PACIFIC DISPLAY DEVICES

LCD Component Data Sheet

Model Number: 160160-02

160 x 160 Dot
Graphic LCD Assembly
With Full Graphic LCD Controller (SED-1335/RA8835)
LED & EL Panel Backlight Assembly

CONTENTS

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1. GENERAL INFORMATION

1.1 Product Overview

- 160 x 160 dot matrix LCD
- STN (Super Twisted Nematic) or FSTN (Film compensated Super Twisted Nematic) Technology
- SED-1335 or RA8835 Graphic LCD Controller.
- Multiplex drive : 1/160 duty, 1/13 bias
- LCD Module Service Life: 100,000 hours minimum

1.2 Part Options and Numbering System

160160	**-02**	**-SL**	**-F**	**-ST**	**-LED**	**-GY**	**-6**

➢ **Custom Option Designator:**
- (-02) SED-1335 Controller

➢ **Operating Mode:**
- (-SL) STN Silver / Gray
- (-GR) STN Green
- (-BN) STN Blue Negative Image
- (-FC) FSTN Black & White Image
- (-FN) FSTN Neg White & Black Image

➢ **Rear Polarizer Options:**
- (-F) Transflective
- (-M) Transmissive
- (-R) Reflective (No Backlight)

➢ **Operating Temperature:**
- (-ST) Standard (0 to +50 ºC)
- (-ET) Extended (-20 to +70 ºC)

➢ **Backlight Options:**
- (-LED) Array Lit LED Backlight

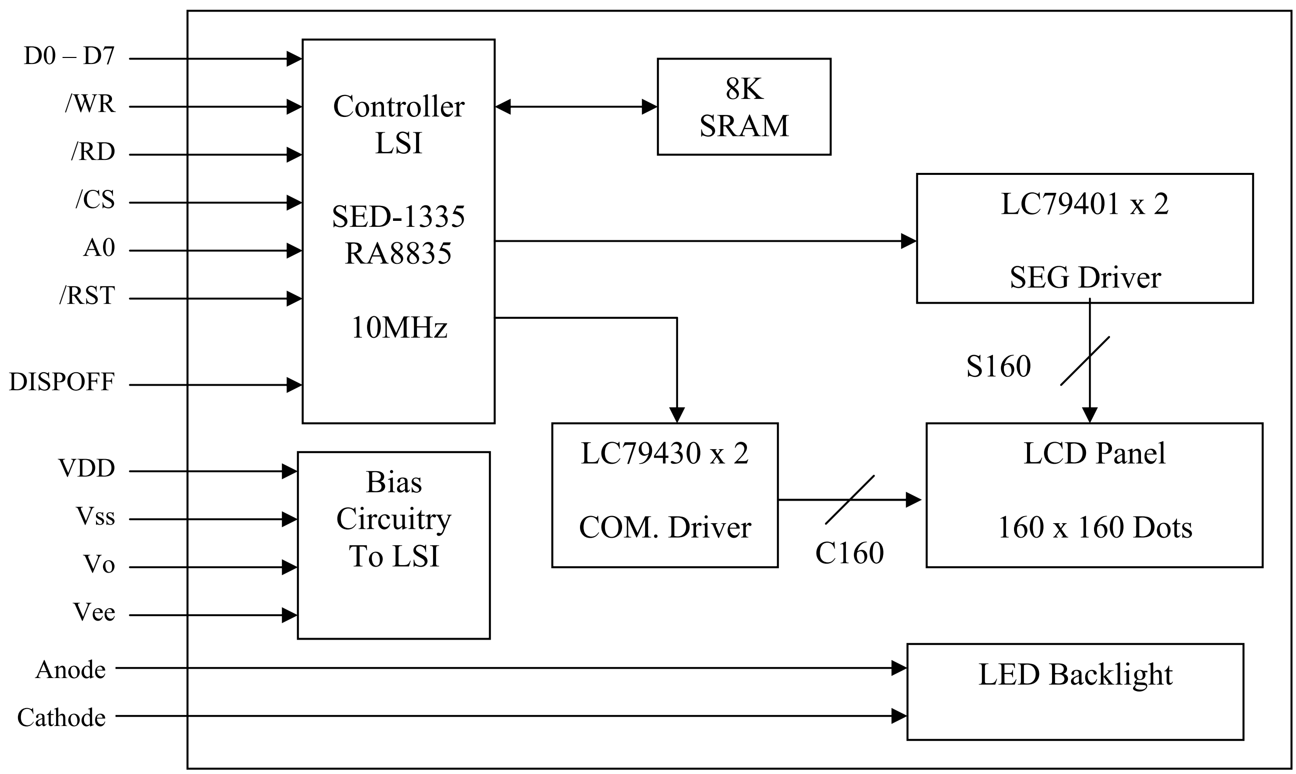
➢ **Backlight Coloration Options:**
- (-GY) LED - Green/Yellow
- (-AM) LED - Amber

➢ **Viewing Angle:**
- (-6) 6 o’clock
- (-12) 12 0’clock

1.3 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	V_{DD}	-0.3	7.0	V
Supply voltage for LCD	$V_{DD} - V0$	-0.3	30.0	V
Input voltage	VI	-0.3	V_{DD} +0.3	V
Standard Operating temperature	TOP (-ST)	0	50	ºC
Standard Storage temperature	TST (-ST)	-10	60	ºC
Extended Operating temperature	TOP (-ET)	-20	70	ºC
Extended Storage temperature	TST (-ET)	-30	80	ºC
Soldering Temp	Tsolder	260		ºC

1.4 Circuit Block Diagram



1.5 Mechanical Characteristics

Item	Contents	Unit
Module size (W×H×T)	80.0 x 84.5 x 14.0 Max (LED Backlight) 80.0 x 84.5 x 10.3 Max (Reflective / ELP Backlight)	mm mm
Viewing area (W×H)	62.0 x 62.0	mm
Active area (W×H)	60.76 x 60.76	mm
Number of dots	160 x 160	dots
Dot size (W×H)	0.34 x 0.34	mm
Dot pitch (W×H)	0.38 x 0.38	mm

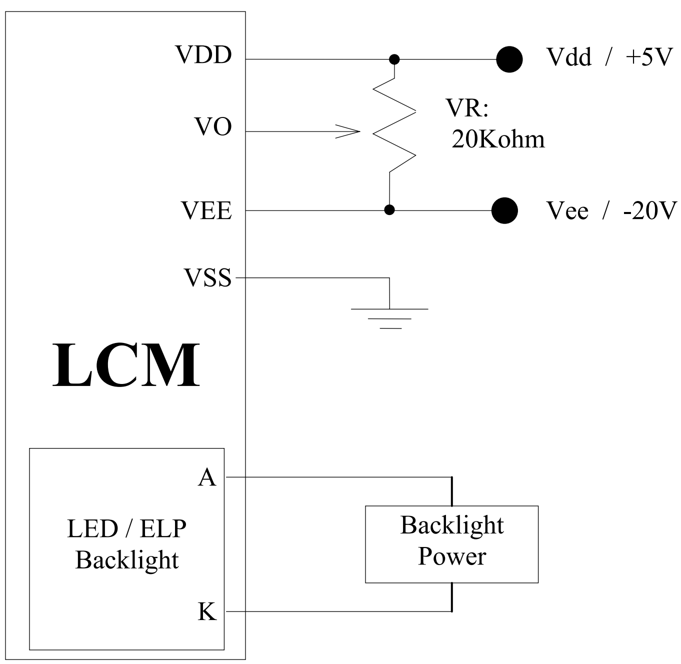
1.6 Input Signal Function

Pin No.	Symbol	Level	I/O	Description
1	/WR	H/L	In	*/Data Write (8080) option: RD - /WR (6800)
2	/RD	H/L	In	*/Data Read (8080) option: E (6800)
3	/CS	H/L	In	/Chip Select
4	A0	H/L	In	Data Type Select
5	/RST	L	In	/Reset
6-13	DB0-DB7	H/L	I/O	Bidirectional Data Bus Lines

Pin No.	Symbol	Level	Level	Description
1	VSS	0V	---	Ground
2	VDD	+5.0V	---	Supply voltage for logic
3	VEE	-20.0V	---	LCD Negative Voltage
4	VO	Input	---	LCD Negative Contrast Adj & Bias
5	/DISPOFF	H/L	In	Display Off Control
6	LED A	---	In	LED Backlight Power - Anode
7	LED K	---	In	LED Backlight Power - Cathode

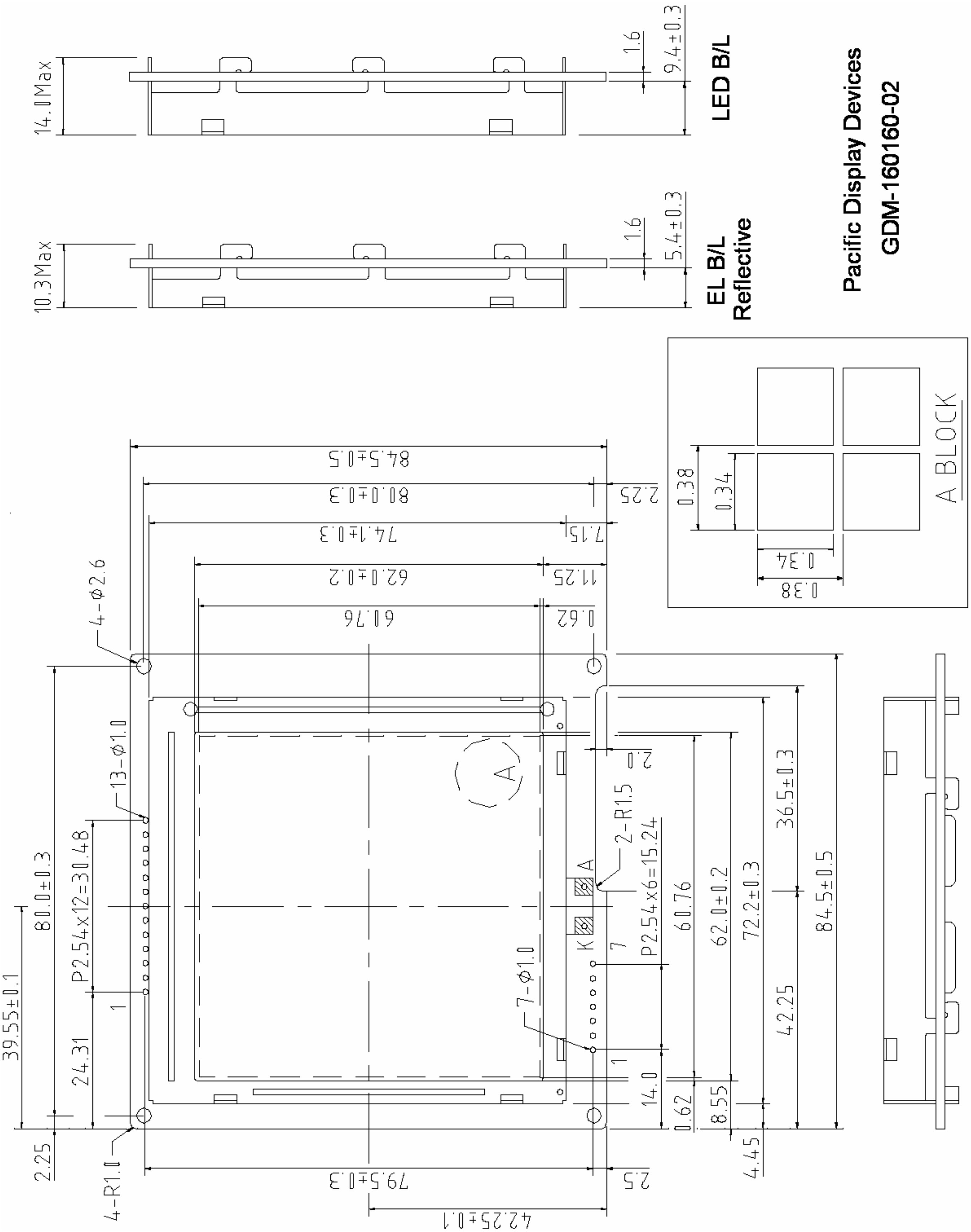
*Note: Module is pre-configured for the 8080 style interface

1.7 LCM Power, Contrast Control and Bias



*Note : Built in DC-to-DC Converter is not currently an option

1.8 LCM Dimensions



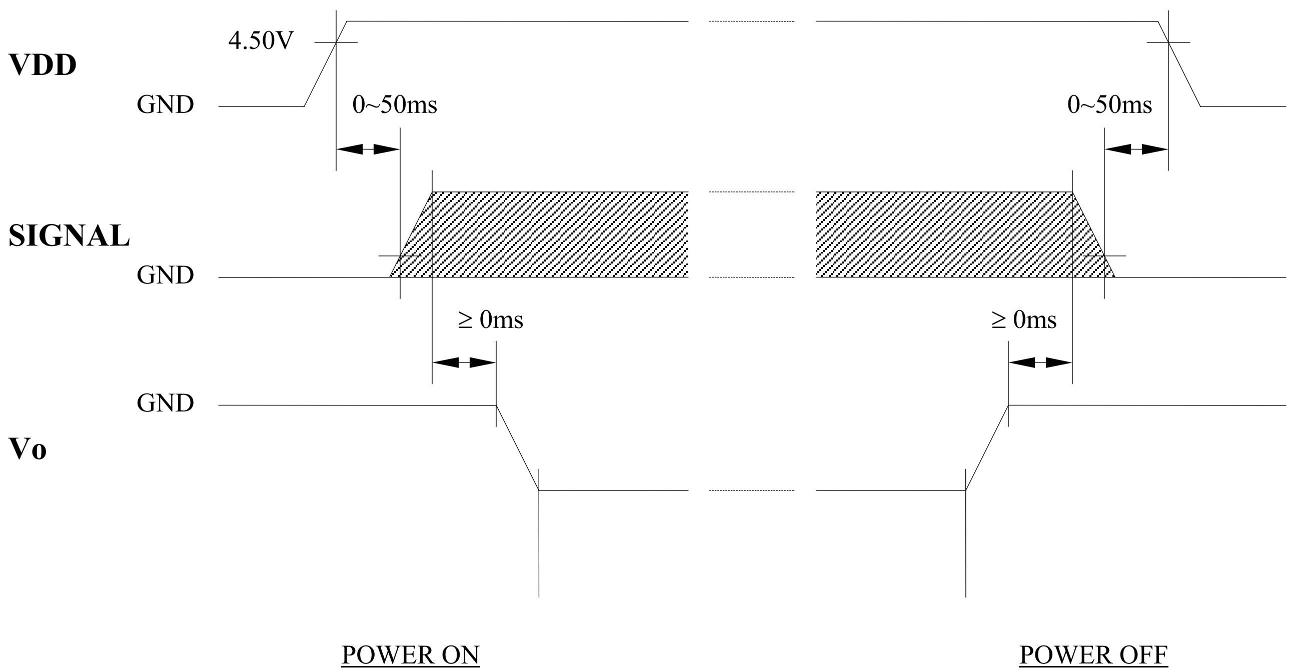
2. ELECTRICAL / OPTICAL CHARACTERISTICS

2.1 DC Electrical Characteristics (V_{DD} = +5V±10% , V_{SS} = 0V, Ta = 25°C)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for logic	V_{DD}	---	4.5	---	5.5	V
Supply current for logic	I_{DD}	V_{DD} = 5V	---	8	13	mA
Input voltage ' H ' level	V_{IH}	---	V_{DD} -2.2	---	V_{DD}	V
Input voltage ' L ' level	V_{IL}	---	0	---	0.8	V
Operating voltage for LCD	V_{DD}- V_o	-10°C	20.2	21.7	23.2	V
		25°C	18.2	19.7	21.2	V
		50°C	16.6	18.1	19.6	V
Supply current for LCD*	I_o	---	---	3	7	mA

*Vee externally supplied

■ TIMING OF POWER SUPPLY

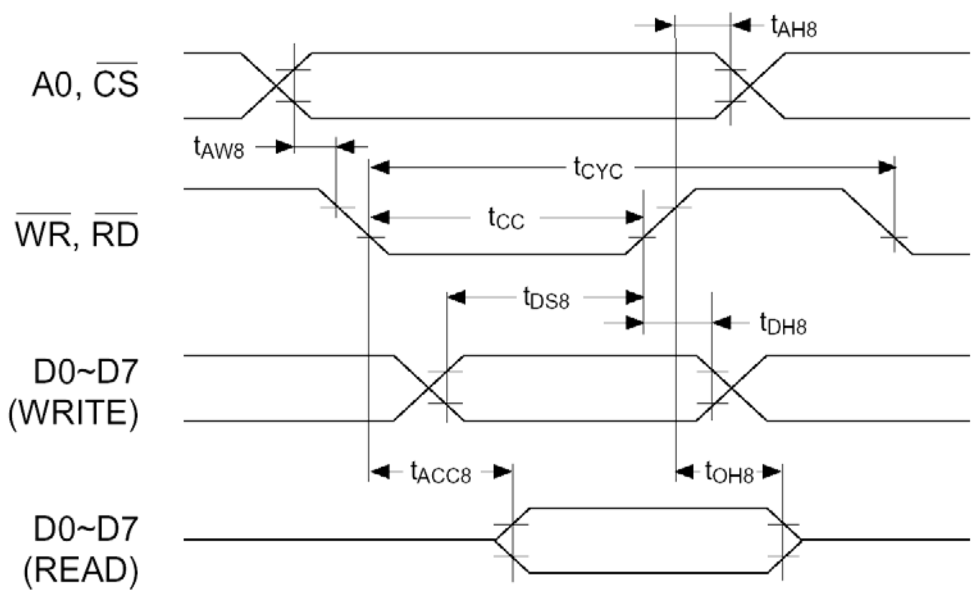


Note : The missing pixels may occur when the LCM is driven except above power supply timing sequence.

2.2 AC Electrical Characteristics

SED-1335 / RA 8835 Graphic Controller IC AC Waveform Interface

- **System Bus READ/WRITE Timing I (8080)**

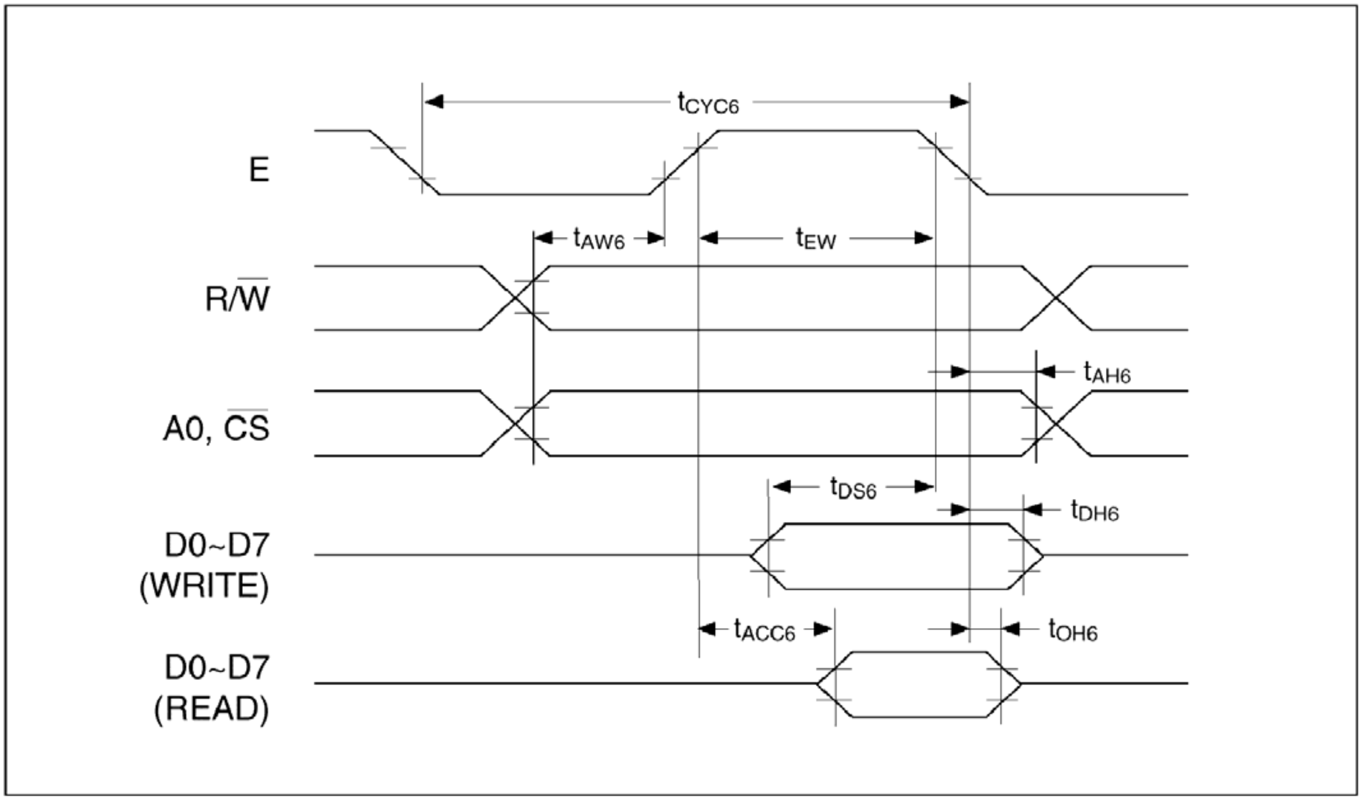


Signal	Symbol	Parameter	Rating		Unit	Condition
			min	max		
A0, /CS	tAH8	Address hold time	10	---	ns	CL = 100 pF
	tAW8	Address setup time	30	---	ns	
/WR, /RD	tCYC	System cycle time	(1)	---	ns	
	tCC	Strobe pulse width	220	---	ns	
D0 to D7	tDS8	Data setup time	120	---	ns	
	tDH8	Data hold time	10	---	ns	
	tACC8	RD access time	---	120	ns	
	tOH8	Output disable time	10	50	ns	

Note:

1. t CYC =2t C + t CC + t CEA + 75 > t ACV + 245…..Memory control/movement control commands:
   = 4t C + t CC + 30…………………………….All other commands:

- **System Bus READ/WRITE Timing II (6800)**



Signal	Symbol	Parameter	Rating		Unit	Condition
			min	max		
A0, CS R/W	tAH6	Address hold time	10	---	ns	CL = 100+1TTL pF
	tAW6	Address setup time	30	---	ns	
	tCYC6	System cycle time	(1)	---	ns	
	tCC	Strobe pulse width	220	---	ns	
D0 to D7	tDS6	Data setup time	120	---	ns	
	tDH6	Data hold time	10	---	ns	
	tACC6	RD access time	---	120	ns	
	tOH6	Output disable time	10	50	ns	
E	tEW	Enable pulse width	220	---	ns	

Notes:

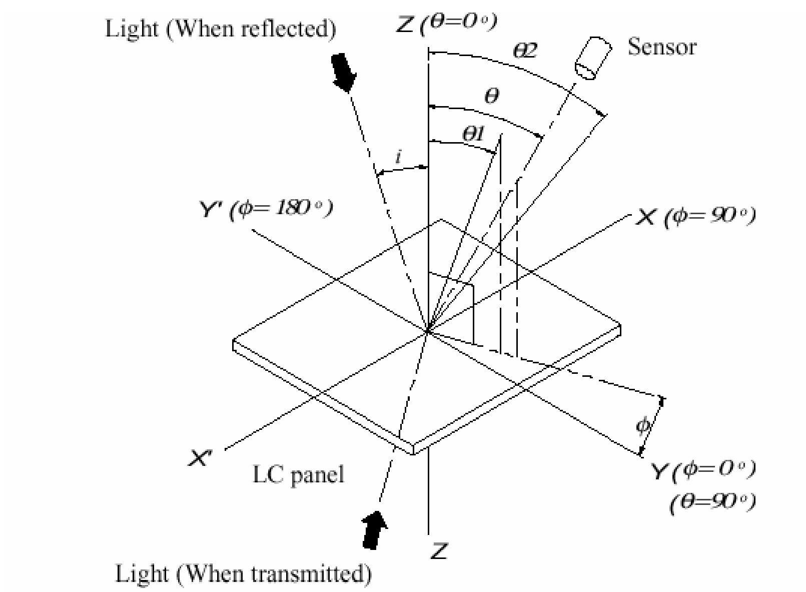
1. tCYC6 means a cycle of (CS.E) not E alone.

2. t CYC6 = 2t C + t EW + t CEA + 75 > t ACV + 245….. memory control/movement control commands
 = 4tC + tEW + 30……………………………… all other commands

2.3 Optical Characteristics (V_{OP} = 4.7V, Ta = 25°C)

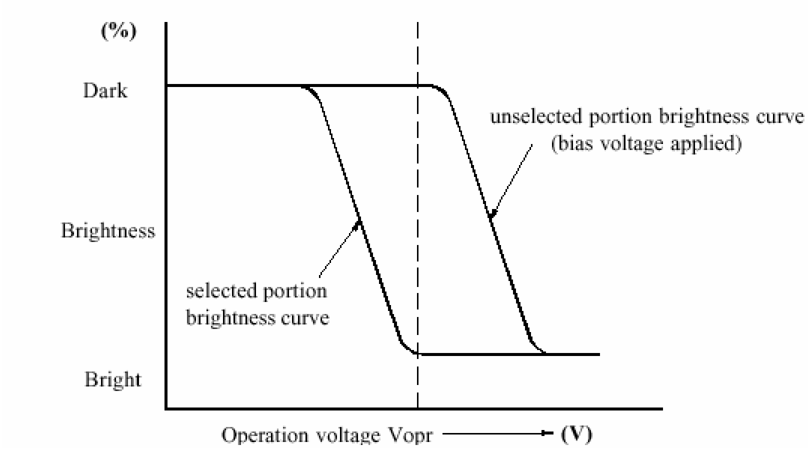
Item	Symbol	Condition	Min	Typ	Max	Unit
Contrast ratio	Cr	θ=0° φ=0°	---	5.0	---	---
Frame Frequency	f_{FRM}	---	32	64	150	Hz
Viewing angle range	θ_1	25°C	-40	---	40	deg
	θ_2		-40	---	40	deg
Response time	Ton	25°C	---	190	---	ms
	Toff		---	300	---	ms

Definition of angles ∅ and θ:

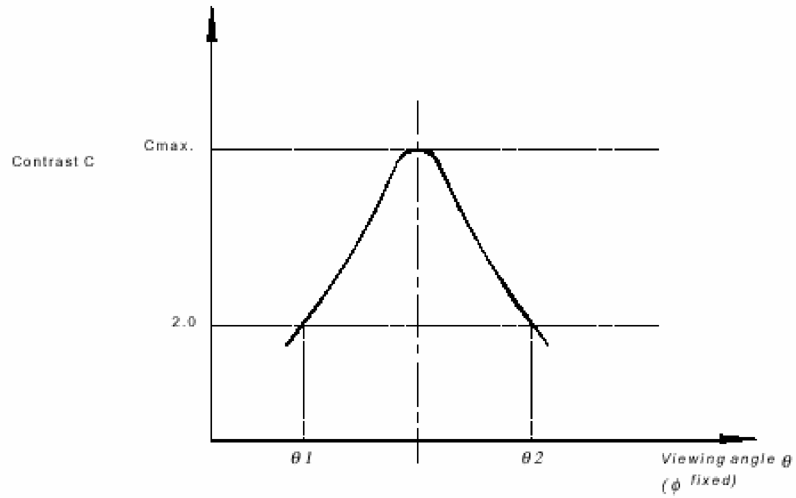


*Definition of contrast C

$$C = \frac{B1}{B2} = \frac{\text{Brightness of selected portion}}{\text{Brightness of unselected portion}}$$

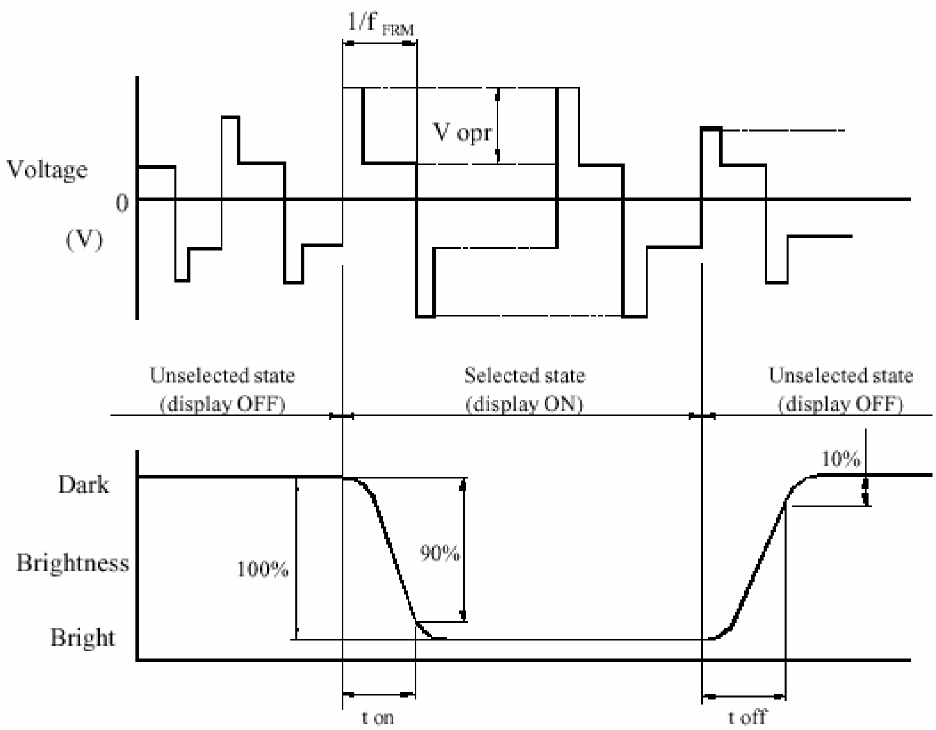


*Definition of viewing angles θ1 and θ2



Note : Optimum vision with the naked eye and viewing angle θ at Cmax above are not always the same.

*Definition of response time



Vop : Operating voltage (V) ton : Response time (rise) (ms)

fFRM : Frame frequency (Hz) toff : Response time (fall) (ms)

2.4 LED Backlight Characteristics

■ Yellow-Green LED Operating Characteristics (5V - Array Lit)

Item	Symbol	Conditions	Standard			Unit
			Min.	Typ.	Max.	
Forward Voltage	V_f	Ta= 25 °C	3.9	4.1	4.4	VDC
Forward Current	I_F	Ta= 25 °C	---	500	850	mA
Reverse Voltage	V_R	---	---	---	8	V
Peak Emission Wavelength	λP	If=500mA Yel/Grn	---	573	---	nm

■ Life (Array or Edge Lit)

Item	Conditions	Standard		Unit
		Min.	Max.	
Life	Ta= 25 °C	100,000	---	hrs

3. OPERATING PRINCIPALS AND METHODS

3.1 LCD Controller Display and Control Functions

◆ Command Description

● The Command Set

Table 1. The Command Set

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	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	0	3.2.2
	DISP ON/OFF	1	0	1	0	1	0	1	1	0	0	D	58, 59	Enalbe and disable display and display flashing	1	3.3.1
Display control	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	0	0	1	0	0	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	CD1	CD0	4Cof 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	---	3.5.1
	MREAD	1	0	1	0	1	0	0	0	0	1	1	43	Read from display memory	---	3.5.2

Notes:

1. In general, the internal registers of the SED1335 / RA8835 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:
   a. CSRW, CSRR: Each byte is processed individually. The microprocessor may read or write just the low byte of the cursor address.
   b. 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 Control Commands

1.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 SED1335 / RA8835, an incorrect SYSTEM SET command may cause other commands to operate incorrectly.

	D7 (MSB)	D6	D5	D4	D3	D2	D1	D0 (LSB)	A0	WR	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

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 can-celing sleep mode.

1.2 M0

Selects the internal or external character generator ROM. The internal character generator ROM con-tains 160, 5 ´ 7 pixel characters. These characters are fixed at fabrication by the metalization 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.

1.3 M1

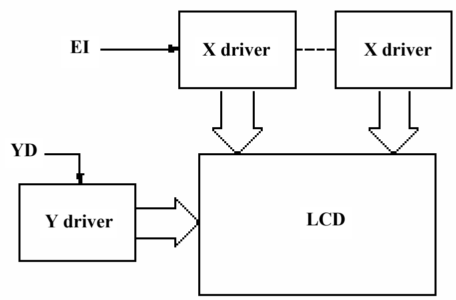
Selects the CG RAM area for user-definable charac-ters. The CG RAM codes are selected from the 64 codes shown in page
M1 = 0: CG RAM1; 32 char
The CG RAM1 and CG RAM2 address spaces are not contiguous, the CG RAM1 address space is treated as character generator RAM, and the CG RAM2 address space is treated 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 genera-tor RAM.

1.4 M2

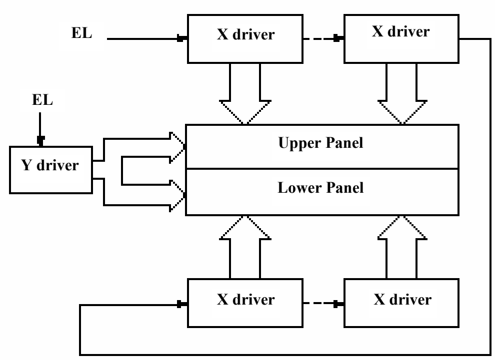
Selects the height of the character defined in external CG ROM and CG RAM. Characters more than 16 pix-els high can be displayed by creating a bitmap for each portion of each character and using the Controller's graphics mode to reposition them.
M2 = 0: 8-pixel character height (2716 or equivalent ROM)
M2 = 1: 16-pixel character height (2732 or equivalent ROM)

1.5 W/S

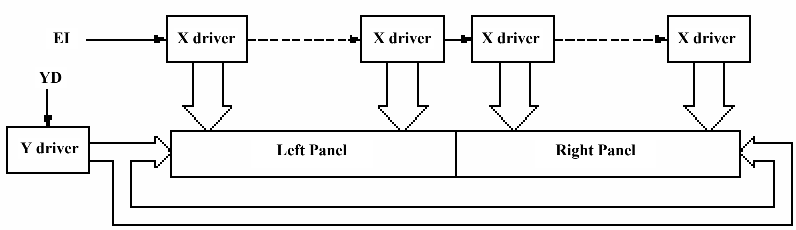
Selects the LCD drive method.
W/S = 0: Single-panel drive
W/S = 1: Dual-panel drive
(1) single-panel display



(2) Above and below two-panel display



(3) Left and right two-panel display

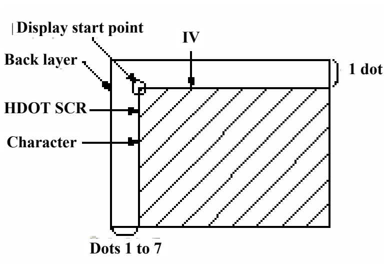


1.6 IV

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 back-ground layer. However, inverted characters at the top or left of the screen are difficult to read as the charac-ter 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 Controller 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 en-sure easy reading of the inverted characters.

IV = 0: Screen top-line correction

IV = 1: No screen top-line correction (no offset)



1.7 T/L

Selects TV or LCD mode. When TV mode is selected,the TV sync generator circuit is ON.

T/L = 0: LCD mode

T/L = 1: TV mode

1.8 DR

Selects output of an additional shift-clock cycle for every 64 pixels. The extra cycles are required for correct operation of the enable chain when using a two-panel display.

DR = 0: Normal operation

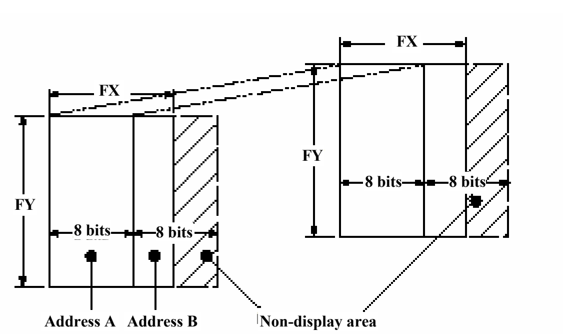
DR = 1: Additional shift-clock cycles

1.9 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 Since the Controller handles display data in 8-bit units, characters larger than 8 pixels wide must be formed from 8-pixel segments. As Figure 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.

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



1.10 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.

1.11 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.
Table 5. Vertical character size selection

FX					[FX] 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
OF	1	1	1	1	16

1.12 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.
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 9.1.1 for the calcula-tion 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 6. 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	00	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

1.13 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 in section 9.1.1 in order to hold the frame period constant and minimize jitter for any given main oscillator frequency, f OSC .

Table 7. Line length selection

TC/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
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
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

1.14 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.

Table 8. Frame height selection

L/F									[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
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
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

Table 9. Frame heights and compatible LCD units

Nombor of linos [LF]	Panel Duty Cycle
64	1/64
128	1/64

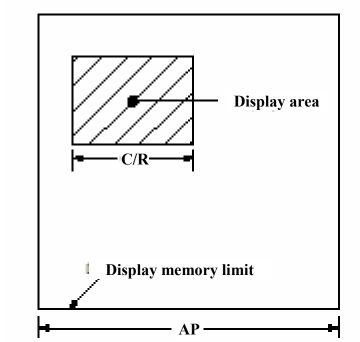
1.15 AP

Defines the horizontal address range of the virtual screen. APL is the least significant byte of the ad-dress.

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

Table 10. Horizontal address range

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	$2^{16} - 1$



2 SLEEP IN

Places the system in standby mode. This command has no parameter bytes. At least one blank frame after receiving this command, the Controller 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 CONTROLLER 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 CONTROLLER can be removed from the sleep state by sending the SYSTEM SET com-mand 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 com-mand is received. Since YDIS forces all display driver outputs to go to the dese-lected 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 CONTROLLER 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.

3 Display Control Commands

3.1 DISP ON/OFF

Turns the whole display on or off. The single-byte parameter enables and disables the cursor and lay-ered screens, and sets the cursor and screen flash rates. The cursor can be set to flash over one charac-ter or over a whole line.

	MSB							LSB
C	0	1	0	1	1	0	0	0
P1	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0

DISP ON/OFF parameters

3.1.1 D

Turns the display ON or OFF. The D bit takes prece-dence over the FP bits in the parameter.
D = 0: Display OFF
D = 1: Display ON

3.1.2 FC

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

Table 11. Cursor flash rate selection

FC1	FC0	Cursor display	
0	0	OFF (blank)	
0	1	ON	No flashing
1	0		Flash at f_{FR}/32Hz (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.

3.1.3 FP

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

Table 12. 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 fFR/32Hz (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.

3.2 SCROLL

3.2.1 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 as shown in Figure 17.

	MSB							LSB	
C	0	1	0	0	0	1	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 2L)
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)

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.

Figure 17. SCROLL instruction parameters

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

Table 13. Screen block start address selection

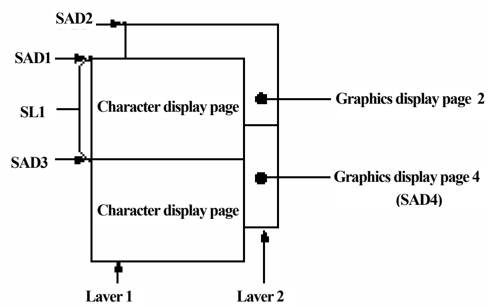
SL1,SL2									[SL] screen lines
HEX	L7	L6	L5	L4	L3	L2	L1	L0	
00	0	0	0	0	0	0		0	1
01	0	0	0	0	0	0	0	1	2
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
7F	0	1	1	1	1	1	1	1	128
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
FE	1	1	1	1	1	1	1	0	255
FF	1	1	1	1	1	1	1	1	256

3.2.2 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 14. Text display mode

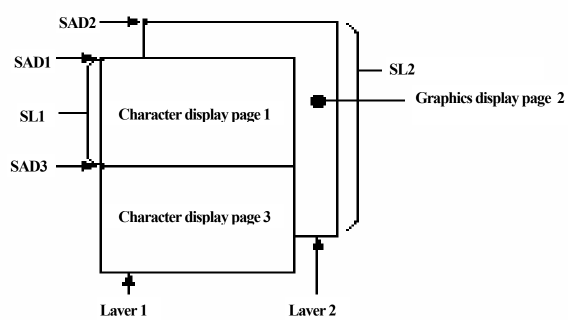
W/S	Screen	First Layer	Second Layer
1	First screen block	SAD1 SL1	SAD2 SL2
	Lower screen	SAD3 (see note 2)	SAD4 (see note 2)
	Set both SL1 and SL2 to ((L/F)/2+1)		
	Screen configuration example:		



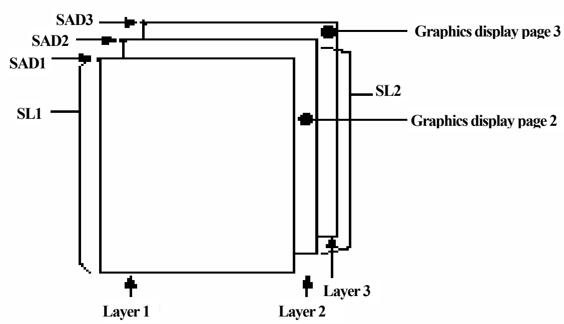
Notes:
1. SAD3 has the same value as either SAD1 or SAD2, whichever has the least number of lines (set by SL1 and SL2).
2. Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set in this mode.

Table 15. Graphics display mode

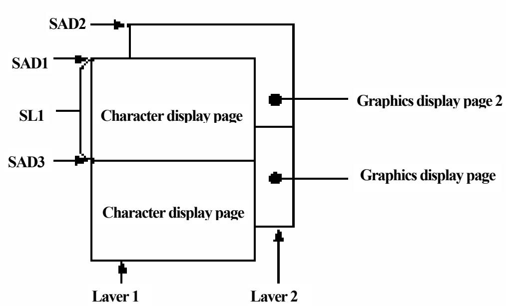
W/S	Screen	First Layer	Second Layer	Third Layer
0	Upper screen	SAD1 SL1	SAD2 SL2	
	Lower screen	SAD3 (see note 3) Set both SL1 and SL2 to L/F +1 if not using a partitioned screen		
	Screen configuration example			



W/S	Screen	First Layer	Second Layer	Third Layer
0	Three-layer configuration	SAD1 SL1 = L/F + 1	SAD1 SL2 = L/F + 1	SAD3 —
	Screen configuration example:			



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)	—
	Set both SL1 and SL2 to ((L/F)/2+1)			
	Screen configuration example (see note 3):			



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.
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.

3.3 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.

	MSB							LSB
C	0	1	0	1	0	0	1	1
P1	0	0	0	0	X3	X2	X1 (CRY)	X0
P2	CM	0	0	0	Y3	Y2	Y1 (CRY)	Y0

Figure 19. CSRFORM parameter bytes

3.3.1 CRX

Sets the horizontal size of the cursor from the charac-ter origin. CRX is equal to the cursor size less one. CRX must be less than or equal to FX.

Table 16. Horizontal cursor size selection

CRX					[CRX] cursor width
HEX	X3	X2	X1	X0	pixels
0	0	0	0	0	1
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
8	1	0	0	0	9
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

3.3.2 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.

Table 17. Cursor height selection

CRX					[CRX] cursor
HEX	X3	X2	X1	X0	height (lines)
0	0	0	0	0	iillegal
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
8	1	0	0	0	9
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

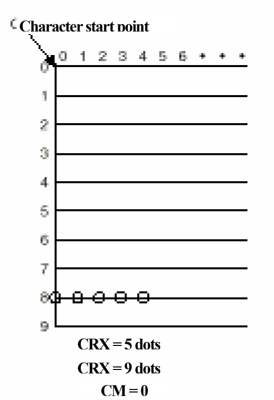


Figure 20. Cursor size and position

3.3.3 CM

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

CM = 0: Underline cursor

CM = 1: Block cursor

3.4 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. in character units. See Section 5.3.

	MSB							LSB
C	0	1	0	0	1	1	CD1	CD2

Figure 21. CSRDIR parameters

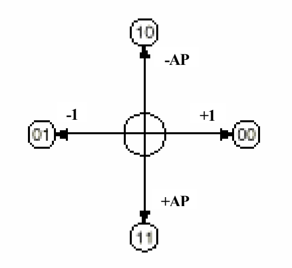


Figure 22. Cursor direction

Table 18. 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 ³ 9, the cursor address increment must be preset for move-ment in character units. See Section 5.3.

3.3.5 OVLAY

Selects layered screen composition and screen text/ graphics mode.

	MSB							LSB
C	0	1	0	1	1	0	1	1
P1	0	0	0	OV	DM 2	MD 1	MX 1	MX 2

Figure 23. OVLAY parameter

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 orga-nized in layers and not by screen blocks, when using a layer divided into two screen blocks, different com-position methods cannot be specified for the indi-vidual screen blocks.
The Priority-OR mode is the same as the OR mode unless flashing of individual screens is used.

Table 19. Composition method selection

MX 1	MX 0	Function	Composition Method	Applications
0	0	L1∪L2∪L3	OR	Underlining,rules,mixed text and graphics
0	1	(L1⊕L2)∪L3	Exclusive-OR	Inerted characters, flashing regions, underlining
1	0	(L1∩L2)∪L3	AND	Simple animation, three-dimensional
1	1	L1>L2>L3	Priority-OR	appearance

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)

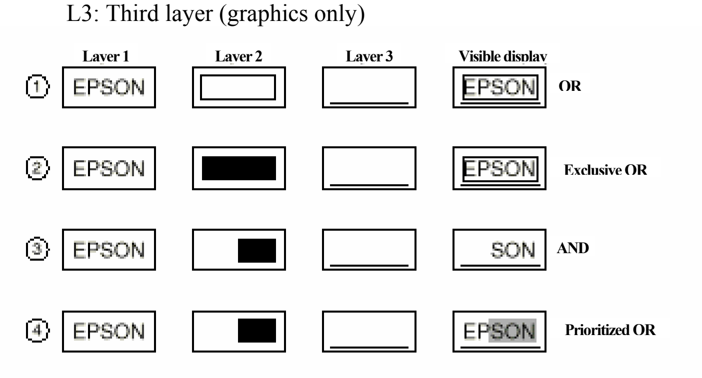


Figure 24. Combined layer display

Notes:

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

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.

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.

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)

Figure 25. CGRAM ADR parameters

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	1	0	0
P1	0	0	0	0	0	D2	D1	D0

Figure 26. HDOT SCR parameters

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 CONTROLLER

Table 20. 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

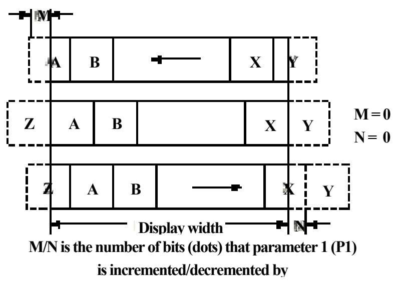


Figure 27. Horizontal scrolling

4 Drawing Control Commands

4.1 CSRW

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

	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)

Figure 28. CSRW parameters

Note that the microprocessor cannot directly access the display memory.
The MREAD and MWRITE commands use the ad-dress in this register.
The cursor address register can only be modified by the CSRW command, and by the automatic incre-ment after an MREAD or MWRITE command. It is not affected by display scrolling.

4.2 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.

	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)

Figure 29. CSRR parameters

5 Memory Control Commands

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 CONTROLLER. 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.

	MSB							LSB	
C	0	1	0	0	0	0	1	0	
P1									
P2									
Pn									n≥1

Figure 30. MWRITE parameters

5.2 MREAD

Puts the SED1330F/1335F/1336F 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 CONTROLLER
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.

	MSB							LSB	
C	0	1	0	0	0	0	1	1	
P1									
P2									
Pn									n≥

Figure 31. MREAD parameters

3.2 LCD Controller Character Code Map

Note: means all dots of 6 × 8 matrix are on.

4. RELIABILITY

No.	Test Item	Content of Test	Test Condition	Applicable Standard
Environmental Test				
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	60 °C 200 hrs	------
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-10 °C 200 hrs	------
3	High temperature operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	50 °C 200 hrs	------
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	0 °C 200 hrs	------
5	High temperature / Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	60 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
6	High temperature / Humidity operation	Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.	40 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -20°C 30min ⇄ 25°C 5min. ⇄ 70°C 30min ← 1 cycle →	-10°C / 60°C 10 cycles	------
Mechanical Test				
8	Vibration test	Endurance test applying the vibration during transportation and using.	10~22Hz → 1.5mmp-p 22~500Hz → 1.5G Total 0.5hrs	MIL-202E-201A JIS-C5025 JIS-C7022-A-10
9	Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G Half sign wave 11 msedc 3 times of each direction	MIL-202E-213B
10	Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115 mbar 40 hrs	MIL-202E-105C
Others				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V , RS=1.5 kΩ CS=100 pF 1 time	MIL-883B-3015.1

*** Supply voltage for logic system = VDD. Supply voltage for LCD system = Operating voltage at 25°C

■ LCD Panel Service Life

Definition of panel service life

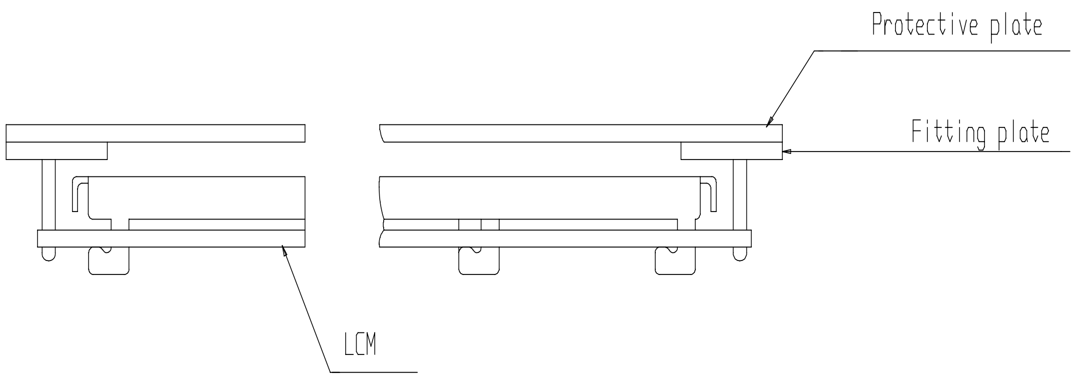
- 100,000 hours minimum at 25° C ±10%
- Contrast becomes 30% of initial value
- Current consumption becomes three times higher than initial value
- Remarkable alignment deterioration occurs in LCD cell layer
- Unusual operation occurs in display functions

5. PRECAUTIONS FOR USING LCD MODULES

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.

Precaution for Handing LCD Modules

Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.

1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.
2) Do not alter, modify or change the shape of the tab on the metal frame.
3) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
4) Do not damage or modify the pattern writing on the printed circuit board.
5) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
6) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
7) Do not drop, bend or twist LCM.

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 commutator 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.

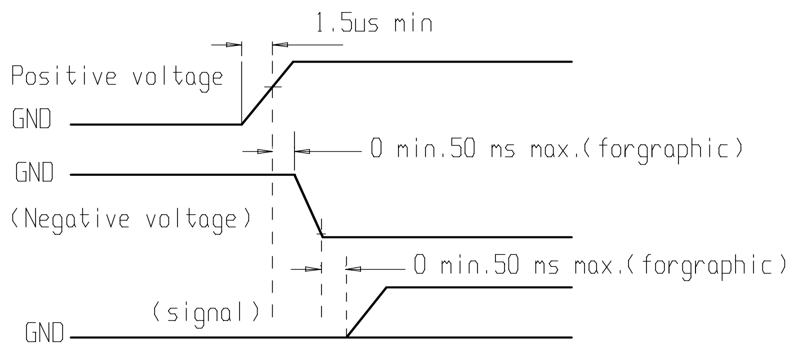
Precaution for soldering to the LCM

1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.
   a) Soldering iron temperature : 280°C ± 10°C.
   b) Soldering time : 3-4 sec.
2) Solder : eutectic solder.

3) 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.
4) 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.
5) 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.

Precautions for 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.



Safety

- If the LCD panel breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Handling

- The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.
- 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.
- Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- 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
- Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.
  - Water
  - Ketone
  - Aromatic solvents
- 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.
- 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.
- Do not attempt to disassemble or process the LCD module.
- NC terminal should be open. Do not connect anything.
- If the logic circuit power is off, do not apply the input signals.

- 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.

Storage

- When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps
- Store the module in a dark place where the temperature is 25 ^{o}C ±10 ^{o}C and the humidity below 65% RH.
- Do not store the module near organic solvents or corrosive gases.
- Do not crush, shake, or jolt the module (including accessories).

Cleaning

- Do not wipe the polarizing plate with a dry cloth, as it may scratch the surface.
- Wipe the module gently with soft cloth soaked with a petroleum benzene.
- Do not use ketonic solvents (ketone and acetone) or aromatic solvents (toluene and xylene), as they may damage the polarizing plate.

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.