XDclear Transducer Technology

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Background

Through our Healthymagination initiative, GE Healthcare continuously invests in innovations that help lower the cost, increase the access, and improve the quality of healthcare. In 2008, GE Ultrasound pioneered a new ultrasound system architecture based on sophisticated models that resulted in a new level of GE image quality on a broad spectrum of patient body types.

Now, GE has returned to the basics of ultrasound and made similar dramatic improvements by introducing a new GE transducer architecture, XDclear, that challenges expectations regarding the limits of ultrasound image quality. XDclear transducers help deliver a more powerful, pure, and efficient sound wave with wider bandwidth than traditional GE transducer technology. This results in impressive deep penetration and high resolution, enabling ultrasound to be used on a broad range of patients.

Truly extraordinary image quality requires innovation throughout the image chain. From signal transmission to final display, technical barriers in ultrasound can begin to degrade image quality. These technical barriers include generation of a high quality transmit pulse; efficient coupling between the system electronics and the transducer to convert the electrical energy to acoustic energy within the transducer and couple that energy into the body; then compensating for the attenuation, diffraction, and reflection of the signal within the human body until the reflected signal is received and carefully processed. GE's Agile Acoustic Architecture provides a powerful platform that helps optimize the ultrasound system to address these barriers. XDclear transducers complement the system architecture, providing an equally powerful acoustic platform composed of innovative new technologies. The combination of GE's system architecture and XDclear transducers takes image quality to a high level.

The building blocks of XDclear: Acoustic Amplifier, Single Crystal, and Cool Stack

XDclear transducers are a proprietary combination of advanced materials and innovative design. The XDclear design incorporates an enhanced piezoelectric material, Single Crystal, to generate a high quality acoustic signal.

Figure 1. XDclear proprietary design is a combination of innovative technologies that help maximize the potential acoustics to measurably increase penetration[1] and simultaneously deliver high definition resolution throughout the image.

The quality of that signal is preserved through an innovative Acoustic Amplifier design coupled with GE's Cool Stack technology to help optimize energy management. The ability to effectively and efficiently combine these technologies is what makes XDclear extraordinary.

Single Crystal: The foundation of an extraordinary image

Ultrasound transducer performance is directly related to the piezoelectric material efficiency and quality. Many traditional transducers use a polycrystalline ceramic material such as PZT (lead-zirconate-titanate). Single Crystal PMN-PT (lead magnesium niobate/lead titanate) and PZN-PT (lead zirconate niobate/lead titanate) are newer, highly efficient piezoelectric materials, which are manufactured by carefully 'growing' a cylinder of the single crystal material, much like semiconductors are manufactured in the electronics industry. Fabrication challenges initially limited Single Crystal to small aperture size and lower frequency transducers, but more recently, advances in fabrication techniques have allowed broader implementation of Single Crystal across a variety of clinical applications and probe types.

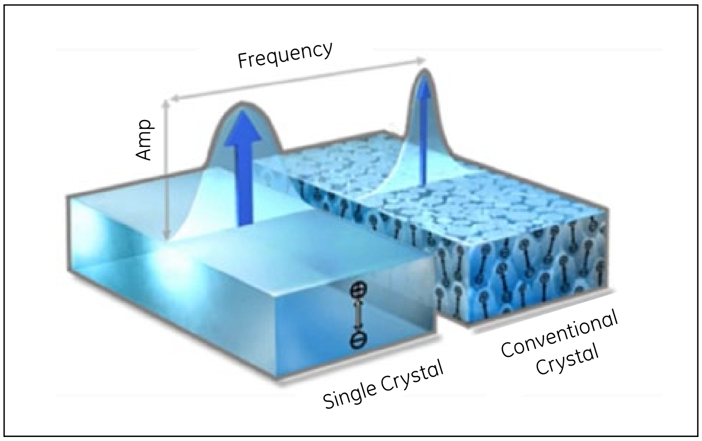

Figure 2. Single Crystal materials exhibit a wider bandwidth than conventional PZT crystals.

Acoustic Amplifier: Preservation of the acoustic signal

Acoustic Amplifier Architecture extends bandwidth and sensitivity, while simultaneously improving electrical impedance matching efficiency to system electronics.[2]

Many medical imaging transducers have a backing structure that uses multiple layers, the last of which is suitable for mechanical impedance and reliable support. However, this backing structure contributes negatively to transducer acoustic operation. It is a source of energy waste and artifact risks, and is subject to many process constraints that result in performance trade-offs. GE's Acoustic Amplifier design leverages a patented layer that sits between the transducer core structure and the rest of the mechanical housing, providing comprehensive acoustic insulation from mechanical structures.

In addition to the acoustic insulation, the Acoustic Amplifier design results in widened power efficiency bandwidth with reduced noise and less heat dissipation since energy that was formerly wasted is now reflected and re-used.[1]

GE Healthcare's advanced manufacturing capabilities are used to implement the Acoustic Amplifier design as the assembly requires submicron accuracies.

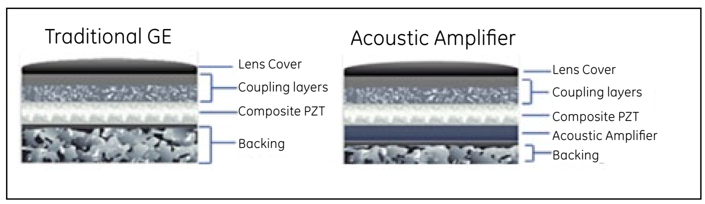

Figure 3. The Acoustic Amplifier is an innovative design that captures and redirects the unused energy that passes through the crystal to enhance sensitivity, axial resolution, and penetration.

Cool Stack: Helping optimize energy usage

Ultrasound transducers utilize piezoelectric material to generate and then transfer ultrasound energy through coupling layers to the body. The heat generated in the transducer often reduces the performance of the ultrasound application. Cool Stack is an advanced GE technology in the XDclear architecture that relieves inherent heat generation that can otherwise reduce sensitivity and penetration.

The Cool Stack design includes an embedded special material that has a high degree of thermal connectivity. This Cool Stack is then integrated with the thermal management material behind the acoustic stack to efficiently disperse the heat generated by the signal generation process. This frees the ultrasound transducer to help optimize energy usage, resulting in extended penetration and diagnostic power in different modes of the ultrasound system.

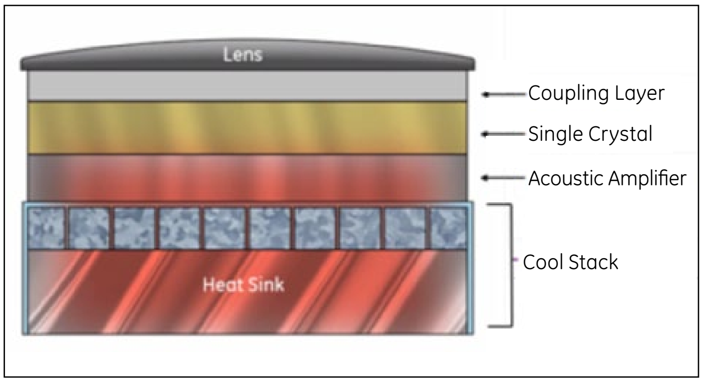

Figure 4. Cool Stack is a patented technology integrated into the transducer's internal architecture that relieves inherent heat generation that can otherwise reduce sensitivity and penetration.

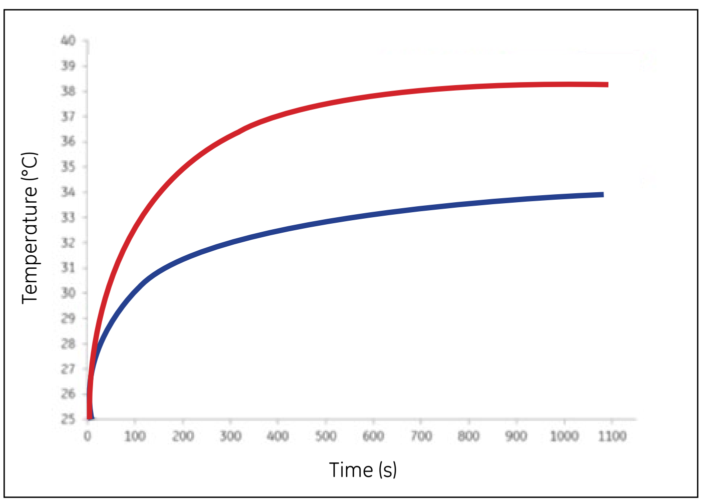

Figure 5. Illustration of the improved thermal management provided by Cool Stack. Note the reduced rise in temperature inside the transducer (blue) compared with traditional GE technologies (red).

The Result: Deep penetration and resolution

One objective measure of transducer performance is bandwidth, the range of frequencies which the transducer can transmit and receive. Increased bandwidth allows a transducer to cover a broader frequency range. This helps achieve deep penetration and high resolution, enhanced performance in harmonic imaging, and even helps make it possible to cover the range of acoustic frequencies that previously required separate transducers. XDclear transducers with Single Crystal materials have measurably enhanced bandwidth, achieving a -6 dB fractional bandwidth[1] that can exceed 100% compared to 70-80% for traditional GE transducers.

The result is a new GE level of penetration, resolution, and sensitivity in imaging performance.

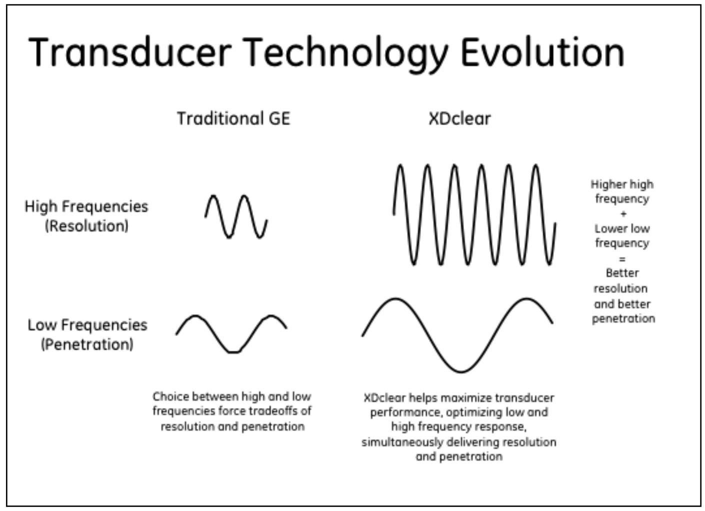

Figure 6. Additional low and high frequency signals with XDclear help achieve both better penetration and resolution.

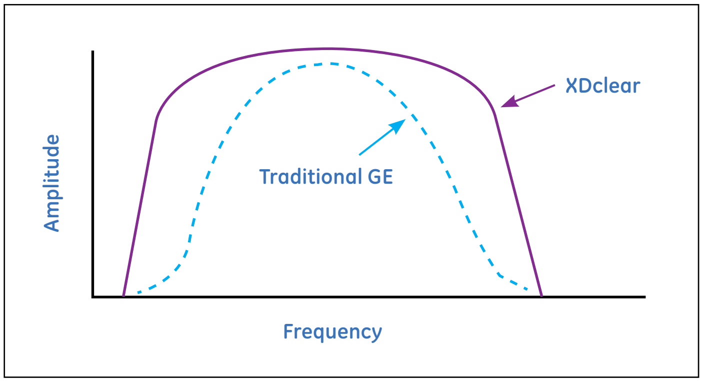

Figure 7. Increased bandwidth of XDclear transducers is made possible by the efficient combination of technologies including Single Crystal material.

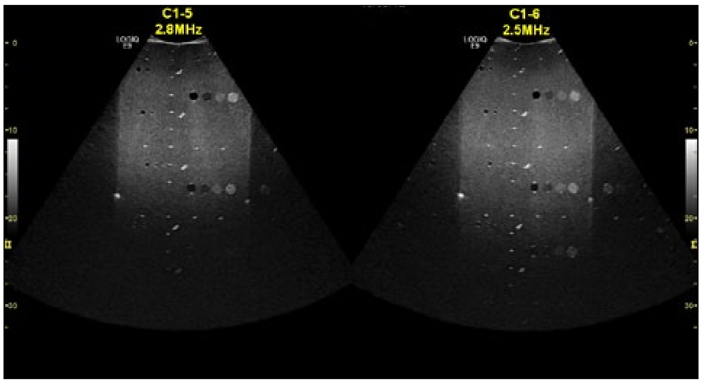

Figure 8. Resulting imaging performance. Note the simultaneous enhancement in penetration and resolution with XDclear.

XDclear transducers represent a leap forward in GE acoustic engineering and performance, helping maximize the potential of Single Crystal performance by combining this breakthrough material with Acoustic Amplifier and Cool Stack technologies. This combination helps enhance penetration and resolution, helping produce extraordinary image quality on a broad range of patients. When combined with GE's advanced ultrasound systems, users can achieve extraordinary imaging.

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[1] As compared to GE transducer technology.
[2] United States Patent No: US 7,621,028 B2, Method for optimized dematching layer assembly in an ultrasound transducer, November 24, 2009. Assignee: General Electric Company.

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