

1. Introduction:

The “Bumblebee Electronic Hub (BBEH)” was developed by Bumblebee Instruments to the requirements of the Indian Institute of Technology, Palakkad as a basic electronics teaching aid for high school students.

This self contained unit provides power to the circuit under test, permits manual analog voltage and digital test signal generation, voltage/ digital signal data display in graphical form on a standard Android mobile phone.

Without the need for a Personal Computer (PC) an Android application provides connectivity to the BBEH using Bluetooth.

Experiments that can be carried out using this system cover basic devices, op-amps, digital devices and other miscellaneous circuits.

The unit is built around the ESP32-WROOM microcontroller module which has an inbuilt Bluetooth interface, ADC, DAC, PWM and Digital I/O.

2. Bumblebee Electronic Hub

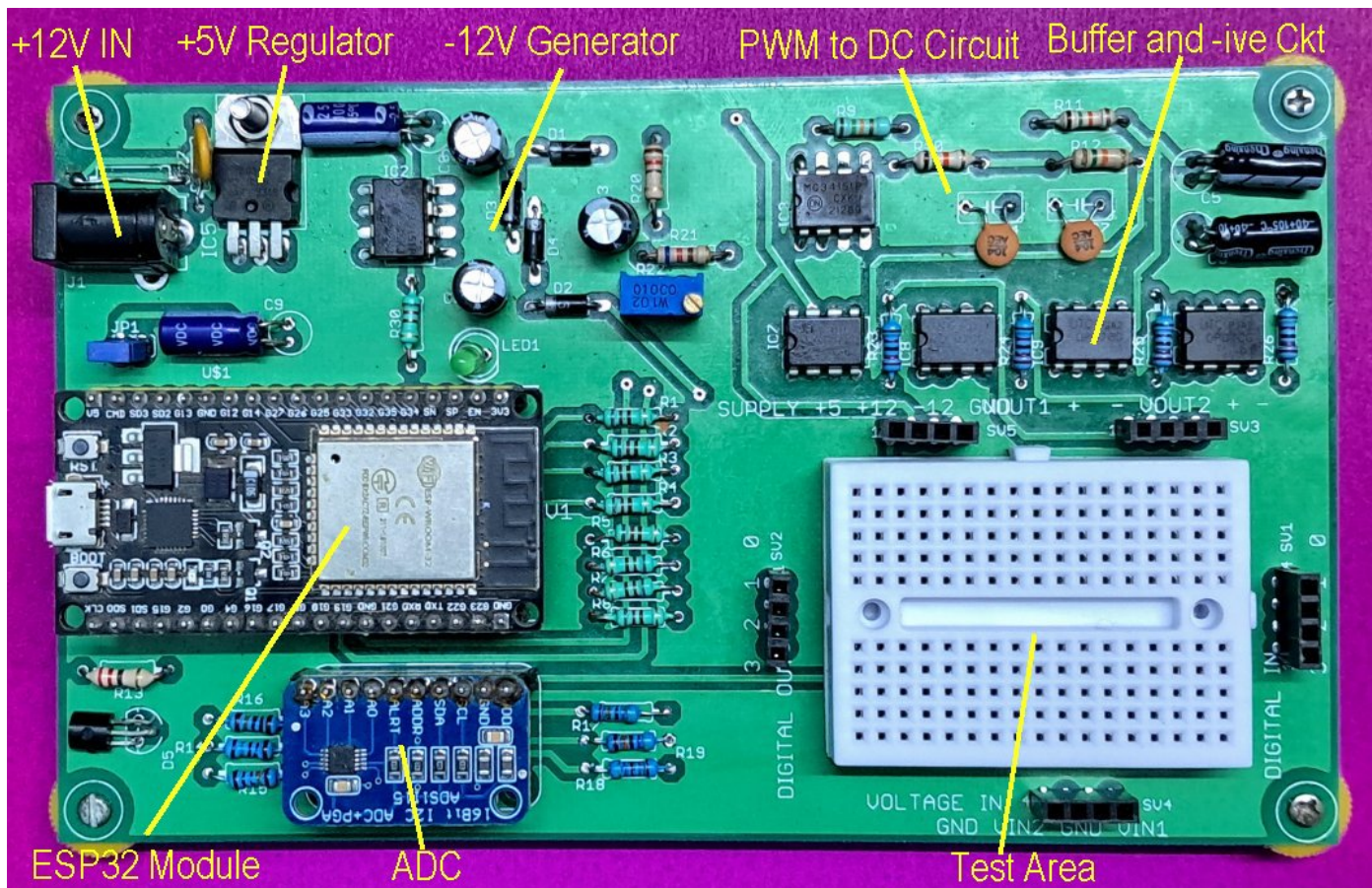


Figure1. Bumblebee Electronic Hub

3. Block Schematic

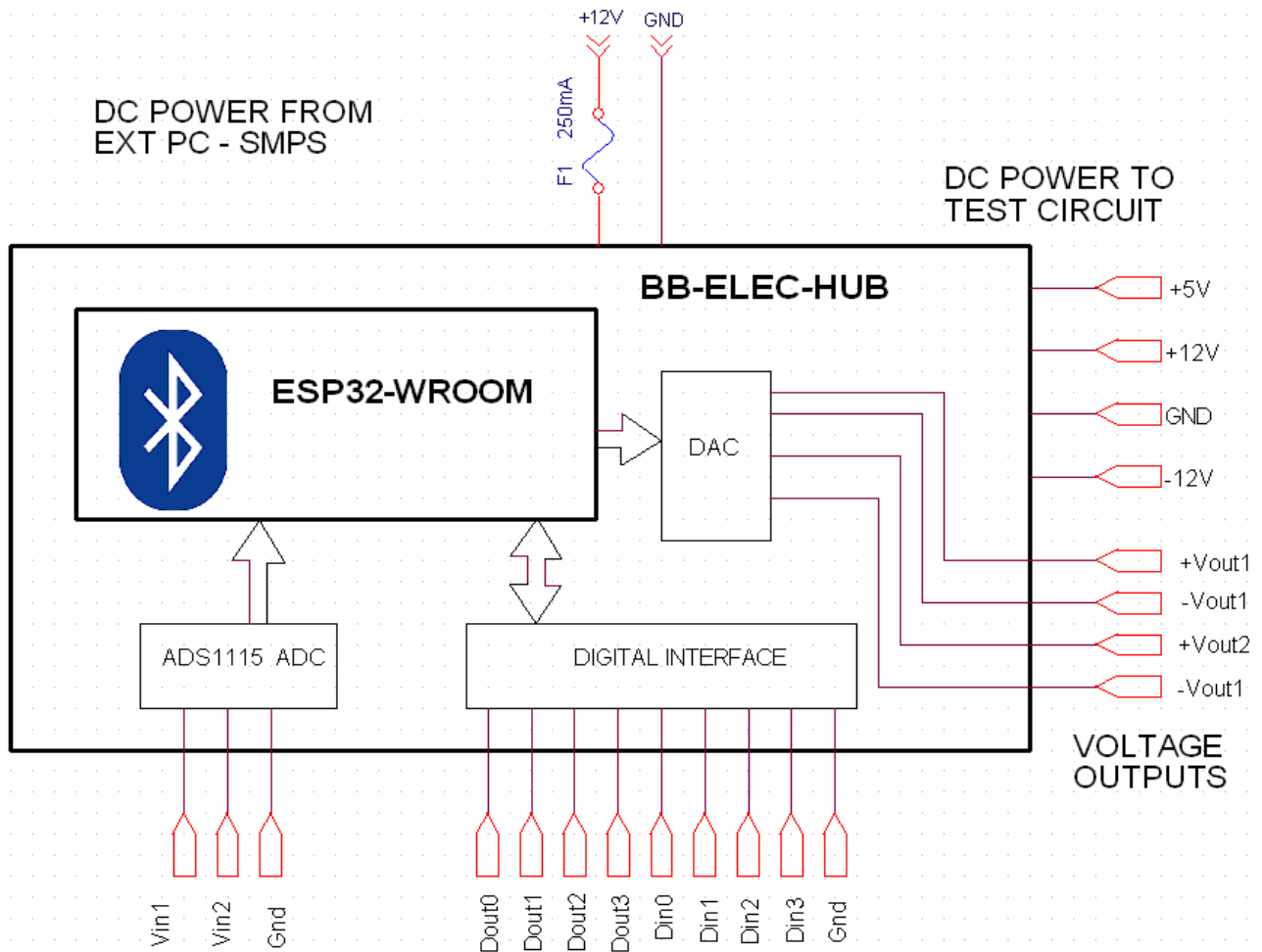


Figure 2. BBEH simplified block schematic

The Bumblebee Electronic Hub is powered by an external 12V DC derived from a standard 120-240V Ac to 12V DC power converter. The maximum current requirement at 12V is 250mA.

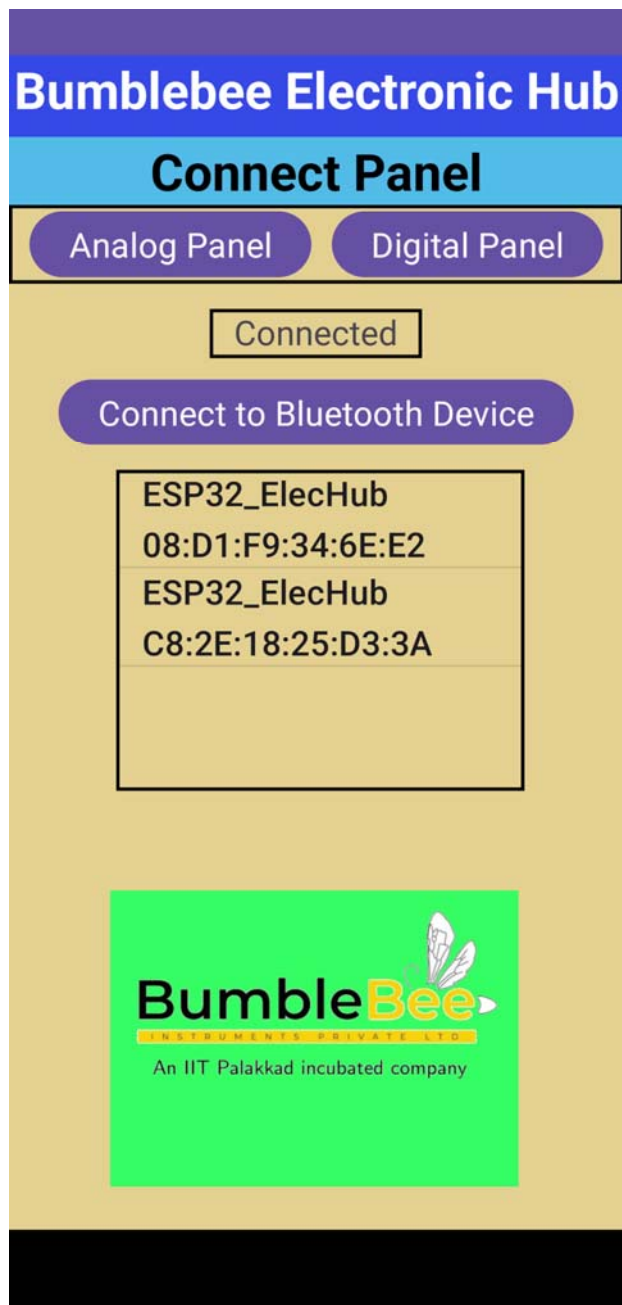
Secondary supplies required for powering the ESP32 module, other circuits and test circuits are derived on the hub.

Setting DC test voltages and reading back voltages from the circuit under test is carried out using a mobile application connected via Bluetooth to the ESP32 module.

Four digital I/O connections are provided for testing of digital circuits. The values are set and read back using the mobile application.

Plotting of Analog/Digital test sequences in both IO mode and XY mode is catered for.

4. Android Application GUI : Connect Panel



Connect Panel GUI

A simple GUI Application is used to communicate with the Bumblebee Electronic Hub using Bluetooth.

Using this application connection is initially achieved with the paired ESP32_ElecHub.

Subsequently commands to set output analog voltages or digital output states can be initiated by changing to the 'Analog/Digital Panels'

Connect to Bluetooth Device: When tapped shows the available paired devices

Tap on the selected paired device ESP32_ElecHub to connect via Bluetooth. The connection status will change to from "Disconnected" to "Connected"

Tap on "Analog Panel" or "Digital Panel" to select the desired Analog/Digital test modes.

5. Analog Panel

Analog Panel GUI

Analog Panel

Connect Panel Digital Panel

Connected 2774.00v243.00v

Vout1 V Vout2 V

Set Vout 2.0 2.5

Vin1 Vin2

Read Vin 2.00V 0.17V

Vin2 - Vin1 = -1.82V

Save Current Values

Reset Index Index: 0

Plot XY (VI) Plot IO (VI)

Plot XY (VoVin) Plot IO (VoVin)

The Analog Panel permits the carrying out of analog experiments where test voltages can be fed to the circuit under test and the responses captured. Test sequence values can be stored and plotted either in IO-mode or XY-mode.

First check that the Bluetooth status shows “Connected”

Values of Vout1 and Vout2 can be entered from 0-9V. Negative voltages should be prefixed with a –ive sign.

“**Set Vout**” sets the Vout1 and Vout2 values which are available as +Vout1, -Vout1, +Vout2 and - Vout2 on the test panel. These may be fed to the circuit under test.

“**Read Vin**” reads and displays the values of Vin1 and Vin2.

Vin2-Vin1 is computed and displayed for convenience.

“**Save Current Values**” Saves the current on-screen values and updates the Index.

Index should be reset to zero for capturing a test sequence.

To facilitate plotting a sequence of test values four plot modes are included.

Plot XY (VI) Plots Vin2-Vin1 vs. Vout1 in XY-mode

Plot IO (VI) Plots Vin2-Vin1 and Vout1 vs. Index in Linear mode

Plot XY (VoVin) Plots Vin2 vs. Vin1 in XY-mode

Plot IO (VoVin) Plots Vin2 vs. Vin1 in vs. Index in Linear mode

Recalling a Plot displays/hides the voltage values

6. Digital Panel

Digital Panel GUI

The Digital Panel permits the carrying out of digital experiments where test logic levels can be fed to the circuit under test and the responses captured. Test sequence values can be stored and plotted in a linear mode.

First check that the Bluetooth status shows “Connected”

Values of DOUT0 to DOUT3 can be entered “L” or “H”. 0-9V.

“**Set Digital Out**” sets the DOUT0 to DOUT3 values which are available as 0/3.3V logic levels on the test panel. These may be fed to the circuit under test.

“**Read Digital In**” reads and displays the values of DIN0 to DIN3. Saves the current on-screen values and updates the Index.

Index should be reset to zero for capturing a test sequence.

To facilitate plotting a sequence of test values a plot mode is included.

Plot Digital Plots DIN0 to DIN3 and DOUT0 to DOUT3 vs. Index in Linear mode

Digital Panel

Connect Panel Analog Panel

Connected 10d

Set Digital Out Read Digital In

DOUT0=L DIN0 = L

DOUT1=H DIN1 = H

DOUT2=L DIN2 = L

DOUT3=H DIN3 = H

Reset Index Index: 1

Plot Digital

7. Precautions:



Power Connector on ESP32 Module should not be powered from PC if Jumper is connected.

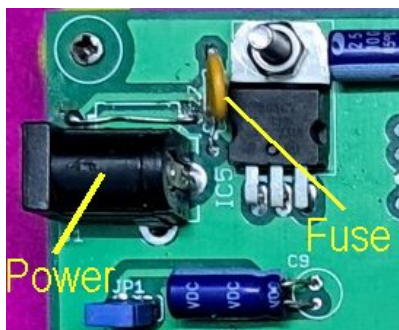
(Jumper when disconnected permits connection to PC for program update)



A Digital Buffer IC placed below the ESP32 Module buffers the I/O signals to and from the ESP32.

Limited protection is provided for short-term connection of I/O pins to voltages between -12V and +12V available on the board.

(This chip is easily replaceable in case of I/O faults caused by feeding higher voltages to 0-3.3V logic pins)



Power input is 12V with +ive center pin. Current requirements ~250mA.

Do not reverse the connections.

A resettable 500mA Fuse has been provided for additional protection. However avoid shorting +12V, +5V and -12V power pins to Ground.

2774.00v243.00v

10d

Diagnostic messages are provided in the Analog/Digital panel for development purposes.

8. Warning & Disclaimer:

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