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VL53L8CX Features introduction and how to use EVK

STMicroelectronics

신진욱 부장

FlightSense™ making light work

Time-of-Flight Principle

- ST proprietary FlightSense™ technology
- True distance measurement
- Fast and low power
- Truly invisible 940nm illumination

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ST pioneer and leader in Time-of-Flight (ToF)

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

4 Generations

of all-in-one ToF solution deployed since 2014

>500 devices

Over 200 phones with ST's Time of Flight technology
Several hundreds of non wireless end products on the market
Unlimited variety of use-cases beyond smartphones

>80,000

Evaluation kits deployed

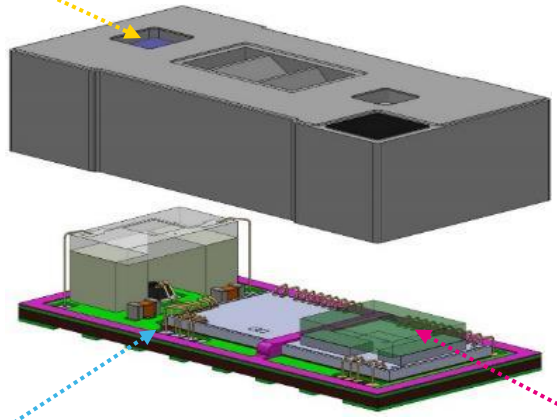
>2 Billions

ToF units shipped. Mastering end-to-end supply chain

All-in-One (illumination & sensor) Time-of-Flight system

Advanced optics with integrated IR filters

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



Monolithic ToF SoC, SPAD Array, high safety Class1 VCSEL driver

Full Class 1 safety high efficiency VCSEL

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FlightSense industrial & mass market portfolio

LONGEVITY 7 YEARS COMMITMENT

Multizone

- Up to 64 zones (8x8)
  Artificial intelligence enabler
  CNH data
- Up to 64 zones (8x8)
  Histogram mode
  Autonomous mode

Single zone

- Histogram mode
  Long distance up to 8 m
  High ambient immunity
- Ranging up to 4 m
  Autonomous mode
- Proximity up to 1.3 m
  Short distance linearity
  Low power consumption

VL53L7CH
90° FoV
64 zones (8x8)
350 cm dark

VL53L8CH
65° FoV
64 zones (8x8)
400 cm dark/285cm amb
Low power consumption

Compact normalized histogram

STGesture™ recognition

VL53L5CX
65° FoV
64 zones (8x8)
400 cm dark/170cm amb

VL53L7CX
90° FoV
64 zones (8x8)
350 cm dark

VL53L8CX
65° FoV
64 zones (8x8)
400 cm dark/285cm amb
Low power consumption

VL53L3CX
25° FoV
500 cm dark/140cm amb
ULP mode

VL53L4CX
18° FoV
600 cm dark/180cm amb
10 mm linearity

VL53L1CB
27° FoV configurable
800 cm dark/160cm amb
Sequential 2x2 zones

VL53L0CX
25° FoV
200 cm dark

VL53L1CX
27° FoV configurable
400 cm dark/130cm amb
ULP mode

VL53L4CD
18° FoV
130 cm dark
1 mm linearity
ULP mode

Ultralow power mode

Legend:
- Legacy product
- Recent product
- New product

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VL53L8CX product

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VL53L7CX and VL53L8CX

		 VL53L5CX	 VL53L7CX	 VL53L8CX
Field of view		45° x 45° (65° diag.)	**60° x 60° (90° diag.)**	45° x 45° (65° diag.)
Resolution		8x8 and 4x4		
Processing mode		Histogram		
Common features		Autonomous low power mode Motion indicator Crosstalk immunity >60 cm		
Additional features				**Auto-stop** **External synchronization pin**
Driver		100% compatible		
Module size		6.4 x 3.0 x 1.5 mm	6.4 x 3.0 x 1.6 mm	6.4 x 3.0 x 1.75 mm
Interface		I²C	I²C	I²C and **SPI**
Distance ranging	Dark condition*	400 cm	350 cm	400 cm
	Under ambient light*	170 cm	65 cm	**285 cm**
Power consumption**		4.5mW	8.3mW	**1.6mW**

* Best conditions using white target (88% reflectance)
** Power consumption measured at 1hz frequency and with 3.3 V analog and VCSEL supply

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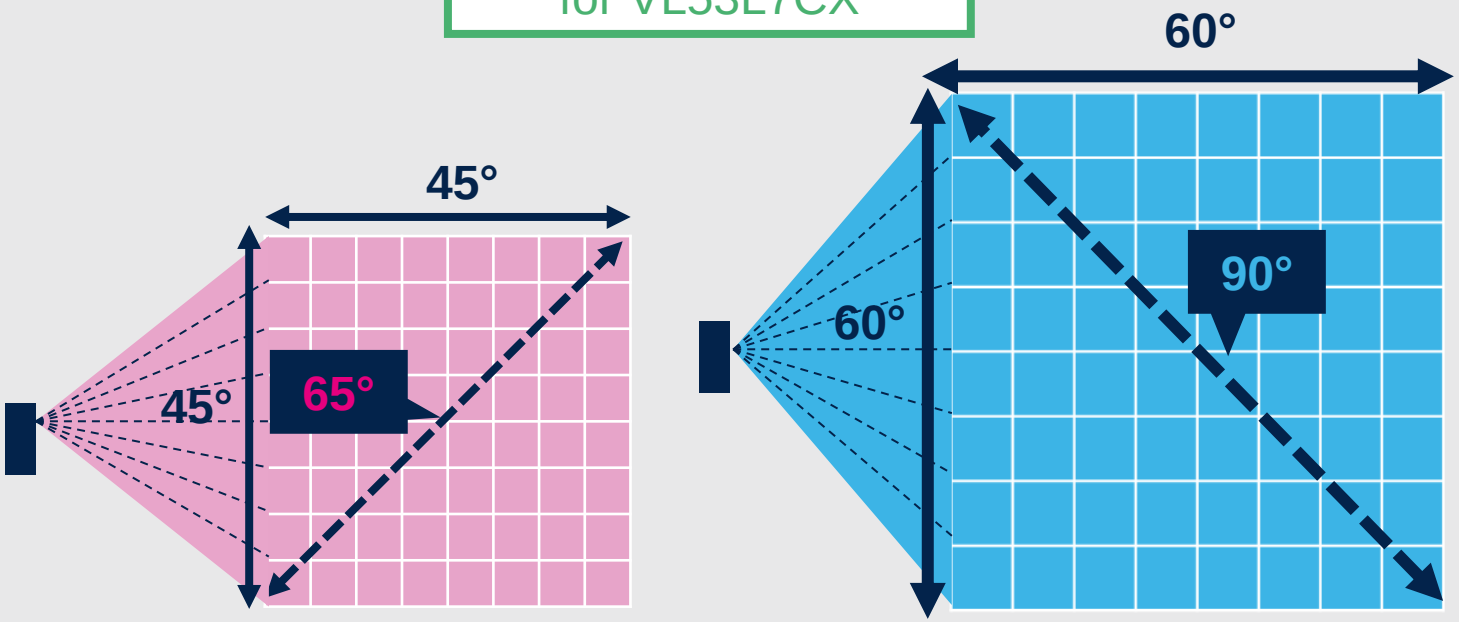
Field of View

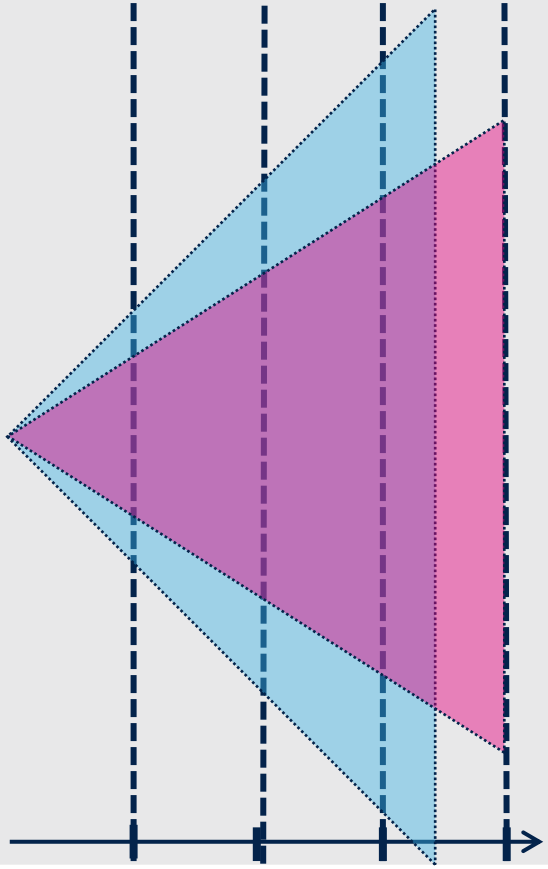
The VL53L7CX has a wider FoV, the VL53L8CX ranges further

Coverage zone

+ 33% of Field of View for VL53L7CX



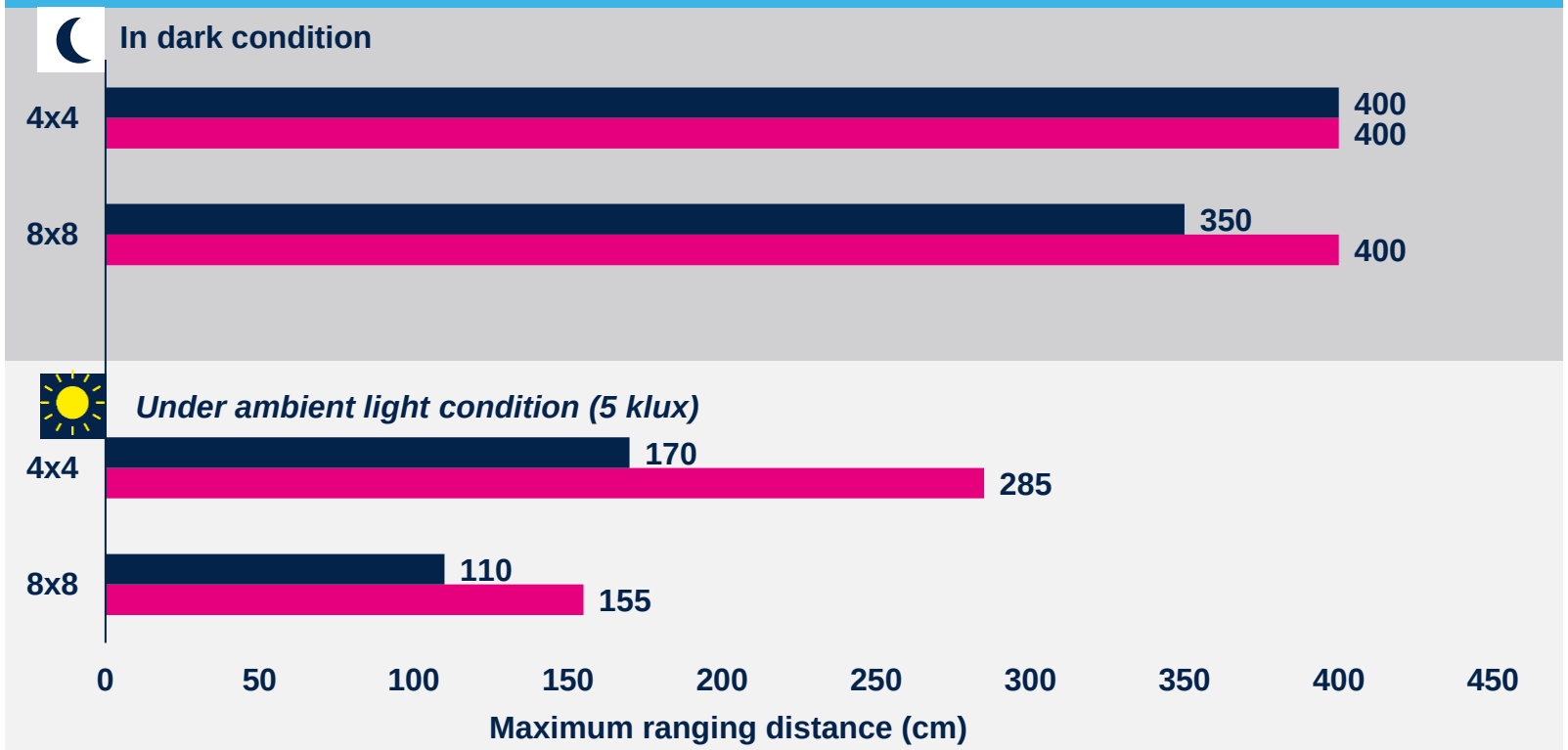
Maximum distance ranging
Drawing at scale



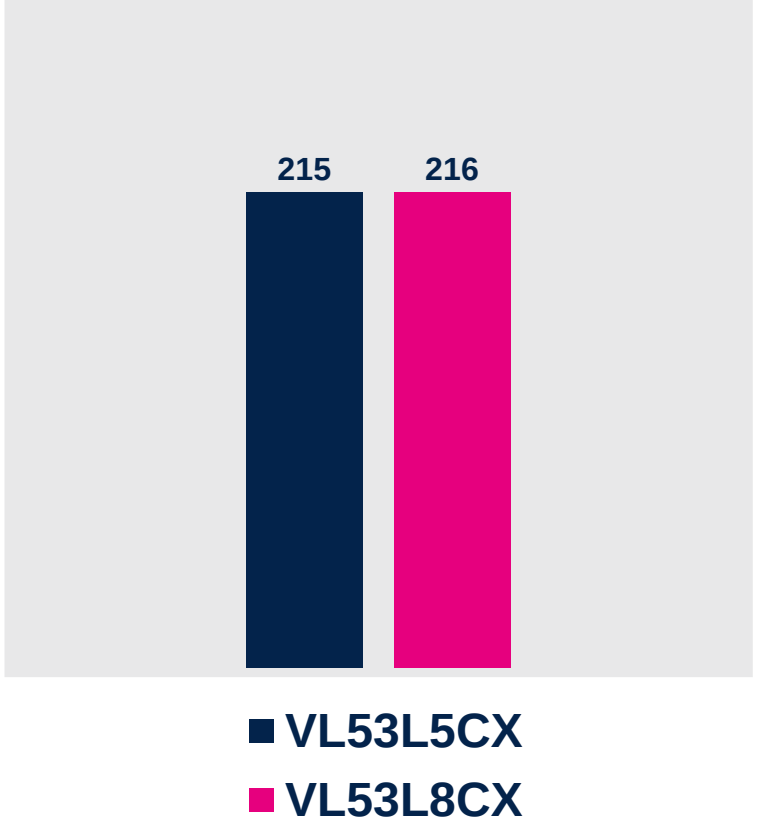
VL53L8CX - Continuous mode

Equal power consumption for increased maximum ranging distance with VL53L8CX

Maximum distance ranging



Typical power consumption in Continous mode (mW)

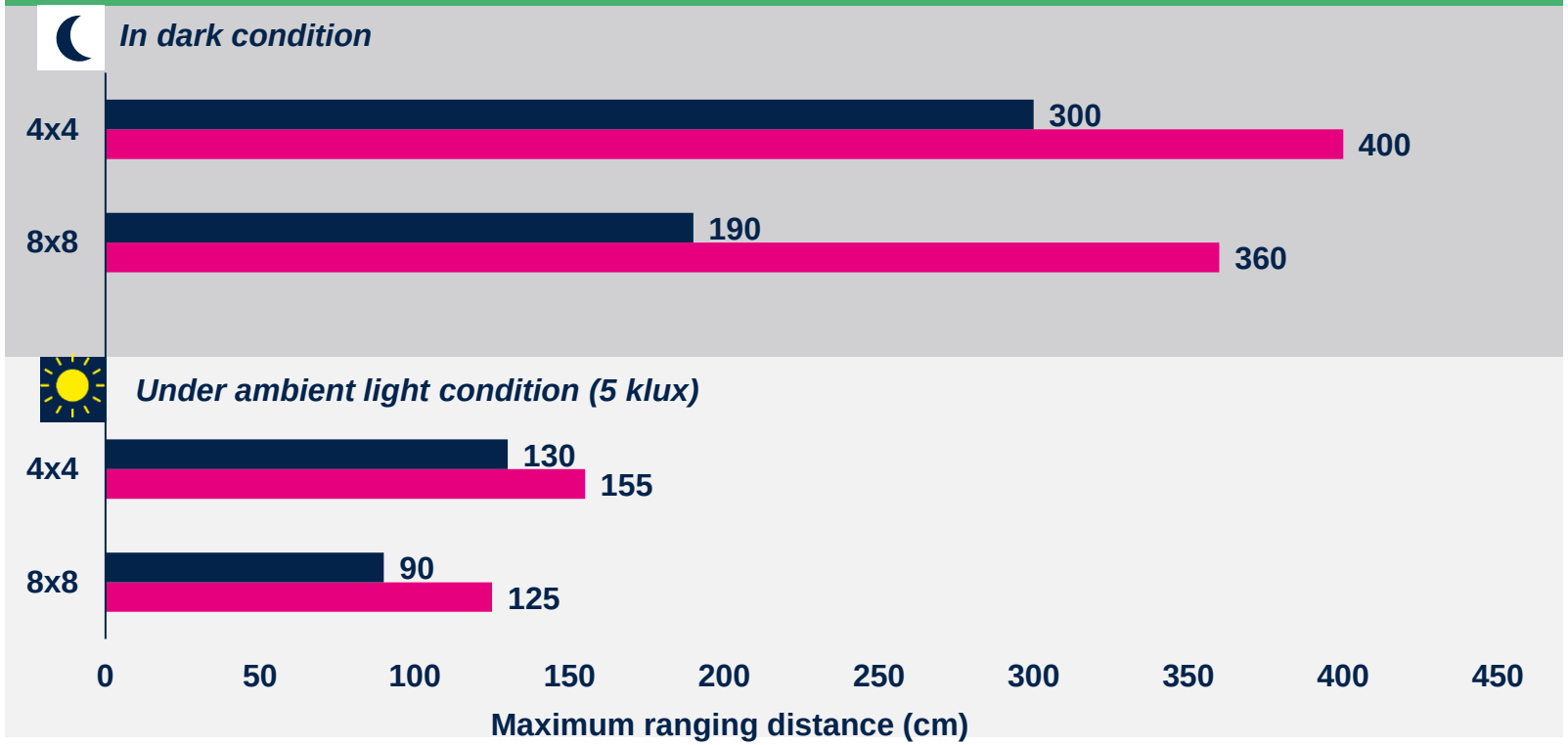


- Measurement conditions :
  - Power consumption measured with 3.3 V analog and VCSEL supply
  - Ranging continuously at 30Hz, with white target reflectance 88%

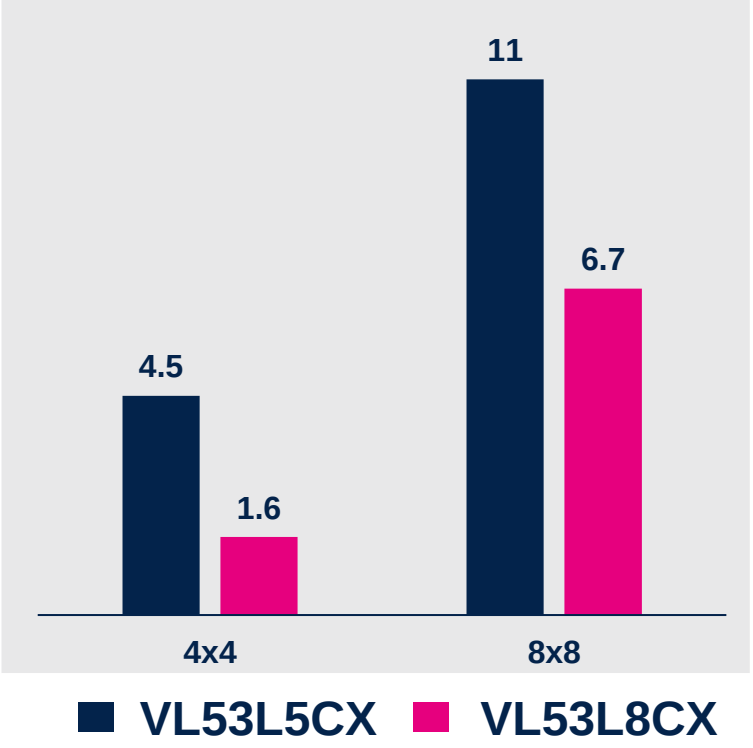
VL53L8CX - Autonomous mode

Reduced power consumption for increased maximum ranging distance with VL53L8CX

Maximum distance ranging



Typical power consumption in Autonomous mode (mW)



- Measurement conditions :
  - Power consumption measured with 3.3 V analog and VCSEL supply
  - Integration time 5 ms at 1Hz, with white target reflectance 88%

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Technical

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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

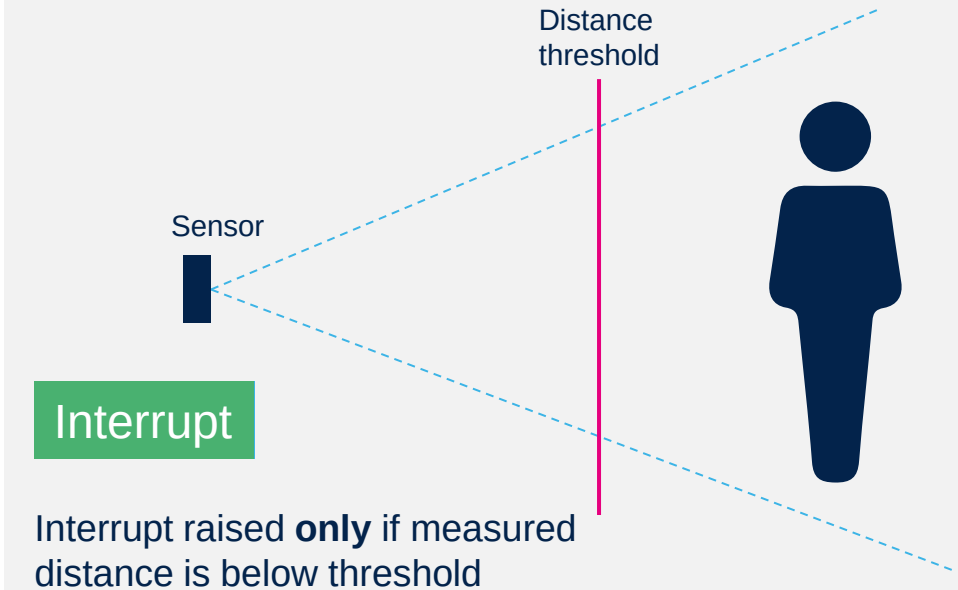
For more information

User Manuals
VL53L7CX → UM3038
VL53L8CX → UM3109

Threshold criteria
▪ Distance
▪ Signal rate
▪ Motion
▪ …

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

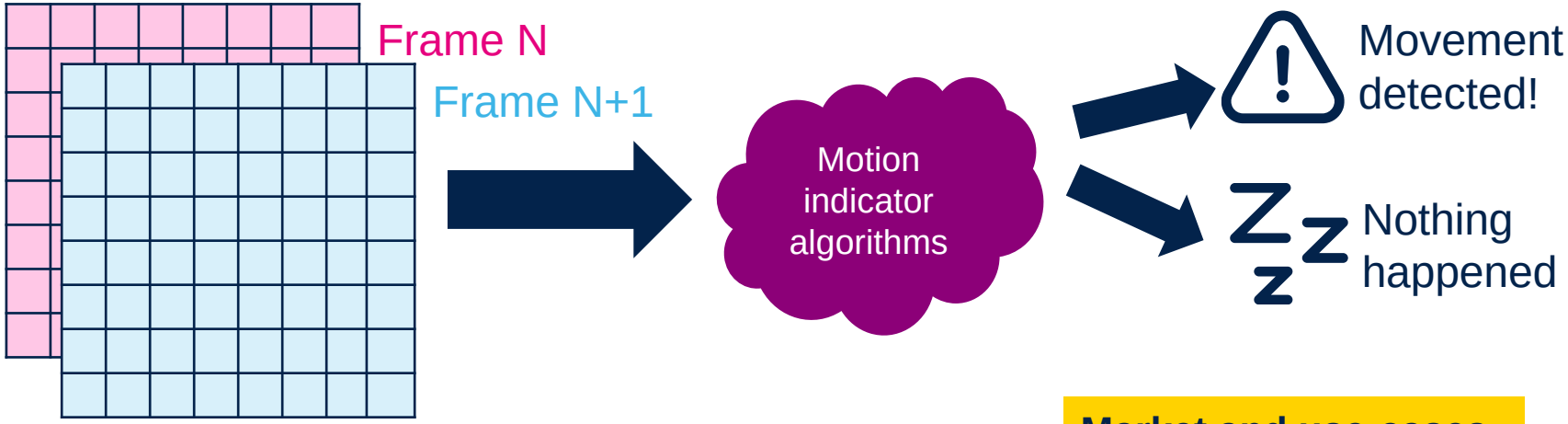
Example with a distance threshold



Interrupt raised **only** if measured distance is below threshold

Motion indicator

Sensor detects motion in each zone



Features

- Based on histogram algorithms
- Movement variation in each zone
- Motion intensity is the output data

Benefits

- Works in 4x4 or 8x8 zones
- Works with detection thresholds
- Runs in Autonomous mode

Market and use-cases

Home Appliance & Home Automation

White Goods

Smart Home

Laptops

Monitors

For more information

User Manuals
VL53L7CX → UM3038
VL53L8CX → UM3109

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NEW

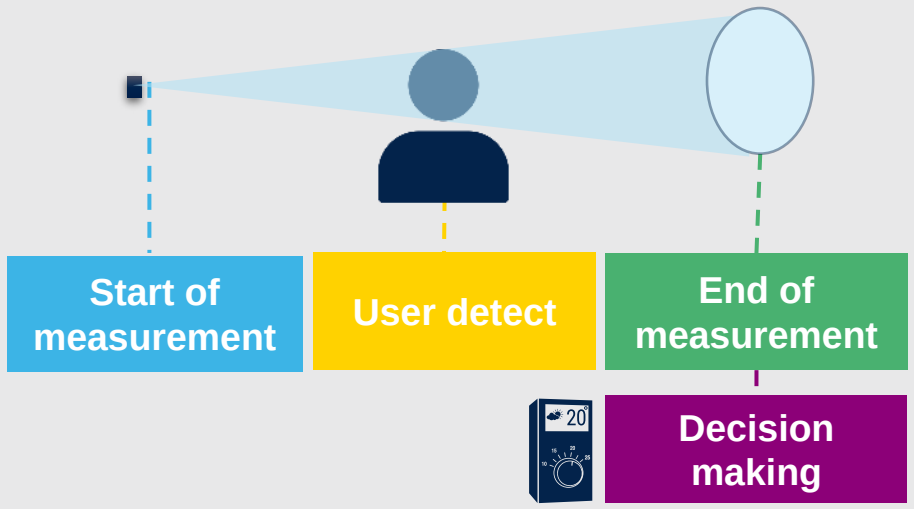
VL53L8CX, auto-stop feature

Example of faster decision making of the 8x8 multizone Time of-Flight sensor with user detection

Benefits

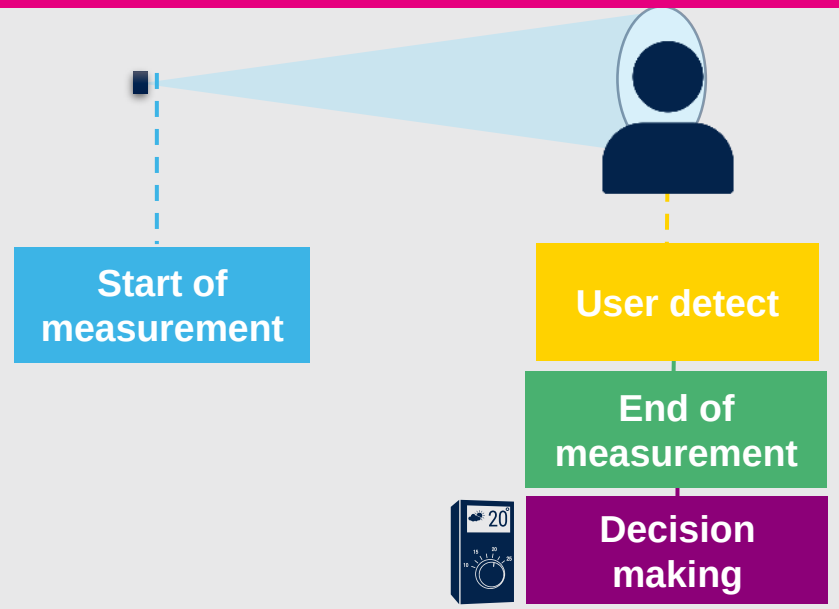
- Real-time action
- Measuring efficiency
- Power saving

Without auto-stop feature



The measurement continues during a determined timing budget, and stops at the end, even if a change has been detected

With auto-stop feature



An interrupt stops the measurement as soon as a change is detected, and the system can act directly

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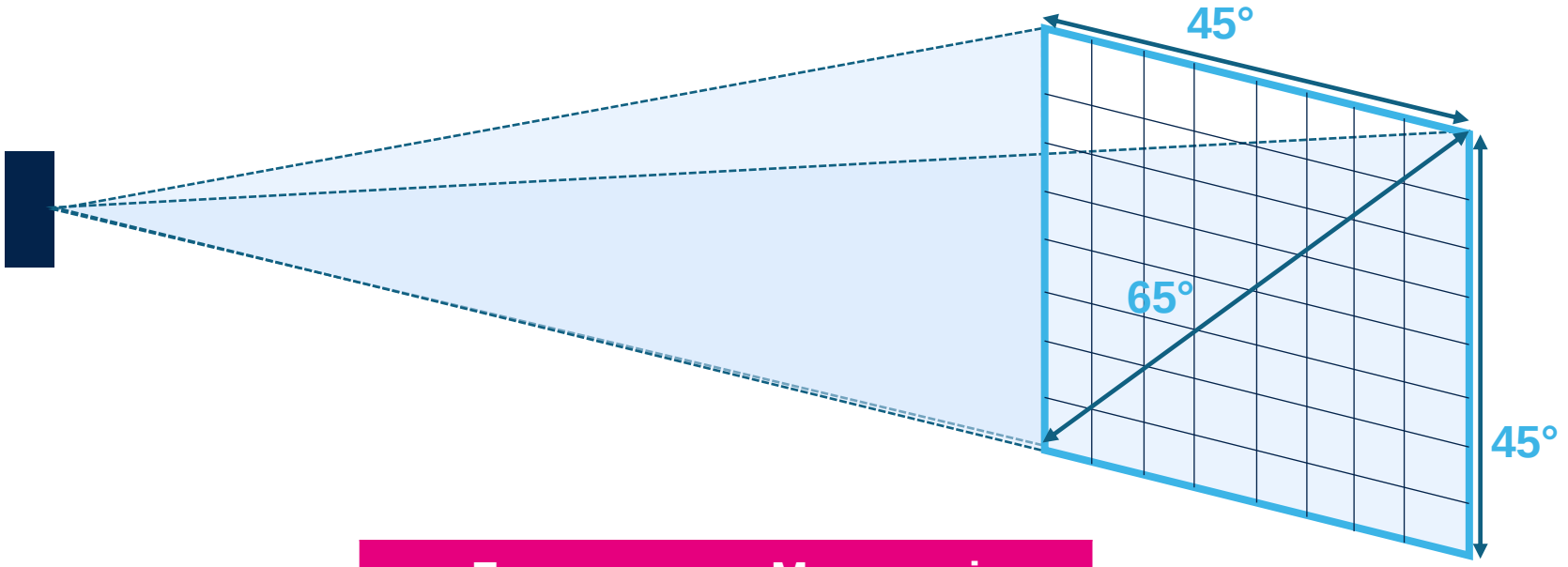
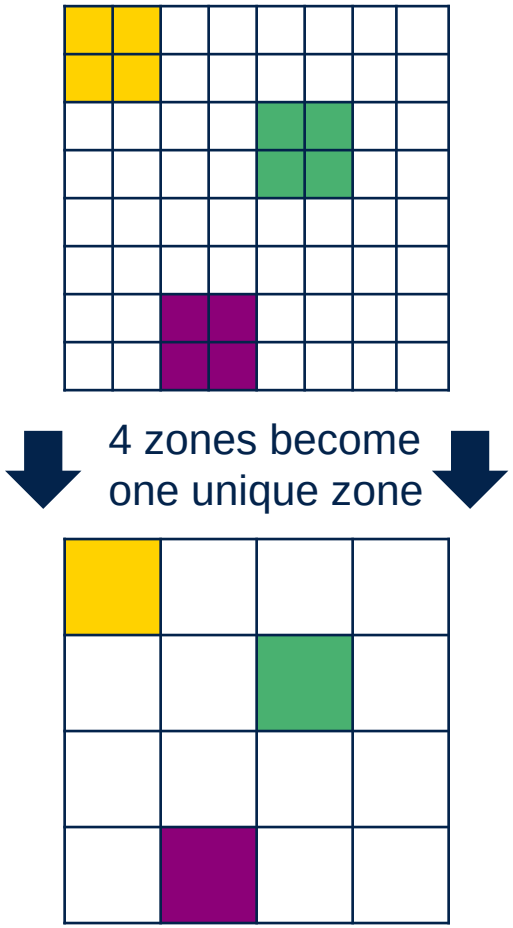
Multi-zones resolution & ranging frequency

Choose between high ranging frequency or high resolution



Zones	Max ranging frequency
4x4 = 16 zones	**60Hz**
8x8 = 64 zones	**15Hz**



VL53L8CX Demo

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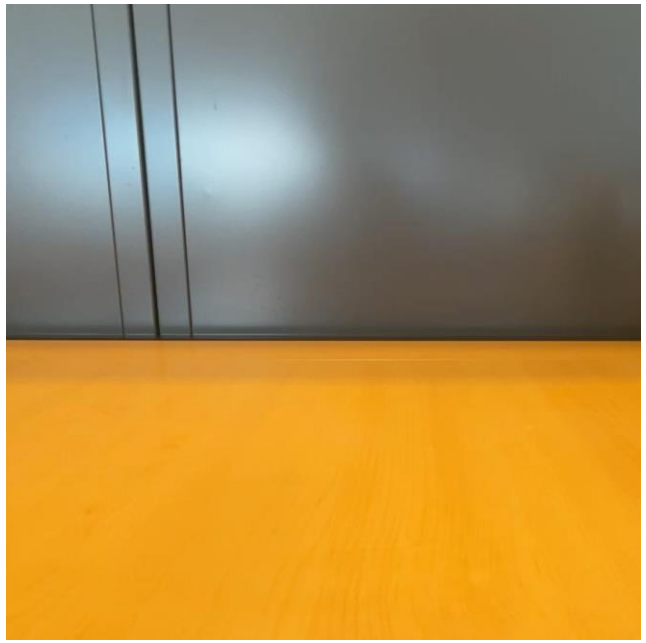
What does an 8x8 multizone ToF sensor see?

VL53L8CX live demo



FlightSense™
100% Privacy
(no image)

Visit landing pages

www.st.com/VL53L7CX

www.st.com/VL53L8CX

You will find:

- Technical resources
- Ordering codes
- On-demand webinar

On-demand webinar from March 2023 available for viewing on st.com

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Applications and solutions

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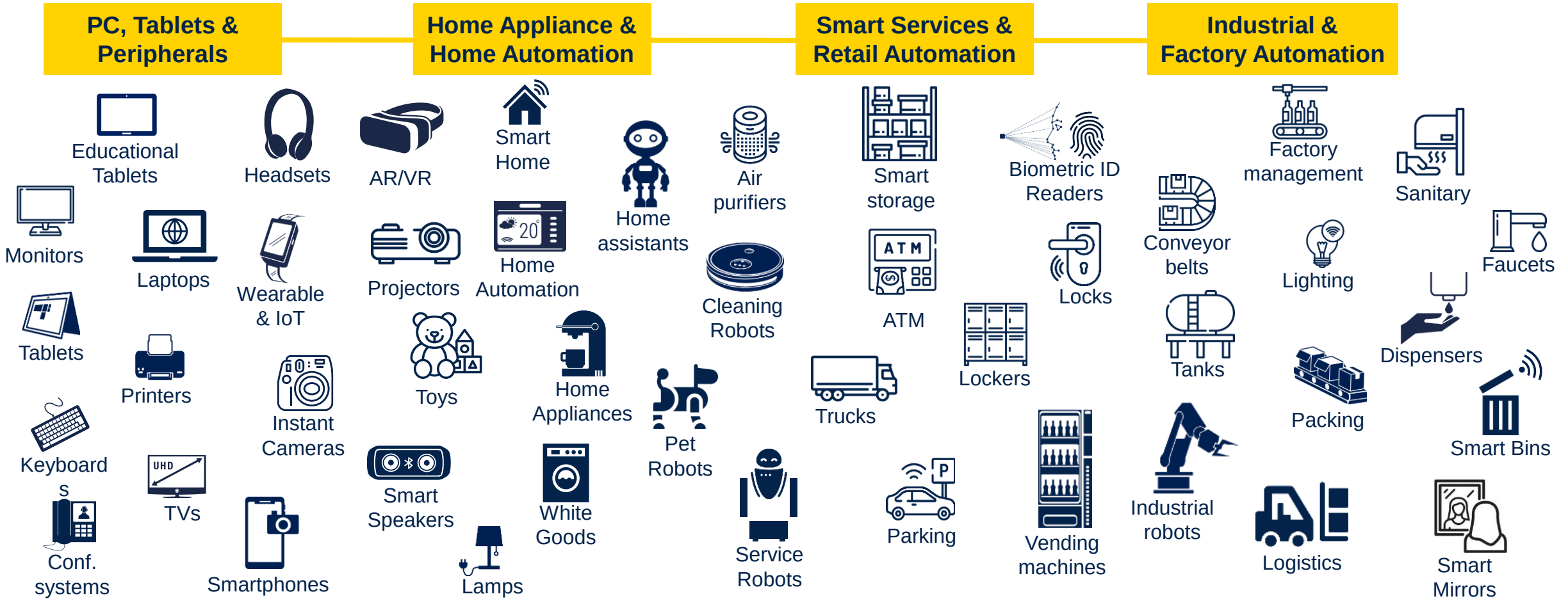
Applications everywhere



VL53L8CX for System Activation and Presence detection

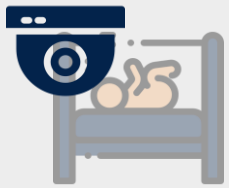
VL53L8CX 8x8 multizone Time of-Flight sensor to enhance system activation under ambient light

Presence detection

Power saving	Security	Accessibility
Thermostat • To adapt the temperature when a person is detected	**ATM** • To wake up when someone approaches • To alert that someone is behind the user	**Car park** • To notify availability in the car park

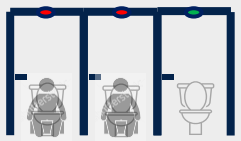
Other applications

everyday need



Baby movement detection

Scorekeeper Sports/Arcade games



Occupancy detection (No camera)

Two-in-one application

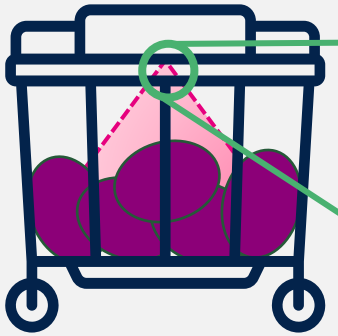
Enhance your devices with ST Gesture recognition

Quickly interact with the thermostat interface

VL53L8CX for Content management and Liquid level monitoring

Content management and liquid level monitoring eased with the VL53L8CX

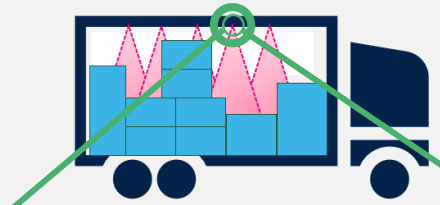
Trash bins



Content level monitoring
Level management

Monitoring in real time
Track full and empty bins

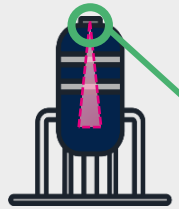
Trucks & Container



Content level Management
Remaining space measurement

Package falling detection
Detect if something is moving in the truck/container

Storage tank



Water tower

Monitoring in real time
Avoiding empty tank

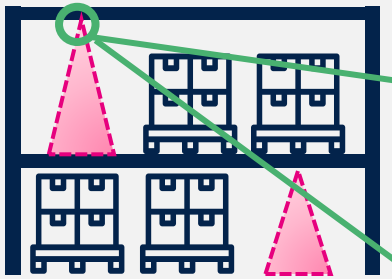
Other applications


Tanks


Logistics


Warehouse

Storage racks



Occupancy detection
Storage management

Entry/Exit counting
Statistics and flow management

Coffee cup

Coffee cup detection
Avoiding to dispense coffee if there is no coffee cup

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VL53L8CX dedicated to Robotics

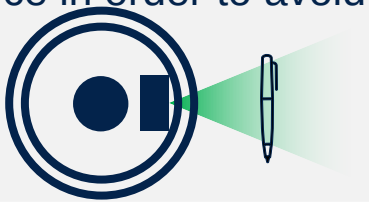
Cleaning robots' performance enhanced by VL53L8CX 8x8 multizone Time of-Flight sensor

Floor Sensing

- Surface recognition (soft or hard) to support mopping or vacuum mode

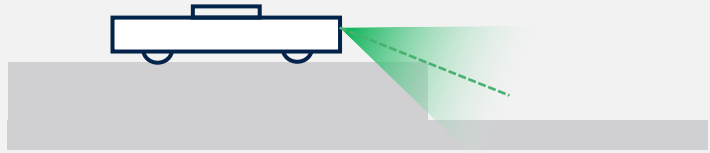
Small Object Detection

- Estimate object size (inc flat object & cables) and precise distance in order to avoid them



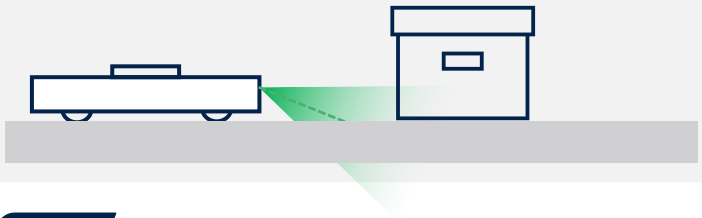
Cliff/Edge/Slope Prediction

- Signature change on lower rows can detect approach to stairs/slope as far as 50cm



Collision Avoidance

- Robot can avoid furniture and other large objects

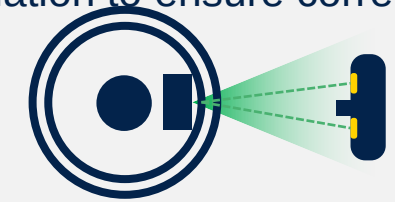


Ceiling/Gap Detection

- Signature ranging change on upper rows to detect low furniture ledge and measure height

Safe Docking Assist

- Specular target detection for location of docking station location
- Angle calculation to ensure correct approach



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Laser auto-focus using the VL53L8CX

Get optimal focus with speed and accuracy

Features

- External Synchronization Pin
- Motion Indicator feature
- Linux driver available

Benefits

Real-time distance measurement for accurate autofocus

Distance ranging allows for smooth and continuous focusing

Other markets

Mode	Max frequency	Target reflectance	Max distance in dark	Max distance under 5Klux
4 x 4	30Hz	White 88%	400cm	285cm
		Grey 17%	400cm	165cm
8 x 8	15Hz*	White 88%	400cm	155cm
		Grey 17%	245cm	115cm

* Possibility to increase the max frequency up to 30Hz in 8x8 mode

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Technical resources

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FlightSense ecosystem and tools

Imaging products supported by ST ecosystem & and expanding optical partnership network

Complete package

- X-NUCLEO expansion board

- P-NUCLEO packs with STM32 NUCLEO

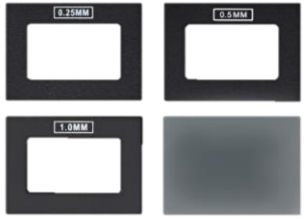
- Stand-alone Breakout boards

Expansion boards

- Fully integrated in STM32 Ecosystem
- Compatible with all STM32 Nucleo boards

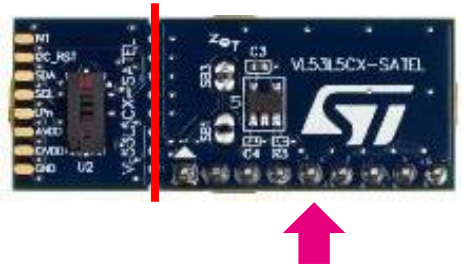
- Cover Glasses:
  - Referenced cover glass proposed in NUCLEO development boards

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



Breakout boards

- Enabling easy & swift integration at customers
- The expansion boards can accept breakout boards via connectors or fly wires



5V to 3.3V supply application

3.3V supply application

X-CUBE-TOF1

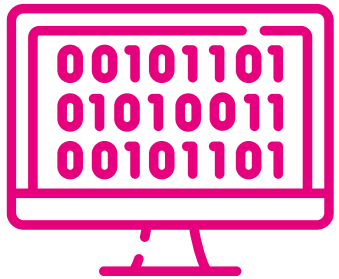
Discover our STM32Cube expansion software for Time-of-Flight sensors

Sample applications
Simple ranging
Multi-sensor ranging

ToF products supported
VL53L1CB | VL53L3CX | VL53L4CD VL53L4CX | VL53L5CX | VL53L7CX VL53L8CX (X-NUCLEO & SATEL)

X-CUBE-TOF1

STM32 CubeMX



Code ready to use

STM32 MCUs supported
Any STM32 MCU (any boards)

Keys benefits
• Compatible with **all STM32** • Compatible with X-NUCLEO & **SATEL** (directly plugged on NUCLEO board) • Many code examples • Only one tool

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FlightSense™ Summary

Leader on Direct ToF

= 1st

6 single-zone ToF sensors

- Wide product portfolio
  - Ranging up to 800cm
  - Histogram mode
  - Very short distance linearity
  - Ultra low power mode

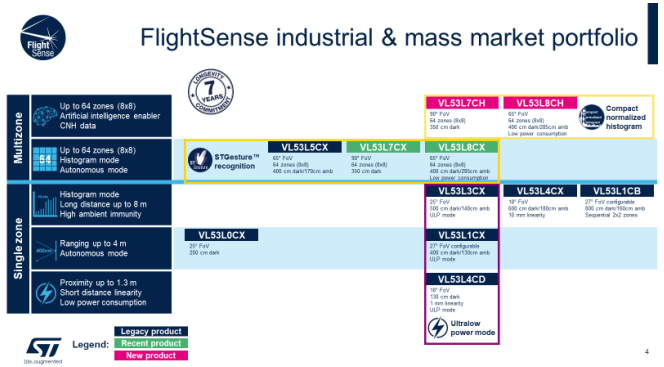
5 multizone ToF sensors

- Up to 8x8 zones
- Wide FoV from 65° to 90°
- Ranging up to 400cm
- Strong ambient light immunity
- 2 new sensors for AI applications

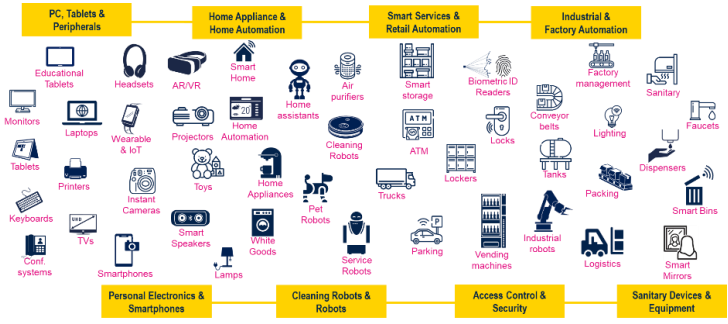
Turnkey solutions

- Gesture recognition
- Presence detection
- Liquid level monitoring
- Content management
- Floor sensing prediction
- …

Continuous improvement

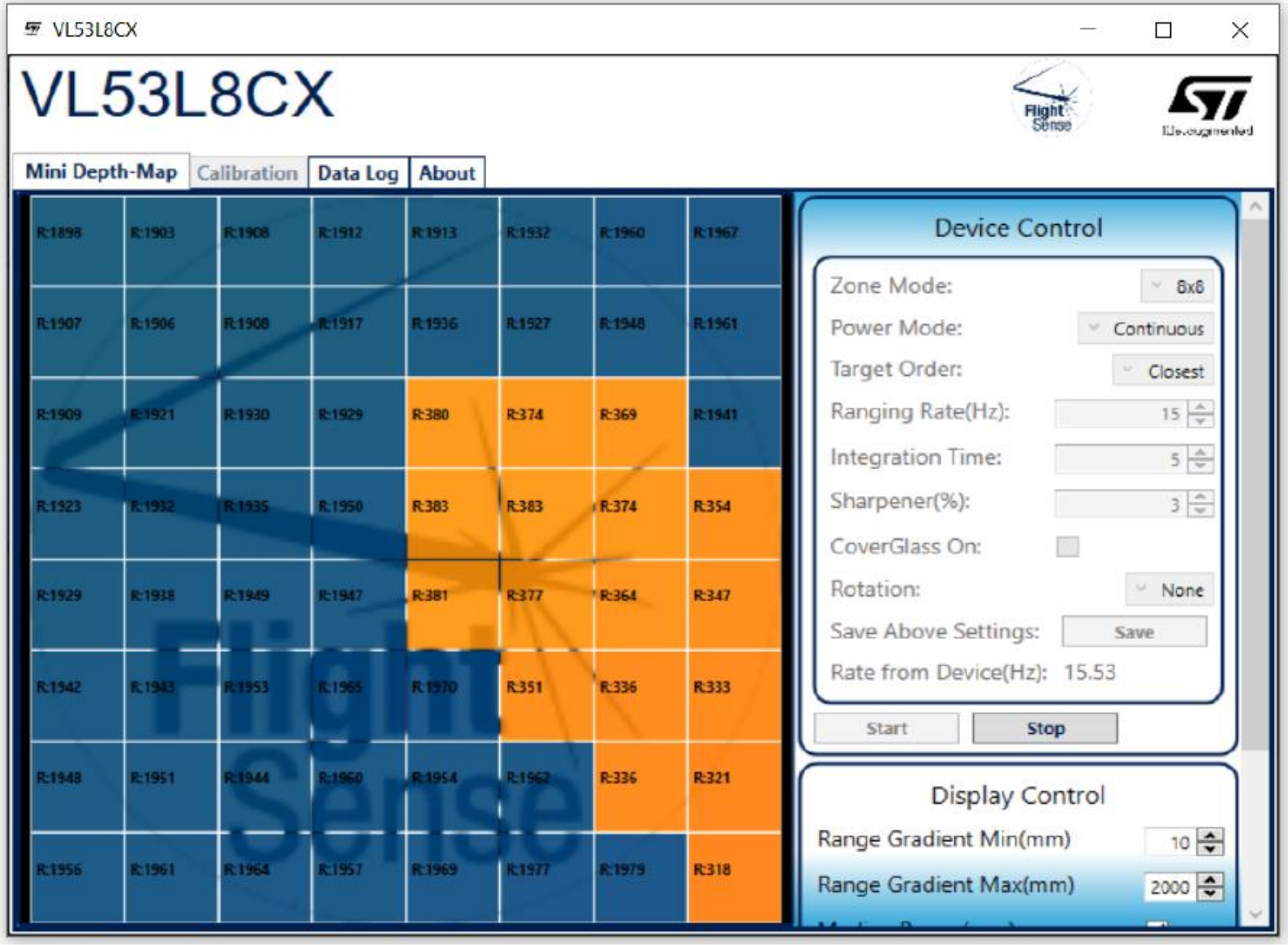


Unlimited markets & applications



EVK GUI demonstration

VL53L8CX – GUI Demo



VL53L8CX – GUI Demo

Figure 2. Expansion board with VL53L8CX

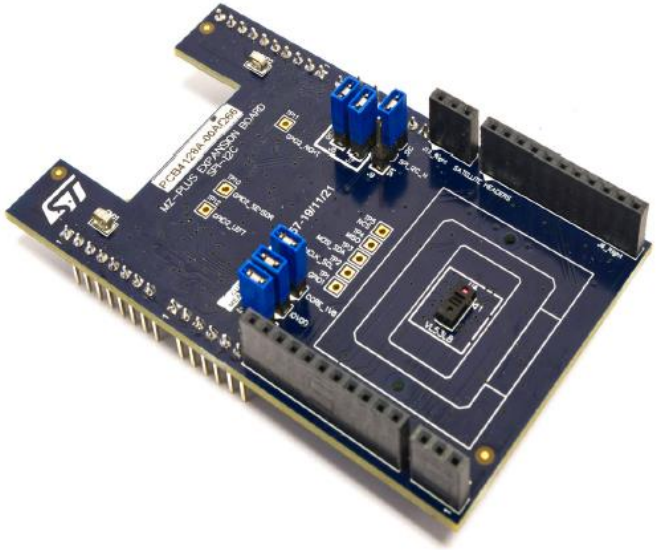
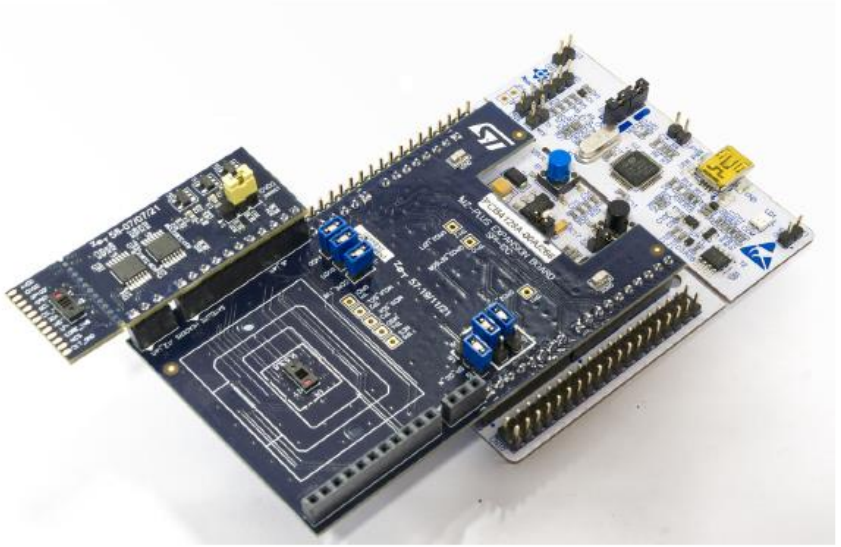


Figure 3. (Optional) VL53L8CX satellite board

Figure 4. Evaluation kit board installed on Nucleo STM32-F401RE, with one optional satellite



VL53L8CX – GUI Demo

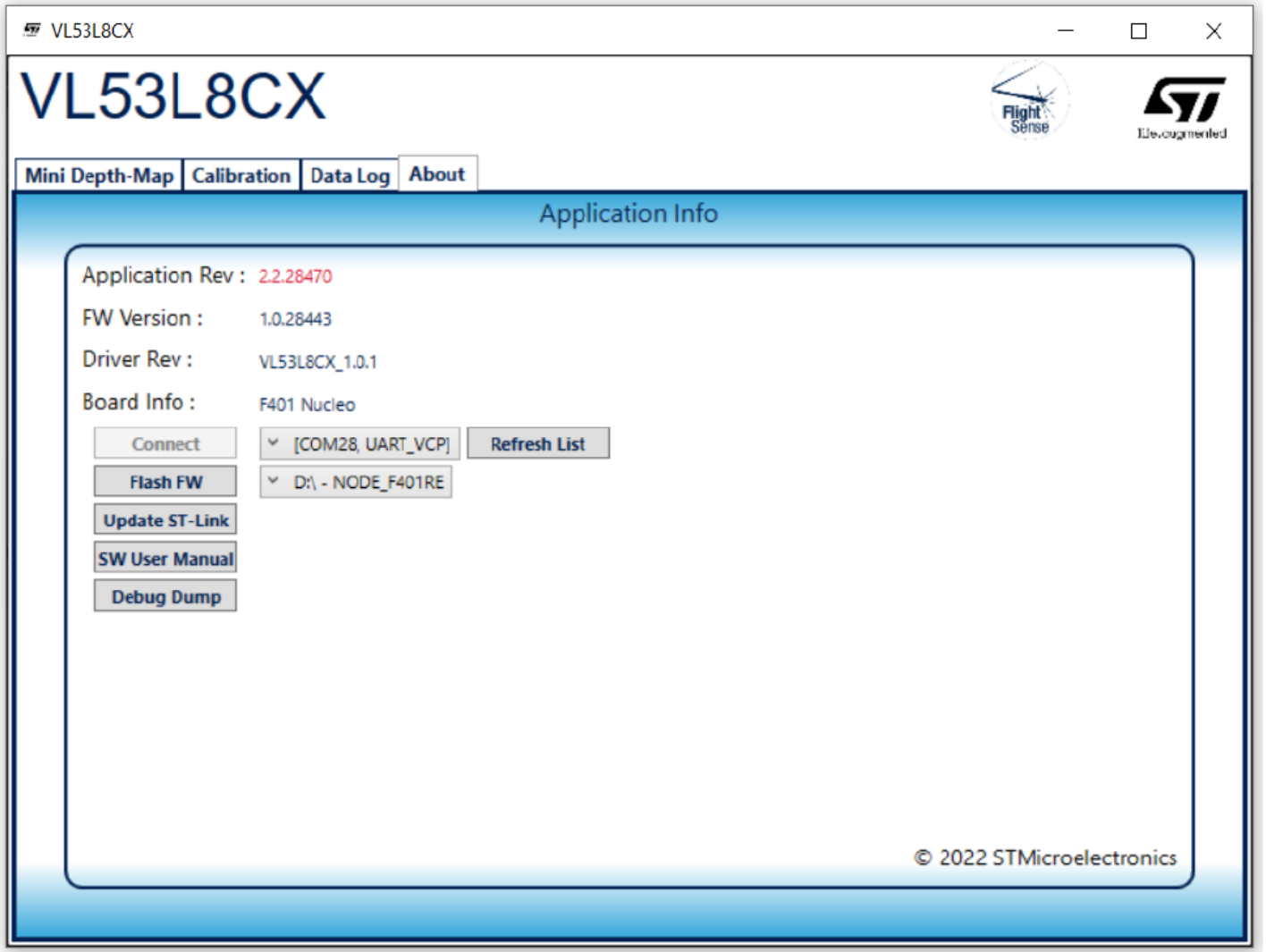
1.3 Getting started with evaluation kit

To use the evaluation, follow the general steps recommended below:

- Assemble the kit as described in *Section 1.1: Hardware installation*
- Install the GUI as described in *Section 1.2: Software installation*
- (Optional) If a cover glass is to be used, put the cover glass sample into the cover glass holder. Make sure that the cover glass is positioned flat above the sensor.
- Connect the Nucleo board to the host PC
- Start the VL53L8CX_Gui application
- Flash the firmware to the Nucleo board using the button on the About tab
- (Optional) If the cover glass is to be used, perform Xtalk sensor calibration.
- Proceed to obtaining and logging ranging data as reported by the sensor
- Once all the above is finished, close the VL53L8CX_Gui application
- Disconnect the Nucleo board from the host PC

VL53L8CX – GUI Demo

Figure 5. About tab layout



VL53L8CX – GUI Demo

Table 1. Functional description of the fields contained in the “About” tab

Item	Description
Application REV	This field displays the revision number of the GUI
FW Version	If a sensor device is detected, the Nucleo firmware version will be displayed here
Driver version	If a VL53L8CX driver (ULD) is loaded into the Nucleo, the driver version will be displayed here
Connect	Press this button to connect the application to the selected COM port in the list. The text in the bottom corner of the tab will change from "OFFLINE" to "CONNECTED"
Refresh list	Press this button to update the list of detected COM ports available
Flash FW	After clicking this button, firmware is uploaded to the Nucleo board. The text "flashing will be displayed while the update is performed
Update ST-link	If the Nucleo host board for the evaluation kit has an older version of ST_Link installed, use this button to update it
SW User Manual	After clicking this button, GUI user manual opens as a PDF file
Debug dump	This button may be used to upload and store the revisions of firmware and driver used in the setup

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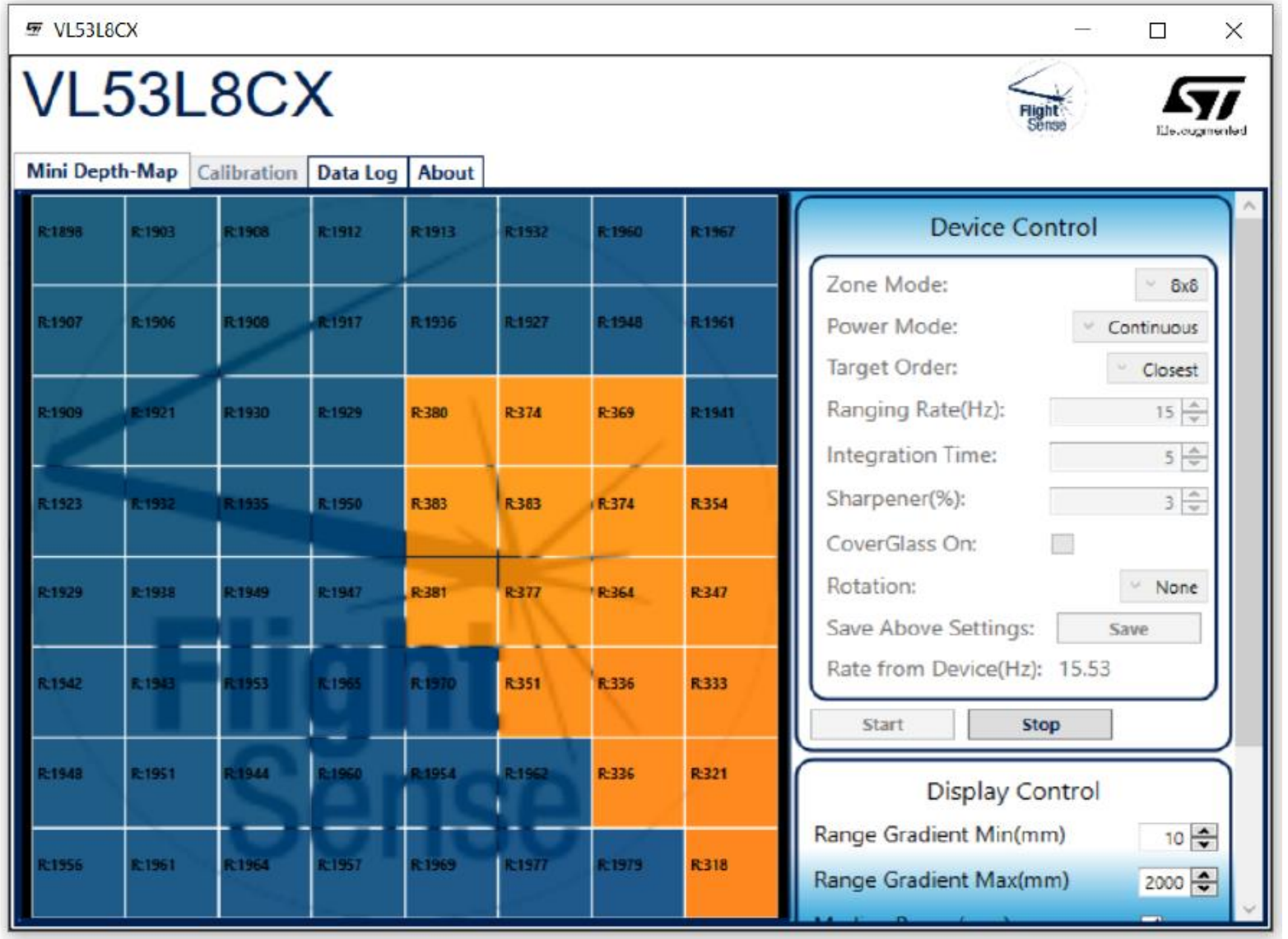

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Figure 7. Control panel of the mini-depth map tab

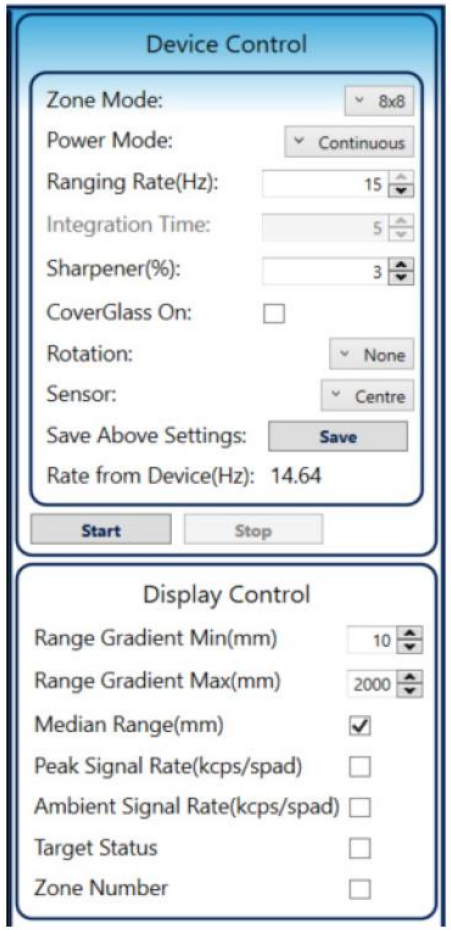

Table 2. Description of the function of the fields and buttons available to user in control panel of the mini-depth map tab

Item	Description
Zone mode	Selection of the number of regions used during ranging: 4x4 or 8x8. Default 8X8.
Power mode	Selection of ranging mode continuous (better maximum ranging distance and ambient immunity), or autonomous (lower power consumption). When the ranging mode autonomous is selected, it enables the possibility to change integration time.
Ranging rate (Hz)	Selection of the communication frame rate with the sensor. For 4x4 mode, valid values are between 1Hz and 60Hz. For 8x8 mode, valid values are between 1Hz and 15Hz.
Integration time (ms)	For autonomous mode only, it allows dimming the VCSEL timeout. A lower value allows a reduction of power consumption, but it also reduces the ranging performances.
Sharpener (%)	Select a new sharpener value. A higher value blurs more zones when objects are close into the FOV. For more information, please read VL53L8CX User Manual (UM3109)
Coverglass on	Use Xtalk calibration data when a coverglass is present at the top of the sensor
Rotation	Select the rotation of the displayed data. May be used to align with a camera orientation. Options are: NONE, 90°, 180°° 270°, MirrorX, MirrorY

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Figure 8. Calibration tab layout

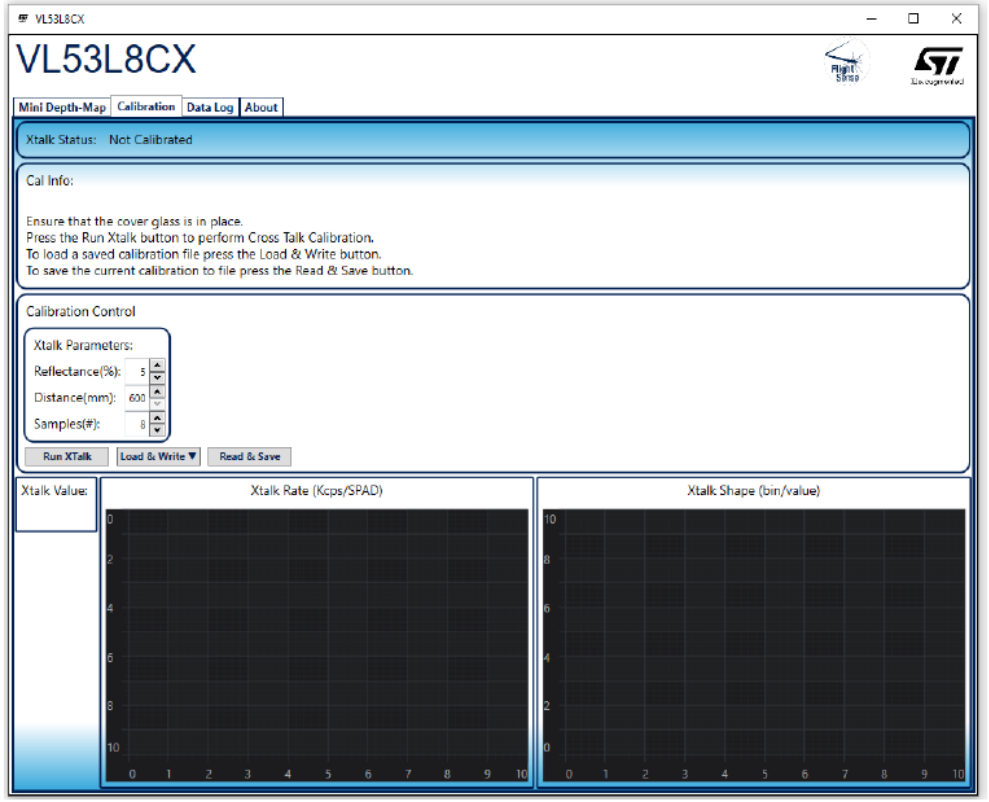

Table 3. Description of the functionality of the controls available to user on the calibration tab

Item	Description
Run Xtalk	When pressed, the GUI will perform xtalk calibration and display the results.
Load and write	Allows the user to select an existing calibration file and load it into the sensor memory
Read and save	Allows the user to read current sensor calibration configuration and save it to file
Reflectance [%]	Option to change the default calibration target reflectance. A low reflectance is recommend for xtalk to ensure no /minimal target is signal is returned during calibration
Distance [mm]	Option to change the default calibration distance. Xtalk calibration requires a target >600mm to ensure the target signal does not interfere with the xtalk calculation
Nb samples	Option to change the default calibration number of samples. Default unchecked. More samples mean more time but also give more signal to calibrate from

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Figure 9. Data logging tab

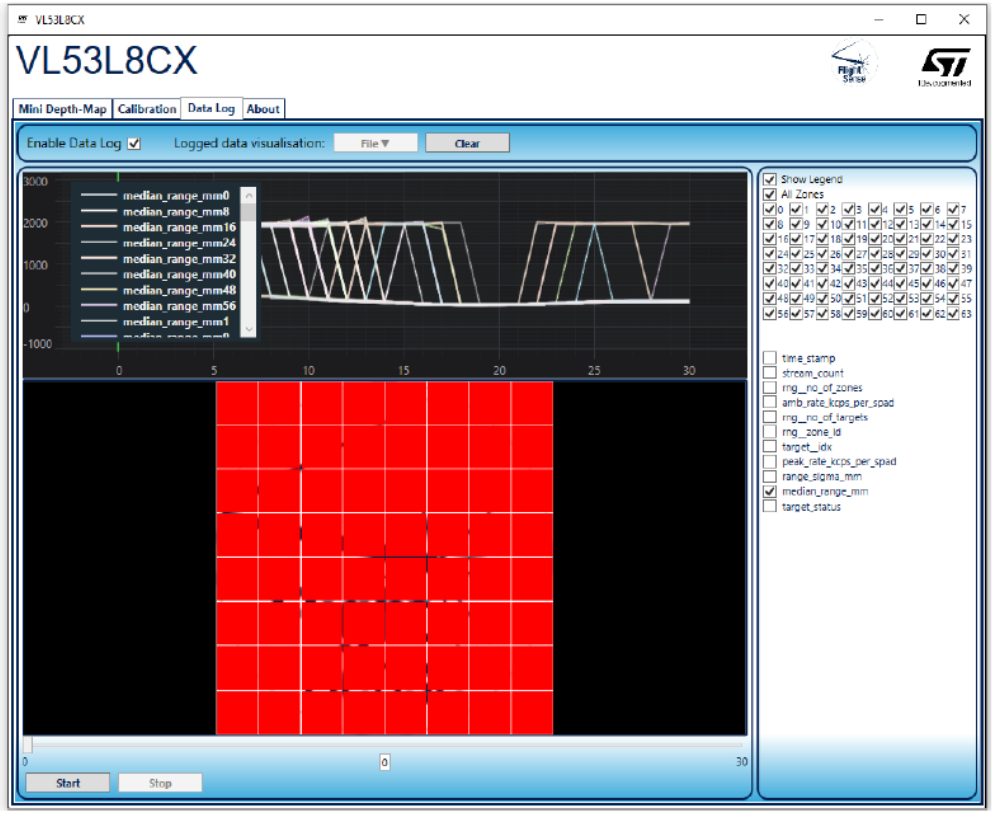

Table 4. Description of the function of the fields and buttons on the data logging tab

Item	Description
Enable data log	Turns on data logging when ranging to create a csv file in default file location: C:\Users\<username>\AppData\Local\STMicroElectronics\VL53L8CX\DataLog
File	Loads in a previously created data log .csv file. The user can select which values to view on a graph using the checkboxes on the right
Clear	Button to clear any loaded files and so revert back to default data log tab state
Start	Start playback of the log sequencing through frame by frame
Stop	Stop the playback and freeze the display on the current frame

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Table 5. Description of datalog elements

Item	Description
All Zones, 0-15 / 0-63	Zone number based on 4x4 or 8x8 configuration. It is possible to enable or disable displaying data for all zones with the "All Zones" option or select individual zones by their number.
time_stamp	Measurement timestamp in ms.

Item	Description
stream_count	Range measurement identifier. On starting ranging this value increments for every range from 0 to 255 then from 128 to 255, repeating. Note: For 8x8 mode the increment will be +4 each count.
amb_rate_kcps_per_spad	Ambient rate measurement performed on the return array, with no active photon emission, so as to measure the ambient signal rate due to noise. Expressed in kcps (kilo counts per sec.) per spad.
rng_no_of_targets	Number of targets found in the zone.
ng__zone_id	The zone identifier for the subsequent data in the log
target__idx	The target identifier (0, 1,2, 3) within a particular zone
peak_rate_kcps_per_spad	Signal rate measured during the VCSEL pulse divided by the number of SPAD's expressed in kcps per spad.
range_sigma_mm	Range sigma estimate. A sigma estimate for the noise in the reported target distance.
median_range_mm	Measured distance in millimeter
target_status	Status of the measurement. 5 is consider as 100% valid. See User Manual UM3109 for more information.

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