

INTEGRATION OF “HIGH FREQUENCY POWER LINE CURRENTS” EQUIPMENT IN THE PUBLIC DISTRIBUTION NETWORKS

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ABSTRACT

This article presents the step carried out by the EDF distributor, by means of the technique of the power line currents (PLC), to contribute to the deployment of the high flow Internet in the zones not yet covered on the French territory. The stakes, the guiding principles and the actors recipient of this step are initially introduced. The technical principles of the PLC are also pointed out briefly. The article presents then the conditions of integration which were defined by EDF to allow the installation of PLC equipment on the public distribution networks. Lastly, some examples of experiments in networks are indicated.

INTRODUCTION

In France, approximately 10% of the population do not have access to high flow Internet, with strong disparities in rural zones (more than 30% in 9 departments). Governmental objectives fix the cover rate at 96% at the national level and more than 70% in each department.

In this context, the towns are authorized by the law to establish and operate infrastructures and electronic communication networks (Internet) on their territory, to acquire rights of user for this purpose or to buy existing infrastructures or networks by possibly soliciting operators. These towns can place these infrastructures or networks at the disposal of operators or independent users or use them to directly provide services of electronic communications to the end-users.

Within this framework, the EDF distributor studied in collaboration with the French “Interdepartmental Delegation with the Installation and the Competitiveness of the Territories” the possibilities of complementarities of services between the public distribution networks of electricity he is a concession holder, and the networks suitable for the deployment of technologies of numerical communication, of which mainly the high flow Internet. These complementarities can be exerted through two technologies :

- the creation of an optical fiber network associated with the infrastructures of the public aerial networks ;
- the emulation of the public distribution network in network of power line currents (PLC).

An offer was built and published on the distributor web site (offers for the use of towns) : it is available on the following web site : www.edfdistribution.fr, at the heading “Local Local collectivities / Conceding Authorities.

At the same time, EDF perceive a future need for own applications (data relating to the state of the networks, control of the networks...).

This article is only focused on the use of the high flow PLC on the public distribution networks.

STAKES, GUIDING PRINCIPLES AND ACTORS

Stakes

Stakes related to the deployment of the high flow Internet in the zones which are not covered are major for the local collectivities. It is important for the development of the rural zones and the equal opportunity on the French territory. The Distributor is thus, from its position of concession holder, an essential actor of this development : it is for him an opportunity of consolidating or of improving quality of the relationships to the local collectivities.

Guiding principles

The EDF distributor does not position like a commercial actor of the development or operation of the electronic communication networks. Its mission is to place at the disposal the infrastructures in the respect of the following rules.

- There should not be any financial effect on the loads to cover by the tariffs of use of the electrical supply networks, in order to guarantee the absence of discrimination, cross subsidies and distortion of competition. The whole of the expenses induced by the implementation, the operation or the demounting of the electronic communication networks are thus invoiced at the real cost.
- The equipment and systems leant with the infrastructures of the distributor should not attack the correct operation of these last.
- The public utility of distribution of electricity has priority on the public utility of establishment and operation of a PLC network.
- The equipment suitable for PLC network or related to this network (repeaters...) are the property of the building owner of these installations and are thus not integrated in the concession of the public distribution networks. Only the public distribution equipment (boxes, grids of connection or others) established or modified to connect PLC equipment to the distribution network of electricity belong to the goods in

concession for the public utility of electric power supply.

According to choices of organization of the collectivities, the contractual framework is declined in one or two stages :

- The collectivity entrusts the realization and the operation with a single operator, it is the *concessive* model.
- The collectivity carries out the networks with a selected operator then entrusts the operation to another operator, it is the model of *leasing*. In this last case, the signature of two conventions is necessary.

Lastly, a convention of reference specific to the experiments is also available.

Actors

- *The high flow building owner* is the organizing authority (general council, community of agglomerations, departmental trade union, inter town trade union even more rarely a town) as a building owner.
- *The operator providing telecommunications* is in charge of the operation of the infrastructures and possibly the construction of these infrastructures, and also manages the customers relation with the users.
- *The PLC integrator* carries out the study and the construction of the infrastructures if this mission is not entrusted to the operator.
- *The conceding authority* (trade union of electricity or commune) authorizes the use of the public distribution networks for the PLC.
- *The concession holder* of the public distribution networks ensures in particular safety and the access to the network of the competent staff.

TECHNICAL PRINCIPLES OF THE PLC

It is pointed out briefly that it is a superposition of low power high frequency signals on the electrical power supply network (1 to 30 MHz). That applies to two fields : indoor (inside the houses) and outdoor (outside). The flow ranges between 1 and 10 Mbits/s. In this field, standardization is drawn by American (Homeplug).

The technology of the power line currents (PLC) makes it possible to transmit data with high flow through the existing electrical power supply network by using the frequency band ranging between 1 MHz and 30 MHz.

Information to be distributed locally via low voltage (LV) electrical power supply network (local electric rings) is conveyed by collecting systems (optical fibber, DSL, radio-relay systems...) towards a MV/LV substation charged to ensure their transmission until the electrical current sockets of the customers.

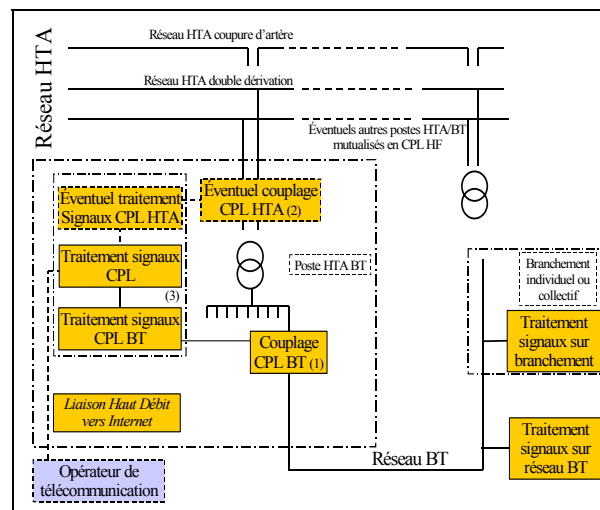
Downstream from each MV/LV transformer, the LV network constitutes an independent PLC network. This PLC network can be regarded as a "cell" being able to address

several hundreds of customers' installations. The diffusion of the high flow on the whole of the cells is thus operated in a reliable and very economic way. Repeaters are installed along the LV network to ensure the quality of the transmission. The signal is thus available on the electrical current sockets of the user.

The technical solutions being able to be very varied, the definitions which follow briefly state the functionalities associated with the principal sets concerned :

- Energy supply and treatment of PLC signals (primarily in the MV/LV substation),
- Possible coupling on MV network (often in the MV/LV substation),
- LV coupling in MV/LV substation, even in LV network and/or on LV collective connections (electric columns),
- Repetition, amplification of signals in LV network,
- Repetition, amplification of signals on collective connections (electric columns).

The whole of PLC equipment corresponds to a regrouping of equipment fulfilling a principal function. It can be related to MV coupling, like that of treatment of PLC signals in LV network... The simplified diagram hereafter presents an example of structure making it possible to locate the various sets (or principal functions) to which it is made recourse in the various solutions (non exhaustive representation).



It will be noted that high frequency PLC technology described above can coexist with other technologies such as the low frequency PLC or tariff signals (175Hz).

CONDITIONS OF INTEGRATION OF CPL EQUIPMENT IN NETWORKS

The conditions of integration exposed hereafter relate to the high frequency PLC exclusively.

Conditions of integration of CPL equipment in networks

The equipment must be in conformity with the reference document presenting the general conditions of installation and connection (technical note drawn up by EDF R & D).

This document was produced in order to satisfy a request for a whole of local towns gathered in only one conceding authority for the Parisian periphery. The goal was to define the framework governing the conditions of validation of the equipment in contact with the public distribution networks in dense urban zones, in terms of safety (of the goods, the operators, of the thirds...) and of maintenance of the continuity of service of the distributor.

An additive was then written in order to extend the field of application to the perish-urban or rural zones supplied with MV underground links.

Contents of the reference document and its additive

The principle of integration is to make that PLC equipment does not modify the characteristics imposed on the equipment of distribution networks in terms of :

- insulation coordination,
- dielectric behaviour of MV and LV equipment,
- short time current withstand of MV and LV equipment,
- protection against the direct contacts with the equipment (protection degree index),
- mechanical resistance of the equipment,
- guarantee of the manufacturers,
- respect of the normative framework.

The document is articulated around the following points :

- a recall of the operating conditions of the networks,
- the operating conditions of the PLC equipment which are connected (conditions at least aligned with the requirements imposed on the networks),
- conditions of safety relating to connections with the upstream transmission networks (insulation, galvanic separation, separation of earthings...),
- conditions relating to compatibility with the electromagnetic fields (EMC),
- conditions relating to the noise,
- rated characteristics of the public distribution networks,
- rated characteristics of PLC equipment (at the points of connection with the networks of the distributor),
- the technical dossier to produce to the distributor so that it can examine the conditions of validation of the equipment,
- modalities of the step of validation ,
- typologies of the validation tests,
- appendices clarifying the composition of the technical dossier.

In complement, the reference document describes the following levels :

- dielectric behaviour,
- requirement as regards principle of overloading currents and against the short-circuits,
- coordination of protections of the various circuits in link with the network,
- electromagnetic compatibility,
- mechanical resistance (withstand to shocks),
- protection against the direct contacts (and the penetration of objects),
- special tests of the enclosures and boxes of PLC equipment,
- behaviour to fire of synthetic materials.

These characteristics and levels of performance are checked by suitable tests.

Procedures of integration

To ensure the validation of PLC equipment, the manufacturers (or integrators) have recourse to a procedure of acceptance of the equipment (operator of distribution):

- A reference document exists and each integrator must conform to it.
- Each equipment or subsystem suggested by an integrator must be the subject of a file of identification and a file of tests. The distributor reserves the possibility of producing or of requiring complementary tests.
- At the end of a possible period of experimentation, the equipment is authorized of employment and is listed in a specific data base.

The distributor reserves the right to ask or carry out complementary tests, at the expenses of the operator.

ALREADY CARRIED OUT EXPERIMENTS

Initially, specifications of safety tests, being based on experimental technical constructions, were written for started PLC experiments.

To answer a request for local towns of the Paris area, an experimentation in dense urban zone was carried out in Courbevoie. This experimentation is based on the following architecture :

- a link with an operator of telecommunication, arriving in a MV/LV substation of public distribution named "substation head of bunch",
- a PLC link with LV network of this substation through a workshop of treatment of the signal and including in particular a LV modem and devices for LV PLC couplings,
- a link with, on average, four other MV/LV substations via the MV underground network through modems and MV PLC couplings,
- a communication between each MV part and the LV networks of the four other substations of public distribution through a workshop of treatment of the

signal connected to each network by a dedicated modem and adapted couplers.

This first step related to a hundred substations of public distribution serving 1200 customers approximately.

Other experiments were also carried out or are in progress, among which one can quote the following examples :

- "La Garrigue" (department of "Tarn") : experimentation in progress relating to around ten MV/LV substations in rural zone.
- "La Haie du Puy" (department of "Manche") : experimentation in progress of some substations.
- Department of "Seine and Marne" : experimentation in progress of a few tens of substations in perish-urban zone.
- "Vallée d'Aspe" in the "Pyrenees" : experimentation in progress of some substations.
- "Anzème" (department of "Creuse") : experimentation in progress of some substations in rural zone.
- Department of "Dordogne" : experimentation in progress of some substations in rural zone (LV PLC experimentation and on MV overhead lines)...

CONCLUSIONS AND PROSPECTS

In order to contribute to the will to facilitate the development of the high flow Internet in the whole of the French towns, EDF set up an offer for the use of the technique of the power line currents (PLC) on the public distribution networks.

For that, a reference document was designed defining the conditions of integration of high frequency PLC equipment in the public distribution networks. Fixing the conditions which PLC equipment must observe to be able to be installed in networks, this document treats requirements of safety relating to the points of supply and coupling with the public distribution networks (voltage, short-circuits withstand, fire withstand...). It also treats lawful requirements in term of EMC and noises at the level of MV/LV substations and columns electric).

The step thus established was applied to the perish-urban or rural zones supplied with MV and LV underground networks. Within this framework, experimental deployments were carried out for the needs for conceding towns. Other experiments were carried out in zone of "Internet fracture". Some experiments of video surveillance using urban LV networks were also born. Lastly, more recently, experiments integrated into MV overhead lines were deployed in several departments.

The conceding towns and authorities thus have the possibility of resorting to the public distribution networks of electricity to facilitate the regional planning and to bring to the isolated zones the access to the high flow Internet.