

Wind Turbines Today

Enhanced Reliability with Dataforth Signal Conditioners

Clean, Green, and Renewable

In today's ongoing search for sources of alternative energy, clean, green, and renewable are top priorities. Using wind power to produce electricity is a perfect fit.

Wind is air set in motion naturally. According to Evangelista Torricelli, who first gave the correct scientific explanation in the mid 1600s, "...winds are produced by differences of air temperature, and hence density, between two regions of the earth." The sun heats the earth unevenly because of differences in earth surfaces. The earth's rotation is also a key factor in wind production.



Turbine Technology

Wind power is the conversion of wind energy into electricity. This is achieved using wind turbines, which convert the kinetic energy of wind into electrical energy as follows:

1. Wind turns propeller-like blades around a rotor.
2. The rotor, which is made up of the blades and hub, causes a low-speed shaft to turn at approximately 30-60 rotations per minute (rpm).
3. The low-speed shaft connects to a 2- or 3-stage speed-increasing gearbox that connects it to a high-speed shaft and increases the rpm to approximately 1000-1800 rpm. This is the rotational speed most generators require to produce electricity.
4. The high-speed shaft drives a generator.
5. The generator produces electricity.

The process of converting wind power to electricity is clean, environmentally sound and, as long as the sun keeps shining and winds are created, completely renewable.

Utility-Scale Wind Turbines

Utility-scale wind turbines are large and medium-sized turbines that range from about 500kW up to 6MW. The larger turbines are usually arrayed in wind farms that generate bulk energy for sale in the power market.

Most commercially available utility-scale wind turbines today are built according to Danish design. This turbine configuration calls for a horizontal axis, three-bladed rotor, upwind orientation, and active yaw system to keep the rotor oriented into the wind.

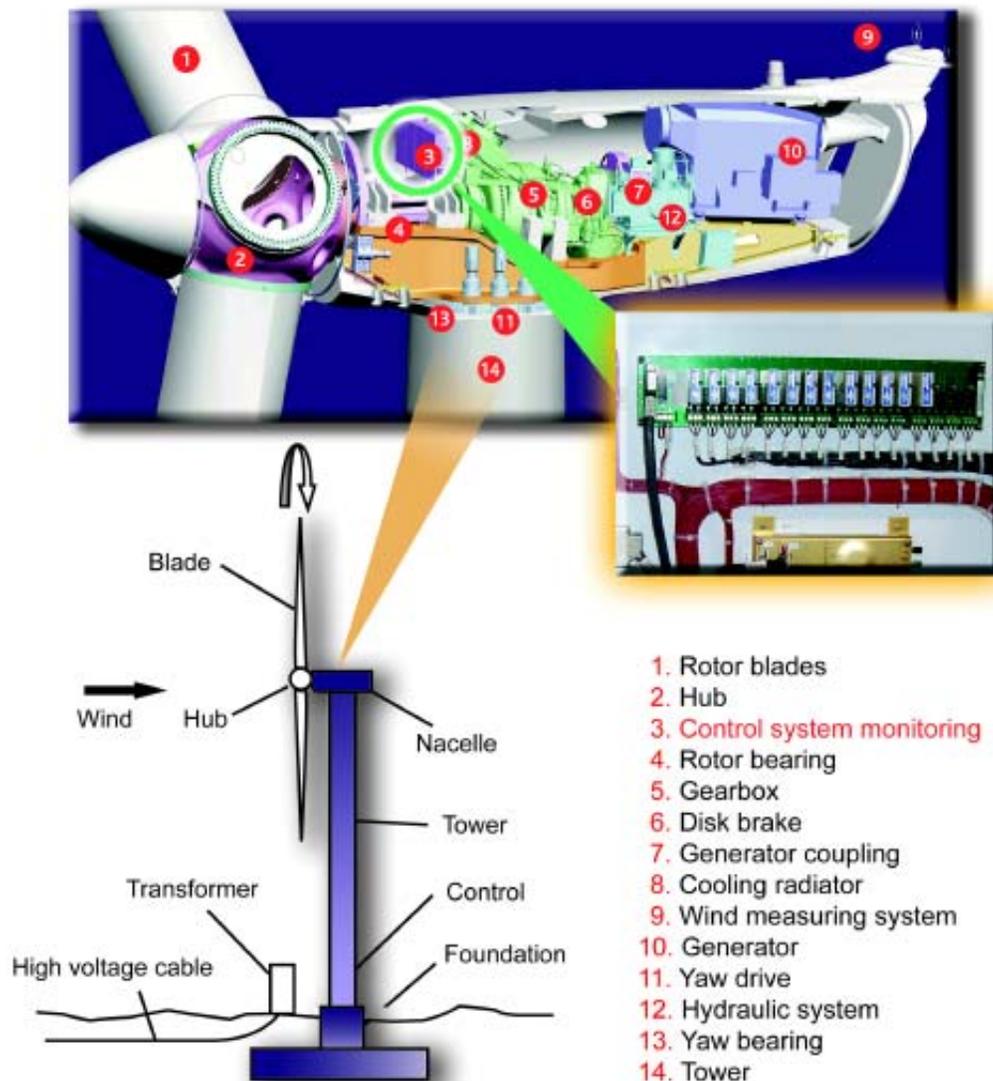
The amount of power produced by a wind turbine is directly dependent on wind speed. In general, wind turbines start to produce power at wind speeds of approximately 4m/s (9mph), attain rated power at about 13m/s (29mph), and stop producing power at about 25m/s (56mph).

As wind speeds increase with height above the earth, wind turbines are mounted on high towers of approximately 100 feet (30 meters) or more to ensure access to more wind energy.

Wind Turbine Safety and Control

Wind turbine control and safe operation are key concerns when using wind power. Unlike virtually every other industry, wind turbines operate without direct supervision. Components are mounted at the top of the tower, where six months may go by between regularly scheduled maintenance operations. In the meantime, rotating components are generating vibration and heat that can cause parts to malfunction and fail.

As an antidote to these issues, Dataforth Corporation's SCM5B, SCM7B, and SensorLex® 8B signal conditioning modules are all fully encapsulated, thereby ensuring they are corrosion resistant and well suited for use in rugged environments. In addition to encapsulated conditioners, Dataforth offers rugged, non-encapsulated products that could be applicable as well. These include DSCA DIN rail mount isolated signal conditioners, DSCT DIN rail mount 2-wire transmitters, and DSCL loop isolators.



Inside a Wind Turbine

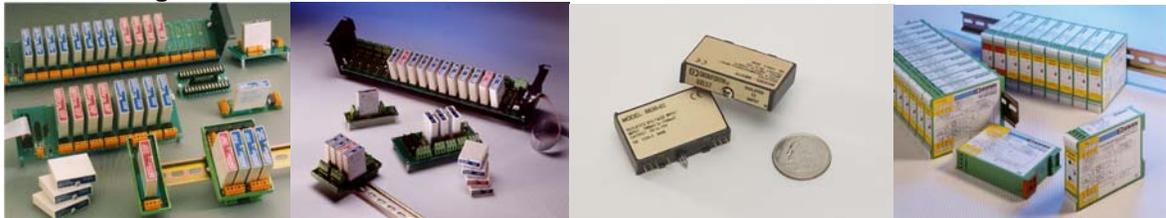
Wind turbines operate under a wide range of environmental conditions, including extremes such as 100% humidity and ambient temperatures from -40°C to 85°C. Again, Dataforth's signal conditioners meet the need with their wide operating temperature range of -40°C to 85°C.

Wind turbines also generate high voltages and currents. Electrical components must therefore be able to withstand high surge voltages and be immune to the electrical noise that can radiate from generators and switch networks. In accord with these needs, the signal conditioners offered by Dataforth meet the requirements of EN61000-6-2 (ESD/RF/EFT immunity). In addition, Dataforth's conditioners provide 240VAC continuous input protection, 1500Vrms transformer isolation, and ANSI/IEEE C37.90.1 transient protection. As an indicator of how essential effective protection is, lightning rods are a prominent wind turbine feature. Dataforth conditioners provide secondary protection against lightning strikes and other overvoltage events. In sum, the challenging environments in which wind turbines operate demand reliable and broad ranging protections – which Dataforth designs into all of its signal conditioner modules.

In fact, the failure rate of Dataforth's signal conditioners is better than six sigma. A six sigma process, according to the commonly accepted definition, produces 3.4 defective parts per million opportunities, which translates to 99.9997% efficiency.

For wind turbines to remain both operable and in safe condition, components must be accurately monitored and assessed while being continuously protected. A key aspect critical to wind turbine safety, therefore, is wind turbine control. Without effective control, wind turbines will speed up in high winds, producing much higher yields than their rated power. Overspeed will also result if critical components fail, for example, if the generator overheats or is disconnected and therefore stops braking the rotor's rotation. Out-of-control speed is considered a runaway condition; the safety system must be able to quickly regain control of the wind turbine and stop it. This is accomplished primarily through an aerodynamic braking system that prevents the rotor blades from increasing power production, as well as a hydraulic disk brake system.

Dataforth Signal Conditioners



SCM5B Family

SCM7B Family

SensorLex® 8B

DSCA Family

In conjunction with effective systems, wind turbine safety and control are absolutely dependent on the impeccable reliability of all parts.

With their outstanding accuracy and reliability specifications, broad operating temperature range, wide ranging protections, and encapsulated construction, Dataforth's rugged, isolated signal conditioners help ensure that wind turbine reliability requirements are met.

The Controller

The wind turbine controller plays many roles and is at the heart of wind turbine safety and operability:

- Participates in virtually all safety system decision-making processes
- Oversees normal wind turbine operations
- Monitors hundreds of different functions
- Collects statistical measurements
- Communicates with the wind turbine operator

- Provides internal communications: Dataforth's DCP485 fully isolated DIN rail RS-232 to RS-485 converter, LDM80/85 fiber optic communication modems, and other LDM isolated communication products are all exceptionally well suited to this task

The controller consists of computers that monitor wind turbine conditions while also controlling particular switches, valves, hydraulic pumps, etc. Given the difficulty of accessing components, it is crucial that controllers are capable of internal monitoring and self-regulation.

There are usually controllers at the bottom of the tower and in the nacelle at the top of the tower. A third controller is found in some newer wind turbines in the hub of the rotor.

To make sure controllers provide the requisite safety and operating availability, redundant, backup systems are part of modern wind turbine design.

What is Monitored?

Sensors are used to measure as many as 500 parameters in a modern wind turbine. Conditions that can be monitored – and specific Dataforth models that can be used for these purposes – include:

- Generator voltage and current frequency: SCM5B/7B/8B30, 31, 32, 40, 41 and 8B50/51 voltage and current input models
- Low-speed shaft rotational speed: SCM5B/7B/8B45 frequency input models
- High-speed shaft rotational speed: SCM5B/7B/8B45 frequency input models
- Wind direction and speed: SCM5B/7B/8B36 and 45 potentiometer and frequency input models
- Vibration in nacelle, rotor blades, and bearings: SCM5B48 accelerometer model
- Hydraulic pressure: Model depends on transducer type
- Pitch angle of each rotor blade (for pitch controlled or active stall controlled wind turbines): Model depends on transducer type
- Yaw angle: Model depends on transducer type

Possible temperature measurements include:

- Outside air temperature
- Temperature in nacelle and electronic cabinets
- Generator temperature
- Oil temperature in gearbox
- Drive shaft and gearbox bearing temperatures

Dataforth's SCM5B/7B/8B RTD and/or thermocouple models are excellent choices for these types of temperature measurements.

Parameters measured as analog signals (temperature readings, for example) provide specific values and can use any of the Dataforth analog signal conditioners; parameters measured as digital signals (such as correct valve function) give an on/off signal and can utilize Dataforth's SCMD series of digital input/output modules.

Dataforth Signal Conditioners

Dataforth offers the industry's largest selection of 1000+ Instrument Class[®] performance isolated analog I/O signal conditioning modules. These modules are designed specifically to condition and protect critical data acquisition and control signals as well as sensitive connected equipment. Miniature digital I/O modules also are available to create a rugged, protective isolation barrier, effective to 4kV, between the field and the computer system.

Key Dataforth signal conditioner features

- ± 0.03 to 0.05% accuracy
- Better than six sigma reliability

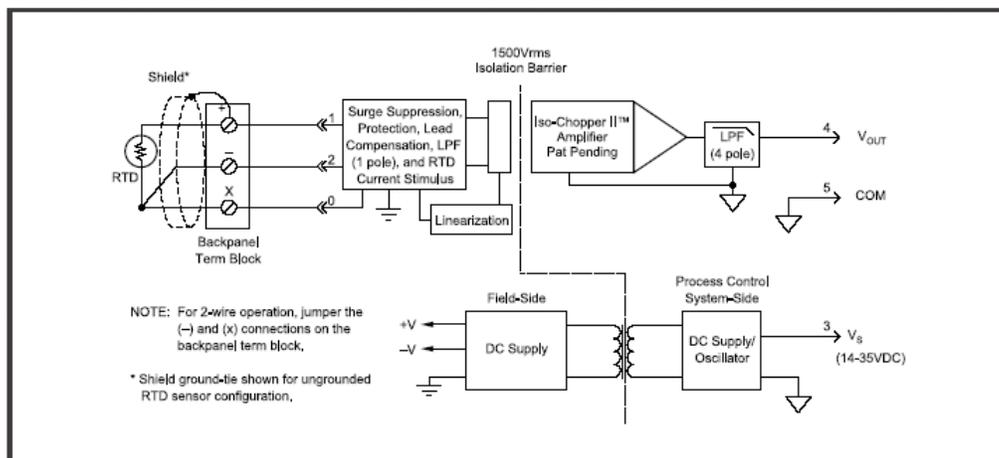
- Low output noise
- High surge withstand
- 1500Vrms transformer isolation
- 240VAC continuous input protection
- ANSI/IEEE C37.90.1 transient protection
- -40°C to 85°C operating temperature range (most modules)
- Encapsulation in solidly potted thermoplastic plug-in-the-panel package
- CE compliant

Dataforth's signal conditioners interface to a wide variety of voltage, current, temperature, position, frequency, and strain measuring devices and to a broad spectrum of analog signals, including millivolt, volt, milliamp, thermocouple (linearized and nonlinearized), RTD, potentiometer, slidewire, strain gage, frequency, and 2-wire transmitter.

Specific module types include voltage and current input modules in narrow and wide bandwidths; linearized 2-, 3-, and 4-wire RTD modules; accelerometer, potentiometer, strain gage, and both linearized and non-linearized thermocouple input modules; frequency input modules, True RMS, and 2-wire transmitter interface modules.

The SCM7B34, for example, is a linearized 2-or 3-wire RTD input module whose characteristics make it very well suited to wind turbine use. The modules incorporate a five-pole filtering approach to maximize both time and frequency response by taking advantage of both Thomson (Bessel) and Butterworth characteristics. In response to the low-level current excitation signal, the RTD input signal is chopped by a proprietary chopper circuit and transferred across the transformer isolation barrier, suppressing transmission of common mode spikes and surges. The signal is then reconstructed and filtered for process control system output.

These characteristics make the SCM7B34 ideal for temperature measurements in many wind turbine components.



SCM7B34 Block Diagram

Custom SCM5B, SCM7B, SensorLex[®] 8B, DSCA, and DSCT modules also are offered to meet specific customer needs.

Given the outstanding specifications of Dataforth's expansive and versatile signal conditioner families, they are the top-of-the-line choice to meet the rigorous reliability standards required to safeguard wind turbine operations.

Established in 1984, Dataforth Corporation is a worldwide leader in the design and manufacture of signal conditioning, data acquisition, and data communication products for industrial and institutional markets. The company is ISO9001:2000 registered.