Steady-State Integral Proportional Integral Controller for PI Motor Speed Controllers

Choon Lih Hoo[a], Sallehuddin Mohamed Haris[a], Edwin Chin Yau Chung[b], and Nik Abdullah Nik Mohamed[c]

[a]Department of Mechanical and Material Engineering, Universiti Kebangsaan Malaysia, Bangi, Malaysia

[b]School of Eng., Taylor's University Lakeside Campus, Subang Jaya, Malaysia

[c]German Academic and Career Centre, Universiti Malaysia Pahang, Pekan, Malaysia

ABSTRACT

The output of the controller is said to exceed the input limits of the plant being controlled when a control system operates in a non-linear region. This process is called the windup phenomenon. The windup phenomenon is not preferable in the control system because it leads to performance degradation, such as overshoot and system instability. Many anti-windup strategies involve switching, where the integral component differently operates between the linear and the non-linear states. The range of state for the
non-overshoot performance is better illustrated by the boundary integral error plane than the proportional–integral (PI) plane in windup inspection. This study proposes a PI controller with a separate closed-loop integral controller and reference value set with respect to the input command and external torque. The PI controller is compared with existing conventional proportional integral, conditional integration, tracking back calculation, and integral state prediction schemes by using ScicosLab simulations. The controller is also experimentally verified on a direct current motor under no-load and loading conditions. The proposed controller shows a promising potential with its ability to eliminate overshoot with short settling time using the decoupling mode in both conditions.

KEYWORDS: Anti-windup, Integral state prediction, PI plane, Speed control, Steady-state integral proportional integral control, Tracking back calculation

DOI: 10.6113/JPE.2015.15.1.177