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## Application Note

## Multimedia Processor for Mobile Applications

# Camera Interface

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# EMMA Mobile1

Document No. S19892EJ1V0AN00
Date Published Aug. 2009

# PREFACE

**Purpose** The purpose of this document is to specify the usage of EMMA Mobile1 Camera interface.

**Organization** This document includes the following:

- Introduction
- Usage of Camera Interface
- Example of Camera Interface Operation
- Camera Driver Function

**Notation** Here explains the meaning of following words in text:

**Note** Explanation of item indicated in the text

**Caution** Information to which user should afford special attention

**Remark** Supplementary information

**Related document** The following tables list related documents.

**Reference Document**

| Document Name | Version/date | Description |
|---|---|---|
| S19265EJ1V0UM00_ASMUGIO.pdf | 1st Edition | SMU&GPIO user's manual |
| S19268EJ1V0UM00_1chip.pdf | 1st Edition | 1 chip user's manual |
| S19285EJ1V0UM00_CAMERA.pdf | 1st Edition | Camera Interface user's manual |
| S19907EJ1V0AN00_GD.pdf | 1st Edition | GD Spec |
| S19905EJ1V0AN00_I2C.pdf | 1st Edition | Application Note |
| S19899EJ1V0AN00_LCD.pdf | 1st Edition | Application Note |
| S19906EJ1V0AN00_IMC.pdf | 1st Edition | Application Note |

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## LIST OF FIGURES

# Chapter 1 Introduction

## 1.1 Outline

This document will show users how to operate Camera interface on EMMA Mobile1 evaluation board.

More details about Camera interface feature please refer to EMMA Mobile 1 Camera interface user's manual.

## 1.2 Development Environment

- Hardware environment of this project is listed as below.

**Table 1-1 Hardware Environment**

| Name | Version | Maker |
|---|---|---|
| EMMA Mobile 1 evaluation board (PSKCH2Y-S-0016-01) | - | NEC Electronics |
| PARTNER-Jet ICE ARM | M20 | Kyoto Microcomputer Co. Ltd |

- Software used in this project is listed as below.

**Table 1-2 Software Environment**

| Name | Version | Maker |
|---|---|---|
| GNUARM Toolchain | V4.3.2 | GNU |
| WJETSET-ARM | V5.10a | Kyoto Microcomputer Co. Ltd |

# Chapter 2 Usage of Camera Interface

## 2.1 Camera Interface Function

EMMA Mobile 1 Camera interface supports following function.

1) Basic capture function

**Table 2-1 Basic Capture Function**

| Item | Description |
|---|---|
| Image size | Max: 4088 pixels (horizontal) x 4092 pixels (vertical) |
| Input data format | YUV422<br>(Support two orders: U0Y0V0Y1 or Y0U0Y1V0) |
| Output data format | YUV 422 Interleave<br>YUV 420/422 Semi-Planar<br>YUV 420/422 Planar |
| Data sampling | Rising edge<br>Falling edge<br>Both edges |
| Sampling mode | Vertical/horizontal sync signal sampling<br>Enable signal sampling<br>ITU-R BT.656 encoding |
| Byte lane switch | Big/little endian or 32-bit units specification |

2) Reduction

**Table 2-2 Reduction Function**

| Item | Description |
|---|---|
| Sampling method | Nearest-neighbor sampling |
| Range | 1 to 1/16 (can be set to any size) |

3) Horizontal/vertical flip

**Table 2-3 Flipping Function**

| Item | Description |
|---|---|
| Flipping mode | No flip<br>Horizontal flip<br>Vertical flip<br>Horizontal and vertical flip (180º rotation) |

4) Level adjustment

**Table 2-4 Level Adjustment Function**

| Item | Description |
|---|---|
| Gain range | $Y_{gain}$ : 0 to 255/128<br>$U_{gain}$ : 0 to 255/128<br>$V_{gain}$ : 0 to 255/128 |
| Offset range | $Y_{offset}$ : -128 to 127<br>$U_{offset}$ : -128 to 127<br>$V_{offset}$ : -128 to 127 |

**Note:**

Following formulary shows the relationship between input Y/U/V value and output Y/U/V value.

$Y_{out} = Y_{in} * Y_{gain} + Y_{offset}$

$U_{out} = U_{in} * U_{gain} + U_{offset}$

$V_{out} = V_{in} * V_{gain} + V_{offset}$

## 2.2 Operation Flow

Following figure shows the flow chart of camera.

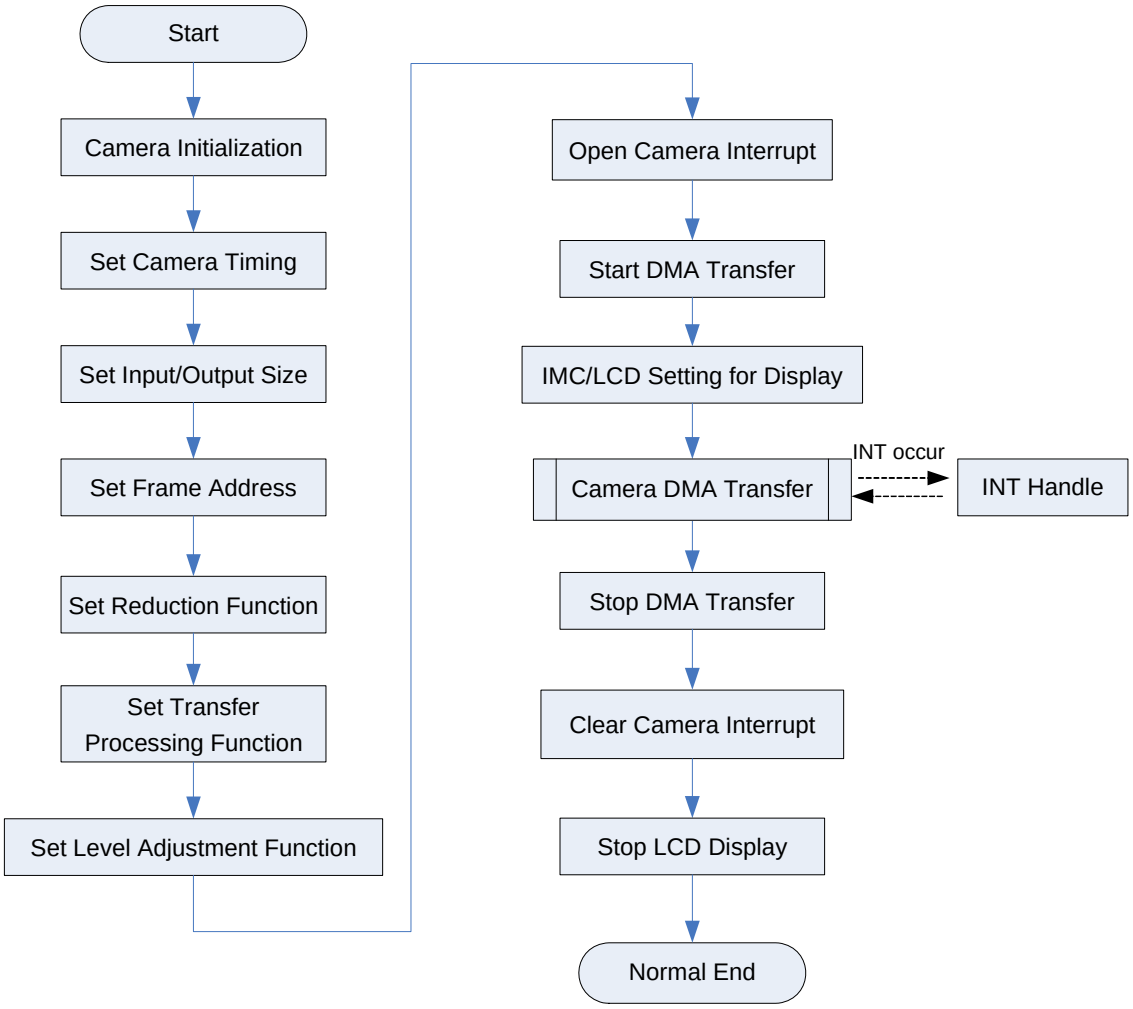


Figure 2-1 Flow Chart of Camera Operation

## 2.3 Details

### 2.3.1 Camera Initialization

Camera initialization progress includes two steps:

1) Camera module initialization

This step is different according to the type of camera module. For details, please refer the User's Manual of camera sensor module.

2) Camera interface initialization

EMMA Mobile 1 camera interface initialization including following sequences:

- Switch pins to camera function

  Register list:

  CHG_PINSEL_G00
  CHG_PINSEL_G64
  CHG_PINSEL_SD1
  CHG_PINSEL_G80

- Enable input function and pull-down setting for camera pins

  Register list:

  CHG_PULL_G72
  CHG_PULL2
  CHG_PULL_G88

- Driver capability setting:

  Register list:

  CHG_DRIVE0
  CHG_DRIVE1
  CHG_DRIVE2

- Clock setting

  Register list:

  ASMU_GCLKCTRL0
  ASMU_AHBCLKCTRL0
  ASMU_APBCLKCTRL0
  ASMU_DIVCAMSCLK**Note**

  **Note:**

  The source clock of CAM_SCLK can be selected as PLL2 (default value is 499.712MHz) or PLL3 (default value is 229.376MHz).

  $f_{cam\_sclk} = f_{source} / DIV$

  The DIV range is from 1 to 32.

- Reset and cancel reset camera

  Register list:

  ASMU_RESETREQ0ENA

  ASMU_RESETREQ0

### 2.3.2 Set Camera Timing

The camera timing of EMMA Mobile 1 should be setting according to connected sensor module's features.

About mainly parameters of camera timing, please refer Table 2-5.

**Table 2-5 Parameters of Camera Timing**

| Item | Description | Related Register |
|---|---|---|
| Input data format [Note] | U0Y0V0Y1 | DATA_ID = 0 (CA_CSR) |
| | Y0U0Y1V0 | DATA_ID = 1 (CA_CSR) |
| Output data format [Note] | YUV 422 Interleave | PIXELMODE = 1 (CA_CSR)<br>PIXEL_YUV = 0 (CA_CSR)<br>MAINYUV = 0 (CA_DMACNT) |
| | YUV 422 Semi-Planar | PIXELMODE = 0 (CA_CSR)<br>PIXEL_YUV = 0 (CA_CSR)<br>MAINYUV = 0 (CA_DMACNT) |
| | YUV 422 Planar | PIXEL_YUV = 1 (CA_CSR)<br>MAINYUV = 0 (CA_DMACNT) |
| | YUV 420 Semi-Planar | PIXELMODE = 0 (CA_CSR)<br>PIXEL_YUV = 0 (CA_CSR)<br>MAINYUV = 1 (CA_DMACNT) |
| | YUV 420 Planar | PIXEL_YUV = 1 (CA_CSR)<br>MAINYUV = 1 (CA_DMACNT) |
| Data sampling | Rising edge | VS_DET = 0 (CA_CSR)<br>HS_DET = 0 (CA_CSR)<br>DATA_DET = 0 (CA_CSR)<br>CLK_DEGE = 0 (CA_CSR) |
| | Falling edge | VS_DET = 1 (CA_CSR)<br>HS_DET = 1 (CA_CSR)<br>DATA_DET = 1 (CA_CSR)<br>CLK_DEGE = 0 (CA_CSR) |
| | Both edges | VS_DET = 0 (CA_CSR)<br>HS_DET = 0 (CA_CSR)<br>CLK_DEGE = 1 (CA_CSR) |
| Sampling mode | VS/HS signal sampling | SYNCTYPE = 0 (CA_CSR)<br>SYNCMODE = 0 (CA_CSR) |
| | Enable signal sampling | SYNCTYPE = 0 (CA_CSR)<br>SYNCMODE = 1 (CA_CSR) |
| | ITU-R BT.656 encoding | SYNCTYPE = 1 (CA_CSR)<br>SYNCMODE = 0 (CA_CSR) |
| Signal polarity | Positive logic | For VS:<br>VS_POL = 0 (CA_CSR)<br>For HS:<br>HS_POL = 0 (CA_CSR) |
| | Negative logic | For VS:<br>VS_POL = 1 (CA_CSR)<br>For HS:<br>HS_POL = 1 (CA_CSR) |
| Limit value of YUV output data | Conforms to ITU-R BT.656<br>(Y: 16 to 235, U and V: 16 to 240) | LIMITSEL = 0 (CA_CSR) |

| Item | Description | Related Register |
|---|---|---|
| | All 8 bits are valid<br>(Y, U and V: 0 to 255) | LIMITSEL = 1 (CA_CSR) |
| Byte lane switch Note | For YUV 422 Interleave:<br>Select the range of Y0, Y1, U0, V0. | YUV_OD_BYTELANE<br>(CA_OD_BYTELANE2)<br>Y_BYTELANE(CA_OD_BYTELANE2) |
| | For YUV 420/422 Semi-Planar:<br>(1) Select the range of Y0, Y1, Y2, Y3<br>(2) Select the range of U0, V0, U1, V1 | DATA_OD (CA_CSR)<br>Y_BYTELANE and UV_BYTELANE<br>(CA_OD_BYTELANE2) |
| | For YUV 420/422 Planar:<br>(1) Select the range of Y0, Y1, Y2, Y3<br>(2) Select the range of U0/V0, U1/V1, U2/V2, U3/V3 | Y_BYTELANE<br>UV_BYTELANE<br>(CA_OD_BYTELANE2) |

**Note:**

More details about the data format and byte lane switch please refer to "**4.10 Data Format**" of EMMA Mobile 1 Camera Interface User's Manual.

Register list:

CA_CSR
CA_DMACNT
CA_OD_BYTELANE
CA_OD_BYTELANE2

### 2.3.3 Set Input/Output Size

Table 2-6 shows the description of input/output size.

**Table 2-6 Discription of Input/Output Size**

| Item | Description |
|---|---|
| Input size [Note] | **For VS/HS sync signal sampling:**<br>When rising or falling edge:<br>CA_X1R = HS blank * 2 CA_X2R = CA_X1R + input width * 2<br>CA_Y1R = VS blank CA_Y2R = CA_Y1R + input height<br><br>When both-edge:<br>CA_X1R = HS blank CA_X2R = CA_X1R + input width<br>CA_Y1R = VS blank CA_Y2R = CA_Y1R + input height<br><br>Note:<br>The value set to CA_X3R is ignored. More details, please refer to **"4.9.1 Vertical/horizontal synchronization signal sampling"** of EMMA Mobile 1 Camera Interface User's Manual. |
| | **For enable signal sampling: (Normal)**<br>When rising or falling edge:<br>CA_X1R = 0 CA_X2R = input width * 2 CA_X3R = input width * 2<br>CA_Y1R = 0 CA_Y2R = input height<br><br>When both-edge:<br>CA_X1R = 0 CA_X2R = input width CA_X3R = input width<br>CA_Y1R = 0 CA_Y2R = input height<br><br>**For enable signal sampling: (Cropping)**<br>When rising or falling edge:<br>CA_X1R = Cropping starting pixel * 2 CA_X2R = Cropped image X size * 2<br>CA_X3R = Effective image X size * 2 CA_Y1R = Cropping starting line<br>CA_Y2R = Cropped image Y size + CA_Y1R<br><br>When both-edge:<br>CA_X1R = Cropping starting pixel CA_X2R = Cropped image X size<br>CA_X3R = Effective image X size CA_Y1R = Cropping starting line<br>CA_Y2R = Cropped image Y size + CA_Y1R<br><br>Note:<br>Be sure to set CA_X3R. More details, please refer to **"4.9.2 Enable signal sampling"** of EMMA Mobile 1 Camera Interface User's Manual. |
| | **For ITU-R BT.656 signal sampling:**<br>When NTSC:<br>CA_X1R = 272 CA_X2R = 1712 CA_Y1R = 0 CA_Y2R = 243<br><br>When PAL:<br>CA_X1R = 284 CA_X2R = 1724 CA_Y1R = 0 CA_Y2R = 288<br>Note:<br>The value set to CA_X3R is ignored. More details, please refer to **"4.9.3 ITU-R BT.656 signal sampling"** of EMMA Mobile 1 Camer a Interface User's Manual. |

| Item | Description |
|---|---|
| Output size [Note] | CA_DMAX_MAIN = output width<br>CA_DMAY_MAIN = output height<br><br>For YUV 422 Interleave mode:<br>CA_LINESIZE_MAIN = output width * 2<br><br>For YUV Semi-Planar and YUV Planar mode:<br>CA_LINESIZE_MAIN = output width |

**Note:**

More details about input size setting, please refer to "**4.9 Restrictions on Data Transfer Range Values**" of EMMA Mobile 1 Camera Interface User's Manual.

More details about output size setting, please refer to "**4.8 Data Transfer Range Specification**" of EMMA Mobile 1 Camera Interface User's Manual.

Register list:

CA_X1R
CA_X2R
CA_X3R
CA_Y1R
CA_Y2R
CA_DMAX_MAIN
CA_DMAY_MAIN
CA_LINESIZE_MAIN

### 2.3.4 Set Frame Address

Camera Interface of EMMA Mobile 1 supports two frames: A/B frame. The parameters of frame address include YPLANE_A/B (the transfer destination address of Y plane data), UVPLANE_A/B (the transfer destination address of UV plane data) and VPLANE_A/B (the transfer destination address of V plane data).

Table 2 -7 shows the description of frame address setting according to data format type.

**Table 2-7 Description of Frame Address**

| Data Format | Frame Address |
|---|---|
| YUV422 interleave | Only set YPLANE_A/B |
| YUV 420/422 Semi-Planar | Need set YPLANE_A/B and UVPLANE_A/B |
| YUV 420/422 Planar | Need set YPLANE_A/B, UVPLANE_A/B and VPLANE_A/B |

Register list:

CA_YPLANE_A
CA_YPLANE_B
CA_UVPLANE_A
CA_UVPLANE_B

CA_VPLANE_A
CA_VPLANE_B
CA_MAINFRM

**Remark:**

More details about frame address setting, please refer to "**4.10.2 Memory mapping**" of EMMA Mobile 1 Camera Interface User's Manual.

### 2.3.5 Set Reduction

The reduction method of EMMA Mobile 1 is nearest-neighbor sampling, which copies the nearest neighbor pixels of an original image to the pixel positions of a reduced image.

Following show the reduction formulary.

Output size = Input size * 64 / (64 + RATIO)

The range of RATIO is 0 to 959, so the reduction ratio is 1 to 1/16.

Register list:

CA_XRATIO_MAIN

CA_YRATIO_MAIN

CA_DMACNT

**Remark:**

More details about reduction setting please refer to "**4.7 Reduction Method**" of EMMA Mobile 1 Camera Interface User's Manual.

### 2.3.6 Set Transfer Processing

The transfer processing of EMMA Mobile 1 includes 3 functions: frame skipping, transfer mode and horizontal/vertical flip control.

Table 2-8 shows the description of transfer processing setting.

**Table 2-8 Description of Transfer Processing**

| Function | Description |
|---|---|
| Frame skipping | Including 4 types:<br>(1) No skipping<br>(2) 1/2 skipping<br>(3) 1/3 skipping<br>(4) 1/4 skipping |
| Transfer mode | Including 3 types:<br>(1) Single transfer<br>(2) Repeat transfer (frame fixed)<br>(3) Repeat transfer (double) |
| Horizontal/vertical flip control | Including 4 types:<br>(1) No flip<br>(2) Horizontal flip<br>(3) Vertical flip<br>(4) Horizontal and vertical flip (180º rotation) |

Register list:

CA_DMACNT

CA_MIRROR

**Remark:**

More details about transfer processing setting, please refer to "**4.11 Transfer Processing**" of EMMA Mobile 1 Camera Interface User's Manual.

### 2.3.7 Set Level Adjustment

Level adjustment function is used to adjust gain and offset for the input data level.

More details about lever adjustment, please refer to "**4.6 Level Adjustment**" of EMMA Mobile 1 Camera Interface User's Manual.

Register list:

CA_BNZR
CA_BNGR
CA_CBZR
CA_CBGR
CA_CRZR
CA_CRGR

### 2.3.8 Open Camera Interrupt

Camera interrupt of EMMA Mobile 1 has 4 types:

1) main frame overrun
2) main frame transfer completion
3) transfer error
4) vertical synchronization

More details about camera interrupt, please refer to "**3.2.1 Interrupt registers**" of EMMA Mobile 1 Camera Interface User's Manual.

Register list:

CA_ENSET
CA_ENCLR
CA_FFCLR
INTC_IT0_IEN0
SEC_IT0_IENS0

**Remark:**

More details about INTC_IT0_IEN0 and SEC_IT0_IENS0 register, please refer to EMMA Mobile 1 One Chip User's Manual.

### 2.3.9 Start DMA Transfer

Issue camera DMA request to start DMA transfer

Register list:

CA_DMAREQ

### 2.3.10 IMC/LCD Setting for Display

Through IMC/LCD setting, camera image data will be displayed on LCD panel.

**Remark:**

More detail about IMC and LCD setting, please refer to EMMA Mobile 1 IMC User's Manual and EMMA Mobile 1 LCDC User's Manual.

### 2.3.11 Camera DMA Transfer

After issue camera DMA request, camera interface will start to capture image data from external camera sensor module and save data in specified frame address. In this step, some interrupts should be issued and registered interrupt handler function will be called to handle issued interrupt.

Register list:

CA_STATUS
CA_FFCLR

### 2.3.12 Stop DMA Transfer

Cancel camera DMA request to stop DMA transfer

Register list:

CA_DMASTOP

### 2.3.13 Close Camera Interrupt

This step will clear all camera interrupts.

Register list:

CA_ENSET
CA_ENCLR
CA_FFCLR
INTC_IT0_IEN0
SEC_IT0_IENS0

### 2.3.14 Stop LCD Display

This step will stop LCD display.

**Remark:**

More detail about LCD setting, please refer to EMMA Mobile 1 LCDC User's Manual.

# Chapter 3 Example of Camera Interface Operation

This chapter will show users how to realize following functions.

- Preview function
- Mirror function
- Level adjustment function
- Reduction function

## 3.1 Hardware Connection

On EMMA Mobile 1 evaluation board (PSKCH2Y-S-0016-01), there is a JP11 connection which includes all pins of camera interface. For camera evaluation, EMMA Mobile 1 camera board is designed. This board includes:

1) an external camera sensor module
2) power supply circuit for sensor module
3) a connection which is suitable for JP11

Figure 3-1 shows the connection of EMMA Mobile 1 evaluation board and EMMA Mobile camera board.

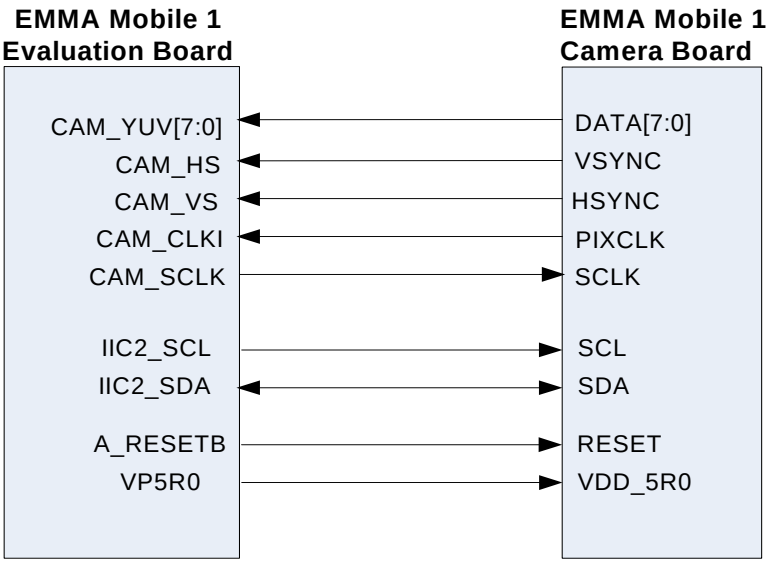


Figure 3-1 Connection between EMMA Mobile 1's Evaluation Board and Camera Board

**Note:**

For evaluation of EMMA Mobile 1 camera interface, the original EMMA Mobile 1 evaluation board has been modified. Please confirm the number of evaluation board is bigger than 50th.

## 3.2 Initialization

### 3.2.1 Operation Flow

Figure 3-2 shows the operation flow of initialization before test.

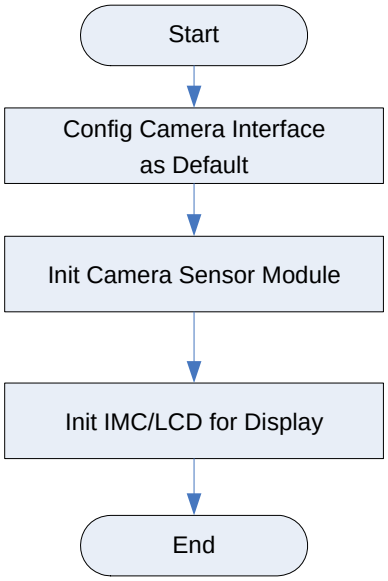


Figure 3-2 Initialization before Test

### 3.2.2 Operation Detail

#### 3.2.2.1 Config Camera Interface as Default

This step will init camera interface, set camera timing, set input/output size, set reduction, set frame address, set transfer processing, set level adjustment and open camera interrupt.

**1) Init Camera Interface**

Table 3-1 shows the description of camera interface initialization.

**Table 3-1 Description of Camera Interface Initialization**

| Sequence | Registers Description |
|---|---|
| (1) Switch pins to camera function | CHG_PINSEL_G00[9:8] = 11b (CAM_SCLK)<br>CHG_PINSEL_G64[31:22] = 1111_1111_11b (CAM_YUV[4:0])<br>CHG_PINSEL_SD1[1:0] = 10b (CAM_YUV[7:5], CAM_VS, CAM_HS)<br>CHG_PINSEL_G80[25:24] = 10b (CAM_CLKI) |
| (2) Enable pins input function | CHG_PULL_G72[31:12] = 0100_0100_0100_0100_0100b<br>(CAM_YUV[4:0])<br>CHG_PULL2 [23:12] = 0100_0100_0100b<br>(CAM_YUV[7:5], CAM_VS, CAM_HS)<br>CHG_PULL_G88 [19:16] = 0100b (CAM_CLKI) |
| (3) Driver capability setting | Set driver capability to max value<br>CHG_DRIVE0[29:28] = 11b<br>CHG_DRIVE1[21:20] = 11b<br>CHG_DRIVE1[13:12] = 11b<br>CHG_DRIVE2[1:0] = 11b |
| (4) Clock setting | ● Set division of CAM_SCLK<br>ASMU_DIVCAMSCLK = 0x113<br>bit[9:8] = 01b - Set PLL3 (229.376MHz) as source clock<br>bit[4:0] = 0x13 - Division ratio is 20. $f_{cam\_sclk}$ = 229.376MHz/20 =11.468MHz<br>● close camera clock<br>ASMU_AHBCLKCTRL0[12] = 0b (disable automatic control of CAMLP)<br>ASMU_APBCLKCTRL0[3] = 0b (disable automatic control of CAMPCLKLP)<br>ASMU_GCLKCTRL0[22:20] = 000b (stop clock supply for camera interface)<br>● open camera clock<br>ASMU_GCLKCTRL0[22:20] = 111b (supply clock for camera interface)<br>ASMU_AHBCLKCTRL0[12] = 1b (enable automatic control of CAMLP)<br>ASMU_APBCLKCTRL0[3] = 1b (enable automatic control of CAMPCLKLP |
| (5) reset camera | ASMU_RESETREQ0ENA[12] = 1b (enable camera reset)<br>ASMU_RESETREQ0[12] = 0b (reset camera)<br>ASMU_RESETREQ0[12] = 1b (cancel reset of camera)<br>ASMU_RESETREQ0ENA[12] = 0b (disable camera reset) |

**2) Set Camera Timing**

Table 3-2 shows the description of camera timing setting.

**Table 3-2 Description of Camera Timing Setting**

| Item | Description | Related Register |
|---|---|---|
| Input data format | U0Y0V0Y1 | DATA_ID = 0 (CA_CSR) |
| Output data format | YUV 420 Planar | PIXEL_YUV = 1 (CA_CSR)<br>MAINYUV = 1 (CA_DMACNT) |
| Data sampling | Rising edge | VS_DET = 0 (CA_CSR)<br>HS_DET = 0 (CA_CSR)<br>DATA_DET = 0 (CA_CSR)<br>CLK_DEGE = 0 (CA_CSR) |
| Sampling mode | Enable signal sampling | SYNCTYPE = 0 (CA_CSR)<br>SYNCMODE = 1 (CA_CSR) |
| Signal polarity | Positive logic | For VS:<br>VS_POL = 0 (CA_CSR)<br>For HS:<br>HS_POL = 0 (CA_CSR) |
| Limit value of YUV output data | Conforms to ITU-R BT.656<br>(Y: 16 to 235, U and V: 16 to 240) | LIMITSEL = 0 (CA_CSR) |
| Byte lane switch | No use | No setting |

**3) Set Input/Output Size**

Table 3-3 shows the description of input/output size setting.

**Table 3-3 Description of Camera Input/Output Size Setting**

| Item | Description | Related Register |
|---|---|---|
| Input size | Input width = 640<br>Input height = 480 | CA_X1R = 0 CA_X2R = 1280<br>CA_X3R = 1280 CA_Y1R = 0<br>CA_Y2R = 640 |
| Output size | Output width = 640<br>Output height = 480 | CA_DMAX_MAIN = 640<br>CA_DMAY_MAIN = 480<br>CA_LINESIZE_MAIN = 640 |

**4) Set Frame Address**

Table 3-4 shows the description of frame address setting.

**Table 3-4 Description of Frame Address Setting**

| Data Format | Frame Address |
|---|---|
| YUV 420 Planar | YPLANE_A = 0x32000000 YPLANE_B = 0x32100000<br>UVPLANE_A = 0x3204B000 UVPLANE_B = 0x3214B000<br>VPLANE_A= 0x3205DC00 VPLANE_B= 0x3215DC00 |

**5) Set Reduction**

Because the input size is same with output size, reduction function is not used as default.

The related register setting is as following.

CA_DMACNT[3] = 0b – does not resize main frames

**6) Set Transfer Processing**

Table 3-5 shows the description of transfer processing setting.

**Table 3-5 Description of Transfer Processing Setting**

| Item | Description | Related Register |
|---|---|---|
| Frame skipping | No skipping | PCULLR = 00b (CA_DMACNT) |
| Transfer mode | Repeat transfer (double) | MAINMODE = 11b (CA_DMACNT) |
| Flip control | No flip | MAIN_MIRROR = 00b (CA_MIRROR) |

**7) Set Level Adjustment**

Table 3-6 shows the description of level adjustment setting.

**Table 3-6 Description of Level Adjustment**

| Item | Description | Related Register |
|---|---|---|
| Gain value | $Y_{gain} = U_{gain} = V_{gain} = 128$ | CA_BNGR = 0x80<br>CA_CBGR = 0x80<br>CA_CRGR = 0x80 |
| Offset value | $Y_{offset} = U_{offset} = V_{offset} = 0$ | CA_BNZR = 0<br>CA_CBZR = 0<br>CA_CRZR = 0 |

**8) Open camera Interrupt**

This step will cancel camera interrupt masking, clear camera interrupt and enable camera interrupt.

The setting of related registers is as following.

CA_ENSET = 0x0E – cancel overrun/transfer completion/transfer error interrupt masking

CA_FFCLR = 0x0F – clear all interrupt

INTC_IT0_IEN0[21] = 0b & SEC_IT0_IENS0[21] = 0b – enable camera interrupt

#### 3.2.2.2 Init Camera Sensor Module

For initialization of camera sensor module, IIC2 interface of EMMA Mobile 1 is used to write/read registers of camera sensor module. About the usage of IIC2 interface of EMMA Mobile 1, please refer to **"EMMA Mobile 1 IIC Application Note"**.

More details about registers of camera sensor module please refer to the User's Manual of camera sensor module.

#### 3.2.2.3 Init IMC/LCD for Display

In this sample, LCD and IMC module will be called to display the rotated image. So need to initialize LCD and IMC module.

More detail about these two modules, please refer to "EMMA Mobile 1 IMC Application Note" and "EMMA Mobile 1 LCDC Application Note".

## 3.3 Example of Preview Function

### 3.3.1 Operation Flow

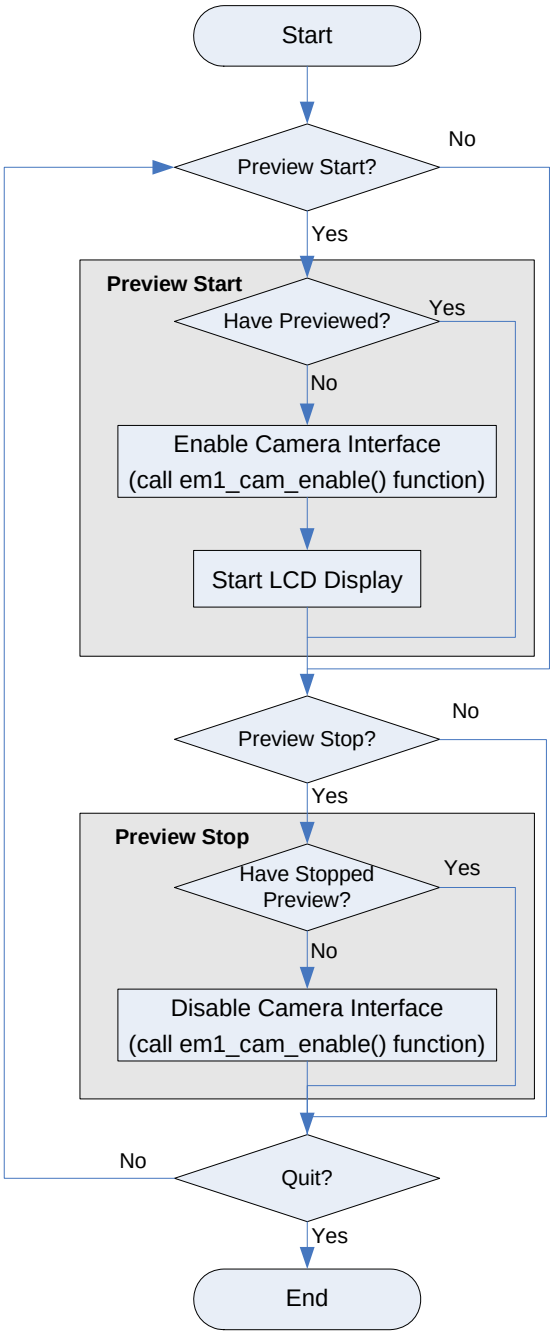


Figure 3-3 Operation Flow of Preview Start Function

More details about the functions used in this example please refer to "**APPENDIX A Camera Driver Function**"

### 3.3.2 Operation Detail

#### 3.3.2.1 Preview Start

**1) Enable Camera Interface**

It will call “em1_cam_enable()” function. In this function, following operations are executed.

Step 1: cancel camera hardware reset

CA_MODULECONT = 0x01

Step 2: Start camera DMA transfer

CA_DMAREQ = 0x01

**2) Start LCD Display**

This step will call “em1_lcd_start()” function. More detail about this function, please refer to “**EMMA Mobile 1 LCDC Application Note**”.

#### 3.3.2.2 Preview Stop

In this step, will call “em1_cam_enable()” function. In this function, following operations are executed.

Step 1: wait until DMA transfer stop.

Read the CA_DMAREQ register. If register bit0 is 0, it means that DMA transfer has been stopped.

Step 2: camera hardware reset

CA_MODULECONT = 0x0

## 3.4 Example of Mirror Function

### 3.4.1 Operation Flow

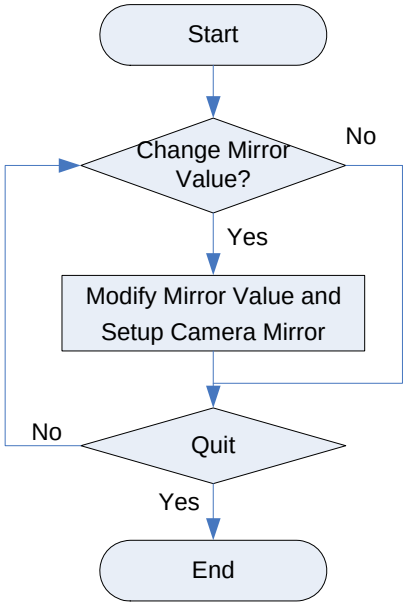


Figure 3-4 Operation Flow of Mirror Function

**Note:**

Please confirm that preview has been started before mirror function test.

### 3.4.2 Operation Detail

Mirror function of EMMA Mobile 1 Camera Interface has 4 types:

1) No flip
2) Horizontal flip
3) Vertical flip
4) Horizontal and vertical flip (180º rotation)

In this example, users will choose the mirror type and then call “em1_cam_set_mirror()” function to setup camera mirror. In this function, will set following registers.

CA_MIRROR[3:2] (set flip mode)

00b – No flip

01b – Horizontal flip

10b – Vertical flip

11b – Horizontal and vertical flip (180º rotation)

CA_UPDATE = 0x01 (update flip mode setting)

## 3.5 Example of Level Adjustment Function

### 3.5.1 Operation Flow

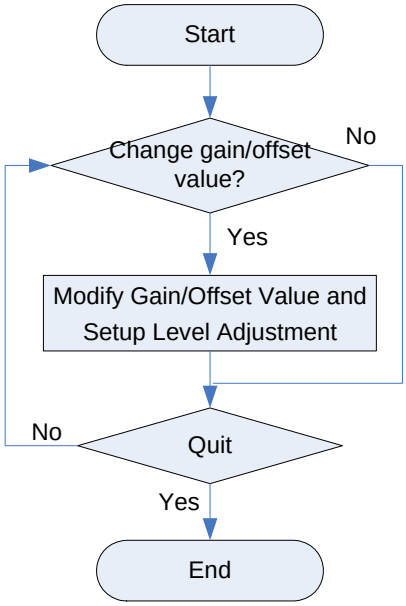


Figure 3-5 Operation Flow of Level Adjustment Function

**Note:**

Please confirm that preview has been started before level adjustment function test.

### 3.5.2 Operation Detail

About the range value of gain/offset, please refer to “Table 2-4 Level Adjustment Function”.

In this example, users will change the gain/offset value and then call “em1_cam_set_gain()” function to setup level adjustment. In this function, will set following registers.

CA_BNZR
CA_BNGR
CA_CBZR
CA_CBGR
CA_CRZR
CA_CRGR
CA_UPDATE = 0x01 (update gain/offset setting)

## 3.6 Example of Reduction Function

### 3.6.1 Operation Flow

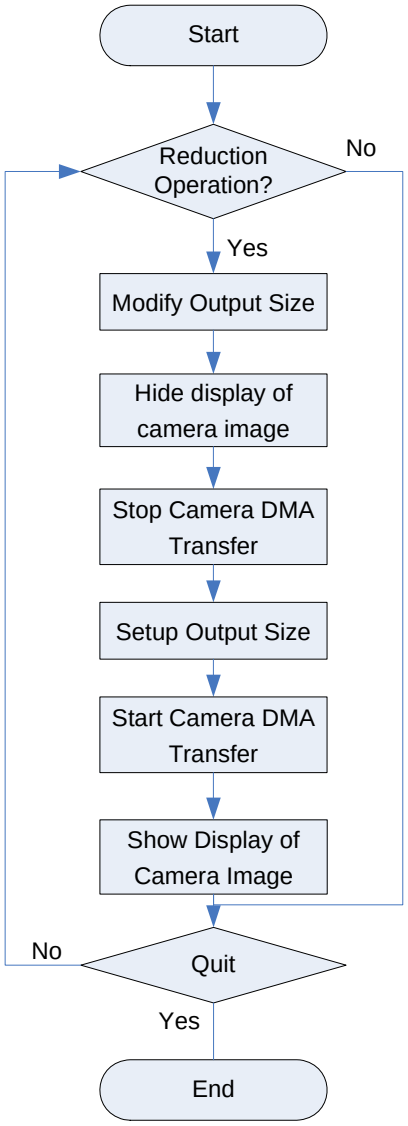


Figure 3-6 Operation Flow of Scale Down Function

**Note:**

Please confirm that preview has been started before scale down function test.

### 3.6.2 Operation Detail

#### 1) Modify Output Size

About the reduction range, please refer to “Table 2-2 Reduction Function”.

In this example, the limit value of output size is as following.

| | |
|---|---|
| Max width: 640 | max height: 480 |
| Min width: 128 | min height: 96 |
| Width step: 32 | height step: 24 |

#### 2) Hide Display of Camera Image

This step will call “em1_imc_hide()” function and“em1_imc_refresh()” function. More detail about this function, please refer to “**EMMA Mobile 1 IMC Application Note**”.

#### 3) Stop Camera DMA Transfer

This step will call “em1_cam_dma_stop()” function. In this function, will set following registers.

- CA_DMASTOP = 0x01 (stop DMA transfer)
- Read the CA_DMAREQ register until DMA transfer has been stopped. If register bit0 is 0, it means DMA transfer have been stopped.
- CA_FFCLR = 0x0F (clear all interrupt)

#### 4) Setup Output Size

This step will set reduction function and following registers are used.

- CA_DMAX_MAIN (set the number of horizontal pixels to be transferred)
  CA_DMAX_MAIN = output width
- CA_DMAY_MAIN (set the number of lines to be transferred vertically)
  CA_DMAY_MAIN = output height
- CA_XRATIO_MAIN (set the reduction ratio in the horizontal direction )
  XRATIO = 64 * input width/output size – 64
- CA_YRATIO_MAIN (set the reduction ratio in the vertical direction )
  YRATIO = 64 * input height/output height – 64
- CA_LINESIZE_MAIN (set the number of horizontal pixels to be transferred)
  Because the data format of camera sensor module is YUV 420 Planar mode, set the value of output width to CA_LINESIZE_MAIN
- CA_DMACNT[3] (set resize or doesn’t resize)
  It the output size is same with input size, set CA_DMACNT[3] to 0b.
  It the output size is smaller than input size, set CA_DMACNT[3] to 1b.

#### 5) Start Camera DMA Transfer

This step will call “em1_cam_dma_start()” function. In this function, will set following register.

- CA_DMAREQ = 0x01 (start DMA transfer)

**6) Show Display of Camera Image**

This step will call “em1_imc_l2x_config” function, “em1_imc_show()” function and “em1_imc_refresh()” function. More detail about this function, please refer to “**EMMA Mobile 1 IMC Application Note**”.

# APPENDIX A Camera Driver Function

## A.1 Function List

The following table shows the camera driver interface functions:

**Table A-1 LCD Driver Function List**

| Class | Function Name | Function Detail |
|---|---|---|
| External function | em1_cam_init | Camera interface initialization |
| | em1_cam_set_gain | Gain/offset parameters setting |
| | em1_cam_set_size | Input/output size parameters setting |
| | em1_cam_set_frame | Frame parameters setting |
| | em1_cam_set_timing | Timing parameters setting |
| | em1_cam_set_mirror | Mirror parameters setting |
| | em1_cam_enable | Enable/disable camera interface |
| | em1_cam_dma_start | Start camera DMA transfer |
| | em1_cam_dma_stop | Stop camera DMA transfer |
| | em1_cam_set_INT_on | Open camera interrupt |
| | em1_cam_set_INT_off | Close camera interrupt |
| | INT_cam_irq | Camera interrupt handler |

## A.2 Global Variable Define

**Table A-2 Global Variable Define**

| Variable Name | Detail |
|---|---|
| g_frame_count | Count the frame number of camera DMA transfer |

## A.3 Structure Define

**Table A-3 Structure Define**

| Structure Name | Detail |
|---|---|
| em1_cam_gain_t | Gain/offset parameters setting structure |
| em1_cam_size_t | Input/output size parameters setting structure |
| em1_cam_frame_t | Frame parameters setting structure |
| em1_cam_sensor_t | Sensor parameters setting structure |
| em1_cam_data_t | Camera parameters setting structure |

### A.3.1 em1_cam_gain_t

**Table A-4 Structure of em1_cam_gain_t**

| Member | Detail |
|---|---|
| uchar y_gain | Y gain value |
| uchar u_gain | U gain value |
| uchar v_gain | V gain value |
| char y_offset | Y offset value |
| char u_offset | U offset value |
| char v_offset | V offset value |

### A.3.2 em1_cam_size_t

**Table A-5 Structure of em1_cam_size_t**

| Member | Detail |
|---|---|
| int width | Width size |
| int height | Height size |

### A.3.3 em1_cam_frame_t

**Table A-5 Structure of em1_cam_frame_t**

| Member | Detail |
|---|---|
| uchar framenum | The number of total frame |
| uint A_y_addr | Y data address of A frame |
| uint A_uv_addr | UV data address of A frame |
| int A_v_addr | V data address of A frame |
| uint B_y_addr | Y data address of B frame |
| uint B_uv_addr | UV data address of B frame |
| uint B_v_addr | V data address of B frame |

### A.3.4 em1_cam_sensor_t

| Member | Detail |
|---|---|
| uint hblank | The blank value of CAM_HS signal |
| uint vblank | The blank value of CAM_VS signal |
| uchar sample_mode | The sampling mode |
| uchar yuv_format | YUV data format |
| BOOL data_id | Input data format |
| BOOL data_od | Output data format |
| BOOL limit_set | Data limit setting |
| BOOL vs_det | CAM_VS detect timing |
| BOOL hs_det | CAM_HS detect timing |
| BOOL clk_edge | CAM_CLKI detect timing |
| BOOL data_det | Detect timing of data sampling |
| BOOL vs_pol | Polarity of CAM_VS |
| BOOL hs_pol | Polarity of CAM_HS |

### A.3.5 em1_cam_data_t

| Member | Detail |
|---|---|
| em1_cam_sensor_t sensor | Sensor parameters setting structure |
| em1_cam_size_t in_size | Input size parameters setting structure |
| em1_cam_size_t out_size | Output size parameters setting structure |
| em1_cam_gain_t gain | Gain/offset parameters setting structure |
| em1_cam_frame_t frame | Frame parameters setting structure |
| uchar transfer_mode | Camera transfer mode |
| uchar mirror_mode | Camera mirror mode |
| uchar skip_mode | Camera skip mode |

## A.4 Function Details

### A.4.1 Camera Initialization Function

**[Function Name]**

em1_cam_init

**[Format]**

void em1_cam_init (void);

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

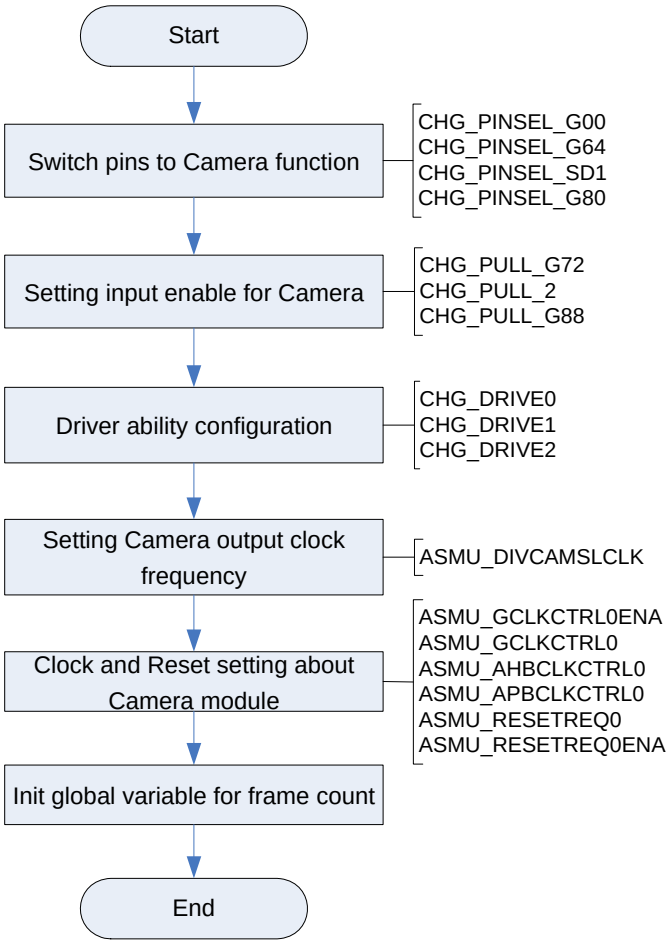


Figure A-1 Camera Controller Initialization

**[Note]**

None

### A.4.2 Camera Gain/Offset Setting Function

**[Function Name]**

em1_cam_set_gain

**[Format]**

void em1_cam_set_gain(em1_cam_gain_t *gain);

**[Argument]**

em1_cam_gain_t *gain – the structure pointer for gain/offset parameters

**[Function Return]**

None

**[Flow Chart]**

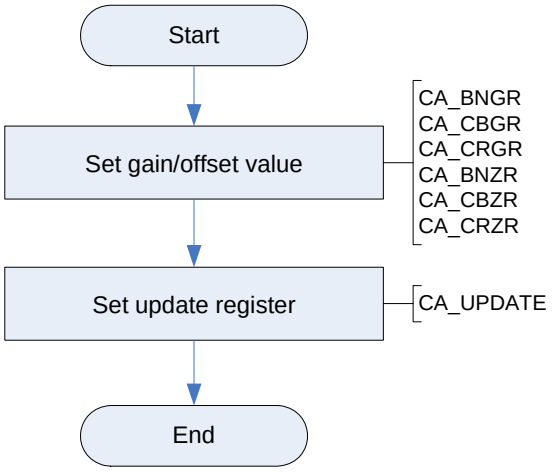


Figure A-2 Camera Gain/Offset Setting

**[Note]**

None

### A.4.3 Camera Input/Output Size Setting Function

**[Function Name]**

em1_cam_set_size

**[Format]**

uchar em1_cam_set_size(em1_cam_data_t *cam);

**[Argument]**

em1_cam_data_t *cam – the structure pointer for camera parameters

**[Function Return]**

DRV_OK

DRV_ERR_PARAM

**[Flow Chart]**

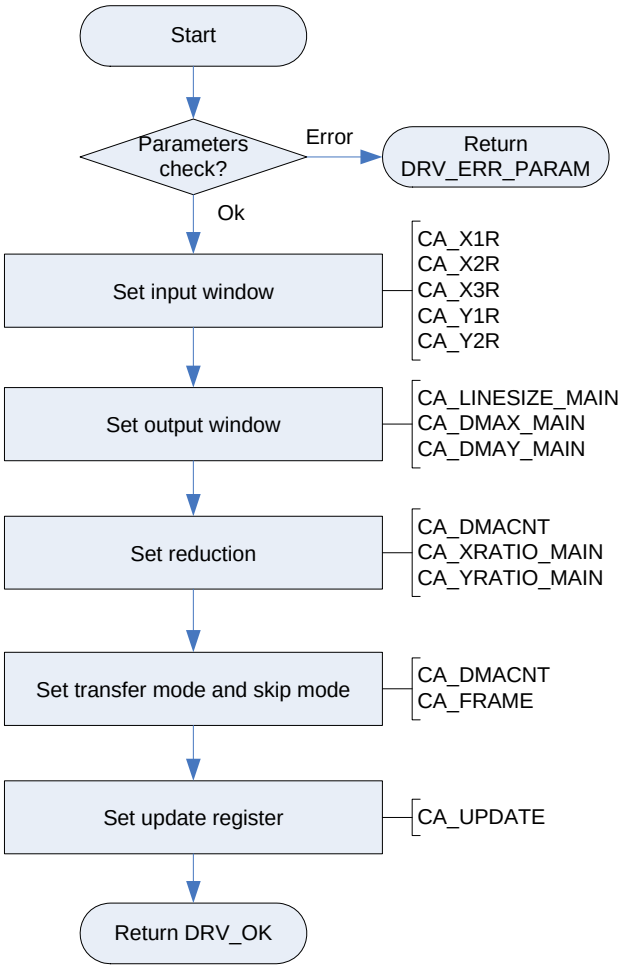


Figure A-3 Camera Gain/Offset Setting

**[Note]**

None

### A.4.4 Camera Frame Setting Function

**[Function Name]**

em1_cam_set_frame

**[Format]**

void em1_cam_set_frame(em1_cam_frame_t *frame);

**[Argument]**

em1_cam_frame_t *frame – the structure pointer for frame parameters

**[Function Return]**

None

**[Flow Chart]**

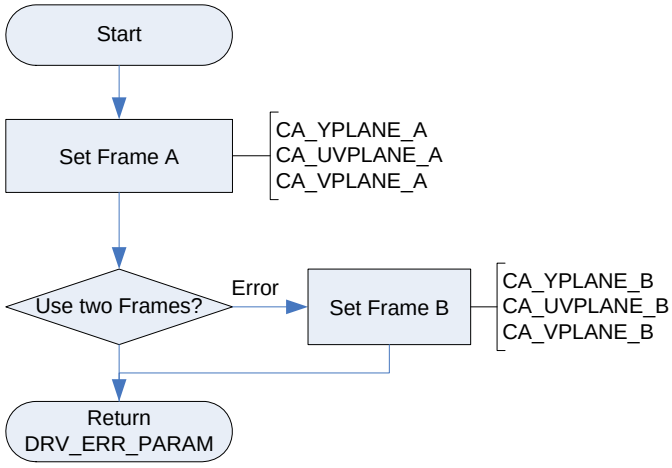


Figure A-4 Camera Frame Setting

**[Note]**

None

### A.4.5 Camera Timing Setting Function

**[Function Name]**

em1_cam_set_timing

**[Format]**

uchar em1_cam_set_timing(em1_cam_sensor_t *sensor);

**[Argument]**

em1_cam_sensor_t *sensor – the structure pointer for sensor parameters

**[Function Return]**

None

**[Flow Chart]**

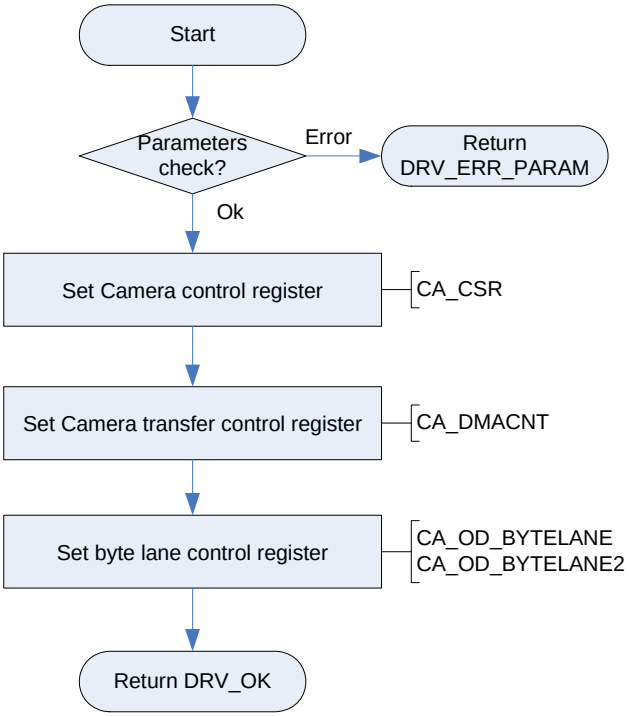


Figure A-5 Camera Timing Setting

**[Note]**

None

### A.4.6 Camera Mirror Setting Function

**[Function Name]**

em1_cam_set_mirror

**[Format]**

void em1_cam_set_mirror(uchar mirror);

**[Argument]**

uchar mirror – mirror mode

**[Function Return]**

None

**[Flow Chart]**

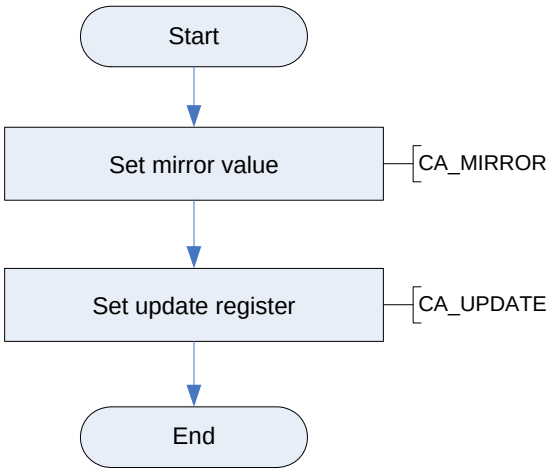


Figure A-6 Camera Mirror Setting

**[Note]**

None

### A.4.7 Enable/Disable Camera Interface Function

**[Function Name]**

em1_cam_enable

**[Format]**

void em1_cam_enable( BOOL flag );

**[Argument]**

BOOL flag – enable/disable flag

**[Function Return]**

None

**[Flow Chart]**

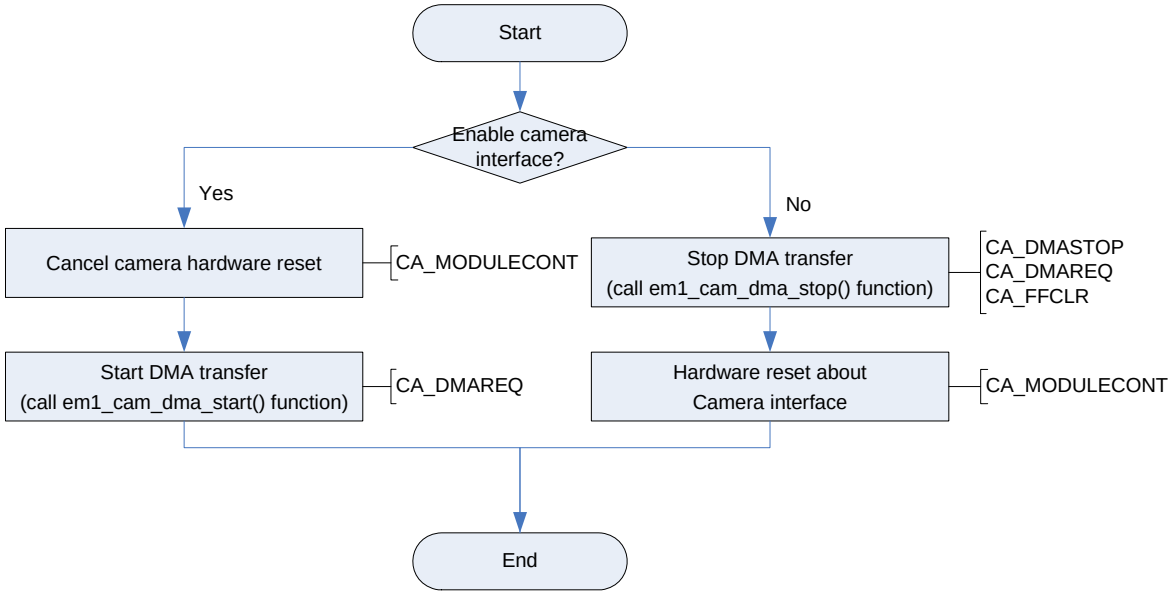


Figure A-7 Camera Interface Enable/Disable Setting

**[Note]**

About “em1_cam_dma_start()” function and “em1_cam_dma_stop()” function, please refer **“A.4.8 Camera DMA Start Function”** and **“A.4.9 Camera DMA Stop Function”**.

### A.4.8 Camera DMA Start Function

**[Function Name]**

em1_cam_dma_start

**[Format]**

void em1_cam_dma_start( void );

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

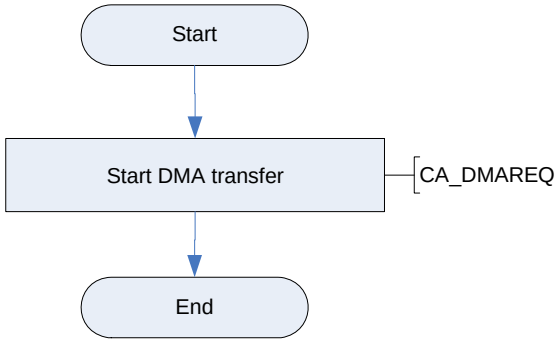


Figure A-8 Camera DMA Start

**[Note]**

None

### A.4.9 Camera DMA Stop Function

**[Function Name]**

em1_cam_dma_stop

**[Format]**

void em1_cam_dma_stop( void );

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

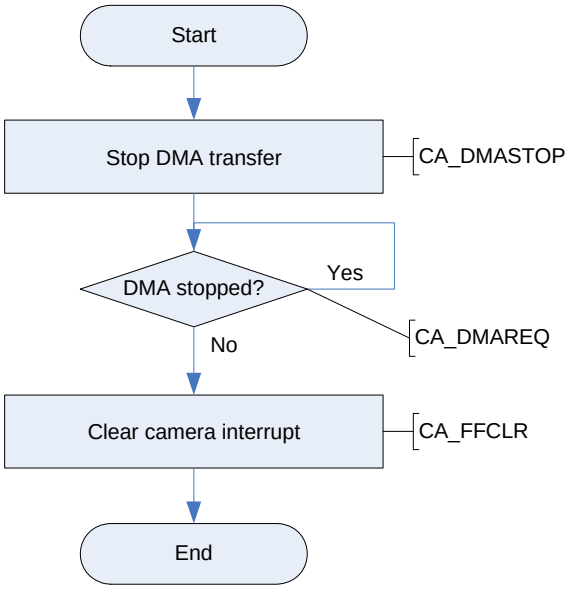


Figure A-9 Camera DMA Stop

**[Note]**

None

### A.4.10 Camera Interrupt Open Function

**[Function Name]**

em1_cam_set_INT_on

**[Format]**

void em1_cam_set_INT_on( void );

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

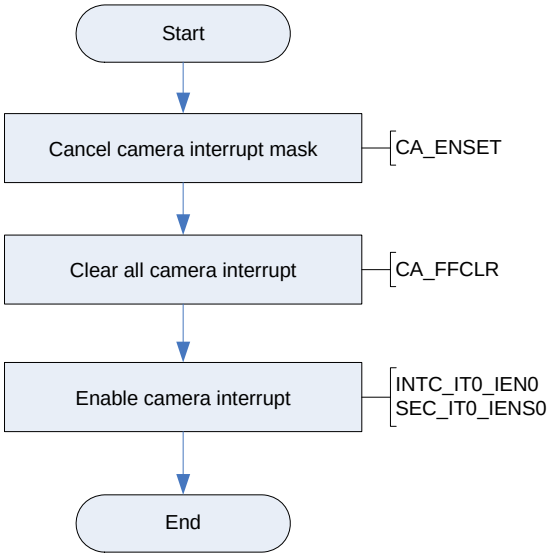


Figure A-10 Open Camera Interrupt

**[Note]**

None

### A.4.11 Camera Interrupt Close Function

**[Function Name]**

em1_cam_set_INT_off

**[Format]**

void em1_cam_set_INT_off( void );

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

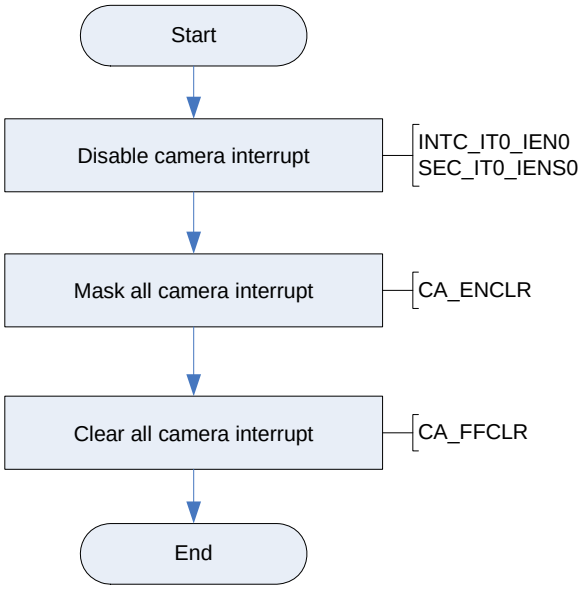


Figure A-10 Open Camera Interrupt

**[Note]**

None

### A.4.12 Camera Interrupt Handler Function

**[Function Name]**

INT_cam_irq

**[Format]**

void INT_cam_irq( void );

**[Argument]**

None

**[Function Return]**

None

**[Flow Chart]**

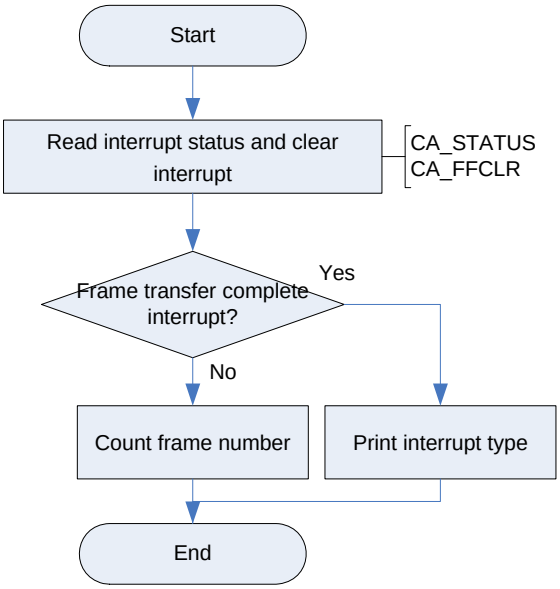


Figure A-12 Camera Interrupt Handler

**[Note]**

None

# ANNEX Modification History

| Number | Modification Contents | Author | Date |
|---|---|---|---|
| Ver 1.00 | New version | | Aug,4,2009 |
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