Smart Power Supply

Welcome to the project booklet for the Smart Power Supply, developed by the Solder Squad team
Under super vision **Dr. Ibrahim Zewail**

Member team

- Mohamed Hamada Zidan Atiya
- Mohamed Abdelmawla Mohamed Shahata
- Ahmed Mostafa Mohamed Elnenaey
- Ahmed Elsayed Mohamed Mahmoud
- Asmaa Ahmed Allam Ibrahim

index

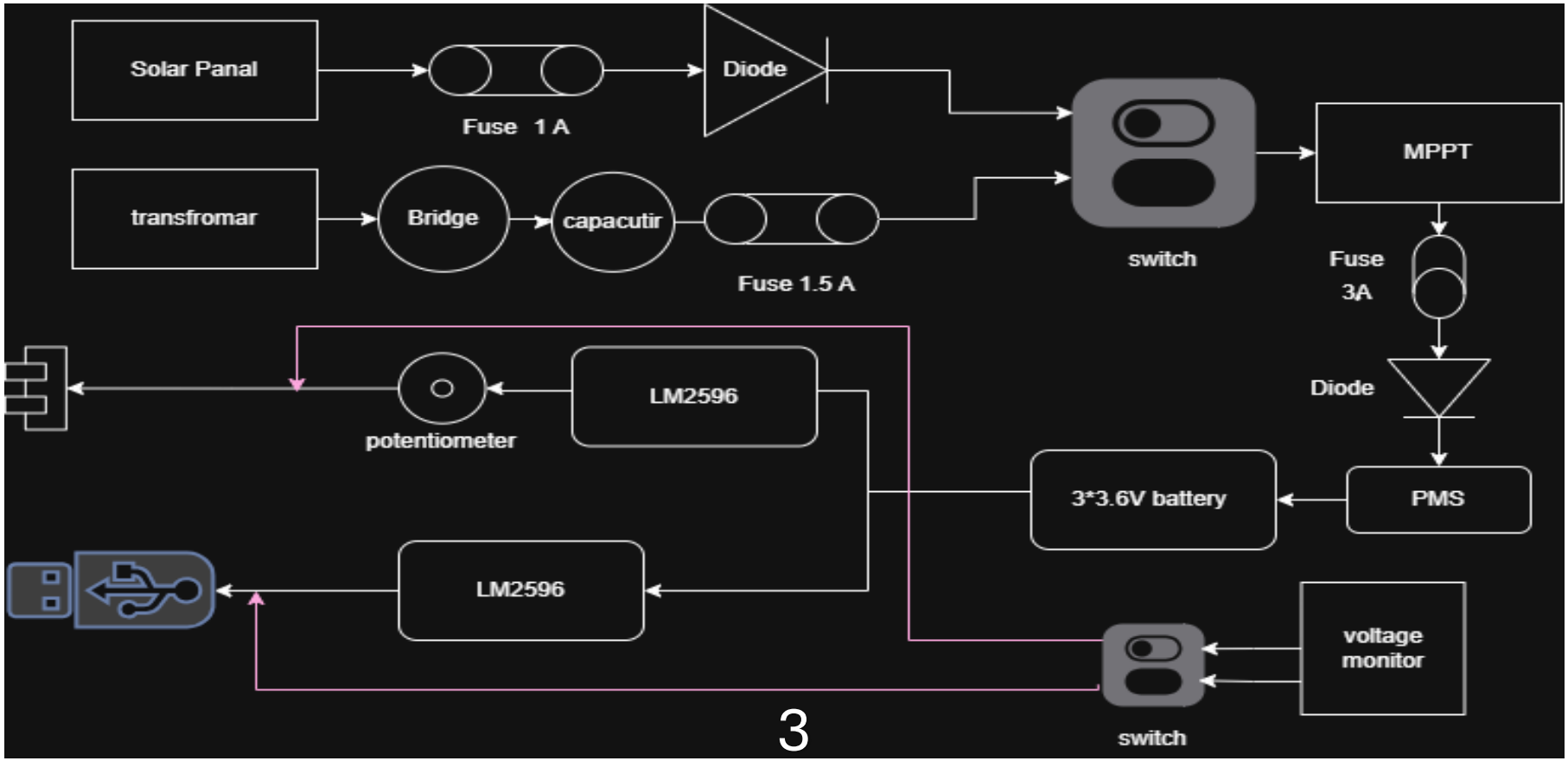
- Introduction----------2
- Circuit Design----------3
- Power Input Sources----------4
- Main Component
- MPPT Charging System----------5
- BMS ----------6
- Output Stage ----------7
- Enclosure Design ----------8
- Experiment Overview Complete Workflow -----9

Introduction

- The **Smart Power Supply** provides multi-source DC power, battery charging with MPPT, fixed & adjustable outputs, and monitoring — ideal for education and practical applications.
- **Use-cases**
  Lab experiments, portable charging, electronics protyping.
- **Design goals**
  Safety, flexibility, efficiency.
- **Outputs**
  5V fixed + 1.25–12V adjustable.

Circuit Design

- The circuit diagram shows all the electronic units used and their logical interconnection, including the power stage, the MPPT unit, the battery management system, and the regulated output stages.
- The components were selected based on efficiency requirements, with a focus on using standard modules to ensure ease of understanding and implementation in an educational environment.



Power Input Sources

Two main charging sources:

- **Solar Panel**

18V – 10W panel connects through a source-selection switch to the MPPT module.

- **AC Transformer**

220V AC → transformer → bridge rectifier → filter capacitor → MPPT input.

MPPT Charging System

Maximizes solar power extraction by tracking the maximum power point.

Adapts to changes in light and temperature for stable performance.

Provides advanced battery protection (overcharge, low voltage, overload).

Offers control over output voltage and current.

Includes a display for monitoring input and output voltages.

Contains an integrated buck converter for efficient voltage regulation.

Delivers up to 30% higher efficiency compared to traditional PWM chargers.

Battery Management system (BMS)

Protects three Li-ion cells (3.6V each) with overcharge, over-discharge and overcurrent protections. Output routed via main power switch.

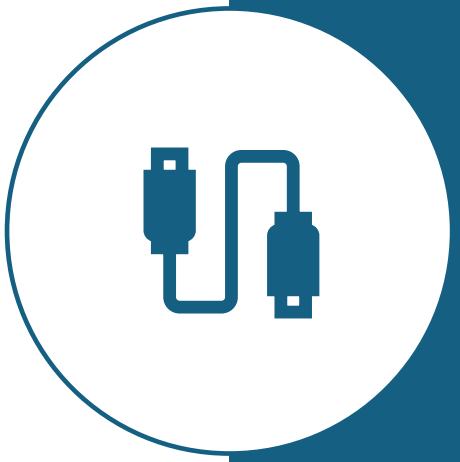
Overcharge protection

Over-discharge protection

Overcurrent protection

Output Stage

- **5V USB (Fixed)**
- LM2596 buck module set to 5V for USB devices and microcontrollers.
- **Adjustable Output**
- LM2596-based adjustable output (1.25–12V) with external potentiometer for easier control.
- Voltage monitor toggles between 5V and adjustable output



Enclosure Design

- The enclosure was designed to be functional and safe, allowing easy access to all inputs and outputs, in addition to providing proper ventilation for the internal components.
- **Material**
  High-impact Aluminum for durability.
- **Safety**
  Insulated terminals and clearly labeled ports.
- **Interface**
  Digital display for voltage monitoring.

Experiment Overview Complete Workflow

- This experiment demonstrates the full operational workflow of the Smart Power Supply. The process begins with selecting an input source (solar panel or AC transformer), followed by power conditioning through the bridge rectifier and filter capacitor. The MPPT module then optimizes energy extraction and delivers a controlled charging current to the BMS, which manages the protection and balancing of the lithium cells.
- After the battery is charged, students examine how the output stage delivers both fixed (5V USB) and adjustable (1.25–12V) voltages using the LM2596 regulator. The voltage monitor is used to observe real-time readings, helping students understand load behavior, voltage stability, and regulator response under different operating conditions.