

THREE PHASE CONVERTER SYSTEMS FOR ELECTRICAL MACHINES WITH SERIES CONNECTED DC BUS

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ABSTRACT

With the advancement in electrical technology, the transmission voltage level is being increased gradually. Usually, the AC voltage generated by conventional generating system is stepped up for transmission and then stepped down for usage at different level. However, power electronic interfaces and renewable energy generation systems have brought a shift in this, although the fundamental idea remains same. The voltage level is still increased for transmission. However, for renewable energy systems which usually are interfaced by power electronic converter for maximum power extraction requires power electronic solution for this voltage stepping up. The solution should be compact, efficient and low cost. Similar is the case for stepping down of the voltage. Thus the power frequency transformer is being replaced by solid state transformers. Multilevel inverters are used for interfacing high DC bus voltage. This reduces the semiconductor breakdown voltage requirement also. The output AC of the inverter is controlled by modulation index of the inverter.

Problem arises when a low voltage AC motor is driven from a higher voltage DC bus. Multilevel inverter being almost a default choice can be utilized with a low modulation index. However, the resulting speed control can become coarse. Besides, the dv/dt may become high for the AC machine winding when the inverter frequency becomes higher. Thus DC to AC better matching inverter is essential.

An inverter topology in this direction is proposed and investigated in this work. The DC bus voltage is divided into several smaller parts by capacitive voltage divider, each with its own inverter feeding one phase of the open end winding AC machine. The scheme thus divides the total DC bus into 1/3 and thus results in better voltage matching between the DC and AC sides.

The voltage divider created by capacitors when are loaded can have a unbalance in the voltages. However, present work shows that reasonable balance in the voltage will be maintained inherently by the operation of the motor drive system.

There is chance of zero sequence current due to the open end winding motor and inverter connection. Thus suitable switching strategy should be employed to restrict this current. This work also investigated in this direction. Using a zero sequence current loop the zero sequence current is kept nearly zero in this work.

Generation of a higher voltage from a low voltage renewable energy generation is a popular topic to the researchers. For wind energy generation, usually offshore ones, requires long cable for transmission, thus higher voltage is more preferred in this case.

Present work proposes a rectifier system for generating higher voltage from a lower voltage generator. The voltage that can be generated is higher than the convention three limb three-phase rectifier with similar voltage boost rating. The extra voltage gain achieved by series connection of the rectifier outputs.

Once again there would be voltage balancing and zero sequence current issues here. These issues are also investigated and mitigating steps are proposed.

Both topologies are simulated on MATLAB SIMULINK tool and then validated experimentally. The voltage balancing, zero sequence current issues are shown and mitigated in software platform as well as hardware implementation.