SHARC DSPs Maximize Windmill Energy Extraction

Northern Power Systems (Barre, Vermont) is positioned at the forefront of the wind power technology movement, offering community and utility-scale wind turbine systems differentiated by their innovative 'gearless' turbine designs, efficient energy capture capabilities, and low maintenance requirements.

The company's flagship Northwind 100 wind turbine is designed for community-scale wind power generation installations, enabling municipalities, businesses, farms, schools and other organizations to produce power at the source of the need, even in locations where wind speeds are relatively low. To help ensure that Northwind 100 systems deliver the highest possible energy yield and return on investment, Northern Power Systems relies on precision ADI digital signal processors and components to maximize system management efficiencies.

Design Advances

Northern Power Systems' wind turbine technology is based on its proprietary permanent magnet direct drive (PMDD) design architecture, which precludes the need for a gearbox in between the turbine's rotor and generator. By directly coupling the rotor with the generator, Northern Power Systems' engineering team significantly reduced the number of moving parts within the system, which ultimately yields a more reliable machine that requires less maintenance than traditional gearbox-based turbines. This 'less is more' design approach epitomizes Northern Power Systems' engineering philosophy, and ultimately led the company's engineering team to seek out a similarly elegant signal processing platform that wouldn't compromise performance or functionality. They found what they were looking for in Analog Devices.

Leveraging ADI SHARC digital signal processors, data converters and other advanced components to ensure high-performance system operation, Northern Power Systems' Northwind 100 delivers 100 kilowatts of rated power for community wind applications such as schools/universities, businesses, farms, and municipalities. ADI's expertise in next-generation energy infrastructure assures that companies like Northern Power Systems are equipped with advanced components across the entire signal chain to enhance the value, performance and innovation of their system designs.

High-Performance Signal Processing

Within a Northwind 100 turbine, wind capture and energy conversion functions are facilitated by the system's rotor, generator and power converter components. The rotor converts the wind's aerodynamic energy to mechanical shaft torque; the generator converts the mechanical shaft power to electrical power at variable frequency and provides reaction torque to the rotor; and the power converter converts the variable frequency generator output to constant frequency for feeding into the grid.

The Northwind 100 generator's power flow is regulated by the power converter to compensate for variable wind speeds, which helps to maximize energy extraction. This capability ultimately enables a Northwind 100 wind turbine to provide a steady flow of clean power to a local grid, simplifying grid interconnect infrastructure and maintaining grid stability. Eliminating the need for a gearbox transmission dramatically reduces lifecycle maintenance and increases system reliability.

At the heart of this system is ADI's 32-bit floating point SHARC 21363 digital signal processor, which hosts real-time closed-loop control algorithms to efficiently control the Northwind 100's generator and power converter subsystems, based in part on incoming data provided by the ADI AD7656 16-bit analog-to-digital converter (ADC) embedded in the data acquisition hardware and ADI dual-axis iMEMS® ADXL203 accelerometer sub-assembly part affixed to the turbine's nacelle. Delivering core processing performance up to 333 MHz/2 GFLOPS with support for IEEE 32-bit/40-bit floating point and 32-bit fixed point operations, SHARC 21363 processors employ an enhanced Single Instruction, Multiple-Data (SIMD) architecture to provide the real-time processing bandwidth and atomicity required to keep these subsystems running in precise coordination.

SHARC 21363 processors feature integrated 3 Mb SRAM/4 Mb ROM on-chip memory and a rich peripheral set to accommodate a wide range of configuration options. The Northwind 100's data acquisition platform hosts the ADI AD7656, which provides the high-speed signal sampling and data conversion that feeds into the system's real-time closed-loop control algorithms. This is facilitated by the SHARC 21363's six high-speed serial ports (SPORTs), yielding a seamlessly connected signal chain that helped minimize design complexity.

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