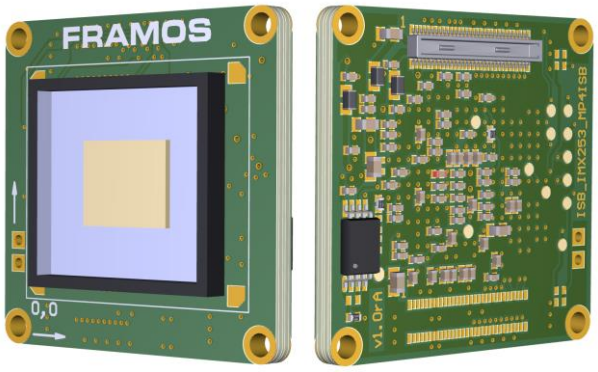
FSM-IMX264 Datasheet

Sony IMX264LLR / IMX264LQR Sensor Module

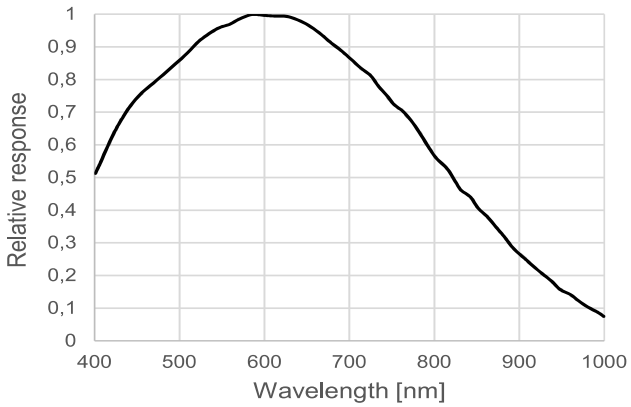
FRAMOS Sensor Module



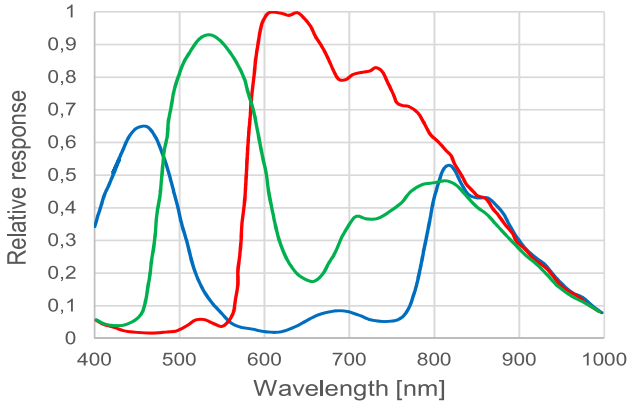
Key Benefits & Features:

- 5.1 Mpx Sony CMOS Global Shutter sensor module, ready to embed!
- All FSMs are part of a rapid prototyping ecosystem, consisting of:
  - ✓ Adapters to various processing boards
  - ✓ Design sources for deep embedding
  - ✓ Various accessories and design in services

FSM-IMX264M (Monochrome):



FSM-IMX264C (Color):



Specification	
Model Name	**FSM-IMX264M / FSM-IMX264C** (V1A)

Image Sensor	
Vendor / Name	Sony IMX264LLR / IMX264LQR
Shutter Type	CMOS Global Shutter
Technology / Grade	Pregius (Gen2) / Industrial
Chromaticity	Color / Mono
Optical Format	2/3“
Pixel Size	3.45 x 3.45 µm
Max. Resolution	5.1 Mpx / 2464 x 2056 px
Framerate (max.)	CSI-2: 35.7 FPS (4-Lane)
Bit Depth(s)	12 bit

Interface	
Data Interface	SubLVDS (4 Lane)
Communication Interface	I²C (4-wire serial)
Drive Frequency(s)	37.125 / 54 / 74.25 MHz
Input Voltages	1.2V, 1.8V, 3.3V
Interface Connector	Hirose DF40C-60DP-0.4V(51)
EEPROM (Sensor ID)	Yes

Mechanical	
Dimensions (HxWxD)	28 x 28

Environmental	
Operating Temperature	-30°C to +75°C (function) -10°C to +60°C (performance)
Storage Temperature	-40°C to +85°C
Ambient Humidity	20% to 95% RH, non condensing

Software Support (requires FSA with MIPI CSI-2 conversion)	
Driver	V4L2 Based Device Driver Libargus / Argus Camera (ISP Tuned) Isaac ROS compliant
Supported Platform(s)	NVIDIA Jetson AGX Xavier, TX2
Software Version(s)	NVIDIA JP4.6 / L4T32.6.1

Suggested Accessories & Adapters	
Compatible FSA Type	FSA-FT14/A-00G
Recommended Devkit(s)	FSM-IMX264x/TXA_Devkit (TX2, AGX)
Lens Mounts	C/CS-Mount option

A matrix with compatible *Sensor Adapters (FSA)* and *Processor Board Adapters (FPA)* for various setups can be found at the end of this document.

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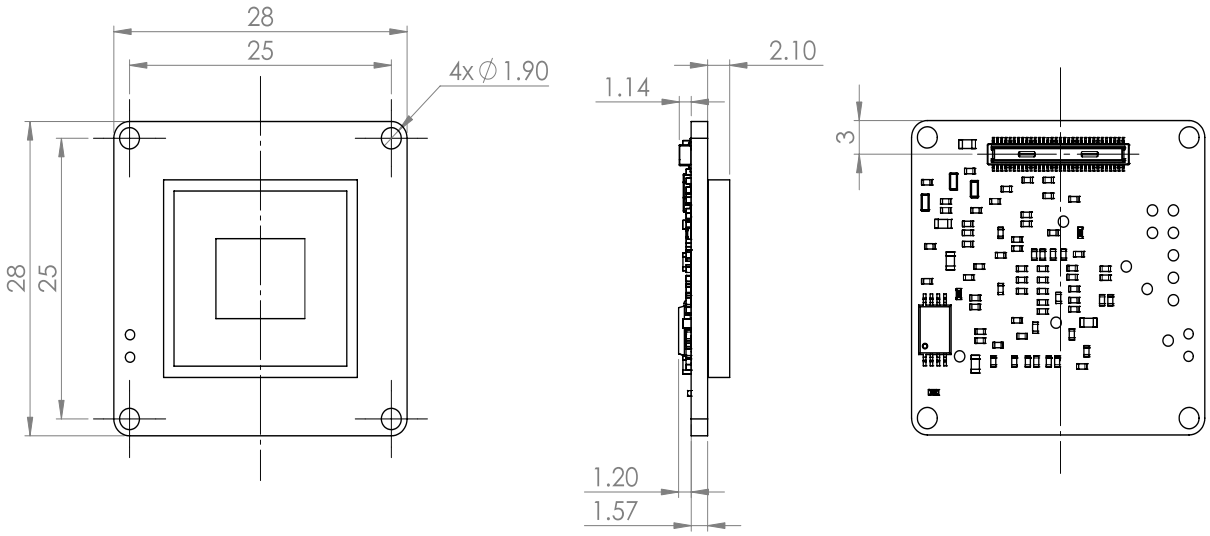
Mechanical Drawing



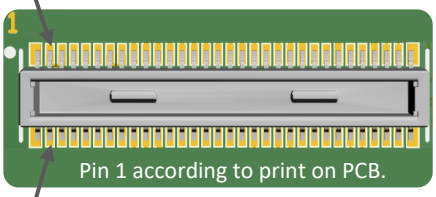
Sensor image optical center is in mechanical board center.

Connector Pinout

Type: Hirose DF40C-60DP-0.4V(51)

Mating Type: Hirose DF40HC(4.0)-60DS-0.4V(51)

Name	NC	NC	3V3	3V3	1V8	GND	GND	SDA	SDO	TOUT0	TOUT1	TOUT2	NC	NC	NC	GND	RST	MCLK	GND	D_DATA_6_P	D_DATA_6_N	GND	D_DATA_4_P	D_DATA_4_N	GND	D_DATA_2_P	D_DATA_2_N	GND	D_DATA_0_P	D_DATA_0_N
Pin	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59



Pin	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
Name	1V8_EEPROM	1V8_EEPROM	1V2	1V2	NC	GND	GND	SCL	XCE	SLAMODE	XMASTER	NC	XTRIG	XHS	XVS	GND	D_DATA_7_P	D_DATA_7_N	GND	D_DATA_5_P	D_DATA_5_N	GND	D_DATA_3_P	D_DATA_3_N	GND	D_DATA_1_P	D_DATA_1_N	GND	D_CLK_0_P	D_CLK_0_N

Signals are routed directly from image sensor to connector. Details on specific signals are described in the respective image sensor datasheet.

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Table of Contents

1 FRAMOS Sensor Module Ecosystem 2
1.1 Ecosystem Overview 3
1.2 Materials and Services 4
1.2.1 Native MIPI CSI-2 Modules 5
1.2.2 Sub-LVDS, SLVS and SLVS-EC Modules 9
2 Software Package and Drivers 10
2.1 Reference Software: NVIDIA Jetson Family 11
2.1.1 Platform and Sensor Device Drivers 11
2.1.2 Image Pre-Processing Examples 13
3 Ecosystem Compatibility Matrix 15
3.1 Hardware Support 15

Version v1.1d from 2022-02-18

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1 FRAMOS Sensor Module Ecosystem

The FSM Ecosystem consists of FRAMOS Sensor Modules, Adapters, Software and Sources, and provides one coherent solution supporting the whole process of integrating image sensors into embedded vision products.

During the evaluation and proof-of-concept phase, off-the-shelf sensor modules with a versatile adapter framework allow the connection of latest image sensor technology to open processing platforms, like the NVIDIA Jetson Family or the 96boards.org standard. Reference drivers and sample applications deliver images immediately after installation, supporting V4L2 and an optional derivate API providing comfortable integration. Within the development phase, electrical design references and driver sources guide with a solid and proven baseline to quickly port into individual system designs and extend scope, while decreasing risk and efforts.

To simplify and relieve the whole supply chain, all FRAMOS Sensor Modules and adapters are optimized and ready for delivery in volume and customization with pre-configured lens holder, lens and further accessories.

Off-the-Shelf Hardware

- FRAMOS Sensor Modules (FSM) from stock, ready for evaluation and optimized for initial mass production.
- Versatile adapter framework, allowing flexible testing of different modules, on different processing boards:
  - FRAMOS Sensor Adapter (FSA): Everything the specific sensor needs for operation
  - FRAMOS Processor Adapter (FPA): Connect up to four FSM + FSA to a specific processor board
- From lenses, mechanics and cables, all needed imaging accessories from one hand

Kickstart Software Package

- Drivers with basic sensor integration:
  - V4L2 drivers for specific image sensors
  - Platform specific device tree overlays
- Streamlined V4L2 library (LibSV) with comfortable and generic C/C++ API
- Example applications demonstrating initialization, configuration and image acquisition

Further to the off-the-shelf hard- and software, the Ecosystem supports you on project basis with:

- Driver sources allowing the focus on application specific scope and sensor features
- Electrical references for FSA and FPA, supporting quick and optimized embedding of FSMs
- Engineering services via FRAMOS and its partners, allowing you to focus on your product's unique value

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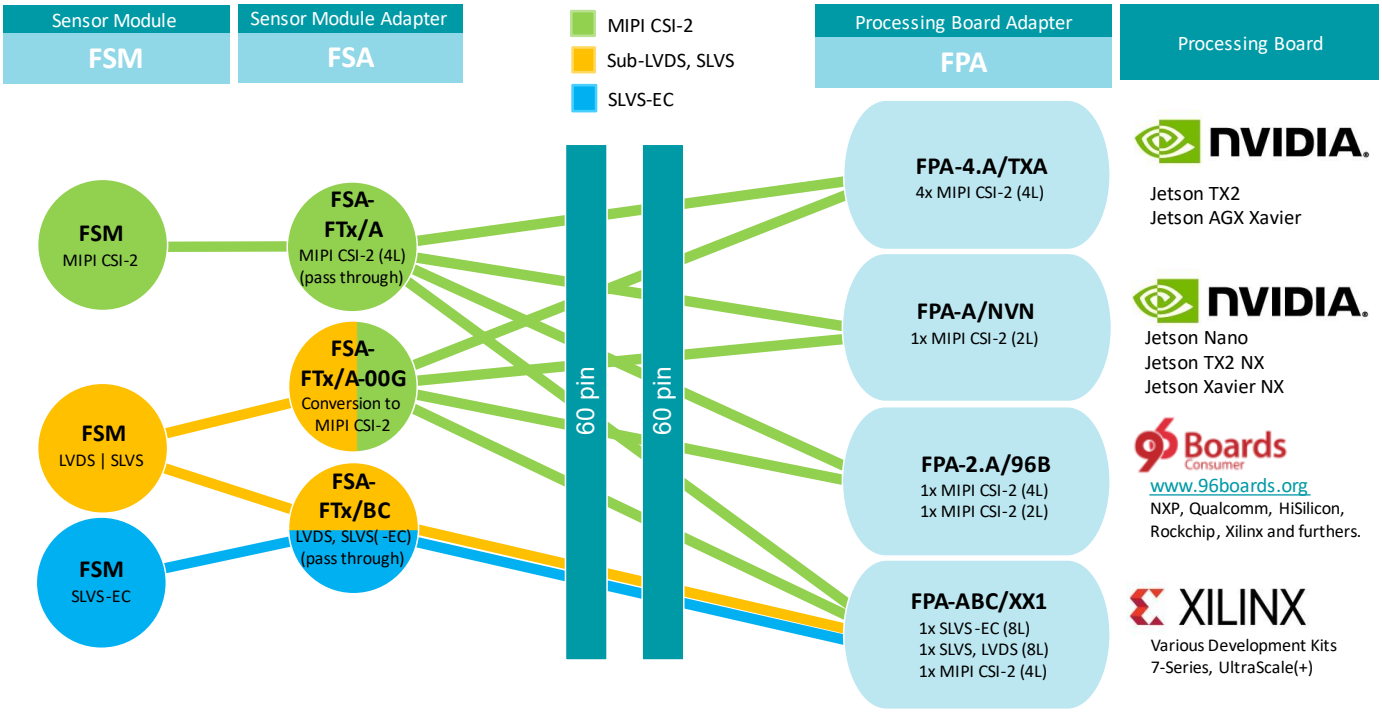
1.1 Ecosystem Overview

The figure below shows a map of compatibility with all components inside the Ecosystem. Every element (or hardware) and connection displayed in **Green** operates with native MIPI CSI-2 (D-PHY) data.



Every component and connection displayed in **Orange** or **Blue** operates with proprietary (Sub-LVDS, SLVS) or standardized (SLVS-EC) LVDS data, that requires further attention to the physical processing of the image data by either data conversion or specific FPGA IP. Users of MIPI CSI-2 based processing systems are supported by FSM specific data conversion located on dedicated FRAMOS Sensor Adapters (FSAs).

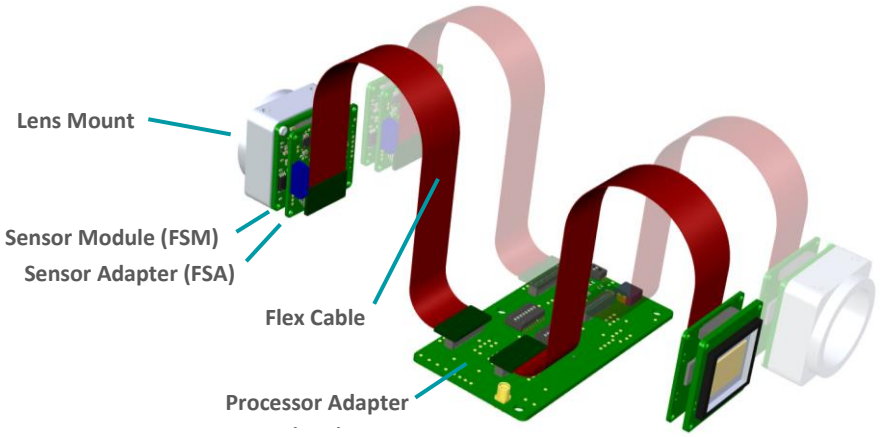


Figure 1: Assembly of a typical Sensor Module Development Kit

Specification and compatibility of all individual components are listed in the appropriate chapter of the full datasheet. Access to software and drivers is only granted with the purchase of the appropriate development kit. Electrical design sources, support and services are provided on individual basis, they are not part of the development kit or component purchase.

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1.2 Materials and Services

Below you can find a list of materials and services as part of the FRAMOS Sensor Module Ecosystem.

Hardware

- FRAMOS Sensor Module Development Kits
- Individual Parts:
    - FRAMOS Sensor Modules
    - FRAMOS Sensor Adapters
    - FRAMOS Processor Adapters
    - FRAMOS Module Accessories (Cables, Mounts)

Software (part of the Development Kit)

- Software Package for NVIDIA Jetson AGX Xavier, Nano, TX2, TX2 NX and Xavier NX
- Software Package for DragonBoard 410c (96Boards)
- Xilinx FPGA reference implementation for SLVS-EC (Sony IMX421, IMX530)

Design Sources (on Project Basis)

- Software Driver Sources
- Electrical References for FSA, FPA (Schematics)

Design Services

- Off-the-shelf hardware customization including size, shape, connector and extended functionality
- Software customization and extension
    - Additional processor board support
    - Further sensor features and image (pre-)processing
- Integration of additional sensors
- Optimization for volume production
- Lens assembly and alignment
- System / solution development
- Production and integration

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1.2.1 Native MIPI CSI-2 Modules

Global Shutters

Model Name	FSM-IMX297	FSM-AR0144	FSM-IMX296	FSM-HDP230	FSM-IMX565
Shutter Type	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter
Technology	Pregius (Gen2)(Bin)	-	Pregius (Gen2)	-	Pregius S (Gen4)
Resolution [MP]	0.4	1	1.6	2.3	12.3
Resolution [HxV]	728 x 544	1280 x 800	1456 x 1088	1944 x 1204	4128 x 3008
Max. Framerate [FPS]	120.9 FPS (1-Lane)	60.3 FPS (2-Lane)	60.4 FPS (1-Lane)	59.9 FPS (4-Lane) 59.9 FPS (2-Lane)	42.6 FPS (4-Lane) 22.3 FPS (2-Lane)
Mono / Color	Mono	Color / Mono	Mono	Color / Mono	Color / Mono
Sensor Manufacturer	Sony	ON Semiconductor	Sony	Pyxalis	Sony
Sensor Name	IMX297LLR / IMX297LQR	AR0144CSSM / AR0144CSSC	IMX296LLR / IMX296LQR	HDPYX 230-G Mono / HDPYX 230-G RGB	IMX565AAMJ-C / IMX565AAQJ-C
Application / Grade	Sensing	Industrial	Sensing	Automotive	Industrial
Optical Format [inch]	1/2.9	1/4	1/2.9	1/2.5	1/1.1
Pixel Size [µm]	6.9 x 6.9	3 x 3	3.45 x 3.45	3.2 x 3.2	2.74 x 2.74
Pixel Bitdepth [bit]	10 bit	10 / 12 bit	10 bit	8 / 10 / 12 / 14 / 16 bit	8 / 10 / 12 bit
Data Interface [Type]	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2
Data Interface [# Lanes]	1	1 / 2	1	2 / 4	2 / 4
Communication Interface	I^2C (4-wire serial)	I^2C	I^2C (4-wire serial)	I^2C	I^2C
Drive Frequency [MHz]	37.125 / 74.25 / 54	6 to 48	37.125 / 74.25 / 54	6 to 27	37.125 / 54 / 74.25 MHz
Input Voltages	1.2V, 1.8V, 3.3V	1.2V, 1.8V, 2.8V	1.2V, 1.8V, 3.3V	1.2V, 1.8V, 2.8V	1.1V, 1.8V, 2.9V, 3.3V
Supported Lens Mounts	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	C/CS-Mount option
Board Dimensions [mm²]	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm

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Rolling Shutters (Part 1/3) – up to 5 MP

Model Name	FSM-IMX327	FSM-IMX290	FSM-IMX462	FSM-IMX464	FSM-IMX335	FSM-AR0521
Shutter Type	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter
Technology	Starvis + NIR	Starvis + NIR	Starvis	Starvis + NIR	Starvis	-
Resolution [MP]	2.1	2.1	2.1	4.2	5	5
Resolution [HxV]	1920 x 1080	1920 x 1080	1920 x 1080	2712 x 1538	2616 x 1964	2592 x 1944
Max. Framerate [FPS]	60 FPS (4-Lane) 60 FPS (2-Lane)	120 FPS (4-Lane) 60 FPS (2-Lane)	120 FPS (4-Lane) 60 FPS (2-Lane)	90 FPS (4-Lane) 30 FPS (2-Lane)	60 FPS (4-Lane) 30 FPS (2-Lane)	69 FPS (4-Lane) 34 FPS (2-Lane)
Mono / Color	Color	Color	Mono	Color / Mono	Color / Mono	Color / Mono
Sensor Manufacturer	Sony	Sony	Sony	Sony	Sony	ON Semiconductor
Sensor Name	IMX327LQR1	IMX462LQR-C	IMX290LLR / IMX290LQR	IMX464LQR-C	IMX335LLN / IMX335LQN	AR0521SR2M / AR0521SR2C
Application / Grade	Security	Security	Security	Security	Security	
Optical Format [inch]	1/2.8	1/2.8	1/2.8	1/1.8	1/2.8	1/2.5
Pixel Size [µm]	2.9 x 2.9	2.9 x 2.9	2.9 x 2.9	2.9 x 2.9	2 x 2	2.2 x 2.2
Pixel Bitdepth [bit]	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	8 / 10 / 12 bit
Data Interface [Type]	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2
Data Interface [# Lanes]	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4
Communication Interface	I^2C (4-wire serial)	I^2C	I^2C (4-wire serial)	I^2C	I^2C	I^2C
Drive Frequency [MHz]	37.125 / 74.25	37.125 / 74.25	37.125 / 74.25	6 to 27 / 37.125 / 74.25	6 - 27 / 37.125 / 74.25	10 to 48
Input Voltages	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.7V
Supported Lens Mounts	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options
Board Dimensions [mm²]	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5

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Rolling Shutters (Part 2/3) – 8 MP

Model Name	FSM-IMX334	FSM-IMX485	FSM-IMX585	FSM-IMX678	FSM-IMX415	FSM-IMX715
Shutter Type	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter
Technology	Starvis	Starvis + NIR	Starvis2	Starvis2	Starvis + NIR	Starvis + NIR
Resolution [MP]	8.3	8.3	8.3	8.3	8.4	8.4
Resolution [HxV]	3864 x 2180	3864 x 2180	3856 x 2180	3856 x 2180	3864 x 2192	3864 x 2192
Max. Framerate [FPS]	60 FPS (4-Lane)	72 FPS (4-Lane) 38 FPS (2-Lane)	90.1 FPS (4-Lane) 30 FPS (2-Lane)	72 FPS (4-Lane) 30 FPS (2-Lane)	90 FPS (4-Lane) 44 FPS (2-Lane)	90 FPS (4-Lane) 44 FPS (2-Lane)
Mono / Color	Color / Mono	Color	Color	Color / Mono	Color	Color
Sensor Manufacturer	Sony	Sony	Sony	Sony	Sony	Sony
Sensor Name	IMX334LLR / IMX334LQR	IMX485LQJ	IMX585AAQJ1-C	IMX678AAQR1	IMX415-AAQR	IMX715AAQR1
Application / Grade	Security	Security	Security	Security	Security	Security
Optical Format [inch]	1/1.8	1/1.2	1/1.2	1/1.8	1/2.8	1/2.8
Pixel Size [µm]	2 x 2	2.9 x 2.9	2.9 x 2.9	2 x 2	1.45 x 1.45	1.45 x 1.45
Pixel Bitdepth [bit]	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit
Data Interface [Type]	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2
Data Interface [# Lanes]	4	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4
Communication Interface	I²C	I²C	I²C	I²C	I²C	I²C
Drive Frequency [MHz]	6 - 27 / 37.125 / 74.25	6 to 27 / 37.125 / 74.25	6 to 27 / 37.125 / 72 / 74.25	6 - 27 / 37.125 / 74.25	24 / 27 / 37.125 / 72 / 74.25	24 / 27 / 37.125 / 72 / 74.25
Input Voltages	1.2V, 1.8V, 2.9V	1.2V, 1.8V, 2.9V	1.1V, 1.8V, 3.3V	1.1V, 1.8V, 3.3V	1.1V, 1.8V, 2.9V	1.1V, 1.8V, 2.9V
Supported Lens Mounts	M12 or C/CS-Mount options	C/CS-Mount option	C/CS-Mount option	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options
Board Dimensions [mm²]	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5

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Rolling Shutters (Part 3/3) – equal or higher than 12 MP

Model Name	FSM-IMX412	FSM-IMX577	FSM-IMX477	FSM-AR1335	FSM-IMX283
Shutter Type	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter
Technology	Starvis	Starvis	Starvis	-	Starvis
Resolution [MP]	12.3	12.3	12.3	13.1	20.2
Resolution [HxV]	4056 x 3040	4056 x 3040	4056 x 3040	4208 x 3120	5496 x 3694
Max. Framerate [FPS]	59.9 FPS (4-Lane) 30 FPS (2-Lane)	59.9 FPS (4-Lane) 30 FPS (2-Lane)	59.9 FPS (4-Lane) 30 FPS (2-Lane)	27.2 FPS (4-Lane) 13 FPS (2-Lane)	24.7 FPS (4-Lane)
Mono / Color	Color	Color	Color	Color	Color
Sensor Manufacturer	Sony	Sony	Sony	ON Semiconductor	Sony
Sensor Name	IMX412-AACK	IMX477-AAPK	IMX577-AACK	AR1335CSSM / AR1335CSSC	IMX283CQJ
Application / Grade	Security	Security	Security	Industrial	Audio/Video
Optical Format [inch]	1/2.3	1/2.3	1/2.3	1/3.2	1
Pixel Size [µm]	1.55 x 1.55	1.55 x 1.55	1.55 x 1.55	1.1 x 1.1	2.4 x 2.4
Pixel Bitdepth [bit]	10 / 12 bit	8 / 10 / 12 bit	8 / 10 / 12 bit	8 / 10 bit	10 / 12 bit
Data Interface [Type]	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2
Data Interface [# Lanes]	2 / 4	2 / 4	2 / 4	2 / 4	4
Communication Interface	I²C (CCI)	I²C (CCI)	I²C (CCI)	I²C	I²C
Drive Frequency [MHz]	6 / 12 / 18 / 27	6 to 27	6 to 27	6 to 48	6 to 27
Input Voltages	1.05V, 1.8V, 2.75V	1.05V, 1.8V, 2.8V	1.05V, 1.8V, 2.8V	1.2V, 1.8V, 2.7V	1.2V, 1.8V, 2.9V
Supported Lens Mounts	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options	C/CS-Mount option
Board Dimensions [mm²]	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5	26.5 x 26.5

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1.2.2 Sub-LVDS, SLVS and SLVS-EC Modules

Model Name	FSM-IMX264	FSM-IMX304	FSM-IMX530
Shutter Type	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter
Technology	Pregius (Gen2)	Pregius (Gen2)	Pregius S (Gen4)
Resolution [MP]	5.1	12.4	24.5
Resolution [HxV]	2464 x 2056	4112 x 3008	5328 x 4608
Max. Framerate [FPS]	CSI-2: 35.7 FPS (4-Lane)	CSI-2: 23.4 FPS (4-Lane)	SLVS-EC: 106.9 FPS (8-Lane) CSI-2: 30 FPS (4-Lane)
Mono / Color	Color / Mono	Color / Mono	Color / Mono
Sensor Manufacturer	Sony	Sony	Sony
Sensor Name	IMX264LLR / IMX264LQR	IMX304LLR / IMX304LQR	IMX530-AAMJ / IMX530-AAQJ
Application / Grade	Industrial	Industrial	Industrial
Optical Format [inch]	2/3	1.1	1.2
Pixel Size [µm]	3.45 x 3.45	3.45 x 3.45	2.74 x 2.74
Pixel Bitdepth [bit]	12 bit	12 bit	8 / 10 / 12 bit
Data Interface [Type]	SubLVDS	SubLVDS	SLVS, SLVS-EC
Data Interface [# Lanes]	4	4 / 8	1 / 2 / 4 / 8
Communication Interface	I²C (4-wire serial)	I²C (4-wire serial)	I²C (4-wire serial)
Drive Frequency [MHz]	37.125 / 54 / 74.25	37.125 / 54 / 74.25	37.125 / 54 / 74.25
Input Voltages	1.2V, 1.8V, 3.3V	1.2V, 1.8V, 3.3V	1.1V, 1.8V, 2.9V, 3.3V
Supported Lens Mounts	C/CS-Mount option	C/CS-Mount option	C/CS-Mount option
Board Dimensions [mm²]	28 x 28	28 x 28	28 x 28

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2 Software Package and Drivers

As FRAMOS we know that the getting started with a new technology is the biggest challenge. The idea behind the Software Package is to enable embedded software engineers to get quickly to a streaming system and provide at the same time all tools that are needed to extend and adapt it according the individual needs of the application.

What the software package and driver are:

- A reference for a custom sensor implementation
- Demonstrating how to use the required interfaces
- Demonstrating how to communicate with the image sensor
- Demonstrating how to generaly initialize and configure the image sensor
- Provide initial image streaming output to the user space
- Demonstrating how to run basic image processing on pixel data

Supported Processor Platforms

The table below shows which platforms are supported by the standard driver package, and how many FSMs can at maximum be operated in parallel.

Sensor Module	NVIDIA Jetson TX2	NVIDIA AGX Xavier	NVIDIA Jetson Nano, TX2 NX, Xavier NX	DragonBoard 410c	96Boards Consumer Edition	Xilinx Development Boards
FSM-AR0144	4		2		HW only, driver development on project basis.	
FSM-AR0521	4		2	2		
FSM-AR1335	4		2			
FSM-HDP230	4	4	2			
FSM-IMX264	2	4	-			
FSM-IMX283	2	4	-			
FSM-IMX290	4		2	2		
FSM-IMX296	4		2	2		
FSM-IMX297	4		2			
FSM-IMX304	2	4	-			
FSM-IMX327	4		2	2		
FSM-IMX334	2	4	-			
FSM-IMX335	4		2			
FSM-IMX412	4		2	2		
FSM-IMX415	4		2			
FSM-IMX462	4		2			
FSM-IMX464	4		2			
FSM-IMX477	4		2			
FSM-IMX485	4		2			
FSM-IMX565	4		2			
FSM-IMX577	4		2			
FSM-IMX585	4		2			
FSM-IMX678	4		2			
FSM-IMX715	4		2			
FSM-IMX530	2	4	-			1[1]

Table 1: Ecosystem Software Package - Supported number of FSMs per processing board

[1] SLVS-EC based FPGA reference implementation as part of the SLVS-EC RX IP Core offering.

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2.1 Reference Software: NVIDIA Jetson Family

The software package provided with the Development Kits of the FRAMOS Sensor Module Ecosystem provided for NVIDIA Jetson platforms provides a reference implementation of sensor and device drivers for MIPI CSI-2. It contains a minimum feature set demonstrating how to utilize the platform specific data interface and communication implementation, as well as the initialization of the image sensor and implementation of basic features.

Package Content:

- Platform and device drivers with Linux for Tegra Support
- V4L2 based subdevice drivers (low-level C API)
- Streamlined V4L2 library (LibSV) providing generic C/C++ API
- Display Examples:
    - OpenCV (Software)
    - LibArgus (Hardware)

Supported Devices:

- NVIDIA Jetson Nano Developer Kit (B01)
- NVIDIA Jetson TX2 Developer Kit
- NVIDIA Jetson TX2 NX Developer Kit
- NVIDIA Jetson Xavier NX Developer Kit
- NVIDIA Jetson AGX Xavier Developer Kit

2.1.1 Platform and Sensor Device Drivers

The driver divides into two main parts that are configured in separate ways – the Image Modes and the General Features of the image sensor.

Image Modes

These are major attributes that have impact to the image data stream formatting. They require a static pre-configuration within the device tree (DT):

- Image / streaming resolution
- Pixel format / bit depth
- Data rate / lane configuration

Each driver provides access to 3 – 5 pre-built configurations, reflecting the main operation modes of the imager. Beside the full resolution, that is always available, they allow to receive image streams in common video resolutions like VGA, Full HD and UHD as they are supported or make sense by the imagers, and utilize sensor features like ROI and binning.

They act as an example for implementation and usage and are available as source. Due to the size limitation of the device tree, it is not possible to integrate an extensive set of options.

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General Features

These are attributes of the image sensor that do not manipulate the data stream formatting. The drivers provided with the Software Pack integrate the sensor features as shown in the table below.

Pre-Implemented Features per Model	Gain (Analog / Digital)	Frame Rate	Exposure Time	Flip / Mirror	IS Mode (Master / Slave)	Sensor Mode ID	Test Pattern Output	Black Level	HDR Output	Broadcast	Data Rate	Synchronizing Master
FSM-AR0144												
FSM-AR0521												
FSM-AR1335												
FSM-HDP230												
FSM-IMX264												
FSM-IMX283												
FSM-IMX290												
FSM-IMX296												
FSM-IMX297												
FSM-IMX304												
FSM-IMX327												
FSM-IMX334												
FSM-IMX335												
FSM-IMX412												
FSM-IMX415												
FSM-IMX462												
FSM-IMX464												
FSM-IMX477												
FSM-IMX485												
FSM-IMX530												
FSM-IMX565												
FSM-IMX577												
FSM-IMX565												
FSM-IMX585												
FSM-IMX678												
FSM-IMX715												

V4L (libsv) and libargus
V4L (libsv)
Not Supported/Implemented

Table 2: Supported sensor features on NVIDIA Jetson Family

Further features, as they are supported by the image sensor, can be integrated into the driver sources using the image sensor datasheet.

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2.1.2 Image Pre-Processing Examples

The provided image processing examples show the general mechanisms of data handling for an image processing using 3rd-party libraries. The OpenCV example provides data that is raw (mono) or demosaiced (color) and not further optimized for visual experience, while the LibArgus examples leverages the discrete ISP (Image Signal Processor) inside the Jetson SoC to optimize image reproduction.

Argus Camera Example:

- Using hard ISP in NVIDIA Jetson SoCs, most performant option for image preprocessing
- Only applicable for color sensors (color processing can't be disabled)
- Most performant option
- Utilizing libArgus closed source library, support and tuning on individual basis through FRAMOS
- Example Implementation: Shows Demo Tuning per FSM Devkit

	Xavier (AGX, NX)	**Tegra X2** (TX2, TX2 NX)	**Tegra X1** (TX1, Nano)
Performance			
Max. # of streams through ISP	16	12	6
Pixel Bandwidth (max.)	2 Gpix/s	1.4 Gpix/s	1.4 Gpix/s
Image Resolution (max.)	64 MP	24 MP	24 MP
Image Width (max.)	6144 px	6144 px	6144 px

Table 3: ISP capabilities / limitations of NVIDIA Jetson Family

The software package provided with our FSM Devkits contains a functionally and performance limited example configuration for the Jetson ISP. The configuration is sensor and lens related and demonstrates the combination of our standard kit in environments that are illuminated with fluorescent light, like in office or laboratory.

Supported Features in Default Configuration	
Lens Considered (Type)	Yes (Devkit Lens)
IR Cut Filter (Type)	Yes (650nm/50%)
Sensor Configuration	Driver Default
Demosaic	Yes[2]
Black Level Compensation	Yes (Calibrated)
Bad Pixel Correction	Yes (Calibrated)
Color Correction	Yes (Calibrated)
Auto White Balance (A, TL84, D65)	Limited (Calibrated for TL84 only)
Manual White Balancing	Limited (Not Calibrated)
Lens Shading / Falloff Correction	Limited (Calibrated for Devkit lens)
Noise Reduction	Limited (Not Calibrated)
Sharpening	Limited (Not Calibrated)
Auto Exposure, Gain, Gamma, Color/Tone, Contrast Tuning	Requires Application Specific Tuning

Table 4: Default tuning of NVIDIA Jetson, supplied with FSM Devkits

[2] Demosaicing is always active and can't be disabled. For monochrome sensors refer to libSV to bypass the ISP.

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To archive best performance and stable results also in variable lighting conditions, a fully featured calibration will be required. As NVIDIA camera partner, FRAMOS provides full ISP configurations for standard setups on request. Further, full custom calibration services considering lens and application specific requirements for sophisticated applications are provided on per project basis.

OpenCV Example:

- Open software library
- Easy to use and large feature set
- Very resource hungry (CPU)
- Not recommended for pre-processing
- Example Implementation: Demosaicing, Displaying

Due to limited performance and extreme resource utilization, the image processing support utilizing the CPU will not be further enhanced.

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3 Ecosystem Compatibility Matrix

3.1 Hardware Support

The following matrix shows the compatibility of FSMs, FSAs and FPAs to each other. The FSAs differentiate to each other by supplied voltages, power up sequence, generated clock (oscillator) and physical attributes.

Sensor Modules with MIPI CSI-2 (D-PHY) Output

Item	FSM-IMX412 FSM-IMX477 FSM-IMX577	FSM-IMX290 FSM-IMX327 FSM-IMX334 FSM-IMX335 FSM-IMX462 FSM-IMX464 FSM-IMX485	FSM-IMX296 FSM-IMX297	FSM-AR0521 FSM-AR1335	FSM-IMX415 FSM-IMX715	FSM-IMX283	FSM-AR0144	FSM-HDP230	FSM-IMX565 FSM-IMX585 FSM-IMX678
FSA-FT1/A	FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]								
FSA-FT3/A		FPA-4.A/TXA FPA-A/NVN[4] FPA-2.A/96B FPA-ABC/XX1[3]							
FSA-FT6/A			FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]						
FSA-FT7/A				FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]					
FSA-FT11/A					FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]				
FSA-FT12/A						FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1[3]			
FSA-FT13/A							FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]		
FSA-FT19/A								FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]	
FSA-FT26/A									FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1[3]

Table 5: Ecosystem Compatibility Matrix – Native CSI-2 (D-PHY) FSMs

[3] Not verified, Xilinx Development Board with hard MIPI CSI-2 / D-PHY interface.
[4] FSM-IMX334 is not supported due to the sensor requiring 4-lanes MIPI.

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Sensor Modules with (Sub-) LVDS and SLVS Output

Item	Data Output (FSA)	FSM-IMX264	FSM-IMX304	FSM-IMX421	FSM-IMX530
FSA-FT14/A-00G	MIPI CSI-2	FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1[3]			
FSA-FT15/A-00G	MIPI CSI-2		FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1[3]		
FSA-FT18/A-00G	MIPI CSI-2				FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1[3]
FSA-FT18/BC	SLVS, SLVS-EC				FPA-ABC/XX1 FPA-C/AGX
FSA-FT20/BC	SLVS-EC			FPA-ABC/XX1	

Table 6: Ecosystem Compatibility Matrix – Sub-LVDS, SLVS and SLVS-EC FSMs

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