

# LCD Module Specification

Model: LG3202401-LMDWH6V-CN1 (RA8835)

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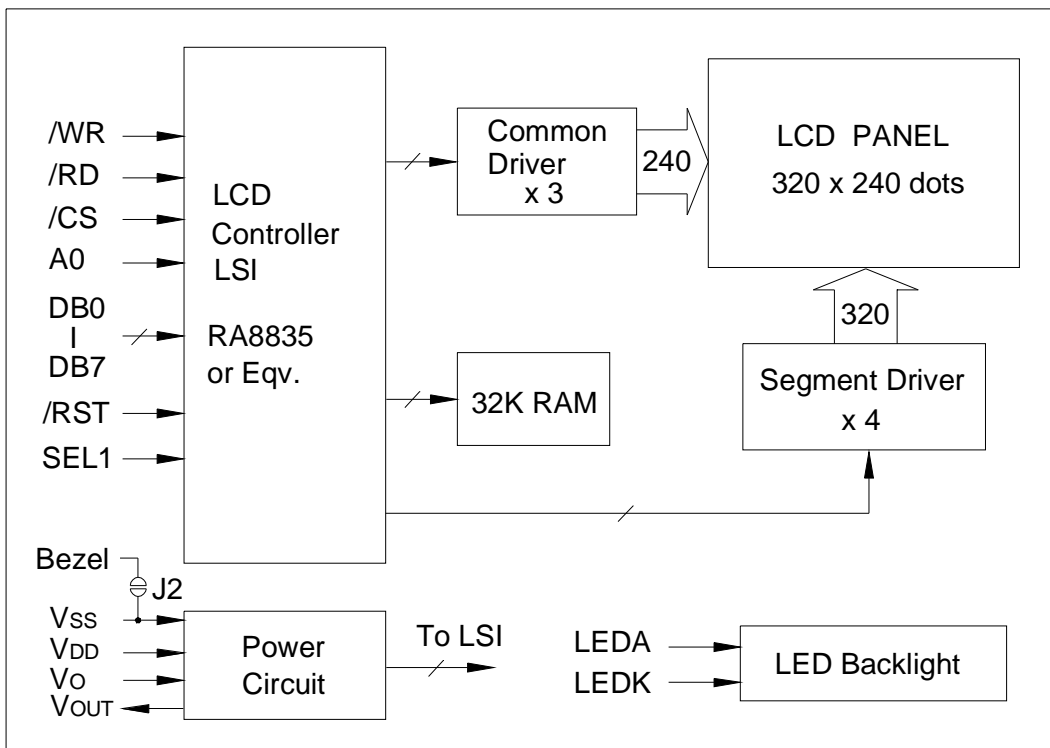
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# 1. BASIC SPECIFICATIONS

## 1.1 Features

- Display Format : 320 X 240 Dots
- LCD Mode : FSTN—Blue—Negative—Transmissive
- Driving Method : 1/240 Duty, 1/15 Bias
- Viewing Direction : 6:00
- Backlight : LED, white color
- Outline Dimension : 160.0(W) X 109.0(H) X 13.0(T) mm
- Viewing Area : 122.0(W) X 92.0(H) mm
- Dot Size : 0.33 X 0.33 mm
- Dot Pitch : 0.36 X 0.36 mm
- Weight : 230 g
- Controller : RA8835 (Compatible with S1D13305)
- Display RAM : 32K Bytes
- Internal CGROM : 160 words 5x7 pixel character generator ROM
- Display Mode : Text, graphics and combination of text/graphics display
- Power supply : 3.3 to 5.0V for logic  
 Built in DC-DC converter for LCD driving  
 5.0V for LED backlight

## 1.2 Block Diagram



### 1.3 Terminal Functions (CN1, CN2, CN3)

Pin No.		Symbol	Level	Function
CN1	CN2, CN3			
1	16	/RST	L	Reset signal, active "L"
2	6	/RD (E)	--	/RD (Read) signal for 8080 series MPU: Read bus data when /RD is "L". E (Enable) signal for 6800 series MPU: Read bus data when E is "H", write bus data at falling edge of E.
3	5	/WR (R/W)	--	/WR (Write) signal for 8080 series MPU: Bus data is latched at the rising edge of /WR. R/W (Read/Write control) signal for 6800 series MPU: R/W="H" : Read operation; R/W="L": Write operation.
4	15	/CS	L	Chip selection signal, active "L"
5	4	A0	H/L	Write mode: H: Command write L: Display data or parameter write Read mode: H: Display data or cursor address read L: Status read
6	7	DB0	H/L	Data bit0
7	8	DB1	H/L	Data bit1
8	9	DB2	H/L	Data bit2
9	10	DB3	H/L	Data bit3
10	11	DB4	H/L	Data bit4
11	12	DB5	H/L	Data bit5
12	13	DB6	H/L	Data bit6
13	14	DB7	H/L	Data bit7
14	2	VDD	+3.3~5V	Power supply for logic
15	1	VSS	0V	Ground
16	17	VOUT	-22.0V	Output voltage for LCD driving
17	3	VO	--	Operating voltage for LCD (contrast adjusting)
18	18	SEL1	H/L	MPU interface selection H: 6800 series MPU L: 8080 series MPU
19	19	LEDA	+5V	Power supply for LED backlight
20	20	LEDK	0V	Power supply for LED backlight

### 1.4 Setting SEL1 Level by Jumpers

J3	J4	SEL1 Level	Function
Close	Open	L	8080 series MPU selected ( <b>Initial Setting</b> )
Open	Close	H	6800 series MPU selected

## 2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage(Logic)	VDD-VSS	-0.3	7.0	V
Supply Voltage(LCD)	VDD-VO	-0.3	30.0	V
Input Voltage	VI	-0.3	VDD+0.3	V
Operating Temp.	Topr	-20	70	°C
Storage Temp.	Tstg	-30	80	°C

## 3. ELECTRICAL CHARACTERISTICS

### 3.1 DC Characteristics (Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage (Logic)	VDD		3.3	--	5.5	V
Supply Voltage (LCD Drive)	VDD-VO		--	22.6	--	V
Input High Voltage	VIH		0.5VDD	--	VDD	V
Input Low Voltage	VIL		0	--	0.2VDD	V
Supply Current (Logic)	IDD	VDD=5.0V	--	35.0	60.0	mA
		VDD=3.3V	--	45.0	80.0	mA

3.2 Interface Timing Chart (80 Series MPU, Ta=25°C)

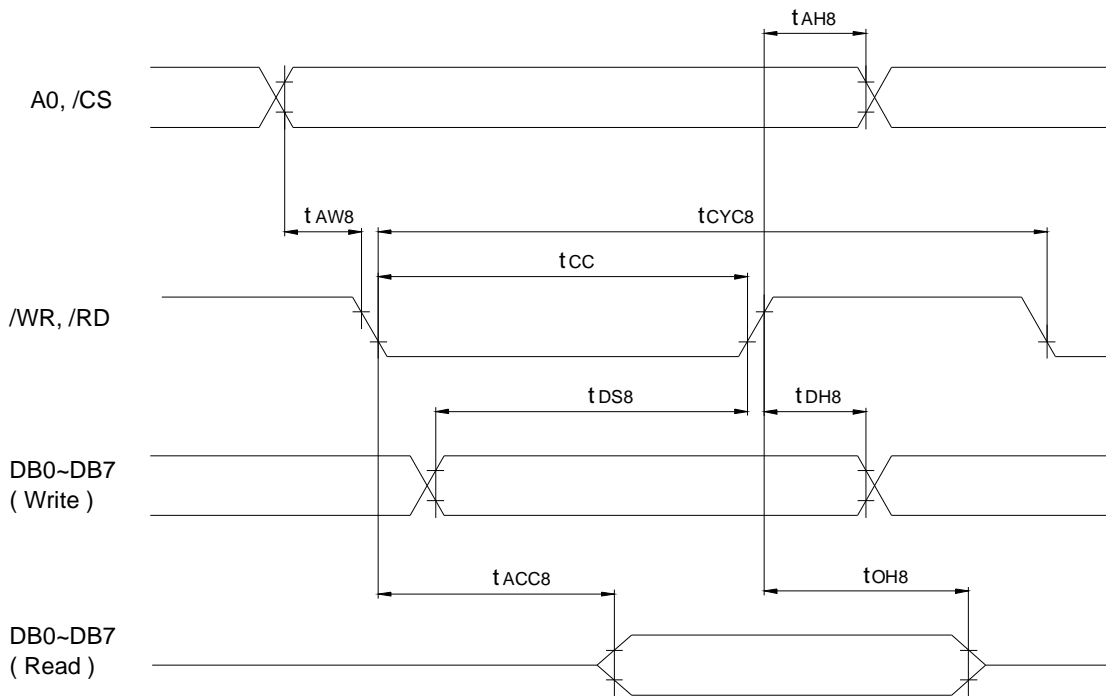
Parameters	Signal	Symbol	VDD=4.5 to 5.5V		VDD=3.3 to 4.5V		Condition	Unit
			Min.	Max.	Min.	Max.		
Address Hold Time	A0,	tAH8	10	--	10	--	CL=100pF	ns
Address Set-up Time	/CS	tAW8	0	--	0	--		
System Cycle Time	/RD,	tCYC8	See note	--	See note	--		
Control Pulse Width	/WR	tCC	120	--	150	--		
Data Set-up Time	D0~D7	tDS8	120	--	120	--		
Data Hold time		tDH8	5	--	5	--		
/RD Access Time		tACC8	--	50	--	80		
Output Disable Time		tOH8	10	50	10	55		

Note: For memory control and system control commands:

$$t_{CYC8} = 2t_c + t_{CC} + t_{CEA} + 75 > t_{ACV} + 245 \text{ (} t_c \text{ is clock period, } t_c=100\text{ns)}$$

For all other commands:

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



Bus Read/Write Timing(80 Series MPU)

3.3 Interface Timing Chart (68 Series MPU, Ta=25°C)

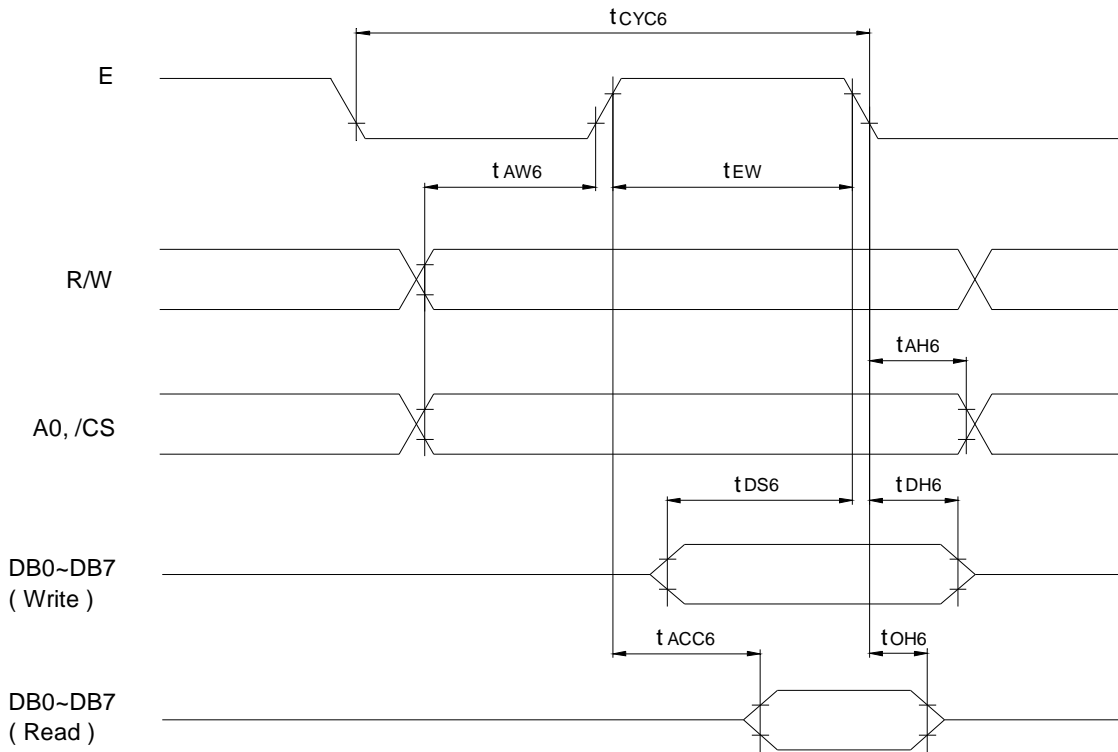
Parameters	Signal	Symbol	VDD=4.5 to 5.5V		VDD=3.3 to 4.5V		Condition	Unit
			Min.	Max.	Min.	Max.		
System Cycle Time	A0, /CS, R/W	tCYC6	See note	--	See note	--	CL=100pF	ns
Address Set-up Time		tAW6	0	--	0	--		
Address Hold Time		tAH6	0	--	0	--		
Data Set-up Time	D0-D7	tDS6	100	--	120	--		
Data Hold Time		tDH6	0	--	0	--		
Output Disable Time		tOH6	10	50	10	75		
Access Time		tACC6	--	85	--	130		
Enable Pulse Width	E	tEW	120		150			

Note: For memory control and system control commands:

$$t_{CYC6} = 2t_c + t_{EW} + t_{CEA} + 75 > t_{ACV} + 245 \text{ (} t_c \text{ is clock period, } t_c=100\text{ns)}$$

For all other commands:

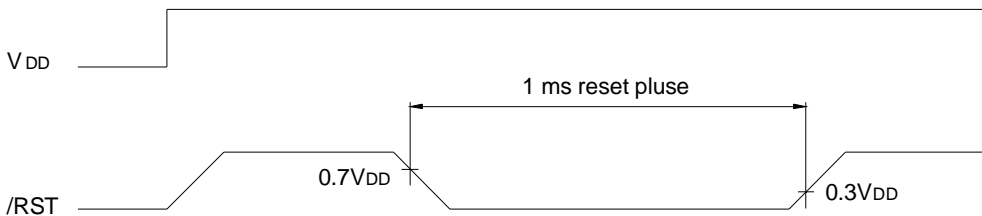
$$t_{CYC6} = 4t_c + t_{EW} + 30$$



Bus Read/Write Timing(68 Series MPU)

### 3.4 Reset

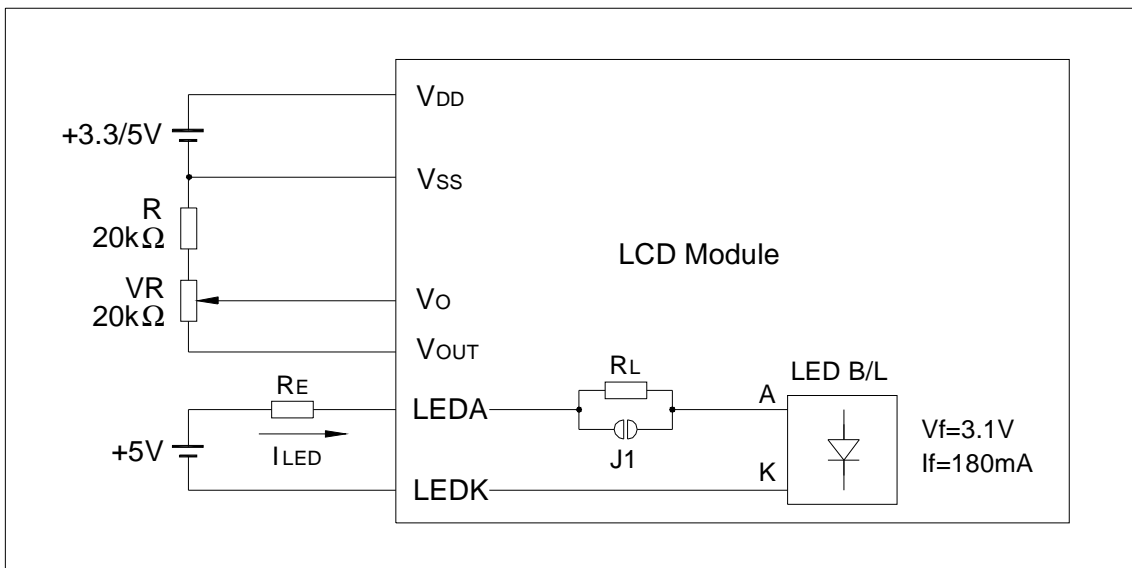
RA8835 requires a reset pulse at least 1ms long after power-on in order to re-initialize its internal state. RA8835 can not receive commands while it is reset. Commands to initialize the internal registers should be issued soon after the reset. A delay of 3 ms (maximum) is required following the rising edges of both /RST and VDD to allow for system stabilization.



### 3.5 LED Backlight Characteristics (Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward Voltage	Vf		2.9	3.1	3.3	V
Forward Current	If	Vf=3.1V	--	180	--	mA
Color	White					

### 3.6 Power Supply



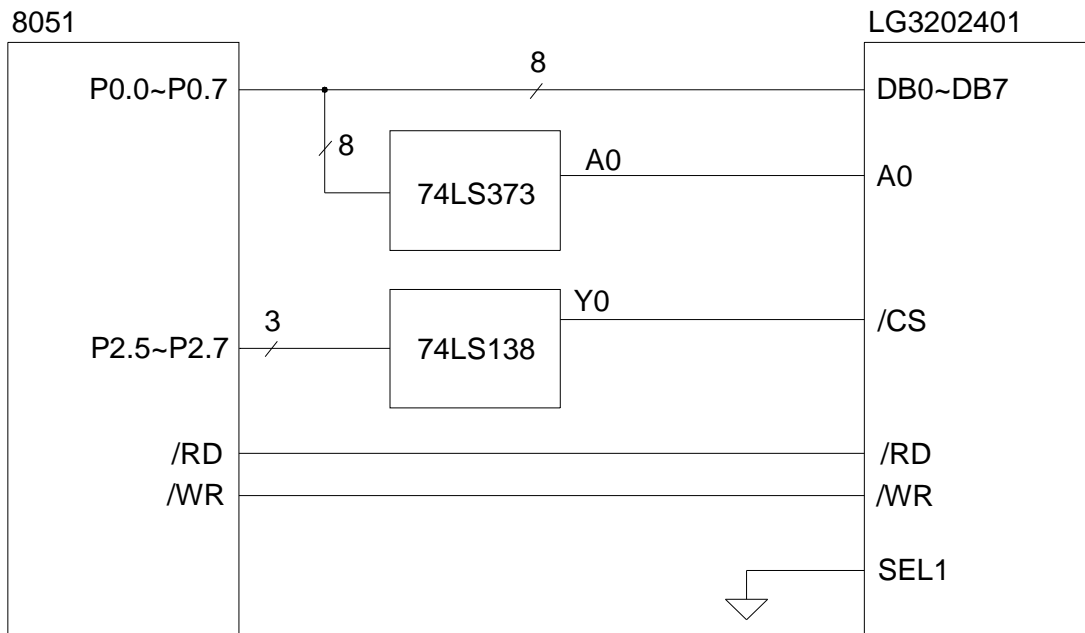
\* VR is for LCD contrast adjusting, VDD-VO is around 22.6V

\* RL (internal) and RE (external) is the current limiting resistor for LED backlight

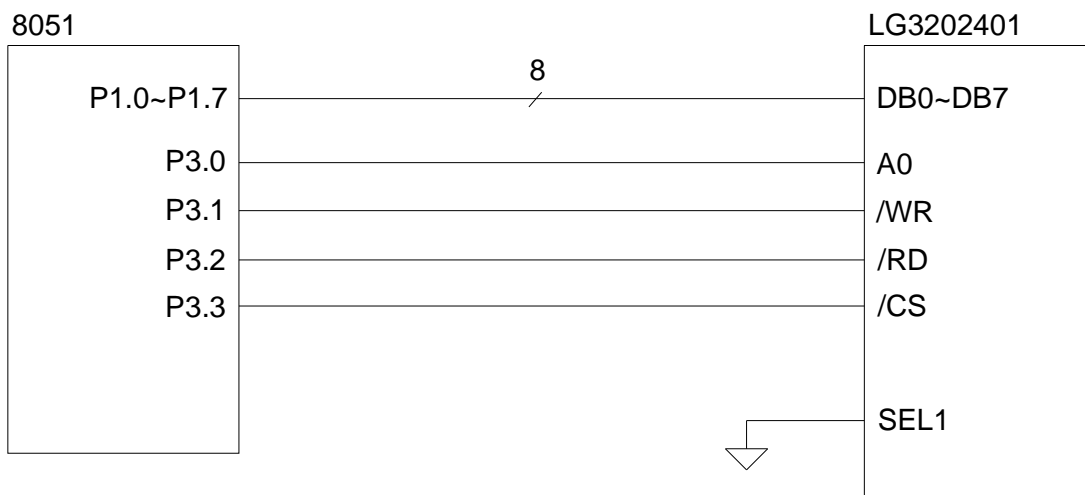
J1 Open: RE=0Ω, supply 5.0V to LEDA (Pin 19) and LEDK (Pin 20) **(Initial Setting)**

J1 Close: RE=(5.0V-3.1V)/180mA=11Ω, supply 3.1V to LEDA (Pin 19) and LEDK (Pin 20)

#### 4. CONNECTION WITH 8051 FAMILY MPU



a. Application Circuit 1



b. Application Circuit 2



## 5. INSTRUCTION SET

Class	Command	Code											Command description	Command read parameters	
		/RD	/WR	A0	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
System control	SYSTEM SET	1	0	1	0	1	0	0	0	0	0	0	0	Initialize device and display	8
	SLEEP IN	1	0	1	0	1	0	1	0	0	1	1	0	Enter standby mode	0
Display control	DISP ON/OFF	1	0	1	0	1	0	1	1	0	0	D	0	Enable and disable display and display flashing	1
	SCROLL	1	0	1	0	1	0	0	0	1	0	0	0	Set display start address and display regions	10
	CSRFORM	1	0	1	0	1	0	1	1	1	0	1	0	Set cursor type	2
	CGRAM ADR	1	0	1	0	1	0	1	1	1	0	0	0	Set start address of character generator RAM	2
	CSRDIR	1	0	1	0	1	0	0	1	1	CD1	CD0	0	Set direction of cursor movement	0
	HDOT SCR	1	0	1	0	1	0	1	1	0	1	0	0	Set horizontal scroll position	1
	OVLAY	1	0	1	0	1	0	1	1	0	1	1	1	Set display overlay format	1
Drawing control	CSRW	1	0	1	0	1	0	0	0	1	1	0	0	Set cursor address	2
	CSRR	1	0	1	0	1	0	0	0	1	1	1	0	Read cursor address	2
Memory control	MWRITE	1	0	1	0	1	0	0	0	0	1	0	0	Write to display memory	-
	MREAD	1	0	1	0	1	0	0	0	0	1	1	0	Read from display memory	-

### Notes:

- In general, the internal registers of e 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:
  - CSRW, CSRR: Each byte is processed individually. The microprocessor may read or write just the low byte of the cursor address.
  - SYSTEM SET, SCROLL, CGRAM ADR: Both parameter bytes are processed together. If the command is changed after half of the parameter has been input, the single byte is ignored.
- APL and APH are 2-byte parameters, but are treated as two 1-byte parameters.
- Please refer to RA8835/S1D13305 datasheet for details.

## 6. INITIALIZATION

The initialization example is based on the following conditions:

- 320 x 240 pixels, single panel drive, combining text and graphic, no portioned screen
- First layer: Text display.  $320/8 = 40$  characters per line,  $240/8 = 30$  lines.  
Required memory size =  $40 \times 30 = 1,200$  (04B0H) bytes
- Second layer: Graphic display.  $320/8 = 40$  bytes per line,  $240/1 = 240$  lines  
Required memory size =  $40 \times 240 = 9,600$  (2580H) bytes
- 8 x 8 pixels character font
- CGRAM not required

### Initialization procedure

No.	Command	Operation
1	Power on	
2	Reset	/RST = "L" 1 ms minimum after VDD > 4.75V. Initialization commands should be issued after a delay of 3 ms (maximum) following the rising edges of /RST
3	SYSTEM SET C = 40H P1 = 30H  P2 = 87H  P3 = 07H P4 = 27H P5 = 41H  P6 = EFH P7 = 28H P8 = 00H	M0 = 0: Internal ROM M1 = 0: CGRAM is 32 characters maximum M2 = 0: 8 pixels character height W/S = 0: Single panel drive IV = 1: No top-line compensation FX = 7: Horizontal character size = 8 pixels WF = 1: Two-frame AC drive FY = 7: Vertical character size = 8 pixels C/R = 39: 40 display addresses per lines TC/R = 65: Total address range per line = 65 fosc=10 MHz, fFR = 70 Hz L/F = 239: 240 display lines AP = 40: Virtual screen horizontal address range is 40
4	SCROLL C = 44H P1 = 00H P2 = 00H P3 = EFH P4 = 00H P5 = 10H P6 = EFH P7 ~ P10 is not required	First screen block start address: 0000H  SL1 = 239: Display lines in first screen block = 240 lines Second screen block start address: 1000H  SL2 = 239: Display lines in second screen block = 240 lines
5	HDOT SCR C = 5AH P1 = 00H	Horizontal pixel shift is 0

Initialization procedure (continued)

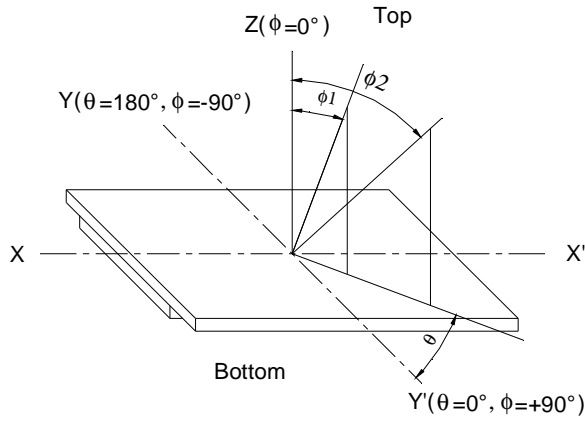
No.	Command	Operation
6	OVLAY C = 5BH P1 = 00H	MX1, MX0 = 00: OR composition DM2, DM1 = 00: Screen block 1 and 3 text mode OV = 0: Two-layer composition
7	DISP ON/OFF C = 58H P1 = 16H	D = 0: Display off FC1, FC0 = 10: Cursor on, flashing at 2 Hz FP1, FP0 = 01: First screen block on, no flashing FP3, FP2 = 01: Second screen block on, no flashing FP5, FP4 = 00: Third screen block off
8	CSR FORM C = 5DH P1 = 04H P2 = 86H	CRX = 4: Horizontal cursor size = 5 pixels CRY = 6: Vertical cursor size = 7 pixels CM = 1: Block cursor
9	Clear data in first layer	Fill first screen layer memory (0000H ~ 04AFH) with 20H (space character)
10	Clear data in second layer	Fill second screen layer memory (1000H ~ 357FH) with 00H (blank data)
11	CSRW C = 46H P1 = 00H P2 = 00H	Set cursor to start of first screen block
12	DISP ON/OFF C = 59H	D = 1: Display on
13	CSR DIR C = 4CH	CD1, CD2 = 00: Set cursor shift direction to right
14	MWRITE C = 42H P1 = 33H P2 = 32H P1 = 30H P2 = 78H P1 = 32H P2 = 34H P1 = 30H P2 = 20H P1 = 4CH P2 = 43H P1 = 44H	'3' '2' '0' 'x' '2' '4' '0' ' ' 'L' 'C' 'D'



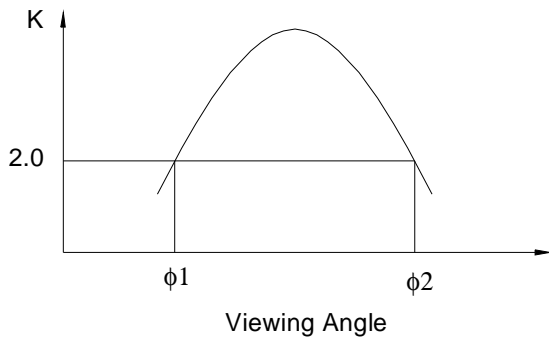
### 8. ELECTRO—OPTICAL CHARACTERISTICS ( $T_a=25^{\circ}C$ )

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
View Angle	$\Phi 2-\Phi 1$	$K \geq 2, \theta = 0^{\circ}$	--	60	--	Deg	Note1, Note2
Contrast	K	$\Phi = 0^{\circ}, \theta = 0^{\circ}$	3	--	--	--	Note3
Response Time	tr (rise)	$\Phi = 0^{\circ}, \theta = 0^{\circ}$	--	250	--	ms	Note3
	tf (fall)	$\Phi = 0^{\circ}, \theta = 0^{\circ}$	--	250	--	ms	

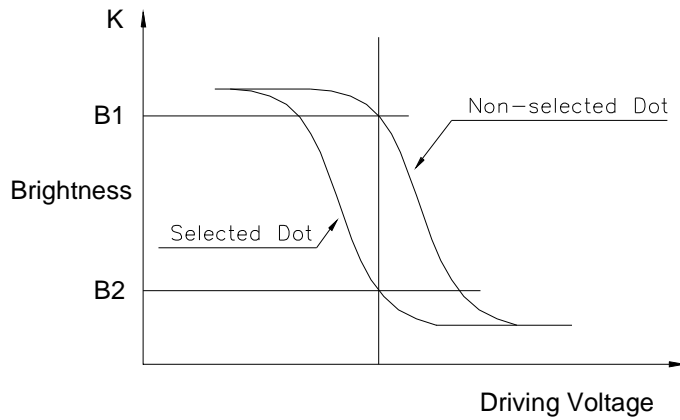
Note1: Definition of Viewing Angle  $\theta, \Phi$



Note2: Definition of viewing Angle Range:  $\Phi 1, \Phi 2$

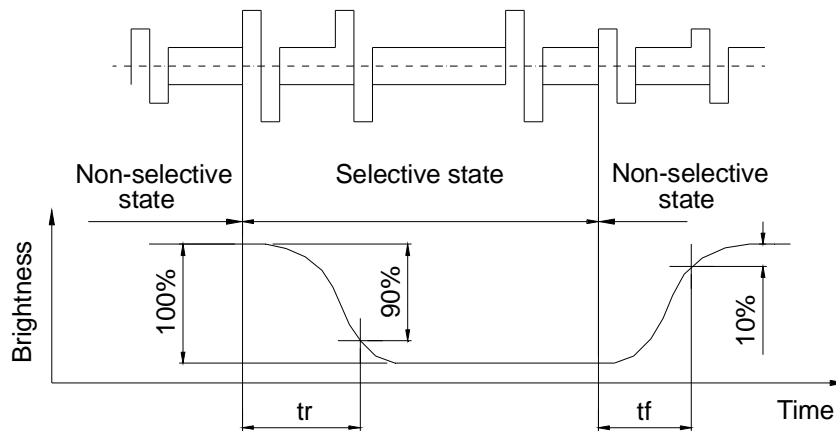


Note3: Definition of Contrast

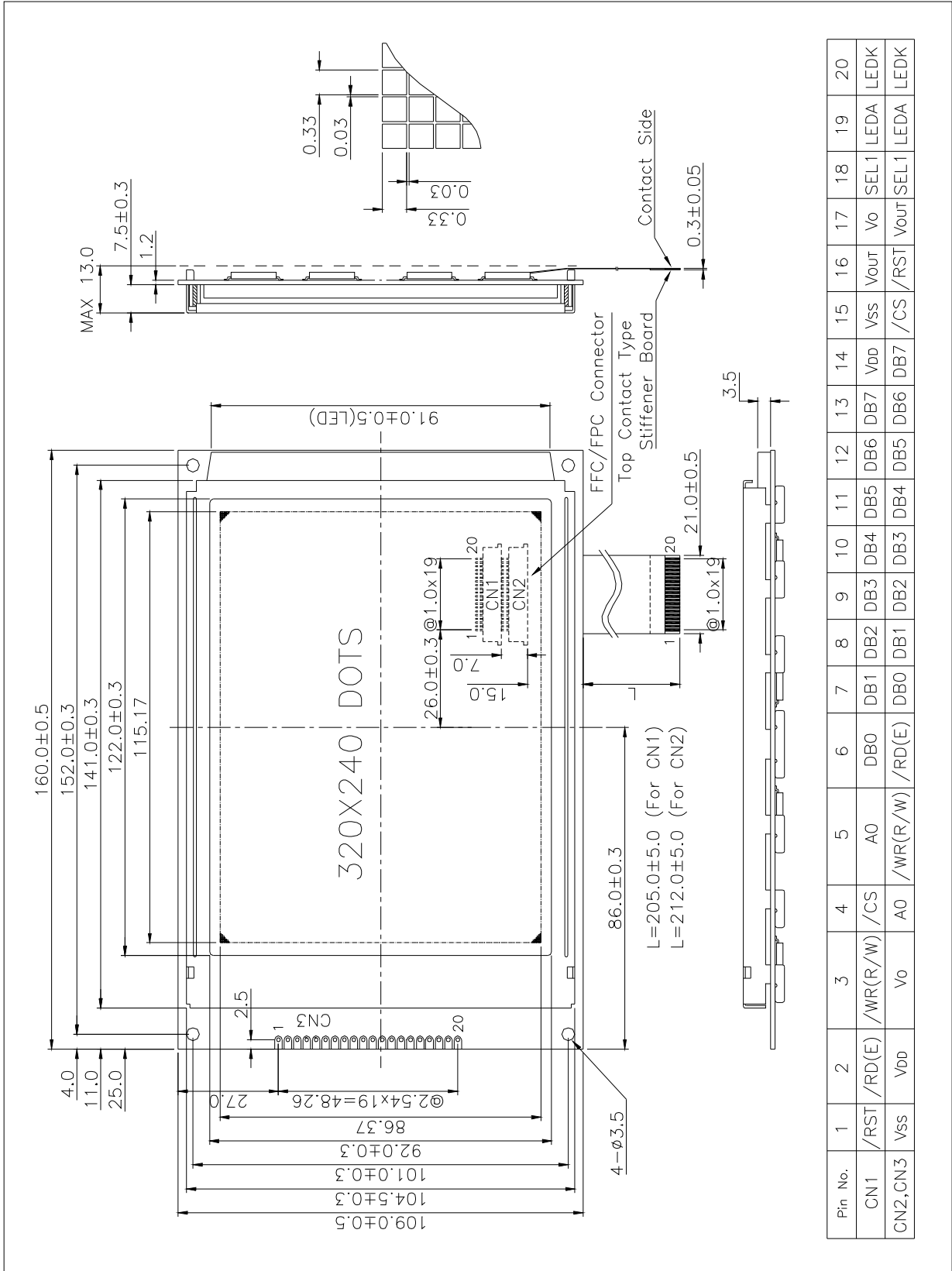


$$\text{Contrast} = \frac{\text{Brightness of non-selected dot (B1)}}{\text{Brightness of selected dot (B2)}}$$

Note4: Definition of Response Time



### 9. DIMENSIONAL OUTLINE



## 10. LCD MODULE NUMBERING SYSTEM

**L G 320 240 5 — L M D W H 6 V — XXX**  
 (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13)

(1) Brand

(2) Module type

**C** - Character module

**G** - Graphic module

(3) Display format

Character module : Number of characters per line, two digits XX

Graphic module : Number of columns, two or three digits XX or XXX

(4) Display format

Character module : Number of lines, one digit X

Graphic module : Number of rows, two or three digits XX or XXX

(5) Development number : One or two digits X or HX

(6) LCD mode

**T** - TN Positive, Gray

**N** - TN Negative, Blue

**S** - STN Positive, Yellow-green

**G** - STN Positive, Gray

**B** - STN Negative, Blue

**F** - FSTN Positive, White

**K** - FSTN Negative, Black

**L** - FSTN Negative, Blue

(7) Polarizer mode

**R** - Reflective

**F** - Transflective

**M** - Transmissive

(8) Backlight type

**N** - Without backlight

**L** - Array LED

**D** - Edge light LED

**E** - EL

**C** - CCFL

(9) Backlight color

**Y** - Yellow-green

**B** - Blue

**W** - White

**G** - Green

**A** - Amber

**R** - Red

**M** - Multi color

**Nil** - Without backlight

(10) Operating temperature range

**S** - Standard temperature ( 0 ~ +50 °C )

**H** - Extended Temperature ( -20 ~ +70 °C )

(11) Viewing direction

**3** - 3:00

**6** - 6:00

**9** - 9:00

**U** - 12:00

(12) DC-DC Converter

**N or Nil** - Without DC-DC converter

**V** - Built in DC-DC converter

(13) Version code

**Nil or 0~ZZZ** - Version code



## 11. PRECAUTIONS FOR USE OF LCD MODULE

### 11.1 Handling Precautions

- 1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- 2) If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth. If the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.
- 3) Do not apply excessive force on the surface of display or the adjoining areas of LCD module 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 of LCD module becomes contaminated, blow 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 mentioned above may damage the polarizer.

Especially, do not use the following:

- Water
  - Ketone
  - Aromatic Solvents
- 6) When mounting the LCD module make sure that it is free of twisting, warping, and distortion. Distortion has great influence upon display quality. Also keep the stiffness enough regarding the outer case.
  - 7) Be sure to avoid any solvent such as flux for soldering never stick to Heat-Seal. Such solvent on Heat-Seal may cause connection problem of heat-Seal and TAB.
  - 8) Do not forcibly pull or bend the TAB I/O terminals.
  - 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 module.
    - Tools required for assembly, such as soldering irons, must be properly grounded.
    - To reduce the amount of static electricity generated, do not conduct assembly 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.

### 11.2 Storage Precautions

- 1) When storing the LCD module, avoid exposure to direct sunlight or to the light of fluorescent lamps and high temperature/high humidity. Whenever possible, the

LCD module should be stored in the same conditions in which they were shipped from our company.

- 2) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets or a current flow in a high humidity environment.

### 11.3 Design Precautions

- 1) The absolute maximum ratings represent the rated value beyond which LCD module can not exceed. When the LCD modules are used in excess of this rated value, their operating characteristics may be adversely affected.
- 2) To prevent the occurrence of erroneous operation caused by noise, attention must be paid to satisfy VIL, VIH specification values, including taking the precaution of using signal cables that are short.
- 3) The liquid crystal display exhibits temperature dependency characteristics. Since recognition of the display becomes difficult when the LCD is used outside its designated operating temperature range, be sure to use the LCD within this range. Also, keep in mind that the LCD driving voltage levels necessary for clear displays will vary according to temperature.
- 4) Sufficiently notice the mutual noise interference occurred by peripheral devices.
- 5) To cope with EMI, take measures basically on outputting side.
- 6) If DC is impressed on the liquid crystal display panel, display definition is rapidly deteriorated by the electrochemical reaction that occurs inside the liquid crystal display panel. To eliminate the opportunity of DC impressing, be sure to maintain the AC characteristics of the input signals sent to the LCD Module.

### 11.4 Others

- 1) Liquid crystals solidify under low temperatures (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 LCD module is subjected to a strong shock at a low temperature.
- 2) 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.
- 3) To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity, etc., exercise care to avoid touching the following sections when handling the module:
  - Terminal electrode sections.
  - Part of pattern wiring on TAB, etc.