

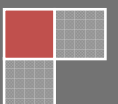
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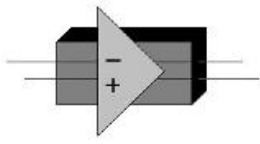
# Accurately Characterizing High Power Laser Diodes

## The challenges of testing laser diodes for real world applications

As high optical power laser diodes evolve, new applications of their use are constantly being evaluated. As such, the production and test equipment must evolve as well. This paper describes such equipment for one particular laser development company and how it evolved into a product in itself along with the use of other high technology support equipment.

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## **Accurately Characterizing High Power Laser Diodes**

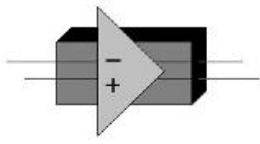
### **The challenges of testing laser diodes for real world applications**

Careful measurements are considered when testing the optical power, current, voltage, wavelength, and temperature of high output laser diodes. The test system energizes and measures the laser parameters as it will be used in the application. In some critical constant wave (CW) applications, the required output power from the laser is pushing the laser's maximum specifications. Therefore, an accurate, stable, low drift laser power meter is required.

This paper shall describe the laser diode testing solution for Sheumann Laser Inc. as used in real world applications. Often times, an application requires a specific wavelength at a specific power level. To achieve the specified wavelength, laser temperature is controlled. As the laser temperature changes, so does a small amount of the laser output power. This small power change along with the targeted wavelength could determine the laser's feasibility in the application. It is now easy to see how critical the need is for a stable and accurate laser power meter.

### **Hardware requirements of a high power laser diode test system**

- Laser Diode constant current control CW to 40 amps
- Thermo-Electric Cooler (TEC) Controller to 10 amps
- Monitor laser output power
- Monitor laser current, laser voltage
- Monitor wavelength
- Monitor laser temperature
- Monitor optical power feedback from a photodiode
- Multiple optical power head range compatibility



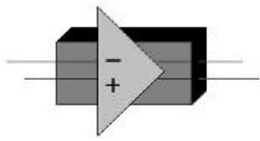
## **Accurately Characterizing High Power Laser Diodes**

### **Software Requirements of a high power laser diode test system**

- Automatic LIV testing
- Determine operating parameters from the LIV, such as:
  - Operating Current ( $I_{op}$ )
  - Operating Power ( $P_{op}$ )
  - Threshold Current ( $I_{th}$ )
  - Threshold Voltage ( $V_{th}$ )
  - Operating Voltage at Operating Power ( $V_{op} @ P_{op}$ )
  - Operating Current at Operating Power ( $I_{op} @ P_{op}$ )
  - Slope Efficiency (SE)
  - Power Efficiency (PE)
  - Center Wavelength
  - Spectral Width
- Set and hold temperature
- Manual Laser Controls
- Life Testing
- Report, Data sheet generation

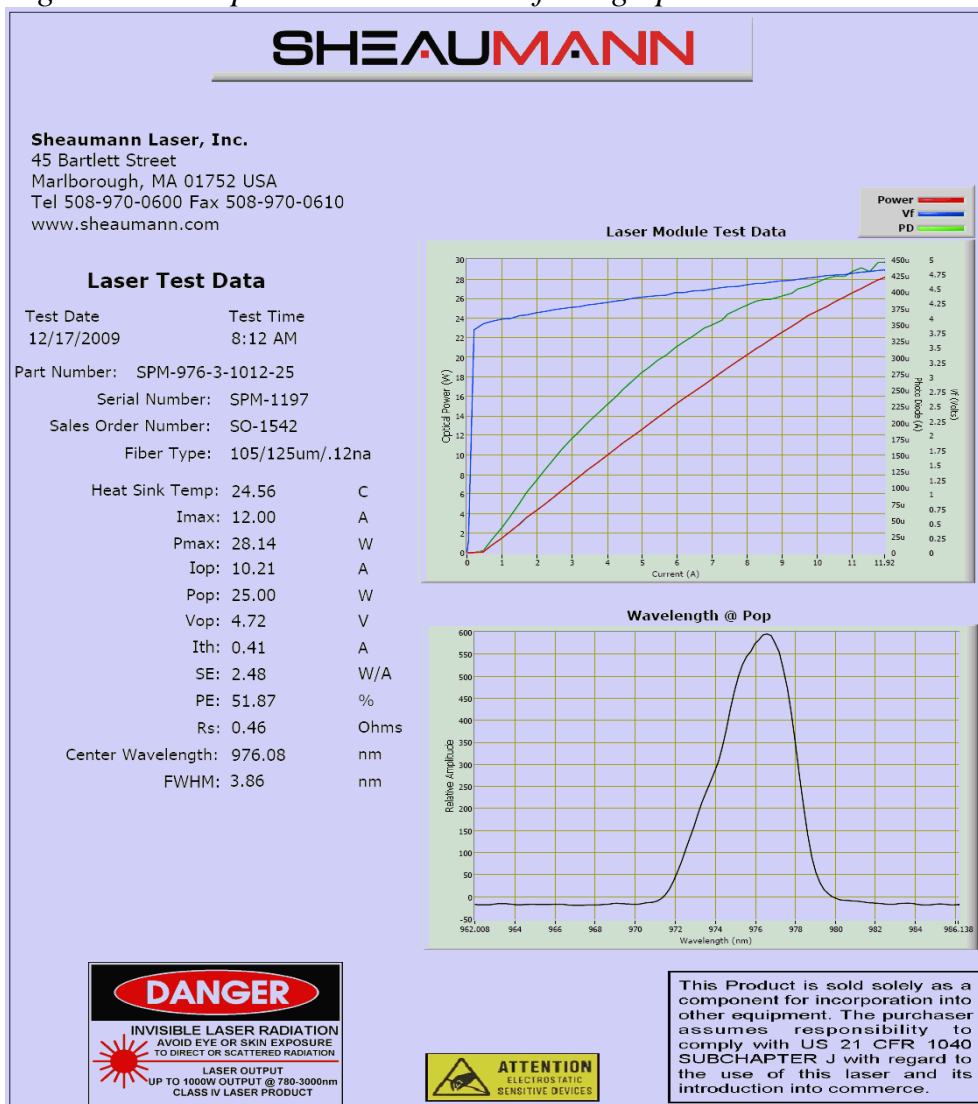
The operating power parameter ( $P_{op}$ ) is the key to these measurements and calculations. It is extremely important to achieve accurate, stable, and repeatable optical power measurements. The following is a typical Sheumann Laser product data sheet. The information on the left side of the data sheet shows a value for  $P_{max}$  to be 28.14. Notice the resolution is displayed in two decimal places for a 10mW resolution or +/- 5 mW since rounding will occur.

The optical power meter shall also have interchangeability with power heads of varying power level capability, have full calibration traceability, and integrate well with the test equipment computer. Ophir's power meters meet these requirements.

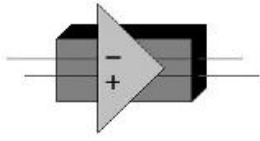


## Accurately Characterizing High Power Laser Diodes

Figure 1. Example LIV Data Sheet of a high power laser diode



The Power trace (in red) on the Laser Module Test graph shows power versus current. The power is measured as the test system steps the current incrementally. The test system sets the laser current and waits a predefined delay for both the laser

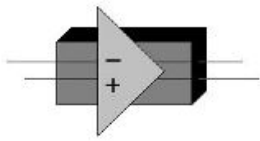


### Accurately Characterizing High Power Laser Diodes

power head and the laser temperature to stabilize. This is critical for power measurement accuracy. The laser power meter is an Ophir Nova II Series and the laser high power air cooled, thermopile head.

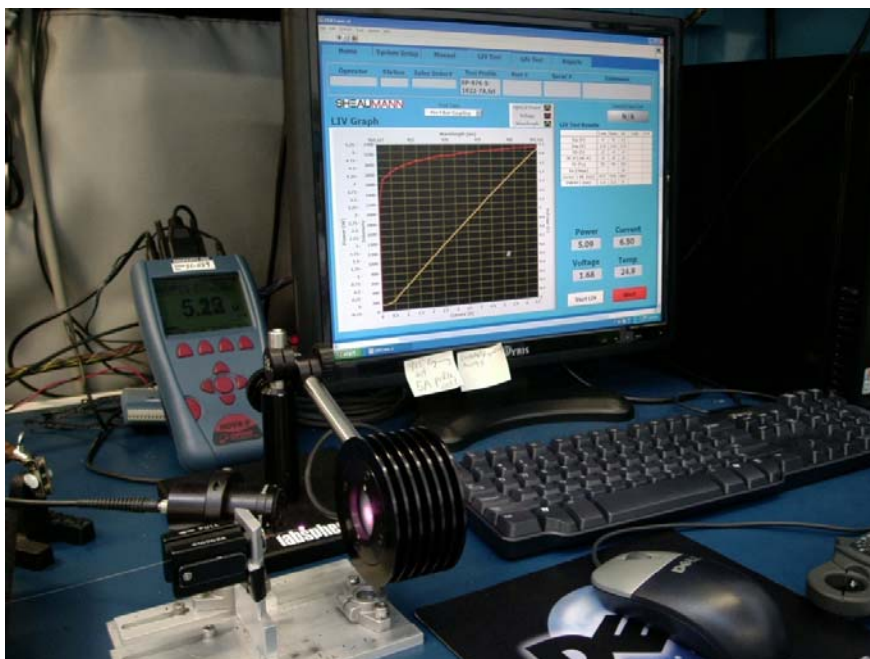
Figure 2. Ophir Nova II Power Meter





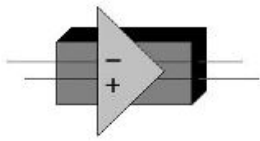
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*Figure 3. Test System showing the power meter, thermal head, and test software.*



If you look closely, you can see the active area of the power head illuminated by the laser light. The Ophir meter is connected to the laser test system by USB serial communication. The test software was developed to control a variety of functions from the Vega or Nova II meters, including a zero function and range setting. The shown Nova II optical meter is using an L30A series thermal power head.

The custom LabVIEW based software, when first run, scans any connected equipment and establishes a communication link. The software will recognize either the Vega or the Nova II series power meters. The software also recognizes the laser power supply, a spectrophotometer, and a custom designed interface circuit for a multitude of other functions such as a temperature controller and a photodiode feedback circuit. The temperature controller can control the laser



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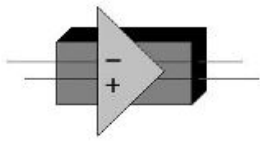
temperature from either a TEC or from a chiller with a computer communications port.

*Figure 4. A test station at Final Test*



Final Test is a test station to perform full functional testing at the customer's specifications before shipment to the customer. A data sheet like the one shown in Figure 1 is included with the product. The black box at the top right of the above picture is the custom designed laser test system including the custom designed interface circuit. This laser drive system is also used for certain laser production stations as well. Along with the software, this laser drive system is versatile and easy to operate. The system also incorporates extensive safety measures including interlocks and is compliant with applicable ANSI specifications.





## **Accurately Characterizing High Power Laser Diodes**

### **“Solutions for a young cutting edge laser diode system’s company”**

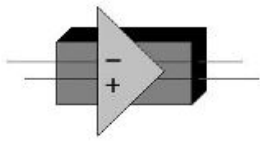
Sheaumann Laser, Inc., a high technology laser diode systems manufacturer focuses on unique, cutting edge, advanced laser diode applications. These applications require innovative solutions with often difficult to achieve wavelengths and peak power requirements. As the team designed and developed these systems, it became clear that the need for both robust and accurate production support and test equipment was required.

BlackBox Technologies was assigned to provide this equipment as well as support for continually evolving laser systems. With the direction of the Sheaumann laser design team, we devised a definition of requirements for multiple production support stations as well as multiple R&D test sets. It was desired to develop an electronic system and software to support all areas of the company. The following is a portion of the resultant functionality of the laser system:

- L,I,V Laser Characterization Testing
- Peak Power
- Wavelength @ operating power
- COD Testing
- Chip Testing
- Final Test Verification
- Temperature Control
- Manual Control

This Integrated Test System has developed into a marketable product for support of customers who need such functionality. The integrated test system can also be customized to fit a particular customer’s needs. This value added service is critical to the needs of each customer’s requirements.





## **Accurately Characterizing High Power Laser Diodes**

### **Ophir's optical power meters meet stringent requirements**

In all of the above requirements, a high power detector is required. This detector needed to handle up to 25 watts of CW laser power at a wide range of multiple wavelengths. The detector needed to interface to a computer with ease and specifically with LabVIEW™. The detector also required robustness, reasonable cost, and support and service from the manufacturer. The display is the Nova II Ophir-Spiricon LLC. The display is portable with a USB computer interface that includes data logging software, along with a variety of laser power heads that are interchangeable. The detectors have a quick turnaround time when calibration is needed and contains the required certifications needed to satisfy the Company's ISO and military requirements.

#### **Author**

Mike Martino, BlackBox Technologies, Mike founded BlackBox Technologies in 1994 as an electronics systems consulting firm. The Company has since grown to be known for accomplishing the highly specialized and difficult design and integration projects. BlackBox Technologies provides electronics and test systems for military, aerospace, R&D, commercial, and industrial applications.

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#### **Acknowledgements**

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#### **Sheumann Laser Inc.**

[www.sheumann.com](http://www.sheumann.com)

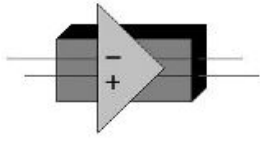
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