Exact state-plane analyses of the series and parallel resonant converters

Textbook Section 19.5

Additional typed notes on the course website
Chapter 4: Series resonant converter
Chapter 5: Parallel resonant converter

State-plane analysis of the series resonant converter
Series resonant converter

Below resonance operation \((k = 1, \text{ CCM}^*)\)
definition of subintervals Q1, D1, Q2, D2

Textbook Fig. 19.25, waveforms based on sinusoidal approximation

*The operating mode notation will be explained later.
Subinterval Q1: $i_L > 0$, conducting devices: Q1, Q4, D5, D8

Subinterval D1*: $i_L < 0$, conducting devices: D1, D4, D6, D7

*Error in Fig.4.3 of Ch.4 typed notes: $M_f = 1+M$, not 1-M
Subinterval Q2: $i_L < 0$, conducting devices: Q2, Q3, D6, D7

Subinterval D2: $i_L > 0$, conducting devices: D2, D3, D5, D8
State plane for SRC (below resonance, $k = 1$, CCM)

Typical SRC waveforms (below resonance, $k=1$, CCM)
Capacitor charge arguments

SRC Steady-State Solution (below resonance, $k=1$, CCM)
SRC Steady-State Solution (below resonance, $k=1$, CCM)

![Diagram of SRC Steady-State Solution]

 SRC Steady-State Solution (below resonance, $k=1$, CCM)

![Diagram of SRC Steady-State Solution]

Fig. 4.14 The Law of Cosines
SRC Steady-State Solution (below resonance, $k=1$, CCM)

$$M^2 \sin^3\left(\frac{\pi}{2}\right) + \left(\frac{\pi}{2} - 1\right)^2 \cos^3\left(\frac{\pi}{2}\right) = 1$$

SRC Steady-State Characteristics (below resonance, $k=1$, CCM)
SRC Steady-State Output-Plane Characteristics (below resonance, $k=1$, CCM)

\[ M^2 \sin^2 \left( \frac{y}{2} \right) + \left( \frac{y}{2} - 1 \right)^2 \cos \left( \frac{y}{2} \right) = 1 \]

Special cases: discussion

 SRC Steady-State Control-Plane Characteristics (below resonance, $k=1$, CCM)

\[ M^2 \sin^2 \left( \frac{y}{2} \right) + \left( \frac{y}{2} - 1 \right)^2 \cos \left( \frac{y}{2} \right) = 1 \]
SRC Steady-State Control-Plane Characteristics (below resonance, $k=1$, CCM)

SRC below resonance, $k=1$, CCM mode boundaries