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Measurement, Monitoring of DC Voltage and frequency of a Trivector meter by using PIC-Microcontroller

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Abstract: *this paper presents the measurement, control and monitoring of DC voltage and frequency of a Trivector meter, since the exact measurement of DC voltage and frequency is required for the accurate calculation of power consumption of a load. The program written in C is embedded to the PIC Microcontroller which will have a complete function of the hardware parts which are used, here the C compiler i.e., Hi-tech PIC C and MPLAB will be inter linked, since MPLAB controls the hardware part. The 8 input lines of voltage are given to the microcontroller and give one output. Also the input lines of voltage will be 230V but the microcontroller capacity is only 5V so stepping down of voltage is necessary. Another input is frequency, for that it is necessary to find the rising time and falling time so that the counter value should know to give the exact value of frequency between 1Hz to 1 KHz. The Controlling of 4 Relays has been done here. The input lines are monitored to check whether the input is transmitting correctly or else it will transmit back. MCM System is a microcontroller based system which gives accurate DC voltage of series connected load and frequency of the voltage.*

Keywords: *Trivector meter; PIC-Microcontroller;MPLAB; Hi-tech C compiler;Relay*

I. Introduction

Nowadays, the use of microcontroller in various application such as automotive and transportation consumer and portable electronics, Industrial, Medical and Smart grid. Microcontrollers are hidden inside a number of consumer and commercial products from microwaves to TVs and more, allowing a device to interact with user through the embedded processor within. A broad range of microcontroller allows for ultra-low power to real-time control functionalities for the suite of embedded design solutions. Here we preferred PIC microcontroller because of its code efficiency, safety, instruction set, speed, static operation, drive capability and its versatility. Also a range of speed, temperature, package, I/O lines, timer functions, serial commands and memory sizes is available from the PIC family to suit virtually all your requirements [2]. The PIC executes instructions from program memory in sequential addresses, starting from address zero, when the PIC is reset upon power-up. The address of the current instruction being executed is given in a special register [3]. Microchip (PIC16F877A) microcontroller has 40 pins, which is used for controlling the input lines, measuring DC voltage and frequency and monitoring the input lines of Trivector meter. Basically the microcontroller work with DC voltage of 5V. The voltage is regulated in to 5V by using an Adaptor. Trivector meter can measure active power, reactive power apparent power i.e., with the help of single meter we can measure KVA, KW, KVAR. The power triangle is sum of (KW, KVA, and KVAR). The C language is used to write a program; C is a portable language intended to have minimal modification when transferring programs from one computer to another. The use of C in Microcontroller applications has been brought about by manufacturers providing larger program and RAM memory areas in addition to faster operating speeds. Since the software controls a microcontroller, it has almost unlimited applications otherwise it is a lump of plastic, metal and purified sand, which without any software, does nothing. [1] Trivector meter is electronic type energy meter which measures energy parameters, like active energy, reactive energy, apparent energy, power factor, frequency etc. Through which we can know how much energy received or sent [4]. The Trivector meters are normally used in substations and to measure the power flowing through the feeders. They are used for billing power drawn by industrial customers. The Trivector enables the simultaneous measurement of different electrical parameters which enables accurate assessment of the power consumed. The MCM system is used to accurate measure of voltage and frequency of the number of Trivector meter connected in a group.

Parameter Name	Value
Program Memory Type	Flash
Program Memory (KB)	14
CPU Speed (MIPS)	5
RAM Bytes	368
Data EEPROM (bytes)	256
ADC	8 ch, 10-bit
Pin Count	40

The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface or the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

II. Design And Implementation

The PIC-Microcontroller works only with the 5V DC supply; hence 230V AC supply is converted to a DC supply by power circuit. Power circuit consists of a isolation transformers, full wave rectifiers, IC7805, LED, switch, capacitors. Rectifier converts the 230V DC supply into the 6V DC supply. There are two types of capacitors are used: Ceramic capacitors and Electrolytic capacitors. Ceramic capacitors are used when very low capacitance values are required. Electrolytic capacitors are used when very high capacitance values are required. These capacitors helps to reduce the ripple voltage or for coupling and decoupling applications. They are used only for DC supply. Ceramic capacitors exhibits large non-linear changes in capacitance against temperature and as a result are used as decoupling or bypass capacitors as they are also non-polarised devices. The 1000µF capacitors are used at the output terminals to reduce the ripple in the DC voltage.

IC7805: A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them to have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate. The AC power supply gets converted into constant DC by this circuit. By the help of a voltage regulator DC, unregulated output will be fixed to a constant voltage. The circuit is made up of linear voltage regulator. IC7805 along with capacitors and resistors with bridge rectifier made up from diodes. From giving an unchanging voltage supply to building confident that output reaches uninterrupted to the appliances.

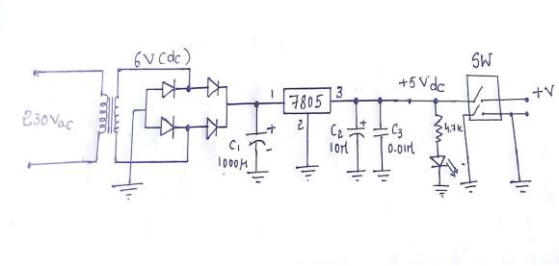

Fig a: Power supply section

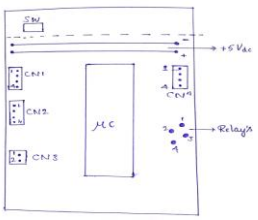

Fig b: Mother board layout

Mother Board:

The mother board consists of Power circuit, CN1, CN2, CN3, and CN4.

Power circuit converts 230V to 5V and gives supply to the circuit; an LED will be blinked if there is a proper connection between the circuit.

CN1 (Connection1) has 4 inputs of voltage which is drawn from power circuit this terminals will connected to RA0, RA1, RA2 and RA3 channels of microcontroller in order to measure the DC voltage.

CN2 has 4 inputs of voltage which is also drawn from power circuit this terminals will connected to RA5, RE0, RE1 and RE2 channels of microcontroller in order to measure the DC voltage which is also a analog to digital converter channel.

CN3 has 2 inputs terminals in which the signal is given from frequency generator. The positive terminal is given to RC2 channel of microcontroller and negative terminal is grounded.

CN4 has 4 Channels for input monitoring purpose, these channels are connected to RB4, RB5, RB6 and RB7 terminals of microcontroller.

RS232 CIRCUIT:

RS-232 is a standard communication protocol for linking computer and its peripheral devices to allow serial data exchange. In simple terms RS232 defines the voltage for the path used for data exchange between the devices. Simple analog communication over the telephone wires to the typical USB cables for data exchange, we surely have come a long way in the field of communication. RS232 was the first milestone reached in this journey. It was a standard for electromechanical typewriters and modems for digital data exchange introduced in 1962 by the Radio Sector of EIA. It made the data exchange more reliable over analog channel. The standard defined voltage levels that made it immune to noise disturbances and reduced the error in data exchange. RS232 was the only available standard at the time which was used for data exchange. So, they thought of adopting this

standard in electronic devices for digital data exchange. But the standard was unable to fulfil the requirements as it was developed specifically for modem and teletypewriter. To overcome this problem, designers started implementing an RS232 interface compatible to their equipments.

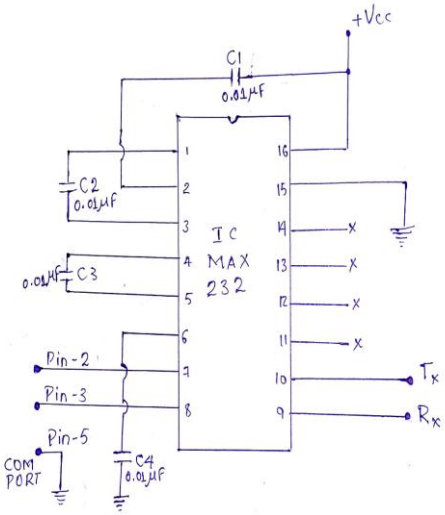

Fig c: RS232 circuit

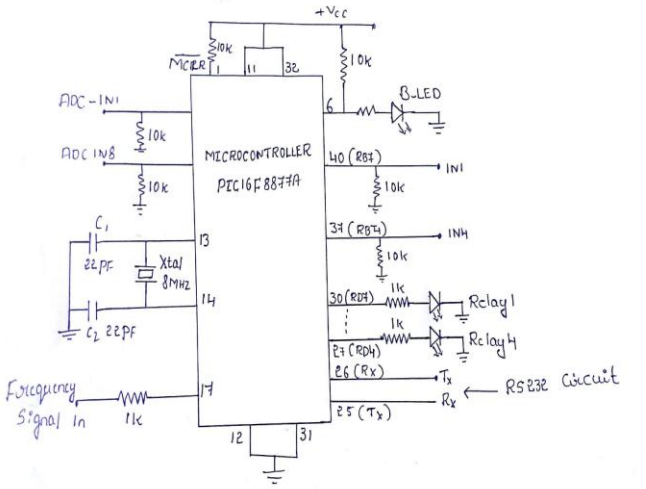

Fig d: Main mother board circuit

Main Motherboard Circuit:

The PIC microcontroller is a low cost 'computers on a chip manufactured by Microchip. They allow electronic designers and hobbyists impart intelligence and logic to a single chip for special purpose applications and products. The PIC microcontroller programming is done using the popular software 'Mikro C'. This powerful yet easy to program into a 40-pin package is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices.

PIC16F877 is one of the most advanced microcontrollers from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on. The PIC16F877 features all the components which modern microcontrollers normally have.

Following are the Pin configuration of PIC-microcontroller.

Pin 1 – $\overline{\text{MCLR}}$
Pin 2, 3, 4, 5, 7, 8, 9, and 10 – ADC Inputs
Pin 6 – RA4
Pin 11 – +VCC
Pin 12 – GND
Pin 13 & 14 – Crystal capacitors
Pin 15 & 16 – Not connected
Pin 17 – Frequency Input
Pin 18 to 24 – Not connected
Pin 25 – RX
Pin 26 – TX
Pin 27 to 30 – Relays
Pin 31 – GND
Pin 32 – +VCC
Pin 33 to 36 – Not connected
Pin 37 to 40 – Input monitoring

III. Results And Discussion

The power circuit showed in fig a gives the power supply to the circuit. As soon as the circuit turn on the circuit activates, the measurement of voltage is given as

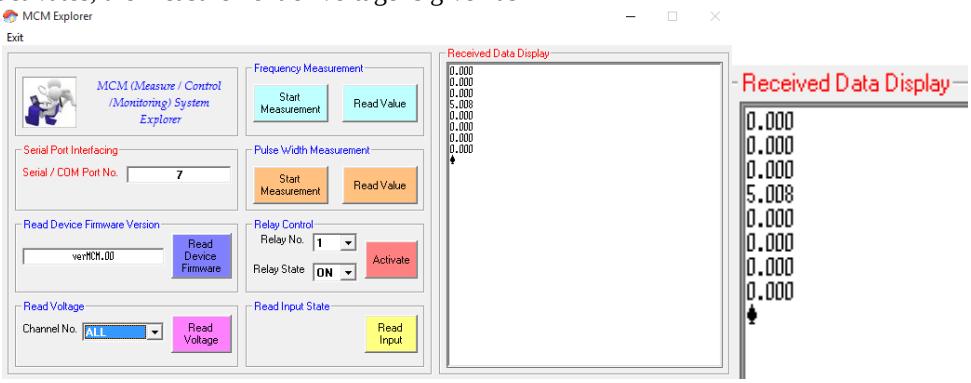

Fig e: Voltage Measurement

The output of Frequency measurement is

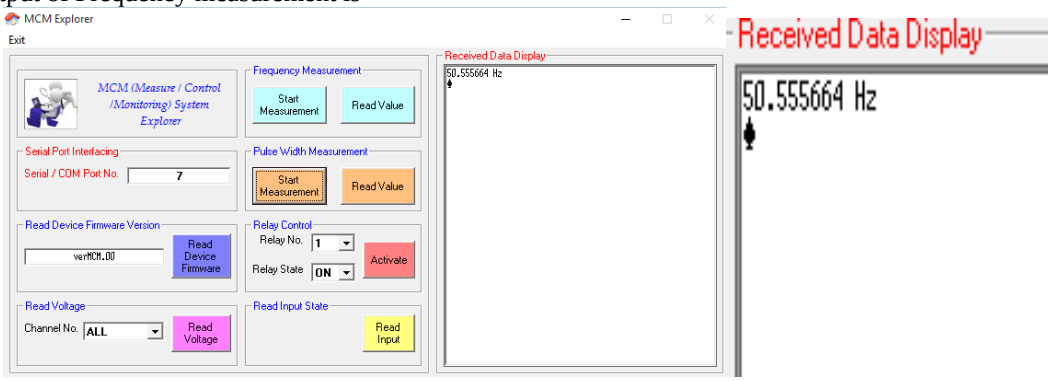

Fig f: Frequency Measurement

Pulse width measurement is shown below,

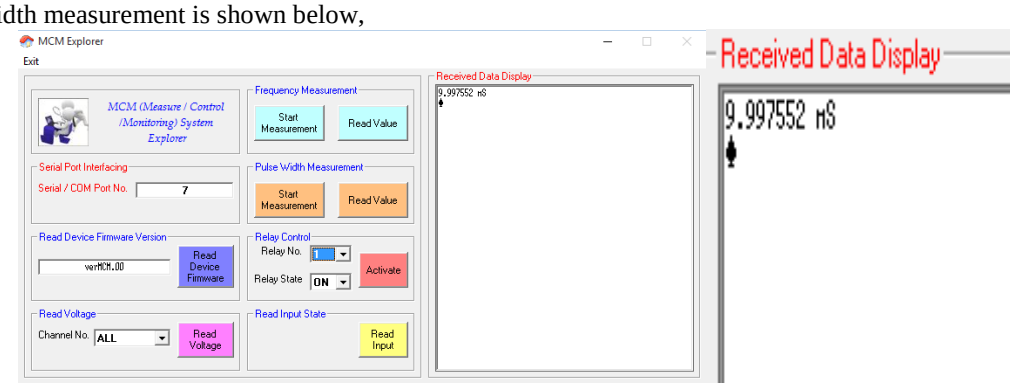

Fig g: Pulse width measurement

Output of Relay Control

Fig h: Relay control when Relay is ON

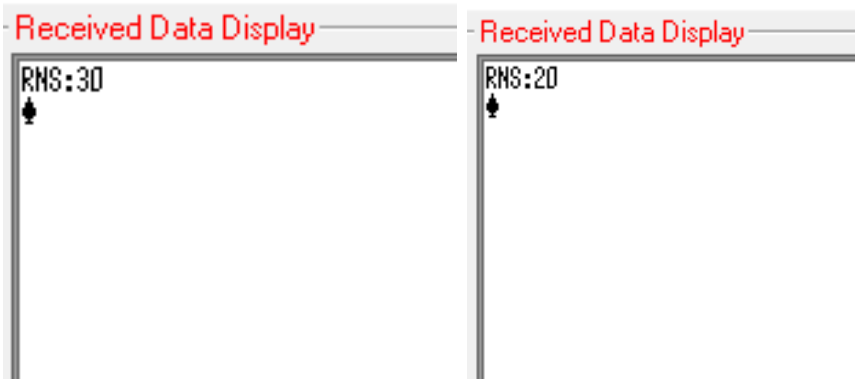

Fig h: Relay Control when relay is OFF

To read input state and monitoring of Input,

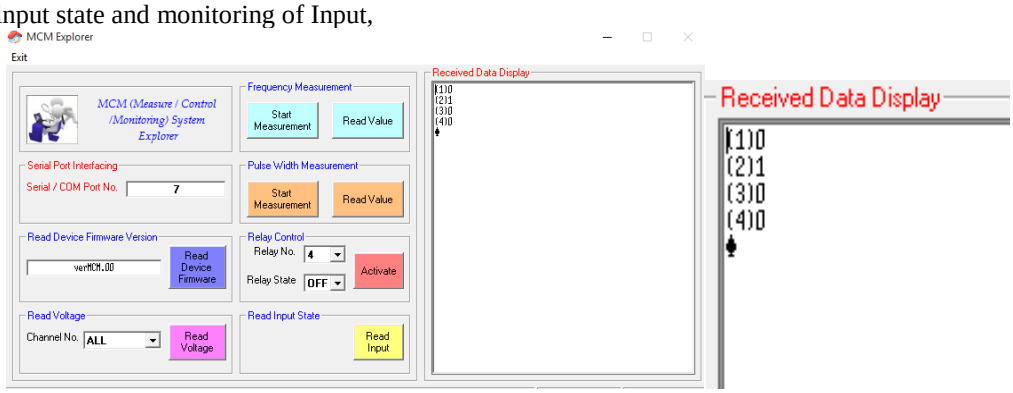

Fig i: Monitoring of Input

IV. Conclusion

In Industries we cannot measure the all voltage using an Energy meter so that we use MCM system to get accurate reading of the entire energy meter. It is a flexible device and it can be used to other maters except Trivector meter. Also it can continuously monitor the input lines and can control the Relays accurately.

Acknowledgement

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