Limitations and Discussion

$$\boldsymbol{X_0} = \left(I - \prod_{i=k}^{0} e^{\boldsymbol{A}_i t_i}\right)^{-1} \sum_{i=1}^{k} \left(\prod_{j=k}^{i+1} e^{\boldsymbol{A}_j t_j}\right) \boldsymbol{A}_i^{-1} (e^{\boldsymbol{A}_i t_i} - \boldsymbol{I}) \boldsymbol{B}_i \boldsymbol{u}_i$$

Topological Time Invariance

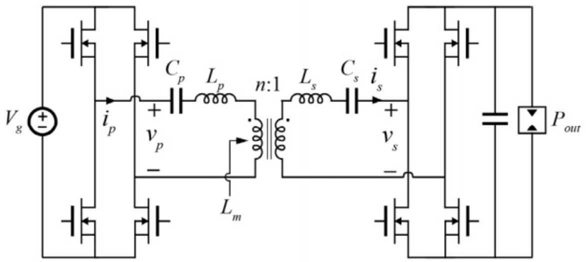

Fig. 1: Series Resonant Converter

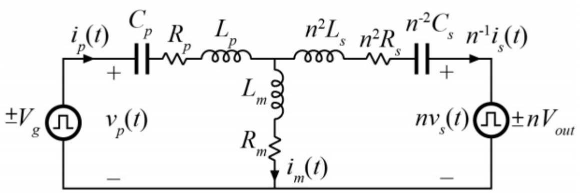

Fig. 2: Time-Invariant Circuit Model of SRC

Augmented State Space Approach

$$\boldsymbol{x}(t) = e^{\boldsymbol{A}t}\boldsymbol{x}_0 + \int_0^t e^{\boldsymbol{A}(t-\tau)}\boldsymbol{B}\boldsymbol{u}(\tau)d\tau \Longrightarrow \boldsymbol{x}(t) = e^{\boldsymbol{A}t}\boldsymbol{x}_0 + \boldsymbol{A}^{-1}(e^{\boldsymbol{A}t} - \boldsymbol{I})\boldsymbol{B}\boldsymbol{u}$$

H. R. Visser and P. P. J. van den Bosch, “Modelling of periodically switching networks,” in PESC ’91

Non-invertible A Matrices

$$C = \begin{bmatrix} A_1 & B_1 & C_1 & D_1 \\ 0 & A_2 & B_2 & C_2 \\ 0 & 0 & A_3 & B_3 \\ 0 & 0 & 0 & A_4 \end{bmatrix} \begin{matrix} \}\, n_1 \\ \}\, n_2 \\ \}\, n_3 \\ \}\, n_4 \end{matrix}$$

$$\quad \underbrace{}_{n_1} \quad \underbrace{}_{n_2} \quad \underbrace{}_{n_3} \quad \underbrace{}_{n_4}$$

$$e^{Ct} = \begin{bmatrix} F_1(t) & G_1(t) & H_1(t) & K_1(t) \\ 0 & F_2(t) & G_2(t) & H_2(t) \\ 0 & 0 & F_3(t) & G_3(t) \\ 0 & 0 & 0 & F_4(t) \end{bmatrix}$$

$$F_j(t) = e^{A_j t}, \qquad j = 1,2,3,4$$

$$G_j(t) = \int_0^t e^{A_j(t-s)} B_j e^{A_{j+1}s}\, ds, \qquad j = 1,2,3$$

$$H_j(t) = \int_0^t e^{A_j(t-s)} C_j e^{A_{j+2}s}\, ds$$

$$+ \int_0^t \int_0^s e^{A_j(t-s)} B_j e^{A_{j+1}(s-r)}$$

$$\cdot B_{j+1} e^{A_{j+2}r}\, dr\, ds, \qquad j = 1,2$$

$$K_1(t) = \int_0^t e^{A_1(t-s)} D_1 e^{A_4 s}\, ds + \int_0^t \int_0^s e^{A_1(t-s)} \left[C_1 e^{A_3(s-r)} B_3 \right.$$

$$\left. + B_1 e^{A_2(s-r)} C_2 \right] e^{A_4 r}\, dr\, ds$$

$$+ \int_0^t \int_0^s \int_0^r e^{A_1(t-s)} B_1 e^{A_2(s-r)} B_2 e^{A_3(r-w)} B_3 e^{A_4 w}\, dw\, dr\, ds.$$

Computing Integrals