

RICO-3288

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# MIPI CSI

*Edit by Jason Wang*

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## 1. Introduction

The CSI-2 Host Controller implements the CSI-2 protocol on the host side. The CSI-2 link protocol specification is a part of communication protocols defined by MIPI Alliance standards intended for mobile system chip-to-chip communications. The CSI-2 specification is for the image application processor communication in cameras.

The CSI-2 Host Controller is designed to receive data from a CSI-2 compliant camera sensor. A D-PHY configured as a Slave acts as the physical layer.

The MIPI CSI-2 Host Controller supports the following features:

- Compliant with MIPI Alliance Specification for CSI-2, Version 1.01.00-9 November 2010
- Interface with MIPI D-PHY following PHY Protocol Interface, as defined in MIPI Alliance Specification for D-PHY, Version 1.1-7 November 2011
- Up to four D-PHY RX data lanes
- Camera Interface and Image Processor(Interface and Image Processing)
  - Maximum input resolution of 14M(4416x3312) pixels
  - Main scaler with pixel-accurate up- and down-scaling to any resolution between 4416x3312 and 32x16 pixel in processing mode
  - Self scaler with pixel-accurate up- and down-scaling to any resolution between 1920x1080 and 32x16 pixel in processing mode
- Long and Short packet decoding
- Timing accurate signaling of Frame and Line synchronization packets
- Several Frame formats
  - General Frame or Digital Interlaced Video with or without accurate sync timing
  - Data Type (Packet or Frame Level) and Virtual Channel interleaving
- 32-bit Image Data Interface delivering data formatted as recommended in CSI-2 Specification
- All primary and secondary data formats
  - RGB, YUV, and RAW color space definitions
  - From 24-bit down to 6-bit per pixel
  - Generic or user-defined byte-based data types
- Error detection and correction
  - PHY level
  - Packet level
  - Line level
  - Frame level

## 2. How to Use

### Onboard resources

RK3288 SoC has a MIPI camera interface, and the camera has an image processing capacity of 4416 x 3312 pixels and supports 4K video recording. In addition, the RK3288 SoC also supports USB camera. This text takes RK3288 SoC and single OV13850 camera as example, and explains the configuration process of MIPI camera on this source code.

### Related code catalog

The code catalog related to camera is as follows:

Android:

```
`- hardware/rockchip/camera
  |- Config
  |   `- cam_board.xml      // parameter setting of camera
  |- CameraHal              // HAL source code of camera
  `- SiliconImage          // ISP library, including all drivers source codes supporting module
      `- isi/drv/OV13850    // Driver source code of OV13850 module
          `- calib/OV13850.xml // Adjustment parameters of OV13850 module
```

Kernel:

```
|- kernel/drivers/media/video/rk_camsys // CamSys driver source code
`- kernel/include/media/camsys_head.h
```

### Configuration steps

#### Configure Android

Modify hardware/rockchip/camera/Config/cam\_board\_rk3288.xml to register camera:

```
<?xml version="1.0" ?>
  <BoardFile>
    <BoardXmlVersion version="v0.7.0">
      </BoardXmlVersion>
      <CamDevie>
        <HardWareInfo>
          <Sensor>
```

```

<SensorName name="OV13850" ></SensorName>
<SensorDevID IDname="CAMSYS_DEVID_SENSOR_1B"></SensorDevID>
<SensorHostDevID busnum="CAMSYS_DEVID_MARVIN" ></SensorHostDevID>
<SensorI2cBusNum busnum="3"></SensorI2cBusNum>
<SensorI2cAddrByte byte="2"></SensorI2cAddrByte>
<SensorI2cRate rate="100000"></SensorI2cRate>
<SensorMclk mclk="24000000"></SensorMclk>
<SensorAvdd name="NC" min="0" max="0"></SensorAvdd>
<SensorDovdd name="NC" min="18000000" max="18000000"></SensorDovdd>
<SensorDvdd name="NC" min="0" max="0"></SensorDvdd>
<SensorGpioPwdn ioname="RK30_PIN2_PB6" active="0"></SensorGpioPwdn>
<SensorGpioRst ioname="RK30_PIN3_PB0" active="0"></SensorGpioRst>
<SensorGpioPwen ioname="RK30_PIN0_PB3" active="1"></SensorGpioPwen>
<SensorFacing facing="front"></SensorFacing>
<SensorInterface interface="MIPI"></SensorInterface>
<SensorMirrorFlip mirror="0"></SensorMirrorFlip>
<SensorOrientation orientation="0"></SensorOrientation>
<SensorPowerupSequence seq="1234"></SensorPowerupSequence>
<SensorFovParameter h="60.0" v="60.0"></SensorFovParameter>
<SensorAWB_Frame_Skip fps="15"></SensorAWB_Frame_Skip>
<SensorPhy phyMode="CamSys_Phy_Mipi" lane="2" phyIndex="1"
sensorFmt="CamSys_Fmt_Raw_10b"></SensorPhy>
</Sensor>
<VCM>
<VCMDrvName name="BuiltInSensor"></VCMDrvName>
<VCMName name="NC"></VCMName>
<VCMI2cBusNum busnum="3"></VCMI2cBusNum>
<VCMI2cAddrByte byte="0"></VCMI2cAddrByte>
<VCMI2cRate rate="0"></VCMI2cRate>
<VCMVdd name="NC" min="0" max="0"></VCMVdd>
<VCMGpioPwdn ioname="NC" active="0"></VCMGpioPwdn>
<VCMGpioPower ioname="NC" active="0"></VCMGpioPower>
<VCMCurrent start="20" rated="80" vcmmax="100" stepmode="13"
drivermax="100"></VCMCurrent>
</VCM>
<Flash>
<FlashName name="Internal"></FlashName>
<FlashI2cBusNum busnum="0"></FlashI2cBusNum>
<FlashI2cAddrByte byte="0"></FlashI2cAddrByte>

```

```

    <FlashI2cRate rate="0"></FlashI2cRate>
    <FlashTrigger ioname="NC" active="0"></FlashTrigger>
    <FlashEn ioname="NC" active="0"></FlashEn>
    <FlashModeType mode="1"></FlashModeType>
    <FlashLuminance luminance="0"></FlashLuminance>
    <FlashColorTemp colortemp="0"></FlashColorTemp>
  </Flash>
</HardWareInfo>
<SoftWareInfo>
  <AWB>
    <AWB_Auto support="1"></AWB_Auto>
    <AWB_Incandescent support="1"></AWB_Incandescent>
    <AWB_Fluorescent support="1"></AWB_Fluorescent>
    <AWB_Warm_Fluorescent support="1"></AWB_Warm_Fluorescent>
    <AWB_Daylight support="1"></AWB_Daylight>
    <AWB_Cloudy_Daylight support="1"></AWB_Cloudy_Daylight>
    <AWB_Twilight support="1"></AWB_Twilight>
    <AWB_Shade support="1"></AWB_Shade>
  </AWB>
  <Sence>
    <Sence_Mode_Auto support="1"></Sence_Mode_Auto>
    <Sence_Mode_Action support="1"></Sence_Mode_Action>
    <Sence_Mode_Portrait support="1"></Sence_Mode_Portrait>
    <Sence_Mode_Landscape support="1"></Sence_Mode_Landscape>
    <Sence_Mode_Night support="1"></Sence_Mode_Night>
    <Sence_Mode_Night_Portrait support="1"></Sence_Mode_Night_Portrait>
    <Sence_Mode_Theatre support="1"></Sence_Mode_Theatre>
    <Sence_Mode_Beach support="1"></Sence_Mode_Beach>
    <Sence_Mode_Snow support="1"></Sence_Mode_Snow>
    <Sence_Mode_Sunset support="1"></Sence_Mode_Sunset>
    <Sence_Mode_Steayphoto support="1"></Sence_Mode_Steayphoto>
    <Sence_Mode_Pireworks support="1"></Sence_Mode_Pireworks>
    <Sence_Mode_Sports support="1"></Sence_Mode_Sports>
    <Sence_Mode_Party support="1"></Sence_Mode_Party>
    <Sence_Mode_Candlelight support="1"></Sence_Mode_Candlelight>
    <Sence_Mode_Barcode support="1"></Sence_Mode_Barcode>
    <Sence_Mode_HDR support="1"></Sence_Mode_HDR>
  </Sence>
  <Effect>

```

```

<Effect_None support="1"></Effect_None>
<Effect_Mono support="1"></Effect_Mono>
<Effect_Solarize support="1"></Effect_Solarize>
<Effect_Negative support="1"></Effect_Negative>
<Effect_Sepia support="1"></Effect_Sepia>
<Effect_Posterize support="1"></Effect_Posterize>
<Effect_Whiteboard support="1"></Effect_Whiteboard>
<Effect_Blackboard support="1"></Effect_Blackboard>
<Effect_Aqua support="1"></Effect_Aqua>
</Effect>
<FocusMode>
  <Focus_Mode_Auto support="1"></Focus_Mode_Auto>
  <Focus_Mode_Infinity support="1"></Focus_Mode_Infinity>
  <Focus_Mode_Marco support="1"></Focus_Mode_Marco>
  <Focus_Mode_Fixed support="1"></Focus_Mode_Fixed>
  <Focus_Mode_Edof support="1"></Focus_Mode_Edof>
  <Focus_Mode_Continuous_Video support="0"></Focus_Mode_Continuous_Video>
  <Focus_Mode_Continuous_Picture support="1"></Focus_Mode_Continuous_Picture>
</FocusMode>
<FlashMode>
  <Flash_Mode_Off support="1"></Flash_Mode_Off>
  <Flash_Mode_On support="1"></Flash_Mode_On>
  <Flash_Mode_Torch support="1"></Flash_Mode_Torch>
  <Flash_Mode_Auto support="1"></Flash_Mode_Auto>
  <Flash_Mode_Red_Eye support="1"></Flash_Mode_Red_Eye>
</FlashMode>
<AntiBanding>
  <Anti_Banding_Auto support="1"></Anti_Banding_Auto>
  <Anti_Banding_50HZ support="1"></Anti_Banding_50HZ>
  <Anti_Banding_60HZ support="1"></Anti_Banding_60HZ>
  <Anti_Banding_Off support="1"></Anti_Banding_Off>
</AntiBanding>
<HDR support="1"></HDR>
<ZSL support="1"></ZSL>
<DigitalZoom support="1"></DigitalZoom>
<Continue_SnapShot support="1"></Continue_SnapShot>
<PreviewSize width="800" height="600"></PreviewSize>
<DV>
  <DV_QCIF name="qcif" width="176" height="144" fps="10" support="1"></DV_QCIF>

```

```

    <DV_QVGA name="qvga" width="320" height="240" fps="10"
support="1"></DV_QVGA>
    <DV_CIF name="cif" width="352" height="288" fps="10" support="1"></DV_CIF>
    <DV_VGA name="480p" width="640" height="480" fps="10" support="0"></DV_VGA>
    <DV_480P name="480p" width="720" height="480" fps="10" support="0"></DV_480P>
    <DV_720P name="720p" width="1280" height="720" fps="10" support="1"></DV_720P>
    <DV_1080P name="1080p" width="1920" height="1080" fps="10"
support="1"></DV_1080P>
    </DV>
    </SoftWareInfo>
    </CamDevie>
</BoardFile>

```

### The main modified contents are as follows:

Item	XML syntax	Description
Sensor name	<SensorName name="OV13850" ></SensorName>	This name must coincide to the name of Sensor driver, and the format of Sensor driver currently provided is as follows:
Sensor software identification	<SensorDevID IDname="CAMSYS_DEVID_SENSOR_1A"></SensorDevID>	Any inconsistent registration identification is okay, the following value can be filled in:  CAMSYS_DEVID_SENSOR_1A CAMSYS_DEVID_SENSOR_1B CAMSYS_DEVID_SENSOR_2
Name of acquisition controller	<SensorHostDevID busnum="CAMSYS_DEVID_MARVIN" ></SensorHostDevID>	At present, it only supports: CAMSYS_DEVID_MARVIN
Number of I2C channel connected to master control of Sensor	<SensorI2cBusNum busnum="3"></SensorI2cBusNum>	For the specific channel number, please refer to the number of I2C channel connected to master control on the schematic diagram of camera.
Sensor register address size, unit: bytes	<SensorI2cAddrByte byte="2"></SensorI2cAddrByte>	

I2C frequency of Sensor, unit: Hz, which is used for setting I2C frequency.	<SensorI2cRate rate="100000"></SensorI2cRate >	
Sensor input clock frequency, unit: Hz, which is used for setting camera clock.	<SensorMclk mclk="24000000"></SensorMclk >	
PMU LDO name of Sensor AVDD. If it cannot be connected to PMU, fill in NC only.	<SensorAvdd name="NC" min="0" max="0"></SensorAvdd>	
PMU LDO name of Sensor DOVDD.	<SensorDovdd name="NC" min="18000000" max="18000000"></SensorDovdd>	If it is not connected to PMU, fill in NC only. The values of min and max must be filled in, which decide the IO voltages of Sensor.
PMU LDO name of Sensor DVDD.	<SensorDvdd name="NC" min="0" max="0"></SensorDvdd>	If it is not connected to PMU, fill in NC only.
Sensor PowerDown pin.	<SensorGpioPwdn ioname="RK30_PIN2_PB6" active="0"></SensorGpioPwdn >	Directly fill in the name, and fill in the active level of sleep in active field.
Sensor Reset pin.	<SensorGpioRst ioname="RK30_PIN3_PB0" active="0"></SensorGpioRst>	Directly fill in the name, and fill in the active level of reset in active field.
Sensor Power pin.	<SensorGpioPwen ioname="RK30_PIN0_PB3" active="1"></SensorGpioPwen>	Directly fill in the name, and fill in the active level of power in active field.
Select front or back for the Sensor.	<SensorFacing facing="front"></SensorFacing >	"Front" or "back" can be filled in.
Sensor interface mode	<SensorInterface mode="MIPI"></SensorInterface>	The following value can be filled in:  CCIR601 CCIR656 MIPI SMIA
Sensor image mode	<SensorMirrorFlip mirror="0"></SensorMirrorFlip>	Do not support at present.



	>	
Sensor angle information	<SensorOrientation orientation="0"></SensorOrientation>	
Physical interface settings	<SensorPhy phyMode="CamSys_Phy_Mipi" lane="2" phyIndex="1" sensorFmt="CamSys_Fmt_Raw_10b"></SensorPhy>	<ul style="list-style-type: none"> <li>• phyMode: Sensor port hardware connection mode, for MIPI Sensor, this value shall take "CamSys_Phy_Mipi"</li> <li>• Lane: number of data channels in Sensor mipi interface</li> <li>• Phyindex: mipi phy number of master control connected to Sensor mipi</li> <li>• sensorFmt: Sensor output data format, which only supports CamSys_Fmt_Raw_10b at present</li> </ul>