Abstract—A novel method of recording energy at the consumer premises and remote reading of energy from a central location is developed. A micro controller based energy meter records energy at the consumer premises and fibre optic link is used for communication between the energy meter and central computer. This method can be extended to read consumer voltage, current, power, etc and to isolate non-critical load agencies in emergencies.

Index Terms—Inter integrated circuit, Master slave synchronous port, Peripheral interrupt controller, Universal synchronous asynchronous receiver transmitter

I. INTRODUCTION

The State Electricity Boards supply power to millions of consumers. Periodically Electricity Board employees visit the consumers’ premises to take energy meter readings. Later, the consumers are given bills. Reading energy meters by sending persons to different premises is time consuming as well as unreliable. Network computers are used in a factory environment for data collection and control [1]. Authentication mechanisms can be built using microprocessor based local area network so that only authorized persons can access data [2]. If energy meter reading of thousands of consumers can be taken quickly using computer networking, it will be definitely more advantageous than conventional methods.

There is great advancement in microcomputer technology. The peripheral features of the micro controller, which are of significance, include the serial communication module and the Universal Synchronous Asynchronous Receiver Transmitter (U.S.A.R.T.). [3] Peripheral Interrupt Controller (P.I.C.) is a member of the micro controller family. P.I.C. device can be used along with suitable voltage and current sensors to record electric energy consumed[4]. The output port can be used to control different parallel circuits in the consumer premises. The core aspects of the micro controller like interrupt capability and flash memory are put to use to sense the electrical energy and transferring the data through optical fibre. For the purpose of this work 8 bit microcontrollers (P.I.C. 16 series) are used.

The second section of the paper depicts the structure of P.I.C. series and the hardware realization of energy recording.

The third section explains the fibre optic link and the protocol used for data transfer. The conclusions of the work and suggestions for further development are given in fourth section.

II. ENERGY MEASUREMENT AND REMOTE DATA READING

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Fig. 1. Block diagram scheme for reading energy using a central computer

Fig. 2. Block diagram of energy meter
Fig. 1. shows the block diagram of the integrated unit where a number of energy meters are linked with a central computer through a fibre optic cable. Each micro controller has master synchronous serial port (M.S.S.P.) and this port is utilized for linking the energy meter to the central computer. For the laboratory module 128 energy meters can be linked in this way.

A microcontroller based energy meter is constructed using P.I.C. The different blocks of this energy meter are shown in Fig. 2.

The voltage and current at the consumer end are sensed using potential transformer and current transformer respectively. The output of current transformer and potential transformer are fed to the power IC which samples the voltage and current and computes instantaneous power, R.M.S. value of voltage and current. The time integration of instantaneous power gives energy consumed. All the data are stored in P.I.C. and can be read.

III. COMMUNICATION IMPLEMENTATION

The entire communication between the microcontrollers and the computer is indicated in Fig. 3.

Communication is done between the two microcontroller devices using an M.S.S.P. module present in P.I.C. For the purpose of the work I^2C protocol with master slave support is used. Two pins of the P.I.C. are used for data transfer. These are the S.C.L. (serial clock) pin, and the S.D.A (serial data) pin. Before selecting any I^2C mode, the S.C.L. and S.D.A. pins are to be programmed to inputs by setting the appropriate bits. The S.S.P. module has six registers for I^2C operation. They are:

(i) S.S.P. Control Register 1 (S.S.P.CON1)
(ii) S.S.P. Control Register 2 (S.S.P.CON2)
(iii) S.S.P Status Register (S.S.P.STAT)
(iv) Serial Receive/Transmit Buffer (S.S.P.BUF)
(v) S.S.P. Shift Register (S.S.P.S.R.) - Not directly accessible
(vi) S.S.P. Address Register (S.S.P.ADD)

The S.S.P.CON1 register allows I^2C slave mode to be selected with 7-bit address. The S.S.P.STAT register gives the status of the data transfer. The S.S.P.BUF is the register to which transfer data is written to or read from. The S.S.P.S.R register shifts the data in or out of the device.

In receive operations, the S.S.P.BUF and S.S.P.S.R create double-buffered receiver. This allows reception of the next byte to begin before reading the last byte of received data. When the complete byte is received, it is transferred to the S.S.P.BUF register.

The S.S.P.ADD register holds the slave address.

In slave mode, the S.C.L. and S.D.A. pins are configured as inputs. The S.S.P. module will override the input state with the output data when required (slave-transmitter). When an address is matched or the data transfer after an address match is received, the hardware automatically will generate the acknowledge (ACK) pulse, and then load the S.S.P.BUF register with the received value currently in the S.S.P.S.R.

Fig. 3. Flowchart for communication implementation between central office and the energy meters

The computer in the central office transmits the address of the energy meter whose energy needs to be displayed to the microcontroller using U.S.A.R.T (Universal Synchronous Asynchronous Receiver Transmitter). The communication sequence is indicated in Fig. 4.

The transmit sequence of the microcontroller placed in the central office is shown in Fig. 5. and data reception sequence in shown in Fig. 6.
The information reaches the energy meter through a fibre optic link. The various steps to be followed for reception and transmission of data in the energy meter are indicated in Fig. 7.

The sequence of reception and display of data on the computer is shown in Fig. 8.
Fig. 6. Reception of data by the microcontroller in central office.

Fig. 7. M.S.S.P. Reception cum transmission in the microcontroller based energy meter data from energy meter.
IV. CONCLUSIONS

A P.I.C. 16F873 based energy meter is implemented for sensing voltage and current. A potential transformer and current transformer are used. An optical fibre link is developed based on I²C protocol for transmitting and receiving data. Work is under way for interfacing with computer.

V. REFERENCES