

# AMOTEC

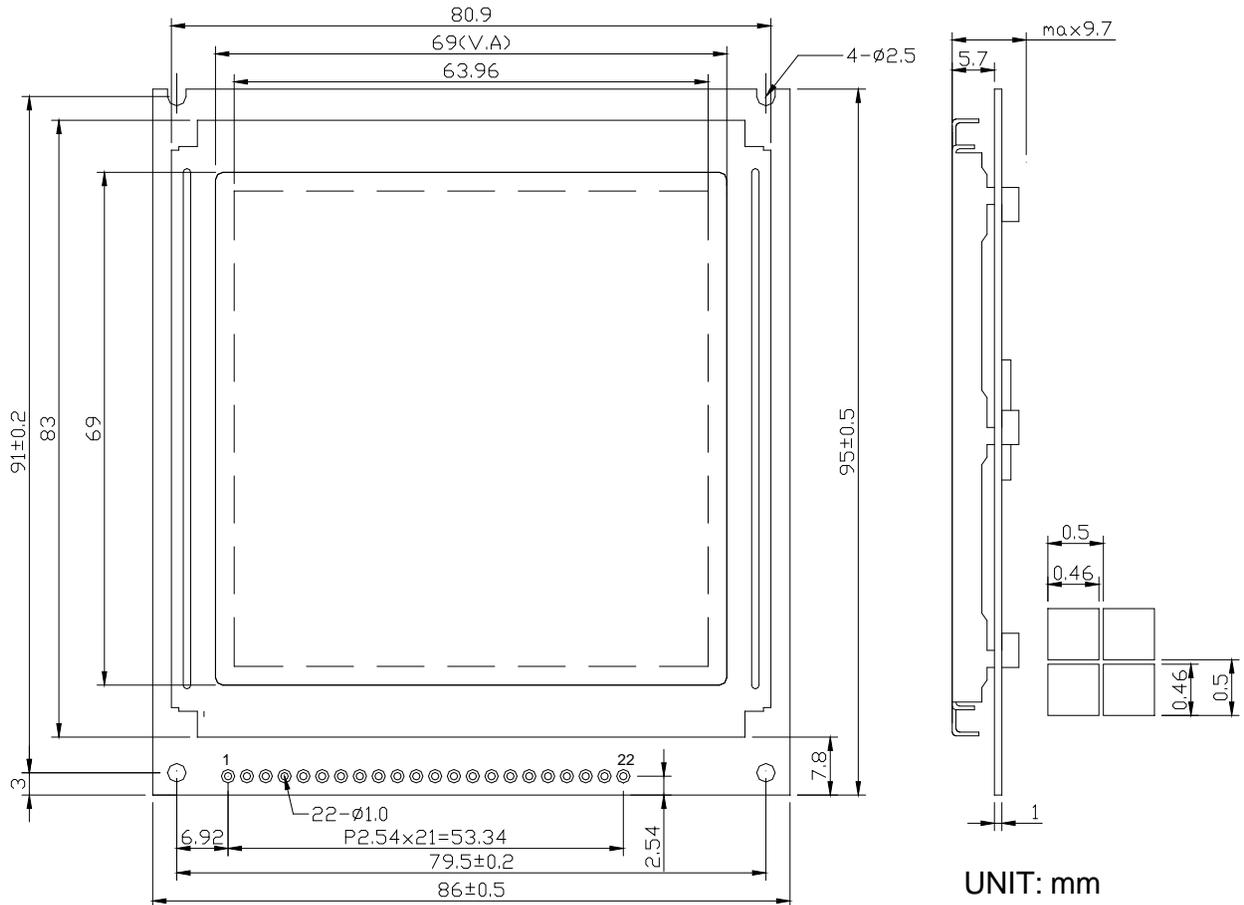
## ADM128128D

## SPECIFICATIONS OF LCD MODULE

### 1.Features

- a) 128\*128 dots graphic LCD module
- b) Built-in controller (RA8835 or Equivalent)
- c) +5.0V power supply
- d) Easy interface with 8-bit MPU
- e) 1/128 duty cycle
- f) LED sidelight optional
- g) Negative voltage option

### 2.Outline dimension

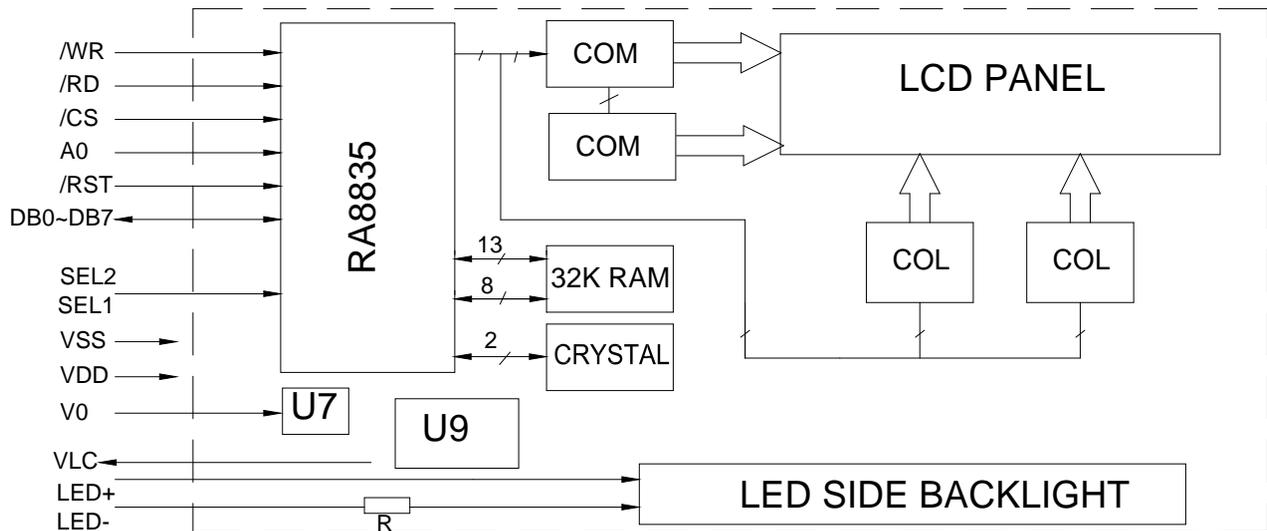


### 3.Absolute maximum ratings

Item	Symbol		Standard		Unit
Power voltage	$V_{DD}-V_{SS}$	-0.3	-	7.0	V
Input voltage	$V_{IN}$	-0.3	-	$V_{DD}+0.3$	
Operating temperature range	$T_{op}$	0	-	+50	°C
Storage temperature range	$T_{st}$	-10	-	+60	

\*Wide temperature range is available  
(operating/storage temperature as  $-20\sim+70/-30\sim+80^{\circ}\text{C}$ )

### 4. Block diagram



### 5. Interface pin description

Pin No.	Symbol	External connection	Function
1	/RES	MPU	Reset signal
2	/RD	MPU	Read enable signal
3	/WR	MPU	Write enable signal
4	SEL2		Microprocessor interface select pin. SEL2=SEL1="0", 8080 family, SEL2="0", SEL1="1" 6800 family
5	SEL1		
6	/CS	MPU	Chip enable signal
7	A0	MPU	H: Instruction L: Data
8~15	DB0~DB7	MPU	Data bus line
16	V <sub>DD</sub>	Power supply	Power supply for logic for LCM
17	V <sub>SS</sub>		Signal ground for LCM (GND)
18	V <sub>0</sub>		Operating voltage for LCD
19	VLC		Negative voltage output
20	INH		Display on/off control terminal
21	LED+	BKL power supply	Power supply for BKL (Anode)
22	LED-		Power supply for BKL (GND)

## 6. Optical characteristics

### ➤ STN type display module (Ta=25 °C, VDD=5.0V)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	$\theta$	$C_r \geq 2$	-60	-	35	Deg
	$\Phi$		-40	-	40	
Contrast ratio	$C_r$		-	8	-	-
Response time (rise)	$T_r$	-	-	200	250	ms
Response time (fall)	$T_r$	-	-	300	350	

### ➤ FSTN Type Display Module (Ta=25 °C, VDD=5.0V ± 0.25V)

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Viewing angle	$\theta$	$C_r \geq 2$	-60		45	deg
	$\Phi$		-40		40	
Contrast ratio	$C_r$		—	9	—	—
Response time(rise)	$T_r$	—	—	300		ms
Response time(fall)	$T_r$	—	—	280		ms

## 7. Electrical characteristics

### ➤ DC characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	$V_{DD}-V_0$	Ta =25 °C	—	20.0	—	V
Input voltage	$V_{DD}$		4.5	5.0	5.3	
Supply current	$I_{DD}$	Ta=25 °C, VDD=3.0V	—	5	10	mA
Input leakage current	$I_{LKG}$		—	—	1.0	uA
“H” level input voltage	$V_{IH}$		2.2	—	$V_{DD}$	V
“L” level input voltage	$V_{IL}$	Twice initial value or less	0	—	0.6	
“H” level output voltage	$V_{OH}$	LOH=-0.25mA	2.4	—	—	
“L” level output voltage	$V_{OL}$	LOH=1.6mA	—	—	0.4	
Backlight supply voltage	$V_F$		—	-	-	

### ➤ Switching characteristics

(Ta=25 °C, VDD=5.0V, CL=100pF)

Item	Symbol		Min.	Typ.	Max.	Unit
A0,/CS	$T_{AH8}$	Address hold time	10	—	—	ns
	$T_{AW8}$	Address setup time	10	—	—	
/RD, /WR	$T_{CYC}$	System cycle time	See note	—	See note	
	$T_{CC}$	Strobe pulse width	120	—	150	
D0 to D7	$T_{DS8}$	Data setup time	100	—	120	
	$T_{DH8}$	Data hold time	50	—	80	
	$T_{OH8}$	Output disable time	10	—	50	

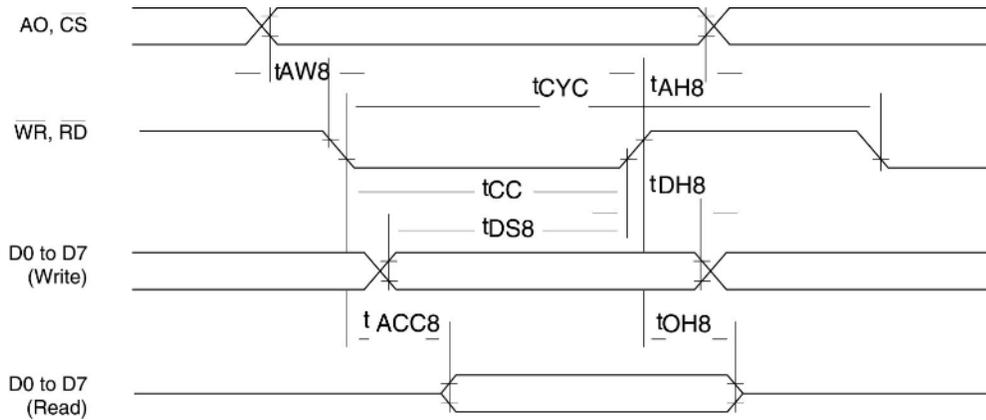
**Note:** For memory control and system control commands:

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

For all other commands:

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

Bus timing diagram



8、 System Control Commands

Class	Command	Code											Hex	Command Description	Command Read Parameters	
		RD	WR	A0	D7	D6	D5	D4	D3	D2	D1	D0			No. of Bytes	Section
System control	SYSTEM SET	1	0	1	0	1	0	0	0	0	0	0	40	Initialize device and display	8	3.2.1
	SLEEP IN	1	0	1	0	1	0	1	0	0	1	1	53	Enter standby mode	0	3.2.2
Display control	DISP ON/OFF	1	0	1	0	1	0	1	1	0	0	D	58, 59	Enable and disable display and display flashing	1	3.3.1
	SCROLL	1	0	1	0	1	0	0	0	1	0	0	44	Set display start address and display regions	10	3.3.2
	CSRFORM	1	0	1	0	1	0	1	1	1	0	1	5D	Set cursor type	2	3.3.3
	CGRAM ADR	1	0	1	0	1	0	1	1	1	0	0	5C	Set start address of character generator RAM	2	3.3.6
	CSRDIR	1	0	1	0	1	0	0	1	1	CD	CD	4C to 4F	Set direction of cursor movement	0	3.3.4
	HDOT SCR	1	0	1	0	1	0	1	1	0	1	0	5A	Set horizontal scroll position	1	3.3.7
	OVLAY	1	0	1	0	1	0	1	1	0	1	1	5B	Set display overlay format	1	3.3.5
Drawing control	CSRW	1	0	1	0	1	0	0	0	1	1	0	46	Set cursor address	2	3.4.1
	CSRR	1	0	1	0	1	0	0	0	1	1	1	47	Read cursor address	2	3.4.2
Memory control	MWRITE	1	0	1	0	1	0	0	0	0	1	0	42	Write to display memory	N	3.5.1
	MREAD	1	0	1	0	1	0	0	0	0	1	1	43	Read from display memory	N	3.5.2

Notes:

- In general, the internal registers of the RA8835 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 one 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.

2. APL and APH are 2-byte parameters, but are treated as two 1-byte parameters.

## ➤ SYSTEM SET

Initializes the device, sets the window sizes, and selects the LCD interface format. Since the command sets the basic operating parameters of the RA8835 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	DR	T/L	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

**Note:**suggestion P1~P8: 30H,87H,07H,21H,2CH,80H,20H,00H

**M0:** Selects the internal or external character generator ROM. The internal character generator ROM contains 160, 5 × 7 pixel characters. These characters are fixed at fabrication by the moralization mask. The external character generator ROM 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.

**M1:** Selects the CG RAM area for user-definable characters. The CG RAM codes are selected from the 64 codes shown in Figure 59.

**M1 = 0:** CG RAM1; 32 char

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:** 64 char CG RAM + CG RAM2

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

**M2:** Selects the height of the character defined in external

CG ROM and CG RAM. Characters more than 16 pixels high can be displayed by creating a bitmap for each portion of each character and using the RA8835 series's 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)

**W/S:** Selects the LCD drive method.

**W/S = 0:** Single-panel drive      **W/S = 1:** Dual-panel drive

**FX:** Sets the width, in pixels, of the character field. 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. Note that the maximum character width in TV mode is eight pixels. Since the RA8835 series handles display data in 8-bit units, characters larger than 8 pixels wide must be formed from 8-pixel segments. 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.

**WF:** Selects 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.

**FY:** Sets the height, in pixels, of the character. 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.

**C/R:** Sets 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.

[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.

**TC/R:** Sets 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 by:

$$f_{OSC} \geq ([TC/R] \times 9 + 1) \times [L/F] \times f_{FR}$$

**L/F:** Sets 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. 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.

**AP:** Defines the horizontal address range of the virtual screen. APL is the least significant byte of the address.

## ➤ SLEEP IN

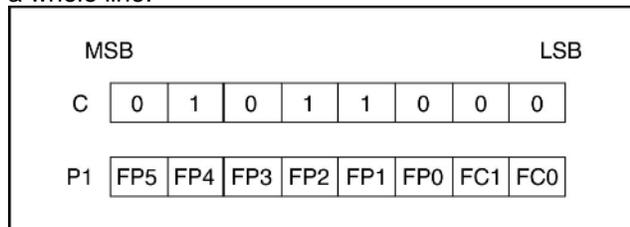
D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	1	0	0	1	1

Places the system in standby mode. This command has no parameter bytes. At least one blank frame after receiving this command, the RA8835 halts all internal operations, including the oscillator, and enters the sleep mode. 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 RA8835 maintain their values during the sleep mode. The display memory control pins maintain their logic levels to ensure that the display memory is not corrupted. The SED1330F/RA8835 series/1336F 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.

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 RA8835 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 pull-down resistors on the bus line will force these lines to a known state.

## ➤ DISP ON/OFF

Turns 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.



**D:** Turns 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

**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 $f_{FR}/32$ Hz (approx. 2 Hz)
1	1		Flash at $f_{FR}/64$ 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.

**FP:** Each pair of bits in FP sets the attributes of one screen block, 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 $f_{FR}/32$ 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.

➤ **SCROLL**

	MSB									LSB
C	0	1	0	0	0	1	0	0	0	
P1	A7	A6	A5	A4	A3	A2	A1	A0		(SAD 1L)
P2	A15	A14	A13	A12	A11	A10	A9	A8		(SAD 1H)
P3	L7	L6	L5	L4	L3	L2	L1	L0		(SL 1)
P4	A7	A6	A5	A4	A3	A2	A1	A0		(SAD 2 L)
P5	A15	A14	A13	A12	A11	A10	A9	A8		(SAD 2H)
P6	L7	L6	L5	L4	L3	L2	L1	L0		(SL 2)
P7	A7	A6	A5	A4	A3	A2	A1	A0		(SAD 3L)
P8	A15	A14	A13	A12	A11	A10	A9	A8		(SAD 3H)
P9	A7	A6	A5	A4	A3	A2	A1	A0		(SAD 4L)
P10	A15	A14	A13	A12	A11	A10	A9	A8		(SAD 4H)

**C** : Sets 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.

**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:** 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
	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.	
0	<p>Screen configuration example:</p> <p>The diagram shows a vertical rectangular screen divided into three horizontal sections. The top section is labeled 'Character display page 1' and contains a small black dot. The middle section is labeled 'Character display page 3'. The bottom section is labeled 'Character display page 3'. To the left of the screen, three labels are connected to the top, middle, and bottom sections by brackets: 'SAD1' for the top section, 'SL1' for the middle section, and 'SAD3' for the bottom section. To the right of the screen, two labels are connected to the top and middle sections by brackets: 'SL2' for the top section and 'Graphics display page 2' for the middle section. Below the screen, two labels are connected to the bottom section by brackets: 'Layer 2' for the top part of the bottom section and 'Layer 1' for the bottom part of the bottom section. A line labeled 'SAD2' at the top left connects to the top section of the screen. A line labeled 'SAD3' at the top left connects to the bottom section of the screen. A line labeled 'SL2' at the top right connects to the top section of the screen. A line labeled 'Graphics display page 2' at the top right connects to the middle section of the screen. A line labeled 'Layer 2' at the bottom right connects to the top part of the bottom section. A line labeled 'Layer 1' at the bottom right connects to the bottom part of the bottom section.</p>		

Graphics display mode

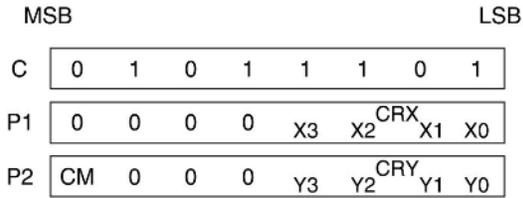
W/S	Screen	First Layer	Second Layer	Third Layer
0	Two-layer composition	SAD1 SL1	SAD2 SL2	
	Upper screen	SAD3 (see note 3) Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen		
	<p>Screen configuration example:</p>			
0	Three-layer configuration	SAD1 SL1 = L/F + 1	SAD2 SL1 = L/F + 1	SAD3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

**Notes:**

1. SAD3 has the same value as either SAD1 or SAD 2, 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.
3. 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.

➤ **CSRFORM**

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



**CRX:** Sets 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.

**CRY:** Sets 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.

**CM :** Sets the cursor display mode. Always set CM to 1 when in graphics mode.

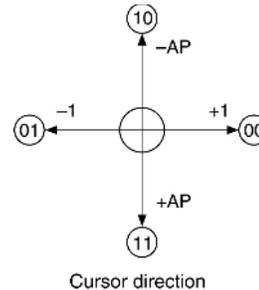
**CM = 0:** Underline cursor      **CM = 1:** Block cursor

➤ **CSRDIR**



Sets 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.

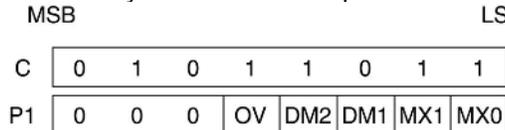
C	CD1	CD0	Shift direction
4CH	0	0	Right
4DH	0	1	Left
4EH	1	0	Up
4FH	1	1	Down



**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.

➤ **OVLAY**

Selects layered screen composition and screen text/graphics mode.



**MX0, MX1 :**MX0 and MX1 set the layered screen composition method, which can be either OR, AND, blocks, when using a layer divided into two screen blocks, different com -position 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.

**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)

## ADM128128D

**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.

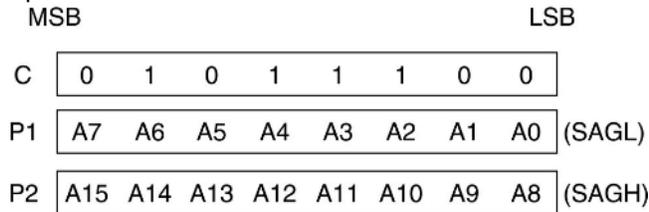
**OV** : Specifies two- or three-layer composition in graphics mode.

**OV = 0**: Two-layer composition    **OV = 1**: Three-layer composition

Set OV to 0 for mixed text and graphics mode.

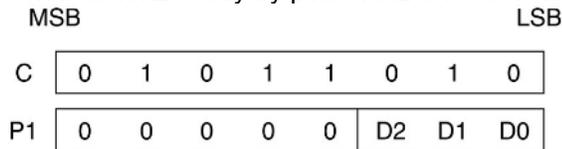
### ➤ **CGRAM ADR**

Specifies the CG RAM start address.



### ➤ **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.

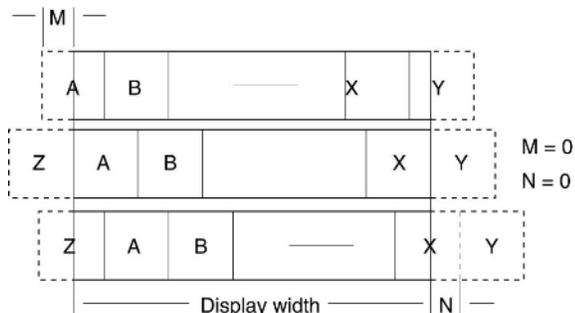


### **CGRAM ADR D0 to D2**

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 RA8835.

HEX	P1			Number of pixels to scroll
	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

**Scroll step selection**



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

### Horizontal scrolling

## ➤ Drawing Control Commands

### CSRW

The 16-bit cursor address register contains the display memory of the data at the cursor position as shown in Figure 28.

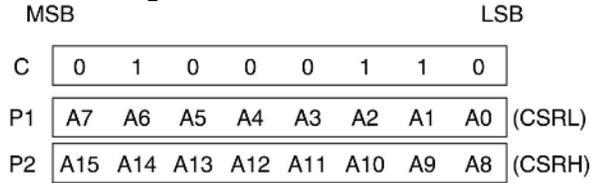
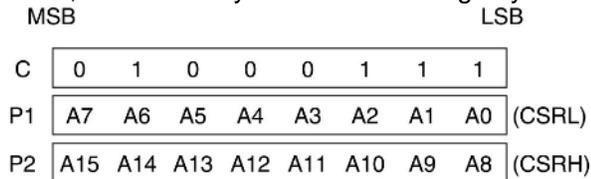


Figure 28. CSRW parameters

Note that the microprocessor cannot directly access the display memory. The MREAD and MWRITE commands use the address in this register. 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.

### CSRR

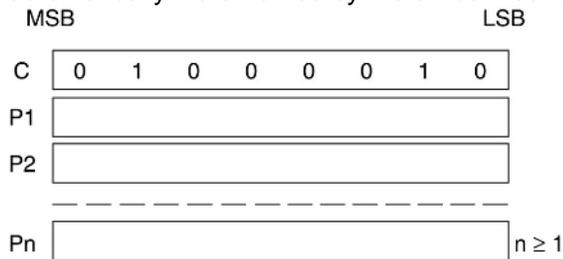
Reads from the cursor address register. After issuing the command, the data read address is read twice, for the low byte and then the high byte of the register.



## ➤ Memory Control Commands

### MWRITE

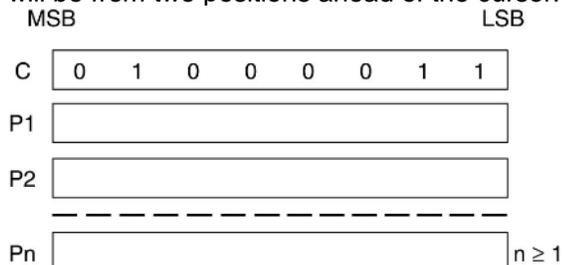
The microprocessor may write a sequence of data bytes to display memory by issuing the MREAD command and then writing the bytes to the RA8835. There is no need for further MWRITE commands or for the microprocessor to update the cursor address register after each byte as the cursor address is automatically incremented by the amount set with CSRDIR, in preparation for the next data write.



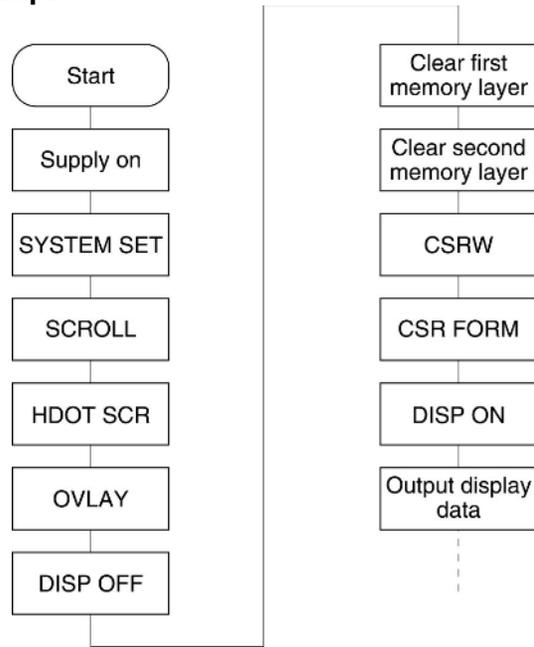
**Note:** P1, P2, ..., Pn: display data.

### MREAD

Puts the RA8835 into the data out-put state. On the MREAD command, the display memory data at the cursor address is read into a buffer in the SED1330F/RA8835 series/1336F. 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.



9、 Initialization Example

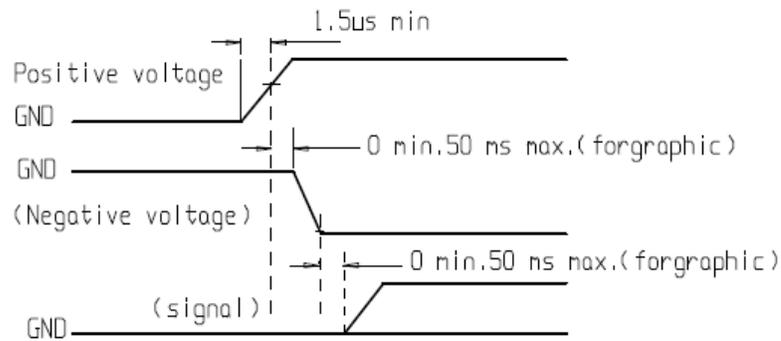


10、 Internal Character Generator Font

		Character code bits 0 to 3															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Character code bits 4 to 7	2		!	"	#	\$	%	&	'	(	)	*	+	,	-	.	/
	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
	6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
	7	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
	A		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
	B		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
	C		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
	D		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
1																	

## 11、 LCM Operation Precautions

- (1) It is an indispensable condition to drive LCD within the specified voltage limit since the higher voltage than the limit causes the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current driver should be avoided.
- (2) Response time will be extremely delayed at lower temperature than the specified operating temperature range and on the other hand LCD's show dark blue color in the higher temperature. However, those phenomena do not mean any malfunction or display out of order with LCD's, which will come back in the specified operation temperature range.
- (3) If the display area is pushed hard during operation, some fonts will be abnormally displayed. But it resumes normal condition after turning off once.
- (4) A slight dew depositing on terminals could be a cause for electrochemical reaction resulting in terminal open circuit.
- (5) Display contrast varies with the change of liquid crystal driving voltage ( $V_o$ ). Adjust  $V_o$  to show the best contrast.
- (6) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it is suggested to use the LCD under the relative condition of 40°C, 85% RH.
- (7) When turning the power on, input each signal after the positive/negative voltage becomes stable.



- (8) The backlight must be operated within the condition of specification. The overload current or too high voltage will reduce the life time or destroy the backlight.

## 12、 Handling 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. Please handle the 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 IO 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.

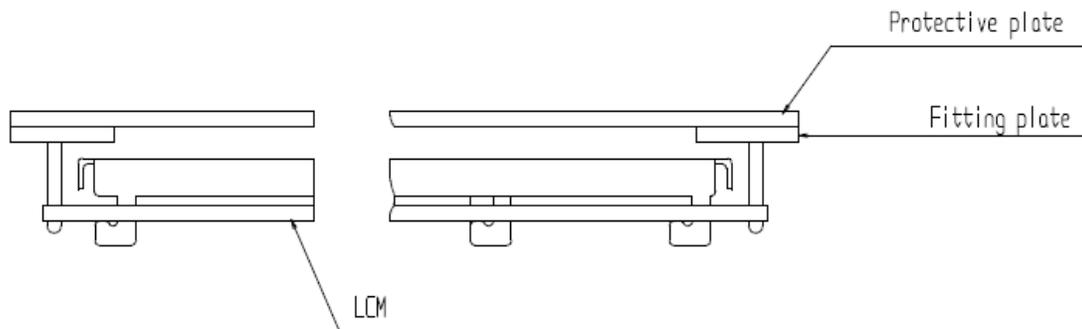
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.

- 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.

### 13、Installing Precautions

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.

### 14、Storage Precautions

In case of storing for a long period of time for the purpose of replacement use, the following ways are recommended.

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

(2) Placing in a dark place where neither exposure to direct sunlight nor light is, keeping temperature in the range from -30°C to 80°C

(3) Storing with no touch on polarizer surface by anything else. (It is recommended to store them as they have been contained in the inner container at the time of delivery from us.)

### 15、 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 leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

### 16、 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 subjected 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.