

Performance Parameters

$$FormFactor = \frac{V_{rms}}{V_{avg}}$$

$$CrestFactor = \frac{V_{peak}}{V_{rms}}$$

$$DistortionFactor = \frac{I_{1rms}}{I_{rms}}$$

$\phi$  : phase difference between fundamentals of current and voltage

$$DisplacementPowerFactor = \cos(\phi)$$

$$TruePowerFactor = \frac{P}{S} = DPF \frac{I_{1,RMS}}{I_{RMS}}$$

$$THD = \sqrt{\left(\frac{I_{rms}}{I_{1rms}}\right)^2 - 1}$$

Single Phase Diode Rectifier

$$V_{av} = \frac{2\sqrt{2}V_s}{\pi}$$

$u$ : commutation period

$$\cos(u) = 1 - \frac{2\omega L_s I_d}{\sqrt{2}V_s}$$

$$I_{d,avg} = \frac{\int_b^f i(\theta) d\theta}{\pi}$$

$$I_{d,shortcircuit} = \frac{V_s}{\omega L_s}$$

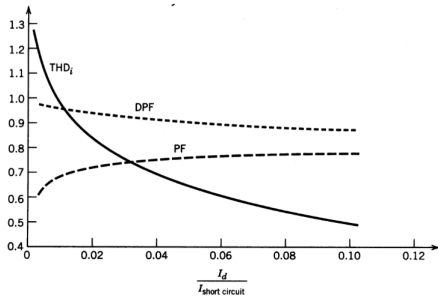


Figure 1: Characteristics of source current wrt  $w \cdot L_s$  (battery on load side)

Three Phase Rectifier

• Half Wave

$$V_{av} = \frac{3\sqrt{6}V_s}{2\pi}$$

Crossing points (integration) on the waves are from  $\pi/6$  to  $5\pi/6$

• Full Wave

Full Bridge Rectifier Average Output  $V_s$ :rms value of source voltage

$$V_{av} = \frac{3\sqrt{6}V_s}{\pi} - \frac{3\omega L_s I_d}{\pi}$$

Single Phase Controlled Rectifiers-Thyristors

• Idealized Circuit  $\alpha$  : firing angle

$$V_{av}(\alpha) = \frac{2\sqrt{2}V_d}{\pi} \cdot \cos \alpha$$

• Effect of  $L_s$

$$\cos(\alpha + u) = \cos(\alpha) - \frac{2\omega L_s I_d}{\sqrt{2}V_s}$$

$$V_d = 0.9V_s \cos(\alpha) - \frac{2\omega L_s I_d}{\pi}$$

• Inverter Mode

$$ExtinctionAngle = \gamma = 180 - (\alpha + u)$$

Three Phase Controlled Rectifiers-Thyristors

• Idealized Circuit  $\alpha$  : firing angle

$$V_{av}(\alpha) = \frac{3\sqrt{2}V_{LL}}{\pi} \cdot \cos \alpha$$

• Effect of  $L_s$

$$\cos(\alpha + u) = \cos(\alpha) - \frac{2\omega L_s I_d}{\sqrt{2}V_{LL}}$$

$$V_d = \frac{3\sqrt{2}}{\pi} V_{LL} \cos(\alpha) - \frac{3\omega L_s I_d}{\pi}$$

• Output Waveforms

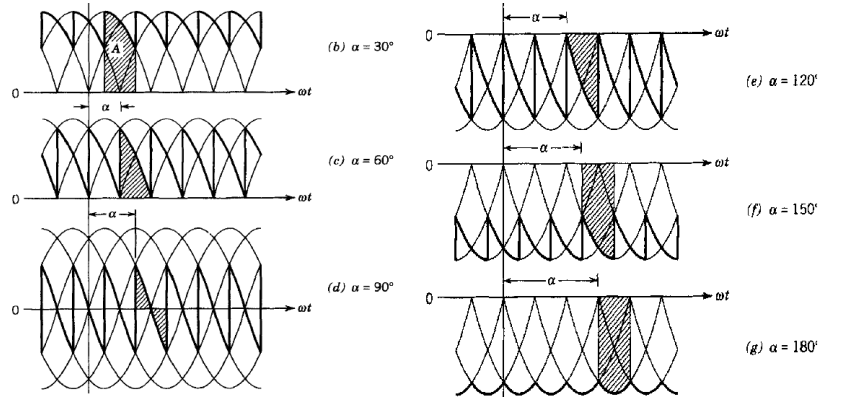


Figure 2: Output Voltage Waveforms

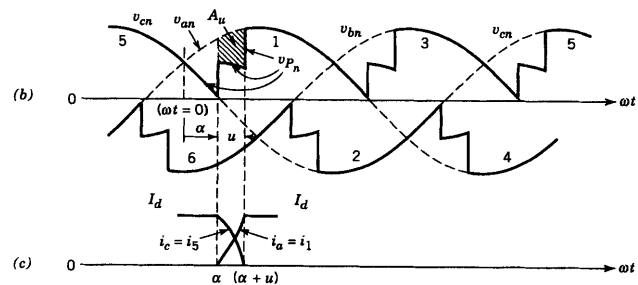


Figure 6-25 Commutation in the presence of  $L_s$ .

Figure 3: Effect of Commutation

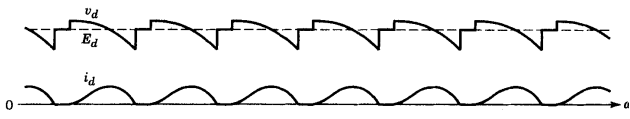


Figure 6-30 Waveforms in a discontinuous-current-conduction mode.

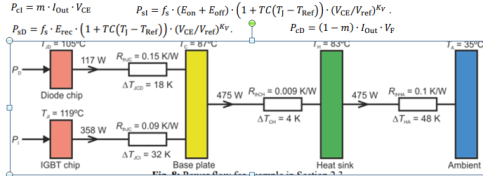


Figure 4: Discontinuous Current Conduction Mode

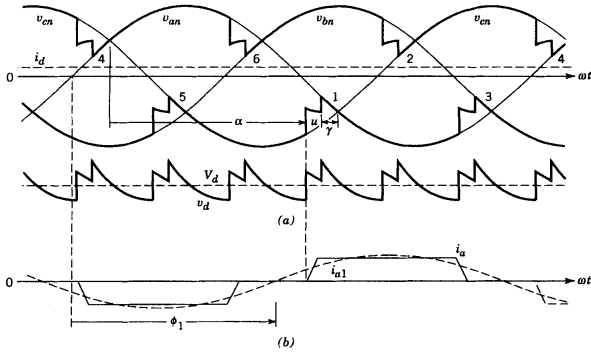


Figure 6-32 Waveforms in the inverter of Fig. 6-31.

Figure 5: Inverter Waveforms

### Trigonometric

$$\sin A \cos B = \frac{1}{2} [\sin(A - B) + \sin(A + B)]$$

$$\sin A \sin B = \frac{1}{2} [\cos(A - B) - \cos(A + B)]$$

$$\cos A \cos B = \frac{1}{2} [\cos(A - B) + \cos(A + B)]$$

$$\cos A + \cos B = 2 \cos\left(\frac{A + B}{2}\right) \cos\left(\frac{A - B}{2}\right)$$

$$\cos A - \cos B = -2 \sin\left(\frac{A + B}{2}\right) \sin\left(\frac{A - B}{2}\right)$$

$$\sin^2(A) = \frac{1}{2} - \frac{\cos(2A)}{2}$$

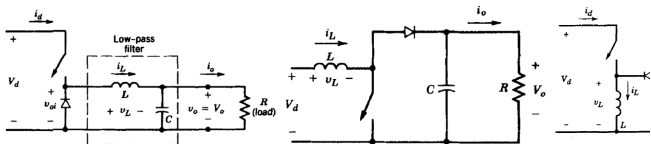
Symmetry	Condition Required	$a_n$ and $b_n$
Even	$f(-t) = f(t)$	$b_n = 0$ $a_n = \frac{2}{\pi} \int_0^\pi f(t) \cos(h\omega t) d(\omega t)$
Odd	$f(-t) = -f(t)$	$a_n = 0$ $b_n = \frac{2}{\pi} \int_0^\pi f(t) \sin(h\omega t) d(\omega t)$
Half-wave	$f(t) = -f(t + \frac{1}{2}T)$	$a_n = b_n = 0$ for even $h$ $a_n = \frac{2}{\pi} \int_0^\pi f(t) \cos(h\omega t) d(\omega t)$ for odd $h$ $b_n = \frac{2}{\pi} \int_0^\pi f(t) \sin(h\omega t) d(\omega t)$ for odd $h$

Figure 6: Fourier Transform Table

### Power Flow

$$P = V_s I_{s1} \cos(\phi) = V_d I_d$$

$$S = V_s I_s$$



### Convection Thermal Resistance

$$R_c = \frac{1}{Ah}$$

### Fluid Temperature Rise

For a liquid cooled system

$$\Delta T = \frac{P}{Q \cdot d \cdot C_p}$$

### Conduction Heat Loss

$$P = \frac{\Delta T}{R}$$

### Radiation Heat Loss (Black body radiation)

$q_R$ : radiation heat flow (W/m<sup>2</sup>)

$$q_R = \rho \epsilon F (T_1^4 - T_2^4)$$

### LC Filter(Undamped)

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

### Transfer Function

$$H(s) = \frac{1}{1 + LCs^2}$$