



FSM-IMX296 Datasheet

Sony IMX296LLR / IMX296LQR Sensor Module

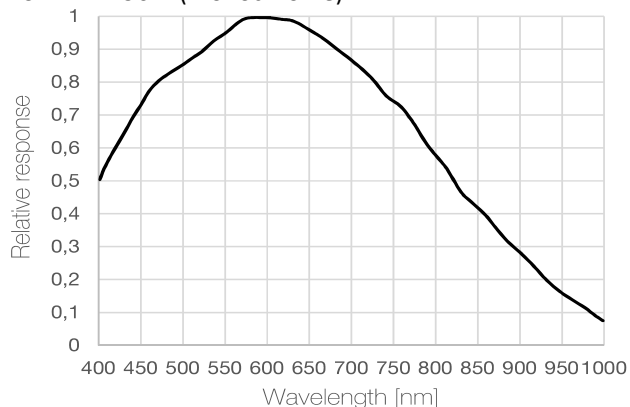
FRAMOS Sensor Module



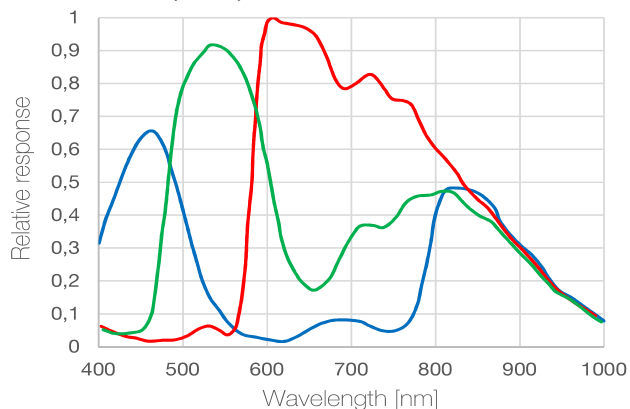
Key Benefits & Features:

- 1.6 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-IMX296M (Monochrome):



FSM-IMX296C (Color):



Specification

Model Name FSM-IMX296M / FSM-IMX296C (V1A-V1B)

Image Sensor

Vendor / Name	Sony IMX296LLR / IMX296LQR
Shutter Type	CMOS Global Shutter
Chromaticity	Mono
Optical Format	1/2.9"
Pixel Size	3.45 x 3.45 μ m
Max. Resolution	1.6 Mpx / 1440 x 1080 px
Framerate (max.)	60.4 FPS (1-Lane)
Bit Depth(s)	10 bit

Interface

Data Interface	MIPI CSI-2 (1 Lane)
Communication Interface	I ² C (4-wire serial)
Drive Frequency(s)	37.125 / 74.25 / 54 MHz
Input Voltages	1.2V, 1.8V, 3.3V
Interface Connector	Hirose DF40C-60DP-0.4V(51)
EEPROM (Sensor ID)	No

Mechanical

Dimensions (HxWxD) 26.5 mm x 26.5 mm

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

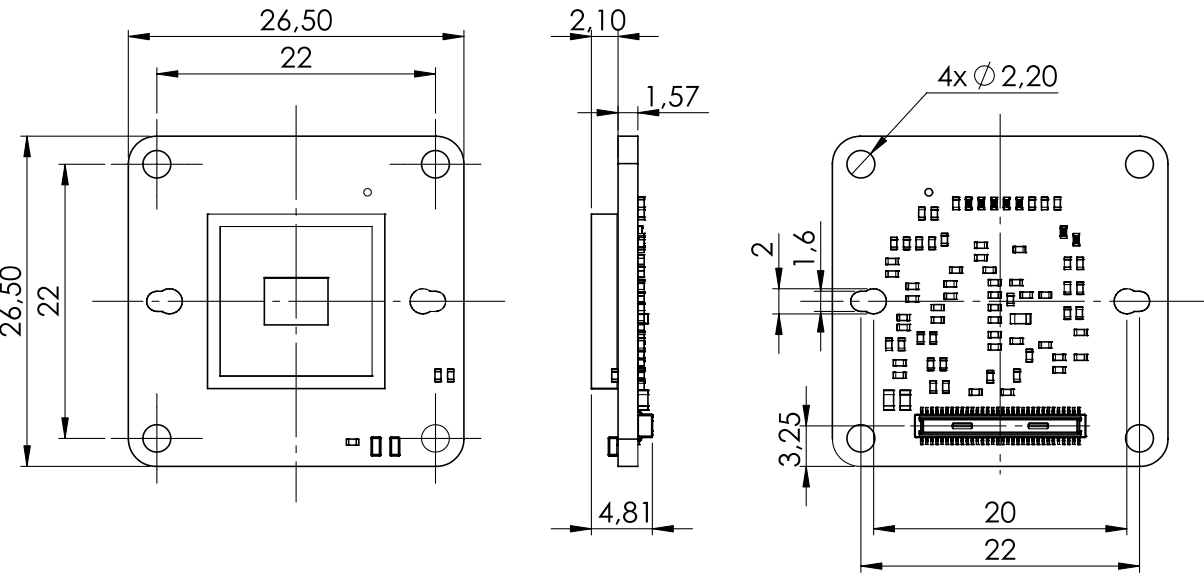
Driver	V4L2 Based Device Driver
Supported Platform(s)	NVIDIA Jetson Family: AGX Xavier, Nano, TX2, Xavier NX Qualcomm DragonBoard 410C
Software Version(s)	NVIDIA JP4.4 / L4T32.4.3 DB410C: Linaro 18.01 / Kernel 4.14

Suggested Accessories & Adapters

Compatible FSA	
Recommended Devkit(s)	FSM-IMX296x/TXA_Devkit (TX2, AGX) FSM-IMX296x/NVN_Devkit (Nano, NX)
Lens Mounts	M12 or C/CS-Mount options

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

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	XCLR	NC	XMASTER	SCK_SCL	XCE	XVS	SDI_SDA	XHS	XTRIG	NC	SLAMODE	GND	INCK	NC	GND	NC	NC	GND	NC	CSI_D0_N	CSI_D0_P	GND	NC	NC
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 1 according to print on PCB.

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	NC	NC	1V2	1V2	NC	GND	GND	NC	SDO	TOUT1	NC	NC	TOUT2	NC	NC	TOUT0	NC	NC	GND	NC	NC	GND	NC	NC	GND	NC	NC	GND	CSI_CLK_P	CSI_CLK_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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Full Datasheet

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ATTENTION

Electrostatic sensitive devices!
Observe precautions for handling!

Handling ESD Sensitive Components

The electronic components like Printed Circuit Boards (PCB) described in this document are sensitive to Electrostatic Discharge (ESD) and need to be handled with high care in static controlled environments. It is strongly recommended to follow the general handling practices for ESD sensitive parts, that include, but are not limited to, the following points:

- Treat all PCBs and components as ESD sensitive.
- Assume that you will damage the PCB or component if you are not ESD conscious
- Handling areas must be equipped with a grounded table, floor mats and wrist strap
- A relative humidity level must be maintained between 20% and 80% non-condensing
- PCBs should not be removed from their protective package, except in a static controlled location
- PCBs must be handled only after personnel have grounded themselves via wrist straps and mats
- PCBs or components should never come in contact with clothing
- Try to handle all PCBs only by their edges, preventing contact with any components.

FRAMOS is not responsible for any damages caused by ESD on customer side.

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

Ready to go Software Package

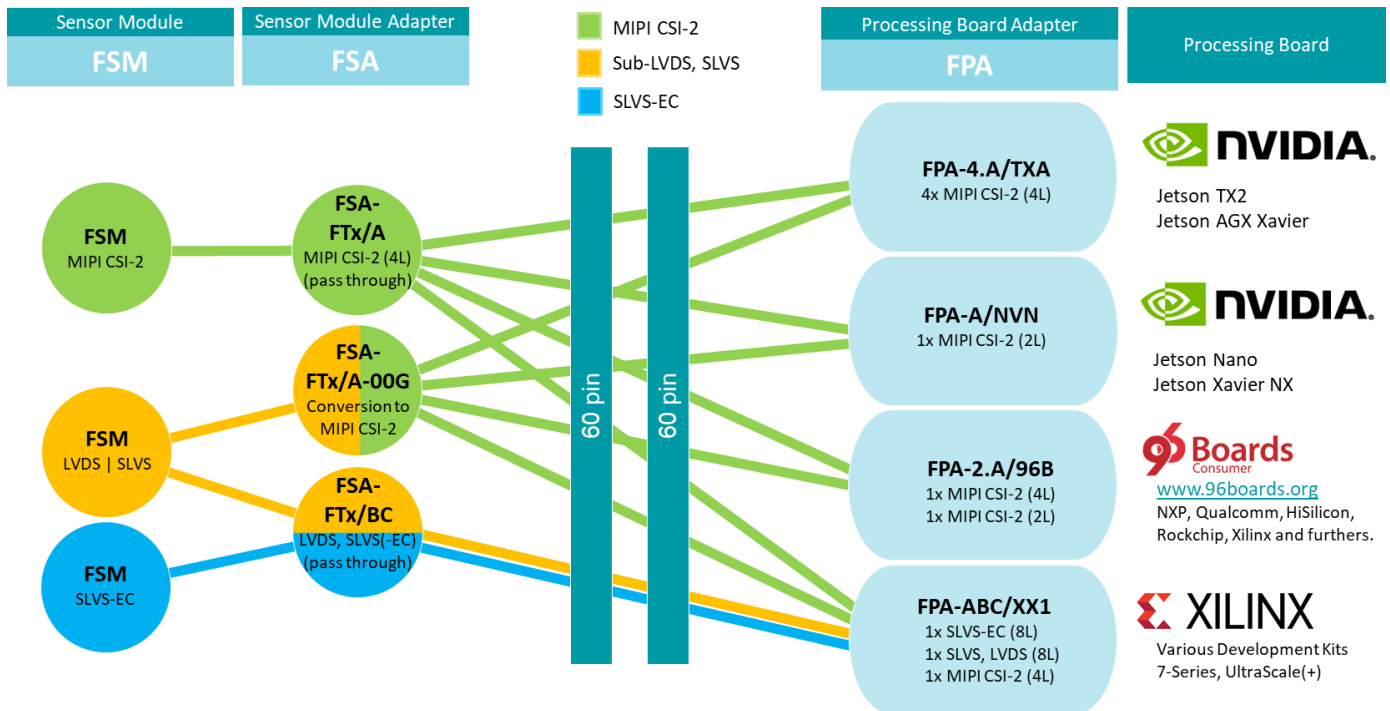
- Drivers with basic sensor integration:
 - Platform specific device drivers
 - V4L2 subdevice drivers for specific image sensors (low-level C API)
- Streamlined V4L2 library (LibSV) with comfortable and generic C/C++ API
- Example applications demonstrating initialization, main configuration and image stream processing

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

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).

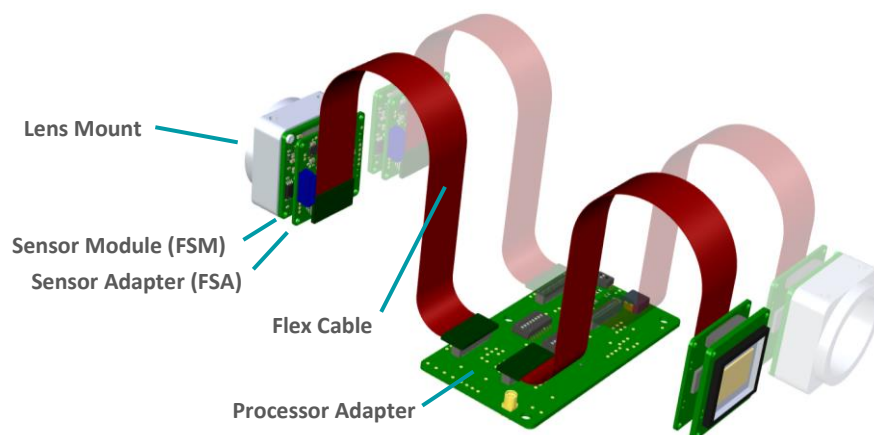


Figure 1: Assembly of a typical Sensor Module Development Kit

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.

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 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

2 Start-Up Instructions

The following chapter describes the hardware assembly procedure by reference to a generalized example. The actual setup depends much on the actually used components and might differ from the description. However, the main steps, rules and cautions apply to every system.

2.1 Hardware Assembly

All Development Kits come pre-assembled. It is only required to connect the FSM, FSA and Flex Cable assembly to the FPA and attach it to the appropriate Processor Board.

Required Materials

FRAMOS Sensor Module Development Kit or individual components:

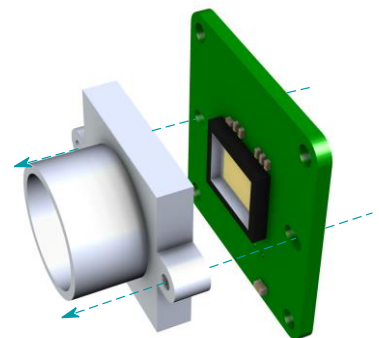
- FSM-xxxxxx
- FSA-FTxx/A
- FPA-xxxxxx
- FMA-FC-150/60-xxxx
- M12 lens mount (optional)

Note: Due to manual alignment requirements for back focal distance and position, C/CS-mounts are regularly shipped already mounted to the FSM.

1. Add M12 lens mount (optional)

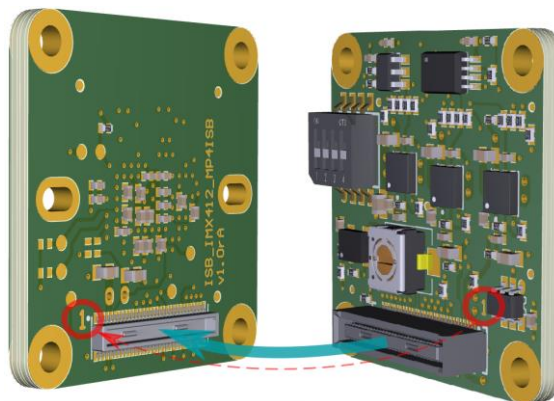
Prior to assembling the FSM to the FSA, screw an optional M12 lens mount to the FSM.

Fitting screws are provided with the lens mount. If assembling a 3rd-party mount, please check the hole diameters for the specific module in its technical drawings to select fitting screws.



2. Connect FSM and FSA

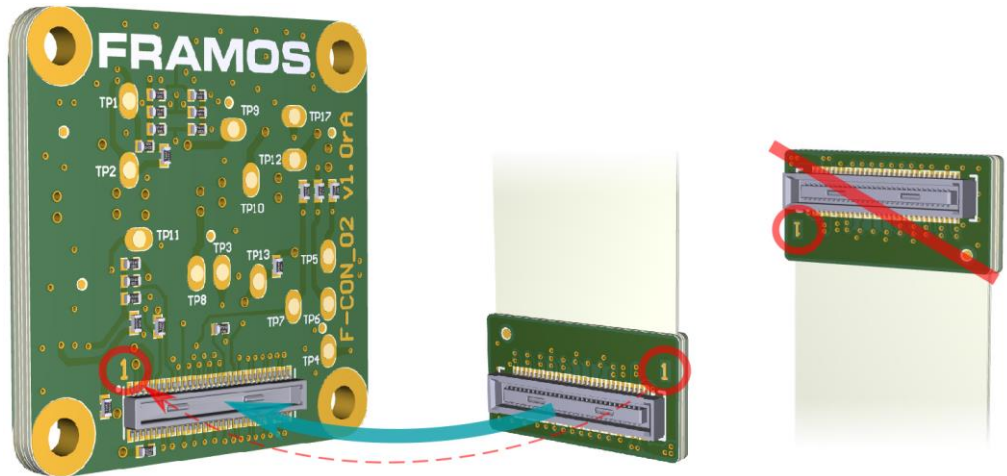
Connect the FSM to the FSA, by pressing the two 60 pin connectors together. Watch carefully for the correct connector orientation and the match of both "Pin1".



Fix the mechanical connection by using the provided screws with distance holders and nuts between both boards. In case of an C/CS-mount, screw the board stack into the lens mount mechanics instead of using the nuts.

3. Add Flex Cable

Connect the FSM, FSA stack via the connector on the rear side of the FSA to the appropriate side of the FMA-FC-150/60 flex cable.

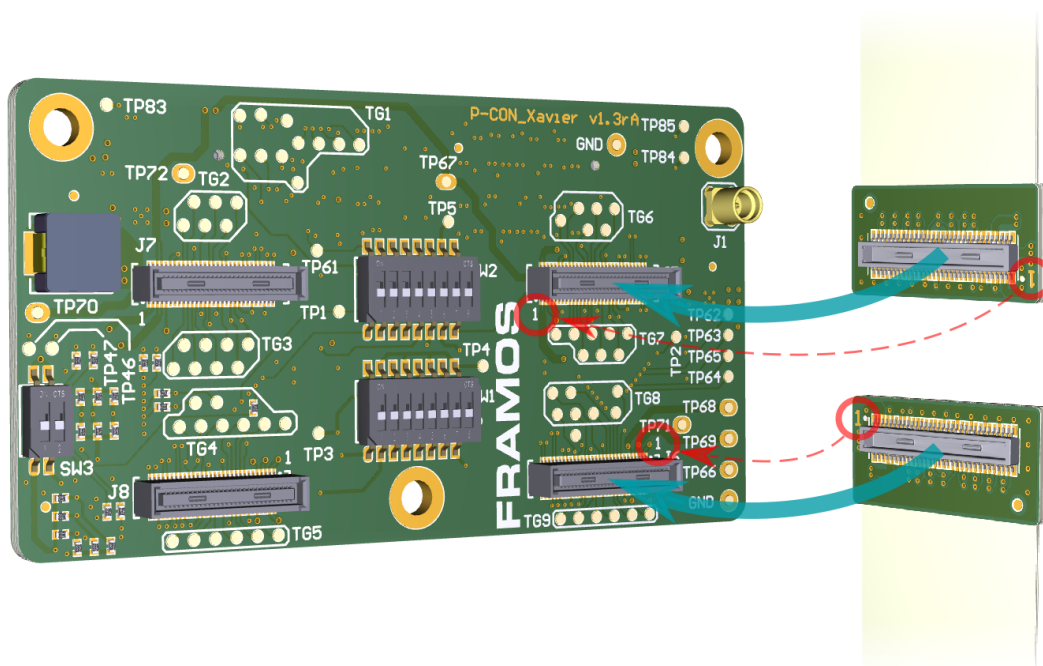


Skip this step, in case you are going to connect a piggy-back FPA like the FPA-A/NVN.

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters or the Processor Board!

4. Connect to FPA

Connect the other side of the flex cable to a sensor connector on the FPA. According to the available sensor interface count, multiple FSM+FSA assemblies can be connected.



With processor boards like the NVIDIA Jetson TX2 Development Kit, the FPA provides access to only two MIPI CSI-2 lanes on FSM3 (J7) and FSM4 (J8). This might lead to restrictions in combination with some FSMs. For compatibility, please review the connector description of the specific FPA.

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters or the Processor Board!

5. Finalize Assembly

Remove the power supply of the processor board and connect the complete assembly to the processor board. Follow the guidelines of the processor board manufacturer for the appropriate camera connector.

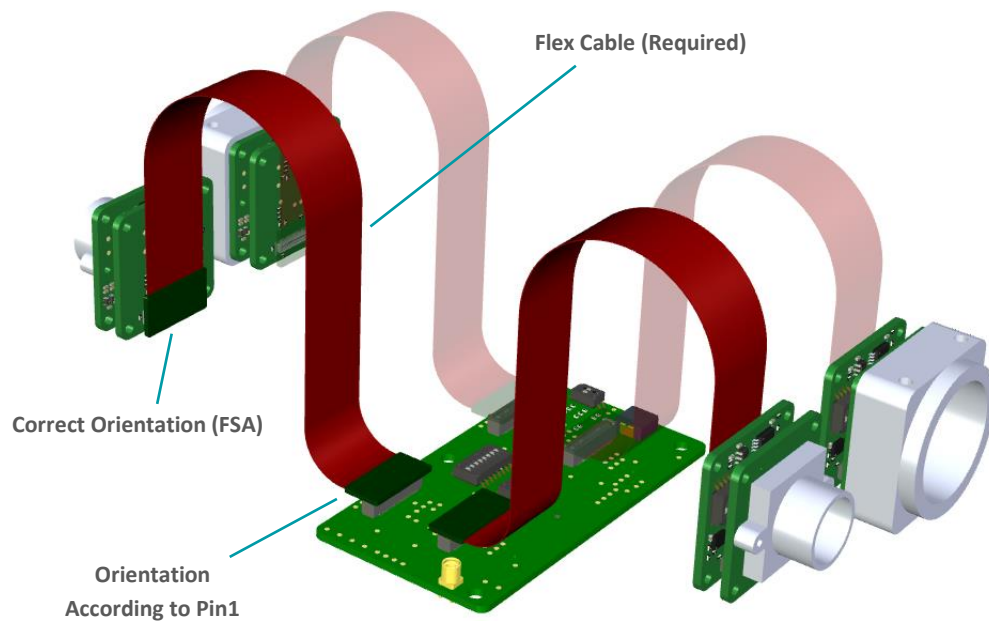


Figure 2: Correct orientation of Flex Cable in an example Multi-Sensor Setup (NVIDIA Jetson)

Power up the processing board and start the software setup.

2.2 Software Setup

For instructions on the setup of the target processor board and driver installation procedure, please refer to the "User Guide" included in the appropriate installation package.

The link to the software download section is included in the Development Kit.

3 FRAMOS Sensor Modules (FSM)

The FRAMOS Sensor Modules are printed circuit boards, interfacing various types of image sensors with standardized connectivity like connector type, pinout, mechanical format and compatible accessories. The target is to provide various sensor boards that can be used 'off the shelf' to connect a variety of image sensors to a host system. Starting from evaluation and proof-of-concept, but also in mass production where adjustments to actual needs are easily possible.

The following chapter provides information on the generic attributes as well as the individual modules, in addition to the individual FSM datasheets.

Common Specification

In general, FSMs are differentiated by two main attributes:

- Image sensor size dependent mechanical footprint (26.5 mm, 28 mm)
- Data interface type specific pinout (MIPI CSI-2, LVDS)

All image sensor signals are routed directly from sensor to the 60-pin connector. All passives visible on the PCB decouple the various power loads of the image sensor. Please refer to the appropriate image sensor documentation for further information.

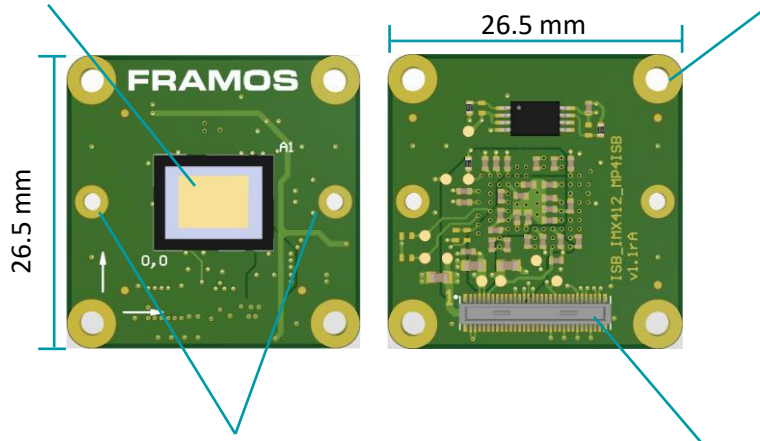
3.1.1 Generic 26.5 mm footprint

Various Image Sensors

- Global & Rolling Shutters
- Optically centered to square PCB

4 Mounting Holes

- Reliable mechanical fixing
- C/CS-Mount options



M12 Lens Options

- Default usage of standard mounts
- Customer Specific lens assembly and focusing

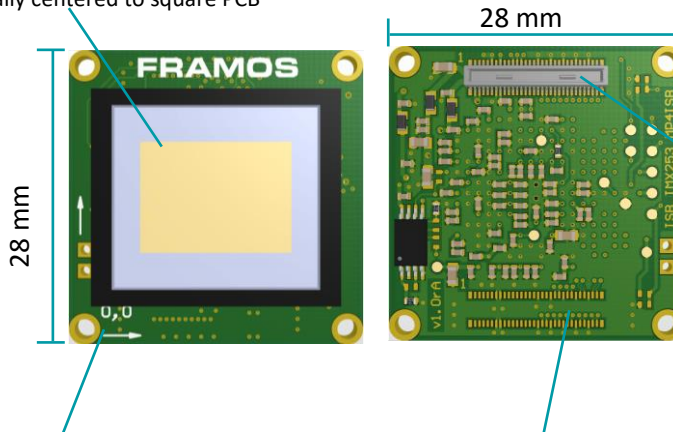
60 pin Standard Interface

- Standardized pinout
- Hirose DF40C-60DP-0.4V(51)
- 4-Lane MIPI CSI-2, D-PHY
- Bottom position

3.1.2 Generic 28 mm footprint

Various Image Sensors $\geq 2/3''$

- Focus on industrial Global Shutters
- Optically centered to square PCB



4 Mounting Holes

- Reliable fixing
- C/CS-Mount options

Second Connector Optional

- Hirose DF40C-60DP-0.4V(51)
- Support for 16 Lane LVDS (8+8 Lanes)
- Bottom position

60 pin Standard Interface

- Standardized pinout
- Hirose DF40C-60DP-0.4V(51)
- Up to 8-Lane Sub-LVDS, SLVS or SLVS-EC output
- MIPI CSI-2 converter options
- Top position

3.2 Connector Pinouts

The FSM Ecosystem adopts a standard Hirose 60 pin board to board connector supporting 5Gbps and beyond, to connect to all relevant signals from the image sensor.

- Connector Type (All FSM): Hirose DF40C-60DP-0.4V
- Number of Pins: 60
- Locking: No
- Shielding: No
- Pinning Layouts:
 - MIPI CSI-2
 - LVDS, SLVS, SLVS-EC

Actual signals used by the individual FSM is image sensor dependent and may vary.

3.2.1 MIPI CSI-2 Pinout (4-Lane)

This pinout scheme applies to all sensors that natively output image data according to the MIPI CSI-2 standard. As by the definition in the MIPI standard, this layout provides 1x4 or 2x2 data lanes on the connector.

Pin#	Signal	Pin#	Signal
1	3V8	2	1V8
3	3V8	4	1V8
5	V_ANA	6	V_DIG
7	V_ANA	8	V_DIG
9	V_IF	10	AUX_V
11	GND	12	GND
13	GND	14	GND
15	RST_0	16	RST_1
17	SPI_MISO	18	SPI_MOSI
19	XMASTER0	20	XMASTER1
21	I2C_0_SCL	22	I2C_1_SCL
23	SPI_CS	24	SPI_SCK
25	XVS0	26	XVS1
27	I2C_0_SDA	28	I2C_1_SDA
29	XHS0	30	XHS1
31	XTRIG0	32	XTRIG1
33	PW_EN_0	34	PW_EN_1
35	SLAMODE1	36	SLAMODE2
37	GND	38	GND
39	INCK	40	UART_TXD
41	MCLK_1	42	UART_RXD
43	GND	44	GND
45	D_CLK_1_P	46	D_DATA_3_P
47	D_CLK_1_N	48	D_DATA_3_N
49	GND	50	GND
51	D_DATA_0_N	52	D_DATA_1_N
53	D_DATA_0_P	54	D_DATA_1_P
55	GND	56	GND
57	D_DATA_2_P	58	D_CLK_0_P
59	D_DATA_2_N	60	D_CLK_0_N

	Common Voltages (from FPA)
	Sensor Specific Voltages (FSA)
	Sensor Signals
	Driving Clocks
	Data Lines

Table 1: Standard Pinout of MIPI CSI-2 (4-Lane) interface

The table above shows the position of each signal on the 60-pin connector in case the image sensor provides it. For further details, please refer to the image sensor Datasheet.

3.2.2 Sub-LVDS, SLVS and SLVS-EC Pinout (8-Lane)

This pinout scheme applies to all sensors that natively output image data using signals according to Sub-LVDS, SLVS or SLVS-EC specification. This layout provides eight data lanes on the connector. Devices with SLVS and SLVS-EC share the same sensor package pins therefore share the same connector pins.

Note: Lane number assignment is applied according to SLVS numbering, which differs in most cases from the SLVS-EC lane numbering. Please refer to image sensor datasheet for correct SLVS-EC numbering.

Pin#	Signal	Pin#	Signal
1	3V8	2	1V8
3	3V8	4	1V8
5	V_ANA	6	V_DIG
7	V_ANA	8	V_DIG
9	V_IF	10	AUX_V
11	GND	12	GND
13	GND	14	GND
15	SDA	16	SCL
17	SDO	18	XCE
19	TOUT0	20	SLAMODE
21	TOUT1	22	XMASTER
23	TOUT2	24	NC
25	NC	26	XTRIG
27	NC	28	XHS
29	NC	30	XVS
31	GND	32	GND
33	RST	34	D_DATA_7_P
35	MCLK	36	D_DATA_7_N
37	GND	38	GND
39	D_DATA_6_P	40	D_DATA_5_P
41	D_DATA_6_N	42	D_DATA_5_N
43	GND	44	GND
45	D_DATA_4_P	46	D_DATA_3_P
47	D_DATA_4_N	48	D_DATA_3_N
49	GND	50	GND
51	D_DATA_2_P	52	D_DATA_1_P
53	D_DATA_2_N	54	D_DATA_1_N
55	GND	56	GND
57	D_DATA_0_P	58	D_CLK_0_P
59	D_DATA_0_N	60	D_CLK_0_N

	Common Voltages (from FPA)
	Sensor Specific Voltages (FSA)
	Sensor Signals
	Driving Clock
	Data Lines

Table 2: Standard Pinout of LVDS (8-Lane) interface

The table above shows the position of each signal on the 60-pin connector in case the image sensor provides it. For further details, please refer to the image sensor Datasheet.

3.3 Portfolio Overview of Sensor Modules

The portfolio of sensor modules includes several FSMs, which are listed with their main attributes on the following pages:

- Native MIPI CSI-2 Modules – Global Shutters
- Native MIPI CSI-2 Modules – Rolling Shutters
- Sub-LVDS, SLVS and SLVS-EC Modules

These attributes describe the individual FSMs without any additional hardware like FSA or FPA. They are defined by the integration of the bare image sensor and are not manipulated or preprocessed in any way.

3.3.1 Native MIPI CSI-2 Modules

Global Shutters

Model Name	FSM-IMX297	FSM-AR0144	FSM-IMX296	FSM-HDP230
Shutter Type	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter	CMOS Global Shutter
Resolution [MP]	0,4	1	1,6	2,3
Resolution [HxV]	720 x 540	1280 x 800	1440 x 1080	1944 x 1204
Max. Framerate [FPS]	120	60	60	60
Mono / Color	Mono	Color / Mono	Mono	Color / Mono
Sensor Manufacturer	Sony	ON Semiconductor	Sony	Pyxalis
Sensor Name	IMX297LLR / IMX297LQR	AR0144CSSC	IMX296LLR / IMX296LQR	HDPYX 230-G Mono / Color
Optical Format [inch]	1/2.9	1/4	1/2.9	1/2.5
Pixel Size [µm]	6.9 x 6.9	3 x 3	3.45 x 3.45	3.2 x 3.2
Pixel Bitdepth	10 bit	10 /12 bit	10 bit	8 /10 /12 /14 /16 bit
Data Interface [Type]	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2	MIPI CSI-2
Data Interface [# Lanes]	1	1 / 2	1	4
Communication Interface	I ² C (4-wire serial)	I ² C	I ² C (4-wire serial)	I ² C
Drive Frequency [MHz]	37.125 / 74.25 / 54	6 to 48	37.125 / 74.25 / 54	6 to 27 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
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
Board Dimensions	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

Rolling Shutters (Part 1/2)

Model Name	FSM-IMX327	FSM-IMX290	FSM-IMX462	FSM-IMX464	FSM-IMX335	FSM-AR0521	FSM-IMX334
Shutter Type	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter	CMOS Rolling Shutter
Resolution [MP]	2,1	2,1	2,1	4,2	5	5	8,3
Resolution [HxV]	1920 x 1080	1920 x 1080	1920 x 1080	2712 x 1538	2592 x 1944	2592 x 1944	3840 x 2160
Max. Framerate [FPS]	60	120	120	90	60	60	60
Mono / Color	Color	Mono	Color	Color	Color / Mono	Color / Mono	Color / Mono
Sensor Manufacturer	Sony	Sony	Sony	Sony	Sony	ON Semiconductor	Sony
Sensor Name	IMX327LQR	IMX290LLR / IMX290LQR	IMX462LQR	IMX464LQR	IMX335LQN / IMX335LLN	AR0521SR2C / AR0521SR2M	IMX334LQR / IMX334LLR
Optical Format [inch]	1/2.8	1/2.8	1/2.8	1/1.8	1/2.8	1/2.5	1/1.8
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	2 x 2
Pixel Bitdepth	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	10 / 12 bit	8 / 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	MIPI CSI-2
Data Interface [# Lanes]	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4	4
Communication Interface	I ² C (4-wire serial)	I ² C (4-wire serial)	I ² C	I ² C	I ² C	I ² C	I ² C
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 - 48	6 - 27 / 37.125 / 74.25 / 54
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	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	M12 or C/CS-Mount options	M12 or C/CS-Mount options	M12 or C/CS-Mount options
Board Dimensions	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	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm

Rolling Shutters (Part 2/2)

Model Name	FSM-IMX485	FSM-IMX415	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	CMOS Rolling Shutter	CMOS Rolling Shutter
Resolution [MP]	8,3	8,4	12,3	12,3	12,3	13,1	20,2
Resolution [HxV]	3840 x 2160	3864 x 2176	4056 x 3040	4056 x 3040	4056 x 3040	4208 x 3120	5496 x 3672
Max. Framerate [FPS]	60	90	60	60	60	30	25
Mono / Color	Color	Color	Color	Color	Color	Color	Color
Sensor Manufacturer	Sony	Sony	Sony	Sony	Sony	ON Semiconductor	Sony
Sensor Name	IMX485LQJ	IMX415-AAQR	IMX412-AACK	IMX577-AACK	IMX477-AACK	AR1335CSSC	IMX283CQJ
Optical Format [inch]	1/1.2	1/2.8	1/2.3	1/2.3	1/2.3	1/3.2	1
Pixel Size [µm]	2.9 x 2.9	1.45 x 1.45	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	10 / 12 bit	10 / 12 bit	10 / 12 bit	8 / 10 / 12 bit	8 / 10 / 12 bit	10 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	MIPI CSI-2
Data Interface [# Lanes]	2 / 4 (/ 8)	2 / 4	2 / 4	2 / 4	2 / 4	2 / 4	4
Communication Interface	I ² C	I ² C	I ² C (CCI)	I ² C (CCI)	I ² C (CCI)	I ² C	I ² C
Drive Frequency [MHz]	6 to 27 / 37.125 / 74.25	24 / 27 / 37.125 / 72 / 74.25	6 / 12 / 18 / 24 / 27	6 to 27	6 to 27	6 to 48	6 to 27
Input Voltages	1.2V, 1.8V, 2.9V	1.1V, 1.8V, 2.9V	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	C/CS-Mount option	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	C/CS-Mount
Board Dimensions	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	26.5 mm x 26.5 mm	26.5 mm x 26.5 mm

3.3.2 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
Resolution [MP]	5,1	12,4	24,5
Resolution [HxV]	2464 x 2056	4112 x 3008	5320 x 4600
Max. Framerate [FPS]	35	23	98
Mono / Color	Color / Mono	Color / Mono	Color / Mono
Sensor Manufacturer	Sony	Sony	Sony
Sensor Name	IMX264LLR / IMX264LQR	IMX304LQR / IMX304LLR	IMX530-AAMJ / IMX530-AAQJ
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	12 bit	12 bit	8 /10 /12 bit
Data Interface [Type]	Sub-LVDS	Sub-LVDS	SLVS, SLVS-EC
Data Interface [# Lanes]	4	4 / 8	1 /2 /4/ 8
Communication Interface	I ² C (4-wire serial)	I ² C (4-wire serial)	I ² C (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	C/CS-Mount option
Board Dimensions	28 mm x 28 mm	28 mm x 28 mm	28 mm x 28 mm

4 Ecosystem for Native MIPI CSI-2 Image Sensors

The following chapters provide the relevant technical information for sensor modules (FSM) with native MIPI CSI-2 data output.

A setup with single or multiple sensor modules consists of one to four FSMs, each with an appropriate sensor specific FSA, and one FPA for the target processor board. Only FSA and FPA designs shown in this chapter are compatible to each other.

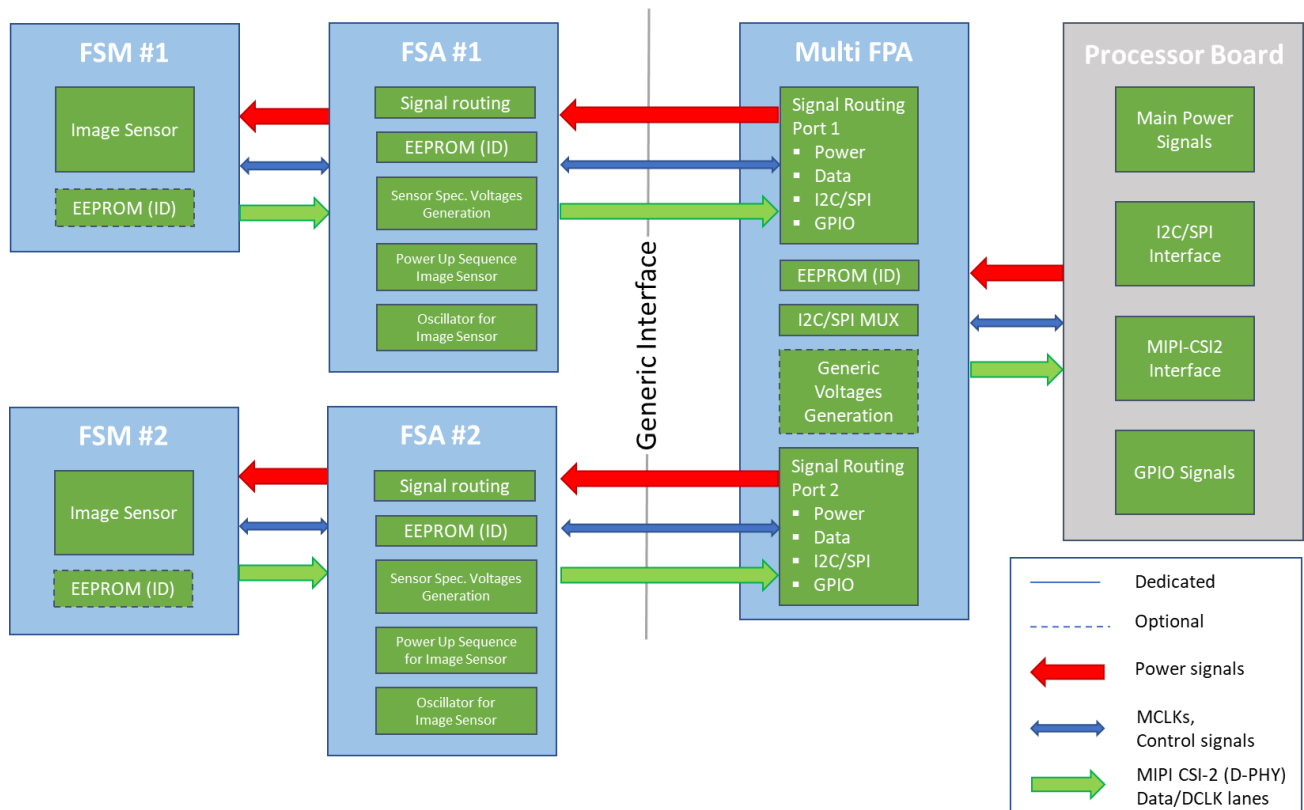


Figure 3: Block Diagram of Components in Multi Sensor Setup

While the FRAMOS Sensor Modules (FSM) are targeting at the most efficient design, the FRAMOS Sensor Adapters (FSA) support all present sensors and their individual electronic requirements from voltage rails to reference clock generation. The goal is to reduce noise and heat generation on image sensor board by moving this to the FSA. Further, it leaves the choice to the user to integrate this circuitry into their own processor board designs with the target to also reduce size and redundancy. All electrical references are created and available on a project by project basis.

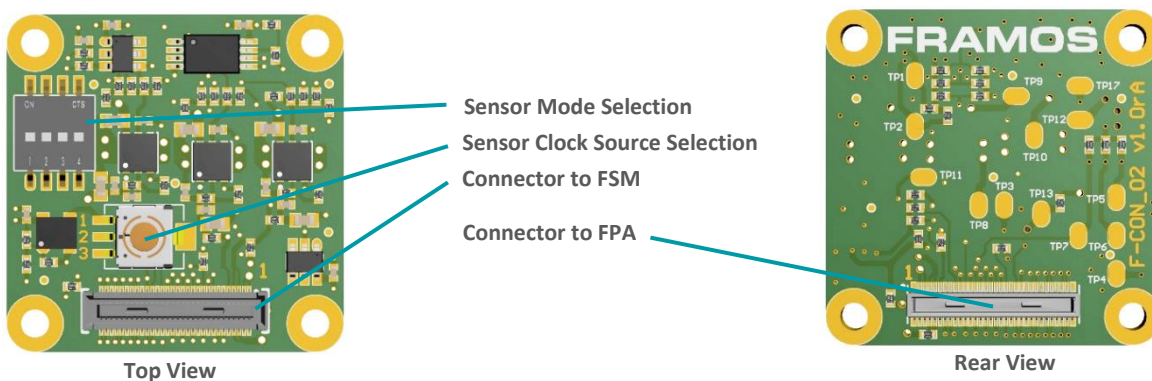
5 FSA-FTx/A: FRAMOS Sensor Adapter for MIPI CSI-2

- Connects FSM with MIPI CSI-2 Output to FPA
- Each FSM has a specific FSA

Functional Blocks:

- Signal routing
- Voltage generation for image sensor
- Power up sequence for image sensor
- Driving frequency generation (oscillator)
- EEPROM (config / ID)

5.1 Interface Description



5.1.1 Sensor Mode Selection

Pos.	Select	State	Description
1	ON OFF	Enabled Disabled	Enable / Disable EEPROM on FSA. Note: It is recommended to be disabled, if FSM is equipped with EEPROM.
2	ON OFF	High Low	Select I2C address of sensor, signal depending on sensor type: SLAMODE, SLASEL or SLAMODE1. Please refer to sensor documentation for available signals.
3	ON OFF	High Low	Select I2C address of sensor, signal availability depending on sensor type: SLAMODE2. Please refer to sensor documentation for available signals.
4	ON OFF	High Low	Drive XMASTER pin of FSM (see sensor documentation for details).

Table 3: Selection of Sensor Mode on FSA-FTx/A-V1

5.1.2 Sensor Clock Source Selection

Pos.	Description
1	Clock Provided from FSA (Default)
2	External Clock 1 (MCLK0)
3	External Clock 2 (MCLK1)

Table 4: Selection of Sensor Clock Source on FSA-FTx/A-V1

5.1.3 Test Points

Name	Signal
TP1	I2C_0_SCL (SPI_SCK)
TP2	I2C_0_SDA (SPI_MOSI)
TP3	IS_MCLK_0
TP4	IS_RST_0
TP5	SLAMODE1
TP6	SLAMODE2
TP7	IS_GPIO0 (XMASTER0)
TP8	GND
TP9	3V8_VDD
TP10	1V8_VDD
TP11	V_ANA
TP12	V_IF
TP13	V_DIG
TP17	GND

Table 5: Test Points on FSA-FTx/A-V1

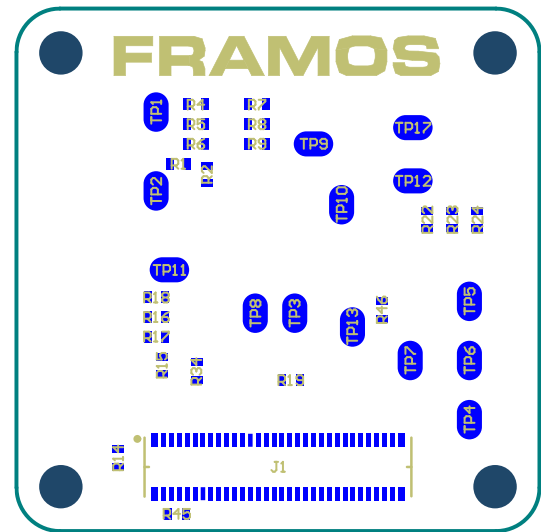


Figure 4: Test Points on FSA-FTx/A-V1

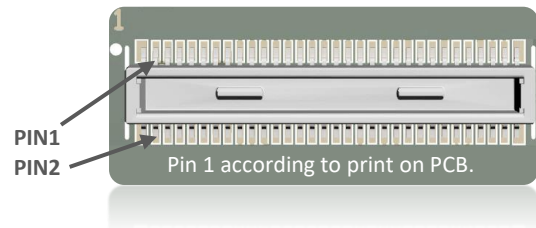
5.1.4 Connector to FPA

Type: Hirose DF40C-60DP-0.4V

Name: J4

Pin #	Name	Pin #	Name
1	3V8_VDD	2	1V8_VDD
3	3V8_VDD	4	1V8_VDD
5	V_ANA	6	V_DIG
7	V_ANA	8	V_DIG
9	V_IF	10	AUX_V
11	GND	12	GND
13	GND	14	GND
15	RST_0_IS	16	RST_1
17	SPI_MISO	18	SPI_MOSI
19	GPIO0(XMASTER0)	20	GPIO8(XMASTER1)
21	I2C_0_SCL	22	I2C_1_SCL
23	SPI_CS	24	SPI_SCK
25	GPIO1(XVS0)	26	GPIO9(XVSI)
27	I2C_0_SDA	28	I2C_1_SDA
29	GPIO2(XHS0)	30	GPIO10(XHS1)
31	GPIO3(XTRIG0)	32	GPIO11(XTRIG1)
33	PW_EN_0	34	PW_EN_1
35	GPIO6(SLAMODE)	36	GPIO7
37	GND	38	GND
39	INCK	40	GPIO4(UART_TXD)
41	MCLK_1	42	GPIO5(UART_RXD)
43	GND	44	GND
45	D_CLK_1_P	46	D_DATA_3_P
47	D_CLK_1_N	48	D_DATA_3_N
49	GND	50	GND
51	D_DATA_0_N	52	D_DATA_1_N
53	D_DATA_0_P	54	D_DATA_1_P
55	GND	56	GND
57	D_DATA_2_P	58	D_CLK_0_P
59	D_DATA_2_N	60	D_CLK_0_N

Table 6: Pinout of FSA-FTx/A-V1, connector to FRAMOS Processor Adapter (FPA)





J4: Signal Description to FPA (Part 1/2)

Pin	Net name	I/O	Primary function description	Connected to	I/O Standard	I/O State	I/O DC Characteristic
1	3V8_VDD	Power	3.8V Power Supply	LDO_ICs, FSM			3V8_VDD=3.7V-5.1V
2	1V8_VDD	Power	1.8V Power Supply	LDO_ICs, FSM			1V8_VDD=1.7V-1.9V
3	3V8_VDD	Power	3.8V Power Supply	LDO_ICs, FSM			3V8_VDD=3.7V-5.1V
4	1V8_VDD	Power	1.8V Power Supply	LDO_ICs, FSM			1V8_VDD=1.7V-1.9V
5	AUX_ANA	Power	Not Connected	(FSM)			
6	AUX_DIG	Power	Not Connected	(FSM)			
7	AUX_ANA	Power	Not Connected	(FSM)			
8	AUX_DIG	Power	Not Connected	(FSM)			
9	AUIF	Power	Not Connected	(FSM)			
10	AUV	Power	Not Connected	(FSM)			
11	GND	GND	Common Ground				
12	GND	GND	Common Ground				
13	GND	GND	Common Ground				
14	GND	GND	Common Ground				
15	RST_0	IN	General reset for FSM, resets images sensor (XCLR).	Reset_IC	LVC MOS18 (1.8V)	Normal: High, Reset: Low	VILmax=0.36V, VIHmin=1.44V
16	RST_1	IN		(Reset_IC)	LVC MOS18 (1.8V)	Normal: High, Reset: Low	VILmax=0.36V, VIHmin=1.44V
17	GPIO14	IN/OUT		FSM			
18	GPIO15_SPI_MISO	OUT		FSM	LVC MOS18 (1.8V)		VOLmax=0.2V, VOHmin=1.6V
19	GPIO0_XMASTER0	IN		(FSM)	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
20	GPIO8	IN/OUT		FSM			
21	I2C_0_SCL_SPI_SCK	IN	I2C SCL for EEPROM and FSM	EEPROM, FSM	LVC MOS18 (1.8V)		VILmax=0.54V, VIHmin=1.26V
22	I2C_1_SCL	IN	Additional I2C SCL for FSM	FSM	LVC MOS18 (1.8V)		VILmax=0.54V, VIHmin=1.26V
23	GPIO17_SPI_CS	IN		FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
24	GPIO16_SYS_PW_EN	IN/OUT		FSM			
25	GPIO1_XVS0	IN/OUT	XVS from/to FSM	FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V, VOLmax=0.2V, VOHmin=1.6V
26	GPIO9	IN/OUT		FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
27	I2C_0_SDA_SPI_MOSI	IN/OUT	I2C SDA for EEPROM and FSM	EEPROM, FSM	LVC MOS18 (1.8V)		VILmax=0.54V, VIHmin=1.26V, VOLmax=0.36V, VOHmin=1.44V
28	I2C_1_SDA	IN/OUT	Additional I2C SDA for FSM	FSM			
29	GPIO2_XHS0	IN/OUT	XHS from/to FSM	FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V, VOLmax=0.2V, VOHmin=1.6V
30	GPIO10	IN/OUT		FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
31	GPIO3_XTRIG0	IN	XTRIG for FSM	FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
32	GPIO11_FSTROBE	OUT	FSTROBE from FSM	FSM	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
33	PW_EN_0	IN	PW_EN for FSM	FSM	LVC MOS18 (1.8V)	Normal: High, Pwr Down: Low	VILmax=0.36V, VIHmin=1.44V
34	PW_EN_1	IN	Additional PW_EN for FSM	FSM	LVC MOS18 (1.8V)	Normal: High, Pwr Down: Low	VILmax=0.36V, VIHmin=1.44V

J4: Signal Description to FPA (Part 2/2)

Pin	Net name	I/O	Primary function description	Connected to	I/O Standard	I/O State	I/O DC Characteristic
35	GPIO6	IN		(FSM)	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
36	GPIO7	IN		(FSM)	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
37	GND	GND	Common Ground				
38	GND	GND	Common Ground				
39	MCLK_0	IN CLK	Master clock 0 (FSM input clock when SW1 in position 2)	Rotary Switch	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
40	GPIO4_MCLK2	IN/OUT		FSM			
41	MCLK_1	IN CLK	Master clock 1 (FSM input clock when SW1 in position 3)	Rotary Switch	LVC MOS18 (1.8V)		VILmax=0.36V, VIHmin=1.44V
42	GPIO5_MCLK3	IN/OUT		FSM			
43	GND	GND	Common Ground				
44	GND	GND	Common Ground				
45	D_CLK_1_P	OUT	MIPI-CSI2 output clock (1, P)	FSM	MIPI D-PHY		
46	D_DATA_3_P	OUT	MIPI-CSI2 output data (3, P)	FSM	MIPI D-PHY		
47	D_CLK_1_N	OUT	MIPI-CSI2 output clock (1, N)	FSM	MIPI D-PHY		
48	D_DATA_3_N	OUT	MIPI-CSI2 output data (3, N)	FSM	MIPI D-PHY		
49	GND	GND	Common Ground				
50	GND	GND	Common Ground				
51	D_DATA_0_N	OUT	MIPI-CSI2 output data (0, N)	FSM	MIPI D-PHY		
52	D_DATA_1_N	OUT	MIPI-CSI2 output data (1, N)	FSM	MIPI D-PHY		
53	D_DATA_0_P	OUT	MIPI-CSI2 output data (0, P)	FSM	MIPI D-PHY		
54	D_DATA_1_P	OUT	MIPI-CSI2 output data (1, P)	FSM	MIPI D-PHY		
55	GND	GND	Common Ground				
56	GND	GND	Common Ground	FSM			
57	D_DATA_2_P	OUT	MIPI-CSI2 output data (2, P)	FSM	MIPI D-PHY		
58	D_CLK_0_P	OUT CLK	MIPI-CSI2 output clock (0, P)	FSM	MIPI D-PHY		
59	D_DATA_2_N	OUT	MIPI-CSI2 output data (2, N)	FSM	MIPI D-PHY		
60	D_CLK_0_N	OUT CLK	MIPI-CSI2 output clock (0, N)	FSM	MIPI D-PHY		

5.2 Technical Drawing

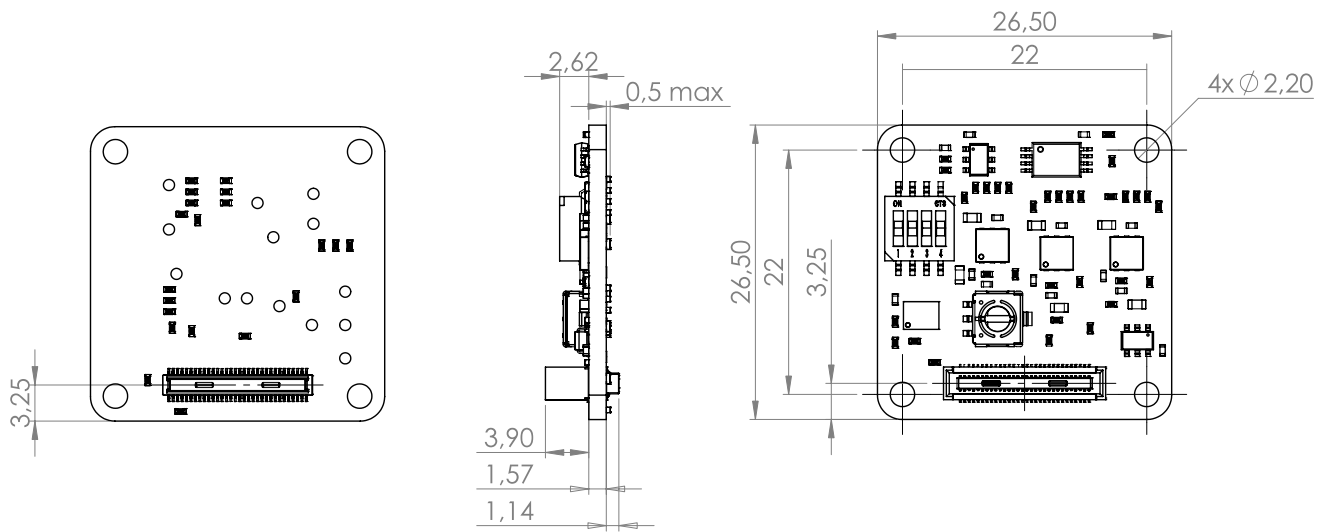


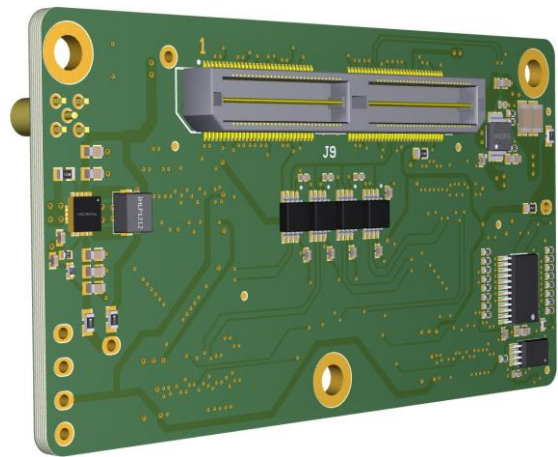
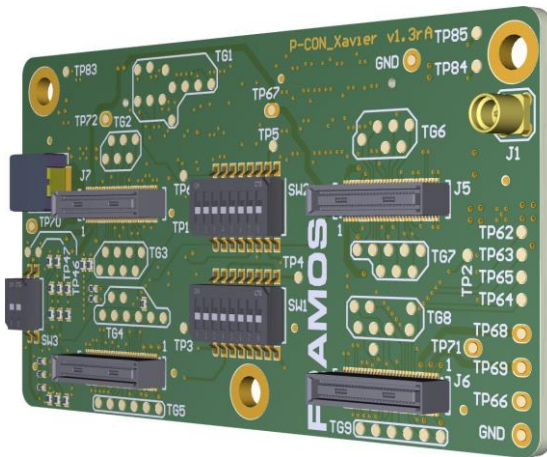
Figure 5: Technical Drawing of FSA-FTx/A-V1

6 FRAMOS Processor Adapter (FPA)

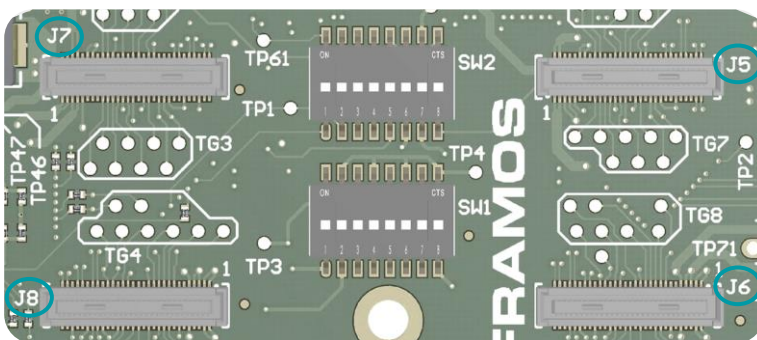
- Connects multiple FSAs to one processor board
- Processor board specific
- Differentiates two input interface types:
 - A:** MIPI CSI-2
 - BC:** Sub-LVDS / SLVS (**B**) and SLVS-EC (**C**)

6.1 FPA-4.A/TXA: Quad FPA to NVIDIA Jetson TX2 and AGX Xavier

- Four 4-Lane MIPI CSI-2 Inputs
- Signal routing and I2C multiplexing
- Testpoints to important sensor signals
- Dynamic device tree management (EEPROM)
- Configuration of trigger routing
- Compatible Processor Boards:
 - NVIDIA Jetson TX2 Development Kit
 - NVIDIA AGX Xavier Development Kit



6.1.1 J5, J6, J7, J8: Connectors to Sensor Adapters (FSA)



Name	Description	Connector Type	Orientation
J5	Port 1, 4-Lanes CSI-2, to FSA	Hirose DF40HC(4.0)-60DS-0.4V	Pin 1 Printed on PCB next to each connector.
J6	Port 2, 4-Lanes CSI-2, to FSA		
J7	Port 3, 4-Lanes CSI-2 (TX2: 2-Lanes), to FSA		
J8	Port 4, 4-Lanes CSI-2 (TX2: 2-Lanes), to FSA		

Table 7: Image Sensor Connectors on FPA-4.A/TXA-V1

All ports provide the same pinout. The pin assignment is according to the corresponding FSA.

Further notes for signals on FSA connectors J5, J6, J7, J8:

- CAM0_MCLK and CAM1_MCLK are routed through four bus transceiver for better integrity of the signal
- CAM0_PWDN and CAM0_RST signals are routed in parallel to all connectors
- I2C_GP3_CLK and I2C_GP3_DATA are routed parallel to EEPROM and I2C multiplexer (8 channels)
- EEPROM functionality is primarily used to utilize functionality of L4T Plugin manager (driver) but offers additional user space for configuration etc.
- Each FSA connector is connected to two multiplexer channels:
 - MUX-ch0/ch1 are connected to J5
 - MUX-ch2/ch3 are connected to J6
 - MUX-ch4/ch5 are connected to J7
 - MUX-ch6/ch7 are connected to J8

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters or the Processor Board. Using flex cable (FMA-FC-150/60-v1) between FSA and FPA is mandatory.

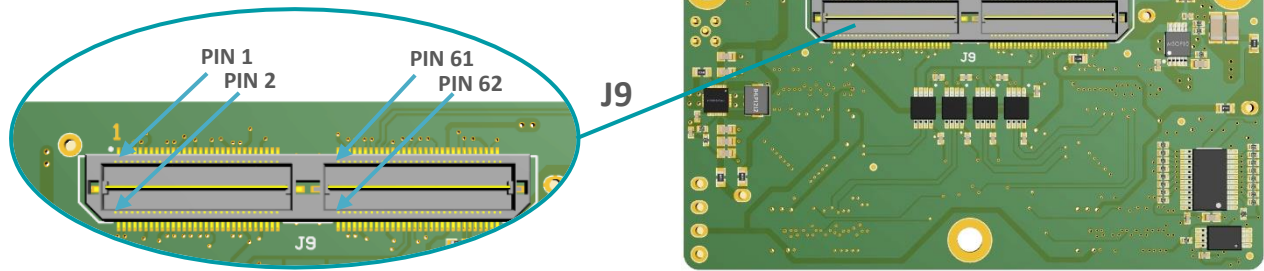
Image Sensor CSI-2 lane Support per Port

The table below shows the possible MIPI CSI-2 lane configurations per FSM / Processor Board combination, that are supported in HW using the FPA-4.A/TXA-V1.

FSM with FSA-FTx/A (all)	NVIDIA Jetson TX2				NVIDIA AGX Xavier			
	J5	J6	J7	J8	J5	J6	J7	J8
FSM-AR0144	2	2	2	2	2	2	2	2
FSM-AR0521	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-AR1335	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-HDP230	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX264	4	4	-	-	4	4	4	4
FSM-IMX283	4	4	-	-	4	4	4	4
FSM-IMX290	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX296	1	1	1	1	1	1	1	1
FSM-IMX297	1	1	1	1	1	1	1	1
FSM-IMX304	4	4	-	-	4	4	4	4
FSM-IMX327	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX334	4	4	-	-	4	4	4	4
FSM-IMX335	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX412	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX415	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX462	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX464	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX477	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX485	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4
FSM-IMX530	4	4	-	-	4	4	4	4
FSM-IMX577	2 / 4	2 / 4	2	2	2 / 4	2 / 4	2 / 4	2 / 4

Table 8: Image Sensor Support per Port with FPA-4.A/TXA-V1

6.1.2 J9: Connector to Processor Board



Label: J9

Type: QTH-060-01-L-D-A

Pinout:

Pin #	Name	Pin #	Name	Pin #	Name	Pin #	Name
1	D_DATA_0_P	2	D_DATA_2_P	61	D_DATA_10_N	62	D_DATA_14_N
3	D_DATA_0_N	4	D_DATA_2_N	63	GND	64	GND
5	GND	6	GND	65	D_CLK_5_P	66	D_CLK_7_P
7	D_CLK_0_P	8	D_CLK_1_P	67	D_CLK_5_N	68	D_CLK_7_N
9	D_CLK_0_N	10	D_CLK_1_N	69	GND	70	GND
11	GND	12	GND	71	D_DATA_11_P	72	D_DATA_15_P
13	D_DATA_1_P	14	D_DATA_3_P	73	D_DATA_11_N	74	D_DATA_15_N
15	D_DATA_1_N	16	D_DATA_3_N	75	I2C_SCL	76	NC
17	GND	18	GND	77	I2C_SDA	78	NC
19	D_DATA_4_P	20	D_DATA_6_P	79	GND	80	GND
21	D_DATA_4_N	22	D_DATA_6_N	81	2V8_AUX	82	2V8_AUX
23	GND	24	GND	83	2V8_AUX	84	NC
25	D_CLK_2_P	26	D_CLK_3_P	85	TP_85	86	XVS0
27	D_CLK_2_N	28	D_CLK_3_N	87	TP_87	88	MCLK_1
29	GND	30	GND	89	TP_89	90	PW_EN_1
31	D_DATA_5_P	32	D_DATA_7_P	91	MCLK_0	92	RST_1
33	D_DATA_5_N	34	D_DATA_7_N	93	PW_EN_0	94	MCLK_2
35	GND	36	GND	95	RST_0	96	NC
37	D_DATA_8_P	38	D_DATA_12_P	97	TP_97	98	NC
39	D_DATA_8_N	40	D_DATA_12_N	99	GND	100	GND
41	GND	42	GND	101	1V2_AUX	102	1V8_AUX
43	D_CLK_4_P	44	D_CLK_6_P	103	TP_103	104	TP_104
45	D_CLK_4_N	46	D_CLK_6_N	105	TP_105	106	TP_106
47	GND	48	GND	107	TP_107	108	3V3_VDD
49	D_DATA_9_P	50	D_DATA_13_P	109	NC	110	3V3_VDD
51	D_DATA_9_N	52	D_DATA_13_N	111	NC	112	TP_112
53	GND	54	GND	113	NC	114	NC
55	NC	56	NC	115	GND	116	GND
57	NC	58	NC	117	TP_117	118	3V3-5V_VDD
59	D_DATA_10_P	60	D_DATA_14_P	119	SYS_PW_EN	120	3V3-5V_VDD

Table 9: Pinout of FPA-4.A/TXA-V1 connector to NVIDIA Jetson TX2 and AGX Xavier

6.1.3 SW1, SW2: Configuration Switches

DIP switches SW1 and SW2 are mainly for interconnecting FSA's triggering signals (XVS, XHS and XTRIG).

DIP switch SW1 is designated to interconnect XVS/XHS pins while DIP switch SW2 is designated to interconnect XTRIG pins and aggregate CAM2_MCLK04(MCLK2) and GPIO25_VDD_SYS_EN(SYS_PW_EN) from FPA in parallel to all FSA connectors.

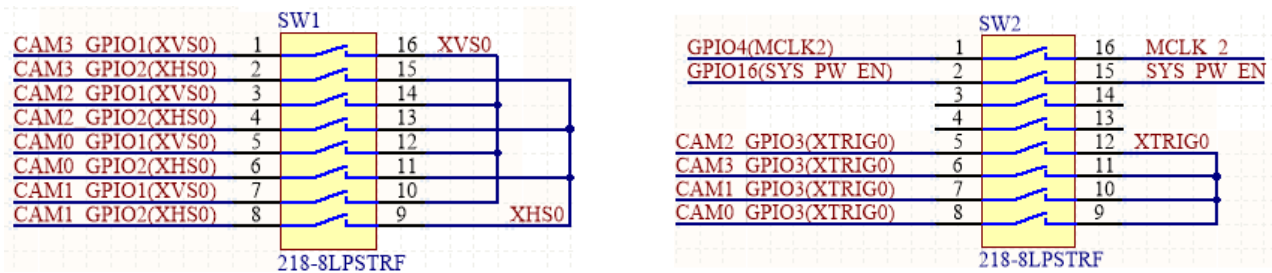


Table 10: Configuration of SW1 and SW2 on FPA-4.A/TXA-V1

6.1.4 SW3: Configuration Switches

DIP switch SW3 is designated to enable/disable FPA EEPROM and it's write protection.

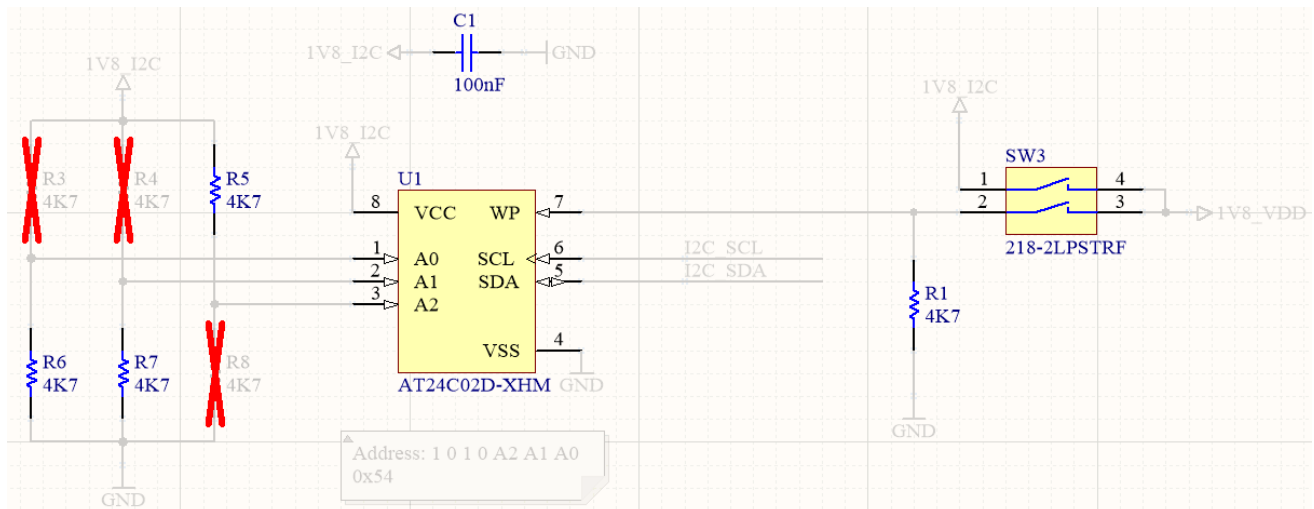
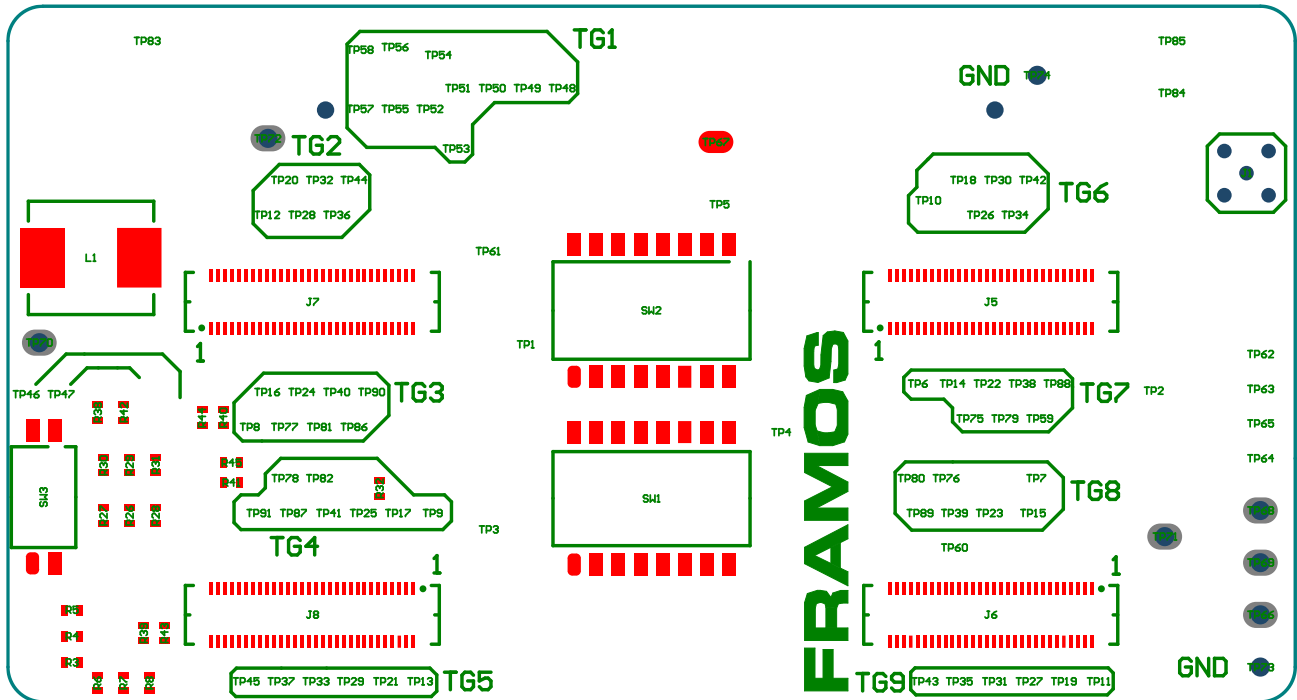


Table 11: Configuration of SW3 on FPA-4.A/TXA-V1

Default state of DIP switches

- SW1 – all positions OFF (XVS/XHS pins are NOT interconnected)
- SW2 – all positions OFF (XTRIG pins are NOT interconnected, MCLK2 and SYS_PW_EN are NOT aggregate)
- SW3 – positions-1 ON, position-2 OFF (EEPROM is ENABLED without write protection)

6.1.5 TGx, TPx: Test Groups and Test Points



Connector J9: TG1 and Ungrouped Test Points

Label	Signal (TG1)	Label	Signal
TP48	TP_85	TP46	I2C_SCL
TP49	TP_87	TP47	I2C_SDA
TP50	TP_89	TP61	MCLK_2
TP51	TP_97	TP62	PW_EN_0
TP52	TP_103	TP63	PW_EN_1
TP53	TP_104	TP64	RST_0
TP54	TP_105	TP65	RST_1
TP55	TP_106		
TP56	TP_107		
TP57	TP_112		
TP58	TP_117		

Connector J5 (TG6, TG7) and J6 (TG8, TG9)

Label (J5)	Signal (TG6, TG7)	Label (J6)	Signal (TG8, TG9)
TP59	CAM0_MCLK_0	TP60	CAM1_MCLK_0
TP88	CAM0_MCLK_1	TP89	CAM1_MCLK_1
TP6	CAM0_GPIO14	TP7	CAM1_GPIO14
TP10	CAM0_GPIO15(SPI_MISO)	TP11	CAM1_GPIO15(SPI_MISO)
TP14	CAM0_GPIO0(XMASTER0)	TP15	CAM1_GPIO0(XMASTER0)
TP18	CAM0_GPIO8	TP19	CAM1_GPIO8
TP22	CAM0_GPIO17(SPI_CS)	TP23	CAM1_GPIO17(SPI_CS)
TP26	CAM0_GPIO9	TP27	CAM1_GPIO9
TP30	CAM0_GPIO10	TP31	CAM1_GPIO10
TP34	CAM0_GPIO11	TP35	CAM1_GPIO11
TP38	CAM0_GPIO6	TP39	CAM1_GPIO6
TP42	CAM0_GPIO7	TP43	CAM1_GPIO7
TP75	I2C_0_SCL(SPI_SCK)	TP76	I2C_2_SCL(SPI_SCK)
TP79	I2C_0_SDA(SPI_MOSI)	TP80	I2C_2_SDA(SPI_MOSI)

Connector J7 (TG2, TG3) and J8 (TG4, TG5)

Label (J5)	Signal (TG6, TG7)	Label (J6)	Signal (TG8, TG9)
TP86	CAM2_MCLK_0	TP87	CAM3_MCLK_0
TP90	CAM2_MCLK_1	TP91	CAM3_MCLK_1
TP8	CAM2_GPIO14	TP9	CAM3_GPIO14
TP12	CAM2_GPIO15(SPI_MISO)	TP13	CAM3_GPIO15(SPI_MISO)
TP16	CAM2_GPIO0(XMASTER0)	TP17	CAM3_GPIO0(XMASTER0)
TP20	CAM2_GPIO8	TP21	CAM3_GPIO8
TP24	CAM2_GPIO17(SPI_CS)	TP25	CAM3_GPIO17(SPI_CS)
TP28	CAM2_GPIO9	TP29	CAM3_GPIO9
TP32	CAM2_GPIO10	TP33	CAM3_GPIO10
TP36	CAM2_GPIO11	TP37	CAM3_GPIO11
TP40	CAM2_GPIO6	TP41	CAM3_GPIO6
TP44	CAM2_GPIO7	TP45	CAM3_GPIO7
TP77	I2C_4_SCL(SPI_SCK)	TP78	I2C_6_SCL(SPI_SCK)
TP81	I2C_4_SDA(SPI_MOSI)	TP82	I2C_6_SDA(SPI_MOSI)

Other Test Points (Ungrouped)

Label	Signal
TP1	GPIO16(SYS_PW_EN)
TP2	GPIO5(MCLK3)
TP3	XVS0
TP4	XHS0
TP74	GND
TP5	XTRIG0
TP83	GPIO4(MCLK2)
TP84	CAM0_GPIO2(XHS0)
TP85	CAM0_GPIO3(XTRIG0)

6.1.6 Technical Drawing

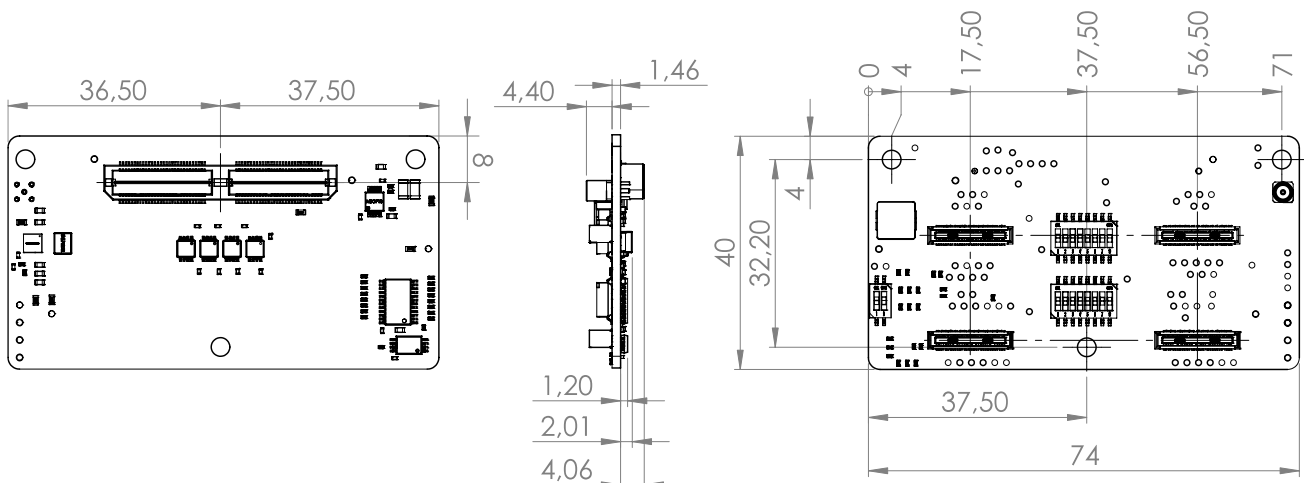
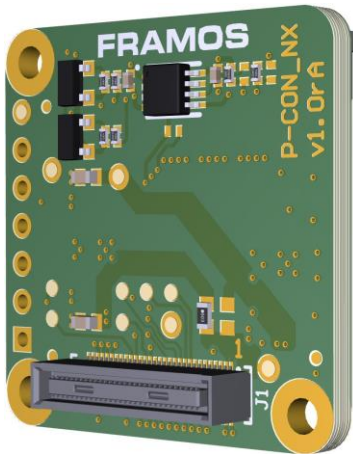


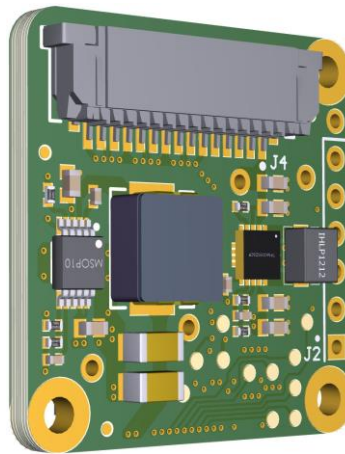
Figure 6: Technical Drawing of FPA-4.A/TXA-V1

6.2 FPA-A/NVN: Piggyback FPA to NVIDIA Jetson Nano and Xavier NX

- One 2-Lane MIPI CSI-2 Input
- Signal routing and power conversion
- Voltage level translation for control signals
- Testpoints to important sensor signals
- Dynamic device tree management (EEPROM)
- Board-to-board stacking to FSA
- Compatible Processor Boards:
 - NVIDIA Jetson Nano Development Kit
 - NVIDIA Xavier NX Development Kit



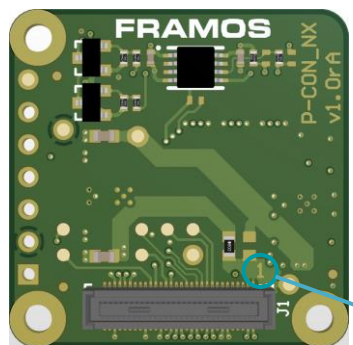
Top View (to FSA)



Bottom View (to Processor Board)

Note: All signals are directly routed from J1 (to FSA) to J4 (to processor), test points and pin row. They follow the signal specification according to the FSA output interface.

6.2.1 J1: Connector to Sensor Adapters (FSA)



Name	Description	Connector Type	Orientation
J1	2-Lanes CSI-2, to FSA	Hirose DF40HC(4.0)-60DS-0.4V	Pin 1 marking in copper on PCB, next to connector.

Table 12: Image Sensor Connector on FPA-A/NVN-V1

The pin assignment of J1 is according to the corresponding FSA.

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters, or the Processor Board. Using flex cable (FMA-FC-150/60-V1) between FSA and FPA is optional.

Image Sensor CSI-2 lane Support per Port

The table below shows the possible MIPI CSI-2 lane configurations per FSM / Processor Board combination, that are supported in HW using the FPA-A/NVN-V1.

FSM with FSA-FTx/A	NVIDIA Jetson Nano / Xavier NX
	J4 [# Lanes]
FSM-AR0144	2
FSM-AR0521	2
FSM-AR1335	2
FSM-HDP230	2
FSM-IMX264	Not Supported ¹
FSM-IMX283	Not Supported ¹
FSM-IMX290	2
FSM-IMX296	1
FSM-IMX297	1
FSM-IMX304	Not Supported ¹
FSM-IMX327	2
FSM-IMX334	Not Supported ¹
FSM-IMX335	2
FSM-IMX412	2
FSM-IMX415	2
FSM-IMX462	2
FSM-IMX464	2
FSM-IMX477	2
FSM-IMX485	2
FSM-IMX530	Not Supported ¹
FSM-IMX577	2

Table 13: Image Sensor Support per Port with FPA-A/NVN-V1

Note: Due to different interface routing and thus Device Tree configuration, the drivers provided for the Jetson Nano only support Development Kits of the revision B01.

¹ NVIDIA Jetson Nano / Xavier NX Development Kits only provide 2-lanes MIPI CSI-2, sensor requires 4-lanes.

6.2.2 J4: Connector to Processor Board

Label: J4

Type: Amphenol SFW15R-2STE1LF

Pinout:

Pin #	Name	Pin #	Name
1	3V3_VDD	9	GND
2	I2C_SDA_IN	10	CSIO_D1_P
3	I2C_SCL_IN	11	CSIO_D1_N
4	MCLK_0	12	GND
5	CAM_PWDN	13	CSIO_D0_P
6	GND	14	CSIO_D0_N
7	CSIO_CLK_P	15	GND
8	CSIO_CLK_N		

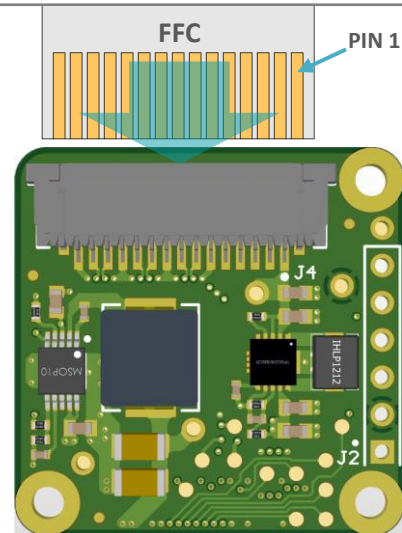


Table 14: Pinout of FPA-A/NVN-V1 connector to NVIDIA Jetson Nano / Xavier NX Development Kits

Caution: Use only FFC with opposing contacts (TOP-BOT), like Würth 686715200001.

6.2.3 External Signals & Test Points

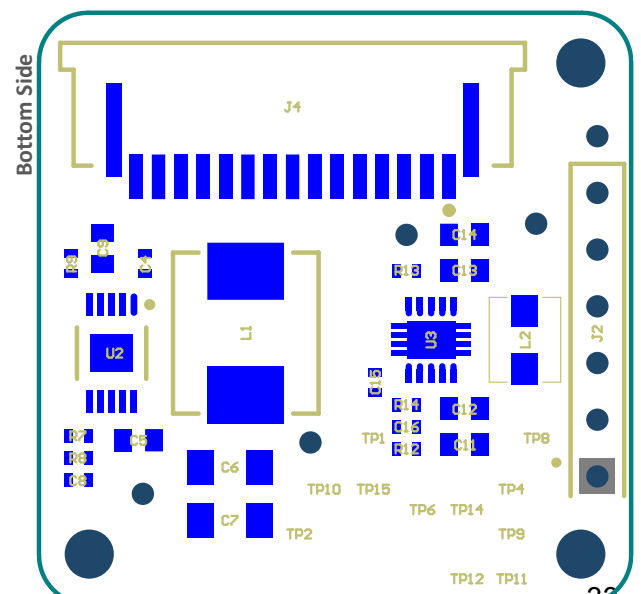
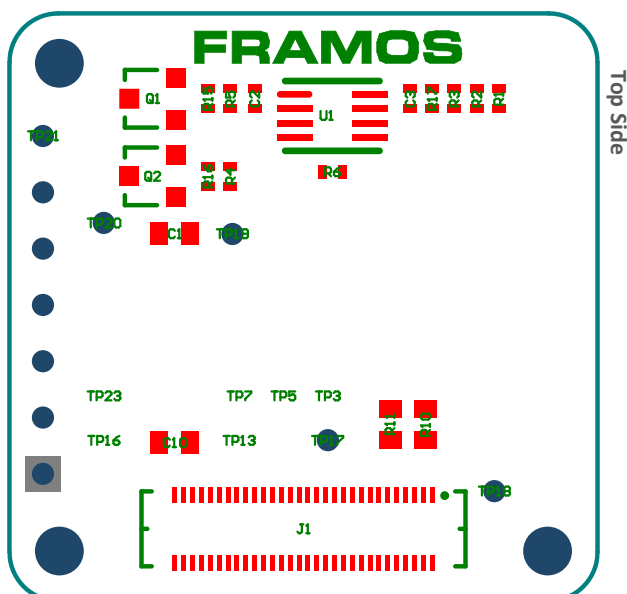
Test Points

Top Side (heading to FSA):

Label	Signal
TP3	CAM0_GPIO14
TP5	CAM0_GPIO0 (XMASTER0)
TP7	CAM0_GPIO17 (SPI_CS)
TP13	CAM0_GPIO6
TP16	CAM0_MCLK1
TP17	1V8_VDD
TP18	3V8_VDD
TP19	3V3_VDD
TP20	GND
TP21	CAM0_PW_EN0
TP23	CAM0_GPIO3 (XTRIG0)

Bottom Side (heading to Processor Board):

Label	Signal
TP1	I2C_0_SDA (SPI_SCK)
TP2	CAM0_RST_0
TP4	CAM0_GPIO15 (SPI_MISO)
TP6	CAM0_GPIO8
TP8	CAM0_SYS_PW_EN)
TP9	CAM0_GPIO9
TP10	I2C_0_SDA (SPI_MOSI)
TP11	CAM0_GPIO10
TP12	CAM0_GPIO11 (FSTROBE)
TP14	CAM0_GPIO7
TP15	CAM0_MCLK0



Pin Rail J2 (not assembled²)

Pin	Signal
1	1V8_VDD
2	GND
3	CAM0_GPIO1 (XVS0)
4	CAM0_GPIO2 (XHS0)
5	CAM0_GPIO11 (FSTROBE)
6	CAM0_PW_EN1



Note: All signals on Test Points and Pin Rail are LVCMOS18 (1.8V) logic, according to image sensor specification.

6.2.4 Technical Drawing

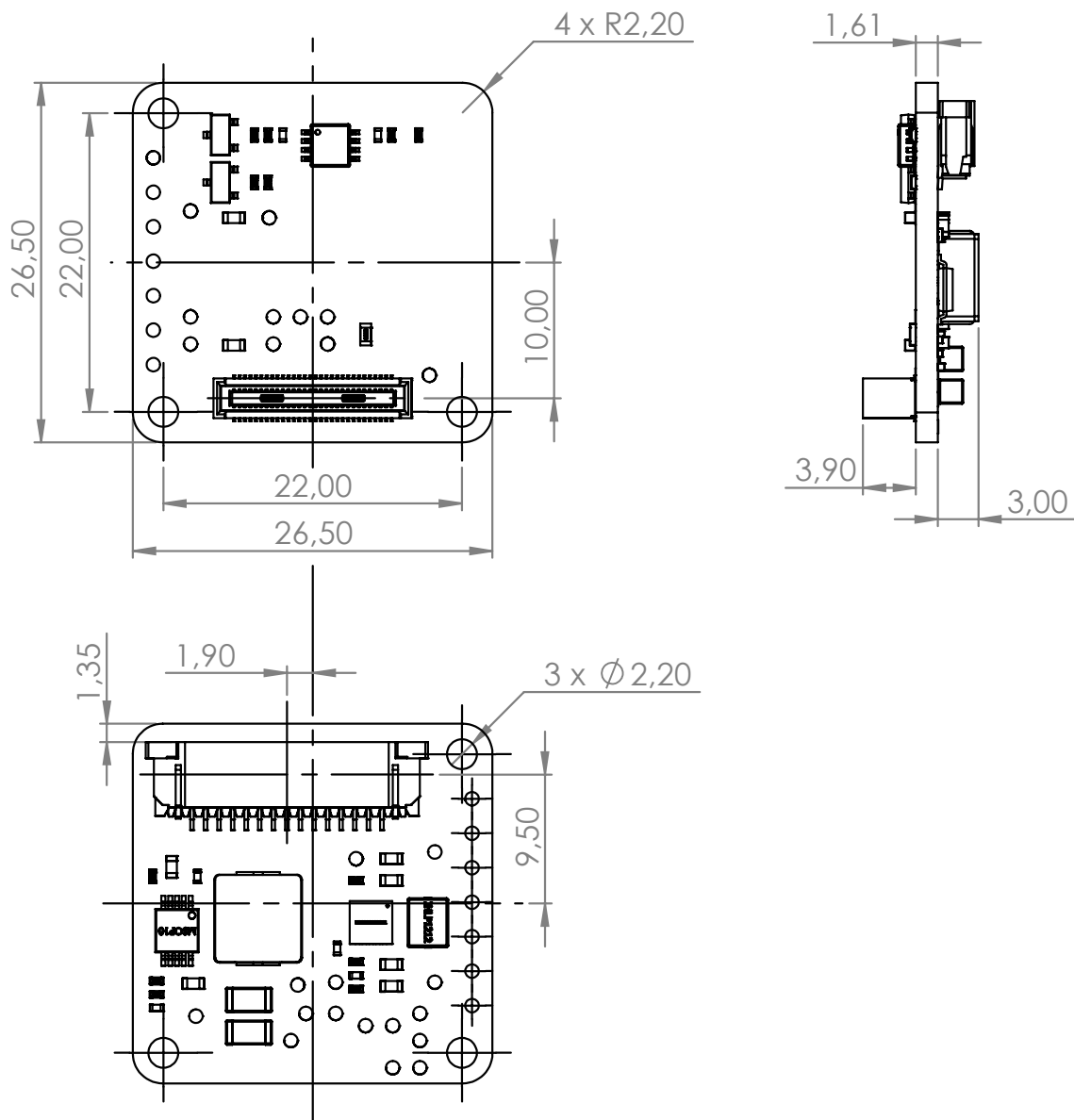
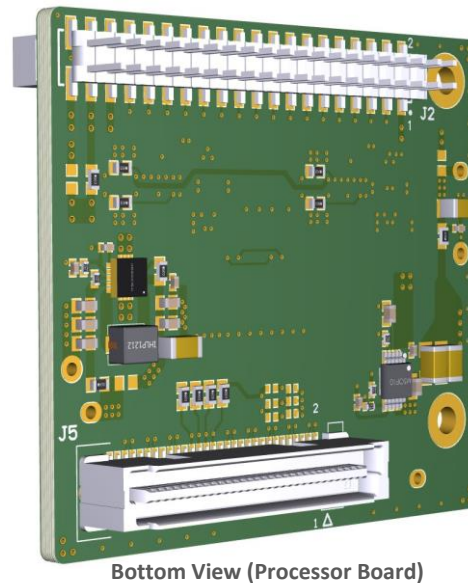
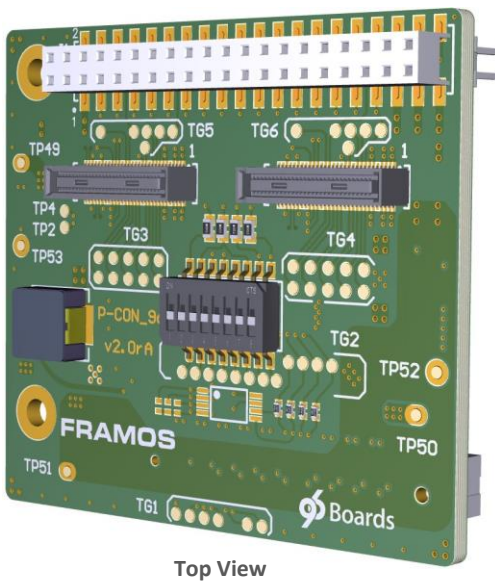


Figure 7: Technical Drawing of FPA-A/NVN-V1

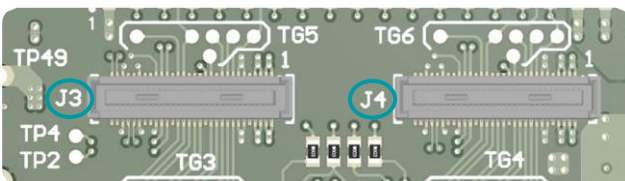
² By default, J2 is not assembled. Soldering a regular 1x6 pin stripe with 2.54 pitch is recommended for usage.

6.3 FPA-2.A/96B: Dual FPA to 96Boards.org Consumer Edition

- Two MIPI CSI-2 Inputs with 4- and 2-Lanes
- Signal routing and I2C multiplexing
- EEPROM for dynamic device tree management
- Testpoints to important sensor signals
- Configuration of trigger routing
- Compatible Processor Boards:
 - 96boards Consumer Edition (CE) Standard
<https://www.96boards.org/products/ce/>



6.3.1.1 J3, J4: Image Sensor Connectors



Name	Description	Connector Type	Orientation
J3	Port 1, 4-Lanes CSI-2, to FSA	Hirose DF40HC(4.0)-60DS-0.4V	Pin 1 Printed on PCB next to each connector.
J4	Port 2, 4-Lanes CSI-2, to FSA ³		

Table 15: Image Sensor Connectors on FPA-2.A/A-V1

All ports provide the same pinout. The pin assignment is according to the corresponding FSA.

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters or the Processor Board. Using flex cable (FMA-FC-150/60-v1) between FSA and FPA is mandatory.

³ The usage of the second port might require a minor hardware modification by the user. Further details are described in the "User Guide" in the platform specific software package.

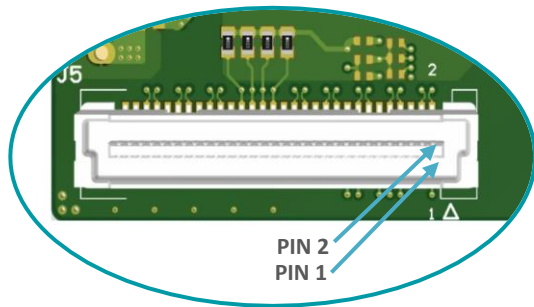
Image Sensor Support per Port

The table below shows the possible MIPI CSI-2 lane configurations per FSM / Processor Board combination, that are supported in HW using the FPA-2.A/96B-V1.

FSM with FSA-FTx/A (all)	96Boards CE	
	J5	J6
FSM-AR0144	2	2
FSM-AR0521	2 / 4	2
FSM-AR1335	2 / 4	2
FSM-HDP230	4	2
FSM-IMX264	4	-
FSM-IMX283	4	-
FSM-IMX290	2 / 4	2
FSM-IMX296	1	1
FSM-IMX297	1	1
FSM-IMX304	4	-
FSM-IMX327	2 / 4	2
FSM-IMX334	4	-
FSM-IMX335	2 / 4	2
FSM-IMX412	2 / 4	2
FSM-IMX415	2 / 4	2
FSM-IMX462	2 / 4	2
FSM-IMX464	2 / 4	2
FSM-IMX477	2 / 4	2
FSM-IMX485	2 / 4	2
FSM-IMX530	4	-
FSM-IMX577	2 / 4	2

Table 16: Image Sensor Support per Port with FPA-2.A/96B-V1

6.3.2 J5: Processor Board Connector

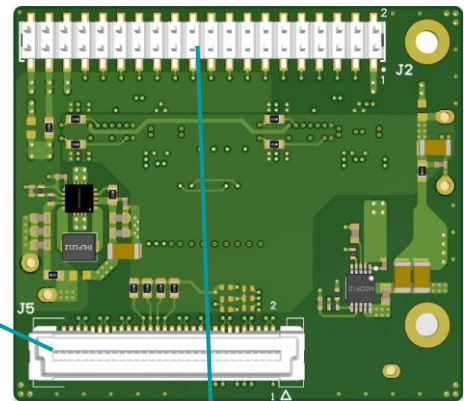


Label: J5

Type: 61083-063402LF

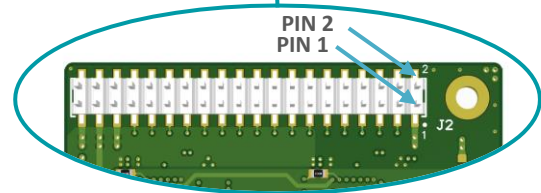
Pinout:

Pin #	Name	Pin #	Name
1	SPI_MOSI	2	D_CLK_0_P (J3)
3	NC	4	D_CLK_0_N (J3)
5	NC	6	GND
7	SPI_CS	8	D_DATA_0_P (J3)
9	SPI_SCK	10	D_DATA_0_N (J3)
11	SPI_MISO	12	GND
13	GND	14	D_DATA_1_P (J3)
15	MCLK_0	16	D_DATA_1_N (J3)
17	MCLK_1	18	GND
19	GND	20	D_DATA_2_P (J3)
21	NC	22	D_DATA_2_N (J3)
23	NC	24	GND
25	GND	26	D_DATA_3_P (J3)
27	NC	28	D_DATA_3_N (J3)
29	NC	30	GND
31	GND	32	I2C_0_SCL
33	NC	34	I2C_0_SDA
35	NC	36	I2C_2_SCL
37	GND	38	I2C_2_SDA
39	NC	40	GND
41	NC	42	D_DATA_4_P (J4)
43	GND	44	D_DATA_4_N (J4)
45	NC	46	GND
47	NC	48	D_DATA_5_P (J4)
49	GND	50	D_DATA_5_N (J4)
51	NC	52	GND
53	NC	54	D_CLK_0_P (J4)
55	GND	56	D_CLK_0_N (J4)
57	NC	58	GND
59	NC	60	NC



J5

J2



Label: J1/J2

Type: 61083-063402LF

Pinout:

Pin #	Name	Pin #	Name
1	GND	2	GND
3	96B_UART0_CTS	4	96B_PWR_BTNn
5	96B_UART0_TXD	6	96B_PWR_BTNn
7	96B_UART0_RXD	8	96B_SPI0_CLK
9	96B_UART0_RTS	10	96B_SPI0_MISO
11	96B_UART1_TXD	12	96B_SPI0_CS
13	96B_UART1_RXD	14	96B_SPI0_MOSI
15	96B_SCL_0	16	96B_PCM_FS
17	96B_SDA_0	18	96B_PCM_CLK
19	96B_SCL_1	20	96B_PCM_DO
21	96B_SDA_1	22	96B_PCM_DI
23	96B_GPIO_A	24	96B_GPIO_B
25	96B_GPIO_C	26	96B_GPIO_D
27	96B_GPIO_E	28	96B_GPIO_F
29	96B_GPIO_G	30	96B_GPIO_H
31	CAM0_RST_0	32	CAM0_PW_EN_0
33	CAM1_RST_0	34	CAM1_PW_EN_0
35	96B_1V8	36	96B_SYS_DCIN
37	96B_5V0	38	
39	GND	40	GND

Table 17: Pinout of FPA-2.A/96B-V1 connector to 96Boards.org Consumer Edition Standard

6.3.3 SW1: Configuration Switch

The DIP switch SW1 is for interconnecting FSA's triggering signals (XVS, XHS and XTRIG). It is designated to interconnect XVS, XHS and XTRIG pins from FPA in parallel to both FSA connectors.

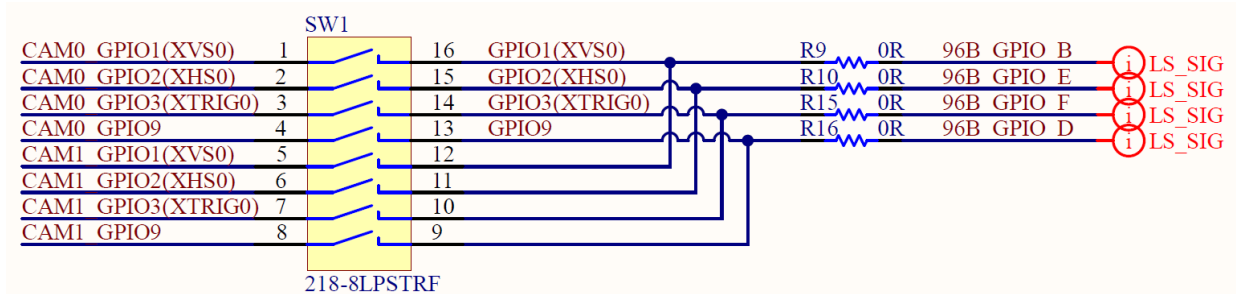


Table 18: Configuration of SW1 on FPA-2.A/96B-V1

Default state of DIP switch

- SW1 – all positions OFF (XVS/XHS pins are NOT interconnected)

6.3.4 TGx, TPx: Test Groups and Test Points

6.3.5 Ungrouped (according to silk print)

Label	Signal	Label	Signal
TP2	GPIO4(MCLK2)	TP51	5V0_VDD
TP4	GPIO5(MCLK3)	TP52	GND
TP49	1V8_VDD	TP53	GND
TP50	3V8_VDD		

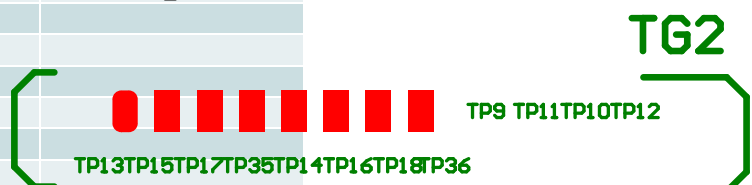
TG1: Clocks and SPI

Label	Signal	Label	Signal
TP1	MCLK_0	TP55	SPI_CS
TP3	MCLK_1	TP56	SPI_SCK
TP54	SPI_MOSI	TP57	SPI_MISO



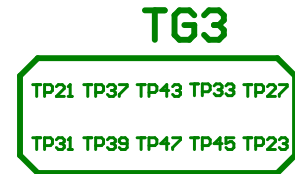
TG2: Synchronisation Signals

Label	Signal	Label	Signal
TP9	CAM0_I2C_0_SCL(SPI_SCK)	TP18	CAM1_GPIO3(XTRIG0)
TP10	CAM1_I2C_0_SCL(SPI_SCK)	TP35	CAM0_GPIO9
TP11	CAM0_I2C_0_SDA(SPI_MOSI)	TP36	CAM1_GPIO9
TP12	CAM1_I2C_0_SDA(SPI_MOSI)		
TP13	CAM0_GPIO1(XVS0)		
TP14	CAM1_GPIO1(XVS0)		
TP15	CAM0_GPIO2(XHS0)		
TP16	CAM1_GPIO2(XHS0)		
TP17	CAM0_GPIO3(XTRIG0)		



TG3: Control Signals and GPIOs J3 (CAM0)

Label	Signal	Label	Signal
TP21	CAM0_PW_EN_1	TP37	CAM0_GPIO10
TP23	CAM0_GPIO15(SPI_MISO)	TP39	CAM0_GPIO11
TP27	CAM0_RST_1	TP43	CAM0_GPIO16(SYS_PW_EN)
TP31	CAM0_GPIO7	TP45	CAM0_I2C_1_SCL
TP33	CAM0_GPIO8	TP47	CAM0_I2C_1_SDA


TG4: Control Signals and GPIOs J4 (CAM1)

Label	Signal	Label	Signal
TP22	CAM1_PW_EN_1	TP38	CAM1_GPIO10
TP24	CAM1_GPIO15(SPI_MISO)	TP40	CAM1_GPIO11
TP28	CAM1_RST_1	TP44	CAM1_GPIO16(SYS_PW_EN)
TP32	CAM1_GPIO7	TP46	CAM1_I2C_1_SCL
TP34	CAM1_GPIO8	TP48	CAM1_I2C_1_SDA


TG6: Control Signals and GPIOs J3 (CAM0)

Label	Signal	Label	Signal
TP5	CAM0_RST_0	TP25	CAM0_GPIO17(SPI_CS)
TP7	CAM0_GPIO0(XMASTER0)	TP29	CAM0_GPIO6
TP19	CAM0_PW_EN_0	TP41	CAM0_GPIO14


TG6: Control Signals and GPIOs J4 (CAM1)

Label	Signal	Label	Signal
TP6	CAM1_RST_0	TP26	CAM1_GPIO17(SPI_CS)
TP8	CAM1_GPIO0(XMASTER0)	TP30	CAM1_GPIO6
TP20	CAM1_PW_EN_0	TP42	CAM1_GPIO14

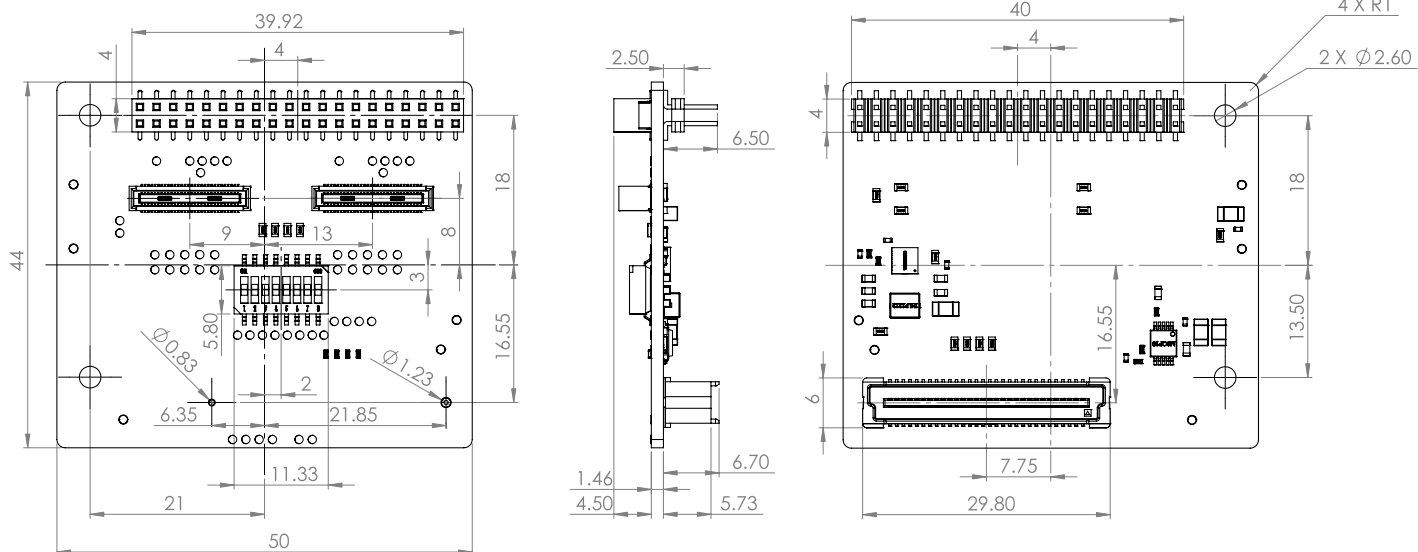
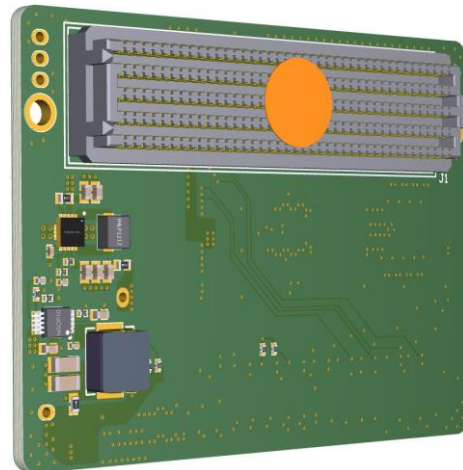
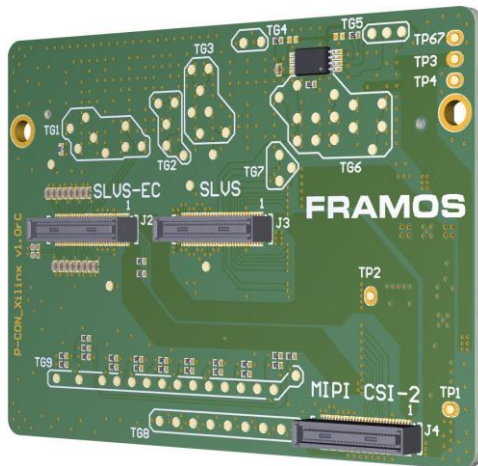

6.3.6 Technical Drawing


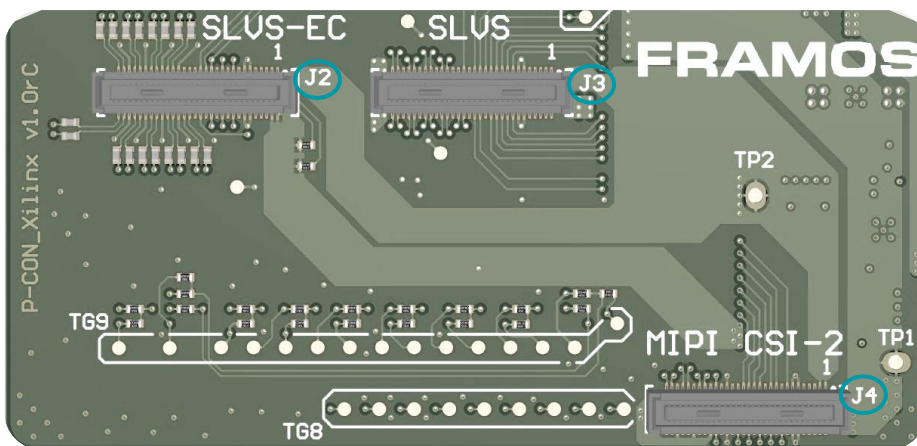
Figure 8: Technical Drawing of FPA-2.A/96B-V1

6.4 FPA-ABC/XX1: Multi-Format FPA to Xilinx Development Boards

- Three inputs, one for each interface:
 - SLVS-EC
 - Sub-LVDS / SLVS
 - MIPI CSI-2
- EEPROM for dynamic device tree management
- Testpoints to important sensor signals
- Configurable trigger routing
- Compatible Processor Boards:
 - Various Xilinx Development Boards



6.4.1 Image Sensor Connectors



Label	Name	Description	Connector Type	FPGA Routing
J2	SLVS-EC	Port 2, 8-Lanes SLVS-EC, to FSA	Hirose DF40HC(4.0)-60DS-0.4V	8-Lanes to Transceivers
J3	SLVS	Port 1, 8-Lanes SLVS / Sub-LVDS, to FSA		8-Lanes to differential IOs
J4	MIPI CSI-2	Port 3, 4-Lanes MIPI CSI-2, to FSA		4-Lanes to CSI-2 D-PHY

Table 19: Image Sensor Connectors on FPA-ABC/XX1-V1

All ports provide the same pinout. The pin assignment is according to the corresponding FSA.

Caution: Direct connection of FSM to FPA (without FSA) or wrong cable orientation will lead to permanent damage of FSM, Adapters or the Processor Board. Using flex cable (FMA-FC-150/60-v1) between FSA and FPA is mandatory.

Processor Board Compatibility Matrix

The FPA has been designed to comply to the following Xilinx Development Boards.

Xilinx Development Board	SLVS-EC	SLVS	MIPI CSI-2
AC701-G (Artix-7)	Yes	TBD	TBD
KC705-G (Kintex-7)	Yes	TBD	TBD
ZC706-G (Zynq-7000)	Yes	TBD	TBD
KCU105-G (Kintex UltraScale)	Yes	Yes	TBD
KCU116-G (Kintex UltraScale+)	Yes	TBD	TBD
ZCU102-G (Zynq UltraScale+)	Yes	Yes	Yes

Note – SLVS-EC: The different Xilinx Development Boards provide access to a different count of Gigabit Transceivers (GTx). This might limit the utilization of the 8-Lanes available from the FPA. Please refer to the datasheet of the Xilinx Development Board for more information.

Note - MIPI CSI-2: The Xilinx XCU102-G provides hard D-PHY lanes on the appropriate pins of the FPA connector. The usage of the MIPI CSI-2 port is routed but has not been verified. Operation is in the responsibility of the user. Further Xilinx Development Kits might be compatible but have not been validated for correct electrical connectivity.

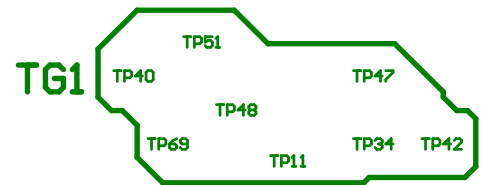
6.4.2 TGx, TPx: Test Groups and Test Points

Ungrouped (according to silk print)

Label	Signal	Label	Signal
TP1	1V8_VDD	TP67	UTIL_3V3_10A
TP2	3V8_VDD	TP75	GND
TP3	UTIL_3V3	TP76	GND
TP4	GND	TP77	GND
TP12	CAM1_GPIO0(XMASTER0)	TP78	GND

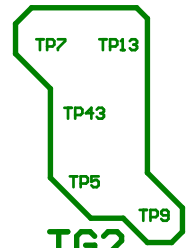
TG1: Clocks and various GPIOs

Label	Signal	Label	Signal
TP11	CAM1_GPIO8(TOUT1)	TP47	CAM1_GPIO14
TP34	CAM1_GPIO10	TP48	CAM1_MCLK0
TP40	CAM2_GPIO3(XTRIG0)	TP51	CAM3_MCLK0
TP42	CAM1_GPIO16	TP69	CAM2_MCLK0



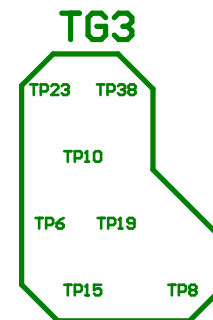
TG2: Various

Label	Signal	Label	Signal
TP5	CAM1_I2C_0_SDA(SPI_MOSI)	TP13	CAM1_GPIO9(TOUT2)
TP7	CAM1_GPIO15(SPI_MISO)	TP43	CAM1_RST0
TP9	CAM1_GPIO11(TOUT0)		



TG3:

Label	Signal	Label	Signal
TP6	CAM1_I2C_0_SCL(SPI_SCK)	TP19	CAM1_GPIO3(XTRIG0)
TP8	CAM1_GPIO17(SPI_CS)	TP23	CAM1_GPIO2(XHS0)
TP10	CAM1_GPIO6(SLAMODE)	TP38	CAM1_GPIO1(XVS0)
TP15	CAM1_GPIO7(XTRIG2)		



TG4: I2C Clock and Data

Label	Signal
TP25	SCL
TP26	SDA

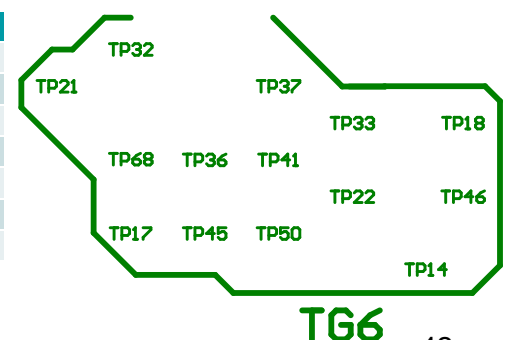


TG5: EEPROM Address

Label	Signal
TP27	GA1
TP28	GA0
TP30	GND

TG6:

Label	Signal	Label	Signal
TP14	CAM3_RST0	TP36	CAM2_GPIO7(XTRIG2)
TP17	CAM2_GPIO6(SLAMODE)	TP37	CAM3_I2C_0_SDA(SPI_MOSI)
TP18	CAM3_GPIO0(XMASTER0)	TP41	CAM3_GPIO2(XHS0)
TP21	CAM2_GPIO8(TOUT1)	TP45	CAM2_GPIO2(XHS0)
TP22	CAM3_I2C_0_SCL(SPI_SCK)	TP46	CAM3_GPIO3(XTRIG0)
TP32	CAM2_GPIO0(XMASTER0)	TP50	CAM2_GPIO1(XVS0)
TP33	CAM3_GPIO1(XVS0)	TP68	CAM2_RST0



TG7:

Label	Signal
TP44	CAM2_GPIO9(TOUT2)
TP49	CAM2_GPIO10
TP64	CAM3_GPIO5(MCLK3)


TG8:

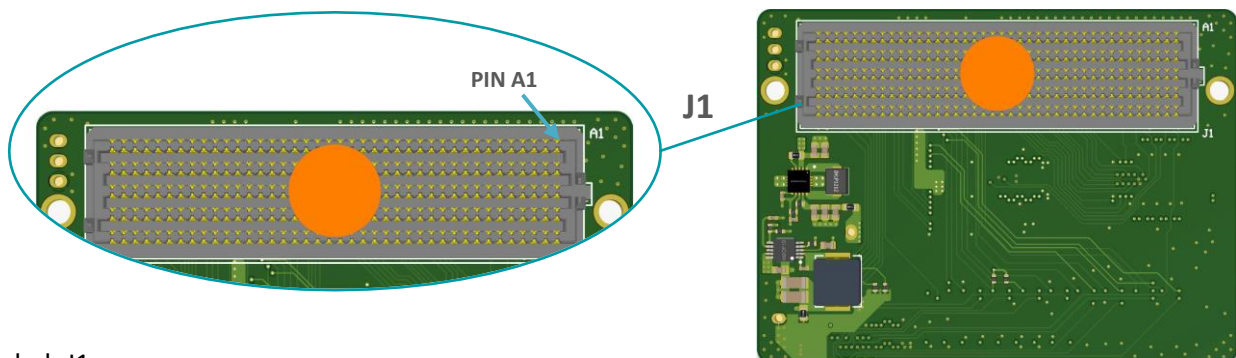
Label	Signal	Label	Signal
TP52	CAM3_GPIO16(SYS_PW_EN)	TP62	CAM3_GPIO4(MCLK2)
TP53	CAM3_GPIO8	TP63	CAM3_MCLK1
TP54	CAM3_GPIO14	TP64	CAM3_GPIO5(MCLK3)
TP55	CAM3_RST1		
TP60	CAM3_GPIO6		
TP61	CAM3_GPIO7		


TG9:

Label	Signal	Label	Signal
TP16	CAM2_I2C_0_SDA(SPI_MOSI)	TP59	CAM3_GPIO9
TP20	CAM2_I2C_0_SCL(SPI_SCK)	TP66	CAM2_GPIO14
TP24	CAM2_GPIO15(SPI_MISO)	TP70	CAM3_I2C_1_SDA
TP35	CAM2_GPIO17(SPI_CS)	TP71	CAM3_GPIO10
TP39	CAM2_GPIO11(TOUT0)	TP72	CAM3_GPIO11
TP56	CAM3_GPIO15(SPI_MISO)	TP73	CAM3_PW_EN0
TP57	CAM3_I2C_1_SCL	TP74	CAM3_PW_EN1
TP58	CAM3_GPIO17(SPI_CS)		



6.4.3 Processor Board Connector



Label: J1

Type: ASP-134488-01

Pinout (A – J): Table 20 / Table 21

Notes: **CAM1:** J2 (SLVS-EC), **CAM2:** J3 (SLVS), **CAM3:** J4 (MIPI CSI-2)

Table 20: Pinout J1 - Part1 (A-E) of FPA-ABC/XX1-V1 connector to Xilinx Development Board

PIN #	A	B	C	D	E
1	GND	NC	GND	NC	GND
2	FMC_CAM1_DO1_P	GND	NC	GND	NC
3	FMC_CAM1_DO1_N	GND	NC	GND	NC
4	GND	NC	GND	FMC_CAM1_D_CLK_0_P	GND
5	GND	NC	GND	FMC_CAM1_D_CLK_0_N	GND
6	FMC_CAM1_DO2_P	GND	FMC_CAM1_DO0_P	GND	NC
7	FMC_CAM1_DO2_N	GND	FMC_CAM1_DO0_N	GND	NC
8	GND	NC	GND	CAM2_D_DATA_1_P	GND
9	GND	NC	GND	CAM2_D_DATA_1_N	NC
10	FMC_CAM1_DO3_P	GND	CAM2_D_DATA_5_P	GND	NC
11	FMC_CAM1_DO3_N	GND	CAM2_D_DATA_5_N	CAM2_D_DATA_6_P	GND
12	GND	FMC_CAM1_DO7_P	GND	CAM2_D_DATA_6_N	NC
13	GND	FMC_CAM1_DO7_N	GND	GND	NC
14	FMC_CAM1_DO4_P	GND	CAM2_D_DATA_7_P	CAM1_GPIO15(SPI_MISO)	GND
15	FMC_CAM1_DO4_N	GND	CAM2_D_DATA_7_N	CAM1_GPIO9(TOUT2)	NC
16	GND	FMC_CAM1_DO6_P	GND	GND	NC
17	GND	FMC_CAM1_DO6_N	GND	CAM1_GPIO2(XHS0)	GND
18	FMC_CAM1_DO5_P	GND	CAM1_GPIO1(XVS0)	CAM1_GPIO6(SLAMODE)	NC
19	FMC_CAM1_DO5_N	GND	CAM_GPIO14	GND	NC
20	GND	NC	GND	CAM_GPIO10	GND
21	GND	NC	GND	CAM_GPIO9	NC
22	NC	GND	CAM_GPIO11	GND	NC
23	NC	GND	CAM_GPIO15	CAM3_D_CLK_0_P	GND
24	GND	NC	GND	CAM3_D_CLK_0_N	NC
25	GND	NC	GND	GND	NC
26	NC	GND	CAM_I2C_SDA	CAM3_D_DATA_3_P	GND
27	NC	GND	CAM_GPIO17	CAM3_D_DATA_3_N	NC
28	GND	NC	GND	GND	NC
29	GND	NC	GND	NC	GND
30	NC	GND	SCL	TDI	NC
31	NC	GND	SDA	TDO	NC
32	GND	NC	GND	UTIL_3V3_10A	GND
33	GND	NC	GND	NC	NC
34	NC	GND	GA0	NC	NC
35	NC	GND	NC	GA1	GND
36	GND	NC	NC	UTIL_3V3	NC
37	GND	NC	NC	GND	NC
38	NC	GND	NC	UTIL_3V3	GND
39	NC	GND	UTIL_3V3	GND	VADJ
40	GND	NC	NC	UTIL_3V3	GND

Table 21: Pinout J1 – Part2 (F-J) of FPA-ABC/XX1-V1 connector to Xilinx Development Board

PIN #	F	G	H	I	J
1	NC	GND	NC	GND	NC
2	GND	CAM2_GPIO3(XTRIG)	PRSNT_M2C_L	NC	GND
3	GND	CAM3_MCLK0	GND	NC	GND
4	NC	GND	CAM2_MCLK_0	GND	NC
5	NC	GND	CAM1_MCLK_0	GND	NC
6	GND	CAM2_D_CLK_0_P	GND	NC	GND
7	NC	CAM2_D_CLK_0_N	CAM1_GPIO8(TOUT1)	NC	NC
8	NC	GND	CAM1_GPIO10	GND	NC
9	GND	CAM2_D_DATA_3_P	GND	NC	GND
10	NC	CAM2_D_DATA_3_N	CAM2_D_DATA_0_P	NC	NC
11	NC	GND	CAM2_D_DATA_0_N	GND	NC
12	GND	CAM2_D_DATA_4_P	GND	NC	GND
13	NC	CAM2_D_DATA_4_N	CAM2_D_DATA_2_P	NC	NC
14	NC	GND	CAM2_D_DATA_2_N	GND	NC
15	GND	CAM1_RST0	GND	NC	GND
16	NC	CAM1_I2C_0_SDA(SPI_MOSI)	CAM1_GPIO11(TOUT0)	NC	NC
17	NC	GND	CAM1_GPIO7(XTRIG2)	GND	NC
18	GND	CAM1_I2C_0_SCL(SPI_SCK)	GND	NC	GND
19	NC	CAM1_GPIO3(XTRIG0)	CAM1_GPIO0(XMASTER0)	NC	NC
20	NC	GND	CAM1_GPIO17(SPI_CS)	GND	NC
21	GND	CAM3_D_CLK_1_P	GND	NC	GND
22	NC	CAM3_D_CLK_1_N	CAM3_D_DATA_2_P	NC	NC
23	NC	GND	CAM3_D_DATA_2_N	GND	NC
24	GND	CAM3_D_DATA_0_P	GND	NC	GND
25	NC	CAM3_D_DATA_0_N	CAM3_D_DATA_1_P	NC	NC
26	NC	GND	CAM3_D_DATA_1_N	GND	NC
27	GND	CAM_I2C_SCL	GND	NC	GND
28	NC	CAM2_GPIO8(TOUT1)	CAM2_RST0	NC	NC
29	NC	GND	CAM2_GPIO6(SLAMODE)	GND	NC
30	GND	CAM2_GPIO0(XMASTER0)	GND	NC	GND
31	NC	CAM2_GPIO7(XTRIG2)	CAM2_GPIO2(XHS0)	NC	NC
32	NC	GND	CAM2_GPIO1(XVS0)	GND	NC
33	GND	CAM3_I2C_0_SDA(SPI_MOSI)	GND	NC	GND
34	NC	CAM3_GPIO2(XHS0)	CAM_GPIO16	NC	NC
35	NC	GND	CAM3_I2C_0_SCL(SPI_SCK)	GND	NC
36	GND	CAM3_GPIO1(XVS0)	GND	NC	GND
37	NC	CAM3_GPIO0(XMASTER0)	CAM3_RST0	NC	NC
38	NC	GND	CAM3_GPIO3(XTRIG0)	GND	NC
39	GND	NC	GND	NC	GND
40	NC	GND	NC	GND	NC

6.4.4 Technical Drawing

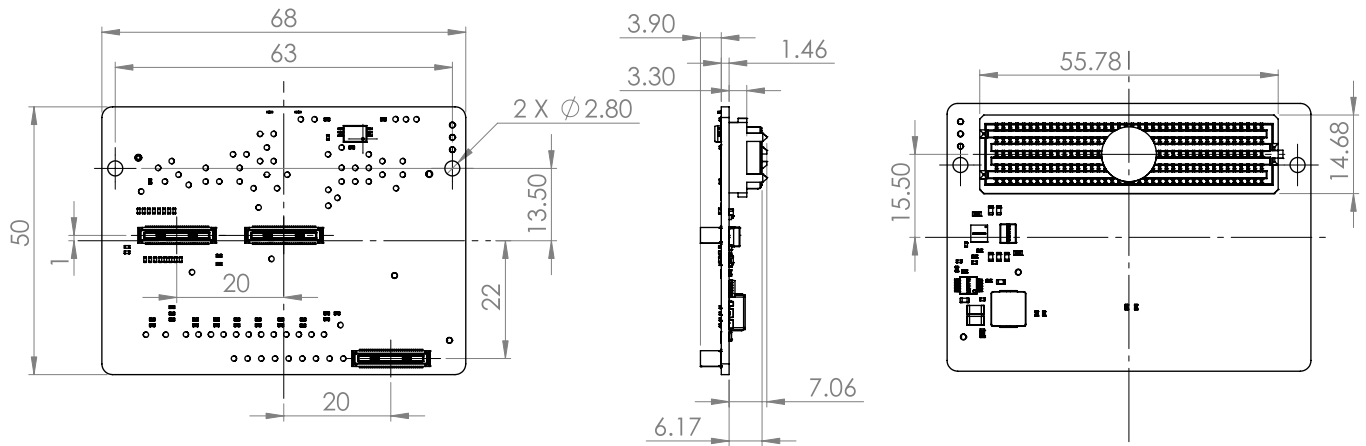


Figure 9: Technical Drawing of FPA-4.A/TXA-V1

7 FRAMOS Module Accessories (FMA)

7.1 FMA-MNT-CCS/265_v1: C/CS-Mount for 26.5mm Footprint

CS-mount body (Figure 10) delivered with 5mm CS- to C-Mount extension ring.

- Material: AlMgSi0.5
- Finish: Black Anodizing

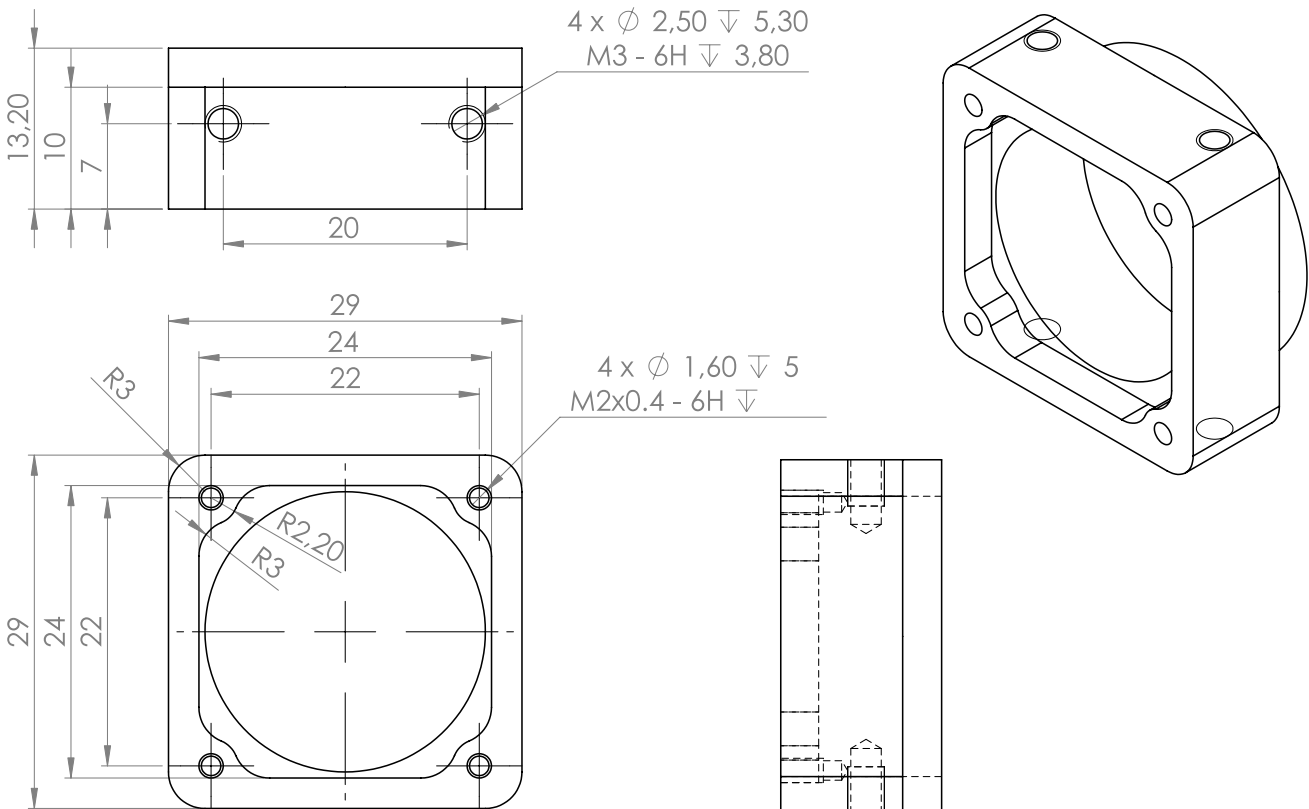


Figure 10: CS-Mount Body for 26.5 mm FSM

Note: The actual distance of the active sensor surface to PCB and different types of sensor cover glasses on the different supported sensors might require the adding a number of 0.1 mm distance rings to raise the flange height. Appropriate spacers or extension rings are not provided with the lens mount. All FSMs delivered with this mount applied are adjusted accordingly to meet the correct back focal distance by C- and CS-Mount standard.

7.2 FMA-FC-150/60: Flex Cable for MIPI CSI-2 Connections

- FSA to FPA for MIPI CSI-2 connections (mandatory)
- Extension through “daisy-chaining” possible (maximum length is sensor and setup depending)
- Rigit-flex design (connectors on right PCBs)

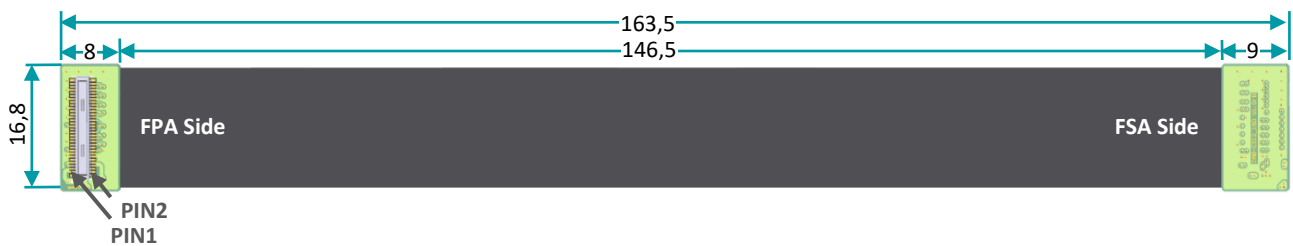
Note: Don't use for any other connections than for MIPI CSI-2. Might lead to signal degradations and even damage!

7.2.1 Flex Cable Connectors

- FSA Side: Hirose DF40C-60DS-0.4V
- FPA Side: Hirose DF40C-60DP-0.4V
- Pin Assignment: Pin 1 to Pin 1

7.2.2 Mechanical Drawing and Pinout

Top Side



Bottom Side



8 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 generally 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

What it is not:

- A fully featured camera implementation - not all sensors features might be implemented
- Ready to be use in the field
- A benchmark for the capabilities of the image sensor
- Focused on image processing

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, 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-IMX577	4		2			
FSM-IMX530	2	4	-			1 ⁴

Table 22: Ecosystem Software Package - Supported number of FSMs per processing board

⁴ SLVS-EC based FPGA reference implementation as part of the SLVS-EC RX IP Core offering.

8.1 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
- Image Pre-Processing Examples:
 - OpenCV (Software)
 - LibArgus (Hardware)

Supported Devices:

- Jetson Nano (B01)
- Jetson TX2
- Jetson Xavier NX
- Jetson AGX Xavier

8.1.1 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.

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-IMX577												

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

Table 23: Supported sensor features on NVIDIA Jetson TX2 / AGX Xavier

*Only supported in all pixel mode

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

8.1.2 Image Pre-Processing Examples

The provided image processing examples show the general mechanisms of data handling, for an image processing using 3rd-party IP. Both, the OpenCV and the LibArgus examples do not output data that is tuned for best visual experience.

LibArgus Example:

- Closed source ISP implementation
- Using hard ISP in NVIDIA Jetson SOCs
- Most performant option
- Example Implementation: Full but not tuned image pipeline, displaying

Color tuning and lens correction needs to be calibrated for every image sensor separately and depends on sensor and lens attributes as well as illumination situation.

Image Pre-Processing Features per Model	Bad Pixel Correction	Noise Reduction	Black Level Comp.	Auto Exposure, Gain	Auto White Balance	Demosaic	Color Correction	Color Artifact Suppr.	Downscaling	Edge Enhancement
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-IMX577										

Implemented
 Using Default Config
 Not Implemented

Table 24: Implemented LibArgus features for NVIDIA Jetson TX2 / AGX Xavier

Default Config

Image streaming is performed through the LibArgus pipeline, using a common configuration. It demonstrates the usage of LibArgus but is not optimized for the certain sensor configuration and might not lead to good image representation.

As NVIDIA camera partner, FRAMOS provides appropriate ISP tuning services on project basis for the individual customer system.

OpenCV Example:

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

Image Pre-Processing Features per Model	Bad Pixel Correction	Noise Reduction	Black Level Comp.	Auto Exposure, Gain	Auto White Balance	Demosaic	Color Correction	Color Artifact Suppr.	Downscaling	Edge Enhancement
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-IMX577										

 Implemented
 Not Implemented

Table 25: Implemented features in OpenCV example

Due to limited performance and extreme resource utilization, it is not planned to enhance the image processing support on software side.

9 Ecosystem Compatibility Matrix

9.1 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-IMX283	FSM-AR0144	FSM-HDP230
FSA-FT1/A	FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵							
FSA-FT3/A		FPA-4.A/TXA FPA-A/NVN ⁶ FPA-2.A/96B FPA-ABC/XX1 ⁵						
FSA-FT6/A			FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵					
FSA-FT7/A				FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵				
FSA-FT11/A					FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵			
FSA-FT12/A						FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1 ⁵		
FSA-FT13/A							FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵	
FSA-FT19/A								FPA-4.A/TXA FPA-A/NVN FPA-2.A/96B FPA-ABC/XX1 ⁵

Table 26: Ecosystem Compatibility Matrix – Native CSI-2 (D-PHY) FSMs

⁵ Not verified, Xilinx Development Board with hard MIPI CSI-2 / D-PHY interface.

⁶ FSM-IMX334 is not supported due to the sensor requiring 4-lanes MIPI.

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 ⁵			
FSA-FT15/A-00G	MIPI CSI-2		FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1 ⁵		
FSA-FT18/A-00G	MIPI CSI-2				FPA-4.A/TXA FPA-2.A/96B FPA-ABC/XX1 ⁵
FSA-FT18/BC	SLVS, SLVS-EC				FPA-ABC/XX1
FSA-FT20/BC	SLVS, SLVS-EC			FPA-ABC/XX1	

Table 27: Ecosystem Compatibility Matrix – Sub-LVDS, SLVS and SLVS-EC FSMs