

# SPECIFICATION



## YMSC-G12232BDYLYSN-1

September 28, 2007  
Version 1.01

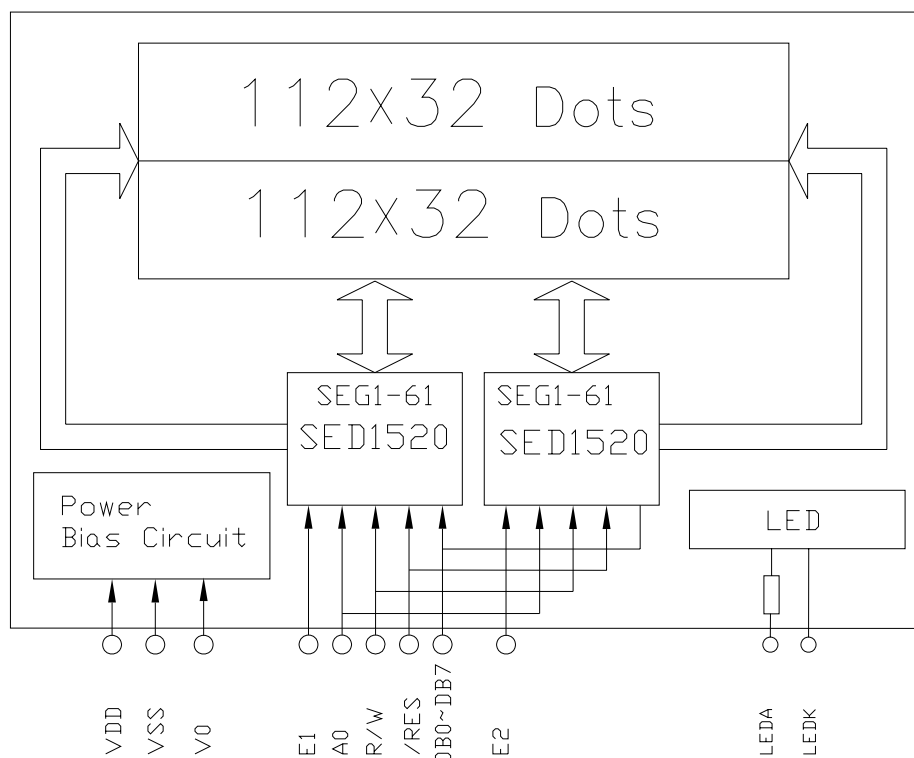


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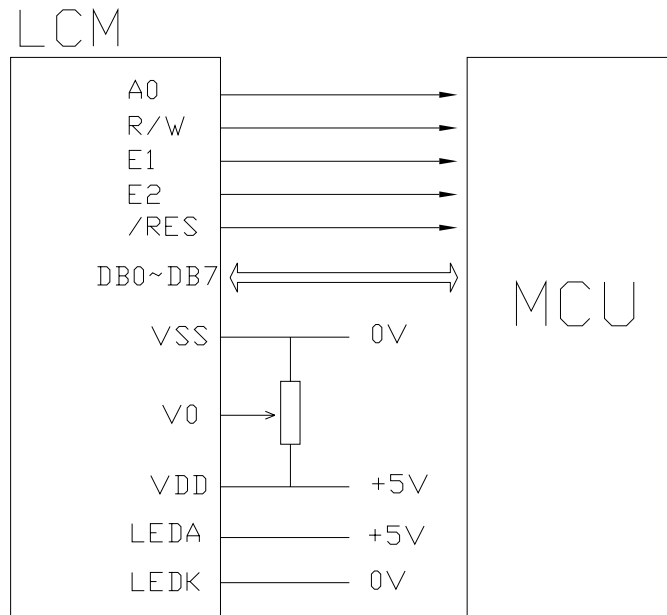
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**1. FEATURES :**

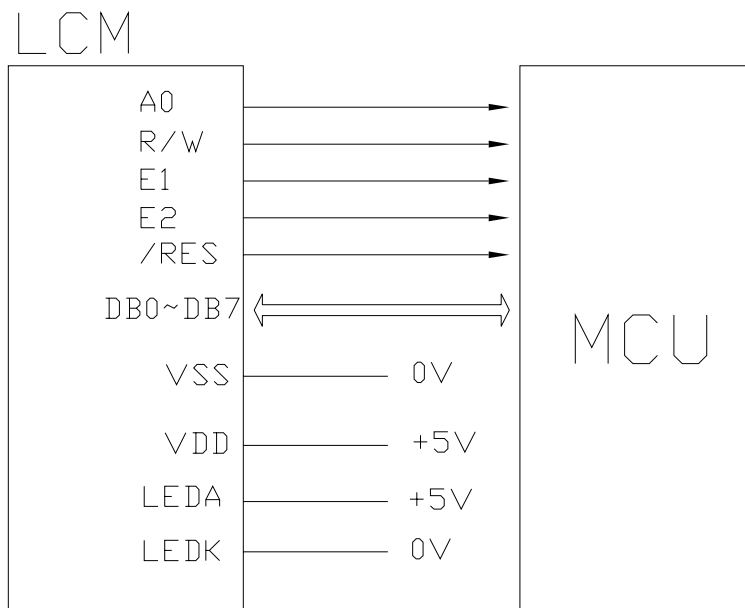
ITEM	STANDARD VALUE	UNIT
Display Type	112* 32dots	-
LCD Type	<input type="checkbox"/> STN, BLUE, Transflective, Negative <input checked="" type="checkbox"/> STN, YELLOW-GREEN, Transflective, Position <input type="checkbox"/> STN, GREY, Transflective, Negative <input type="checkbox"/> FSTN,, Transflective, Position,	-
LCD Duty	1/16	-
LCD Bias	1/5	-
Viewing Direction	6:00	-
Backlight Type	<input type="checkbox"/> S-LEDL(BLUE) <input checked="" type="checkbox"/> L-LEDL(YELLOW_GREEN) <input type="checkbox"/> S-LED(White)	-
Interface	6800 Series or 8080 series	-
Driver IC	SED1520	-
Module Dimension	84.0(W) X44.0(H) X13.0 (MAX)(T)	mm
Effective Display Area	48.76 (W) X15.32 (H)	mm
Dot Size	0.36 (W) X 0.41 (H)	mm
Dot Pitch	0.40W) X 0.45 (H)	mm

**2. BLOCK DIAGRAM &APPLICATION CIRCUIT :**


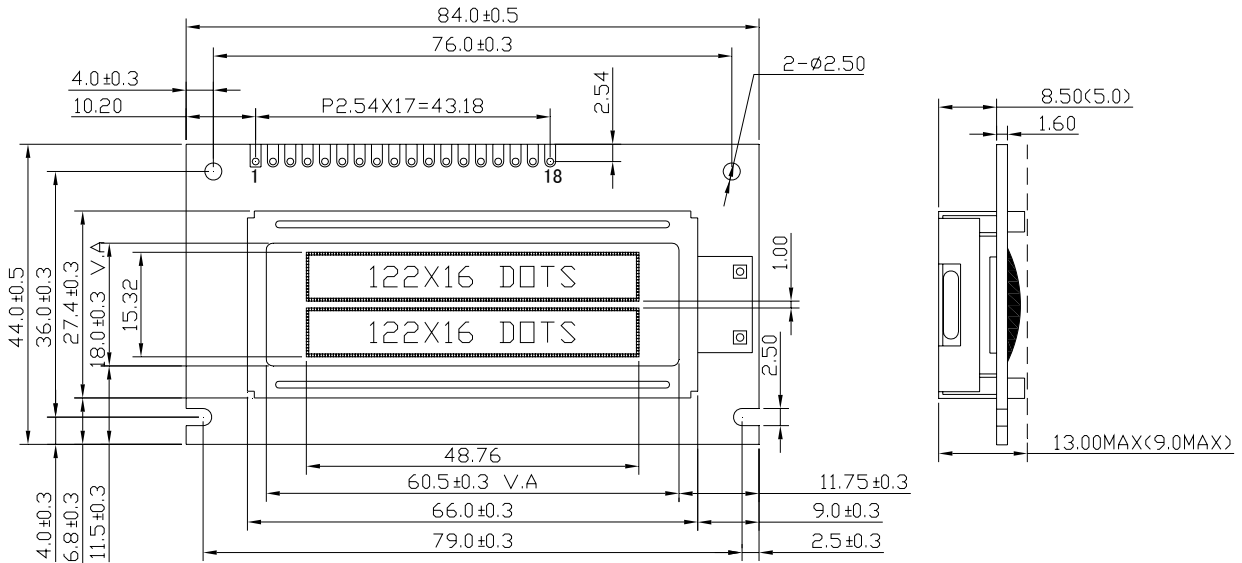
**Application For Adjustable Contrast**



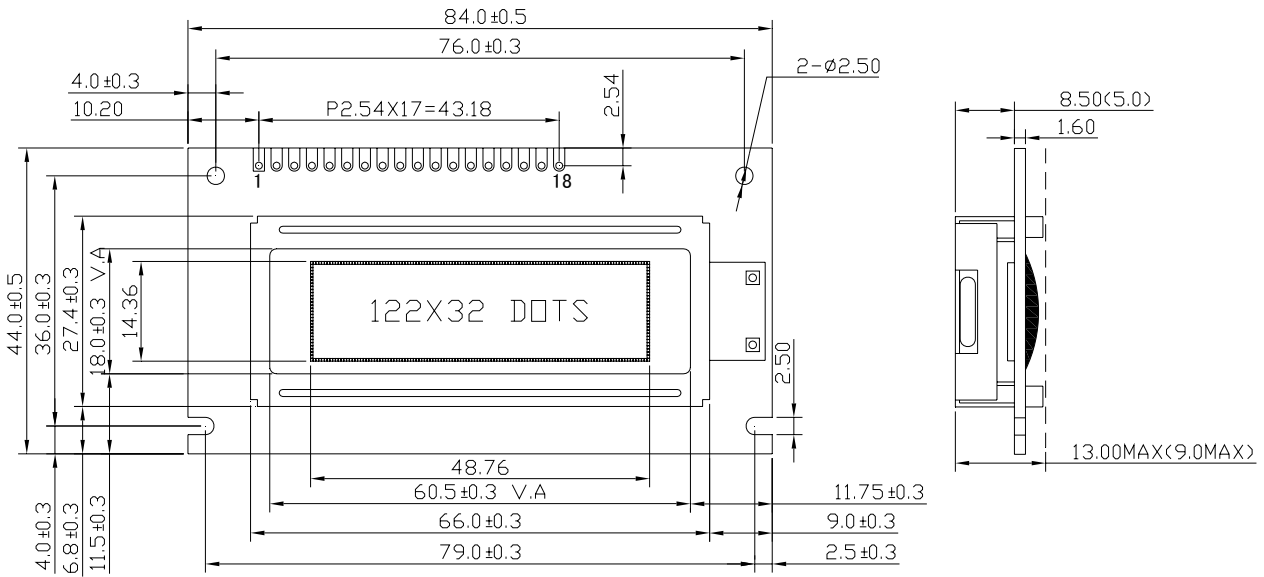
**Application For Immovable Contrast**



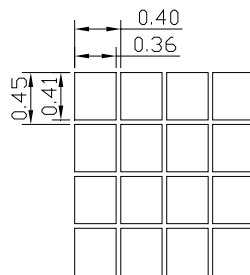
**3. OUTLINE DIMENSIONS**



LCM 1



LCM 2



**4. ABSOLUTE MAXIMUM RATING**

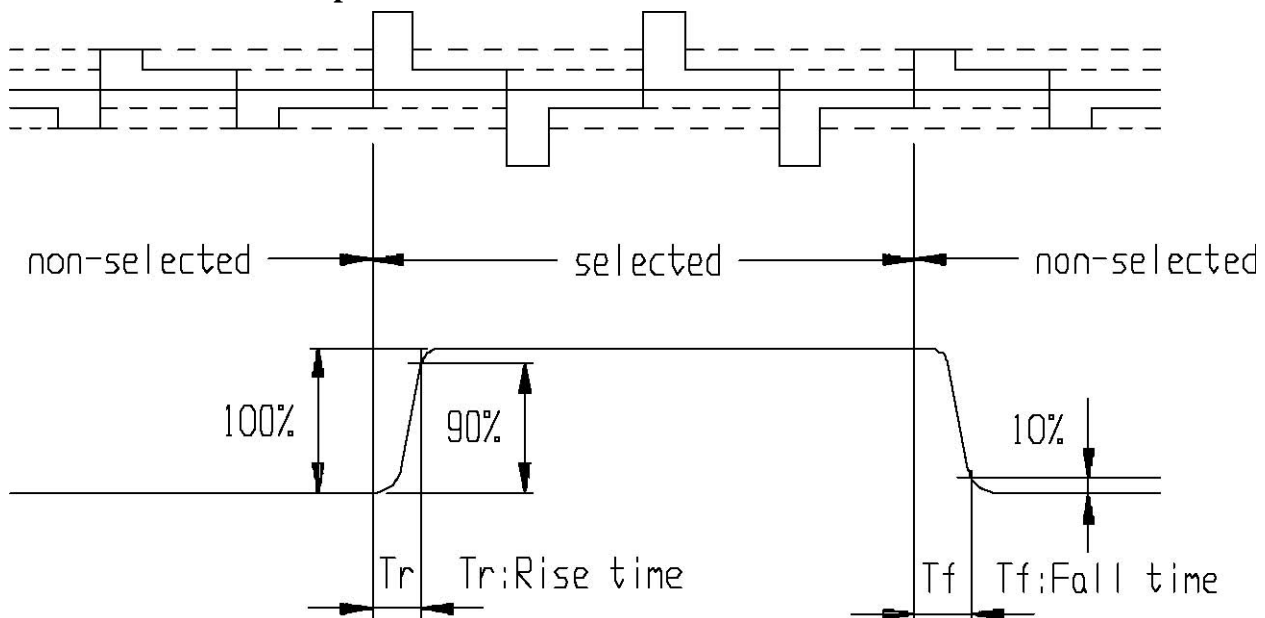
ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN	TYP	MAX	
POWER SUPPLY FOR LOGIC	VDD	Ta=25°C	-0.3	-	8.0	V
INPUT VOLTAGE	VIN	Ta=25°C	-0.3	-	VDD+0.3	V
Module OPERATION TEMPERATURE	TOPR	LCM 1	-20	-	+70	°C
		LCM 2	-10	-	+60	
Module STORAGE TEMPERATURE	TSTG	LCM 1	-30	-	+80	°C
		LCM 2	-20	-	+70	
Storage Humidity	H <sub>D</sub>	Ta < 40 °C	-		90	%RH

**5. ELECTRICAL CHARACTERISTICS**

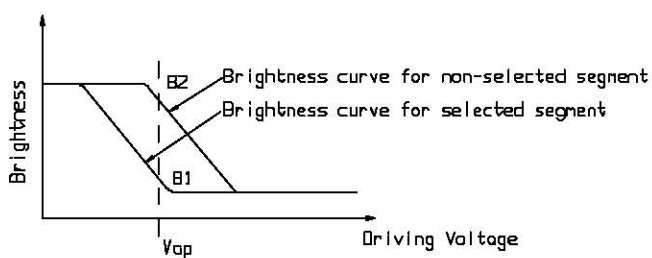
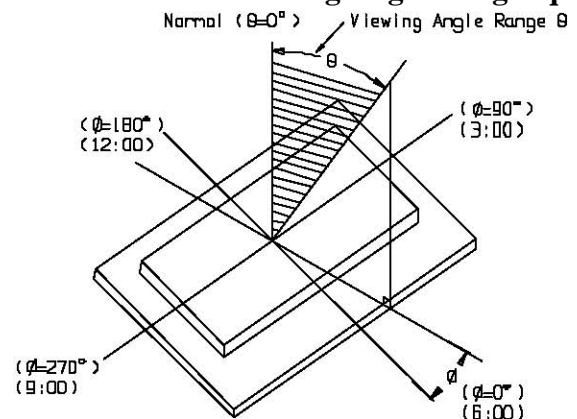
ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage (logic)	VDD-VSS	-	4.5	5	5.5	V
Supply Voltage (LCD)	VDD-V0	Ta= +25°C	-	5	-	V
Input signal voltage	V-IH	“H” level	0.8 VDD	-	VDD	V
	V-IL	“L” level	VSS	-	0.2 VDD	V
Output signal voltage	V-OH	“H” level	0.5 VDD	-	-	V
	VOL	“H” level	-	-	0.1VDD	V
Supply Current (logic)	IDD	VDD=5.0V	-	0.12	-	mA
Backlight Voltage	V-BL	LED(White)	-	3.1	-	V
		L-LED(Yellow-Green)	-	4.1	-	
		LED(Blue)	-	0.06	-	
Backlight Current	I-BL	LED(White)	-	40	-	mA
		L-LED(Yellow-Green)	-	80	-	
		LED(Blue)	-	40	-	
Backlight Driver Wave						kHz
Backlight Brightness						
Backlight Life Time						

**6. OPTICAL CHARACTERISTICS**

Item	Symbol	Condition	Min	Typ	Max	Unit	Remarks	Note
Response Time	Tr	-	-	140	-	ms	-	1
	Tf	-	-	133	-	ms	-	1
Contrast Ratio	Cr	-	-	5.1	-	-	-	2
Viewing Angle Range	$\theta$	$Cr \geq 2$	41	-	-	deg	$\theta = 90$	3
			38	-	-	deg	$\theta = 270$	3
			32	-	-	deg	$\theta = 0$	3
			19	-	-	deg	$\theta = 180$	3

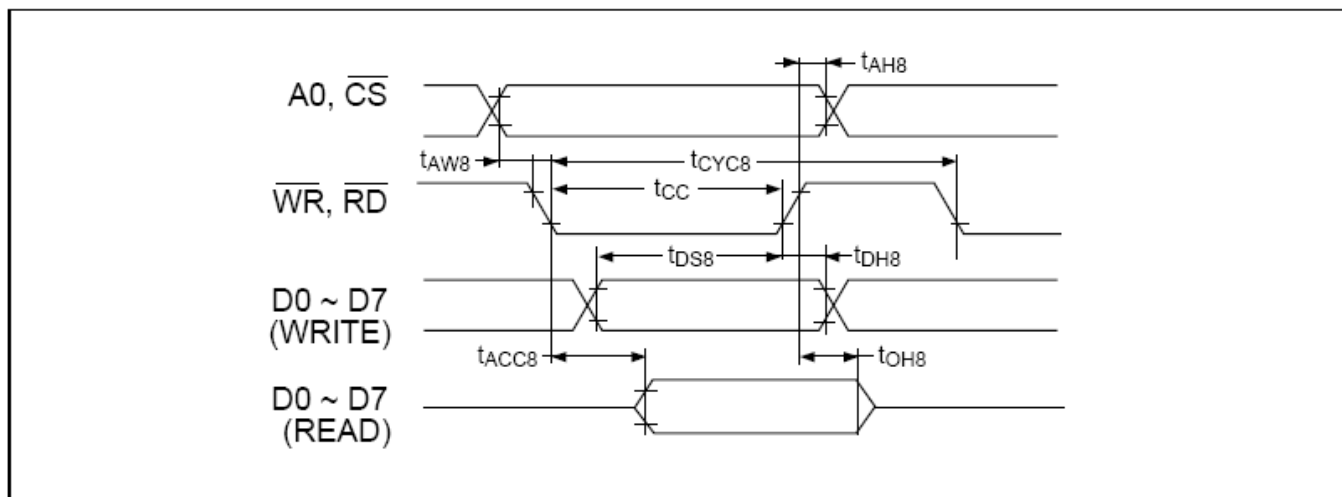
**Note 1. Definition of response time**

**Note 2. Definition of Contrast Ratio 'Cr'**

$$Cr = \frac{\text{Brightness of non-selected segment}(B2)}{\text{Brightness of selected segment}(B1)}$$


**Note 3. Definition of Viewing Angle Range 'q'**


## 7. TIMING CHARACTERISTICS

### 7.1 System Bus Read/Write (8080 family)



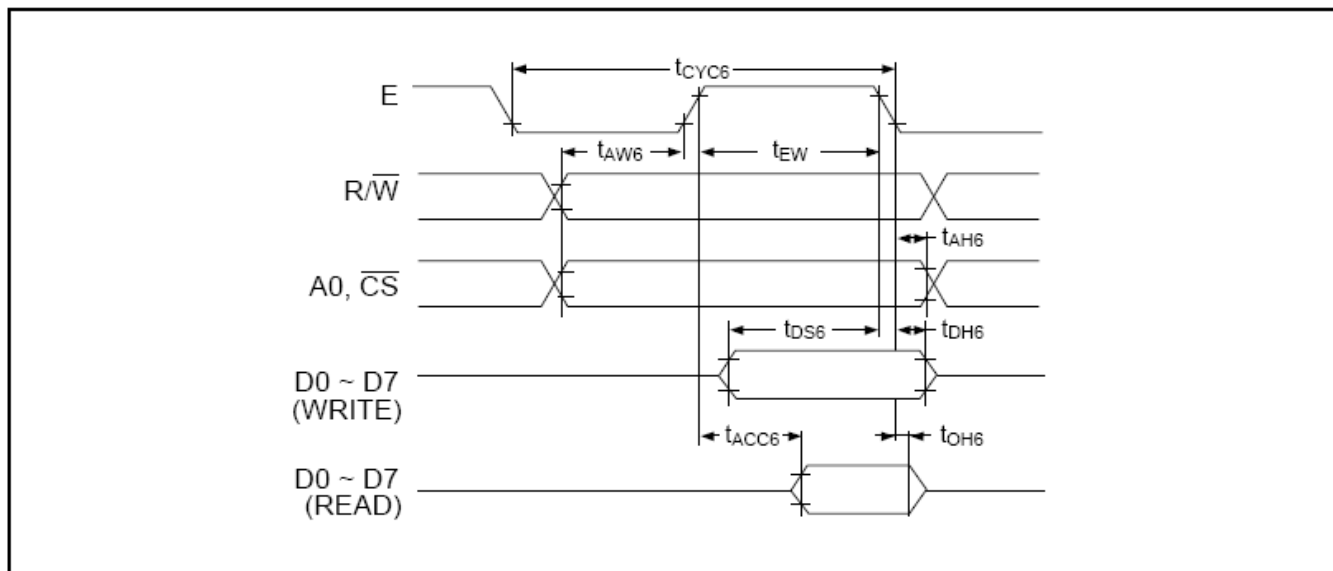
$T_a = -20$  to  $75^\circ\text{C}$ ,  $V_{ss} = -5.0\text{V} \pm 10\%$ , Unit: ns

Signal	Symbol	Parameter	Min.	Max.	Condition
A0, $\overline{\text{CS}}$	$t_{\text{AH8}}$	Address hold time	10		
	$t_{\text{AW8}}$	Address setup time	20		
$\overline{\text{WR}}, \overline{\text{RD}}$	$t_{\text{CYC8}}$	System cycle time	1000		
	$t_{\text{CC}}$	Control pulse width	200		
D0-D7	$t_{\text{DS8}}$	Data setup time	80		CL = 100pF
	$t_{\text{DH8}}$	Data hold time	10		
	$t_{\text{ACC8}}$	$\overline{\text{RD}}$ access time		90	
	$t_{\text{OH8}}$	Output disable time	10	60	

\*1. Each of the values where  $V_{ss} = -3.0\text{V}$  is about 200% of that where  $V_{ss} = -5.0\text{V}$  (i.e., the listed value).

\*2. The rise or fall time of input signals should be less than 15 ns.

7.2 System Bus Read/Write (6800 family)



Ta = -20 to 75°C, Vss = -5.0V ± 10%, Unit: ns

Signal	Symbol	Parameter	Min.	Max.	Condition
A0, $\overline{CS}$	$t_{CYC6}^{*1}$	System cycle time	1000		
R/ $\overline{W}$	$t_{AW6}$	Address setup time	20		
	$t_{AH6}$	Address hold time	10		
D0-D7	$t_{DS6}$	Data setup time	80		CL = 100pF
	$t_{DH6}$	Data hold time	10		
	$t_{OH6}$	Output disable time	10	60	
	$t_{ACC6}$	Access time		90	
E	$t_{EW}$	Enable pulse width	Read	100	
			Write	80	

- \*1.  $t_{CYC6}$  indicates the cycle time during which CS·E = "H". It does not mean the cycle time of signal E.
- \*2. Each of the values where Vss = -3.0V is about 200% of that where Vss = -5.0V (i.e., the listed value).
- \*3. The rise or fall time of input signals should be less than 15 ns.

## 8. Display Control Instruction

Please Consult SED1520 Data Sheet

Table 3 lists the commands used with the SED1520. This LSI uses a combination of A0, R/W ( $\overline{RD}$ ,  $\overline{WR}$ ) to identify a data bus signal. Interpretation and execution of a command depends not on external clock but on internal timing alone. Therefore, a command can be executed so fast that no busy check is needed.

A detailed description of commands follows.

### 8.1 DISPLAY ON/OFF

This command forces all display to turn on or off.

R/W										
A0	$\overline{RD}$	$\overline{WR}$	D7	_____						D0
0	1	0	1	0	1	0	1	1	1	D

D 0 = Display OFF  
1 = Display ON

### 8.2 DISPLAY START LINE

This command specifies a line address (shown in Fig. 2.3.8.1) thus marking the display line that corresponds to COM0. Display begins with the specified line address and covers as many lines as match the display duty in address ascending order. Dynamic line address change with the Display Start Line command enables column-wise scrolling or page change.

R/W										
A0	$\overline{RD}$	$\overline{WR}$	D7	_____						D0
0	1	0	1	1	0	A4	A3	A2	A1	A0

– High-order bits

A4	A3	A2	A1	A0	Line address
0	0	0	0	0	0
0	0	0	0	1	1
		—			—
		—			—
1	1	1	1	1	31

### 8.3 SET PAGE ADDRESS

This command is used to specify a page address equivalent to a row address for MPU access to the display data RAM. A required bit of the display data RAM can be accessed by specifying its page address and column address. Changing the page address causes no change in display.

R/W

A0	$\overline{RD}$	WR	D7							D0
0	1	0	1	0	1	1	1	0	A1	A0

A1	A0	Page
0	0	0
0	1	1
1	0	2
1	1	3

### 8.4 COLUMN ADDRESS

This command specifies a display data RAM column address. The column address is incremented by 1 each time the MPU accesses from the set address to the display data RAM. Thus, it is possible for the MPU to gain continuous access to only the data. This incrementing stops with address 80; the page address is not continuously changed.

R/W

A0	$\overline{RD}$	WR	D7							D0
0	1	0	0	A6	A5	A4	A3	A2	A1	A0

A6	A5	A4	A3	A2	A1	A0	Column address
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
			—				—
			—				—
1	0	0	1	1	1	1	79

## 8.5 READ STATUS

R/W											
A0	$\overline{RD}$	$\overline{WR}$	D7	_____							D0
0	0	1	Busy	ADC	ON/ OFF	Reset	0	0	0	0	

**BUSY:** BUSY being "1" means that system is performing an internal operation or is reset. No command is accepted before BUSY = "0". As long as the cycle time requirement is met, no BUSY check is needed.

**ADC:** Indicates assignment of column addresses to segment drivers.

- 0: Inverted (column address 79-n ↔ segment driver n)
- 1: Forward (column address n ↔ segment driver n)

**ON/OFF:** Indicates display on or off.

- 0: Display on
- 1: Display off

This bit has polarity reverse to the Display ON/OFF command.

**RESET:** Indicates that system is being initialized by the  $\overline{RES}$  signal or the Reset command.

- 0: Display mode
- 1: Being reset

## 8.6 WRITE DISPLAY DATA

This command allows the MPU to write 8 bits of data into the display data RAM. Once the data is written, the column address is automatically incremented by 1; this enables the MPU to write multi-word data continuously.

R/W											
A0	$\overline{RD}$	$\overline{WR}$	D7	_____							D0
1	1	0	Write data								

### 8.7 READ DISPLAY DATA

This command allows the MPU to read 8 bits of data from the display data RAM location specified by a column address and a page address. Once the data is read, the column address is automatically incremented by 1; this enables the MPU to read multi-word data continuously.

A dummy read is needed immediately after the column address is set. For details, see 3. (1)–(c).??

R/W									
A0	RD	WR	D7 ————— D0						
1	0	1	Read data						

### 8.8 SELECT ADC

This command inverts the relation of assignment between display data RAM column addresses and segment driver outputs. In other words, the Select ADC command can software-invert the order of segment driver output pins, reducing the restrictions on the configuration of ICs at LCD module assembly. For details, see Fig. 2.3.8.1.

Incrementing the column address by 1, which takes place after the MPU writing or reading display data, follows the sequence of column addresses specified in Fig. 2.3.8.1.

A0	RD	WR	D7 ————— D0							
0	1	0	1	0	1	0	0	0	0	D

- D = 0: Clockwise output (forward)
- D = 1: Counterclockwise output (reverse)

### 8.9 STATIC DRIVE ON/OFF

This command forces all display to be on and, at the same time, all common output to be selected.

R/W										
A0	RD	WR	D7 ————— D0							
0	1	0	1	0	1	0	0	1	0	D

- D = 0: Static drive off
- D = 1: Static drive on

### 8.10 SELECT DUTY

This command is used to select the duty (degree of multiplexity) of LCD driving. It is valid for the SED1520F (actively operating LSI) only, not valid for the SED1521F (passively operating LSI). The SED1521F operates with any duty determined by the FR signal.

R/W										
A0	$\overline{RD}$	$\overline{WR}$	D7	_____						D0
0	1	0	1	0	1	0	1	0	0	D

D = 0: Duty 1/16

D = 1: Duty 1/32

If the system contains both SED1520FOA (internal oscillation) and the SED1521FOA LSIs, they must have the same duty.

### 8.11 READ MODIFY WRITE

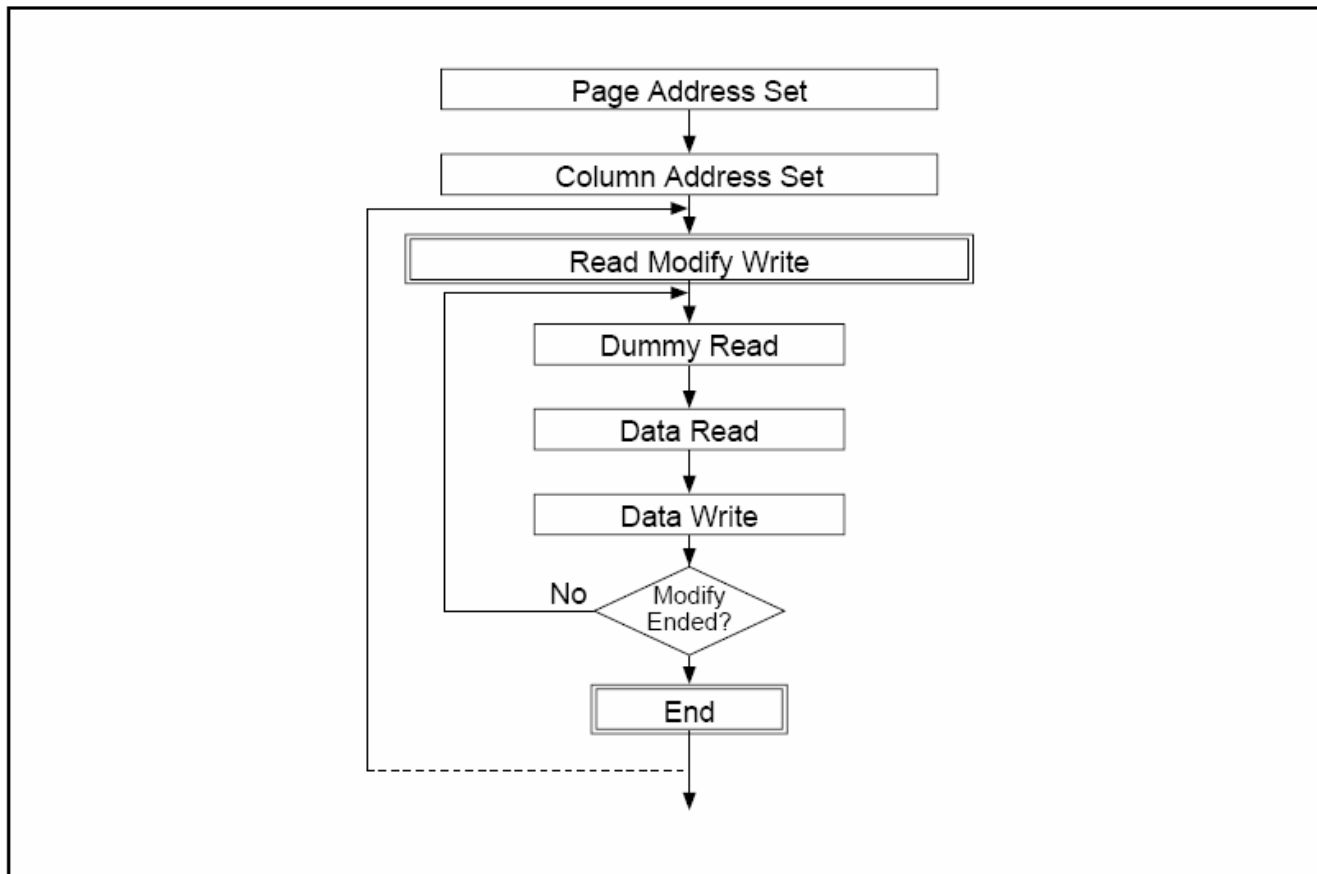
This command is used with the End command in a pair. Once it has been entered, the column address will be incremented not by the Read Display Data command but by the Write Display Data command only. This mode will stay until the End command is entered.

Entry of the End command causes the column address to return to the address which was valid when the Read Modify Write command was entered. This function lessens the load of the MPU when the data in a specific display area are repeatedly updated (as blinking cursor).

R/W										
A0	$\overline{RD}$	$\overline{WR}$	D7	_____						D0
0	1	0	1	1	1	0	0	0	0	0

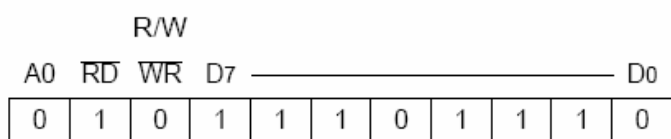
Even in the Read Modify Write mode, any command other than Read/Write Data and Set Column Address may be used.

### 8.11.1 Cursor Blinking Sequence

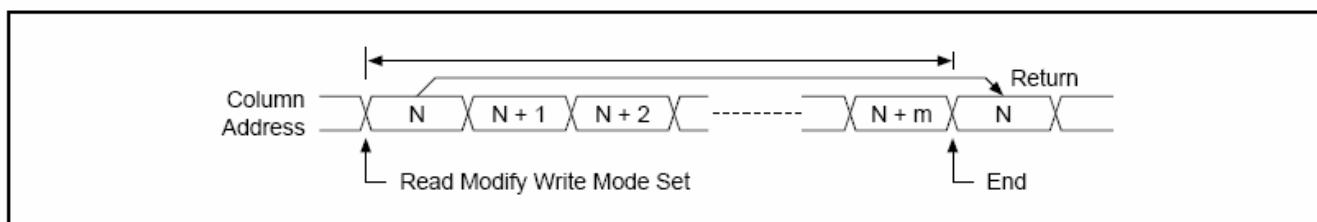


### 8.12 END

This command cancels the Read Modify Write command, returning the column address to the initial mode address.



#### 8.12.1 End Timing



### 8.13 RESET

This command initializes the display start line register, column address counter, and page address counter without any effect on the display data RAM. For details, see section 2.3.12.

The reset operation follows entry of the Reset command.

R/W										
A0	R $\bar{D}$	WR	D7							D0
0	1	0	1	1	1	0	0	0	1	0

Initialization at power-on is performed not by the Reset command but by a reset signal applied to the  $\bar{RES}$  pin.

### 8.14 SAVE POWER (COMBINED COMMAND)

Static drive going on with display off invokes power-saving mode, reducing current consumption to nearly static current level. During this mode, the SED1520 holds the following conditions:

- (a) It stops driving the LCD; the segment and common driver outputs are at  $V_{DD}$  level.
- (b) Oscillation and external clock input are disabled; OSC2 is in floating condition.
- (c) The display data and operational mode are held.

The power-saving mode is cancelled by display on or static drive off.

If an external resistor division circuit is used to give LCD driving voltage level, the current flowing into the resistors must be cut off by the power-save signal.

#### 8.14.1 External Resistor Division Circuit

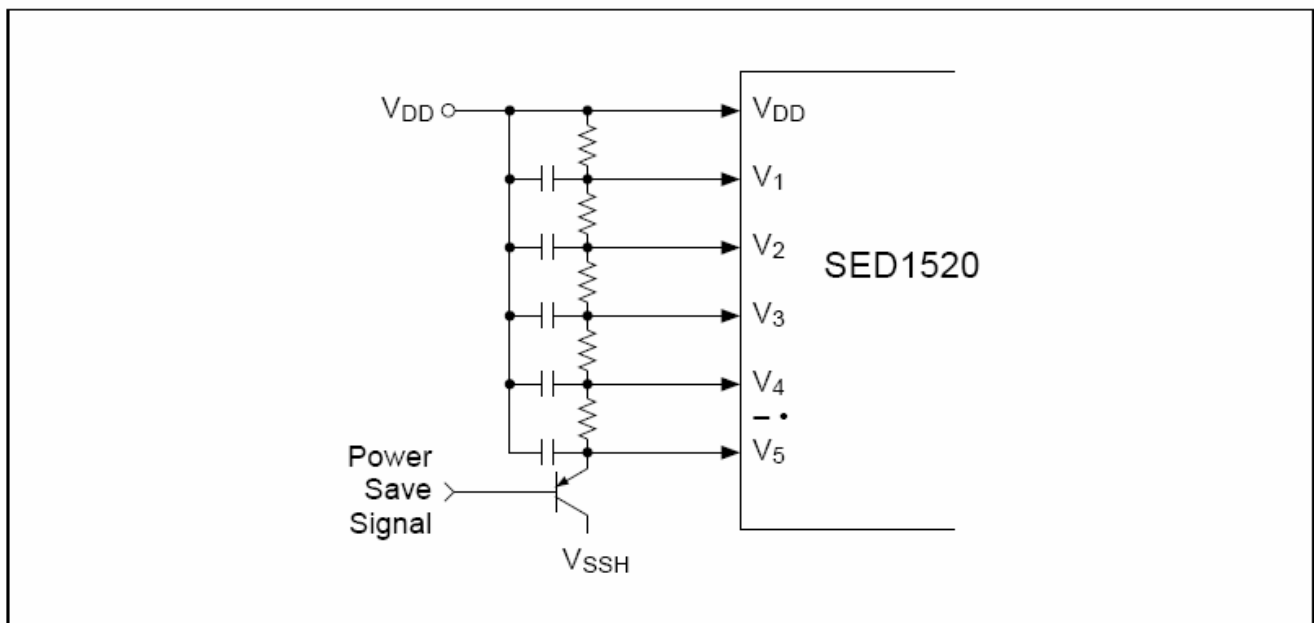


Table 3 Commands

	Command	Code											Function	
		A0	$\overline{RD}$	$\overline{WR}$	D7	D6	D5	D4	D3	D2	D1	D0		
(1)	Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0/1	Turns all display on or off, independently of display RAM data or internal status. 1: ON 0: OFF (Power-saving mode with static drive on)*	
(2)	Display start line	0	1	0	1	1	0	Display Start Address (0–31)				0	Specifies RAM line corresponding to uppermost line (COM0) of display.	
(3)	Set page address	0	1	0	1	0	1	1	1	0	Page (0–3)		Sets display RAM page in page address register.	
(4)	Set column (segment) address	0	1	0	0	Column Address (0–79)						0	Sets display RAM column address in column address register.	
(5)	Read status	0	0	1	Busy	ADC	ON/OFF	RESET	0	0	0	0	Reads the following status: BUSY 1: Internal operation, 0: Ready ADC 1: CW output (forward), 0: CCW output (reverse) ON/OFF 1: Display off, 0: Display on RESET 1: Being reset, 0: Normal	
(6)	Write display data	1	1	0	Write Data							Writes data from data bus into display RAM.		Display RAM location whose address has been preset is accessed. After access, the column address is incremented by 1.
(7)	Read display data	1	0	1	Read Data							Reads data from display RAM onto data bus.		
(8)	Select ADC	0	1	0	1	0	1	0	0	0	0	0/1	Used to invert relationship of assignment between display RAM column addresses and segment driver outputs. 0: CW output (forward) 1: CCW output (reverse)	
(9)	Static drive ON/OFF	0	1	0	1	0	1	0	0	1	0	0/1	Selects normal display or static driving operation. 1: Static drive (power-saving mode) 0: Normal driving	
(10)	Select duty	0	1	0	1	0	1	0	1	0	0	0/1	Selects LCD cell driving duty. 1: 1/32 0: 1/16	
(11)	Read modify write	0	1	0	1	1	1	0	0	0	0	0	Increments column address counter by 1 when display data is written. (This is not done when data is read.)	
(12)	End	0	1	0	1	1	1	0	1	1	1	0	Clears read modify write mode.	
(13)	Reset	0	1	0	1	1	1	0	0	0	1	0	Sets display start line register on the first line. Also sets column address counter and page address counter to 0.	

\* With display off (command (1)), static drive going on (9) invokes power-saving mode.

## 9. DISPLAY CONTROL FUNCTIONS

### System Bus

#### MPU interface



##### 1. Selecting an interface type

The SED1520 series transfers data via 8-bit bidirectional data buses (D0 to D7). As its Reset pin has the MPU interface select function, the 80-series MPU or the 68-series MPU can directly be connected to the MPU bus by the selection of high or low RES signal

level after reset (see Table 1).

When the CS signal is high, the SED1520 series is disconnected from the MPU bus and set to stand by. However, the reset signal is entered regardless of the internal setup status.

Table 1

RES signal input level	MPU type	A0	E	R/W	CS	D0 to D7
 Active	68-series	↑	↑	↑	↑	↑
 Active	80-series	↑	RD	WR	↑	↑

#### Data transfer

The SED1520 and SED1521 drivers use the A0, E (or RD) and R/W (or WR) signals to transfer data between the system MPU and internal registers. The combinations used are given in the table below.

In order to match the timing requirements of the MPU with those of the display data RAM and control registers all data is latched into and out of the driver. This introduces a one cycle delay between a read request for data and the data arriving. For example when the MPU

executes a read cycle to access display RAM the current contents of the latch are placed on the system data bus while the desired contents of the display RAM are moved into the latch.

This means that a dummy read cycle has to be executed at the start of every series of reads. See Figure 1.

No dummy cycle is required at the start of a series of writes as data is transferred automatically from the input latch to its destination.

Common	68 MPU	80 MPU		Function
	R/W	RD	WR	
A0				
1	1	0	1	Read display data
1	0	1	0	Write display data
0	1	0	1	Read status
0	0	1	0	Write to internal register (command)

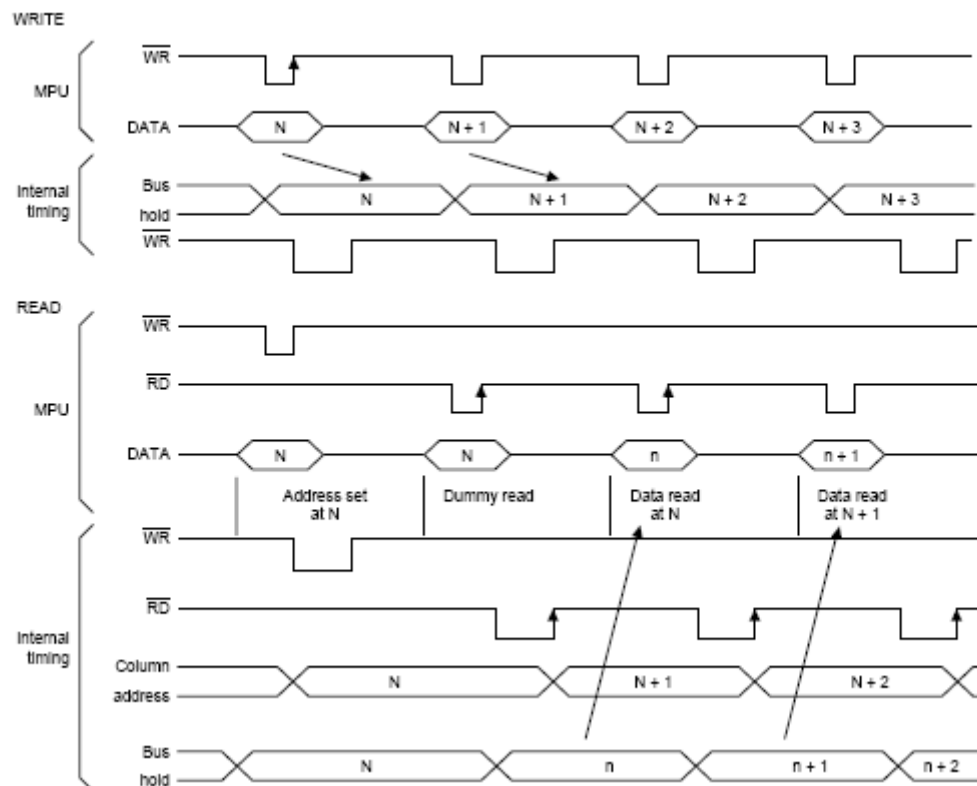


Figure 1 Bus Buffer Delay

### Busy flag

When the Busy flag is logical 1, the SED1520 series is executing its internal operations. Any command other than Status Read is rejected during this time. The Busy flag is output at pin D7 by the Status Read command. If an appropriate cycle time (tcyc) is given, this flag needs not be checked at the beginning of each command and, therefore, the MPU processing capacity can greatly be enhanced.

### Display Start Line and Line Count Registers

The contents of this register form a pointer to a line of data in display data RAM corresponding to the first line of the display (COM0), and are set by the Display Start Line command. See section 3.

The contents of the display start line register are copied into the line count register at the start of every frame, that is on each edge of FR. The line count register is incremented by the CL clock once for every display line, thus generating a pointer to the current line of data, in display data RAM, being transferred to the segment driver circuits.

### Column Address Counter

The column address counter is a 7-bit presettable counter that supplies the column address for MPU access to the display data RAM. See Figure 2. The counter is incremented by one every time the driver receives a Read or Write Display Data command. Addresses above 50H are invalid, and the counter will not increment past this value. The contents of the column address counter are set with the Set Column Address command.

### Page Register

The page register is a 2-bit register that supplies the page address for MPU access to the display data RAM. See Figure 2. The contents of the page register are set by the Set Page Register command.

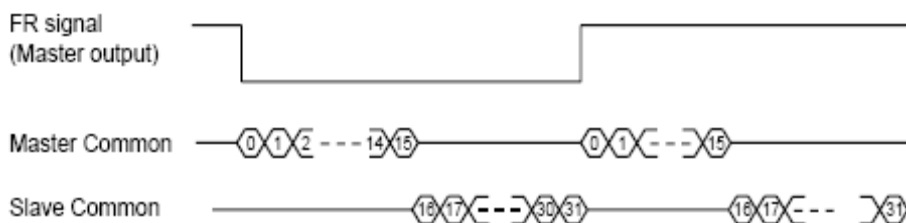
### Display Data RAM

The display data RAM stores the LCD display data, on a 1-bit per pixel basis. The relationship between display data, display address and the display is shown in Figure 2.

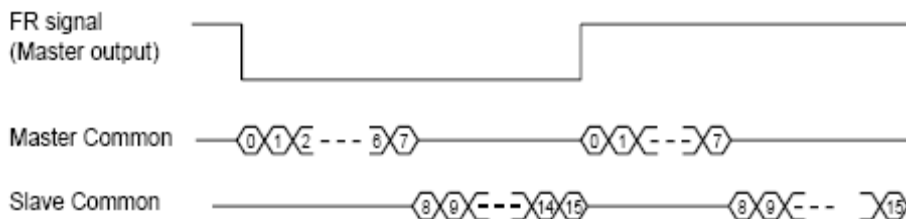
### Common Timing Generator Circuit

Generates common timing signals and FR frame signals from the CL basic clock. The 1/16 or 1/32 duty (for SED1520) or 1/8 or 1/16 duty (for SED1522) can be selected by the Duty Select command. If the 1/32 duty is selected for the SED1520 and 1/16 duty is selected for the SED1522, the 1/32 and 1/16 duties are provided by two chips consisting of the master and slave chips in the common multi-chip mode.

#### SED1520



#### SED1522



### Display Data Latch Circuit

This latch stores one line of display data for use by the LCD driver interface circuitry. The output of this latch is controlled by the Display ON/OFF and Static Drive ON/OFF commands.

### LCD Driver Circuit

The LCD driver circuitry generates the 80 4-level signals used to drive the LCD panel, using output from the display data latch and the common timing generator circuitry.

### Display Timing Generator

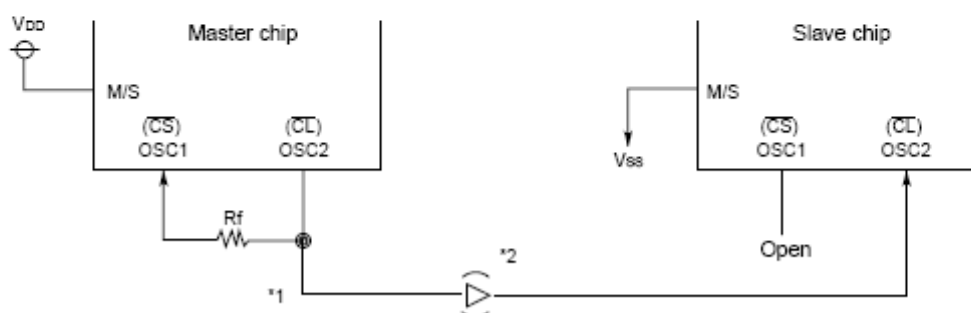
This circuit generates the internal display timing signal using the basic clock, CL, and the frame signals, FR. FR is used to generate the dual frame AC-drive waveform (type B drive) and to lock the line counter and common timing generator to the system frame rate. CL is used to lock the line counter to the system line scan rate. If a system uses both SED1520s or SED1522 and SED1521s they must have the same CL frequency rating.

### Oscillator Circuit (SED1520\*0A Only)

A low power-consumption CR oscillator for adjusting the oscillation frequency using Rf oscillation resistor only. This circuit generates a display timing signal. Some of SED1520 and SED1522 series models have a built-in oscillator and others use an external clock. This difference must be checked before use.

Connect the Rf oscillation resistor as follows. To suppress the built-in oscillator circuit and drive the MPU using an external clock, enter the clock having the same phase as the OSC2 of mater chip into OSC2 of the slave chip.

- MPU having a built-in oscillator



- \*1 If the parasitic capacitance of this section increases, the oscillation frequency may shift to the lower frequency. Therefore, the Rf oscillation frequency must be reduced below the specified level.
- \*2 A CMOS buffer is required if the oscillation circuit is connected to two or more slave MPU chips.

- MPU driven with an external clock



### Reset Circuit

Detects a rising or falling edge of an  $\overline{\text{RES}}$  input and initializes the MPU during power-on.

- Initialization status
  1. Display is off.
  2. Display start line register is set to line 1.
  3. Static drive is turned off.
  4. Column address counter is set to address 0.
  5. Page address register is set to page 3.
  6. 1/32 duty (SED1520) or 1/16 duty (SED1522) is selected.
  7. Forward ADC is selected (ADC command D0 is 1 and ADC status flag is 1).
  8. Read-modify-write is turned off.

The input signal level at  $\overline{\text{RES}}$  pin is sensed, and an MPU interface mode is selected as shown on Table 1. For the 80-series MPU, the  $\overline{\text{RES}}$  input is passed through the inverter and the active high reset signal must be entered. For the 68-series MPU, the active low reset signal must be entered.

As shown for the MPU interface (reference example), the  $\overline{\text{RES}}$  pin must be connected to the Reset pin and reset at the same time as the MPU initialization.

If the MPU is not initialized by the use of  $\overline{\text{RES}}$  pin during power-on, an unrecoverable MPU failure may occur.

When the Reset command is issued, initialization

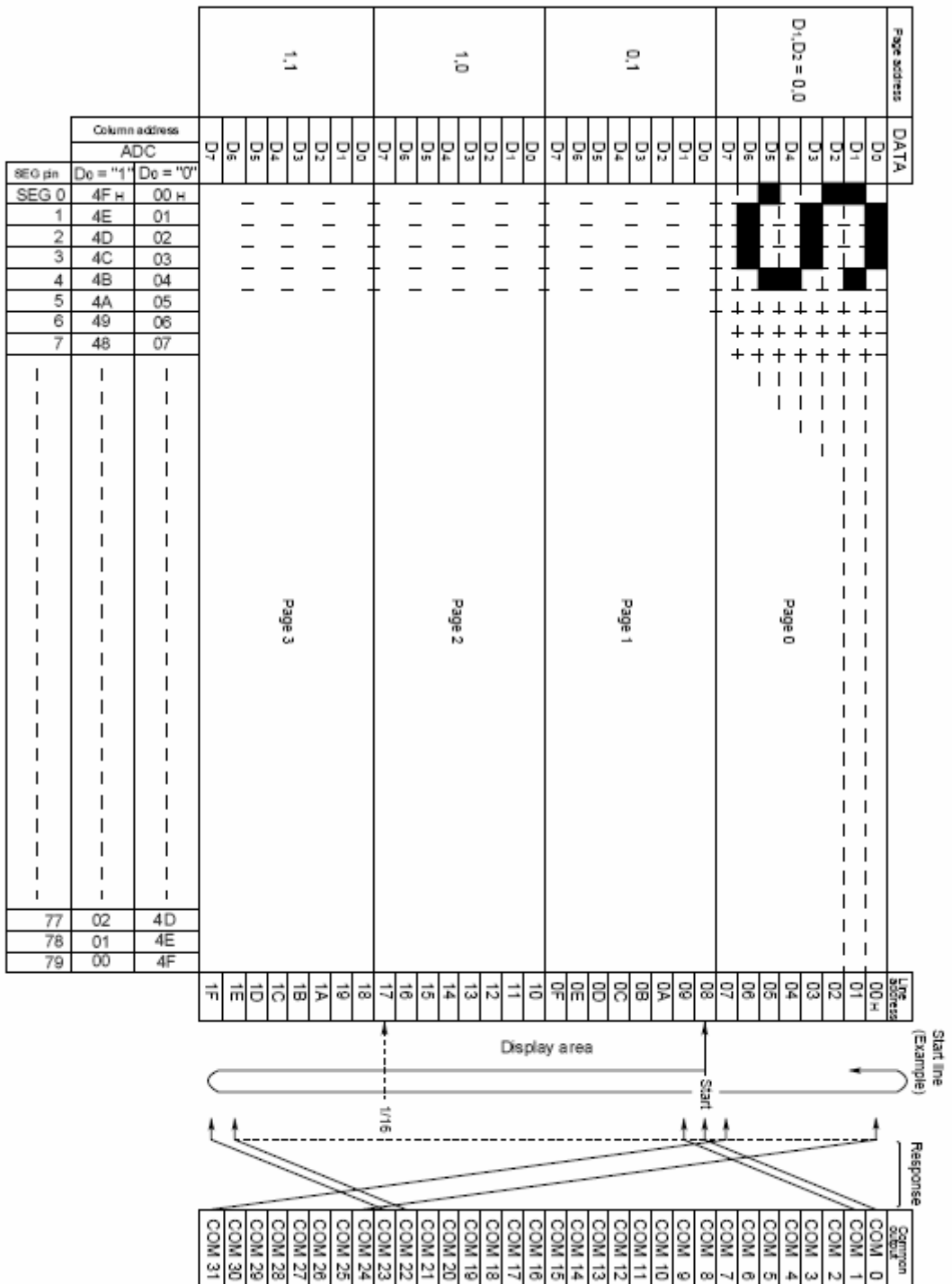


Figure 2 Display Data RAM Addressing

1/5 bias, 1/16 duty  
 1/6 bias, 1/32 duty

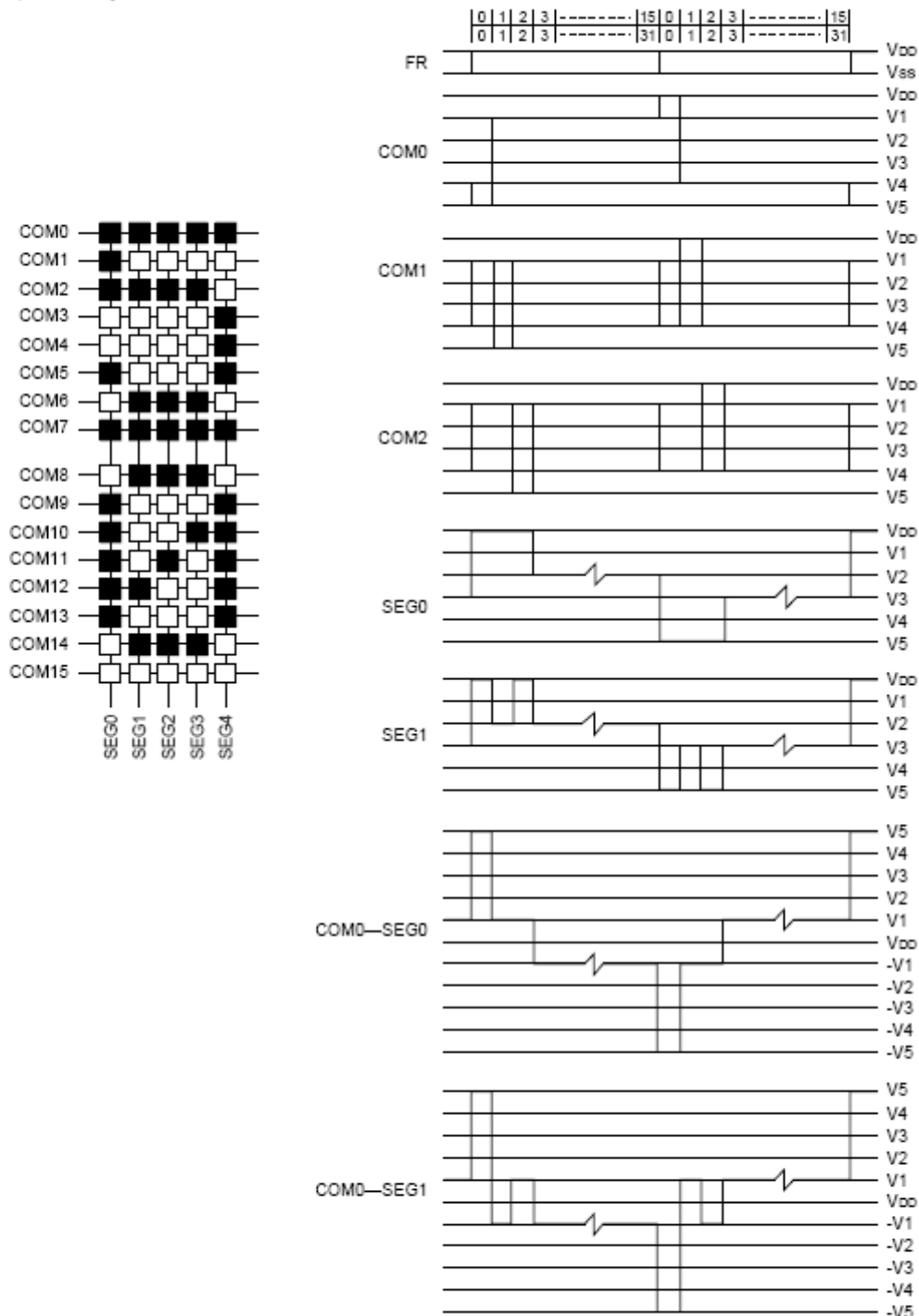




Figure 4 LCD drive waveforms example

## 11. INTERFACE PIN CONNECTIONS

### CN1 (SED1335 Controller)

PIN	SYMBOL	I/O	FUNCTION
1	VDD	I	Ground pin, connected to 0V
2	VSS	I	Power supply pin for logic .(+5V)
3	V0	I	Contrast control (VDD~VOOUT)
4	/RES	I	When the /RES signal goes  the 6800-series MPU is initialized, and when it goes  , the 8080-series MPU is initialized. The system is reset during edge sense of the /RES signal. The interface type to the 6800-series or 8080-series MPU is selected by the level input as follows: High level: 6800-series MPU interface. Low level: 8080-series MPU interface.
5	E1	I	Chip1: If the 6800-series MPU is connected: Used as an enable clock input of the 6800-series MPU. If the 8080-series MPU is connected: The /RD signal of the 8080-series MPU is entered in this pin. When this signal is kept low, the SED1520 data bus is in the output status.
6	E2	I	Chip2: If the 6800-series MPU is connected: Used as an enable clock input of the 6800-series MPU. If the 8080-series MPU is connected: The /RD signal of the 8080-series MPU is entered in this pin. When this signal is kept low, the SED1520 data bus is in the output status.
7	R/W	I	If the 6800-series MPU is connected: Used as an input pin of read control signals (if R/W is high) or write control signals(if low). If the 8080-series MPU is connected: The /WR signal of the 8080-series MPU is entered in this pin. A signal on the data bus is fetched at the rising edge of /WR signal.
	A0	I	Usually connected to the low-order bit of the MPU address bus and used to identify the data or a command. A0=0: DB0~DB7 are display control data. A0=1: DB0~DB7 are display data.
9	DB0	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
10	DB1	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
11	DB2	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.

12	DB3	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
13	DB4	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
14	DB5	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
15	DB6	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
16	DB7	I/O	Tristate input/output pins. Connect these pins to an 8- or 16-bit microprocessor bus.
17	LEDA	I	LED anode (+5V)
18	LEDK	I	LED cathode (0V)

## 12.RELIABILITY

### Content of Reliability Test

Environmental Test				
No.	Test Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	80 °C 200 hrs	
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-30 °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.	70 °C 200 hrs	
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	-20 °C 200 hrs	
5	High temperature Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	50 °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.	50 °C , 90,RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle.  $\begin{array}{c} -20^{\circ}\text{C} \quad \rightleftharpoons \quad 25^{\circ}\text{C} \quad \rightleftharpoons \quad 70^{\circ}\text{C} \\ 30\text{min.} \quad \leftarrow \quad 5\text{min.} \quad \leftarrow \quad 30\text{min.} \\ \longleftarrow \hspace{10em} \longrightarrow \\ \text{1 cycle} \end{array}$	-20°C – 70°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 1l 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
<b>Others</b>				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V, RS=1.5 k CS=100 pF 1 time	MIL-883B-3015.1

\*\*\* Supply voltage for logic system = 3V. Supply voltage for LCD system = Operating voltage at 25°C.

### Failure Judgement Criterion

Criterion Item	Test Item No.											Failure Judgment Criterion	
	1	2	3	4	5	6	7	8	9	10	11		
Basic specification													Out of the Basic Specification
Electrical characteristic													Out of the DC and AC Characterstic
Mechanical characteristic													Out of the Mechanical Specification Color change : Out of Limit Apperance Specification
Optical characterstic													Out of the Apperance Standard

## 13. QUALITY GUARANTEE

### Acceptable Quality Level

Each lot should satisfy the quality level defined as follows.

- Inspection method : MIL-STD-105E LEVEL II Normal one time sampling
- AQL

Partition	AQL	Definition
A: Major	0.4%	Functional defective as product
B: Minor	1.5%	Satisfy all functions as product but not satisfy cosmetic standard

### Definition of 'LOT'

One lot means the delivery quantity to customer at one time.

### Conditions of Cosmetic Inspection

#### Environmental condition

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

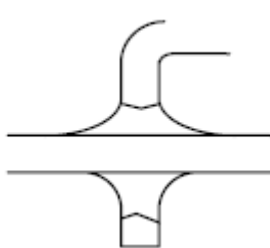
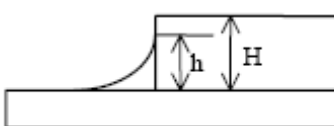
**Inspection method**

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

**Driving voltage**

The VO value which the most optimal contrast can be obtained near the specified VO in the specification. (Within  $\pm 0.5V$  of typical value at 25°C.).

**14. INSPECTION CRITERIA**
**14.1 Module Cosmetic Criteria**

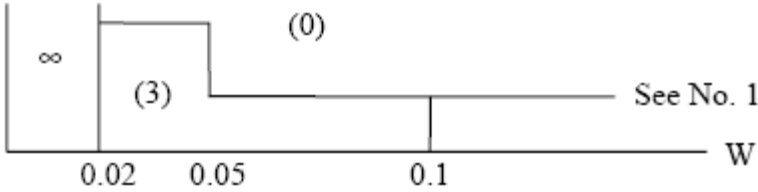
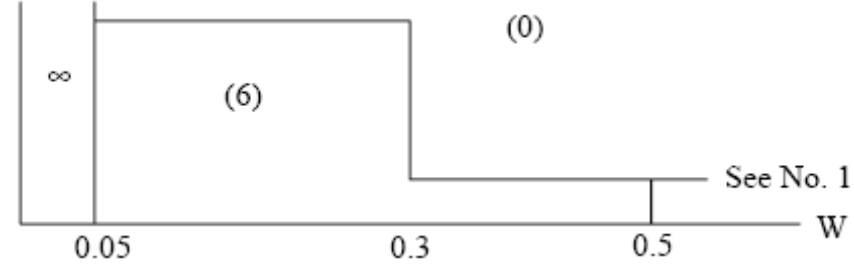
No.	Item	Judgement Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Major
4	Resist flaw on substrate	Invisible copper foil ('0.5mm or 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	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
	1. Lead parts		
	2. Flat packages	Either 'Toe' (A) or 'Seal' (B) of the lead to be covered by 'Filet'.  Lead form to be assume over solder. A B	Minor
	3. Chips	$(3/2) H \geq h \geq (1/2) H$ 	Minor

**14.2 Screen Cosmetic Criteria (Non-Operating)**

No.	Defect	Judgement Criterion	Partition										
1	Spots	In accordance with <i>Screen Cosmetic Criteria (Operating) No.1.</i>	Minor										
2	Lines	In accordance with <i>Screen Cosmetic Criteria (Operating) No.2.</i>	Minor										
3	Bubbles in polarizer	<table border="1"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>d ≤ 0.3</td> <td>Disregard</td> </tr> <tr> <td>0.3 &lt; d ≤ 1.0</td> <td>3</td> </tr> <tr> <td>1.0 &lt; d ≤ 1.5</td> <td>1</td> </tr> <tr> <td>1.5 &lt; d</td> <td>0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	d ≤ 0.3	Disregard	0.3 < d ≤ 1.0	3	1.0 < d ≤ 1.5	1	1.5 < d	0	Minor
Size : d mm	Acceptable Qty in active area												
d ≤ 0.3	Disregard												
0.3 < d ≤ 1.0	3												
1.0 < d ≤ 1.5	1												
1.5 < d	0												
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										

**14.3. Screen Cosmetic Criteria (Operating)**

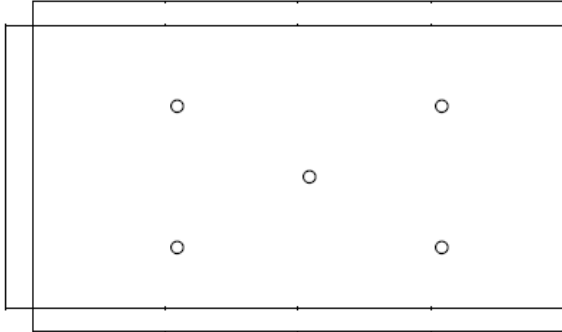
No.	Defect	Judgement Criterion	Partition																				
1	Spots	<p>A) Clear Note :</p> <table border="1"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>d ≤ 0.1</td> <td>Disregard</td> </tr> <tr> <td>0.1 &lt; d ≤ 0.2</td> <td>3</td> </tr> <tr> <td>0.2 &lt; d ≤ 0.3</td> <td>2</td> </tr> <tr> <td>0.3 &lt; d</td> <td>0</td> </tr> </tbody> </table> <p>Including pin holes and defective dots which must be within one pixel size.</p> <p>B) Unclear Size :</p> <table border="1"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>d ≤ 0.2</td> <td>Disregard</td> </tr> <tr> <td>0.2 &lt; d ≤ 0.5</td> <td>6</td> </tr> <tr> <td>0.5 &lt; d ≤ 0.7</td> <td>2</td> </tr> <tr> <td>0.7 &lt; d</td> <td>0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	d ≤ 0.1	Disregard	0.1 < d ≤ 0.2	3	0.2 < d ≤ 0.3	2	0.3 < d	0	Size : d mm	Acceptable Qty in active area	d ≤ 0.2	Disregard	0.2 < d ≤ 0.5	6	0.5 < d ≤ 0.7	2	0.7 < d	0	Minor
Size : d mm	Acceptable Qty in active area																						
d ≤ 0.1	Disregard																						
0.1 < d ≤ 0.2	3																						
0.2 < d ≤ 0.3	2																						
0.3 < d	0																						
Size : d mm	Acceptable Qty in active area																						
d ≤ 0.2	Disregard																						
0.2 < d ≤ 0.5	6																						
0.5 < d ≤ 0.7	2																						
0.7 < d	0																						

2	Lines	<p>A) Clear</p>  <p>Note : ( ) - Acceptable Qty in active area L          -Length (mm) W - Width (mm)          ∞ - Disregard</p> <p>B) Unclear</p> 	Minor
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'Clear' = The shade and size are not changed by VO.

'Unclear' = The shade and size are changed by VO.

**14.4. Screen Cosmetic Criteria (Operating) (Continued)**

No.	Defect	Judgement Criterion	Partition
3	Rubbing line	Not to be noticeable.	
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 'Spot'. (see <i>Screen Cosmetic Criteria (Operating) No.1</i> )	Minor
7	Uneven brightness (only back-lit type module)	<p>Uneven brightness must be <math>B_{MAX} / B_{MIN} \leq 2</math></p> <ul style="list-style-type: none"> <li>- BMAX : Max. value by measure in 5 points</li> <li>- BMIN : Min. value by measure in 5 points</li> </ul> <p>Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.</p>  <p>○ : Measuring points</p>	Minor

**Note :**

- (1) Size :  $d = (\text{long length} + \text{short length}) / 2$
- (2) The limit samples for each item have priority.

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

- (4) 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 '5mm.
- 10 or over defects in circle of '10mm.
- 20 or over defects in circle of '20mm.

**15. PRECAUTIONS FOR USING LCD MODULES****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 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.

### **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.

### **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.

## **16. USING LCD MODULES**

### **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 polarizers 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 polarizers and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropylalcohol.
- (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 polarizers. 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.

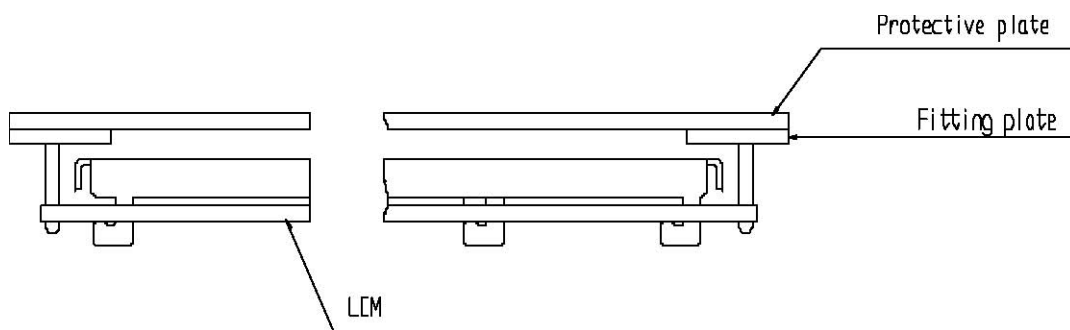
(9) Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are determined to the polarizers).

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

### 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 Handling 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) Do not alter, modify or change the the shape of the tab on the metal frame.

(2) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.

(3) Do not damage or modify the pattern writing on the printed circuit board.

(4) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.

(5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.

(6) 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 handling 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.

- Soldering iron temperature : 280℃ ± 10℃.
- 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.

#### **Precautions for Operation**

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

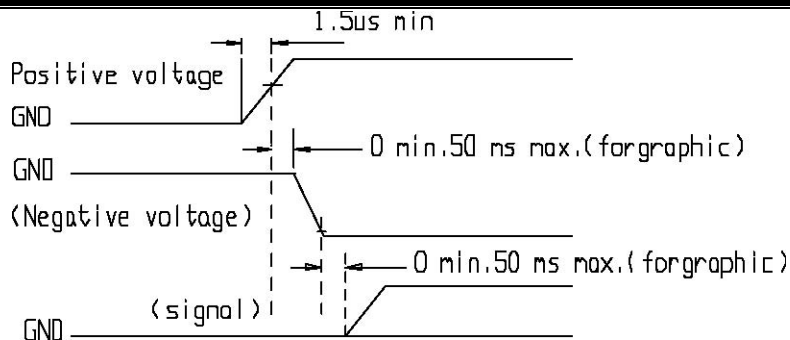
(2) Driving the LCD in the voltage above the limit shortens its life.

(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℃ , 50% RH.

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



### 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.)

### 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.

### Limited Warranty

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

### 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's, conductors and terminals.