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SOLAR BASED AIR COMPRESSOR FOR CAR/BIKE TIRE INFLATE

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ABSTRACT: With the increased urge for the vehicles in the day to day life for today's generation has led to have a continuous review over the status and working condition of the vehicles. Basically the inflation of the tire and its wear condition. One of the presently used methods is, using the compressors running on the electricity. This manual or electric inflation causes following difficulties.

- ***Heavy force is required manually to push the piston along with the bearing in the head stock bore.***
- ***Regular increase in the electric fares.***
- ***Unreachable to the remote areas, where electricity is still a dream.***
- ***Not safe for the user on a monetary basis.***

This project is to design and fabricate to minimize manual work as well as to use renewable source of energy by using a solar panel and to overcome the above difficulties. Designing and Fabrication of solar based air compressor has the following merits,

- ***Environmental friendly.***
- ***More economical, as solar energy is abundantly available.***
- ***Continuous monitoring of air pressure on LCD.***
- ***Easy to maintain.***

This process started from the literature survey. Some of the papers reviewed were "Dynamically self inflating tire system". Accordingly a PIC microcontroller is used in this project. Micro controller has the input modules like pressure sensor, control buttons and output modules are LCD display, compressor switching driver and buzzer to give alarm in case of high pressure.

Keywords: PIC microcontroller, Pressure sensors, LCD display, Compressor, Buzzer .

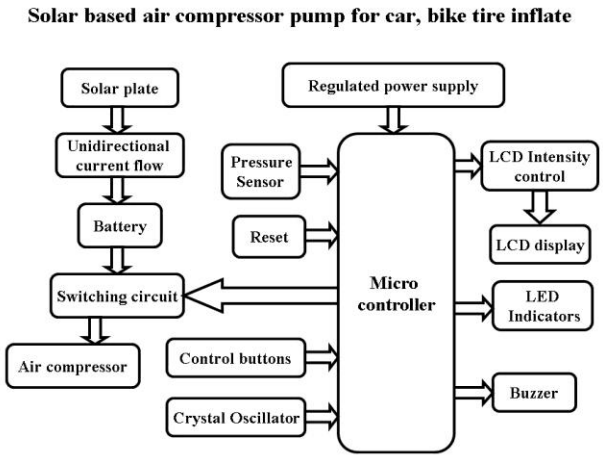
I. INTRODUCTION

With the existing push in the direction of sustainable, clean sources of power, it is no surprise that solar power has become one of the most popular alternative energy sources. Free and available everywhere, the power of the sun can be employed to power everything like cell phones and motors. The sun's energy is usually harvested through solar panels that are made up of photovoltaic cells. These cells can convert the sun's power into electricity that can be used for a number of purposes. For private use, a handheld solar hybrid charger can be employed to recharge little device for instance a DC fan, a cell phone, or a camera. This project consists of Microcontroller based control unit that continuously monitors and controls the air pressure. This live pressure value gets display on Alpha Numeric LCD display in real time.

Regulated output of Solar cell is connected to rechargeable battery through a unidirectional current flow circuitry. This particular charged battery output given as input to the air compressor motor, this motor will controlled by the user manually using control buttons and also automatically by micro controller by a set point. In this project micro controller has the input modules like pressure sensor, control buttons and output modules are LCD display, compressor switching driver and buzzer to give alarm in case of high pressure..

Fig 1.1: Working model of the solar based air compressor.

II. WORKING PRINCIPLE



The photons or solar energy from the sun are trapped by the photovoltaic cells present in the solar panels. Which is made to flow in a unidirection way to the battery such that the battery does not discharge back. The battery is connected to switching circuit which finally drives the air compressor by turning it on. On the other hand, the switching circuit is made to work on the basis of the instructions given from the PIC microcontroller, which is the heart of the project. The pin 1 of the microcontroller is connected to the control buttons. The pin 9 and 10 are attached with crystal oscillator, the purpose of external crystal oscillator is to speed up the execution part of instructions per cycle and here the crystal oscillator is having 20 MHz frequency. One of the regulated power supply circuit is used to control the flow of input voltage to the microcontroller. LED and LCD indicators are used in the 27 and 21 pin position of the PIC microcontroller. LCD displays intensity is controlled by the LCD intensity controller. The pressure sensors are also connected to sense the pressure of the tire to be inflated. If the pressure is found to be maximum then a buzzer beeps making a sense to reset the circuit. Such that the whole project model comes to its initial conditions.

III. ADVANTAGES OF SOLAR BASED AIR COMPRESSOR.

- Dynamic tire pressure setting.
- Usage of Solar energy.
- Continuous monitoring of air pressure on LCD.
- Alerts of improper inflated tires.

IV. MATERIAL SPECIFICATION

Selection of solar based air compressor materials depends on any considerations, which can in general be categorized as cost and technically overall performance. Cost includes initial material cost, manufacturing cost and maintenance cost. The key material properties that are pertinent to maintenance cost and overall performance are

- size of the solar panel
- capacity of the battery
- Power of the air compressor

4.1 PIC MICROCONTROLLER

PIC stands for Peripheral Interface Controller given by Microchip Technology to identify its single-chip microcontrollers. These devices have been very successful in 8-bit microcontrollers. The PIC16F72 CMOS FLASH-based 8-bit microcontroller is upward compatible with PIC16C72/72A and PIC16F872devices. It features 200 ns instruction execution, self-programming, an ICD, 2 Comparators, 5 channels of 8-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. Some major features are

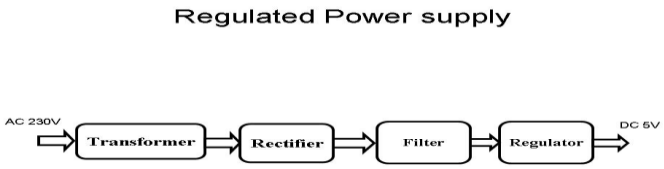
• High performance RISC CPU
• Only 35 single word instructions to learn
• All single cycle instructions except for program branches which are two-cycle
• Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
• 2K x 14 words of Program Memory
128 x 8 bytes of Data Memory (RAM)
• Pin out compatible to the PIC16C72/72A and PIC16F872
• Interrupt capability
• Eight level deep hardware stack
• Direct, Indirect and Relative Addressing modes

4.2 CRYSTAL OSCILLATOR

The crystal oscillator speed that can be connected to the PIC microcontroller range from DC to 20Mhz. Using the CCS C compiler normally 20Mhz oscillator will be used and the price is very cheap. The 20 MHz crystal oscillator should be connected with about 22pF capacitor. Please refer to my circuit schematic.

There are 5 input/output ports on PIC microcontroller namely port A, port B, port C, port D and port E. Each port has different function. Most of them can be used as I/O port.

4.3 REGULATED POWER SUPPLY



The main blocks of regulated power supply circuit are

- 230V Ac mains
- Transformer
- Bridge rectifier(Diodes)
- Capacitor
- Voltage regulator(IC 7805)
- Resistor
- LED(Light emitting diode)

4.4 AIR COMPRESSOR

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into kinetic energy by compressing and pressurizing air, which, on command, can be released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or negative-displacement types. A reciprocating compressor or piston compressor used here is a positive-displacement compressor that uses pistons driven by a crankshaft to deliver gases at high pressure. The intake gas enters the suction manifold, then flows into the compression cylinder where it gets compressed by a piston driven in a reciprocating motion via a crankshaft, and is then discharged. Applications include oil refineries, gas pipelines, chemical plants, natural gas processing plants and refrigeration plants. One specialty application is the blowing of plastic bottles made of polyethylene terephthalate.

4.5 LCD DISPLAY

One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively. In this project we have used 16x2 displays.

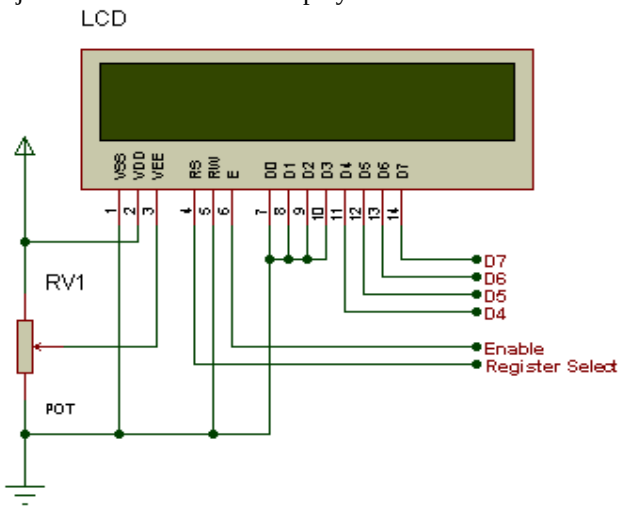


Fig 4.5.1 LCD Pin diagram.

Pin No.	Name	Description
Pin no. 1	**VSS**	Power supply (GND)
Pin no. 2	**VCC**	Power supply (+5V)
Pin no. 3	**VEE**	Contrast adjust
Pin no. 4	**RS**	0 = Instruction input 1 = Data input
Pin no. 5	**R/W**	0 = Write to LCD module 1 = Read from LCD module
Pin no. 6	**EN**	Enable signal
Pin no. 7	**D0**	Data bus line 0 (LSB)
Pin no. 8	**D1**	Data bus line 1
Pin no. 9	**D2**	Data bus line 2
Pin no. 10	**D3**	Data bus line 3
Pin no. 11	**D4**	Data bus line 4
Pin no. 12	**D5**	Data bus line 5
Pin no. 13	**D6**	Data bus line 6
Pin no. 14	**D7**	Data bus line 7 (MSB)

Table 4.5.1 PIN DESCRIPTION

The LCD requires 3 control lines as well as either 4 or 8 I/O lines for the data bus. 8-bit data bus is used the LCD will require a total of 11 data lines (3 control lines plus the 8 lines for the data bus). The three control lines are referred to as EN, RS, and RW. The EN line is called "Enable."The RS line is the "Register Select" line. The RW line is the "Read/Write" control line. Finally, the data bus consists of 4 or 8 lines namely as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

4.6 BUZZER

Basically, the sound source of a piezoelectric sound component is a piezoelectric diaphragm. To interface a buzzer the standard transistor interfacing circuit is used. Note that if a different power supply is used for the buzzer, the 0V rails of each power supply must be connected to provide a common reference. If a battery is used as the power supply, it is worth remembering that piezo sounders draw much less current than buzzers. Buzzers also just have one 'tone', whereas a piezo sounder is able to create sounds of many different tones.

To switch on buzzer -high 1

To switch off buzzer -low 1

1) When the piezoelectric buzzer is set to produce intermittent sounds, sound may be heard continuously even when the self drive circuit is turned ON / OFF. This is because of the failure of turning off the feedback voltage.

2) The self drive circuit is already contained in the piezoelectric buzzer. So there is no need to prepare another circuit to drive the piezoelectric buzzer.

3) Rated voltage (3.0 to 20Vdc) must be maintained.

4) Do not place resistors in series with the power source, as this may cause abnormal oscillation. If a resistor is essential to adjust sound pressure, place a capacitor (about 1μF) in parallel with the piezo buzzer.

5) Do not close the sound emitting hole on the front side of casing.

6) Carefully install the piezo buzzer so that no obstacle is placed within 15mm from the sound release hole on the front side of the casing.

4.7 Pressure Sensor

A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical.

The piezo resistive pressure sensor or silicon cell consists of a micro-machined silicon diaphragm with piezo resistive strain gauges diffused into it, fused to a silicon or glass back plate. The resistors have a value of approx. 3.5 kOhm. Pressure induced strain increases the value of the radial resistors (r), and decreases the value of the resistors (t) transverse to the radius. This resistance change can be high as 30%.

4.8 Solar cell/Plate:

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Solar cell efficiencies vary from 6% for amorphous silicon-based

solar cells to 40.7% with multiple-junction research lab cells and 42.8% with multiple dies assembled into a hybrid package. Solar cell energy conversion efficiencies for commercially available multi crystalline Si solar cells are around 14-19%.

1. Photons in sunlight hit the solar panel and are absorbed by semi conducting materials, such as silicon.
2. Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. Due to the special composition of solar cells, only allow the electrons to move in a single direction. The complementary positive charges that are also created (like bubbles) are called holes and flow in the direction opposite of the electrons in a silicon solar panel.
3. An array of solar panels converts solar energy into a usable amount of direct current (DC) electricity.

4.9 LED

A light-emitting diode (LED) is a semiconductor light source. When a diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. The electrical symbol and polarities of led are shown in fig.

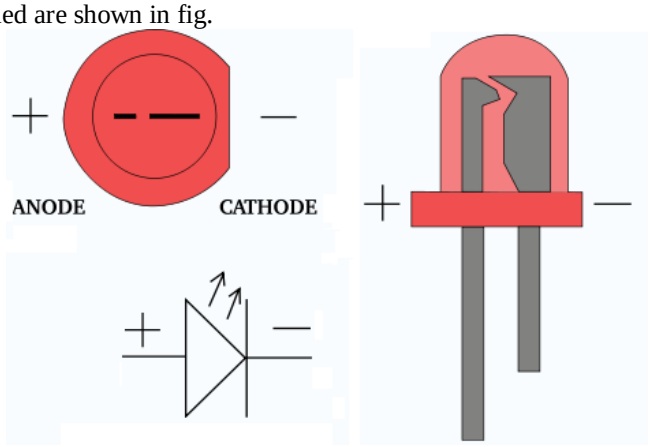


Fig 4.9.1 Electrical Symbol & Polarities of LED.

4.10 Control Buttons

A push-button is a simple switch mechanism for controlling some aspect of a machine or a process. In industrial and commercial applications, push buttons can be linked together by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process have no electrical circuits for control.

V. SOFTWARE DESCRIPTION

This project is implemented using following software's:

- Express PCB – for designing circuit
- PIC C compiler - for compilation part
- Proteus 7 (Embedded C) – for simulation part

5.1 Express PCB

Express PCB is a software tool to design PCBs specifically for manufacture by the company Express PCB (no other PCB maker accepts Express PCB files). It is very easy to use, but it does have several limitations. Express PCB has been used to design many PCBs (some layered and with surface-mount parts. Print out PCB patterns and use the toner transfer method with an Etch Resistant Pen to make boards. However, Express PCB does not have a nice print layout.

5.2 PIC Compiler

PIC compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. PIC compiler also supports C language code. As we are going to use PIC Compiler, hence we also call it PIC C. The PCB, PCM, and PCH are separate compilers. PCB is for 12-bit opcodes, PCM is for 14-bitopcodes, and PCH is for 16-bit opcode PIC microcontrollers. We have to add header file for controller you are using, otherwise you will not be able to access registers related to peripherals.

```
#include <16F877A.h> // header file for PIC 16F877A//
```

5.3 Proteus

Proteus is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proteus. Proteus is a programmer which itself contains a microcontroller in it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the pic compiler and dumps this hex file into the microcontroller which is to be programmed. As the Proteus programmer requires power supply to be operated, this power supply is given from the power supply circuit designed and connected to the microcontroller in proteus. The program which is to be dumped in to the microcontroller is edited in proteus and is compiled and executed to check any errors and hence after the successful compilation of the program the program is dumped in to the microcontroller using a dumper.

VI. PROJECT DESCRIPTION

Schematic diagram and interfacing of PIC16F72 microcontroller with each module is considered.

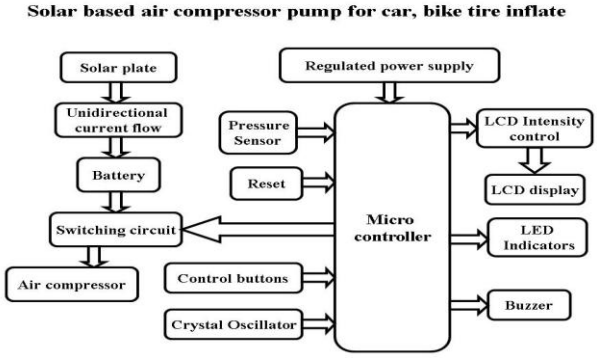


Fig 6.1 Schematic diagram.

The above schematic diagram of Solar Based Air Compressor explains the interfacing section of each component with micro controller and LCD. The crystal oscillator connected to 9th and 10th pins of micro controller and regulated power supply is also connected to micro controller and LED's also connected to micro controller through resistors and motor driver connected to micro controller.

6.1 Interfacing crystal oscillator with micro controller

Fig 6.2: explains crystal oscillator and reset button which are connected to micro controller. The two pins of oscillator are connected to the 9th and 10th pins of micro controller; the purpose of external crystal oscillator is to speed up the execution part of instructions per cycle and here the crystal oscillator having 20 MHz frequency. The 1st pin of the microcontroller is referred as MCLR ie, master clear pin or reset input pin is connected to reset button or power-on-reset.

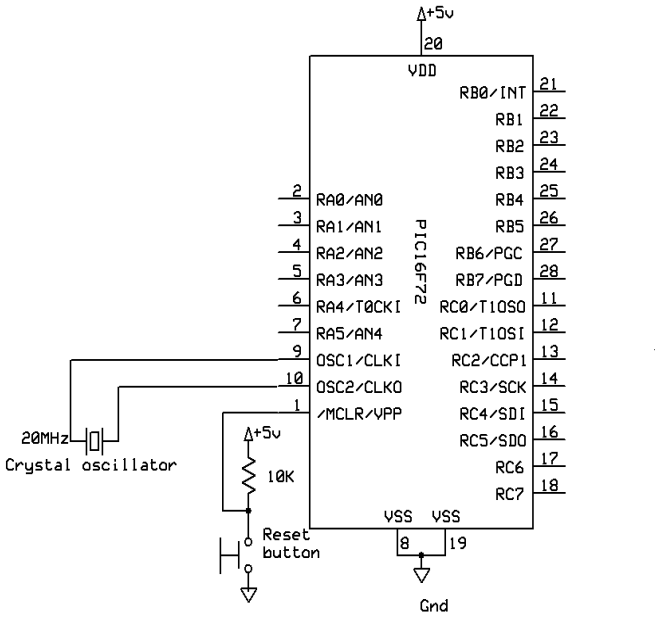


Fig 6.2 Crystal oscillator interfacing with micro controller

Result

The project "Solar Based Air Compressor" was designed such that the system continuously monitors and controls the air pressure. The system also displays the amount of voltage generated by the solar panel on the LCD.

VII. CONCLUSION

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. Future Scope This project can be extended by using GSM technology, which helps in sending the monitored and controlled data to any place in the world by an SMS.

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