Discrete-Time Complex Bandpass Filters for Three-Phase Converter Systems

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A first-order complex bandpass filter (CBF) derived in the discrete frequency domain is proposed as a building block for the complex signal processing unit in three-phase converter systems. The first-order discrete CBF can be directly implemented in a digital system, is stable at all center frequencies and has a low computational burden. The first-order CBF is extended to a pth-order discrete CBF. A normalized frequency-locked loop (FLL) is then developed that allows the frequency adaption to satisfy a desired settling time regardless of the input signal magnitude or discrete CBF form. The pth-order discrete CBF-FLL was tested on an FPGA in the form of two industrial applications: voltage synchronization under grid fault and extraction of an unknown frequency component. The second-order discrete CBF-FLL offered significantly improved stopband attenuation and frequency estimation relative to the first-order discrete CBF-FLL, for a small increase in computational burden.