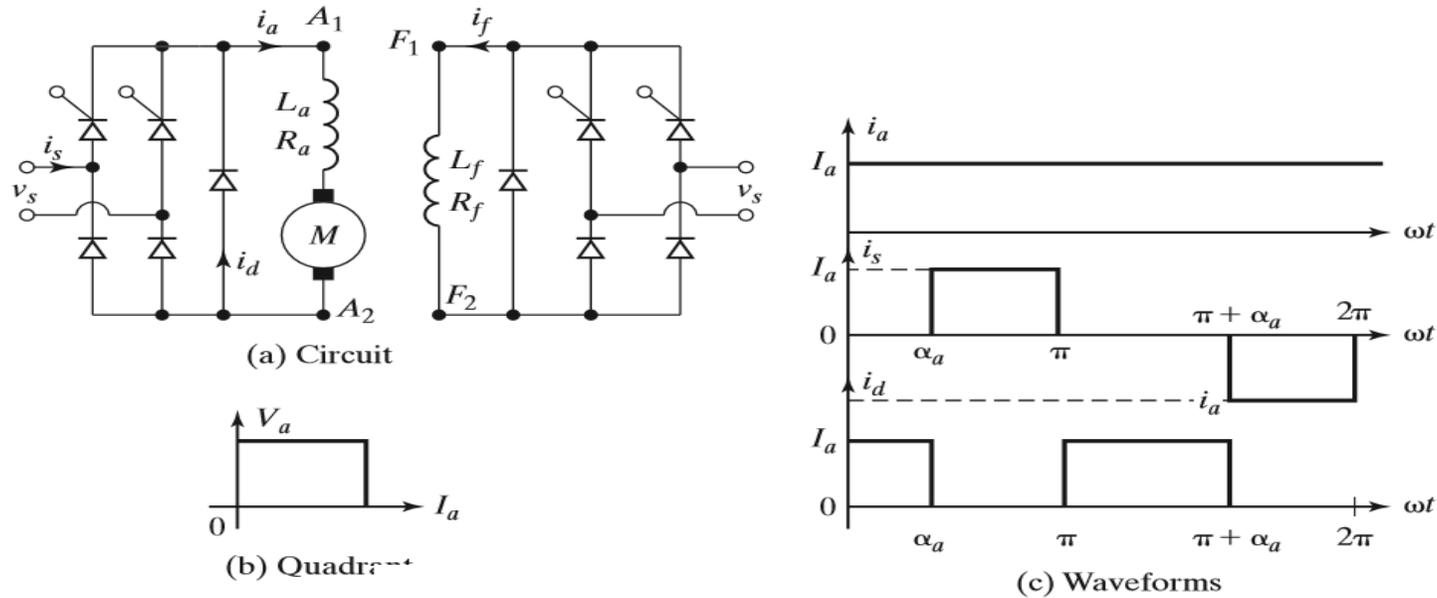


كلية الهندسة	الكلية
الكهرباء	القسم
Electrical Drives	المادة باللغة الإنجليزية
المساقات	المادة باللغة العربية
الرابعة	المرحلة الدراسية
د.م. زياد طارق محمد	اسم التدريسي
AC – DC Single Phase Drives	عنوان المحاضرة باللغة الإنجليزية
محركات التيار المتردد والتيار المستمر أحادية الطور	عنوان المحاضرة باللغة العربية
3	رقم المحاضرة
1) Mohummed Rashid" Power electronics circuits, Devices application" 4th edition, 2014 and	المصادر والمراجع
2) Gopal K. Dubey " power semiconductor controlled Drives" 1st edition, 1989	

# AC –DC single phase drive

## 1 -single-phase semiconverter Drives

A single-phase semiconverter feeds the armature circuit, as shown in Figure below .It is a one-quadrant drive, and is limited to applications up to 15 kW. The converter in the field circuit can be a semiconverter.

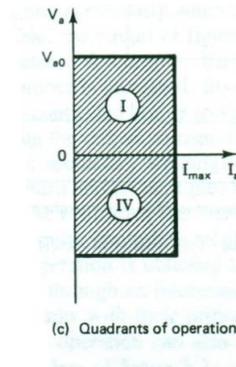
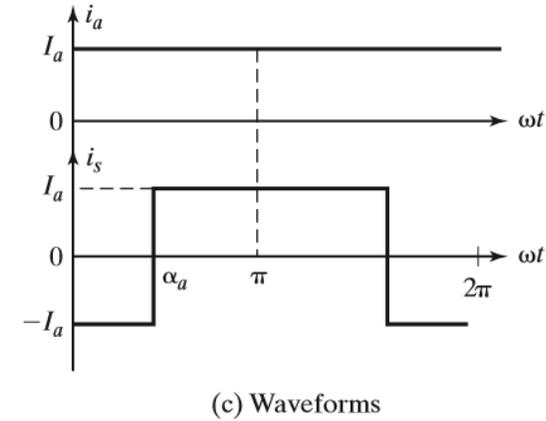
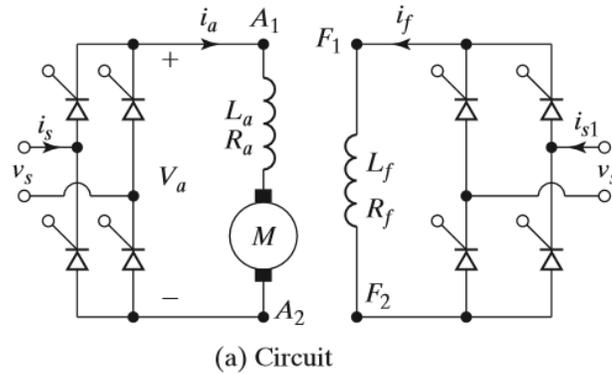


Single-phase semiconverter drive.

$$V_a = \frac{V_m}{\pi} (1 + \cos \alpha_a) \quad \text{for } 0 \leq \alpha_a \leq \pi$$

## 2- single-phase full-Converter Drives

The armature voltage is varied by a single-phase full-wave converter, as shown in Figure below. It is a two-quadrant drive, and is limited to applications up to 15kW. The armature converter gives  $+V_a$  or  $-V_a$ , and allows operation in the first and fourth quadrants.



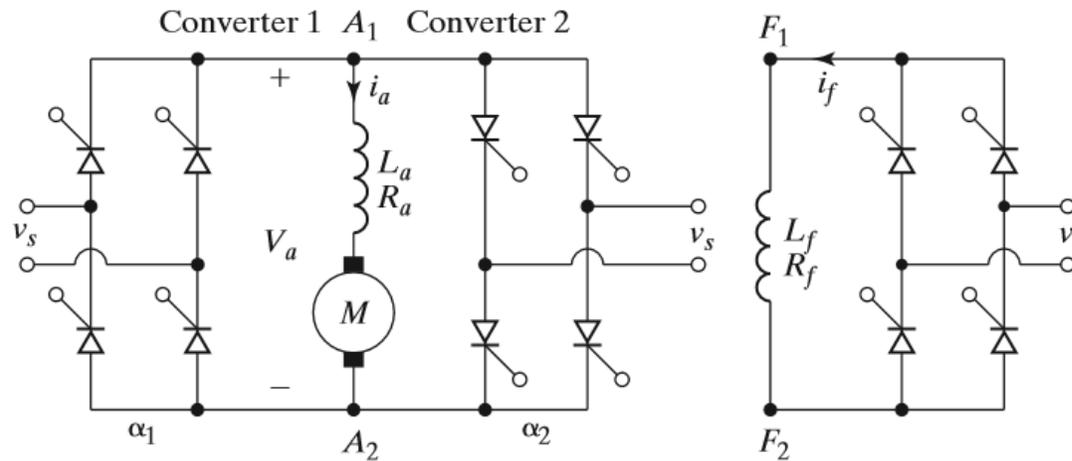
$$V_a = \frac{2V_m}{\pi} \cos \alpha_a \quad \text{for } 0 \leq \alpha_a \leq \pi$$

$$V_f = \frac{2V_m}{\pi} \cos \alpha_f \quad \text{for } 0 \leq \alpha_f \leq \pi$$

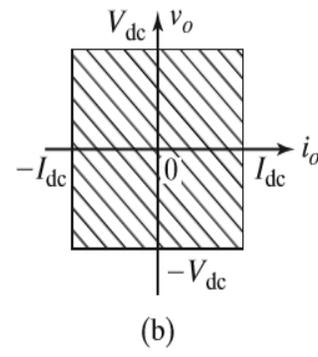
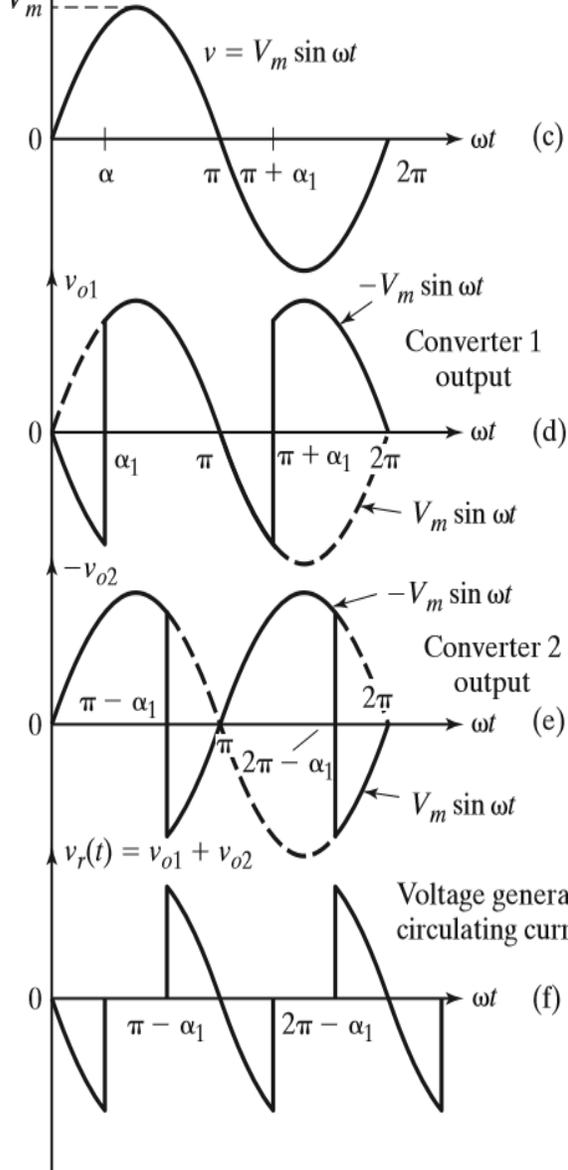
Single-phase full-converter drive.

### 3-single-phase Dual-Converter Drives

Two single-phase full-wave converters are connected, as shown in Figure below. Either converter 1 operates to supply a positive armature voltage,  $V_a$ , or converter 2 operates to supply a negative armature voltage,  $-V_a$ . Converter 1 provides operation in the first and fourth quadrants, and converter 2, in the second and third quadrants. It is a four-quadrant drive and permits four modes of operation: forward powering, forward braking (regeneration), reverse powering, and reverse braking (regeneration). It is limited to applications up to 15 kW. The field converter could be a full-wave, a semi-, or a dual converter.



Single-phase dual-converter drive.



$$V_{dc1} = \frac{2V_m}{\pi} \cos \alpha_1$$

and

$$V_{dc2} = \frac{2V_m}{\pi} \cos \alpha_2$$

Because one converter is rectifying and the other one is inverting,

$$V_{dc1} = -V_{dc2} \quad \text{or} \quad \cos \alpha_2 = -\cos \alpha_1 = \cos(\pi - \alpha_1)$$

Therefore,

$$\alpha_2 = \pi - \alpha_1$$

Note. Read example 10.3 to know about circulating current

## AC –DC three phase drive

The armature circuit is connected to the output of a three-phase controlled rectifier or a forced-commutated three-phase ac–dc converter. Three-phase drives are used for high-power applications up to megawatt power levels. The ripple frequency of the armature voltage is higher than that of single-phase drives and it requires less inductance in the armature circuit to reduce the armature ripple current. The armature current is mostly continuous, and therefore the motor performance is better compared with that of single-phase drives. Similar to the single-phase drives, three-phase drives may also be subdivided into:

1. Three-phase half-wave-converter drives .
2. Three-phase semiconverter drives .
3. Three-phase full-converter drives.
4. Three-phase dual-converter drives

### 1. Three-phase half-wave-converter drives

A three-phase half-wave converter-fed dc motor drive operates in one quadrant and could be used in applications up to a 40-kW power level. The field converter could be a single-phase or three-phase semiconverter. This drive is not normally used in industrial applications because the ac supply contains dc components.

$$V_a = \frac{3\sqrt{3}V_m}{2\pi} \cos \alpha_a \quad \text{for } 0 \leq \alpha_a \leq \pi$$

$$V_f = \frac{3\sqrt{3}V_m}{2\pi} (1 + \cos \alpha_f)$$

## 2- Three-phase semiconverter Drives

A three-phase semiconverter-fed drive is a one-quadrant drive without field reversal, and is limited to applications up to 115 kW. The field converter should also be a single-phase or a three-phase semiconverter.

With a three-phase semiconverter in the armature circuit,

$$V_a = \frac{3\sqrt{3}V_m}{2\pi}(1 + \cos \alpha_a) \quad \text{for } 0 \leq \alpha_a \leq \pi$$

With a three-phase semiconverter in the field circuit,

$$V_f = \frac{3\sqrt{3}V_m}{2\pi}(1 + \cos \alpha_f) \quad \text{for } 0 \leq \alpha_f \leq \pi$$

## 3-Three-phase full-Converter Drives

A three-phase full-wave-converter drive is a two-quadrant drive without any field reversal, and is limited to applications up to 1500 kW. During regeneration for reversing direction of power flow, the back emf of the motor is reversed by reversing the field excitation. The converter in the field circuit should be a single- or three-phase full converter. With a three-phase full-wave converter in the armature circuit,

$$V_a = \frac{3\sqrt{3}V_m}{\pi} \cos \alpha_a \quad \text{for } 0 \leq \alpha_a \leq \pi$$

$$V_f = \frac{3\sqrt{3}V_m}{\pi} \cos \alpha_f \quad \text{for } 0 \leq \alpha_f \leq \pi$$

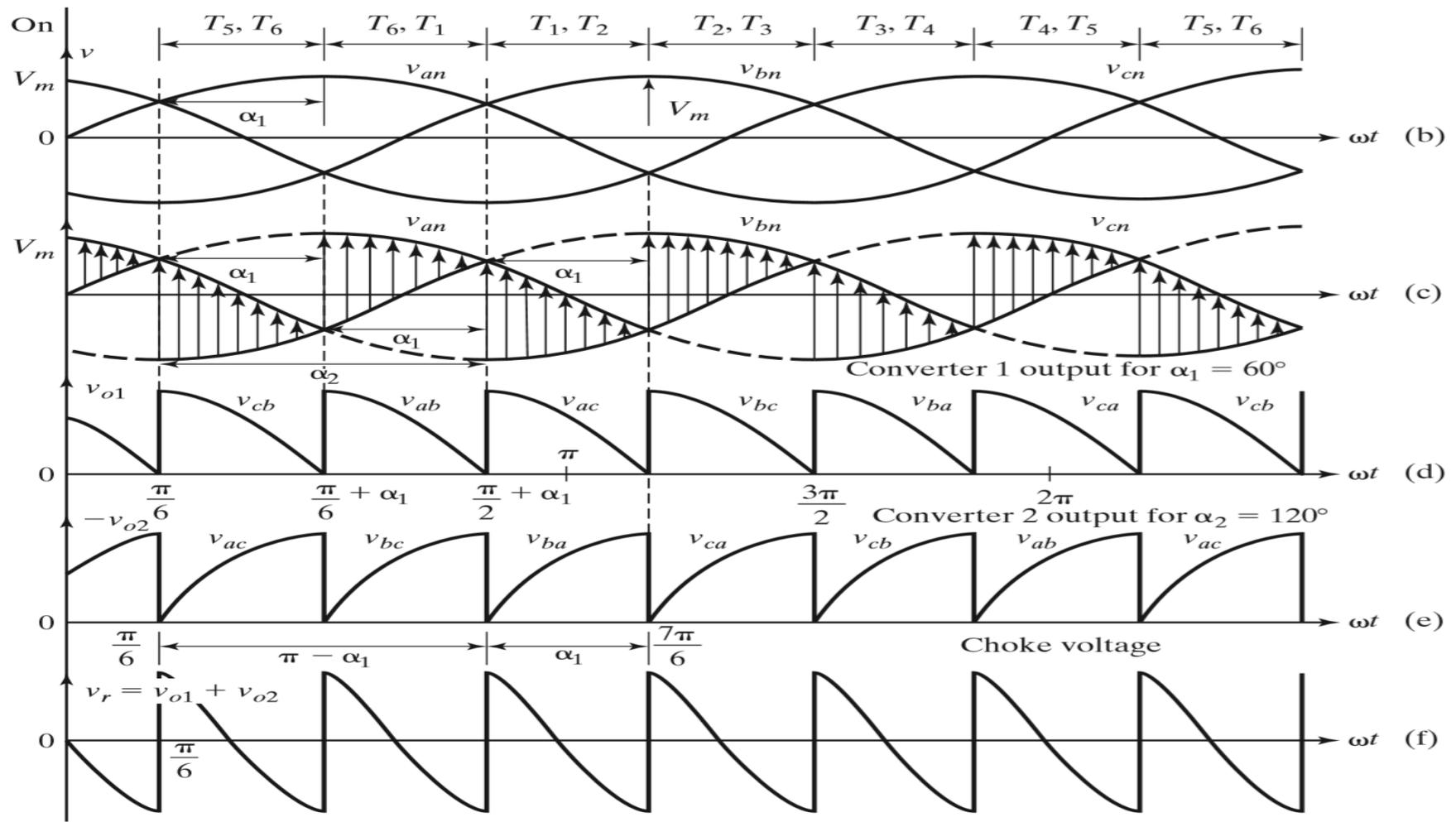
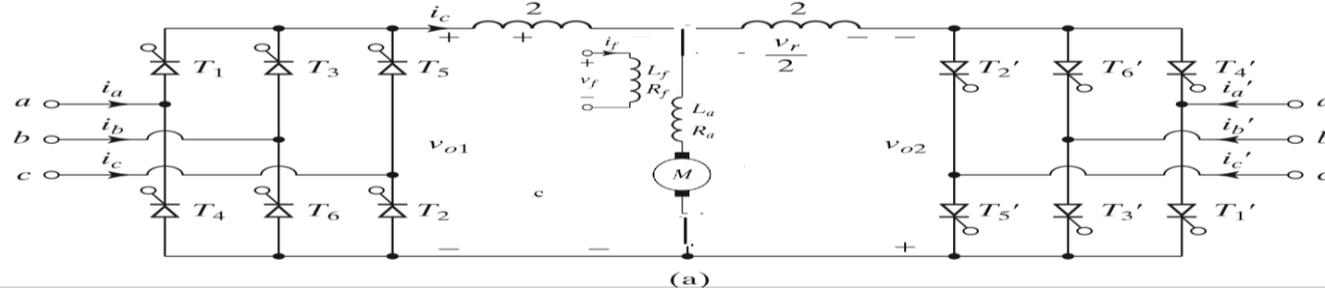
## 4-Three-phase Dual-Converter Drives

Two three-phase full-wave converters are connected in antiparallel. Either converter 1 operates to supply a positive armature voltage,  $V_a$ , or converter 2 operates to supply a negative armature voltage,  $-V_a$ . It is a four-quadrant drive and is limited to applications up to 1500 kW. Similar to single-phase drives, the field converter can be a full-wave converter or a semiconverter. If converter 1 operates with a delay angle of  $\alpha_{a1}$ ,

$$V_a = \frac{3\sqrt{3}V_m}{\pi} \cos \alpha_{a1} \quad \text{for } 0 \leq \alpha_{a1} \leq \pi$$

$$V_a = \frac{3\sqrt{3}V_m}{\pi} \cos \alpha_{a2} \quad \text{for } 0 \leq \alpha_{a2} \leq \pi$$

$$V_f = \frac{3\sqrt{3}V_m}{\pi} \cos \alpha_f \quad \text{for } 0 \leq \alpha_f \leq \pi$$



Three-phase dual converter. (a) Circuit, (b) Triggering sequences, (c) Input supply voltages, (d) Output voltage for converter 1, (e) Output voltage for converter 2, and (f) Circulating inductor voltage.