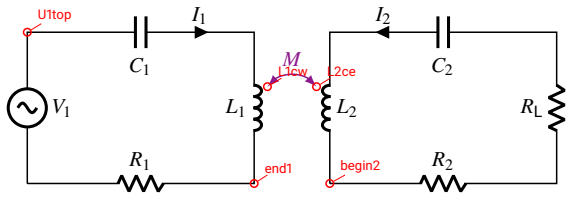
Power Electronics Cheat Sheet — Youhao HU

SS-Type Wireless Power Transfer



Resonant frequency f, angular frequency ω:

$$f = \frac{1}{2\pi\sqrt{L_1C_1}} = \frac{1}{2\pi\sqrt{L_2C_2}}$$
$$\omega = 2\pi f$$

Equivalent resistance:

$$Z_{in1} = R_1 + \frac{\omega^2 M^2}{R_2 + R_e}$$
$$Z_{in2} = j\left[\omega M + \frac{R_1(R_2+R_e)}{\omega M}\right] \approx j\omega M$$

Inverter output voltage V_1, rectifier input voltage V_2:

$$V_1 \approx \frac{4}{\pi}V_{DC}\sin(\omega t) = 1.27V_{DC}\sin(\omega t)$$
$$V_2 = R_e I_2 = \frac{4R_eV_{DC}\cos(\omega t)}{\pi\left[\omega M + \frac{R_1(R_2+R_e)}{\omega M}\right]} \approx \frac{4R_e}{\pi\omega M}V_{DC}\cos(\omega t)$$

Current:

$$I_1 = \frac{V_1}{Z_{in1}} = \frac{4V_{DC}\sin(\omega t)}{\pi\left(R_1 + \frac{\omega^2M^2}{R_2+R_e}\right)}$$
$$I_2 = \frac{V_1}{Z_{in2}} = \frac{4V_{DC}\cos(\omega t)}{\pi\left[\omega M + \frac{R_1(R_2+R_e)}{\omega M}\right]} \approx \frac{4}{\pi\omega M}V_{DC}\cos(\omega t)$$

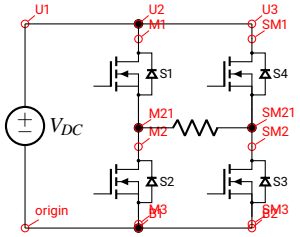
Note: I_2 is constant with respective to different R_L since $R_1 \approx 0$.

RMS value

$$V = V_m\sin(\omega t)$$

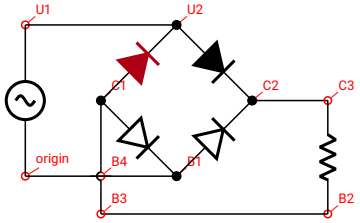
$$V_{RMS} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V^2\,\mathrm{d}t} = \frac{V_m}{\sqrt{2}}$$

Phsae Shift Control



$$S_1 = \bar{S}_2 = \frac{1}{2}\left\{\text{sign}\left[\sin\left(\omega t + \frac{D}{2}\pi - \frac{2\pi}{4}\right)\right] + 1\right\}$$
$$S_3 = \bar{S}_4 = \frac{1}{2}\left\{\text{sign}\left[\sin\left(\omega t - \frac{D}{2}\pi - \frac{2\pi}{4}\right)\right] + 1\right\}$$
$$V_R = V_{DC}(S_1 - S_3) \approx \frac{4}{\pi}V_{DC}\sin\left(D\frac{\pi}{2}\right)\sin(\omega t)$$

Full Bridge Rectifier



Average output voltage:

$$V_{ave} = \frac{1}{\pi}\int_\alpha^\pi \sqrt{2}V_s\sin(\omega t)d(\omega t) = \frac{2\sqrt{2}V_s}{\pi}\frac{1+\cos\alpha}{2}$$

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