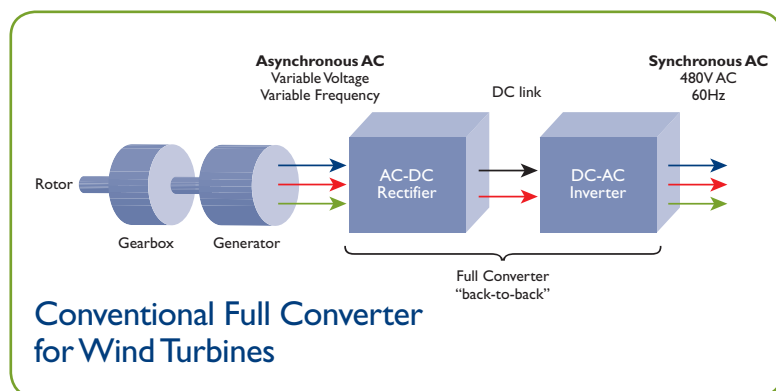
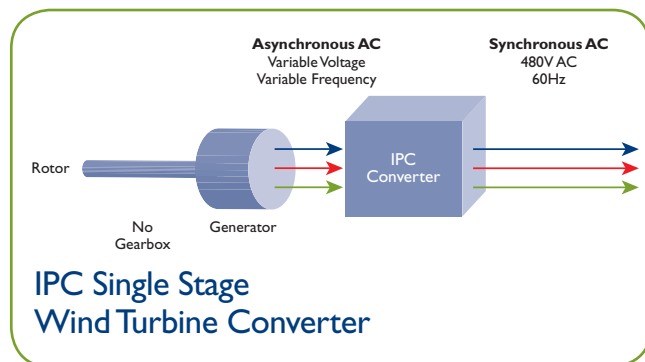


New Power Converter Topology Improves Efficiency while Reducing Size and Weight

Power converters provide a crucial function in wind turbines by converting power from the turbine generators to match the voltage, frequency and other requirements of the power grid. Several different types of wind turbine power conversion architectures are used by the industry, but four quadrant full converters have emerged as the most attractive solution by providing superior grid support and wider turbine operating range.

A conventional full converter consists of a two stage or “back-to-back” converter where the first stage provides asynchronous AC to DC conversion (rectification) and the second stage provides DC to AC conversion (inversion).

Ideal Power Converters (IPC) has developed and patented an entirely new current-modulation electronic power converter that reduces weight, size, and material costs for wind turbines, while improving efficiency and grid support capabilities. This is accomplished through



the industry's first cost and energy efficient single stage asynchronous AC to grid synchronous AC converter. IPC's power converter enables asynchronous AC (variable voltage and variable frequency) from the generator to be converted directly to synchronous AC (480 V AC, 60Hz) needed for interconnection with the power grid and commercial 480 V AC loads.

IPC is developing 30kW and 180kW wind power converters targeting a new class of medium scale wind turbines. The converters can also be used in parallel for high power turbine systems.

Benefits

- Higher efficiency, particularly when the turbine is operating at only 10–30% of rated power.
- Lower weight, lower size and lower cost of wind converter.
- Near sinusoidal voltage applied to the generator for low dv/dt and harmonics to reduce generator costs, while increasing reliability and efficiency.
- Meets all required harmonics limits to the grid
- The IPC converter also supportive reactive output and low voltage ride-through. A special resistor dumping interface reduces generator stress during grid faults.

Converter Efficiency and Weight

The IPC wind power converter will deliver full power efficiency of 96–97%. Since wind turbines operate predominately at relatively low rated power, partial load efficiency is more critical than full power efficiency. Since IPC's converter has minimal switching losses, due to its the 100% soft switched operation, the efficiency versus load profile is almost flat, delivering over 93% efficiency at 10% of rated load. The efficiency of IPC's topology has been verified on IPC's initial 30kW PV inverter product by Intertek, a major independent testing lab. The detailed test results are available on request.

The IPC 30 kW and 180kW wind power converters will weigh approximately 100lbs and 420lbs. They will be available in outdoor rated enclosures and certified to UL1741, IEEE1547 and other required industry certifications. The light weight and small sizes eases installation either in the nacelle or at the base of the turbine.

Since the IPC converter has no DC link, no link pre-charge circuit and contactor are needed.

Generator Interface

A near sinusoidal waveform is applied to the generator at all speeds and power levels. The converter is able to interface with a motor/generator that has a grounded neutral, or in the absence of a neutral, the converter can minimize any common mode excursions of the generator. Thus no external inductive filter is needed, and rotor heating of the generator is reduced dramatically. Also, lower cost stator windings may be used since dv/dt is very low, similar to utility power.

The IPC converter supports a wider operating range, which helps enable use of direct drive turbines without a gearbox.

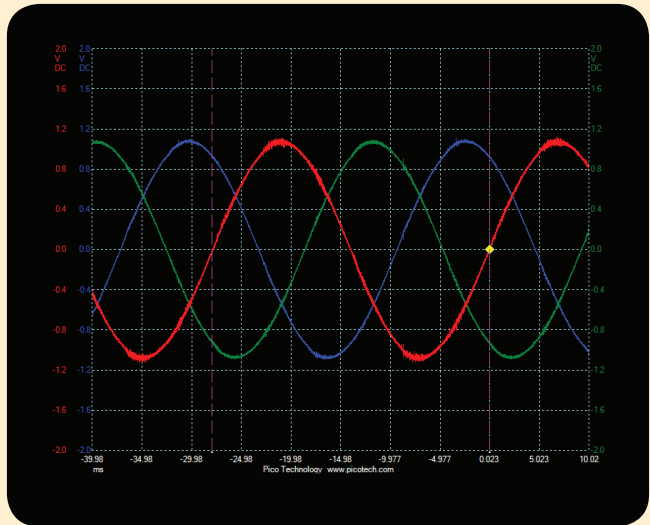
Since the AC power between the generator and IPC converter is nearly sinusoidal, the converter may be located further from the generator without high wiring losses. This can allow system designers increased flexibility to move the converter from the nacelle and mount it more conveniently at the base of the turbine so as simplify converter maintenance.

The IPC wind converter will support Permanent Magnet and Induction generators. IPC's support for low cost AC induction generators can eliminate the need for the rare earth elements found in permanent magnet generators.

Grid Interface

The IPC converter delivers a near utility quality sinusoidal output. As a result only modest capacitive-inductive filtering is required, with grid side line reactance being very low at less than 0.5%.

The IPC wind converter can connect directly to standard 480V AC loads and the power grid. The IPC converter will



Three Phase Voltage Output Waveforms from the IPC Converter

provide grid support features including controls for reactive power output and low voltage ride through requirements.

During grid faults or sudden disconnections the converter can dissipate energy from the generator through the special resistor interface. This eliminates instantaneous torque changes that create damaging mechanical stress on the turbine drive train.

Technology Status

IPC has two issued US patents and multiple additional US and foreign patents pending. The company has also licensed its technology to Lockheed Martin and together have won a contract to develop Hybrid Intelligent Power micro-grid power converter for Forward Operations of the US military.

IPC's initial product is a 30kW PV inverter. IPC is completing development and industry certifications including UL1741 and IEEE1547.

IPC has also developed a 15kW VFD (Variable Frequency Drive) motor control for AC induction motors. This is a 3-phase synchronous AC to asynchronous AC converter. The IPC wind converter share a similar hardware design to the PV inverter and VFD. IPC will leverage this experience at a higher power level and with new control algorithms for its wind turbine converter.