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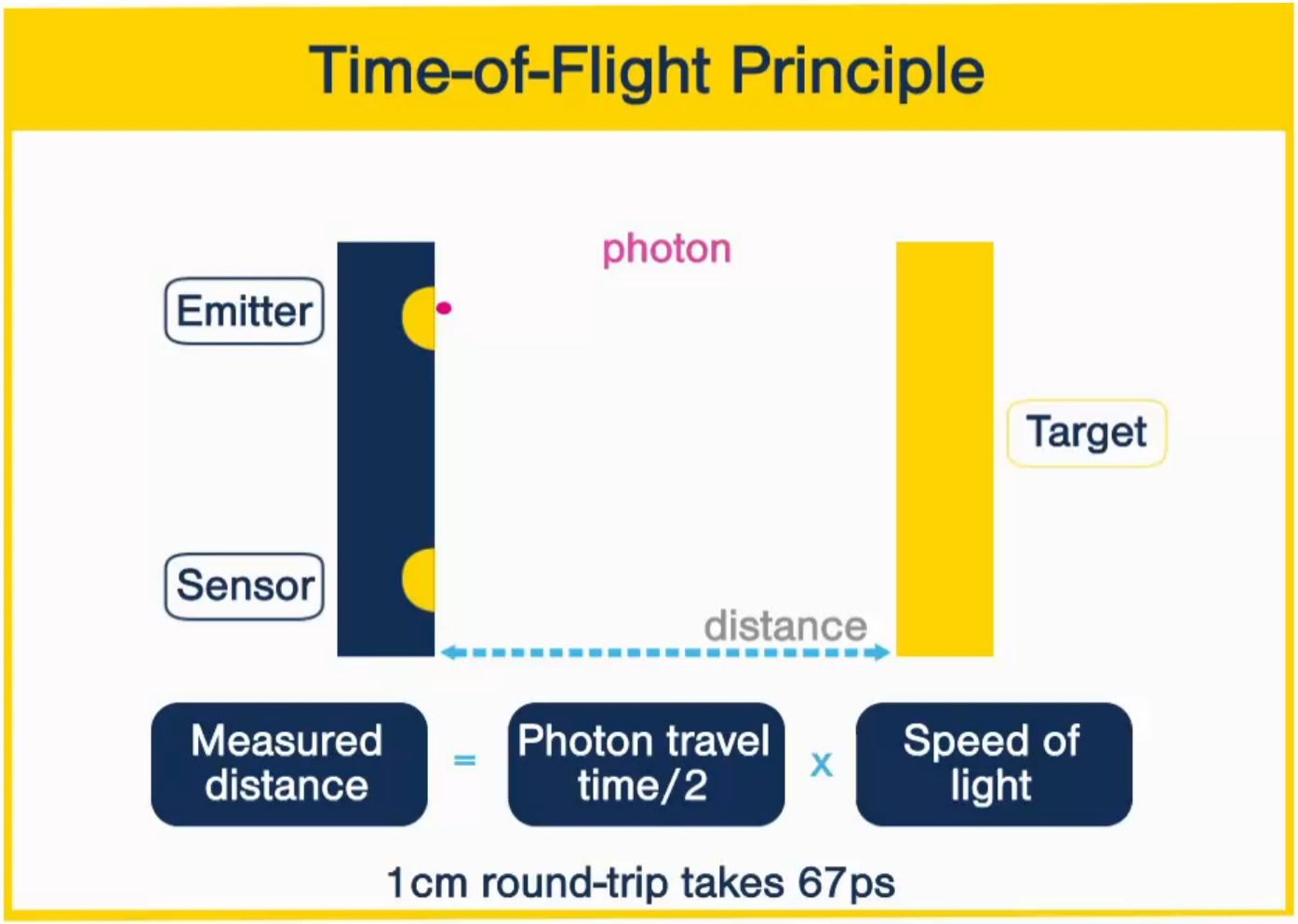
Latest ToF sensors featuring improved short distance performance

June 28, 2022

Flight Sense

FlightSense*
… Making Light work



- ST proprietary FlightSense* technology
- True distance measurement
  - Independent of target size, color & reflectance
- Fast and low power
- Truly invisible 940nm illumination

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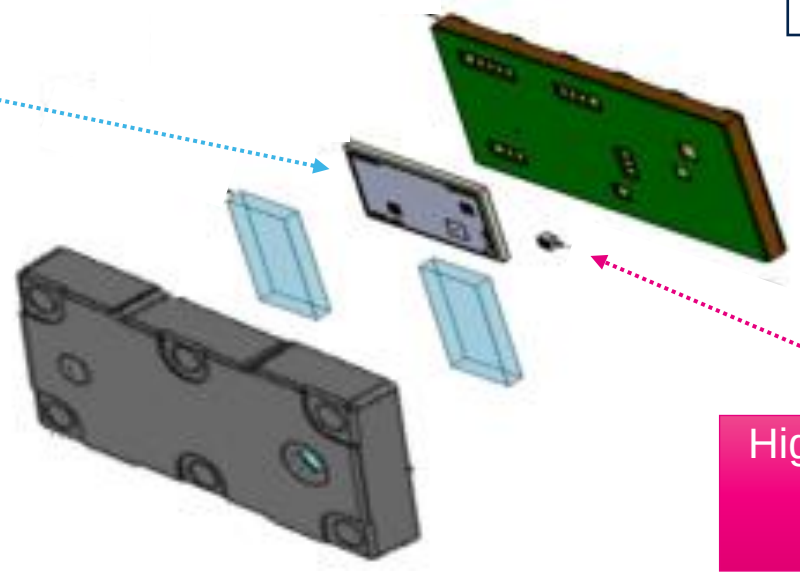
* is a registered and/or unregistered trademark of STMicroelectronics International NV or its affiliates in the EU and/or elsewhere.

FlightSense
Typical module overview

Easy and quick integration thanks to all-in-one module including IR light VCSEL emitter and SPAD sensor receiver

State-of-art assembly & testing
ST manufacturing line in Shenzhen

Time-of-Flight SoC:
SPAD receiver array
and control logic



High-efficiency VCSEL
940nm IR emitter
Class 1 certified

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FlightSense
ST Pioneer and Leader in Time-of-Flight (ToF)

ST is the #1 Worldwide Time-of-Flight sensor supplier

4 Generations
of all-in-one ToF solutions deployed in the last 7 years

> 500 customer end-products
Unlimited variety of use-cases and markets

>65,000
Evaluation kits deployed

>1.5 Billion
ToF units shipped. Mastering end-to-end supply chain

VL53L4CD / VL53L4CX
Time-of-Flight sensors
3rd generation FlightSense

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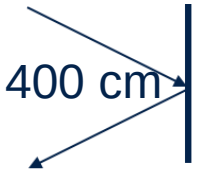
FlightSense™ technology
Key features

High-performance distance measurement

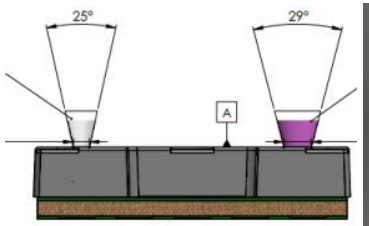
Actual distance measurement
Accurate distance measurement
Immunity to color, texture, and material



± mms

Easy and quick integration

All-in-one with small footprint
Can be hidden behind black cover glass
Full package available for prototyping



Low power consumption

Can be integrated in battery-powered devices
Autonomous low-power mode available

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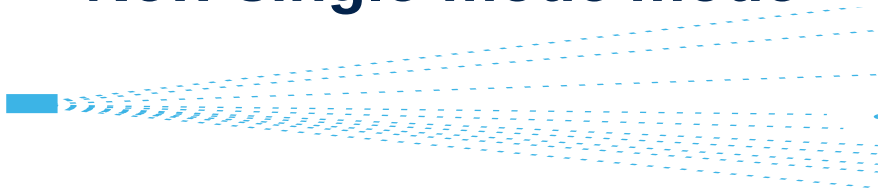
VL53L4CD/CX, what's new?

New laser emitter

New single-mode mode



Increasing performances in short distance

Narrower Field-of-View

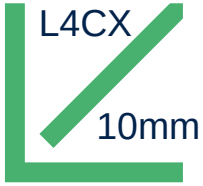
18° FoV

Other F**light**Sense sensors **25° - 63°** FoV

Better linearity

Starting at 1mm for VL53L4CD

and 10mm for VL53L4CX



Thanks to new laser emitter

Better ambient immunity

Up to 1.8m under ambient light

Thanks to narrow FoV and new laser emitter

VL53L4CD – High accuracy proximity sensor

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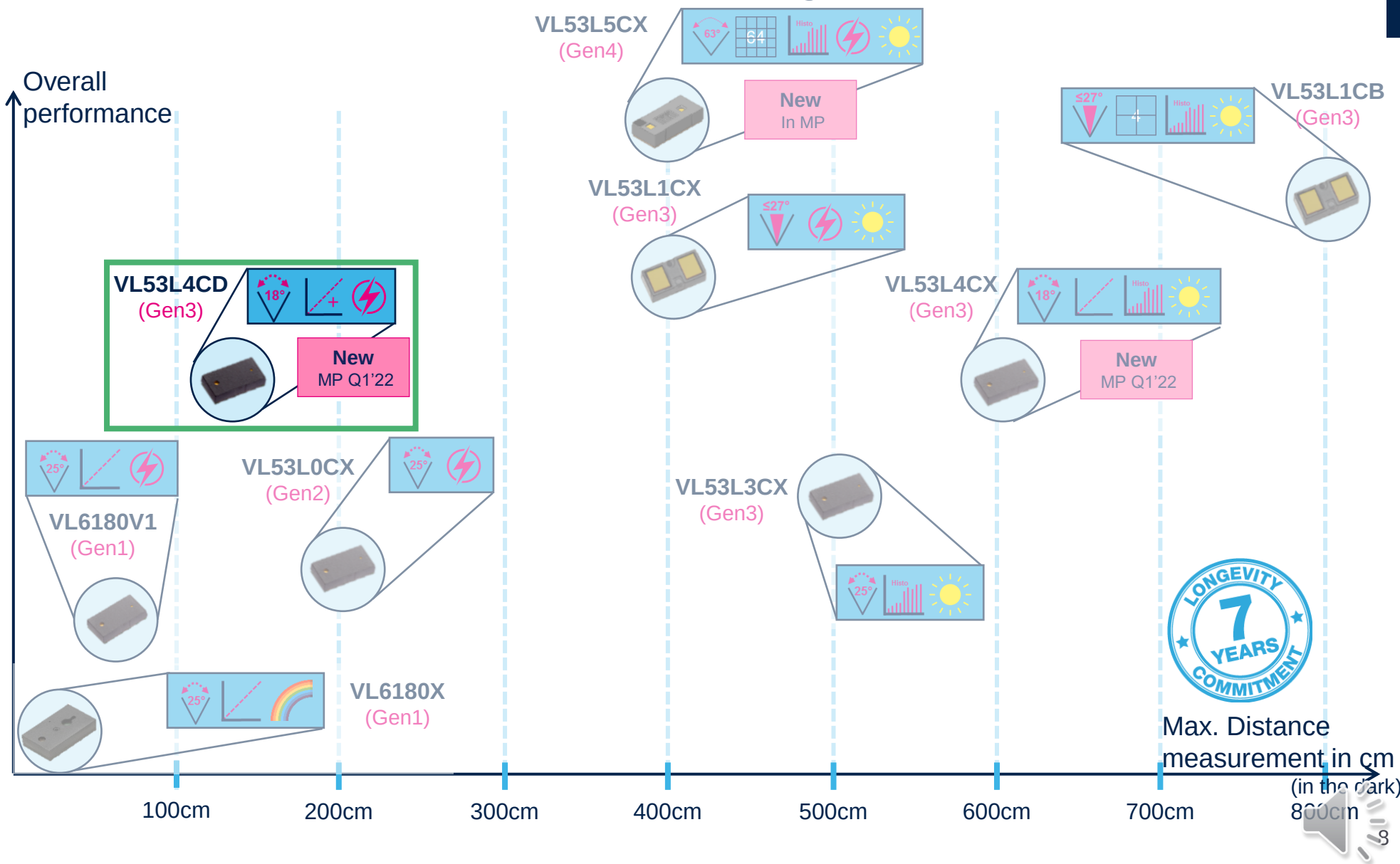
FlightSense Portfolio

- XX° FoV
- ≤XX° Programmable FoV XX° Max
- Sequential Multizone
- Up to 64 zones
- Histogram MultiObject detection
- Perf. Under Ambient (>100cm)
- Low Power Mode
- Ambient Light Sensing
- Close distance Linearity

+ : High Perf in short distance



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FlightSense™ VL53L4CD

Time-of-flight high accuracy proximity sensor with excellent short distance linearity

Package size : 4.4 x 2.4 x 1 mm
FoV : 18°
Single zone

Highlights

- Full FoV ranging up to **130cm** (white target, no IR)
- **Very high-performance proximity** sensor
- Excellent **short distance linearity** (>0.1cm)
- **Low power autonomous** mode with interrupts thresholds for user / object detection
- **Fast ranging frequency** (up to 100Hz)
- Same pinout of VL53L0CX, VL53L1CX/CB, VL53L3CX and VL53L4CX

Short distance linearity

Low Power mode available

Distance measurement	Proximity up to 1.3 meters
Close distance linearity	+++++ >0.1cm
Performance under ambient light (5klux)	60cm
Multi-target detection (Histogram)	No
Crosstalk / Smudge immunity	Crosstalk compensation
Power Consumption	22mA (low power mode available)

Applications examples

Vacuum cleaners

Home Automation

Dispensers

White Goods

Faucets

Lighting

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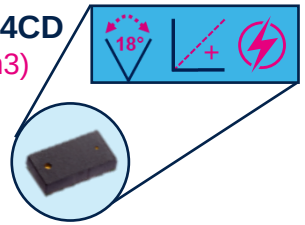
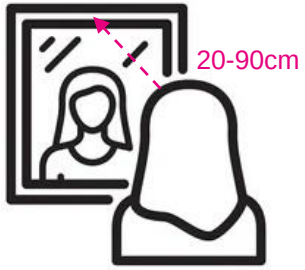
VL53L4CD
(Gen3)

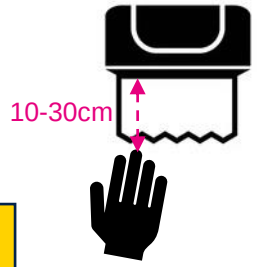


VL53L4CD markets and use-cases

Faucets



Mirrors

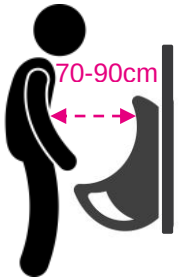


Dispensers

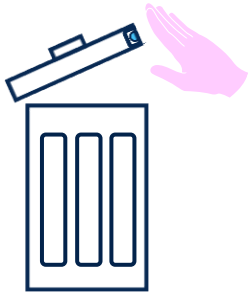
Sanitary

System activation
Triggers when users hand is detected

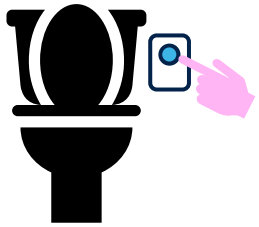
Presence detection
Wake the system upon user approach



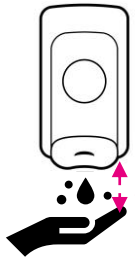
Urinals



Bins



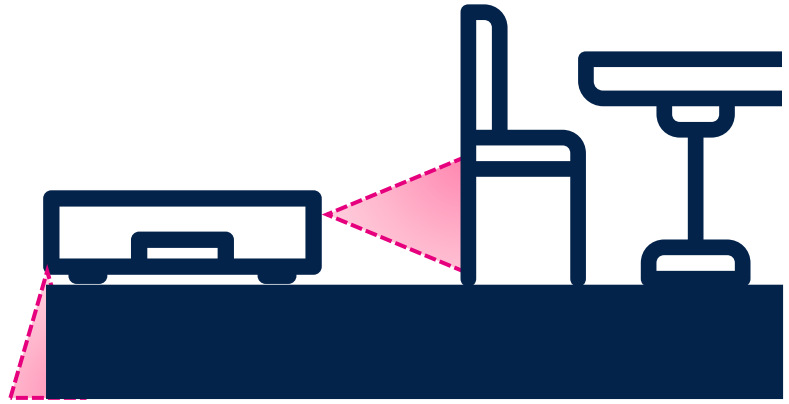
Toilet flush



Robotics

Wall tracking and obstacle avoidance
Anti-collision system

Cliff detection
Fast and accurate ranging at short distance



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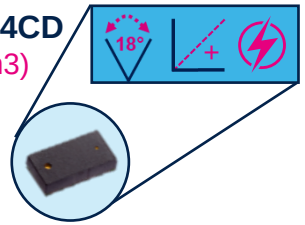
VL53L4CD markets and use-cases

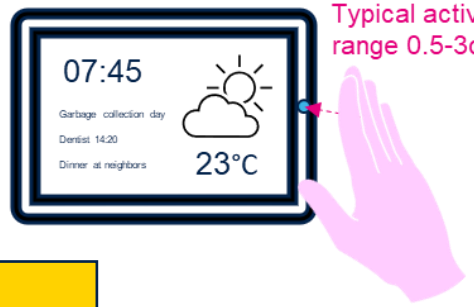
VL53L4CD
(Gen3)



Smart lighting

Washing machines

Thermostats



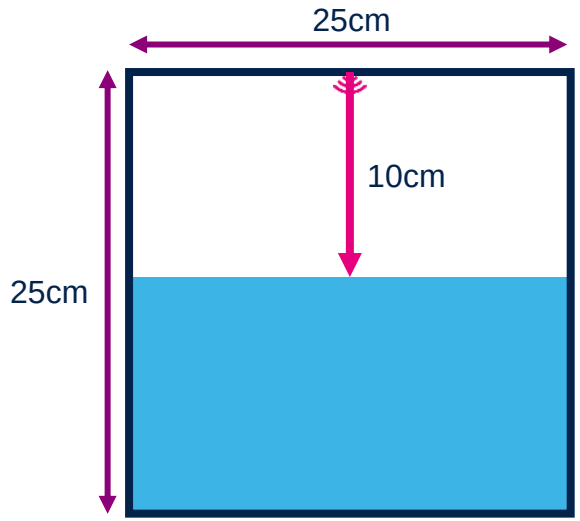
Home automation

System activation
Enable device display on approach

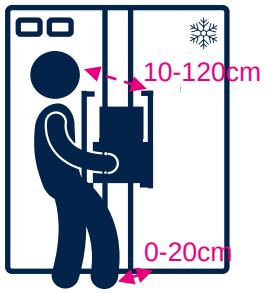
Touchless switch
Turn on/off the light without touching the button

Tanks

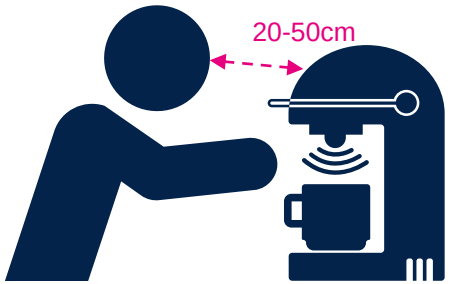
Liquid level control
Measure the volume, whatever the liquid and the tank shape/color



Fridges



Coffee machines



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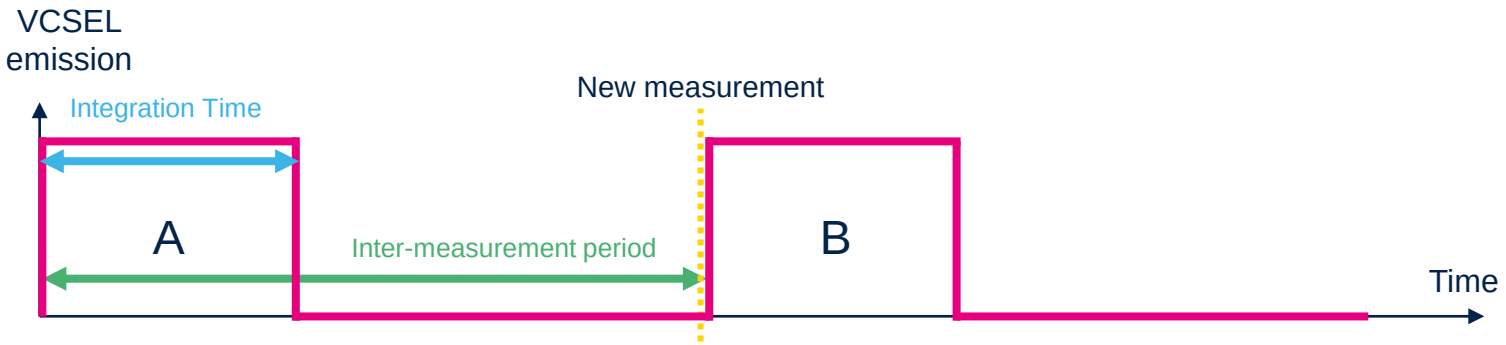
VL53L4CD
(Gen3)

Low power “autonomous ranging mode”

Low power consumption thanks to the autonomous mode

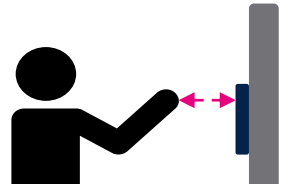


Benefits

- Low power consumption
- The system can sleep until an interrupt is sent by the sensor to the host
- Can be integrated to battery powered devices

- The sensor is active only during the Integration Time
- During the remaining time of the Inter-measurement period, the sensor is sleeping and consumes low power, the SW is in stand-by
- The user can define the Inter-measurement period and the Ranging period depending on his application
- Thresholds can be programmed, in order to send an interrupt to the host and wake-up the system only when a target is approaching the sensor

Market and use-cases



System Activation

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VL53L4CD
(Gen3)

Detection thresholds

Autonomous mode permits to wake up the host only when a threshold is reached

- Can be used to trigger an interrupt when conditions are met
- Smart reduction of I2C bandwidth: sensor wakes up the host only under predefined criteria

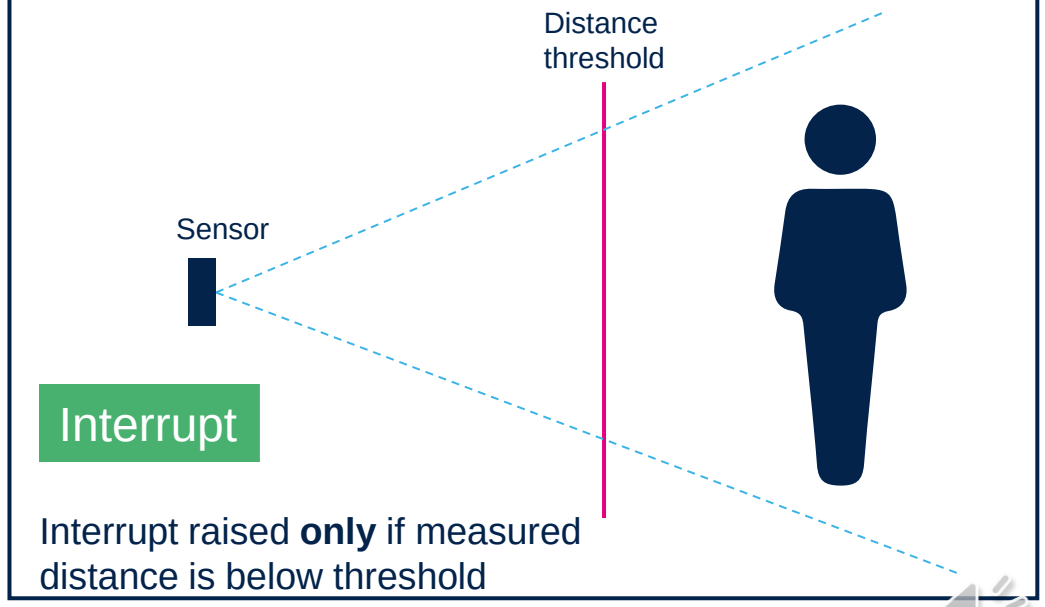
Threshold criteria

- Distance
- Signal rate
- Motion
- …

Configurable windows

- One or two thresholds per zone
- Multiple criteria available
  - Above threshold
  - In windows
  - Out windows
  - ...

Example with a distance threshold



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VL53L4CX - Extended range measurement sensor

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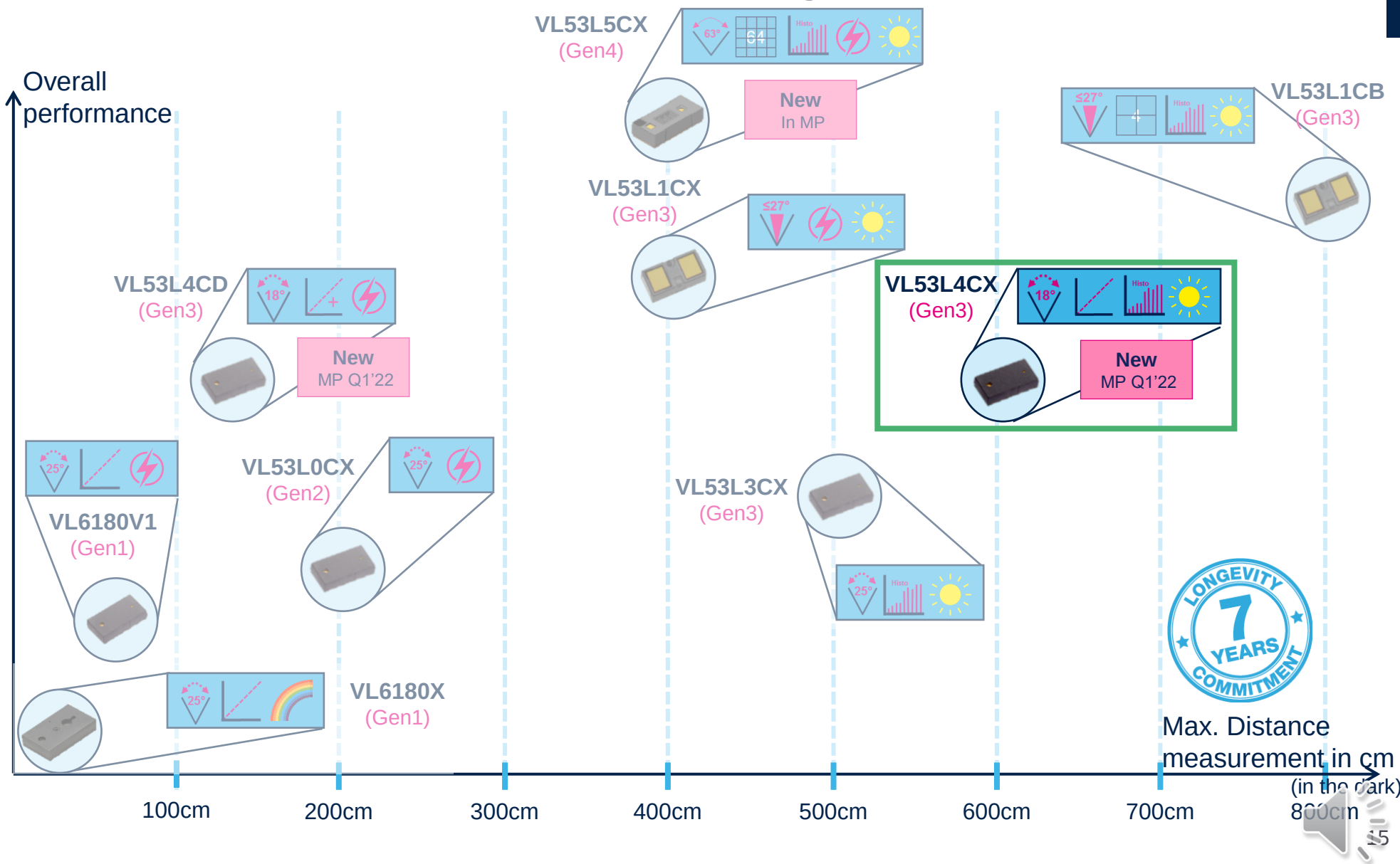
FlightSense Portfolio

- XX° FoV
- Programmable FoV XX° Max
- Sequential Multizone
- Up to 64 zones
- Histogram MultiObject detection
- Perf. Under Ambient (>100cm)
- Low Power Mode
- Ambient Light Sensing
- Close distance Linearity

+ : High Perf in short distance



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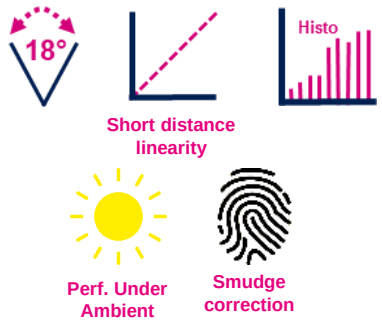
FlightSense™ VL53L4CX

Time-of-Flight sensor with extended range measurement

Package size : 4.4 x 2.4 x 1 mm
FoV : 18°
Single zone

Highlights

- Full FoV ranging - up to **600cm** (white target, no IR)
- Good performance for proximity sensing
- Good **short distance linearity** (>1cm)
- **Multi-target distance measurement** based on ST Histogram patented algorithms
- **Immunity to cover glass cross-talk** beyond 80cm
- Automatic **fingerprint smudge compensation**
- Same pinout of VL53L0CX, VL53L1CX/CB, VL53L3CX and VL53L4CD



Distance measurement	Short to long ranging, multi-target sensor up to 6 meters
Close distance linearity	+++ >1cm
Performance under ambient light (5klux)	180cm
Multi-target detection (Histogram)	Yes
Crosstalk / Smudge immunity	Immunity >80cm <80cm: Smudge compensation
Power Consumption	19mA

Applications examples

Vacuum cleaners | Home Automation | Smart storage | Logistics & Industrial | Drones | White Goods

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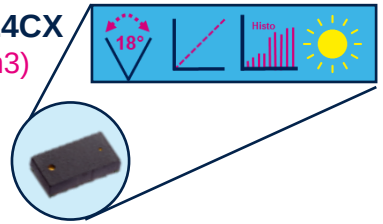
VL53L4CX
(Gen3)

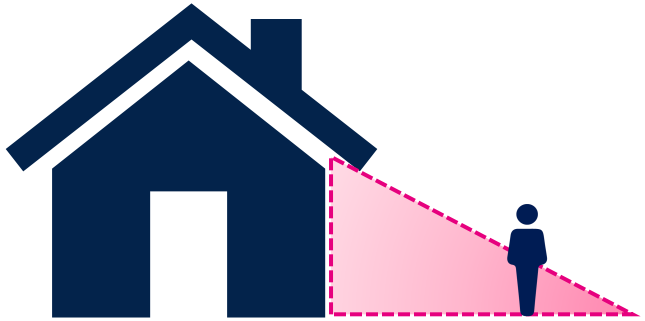


VL53L4CX markets and applications

ATM / Automatic access

System activation
Turn on/off device when approaching

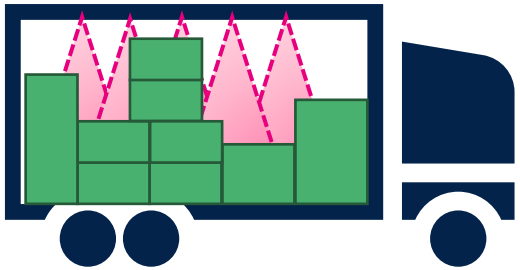
Presence detection
Wake the system upon user approach



Security control

People detection
Check if someone is approaching

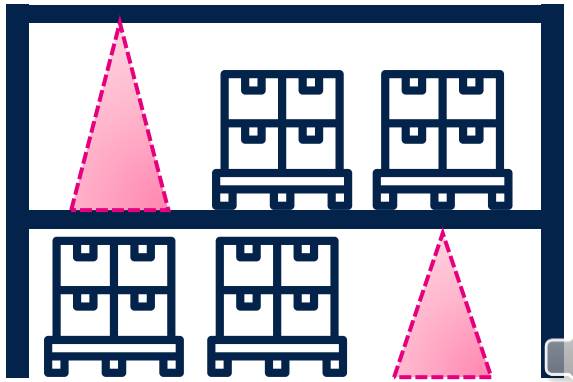
Access control
Wake-on-Approach



Logistics

Occupancy detection
Storage/Parking management

Entry/Exit counting
Statistics and flow management



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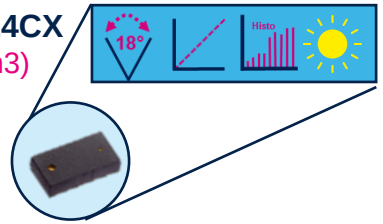
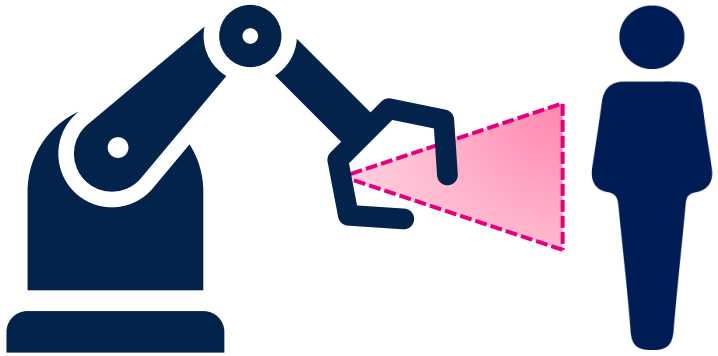
VL53L4CX
(Gen3)

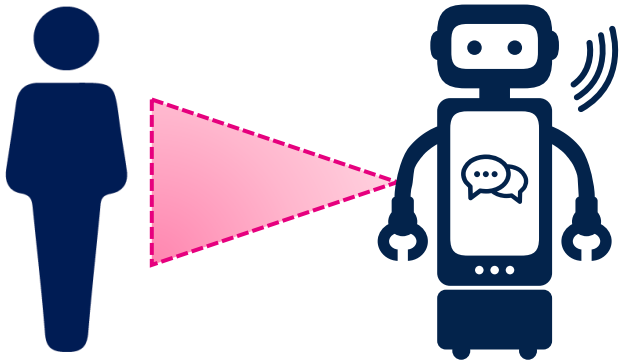


VL53L4CX markets and applications

Industrial

Safety
Keep safe the operators using the machines





Service robots

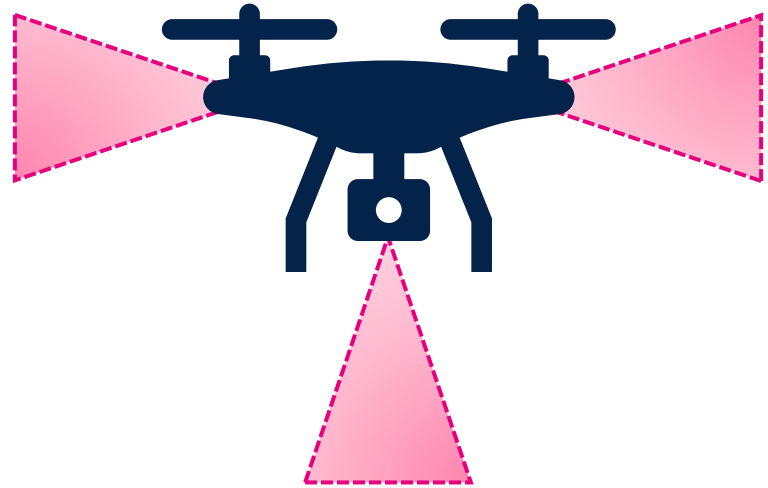
Wall tracking and obstacle avoidance
Anti-collision system

Cliff detection
Fast and accurate ranging at short distance

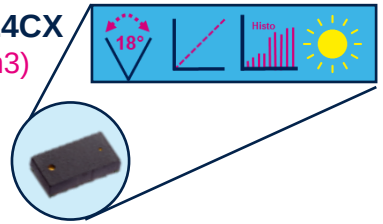
Indoor drones

Landing assist
Make sure that the drone will land slowly

Obstacle avoidance
Anti-collision system



VL53L4CX
(Gen3)



Histogram architecture

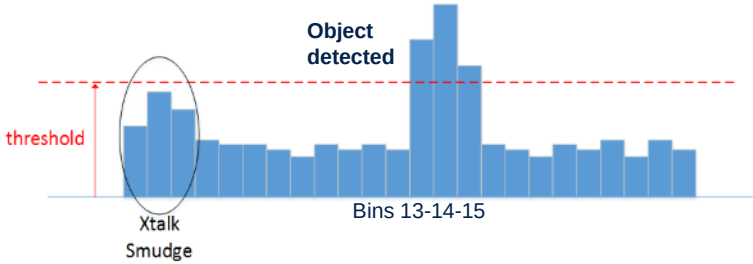
Multi-object detection is enabled due to histogram architecture

- XX° FoV
- Programmable FoV XX° Max
- Sequential Multizone
- Histogram MultiObject detection
- Perf. Under Ambient
- Smudge correction
- Close distance Linearity
- Ambient Light Sensing

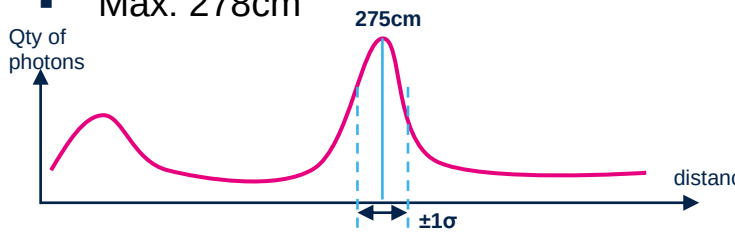
- **Histogram is based on 24 bins:**
  - A bin is a “time window”, representing the quantity of photons received by the sensing array during a specific period.
  - Each bin represents **approx. 20cm**
  - Two distinct objects can be detected if there is a minimum of 80cm between them
- **The exact distance of the target is calculated:**
  - Using a Normal distribution
  - The **average distance** is calculated
  - The **max** & **min** distances are calculated using standard deviation

Example

- **With raw data:**
  - If each bin represents 20cm
  - Object is detected in bins 13 - 15
  - Target is **between 260cm and 300cm**



- **Target distance calculation:**
  - Min: 273cm
  - **Avg: 275cm**
  - Max: 278cm



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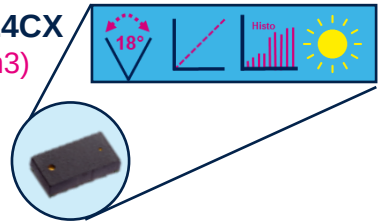
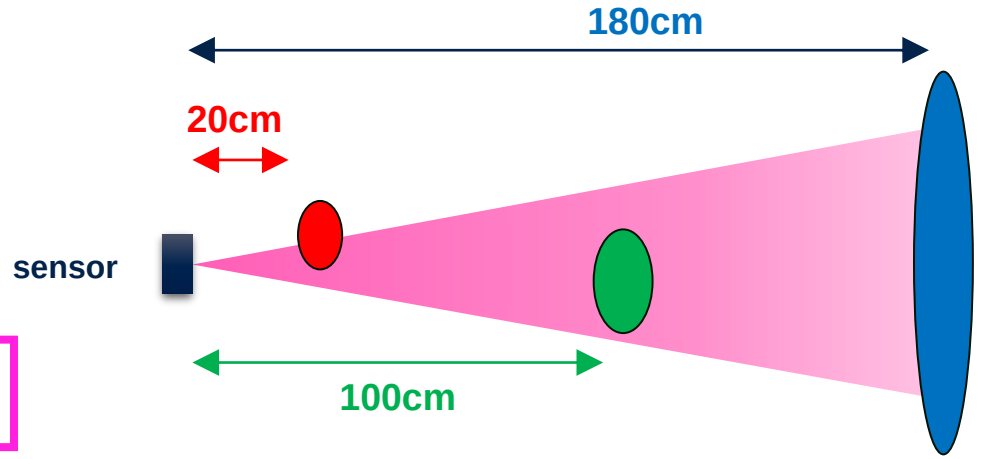
VL53L4CX
(Gen3)



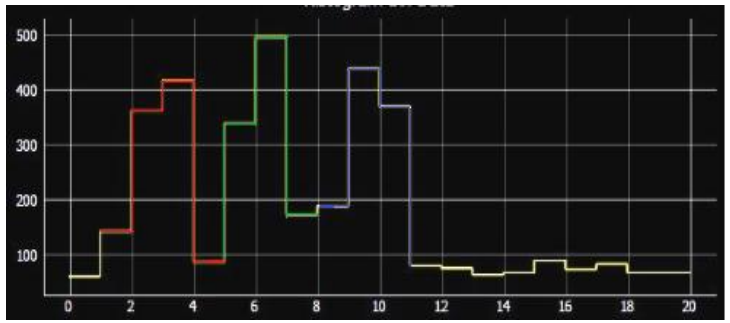
Multi-object detection

Histogram based multi-object detection enables new use-cases & flexible implementation

- XX° FoV
- Programmable FoV XX° Max
- Sequential Multizone
- **Histogram MultiObject detection**
- Perf. Under Ambient
- Smudge correction
- Close distance Linearity
- Ambient Light Sensing



Histogram based signal rate :



- Output ranging distance for each object (~80cm granularity)
- Unique to direct Time of Flight
  Indirect ToF cannot output multi-bins and extract distance with a correct resolution
- Allows first object detection
- Allows background removal

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Open Development Environment

Ecosystem and tools

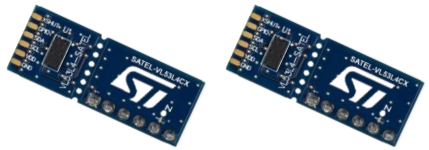
Imaging products supported by ST ecosystem

Complete package

- X-NUCLEO expansion board

- P-NUCLEO packs with STM32 NUCLEO

- Stand-alone Breakout boards



STM32 ODE

- F**light**Sense™ fully integrated in STM32 Ecosystem
- Compatible with all STM32 NUCLEO boards thanks to **CubeMX**
- Referenced on mbed, Arduino & Raspberry Pi platforms

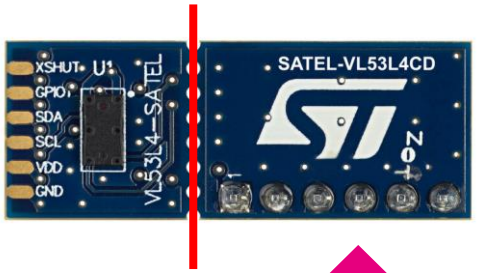
Cover glass

- Oval cover glass
- Square cover glass
- 3 spacers 0.25/0.5/1mm to create various air gaps
- Cover glass holder

Breakout boards

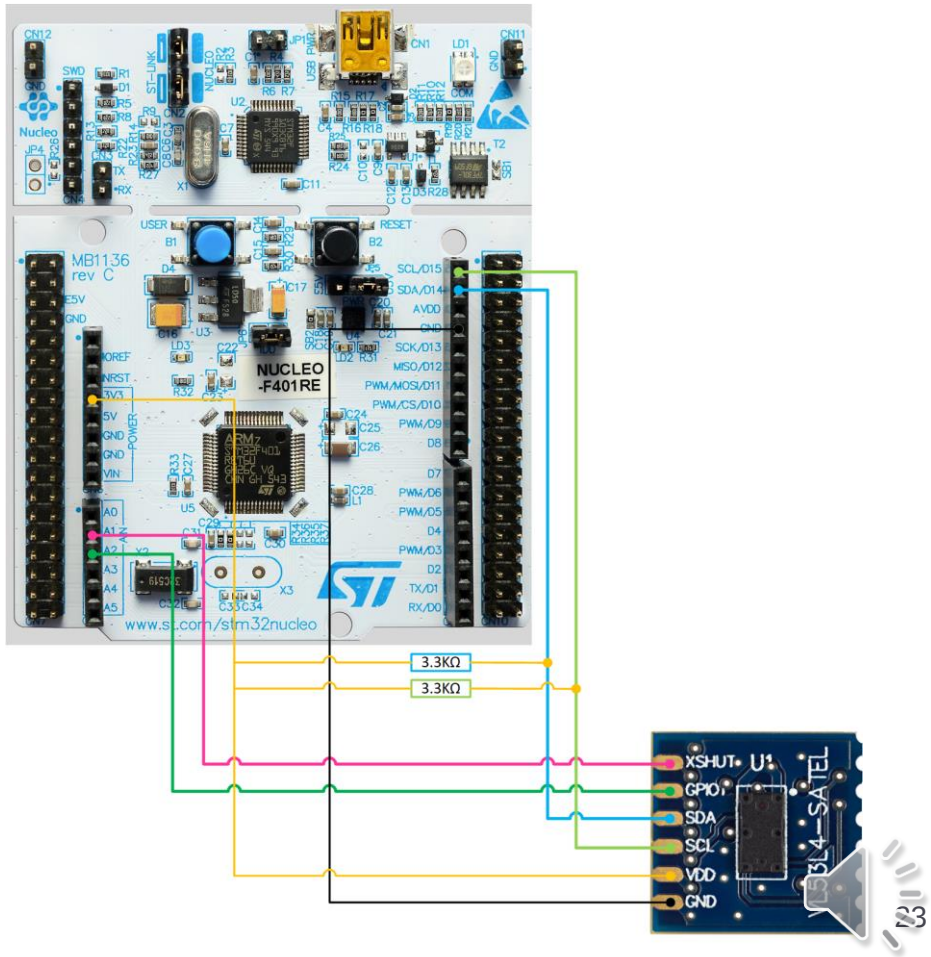
Breakout boards enable easy integration at customers

- The expansion boards can accept breakout boards via connectors or flying wires
- For 3.3V supply applications, the breakout board can be separated in order to use only the “mini-PCB”, easier to integrate into a customer device



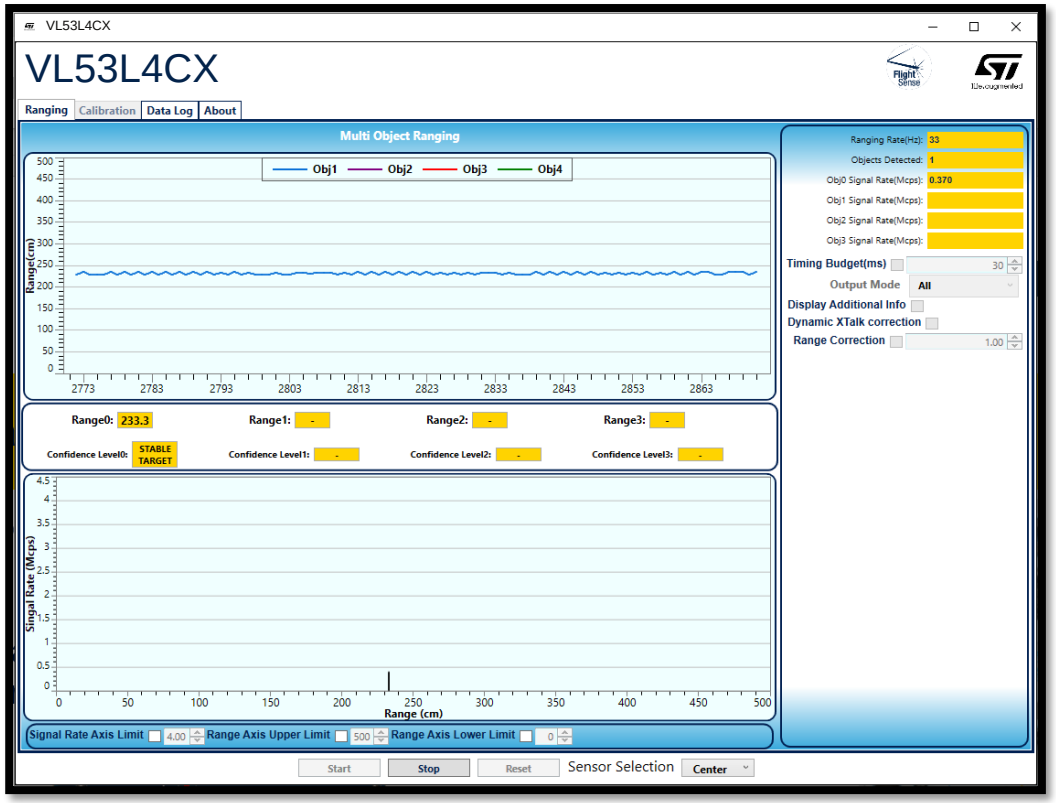
supply application

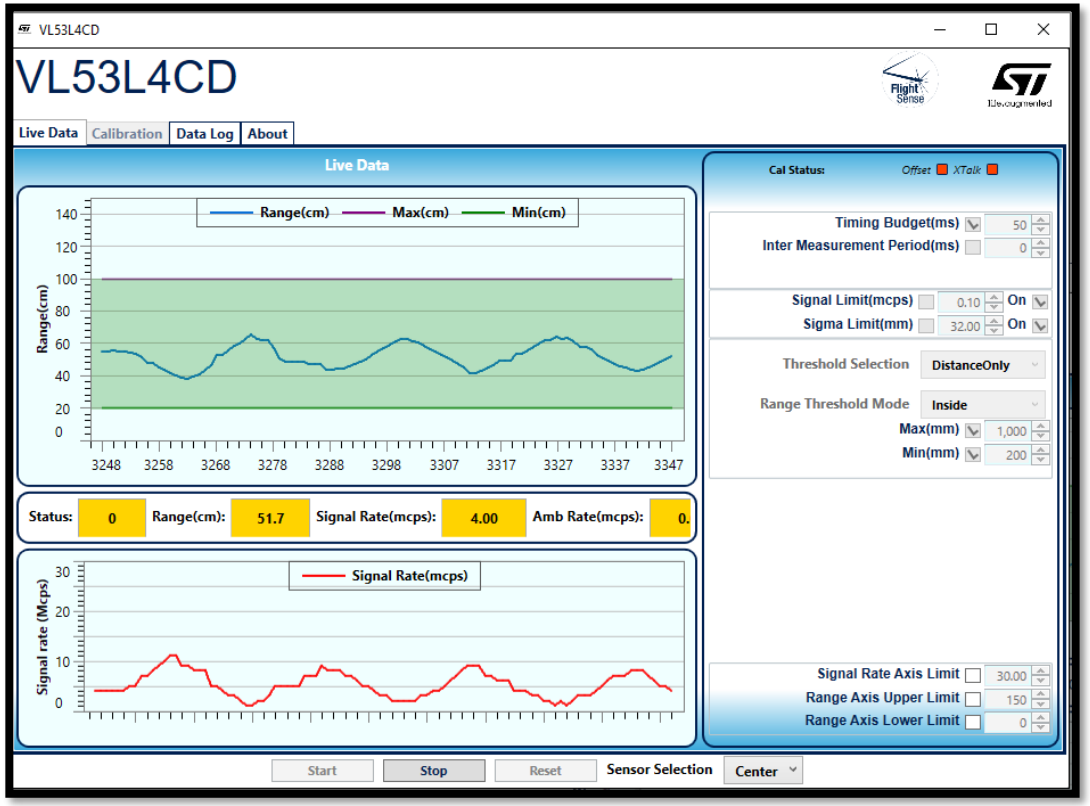
supply application



Graphical User Interface

For quick verification that your idea will really work.





VL53L4CD/CX support on st.com

www.st.com/FlightSense

Software VL53L4CD

- API (ULD “Ultra Light Driver”)
  - STSW-IMG026
- GUI for X-NUCLEO expansion board
  - STSW-IMG027
- Linux driver
  - STSW-IMG028
- X-CUBE example
  - X-CUBE-TOF1 compatible with Cube MX

User Manuals VL53L4CD

- ULD driver User Manual
  - UM2931
- X-NUCLEO Start Guide
  - Detailed Quick Start Guide for X-NUCLEO-53L4A1

Software VL53L4CX

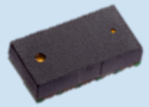
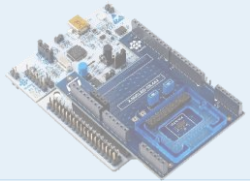
- API
  - STSW-IMG029
- GUI for X-NUCLEO expansion board
  - STSW-IMG030
- Linux driver
  - STSW-IMG031
- X-CUBE example
  - X-CUBE-TOF1 compatible with Cube MX

User Manuals VL53L4CX

- API driver User Manual
  - API 1.2.8.2578
- X-NUCLEO Start Guide
  - Detailed Quick Start Guide for X-NUCLEO-53L4A2

FlightSense™ VL53L4CD Ordering codes

Go to https://st.com/VL53L4CD or contact your usual distributor

Item	Picture	Commercial Product (= Order Code)	Comments
VL53L4CD sensor		**VL53L4CDV0DH/1**	Delivery in T&R MOQ: 4.5ku With protective liner LT = 16 weeks
VL53L4CD Nucleo™ Expansion board		**X-NUCLEO-53L4A1-**	To go along with STM32F401 Nucleo board. Comes with cover-glass holder, 2x cover-window samples
Pack: VL53L4CD Nucleo™ Expansion board + STM32F401 NUCLEO		**P-NUCLEO-53L4A1-**	X-NUCLEO-53L4A2 expansion board delivered together with STM32F401 NUCLEO board
VL53L4CD Breakout boards		**SATEL-VL53L4CD**	2x Breakout boards delivered

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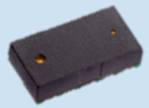
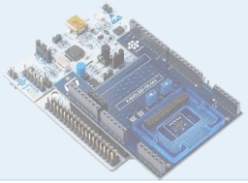
FlightSense™ VL53L4CX Ordering codes

Go to https://st.com/VL53L4CX or contact your usual distributor

Item	Picture	Commercial Product (= Order Code)	Comments
VL53L4CX sensor		**VL53L4CXV0DH/1**	Delivery in T&R MOQ: 4.5ku With protective liner LT = 16 weeks
VL53L4CX Nucleo™ Expansion board		**X-NUCLEO-53L4A2-**	To go along with STM32F401 Nucleo board. Comes with cover-glass holder, 2x cover-window samples
Pack: VL53L4CX Nucleo™ Expansion board + STM32F401 NUCLEO		**P-NUCLEO-53L4A2-**	X-NUCLEO-53L4A2 expansion board delivered together with STM32F401 NUCLEO board
VL53L4CX Breakout boards		**SATEL-VL53L4CX**	2x Breakout boards delivered

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FlightSense™ Summary

Leader on Direct ToF

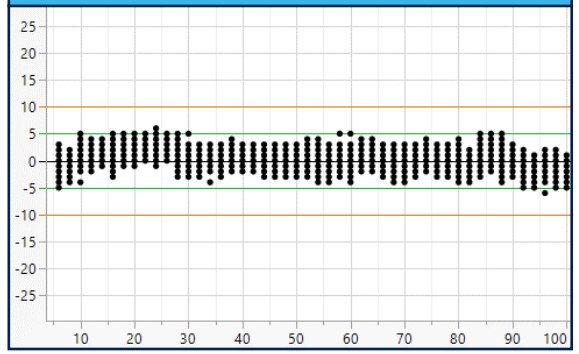
= 1st

Two products / Two usages

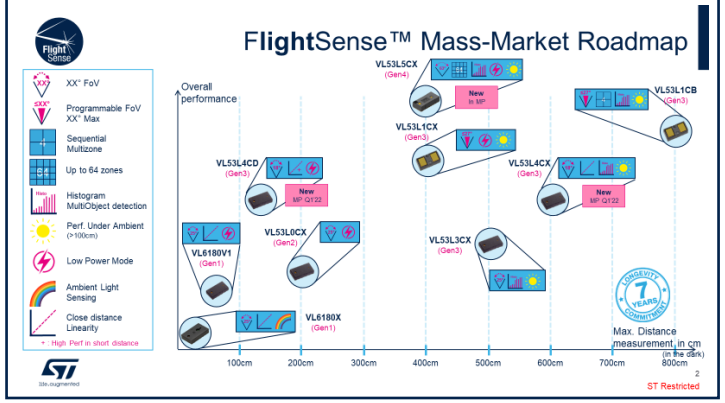
VL53L4CD → Proximity sensor

VL53L4CX → Long ranging sensor

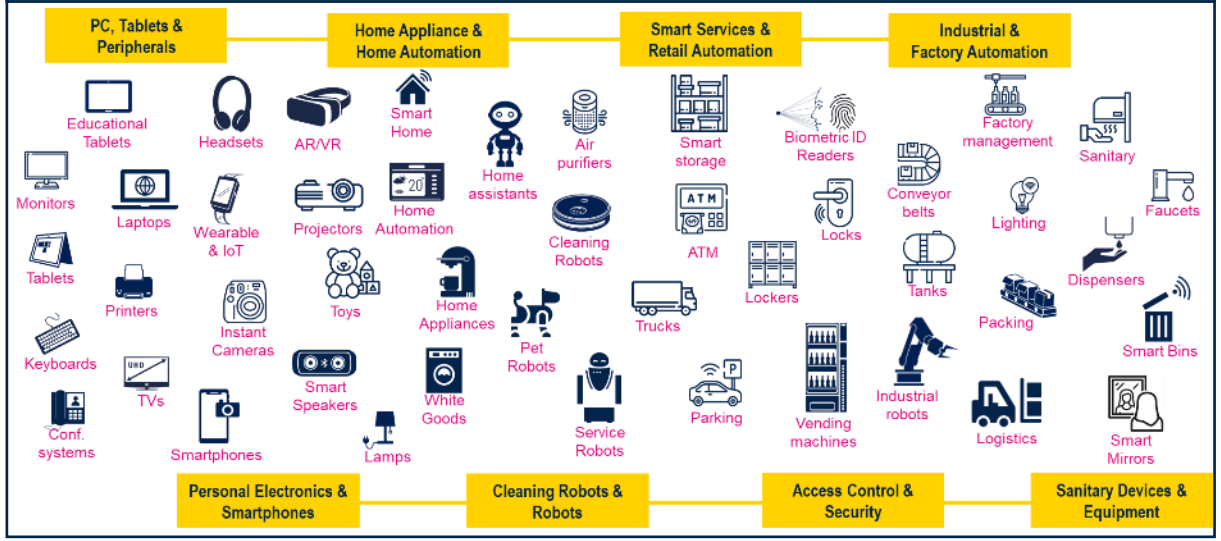
Short distance accuracy



Permanent evolution



Unlimited markets & applications



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Our technology starts with You

Find out more at www.st.com/FlightSense

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