Model Documentation of the Buck Converter

1 Nomenclature

1.1 Nomenclature for Model Equations

L	inductivity of the inductor
C	capacity of the capacitor
R	resistance of the load
U_E	input voltage
i_L	current through the inductor
u_C	voltage over the capatitor
d	duty ratio of the switch

1.2 Circuit Diagram

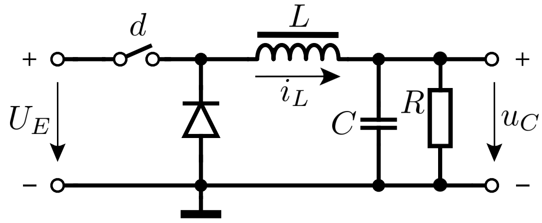

Figure 1: Circuit

2 Model Equations

State Vector and Input Vector:

$$\underline{x} = (x_1 \ x_2)^T = (i_L \ u_C)^T$$
$$\underline{u} = d$$

System Equations:

$$\dot{x}_1 = -\frac{1}{L}x_2 + \frac{U_E}{L}u \tag{1a}$$
$$\dot{x}_2 = \frac{1}{C}x_1 - \frac{1}{RC}x_2 \tag{1b}$$

Parameters: L, C, R, U_E
Outputs: $x_2 = u_C$

2.1 Exemplary parameter values

		Symbol	Value
Inductiviy	L	0.00018	H
Capacity	C	$2.0 \cdot 10^{-5}$	F
Resistence	R	10	Ω
Input Voltage	U_E	24	V

3 Derivation and Explanation

See boost converter.

4 Simulation

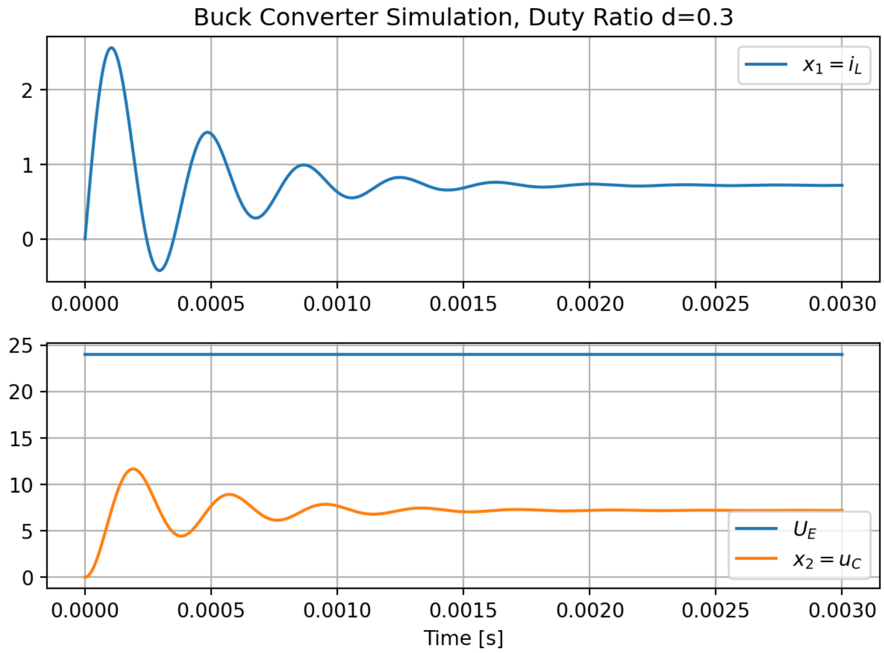

Figure 2: Simulation of the buck converter.

References

[1] R. H. G. Tan and L. Y. H. Hoo, DC-DC converter modeling and simulation using state space approach, in 2015 IEEE Conference on Energy Conversion (CENCON), Oct. 2015, pp. 42–47. doi: 10.1109/CENCON.2015.7409511.

[2] K. Röbenack, Nichtlineare Regelungssysteme: Theorie und Anwendung der exakten Linearisierung. Berlin, Heidelberg: Springer Berlin Heidelberg, 2017. doi: 10.1007/978-3-662-44091-9.