

## FG96-8CH GMSL adapt Board User Manual

Project GMSL Adapt Board on NVIDIA Jetson® AGX Orin™/Xavier™ Devkit

Product name FG96-8CH-V1.0

Submission date 2022-12-10

### Change History :

Version	Date	Description	Author
V1.0	2022/12/10	First version	

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## Table of contents

<b>Perface</b> .....	3
<b>Copyright Notice</b> .....	3
<b>Disclaimer</b> .....	3
<b>Technical Support</b> .....	3
<b>Warranty</b> .....	3
<b>Safety Warnings and Precautions for Use</b> .....	3
<b>Glossary</b> .....	4
<b>Introduction</b> .....	6
<b>Product specification description</b> .....	6
<b>Product Description</b> .....	7
Product block diagram.....	7
120Pin MIPI connector definition[J2] .....	8
FG96 DXF diagram.....	11
Product pictures .....	12
Software installation and application .....	14
Verified camera list.....	14
Test Procedures.....	16

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## Perface

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## Safety Warnings and Precautions for Use

- Safety instructions

Before using this product, you must first read this document to have a preliminary knowledge

and understanding of the product, and you must abide by the safety instructions in the manual of this product to ensure your personal safety and avoid damage to the equipment. If blind operation causes losses or Injury, the manufacturer is not responsible for any problems of equipment and personal life and property safety caused by its wrong operation

- Voltage

FG96-8CH GMSL camera adaptation supports input power: 12V DC; current: above 2A

- Environmental requirements

Working temperature: -20°C - 85°C

Ventilation requirements: There must be good ventilation conditions around the installation of the computing platform.

- Grounding requirements

The power supply of the power adapter must be well grounded. In special scenarios, a grounding screw must be installed to connect it to the earth.

- Static Protection 

Electronic components and circuits are very sensitive to electrostatic discharge. Although our company will design anti-static protection for the main interfaces on the board when designing circuit board products, it is difficult to implement anti-static safety protection for all components and circuits. It is therefore recommended to observe anti-static safety precautions when handling any circuit board assembly. Anti-static safety protection measures include, but are not limited to the following points:

- ◆ The box should be placed in an anti-static bag during transportation and storage, and the device should not be taken out until installation and deployment;
- ◆ Before the body touches the box, the static electricity stored in the body should be discharged: wear a discharge grounding wrist strap;
- ◆ Circuit boards can only be handled in anti-static safe areas (including anti-static floors, anti-static wrist strap workbench, anti-static work clothes, etc.);
- ◆ Avoid moving this equipment in carpeted areas.

## Glossary

POC	Power Over Coax
GMSL	Gigabit Multimedia Serial Links
FPDLINK	Flat Panel Display Link
SerDes	Serializer and Deserializer
D-PHY	The initial version of MIPI D-PHY was designed to target 500Mbps/s, where D is 500 in Roman numerals (Latin numerals). Similarly, C and M are 100 and 1000 in Roman numerals respectively, that is, C and M in C-PHY and M-PHY
C-PHY	C-PHYs may be used in channel-limited applications, hence the use of the character "C", 3-Phase symbol encoding technology, each symbol can transmit 2.28bits of data, using 5-digit transmission, and the efficiency is D-PHY 2.27 times



## Introduction

Fangzhu Technology's FG96-8CH GMSL camera platform is an expansion board that allows up to 8 cameras to be connected to the Jetson® AGX Orin™/Xavier™ module, and it is fully compatible with the NVIDIA Jetson® AGX Orin™/Xavier™ development kit. Since there are many different types of GMSL cameras available, the FG96 can adapt to work at different frequencies, that is, it is compatible with both GMSL1 and GMSL2 protocol interfaces through software configuration. The power of the GMSL camera is provided by PoC (Power over Coax), so all data, control signals and power are sent through a single 50-ohm coaxial cable, which makes the camera's cable routing flexible and easy to install in automotive applications.

Since the 120Pin connector on the NVIDIA Jetson® AGX Orin™/Xavier™ development kit cannot provide the voltage required by the camera, FG96-8CH has a hot-swappable 12V power external connector.

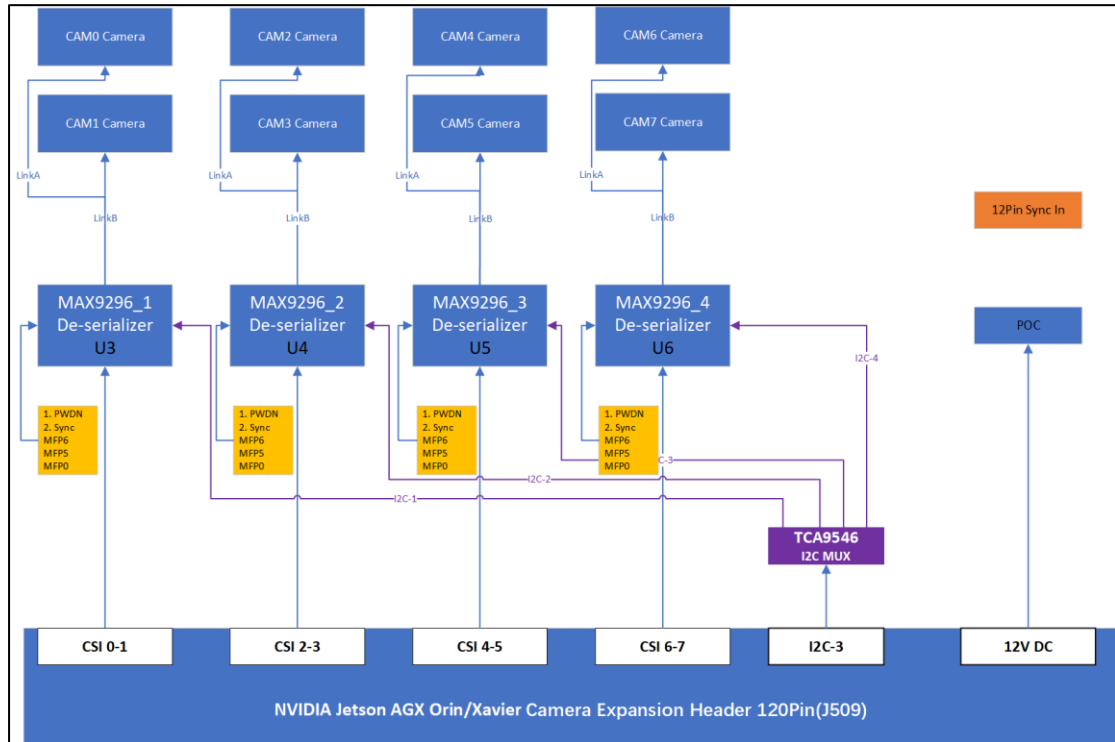
## Product specification description

Product Features and Specifications	
Size	104x74mm
Weight	50g
Jetson® AGX Orin™/Xavier™ Dev kit	1x120Pin high density connector Camera extension connects to NVIDIA Jetson "Camera Expansion Header" via 120Pin
(GMSL) Camera Inputs	8 cameras(GMSL2/GMSL1)
Deserializer	MAXIM(ADI) MAX9296A
MIPI Output MIPI	One 4-Lane MIPI CSI-2 v1.3 per deserializer (16-Lanes total)
Camera Input Connectors	8x MATE-AX FAKRA connectors
PoC (Power-Over-COAX)	8 cameras powered by 12V PoC
Power电	External 12V power supply
Operating Temperature	-20°C to +85°C
Warranty and Support	One year warranty and technical support

Model	Description
FG96-8CH	AGX Orin/Xavier GMSLCamera development platform
FAKRA cable	Mate-AX to 1x FAKRA cable

# Product Description

## Product block diagram



Note:

1. The I2C bus number is the hardware location (matches connector J2 pin). Bus numbers do not necessarily correspond to those listed in the software.
2. Coaxial power is shared, but each GMSL line has its own filter.

## 120Pin MIPI connector definition[J2]

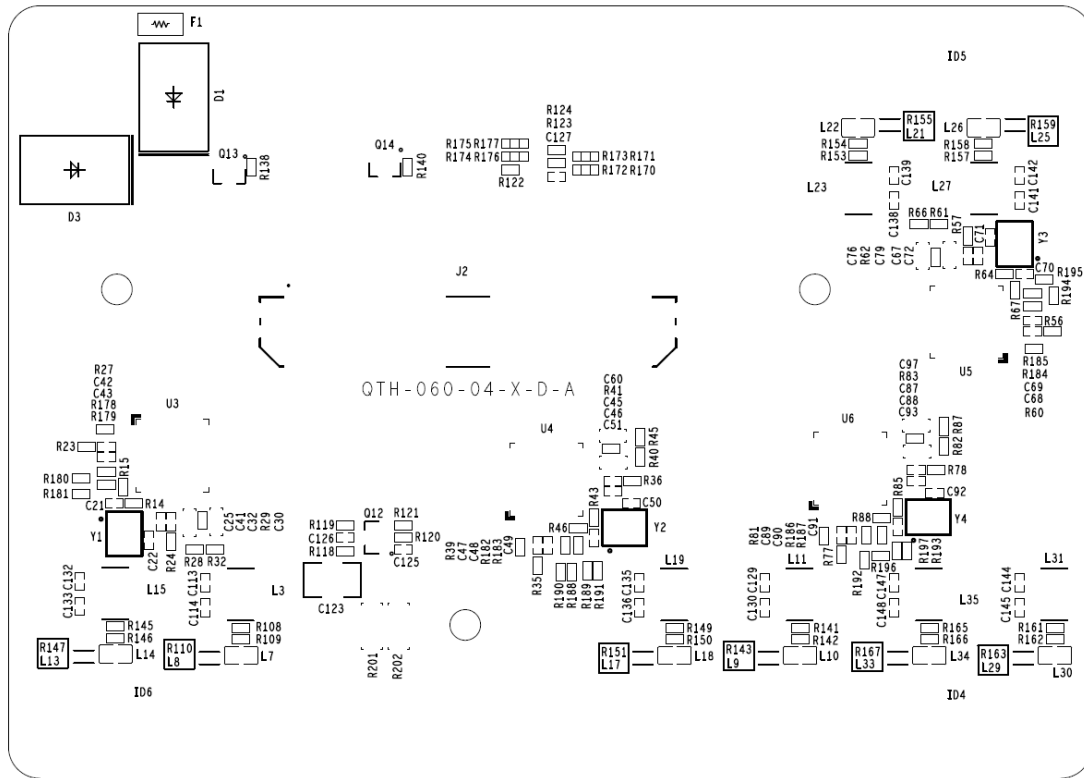
### AGX Orin/Xavier Camera Expansion Connector Pinout J509

Pin#	Assoc. Module Pin Name	Module Pin #	Usage/Description	DeSerializer	Type/Dir	Voltage Level
1	CSI0_D0_P	E42	CSI 0 Data 0	<b>MAX1</b> CSI0&1	Input	MIPI DPHY/CPHY
3	CSI0_D0_N	E41				
5	-	-	Ground		Ground	
7	CSI0_CLK_P	F43	CSI 0 Clock		Input	MIPI DPHY/CPHY
9	CSI0_CLK_N	F42				
11	-	-	Ground		Ground	
13	CSI0_D1_P	E39	CSI 0 Data 1		Input	MIPI DPHY/CPHY
15	CSI0_D1_N	E38				
17	-	-	Ground		Ground	
19	CSI2_D0_P	A41	CSI 2 Data 0		<b>MAX2</b> CSI2&3	Input
21	CSI2_D0_N	A42				
23	-	-	Ground	Ground		
25	CSI2_CLK_P	B43	CSI 2 Clock	Input		MIPI DPHY/CPHY
27	CSI2_CLK_N	B42				
29	-	-	Ground	Ground		
31	CSI2_D1_P	C42	CSI 2 Data 1	Input		MIPI DPHY/CPHY
33	CSI2_D1_N	C41				
35	-	-	Ground	Ground		
37	CSI4_D0_P	G48	CSI 4 Data 0	<b>MAX3</b> CSI4&5		Input
39	CSI4_D0_N	G47				
41	-	-	Ground		Ground	
43	CSI4_CLK_P	F48	CSI 4 Clock		Input	MIPI DPHY/CPHY
45	CSI4_CLK_N	F47				
47	-	-	Ground		Ground	
49	CSI4_D1_P	E47	CSI 4 Data 1		Input	MIPI DPHY/CPHY
51	CSI4_D1_N	E48				
53	-	-	Ground		Ground	
55	-	-	DVDD_CAM_LV. Low Voltage Digital Supply			(Power)
57	-	-				
59	CSI5_D0_P	D42	CSI 5 Data 0	<b>MAX4</b> CSI6&7	Input	MIPI DPHY/CPHY
61	CSI5_D0_N	D43				
63	-	-	Ground			
65	CSI5_CLK_P	C44	CSI 5 Clock		Input	MIPI

67	CSI5_CLK_N	C45				DPHY/CPHY	
69	-	-	Ground				
71	CSI5_D1_P	D46	CSI 5 Data 1		Input	MIPI DPHY/CPHY	
73	CSI5_D1_N	D45					
75	I2C3_CLK	F53	Camera I2C	<b>MAX9296-I2C</b>	Bidir/OD	1.8V (3.3V tolerant)	
77	I2C3_DAT	E53					
79	-	-	Ground				
81	-	-	2.8V Analog Camera supply (see note)		Power	-	
83							
85	GPIO10	A62	Camera FRSYNC #1	<b>MAX1/MFP5</b>	Output	1.8V	
87	I2C2_CLK	J61	General Purpose I2C #2	NC	Bidir/OD	1.8V (3.3V tolerant)	
89	I2C2_DAT	K61					
91	MCLK02	J54	Camera #0 Master Clock		Output	1.8V	
93	UART4_CTS	L49	Camera #0 Power down	<b>MAX1/PWDNB</b>	Output	1.8V	
95	UART4_TX	L5	Camera #0 Reset	<b>MAX2/PWDNB</b>	Output	1.8V	
97	GPIO6	E59	Camera FRSYNC #3	<b>MAX1/MFP0</b>	Output	1.8V	
99	-	-	Ground				
101	-	-	Unused		Unused	-	
103	SPI2_MOSI	F60	Camera Interrupt #3/GPIO3_PCC.0	<b>MAX3/MFP0</b>	Input	1.8V	
105	I2C5_CLK	A53	General I2C #5	NC	Bidir/OD	1.8V (3.3V tolerant)	
107	I2C5_DAT	C53					
109	-	-	Unused		Unused	-	
111							
113							
115	-	-	Ground				
117	SPI2_CLK	E61	Camera Interrupt #1	<b>MAX1234/MFP6</b>	Input	1.8V	
119	GPIO12	E10	System power enable	<b>POC Ctrl GPIO</b>	Output	1.8V	
2	CSI_1_D0_P	G41	CSI 1 Data 0	<b>MAX1</b> CSI0&1	Input	MIPI DPHY/CPHY	
4	CSI_1_D0_N	G42					
6	-	-	Ground				
8	CSI_1_CLK_P	H43	CSI 1 Clock		Input	MIPI DPHY/CPHY	
10	CSI_1_CLK_N	H42					
12	-	-	Ground				
14	CSI_1_D1_P	J41	CSI 1 Data 1		Input	MIPI DPHY/CPHY	
16	CSI_1_D1_N	J42					
18	-	-					
20	CSI_3_D0_P	E45	CSI 3 Data 0		<b>MAX2</b> CSI2&3	Input	MIPI DPHY/CPHY
22	CSI_3_D0_N	E44					
24	-	-	Ground				
26	CSI_3_CLK_P	F46	CSI 3 Clock	Input		MIPI DPHY/CPHY	
28	CSI_3_CLK_N	F45					

30	-	-	Ground				
32	CSI_3_D1_P	G44	CSI 3 Data 1		Input	MIPI DPHY/CPHY	
34	CSI_3_D1_N	G45					
36	-	-	Ground				
38	CSI6_D0_P	K44	CSI 6 Data 0	MAX4 CSI6&7	Input	MIPI DPHY/CPHY	
40	CSI6_D0_N	K43					
42	-	-	Ground				
44	CSI6_CLK_P	J44	CSI 6 Clock		Input	MIPI DPHY/CPHY	
46	CSI6_CLK_N	J45					
48	-	-	Ground				
50	CSI6_D1_P	H46	CSI 6 Data 1		Input	MIPI DPHY/CPHY	
52	CSI6_D1_N	H45					
54	-	-	Ground			-	-
56	-	-	DVDD_CAM_LV. Low Voltage Digital Supply			(Power)	-
58	-	-	-	-	-	-	
60	CSI7_D0_P	A44	CSI 7 Data 0	MAX4 CSI6&7	Input	MIPI DPHY/CPHY	
62	CSI7_D0_N	A45					
64	-	-	Ground				
66	CSI7_CLK_P	B45	CSI 7 Clock		Input	MIPI DPHY/CPHY	
68	CSI7_CLK_N	B46					
70	-	-	Ground				
72	CSI7_D1_P	C47	CSI 7 Data 1		Input	MIPI DPHY/CPHY	
74	CSI7_D1_N	C48					
76	GPIO14	L15	Camera Error #1		MAX3/MFP5	Input	1.8V
78	GPIO28	L9	Camera Error #2		NC	Input	1.8V
80	-	-	Ground	s			
82	-	-	2.8V Analog Camera supply (see note)		Power	-	
84	GPIO29	A7	Camera Error #3	NC	Input	1.8V	
86	UART4_RTS	L4	Camera Error #4	NC	Input	1.8V	
88	MCLK03	H53	Camera #1 Master Clock	NC	Output	1.8V	
90	GPIO15	F10	Camera #1 Power down	MAX3/PWDNB	Output	1.8V	
92	GPIO16	F9	Camera #1 Reset	MAX4/PWDNB	Output	1.8V	
94	MCLK04	H55	Camera #2 Master Clock	NC	Output	1.8V	
96	GPIO13	G7	Camera FRSYNC #4	MAX4/MFP5	Output	1.8V	
98	GPIO7	F59	Camera FRSYNC #2	MAX2/MFP5	Output	1.8V	
100	-	-	Ground				
102	-	-	1.8V Camera supply.		Power	-	
104	SPI2_CS0_N	D60	Camera Interrupt #4	MAX2/MFP0	Input	1.8V	
106	SPI2_MISO	D62	Camera Interrupt #2	MAX4/MFP0	Input	1.8V	
108	-	-	3.3V supply		Power	-	
110							

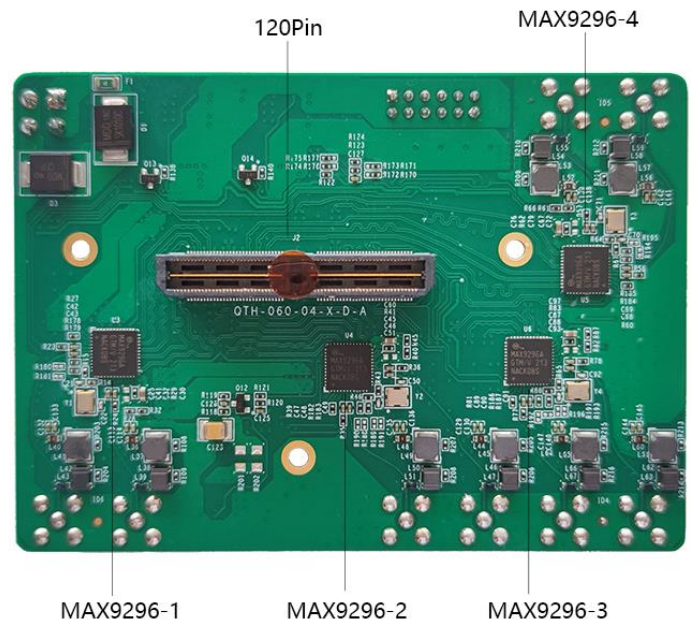
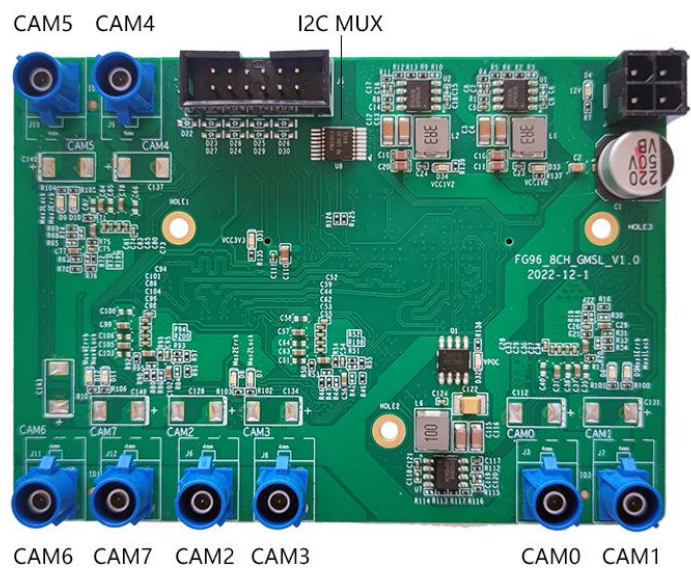




BOTTOM

## Product pictures





## Software installation and application

### Software settings

Before hardware installation, please install the correct software on the NVIDIA Jetson® AGX Orin™/Xavier™ module. BSP can support Sunny, Sensing, Huayang, Jingwei Hirain, Lijing, Leopard, Alli Light, etc. Different brands and different camera models, as long as the power requirements match those provided by FG96, all camera power can be turned off by setting the 119Pin GPIO12 (System power enable) in the 120Pin to low. Installation instructions can be found at [www.fangzhutech.com](http://www.fangzhutech.com). All other GMSL1 and GMSL2 (MIPI) cameras require the appropriate software and firmware configuration (just ask your salesperson for the corresponding firmware)

1. 1. Make sure all external system power is off;
2. Connect the FG96 GMSL expansion board to the AGX Orin™/Xavier™ 120Pin connector;
3. Install 3x8mm M2.5 screws (provided in the package);
4. Connect the GMSL camera to the 8-way FAKRA connector;
5. 5. Connect J1 to a 12V DC power supply, that is, power the camera externally. The power supply at this input terminal should not exceed 16V;
6. Turn on the power, wait for the system to start, and refer to Readme for software operation

### Verified camera list

Brand	Sensor Model (YUV)	Note
Sunny	OX08B40	
Intel realsense	D457	
iRay	M6	
	Pilot640	
Gaode Infraray	红外 IR	
Whetron	OSX019	
Desay	OX01FC	
	OSX019	
Sensing world	AR0147	
	AR0231	
	OX03C	
	IMX390	
	ISX031	
	OX05B	
	IMX490	
	AR0820	
	OX08BC	

Leopard Imaging	IMX490	
	IMX390	
	AR0233	
	AR0820	
Jinghua	OX08BC	
	IMX390	
	OX01FC	
LiJing	IMX390	
	ISX031	
	OX08B40	
Aililight	OSX019	
	OX03C	
	ISX031	
	ISX021	
	OX08B40	
HiRain	OV2311	

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## Test Procedures

(Take Sensing world IMX390/GW5200/MAX9295 1920x1080@30fps camera as an example)

### 1. Test 1 channel GMSL camera

Connect the camera to the eight FAKRA ports of CAM1 ~ 8 in sequence, and run the command to open the camera, such as:

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=UYVY,width=1920,height=1080' ! videoconvert !
fpsdisplaysink video-sink=xvimagesink sync=false
```

### 2. Test 2 channels GMSL camera

Connect the camera to the combination of CAM1/2, CAM3/4, CAM5/6, and CAM7/8 in sequence, and run the command to open:

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=UYVY,width=1920,height=1080' ! videoconvert !
fpsdisplaysink video-sink=xvimagesink sync=false & gst-launch-1.0 v4l2src device=/dev/video1 ! 'video/x-
raw,format=UYVY,width=1920,height=1080' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false
```

Connect the camera to any two FAKRA sockets randomly, such as CAM1/6, and run the command to open the camera

### 3. Test 4 channels GMSL camera

Connect the camera to the CAM1/2/3/4 combination and CAM5/6/7/8 combination in sequence and run the command to open the camera:

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=UYVY,width=1920,height=1080' ! videoconvert !
fpsdisplaysink video-sink=xvimagesink sync=false & gst-launch-1.0 v4l2src device=/dev/video1 ! 'video/x-
raw,format=UYVY,width=1920,height=1080' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false & gst-
launch-1.0 v4l2src device=/dev/video2 ! 'video/x-raw,format=UYVY,width=1920,height=1080' ! videoconvert !
fpsdisplaysink video-sink=xvimagesink sync=false & gst-launch-1.0 v4l2src device=/dev/video3 ! 'video/x-
raw,format=UYVY,width=1920,height=1080' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false
```

### 4. Test 8 channels GMSL camera

Connect to 8 FAKRA cameras at the same time, run the command to open the camera to view the preview effect

### 5. Trigger method

The GMSL expansion board hardware design supports external input trigger signals and also supports control through Orin/Xavier GPIO. For specific pin definitions, refer to the 120Pin connector definition. Four MFP6s of MAX9296 are simultaneously linked to the 117th pin of 120Pin. The reference code can enable Trigger. , the specific method of setting Tigger trigger refers to (set25fps\_SyncSignal.sh). By default, it has been set to PWM duty cycle of 20% but it is not triggered. You need to follow the steps below to set the trigger.:

```
$ sudo su -
$ cd /sys/class/leds/camsyncall-gpio
Close trigger
```

\$ echo none > trigger

open trigger

\$ echo timer > trigger

Modify the duty cycle to set different trigger frame rates

\$ echo 10> delay\_on; echo 20> delay\_off (1s trigger 25 times  $1000/(20+20)$ )

\$ echo 25 > delay\_on; echo 100 > delay\_off (1s trigger 8 times  $1000/(25+100)$ )

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## Appendix

### 1. Common commad

Gstreamer open and preview:

#### 1920x1080 RAW format camera

```
gst-launch-1.0 nvarguscamerasrc sensor-id=0 ! 'video/x-raw(memory:NVMM),width=1920,height=1080,framerate=30/1,format=NV12' ! nvvidconv ! fpsdisplaysink video-sink=xvimagesink sync=false
```

#### 3840x2160 UYVY format camera

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=UYVY,width=3840,height=2160' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false
```

#### 1920x1080 UYVY format camera

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=UYVY,width=1920,height=1080' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false
```

#### 1280x720 YUYV format camera

```
gst-launch-1.0 v4l2src device=/dev/video0 ! 'video/x-raw,format=YUY2,width=1280,height=720' ! videoconvert ! fpsdisplaysink video-sink=xvimagesink sync=false
```

### 2. Simultaneous preview screen of 4 cameras as shown below:

