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3PHASE ENERGY METER USING MCP 3909

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ABSTRACT

The purpose of this paper is to develop a 3-phase Energy Meter, using PIC32MZ2048ECG064 microcontroller and MCP3909 energy metering IC. Basically, the energy meter is designed to measure the energy, equivalent to the power consumption over time, using frequency output from MCP 3909.Analog signals will be detected from the two input channels, which will be converted into digital signals by ADCs respectively. With the two digital input voltage and current signals transmitted to the microcontroller PIC32MZ2048ECG064 calculates the active power.

***Keywords*: Active power, MCP3909 Energy metering IC, PIC32MZ2048ECG064 Microcontroller.**

I. INTRODUCTION

Electrical Energy is becoming very important in human life day to day. We never think the life without the electrical power because human survival and development totally depends over it. Energy monitoring of commercial consumer is becoming critical now a day's.

This paper helps the consumer to manage screening and monitoring their energy use for each phase in watts. Energy meter with a display outside their homes and industries could provide up-to-date information on electricity consumption and in doing so help people to manage their energy use.

In this application a 3-phase 4 wire (star configuration) energy meter is designed using 32 bit PIC microcontroller and MCP3909. In this approach the 3-phase energy meter is unique in fact all the calculations take advantage of microcontroller, and all output quantities are calculated in frequency domain. The PIC32MZ devices belong to the PIC family devices. These find its application in energy measurement and have the necessary architecture to support it.

The intention of this project is to come out with a design of a prototype for three phase energy meter. The function of this prototype is to calculate measured power and energy with high accuracy. The objective of this prototype design of a three phase energy meter is to be at a low cost, high precision accuracy in measurement of energy and power.

II.OBJECTIVE

The objectives of proposed work are as follows:

1.To develop an efficient and intelligent energy monitoring System for electricity board.

2.To calculate and monitor Active power of each phase.

3.The meter will be capable of displaying and monitoring energy in KWH for three phase four wire A.C.

4. The meter will be also capable of displaying and monitoring energy in WH for three phase four wire A.C.

5. The meter is able to measure and display number of units consumed per month.

6. The meter is also able for displaying the load connected to each phase in Watts.

III.METHODOLOGY

The advanced metering system includes current transformer unit and voltage transformer, energy meter IC, PIC controller, RTC & LCD display.

Step1: The voltage and current transformer units feed the current and voltage signal from the supply and send to each phase(R, Y, B) energy metering IC MCP3909.

Step2: The energy meter IC produces digital data after getting current and voltage signal from the CT and PT.

Step3: The pulse output is transferred to PIC for further calculation of unit additional and does the functions according to the program loaded in it.

Step4: LCD display shows the total unit consumption, date, time.

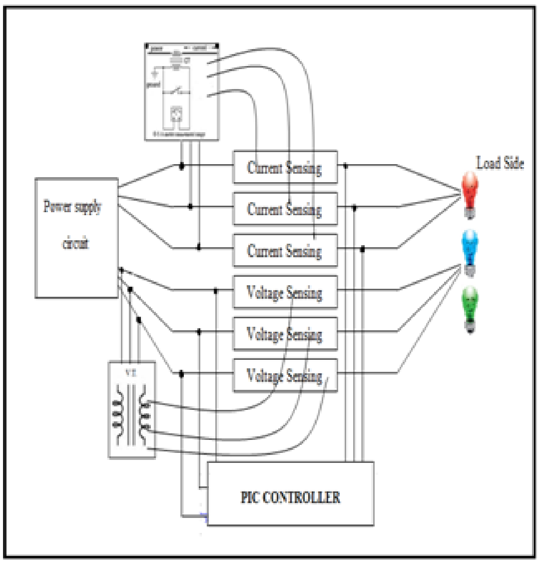

Fig. 1: Background of project.

IV.WORKING

When power is on CH1+ (pin 8) and CH1- (pin 7) of MCP 3909 gets voltage input from voltage transformer (PT) through 1k ohm resistor which in the range of 6mv to 660mv max. Also CH0+ (pin 5) and CH0- (pin 6) of MCP 3909 gets current input from current transformer(CT), as current input cannot be connected directly to MCP 3909 voltage is generated by connecting 1k ohm resistor across CT.

The ADCs used in the MCP3909 for both current and voltage channel measurements are delta-sigma ADCs. They comprise a second-order, delta-sigma modulator using a multi-bit DAC and a third-order SINC filter. Both ADCs have a 16-bit resolution, allowing wide input dynamic range sensing. The oversampling ratio of both converters is 64. Both converters are continuously converting during normal operation. When the MCLR pin is low, both converters will be in Reset and output code 0x0000h. The clocking signals for the ADCs are equally distributed between the two channels in order to minimize phase delays to less than 1 MCLK period. The MCP3909 contains an internal voltage reference source specially designed to minimize drift over temperature. This internal VREF supplies reference voltage to both current and voltage channels ADCs. The typical value of this voltage reference is 2.4V ±100 mV.

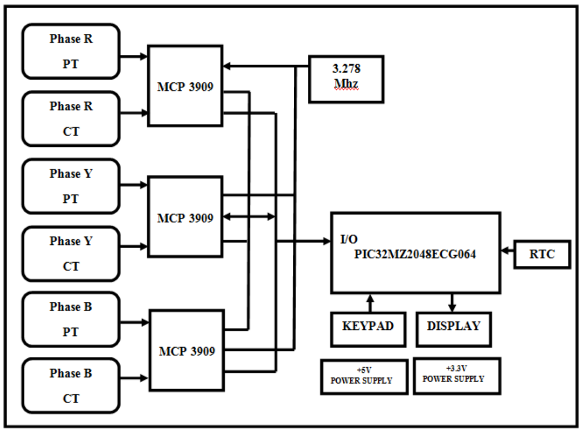

Fig. 2: Block Diagram

RTC DS1307 is used to update time and date in microcontroller to keep track of current date and time. RTC DS1307 is powered separately by using battery because in case if power is cut RTC should keep on working without losing date and time information. RTC can be programmed using keyboard provided with energy meter

4.1 Calculation of Active Power

The instantaneous power signal contains the active power information; it is the DC component of the instantaneous power. The averaging technique can be used with both sinusoidal and non-sinusoidal waveforms, as well as for all power factors. The instantaneous power is thus low-pass filtered in order to produce the instantaneous real-power signal. A digital-to-frequency converter accumulates the instantaneous active real power information to produce output pulses with a frequency proportional to the average real power. The low-frequency pulses present at the FOUT0 and FOUT1 outputs are designed to drive electromechanical counters and two-phase stepper motors displaying the real-power energy consumed. Each pulse corresponds to a fixed quantity of real energy, selected by the F2, F1 and F0 logic settings. The HFOUT output has a higher frequency setting and less integration period such that it can represent the instantaneous real-power signal. Due to the shorter accumulation time, it enables the user to proceed to faster calibration under steady load conditions [10]

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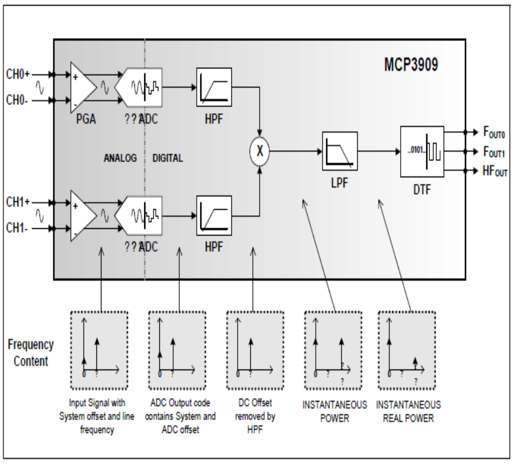
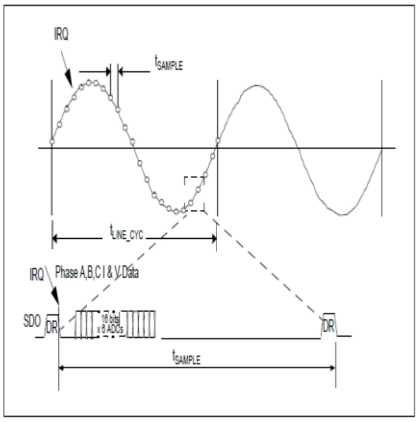


Fig. 3: Active Power signal flow with frequency contents.

4.2 Active Power Low Pass Filter

For the active power signal calculation, the MCP3909 uses a digital low-pass filter. This low-pass filter is a first-order IIR filter, which is used to extract the active real-power information (DC component) from the instantaneous power signal. Due to the fact that the instantaneous power signal has harmonic content and since the filter is not ideal, there will be some ripple at the output of the low-pass filter at the harmonics of the line frequency. The cut-off frequency of the filter (8.9 Hz) has been chosen to have sufficient rejection for commonly-used line frequencies (50 Hz and 60 Hz). The output of the low-pass filter is accumulated in the digital-to-frequency converter. This accumulation is compared to a different digital threshold for FOUT0/1 and HFOUT, representing a quantity of real energy measured by the part. Every time the digital threshold on FOUT0/1 or HFOUT is crossed, the part will output a pulse. The equivalent quantity of real energy required to output a pulse is much larger for the FOUT0/1 outputs than the HFOUT. Averaging the output pulses with a counter or a MCU in the application will then remove the small sinusoidal content of the output frequency and filter out the remaining ripple [10].



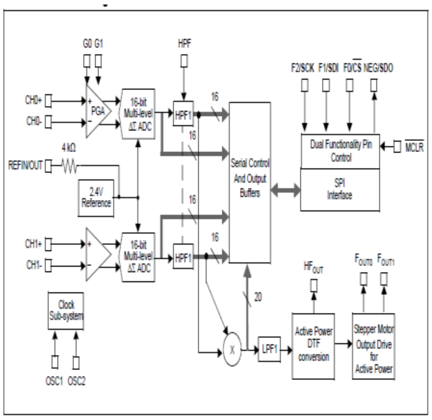


Fig. 4:Data Access Fig. 5: Working at MCP 3909.

4.3 Foreground Process

The initialization routines involves the setup of the MCP 3909, Clock System, LCD controller, general purpose input/output (port) pins, timer and the Universal Serial Communication Interface (USCI) for UART functionality. A check is made if the main power is OFF; the background process notifies the foreground process through a status flag every time a frame of data is available for processing. This data frame consists of accumulation of energy for 1 second. This is equivalent to accumulation of 50 or 60 cycles of data samples synchronized to the incoming voltage signal. In addition, a sample counter keeps track of how many samples have been accumulating over the frame period. This count can vary as the software synchronizes with the incoming mains frequency.

4.4 Background Process

The background process uses the SD16 interrupt as a trigger to collect voltage and current samples for each phase. These samples are further processed and accumulated in dedicated 48-bit registers. The background function deals mainly with timing critical events in software. Once sufficient samples have been accumulated then the foreground function is triggered to calculate the final values of VRMS, IRMS, power and energy.

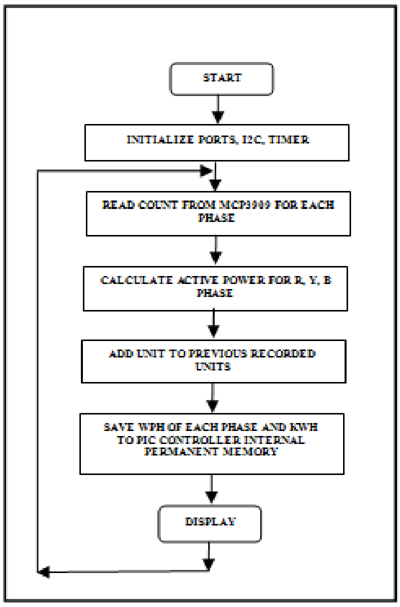


Fig. 6: Flow diagram

V.FUTURE SCOPE

1. A mini printer can be interfaced to get a printed bill or details of billing.
2. The controller is precise, predictive and informative to get alarm and trip when the threshold limit is crossed.
3. Many other parameters can be calculated such as voltage, current, reactive power, power factor.
4. Energy meter can be interfaced to Computer through UART.
5. GSM module can be interfaced with meter for billing purpose.

VI. CONCLUSION

In this paper, a low cost PIC-controller based three phase energy measurement unit has been discussed that can sense the fault in the PT secondary circuit and always displays the actual consumed energy both under normal and faulty conditions provided the power circuit is in healthy condition. The proposed energy meter also affords significant accuracy at the presence of harmonics. The absence of rotating parts in the measuring unit helps in the prevention of frauds due to tempering which is another attractive feature for the utilities. The developed scheme is cheap, fast, highly reliable and provides enough flexibility to suit the requirements of different systems. Moreover, a lot of extra facilities such as monitoring power factor, indication of maximum demand, calculation of unit cost including fuel surcharge, government duty, meter rent etc. can be introduced changing only the software.

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