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Double-Stator Permanent-Magnet Vernier Linear Machine With PMs Surface-Mounted on the Mover

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PM linear machine is an important category of PM machine, which is suitable for rail transit. The existence of the end effect will cause the unbalanced back-EMF, which can enlarge the ripple of the thrust. A novel linear vernier mover-PM (LVMPM) machine will be proposed in this paper. It is economical to be used in long distance. The characteristics of the proposed machine are analyzed by finite element method (FEM). In the LVMPM machine, the mover is sandwiched between the two stators. The stator is composed of silicon steel sheet with equidistant straight teeth, which work as modulation teeth. On the mover, the PMs are mounted on the top of teeth and windings are placed in slots. The magnetic circuit of the permanent magnet of the two side of the mover is connected in series with each other. Besides, due to the vernier effect, the proposed machine has the advantage of high thrust density. However, linear machines have end effects; thus the thrust ripple is higher than general vernier machine. The waveforms of back-EMF are sinusoidal and the amplitude of three-phase is equal. This can effectively reduce the thrust ripple of linear machine. In linear machine, the detent force is composed of cogging force and end force. The peak-to-peak value of detent force is about 46N, while the value of cogging force and end force are about 32.6 N and 20.9 N, respectively. The average thrust is 906 N when the electric load is 137 A/cm, while the thrust density is about 219.26 kN/m^3. However, the thrust ripple of proposed MPMLV machine is up to 23.7%, which is higher than general vernier machine. Some design approaches may be done to reduce it. All details will be given in the paper.

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