IMX296 Sensor Module User Manual

Date	Revision	Change Details
2025/9/8	V2.0	First Released

Document Purpose

This Document is for innomaker imx296 mono version camera module and imx296 color version camera module.

Product Name	Sensor Name	Sensor Description
CAM-IMX296Mono-GS (Old Name: CAM-IMX296RAW)	**IMX296LLR**	Mono Sensor Sony Official Description
CAM-IMX296Color-GS	**IMX296LQR**	Color Sensor Sony Official Description

Normally We will update our development Mannual here
https://github.com/INNO-MAKER/cam-imx296raw-trigger
https://www.inno-maker.com/product/cam-mipi296raw-trigger/

1 Module Overview

InnoMaker IMX296 Sensor Module is a Global Shutter Camera with IMX296LLR-C CMOS Sensor Module for raspberry pi, compatible with raspberry pi build in driver. It supports up to 60fps at 1456×1088 Pixels operate with shorter exposure times down to 30μs, given enough light than a rolling shutter camera, which makes it useful for high-speed photography.

1.1 Module Features

- Support up to 60fps@1456×1088,totally Compatible with raspberry pi GS camera;
- Support M12 Len/ CS Len, comes with 1xM12 Wide angle lens/Cs Lens Seat.
- Support output format YUV with Resolution 1456*1088 up to 60fps;
- Support Hardware External Trigger.
- Support Strobe Function.

1.2 Sensor Overview:

This chip operates with analog 3.3V, digital 1.2V, and interface 1.8V triple power supply:

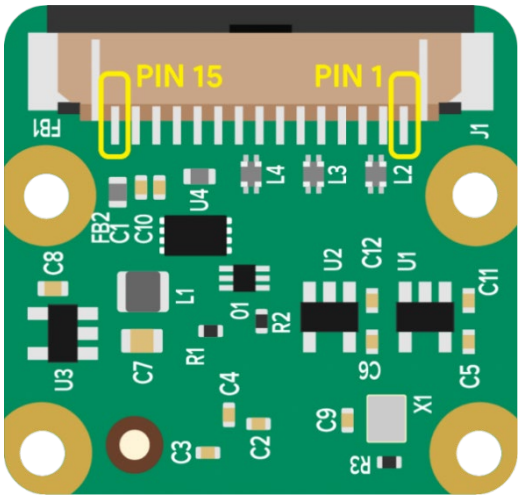
- **low power consumption.**

- **High sensitivity, low dark current and low PLS characteristics are achieved. (Applications: Sensing**

IMX296LLR / IMX296LQR-C	
FPS (Sensors):	60.3 fps
Pixel Size (Sensors):	3.4μm x 3.4μm
Resolution (Sensors):	1.58M
Scan/Series:	Pregius
Shutter (Sensors):	Global Shutter
Signal (Sensors):	**IMX296LLR** Mono **IMX296LQR** Color
Sensor Size	1/2.9 Diagonal 6.3 mm

2 Hardware Description

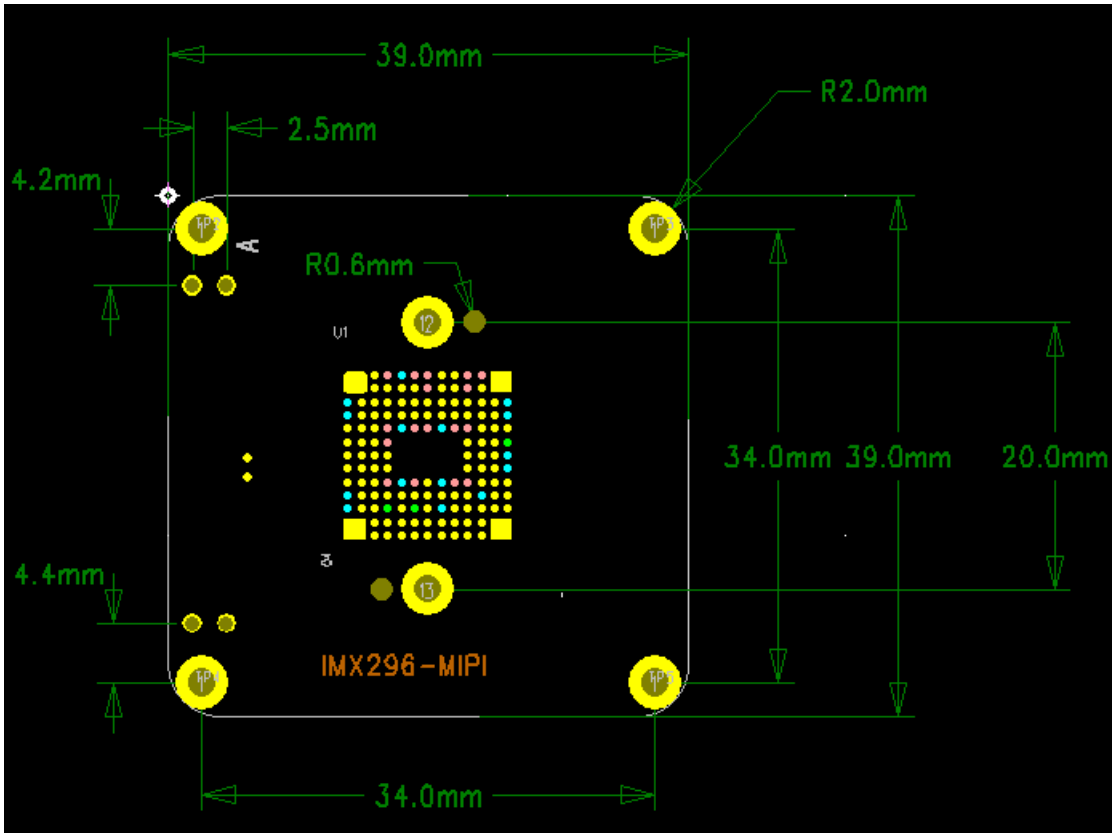
2.1 Pins Out Table(J1)



Pin #	Name	Description
1	GND	Ground

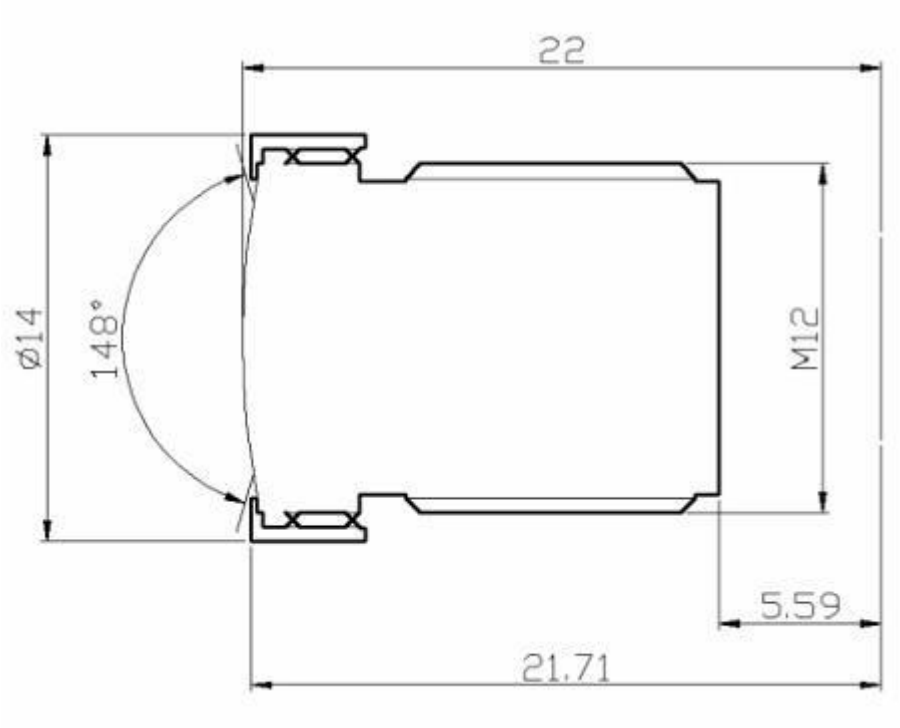
2	CAM_D0_N	MIPI Data Lane 0 Negative
3	CAM_D0_P	MIPI Data Lane 0 Positive
4	GND	Ground
5	CAM_D1_N	MIPI Data Lane 1 Negative
6	CAM_D1_P	MIPI Data Lane 1 Positive
7	GND	Ground
8	CAM_CK_N	MIPI Clock Lane Negative
9	CAM_CK_P	MIPI Clock Lane Positive
10	GND	Ground
11	CAM_IO0	Power Enable
12	CAM_IO1	LED Indicator
13	CAM_SCL	I2C SCL
14	CAM_SDA	I2C SDA
15	CAM_3V3	3.3V Power Input

2.2 Camera Size



2.3 Camera Lens

M12 Len

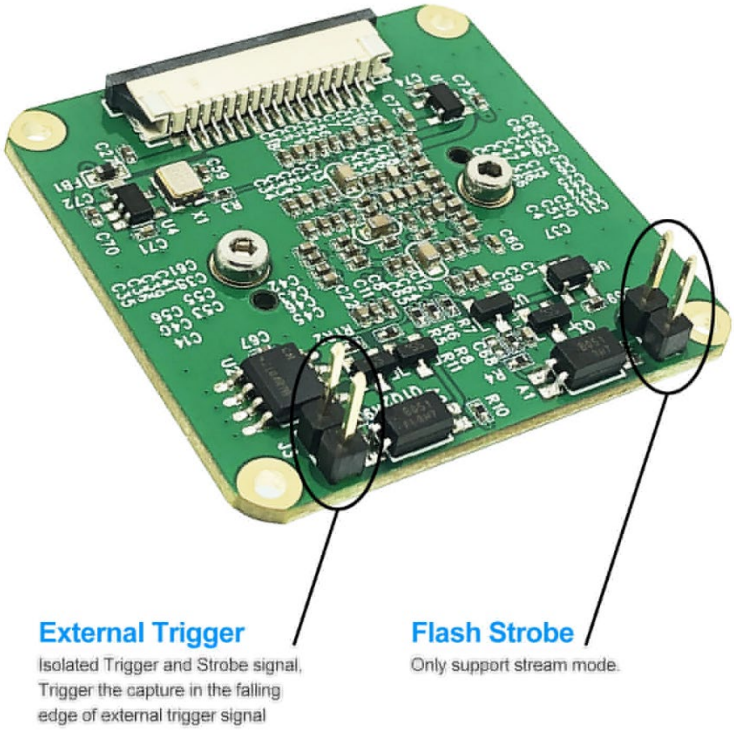


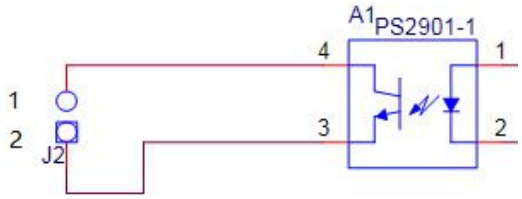
- Interface: M12
- Field of view Fov(D) = wide angle
- Focal Length 2.8 mm
- Focal Distance Adjustable
- TV DISTORTION <-17%
- F(N) /Aperture 2.2
- IR-Filter
  - Yes for Color Version
  - No for Mono Version

M12 LEN Seat

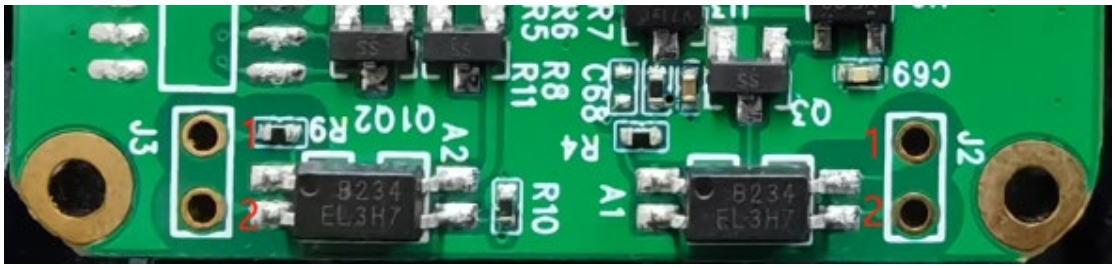
CS Len Seat

2.4 Camera Flash Strobe Pins(J2)



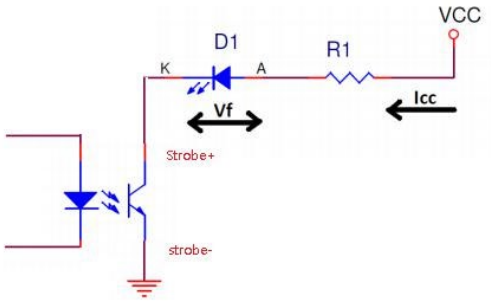


ISO FLASH



J2 PIN	Symbol
1	STROB+
2	STROB-

2.4.1 Reference Circuit



On-board TLP281 optocoupler isolation, Notice the max collector current is 50mA.

Output Specifications

S. No	Parameter	Test Condition	Value			Unit
			Min	Typ	Max	
1	Driver Voltage (VCC)			12	24	V
2	Drive current (Icc)			10	50	mA
3	Collector Emitter Breakdown Voltage				80	V
4	Collector Emitter Saturation Voltage	Icc = 1 mA		0.1	0.2	V
5	Power Dissipation				150	mW

Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_F = 10mA, I_C = 1mA		0.1	0.2	V

So, if the current required to drive the Flash LED is no more than 50mA

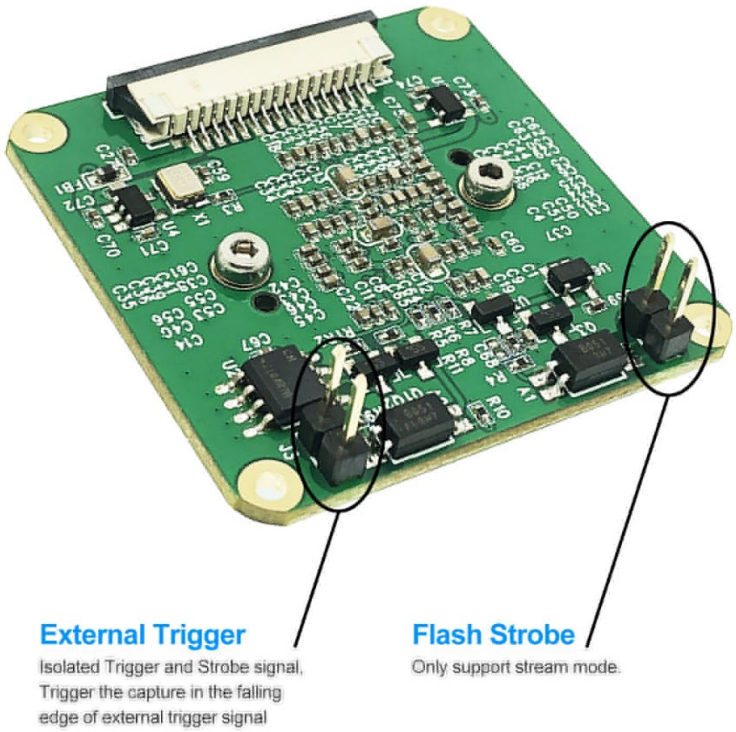
The value of series resistor: R1 = (VCC- Vf - VCE) / If

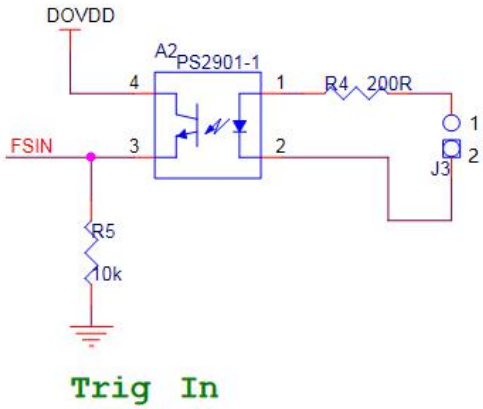
- VCC: system Voltage
- Vf: Forward voltage of Flash LED for current Icc
- VCE: Collection Emitter voltage, typical:0.1V

If the current required to drive the flash exceeds 50mA,

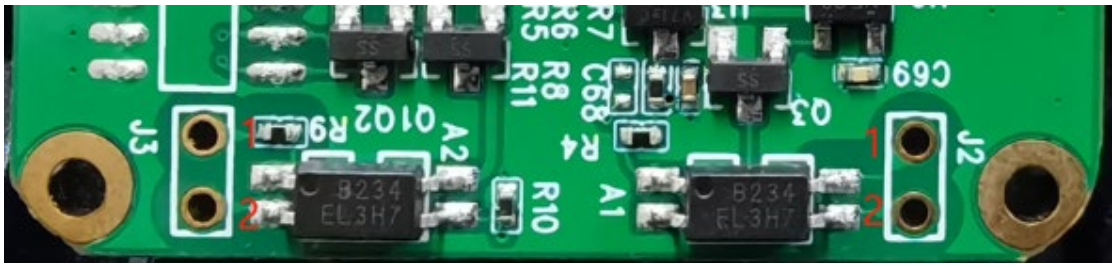
- then it is required to drive it with the help of LED driver circuit, and LED driver circuit can be controlled by using the strobe output pin.

2.5 Camera External TRIG Pins(J3)



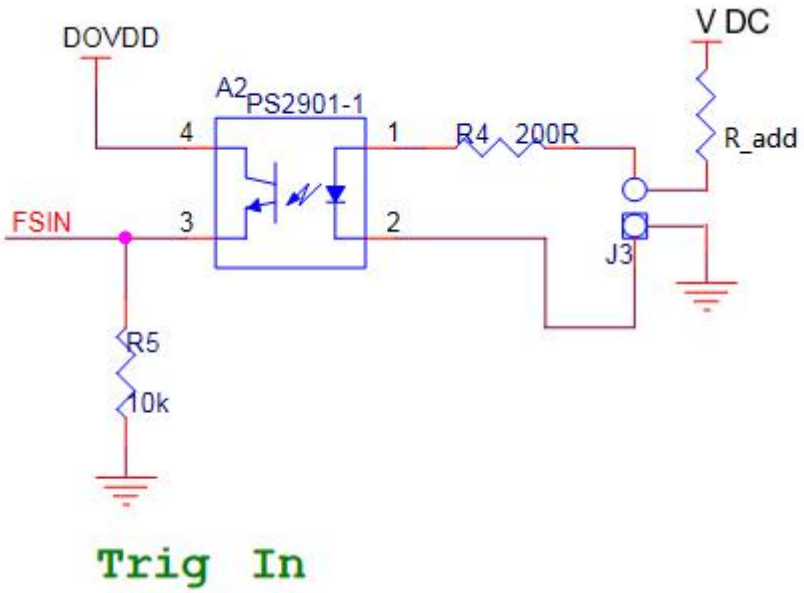


Trig In



J3 PIN	Symbol	Description
1	TRIG+	3.3V-5.0V External Trigger Input
2	TRIG-	External GND

2.5.1 Reference Circuit



For example, VCC = 12V, Vf = 1.25V

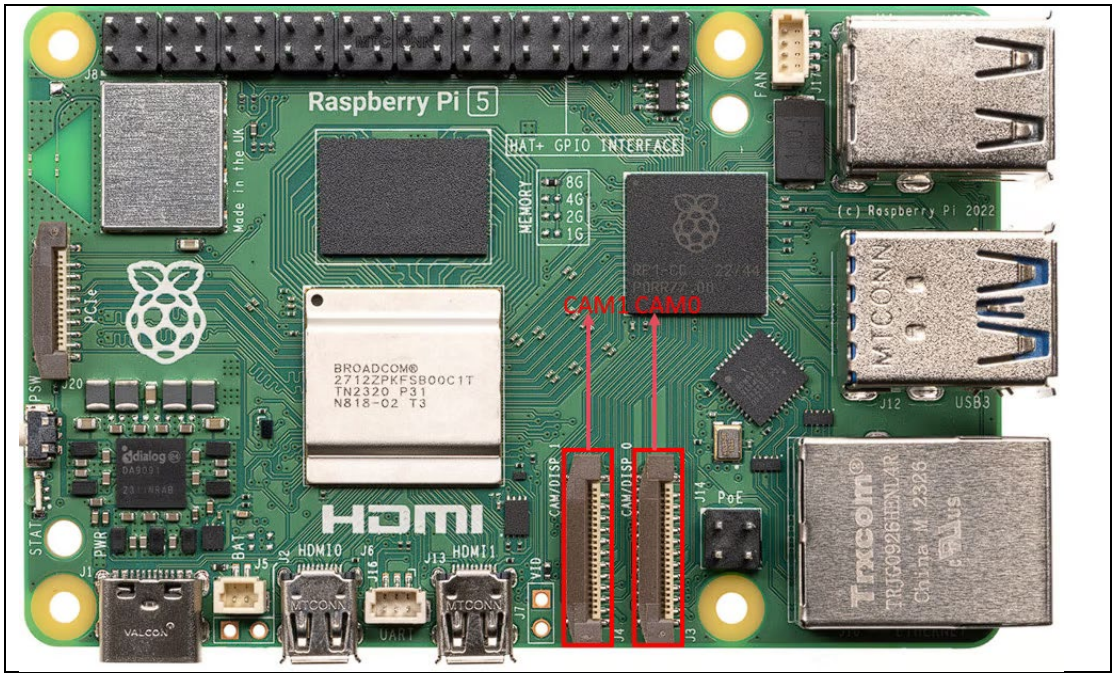
The calculations done here are based on 12VDC. Please do follow these calculations for other voltages like 24VDC.

Let's take the current through IR LED I_f = 20mA.
Voltage drop across the IR LED = 1.25V
The value of Resistor $R_1 = (V_{cc}-V_f)/I_f = (12 – 1.25)/0.02 = 537.5\ \Omega$
Wattage of resistor $R_1 > I_f^2 * R_1 = 0.02^2*537.5 = 0.215W$
Wattage of the resistor R_1 selected should be greater than 0.215W.

And there is a resistor on board(R4 = 200Ω), So the R_add = R1 - R4 = 537.5 - 200 = 337.5Ω

3 Quick Start Guide

Connection



3.1 Modify config.txt

```
sudo nano /boot/firmware/config.txt
```

older os it should be sudo nano /boot/ config.txt

3.2 Add dtoverlay

For CAM1 Interface

```
dtoverlay=imx296, cam1
```

For CAM0 Interface

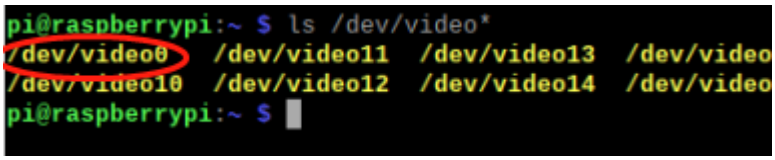
```
dtoverlay=imx296, cam0
```

Change camera_auto_detect=1 to camera_auto_detect=0
Save file and reboot.

3.2 Preview

Reboot and check camera Status

```
$ls /dev/video*
```




```
$libcamera-vid --width 1456 --height 1088 -t 0
```

More about libcamera and libcamera-apps Please Refer:

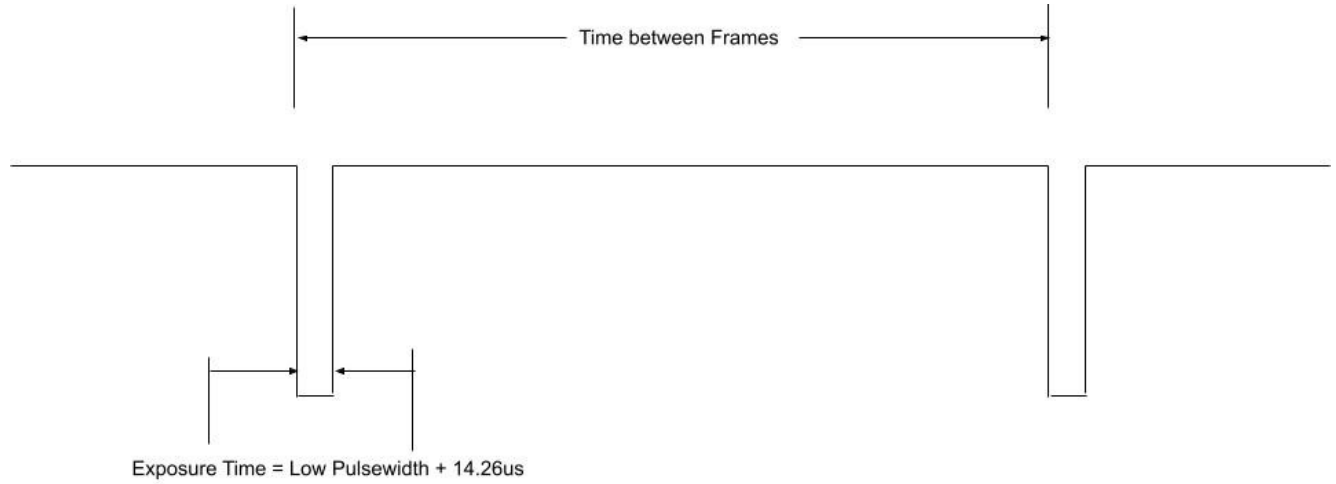
https://www.raspberrypi.com/documentation/computers/camera_software.html#libcamera-and-libcamera-apps

4 External Trigger Mode

4.1 Description

- The Global Shutter (GS) camera can be triggered externally by pulsing the external trigger (denoted on the board as XTR（Trig+）,GND(Trig-)) connection on the board. Multiple cameras can be connected to the same pulse, allowing for an alternative way to synchronize two cameras.
- The exposure time is equal to the low pulse-width time plus an additional 14.26us. i.e. a low pulse of 10000us leads to an exposure time of 10014.26us. Framerate is directly controlled by how often you pulse the pin. A PWM frequency of 30Hz will

lead to a framerate of 30 frames per second.



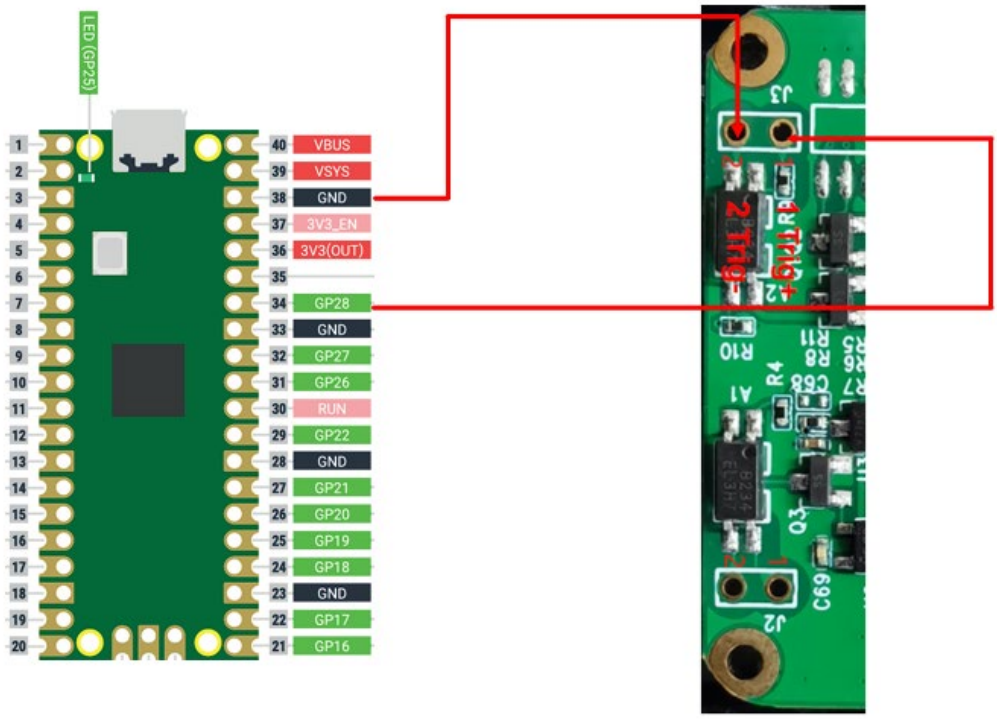
External Trigger Function

PULSE2_EN_NOR	79h (3079h)	[0]	0	Pulse2 enable in normal mode 0: disable 1: enable
PULSE2_EN_TRIG		[1]	0	Pulse2 enable in trigger mode 0: disable 1: enable
PULSE2_POL		[2]	0	Pulse2 polarity selection 0: High active 1: Low active
		[3]	0	Fixed to 1
PULSE2_UP [19:0]	7Ch (307Ch)	[7:0]	00000h	Pulse2 active period start timing setting Designated in line units from reference point
	7Dh (307Dh)	[7:0]		
	7Eh (307Eh)	[3:0]		
PULSE2_DN [19:0]	80h (3080h)	[7:0]	00000h	Pulse2 active period end timing setting Designated in line units from reference point
	81h (3081h)	[7:0]		
	82h (3082h)	[3:0]		

4.2 Raspberry Pi Pico MicroPython Code

We can use Raspberry Pi Pico to provide the trigger.

Connect Pico GPIO pin (GP28 is used in this example) to XTR(Trig+).
Also connect GND To Trig-. A wiring diagram is shown below.



GND--------J3 1 Trig-
GPIO28------J3 2 Trig+ (3.3V)

Raspberry Pi Pico MicroPython Code

```
from machine import Pin, PWM
from time import sleep
pwm = PWM(Pin(28))
framerate = 30
shutter = 6000    # In microseconds
frame_length = 1000000 / framerate
pwm.freq(framerate)
pwm.duty_u16(int((1 - (shutter - 14) / frame_length) * 65535))
```

The low pulse width is equal to the shutter time, and the frequency of the PWM equals the framerate.

Note	In this example, Pin 28 connects to the XTR touchpoint on the GS camera board.

4.3 Camera driver configuration

This step is only necessary if you have more than one camera with XTR wired in parallel. Edit /boot/firmware/config.txt. Change camera_auto_detect=1 to camera_auto_detect=0.

Append this line:

```
dtoverlay=imx296,always-on
```

When using the CAM0 port on a Raspberry Pi 5, CM4 or CM5, append ,cam0 to that line without a space. If both cameras are on the same Raspberry Pi you will need two dtoverlay lines, only one of them ending with, cam0.

If the external trigger will not be started right away, you also need to increase the libcamera timeout as above.

4.4 Starting the camera

```
$ echo 1 | sudo tee /sys/module/imx296/parameters/trigger_mode
```

Run the code on the Pico, then set the camera running:

```
$ rpicam-hello -t 0 --qt-preview --shutter 3000
```

Every time the Pico pulses the pin, it should capture a frame. However, if --gain and --awbgains are not set, some frames will be dropped to allow AGC and AWB algorithms to settle.

Note:
When running rpicam-apps, always specify a fixed shutter duration, to ensure the AGC does not try to adjust the camera's shutter speed. The value is not important, since it is

actually controlled by the external trigger pulse.

4.5 Official User Guide And Difference

https://github.com/raspberrypi/documentation/blob/develop/documentation/asciidoc/accessories/camera/external_trigger.adoc#starting-the-camera

Difference between Raspberry PI Official GS Camera with Raspberry PI IMX296 Camera.

XTR(Trig+)	Voltage
Raspberry PI GS Camera	XTR-----1.8V
CAM-IMX296Mono-GS	XTR-----3.3V
CAM-IMX296Color-GS	XTR-----3.3V

5 Strobe Mode

5.1 I2c tools download

i2c-tools-arch32.zip
i2c-tools-arch64.zip

5.2 Description

IMX296 official driver that provide by RPI default kernel not enable strobe by default.
Imx296 can output strobe while work in normal or fast trigger mode, We can enable strobe by i2c tools.

- **Imx296 I2c address: 0x1a**
- **Pi5 csi1 i2c bus address : i2c-4**

Note: strobe setting must be done while camera stream is off.

Regs and setting values

0x3026: 0x0F
0X3029:0x21

0x306D: 0X02(trigger mode strobe enable) /0x01(normal mode strobe enable)
Strobe start point 3byte:
0x3070 :0x00
0x3071 :0x00
0x3072 :0x00
Strobe end point 3byte:
0x3074:0x2c
0x3075:0x01
0x3076:0x00

0x3079: 0X0A(trigger mode strobe enable) /0x09(normal mode strobe enable)
Strobe start point 3byte:
0x307c :0x00
0x307d :0x00
0x307e :0x00
Strobe end point 3byte:
0x3080 :0x2c
0x3081 :0x01
0x3082 :0x00

I2c tools write register:
./i2c_write 4 0x1a <reg addr> <reg val>

I2c tools read register:
./i2c_read 4 0x1a <reg addr> <num of regs regs to read>

6 Dual GS Cameras Working Mode

Two of imx296 camera module: one free running and the other in trigger mode.
This can be done by below way:

6.1 Download setting Trigger Tools

imx296_trigger

6.2, setting config.txt

```
dtoverlay=imx296,always-on,cam0
dtoverlay=imx296,always-on
```

6.3, setting libcamera timeout

```
cp /usr/share/libcamera/pipeline/rpi/pisp/example.yaml timeout.yaml
```

Edit timeout.yaml by sudo nano /usr/share/libcamera/pipeline/rpi/pisp/timeout.yaml

delete the # (comment) from the "camera_timeout_value_ms": line, and change the number to 60000 export LIBCAMERA_RPI_CONFIG_FILE=timeout.yam

6.4, Running libcamera tools to make two camera module work in free running mode

for example:

```
libcamera-hello -t 0 --camera 0
libcamera-hello -t 0 --camera 1
```

6.5, running our trigger enable/disable tools, this tools can enable imx296 trigger mode individually.

```
chmod a+x   imx296_trigger
```

```
./imx296_trigger   [i2c bus] [on/off]
```

Note:

on pi5 camera1 i2c bus =4 camera0 i2c bus =6

on=1 off=0

example:
camera 1 trigger on:
./imx296_trigger 4 1

camera 1 trigger off:
./imx296_trigger 4 0

camera 0 trigger on:
./imx296_trigger 6 1

camera 0 trigger off:
./imx296_trigger 6 0

6.6 Send trigger signal to imx296 camera module.

Follow Chapter4

7 Official Software Manual

- https://www.raspberrypi.com/documentation/computers/camera_software
- https://github.com/raspberrypi/documentation/tree/develop/documentation/asciidoc/accessories/camera

8 Preset System IMAGE

This is preset system IMG for raspberry pi 5.

https://www.jianguoyun.com/p/DY_2JXYQpdSrBxj-nf4FIAA

(Password : o1drfz)