Project Title:

LM2596-Based Buck Converter (5V Output)

Objective:

To design and implement a **DC-DC buck converter** circuit that steps down a **12 V DC input** to a regulated **5 V DC output** using the **LM2596S-ADJ** switching regulator. The design focuses on achieving high efficiency, stable output voltage, and short-circuit protection.

Working Principle:

The **LM2596** is a step-down (buck) switching regulator. It operates by rapidly switching a transistor on and off to transfer energy from the input to the output through an **inductor**. During the ON cycle, energy is stored in the inductor's magnetic field. During the OFF cycle, this stored energy is released through the **Schottky diode** to the output capacitor and load.
The output voltage is regulated by adjusting the **duty cycle** based on feedback from the output via the **feedback (FB)** pin. The **LM2596** maintains a constant output voltage (here 5 V) even when the load or input voltage varies.

Key Components and Design Details:

Component	Description	Function
LM2596S-ADJ	Adjustable DC-DC buck converter IC (up to 3A)	Main switching regulator; controls duty cycle to regulate output voltage.
Inductor (330 µH, DRC125)	Power inductor	Stores energy and smooths current; rated for ~3A to prevent saturation.
Schottky Diode (SS34)	Fast-recovery diode (3A, 40V)	Provides a path for inductor current when switch is off; reduces losses due to low forward voltage drop.
Input Capacitor (220 µF, 100nf ,25 V)	Electrolytic capacitor	Reduces input voltage ripple and noise.
Output Capacitor (220 µF, 16 V)	Electrolytic capacitor	Filters output ripple for a stable DC voltage.
Potentiometer (10 kΩ)	Variable resistor	Adjusts the feedback voltage to fine-tune the output voltage (e.g., from 1.23 V to 35 V).
LED + 100 Ω Resistor	Indicator circuit	LED glows to indicate output power is present.

Component	Description	Function
Fuse (Polyfuse 3A)	Resettable fuse	Protects circuit from overcurrent or short-circuit conditions.

PCB Design Overview:

The PCB is designed in **KiCad** with a **two-layer layout**.

- **Top layer (F.Cu):** Contains most signal traces and components.
- **Bottom layer (B.Cu):** Serves as a **ground plane** for better noise suppression and heat dissipation.
- A **large copper area** is provided around the LM2596 and diode for thermal management.
- **Ground vias** connect top and bottom layers to reduce noise and improve current flow.

Applications:

- Power supply modules for **Arduino, Raspberry Pi, sensors, and embedded systems**.
- Battery-powered devices where efficient voltage regulation is required.
- Automotive and industrial low-voltage DC applications