Elimination, Tracking and Control of Variables with Periodic Waveforms in Power Electronics and Electrical Drives

Dr. Vladimir Blasko, IEEE Fellow
UNITED TECNHNOLOGIES RESEARCH CENTER
East Hartford, CT, USA

Abstract: A historic perspective, evolution and common theoretical framework for tracking and elimination of periodic disturbances/harmonics with arbitrary waveforms with focus on applications in electrical drives and power electronics is presented. Three different approaches from three different fields, namely from classical-general-control, electrical drives and adaptive noise canceling are analyzed.

The internal model principle, originating from control community, is introduced first as it provides a general and elegant solution for tracking and elimination of (a) DC type of signals (b) harmonic - sine and cosine signals and (c) repetitive - arbitrary periodic waveforms. After that, as a second approach, the synchronous reference frame current regulators are reviewed as broadly used and still dominant for current control in electrical drives. The synchronous regulators have difficulty to control distorted current having direct and inverse components. As a remedy, a combination of two separate synchronous regulators rotating in synchronous frames aligned with direct and inverse components is used. It is shown in the paper that after the transformation of integral parts of combined direct and inverse synchronous regulators into stationary reference frame, a single harmonic regulator in stationary reference is derived. Adaptive Noise Canceling (ANC) algorithm broadly used in digital signal and acoustic noise processing is reviewed as a third option and demonstrated for current control and selective harmonic elimination in grid tied inverters. It is shown that linear combiner and lest mean square (LMS) algorithm as parts of ANC have the same transfer function as a harmonic regulator and therefore can perform the same function.

High level of similarity and results between the approaches in three different fields (control, signal processing and power electronics) is shown and performances of different regulators are demonstrated through simulation. Experimental results from multiple applications are presented to demonstrate performances and capability.