A UNIVERSAL ALGORITHM OF SPACE VECTOR PULSE WIDTH MODULATION FOR THREE-LEVEL THREE- AND MULTI-PHASE NPC INVERTERS WITH DC-LINK VOLTAGE BALANCING

The project concerns the development of the universal space-vector pulse width modulation algorithm of multi-phase drive supplied by three-level Neutral Point Clamping Voltage Source Inverters (NPC VSIs) with DC-link voltage balancing.

Nowadays, the three-phase motors supplied by three-phase voltage source inverters are mainly used in drive systems. Along with this growing interest among scientists and engineers are multiphase systems. It is the properties of multi-phase motors that make these motors an interesting alternative to three-phase motors. The properties of multi-phase motors make these machines an interesting alternative to three-phase motors. In five-phase induction motors, the nominal torque can be enhanced by up to 15% by injection the third harmonic into the motor current. It is also possible to control independently several motors supplied by a single inverter. This approach, however, requires the utilizing of complex modulation methods. These modulation algorithms use m^n space vectors, where *m*-number of levels and *n*-number of phases of the inverter, so for a three-level, five-phase inverter, the modulation algorithm deals with 243 vectors. The multiphase motors are also more reliable than their three-phase counterparts. They allow generating the torque also in the case of the failed phase. In conjunction with a number of advantages, the multiphase motors are supplied by inverters with an increased number of legs, which requires using more transistors compared to classic three-phase systems. Nonetheless, it is possible to use cheaper transistors with a lower nominal current to build such inverter. This is due to the lower phase current at the same nominal motor power. The total cost of transistors for multiphase Voltage Source Inverter (VSI) can be comparable to the cost of transistors for the classic three phases VSI.

The research will be carried out using the three-level five-phase neutral point clamped (NPC) inverters. The three-level (but three-phase) NPC inverters are commonly used in industrial applications. They can be used in medium voltage applications, where give the ability to generate the output voltages higher than the blocking voltage of semiconductors. In low voltage applications, the NPC inverters can replace commonly used two-level inverters. The NPC inverters can be built of cheaper transistors with a lower blocking voltage. The main problems to be solved in VSIs with more than 2 levels is the requirement to maintain (preferably) the same DC link voltages and correct generation of output voltages when the DC-link voltages are not identical.

As it was mentioned at the beginning, the drive system with a five-phase motor allows to increase the generated torque (about 15%) concerning a three-phase motor. Further increasing the number of phases results in a smaller further increase in the motor torque, therefore, it is not economically justified in the case of drives with a single motor. In multi-motor systems, increasing the number of phases makes sense primarily to reduce the cost of building the inverter and the entire system. The three-level 5-phase NPC inverter is made of 20 transistors and allows controlling independently 2 motors while in the case of 3-phase drives two three-level inverters built with a total of 24 transistors have to be used. The benefits of using multi-phase drives increase as the number of phases increases. In the case of 7-phase NPC inverters, a single VSI with 28 transistors can replace 3 inverters with 36 transistors (in total). As a result, such drives can be cheaper to produce (the cost of an inverter is reduced, the cost of motors remains at the same level). This means that such drives have a chance to be popularized in industrial applications. The developed SVPWM will be able to be used in both applications: to supply a single multi-phase motor with increased electromagnetic torque, as well as to supply (n-1)/2 (n is an odd number) motors supplied by a single inverter. Proposed solution will be developed taking into account the necessity to balance the DC-link voltages.

The superordinate control algorithms are used in drive systems to control torque and speed. Those control algorithms were well known from several papers.