the spatial mean of the field do not permit to detect any signals as the magnitude of radiated fields is very low. Thus we were only able to use the EMCO probes.

In each room we looked for the point of maximum electric and magnetic field at PLC frequencies. The measured values are reported in Table 4. Again, we observed that the obtained results are much lower than the reference levels of the European Recommendation.

The electromagnetic field levels in the entrance hall correspond to the measurement in front of the Linky smart meter. We can see that the order of magnitude is the same than the one of the levels measured in laboratory.

Figure 3 compares reference level, ambient noise and magnetic field measured in the entrance hall and in one bedroom of the apartment. This figure confirms that measured levels are far below the reference levels. We also notice a peak near the 63.3 kHz frequency which corresponds to the magnetic field emitted by the network analyzer screen. This peak is always present and is more visible in the case of ambient noise measurement. Its magnitude is similar to the one of the fields emitted by the Linky smart meter.

Comparison to other sources in the same frequency band

We compared emission due to PLC signal from Linky smart meter to other sources that can be found in a domestic environment in the same frequency band. We considered identical measurement distances from the sources.

Figure 4 shows measured magnetic field emitted by an internet box, a screen computer and a Linky smart meter. In each case, the maximum value is around 0.1 µT, which is much lower than the reference level. Thus, the PLC technology used by Linky smart meter does not significantly increase the electromagnetic field emission in this frequency band and measured levels are totally negligible.

Table 4 : Maximum values of electromagnetic fields measured in each room of the apartment

	$B_{63,3kHz}$ (µT)	B_{74kHz} (µT)	$E_{63,3kHz}$ (V/m)	E_{74kHz} (V/m)
Entrance hall	0.02	0.26	0.39	1.14
Kitchen	0	0	0.8	1.1
Bathroom	0.01	0	0.41	0.76
Bedroom 1	0.01	0	0.77	1.39
Bedroom 2	0.01	0.01	0.59	0.55
Bedroom 3	0.01	0.02	0.55	1.14
Bedroom 4	0.01	0	0.71	1.48
Bedroom 5	0.01	0.01	0.76	1.22
Living room	0.01	0	0.5	1.09

CONCLUSION

This study shows that the electromagnetic field emission from PLC of the new Linky smart meter fully respects the reference levels given in the European recommendation for public. It confirms that the PLC signal is a conducted signal which is not supposed to radiate. It does not contribute to increase the public exposure to electromagnetic fields.

We only dealt with G1 PLC technology in this article however we can assume that the results would not be very different with G3 PLC technology. Indeed we are still in the case of conducted emission so radiated fields are supposed to be negligible. The main difference is that the measurement would concern a slightly larger frequency band as the signal is coded on 36 carriers from 30 to 90 kHz.

REFERENCES

[1] Council of the European Union, 1999, "Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC)," *Official Journal of the European Communities*, pp. 59-70.

[2] Linky Equipment Department, 2009, "Linky PLC profile functional specifications"

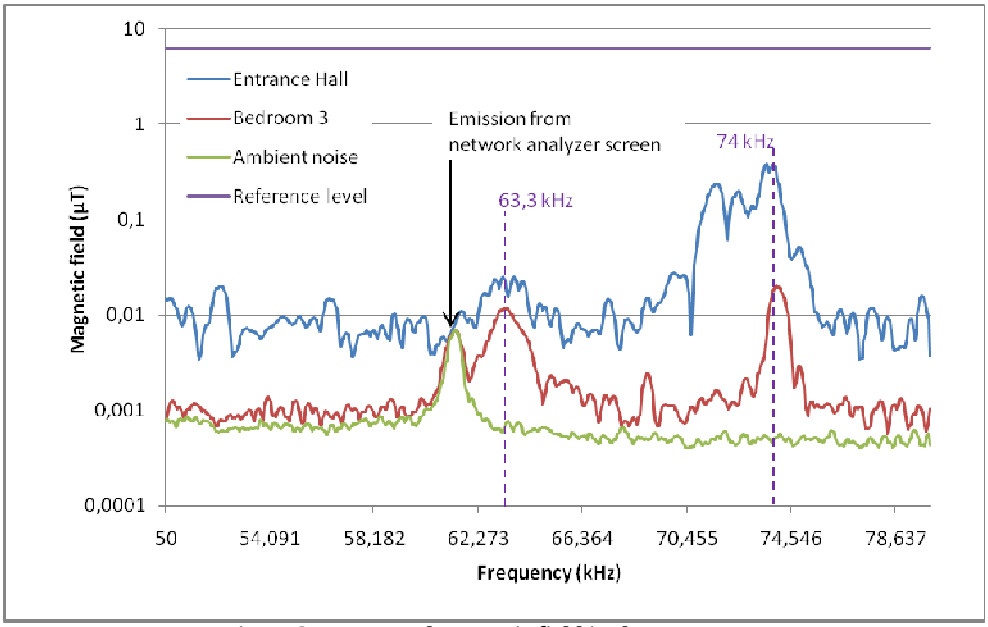

Figure 3 : Measured magnetic field in the apartment

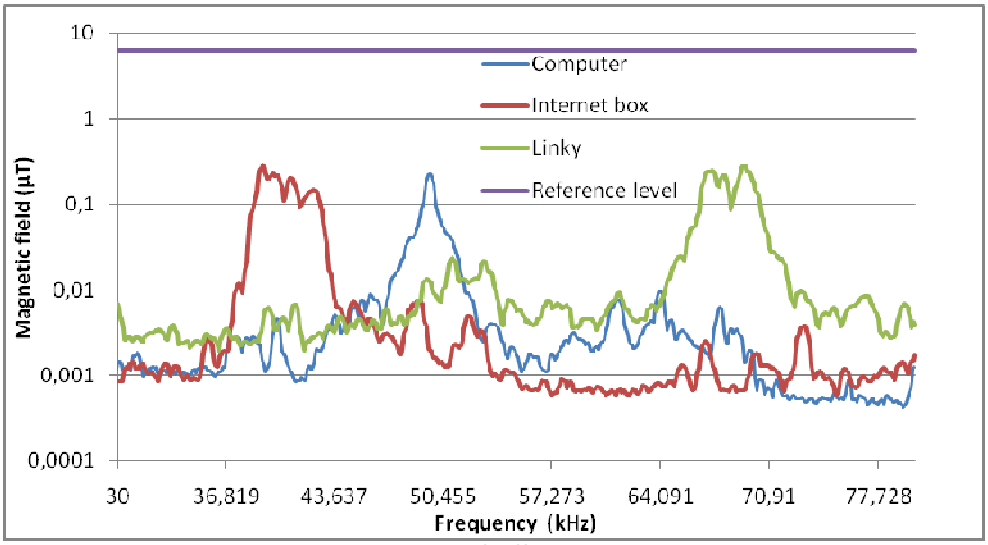

Figure 4 : Comparison of different emission sources