

# Intelligent Solar Tracker System Implemented On 8051 Microcontroller

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**Abstract**— Solar energy is becoming increasingly attractive as we grapple with global climate changes. However, while solar energy is free, non-polluting, and inexhaustible, solar panels are fixed. As such, they cannot take advantage of maximum sunlight as weather conditions and seasons change. A solar panel receives the most sunlight when it is perpendicular to the sun's rays, but the sunlight direction changes regularly with changing seasons and weather. Currently, most solar panels are fixed, i.e., the solar array has a fixed orientation to the sky and does not turn to follow the sun. To increase the unit area illumination of sunlight on solar panels, we designed a solar tracking electricity generation system. The design mechanism holds the solar panel and allows the panel to perform an approximate 3-dimensional (3-D) hemispheroidal rotation to track the sun's movement during the day and improve the overall electricity generation. This system can achieve the maximum illumination and energy concentration and cut the cost of electricity by requiring fewer solar panels, therefore, it has great significance for research and development. The main use of this report is to utilize the maximum power from the sun. Now a day we are in heavy need to use the solar power as in the coming days everything we use might depend on this kind of systems.

**Keywords**—Solar Tracking, Solar Panel, Microcontroller, Stepper Motor, Analog-to-Digital Converter, Liquid Crystal Display.

## I. INTRODUCTION

Solar energy refers to the utilization of the radiant energy from the sun. Solar power is used interchangeably with solar energy, but refers more specifically to the conversion of sunlight into electricity by photovoltaic, concentrating solar thermal devices, or by an experimental technology such as a solar chimney or solar pond.

Solar panels are Photovoltaic cells which gives voltage directly if you place them in sun light. Here if you change the position of panels the power output will vary. Means, direct sunrays on solar panel can give good output otherwise there might be decrease in the value of their outputs. So we have to track the path where the maximum power will attain.

Solar panel devices are of two types that collect energy from the sun. One is solar photovoltaic modules which use solar cells to convert light from the sun into electricity and the other is solar thermal collector which converts the sun's

energy to heat water or another fluid such as oil or antifreeze. In this project we are using the photovoltaic type.

The main aim of the project is to design one system for automated solar tracking system. For this we are using 8051 family microcontroller and two LDR for finding the light intensity and stepper motor for rotation of the solar panel. We are implementing one application program using embedded C and loading the program into microcontroller through ISP (in system programmer) and it will read data from the sensors through ADC MCP3208 and according to the data stepper motor is rotating. Stepper motor is not directly connected to microcontroller it is connected through ULN2003.

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## II. SYSTEM ANALYSIS

### A. Circuit Operation:

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In the following block diagram, when sun rays fall on the LDR then according to intensity of light, it generates variable analog output. AT89S52 microcontroller will read data from the LDR through MCP3208 which is serial ADC used for converting analog signal to digital one. Oscillator gives the clock to microcontroller which is necessary for program execution. In program, AT89S52 microcontroller compares the output of LDR which is already fetched. Program generates control signals which are given to stepper motor driver. Stepper motor is rotating via stepper motor driver ULN2003.

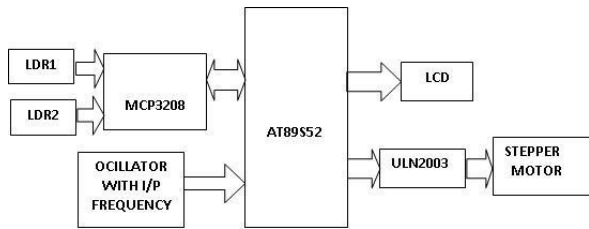


Fig. 1 Schematic representation of Solar Tracking System

**B. Hardware:**

- ✓ AT89S52(Microcontroller)
- ✓ LDR (Light Dependent Resistor)
- ✓ MCP3208 (Analog-to-Digital Converter)
- ✓ LCD (Liquid Crystal Display)
- ✓ ULN2003 (Driver)
- ✓ Stepper Motor

**C. Software:**

- ✓ Embedded C programming
- ✓ Keil C compiler

**III. SELECTION OF HARDWARE**

**A. Selection of Microcontroller:**

As we know that there so many types of micro controller families that are available in the market.

Those are:

- ✓ 8051 Family
- ✓ AVR microcontroller Family
- ✓ PIC microcontroller Family
- ✓ ARM Family

Basic 8051 family is enough for our application; hence we are not concentrating on higher end controller families.

In order to fulfil our application basic that is AT89C51 controller is enough. But still we selected AT89S52 controller because of inbuilt ISP (in system programmer) option.

There are minimum six requirements for proper operation of microcontroller.

Those are:

- ✓ Power supply section
- ✓ pull-ups for ports (it is must for PORT0)
- ✓ Reset circuit
- ✓ Crystal circuit
- ✓ ISP circuit (for program dumping)
- ✓ EA/VPP pin is connected to Vcc.

PORT0 is open collector that's why we are using pull-up resistor which makes PORT0 as an I/O port. Reset circuit is used to reset the microcontroller. Crystal circuit is used for the microcontroller for timing pluses. In this project we are not using external memory that's why EA/VPP pin in the microcontroller is connected to Vcc that indicates internal memory is used for this application.

**B. Selection of Driver:**

Driver is used increase the strength of signal. In this application we are using stepper motor to rotate the solar panel. So to drive the stepper motor we have to increase the strength of signal. In the market so many IC's are available but we selected ULN 2003 which is inbuilt 7 NPN transistors. And the working voltage of this IC is 5 volts which is same as microcontroller working voltage. And there is no need to design any other power supply section that's why we selected this IC in our project.

**C. Selection of ADC:**

Here in this project we selected MCP3208 ADC. In this project ADC is used to convert analog voltage sent by the LDR to digital voltage. We can use parallel ADC (ADC 0804) but we need more pins to interface that, so to reduce port pins we can use MCP3208.

**D. Selection of LCD:**

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images, and moving pictures. Its uses include monitors for computers, televisions, instrument panels, and other devices ranging from aircraft cockpit displays, to every-day consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. Among its major features are its lightweight construction, its portability, and its ability to be produced in much larger screen sizes than are practical for the construction of cathode ray tube (CRT) display technology. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in colour or monochrome.

**E. Connections to Microcontroller:**

Microcontroller has 4 ports and every port has 8 pins we are connecting all external components to this ports only. LCD is connected to the PORT0 and ULN2003 is connected to PORT2 and MCP 3208 which is acting as ADC is connected to the P1.

**F. Connections of Driver IC (ULN 2003):**

ULN 2003 has 16 pins in this 1<sup>st</sup> pin is connected to 2.7 pin and 2<sup>nd</sup> pin is connected to 2.6 and 3<sup>rd</sup> pin is connected to 2.5 and 4<sup>th</sup> pin is connected to 2.4 pin of the microcontroller. And 8<sup>th</sup> pin is connected to ground 9<sup>th</sup> to Vcc and 13<sup>th</sup> to 16<sup>th</sup> pins are connected to the stepper motor. And other pins are not connected.

**IV. SCHEMATIC DIAGRAM**

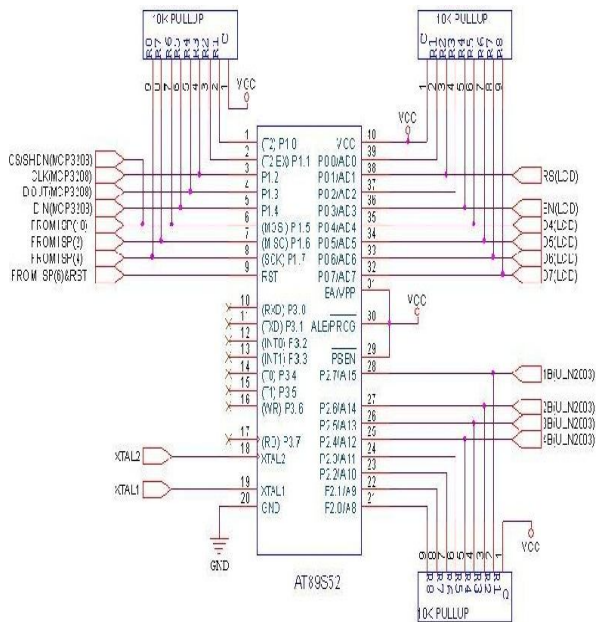


Fig. 2 Microcontroller

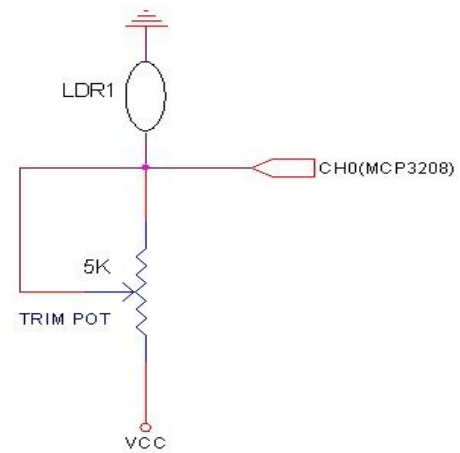


Fig. 5 Light Dependent Resistor

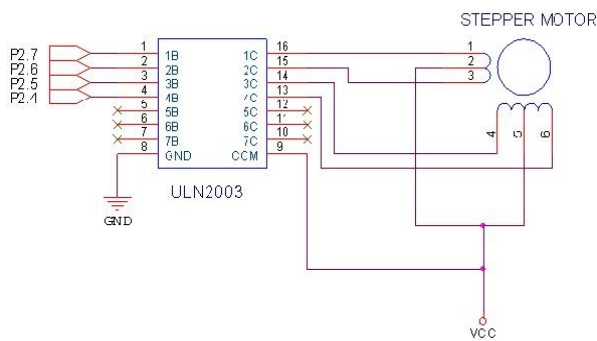


Fig. 3 Driver

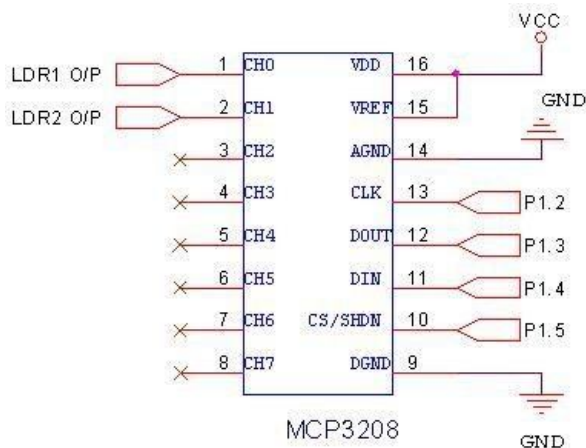


Fig. 4 ADC Converter

### V. POWER SUPPLY SECTION

In-order to work with any components basic requirement is power supply. In this section there is a requirement of one voltage level i.e. 5V DC power supply.

Now the aim is to design the power supply section which converts 230V AC in to 5V DC. Since 230V AC is too high to reduce it to directly 5V DC, therefore we need a step-down transformer that reduces the line voltage to certain voltage that will help us to convert it in to a 5V DC. Considering the efficiency factor of the bridge rectifier, we came to a conclusion to choose a transformer, whose secondary voltage is 3 to 4 V higher than the required voltage i.e. 5V. For this application 0-9V transformers is used, since it is easily available in the market.

The output of the transformer is 9V AC; it feed to rectifier that converts AC to pulsating DC. As we all know that there are 3 kinds of rectifiers that are:

- Half wave rectifier
- Full wave rectifier
- Bridge rectifier

Here we short listed to use Bridge rectifier, because half wave rectifier has we less in efficiency. Even though the efficiency of full wave and bridge rectifier are the same, since there is no requirement for any negative voltage for our application, we gone with bridge rectifier.

Since the output voltage of the rectifier is pulsating DC, in order to convert it into pure DC we use a high value (1000UF/1500UF) of capacitor in parallel that acts as a filter. The most easy way to regulate this voltage is by using a 7805 voltage regulator, whose output voltage is constant 5V DC irrespective of any fluctuation in line voltage.

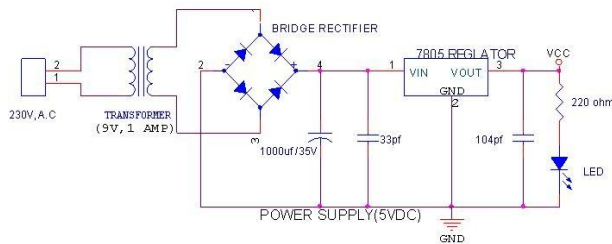


Fig. 6 Power Supply

## VI. FLOW CHART

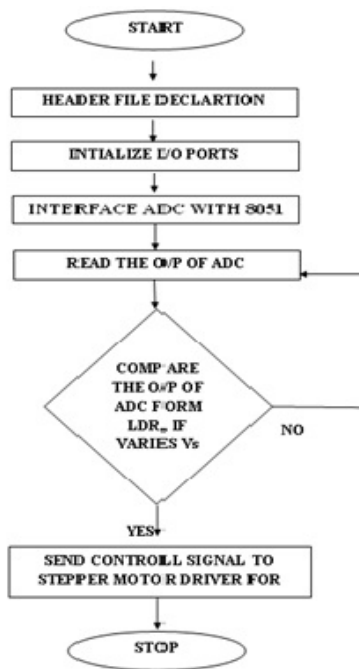


Fig. 7 Flowchart of Solar Tracking System

## VII. CODE IMPLEMENTATION

### A. Kiel-C Compiler:

Many companies provide the 8051 assembler, some of them provide shareware version of their product on the Web, Kiel is one of them. We can download them from their Websites. However, the size of code for these shareware versions is limited and we have to consider which assembler is suitable for our application.

### B. Kiel U Vision2:

This is an IDE (Integrated Development Environment) that helps you write, compile, and debug embedded programs. It encapsulates the following components:

- ✓ A project manager
- ✓ A make facility
- ✓ Tool configuration

- ✓ Editor
  - ✓ A powerful debugger
- To get start here are some several example programs

- 1) *Building an application in U vision2:* To build (compile, assemble, and link) an application in uVision2, you must:
  - ✓ Select Project–Open Project  
(For example, \C166\EXAMPLES\HELLO\HELLO.UV2)
  - ✓ Select Project - Rebuild all target files or Build target. UVision2 compiles, assembles, and links the files in your project.

- 2) *Creating Your Own Application In Uvision2:* To create a new project in uVision2, you must:

- ✓ Select Project - New Project.
- ✓ Select a directory and enter the name of the project file.
- ✓ Select Project - Select Device and select an 8051, 251, or C16x/ST10 device from the device
- ✓ Database
- ✓ Create source files to add to the project.
- ✓ Select Project - Targets, Groups, and Files. Add/Files, select Source Group1, and add the source files to the project.
- ✓ Select Project - Options and set the tool options. Note when you select the target device from the Device Database all-special options are set automatically. You only need to configure the memory map of your target hardware. Default memory model settings are optimal for most.

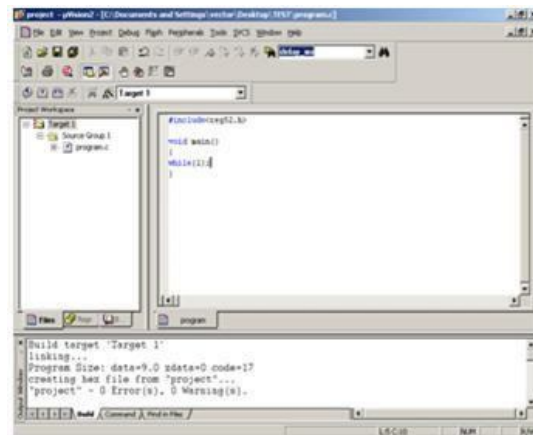


Fig. 8 IDE Window

### Applications:

- Select Project - Rebuild all target files or build target.

### 3) Debugging An Application In Uvision2:

To debug an application created using uVision2, you must:

- ✓ Select Debug - Start/Stop Debug Session.  
Use the Step toolbar buttons to single-step through your program. You may enter G, main in the Output Window to execute to the main C function.
- ✓ Open the Serial Window using the Serial #1

- ✓ Button on the toolbar.
  - ✓ Debug your program using standard options.
- Like Step, Go, Break, and so on.

#### A. CONCLUSION

In this design, we used Atmel 8051 microcontroller. This design represents a new system design technology, and Keil C - Compiler helped us see the powerful design technologies of software and hardware systems. Most traditional circuit designs are composed of hardware components building on a printed circuit board (PCB), we used same. If errors are found or the system needs to be improved or upgraded, the PCB must be redesigned. Adjusting and modifying the PCB is very inconvenient and increased the design cost and development period. This implementation has great future scope because the Sun is important source of energy which available in free of cost. As today's world need greater amount of energy it can be satisfy by our project use.

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