LCD Module Specification

Model No.: LG2401283-FFDWH6V
LG2401283-LMDWH6V
LG2401283-SFDWH6V
LG2401283-BMDWH6V

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RECORD OF REVISION

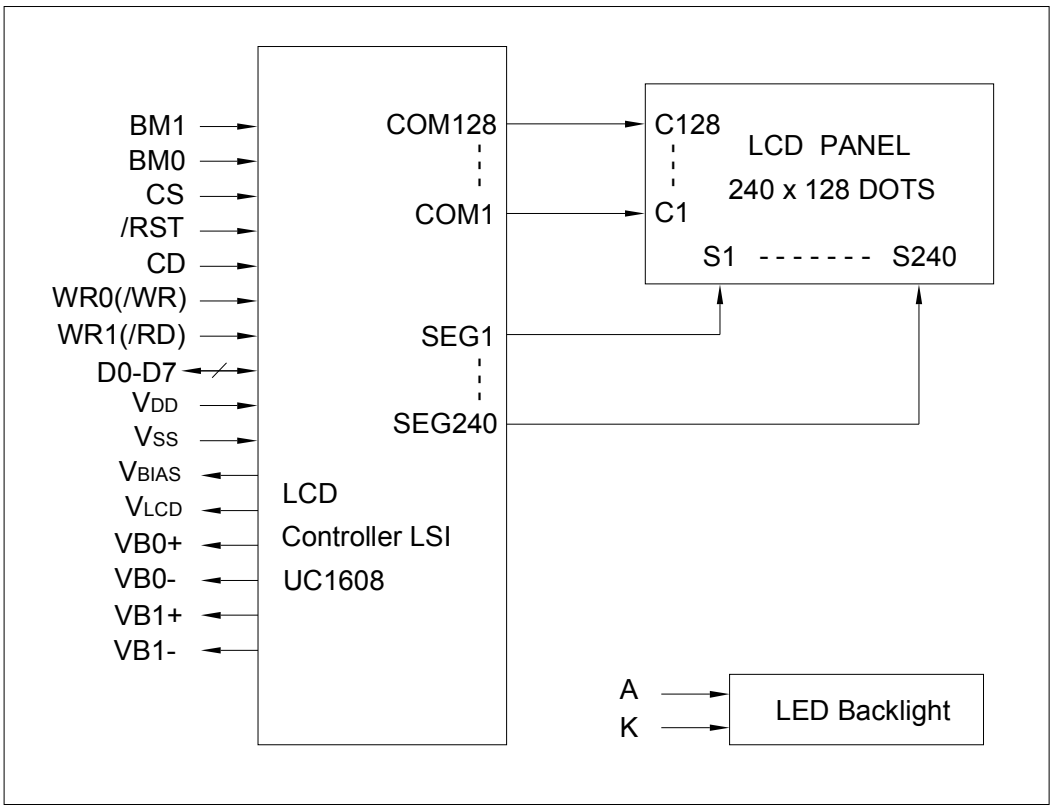
Rev.	Date	Page	Item	Description
0.1	2008/06/18	--	--	New release

1. BASIC SPECIFICATIONS

1.1 Features

Item	Specifications	Unit
Display Format	240 x 128	dot
LCD Mode	Refer to section 1.4	-
Driving Method	1/128 Duty, 1/12 Bias	-
Viewing Direction	6:00	O'clock
Backlight & Color	LED, white color	-
Outline Dimension (WxHxT)	98.7 x 67.7 x 11.7 (LCD pin length included)	mm
Viewing Area (WxH)	92.0 x 53.0	mm
Active Area (WxH)	83.975 x 44.775	mm
Dot Pitch (WxH)	0.35 x 0.35	mm
Dot Size (WxH)	0.325 x 0.325	mm
Weight	60	g
Controller	UC1608 (COG)	-
Interface	4-bit, 8-bit parallel or 3/4 wire SPI	-
Power Supply (V_{DD})	2.7 to 3.3	V

1.2 Block Diagram



1.3 Terminal Functions

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>Level</th><th>Function</th></tr>
<tr><td>1</td><td>VB1-</td><td>-</td><td rowspan="2">LCD Bias Voltages. These voltages are generated internally. Connect a 4.7uF/6.3V capacitor between VB1+ and VB1–.</td></tr>
<tr><td>2</td><td>VB1+</td><td>-</td></tr>
<tr><td>3</td><td>VB0-</td><td>-</td><td rowspan="2">LCD Bias Voltages. These voltages are generated internally. Connect a 4.7uF/6.3V capacitor between VB0+ and VB0–.</td></tr>
<tr><td>4</td><td>VB0+</td><td>-</td></tr>
<tr><td>5</td><td>VLCD</td><td>-</td><td>LCD driving voltage (VLCD is generated internally by UC1608). Connect a 0.1uF/25V capacitor and a 10MΩ resistor to VSS.</td></tr>
<tr><td>6</td><td>VBIAS</td><td></td><td>The reference voltage to generate LCD driving voltage. VBIAS can be used to fine turn VLCD (contrast) by external variable resistors. When use the internal resistor network, connect a 0.1uF capacitor to VSS.</td></tr>
<tr><td>7</td><td>VSS</td><td>0V</td><td>Ground</td></tr>
<tr><td>8</td><td>VDD</td><td>2.7 to 3.3V</td><td>Power supply for logic and charge pump</td></tr>
<tr><td>9</td><td>D7</td><td rowspan="8">H/L</td><td rowspan="8">Bi-directional bus for both serial and parallel host interfaces.
In serial modes, connect D0 to SCK, D3 to SDA.
<table>
<tr><td></td><td>BM[1:0]=1x</td><td>BM[1:0]=0x</td><td>BM[1:0]=01</td><td>BM[1:0]=00</td></tr>
<tr><td></td><td>8-bit parallel</td><td>4-bit parallel</td><td>S9</td><td>S8/S8uc</td></tr>
<tr><td>D0</td><td>D0</td><td>D0/D4</td><td>SCK</td><td>SCK</td></tr>
<tr><td>D1</td><td>D1</td><td>D1/D5</td><td>–</td><td>–</td></tr>
<tr><td>D2</td><td>D2</td><td>D2/D6</td><td>–</td><td>–</td></tr>
<tr><td>D3</td><td>D3</td><td>D3/D7</td><td>SDA</td><td>SDA</td></tr>
<tr><td>D4</td><td>D4</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>D5</td><td>D5</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>D6</td><td>D6</td><td>–</td><td>S9</td><td>S8/S8uc</td></tr>
<tr><td>D7</td><td>D7</td><td>0</td><td>1</td><td>1</td></tr>
</table>
Connect unused pins to VDD or VSS.</td></tr>
<tr><td>10</td><td>D6</td></tr>
<tr><td>11</td><td>D5</td></tr>
<tr><td>12</td><td>D4</td></tr>
<tr><td>13</td><td>D3</td></tr>
<tr><td>14</td><td>D2</td></tr>
<tr><td>15</td><td>D1</td></tr>
<tr><td>16</td><td>D0</td></tr>
<tr><td>17</td><td>WR1</td><td rowspan="2">H/L</td><td rowspan="2">WR[1:0] control the read/write operation of the host interface.
In 8080 mode: WR0 is /WR signal, WR1 is /RD signal.
In 6800 mode: WR0 is R/W signal, WR1 is Enable signal.
In serial modes: These two pins are not used, connect them to VSS.</td></tr>
<tr><td>18</td><td>WR0</td></tr>
<tr><td>19</td><td>CD</td><td>H/L</td><td>Data or instruction selection
L: D0 to D7 are Instruction code H: D0 to D7 are display data
In S9 mode, CD pin is not used and connect it to VDD or VSS.</td></tr>
<tr><td>20</td><td>/RST</td><td>L</td><td>Reset signal, active “L”. There is built-in power-on-reset circuit in UC1608. Connect /RST to VDD when it is not used.</td></tr>
<tr><td>21</td><td>CS</td><td>H</td><td>Chip selection signal, active “H”.</td></tr>
<tr><td>22</td><td>BM0</td><td rowspan="2">H/L</td><td rowspan="2">Bus mode selection. The interface bus mode is determined by BM[1:0] and [D7:D6] by the following relationship.
<table>
<tr><th>BM[1:0]</th><th>[D7:D6]</th><th>Mode</th></tr>
<tr><td>11</td><td>Data</td><td>6800/8-bit</td></tr>
<tr><td>10</td><td>Data</td><td>8080/8-bit</td></tr>
<tr><td>01</td><td>0x</td><td>6800/4-bit</td></tr>
<tr><td>00</td><td>0x</td><td>8080/4-bit</td></tr>
<tr><td>01</td><td>10</td><td>3-wire SPI w/ 9-bit token (S9: conventional)</td></tr>
<tr><td>00</td><td>10</td><td>4-wire SPI w/ 8-bit token (S8: conventional)</td></tr>
<tr><td>00</td><td>11</td><td>3/4-wire SPI w/ 8-bit token (S8uc: Ultra-Compact)</td></tr>
</table></td></tr>
<tr><td>23</td><td>BM1</td></tr>
</table>

1.4 Ordering Information

Part No.	Description
LG2401283-FFDWH6V	FSTN positive/transflective/white LED backlight
LG2401283-LMDWH6V	FSTN negative/blue/transmissive/white LED backlight
LG2401283-SFDWH6V	STN positive/yellow green/transflective/white LED backlight
LG2401283-BMDWH6V	STN negative/blue/transmissive/white LED backlight

Note: For more information, refer to section 9 (Page 16)

2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic & Charge Pump)	V_{DD}	-0.3	4.0	V
LCD Generated voltage	V_{LCD}	-0.3	17.0	V
Input Voltage	Vin	-0.4	V_{DD}+0.5	V
Operating temperature	T_{OPR}	-20	+70	°C
Storage temperature.	T_{STR}	-30	+80	°C

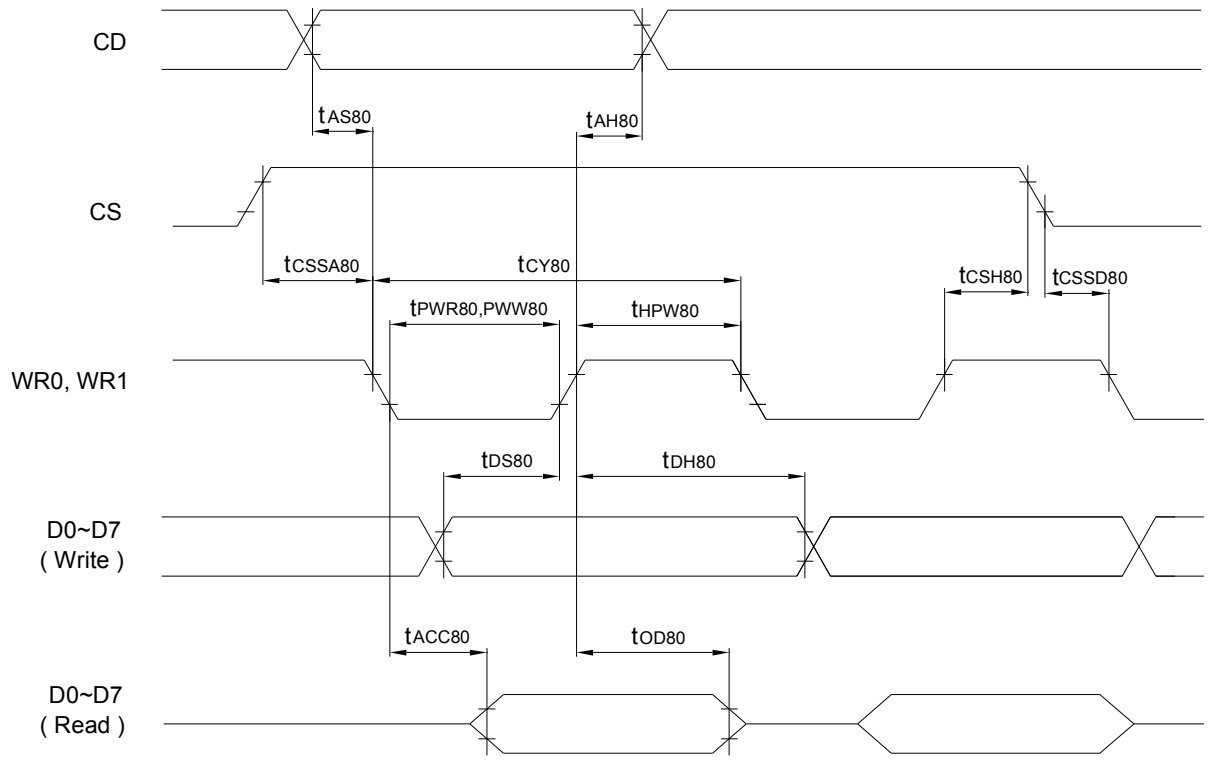
3. ELECTRICAL CHARACTERISTICS

3.1 DC Characteristics (Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage (Logic & Charge Pump)	V_{DD}		2.7	3.0	3.3	V
Charge Pump Output Voltage	V_{LCD}		--	15.2	16.0	V
Input Low Voltage	V_{IL}		0	--	0.2V_{DD}	V
Input High Voltage	V_{IH}		0.8V_{DD}	--	V_{DD}	V
Output Low Voltage	V_{OL}		0	--	0.2V_{DD}	V
Output High Voltage	V_{OH}		0.8V_{DD}	--	V_{DD}	V
Supply Current	I_{DD}	V_{DD}=3.0V V_{LCD}=15.2V	--	1.0	1.5	mA

3.2 Parallel Bus Timing Characteristics (8080 Series MPU, VDD=2.7V to 3.3V, Ta=25°C)

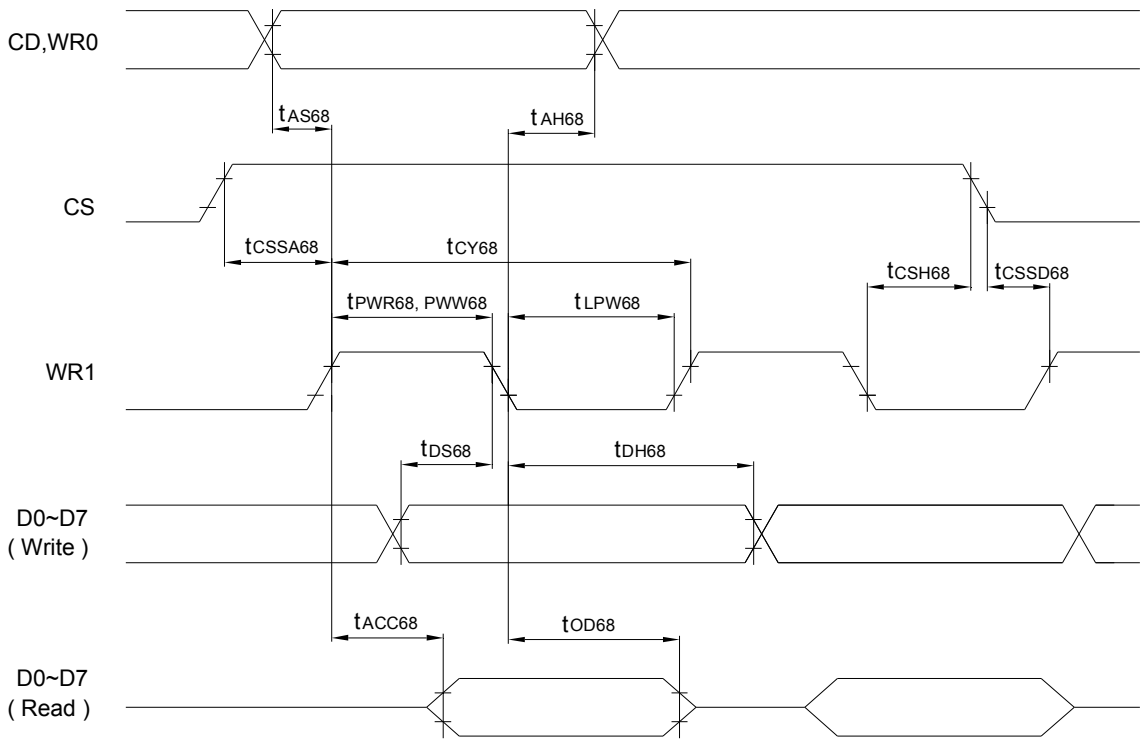
Description	Signal	Symbol	Condition	Min.	Max.	Units
Address setup time Address hold time	CD	t_{AS80} t_{AH80}		0 20	--	ns
System cycle time 8 bits bus (read) (write) 4 bits bus (read) (write)	WR0, WR1	t_{CY80}		 140 140 140 140	--	
Pulse width 8 bits (read) 4 bits	WR1	t_{PWR80}		65 65	--	
Pulse width 8 bits (write) 4 bits	WR0	t_{PWW80}		35 35	--	
High pulse width 8 bits bus (read) (write) 4 bits bus (read) (write)	WR0, WR1	t_{HPW80}		 65 35 65 35	--	
Data setup time Data hold time	D0 to D7	t_{DS80} t_{DH80}		30 20	--	
Read access time Output disable time	D0 to D7	t_{ACC80} t_{OD80}	CL=100pF	-- 12	60 20	
Chip select setup time	CS	t_{CSSA80} t_{CSSD80} t_{CSH80}		10 10 20	--	



Parallel Bus Timing Characteristics (for 8080 MPU)

3.3 Parallel Bus Timing Characteristics (6800 Series MPU, VDD=2.7V to 3.3V, Ta=25°C)

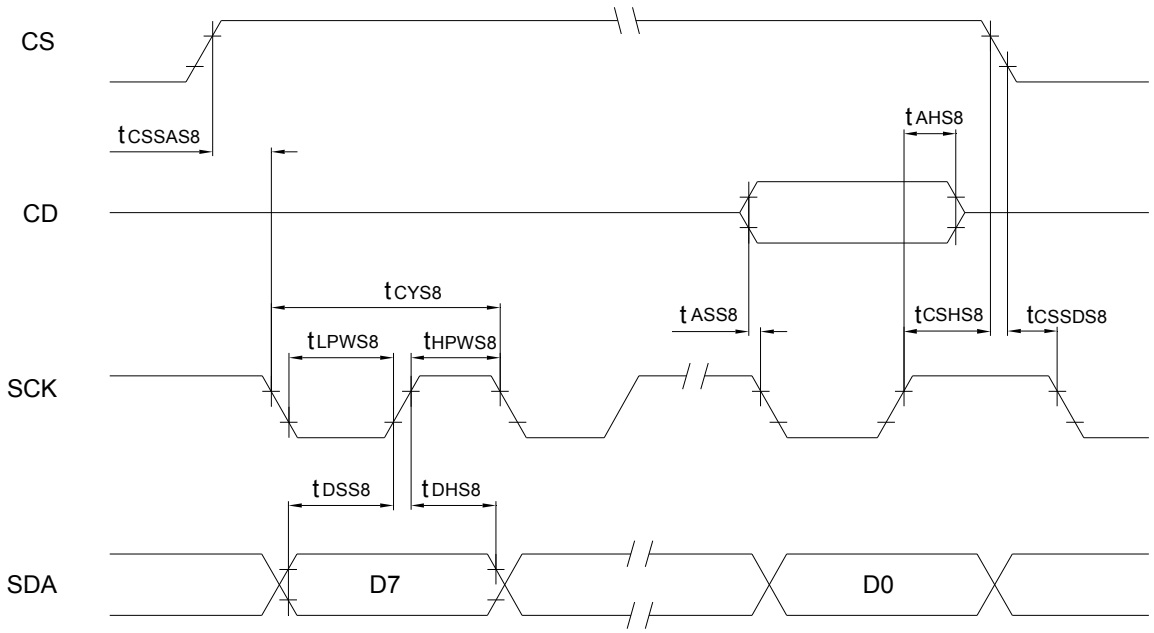
Description	Signal	Symbol	Condition	Min.	Max.	Units
Address setup time Address hold time	CD, WR0	t_{AS68} t_{AH68}		0 20	--	ns
System cycle time 8 bits bus (read) (write) 4 bits bus (read) (write)	WR1	t_{CY68}		 140 140 140 140	--	
Pulse width 8 bits (read) 4 bits	WR1	t_{PWR68}		65 65	--	
Pulse width 8 bits (write) 4 bits	WR1	t_{PWW68}		35 35	--	
Low pulse width 8 bits bus (read) (write) 4 bits bus (read) (write)	WR1	t_{LPW68}		65 35 65 35	--	
Data setup time Data hold time	D0 to D7	t_{DS68} t_{DH68}		30 20	--	
Read access time Output disable time	D0 to D7	t_{ACC68} t_{OD68}	CL=100pF	-- 12	60 20	
Chip select setup time	CS	t_{CSSA68} t_{CSSD68} t_{CSH68}		10 10 20	--	



Parallel Bus Timing Characteristics (for 6800 MPU)

3.4 Serial Bus Timing Characteristics (for S8, VDD=2.7V to 3.3V, Ta=25°C)

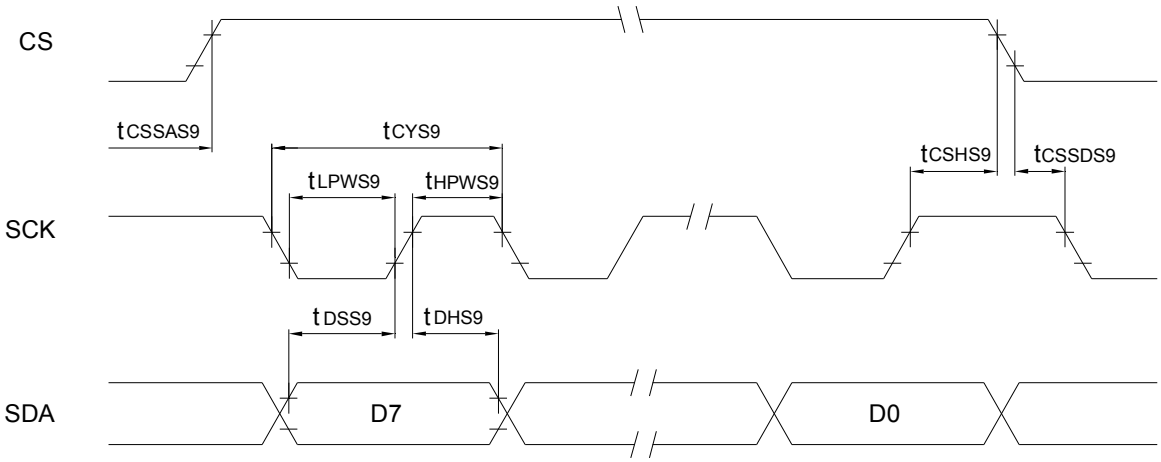
Description	Signal	Symbol	Condition	Min.	Max.	Units
Address setup time	CD	t_{ASS8}		0	--	ns
Address hold time		t_{AHS8}		20	--	
System cycle time	SCK	t_{CYS8}		140	--	
Low Pulse width		t_{LPWS8}		65	--	
High Pulse width		t_{HPWS8}		65	--	
Data setup time Data hold time	SDA	t_{DSS8} t_{DHS8}		30 20	--	
Chip select setup time	CS	t_{CSSAS8} t_{CSSDS8} t_{CSHS8}		10 20 10	--	



Serial Bus Timing Characteristics (for S8)

3.5 Serial Bus Timing Characteristics (for S9, VDD=2.7V to 3.3V, Ta=25°C)

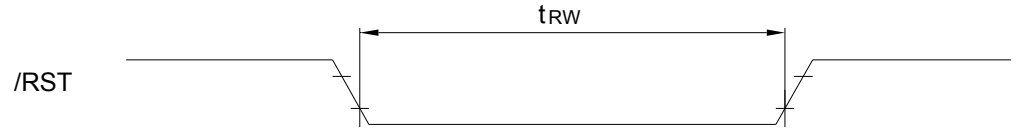
Description	Signal	Symbol	Condition	Min.	Max.	Units
System cycle time	SCK	t_{CYS9}		140	--	ns
Low Pulse width		t_{LPWS9}		65	--	
High Pulse width	SDA CS	t_{HPWS9}		65	--	
Data setup time Data hold time		t_{DSS9} t_{DHS9}		30 20	--	
Chip select setup time		t_{CSSAS9} t_{CSSDS9} t_{CSHS9}		10 20 10	--	



Serial Bus Timing Characteristics (for S9)

3.6 Reset Characteristics (VDD=2.7V to 3.3V, Ta=25°C)

Description	Signal	Symbol	Condition	Min.	Max.	Units
Reset low pulse width	/RST	t_{RW}		1000	--	ns

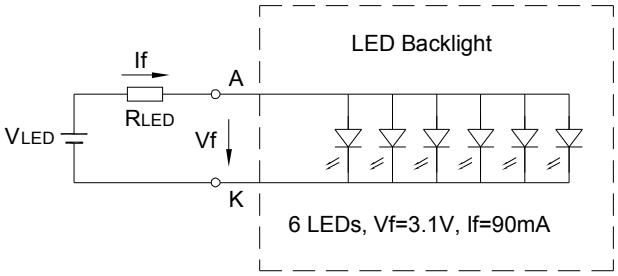


Reset Characteristics

3.7 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	--	90	--	mA
Color	White					

* R_{LED} is the current limiting resistor for LED backlight. R_{LED}=(V_{LED}-3.1V)/90mA

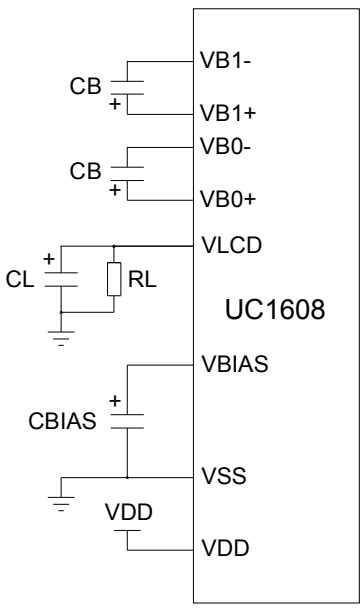


Recommended vaule for R_{LED}

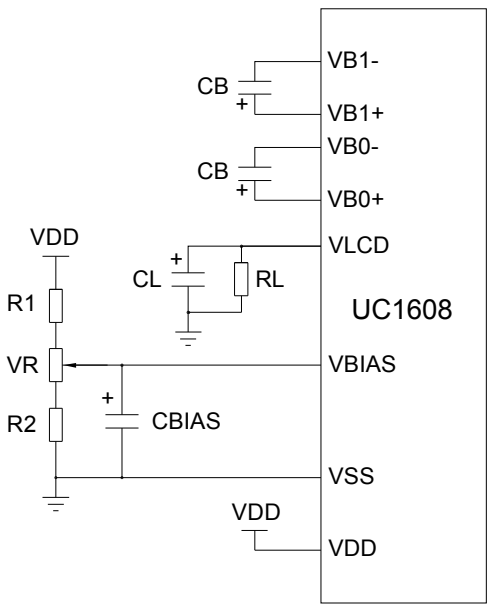
V_{LED}	R_{LED}
5.0V	22Ω ± 1%,1/4W
3.3V	2.4Ω ± 1%,1/10W
3.0V	0Ω ,1/10W

3.8 Power Supply for Logic and LCD Driving

A. Use internal bias source



B. Use exernal bias source



1. CB=4.7uF/6.3V, CL=0.1uF/25V, CBIAS=0.1uF/6.3V
2. R1=330KΩ± 1%, R2=91KΩ± 1%, VR=100KΩ± 1%, RL=10MΩ
3. When use internal bias source, LCD contrast can only be adjusted by software.
4. When use external bias source, LCD contrast can be adjusted by either VR or software.
5. To ensure consistency of LCD contrast, circuitry B is recommended prior to circuitry A.

4. DISPLAY CONTROL COMMANDS

The following is a list of host commands supported by UC1608

C/D: 0: Control, 1: Data
W/R: 0: Write Cycle, 1: Read Cycle
Useful Data bits
– Don't Care

	Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action	Default
1	Write Data Byte	1	0	#	#	#	#	#	#	#	#	Write 1 byte	N/A
2	Read Data Byte	1	1	#	#	#	#	#	#	#	#	Read 1 byte	N/A
3	Get Status	0	1	BZ	MX	DE	RS	WA	GN1	GN0	1	Get Status	N/A
4	Set Column Address LSB	0	0	0	0	0	0	#	#	#	#	Set CA[3:0]	0
	Set Column Address MSB	0	0	0	0	0	1	#	#	#	#	Set CA[7:4]	0
5	Set Mux Rate and Temperature Compensation	0	0	0	0	1	0	0	#	#	#	Set {MR, C[1:0]}	MR: 1 TC: 00b
6	Set Power Control	0	0	0	0	1	0	1	#	#	#	Set PC[2:0]	101b
7	Set Adv. Program Control (double byte command)	0	0	0	0	1	1	0	0	0	R	For UltraChip only. Do not use.	N/A
		0	0	#	#	#	#	#	#	#	#		
8	Set Start Line	0	0	0	1	#	#	#	#	#	#	Set SL[5:0]	0
9	Set Gain and Potentiometer (double byte command)	0	0	1	0	0	0	0	0	0	1	Set {GN[1:0], PM[5:0]}	GN=3 PM=0
		0	0	#	#	#	#	#	#	#	#		
10	Set RAM Address Control	0	0	1	0	0	0	1	#	#	#	Set AC[2:0]	001b
11	Set All-Pixel-ON	0	0	1	0	1	0	0	1	0	#	Set DC[1]	0=disable
12	Set Inverse Display	0	0	1	0	1	0	0	1	1	#	Set DC[0]	0=disable
13	Set Display Enable	0	0	1	0	1	0	1	1	1	#	Set DC[2]	0=disable
14	Set Fixed Lines	0	0	1	0	0	1	#	#	#	#	Set FL[3:0]	0
15	Set Page Address	0	0	1	0	1	1	#	#	#	#	Set PA[3:0]	0
16	Set LCD Mapping Control	0	0	1	1	0	0	#	#	#	#	Set LC[3:0]	0
17	System Reset	0	0	1	1	1	0	0	0	1	0	System Reset	N/A
18	NOP	0	0	1	1	1	0	0	0	1	1	No operation	N/A
19	Set LCD Bias Ratio	0	0	1	1	1	0	1	0	#	#	Set BR[1:0]	10b=12
20	Reset Cursor Mode	0	0	1	1	1	0	1	1	1	0	AC[3]=0, CA=CR	N/A
21	Set Cursor Mode	0	0	1	1	1	0	1	1	1	1	AC[3]=1, CR=CA	N/A
22	Set Test Control (double byte command)	0	0	1	1	1	0	0	1	TT		For UltraChip only. Do not use.	N/A
		0	0	#	#	#	#	#	#	#	#		

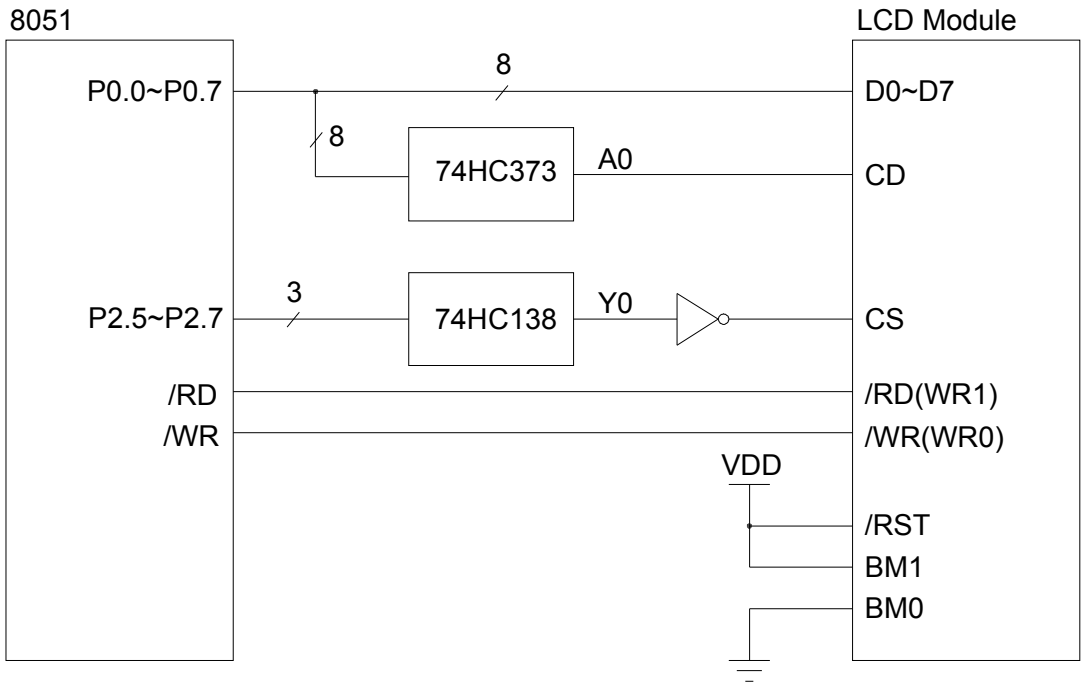
Note: Please refer to UC1608 datasheet for details.

5. CONNECTION WITH MPU

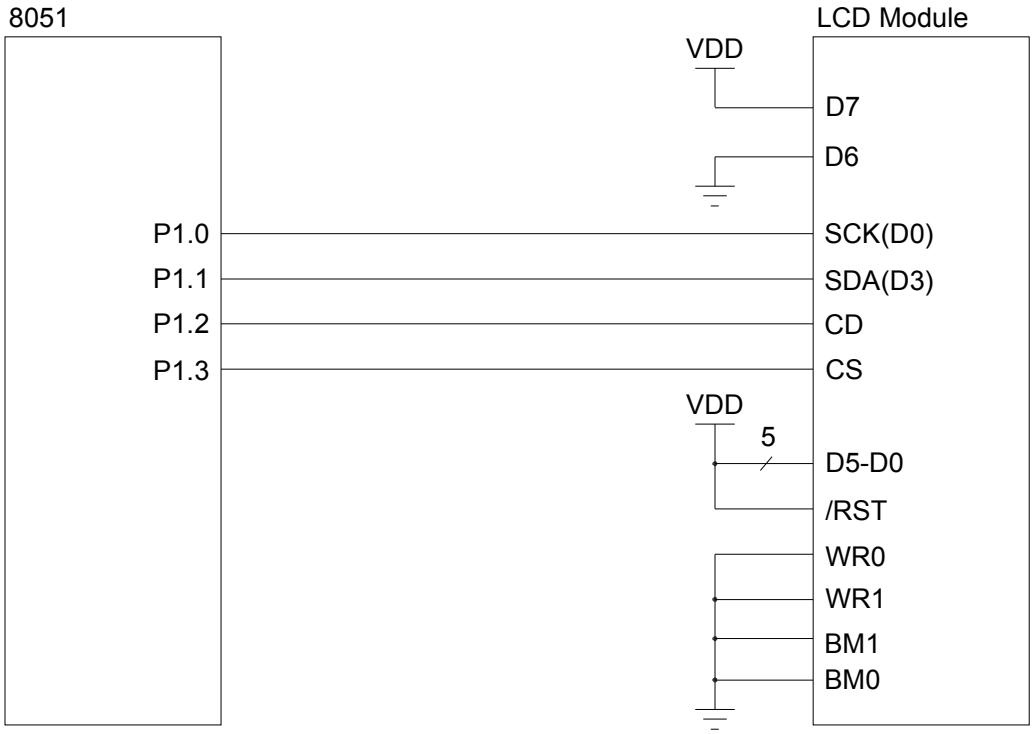
UC1608 supports two parallel bus protocols, in either 8-bit or 4-bit bus width, and three serial bus protocols. Designers can either use parallel bus to achieve high data transfer rate, or use serial bus to save the I/O terminals. The interface bus mode is determined by BM[1:0] and [D7:D6] by the following relationship.

Bus type		8080		6800		S8 (4wr)	S8uc (3wr)	S9 (3wr)
Width		8-bit	4-bit	8-bit	4-bit	Serial		
Access		Read/Write				Write Only		
Control & Data Pins	BM[1:0]	10	00	11	01	00		01
	D[7:6]	Data	0x	Data	0x	10	11	10
	CS	Chip Select						
	CD	Control / Data						0 or 1
	WR0	/WR		R/W		0		
	WR1	/RD		EN		0		
	D[5:4]	Data	–	Data	–	–		
	D[3:0]	Data	Data	Data	Data	D0=SCK, D3=SDA		

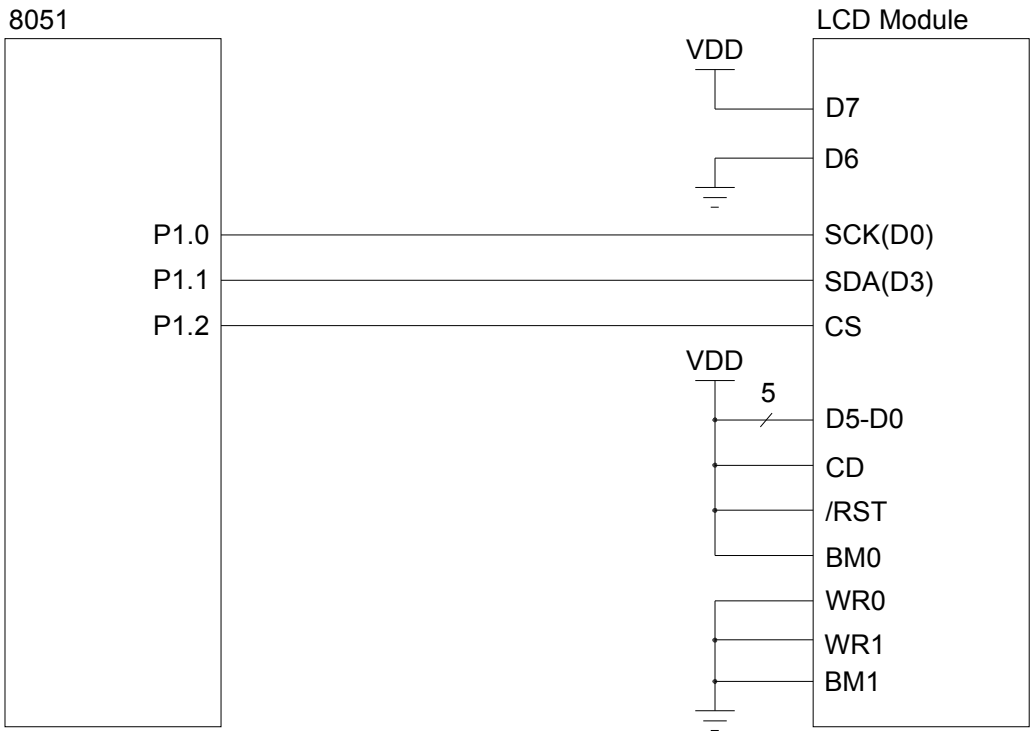
Note: Connect unused control pins and data bus pins to VDD or VSS.



a. 8080 8-bit parallel interface



b. 4-wire SPI (S8) interface



c. 3-wire SPI (S9) interface

6. INITIALIZATION AND POWER OFF

6.1 Power on Initialization Sequence

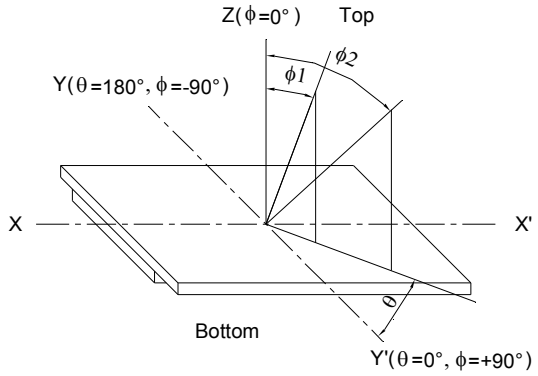
No.	Command	Operation
1	Power on	Power on
2	Automatic Power-ON-Reset	There is built-in Power-On-Reset circuit in UC1608. System reset will be activated automatically after VDD is stabilized. Delay 15ms, and then start the following initialization commands.
3	Set Mux Rate and Temperature Compensation: 26H	MR=1b: 1/128 duty TC[1:0]=10b: -0.10%/℃
4	Set Power Control: 2DH	PC[1:0]=01b: 26nF < LCD < 43NF PC[2]=1b: Internal V_{LCD}
5	Set LCD Bias Ratio: EAH	BR[1:0]=10b: 1/12 bias
6	Set Gain and Potentiometer: 81H, 8BH	GN[1:0]=10b PM[5:0]=001011b: “001011b” is a reference value, modify this value to get the best display contrast. Because of the manufacturing dispersion of LCD modules, potentiometer (PM[5:0]) value may need be changed to match the driving voltage (VLCD) for different lot of LCD modules.
7	Set LCD Mapping Control: C8H	MY=1b: COM Reverse MX=0b: SEG Normal MSF=0b: D[0:7] LSB first
8	Set start Line: 40H	SL[5:0]=00000b: Start line number=0
9	Set Display Enable: AFH	DC2=1b: Normal operation mode
10	End of initialization	
11	Write display data	

6.2 Power off Sequence

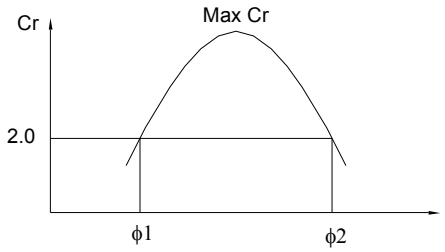
No.	Command	Description
1	Optional status	Normal operation
2	System Reset: E2H	Reset system, delay 2 ms.
3	Power off	Power off

7. ELECTRO-OPTICAL CHARACTERISTICS (Ta=25°C)

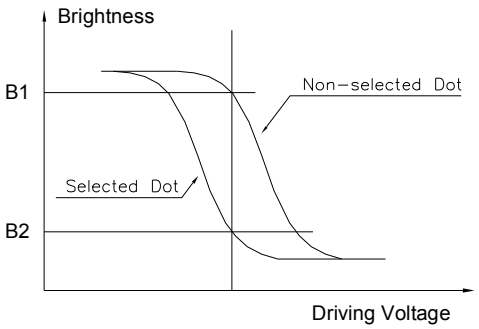
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
View Angle	Φ2-Φ1	Cr≥2 , θ=0°	--	60	--	Deg	Note1, Note2
Contrast Ratio	Cr	Φ=0°,θ=0°	3	--	--	--	Note3
Response Time	tr (rise)	Φ=0°,θ=0°	--	200	--	ms	Note4
	tf (fall)	Φ=0°,θ=0°	--	250	--	ms	



Note1: Definition of viewing angle ϕ, θ

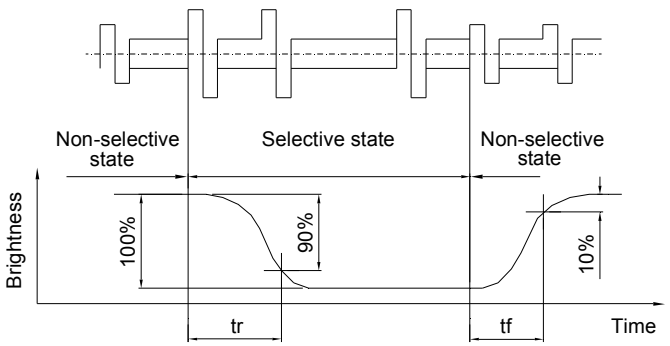


Note2: Definition of viewing angle range ϕ1, ϕ2



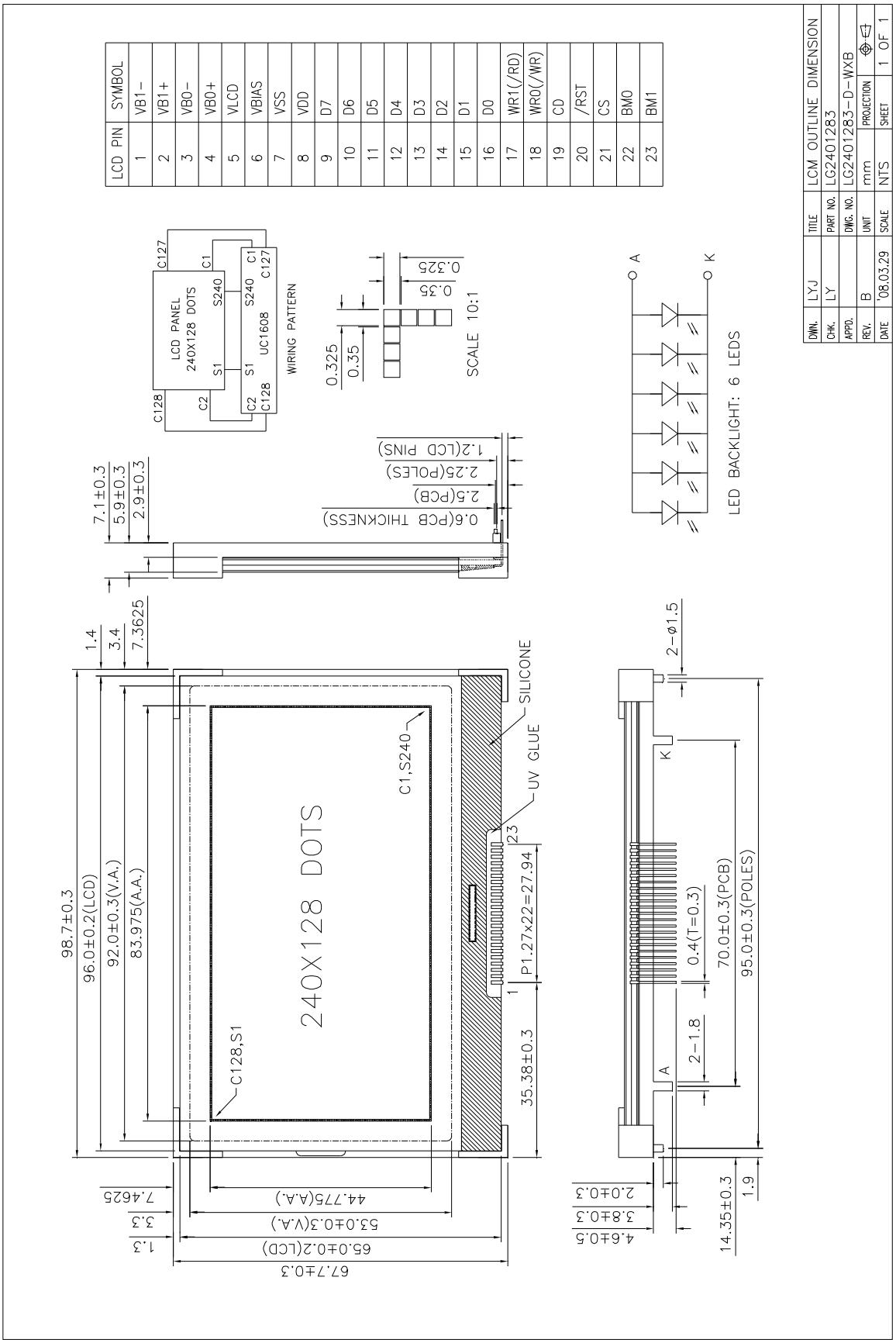
$$\text{Contrast Ratio} = \frac{\text{Brightness of non-selected dot (B1)}}{\text{Brightness of selected dot (B2)}}$$

Note3: Definition of contrast ratio (positive type)



Note3: Definition of response time

8. DIMENSIONAL OUTLINE



9. LCD MODULE NUMBERING SYSTEM

L	G	240	128	3	—	F	F	D	W	H	6	V	—	XXXXX
(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, three digits 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 XX

(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 ^{o}C) **H** - Extended Temperature (-20 ~ +70 ^{o}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~ZZZZZ – Version code

10. PRECAUTIONS FOR USE OF LCD MODULE

10.1 Handing 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.

10.2 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.

10.3 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.

10.4 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.