ECE330: Power Circuits & Electromechanics

Lecture 26. Rectifying sine waves into DC

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Last time: Inverters

Today

Ideally, zero loss

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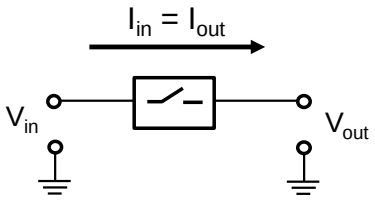
Rules for high efficiency



100% Efficiency

Short circuit $V_{in} = V_{out}$

Open circuit $I_{in} = I_{out} = 0$

The switch is the only device with 100% efficiency

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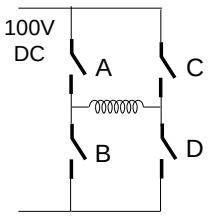
Full-bridge inverter



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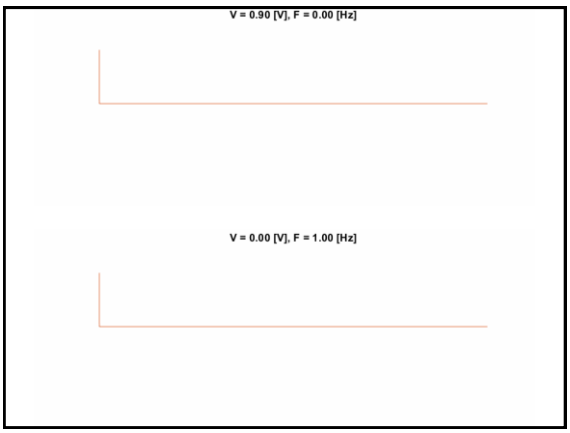

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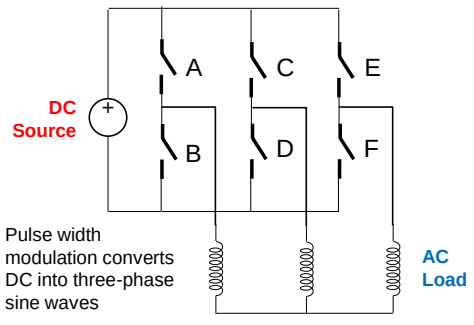
Six pulse inverter



Pulse width modulation converts DC into three-phase sine waves

Complicated control, but <u>arbitrary</u> voltage / frequency

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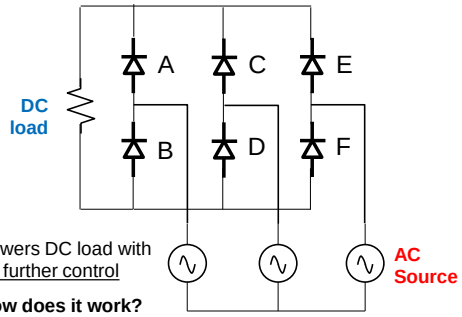
Six pulse rectifier



Powers DC load with no further control

How does it work?

Uncontrolled. How many DC volts?

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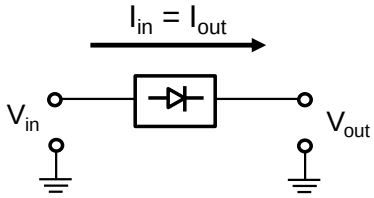
The ideal diode



If $I_{in} = I_{out} \geq 0$, then short circuit $V_{in} = V_{out}$

If $V_{in} < V_{out}$, then open circuit $I_{in} = I_{out} = 0$

The diode is an automatic one-way switch
100% efficient self-programming

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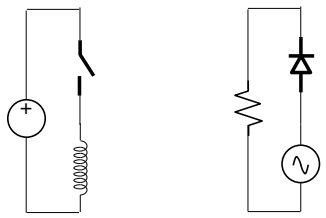
Duality of inverters and rectifiers



One-switch inverter

One-switch rectifier

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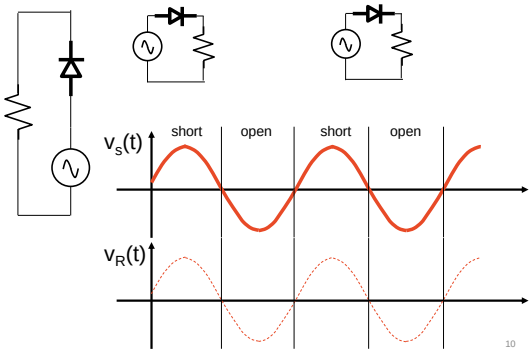
Analyzing the one-diode rectifier



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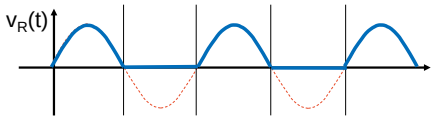
Half-rectified sine wave



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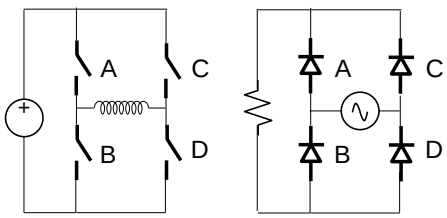
Duality of inverters and rectifiers



Full-bridge inverter

Full-bridge rectifier

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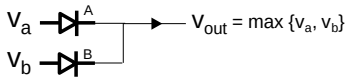
An important lemma



Proof. Assume $v_a > v_b$. Want to show $v_{out} = v_a$

- Since current > 0, at least one switch must be closed.
- If B is closed, A is open, then $v_{out} = v_b$. But $v_a > v_b$, so A closes.
- If A, B both closed, then current wants to flow a → b. This closes B.
- If A is closed, B is open, then $v_{out} = v_a$ as desired. □

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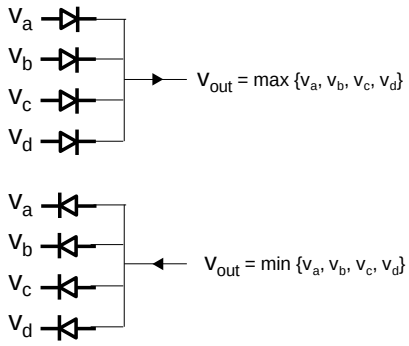
An important lemma



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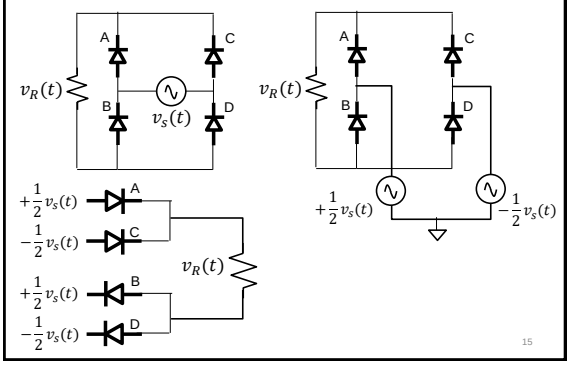
Mechanism of a full-bridge recifier



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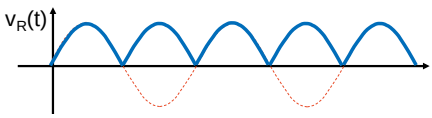
Fully-rectified sine wave



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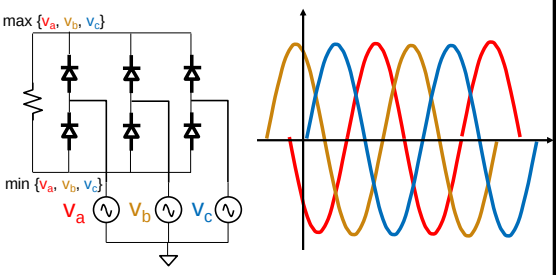
Sketch of the six pulse rectifier



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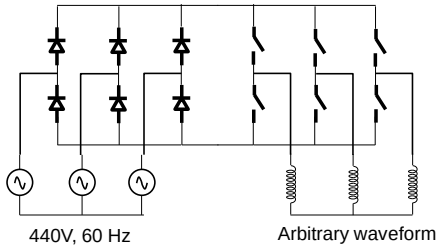
Summary – Power Electronics



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