To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

SH7764 Group

LCD Controller TFT-LCD Interfacing Example

Introduction

This application note shows the TFT-LCD interfacing example using the SH7764 Microcontrollers (MCUs) on-chip LCD Controller (LCDC).

Target Device

SH7764 (R0K507764E001BR from Renesas Technology Corp.)

Contents

1. Preface

1.1 Specifications

The SH7764 MCU on-chip LCD controller (LCDC) is connected with a TFT-LCD panel to display the graphic image.

1.2 Module Used

- LCD controller (LCDC)
- General-purpose I/O ports (GPIO)

1.3 Applicable Conditions

- MCU: SH7764
- Operating frequency:
  - CPU clock: 324 MHz
  - SuperHyway clock: 108 MHz
  - Peripheral clock: 54 MHz
  - Bus clock: 108 MHz
- Integrated development environment
  from Renesas Technology Corp.
- C compiler: SuperH RISC Engine Family C/C++ Compiler Package Ver.9.03 Release00
  from Renesas Technology Corp.
- Compiler options: Default settings of the High-performance Embedded Workshop
  -cpu=sh4a -endian=little -include="$(WORKSPDIR)\inc"
  -object="$(CONFIGDIR)\$(FILELEAF).obj" -debug -optimize=0
  -gbr=auto -chgincpath -errorpath
  -global_volatile=0 -opt_range=all -infinite_loop=0
  -del_vacant_loop=0 -struct_alloc=1 –nologo

1.4 Related Application Note

Refer to the related application notes as follows:

- SH7764 Group Application Note: SH7764 Example of Initialization (REJ06B0919)

2. Description of the Sample Application

This application note shows the pin connection example and configuration example to display the graphic image by the LCDC. The specifications of the TFT-LCD panel used in this application note are shown in 2.2.

2.1 LCDC Operation

2.1.1 Overview

A unified memory architecture is adopted for the LCD controller (LCDC) so that the image data for display is stored in system memory. The LCDC module reads data from system memory, uses the palette memory to determine the colors, then puts the display on the LCD panel. It is possible to connect the LCDC to the LCD module* other than microcomputer bus interface types and NTSC/PAL types and those that apply the LVDS interface.

Note: * LCD module can be connected to the LVDS interface by using the LSI with LVDS conversion LSI.

2.1.2 Features

Table 1 lists the LCDC features. Figure 1 shows a block diagram of LCDC.

Table 1 LCDC Features

Item	Function
Panel interface	Serial interface method
Type of LCD	STN/dual-STN/TFT panels
Panel data formats	8/12/16/18-bit bus width
Color modes	4/8/15/16-bpp
Grayscale modes	1/2/4/6-bpp
Panel sizes	16 × 1 to 1024 × 1024 dots
Color palette	24-bit
Display in neutral colors for STN/DSTN panels	24-bit space-modulation FRC with 8-bit RGB values for reduced flicker
VRAM	A certain area of the synchronous DRAM (CS1 or CS2) is used as VRAM.
Line buffer	2.4-kbyte
Signal polarity	Programmable
Data formats	The endian of bytes is set. A packed pixel method is available.
Interrupt	An interrupt can be generated at a user-specified position.

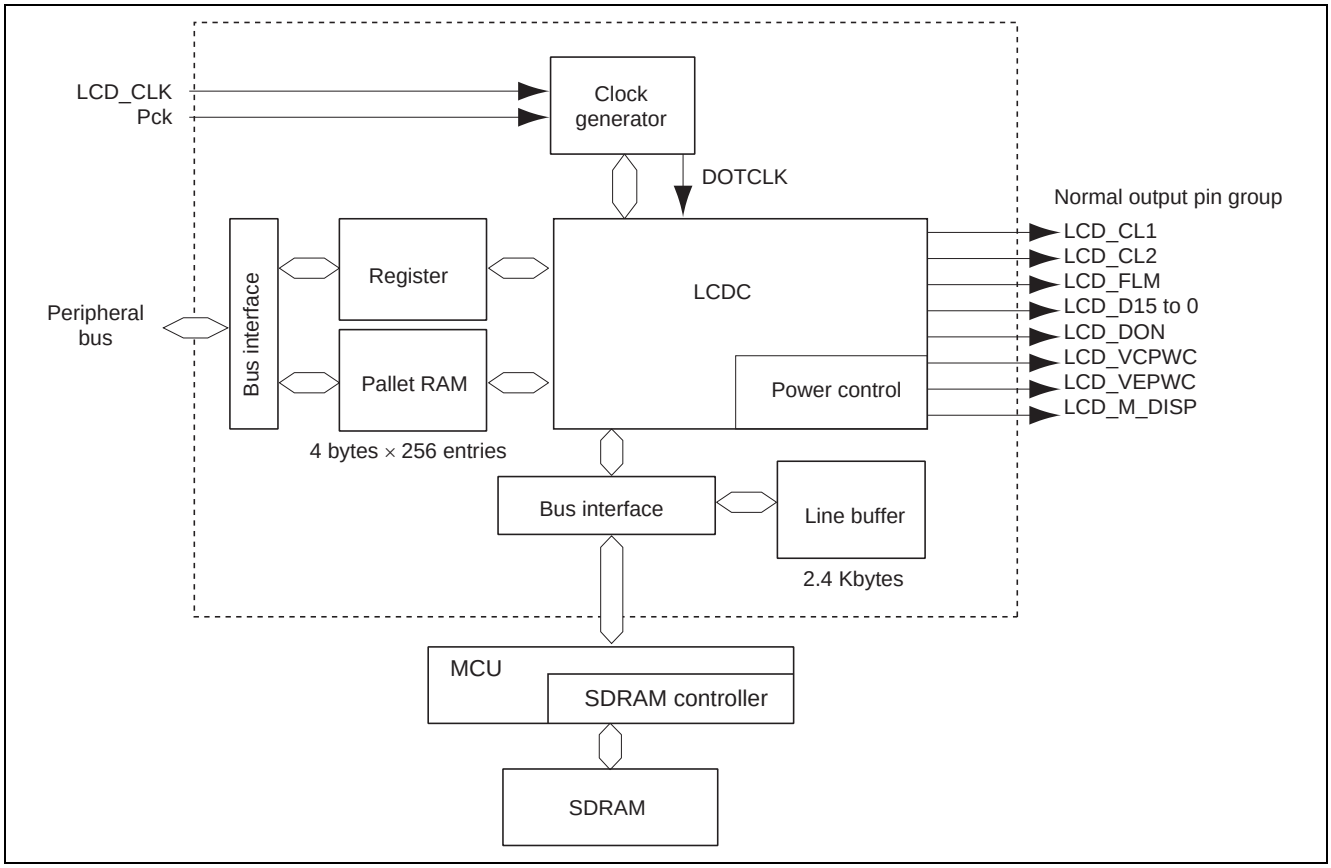


Figure 1 LCDC Block Diagram

2.1.3 I/O Pins

Table 2 lists the LCDC I/O pins.

Table 2 LCDC I/O Pins

Pin Name	I/O	Function
LCD_D15 to 0	Output	Data for LCD panel
LCD_DON	Output	Display-on signal (DON)
LCD_CL1	Output	Shift-clock 1 (STN/DSTN)/horizontal sync signal (HSYNC)
LCD_CL2	Output	Shift-clock 2 (STN/DSTN)/dot clock (DOTCLK)
LCD_M_DISP	Output	LCD current-alternating signal/DISP signal
LCD_FLM	Output	First line marker/vertical sync signal (VSYNC) (TFT)
LCD_VCPWC	Output	LCD-module power control (VCC)
LCD_VEPWC	Output	LCD-module power control (VEE)
LCD_CLK	Input	LCD clock-source input

2.1.4 LCD Module Sizes which can be Displayed

This LCDC is capable of controlling displays with up to 1024 × 1024 dots and 16 bpp (bits per pixel). The image data for display is stored in VRAM, which is shared with the CPU. This LCDC should read the data from VRAM before display.

This LSI has a maximum 16-burst (32-bit bus width) memory read operation and a 2.4-Kbyte line buffer, so although a complete breakdown of the display is unlikely, there may be some problems with the display depending on the combination. A recommended size at the frame rate of 60 Hz is 320 × 240 dots in 16 bpp or 640 × 480 dots in 8 bpp.

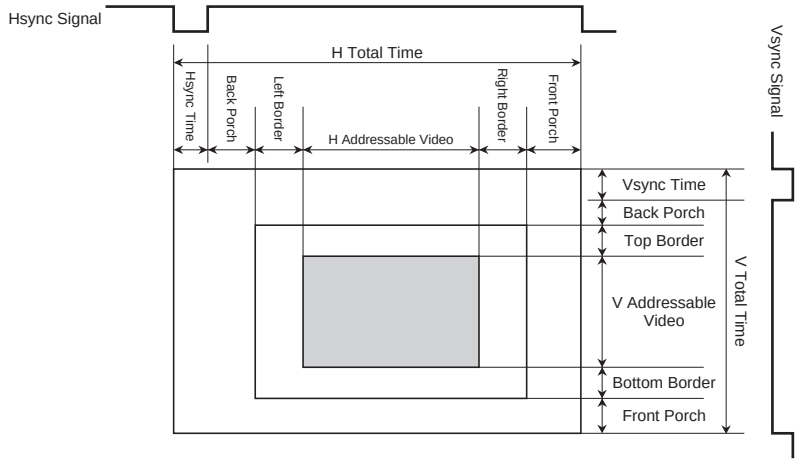
As a rough standard, the bus occupation ratio shown below should not exceed 40%. The overhead coefficient becomes 2.000 when the CL2 SDRAM is connected to a 32-bit data bus and 1.825 when connected to a 64-bit data bus. The each value is ideal value under the best condition.

$$\text{Bus occupation ratio (\%)} = \frac{\text{Overhead coefficient} \times \text{Total number of display pixels ((HDCN + 1)} \times 8 \times \text{(VDLN + 1))} \times \text{Frame rate (Hz)} \times \text{Number of colors (bpp)}}{\text{CLKOUT (Hz)} \times \text{Bus width (= 32 bits)}} \times 100$$

Example) Total number of display pixels = H480 × V640, Frame rate = 60 Hz,
Number of colors 16 bits, Overhead coefficient = 2.00, Bus clock = 108 MHz

$$\text{Bus occupation ratio} = \frac{2.00 \times 480 \times 640 \times 60 \times 16}{108 \times 10^6 \times 32} \times 100 = 17.06\%$$

Figure 2 shows the valid display and the retrace period.



Active Video = Top/ Left Border + Addressable Video + Bottom/ Right Border
Total H Blank = Hsync Time + Back Porch + Front Porch
Total V Blank = Vsync Time + Back Porch + Front Porch

HTCN = H Total Time
HDCN = H Addressable Video
HSYNP = H Addressable Video + Right Border + Front Porch
HSYNW = Hsync Time

VTLN = V Total Time
CDLN = V Addressable Video
VSYNP = V Addressable Video + Bottom Border + Front Porch
VSYNW = Vsync Time

Figure 2 Valid Display and the Retrace Period

2.1.5 Color Palette

Color palette registers are not set in the sample application. If a color palette is to be used, please refer to the *SH7764 Group Hardware Manual* (REJ09B0360). It gives an outline in this section.

This LCDC has a color palette which outputs 24 bits of data per entry and is able to simultaneously hold 256 entries. The color palette thus allows the simultaneous display of 256 colors chosen from among 16-M colors.

The procedure below may be used to set up color palettes at any time.

1. The PALEN bit in the LDPALCR is 0 (initial value); normal display operation
2. Access LDPALCR and set the PALEN bit to 1; enter color-palette setting mode after three cycles of peripheral clock.
3. Access LDPALCR and confirm that the PALS bit is 1.
4. Access LDPR00 to LDPRFF and write the required values to the PALD00 to PALDFF bits.
5. Access LDPALCR and clear the PALEN bit to 0; return to normal display mode after a cycle of peripheral clock.

Figure 3 shows the data format for a color-palette entry.

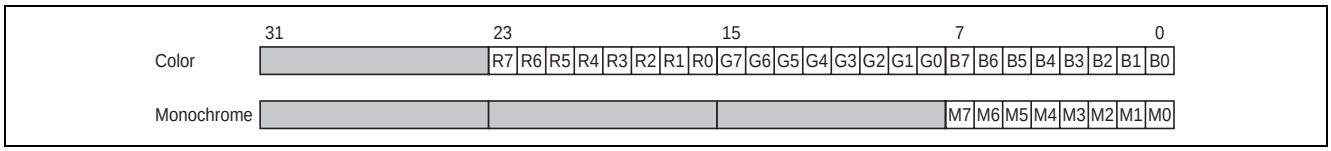


Figure 3 Data Format for Color-Palette Entry

2.1.6 Clock and LCD Data Signal Example

Figure 4 shows the LCD data signal example.

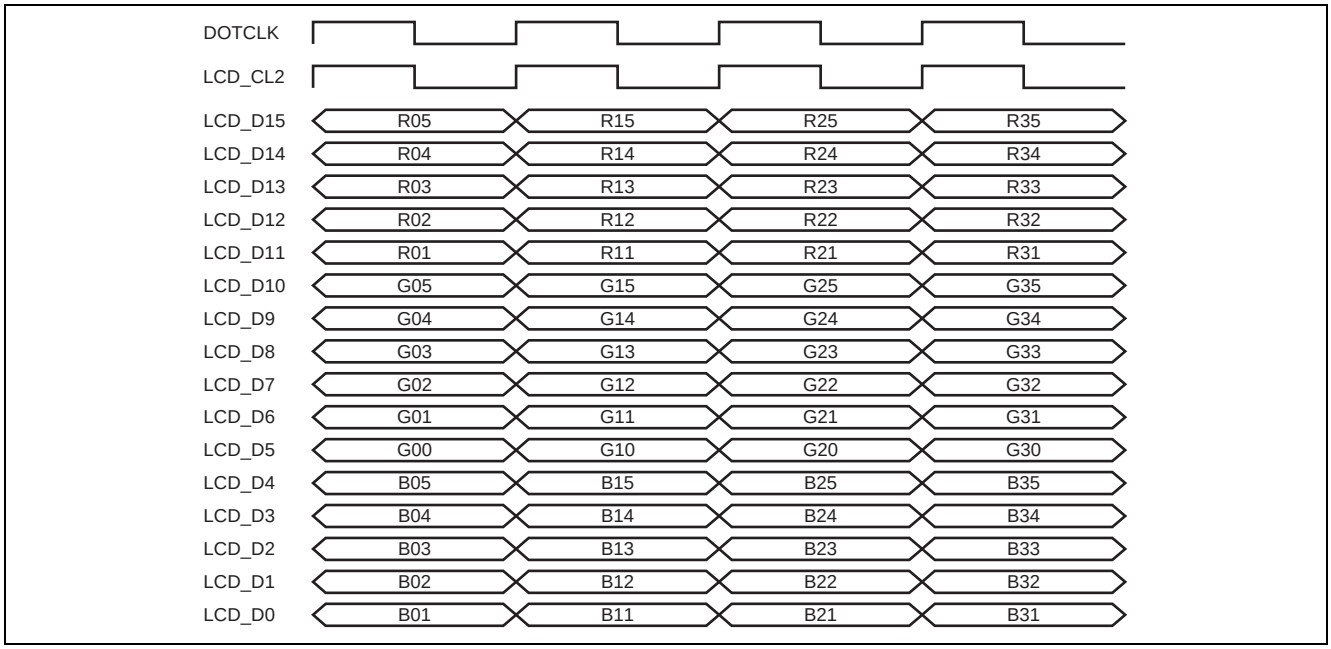


Figure 4 Clock and LCD Data Signal Example (TFT Color 16-Bit Data Bus Module)

2.1.7 Power-Supply Control Sequence

An LCD module normally requires a specific sequence for processing to do with the cutoff of the input power supply. Settings in LDPMMR, LDPSPR, and LDCNTR, in conjunction with the LCD power-supply control pins (LCD_VCPWC, LCD_VEPWC, and LCD_DON), are used to provide processing of power-supply control sequences that suits the requirements of the LCD module.

If LCD module power-supply control-sequence processing is in use by the LCDC or the supply of power is cut off while the LCDC is in its display-on mode, normal operation is not guaranteed. In the worst case, the connected LCD module may be damaged.

Figures 5 is timing charts that show outlines of power-supply control sequences and table 3 is a summary of available power-supply control sequence periods.

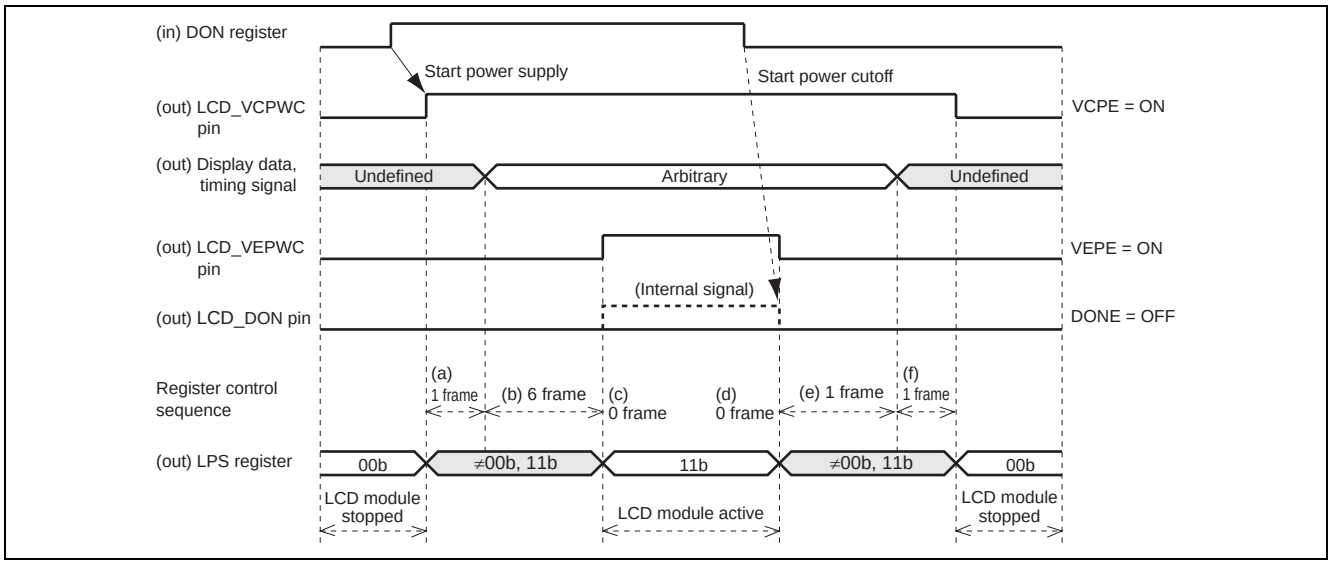


Figure 5 Power-Supply Control Sequence and States of the LCD Module

Table 3 Available Power-Supply Control-Sequence Periods at Typical Frame Rates

	Frame Rate	
ONX, OFFX Register Value	**120 Hz**	**60 Hz**
H'F	(–1+1)/120 = 0.00 (ms)	(–1+1)/60 = 0.00 (ms)
H'0	(0+1)/120 = 8.33 (ms)	(0+1)60 = 16.67 (ms)
H'1	(1+1)/120 = 16.67 (ms)	(1+1)/60 = 33.33 (ms)
H'2	(2+1)/120 = 25.00 (ms)	(2+1)/60 = 50.00 (ms)
.	.	.
.	.	.
.	.	.
H'D	(13+1)/120 = 116.67 (ms)	(13+1)/60 = 233.33 (ms)
H'E	(14+1)/120 = 125.00 (ms)	(14+1)/60 = 250.00 (ms)

2.2 TFT-LCD Panel Specifications

Table 4 lists the specification of the TFT-LCD panel to use in this application. The specifications of the TFT-LCD panel used for this application note (LS037V7DW01, manufactured by Sharp Corporation) are listed in the table below. As detailed specifications differ with the TFT-LCD panel, be sure to check the data sheet for the product you will be using.

2.2.1 General Specifications

Table 4 lists the general specifications of the TFT-LCD panel to use in this application.

Table 4 TFT-LCD Panel General Specifications (Excerpt from Datasheet)

Item	Specifications
Resolution	VGA or QVGA
Number of pixels	H 480 × V 640 (Number of dots: H (480 × 3) × V 640)
Pixel configuration	R, G, B vertical stripes
Number of colors	260,000 colors
Input signal	CMOS RGB (6 bits each digital)

2.2.2 Pin Functions

Table 5 lists the pin functions of the TFT-LCD panel used in this application.

Table 5 TFT-LCD Panel Pin Functions (Excerpt from Datasheet)

Symbol	Description
RESB	Reset signal
INI	Power-on control
DEN	Display-on signal
HSYNC	Horizontal sync signal
VSYNC	Vertical sync signal
CLKIN	Dot clock
R5-0	Red data signal (MSB: R5)
G5-0	Green data signal (MSB: G5)
B5-0	Blue data signal (MSB: B5)

2.2.3 Interface Timing

Figure 6 and figure 7 shows the interface timing of the TFT-LCD panel used in this application. Table 6 lists the timing characteristics.

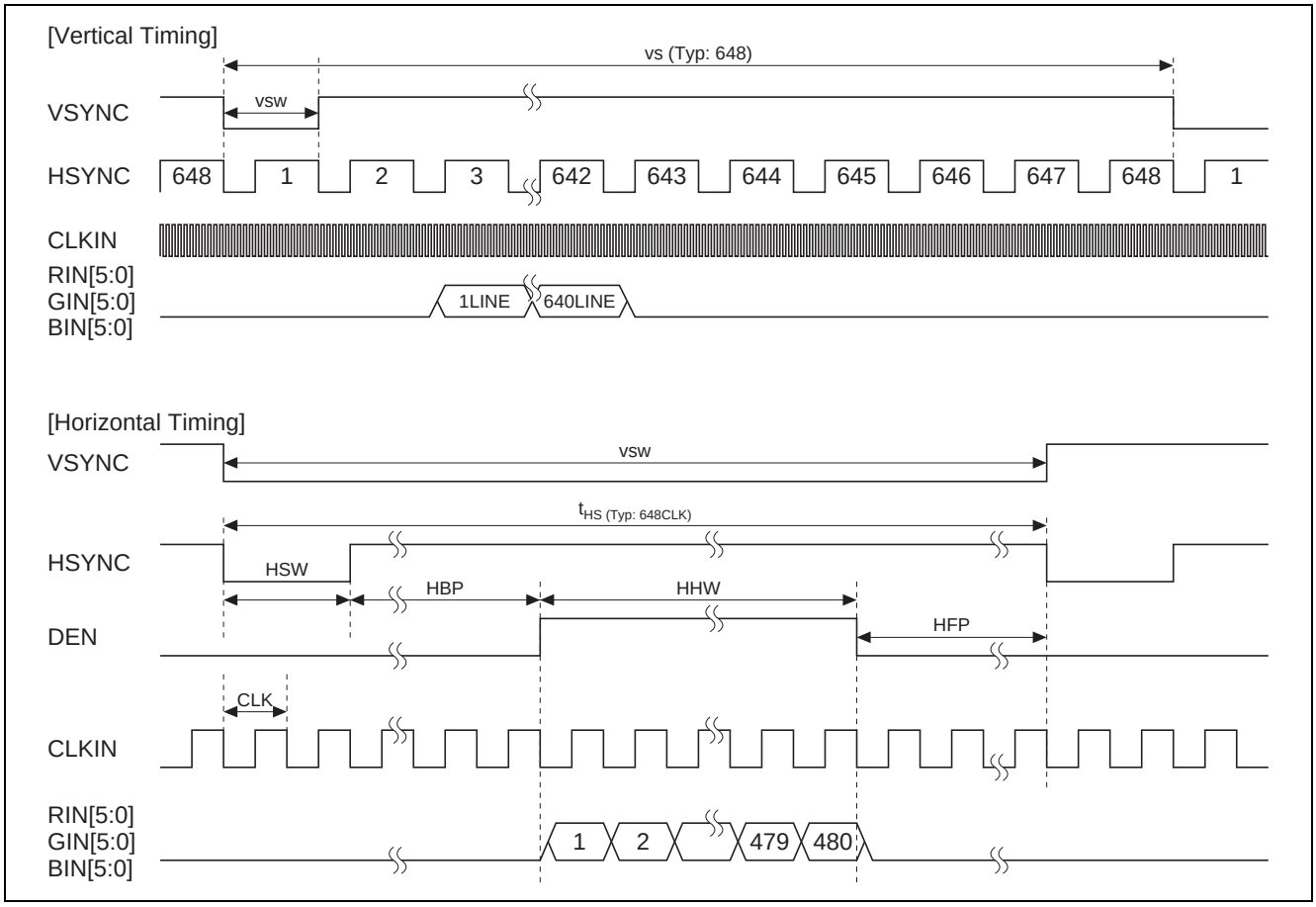


Figure 6 TFT-LCD Panel Interface Timing Example (Excerpt from Datasheet)

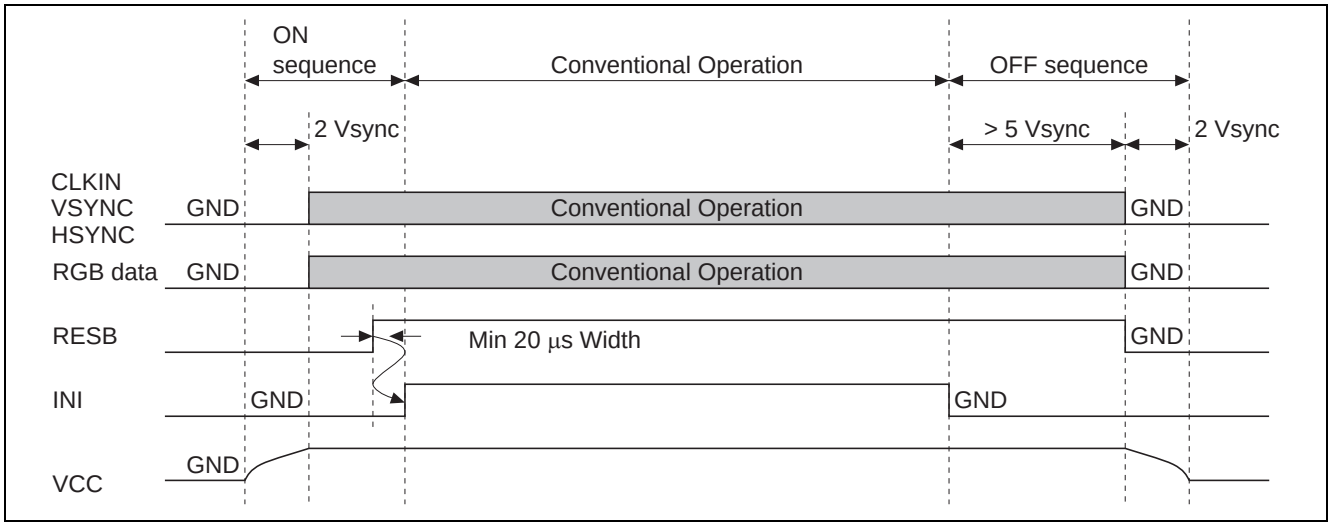


Figure 7 TFT-LCD Panel Power-Supply Sequence (Excerpt from Datasheet)

Table 6 TFT-LCD Panel Timing Characteristics (Excerpt from Datasheet)

Item		MODE	Symbol	Min	Typ	Max	Unit
CLK	Cycle time	VGA	t_{CLK}	38	39.7	41.7	ns
		QVGA		152	158.8	167	
Hsync	Cycle time	VGA	t_{HS}	—	648	—	CLK
		QVGA		—	324	—	
	Valid width		t_{HSW}	—	2	—	
Vsync	Cycle time	VGA	t_{VS}	—	648	—	HCYC
		QVGA		—	324	—	
	Valid width		t_{VSW}	—	1	—	
DEN	Horizontal back porch time	VGA	t_{HBP}	28	78	166	t_{CLK}
		QVGA		14	38	82	
	Horizontal front porch time	VGA	t_{HFP}	0	88	138	t_{CLK}
		QVGA		0	44	68	
	Valid width		t_{HHW}	—	480	—	t_{CLK}

2.3 TFT-LCD Panel Circuit Example

2.3.1 Pin Connection Example

Figure 8 shows the TFT-LCD panel hardware connection in this application.

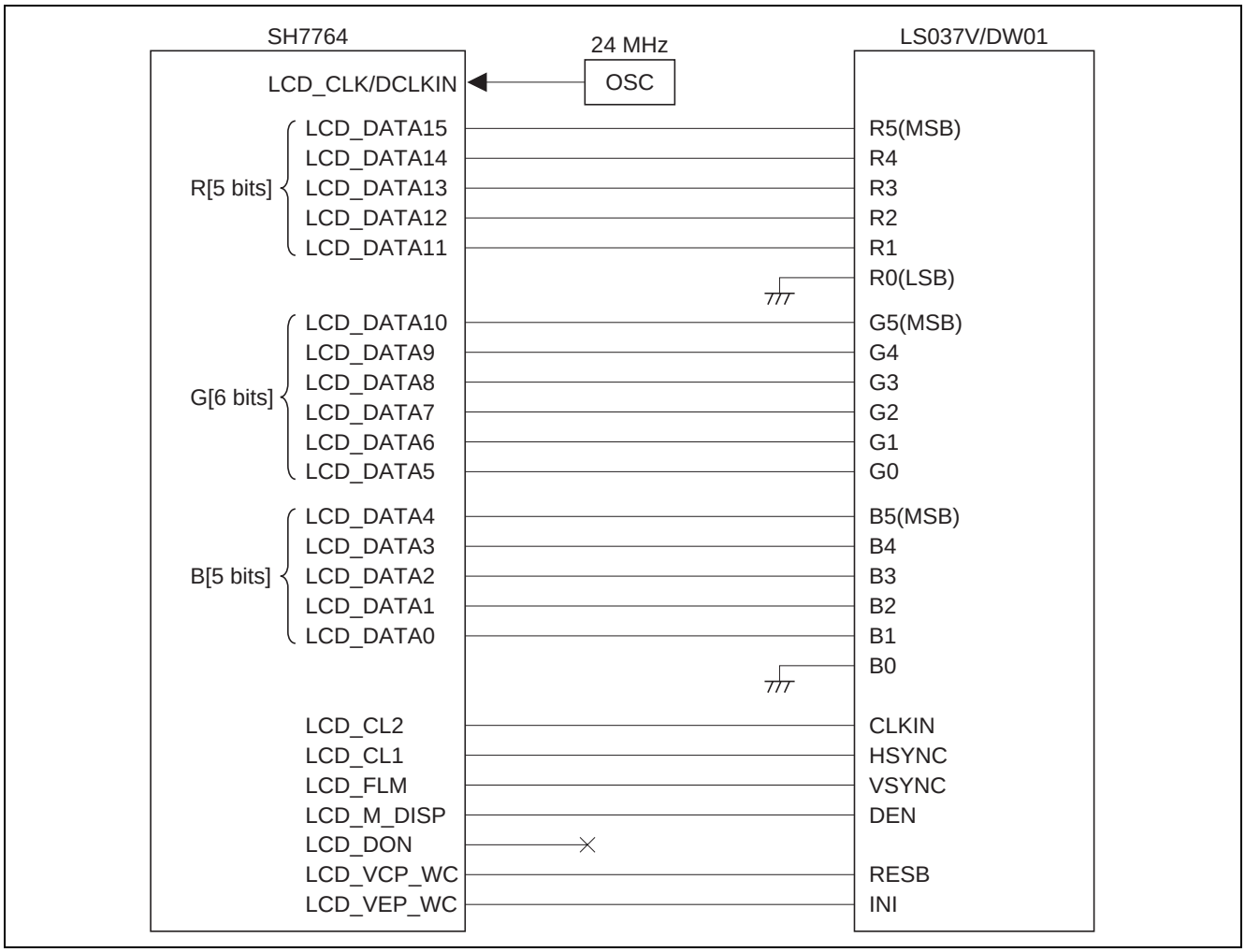


Figure 8 TFT-LCD Panel Hardware Connection

2.4 Sample Program Specifications

This section describes the specifications of the sample program and shows the flow chart of each processing.

2.4.1 Specifications

- Outputs the graphic image to the VGA size (V 480 x H 640) TFT-LCD panel.
- Red, green, and blue bars are displayed on the panel.

2.4.2 Main Flow Chart of the Sample Program

Figure 9 shows the main flow chart of the sample program. Initialization of the LCDC by the sample program is shown in figures 10 to 12, and the display is turned on after execution of the processing shown in figure 13. After graphics have been displayed on the TFT-LCD panel over a certain period, the display is turned off following execution of the processing shown in figure 14.

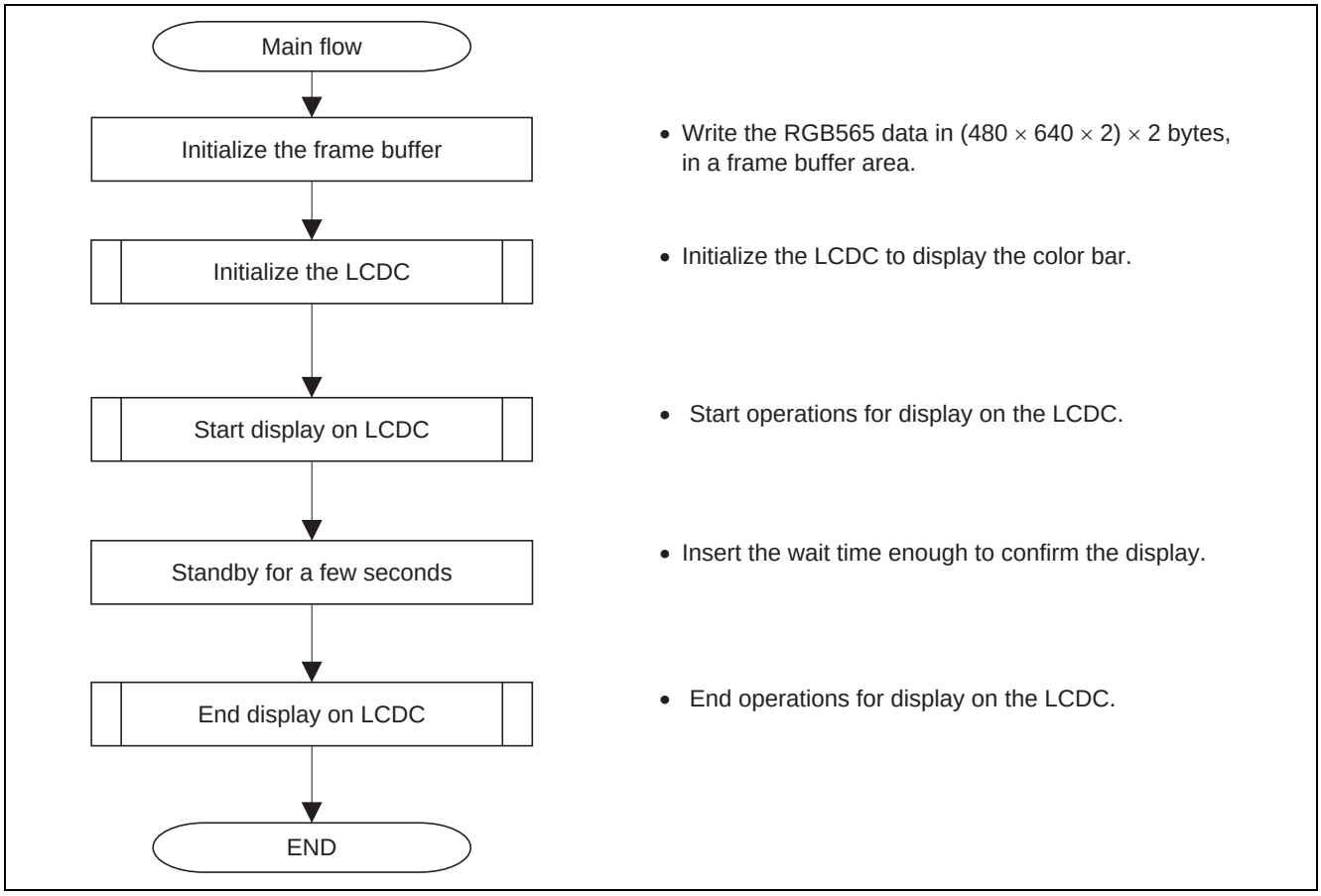


Figure 9 Sample Program Main Flow

2.4.3 Initialization of the LCDC

Figure 10 shows the flow for initialization of the LCDC.

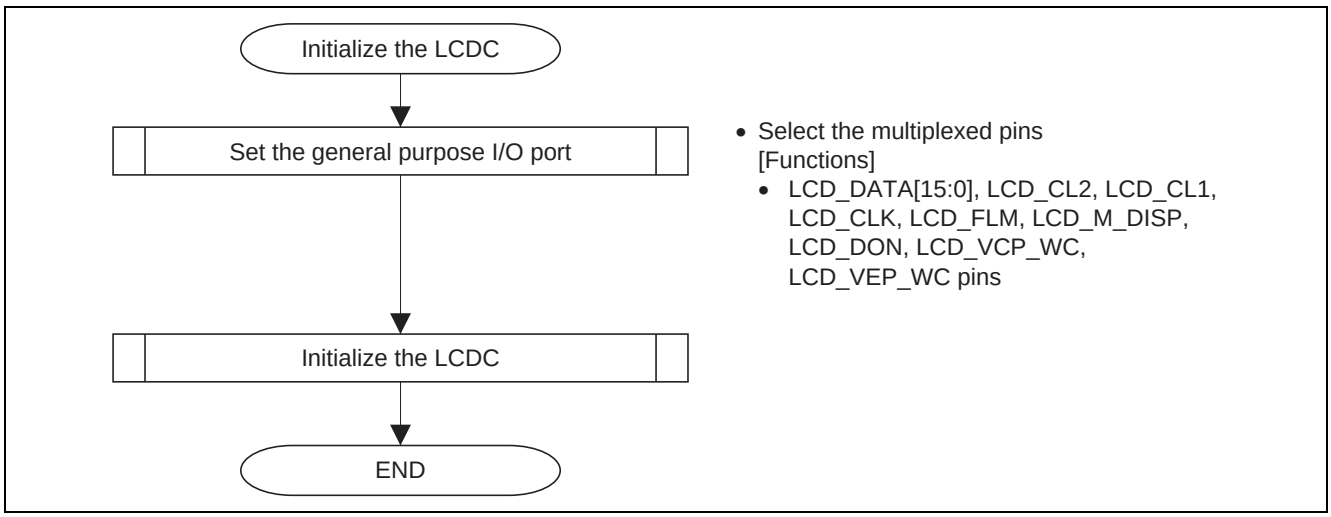


Figure 10 Flow for Initialization of the LCDC

2.4.4 Setting the LCDC

Figure 11 and figure 12 show the setting examples of the LCDC. Follow this procedure to set the control signal output for the TFT-LCD panel. Values listed in figure 11 and figure 12 are set according to the TFT-LCD panel specifications described in section 2.2.

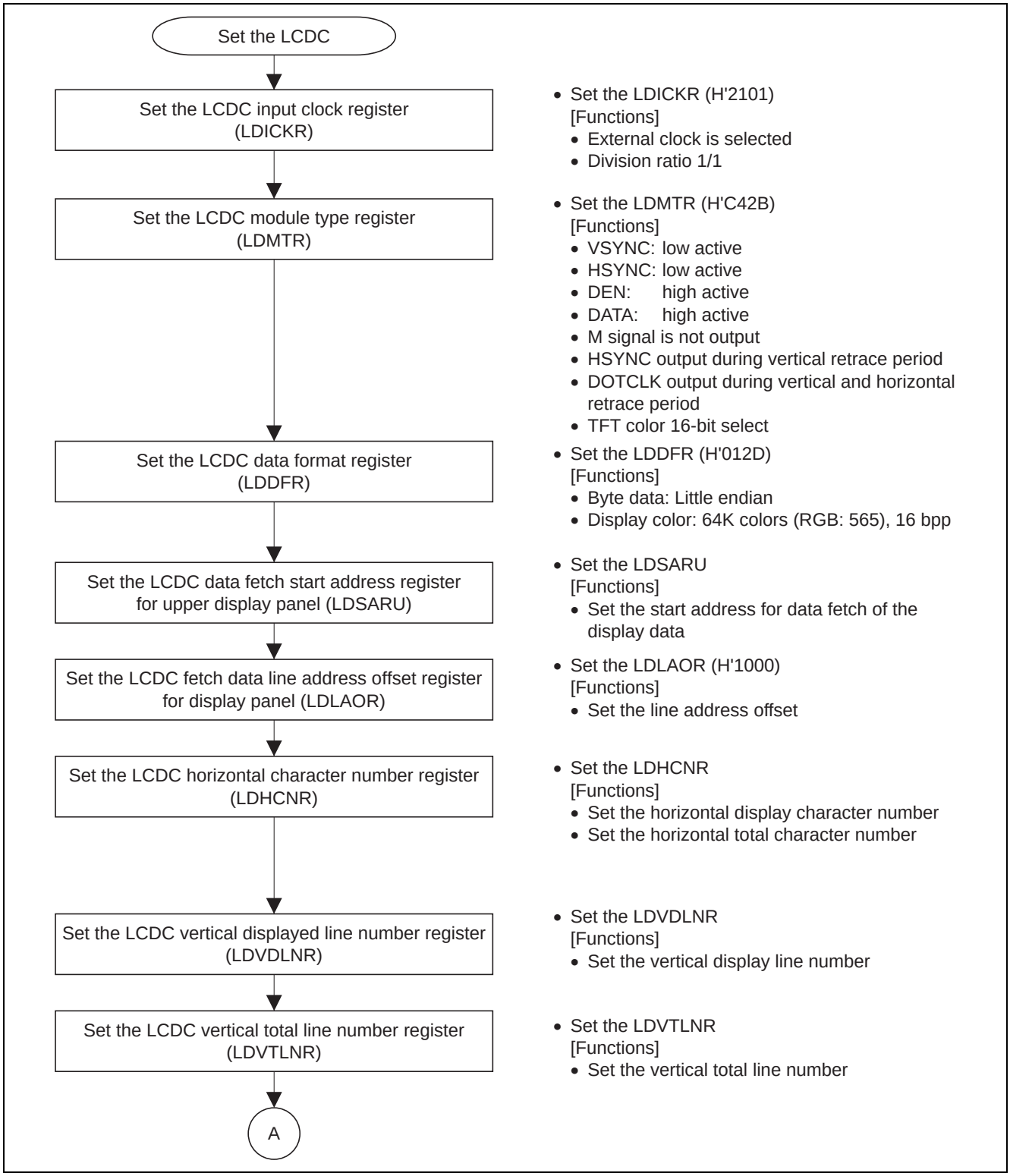


Figure 11 Setting Examples of the LCDC (1)

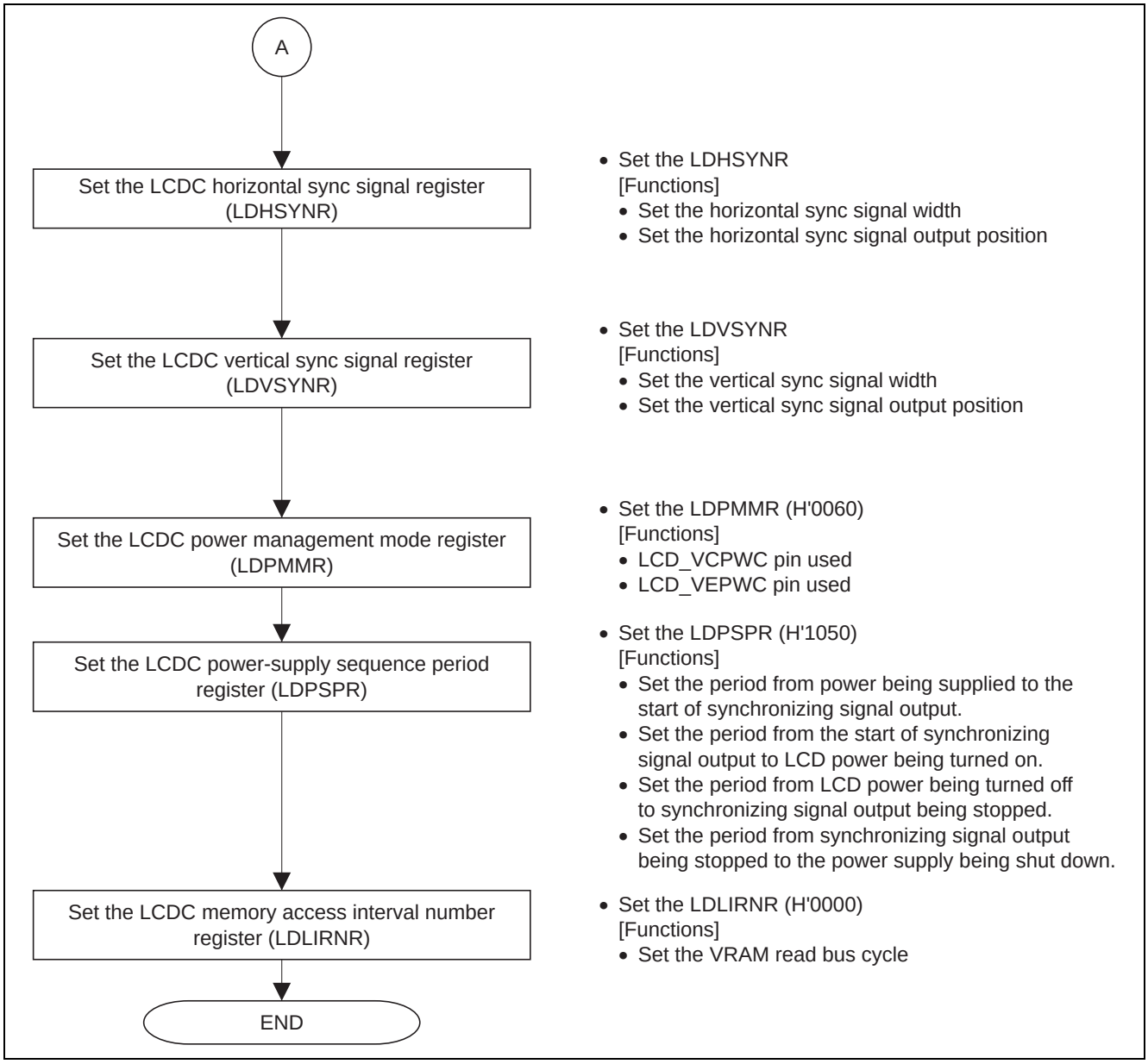


Figure 12 Setting Examples of the LCDC (2)

2.4.5 Setting the LCDC Starts Display and LCDC Stops Display

Figure 13 shows the setting example of the LCDC starts display, and figure 14 shows the setting example of the LCDC stops display.

When 1s are written to the DON2 bit and the DON bit, the LCDC starts display. When 0 is written to the DON bit, the LCDC stops display.

When display starts or ends, LCDC operation must be in accord with the power-control sequences specified in section 2.4.4, Setting the LCDC. The DON bit must not be manipulated until the given sequence is complete.

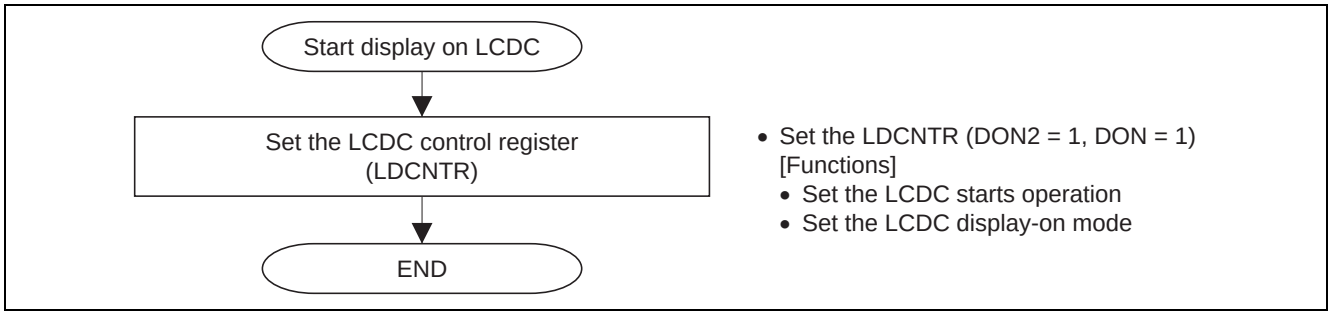


Figure 13 Setting Examples of the Start of LCDC Display

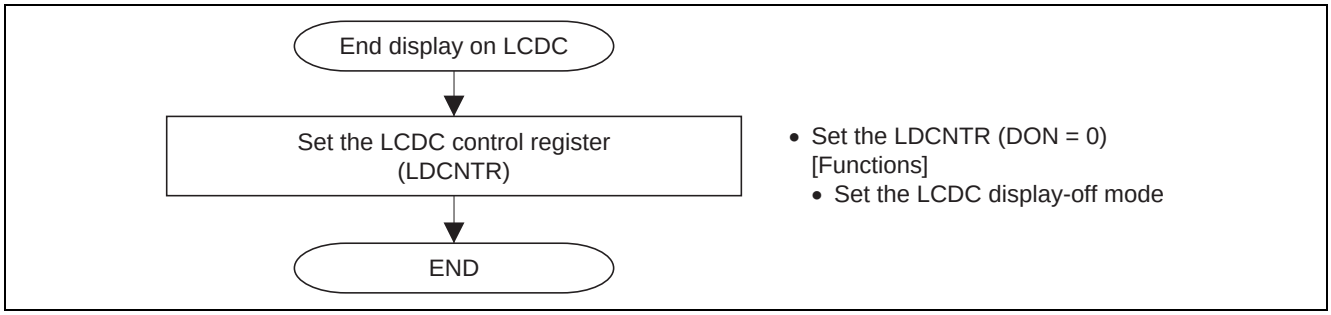


Figure 14 Setting Examples of the Stop of LCDC Display

3. Sample Program "lcdc.c"

3.1 Listings of Sample Program "Macro definition"

```
1     /*""FILE COMMENT""*********** Technical reference data ************************
2     *
3     *       System Name : SH7764 Sample Program
4     *       File Name   : lcdc.c
5     *       Abstract    : VDC2 TFT-LCD Panel Display Example
6     *       Version     : 1.00.00
7     *       Device      : SH7764
8     *       Tool-Chain  : High-performance Embedded Workshop (Ver.4.05.01).
9     *                   : C/C++ compiler package for the SuperH RISC engine family
10    *                   :                              (Ver.9.03 Release00).
11    *       OS          : none
12    *       H/W Platform: R0K507764E001BR
13    *       Disclaimer  :
14    *                     <Note>
15    *                     This sample program is provided only as a reference and
16    *                     its operation is not guaranteed.
17    *                     Use this sample program as a technical reference when
18    *                     developing software.
19    *
20    *       The information described here may contain technical inaccuracies or
21    *       typographical errors. Renesas Technology Corporation and Renesas Solutions
22    *       assume no responsibility for any damage, liability, or other loss rising
23    *       from these inaccuracies or errors.
24    *
25    *       Copyright (C) 2009 Renesas Technology Corp. All Rights Reserved
26    *       AND Renesas Solutions Corp. All Rights Reserved
27    *
28    *       History     : June.01,2009 Ver.1.00.00
29    *""FILE COMMENT END""*************************************************************/
30    #include "iodefine.h"
31
32    /* ==== Macro definition ==== */
33    /* ---- TFT panel display module ---- */
34    #define      TFT_TOTAL_CLOCK    648     /* Width including the blanking interval       */
35    #define      TFT_TOTAL_LINE     648     /* Height including the blanking interval      */
36    #define      TFT_PANEL_CLOCK    480     /* Number of pixels in horizontal direction        */
37    #define      TFT_PANEL_LINE     640     /* Number of pixels in vertical direction        */
38    #define      TFT_H_FRONT_PORCH  88      /* Horizontal front porch      */
39    #define      TFT_HSYNC_START    (TFT_PANEL_CLOCK + TFT_H_FRONT_PORCH)
40                                        /* Display start position in horizontal direction  */
41    #define      TFT_HSYNC_WIDTH    8       /* Hsync pulse width (min = 8 dots) */
42    #define      TFT_VSYNC_WIDTH    1       /* Vsync pulse width */
43    #define      LINE_OFFSET        2048    /* Line offset */
44
45    /* ==== Function prototype declaration ==== */
46    void lcdc_main(void);
47    void lcdc_initial(void);
48    void lcdc_port_set(void);
49    void lcdc_control_initial(void);
50    void lcdc_enable(void);
51    void lcdc_disable(void);
52    void fill_rect(unsigned int x, unsigned int y,
53        unsigned int w, unsigned int h, unsigned short color,
54        unsigned int base_address, unsigned int line_offset);
55    void delay(void);
56
57    /* ==== Variable definition ==== */
58    #pragma section _LCDC_FRAME_BUFFER /* Places on a 512-byte boundary in the cache disabled area */
59    unsigned short frame_buffer[TFT_PANEL_CLOCK][TFT_PANEL_LINE];
60    #pragma section
```

3.2 Listings of Sample Program "Display main"

```
/*""FUNC COMMENT""*****************************************************************
 * ID          :
 * Outline     : Display main
 *-------------------------------------------------------------------------------
 * Include     :
 *-------------------------------------------------------------------------------
 * Declaration : void lcdc_main(void);
 *-------------------------------------------------------------------------------
 * Function    :
 *-------------------------------------------------------------------------------
 * Argument    : void
 *-------------------------------------------------------------------------------
 * Return Value: void
 *""FUNC COMMENT END""*************************************************************/
void lcdc_main(void)
{
    /* ---- Initializes the frame buffer ---- */
    fill_rect(0,0,TFT_PANEL_CLOCK / 3,TFT_PANEL_LINE,0xF800,
     (unsigned int)frame_buffer,LINE_OFFSET);
    fill_rect(TFT_PANEL_CLOCK / 3,0,(TFT_PANEL_CLOCK / 3) * 2,TFT_PANEL_LINE,0x07E0,
     (unsigned int)frame_buffer,LINE_OFFSET);
    fill_rect((TFT_PANEL_CLOCK / 3) * 2,0,TFT_PANEL_CLOCK,TFT_PANEL_LINE,0x001F,
     (unsigned int)frame_buffer,LINE_OFFSET);
      /* Draws a color bar in the frame buffer */

    /* ---- Initializes the LCDC module ---- */
    lcdc_initial();

    /* ---- Outputs the color bar on the TFT-LCD ---- */
    lcdc_enable();
    delay(); /* Waits for several seconds */
    lcdc_disable();
}
```

3.3 Listings of Sample Program "LCDC initialization"

```
94    /*""FUNC COMMENT""*****************************************************************
95     * ID          :
96     * Outline     : LCDC initialization
97     *-------------------------------------------------------------------------------
98     * Include     :
99     *-------------------------------------------------------------------------------
100    * Declaration : void lcdc_initial(void);
101    *-------------------------------------------------------------------------------
102    * Function    :
103    *-------------------------------------------------------------------------------
104    * Argument    : void
105    *-------------------------------------------------------------------------------
106    * Return Value: void
107    *""FUNC COMMENT END""*************************************************************/
108   void lcdc_initial(void)
109   {
110       lcdc_port_set();     /* I/O pin setting */
111       lcdc_control_initial(); /* LCDC setting */
112   }
```

3.4 Listings of Sample Program "I/O pin setting"

```
/*""FUNC COMMENT""*****************************************************************
 * ID          :
 * Outline     : I/O pin setting
 *-------------------------------------------------------------------------------
 * Include     :
 *-------------------------------------------------------------------------------
 * Declaration : void lcdc_port_set(void);
 *-------------------------------------------------------------------------------
 * Function    : Sets I/O pins for the LCDC.
 *-------------------------------------------------------------------------------
 * Argument    : void
 *-------------------------------------------------------------------------------
 * Return Value: void
 *""FUNC COMMENT END""*************************************************************/
void lcdc_port_set(void)
{
    /* ---- LCD_DATA15,14,13,12,11,10,9,8 ---- */
    GPIO.PTSEL_G.WORD = 0x0000;

    /* ---- LCD_CL2,LCD_DON,LCD_VCP_WC,LCD_VEP_WC ---- */
    GPIO.PTSEL_H.BIT._PTSEL_H3 = GPIO.PTSEL_H.BIT._PTSEL_H2 =
    GPIO.PTSEL_H.BIT._PTSEL_H1 =GPIO.PTSEL_H.BIT._PTSEL_H0 = 0;

    /* ---- LCD_DATA7,6,5,4,3,2,1 ---- */
    GPIO.PTSEL_I.WORD = 0x0000;

    /* ---- LCD_DATA0,LCD_CL1,LCD_CLK,LCD_FLM,LCD_M_DISP --- */
    GPIO.PTSEL_K.BIT._PTSEL_K4 = GPIO.PTSEL_K.BIT._PTSEL_K3 =
    GPIO.PTSEL_K.BIT._PTSEL_K2 = GPIO.PTSEL_K.BIT._PTSEL_K1 =
    GPIO.PTSEL_K.BIT._PTSEL_K0 = 0;
}
```

3.5 Listings of Sample Program "LCDC initialization"

```
/*""FUNC COMMENT""*****************************************************************
 * ID          :
 * Outline     : LCDC initialization
 *-----------------------------------------------------------------------------
 * Include     :
 *-----------------------------------------------------------------------------
 * Declaration : void lcdc_control_initial(void);
 *-----------------------------------------------------------------------------
 * Function    : Initializes the LCDC.
 *-----------------------------------------------------------------------------
 * Argument    : void
 *-----------------------------------------------------------------------------
 * Return Value: void
 *""FUNC COMMENT END""*************************************************************/
void lcdc_control_initial(void)
{
    /* ---- Clock selection and divider setting ---- */
    LCDC.LDICKR.WORD = 0x2101;
      /* bit13:12(ICKSEL)=01 uses LCD_CLK (external pin) */
      /* bit5:0(DCDR)=000001 divider 1/1 */

    /* ---- Pin polarity selection ---- */
    LCDC.LDMTR.WORD = 0xC42B;
      /* bit15(FLMPOL)=1        Vsync is "L" active */
      /* bit14(CL1POL)=1        Hsync is "L" active */
      /* bit13(DISPPOL)=0           DEN is "H" active */
      /* bit12(DPOL)=0          DATA is "H" active */
      /* bit10(MCNT)=1          M signal is not output */
      /* bit9(CL1CNT)=0         Hsync is output during the vertical interval */
      /* bit8(CL2CNT)=0         DotCLK is output during the vertical interval */
      /* bit5:0(MIFTYP)=101011  TFT color-16bit */

    /* ---- Data format setting ---- */
    LCDC.LDDFR.WORD = 0x012D;
      /* bit8(PABD)=1           Little endian */
      /* bit6:0(DSPCOLOR)=0101101 64k-Color RGB:5-6-5 */

    /* Setting for reading images from external memory ---- */
    LCDC.LDSARU = (unsigned long *)frame_buffer;

    /* ---- Line offset setting ----*/
    LCDC.LDLAOR = LINE_OFFSET * sizeof(short);

    /* ---- Settings of the horizontal display character and the total number of characters ---- */
    LCDC.LDHCNR.BIT._HDCN = (TFT_PANEL_CLOCK / 8) - 1;
    LCDC.LDHCNR.BIT._HTCN = (TFT_TOTAL_CLOCK / 8) - 1;

    /* ---- Settings of the vertical display line and the total number of lines ---- */
    LCDC.LDVDLNR.BIT._VDLN = TFT_PANEL_LINE - 1;
    LCDC.LDVTLNR.BIT._VTLN = TFT_TOTAL_LINE - 1;

    /* ---- Horizontal/vertical sync signal timing settings ---- */
    LCDC.LDHSYNR.BIT._HSYNW = (TFT_HSYNC_WIDTH / 8) - 1;
    LCDC.LDHSYNR.BIT._HSYNP = (TFT_HSYNC_START / 8) - 1;
    LCDC.LDVSYNR.BIT._VSYNW = TFT_VSYNC_WIDTH - 1;
    LCDC.LDVSYNR.BIT._VSYNP = (TFT_TOTAL_LINE - TFT_VSYNC_WIDTH) - 2;

    /* ---- Power control pin setting ---- */
    LCDC.LDPMMR.WORD = 0x0060;
      /* bit[6](VCPE) = 1       uses the LCD_VCPWC pin */
      /* bit[5](VEPE) = 1           uses the LCD_VEPWC pin */
```

```
205       LCDC.LDPSPR.WORD = 0x1050;
206         /* bit[15:12](ONA) = 0001  Power-on to start of the sync signal (33.33ms) */
207         /* bit[11:8](ONB) = 0000   Start of the sync signal to LCD power-on (16.67ms) */
208         /* bit[7:4](OFFE) = 0101   LCD power-off to end of the sync signal (100ms) */
209         /* bit[3:0](OFFF) = 0000   End of the sync signal to power-off (16.67ms) */
210
211       /* ---- VRAM read clock cycle interval setting ---- */
212       LCDC.LDLIRNR.WORD = 0x0000;
213   }
```

3.6 Listings of Sample Program "Start LCDC display operation, Stop LCDC display operation"

```
/*""FUNC COMMENT""*************************************************************
 * ID          :
 * Outline     : Start LCDC display operation
 *-----------------------------------------------------------------------------
 * Include     :
 *-----------------------------------------------------------------------------
 * Declaration : void lcdc_enable(void);
 *-----------------------------------------------------------------------------
 * Function    : Starts the display operation.
 *-----------------------------------------------------------------------------
 * Argument    : void
 *-----------------------------------------------------------------------------
 * Return Value: void
 *""FUNC COMMENT END""*********************************************************/
void lcdc_enable(void)
{
    /* ---- Starts the LCDC display operation ---- */
    LCDC.LDCNTR.BIT._DON2 = 1;
    LCDC.LDCNTR.BIT._DON = 1;
      /* bit[4](DON2) = 1 Starts the LCDC display operation */
      /* bit[0](DON)  = 1 Display-on mode */
}

/*""FUNC COMMENT""*************************************************************
 * ID          :
 * Outline     : Stop LCDC display operation
 *-----------------------------------------------------------------------------
 * Include     :
 *-----------------------------------------------------------------------------
 * Declaration : void lcdc_disable(void);
 *-----------------------------------------------------------------------------
 * Function    : Stops the display operation.
 *-----------------------------------------------------------------------------
 * Argument    : void
 *-----------------------------------------------------------------------------
 * Return Value: void
 *""FUNC COMMENT END""*********************************************************/
void lcdc_disable(void)
{
    /* ---- Stops the LCDC display operation ---- */
    LCDC.LDCNTR.BIT._DON = 0;
      /* bit[0](DON)  = 0 Display-off mode */
}
```

4. Documents for Reference

- Hardware Manual
  SH7764 Group Hardware Manual (REJ09B0360)
  The most up-to-date version of this document is available on the Renesas Technology Website.

- Software Manual (REJ09B0003)
  SH-4A Software Manual
  The most up-to-date version of this document is available on the Renesas Technology Website.

Website and Support

Renesas Technology Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry
csc@renesas.com

Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Sep.28.09	—	First edition issued

Notes regarding these materials

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)
5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.
8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
   (1) artificial life support devices or systems
   (2) surgical implantations
   (3) healthcare intervention (e.g., excision, administration of medication, etc.)
   (4) any other purposes that pose a direct threat to human life

   Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.
9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.