Typical value of rated phase voltage of pole phase modulated multiphase induction motor (PPMMIM) drives with wider speed range is in the order of few hundreds of kilovolts. This high value of phase voltage for high power density applications results in higher dc-link voltage requirement and switch voltage rating of two-level multiphase inverter. Further, using multiphase space vector pulse width modulation (SVPWM) yields less dc-link utilization. Methods to increase dc-link utilization using SVPWM with offset value of third harmonic order introduces dominant lower order harmonic currents into phase windings. One more major problem in high pole mode of PPMMIMs is higher torque pulsation due to decrease in phase number. To address these problems this paper proposes a dual-inverter-based multilevel voltage excitation scheme for nine-phase PPMMIM with 1:3 speed ratio. In four-pole mode a simple phase grouping technique to eliminate lower order harmonic currents in the phase windings is proposed. In addition each inverter feeding these phase groups is modulated using carrier-based three-phase SVPWM to achieve higher dc-link utilization. This paper also proposes a multilevel voltage generation scheme for 12-pole mode of operation using carrier phase shifted pulse width modulation (PWM) for inherently available equal voltage profile coils with the same dual inverter structure. The torque ripple using phase shifted carriers PWM and single carrier PWM are compared. Finite element method model of nine-phase PPMMIM is developed in Ansys Maxwell two-dimension and is cosimulated with three three-phase dual inverters in Simplorer environment. Experimental validation is done for linear and over modulation case on 9ΦIM fed from three three-phase dual inverters controlled using Spartan six field programmable gate array board programmed in VHDL.