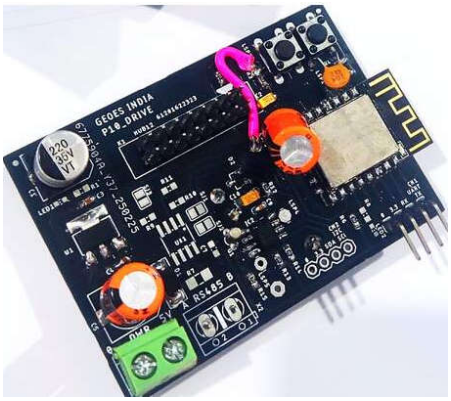
GEOES Smart P10 LED Matrix Controller



Developer Datasheet & User Manual
Document Version: 1.0
Architecture: ESP8266 (Wi-Fi Enabled)
Manufacturer : GEOES INDIA

1. Product Overview

The GEOES INDIA Smart P10 Controller is a low-cost, production-grade Wi-Fi module designed to drive HUB12 P10 LED matrix panels. Engineered for both commercial digital signage and developer experimentation, the module features a completely non-blocking scrolling engine, an embedded web-based control panel, and Over-The-Air (OTA) firmware update capabilities.

Out of the box, the module operates as an independent Access Point (AP) and can seamlessly connect to existing local area networks (Station Mode) for remote management and external API polling.

2. Key Features

- **Dual-Mode Networking:** Operates simultaneously as a Wi-Fi Access Point (AP) and Station (STA).
- **Embedded Control Portal:** Built-in web server for live, on-the-fly updates to text, brightness, and network settings without halting the display.
- **Non-Blocking Architecture:** Hardware multiplexing is handled asynchronously, preventing display flicker during network requests or HTTP handling.
- **Non-Volatile Memory:** Uses LittleFS to store configuration data (`config.json`), ensuring settings survive power cycles.
- **OTA Upgradable:** Flash new firmware wirelessly via the built-in HTTP update server.
- **NTP Synchronization:** Built-in support for Network Time Protocol (NTP) for synchronized live clocks.

3. Technical Specifications

Parameter	Specification
Microcontroller	ESP8266 (Tensilica L106 32-bit MCU)
Clock Speed	80 MHz / 160 MHz
Wireless Protocol	Wi-Fi 802.11 b/g/n (2.4 GHz)

Parameter	Specification
Operating Voltage (Module)	5V DC (via standard HUB12/Power terminals)
Logic Level	3.3V (ESP8266 standard)
Display Protocol	HUB12 (Standard P10 LED Matrix)
Flash Memory	4MB (Configured with LittleFS partition)
Default AP IP Address	`192.168.4.1`
Supported Configurations	1x1 (32x16), 2x1 (64x16), and scalable via library

3.1 Hardware Pinout Mapping (ESP8266 to HUB12)

The GEOES INDIA controller utilizes the ESP8266's hardware SPI bus (HSPI) for high-speed data transfer to the P10 panel, preventing scrolling artifacts.

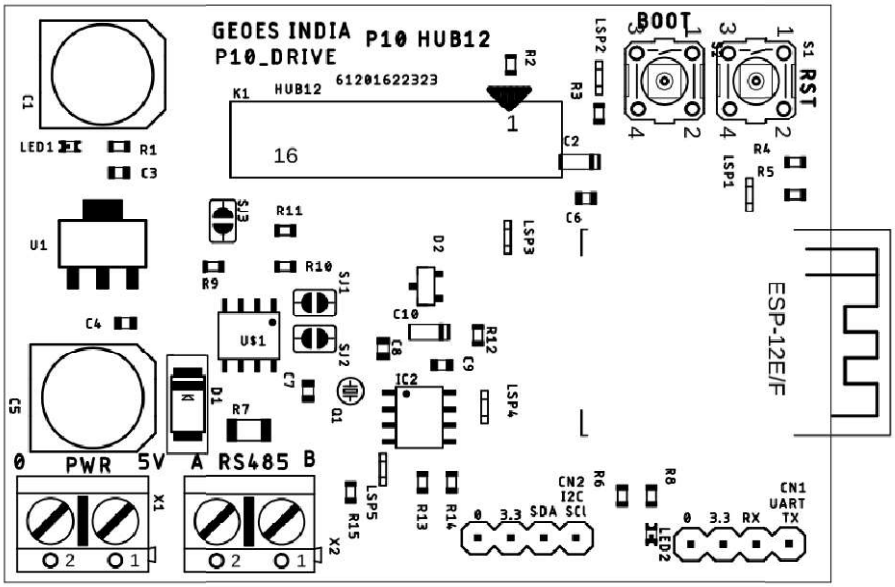
If modifying the hardware shield or wiring manually, ensure the following connections are made between the ESP8266 and the 16-pin HUB12 port on the back of the P10 panel:

HUB12 Pin	Pin Name	ESP8266 Pin (NodeMCU/Wemos)	GPIO	Function
1	**OE** (Output Enable)	D0	GPIO 16	Controls overall panel brightness/PWM
2	**A**	D3	GPIO 0	Row multiplexing selector A
3	**GND**	GND	GND	Common Ground
4	**B**	D4	GPIO 2	Row multiplexing selector B
5	**GND**	GND	GND	Common Ground
6	**C**	*Not Connected*	-	(Used for 1/8 scan, P10 is 1/4 scan)
7	**GND**	GND	GND	Common Ground
8	**CLK** (Clock)	D5	GPIO 14	Hardware SPI Clock (HSCLK)

HUB12 Pin	Pin Name	ESP8266 Pin (NodeMCU/Wemos)	GPIO	Function
9	**GND**	GND	GND	Common Ground
10	**LAT / SCLK** (Latch)	D8	GPIO 15	Latch data to LEDs
11	**GND**	GND	GND	Common Ground
12	**R / DAT** (Data)	D7	GPIO 13	Hardware SPI Data (HMOSI)
13-16	**GND**	GND	GND	Common Ground

Power Supply & Grounding

Never power the P10 panel directly from the ESP8266's 5V/VIN pin. A single P10 panel can draw over 3 Amps at maximum brightness, which will instantly destroy the microcontroller's voltage regulator. Power the panel directly from a dedicated 5V switching power supply (SMPS) and ensure the ESP8266's GND is connected to the SMPS GND (Common Ground).



4. Initial Setup & Configuration (Out-of-Box)

When the module is powered on for the first time (or if no Station Wi-Fi is configured), it broadcasts its own network.

1. **Power the Module:** Supply a stable 5V DC power source to the P10 panel and the controller module.
2. **Connect to Access Point:**
    - Open the Wi-Fi settings on your smartphone or PC.
    - Look for the network name starting with **`GEOES_P10_`** (e.g., `GEOES_P10_A1B2C3`). The suffix is uniquely generated based on the ESP8266 Chip ID.
    - **Default Password:** `88888888`
3. **Access the Control Panel:**
    - Open any web browser.
    - Navigate to **`[http://192.168.4.1](http://192.168.4.1)`**.
    - The GEOES P10 Control Panel will load.

5. Web UI Operations

The onboard web interface allows users to manage the display in real-time.

- **Scrolling Message:** Enter the desired text in the text area. The display will update instantly upon saving and reset its scroll position to the right edge.
- **Brightness Control:** Set a value between `1` (Dim) and `100` (Maximum brightness). Note: Higher brightness values significantly increase power consumption. Ensure your 5V power supply is rated appropriately (e.g., at least 3A per P10 panel for peak brightness).
- **Station Wi-Fi Credentials:** Enter the SSID and Password of your local Wi-Fi router. Upon saving, the module will attempt to connect to this network while maintaining its AP network. Once connected, the module's new local IP address will be displayed on the web dashboard.

6. Over-The-Air (OTA) Firmware Updates

Developers can flash custom compiled `.bin` files wirelessly.

1. Compile your custom code in the Arduino IDE and select **Sketch > Export compiled Binary**.
2. Connect to the module's Wi-Fi network (or the local router it is connected to).
3. From the web control panel, click the **Firmware Update (OTA)** link (or navigate manually to `[http://192.168.4.1/update](http://192.168.4.1/update)`).
4. Click **Choose File**, select your exported `.bin` file, and click **Update**.
5. The module will unpack the firmware, flash the memory, and reboot automatically.

7. Developer Notes & Core Libraries

For customers modifying the source code, the system relies on the following standard libraries and structural paradigms:

- **Display Driver:** `RoninDMD` is strictly utilized instead of standard DMD/DMD2 libraries. It handles hardware timer interrupts more efficiently alongside the ESP8266 Wi-Fi stack, preventing flicker.
- **File System (`LittleFS`):** EEPROM is deprecated. All settings must be serialized and deserialized using `ArduinoJson` and stored in `/config.json`.
- **Blocking Code Warning:** Do not use `delay()` functions inside the main `loop()`. All display scrolling and API polling must use non-blocking `millis()` timers to ensure `server.handleClient()` is executed continuously.
- **Pin Configuration:** The module uses standard SPI pins (HMOSI, HSCLK) and designated GPIOs for A, B, SCLK, and OE on the HUB12 interface. Ensure any custom firmware matches the hardware pinout of the GEOES shield.

8. Hardware Expansion & Advanced Features

The GEOES INDIA P10 Controller includes several built-in expansion ports, onboard ICs, and solderable jumpers to support highly customized IoT, timing, and industrial communication projects beyond standard LED scrolling.

- **Logic-Level UART & Programming Port:** A dedicated 4-pin UART header (**TX, RX, VDD, GND**) is provided. This can be used to interface with external serial peripherals (such as GPS modules, barcode scanners, or GSM modems). Additionally, it allows developers to flash new customized Arduino sketches directly from a PC using an external USB-to-TTL bridge module. Dedicated onboard **BOOT** and **RST** tactile switches are provided for easy manual bootloader entry.
- **Onboard RS485 Transceiver:** For industrial applications requiring long-distance or high-noise immunity communication, the main UART lines can be routed to an onboard RS485 transceiver chip via solderable jumper pads. This configuration routes the RX, TX, and a dedicated SCL line (used for RS485 transmit/receive direction control) to accommodate Modbus or multi-drop RS485 networks.
- **I2C Breakout & Integrated RTC (PCF8563):** The board features breakout pins for the I2C bus, RS485 direction control, VDD, and GND. The I2C lines are internally wired to a highly precise onboard **PCF8563 Real-Time Clock (RTC)** IC. Backed by a dedicated 3.3V coin cell battery, the RTC ensures that projects retain accurate timekeeping during power outages or when deployed in environments without Wi-Fi/NTP access.
- **Audio-Enabled Model Variant:** For projects requiring synchronized voice announcements (such as automated railway platform alerts or PA systems), an alternative version of the board is available. This variant includes dedicated mounting footprints and pin routing to directly host a **DFPlayer Mini MP3 module** alongside a **PAM8403 (3W+3W) Class-D audio amplifier module**, providing a complete all-in-one audiovisual controller.