Wind Turbine Condition Monitoring & Assessment

Sensors and Instrumentation for Permanent Installation and Testing of Wind Turbines and Turbine Components

IMI SENSORS
A PCB PIEZOTRONICS DIV.

visit us at www.imi-sensors.com ☎ Toll-free in the USA 800-959-4464 ☎ 716-684-0003

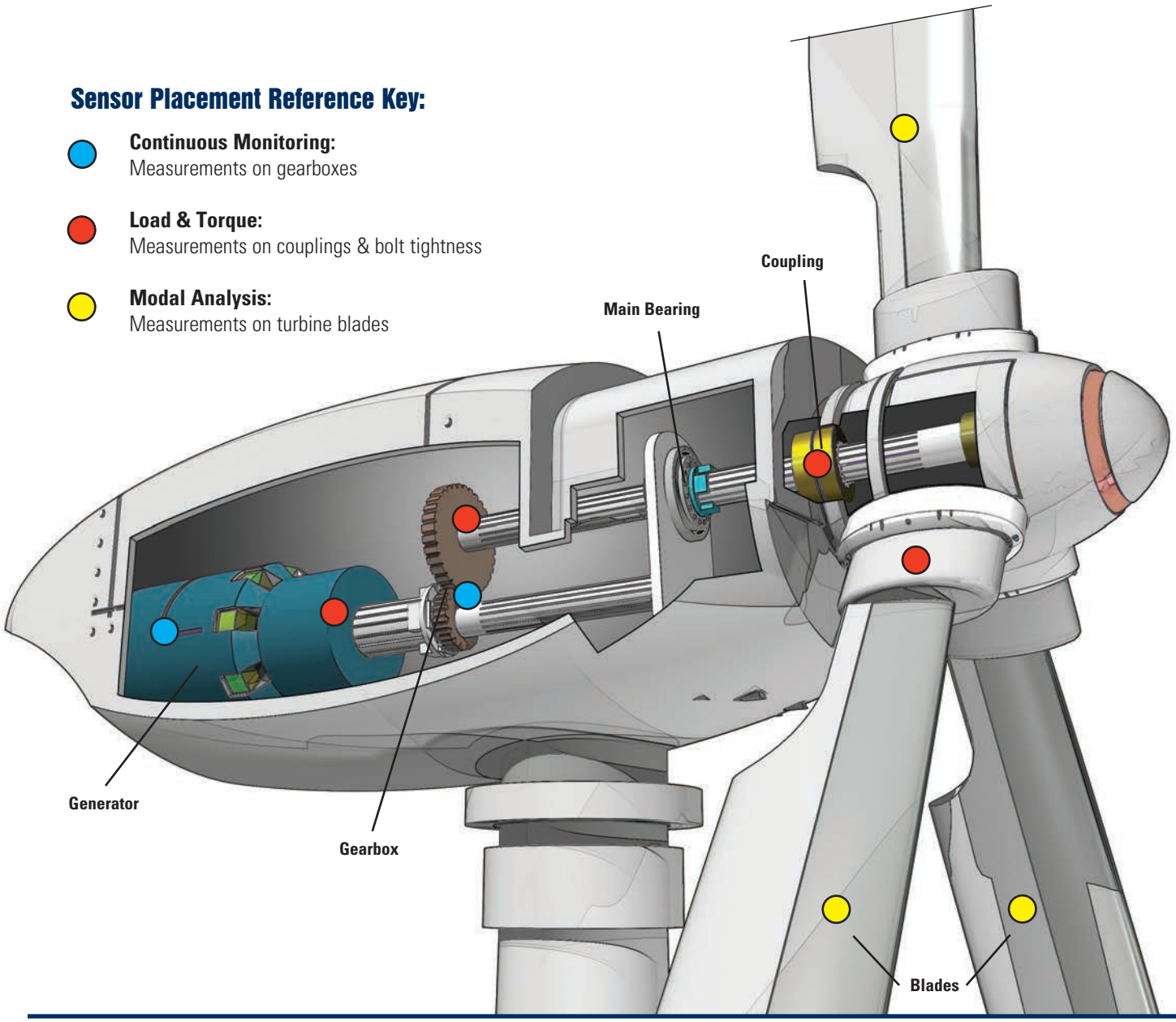
Energy & Power Generation

Wind Turbine Condition Monitoring

Some of the world's largest wind farms rely on IMI Sensors to keep their wind turbine operations at optimal performance by increasing reliability and reducing downtime. A broad range of industrial grade sensors from PCB® measure vibration, strain, torque and noise in new and existing wind turbines, providing measurements that are crucial to keep the operating health of these systems in tip-top shape.

Sensor Placement Reference Key:

- **Continuous Monitoring:** Measurements on gearboxes
- **Load & Torque:** Measurements on couplings & bolt tightness
- **Modal Analysis:** Measurements on turbine blades



IMI SENSORS
A PCB PIEZOTRONICS DIV.

Complete specifications available at www.imi-sensors.com

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Condition Monitoring Accelerometers - Energy & Power Generation

Low Cost ICP® Accelerometer
Series 607A

- Unique 360° swivel design
- Allows for easy cable orientation
- Integral or armored integral cable options available

Low Cost ICP® Accelerometer
Model 602D01, Model M602D01

- Easy installation in tight spaces
- 360° connector orientation
- Integral or armored integral cable options available
- M12 connector version available

Low Cost ICP® Accelerometer
Model 603C01, Model M603C01

- General purpose, hermetically sealed
- IMI's most popular accelerometer
- Small footprint
- M12 connector version available

Low Cost ICP® Accelerometer
Series 601

- Low noise
- Ceramic shear
- 100 mV/g or 500 mV/g
- M12 connector version available

Low Frequency ICP® Accelerometer
Model 626B01

- Ideal for slow rotating equipment
- Low noise floor
- High output sensitivity

Embeddable Accelerometer
Series 660

- ICP®, charge and low power versions available
- Easily designed into PC boards
- Variety of sensitivities

Wind Turbine Assessment

Wind turbines and towers utilize literally thousands of fasteners. Selecting the proper tools and applying the correct amount of torque to each fastener is imperative for optimizing the costs of operation.

RS Technologies, a division of PCB Load & Torque, Inc., serves the product assembly and fastener manufacturing communities with a complete line of rotary and stationary torque sensors, hand torque wrenches, measuring instruments and threaded fastener torque-tension testing systems. For more information on any of these products, please visit www.pcbloadtorque.com.

Hand Torque Wrenches - Energy & Power Generation

Torque Wrench
Series HT7000

- Durable ergonomic construction
- Lightweight and high strength
- Excellent accuracy of measurements
- Compatible with most data collectors

Visit www.pcbloadtorque.com for more information

RS Technologies, a division of PCB Load & Torque, Inc., manufactures a complete line of lightweight, precision hand torque wrenches that are among the lightest in the industry and durable enough to be used in the toughest industrial environments.

Auditing the torque applied to tightened fasteners is an important part of assembly and maintenance of wind turbines. Monitoring the residual torque in assembled fasteners can be accomplished by using Series HT7000 Hand Torque Wrenches along with Model 920 Portable Digital Transducer Instrument.

Rotary Torque Transducers - Energy & Power Generation

Rotary Torque Transducer
Series PC9000

- Industrial-rated for power and pulse tools
- Measure torque only or torque and angle
- 2 mV/V output with matched shunt calibration

Visit www.pcbloadtorque.com for more information

Series PC9000 Rotary Torque Sensors are widely used in the fastener assembly market to verify the performance of hand and power torque tools. These strain gage-based transducers are fitted on the output drive of a power tool and measure the torque applied by the tool to the fastener on an actual assembly. When equipped with a Model 920 Portable Digital Transducer Instrument, this measurement provides important information about tool shut off and can assist in establishing specifications for proper assembly.

Portable Transducer, Model 962 - Energy & Power Generation

Portable Data Recorder
Model 962

- Battery operated
- Cost-effective option
- Easy to operate
- Print both numeric and graphic data

Visit www.pcbloadtorque.com for more information

Model 962 Portable Data Recorder Instrument can be used with other RS Technologies' products such as the Stationary Torque Transducer, Rotary Torque Transducers, Hand Torque Wrenches and more. The instrument is powerful and accurate enough to be used as a primary standard for auditing most torque applications in manufacturing and quality departments. When connected to a Rotary Torque Transducer, the unit can be used to test the capability of power tools, verify the accuracy of hand tools, monitor the capability of a fastening process, or audit the quality of an assembled joint.

Microphones & Preamplifiers - Energy & Power Generation

Microphones are used to measure the noise generated by wind turbines both internal and external to the structure. PCB®'s new model 378A07, with a 0.1 Hz (+/-3dB) capability, was designed specifically for assessing the low frequencies required of this application. The gearbox and the main bearing are typical noise sources that are analyzed to predict possible machine faults and monitor for preventative maintenance. This will reduce maintenance costs and minimize downtime. Resonance frequencies can be determined and corrective actions can be taken to counteract and extend the life cycle of the components. A grouping of free-field, model 378B02 or value oriented, model 130 series array microphones can be used to pinpointed noise sources to help engineers target problem areas. PCB® microphones use standard coaxial cables and low-cost, constant-current power supplies that are interchangeable with other ICP® compatible sensors. They can be used with IMI's 4-20 mA DIN rail transmitters.

- Type 1 compliant, modern prepolarized (0 V) and externally polarized (200 V) microphones
- High-temperature (800 °C) 1472 °F microphones
- Water and dust resistant microphones for rough environments
- TEDS compliant and CE marked

Visit www.pcb.com/acoustics for more information

Sound Level Meters - Energy & Power Generation

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

For environmental noise monitoring and building acoustics, Larson Davis offers a full line of instruments, accessories and software. For personal noise and vibration exposure monitoring, Larson Davis complements this with sound level meters, personal noise dosimeters, human vibration meters, audiometric calibration systems and hearing conservation programs.

The rugged, ergonomic design of the Larson Davis Sound Level Meter, Model 831, is ideal for one-handed operation and its large display can be read in any lighting conditions. The 831 can also be used with a complete range of microphones and preamplifiers including weather-resistant units for unattended and semi-permanent wind turbine monitoring applications. Advances in technology provide 2GB of internal memory, with superior performance and a reliable design. The inclusion of Weather Parameters allows all environmental noise data to be integrated in one common report.

Sound Level Meter
Model 831

- Over 16 hours of runtime on 4 AA batteries
- USB 2.0 peripheral connectors
- 120dB dynamic range
- 2 GB memory standard
- RMS & peak A, C & Z frequency weighting
- RMS slow, fast & impulse detection characteristics
- Real time 1/1 & 1/3 octave frequency analysis
- 6400 line FFT analysis
- WAV sound recording for source identification
- Automatic data logging (20ms to 24 hours)
- Complete environmental packages available

Visit www.larsondavis.com for more information

Wind Turbine Assessment

Instrumentation that can provide voltage excitation and bridge completion is ideal for this measurement. Strain gages can be placed anywhere on the blade, but the distribution varies with the amount of sensors. These sensors should be in a configuration to optimally model the stress on the blade, taking measurements from both the flap-wise and edge-wise directions.

Load, Strain & Torque - Energy & Power Generation

ICP® Strain Sensor

Model RHM240A02

- Measure Longitudinal Strain on Machinery Structures
- Monitor Quality, Safety and Reliability
- Robust Construction Endures Harsh, Industrial Environments
- Simple Installation is Non-Invasive to Process

Visit www.pcb.com for more information

PCB Piezotronics, Inc. Model RHM240A02 single axis ICP® Strain Sensor is structured with a quartz sensing element and microelectronic circuitry in a low profile titanium housing, making this sensor ideal for high resolution measurements of dynamic strain on wind turbine blades. This unit is compatible with PCB's ICP® Sensor signal conditioners and is capable of driving long cables.

PCB LOAD & TORQUE
A PCB GROUP COMPANY

PCB Load & Torque, Inc. designs and manufactures a full line of load cell and torque sensors for numerous industries including: aerospace & defense, automotive, medical rehabilitation, material testing, textile, process control, robotics & automation and more. PCB Load & Torque offers exceptional customer service, 24-hour technical assistance and a Total Customer Satisfaction guarantee.

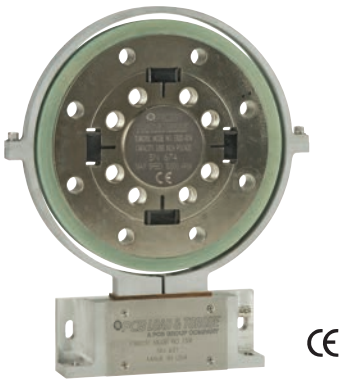
Load Cells

Series 1200 & Series 1400

- Low deflection, high accuracy
- Low profile for easy installation
- NIST traceable, A2LA accredited calibration to ISO 17025
- Temperature & pressure compensated

Visit www.pcbloadtorque.com for more information

PCB Load & Torque, Inc. manufactures a wide range of high accuracy, strain gage load cells. The 1200 and 1400 series load cells are compact and are available in various capacities from 250 lbf and up. While the 1200 series is a general purpose load cell with a cycle life of 10 million plus reversing cycles, the 1400 series is a fatigue rated load cells with a life cycle of 100 million plus reversing cycles. The 1400 series load cell is available in both single and dual bridge configurations.



TORKDISC® Rotary Torque Sensor System

Series 5300

- Digital system alleviates noise & data corruption
- Immune to RF & EMI
- Maintenance free

Visit www.pcbloadtorque.com for more information

PCB Load & Torque, Inc. Series 5300 TORKDISC® in-line rotary torque sensor systems are designed for test applications requiring a robust rotary torque transducer where axial space is at a premium.

Single Channel Telemetry Systems - Energy & Power Generation

PCB LOAD & TORQUE
A PCB GROUP COMPANY

PCB Load & Torque, Inc. single channel telemetry systems provide a simple, accurate method of conditioning and transmitting strain signals on rotating or moving machinery while operating in a completely contactless mode. Power is transferred inductively and the signal is RF-transferred between the moving and static component - no brushes or wires required. This method guarantees an absolute maintenance-free continuous operation and accurate transmission of measured data. Series 8180 performs a remote shunt calibration when the unit is powered up.

- Factory configurable for strain, thermocouple, voltage, or ICP®
- Easy to use, wear & maintenance free
- Extremely robust, dust & waterproof, yet compact and lightweight
- Contact-free signal transmission and power supply for continuous operation
- Remote shunt calibration
- Adjustable output

Receiving Unit
Model 8180-CUTO

- Extremely robust, dust and waterproof
- Remote shunt calibration
- Factory configurable for strain, thermocouple, voltage, or ICP®

Visit www.pcbloadtorque.com for more information

Rotor Electronics
Model 8180-RE110A

- Compact size, lightweight
- Easy to use, wear and maintenance free
- Contact free signal transmission and power supply

Visit www.pcbloadtorque.com for more information

Stator Head
Model 8180-SH2

- Compact size, lightweight
- Inductive power
- Distance to shaft 10 mm

Visit www.pcbloadtorque.com for more information

Stator Head
Model 8180-SH4

- Compact size, lightweight
- Inductive power
- Distance to shaft 200 mm

Visit www.pcbloadtorque.com for more information

Wind Turbine Assessment

Test engineers have used the principles of modal analysis, using PCB Piezotronics, Inc. ICP® accelerometers, Modally Tuned® Impulse Hammers and ICP® quartz force sensors to determine the strength and structural integrity. Single-axis and triaxial MEMS DC accelerometers are placed on the tip of each blade. The photo on page 9 shows a wind turbine blade mounting in a dynamically controlled, hydraulic structural loading machine, along with the various sensors and cables mounted on the blade.

Modal Shakers & Hammers - Energy & Power Generation

ICP® Impact Hammer

Model 086D20

- Sensitivity: (±15%) 1 mV/lbf (0.23 mV/N)
- Measurement Range: ±5000 lbf pk (±22,240 N pk)
- Hammer Mass: 2.4 lb (1.1 kg)

Visit www.pcb.com for more information

THE MODAL SHOP INC. A PCB GROUP CO.

The Modal Shop, a PCB Group Company based in Cincinnati, Ohio, USA, offers a complete line of electrodynamic modal and vibration shakers ideal for applications ranging from experimental modal analysis and general vibration testing to accelerometer calibration. Shakers are also available through the TMS Rental Program in addition to accelerometers, force sensors, hammers, microphones and sound level meters. As a global leader in sound and vibration, The Modal Shop is PCB Group's focal point for a comprehensive product range of dynamic calibration systems.

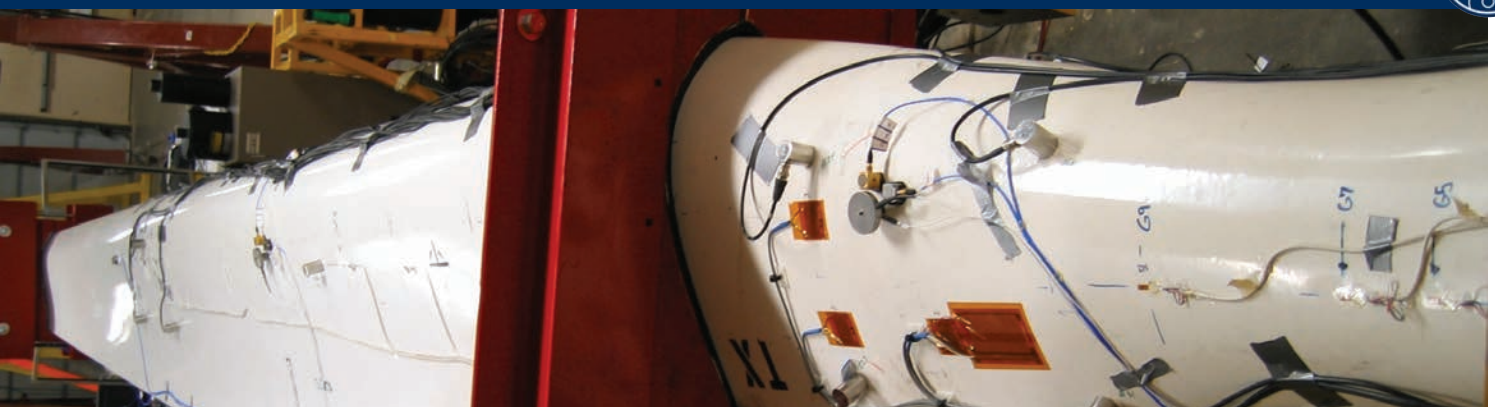
Modal Shaker

Model 2100E11

- Through-hole armature provides simple setup with modal stingers
- Lightweight and portable – weighing just 33 lbs (15 kg)
- Trunnion base provides flexibility when choosing best exciter location(s)
- 1" stroke supplies adequate input energy for most modal test applications

Visit www.modalshop.com for more information

For structural excitation, Modally Tuned® ICP® impulse hammers and shakers are also available, allowing PCB® to be a complete, front-end instrumentation provider. If the excitation is coming from a shaker, The Modal Shop offers a full line of modal and vibration shakers. The Model 2100E11, a lightweight electrodynamic modal exciter, is capable of providing up to 100 lbf (440 N) of peak force excitation in a small footprint weighing just 33 pounds (15 kg).



MEMS DC Response - Energy & Power Generation

Series 3711 (singe-axis), 3713 (triaxial) and 3741(single-axis) MEMS DC response accelerometers are designed to measure low frequency vibration and motion and are offered in full-scale ranges from ± 2 to ± 200 g to accommodate a variety of testing requirements. The units feature gas-damped, silicon MEMS sensing elements for uniform, repeatable performance and offer high frequency overload protection. Electrically, the units offer a single ended or differential output signal with power, signal and ground leads for each channel. Supply voltage regulation permits operation from + 6 to + 30 VDC and the low-noise, low-impedance output signal may be transmitted over long cable lengths without degradation.

Single-axis MEMS DC Accelerometer
Series 3711

- Hermetically sealed
- Robust titanium housing
- Single ended output

Visit www.pcb.com for more information

Triaxial MEMS DC Accelerometer
Series 3713

- Hermetically sealed
- Robust titanium housing
- Single ended output

Visit www.pcb.com for more information

Single-axis MEMS DC Accelerometer
Series 3741

- Low profile and low mass
- Anodized aluminum housing
- Differential output

Visit www.pcb.com for more information

Blade Pitch Control

Blade mounted pressure sensors can provide a signal to a blade pitch controller, which uses the signal to adjust the blade pitch to an acceptable level. PCB Piezotronics, Inc. pressure transducers, Series 1500, achieve the accuracy, repeatability and stability requirements of wind turbine measurement and control.

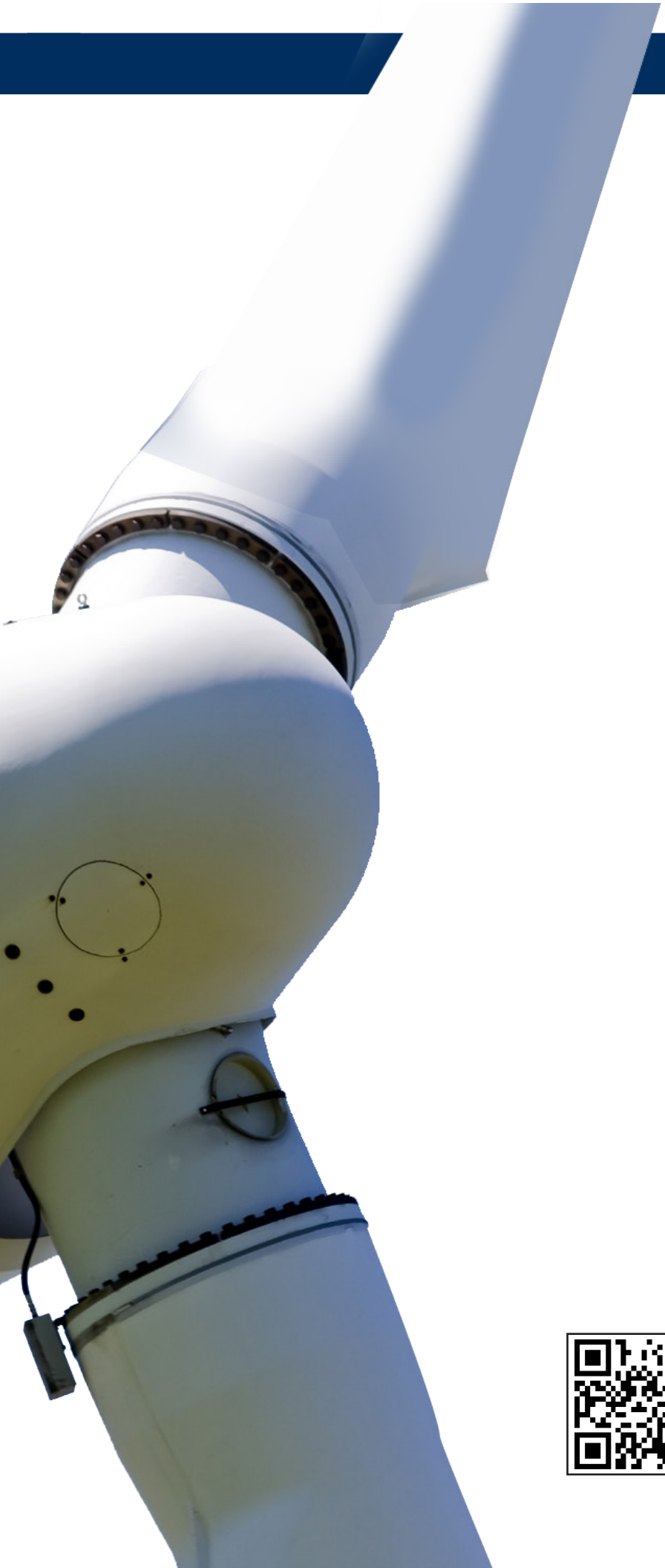
Pressure Transducers - Energy & Power Generation

PCB® pressure sensors have been specifically designed to provide high accuracy, excellent repeatability and unmatched long term stability. This is achieved by a unique thin-film process, which "atomically fuses" sensitive resistive material directly to the pressure sensing element. This process eliminates the traditional use of adhesives, as well as the need for a "fluid fill." The pressure sensing element is mated to an integrated circuit, programmed to provide the required span, zero and output configuration. Then, to ensure reliability, the sensing cores are encapsulated by an all-welded, corrosion resistant, stainless steel diaphragm and housing.

Pressure Transducers & Transmitters
Series 1500

- Available in gauge, absolute, and sealed gauge
- High precision final assembly
- Configure with a variety of electrical connectors and integral cables

Visit www.pcb.com for more information



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Corporate Headquarters - Depew, NY

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- Gearboxes
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- Oil & Gas Wells and Pipelines
- Vibration Screens & Feeders
- Reciprocating Machinery
- Machine Tool Spindles
- Steel Rolling & Annealing
- Rotary Screw Compressors
- Nuclear Power Instrumentation
- Shock Monitoring

IMI Sensors Platinum Stock Products represent some of our most popular models and can be used in a wide range of applications. As you browse this brochure, you will find Platinum Products indicated with the "Platinum Shield" icon (right).

Our Platinum Products are available with our Lifetime Warranty and fast delivery. If for any reason you are not 100% satisfied with your IMI Sensors Platinum Stock Product, we will repair, replace or exchange the product at no charge. For U.S. customers, all IMI Sensors Platinum Stock Products will ship within 24 hours. IF NOT, YOUR SHIPPING IS FREE!

Visit www.imi-sensors.com for complete details.

IMI SENSORS
A PCB PIEZOTRONICS DIV.

Corporate Headquarters 3425 Walden Avenue Depew, NY 14043-2495 USA
Toll-free in the USA 800-959-4464 ■ **24-hour SensorLine℠** 716-684-0003
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