Adaptive Switching Frequency Boundary in Hybrid DCM and BCM Method for Flyback Microinverter

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Contents

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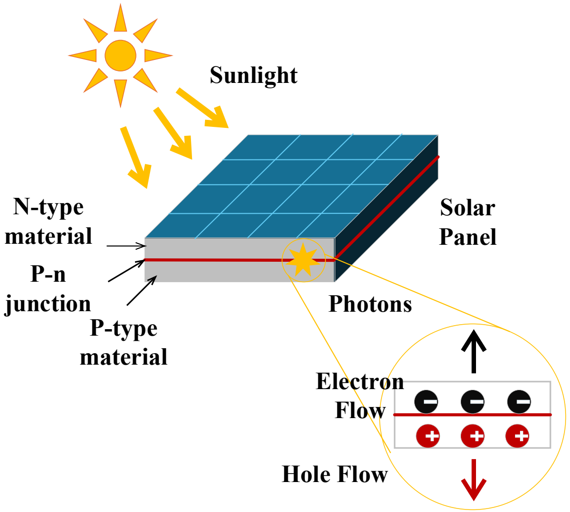
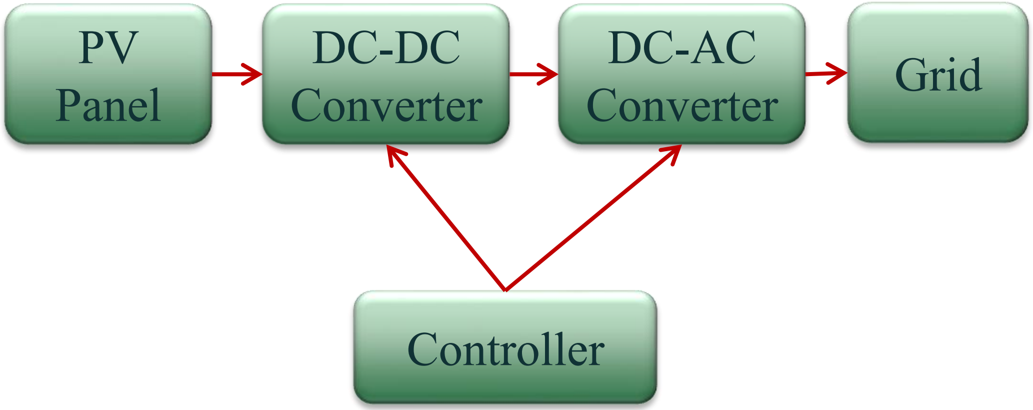
Introduction

Introduction





A microinverter is a key component that converts DC from PV panels into AC for grid or local use

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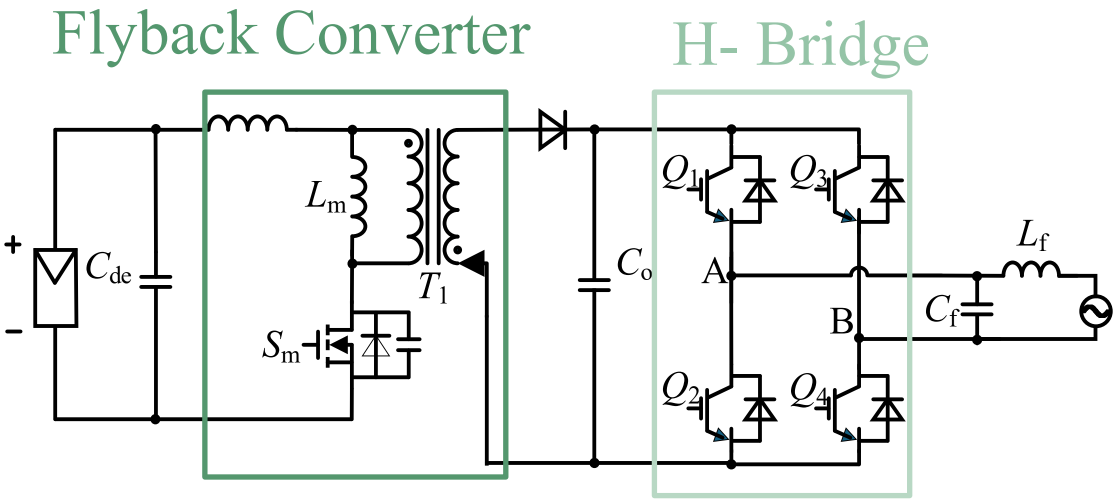
Flyback Topology

Flyback Microinverter



The flyback inverter is particularly advantageous when combined with an H-bridge for grid-tied applications.

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DBCM Method

For Flyback Microinverter

Operation Modes of Flyback Microinverter

Discontinuous Conduction Mode (DCM)

Boundary Conduction Mode (BCM)

Discontinuous Conduction Mode (CCM)

Operation Modes of Flyback Microinverter

Discontinuous Conduction Mode (DCM)

+

Boundary Conduction Mode (BCM)

=

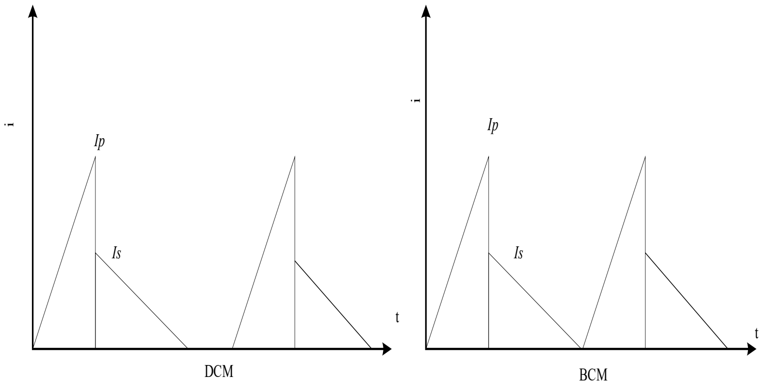
Discontinuous Boundary Conduction Mode (BCM)

DBCM Method for Flyback Microinverter

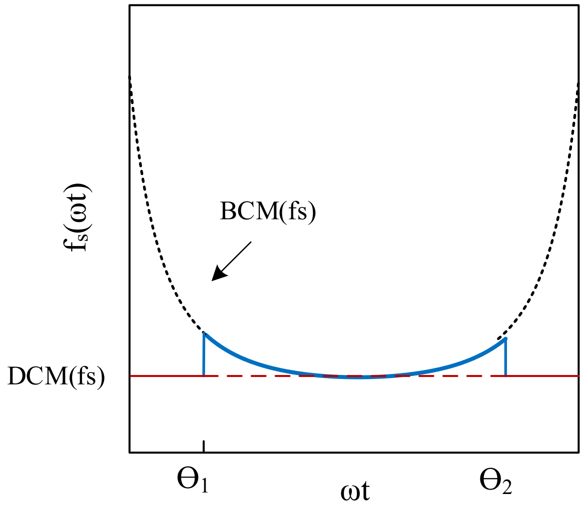
Conduction Mode	Advantages	Disadvantages
DCM (Discontinuous Conduction Mode)	❑ Simple control ❑ Zero current at turn-on ❑ No need for current feedback loop	❑ Higher peak and RMS currents ❑ Limited power throughout for given magnetics. ❑ Moderate efficiency at heavy loads
BCM (Boundary Conduction Mode)	❑ Improved magnetic utilization ❑ Lower peak current for same output ❑ Higher power density	❑ Variable switching frequency complicates EMI filtering and control. ❑ Extremely high switching frequency at light load

DBCM Method for Flyback Microinverter

Ip – Primary Current
Is – Secondary Current



Current waveforms of the primary and secondary sides in DCM and BCM



Graph of fixed switching frequency

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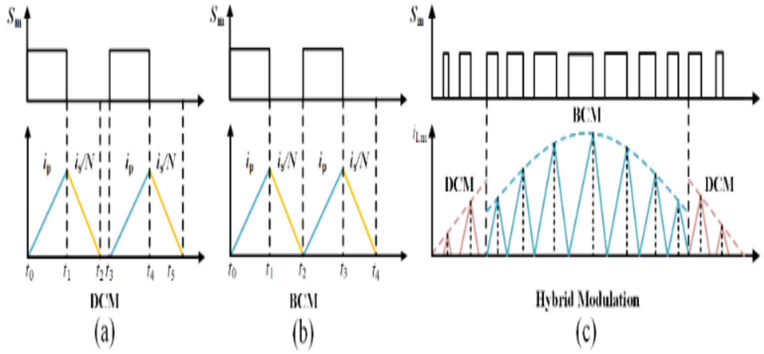
Contribution

Adaptive Switching Frequency Boundary in Hybrid DCM and BCM Method for Flyback Microinverter

Contribution-Adaptive Switching Frequency Boundary in Hybrid DCM and BCM Method for Flyback Microinverter



$$f_{\_limit} = f_{\_base} + kP_{O}, k > 0$$

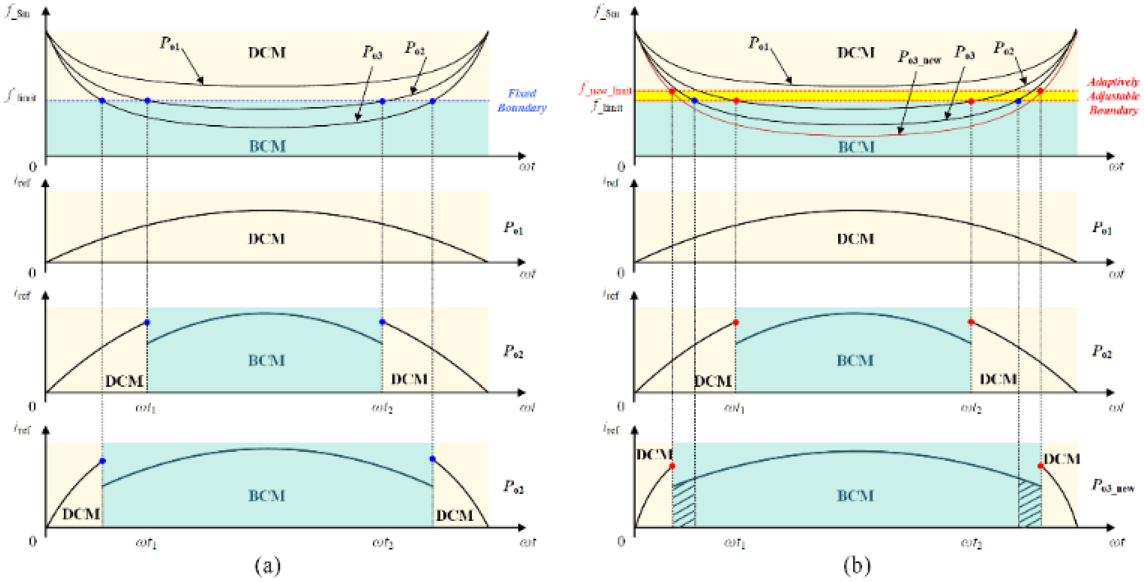
Hybrid Principle

Proposed Adaptive Boundary Equation

Contribution-Adaptive Switching Frequency Boundary in Hybrid DCM and BCM Method for Flyback Microinverter

Instantaneous Power P(t)	Switching Frequency fs	Suggested mode
0-20W	200-450Khz	DCM
20-80W	150-300Khz	BCM (adaptative)
80-100W	130-180Khz	BCM

Contribution-Adaptive Switching Frequency Boundary in Hybrid DCM and BCM Method for Flyback Microinverter



Proposed Waveforms

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Experimental Results

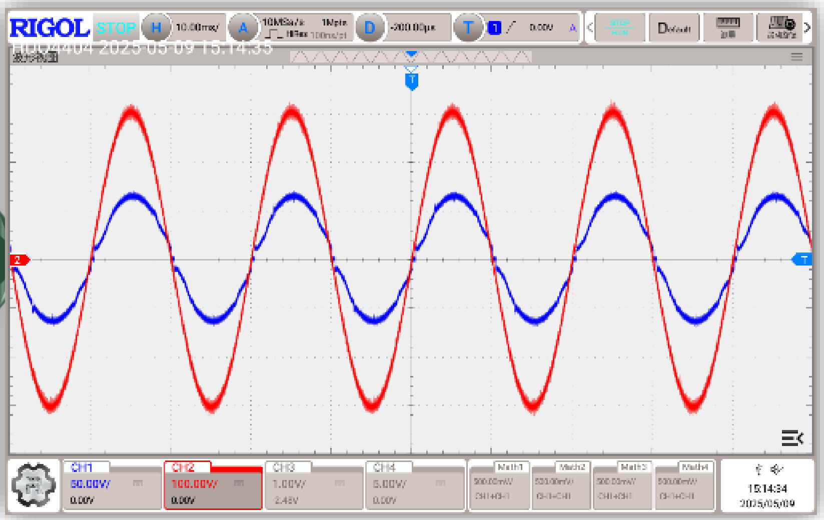
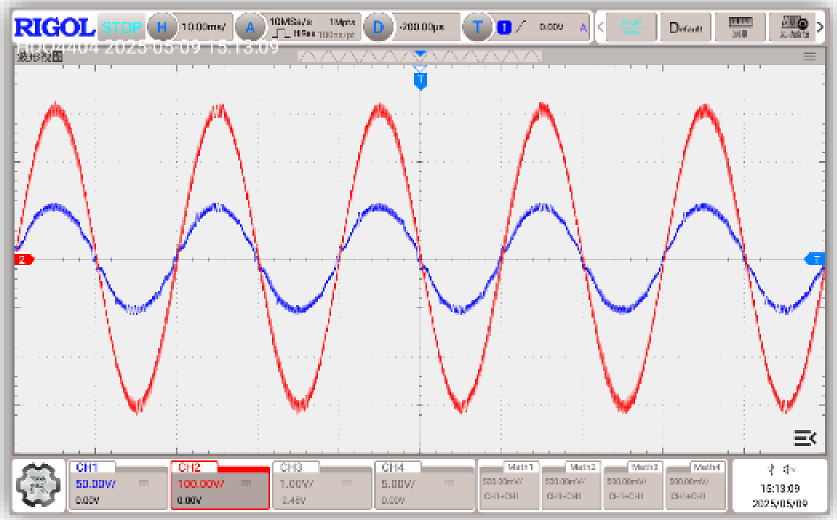
Experimental Results

Proposed Prototype

- Vin (PV) = 25.45V
- Po = 200 W
- MOSFET =
  S_freq=500KHz
- Transformer turn ratio(N) 1:10
- F_base=100Khz
- K=0.15

Experimental Results

10 ms/div

Waveforms of Grid voltage and output current
a) at 200 W b) at 160 W

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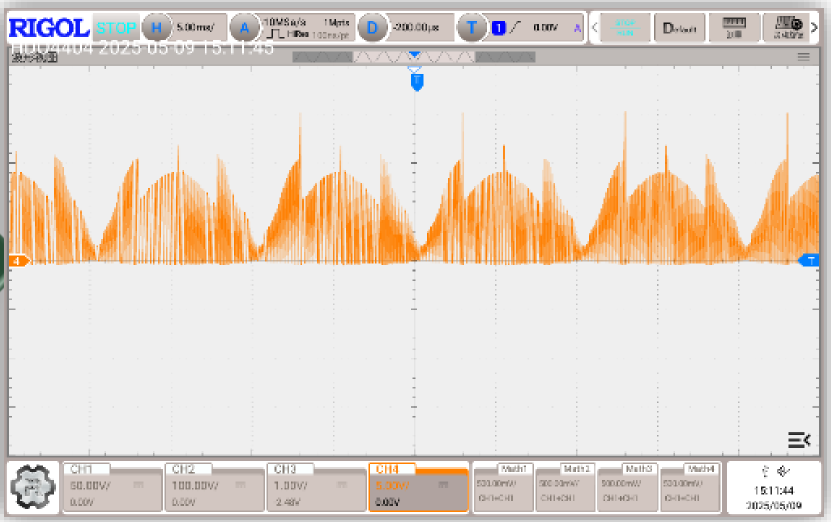
Experimental Results

5 ms/ div



Waveforms of Grid voltage and output current
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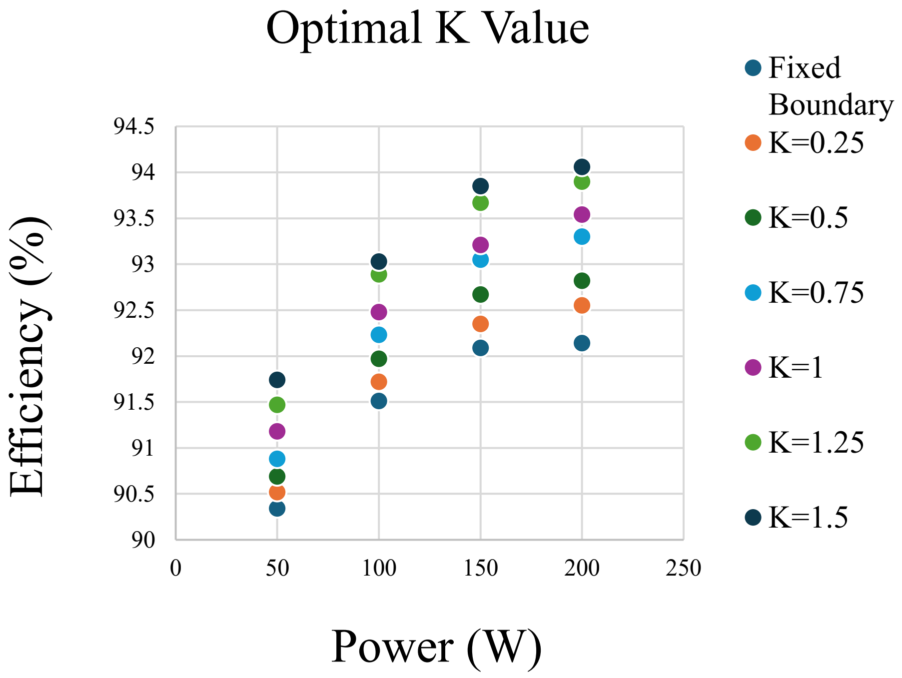
Experimental Results



The optimal value of k was found to be 0.15, which offers the best balance between high efficiency and manageable thermal rise.

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Conclusion

Future Directions

- Digital Implementation
- Hybrid Power Stages
- Battery-PV Hybrid Systems
- Smart Grid Integration

Conclusion

The proposed system paves the way for more efficient, flexible, and scalable solutions in the field of PV micro-inverters, with promising implications for higher power applications, energy storage integration, and smart grid systems

Thank you for your attention!

Q & A