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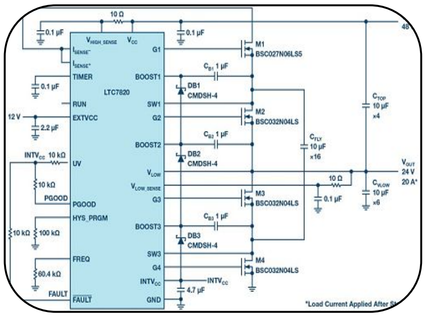
THEORETICAL ASSPECTS OF SWITCHED-CAPACITOR POWER ELECTRONICS NETWORK

Rajesh Kumar
Research Scholar , J.P.Univ. Chapra.

ABSTRACT

The high density and sufficient capacitors of switched-capacitor(SC) converters for Small Circuit Integration have increased the interest. The key reason for higher power density is the buildingaSCDC-to- DC conversion with condensers and switch. The SC converters are therefore prevailingly influenced by sand conversion losses. The SC converters are calculated by scanning and improving the output impedance of the conversioner in their both asymptotic limits.

A step-up resonant converter is proposed for the switched-converter.



KEYWORDS: *Switched-capacitor, SC, Power, Electronic, Circuits.*

INTRODUCTION :

Converters with switched condensers (SC) have become more common in the last few years [l] and are being used in growing power levels. With growing performance requirements, an effective design requires an understanding of the limitations of a SC converter.

SC converters are slightly different from magnetic energy storage power converters. In theory, SC converters dispose of an equal output resistance which is usually much higher than the power impedance of a converter with energy storage induction. For output voltage control, several methods are available. The conventional methods in [2]-[3] use duty cycle power, which improves the equivalent resistance of the converter effectively.The control of the duty cycle depends on the load which draws the power down to create a voltage divider between the resistance and load equivalents of Thevenin. For load fluctuation, the efficient regulation of the output voltage requires sophisticated techniques[4].

The design of a SC converter involves a knowledge of the technical compromises involved. Various condensers from aluminium-electrolytic to various types of dielectric did, via film and ceramic, have been given, depending on its loss characteristics each technology has a relevant field of application. For High Power Converters as proposed in the [5] 14V to 42V conversion, the choice of technology for Capacitor is especially relevant. A practically resonant converter is a rational alternative to be explored.A standard SC-Topology is used here, but the condenser is replaced with a series LC tank and there is potential for improved output if the resonant frequency can be traced. The study of this topology has repercussions for regular SC transformers because all condensers have an inductance, so all SC transformers can be run quasi-resonantly. In the [6] versus the conversion converter with a minimum equivalent strength because there is a condenser impedance, the near-resonant converter is shown to achieve maximum performance.

Power conversion is the subject of this article. Similar study of analogue philtre applications has been conducted in previous work[7], with correspondingly different approaches and findings. It focuses on continuous action, not dynamics of small signals, so the approach for modelling varies from[8,].

MODEL DERIVATION

A generic SC converter with two switching modes may be used to define the derivation of the model. The converter contains p condensers which have vector v voltages and which vector current is composed of, i. The condensers and switches are arranged for a static M increase. In diagonal, C, the value of each condenser is set, where Cjj is the power of condenser j. On the basis of a condenser description,

$$\mathbf{i} = \mathbf{C}\mathbf{v} \quad . \qquad (1)$$

The voltage sources Vin and Vout on both the input and output ports are
A vector composed into$\mathbf{u}=[Vin Vout]T$.
KVL and KCL can be used in the first mode of switching to find p independent equations of condenser tensions and currents, expressed as matrix.

$$\mathbf{E1\ i + F1\ v + G\ 1u = 0} \qquad (2)$$

$$\mathbf{i} = -\mathbf{E}_1^{-1}\mathbf{F}_1\,\mathbf{v} - \mathbf{E}_1^{-1}\mathbf{G}_1\,\mathbf{u} \qquad (3)$$

Each row of $\mathbf{E}_1$,$\mathbf{F}_1$, and $\mathbf{G}_1$Reflect KVL or KCL application. In E1 the entries for KVL rows are resistances and in F1 and G1, the voltage decreases are ±1 or zero. For rows of KCL, E1 entries are ±1 or zero and F1 and G1 entries are both zero, with node current summarised. E1 is invertible when KVL and KCL have been correctly added. Solving the results for me.
and substituting (1) gives

$$\mathbf{v} = (-\mathbf{C}^{-1}\mathbf{E}_1^{-1}\mathbf{F}_1)\,\mathbf{v} + (-\mathbf{C}^{-1}\mathbf{E}_1^{-1}\mathbf{G}_1)\mathbf{u} \qquad (4)$$

The matrices A1 and B1 are used to consolidate the coefficient vectors to simplify symbolic representation and thus to generate

$$\begin{aligned} \mathbf{v} &= \mathbf{A}_1\mathbf{v} + \mathbf{B}_1\mathbf{u} \\ &= -\mathbf{C}^{-1}\mathbf{E}_1^{-1}\mathbf{F}_1 \qquad (5) \\ &= -\mathbf{C}^{-1}\mathbf{E}^{-1}\mathbf{G}\ \mathbf{1} \end{aligned}$$

The matrices A2 and B2 for the second switching mode can be detected in related studies. A number of other circuit analysis techniques can also be used to search for a model as defined in (5).The switching modes alternate with a SC converter. The switches are available in Mode 1 for t1 and Mode 2 and t2. Usually, t1 is D1T and t2 is D2T, with T being the time of switching and D1 and D2 being the waveforms' duty proportions. The converter is expected to be in mode 1 at t 0and in mode2 at t t = t1, without loss of generality, and the loop ends at t = t1 t + t2. If the capacitor voltages are known as status, the notation of vector can be changed to relate v to x. (The duration T is used later during the analysis). The state equations therefore produce

$$\mathbf{x}\,(t_1) = \mathbf{\Phi}_1\,\mathbf{x}\,(0) + \mathbf{\Gamma}_1\mathbf{u}$$

$$\mathbf{x}\,(t_1+t_2) = \mathbf{\Phi}_2\,\mathbf{x}\,(t_1) + \mathbf{\Gamma}_2\,\mathbf{u} \qquad (6)$$

$$\Phi = e^{\mathbf{A}_1 t_1}$$

$$\mathbf{1}$$

$$\mathbf{(1)}_{\mathbf{2}} = e^{\mathbf{A}_{\mathbf{2}} t_2}$$

The matrices can be determined in the following way to complete the model:

$$\Gamma_1 = \mathbf{A}_1^{-1}\left(e^{\mathbf{A}_1 t_1} - \mathbf{I}\right)\mathbf{B}_1$$

$$\Gamma_2 = \mathbf{A}_2^{-1}\left(e^{\mathbf{A}_2 t_2} - \mathbf{I}\right)\mathbf{B}_2 \qquad (7)$$

To complete the model, the **Γ** matrices can be calculated as follows:

$$\Gamma_1 = \mathbf{A}_1^{-1}\left(e^{\mathbf{A}_1 t_1} - \mathbf{I}\right)\mathbf{B}_1$$

$$\Gamma_2 = \mathbf{A}_2^{-1}\left(e^{\mathbf{A}_2 t_2} - \mathbf{I}\right)\mathbf{B}_2 \qquad (8)$$

The symbolic formula sadly requires A1 and A2 matrix reversal. In certain cases, one of the two switching modes offers a special A matrix such as a ladder SC converter. Therefore, a numerical outcome is required instead of the symbolic outcome. In the Matlab c 2d function (and in other mathematical programmes) the traditional algorithm given as [10] is implemented. Numerical values can be found for **Φ**and**Γ**.for a certain SC converter with known values and switching times. The full data model for both switching and sampling time T contains the sample data

$$\mathbf{x}((k+1)T) = \mathbf{\Phi x}(kT) + \mathbf{\Gamma u}(kT)$$

$$\mathbf{\Phi} = \mathbf{\Phi}_2\mathbf{\Phi}_1 \qquad (9)$$

$$\mathbf{\Gamma} = \mathbf{\Phi}_2\mathbf{\Gamma}_1 + \mathbf{\Gamma}_2$$

Two uses (9) are open. The dynamic characteristics of the SC converter can be studied with this discrete time model, which is used to position voltage sources on the input and output terminals. One would want to decide how fast voltage is transmitted between the condensers, for example. Secondly, the equivalent resistance of the converter can be identified using static conditions for (9). Note that this equivalent resistance is the main output metric for switched condenser converters.

At steady-state, $\mathbf{x}((k+1)T)$ is equal to $\mathbf{x}(kT)$. With this assumption, (9) can be solved for $\mathbf{x}_0$, the equilibrium value of **x** at the beginning of each cycle:

$$\mathbf{x}_0 = (\mathbf{I} - \mathbf{\Phi})^{-1}\mathbf{\Gamma u} \qquad (10)$$

Here, **I**is the $p \times p$ identity matrixThus, at midpoint of a loop, you can evaluate the value of x (i.e. when mode 1 is shifted to mode 2):

$$\mathbf{x}_1 = \mathbf{\Phi}_1\mathbf{x}_0 + \mathbf{\Gamma}_1\mathbf{u} \qquad (11)$$

The designer identifies one capacitor, the i^{th} capacitor, that delivers all of the charge to the output. For eg, the last switching (flying) condenser will be selected for a converter with a ladder topology. The voltage change, multiplied by its power, gives the charge which it supplies, q. This time split charge is the current performance i_{out}. Thus, a SC converter with a static gain of M can easily derive its equivalent resistance as follows:

$$- = C_{ii}(x_{1,i} - x_{0,i})$$

$$^{i}o \qquad q$$

$$ut \;= \; \overline{} \qquad\qquad (12)$$

$$T$$

$$- \quad _{=}{}^{MV}in^{-V}out$$

$$^{eq}i_{out}$$

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