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Solar-powered electronics charger using Gallium Nitride (GaN) based power converter

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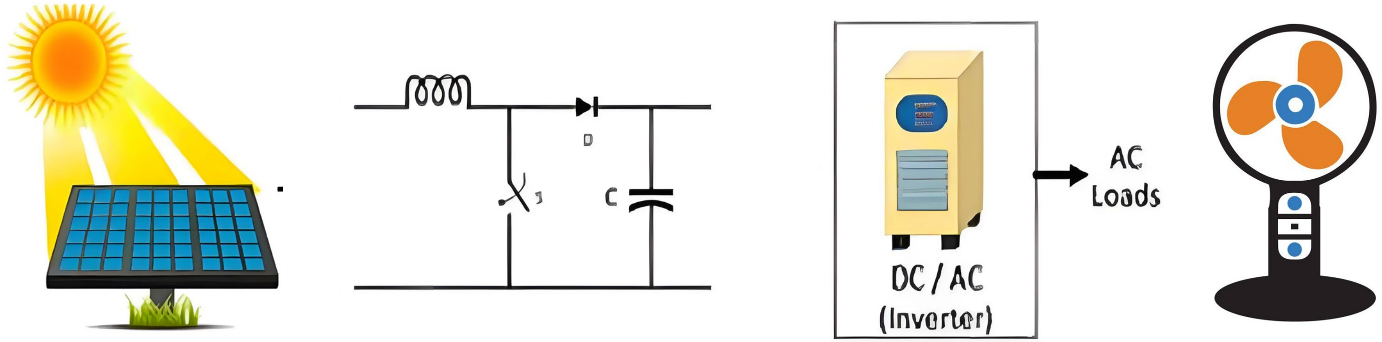
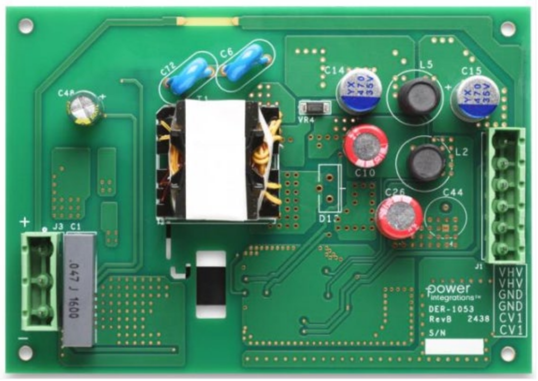
1. Research background and motivation

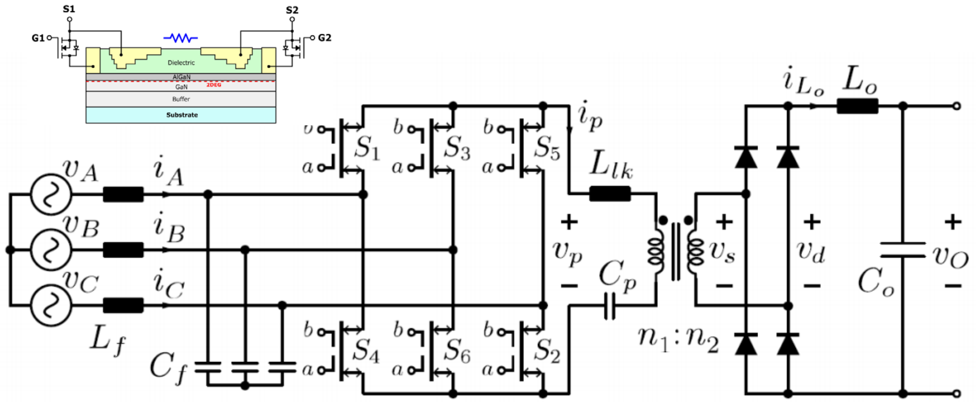
The process of solar energy to electrical energy



The Application of GaN Devices in Power Conversion (APEC 2025)



Flyback Converter



Vienna rectifier

- Advantages of solar energy

(1) Pollution-free

(2) Sustainable and affordable

(3) Environmentally friendly

- **Disadvantages of solar energy**

(1) Weather factors

(2) Sun orientation

(3) Temperature changes

- **Advantages of GaN**

(1) Wide bandgap

(2) High switching frequency

(3) Low conduction losses

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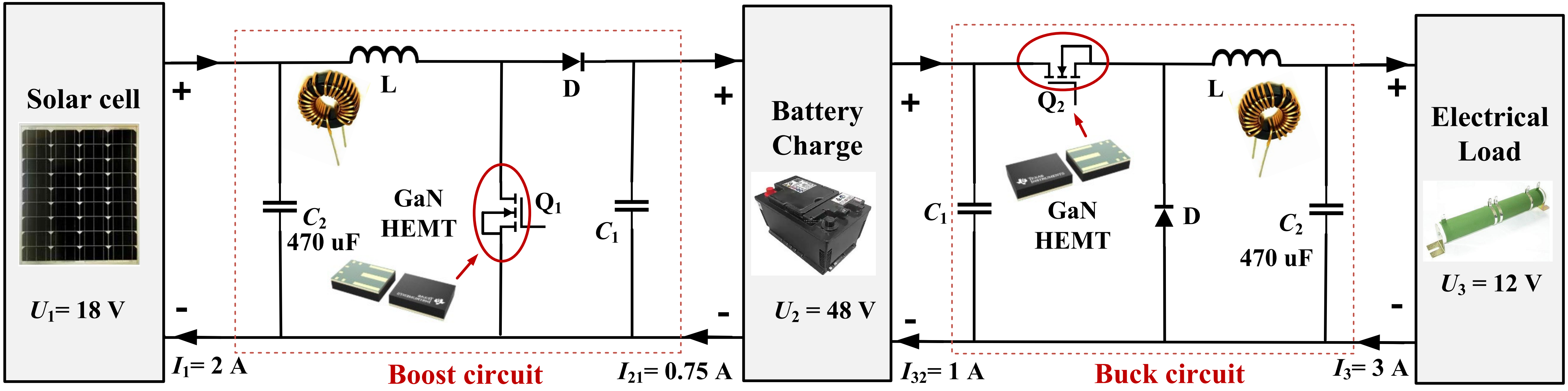
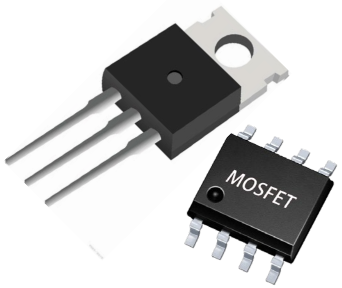
The Solar energy storage system of 48 V based on DC-DC circuit



Main functions

- Core function: Accurately realize the "transformation and regulation" of DC power sustainable and affordable.
- Key upgrade: relying on the characteristics of gallium nitride to achieve efficiency and miniaturization.
- Application adaptation function: meet the safety and reliability requirements of multiple scenarios.

3. Experimental results and discussion



Silicon MOSFET

GaN HEMT

Advantages of GaN Devices

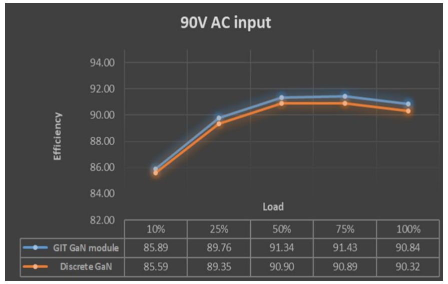
- significantly reducing switching losses
- reduces system size
- multiple times higher output power

Advantages of Silicon Devices

- High cost and Gate reliability
- The driver design is complex

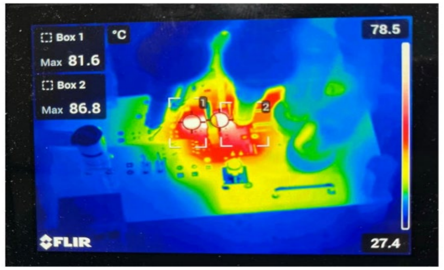
Proposed experiment

1. Converter efficiency comparison test



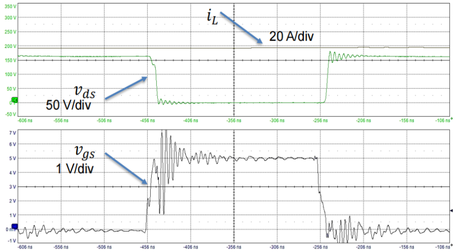
Compare the conversion efficiency of two devices under different operating conditions.

2. Device working junction temperature test



Using an infrared detector to observe the temperature changes of the device during operation.

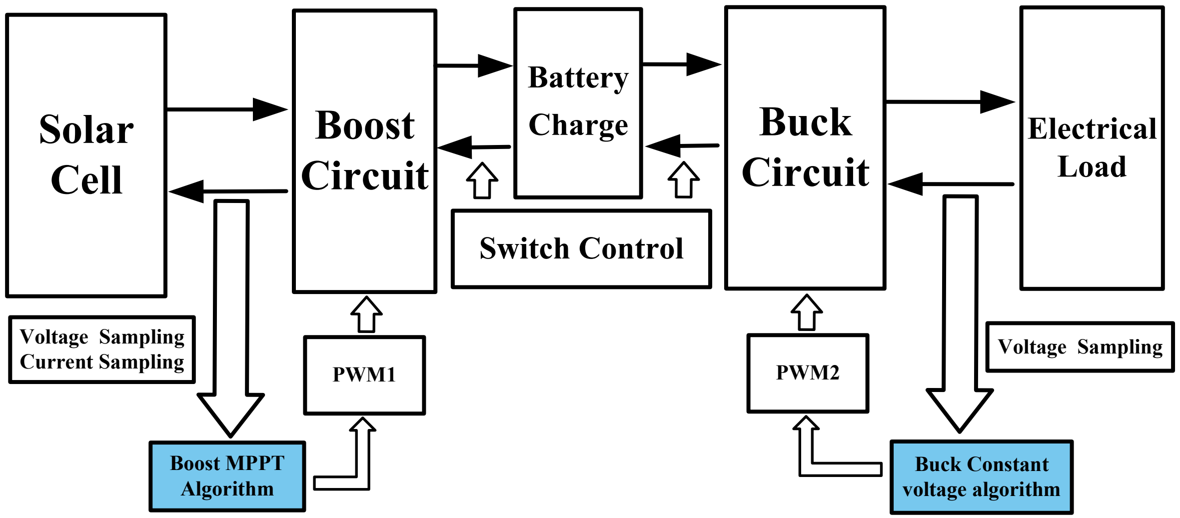
3. Device switching transient noise test



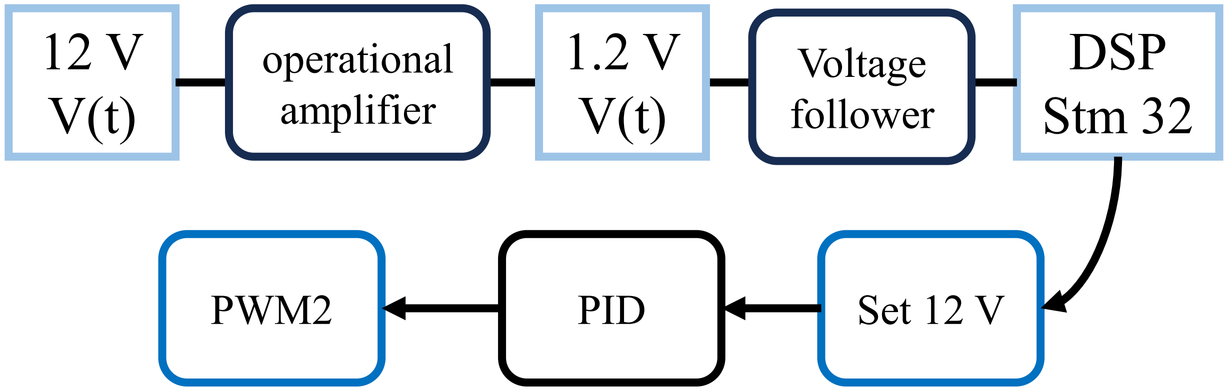
Compare the gate voltage waveform and drain voltage current waveform of two devices.

4. Software design

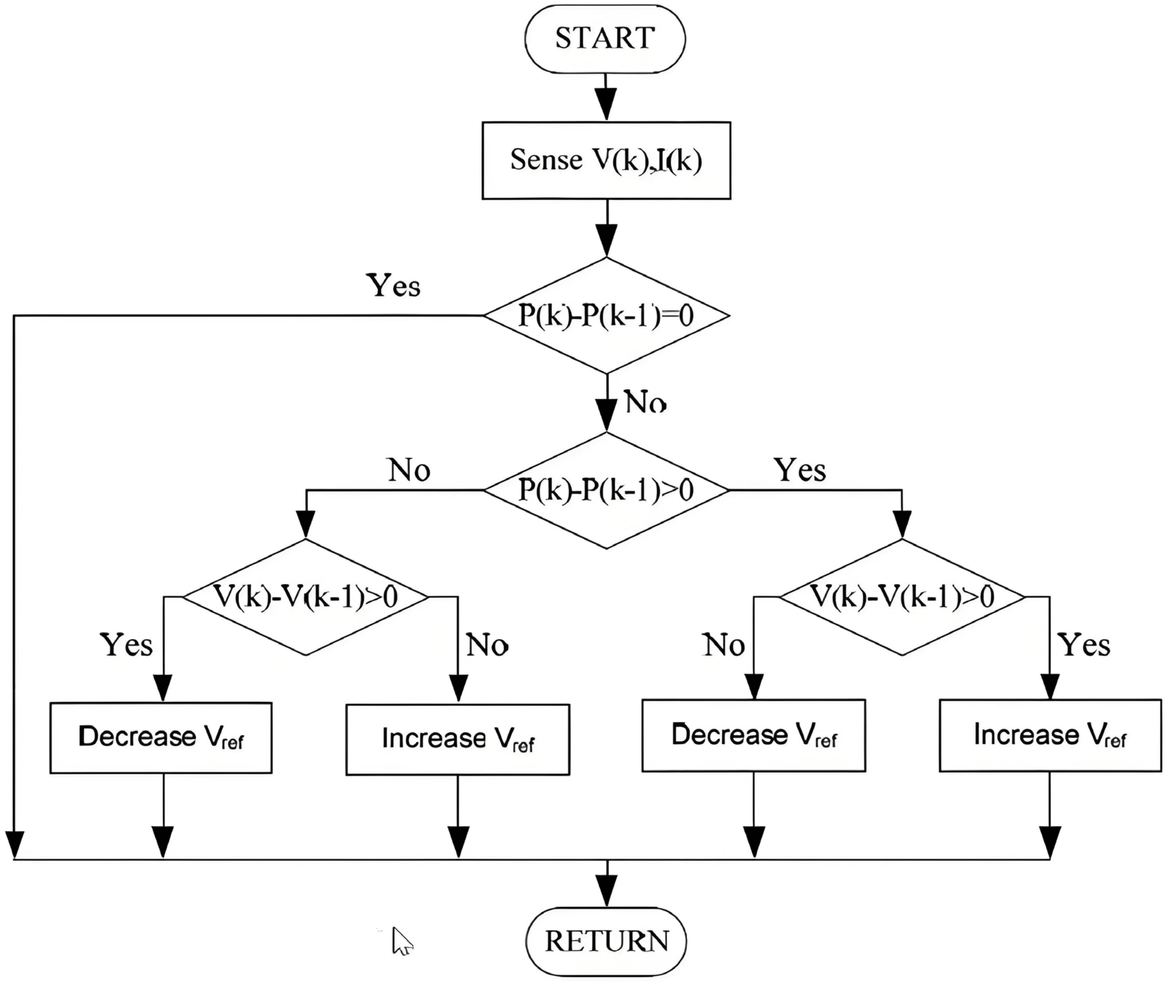
Overall design diagram



Buck Constant Voltage Algorithm



Boost MPPT (Perturbation observation method)



5. Circuit design

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Calculation of Circuit Parameters

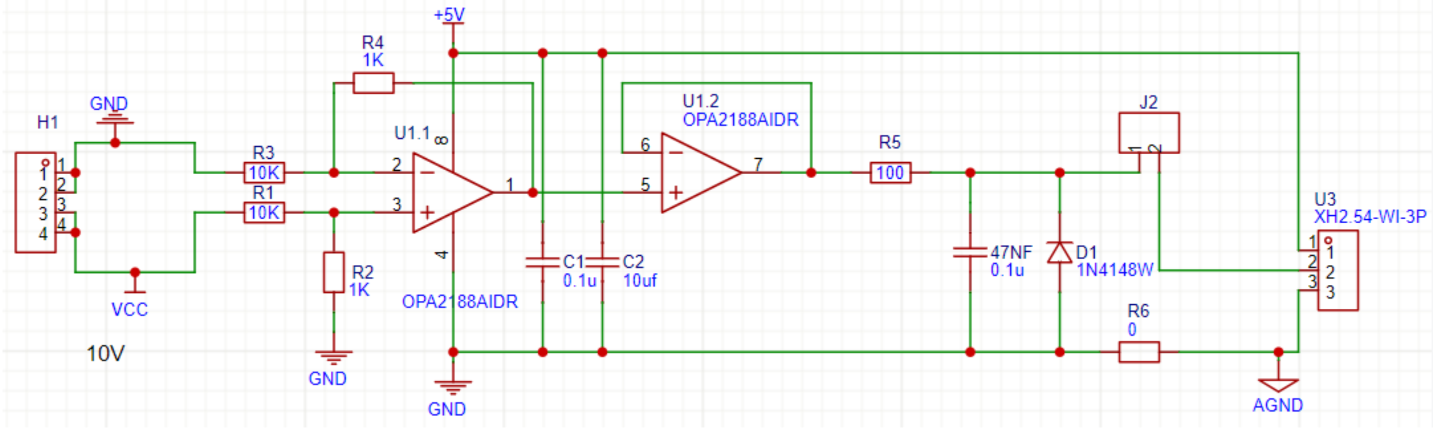
Boost circuit

	HEMT	MOSFET
f	5 MHz	50 kHz
Cin Cout	470 uF	470 uF
Formula	$L = \frac{(V_{in} - V_{out}) \times V_{out}}{\Delta I_L \times f_{sw} \times V_{in}}$	
L	21.6 uH	2.16 mH

Buck circuit

	HEMT	MOSFET
f	10 MHz	100 kHz
Cin Cout	470 uF	470 uF
Formula	$L = \frac{(V_{in} - V_{out}) \times V_{out}}{\Delta I_L \times f_{sw} \times V_{in}}$	
L	10.5 uH	10.5 mH

Design of Voltage Sampling Circuit



Boost Main circuit design