Design Manual

Smart Meeting Automaton

Version 1.0

28th May 2021

Group Members: Group 12

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Hardware Information

Raspberry Pi 3 Model B+

Raspberry Pi 3 Model B+ is a single-board computer which is developed for the applications of IoT and wearable electronics.

The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market.

Product Documentation: https://static.raspberrypi.org/files/product-briefs/Raspberry-Pi-Model-Bplus-Product-Brief.pdf

Features

1. **Microprocessor**
   - Broadcom BCM2837 64bit Quad Core Processor
   - 64-bit SoC @ 1.4GHz

2. **Flash Memory**
   - 16Gbytes SSD memory card

3. **Internal RAM**
   - 1Gbytes DDR2

4. **Clock Frequency**
   - 1.2GHz

5. **GPU**
   - Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high- profile decode.
   - Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure.

6. **Board Connectors**
   - **Ethernet -** Base T Ethernet Socket
   - **USB -** 2.0 (Four sockets)
   - **Audio Output -** 3.5mm Jack and HDMI
   - **Video output -** HDMI
   - **Camera Connector -** 15-pin MIPI Camera Serial Interface (CSI-2)
   - **Display Connector -** Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane.
   - **Memory Card Slot -** Push/Pull Micro SDIO

7. **Wireless Connectivity**
   - BCM43143 (802.11 b/g/n Wireless LAN and Bluetooth 4.1)

8. **Ethernet**
   - 10/100 Ethernet

9. **Pin Configuration**
   - **POWER SOURCE**: +5V, +3.3V, GND and Vin
   - **COMMUNICATION INTERFACE**: UART Interface (RXD, TXD) [(GPIO15, GPIO14)]
   - **SPI Interface (MOSI, MISO, CLK, CE) x 2**: SPI (Serial Peripheral Interface) used for communicating with other boards or peripherals.
   - **[SPI0-(GPIO10, GPIO9, GPIO11, GPIO8)]**: SPI (Serial Peripheral Interface) used for communicating with other boards or peripherals.
   - **[SPI1--(GPIO20, GPIO19, GPIO21, GPIO7)]**: SPI (Serial Peripheral Interface) used for communicating with other boards or peripherals.
   - **TWI Interface (SDA, SCL) x 2**: TWI (Two Wire Interface) Interface can be used to connect peripherals.
   - **[(GPIO2, GPIO3)] [(ID_SD, ID_SC)]**: TWI (Two Wire Interface) Interface can be used to connect peripherals.
   - **INPUT OUTPUT PINS**: 26 I/O
   - **PWM**: Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19
   - **EXTERNAL INTERRUPTS**: All I/O

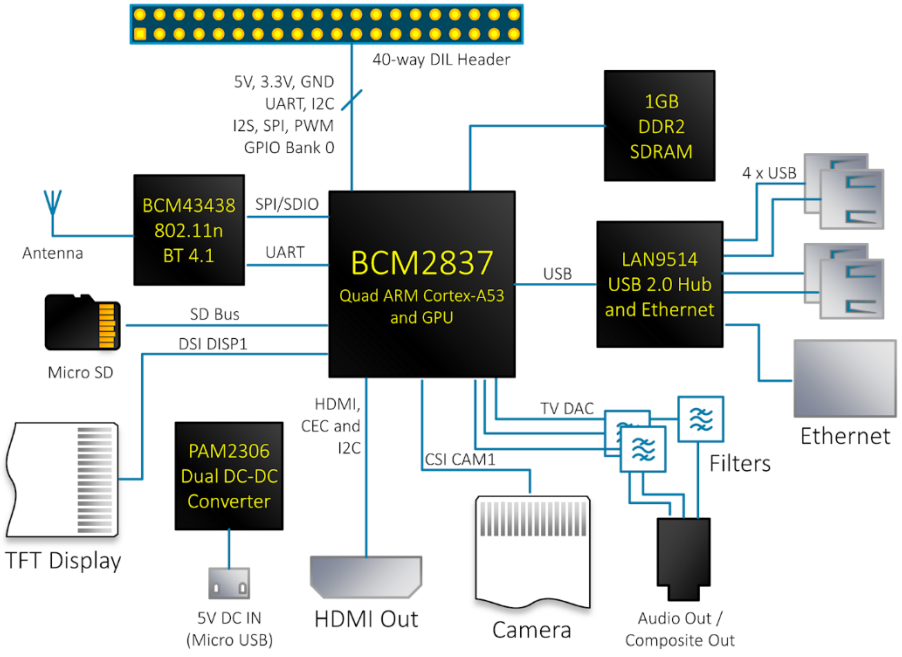


Figure: Functional Block Diagram

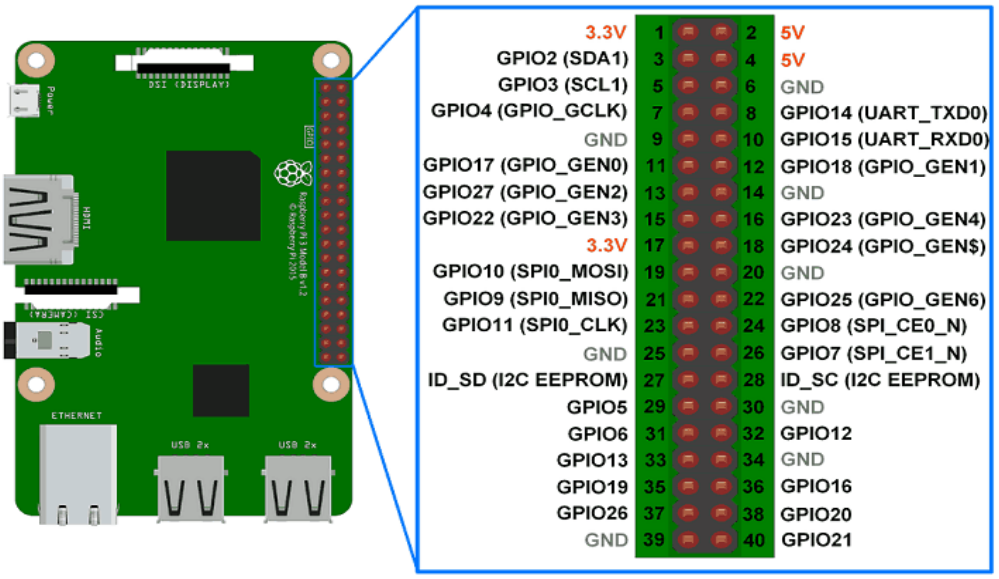
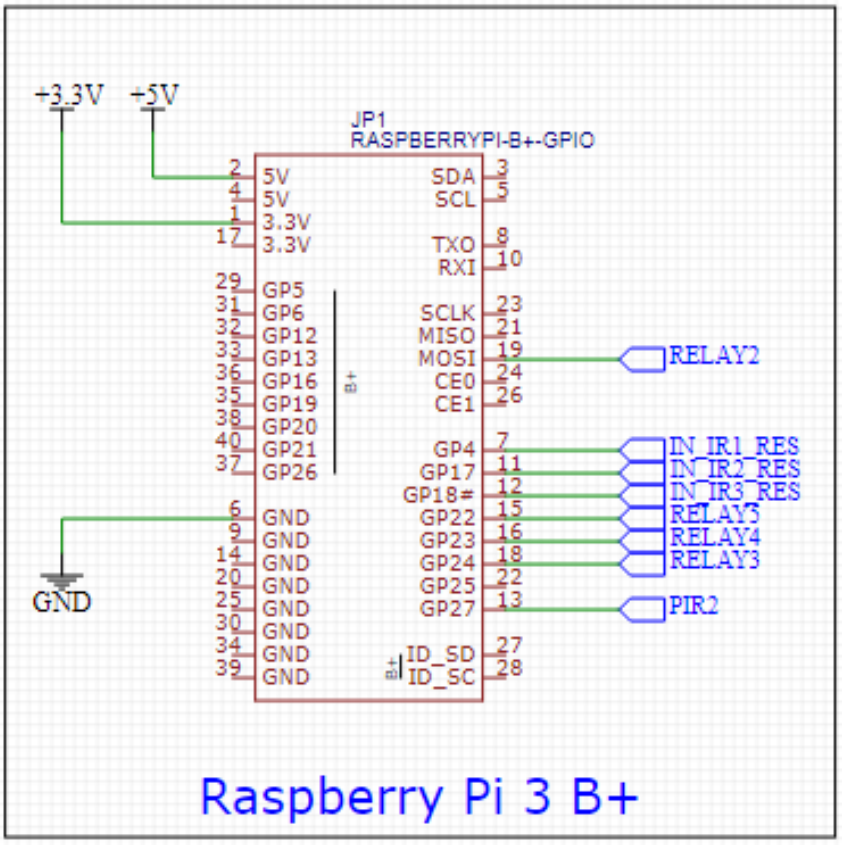


Figure: Raspberry pi 3 GPIO Pinout Diagram

Schematic Diagram



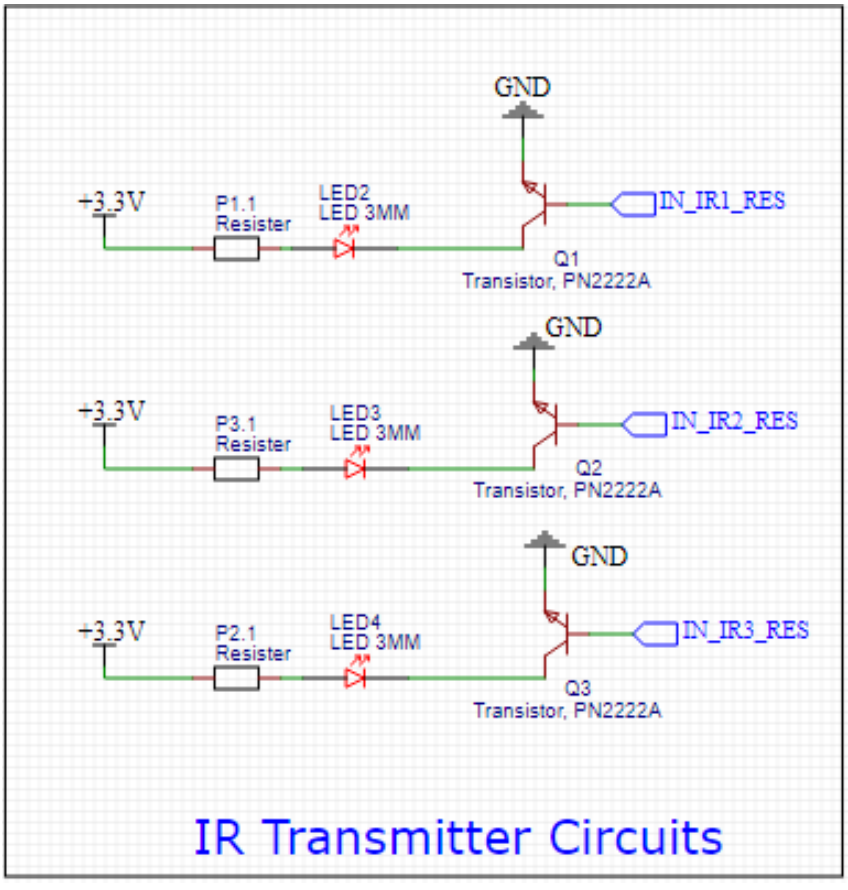
IR Transmitter

Hardware device has three IR senders to transmit IR signals to the air conditioners and projectors. Here, device is using a technique called modulation to reduce noise and data loss. They take a frequency (38kHz is most commonly used for remotes) and turns the IR LED on and off at that frequency. The IR LED's cycle will be 1/38000 seconds = 0.0000263 seconds = 0.0263 milliseconds long. So, the LED will turn on for half of that duration. Data is sent by measuring how long we keep turning the IR LED on-off at 38kHz.

Elementary Functions

acStateOperation(state, id)	Turn on/off air conditioners
proStateOperation(state, id)	Turn on/off projectors

Schematic Diagram

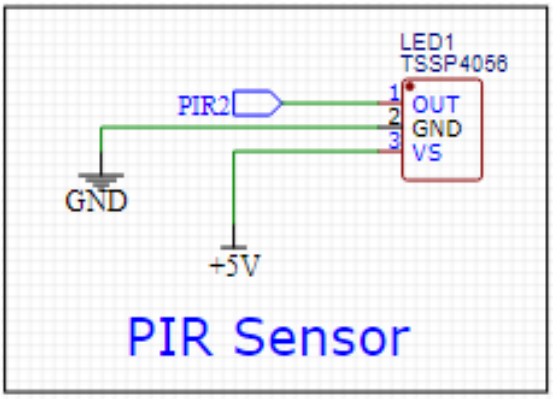


PIR Motion Sensor

PIR motion sensor is attached to the circuit in order to identify the presence of any person in the meeting room. If PIR motion sensor detects human presence, it indicates that light system should turn on.

Here, this component functions, when a warm body of a human passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

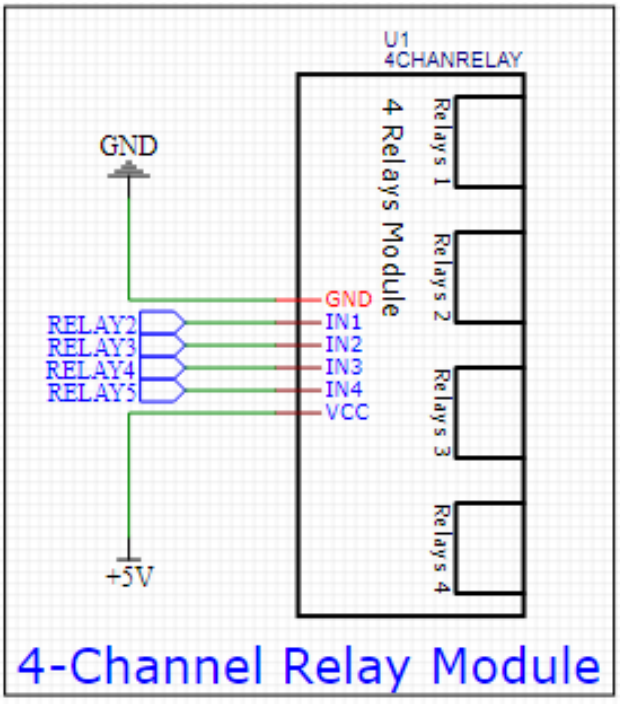
Schematic Diagram



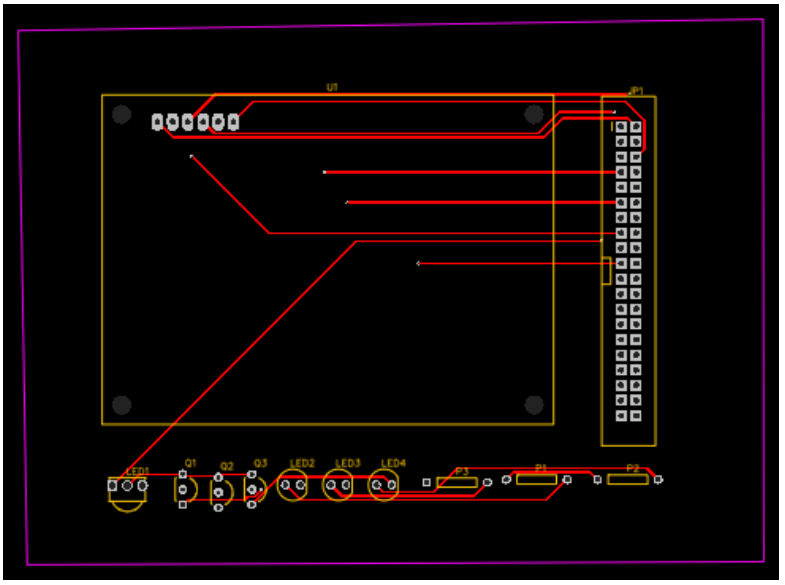
Relay Module with 4 Channels

The 4 Channel Relay Module is a convenient board which is used to control high voltage, high current load lamps. It is designed to interface with microcontroller. External light sources are connected to this board to control them through the signals coming from Raspberry Pi.

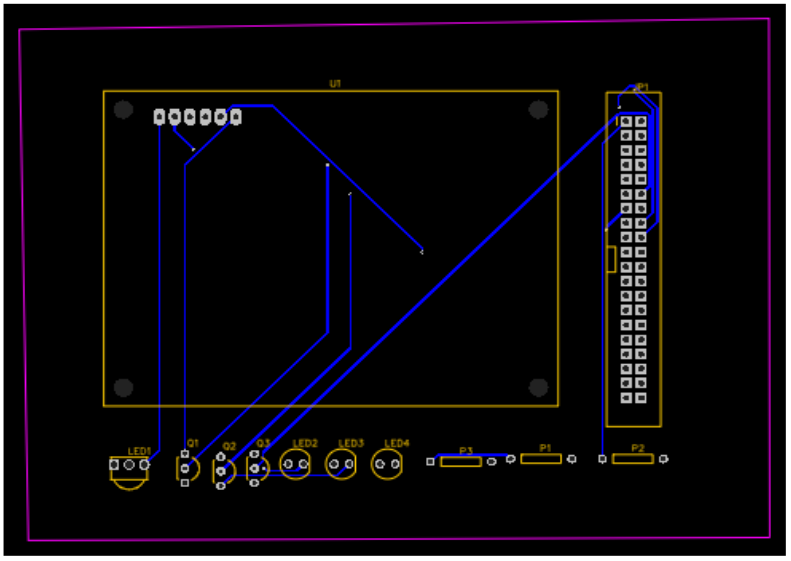
Schematic Diagram



PCB Designs



Top View of the PCB Layout Design



Bottom View of the PCB Layout Design

API Guide

- **getScheduleJob** - Auto trigger function - Take all the schedules at a pre-configured time

- **authJob** - Auto trigger function - Managing authorization

- **runScheduleJob** - Auto trigger function - Turning on/off ACs and Projects

- **getComponentsJob** - Auto trigger function - Take details of the components in the meeting rooms

- **http://*{control-unit-IP}:port*/schedule/add/schedule**
  To save a schedule to the database

- **http://*{control-unit-IP}:port*/components/control/ac**
  To turn on/off air conditioners

- **http://*{control-unit-IP}:port*/components/control/proj**
  To turn on/off projectors

- **http://*{control-unit-IP}:port*/components/all**
  To get a list of all the components (air conditioners and projectors)

- **MQTT Subscriber** - Realtime data synchronization

Setting up a hardware node

Hardware node should be prepared by installing Node.js and MongoDB. Once it is set up, “localServer” code should be uploaded and node server should be started.

Compatibility and Performance Measurements

Performance Test

At the performance side, we had to focus on both the performance of the control unit and the performance of the web platform.

For the web application

- Communication delays
- Accessibility

And Local Server

- Synchronize with our backend server

Test 1

Objectives:

- To verify server is working properly with important tasks of the system
- To verify whether devices work properly with the configured data given by system admins.

Methodology:

Test control unit for different configuration setups by adding schedules via web application and mobile application.

Hardware requirements:

- Pre-setup control unit
- Working air conditioner, projector

Procedure:

1. Place the control unit in a random position of the meeting room where there is an accessibility to the electricity.
2. Direct the IR transmitters towards air conditioners and projectors using the flexible rod
3. Power on the control unit to allow booting the system and running local server within Raspberry Pi unit
4. Add few schedules via web application
5. Place control unit in different places in the meeting room

Dependencies:

- Capture of IR signals by air conditioner, projector varies with the position of control unit

Assumptions:

- The relevant IR signal specified by the brand and model of air conditioner/projector, is transmitted by the IR transmitter.

Conclusion:

Selecting a position for the control unit is important as air conditioners and projectors need a proper IR signal to work as desired. Proper functionality can be expected, if a position which is in the same level of air conditioner or projector can be selected to place the control unit.

Unit Test

For unit testing, we need to isolate every single sensor and actuator. We need to test them individually to identify the accuracy and limitations of the particular unit. Mainly there are 3 components that we need to test.

- IR transmitters
- PIR sensor
- Relay module with 4 channels

Test 2

Objective:

- Identifying the scope, minimum and maximum distances that can identify, the variation against the distance of IR transmitter and PIR sensor.

Methodology:

- Placing separate IR transmitter circuits at different distances from the air conditioners, projectors and checking for proper working.
- Placing PIR motion sensor circuit at different places and observing person detection.

Hardware requirements:

- IR transmitter circuit
- PIR motion sensor circuit
- Working air conditioner, projector

Procedure:

1. Place the IR transmitter circuit setup in a random position of the meeting room, directed towards an air conditioner or projector
2. Check whether the devices work properly, changing the position of the circuit setups
3. Follow the same procedure for PIR motion sensor

Assumptions:

- The relevant IR signal specified by the brand and model of air conditioner/projector, is transmitted by the IR transmitter.

Conclusion:

The IR transmitter circuit that is developed, is capable of sending control signals to the devices in the range of 5 meters. Beyond that distance, proper working of devices can not be expected. Therefore, it is important to select a position for the IR transmitters which air conditioners and projectors are inside that above mentioned range.

The PIR motion sensor circuit that is developed, is capable of detecting human appearance in the range of 5 meters.

Links and References

1. Raspberry Pi 3 B+ Datasheet

   https://static.raspberrypi.org/files/product-briefs/Raspberry-Pi-Model-Bplus-Product-Brief.pdf

   https://components101.com/microcontrollers/raspberry-pi-3-pinout-features-datasheet

2. Install Ubuntu Server on Raspberry Pi in Headless Mode

   https://linuxhint.com/install_ubuntu_ssh_headless_raspberry_pi_4/

3. Read/emulate Remotes With Arduino and Raspberry Pi

   https://www.instructables.com/How-To-Useemulate-remotes-with-Arduino-and-Raspber/

4. Control your home appliances from the web – using a Raspberry pi

   https://www.digitaljunky.io/control-your-home-appliances-from-the-web-using-a-raspberry-pi/

5. Using a Raspberry Pi as a Universal Remote

   https://blog.digilentinc.com/using-a-raspberry-pi-as-a-universal-remote/