# TRANSCONVERTER

## Universal mathematical model of single-phase DC-DC bridge converter for different control algorithms

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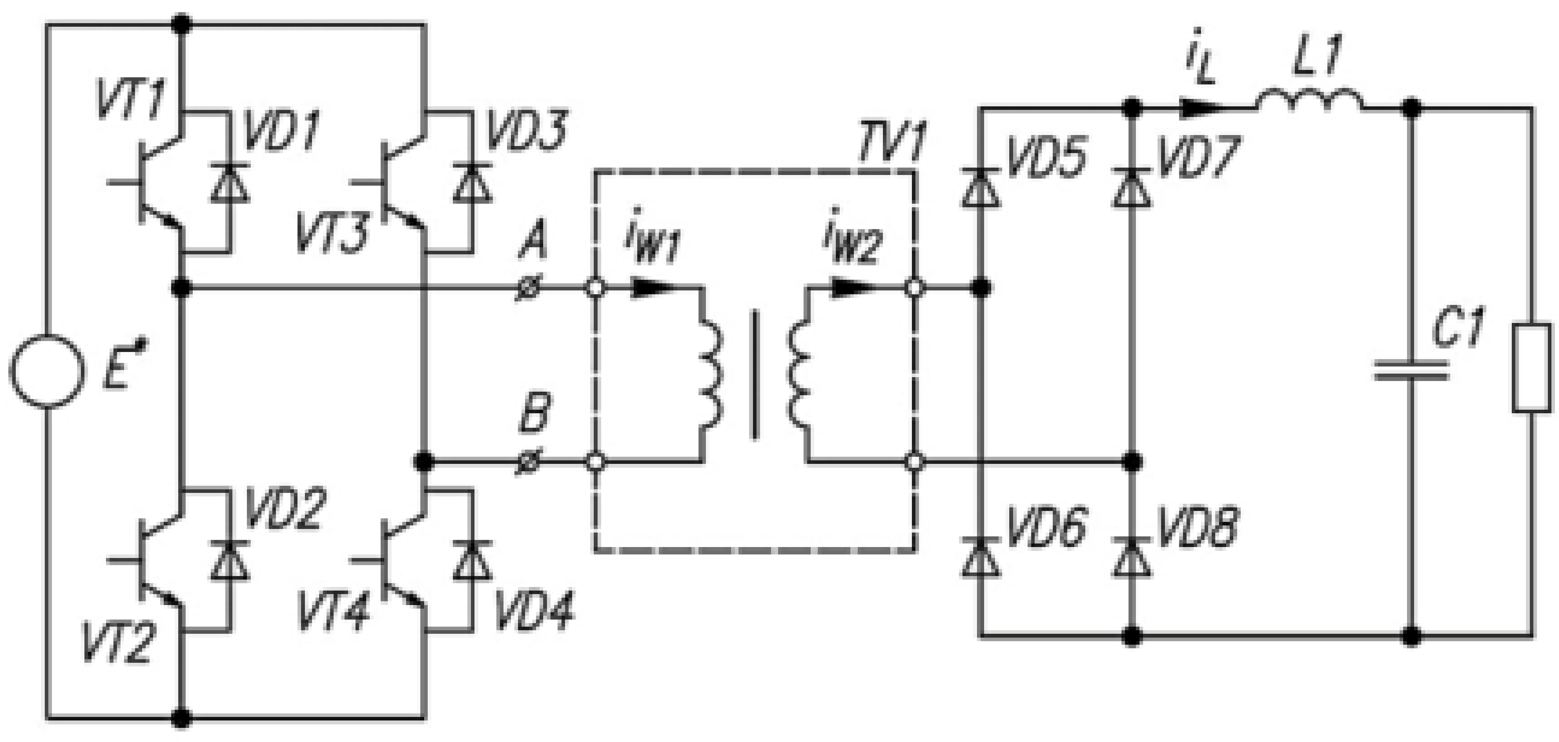


**Fig. 1.** Power circuit of the converter

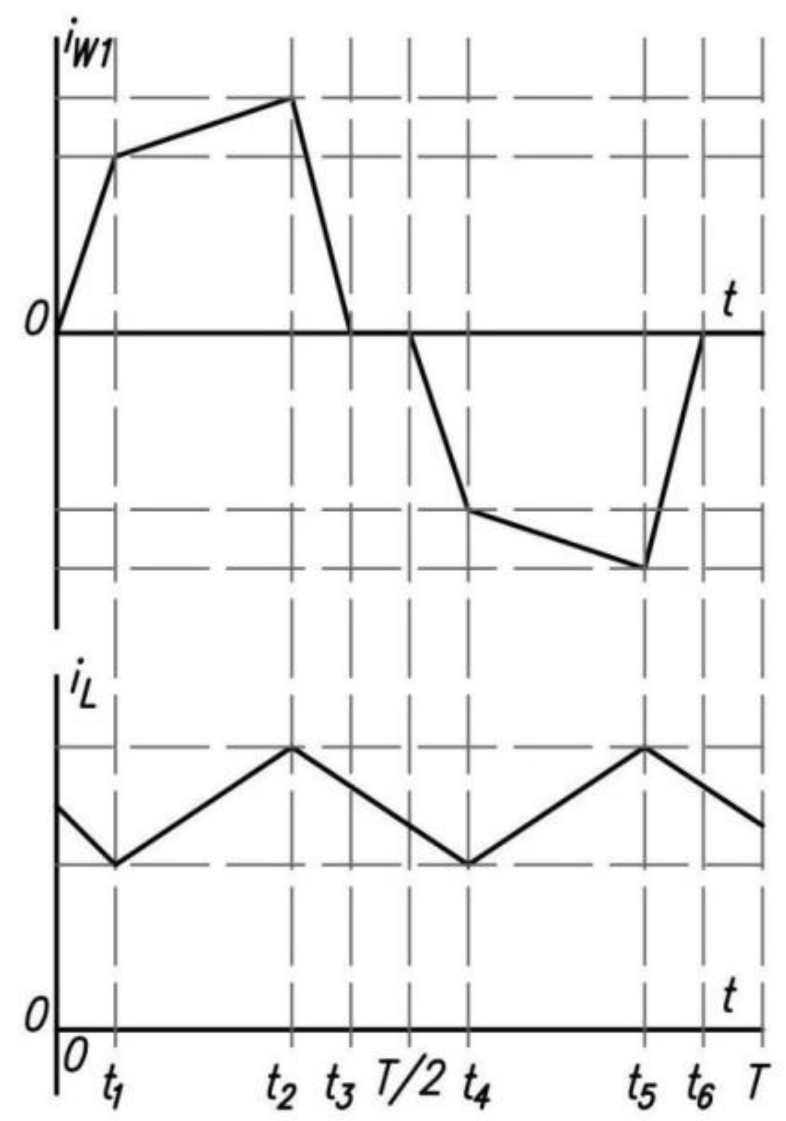


**Fig. 2.** The current of the primary winding $i_{1w}$ of the TV1 and the current $i_L$ of the L1 choke at PWR-control

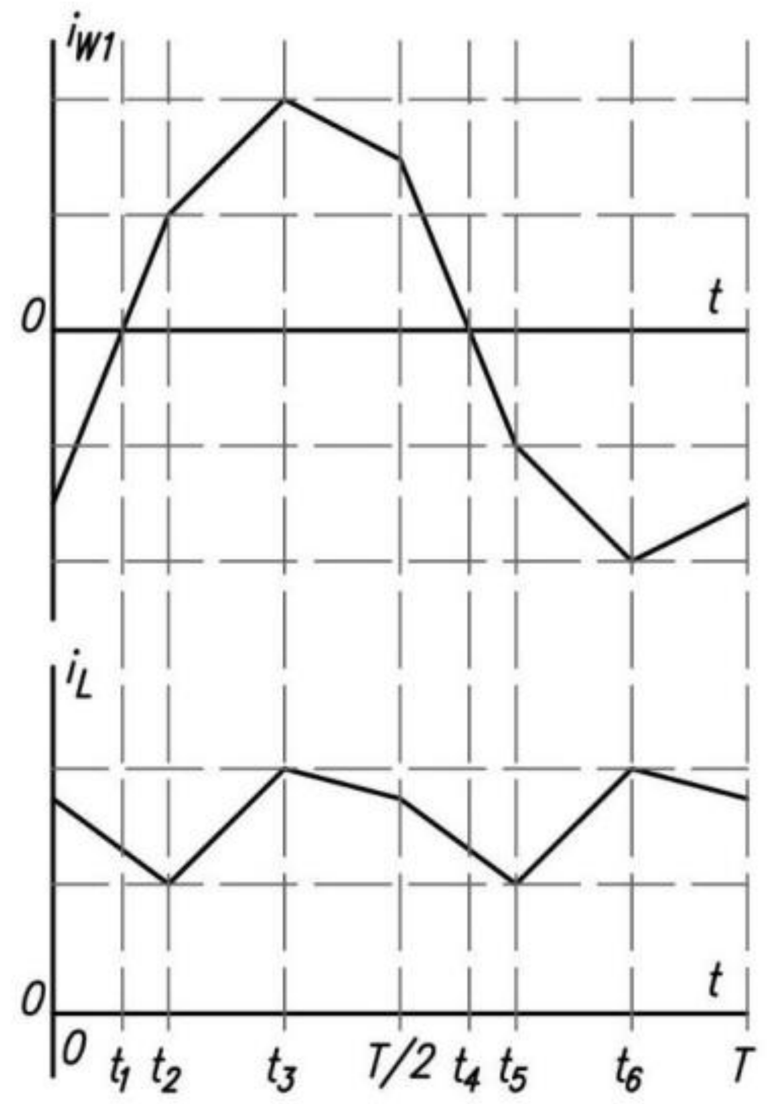


**Fig. 3.** The current of the primary winding $i_{1w}$ of the TV1 and the current $i_L$ of the L1 choke at PF-control

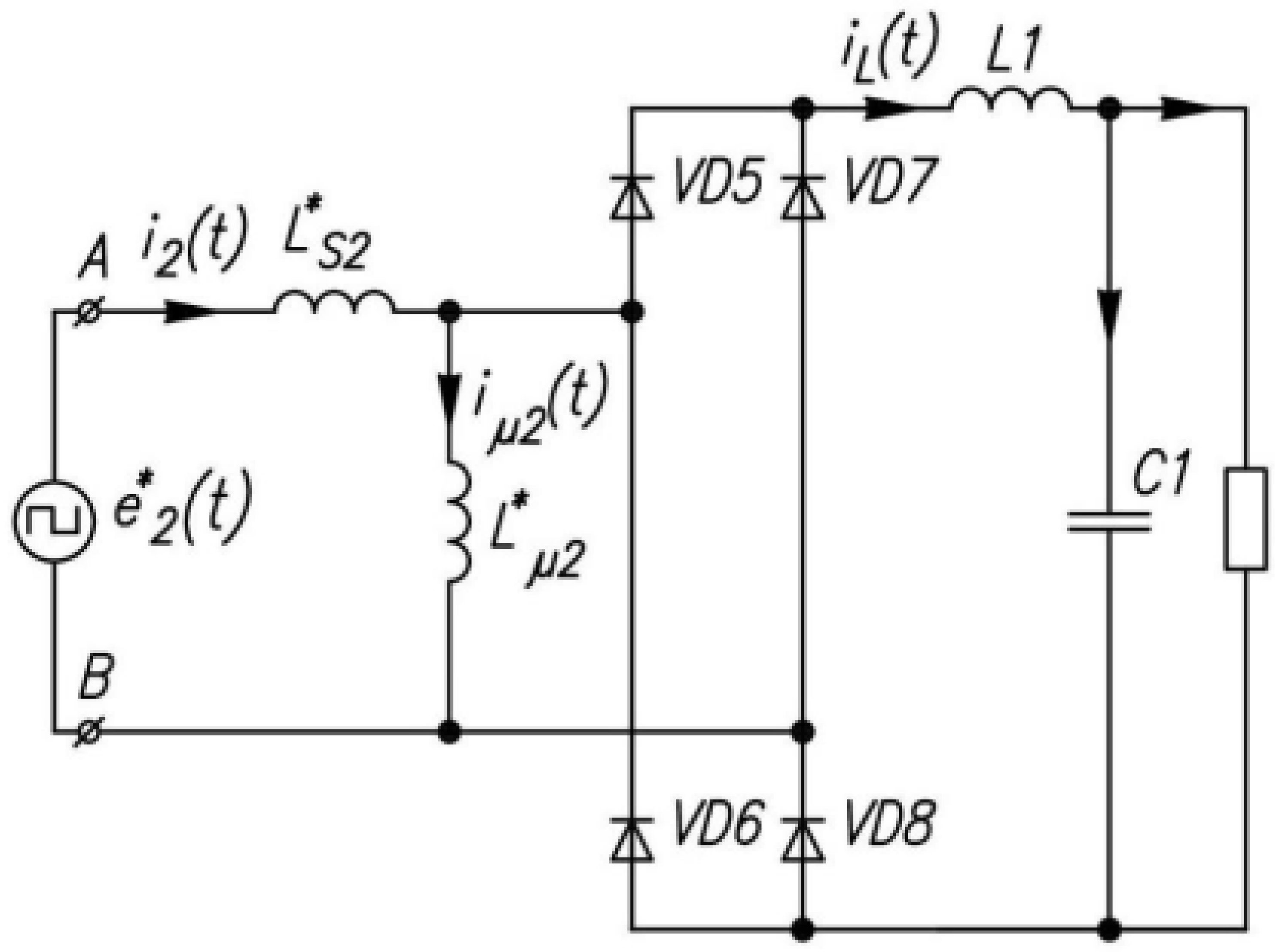


**Fig. 5.** The suggested equivalent circuit

$e_2^*(t) = E \cdot \left(d_1 \cdot d_4 - d_2 \cdot d_3 - sign[i_1(t)] \prod_{n=1}^{4} \overline{d_n}\right)$, (3)

where $d_n = \begin{cases} 0, & transistor\ is\ off-state; \\ 1, & transistor\ is\ on-state \end{cases}$ – are controlled switching functions of VT1-VT4 transistors;

$n \in \{1, 2, 3, 4\}$ – number that corresponds to the VT1-VT4 transistors;

$$sign[i_2(t)] = \begin{cases} -1, & i_2(t) < 0 \\ 0, & i_2(t) = 0. \\ 1, & i_2(t) > 0 \end{cases} \quad (4)$$

$$d_{VD5} = d_{VD8} = \begin{cases} 1, & i_L(t) + [i_2(t) - i_{\mu 2}(t)] > 0 \\ 0, & i_L(t) + [i_2(t) - i_{\mu 2}(t)] = 0 \end{cases},$$

$$d_{VD6} = d_{VD7} = \begin{cases} 1, & i_L(t) - [i_2(t) - i_{\mu 2}(t)] > 0 \\ 0, & i_L(t) - [i_2(t) - i_{\mu 2}(t)] = 0 \end{cases}.$$

$$i_{VD5}(t) = i_{VD8}(t) = [i_2(t) - i_{\mu 2}(t)] \cdot \overline{d_{VD6}(t)} + \\ + \frac{1}{2}[i_L(t) + i_2(t) - i_{\mu 2}(t)] \cdot d_{VD5}(t) \cdot d_{VD6}(t),$$

$$i_{VD6}(t) = i_{VD7}(t) = [i_{\mu 2}(t) - i_2(t)] \cdot \overline{d_{VD5}(t)} + \\ + \frac{1}{2}[i_L(t) + i_2(t) - i_{\mu 2}(t)] \cdot d_{VD5}(t) \cdot d_{VD6}(t),$$

$$u_{VD5}(t) = u_{VD8}(t) = \left[-u_C(t) - L1\frac{di_L(t)}{dt}\right] \overline{\cdot\, d_{VD5}(t)},$$

$$u_{VD6}(t) = u_{VD7}(t) = \left[-u_C(t) - L1\frac{di_L(t)}{dt}\right] \cdot \overline{d_{VD6}(t)}, (\text{'}$$

mathematical model of C-DC-DC:

$$e_2^*(t) = L_{s2}\frac{di_2(t)}{dt} + L_{\mu 2}\frac{di_\mu(t)}{dt},$$

$$e_2^*(t) = L_{s2}\frac{di_2(t)}{dt} + \\ + \left[L1\frac{di_L(t)}{dt} + u_C(t)\right] \cdot \left[\overline{d_{VD6}(t)} - \overline{d_{VD5}(t)}\right],$$

$$0 = i_L(t) - C1\frac{du_C(t)}{dt} - \frac{u_C(t)}{R},$$

$$0 = [i_2(t) - i_{\mu 2}(t)] \cdot \left[\overline{d_{VD6}(t)} - \overline{d_{VD6}(t)}\right] + \\ + 2i_L(t) \cdot d_{VD5}(t) \cdot d_{VD6}(t) - i_L(t).$$

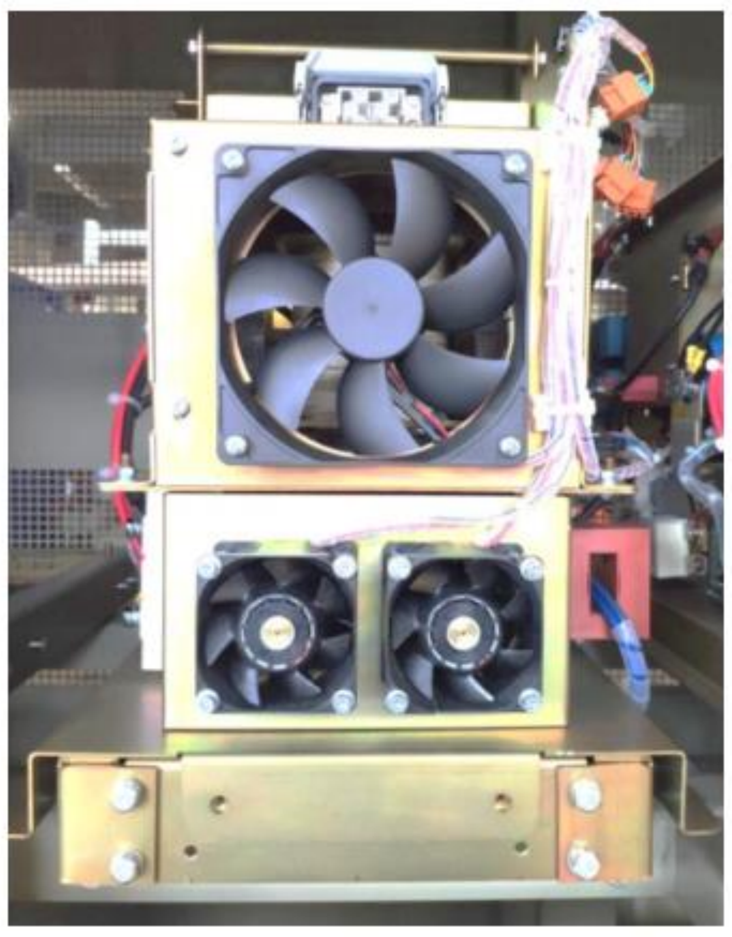

**Fig. 6.** The prototypical unit TKP43

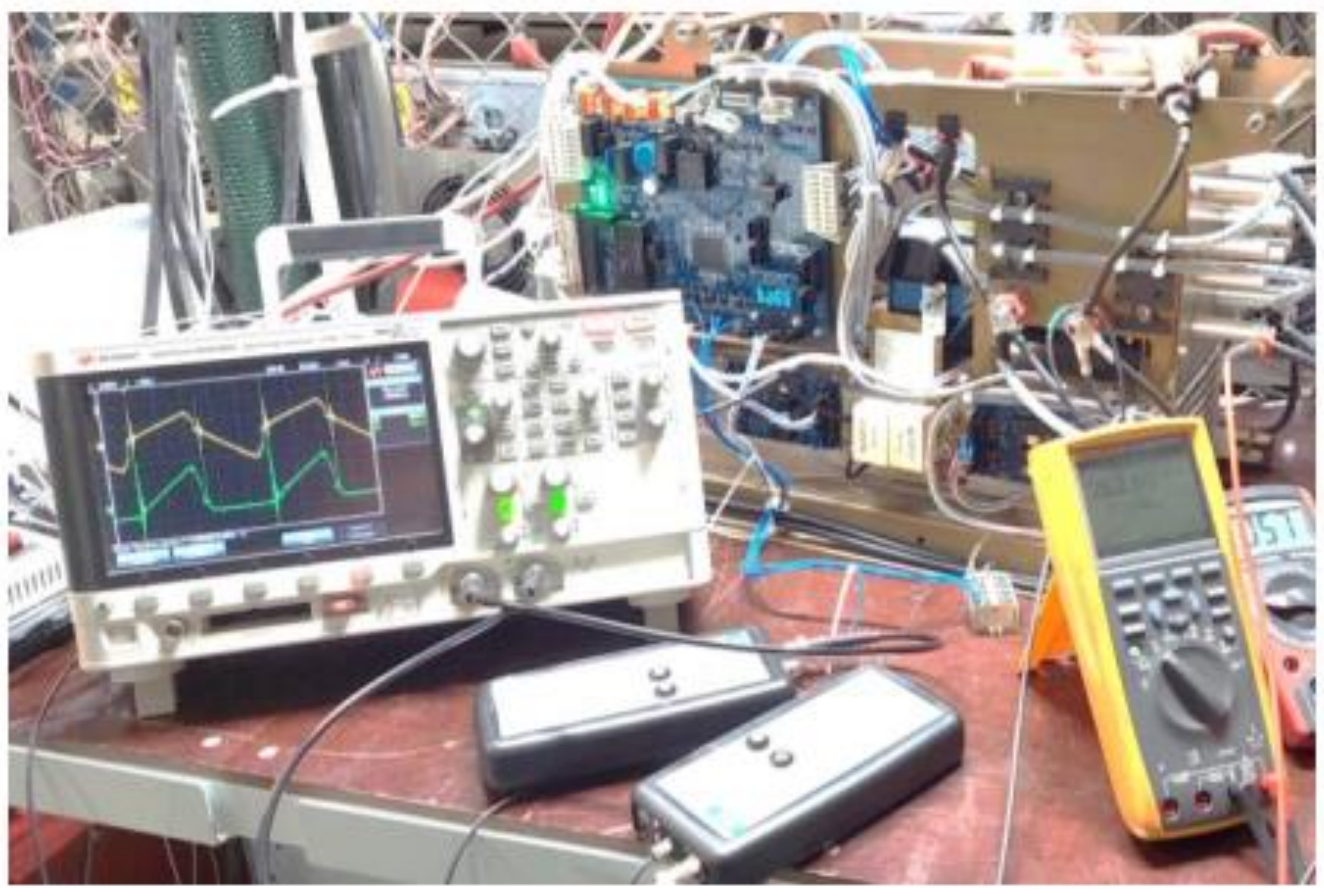

**Fig. 7.** The experimental studies

In the course of experimental studies, we obtained oscillograms of currents and voltages on C-DC-DC elements with PWM control and PF-control (Fig.7). We also calculated similar currents and voltages using the developed mathematical model. Then we conducted a comparative analysis of the corresponding oscillograms and the calculation results. The analysis showed that the experimental and calculated values of voltages and currents in C-DC-DC differ by no more than 11%