Coherent Integrates Marway's Power Distribution Solution into New, Energy-Efficient, Direct-Diode Laser System Design

Achieving increased energy efficiencies and reduced maintenance through savvy design, and smart integration of power distribution

Marway Power Solutions
Coherent, Inc.

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When one thinks about medical products, automotive components or even miniature models used in movies, lasers aren't the first thing that usually comes to mind. However, these high-powered beams of light are vital to the successful processing of materials used in a myriad of products consumed around the world.

Founded in 1966, Coherent, Inc. is one of the world's leading providers of lasers and laser-based solutions for scientific, commercial and industrial customers competing in the most demanding markets. Coherent has production and research facilities spanning the globe supplying laser systems and components, laser measurement and control products, and precision optics to over 80 countries. Notably, many of its customers are Fortune 500™ manufacturers and scientific researchers from numerous universities and institutes across the Americas, Europe, and Pacific Rim.

Recently, Coherent developed prototypes for its next-generation HighLight 8000D direct diode laser system. This system was designed specifically for the needs of industrial materials processing including cladding, heat treating, and welding. The challenge was to design the new product with fewer discrete components, high energy efficiencies, and low maintenance time.

Diode Laser Construction

The diode laser is a semiconductor device which directly converts electrical energy into laser light. Typically, higher-power diode lasers output light in the near infrared, most commonly at either 808 or 980 nanometers (nm). A typical individual diode laser emitter might produce at most a few Watts of output power. However, numerous emitters can be fabricated on a single, monolithic semiconductor substrate or bar with a total output as high as 100 Watts. These linear bars can, in turn, be combined in horizontal and vertical stacks to produce high-power, direct-diode laser systems with total output power in the multi-kilowatt range.

The maximum conversion efficiency of transforming input electrical energy into light in diode laser bars is about 59 percent, which is many times higher than for any other laser type. This includes CO_2, lamp-pumped solid-state (LPSS), diode-pumped solid-state (DPSS), and even fiber lasers. The primary benefit of higher efficiency is that it lowers the operating cost of the system since less electricity is required to produce a given amount of output power. Of course, this reduced power consumption also decreases the carbon footprint of the laser's operation.

The small size of diode lasers means that they produce their waste heat in a relatively small physical area. As a result, they can be effectively cooled with a small volume of circulating water and a chiller. In the past, direct-diode lasers were more expensive to build and not energy efficient enough for mainstream use. Over the last 5 years, thanks to smarter components and research and development conducted at Coherent's labs, its new direct-diode laser systems produce much more light than previous diode lasers and can reach energy efficiencies of up to

Figure 1 : Coherent's new Highlight 8000D Series Direct Diode Laser

50 percent. This efficiency is measured by comparing how much power is drawn (from the wall) with how much light comes out of the laser. Reaching 50 percent energy efficiency is a substantial achievement for direct diode lasers, and provides customers with a more attractive laser solution. Another key achievement is the laser's shorter wavelength of 975 nm compared with CO_2 lasers which have a wavelength of 10 micrometers. The absorption of light into metals at 975 nm instead of at 10 micrometers is 3 to 5 times better. This allows more localized light interaction with the material while generating less heat in the part being created. The result is reduced distortion in the manufactured part, and significantly reduced scrap. In addition, due to the better absorption, the laser light is used more efficiently, consuming less energy. Often times this qualifies for government-funded, energy-reduction, tax benefits. This technical advancement will allow Coherent to serve a wider range of applications.

Newest Laser Technology Comes to Market

Coherent's new HighLight 8000D (figure 1), with output power of 2, 4, 6, or 8 kilowatts at 975 nanometers, is the most powerful, industrial, direct-diode laser system currently available with free-space beam delivery. Free-space beam delivery preserves the inherent brightness of the diode laser source, and enables the use of an optical system with a large (~275 mm) working distance.

Together, these factors translate directly into enhanced laser capabilities in industrial processing applications. Specifically in cladding, it yields a higher material deposition rate (up to 18 pounds/hour), allowing the laser to "paint-on" metal. Increased production speed enabled new benchmark levels in both cladding and heat treating due to the laser's higher power and longer-line beams which allow processing of larger areas in a single pass.

The laser is comprised of the laser head, laser control unit (LCU)—which consists of a DC power supply and power distribution unit—and a chiller. A cable is connected from the three-phase, 480-watt, power outlet (or 400 watt in Europe/Asia) to the LCU where the power is stepped down to create lower power at a higher current. "In the new design, I wanted to contain all the power tasks into one box instead of having discrete parts," said Jussi Ylanen, Coherent's project engineer for the HighLight D-Series. "Because of the high-voltage nature of this product, I wanted to collaborate with experts in power to ensure that what I wanted to achieve was indeed possible."

During Ylanen's research for power distribution experts, Marway Power Solutions was recommended. "The folks at Marway understood immediately what I wanted to accomplish with the power distribution for the new laser," said Ylanen. "In working with the engineers at Marway, they helped guide us to a technical solution, and a custom power distribution system which was a great fit for our prototype design was designed very quickly."

For the new laser design, Coherent needed Marway to create a cost-effective power distribution unit (PDU) that would house most of the power distribution, conditioning, and control components inside a single chassis to enable easy integration into the HighLight during manufacturing. The PDU would need to be field replaceable, run on various international facility voltages, and provide the desired output power. Although the HighLight required high capacity power from two PDU outputs for the laser system, it also required clean, conditioned, low-capacity power from one output to run the intelligent controller for the laser system. The high-capacity outputs needed to be managed by a fail-safe emergency power off (EPO) circuit to shut down the laser system

Figure 2 : Marway's Power Distribution design for Coherent incorporates power distribution, conditioning and control components inside a single chassis.

in an emergency without disrupting the controller. The PDU controls AC/DC on and off which is critical to the laser. Should a problem occur, a user needs to be able to turn off the laser immediately. The PDU provides this fast disconnect from power.

In addition, Coherent needed the entire PDU (figure 2) to mount inside the laser control unit so that it was not visible. However, they wanted the ability to switch the main circuit breaker for the PDU, and to remotely reset the EPO circuit without requiring user access directly to the PDU. These requirements, as well as an overall restriction on available space, created some interesting design and packaging challenges for the PDU. "We were able to implement a mechanical actuator for the main circuit breaker, which then extended through a matching hole in the LCU enclosure to provide the desired remote access," said Dave Proli, engineering manager for Marway. "An electrical remote control circuit was also implemented to allow the EPO circuit to be triggered and reset from external controls."

To support ease of installation, special pass-through terminals were used for all electrical connections on the PDU. Cable mounts were also included on the PDU chassis to secure all connections. "Our custom design provided a solution which could be cleanly integrated into the new laser while meeting both the electrical design requirements and the remote access requirements," said Proli.

"Designing from scratch would have taken me many, many months to design and implement," said Ylanen. "Off-the-shelf products were unable to perform from a technical standpoint what we needed. Marway's engineers were able to help us achieve a design that we needed without compromising reliability."

COHERENT

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