Series Resonant Converter

Subinterval Equivalent Circuits

Assumptions:
- \( V_{in} = nV_g \)
- Devices are ideal → no parasitic effects
Complete State Plane – Phase Shift Modulation

\[ r_2^2 = (2r m_2)^2 + s_2^2 = (2r m_2)^2 + s_2^2 \]
\[ \beta = \tan^{-1}\left(\frac{s_2}{2r m_2}\right) + \tan^{-1}\left(\frac{3s_2}{2r m_2}\right) \]

\[ r_1^2 = m_1^2 + s_1^2 = m_1^2 + s_1^2 \]
\[ \alpha = \tan^{-1}\left(\frac{m_1}{3s}\right) + \tan^{-1}\left(\frac{m_1}{3s}\right) \]

\[ m_1^2 + s_1^2 = m_2^2 + s_2^2 \]
\[ y + m_1^2 + y m_1 + s_1^2 = y + m_2^2 + y m_2 + s_2^2 \]
\[ -y - y m_1 = -y - y m_1 \]
\[ -y - y m_1 = -y - y m_1 \]

\[ M_1 = M_2 \]
\[ x = \beta \]
\[ z = s_2 \]
Averaging Step

\[ n \langle i_{out} \rangle = \frac{1}{T_5} \int_{0}^{T_5} i_c(t) \, dt \]

\[ = \frac{2}{T_5} \left[ B_1 + B_2 \right] \]

\[ = \frac{2}{T_5} \left[ C_r \left( \frac{V_1 + V_2}{2V_1} \right) + C_r \left( \frac{V_1 - V_2}{2V_1} \right) \right] \]

\[ \approx \frac{2}{T_5} 2C_r V_1 \]

\[ J = \frac{\pi \langle i_{out} \rangle}{2V_0} = \frac{2}{T_5} \frac{2C_r V_1}{V_0} \sqrt{\frac{V_0}{C_r}} = \frac{E}{\pi} \frac{2M_1}{2} = J \]

Complete Solution

\[ J = \frac{E}{\pi} 2M_1 \]

\[ \alpha = 2 \tan^{-1} \left( \frac{m_1}{3} \right) \]

\[ \beta = 2 \tan^{-1} \left( \frac{3}{2 + m_1} \right) \]

\[ \tan \left( \frac{\alpha}{2} \right) = \frac{3}{2 + m_1} \]

\[ \tan \left( \frac{\beta}{2} \right) = \frac{3}{2 + m_1} \]

\[ M_1 = \frac{\tan \left( \frac{\alpha}{2} \right) \tan \left( \frac{\beta}{2} \right)}{2 + m_1} \]

\[ M_1 = \frac{2 \tan \left( \frac{\alpha}{2} \right) \tan \left( \frac{\beta}{2} \right)}{1 - \tan \left( \frac{\alpha}{2} \right) \tan \left( \frac{\beta}{2} \right)} \]

\[ J = \frac{E}{\pi} 2 \left( \frac{2 \tan \left( \frac{\alpha}{2} - \frac{\beta}{2} \right) \tan \left( \frac{\beta}{2} \right)}{1 - \tan \left( \frac{\alpha}{2} \right) \tan \left( \frac{\beta}{2} \right)} \right) \]

\[ \text{Det} = r_1 = \sqrt{M_1^2 + J^2} \]
SRC Control Trajectory

SRC Current Stress