50th IECON
IEEE Industrial Electronics Society
ANNUAL CONFERENCE OF THE
IEEE INDUSTRIAL ELECTRONICS SOCIETY
Chicago | Illinois, November 3-6, 2024

Direction-Selective Parallel Module Structure for Cascaded Bridge and Modular Multilevel Converters with Minimum Transistor Count

Jinshui Zhang[1], Stefan Goetz[2]

[1, 2] Duke University

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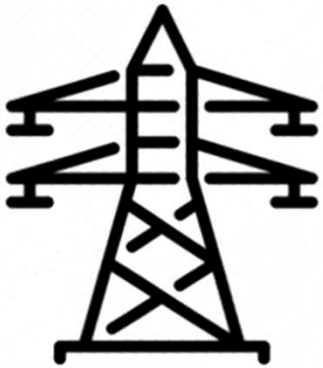
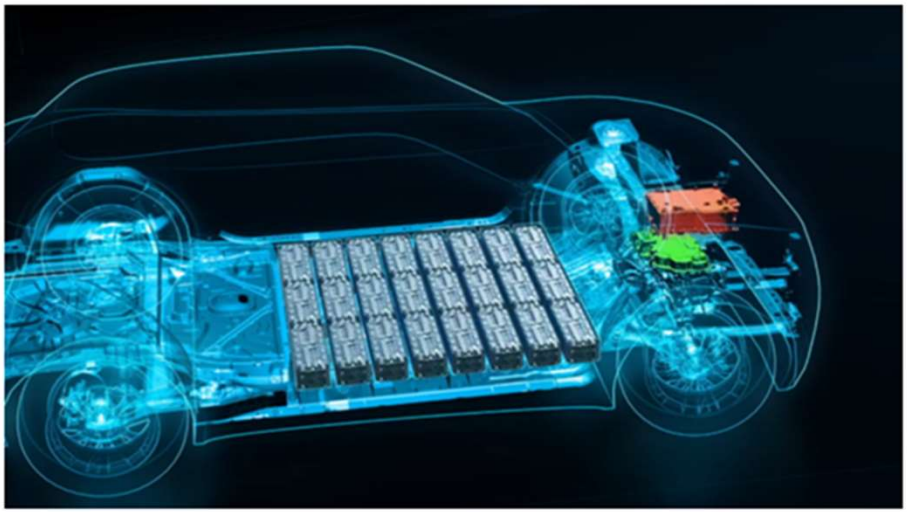
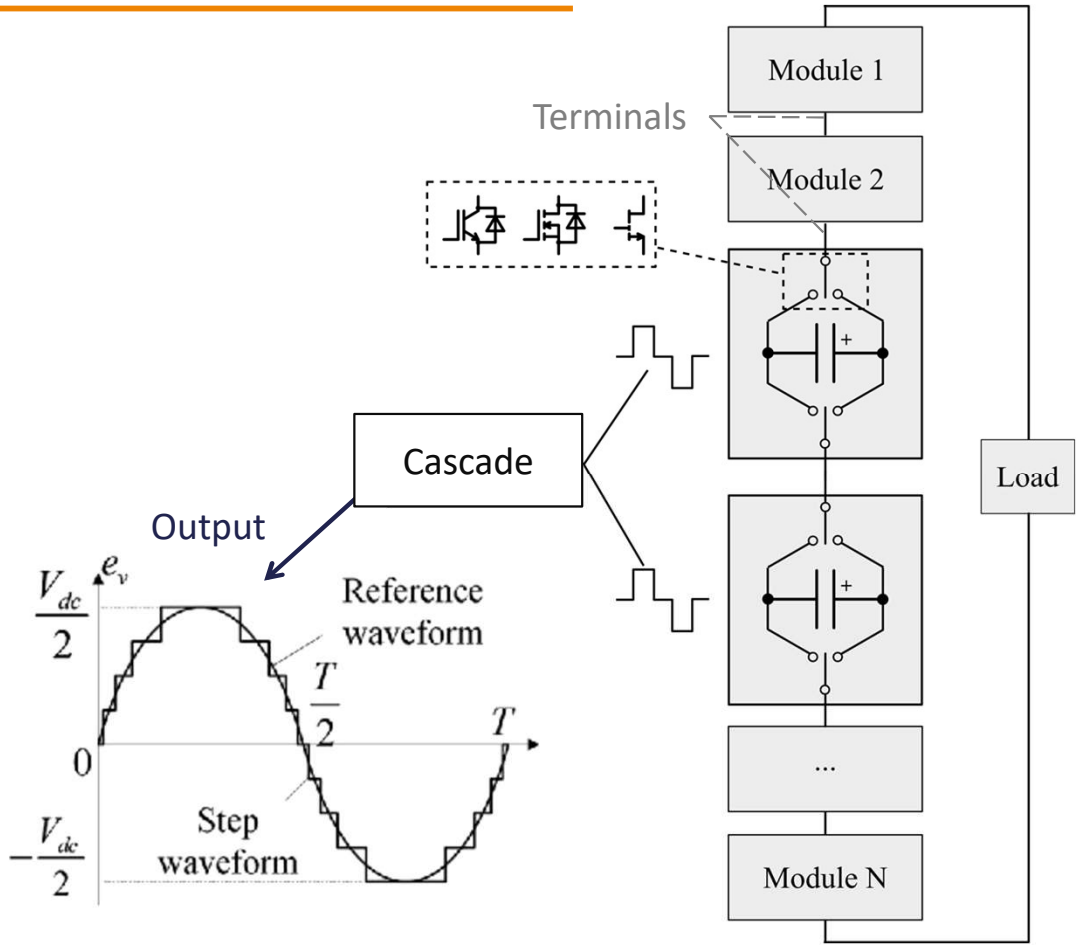
MMC IS EVERYWHERE…





Credit to Stellantis

General Structure of MMC



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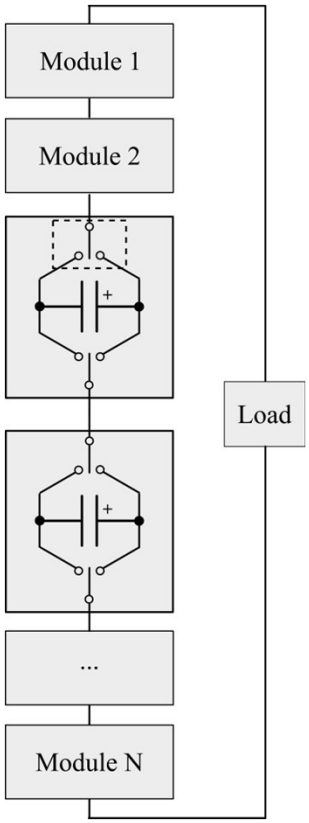
EVOLUTION: ENABLING PARALLEL CONNECTIVITY



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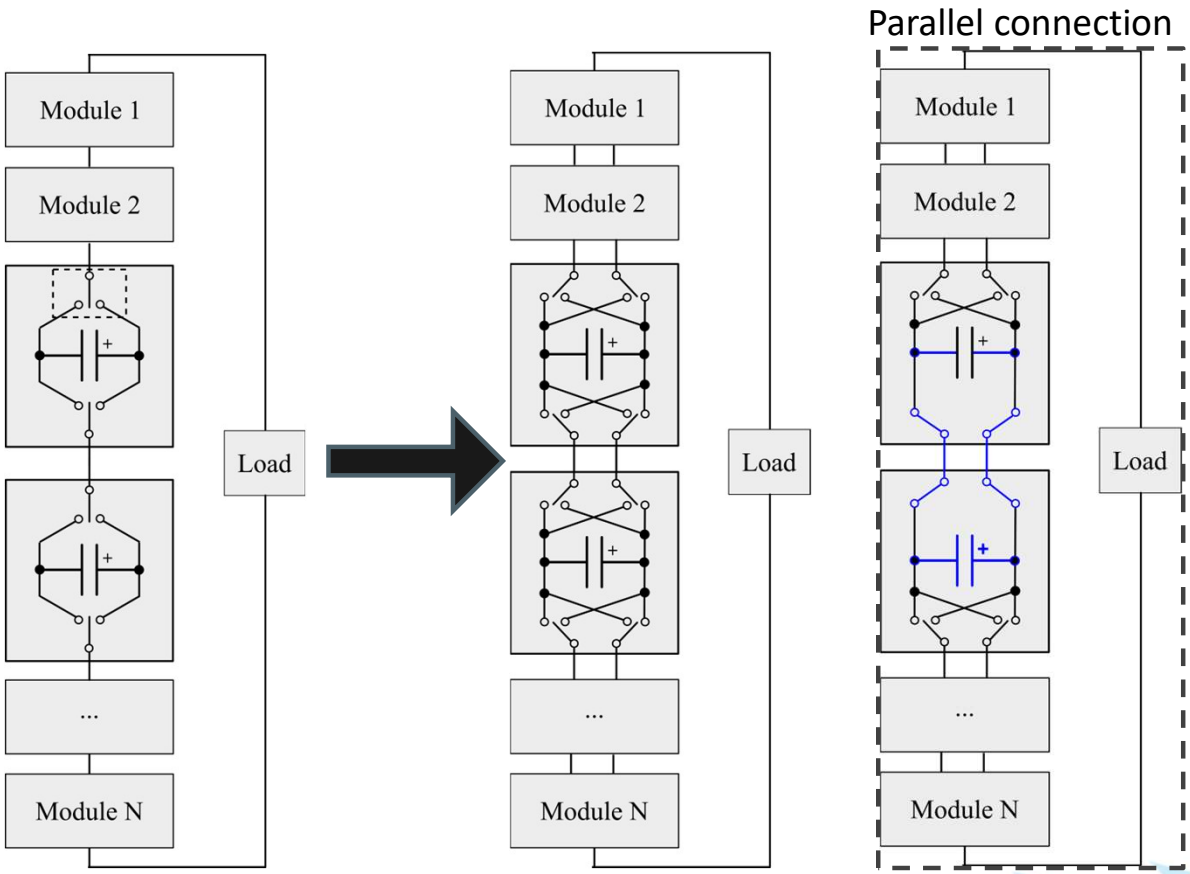

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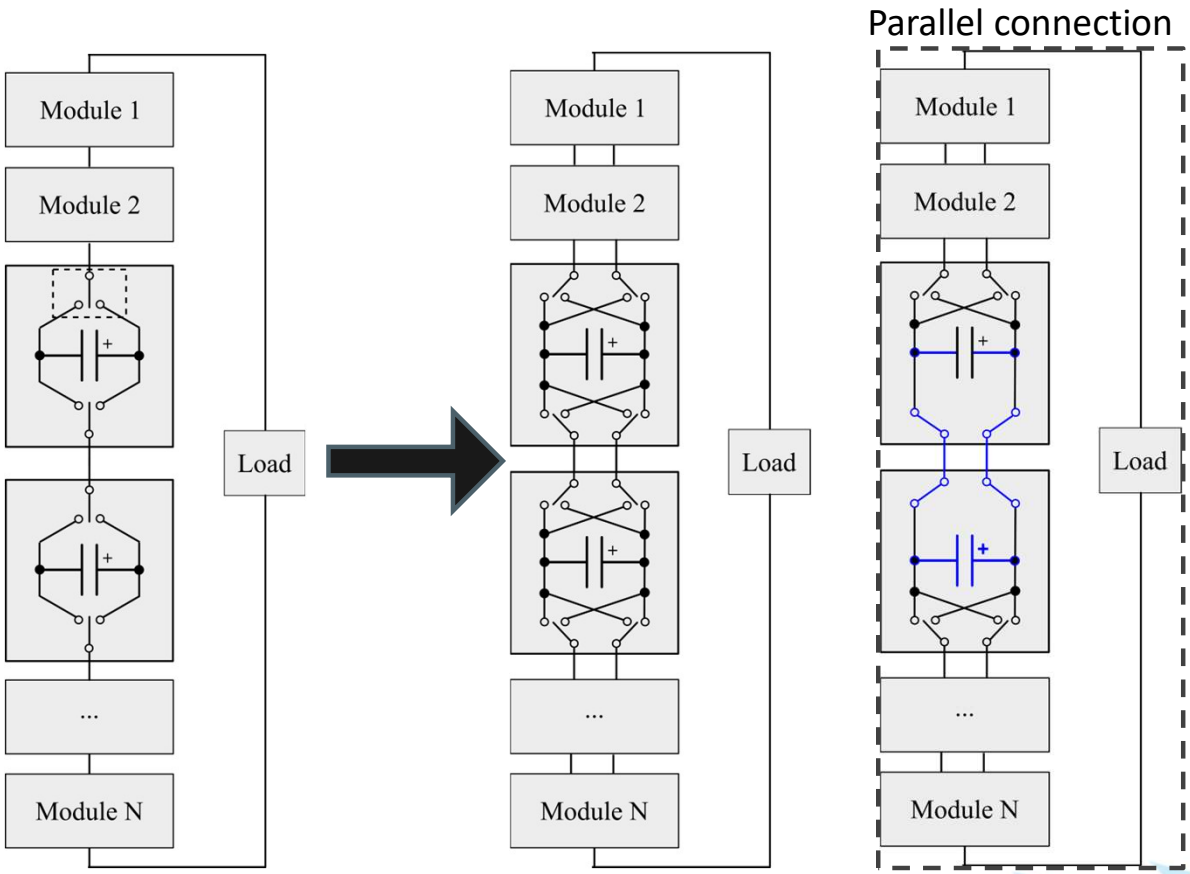
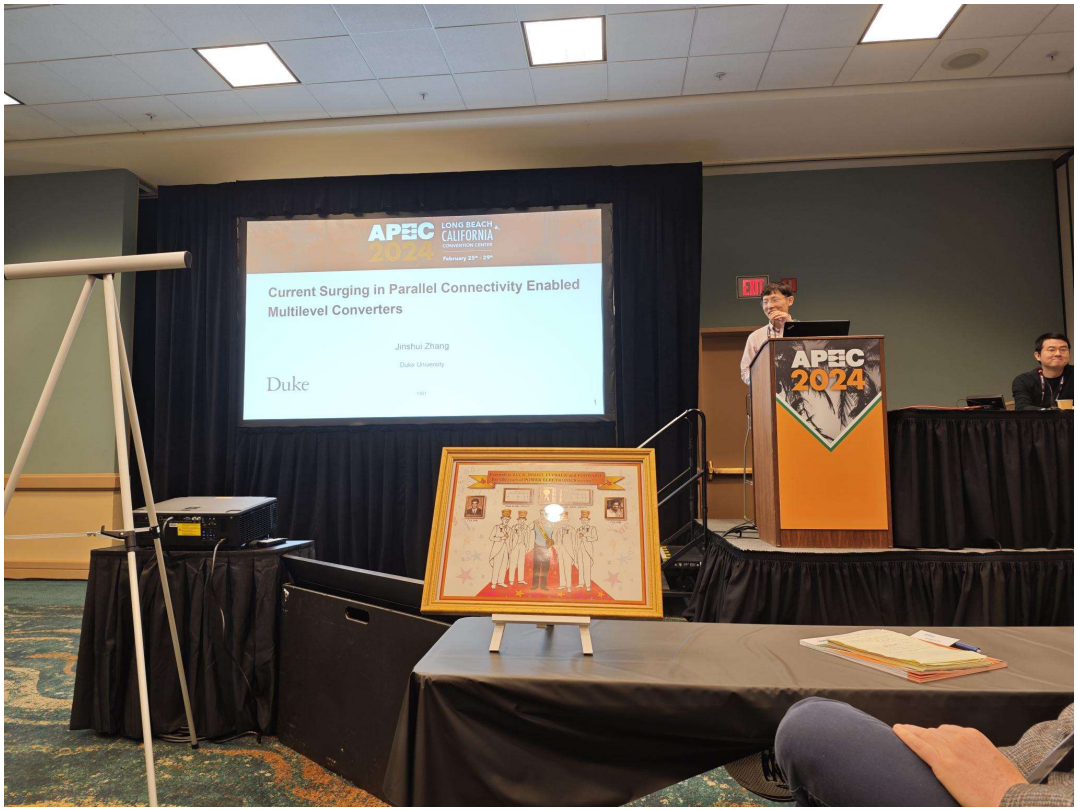


Advantages

- Lower impedance
- Automatic voltage balancing

Disadvantage?

STORY TIME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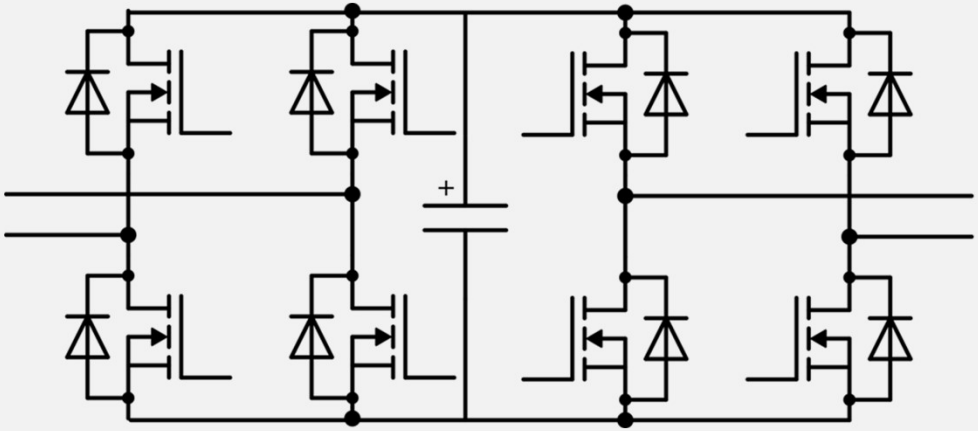
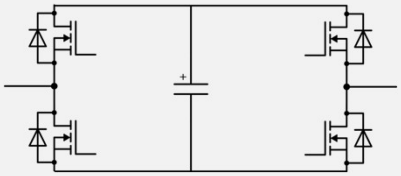
Current Surging in Parallel Connectivity Enabled Multilevel Converters
Jinshui Zhang
Duke University
Duke
EXIT
APEC 2024

Cascaded Double H Bridge Circuit



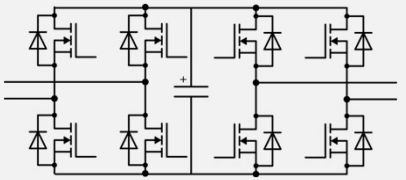
Cascaded double H bridge circuit

Disadvantages: $$$$



Full bridge

VS



Cascaded double H bridge (CH2B)

Topology	Transistor count	Parallel mode?	Output polarity
Full-bridge	4	No	Bipolar
CH2B	8	Yes	Bipolar

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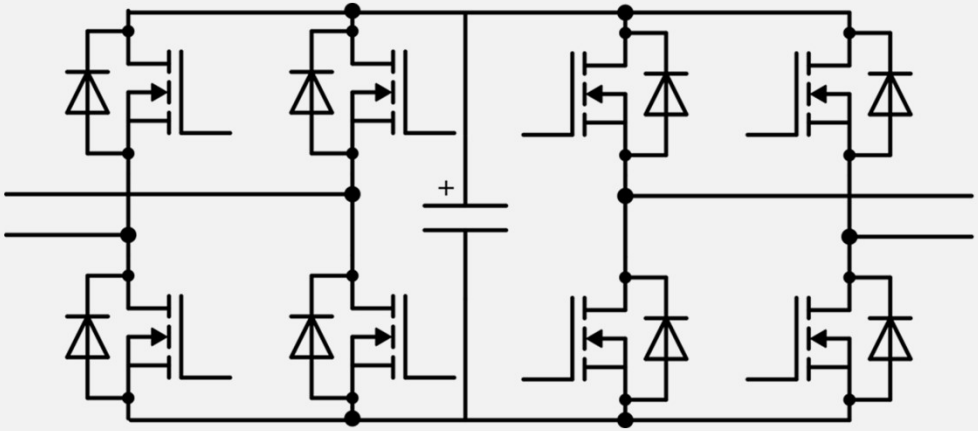
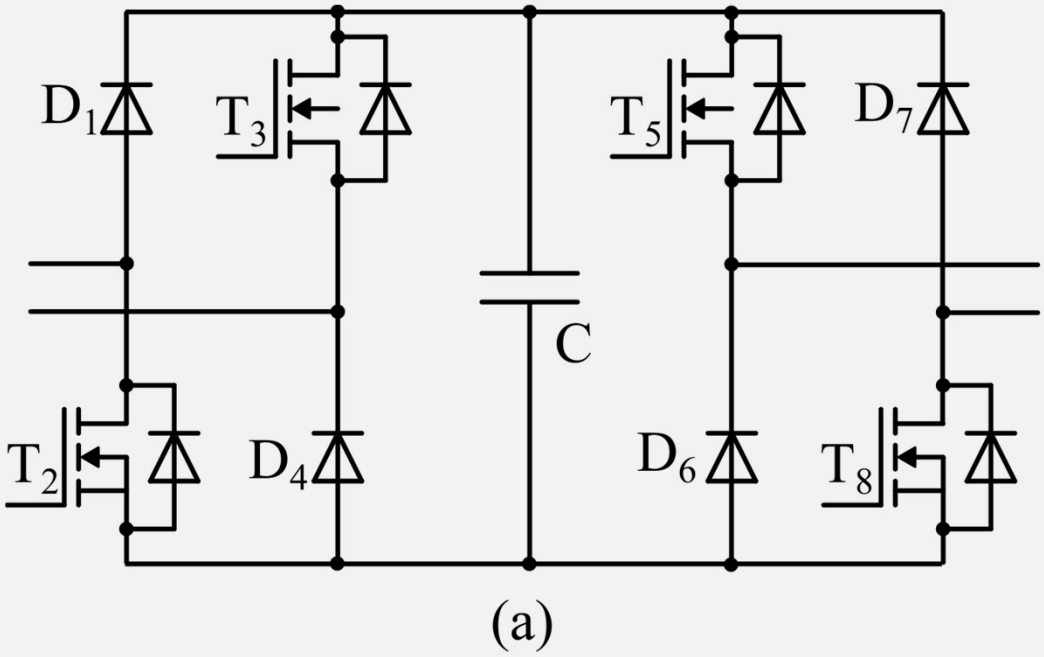
Cascaded Double H Bridge Circuit



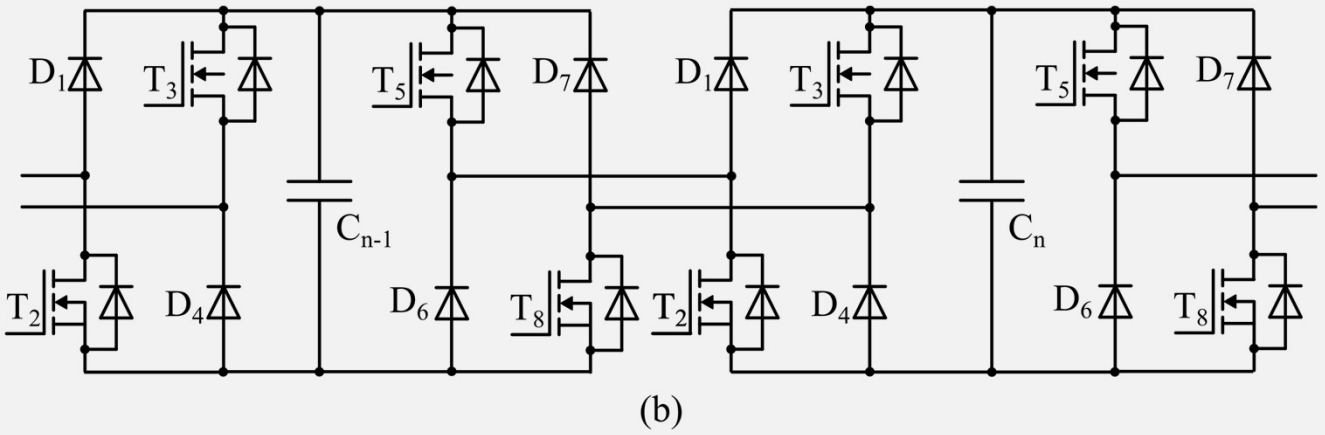
Cascaded double H bridge circuit

DIRECTION-SELECTIVE PARALLEL MODULE STRUCTURE



(a) Topology. (b) Connection. (c) Series connection. (d) Parallel connection. (e) Bypass connection

DIRECTION-SELECTIVE PARALLEL MODULE STRUCTURE



(b)

(a) Topology. (b) Connection. (c) Series connection. (d) Parallel connection. (e) Bypass connection

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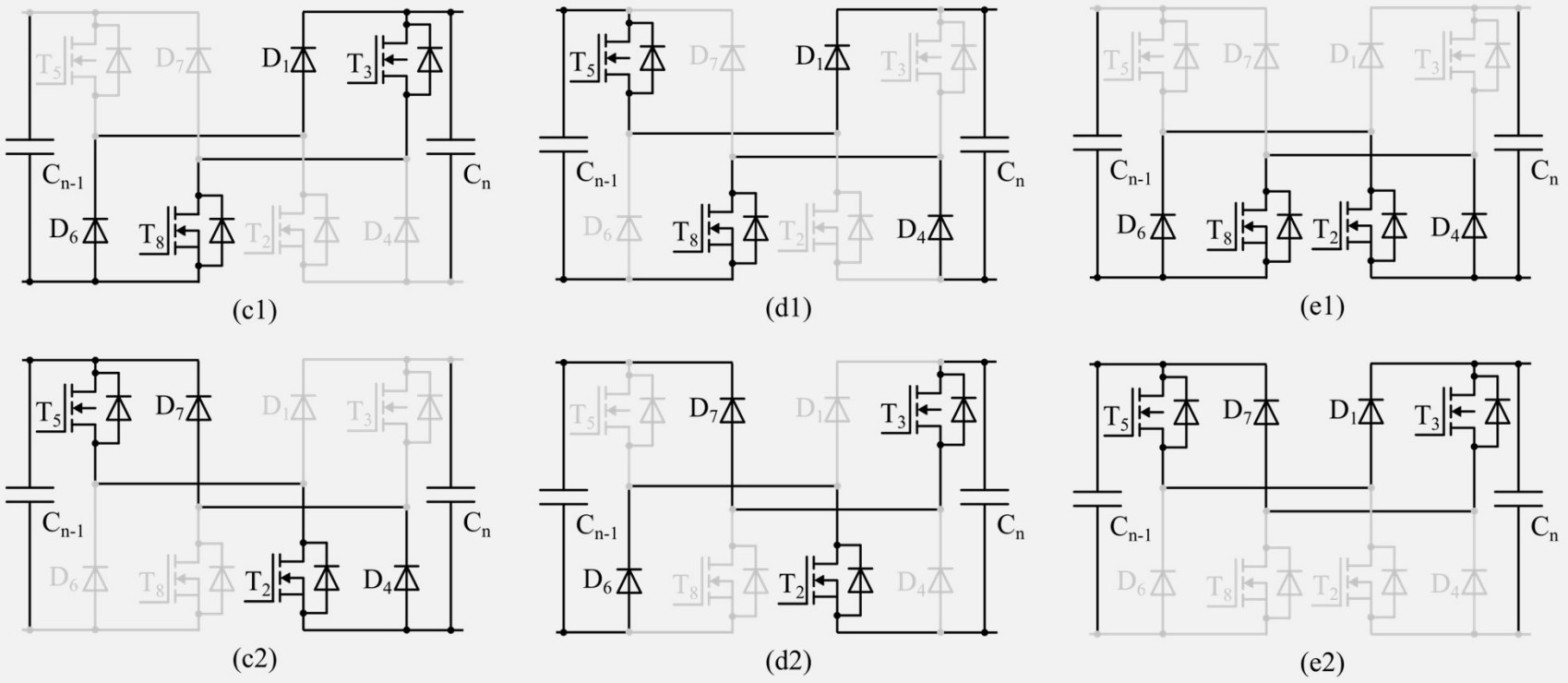

(a) Topology. (b) Connection. (c) Series connection. (d) Parallel connection. (e) Bypass connection

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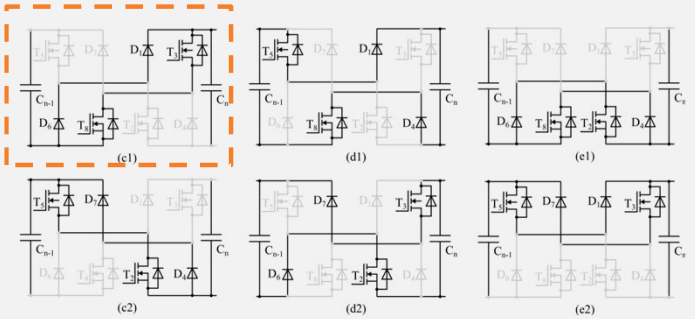
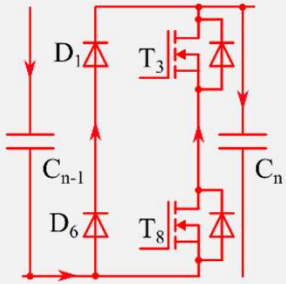
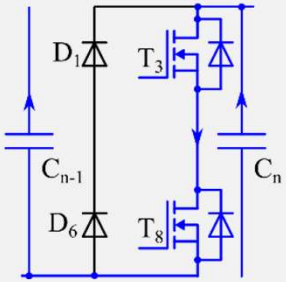
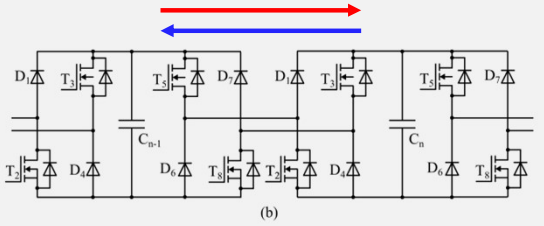
DIRECTION-SELECTIVE PARALLEL MODULE STRUCTURE:

CURRENT PATH









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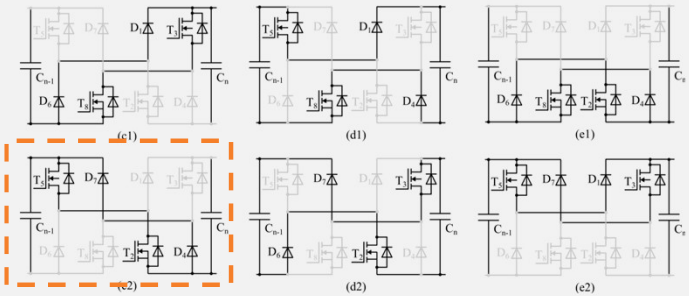

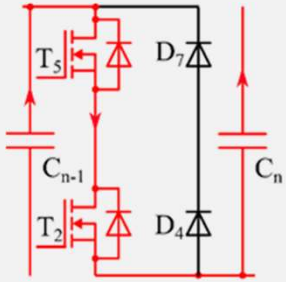

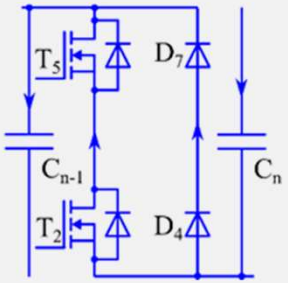

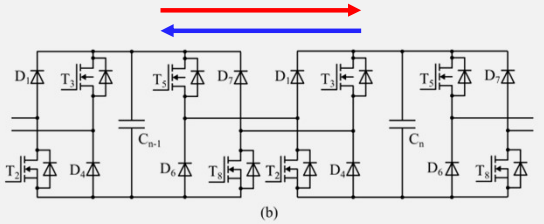

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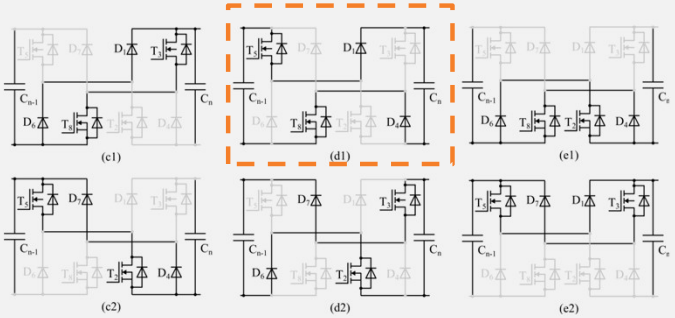

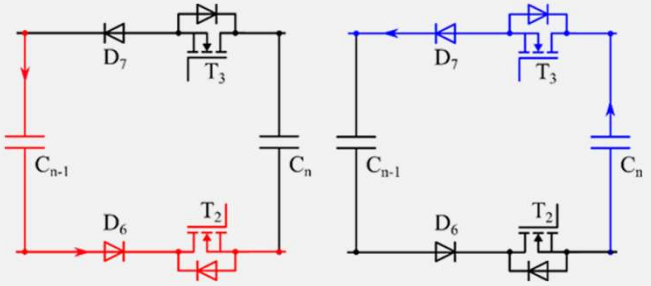

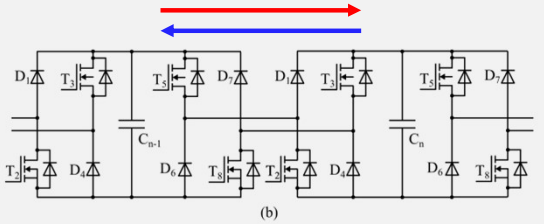

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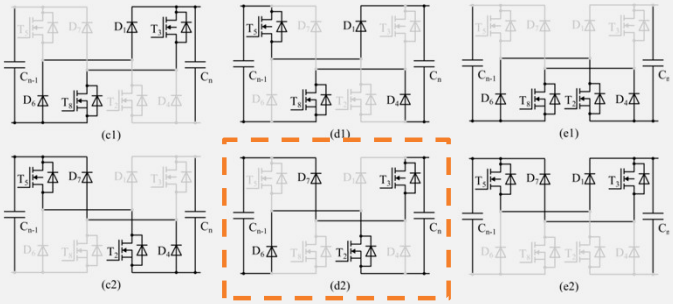
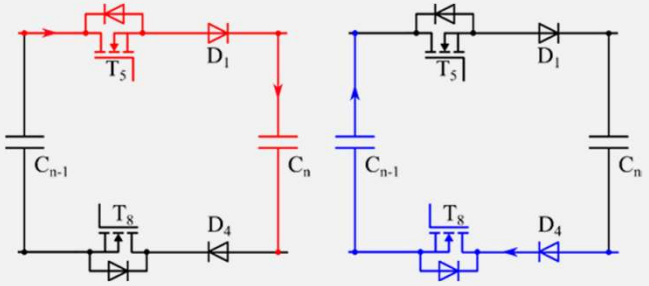
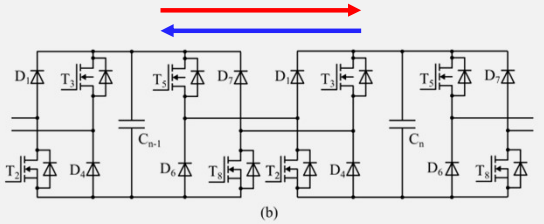
Current Path







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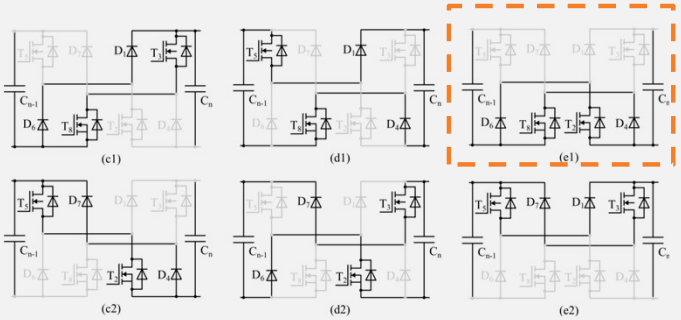

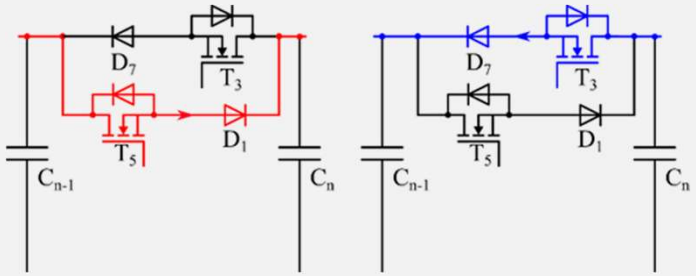

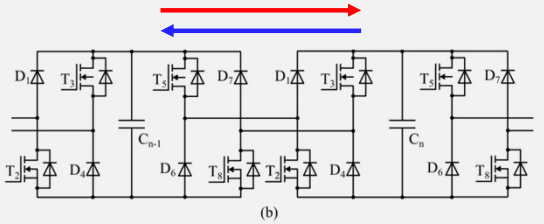

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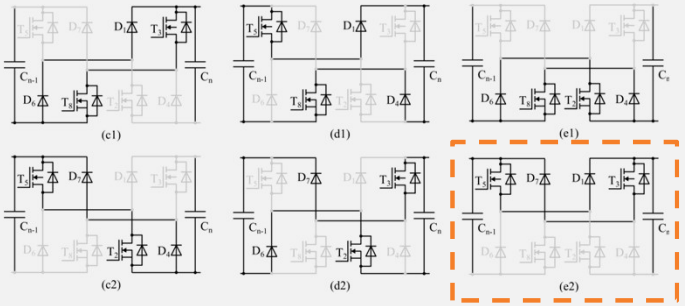

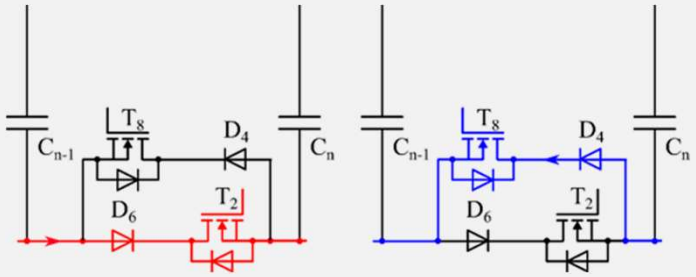

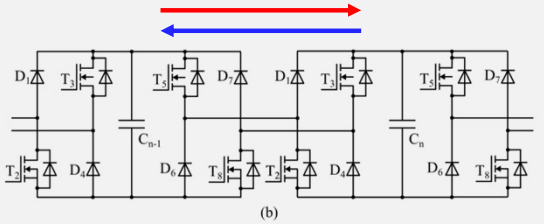

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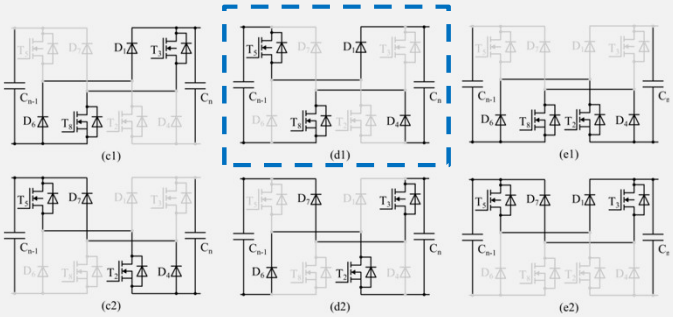
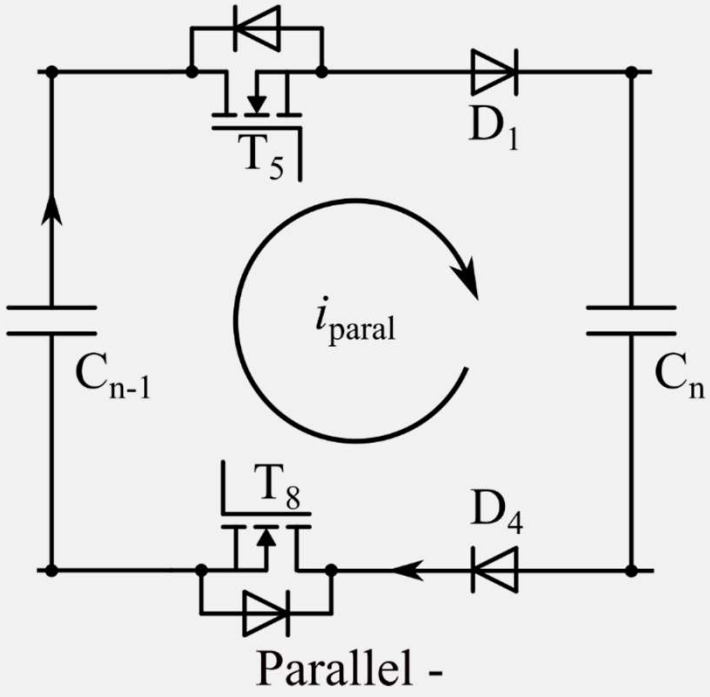
PARALLELING LOOP

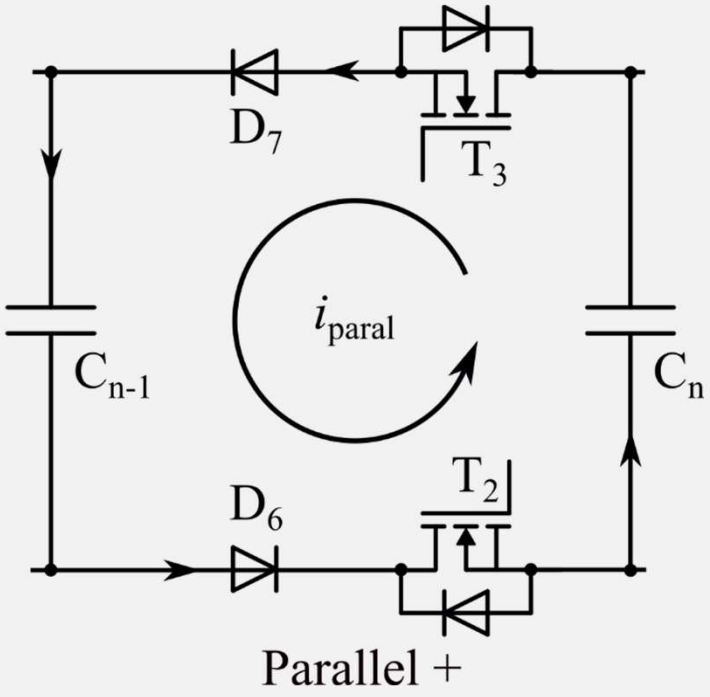


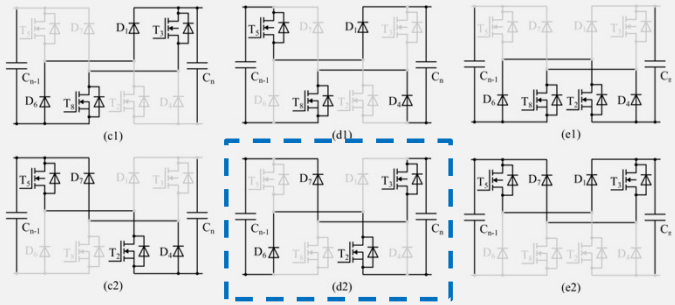


Parallel -

DIRECTION-SELECTIVE PARALLEL MODULE STRUCTURE:

PARALLELING LOOP





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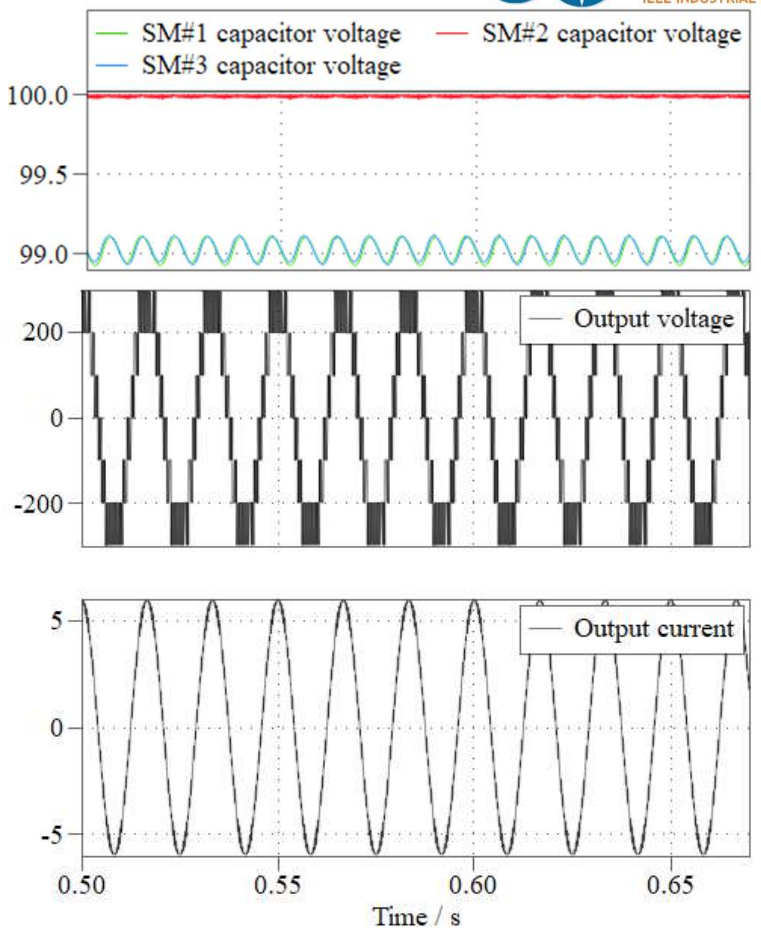
SIMULATION RESULTS

Trial info

- Module number: 3
- Power supply: 100 V to module #2 with 10 mΩ impedance
- Module voltage: 100 V
- Load: 10 Ω + 100 mH



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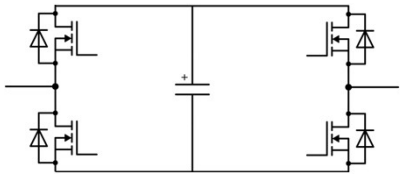
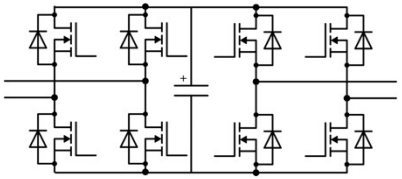
CONCLUSION



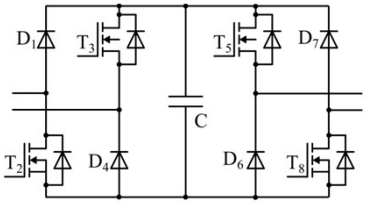
Full bridge

VS



CH2B

VS



Direction-selective parallel topology

Topology	Transistor	Parallel mode?	Output
Full-bridge	4	No	Bipolar
CH2B	8	Yes	Bipolar
Direction-Selective-Parallel	4	Yes	Bipolar

Thank you!