Acquisition And Wireless Transmission Of Readings Of Active Energy Activates Of The Electronic Single-Phase Metering Recorders Of Electrical Energy Of The Parish Of Ibarra´S San Antonio Central Neighborhood

Summary **– To improve the quality indexes of commercial service from EMELNORTE S.A., developed an electronic device that enables the acquisition and transmission of readings of the single-phase electronic recorders; then developed the design of a wireless network for management, access and control of device of data transmissions; also took place on radio link that allows the transfer of information from each meter. At the end there is the financial evaluation of the project for the central neighborhood of San Antonio and determining the cost and time to payback.**

Index **– Wireless Communication, Radio Link, Single-phase electronic recorders of electric power, Telemetry.**

INTRODUCTION

Despite the great effort made by companies distributing electricity, to collect data from energy meters not yet have reliable results, customer problems detected at the time to cancel your bills, either because the form of consumption constant few, or failing that, a large number of kWh of monthly consumption; these problems can occur by various factors, visual failure by staff to perform this activity, does not have

easy access to electricity recorders; readings typing error in the commercial system, or unrealistic readings or estimated at the time of data collection

To solve these problems is not enough to monitor compliance with these activities because they are conducted under a process susceptible to human error, need also to look at other factors involved as the accountability of those responsible for this task, the weather on the day of data collection, free access to the measurement system, etc.

With the aim of improving customer care and quality indices of commercial service of EMELNORTE S. A., takes place the development and execution of the Acquisition and Wireless Transmission of readings of active energy of the electronic recorders single phase power in the parish of San Antonio – Central Neighborhood.

DATA SYSTEM ACQUISITION.

The data acquisition system is developed for single-phase electronic recorders of electric power, the interface is not limited to one type of registrar, instead be used for any meter if it has a pulse output, usually known as opto-coupled output or disk emulator.

A. Design of Data Acquisition System

The design consists of the following processes:

1. Acquire information from the electronic recorder.
2. Process and control information in the microcontroller.
3. Transmit and receive the processed information

In Fig 1 shows indicated

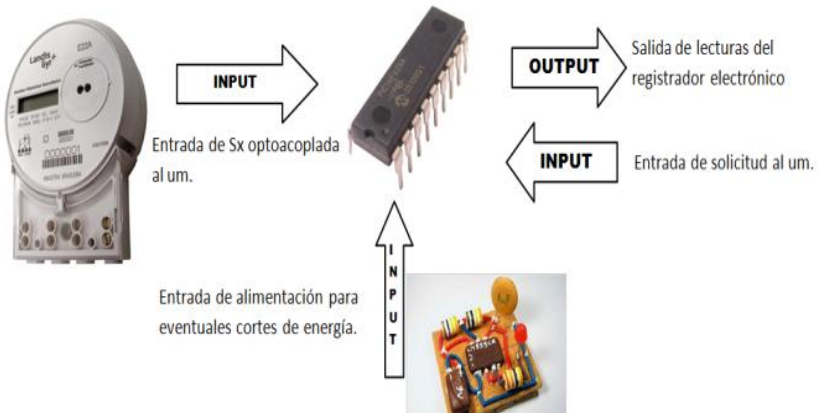


Fig. 1 Elements for System Data Acquisition

In the circuit design for data acquisition system have this energy deprivation, in consequence, the circuit has no power, this is a very important factor because the information being processed at this time can be lost.

To resolve this problem we implemented a circuit serving as the alarm and provide sufficient power supply to save the values of the variables in the EEPROM memory of microcontroller.

The programming the microcontroller functions has been done in assembly language because it allows complete control of each of the functions to be executed

B. Power supply for the electronic interface

We consider the interface between the data acquisition system and wireless network modules that are used to implement this interface consume an approximate current of 0.3 Ah., Module Wifly and 0.8 Ah, WIZ610wi module.

Other electronic elements together have a current consumption of about 0.15 Ah.

The source developed for this project has the following characteristics:

- Output current 1 A.
- Input voltage 110 V AC.
- Output voltage 5 V DC, 3.3 V DC.

The above characteristics support the requirements of current and voltage to operate the data acquisition system and the modules responsible for the wireless network interface. The fig. 4 shows the circuit developed for the power supply

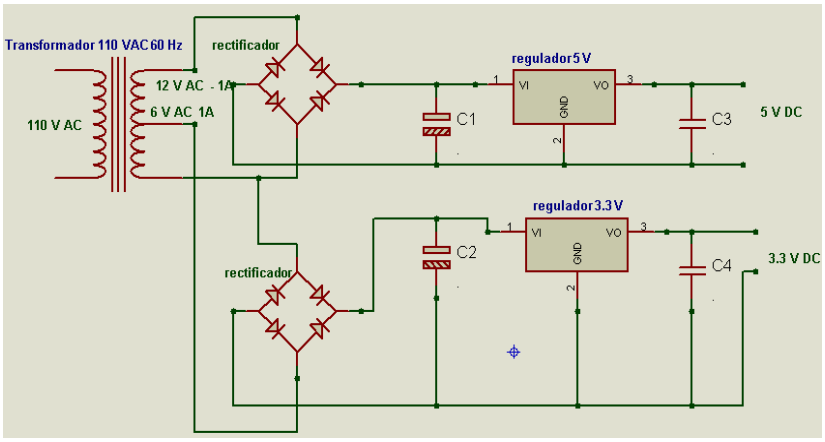


Fig. 4 Circuit for power supply

C. Features developed for the electronic interface of data acquisition.

The data acquisition system has advantages and characteristics that make it interesting when selecting devices for telemetry applications, as well as optimizing the resources of the utility and provides a perfect automated data collection of single-phase electronic recorders.

Advantages and features of the electronic interface

- Compatible with any single-phase electronic recorder that has an output coupled opto.
- Small size
- Standard RS232 communication port, 8 bits, no parity, 1 stop bit, no flow control, 9600 bps.
- Remote Administration.

The data acquisition system was developed to be compatible with a wide range of transmission technologies, to be designed in two parts: the data acquisition system in one part and the data transmission system to another, besides having a standard communication interface (RS232).

The transmission of the readings of electronic records it can be done in different ways, using an RS232 converter to the desired technology, such as ETHERNET, WIMAX, WIFI, GPRS, ZIGBEE, which among others could be used.

This makes the data acquisition circuit is the essential part of the single-phase electronic telemetry recorders. Fig. 5 shows the circuit developed.

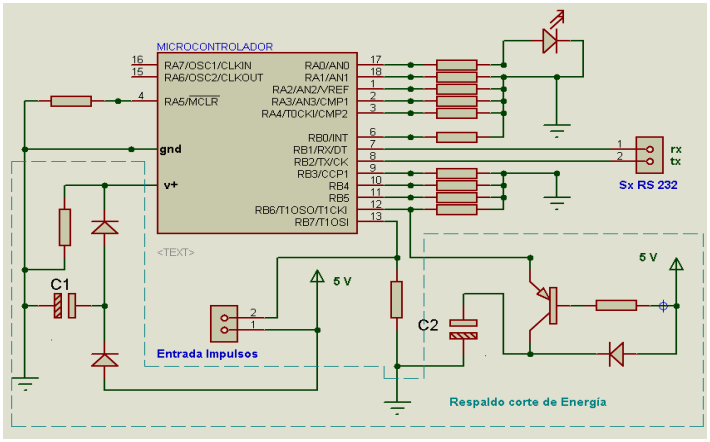


Fig. 5 Circuit for Data Acquisition

D. Acquisition device and wireless data transmission..

The data acquisition circuit in conjunction with the wireless module, form a system to acquire, process, control and send the readings of the single-phase electronic meters.

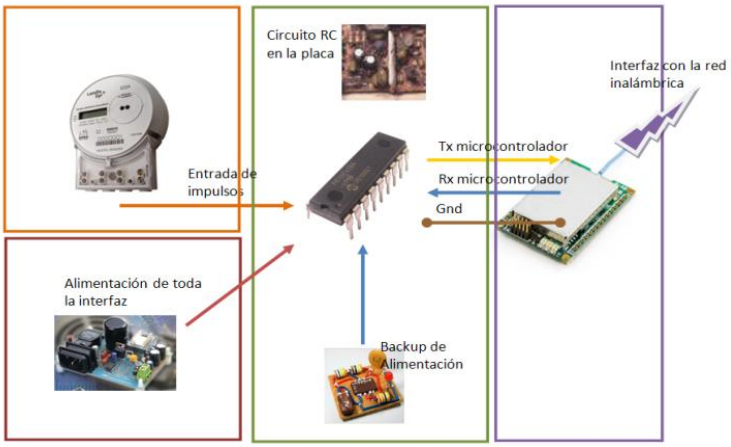


Fig. 6 Data Acquisition and wireless transmission for electronic Single-phase recorders

In Figure 7 and Figure 8 shows the device makers to acquire and wirelessly transmit readings from the single-phase electronic recorders.

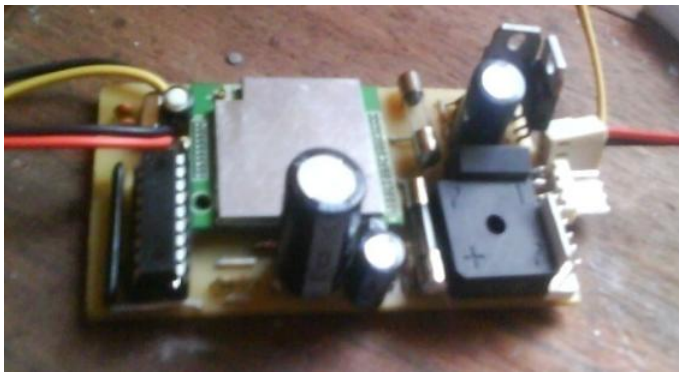
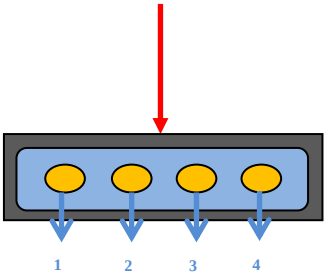


Fig. 7 System Board of Acquisition and Wireless Transmission Readings



Pin 1 y 2
Output 110V AC

Pin 3 y 4
Opto-coupled to the output of the Registrar

(a) (b)

Fig. 8 (a) Device Acquisition and Transmission of readings, (b) Pin Connection

E. Wireless network design for the acquisition and transmission of readings.

The wireless network must have coverage in the central area of San Antonio from the Pan north to the railroad and from the streets Aug. 10 to Simón Bolívar, the network is designed with different factors that occur when installing the devices that to acquire and transmit the readings of electronic records; also considering the expansion of network coverage to provide connectivity to other rural areas or away from the center of San Antonio.

The wireless network operates under the IEEE 802.11b / g, and the link from San Antonio to EMELNORTE S.A. data center developed under the IEEE 802.11a standard.

Figure 9 shows the formation a wireless network with two concentrators working under the IEEE 802.11 b / g, each concentrators has a coverage area of 800 meters

to 1000 meters in diameter, taking into account the shape and material of construction that are present instead of the implementation, concentrator reach a coverage of approximately 800 meters in diameter. The radios come with 4 outputs for connecting external antennas or also called "RF outputs", which are completely independent power management settings and therefore used an array of four 90 ° sectorial antennas.

The configuration of each output RF (Radio Frequency) is as AP (Access Point) except the output that connects to adjacent equipment, setup is as WDS (Wireless Distribution System), in this way are able to link the two concentrators forming a Wireless Distributed System.

The coverage provided by the Hub is about 400 meters around, but must be considered that some buildings may be farther, to solve this problem is set to the registrar limit the coverage area as WDS, thus optimizing resources network, for registrars to work as an AP and can provide connectivity to places where they want to expand the network without installing an expensive equipment.

This can be seen in Figure 9, which represent: the link between major concentrators, the link with the registrars are configured as WDS also circles symbolize the area where there are coverage, finally the link to the data to reach EMELNORTE SA with a 5.8 GHz backhaul.

It should be noted that the main concentrations offer the ability to expand the network to several kilometers, the operating mode WDS and have a coverage of 360 º can be attached to more hubs and having the advantage of having 4 outputs RF is possible to improve the administration of themselves.

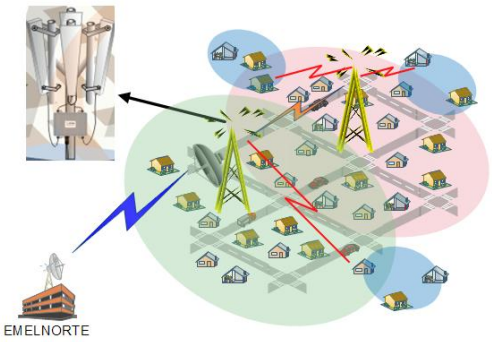


Fig. 9 Network Topology central area San Antonio de Ibarra.

Whereas the reading of electronic records is done once a month, intends to take the reading once a day at a certain time, which generates a more detailed control of subscriber consumption.

With this information, the traffic generated by each registrar is:

$$Tsl = \frac{bytes\ de\ application}{an\ application} * \frac{8\ bites}{1\ byte} * \frac{solicitud}{1\ segundo} \qquad (1)$$

$$Tráfic Traffico_{readings\ application} \approx 152\ bps$$

The value shown above is the result of adding the bytes of request that is sent to each meter and the response bytes for each meter, then makes the appropriate conversion from bytes to bits and is divided to 1 s.

If all registrars transmit at the same time and with an estimated 1200 clients the result is as follows.

$$Traffic_{accumulated\ readings\ application} \approx 178{,}125\ Kbps$$

The traffic generated by the requests and responses from the readings all registrars is 178.125 Kbps, which is relatively low considering that the data transmission is performed under the IEEE 802.11 a / b / g, which provide speeds higher transmission.

F. Location and coverage of concentrators in the Central Neighborhood of San Antonio.

Figure 10 shows the base station acting as concentrator using the RF output and provide connectivity throughout its in the coverage area.

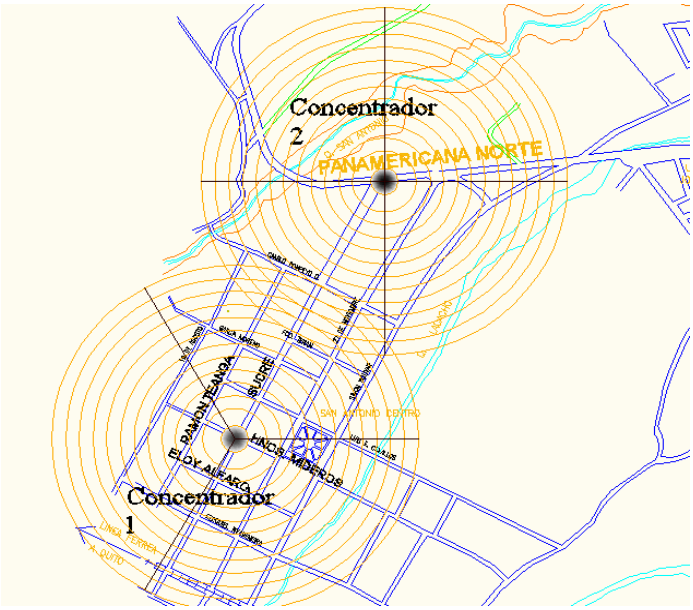


Fig. 10 Location and coverage of concentrators, in the central neighborhood of San Antonio

To achieve operational segmentation makes use of different networks for each output RF as shown in Tables 1 and 2, also making use of routing protocols, to enable classless routing is able to integrate the different networks.

Concengtrator 1 Backhaul		
Nº RF OUTPUT	Subnet name	Mask
RF OUTPUT 1	A.B.C.1	1.2.3.4
RF OUTPUT 2	A.B.C.2	1.2.3.4
RF OUTPUT 3	A.B.C.3	1.2.3.4
Backhaul OUTPUT	A.B.C.4	1.2.3.4

Table 1. Addressing to the concentrator 1

Concentrator 2		
Nº RF OUTPUT	Subnet name	Mask
RF OUTPUT 1	A.B.C.5	1.2.3.4
RF OUTPUT 2	A.B.C.6	1.2.3.4
RF OUTPUT 3	A.B.C.7	1.2.3.4
RF OUTPUT 4	A.B.C.8	1.2.3.4

Table 2. Addressing to the concentrator 2

The name of subnet is A.B.C.D and the mask is 1.2.3.4.

The design presented above is important for the following reasons.

- It is essential to maintain a significant number of IP addresses for allocation of new customers.
- One should think of expanding the network, both in the number of users and coverage.
- By maintaining a physical and logical segmentation is achieved better control of collisions and therefore keep the network more operational.

G. . Fresnel Zones

Besides the sight between the antennas should be considered the first Fresnel zone, there must be at least 60% of clearance in this area all the way link from San Antonio - EMELNORTE.

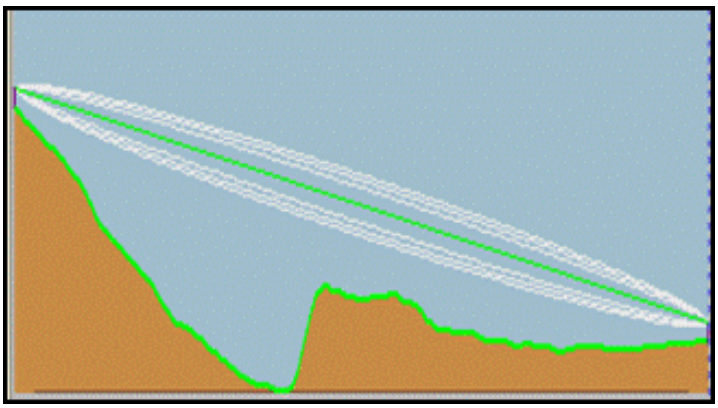


Fig. 11 Fresnel zones Path San Antonio - EMELNORTES.A.

Then calculated the radio for the first Fresnel zone, as shown in Table 3.

$$\boldsymbol{r} = 17{,}32 * \sqrt{[(d1 * d2) \div (d * f)]} \qquad (2)$$

Where:

d1 = distance to obstacle from transmitter [km]
d2 = distance to obstacle from receiver [km]
d = distance between transmitter and receiver [km]
f = frequency [GHz]
r = radio [m]

D1 (Km)	D2 (Km)	RADIO first Fresnel zone (m)	RADIO 60% of first Fresnel zone (m)
0	6,1	0,00	0,00
0,5	5,6	4,87	2,92
1	5,1	6,58	3,95
1,5	4,6	7,65	4,59
2	4,1	8,34	5,00
2,5	3,6	8,74	5,24
3	3,1	8,88	5,33
3,5	2,6	8,78	5,27
4	2,1	8,44	5,06
4,5	1,6	7,81	4,69
5	1,1	6,83	4,10
5,5	0,6	5,29	3,17
6	0,1	2,26	1,35

Table 3. Radius of the Fresnel zone 500m interval.

H. Electronic interfaces Installed in the registrars in the center neighborhood of San Antonio

The homes in which we have implemented the electronic interface with electronic recorders have single phase with the following characteristics:

- 1600 impululses 1 kWh.
- optocoupler Output.
- 110 V / 60 Hz

The following figure shows the installed modules

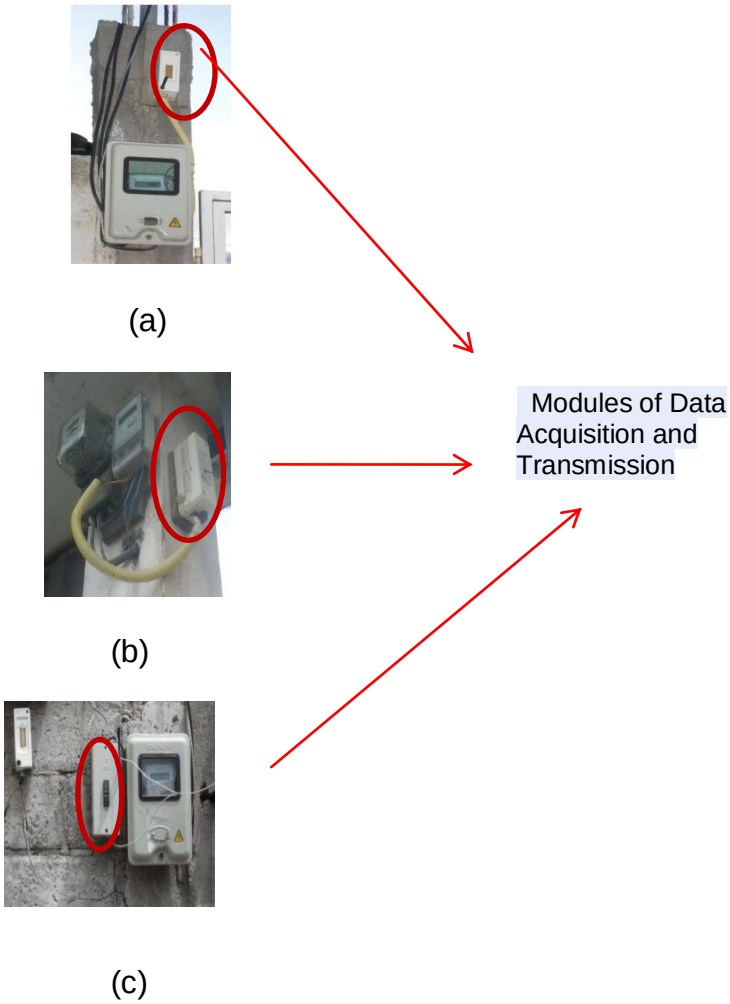


Fig. 12 (a) (b) (c) Data acquisition modules installed in the three test sites.

I. Economic Analysis

The financial study was realized to know the Feasibility of the project implementation, considering the network design, the investment and the cost, the detail shows below:

INVESTMENT			
Materials	quantify	Unit price	Total Price
Radios de transmisión	3	1678,88	5036,64
Antenna 120º	3	350,00	1050,00
Antenna 90º 2,4 GHz	4	393,00	1572,00
Antenna 90º 5,8 GHz	1	350,00	350,00
Grid Antenna 5.8 GHz	1	128,80	128,80
airtight box	3	99,68	299,04
Pigtail	9	39,20	352,80
Line arrestor	9	35,84	322,56
Data Acquisition Equipment	1200	65,00	78000,00
Electronic single phase Metering	1200	12,00	14400,00
Transmission towers	2	2500,00	5000,00
TOTAL			**106511,84**
ENGINEERING AND OPERATIONS CAPITAL			
Ingeniería	1	5000	5000,00
Diseño de Redes	1	5000	5000,00
TOTAL DE DISEÑO (MANO DE OBRA INDIRECTA)			**10000,00**
DIRECT LABOR (AUTOMATION SYSTEM OPERATION)			
Annual Operation	1	2500	2500,00
Annual Maintenance	1	2500	2500,00
TOTAL DIRECT LABOR			**5000,00**
Miscellaneous and Unforeseen	1	12151,18	12151,18
TOTAL INVESTMENT			**133663,02**

Table 4 investment detail

COST CLASIFIER			
DETAIL	Fixed Cost	Variable Cost	TOTAL
Service Coast	974,4		974,4
Direc Labor		6200,00	6200,00
Indirect Labor	10000,00		10000,00
Manufacturing expenses			
Depretation	9248,37		9248,37
TOTAL COST	**20222,77**	**6200,00**	**26422,77**

Table 5. Clasification of Cost

To justify the investment has been income calculation, costs and depreciation of equipment, its has been projected for a period of 15 years and using the inflation rate in the country which in 2009 was 4.31%

Using (3) the relation between the cost and the benefice was obtained

$$Beneficie\ Cost = \frac{\sum incomes\ /(1+i)^n}{\sum Incomes\ /(1+i)^n} = 2.72 \qquad (3)$$

i = discount rate
n = year

The relation between the cost and the benefice of this project is 2.72, this shows the economic viability of it, and settles down that the recovery time of the investment happened at the eight year.

CONCLUSIONES

The acquisition and transmission of readings circuit was designed to offer reliable interface and easy handling for the configuration setting for EMELNORTE CORP. workers, since it possesses characteristics so know like HTTP and Telnet interface.
The wireless network design was structured considering that allows a future expansion, only including new equipment, in the different network layers, at this way it allows enlarge the covering area and increase the number of users.

To connect between San Antonio and EMELNORTE is complete reliable and economically viable since the investment will be recover in 8 year and5 months and the relation between the coast and benefice is about 2.72

to design, to build, to implement, a data acquisition and wireless transmission of the single phase metering readings which is able to automate the gathering of the electronic single phase readings of the clients of EMELNORTE S.A. located in San Antonio.

The implementation of the data acquisition and wireless transmission of readings takes time is working up to now about six months and during this period have not shown operation errors

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