Secondary Rectifier For Buck-Derived Converters

Presented by

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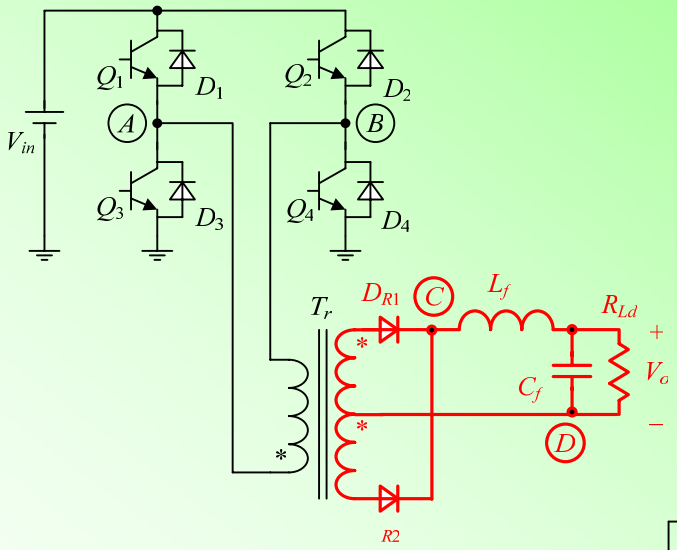
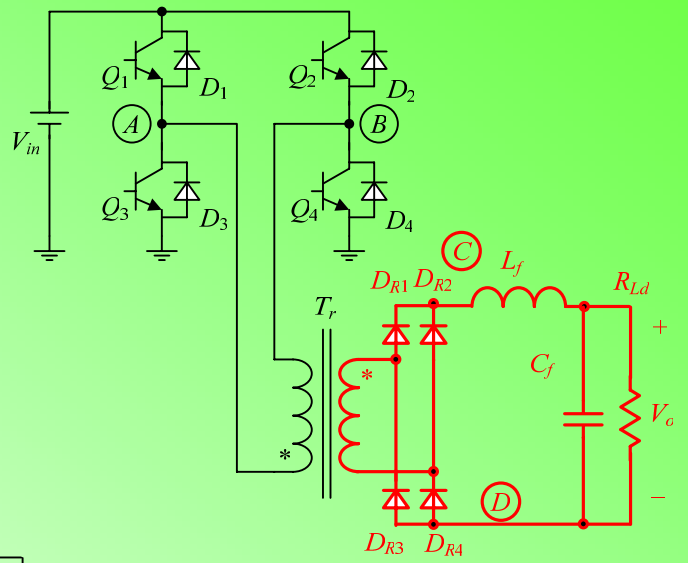
Nanjing University of Aeronautics & Astronautics

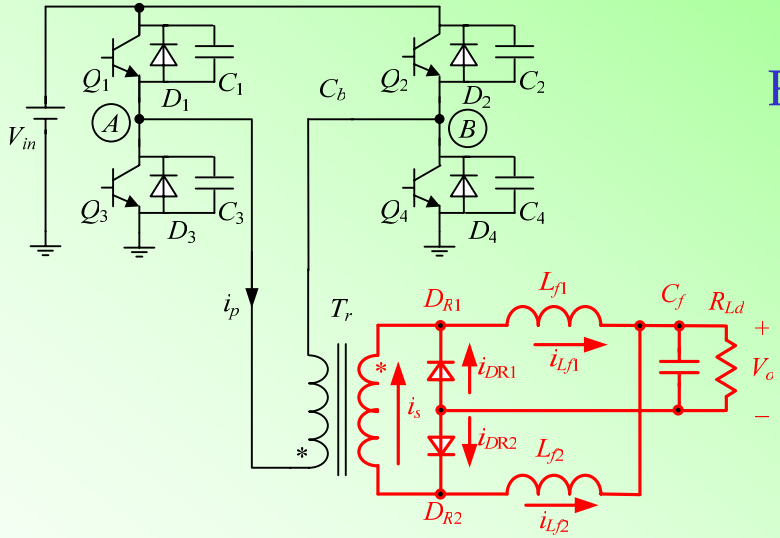
Full-wave, Full-Bridge and Current Doubler Rectifier



Full-Wave

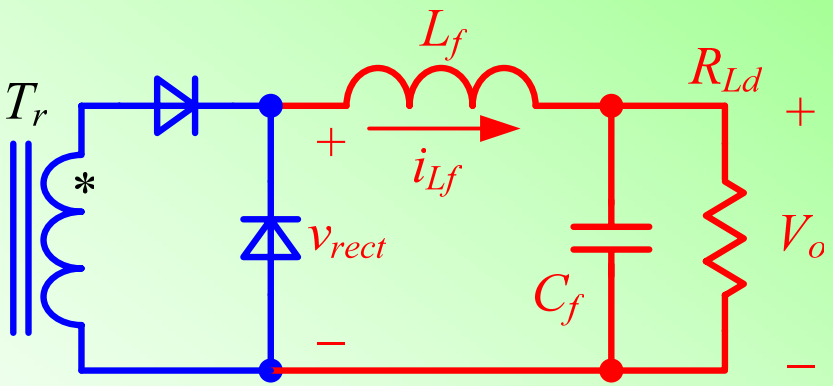


Full-Bridge

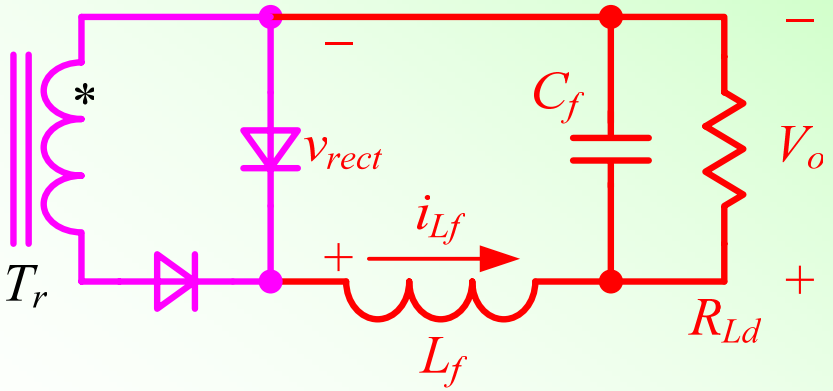


Current Doubler Rectifier

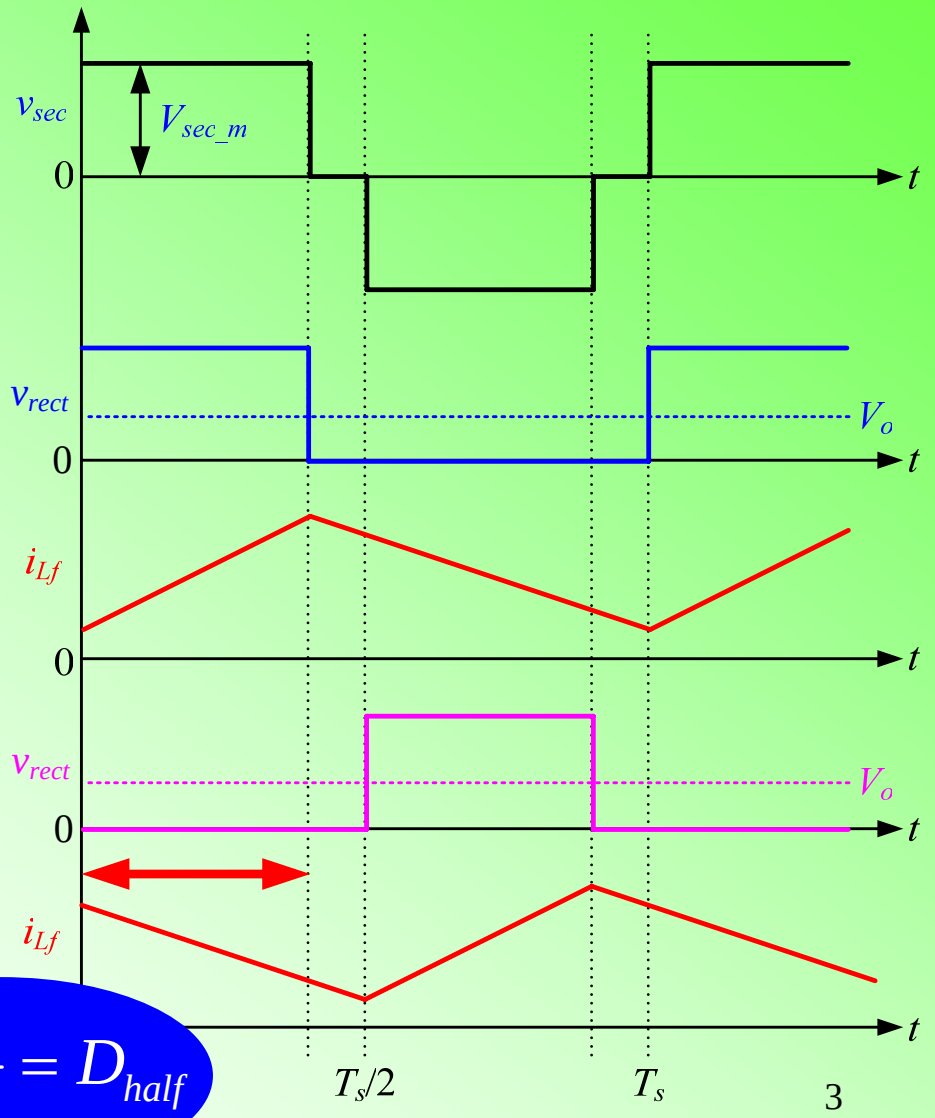
Half-Wave Rectifier



Positive cycle



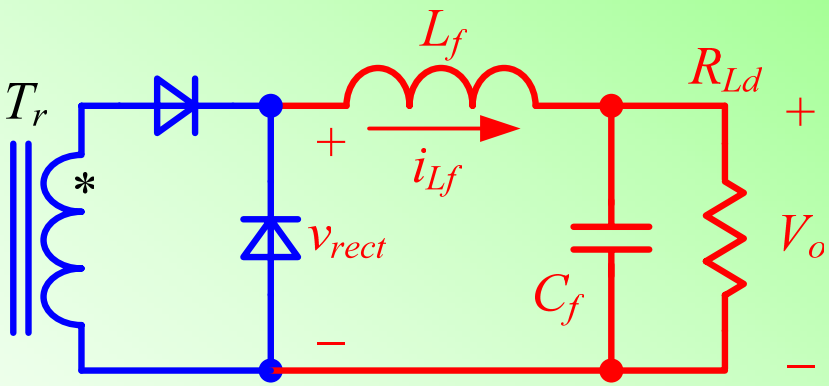
Negative cycle



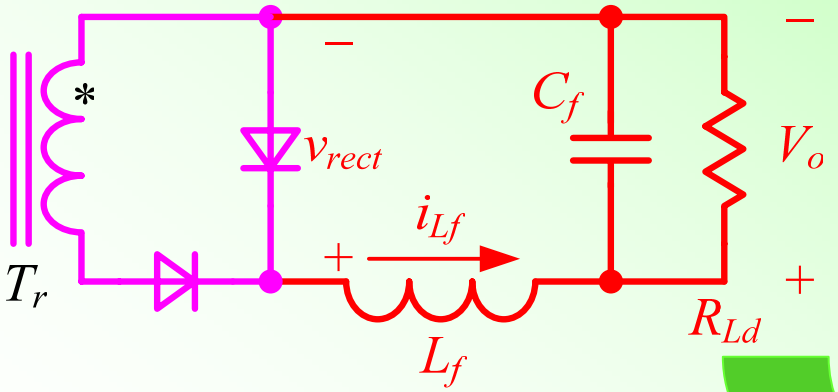
$$\frac{V_o}{V_{sec\_m}} = D_{half}$$

Derivation of Full-Wave Rectifier

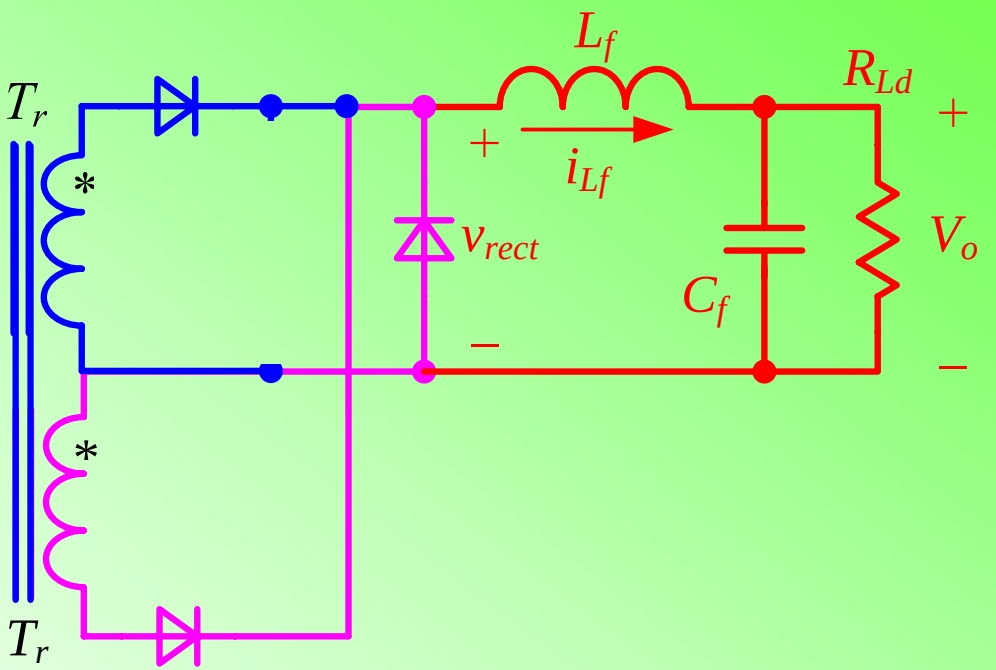
Two rectifiers with two coupled windings share the filter.



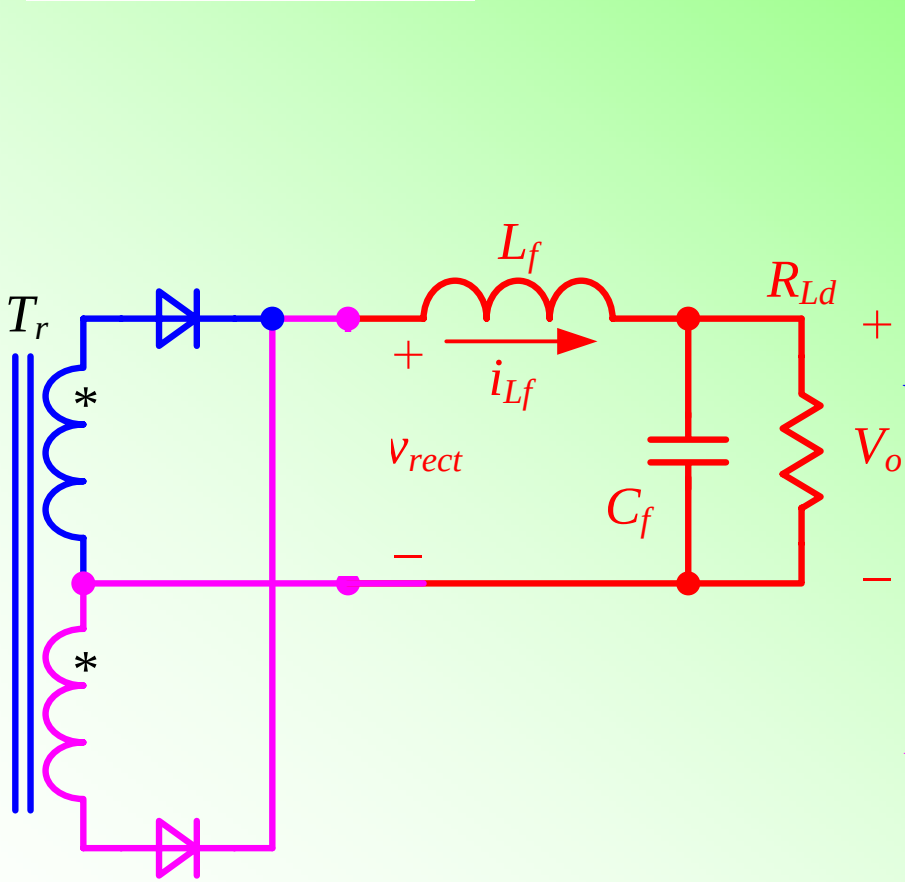
Positive cycle

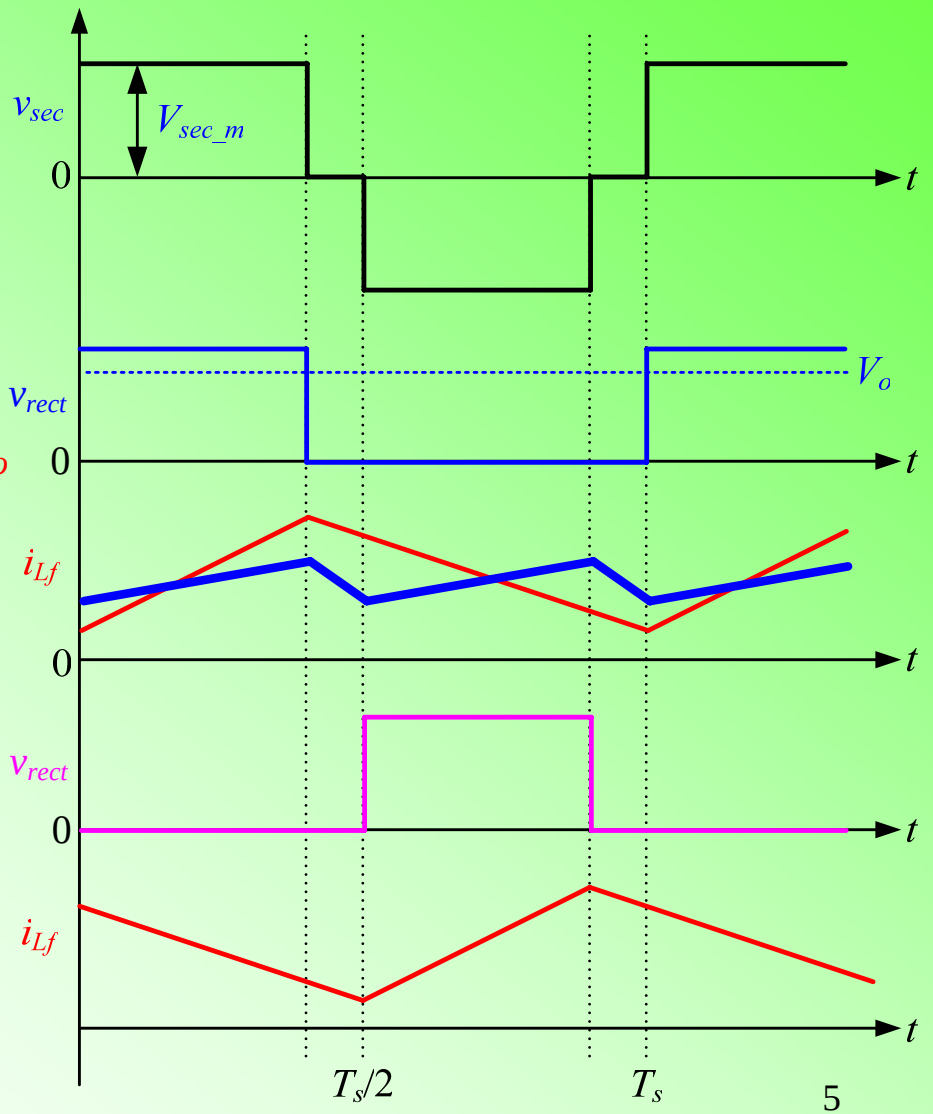


Negative cycle

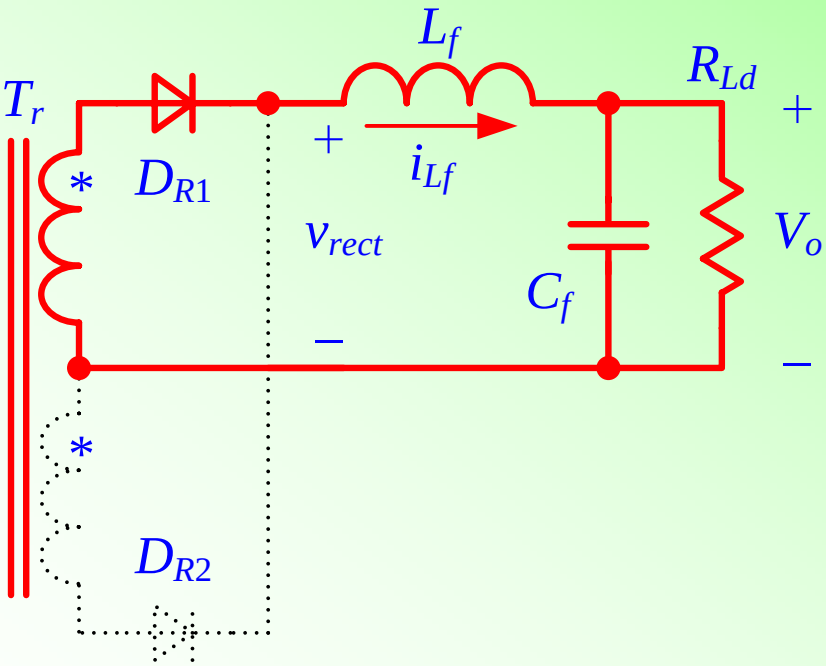


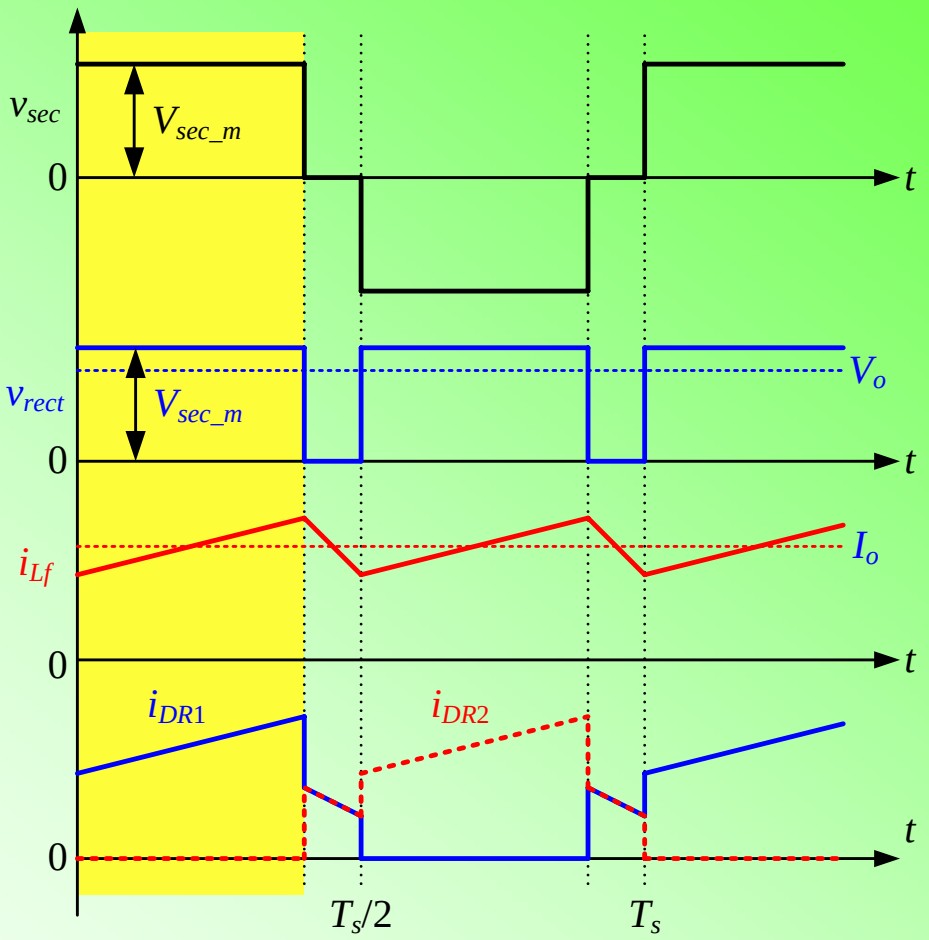
Derivation of Full-Wave Rectifier



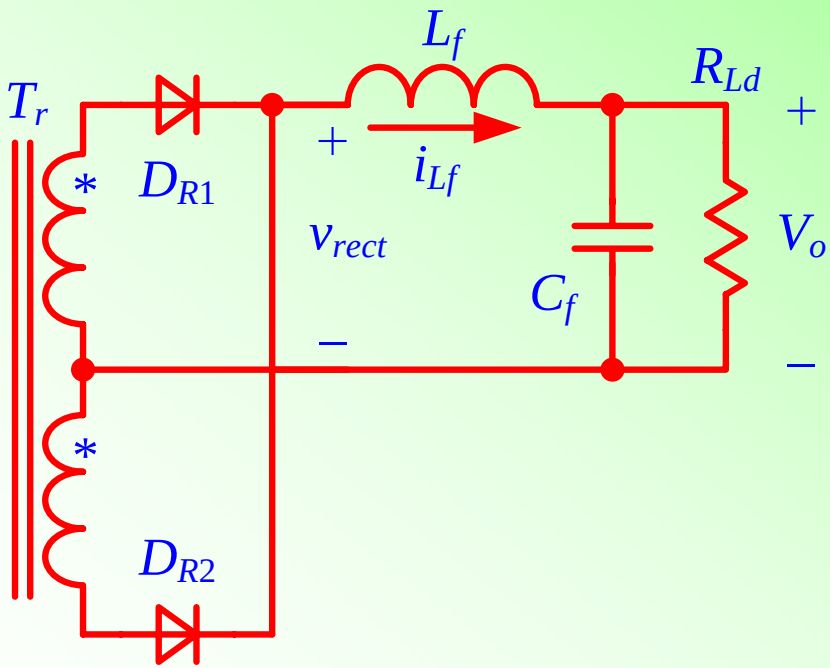


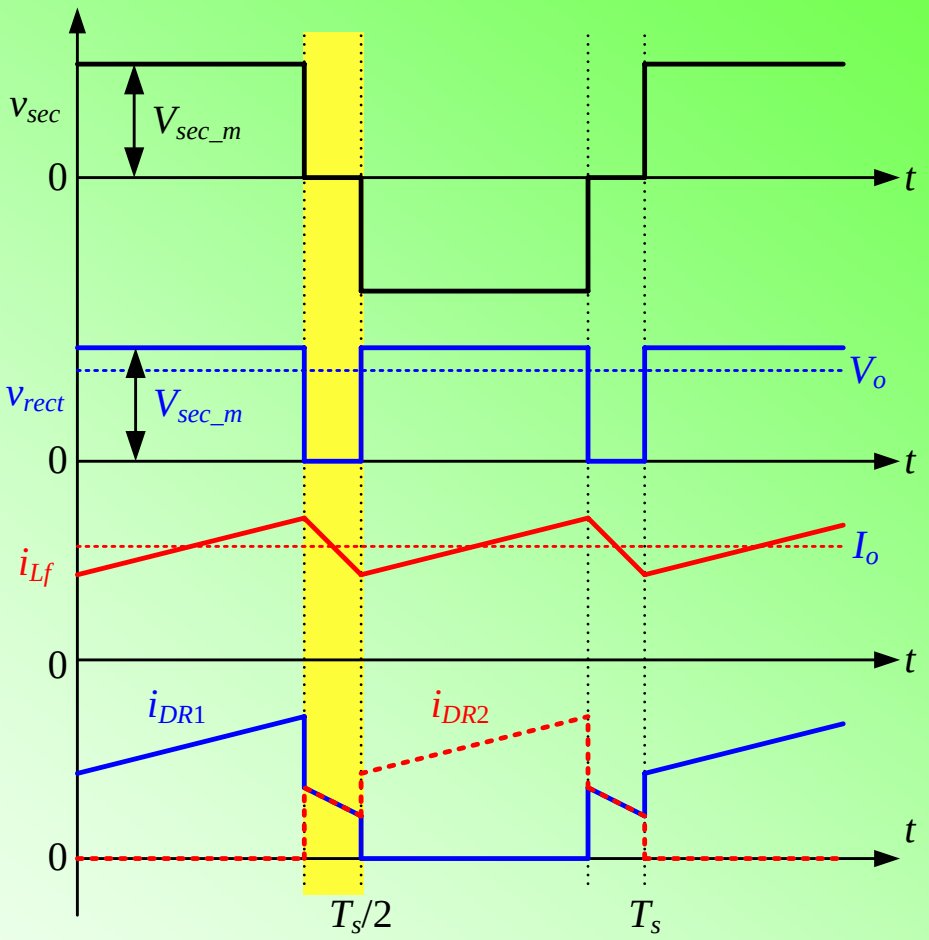
Operation Principle of Full-Wave Rectifier (1)



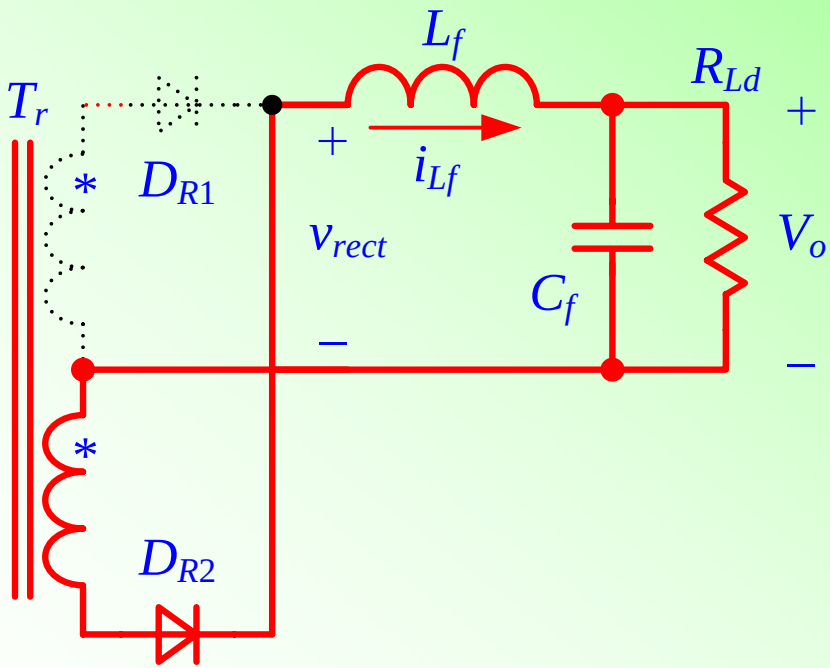


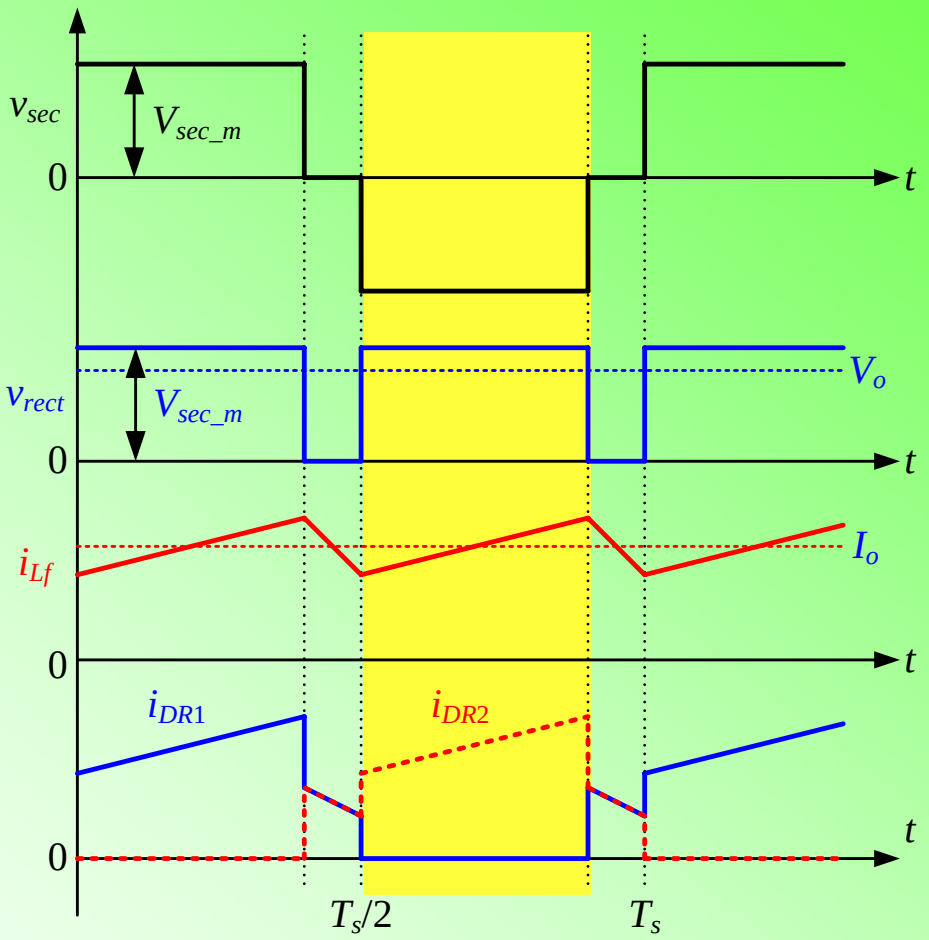
Operation Principle of Full-Wave Rectifier (2)



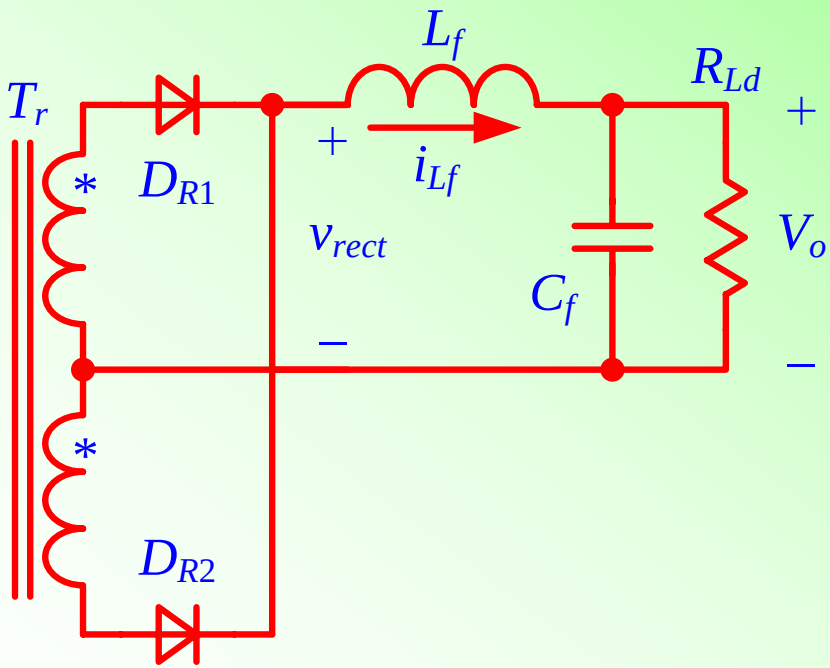


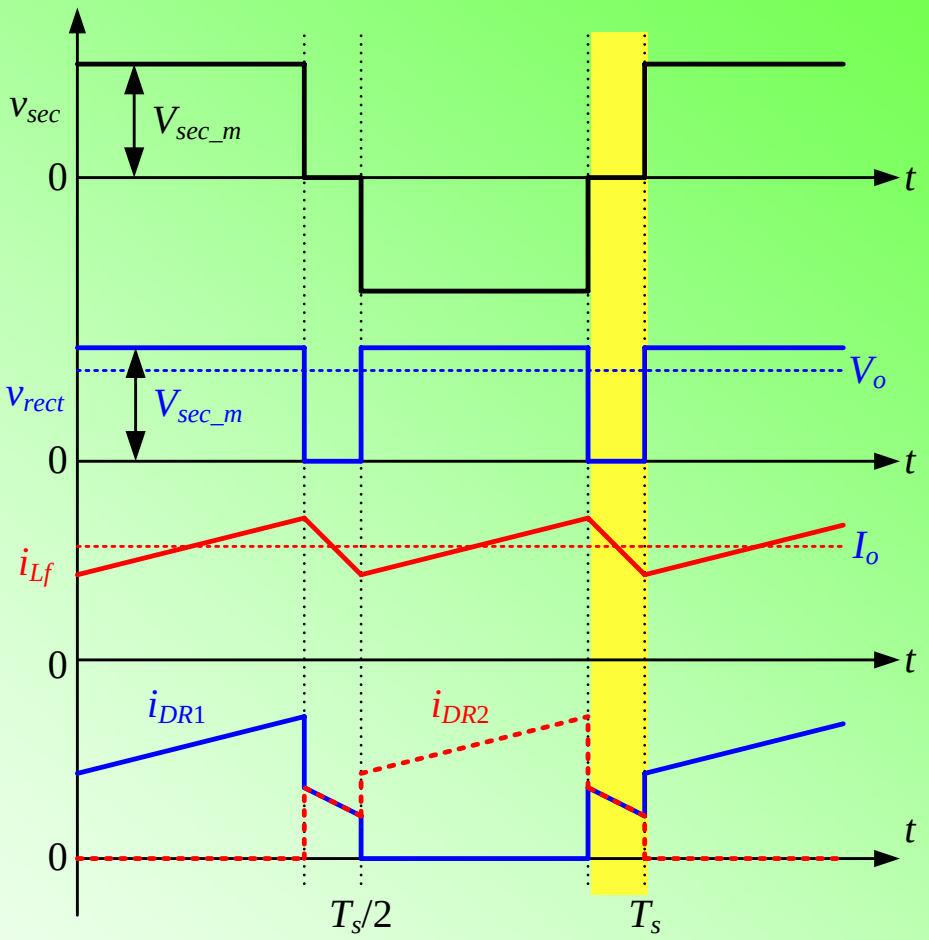
Operation Principle of Full-Wave Rectifier (3)





Operation Principle of Full-Wave Rectifier (4)





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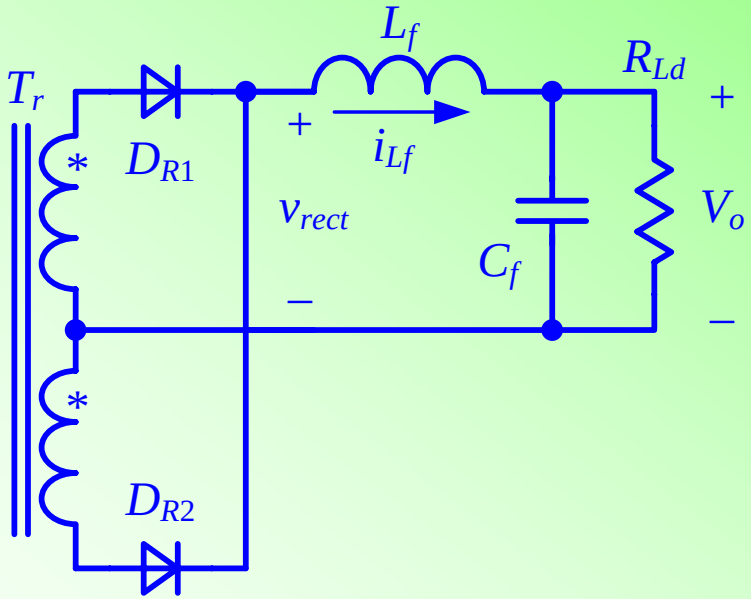
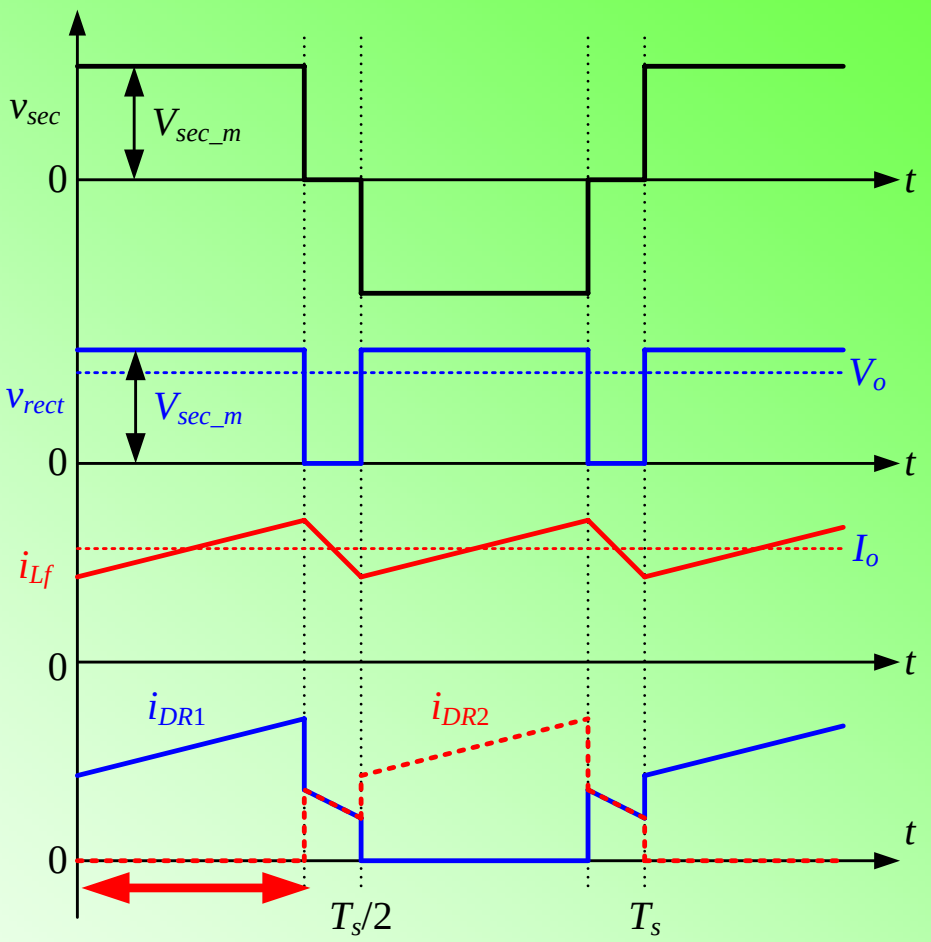
Relationships of Full-Wave Rectifier





$$\frac{V_o}{V_{\sec\_m}} = D_{eq} = 2D_{half}$$

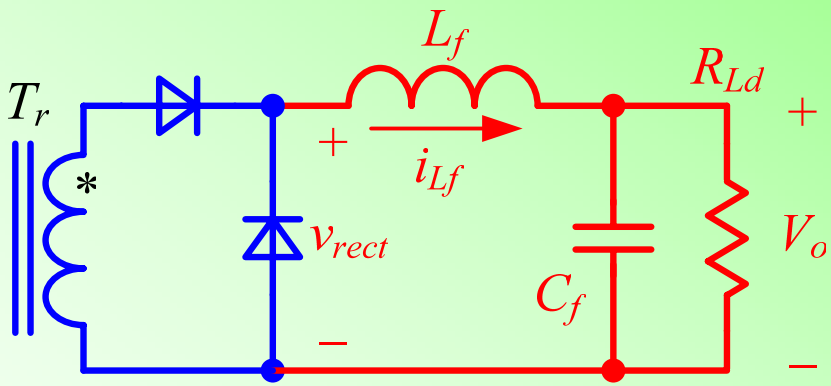
$$V_{DR1} = V_{DR2} = 2V_{\sec\_m}$$

$$I_{DR1} = I_{DR2} = \frac{1}{2} I_o$$

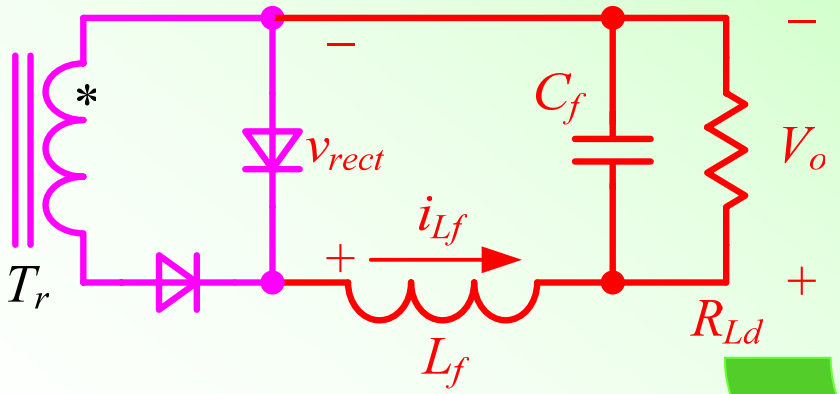
Inductor current can not flow in the negative direction.

Derivation of Full-Bridge Rectifier (1)

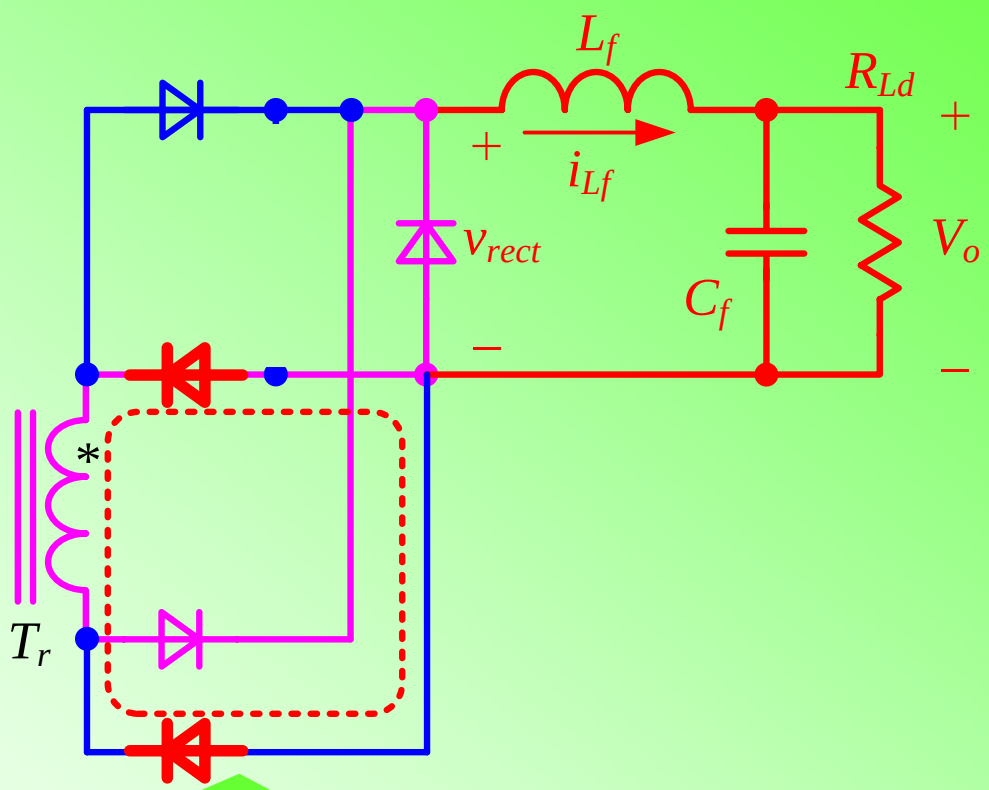
Two rectifiers share
both the winding and the filter.



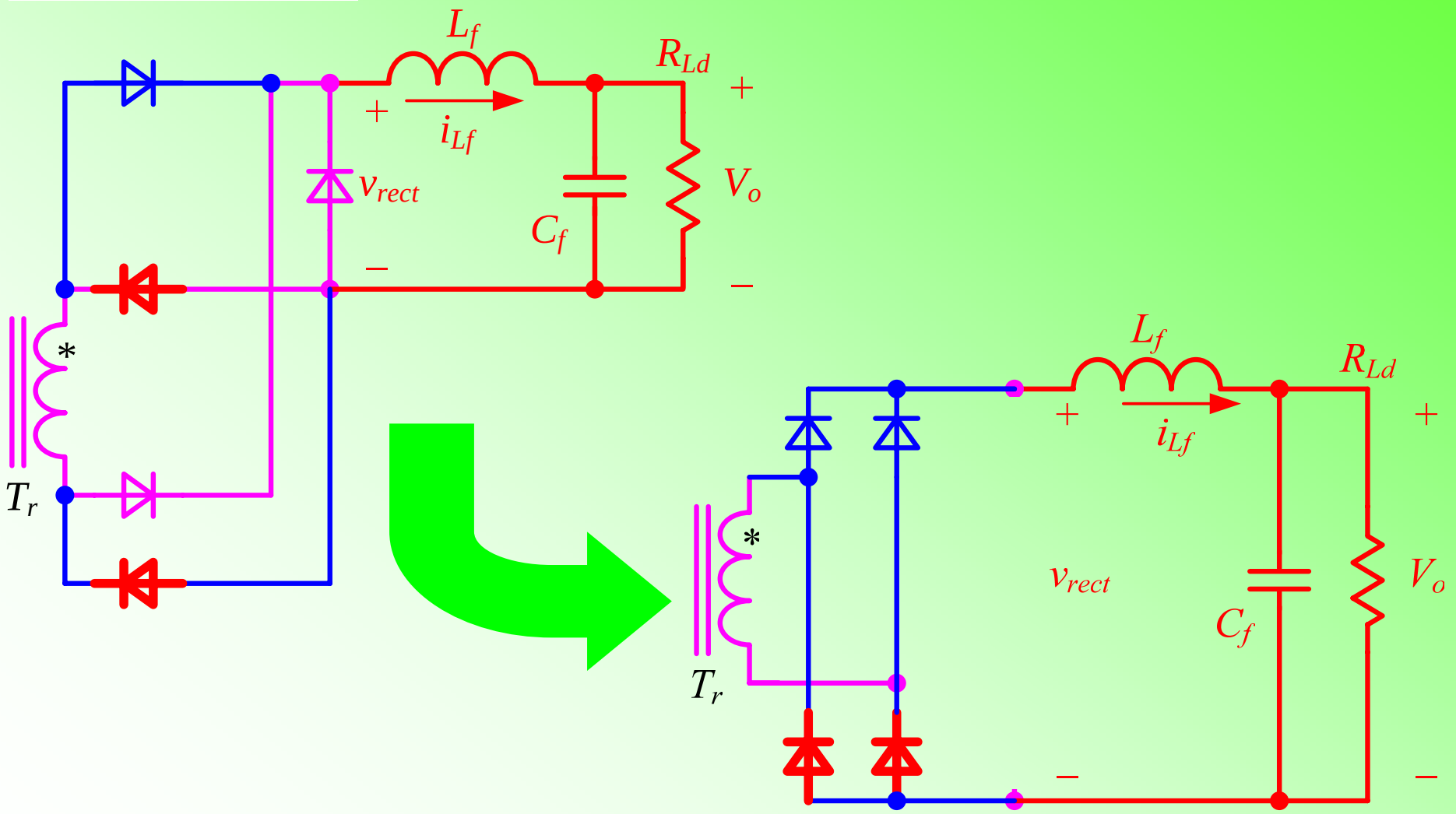
Positive cycle



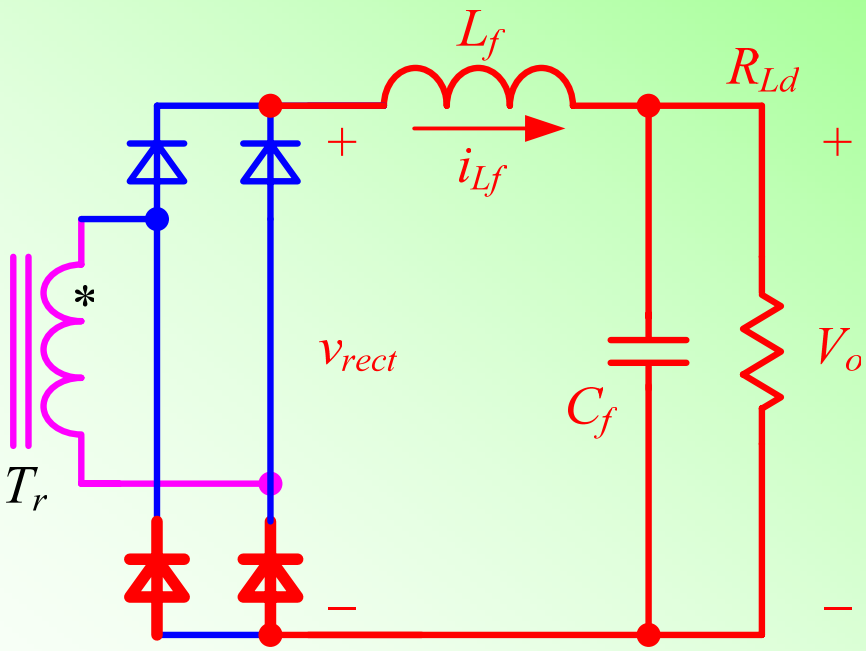
Negative cycle

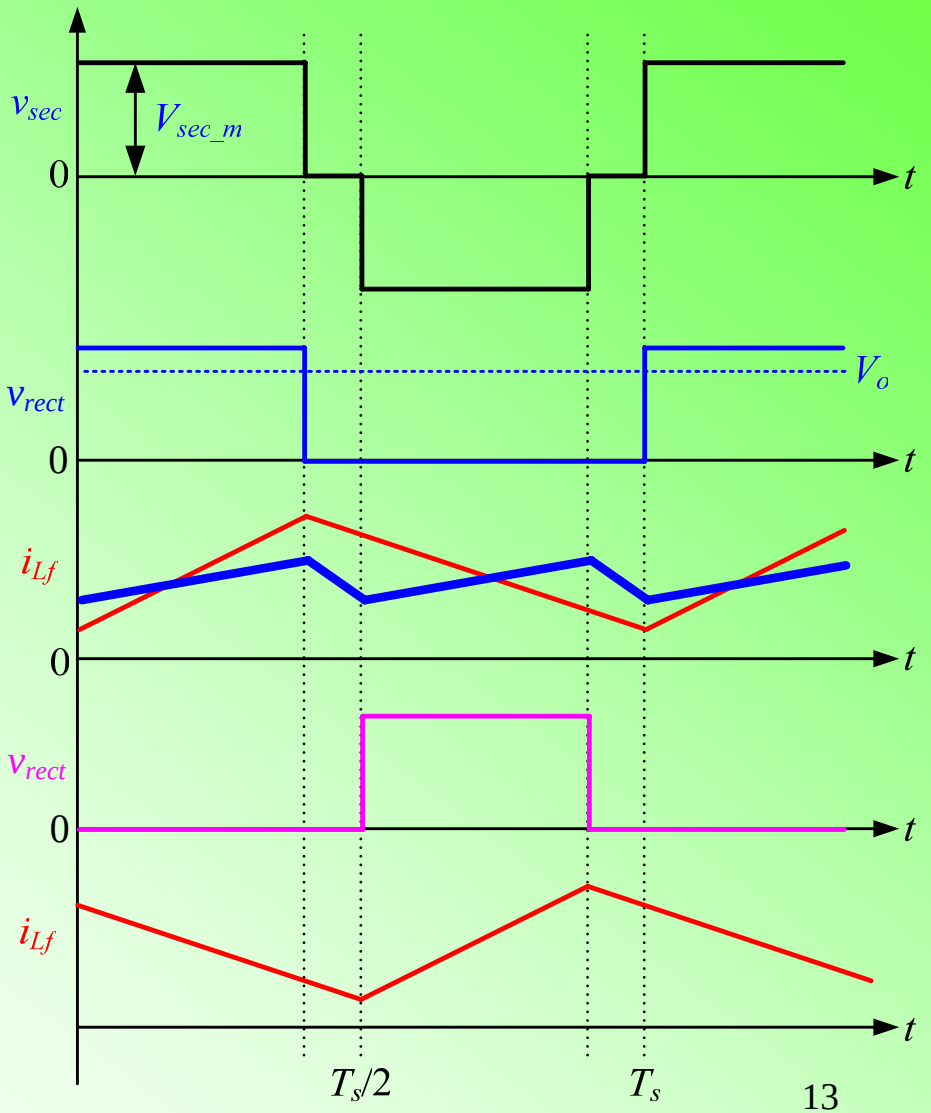


Derivation of Full-Bridge Rectifier (2)

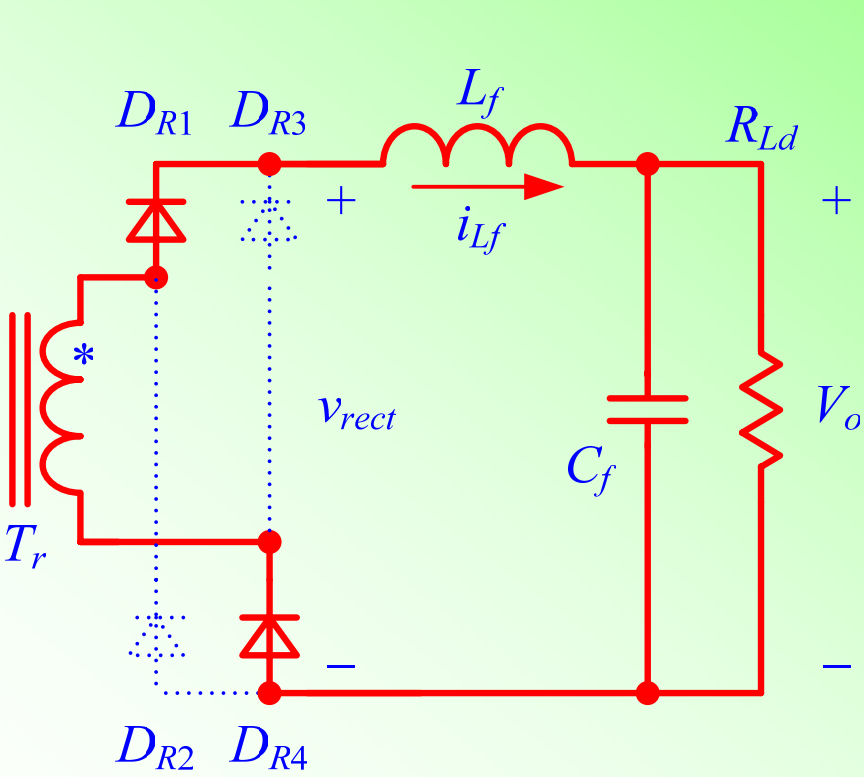


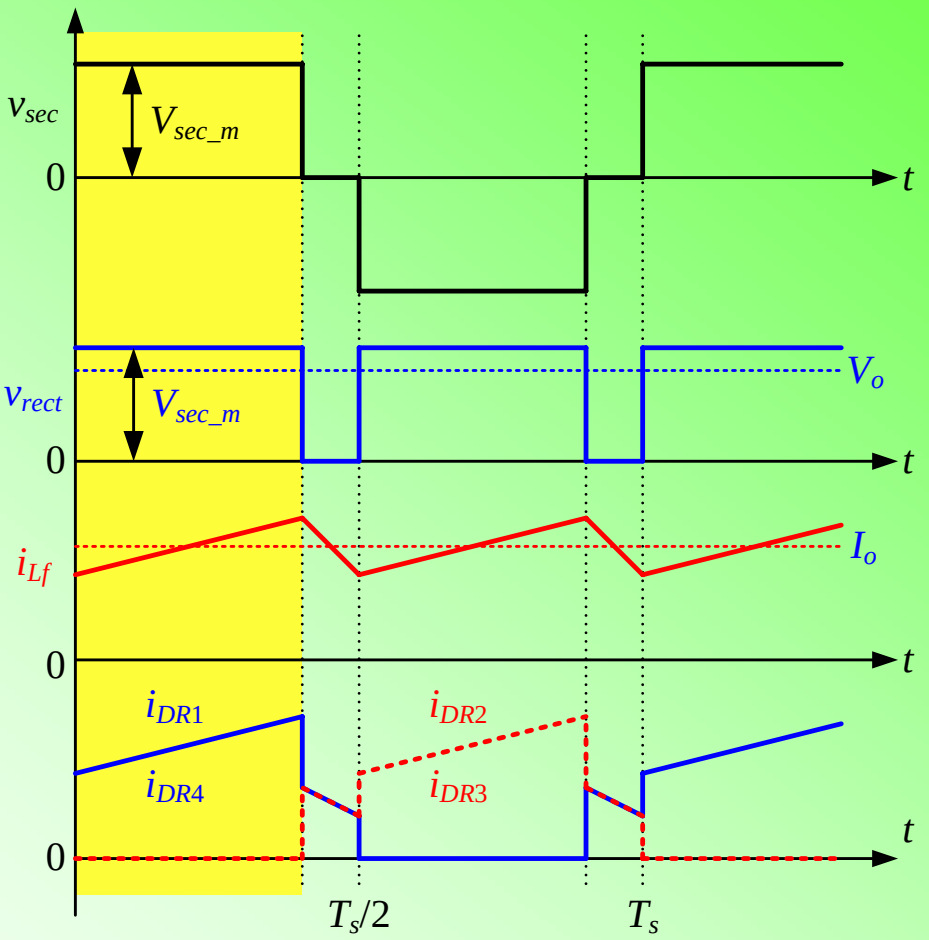
Derivation of Full-Bridge Rectifier (2)



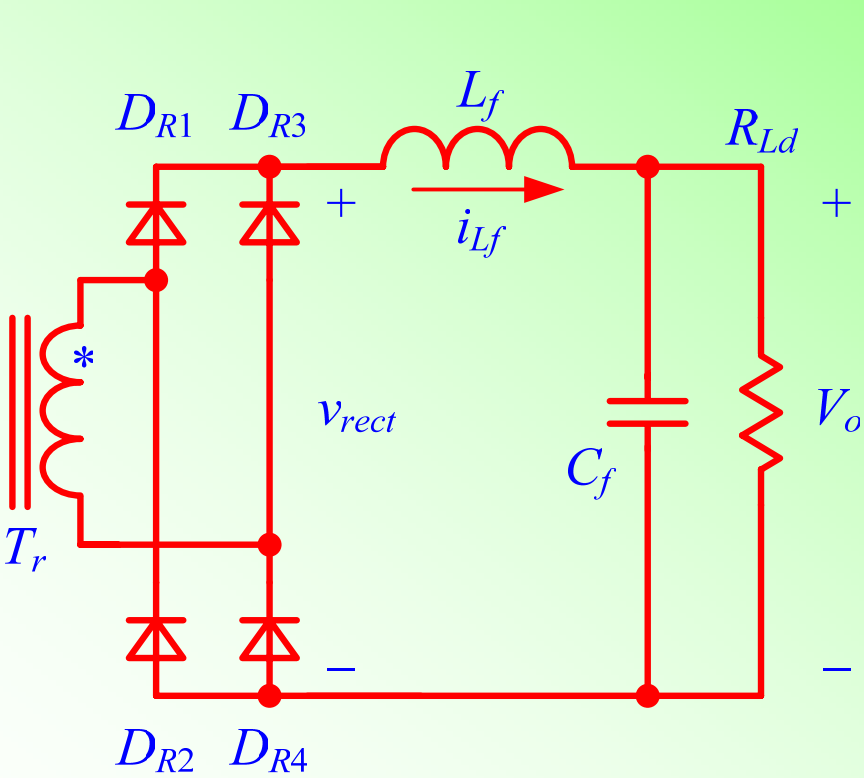


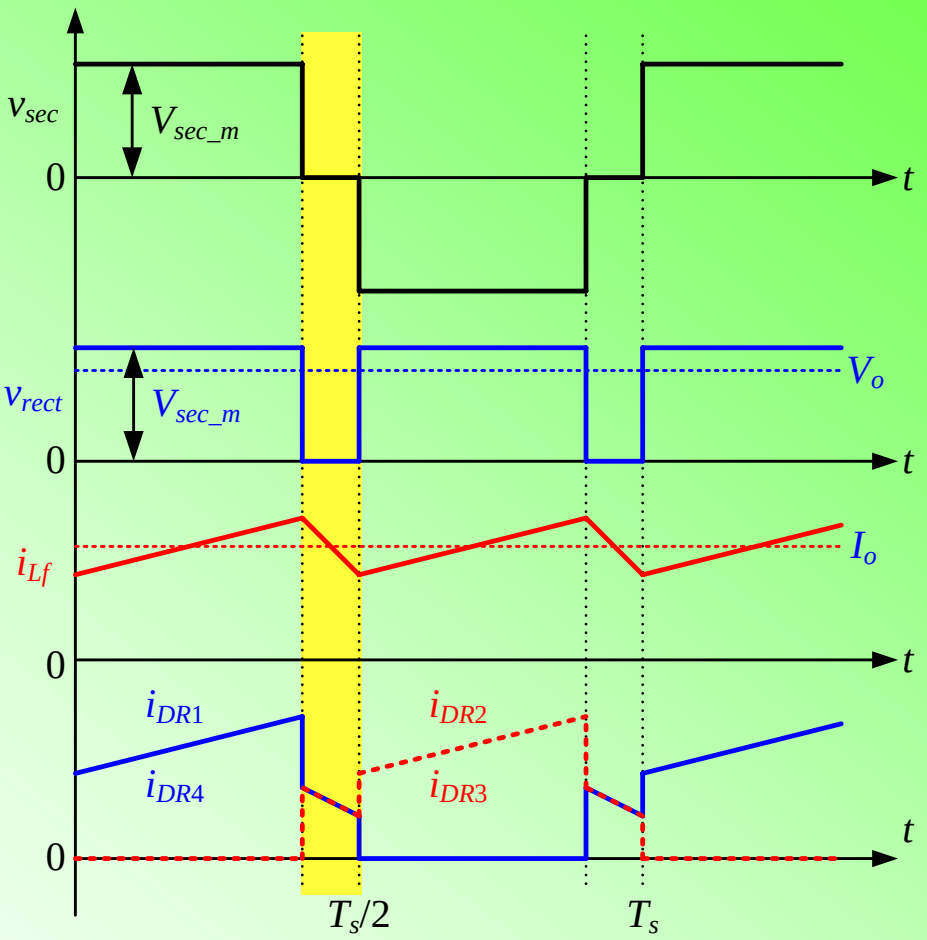
Operation Principle of Full-Bridge Rectifier (1)



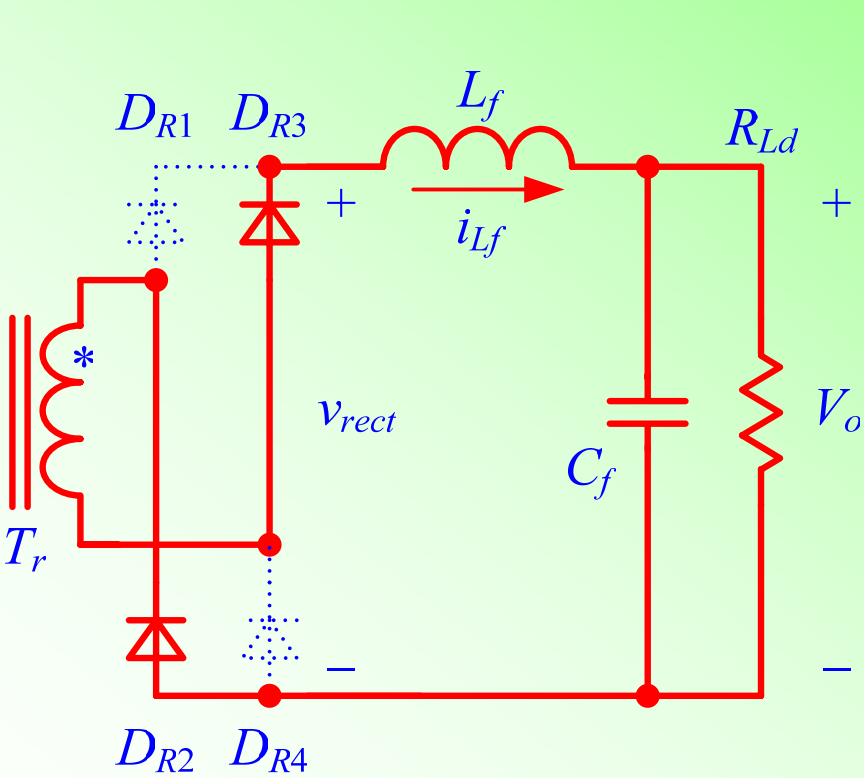


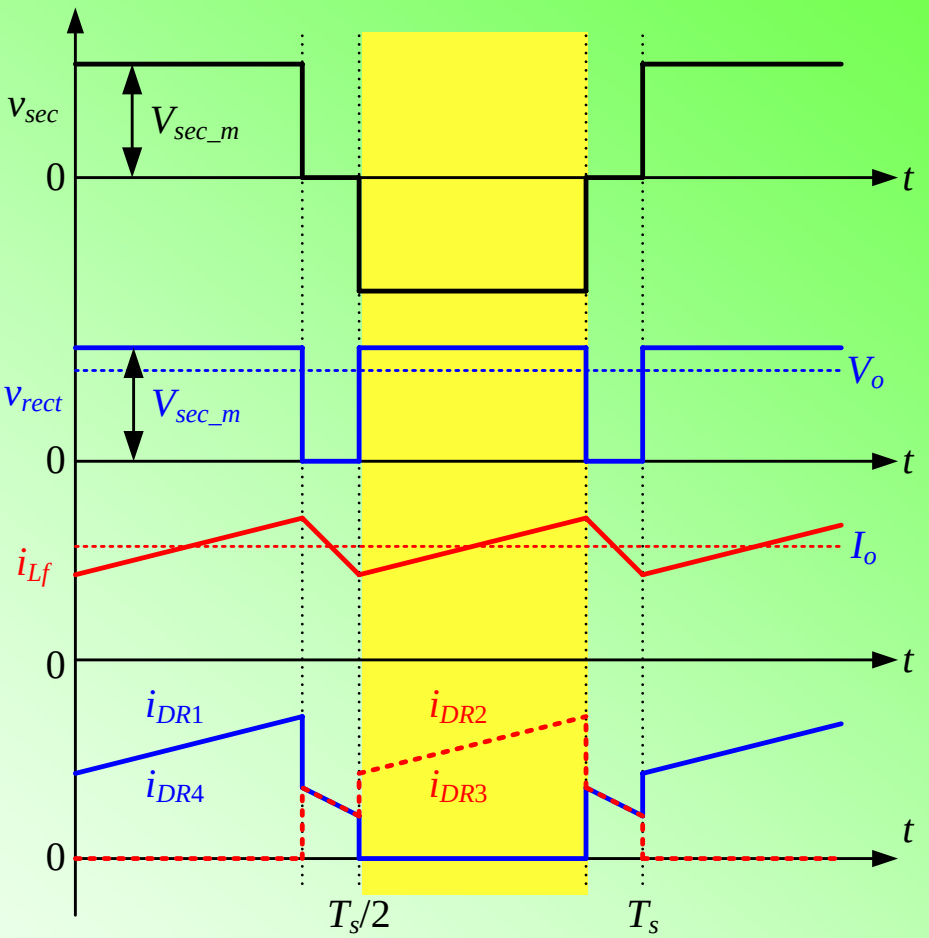
Operation Principle of Full-Bridge Rectifier (2)



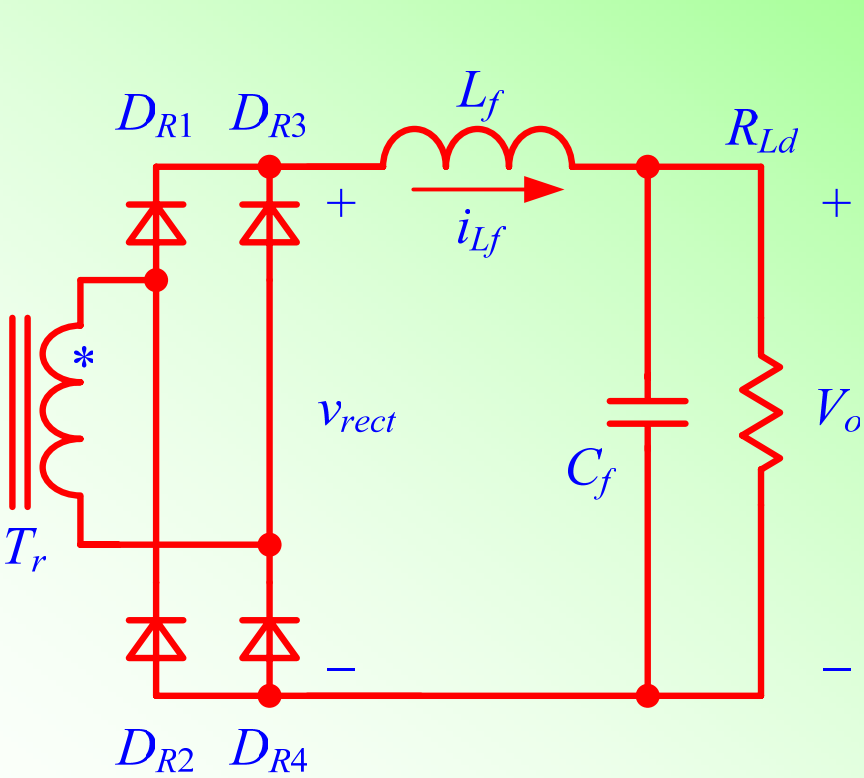


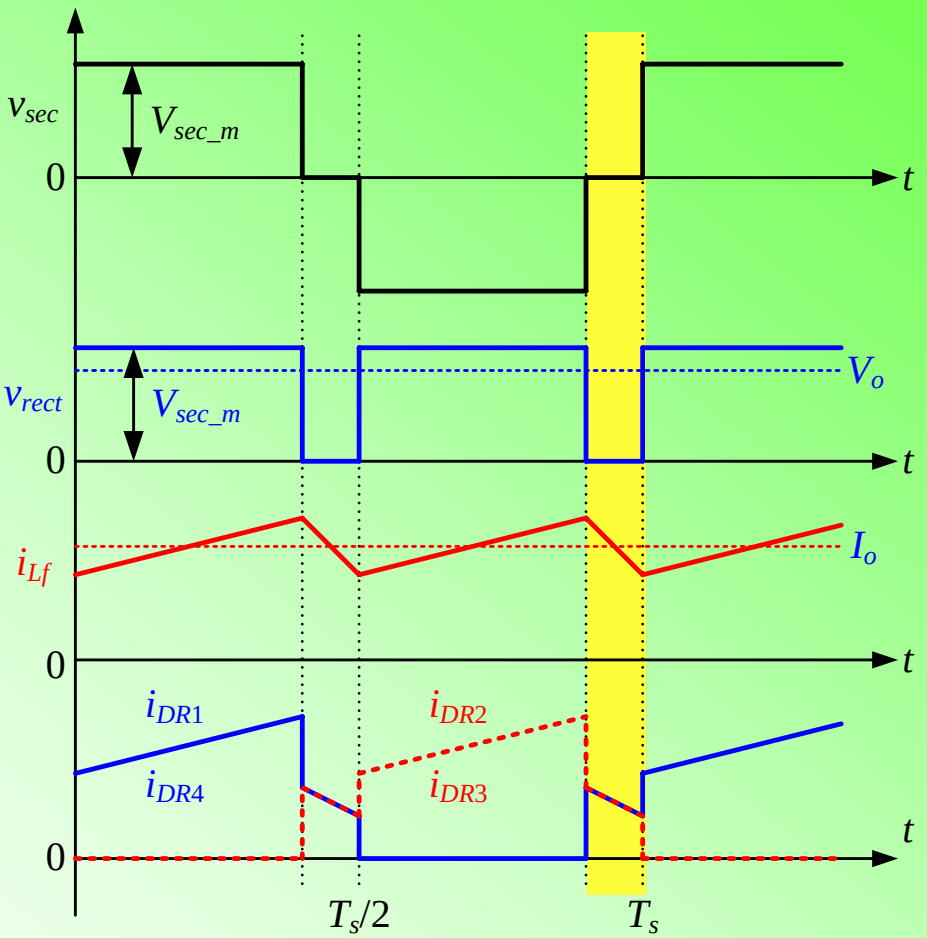
Operation Principle of Full-Bridge Rectifier (3)





Operation Principle of Full-Bridge Rectifier (4)





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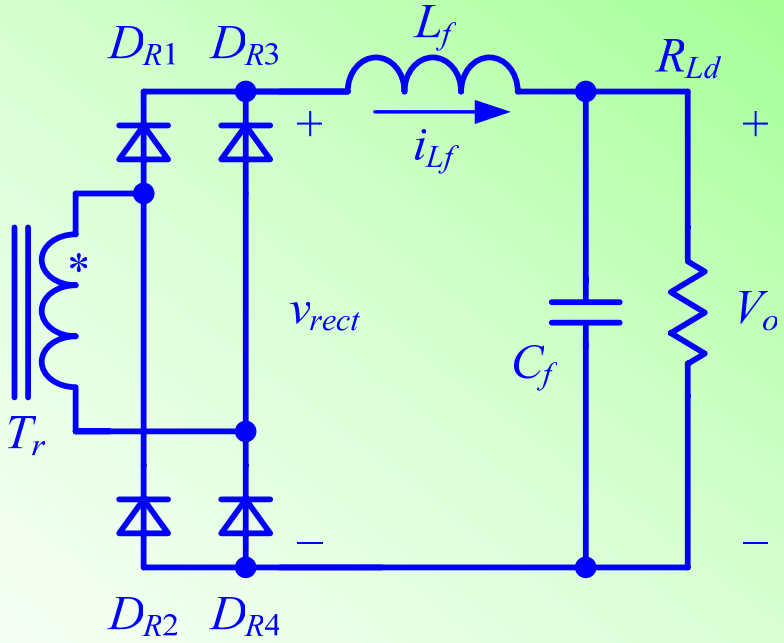
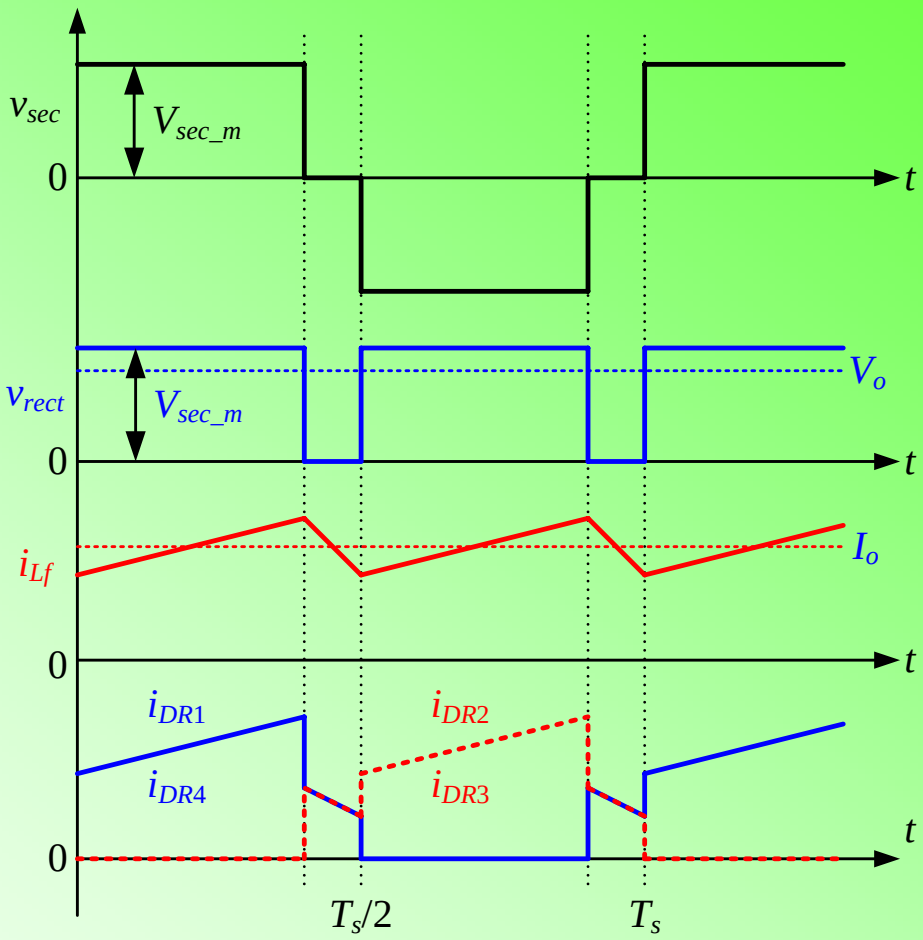
Relationships of Full-Bridge Rectifier





$$\frac{V_o}{V_{sec\_m}} = D_{eq} = 2D_{half}$$

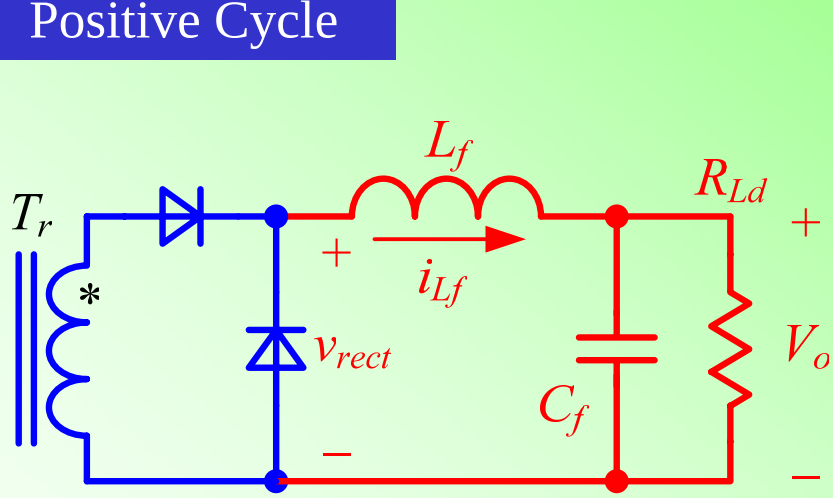
$$V_{DR1} = V_{DR2} = V_{sec\_m}$$

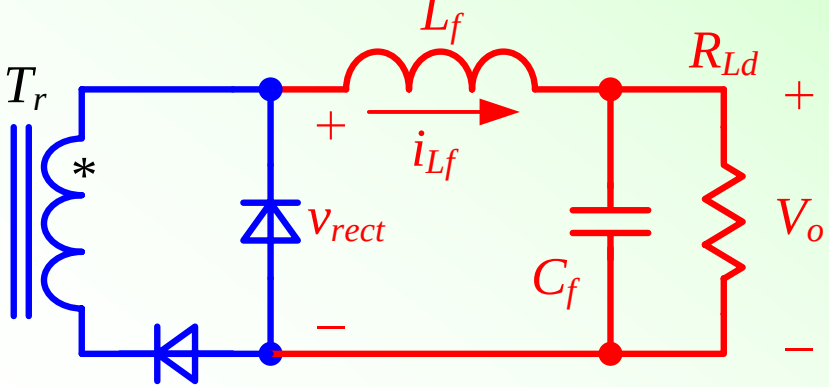
$$I_{DR1} = I_{DR2} = \frac{1}{2} I_o$$

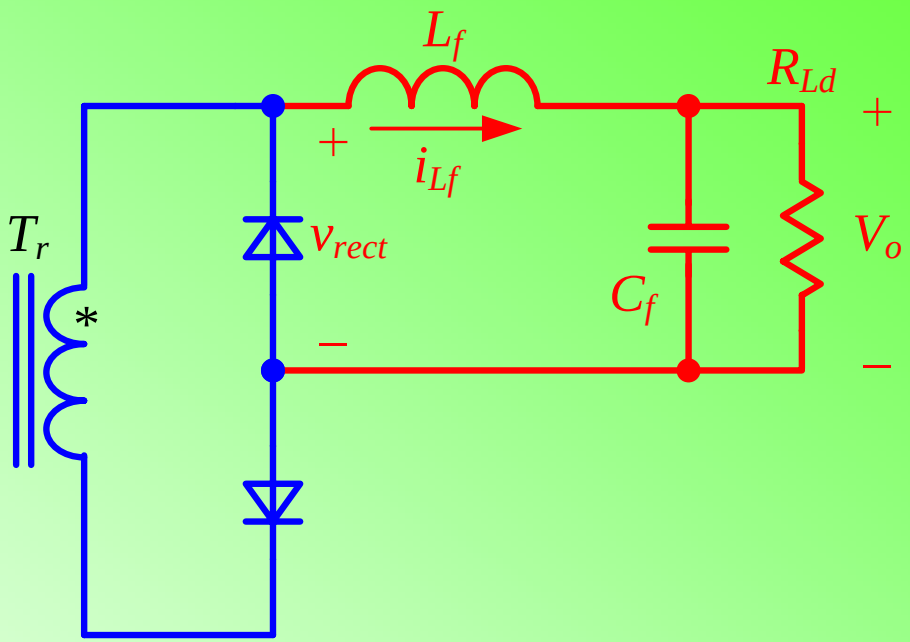
Inductor current can not flow in the negative direction.

Derivation of Current-Doubler Rectifier (1)

Positive Cycle

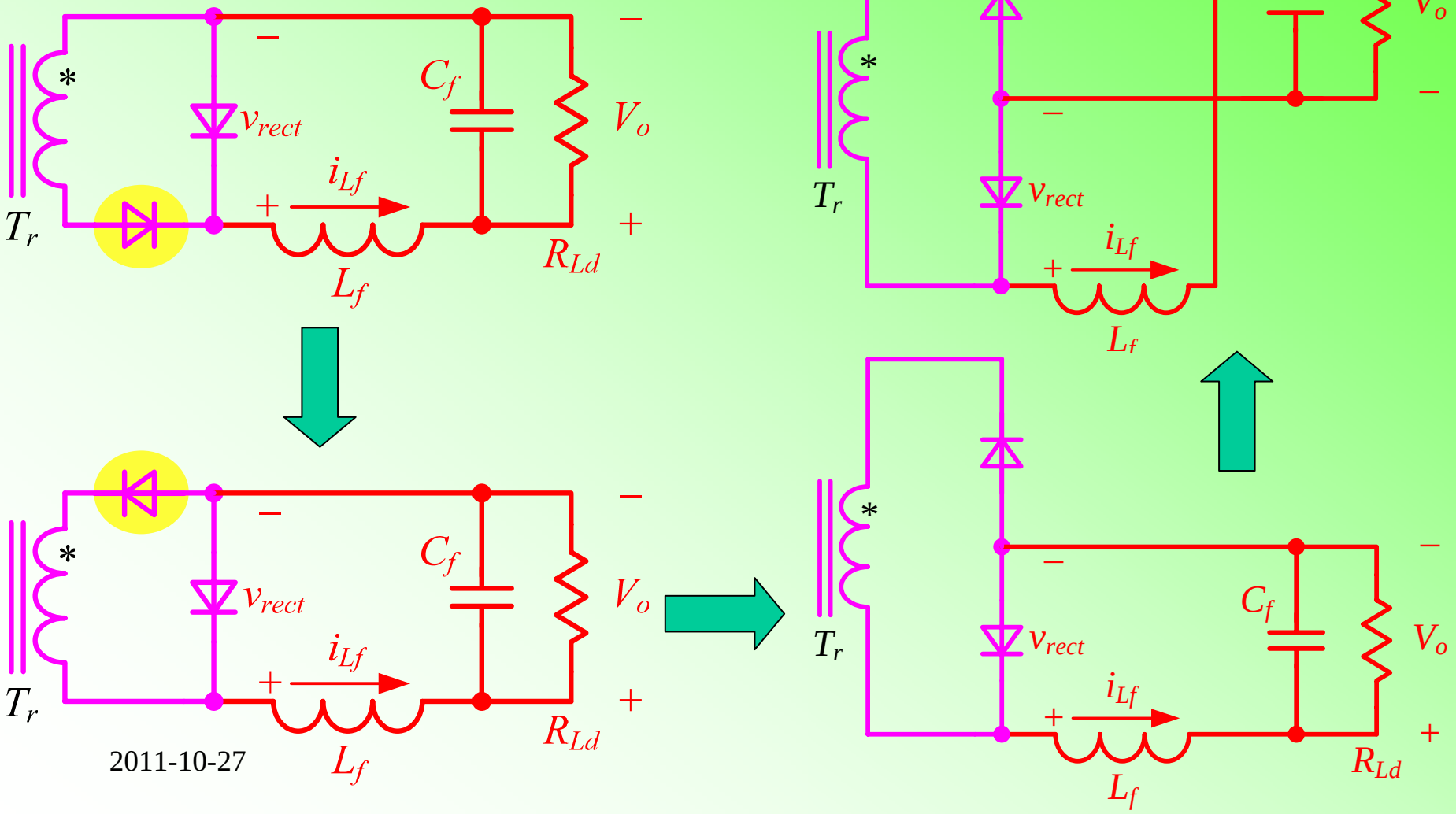






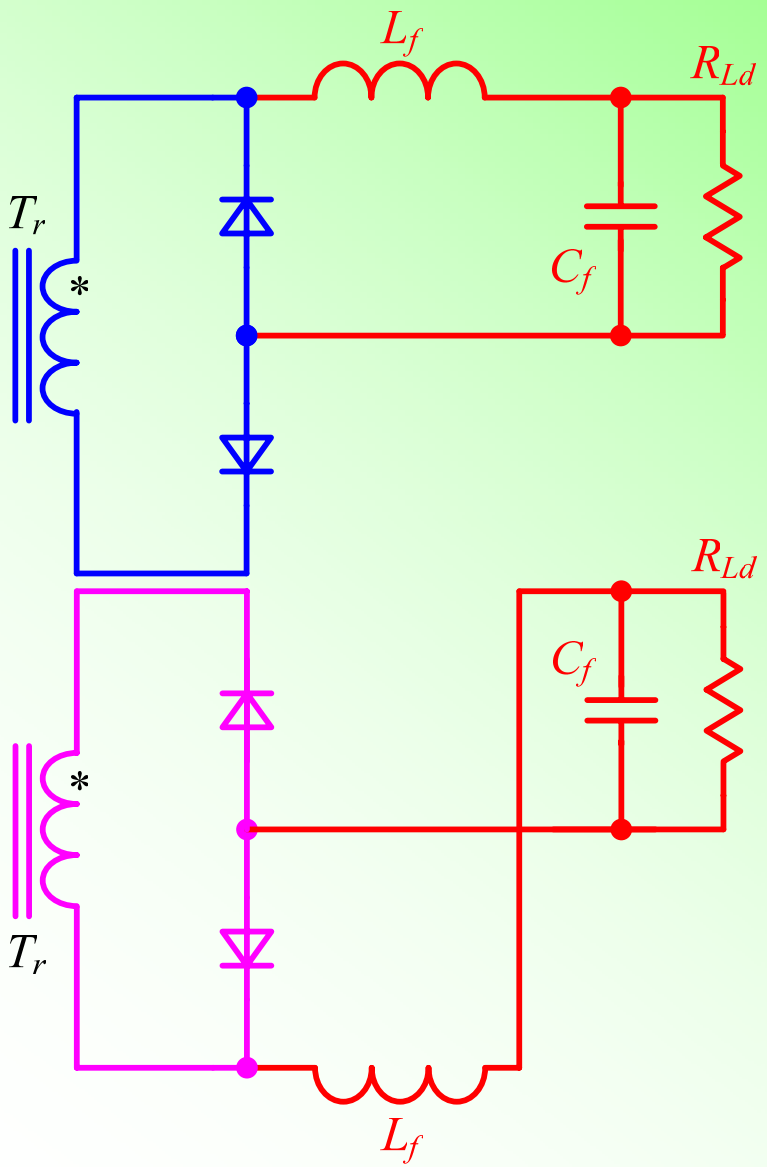
Derivation of Current-Doubler Rectifier (2)

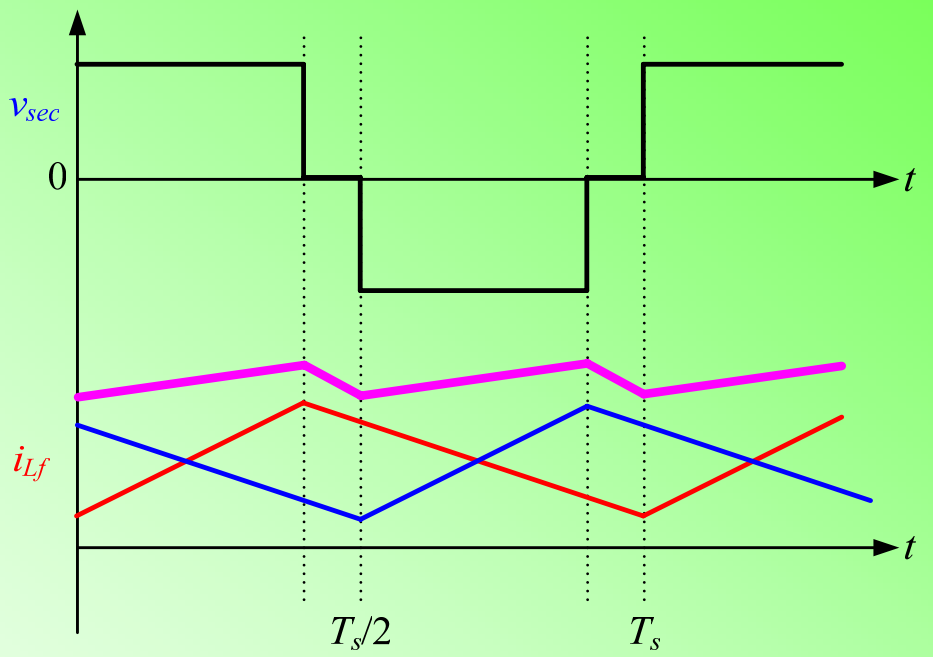
Negative Cycle



Derivation of Current-Doubler Rectifier (3)

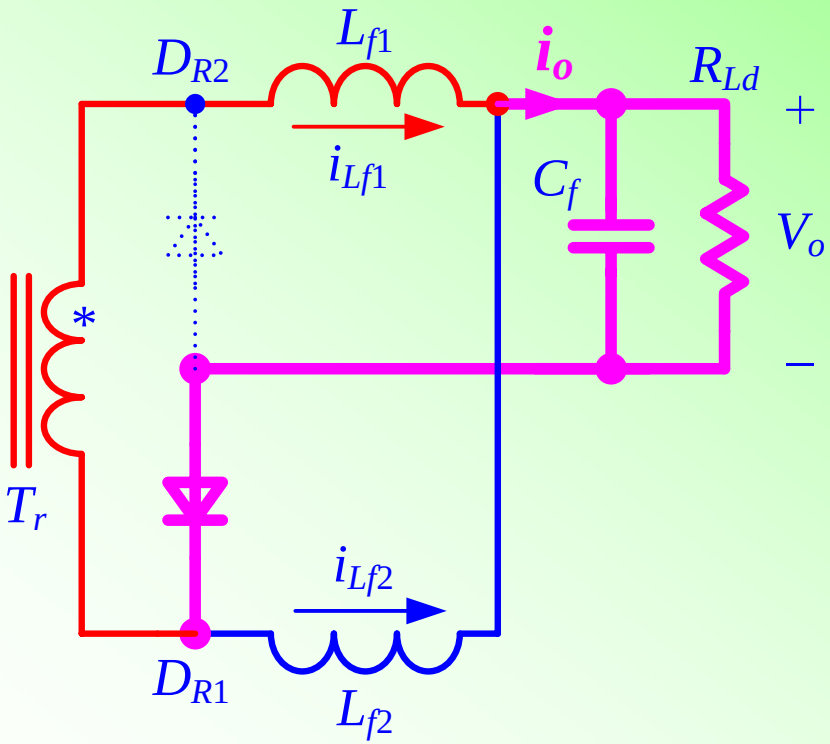
Two rectifiers share the winding and filter capacitor.

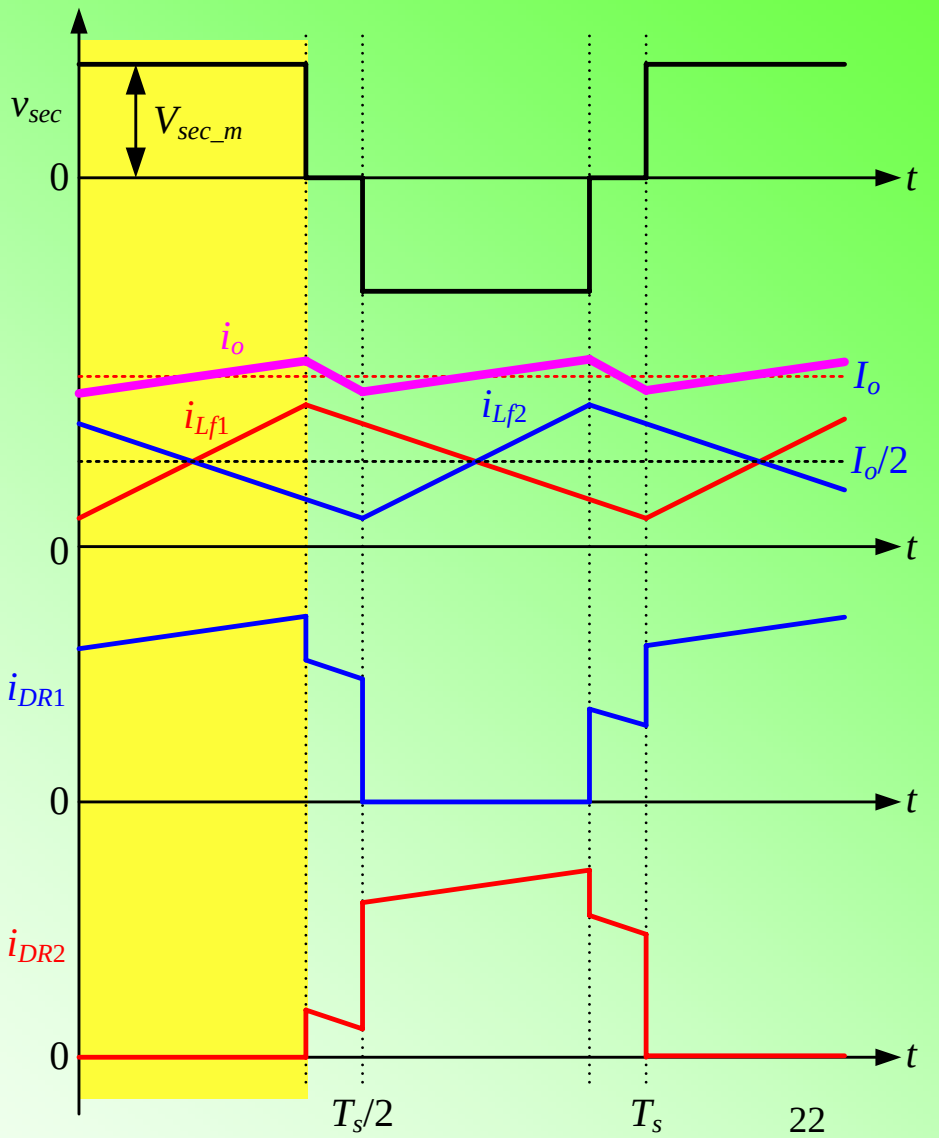




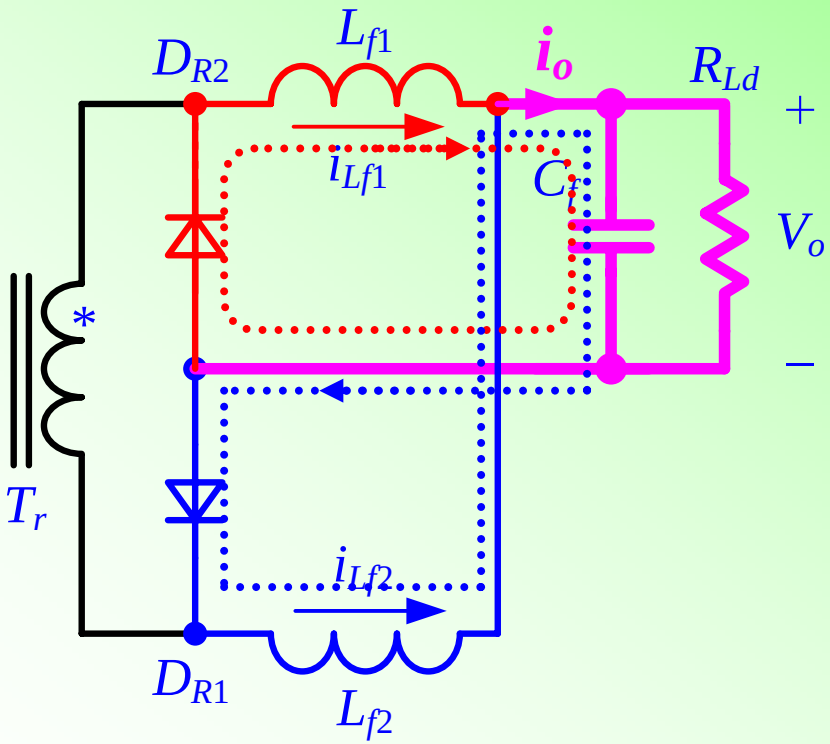
$$\frac{V_o}{V_{sec\_m}} = D_{half}$$

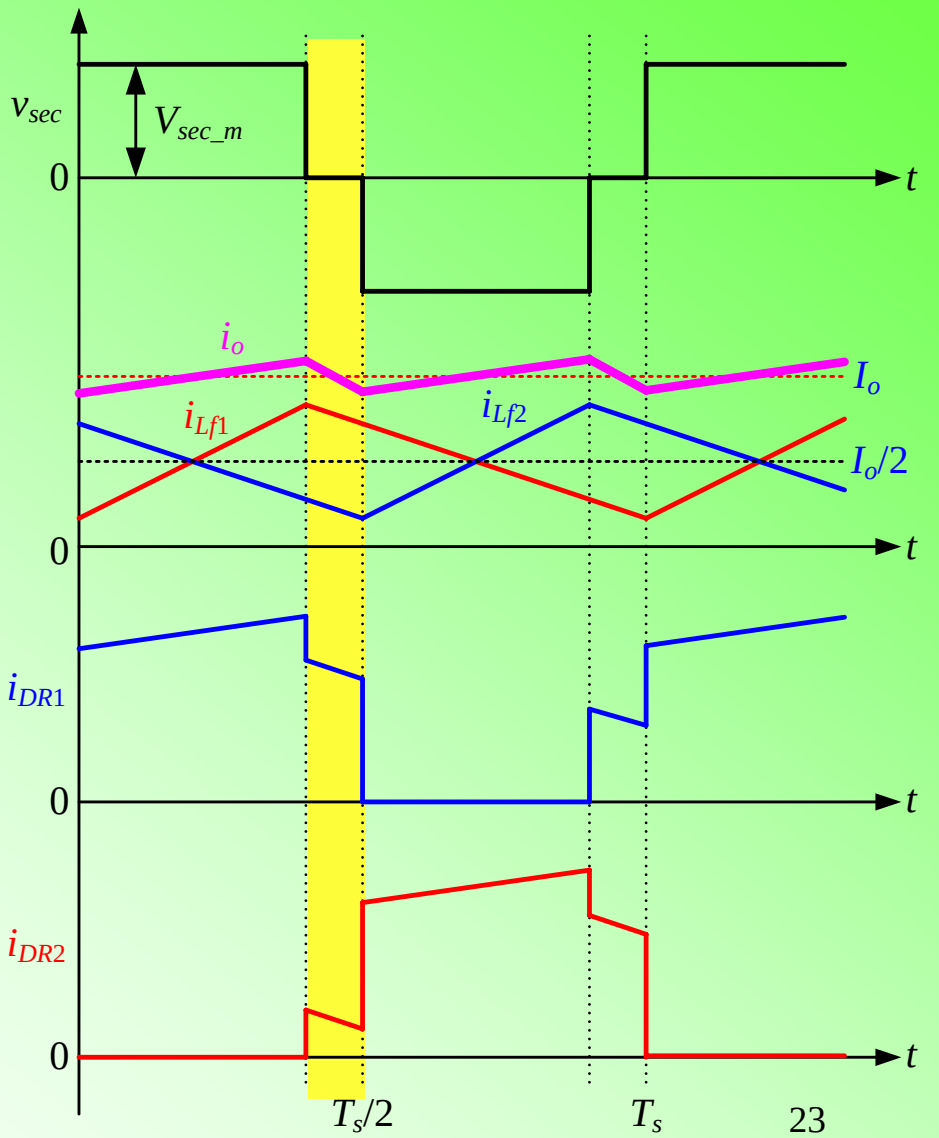
Operation Principle of Current-Doubler Rectifier (1)



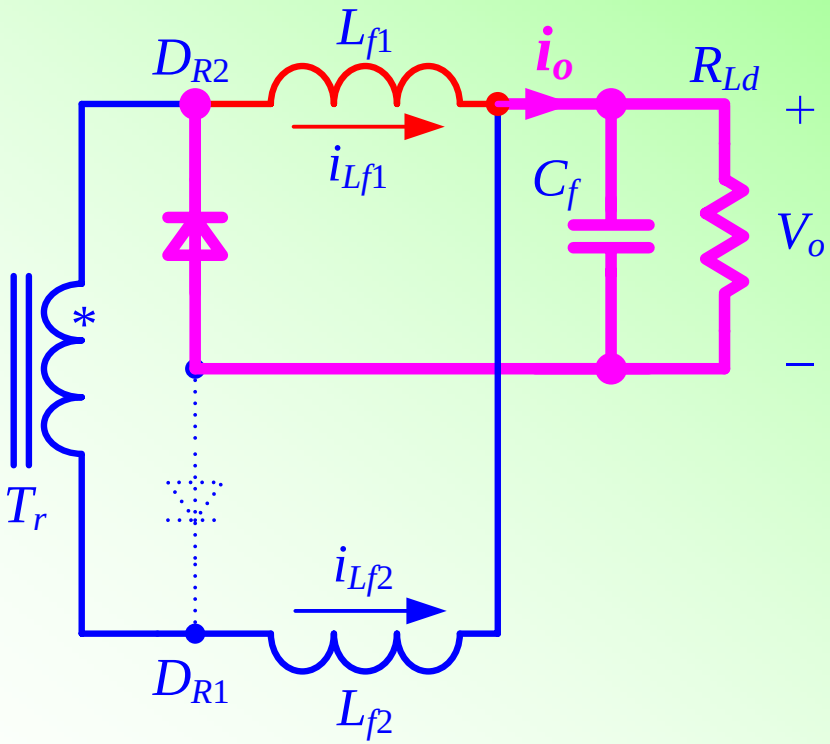


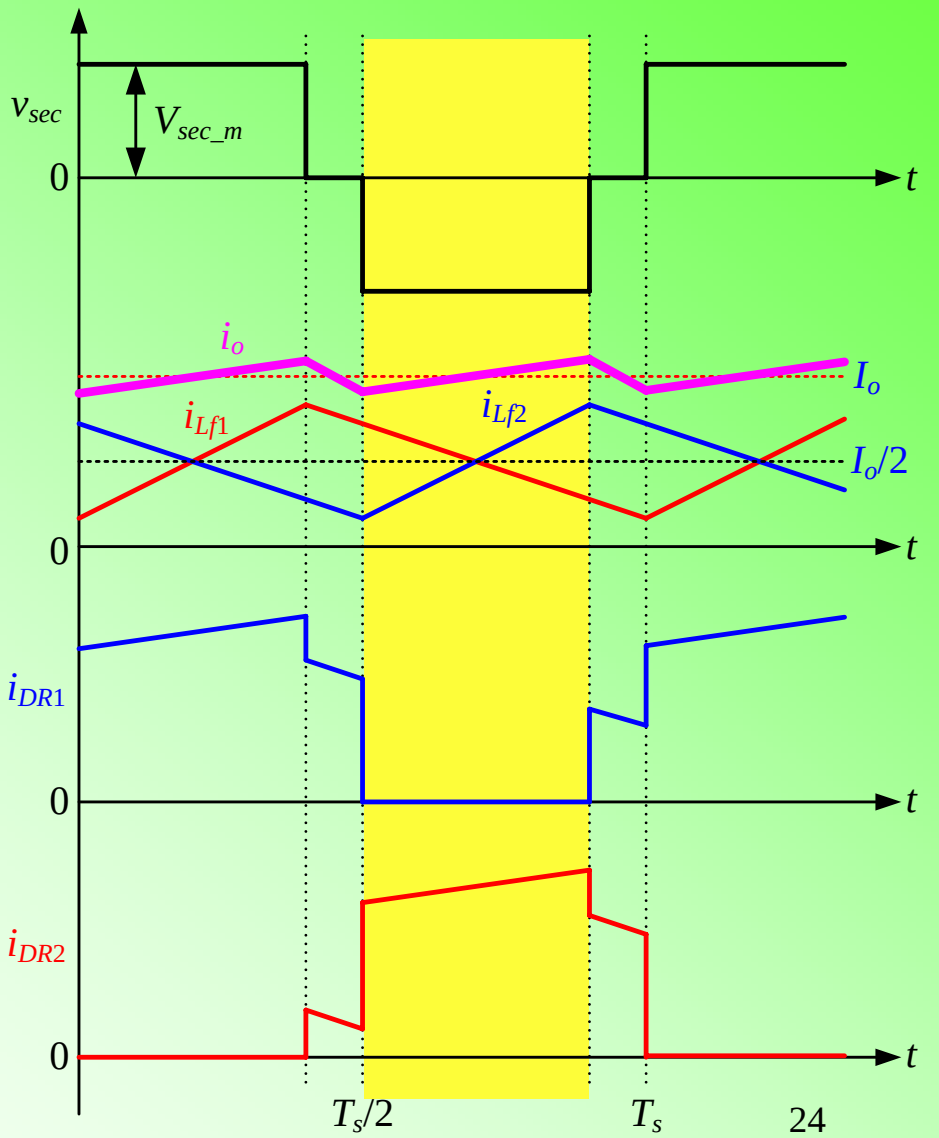
Operation Principle of Current-Doubler Rectifier (2)



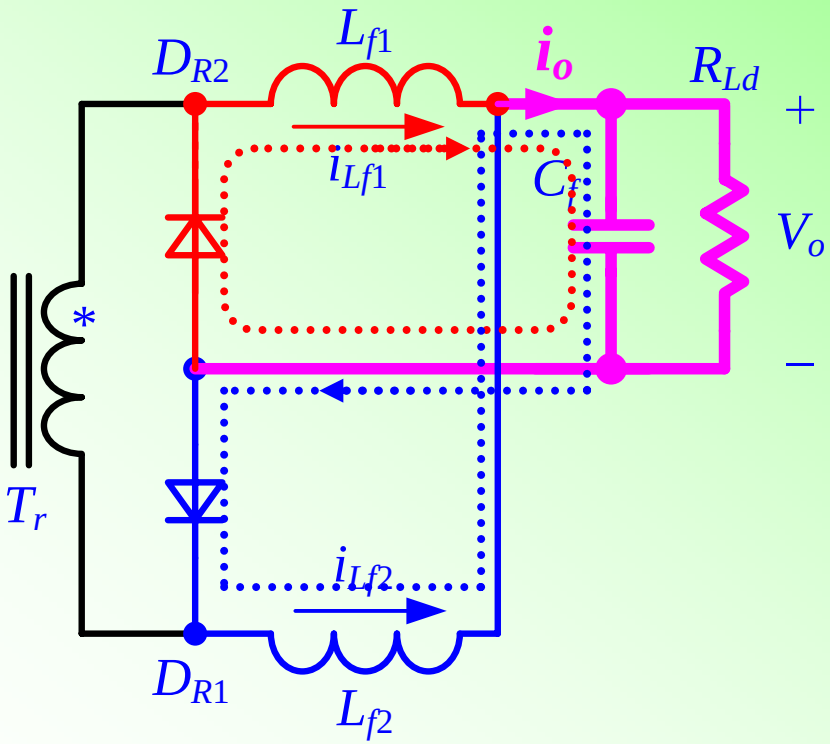


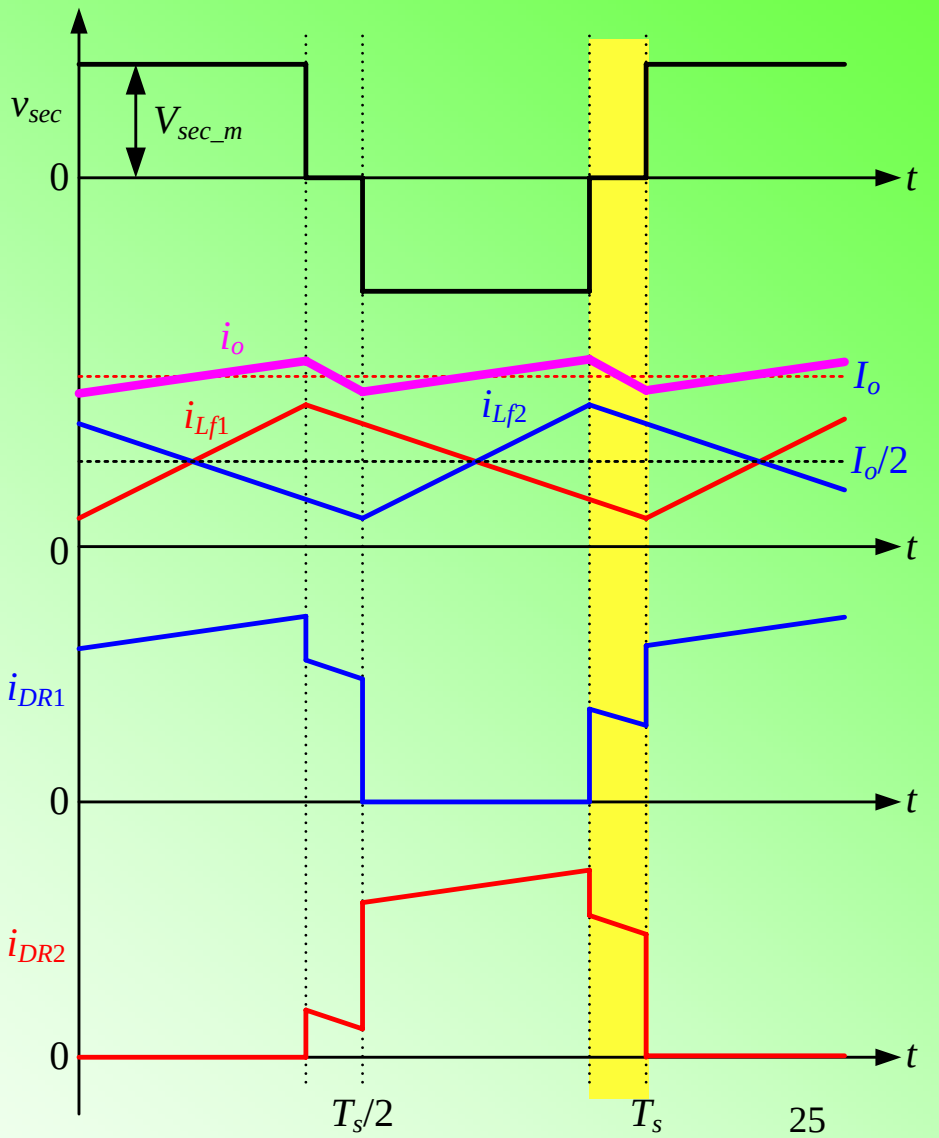
Operation Principle of Current-Doubler Rectifier (3)





Operation Principle of Current-Doubler Rectifier (4)





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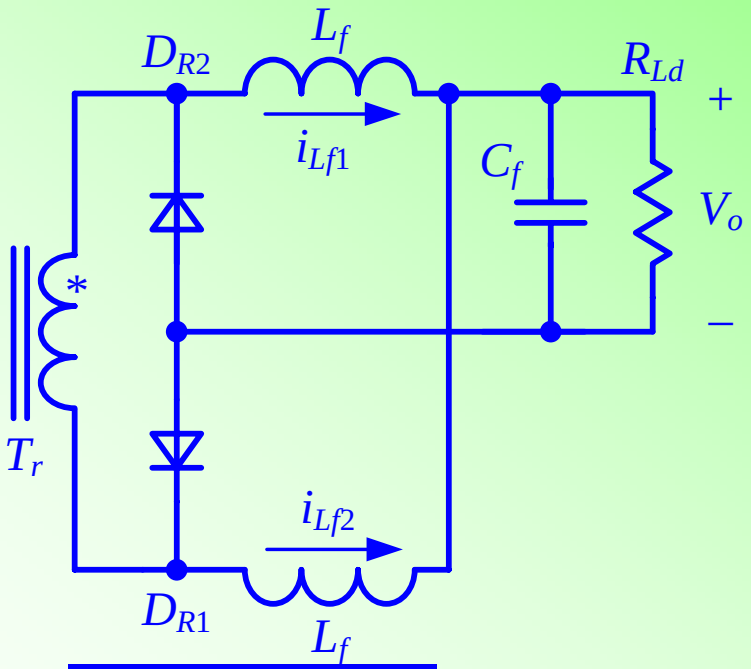
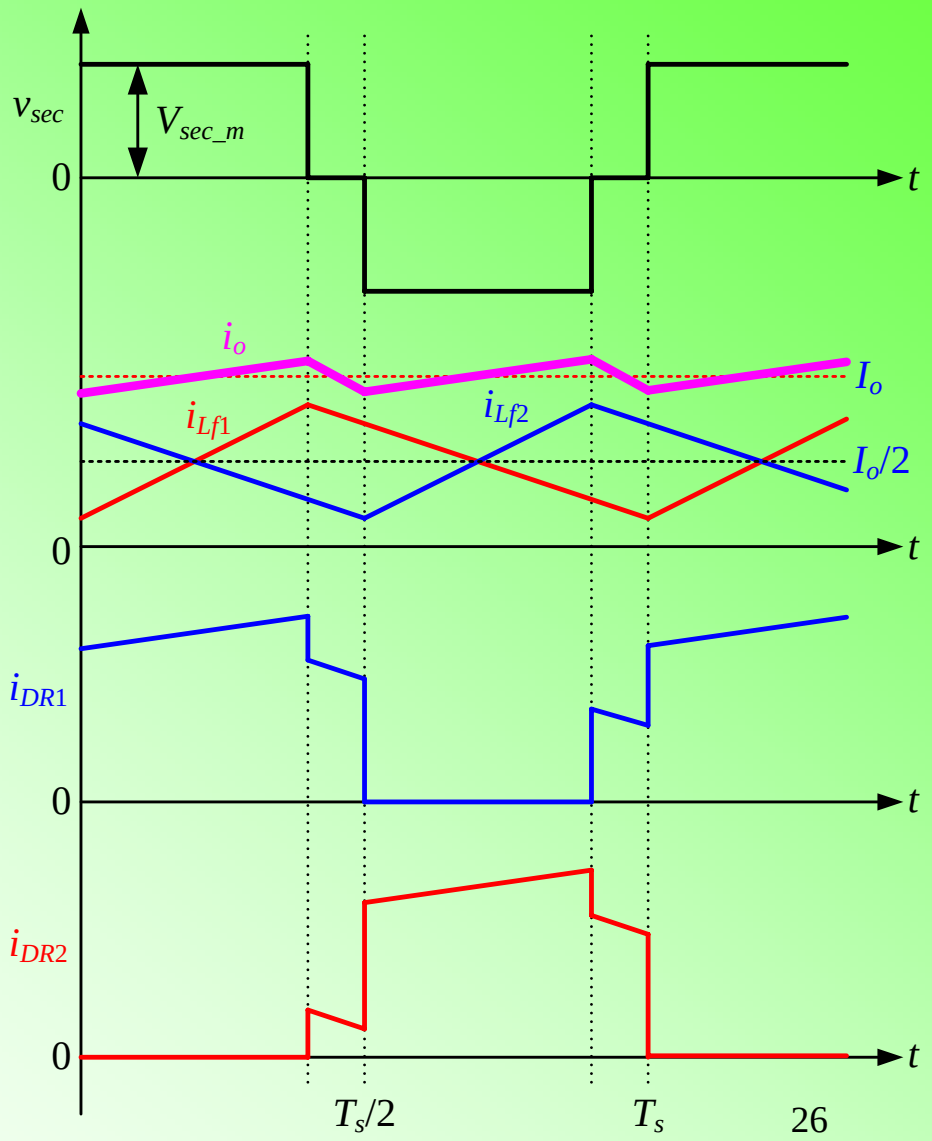
Relationships of Current-Doubler Rectifier



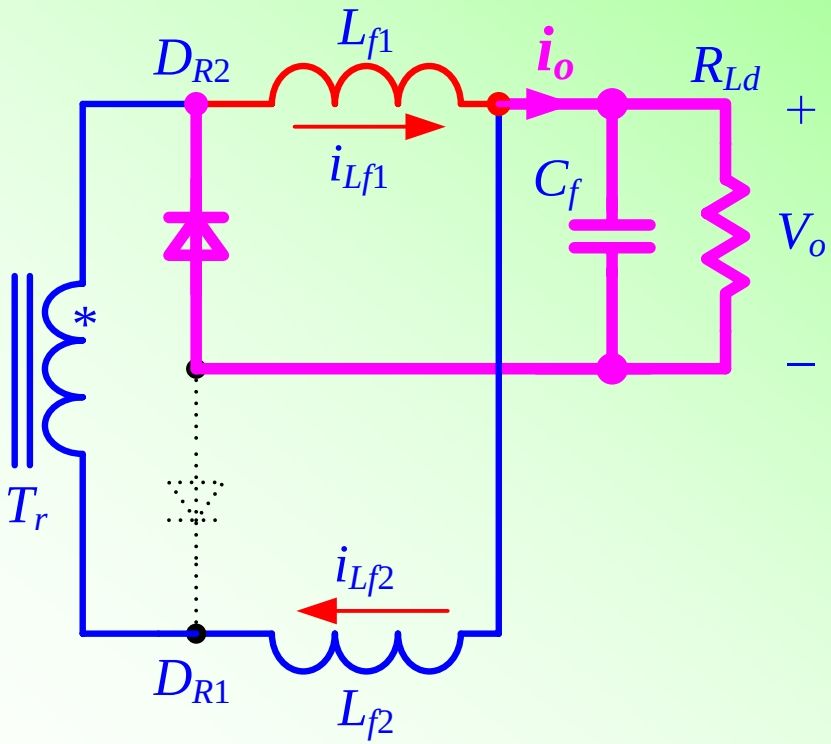
$$\frac{V_o}{V_{\text{sec}\_m}} = D_{half}$$

$$V_{DR1} = V_{DR2} = V_{\text{sec}\_m}$$

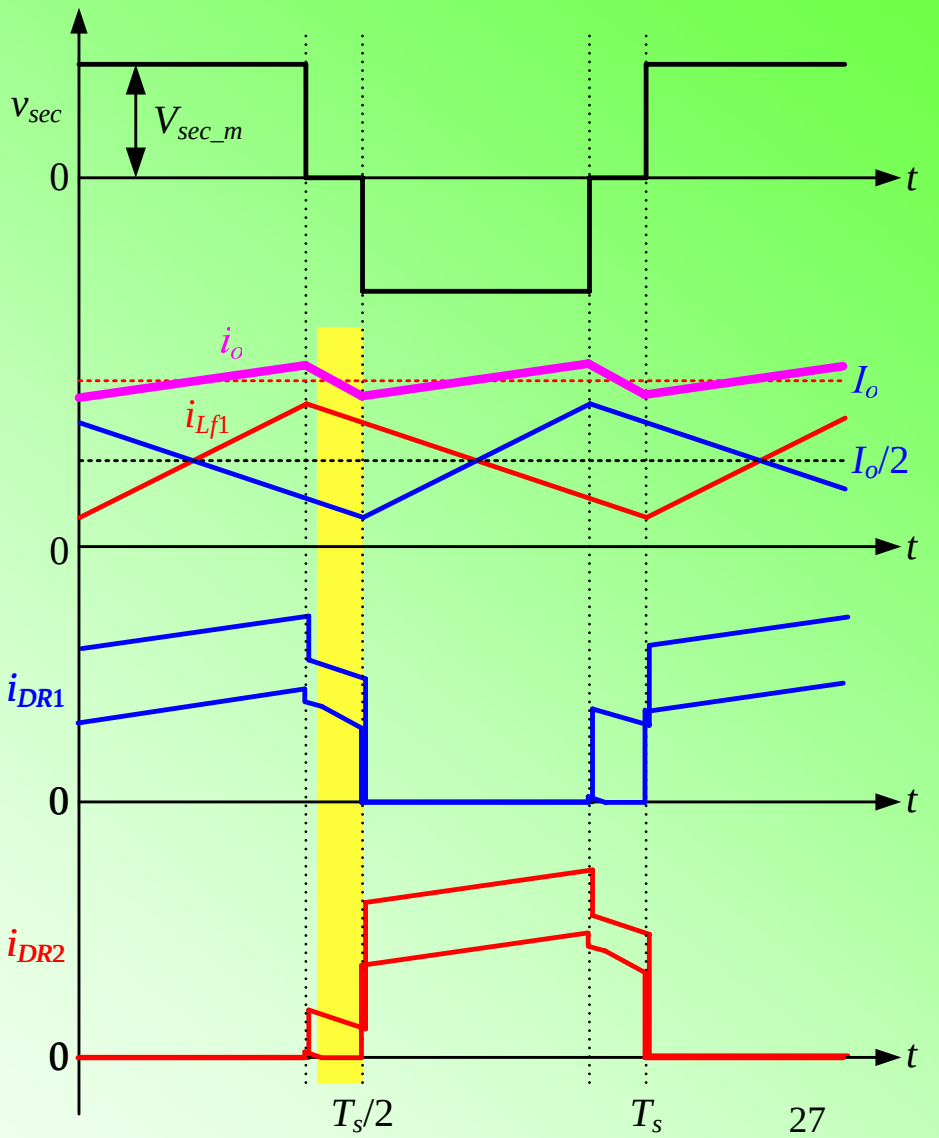
$$I_{DR1} = I_{DR2} = \frac{1}{2} I_o$$



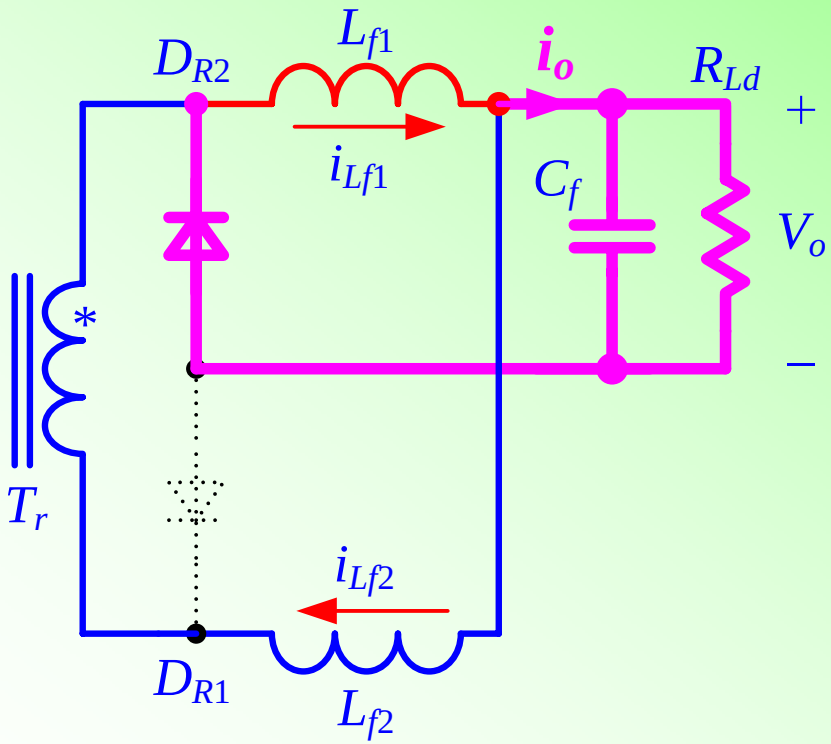
DCM of Current-Doubler Rectifier (1)

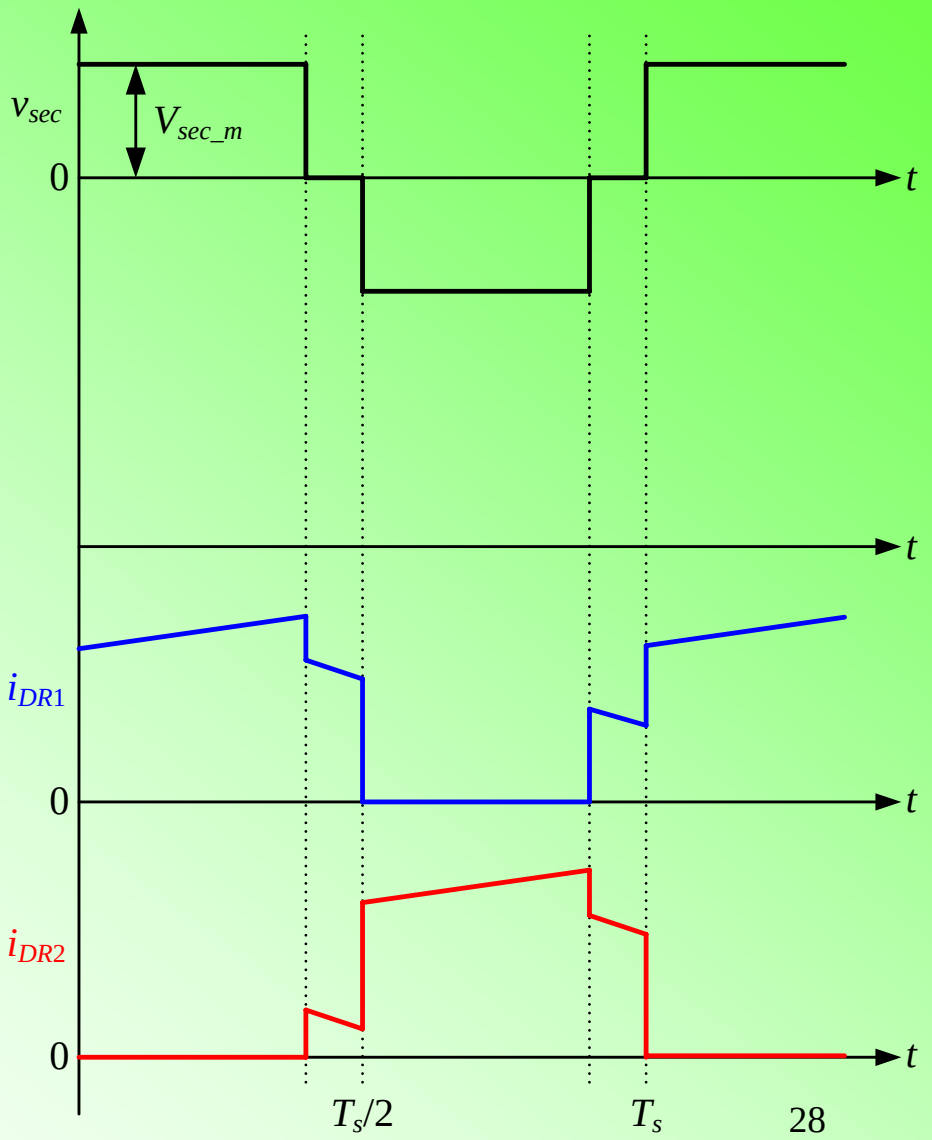


Inductor current can flow in the negative direction.

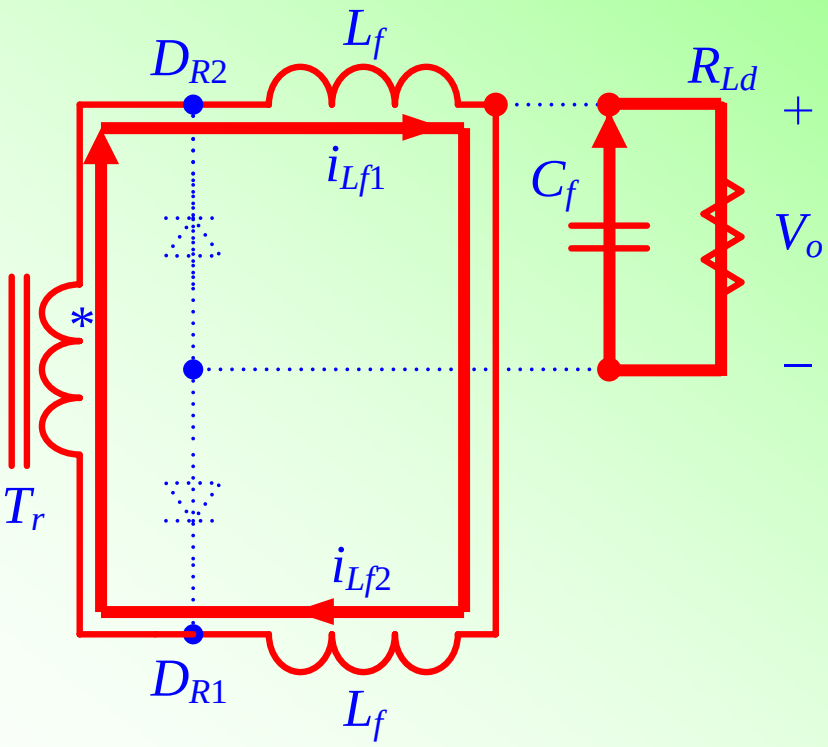


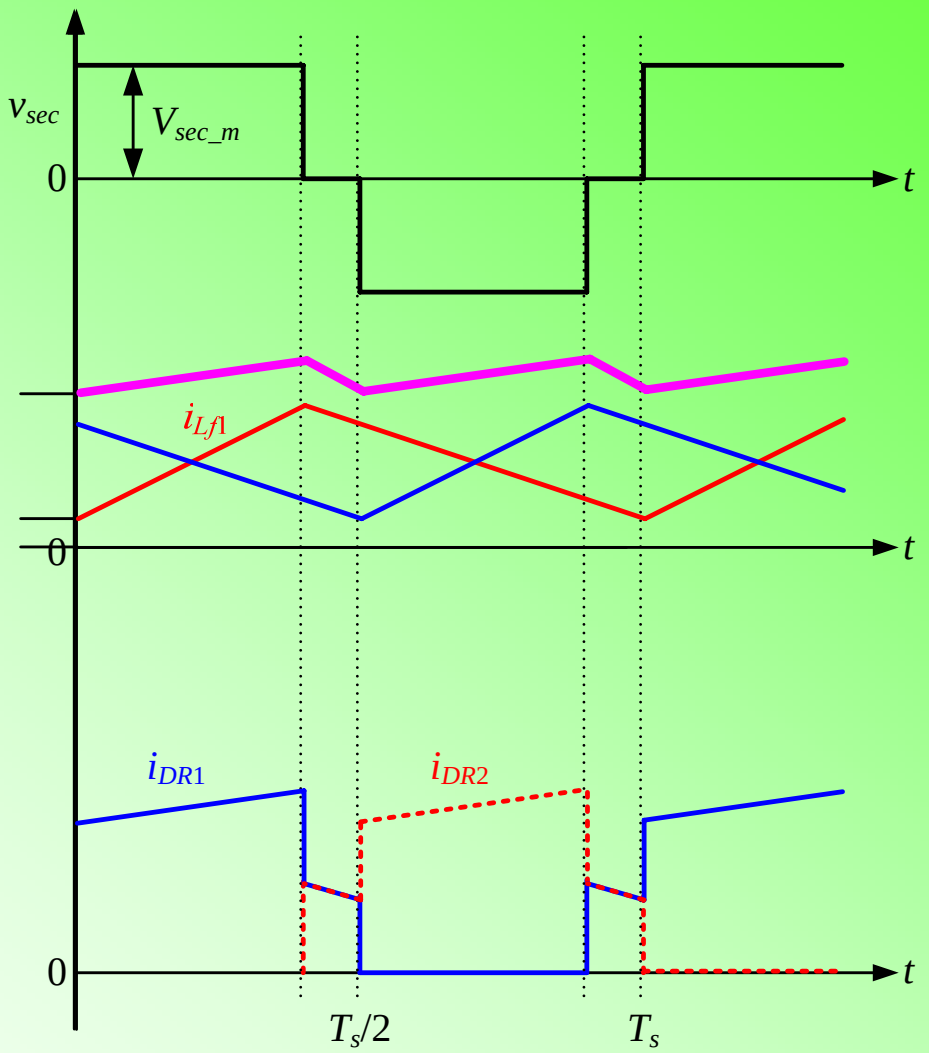
DCM of Current-Doubler Rectifier (2)





DCM of Current-Doubler Rectifier (2)





Inductor current can flow in the negative direction.

Comparison of Reectifiers (1)

Design a DC/DC converter

- Input Voltage: V_{in}
- Output Voltage: V_o
- Output Current: I_o

Given the duty cycle of all the switches be 0.5

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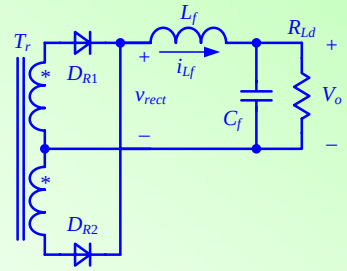
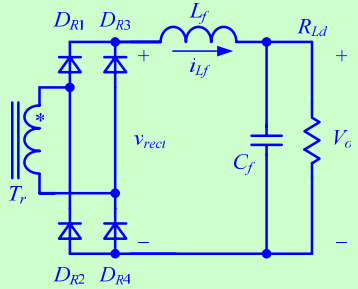
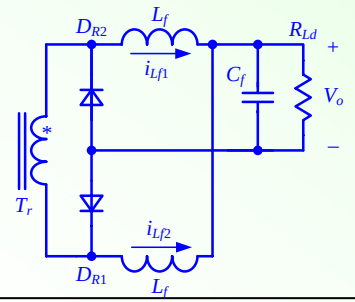
Comparison of Reectifiers (2)

Rectifier	Topology	Winding Ratio	Current Stress	Voltage Stress	No. of Diodes	Total Power of Diodes	Applica-tions
Full-Wave		K_0	I_o	$2V_{in}/K_0$	2	$4V_{in}I_o$	Low output voltage
Full-Bridge		K_0	I_o	V_{in}/K_0	4	$4V_{in}I_o$	High output voltage
CDR		$K_0/2$	I_o	$2V_{in}/K_0$	2	$4V_{in}I_o$	Low output voltage, high cureent