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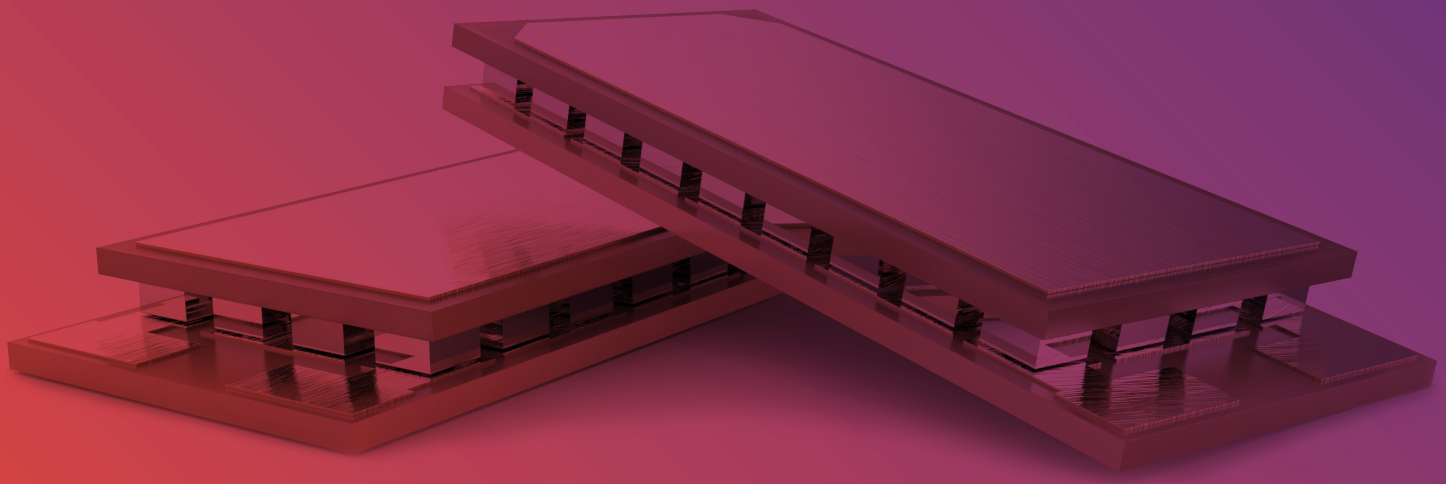
Ebook

Understanding the ReefTEC™ Platform:

How a Non-Hermetic TEC Can Deliver **5X** Reliability and **50%** Cost Savings



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The Pressure for Cost Savings

Optical component and transceiver manufacturers are facing immense pressure to reduce their cost per bit. But, performance and reliability cannot be sacrificed in the name of cost savings.

One traditional strategy to reduce costs has been to go with uncooled laser packages. But the skyrocketing data transmission rates and intricate signaling schemes that today's cutting-edge applications are demanding (PAM4, QAM62 and QPSK) mean that going uncooled is not always a viable option.

The negative effects on laser performance and yield that result from going uncooled will require investments in product development that will undermine any potential cost savings from designing out the TEC. So, what options exist for designing with a cooled laser package?

Design trends driven by cutting-edge applications:

- Tighter integration of photonics & electronics on the same chip
- On-board optics pushing light closer to the CPU

The result of both of these trends is higher heat density that will ultimately need to be dissipated by a thermoelectric cooler (TEC).

Hermetic Laser Package

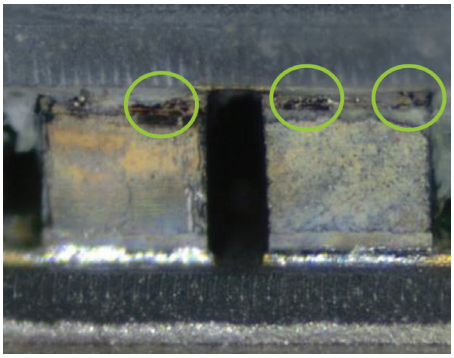
Hermetically sealing your laser package with a gold box, often composed of gold-coated Kovar or Copper Tungsten, is one traditional approach, but it's extremely expensive (the gold box is often the most expensive item on your BOM), as you'll need to account for not only procuring the box package, but for additional process equipment and steps as well. Hermetic packages also have a very long process cycle time, as you'll need to account for hours (or days) spent on "bake out" and preparation steps for the hermetic sealing process. If you want to integrate cooling into a hermetically-sealed package, a hermetic-rated TEC is completely acceptable.

Non-hermetic Laser Package

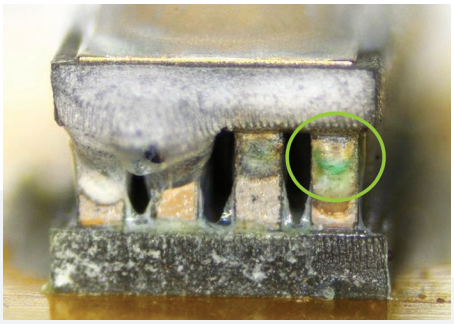
A cost-effective alternative to hermetic packages is a cooled, non-hermetic laser package using a non-hermetic TEC. Non-hermetic package design can enable significant cost savings, as you'll reduce BOM costs (no gold box), operations and overhead costs (less processing time) and capex costs (no expensive machining or equipment). But, non-hermetic laser packages have their own unique design challenges.

Other Non-hermetic TEC solutions fail in highly-accelerated condensing environments, where they are susceptible to corrosion. Common sealing approaches such as coating and edge sealants fall victim to pin holes or gaps in coverage, and can't deliver consistent, high-quality protection. These "band-aids" may actually *accelerate* failure in certain use cases: moisture will find a way in.

Hermetic-rated TEC



Coated, Hermetic-rated TEC



Moisture-induced corrosion on hermetic-rated and coated, hermetic-rated TEC contacts

Yes, Condensation Will Occur

In a cooled, non-hermetic laser package, you face significant environmental challenges from humidity, condensation and even ice. Condensation will occur inside the laser package any time the temperature of the laser CoC (Chip-On-Carrier) assembly, or even just the TEC, drops below the dew point. To ensure reliability, you must plan for - and test for - condensing environments. But, that test and failure criteria should be carefully designed.

The moisture from condensation can corrode the electrical contacts as well as any contacts on an unprotected TEC, interrupt the optical pathway which will result in coupling loss, and lead to thermal shorting caused by water bridging, which ultimately leads to a loss of temperature control. All of this will significantly degrade TOSA performance: laser slope efficiency will decrease and optical coupling losses will increase, resulting in slower data transmission and shorter TOSA lifespans. Eventually, total failure will occur.

Of course, laser package and product level design decisions will be made to minimize the risks of condensation. In reality, these devices will not operate in steady state condensing conditions. But, what are the use cases where condensation will happen?

- Cold-start conditions, climate control failures or other times when temporary sub-dew point operation occurs - the risk of condensation is very strong
- Anytime the TEC cold side is operating at a temperature lower than the dew point, which is then in turn lower than laser diode temperature

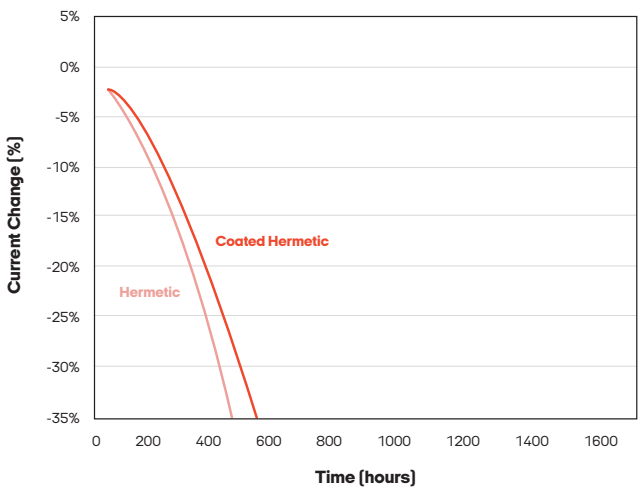
Let's take a closer look at a cold start use case. If we conservatively assume that cold starts happen for five minutes at a time once per day, after 10 years of continuous service, a device will have operated for 18,250 minutes (304 hours!) in a condensing environment. With a standard hermetic TEC operating under these conditions, usable lifetime will be less than 200 hours, with the first failures occurring at approximately 50 hours of use. 50 hours translates to a meager 1.6 years of service life before failures start to occur.

10 YEARS of use with **5 MINUTES** of cold start operation per day **= 304 HOURS OF OPERATION** in condensing environments

Condensing 85°C/85% Relative Humidity Testing

This all means that you can't just rely on the standard Telcordia testing specs to ensure survivability. They don't account for condensing environments, and as we've seen, in real-world use, some condensation is unavoidable.

In 85°C/85% RH testing such as HAST (highly-accelerated stress testing), the dew point is approximately 81°C. With that, a laser or TEC cold side temperature of 40-50°C will cause condensation inside the package, regardless of the TEC design. This testing will allow you to validate TEC performance in condensing conditions as opposed to just ideal conditions. The table below shows the severe drop off in performance of hermetic and coated hermetic TECs over time.



Hermetic-rated & coated hermetic-rated TECs see significant drop-off in performance over time, reaching 10% degradation after just 200 hours of use. Data shown above is from real 85°C/85% RH (condensing) testing.

The Solution is Here

Optical communications manufacturers can't settle for band-aid solutions like edge sealants and coatings. Phononic's non-hermetic ReefTEC platform has been fundamentally re-engineered from the ground up to solve the root cause of failure in highly-accelerated condensing environments, reliably and consistently in real-world use cases.

This solution delivers telecom-grade performance and reliability, even in environments where condensation may occur.

Why Choose ReefTEC:

- **Save up to 50%** on TOSA package costs
- Solve the root cause of failure to ensure consistent high quality - not a "band-aid"
- Support high volumes for datacenter demand and 1.2Tbps speeds
- Get **5X better survivability** in high heat, condensing environments
- Protect TEC performance, as compared to edge sealants (epoxies or silicones) that **impact performance by 30% or more**
- Don't limit your design options - a true drop-in replacement for hermetic-rated TECs

ReefTEC passes Telcordia testing requirements for:

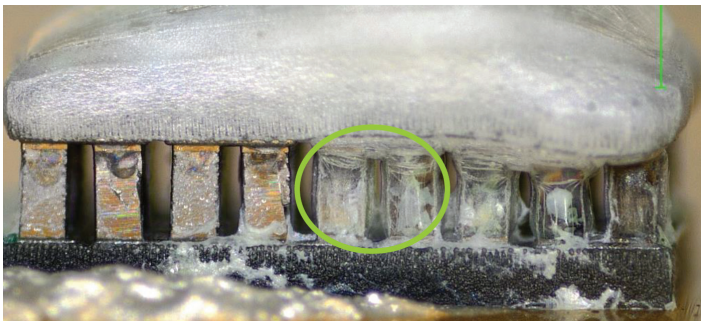
- Power cycling
- High & low temperature storage
- Temperature cycling
- Mechanical shock & vibration

And it also passes 85°C/85% RH testing. As you'll see in the chart to the right, ReefTEC's performance is minimally degraded over time, by just 10% over 1,000 hours of use, relative to hermetic-rated and even coated TECs.

RoHS Compliant

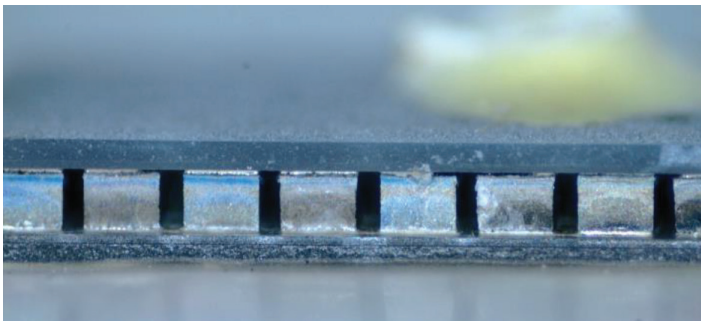
2019 LIGHTWAVE INNOVATION REVIEWS 4.0

Hermetic-rated TEC

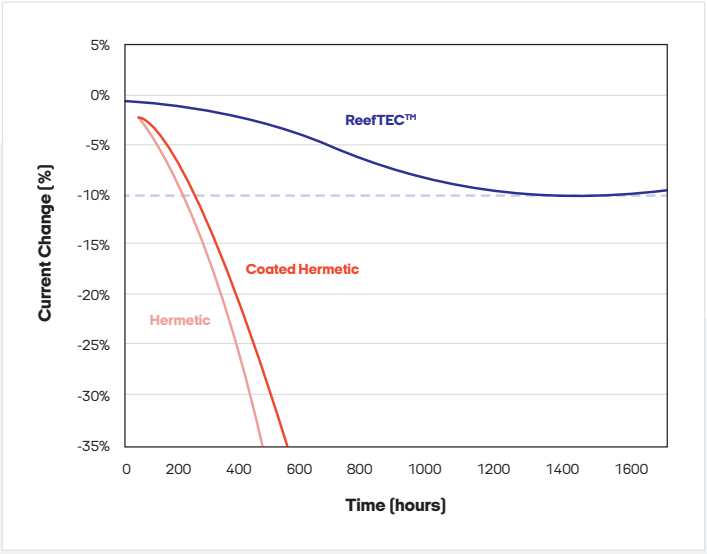


Post failure, ~200 hours

ReefTEC



Post test completion, 1050 hours



ReefTEC experiences no more than a 10% reduction in performance over time, starting after 1,000 hours of use

Are you curious how much ReefTEC could help you save? **Contact us** to discuss how much going non-hermetic could save you on your laser package.

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About

Phononic is reimagining cooling and heating in ways never thought possible. Its breakthrough solid-state technology is transforming industries and creating new markets with innovative solutions that disrupt antiquated business models and incumbent technologies. Phononic is the critical element of innovation needed to radically change what it means to be efficient, effective and sustainable. The company has been named to the 2016, 2017 and 2019 CNBC Disruptor 50 lists, received the US EPA's 2017 Emerging Tech Award, R&D 100 Award and more.

Learn more at **www.phononic.com/solid-state-products/optoelectronics**

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