

FULLY CONTROLLED 5 PHASE, 10 PULSE RECTIFIER

Circuit simulated by

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Theory

High power drives are being used in electric ship propulsion, locomotive tractions and air craft propulsion. Few of these drives use DC motor as the load. These kind of circuits uses a multi-phase generator with a rectifier. The multiphase rectifier converter converts multiphase AC into DC and it feeds the load.

The circuit shown below is a 5 phase rectifier. It has 10 semiconductor switches i.e. T_1 to T_{10} , here T_1 to T_5 are positive group of switches and T_6 to T_{10} are negative group of switches. During each cycle of the input one switch from positive group of switches and one from negative group of switches will conduct. No switch pair in same leg should conduct simultaneously as it short circuits the source. The switches are fired at delay angle of 36° with the next switch in the following sequence $T_1, T_{10}, T_2, T_6, T_3, T_7, T_4, T_8, T_5, T_9$. Each switch will conduct for duration of 180° . The DC output produced here will have 10 pulses.

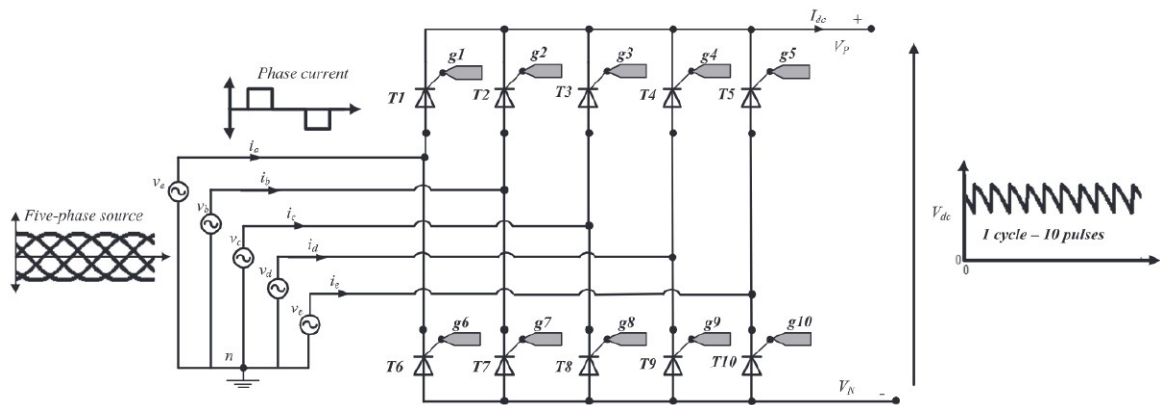


Fig 1: Circuit diagram for 5 phase 10 pulse rectifier

Schematic diagram

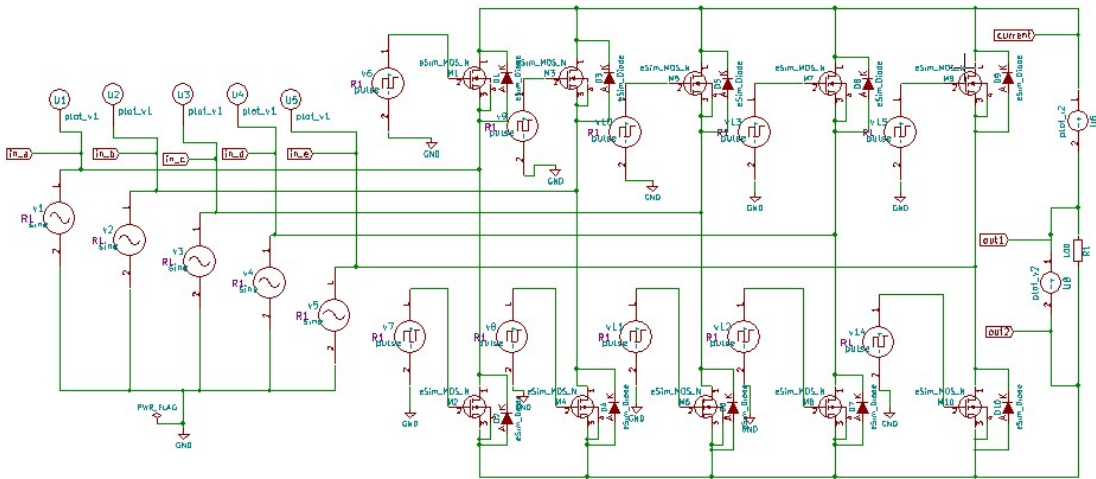


Fig 2: Schematic diagram using esim

Simulation results

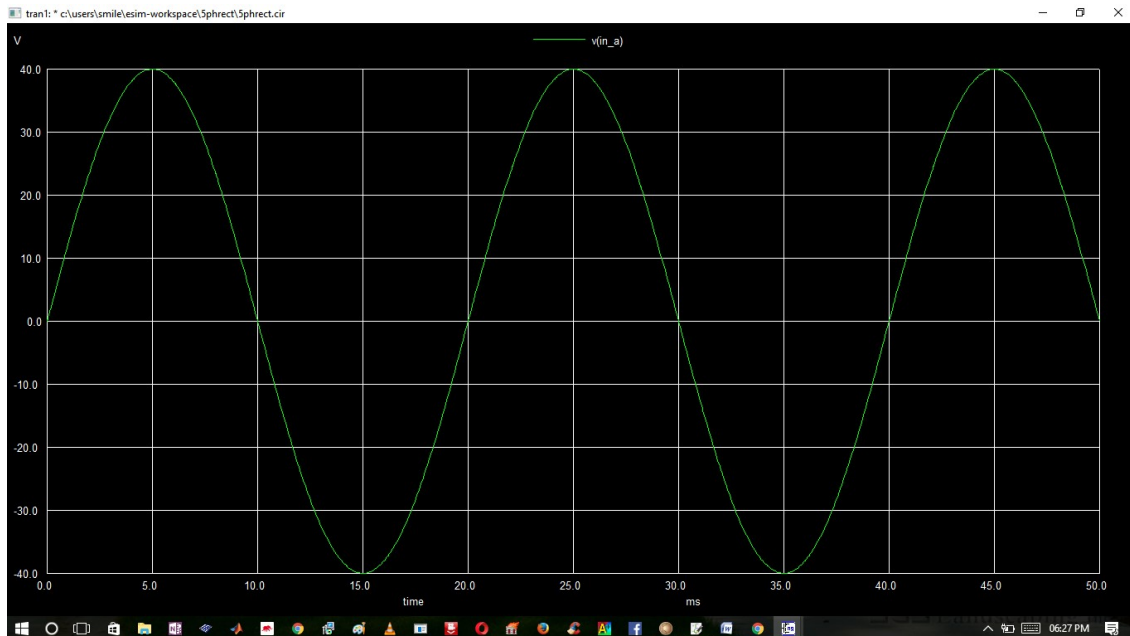


Fig 3: Ngspice plot for AC input with 0° phase shift (Phase A).

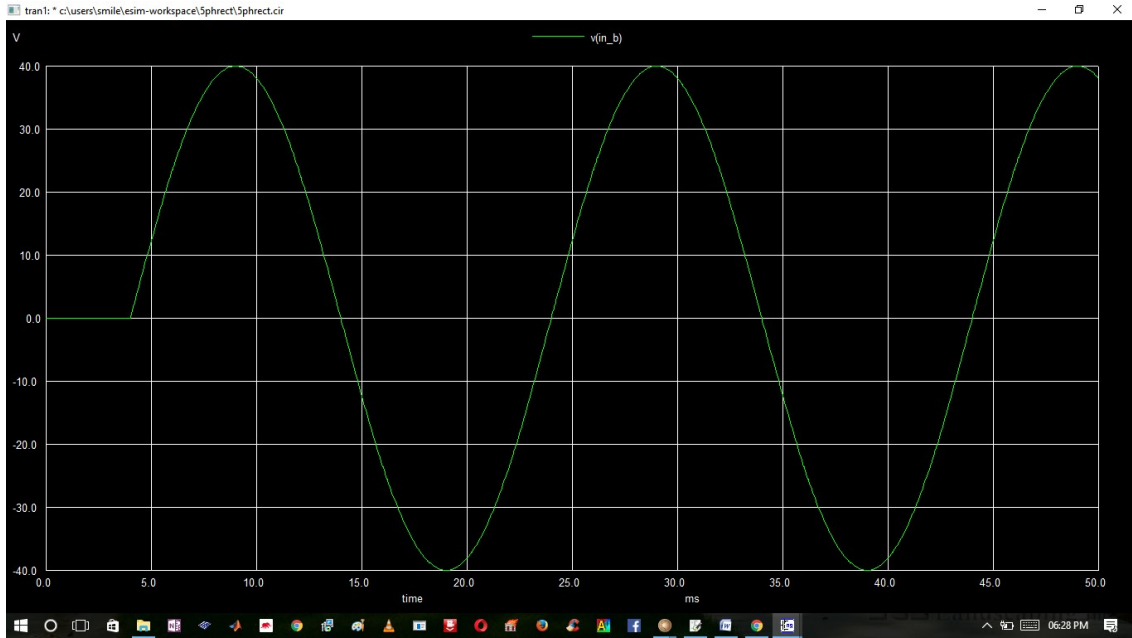


Fig 4: Ngspice plot for AC input with 72° phase shift (Phase B).

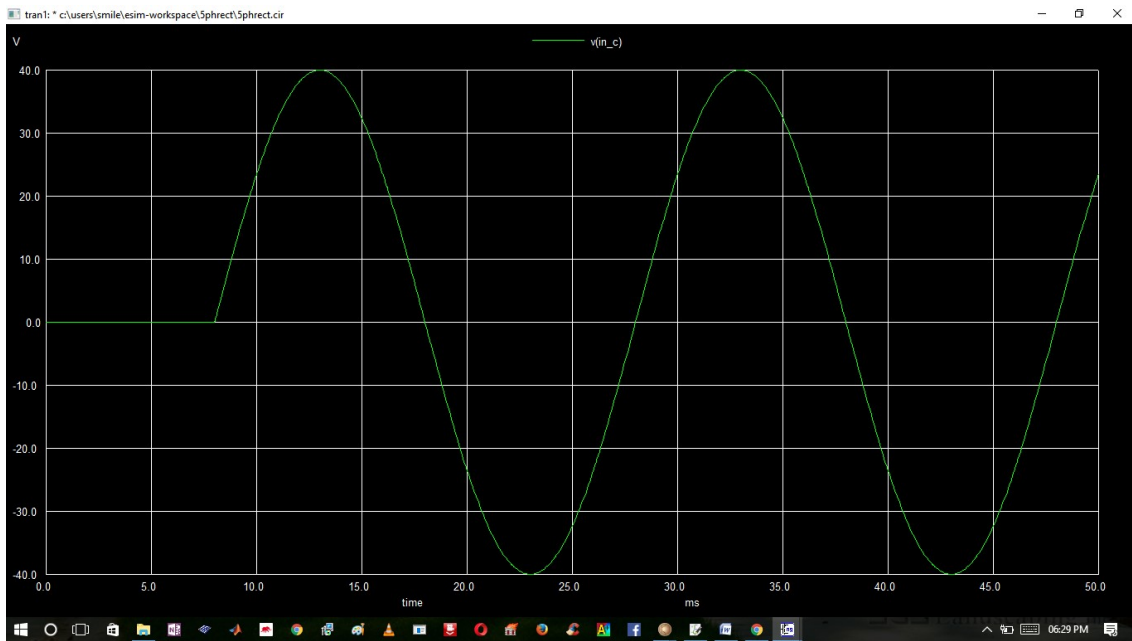


Fig 5: Ngspice plot for AC input with 144° phase shift (Phase C).

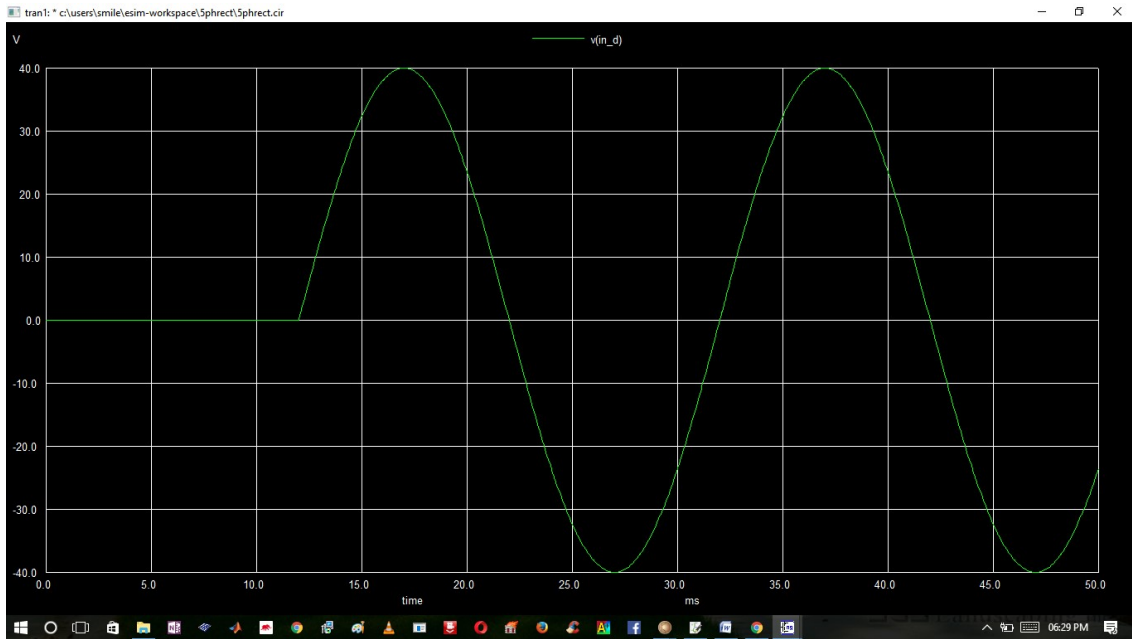


Fig 6: Ngspice plot for AC input with 216° phase shift (Phase D).

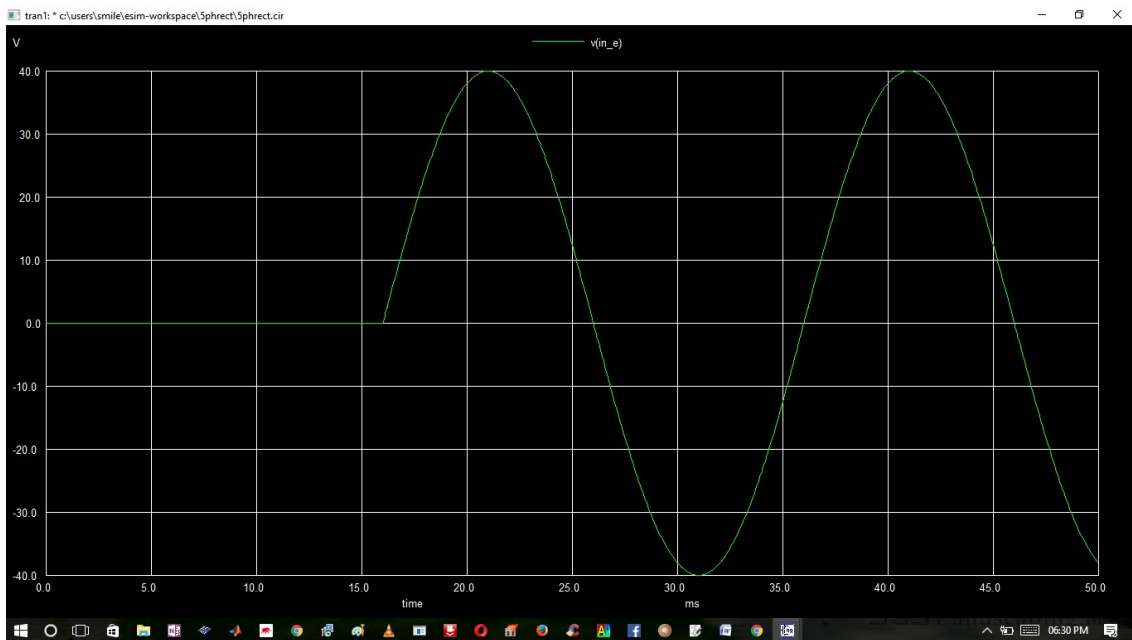


Fig 7: Ngspice plot for AC input with 288° phase shift (Phase E).



Fig 8: Ngspice plot for DC output voltage (10 pulse)

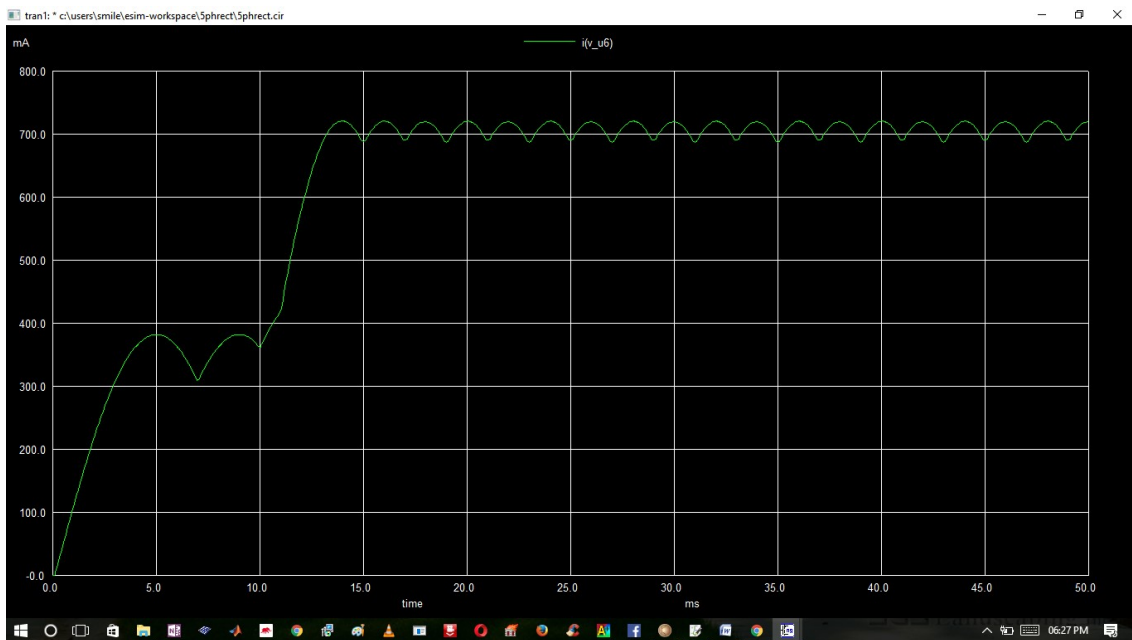


Fig 9: Ngspice plot for DC output current (10 pulse)

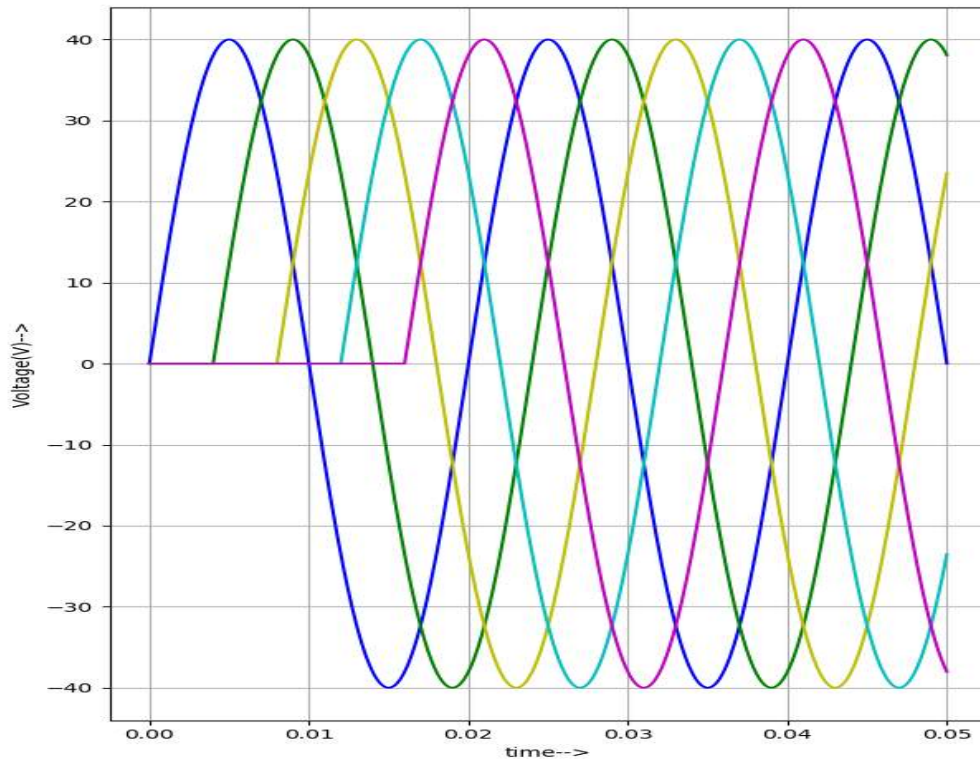


Fig 10: Python plot for inputs at a phase difference of 72°

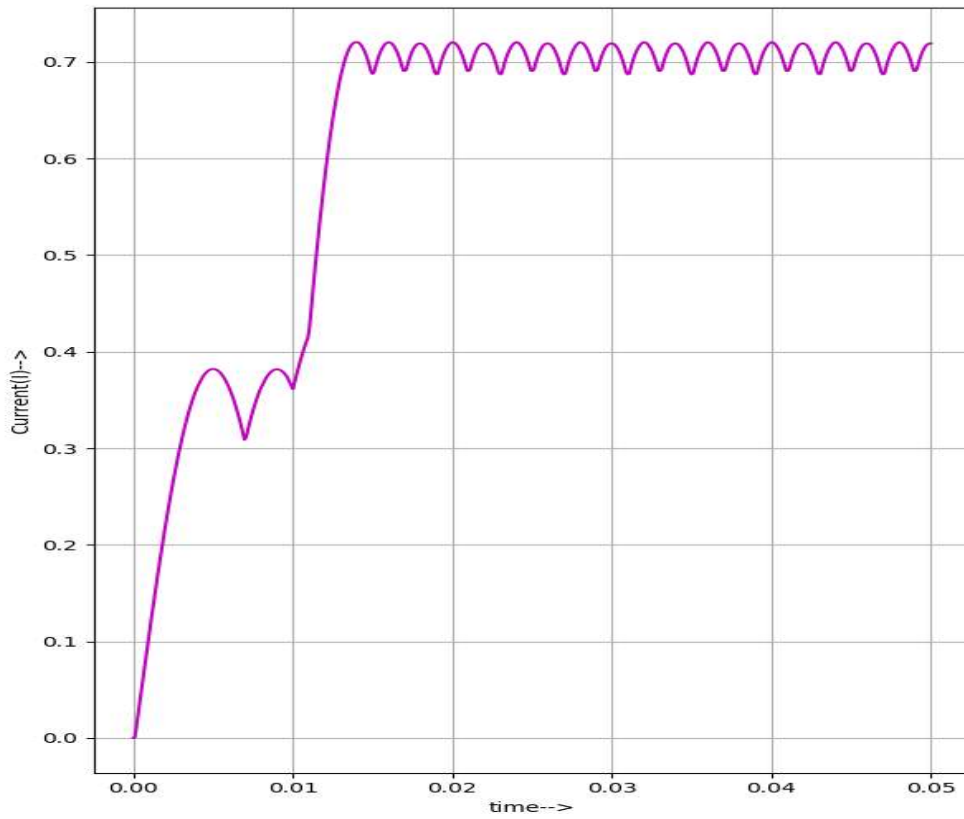


Fig 11: Python plot for DC output current

Reference:

<https://www.sciencedirect.com/science/article/pii/S1110016815001076>