深圳市华远显示器件有限公司

SHENZHEN HUAYUAN DISPLAY CO.,LTD.

液晶显示模块规格书

Specification for Liquid Crystal Display Module

HYG3206401G-fT60L-VB

Prepared By	Reviewed By	Approved By
Date:	Date:	Date:

REVISION HISTORY

The following table tracks the history of the changes made to this document.

SN	Rev.	Content	Date	Design
1	R00	Origin Released	2010-04-10	

CONTENTS

1. 0 GENERAL DESCRIPTION

The HYG3206401G-fT60L-VB is a 320x64 dots dot-matrix LCD module. It has a FSTN panel composed of 320 segments and 64 commons. The LCM can be easily accessed by microcontroller via 8080 series interface.

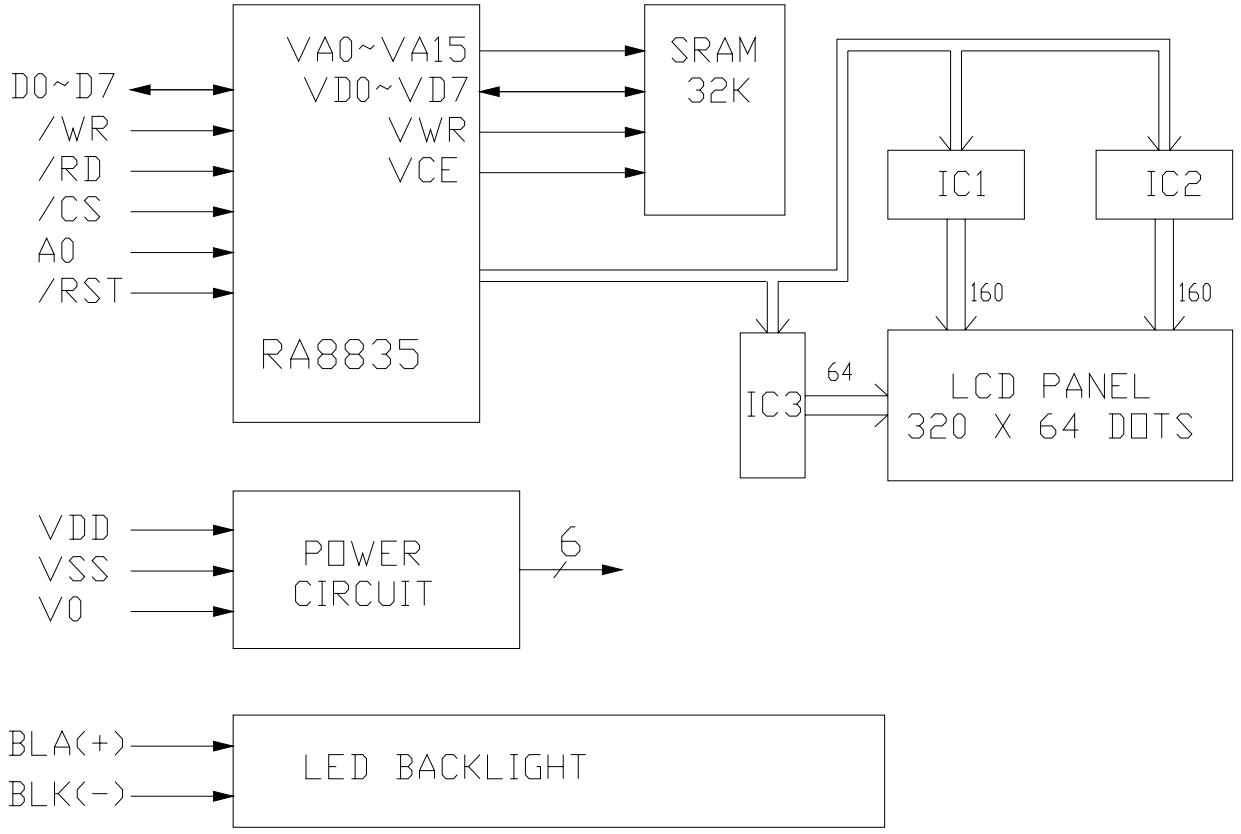
2. 0 FEATURES

Display Format	320 x 64 dots
LCD Type	FSTN-NEGATIVE
Polarizer Mode	TRANSMISSIVE
Drive Method	1/64 Duty, 1/9 Bias
Viewing Direction	6 O'clock
Controller	RA8835P3N
Interface	8080 Series 8-Bit Parallel Interface
Backlight	White LED Backlight

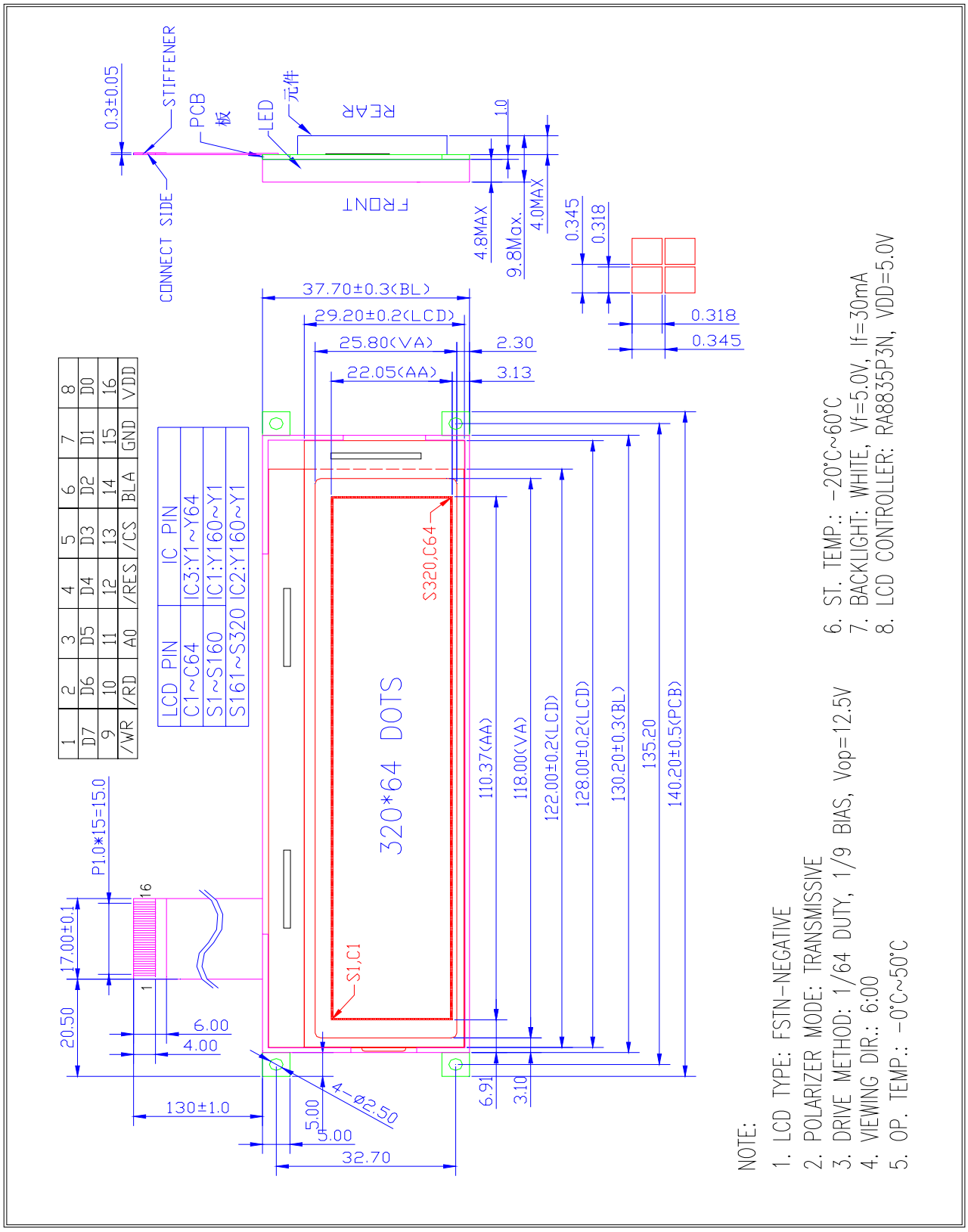
3. 0 MECHANICAL SPECIFICATION

Item	Description	Unit
Module Dimension	140.2(W) × 37.7(H) × 9.8(Max)(T)	mm
Viewing Area	118.0(W) × 25.8(H)	mm
Active Area	110.373(W) × 22.053(H)	mm
Dot Size	0.318(W) × 0.318(H)	mm
Dot Pitch	0.345(W) × 0.345(H)	mm
Character Size	——	mm

4. 0 BLOCK DIAGRAM



5. 0 EXTERNAL DIMENSIONS



6. 0 INTERFACE PIN DESCRIPTIONS

PIN No.	Symbol	Level	Description
1	D7	H/L	Data bit 7
2	D6	H/L	Data bit 6
3	D5	H/L	Data bit 5
4	D4	H/L	Data bit 4
5	D3	H/L	Data bit 3
6	D2	H/L	Data bit 2
7	D1	H/L	Data bit 1
8	D0	H/L	Data bit 0
9	/WR	H/L	**Write Control.** This signal acts as the active-LOW write strobe. The bus data is latched on the rising edge of this signal.
10	/RD	H/L	**Read Control.** This signal acts as the active-LOW read strobe. The output buffers are enabled when this signal is active.
11	A0	H/L	**Command/Data Select.** A0=0 : Display data and parameter A0=1 : Command
12	/RST	H/L	**Hardware Reset.** This active-LOW input performs a hardware reset.
13	/CS	H/L	**Chip Select.** This active-LOW input enables the RA8835A series.
14	BLA	P	Power supply for LED Backlight (+5.0V)
15	V_{SS}	P	Ground
16	V_{DD}	P	Power supply for logic(+5.0V)

7. 0 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic)	V_{DD}	-0.3	7.0	V
Supply Voltage (LCD)	V0	--	27.0	V
Input Voltage	V_I	-0.3	V_{DD}+0.3	V
Operating Temperature	Topr	0	+50	℃
Storage Temperature	Tstg	-20	+60	℃

8. 0 ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for Logic	V_{DD}	--	4.8	5.0	5.2	V
LCD Operating Voltage	V0	0℃				V
		+25℃	12.2	12.5	12.7	V
		+50℃				V
Input voltage H level	V_{IHC}	See note 1,2	0.5V_{DD}	---	V_{DD}	V
Input voltage L level	V_{ILC}	See note 1,2	V_{SS}	---	0.2V_{DD}	V
Output High Voltage	V_{OHC}	I_{OH}= 4.0 mA. See note 1, 2	V_{DD}-0.3	---	V_{DD}	V
Output Low Voltage	V_{OLC}	I_{OL}= -2 mA. See note 1, 2	0	---	0.3	V
Operating supply current	I_{OPR}	See note 3	—	3.5	8	mA

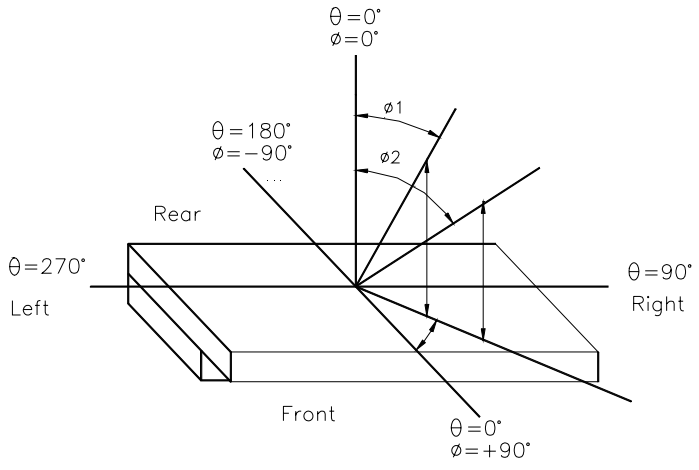
Notes:

1. /CS, /RD , /WR , A0 are inputs.
2. D0 to D7 are Bi-direction.
3. f_{OSC} = 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.

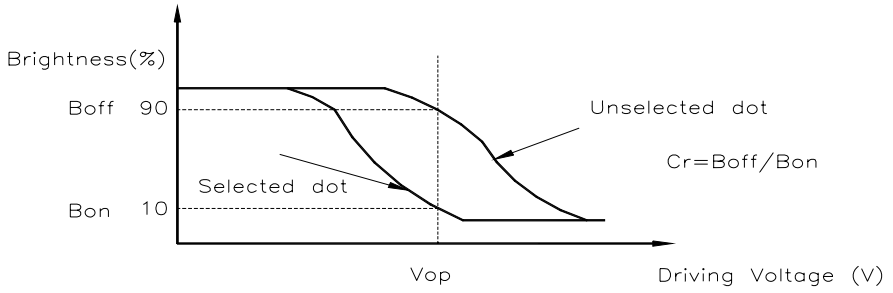
9. 0 OPTICAL CHARACTERISTICS

Item	Symbol	Condition		Min	Typ	Max	Unit
Response time	Ton	θ=0 ° and Ta=0℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+50℃			--		ms
	Toff	θ=0 ° and Ta=0℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+50℃			--		ms
Contrast ration	CR(MAX)	Ta=25℃		5	10		---
Viewing Angle	Ø	Deg θ=0 °	CR≥2.0 Ta=25℃		50		Deg
		Deg θ=90 °			35		
		Deg θ=180 °			30		
		Deg θ=270 °			35		
Crosstalk		Ta=25℃			1.2		---

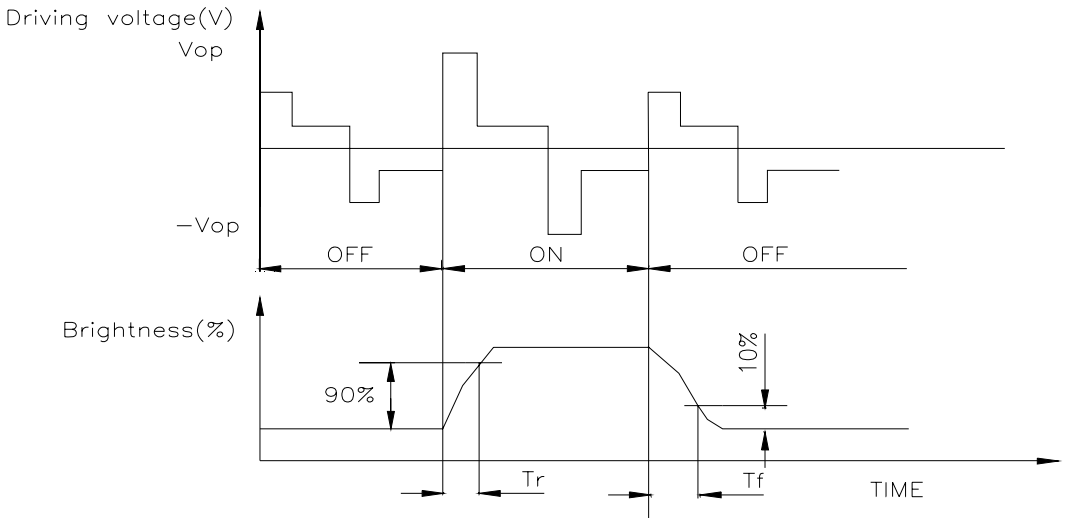
9.1 Viewing Angle θ , Ø and Viewing Angle Range: Δ Ø =|Ø2-Ø1|



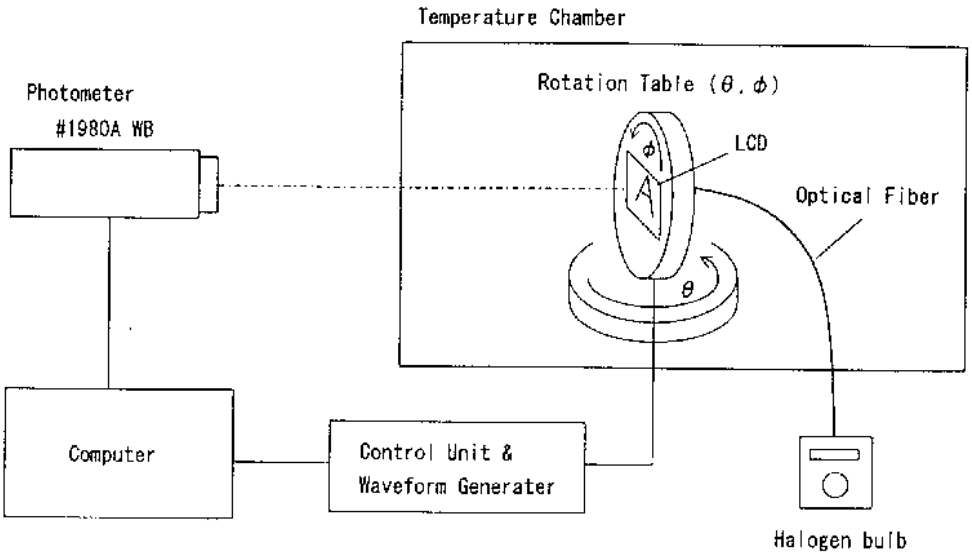
9.2 Contrast ratio(CR)



9.3 Response Time

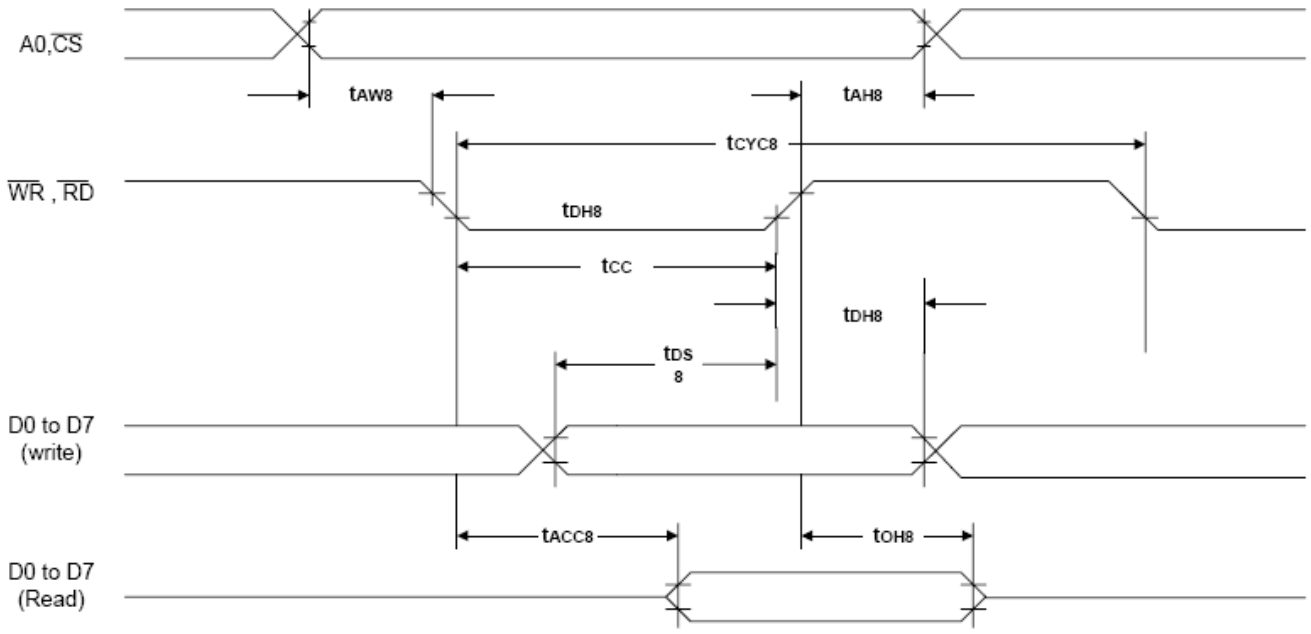


9.4 Optical Measurement System



10. 0 TIMING CHARACTERICS

10.1 8080 Family Interface Timing



Signal	Symbol	Parameter	Min.	Max.	Conditions	Unit
A0,/CS	tAW8	Address setup time	10	—	CL = 100pF	ns
	tAH8	Address hold time	0	—		
/WR,/RD	tCYC8	System cycle time	Note.	—		
	tCC	Strobe pulse width	120	—		
D0 to D7	tDS8	Data setup time	120	—		
	tDH8	Data hold time	5	—		
	tACC8	RD access time	—	50		
	tOH8	Output disable time	10	50		

Note :

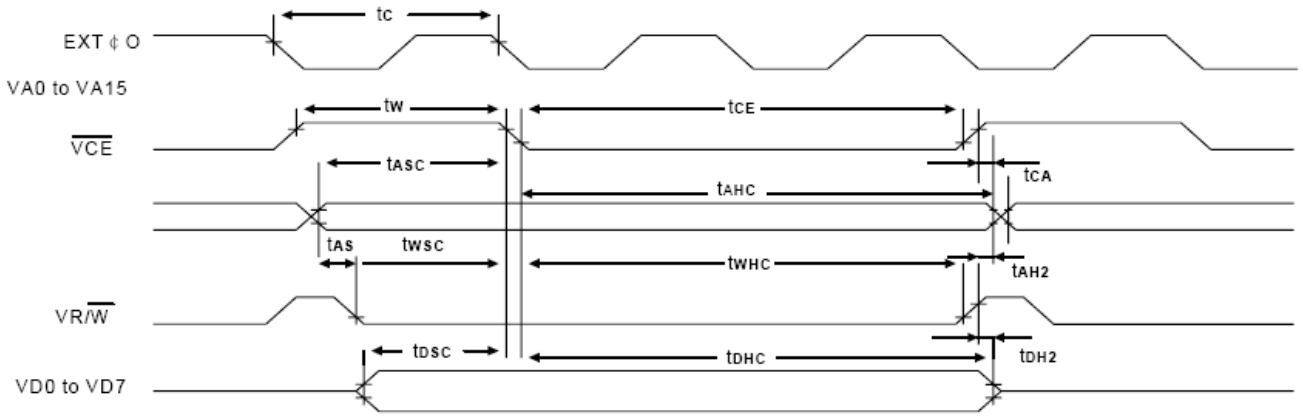
For memory control and system control commands:

tCYC8 = 2tC + tCC + tCEA + 75 > tACV + 245

For all other commands:

tCYC8 = 4tC + tCC + 30

10.2 Display Memory Write Timing



Signal	Symbol	Parameter	Min.	Max.	Unit	Condition
EXT Φ0	tC	Clock period	55.5	—	ns	
VCE	tW	VCE HIGH-level pulse width	tC – 50	—	ns	CL = 100 pF
	tCE	VCE LOW-level pulse width	2tC – 30	—	ns	
VA0 to VA15	tCYW	Write cycle time	3tC	—	ns	
	tAHC	Address hold time from falling edge of VCE	2tC – 30	—	ns	
	tASC	Address setup time to falling edge of VCE	tC – 70	—	ns	
	tCA	Address hold time from rising edge of VCE	0	—	ns	
	tAS	Address setup time to falling edge of VWR	0	—	ns	
	tAH2	Address hold time from rising edge of VWR	10	—	ns	
VWR	tWSC	Write setup time to falling edge of VCE	tC – 80	—	ns	
	tWHC	Write hold time from falling edge of VCE	2tC – 20	—	ns	
	tDSC	Data input setup time to falling edge of VCE	tC – 85	—	ns	
VD0 to VD7	tDHC	Data input hold time from falling edge of VCE	2tC – 30	—	ns	
	tDH2	Data hold time from rising edge of VWR	5	50	ns	

11. 0 BACKLIGHT CHARACTERISTICS

11.1 ABSOLUTE MAXIMUM RATINGS

(Ta=25℃)

Item	Symbol	Condition	Rating	Unit
Reverse Voltage	Vr		5	V
Absolute maximum forward current	Ifm		60	mA
Forward Current	Ifp	1ms plus 10% Duty cycle	30	mA
Power Description	Pd		90	mW
Operating temperature range	Topr		0~+50	^{0}C
Storage temperature range	Tst		-20~+60	^{0}C

For operation above 25℃ ,The Ifm Ifp & Pd must be derated ,the Current derating is–0.36×24mA/℃ for DC drive and –0.86×24mA/℃ for Pulse drive, the Power dissipation is –0.75×48 mW/℃. The product working current must not more than the 60% of the Ifm or Ifp according to the working temperature.

11.2 ELECTRICAL/OPTLCAL CHARACTERISTICS

(Ta=25℃)

Item	Symbol	Min	Typ	Max	Unit	Condition
Forward Voltage	Vf	4.8	5.0	5.1	V	If=30mA
Reverse Current	Ir		30		uA	Vr=5 V
Dominant wave length	λp		--		nm	If=30mA
Spectral Line Half width	Δ λ		--			If=30mA
Luminance	Lv		--		cd/㎡	If=30mA
Color Coordinate	X		WHITE			If=30mA
	Y					

12. 0 OPERATING PRINCIPLES & METHODS

12.1 RESET

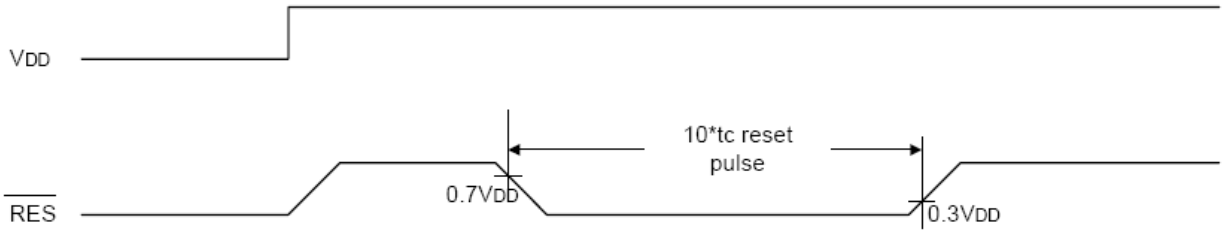


Figure 12-1 Reset Timing

The RA8835A series requires a reset pulse at least 10*tc long after power-on in order to re-initialize its internal state. If the oscillator frequency is 10Mhz, then the Reset pulse is at least 1μs. For maximum reliability, it is not recommended to apply a DC voltage to the LCD panel while the RA8835A series is reset. Turn off the LCD power supplies for at least one frame period after the start of the reset pulse.

The RA8835A series cannot receive commands while it is reset. Commands to initialize the internal registers should be issued soon after a reset. During reset, the LCD drive signals XD, LP and FR are halted. A delay of 3 ms (maximum) is required following the rising edges of both RES and VDD to allow for system stabilization.

12.2 RESET

Status Flag

The RA8835A series has a single bit status flag.

D6: X line standby

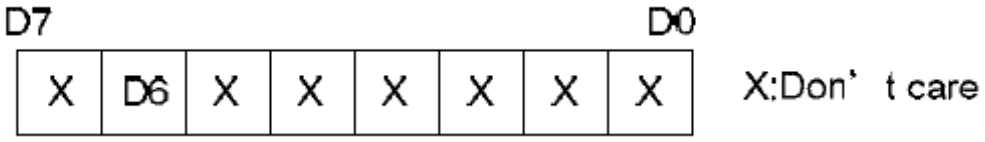


Figure 12-2 Status Flag

The D6 status flag is HIGH for the TC/R-C/R cycles at the end of each line where the RA8835A series is not reading the display memory. The microprocessor may use this period to update display memory without affecting the display, however it is recommended that the display be turned off when refreshing the whole display.

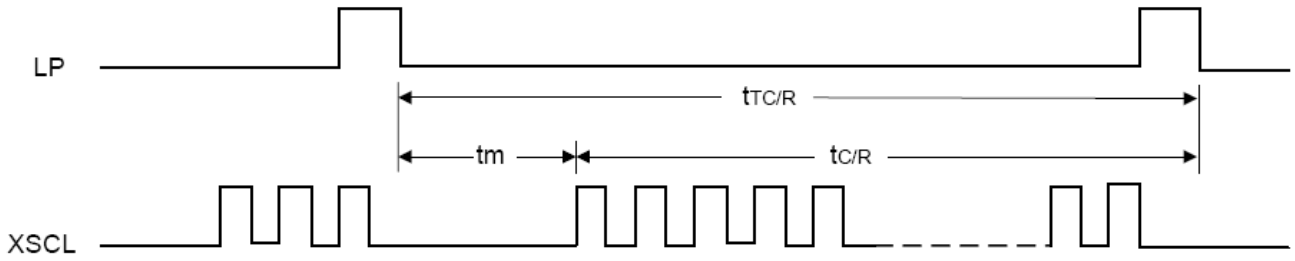


Figure 12-3 C/R to TC/R Time Difference

CS	A0	RD	D6(flag)
0	0	0	0: Period of retrace lines 1: Period of display

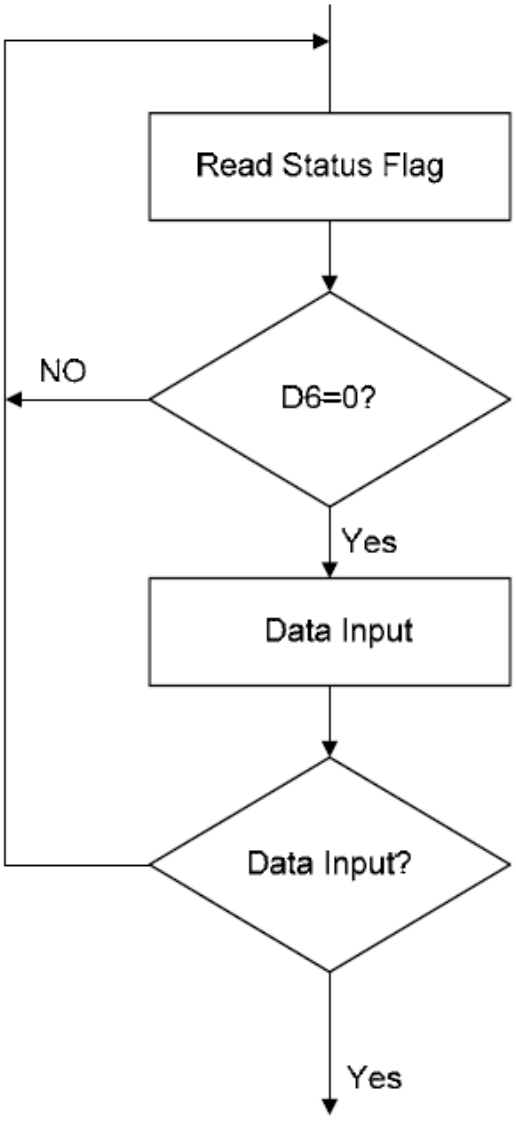


Figure 13-4 Flowchart for Busy Flag Checking

12.3 Display Address Scanning

The RA8835A series scans the display memory in the same way as a raster scan CRT screen. Each row is scanned from left to right until the address range equals C/R. Rows are scanned from top to bottom.

In graphics mode, at the start of each line, the address counter is set to the address at the start of the previous line plus the address pitch, AP.

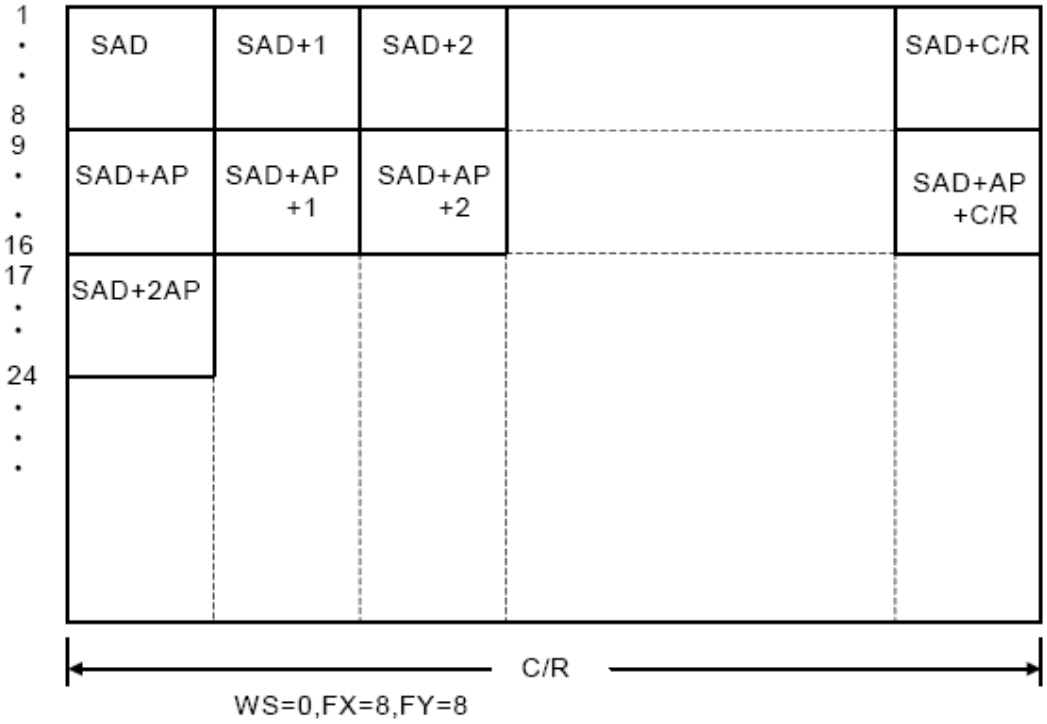


Figure 13-5 Character Position Parameters

Note: One byte of display memory corresponds to one character.

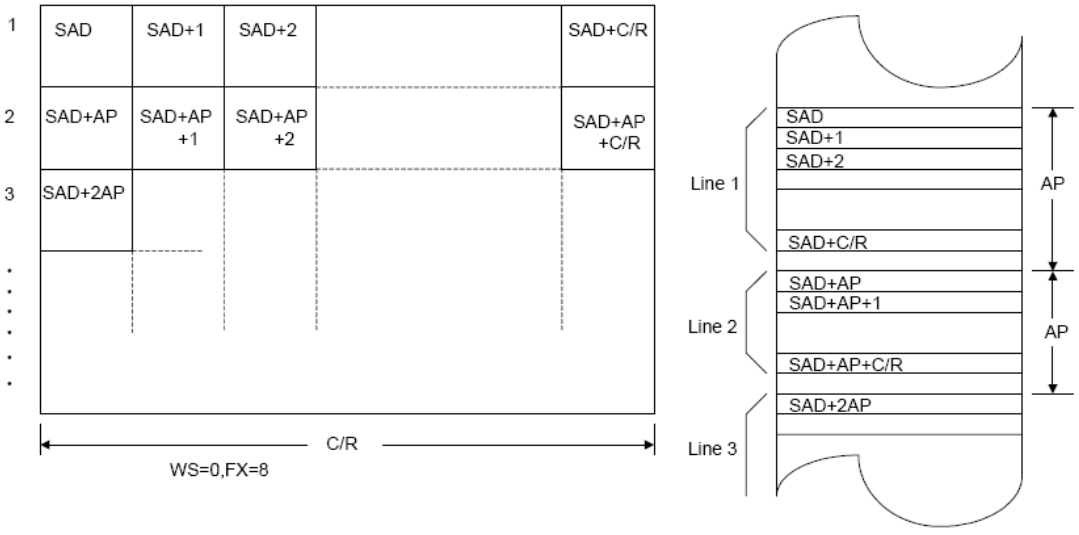
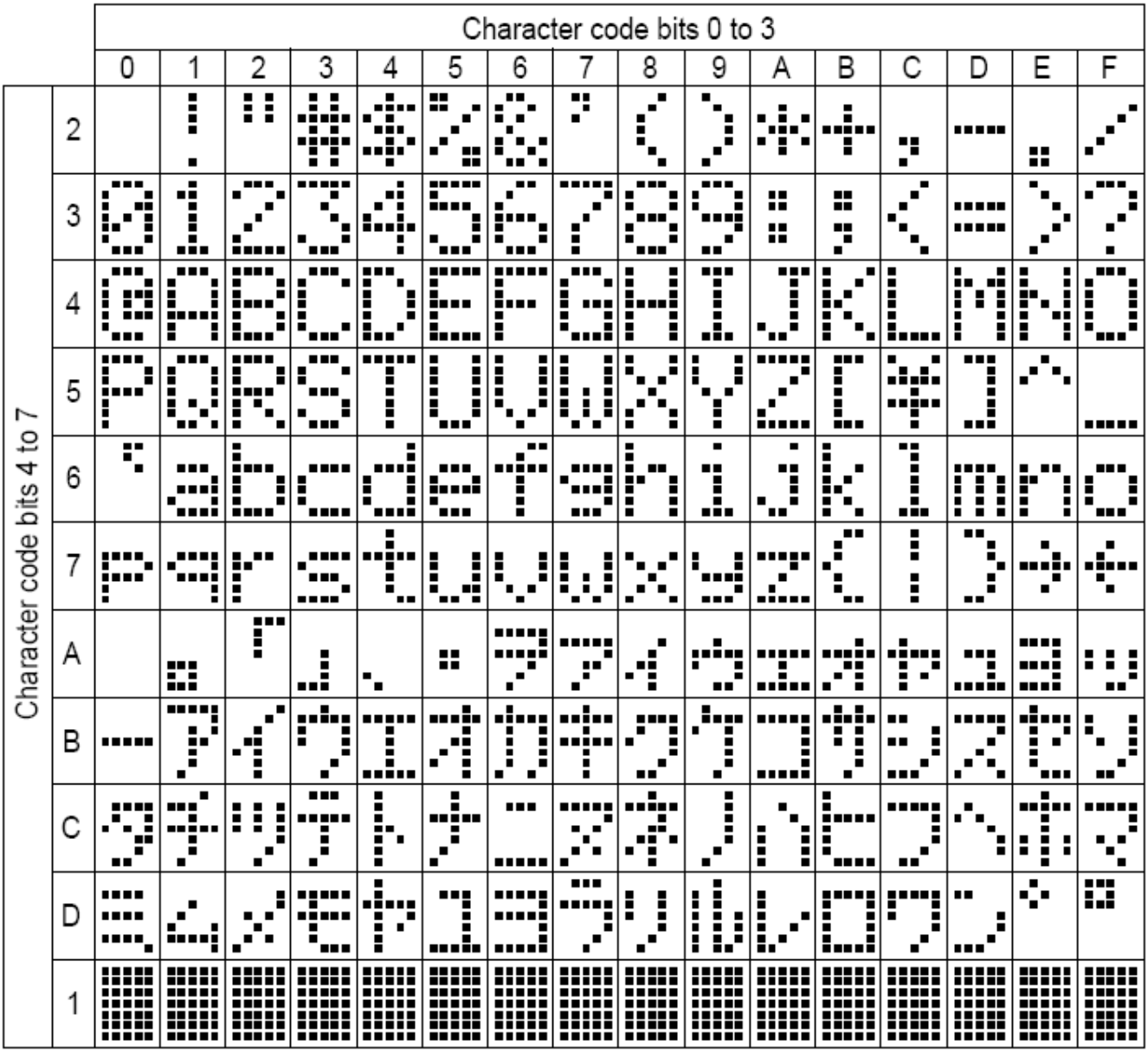


Figure 13-5 Character Parameters vs. Memory

Note: One bit of display memory corresponds to one pixel.

In text mode, the address counter is set to the same start address, and the same character data is read, for each row in the character bitmap. However, a new row of the character generator output is used each time. Once all the rows in the character bitmap have been displayed, the address counter is set to the start address plus AP and the next line of text is displayed.

12.4 On-chip character set



13. 0 INSTRUCTION DESCRIPTION

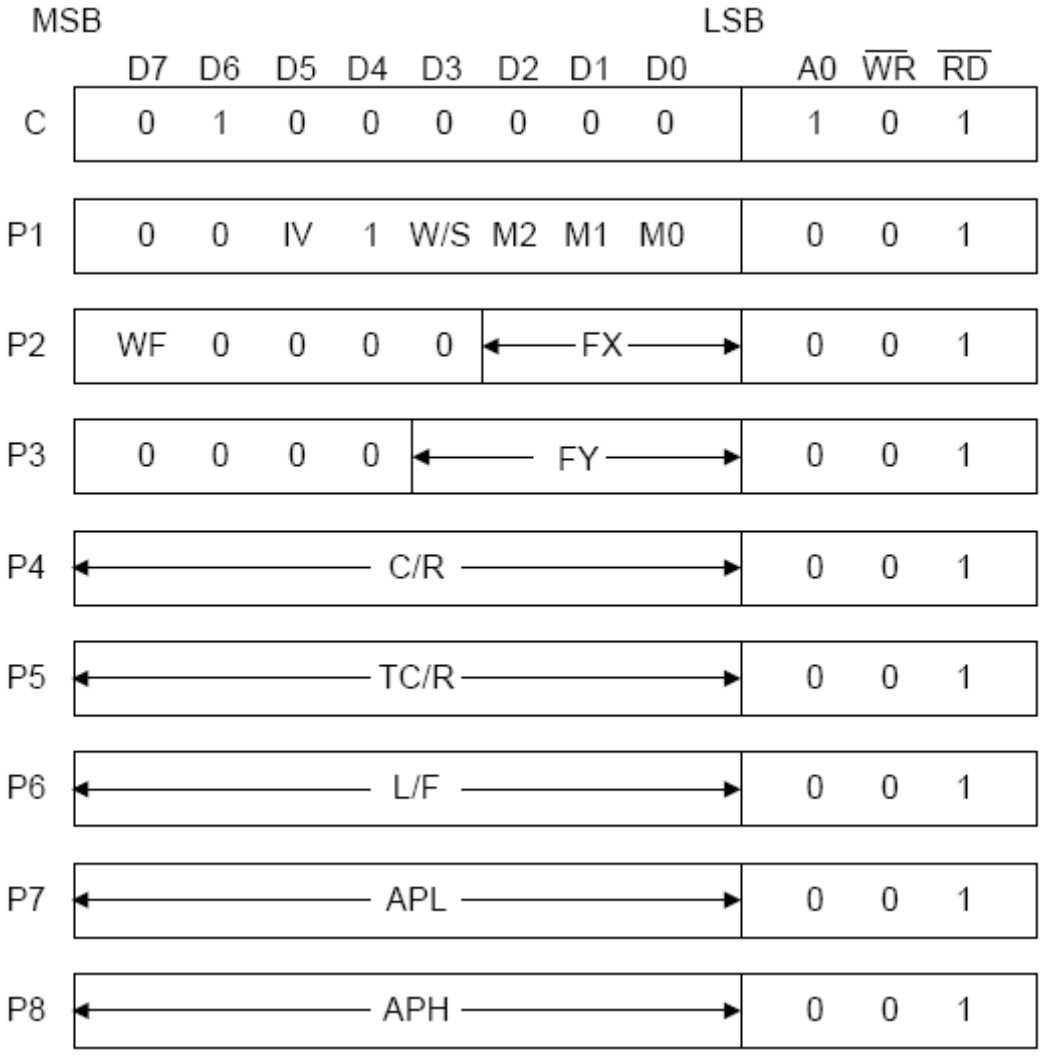
13.1 INSTRUCTION TABLE

Class	Command	Code												Command Description	No. of Para.
		RD	WR	A0	D7	D6	D5	D4	D3	D2	D1	D0	HEX		
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 regions	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	CD1	CD0	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	—

13.2 SYSTEM CONTROL COMMAND

13.2.1 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.



13.2.1.1 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.

13.2.1.2 M0

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

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

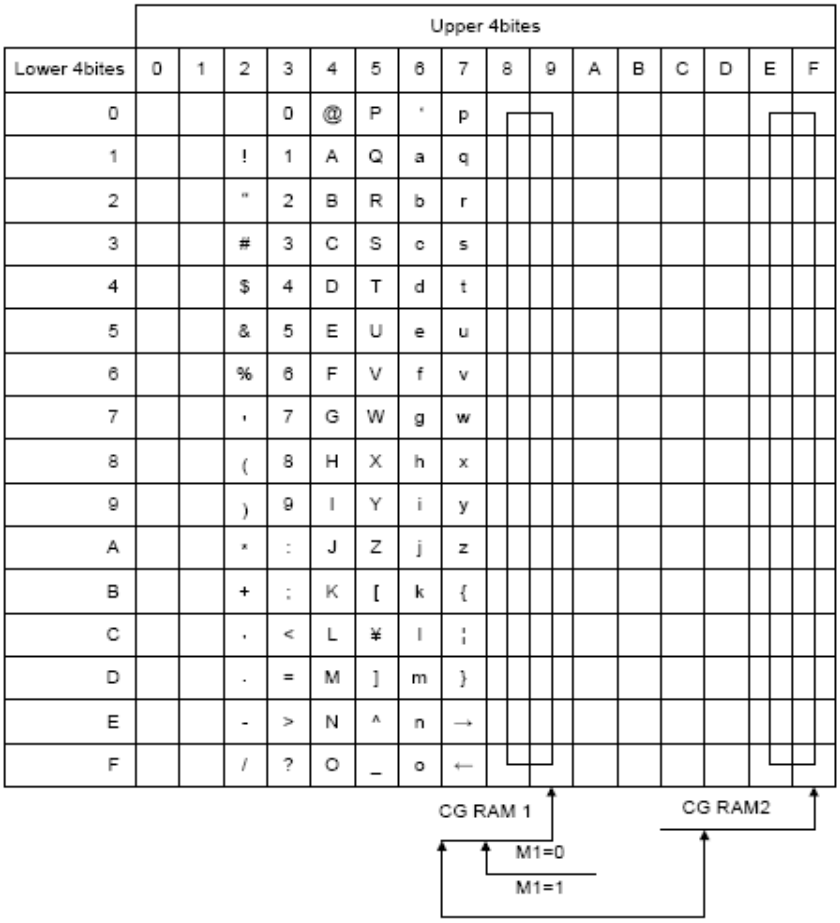
M0 = 0: Internal CG ROM

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.

13.2.1.3 M1

Select the memory configuration for user-definable characters. The CG RAM codes select one of the 64 codes shown in the following figure.



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.

13.2.1.4 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)

13.2.1.5 W/S

Select the LCD drive method.

W/S = 0: Single-panel drive (Fix to 0)

13.2.1.6 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.

IV = 0: Screen top-line correction

IV = 1: No screen top-line correction

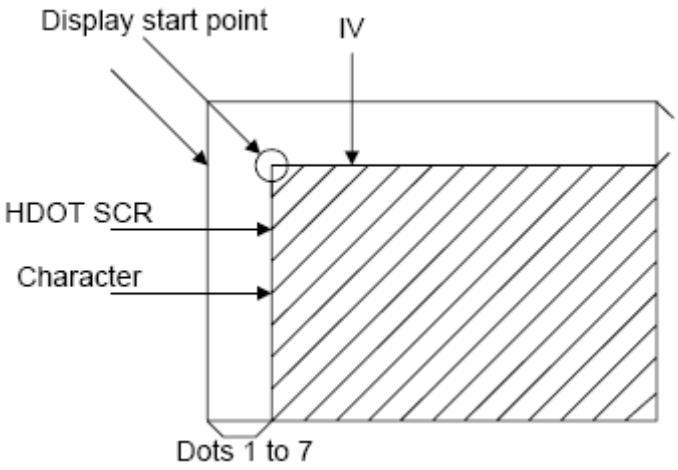


Figure 13-1: IV and HDOT SCR Adjustment

13.2.1.7 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.

FX					[FX] character width (pixels)
HEX	D 3	D 2	D 1	D 0	
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 13-2 shows, the remainder of the second eight bits are not displayed. This also applies to the second screen layer.

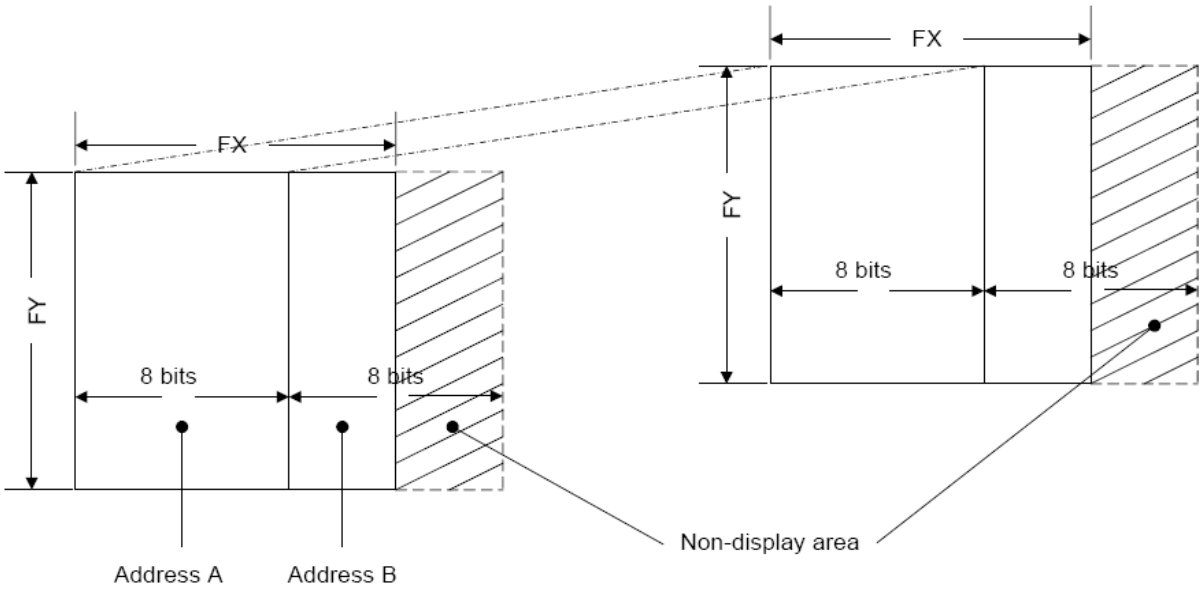


Figure 13-2: FX and FY Display Addresses

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.

13.2.1.8 WF

Select the AC frame drive waveform period. WF is usually set to 1.

WF = 0: 16-line AC drive

WF = 1: two-frame AC drive

In two-frame AC drive, the WF period is twice the frame period. In 16-line AC drive, WF inverts every 16 lines.

Although 16-line AC drive gives a more readable display, horizontal lines may appear when using high LCD drive voltages or at high viewing angles.

13.2.1.9 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.

FY					[FY] character height (pixels)
HEX	D 3	D 2	D 1	D 0	
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

13.2.1.10 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.

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

13.2.1.11 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, fOSC.

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

13.2.1.12 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.

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

3.2.1.13 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

Hex code				[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	$2^{16}-1$

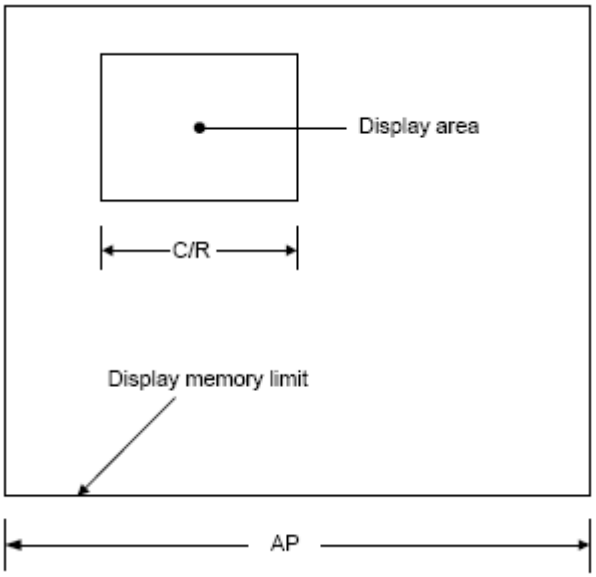


Figure 13-3: AP and C/R Relationship

13.2.2 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.

	MSB							LSB
C	0	1	0	1	0	0	1	1

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.

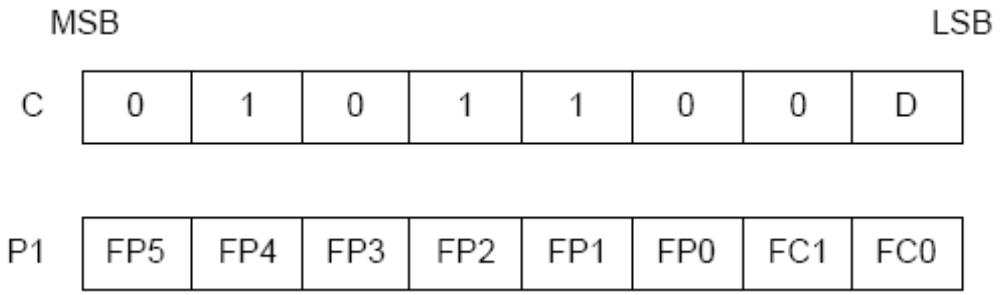
2. Since all internal clocks in the RA8835A series are halted while in the sleep state, a DC voltage will be applied to the LCD panel if the LCD drive supplies remain on. If reliability is a prime consideration, turn off the LCD drive supplies before issuing the SLEEP IN command.

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.

13.3 Display Control Commands

13.3.1 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.



13.3.1.1 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

13.3.1.2 FC

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

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

13.3.1.3 FP

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

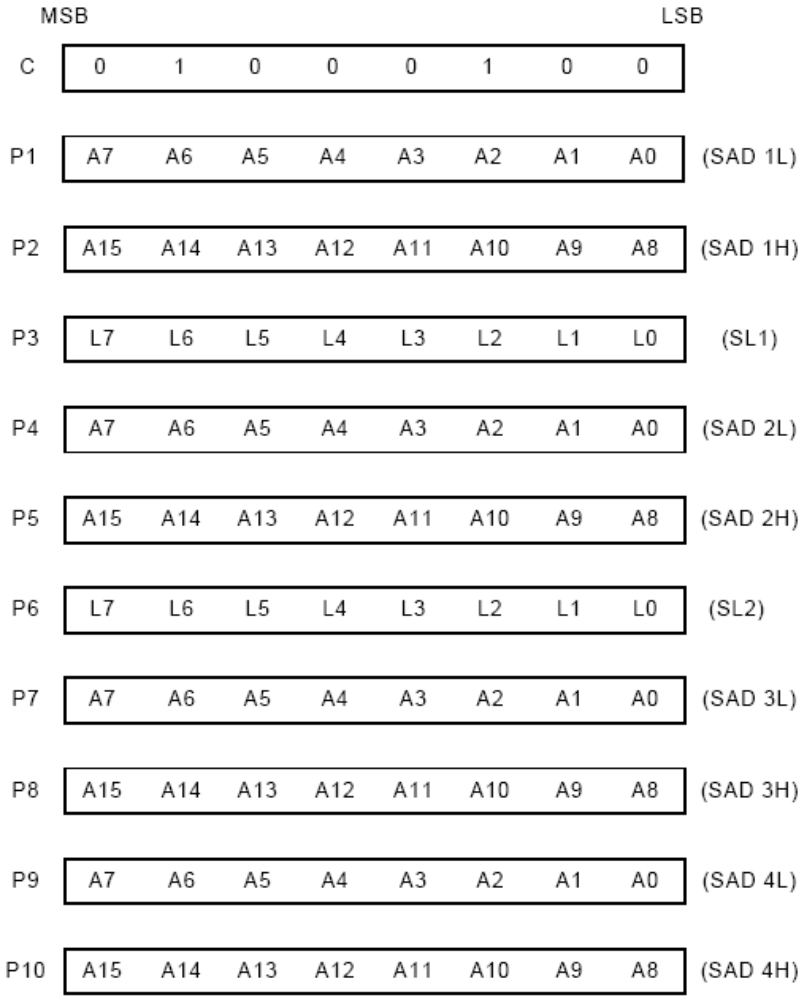
FP1	FP0	First screen block (SAD1)	
FP3	FP2	Second screen block (SAD2, SAD4). See note.	
FP5	FP4	Third screen block (SAD3)	
0	0	OFF (blank)	
0	1	ON	No flashing
1	0		Flash at fFR/32 Hz (approx. 2 Hz)
1	1		Flash at fFR/4 Hz (approx. 16 Hz)

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.

13.3.2 SCROLL

13.3.2.1 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 in the following figure.



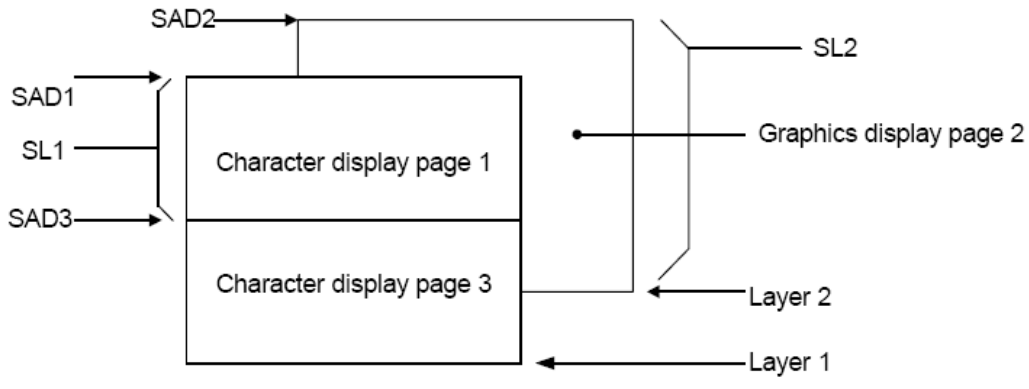
Note: Set parameters P9 and P10 only if both two-screen drive (W/S = 1) and two-layer configuration are selected. SAD4 is the fourth screen block display start address.

SL1, SL2									[SL] screen lines
HEX	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

13.3.2.2 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.

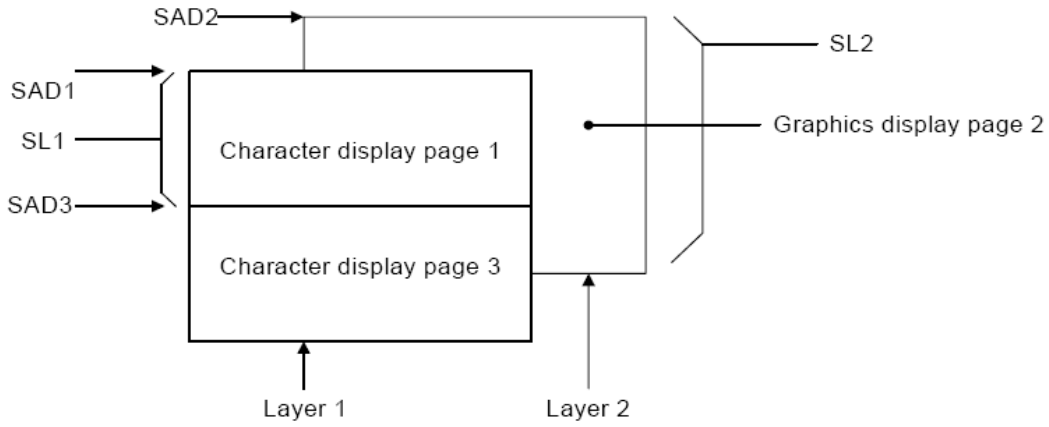
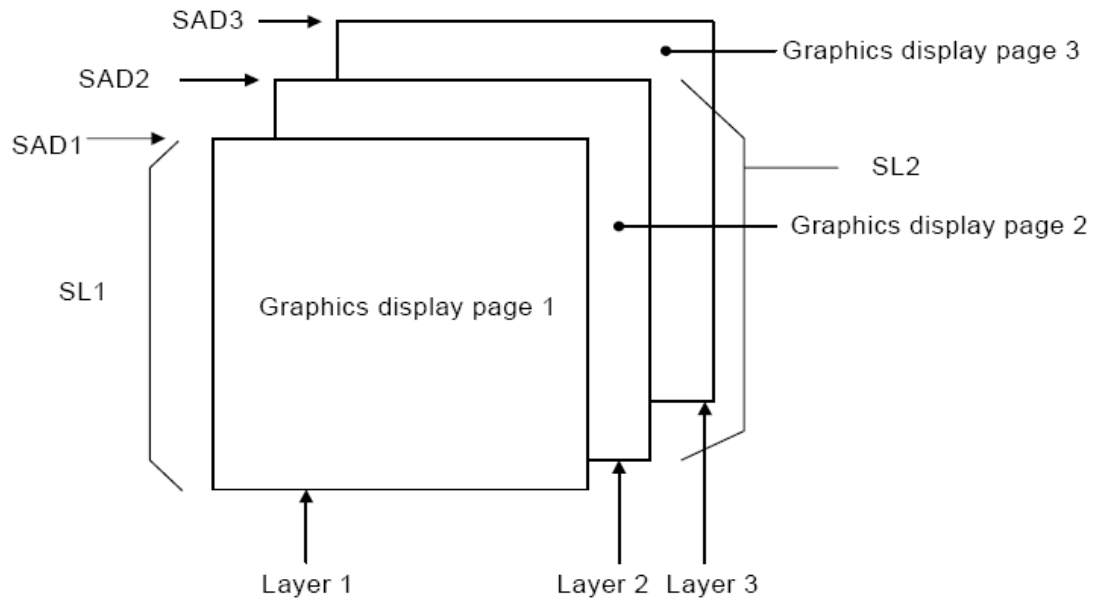
- **Text Display Mode**

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:  		

Notes:

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

● Graphics Display Mode

<table>
<tr><th>W/S</th><th>Screen</th><th>First Layer</th><th>Second Layer</th><th>Third Layer</th></tr>
<tr><td rowspan="5">0</td><td>Two-layer composition</td><td>SAD1
SL1</td><td>SAD2
SL2</td><td>—</td></tr>
<tr><td>Upper screen</td><td colspan="2">SAD3 (see note 3)
Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen</td><td>—</td></tr>
<tr><td colspan="4">Screen configuration example:
 
</td></tr>
<tr><td>Three-layer configuration</td><td>SAD1
SL1 = L/F + 1</td><td>SAD2
SL1 = L/F + 1</td><td>SAD3
—</td></tr>
<tr><td colspan="4">Screen configuration example:
 
</td></tr>
</table>

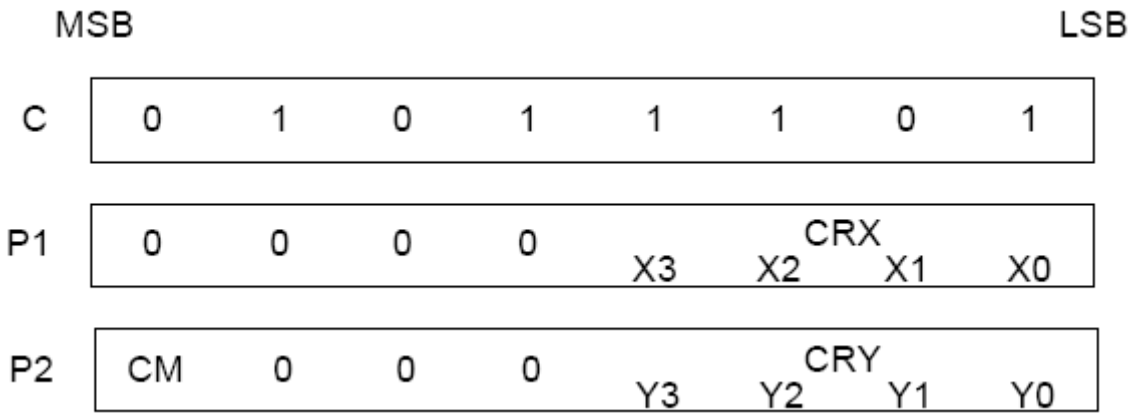
Notes:

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.

13.3.3 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.



13.3.3.1 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.

CRX					[CRX] cursor width (pixels)
HEX	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

13.3.3.2 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.

CRY					[CRY] cursor width (lines)
HEX	Y3	Y2	Y1	Y0	
0	0	0	0	0	Illegal
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
4	0	1	0	0	9
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

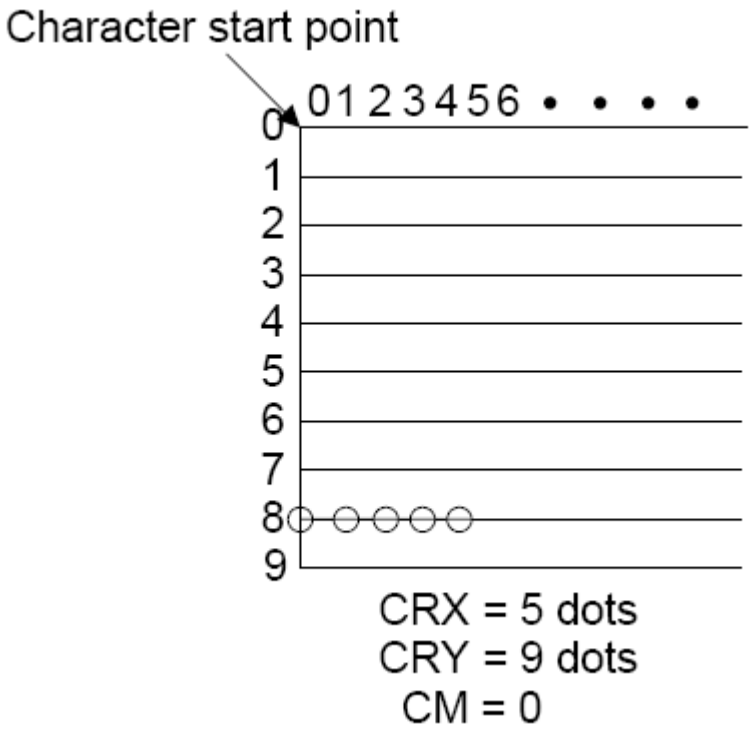


Figure 13-4: Cursor Size and Position

13.3.3.3 CM

Set the cursor shape. Always set CM to 1 when in graphics mode.
CM = 0: Underscore cursor
CM = 1: Block cursor

13.3.4 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.

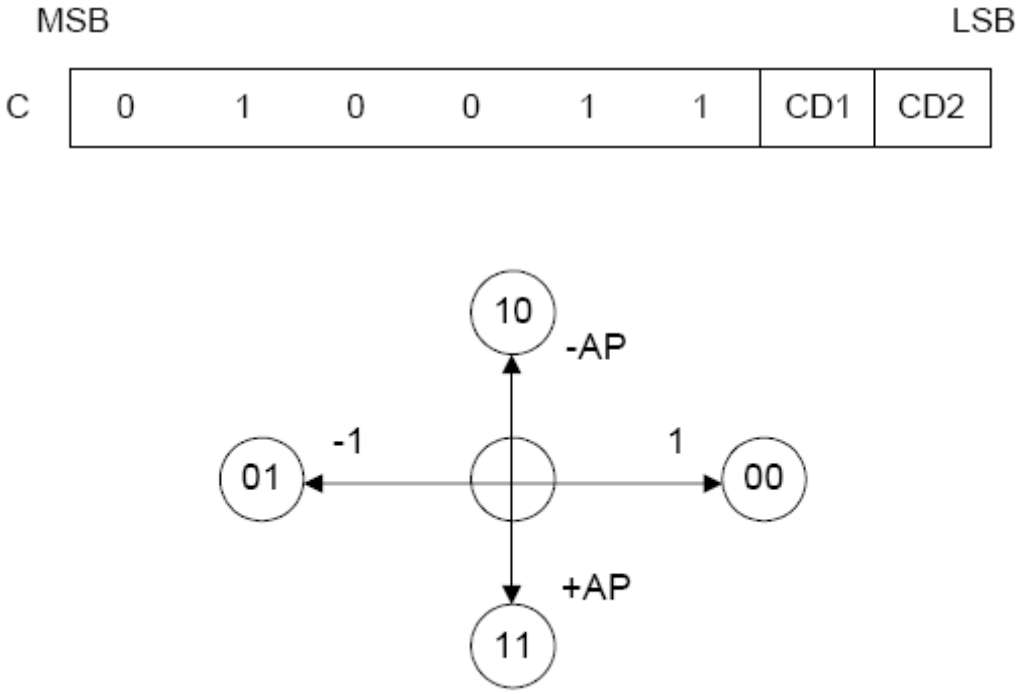


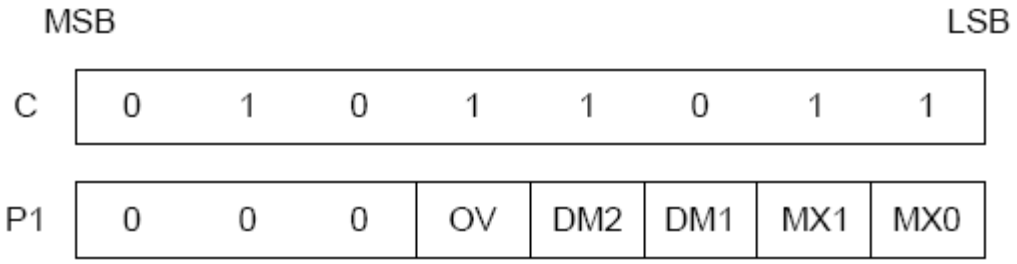
Figure 13-4: Cursor Direction

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 ≥ 9 , the cursor address increment must be preset for movement in character units.

13.3.5 OVLAY

Selects layered screen composition and screen text/ graphics mode.



13.3.5.1 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.

MX1	MX0	Functio n	Composition Method	Applications
0	0	L1 ∪ L2 ∪ L3	OR	Underlining, rules, mixed text and graphics
0	1	(L1 ⊕ L2) ∪ L3	Exclusive-OR	Inverted characters, flashing regions, underlining
1	0	(L1 ∩ L2) ∪ 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)

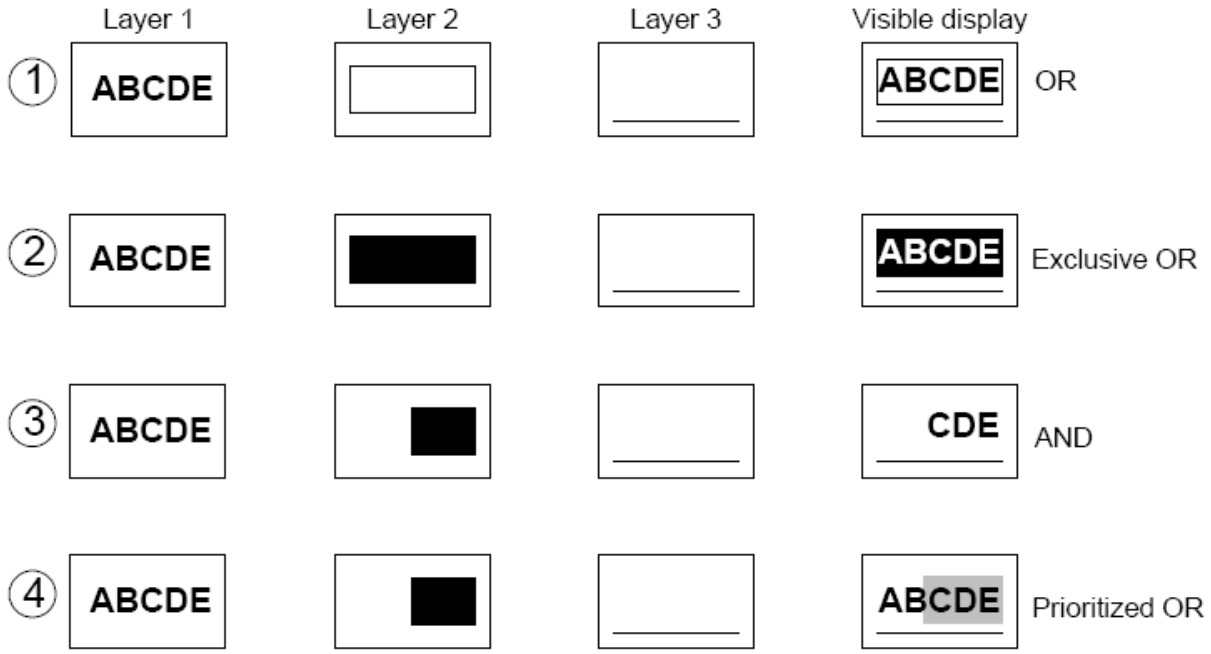


Figure 13-5: Combined Layer Display

Notes:
L1: Not flashing ; L2: Flashing at 1 Hz ; L3: Flashing at 2 Hz

13.3.5.2 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.

13.3.5.3 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.

13.3.6 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

Note: See section 10 for information on the SAG parameters.

13.3.7 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.

	MSB							LSB
C	0	1	0	1	1	0	1	0
P1	0	0	0	0	0	D2	D1	D0

13.3.7.1 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.

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

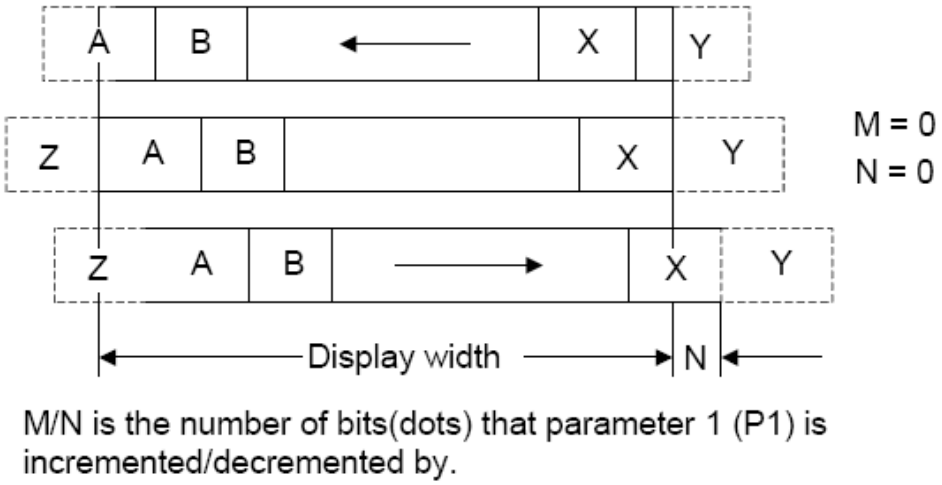


Figure 13.6 Horizontal Scrolling

13.4 Drawing Control Commands

13.4.1 CSRW

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

	MSB							LSB	
C	0	1	0	0	0	1	1	0	
P1	A7	A6	A5	A4	A3	A2	A1	A0	(CSRL)
P2	A15	A14	A13	A12	A11	A10	A9	A8	(CSRH)

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.

13.4.2 CSRR

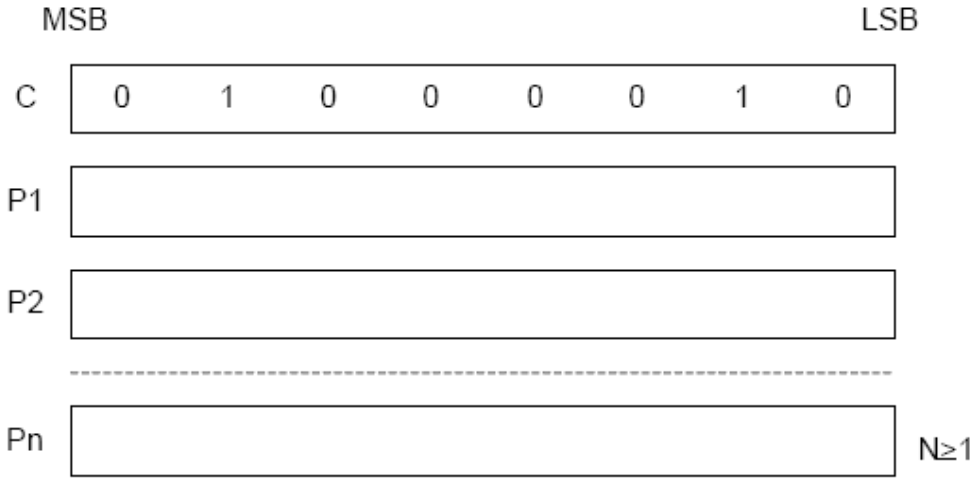
Read from the cursor address register. After issuing the command, the data read address is read twice, for the low byte and then the high byte of the register.

	MSB							LSB	
C	0	1	0	0	0	1	1	1	
P1	A7	A6	A5	A4	A3	A2	A1	A0	(CSRL)
P2	A15	A14	A13	A12	A11	A10	A9	A8	(CSRH)

13.5 Memory Control Commands

13.5.1 MWRITE

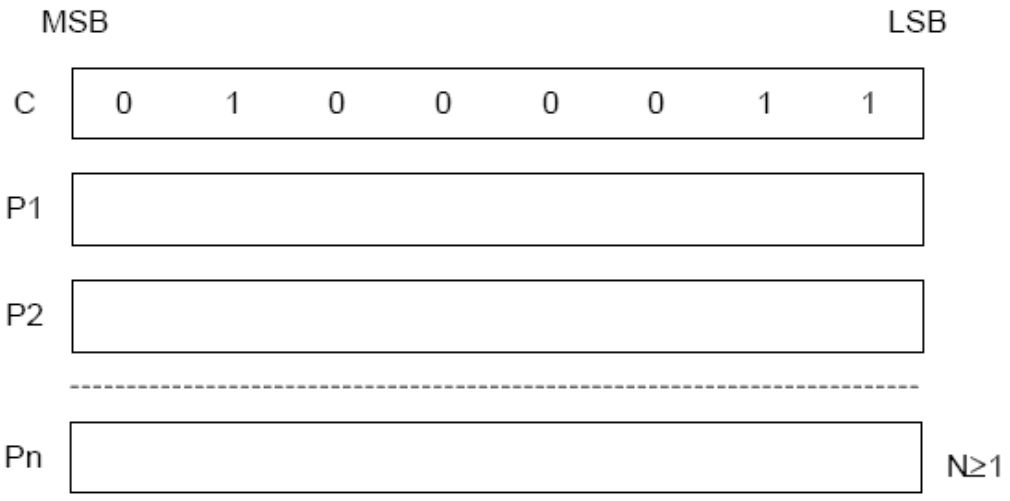
The microprocessor may write a sequence of data bytes to display memory by issuing the MREAD command and then writing the bytes to the RA8835A series. There is no need for further MWRITE commands or for the microprocessor to update the cursor address register after each byte as the cursor address is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



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

13.5.2 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.



14. 0 QUALITY GUARANTEE

14.1 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

14.2 Conditions of Cosmetic Inspection

- Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25℃ and normal humidity 60±15%RH).

- Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

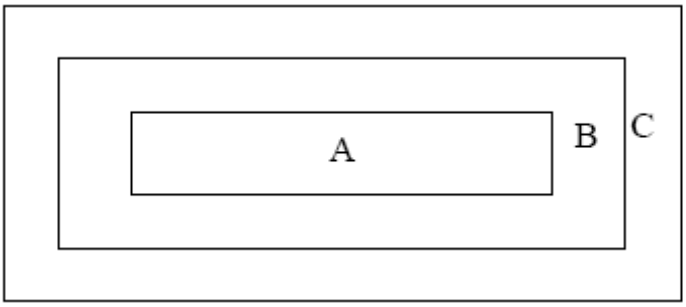
The V0 value which the most optimal contrast can be obtained near the specified V0 in the specification. (Within ±0.5V of the typical value at 25℃.).

14.3 Definition of inspection zone in LCD

Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)



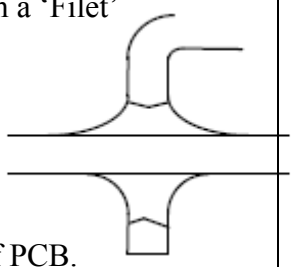
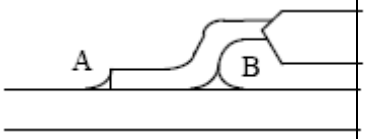
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

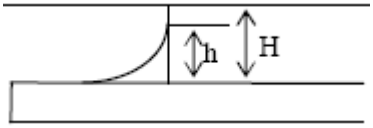
14.4 Inspection Standard

- **Major Defect**

Item No	Items to be inspected	Inspection Standard	Classification of defects
1	All functional defects	1) No display 2) Display abnormally 3) Missing vertical，horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting.	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	

- **Module Cosmetic Criteria**

No.	Item	Judgment Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. Lead parts	a. Soldering side of PCB Solder to form a ‘Filet’ all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of ‘Through Hole PCB’) Solder to reach the Components side of PCB. 	Minor
	2. Flat packages	Either ‘Toe’ (A) or ‘Seal’ (B) of the lead to be covered by ‘Filet’. Lead form to be assume over solder. 	Minor

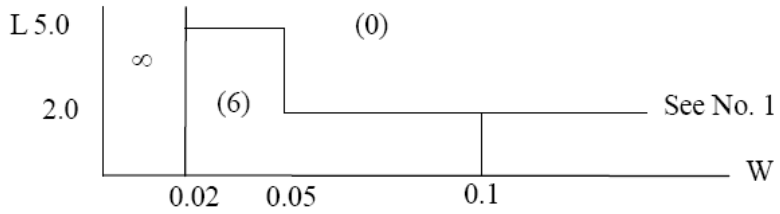
No.	Item	Judgment Criterion	Partition
8	3. Chips	(3/2) H ≥ h ≥ (1/2) H 	Minor

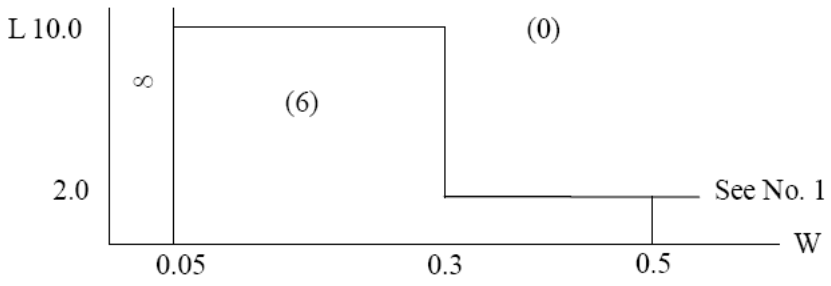
● Screen Cosmetic Criteria (Non-Operating)

No.	Defect	Judgement Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1*.	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2*.	Minor
3	Bubbles in polarizer	<table><tr><td>Size : d</td><td>mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d</td><td>≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d</td><td>≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d</td><td>≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td></td><td>0</td></tr></table>	Minor
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor
7	Contamination	Not to be noticeable.	Minor

Note: Size : d = (long length + short length) / 2

● Screen Cosmetic Criteria (Operating)

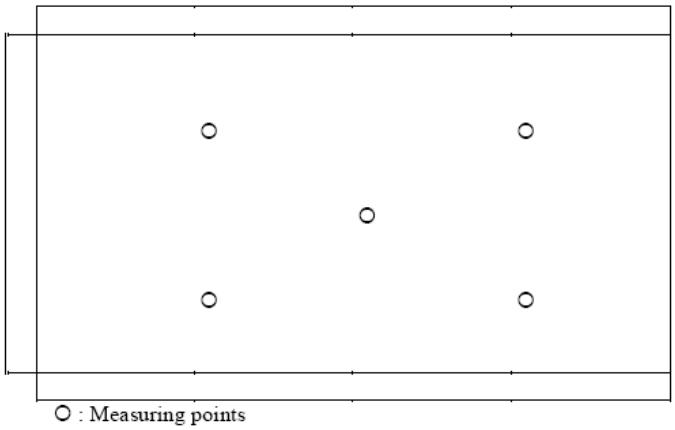
<table>
<tr><th>No.</th><th>Defect</th><th>Judgment Criterion</th><th>Partition</th></tr>
<tr><td>1</td><td>Spots</td><td>A) Clear
<table>
<tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td>d ≤ 0.1</td><td>Disregard</td></tr>
<tr><td>0.1 < d ≤ 0.2</td><td>6</td></tr>
<tr><td>0.2 < d ≤ 0.3</td><td>2</td></tr>
<tr><td>0.3 < d</td><td>0</td></tr>
</table>
Note : Including pin holes and defective dots which must be within one pixel size.
B) Unclear
<table>
<tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td>d ≤ 0.2</td><td>Disregard</td></tr>
<tr><td>0.2 < d ≤ 0.5</td><td>6</td></tr>
<tr><td>0.5 < d ≤ 0.7</td><td>2</td></tr>
<tr><td>0.7 < d</td><td>0</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>2</td><td>Lines</td><td>A) Clear
 

Note :
( ) - Acceptable Qty in active area
L - Length (mm)
W - Width (mm)
∞ - Disregard
B) Unclear
 

‘Clear’ = The shade and size are not changed by Vop.
‘Unclear’ = The shade and size are changed by Vop.</td><td>Minor</td></tr>
</table>

Note: Size : d = (long length + short length) / 2

● Screen Cosmetic Criteria (Operating) (Continued)

No.	Defect	Judgment Criterion	Partition
3	Rubbing line	Not to be noticeable.	Minor
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as pot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.  	Minor

Note :

(1) The limit samples for each item have priority.

(2) Complex defects are defined item by item, but if the numbers of defects are defined in above table, the total number should not exceed 10.

(3) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.

- 7 or over defects in circle of Æ5mm.
- 10 or over defects in circle of Æ10mm.
- 20 or over defects in circle of Æ20mm.

15. 0 RELIABILITY

15.1 Content of Reliability Test

No.	Test Item	Test Condition	Inspection after test
1	High Temperature Storage	+60℃±2℃/200 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack; 6.Current Idd is twice higher than initial value.
2	Low Temperature Storage	-20℃±2℃/200 hours	
3	High Temperature Operating	50℃±2℃/120 hours	
4	Low Temperature Operating	0℃±2℃/120 hours	
5	Temperature Cycle	0℃±2℃~25~50℃±2℃×10cycles (30min.) (5min.) (30min.)	
6	High Temperature / Humidity operation	50℃±5℃×90%RH/120 hours	
7	Vibration Test	Frequency：10Hz~55Hz~10Hz Amplitude：1.5mm, X，Y，Z direction for total 3hours (Packing condition)	
8	Drooping test	Drop to the ground from 1m height, one time, and every side of carton. (Packing condition)	
9	Static electricity test	Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time	

Remark:

1. The test samples should be applied to only one test item.
2. Sample size for each test item is 5~10pcs.
3. For Damp Proof Test, Pure water(Resistance＞10MΩ) should be used.
4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part.
5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.
6. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

16. 0 PRECAUTIONS FOR USING LCD MODULES

16.1 Handing Precautions

(1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :

- Isopropyl alcohol
- Ethyl alcohol

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

16.2 Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below 0°C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

16.3 Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

17. 0 USING LCD MODULES

17.1 About Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizer and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

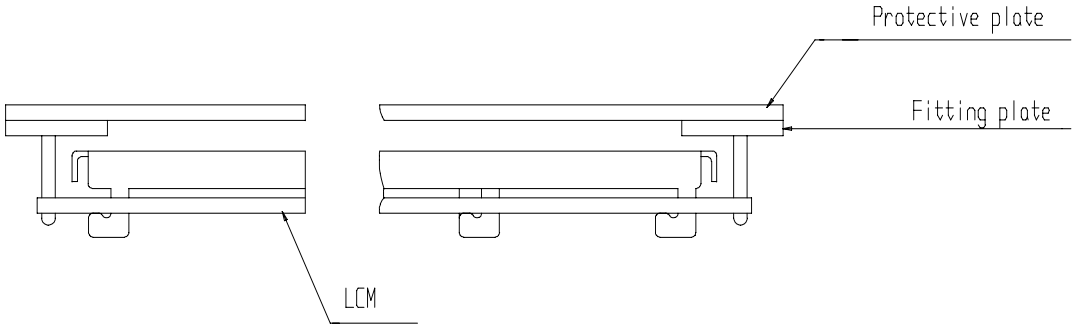
(9) Do not touch the display with bare hands. This will stain the display area and degradate insulation between terminals (some cosmetics are determinate to the polarizer).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.

17.2 Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ±0.1mm.

17.3 Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

(1) Make certain that you are grounded when handing LCM.

(2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.

(3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.

(4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutation of the motor.

(5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.

(6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

17.4 Soldering to the LCM

(1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.

- Soldering iron temperature : 280°C ± 10°C.
- Soldering time : 3-4 sec.
- Solder : eutectic solder.

If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

17.5 Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.

(2) Driving the LCD in the voltage above the limit shortens its life.

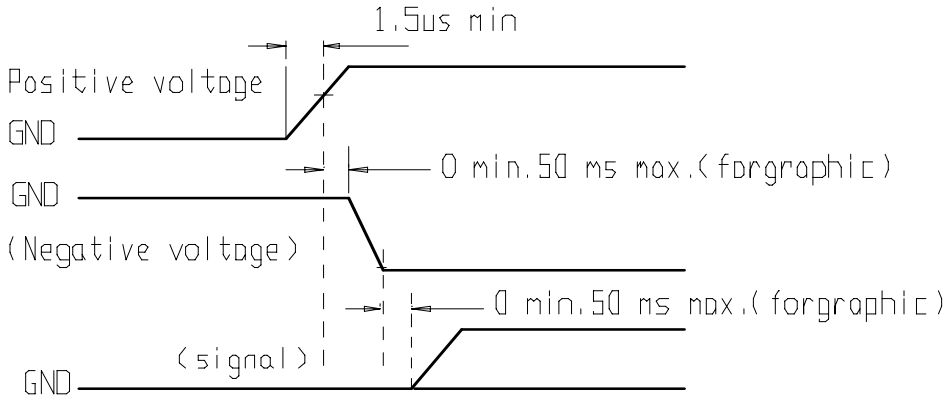
(3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit.

Therefore, it must be used under the relative condition of 40°C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.



17.6 Storage

When storing LCDs as spares for some years, the following precaution are necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

(4) Environmental conditions :

- Do not leave them for more than 168hrs. at 60°C.
- Should not be left for more than 48hrs. at -20°C.

17.7 Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leakes out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

17.8 Limited Warranty

Unless agreed between HYDISPLAY and customer, HYDISPLAY will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with HYDISPLAY LCD/LCM acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to HYDISPLAY within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of HYDISPLAY limited to repair and/or replacement on the terms set forth above. HYDISPLAY will not be responsible for any subsequent or consequential events.

17.9 Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

18. 0 APPENDIX

18.1 Initialization Code

```
void wr_cmd(uchar cmd)
{
    RD_Port = 1;
    WR_Port = 1;
    A0_Port = 1;
    CS1_Port = 0;
    WR_Port = 0;
    DataPort = cmd;
    WR_Port = 1;
    CS1_Port = 1;
}

void wr_dat(uchar dat)
{
    RD_Port = 1;
    WR_Port = 1;
    A0_Port = 0;
    CS1_Port = 0;
    WR_Port = 0;
    DataPort = dat;
    WR_Port = 1;
    CS1_Port = 1;
}

//RA8835 Initial
#pragma disable
void initial()
{
    wr_cmd(0x40);//System Set
    wr_dat(0x30);//P1: IV =1;M0=0,Internal CGRAM; W/S=0,Single-Panel;M2=0,8-Pixel character
    wr_dat(0x87);//P2: WF=1,two-frame AC Driver; FX=8,Set Horizontal Character Size
    wr_dat(0x07);//P3: Set Vertical Character Size
    wr_dat(0x27);//P4: CR, Bytes per display line
    wr_dat(0x36);//P5: T/CR, Line Length
    wr_dat(0x3F);//P6: L/F, Lines per frame
    wr_dat(0x28);//P7: APL
    wr_dat(0x00);//P8: APH, define the horizontal address range of the virtual address

    wr_cmd(0x44);//Scroll
    wr_dat(0x00);//P1: SAD 1L
```

```
    wr_dat(0x00);//P2: SAD 1H
    wr_dat(0x40);//P3: SL1
    wr_dat(0x00);//P4: SAD 2L
    wr_dat(0x30);//P5: SAD 2H
    wr_dat(0x40);//P6: SL2
    wr_dat(0x00);//P7: SAD 3L
    wr_dat(0x60);//P8: SAD 3H
    wr_dat(0x00);//P9: SAD 4L
    wr_dat(0x80);//P10: SAD 4H

    wr_cmd(0x5D);//Set Cursor Size and Shape
    wr_dat(0x07);//P1: Set Horizontal Size
    wr_dat(0x87);//p2: Set Vertical Size

    wr_cmd(0x4C);//Set the direction of automatic cursor increase, +1

    wr_cmd(0x5A);//HDOT SCR
    wr_dat(0x00);

    wr_cmd(0x5B);//Selects layered screen composition and screen text/graphics mode
    wr_dat(0x0C);//P1: DM1/2=1,Graphics Mode; V=0,Two-Layer Composition; OR Mode

    wr_cmd(0x59);//Display On
    wr_dat(0x05);//P1: SAD2+SAD3 Blank;SAD1 No flashing; Cursor No flashing
}
```

18.2 Power Supply Circuit Diagram