DEVELOPMENT OF A MICRO-CONTROLLER BASED AUTO SCHEDULER FOR AIR CONDITIONING SYSTEM

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POST GRADUATE DIPLOMA IN INFORMATION AND COMMUNICATION TECHNOLOGY (PG Dip. in ICT)

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2016

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It is hereby declared that this project report or any part of it has not been submitted elsewhere for the award of any degree or diploma.

Jalal 13.04.18

MD. SHAHJALAL RANA

Dedicated
To

My Parents

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List of Abbreviations

Abbreviations	Elaboration
AC	Air-Conditioning
AS	Auto Scheduler
HAS	Home Automation System
SIM	subscriber identity module
PCB	Printed Circuit Board
IC	Integrated Circuit
μC	Micro Controller
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Service
PLC	Programmable Logic Controllers
TTL	Time To Leave
TCP/IP	Transmission Control Protocol/Internet Protocol
USART	Universal Synchronous Asynchronous Receiver and Transmitter
USB	Universal Serial Bus
RXD	Data to be transmitted over the communication link
TXD	Data that has been received from the communication link
SPDT	Single Pole Double Throw

Acknowledgement

At first, I would like to thank Almighty Allah, the most merciful, the most gracious, the source of knowledge and wisdom endowed to mankind, who provided me with the power of mind, strength, patience and capability to carry me through the work and enable me to complete this project.

I would like to thank my supervisor, Prof. Dr. Md. Liakot Ali, Director, Institute of Information and Communication Technology, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh for his kind, constant, and inspiring guidance and encouragement valuable advice and suggestions at all stages for preparing this report.

In completing this project, I have been fortunate to have help, support and encouragement from many of my friends. I would like to acknowledge them for their cooperation.

I would like to thank my family, specially my parents for their continuous support and inspiration throughout the whole period of this undertaking.

Abstract

Automation is a demand in this era of information and communication technology where a smart control system is used to reduce or replace human operators in the industry, offices or homes to produce some goods or services. Auto Scheduler system is the subset of automation system that allows us to control household appliances like light, door, fan, air-conditioner, etc., in smart way. It also includes those of domestic activities, such as houseplant and yard watering, pet feeding, and the use of domestic robots. Auto Scheduler system provides security and emergency systems to be activated when necessary. It helps handicapped and old aged people which will enable them to control home appliances and alert them in critical situations. There are different types of auto scheduler systems in the market. They are generally proprietary and closed, expensive and not very customizable by the end user. To overcome this limitation, there are scopes of research in this area.

In this project work, a simple automatic scheduler system has been chosen to implement. This project is aimed at developing a low-cost auto scheduler system to control electrical devices to be turned on and off; As an example, in a room or lab environment an auto schedule system will run according to the definite time. This system will be connected with two air condition or two electric devices like AC-1 & AC-2 or Device-1 or Device-2. When the system is powered on, AC-1 will be turned on and AC-2 will be turned off (it will be changed alternatively by the pre-defined time). The proposed system is not fully implemented. To emulate the system, a prototype hardware has been implemented where a microcontroller based auto scheduling program is controlling the on-off switching of two electric bulbs in a predefined time scheduling manner.

Chapter 1

Introduction

1.1 Introduction

The application of the device control in real life is very common nowadays. There are many applications that have been developed by using device control in electronic field such as home automation, industrial automation, etc. Auto Scheduler is the use of control systems to reduce the need for human work in the production of goods and services. In the scope of industrialization, scheduler is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, scheduler greatly decreases the need for human sensory and mental requirements as well. Auto scheduler plays an increasingly important role in the world economy and in daily experience. Automatic systems are being preferred over manual system.

Auto scheduler is the control of any or all electrical devices in our home, office or lab whether we are there or away [2]. Auto schedule is one of the most exciting developments in technology for the home, office, or lab that has come along in decades. There are hundreds of products available today that allow us control over the devices automatically. Automatic scheduler is the residential, industrial, or lab environmental extension of "building schedule". Automatic scheduler may include centralized control of lighting, heating, air-conditioning (AC), irrigation pump and other systems, to provide improved convenience, comfort, time schedule, energy efficiency, and security. Disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care.

Through this project we have tried to show automatic schedule of air condition, fan, bulb or electronic devices as a result of which time is saved to some extent. Moreover, the GSM based auto scheduler saves time and labor.

1.2 Objective with specific aims and possible outcome

The aim of this project is to develop a low cost home automation system. The following objectives will be achieved:

(i) To design the circuit for the proposed system
(ii) To design the firmware of the system
(iii) To simulate the design
(iv) To implement the system in the PCB
(v) To test the functionality of the system in the laboratory

The outcome of this project is a prototype hardware that emulates a low cost home automation system.

1.3 Organization of the Project Report

Chapter 1: Introduction: The project documentation starts with the introduction of the Micro controller based auto scheduler for air conditioning system with a discussion on the existing systems available. It is followed by objectives and organization of the documentation.

Chapter 2: Auto scheduler for air conditioning system: In this chapter, the detailed history or literature review about the Micro controller based auto scheduler for air conditioning system is described along with the purpose of this project work.

Chapter 3: Methodology and design of the Auto scheduler for air conditioning system: In this chapter, the detailed description of the components used is described along with the methodology of the project work and procedure of the design process is given including the block diagram, circuit diagram.

Chapter 4: Results and Discussions: In this chapter, the detailed results and discussions of the project work is given along with the working principle, advantages, disadvantages and applications.

Chapter 5: Conclusion: Finally conclusion on the project and recommendations for
The future is made.

Chapter 2

Auto scheduler for air conditioning system

2.1 Introduction

This chapter describes the fundamentals of Micro controller based auto scheduler for air conditioning system and It helps the reader to understand the reports in an easy way.

2.2 Auto Scheduler System

An auto Schedule or automatic control is the use of various control systems for operating equipment such as air-condition, machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated.

Auto Scheduler is the term of automation, inspired by the earlier word automatic (coming from automaton), was not widely used before 1947, when General Motors established the automation department. It was during this time that industry was rapidly adopting feedback controllers, which were introduced in the 1930s

The biggest benefit of auto scheduler is that it saves time and labor; however, it is also used to save cost and materials and to improve quality, accuracy, and precision.

2.2.1 History of Auto scheduler

The control of the devices when completely taken over by the machines, the process of monitoring and reporting becomes more important. Depending on the location of its usage, automation differs in its name as industrial automation, home automation, etc. With the development of low cost electronic components, home automation migrated from being an industrial application to home automation. So, a home automation system which is our point of concern, deals with the control of home appliances from a central location.

The earliest feedback control mechanism was used to tent the sails of windmills. It was patented by Edmund Lee in 1745 [4]. The centrifugal governor, which dates to the last quarter of the 18th century, was used to adjust the gap between millstones. The centrifugal governor was also used in the automatic flour mill developed by Oliver Evans in 1785, making it the first completely automated industrial process. The governor was adopted by James Watt for use on a steam engine in 1788 after Watt"s partner Boulton saw one at a flour mill Boulton & Watt were building.

The governor could not actually hold a set speed; the engine would assume a new constant speed in response to load changes. The governor was able to handle smaller variations such as those caused by fluctuating heat load to the boiler. Also, there was a tendency for oscillation whenever there was a speed change. As a consequence, engines equipped with this governor were not suitable for operations requiring constant speed, such as cotton spinning.

Several improvements to the governor, plus improvements to valve cut-off timing on the steam engine, made the engine suitable for most industrial uses before the end of the 19th century. Advances in the steam engine stayed well ahead of science, both thermodynamics and control theory.

The governor received relatively little scientific attention until James Clerk Maxwell published a paper that established the beginning of a theoretical basis for understanding control theory. Development of the electronic amplifier during the 1920s, which was important for long distance telephony, required a higher signal to noise ratio, which was solved by negative feedback noise cancellation. This and other telephony applications contributed to control theory. Military applications during the Second World War that contributed to and benefited from control theory were fire-control systems and aircraft controls. The word "automation" itself was coined in the

1940s by General Electric [2]. The so-called classical theoretical treatment of control theory dates to the 1940s and 1950s.

Relay logic was introduced with factory electrification, which underwent rapid adaption from 1900 through the 1920s. Central electric power stations were also undergoing rapid growth and operation of new high pressure boilers, steam turbines and electrical substations created a large demand for instruments and controls.

Central control rooms became common in the 1920s, but as late as the early 1930s, most process control was on-off. Operators typically monitored charts drawn by recorders that plotted data from instruments. To make corrections, operator manually opened or closed valves or turned switches on or off. Control rooms also used color coded lights to send signals to workers in the plant to manually make certain changes.

Controllers, which were able to make calculated changes in response to deviations from a set point rather than on-off control, began being introduced the 1930s. Controllers allowed manufacturing to continue showing productivity gains to offset the declining influence of factory electrification.

In 1959 Texaco‟s Port Arthur refinery became the first chemical plant to use digital control. Conversion of factories to digital control began to spread rapidly in the 1970s as the price of computer hardware fell [10].

2.2.2 Applications of Auto Scheduler

There are is a huge number of applications of automation. Some of them are listed below:

- Automatic Temperature Control System
- Irrigation Control System
- GSM based Train Tracking System

- Irrigation Scheduling Devices
- Automated Retail
- Food and Drink
- Automated Restaurant
- Stores
- Automated Mining
- Automated Video Surveillance
- Automated Highway Systems
- Automated Waste Management
- Home Automation
- Industrial Automation

This project deals with a simple auto scheduler system.

2.2.3 Advantages and Disadvantages

The main advantages of auto scheduler are:

i. Increased throughput or productivity.
ii. Improved quality or increased predictability of quality.
iii. Improved robustness of processes or product.
iv. Increased consistency of output.
v. Reduced direct human labor costs and expenses.

The main disadvantages of auto scheduler are:

i. May cause temporary unemployment and poverty by replacing human labor.
ii. Security Threats/Vulnerability: An auto scheduler system may have a limited level of intelligence, and is therefore more susceptible to committing errors outside of its immediate scope of knowledge (e.g., it is typically unable to apply the rules of simple logic to general propositions).

iii. Unpredictable/excessive development costs: The research and development cost of automating a process may exceed the cost saved by the automation itself.
iv. High initial cost: The automation of a new product or plant typically requires a very large initial investment in comparison with the unit cost of the product, although the cost of automation may be spread among many products and over time.
v. In manufacturing, the purpose of automation has shifted to issues broader than productivity, cost, and time.

2.3 System Elements

The proposed auto scheduler system includes; GSM module (such as confirmation message service); controllers (such as a general-purpose personal computer or a dedicated automation controller), resistor, transistor, voltage regulator IC, breadboard, and relay.

2.3.1 Microcontroller

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals [4]. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

There are five major 8-bit microcontrollers. They are: Freescale Semiconductor"s 68HC08/68HC11, Intel"s 8051, Atmel"s AVR, Zilog"s Z8, and PIC from microchip technology [4]. Each of the above microcontrollers has a unique instruction set and register set; therefore, they are not compatible with each other program written for one will not run on the others. There are also 16-bit and 32-bit microcontrollers made by various chip makers [5]. With all these different microcontrollers, the designers must consider specific criteria in choosing one. Three criteria in choosing microcontrollers are as follows;
(1) meeting the computing needs of the task at hand efficiently and cost effectively;
(2) availability of the software and hardware tools such as compilers, assemblers, debuggers, and emulators; and
(3) Wide availability and reliable sources of the microcontroller.

2.3.2 GSM module

Global System for Mobile (GSM) / General Packet Radio Service (GPRS) TTL – Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz & dual-band 900MHz, 1900MHz. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600- 115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature.

It is suitable for SMS as well as data transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using Universal

Synchronous Asynchronous Receiver and Transmitter (USART) feature (serial communication).

2.3.3 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Since relays are switches, the terminology applied to switches is also applied to relays; a relay switches one or more poles, each of whose contacts can be thrown by energizing the coil.

2.3.4 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses. High-power resistors, that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

2.3.5 Transistor

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

The transistor is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. Following its development in 1947 by American physicists John Bardeen, Walter Brattain, and William Shockley, the transistor revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things.

2.3.6 Voltage Regulator

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

2.3.7 Breadboard

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solder less breadboard (AKA plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these. "Breadboard" is also a synonym for "prototype".

Because the solder less breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solder less breadboards are also extremely popular with students and in technological education. Older breadboard types did not have this property. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).

Chapter 3

Methodology and Design of the Auto Scheduler for air conditioning system

3.1 Introduction

In this project, there are several components included as each of them has its specific function and task. These components are selected based on circuit reliability, function ability, and costs.

3.2 Methodology

The Methodology consists of the following stages:

- First, the requirements of the project were carefully analyzed to design the proposed auto scheduler system. Based on it, the specifications of the necessary components of the hardware and software will be finalized.
- Next, the schematic diagram of the circuit will be designed. Proteus software will be used for this purpose. A microcontroller will be used for information processing.
- Then, the firmware will be developed using Arduino software.
- Then, the circuit will be simulated using Proteus software.
- Then, the circuit will be implemented in the breadboard and tested in the laboratory.
- Then, the Printed Circuit Board (PCB) will be designed for the circuit and the proposed system will be implemented in the PCB.
- Then, the designed system will be tested in the laboratory.

3.3 Block Diagram of the Designed Project

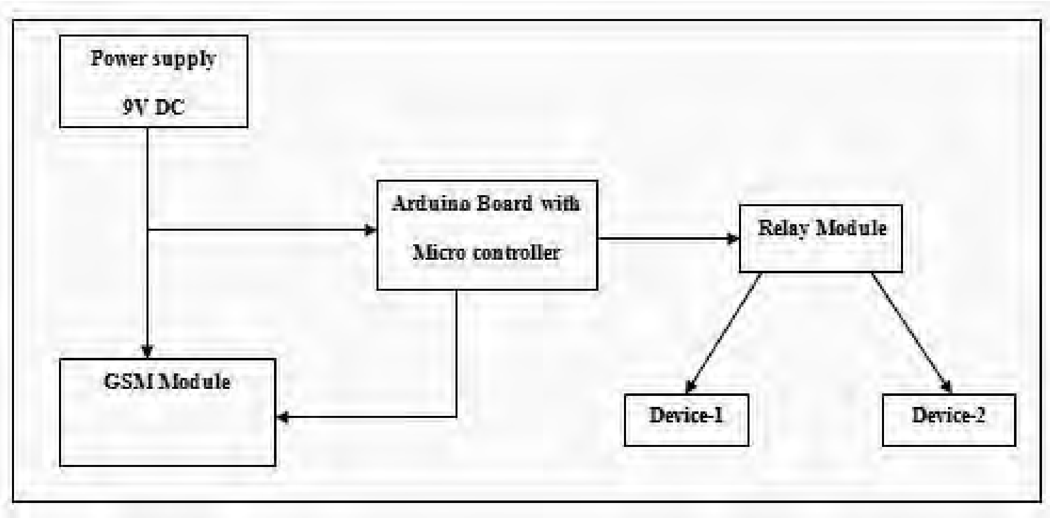


Fig. 3.1: Shows the block diagram of the auto scheduler system.

3.4 Description of the Components in the Block Diagram

The main components are:

(i) ATMEGA328 Microcontroller with Ardunio board
(ii) SIM-900 GSM based Module
(iii) SPDT Relay Module whose coils are driven by 6V DC
(iv) Adapter 9V
(v) Bulb 3W

A short description of each of the components is discussed in this chapter.

3.4.1 Microcontroller

The selected microcontroller is the ATMEGA328 [10] because of its ease of use, built-in timers, IC communication, RS232 port, built-in crystal and it has many analog and digital inputs and outputs. To avoid extra costs, this model is most basic that meets all of the design criteria. It is also a fairly new model; so it should be available for years to come. So, the ATMEGA328 was the best choice available. The microcontroller is used to control the whole operation of the system.

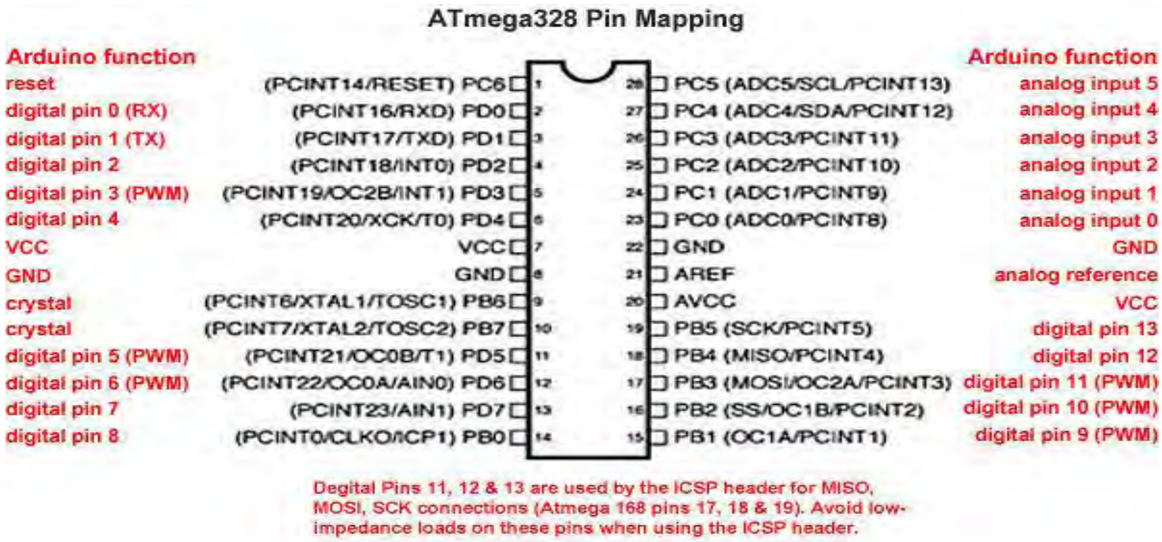


Fig. 3.2: Pin assignment of ATMEGA328

General Characteristics of ATMEGA328

The selected microcontroller is the ATMEGA328 and its various characteristics are described in the following:

- **Power Managed Modes**
  - Run: CPU on, peripherals on, Idle: CPU off, peripherals on, Sleep: CPU off, peripherals off
  - Idle mode currents down to 5.8 µA typical, Sleep mode current down to 0.1 µA typical
  - Timer1 Oscillator: 1.8 µA, 32 kHz, 2V,
  - Watchdog Timer: 2.1 µA, Two-Speed Oscillator Start-up.

Peripheral Highlights

- High-current sink/source 25 mA/25 mA, Three programmable external interrupts, Four input change interrupts, Up to 2 Capture/Compare/PWM (CCP) modules, one with Auto-Shutdown (28-pin devices), Enhanced Capture/Compare/PWM (ECCP), two PWM outputs, Selectable polarity, Programmable dead time, Auto-Shutdown and Auto-Restart, Master Synchronous Serial Port (MSSP) module supporting 3-wire SPI™ (all 4 modes) and I2C™ Master and Slave Modes:
- Enhanced Addressable USART module:
  - Supports RS-485, RS-232 and LIN 1.2
  - RS-232 operation using internal oscillator block (no external crystal required)
  - Auto-Wake-up on Start bit
  - Auto-Baud Detect
- 10-bit, up to 13-channel Analog-to-Digital Converter module (A/D):
  - Auto-acquisition capability
  - Conversion available during Sleep
  - with input multiplexing)
- Flexible Oscillator Structure:
  - Four Crystal modes, up to 40 MHz
  - 4X Phase Lock Loop (available for crystal and internal oscillators)
  - Two External RC modes, up to 4 MHz
  - Two External Clock modes, up to 40 MHz
- Internal oscillator block:
  - 8 user selectable frequencies, from 31 kHz to 8 MHz
  - Provides a complete range of clock speeds from 31 kHz to 32 MHz when used with PLL
  - User tunable to compensate for frequency drift
  - Secondary oscillator using Timer1 @ 32 kHz

- Fail-Safe Clock Monitor:
  - Allows for safe shutdown if peripheral clock stops
- C compiler optimized architecture:
  - Optional extended instruction set designed to optimize re-entrant code
  - 100,000 erase/write cycle Enhanced Flash program memory typical
  - 1,000,000 erase/write cycle Data EEPROM memory typical
  - Flash/Data EEPROM Retention: 100 years typical
  - Self-programmable under software control
  - Priority levels for interrupts
  - 8 x 8 Single-Cycle Hardware Multiplier
- Extended Watchdog Timer (WDT):
  - Programmable period from 4 ms to 131s
  - Single-supply 5V In-Circuit Serial
  - In-Circuit Debug (ICD) via two pins
  - Wide operating voltage range: 2.0V to 5.5V
  - Programmable 16-level High/Low-Voltage
- Detection (HLVD) module:
  - Supports interrupt on High/Low-Voltage Detection
  - Programmable Brown-out Reset (BOR - With software enable option)

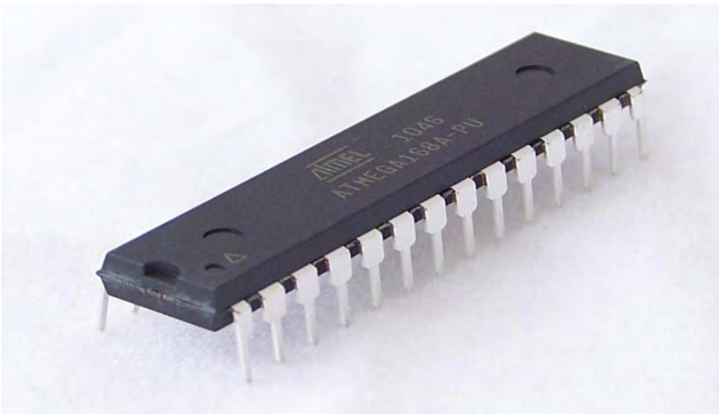


Fig. 3.3: ATMEGA328 Microcontroller

Features

- High-performance, Low-power AVR® 8-bit Microcontroller
- Advanced RISC Architecture
- 130 Powerful Instructions – Most Single-clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz
- On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory segments
- 8K Bytes of In-System Self-programmable Flash program memory
- 512 Bytes EEPROM
- 1K Byte Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- Programming Lock for Software Security

• Peripheral Features:

- Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture mode
- Real Time Counter with Separate Oscillator
- Three PWM Channels
- 8-channel ADC in TQFP and QFN/MLF package
- Eight Channels 10-bit Accuracy
- 6-channel ADC in PDIP package
- Six Channels 10-bit Accuracy
- Byte-oriented Two-wire Serial Interface

- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator

• Special Microcontroller Features:
- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated RC Oscillator
- External and Internal Interrupt Sources
- Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby

• I/O and Packages:
- 23 Programmable I/O Lines
- 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF

• Operating Voltages
- 2.7 - 5.5V (ATmega8L)
- 4.5 - 5.5V (ATmega8)

• Speed Grades
- 0 - 8 MHz (ATmega8L)
- 0 - 16 MHz (ATmega8)

• Power Consumption at 4 Mhz, 3V, 25°C
- Active: 3.6 mA
- Idle Mode: 1.0 mA
- Power-down Mode: 0.5 µA

Pin Description of ATMEGA328

Port B (PB7.PB0) XTAL1/XTAL2/TOSC1/TOSC2: Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2..1input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set. The various special features of Port B are elaborated in the following.

Port C (PC5.PC0): Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is, XC not running

PC6/RESET: If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is un programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Shorter pulses are not guaranteed to generate a Reset.

Port D (PD7.PD0): Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega8.

RESET: If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is not programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

AVCC: AVCC is the supply voltage pin for the A/D Converter, Port C (3.0), and ADC (7.6). It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that Port C (5.4) use digital supply voltage, VCC.

AREF: AREF is the analog reference pin for the A/D Converter.

ADC7.6 (TQFP and QFN/MLF Package Only): In the TQFP and QFN/MLF package, ADC7..6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

Overview of ATMEGA328

The ATMEGA328 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATMEGA328 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1K byte of SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two wire Serial Interface, a 6-channel ADC (eight channels in TQFP and QFN/MLF packages).

10-bit accuracy, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next Interrupt or Hardware Reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping.

The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

The device is manufactured using Atmel‟s high density non-volatile memory technology. The Flash Program memory can be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip boot program running on the AVR core. The boot program can use any interface to download the application program.

Application Flash memory. Software in the Boot Flash Section will continue to run while the Application Flash Section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the ATmega8 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.

The ATMEGA328 is supported with a full suite of program and system development tools, including C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits. Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.

3.4.2 The Arduino Board

Arduino board [10] is chosen for this project work as it gives so many facilities. Such as-

1. It is a complete board with PCB and gives very accurate result.
2. It is very easy to implement.
3. It is very cost effective with compared to the ordered-given and prepared PCB, so on.
4. It is very compatible with the ATMEGA328 Microcontroller

The Arduino UNO board used in this project is shown below:

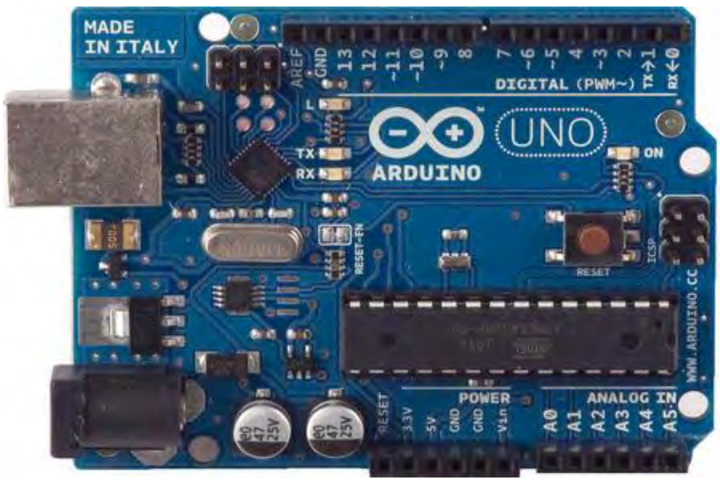


Fig 3.4: The Arduino UNO Board with microcontroller

3.4.3 GSM Module (SIM900)

A Quad-band SIM900 [10] GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL –Modem has been used in this project. It works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.).

It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface

Features

- Quad-Band 850/ 900/ 1800/ 1900 MHz
- Dual-Band 900/ 1900 MHz
- Configurable Baud Rate
- SMA (Sub Miniature version A) connector with GSM L Type Antenna
- Built in SIM (Subscriber Identity Module) Card holder
- Built in Network Status LED
- Inbuilt Powerful TCP / IP (Transfer Control Protocol / Internet Protocol) stack for internet data transfer through GPRS (General Packet Radio Service)
- Audio Interface Connectors (Audio in and Audio out)
- Most Status and Controlling pins are available
- Normal Operation Temperature : -20 °C to +55 °C
- Input Voltage : 5V to 12V DC
- LDB9 connector (Serial Port) provided for easy interfacing

Hardware Description

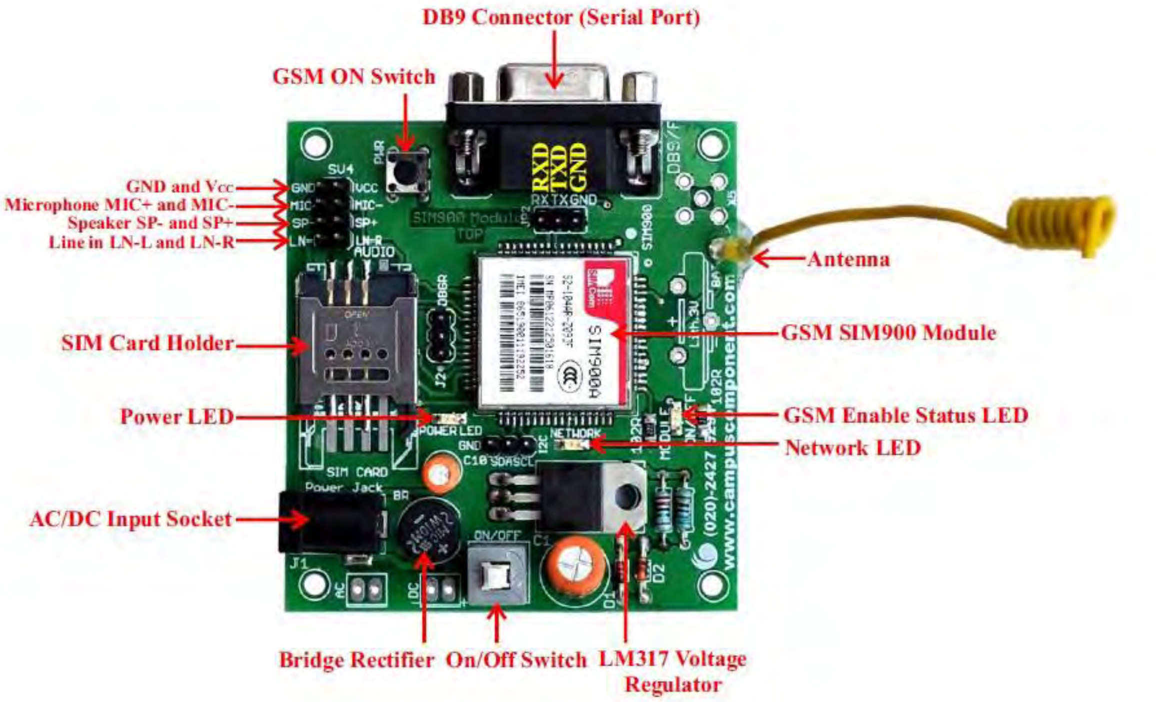


Figure: 3.5: Hardware Description of GSM Module

SIMCom SIM900A GSM Module:

This is actual SIM900 GSM module which is manufactured by SIMCom. Designed for global market, SIM900 is a quad-band GSM/GPRS engine that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM900 features GPRS multi slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 24mm x 24mm x 3mm, SIM900 can meet almost all the space requirements in User‟s applications, such as M2M, smart phone, PDA and other mobile devices.

MAX232 IC:

The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits, so that devices works on TTL logic can share the data with devices connected through Serial port (DB9 Connector).

Serial port / DB9 connector:

User just needs to attach RS232 cable here so that it can be connected to devices which have Serial port / DB9 Connector.

Power Supply Socket:

This power supply socket which actually named as AC/DC Socket provides the functionality to user to connect external power supply from Transformer, Battery or Adapter through DC jack. User can provide maximum of 12V AC/DC power supply through AC/DC socket. This is power supply designed into maximum protection consideration so that it can even prevent reverse polarity DC power supply as well as DC conversion from AC power Supply. It also includes LM317 Voltage Regulator which provides an output voltage adjustable over a1.2V to 37V.

Power On/Off and GSM On Switch:

Power On/Off switch is type of push-on push-off DPDT switch which is used for only make power supply on/off provided through AC/DC Socket indicated by „Power LED". GSM On Switch is type of Push on DPST tactile switch which is used for only to make GSM module „On" indicated by „Module On/Off LED" while initiating with Network indicated by „Network Indication LED".

SIM (Subscriber Identity Module) Card Slot:

This onboard SIM card slot provide User functionality of insert a SIM (GSM only) card of any service provider. Process of inserting and locking SIM card into SIM card slot is given in this manual. While inserting in and removing out SIM card from SIM card slot, User needs to take precaution that power supply should be OFF so that after making Power supply ON it will be easy to reinitialize with SIM for this module.

Indicator LEDs:

Indicator LEDs just used to indicate status accordingly. These are three LEDs represents Power On/Off Status, Network Status and Module On/Off Status respectively. Power LED will keep on until the power supply is enabling to this board by using *push-on push-off* switch. Network Status LED will show whether inserted SIM card successfully connected to service provider‟s Network or not, in short signal strength. Module On/Off indicator LED will show status of GSM module‟s power on/off.

RXD, TXD and GND pins (JP2):

These pins are used to connect devices which need to be connected to GSM module through Universal Synchronous Asynchronous Receiver and Transmitter (USART) communication. Devices may be like Desktop or Laptop Computer System, Microcontrollers, etc. RXD (Receive Data) should be connected to TXD (Transmit Data) of other device and vice versa, whereas GND (Ground) should be connected to other device‟s GND pin to make ground common for both systems.

Audio Connectors:

Audio Connectors deals with Audio related operations. These pins already shown in hardware description diagram. These are eight pins in a group of two each denoted by SV4. GND (0V Supply) and VCC (+5V Supply) are used to have source for external device. MIC+ and MIC used to connect Microphone (abbr. as Mic) through which user can give audio input while calling. SP- and SP+ used to connect Speaker (can be connected to amplifier circuit if necessary) through which User can hear audio output. LN-L and LN-R used to connect Line in to GSM module.

Debugger (DBG-R and DBG-T) Connectors (J2):

These connectors are 2-wire null modem interface DBG_TXD and DBG_RXD. These pins can be used for debugging and upgrading firmware. Users generally do not need to deal with these pins.

Inserting SIM card into SIM card Slot/Holder:

Here is the process how to insert SIM card into SIM card slot. Users just need to unlock SIM card cover by sliding back. Then user needs to open this cover and insert SIM card according to slot. Put down cover on SIM card and then lock by sliding forward.

Power On/Off and Module On/Off process:

Here is the process how user should make power supply on/off and module on/off. First of all the user need to connect external power supply by using Battery / Adapter /Transformer. Now the user needs to press Power On/Off switch (It is push-on push-off switch, thus user need to push it to make power on and push it again to make power supply off). Two LEDs will glow, one is Power On/Off indicator LED and another one is Network Status LED (which glows continuous to indicate no network or searching for network). After this, user needs to press Module on switch (denoted as PWR) for at least 2 seconds. As soon as Module On/Off LED will glow, user can release this switch; Network LED will blink to indicate signal strength.

Connecting GSM module with RS232 (SB9-DB9) Serial Cable:

A user can connect GSM interfacing board either through Serial port or through Serial to USB converter. Here is process to connect RS232 cable to GSM interfacing board.

Connecting GSM Module with Serial to USB converter through RXD, TXD and GND:

This module is designed in a way so that User can connect this module without Serial cable, this module can be connected to any of Serial to USB converter module or cable. Here we have shown demo how to connect this interfacing board with CP2102 Serial to USB converter Module through RXD, TXD and GND. Connect CP2102 Serial to USB converter module to PC through USB cable, connect one end of USB cable to PC‟s USB connector and connect another end of USB to CP2102 module‟s USB connector

Connect three Single Berg Wires to CP2102 module‟s RXD, TXD and GND pin. Then connect RXD wire to TXD of GSM module and TXD wire to RXD of GSM module. Make GND common by connecting GND wire to GND pin of GSM module.

Figure: 3.6: GSM Module

3.4.4 Relay

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The Control Circuit is the part of the relay that determines when the output component is energized or de-energized. The control circuit functions as the coupling between the input and output circuits. In electromechanical relays, the coil accomplishes this function. Various types of relays are available in the market. In this project a SPDT Relay has been used to accomplish this work.

- **SPDT** – Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

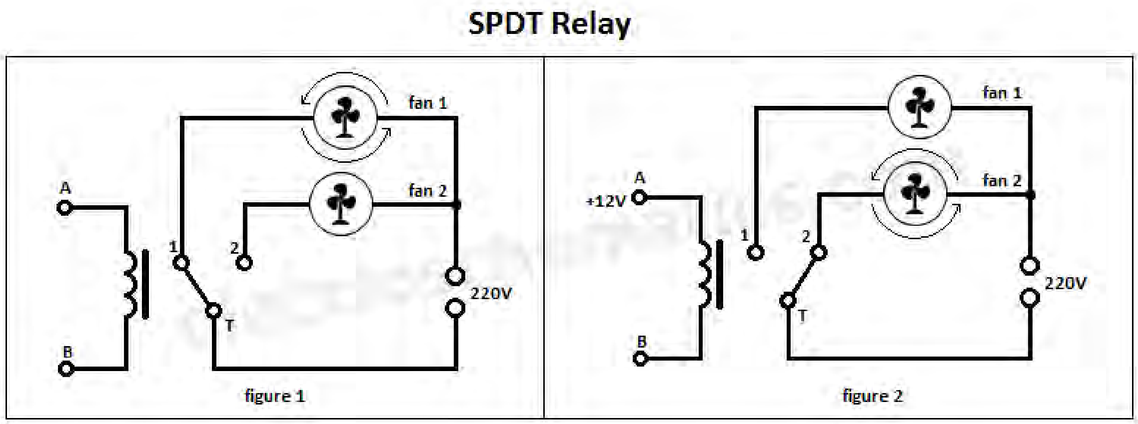


Figure.3.7: SPDT Functional Diagram Relay

3.4.5 Resistor

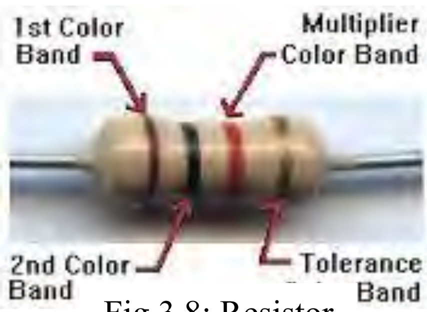


Fig 3.8: Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity. A variable resistor has been used for this project.

3.4.6 Transistor

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. There are two main types NPN and PNP. NPN transistor which is often used as a type of switch. A small current or voltage at the base allows a larger voltage to flow through the other two leads (from the collector to the emitter). And in the PNP transistor a large voltage at the base allows a small voltage to flow through the other two leads. So a PNP transistor has been used in this project work.

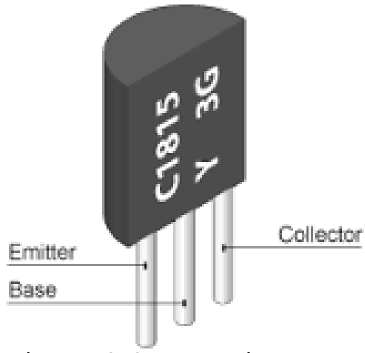


Figure.3.9: Transistor

3.4.7 Voltage Regulator

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. Electronic voltage regulators are

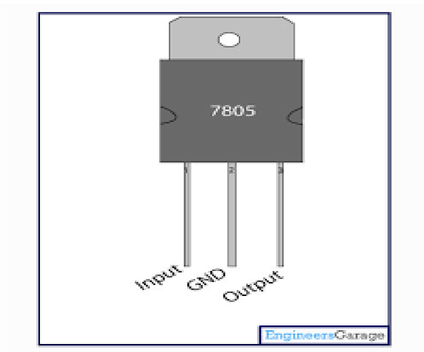


Figure.3.10: Voltage Regulator

found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. A 7805 model voltage regulator has been used for this project.

3.5 Flowchart of the Designed Project

The flowchart of the designed auto scheduler system is given below:

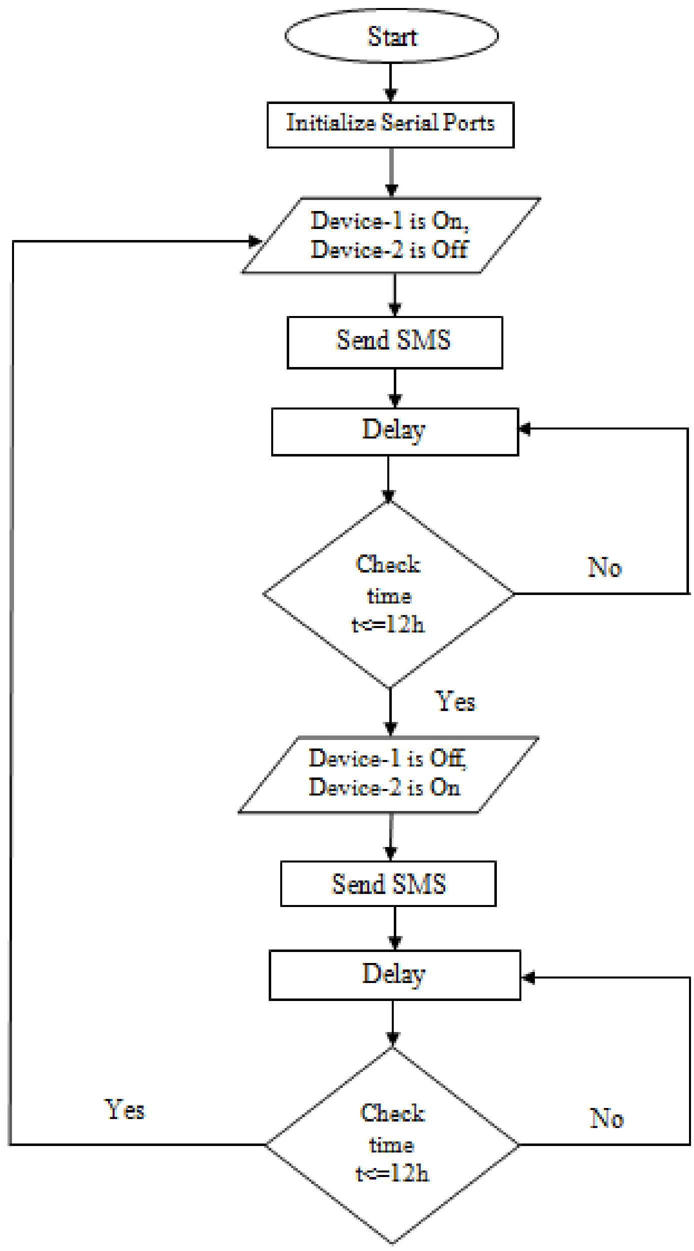


Fig 3.11: Flowchart of the designed project

3.6 Working Principle

This system's working principle is very simple. After turning on the system, the system will start its operation by turning ON device-1 and turning OFF device-2, when device-1 is ON and device-2 is OFF. Then, a confirmation SMS will be sent to a programmed number. (When predefined time will change after certain period then the device-1 will be turned OFF and device-2 will be turned ON and again a confirmation SMS will be send to that programmed number). And the system will work for regular operation.

3.7 Algorithm of the Designed Project

The algorithm of the designed home automation system is given below:

1. Turn on the system
2. Initialize the system
3. Device-1 will turn ON and Device-2 is OFF (Send SMS)
4. After finishing the predefine time Device-1 will turn OFF and Device-2 is ON (Send SMS)
5. After finishing the predefine time back to step 3
6. Continue this work till there is power available.
7. When power is interrupt then go back to step 3

3.8 Pseudo-code of the Designed Project

Start the program

Initialize the serial ports

```
Delay = 0 sec
Loop:
        IF (Delay < 12 hrs)
                {
                START Device-1
                STOP Device-2
                IF(Delay = 0 sec)
                        { SEND SMS }
                }
        ELSE IF (Delay >= 12 hrs AND Delay <= 24 hrs)
                {
                START Device-2
                STOP Device-1
                IF(Delay = 12 hrs)
                        { SEND SMS }
                }
        ELSE
                {
                Delay = 0 sec
                GOTO Loop
                }
        Delay++
GOTO Loop
```

3.9 Circuit Diagram of the Designed Project

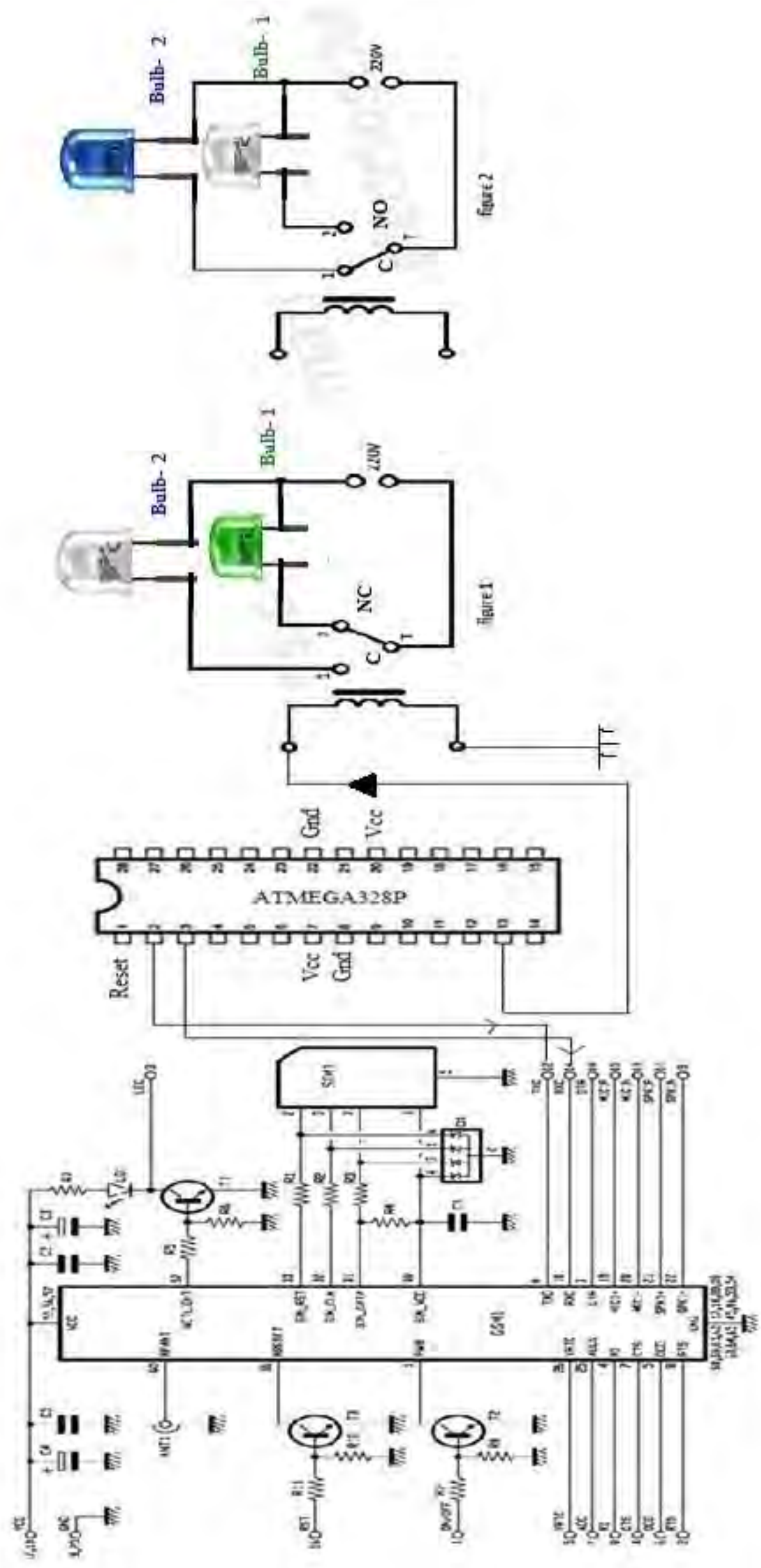


Fig. 3.12: Circuit diagram of the designed project

3.10 Design Steps

In this paragraph, the design steps of this project are outlined:

1. At first, the circuit was designed to fulfill project requirements.
2. Then it was implemented in the Proteus software to check the simulation process.
3. Then the firmware was written.
4. When it was okay in the simulation step, the list of components ware prepared.
5. Then those were bought from the local market.
6. After that the program code was downloaded in the microcontroller.
7. Then circuit connection was given and tested thoroughly.
8. When it works properly, the whole circuit was implemented on a sheet-like board.

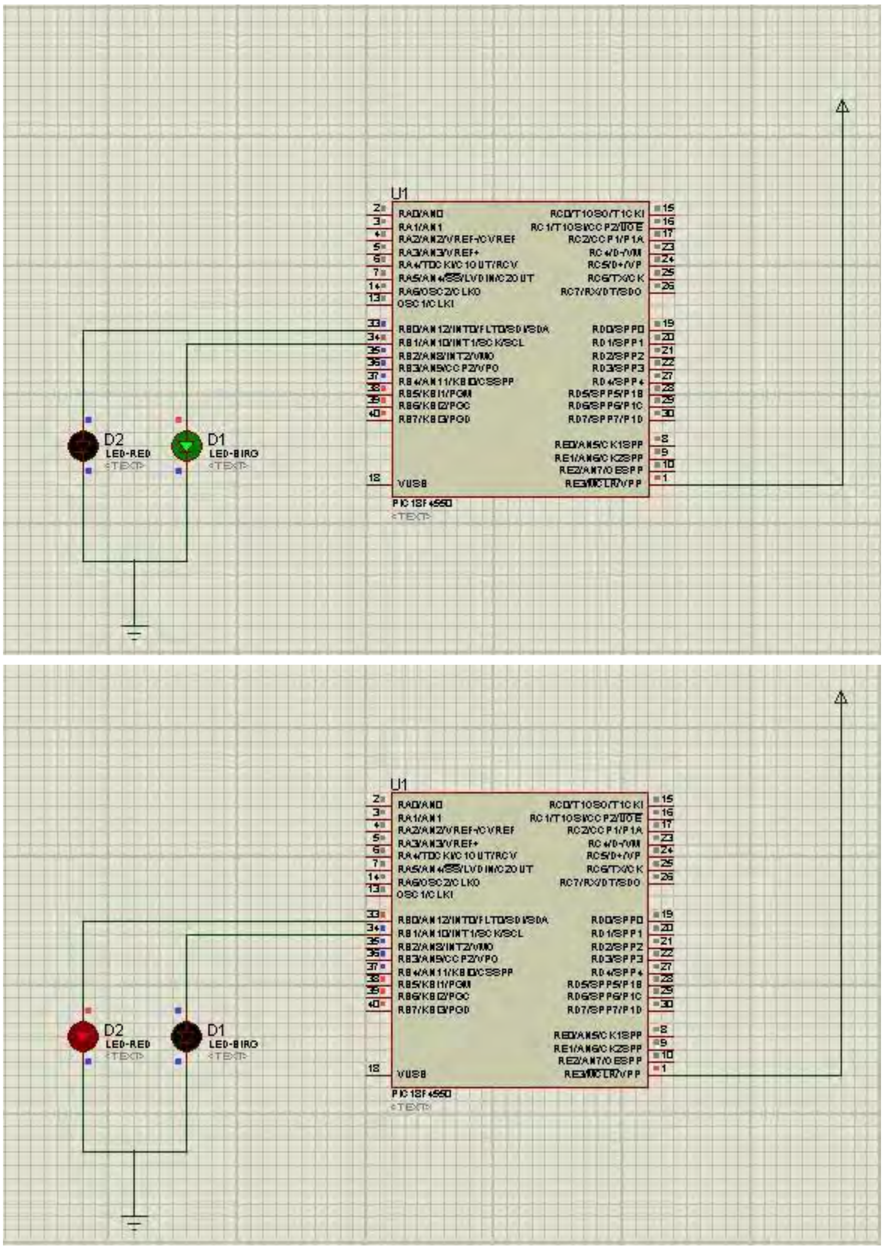
3.11 Simulation of this project

In this paragraph, how this project was simulated using MPLAB and Proteus Software is mentioned in the following:

1. At first, the program was coded by using MPLAB.
2. Then, it was implemented in the Proteus software to check the simulation process.
3. Then, the firmware was written.

3.12 View of the Simulated Project

The following pictures show the simulated project in the pictorial view format.



3.13: View of the simulated project

View of the simulated project and the Fig. 3.18 shows that the circuit board is connected with power supply and it is working. It shows that when the system is powered on then it will start with one LED (green color), after the defined time another one LED (red color) is on and green color LED is off simultaneously.

Chapter 4

Results and Discussions

4.1 Overview

In this chapter, the detail of the results found of this project has been described including the discussions, working principle, advantages, disadvantages, and applications.

4.2 Pictorial View of the Designed Project

The following picture shows the different parts of the designed project in the pictorial view format.

Fig. 4.1: Pictorial view of the designed project

Fig. 4.2: Pictorial view of the designed project (with power supply)

Fig. 4.1 shows pictorial view of the designed project and the Fig. 4.2 shows that the circuit board is connected with power supply. It shows that when the system is powered on then it will be started with device-1. Fig. 4.3 shows that after the defined time devic-2 on and device-1 off simultaneously. And a confirmation SMS is sent every time of changing the devices.

Fig. 4.3: Pictorial view of the designed project (With GSM based SMS to Mobile)

4.3 List of Components with Price

Sl. No.	Name of the Component	Quantity	Unit Price	Price (BDT)
1	Power Supply (9V DC Adapter)	1	150	150
2	Arduino Board	1	900	900
3	SIM 900 GSM Module	1	3400	3400
4	Relay Module(10V)	1	450	450
5	Connecting Wires and others	–	100	100
Total = Five thousand taka only				5,000/=

4.4 Results and Discussions

This device works very efficiently. It gives very quick response. In this section, how this device is designed and what difficulties were being faced will be discussed.

As described in 3.10 sections in which the design steps are given, the circuit was designed using Proteus software. The firmware was written with the Arduino‟s IDE. Then, after that the firmware was downloaded in the microcontroller of Arduino board and then the circuit connection was done. Then, the circuit was being checked in various areas such as in the lab, office room, etc. and it works as desired. Though at first the circuit didn‟t work as it is desired due to some faulty components and wrong connections, but finally it worked. And after that it was placed on a board so that it can be portable.

This circuit was designed using Arduino board with ATMEGA328 microcontroller, GSM module and relay module. All of these are very cost effective and gives very good response. Also it is very easy to implement the whole device in a portable format.

4.5 Advantages of the Designed Project

The advantages are mentioned below:

- As the device is worked for nonstop service, so it can be said that the device is high efficient.
- Cost effective
- The size of the system is 6 x 6 inch, thus the device is portable.
- Low power consumption
- Reliable
- When power is on then the device will be initialized within 2 seconds and the connected device will be changed within 1 second after getting the signal from the microcontroller and the SMS will be sent to the program number. So, it can

be said that the device is capable to quick response.

- Very easy to implement

4.6 Disadvantages of the Designed Project

The disadvantages are mentioned below:

- When powered on then always device-1 is ON.
- The GSM module has to switch on manually.

But these disadvantages can be solved by using uninterruptable power system (UPS).

4.7 Applications

This device can be used in the following places after changing the code (if required) –

- Lab
- Industries
- Offices
- Home
- Secured places

And in many more places.

Chapter 5

Conclusion

5.1 Conclusion

At first, the device was designed with PIC microcontroller. The firmware was written in MPLAB and the simulation was done with Proteus. Though the simulation of the circuit was perfectly fine, the implemented one could not deliver such good performance. So the design of the circuit and also different modules of the design were changed to improve the performance. But still the performance could not be improved. Sometimes it gave correct response while sometimes it did not. Hence, the response was not stable.

Afterwards, to solve the problem a different approach was taken. The circuit was redesigned with an Arduino board with Atmel microprocessor, a relay and GSM module. The performance of the new setup increased drastically. As Arduino is an open-source platform, the implementation is easy and cheap and related help is available in the internet. After some further analysis of previous failure it revealed that it was due to faulty components.

Finally, it can be concluded that this device is very low cost compared to the devices available in the market. It has been designed very carefully and after observing its working procedure, it can be said that it is very efficient and reliable device. It gives very quick responsiveness by which the connected devices are turned on/off immediately. It can be used in many places such as research lab where fixed temperature is the main concern and to save time & labor. That means in a research lab where a fixed temperature is controlled by two air condition (AC), but it needs to change the AC‟s after certain time or twelve hour after twelve hour. So someone have to go and change the schedule daily even in the holiday. By using this device the AC‟s or devices are changed by its definite time and a confirmation SMS will be sent to a programmed mobile number regarding “Device-1 is ON and Device-2 is OFF” or “Device-1 is OFF and Device-2 is ON” automatically.

5.2 Future Works

1. To implement this device in the SEM Lab of GCE Dept, OAB building, BUET to save the time and labor during regular and holidays.
2. To implement it in the places where security is concerned using the confirmation SMS.
3. To implement it using mobile app to control the device wirelessly.

Appendix

In this section the program code has been added to understand the project easily. The program is given below:

Program Code

```
void setup()
	{
		Serial.begin(9600);  //Baud rate of the GSM/GPRS Module
		pinMode(13, OUTPUT);
	}
void loop()
	{
		Serial.print("\r");
		delay(1000);
		Serial.print("AT+CMGF=1\r");
		delay(1000);
		Serial.print("AT+CMGS=\"+8801913484692\"\r");  //Number to which you want to send the sms
		delay(1000);
		Serial.print("Device-1 is on\r Device-2 is off\r");    //The text of the message to be sent
		delay(1000);
		Serial.write(0x1A);
		delay(1000);

		digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
		delay(1000);              // wait for a second

		Serial.print("\r");
		delay(1000);
		Serial.print("AT+CMGF=1\r");
		delay(1000);
		Serial.print("AT+CMGS=\"+8801913484692\"\r");   //Number to which you want to send the sms
		delay(1000);
		Serial.print("Device-1 is off\r Device-2 is on\r");    //The text of the message to be sent
		delay(1000);
		Serial.write(0x1A);
		delay(1000);

		digitalWrite(13, LOW);    // turn the LED off by making the voltage
```

```
        LOW
        delay(1000);            // wait for a second
}
```

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