LCD Module Specification

Model: LG192643-BMDWH6V

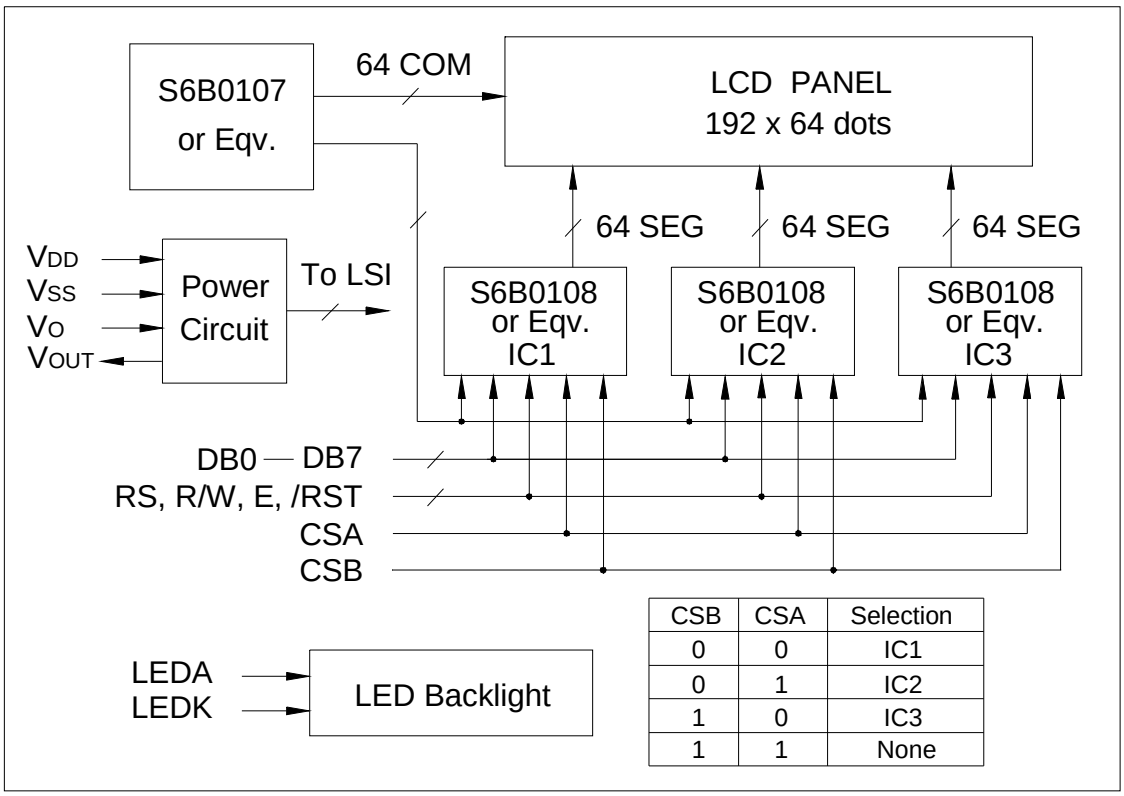
Table of Contents

1. BASIC SPECIFICATIONS

1.1 Features

Display Format	:	192 X 64 Dots	
LCD Mode	:	STN－Blue－Negative－Transmissive	
Driving Method	:	1/64 Duty, 1/9 Bias	
Viewing Direction	:	6:00	
Backlight	:	LED, white color	
Outline Dimension	:	100.0(W) X 60.0(H) X 12.5(T)	mm
Viewing Area	:	84.0(W) X 31.0(H)	mm
Dot Size	:	0.37 X 0.37	mm
Dot Pitch	:	0.41 X 0.41	mm
Weight	:	80	g
Controller	:	S6B0108 (KS0108B)	

1.2 Block Diagram



CSB	CSA	Selection
0	0	IC1
0	1	IC2
1	0	IC3
1	1	None

1.3 Terminal Functions

Pin No.	Symbol	Level	Function
1	DB7	H/L	Data Bit7
2	DB6	H/L	Data Bit6
3	DB5	H/L	Data Bit5
4	DB4	H/L	Data Bit4
5	DB3	H/L	Data Bit3
6	DB2	H/L	Data Bit2
7	DB1	H/L	Data Bit1
8	DB0	H/L	Data Bit0
9	E	H, H→L	Enable signal. Read data when E is “H”, write data at the falling edge of E
10	R/W	H/L	Read/Write selection H: Read operation L: Write operation
11	RS	H/L	Register selection H: Display data L: Instruction code
12	VO	-	Operating voltage for LCD (contrast adjusting)
13	VDD	+5V	Power supply for logic
14	VSS	0V	Ground
15	CSA	H/L	Chip selection signal CSB CSA Selection 0 0 IC1 0 1 IC2 1 0 IC3 1 1 None
16	CSB	H/L	
17	VOUT	-10V	Output voltage for LCD driving
18	/RST	L	Reset signal, active “L”
19	LEDA	+5V	Power supply for LED backlight
20	LEDK	0V	Power supply for LED backlight

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	19.0	V
Input Voltage	VI	-0.3	VDD+0.3	V
Operating Temp.	Topr	-20	70	℃
Storage Temp.	Tstg	-30	80	℃

3. ELECTRICAL CHARACTERISTICS

3.1 DC Characteristics (VDD=5.0V±10%, Ta=25℃)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage (Logic)	VDD		4.5	5.0	5.5	V
Supply Voltage (LCD Drive)	VDD-VO		--	12.7	--	V
Input High Voltage	VIH		2.0	--	VDD	V
Input Low Voltage	VIL		0	--	0.8	V
Output High Voltage	VOH	IOH=-0.2mA	2.4	--	VDD	V
Output Low Voltage	VOL	IOL=1.6mA	0	--	0.4	V
Supply Current (Logic)	IDD	VDD=5.0V	--	7.0	10.0	mA

3.2 Interface Timing Chart (VDD=5.0V±10%, Ta=25℃)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
E Cycle	t_C	1000	--	--	ns
E High Level Width	t_{WH}	450	--	--	ns
E Low Level Width	t_{WL}	450	--	--	ns
E Rise Time	t_R	--	--	25	ns
E Fall Time	t_F	--	--	25	ns
Address Set-Up Time	t_{ASU}	140	--	--	ns
Address Hold Time	t_{AH}	10	--	--	ns
Data Set-Up Time	t_{DSU}	200	--	--	ns
Data Delay Time	t_D	--	--	320	ns
Data Hold Time(Write)	t_{DHW}	10	--	--	ns
Data Hold Time(Read)	t_{DHR}	10	--	--	ns

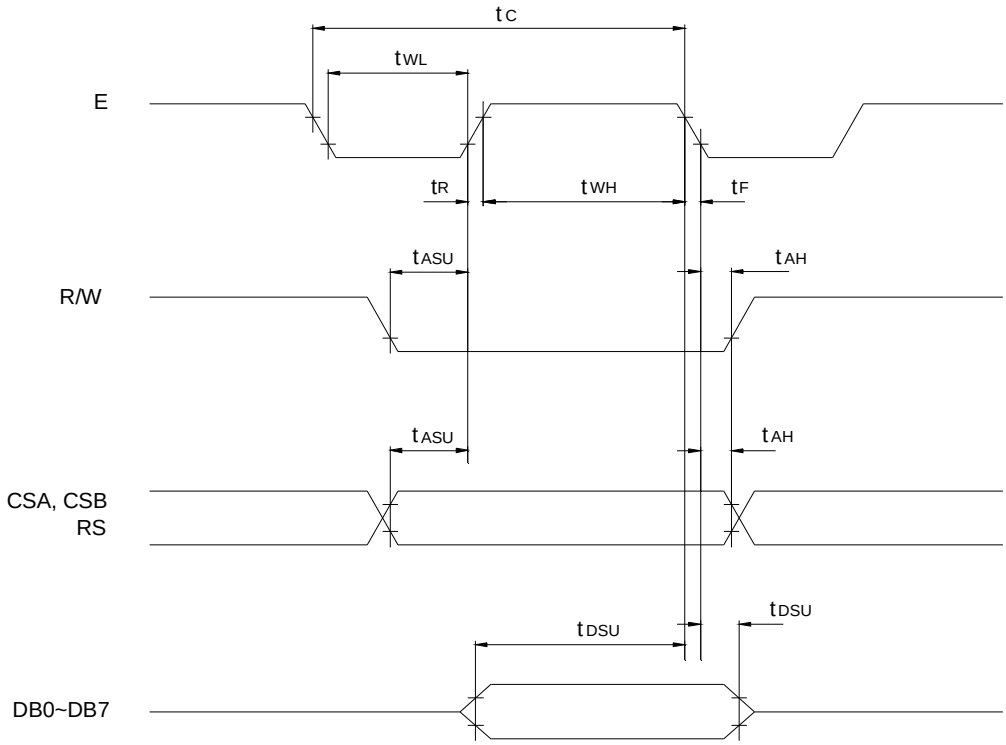


Fig.1 MPU Write Timing

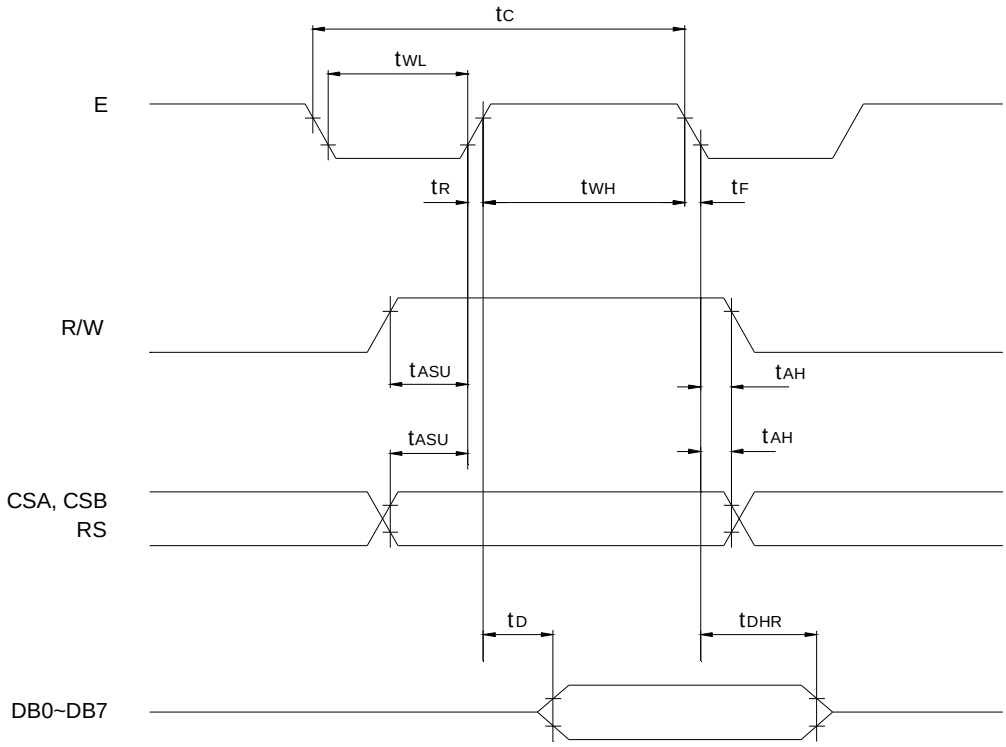
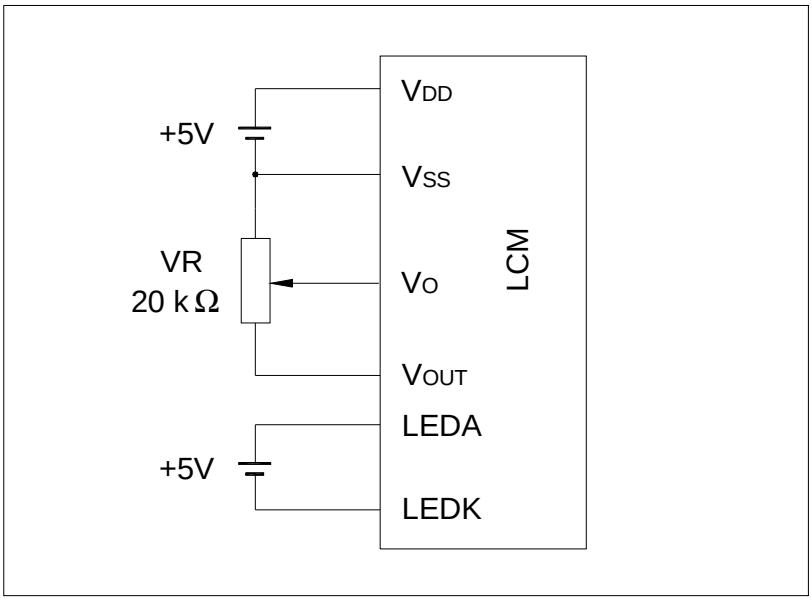


Fig.2 MPU Read Timing

3.3 LED Backlight Characteristics (Ta=25℃)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward Voltage	Vf		2.9	3.1	3.3	V
Forward Current	If	Vf=3.1V	--	45	--	mA
Color	White					

3.4 Power Supply



Note: 5V voltage for the LED backlight should be supplied to Pin19 (LEDA) and Pin20 (LEDK) terminal of the interface, it should not be supplied to the Anode/Cathode terminal of the LED backlight directly.

4. OPERATING PRINCIPLES & METHODES

4.1 I/O Buffer

Input buffer controls the status between the enable and display of chip. Unless the IC (selected by CSA and CSB) is in active mode, input or output of data and instruction does not execute. Therefore internal state is not changed. But /RST can operates regardless CSA or CSB.

4.2 Register

Both input register and output register are provided to interface to MPU of which the speed is different from that of internal operation. The selections of these registers depend on the combination of R/W and RS signals.

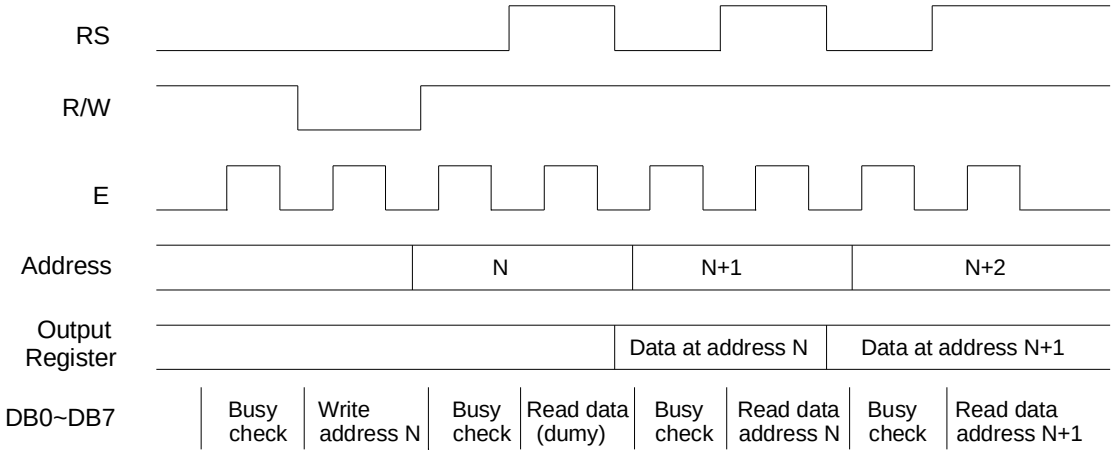
RS	R/W	Function
L	L	Instruction
	H	Status read (busy check)
H	L	Data write (from input register to display data RAM)
	H	Data read (from display data RAM to output register)

4.2.1 Input Register

Input register stores the data temporarily before writing it into display data RAM.
When the IC is in the active mode, R/W and RS select the input register. The data from MPU is written into input register, then into display data RAM. Data is latched at falling edge of the E signal and then written into the display data RAM automatically by internal operation.

4.2.2 Output Register

Output register stores the data temporarily which is read from display data RAM when the IC is in active mode and R/W and RS=H, stored data in display data RAM is latched in output register. When the IC is in active mode and R/W=H, RS=L, status data (busy check) can be read out.
To read the contents of display data RAM, twice access of read instruction is needed. In first access, data in display data RAM is latched into output register. In second access, MPU can read data that is latched in output register. That is, to read the data in display data RAM, it needs dummy read. But status read does not need dummy read.
The following shows the MPU read timing.



MPU Read Timing

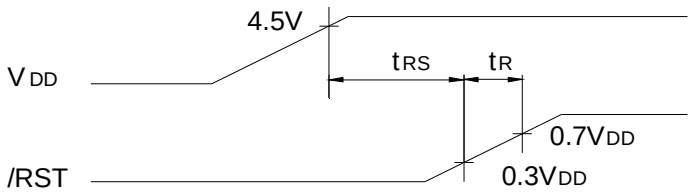
4.3 Reset

The system can be initialized by setting /RST terminal at low level when turning power on. When /RST becomes low, following procedure is occurred.

1. Display off
2. Display start line register is set by 0. (Z-address 0)

While /RST is low level, no instruction except status read can be accepted. Reset status appears at DB4 of status byte, after DB4 becomes “L”, any instruction can be accepted. The Conditions of power supply at initial power up are shown below.

Item	Symbol	Min.	Typ.	Max.	Unit
Reset time	t_{RS}	1.0	--	--	μs
Rise time	t_R	--	--	200	ns



4.4 Busy Flag

Busy flag indicates the system is now internally operating or not. When busy flag is “H”, the system is in internal operation. When busy flag is “L”, the system can accept data or instruction. Busy flag is read out on DB7 by the Status Read instruction.

4.5 Display On/Off Flip-Flop

The display on/off flip-flop makes on/off the liquid crystal display. When flip-flop is reset (logical low), selective voltage or non selective voltage appears on segment output terminals. When flip-flop is set (logical high), non selective voltage appears on segment output terminals regardless of display RAM data.

The display on/off flip-flop can change status by instruction. The display data at all segments disappear while /RST is low. The status of the flip-flop is output on DB5 by Status Read instruction.

4.6 X Page Register

X page register designates page of the internal display data RAM. Count function is not available. An address is set by instruction.

4.7 Y Address Counter

Y address counter designates address of the internal display data RAM. An address is set by instruction and is increased by 1 automatically by read or write operations of display data.

4.8 Display Data RAM

Display data RAM stores a display data for liquid crystal display. 1 bit data of this RAM corresponds to light ON (data=1) or light OFF (data=0) of 1 dot on the display panel.

4.9 Display Start Line Register

The register specifies a line in display data RAM that corresponds to the top line of LCD panel, when displaying contents in display data RAM on the LCD panel. Bit data (DB<0:5>) of the display start line information is written into this register by display start line set instruction. It is used for scrolling of the liquid crystal display screen.

5. DISPLAY CONTROL INSTRUCTIONS

The display control instructions control the internal state of the KS0108. Instruction is received from MPU to KS0108 for the display control. The following table shows various instructions.

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Function
Display ON/OFF	0	0	0	0	1	1	1	1	1	0/1	Controls the display on or off. Internal status and display RAM data are not affected.
Set Address (Y address)	0	0	0	1	Y address (0-63)						Sets the Y address at the Y address counter.
Set Page (X address)	0	0	1	0	1	1	1	Page (0-7)			Sets the X address at the X address register.
Display Start Line (Z address)	0	0	1	1	Display start line (0-63)						Indicates the display data RAM displayed at the top of the screen.
Status Read	0	1	BUSY	0	ON/OFF	RESET	0	0	0	0	Read status. BUSY 0: Ready 1: In internal operation ON/OFF 0: Display ON 1: Display OFF RESET 0: Normal 1: Reset
Write Display Data	1	0	Display Data								Writes data (DB0~DB7) into display data RAM. After writing instruction, Y address is increased by 1 automatically.
Read Display Data	1	1	Display Data								Reads data (DB0~DB7) from display data RAM to the data bus.

5.1 Display On/Off

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	1	1	1	D

The display data appears when D is 1 and disappears when D is 0.
Though the data is not on the screen with D=0, it remains in the display data RAM.
Therefore, you can make it appear by changing D=0 into D=1.

5.2 Set Address (Y Address)

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Y address (AC0~AC5) of the display data RAM is set in the Y address counter.
An address is set by instruction and increased by 1 automatically by read or write operations of display data.

5.3 Set Page (X Address)

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	1	1	AC2	AC1	AC0

X address (AC0-AC2) of the display data RAM is set in the X address register.
Writing to or reading from MPU is executed in this specified page until the next page is set.

5.4 Display Start Line (Z Address)

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	AC5	AC4	AC3	AC2	AC1	AC0

Z address (AC0~AC5) of the display data RAM is set in the display start line register and displayed at the top of the screen.

5.5 Status Read

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BUSY	0	ON/OFF	RESET	0	0	0	0

- BUSY
  When BUSY is 1, the chip is executing internal operation and no instructions are accepted.
  When BUSY is 0, the chip is ready to accept any instructions.
- ON/OFF
  When ON/OFF is 1, the display is off.
  When ON/OFF is 0, the display is on.
- RESET
  When RESET is 1, the system is being initialized.
  In this condition, no instructions except status read can be accepted.
  When RESET is 0, initializing has finished and the system is in the normal operation condition.

5.6 Write Display Data

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write data (D0~D7) into the display data RAM.
After writing instruction, Y address is increased by 1 automatically.

5.7 Read Display Data

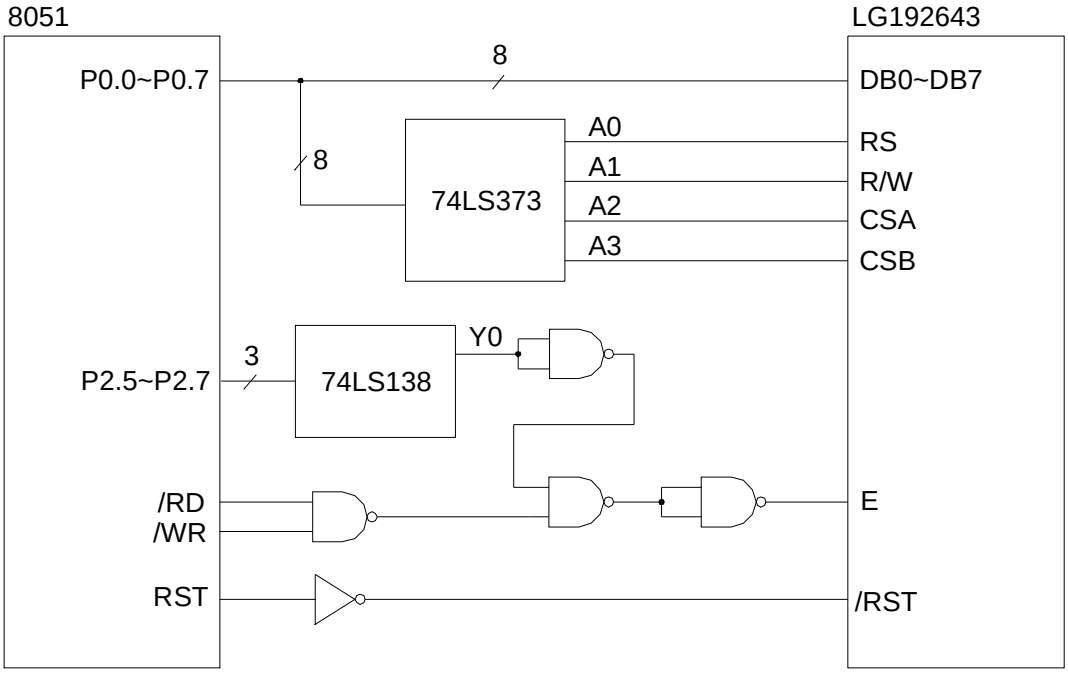
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read data (D0~D7) from the display data RAM.
After reading instruction, Y address is increased by 1 automatically.
One time of dummy read must be required after column address setting.

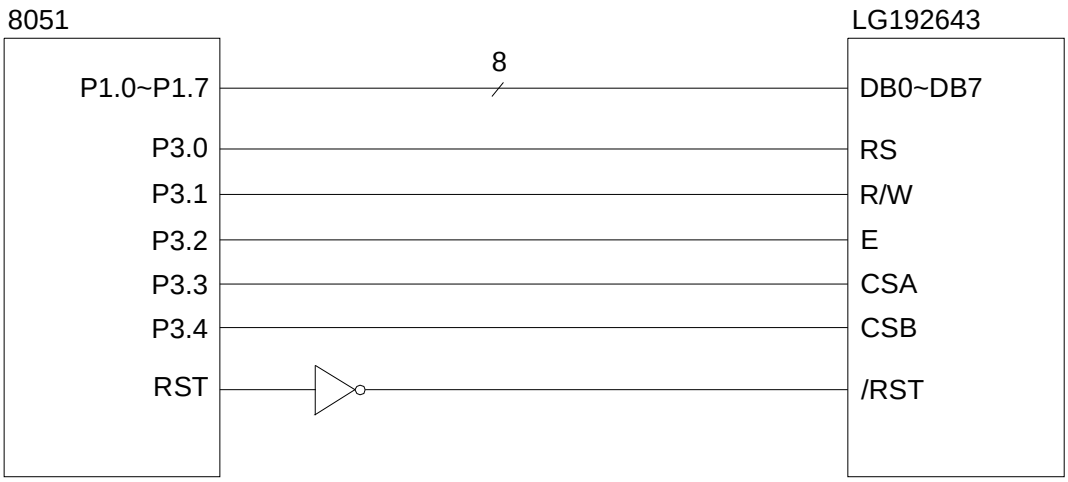
6. DISPLAY DATA RAM ADDRESS MAP

Page Address	Display Data	1st KS0108B					2nd KS0108B					3rd KS0108B					Line Address	Common
B8	D0																C0	COM1
	D1																C1	COM2
	D2																C2	COM3
	D3																C3	COM4
	D4																C4	COM5
	D5																C5	COM6
	D6																C6	COM7
	D7																C7	COM8
B9	D0																C8	COM9
	D1																C9	COM10
	D2																CA	COM11
	D3																CB	COM12
	D4																CC	COM13
	D5																CD	COM14
	D6																CE	COM15
	D7																CF	COM16
BA	D0																D0	COM17
	D1																D1	COM18
	D2																D2	COM19
	D3																D3	COM20
	D4																D4	COM21
	D5																D5	COM22
	D6																D6	COM23
	D7																D7	COM24
BB	D0																D8	COM25
	D1																D9	COM26
	D2																DA	COM27
	D3																DB	COM28
	D4																DC	COM29
	D5																DD	COM30
	D6																DE	COM31
	D7																DF	COM32
BC	D0																E0	COM33
	D1																E1	COM34
	D2																E2	COM35
	D3																E3	COM36
	D4																E4	COM37
	D5																E5	COM38
	D6																E6	COM39
	D7																E7	COM40
BD	D0																E8	COM41
	D1																E9	COM42
	D2																EA	COM43
	D3																EB	COM44
	D4																EC	COM45
	D5																ED	COM46
	D6																EE	COM47
	D7																EF	COM48
BE	D0																F0	COM49
	D1																F1	COM50
	D2																F2	COM51
	D3																F3	COM52
	D4																F4	COM53
	D5																F5	COM54
	D6																F6	COM55
	D7																F7	COM56
BF	D0																F8	COM57
	D1																F9	COM58
	D2																FA	COM59
	D3																FB	COM60
	D4																FC	COM61
	D5																FD	COM62
	D6																FE	COM63
	D7																FF	COM64
	Column Address	40	41	--	7E	7F	40	41	--	7E	7F	40	41	--	7E	7F		
	Segment	SEG1	SEG2	--	SEG63	SEG64	SEG65	SEG66	--	SEG127	SEG128	SEG129	SEG130	--	SEG191	SEG192		

7. CONNECTION WITH 8051 FAMILY MPU



a. Application Circuit 1

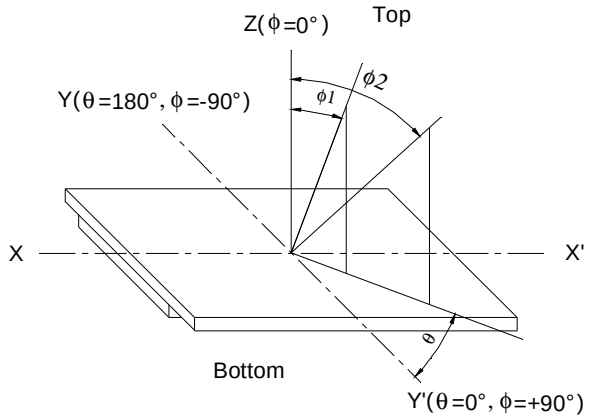


b. Application Circuit 2

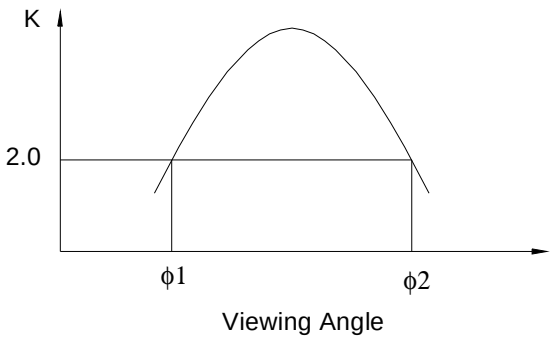
8. ELECTRO—OPTICAL CHARACTERISTICS (Ta=25℃)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
View Angle	Φ2-Φ1	K≥2, θ=0°	--	70	--	Deg	Note1, Note2
Contrast	K	Φ=0° ,θ=0°	3	--	--	--	Note3
Response Time	tr (rise)	Φ=0° ,θ=0°	--	250	--	ms	Note3
	tf (fall)	Φ=0° ,θ=0°	--	250	--	ms	

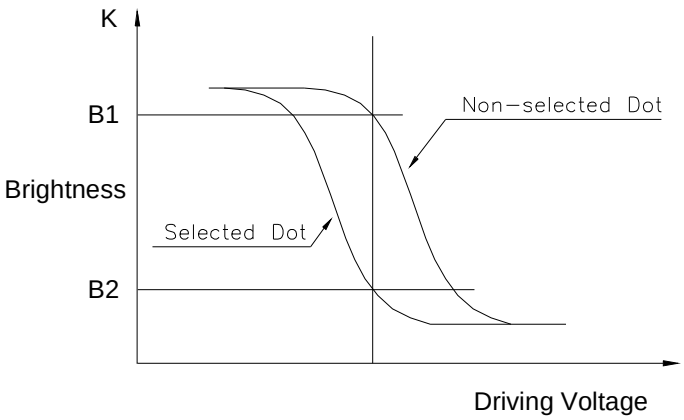
Note1: Definition of Viewing Angle θ , Φ



Note2: Definition of viewing Angle Range: Φ1, Φ2

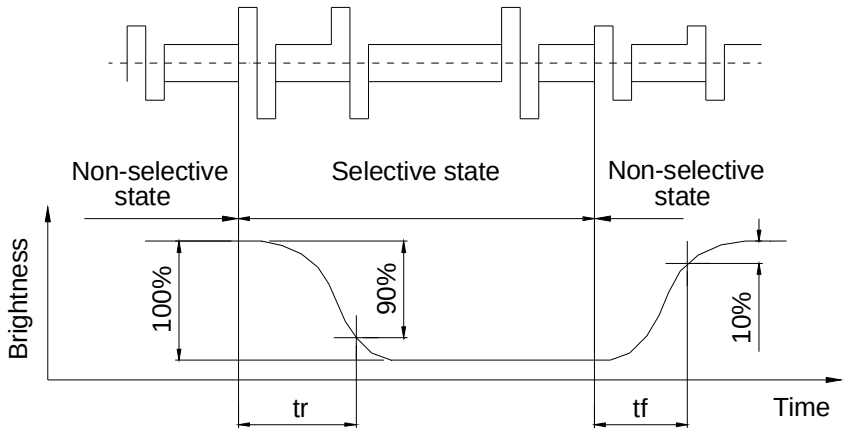


Note3: Definition of Contrast

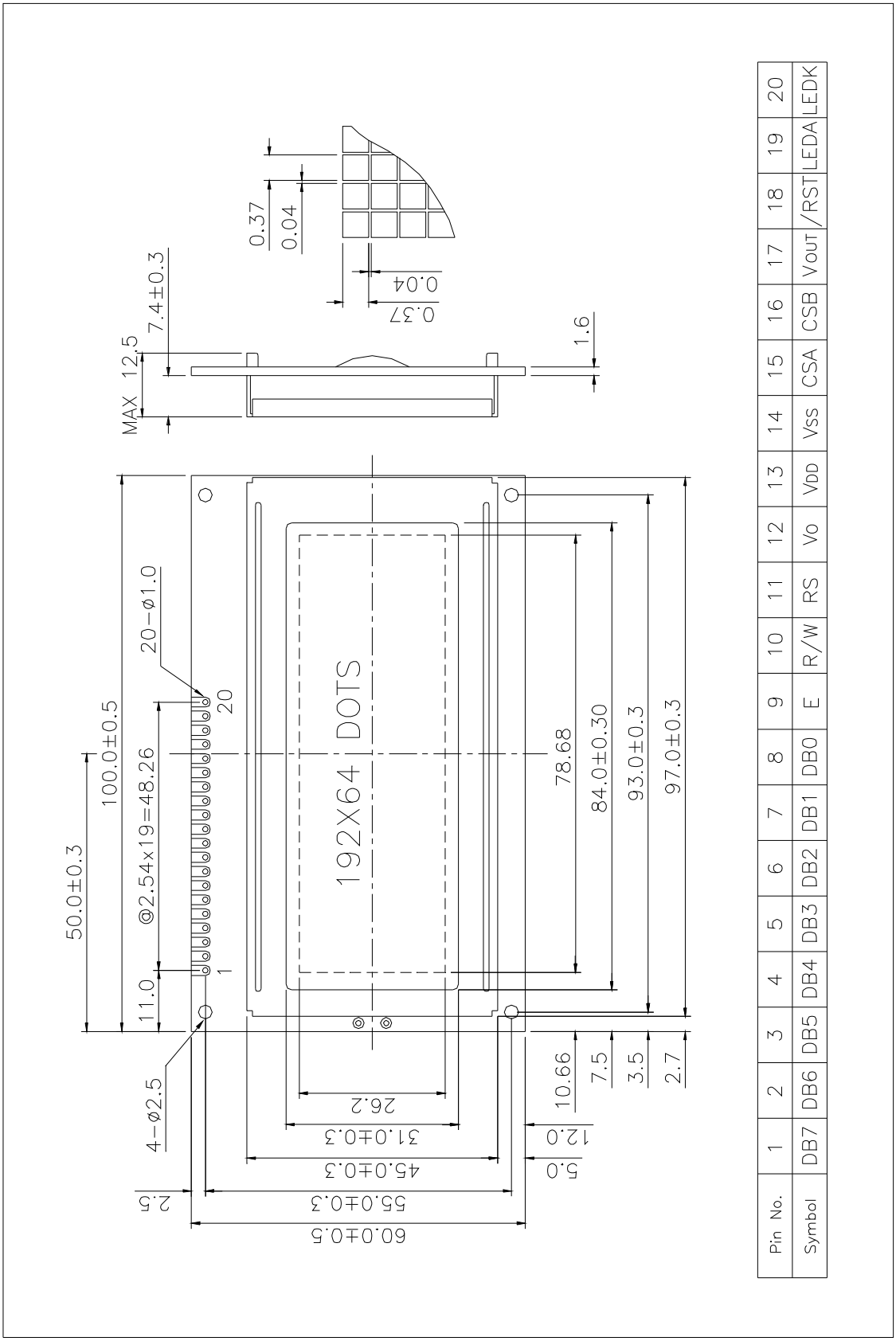


$$\text{Contrast} = \frac{\text{Brightness of non-selected dot (B1)}}{\text{Brightness of selected dot (B2)}}$$

Note4: Definition of Response Time



9. DIMENSIONAL OUTLINE



Pin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Symbol	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	E	R/W	RS	Vo	VDD	Vss	CSA	CSB	VOUT	/RST	LEDA	LEDK

10. LCD MODULE NUMBERING SYSTEM

L	G	192	64	3	—	B	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, tow 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 digit X (**1~9, A~Z**)

(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

0~ZZZ – Version code

11. PRECAUTIONS FOR USE OF LCD MODULE

11.1 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.

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.