Simplification

\[
S = \frac{2\pi}{\pi} m_i \\
\alpha = \pi - 2\tan^{-1}\left(\frac{s_i}{m_i}\right) \\
\frac{\pi}{\beta} = \alpha + \beta \\
\rho = 2\tan^{-1}\left(\frac{s_i}{\beta + m_i}\right) \\
\tan\left(\frac{\beta}{2}\right) (2 + m_i) = S_i \\
\tan\left(-\frac{\beta + \pi}{2}\right) = \frac{s_i}{m_i} = \frac{2 + m_i}{m_i + \tan \frac{\beta}{2}} \\
M_i \tan\left(\frac{\pi - \beta}{2}\right) = 2 \tan \frac{\beta}{2} + m_i \tan \frac{\beta}{2} \\
M_i = \frac{2M_i}{\tan\left(\frac{\pi - \beta}{2}\right) - \tan \frac{\beta}{2}} \\
S = \frac{2\pi}{\pi} \frac{2 \tan \frac{\beta}{2}}{\tan\left(\frac{\pi}{2} - \frac{2\pi}{2} + \frac{\beta}{2}\right) - \tan \frac{\beta}{2}}
\]

SRC Control Trajectory

[Graph showing SRC control trajectory with various modulation types and parameters such as F = 1.05 and F = 1.5.]
**SRC Near Resonance**

\[ f_s \approx f_0 \]
\[ f_s \neq f_0 \]

Slightly

**SRC – Low \( V_{out} \)**

\[ V \neq V_o \]
SRC – $F >> 1$

$F >> f >> f_o$

DAB vs SRC

R. Lenke, F. Mura and R. W. De Doncker, "Comparison of non-resonant and super-resonant dual-active ZVS-operated high-power DC-DC converters."
**DAB vs SRC: Conclusions**

**DAB**
- Smaller resonant tank
- Smaller RMS currents
- Wider Soft-switching range

**SRC**
- Can be designed with larger $XF$ inductance
- Lower AC winding losses
- Reduced device turn-off losses
Linear Averaged Modeling of DAB

- Assuming squarewave outputs of both bridges, inductor current consists of linear segments
- If $L_i$ has zero DC bias, average output current solved algebraically

$$\langle i_o \rangle_{T_s} \approx \int_0^{T_s} \frac{i_o(t)dt}{T_s} = \frac{v_o(t)}{n_{L_i}T_s} \left( T_s t_\varphi - 2t_\varphi^2 \right)$$

Superposition of Output Current

- Considering primary and secondary squarewaves independently
- Contribution of secondary to $i_o$ is purely AC
- Contribution of primary to $i_o$ contains DC component
Superposition of Output Current

- Considering primary and secondary squarewaves independently
- Contribution of secondary to \( i_o \) is purely AC
- Contribution of primary to \( i_o \) contains DC component
- As \( V_{out} \) increases, only AC component from secondary is increased
- Average current unaffected