ADAPTIVE ENERGY TECHNICAL BRIEF

P-Scan Ultrasonic Testing & P-Scan Stack with Phased Array

Adaptive Energy partners with FORCE Technology to address some of the world's most challenging non-destructive testing needs, using P-Scan ultrasonic inspection systems integrated with custom mechanical, electronic and robotic solutions

The Challenges

Ultrasonic material scanning is highly effective as a non-destructive testing (NDT) method for evaluating material characteristics (e.g., thickness and hardness), detecting flaws such as cracks, porosity and delamination and for mapping areas of corrosion. It can pick up normal structures of a material and detect anomalies that are within a tolerable range, as well as critical flaws within a specimen that threaten its structural integrity. However, standard ultrasonic inspection solutions have some limitations.

Manual ultrasonic testing can be labor intensive, requiring a scanner unit to be moved by hand over a test specimen. It also requires a skilled technician who must review and analyze scan results as the test is being done to determine which elements are actually significant, warranting follow-up testing for further assessment.

Another limitation of standard ultrasonic testing methods is they are often ineffective at evaluating parts that are irregularly shaped, rough, very small or non-homogeneous. Additionally, extremely large components can also be difficult to test because of their size, shape and weight, requiring extensive manual inspections that impact production times for manufacturing or high-throughput operations.

Adaptive Energy has partnered with Danish research institute FORCE Technology—one of the world's leading organizations developing cutting edge NDT systems—to create custom-tailored, automated ultrasonic scanning solutions that overcome these limitations, and are fast, accurate and easy to use. The P-Scan family of ultrasonic imaging scanners are combined with mechanical and robotic assemblies for easy deployment. Using P-Scan scanners, Adaptive Energy and FORCE Technology have developed customized solutions that are now providing effective testing in some of the world's most challenging environments, addressing mission-critical test needs.

Next Generation Testing Flexibility and Ease: P-Scan Stack with Phased Array

The latest ultrasonic scanning solution from FORCE Technology is the P-Scan Stack System with Phased Array, representing a significant advancement in automated ultrasonic inspection. The click-and-play stack system enables users to set up in just a few minutes. It offers large frequency range, unlimited data file size and high data throughput, with all of the reliability and accuracy users have come to expect from P-Scan systems.

The P-Scan Stack System is a modular phased array system, combining standard pulse-echo (PE), time-of-flight-diffraction (TOFD) and phased array (PA) in a highly customizable system that includes an integrated scanner controller and full battery operation. Users can choose between phased array/PE or PE only, and can select the ideal number of PA/PE channels for each testing task. The system also includes newly developed software optimized for usability with a Windows® 8 style user interface, accepting both keyboard, mouse and touchpad operation.

What is particularly unique about the P-Scan Stack is that it was designed by the technicians and operators who use P-Scan systems every day, sometimes under difficult conditions and in harsh environments. As a result, usability, flexibility and reliability were key objectives. The system incorporates all the strengths of the P-Scan automated ultrasonic inspection system together with a rugged anodized aluminum frame that offers mobility, and no connecting wires or cables to get tangled or detach; all electrical connections are built into the stack.

Other product benefits include:

- The P-Scan Stack power supply accepts both AC and DC input, and will work with everything from a 12V car battery to a standard power outlet
- There is an integrated battery pack that provides power to both the processor and the scanner for up to eight hours, and allows battery hot swapping
- A pump unit can be operated directly from the processer to control the water supply for the ultrasonic probes

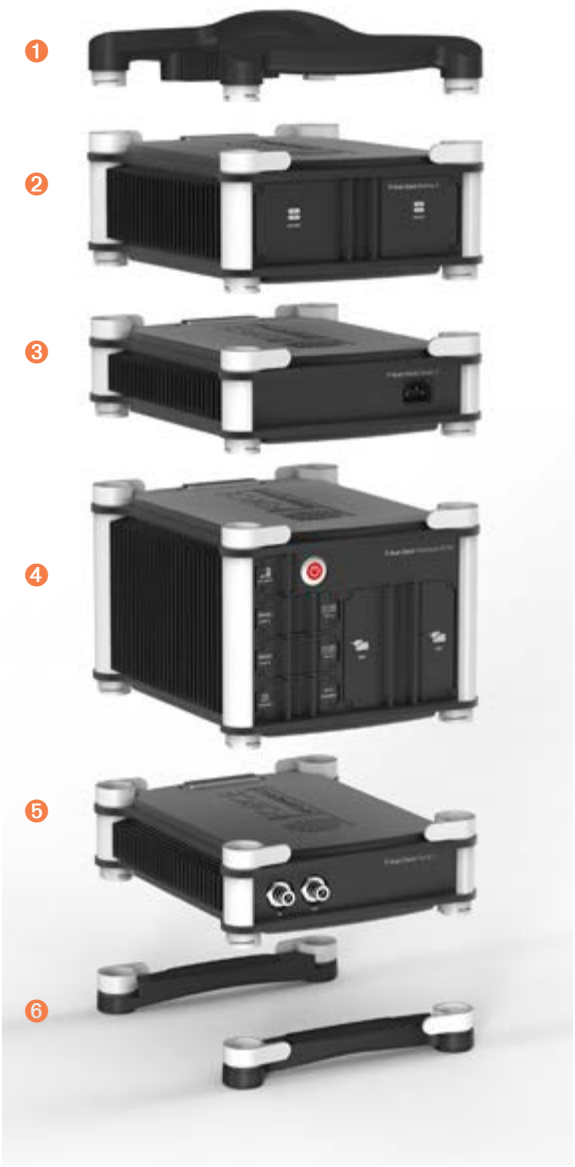
The system offers improved data accuracy, with a dynamic range of 100 dB, sample up to 120 MHz, and 22 bit amplitude resolution. It also provides data throughput speed of up to 15 MB per second. It can be used with P-Scan System 4 scanner units, or the new P-Scan AUS-5.

The P-Scan Product Family

P-Scan is a trade name used by FORCE Technology for its extensive lines of:

- Automated ultrasound and eddy current inspection systems
- Automatic ultrasonic scanners for weld inspection and corrosion mapping
- Tailor-made ultrasound and eddy current inspection solutions for complex structures

The P-Scan system has played a major role in the market for integrity inspection of technical structures since 1977. In 1985, the PSP-3 P-Scan product was an industry breakthrough combining an ultrasonic processor unit with PC software for system control and data analysis.



❶ P-Scan Stack Handle provides easy portability for the entire system

❷ P-Scan Stack includes four batteries, delivering up to eight hours of running time to all modules, including the scanner

❸ The P-Scan Stack power supply: the system can run on AC or DC input and simultaneously charges the batteries while powering the system

❹ P-Scan Stack processor unit

❺ The P-Scan Stack pump unit parameters can be controlled through the easy-to-use system software to adjust water flow and improve data quality

❻ P-Scan Stack feet, for stability

The very compact P-Scan System 4 was the fourth generation of P-Scan systems, and the P-Scan 4 Flex allows users to switch between ultrasonic and eddy current testing.

The latest generation scanner is the P-Scan AUS-5 (described below). As a result of FORCE Technology's continuous product development and enhancement, numerous P-Scan systems are now in regular use in more than 30 countries throughout the world for a variety of advanced NDT applications ranging from sub-sea installations to aerospace crafts. P-Scan systems offer key advantages:

- **Automation**—allowing testing to be conducted quickly and thoroughly according to pre-determined parameters
- **Speed and ease-of-use**—scan units can be set up quickly, and are intuitive with user-friendly operation and interfaces
- **Robust and reliable**—standing up to repeated use under harsh test conditions, and easy for organizations to maintain in-house without a need for extended maintenance contracts
- **Small and easy to transport**—offering flexibility and enabling ultrasonic scanning in confined or hard-to-reach spaces
- **Processing power**—integrated a remotely controlled data acquisition and processing software captures data in real-time and performs analysis to automatically identify possible anomalies and issues, alerting operators to areas that may require further inspection

Phased Array

Phased array is an advanced method of ultrasonic testing that uses multiple small transducers to send pulses in rapid sequence.

The resulting sound wave patterns can be at different angles. To evaluate large objects, a conventional ultrasonic probe must be physically moved across the object. By setting the timing of pulses from the transducer in a phased array, scan beams can sweep through a large volume of material from a single point of emanation.

The phased array technique offers significantly faster scanning time.

Next Generation Ultrasonic Scan Unit: the Rugged & Compact P-Scan AUS-5

Building on the P-Scan reputation for durability, precision and usability, the latest automated ultrasonic system from FORCE Technology is the P-Scan AUS-5. This universal scanner includes an integrated touchscreen so it can be operated directly on a test object, or remotely from a PC. It is compact, allowing it to be used on almost any surface from small pipes to planar surfaces. It has a robust finish that makes it ideal for testing in tough environments.

It can be combined with the P-Scan Stack, drawing power from the stack's battery so no external power source is needed. Magnetic wheels attach easily to steel surfaces for a fast set-up time.

Standard Scanning Applications

The core P-Scan ultrasonic scanners can be combined with a range of robotic systems and mechanical assemblies to provide integrated scan solutions for a range of uses, from robust pipe scanners to innovative multi-axis robots for complex geometry nozzle inspection. They are ideal for applications like weld inspection, corrosion mapping and inspection of composites.

P-Scan systems are used by organizations for conducting both pre-service inspection and in-service inspection of equipment components, and also for production quality control in manufacturing and assembly line applications. For example, one Adaptive Energy customer uses various compact pipe-scanner models for in-service inspection of oil refinery pipe systems.

The ultrasonic scan units are delivered with a control interface to the FORCE Technology P-Scan system. As an option, many of the scanners can be delivered with interface to a third-party motor controller/inspection system. Different standard scanner assemblies are available for various deployment approaches, including:

- Manual scanner
- Automatic magnetic wheel scanner
- Automatic clamp on scanner (by clamp or chain)
- Automatic track scanner

Customized Scan Solutions

Many of Adaptive Energy's customers, however, come with more complex testing needs that cannot be solved with standard, off-the-shelf scanning systems. Whether testing has to be performed in challenging settings such as those often encountered in the nuclear, offshore and petrochemical industries, or whether the items to be tested are unusual or complex, P-Scan systems are flexible and powerful enough to be incorporated into a wide range of custom-designed and custom-fabricated solutions.

Offering reliability, speed and accuracy, the solutions designed, built and deployed by Adaptive Energy and FORCE Technology are providing mission-critical material evaluation solutions that no other products on the market nor other service providers have been able to address. For example:

- **Quality inspection of rolled rings at production speeds.** The company fabricates seamless rolled rings for a variety of industrial, mining and aerospace applications. These rolled rings are made of various metals such as steel, aluminum and titanium alloys, and can come in sizes up to 44 tons (40 metric tons) and 8 meters in diameter.

  To accommodate the different sizes and parameters of the rings, a P-Scan System 4 is integrated with a flexible probe-rail assembly and mechanical controller unit that allows the rings to be rotated for complete scanning of both internal and external surfaces. This solution enables the customer to perform fast, accurate scanning at production-line speeds.

P-Scan 4 ultrasonic scanner and assembly being used to scan a rectangular cross-section forged ring for material homogeneity and defects prior to final machining

- **Water jet probe scanner upgrade for mission-critical aerospace components.** The company had been using an existing water jet probe scanner system, but needed to increase scanning speeds and precision. Unfortunately, the original equipment manufacturer was no longer able to service the system, so Adaptive Energy performed an assessment to determine if it could be refurbished and upgraded, or if a new system would have to be purchased.

  By integrating a P-Scan System 4 scanning unit and replacing the mechanical controllers with a new assembly that provides longitudinal, horizontal and vertical positioning capabilities, the system was put back in service quickly and cost effectively.

- **Remote inspection of radiation waste storage tanks.** At the site of one of the United States' oldest nuclear material manufacturing facilities, aging underground radiation waste storage tanks require regular weld inspection and visual and ultrasonic inspection for micro-cracks, corrosion and wall thinning to ensure their structural safety. The consequences of a leak or failure of one of these double-walled tanks could be catastrophic for residents in communities across the region, resulting in lasting environmental contamination. However, the annulus between the tanks is only five inches wide and is accessed through vertical pipes up to 14 feet long.

  Adaptive Energy and FORCE Technology partnered on a solution incorporating a small ultrasonic scanner unit able to fit through a space just five inches in diameter. It was mounted on an automated robotic crawler, along with a camera for visual inspection. In addition to ensuring an effective inspection regimen to prevent any structural breach of the tanks, the remote solution also protects the facility technicians, allowing testing to be done from a safe distance.

- **Mobile scanner unit for automated wind turbine blade inspection.** The company designs and builds wind turbines for industrial use. The turbine blades can be as much as 50 meters long, made of composite materials. To meet increasing demand for wind power, the customer needed to scale production rapidly, so their manual ultrasonic inspection process was no longer adequate.

Mobile scanning unit with P-Scan traversing a composite wind turbine blade

  The solution was a mobile scanner vehicle that can travel along the length of each wind turbine blade at the rate of 20 feet per minute, rotating to capture ultrasound images from multiple angles. The unit is constructed with its own power supply, pumps and water supply for independent operation for long periods throughout a large facility. The vehicle carries an AMS-20 scanner equipped with 26 probes in flexible holders, integrated with the P-Scan 4 Flex ultrasonic imaging system. The system is able to rapidly and accurately detect any issues in the integrity of the adhesive joints, any delamination, dry fiber areas, porosity, fiber orientation issues or wrinkles.

Additional benefits customers have experienced from each of these solutions are ease of use, automated data analysis and documentation, and low ongoing maintenance requirements.

Ultrasonic Testing

Ultrasonic material testing was first developed in the 1940s and is now in widespread use as a common non-destructive testing (NDT) method for steel and other metals and alloys, although it can also be used on concrete, wood and composites. It's highly effective for evaluating material characteristics (e.g., thickness, hardness), detecting flaws such as cracks, porosity and delamination, and for mapping areas of corrosion.

Ultrasonic testing works by sending sound waves through an object via a transducer and measuring the pathway and timing of the waves as they pass through. A processer unit translates the received signals into an amplitude wave. Variations in the wave can be analyzed to identify flaws or material characteristics. Some of the advantages of ultrasonic testing include:

- Sound waves penetrate deep inside an object to allow evaluation of multiple characteristics
- A high degree of sensitivity to detect even microscopic flaws and cracks
- Ultrasonic testing can be performed when only one surface of an object is accessible, unlike X-ray imaging which requires access to both sides
- Improved accuracy compared to other non-destructive testing methods, especially for determining internal flaws and assessing the thickness of parts with two parallel surfaces
- Ability to capture information about the size, orientation, shape and the nature of any internal flaws or irregularities
- Sound waves pose no hazard to people or materials, unlike X-rays, which emit radiation

Ultrasonic Testing Modes

Reflection (or pulse-echo) ultrasonic testing relies on sound waves reflected back towards and received by the transducer. Reflection comes from the back wall of an object or is the result of in imperfection or flaw detected within the object.

With the attenuation (or through-transmission) testing method, a transmitter sends ultrasound through one surface to a separate receiver on the other. Variations in the sound waves received indicate imperfections or characteristics of the material.

The time-of-flight-diffraction (TOFD) testing method is used for testing welds. A pair of ultrasonic probes is placed on either side of a weld, one acting as the pulser and one as the receiver.

Eddy Current Testing

Eddy-current is a method of non-destructive testing that uses electromagnetic induction to detect flaws. It can be used on any type of conductive material such as metal. A circular coil is placed in proximity to a test specimen, and alternating current through the coil creates a fluctuating magnetic field that generates an eddy current in the material. By analyzing variations in the phase and magnitude of these currents with a second receiver coil, flaws in the specimen can be detected. Eddy current testing is effective for components with complex geometries, or for assessing electrical conductivity and coating thickness.

About Adaptive Energy

Adaptive Energy creates customized, non-destructive material evaluation solutions to address mission-critical, time-sensitive testing needs. By combining the latest digital radiography, computed tomography, and ultrasonic imaging technologies with innovative mechanical and robotic assemblies, Adaptive Energy's integrated systems offer rapid deployment, are easy to learn and maintain, and perform reliably under pressure.

Working collaboratively with organizations in the aerospace, automotive, energy, petro-chemical, defense, infrastructure, and materials industries, our experts develop optimized solutions for flaw and crack detection, composite delamination, weld inspection, hardness testing, custom radiation enclosures and overhead gantry systems, and more.

Adaptive Energy is also the exclusive distributor in the U.S. and Canada of FORCE Technology's P-Scan ultrasonic scanners, including the P-Scan Stack with Phased Array, a next generation automated inspection system.

For more information about FORCE Technology and the P-Scan product line visit www.forcetechnology.com, and for details about the P-Scan Stack with Phased Array visit www.p-scan.com.

CONTACT

+1.253.284.0825

Email info@adaptiveenergy.com

Mailing address
Adaptive Energy
1640 Marine View Drive, Suite B
Tacoma, WA 98422

www.adaptiveenergy.com