Calculation and experimental study of current regulators of current amplifier: three-stable hysteresis and PWM controller.

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In magnetic suspension controllers, current or voltage commands are created by measuring the movement of a suspended object. The electronics circuits apply voltage to the winding terminals to create a current in the winding. The rate of change of current must be fast enough to track the current commands. However, the amplitude and frequency ranges are limited by the nominal allowable values of the voltage and current of the power electronic circuit and the inductance of the bearing windings. If the current response is not fast enough, the feedback loop becomes unstable, causing the shaft to fall [1].

The paper presents a computational and experimental study of a three-stable hysteresis current controller and a current controller based on pulse width modulation (PWM). It is shown that the current control channel built on the PWM controller potentially provides a better quality of the EMB power supply current in comparison with the three-stable hysteresis regulator. The current ripple frequency in the EMB winding with the regulator on the PWM controller is determined by the PWM carrier frequency and can be several kHz. The current rise in the EMB winding in the control channel with PWM corresponds to a hysteresis current regulator. The current drop in the control channel with PWM is faster than in the channel with a three-stable hysteresis regulator. The drawbacks of a channel with a PWM controller include the possibility of overshooting with a non-optimal PI-control, which may affect the stability of the rotor position control.

[1] Schweitzer G., Maslen E. Magnetic Bearings. London: Springer, 2009.