Switch Integrated Mode Power Supply (SIMPS)

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What is SIMPS?

A Switch Integrated Mode Power Supply (SIMPS) is an electrical power converter that takes the 120VAC oscillating voltage from US powerline and converts it to a range of fixed VDC by adjusting the duty cycle of the switching frequency. This is commonly done through a flyback converter (AC-DC conversion with isolation), filtering circuits, and a controller. The other common power supply topology is a Linear Power Supply, which uses a variable resistance to adjust the output voltage.

Why SIMPS?

Power Supplies are useful since many common electronics need a fixed voltage output such as supplying power to common electronics & charging batteries. The adjustable output gives the tool much more versatility in its use case.

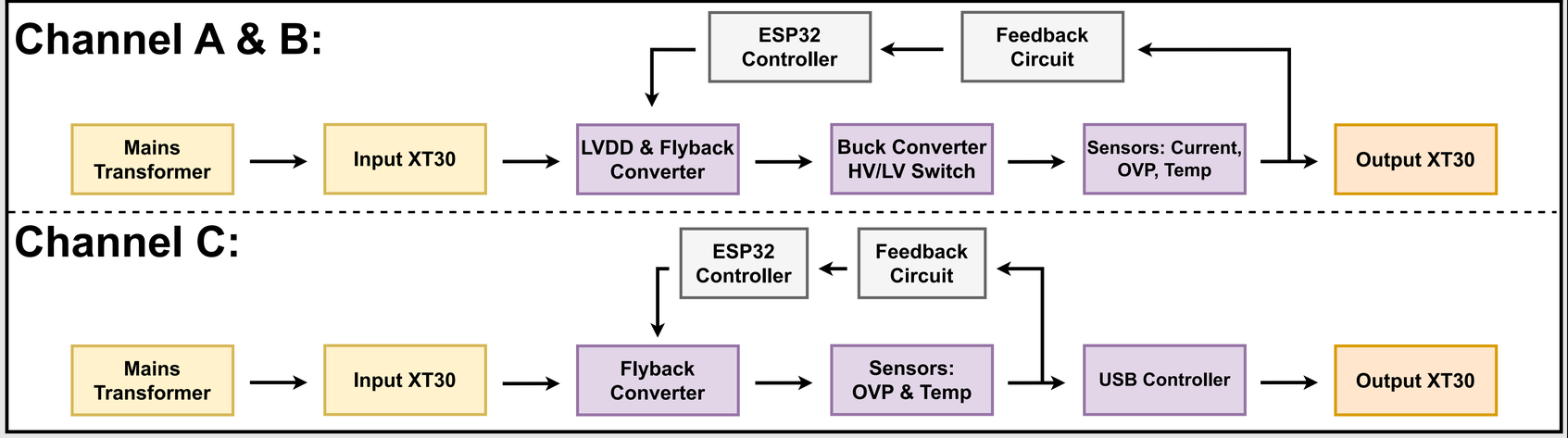
Due to its higher switching frequency, it is lighter (smaller reactance element) and has higher efficiency than a Linear Power Supply.

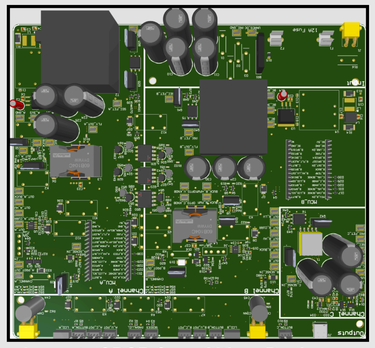
SIMPS Design Process

Simulation: Simulated circuit blocks on LTSpice to validate circuit behavior. Blocks include buck converter, OVP, logical level shift, opto isolator, and feedback.
Schematic & Layout: Altium Designer was used as the PCB design software. This step included various review phases at different points to reduce the number of errors.
Firmware: Written using PlatformIO for the ESP32-WROOM-32. Tested firmware on a mock mini-circuit to validate functionality before placing it on the main PCB.
3D Fixture: 3D Fixture designed in SOFTWARE to ensure the final PCB was safe for demonstration and to make the project aesthetically pleasing to look at.
Testing: Testing procedure was meticulously made so the board can be tested in isolated blocks before moving onto the next one.

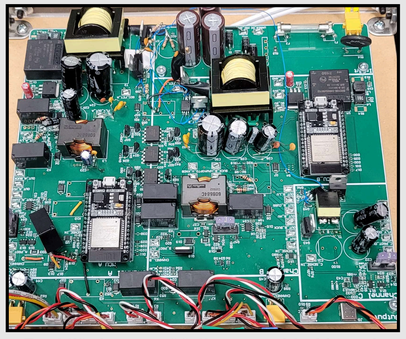
QR code for design files!

Block Diagram

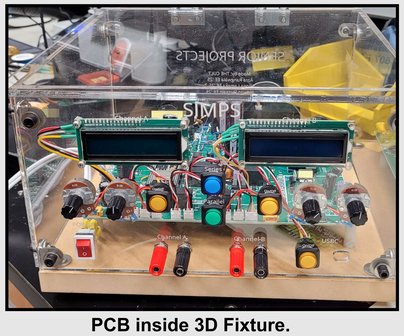




Layout of PCB from Altium Designer.



Real life image of fully assembled board.



PCB inside 3D Fixture.

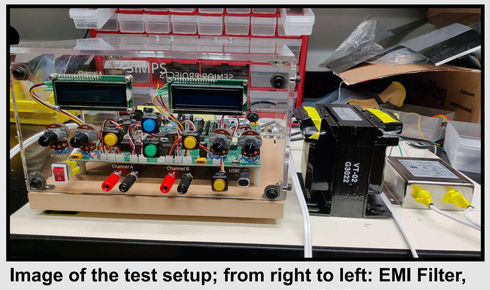


Image of the test setup; from right to left: EMI Filter, main transformer, and PCB.

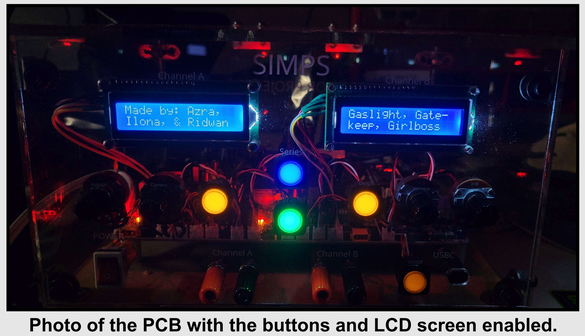


Photo of the PCB with the buttons and LCD screen enabled.

SIMPS Blocks Passed

Input Circuit	Passed
Flyback Transformer	Failed
Buck Converter	Passed
Current Sense	Passed
OVP	Passed
Enable	Failed
Temperature	Passed
Feedback	Passed
Channel A	Passed
Channel B	Failed
Channel C	Passed

Next Steps

- Run simulation for entire system design instead of only blocks
- Correct all schematic errors (dot polarity, channel enable, etc.)
- Add probable current sense, snubber circuits
- Implement PWM generator, current limiter, and active PFC
- Replace ESP32 with a dedicated controller
- Fix the 30 seconds "settle time" for the voltage output
- More robust controller logic using PID and voltage sense