High Power, Multi-channel Laser Diode Enabling High-Resolution LiDAR

White Paper

Introduction

While it has been discussed for a long time in the automotive industry, the light detection and ranging (LiDAR) function, which accurately measures the distance of objects for autonomous driving and specifies space, is rapidly expanding to other fields. It is being employed in sensors for detecting obstacles and implementing algorithms for avoiding them in applications such as robot vacuum cleaners, automated guided vehicles (AGVs). Services for understanding highway traffic volumes and promoting route avoidance have also begun, as have services for providing map data through 3D mapping. Furthermore, using real-time point cloud data obtained by LiDAR, research on object cognition and behavior estimation algorithms is progressing in conjunction with AI (*1), and the importance and need for high-accuracy data that can be obtained with LiDAR is increasing. Further improvement of LiDAR characteristics is expected to lead to innovations that create new services, not just in the automotive market.

Through the development of electronic devices, ROHM will contribute to improving the characteristics of LiDAR applications, to solving social problems, and to the creation of innovations that generate new services. In this white paper, we describe the laser diodes that greatly contribute to improving the characteristics of LiDAR applications.

What is high-power laser diode?

A high-power laser diode is a laser diode that emits high light output with a short current driving time (pulse width). It consists of a wavelength band of 905nm and has high reliability, high beam quality, and stable temperature characteristics. For LiDAR used in object detection, a high-definition and high-power beam light source is essential to improve the accuracy of object position detection, extend the object detection distance, improve the definition of object detection images, and improve the accuracy of object detection algorithms. ROHM has successfully developed a high-output laser diode capable of acquiring high-definition images using its own patented technology, and the product has already launched for mass production.

(1) High-precision, high-power laser diode for high-resolution images

The RLD90QZW3, a product with an optical output of 75 W, has achieved a narrow emission width of 225 μm, which is 22% less than the 290 μm of the competitor's laser diode (Table 1). The high optical density enables high-resolution and wide-range detection (Fig.1). In addition, ROHM's proprietary technology keeps the light emission intensity constant up to the edge of the light emission width, so it is possible to irradiate the object with uniform light intensity (Fig. 2). The temperature dependence of the laser wavelength is 0.15 nm/°C, which is 40% lower than the 0.25 nm/°C of the competition, enabling the use of narrow wavelength bandpass filters and narrow wavelength range system designs. This means an improved signal-to-noise ratio (S/N ratio) and more accurate measurements of objects at greater distances. In addition, ROHM's unique technology achieves a narrow emission width while boasting an industry-leading PCE (Power-Optical Conversion Efficiency) of 21%, minimizing increases in power consumption.

Table 1: RLD90QZW3 Characteristics Comparison *05/2023 ROHM Research

	Competitor	ROHM	Content
Product Type	75W Class	RLD90QZW3	
Emission width	290μm	225μm	**22% reduction,** can emit light with a sharp beam
Wavelength temp dependence	0.25nm/°C	0.15nm/°C	**40%** reduction, improved S/N ratio due to temperature dependence
Light output	75W	75W	pulse width 50ns, Duty ratio 0.05% drive
PCE	-	21%	**Industry top class**

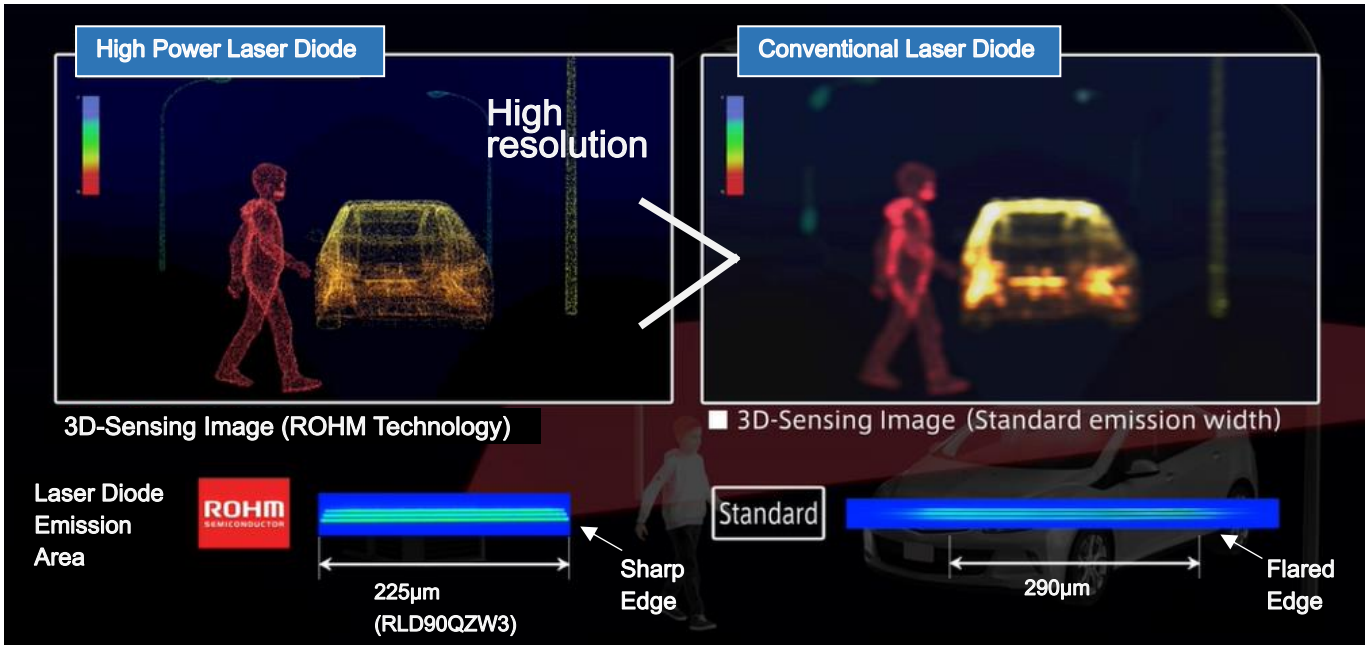


Figure 1 ：Image of ROHM vs conventional laser diodes

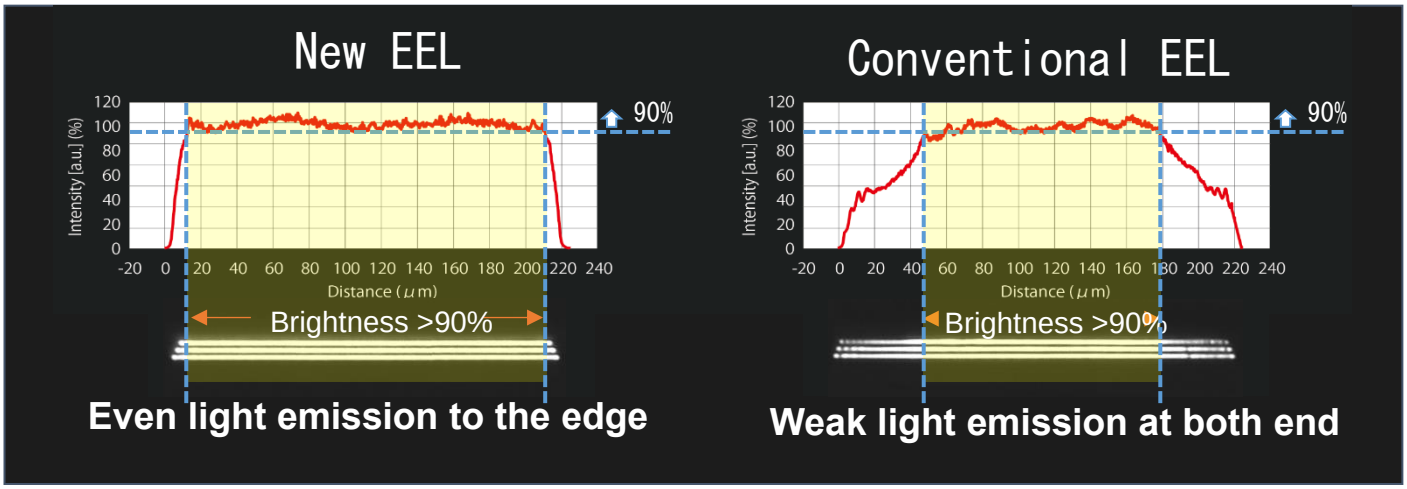


Figure 2：Emission intensity distribution in the emission width direction

(2) High-precision, high-power laser diode for long-distance automotive use

A high-power laser diode with a light output of over 100W is required for measuring the distance of an object exceeding 150m for detection in autonomous vehicle. ROHM has succeeded in developing a high-power laser diode with a wavelength temperature dependence of 0.10 nm/°C or less, which further reduces the wavelength temperature dependence of 0.15 nm/°C developed for 75W products.

The "RLD90QZW8", a product with an optical output of 120 W, has achieved a narrow emission width of 270 µm, which is more than 6% less than the 290 µm or 360 µm emission width of the competitor's laser diode. In addition, the temperature dependence of the laser wavelength is less than 0.10 nm/°C, which is less than 60% lower than the 0.25 nm/°C of the competing products, allowing system designs for narrow wavelength ranges (Fig. 3). This product also complies with the automotive reliability standard AEC-Q102, making it suitable for automotive use.

Table 2: RLD90QZW8 Characteristics Comparison *05/2023 ROHM research

	Competitor	ROHM	Content
Product Type	120W class	120W class	
Emission Width	290～360µm	270µm	Reduced by 6 to 25% or more, can emit light with a sharp beam
Wavelength Temp Dependence	0.25nm/°C	0.10nm/°C or less	60% or more reduction, S/N ratio improvement due to temperature dependence
Light Output	120W	120W	pulse width 50ns, Duty ratio 0.05% drive
PCE	-	25%	**Industry top class**

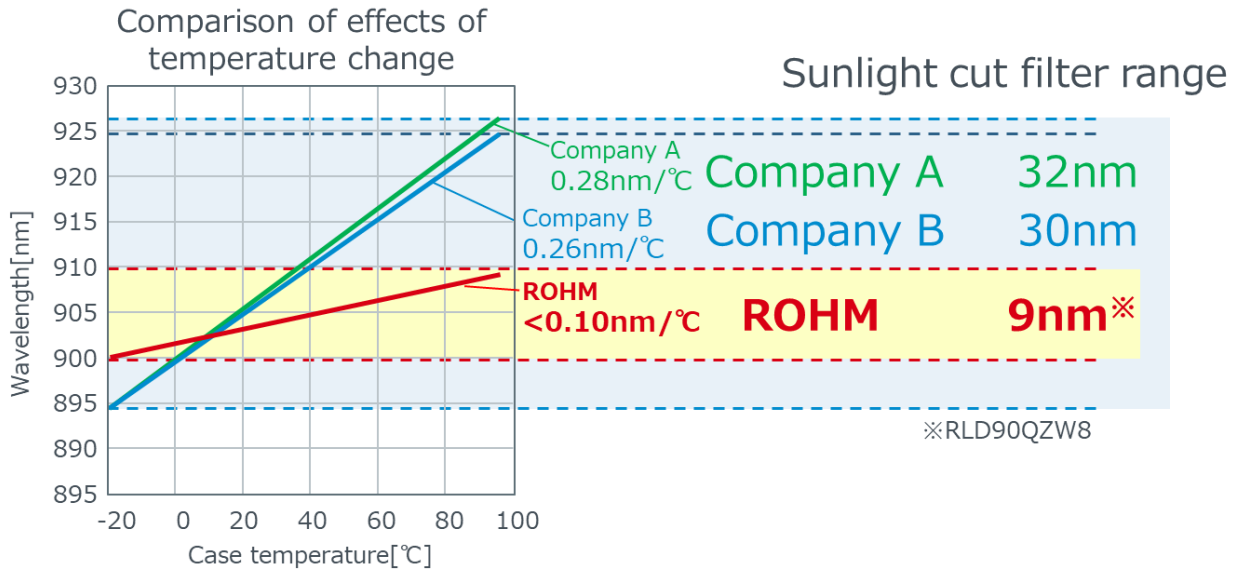


Figure 3: Wavelength temperature dependence of ROHM laser diodes

ROHM has expanded its lineup of high-power laser diodes for LiDAR (Table 3) with technology that achieves these performances, leading the market trend toward higher power output. In addition to the package solution, we also support the design of various LiDAR systems by providing the chip solution that can be applied to the development of multi-channel encapsulation modules by the end users.

Table 3: Lineup of High Power Laser Diodes

* Please contact your sales representative for the latest lineup and supply status

Product	Wavelength	Output	If (max)	Emission (W x L)	PKG
RLD90QZWA	905nm	15W	5A	35μm x 10μm	φ5.6mm CAN (TO-56) Bare chip available 
RLD90QZWB		25W	9A	50μm x 10μm	
RLD90QZWC		25W	9A	70μm x 10μm	
RLD90QZWD		35W	12A	100μm x 10μm	
RLD90QZWJ		25W	9A	50μm x 10μm	
RLD90QZW3		75W	27A	225μm x 10μm	
RLD90QZW8		120W	38A	270μm x 10μm	

(3) Multi-channel high-power laser diode for longer distance and higher accuracy

In the future, LiDAR performance will accelerate the demand for further distant detection and high accuracy. To meet these demands, ROHM is promoting multi-channel high-power laser diodes (Table 4). Multi-channel enables ultra-high output by emitting light from each channel at the same time, enabling further distant detection. On the other hand, by individually emitting light from multiple channels, the number of measurement points for LiDAR detection can be increased, enabling even higher precision.

ROHM is developing an 8-channel high-power laser diode. Emission intensity distribution of each channel adopts ROHM's proprietary technology for uniform emission intensity, resulting in an extremely narrow width of 30 μm between channels where no light is emitted between channels (Fig. 4). In addition, the temperature dependence of the laser wavelength is less than 0.10 nm/°C as mentioned in (2).

Table 4: Lineup of multi-channel high-power laser diodes

* Please contact your sales representative for the latest lineup and supply status

Product	Wavelength	Channel #	Output (per channel)	Emission (W x L)	Channel distance	PKG
8-channel array	905nm	8	125W	300μm x 10μm	30μm	SMD (5.6mm×3.3mm ×1.75mm)

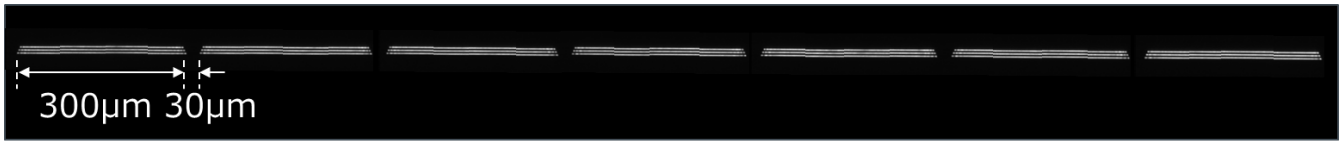


Figure 4: Emission distribution of multi-channel high power laser diode

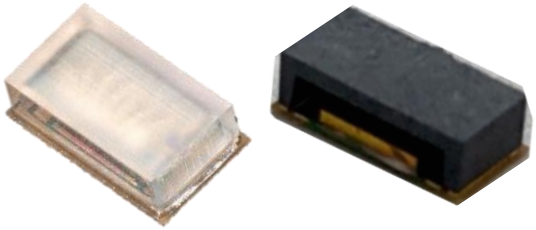
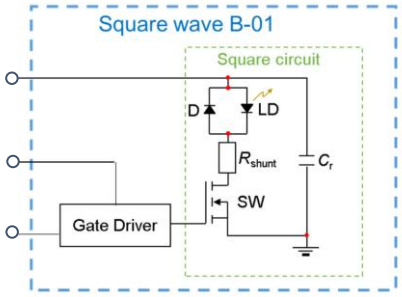
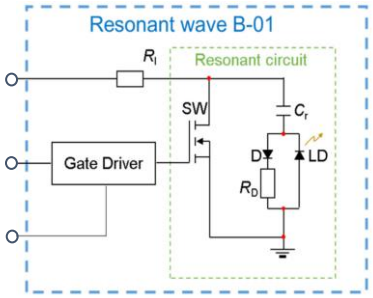
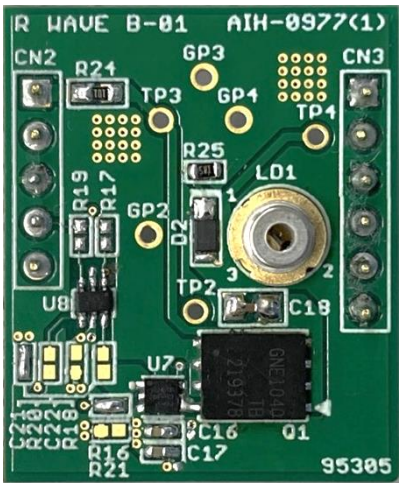


Figure 5 : Package of multi-channel high-power laser diodes

Laser Diode Driver Reference Design for LiDAR

ROHM has developed a reference design that drives the cutting-edge laser diode mentioned above, and the design has been released on the website. (High-power laser diode high-speed drive EcoGaN™ and high-speed Gate Driver reference design for LiDAR). The reference design includes GaN HEMT (EcoGaN™(*2)) for driving laser diodes at high speed as well as gate driver for driving GaN as a total solution.

Table 5：High power laser diode for LiDAR with high speed EcoGaN™ and high speed gate driver
Reference design "REFLD002"

Reference design name		REFLD002-1	REFLD002-2
Board name		S WAVE B-01	R WAVE B-01
Circuitry		Square Wave Circuit	Resonant Circuit
Board Device	Laser Diode	RLD90QZW8	RLD90QZW3
	GaN HEMT	GNE1040TB	GNE1040TB
	Gate Driver	BD2311NVX-C	BD2311NVX-C
Block Diagram			
Board Image			

Generally, GaN HEMT, which can be switched on and off at high speed, is used to drive LiDAR laser diodes, and is configured in a square wave or resonant wave circuit. The square wave circuit turns the switch connected in series to the laser diode connected to the power source on and off, but the rise/fall time is limited by the speed of the semiconductor switch and the loop inductance formed in the circuit. Although resonant wave circuits are common for high-frequency driving circuits, knowledge of high-frequency is required to design the circuit constants. At ROHM, we have developed and published a reference design for both circuits. The board designs and basic operation evaluations are carried out at ROHM, and design data (circuit diagrams, PCB Gerber, BOM) and evaluation data are published, so users can refer to and alter the reference designs freely under their own responsibility. In addition, since the simulation circuit is published on the ROHM Solution Simulator (*4), which is a free simulator available on the web, users can easily

simulate both circuits. Since changes in waveform when the circuit constants are changed can be immediately confirmed, the simulator can be used for initial design studies.

In addition to the reference design data, application notes, simulation models (SPICE models, Ray data), and PCB library data for individual products are also available on the web. By utilizing the reference designs, reference design circuit simulations, and product data, design and evaluation man-hours can be drastically reduced, and the process of introducing products to the market can be speeded up.

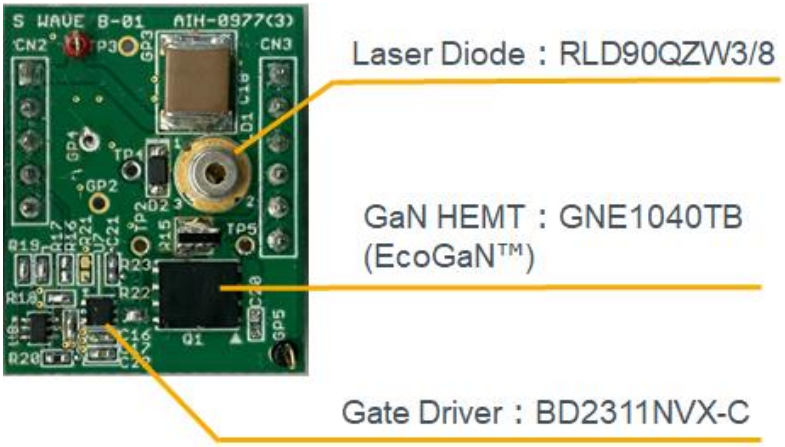


Figure 6: Reference design for LiDAR [REFLD002]

Summary

In response to the increasing market for LiDAR applications, ROHM is providing higher power and multi-channel laser diodes, which are key parts for improving LiDAR performances. In addition, GaN HEMT (EcoGaN™) and GaN gate drivers are offered as a reference design as a hope of speeding up the market introduction process for users, thereby solving social problems through its products and contributing to innovation created by new services.

Terminology, Reference Materials

(*1) AI: Artificial intelligence artificial intelligence)
(*2) EcoGaN™: A ROHM GaN device that contributes to energy efficiency and miniaturization by simultaneously achieving lower application power consumption, smaller peripheral components, and reduced design man-hours and parts count by maximizing GaN's low on-resistance and high-speed switching performance. EcoGaN™ is a trademark or registered trademark of ROHM Co., Ltd.
(*3) ROHM Solution Simulator: A free simulation tool provided by ROHM on the web

Application Note: Semiconductor Laser Application Note
White paper : Laser Driver Reference Design with GaN HEMT for High-Resolution LiDAR

Reference Websites

Applications

LiDAR
Robot Vacuum Cleaner
Automated Guided Vehicle (AGV)

Related News

ROHM's 75W High Optical Output Laser Diode for LiDAR
ROHM starts Production of 150V GaN HEMTs: Featuring Breakthrough 8V Withstand Gate Voltage

Products

High-Power Laser Diode
GaN HEMT
Laser Driver Reference Design with GaN HEMT for High-Resolution LiDAR

Simulation circuit (ROHM Solution Simulator)

* MY ROHM registration is required to access the ROHM Solution Simulator.
Square wave circuit
Resonant wave circuit

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