

A SOFT-SWITCHING TECHNIQUE FOR NOVEL ZVT-PWM INVERTERS

ZHENG FENG MING

Department of Electrical Engineering
School of Electro-Mechanical Engineering
Xidian University
Xi'an 710071, P. R. China
zhfming@gmail.com

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ABSTRACT. *A novel Direct Current (DC)-rail parallel resonant Zero Voltage Transition (ZVT) voltage-source Pulse Width Modulation (PWM) inverter for three-phase motor drives is proposed with two features, i.e., all power devices are switched under soft-switching conditions, and PWM can be realized easily. It has a simple control scheme. Compared with traditional soft-switching inverters, it is less dependent on the load current, and imposes fewer requirements on power ratings of the resonant components and auxiliary switches as verified by analysis and experimental results. This work analyzes and solves the unbalancing problem of neutral-point voltage with light load in the proposed inverter by presenting its generation principle and impacts on a soft-switching circuit. Compared with the hardware switching circuit, when the power of the inverter and switching frequency become higher, the power loss by using the proposed soft-switching circuit is greatly reduced and efficiency is significantly improved.*

Keywords: Three-phase inverter, Soft-switching circuit, Hard-switching circuit, Efficiency, Power systems

1. Introduction. In recent years, much work was conducted on exploring DC-link soft switching inverters for three-phase AC Variable Voltage and Variable Frequency (VVVF) motor drivers. Many soft-switching inverters were proposed to meet the requirements of high switching frequency, small size, light weight, high power density and high efficiency converters. Divan and Skibinski propose for the first time the Resonant DC Link Inverter (RDCLI) circuit [1]. It, however, has such disadvantages as discrete pulse width modulation and higher switching voltage stress. Later, an advanced Quasi-Parallel Resonant DC Link Inverter (QPRDCLI) circuits [2-11] are proposed to overcome the drawbacks of the RDCLI one. These schemes generate notches of the DC link voltage at controllable instants that can therefore be adapted to the needs of Pulse-Width-Modulation (PWM). However, as a dwell time is generally required after every notch, severe interferences occur, mainly in multi-phase inverters, appreciably worsening the modulation quality [9]. Moreover, they need to preset the thresholds of the inductive currents. Next, a new circuit of DC-Rail Soft Switching VSI [6,7] is proposed. It has the following features: (1) All switches are Zero Voltage Switching (ZVS) or Zero Current Switching (ZCS); (2) Although there is a need to add three auxiliary switches, their required power ratings are smaller than those for previous ones, and the four-quadrant operation of the motor can be achieved; (3) Resonance occurs naturally without a need to set a threshold; and (4) The duration of resonance is short. But it has some hard switching zones and its auxiliary switches are turned off at a hard-switching condition.