ST Global Shutter Sensor Webinar for MM VD55G1

STMicroelectronics

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Agenda

1 Key features

2 HW EVK Setup

3 GUI Running

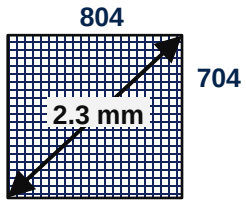
4 GUI Features

5 Use Case Introduction

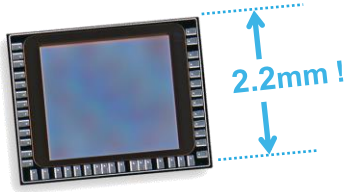
6 Q&A

Key features

VD55G1 | 804x704

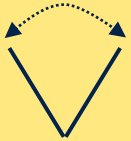


2.16µm BSI Global Shutter: 804x704, only 2.7mm x 2.2mm.
Smallest 804x704 global shutter sensor, even smaller size than other VGA sensors



Sensor Characteristics

- Smallest 2.16 µm BSI Global Shutter
- 804 x 704 pixels array
  Smaller GS sensor than VGA for higher resolution
- High Sensitivity & Sharpness, from visible to near-IR
- Fully encapsulated CDTI pixel for ultra-low crosstalk
- Low noise GS pixel + embedded smart denoising
- **260fps** (VGA), **460fps** (QVGA) & **185fps** (800x700)
- Temperature sensor



804x704
resolution

+26% hor FoV
+47% ver FoV
vs VGA sensor

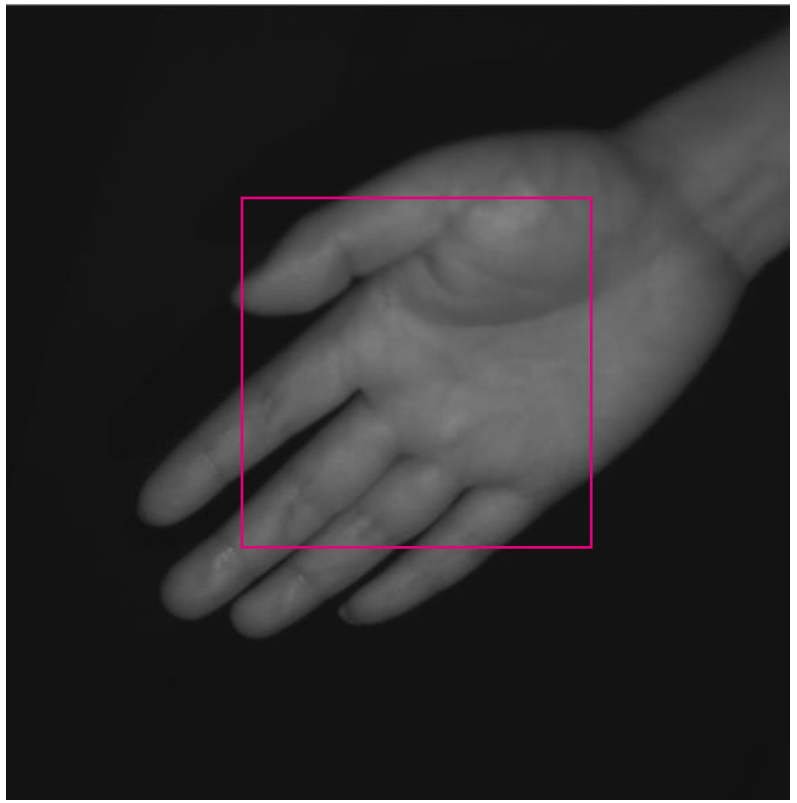
- **Auto wake-up Always-on**
  Scene change detection, ultra-low power
- **Auto Background & Ambient removal**
  In-pixel & no host processing required
- **Innovative Differential image mode**
  Single frame signed pixel change events !
- **Spatial HDR**
  No latency, perfect for SLAM & motion
- **Multiple Auto-exposures**
  Several concurrent AE loops
- **I3C image output** Dual image output
- **10x faster control with I3C**
- **Flexible tone mapping**
- **4 sequence-able contexts fast switch**
  Modes, tone mapping, AE, illumination ctrl…
- **Raw ISP** Dark Calibration, Smart denoising, Adaptative Defect correction …

➡ **Smallest high performance Global Shutter pixel & sensor**

Auto exposure
AE ROI & Multiple AE

Over exposure

Center weight



VD55G1 support very flexible exposure

- 4x4 statistic zones
- Configurable differently for each of the 4 contexts
- Up to 3 parallel auto-exposure loops

Example of contexts sequence with different statistic setups

Context 1

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Context 2

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Context 3

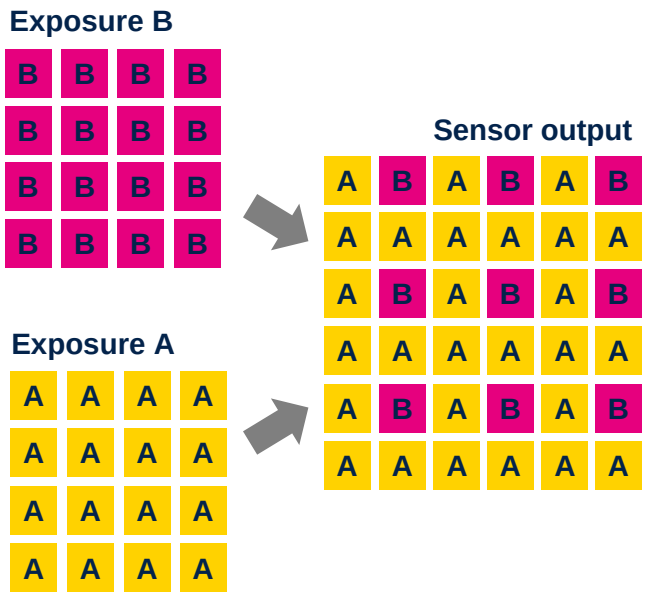
0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Context 4

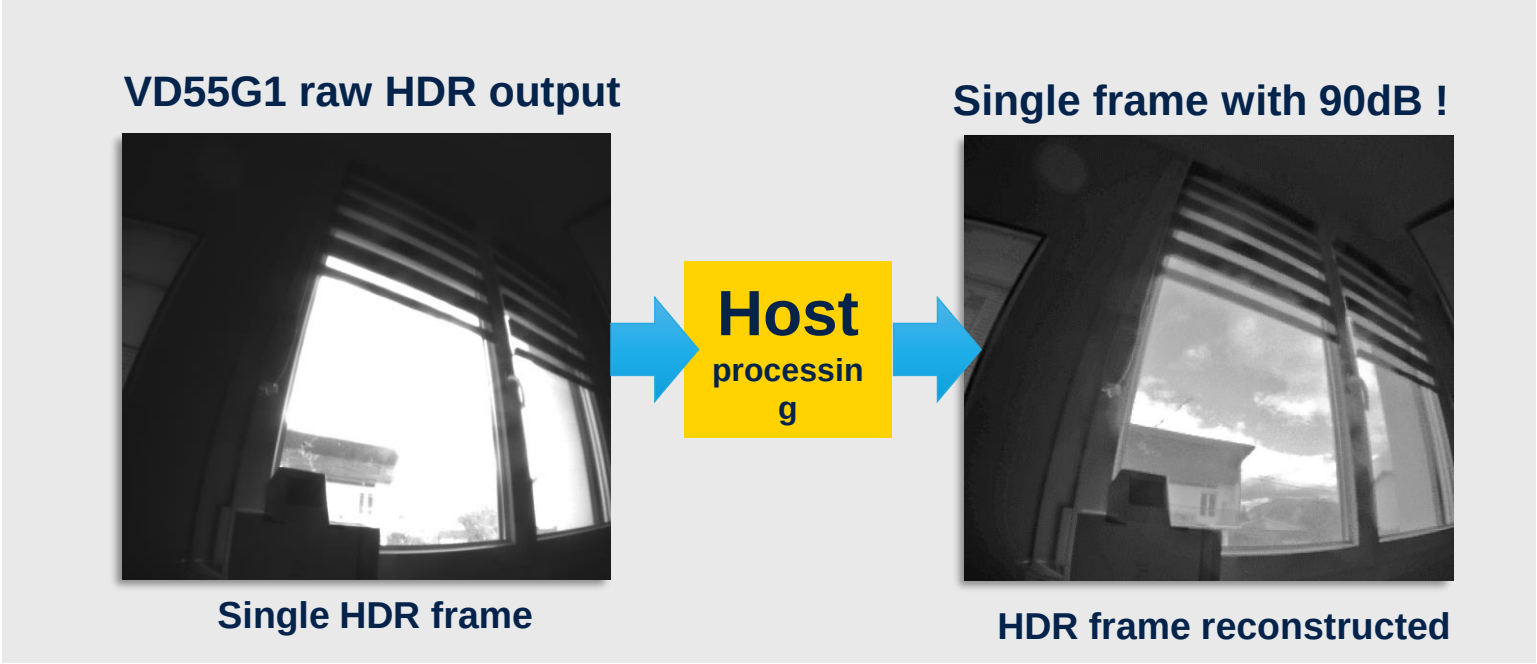
0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Single frame HDR
Different pixel exposures within the same frame

Spatial HDR



Single frame with 2 or 3 exposures for adjacent pixels for no latencies



Linear HDR with a single frame

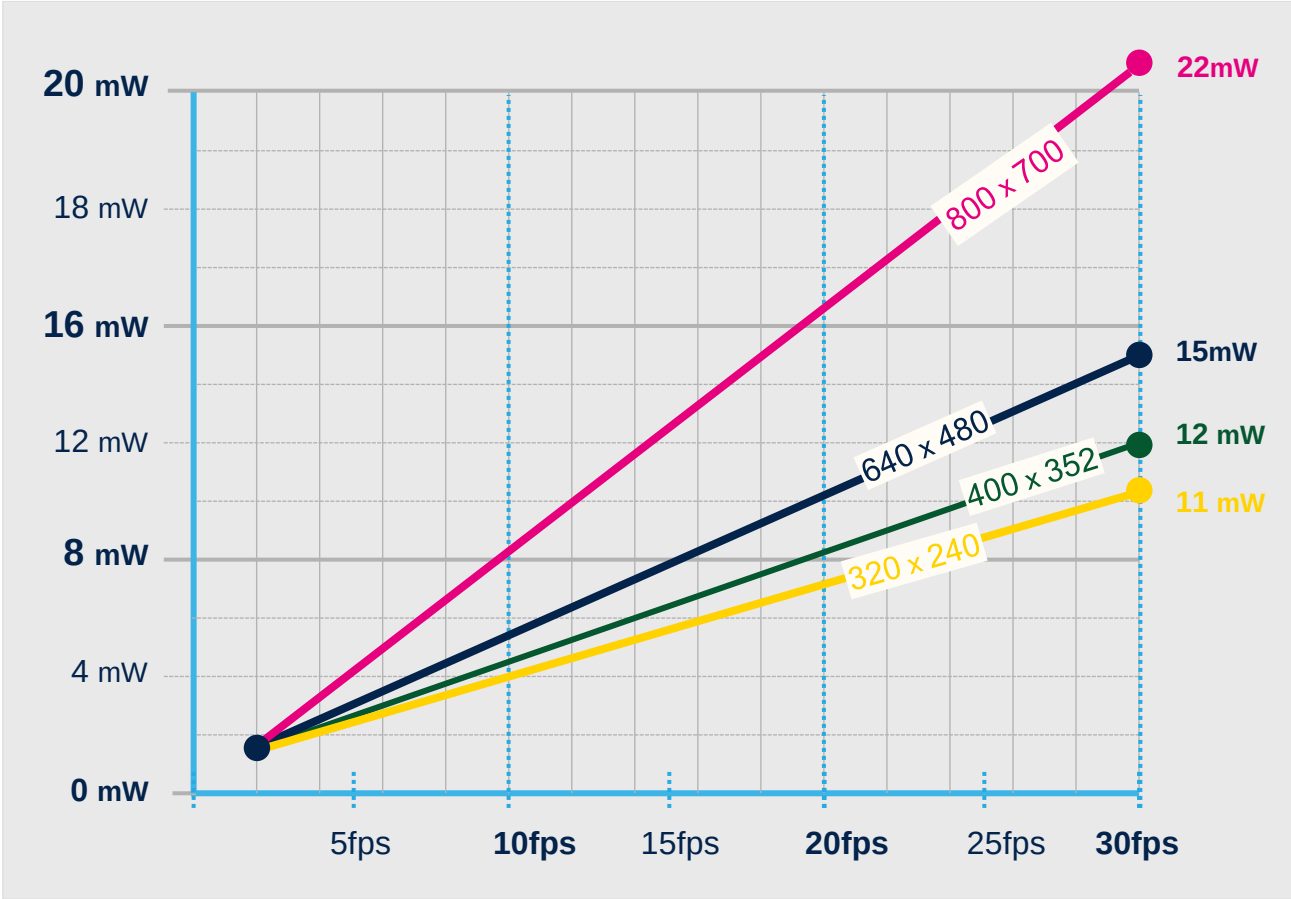
- No impact on latency
- No impact on power consumption
- No ghosting artifacts => perfect for motion

Power high efficiency

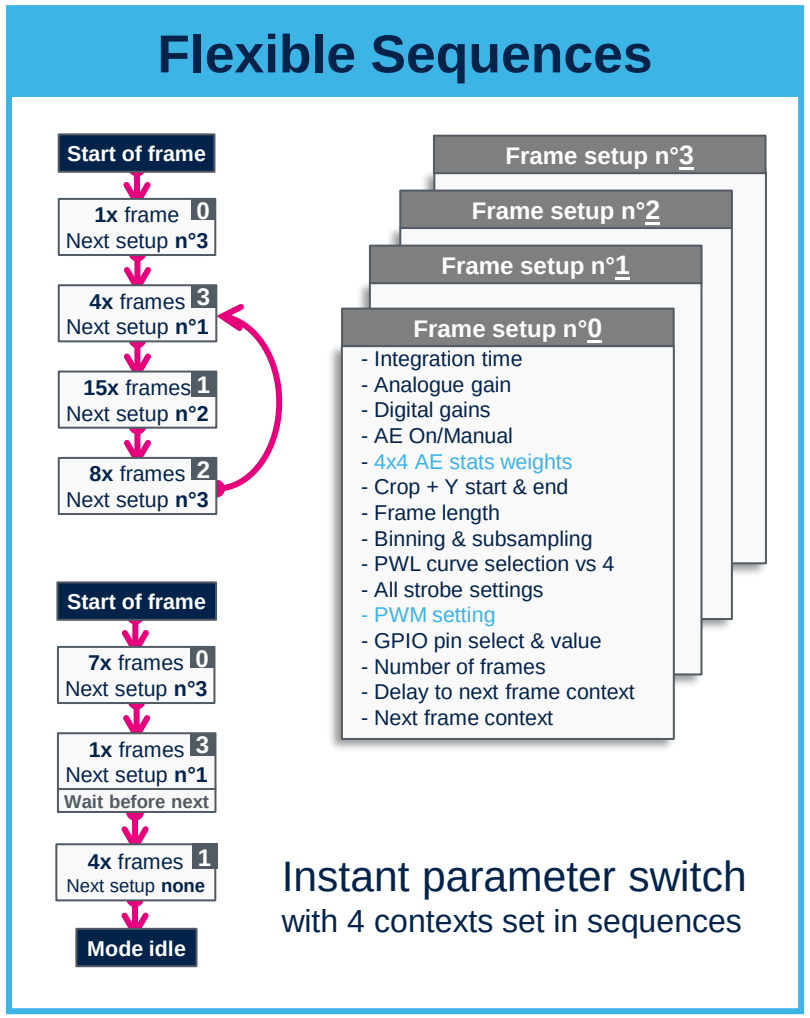
Battery-friendly sensor

- ✓ High image quality even in ultra-low power mode
- ✓ **All features & modes fully functional !**

=> VD55G1 is natively optimized for power efficiency



Context switch



VD55G1 for example:

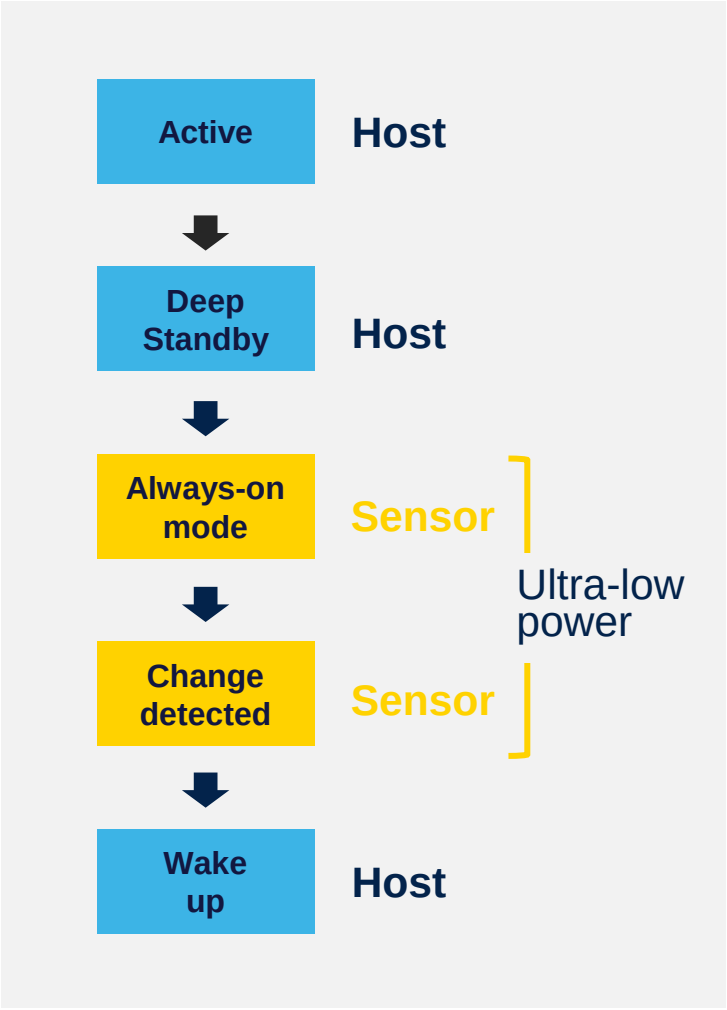
```
$SCRIPT
SetBank(0x20);
//context 0
WriteAutoIncrement(0x0500, 0x0); // (val=0) / UI.STREAM_CTX0.EXPOSURE_MODE.MODE 0:auto, 1:freeze,
WriteAutoIncrement(0x0501, 0x0); // (val=0) /AnalogGain_AGAIN_1 32/(32-X)
WriteAutoIncrement(0x0502, 0x00, 0x01);  //(val=396) /MANUAL_COARSE_EXPOSURE
// Set frame rate
WriteAutoIncrement(0x050c, 0x63, 0x0a); // (val=2659) / UI.STREAM_CTX0.FRAME_LENGTH.VALUE
//GPIO_x_CTRL 0:FSYNC_OUT, 1:GPIO_IN, 2:STROBE, 3:PWM_STROBE, 4:PWM, 5:GPIO_OUT, 6VSYNC_OUT_MODE0,
WriteAutoIncrement(0x051d, 0x2); // (val=2) / UI.STREAM_CTX0.GPIO_0_CTRL.Mode
//ROI
WriteAutoIncrement(0x0510, 0x00, 0x00);  //UI.STREAM_CTX0.Y_START = 0
WriteAutoIncrement(0x0512, 0xbc, 0x02);  //UI.STREAM_CTX0.Y_HEIGHT = 704
WriteAutoIncrement(0x0514, 0x00, 0x00);  //UI.STREAM_CTX0.X_START = 0
WriteAutoIncrement(0x0516, 0x20, 0x03);  //UI.STREAM_CTX0.X_WIDTH = 804
//context 1
WriteAutoIncrement(0x0550, 0x2); // (val=0) / UI.STREAM_CTX0.EXPOSURE_MODE.MODE 0:auto, 1:freeze,
WriteAutoIncrement(0x0551, 0x0); // (val=0) /AnalogGain_AGAIN_1 32/(32-X)
WriteAutoIncrement(0x0552, 0x64, 0x00);  //(val=396) /MANUAL_COARSE_EXPOSURE
// Set frame rate
WriteAutoIncrement(0x055c, 0xe8, 0x03); // (val=1000) / UI.STREAM_CTX1.FRAME_LENGTH.VALUE
//ROI
WriteAutoIncrement(0x0560, 0x00, 0x00);  //UI.STREAM_CTX1.Y_START = 0
WriteAutoIncrement(0x0562, 0xbc, 0x02);  //UI.STREAM_CTX1.Y_HEIGHT = 704
WriteAutoIncrement(0x0564, 0x00, 0x00);  //UI.STREAM_CTX1.X_START = 0
WriteAutoIncrement(0x0566, 0x20, 0x03);  //UI.STREAM_CTX1.X_WIDTH = 804

WriteAutoIncrement(0x03e4, 0x01, 0x00);  //context_next_context
WriteAutoIncrement(0x03dc, 0x64, 0x00);  //context0_repeat
WriteAutoIncrement(0x03de, 0x64, 0x00);  //context1_repeat
```

Auto Wake-up

Always-on scene detection

Ultra-low power scene change analysis

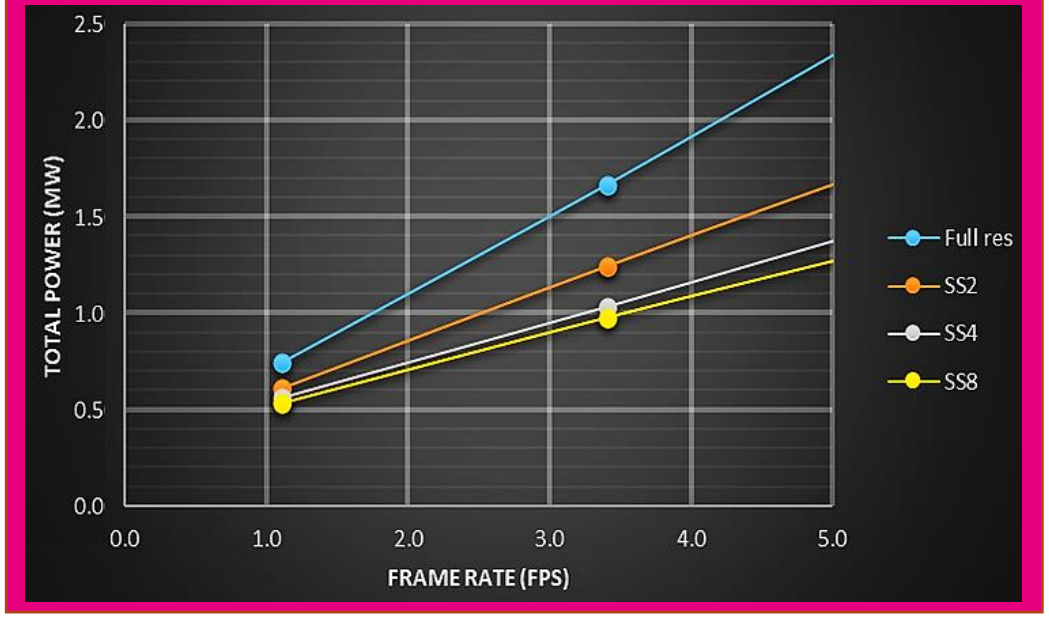
Autonomous Always-on Detection



Battery-friendly feature

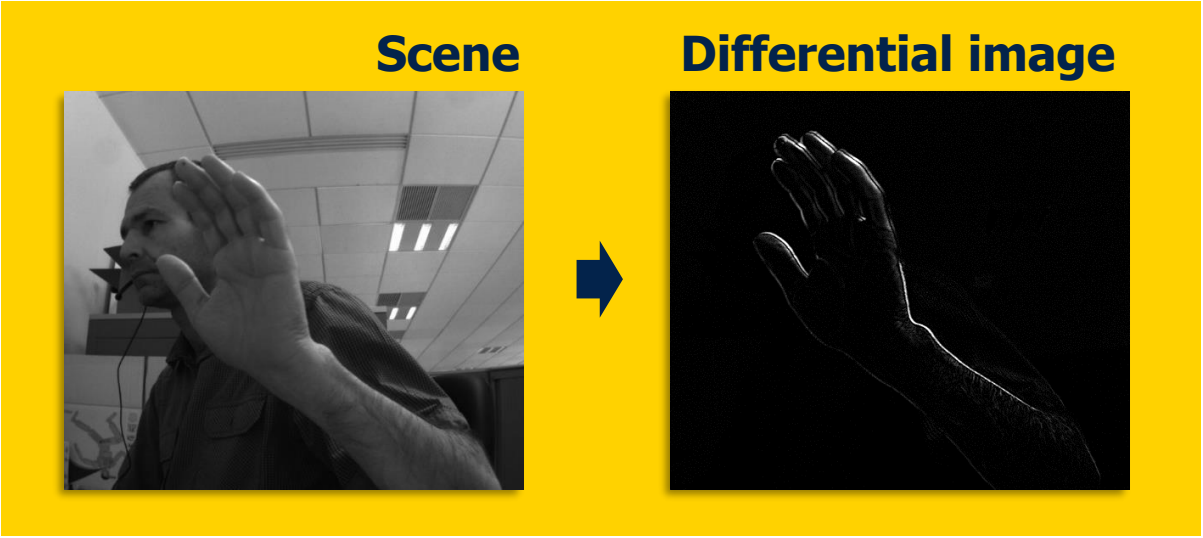
- ✓ Autonomous scene analysis
- ✓ Host could be in deep standby
- ✓ Wake-up the host if change detected
- ✓ Ultra-low power for always-on sensing

Energy saving



Differential mode

Single frame with only pixel changes !



<u>Single</u> frame Differential Mode

- Autonomous
- No need for host computing
- Ultra-low latency motion capture
- No impact on power consumption !

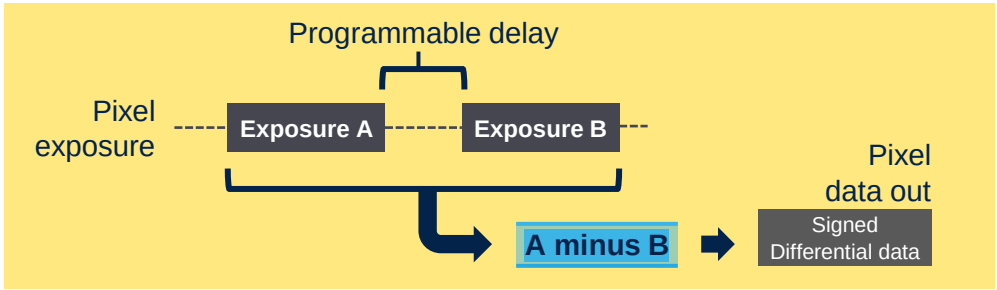
Innovative event-like image

- Only pixel with motion remaining
- Difference is signed & proportional
- Flexible delay between the 2 exposures
- Ultra-short delay possible to catch motion
- Preserving privacy !

Example of possible streaming modes, using context switch

Differential image outputs

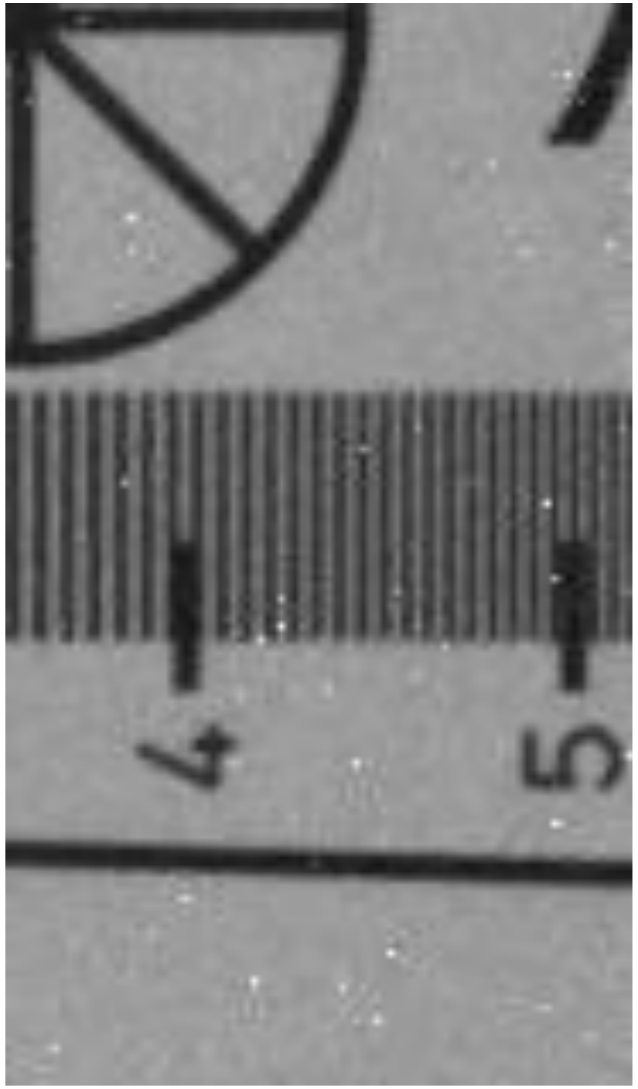
Interlacing of image and differential image

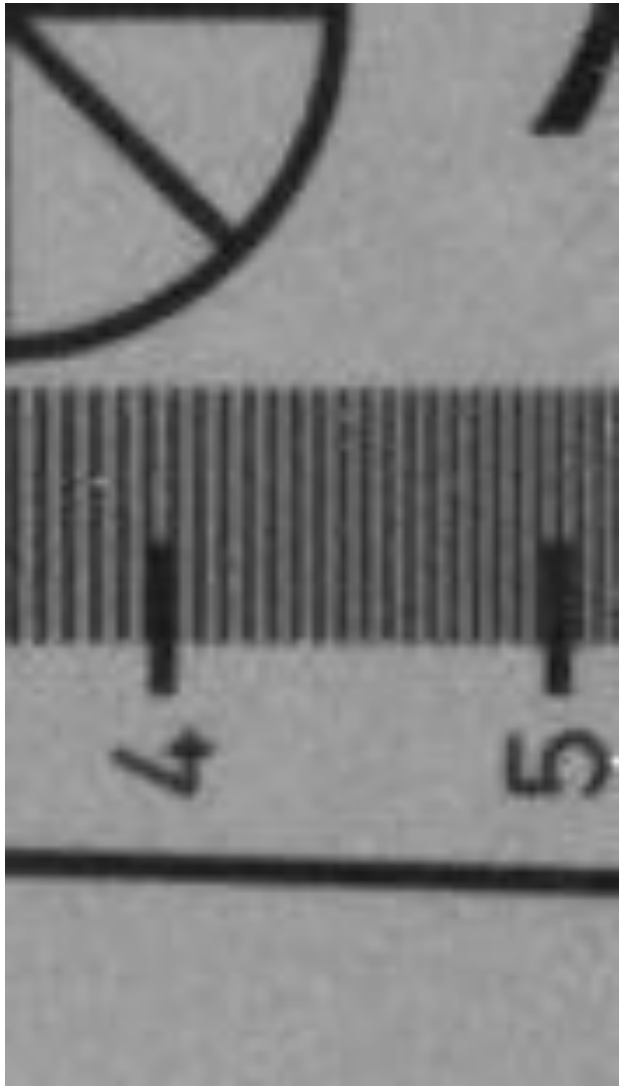


Defect correction

Defect spec

Singlet	
Couplet	
Cluster	
Row	More than 10% of pixel failed in a row
Column	More than 10% of pixel failed in a column





HW EVK Setup

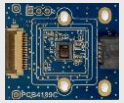
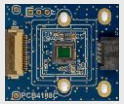
Prerequisites

Hardware

- Platform (PCB4405C)

- S-board / P-board
  - Promodule
  - PCB4189D, PCB4188D
  - PCB4280D + promodule



- USB-C to USB-A cable

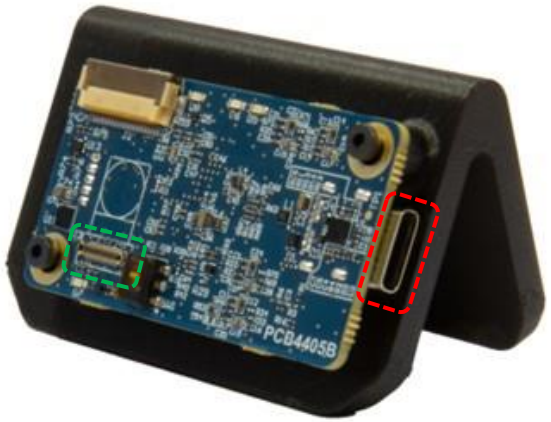
Software

- Windows 10 (or 11)
- Admin rights
- Download & unzip STSW-IMG501 from www.st.com
  - InstallCx3Driver.exe
  - EVK_GS_x.y.z_win64.exe

Hardware Setup

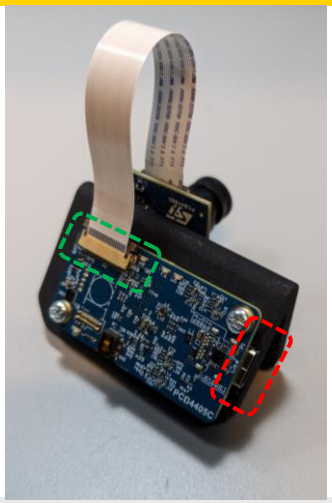
There is 2 way to use the Evaluation Kit

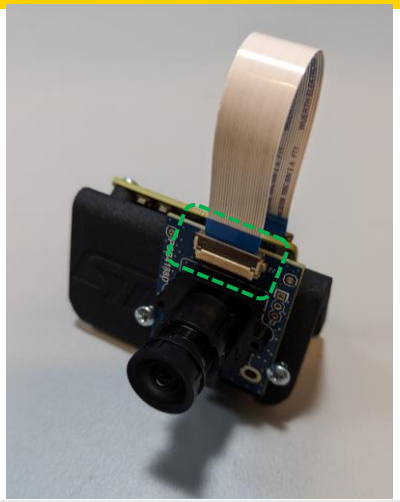
Option 1: Connect Promodule



- Connect first the Promodule (in green)
- Plug the USB (in red)

Option2: Connect Sensor board





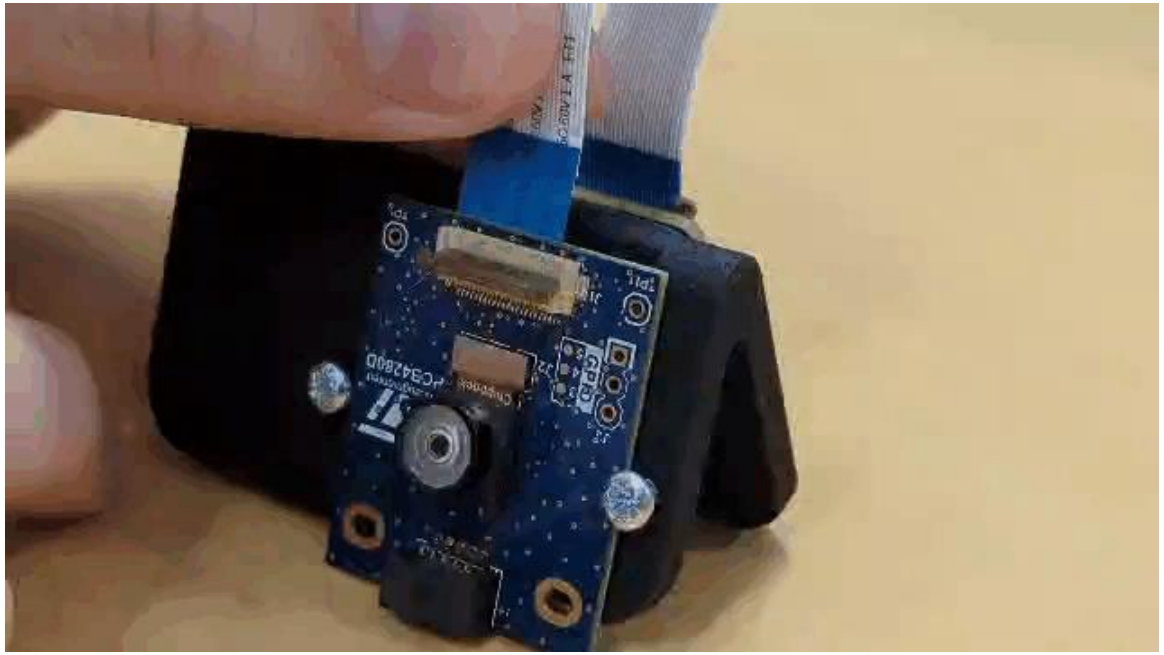
- Connect the ribbon first (in green).
- Plug the USB (in red)

Caution : EVK have no ESD protection. ESD could cause dysfunction of the sensor or the boards.

How to connect flex to connector?

To main board connector

To S-board / P-board connector



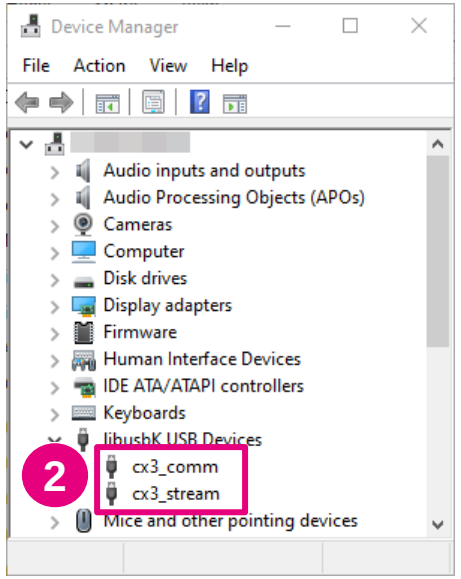
Flex pinout

- Table to list and describe all pin of flex

Pin #	Name	Type	Description
1	GND	Ground	Power Ground
2	CAM_D0_N	Output	Pixel Data Lane0 Negative
3	CAM_D0_P	Output	Pixel Data Lane0 Positive
4	GND	Ground	Power Ground
5	CAM_D1_N	Output	Pixel Data Lane1 Negative
6	CAM_D1_P	Output	Pixel Data Lane1Positive
7	GND	Ground	Power Ground
8	CAM_CK_N	Output	Pixel Clock Output Form Sensor Negaitive
9	CAM_CK_P	Output	Pixel Clock Output Form Sensor Positive
10	GND	Ground	Power Ground
11	CAM_D2_N	Output	Pixel Data Lane2 Negative
12	CAM_D2_P	Output	Pixel Data Lane2 Positive
13	GND	Ground	Power Ground
14	CAM_D3_N	Output	Pixel Data Lane3 Negative
15	CAM_D3_P	Output	Pixel Data Lane3 Positive
16	GND	Ground	Power Ground
17	POWER-EN	Input	Power Enable
18	LED-EN	I/O	LED Enable/XCLK
19	GND	Ground	Power Ground
20	SCL	Input	SCCB serial interface clock input
21	SDA	I/O	SCCB serial interface data I/O
22	VCC	Power	3.3V Power Supply

EVK driver installation

1. Download & unzip STSW-IMG501 from www.st.com
2. Unzip cx3_spider_vX.Y.Z.zip
3. Run setup.exe
4. Connect the EVK Main board (STEVAL-EVK-U0I1) to the PC/laptop through USB



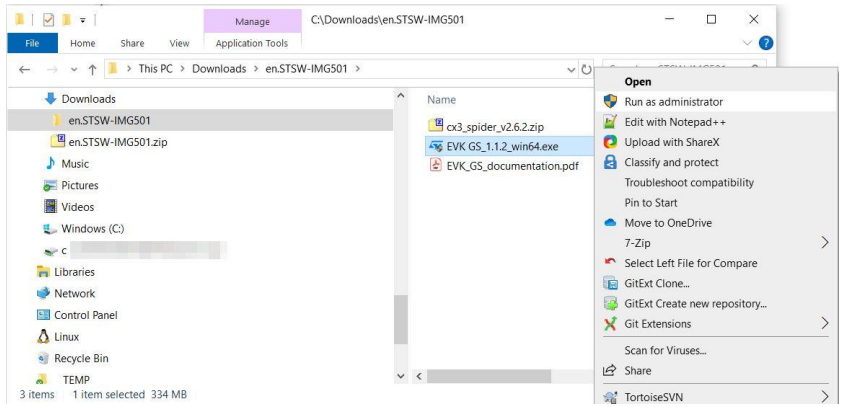
Running GUI

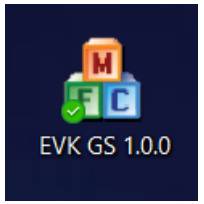
Install and run EVK GS

1 Download & unzip STSW-IMG501 from www.st.com

2 Run EVK GS_X.Y.Z_win64.exe with Admin privileges

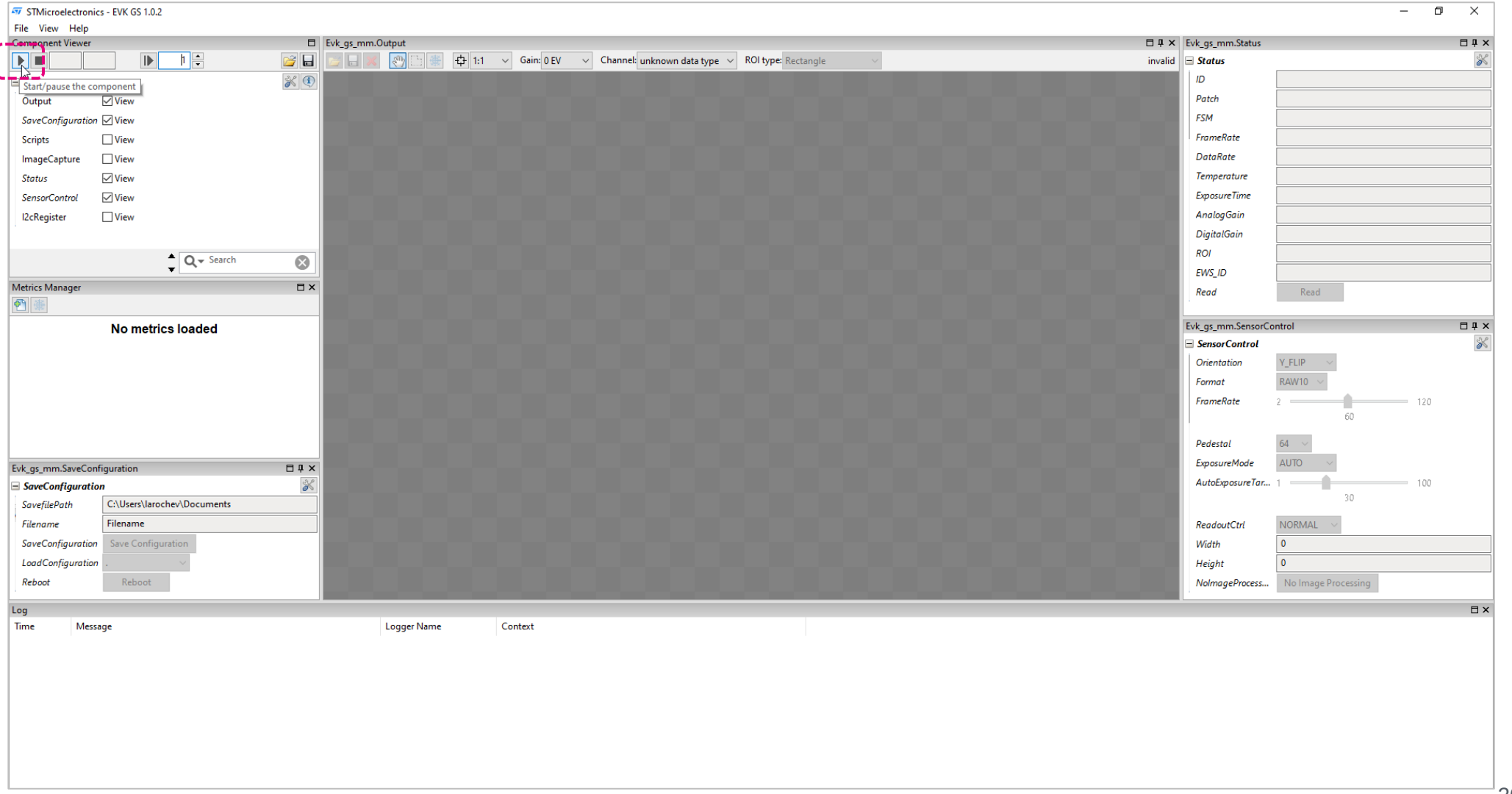
Default location is C:\Program Files\STMicroelectronics\EVK_GS\X.Y.Z





Start Streaming in the GUI

Press **play** button to start streaming



GUI Features

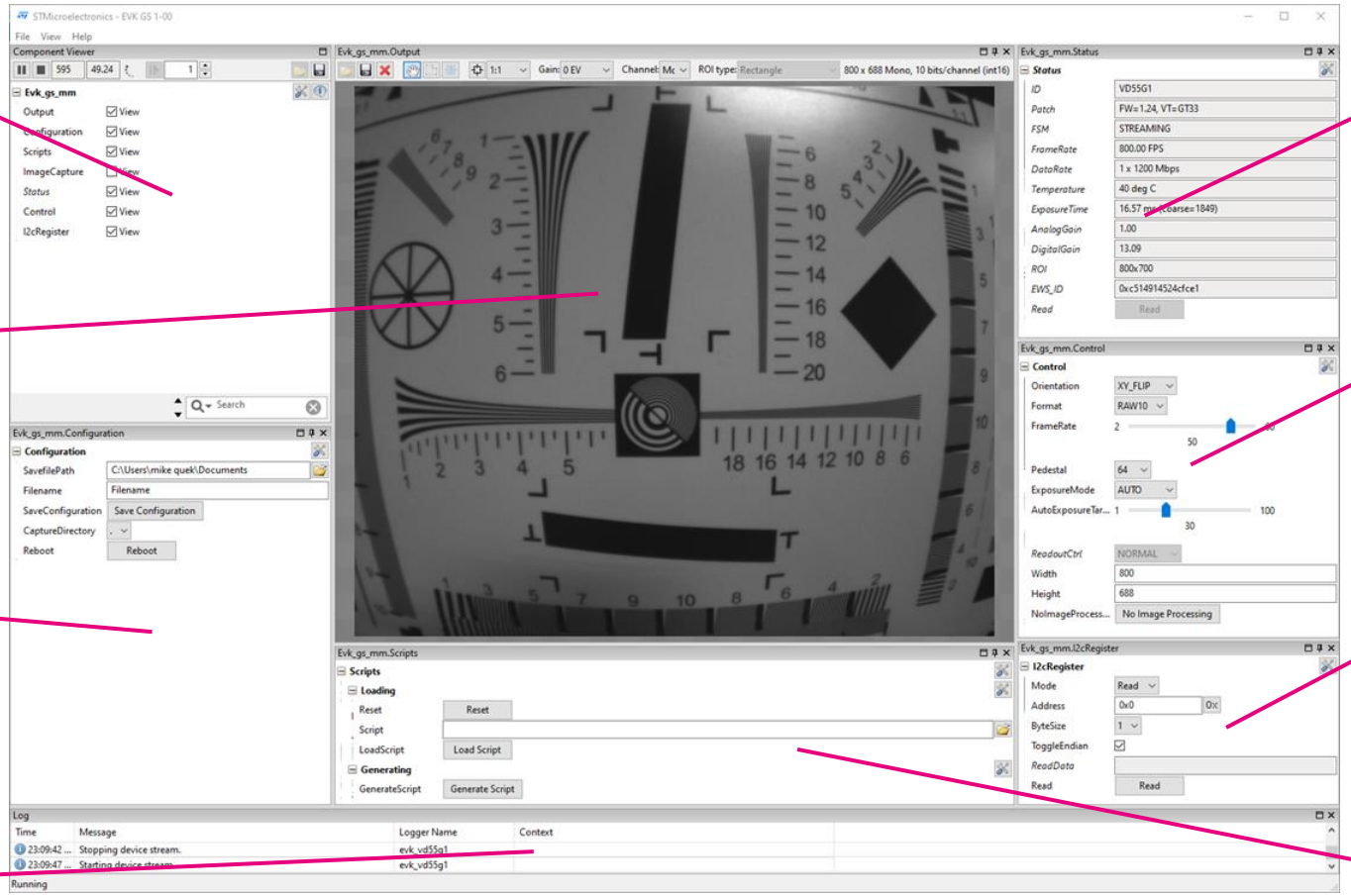
GUI overview

Main panel

Image output

Configuration

Logger



Status panel

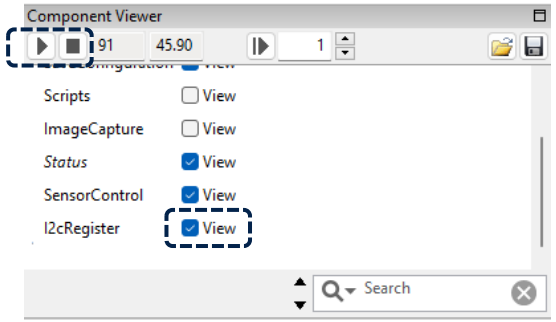
Control panel

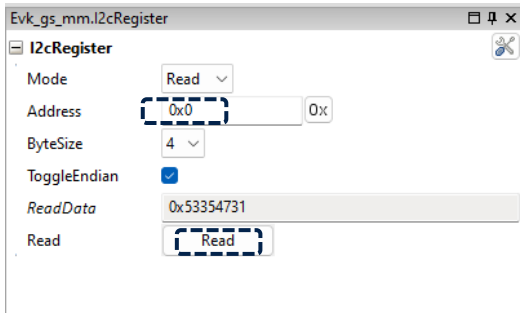
I2c register

Script panel

Read/Write Register
ex) read device ID

1. **Start and Pause** in Component Viewer
2. Open the **I2CRegister** Panel
3. Set the register **Address** for device ID
4. Set the **ByteSize** of register values
5. Click the **Read** button

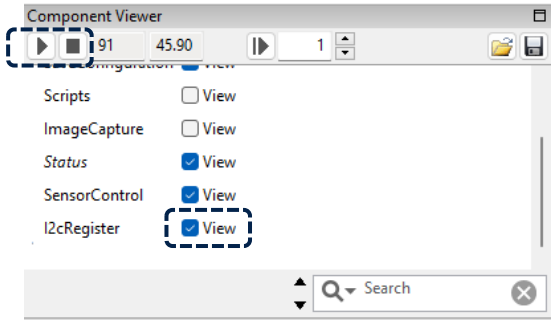


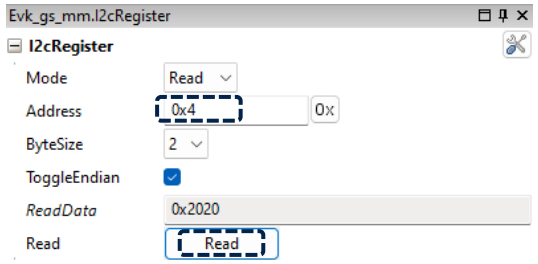


“0x53354731” ➡ ACSII Code ➡ “S5G1”

Read/Write Register
ex) read device revision

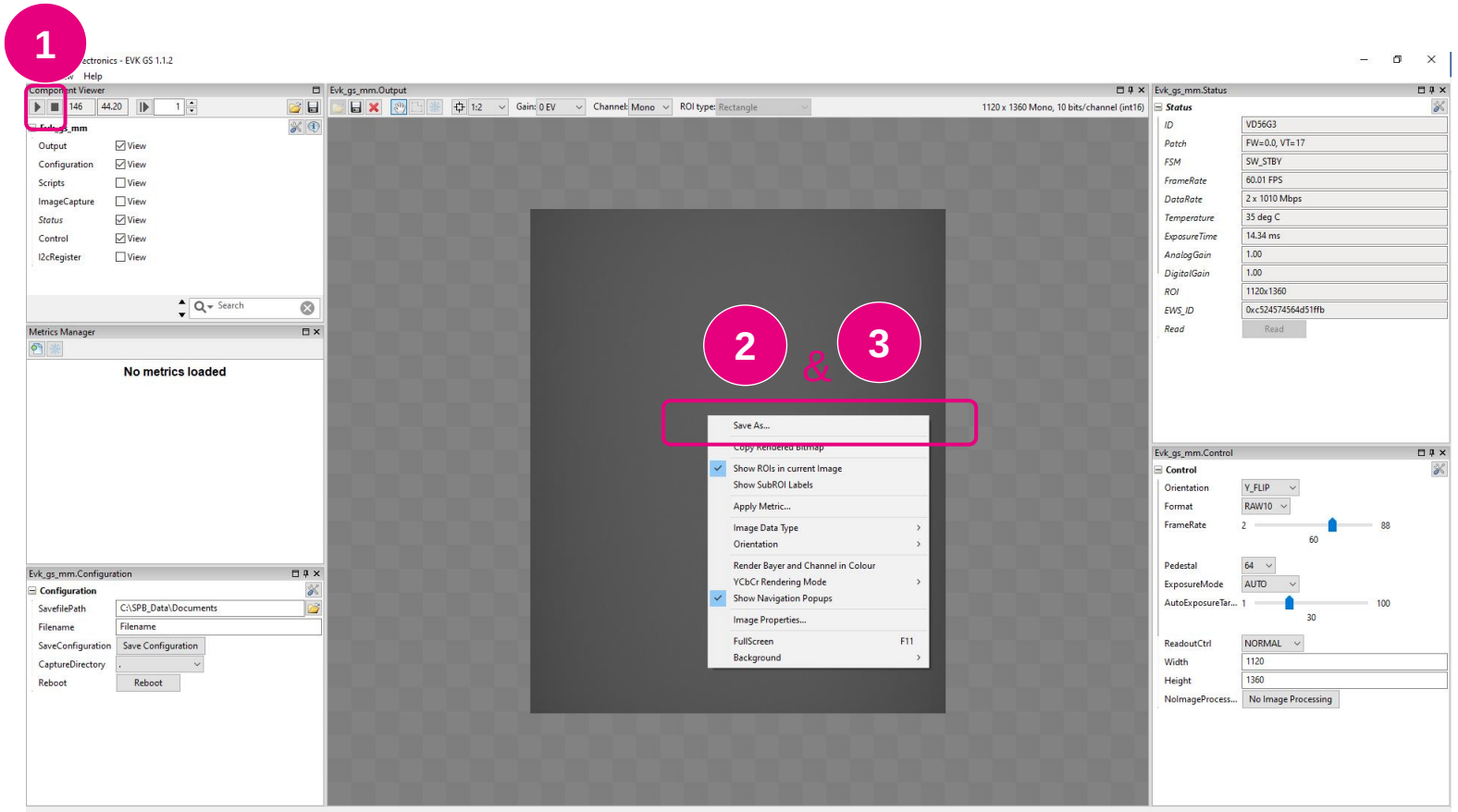
1. **Start and Pause** in Component Viewer
2. Open the **I2CRegister** Panel
3. Set the register **Address** for device ID
4. Set the **ByteSize** of register values
5. Click the **Read** button





Register Value	Revision
0x1010	CUT 1
0x2020	CUT 2

How to save single frame?



1 Press **Pause** button

2 **Right click** on the image

3 Click **Save as…**

Use Case Introduction

Matching sensors

VD55G0	644x604
VD55G1	804x704

Windows Hello

- **Windows Hello**
- Wellness
- Gesture
- Privacy
- Gaze

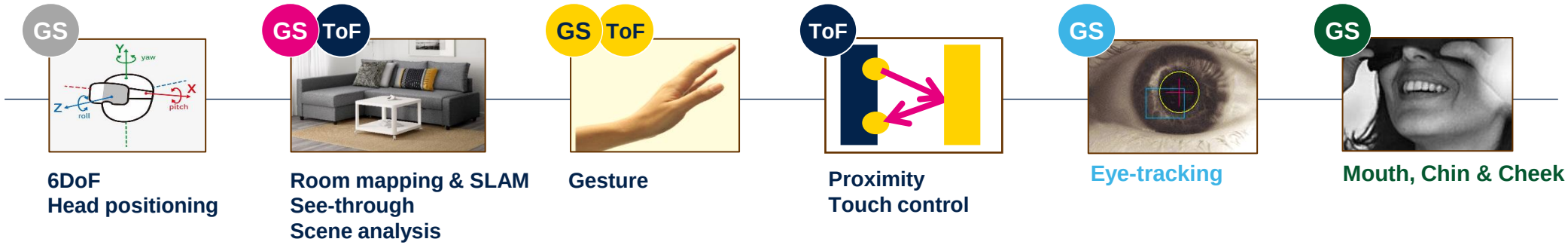
- **Presence**
- Battery duration
- Confidentiality

- Specialized **Global Shutter NIR** sensor
- Option for Active Stereo based on Global Shutter for 3D scanning or based on Structured Light

Matching sensors

VD55G0	644x604
VD56G3	1124x1364

AR/MR glasses



6DoF
Head positioning

Room mapping & SLAM
See-through
Scene analysis

Gesture

Proximity
Touch control

Eye-tracking

Mouth, Chin & Cheek

GS: 2D Image Sensor
ToF: Depth Sensor (Time-of-Flight)

Augmented **R**eality

Mixed **R**eality

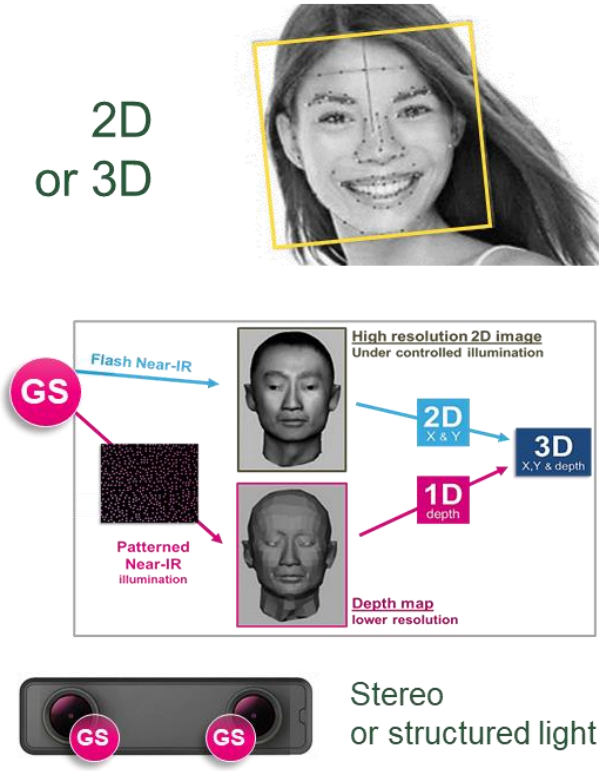
Device may not include all sensors but a sub-set, depending on price positioning

Matching sensors

VD56G3	1124x1364

ST Specialized Imaging Sensors for Biometrics

Palm identification



Face identification

Fingerprint & Eye id

Matching sensors

VD55G1	804x704
VD66GY	1124x1364

Medical

Wire ones

- High sensitivity at LED on
  work inside of body, no active light source

GS Global Shutter imaging sensor

NIR Near-IR 940nm LED or VCSEL light

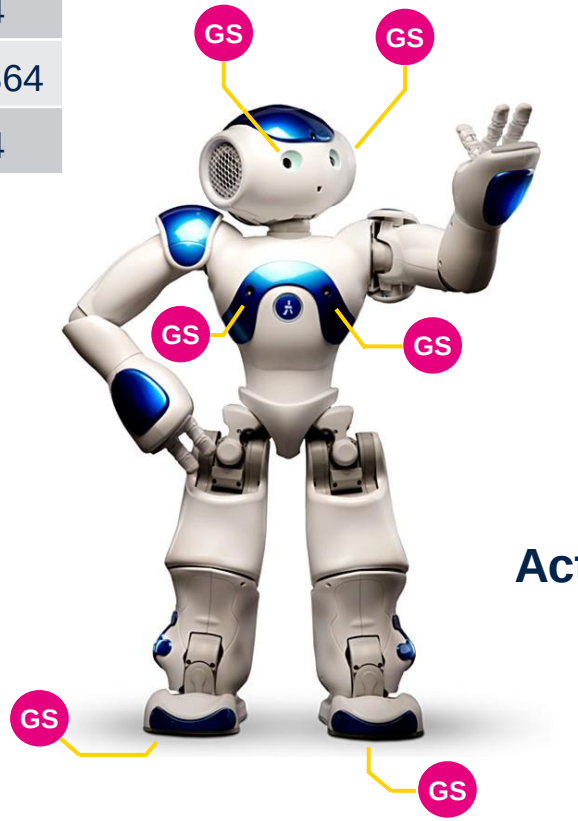
Wireless need

- High sensitivity at LED on
  work inside of body, no active light source
- Ultra_low power
  size limited the battery capacity, ultra_low power is must but for Wolfy low power exist in high speed Mipi which need strong ISP/Host, conflict point

Consumer & Industrial Robotic

Matching sensors

VD55G1	804x704
VD66GY	1124x1364
VD55G0	644x604

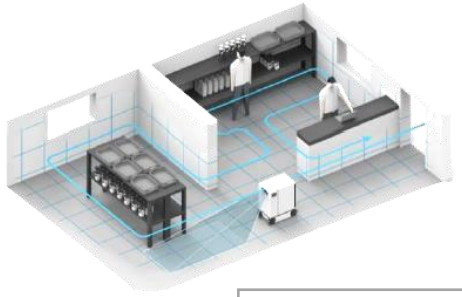


Powered by

VD56G3

VD55G0

Active Stereo



Sensor for Robotic

Specialized sensor for Computer Vision
to enable Odometry or SLAM,
to allow scene & object recognition,..
High performance with Near-IR illumination
or passive visible light with best sensitivity

VD56G3	**VD55G0**		
1124x800	644x604	**2D** X & Y	**3D** X,Y & depth
1124x800 @ 30fps 90° x 70°	640x480 @30fps 62° x 48°	**1D** depth	

Smart Home | Smart Building

Matching sensors	
VD55G1	804x704
VD66GY	1124x1364
VD55G0	644x604

Identification of the user

Coffee pod identification

Smart Alarm detector

Gesture

Face ID

Toys

Home Assistant

Gaming

Everywhere Smart Computer Vision

Computer vision is growing in our daily lives

Bringing assistance & comfort while preserving privacy

Specialized camera, different than webcam enabling new interaction human-machine

Industrial Robotic

Matching sensors

VD55G1	804x704
VD66GY	1124x1364
VD55G0	644x604

Sensor for Barcode reader

Requiring very fast Global Shutter sensor
High sensitivity & sharpness for ultra-fast scanning
The most compact sensors, enabling small modules

Mass Market Launch | webpages

Image sensors (products)

https://www.st.com/en/imaging-and-photonics-solutions/cmos-image-sensors.html

Category	RPN	Description	Webpage
Image Sensors	VD55G0	Compact and high-sensitivity 0.38MP monochrome global shutter image sensor	https://www.st.com/en/imaging-and-photonics-solutions/vd55g0
	VD55G1	Tiny, clever, low power 0.56MP monochrome global shutter image sensor	https://www.st.com/en/imaging-and-photonics-solutions/vd55g1
	VD56G3	Compact and high-sensitivity 1.5MP monochrome global shutter image sensor	https://www.st.com/en/imaging-and-photonics-solutions/vd56g3
	VD66GY	Compact & high-sensitivity 1.5MP color global shutter image sensor	https://www.st.com/en/imaging-and-photonics-solutions/vd66gy

Software

https://www.st.com/en/embedded-software/imaging-software.html

Category	RPN	Description	Webpage
Software for PC	STSW-IMG501	PC evaluation software for CMOS image sensors and camera modules	https://www.st.com/en/embedded-software/stsw-img501
Software for embedded processing platforms	STSW-IMG502	V4L2 Linux driver for VD56G3 image sensor and its derivative camera modules	https://www.st.com/en/embedded-software/stsw-img502
	STSW-IMG503	V4L2 Linux driver for VD66GY image sensor and its derivative camera modules	https://www.st.com/en/embedded-software/stsw-img503
	STSW-IMG505	V4L2 Linux driver for VD55G0 image sensor and its derivative camera modules	https://www.st.com/en/embedded-software/stsw-img505
	STSW-IMG506	V4L2 Linux driver for VD55G1 image sensor and its derivative camera modules	https://www.st.com/en/embedded-software/stsw-img506

Q&A

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