WEB-ENABLED UTILITY METER INTERFACE

Eugen COCA
University "Stefan cel Mare" Suceava
Faculty of Electrical Engineering
13, Universitatii, 720229 - SUCEAVA, ROMANIA
Tel: +40-230-522-978, fax: +40-230-524-801
Email: ecoca@eed.usv.ro

Abstract. *This article presents an utility meter reading interface application using the Internet as a transmission medium. For energy meters, pulses for every quarter of an hour are counted on a local microcontroller and stored on a EEPROM memory, all demand data being transmitted to the energy dispatcher control unit via the Internet communication embedded microcontroller. We used a combination of low cost microcontrollers to interface the existing meters and the utility balance software. The idea may be applied in power substations but is also useful for medium-size consumers who have multiple exchange points with the energy supplier, equipped with standard meters that are able to provide only free potential relay contacts for billing applications. Using standard Ethernet network communications is also a new idea in this field, all data will be available in real time to the energy management unit using IP transmissions. The application was tested in a real life project and does not interfere with the billing data from the meter memory, so there is no need for other legal approvals.*
Keywords: *utility, energy, meter, communications, interface*

Introduction

Real life applications of microcontrollers in the field of utilities and especially electric energy meters focused on developing new devices, most of them communicating over IP networks, without taking into account the large number of old devices, already installed in power stations. This article presents a possible application of a microcontroller system for reading data and load curves from a standard meter, equipped with free potential relay contacts. IP communication links are almost the standard for almost all the electric energy distribution companies. Big and medium size consumers have already installed Internet links, usually available 24 hours a day and 365 days a year. The traffic required to read the data from one meter is between 1 to 10 kbytes per session - depending on the information requested, a negligible quantity compared to the amount of traffic generated by the normal web surfing activity over a 64kbps link. The solutions proposed by this paper include a standard low cost microcontroller used to build the interface between the meter itself and the integrated web server. The embedded web server is also a low cost microcontroller, especially designed to assure the IP over Ethernet network interface communication. The microcontroller used for the tests was from the PIC16F876A family, but the applications works fine with any other standard low cost microcontroller (from the 80C5x family).

The IP communication uses an embedded web-server low cost microcontroller, named SitePlayer™ [1,2]. With a very small number of passive components we may connect this device on a standard Ethernet switch port.

Interface to energy meter

Electric energy meters in use today in our country are induction based ones (without any electronic component inside) or simple electronic meters (with only a small interface generating a number of pulses in relationship with the quantity of energy measured by the meter). The pulses are usually generated on a potential-free relay contacts.

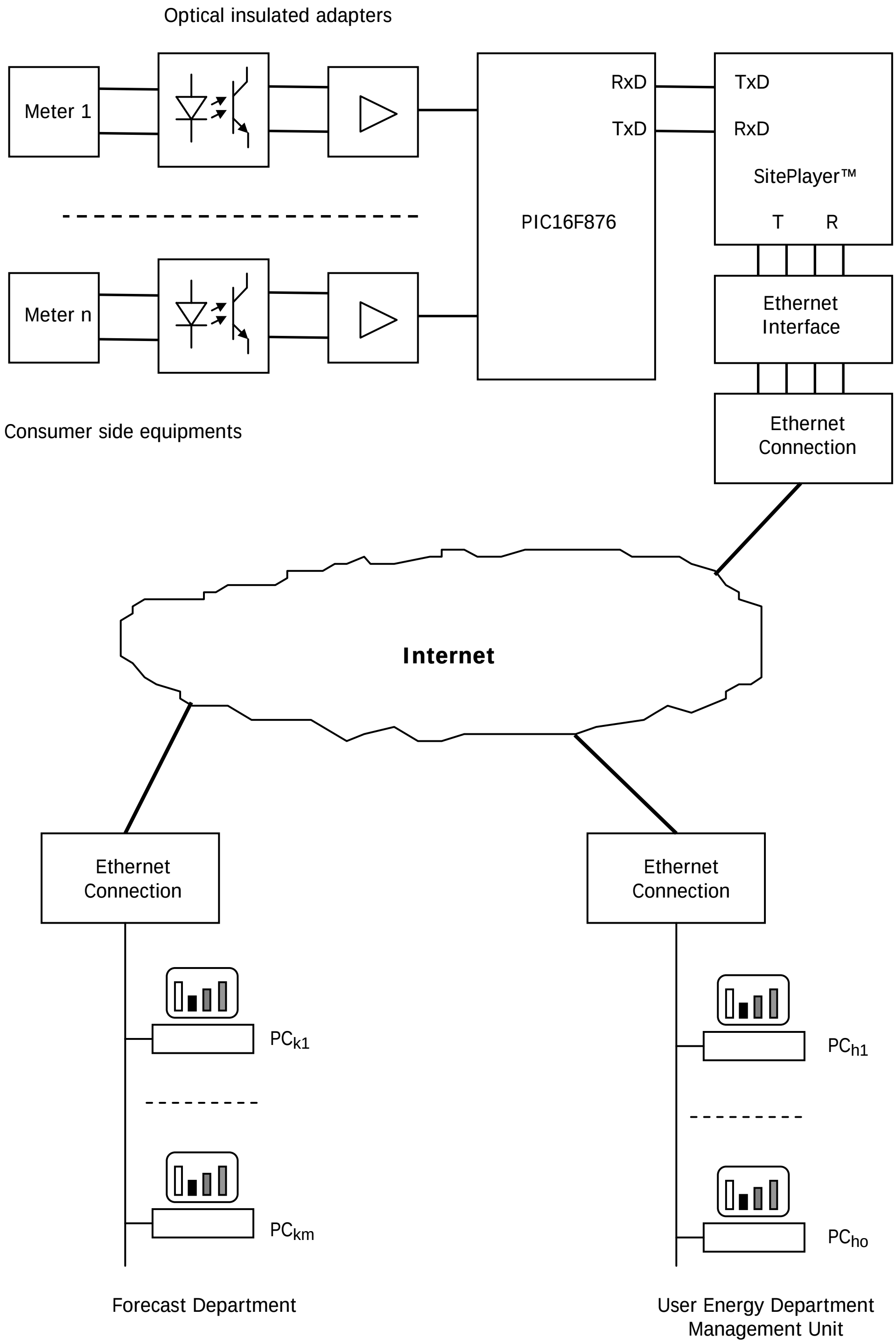

Figure 1. Block diagram of the Internet communication interface

Older induction based meters are equipped with an electronic interface generating a pulse for every disk rotation. The interface proposed by this paper is equipped with all inputs necessary to read four analog inputs, that means the outputs of four different feeder or meters for one completely measured ones (2 inputs for active power and 2 for the reactive power on the feeder). The main advantage of this configuration is that it is not necessary to change anything in the microcontroller software, even we change the feeder or the energy meter [3]. All changes will be made on the client site, without any intervention on the core software. The hardware interfaces are optically insulated from the rest of the electronic components, as shown in Figure 2. High voltages interferences in power substations may lead to input circuit destruction. These inputs are protected from over voltages with varistors and Zener diodes. Fuses are usually inefficient, the time needed to blow up the fuse is much longer than the time needed to damage the interface input. All meter output signals are converted to digital levels in the optical insulated interface logic block. The decoding circuit between the interface logic and the microcontroller itself is necessary in order to avoid any pulse loss. There are to possible strategies to count the pulses. The first one is to scan the input pins of Port D of the microcontroller at known time intervals, fast enough to eliminate any possible pulse lost. A most convenient strategy is to intercalate a decoding circuit witch will generate an interrupt every time a pulse is detected on inputs. If there are more almost simultaneous transitions, the circuit will generate the corresponding code. Due to high working frequency, it is very unusual to loose a pulse with this circuit configuration [4,5].

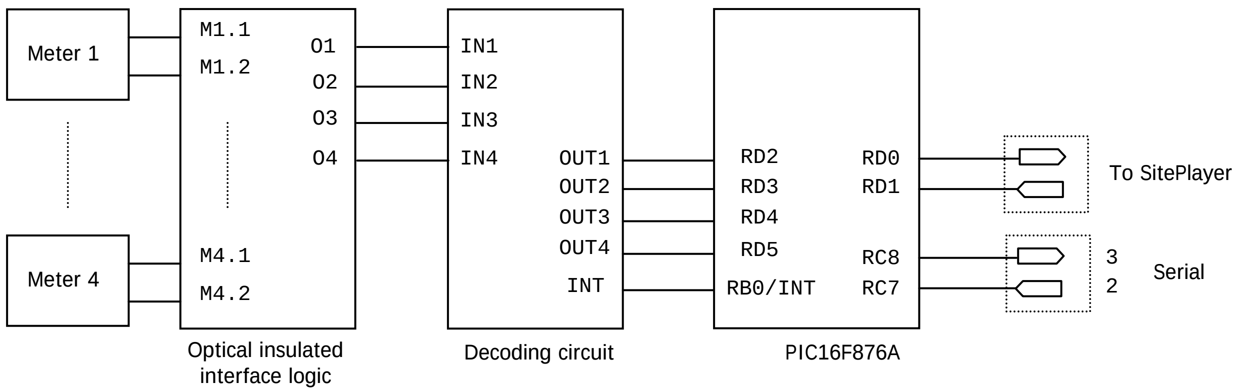

Figure 2. Energy meter to PIC16F876A microcontroller interface

Ethernet network interface

A way to embed the Internet in a device, without writing any TCP/IP source code, is to use an embedded web server. The most powerful solution on the market today is the SitePlayer™ microcontroller, witch could make this task very easy. The only components needed are an external filter that serves as a protection circuit for the Ethernet switch, and a MAX 232 circuit, to provide the levels for a standard RS232C serial interface.

The 16F876A microcontroller has an UART interface on chip. We used it to communicate with the embedded web server circuit, built around the SitePlayer™ Ethernet controller, as shown in Figure 3. The Ethernet connection could be assured in a standard low cost hub or a switch. The link to the dispatcher unit may be via a low speed modem link (at least 1200bps) or a high bandwidth one, like a cable or a wireless link, depending on the number of meters in the substation [6]

.

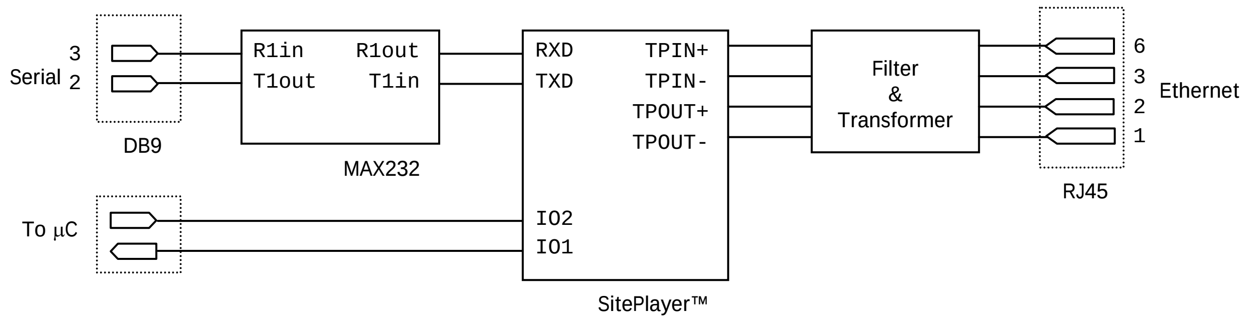

Figure 3. SitePlayer™ to PIC16F876A interface

Conclusions

Electric energy meters in use today are mostly induction based ones (without any electronic component inside except of an interface delivering electric pulses on every disk rotation. Large consumer's feeders are equipped with such meters too. The need to reduce energy consumption requires a fair evaluation of energy absorbed on each exchange point. This is done now by counting the pulses on every meter by an 8 bit microprocessor device and delivers them, via a RS232 interface and a low speed modem, to a control room. The interface circuit proposed in this paper is able to change this vision, by integrating the energy meters in the company Intranet network, using top technology solutions, without changing the energy meters and with minor modifications in balance software. All circuit components are easily to integrate on a custom ASIC or even on a SOC device, reducing the costs at a minimum. Further developments are studied by our team; the main challenge is to design a device capable to be integrated in a local wireless network, eliminating all the wires between the meter and the communication equipment in the power station.

References

[1] ***, *SitePlayer™ SP 1 Embedded Ethernet Web Server Coprocessor Module*, NetMedia Inc., 2000
[2] ***, *SitePlayer™ SPK1 Web Server Coprocessor Developer Kit*, NetMedia Inc., 2001
[3] ***, *PICmicro Mid-Range MCU Family Reference*, MicroChip, 1997
[4] Palmer, M., *Low-Power Real Time Clock*, MicroChip, 1999
[5] Souza, S., *Automatic Calibration of the WDT Time-out Period*, 1997
[6] Kurzweil, J., *An Introduction to Digital Communications*, J.Wiley&Sons, 1999