

Webinar

Innovations in laser driving technology

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Agenda



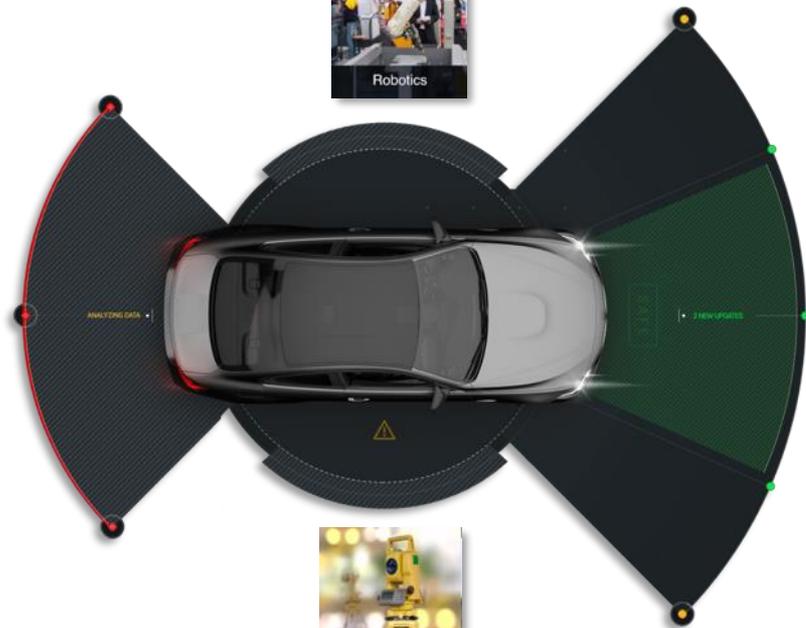
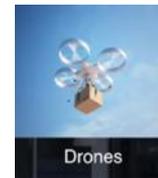
- Basic lidar principles and common lidar architectures
- Lidar applications: automotive and industrial
- Lidar optical front end and signal chain
- Innovations in laser driver technology
- Key discussion points / Q&A



Introduction to lidar



Lidar: Light Detection and Ranging



Why do we need lidar?



Myth: Sonar, radar and cameras are adequate

Sonar



Advantages

- Inexpensive
- Works in all lighting conditions



Disadvantages

- Low resolution
- Limited range
- Slow response

Radar



Advantages

- Long range
- Works in most lighting & weather conditions



Disadvantages

- Medium resolution
- Medium response

Camera



Advantages

- High Resolution
- Can determine colors
- Inexpensive imagers



Disadvantages

- Poor distance measurement
- Poor low light performance
- Can be blinded with bright ambient light or bad weather

Lidar tradeoffs



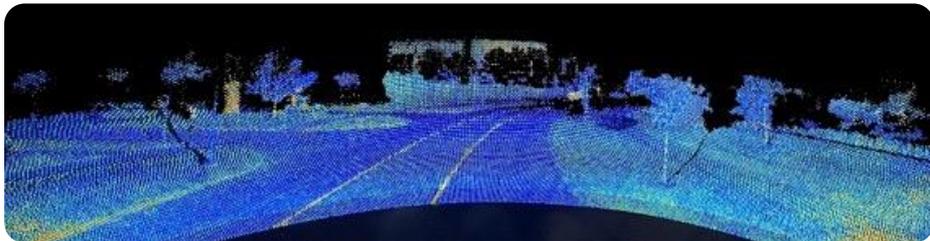
Lidar strengths vs. weaknesses

Strengths:

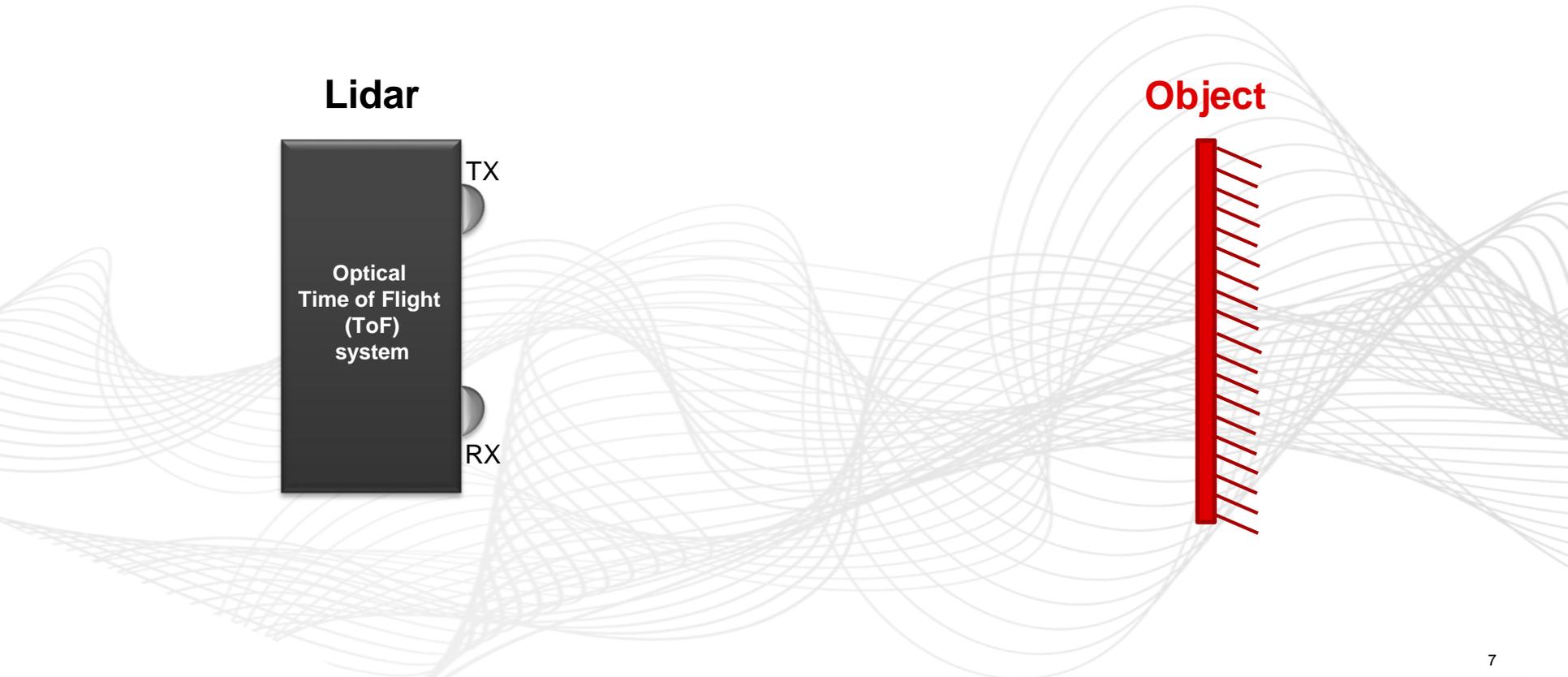
- Fast response time
- High resolution
- Accurate distance measurements
- Measure distance and velocity simultaneously
- Can quickly create a 3D image (point cloud)
- Works in most lighting conditions
- Does not require external illumination

Weaknesses:

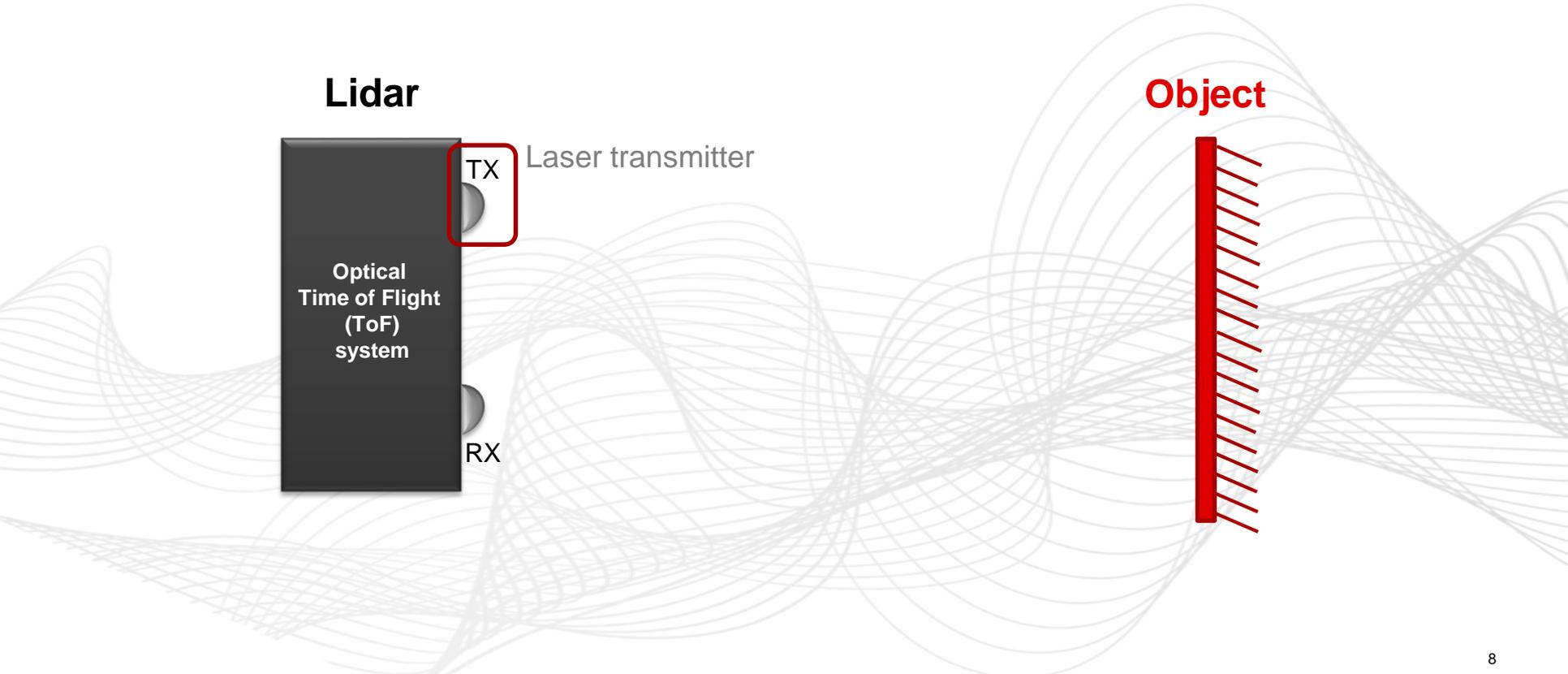
- High cost (*prices are coming down quickly*)
- Limited distance (*ranges are increasing*)
- Poor performance in bad weather
- Some systems can have poor performance in bright sun light



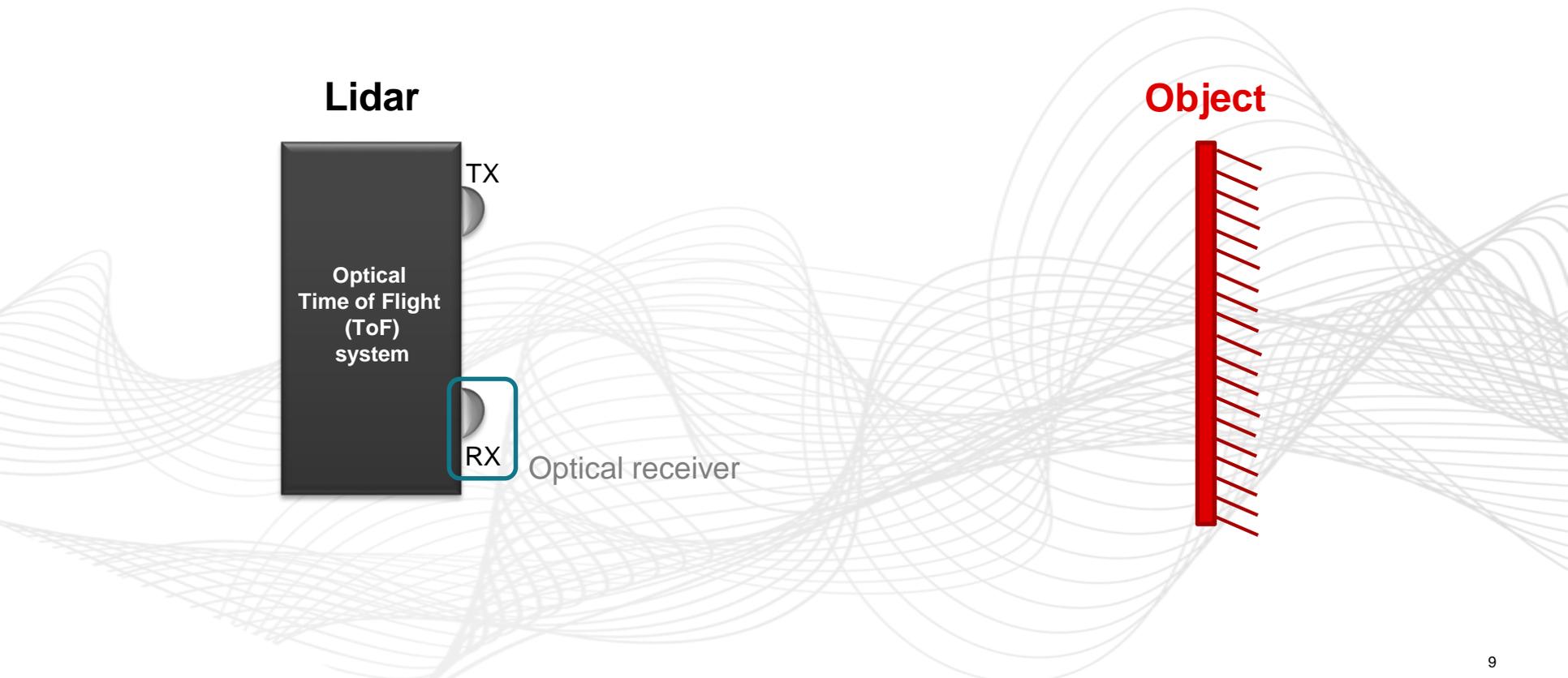
Basic ToF lidar principles



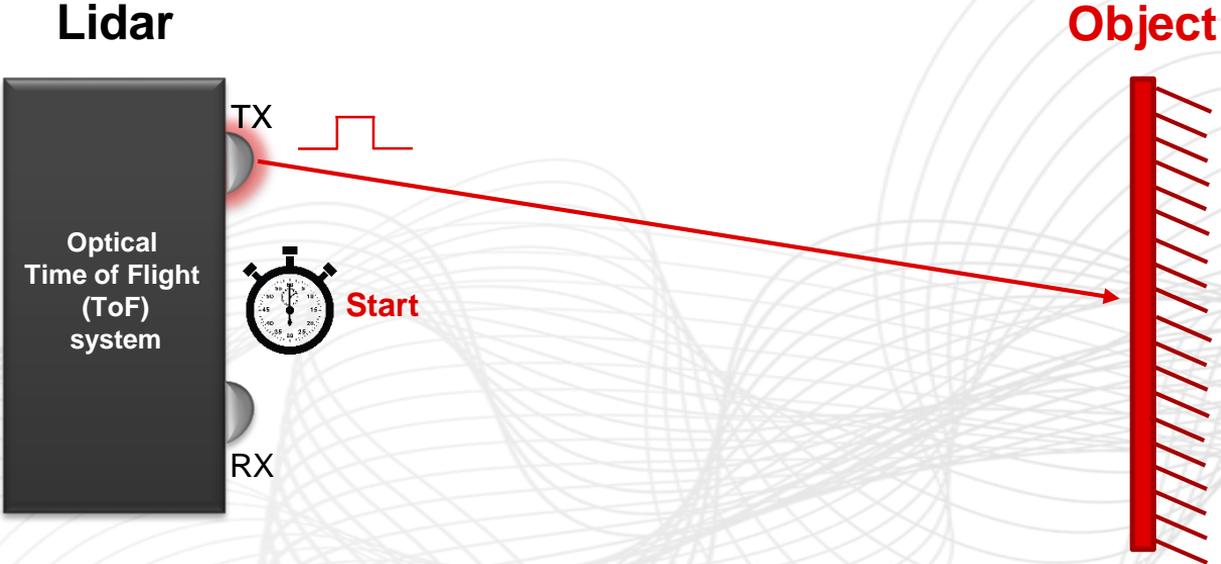
Basic ToF lidar principles



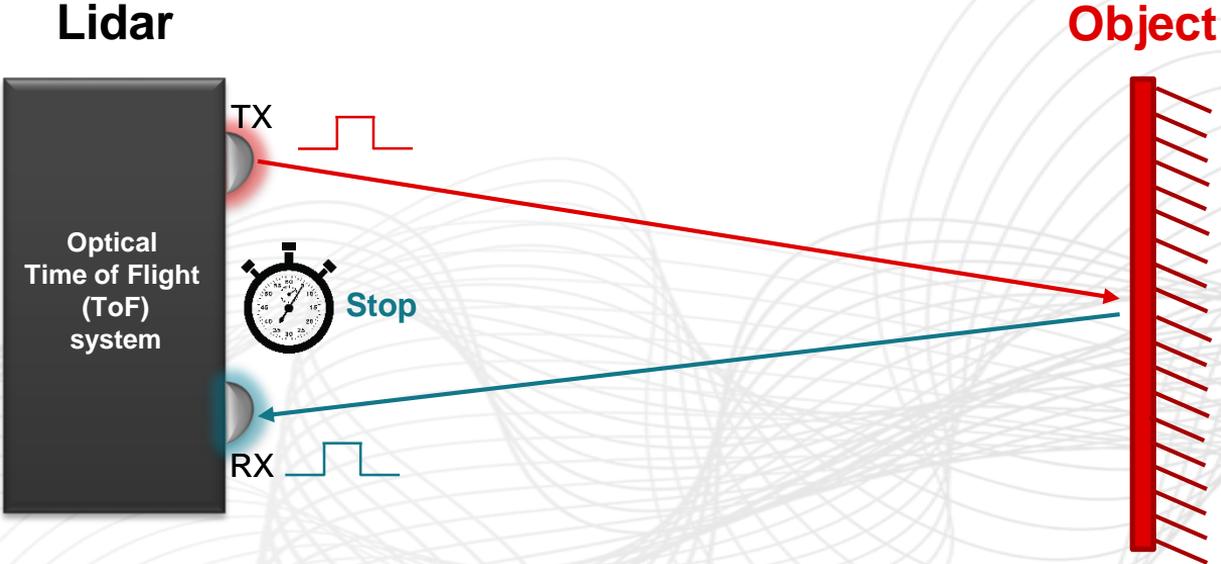
Basic ToF lidar principles



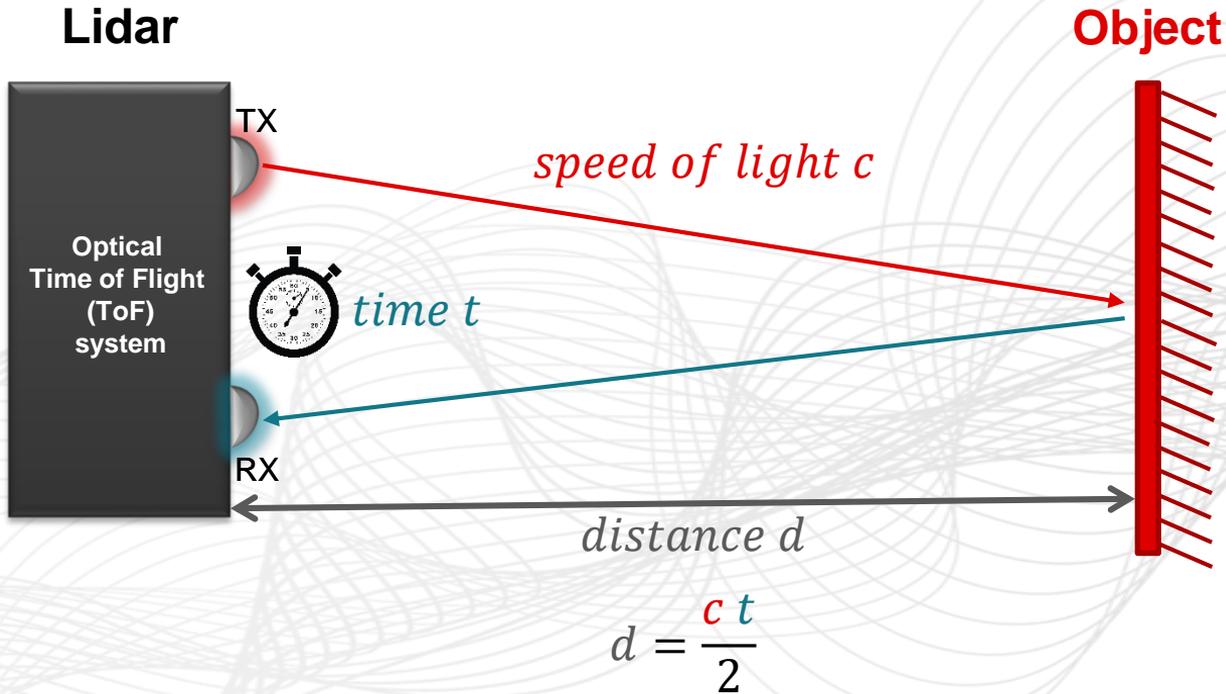
Basic ToF lidar principles



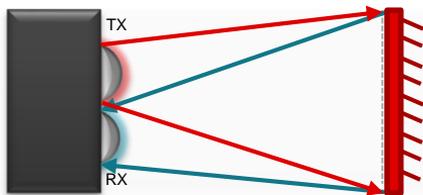
Basic ToF lidar principles



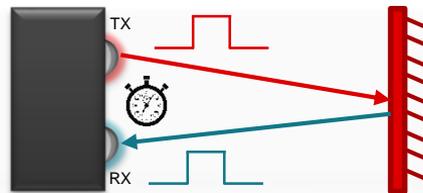
Basic ToF lidar principles



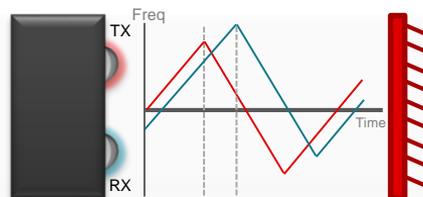
Common lidar architectures



Flash lidar illuminates the entire scene and uses an array of photodetectors to form an image. The photodetectors usually integrate time to digital converters.



Pulsed Time of Flight (ToF) takes a measurement of the time it takes a pulse of light to go from the transmitter to an object and back to the receiver. Multiple channels are frequently used to scan the entire scene.



Frequency modulation (FMCW) uses a continuous wave with varying frequency and measures the time of flight as a frequency difference. **Distance** & **velocity** can be measured.

Scanning and flash lidar systems



Flash lidar systems and scanning lidar systems use different illumination methods.

Flash lidar



Scanning lidar

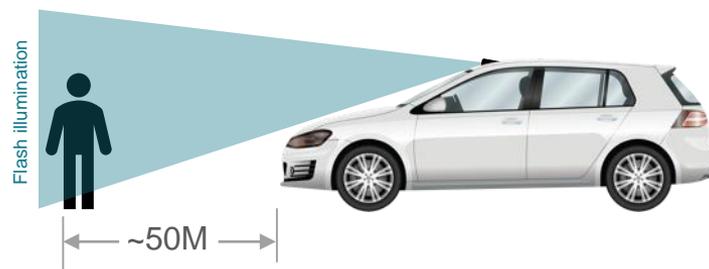


Scanning and flash lidar systems



Flash lidar systems and scanning lidar systems use different illumination methods

Flash lidar



Scanning lidar



Scanning lidar



Most multi-channel scanning lidar systems scan horizontally, vertically or both.

Horizontal scanning



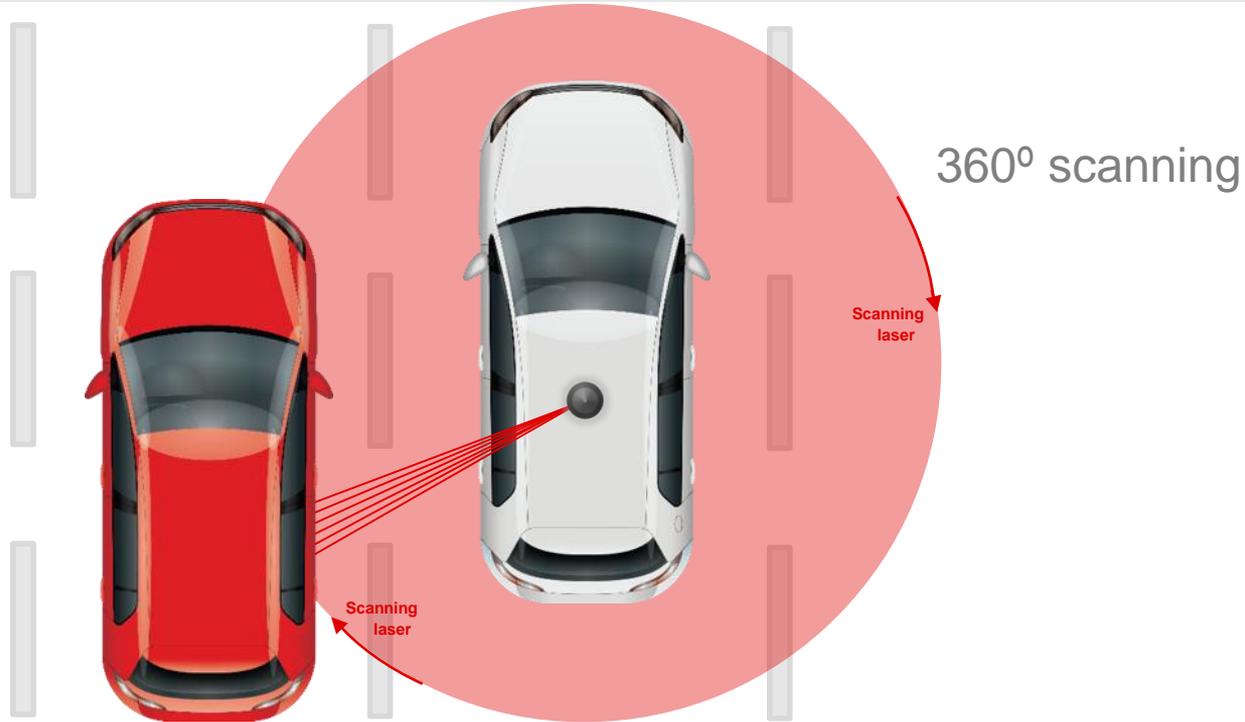
Vertical scanning



Scanning lidar



Some mechanically scanning lidar systems scan in a circle to provide a 360° view.



Industrial lidar applications



Lidar has many industrial applications



Mining



Agriculture



Drones



Defense



Smart infrastructure



Energy



Vacuums



Lawn care



Topography & construction



Logistics



Factory automation

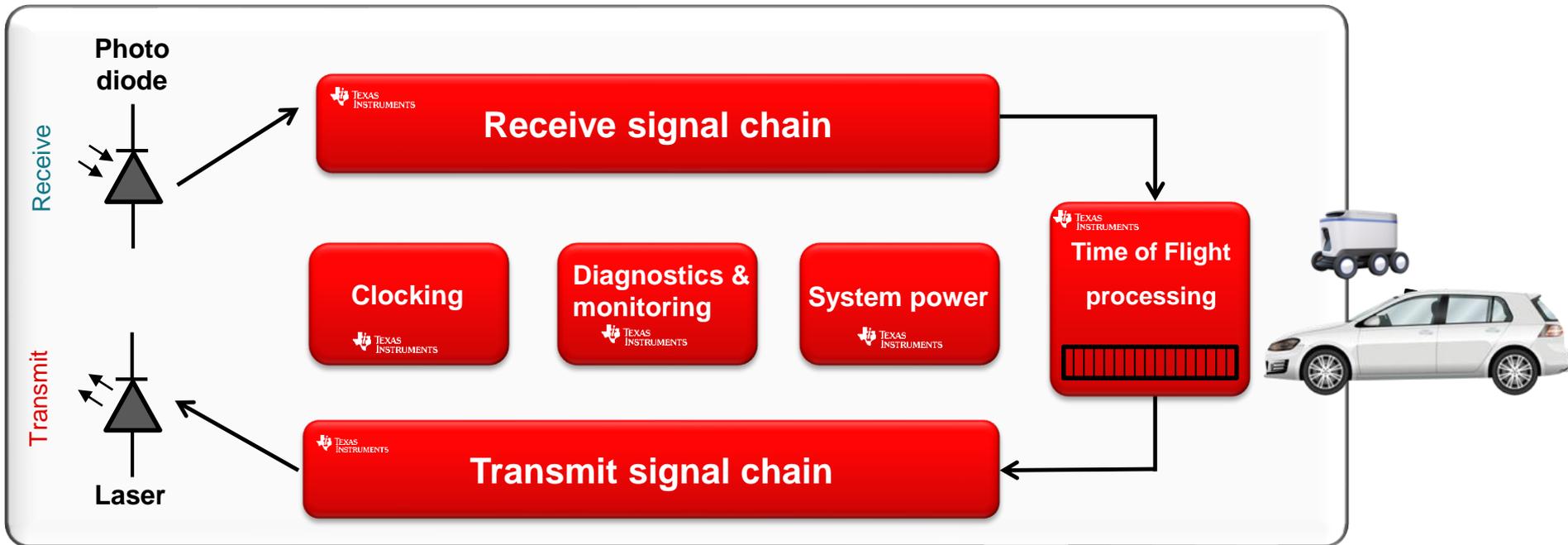


Robotics

Lidar optical front end and signal chain



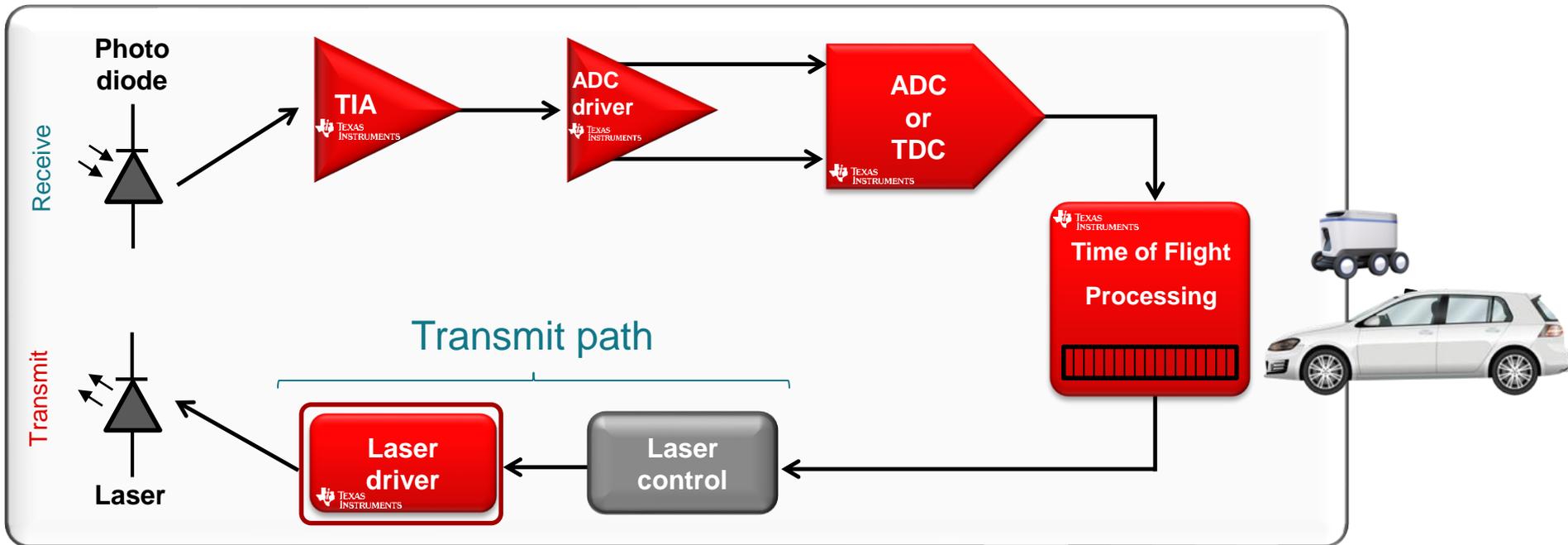
System overview



Lidar optical front end and signal chain



Transmit path / laser drivers



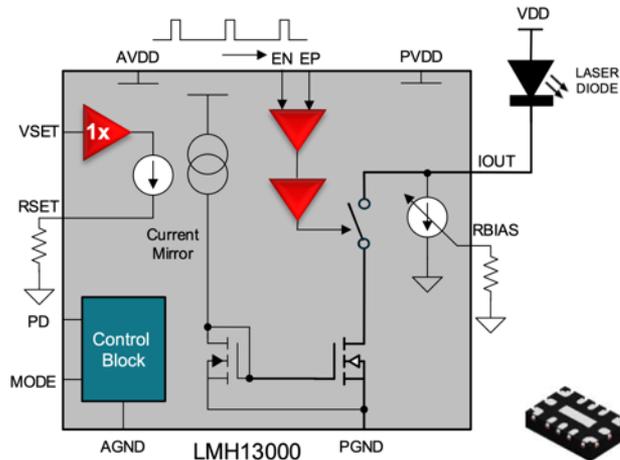
LMH13000: Industry's first integrated laser driver



- **Improve real-time decision-making with 30% longer distance measurement**
 - Faster, more accurate object detection
 - High speed rise and fall time of 800ps and output peak currents of up to 5A
- **Reduce solution size by 4 times compared to discrete solutions**
 - Integrated LVDS, CMOS and TTL control signals
 - Eliminates the need for large capacitors or additional external circuitry
- **Achieve highly accurate measurements for enhanced reliability**
 - Optical peak power control with variations of only 2% over temperature

Learn more at [ti.com/LMH13000](https://www.ti.com/LMH13000).

LMH13000: Device overview

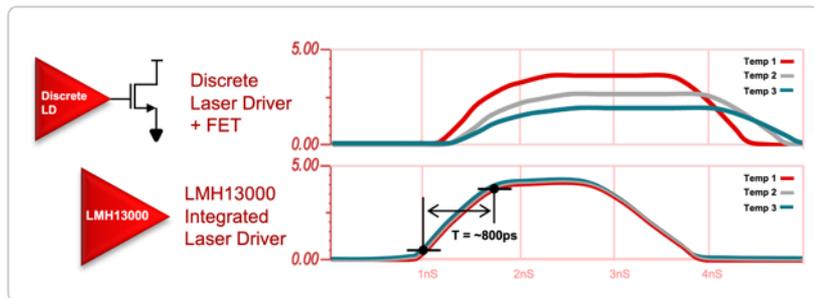


Challenge: laser transmissions that accurately detect objects at longer distances over temperature

Solution: integrated, high-speed laser driver for lidar systems

- Does not require an external FET nor large capacitors
- Decrease the size of the laser driver circuit by 75%
- Output current only varies by 2% over the operating temperature of the device, improving the repeatability of measurements across temperature

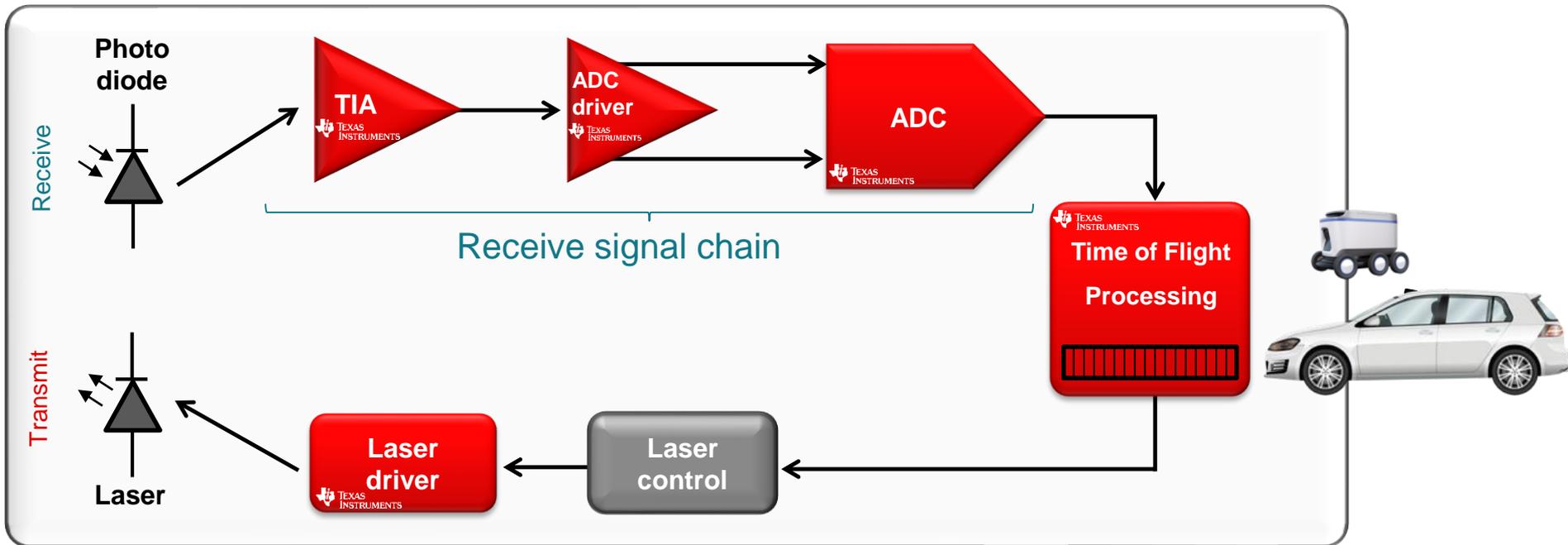
The result for designers: up to 30% longer distance measurements compared to discrete solutions



Lidar optical front end and signal chain



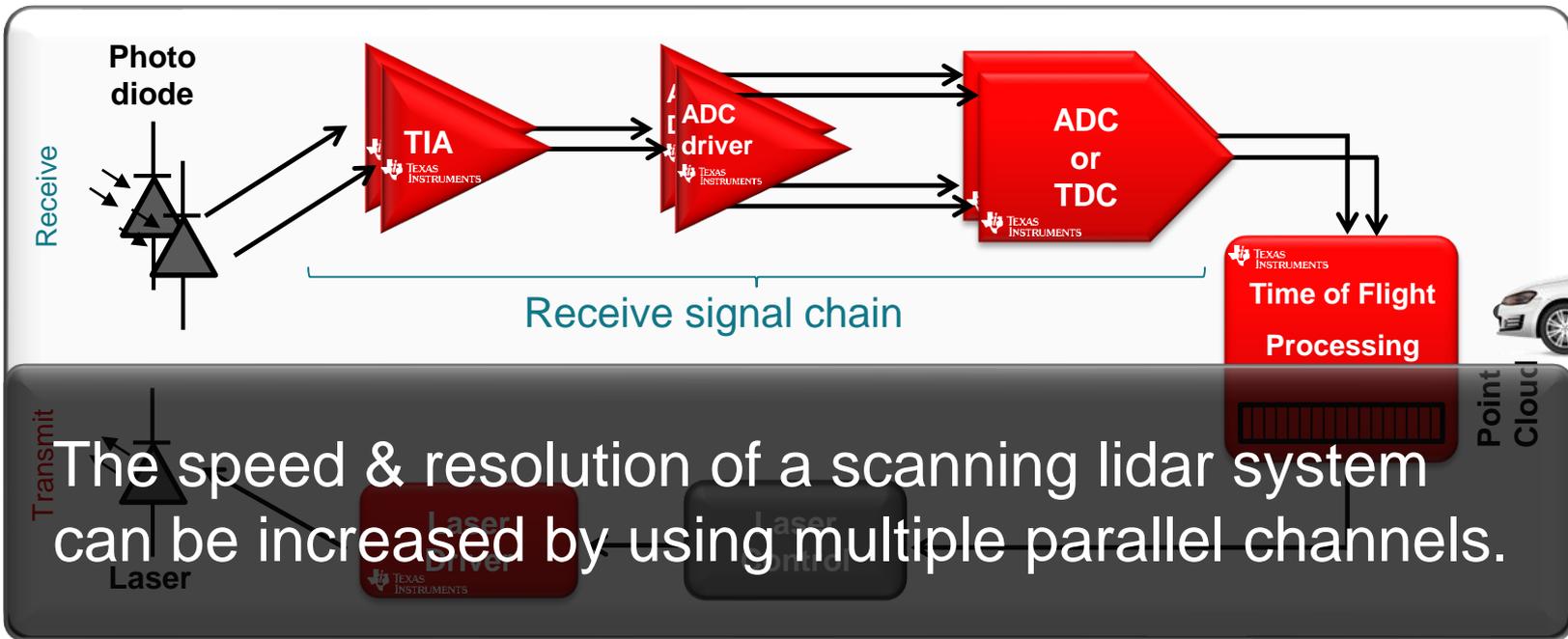
Analog to Digital Converter (ADC) based lidar block diagram



Lidar optical front end and signal chain



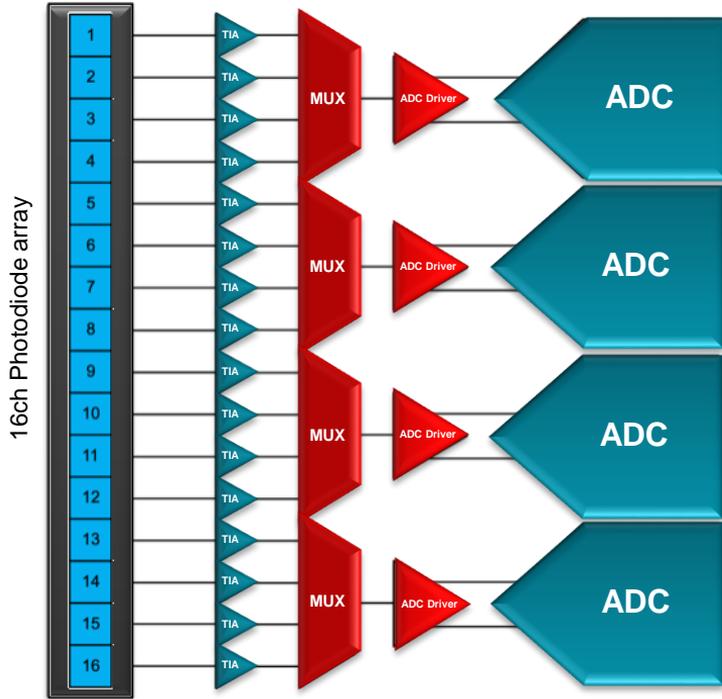
Multi-channel lidar system



Multi-channel lidar system



Multi-channel system complexity



Optimizing multi-channel lidar systems

Photo diode arrays:

- Reduces size
- Reduces cost

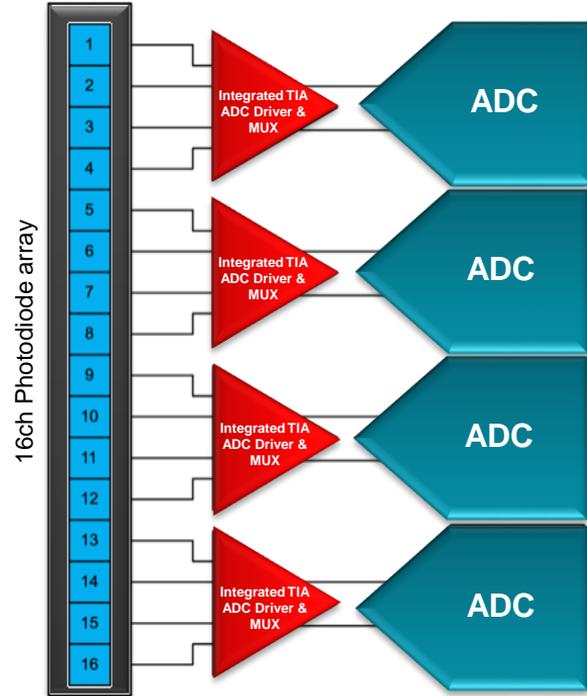
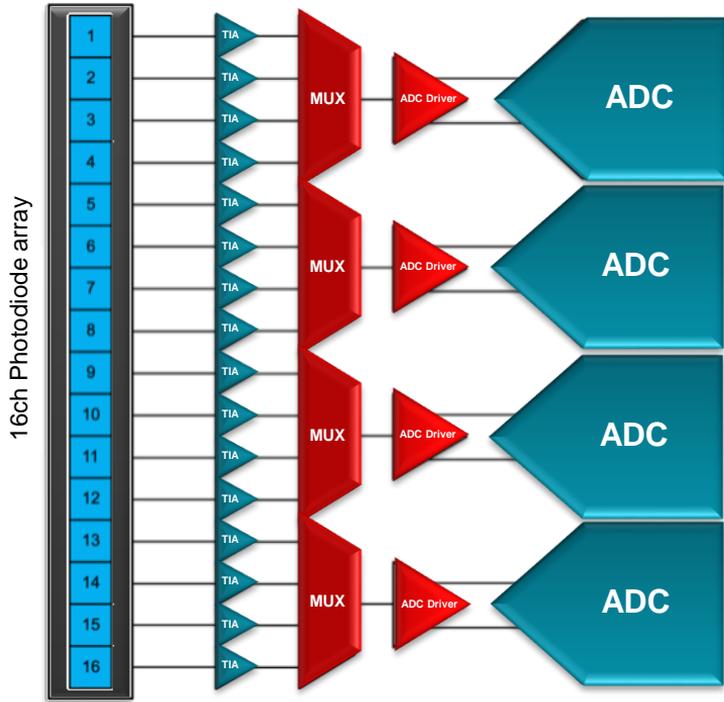
Multiplexers:

- Adds components
- Reduces FDA/ADC drivers necessary
- Reduces number of ADC/TDCs necessary
- Reduces overall system cost

Multi-channel lidar system



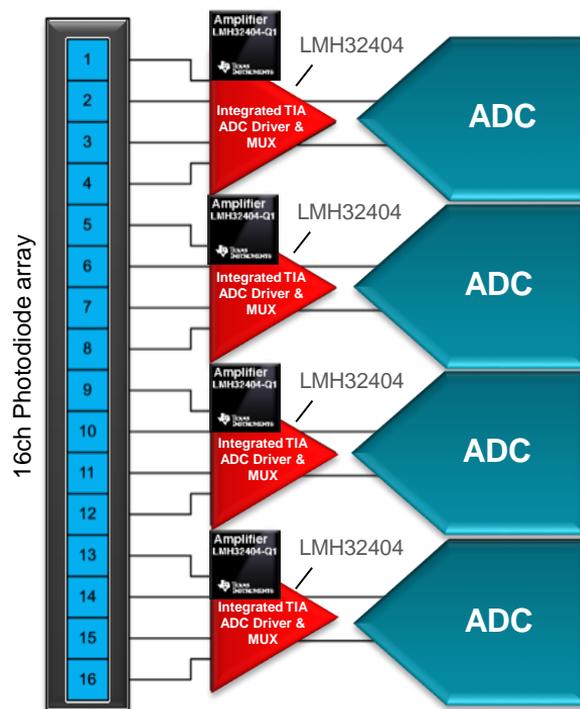
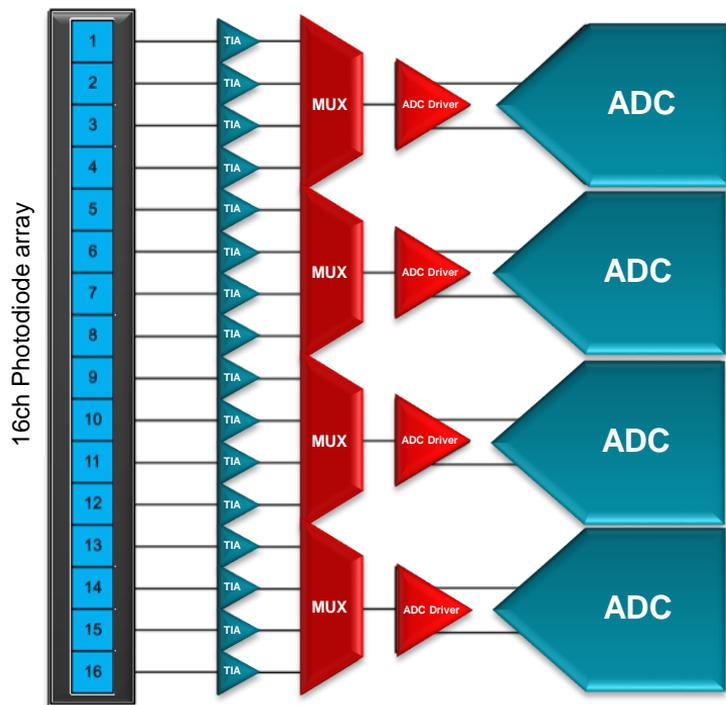
Using integrated components can greatly reduce size and complexity



Multi-channel lidar system



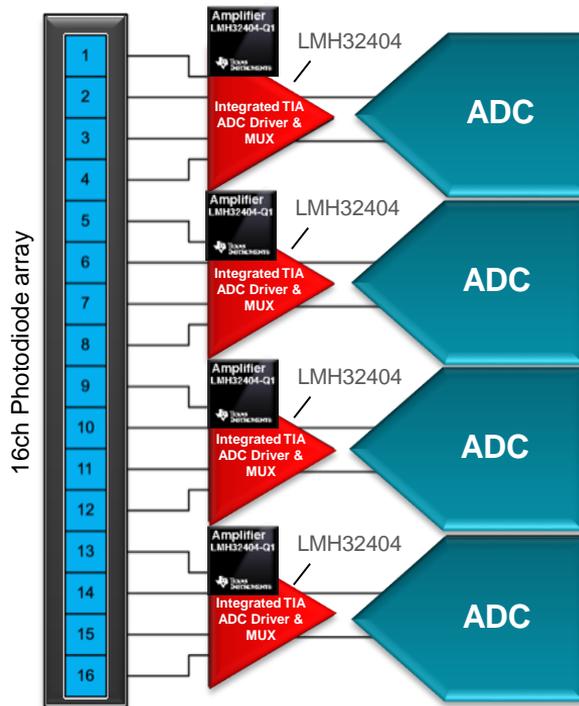
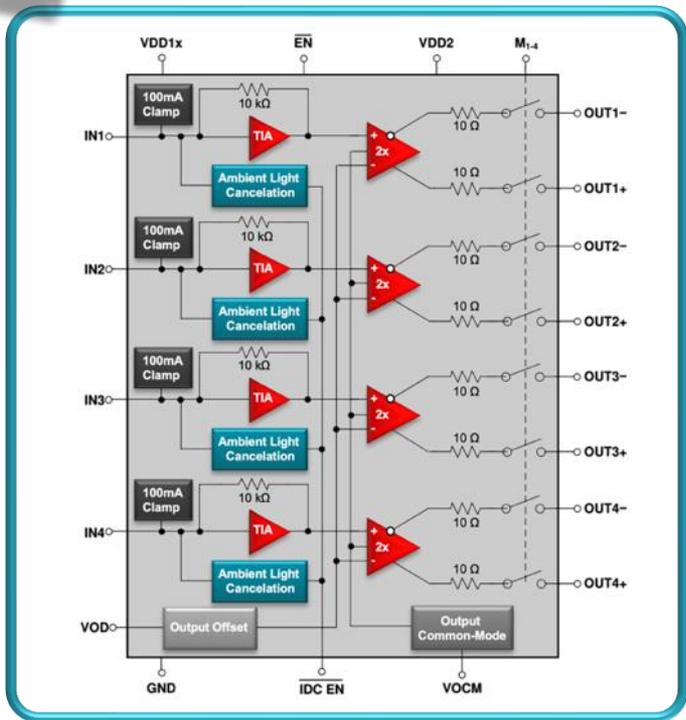
Using integrated components can greatly reduce size, cost and complexity



Multi-channel lidar system



LMH32404-Q1: quad channel integrated TIA, ADC Driver and MUX

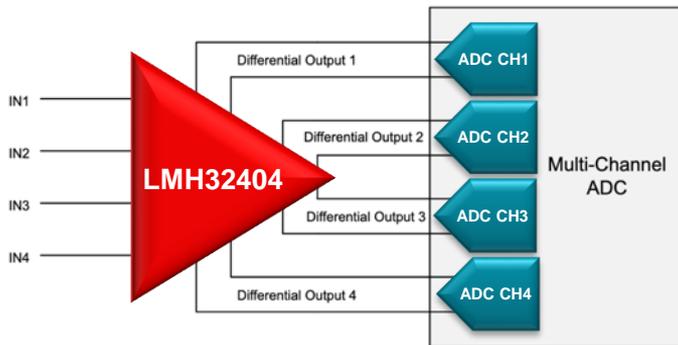


Multi-channel lidar system

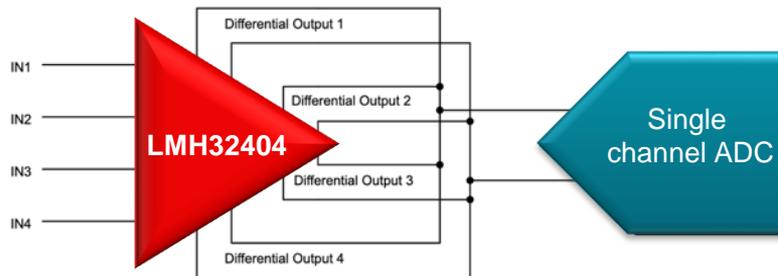


LMH32404-Q1: quad channel integrated TIA, ADC Driver and MUX

Multiple multiplexing options:



4-to-4 channel configuration



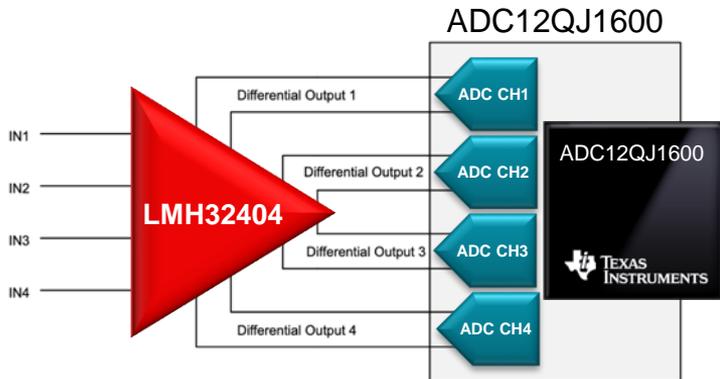
4-to-1 channel configuration

Multi-channel lidar system



LMH32404-Q1: quad channel integrated TIA, ADC Driver and MUX

Multiple multiplexing options:



4-to-4 channel configuration

The quad channel ADC12QJ1600-Q1 was designed specifically to interface with the LMH32404-Q1 for use in automotive lidar systems.

The diagram illustrates a 4-to-1 channel configuration. It shows the same LMH32404 and ADC12QJ1600 components as the 4-to-4 configuration. However, only one line, labeled 'Differential Output 1', is shown connecting the LMH32404 to the ADC12QJ1600. The other three differential output lines are not shown, indicating they are not used in this configuration.

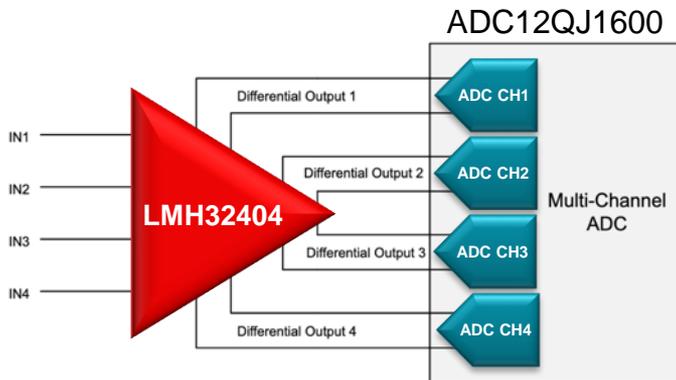
4-to-1 channel configuration

Multi-channel lidar system



LMH32404-Q1: quad channel integrated TIA, ADC Driver and MUX

Multiple multiplexing options:



4-to-4 channel configuration

The ADC family contains single, dual and quad channel options:

Single (1x)



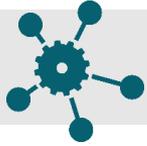
Dual (2x)



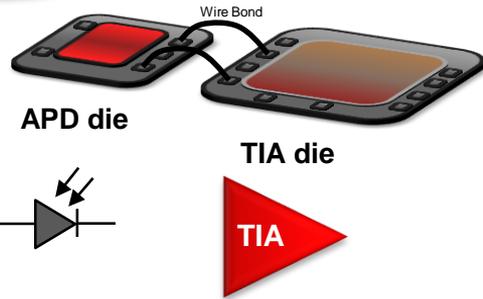
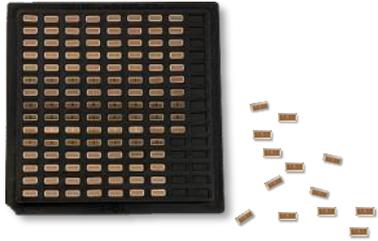
Quad (4x)



Multi-channel lidar system



Using bare die components to reduce size and increase performance



Using bare die components

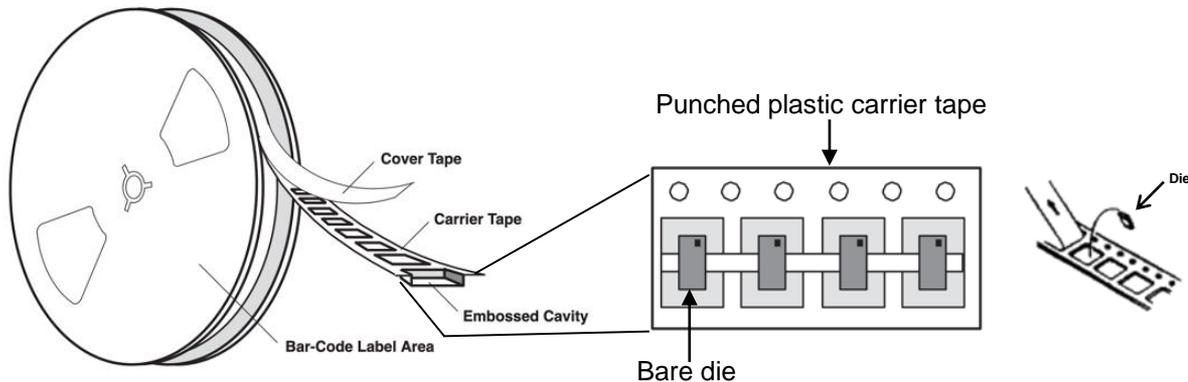
Bare die components:

- Further reduces size
 - Bare die are much smaller than packaged components.
- Increases performance
 - Using bare die eliminates package parasitic capacitance and inductance.

Multi-channel lidar system



Using bare die components to reduce size and increase performance



Die in tape and reel provides several advantages:

- Sampling can be done in the same manner as with packaged parts
- Large and small orders can be supported (custom tape & reel sizes on ti.com store)
- No need to support digital wafer maps (for wafer sale) that require special MIC NDA

<https://www.ti.com/die-wafer-services/overview.html>

Bare die high-speed amps:

Tape & reel option

- [THS3491YR](#)
- [THS4541YR](#)
- [LMH32401YR](#)
- [LMH32404YR](#)
- [OPA855YR](#)
- [OPA858YR](#)
- [OPA859YR](#)

Bare Die FDA

Bare Die TIAs



Getting started with laser driving & lidar

You can learn more about these devices by leveraging the following:

Content type	Content title	Link to content or more details
Technical articles	Lidar leaps forward: Enabling safer vehicles with precise, long-range detection	https://www.ti.com/lit/ta/ssztd78/ssztd78.pdf
	Sharper vision: How lidar is improving robot navigation	https://www.ti.com/lit/ta/ssztd79/ssztd79.pdf
Application notes	Time of Flight and LIDAR - Optical Front End Design	https://www.ti.com/lit/ab/sboa337a/sboa337a.pdf
	How to Increase the Channel Density of LiDAR Systems with the 4-Channel LMH32404 Transimpedance Amplifier	https://www.ti.com/lit/an/sboa516/sboa516.pdf
Product folders	LMH13000 product folder	https://www.ti.com/product/LMH13000
Evaluation module	LMH13000RQEEVM	https://www.ti.com/tool/LMH13000RQEEVM



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