



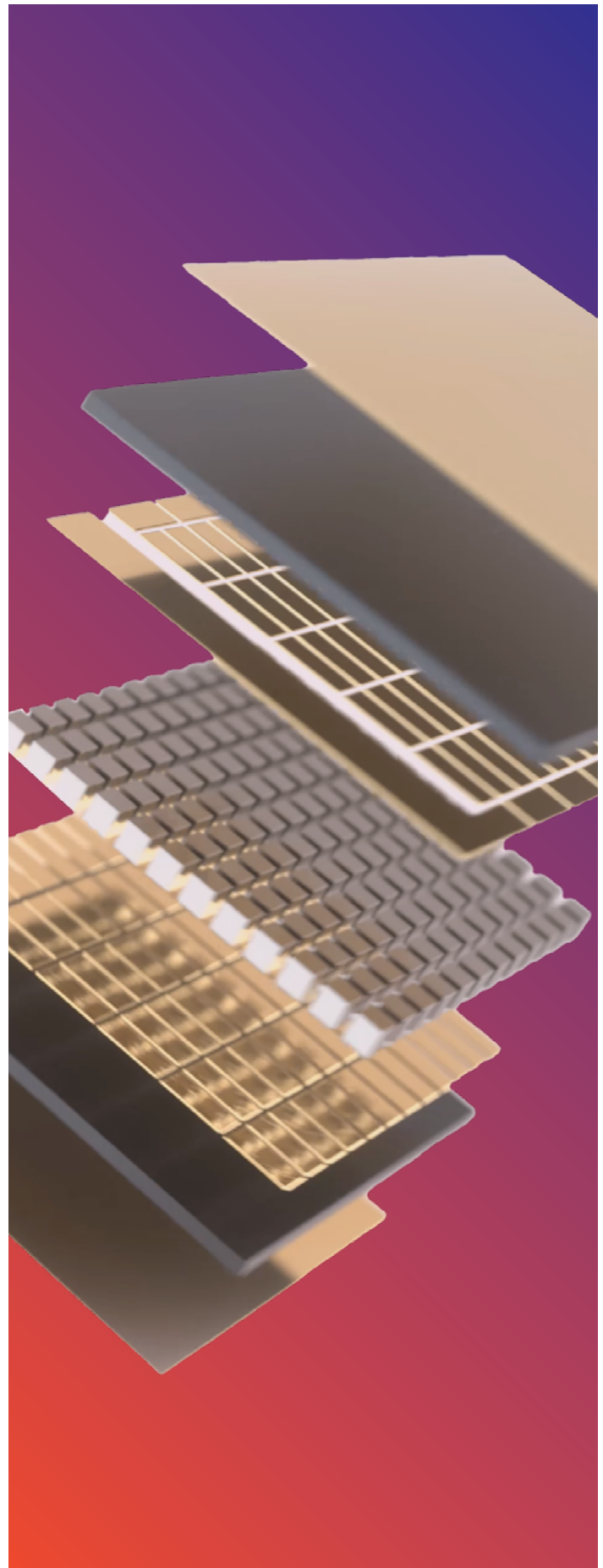
Different by Design

Phononic’s Design Process, Robust QMS and Engineering Expertise Ensure Quality TEC Delivery on Time to Market

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PHONONIC'S
APPROACH
GOES BEYOND
MEETING INDUSTRY
STANDARDS. OUR
FOCUS IS BUILDING
A FOUNDATION
FOR RELIABILITY,
CUSTOMER
SATISFACTION,
REGULATORY
COMPLIANCE,
COMPETITIVE
ADVANTAGE, AND
CONTINUOUS
IMPROVEMENT.

In Brief: Phononic's Rapid Adoption Across an Entire Industry

As data centers continue to keep pace with ever-growing data needs from technological advancements such as video conferencing and AI, thermoelectric coolers (TECs) and other innovative cooling technologies will become more critical than ever in ensuring optimal performance, reliability and energy efficiency.

Phononic's state-of-the-art TECs are quickly becoming the fiber-optic industry's go-to cooling architecture—and with good reason. Over the past five years, Phononic has deployed more than 40 million TECs in the field—achieving unprecedented reliability with zero recalls and field failure rates below our internal target of 10 DPPM. Phononic TECs can currently be found in 40% of data center and datacom infrastructure in North America—a percentage that is only rising as data centers continue to evolve to meet today's skyrocketing data demands.

These exceptional outcomes are the result of Phononic's deliberate commitment to rigorous quality and reliability standards, with a powerful Quality Management System (QMS) as its backbone.

For Phononic, developing and implementing a strong QMS goes beyond the need to meet industry standards. Rather, it's about building a foundation for reliability, customer satisfaction, regulatory compliance, competitive advantage, and continuous improvement. With decades of experience, Phononic's industry-leading engineering team prioritizes quality of design at every stage of development, providing production-quality samples for testing to ensure our TECs meet the rigorous qualification demands of high-speed data centers and other critical applications. In fact, we are the only in the industry to adhere to a 100% electrical testing of thermoelectric performance of all manufactured components.

To ensure Phononic's manufacturing process meets and exceeds our own rigorous demands, we developed and implemented a robust QMS, as well as impeccable Environmental Management System (EMS).

Phononic Certifications & Standards

2015 | Phononic receives ISO 9001:2015

A globally recognized standard for quality management. It means we put in place effective processes and trained our staff to deliver flawless products time after time.

2019 | Phononic receives ISO 14001:2019

An internationally recognized standard for environmental management systems. It means we've committed to more than just environmental regulatory compliance and ongoing environmental improvement.

2022 | Phononic receives IATF 16949:2022

A global Quality Management System Standard for the automotive industry. This standard continues to be met as we manufacture at scale.

Phononic Manufacturing Enables TECs to Achieve Highest Quality and Reliability

The Phononic TEC manufacturing process leads the industry, delivering high-quality and reliable TECs for our customers. Much of our manufacturing success comes from our dedication to materials science and exacting precision.

Precision Ingot Wafering

The reliability of each Phononic TEC's performance characteristics is of the utmost importance, which means consistent wafer thickness is essential. In addition, the performance consistency of Phononic's BiTel materials leads the industry, and delivers clear benefit to our end customers. To meet that end, Phononic has developed a groundbreaking ingot wafering process that slices ingots into individual wafers with micron-level precision. This ensures uniformity and consistency across all wafers, which further enables each TEC to operate within its specified parameters and deliver consistent performance.

Precision ingot wafering comes with a host of other benefits as well. Ingot wafering allows Phononic to achieve target thickness accuracy, which ensures they can achieve their desired thermal and electrical properties, essentially giving customers precise control over heat transfer and electrical conductivity. Our wafering technique also allows for compatibility with the assembly process, creating the ideal conditions for consistent bonding, soldering and placement of elements during the TEC manufacturing process. It also delivers yield improvement, as well as measurement accuracy and repeatability.

Overall, precision ingot wafering delivers consistent and accurate wafer thickness, which is vital for maintaining the performance, compatibility, yield, and quality of the TECs. This exacting method enables Phononic to manufacture thermoelectric devices with reliable and predictable performance characteristics — always meeting the most stringent requirements of our customers.

Industry-Leading Metal and Diffusion Barriers

The contact metal and diffusion barriers employed by Phononic in the manufacturing process play a crucial role in the overall performance of our thermoelectric devices. These highly important components facilitate the efficient transfer of heat and electricity to optimize the functionality of each Phononic TEC.

Contact metal and diffusion barriers enhance TEC performance in a variety of other ways as well:

- They provide greater reliability and durability by acting as protective layers for Phononic TECs, protecting them from environmental factors like oxidation.
- They enable Phononic TECs to maintain its consistent, high-quality manufacturing process by ensuring each device meets its specific design targets and the unique customer requirements, in turn preventing common degradation in efficiency, effectiveness and/or life span.
- They can be seamlessly integrated into a wide variety of heating and cooling applications, since Phononic's contact metal and diffusion barriers are designed to be compatible with the various materials and substrates used in TEC assemblies.

Thanks to industry-leading contact metal and diffusion barriers in its TEC production, Phononic is able to deliver thermoelectric devices with superior performance, reliability, durability, and compatibility, resulting in TECs that always meet the stringent requirements of our customers and provide exacting precise heating and cooling solutions.

Why This is Critically Important

Precision Ingot Wafering:

- Consistent wafer thickness
- Targets thickness accuracy
- Compatible with the assembly process
- Improves yield
- Accurate and repeatable measurements

Industry-Leading Metal & Diffusion Barriers:

- Enhanced performance
- Reliability & durability
- Consistency & conformance
- Compatibility & integration



Phononic: Knowledge On Your Side

Delivering consistent quality starts with the design. That's why Phononic has a robust team of industry-leading experts. Their decades of experience and deep technical knowledge of optical assemblies are leveraged to create bleeding-edge TEC designs that maximize performance while keeping pace with new technology.

Phononic's vigorous QMS and impeccable Environmental Management System (EMS) have been praised by some of the most influential organizations around the world:

- Phononic's management system includes certification to ISO 9001 and ISO 14001 standards.
- Our system is further aligned with IATF 16949's general Minimum Automotive System Requirements [MAQMSR] applicable to the automotive industry.

By adhering to these exceptional standards of quality and reliability, Phononic demonstrates its commitment to being a trusted technology partner who is committed to quality, reliability, continuous improvement, and long-term success—for Phononic's own technology and that of its customers.

Powering Phononic's Advanced Quality Controls

Control measures can't simply be followed. They must be designed and implemented to meet your own toughest and exacting requirements — and those of your customers. That's why Phononic relies on a range of advanced control processes, including Statistical Process Controls [SPC]—essential to maintaining the highest standards of product quality, both improving process efficiency and ensuring customer design specifications.

SPC delivers real-time monitoring and control of the manufacturing process. When combined with inspection of the final product, the combination creates a dynamic quality management system designed to enhance Phononic's overall manufacturing performance and reliability.

SPC is critical to the monitoring and control of all Phononic TECs. Using optical imaging techniques, SPC is able to ensure proper solder volume dispense and uniformity, while simultaneously measuring key quality parameters of the thermoelectric devices—this means it detects and prevents defects in real time, ensuring any issues are solved before customers receive their orders. SPC also provides insights into the capability of the manufacturing process to optimize its output. Taken together, this approach helps to ensure Phononic delivers industry-leading up-time and quality.

Because SPC is constantly monitoring and controlling critical variabilities in the process, any deviations are caught early and immediately corrected, enabling Phononic to reduce waste and minimize costs. This also makes SPC a valuable tool for process improvement — by analyzing the data over time, trends and patterns can be identified, leading to further process enhancements and increased efficiency.

THE PHONONIC
RELIABILITY LAB
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OF OUR
ORGANIZATION,
ENSURING THAT
HIGH-QUALITY,
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MARKET.

Meet the Phononic Reliability Lab: Rigorous Testing, Beyond the Basics

Phononic takes testing of its TECs very seriously, which is why we created the Phononic Reliability Lab. The Lab is the backbone of our organization, ensuring that high-quality, long-lasting durability is baked into every TEC that goes to market. In short, we want to ensure our devices meet or exceed their performance specifications.

One of the Phononic Reliability Lab's primary functions is performance evaluation, in which we put our products through a series of tests and measurements to research, understand, and maximize parameters like ACR [AC Resistance], CoP [Coefficient of Performance], ZT [Figure of Merit] and much more.

The Lab also plays a highly important role in our quality control process by conducting inspections on and taking measurements of each product. This process helps ensure that Phononic products meet their required dimensional and functional specifications.

The Phononic Reliability Lab manages these feats in a variety of ways. One of the most potent tools in its arsenal is the **Rigorous Reliability Test Plan™**. This comprehensive product evaluation technique was developed and inserted into our QMS as a means to test our finished TECs and adhere to the GR-468-CORE standard.

The Rigorous Reliability Test Plan begins with comprehensive testing—a wide range of evaluations designed to measure the overall performance capabilities and durability of Phononic products. These tests include power cycling, temperature cycling, high- and low-temperature storage, shock/vibration resistance and more. They help Phononic identify any issues or weaknesses — actual or potential — and enable us to mitigate them to ensure every product meets the highest standards of reliability.

Data-driven decision-making is another valuable benefit of the Lab. It generates a variety of data and insights about the performance and quality of our products. The information is then analyzed to identify trends, patterns and areas of improvement, which we translate into smart, data-driven decisions that can enhance product design, the manufacturing process and quality control measures.

Most importantly, the Rigorous Reliability Test Plan enables the Phononic Reliability Lab to detect failures before any device goes to market. We're able to identify and address any potential issues, preventing field failures and minimizing the risk of costly recalls or warranty claims.



The Phononic Reliability Lab is deeply committed to quality and reliability as a means to enhance customer confidence and satisfaction, which is why the lab works to ensure our products comply with all industry standards we strive to meet or even exceed, including JEDEC, Telcordia and Mil Spec.

The Phononic Difference

Phononic's knowledge and understanding of the past, present, and future of the optoelectrical market is unrivaled, and we pay close attention to the trends and technology driving this critical field forward. In recognizing the explosive demand for high-powered transceivers due to increasing bandwidth needs due to the work-from-home movement and the advent of AI, we were ahead of the curve in optimizing transceivers.

That's why we've put so much effort into cultivating a world-class FAE team with a deep roster of industry and technological experts. We've also made smart, measured partnerships to keep us ahead of TECs needs, which is why, in 2020, we partnered with Fabrinet.

As a leading provider of advanced optical packaging and precision optical, electro-mechanical and electronic manufacturing services, our Fabrinet partnership has enabled Phononic to become fully qualified with customers as we scaled global production of our TECs without disrupting our supply chain. And to ensure regional and global supply meets the growing demands of the optical transceiver market, Phononic has brokered partnerships with distributors like Photonteck [China], Seikoh Giken [Japan] and El-Gez Electronics Ltd [Israel].

Add to that our unmatched QMS, providing checks and balances to our manufacturing process at every turn—it's no wonder Phononic's name has become synonymous with high-quality and remarkably dependable thermoelectric devices. Our behind-the-scenes QMS work ensures that every TEC shipped to a customer will perform at or above its specifications. Any issues or problems are addressed well before there's a chance for failure in the field.

To learn more about Phononic's successful approach to scaling and producing at scale highest performing TECs, visit us at phononic.com/design-excellence.





About Phononic

Phononic, Inc. is the preeminent leader in solid state cooling solutions for data centers, deployed across every major hyperscaler today with a suite of thermoelectric devices and designs, for networking, GPUs, and AI data centers. Phononic’s portfolio of cooling solutions for AI data centers deliver cooling when and where it is needed so as to optimize AI infrastructure, minimizing overprovisioning, delivering cooling in millisecond timing, unlocking performance, and dramatically improving ROI, useful lifetime, and energy efficiency.

Learn more at phononic.com.

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