1. Introduction

The **ESP32 Fuel Injector Tester** is a device designed to test and control fuel injectors using PWM (Pulse Width Modulation) signals. It simulates different operating conditions (RPM, PWM, time) and includes a built-in web server for remote control via a smartphone or computer.

Key Features:

✅ 6 operating modes (A, B, C, D, E, F)
✅ Rotary encoder + selection button control
✅ 16x2 LCD display for parameter visualization
✅ WiFi server for browser-based control
✅ Individual or simultaneous injector activation
✅ Real-time progress bar

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2. Components and Connections

Buttons and Controls:

Component	Function
Rotary encoder	Navigates menu options / Adjusts submenu values
Center button	Selects an option / Confirms changes
Button 1 (↩)	Returns to previous menu / Exits current mode
Button 2	(Reserved for future functions)

Injector Outputs:

Pin	Injector	Color (Recommended)
16	Injector 1	Yellow
17	Injector 2	Green
18	Injector 3	Blue
19	Injector 4	Red

🔷 **Tip:** Verify injector polarity before connecting.

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3. Operating Modes

📌 Main Menu

When powered on, the device displays the menu with the following options:

```
MODE:  A   B
       C   D   E   F
```

- Rotate the encoder to select a mode.
- Press the center button to confirm.

🔧 Mode A: Simultaneous Activation

Description:

- All injectors activate simultaneously with the same RPM, PWM, and time settings.

Configuration:

1. **RPM:** Engine speed (900–5000 RPM).
2. **PWM:** Duty cycle (1–99%).
3. **Time:** Test duration (minutes:seconds).

Usage:

- Rotate the encoder to adjust values.
- Press the center button to edit a parameter.
- Select "Start" to begin the test.

🔄 Mode B: Sequential Activation

Description:

- Injectors activate one by one in sequence (1→2→3→4).

Configuration:
Same as Mode A, but with individual timing per injector.

Usage:

- The system guides the user step-by-step.
- Each injector activates according to the programmed time.

📈 Mode C: Progressive RPM

Description:

- Automatically increases RPM from 900 to 5000 in steps.
- Ideal for testing injector behavior across different RPM ranges.

Usage:

- Only adjust the initial PWM (default: 50%).
- Press "Start" to begin the sequence.

⚡ Mode D: Progressive PWM

Description:

- Automatically increases PWM from 1% to 99%.
- Useful for calibrating injector response to varying pulse widths.

Usage:

- Set the base RPM (default: 2500).
- Start the test with the center button.

🎮 Mode E: Manual Control

Description:

- Allows real-time adjustment of RPM and PWM without a timer.
- Injectors are activated/deactivated manually.

Usage:

1. Adjust RPM and PWM with the encoder.
2. Press "Start" to activate injectors.
3. Press "Stop" to deactivate them.

🌐 Mode F: Web Control (WiFi)

Description:

- Turns the ESP32 into an Access Point (AP) for remote control.

Steps:

1. Connect to the WiFi network:
   - **SSID:** `ESP32-Injectors`
   - **Password:** `12345678`
2. Open a browser and navigate to: `192.168.4.1`
3. Web interface:
   - Control RPM, PWM, and individual injectors.
   - Enable/disable the system.

📱 **Compatible with smartphones, tablets, and PCs.**

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4. LCD Indicators

Symbol	Meaning
↑	Selected option
*	Edit mode active
T:00:00	Countdown timer
Inj:X	Active injector (1–4)

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5. Safety Recommendations

⚠ Do not exceed the voltage/amperage limits of the injectors.
⚠ Verify connections before powering the system.
⚠ Use a stable power supply (recommended: 12V).
⚠ Disconnect the tester after use.

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6. 📥 Download Code and Schematics

📎 **Project GitHub** (Coming Soon)