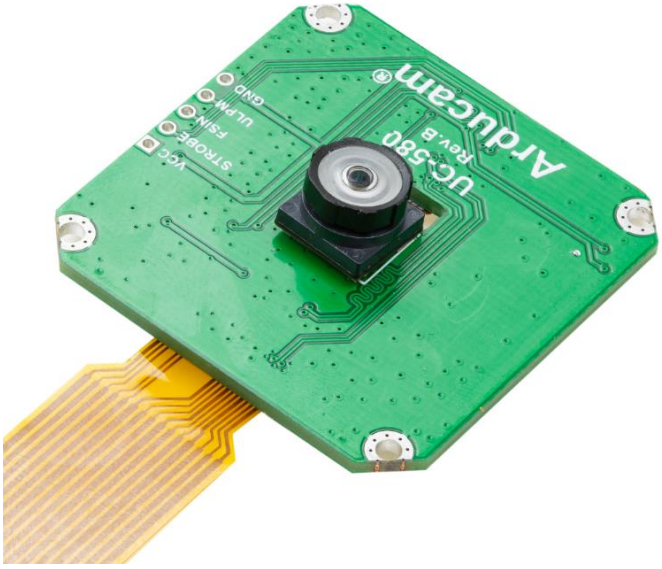
OV9281 MIPI Camera Module

1MP Monochrome Global Shutter Camera

Module Datasheet

Rev 1.0, March 2019



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1 Introduction

The Arducam monochrome (B&W) global shutter 1280x800 resolution OV9281 MIPI camera module is mainly designed for Raspberry Pi boards, and it can be connected directly to RPi's CSI-2 camera interface without additional hardware. This camera is based on 1/4-inch Omnivision OV9281 image sensor which adopts OmniPixel3-GS technology to provide full-frame, sub-sampled, and windowed 8/10-bit MIPI images, and capable of operating at up to 60fps in full resolution at 1lane MIPI bus with complete user control over image quality. The global shutter technology allows to reduce or eliminate unwanted image artifacts, which occur with traditional rolling shutter image sensors as a result of motion during image capture. The sensor's global shutter and excellent low-light sensitivity allow it to be used for any application that needs gesture detection, head and eye tracking, and depth and motion detection.

Leveraging the industry's smallest global shutter pixel, with 1lane MIPI output the OV9281 is capable of capturing 1280x800 resolution video at 60 frames per second (fps), VGA (640x480) at 120fps, QVGA (320x240) at 220 fps with binning, and QQVGA (160x120) at 400 fps with binning and skipping. The OV9281's high frame rates make it an ideal solution for low-latency machine vision applications.

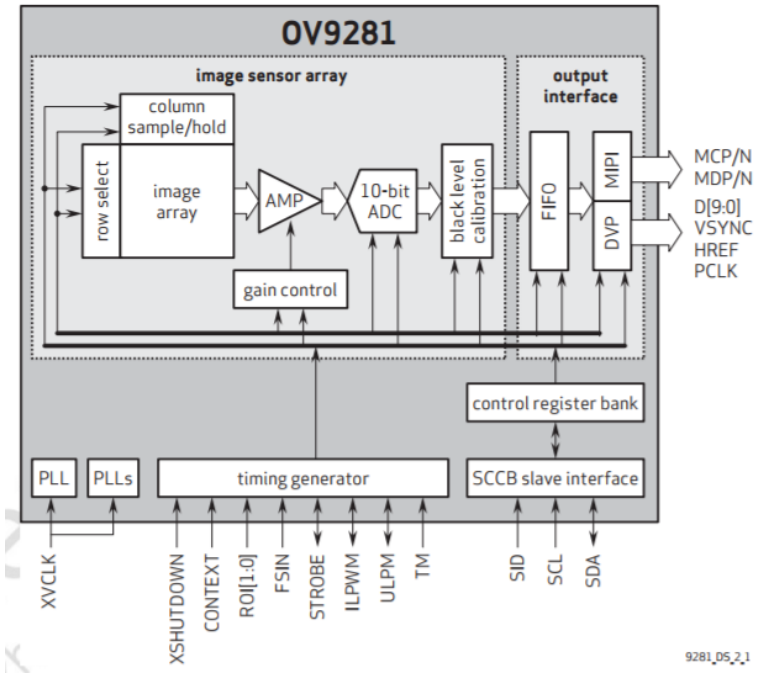
For Raspberry Pi platform Arducam developed a proprietary camera driver which is V4L2 compliance, which provides friendly compatibility to off-the-shelf video capture/playback software like VLC player or OpenCV image processing tools. The driver also provides V4L2-ctrl functions like manual exposure/gain, mirror/flip controls, and even the low-level sensor register access controls. Please note that this camera and RPI driver doesn't support ISP functions like AEC/AGC etc., and not support hardware JPEG/H.264 encoding. It is good for advanced users who need high frame rate unprocessed RAW video for machine vision and is capable of doing image processing using OpenCV.

This MIPI camera module can be used on other ARM, FPGA, DSP, or Nvidia TX1/TX2 hardware platform as well.

2 Key Specifications

Parameter	Typical Value
Sensor	Monochrome global shutter OV9281
Pixel Size	3 µm x 3 µm
Active array size	1280 x 800
Optical Size	1/4 inch
EFL	0.83
F.NO	2.0
FOV	166º diagonal
Build-in IR cut filter	None
Focusing Range	65mm ~ infinite
Output interface	1-lane MIPI serial output
Output formats	8/10-bit BW RAW
Maximum image transfer rate	1280 x 800@60 fps
Board Size	40mm x 40mm

3 Block Diagram



4 Application

- Cellular phones
- Toys
- Tablets
- Machine vision
- ARM/FPGA/DSP based platforms

5 Pin Definition

The OV9281 module uses standard Raspberry Pi camera pinout. The pin number is listed below.

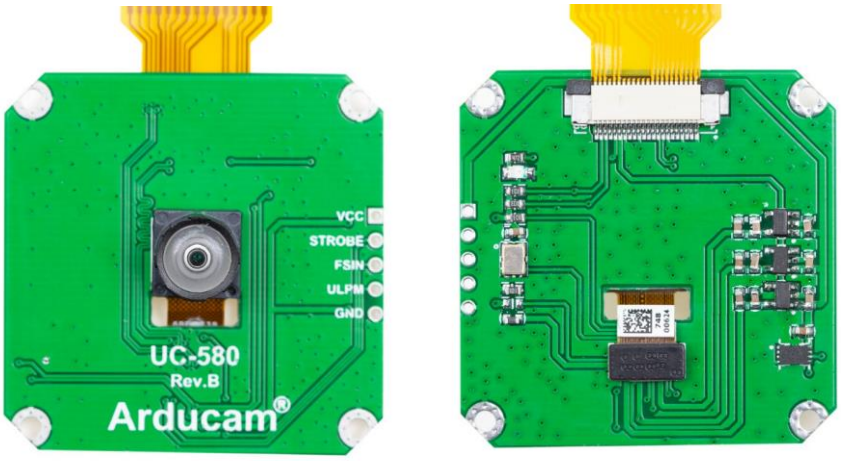


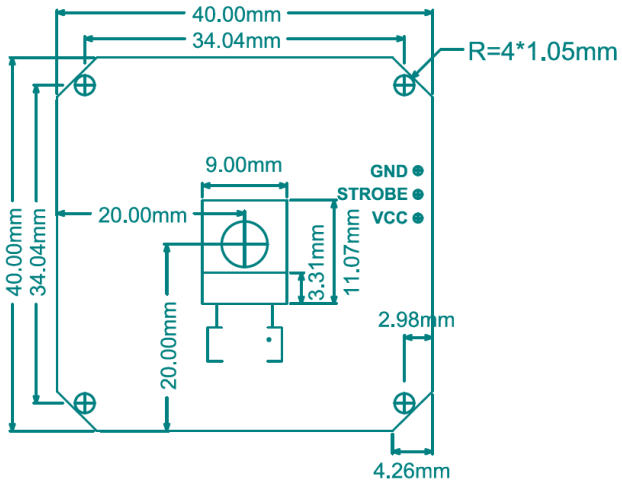
Table 1 J1 Connector Pin Definition

Pin No.	PIN NAME	TYPE	DESCRIPTION
1	DGND	Ground	Power ground
2	MDN0	Output	Pixel Data Lane0 Negative
3	MDP0	Output	Pixel Data Lane0 Positive
4	DGND	Ground	Power ground
5	MDN1	Output	Pixel Data Lane1 Negative
6	MDP1	Output	Pixel Data Lane1Positive
7	DGND	Ground	Power ground
8	MCN	Output	Pixel Clock Output Form Sensor Negative
9	MCP	Output	Pixel Clock Output Form Sensor Positive
10	DGND	Ground	Power ground
11	POWER-EN	Output	Power Enable
12	LED-EN	I/O	Led Enable
13	SCL	Input	SCCB serial interface clock input
14	SDA	I/O	SCCB serial interface data I/O
15	VCC	Power	3.3V Power supply

Table 1 J2 Connector Pin Definition

Pin No.	PIN NAME	TYPE	DESCRIPTION
1	VCC	Power	3.3V Power
2	STROBE	Output	LED Strobe Output
3	FSIN	Input	Frame Sync Input
4	ULPM	Input/Output	Ultra low Power Mode/ ALS trigger indicator
5	GND	Ground	Ground

6 Mechanical Dimension

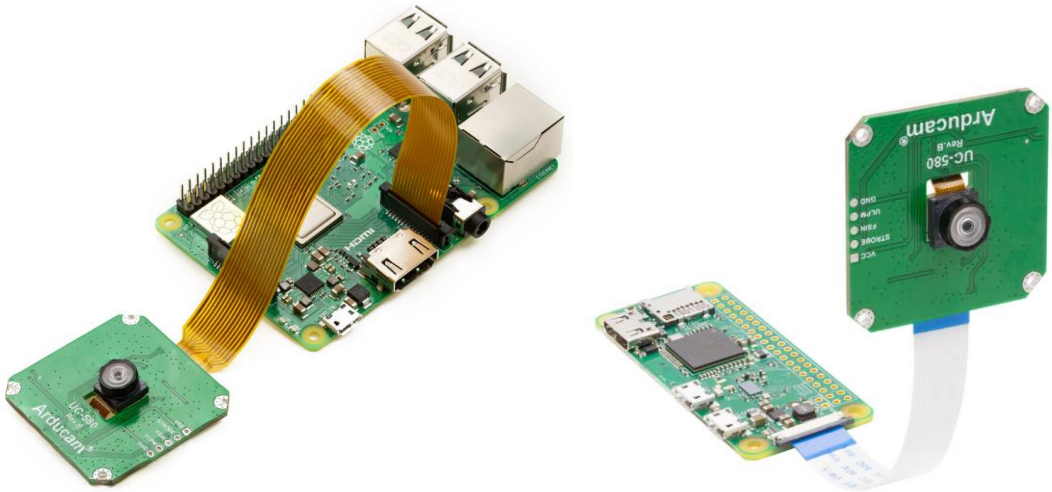


7 Installation For RPi

7.1 Hardware

For RPi 1B/2B/3B/3B+ boards, please connect the FPC cable 15pin side to RPI board and the 22pin side to the camera.

For RPi Zero or RPi compute module, please connect the 22pin to 22pin FPC cable on each side.



7.2 Camera Driver

7.2.1 Important Note

The camera driver should match with your current Raspbian OS kernel version.

For Raspberry Pi A/A+, B/B+, Pi Zero/W, Compute module V1, you need pi1 suffix version driver, for Raspberry pi 2B/3B/3B+, Compute module V3, you need pi3 suffix version driver.

7.2.2 Auto Install

Run the bash script ./preprocess.sh and choose yes to reboot, this step is only need once.

After reboot, run the bash script ./loaddriver.sh with the RPI board version parameter, this step

should be done every time reboot the Raspbian OS. For example:

```
./loaddriver.sh pi1
```

Or

```
./loaddriver.sh pi3
```

7.2.3 Manual Install

Manual install the driver is explained here if you want to investigate the details or fix the problem when the driver installation.

Add the following code to the last line of /boot/config.txt file

```
dtparam=i2c_vc=on
```

Save the file and probe the i2c driver using the command below:

```
sudo modprobe i2c-dev
```

Compile the device tree for the OV9281 camera

```
sudo dtc -I dts -O dtb -o /boot/overlays/arducam-OV9281.dtbo arducam-OV9281.dts
```

Add the following code to the last line of /boot/config.txt file, only one Arducam camera driver allowed here.

```
dtoverlay=arducam-OV9281
```

Save the /boot/config.txt then reboot. The above steps only need to be done for once.

Every time reboot the board or run after raspivid/raspistill command, and you have to run the following commands

```
sudo chmod +x camera_i2c
sudo chmod +x rpi3-gpiovirtbuf
./camera_i2c
```

Install the kernel driver using the following command

```
./loaddepends.sh
sudo insmod arducam-OV9281-v4l2-pi3.ko    (or sudo insmod
arducam-OV9281-v4l2-pi1.ko)
```

After this step, you should find a new video device like /dev/video0.

7.3 VLC Player Demo

7.3.1 Download the VLC player

You can download the vlc player (sudo apt-get install vlc) to open the camera for fast evaluation easily.

7.3.2 Run the VLC player

Run the VLC player by the following command

```
vlc v4l2:///dev/video0
```

7.3.3 V4L2 Control Functions

Arducam OV9281 camera driver supports a list of V4L2 control functions, and you can check the supported functions using the following commands:

1. Check supported resolution

```
v4l2-ctl --list-formats-ext
```

2. Check the supported controls

```
v4l2-ctl -l
```

3.Manual Exposure Setting

```
v4l2-ctl -c exposure=0x50
```

4.Manual Gain Setting

```
v4l2-ctl -c gain=0x02
```

5.Mirror

```
v4l2-ctl -c horizontal_flip=1
```

6.Flip

```
v4l2-ctl -c vertical_flip=1
```

7.Sensor Register Access

First, you have to set the address of the register to be accessed, for example, 0x0202 in our case

```
v4l2-ctl -c register_addr=0x0202
```

Read the value from 0x0202 register

```
v4l2-ctl -C register_val
```

Write the value to 0x0202 register

```
v4l2-ctl -c register_val=0x01
```