LeddarTech®

PRODUCT SELECTION GUIDE

SELECTING THE RIGHT FLASH SOLID-STATE LiDAR FOR E-TOLL SYSTEMS

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Flash Solid-state LiDARs (Flash SSL) represent a high-performance sensor solution for advanced Electronic Toll Collection (ETC) applications. Key benefits of Flash SSLs include: better vehicle detection and profiling capabilities, higher classification rates, increased reliability and accuracy, and reduced operational expenses.

LeddarTech offers two different flash LiDAR products for e-tolling applications: the Leddar T16 Traffic Sensor and the Leddar M16-LSR module. This product guide explains the key elements to consider when selecting a Flash Lidar for ETC.

THE LEDDAR T16 TRAFFIC SENSOR: THE POWERFUL OFF-THE-SHELF LEDDAR SOLUTION FOR ETC

The high-performance Leddar T16 sensor meets the stringent requirements for high-speed open road tolling (ORT) applications, in which a sensor with a frequency/refresh rate of 200 Hz is mandatory for effective vehicle classification at speeds between 180 km/h to 250 km/h. With 8 LEDs providing powerful 80W output emission that illuminates the whole sensor field-of-view (FoV), the Leddar T16 performs simultaneous acquisitions on 16 independent segments—and provides both distance and angular positioning. Other important characteristics of the Leddar T16 include:

- Fixed high data rate of 200 Hz
- 5-cm measurement accuracy
- Various horizontal FoV options from 9 ° to 48 °
- IP67 waterproof enclosure
- Fully IP addressable
- Ethernet communication supporting Power over Ethernet (PoE)

THE LEDDAR M16-LSR MODULE: A COST-EFFECTIVE SOLUTION FOR LOWER-SPEED APPLICATIONS

Depending on the scope and requirements of a given tolling project, a high-performance sensor such as the Leddar T16 may not always be necessary. Factors that determine what type of sensor is required include the average vehicle speed and the number of profiling classes needed for the application. For example, for cash lanes, toll plazas and any other slow-speed installations, a mid-range performance sensor may be sufficient to achieve the performance requirements. Such sensor will also have the benefit of being available at a lower price point. The Leddar M16-LSR is a more cost-effective laser-based 16-segment Flash SSL with various beam options for optimized FoV. It features a rapid data acquisition and refresh rate that is adjustable up to 100 Hz. The module's main characteristics are:

- Adjustable data rate up to 100 Hz
- 5-cm measurement accuracy
- Compact form factor for seamless integration
- Various horizontal FoV options from 19 ° to 99 °
- USB, RS-485, CAN and UART communication protocols

SENSORS VS. MODULES

The Leddar T16 Traffic Sensor offers a more complete and ready solution as it is already integrated mechanically, optically and electrically. The sensor is packaged in a waterproof enclosure and is ready to install and operate once the communication integration is carried by integrators.

On the other hand, the Leddar M16-LSR Module requires further design and development from integrators to make it a fully industrialized solution. The modules do not come with an enclosure or casing. However, this non-integration often offers potential for added value and more flexibility to integrate the module into another equipment enclosure to save space and material costs.

UNDERSTANDING AND COMPARING KEY FLASH SSL SPECIFICATIONS

A Flash SSL's vehicle profiling performance essentially depends on the sensor's following characteristics: measurement rate, emission power, lateral resolution and light density. The choice of the right sensor model should be done according to the project's specific requirements. This section serves as a sensor selection guide by explaining the specification differences between sensors and how these factors affect profiling performance.

a) Measurement Rate and Emission Power

The measurement rate is the speed at which the sensor outputs distance measurements. This specification is referred to in Hertz (Hz) and corresponds to the number of data outputted per second for all the detection segment.

The emission power of a sensor corresponds to the strength of the emitted signal. This specification is referred to in Watts (W).

The table below demonstrates the impact of the measurement rate and emission power on a sensor's vehicle profiling performance. The high measurement rate of the Leddar T16 means a better length resolution, more accurate detection of small objects and improved differentiation at high speeds. High measurement rates also allow for better form definition. High-emission power offers higher detection rates and allows for improved detection of black cars. High-power emission sensors also help to better detect small objects, such as hitches or motorcycles. These types of sensors also perform adequately when installed on gantries higher than 6 m. In summary, the Leddar T16 boasts a higher emission power than the Leddar M16-LSR, delivers better length resolution and enables hitch detection.

SENSOR AND FOV (H X V)	EMISSION POWER	MEASUREMENT RATE	SENSOR COST	LENGTH RESOLUTION *(for vehicle speed of 100 km/h)*	WIDTH RESOLUTION *(at ground level)*	ROAD COVERAGE *(for sensor placed at 6 m high)*	Hitch Detection
Leddar T16 48°x 7.5°	80 W	200 Hz	$$$	14 cm	31 cm	5.3 m	Yes
Leddar M16- LSR 48°x 3.0°	20 W	up to 100 Hz	$	28 cm	31 cm	5.3 m	No

Emission power: Strength of the emitted light.
Measurement rate: Sensor's rate of measurement output, in Hz.
Length resolution: Distance between each surface acquisition over the car passage.
Width resolution: Width of each segment at the vehicle height level.
Road coverage: Detection width at ground level to offer enough coverage on the entire lane and straddling point.
Hitch detection: Sensor's ability to detect the hitch between a vehicle and a trailer.

Table 1. Impacts of Measurement rates and emission power levels on Leddar Flash SSL sensor performance.

b) Angular Resolution and Light Density Factors

The angular resolution of a Leddar sensor is determined by its given horizontal FoV divided the number of detection segments, which is determined by the number of detection elements in the sensor's array. For example, a 48° horizontal FoV divided by 16 segments gives a 3° resolution per segment. Length resolution also impacts the performance levels of sensors installed on gantries higher than 6 m.

Light density is the concentration of power on a given surface. Light density affects the detection rate, the ability to detect black cars and small objects, such as hitches or motorcycles. There are two ways to increase light density: either by increasing emission power or by reducing the FoV for the same emission power. Light density is expressed in Power/Surface (W/mm^2).

The table below demonstrates the impact of angular resolution on sensor profiling performance for two sensors of the same family with different FoV. Angular resolution affects the width resolution and therefore the ability to detect smaller details and even small vehicles, such as motorcycles or micro cars. It also has an impact on form definition.

FOV (H X V)	LENGTH RESOLUTION *(for vehicle speed of 100 km/h)*	WIDTH RESOLUTION *(at ground level)*	ROAD COVERAGE *(for sensor placed at 6 m high)*
48°x 7.5°	13.9 cm	31.4 cm	5.34 m
26°x 4.2°	13.9 cm	17.0 cm	2.77 m

Table 2. Lateral resolution and light density impacts.

c) Field-of-View (FOV)

Leddar sensors come in a variety of configurations, allowing operators, integrators and suppliers to choose the optimal specifications for their intended application. The next table lists the available configurations offered for both Leddar products.

In general, high-performance and high-speed ETC projects will require a higher-end Flash SSL, such as the Leddar T16 Sensor, which offers increased emission power and a higher measurement rate. For lower performance and lower-speed projects, a more cost-effective sensor, such as the M16-LSR Module, represents a perfect alternative.

M16-LSR MODULE FOV CONFIGURATIONS	T16 SENSOR FOV CONFIGURATIONS
99° x (3° or 0.3°)	48° x 7.5°
48° x (5.5° or 3° or 0.3°)	36° x 5.9°
36° x 0.2°	26° x 4.2°
19° x (3° or 0.3°)	19° x 3.0°
	9° x 1.6°

Table 3. List of available FoV.

IN CONCLUSION

LeddarTech's Leddar T16 Traffic Sensor and Leddar M16-LSR Module—based on Flash SSL designs and field-proven Leddar technology—are highly performant, cost-efficient, robust and reliable. They offer ETC operators and suppliers an opportunity to create value by working directly on raw vehicle profiling data. These advantages make them ideal sensors for ETC related applications, such as vehicle detection, profiling and classification. They offer a long-awaited alternative to expensive, limited and legacy detection solutions, such as inductive loop systems and mechanical scanning LiDARs.