Project submitted in partial fulfillment for the Degree of B. Tech in Applied Electronics & Instrumentation Engineering under West Bengal University of Technology

HOME AUTOMATION USING SMARTPHONE

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CERTIFICATE OF APPROVAL

The project report titled " **Home Automation Using Smartphone** " prepared by **Antara Ghosh**, Roll No: 11705514006, **Aishwarya Ghosh**, Roll No: 11705514001, **Swastika Bhattacharya**, Roll No: 11705514037, is hereby approved and certified as a creditable study in technological subjects performed in a way sufficient for its acceptance for partial fulfillment of the degree for which it is submitted.

It is to be understood that by this approval, the undersigned do not, necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the project only for the purpose for which it is submitted.

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RECOMMENDATION

I hereby recommend that the project report titled "**Home Automation Using Smartphone**" prepared by **Aishwarya Ghosh**, Roll No: 11705514001, **Antara Ghosh**, Roll No: 11705514006, **Swastika Bhattacharya**, Roll No: 11705514037, be accepted in partial fulfillment of the requirement for the Degree of Bachelor of Technology in Applied Electronics & Instrumentation Engineering, RCC Institute of Information Technology.

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Table of Contents:

Chapter Name	Page No.

Appendix

List of Figures: Page No.

List of Tables: Page No.

LITERATURE REVIEW

Home automation, often referred to as domotics is building automation for a home, called a smart home or smart house. The scope of home automation is no more limited to just controlling lights and heaters, it has spread its domain to the world of smart devices including TV, Laptop, Tabs etc. and even automated pet feeding machines. With the rapid increase in usage and reliance on the features of several smart devices, the need for interconnecting them has become genuine. As it is said,' Necessity is the mother of invention', working towards home automation has become a new accepted challenge. The past few years have witnessed a lot of solutions being proposed and implemented successfully for the same. The initiative started in 1975, when the first general purpose home automation network technology, X10 was developed. X10 is a communication protocol for electronic devices and is used widely. There are basically three generations of home automation:

1. The first generation: wireless technology with proxy server, E.g. Zigbee Automation;
2. Second generation: artificial intelligence controls electrical devices, e.g. Amazon Echo;
3. Third generation: robot buddy who interacts with humans, e.g. Robot Rovio, Roomba.

A Zigbee based wireless router for home automation systems applications, which is capable of smart devices monitoring, controlling and enabling has been proposed. When a smart device is joined to the domain of the home automation system, the system will automatically require the related basic information of this device using which the device can be monitored and controlled.

Speech based home automation that uses human voice control to operate electrical appliances in the home is also being implemented using the HS-05 Bluetooth module and Arduino Bluetooth controller mobile application for switching on or off the appliances.

Voice recognition using frequency modulation is another approach towards home automation and also adds an edge of security to the system. The devices are switched on and off using voice commands. This approach is a simple and convenient means for elderly and physically handicapped persons to control and monitor the devices.

Home automation is also incorporated through the use of Internet. To control and monitor home appliances using android application over internet, the android mobile is used to send the commands to the Arduino to control all the home appliances. The main feature of this system is to control the voltage levels of home appliance in home, like speed of fan based on temperature, intensity of light based on light intensity etc. And another feature is we may get the status of our home appliances from our android mobile phone.

People are using social networks for every aspect of their lives, and a project taking advantage of this to develop a scalable platform in which the user could monitor their home, interacting with a virtual assistant running on a server listening to all events fired by the user has been undertaken. Therefor a different use of social networks, to manage your home or building through them is proposed. The entire platform has been tested with multiple users, scenarios, and also it has been migrated to various frameworks and programming languages to ensure portability.

The importance of accessing modern smart homes over the Internet is quite evident but there are various security issues associated with it. A two-stage verification process for smart homes, using device fingerprints and login credentials, which verifies the user device as well as the user accessing the home over the Internet. The Device Fingerprinting algorithm considers a device's geographical location while computing its fingerprint using the JavaScript, Flash and Geolocation.

Another proposed system for Smart Home Automation is with Raspberry Pi using IoT and it is done by integrating cameras and motion sensors into a web application. To design this system, a Raspberry Pi module with Computer Vision techniques is used. Using this, we can control home appliances connected through a monitor based internet. Raspberry Pi operates and controls motion sensors and video cameras for sensing and surveillance. For instance, it captures

intruder's identity and detects its presence using simple Computer Vision Technique (CVT). Whenever motion is detected, the cameras will start recording and Raspberry Pi device alerts the owner through an SMS and alarm call.

Existing devices used in home automation are mostly based on ZigBee or Z-Wave technologies. While these solutions are proven, they require additional hardware to be used as gateways. These technologies are based on mesh topology and often require additional routers to provide better connectivity. This increases cost of the system, and can increase communication latency time.

Home automation and personalization have been achieved through individual location determination. The objective of the system is to use individualized location determination to improve lifestyle areas in the home in passive and non-intrusive ways. Being passive is important in that users should not have to take extra steps (e.g., pushing a button when they enter a room) as they move throughout their house.

Being non-intrusive is important because users should not have to wear anything extra (e.g., a special armband) or have personal information scanned (e.g., facial recognition camera). The system uses Bluetooth Low Energy (BLE) to identify and track users' movements throughout a house, where the BLE signal of an individual will be associated with a Smartphone or fitness wearable that they normally carry with them. A unique aspect of this project is the implementation of a flipped BLE architecture, which is implemented with a Texas Instruments development board that acts as a beacon to identify users based on their BLE signals from their Smartphone and wearable.

This architecture is “flipped” because most BLE beacons rely on a Smartphone to “see” the beacons whereas the beacons in this system are “seeing” the Smartphone. After identifying BLE devices in proximity to the beacon, the prototype system will record readings on the beacon locally, store data in an SQL database, and clean and process data through a PHP script. Different use cases for the BLE system within a house were considered.

The final prototype will focus on a Smart Thermostat application which automatically adjusts where a thermostat reads the indoor temperature based on the location of the users. Results include a fully functioning prototype that can be used to demonstrate feasibility of the home automation use cases. Test results from the prototype include using a factorial experiment to measure the effect of distance and obstacles on the signal strength readings as well as performance on the system through a range of scenarios.

A lot of research has already been initiated to achieve Home Automation not only to increase the ease and comfort of living but also to take care of energy management. With the ever running world, people often tend to forget to even switch off their appliances when they leave their apartments. This approach can definitely help them save their money and time. Considering large firms and associations, automation is the need of the hour to both reduce manual efforts and cut down costs on the long run. Automation not only helps in reducing manual labour but increase efficiency of production in limited time. Realizing automation in homes can help the elder section of the family to take care of themselves. And implementing such a system into hospitals can be a great boon to the field of health care.

CHAPTER- 1
INTRODUCTION

Home automation system makes the operations of various home appliances more convenient and saves energy. With the energy saving concept, home automation or building automation makes life very simple nowadays. It involves automatic controlling of all electrical or electronic devices in homes or even remotely through wireless communication. Centralized control of lighting equipments, air conditioning and heating, audio/video systems, security systems, kitchen appliances and all other equipments used in home systems is possible with this system.

This system is mainly implemented by sensors, controlling devices and actuators as shown in the figure. The sensors detects light, motion, temperature and other sensing elements, and then send that data to the main controlling devices. These sensors can be thermocouples or thermisters, photo detectors, level sensors, pressure sensors, current transformers, IR sensors, etc., which need an additional signal conditioning equipment to communicate with the main controller.

Controllers may be personal computers/laptops, touch pads, smart phones, etc., attached to the controlling devices like programmable-logic controllers that receive the information from the sensors, and based on the program, control the actuators. This program can be modified based on the load operations. The programmable controller allows to connect various sensors and actuators through various input and output modules whether they are analog or digital.

Actuators are the final controlling devices like limit switches, relays, motors and other controlling mechanisms which finally control the home equipments. Communication plays an important role in this home automation system for the remote access of these operations. This smart home system also provides continuous monitoring through video surveillance with cameras, scheduling, and energy saving operations. This is the best solution even for the elderly and the disabled persons to operate equipments.

CHAPTER- 2

DESIGN AND PLANNING

OBJECTIVE

To establish a Home Automation System using Smart Phone with the following features:

- The microcontroller that is used is 8051
- Use of a Wi-Fi module that provides a working range of 480m
- An Android App installed in the smart phone to control the electronic devices with ease

WORK PLAN

In this project, we will use ***wireless fidelity (Wi-Fi) technology*** to control the Home Electronic Appliances through an Android Phone. Wi-Fi has a range of 470-500 meters, so that we can switch ON and OFF any electronic appliance within the range.

Here we have used 8051 microcontroller with a Wi-Fi module, to wirelessly receive the data, sent from the Android Phone. So that microcontroller can turn ON and OFF the home appliances accordingly.

- Build a constant power supply of 5V, using IC 7805 Voltage Regulator
- Develop the control actions program code (Hex Code) of 8051 micro controller using Multisim 13.1 of National Instruments.
- Develop the android app for the Smartphone using Android Studio, the Smartphone acts as the sender of control commands.

- A Wi-Fi module (acting as receiver) is connected to the microcontroller and hence initiates control action.
- The electronic device is monitored and controlled with the control actions generated by 8051 microcontroller.

BLOCK DIAGRAM

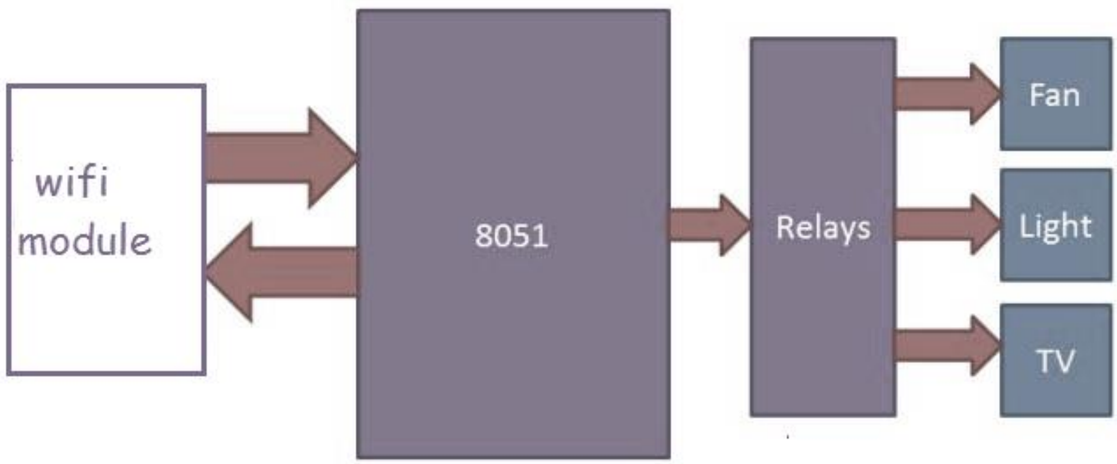

Fig 1: Basic Block Diagram of the system

CHAPTER- 3
REQUIREMENTS

COMPONENTS LIST

I. For Power Supply

S No.	**Name**	**Quantity**	**Range**
1	Centre tap Transformer	1	(16-0-16)V 500mA-1A
2	Diodes (IN 4007)	4	-----
3	Capacitors	3	(i) 470µF (ii) 0.01µF (iii) 0.01µF
4	Voltage Regulator IC	1	IC 7805

II. Components:

Component Name	Quantity	Specification
Power Supply	1	5V
Microcontroller	1	IC AT89C5130 A-M
Vero board	1	----
Wi-Fi Module	1	ESP8266
USB Level Shifter	1	CP2102
Smart Phone	1	Android Platform
Relay Switches	3	5V
Bulb	2	----
Bulb holder	1	----
LEDs	5	20mA
Relimate Connector (M-F, 3 pin)	1	----
Jumper wires	2	----
Resistances	4	10KΩ
ADC/DAC	1	IC 0808

CHAPTER- 4

IMPLEMENTATION

WORK IN PROGRESS

1. Construction of the power supply:

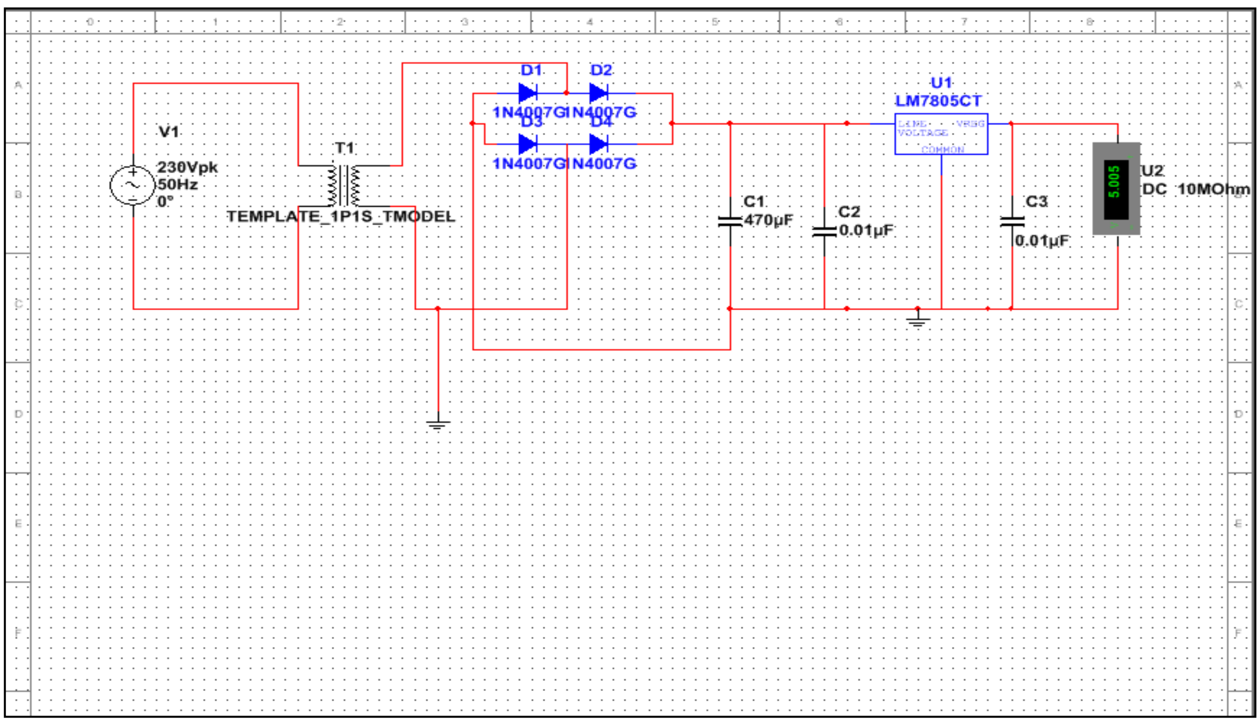

Fig 2: Multisim 13.1 Simulation of the 5V power supply

Successful simulation of the power supply design for the required 5 V supply.

IC 7805 is used as the voltage regulator to obtain the 5 V. The simulation of the model gives 5.004 V as the DC voltage output. The Atmega16A has 3.3V power requirement, a variable resistance Pot can be used along with the 5V power supply to achieve this.

2. Hardwarecircuit of power supply:

Fig 3: Hardware circuit of the 5 volts power

Here we have made a sample circuit of a 5 volts power supply on Bread board and checked whether we are achieving the appropriate and our desired voltage.

2. Circuit for 3.3V power supply

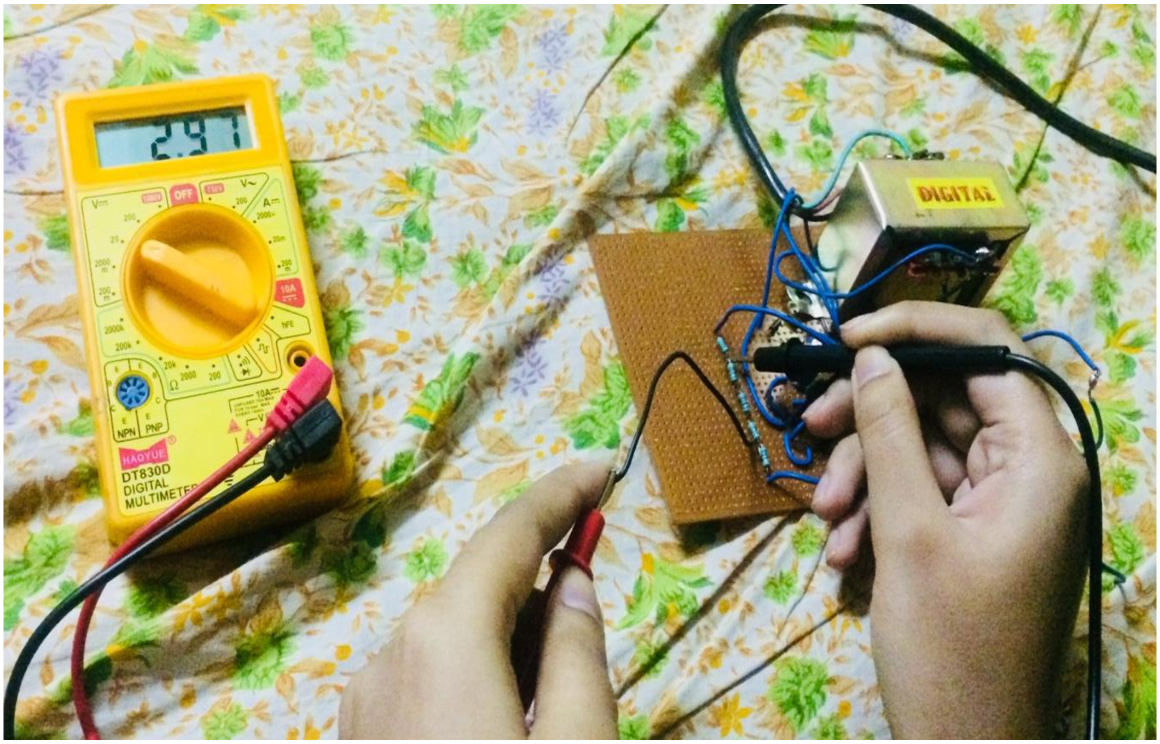

Fig 4:3.3V Power supply hardware circuit

By using the voltage divider method we made a power supply of 3.3 volts. We have used four 1kilo ohm resistors in series.

3. Interfacing of 8051 microcontroller with LEDs

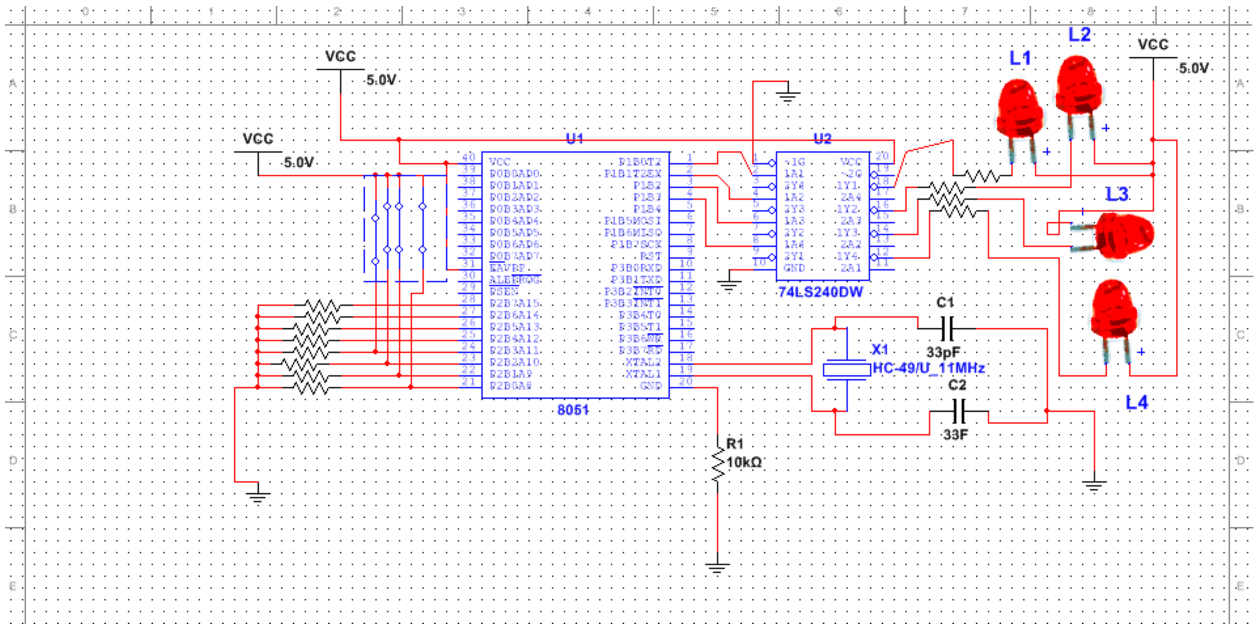

Fig 5: LEDs glowing when all the switches are closed

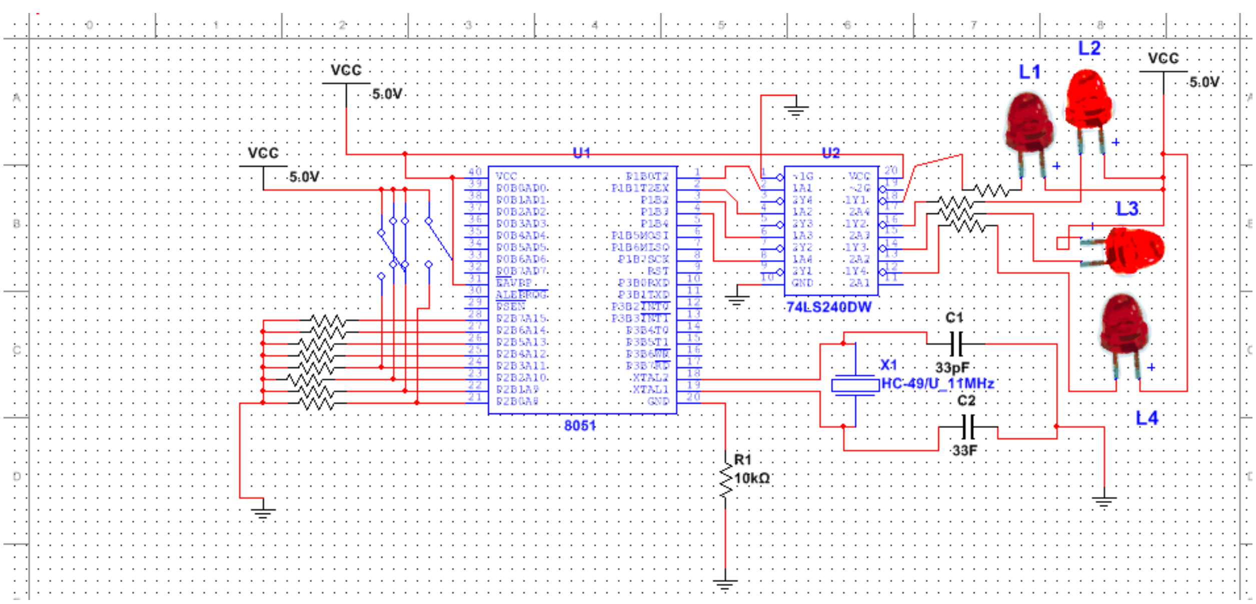

Fig 6: When switches 1 and 4 are opened, LED 1 and 4 are switched off

The figures show the simulation of the interfacing of 4 LEDs with 8051 microcontroller, Port 2 of the 8051 is used as the input port and Port 1 is used as the Output port.

Port 2 is continuously sensed for changes in the logic and the same is represented in the Output through LEDs.

The Assembly Language Program for the same is given below:

```
$MOD51   ; This includes 8051 definitions for the Metalink assembler
ORG 0000H
MOV A,P2
MOV P1,A
RET
; Please insert your code here.

END
```

Fig 7: The Assembly Language Program for Interfacing of LEDs.

4. Development of the Android App

Android Studio is the official integrated development environment for Google's Android operating system, built on Jet Brains' IntelliJ IDEA software and designed specifically for Android development.

Step 1: install android studio

Step 2: open a new project

Step 3: edit the welcome message in the main activity

Step 4: add a button to the main activity

Step 5: create a second activity

Step 6: write the button's "onclick" method

Step 7: test the application

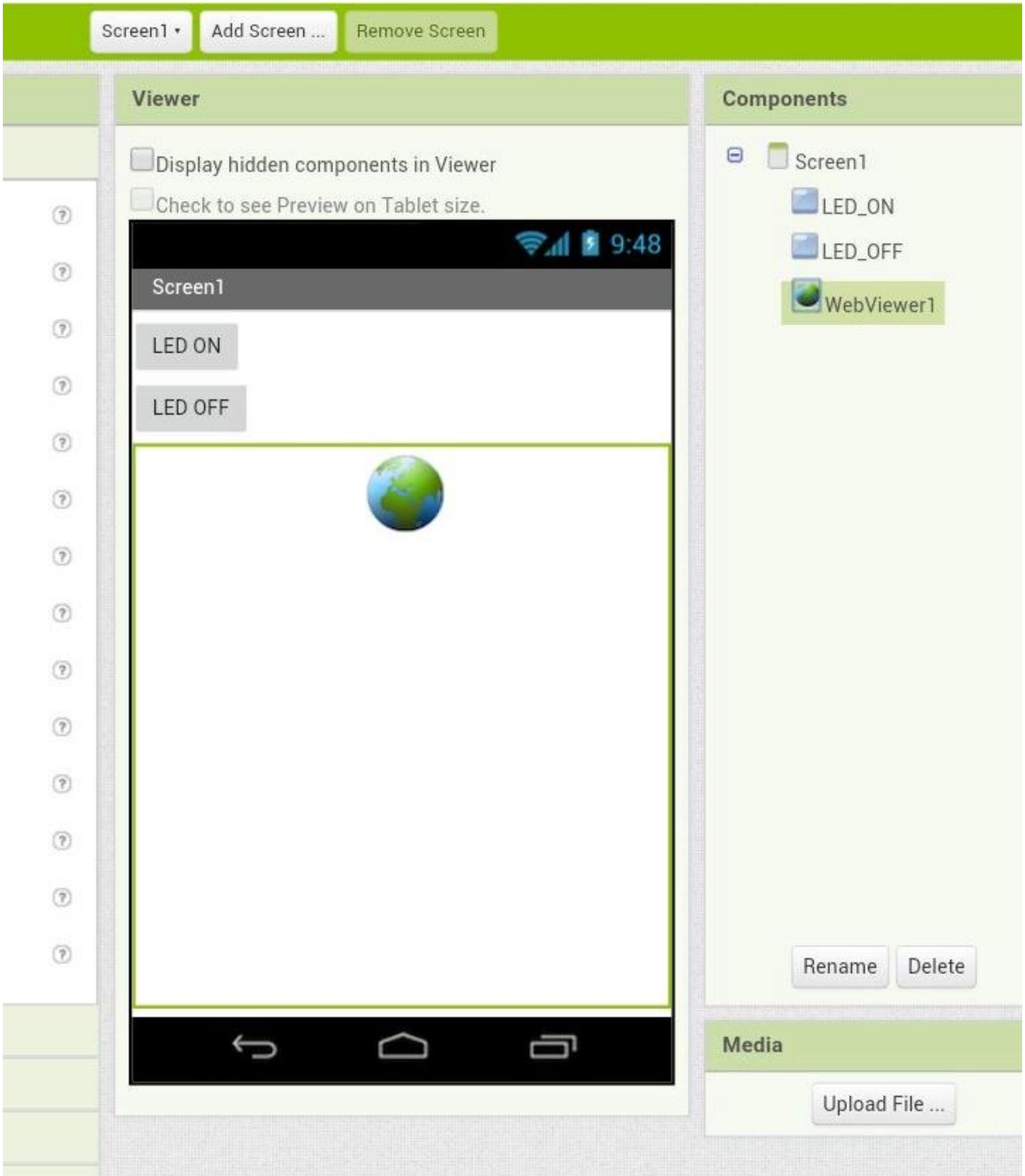

Fig 8: MIT App Inventor (Toggle switches)

5. Hardware implementation of our project

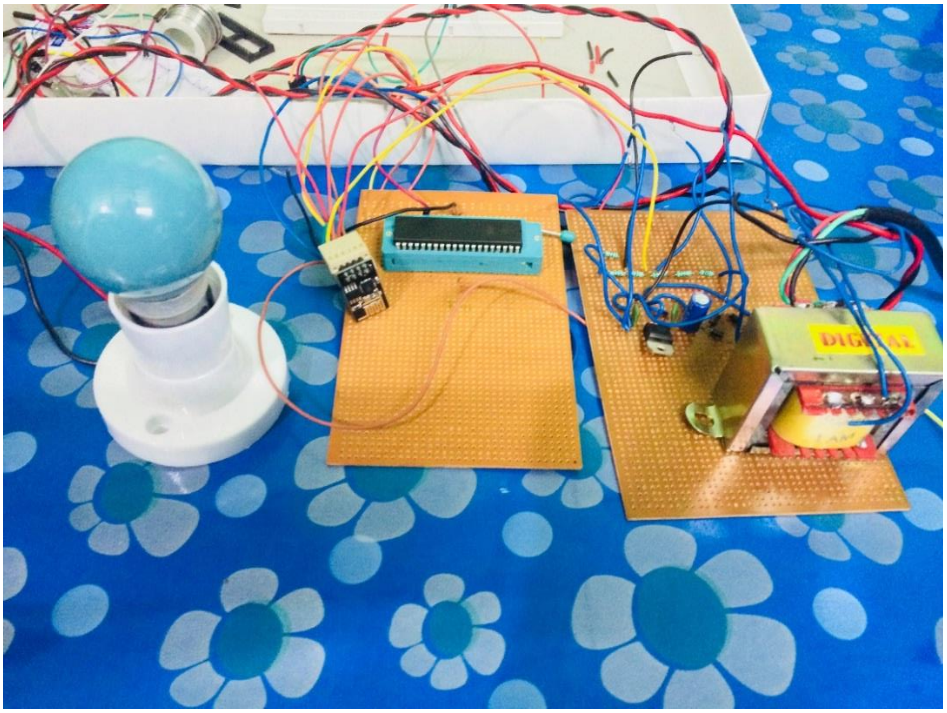

Fig 9: Hardware implementation of our project

On a Vero board we have soldered the microcontroller with the help of IC base and made the necessary connection with connecting wires. We have also connected the crystal circuit in the pin number 12 and 13. We have connected the transmission pin (TXD) of the ESP8266 with the receive pin (RXD) of the microcontroller which is pin number 14 and the receive pin(RXD) of ESP with the transmission pin(TXD) of the chip which is pin number 15. We connected the VCC of the chip from our 5volt power supply circuit. We get the output from the D3 pin of the chip and connected it to a bulb as shown in the figure.

6. Working with the ESP 8266-01 Module:

The ESP 8266-01 is a widely used Wi-Fi-Module that is used to establish wireless interconnection of two or more devices through Wireless Fidelity.
A USB-TTL C2102 is used in conjunction with the Wi-Fi module to connect with the PC.
+++The ESP is loaded with the AiThinker Version Firmware

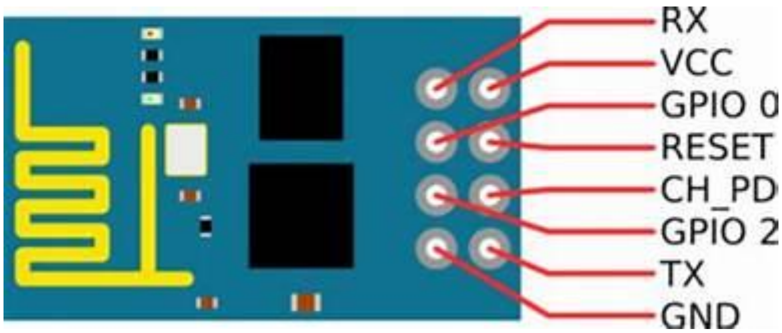

Fig 10: ESP 8266-01 Wi-Fi Module Pin Layout

The ESP 8266-01 requires a 3.3v power supply to function.

The VCC and CH_PD pins are provided the 3.3V.

The RX pin of the ESP is connected to the TX pin of the USB TTL and vice versa.

The GPI0 1 and GPIO 2 pins are not used in general

The GPIO 1 pin is grounded while loading the firmware and hence flashing the ESP 8266-01. The Wi-Fi module is said to be in the Flash Mode then.

We are using the module in its MODE 3 in which it acts as both the server and client and generates two different IP addresses for the same.

We have used the Putty and RealTerm Software in order to use the AT Commands i.e the Attention Commands.

Using AT Commands:

The Baud Rate was specified as 115200 and the COMPORT used was 37 according to our setup.

The following AT commands were used:

1. AT- The ESP responds back with OK and this ensures that the connection between the ESP and the PC is established successfully.
2. AT+BAUDRATE? – The ESP responds back, displaying the Baud Rate being used
3. AT+CWMODE? –The ESP gives its default mode
4. AT+CWMODE=3 : we use this command to set the mode of the ESP to 3
5. AT+CWLAP- This displays all the available Local Area Network connections along with their Mac Address.
6. AT+CWJAP=”ssid”,”password”- This command is used to connect to the desired network
7. AT+CIFSR: This command displays the station point and Access point IP address of the ESP module.
8. AT+MUX=1; This sets the ESP to multiplexing mode.
9. AT+CIPSERVER=1,80; This instruction sets up a temporary server at port 80.
10. AT+CIPSEND is used to send characters to the browser
11. AT+CIPCLOSE is used to close the server.

The station point IP generated was 192.168.4.1 and the access point IP address was 192.168.43.209

7. Microcontroller programming in C language

- This C program is used to connect the ESP8266 with the Atmega16A microcontroller. Whatever character or command is sent to ESP8266 is further communicated with the microcontroller, which in turn carries out that command for example, lighting up a lamp, switch on/off any other loads, etc.

- The crystal of the microcontroller is at pin number 12 and 13. The transfer and receive pin of the controller are 15 and 14 respectively.

- In this program we have set the clock frequency at 16MHz and the BAUD rate is kept 115200. Since Atmega16A is microcontroller that operates on 16MHz clock speed we have set the specifications in the C program accordingly.

- In this program we have used our mobile hotspot to serve as the local area network and thus we have defined our SSID and password in this program as per to our network name and password. Our network name is “Antara G” and password is “9051157116”. Our ESP8266 is connected to the server at port 80.

- We have configured port D3 (pin number: 17) of the microcontroller in this C program as the output port. The message sent via the ESP8266 is transferred to the microcontroller through the transfer pin (TX PIN; pin number: 15). The microcontroller then carries out its task and sends the message to the D3 pin from where we get the output.

- It is an interfacing program between the ESP8266, the microcontroller and the sever. With the help of this program we will be able to send the message to the microcontroller through the server with the help of the Wi-Fi module.

Program Overview

Step 1: The BAUD rate is set using the registers UBRRH and UBRRL.

Step 2: The transmitter and receiver is enabled using UCSRB (UART Control and Status Register B).

Step 3: Send the data after adding data into the transmit buffer.

Step 4: Wait until the data is being received then return the received data from buffer.

Step 5: The received data is checked.

Step 6: Read UART register into value.

Step 7: A function received_command is used. Counters ‘a’ and ‘i’ are introduced. The Array is checked until null. When it is encountered it will enter into the field class. After it has been checked the global counter is cleared.

Step 8: The above function (received_command()) is called and checked using string compare that whether it is receiving the correct signals (ON-OFF signals).

Step 9: Insert unsigned variables receive(char type), control(char type) and check_variable (int type), initialize counter i=0.

Step 10: If receive[i] ==control[i] then increment i by 1 (check until control=null) else if i=check_variable, return 1 else return 0

Step 11: To send the commands, USART transmit function is called.

Step 12: The AT commands are initialized (SSID and Passwords are set using AT+CWSAP to secure access point).

Step 13: Ports are configured as input and output ports.

Step 13: A delay is set for 50 msec. “ON” and “OFF” commands are send to get the desired output.

RESULTS

We have successfully made a connection between the ESP8266 and the server. The characters that we send are displayed on the server. We have used the USB-TTL to connect the ESP module with the laptop. Our IP address for ESP8266 is 192.168.43.209 and the port is 80.

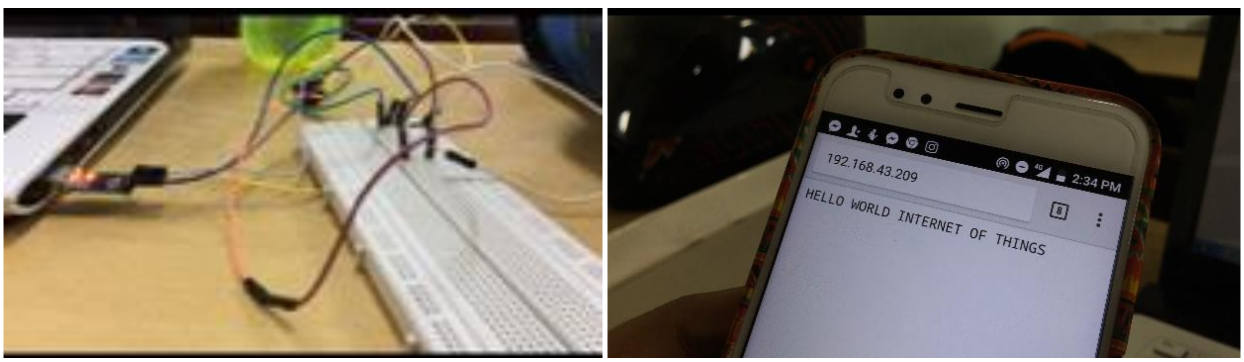

Fig 11: Communication of ESP8266 with the server

The DSO is used to check if the microcontroller is transmitting the signal received from the ESP or not. When the switch button is pressed ON in the App, the signal is being received and transmitted, and a bit pattern is observed in the DSO.

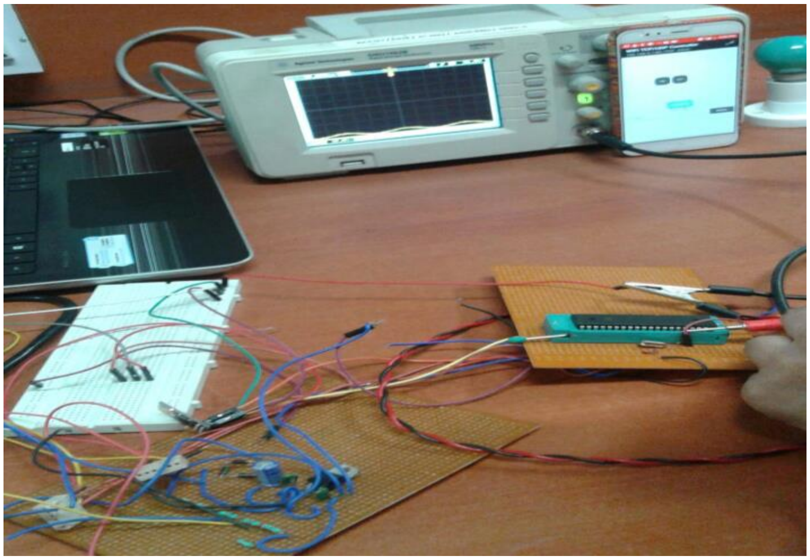

Fig 12a: Bit pattern not observed in DSO when switch is off in App

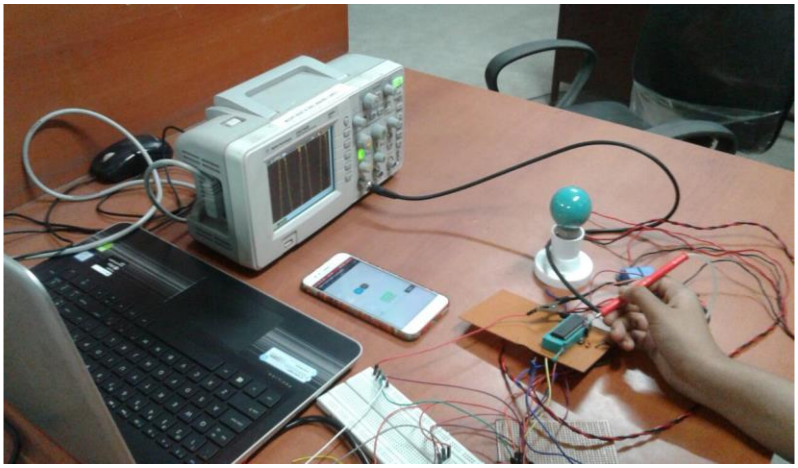

Fig 12b: Bit pattern observed in DSO when switch is on in App

CHAPTER-5

FUTURE ENHANCEMENT

In the future we plan to incorporate more loads into the circuit like fans, lights, etc. We are also planning to interface a Wi-Fi module with 8051 micro controller which will allow us to control all the loads from a smartphone app. We are currently learning how the android studio works in order to progress without Smartphone application.

CHAPTER- 6
CONCLUSION

- Home Automation is undeniably a resource which can make a home environment automated. People can control their electrical devices via these Home Automation devices and set up controlling actions through mobile app.
- In future this product may have high potential for marketing. Old people can make use of this technology and they will not needing anymore to walk up the stairs to switch of the terrace lights or the water pump; now it can be done sitting in your bedroom just by a touch on their Smartphone.

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  - 1K Byte Internal SRAM
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  - Data retention: 20 years at 85°C/100 years at 25°C[(1)]
  - 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
- JTAG (IEEE std. 1149.1 Compliant) Interface
  - Boundary-scan Capabilities According to the JTAG Standard
  - Extensive On-chip Debug Support
  - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Four PWM Channels
  - 8-channel, 10-bit ADC
    - 8 Single-ended Channels
    - 7 Differential Channels in TQFP Package Only
    - 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x
  - 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
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby
- I/O and Packages
  - 32 Programmable I/O Lines
  - 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF
- Operating Voltages
  - 2.7 - 5.5V for ATmega16A
- Speed Grades
  - 0 - 16 MHz for ATmega16A
- Power Consumption @ 1 MHz, 3V, and 25°C for ATmega16A
  - Active: 0.6 mA
  - Idle Mode: 0.2 mA
  - Power-down Mode: < 1µA

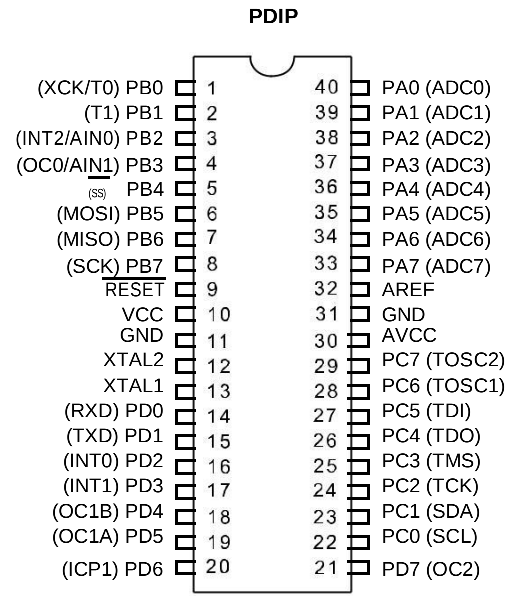
8-bit ® Microcontroller with 16K Bytes In-System Programmable Flash

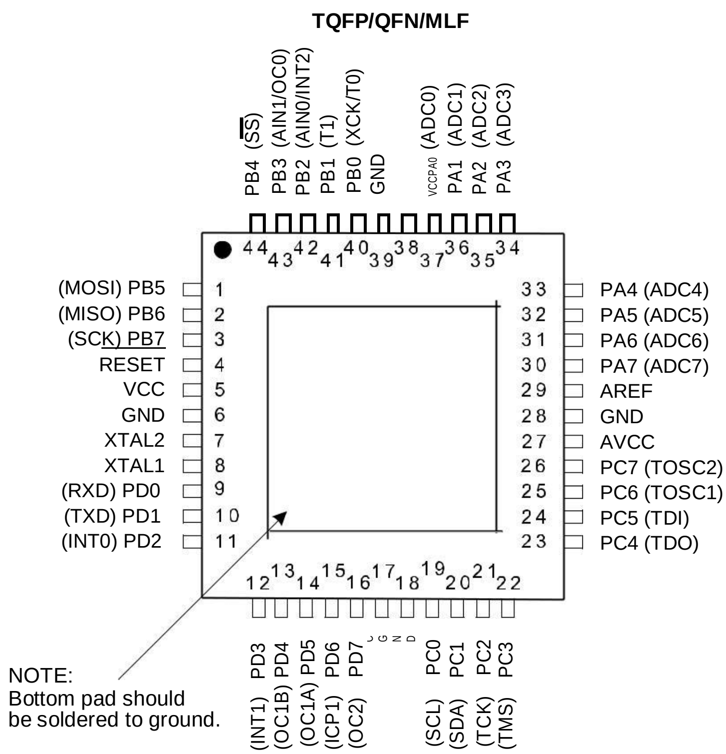
ATmega16A

Summary

1. Pin Configurations

Figure 1-1. Pin out ATmega16A



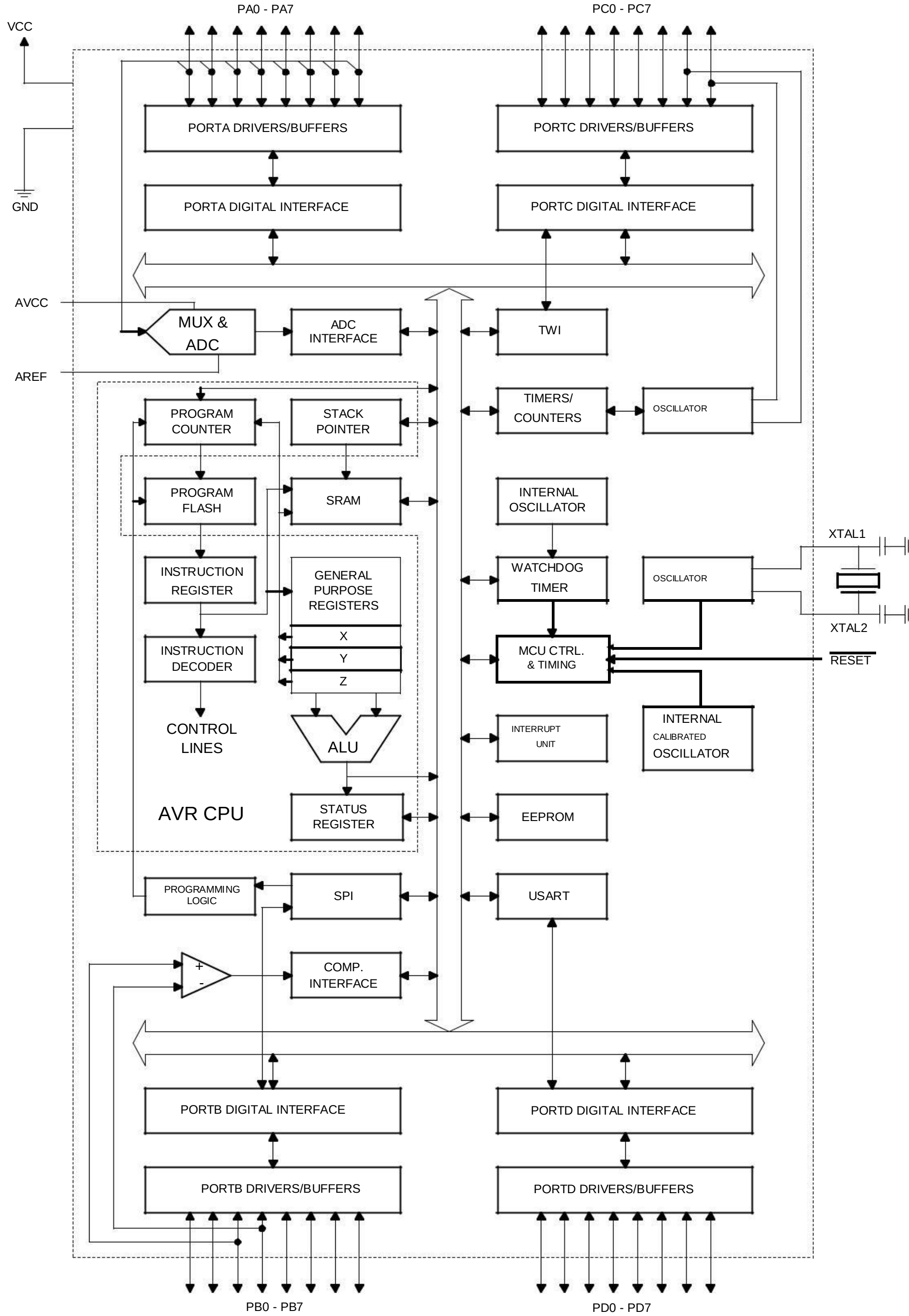


2. Overview

The ATmega16A is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16A achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

2.1 Block Diagram

Figure 2-1. Block Diagram



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 ATmega16A provides the following features: 16K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, three flexible Timer/Counters with com-pare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscil-lator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, 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 External Inter-rupt 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/reso-nator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run.

The device is manufactured using Atmel’s high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile 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 in the 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 Atmel ATmega16A is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.

The ATmega16A AVR 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.

2.2 Pin Descriptions

2.2.1 VCC

Digital supply voltage.

2.2.2 GND

Ground.

2.2.3 Port A (PA7:PA0)

Port A serves as the analog inputs to the A/D Converter.

Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have sym-metrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

2.2.4 Port B (PB7:PB0)

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.

Port B also serves the functions of various special features of the ATmega16A as listed on page 57.

2.2.5 Port C (PC7:PC0)

Port C is an 8-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 not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

Port C also serves the functions of the JTAG interface and other special features of the ATmega16A as listed on page 60.

2.2.6 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 ATmega16A as listed on page 62.

2.2.7 RESET

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 Table 27-2 on page 296. Shorter pulses are not guaranteed to generate a reset.

2.2.8 XTAL1

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

2.2.9 XTAL2

Output from the inverting Oscillator amplifier.

2.2.10 AVCC

AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.

2.2.11 AREF

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

3. Resources

A comprehensive set of development tools, application notes and datasheets are available for download on http://www.atmel.com/avr.

4. Data Retention

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.

ESP-01 Wi-Fi Module

Version1.0

1. Preambles

ESP-01 Wi-Fi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LLNA, on-board antenna.

The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller.

ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

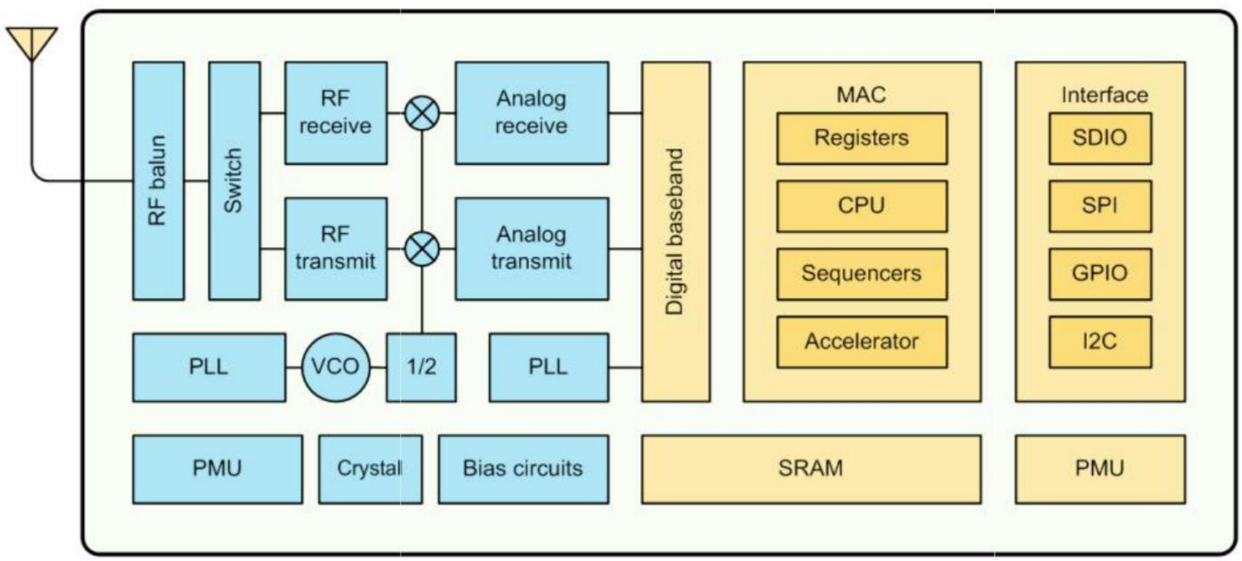


Figure 1 ESP8266EX Block Diagram

ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor.

When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications.

ESP8266EX is among the most integrated Wi-Fi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

Espressif Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing. for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

1.1. Features

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and poweer management units
- Supports antenna diversity
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- Support Smart Link Function for both Android and iOS devices

- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation and 0.4s guard interval
- Deep sleep power <10uA, Power down leakage current < 5uA
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- +20dBm output power in 802.11b mode
- Operating temperature range -40C ~ 125C

1.2. Parameters

Table 1 below describes the major parameters.

Table 1 Parameters

Categories	Items	Values
WiFi Paramters	WiFi Protocles	802.11 b/g/n
	Frequency Range	2.4GHz-2.5GHz (2400M-2483.5M)
Hardware Paramaters	Peripheral Bus	UART/HSPI/I2C/I2S/Ir Remote Contorl
		GPIO/PWM
	Operating Voltage	3.0~3.6V
	Operating Current	Average value: 80mA
	Operating Temperature Range	-40°~125°
	Ambient Temperature Range	Normal temperature
	Package Size	14.3mm*24.8mm*3mm
	External Interface	N/A
Software Parameters	Wi-Fi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network) / download and write firmware via host
	Ssoftware Development	Supports Cloud Server Development / SDK for custom firmware development
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

2. Pin Descriptions

There are altogether 8 pin counts, the deffinitions of which are described in Table 2 below。

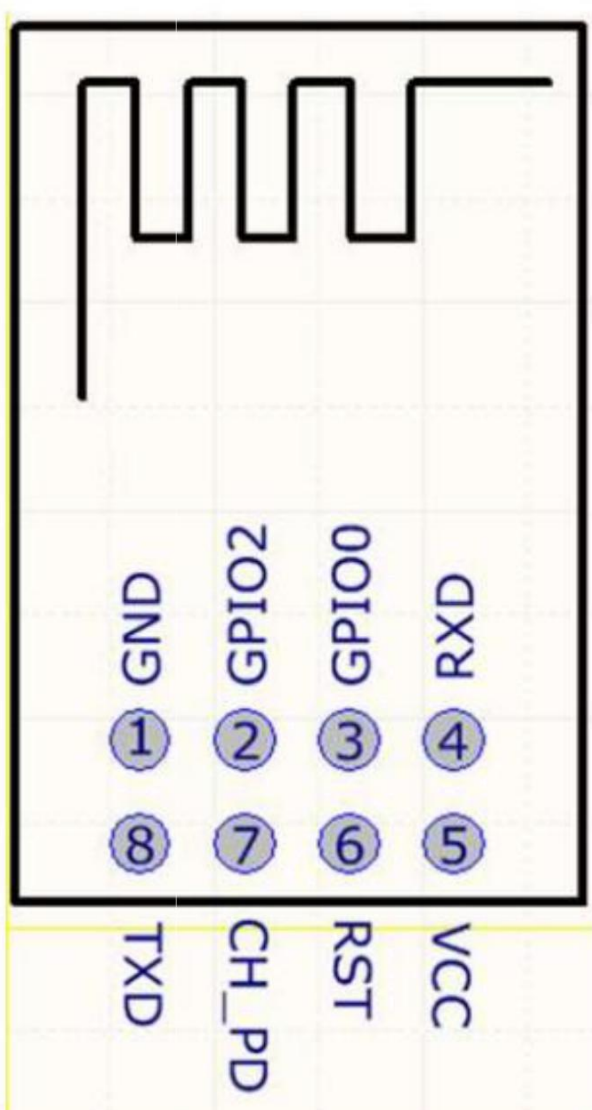


Table 2 ESP-01 Pin design

Table 2 Pin Descriptions

NO.	Pin Name	Function
1	GND	GND
2	GPIO2	GPIO,Internal Pull-up
3	GPIO0	GPIO,Internal Pull-up
4	RXD	UART0,data received pin RXD
5	VCC	3.3V power supply (VDD)
6	RST	1) External reset pin, active low 2) Can loft or external MCU ,
7	CH_PD	Chip enable pin. Active high
8	TXD	UART0,ddata send pin RXD

Table 3 Pin Mode

Mode	GPPIO15	GPIO0	GPIO2
UART	Low	Low	High
Flash Boot	Low	High	High

Table 4 Receiver Sensitivity

Parameters	Min	Typical	Max	Unit
Input frequency	2412		2484	MHz
Input impedance		50		Ω
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
DSSS, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-72		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

3. Packaging and Dimension

The external size of the module is 14.3m m*24.8mm*3mm, as is illustrated in Figure 3 below. The type of flash integrated in this module is an SPI flash, the capacity of which is 1 MB, and the package size of which is SOP-210mil. The antenna applied on this module is a 3DBi PCB-on-board antenna.

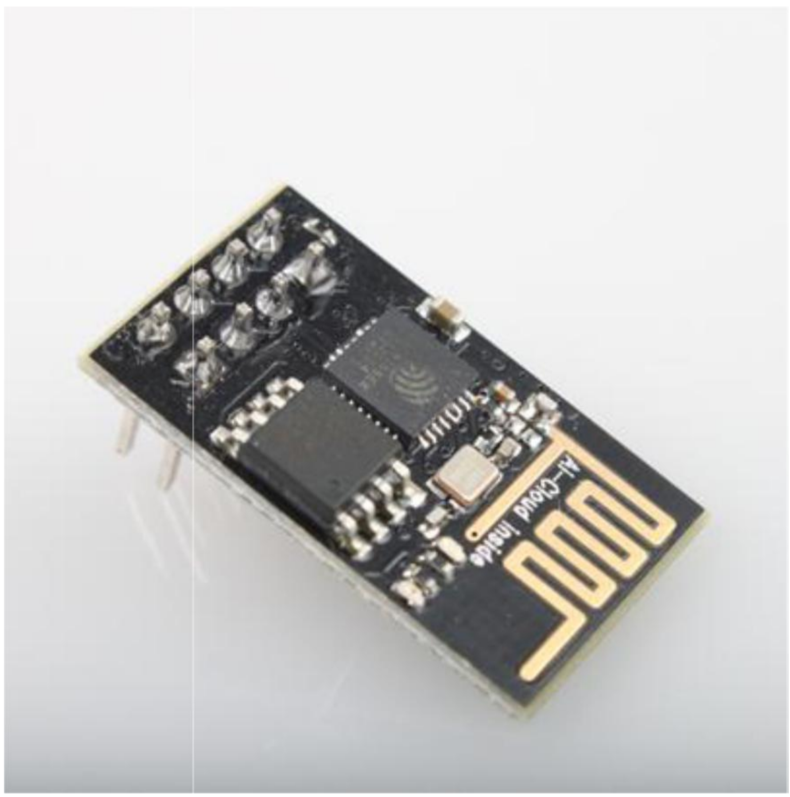


Figure 3 [Module Pin Counts, 8 pin, 14.3 mm *24.8 mm *3.0 mm]