### Document Information

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<tr>
<td>Keywords</td>
<td>AN13712, 8MP ISP OS08A20 Sensor, i.MX Yocto SDK</td>
</tr>
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<td>Abstract</td>
<td>This document describes the OS08a20 sensor on the i.MX 8M Plus ISP. The OS08A20 sensor has image sizes of 4K, 2K, 1080p, and 720p.</td>
</tr>
</tbody>
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1 Introduction

This document describes the OS08a20 sensor on the i.MX 8M Plus ISP. The OS08A20 sensor has image sizes of 4K, 2K, 1080p, and 720p. The output format is 12-bit / 10-bit RAW RGB. The sensor has 2-exposure staggered HDR and it supports the frame start input. The i.MX 8M Plus ISP has a demosaicing sensor for raw data and outputs the YUV format. The ISP also has denoise, sharpen, and gamma modules to improve the sensor image quality.

The following are the features of the OS08a20 sensor:

- Support for dual Os08a20 modules
- Support for 3 ISP output formats:
  - YUV422
  - NV16
  - NV12
- Support for 4 sensor modes:
  - 1920x1080 10-bit linear mode
  - 1920x1080 10-bit HDR mode
  - 3820x2160 12-bit linear mode
  - 3820x2160 10-bit HDR mode

2 Module and board

This section describes the module and the board.

2.1 i.MX 8M Plus EVK

Figure 2 shows the i.MX 8M Plus EVK.
2.2 OS08A20 sensor module

Figure 3 shows the OS08A20 sensor module.
2.3 Hardware connection

The sensor is connected to the switch board and the switch board uses the MiniSas cable to connect CSI1 or CSI2.

3 Configuring software

This section describes how to configure the software.

3.1 OS08A20 SDK HAL source code

```
OS08a20
  ├── calib
  │   ├── OS08a20_8M_10_1080p_linear.xml
  │   ├── OS08a20_8M_10_1080p_hdr.xml
  │   ├── OS08a20_8M_10_4k_linear.xml
  │   └── OS08a20_8M_10_4k_hdr.xml
  ├── source
  │   └── OS08a20.c
  └── dewarp
      ├── sensor_dwe_os08a20_1080P_config.json
      └── sensor_dwe_os08a20_4K_config.json
```

3.2 OS08A20 kernel driver source code

The OS08A20 kernel driver source code is as follows:

```
os08a20
  ├── os08a20_mipi_v3.c
  ├── os08a20_regs_1080p.h
  ├── os08a20_regs_1080p_hdr.h
  └── os08a20_regs_4k.h
```

3.3 Sensor mode table

Table 1 describes the sensor modes.

<table>
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<tr>
<th>Mode</th>
<th>Index</th>
<th>Data format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080P_linear</td>
<td>0</td>
<td>RAW10</td>
</tr>
<tr>
<td>1080P_hdr0</td>
<td>1</td>
<td>RAW10</td>
</tr>
<tr>
<td>4K_linear</td>
<td>2</td>
<td>RAW12</td>
</tr>
<tr>
<td>4K_hdr</td>
<td>3</td>
<td>RAW10</td>
</tr>
</tbody>
</table>

The "/opt/imx8-isp/bin/start_isp.sh" file has a mode-select parameter.

4 Building and testing

This section describes building and testing.
4.1 Creating the i.MX Yocto SDK and installing the toolchain

This section describes how to create the i.MX Yocto SDK and install the toolchain.

4.1.1 Downloading repository (if needed)

$ mkdir ~/bin (this step may not be needed if the bin folder already exists)
$ curl https://storage.googleapis.com/git-repo-downloads/repo > ~/bin/repo
$ chmod a+x ~/bin/repo
$ export PATH=~/bin:$PATH

4.1.2 Setting up Git (if needed)

$ git config --global user.name "Your Name"
$ git config --global user.email "Your Email"
$ git config --list

4.1.3 Creating the Yocto build environment

$ mkdir imx-yocto-bsp
$ cd imx-yocto-bsp
$ repo init -u https://github.com/nxp-imx/imx-manifest -b imx-linux-mickledore -m imx-6.1.22-2.0.0.xml
$ repo sync
$ DISTRO=fsl-imx-xwayland MACHINE=imx8mp-lpddr4-evk source imx-setup-release.sh -b build

4.1.4 Installing the toolchain

To install the toolchain, perform the following steps:
1. From the "build" folder, run the "./tmp/deploy/sdk/fsl-imx-xwayland-glibc-x86_64-imx-image-full-armv8a-imx8mp-lpdd4-evk-toolchain-6.1-mickledore.sh" file.
2. The default directory of the toolchain is "/opt/fsl-imx-xwayland/6.1-mickledore". If you install the toolchain in another location, replace the default path in the following sessions with your own path.

4.2 Building the NXP kernel

This section describes how to build the NXP kernel.

4.2.1 Downloading the latest version of NXP kernel

$ git clone https://github.com/nxp-imx/linux-imx.git -b lf-6.1.22-2.0.0

4.2.2 Building the kernel

$ source /opt/6.1-mickledore/environment-setup-armv8a-poky-linux
$ make mrproper
$ make ARCH=arm64 imx_v8_defconfig O=./build_v8
$ cd build_v8/
$ make ARCH=arm64 -j8
4.3 Building the isp-imx

This section describes how to build the isp-imx.

4.3.1 Downloading the latest version of isp-imx

```bash
$ wget https://www.nxp.com/lgfiles/NMG/MAD/YOCTO/isp-imx-4.2.2.22.0.bin
$ chmod +x isp-imx-4.2.2.22.0.bin
$ ./isp-imx-4.2.2.22.0.bin
```

In Yocto, "isp-imx" is in "tmp/work/aarch64-mx8mp-poky-linux/isp-imx".

4.3.2 Building the SDK

```bash
$ source /opt/6.1-mickledore/environment-setup-armv8a-poky-linux
$ ./build-all-isp.sh release partial
```

4.4 Building the isp-vvcam

This section describes how to build the isp-vvcam.

4.4.1 Downloading the latest version of isp-vvcam

```bash
$ git clone https://github.com/nxp-imx/isp-vvcam.git -b lf-6.1.22-2.0.0
```

In Yocto, "isp-vvcam" is in "build-wayland-8mp/tmp/work/imx8mpevk-poky-linux/kernel-module-isp-vvcam".

4.4.2 Building the vvcam

```bash
$ source /opt/6.1-mickledore/environment-setup-armv8a-poky-linux
$ export KERNEL_SOURCE_DIR = [the build path of the NXP kernel]
$ ./build-all-vvcam.sh
```

4.5 Storing useful files

This section describes how to store useful files.

4.5.1 Copying useful files to the output directory

Perform the following steps to copy useful files to the output directory:

1. Copy the kernel files to the build-out directory:

   ```bash
   $ cp linux-imx/build_v8/arch/arm64/boot/dts/freescale/imx8mp-evk-*.dtb [your build-out directory]/boot
   $ cp linux-imx/build_v8/arch/arm64/boot/Image [the build-out directory]/boot
   $ cp linux-imx/build_v8/drivers/staging/media/imx/imx8-media-dev.ko [the build-out directory]/sdk
   ``

2. Copy the isp-imx files to the build-out directory:

   ```bash
   $ cp -r ./isp-imx-4.2.2.22.0/build_output_release_partial/blob/* [the build-out directory]/sdk
   ```
3. Copy the isp-vvcam files to the build-out directory:

```
$ cp ./isp-vvcam/modules/* [the build-out directory]/sdk
```

4.5.2 Sending a file to a board

```
$ scp -r [the build out directory]/sdk/* root@$EVK_IP_Address:/home/root/[your test directory in root]
$ scp [the build out directory]/boot/* root@$EVK_IP_Address:/run/media/boot-mmcblk1p1/
```

The output directory should contain the following files:

![Output directory](image)

**Figure 4. Output directory**

4.6 Selecting a device tree

To select a device tree, perform the following steps:

1. "imx8mp-evk-os08a20.dtb" - # single os08a20, connect to CSI1
2. "imx8mp-evk-dual-os08a20.dtb" - # dual os08a20, connect to CSI1 and CSI2
3. "imx8mp-evk-os08a20-ov5640.dtb" - # ov5640 and os08a20 (os08a20 -> CSI1, ov5640 -> CSI2)

4.7 Editing the sensor-configuration file and selecting the correct mode

**Sensor0_Entry.cfg (example):**

```
name="os08a20" drv = "os08a20.drv"
mode= 2
[mode.0]
xm = "OS08a20_8M_10_1080p_linear.xml"
dwe = "dewarp_config/sensor_dwe_os08a20_1080P_config.json"
[mode.1]
xm = "OS08a20_8M_10_1080p_hdr.xml"
dwe = "dewarp_config/sensor_dwe_os08a20_1080P_config.json"
[mode.2]
xm = "OS08a20_8M_10_4k_linear.xml"
dwe = "dewarp_config/sensor_dwe_os08a20_4K_config.json"
[mode.3]
xm = "OS08a20_8M_10_4k_hdr.xml"
dwe = "dewarp_config/sensor_dwe_os08a20_4K_config.json"
```

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4.8 Enabling the ISP and camera on the board

This section describes how to enable the ISP and camera on the board.

4.8.1 Adding to a path

```
$ export LD_LIBRARY_PATH=$pwd:$LD_LIBRARY_PATH
```

4.8.2 Stopping the default ISP

```
$ systemctl stop imx8-isp.service
```

4.8.3 Removing existing modules

```
$ rmmod vvcam-dwe
$ rmmod vvcam-isp
$ rmmod vvcam-video
$ rmmod imx8-media-dev.ko
$ rmmod os08a20.ko
```

4.8.4 Installing modules

```
$ insmod vvcam-dwe
$ insmod vvcam-isp
$ insmod vvcam-video
$ insmod imx8-media-dev.ko
$ insmod os08a20.ko
```

4.8.5 Starting the ISP media server

Single sensor:

```
$ ./isp_media_server CAMERA0&
```

Dual sensor:

```
$ ./isp_media_server DUAL_CAMERA&
```

4.9 OS08A20 test cases

**Mode 0: 1080p linear:**

- Change "Sensor0_Entry.cfg" to mode 0:

```
$ gst-launch-1.0 -v v4l2src device=/dev/video2 ! "video/x-raw,format=YUY2,width=1920,height=1080" ! queue ! waylandsink
```

**Mode 1: 1080p HDR:**
• Change "Sensor0_Entry.cfg" to mode 1:

   $ gst-launch-1.0 -v v4l2src device=/dev/video2 ! "video/x-
   raw,format=YUY2,width=1920,height=1080" ! queue ! waylandsink

**Mode 2: 4K linear:**

• Change "Sensor0_Entry.cfg" to mode 2:

   $ gst-launch-1.0 -v v4l2src device=/dev/video2 ! "video/x-
   raw,format=YUY2,width=3820,height=2160" ! queue ! waylandsink

**Mode 3: 4K linear:**

• Change "Sensor0_Entry.cfg" to mode 3:

   $ gst-launch-1.0 -v v4l2src device=/dev/video2 ! "video/x-
   raw,format=YUY2,width=3820,height=2160" ! queue ! waylandsink

### 4.10 Disabling or bypassing dewarp

If you want to bypass the dewarp configuration, you may set the "dewarp bypass" parameter in the dewarp configuration file to "true".

```{json}
{
    "dewarpConfigArray": [
        {
            "source_image": {
                "width": 1920,
                "height": 1080
            },
            "?dewarpType": "LENS_CORRECTION, FISHEYE_EXPAND, SPLIT_SCREEN",
            "dewarpType": "FISHEYE_DEWARP",
            "scale": {
                "roix": 0,
                "roiy": 0,
                "factor": 1.0
            },
            "split": {
                "horizon_line": 540,
                "vertical_line_up": 960,
                "vertical_line_down": 960
            },
            "bypass": true,
            "hflip": false,
            "vflip": false,
            "camera_matrix": [1.9584556270377586e+003, 0.0, 9.681933899253533e+002],
            "distortion_coeff": [-1.2839656060464022e-001, 1.4121087523973114e-001, 2]
        }
    ]
}
```

Figure 5. Disabling or bypassing dewarp

If you want to disable the dewarp functionality, after starting "isp_media_server", you may run the following command before running the "gstream" command:

```bash
$ v4l2-ctl -d 2 -c viv_ext_ctrl=\'{<id>:<pipeline.s.dwe.onoff>;<enable>:false}''
```
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6  Revision history

Table 2 summarizes the changes done to this document.

<table>
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<tr>
<th>Revision number</th>
<th>Release date</th>
<th>Description</th>
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<tbody>
<tr>
<td>2</td>
<td>4 September 2023</td>
<td>Update to Linux kernel version 6.1.22.</td>
</tr>
<tr>
<td>1</td>
<td>29 November 2022</td>
<td>Updated Section 1</td>
</tr>
<tr>
<td>0</td>
<td>24 August 2022</td>
<td>Initial release</td>
</tr>
</tbody>
</table>
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