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Application Note

Multimedia Processor for Mobile Applications

LCD Controller

EMMA Mobile1

Document No. S19899EJ1V0AN00
Date Published Aug.2009

PREFACE

Purpose The purpose of this document is to specify the usage of EMMA Mobile1 LCD controller.

Organization This document includes the following:

- Introduction
- Usage of LCD Controller
- Example of LCD Controller Operation
- LCD 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	Author	Description
S19265EJ1V0UM00_ASMUGIO.pdf	1st Edition	NECEL	SMU&GPIO user's manual
S19268EJ1V0UM00_1chip.pdf	1st Edition	NECEL	1 chip user's manual
S19258EJ1V0UM00_LCDC.pdf	1st Edition	NECEL	LCD controller user's manual
S19907EJ1V0AN00_GD.pdf	1st Edition	NECEL	GD Spec
NL8048HL11-01B_E.pdf	1st Edition	NEC LCD Technologies, Ltd.	LCD panel user's manual

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LIST OF FIGURES

Chapter 1 Introduction

1.1 Outline

This document will show users how to operate LCD controller (LCDC) on EMMA Mobile1 evaluation board.
More details about LCD controller feature please refer to EMMA Mobile 1 LCD controller 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 LCD Controller

According to the LCD controller feature, the EMMA Mobile 1 LCD controller has five kinds of display mode:

1. Display via IMC (local bus) without WB
2. Display via IMC (local bus) with WB
3. Display via MEMC (direct path)
4. Fixed-value display
5. Black back display

Note:

WB: Write Back.

2.1 Display via IMC (Local Bus)

Display via IMC (local bus) including two modes:

1. display via IMC without WB
2. display via IMC with WB

Display via IMC, the source image should be prepared by IMC.

2.1.1 Operation Flow

Following figure shows the flow chart of LCD display progress when use IMC:

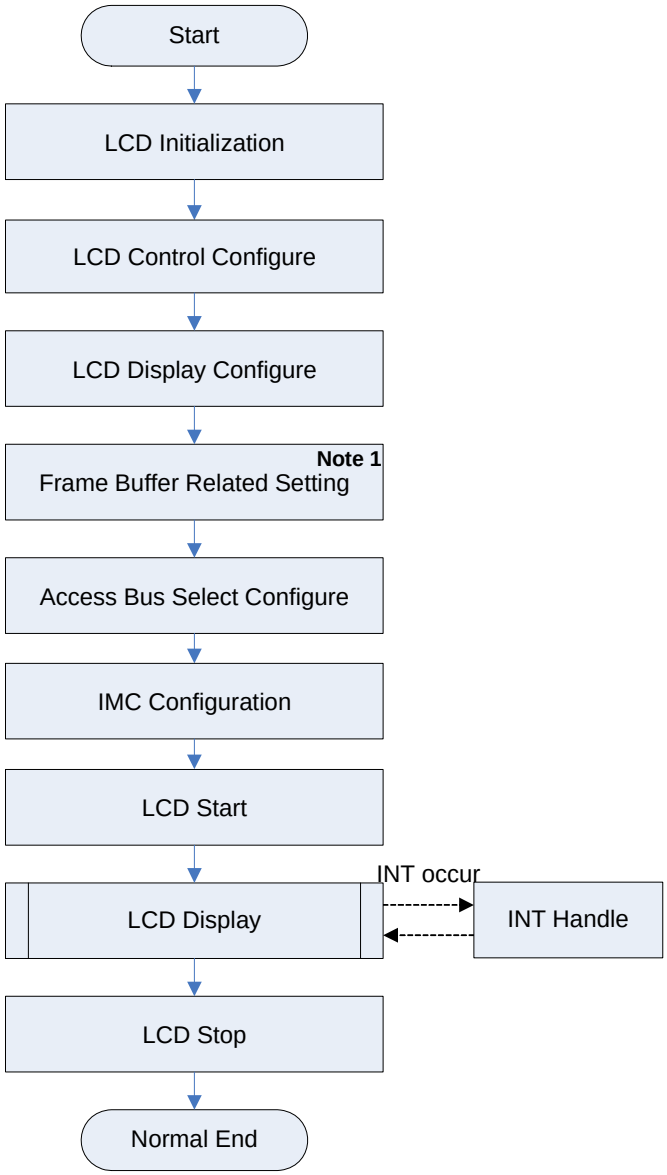

Figure 2-1 Display Progress When Use IMC

Note:

The step of “Frame Buffer Related Setting” only valid in local bus + WB display mode.

2.1.2 Operation Details

In this chapter, only describe the IMC configuration steps in the operation flow chart, other steps operation details please refer to "**Chapter 2.2 Display without IMC**".

(1) IMC Configuration

When display via local bus between IMC and LCD, IMC configuration should be done before LCD display start, the IMC work mode also has restriction. The IMC and LCD configuration relationship should follow the bellows table:

No.	IMC	LCD
1	LCD-synchronous (IMC_CONTROL[0] = 0)	Local bus without WB (LCD_BUFSEL = 0) Local bus + WB (LCD_BUFSEL = 2 or 3)
2	Immediate startup mode (IMC_CONTROL[0] = 1)	Direct path display (LCD_BUFSEL = 1)

The source image configuration includes YUV-RGB conversion setting, overlay setting and gamma adjustment setting.

More details about IMC configuration please refer to the EMMA Mobile 1 IMC application note.

2.2 Display without IMC

Display when not uses IMC including there modes:

1. Display via MEMC (direct path)
2. Fixed-value display
3. Black back display

2.2.1 Operation Flow

Following figure shows the flow chart of LCD display progress when not use IMC:

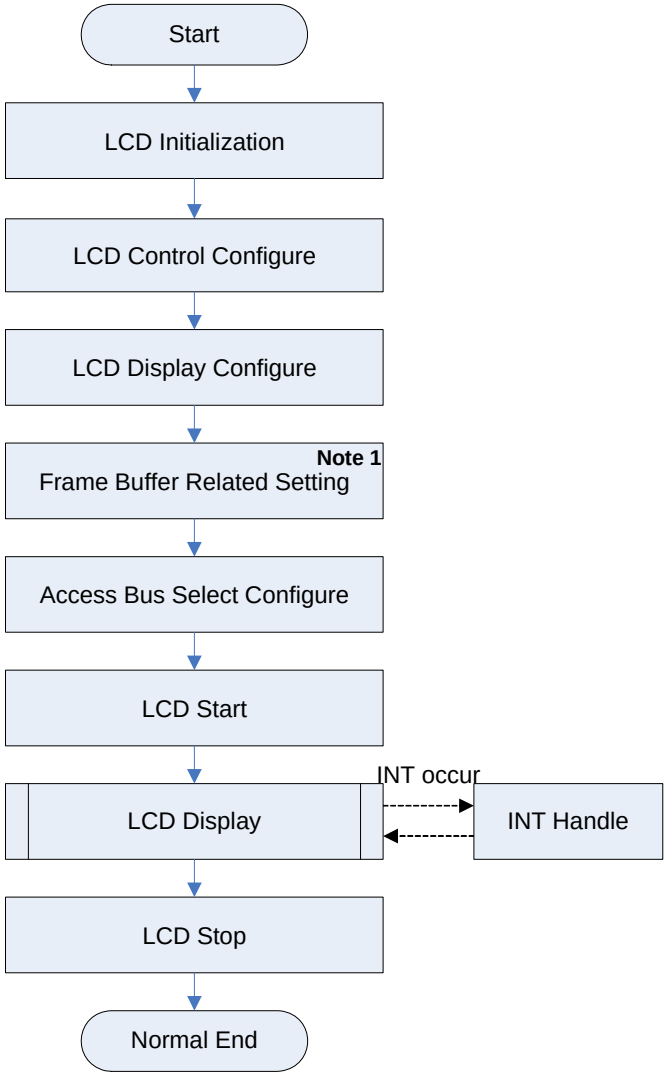

Figure 2-2 Display Progress When not Use IMC

Note:

1) "Frame Buffer Related Setting" only used in direct path display mode (display via MEMC) and local bus + WB display mode.

2.2.2 Operation Detail

(1) LCD Initialization

If the LCD panel has additional initialization sequence, LCD initialization progress will includes two steps: EMMA Mobile 1 LCD controller initialization and LCD panel initialization. Otherwise, only EMMA Mobile 1 LCD controller needs to be init.

EMMA Mobile 1 LCD controller initialization including following steps:

Step1: reset setting:

ASMU_ RESETREQ0;

ASMU_ RESETREQ0ENA;

Step2: clock setting:

ASMU_GCLKCTRL1ENA

ASMU_GCLKCTRL1

ASMU_AHBCLKCTRL0

ASMU_APBCLKCTRL0

ASMU_DIVLCDLCLK (This register value will generate PXCLK which used for pixel frequency)

Step3: switch pins to LCD function:

CHG_PINSEL_G48

CHG_PINSEL_G64

Step4: pull-down/pull-up setting:

CHG_PULL_G48;

CHG_PULL_G56;

CHG_PULL_G64

Step5: driver capability setting:

CHG_DRIVE1;

If the LCD panel has additional initialization sequence, please init the LCD panel according to its user's manual.

(2) LCD Control Configure

Set LCDC control register, include the output format and signals polarity, for details, please refer to "**4.1 LCD Interface**" of EMMA Mobile 1 LCD Controller User's Manual.

Register list:

LCD_CONTROL

(3) LCD Display Configure

Display configuration includes:

Display area

Direction total signal

Synchronous signal edge position

Table 2-1 shows Register List of LCD Display Area Configure.

Table 2-1 Register List of LCD Display Area Configure

Function	Register
Display area	LCD_HAREA LCD_VAREA
Direction total signal	LCD_HTOTAL LCD_VTOTAL
Synchronous signal edge position	LCD_HEDGE1 LCD_HEDGE2 LCD_VEDGE1 LCD_VEDGE2

More details about the display configuration, please refer to "**4.1 LCD Interface**" of EMMA Mobile 1 LCD Controller User's Manual.

Note:

1) When setting the display parameters in this step, please refer to the LCD panel input signal timing (according the LCD panel user's manual).
2) If use fixed-value display mode, please configure the fixed color value in this step.
   Related register:
   LCD_BACKCOLOR

(4) Frame Buffer Related Setting

This step only used in direct path display mode (display via MEMC) and local bus + WB display mode. In direct path display mode, image data will load from the frame buffer in external DDR SDRAM (Refer to Figure 2-2).

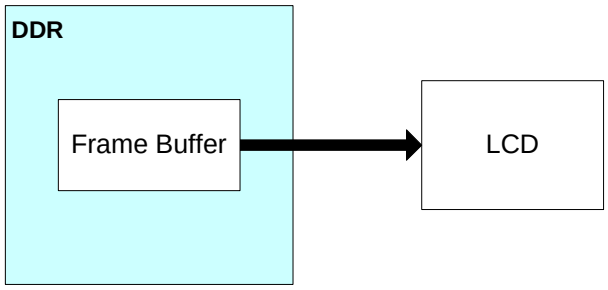

Figure 2-3 LCD Frame Buffer

In local bus + WB display mode, image data showed in LCD will write back to a frame buffer.
Register list:
LCD_AREAADR
LCD_HOFFSET
LCD_IFORMAT

LCD_DATAREQ

More details about the frame buffer configuration, please refer to "**4.2 Frame Buffer and Data Buffer**" of EMMA Mobile 1 LCD Controller User's Manual.

(5) Access Bus Select

Chose LCD controller operation mode by setting the access bus select register.

More details about BUSSEL setting and transition of internal states please refer to "**3.2.5 Access bus select register**" and "**5.3 Mode Change during Operation (BUSSEL)**" of EMMA Mobile 1 LCD Controller User's Manual.

Register list:

LCD_BUSSEL

(6) LCD Start/Stop

The LCD display begins when setting 01H to LCD_LCDOUT register. And setting 00H to LCD_LCDOUT is to stop the display.

Register list:

LCD_LCDOUT

(7) LCD Interrupt

The LCD controller issues five types of interrupts, including display stop, under run, VGA standby shift end, frame count and LCD frame start interrupt status. For details on LCD interrupt, refer to"**3.2.19 Interrupt setting register**" and "**4.5 Interrupt Sources**" of EMMA Mobile 1 LCD Controller User's Manual.

Register list:

LCD_INTSTATUS
LCD_INTRAWSTATUS
LCD_INTENSET
LCD_INTENCLR
LCD_INTFFCLR

Chapter 3 Example of LCD Controller Operation

3.1 Outline of LCD Controller Operation

This chapter will show users how to display image via EMMA Mobile 1 LCD controller.
On EMMA Mobile 1 evaluation board (PSKCH2Y-S-0016-01), the external LCD panel is NL8048HL11-01B (Manufacture: NEC LCD technologies, Ltd.). Color LCD module NL8048HL11-01B is composed of the low temperature poly silicon thin film transistor liquid crystal display(LTPS TFT LCD) panel structure with driver LSIs for driving the TFT(Thin Film Transistor) array, touch panel(T/P) and a backlight.
More details about the NL8048HL11-01B please refer to its user's manual.
Figure 3-1 shows the connection of EMMA Mobile 1 LCD interface and NL8048HL11-01B.

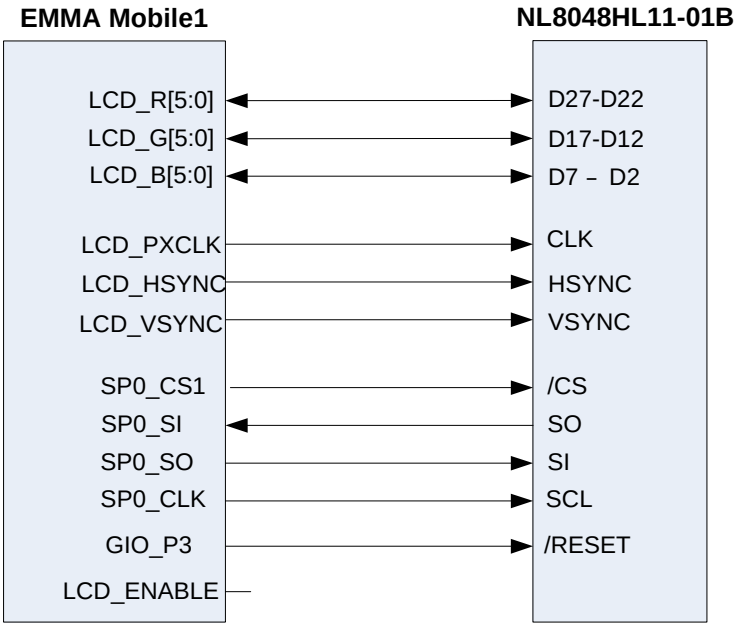

Figure 3-1 Connection between EMMA Mobile 1 and NL8048HL11-01B

Note:
This LCD panel not use LCD_ENABLE pin.
In LCD Controller side, data in frame buffer will be output when LCD_ENABLE is in active level. LCD_ENABLE related to the LCD_HAREA and LCD_VAREA value, more details about the enable signal please refer to "**Chapter 4.1.7 Enable signal**" of EMMA Mobile 1 LCD controller user's manual.

3.2 Initialization

Before display the image, initialization should be executed at first.

3.2.1 Operation Flow

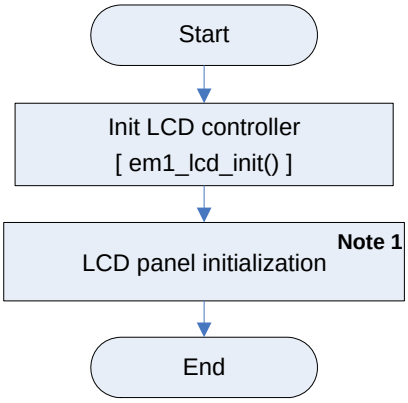

Figure 3-2 Initialization before Test

More details about the functions used in initialization please refer to "**APPENDIX A LCD Driver Function**"

Note:

1) LCD panel initialization in this example means LCD panel power on sequence, because the LCD panel use the EMMA Mobile 1 SPI interface to control registers, so this step will init the SPI interface at first.

3.2.2 Operation Detail

(1) Init LCD Controller

EMMA Mobile 1 LCD controller initialization including following steps:

Step1: reset setting

ASMU_ RESETREQ0 [13]; (0: reset; 1: cancel reset)

ASMU_ RESETREQ0ENA[13]; (0: disable setting; 1: enable setting)

Step2: clock setting

ASMU_GCLKCTRL1ENA[9:12] (0: disable setting; 1: enable setting)

ASMU_GCLKCTRL1[9:12] (0: close clock; 1: open clock)

ASMU_AHBCLKCTRL0[13:14] (0: Disables automatic control ; 1: Enables automatic control)

ASMU_APBCLKCTRL0[0] (0: Disables automatic control ; 1: Enables automatic control)

ASMU_DIVLCDLCLK = 0x00000190 (LCD_LCLK = 229.376 MHz ÷ 10 = 22.938 MHz)

Step3: port setting

CHG_PINSEL_G48 = 0x55555550

CHG_PINSEL_G64 = 0x00005555

Stpe4: pull-up/down setting

CHG_PULL_G48 = 0x11111100; (pull-up/down setting disable)

CHG_PULL_G56 = 0x11111111; (pull-up/down setting disable)

CHG_PULL_G64= 0x11111111; (pull-up/down setting disable)

Step5: drive capability setting

CHG_DRIVE1 = 0x00000050;

(2) LCD Panel Initialization

Use SPI interface to complete the LCD panel initialization progress (power on sequence).

Step1: Configures SPI at first, it includes clock configuration and reset setting, change the GPIO to SPI function, set pull-down/pull-up for SPI pins, soft reset SP0, configure the mode register and chip select polarity register.

The related registers are as follow:

For SPI init setting:

ASMU_APBCLKCTRL1[7]

ASMU_CLKCTRL[2]

ASMU_GCLKCTRL3ENA[21:22]

ASMU_GCLKCTRL3[21:22]

ASMU_RESETREQ1ENA[22]

ASMU_RESETREQ1[22]

CHG_PINSEL_SP0 = 0x00000000

CHG_PINSEL_G48 = 0x00000001

CHG_PULL1 = 0x15110000
SP0_CONTROL (soft reset SP0)
SP0_MODE (initialize SP0 with CS1)
SP0_POL (use 32bit, CS1, Master and CPU mode)

Step2: Write control data to LCD panel registers, more details about LCD panel power on sequence please refer to the "**chapter 4.4 SETTING OF THE INTERNAL REGISTER**" of the LCD panel user's manual.

The related registers are as follow:
SP0_CONTROL
SP0_TX_DATA
SP0_ENCLR
SP0_FFCLR

3.3 Example of Direct Path Display (Display via MEMC)

In this example, use direct path display mode to display two images on LCD, the image feature is as bellows:

Input format: RGB565

Output format: RGB565

Image size: 800*480

Image 1: Frame buffer address: 0x30000000

Frame Buffer Size: 0x000BB800

Image 2: Frame buffer address: 0x300BB800

Frame Buffer Size: 0x000BB800

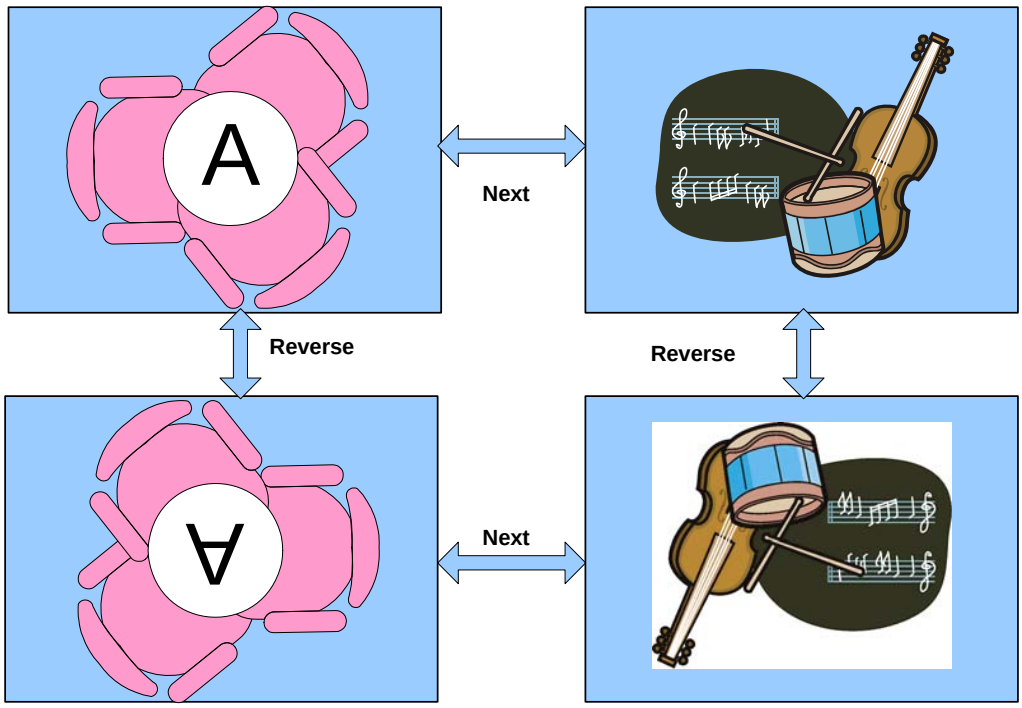

Figure 3-3 Picture Display in Direct Path Mode

3.3.1 Operation Flow

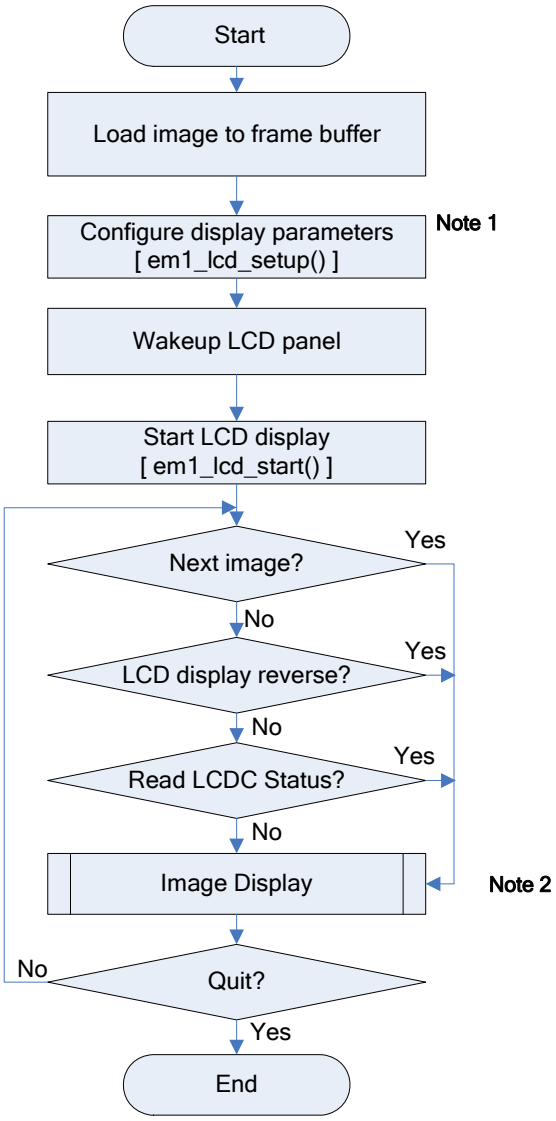

Figure 3-4 Direct Path Dispaly Operation Flow

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

Note:

1) Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting and access bus select register setting, more details about this step, please refer to "**Chapter 3.3.2 Operation Details**".

2) When show next image, display area (LCD_AREAADR) should be change; when reverse the LCD panel display mode, LCD panel operation should be added before display image, more details about this step please refer to "**Chapter 3.3.2 Operation Details**".

3.3.2 Operation Detail

(1) Load Image to Frame Buffer

Before display image via MEMC, user should load image data to frame buffer, in this example, use DDR memory 0x30000000 to 0x30176FFF as the frame buffer for picture 1 and picture 2.

Picture 1: 0x30000000 – 0x300BB7FF

Picture 2: 0x300BB800 – 0x30176FFF

(2) Configure Display Parameters

Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting and access bus select register setting:

Step1: LCD control configuration. Include the output format, and signals polarity setting.

LCD_CONTROL = 0x10 (output format is RGB565, CLKPOL— rising edge, HPOL and VPOL—positive edge, ENPOL— high)

Step2: LCD display configuration.

For display area setting:

LCD_HAREA = 800

LCD_VAREA = 480

For frequency of frame setting:

LCD_HTOTAL = 811

LCD_VTOTAL = 488

For synchronous signal edge position setting:

LCD_HEDGE1 = 6

LCD_HEDGE2 = 7

LCD_VEDGE1 = 3

LCD_VEDGE2 = 4

Step3: Frame buffer related register setting

LCD_AREAADR = 0x30000000/0x300BB800 (frame buffer starting address)

LCD_HOFFSET = 800*2 (total byte count in horizontal direction in a frame buffer area)

LCD_IFORMAT = 1 (input format is RGB565)

LCD_DATAREQ = 0 (8 words available in FIFO space which used for determine data request output timing)

Step4: Access bus select

LCD_BUSSEL = 0x01 (display via MEMC)

Setp5: interrupt setting

Register list:

LCD_ INTFFCLR = 0x1F (clear all the interrupt source)

LCD_INTENSET = 0x1F (enable all the interrupt)

Note:

The step2 settings should refer to the real LCD panel input signals timing, in this example, the LCD panel input signals timing is shown in the following figure, please refer to it:

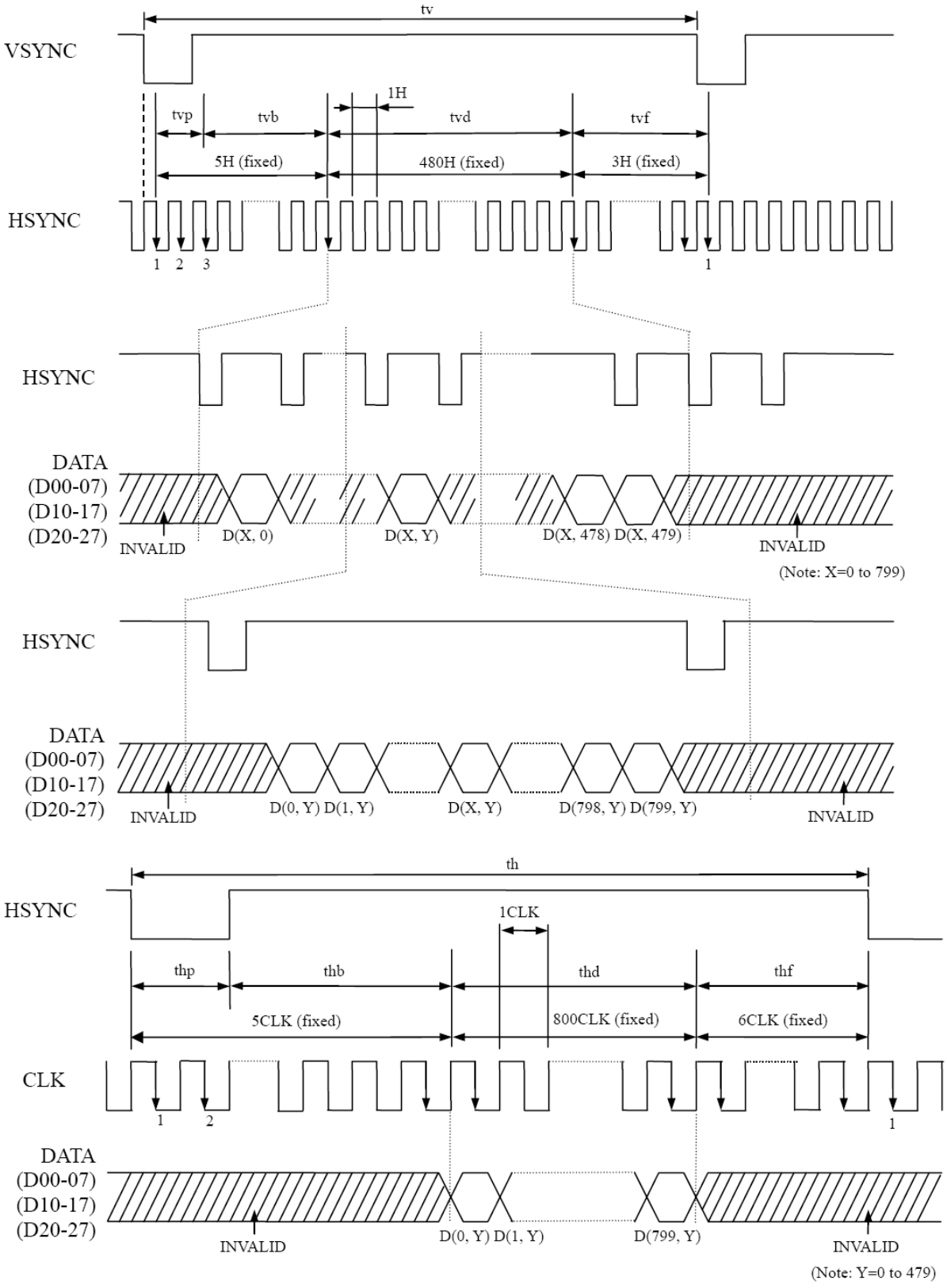

Figure 3-5 LCD Panel Input Signal Timing Chart

Following table shows the input signal timing range:

Table 3-1 LCD Panel Input Signal Timing Characteristics

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	21.8	23.8	25.7	MHz	42ns (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	2	ns	
DATA (D00-07) (D10-17) (D20-27)	CLK-DATA	Setup time	tds	13	-	-	ns	-
		Hold time	tdh	13	-	-	ns	
	Rise time, Fall time		tdrf	-	-	2	ns	
HSYNC	Cycle		th	31.6	34.1	37.2	µs	29.3kHz (typ.)
				811			CLK	-
	Display period		thd	800			CLK	
	Front-porch		thf	6			CLK	
	Pulse width		thp	1			CLK	
	Back-porch		thb	4			CLK	
	CLK-HSYNC	Setup time	ths	13	-	-	ns	
		Hold time	thh	13	-	-	ns	
	Rise time, Fall time		thrf	-	-	2	ns	
VSYNC	Cycle		tv	15.4	16.63	18.2	ms	60Hz (typ.)
				488			H	-
	Display period		tvd	480			H	
	Front-porch		tvf	3			H	
	Pulse width		tvp	1			H	
	Back-porch		tvb	4			H	
	Rise time, Fall time		tvrf	-	-	2	ns	

Note:

1) Definition of parameters is as follows.

tc= 1CLK, tcd= tch/tc, th= 1H

2) All parameters should be kept within the specified range.

3) Following figures shows the relationship of LCD controller signals and relationship of LCD panel signals, when setting the display parameters, please refer to it:

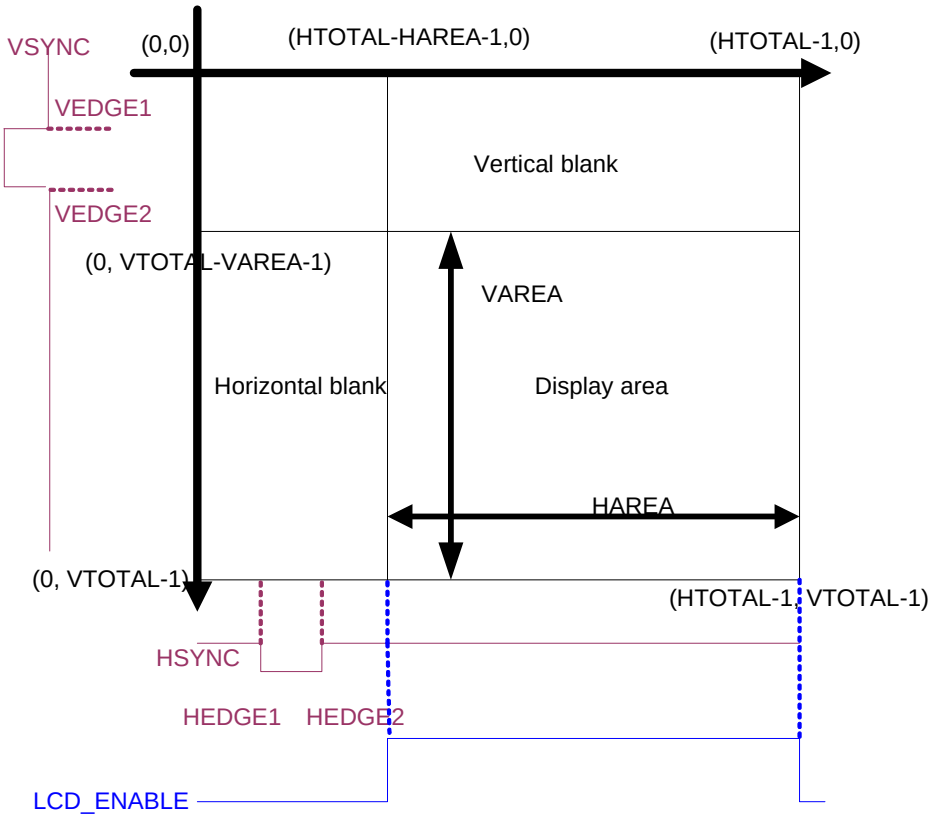

Figure 3-6 LCD Controller Signal Relationship

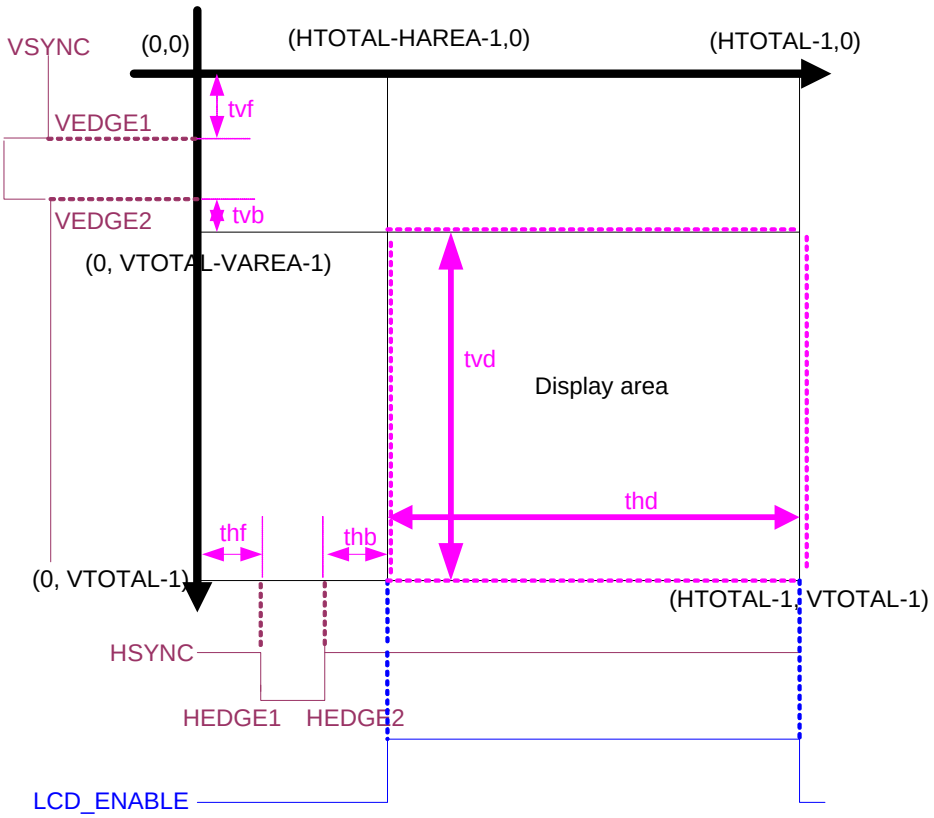

Figure 3-7 LCD Panel Signals Relationship

The LCD controller will start output valid data when reach “(LCD_HTOTAL-LCD_HAREA-1, Vc)” pixel clock, and will be valid until “(LCD_HTOTAL-1, Vc)” pixel clock.
The LCD panel will take the data as valid and show data in panel after (LCD_HEDGE2+thb-1, Vp)” pixel clock, and will be valid until “(LCD_HEDGE2+thb+thd-1, Vp)” pixel clock.
Here “Vc” means LCD controller valid data position in vertical direction, range: “LCD_VTOTAL-LCD_HAREA-1” to “LCD_VTOTAL-1”.
Here “Vp” means LCD panel valid data position in vertical direction, range: “LCD_VEDGE2+tvb-1” to “LCD_VEDGE2+tvb +tvd-1”.
So, in order to display the image correctly, make LCD controller valid data and LCD panel valid data in same period range.
4) Because the LCD controller display data by using the lover right coordinate system (please refer to “**chapter 4.1.4 Display area, and horizontal and vertical blanks**” of EMMA Mobile 1 LCD controller user’s manual), so the “thf” and “tvf” synchronization signal should be reckoned in “LCD_HEDGE1” and “LCD_VEDGE1” range.
5) When LCD_ENABLE in valid level, between “(LCD_HEDGE1-1, Vc)” and “(LCD_HEDGE2-1, Vc)” will be blank area.
6) When LCD_ENABLE in invalid level, LCD controller data lines will output zero.

(3) Wakeup LCD Panel

After configure LCD controller, use SPI interface to wakeup the LCD panel, more details about LCD panel wakeup operation please refer to the “**chapter 4.4 SETTING OF THE INTERNAL REGISTER**” of the LCD panel user’s manual.

(4) Start LCD Display

Call “em1_lcd_start()” function to start display.

Register list:

LCD_ LCDOUT = 1

(5) Make Display Choice

In this example, user can make choice to show next picture or reverse the LCD panel display mode. If show next picture, only the LCD_AREAADR register value should be changed.
LCD panel use SPI interface operation to reverse the display mode(use SPI bus write value to LCD panel register), more details about the LCD panel reverse operation please refer to the “**chapter 4.4 SETTING OF THE INTERNAL REGISTER**” of the LCD panel user’s manual.
Note:
When reverse the normal image, the LCD operate sequence is:
Step1: R1 ->01h and then R1 ->03h
Step2: R121 ->30h and then R121-> 10h
But when resume to normal mode, LCD panel operation sequence is:
Only R1-> 01h and then R121 ->30h

(6) Read LCDC Status

Call “em1_lcd_get_status()” function to read the LCD controller operation status.

Register list:

LCD_STATUS

3.4 Example of Fixed-Value Display

In this example, use fixed-value display mode to display image on LCD, the image feature is as bellows:

Output format: RGB666

Image size: 480*480

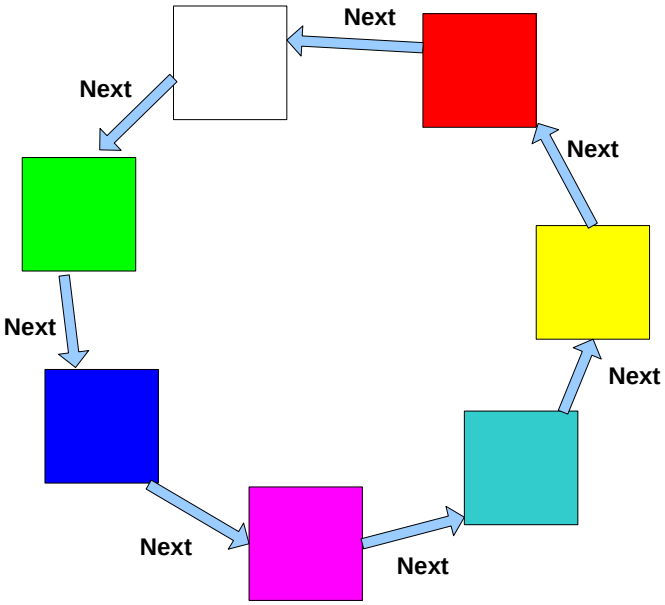

Figure 3-8 Picture Display in Fixed-value Mode

3.4.1 Operation Flow

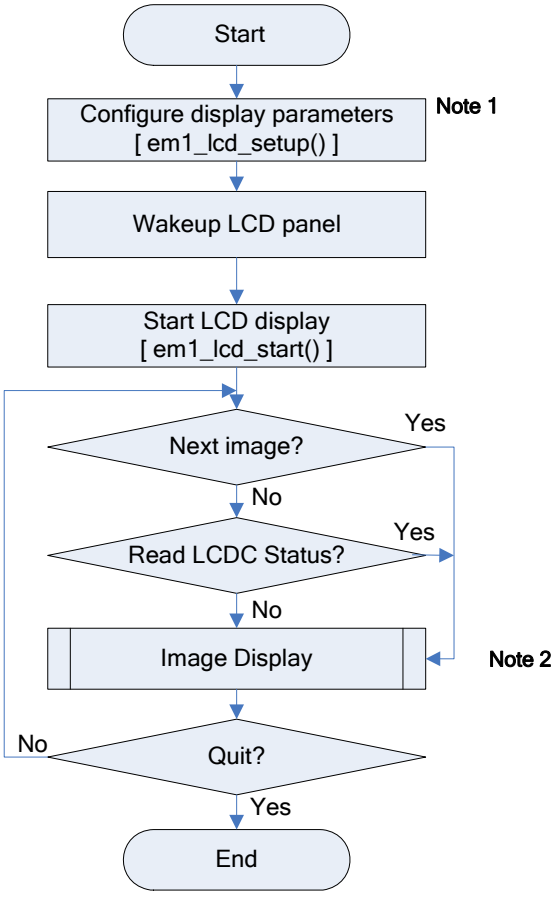

Figure 3-9 Fixed-value Dispaly Operation Flow

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

Note:

1) Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting and access bus select register setting, more details about this step, please refer to "**Chapter 3.4.2 Operation Details**".

2) When show next image, display area update operation should be added before display image, more details about this step please refer to "**Chapter 3.4.2 Operation Details**".

3.4.2 Operation Detail

(1) Configure Display Parameters

Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting and access bus select register setting:

Step1: LCD control configuration. Include the output format, and signals polarity setting.

Register list:

LCD_CONTROL = 0x00 (output format is RGB666, CLKPOL— rising edge, HPOL and VPOL— positive edge, ENPOL— high)

Setp2: LCD display configuration.

For display area setting:

LCD_HAREA = 480

LCD_VAREA = 480

For frequency of frame setting:

LCD_HTOTAL = 811

LCD_VTOTAL = 488

For synchronous signal edge position setting:

LCD_HEDGE1 = 6

LCD_HEDGE2 = 7

LCD_VEDGE1 = 3

LCD_VEDGE2 = 4

Note:

All display parameters that configured in this step are related to the LCD panel input signal timing, please refer to the “figure3-5 LCD Panel Input signal timing chart” and “table 3-1 LCD Panel Input Signal Timing Characteristics” when setting the display parameters.

Step3: Fixed value setting

Please refer to the “Table 3-2 Value of LCD_BACKCOLOR” for register setting.

Register list:

LCD_BACKCOLOR

Step4: Access bus select:

Register list:

LCD_BUSSEL = 0x05 (fixed-value display mode)

Setp5: interrupt setting

Register list:

LCD_ INTFFCLR = 0x1F (clear all the interrupt source)

LCD_INTENSET = 0x1F (enable all the interrupt)

(2) Wakeup LCD Panel

After configure LCD controller, use SPI interface to wakeup the LCD panel, more details about

LCD panel wakeup operation please refer to the "**chapter 4.4 SETTING OF THE INTERNAL REGISTER**" of the LCD panel user's manual.

(3) Start LCD Display

Call "em1_lcd_start()" function to start display.

Register list:

LCD_ LCDOUT = 1

(4) Show Next Image

User can change the LCD_ BACKCOLOR register value to show next picture.

Register list:

LCD_ BACKCOLOR

Table 3-2 Value of LCD_BACKCOLOR

Color	Value
Red	0x003F0000
Green	0x00003F00
Blue	0x0000003F
Magenta	0x003F003F
Cyan	0x00003F3F
Yellow	0x003F3F00
White	0x003F3F3F

(5) Read LCDC Status

Call "em1_lcd_get_status()" function to read the LCD controller operation status.

Register list:

LCD_STATUS

3.5 Example of Black Back Display

In this example, use fixed-value display mode to display image on LCD, the image feature is as bellows:

Output format: RGB565

Image size: 800*480

3.5.1 Operation Flow

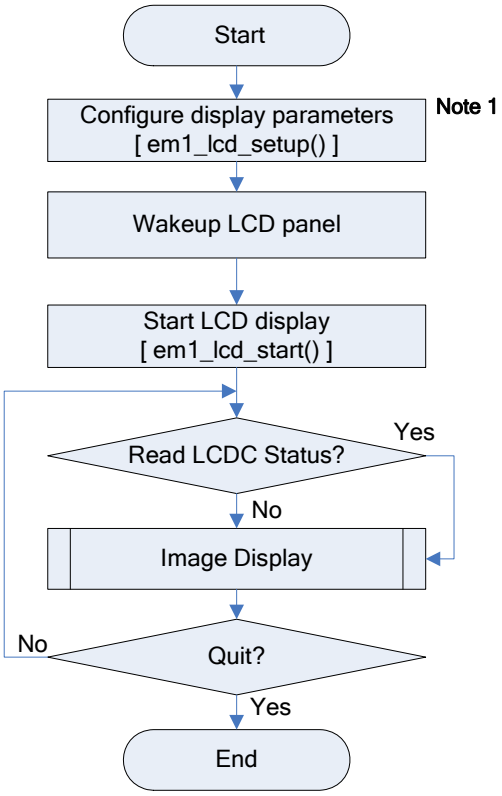

Figure 3-10 Black Bace Dispaly Operation Flow

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

Note:

1) Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting and access bus select register setting, more details about this step, please refer to "**Chapter 3.5.2 Operation Details**".

3.5.2 Operation Detail

(1) Configure Display Parameters

Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting, access bus select register setting and interrupt configuration:

Step1: LCD control configuration. Include the output format, and signals polarity setting.

Register list:

LCD_CONTROL = 0x10 (output format is RGB565, CLKPOL— rising edge, HPOL and VPOL—positive edge, ENPOL— high)

Setp2: LCD display configuration.

For display area setting:

LCD_HAREA = 800

LCD_VAREA = 480

For direction total signal setting:

LCD_HTOTAL = 811

LCD_VTOTAL = 488

For synchronous signal edge position setting:

LCD_HEDGE1 = 6

LCD_HEDGE2 = 7

LCD_VEDGE1 = 3

LCD_VEDGE2 = 4

Note:

All display parameters that configured in this step are related to the LCD panel input signal timing, please refer to the “figure3-5 LCD Panel Input signal timing chart” and “table 3-1 LCD Panel Input Signal Timing Characteristics” when setting the display parameters.

Step3: Access bus select:

Register list:

LCD_BUSSEL = 0x04 (black back display mode)

Setp4: interrupt setting

Register list:

LCD_ INTFFCLR = 0x1F (clear all the interrupt source)

LCD_INTENSET = 0x1F (enable all the interrupt)

(2) Wakeup LCD Panel

After configure LCD controller, use SPI interface to wakeup the LCD panel, more details about LCD panel wakeup operation please refer to the “**chapter 4.4 SETTING OF THE INTERNAL REGISTER**” of the LCD panel user’s manual.

(3) Start LCD Display

Call “em1_lcd_start()” function to start display.

Register list:

LCD_ LCDOUT = 1

(4) Read LCDC Status

Call “em1_lcd_get_status()” function to read the LCD controller operation status.

Register list:

LCD_STATUS

3.6 Example of Display Via IMC

In this example, use display via IMC mode to display image on LCD, the image feature is as bellows:

Image size showed in LCD: 800*480

Image source data (prepared by IMC) is as follows:

- Alpha blending (layer 0 and 1A/1B/1C are all opaque)
- Transparent color (transparent color for layer 0 is blue, for layer 1X is red)
- Resize: no
- Mirror: no
- Layer to be show: Layer 0, layer 1A, 1B and 1C, layer 2A and 2B, layer BG
- Gamma adjustment: no
- Gain offset for layer 2A and 2B: no offset, use default value for gain setting

Note:

More details about IMC feature and function please refer to the EMMA Mobile 1 IMC user's manual and application note.

Figure 3-11 Picture Display in local bus via IMC

3.6.1 Operation Flow

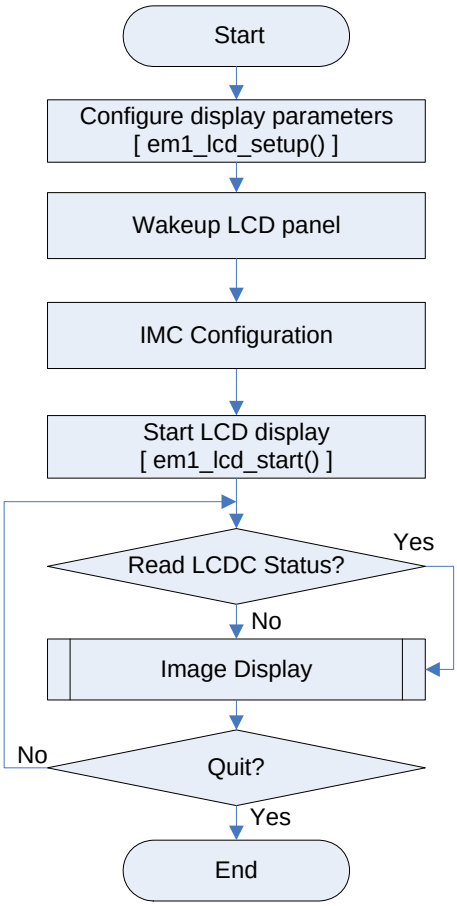

Figure 3-12 Black Bace Dispaly Operation Flow

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

3.6.2 Operation Detail

(1) Configure Display Parameters

Configure display parameters including: control register setting, display registers setting, frame buffer related registers setting, access bus select register setting and interrupt configuration:

Step1: LCD control configuration. Include the output format, and signals polarity setting.

Register list:

LCD_CONTROL = 0x10 (output format is RGB565, CLKPOL— rising edge, HPOL and VPOL—positive edge, ENPOL— high)

Setp2: LCD display configuration.

For display area setting:

LCD_HAREA = 800

LCD_VAREA = 480

For direction total signal setting:

LCD_HTOTAL = 811

LCD_VTOTAL = 488

For synchronous signal edge position setting:

LCD_HEDGE1 = 6

LCD_HEDGE2 = 7

LCD_VEDGE1 = 3

LCD_VEDGE2 = 4

Note:

All display parameters that configured in this step are related to the LCD panel input signal timing, please refer to the “figure3-5 LCD Panel Input signal timing chart” and “table 3-1 LCD Panel Input Signal Timing Characteristics” when setting the display parameters.

Step3: Access bus select:

Register list:

LCD_BUSSEL = 0x00 (Local bus without WB)

Note:

In this example, LCD work in local bus without WB display mode, if the LCD work in local bus + WB mode, then the write back registers also need to be configured. The related WB configures registers is as follows:

LCD_AREAADR

LCD_HOFFSET

LCD_IFORMAT

Setp4: interrupt setting

Register list:

LCD_ INTFFCLR = 0x1F (clear all the interrupt source)

LCD_INTENSET = 0x1F (enable all the interrupt)

(2) Wakeup LCD Panel

After configure LCD controller, use SPI interface to wakeup the LCD panel, more details about LCD panel wakeup operation please refer to the "**chapter 4.4 SETTING OF THE INTERNAL REGISTER**" of the LCD panel user's manual.

(3) IMC Configuration

In this step, configure the IMC, set the IMC work mode to be LCD-synchronous.

Step1: reset setting

ASMU_ RESETREQ0 [17]; (0: reset; 1: cancel reset)

ASMU_ RESETREQ0ENA[17]; (0: disable setting; 1: enable setting)

Step2: clock setting

ASMU_GCLKCTRL0ENA[19:18] (0: disable setting; 1: enable setting)

ASMU_GCLKCTRL0[19:18] (0: close clock; 1: open clock)

ASMU_AHBCLKCTRL0[22] (0: Disables automatic control ; 1: Enables automatic control)

ASMU_APBCLKCTRL0[15] (0: Disables automatic control ; 1: Enables automatic control)

Step3: layer format registers setting.

Register list:

IMC_L0_FORMAT = 1 (RGB565)

IMC_L1X_FORMAT = 1 (RGB565)

IMC_L2A_FORMAT = 2 (YUV422 interleave)

IMC_L2B_FORMAT = 2 (YUV422 interleave)

IMC_BG_ FORMAT = 3 (fixed background color which set by LCD_BACKCOLOR)

Step4: Address addition value registers setting.

Register list:

IMC_L0_OFFSET = 168*2

IMC_L1X_OFFSET = 100*2

IMC_L2A_OFFSET = 100*2

IMC_L2B_OFFSET = 560*2

IMC_BG_OFFSET ignored

Setp5: Buffer start address registers setting.

Register list:

IMC_L0_FRAMEADR = 0x31000000

IMC_L1A_FRAMEADR = 0x31010D10

IMC_L1B_FRAMEADR = 0x31015B30

IMC_L1C_FRAMEADR = 0x3101A950

IMC_L2A_FRAMEADR_YP = 0x3101F770

IMC_L2B_FRAMEADR_YP = 0x31024590

Others ignored

Step6: Layer display position registers setting.

Register list:

IMC_L0_POSITION = (140 << 16) | 270

IMC_L1A_POSITION = (0 << 16) | 40

IMC_L1B_POSITION = (0 << 16) | 250

IMC_L1C_POSITION = (0 << 16) | 660

IMC_L2A_POSITION = (230 << 16) | 400

IMC_L2B_POSITION = (430 << 16) | 100

Step7: Layer display size registers setting

Register list:

IMC_L0_SIZE = (205 << 16) | 100

IMC_L1A_SIZE = (100 << 16) | 100

IMC_L1B_SIZE = (100 << 16) | 100

IMC_L1C_SIZE = (100 << 16) | 100

IMC_L2A_SIZE = (100 << 16) | 100

IMC_L2B_SIZE = (46 << 16) | 560

Step8: Layer 2 double buffer control registers setting

Register list:

IMC_L2A_BUFSEL = 2 (control via CPU)

IMC_L2B_BUFSEL = 2 (control via CPU)

IMC_CPUBUFSEL = 0 (use P buffer)

Step9: Layer 2 byte lane registers setting

Register list:

IMC_L2A_BYTELANE = 0x0000E4E4

IMC_L2B_BYTELANE = 0x0000E4E4

Step10: Mirror flip control registers setting.

Register list:

IMC_L2A_MIRROR = 0 (no flip)

IMC_L2B_MIRROR = 0

IMC_MIRROR = 0

Step11: Resize setting

Register list:

IMC_L0_RESIZE = 0 (no resize)

IMC_L1X_ RESIZE = 0

IMC_L2A_RESIZE = 0
IMC_L2B_ RESIZE = 0
IMC_BG_ RESIZE = 0

Step12: Transparent color setting

Register list:

IMC_L0_KEYENABLE = 1
IMC_L1A_KEYENABLE = 1
IMC_L1B_KEYENABLE = 1
IMC_L1C_KEYENABLE = 1
IMC_L0_KEYCOLOR = 0x0000003F (blue)
IMC_L1X_KEYCOLOR = 0x003F0000 (red)

Step13: Alpha blending setting

Register list:

IMC_L0_ALPHA = 63 (opaque)
IMC_L1A_ ALPHA = 63
IMC_L1B_ ALPHA = 63
IMC_L1C_ ALPHA = 63

Step14: YUV-RGB conversion setting

Register list:

IMC_YUV2RGB [8] = 1 (perform dithering)
IMC_YUV2RGB [1:0] = 0 or 1 (standard coefficient)
IMC_YGAINOFFSET = 0x0080 (default value)
IMC_UGAINOFFSET = 0x0080
IMC_VGAINOFFSET = 0x0080

Step15: Gamma adjustment setting

Register list:

IMC_GAMMA_EN = 0x00 (disable gamma adjustment)

Step16: Select the layers to be synthesized

Register list:

IMC_L0_CONTROL = 1 (select to show)
IMC_L1A_CONTROL = 1
IMC_L1B_CONTROL = 1
IMC_L1C_CONTROL = 1
IMC_L2A_CONTROL = 1
IMC_L2B_CONTROL = 1

Step17: Basic operation setting,

IMC_CONTROL = 0 (LCD-synchronous startup mode)

Step18: Refresh configuration

IMC_REFREASH = 1

Note:

More details about IMC configuration please refer to the EMMA Mobile 1 IMC application note.

(4) Start LCD Display

Call “em1_lcd_start()” function to start display.

Register list:

LCD_ LCDOUT = 1

(5) Read LCDC Status

Call “em1_lcd_get_status()” function to read the LCD controller operation status.

Register list:

LCD_STATUS

APPENDIX A LCD Driver Function

A.1 Function List

The following table shows the LCD driver interface functions:

Table A-1 LCD Driver Function List

Class	Function Name	Function Detail
External function	em1_lcd_init	LCD controller initialization
	em1_lcd_setup	Display parameters setting
	em1_lcd_start	Start LCD display
	em1_lcd_stop	Stop LCD display
	em1_lcd_get_status	Get the LCD controller status

A.2 Global Variable Define

None

A.3 Structure Define

Table A-2 Structure Define

Structure Name	Detail
LCD_SETUP_ST	Display parameters setting structure

A.3.1 LCD_SETUP_ST

Table A-3 Structure of LCD_SETUP_ST

Member	Detail
uint control	LCD control setting
uint Qos	simple Qos setting
uint data_req	set the frequency at which data is loaded from frame buffer
uint bussel	select display mode
uint back_color	fixed-value color for lcd panel
uint area_addr	display area address register
uint hoffset	Set the total bytes of the frame buffer area in the horizontal direction
uint iformat	input image format
uint h_total	Set clock number in the horizontal direction
uint h_area	Set pixle number in the horizontal direction
uint h_edge1	Set the first edge position of a horizontal
uint h_edge2	Set the second edge position of a horizontal
uint v_total	Set clock number in the vertical direction
uint v_area	Set pixle number in the vertical direction
uint v_edge1	Set the first edge position of a vertical
uint v_edge2	Set the second edge position of a vertical

A.4 Function Details

A.4.1 LCDC Initialization Function

[Function Name]

em1_lcd _init

[Format]

void em1_lcd _init (void);

[Argument]

None

[Function Return]

None

[Flow Chart]

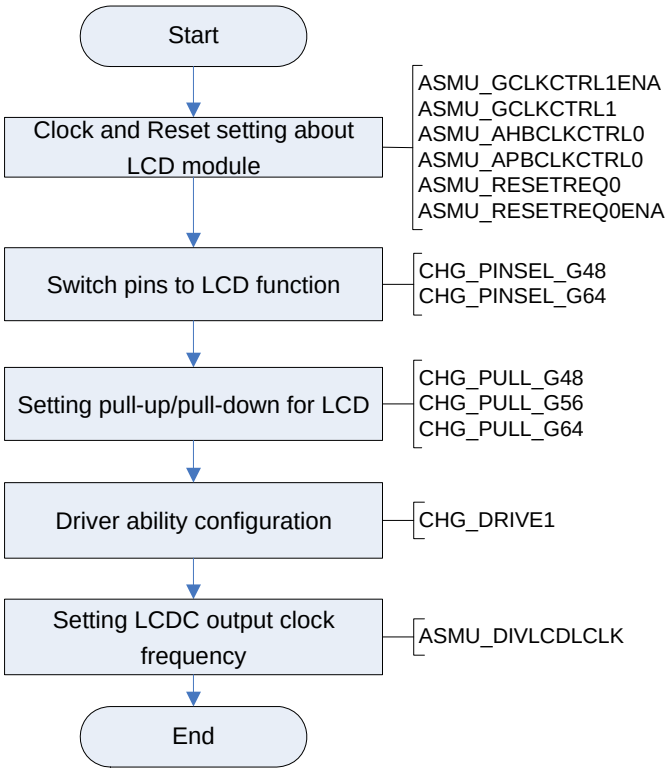

Figure A-1 LCD Controller Initialization

[Note]

None

A.4.2 Display Parameters Setting

[Function Name]

em1_lcd_setup

[Format]

void em1_lcd_setup(LCD_SETUP_ST * lcd_display);

[Argument]

Parameter	Type	I/O	Detail
lcd_display	LCD_SETUP_ST *	I	LCD display paramters setting sturcture

[Function Return]

None

[Flow Chart]

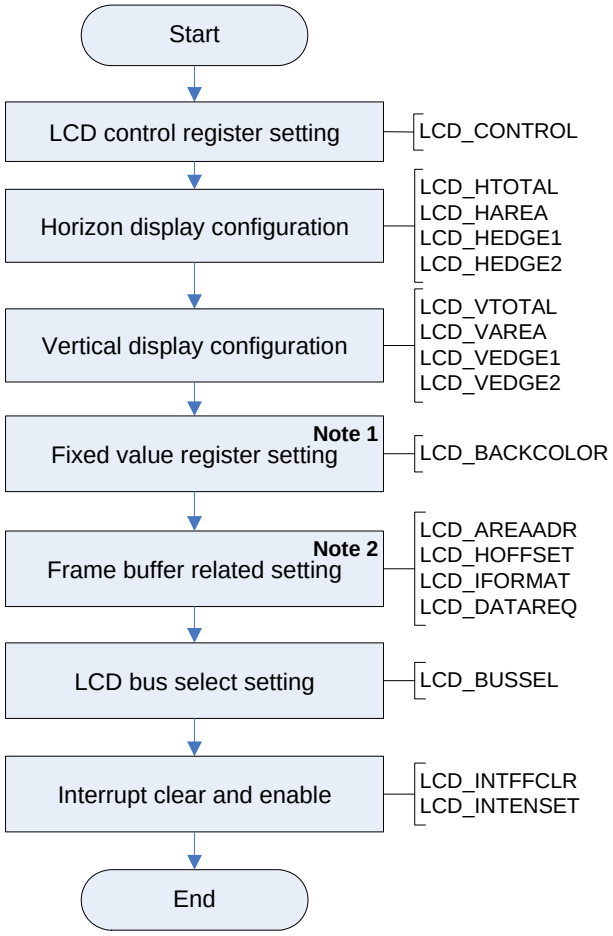

Figure A-2 LCDC Display Configuration

[Note]

1) “Fixed value register setting” only used in fixed-value display mode.

2) “Frame buffer related setting” only used in direct path display mode(display via MEMC).

A.4.3 Start Display

[Function Name]

em1_lcd_start

[Format]

void em1_lcd_start(void);

[Argument]

None.

[Function Return]

None.

[Flow Chart]

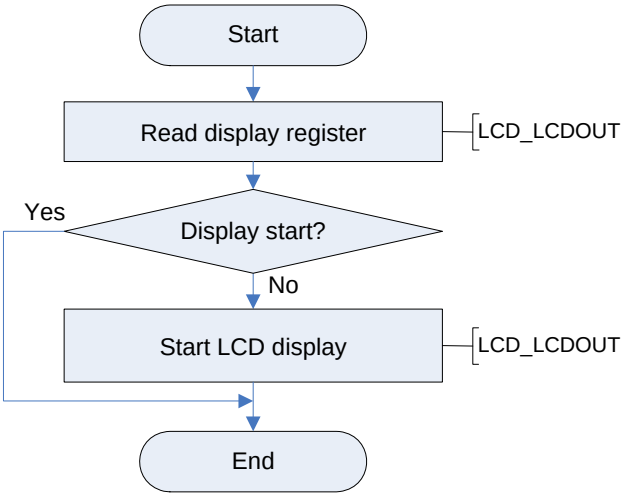

Figure A-3 Start Display

[Note]

None.

A.4.4 Stop Display

[Function Name]

em1_lcd_stop

[Format]

void em1_lcd_stop(void);

[Argument]

None.

[Function Return]

None.

[Flow Chart]

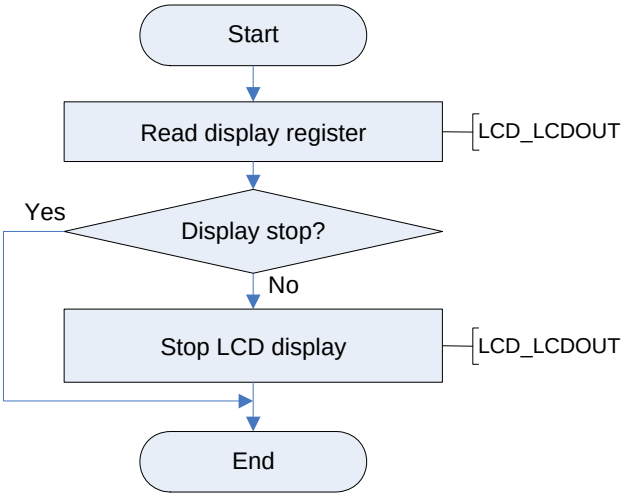

Figure A-4 Stop Display

[Note]

None

A.4.5 Read LCD Controller Status

[Function Name]

em1_ lcd_get_status

[Format]

int em1_lcd_get_status(void);

[Argument]

None.

[Function Return]

LCDC status

[Flow Chart]

None.

[Note]

Read status register: LCD_STATUS.

ANNEX Modification History

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