

PRODUCT SPECIFICATIONS

Product Name: LCD Module

Model PartNumber: HYG32024028G-bT62L-VA

Revision: R00

Date: 2011-03-11

Prepared By:	Reviewed By:	Approved By:

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1. TECHNOLOGY SPECIFICATIONS

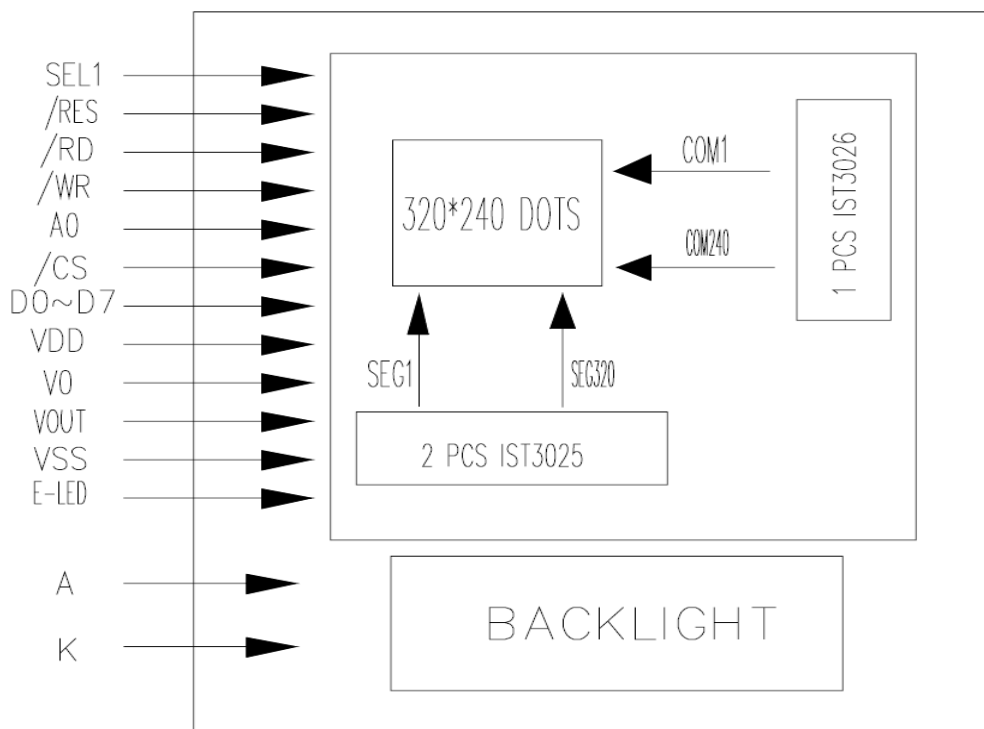
1.1 Features

S/N	Item	SPEC
1	Display Format	320×240 Dots
2	Display Mode	STN-BLUE-NEGATIVE
3	Polarizer Mode	TRANSMISSIVE
4	Driving Method	1/240Duty, 1/14 Bias
5	Viewing Direction	6 O'clock
6	Backlight	LED, White
7	Controller	RA8835AP3N
8	Interface	8080 MPU Type (Default)
9	Weight	---

1.2 MECHANICAL SPECIFICATION

ITEM	SPECIFICATIONS	UNIT
DIMENSIONAL OUTLINE	139.0 (W)×100.0 (H)×10.0 MAX. (T)	mm
VIEW AREA	103.0 (W)×79.0 (H)	mm
ACTIVE AREA	95.985 (W)×71.985 (H)	mm
DOT PITCH	0.285 (W)×0.285 (H)	mm
DOT SIZE	0.3 (W)×0.3 (H)	mm

1.3 BLOCK DIAGRAM



1.4 INTERFACE FUNCTIONS

CON3	CON1	SYMBOL	FUNCTIONS
1	1	VSS	Power Ground
2	2	VDD	Power Supply For Logic (+5.0V)
3	3	V0	Power Supply For LCD
4	4	/WR(R/W)	Write Signal(8080);Read or write signal(6800)
5	5	/RD(E)	Read Signal (8080) ; Enable Signal(6800)
6	6	/CS	Chip Select Signal , Active by "L" level
7	7	A0	Instruction/Display data selection
8	8	/RST	Reset Signal. Active by "L" level
9	9	DB0	Data Bit 0
10	10	DB1	Data Bit 1
11	11	DB2	Data Bit 2
12	12	DB3	Data Bit 3
13	13	DB4	Data Bit 4
14	14	DB5	Data Bit 5
15	15	DB6	Data Bit 6
16	16	DB7	Data Bit 7
17		NC	--
18		Vout	Built-In DC-DC Convert Voltage Out
19	17	LEDA	Power Supply for LED +(5.0V)
20	18	LEDK	Power Supply for LED -(0V)

3. ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	RATINGS			UNITS
		MIN.	TYP.	MAX.	
POWER SUPPLY FOR LOGIC	V _{DD-VSS}	-0.3	-	7.0	V
INPUT VOLTAGE	V _{IN}	-0.3	-	V _{DD} +0.3V	V
OPERATING TEMPERATURE	T _{op}	-20	-	70	°C
STORAGE TEMPERATURE	T _{st}	-30	-	80	°C

4. ELECTRICAL & OPTICAL CHARACTERISTICS

4.1 ELECTRICAL CHARACTERISTICS (Ta=25°C)

Parameter	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max.	V
Supply voltage	VDD		4.5	5.0	5.5	V
Register data retention voltage	VOH		2.0	—	6.0	V
Input leakage current	ILI	VI= VDD. See note 5.	—	0.05	2.0	μA
Output leakage current	ILO	VI= VSS. See note 5.	—	0.10	5.0	μA
Operating supply current	Iopr	See note 4.	—	3.5	8	mA
Quiescent supply current	IQ	Sleep mode, VOOSC1= V(CS)= V(RD)= VDD	—	0.05	20.0	μA
Oscillator frequency	fOSC	Measured at crystal, 47.5% duty cycle. See note 6.	1.0	—	18.0	MHz
External clock frequency	fCL		1.0	—	18.0	MHz
Oscillator feedback resistance	Rf		0.5	1.0	3.0	MΩ
Input						
HIGH-level input voltage	VIHC	See note 1, 2	0.5 VDD	—	VDD	V
LOW-level input voltage	VILC	See note 1, 2	VSS	—	0.2 VDD	V
Output						
HIGH-level output voltage	VOHC	IOH= 4.0 mA. See note 1, 2	VDD – 0.4	—	—	V
LOW-level output voltage	VOLC	IOL= -2 mA. See note 1, 2	—	—	VSS + 0.4	V
Schmitt-trigger						
Rising-edge threshold voltage	VT+	See note 3.	0.5 VDD	0.7 VDD	0.8 VDD	V
Falling-edge threshold voltage	VT–	See note 3.	0.2 VDD	0.3 VDD	0.5 VDD	V

Notes:

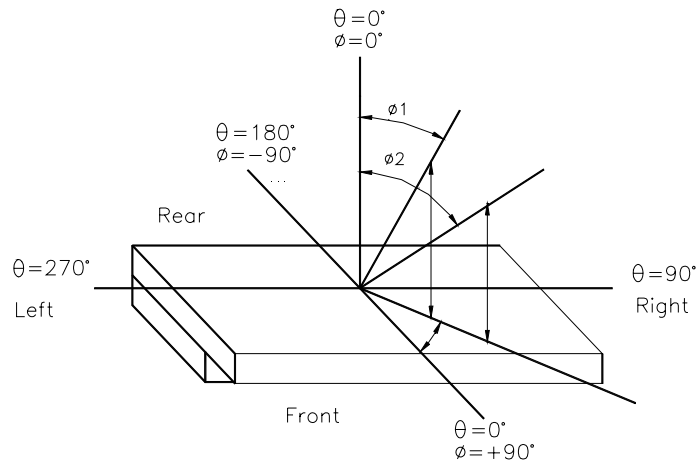
1. /CS, /RD, /WR, A0, SEL1, SEL2 and TEST are inputs. VA0 to VA15, (/VRD), (/VWR), (/VCE), YD, XD0 to XD3, XSCL, LP, WF, YDIS are outputs.
2. D0 to D7, VD0 to VD7 are Bi-direction.
3. The /RES are Schmitt-trigger inputs. The pulse width on /RES must be at least 10*tc. Note that pulses of more than a few seconds will cause DC voltages to be applied to the LCD panel.
4. fOSC = 10 MHz, no load (no display memory), internal character generator, 256x 200 pixel display. The operating supply current can be reduced by approximately 1mA by setting both CLO and the display OFF.
5. VD0 to VD7 and D0 to D7 have internal feedback circuits so that if the inputs become highimpedance, the input state immediately prior to that is held. Because of the feedback circuit, input current flow occurs when the inputs are in an intermediate state.
6. Because the oscillator circuit input bias current is in the order of uA, design the printed circuit board so as to reduce leakage currents.

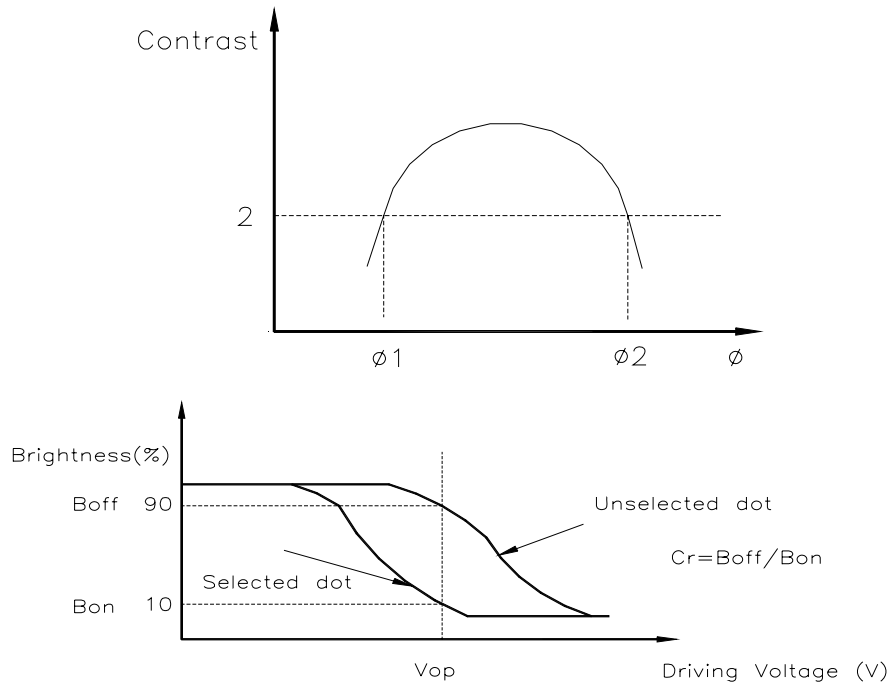
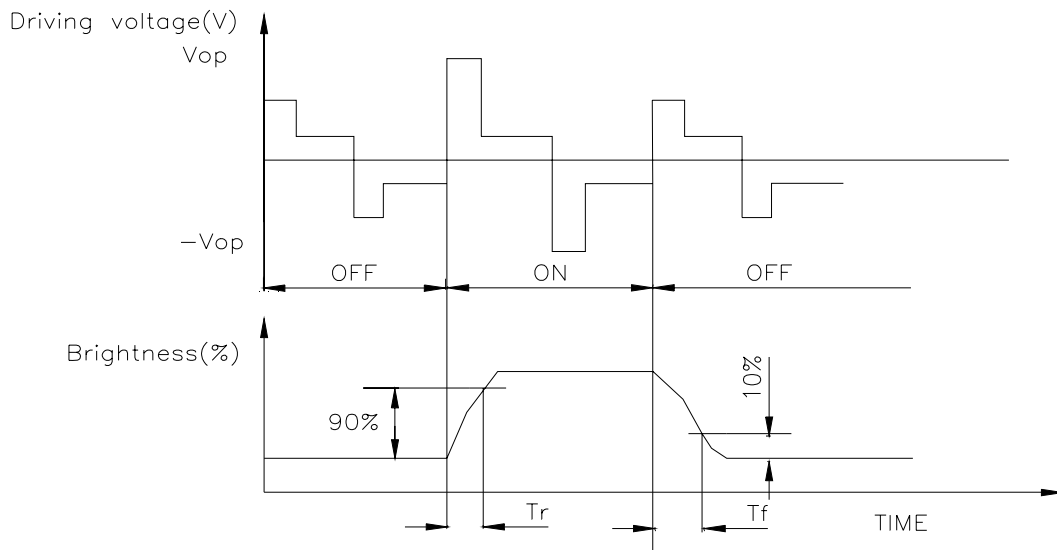
4.2 OPTICAL CHARACTERISTICS(Ta=25 °C)

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX	UNIT	
Driving Voltage	V0~VSS	-20°C	19.7	20.0	20.3	V	
		25°C	19.0	19.3	19.6	V	
		+70°C	18.0	18.3	18.6	V	
Response time	Ton	-20°C		2364	3259	ms	
		25°C	-	123	400	ms	
		+70°C		23	50	ms	
	Toff	-20°C		2729	3589	ms	
		25°C	-	243	400	ms	
		+70°C		140	300	ms	
Contrast ration	CR	25°C	5	10	-		
Viewing Angle	φ	25°C		50		Deg θ=0 °	CR≥2.0
				35		Deg θ=90 °	
				30		Deg θ=180 °	
				35		Deg θ=270 °	
Crosstalk		25°C		1.2			

Panel only characteristics

NOTE1: Definition of Viewing Angle θ,φ

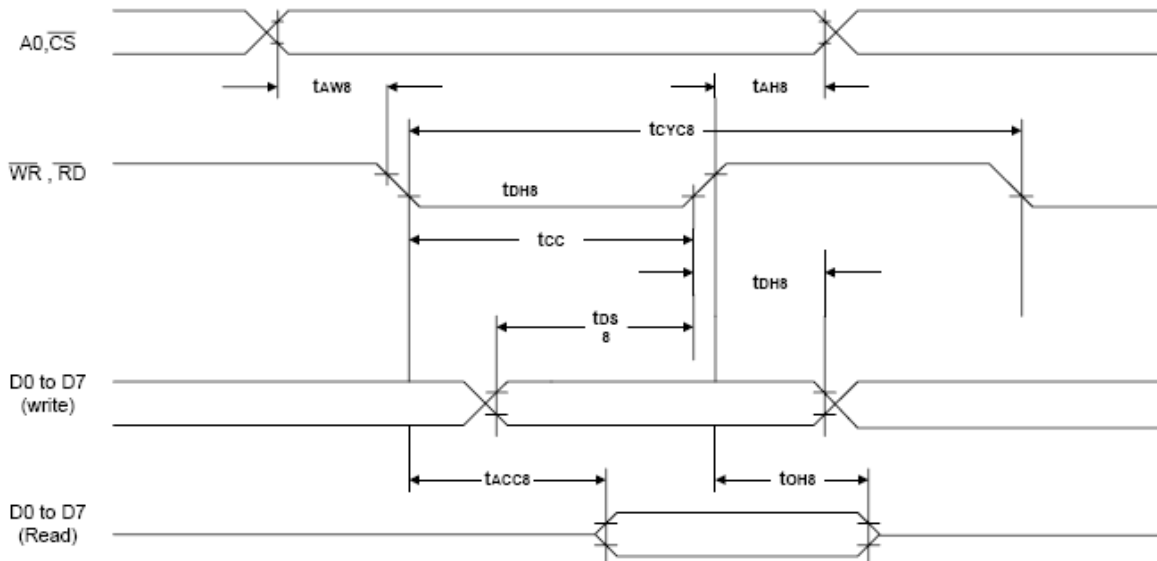
 NOTE2: Definition of viewing Angle Range: $\Delta\phi=|\phi_2-\phi_1|$


NOTE3: Definition of Contrast

NOTE4: Definition of Response Time

5. BACKLIGHT CHARACTERISTICS

ITEM	SYMBOL	MIN.	TYP.	MAX.	Condition	UNITS
Forward Voltage	V_f	4.8	5.0	5.2	$I_f=180mA$	V
Reverse Current	I_r		120		$V_r=5V$	μA
Peak Wave Length	λ_p		WHITE		$I_f=180mA$	nm
Spectral Line Half Width	$\Delta \lambda$				$I_f=180mA$	nm
Luminance	L_v	80			$I_f=180mA$	CD/m^2

6. TIMING CHARACTERISTICS

6.1 8080 Family Interface Timing



$T_a = -20$ to 75°C

Signal	Symbol	Parameter	$V_{DD} = 4.5$ to 5.5V		$V_{DD} = 2.7$ to 4.5V		Unit	Condition
			Min.	Max.	Min.	Max.		
A0, $\overline{\text{CS}}$	t_{AH8}	Address hold time	10	—	10	—	ns	CL = 100pF
	t_{AW8}	Address setup time	0	—	0	—	ns	
$\overline{\text{WR}}$, $\overline{\text{RD}}$	t_{CYC8}	System cycle time	note.	—	note.	—	ns	
	t_{CC}	Strobe pulse width	120	—	150	—	ns	
D0 to D7	t_{DS8}	Data setup time	120	—	120	—	ns	
	t_{DH8}	Data hold time	5	—	5	—	ns	
	t_{ACC8}	$\overline{\text{RD}}$ access time	—	50	—	80	ns	
	t_{OH8}	Output disable time	10	50	10	55	ns	

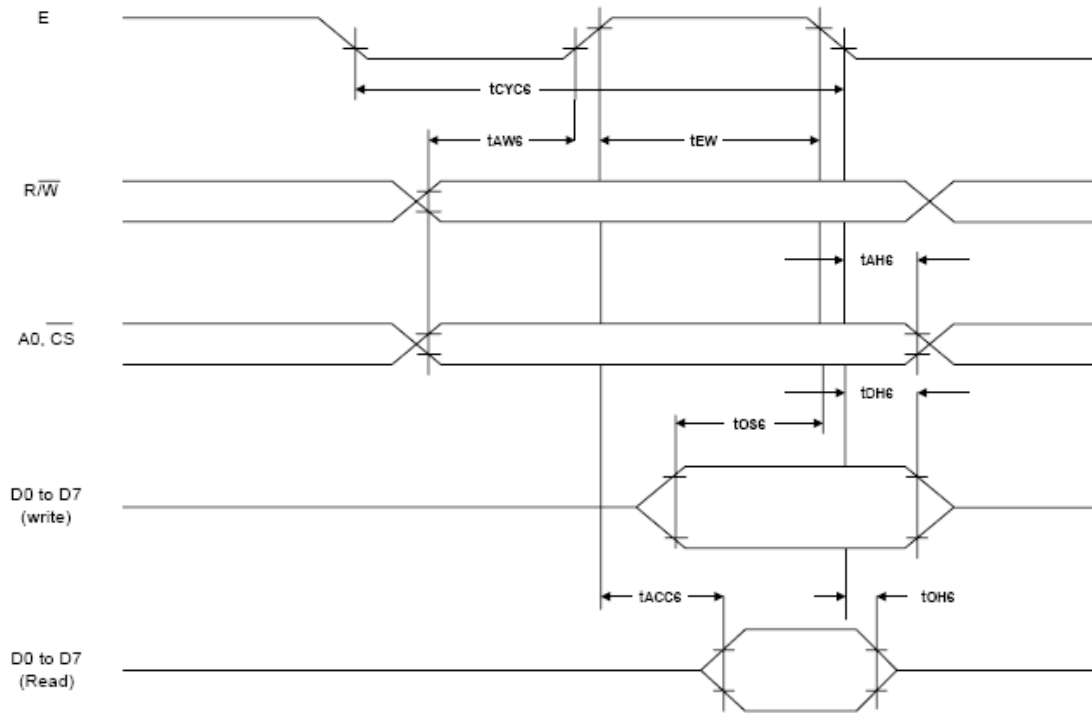
Note: For memory control and system control commands:

$$t_{CYC8} = 2t_c + t_{CC} + t_{CEA} + 75 > t_{ACV} + 245$$

For all other commands:

$$t_{CYC8} = 4t_c + t_{CC} + 30$$

6.2 6800 Family Interface Timing



Ta = -20 to 75°C

Signal	Symbol	Parameter	V _{DD} = 4.5 to 5.5V		V _{DD} = 2.7 to 4.5V		Unit	Condition
			Min.	Max.	Min.	Max.		
A0, \overline{CS} , R/(W)	t _{CYC6}	System cycle time	note.	—	note.	—	ns	CL = 100 pF
	t _{AW6}	Address setup time	0	—	10	—	ns	
	t _{AH6}	Address hold time	0	—	0	—	ns	
D0 to D7	t _{DS6}	Data setup time	100	—	120	—	ns	
	t _{DH6}	Data hold time	0	—	0	—	ns	
	t _{OH6}	Output disable time	10	50	10	75	ns	
	t _{ACC6}	Access time	—	85	—	130	ns	
E	t _{EW}	Enable pulse width	120	—	150	—	ns	

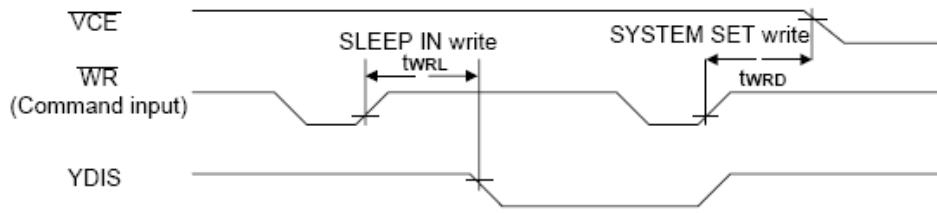
Note: For memory control and system control commands:

$$t_{CYC6} = 2t_c + t_{EW} + t_{CEA} + 75 > t_{ACV} + 245$$

For all other commands:

$$t_{CYC6} = 4t_c + t_{EW} + 30$$

6.2 Sleep In Command Timing



Ta = -20 to 75°C

Signal	Symbol	Parameter	V _{DD} = 4.5 to 5.5V		V _{DD} = 2.7 to 4.5V		Unit	Condition
			Min.	Max.	Min.	Max.		
$\overline{\text{WR}}$	t _{WRD}	VCE falling-edge delay time	note 1.	—	note 1.	—	ns	CL = 100 pF
	t _{WRL}	YDIS falling-edge delay time	—	note 2.	—	note 2.	ns	

Notes:

1. $t_{WRD} = 18t_c + t_{OSS} + 40$ (t_{OSS} is the time delay from the sleep state until stable operation)
2. $t_{WRL} = 36t_c \times [TC/R] \times [L/F] + 70$

7. Instruction Set

7.1 The Command Set

Class	Command	Code											HEX	Command Description	No.of Para.
		RD	WR	A0	D7	D6	D5	D4	D3	D2	D1	D0			
System Control	SYSTEM SET	1	0	1	0	1	0	0	0	0	0	0	40	Initialize device and display	8
	SLEEP IN	1	0	1	0	1	0	1	0	0	1	1	53	Enter standby mode	0
Display Control	DISPLAY ON/OFF	1	0	1	0	1	0	1	1	0	0	D	58, 59	Enable and disable display and display flashing	1
	SCROLL	1	0	1	0	1	0	0	0	1	0	0	44	Set display start address and display region	10
	CSRFORM	1	0	1	0	1	0	1	1	1	0	1	5D	Set cursor type	2
	CGRAM ADR	1	0	1	0	1	0	1	1	1	0	0	5C	Set start address of character generator RAM	2
	CSRDIR	1	0	1	0	1	0	0	1	1	CD	CD	4C to 4F	Set direction of cursor movement	0
	HDOT SCR	1	0	1	0	1	0	1	1	0	1	0	5A	Set horizontal scroll position	1
	OVLAY	1	0	1	0	1	0	1	1	0	1	1	5B	Set display overlay format	1
Drawing Control	CSRW	1	0	1	0	1	0	0	0	1	1	0	46	Set cursor address	2
	CSRR	1	0	1	0	1	0	0	0	1	1	1	47	Read cursor address	2
Memory Control	MWRITE	1	0	1	0	1	0	0	0	0	1	0	42	Write to display memory	—
	MREAD	1	0	1	0	1	0	0	0	0	1	1	43	Read from display memory	—

Notes:

- In general, the internal registers of the RA8835A series are modified as each command parameter is input. However, the microprocessor does not have to set all the parameters of a command and may send a new command before all parameters have been input. The internal registers for the parameters that have been input will have been changed but the remaining parameter registers are unchanged. 2-byte parameters (where two bytes are treated as 1 data item) are handled as follows:
 - CSRW, CSRR: Each byte is processed individually. The microprocessor may read or write just the low byte of the cursor address.
 - SYSTEM SET, SCROLL, CGRAM ADR: Both parameter bytes are processed together. If the command is changed after half of the parameter has been input, the single byte is ignored.
- APL and APH are 2-byte parameters, but are treated as two 1-byte parameters.

7.2 Explanation of Commands

7.2.1 SYSTEM SET

Initializes the device, sets the window sizes, and selects the LCD interface format. Since this command sets the basic operating parameters of the RA8835A series, an incorrect SYSTEM SET command may cause other commands to operate incorrectly.

	MSB								LSB		
	D7	D6	D5	D4	D3	D2	D1	D0	A0	\overline{WR}	\overline{RD}
C	0	1	0	0	0	0	0	0	1	0	1
P1	0	0	IV	1	W/S	M2	M1	M0	0	0	1
P2	WF	0	0	0	0	← FX →			0	0	1
P3	0	0	0	0	← FY →				0	0	1
P4	← C/R →								0	0	1
P5	← TC/R →								0	0	1
P6	← L/F →								0	0	1
P7	← APL →								0	0	1
P8	← APH →								0	0	1

SYSTEM SET Instruction

7.2.1-1 C

This control byte performs the following:

1. Resets the internal timing generator
2. Disables the display
3. Cancels sleep mode

Parameters following P1 are not needed if only canceling sleep mode.

7.2.1-2 M0

Select the internal or external character generator ROM. The internal character generator ROM contains 160, 5 X 7 pixel characters, as shown at below. These characters are fixed at fabrication by the metallization mask.

		Character code bits 0 to 3															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Character code bit 4 to 7	2		|														
	3																
	4																
	5																
	6																
	7																
	A																
	B																
	C																
	D																
	1																

Figure: On-chip Character Set

The external character generator ROM, on the other hand, can contain up to 256 user-defined characters.

M0 = 0: Internal CG ROM

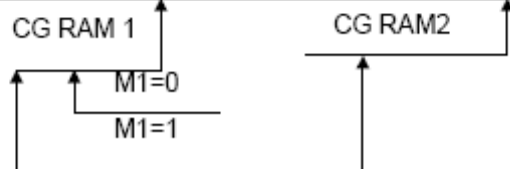
M0 = 1: External CG ROM

Note that if the CG ROM address space overlaps the display memory address space, that portion of the display memory cannot be written to.

7.2.1.3 M1

Select the memory configuration for user-definable characters. The CG RAM codes select one of the 64 codes shown as below.

Lower 4bits	Upper 4bits															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0				0	@	P	·	p								
1			!	1	A	Q	a	q								
2			"	2	B	R	b	r								
3			#	3	C	S	c	s								
4			\$	4	D	T	d	t								
5			&	5	E	U	e	u								
6			%	6	F	V	f	v								
7			·	7	G	W	g	w								
8			(	8	H	X	h	x								
9			)	9	I	Y	i	y								
A			*	:	J	Z	j	z								
B			+	;	K	[	k	{								
C			,	<	L	¥	l	!								
D			.	=	M	]	m	}								
E			-	>	N	^	n	→								
F			/	?	O	_	o	←								



M1 = 0: No D6 correction.

The CG RAM1 and CG RAM2 address spaces are not contiguous, the CG RAM1 address space is treated as character generator RAM, and the CG RAM2 address space is treated as character generator ROM.

M1 = 1: D6 correction.

The CG RAM1 and CG RAM2 address spaces are contiguous and are both treated as character generator RAM.

7.2.1.4 M2

Select the height of the character bitmaps. Characters more than 16 pixels high can be displayed by creating a bitmap for each portion of each character and using the RA8835A series graphics mode to reposition them.

M2 = 0: 8-pixel character height (2716 or equivalent ROM)

M2 = 1: 16-pixel character height (2732 or equivalent ROM)

7.2.1.5 W/S

Select the LCD drive method.

W/S = 0: Single-panel drive

W/S = 1: Dual-panel drive

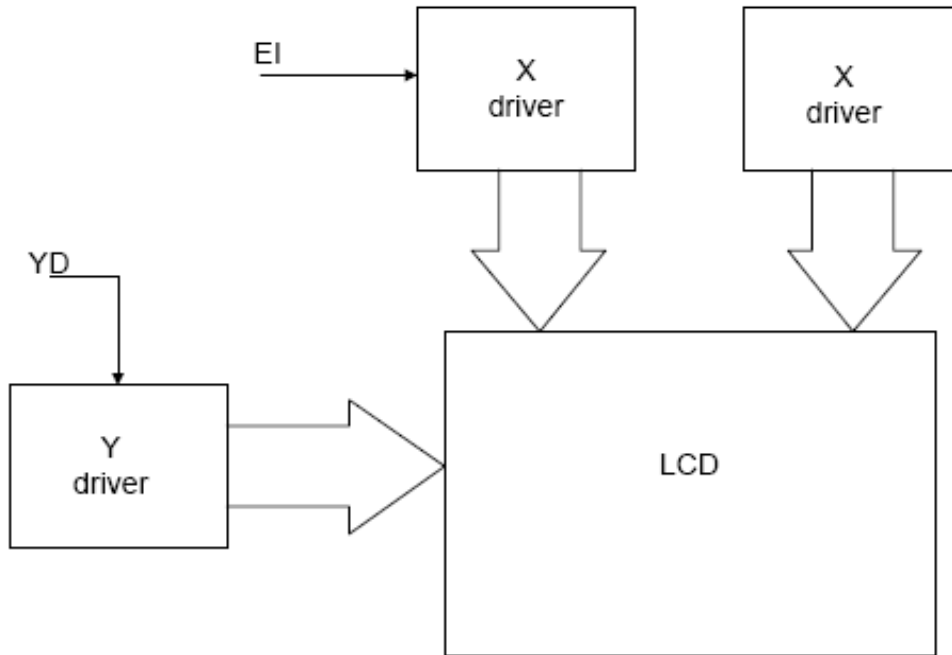


Figure: Single-panel Display

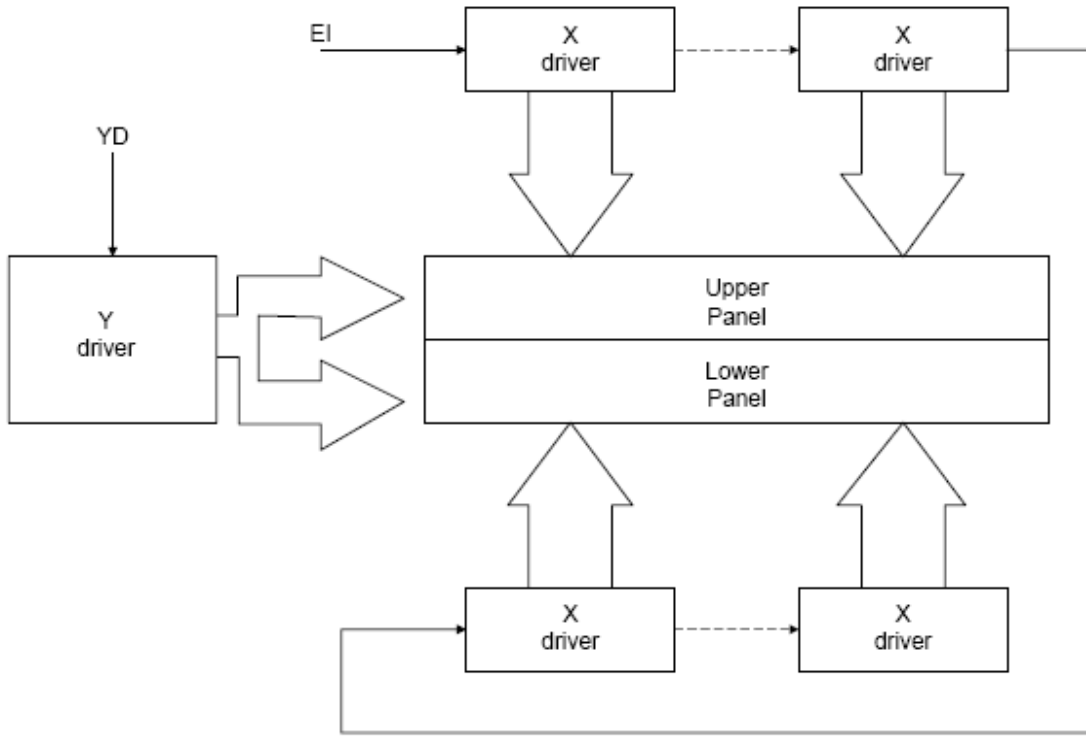


Figure: Above and Below Two-panel Display

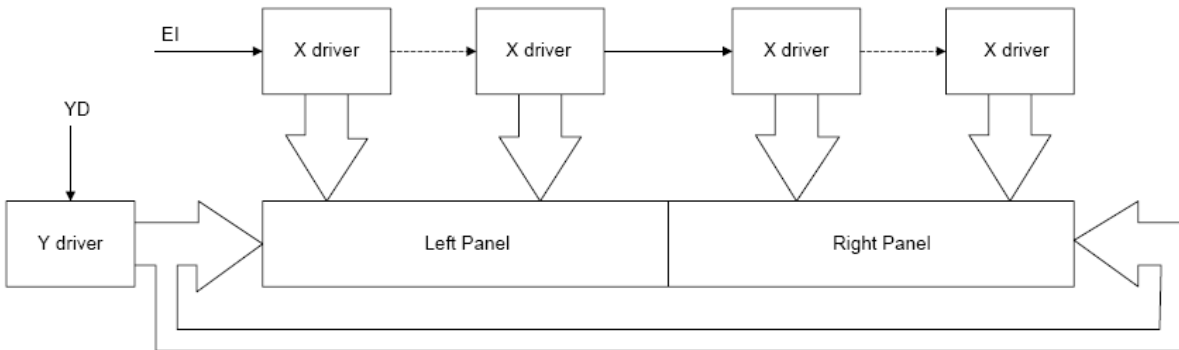


Figure: Left-and-Right Two-panel Display

LCD Parameters Table

Parameter	W/S = 0		W/S = 1	
	IV = 1	IV = 0	IV = 1	IV = 0
C/R	C/R	C/R	C/R	C/R
TC/R	TC/R	TC/R (See note 1.)	TC/R	TC/R
L/F	L/F	L/F	L/F	L/F
SL1	00H to L/F	00H to L/F + 1 (See note 2.)	(L/F) / 2	(L/F) / 2
SL2	00H to L/F	00H to L/F + 1 (See note 2.)	(L/F) / 2	(L/F) / 2
SAD1	First screen block	First screen block	First screen block	First screen block
SAD2	Second screen block	Second screen block	Second screen block	Second screen block
SAD3	Third screen block	Third screen block	Third screen block	Third screen block
SAD4	Invalid	Invalid	Fourth screen block	Fourth screen block
Cursor movement range	Continuous movement over whole screen		Above-and-below configuration: continuous movement over whole screen	

7.2.1.6 IV

Screen origin compensation for inverse display. IV is usually set to 1. The best way of displaying inverted characters is to Exclusive-OR the text layer with the graphics background layer. However, inverted characters at the top or left of the screen are difficult to read as the character origin is at the top-left of its bitmap and there are no background pixels either above or to the left of these characters.

The IV flag causes the RA8835A series to offset the text screen against the graphics back layer by one vertical pixel. Use the horizontal pixel scroll function (HDOT SCR) to shift the text screen 1 to 7 pixels to the right. All characters will then have the necessary surrounding background pixels that ensure easy reading of the inverted characters. See Section 11-5 for information on scrolling.

IV = 0: Screen top-line correction

IV = 1: No screen top-line correction

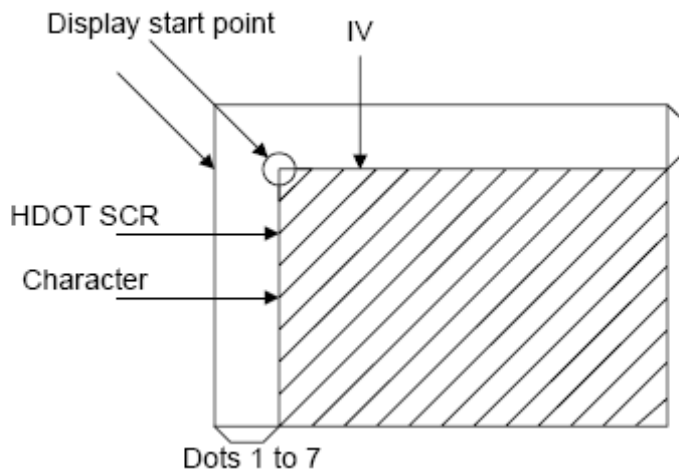


Figure: IV and HDOT SCR Adjustment

7.2.1.7 FX

Define the horizontal character size. The character width in pixels is equal to $FX + 1$, where FX can range from 00 to 07H inclusive. If data bit 3 is set (FX is in the range 08 to 0FH) and an 8-pixel font is used, a space is inserted between characters.

Table: Horizontal Character Size Selection

FX					[FX] character width (pixels)
HEX	D3	D2	D1	D0	
00	0	0	0	0	1
01	0	0	0	1	2
↓	↓	↓	↓	↓	↓
07	0	1	1	1	8

Since the RA8835A series handles display data in 8-bit units, characters larger than 8 pixels wide must be formed from 8-pixel segments. As Figure 6-6 shows, the remainder of the second eight bits are not displayed. This also applies to the second screen layer.

In graphics mode, the normal character field is also eight pixels. If a wider character field is used, any remainder in the second eight bits is not displayed.

7.2.1.9 FY

Set the vertical character size. The height in pixels is equal to $FY + 1$. FY can range from 00 to 0FH inclusive. Set FY to zero (vertical size equals one) when in graphics mode.

Table- Vertical Character Size Selection

FY					[FY] character height (pixels)
HEX	D3	D2	D1	D0	
00	0	0	0	0	1
01	0	0	0	1	2
↓	↓	↓	↓	↓	↓
07	0	1	1	1	8
↓	↓	↓	↓	↓	↓
0E	1	1	1	0	15
0F	1	1	1	1	16

7.2.1.10 C/R

Set the address range covered by one display line, that is, the number of characters less one, multiplied by the number of horizontal bytes per character. C/R can range from 0 to 239.

For example, if the character width is 10 pixels, then the address range is equal to twice the number of characters, less 2. See Section 17-1-1 for the calculation of C/R. [C/R] cannot be set to a value greater than the address range. It can, however, be set smaller than the address range, in which case the excess display area is blank. The number of excess pixels must not exceed 64.

Table: Display Line Address Range

C/R									[C/R] bytes per display line
HEX	D7	D6	D5	D4	D3	D2	D1	D0	
00	0	0	0	0	0	0	0	0	1
01	0	0	0	0	0	0	0	1	2
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
4F	0	1	0	0	1	1	1	1	80
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
EE	1	1	1	0	1	1	1	0	239
EF	1	1	1	0	1	1	1	1	240

7.2.1.11 TC/R

Set the length, including horizontal blanking, of one line. The line length is equal to $TC/R + 1$, where TC/R can range from 0 to 255. TC/R must be greater than or equal to $C/R + 4$. Provided this condition is satisfied, $[TC/R]$ can be set according to the equation given in section 17-1-1 in order to hold the frame period constant and minimize jitter for any given main oscillator frequency, f_{OSC} .

Table: Line Length Selection

TC/R									[TC/R] line length (bytes)
HEX	D7	D6	D5	D4	D3	D2	D1	D0	
00	0	0	0	0	0	0	0	0	1
01	0	0	0	0	0	0	0	1	2
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
52	0	1	0	1	0	0	1	0	83
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
FE	1	1	1	1	1	1	1	0	255
FF	1	1	1	1	1	1	1	1	256

7.2.1.12 L/F

Set the height, in lines, of a frame. The height in lines is equal to $L/F + 1$, where L/F can range from 0 to 255.

Table: Frame Height Selection

L/F									[L/F] lines per frame
HEX	D7	D6	D5	D4	D3	D2	D1	D0	
00	0	0	0	0	0	0	0	0	1
01	0	0	0	0	0	0	0	1	2
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
7F	0	1	1	1	1	1	1	1	128
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
FE	1	1	1	1	1	1	1	0	255
FF	1	1	1	1	1	1	1	1	256

If W/S is set to 1, selecting two-screen display, the number of lines must be even and L/F must, therefore, be an odd number.

7.2.1.13 AP

Define the horizontal address range of the virtual screen. APL is the least significant byte of the address.

APL	AP7	AP6	AP5	AP4	AP3	AP2	AP1	AP0
APH	AP15	AP14	AP13	AP12	AP11	AP10	AP9	AP8

Figure: AP Parameters

Table: Horizontal Address Range

HEX				[AP] addresses per line
APH	APL			
0	0	0	0	0
0	0	0	1	1
↓	↓	↓	↓	↓
0	0	5	0	80
↓	↓	↓	↓	↓
F	F	F	E	$2^{16}-2$
F	F	F	F	$2^{16}-1$

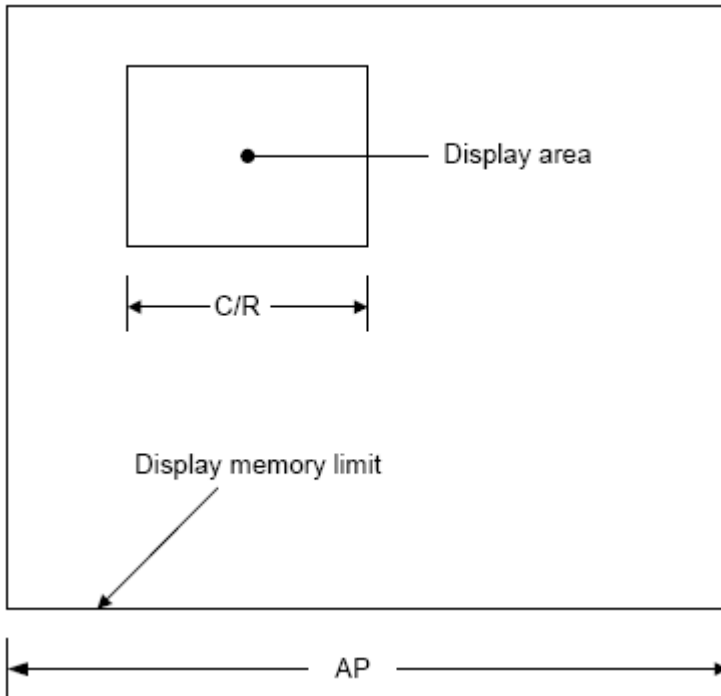


Figure: AP and C/R Relationship

7.2.2 SLEEP IN

Place the system in standby mode. This command has no parameter bytes. At least one blank frame after receiving this command, the RA8835A halts all internal operations, including the oscillator, and enters the sleep state.

Blank data is sent to the X-drivers, and the Y-drivers have their bias supplies turned off by the YDIS signal. Using the YDIS signal to disable the Y-drivers guards against any spurious displays. The internal

registers of the RA8835A series maintain their values during the sleep state. The display memory control pins maintain their logic levels to ensure that the display memory is not corrupted. The RA8835A series can be removed from the sleep state by sending the SYSTEM SET command with only the P1 parameter. The DISP ON command should be sent next to enable the display.

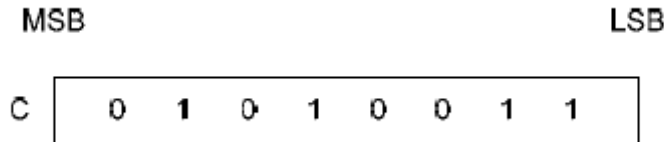


Figure: SLEEP IN Instruction

1. The YDIS signal goes LOW between one and two frames after the SLEEP IN command is received. Since YDIS forces all display driver outputs to go to the deselected output voltage, YDIS can be used as a power-down signal for the LCD unit. This can be done by having YDIS turn off the relatively high power LCD drive supplies at the same time as it blanks the display.

2. Since all internal clocks in the RA8835A series are halted while in the sleep state, a DC voltage will be applied to the LCD panel if the LCD drive supplies remain on. If reliability is a prime consideration, turn off the LCD drive supplies before issuing the SLEEP IN command.

3. Note that, although the bus lines become high impedance in the sleep state, pull-up or pulldown resistors on the bus will force these lines to a known state.

7.2.3 DISP ON/OFF

Turn the whole display on or off. The single-byte parameter enables and disables the cursor and layered screens, and sets the cursor and screen flash rates. The cursor can be set to flash over one character or over a whole line.

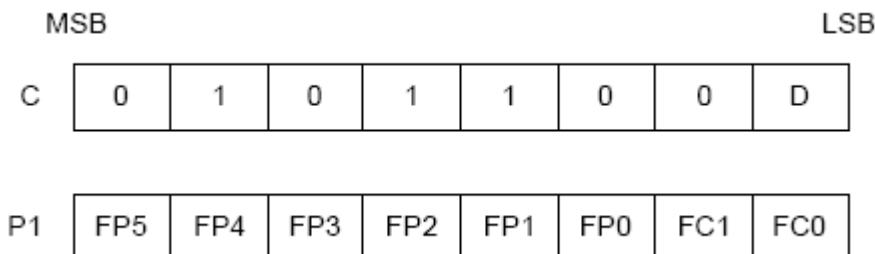


Figure: DISP ON/OFF Parameters

7.2.3.1 D

Turn the display ON or OFF. The D bit takes precedence over the FP bits in the parameter.

D = 0: Display OFF

D = 1: Display ON

7.2.3.2 FC

Enables/disables the cursor and sets the flash rate. The cursor flashes with a 70% duty cycle (ON/OFF).

Table: Cursor Flash Rate Selection

FC1	FC0	Cursor display	
0	0	OFF (blank)	
0	1	No flashing	
1	0	ON	Flash at fFR/32 Hz (approx. 2 Hz)
1	1		Flash at fFR/64 Hz (approx. 1 Hz)

Note: As the MWRITE command always enables the cursor, the cursor position can be checked even when performing consecutive writes to display memory while the cursor is flashing.

7.2.3.3 FP

Each pair of bits in FP sets the attributes of one screen block, as follows. The display attributes are as follows:

Table: Screen Block Attribute Selection

FP1	FP0	First screen block (SAD1)	
FP3	FP2	Second screen block (SAD2, SAD4). See note.	
FP5	FP4	Third screen block (SAD3)	
0	0	OFF (blank)	
0	1	ON	No flashing
1	0		Flash at $f_{FR}/32$ Hz (approx. 2 Hz)
1	1		Flash at $f_{FR}/4$ Hz (approx. 16 Hz)

Note: If SAD4 is enabled by setting W/S to 1, FP3 and FP2 control both SAD2 and SAD4. The attributes of SAD2 and SAD4 cannot be set independently.

7.2.4 SCROLL

7.2.4.1 C

Set the scroll start address and the number of lines per scroll block. Parameters P1 to P10 can be omitted if not required. The parameters must be entered sequentially as shown as below..

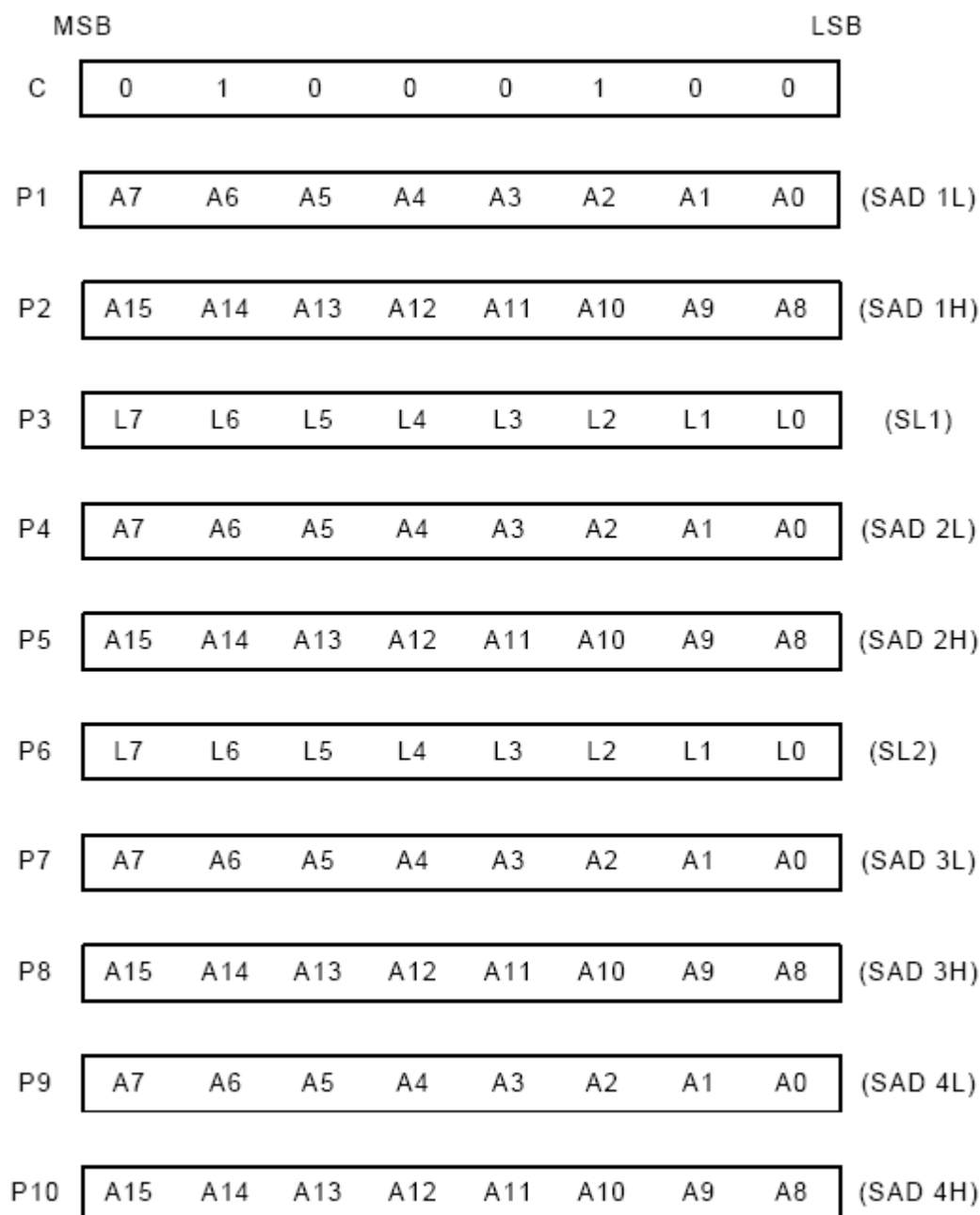


Figure: SCROLL Instruction Parameters

Note: Set parameters P9 and P10 only if both two-screen drive (W/S = 1) and two-layer configuration are selected. SAD4 is the fourth screen block display start address.

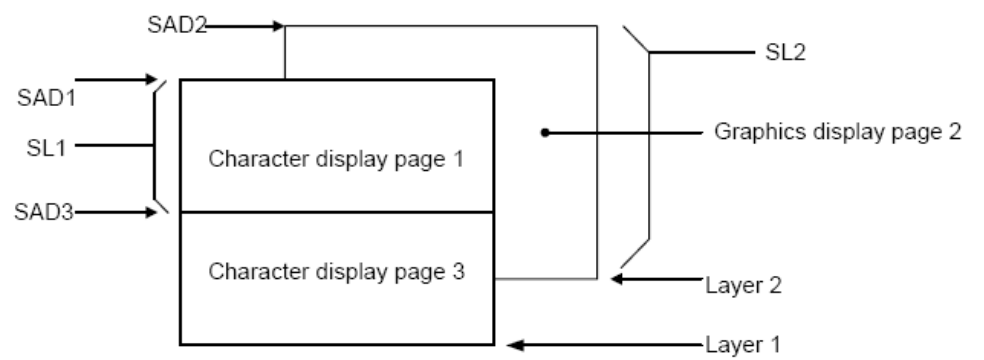
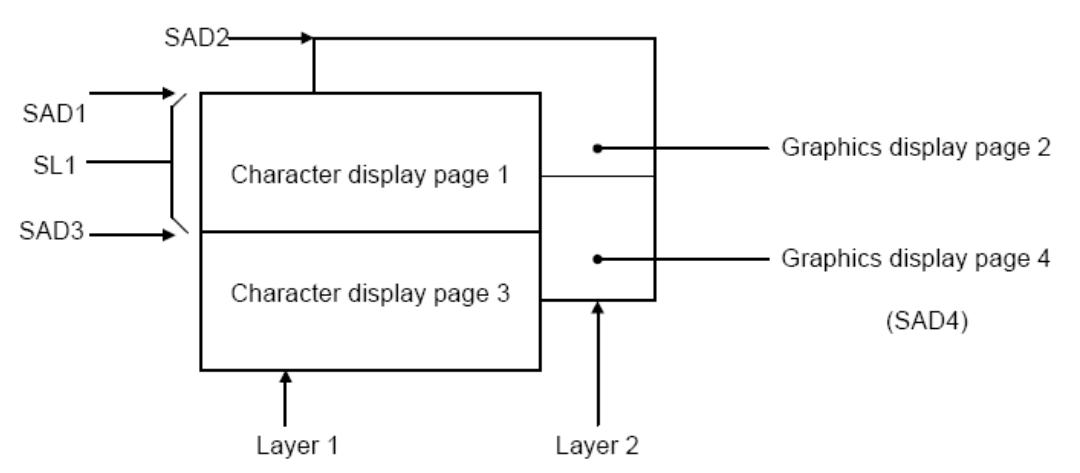
Table: Screen Block Start Address Selection

HEX	SL1, SL2								[SL] screen lines
	L7	L6	L5	L4	L3	L2	L1	L0	
00	0	0	0	0	0	0	0	0	1
01	0	0	0	0	0	0	0	1	2
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
7F	0	1	1	1	1	1	1	1	128
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
FE	1	1	1	1	1	1	1	0	255
FF	1	1	1	1	1	1	1	1	256

7.2.4.2 SL1, SL2

SL1 and SL2 set the number of lines per scrolling screen. The number of lines is SL1 or SL2 plus one. The relationship between SAD, SL and the display mode is described below.

Table: Text Display Mode

W/S	Screen	First Layer	Second Layer	
0	First screen block	SAD1	SAD2	
	Second screen block	SL1	SL2	
	Third screen block (partitioned screen)	SAD3 (see note 1) Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen.		
	Screen configuration example: 			
1	Upper screen	SAD1 SL1	SAD2 SL2	
	Lower screen	SAD3 (See note 2)	SAD4 (See note 2)	
	Set both SL1 and SL2 to $((L/F) / 2 + 1)$			
	Screen configuration example: 			

Notes:

1. SAD3 has the same value as either SAD1 or SAD2, whichever has the least number of lines (set by SL1 and SL2).

2. Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set in this mode.

Table: Graphics Display Mode

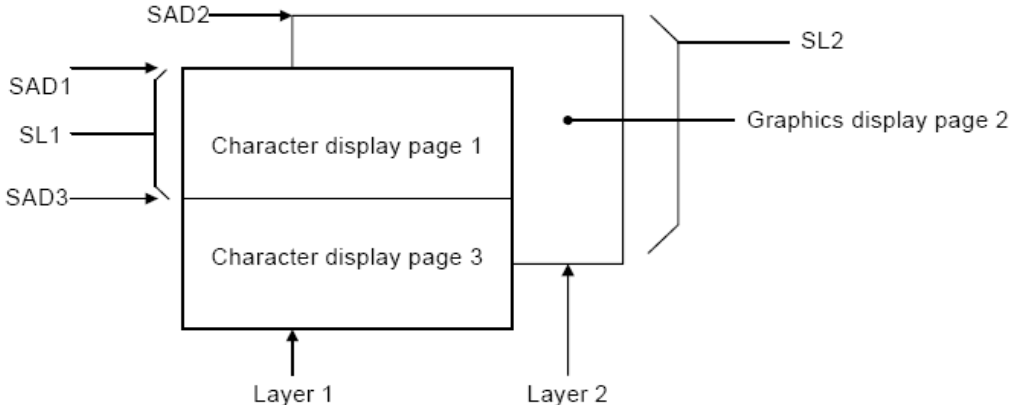
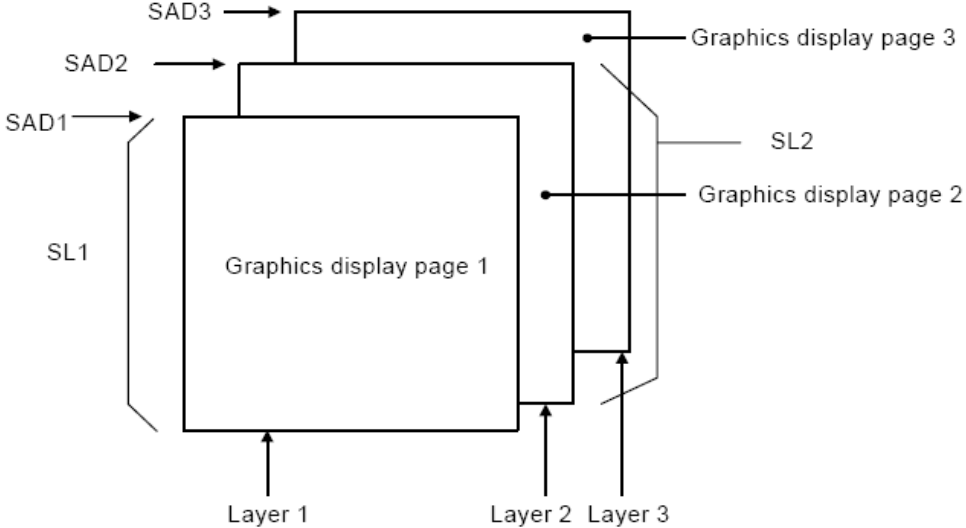
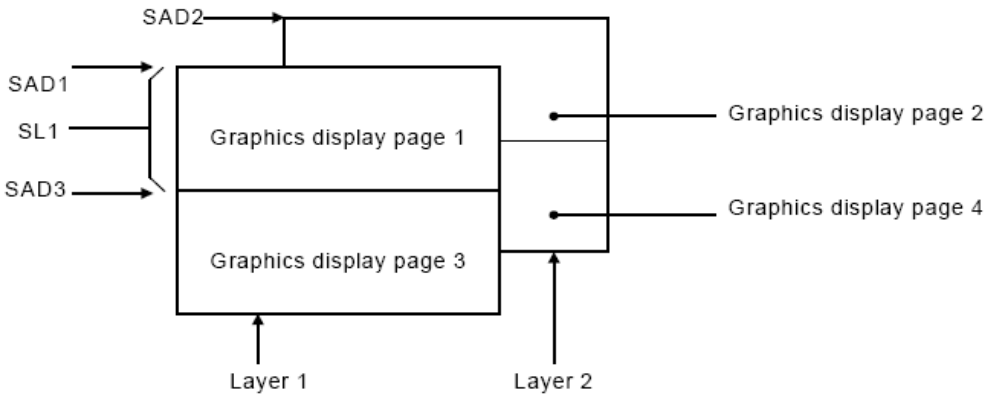
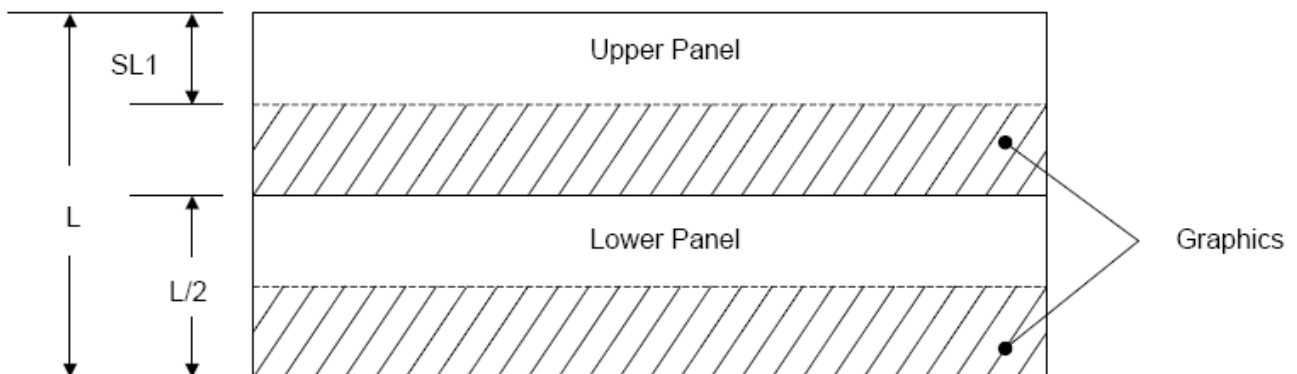
W/S	Screen	First Layer	Second Layer	Third Layer
0	Two-layer composition	SAD1 SL1	SAD2 SL2	—
	Upper screen	SAD3 (see note 3) Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen		—
	Screen configuration example:			
				
0	Three-layer configuration	SAD1 SL1 = L/F + 1	SAD2 SL1 = L/F + 1	SAD3 —
	Screen configuration example:			
				

Table: Graphics Display Mode (continued)

W/S	Screen	First Layer	Second Layer	Third Layer
1	Upper screen	SAD1 SL1	SAD2 SL2	—
	Lower screen	SAD3 (See note 2)	SAD4 (See note 2)	—
Screen configuration example (See note 3):				
				

Notes:

- SAD3 has the same value as either SAD1 or SAD2; whichever has the least number of ines (set by SL1 and SL2).
- Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set.
- If, and only if, $W/S = 1$, the differences between SL1 and $(L/F + 1) / 2$, and between SL2 and $(L/F + 1) / 2$, are blanked.


Figure: Two-panel Display Height
7.2.5 CSRFORM

Set the cursor size and shape. Although the cursor is normally only used in text displays, it may also be used in graphics displays when displaying special characters.

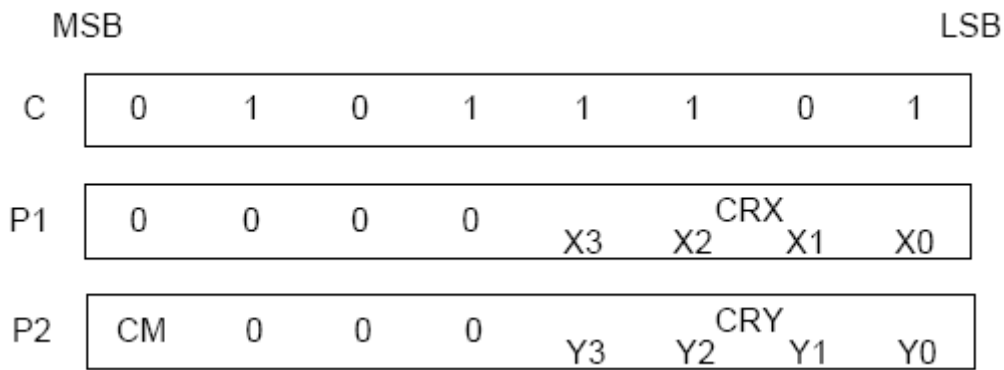


Figure: CSRFORM Parameter Bytes

7.2.5.1 CRX

Set the horizontal size of the cursor from the character origin. CRX is equal to the cursor size less one. CRX must be less than or equal to FX.

Table: Horizontal Cursor Size Selection

HEX	CRX				[CRX] cursor width (pixels)
	X3	X2	X1	X0	
0	0	0	0	0	1
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
4	0	1	0	0	9
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

7.2.5.2 CRY

Set the location of an underscored cursor in lines, from the character origin. When using a block cursor, CRY sets the vertical size of the cursor from the character origin. CRY is equal to the number of lines less one.

Table: Cursor Height Selection

HEC	CRY				[CRY] cursor Height (lines)
	X3	X2	X1	X0	
0	0	0	0	0	Illegal
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
8	1	0	0	0	9
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

Character start point

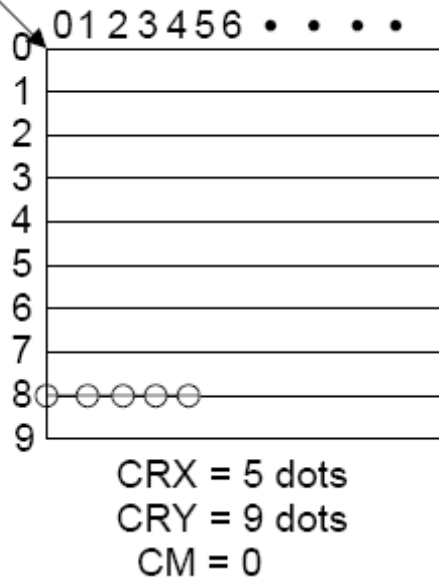


Figure: Cursor Size and Position

7.2.5.3 CM

Set the cursor shape. Always set CM to 1 when in graphics mode.

CM = 0: Underscore cursor

CM = 1: Block cursor

7.2.6 CSRDIR

Set the direction of automatic cursor increment. The cursor can move left or right one character, or up or down by the number of bytes specified by the address pitch, AP. When reading from and writing to display memory, this automatic cursor increment controls the display memory address increment on each read or write.

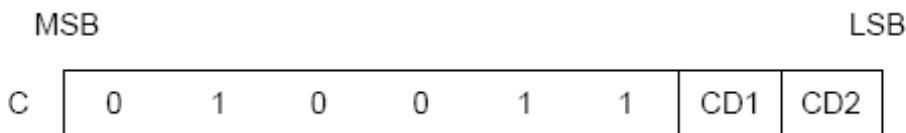


Figure: CSRDIR Parameters

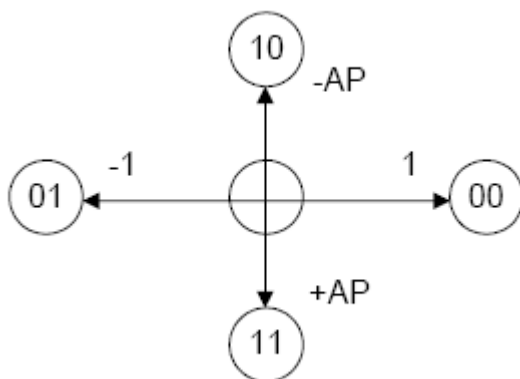


Figure: Cursor Direction

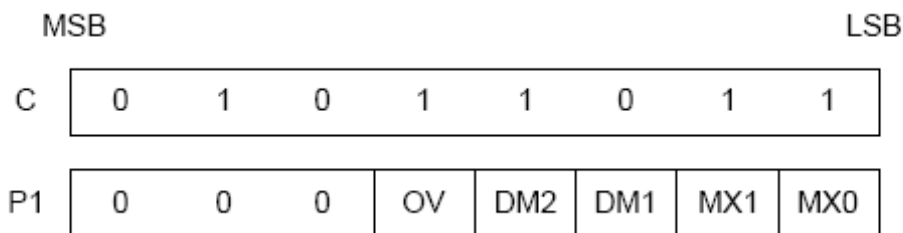
Table: Cursor Shift Direction

C	CD1	CD0	Shift direction
4CH	0	0	Right
4DH	0	1	Left
4EH	1	0	Up
4FH	1	1	Down

Note: Since the cursor moves in address units even if $FX \geq 9$, the cursor address increment must be preset for movement in character units. See Section 10-3.

7.2.7 OVLAY

Selects layered screen composition and screen text/ graphics mode.


Figure: OVLAY Parameters

7.2.7.1 MX0, MX1

MX0 and MX1 set the layered screen composition method, which can be either OR, AND, Exclusive-OR or Priority-OR. Since the screen composition is organized in layers and not by screen blocks, when using a layer divided into two screen blocks, different composition methods cannot be specified for the individual screen blocks. The Priority-OR mode is the same as the OR mode unless flashing of individual screens is used.

Table: Composition Method Selection

MX1	MX0	Function	Composition Method	Applications
0	0	$L1 \cup L2 \cup L3$	OR	Underlining, rules, mixed text and graphics
0	1	$(L1 \oplus L2) \cup L3$	Exclusive-OR	Inverted characters, flashing regions, underlining
1	0	$(L1 \cap L2) \cup L3$	AND	Simple animation, three-dimensional appearance
1	1	$L1 > L2 > L3$	Priority-OR	

Notes:

L1: First layer (text or graphics). If text is selected, layer L3 cannot be used.

L2: Second layer (graphics only)

L3: Third layer (graphics only)

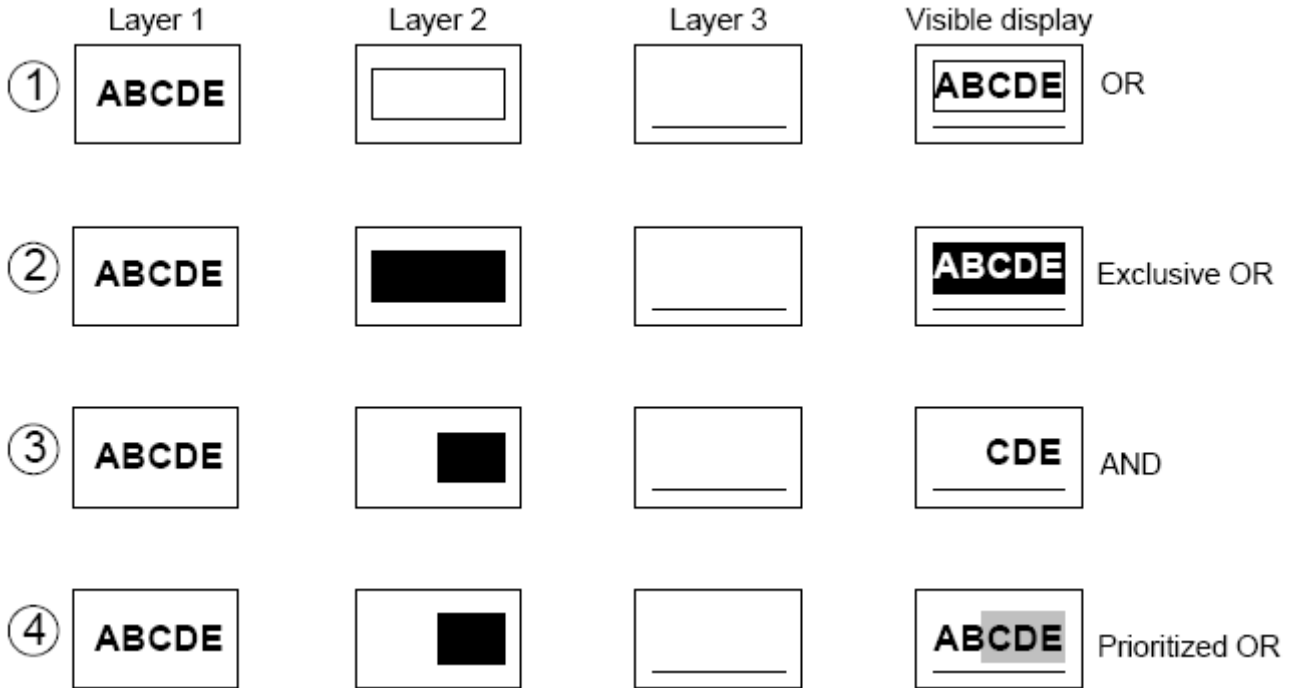


Figure: Combined Layer Display

Notes:

L1: Not flashing

L2: Flashing at 1 Hz

L3: Flashing at 2 Hz

7.2.7.2 DM1, DM2

DM1 and DM2 specify the display mode of screen blocks 1 and 3, respectively.

DM1/2 = 0: Text mode

DM1/2 = 1: Graphics mode

Note 1: Screen blocks 2 and 4 can only display graphics.

Note 2: DM1 and DM2 must be the same, regardless of the setting of W/S.

7.2.7.3 OV

Specifies two- or three-layer composition in graphics mode.

OV = 0: Two-layer composition

OV = 1: Three-layer composition

Set OV to 0 for mixed text and graphics mode.

7.2.8 CGRAM ADR

Specifies the CG RAM start address.

	MSB							LSB	
C	0	1	0	1	1	1	0	0	
P1	A7	A6	A5	A4	A3	A2	A1	A0	SAGL
P2	A15	A14	A13	A12	A11	A10	A9	A8	SAGH

7.2.9 HDOT SCR

While the SCROLL command only allows scrolling by characters, HDOT SCR allows the screen to be scrolled horizontally by pixels. HDOT SCR cannot be used on individual layers.

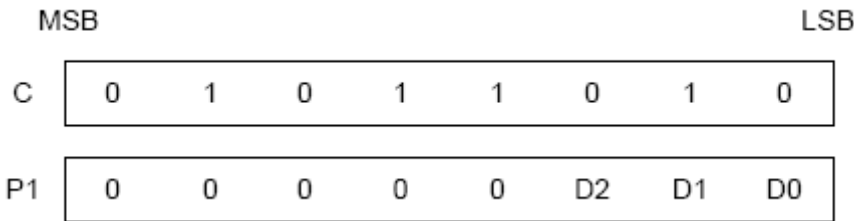


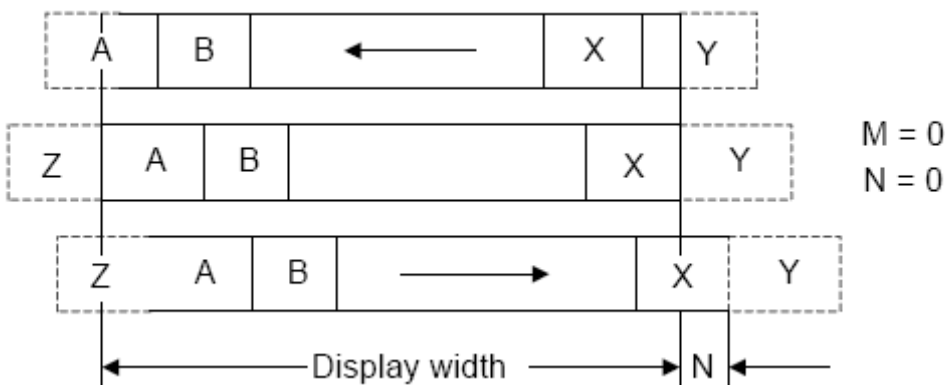
Figure: HDOT SCR Parameters

7.2.9.1 D0 to D2

Specifies the number of pixels to scroll. The C/R parameter has to be set to one more than the number of horizontal characters before using HDOT SCR. Smooth scrolling can be simulated if the controlling microprocessor repeatedly issues the HDOT SCR command to the RA8835A series.

Table: Scroll Step Selection

P1				Number of pixels to scroll
HEX	D2	D1	D0	
00	0	0	0	0
01	0	0	1	1
02	0	1	0	2
↓	↓	↓	↓	↓
06	1	1	0	6
07	1	1	1	7



M/N is the number of bits(dots) that parameter 1 (P1) is incremented/decremented by.

Figure: Horizontal Scrolling

7.2.10 CSRW

The 16-bit cursor address register contains the display memory address of the data at the cursor position as shown at below. Note that the microprocessor cannot directly access the display memory. The MREAD and MWRITE commands use the address in this register.

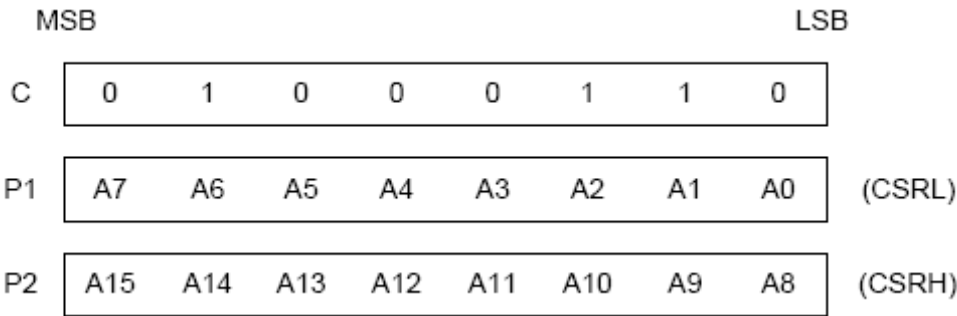


Figure: CSRW Parameters

The cursor address register can only be modified by the CSRW command, and by the automatic increment after an MREAD or MWRITE command. It is not affected by display scrolling. If a new address is not set, display memory accesses will be from the last set address or the address after previous automatic increments.

7.2.11 CSRR

Read from the cursor address register. After issuing the command, the data read address is read twice, for the low byte and then the high byte of the register.

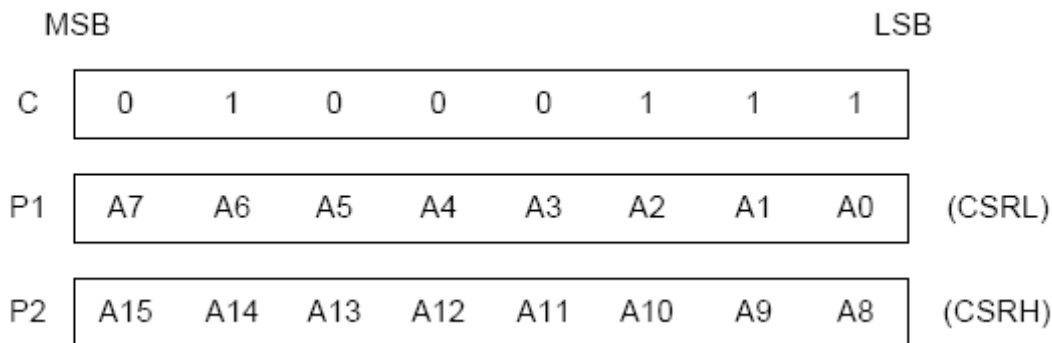


Figure: CSRR Parameters

7.2.12 MWRITE

The microprocessor may write a sequence of data bytes to display memory by issuing the MREAD command and then writing the bytes to the RA8835A series. There is no need for further MWRITE commands or for the microprocessor to update the cursor address register after each byte as the cursor address is automatically incremented by the amount set with CSRDIR, in preparation for the next data write.

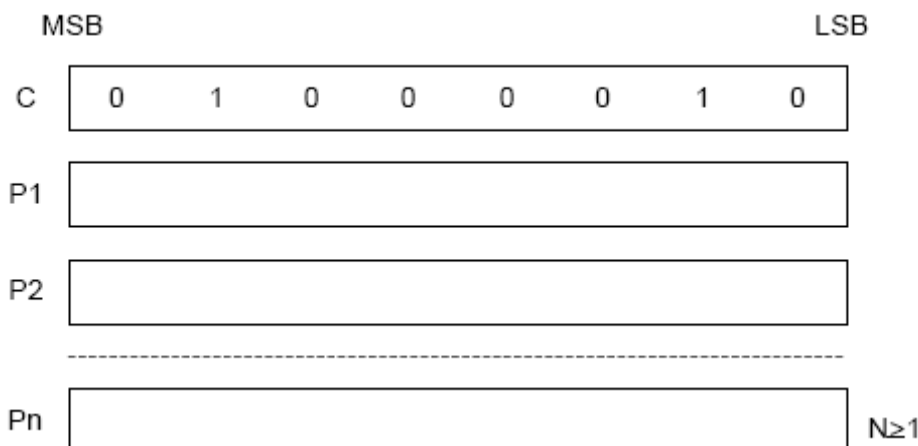
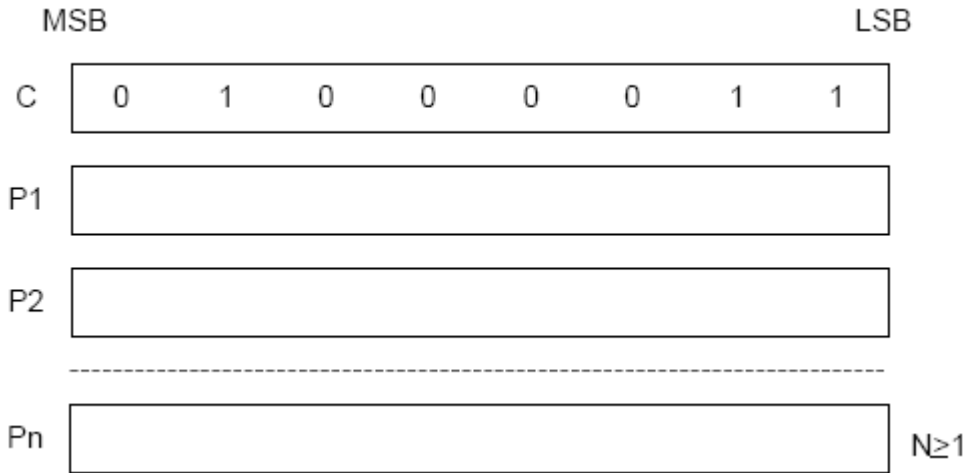


Figure: MWRITE Parameters

Note: P1, P2, ..., Pn: display data.

7.2.13 MREAD

Put the RA8835A series into the data output state. Each time the microprocessor reads the buffer, the cursor address is incremented by the amount set by CSRDIR and the next data byte fetched from memory, so a sequence of data bytes may be read without further MREAD commands or by updating the cursor address register. If the cursor is displayed, the read data will be from two positions ahead of the cursor.


Figure: MREAD Parameters

8.QUALITY SPECIFICATION

8.1 ACCEPTABLE QUALITY LEVEL

Inspection items	Sampling procedures	AQL
Visual-operating (Electro-optical)	GB2828-81 Inspection level II Normal inspection Single sample inspection	0.65
Visual-not operating	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5
Dimension measurement	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5

8.2 INSPECTION CONDITIONS

8.2.1 THE ENVIRONMENTAL

-Room temperature: 25±3 oC

-Humidity: 65±20%RH

8.3 INSPECTION STANDARDS

8.3.1 VISUAL WHILE OPERATING

Items to be inspected	Inspection standard
No display	If any pattern is not active at all, they can be rejected.
Irregular operating	No irregular operating are allowed Appeared different display, which they should be chosen in the pattern, or appeared in different position where they should be chosen.
Irregular display	Any segment doesn't active, they can be rejected.
Over current	The total current required to activate the module should not be exceed the MAX current in specification.
View angles	Valves that don't meet the minimum value noted in the specification. they can be rejected.
Contrast	Valves that don't meet the minimum value noted in the specification, they can be reject.
LCD operate voltage	Meet the specification.

8.3.2 Visual while not operating

Module dimension	Meet the module outline drawing, not exceed the tolerance.
LCD panel scratch	Following scratches inside the effective viewing area considered as the defects when their width & length are larger than the following combinations. Number: one or more Width: 0.1 length: 3.0 three or more Width: 0.05 length: 2.0 three or more Width: 0.03 length: 3.0 When the defects exceed this, it can be rejected.

9.RELIABILITY

9.1 Standard Specification for Reliability of General-purpose LCM

Test Item	Test Condition	Note
High Temperature Store	80 °C,24hr.	2
Low Temperature Store	-30 °C,24hr	2
Humidity Store	40 °C,90~95%RH,96hr	1,2
High Temperature Operation	+70°C,typical operating conditions,48hr	
Low Temperature Operation	-20°C,typical operating conditions,48hr	
Shock	Acceleration: 100m/s ² , Pulse time: 11ms, 6 times in each direction of XYZ	
Mechanical Vibration	10~55Hz sweep, 3G, ampl.=0.75mm(max) XYZ for 20 min, each.	

Note 1: Condensation of water is not permitted on the module.

Note 2: The module should be inspected after 4 hour storage in normal conditions (15~35 °C,45~65%RH)

9.2MTTF (Mean-Time-To-Fail)

The LCD is designed to meet the MTTF by 50,000 hours under normal room conditions (25°C,65%RH,without sun-shine)

10. HANDLING PRECAUTION

10.1 MOUNTING METHOD

The panel of the LCD module consists of two thin glass plates with polarizes which easily get damaged since the module is fixed by utilizing fitting holes in the printed circuit board. Extreme care should be taken when handling the LCD modules.

10.2 CAUTION OF LCD HANDLING & CLEANING

When cleaning the display surface. Use soft cloth with solvent (recommended below) and wipe lightly.

- Isopropyl alcohol
- Ethyl alcohol
- Tri chlorotri fluoroethane

Do not wipe the display surface with dry or hard materials that will damage the polarizes surface.

Do not use the following solvent:

- Water
- Ketone
- Aromatics

10.3 CAUTION AGAINST STATIC CHARGE

The LCD modules use COMS LSI drivers. So we recommend that you connect any unused input terminal to Vdd or Vss, do not input any signals before power is turned on and ground your body. work/assembly table. And assembly equipment to protect against static electricity.

10.4 PACKAGING

Modules use LCD elements, and must be treated as such avoid intense shock and falls from a height.

To prevent modules from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

10.5 CAUTION FOR OPERATION

It is indispensable to drive LCM within the specified voltage limit since the higher voltage than the limit shortens LCM life.

Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD show dark color in them.

However those phenomena do not mean malfunction or out of order with LCD, which will come back in the specified operating temperature range.

If the display area is pushed hard during operation. Some font will be abnormally displayed but it resumes normal condition after turning off once.

A slight dew depositing on terminals is a cause for Electro-chemical reaction resulting in terminal open circuit.

Under the maximum operating temperature, 50%RH or less is required

10.6 STORAGE

In the case of storing for a long period of time (for instance, for years) for the purpose or

replacement use. the following ways are recommended

Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it, and with no desiccant.

Placing in a dark place where neither exposure to direct sunlight nor light is, keeping temperature in the specified storage temperature range.

Storing with no touch on polarizes surface by the anythingelse.

(it is recommended to store them as they have been contained in the inner container at the time of delivery from us.

10.7 SAFETY

It is recommendable to crash damaged or unnecessary LCD into pieces and wash off liquid crystal by using solvents such as acetone and ethanol, which should be burned up later.

When any liquid crystal leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water.

11.PRECAUTION FOR USE

11.1 A limit sample should be provided by the both parties on an occasion when the both parties agree its necessity.

-Judgement by a limit sample shall take effect after the limit sample has been established and confirmed by the both parties.

11.2 On the following occasions, the handling of problem should be decided through discussion and agreement between representative of the both parties

When a question is arisen in this specification.

When a new problem is arisen which is not specified in this specifications.

When an inspection specification change or operating condition change in customer is reported to HUAYUAN, and some problem is arisen in this specification due to the change.

When a new problem is arisen at the customer's operating set for sample evaluation in the customer size.