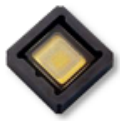
STANLEY ELECTRIC CO.,LTD.

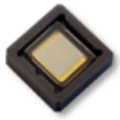
Pushing evolution of autonomous driving technology forward: compliant with AEC-Q102

Stanley Electric's high-power IR VCSEL

Stanley Electric Co., Ltd. (below referred to Stanley Electric) has started mass production and shipment of high-power infrared (IR) VCSEL that complies with the automotive quality standard AEC-Q102. This shipment has been delivered to our customer as the world's first in-cabin sensing device using an IR VCSEL.



UDN1Z54



UEN1ZA9

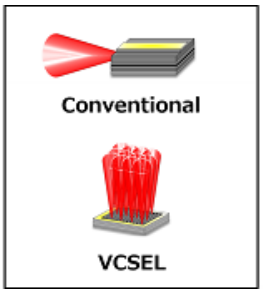
IR sensors are used in a variety of applications, and their performance has improved rapidly in recent years. In automotive field, they are installed in driver monitoring system (DMS), which is one of the ADAS-related applications, and also in occupant monitoring systems (OMS). Currently, IR LEDs are primarily used as the light source for these sensors, and Stanley Electric is also a major supplier of these sensors. In the future, due to the sophistication of autonomous driving and ADAS technology, high-performance sensing that cannot be achieved with conventional IR LEDs is required.

To meet these needs, Stanley Electric is the first in the industry to introduce the high-power IR VCSEL for automobiles, which was developed by the optical control technology and LED packaging technology cultivated over many years.

What is VCSEL

VCSEL is an abbreviation of Vertical Cavity Surface Emitting Laser, and is one kind of semiconductor laser. Conventional semiconductor lasers (edge emitting laser) emit light in a horizontally to the substrate, whereas VCSELs emit laser light vertically to the substrate.

VCSEL is characterized by its small size, high luminous efficiency, low power consumption, and high directivity. Since VCSEL die can be arranged in two dimensions, the output as a package can be increased, and it also features a high-speed response that enables high-speed pulse lighting (high-speed modulation) in the gigabits.



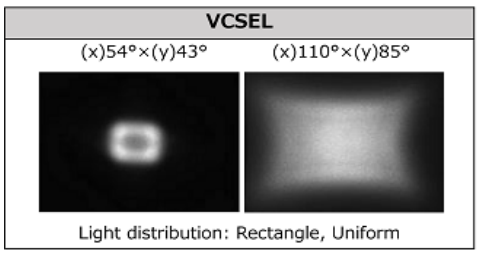
Advantages of IR VCSEL light source: Comparison with LED

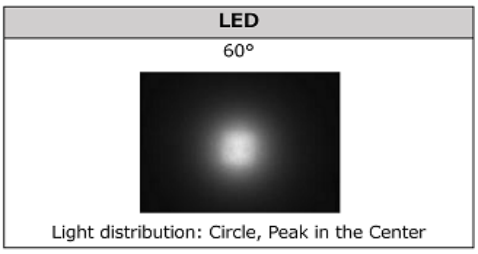
The advantages of VCSELs in smart in-cabin IR sensing applications are mainly the following four points compared with IR LEDs;

①Pattern of Irradiation
②Response Speed
③Emission Spectrum
④Less impact of temperature changes on emission wavelength

①Pattern of Irradiation: Light distribution control suitable for camera (Field of View) is available

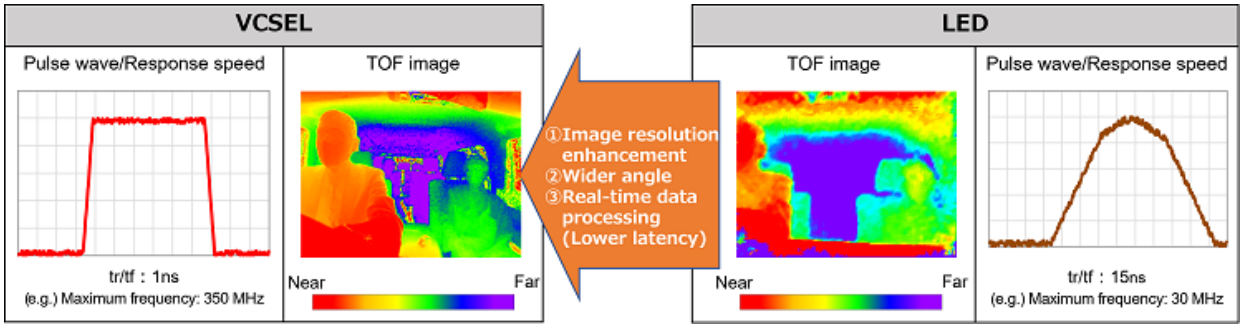
The IR LEDs have a circular light distribution with a peak in the center, while VCSELs are surface-emitting lasers that can be arranged in two dimensions, resulting in uniform irradiation. Furthermore, the light distribution can be controlled in a rectangular shape by installing a diffuser, which improves the performance of occupant monitoring systems (OMS) that monitor the entire vehicle. The light distribution of the VCSEL in the figure below show examples of two types of irradiation angles possible with diffusers.





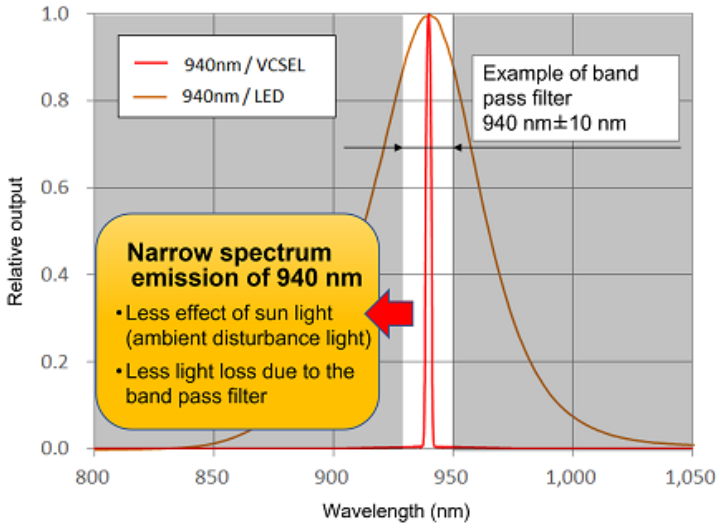
②Response Speed: Achieves image resolution enhancement, wider angle and real-time data processing due to high-speed pulsed lighting

Since the VCSEL has a small volume, pulse lighting (on/off operation) is possible at a frequency in the gigabits, which is not available with LEDs. Due to this, when using a VCSEL as a TOF light source for IR detection and distance measurement, image resolution enhancement, wider angle and real-time data processing can be achieved.



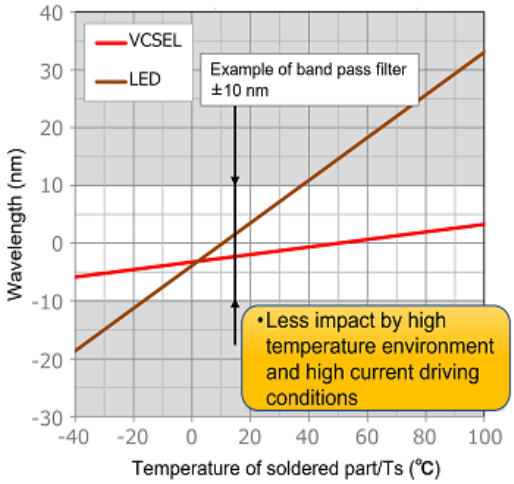
③Emission Spectrum: The narrow spectrum emission reduces the influence of ambient light and the loss due to the band pass filter is also small

Compared to LEDs, VCSELs have a narrower wavelength spectrum. In the example below, it is in the range of a few nm with respect to the standard value of 940 nm. Band pass filter can be narrowed, and even if it is narrowed, the output loss can be kept low. Therefore, the influence of ambient light such as sunlight can be reduced, which enables highly accurate detection.



④Less impact of temperature changes on emission wavelength

Compared to LEDs, the emission wavelength of VCSEL is more stable against temperature changes, and achieves this even under severe temperature change conditions such as in-cabin use. They also maintain this performance even when more heat is generated at high currents.



Direction of in-cabin applications using IR light sources

Existing sensing technology with IR light sources are used for various purposes such as facial recognition systems in smartphones, distance measurement, computer mouse, laser printers etc. Also, in recent years, the performance of advanced driver assistance systems (ADAS) for automobiles has been improving rapidly. In addition to the driver monitoring system (DMS) aimed at preventing traffic accidents, occupant monitoring systems (OMS) that reduce risks to occupants is also becoming popular. Currently, IR LEDs are used for these systems, but as this technology advances, sensors with higher-performance are required, leading to changes in demand for the light sources.

For example, there are currently systems that reliably detect driver's eyes and slight changes in facial expressions, but in the future these also should detect people in the entire vehicle. The system requires a high-power IR light source that can illuminate the entire visual range of the camera. In addition, TOF cameras and LiDAR that detect and measure distance with light require high-speed pulse emission for higher-resolution sensing. Such wide-ranging uniform IR irradiation and high-speed pulse emission are often difficult to achieve with conventional IR LEDs, so VCSELs are gathering attention as a technology to deal with them.

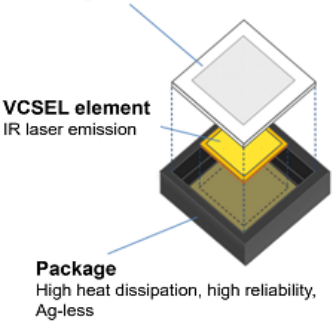
Stanley Electric believes IR VCSELs will be the key to evolve in the future.

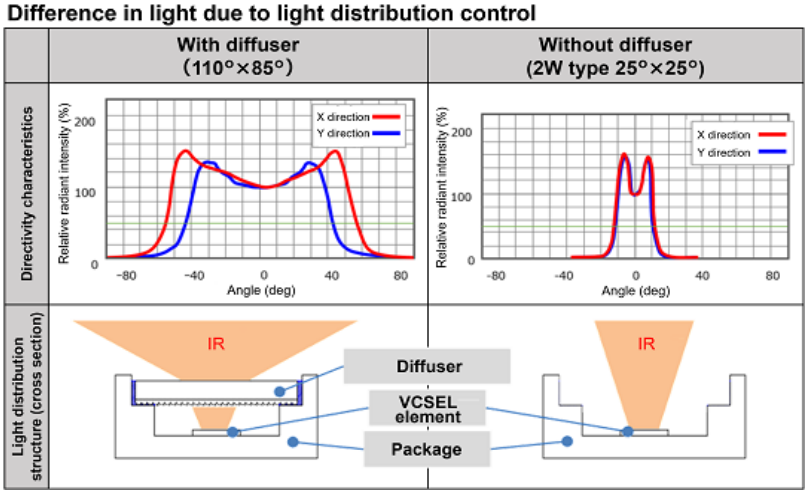
Improvement on sensing technology by IR VCSEL	Evolving applications		
	Automobiles	Security	Industrial device
■Wider-angle ■Longer distance range ■3D / distance detection ■Higher accuracy and higher image resolution	・Driver monitoring system / Occupant monitoring system ・Non-contact operation (gesture, line of sight) ・LiDAR (ADAS, autonomous driving) ・Emergency vehicle notification system, etc.	・Personal / Face authentication ・Intrusion Detection / pop-out detection ・Remote monitoring, etc.	・Prevention of robot collision ・Product inspection of manufacturing line ・Identification and sorting of luggage shape, etc.

Characteristics of Stanley Electric's High-power IR VCSEL

Devices for automotive in-cabin applications require stable quality and high reliability, even in severe environments. Stanley Electric has created a highly reliable and heat-dissipating VCSEL device using packaging technology developed for high-power LEDs for headlamps, etc. In addition, through our light distribution control technology, we can match various application requirements, while ensuring eye safety.

Concept of High-power IR VCSEL for automotive in-cabin applications	Adopted Technology
・Satisfies standards of automotive in-cabin applications (AEC-Q102) ・Product lineup of light distribution and output optimized for usage conditions ・Ensuring eye safety by diffused light distribution	・Highly reliable packaging technology cultivated with high-output LEDs ・Thorough measures against sulfurization (without using Ag) ・High heat dissipation performance, low inductance ・Light distribution control technology





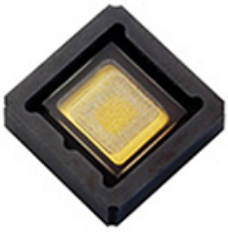
Product lineup of High-power IR VCSEL

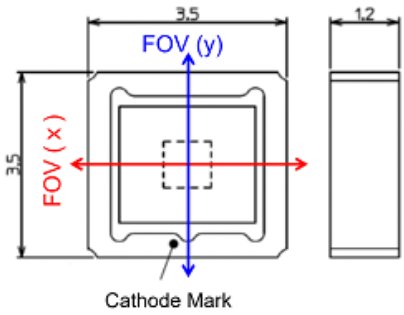
In addition to the current mass production UDN1Z54 and the new product UEN1ZA9, we plan to introduce higher-power versions, as well as an 850 nm solution. We can offer two radiation angles (FOV), depending on your requirements. They meet the safety standard (class 1) of "IEC60825-1&CFR Part1040.10" and are fully safe even with direct exposure. All package sizes and solder pads are the same. Also, each product is available with or without a photodiode (PD) for optical output monitoring. This lineup is planned to be continuously expanded in the future.

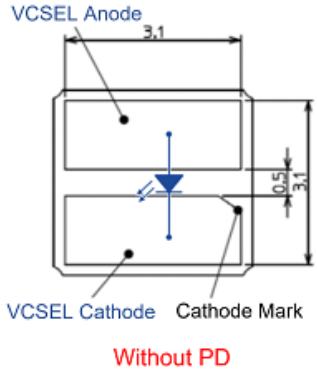
Product	UDN1Z54	UEN1ZA9	High-Power type *1	850nm type *1
Major Apps	DMS	OMS、TOF		
Peak Optical Output	2.1W	2.8W	6.0W	3.0W
Forward Current (I_F)	2.7A	4.0A	4.0A	4.0A
Emission Wavelength	940nm	940nm	940nm	850nm
Radiation Angle FOV (x)×(y) *2	54°×43°	110°×85°	110°×85°	110°×85°
Common Specification	Package: 3.5×3.5×1.2mm, Version with/without PD monitoring			

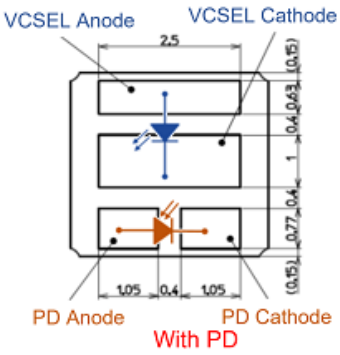
*1: Under contemplation. *2: Radiation angle at 50% light output.
※The characteristic values shown are the standard values when the 300 μs pulse is lit at the forward current I_F at Ta=25℃.

Package

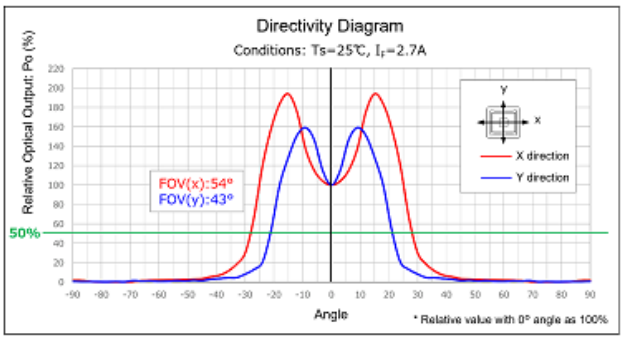


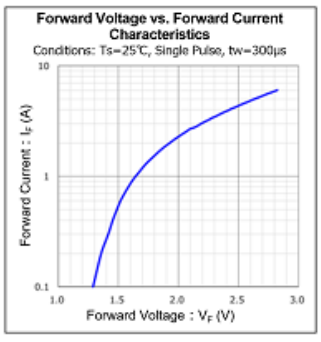


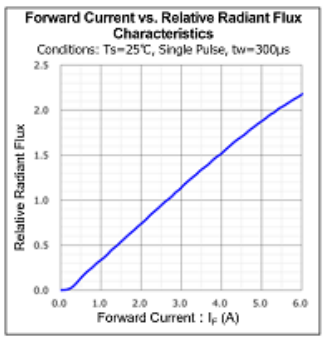




Basic characteristics and maximum rating of UDN1Z54







<Maximum Rating>

- Maximum Current: I_F =6A Pulse (tw≦0.1ms, duty≦1%)
- Junction Temperature: 125℃
- Operating Temperature: -40 to 125℃
- Storage Temperature: -40 to 125℃

Summary

Stanley Electric has developed a high-output IR VCSEL compliant with the in-cabin standard AEC-Q102, and started mass production ahead of the industry in order to support advancements in autonomous driving and ADAS applications. This utilizes the light distribution and automotive specific technology that Stanley Electric has cultivated over many years. There are increasing cases where existing high-power IR LEDs cannot meet the latest demands for automotive applications, but Stanley Electric will provide solutions based on the unique characteristics of high-power IR VCSEL.

Our line up will grow to include 4 products in the near future, and we will be continuing to develop optimal VCSEL products for various applications.

For more details...

- About IR VCSEL of Stanley Electric
- Product info. : IR VCSEL: UDN1Z54
- Product info. : IR VCSEL: UEN1ZA9
- Contact Us

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