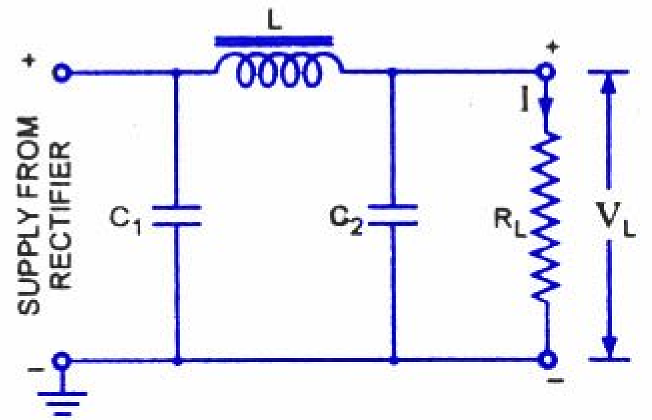
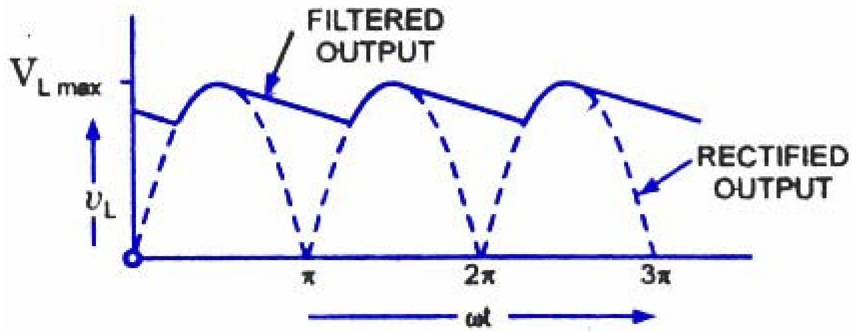
π - SECTION FILTER : (CLC FILTER)



Circuit Diagram



Rectified and Filtered Output Voltage Waveforms
Full-Wave Rectifier With Capacitor Input Filter

The π section or CLC filter basically consists of induction and two capacitors. This circuit appears like a Greek letter π. So it called as π section filter

Inductor $\rightarrow$ blocks a.c.

allows d.c.

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This filter is used when higher voltage and power ripple is required than obtained by L-section filter. In this filter C_1 is selector to offer low resistance to ripple the major part of filtering is done by C_1 most of the remaining ripple is removed by L-Section filter consisting of L and C_2.

In a π-section, it is considered by action of L-section filter upon the triangular output voltage from first capacitor C_1.

Fourier series of triangular waveform is given by

$$v = V_{dc} - \frac{V_{\gamma\ p-p}}{\pi}\left(\sin 2\omega t - \frac{\sin 2\omega t}{2} + \frac{\sin 6\omega t}{2} + ...\right) \qquad - \qquad (1)$$

$$V_{\gamma\ p-p} = V_\gamma = ripple\ voltage$$

In case of FWR with capacitor filter

$$V_\gamma = \frac{I_{dc}}{2fC_1} \qquad (here\ C = C_1) \qquad - \qquad (2)$$

Rms vale of second harmonic $V_2{}' = \dfrac{\frac{V_\gamma}{\pi}}{\sqrt{2}}$

$$V_2{}' = \frac{V_\gamma}{\pi\sqrt{2}} \qquad - \qquad (3)$$

Substitute (2) in (3)

$$V_2{}' = \frac{I_{dc}}{\pi\sqrt{2}\,fC_1}$$

$$= \frac{I_{dc}}{\sqrt{2}\omega C_1}$$

$$= \frac{I_{dc}}{\sqrt{2}} XC_1 \cdot 2$$

$$= \frac{1}{\sqrt{2}} I_{dc} XC_1 \cdot 2$$

$$V_2{}' = \sqrt{2} I_{dc} XC_1$$

Where X_{C_1} is $\frac{1}{2\omega C_1} = \frac{1}{4\pi f C_1}$ which is the reactance of C_1 at 2nd harmonic frequency.

The voltage $V_2{}'$ is imposed on L-section filter.

$\therefore$ Output ripple, $V'_{rms} = I'_{rms} X_{C_2}$

$$= \frac{V'_2}{X_L} X_{C_2} =$$

$$V'_{rms} = \frac{\sqrt{2} I_{dc} X_{C_1} X_{C_2}}{X_L}$$

Ripple factor, $\gamma = \frac{V'_{rms}}{V_{dc}}$

$$= \frac{\sqrt{2} I_{dc} X_{C_1} X_{C_2}}{X_L V_{dc}}$$

$$= \frac{\sqrt{2} I_{dc} X_{C_1} X_{C_2}}{X_L I_{dc} R_L}$$

$$\boxed{\gamma = \frac{\sqrt{2} X_{C_1} X_{C_2}}{X_L R_L}}$$ at 2nd harmonic

$$\gamma = \frac{\sqrt{2}\left(\frac{1}{2\omega C_1}\right)\left(\frac{1}{2\omega C_2}\right)}{2\omega l \quad R_L}$$

$$\boxed{\gamma = \frac{\sqrt{2}}{3\omega^3 L C_1 C_2 R_L}}$$

$$\gamma = \frac{1}{4\sqrt{2}\omega^3 L C_1 C_2 R_L}$$

If f = 50Hz   L is in H,   C in μf

$$\gamma = \frac{\sqrt{2}}{8(2\pi \times 50)^3 L \times 10^{-12} \times C_1 C_2 \times R_L}$$
$$= \frac{5701.3}{L C_1 C_2 R_L}$$

Multiple π -Section filter :

Ripple factor for I stage i.e, $C_1 C_2$ is

$$\gamma = \frac{\sqrt{2} X_{C_1} X_{C_2}}{X_L R_L}$$

$$\gamma = \frac{\sqrt{2} X_{C_1} X_{C_2}}{X_L R_L} \frac{X'_{C_1} X'_{C_2}}{X'_L R_L}$$

Comparison of various filter circuits in terms of ripple factor: (for FWR)

Type of filter	**ripple factor**
Inductor filter	$\frac{R_L}{6\sqrt{2}\pi fL} = \frac{R_L}{3\sqrt{2}\omega L}$
Capacitor filter	$\frac{1}{4\sqrt{3} fCR_L}$
L-Section filter	$\frac{\sqrt{2}}{12\omega^2 LC} = \frac{1}{6\sqrt{2}\omega^2 LC}$
Multiple L-Section filter	$\frac{\sqrt{2}}{3} \cdot \frac{X_{C_1}}{X_{L_1}} \cdot \frac{X_{C_2}}{X_{L_2}} = \frac{\sqrt{2}}{3} \frac{1}{16\pi^2 f^2 L_1 L_2 C_1 C_2}$
π -Section filter	$\frac{\sqrt{2}}{8\omega^3 LC_1 C_2 R_L}$
Multiple π -Section filter	$\frac{\sqrt{2} X_{C_1} X_{C_2}}{X_{L_1} R_L} \frac{X_{C_3} X_{C_4}}{X_{C_2} R_L}$

Problem :

1. A 230V, 50Hz voltage is applied to primary 4:1step down transformer used in bridge rectifier having a load resistance of 600Ω. Assuming diode is ideal find dc output voltage, Dc power delivered to load, Peak inverse voltage. Output frequency.

Sol. $\frac{E_1}{E_2} = \frac{n_1}{n_2}$

$$\frac{230}{E_2} = \frac{4}{1} = E_2 = 57.5V = V_{rms}$$

$$v_M = 57.5 \times \sqrt{2}$$

Dc output voltage, $V_{dc} = \frac{2V_m}{\pi}$

$$= \frac{2 \times 57.5 \times \sqrt{2}}{\pi}$$
$$= 36.6V \times \sqrt{2}$$
$$= 51.768V$$

Dc power delivered to load $= \frac{(V_{dc})^2}{R_L}$

$$= \frac{(51.768)^2}{600}$$
$$= 4.466W$$

Peak inverse voltage $= V_m$

$$= 57.5 \times \sqrt{2}$$
$$= 81.317V$$

Output frequency $= 2f$

$$= 100Hz$$