RASPBERRY PI IOT KIT MANUAL

info@cognfront.com

Cognifront
Research Lab

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Interfacing and Programming Arduino with PC

Objectives:

- To study the layout of Arduino Board.
- To Identify the microcontroller IC on Arduino (ATMEGA328)
- To study the installation and interface of Arduino IDE.
- To learn basic command of Arduino IDE.
- To write a simple program in Arduino IDE to interface the Arduino board with PC.

Software:

- Arduino IDE 1.6.9 or higher

Hardware Modules:

- Arduino Board
- PC / Laptop

Theory:

Introduction to Arduino Board

- Arduino Board is an Open Source software and hardware. The brain of Arduino Board is the microcontroller IC ATMEGA328-UNO-R3 (3rd version) present on the top right corner of the board.
- There are total 20 pins mounted on the board.
- From these, 14 are digital pins denoted by 0, 1….13 or D0, D1….D13. These pins can be set as input or output pins (digital read or write).
- The remaining 6 pins are the Analog pins, denoted by A0, A1….A5. These pins are used to read the analog signal (analog read), these pins can also be used as digital input/output pins.
- From the 14 digital pins, 6 pins are denoted by 'PWM', which are used to write the analog signal (analog write).
- Arduino board can be connected to the PC using USB cable. It has two different connectors at its two ends. One of type-A(PC side)) and the other is type-B(Arduino side).
- Power is given to Arduino Board by two ways, 1. Through USB cable or 2. By external adapter (when there is no need of PC/Laptop).

Introduction to Arduino IDE (Integrated Development Environment)

- The latest version of Arduino IDE is Arduino-1.6.9.
- It can be downloaded freely from the website Arduino.cc.
- It is an exe file.
- After downloading, run it to install on the PC.
- Arduino IDE is available for windows, Linux, and mac-OS.

Using Arduino IDE:

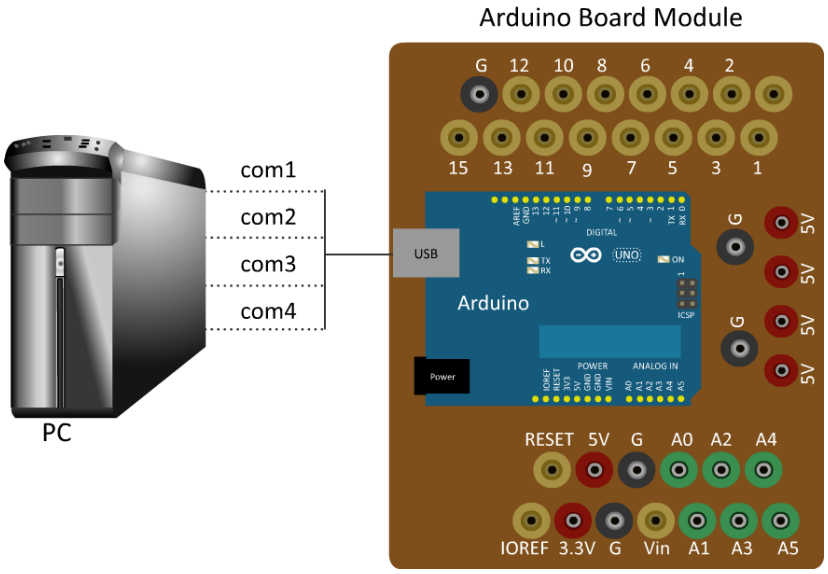
- Start IDE
- In order to exchange data and information between PC and Arduino board, the type of the board and the port number is to be selected. (This selection is available under 'Tool' menu)
- Type the 'c' program in Arduino IDE

- Save and compile the program (tick mark)
- If the program compiles properly, it can be transferred (uploaded) to the microcontroller IC in the Arduino board. For this use the symbol ‘right arrow’.
- When the program is being transferred to the Arduino board, the LEDs on the Arduino board which indicates serial communication start blinking.
- After this the microcontroller should start working on its own.
- In real life applications Arduino is removed from the PC by disconnecting the USB cable and separate power supply is applied.

Safety precautions:

- First, make all the connections as per steps given below
- Then connect Arduino board to PC/Laptop

Interface diagram:



Procedure:

- Write the program as per the algorithm given below.
- Save and compile the program.
- Connect the Arduino board to PC/Laptop using USB cable.
- Upload the compiled program and check the output.

Algorithm:

- Start IDE
- Configure the pin number ‘13’ as ‘OUTPUT’ pin
- Make the ‘OUTPUT’ as ‘HIGH’
- Give delay of one second
- Make the ‘OUTPUT’ as ‘LOW’
- Give delay of one second

Observation:

- Observe the LED near the pin number ‘13’, it starts blinking as soon as the program is uploaded.

Studying architecture of Raspberry Pi board

Aim/Objectives

- To understand the architecture of Raspberry-Pi 3 Model B

Introduction

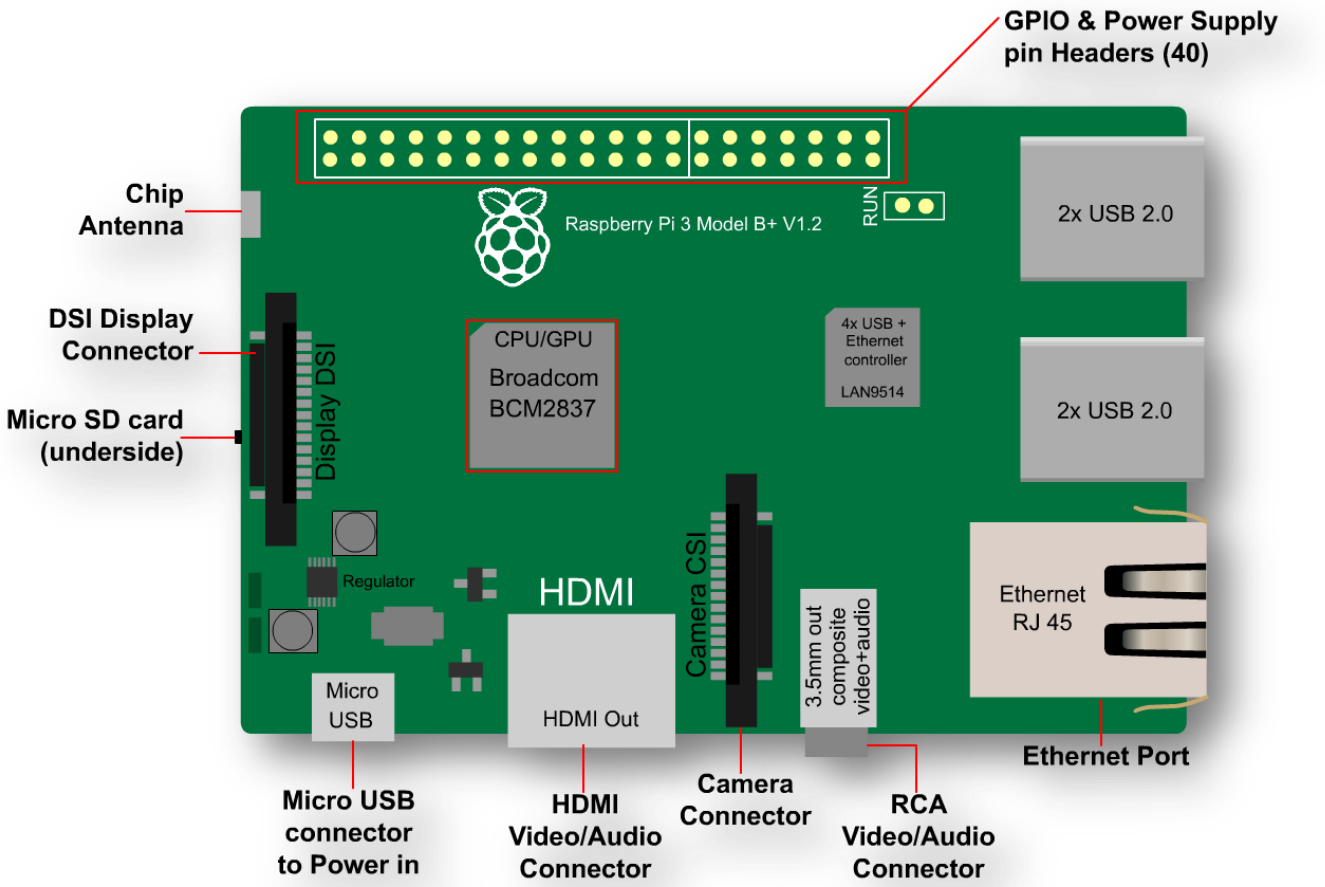
- The Raspberry Pi is developed in the United Kingdom by the Raspberry Pi Foundation.
- These boards are approximately credit-card sized.
- Raspberry Pi world's most inexpensive and powerful Single Board Computer.
- Raspberry Pi runs Debian based GNU/Linux operating system called Raspbian and ports of many other OS exist for Raspberry Pi.
- Python language is popular for programming Raspberry-Pi
- The first generation (**Raspberry Pi 1 Model B**) was released in February 2012.
- Then the Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.
- So several generations of Raspberry Pis have been released

History

- The history of Raspberry-Pi evolution is summarized in the below table.

Parameter	Raspberry pi 1	Raspberry pi 2	Raspberry pi 3
Released	February 2012	February 2015	February 2016
CPU	ARM1176JZF-S	ARM Cortex-A7	ARM Cortex-A53
CPU speed	700MHz single core	900MHz quad core	1,200MHz quad core
RAM	512MB 256MB Rev 1	1GB	1GB
GPU	Broadcom Video core IV	Broadcom Video core IV	Broadcom Video core IV
Storage	SDHC slot Micro SDHC Model A+ And B+	Micro SDHC slot	Micro SDHC slot
USB Ports	2 on Model B	4	4
WiFi	No built-in Wi-Fi	No built-in Wi-Fi	802.11n wireless LAN (WiFi) and Bluetooth 4.1

Raspberry Pi 3 Model B:



Details of the various components on the Raspberry Pi board

ARM CPU/GPU (BCM2837 Chipset)

- This chip is specifically built for the new Pi 3.
- This Broadcom BCM2837 system-on-chip (SOC) includes four high-performance ARM Cortex-A53 processing cores running at 1.2GHz.
- It also has 32kB Level 1 and 512kB Level 2 cache memory, a VideoCore IV graphics processor, and is linked to a 1GB LPDDR2 memory module on the rear of the board.

Broadcom IC

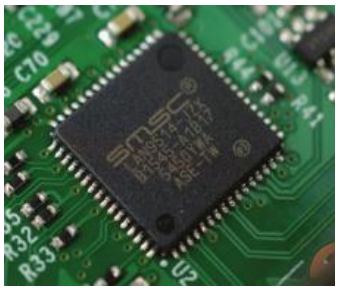
GPIO Header

- GPIO stands for General Purpose Input Output.
- There are 28 GPIO (Digital) pins available on this board via a header.
- These pins allow the user to interface the Pi with the real world.

- For example, using these pins, we can drive the LED, Switches, and Sensors etc.

USB chip

- The Raspberry Pi 3 shares the same SMSC LAN9514 chip as its predecessor, the Raspberry Pi 2.
- But it has additional 10/100 Ethernet connectivity and four USB channels to the board.
- As before, the SMSC chip connects to the SOC via a single USB channel, acting as a USB-to-Ethernet adaptor and USB hub.



USB Chip

Chip Antenna

- There's no need to connect an external antenna to the Raspberry Pi 3.
- Its radios are connected to this chip antenna soldered directly to the board, in order to keep the size of the device to a minimum.
- This antenna is more than capable of picking up wireless LAN and Bluetooth signals – even through walls.

USB Antenna

DSI Display Connector

- DSI [Digital serial Interface] is used for connecting a LCD to the Raspberry Pi board.

Micro SD Card

- SD card is used as a boot device and also persistent storage.
- The Micro SD Card will hold the operating system which will boot while we power on Raspberry Pi 3.

Micro USB Connector

- The micro USB port is used for supplying power to the Raspberry Pi board.

HDMI

- HDMI port (High-Definition Multimedia Interface) is used to quickly connect Raspberry Pi to HDMI Monitor.

CSI Camera Connector

- CSI [Camera serial Interface] is used for connecting a camera to the Raspberry Pi board.

Ethernet Port

- Used for connecting to the Internet.

USB Port

- There are 4 USB ports mainly used for peripherals like Keyboard, mouse and a Wi-Fi Adapter.
- A powered USB hub can be connected and be expanded.

RCA Video/Audio Jack

- Combined 3.5mm audio jack and composite video
- This A/V RCA Cable for Raspberry Pi is a great way to turn your Pi 3 output into a full on composite video and audio device.
- Simply connect the cable to your Raspberry Pi's 3.5mm jack and the other side into whatever device you're looking to connect to and get full RCA visuals and sound.

Raspberry Pi 3 - Model B Technical Specifications

- Broadcom BCM2387 chipset
- 1.2GHz Quad-Core ARM Cortex-A53
- 1GB LPDDR2-900 SDRAM (i.e. 900MHz)
- 64 Bit CPU
- Roughly 50% faster than Raspberry Pi 2
- 802.11n Wireless LAN
- BCM43143 WiFi on board
- Bluetooth 4.1 (including Bluetooth Low Energy)
- Bluetooth Low Energy (BLE) on board
- 40 pins extended GPIO
- 4 x USB 2 ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source (now supports up to 2.4 Amps)
- 400MHz VideoCore IV multimedia
- Micro USB power source

Raspberry Pi 3 - Model B Features

- Now 10x Faster - Broadcom BCM2387 ARM Cortex-A53 Quad Core Processor powered Single Board Computer running at 1.2GHz
- 1GB RAM so you can now run bigger and more powerful applications
- Fully HAT compatible
- 40pin extended GPIO to enhance your “real world” projects.
- Connect a Raspberry Pi camera and touch screen display (each sold separately)
- Stream and watch Hi-definition video output at 1080
- Micro SD slot for storing information and loading your operating systems
- 10/100 BaseT Ethernet socket to quickly connect the Raspberry Pi to the Internet

Applications

- Robotics
- Game emulation
- Media Servers
- Education (Python is the primary language used)
- Powerful enough to be used as a personal computer
- Thousands of other projects (Often used in Senior Design)