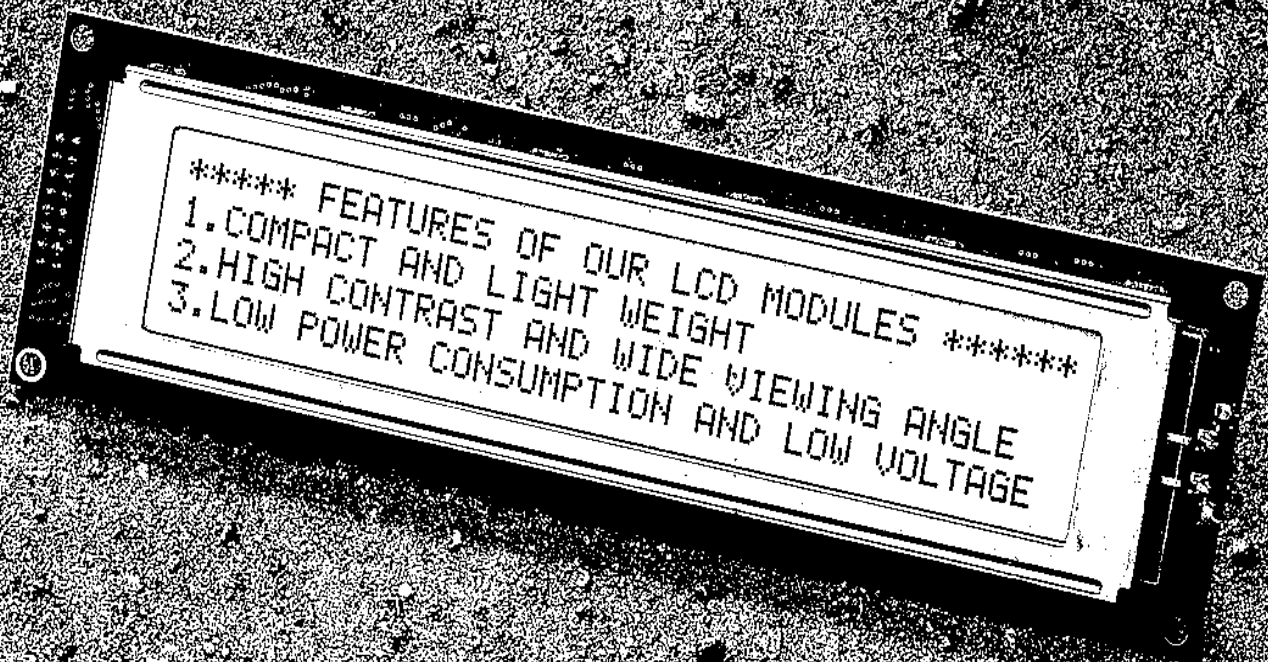


# Liquid Crystal Displays

## Standard Character Modules

### Application Notes



**Seiko Instruments GmbH**



## Notice

This manual describes the technical information, the functions, and the instructions of Liquid Crystal Display Modules from Seiko Instruments GmbH. Please read this instruction manual carefully to familiarise yourself with the functions and make the best use of them. The descriptions here are subject to change without notice.

### Revision Record

Edition	Revision	Date
1	Original	May 29,1998

Seiko Instruments GmbH 1998

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## Dot Matrix Liquid Crystal Display Module

### Character Type

#### ■ FEATURES

- Slim, light-weight and low power consumption
- High contrast and wide viewing angle
- Built-in controller for easy interface
- Available EL and LED backlight type
- Available in wide temperature type

The table below shows a quick reference guide of the character LCD modules. You can see the standard specifications and other optical specifications on the reference page of each model shown in the table below.

Character Format (character x line)		16 x 1	16 x 2	16 x 2	16 x 2	16 x 4	20 x 2
Model		M1641	M1632	L1642	L1652	L1614	L2012
Reflective		M16410AS	M16320AS	L164200J000S	L165200J200S	L161400J000S	L201200J000S
EL backlight		M16419DWS	M16329DWS	L164221J000S	L165221J200S	L161421J000S	L201221J000S
LED backlight		M16417DYS	M16327DYS	L1642B1J000S	L1652B1J200S	L1614B1J000S	L2012B1J000S
Reflective (w ide temp)		M16410CS	M16320CS	L164200L000S	L165200L200S	L161400L000S	L201200L000S
LED backlight (w ide temp)		M16417JYS	M16327JYS	L1642B1L000S	L1652B1L200S	L1614B1L000S	L2012B1L000S
Character font		5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective	80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	EL backlight	80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	LED backlight	80,0 x 36,0 x 15,8	80,0 x 30,0 x 15,8	80,0 x 36,0 x 15,8	122,0 x 44,0 x 15,8	87,0 x 60,0 x 15,8	116,0 x 37,0 x 15,8
Viewing area (HxV) mm		64,5 x 13,8	62,0 x 16,0	64,5 x 13,8	99,0 x 24,0	61,8 x 25,2	83,0 x 18,6
Character size (HxV) mm		3,07 x 5,73	2,78 x 4,27	2,95 x 3,80	4,84 x 8,06	2,95 x 4,15	3,20 x 4,85
Dot size (HxV) mm		0,55 x 0,75	0,50 x 0,55	0,50 x 0,55	0,92 x 1,10	0,55 x 0,55	0,60 x 0,65
Power supply voltage (VDD-VSS)		+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)	IDD	1,5	2,0	1,6	2,0	2,7	2,0
	ILC	0,2	0,2	0,3	0,4	1,1	0,4
Driving method (duty)		1/16	1/16	1/16	1/16	1/16	1/16
Built-in LSI		KS0066 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent
Operating temperature ( °C)	normal temp.	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50
	w ide temp.	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature ( °C)	normal temp.	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
	w ide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective	25	25	25	50	50	40
	EL backlight	30	30	30	55	55	45
	LED backlight	35	40	35	65	65	60
Inverters for EL	Model	5S	5S	5S	5C	5A	5A
	Power supply (V)	+ 5.0	+ 5,0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA)	10	10	10	35	45	45
LED backlight	Forward current consumption (mA)	100	112	100	240	200	154
	Forward input voltage (V,typ.)	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1
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## Dot Matrix Liquid Crystal Display Module

### Character Type

### ■ FEATURES

- Slim, light-weight and low power consumption
- High contrast and wide viewing angle
- Built-in controller for easy interface
- Available EL and LED backlight type
- Available in wide temperature type

The table below shows a quick reference guide of the character LCD modules. You can see the standard specifications and other optical specifications on the reference page of each model shown in the table below.

Character Format (character x line)		20 x 2	20 x 4	24 x 2	40 x 2	40 x 4
Model		L2022	L2014	L2432	L4042	M4024
Reflective		-	L201400J000S	L243200J000S	L404200J000S	M40240AS
EL backlight		-	L201421J000S	L243221J000S	L404221J000S	M40249DWS
LED backlight		-	L2014B1J000S	L2432B1J000S	L4042B1J000S	M40247DYS
Reflective (w ide temp)		L202200P000S	L201400L000S	L243200L000S	L404200L000S	M40240CS
LED backlight (w ide temp)		L2022B1P000S	L2014B1L000S	L2432B1L000S	L4042B1L000S	M40247JYS
Character font		5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective	180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	EL backlight	180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	LED backlight	180,0 x 40,0 x 14,8	98,0 x 60,0 x 15,8	118,0 x 36,0 x 15,8	182,0 x 33,5 x 16,3	190,0 x 54,0 x 16,3
View ing area (HxV) mm		149,0 x 23,0	76,0 x 25,2	94,5 x 17,8	154,4 x 15,8	147,0 x 29,5
Character size (HxV) mm		6,00 x 9,66	2,95 x 4,15	3,20 x 4,85	3,20 x 4,85	2,78 x 4,27
Dot size (HxV) mm		1,12 x 1,12	0,55 x 0,55	0,60 x 0,65	0,60 x 0,65	0,50 x 0,55
Pow er supply voltage (VDD-VSS)		+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)	IDD	4,2	2,9	2,5	3,0	8,0
	ILC	2,6	1,2	0,5	1,0	3,0
Driving method (duty)		1/16	1/16	1/16	1/16	1/16
Built-in LSI		KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent
Operating temperature ( °C)	normal temp.	-	0 to + 50	0 to + 50	0 to + 50	0 to + 50
	w ide temp.	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature ( °C)	normal temp.	-	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
	w ide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective	80	55	40	70	90
	EL backlight	-	60	45	75	105
	LED backlight	110	70	60	95	140
Inverters for EL	Model	-	5A	5A	5C	5D
	Pow er supply (V)	+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA)	-	45	45	25	80
LED backlight	Forw ard current consumption (mA)	320	240	150	260	480
	Forw ard input voltage (V,typ.)	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1
Page		27	29	32	35	38

## 1. Quality Assurance

### 1.1 Conformity

The performances, functions, and reliability of the products conform to the Product Specification.

### 1.2 Responsibility

Customers are responsible for any defect in quality caused after incoming inspection.

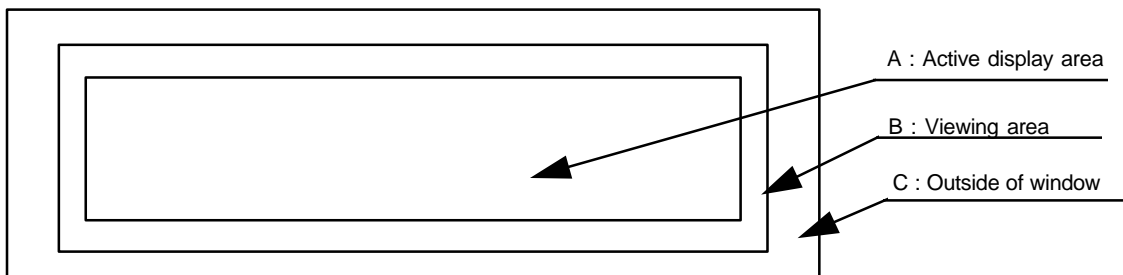
### 1.3 Warranty

The quality warranty is valid for one year after the delivery.

## 2. Shipping assurance level is as follows

Rank	Zone		Defect	AQL
Major defect	A	Display area (Appearance) (Functions)	Display functions current consumption Missing display functions No display	0.4%
Minor defect	A	Display area	Polarizer defect Uneven contrast Crosstalk Black spots	1.0%
	B	Boundary of display area to view ing area	Black streaks Bubbles Cromaticity Uniformity	
	C	Panel frame Circuit board	Scratches Dirt	

## 3. Zone definition



- A : active display area
- B : viewing area excluding active display area
- C : area of entire module excluding viewing area (metal frame, PCB etc)

## 4. Appearance Defect

See individual defects standards in Delivery Specifications

## 1. Reliability Test

### 1.1 Normal Temperature type

Test Item	Test Conditions	result
Operation at high temperature and humidity	40 °C ± 2 °C 90% RH for 500 hours	No abnormalities in functions* and appearance**
Operation at high temperature	60 °C ± 2 °C for 500hrs	No abnormalities in functions* and appearance**
Heat shock	-20 °C ↔ +60 °C Left for 1 hour at each temperature, transition time 5 minutes repeated 10 times	No abnormalities in functions* and appearance**
Low Temperature	-20 °C ± 2 °C for 500hrs	No abnormalities in functions* and appearance**
Vibration	Sweep for 1 min. at 10Hz, 55Hz, 10Hz amplitude 1.5mm 2 hours each in the X,Y and Z directions	No abnormalities in functions* and appearance**
Drop shock	Dropped onto a board from a height of 30cm	No abnormalities in functions* and appearance**

\* Dissipation current, contrast and display functions

\*\* Polarizer deterioration, other appearance defect

### 1.2 Wide Temperature type

Test Item	Test Conditions	result
Operation at high temperature and humidity	60 °C ± 2 °C 90% RH for 500 hours	No abnormalities in functions* and appearance**
Operation at high temperature	80 °C ± 2 °C for 500hrs	No abnormalities in functions* and appearance**
Heat shock	-30 °C ↔ +80 °C Left for 1 hour at each temperature, transition time 5 minutes repeated 10 times	No abnormalities in functions* and appearance**
Low Temperature	-30 °C ± 2 °C for 500hrs	No abnormalities in functions* and appearance**
Vibration	Sweep for 1 min. at 10Hz, 55Hz, 10Hz amplitude 1.5mm 2 hours each in the X,Y and Z directions	No abnormalities in functions* and appearance**
Drop shock	Dropped onto a board from a height of 30cm	No abnormalities in functions* and appearance**

\* Dissipation current, contrast and display functions

\*\* Polarizer deterioration, other appearance defect

## 2. LCD Life Time

Item	Conditions	Standard	Unit
Life time	25 °C ± 10 °C < 65 %RH	100,000 or more	hours

## 3. Definition of LCD service life

- Contrast becomes 30% of initial value
- Current consumption becomes three times higher than initial value
- Remarkable alignment deterioration occurs in LCD cell layer
- Unusual operation occurs in display functions

## 1. Safety

- If the LCD panel is damaged, be careful not to get the liquid crystal in your mouth and not to be injured by crushed glass.
- If you should swallow the liquid crystal, first wash your mouth thoroughly with water, then drink a lot of water induce vomiting and then consult a physician.
- If the liquid crystal should get in your eyes, flush your eyes with running water for at least fifteen minutes.
- If the liquid crystal touches your skin or clothes, remove it and wash the affected part of your skin or clothes with soap and running water.
- High voltage is applied to the lead terminals of the EL lamp. Do not touch any part of the lead terminals. (For LCD module with EL backlight)
- Do not use EL inverters without a load or in the short-circuit mode.
- Use the LCD module within the rated voltage to prevent overheating and/or damage. Also, take steps to ensure that the connector does not come off.

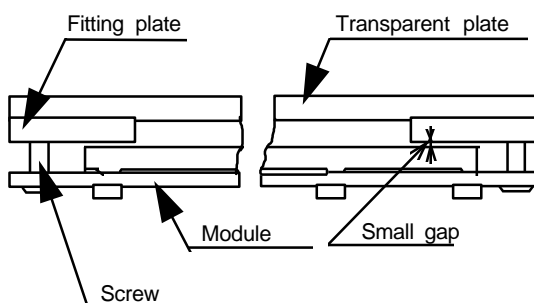
## 2. LCD Handling

- Please keep the temperature within the specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.
- Do not touch, push or rub the exposed polarizers with anything harder than hardness of 3B (glass, tweezers, etc..).
- When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzene. Do not scrub hard to avoid damaging the display surface.
- Wipe off saliva or water drops immediately. Contact with water over a long period of time may cause deformation or color fading.
- Avoid contact with oil and fats.
- Condensation on the surface and contact terminals due to cold will damage, stain or dirty the polarizers. After products are tested at low temperatures they must be warmed up in a container before coming in contact with room temperature air.
- Do not put or attach anything on the display area to avoid leaving marks on.
- Do not touch the display area with bare hands, damage the display area and degrade insulation between terminals. (some cosmetics are detrimental to the polarizers)
- As glass is fragile, it tends to become cracked or chipped during handling especially on the edges, Please avoid dropping or jarring.

## 3. LCD Module

### 3.1 Mounting LCD module

- Use the specified mounting parts and holes to mount the module.
- Connect a 10  $\mu$ F capacitor between the power supply terminals to eliminate noise.



- Make sure that no stress is applied on the module when it is mounted. The application of stress for a long time may damage the LCD panel and the ICs substrates.
- To protect the polarizer and the LCD panel, cover the display surface with a transparent plate, for example, acrylic or glass, with a small gap between the transparent plate and the LCD surface.
- Do not apply input signals when power supply voltage isn't applied.

### 3.2 Precaution for handling LCD module

- Since the module has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any modifications to it.
- Do not alter, modify or change the shape of the tab on the metal frame.
  - Do not make extra holes on the PCB, modify its shape or change the positions of components attached.
  - Do not damage or modify the pattern wiring on the PCB
  - Do not modify the zebra rubber or touch it with another materials.
  - Do not make any modifications with a soldering iron except indicating area.
  - Do not drop, bend or twist the module.

### 3.3 Electro-static discharge

- Since CMOS ICs are mounted on the module, special attention has to be paid to the electric-static discharge.
- Make sure that you are connected to the ground during handling of the module.
  - Before removing the module from packing unit make sure that the module and yourself have the same electric potential.
  - When soldering the terminal of the module, make sure that the AC power source for the soldering iron does not leak.
  - When using an electric screwdriver to attach the module, the screwdriver should be grounded to minimise as much as possible any transmission of electro-magnetic waves produced by sparks coming from the accumulator of the motor.
  - Make your clothes and working bench the ground potential as much as possible.
  - Avoid to generate static electricity, relative humidity should be 50 ~ 60 %RH.

### 3.4 Precaution for operation

- Proper operating voltage for LCD gives optimum viewing angle.
- If LCD surface is pressed harder during operation, the display becomes abnormal and then will return to normal after the pressure is released. However, it may generate bubbles and cause permanent damage to the LCD.
- Condensation may generate electrochemical reaction and then it may cause open or short circuit on the terminal.

### 3.5 Cleaning

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

## 4. Storage

- Store the module in the dark place. Keep the temperature between 15 °C and 35 °C and the humidity below 65%RH.
- Do not store the module near organic solvents or corrosive gases.
- Make sure that no stress or vibration is applied to the module when it is stored.
- Use the products with EL backlight within 6 months after receiving them.



## 5. Handling the LED backlight

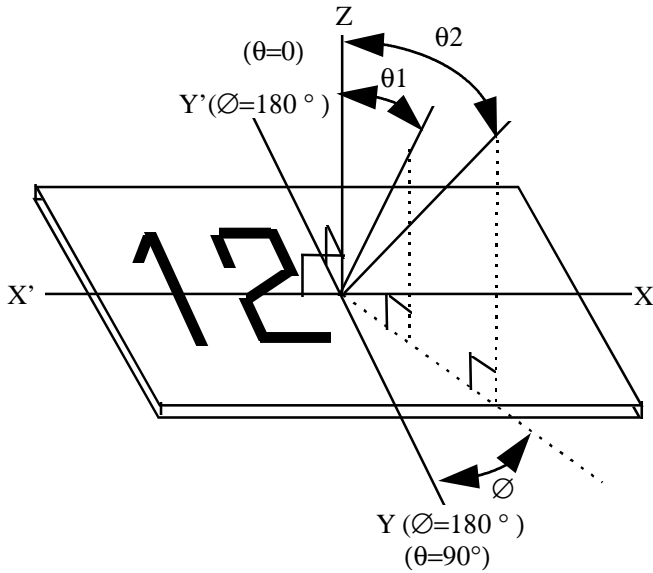
- When soldering the LED connector, the soldering iron temperature should not exceed 260 °C and soldering time should be within 3 seconds
- For cleaning, wipe with soft cloth and use only the following chemicals
  - Ethanol
  - Isopropyl alcohol

## 6. Handling the EL backlight

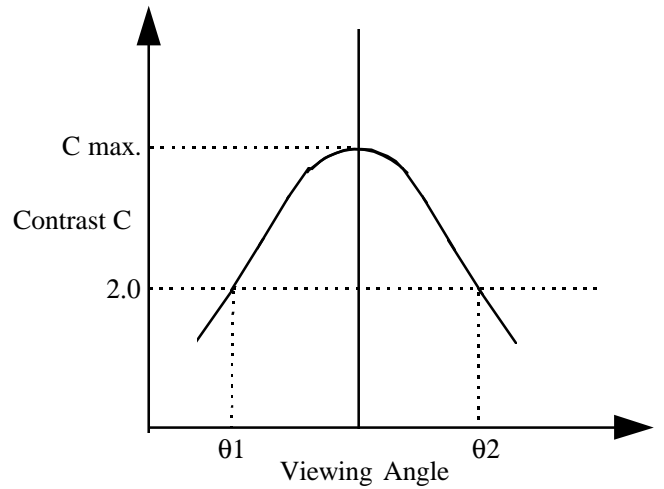
- Your design should make it easy to replace the EL backlight since they have a shorter service life than the other components of LCD modules.
- Do not bend the EL leads when soldering them on the circuit board of the LCD modules otherwise they may break.
- To set the EL backlight into the LCD module, push the EL backlight with its emitting side up, without pushing the rubber connectors too hard. If you damage them, the LCD module may not work properly.
- Do not damage the film surface of the EL backlight otherwise the backlight will be damaged by humidity.
- Since high voltage is applied to the EL lead terminals, be careful not to touch the EL terminals.
- Do not use EL inverters without a load or in the short-circuit mode.

Definition of Optical Characteristics Term

■ Angles  $\phi$  and  $\theta$

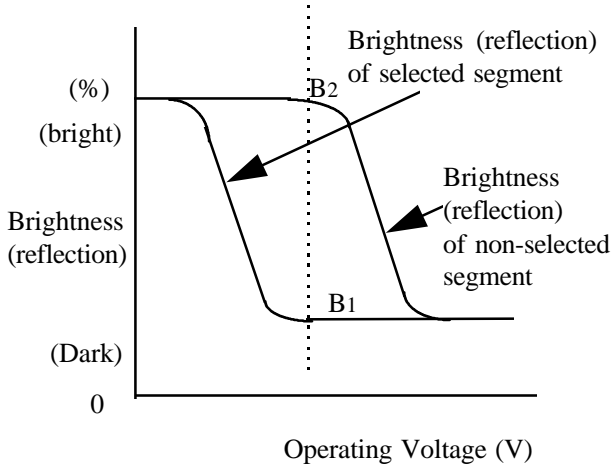


■ Viewing Angle  $\theta_1$  and  $\theta_2$

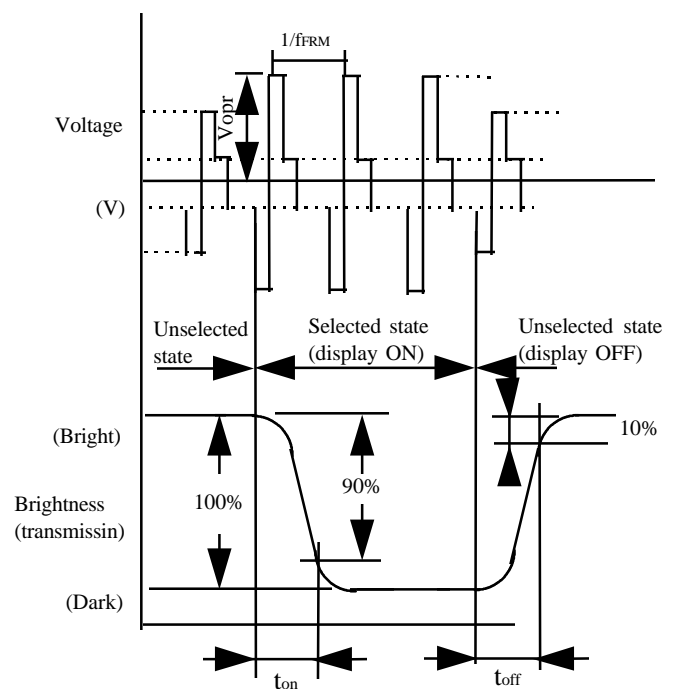


■ Contrast C

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



■ Response Time



Vopr : Operating Voltage  
 f<sub>FRM</sub> : Frame Frequency  
 t<sub>on</sub> : Response time (rise)  
 t<sub>off</sub> : Response time (fall)

- 16 Characters x 1 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

## Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

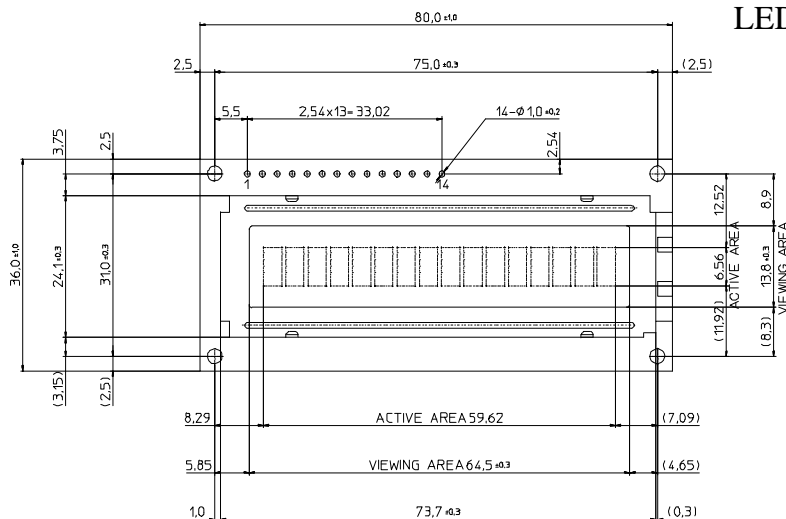
## Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	80.0 x 36.0	mm
Thickness	Reflective/EL	11.3
	LED	15.8
Viewing area (H x V)	64.5 x 13.8	mm
Character size with cursor (H x V)	3.07 x 6.56	mm
Mounting hole distance (H x V)	75.0 x 31.0	mm
Weight	Reflective	25
	EL backlight	30
	LED backlight	35

H : Horizontal, V : Vertical

## Dimensions

M1641 (1x16) Unit: mm. General tolerance ±0,5 mm



## Electrical Characteristics

V<sub>DD</sub>=5V±5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

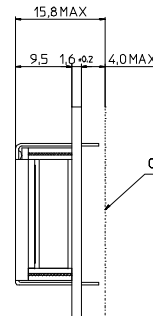
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>OL1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4
Current consumption *						
Normal Temp type	I <sub>DD</sub>	Ta=25°C	-	1.3	2.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	0.2	0.6	mA
Wide Temp. type	I <sub>DD</sub>	Ta=25°C	-	1.6	2.5	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	0.3	1.0	mA

\* test pattern : check board pattern

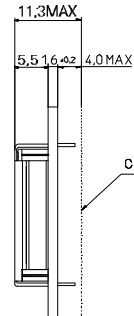
## Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line

### LED Backlight

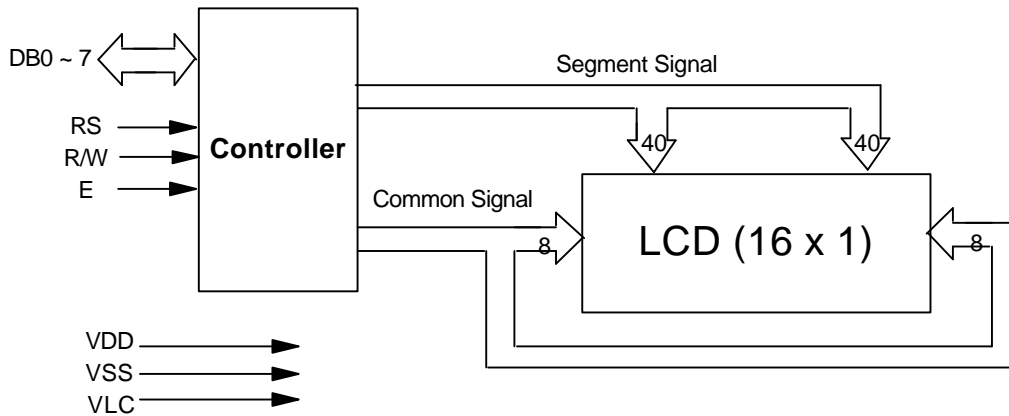


### Reflective/EL Backlight



Note : Only dimension changes between Reflective/EL and LED backlight is the thickness

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ ,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ$ , $F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ$ , $F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}$ , $V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +20^\circ$ , $F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$ , $F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}$ , $V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ$ , $F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}$ , $V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

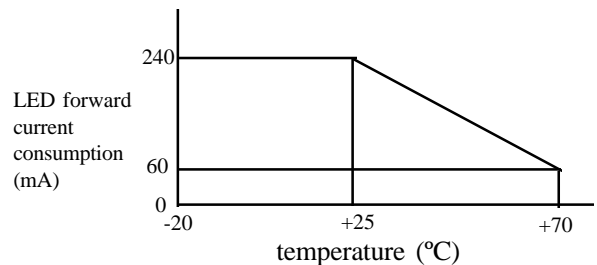
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	240	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	PD	1.05	W
Operating temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

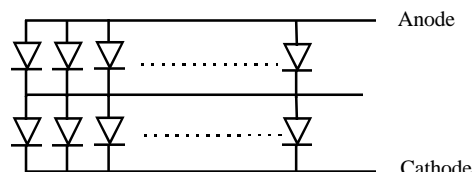
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 120\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.16	mA
Peak Emitting wavelength		$I_F = 120\text{mA}^*$	-	570	-	nm
Spectral half-width		$I_F = 120\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 120\text{mA}^*$	120	150	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 8 = 16 pcs

■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	0 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz Sinew ave	40 min.	cd/m <sup>2</sup>
Current	100V, 400Hz Sinew ave	1.5 max.	mA
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	3,000	hrs
	Using 5S Inverter 25°C, 50%RH	6,000	

3. Suitable Inverter 5S

3.1 Electrical Characteristics  
(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	550 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	100 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current Voltage	V <sub>IN</sub>		10	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	5 typ	VDC

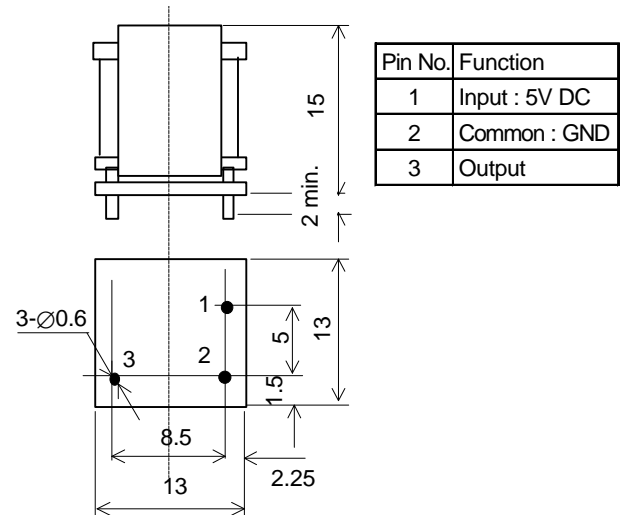
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)





- 16 Characters x 2 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

■ Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

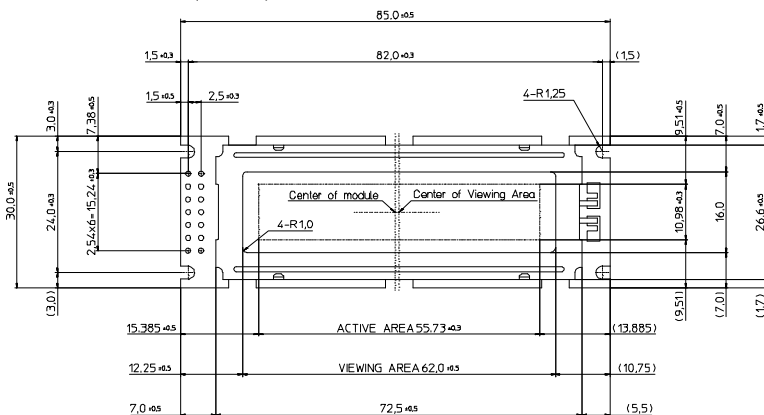
■ Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	85.0 x 30.0	mm
Thickness	Reflective/EL	10.1
	LED	15.8
Viewing area (H x V)	62.0 x 16.0	mm
Character size with cursor (H x V)	2.78 x 4.89	mm
Mounting hole distance (H x V)	82.0 x 24.0	mm
Weight	Reflective	25
	EL backlight	30
	LED backlight	40

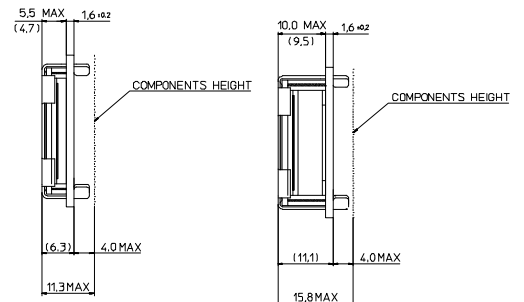
H : Horizontal, V : Vertical

■ Dimensions

M1632 (2x16) Unit: mm, General tolerance ±0.5 mm



Reflective/EL Backlight      LED Backlight



Note : Only dimension changes between Reflective/EL and LED backlight is the thickness.

■ Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

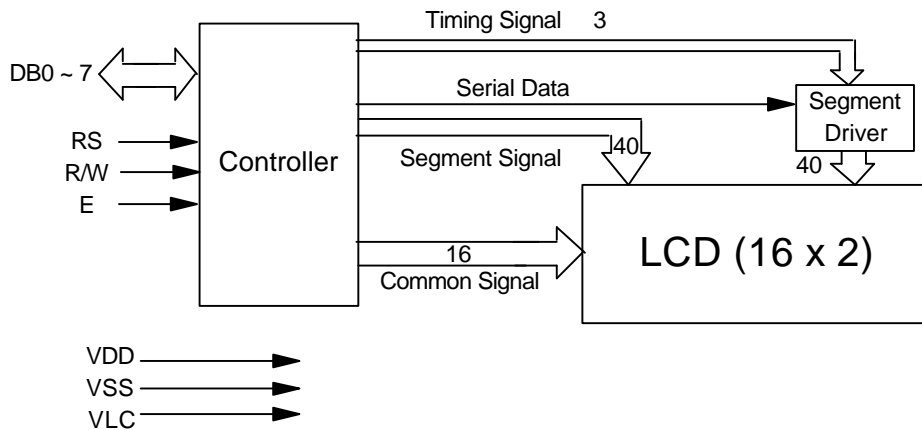
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>OL1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4
Current consumption *						
Normal Temp type	I <sub>DD</sub>	Ta=25°C	-	1.6	2.5	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	0.2	1.0	mA
Wide Temp. type	I <sub>DD</sub>	Ta=25°C	-	1.6	2.5	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.6V	-	0.3	1.0	mA

\* test pattern : check board pattern

■ Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H: Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = 25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{op} = 5.6\text{v}$	70	-	-	
Contrast	C	$q = 20^\circ, F = 0^\circ$ $V_{op} = 5.6\text{v}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

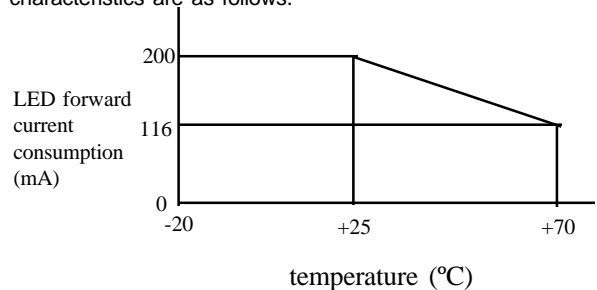
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	200	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	0.92	W
Operating Temperature	$T_{opr}$	- 20 ~ +70	°C
Storage Temperature	$T_{stg}$	- 40 ~ + 80	°C

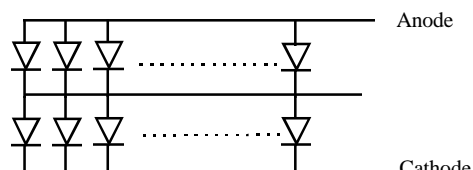
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 112\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.16	mA
Brightness	L	$I_F = 112\text{mA}^*$	40	50	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 8 = 16 pcs

■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	-10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	30 min.	cd/m <sup>2</sup>
	Sinew ave	35 typ.	
Current	100V, 400Hz	1.2 typ.	mA
	Sinew ave	1.7 max	
Life *	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5S Inverter 25°C, 50%RH	4,000	

\* Definition of Life : Used continuously down to 10 cd/m<sup>2</sup>

3. Suitable Inverter 5S

3.1 Electrical Characteristics

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	550 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	100 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5 typ	VDC
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	10 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	35 typ.	cd/m <sup>2</sup>
Surface brightness (panel upper side)	B <sub>P</sub>	V <sub>IN</sub> =5VDC Vopr=0V	7 typ.	cd/m <sup>2</sup>

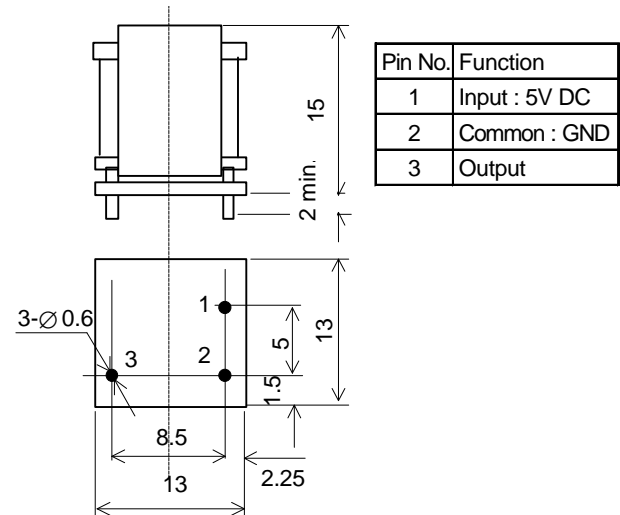
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 15	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)



- 16 Characters x 2 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

## Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

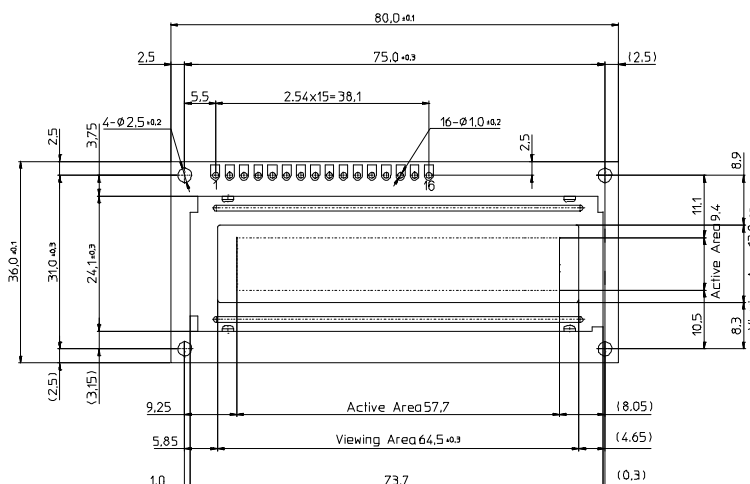
## Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	80.0 x 36.0	mm
Thickness	Reflective/EL	11.3
	LED	15.8
Viewing area (H x V)	64.5 x 13.8	mm
Character size with cursor (H x V)	2.95 x 4.35	mm
Mounting hole distance (H x V)	75.0 x 31.0	mm
Weight	Reflective	25
	EL backlight	30
	LED backlight	35

H : Horizontal, V : Vertical

## Dimensions

L1642 (2x16) Unit: mm, General tolerance ±0.5 mm



## Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

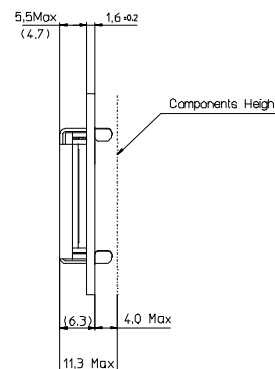
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>LH1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4
Current consumption *						
Normal Temp type	I <sub>DD</sub>	Ta=25°C	-	1.6	3.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	0.3	1.0	mA
Wide Temp. type	I <sub>DD</sub>	Ta=25°C	-	1.6	3.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	0.4	1.0	mA

\* test pattern : check board pattern

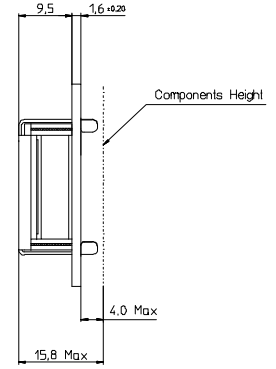
## Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

Reflective/EL Backlight

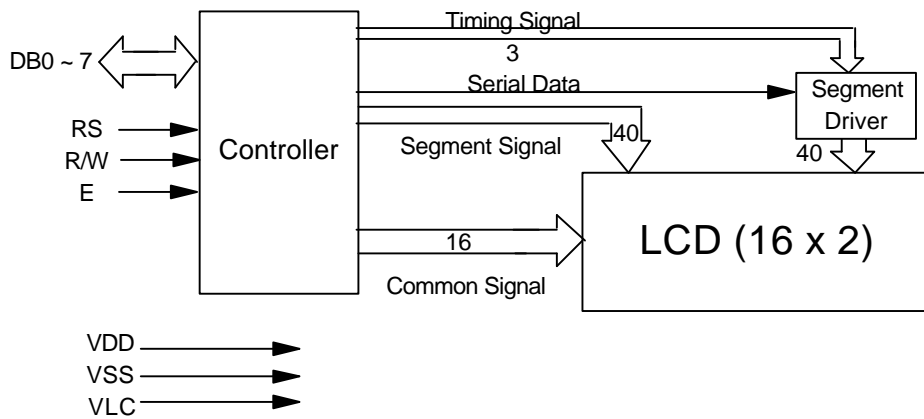


LED Backlight



Note : Only dimension changes between Reflective/EL and LED backlight is thickness.

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = 2.5^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{v}$	70	-	-	
Contrast	C	$q = 20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{v}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

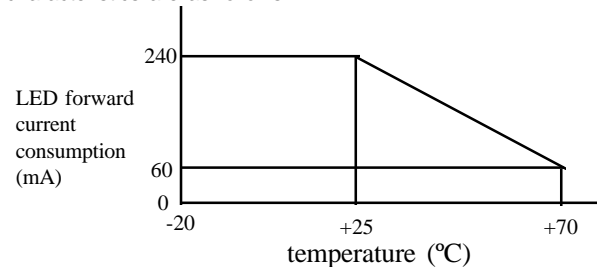
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	240	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	1.05	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

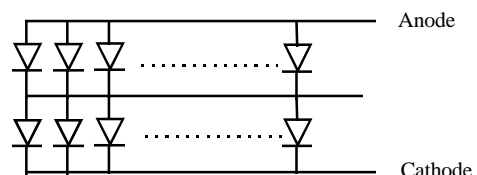
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 120\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 120\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 120\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 120\text{mA}^*$	-	40	50	cd/m <sup>2</sup>



total number of LED chips = 2 x 12 = 24 pcs



■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	0 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	30 min.	cd/m <sup>2</sup>
	Sinew ave	35 typ.	
Current	100V, 400Hz	1.2 typ.	mA
	Sinew ave	1.7 max	
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5S Inverter 25°C, 50%RH	4,000	

3. Suitable Inverter 5S

3.1 Electrical Characteristics  
(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	550 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	100 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		10	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	5 typ	VDC

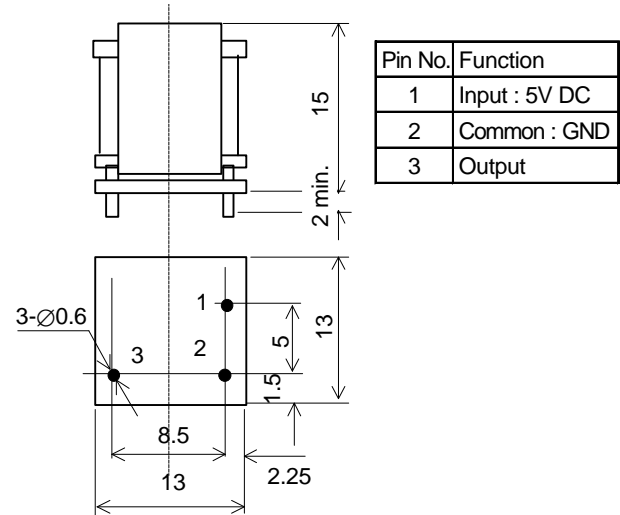
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)



- 16 Characters x 2 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

## Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

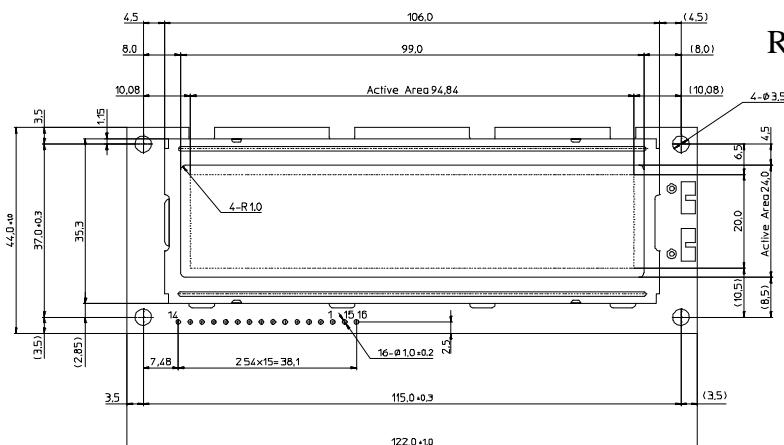
## Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	122.0 x 44.0	mm
Thickness	Reflective/EL	11.3
	LED	15.8
Viewing area (H x V)	99.0 x 24.0	mm
Character size with cursor (H x V)	4.84 x 9.66	mm
Mounting hole distance (H x V)	115.0 x 37.0	mm
Weight	Reflective	50
	EL backlight	55
	LED backlight	65

H : Horizontal, V : Vertical

## Dimensions

L1652 (2x16) Unit: mm, General tolerance ±0.5 mm



## Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>LH1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4
Current consumption *						
Normal Temp. type	I <sub>BD</sub>	Ta=25°C	-	1.8	3.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	0.4	1.0	mA
Wide Temp. type	I <sub>BD</sub>	Ta=25°C	-	2.0	3.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	0.5	1.0	mA

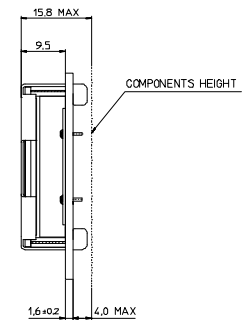
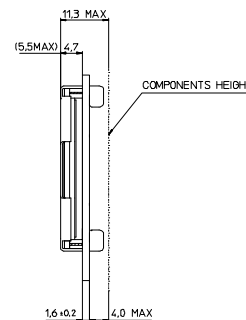
\* test pattern : check board pattern

## Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

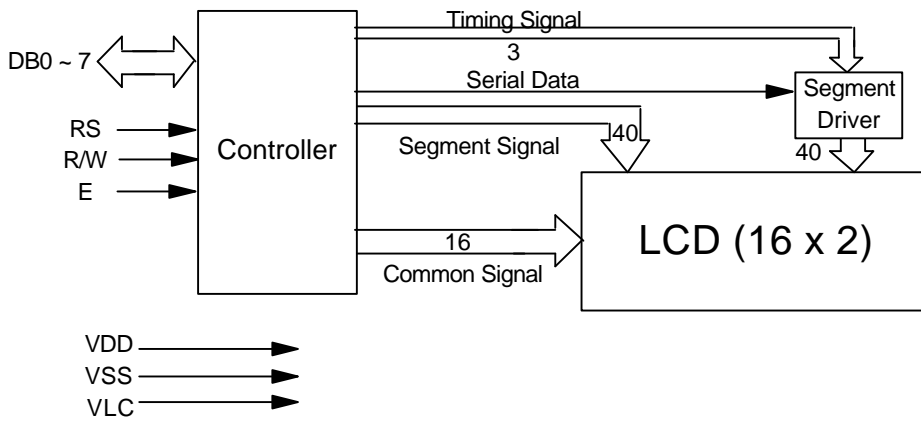
Reflective/EL Backlight

LED Backlight



Note : Only dimension changes between Reflective/EL and LED backlight is thickness.

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 90^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = \pm 5^\circ, F = 90^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 90^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = \pm 20^\circ, F = 90^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 90^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 90^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

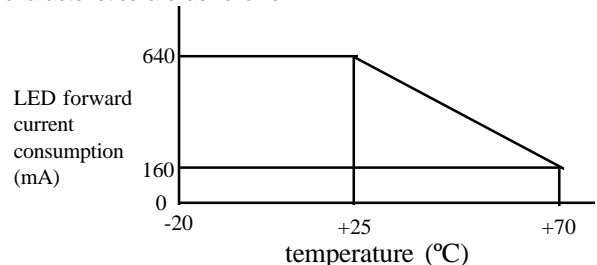
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	640	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	2.8	W
Operating Temperature	$T_{opr}$	-20 ~ +70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-40 ~ +80	$^\circ\text{C}$

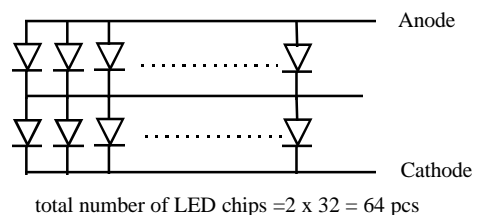
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 320\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 320\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 320\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 320\text{mA}^*$	150	170	-	$\text{cd/m}^2$



■ EL Backlight

1.Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	40 min.	cd/m <sup>2</sup>
	Sinew ave	50 typ.	
Current	100V, 400Hz	3.0 typ.	mA
	Sinew ave	4.5 max	
Life	100V, 400Hz, Sinew ave 25°C,50%RH	1,500	hrs
	Using 5C Inverter 25°C,50%RH	3,500	

3. Suitable Inverter 5C

3.1 Electrical Characteristics  
(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	490 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	92 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	3.0 typ.	mA
Input current voltage	V <sub>IN</sub>		5	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	35 typ	mA

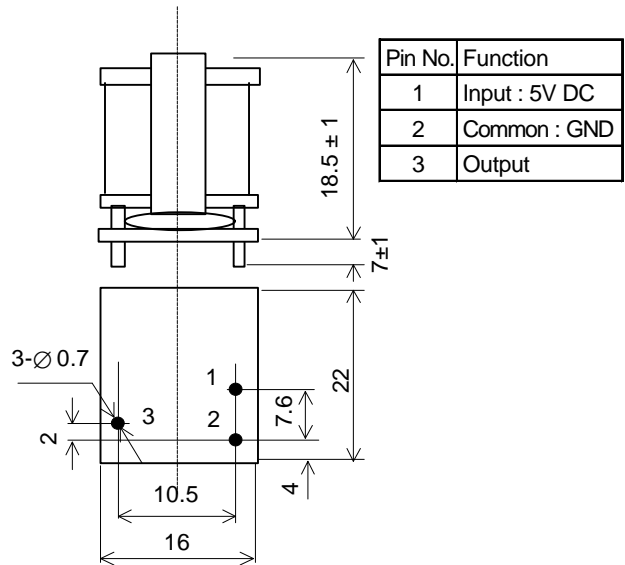
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)



- 16 Characters x 4 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

■ Absolute Maximum Ratings

V<sub>SS</sub>=0V, T<sub>a</sub>=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power Supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

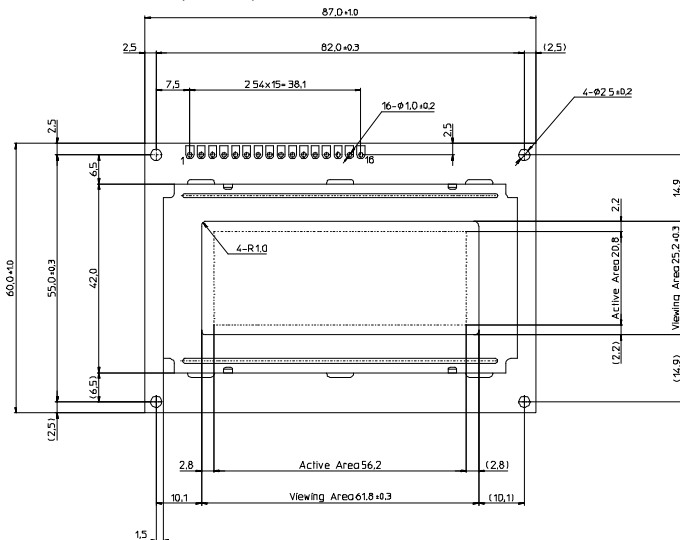
■ Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	87.0 x 60.0	mm
Thickness	Reflective/EL	11.6
	LED	15.8
Viewing area (H x V)	61.8 x 25.2	mm
Character size with cursor (H x V)	2.95 x 4.75	mm
Mounting hole distance (H x V)	82.0 x 55.0	mm
Weight	Reflective	50
	EL backlight	55
	LED backlight	65

H : Horizontal, V : Vertical

■ Dimensions

L1614 (4x16) Unit: mm, General tolerance ±0.5 mm



Note : Only dimension changes between Reflective/EL and LED backlight is thickness.

■ Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, T<sub>a</sub>=0 ~ 50°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>OL1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4
Current consumption *						
Normal Temp. type	I <sub>BD</sub>	T <sub>a</sub> =25°C	-	2.8	4.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	1.3	2.2	mA
Wide Temp. type	I <sub>BD</sub>	T <sub>a</sub> =25°C	-	3.0	4.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	1.5	2.5	mA

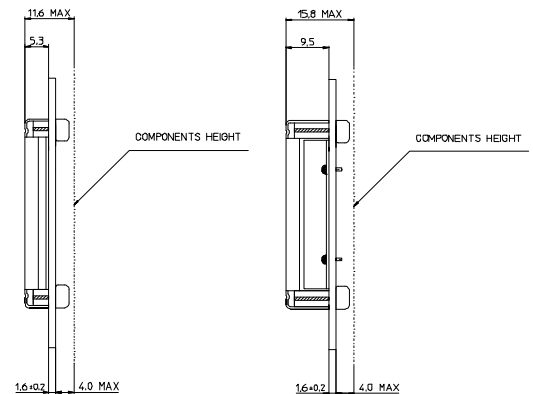
\* test pattern : check board pattern

■ Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

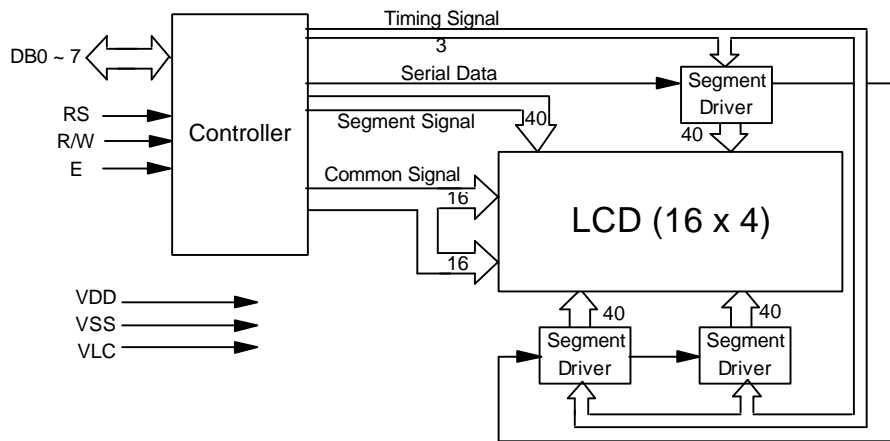
Reflective/EL Backlight

LED Backlight





■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

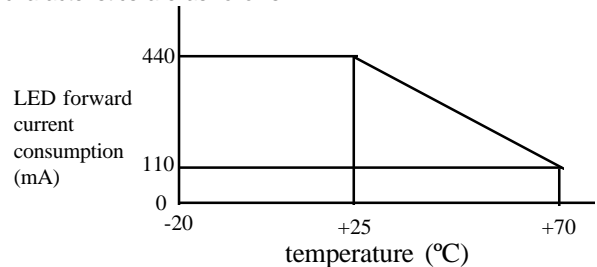
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	440	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	1.9	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

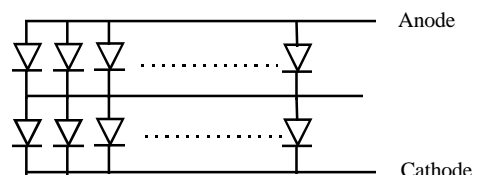
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 220\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 220\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 220\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 220\text{mA}^*$	150	170	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 22 = 44 pcs

■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage Humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	40 min.	cd/m <sup>2</sup>
	Sinew ave	50 typ.	
Current	100V, 400Hz	3.0 typ.	mA
	Sinew ave	4.5 max	
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5A Inverter 25°C, 50%RH	3,500	

3. Suitable Inverter 5A

3.1 Electrical Characteristics

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	350 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	95 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	35 typ	mA

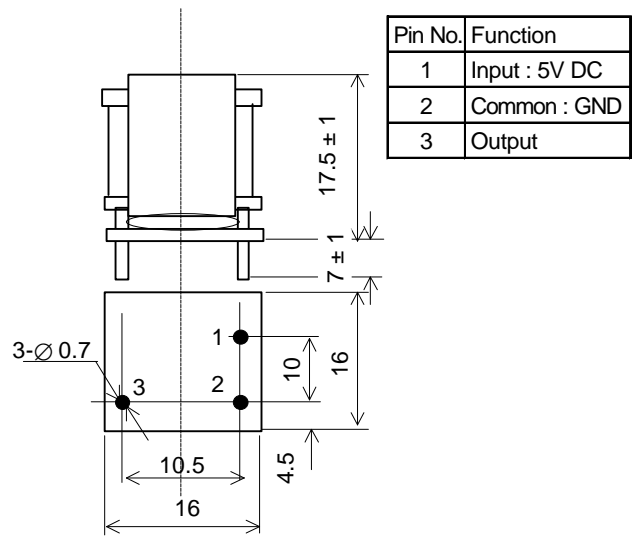
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

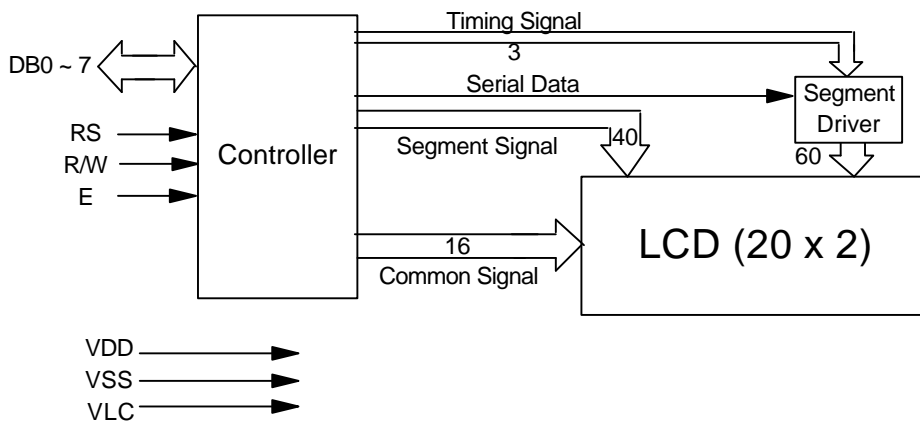
Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)





■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

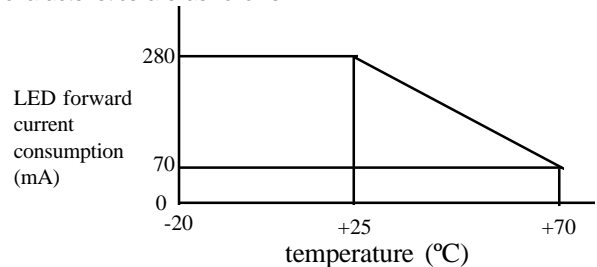
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	280	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	1.23	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

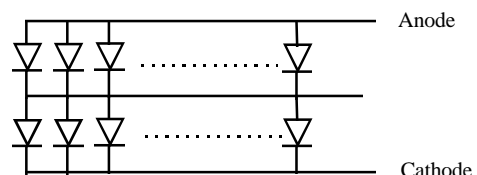
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 120\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 120\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 120\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 120\text{mA}^*$	120	150	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 14 = 28 pcs

■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	0 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	35 min.	cd/m <sup>2</sup>
	Sinew ave	45 typ.	
Current	100V, 400Hz	2.2 typ.	mA
	Sinew ave	3.0 max	
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5A Inverter 25°C, 50%RH	4,000	

3. Suitable Inverter 5A

3.1 Electrical Characteristics

(When combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	350 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	95 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5 typ	VDC
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	45 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	35 typ.	cd/m <sup>2</sup>

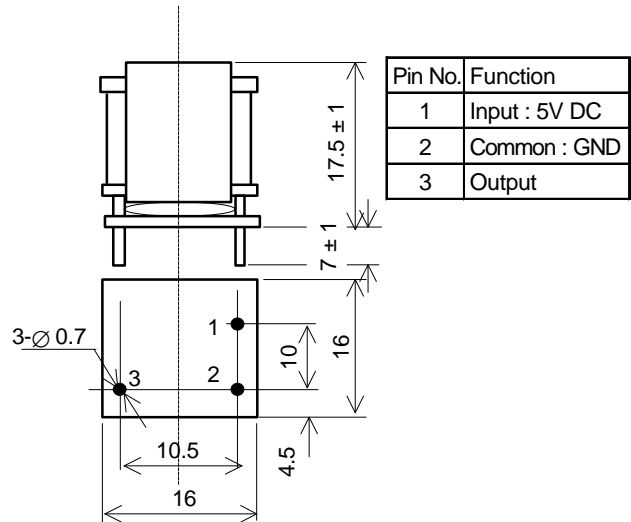
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)



- 20 Characters x 2 line
- 5 x 8 Dot Matrix
- 1/16 Duty
- 5V single Power Supply for Wide Temperature type

■ Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power Supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		V <sub>DD</sub> - 12	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> + 0.3	V
Operating Temp.	Topr		-20	+70	°C
Storage temp.	Tstg		-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

■ Electrical Characteristics

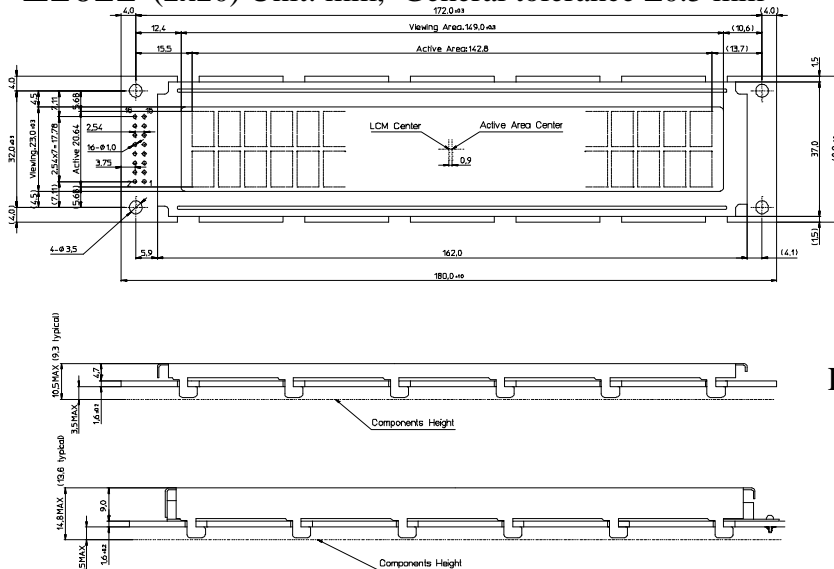
V<sub>DD</sub>=5V±5%, V<sub>SS</sub>=0V, Ta=-20 ~ +70 °C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub> **		4	-	11	V
Input High voltage	V <sub>IH1</sub>		2.2	-	V <sub>DD</sub>	V
	V <sub>IL1</sub>		0	-	0.6	V
Output High voltage	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	-	V
	V <sub>LH1</sub>	-I <sub>OL</sub> =1.2mA	-	-	0.4	V
Current consumption *	I <sub>DD</sub>	Ta=21°C	-	4.2	6***	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.3V	-	2.6	3***	mA
Clock oscillation frequency	fosc	Resistance oscillation	140	220	300	KHz

- \* Test pattern : checker board pattern
- \*\* Operating voltage range of components
- \*\*\* V<sub>LC</sub>=0V, Ta=-20°C

■ Dimensions

L2022 (2x20) Unit: mm, General tolerance ±0.5 mm



Reflective/EL Backlight

LED Backlight

Note : Only dimension changes between Reflective and LED backlight is thickness.

■ Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	180 x 40	mm
Thickness	Reflective	10.5
	LED	14.8
Viewing area (H x V)	149.0 x 23.0	mm
Character size (5x8 dots) (H x V)	6.00 x 9.66	mm
Mounting hole distance (H x V)	172.0 x 32.0	mm
Weight	Reflective	74
	LED backlight	97

■ Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	H : Data register, L : Instruction register
5	R/W	H : Read, L : Write
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
15	( LED + )	Power supply for LED backlight
16	( LED - )	Power supply for LED backlight

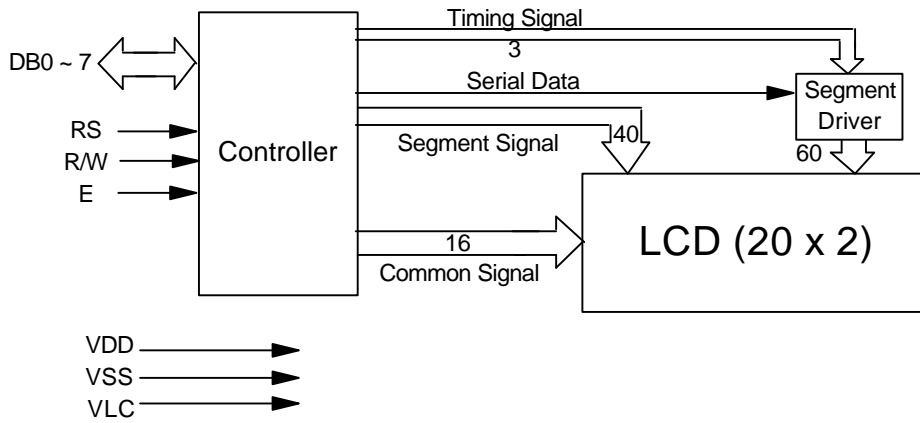
■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.

Vopr = V<sub>DD</sub> - V<sub>LC</sub>

Temperature (°C)	-20	0	+25	+50	+70
Voltage (V)	5.0	4.8	4.7	4.5	4.3

■ Circuit Block diagram



■ Optical Characteristics

Ta=21°C, Vopr=4.7V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$ $F = 0^\circ$	-	-	0	deg.
	$q_2$		60	-	-	
	$q_2 - q_1$		60	-	-	
Contrast	C	$q = 25^\circ, F = 0^\circ$	2	3	-	-
Response time *	ton (rise)	$q = 0^\circ$	-	110	170	msec
	toff (fall)	$F = 0^\circ$	-	70	110	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	380	500	msec
	toff (fall)	Ta = 0°C, Vopr=4.8V	-	250	350	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	2500	3200	msec
	toff (fall)	Ta=-20°C, Vopr=5.0V	-	1000	1300	msec

\* Response time measurement

Use a transmissive standard panel with a display area of 1 cm<sup>2</sup> to measure the response time

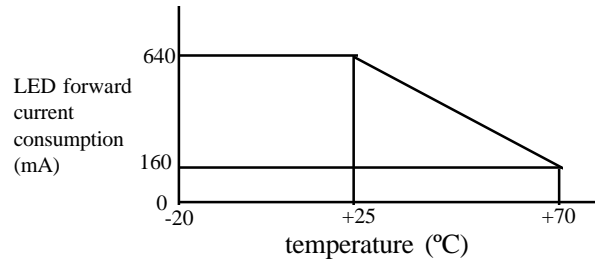
■ LED Backlight

1. Absolute Maximum Ratings

Ta=25°C

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	640	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	2.7	W
Operating temperature	$T_{opr}$	- 20 to +70	°C
Storage temperature	$T_{stg}$	- 30 to +80	°C

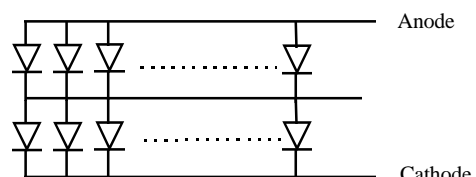
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F=320mA$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R=8V$	-	-	3.2	mA
Peak emitting wavelength	$\lambda_P$	$I_F=320mA$	-	567	-	nm
Spectral half-width	$\delta\lambda$	$I_F=320mA$	-	30	-	nm
Brightness	L	$I_F=320mA$	40	-	-	cd/m <sup>2</sup>

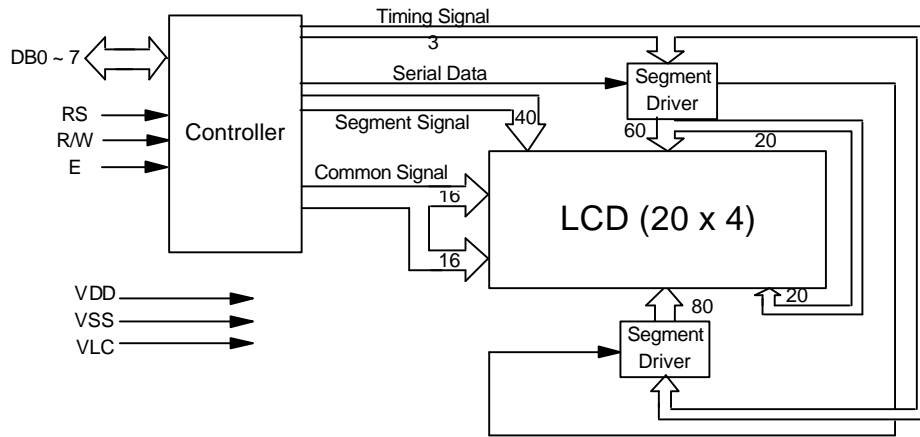


total number of LED chips = 2 x 32 = 64pcs





■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

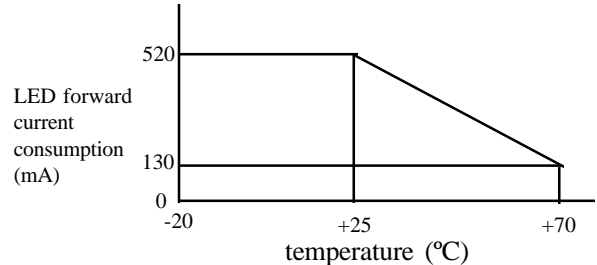
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	520	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	2.28	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

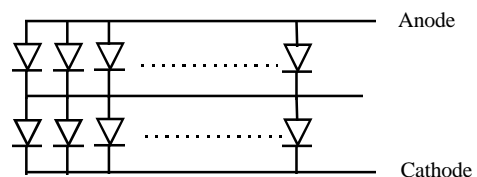
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 260\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 260\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 260\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 260\text{mA}^*$	120	170	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 26 = 52 pcs

■ EL Backlight

1. Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	35 min.	cd/m <sup>2</sup>
	Sinew ave	45 typ.	
Current	100V, 400Hz	3.0 typ.	mA
	Sinew ave	4.5 max	
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5A Inverter 25°C, 50%RH	3,500	

3. Suitable Inverter 5A

3.1 Electrical Characteristics

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	350 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	95 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	45 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	35 typ.	cd/m <sup>2</sup>

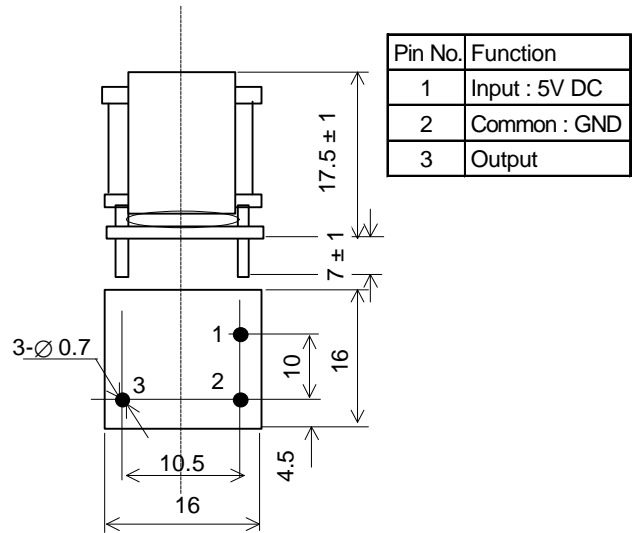
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)



- 24 Characters x 2 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

■ Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

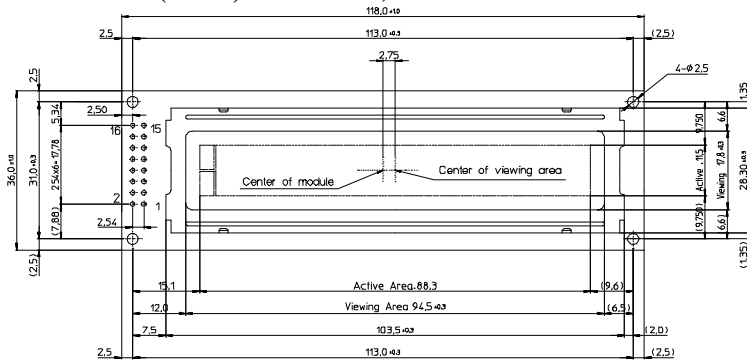
■ Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	118.0 x 36.0	mm
Thickness	Reflective/EL	11.3
	LED	15.8
Viewing area (H x V)	94.5 x 17.8	mm
Character size with cursor (H x V)	3.20 x 5.55	mm
Mounting hole distance (H x V)	113.0 x 31.0	mm
Weight	Reflective	40
	EL backlight	45
	LED backlight	60

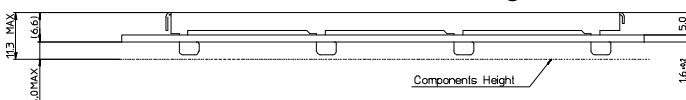
H : Horizontal, V : Vertical

■ Dimensions

L2432 (2x24) Unit: mm, General tolerance ±0.5 mm



Reflective/EL Backlight



■ Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

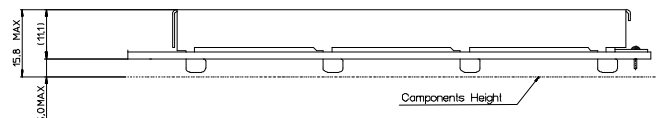
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>OL1</sub>	-I <sub>OL</sub> =1.2mA	-	0.4	V
Current consumption *						
Normal Temp. type	I <sub>DD</sub>	Ta=25°C	-	1.6	3.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	0.4	1.2	mA
Wide Temp. type	I <sub>DD</sub>	Ta=25°C	-	2.5	4.0	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	0.6	1.2	mA

\* test pattern : check board pattern

■ Pin Function

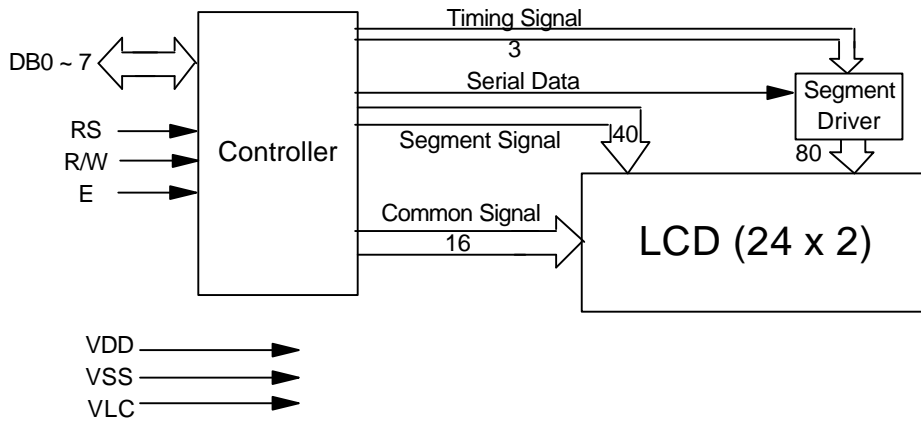
No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

LED Backlight



Note : Only dimension changes between Reflective/EL and LED backlight is thickness.

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

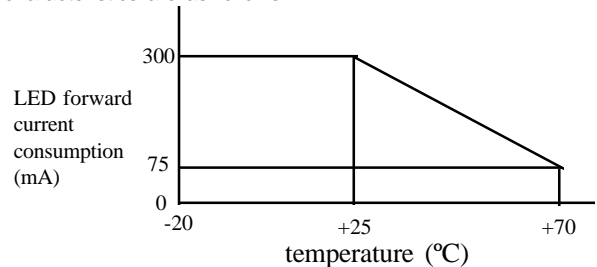
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	300	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	1.3	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

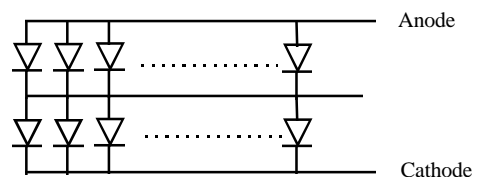
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 150\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	1.5	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 150\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 150\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 150\text{mA}^*$	40	50	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 15 = 30 pcs

**■ EL Backlight**

**1. Absolute Maximum Ratings**

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

**2. Brightness, Current, Life Characteristics**

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	35 min.	cd/m <sup>2</sup>
	Sinew ave	45 typ.	
Current	100V, 400Hz	2.2 typ.	mA
	Sinew ave	3.0 max	
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5A Inverter 25°C, 50%RH	4,000	

**3. Suitable Inverter 5A**

**3.1 Electrical Characteristics**

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	350 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	95 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	1.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	45 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	35 typ.	cd/m <sup>2</sup>

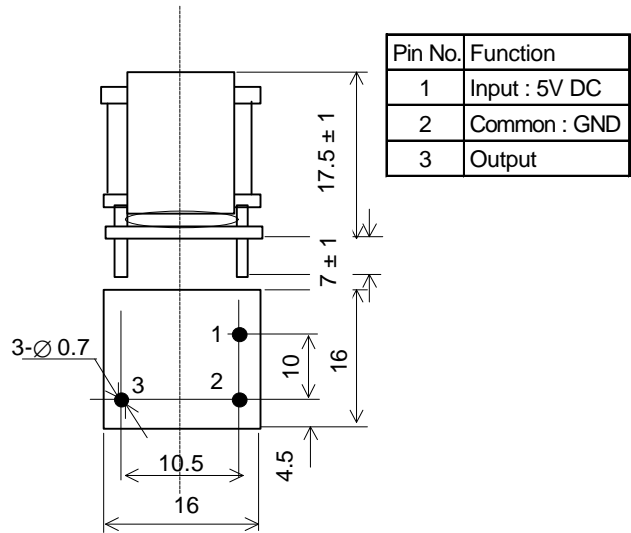
**3.2 Tolerance (Inverter only)**

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm <sup>2</sup>

**3.3 Maximum Ratings (Inverter only)**

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

**3.4 Inverter Dimensions (unit : mm)**



- 40 Characters x 2 line
- 5 x 7 Dot Matrix + Cursor
- 1/16 Duty
- 5V single Power Supply
- Available in EL and LED Backlight type

■ Absolute Maximum Ratings

V<sub>SS</sub>=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		-0.3	6.0	V
	V <sub>LC</sub>		-0.3	V <sub>DD</sub>	V
Input voltage	V <sub>in</sub>		-0.3	V <sub>DD</sub> +0.3	V
Operating temperature					
	Normal	Topr	0	+50	°C
	Wide	Topr	-20	+70	°C
Storage temperature					
	Normal	Tstg	-20	+60	°C
	Wide	Tstg	-30	+80	°C
Storage humidity		< 48 hrs	+20	+85	%RH
		<1000 hrs	+20	+65	%RH

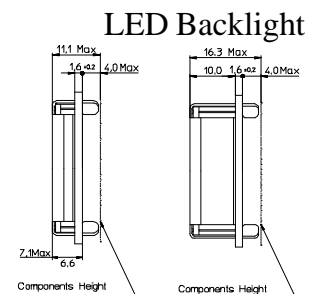
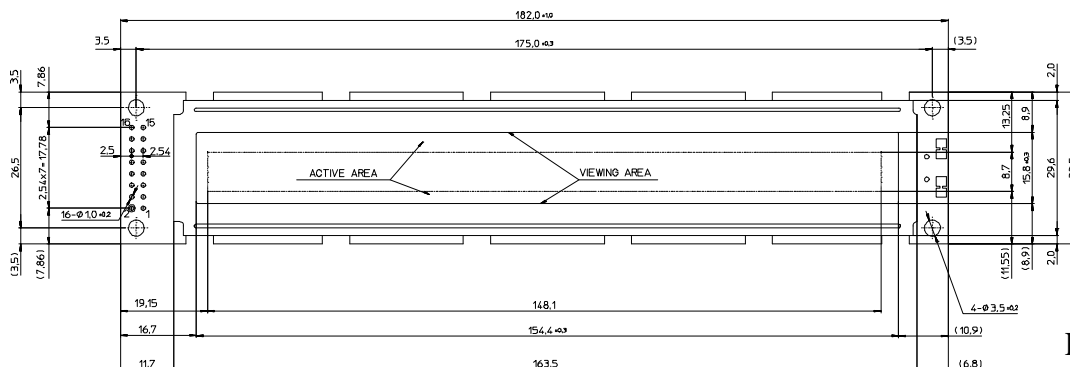
■ Mechanical Characteristics

Item	Specifications	Unit
Module size (H x V)	182.0 x 33.5	mm
Thickness	Reflective/EL	11.3
	LED	16.3
Viewing area (H x V)	154.4 x 15.8	mm
Character size with cursor (H x V)	3.20 x 5.55	mm
Mounting hole distance (H x V)	175.0 x 26.5	mm
Weight	Reflective	70
	EL backlight	75
	LED backlight	95

H : Horizontal, V : Vertical

■ Dimensions

L4042 (2x40) Unit: mm, General tolerance ±0.5 mm



Reflective/EL Backlight

■ Electrical Characteristics

V<sub>DD</sub>=5V± 5%, V<sub>SS</sub>=0V, Ta=0 ~ 50°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
	V <sub>DD</sub> - V <sub>LC</sub>		3.0	-	6.3	V
Input voltage	High	V <sub>IH1</sub>	2.2	-	V <sub>DD</sub>	V
	Low	V <sub>IL1</sub>	0	-	0.6	V
Output voltage	High	V <sub>OH1</sub>	-I <sub>OH</sub> =0.205mA	2.4	-	V
	Low	V <sub>OL1</sub>	-I <sub>OL</sub> =1.2mA	-	-	V
Current consumption *						
Normal Temp. type	I <sub>DD</sub>	Ta=25°C	-	3.0	4.5	mA
	I <sub>LC</sub>	V <sub>LC</sub> =0.25V	-	1.0	1.5	mA
Wide Temp. type	I <sub>DD</sub>	Ta=25°C	-	2.5	3.5	mA
	I <sub>LC</sub>	V <sub>LC</sub> =-0.6V	-	1.1	1.8	mA

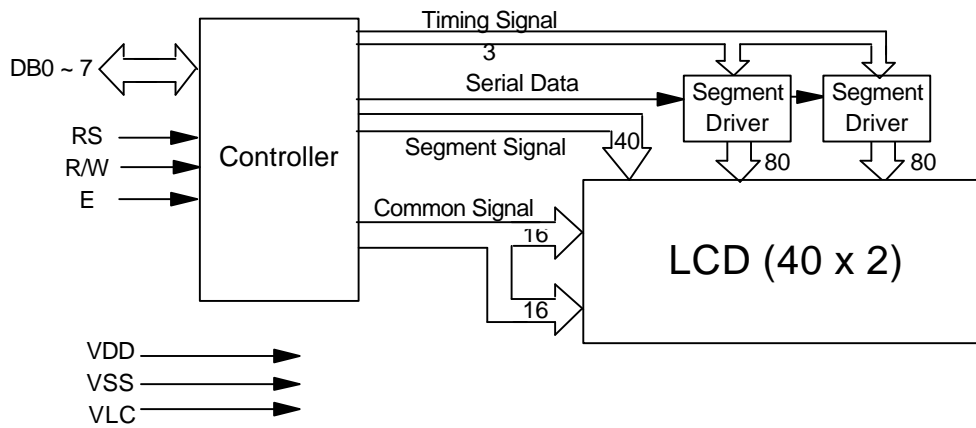
\* test pattern : check board pattern

■ Pin Function

No.	Name	Function
1	VSS	GND
2	VDD	Power supply voltage +5V
3	VLC	Liquid crystal driving voltage
4	RS	L : Instruction code input H : Data input
5	R/W	L : Data write from MPU to LCM H : Data read from LCM to MPU
6	E	Enable
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
( 15 )	A	Anode (+) for LED backlight
( 16 )	K	Cathode (-) for LED backlight

Note : Only dimension changes between Reflective/EL and LED backlight is thickness.

■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.  $V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{V}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{V}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

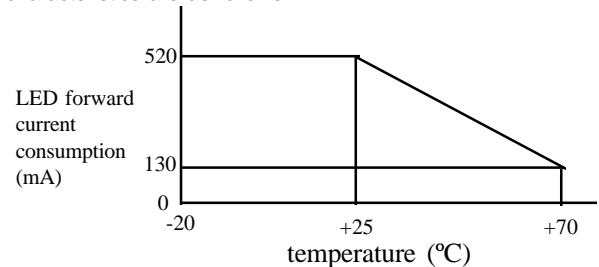
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	520	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	2.3	W
Operating Temperature	$T_{opr}$	-20 ~ +70	°C
Storage Temperature	$T_{stg}$	-40 ~ +80	°C

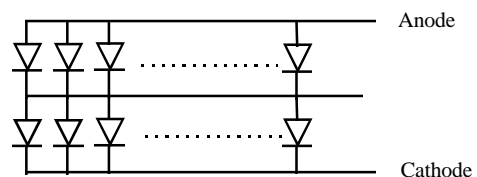
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 260\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 260\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 260\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 260\text{mA}^*$	120	150	-	cd/m <sup>2</sup>



total number of LED chips = 2 x 26 = 52 pcs

**■ EL Backlight**

**1. Absolute Maximum Ratings**

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

**2. Brightness, Current, Life Characteristics**

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz Sinew ave	30 min. 40 typ.	cd/m <sup>2</sup>
Current	100V, 400Hz Sinew ave	4.0 typ. 5.0 max	mA
Life	100V, 400Hz, Sinew ave 25°C, 50%RH	1,500	hrs
	Using 5C Inverter 25°C, 50%RH	4,000	

**3. Suitable Inverter 5C**

**3.1 Electrical Characteristics**

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	480 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	105 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	3.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5	VDC
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	25 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	45 typ.	cd/m <sup>2</sup>

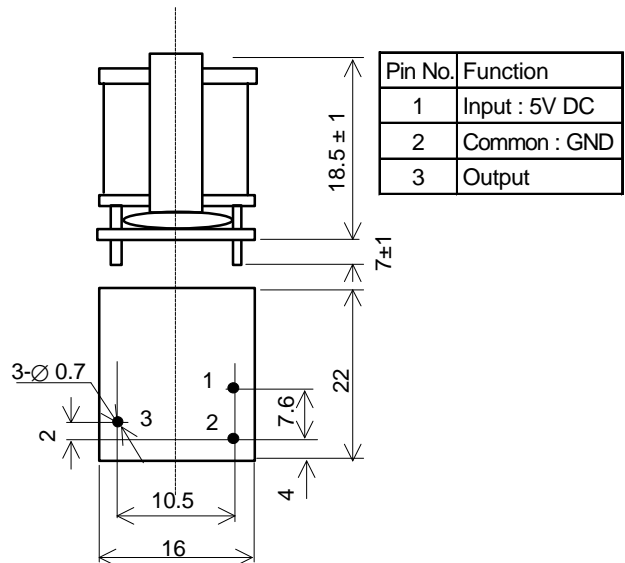
**3.2 Tolerance (Inverter only)**

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm <sup>2</sup>

**3.3 Maximum Ratings (Inverter only)**

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

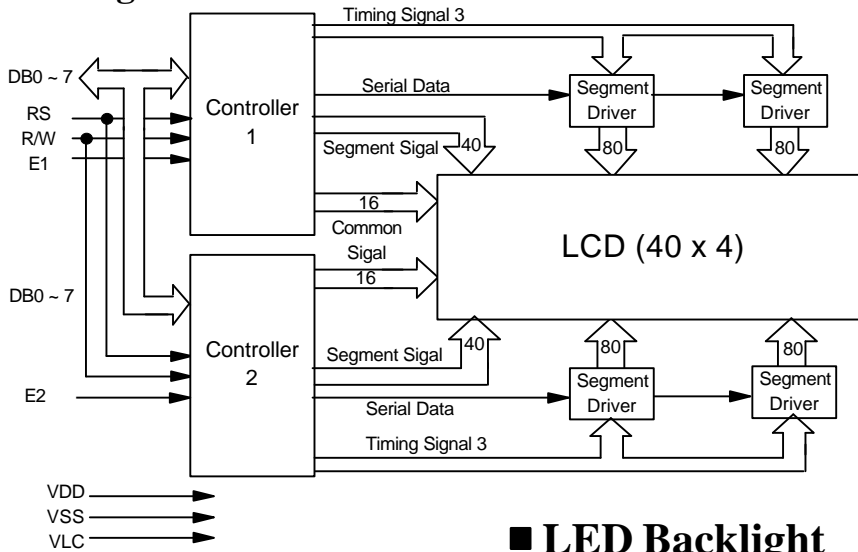
**3.4 Inverter Dimensions (unit : mm)**







■ Circuit Block diagram



■ Recommended Operating Voltage

The recommended value (Vopr) for an ambient temperature is as follows.

$V_{opr} = V_{DD} - V_{LC}$

Temperature (°C)	-20	0	+25	+50	+70
Vopr (V)	Normal	-	5.00	4.75	4.50
	Wide	6.20	5.90	5.60	5.40

■ Optical Characteristics

1. Normal Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = 4.75\text{V}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$		70	-	-	
Contrast	C	$q = +25^\circ, F = 0^\circ$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ$	-	150	200	msec
	toff (fall)	$F = 0^\circ$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.0\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

2. Wide Temperature Range Type

$T_a = 21^\circ\text{C}$ , 1/16 Duty,  $V_{opr} = V_{DD} - V_{LC}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	$q_1$	$C \geq 2$	-	-	-15	deg.
	$q_2$	$F = 0^\circ$	55	-	-	
	$q_2 - q_1$	$V_{opr} = 5.6\text{v}$	70	-	-	
Contrast	C	$q = +20^\circ, F = 0^\circ$ $V_{opr} = 5.6\text{v}$	-	5	-	-
Response time	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	150	200	msec
	toff (fall)	$T_a = 21^\circ\text{C}, V_{opr} = 5.6\text{V}$	-	200	220	msec
	ton (rise)	$q = 0^\circ, F = 0^\circ$	-	750	800	msec
	toff (fall)	$T_a = 0^\circ\text{C}, V_{opr} = 5.9\text{V}$	-	600	700	msec

Measuring equipment : Canon illuminater LC-4SR

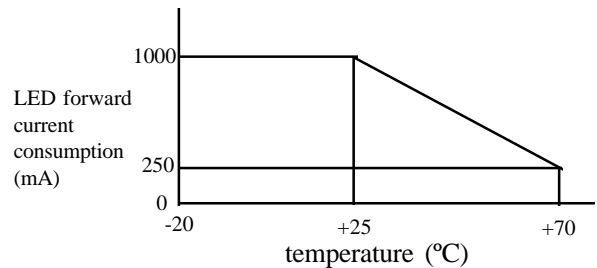
■ LED Backlight

1. Absolute Maximum Ratings

$T_a = 25^\circ\text{C}$

Item	Symbol	Specifications	Unit
LED forward current consumption *	$I_F$	1000	mA
LED reverse voltage	$V_R$	8	V
Allowable loss	$P_D$	4.4	W
Operating Temperature	$T_{opr}$	- 20 ~ +70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	- 40 ~ +80	$^\circ\text{C}$

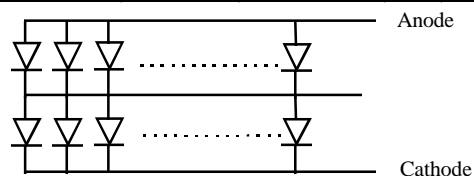
\* LED forward current consumption and operating temperature characteristics are as follows.



2. Electrical Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	$V_F$	$I_F = 500\text{mA}$	3.8	4.1	4.4	V
LED reverse current	$I_R$	$V_R = 8\text{V}$	-	-	0.2	mA
Peak emitting wavelength	$\lambda_R$	$I_F = 500\text{mA}^*$	-	570	-	nm
Spectral half-width	$\Delta\lambda$	$I_F = 500\text{mA}^*$	-	30	-	nm
Brightness	L	$I_F = 500\text{mA}^*$	120	170	-	$\text{cd}/\text{m}^2$



total number of LED chips = 2 x 50 = 100 pcs

■ EL Backlight

1.Absolute Maximum Ratings

Item	Symbol	Standard	Unit
Operating voltage	Vopr	AC 150V, 1KHz Sinew ave	V
Operating temperature	Topr	- 10 ~ +50	°C
Storage temperature	Tstg	-20 ~ + 60	°C
Storage humidity		0 ~ 10 % RH (60 °C) 0 ~ 30 % RH (40 °C)	

2. Brightness, Current, Life Characteristics

Item	Conditions	Specifications	Unit
Brightness	100V, 400Hz	30 min.	cd/m <sup>2</sup>
	Sinew ave	35 typ.	
Current	100V, 400Hz	5.8 typ.	mA
	Sinew ave	8.0 max	
Life	100V, 400Hz, Sinew ave 25°C,50%RH	1,500	hrs
	Using 5D Inverter 25°C,50%RH	3,500	

3. Suitable Inverter 5D

3.1 Electrical Characteristics

(When combined with EL lamp)

Ta=25°C

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f <sub>INV</sub>	V <sub>IN</sub> =5VDC	350 typ.	Hz
Output voltage	V <sub>OUT</sub>	V <sub>IN</sub> =5VDC	130 typ.	V
Output current	I <sub>OUT</sub>	V <sub>IN</sub> =5VDC	5.5 typ.	mA
Input current voltage	V <sub>IN</sub>		5	V <sub>rms</sub>
	I <sub>IN</sub>	V <sub>IN</sub> =5VDC	80 typ	mA
Initial brightness	B	V <sub>IN</sub> =5VDC	45 typ.	cd/m <sup>2</sup>

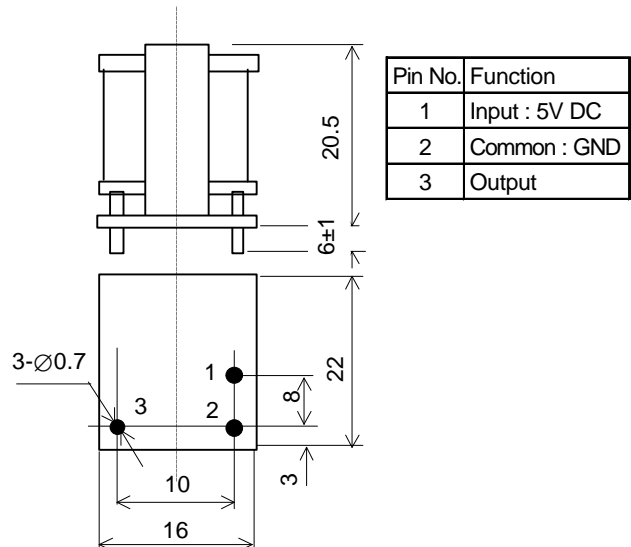
3.2 Tolerance (Inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	35 to 60	cm <sup>2</sup>

3.3 Maximum Ratings (Inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm <sup>2</sup>
Operating temperature	-10 to +60	°C
Storage temperature	-20 to +70	°C

3.4 Inverter Dimensions (unit : mm)

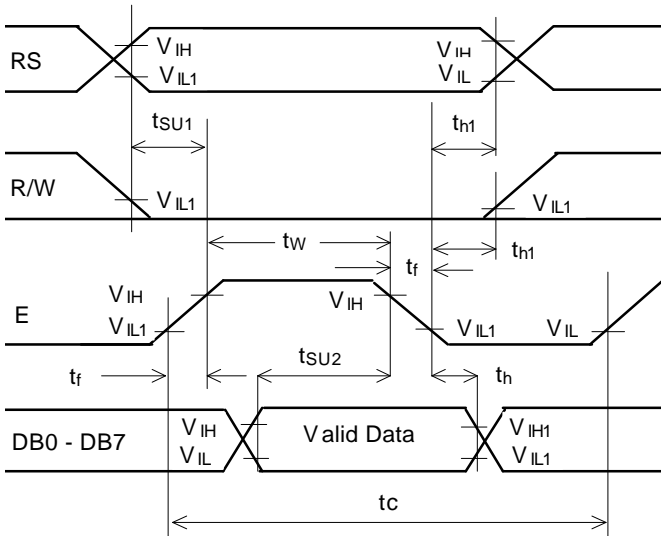


## 1. Timing Characteristics

### 1.1 Write operation

 $V_{DD}=5V \pm 10\%$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ 

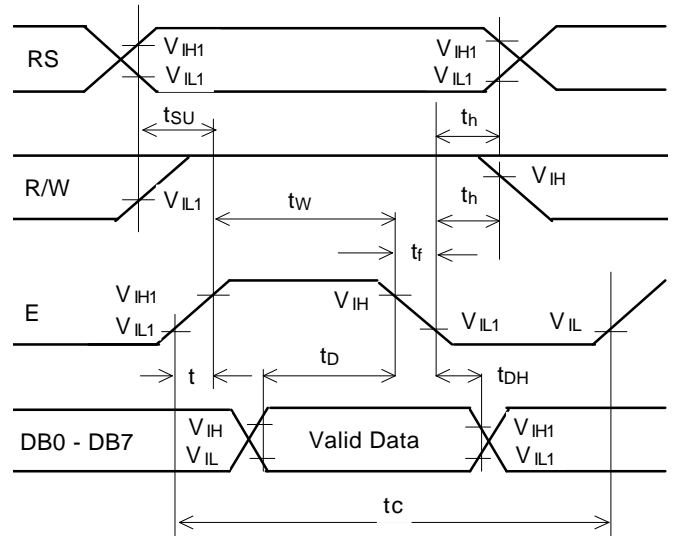
Item	Symbol	Min.	Max.	Unit
Enable cycle time	$t_c$	500	-	ns
Enable rise time	$t_r$	-	25	ns
Enable fall time	$t_f$	-	25	ns
Enable pulse width	$t_w$	220	-	ns
Setup time R/W, RS	$t_{SU1}$	40	-	ns
Hold time R/S, RS	$t_{H1}$	10	-	ns
Data setup time	$t_{SU2}$	60	-	ns
Data hold time	$t_{H2}$	10	-	ns



### 1.2 Read operation

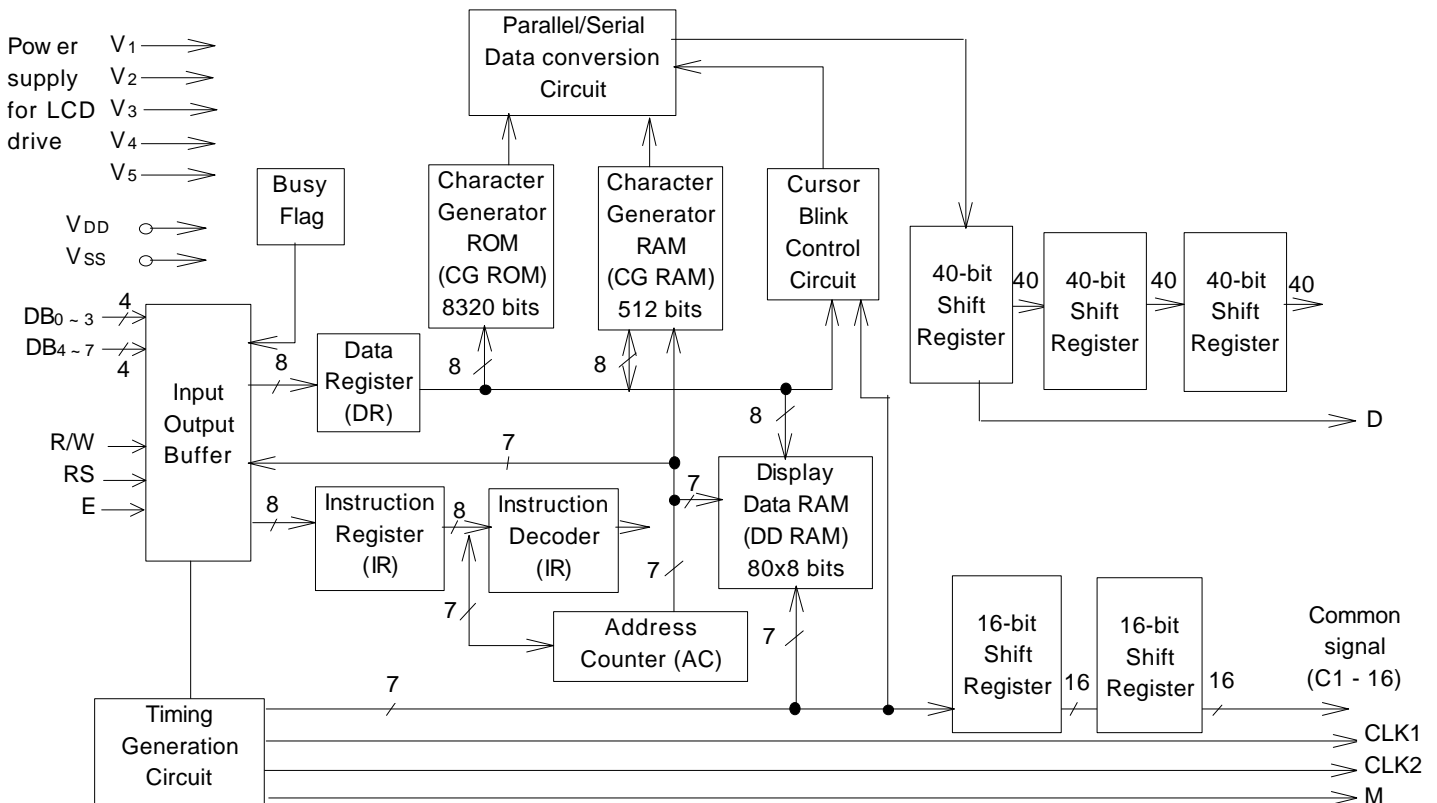
 $V_{DD}=5V \pm 10\%$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ 

Item	Symbol	Min.	Max.	Unit
Enable cycle time	$t_c$	500	-	ns
Enable rise time	$t_r$	-	25	ns
Enable fall time	$t_f$	-	25	ns
Enable pulse width	$t_w$	220	-	ns
Setup time R/W, RS	$t_{SU}$	40	-	ns
Hold time R/S, RS	$t_H$	10	-	ns
Data delay time	$t_D$	-	120	ns
Data hold time	$t_{DH}$	10	-	ns



## 2. Basic Operation

### 2.1 Block Diagram of Controller KS0066



## 2.2 Registers

The controller (KS0066) has two kinds of eight-bit registers; the instruction register (IR) and the data register (DR). They are selected by the register select (RS) signal as shown below table 1. The IR stores instruction codes such as Display Clear and Cursor Home, and the address information of display data RAM (DD RAM) and character generator RAM (CG RAM). They can be written from the MPU, but can not be read to the MPU. The DR temporarily stores data to be written into DD RAM or CG RAM, or data read from DD RAM or CG RAM. For data write, the data written into the DR from the MPU is automatically written into DD RAM or CG RAM by internal operation. For data read, when the data address is written into the IR, the specified data is read out to the DR by internal operation. Then the MPU reads it from the DR. After the read operation, the next address is set and DD RAM or CG RAM data at the address is read into the DR for the next read operation.

Table 1 Register Selection

RS	R/W	Operation
0	0	IR selection, IR write. Internal operation : Display Clear, Cursor Home, etc
0	1	Busy flag (DB7) and address counter (DB0 to DB6) read
1	0	DR selection, DR write. Internal operation : DR to DD RAM or to CG RAM
1	1	DR selection, DR read. Internal operation : DD RAM or CG RAM to DR

## 2.3 Busy Flag (BF)

The busy flag indicates whether the module is ready to accept the next instruction. As shown in table, the signal is output to DB7, if RS=0 and R/W=1. If the busy flag is 0, the next instruction can be written. Therefore, the busy flag status needs to be checked before executing an instruction. To execute an instruction without checking the flag status, wait for more than the execution time of prior instruction. For the execution time of each instruction, see section 3 "Instruction Outline".

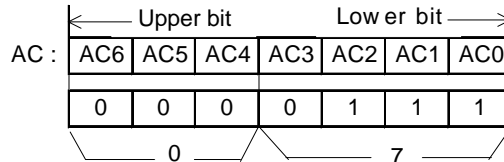
## 2.4 Address Counter (AC)

The address counter specifies an address when data is written into DD RAM or CG RAM and when the data stored in DD RAM or CG RAM is read out. If an address Set instruction (for DD RAM or CG RAM) is written into IR, the address information is transferred from the IR to the AC. When display data is written into or read from DD RAM or CG RAM, the AC is automatically incremented or decremented by one according to the Entry Mode Set. The contents of the AC are output to DB0 to DB6 if RS=0 and R/W=1 as shown in table 1.

## 2.5 Display Data RAM (DD RAM)

DD RAM has a capacity of up to 80 x 8 bits and stores display data of 80 eight-bit character codes. Some storage areas of DD RAM that are not used for display can be used as general data RAM. A DD RAM address to be set in the AC is expressed in hexadecimal form as follows. Example : DD RAM address "07"

The correspondence between the DD RAM address and the display digits of the LCD panel is described in the followings.



## 2.6 Address Location

The DD RAM address and the display digit of the LCD panel correspond as follows for LCD modules driven by 1/16 duty and one controller can display maximum 80 characters.

	1	2	3	.....	15	16	17	18	19	20	.....	38	39	40	Display digit
Line 1	00	01	02	.....	0E	0F	10	11	12	13	.....	25	26	27	DD RAM
Line 2	40	41	42	.....	4E	4F	50	51	52	53	.....	65	66	67	address (HEX)

When the display digits are less than 40, the display begins at the head positions of the two lines. In this case, first line end address and the second line start address are not consecutive.

### 2.6.1 M1641

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47	DD RAM address (HEX)

Note : This is initialised as a 2 line display because of no LCD driver. Character No.9 must be addressed as first position of 2nd line, which is 40 (HEX).

### 2.6.2 M1632, L1642, L1652

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	address (HEX)

### 2.6.3 L1614

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	DD RAM
Line 3	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	address (HEX)
Line 4	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	DD RAM

Consequently, the end address of line 1 and the start address of line 3 are consecutive. Also, the end address of line 2 and the start address of line 4 are consecutive. The DD RAM address 00H to 27H are displayed in line 1 and line 3 and 40H to 67H in line 2 and line 4 by executing Display Shift.

## 2.6.4 L2012, L2022

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	address (HEX)

## 2.6.5 L2014

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	DD RAM
Line 3	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27	address (HEX)
Line 4	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67	address (HEX)

Consequently, the end address of line 1 and the start address of line 3 are consecutive. Also, the end address of line 2 and the start address of line 4 are consecutive. The DD RAM address 00H to 27H are displayed in line 1 and line 3 and 40H to 67H in line 2 and line 4 by executing Display Shift.

## 2.6.6 L2432

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	address (HEX)

## 2.6.3 L4042

	1	2	3	-----	15	16	17	18	19	20	-----	38	39	40	Display digit
Line 1	00	01	02	-----	0E	0F	10	11	12	13	-----	25	26	27	DD RAM
Line 2	40	41	42	-----	4E	4F	50	51	52	53	-----	65	66	67	address (HEX)

## 2.6.4 M4024

	1	2	3	-----	15	16	17	18	19	20	-----	38	39	40	Display digit
Line 1	00	01	02	-----	0E	0F	10	11	12	13	-----	25	26	27	DD RAM
Line 2	40	41	42	-----	4E	4F	50	51	52	53	-----	65	66	67	DD RAM
Line 3	00	01	02	-----	0E	0F	10	11	12	13	-----	25	26	27	address (HEX)
Line 4	40	41	42	-----	4E	4F	50	51	52	53	-----	65	66	67	address (HEX)

M4024 has two LCD controllers. Since the capacity for each is 80 characters (40 characters x 2 lines), M4024 can display 160 characters (40 characters x 4 lines) by using two LCD controllers. Line 1 and 2 are activated by E1. Line 3 and 4 are activated by E2. All the four lines cannot be shifted at the same time. Instructions must be written using E1 and E2 to distinguish the upper two lines from the lower two lines.

## 2.7 Character Generator ROM (CG ROM)

CG ROM generates 5x7 dot-matrix character patterns from eight-bit character codes. In LCD modules of 5x7 dot-matrix character pattern, CG generates 192 types of 5x7 characters. Table 2 shows the correspondence between the CG ROM character codes and character patterns of 5x7 dot-matrix.

## 2.8 Character Generator RAM (CG RAM)

CG RAM is used to create character patterns freely by program. Eight types of 5x7 dot-matrix character patterns can be written into a CG RAM. Table 3 shows the character patterns created from CG RAM addresses and CG RAM data. To display a created character pattern, the character code in the left column of the table is written into DD RAM corresponding to the display position (digit). The areas not used for display are available as general data RAM.

## 2.9 Cursor/Blink Control Circuit

The circuit generates the cursor or blink. When the address counter (AC) selects the address of DD RAM, the cursor or the blink appears in the digit corresponding to the address. When the address counter is 08H, a cursor or blink position is in the 9th digit in line 1 as shown below.

The cursor or blink also appears when the character generator RAM (CG RAM) is selected by the address counter. In this case, the cursor or blink position has no meaning.

	AC <sub>6</sub> AC <sub>5</sub> AC <sub>4</sub> AC <sub>3</sub> AC <sub>2</sub> AC <sub>1</sub> AC <sub>0</sub>																
AC	0	0	0	1	0	0	0										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	address (HEX)

Table 2 Correspondence between character codes and character pattern (5x7 dot -matrix)

Upper 4 bits Lower 4 bits	0000	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)														
		(2)													
XXXX0010	(3)														
		(4)													
XXXX0100	(5)														
		(6)													
XXXX0110	(7)														
		(8)													
XXXX1000	(1)														
		(2)													
XXXX1010	(3)														
		(4)													
XXXX1100	(5)														
		(6)													
XXXX1110	(7)														
		(8)													

Table 3 Relation between CG RAM addresses and character codes (DD RAM) and character patterns (CG RAM) (5x7 dot-matrix)

Character Code (DD RAM data)								CG RAM Address								Character Pattern (CG RAM data)																																																																					
7	6	5	4	3	2	1	0	5	4	3	2	1	0	7	6	5	4	3	2	1	0																																																																
← Upper bit				Lower bit →				← Upper bit				Lower bit →				← Upper bit				Lower bit →																																																																	
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Example of character pattern (R) and (¥)  
 \* : don't care bit

- Notes :
- In CG RAM data, "1" corresponds to Selection and "0" to Non-selection on the display.
  - Character code bits 0 to 2 and CG RAM address bits 3 to 5 correspond to each other (three bits, eight bytes).
  - CG RAM address bits 0 to 2 specify a line position for a character pattern, Line 8 of a character pattern is the cursor position where the logical OR of the cursor and CG RAM data is displayed. Set the data of line 8 to "0" to display the cursor. If the data is changed to "1", bit 1 lights, regardless of the cursor.
  - The character pattern column positions correspond to CG RAM data bits 0 to 4 and bit 4 comes to the left end. CG RAM data bits 5 to 7 are not displayed but can be used as general data RAM.
  - When regarding a character pattern from CG RAM, set to "0" all of character code bits 4 to 7. Bits 0 to 2 determine which pattern will be read out. Since bit 3 is not valid, 00H and 08H select the same character.



## 3. Instruction Outline

When MPU controls LCD controller on the LCD module, MPU directly controls only two registers of the controllers; the Instruction Register (IR) and the Data Register (DR). Prior to internal operation start, the controller temporarily stores control information in these registers, so as to interface with various types of MPUs or peripheral control ICs which operate at different speeds from speed of controller internal operation.

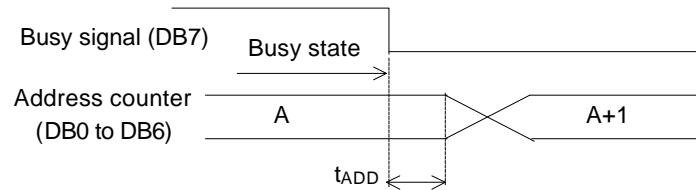
Table 4 shows the instructions and their execution time.

While the controller is executing an instruction and internal operation is in progress, the controller will accept and execute no instruction other than the Busy Flag/Address Read instruction.

Since the busy flag is set to "1" while an instruction is being executed, check the busy flag status and make sure it is "0" before sending an instruction from the MPU to the controller.

To send instructions without checking the busy flag, make sure that the interval between two instructions is much longer than the execution time of the prior instruction.

After the execution of writing/reading data instruction to/from CG/DD RAM, RAM address counter is automatically incremented or decrement by one. This increment/decrement / is executed after the busy flag is set to "0". The time from the fall edge of busy flag to the end of address counter renewal ( $t_{ADD}$ ) is as shown below.



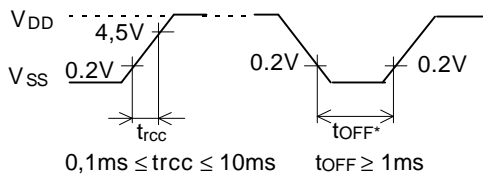
$t_{ADD}$  depends on the clock oscillation frequency ( $f_{osc}$ )

$$t_{ADD} = \frac{1.5(s)}{f_{osc}}$$

## 4. Initialization

### 4.1 Automatic Initialisation

The system is automatically initialised at power-on if the following power supply conditions are satisfied.



$$0,1ms \leq trcc \leq 10ms \quad t_{OFF} \geq 1ms$$

$t_{OFF}^*$  : Time when power supply is OFF if cut instantaneously or turned ON and OFF repeatedly

In automatic initialisation, the following instructions are executed.

- \* Display Clear
- \* Function Set
  - DL = 1 : Interface data length : Eight bits
  - N = 0, F = 0 : 1/8 duty, character font : 5 x 7 dot-matrix
- \* Display ON/OFF control
  - D = 0 : Display OFF
  - C = 0 : Cursor OFF
  - B = 0 : Blink OFF
- \* Entry Mode Set
  - I/D = 1 : Increment
  - S = 0 : No display shift

Since some conditions set by initialisation may not be suitable for the LCD module, execute further Function Set instruction.

The busy flag (BF) is kept busy until initialisation ends. The busy state remains for 20ms after VDD reaches to 4.5V.

If the power supply conditions are not satisfied and automatic initialisation is not executed. Execute initialisation using instruction according to section 4.2, "Initialisation by Instruction".

### 4.2 Initialisation by Instruction

If automatic initialisation is not executed because the power supply conditions are not satisfied, use interface data length of eight bits or four bits instructions shown in table 4 and table 5 to implement initialisation.

Since it is unknown whether the interface data length is set to eight bits or four bits at power on, execute Function Set twice to set the interface data length to eight bits and then set the required interface data length by executing further Function Set instruction.

**Table 4 List of Instruction**

Instruction	Code										Function	Execution time **
	RS	R/W	DB <sub>7</sub>	DB <sub>6</sub>	DB <sub>5</sub>	DB <sub>4</sub>	DB <sub>3</sub>	DB <sub>2</sub>	DB <sub>1</sub>	DB <sub>0</sub>		
(1) Display Clear	0	0	0	0	0	0	0	0	0	1	Clears all display and returns cursor to home position (address 0)	1,64 ms
(2) Cursor Home	0	0	0	0	0	0	0	0	1	*	Returns cursor to home position, shifted display returns to home position and DD RAM contents do not change	1,64 ms
(3) Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets direction of cursor movement and whether display will be shifted when data is written or read	40 μm
(4) Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns ON/OFF total display (D) and cursor (C), and makes cursor position column start blinking (B)	40 μm
(5) Cursor/Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves cursor and shifts display without changing DD RAM contents.	40 μm
(6) Function Set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), the duty (N), and character fonts (F)	40 μm
(7) CG RAM Address Set	0	0	0	1	A <sub>CG</sub>					Sets CG RAM address to start transmitting or receiving CG RAM data		40 μm
(8) DD RAM Address Set	0	0	1	A <sub>DD</sub>					Sets DD RAM address to start transmitting or receiving DD RAM data		40 μm	
(9) BF/Address Read	0	1	BF	AC					Reads BF indicating module in internal operation and AC contents (use for both CG RAM and DD RAM)		0 μm	
(10) Data Write to CG RAM or DD RAM	0	1	Write Data					Writes data into DD RAM or CG RAM		40 μm t <sub>ADD</sub> =6μm		
(11) Data Read from CG RAM or DD RAM	1	1	Read Data					Reads data from DD RAM or CG RAM		40 μm t <sub>ADD</sub> =6μm		

\* : Don't care bit

I/D = 1 : Increment

B = 1 : Blink ON

N = 1 : 1/16 duty

 A<sub>CG</sub> : CG RAM address

I/D = 0 : Decrement

B = 0 : Blink OFF

N = 0 : 1/8 duty or 1/11 duty

 A<sub>DD</sub> : DD RAM address

S = 1 : Display shift

S/C = 1 : Display shift

F = 1 : 5 x 10 dot matrix

S = 0 : No display shift

S/C = 0 : Cursor movement

F = 0 : 5 x 7 dot matrix

D = 1 : Display ON

R/L = 1 : Right shift

BF = 1 : Internal operation in progress

D = 0 : Display OFF

R/L = 0 : Left shift:

BF = 0 : Instruction can be accepted

C = 1 : Cursor ON

DL = 1 : 8 bits

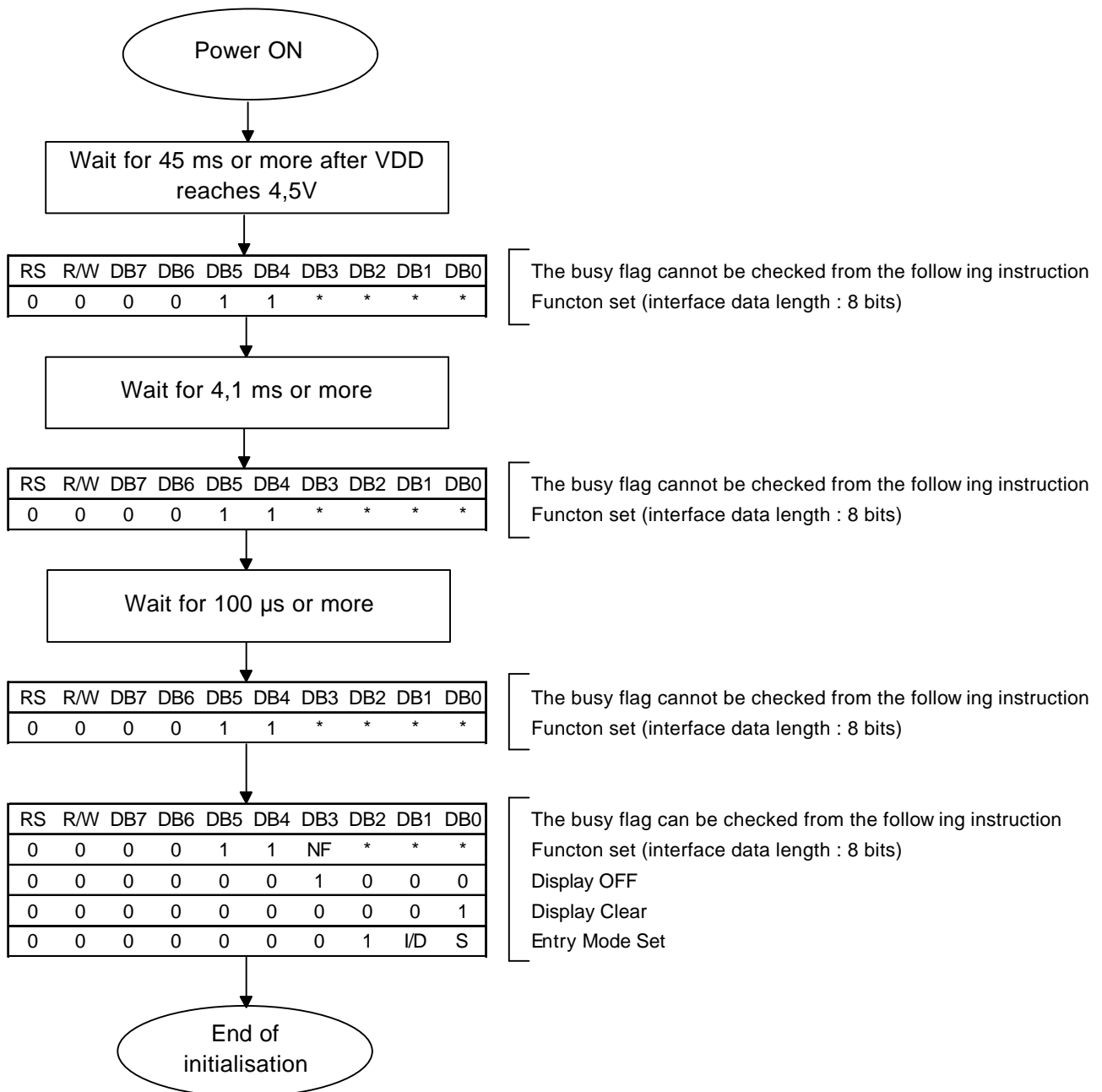
C = 0 : Cursor OFF

DL = 0 : 4 bits

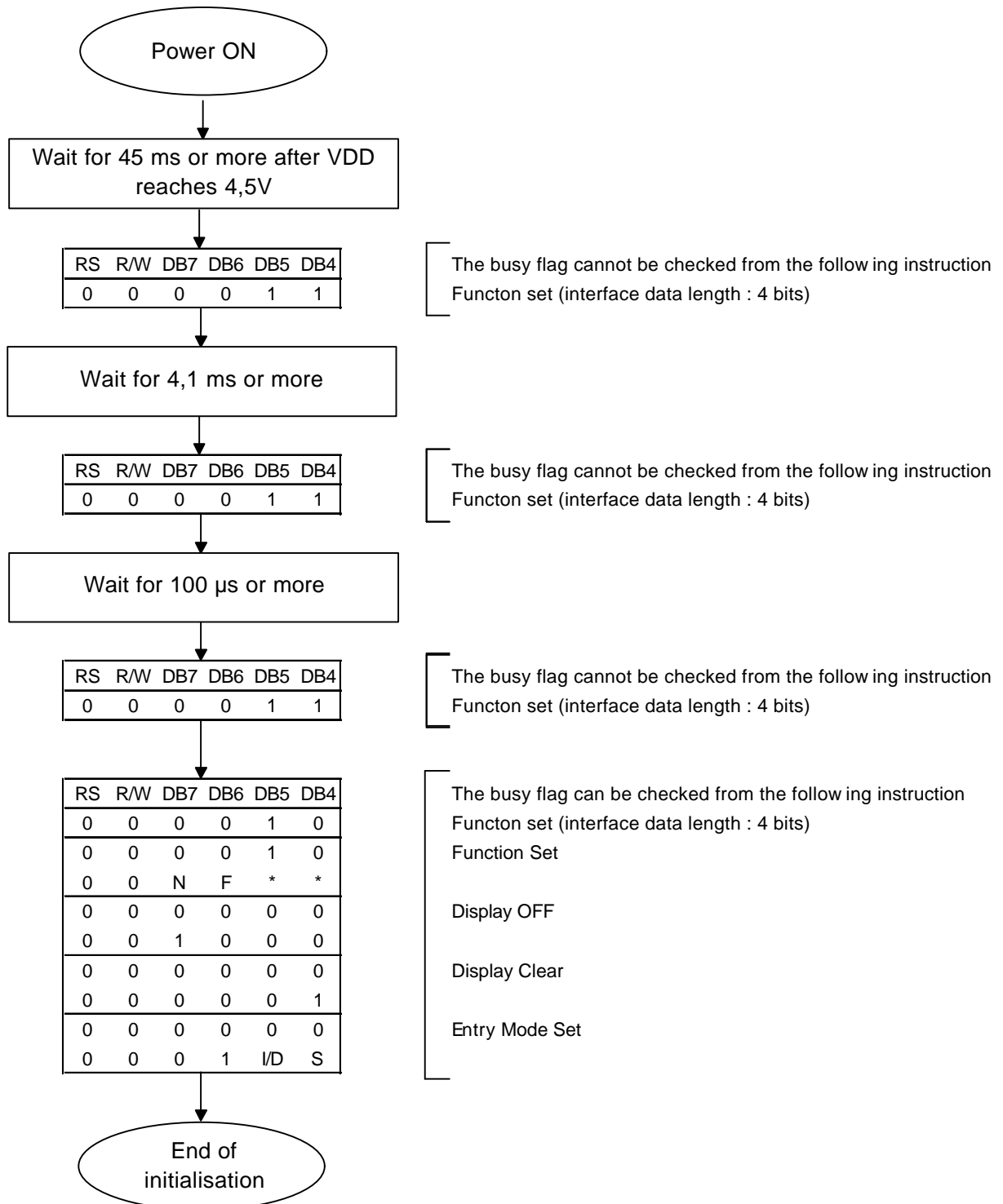
\*\* Execution time in the above Table indicated the maximum value when fosc is 250KHz. It changes when fosc changes.

 When fosc = 270 KHz :  $40 \mu s \times 250 / 270 = 37 \mu s$

**Table 5. Interface Data Length : Eight bits**



**Table 6. Interface Data Length : Four bits**



Note : in M4024, execute initialisation on E1 and E2 respectively

## 5. Instruction Detail

### 2.5.1 Display Clear

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

Display CLEAR clears all display and returns cursor to home position (address 0). Space code 20H is written into all the addresses of DD RAM, and DD RAM address 0 is set to the AC, if it was shifted, the display returns to the original position. The cursor or blink go to the left end on line 1, except M4024. In M4024, if the cursor or blink is on line 3 or line 4, it returns to the left end of line 3. After execution of the Display Clear instruction, I/D = 1 (increment) of Entry Mode is set.

### 2.5.2 Cursor Home

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

CURSOR Home returns cursor to home position (address 0). DD RAM address 0 is set to the AC. The display returns to the original position if it was shifted. The DD RAM contents do not change. If the cursor or blinking is ON, it returns to the left end, except M4024. In M4024, if the cursor or blink on line 3 or line 4, it returns to the left end of line 3.

### 2.5.3 Entry Mode Set

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

ENTRY Mode Set sets the direction of cursor movement and determines whether display is shifted.

I/D :The DD RAM address is incremented or decremented by one when a character code is written into or read from DD RAM. This is also true for writing into or reading from CG RAM.

When I/D = 1, the address is incremented by one and the cursor or blink moves to the right.

When I/D = 0, the address is decremented by one and the cursor or blink moves to the left.

S : If S = 1, the entire display is shifted either to the right or left for writing into DD RAM. The cursor position does not changed only the display moves, There is no display shift for reading form DD RAM.

When S = 1 and I/D = 1, the display shifts one digit to the left after data write to DD RAM.

When S = 1 and I/D = 0, the display shifts one digit to the right after data write to DD RAM.

If S = 0, the display does not shift.

### 2.5.4 Display ON/OFF Control

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

Display ON/OFF Control turns the total display and the cursor ON and OFF, and makes the character on the cursor position start blinking Cursor ON/OFF and blinking is done at the digit indicated by the DD RAM address specified by the AC

D : When D = 1, the display is turned ON

When D = 0, the display is turned OFF

If D = 0 is used, display data remains in DD RAM. Therefore the data can be displayed again by setting D = 1.

C : When C = 1, the cursor is displayed

When C = 0, the cursor is not displayed.

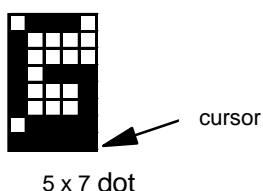
The cursor is displayed in the dot line below the character fonts.

B : When B = 1, the character at the cursor position starts blinking.

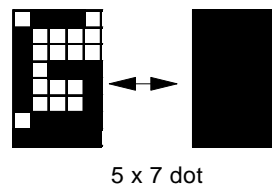
When B = 0, it does not blink.

For blinking, all-black dots and the character are switched about every 0.4 seconds when fosc is 250KHz. The cursor and blinking can be set at the same time.

\* C = 1 (cursor display)



\* B = 1 (blink)



### 2.5.5 Cursor/Display Shift

	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	1	S/C	R/L	*	*

\* : don't care bit

Cursor/Display Shift moves the cursor and shifts the display without changing the DD RAM contents. The cursor position and the AC contents match. This instruction is useful for display correction and retrieval because the cursor position or display can be shifted without writing or reading display data, In a 2-line display, the cursor is shifted from digit 40 (DD RAM address 27) of line 1 to digit 1 of line 2.

Displays of lines 1 and 2 are shifted at the same time Display shift moves the display of each line only horizontally. Therefore, the display pattern of line 2 is not shifted to line 1 and display pattern of line 1 is not shifted to line 2.

Note : M1641 operates internally as 8 characters x 2 line display, L1614 as 32 characters x 2 line-display, L2014 as 40 characters x 2 line-display and M4024 as two 40 characters x 2 line-display. See section 2.6 Address Location.

S/C	R/L	Operation
0	0	The cursor position is shifted to the left (the AC is decremented by one)
0	1	The cursor position is shifted to the right (the AC is incremented by one)
1	0	The entire display is shifted to the left with the cursor
1	1	The entire display is shifted to the right with the cursor

## 2.5.6 Function Set

	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Code	0	0	0	0	1	DL	N	F	*	*	* : don't care bit

Function Set sets the interface data length, the number of display lines and the character font.

DL : Interface data length

When DL = 1, the data length is set at eight bits (DB7 to DB0)

When DL = 0, the data length is set at four bits (DB7 to DB4). In 4-bit interface, the upper four bits are transferred first, then the lower four bits follow.

N : When N = 1, the duty is set to 1/16

When N = 0, the duty is set to 1/8 or 1/11

F : Character font

When F = 1, the character font is set to 5 x 10 dot matrix

When F = 0, the character font is set to 5 x 7 dot matrix.

If N is set to 1, F becomes " Don't care bit"

N	F	Number of display line	Character font	Duty	LCD module
0	0	1	5 x 7	1/8	-
0	1	1	5 x 10	1/11	-
1	*	2	5 x 7	1/16	M1641, M1632, L1642, L1652, L1614, L2012, L2022, L2014, L2432, L4042, M4024

Function Set instruction must be executed prior to all other instructions except Busy Flag/Address Read. If another instruction is executed first, no interface data length is effective.

## 2.5.7 CG RAM Address Set

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

← Upper bit
Lower bit →

CG RAM addresses expressed as binary AAAAAA are set to the AC. The data written from or read to the MPU is for the CG RAM.

## 2.5.8 DD RAM Address Set

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

← Upper bit
Lower bit →

DD RAM address expressed as binary AAAAAA are set to the AC. Then data written from or read to the MPU is for the DD RAM. When N = 0 (one-line display) the addresses are 00H to 4HH. When N=1 (two-line display : M1632, L1642, L1652, L2012, L2022, L2432, L4042), the addresses used for display in line 1 (AAAAAA) are 00H to 27H and those for line 2 (AAAAAA) are 40H to 67H. As for M1641, L1614, L2014 and M4024, see section 2.6 Address Location.

## 2.5.9 Busy Flag/Address Read

	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	1	BF	1	A	A	A	A	A	A

← Upper bit
Lower bit →

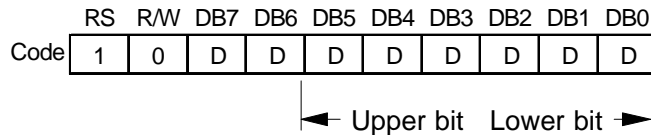
The BF signal is read out, indicating whether the module is working internally because of the previous instruction.

When BF = 1, the module is working internally and the next instruction cannot be accepted until the BF value becomes 0.

When BF = 0, the next instruction can be accepted, Therefore, make sure that BF = 0 before writing the next instruction.

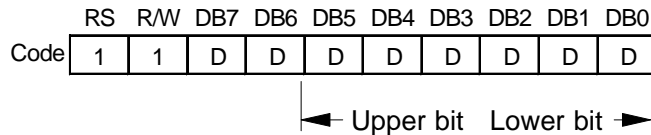
The AC values binary AAAAAA are read out at the same time as the busy flag read. The AC addresses are used for both CG RAM and DD RAM, and the Address Set before the execution of this instruction determines whether the address is for CF RAM or DD RAM.

## 2.5.10 Data Write to CG RAM or DD RAM



Binary eight-bit data DDDDDDDD is written into CG RAM or DD RAM. CG RAM Address Set or DD RAM Address Set before this instruction selects either RAM. After the write operation, the address is incremented or decremented automatically according to Entry Mode Set. Entry Mode Set also determines whether display shifts or not after the write operation.

## 2.5.11 Data Read from CG RAM or DD RAM



Binary eight-bit data DDDDDDDD is read from CG RAM or from DD RAM. CG RAM Address Set or the DD RAM Address Set before this instruction selects either RAM. CG RAM Address Set or the DD RAM Address Set must be executed immediately before this instruction. If no Address Set instruction is executed before a read instruction, the first read data is invalid. Data is normally read from the second time, if read instructions are executed consecutively. For DD RAM, if Cursor Shift instruction is executed just before reading DD RAM, there is no need to execute an Address set instruction because the Cursor Shift instruction does this. After a read operation, the address is automatically incremented or decremented by one according to Entry Mode Set, but the display isn't shifted regardless of Entry Mode set.

Note : The AC is automatically incremented or deremented by one according to Entry Mode Set after Data Write to CG RAM or DD RAM instruction is executed. If a read instruction is executed immediately after this instruction, RAM data specified by the AC is not read out. Correct data is read out under the following conditions.

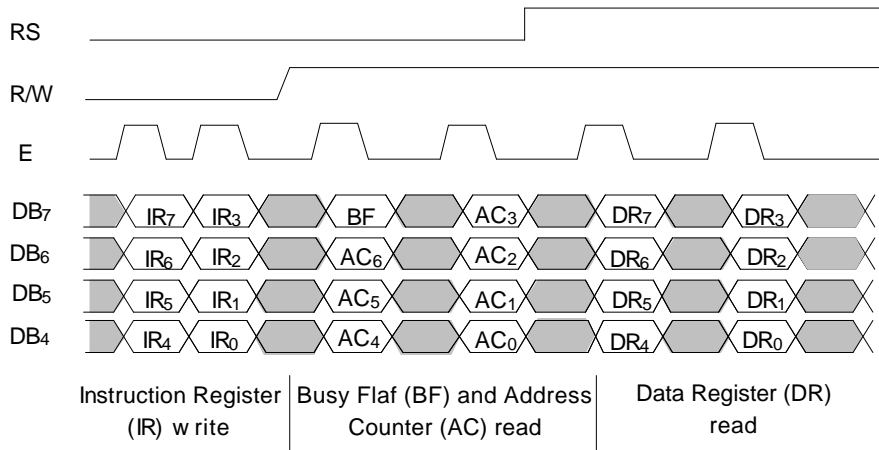
- \* An Address Set instruction is executed immediately before a read instruction
- \* For DD RAM. the Cursor Shift instruction is executed immediately before a read instruction
- \* The second, or later, instruction is executed in consecutive execution of read instructions

## 6. Interfacing to MPU

LCD modules containing controller can interface to both 4-bit and 8-bit MPU

### 6.1 Interface in 4-bit operation

When interface data is 4 bits long, data is transferred using only four buses; DB4 to DB0. DB0 to DB3 are not used. Data transfer between the controller and the MPU ends when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of DB4 to DB7 when interface data is 8 bits long) are transferred first, then lower order 4 bits (content of DB0 to DB3 when interface data is 8 bits long) are transferred. Check the busy flag after 4-bit data has been transferred twice. Then the busy flag and address counter data are read out by two transfers.



### 6.2 Interface in 8-bit operation

When interface data is 8 bits long, data is transferred using the 8 data buses of DB0 to DB7.

