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Renesas Electronics Corporation

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H8/300H SLP Series

LCD Display Using 3-V Constant-Voltage Power Supply Circuit

Introduction

The segment type LCD controller/driver of the H8/38076R is used to perform 1/4 duty drive LCD display. The 3-V constant-voltage power supply circuit is used for the power supply to drive the LCD.

Target Device

H8/38076R

Contents

1. Specifications

- The segment type LCD controller/driver of the H8/38076R is used to perform 1/4 duty drive LCD display.
- The 3-V constant-voltage power supply circuit is used for the power supply to drive the LCD.
- A 4-common, 16-segment LCD panel is used. The frame frequency is 64 Hz.
- As the 3-V constant-voltage power supply circuit is used, a 0.1-µF capacitor is connected between the C1 pin and C2 pin, and to each of pins V1 to V3.
- An example of connection between the H8/38076R and the LCD panel is shown in figure 1.

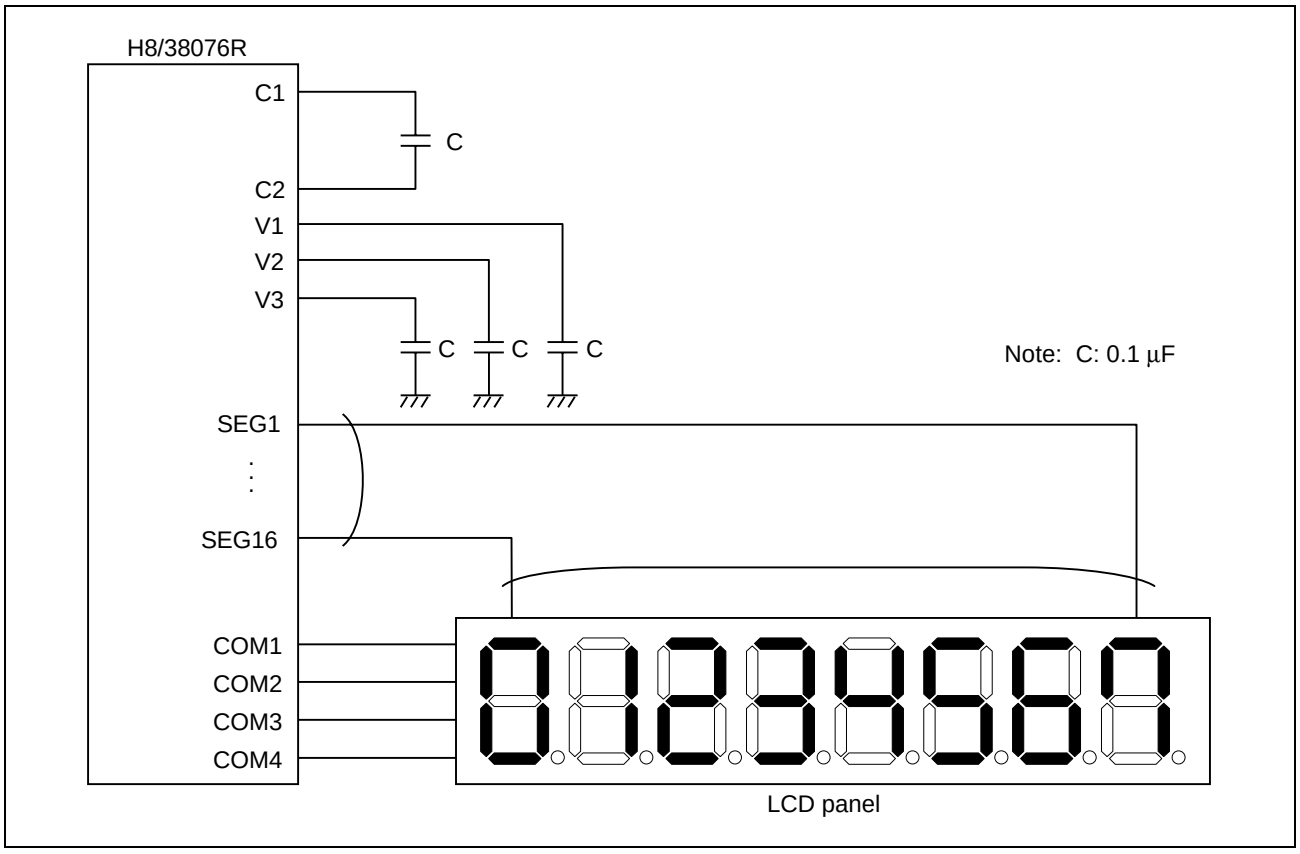


Figure 1 Example of LCD Panel Connection

2. Functions Used

2.1 LCD Controller/Driver Functions

(1) The functions of the LCD controller/driver are described below, and a block diagram of the LCD controller/driver function is shown in figure 2.

- LCD port control register (LPCR)

  LPCR is an 8-bit readable/writable register that selects duty cycle, and LCD driver and pin function selection.

- LCD control register (LCR)

  LCR is an 8-bit readable/writable register that turns on or off the power supply to drive the LCD, activates or halts display function, controls display data, and selects the frame frequency.

- LCD control register 2 (LCR2)

  LCR2 is an 8-bit readable/writable register that specifies whether the A waveform or B waveform is used as the LCD drive waveform, selects a step-up clock for use in the 3-V constant voltage power supply circuit, selects whether an LCD power-supply split resistor is disconnected or connected from or to LCD drive power supply, and turns on or off the 3-V constant-voltage power supply.

- LCD trimming register (LTRMR)

  Adjusts 3-V constant-voltage used for LCD drive power supply and trims the output voltage adjustment of 3-V constant-voltage power supply circuit.

- BGR control register (BGRMR)

  Controls whether the band-gap reference circuit (BGR) which generates the reference voltage of the 3-V constant-voltage power supply operates or halts, and adjusts the reference voltage.

- Segment output pins (SEG32 to SEG1)

  The LCD segment drive pins. All pins are programmable to be used as port pins.

- Common output pins (COM4 to COM1)

  The LCD common drive pins. Pins can be used in parallel in 1/2 duty cycle modes.

- LCD power supply pins (V1, V2, V3)

  Used when a bypass capacitor is connected externally and when an external power supply is used.

- LCD step-up capacitance pins (C1, C2)

  Capacitance pins for connecting the step-up capacitor for the power supply to drive the LCD

- LCD RAM

  Used to set display data. The relationship between LCD RAM and display segments differs according to the duty cycle. After the registers necessary for display are set, display is started automatically when data is written to the part corresponding to the duty cycle by means of an instruction in the same way as with ordinary RAM, and the display is turned on. A word or byte access by using the same kind of instruction as for ordinary RAM setting.

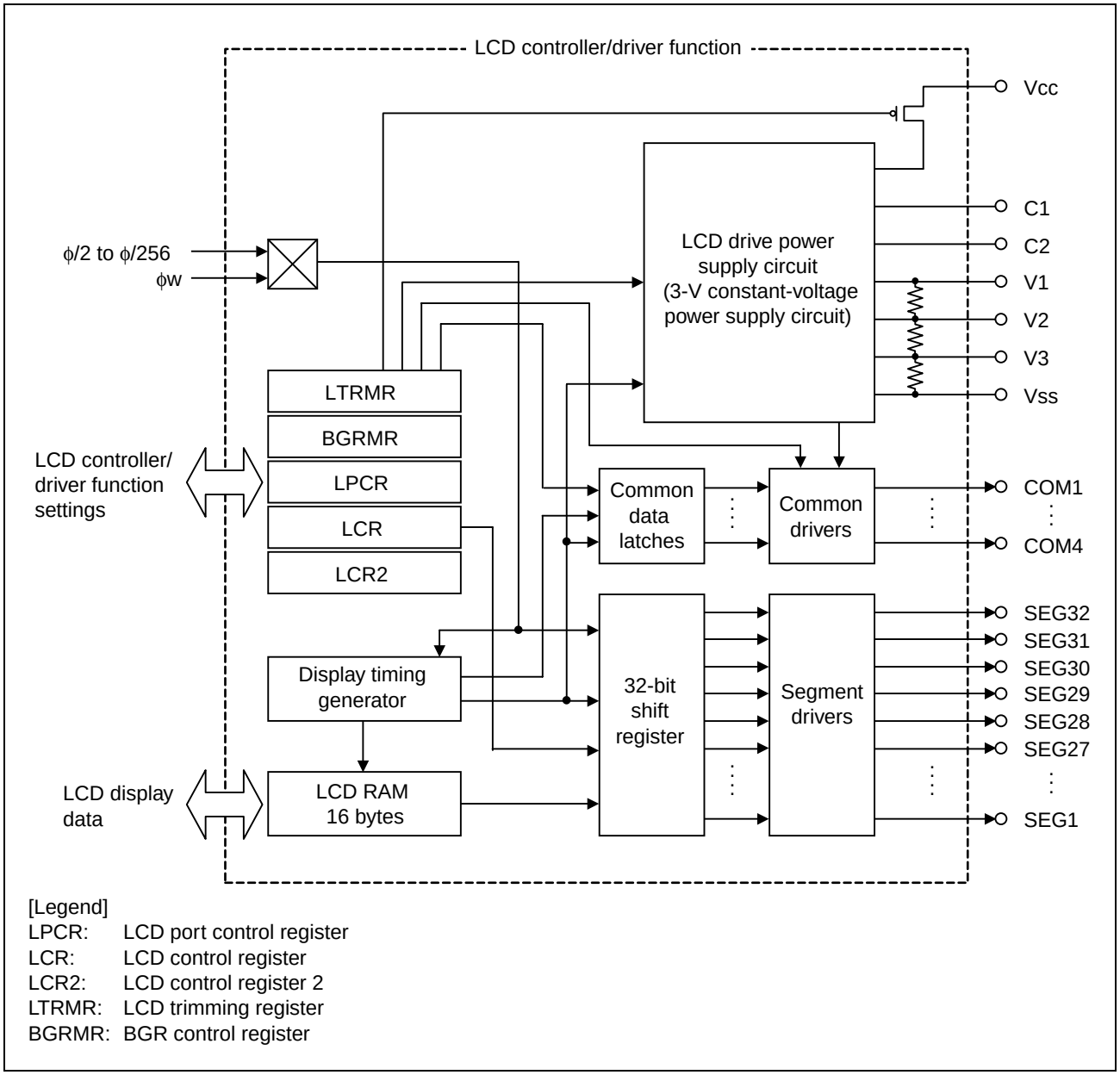


Figure 2 Block Diagram of LCD Controller/Driver

(2) The 3-V constant-voltage power supply circuit is described below.

The H8/38076R incorporates a 3-V constant-voltage power supply circuit comprising a band gap reference circuit (BGR), 3x step-up circuit, and so forth, and a 3-V constant-voltage can be used as the LCD drive power supply independently of the Vcc power supply. As shown in figure 3, when the 3-V constant-voltage power supply circuit is used, a 0.1 µF capacitor is connected between the C1 pin and C2 pin, and to each of pins V1 to V3. The setting procedure when using the 3-V constant-voltage power supply circuit is shown in figure 4.

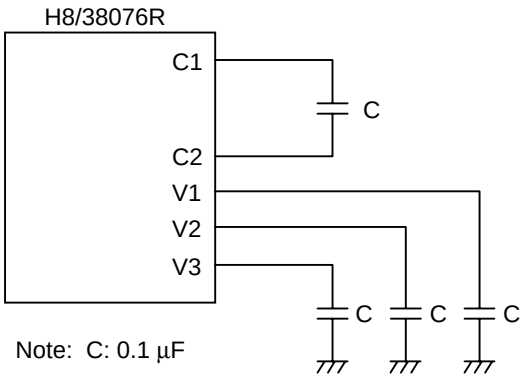


Figure 3 Connection when Using 3-V Constant-Voltage Power Supply Circuit

(1)	Select duty cycle and segment drivers by setting the bits of LPCR.
(2)	Set LCR to use or not use the LCD controller/driver function, control display data, and select the frame frequency.
(3)	Set the BGRSTPN bit in the BGR control register (BGRMR) to 1 to activate the band gap reference circuit, generating 1-V constant voltage (VLCD3) at the V3 pin.
(4)	Select the waveform to drive the LCD and 3-V constant-voltage power supply circuit step-up clock, and connect or disconnect the clock selection, and LCD power supply split-resistor by setting the bits of LCR2 and setting the SUPS bit to 1, a the 3-x step-up circuit operates, a 2-V constant voltage twice V_{LCD3} is generated at the V2 pin, and a 3-V constant voltage three times V_{LCD3} is generated at the V1 pin
(5)	LCD display is started by setting display data in LCD RAM

Figure 4 Setting Procedure when Using 3-V Constant-Voltage Power Supply Circuit

(3) The functions of the LCD controller/driver are described below. This sample task uses 1/4 duty cycles to enable display on the 8-digit LCD panel. The LCD panel segment signals and common signals used in this sample task are shown in figure 5.

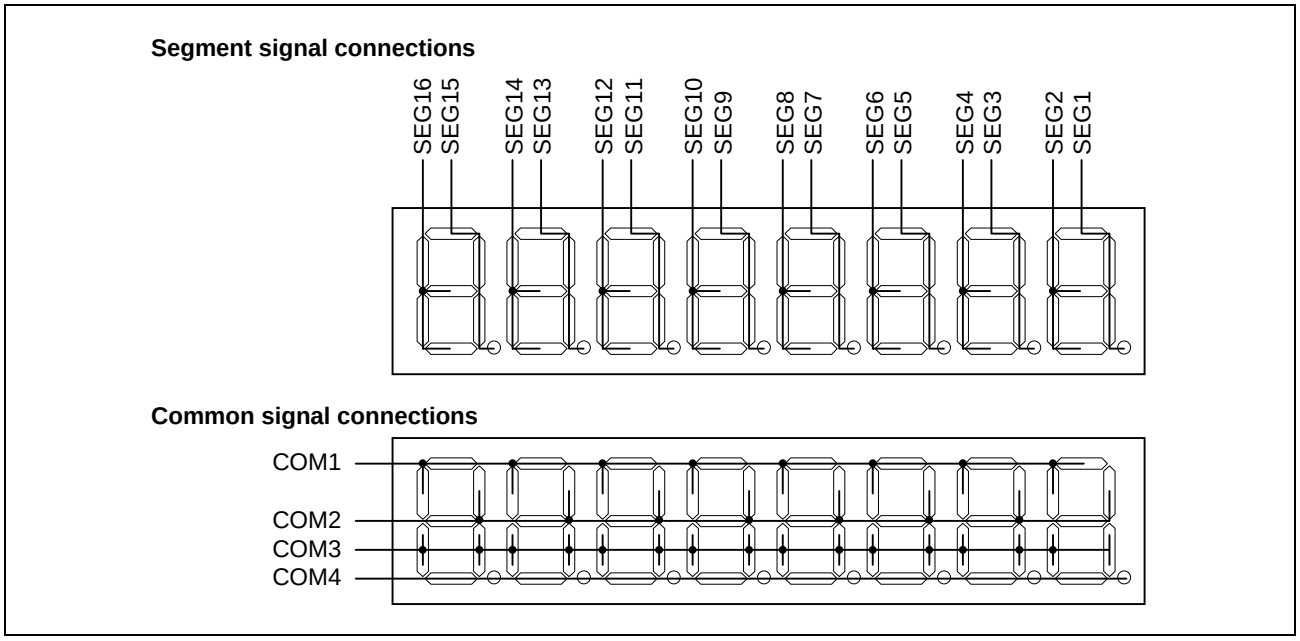


Figure 5 LCD Panel Segment Signal and Common Signal Connections

(4) The LCD RAM map for 1/4 duty is shown in figure 6.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
H'F370	SEG2	SEG2	SEG2	SEG2	SEG1	SEG1	SEG1	SEG1
H'F371	SEG4	SEG4	SEG4	SEG4	SEG3	SEG3	SEG3	SEG3
H'F372	SEG6	SEG6	SEG6	SEG6	SEG5	SEG5	SEG5	SEG5
H'F373	SEG8	SEG8	SEG8	SEG8	SEG7	SEG7	SEG7	SEG7
H'F374	SEG10	SEG10	SEG10	SEG10	SEG9	SEG9	SEG9	SEG9
H'F375	SEG12	SEG12	SEG12	SEG12	SEG11	SEG11	SEG11	SEG11
H'F376	SEG14	SEG14	SEG14	SEG14	SEG13	SEG13	SEG13	SEG13
H'F377	SEG16	SEG16	SEG16	SEG16	SEG15	SEG15	SEG15	SEG15
	↓	↓	↓	↓	↓	↓	↓	↓
	COM4	COM3	COM2	COM1	COM4	COM3	COM2	COM1

Figure 6 LCD RAM Map for 1/4 Duty Cycles

(5) The relationship between the LCD panel display and LCD RAM set values used in this sample task is shown in Figure 7. Setting LCD RAM as shown in Figure 7 displays “01234567” on the LCD panel.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
H'F370	0	0	0	1	0	1	1	1	Setting to display "7"
H'F371	1	1	1	1	0	1	0	1	Setting to display "6"
H'F372	1	0	1	1	0	1	0	1	Setting to display "5"
H'F373	0	0	1	1	0	1	1	0	Setting to display "4"
H'F374	1	0	1	0	0	1	1	1	Setting to display "3"
H'F375	1	1	1	0	0	0	1	1	Setting to display "2"
H'F376	0	0	0	0	0	1	1	0	Setting to display "1"
H'F377	1	1	0	1	0	1	1	1	Setting to display "0"

Figure 7 Relationship between LCD Display and LCD RAM Set Values

(6) The relationship of LCD RAM to SEG1 and SEG2 of the LCD panel is shown in Figure 8. When 1 is set in LCD RAM bits corresponding to a through g and P, as shown in Figure 8, the LCD display is turned on, and when 0 is set in these bits, the LCD display is turned off.

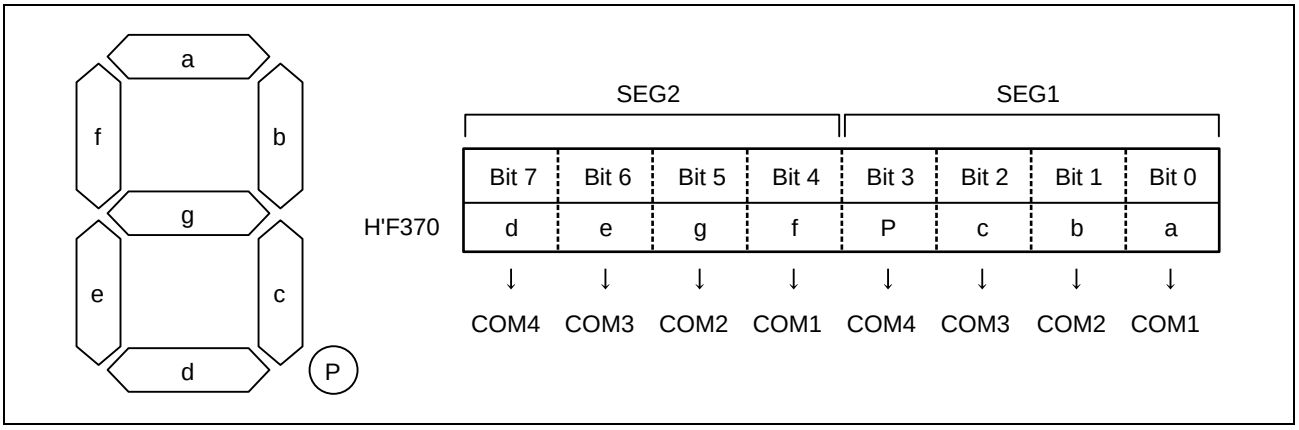


Figure 8 Relationship of LCD RAM Set Values and LCD Display/Non-Display

(7) Examples of LCD panel SEG1 and SEG2 display and display data are shown in table 1.

Table 1 Examples of Display Data

Symbol	Display	Address	Display Data								
			Binary								Hexadecimal
0		H'F370	1	1	0	1	0	1	1	1	H'D7
1		H'F370	0	0	0	0	0	1	1	0	H'06
2		H'F370	1	1	1	0	0	0	1	1	H'E3
3		H'F370	1	0	1	0	0	1	1	1	H'A7
4		H'F370	0	0	1	1	0	1	1	0	H'36
5		H'F370	1	0	1	1	0	1	0	1	H'B5
6		H'F370	1	1	1	1	0	1	0	1	H'F5
7		H'F370	0	0	0	1	0	1	1	1	H'17
8		H'F370	1	1	1	1	0	1	1	1	H'F7
9		H'F370	1	0	1	1	0	1	1	1	H'B7

2.2 Assignment of Functions

Table 2 shows the assignment of functions in this sample task.

Table 2 Assignment of Functions

Elements	Description
LPCR	Selects duty cycle, LCD driver, and pin function.
LCR	Turns on or off the power supply to drive the LCD, activates or halts display function, controls display data, and selects the frame frequency.
LCR2	Specifies whether the A waveform or B waveform is used as the LCD drive waveform, selects a step-up clock for use in the 3-V constant voltage power supply circuit, selects whether an LCD power-supply split resistor is disconnected or connected from or to LCD drive power supply, and turns on or off the 3-V constant-voltage power supply.
LTRMR	Adjusts 3-V constant voltage used for LCD drive power supply
BGRMR	Controls whether the band gap reference circuit operates or halts.
SEG1 to SEG16	Used as segment drivers
COM1 to COM4	Used as common drivers
LCD RAM	Used to set LCD display data

3. Principles of Operation

The principles of operation of this sample task are illustrated in figure 9. Data is displayed on the LCD panel by writing display data to the LCD RAM after making LCD controller/driver function and 3 V constant-voltage power supply circuit settings.

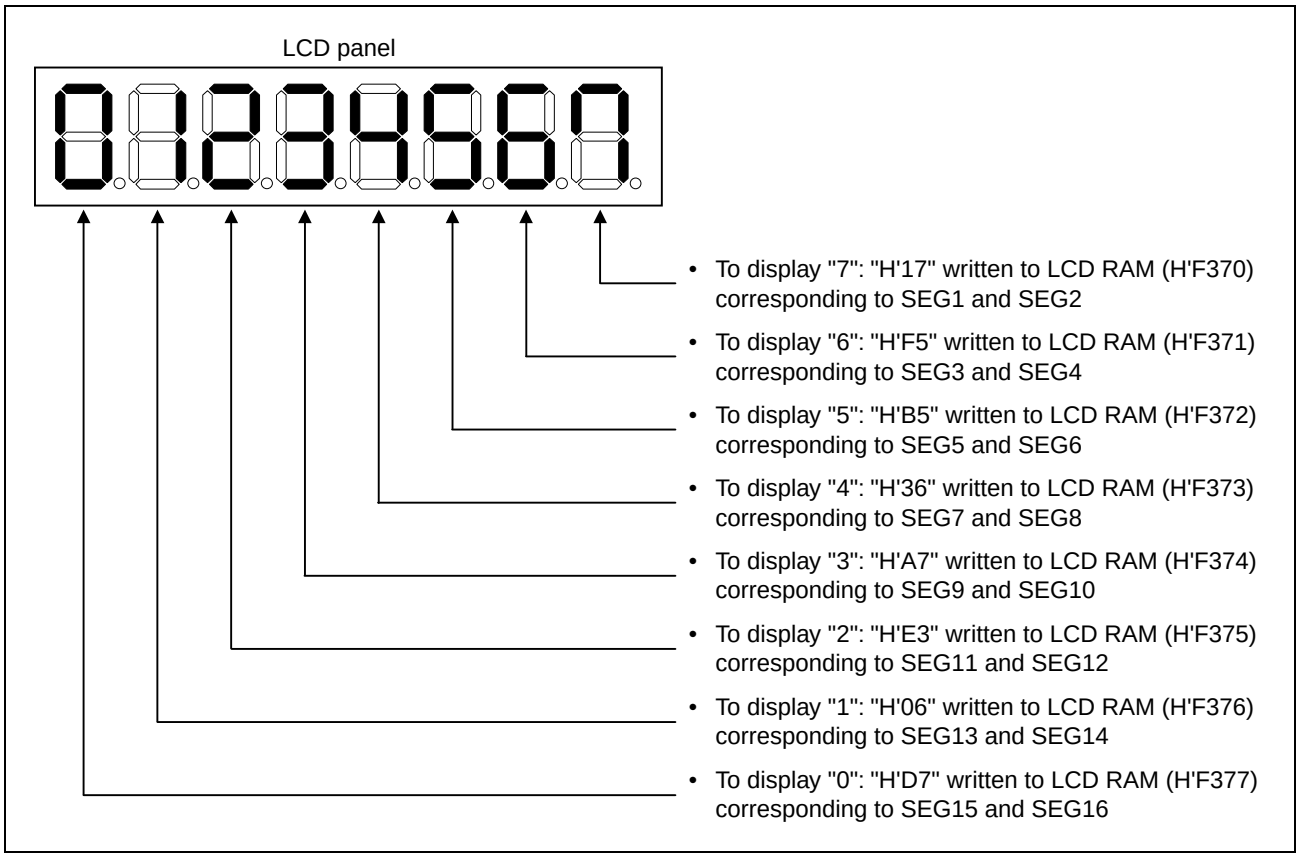


Figure 9 Principles of Operation

4. Description of Software

4.1 Modules

Table 3 shows the modules used in this sample task.

Table 3 Modules

Function Name	Description
main	Main routine Sets LCD RAM, LCD controller/driver initially, sets 3-V constant-voltage power supply circuit, and sets LCD display data

4.2 Arguments

No arguments are used in this sample task.

4.3 Internal Registers Used

The internal registers used in this sample task are shown below.

- LCD RAM Addresses: H'F370 to H'F37F

  Function: Automatically starts display when data is written to the corresponding addresses and LCD display is turned on.

  Set value: LCD panel display data (see Figure 9, Principles of Operation)

  R/W: R/W

- LPCR LCD port control register Address: H'FFA0

Bit	Bit Name	Set Value	R/W	Description
7	DTS1	1	R/W	Duty cycle select 1, 0
6	DTS0	1	R/W	Common function select
5	CMX	0	R/W	The combination of DTS1 and DTS0 selects static mode or 1/2 to 1/4 duty cycles. CMX selects either static, 1/2, 1/3, or 1/4 duty cycle. CMX specifies whether or not the same waveform is to be output from multiple pins to increase the common drive power when not all common pins are used because of the duty setting. DTS1 = 1, DTS0 = 1, CMX = -: Duty cycle set to 1/4, COM1 to COM4 set as common drivers
3	SGS3	0	R/W	Segment driver select 3 to 0
2	SGS2	1	R/W	Select segment drivers to be used.
1	SGS1	0	R/W	SGS3 = 0, SGS2 = 1, SGS1 = 0, SGS0 = 0: SEG1 to SEG16 set as segment drivers
0	SGS0	0	R/W	

-: Don't care

- LCR LCD control register Address: H'FFA1

Bit	Bit Name	Set Value	R/W	Description
6	PSW	0	R/W	LCD drive power supply control When LCD display is not necessary in power-down modes, or when an external power supply is used, the LCD drive power supply can be turned off. When the ACT bit is cleared to 0, or in the standby mode, the LCD drive power supply is turned off regardless of the setting of this bit. 0: The LCD drive power supply is turned off 1: The LCD drive power supply is turned on
5	ACT		R/W	Display function start
		1		Selects whether or not LCD controller/driver is to be used. Clearing this bit to 0 stops LCD controller/driver operation. The LCD drive power supply is turned off regardless in the value of PSW. However, register contents are retained. 0: LCD controller/driver stops 1: LCD controller/driver operates
4	DISP	-	R/W	Display data control
		1		Selects whether LCD RAM contents are to be displayed, or blank data is to be displayed regardless of LCD RAM contents. 0: Blank data is displayed 1: LCD RAM data is displayed
3	CKS3	0	R/W	Frame frequency select 3 to 0
2	CKS2	0	R/W	Selects the operating clock and the frame frequency.
1	CKS1	0	R/W	CKS3 = 0, CKS2 = -, CKS1 = 0, CKS0 = 1: Operating clock = ϕw/2, frame frequency = 64 Hz (frame frequency when ϕw = 32.768 kHz)
0	CKS0	1	R/W	

-: Don’t care

- LCR2 LCD control register 2 Address: H'FFA2

Bit	Bit Name	Set Value	R/W	Description
7	LCDAB	0	R/W	Waveform A or B switchover Selects waveform A or waveform B as the LCD drive waveform. 0: Drive using waveform A 1: Drive using waveform B
6	HCKS	0	R/W	3 V constant-voltage circuit step-up clock select Selects step-up clock used for 3-V constant-voltage circuit. The step-up clock is the clock selected by bits CKS3 to CKS0 of LCR divided by 4 or 8. 0: Step-up clock is LCD clock divided by 4 1: Step-up clock is LCD clock divided by 8
5	CHG	1	R/W	LCD split-resistance connection control Selects whether the LCD power supply split-resistor is to be disconnected from or connected to LCD drive power supply. 0: Disconnected 1: Connected
4	SUPS	1	R/W	3-V constant-voltage power supply control When LCD display is not necessary in power-down modes, or when an external power supply is used, the 3 V constant-voltage power supply can be turned off. 0: Turns off 3-V constant-voltage power supply 1: Turns on 3-V constant-voltage power supply

- LTRMR LCD trimming register Address: H'FFA3

Bit	Bit Name	Set Value	R/W	Description
7	TRM3	0	R/W	Output voltage adjustment of 3-V constant-voltage power supply circuit
6	TRM2	0	R/W	
5	TRM1	0	R/W	Adjust reference voltage (voltage on pin V1) for generating the 3-V constant voltage.
4	TRM0	0	R/W	
2	CTRM2	0	R/W	Variable voltage adjustment of 3-V constant-voltage power supply
1	CTRM1	0	R/W	Adjust 3-V constant voltage used for LCD drive power supply within the range of 3-V ±10%.
0	CTRM0	0	R/W	

- BGRMR BGR control register Address: H'FFA4

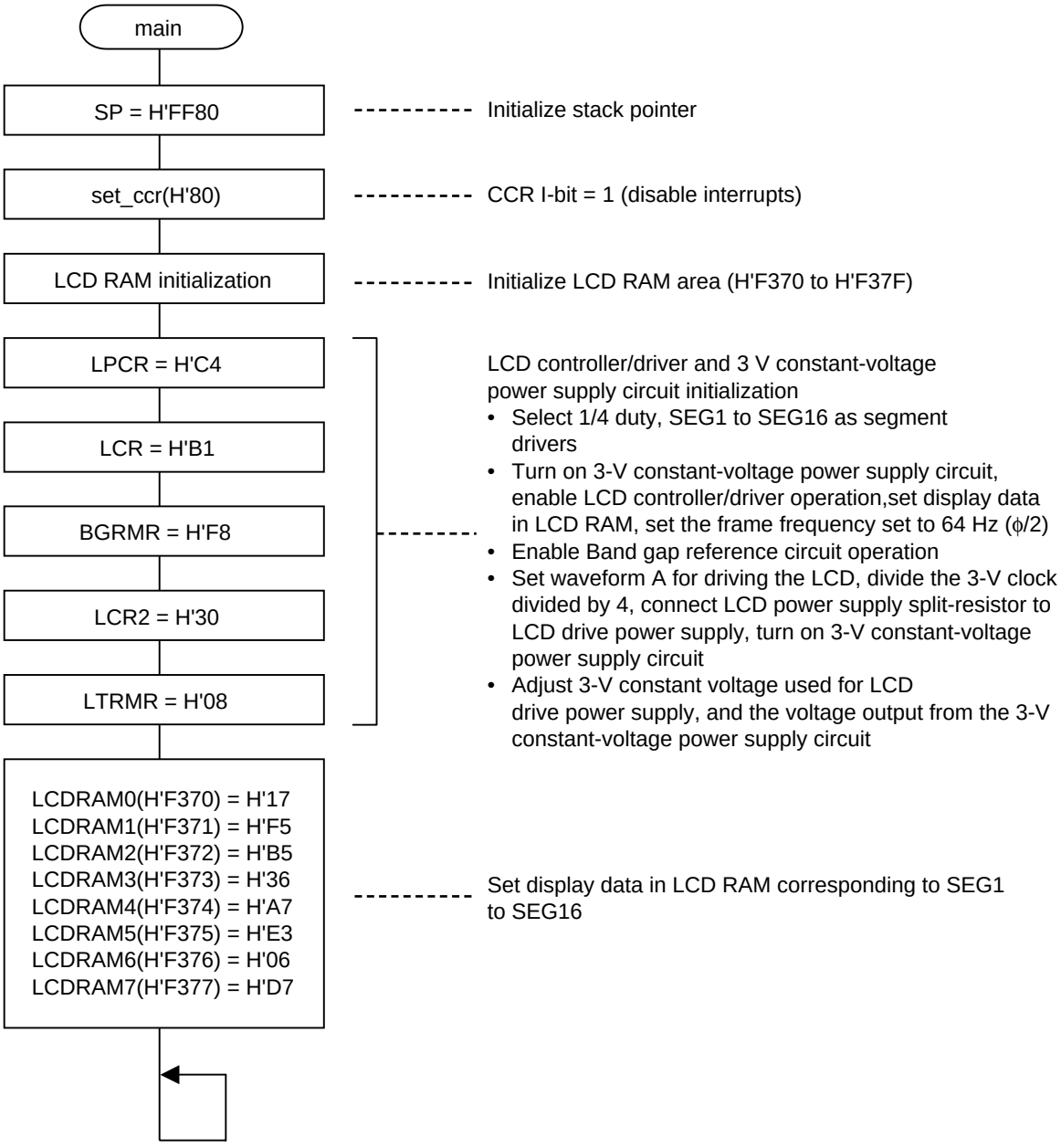
Bit	Bit Name	Set Value	R/W	Description
7	BGRSTPN	1	R/W	Band gap reference circuit (BGR) control Controls whether the band gap reference circuit operates or halts. 0: Band gap reference circuit halts 1: Band gap reference circuit operates

4.4 RAM Usage

No RAM is used in this sample task.

5. Flowcharts

5.1 main (Main Routine)



5.2 Link Address Specifications

Section Name	Address
CV1	H'00000000
P	H'00001000

Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Sep.16.04	—	First edition issued

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