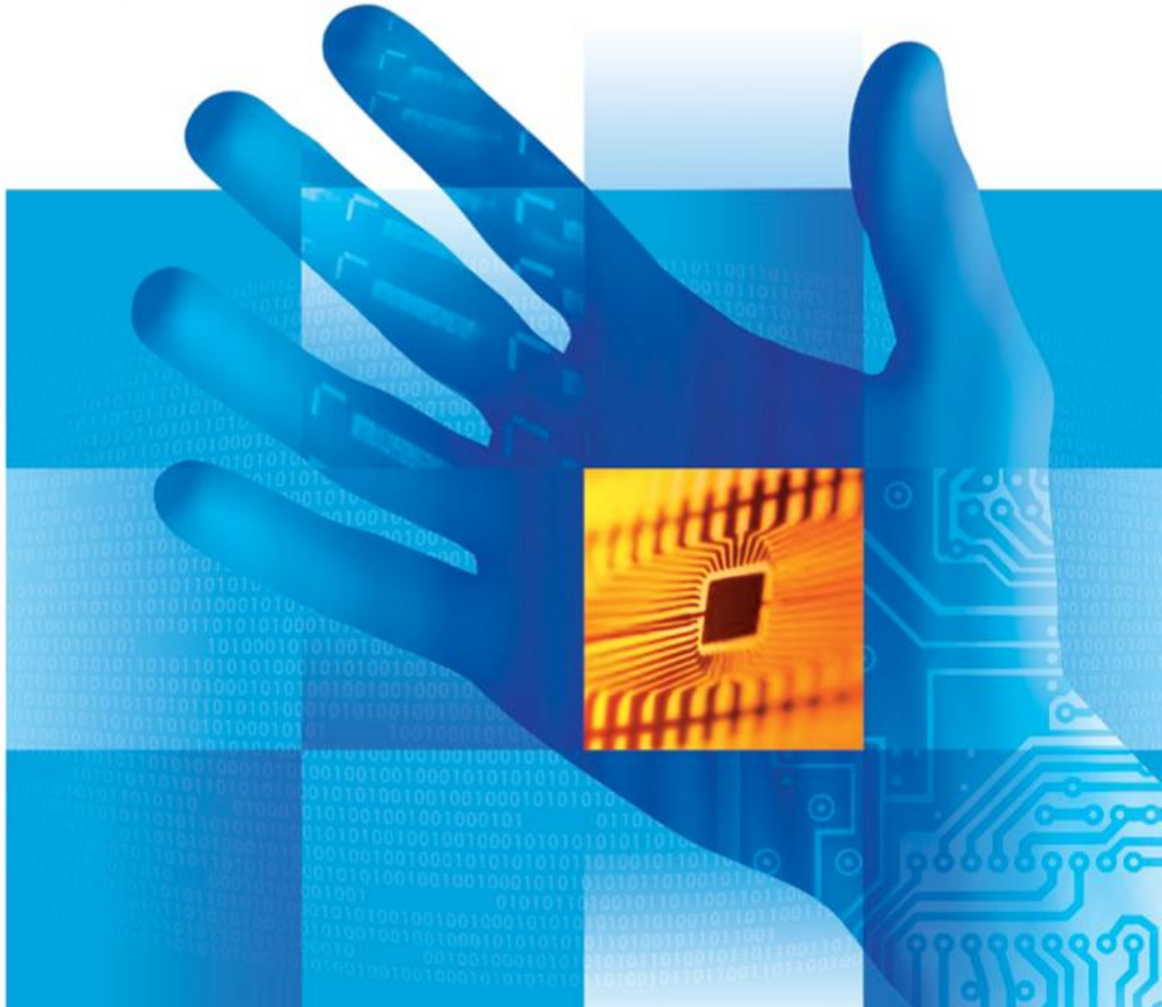
EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

6. SEMICONDUCTOR CONVERTERS



Doc. Ing. Stanislav Kocman, Ph.D.

29. 1. 2018, Ostrava

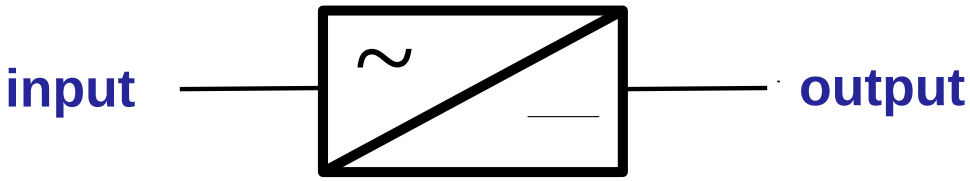
LECTURE PLAN

- classification of semiconductor converters
- fundamental principle of non-controlled and controlled rectifiers
- principle of AC voltage converter and inverter
- frequency converter with voltage inverter: principle, characteristics

Classification of semiconductor converters

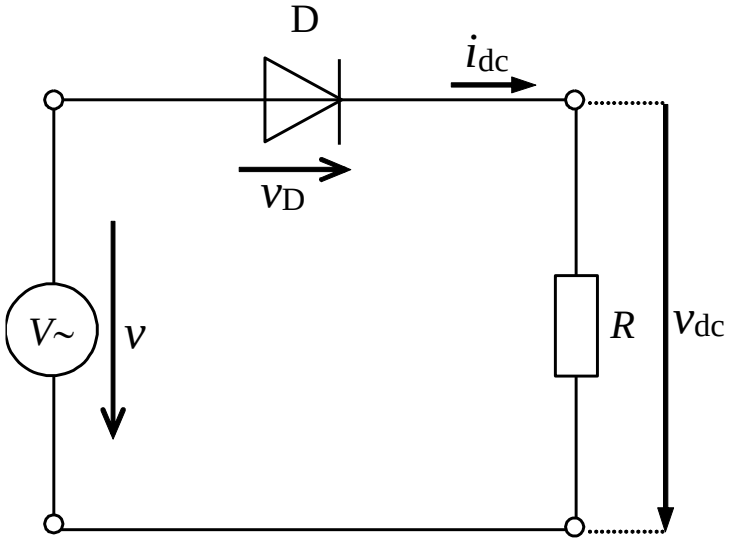
- rectifiers (to convert AC current into DC current)
  - non-controlled (with diodes)
  - controlled (with thyristors)
- AC controller (to control rms value of AC voltage)
  - with triacs
  - with thyristors
- choppers (to control value of DC voltage)
  - with transistors and diodes
- inverters (to convert DC current into AC current)
  - with transistors
  - with thyristors
- frequency converters (to control frequency of AC voltage)
  - direct (cycloconverter)
  - indirect (with voltage or current source inverter)

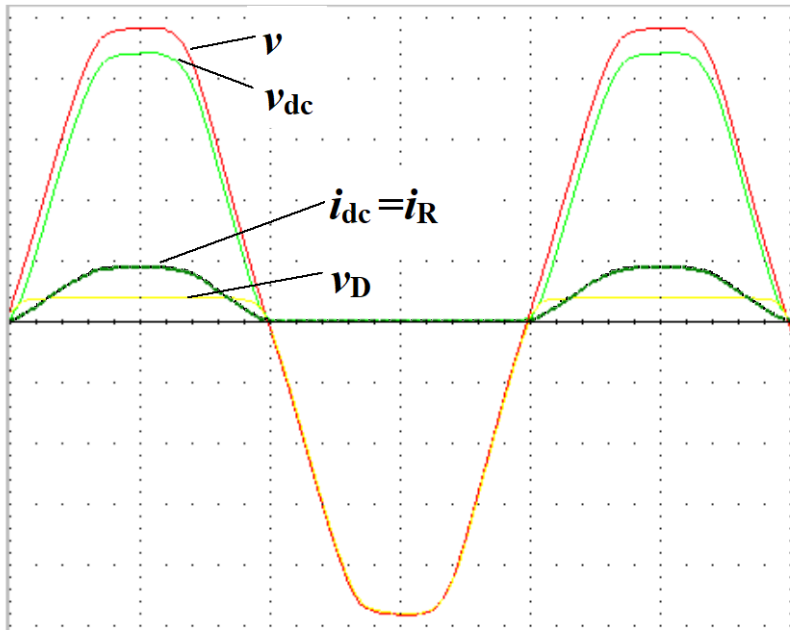
Fundamental principle of non-controlled rectifiers



Single-phase rectifier with *R* load

Half-wave rectification

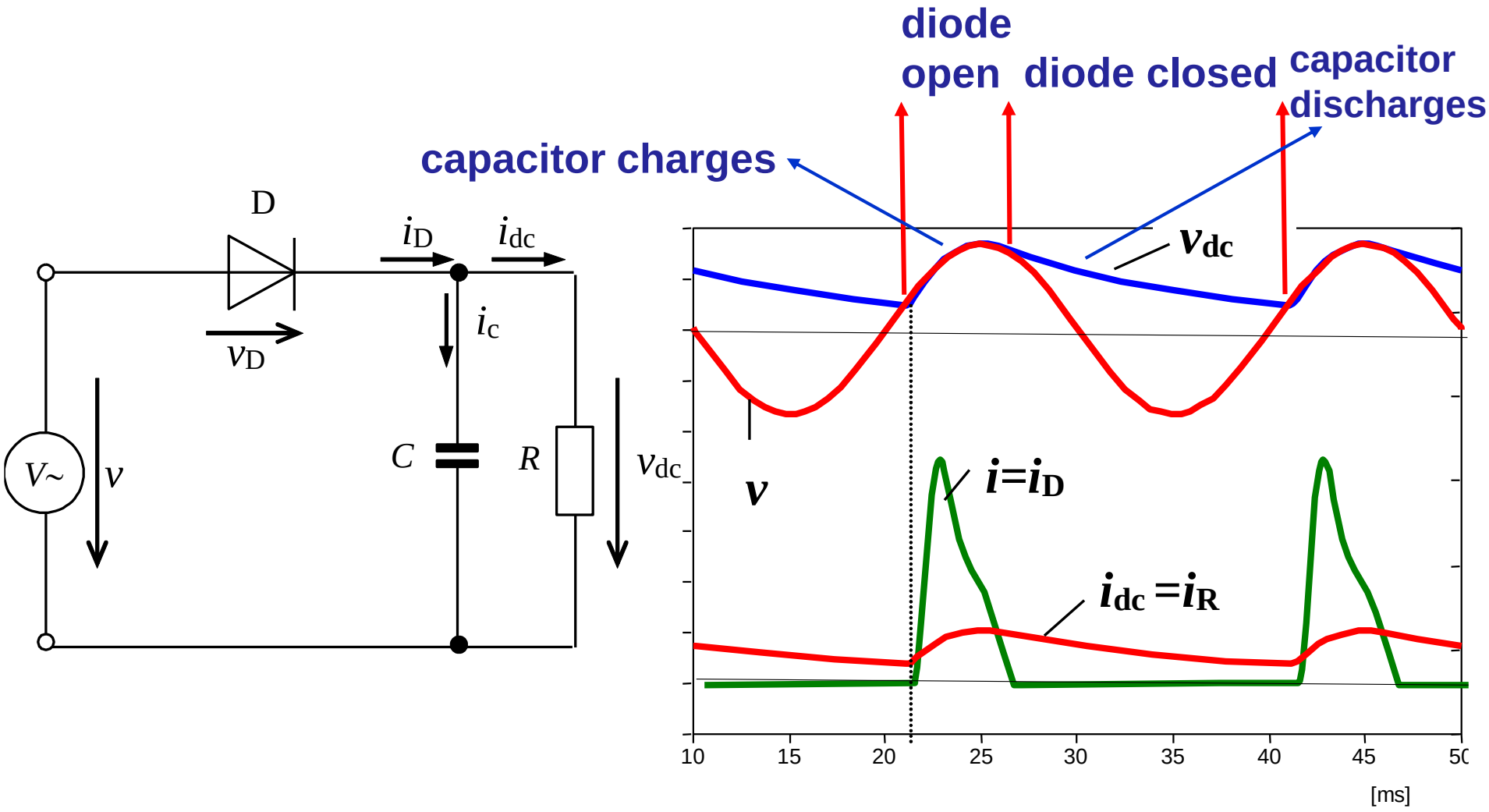




$$V_{dc}=V_{av}=0{,}45\cdot V \qquad I_{dc}=I_{av}=0{,}45\cdot I$$

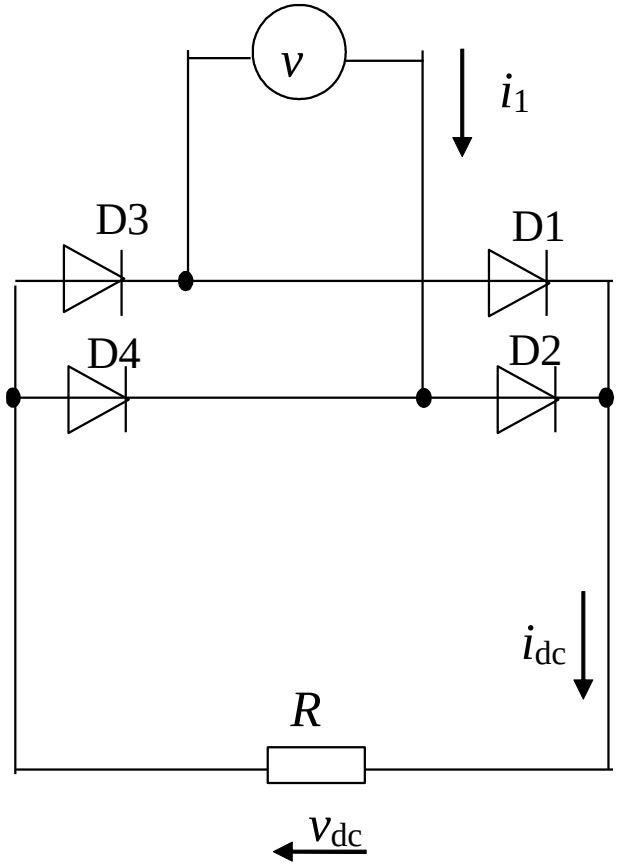
Single-phase rectifier with smoothing capacitor with *R* load

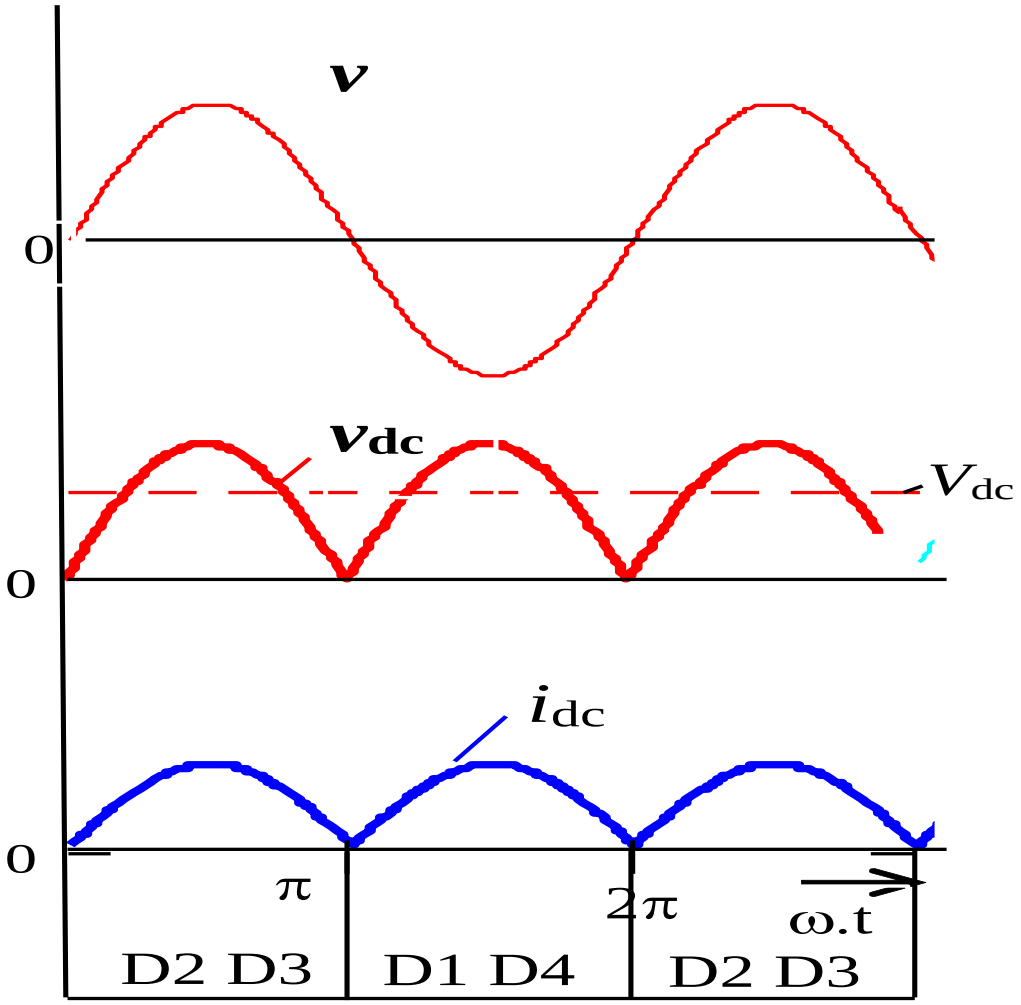
Half-wave rectification



Single-phase rectifier with *R* load

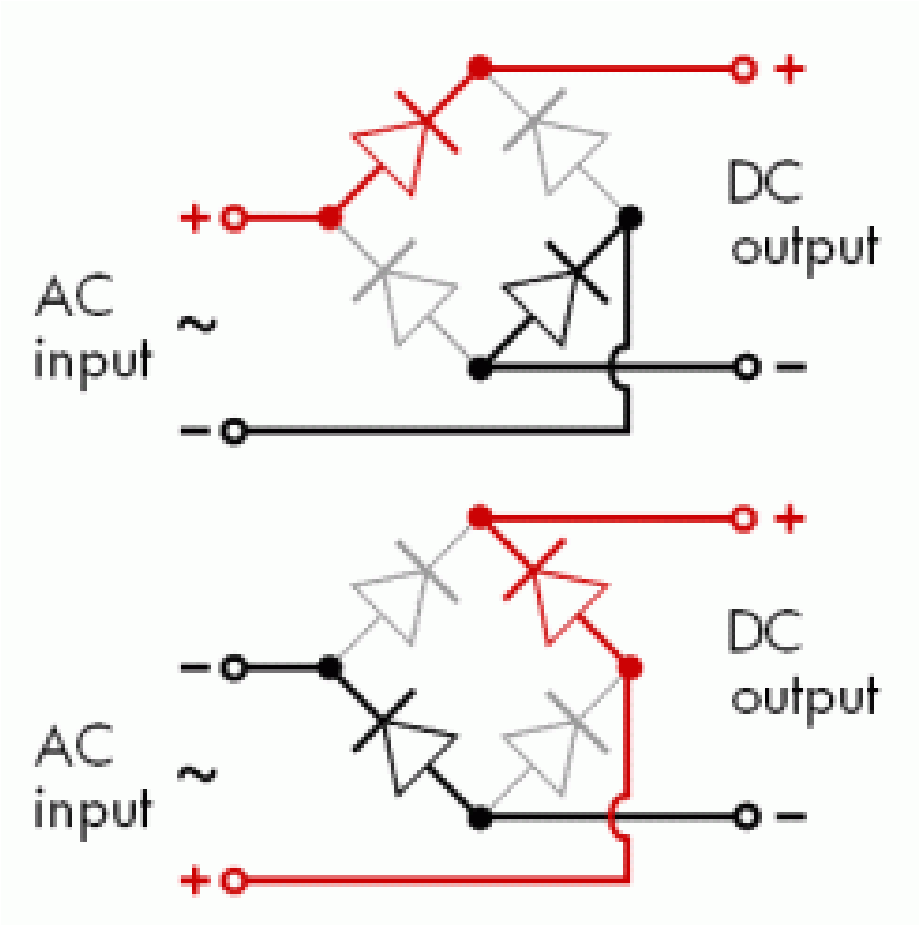
Full-wave rectification





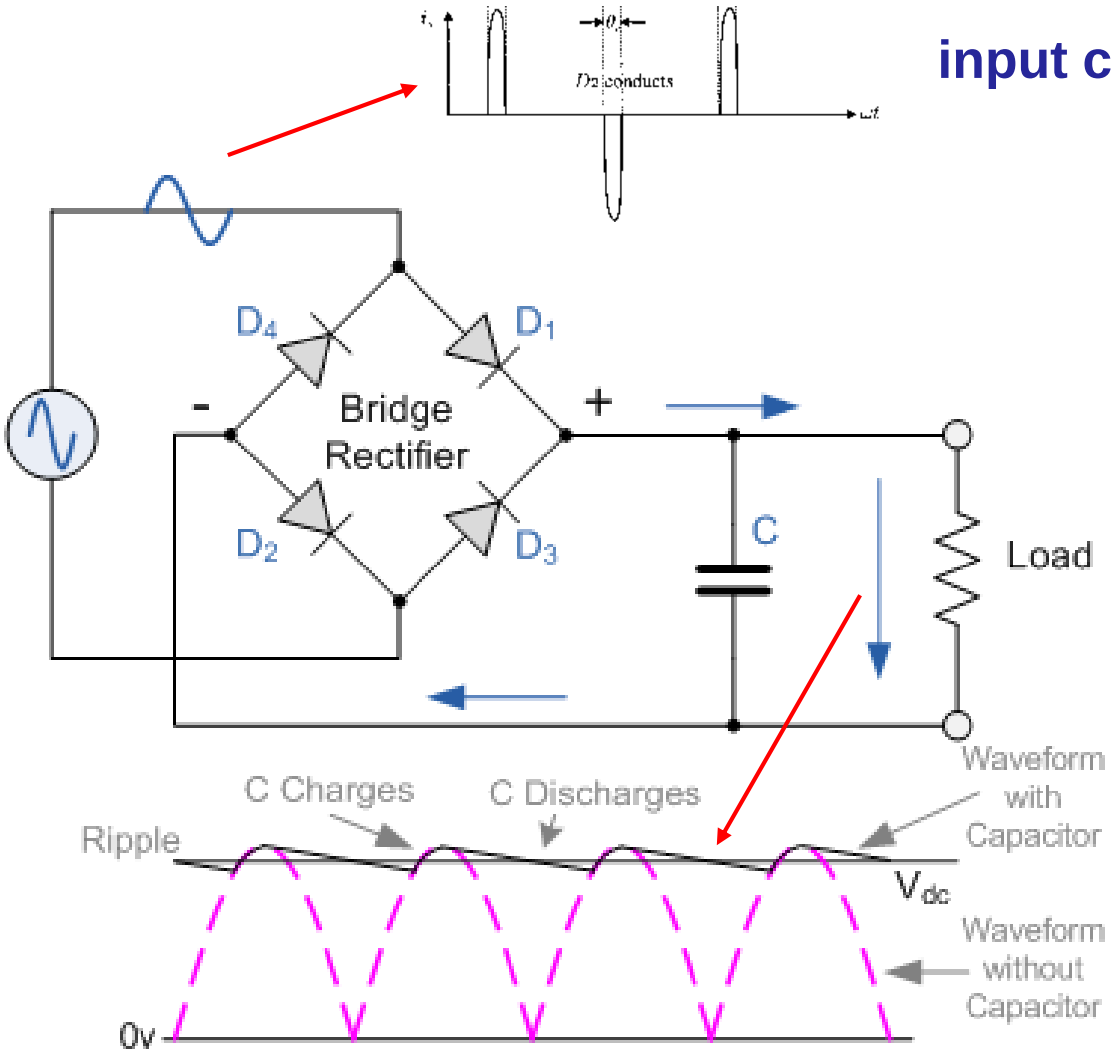
$$V_{dc} = V_{av} = 0{,}9 \cdot V$$

Principle of operation



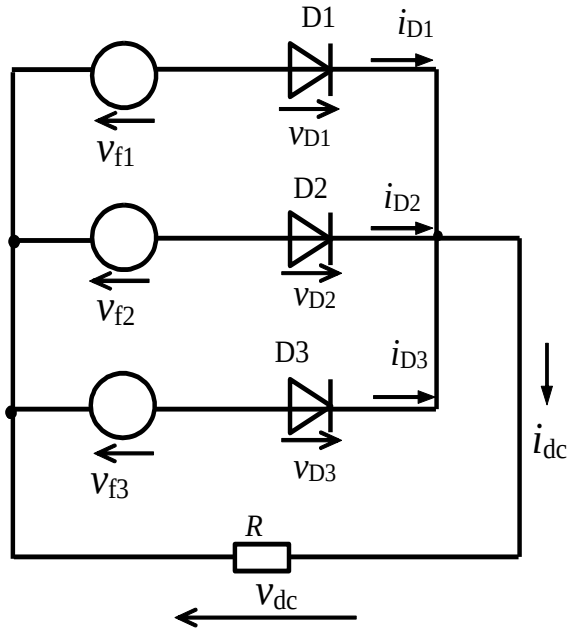
Single-phase rectifier with smoothing capacitor with *R* load

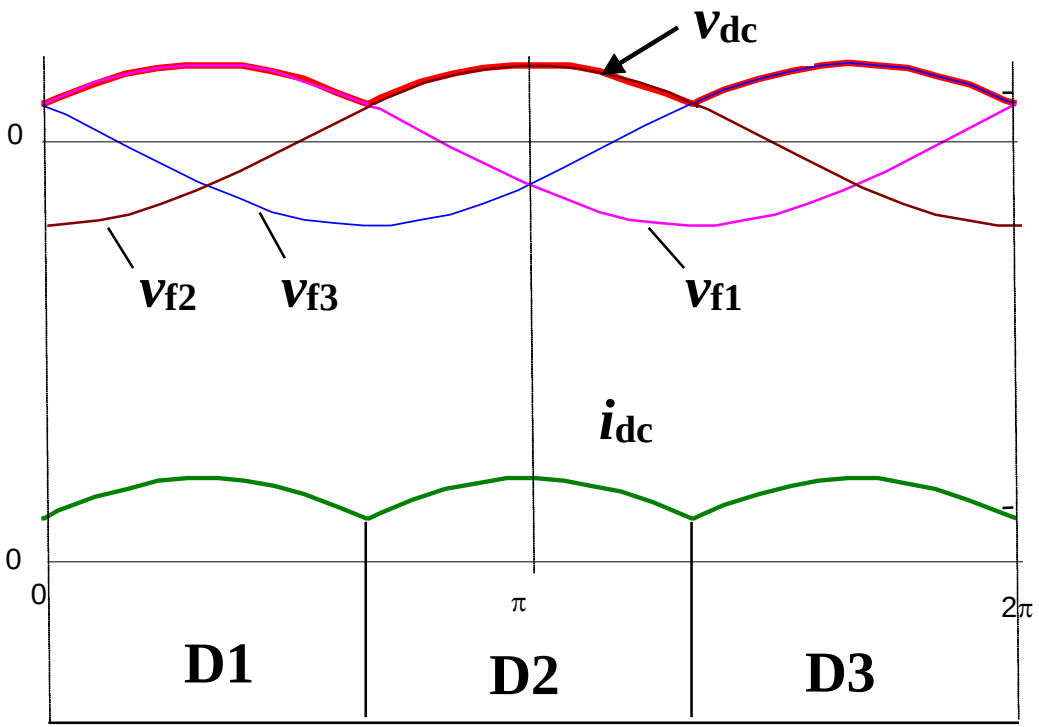
Full-wave rectification



Three-phase rectifier with *R* load

Half-wave circuit

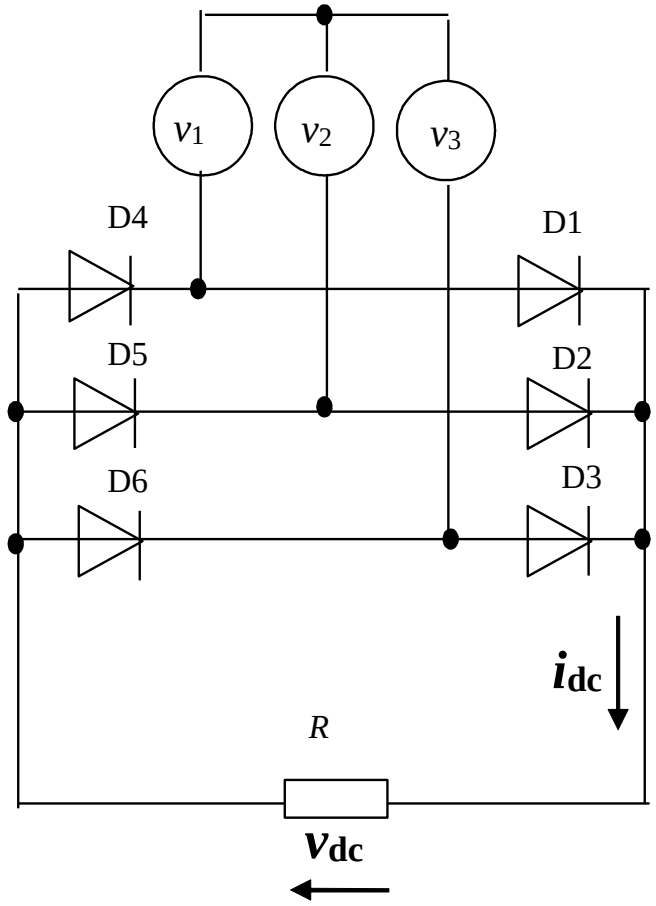


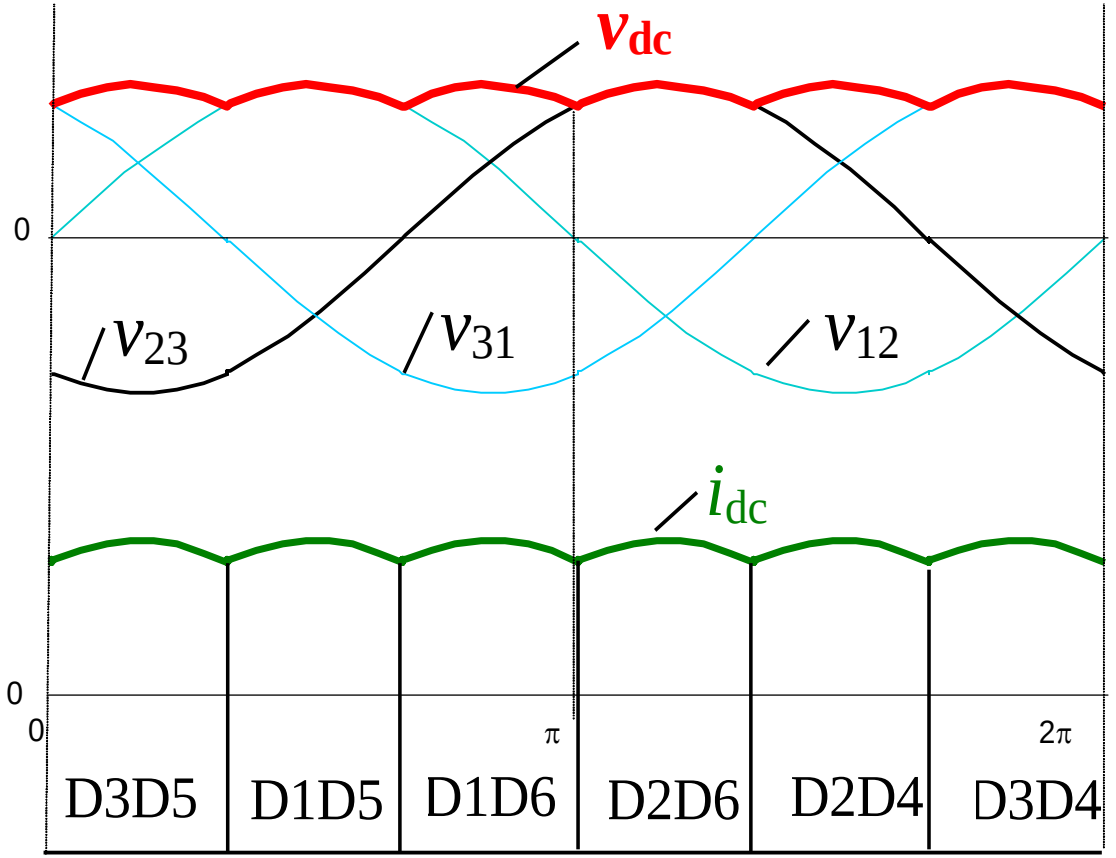


$$V_{dc} = V_{av} = 1{,}17 \cdot V_f$$

Three-phase rectifier with *R* load

Full-wave circuit

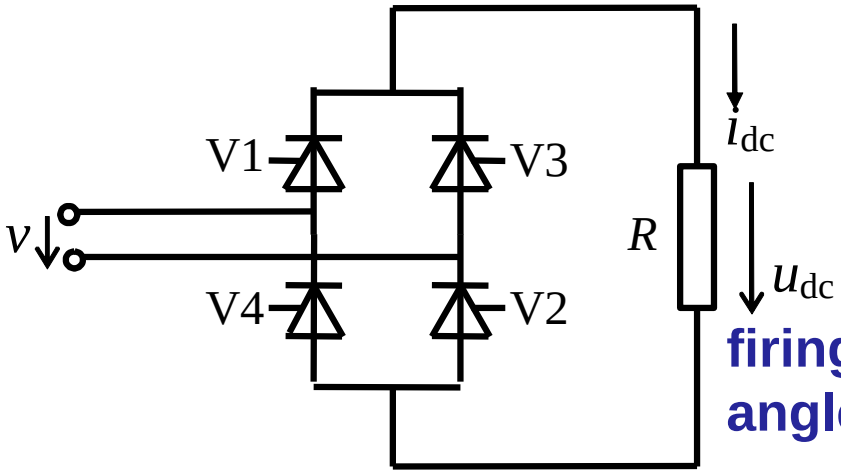


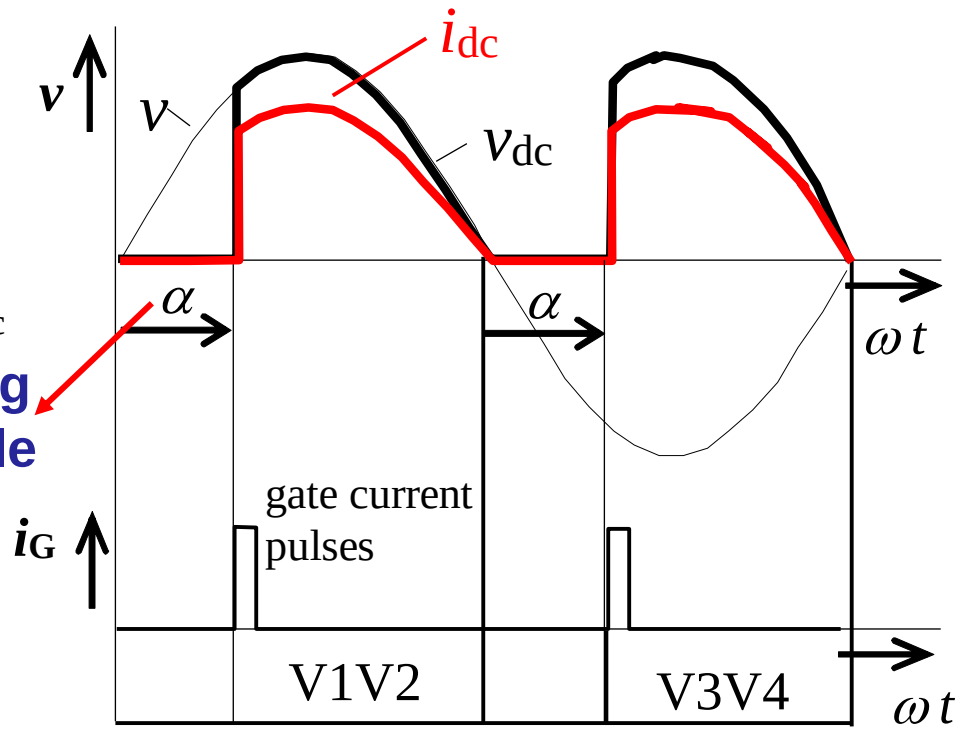


$$V_{\mathrm{dc}} = V_{\mathrm{av}} = 2{,}34 \cdot V_{\mathrm{f}}$$

Fundamental principle of controlled rectifiers

Single-phase rectifier with *R* load





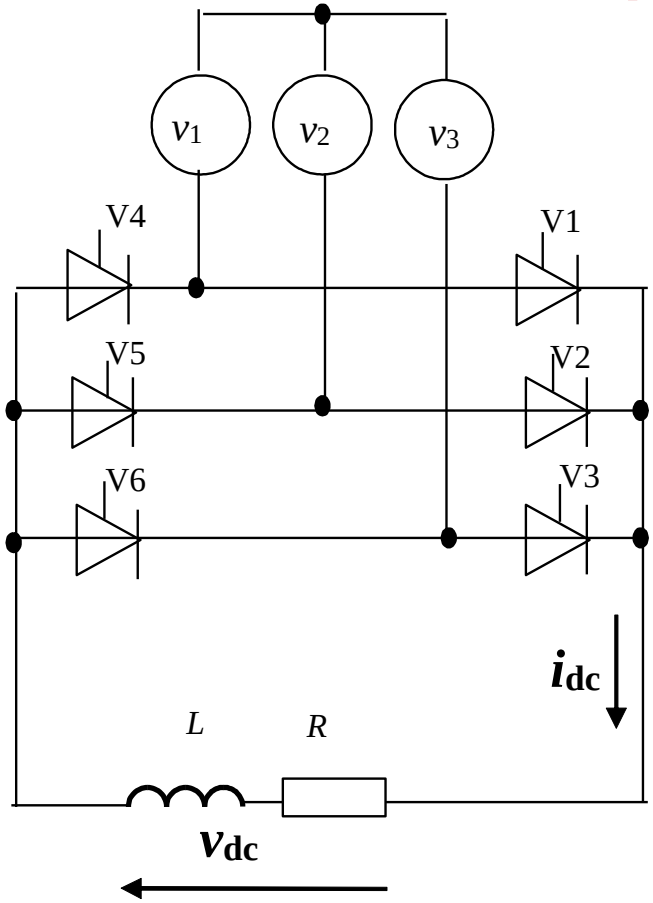
$$V_{av(\alpha)} = V_{av} \cdot \frac{1 + \cos\alpha}{2}$$

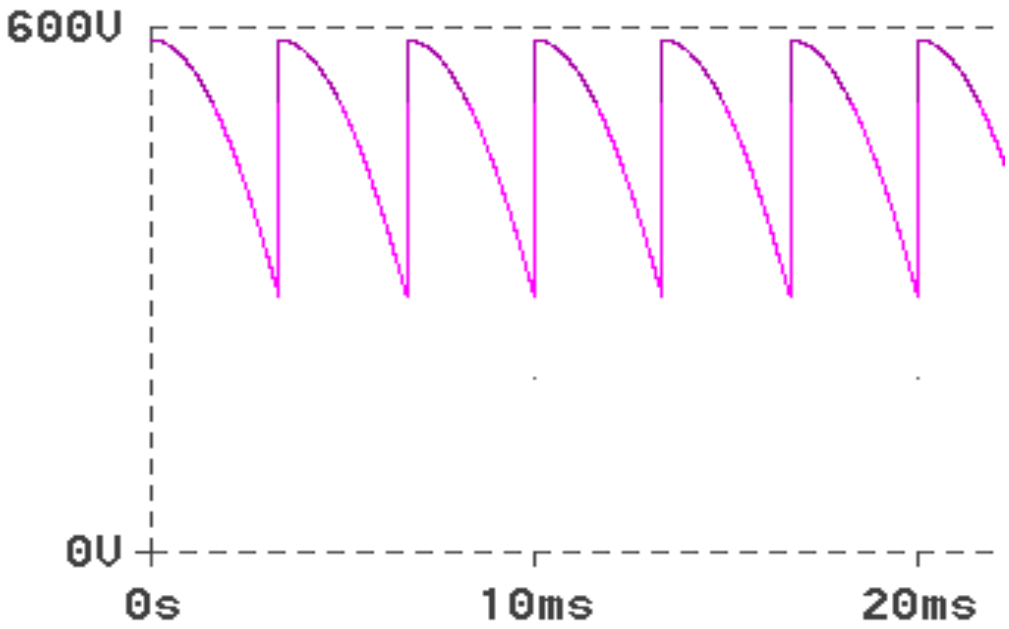
$$V_{av} = 0{,}9 \cdot V$$

For load with *R* and *L* $\longrightarrow \infty$ ⟹ $V_{av(\alpha)} = V_{av} \cdot \cos\alpha$

Three-phase rectifier with *RL* load

Full-wave bridge





For load with *R* and *L* $\longrightarrow \infty$ ⇒

$$V_{av(\alpha)} = V_{av} \cdot \cos\alpha$$

$$V_{av} = \frac{3\sqrt{6}}{\pi} \cdot V_f$$

Applications

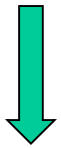






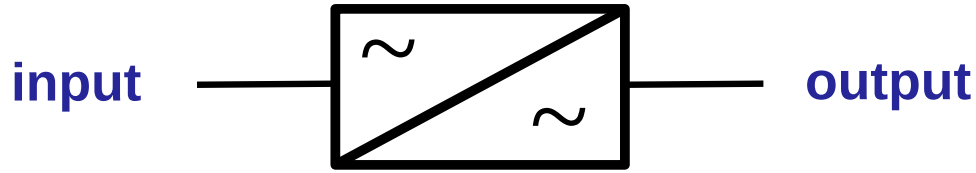
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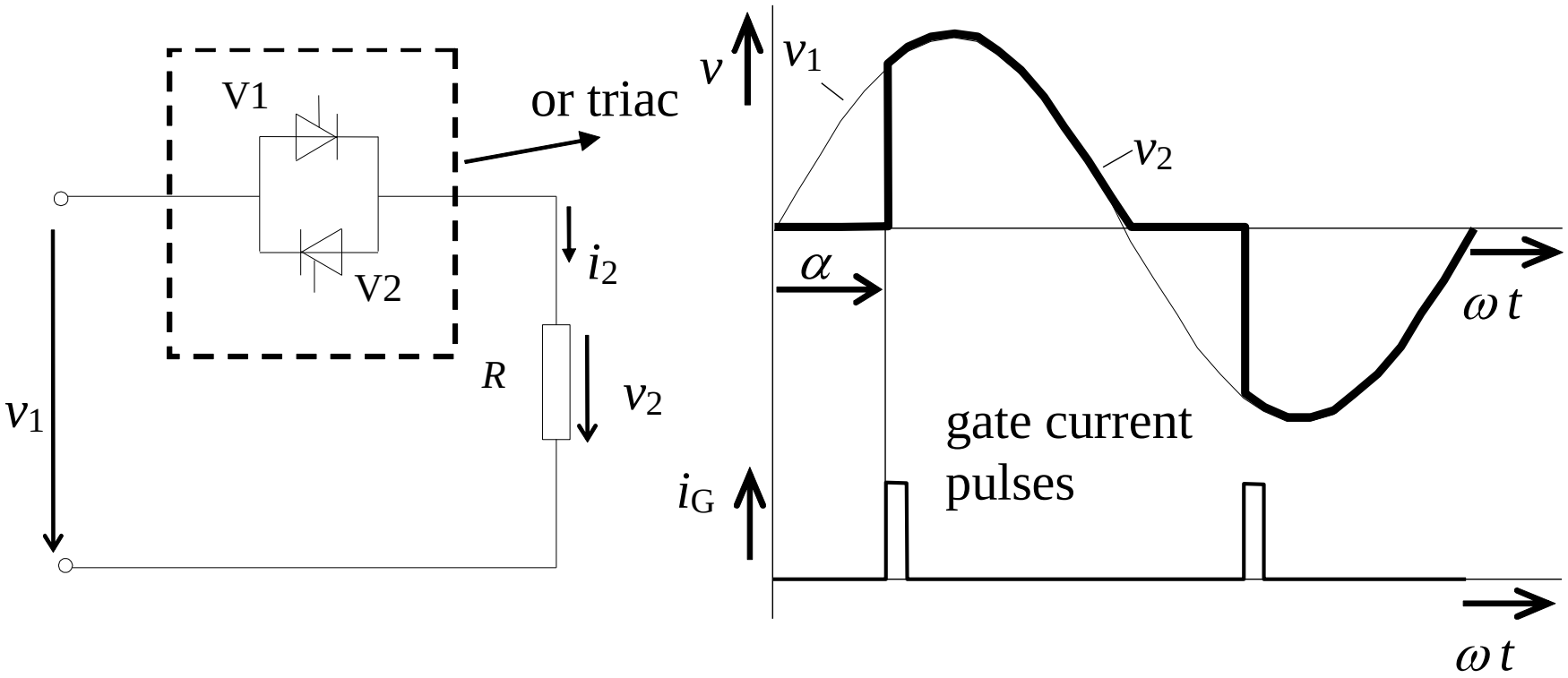


DC drive

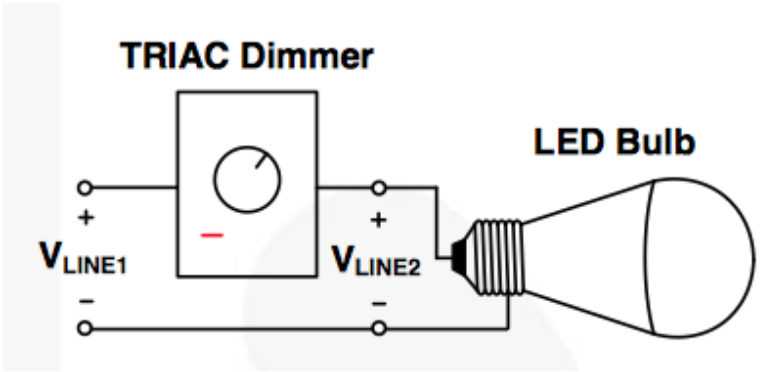
Principle of AC voltage converter



Single-phase AC voltage converter with *R* load



Applications



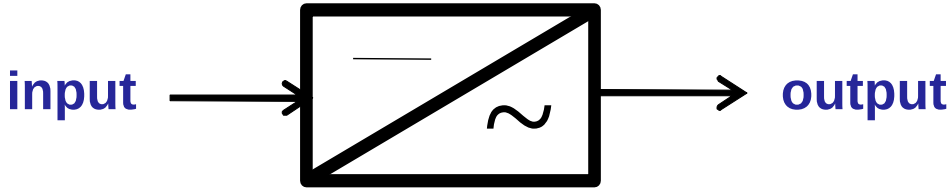




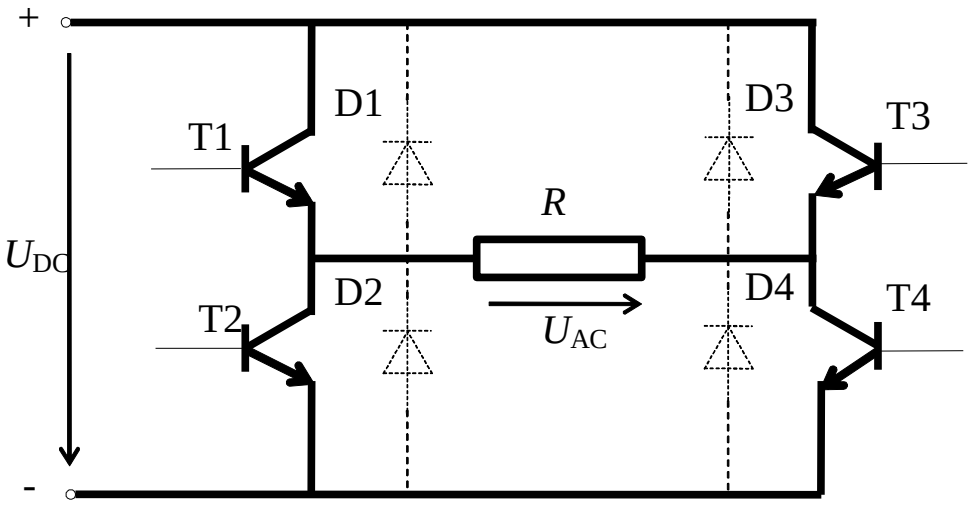




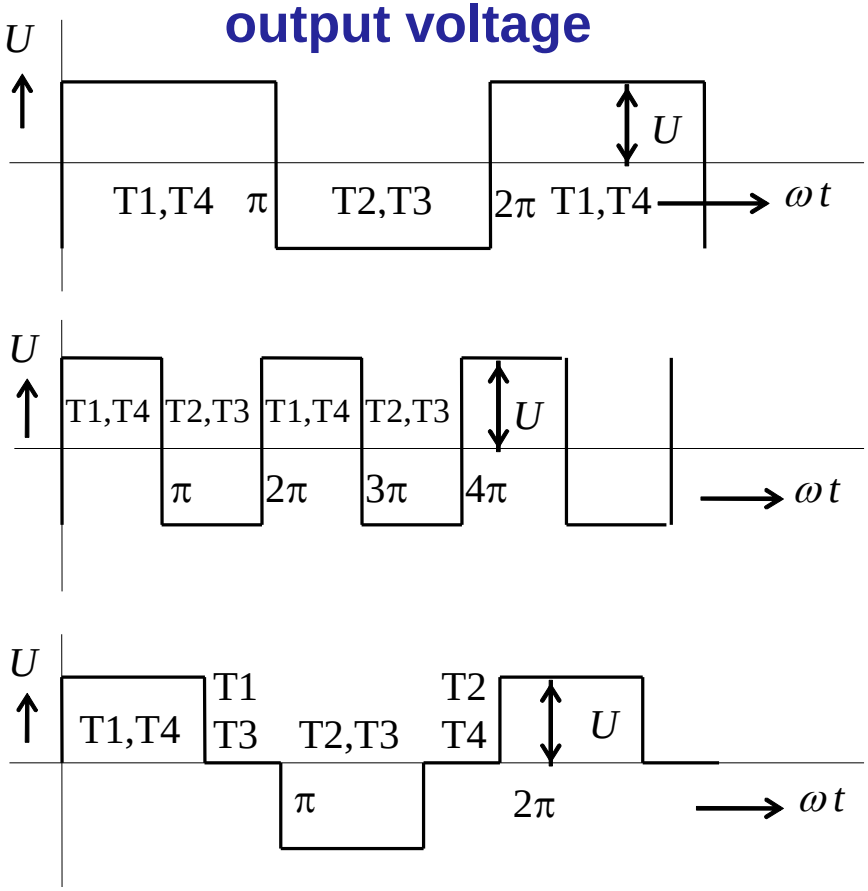
Principle of inverter



Single-phase transistor inverter with *R* load

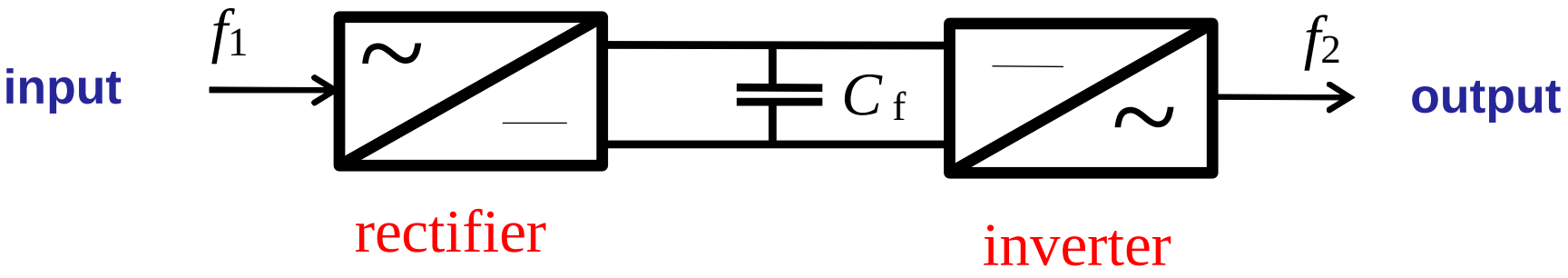


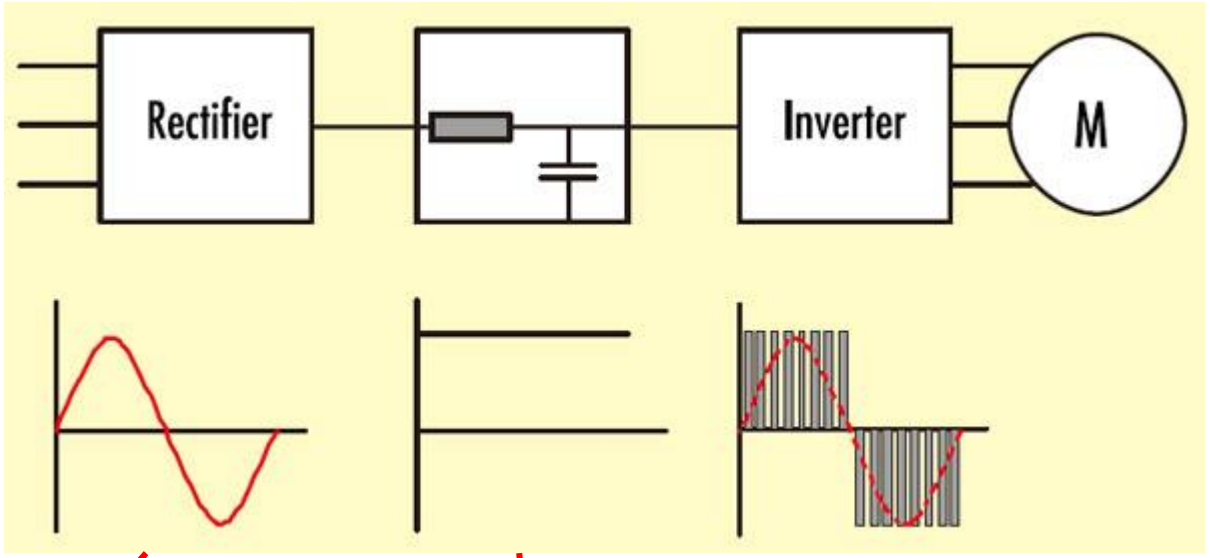
output voltage



output waveform depends on transistors triggering: variable rms or frequency

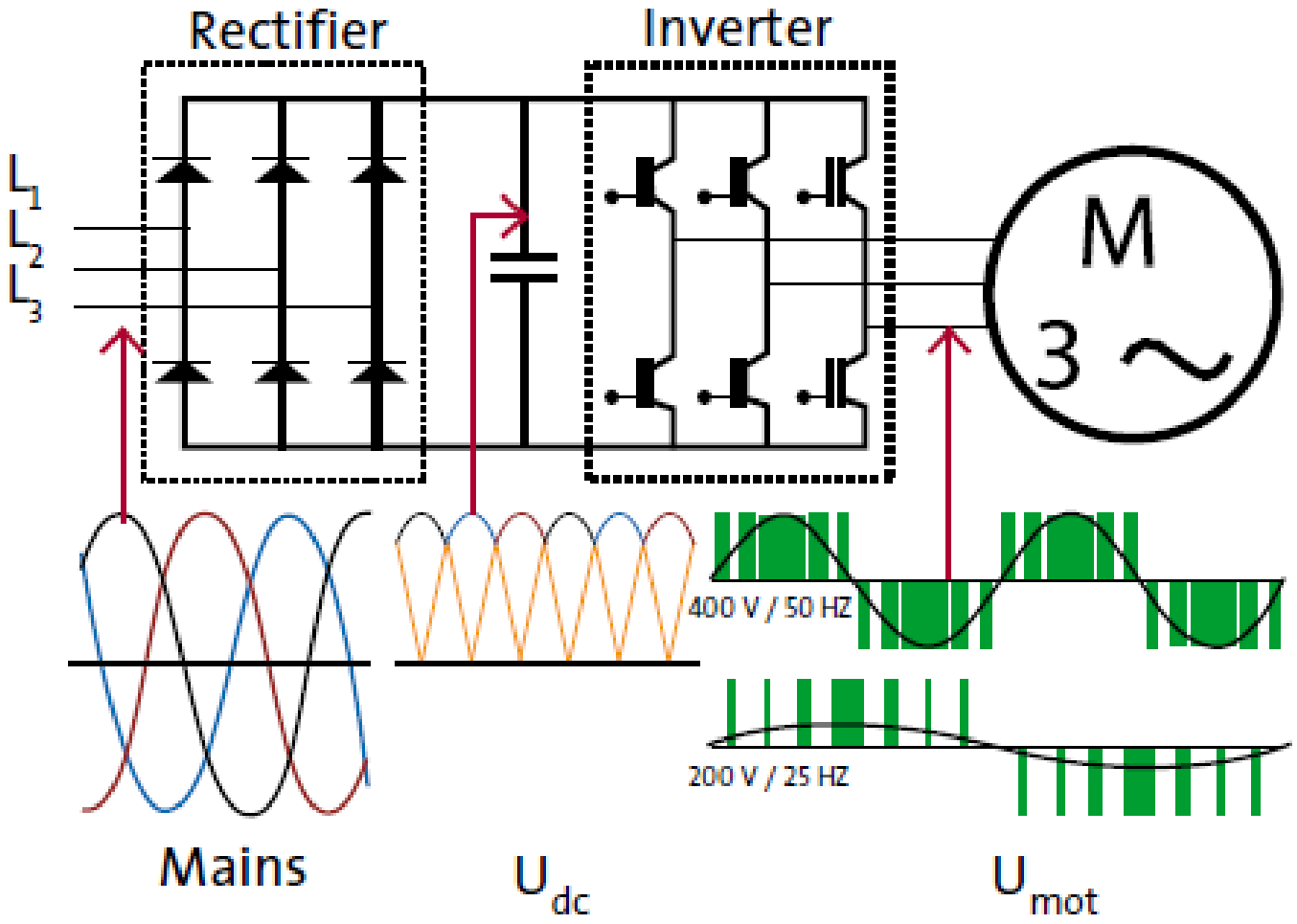
Frequency converter with voltage inverter





input voltage smoothed DC voltage output voltage

Characteristics



Frequency converters for AC drives



