EN 659: Energy Efficient Industrial Drives

January – April 2025

Assignment – 3: **Efficiency of Diode Rectifiers**

The diode bridge module shown in Fig. 1 is used as a front-end rectifier in a variable frequency drive (VFD). Refer to the datasheet of the module for further details.

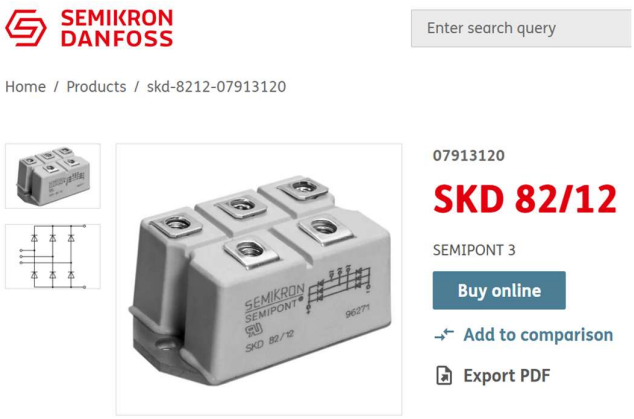

Fig. 1: Diode bridge module

1. Input line-to-line RMS voltage of the rectifier is 400V, 50Hz and the rectifier delivers an average power of 15kW. Assuming the diodes to be ideal, derive expressions for voltage and current across one of the diodes in the bridge under the following conditions –
    a. No capacitor across the DC-link and the (Inverter+Motor) combination is modelled as a resistor.
    b. Capacitor across the DC-link (to limit the peak-to-peak ripple to 10V) and the (Inverter+Motor) combination is modelled as a resistor.
    c. The rectifier output current is almost constant - (LC Filter+Inverter+Motor) combination is modelled as a current source.

2. Sketch the ideal voltage and current waveforms across the diode in the above three conditions.

3. Using the characteristics given in the datasheet of the module and the ideal voltage and current waveforms, estimate the total losses in the diode bridge module under the above three operating conditions. Separate the total loss into conduction loss and switching loss. Also estimate the rise in junction temperature at an ambient of 40 ^{o}C.

4. Simulate the circuit in MATLAB / PLECS using **non-ideal** switches and validate the above analysis. Present voltage, current and power loss waveforms, in one of the diodes. Validate the total loss in the module. Compare the losses in different conditions and comment on the same.

5. Compare the total RMS line current drawn from the AC mains in the three cases, from simulation results and comment on the same.