WIND TURBINE PRESSURE MEASUREMENT

Application Note 10

General Description

Wind Turbines are becoming common place throughout the world. They provide clean energy and are typically located in wind farms. The definition of a wind turbine is a rotating machine that converts the kinetic energy of wind into mechanical energy. When this energy is converted to electricity, the machine is called a wind generator, a wind turbine, a wind power unit (WPU), or a wind energy converter (WEC).

To obtain the maximum power efficiency, the turbine blades need to be optimized in their shape and angle of attack. This research and development aerodynamic work is done both in wind tunnels and with actual full scale wind turbines. Scanivalve's pressure scanners are ideal for measuring these pressures.

Pressure Measurement

Scanivalve's pressure scanners have been used in research wind tunnels for years. Typically the ZOC33 (64 channel scanner) will be located inside the wind tunnel to make a pressure survey on the airfoil blade model.

In the past several years wind turbine manufacturers have done research onsite by placing pressure scanners inside the blade root at stations along the length of a full size working turbine blade. These scanners can be either Scanivalve's DSA3217 (16 channel scanner) or the ZOC33 (64 channel scanner) depending on number of pressures required. Real time pressures are measured at all angles of attack and at all wind speeds and in all weather conditions. These tests run 24/7 for months at a time. A pneumatic calibration valve is integral to each of Scanivalve's pressure scanners. This valve allows the user to purge the pressure input lines of condensation that could adversely affect the measurement reading. The user can purge the pressure input lines on demand while the turbine is rotating.

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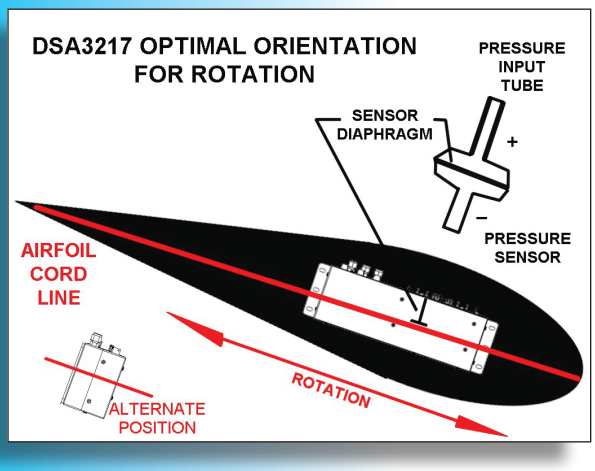
Data Correction

The pressure measurements are steady state. Tubing connects the measurement points with the pressure scanners located inside the blade. Location of the pressure scanners is critical to good measurements.



1. The pressure scanners need to be located as close to the hub as possible to minimize centrifugal forces as the turbine rotates.

2. Besides being located near the hub, the scanners need to be positioned such that the pressure sensor diaphragms in the scanner are parallel with the direction of rotation in line with the airfoil cord line. (See figure left) This orientation will insure that the sensor diaphragm will not be influenced by centrifugal force.

3. Gravity also must be accounted for when correcting the data. Gravitational forces add to the measurements as the blade swings upward and subtracts from the measurements when the blade is swinging down. Scanivalve has performed tests to allow for blade orientation correction.

4. When the turbine blades are not rotating due to being in the safe mode or no wind, a zero offset correction can be made to all of the pressure sensors via a software command. This zero correction takes about 10 seconds.

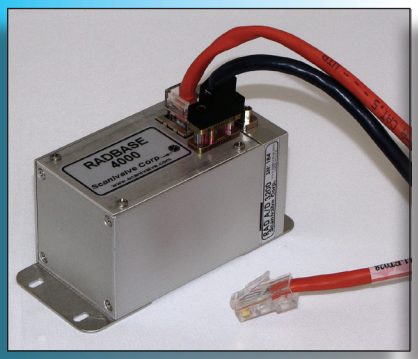
Pressure Measurement Data System

The pressure scanners can be configured to acquire data from 1 Hz up to 625 Hz/channel. The type of pressure scanner to be used depends on available space, and the application.

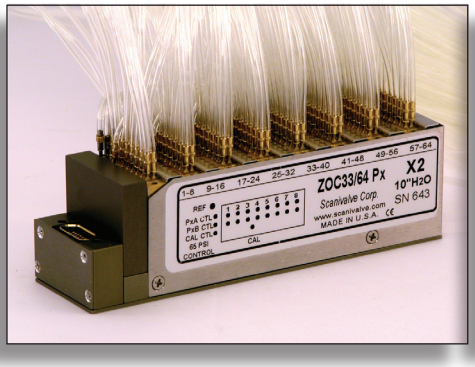
DSA3217/16Px

1. Scanivalve has developed a low profile DSA3217 pressure scanner especially for wind turbine work. This special high “G” model has a robust Ethernet bayonet style connector. This model measures up to 16 pressures and communicates Ethernet 10baseT. Multiple units can be placed in one turbine blade transmitting independent parallel data. Maximum sampling/throughput speed is 500Hz/channel.

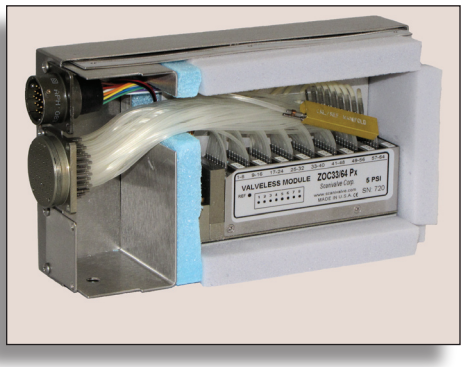
2. When space is more limited and a larger number of measurements are to be made, Scanivalve's ZOC33 pressure scanner with E-RAD4000 data system are the logical choice. Each ZOC33 contains 64 pressure sensors and can be installed in a temperature controlled unit, model ZOCTCU64. Up to 8 ZOC33 scanners can be used on one E-RAD4000 data system (512Px). The E-RAD4000 is compact, uses DSP (Digital Signal Processing), and communicates Ethernet 100baseT. It can be placed in the blade with the ZOC33 pressure scanners and provide real time data. Maximum sampling/throughput speed is 625Hz/channel.



E-RAD4000



ZOC33/64Px



ZOCTCU64

Communication

Communications to both the DSA3217 and E-RAD4000 is Ethernet TCP/IP. Data is output in temperature corrected Engineering Units.

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