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CHARACTER LCD MODULES

USER'S MANUAL

1. GENERAL

Character Liquid Crystal Display Modules are high-contrast, wide-viewing-angle and low-power-consumption display incorporating CMOS LCD controller. The LCD controller has a built-in character generator ROM/RAM and display data RAM , and all the display functions are controlled by instructions. Therefore the LCD module can easily be interfaced with an MPU. This makes the module applicable to a wide range of purposes including terminal display units for microcomputers and display units for measuring equipment.

The table below shows model names of character LCD modules according to the number of characters displayed. Each model has standard specifications and optional specifications such as built-in LED backlight type, built-in EL backlight type, wide-temperature-range type. Standard specifications and other optional specifications, see the reference page of each model shown in the table below.

Table 1

Number of characters	Model	Reference page
16 chars × 1 line	L1671 Series	6
	L1681 Series	12
16 chars × 2 lines	L1672 Series	18
	L1682 Series	24
	L1692 Series	30
16 chars × 4 lines	L1634 Series	36
20 chars × 2 lines	L2032 Series	42
20 chars × 4 lines	L2034 Series	48
24 chars × 2 lines	L2462 Series	54
40 chars × 1 line	L4051 Series	60
40 chars × 2 lines	L4052 Series	62
40 chars × 4 lines	L4044 Series	68

2. PRECAUTIONS

2.1 Handling the LCD Module

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 glasses.
- If you should swallow the liquid crystal, first, wash your mouth thoroughly with water, then, drink a lot of water and induce vomiting; and then, consult a physician.
- If the liquid crystal should get in your eye, flush your eye 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 modules 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 dose not come off.

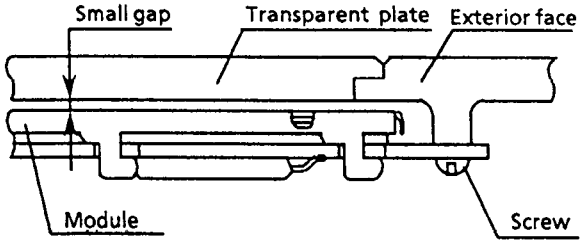
Handling

- Avoid static electricity, as it may damage CMOS LSIs mounted on the module..
- Since the LCD panel has glass substrate, avoid applying mechanical shock or pressure on the module. Do not drop, bend, twist or press the module.
- Do not disassemble the module.
- Since the polarizer is made of easily-scratched material, be careful not to touch or place objects on the display surface.
- Keep the display surface clean. Do not touch it with your skin.

Mounting and design

- Use the specified mounting parts and holes to mount the module.
- Make sure that no stress is applied on the module when it is mounted; stress applied for a long time may damage the LCD panel and the IC substrates.
- Connect a 10-μF capacitor between the power supply terminals to eliminate noise.
- To protect the polarizer and the LCD panel, cover the display surface with a transparent plate (e.g., acrylic or glass) with a small gap between the transparent plate and the display surface.

☆Example



- Do not apply input signals when power supply voltage is not applied.
- Avoid condensation, or the transparent electrodes may break. Use the module within the specified temperature range.

Storage

- Store the module in a dark place, where the temperature is 25±10℃ and the relative humidity below 65%. If possible, store the module in the packaging situation when it was delivered.
- Do not store the module near organic solvents or corrosive gases.
- Keep the module (including accessories) safe from vibration, shock and pressure.
- Use the products within 6 months of receiving it. (For LCD modules with EL backlight)
- Because the EL backlight uses organic materials that are very sensitive to heat and humidity, there may be some loss of quality when stored for long periods of time. Contact SII for further detail.
- Black or white air-bubbles may be produced if the module is stored for a long time in the lower temperature or mechanical shocks are applied onto the module.

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 benzine.
- Do not use ketonic solvents (ketone and acetone) or aromatic solvents (toluene and xylene), as they may damage the polarizer.

2.2 Handling the LED Backlight Unit

- When soldering the connector for LED backlight unit, the soldering iron temperature should not exceed 260°C, and soldering time should be within 3 seconds.
  (L1681, L1672, L1692, L2032, L4051, L4052)
- For cleaning, wipe with soft cloth and use only the following chemicals.
  - Ethanol
  - Isopropyl alcohol

2.3 Mounting of an EL Lamp and an Inverter

- Your design should make it easy to replace EL lamps 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 an EL lamp in an LCD module, push the EL lamp 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 lamp; otherwise the lamp will be damaged by humidity.

3. RELIABILITY

3.1 Reliability Test

(1) Standard type

Test item	Test conditions	Results
High temp. and humidity operation*	40°C ± 2°C 90%RH 500 hours	No abnormalities in functions** and appearance***
High temp. operation*	60°C ± 2°C 500 hours	
Heat shock*	– 20°C⇆ + 60°C : 10 cycles 1 hour at each temp. 5 min. transition	
Low temp. storage*	– 20°C ± 2°C 500 hours	
Vibration	Sweep : 10 Hz to 55 Hz 1 min/cycle Amplitude : 1.5 mm 2 hours in X, Y and Z directions	
Drop shock	Hight : 30 cm Dropped onto a board	

(2) Wide temperature range type

Test item	Test conditions	Results
High temp. and humidity operation*	60°C ± 2°C 90%RH 500 hours	No abnormalities in functions** and appearance***
High temp. operation*	80°C ± 2°C 500 hours	
Heat shock*	– 30°C⇆ + 80°C : 10 cycles 1 hour at each temp. 5 min. transition	
Low temp. storage*	– 30°C ± 2°C 500 hours	
Vibration	Sweep : 10 Hz to 55 Hz 1 min/cycle Amplitude : 1.5 mm 2 hours in X, Y and Z directions	
Drop shock	Hight : 30 cm Dropped onto a board	

* Measurement conditions: Evaluation and judgment of the module should be done two hours after it is returned to room temperature. There should not be any condensation during the test and the ensuing evaluation.

** Current consumption, contrast and display functions

*** Polarizer deterioration and other appearance defects

3.2 LC Panel Life Time

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

- Definition of life time

(1) Contrast reduces to 30% of the initial value.

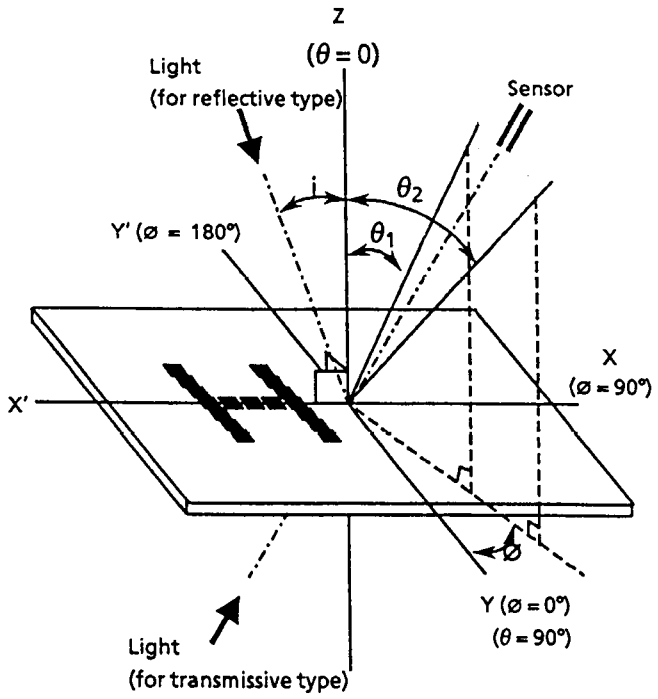
(2) Current consumption becomes three times the initial value.

(3) Orientation deteriorates significantly.

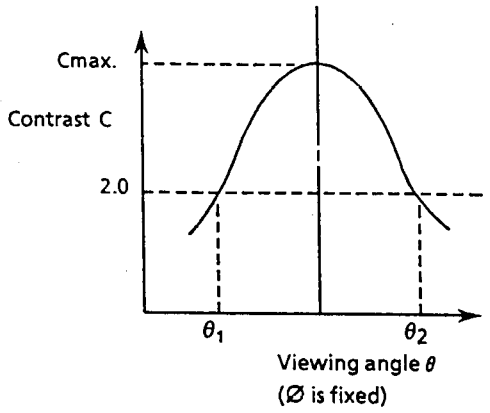
(4) The display malfunctions.

4. DEFINITION OF OPTICAL CHARACTERISTICS TERM

■ Angles Ø and θ



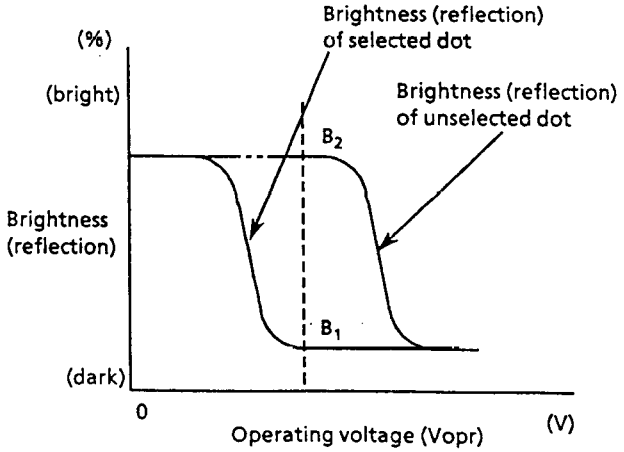
■ Viewing angles θ_1 and θ_2



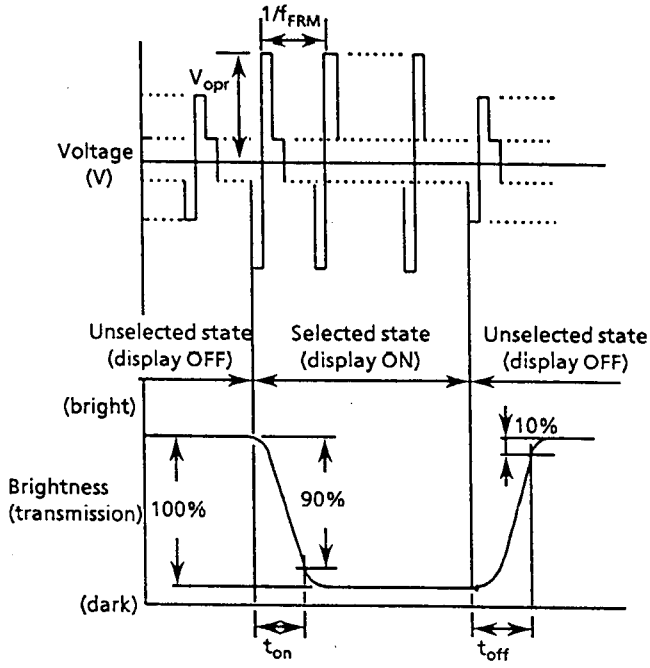
Remark: The optimum viewing angle by visual inspection and angle θ at Cmax do not always match.

■ Contrast C

$$C = \frac{\text{Brightness (reflection) of unselected dot } (B_2)}{\text{Brightness (reflection) of selected dot } (B_1)}$$



■ Response time



V_{opr} : Operating voltage (V)
f_{FRM} : Frame frequency (Hz)
t_{on} : Response time (rise) (ms)
t_{off} : Response time (fall) (ms)

5. SPECIFICATION

■ Features of L1671 Series

- 16 characters × 1 line
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	80.0×36.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	80.0×36.0×15.8	mm
Viewing area (H×V)	64.5×13.8	mm
Character size (5×7 dot, H×V)	3.07×5.73	mm
Dot size (H×V)	0.55×0.75	mm
Dot space	0.08	mm
Center to center dimension of mounting holes (H×V)	75.0×31.0	mm
Weight (Reflective type)	25	g
Weight (Built-in LED backlight type)	35	g
Weight (Built-in EL backlight type)	30	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≦ 48 hrs	+20	+85	%RH
		≦ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		1.5	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	1.5	2.5	mA
		I_{LC}		−	0.2	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

D. Optical Characteristics

D-1 TN LCD module (reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	5	deg.
	θ_2		40	−	−	
	$\theta_2-\theta_1$		35	−	−	
Contrast	C	θ = 30°, ø = 0°	5	8	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	60	70	ms
Response time(fall)	t_{off}		−	150	170	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	210	300	ms
Response time(fall)	t_{off}		−	480	550	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2-\theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

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

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

E-2 STN LCD module (gray)

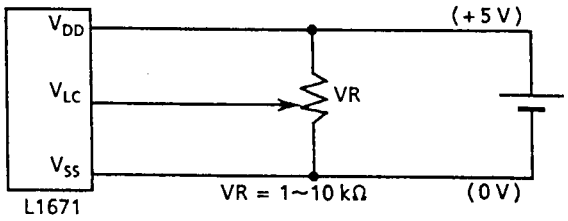
$V_{opr} = V_{DD} - V_{LC}$

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ TN/STN Reflective type

Item	L1671000000	L167100J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C	C
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

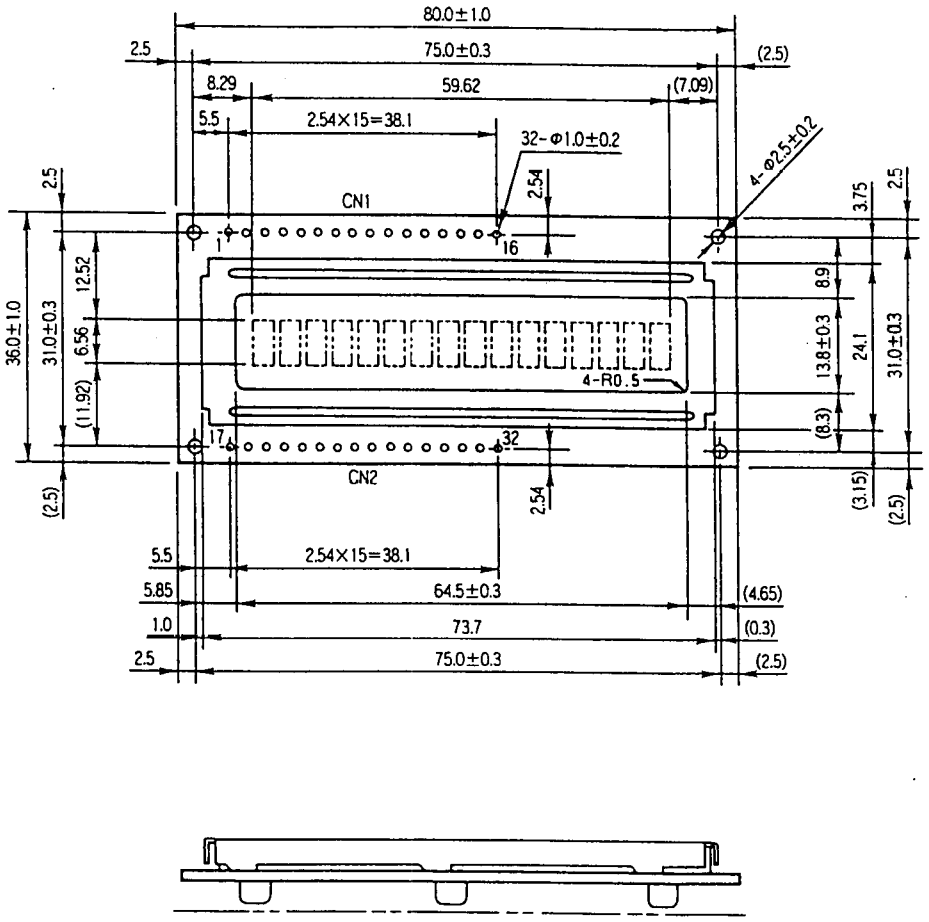
F-1 Power Supply

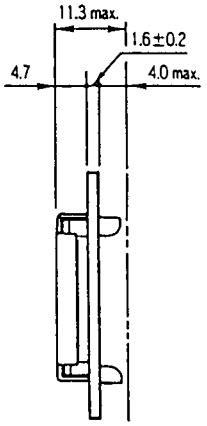


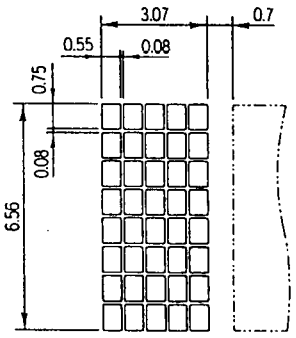
F-2 Dimensions

Unit : mm

General tolerance : ±0.5



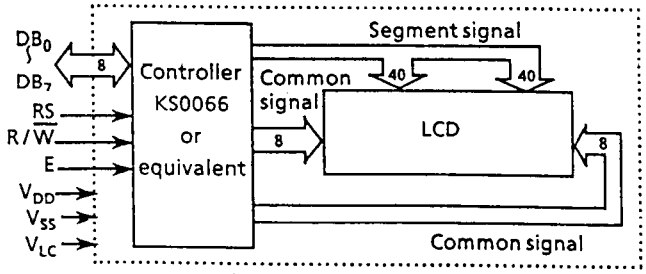




F-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

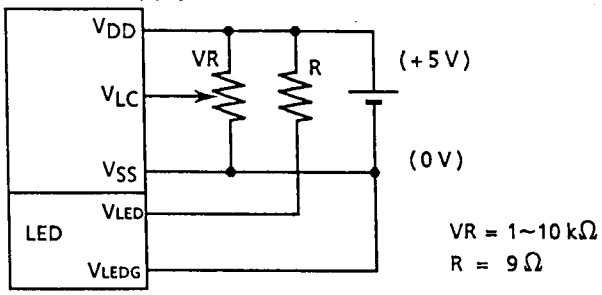
F-4 Block Diagram



■ **STN Transflective, Built-in LED Backlight type**

Item	L1671B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

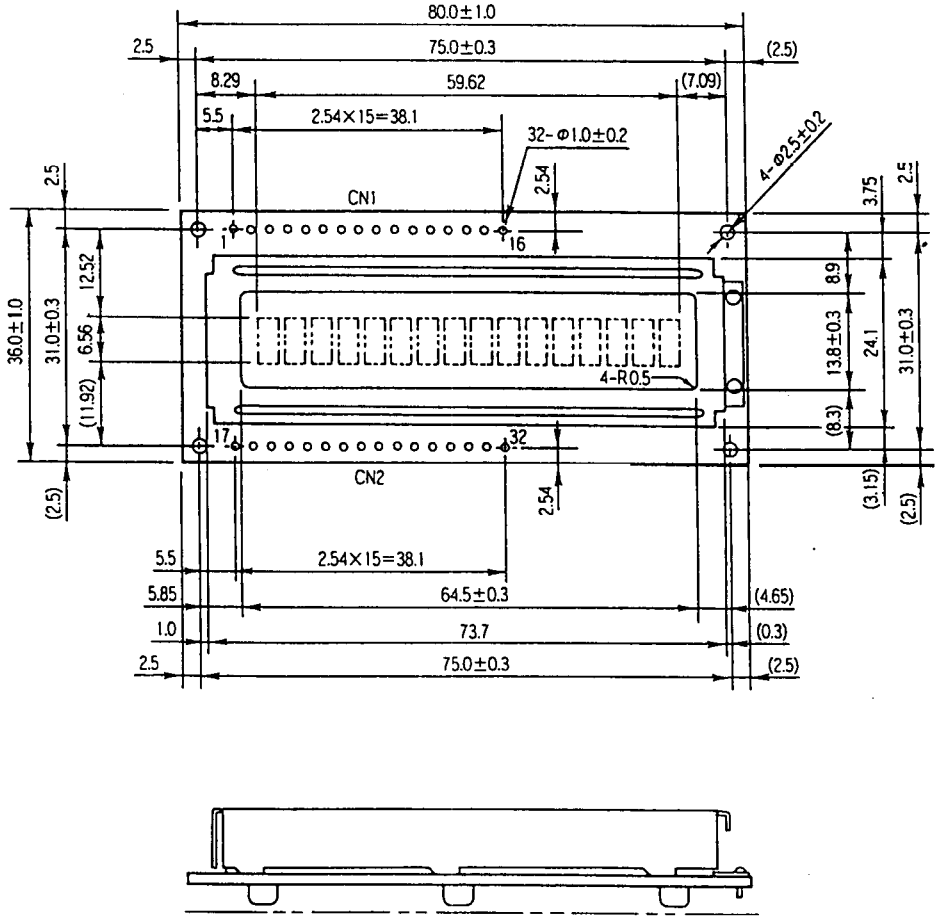
G-1 Power Supply

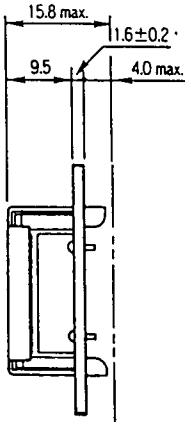


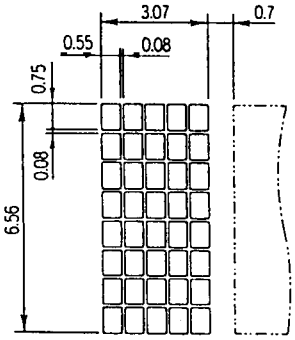
G-2 Dimensions

Unit: mm

General tolerance : ±0.5



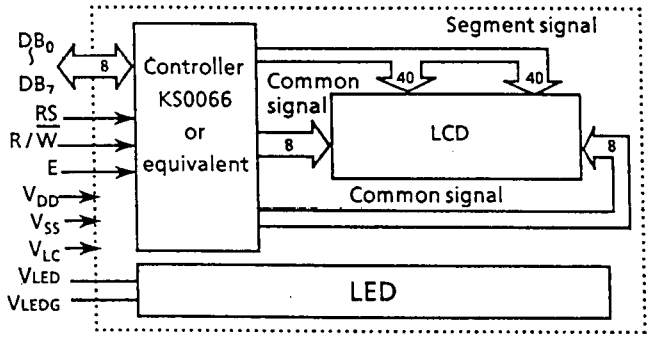




G-3 Pin Functions

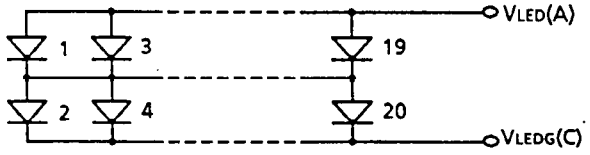
No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	V_{LED}	Anode
16	32	V_{LEDG}	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

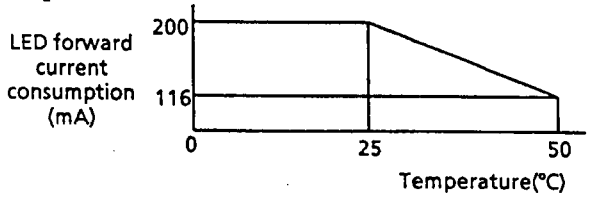


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.8	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 100 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	1.0	mA

G-5-4 Optical Characteristics

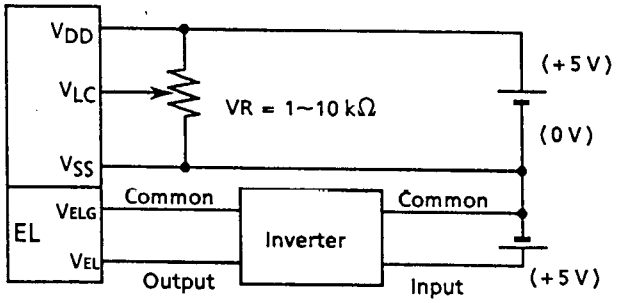
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 100 mA V_{opr} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 100 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L167121J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

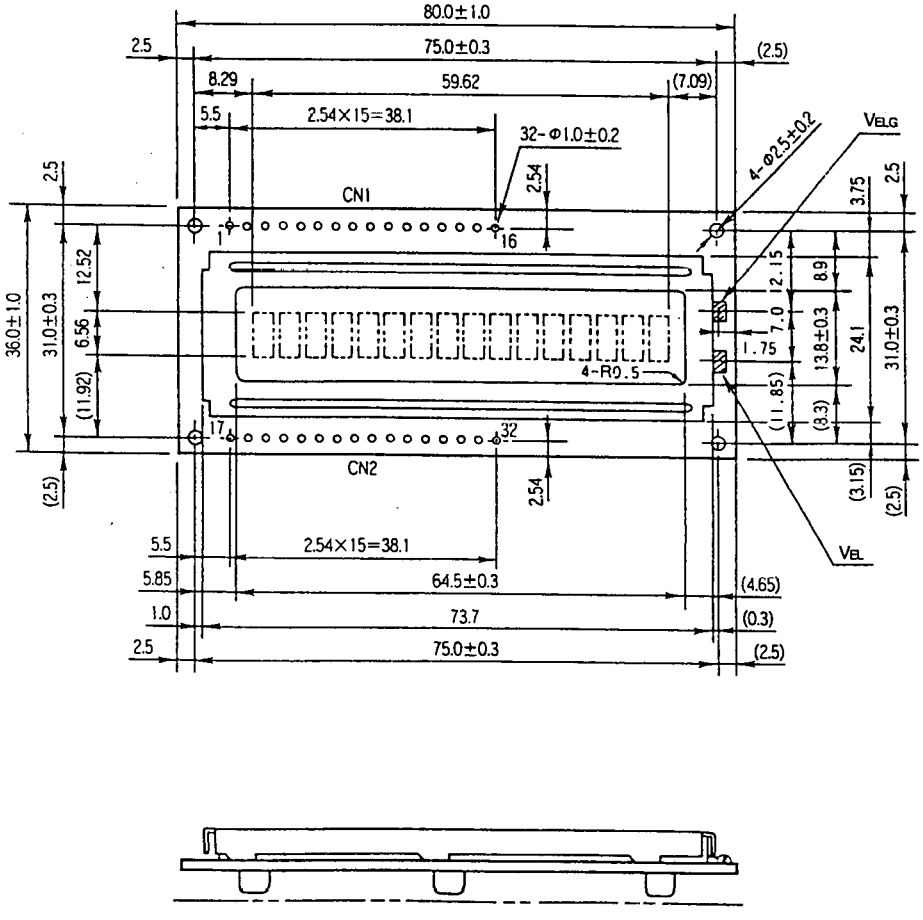
H-1 Power Supply

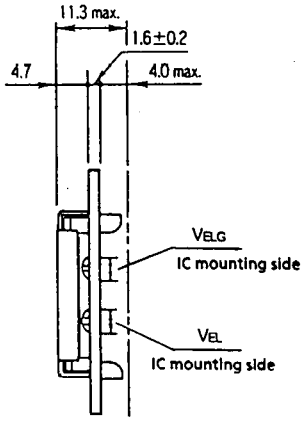


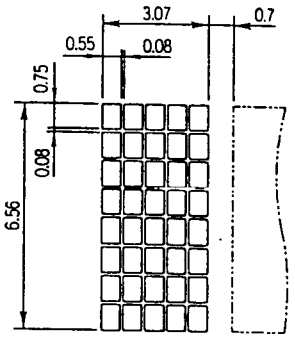
H-2 Dimensions

Unit : mm

General tolerance : ±0.5



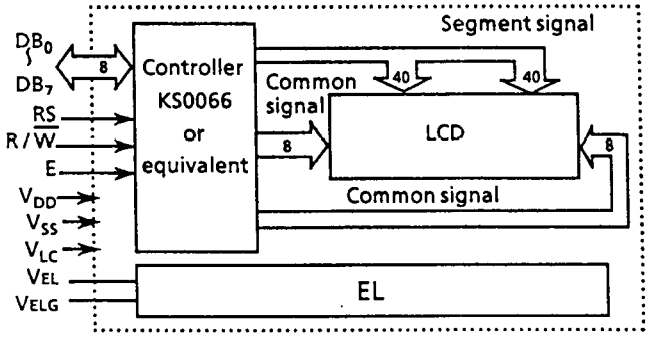




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3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	2.7 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	1.5 max. 1.1 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1 min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	40 min. 45 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5S

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	550 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	100 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	10 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	40 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	8 typ.	cd/m^2

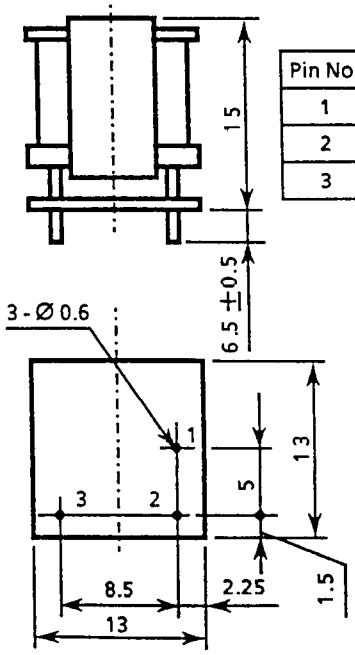
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 15	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	15	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input : 5V DC
2	Common : GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		1.5	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	1.5	2.5	mA
		I_{LC}		−	0.2	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2 - \theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L167100P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1671B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

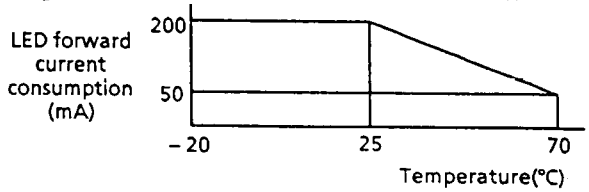
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.8	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 100 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 100 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L1681 Series

- 16 characters × 1 line
- STN LCD is used
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	151.0×40.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	151.0×40.0×15.8	mm
Viewing area (H×V)	120.0×23.0	mm
Character size (5×7 dot, H×V)	6.0×12.715	mm
Dot size (H×V)	1.152×1.765	mm
Dot space	0.06	mm
Center to center dimension of mounting holes (H×V)	143.0×32.0	mm
Weight (Reflective type)	60	g
Weight (Built-in LED backlight type)	75	g
Weight (Built-in EL backlight type)	65	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		1.5	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	1.8	3.0	mA
		I_{LC}		−	0.3	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

D-1 Reflective type

Ta = 25°C, V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−25	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		75	−	−	
Contrast	C	θ = 5°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	180	270	ms
Response time(fall)	t_{off}		−	250	380	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	400	600	ms
Response time(fall)	t_{off}		−	720	1100	

D-2 Transflective type

Ta = 25°C,, V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−20	deg.
	θ_2		45	−	−	
	$\theta_2-\theta_1$		65	−	−	
Contrast	C	θ = 5°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	180	270	ms
Response time(fall)	t_{off}		−	250	380	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	400	600	ms
Response time(fall)	t_{off}		−	720	1100	

E. Recommended Operating Voltage (STN gray type)

The recommended value of (V_{opr}) for an ambient temperature is as follows.

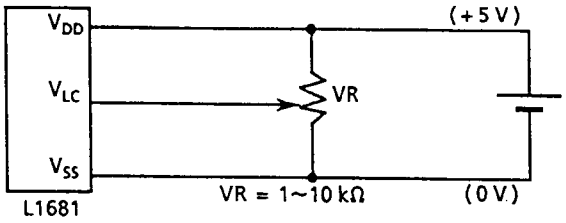
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.40

■ STN Reflective type

Item	L168100J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-1
Recommended Operating Voltage	E

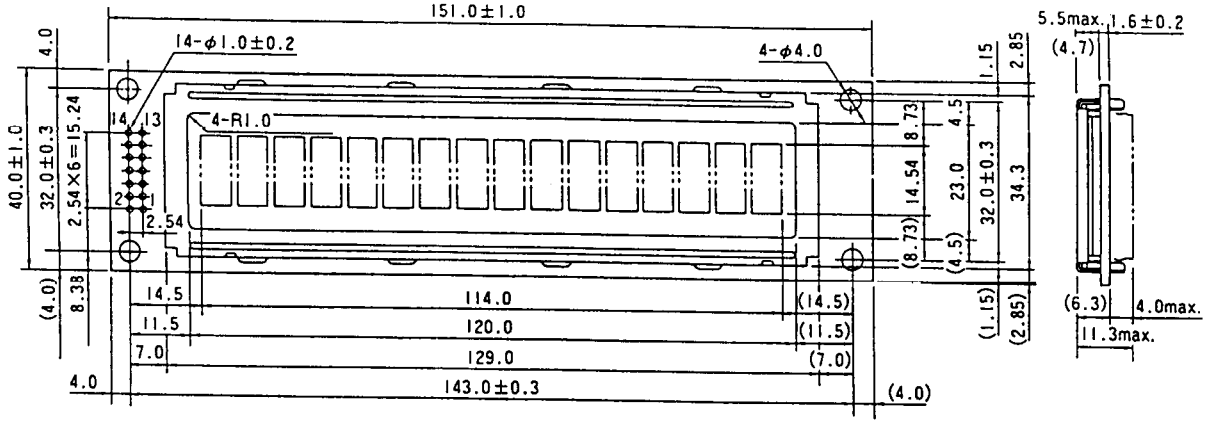
F-1 Power Supply

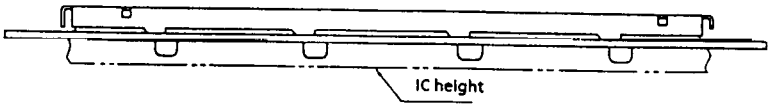


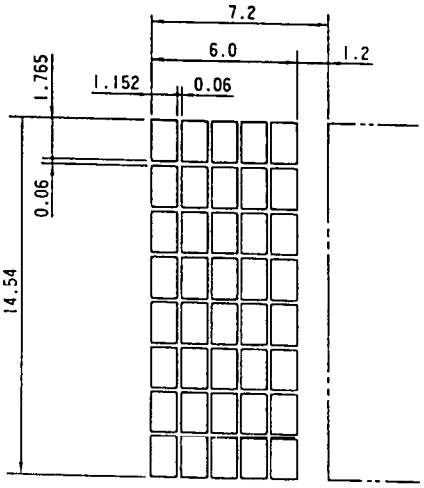
F-2 Dimensions

Unit : mm

General tolerance : ±0.5



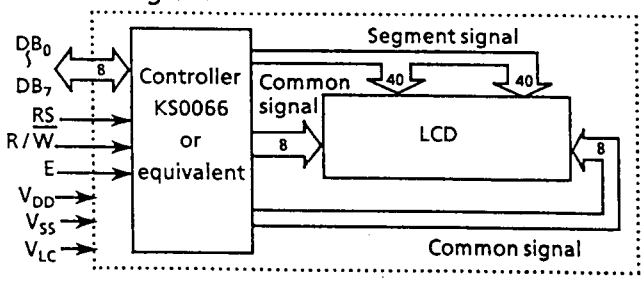




F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

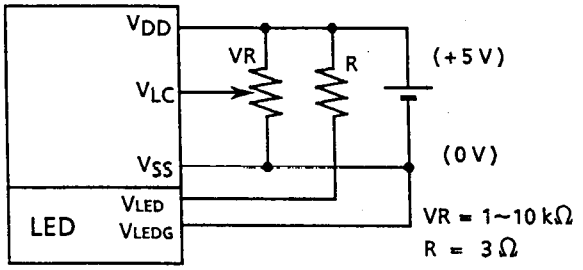
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

Item	L1681B1J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

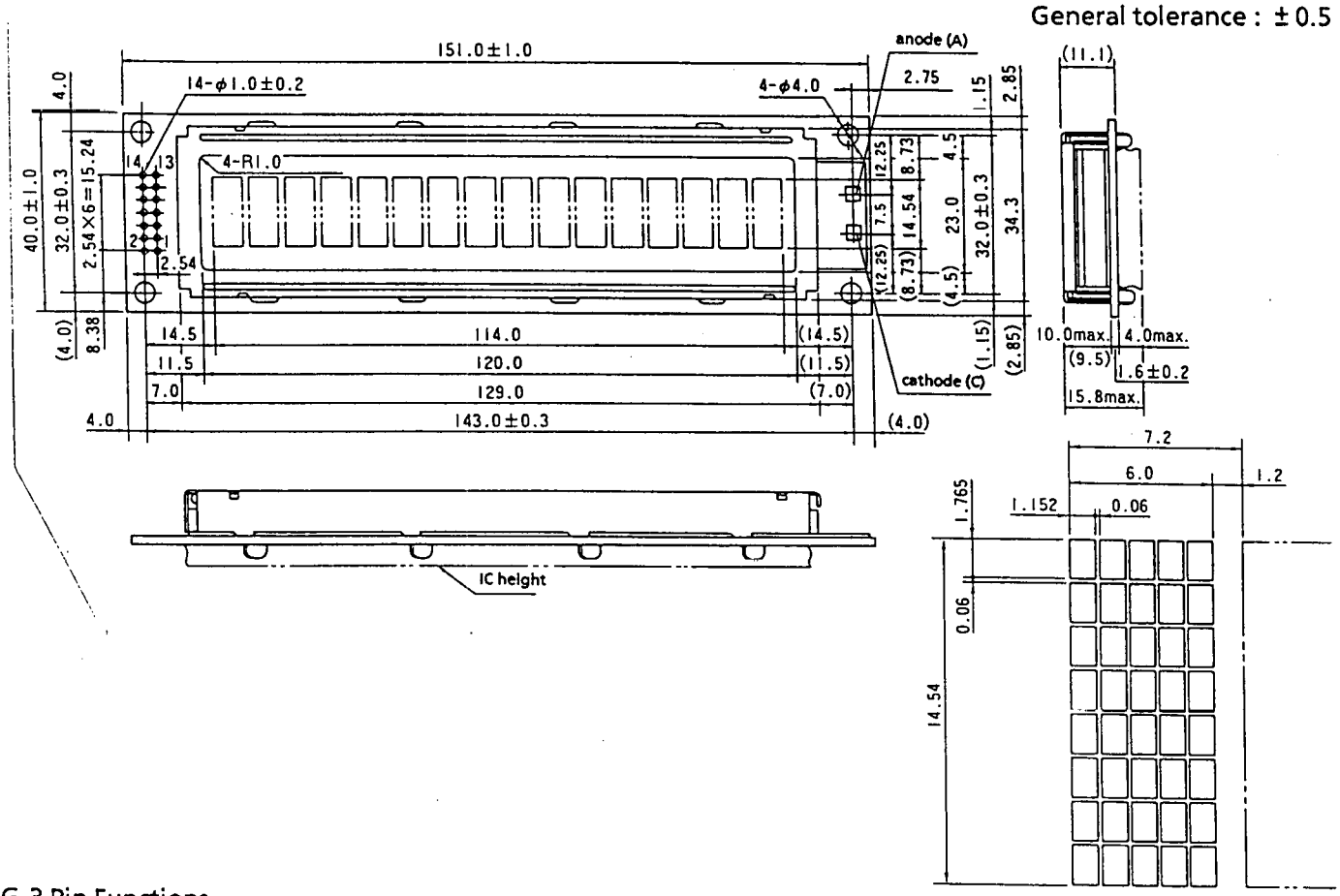
G-1 Power Supply



G-2 Dimensions

Unit: mm

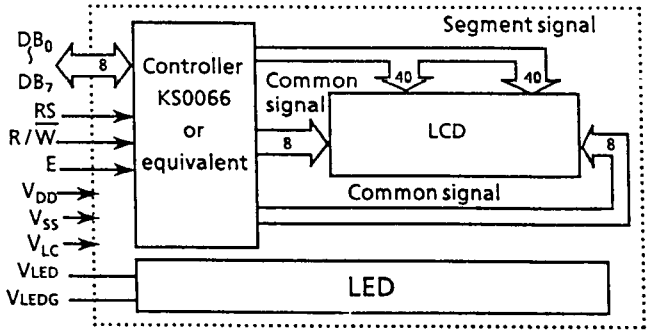
General tolerance : ±0.5



G-3 Pin Functions

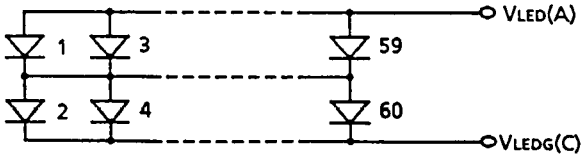
No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

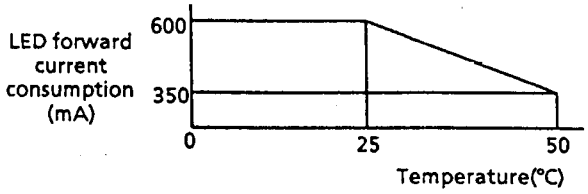


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	600	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.6	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 300 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	3.0	mA

G-5-4 Optical Characteristics

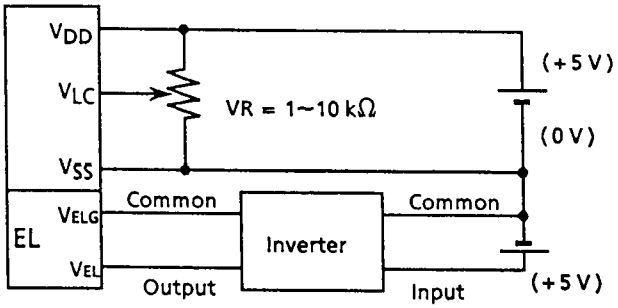
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 300 mA V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 300 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L168121J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

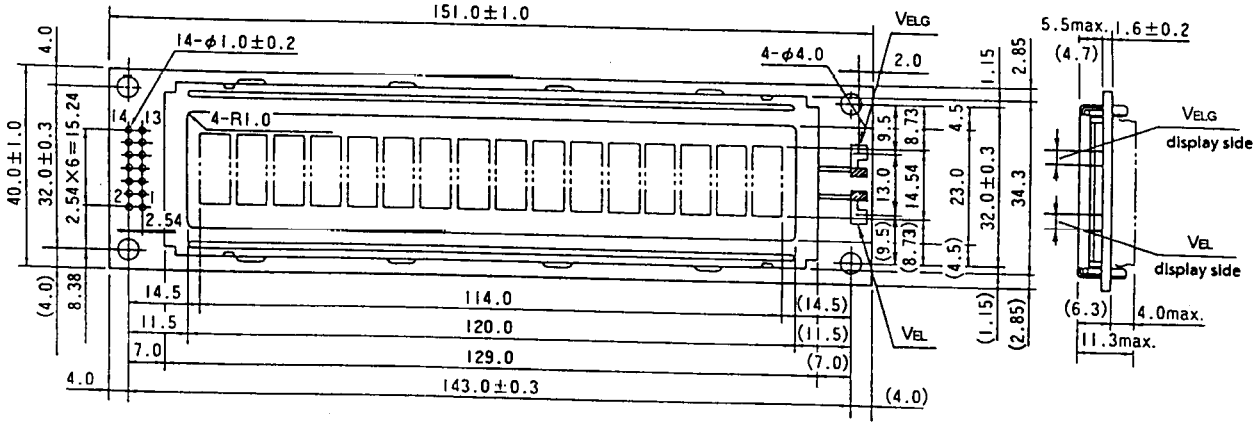
H-1 Power Supply

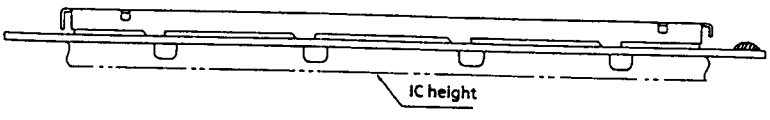


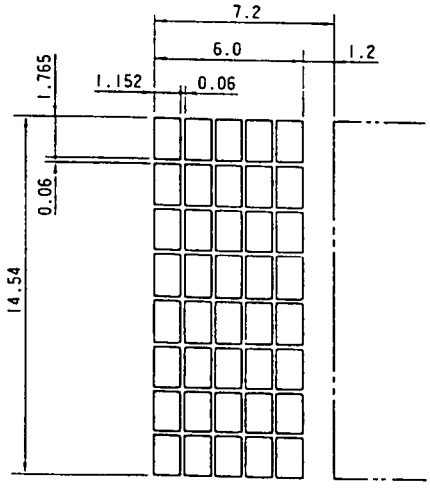
H-2 Dimensions

Unit : mm

General tolerance : ±0.5



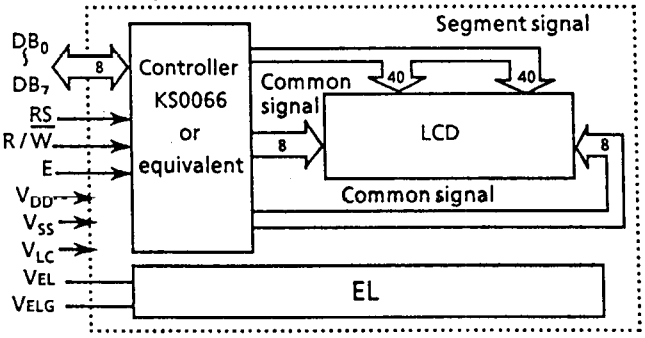




H-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Specifi-cations	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 1 VAC	8.5 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	5.0 max. 3.5 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	40 min. 50 typ.	cd/m²
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	3500	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5C

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	480 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	85 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	3.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	50 typ.	cd/m²
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	5 typ.	cd/m²

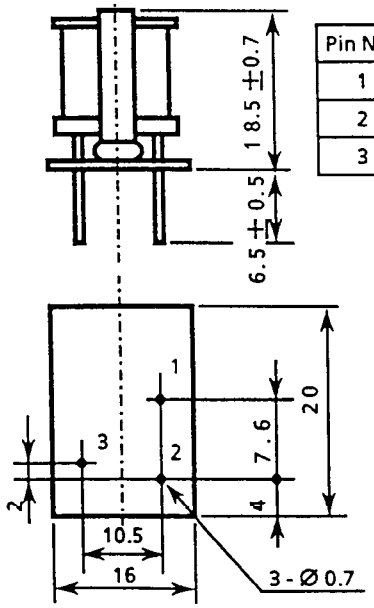
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm²

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm²
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		-0.3	7.0	V
	V_{LC}		V_{DD} - 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		-0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		-20	+70	°C
Storage temp.	T_{stg}		-30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = -20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD}-V_{LC}		1.5	–	11.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	–	1.8	3.0	mA
		I_{LC}		–	0.3	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	-10	deg.
	θ_2		40	–	–	
	$\theta_2 - \theta_1$		50	–	–	
Contrast	C	θ = 5°, ø = 0°	2	3	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	50	80	ms
Response time(fall)	t_{off}		–	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	200	320	ms
Response time(fall)	t_{off}		–	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = -20°C, V_{opr} = 5.0 V	–	1500	2400	ms
Response time(fall)	t_{off}		–	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

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

Temperature(°C)	-20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L168100P200
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1681B1P200
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

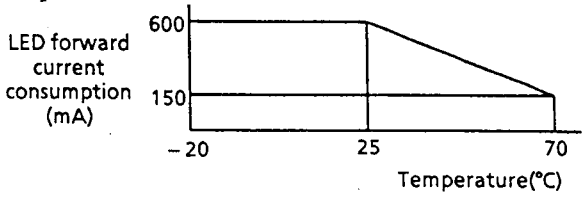
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	600	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.6	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 300 mA*, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 300 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color				

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L1672 Series

- 16 characters × 2 lines
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective type)	85.0×30.0×10.1	mm
Module size (H×V×T) (Built-in LED backlight type)	85.0×30.0×15.8	mm
Module size (H×V×T) (Built-in EL backlight type)	85.0×30.0×11.3	mm
Viewing area (H×V)	62.0×16.0	mm
Character size (5×7 dot, H×V)	2.78×4.27	mm
Dot size (H×V)	0.50×0.55	mm
Dot space	0.07	mm
Center to center dimension of mounting holes (H×V)	82.0×24.0	mm
Weight (Reflective type)	25	g
Weight (Built-in LED backlight type)	40	g
Weight (Built-in EL backlight type)	30	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≦48 hrs	+20	+85	%RH
		≦1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		1.5	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	2.0	3.0	mA
		I_{LC}		−	0.2	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

D. Optical Characteristics

D-1 TN LCD module (reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	5	deg.
	θ_2		40	−	−	
	$\theta_2-\theta_1$		35	−	−	
Contrast	C	θ = 30°, ø = 0°	5	8	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	60	70	ms
Response time(fall)	t_{off}		−	150	170	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	210	300	ms
Response time(fall)	t_{off}		−	480	550	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2-\theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

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

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

E-2 STN LCD module (gray)

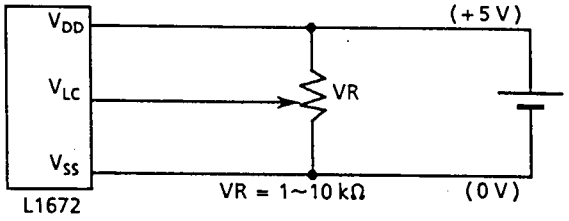
$V_{opr} = V_{DD} - V_{LC}$

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ TN/STN Reflective type

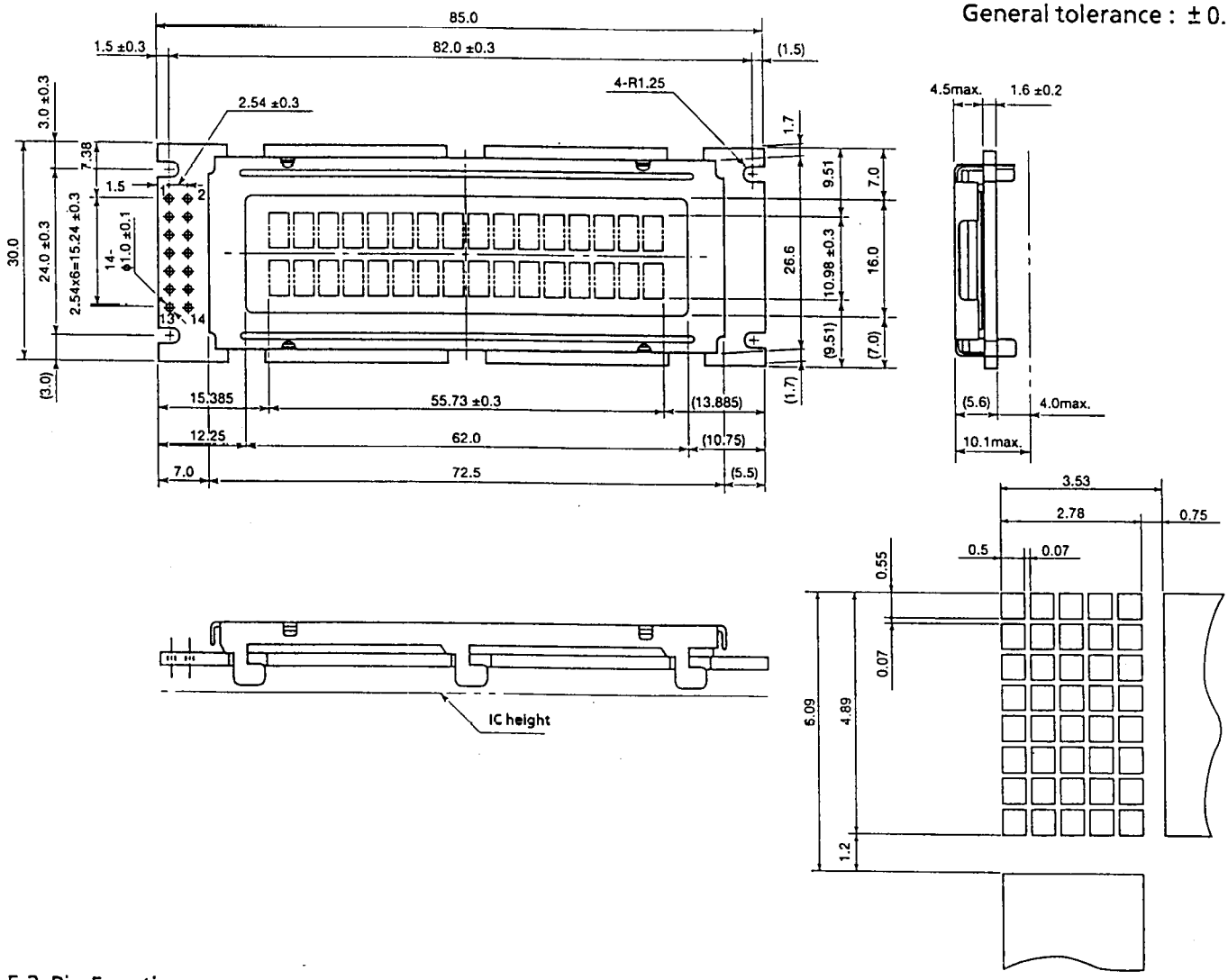
Item	L1672000000	L167200J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C	C
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

F-1 Power Supply



F-2 Dimensions

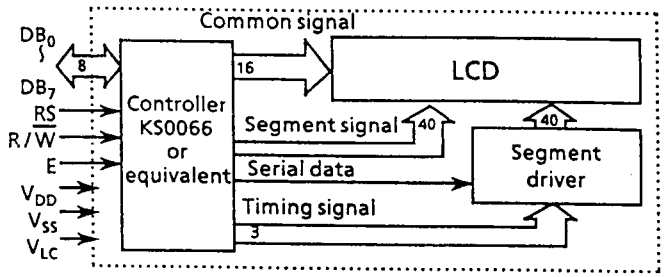
Unit : mm
General tolerance : ±0.5



F-3 Pin Functions

No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E	Enable
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V

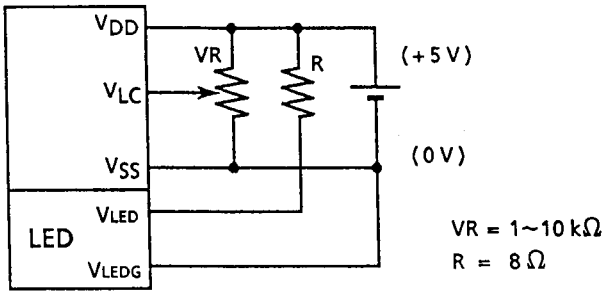
F-4 Block Diagram



■ **STN Transflective, Built-in LED Backlight type**

Item	L1672B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

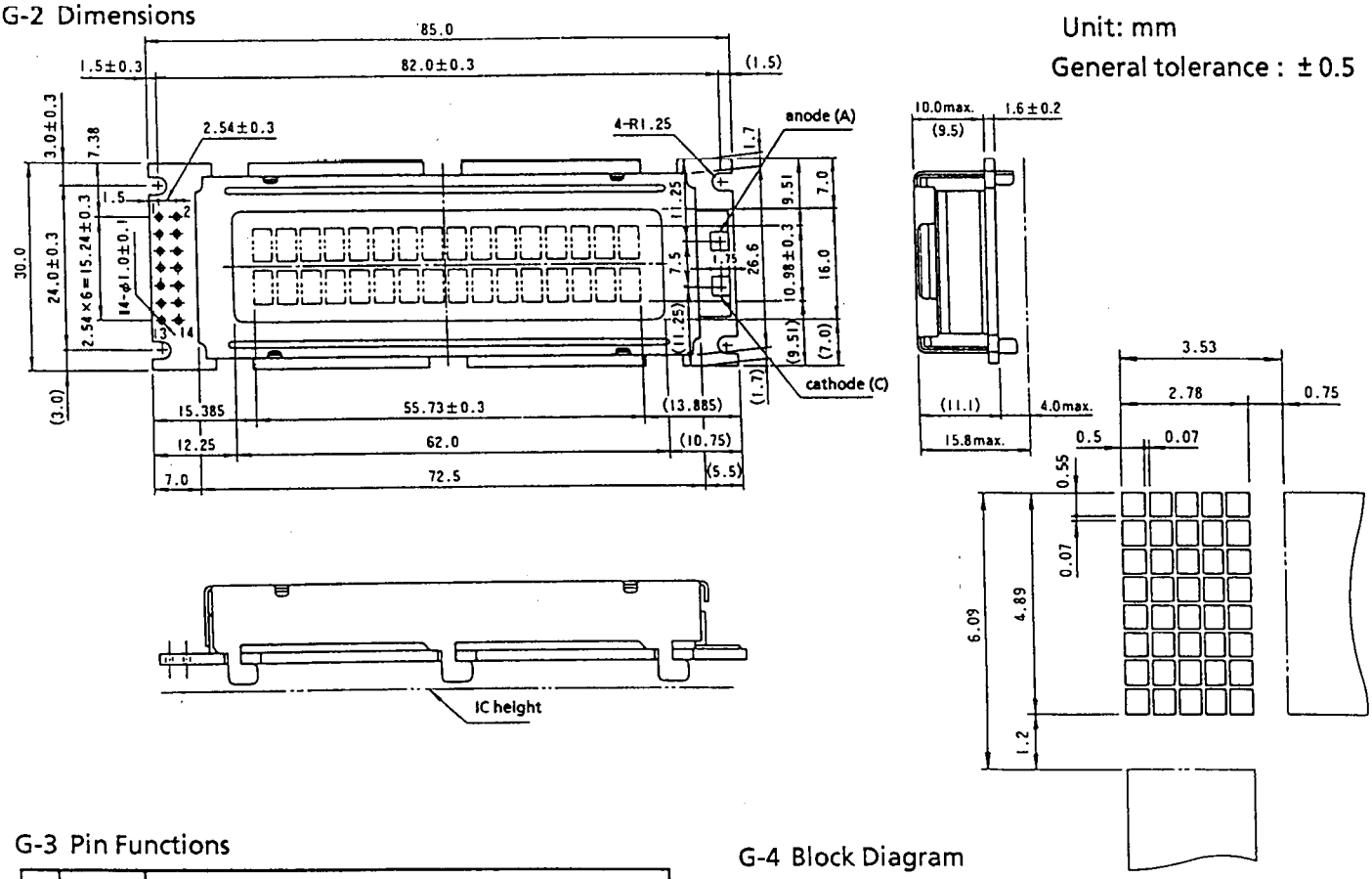
G-1 Power Supply



G-2 Dimensions

Unit: mm

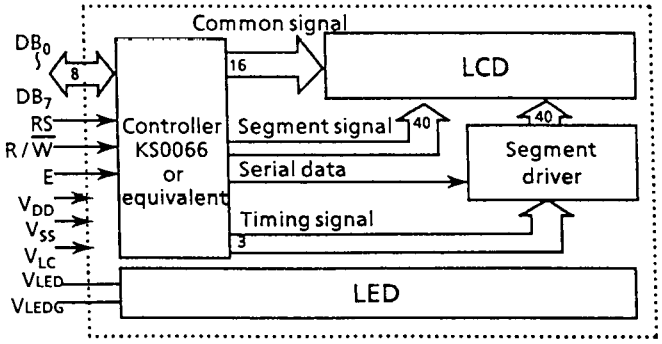
General tolerance : ±0.5



G-3 Pin Functions

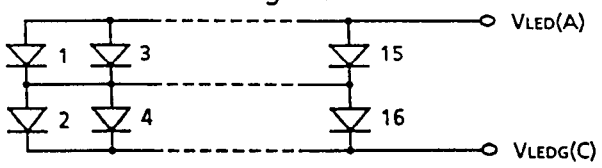
No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E	Enable
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

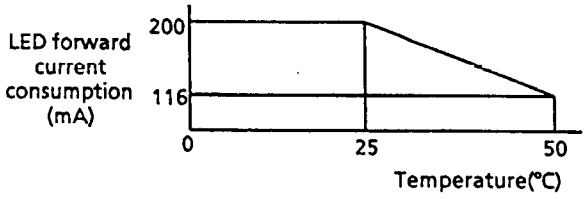


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.92	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 112 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	0.16	mA

G-5-4 Optical Characteristics

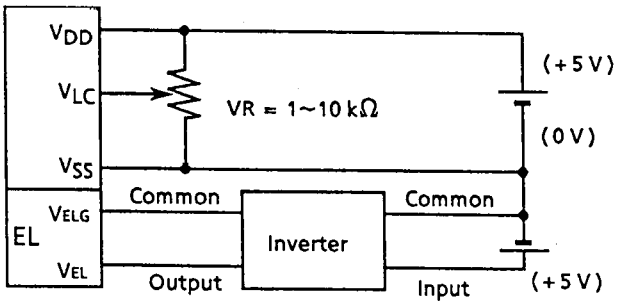
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 112 mA V_{opr} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 112 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L167221J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

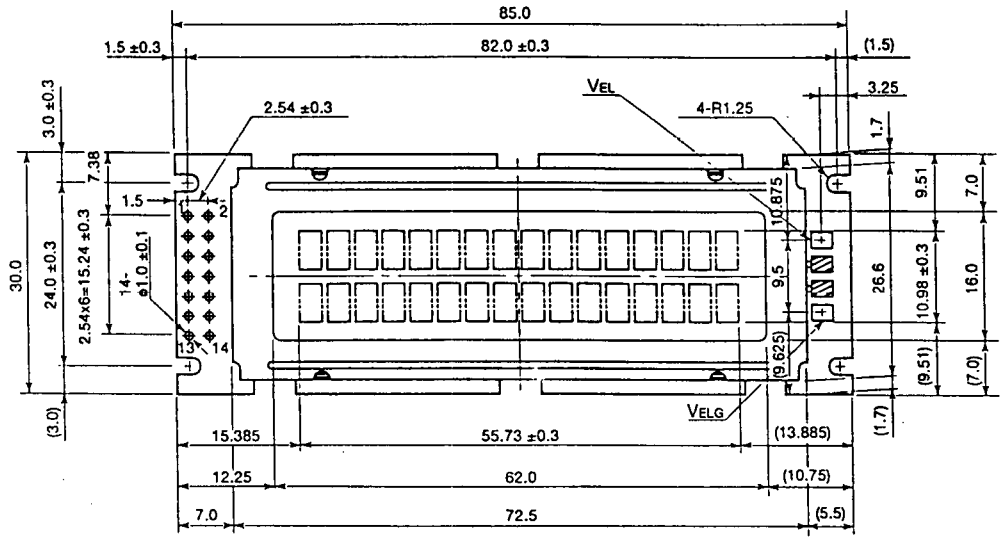
H-1 Power Supply

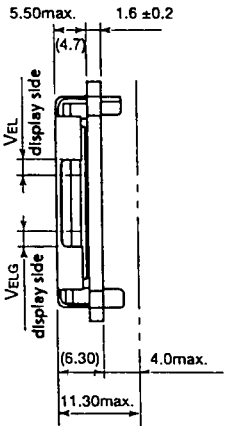


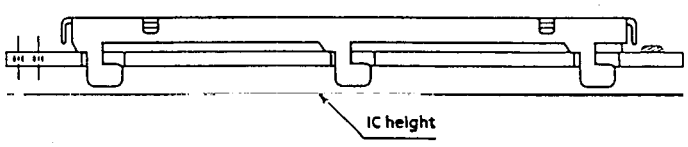
H-2 Dimensions

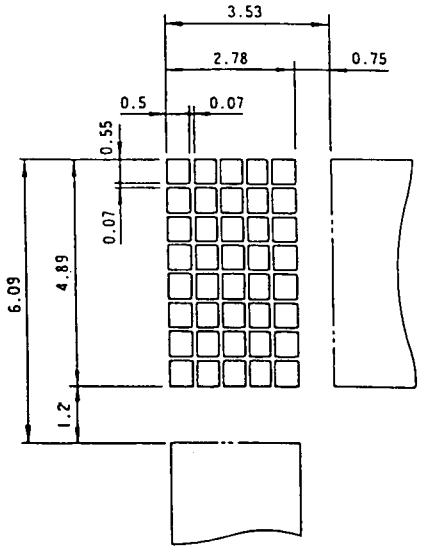
Unit : mm

General tolerance : ±0.5





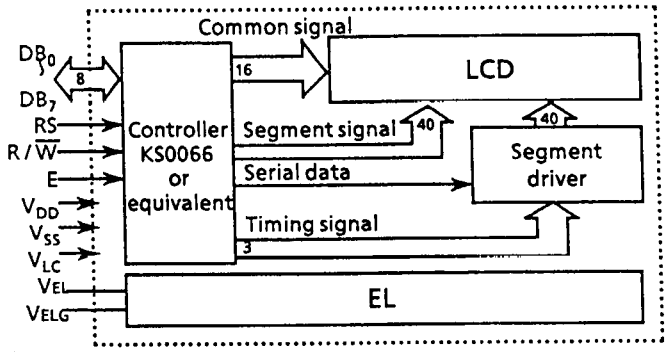




H-3 Pin Functions

No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E	Enable
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	3.0 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	1.7 max. 1.2 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5S

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	550 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	100 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	10 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	7 typ.	cd/m^2

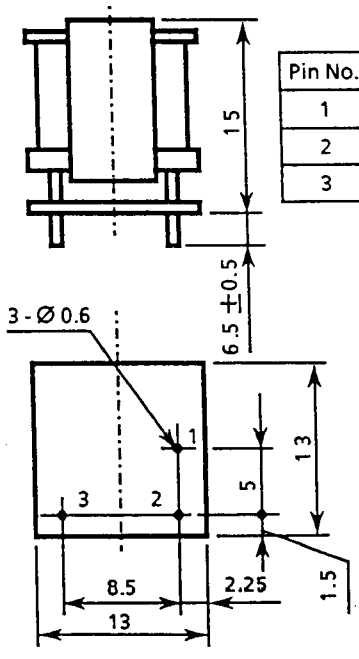
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 15	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	15	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input : 5V DC
2	Common : GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 13.5	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		1.5	–	11.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	–	2.0	3.0	mA
		I_{LC}		–	0.2	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	0	deg.
	θ_2		50	–	–	
	$\theta_2-\theta_1$		50	–	–	
Contrast	C	θ = 20°, ø = 0°	2	3	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	50	80	ms
Response time(fall)	t_{off}		–	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	200	320	ms
Response time(fall)	t_{off}		–	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	–	1500	2400	ms
Response time(fall)	t_{off}		–	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

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

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L167200P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1672B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

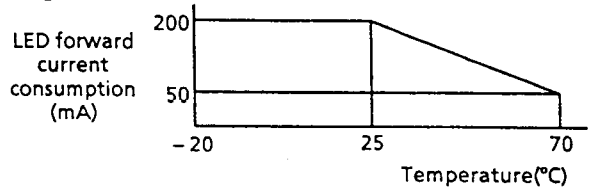
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.92	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 112 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 112 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L1682 Series

· 16 characters × 2 lines · 5×7 dot matrix + cursor
· 1/16 duty · 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	80.0×36.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	80.0×36.0×15.8	mm
Viewing area (H×V)	64.5×13.8	mm
Character size (5×7 dot , H×V)	2.95×3.80	mm
Dot size (H×V)	0.55×0.50	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	75.0×31.0	mm
Weight (Reflective type)	25	g
Weight (Built-in LED backlight type)	35	g
Weight (Built-in EL backlight type)	30	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

C-1 TN LCD module

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		4.0	−	11.0	V
Input* voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.6 V	−	1.6	3.0	mA
		I_{LC}		−	0.3	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

C-2 STN LCD module (gray)

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		4.0	−	11.0	V
Input* voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	1.5	3.0	mA
		I_{LC}		−	0.3	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

D. Optical Characteristics

D-1 TN LCD module (reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.4 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	10	deg.
	θ_2		45	−	−	
	$\theta_2 - \theta_1$		35	−	−	
Contrast	C	θ = 30°, ø = 0°	5	8	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	40	80	ms
Response time(fall)	t_{off}		−	120	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.65 V	−	240	330	ms
Response time(fall)	t_{off}		−	425	650	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2 - \theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2 - \theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	4.65	4.4	4.1

E-2 STN LCD module (gray)

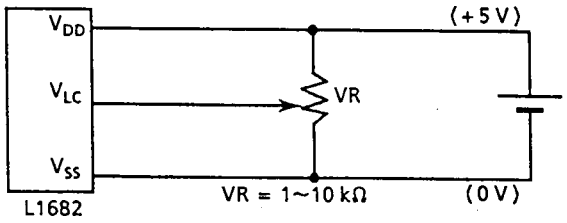
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.0	4.75	4.5

■ TN/STN Reflective type

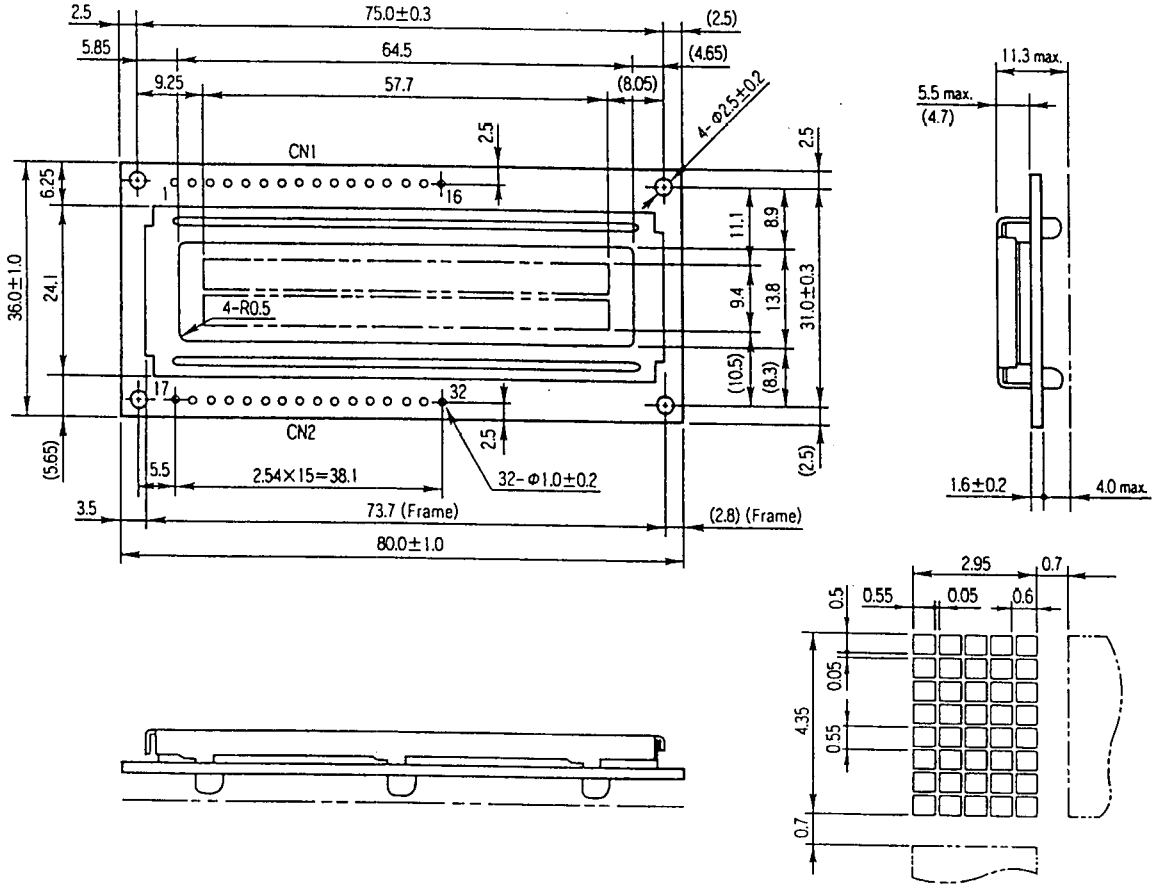
Item	L1682000000	L168200J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C-1	C-2
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

F-1 Power Supply



F-2 Dimensions

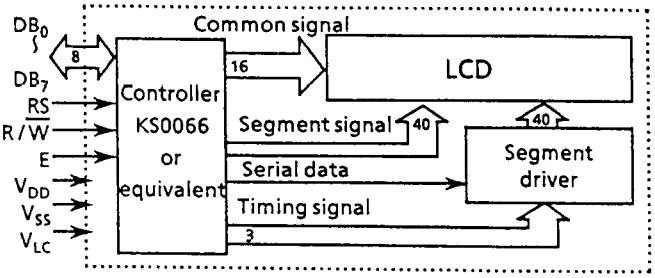
Unit : mm
General tolerance : ±0.5



F-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L: Instruction code input H: Data input
5	21	R/W	L: Data write (LCM←MPU) H: Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

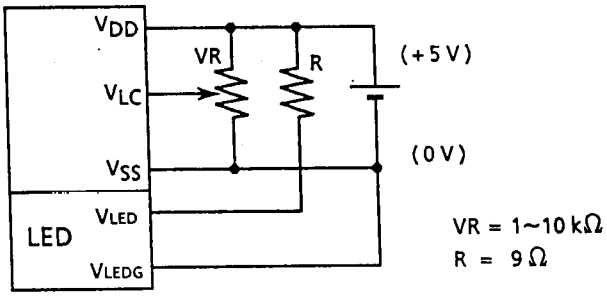
F-4 Block Diagram



■ **STN Transflective, Built-in LED Backlight type**

Item	L1682B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C-2
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

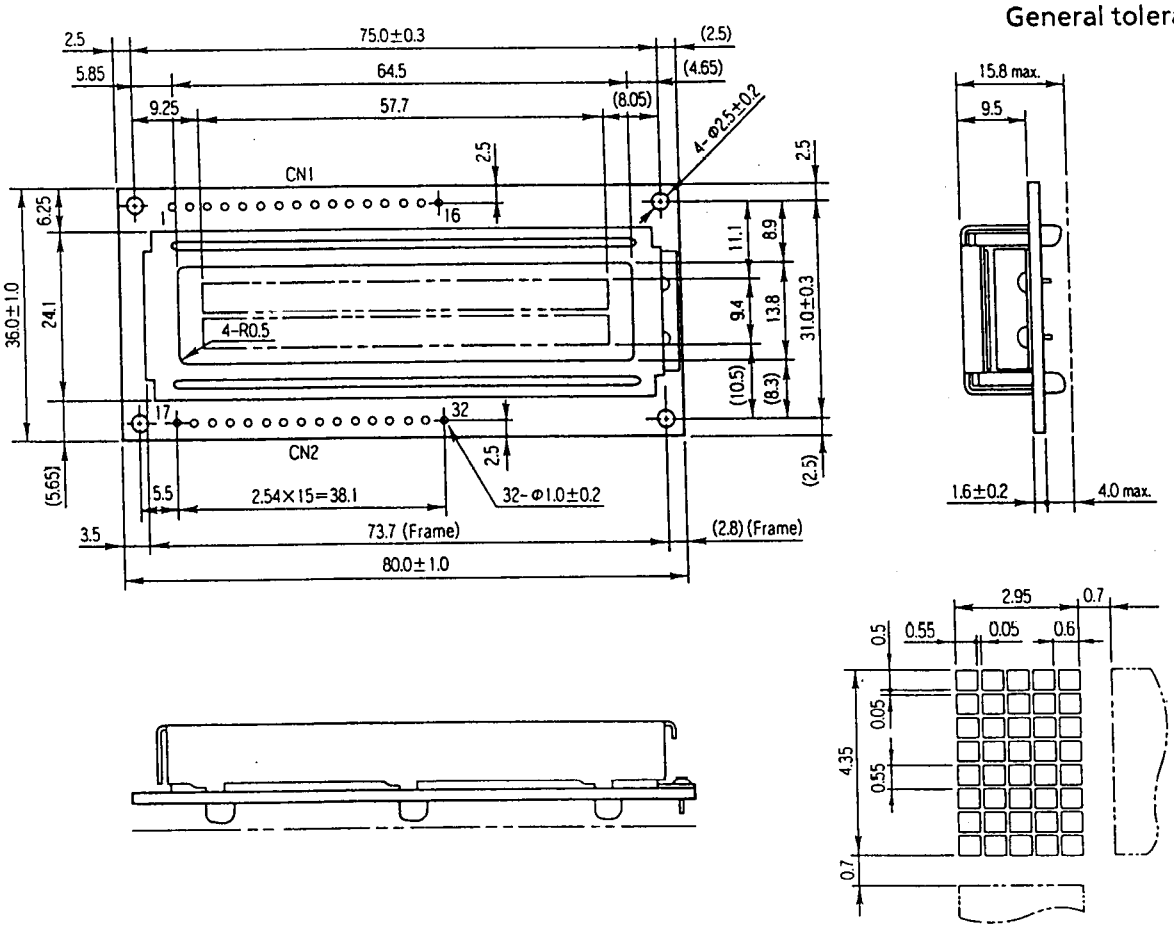
G-1 Power Supply



G-2 Dimensions

Unit: mm

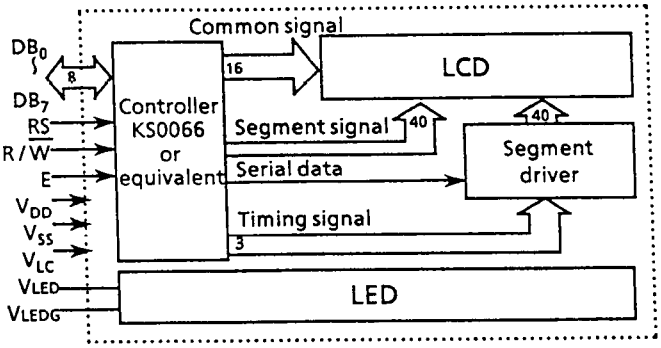
General tolerance : ±0.5



G-3 Pin Functions

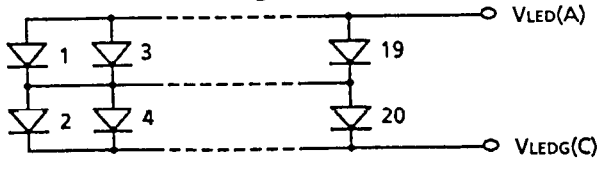
No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L: Instruction code input H: Data input
5	21	R/W	L: Data write (LCM←MPU) H: Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	V_{LED}	Anode
16	32	V_{LEDG}	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

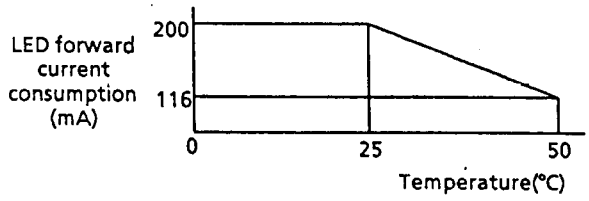


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.8	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 100 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	1.0	mA

G-5-4 Optical Characteristics

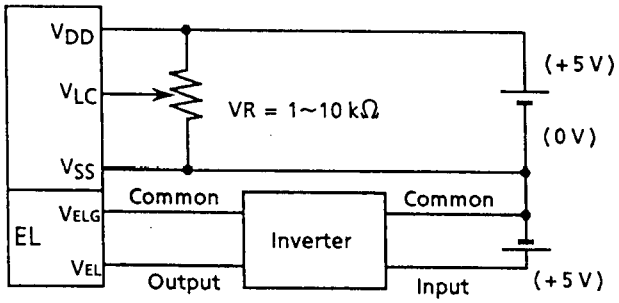
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 100 mA, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 100 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L168221J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C-2
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

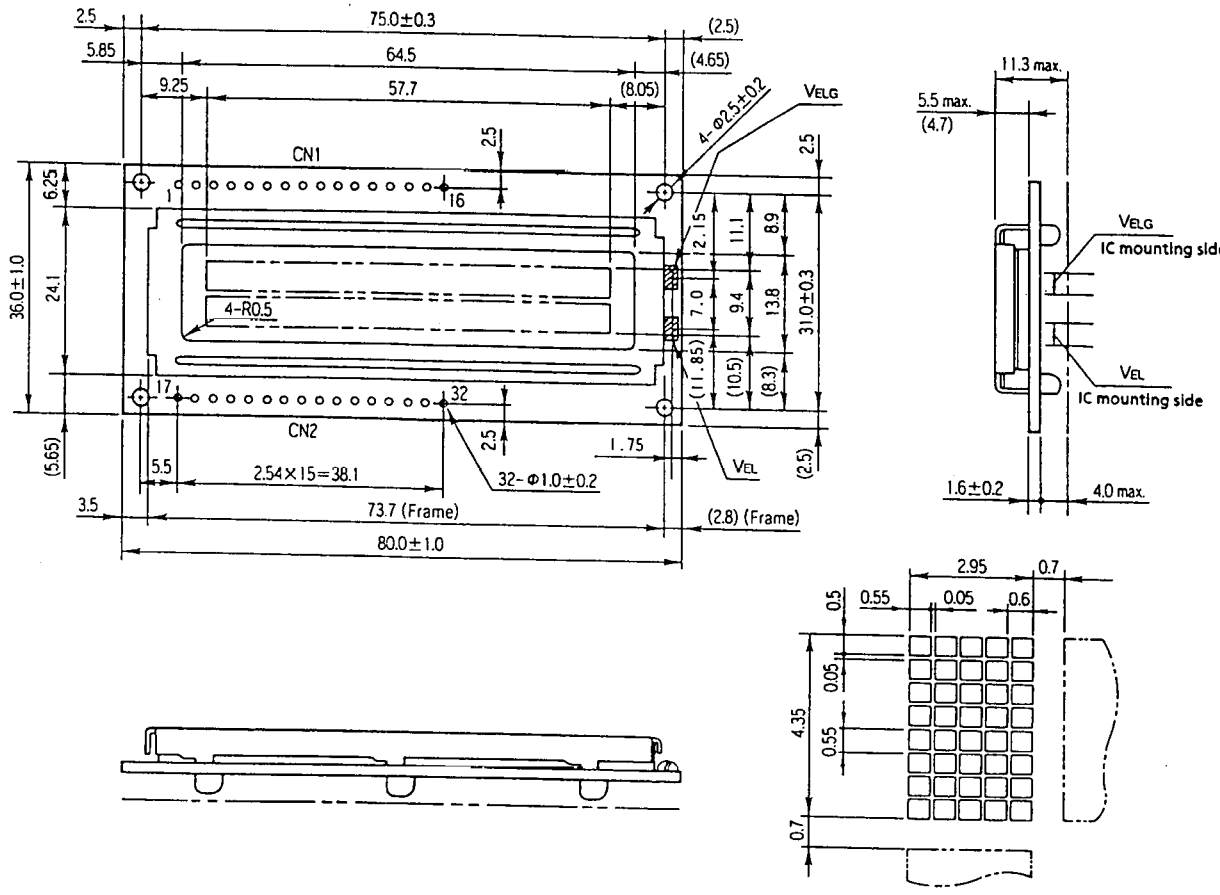
H-1 Power Supply



Unit : mm

General tolerance : ±0.5

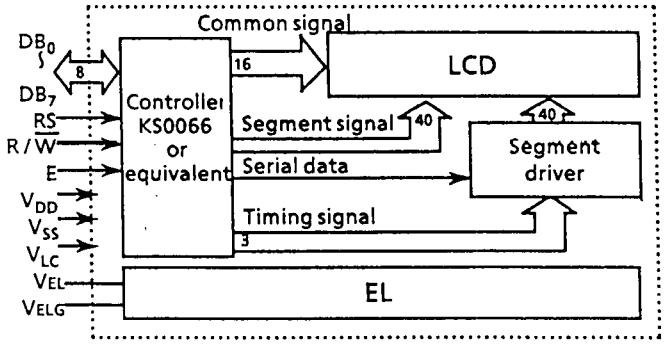
H-2 Dimensions



H-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L: Instruction code input H: Data input
5	21	R/W	L: Data write (LCM←MPU) H: Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

H-4 Block Diagram



H-5 Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	2.7 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	1.5 max. 1.1 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	40 min. 45 typ.	cd/m²
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5S

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	550 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	100 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	10 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	40 typ.	cd/m²
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	4 typ.	cd/m²

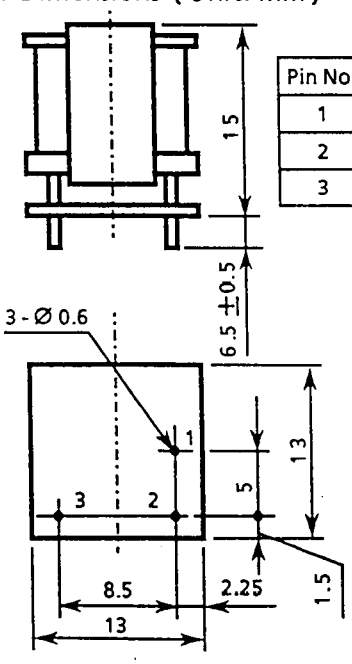
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 15	cm²

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	15	cm²
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	1.5	3.0	mA
		I_{LC}		−	0.3	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	= 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

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

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L168200P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1682B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

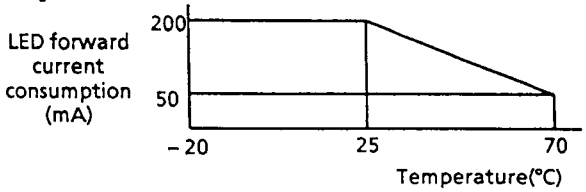
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	200	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	0.8	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 100 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 100 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L1692 Series

- 16 characters × 2 lines
- STN LCD is used
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specifications

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	122.0×44.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	122.0×44.0×15.8	mm
Viewing area (H×V)	99.0×24.0	mm
Character size (5×7 dot, H×V)	4.84×8.06	mm
Dot size (H×V)	0.92×1.10	mm
Dot space	0.06	mm
Center to center dimension of mounting holes (H×V)	115.0×37.0	mm
Weight (Reflective type)	50	g
Weight (Built-in LED backlight type)	65	g
Weight (Built-in EL backlight type)	55	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≦ 48 hrs	+20	+85	%RH
		≦ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditons	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
Input* voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	2.0	3.0	mA
		I_{LC}		−	0.4	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

D-1 Reflective type

Ta = 25°C, V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−25	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		75	−	−	
Contrast	C	θ = 5°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	180	270	ms
Response time(fall)	t_{off}		−	250	380	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	400	600	ms
Response time(fall)	t_{off}		−	720	1100	

D-2 Transflective type

Ta = 25°C, V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−20	deg.
	θ_2		45	−	−	
	$\theta_2-\theta_1$		65	−	−	
Contrast	C	θ = 5°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	180	270	ms
Response time(fall)	t_{off}		−	250	380	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	400	600	ms
Response time(fall)	t_{off}		−	720	1100	

E. Recommended Operating Voltage (STN gray type)

The recommended value of (V_{opr}) for an ambient temperature is as follows.

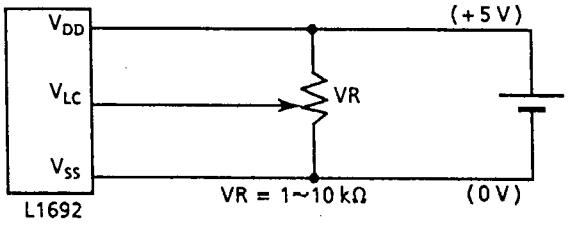
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.40

■ STN Reflective type

Item	L169200J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-1
Recommended Operating Voltage	E

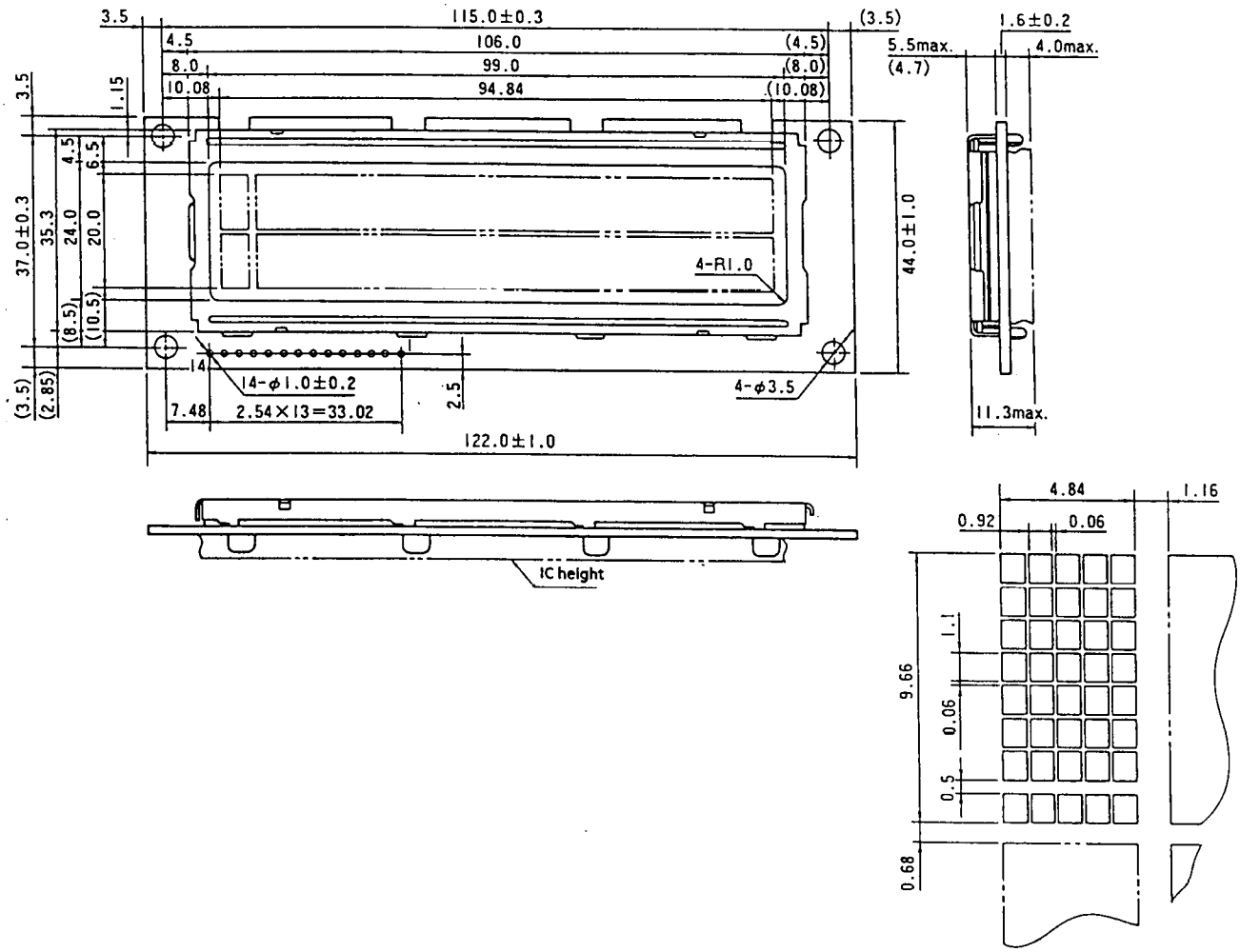
F-1 Power Supply



F-2 Dimensions

Unit : mm

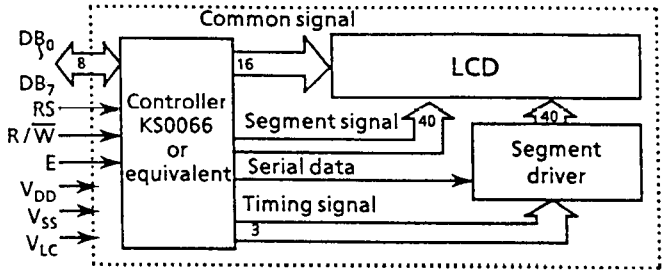
General tolerance : ±0.5



F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

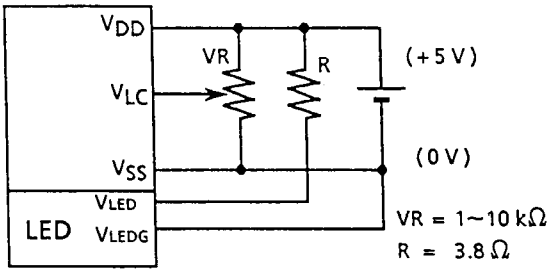
F-4 Block Diagram



■ **STN Transflective, Built-in LED Backlight type**

Item	L1692B1J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

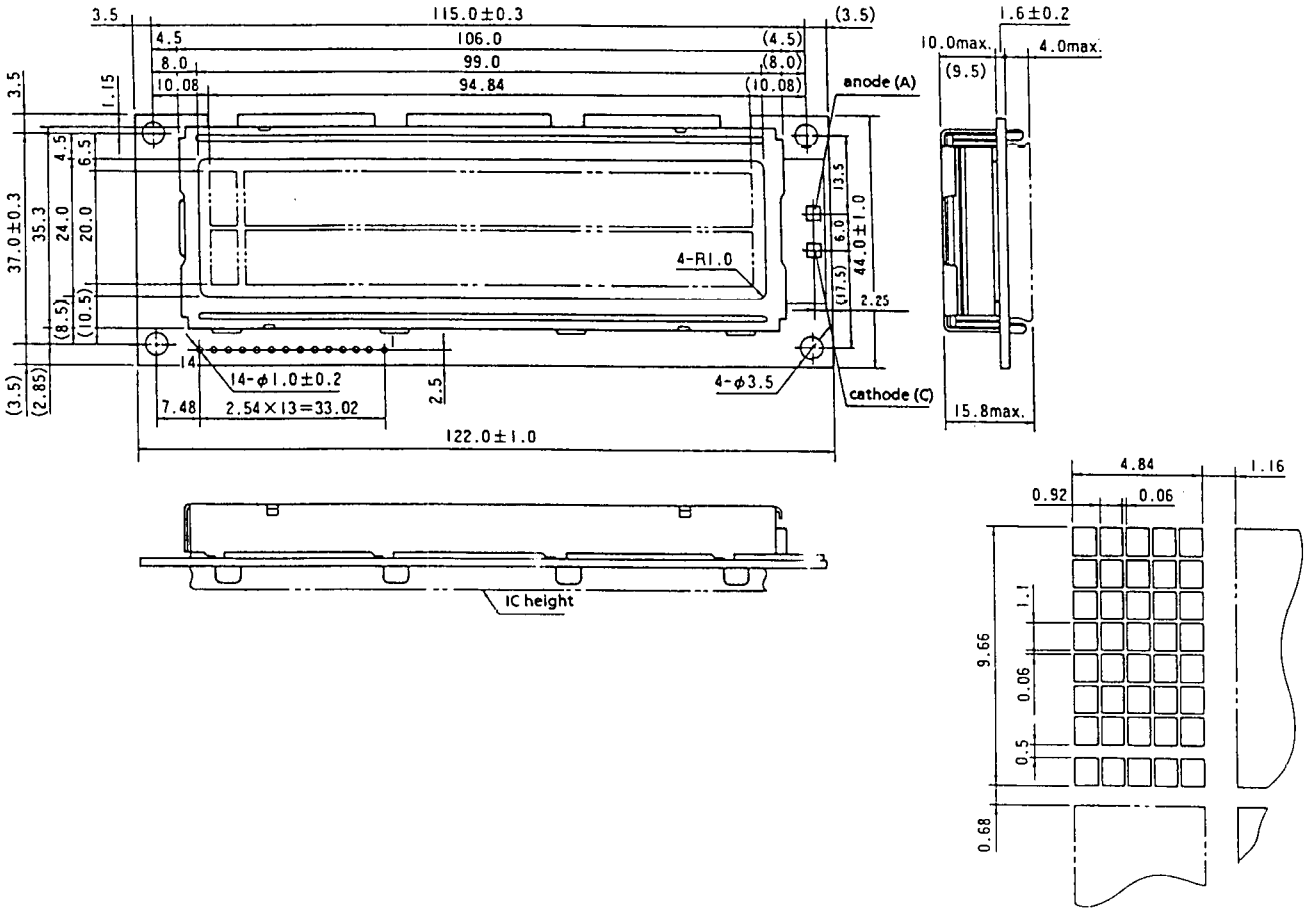
G-1 Power Supply



G-2 Dimensions

Unit: mm

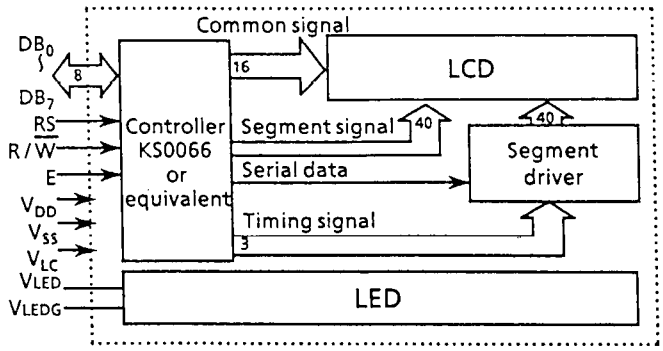
General tolerance : ±0.5



G-3 Pin Functions

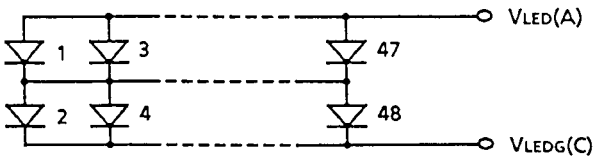
No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

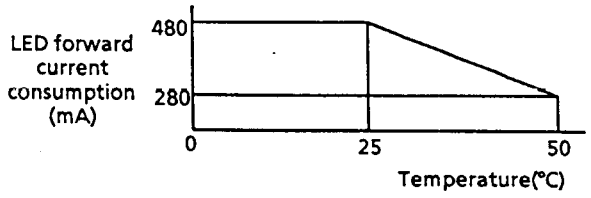


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	480	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.0	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 240 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	2.4	mA

G-5-4 Optical Characteristics

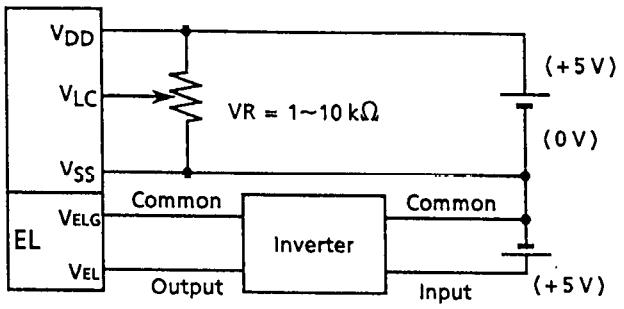
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 240 mA, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 240 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L169221J200
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

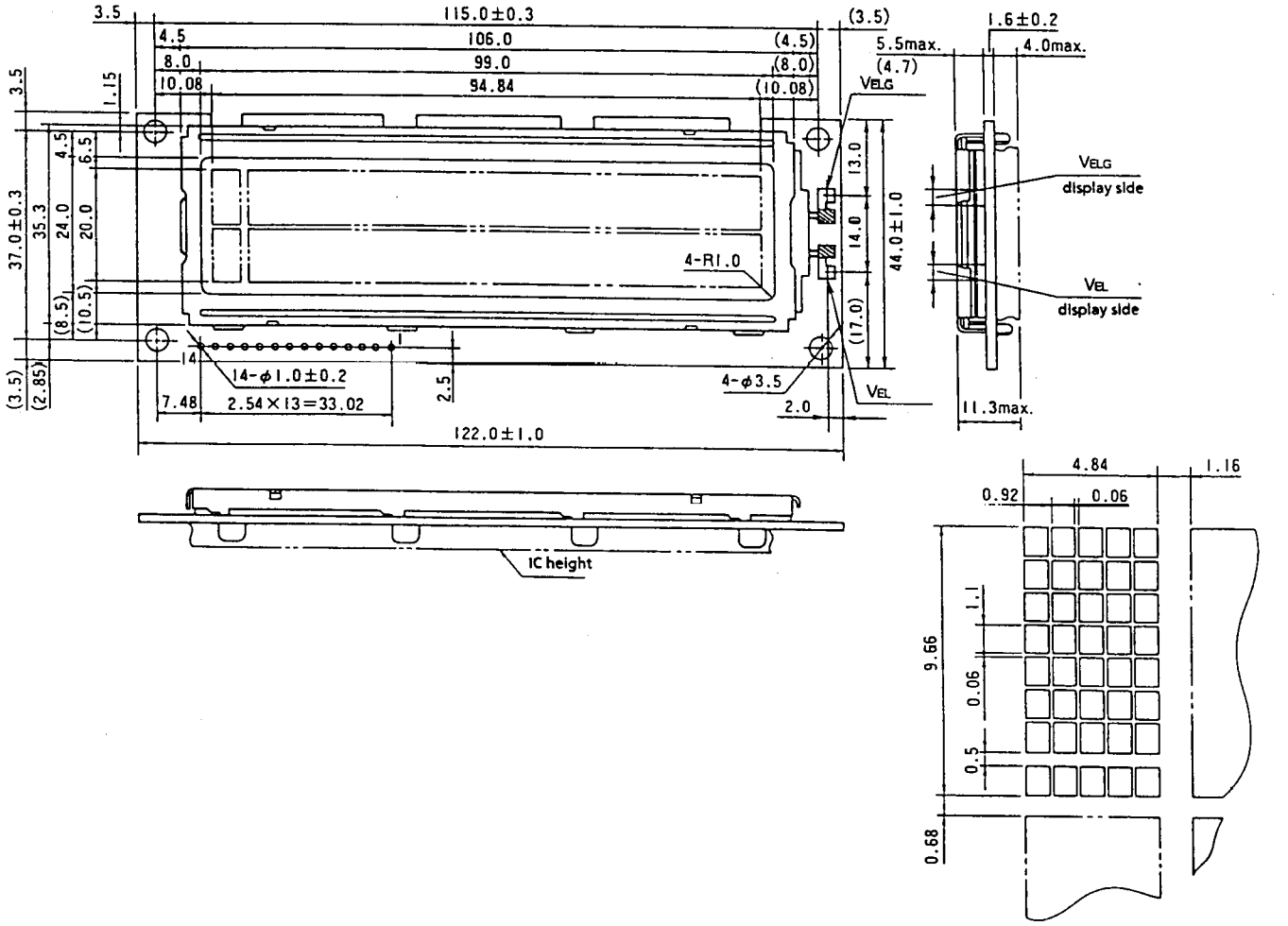
H-1 Power Supply



H-2 Dimensions

Unit : mm

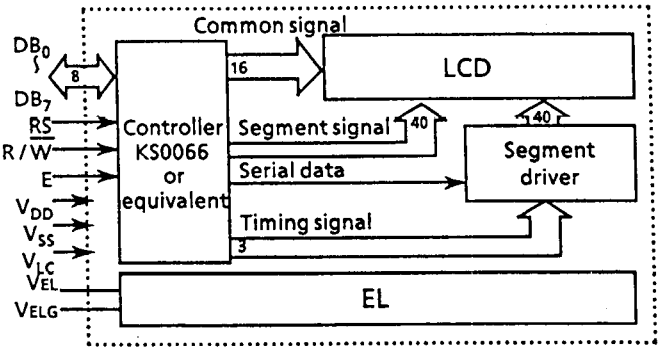
General tolerance : ±0.5



H-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Specifi-cations	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 1 VAC	7.0 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	4.5 max. 3.0 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	40 min. 50 typ.	cd/m²
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	3500	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5C

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	490 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	92 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	3.0 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	55 typ.	cd/m²
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	5.5 typ.	cd/m²

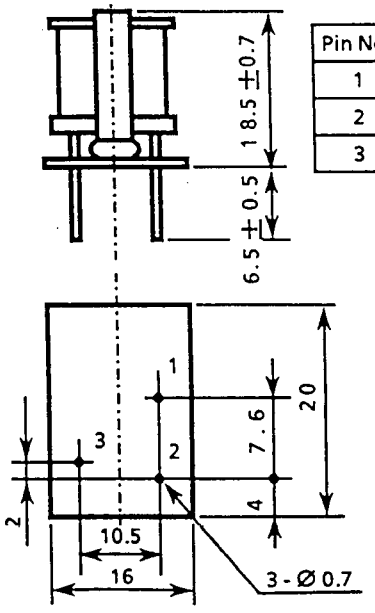
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm²

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm²
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	–	11.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	–	2.0	3.0	mA
		I_{LC}		–	0.4	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	10	deg.
	θ_2		40	–	–	
	$\theta_2-\theta_1$		50	–	–	
Contrast	C	θ = 5°, ø = 0°	2	3	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	50	80	ms
Response time(fall)	t_{off}		–	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	200	320	ms
Response time(fall)	t_{off}		–	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	–	1500	2400	ms
Response time(fall)	t_{off}		–	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L169200P200
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1692B1P200
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

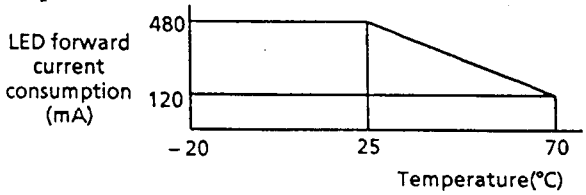
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	480	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.0	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 240 mA*, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 240 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

▮ Features of L1634 Series

16 characters × 4 lines
STN LCD is used
5×7 dot matrix + cursor
1/16 duty
5V single power supply

▮ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	87.0×60.0×11.6	mm
Module size (H×V×T) (Built-in LED backlight type)	87.0×60.0×15.8	mm
Viewing area (H×V)	61.8×25.2	mm
Character size (5×7 dot, H×V)	2.95×4.15	mm
Dot size (H×V)	0.55×0.55	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	82.0×55.0	mm
Weight (Reflective type)	50	g
Weight (Built-in LED backlight type)	65	g
Weight (Built-in EL backlight type)	55	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	2.7	4.0	mA
		I_{LC}		−	1.1	2.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

D-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2-\theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage (STN gray type)

The recommended value of (V_{opr}) for an ambient temperature is as follows.

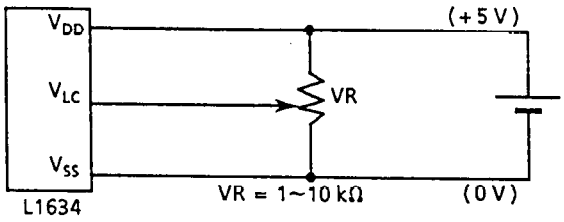
$V_{opr} = V_{DD} - V_{LC}$

Temperature(℃)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ STN Reflective type

Item	L163400J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-1
Recommended Operating Voltage	E

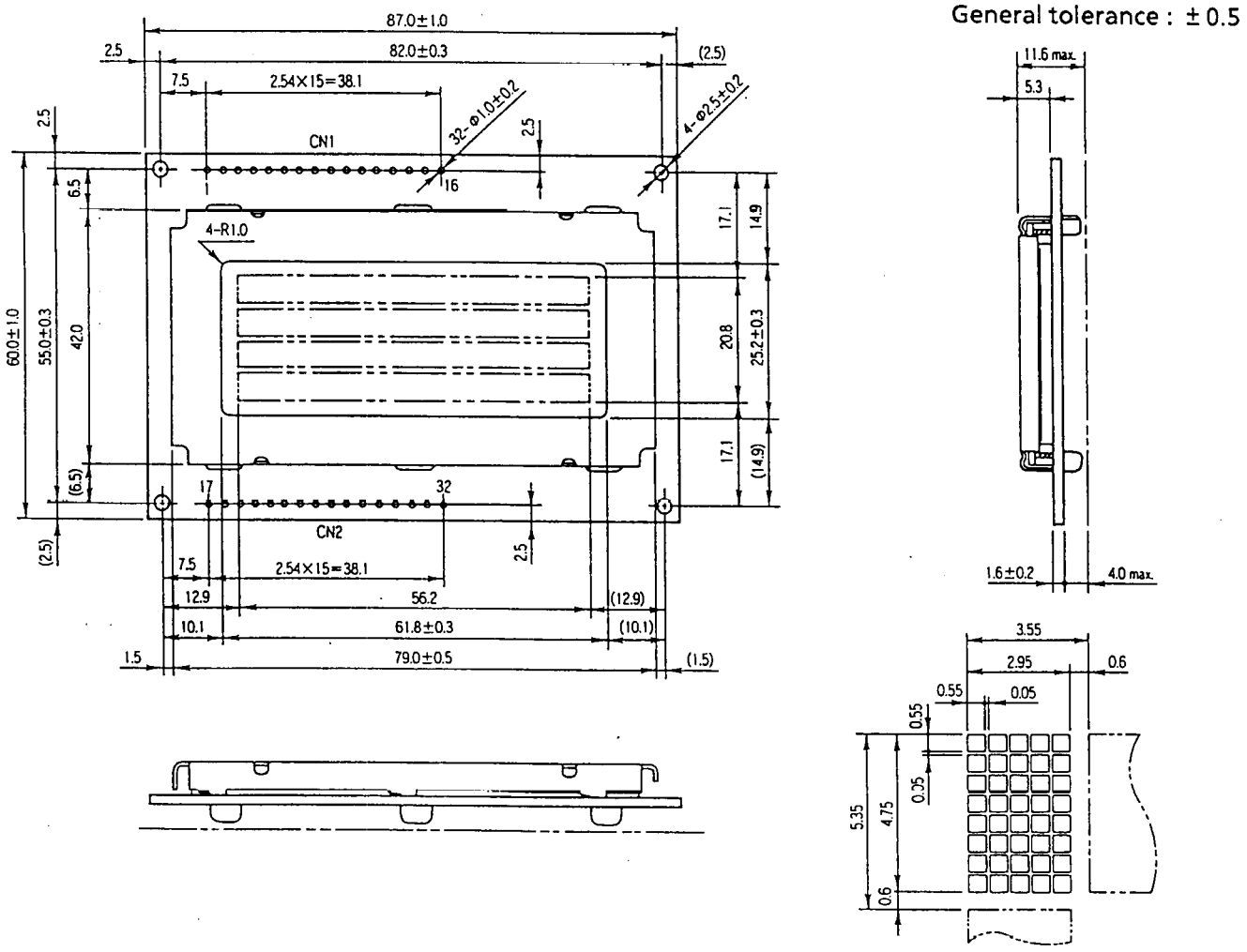
F-1 Power Supply



F-2 Dimensions

Unit : mm

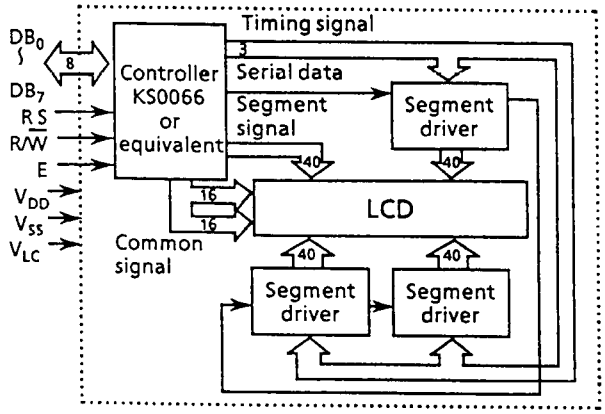
General tolerance : ±0.5



F-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L: Instruction code input H: Data input
5	21	R/W	L: Data write (LCM←MPU) H: Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

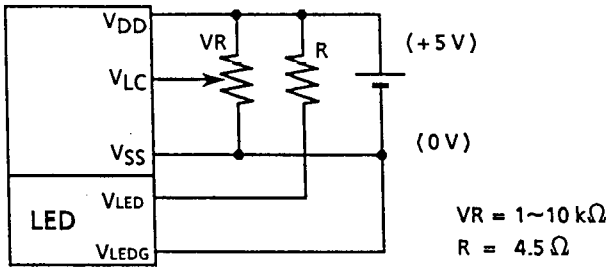
F-4 Block Diagram



■ **STN Transflective, Built-in LED Backlight type**

Item	L1634B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

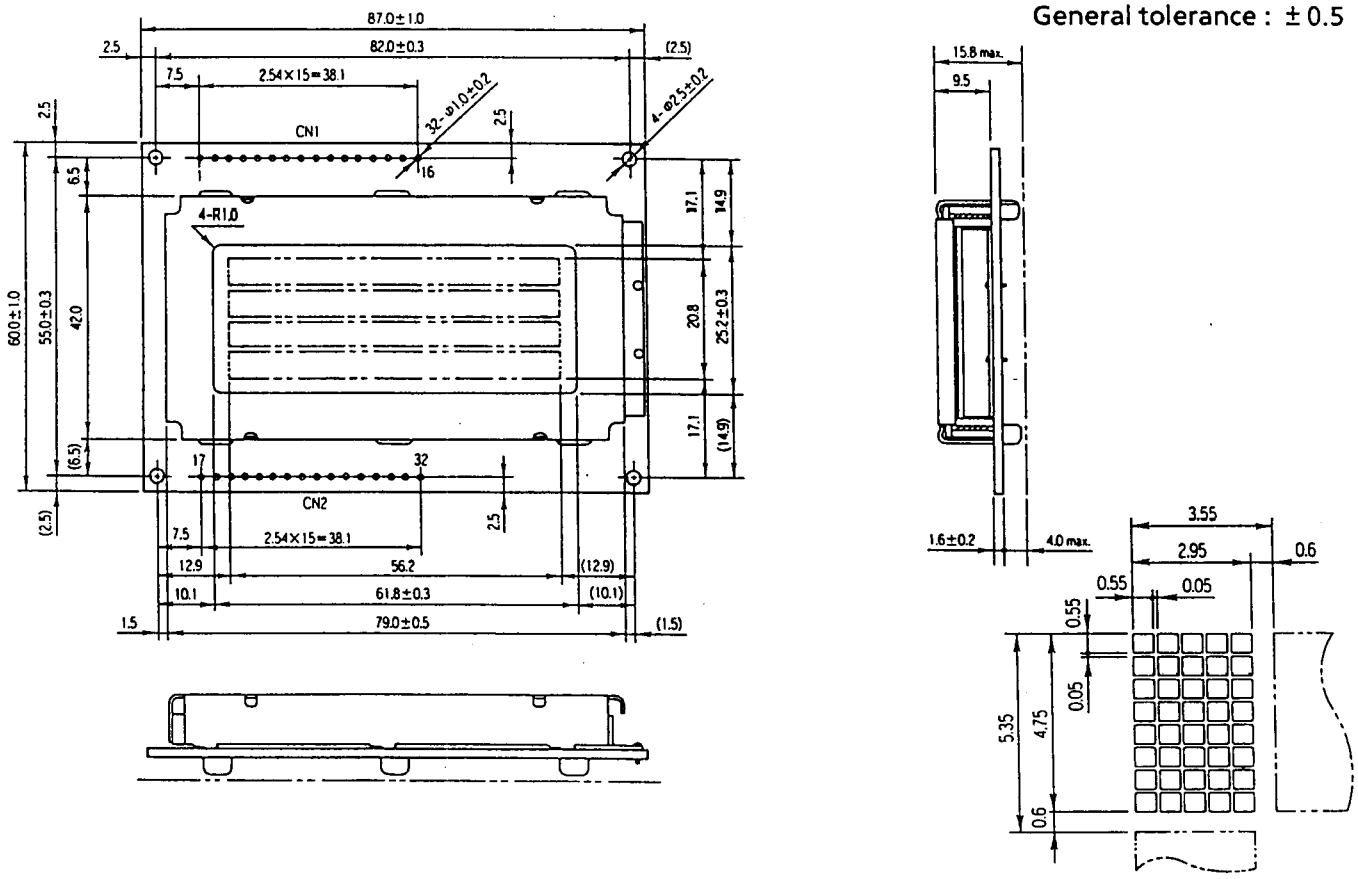
G-1 Power Supply



G-2 Dimensions

Unit: mm

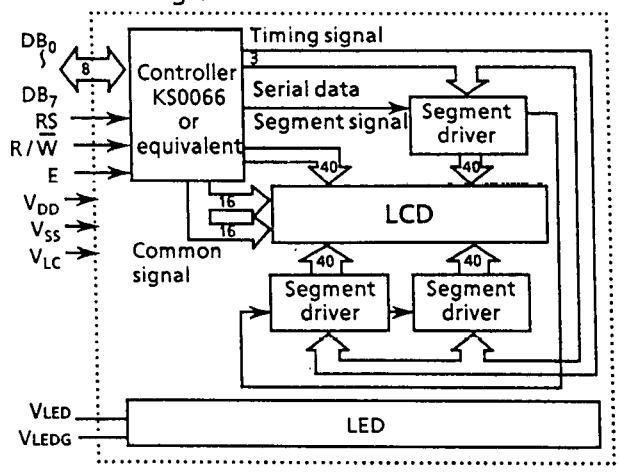
General tolerance : ± 0.5



G-3 Pin Functions

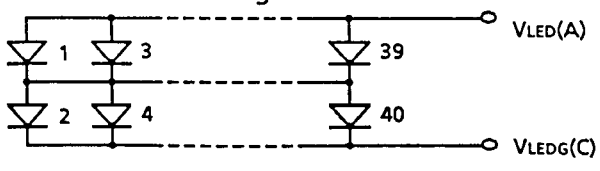
No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	V_{LED}	Anode
16	32	V_{LEDG}	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

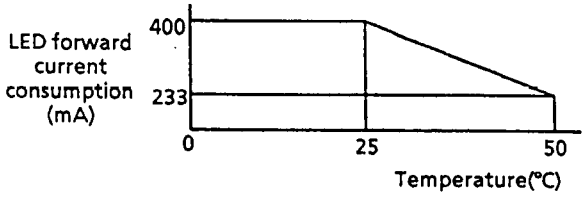


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	400	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.7	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 200 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	2.0	mA

G-5-4 Optical Characteristics

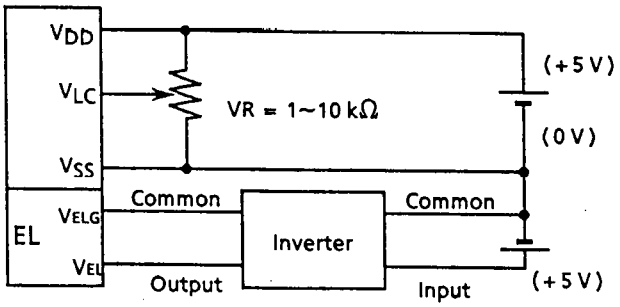
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 200 mA, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 200 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L163421J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

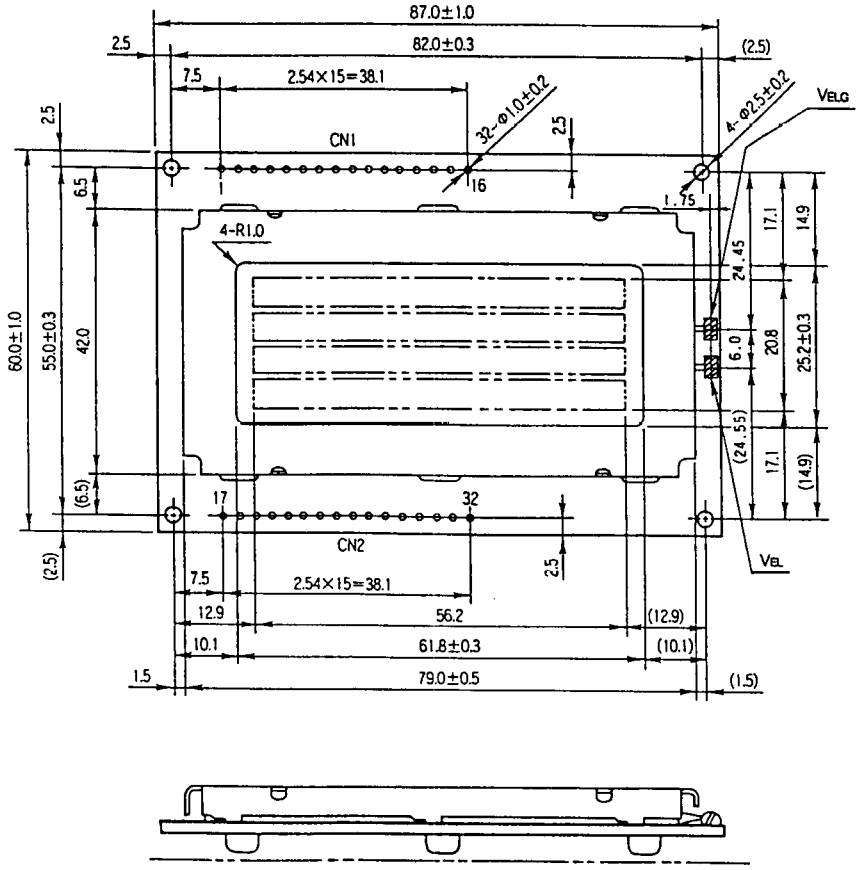
H-1 Power Supply

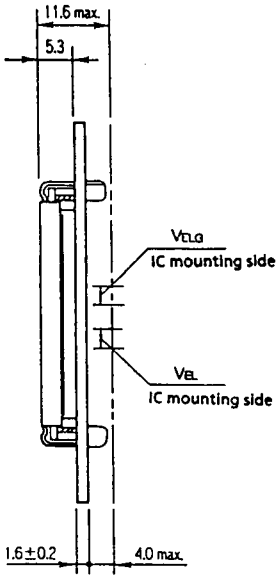


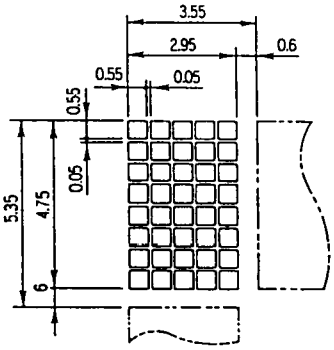
H-2 Dimensions

Unit : mm

General tolerance : ±0.5



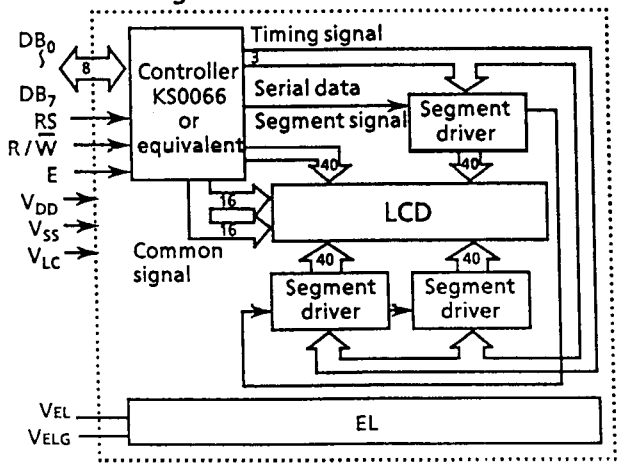




H-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	5.5 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	3.0 max. 2.2 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5A

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	350 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	95 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	45 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	3.5 typ.	cd/m^2

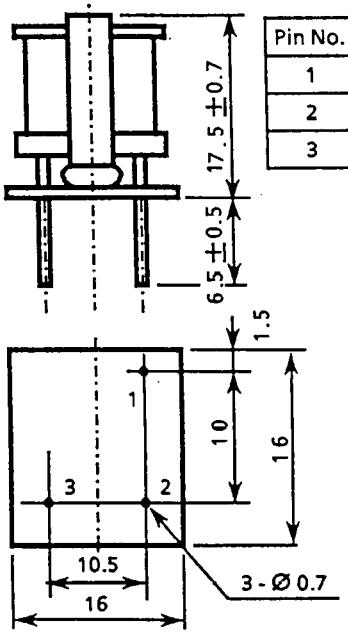
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	25	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≦ 48 hrs	+20	+85	%RH
		≦ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	2.7	4.0	mA
		I_{LC}		−	1.1	2.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L163400P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L1634B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

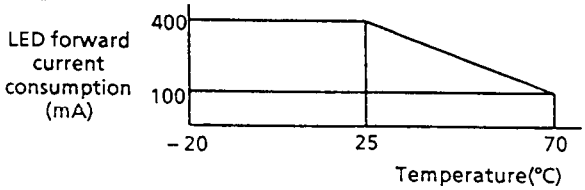
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	400	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.7	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 200 mA*, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 200 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L2032 Series

- 20 characters × 2 lines
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	116.0×37.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	116.0×37.0×15.8	mm
Viewing area (H×V)	83.0×18.6	mm
Character size (5×7 dot, H×V)	3.20×4.85	mm
Dot size (H×V)	0.60×0.65	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	108.0×29.0	mm
Weight (Reflective type)	40	g
Weight (Built-in LED backlight type)	60	g
Weight (Built-in EL backlight type)	45	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD}−7.0	V_{DD}+0.3	V
Input voltage	V_{IN}		−0.3	V_{DD}+0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	–	6.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$=0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL}=1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC}***	–	2.0	3.0	mA
		I_{LC}		–	0.4	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

*** TN LCD module: V_{LC} = 0.4 V, STN LCD module: V_{LC} = 0.25 V

D. Optical Characteristics

D-1 TN LCD module (reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.6 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	10	deg.
	θ_2		45	–	–	
	$\theta_2-\theta_1$		35	–	–	
Contrast	C	θ = 30°, ø = 0°	5	8	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	40	80	ms
Response time(fall)	t_{off}		–	120	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.8 V	–	240	330	ms
Response time(fall)	t_{off}		–	425	650	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−15	deg.
	θ_2		55	–	–	
	$\theta_2-\theta_1$		70	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−10	deg.
	θ_2		50	–	–	
	$\theta_2-\theta_1$		60	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	4.8	4.6	4.1

E-2 STN LCD module (gray)

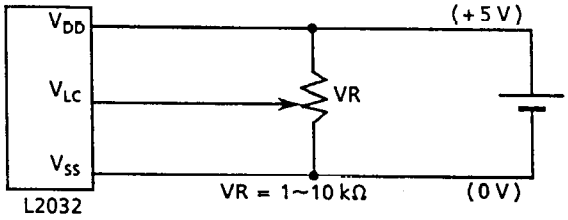
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ TN/STN Reflective type

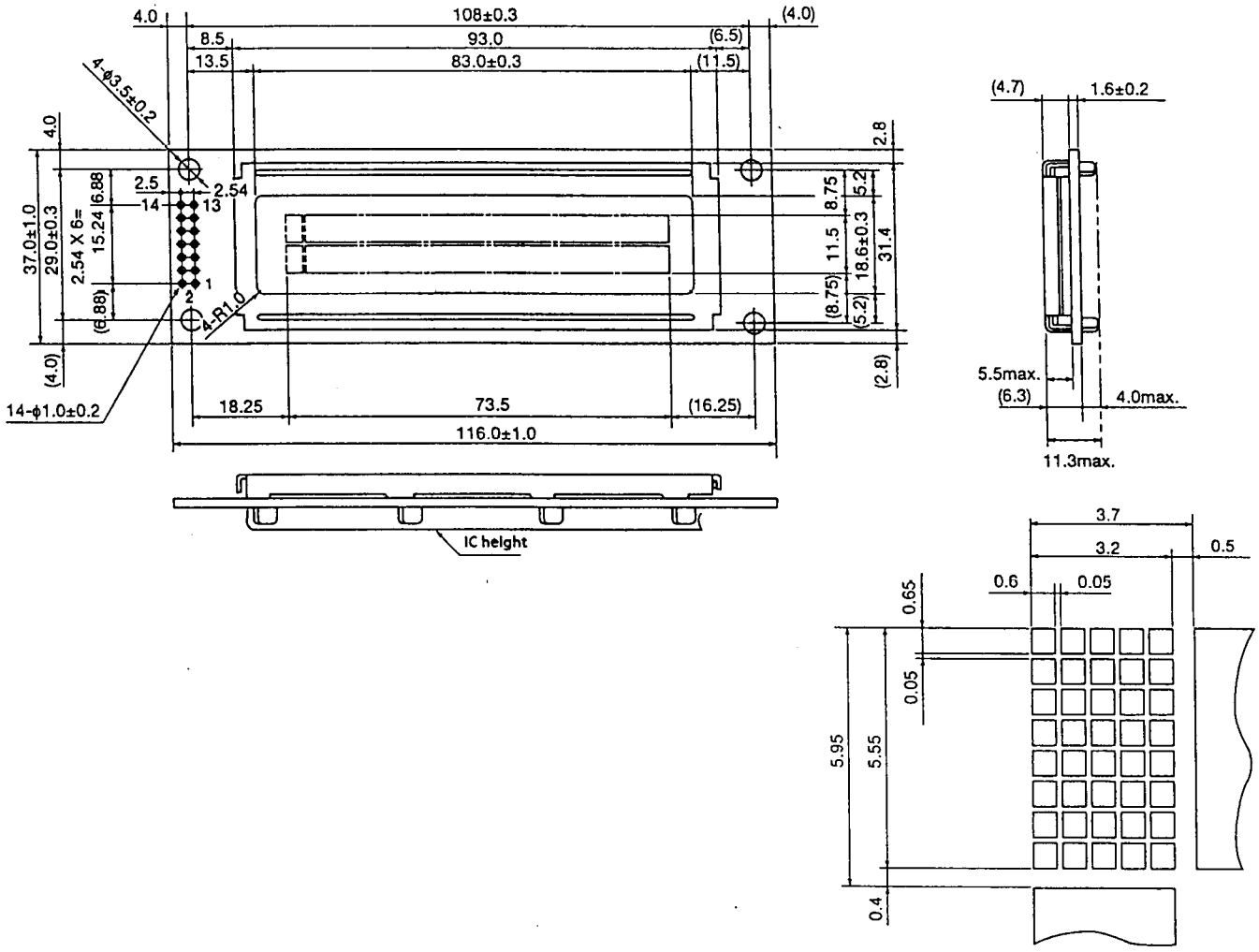
Item	L2032000000	L203200J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C	C
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

F-1 Power Supply



F-2 Dimensions

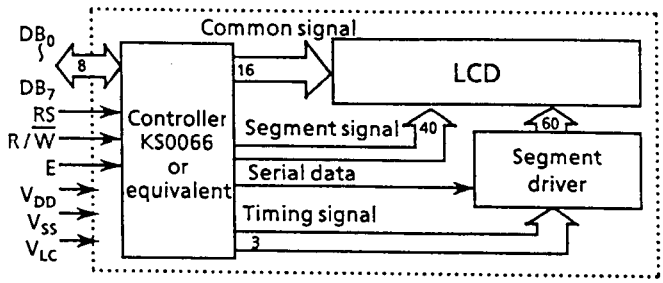
Unit : mm
General tolerance : ±0.5



F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

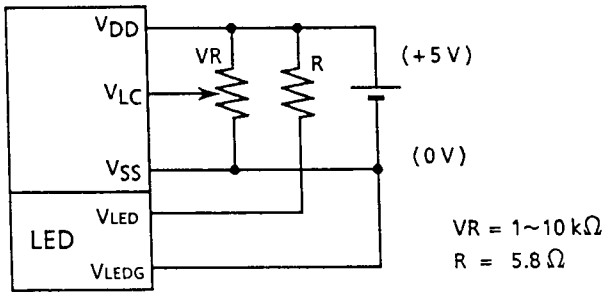
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

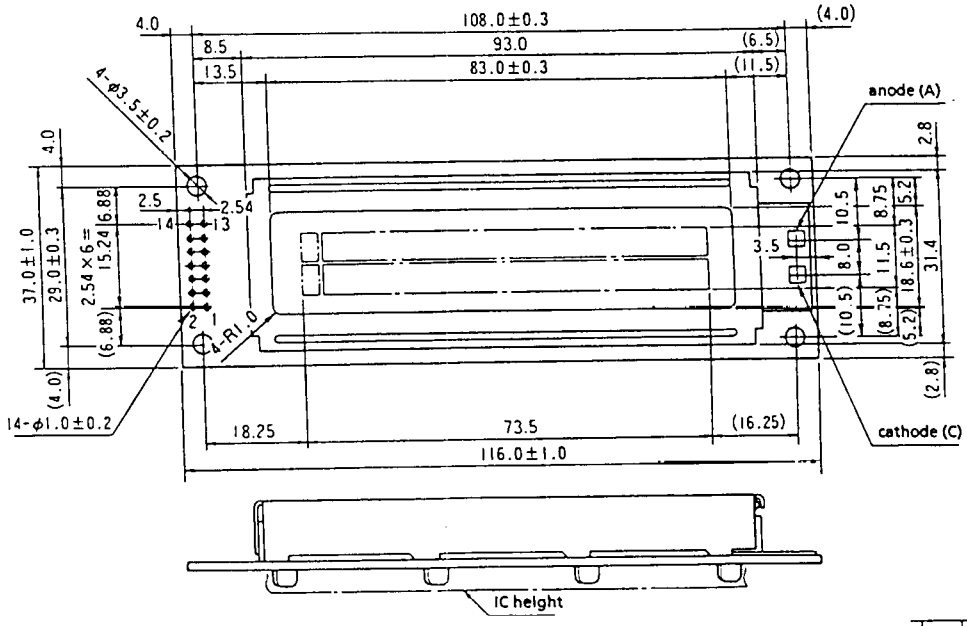
Item	L2032B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

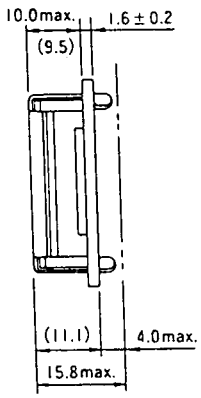
G-1 Power Supply

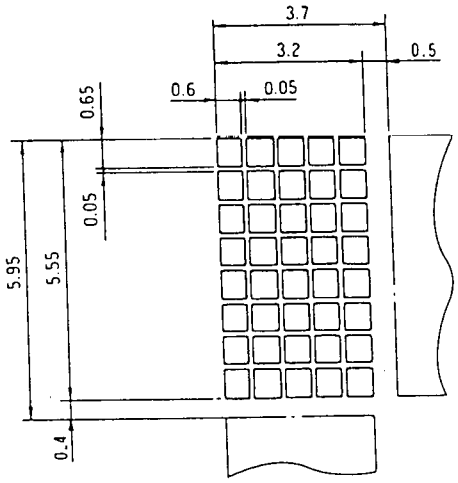


G-2 Dimensions

Unit: mm
General tolerance : ±0.5



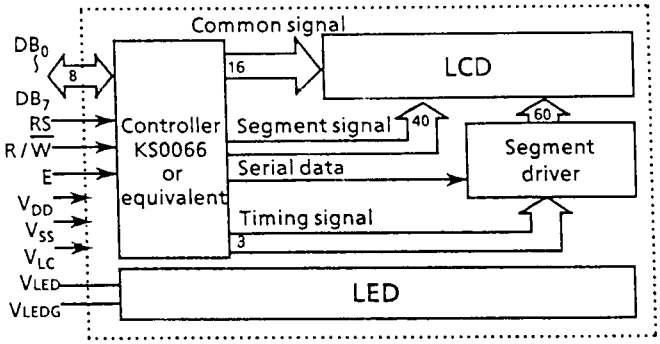




G-3 Pin Functions

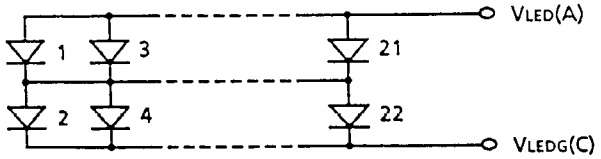
No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

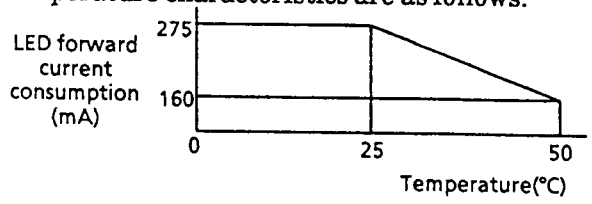


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	275	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.27	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 154 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	0.22	mA

G-5-4 Optical Characteristics

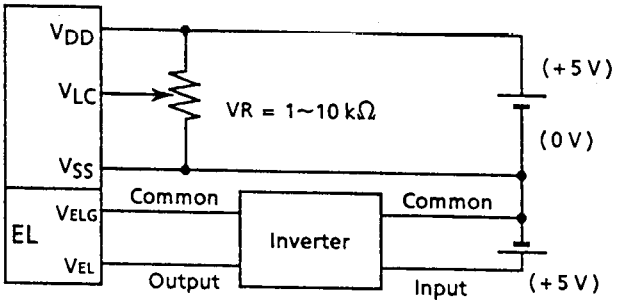
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 154 mA V_{opr} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 154 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L203221J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

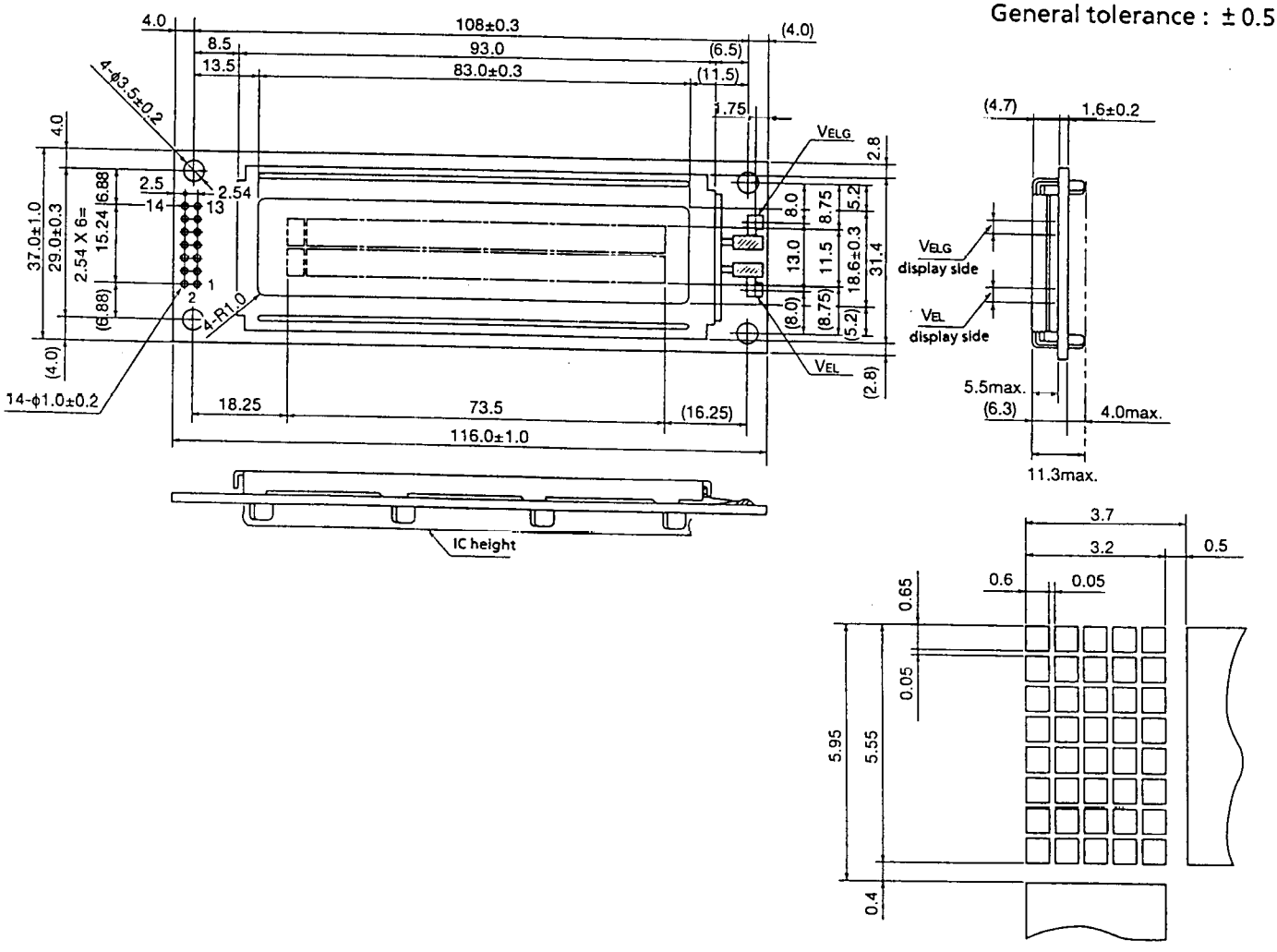
H-1 Power Supply



H-2 Dimensions

Unit: mm

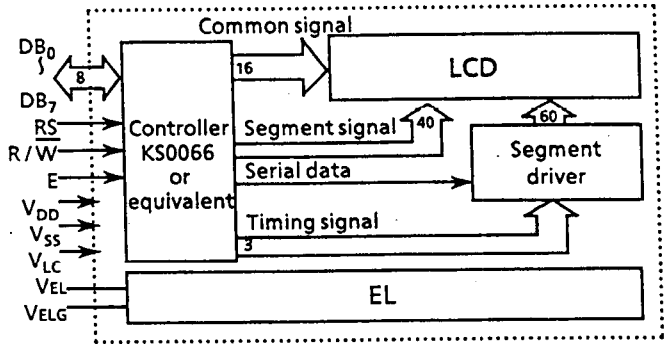
General tolerance : ±0.5



H-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	5.5 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	3.0 max. 2.2 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5A

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	350 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	95 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	45 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	7 typ.	cd/m^2

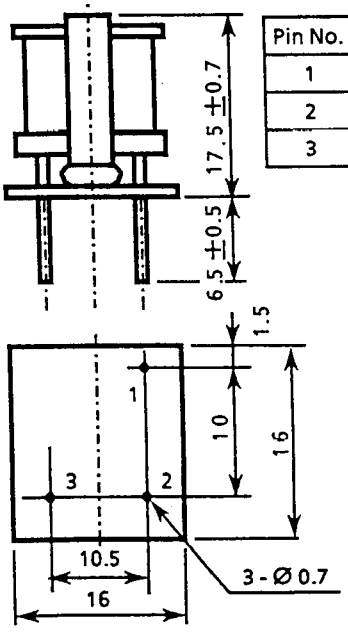
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	25	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 7.0	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≦ 48 hrs	+20	+85	%RH
		≦ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		3.0	−	6.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	2.0	3.0	mA
		I_{LC}		−	0.4	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2 - \theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L203200P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L2032B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

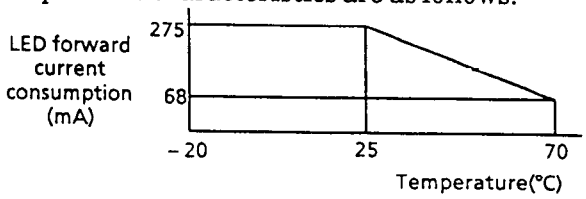
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	275	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.27	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 154 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 154 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L2034 Series

- 20 characters × 4 lines
- STN LCD is used
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	98.0×60.0×11.6	mm
Module size (H×V×T) (Built-in LED backlight type)	98.0×60.0×15.8	mm
Viewing area (H×V)	76.0×25.2	mm
Character size (5×7 dot , H×V)	2.95×4.15	mm
Dot size (H×V)	0.55×0.55	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	93.0×55.0	mm
Weight (Reflective type)	55	g
Weight (Built-in LED backlight type)	70	g
Weight (Built-in EL backlight type)	60	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	2.9	4.0	mA
		I_{LC}		−	1.2	2.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

D-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2-\theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

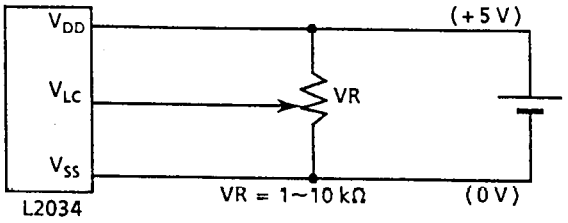
$V_{opr} = V_{DD} - V_{LC}$

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ STN Reflective type

Item	L203400J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-1
Recommended Operating Voltage	E

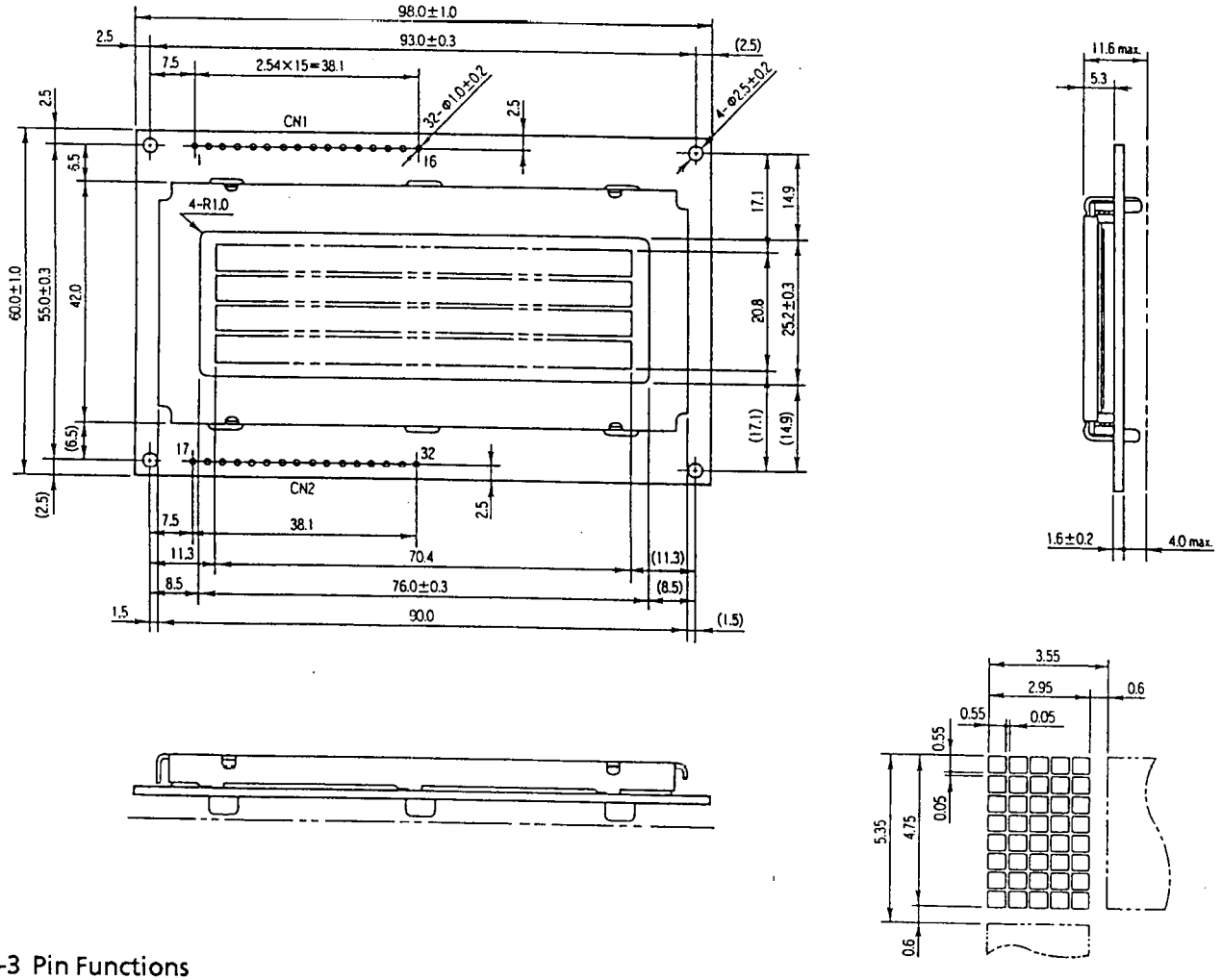
F-1 Power Supply



F-2 Dimensions

Unit : mm

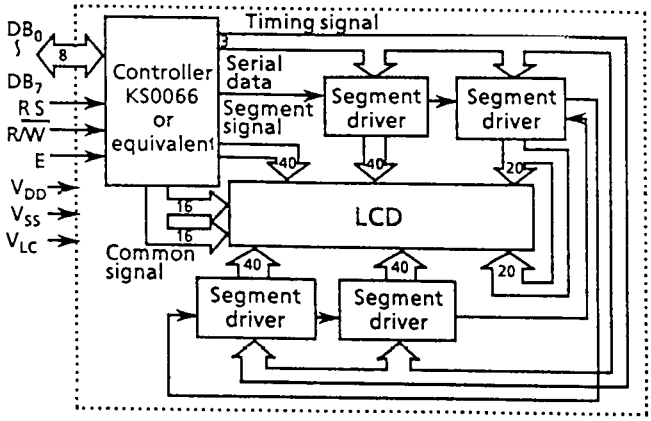
General tolerance : ±0.5



F-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

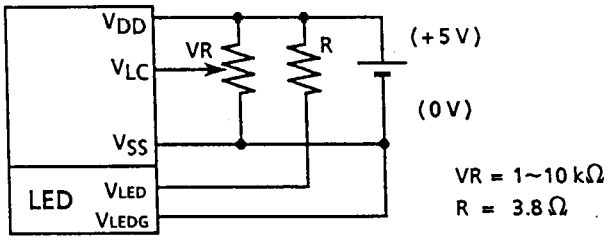
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

Item	L2034B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

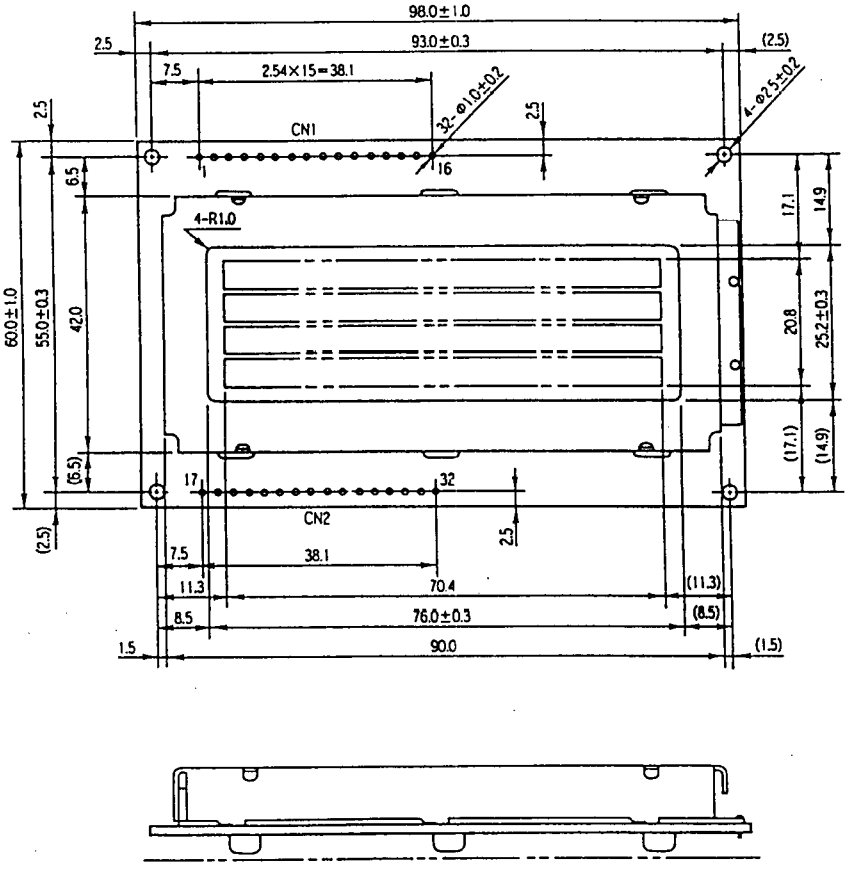
G-1 Power Supply

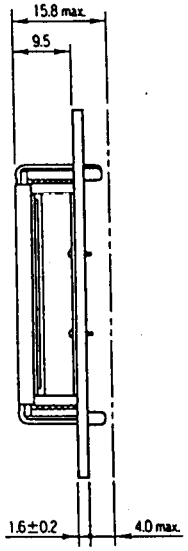


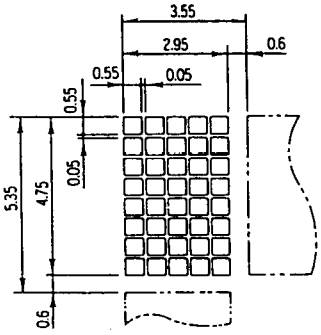
G-2 Dimensions

Unit : mm

General tolerance : ±0.5



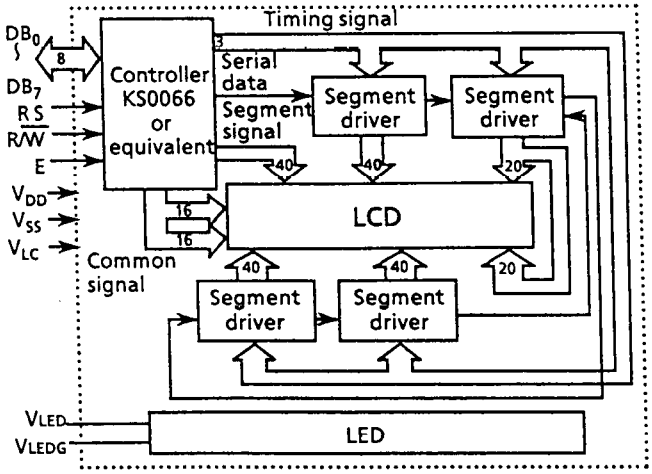




G-3 Pin Functions

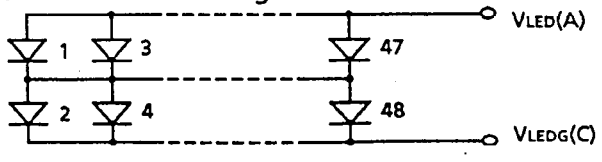
No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	V_{LED}	Anode
16	32	V_{LEDG}	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

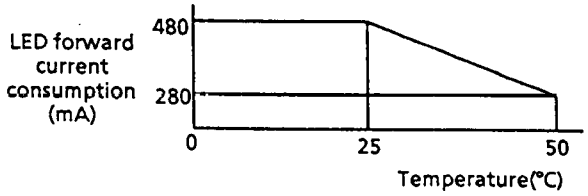


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	480	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.0	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 240 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	2.4	mA

G-5-4 Optical Characteristics

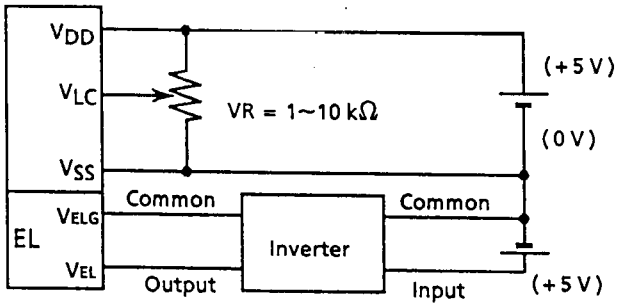
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 240 mA V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 240 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L203421J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

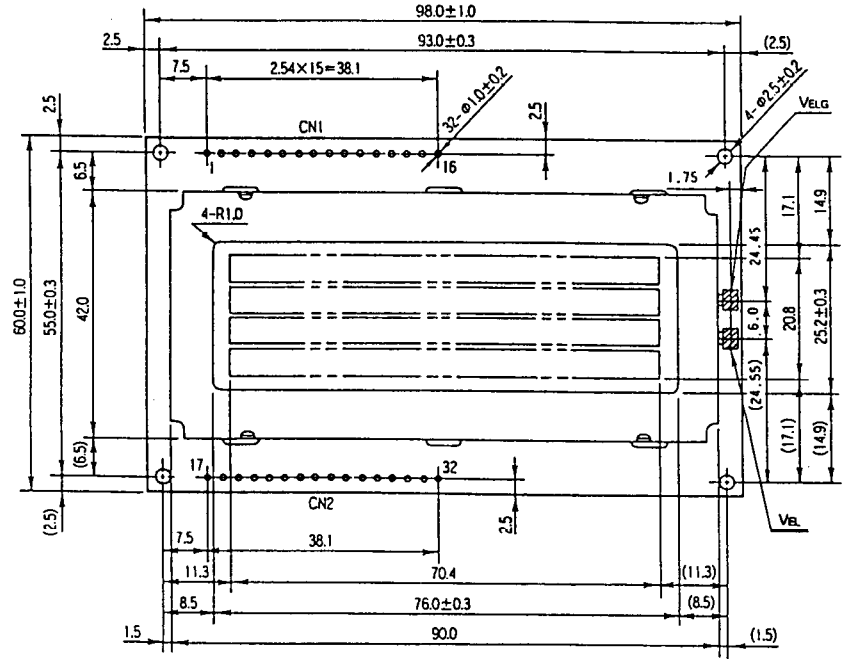
H-1 Power Supply

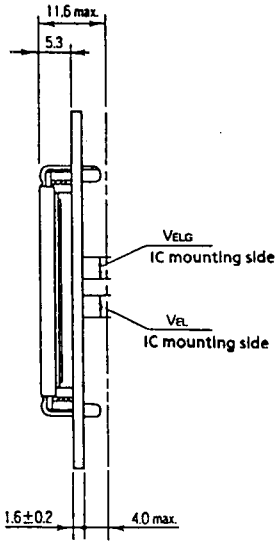


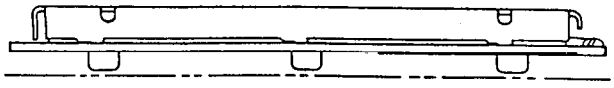
H-2 Dimensions

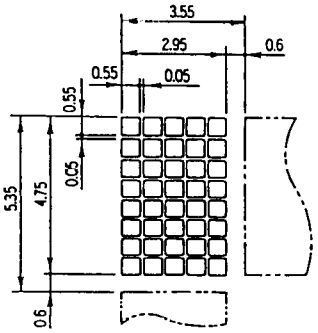
Unit : mm

General tolerance : ±0.5





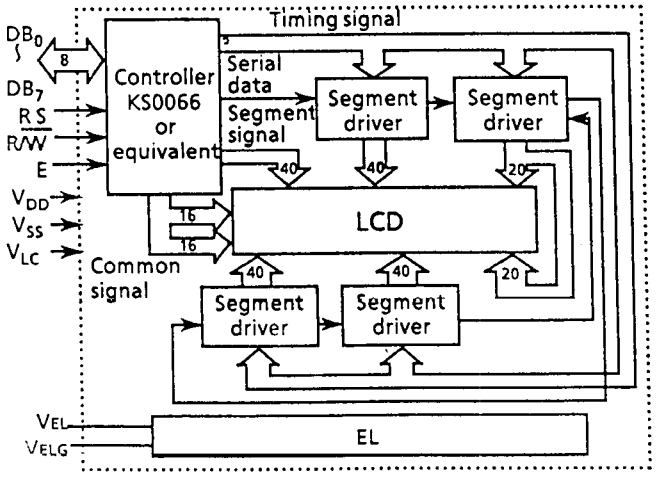




H-3 Pin Functions

No.	No.	Name	Function
1	17	V_{SS}	GND
2	18	V_{DD}	Power supply voltage + 5 V
3	19	V_{LC}	Liquid crystal driving voltage
4	20	RS	L:Instruction code input H: Data input
5	21	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	22	E	Enable
7	23	DB_0	Data bus line
8	24	DB_1	Data bus line
9	25	DB_2	Data bus line
10	26	DB_3	Data bus line
11	27	DB_4	Data bus line
12	28	DB_5	Data bus line
13	29	DB_6	Data bus line
14	30	DB_7	Data bus line
15	31	NC	–
16	32	NC	–

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	7.0 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	4.5 max. 3.0 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	35 min. 45 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	3500	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5A

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	350 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	95 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	45 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	3.5 typ.	cd/m^2

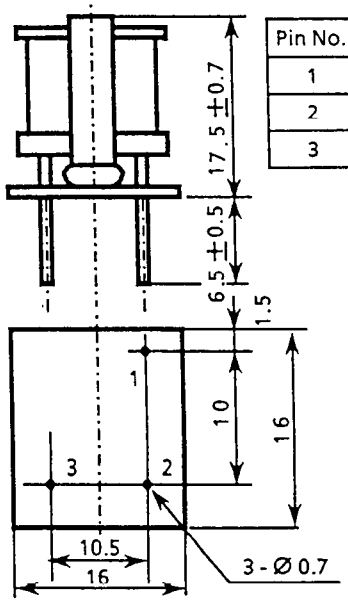
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	25	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		4.0	–	11.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	–	2.9	4.0	mA
		I_{LC}		–	1.2	2.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	0	deg.
	θ_2		50	–	–	
	$\theta_2 - \theta_1$		50	–	–	
Contrast	C	θ = 20°, ø = 0°	2	3	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	50	80	ms
Response time(fall)	t_{off}		–	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	200	320	ms
Response time(fall)	t_{off}		–	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	–	1500	2400	ms
Response time(fall)	t_{off}		–	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L203400P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L2034B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

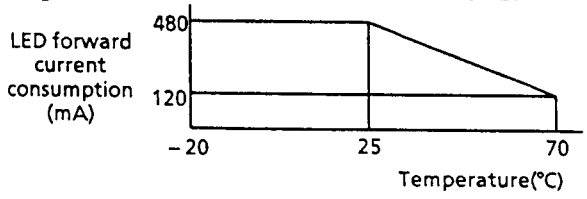
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	480	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.0	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 240 mA*, V_{opr} = 0 V	4.5 min. 5 typ.	cd/m²
LED brightness	L	I_F = 240 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics

■ Features of L2462 Series

- 24 characters × 2 lines
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	118.0×36.0×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	118.0×36.0×15.8	mm
Viewing area (H×V)	94.5×17.8	mm
Character size (5×7 dot, H×V)	3.20×4.85	mm
Dot size (H×V)	0.60×0.65	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	113.0×31.0	mm
Weight (Reflective type)	40	g
Weight (Built-in LED backlight type)	60	g
Weight (Built-in EL backlight type)	45	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD}−7.0	V_{DD}+0.3	V
Input voltage	V_{IN}		−0.3	V_{DD}+0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≦ 48 hrs	+20	+85	%RH
		≦ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	–	6.0	V
Input* voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$=0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL}=1.2 mA	–	–	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC}***	–	2.5	4.0	mA
		I_{LC}		–	0.5	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7
*** TN LCD module : V_{LC} = 0.4 V, STN LCD module : V_{LC} = 0.25 V

D. Optical Characteristics

D-1 TN LCD module(reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.6 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	10	deg.
	θ_2		45	–	–	
	$\theta_2-\theta_1$		35	–	–	
Contrast	C	θ = 30°, ø = 0°	5	8	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	40	80	ms
Response time(fall)	t_{off}		–	120	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.8 V	–	240	330	ms
Response time(fall)	t_{off}		–	425	650	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−15	deg.
	θ_2		55	–	–	
	$\theta_2-\theta_1$		70	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−10	deg.
	θ_2		50	–	–	
	$\theta_2-\theta_1$		60	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	4.8	4.6	4.1

E-2 STN LCD module (gray)

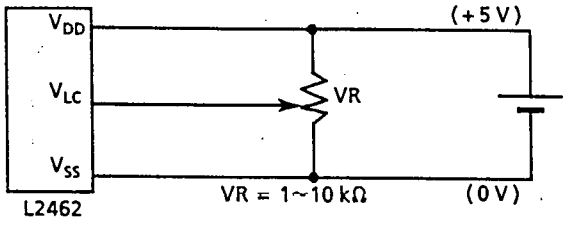
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ TN/STN Reflective type

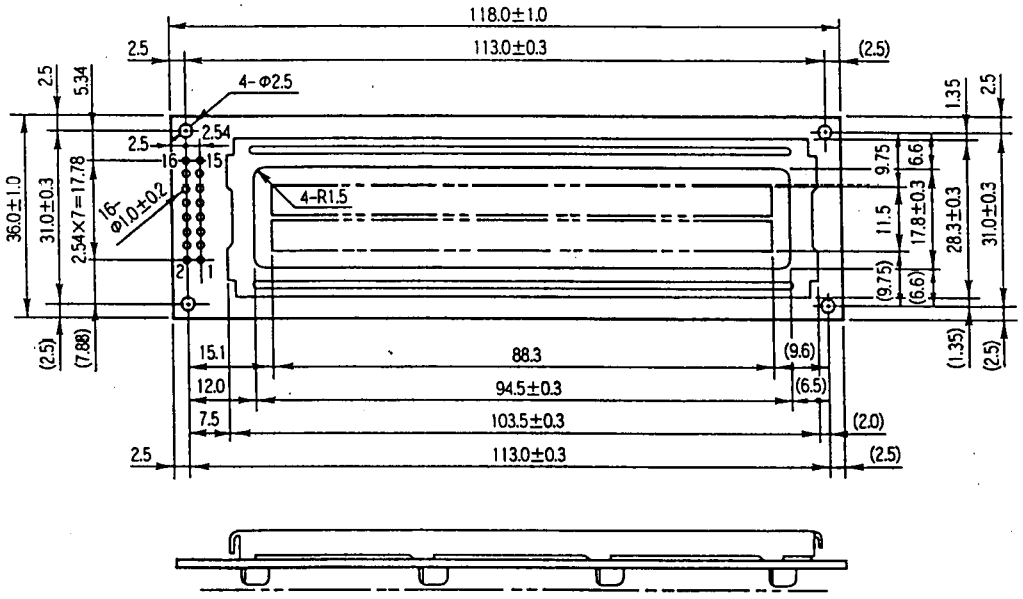
Item	L2462000000	L246200J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C	C
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

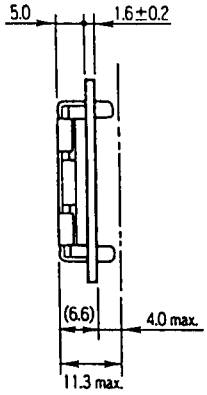
F-1 Power Supply

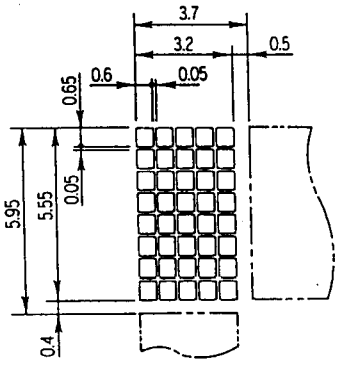


F-2 Dimensions

Unit : mm
General tolerance : ±0.5



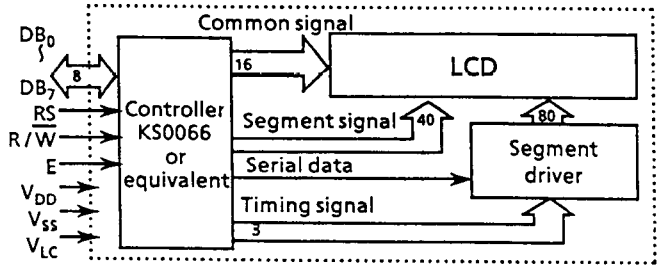




F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input H: Data input
5	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line
15	NC	–
16	NC	–

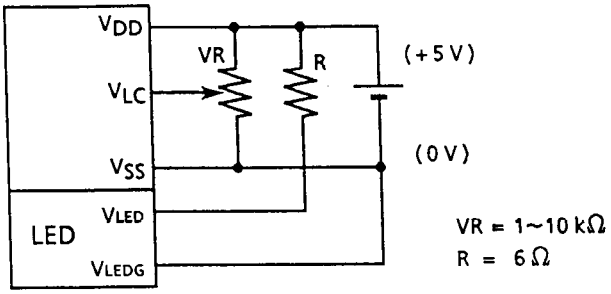
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

Item	L2462B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

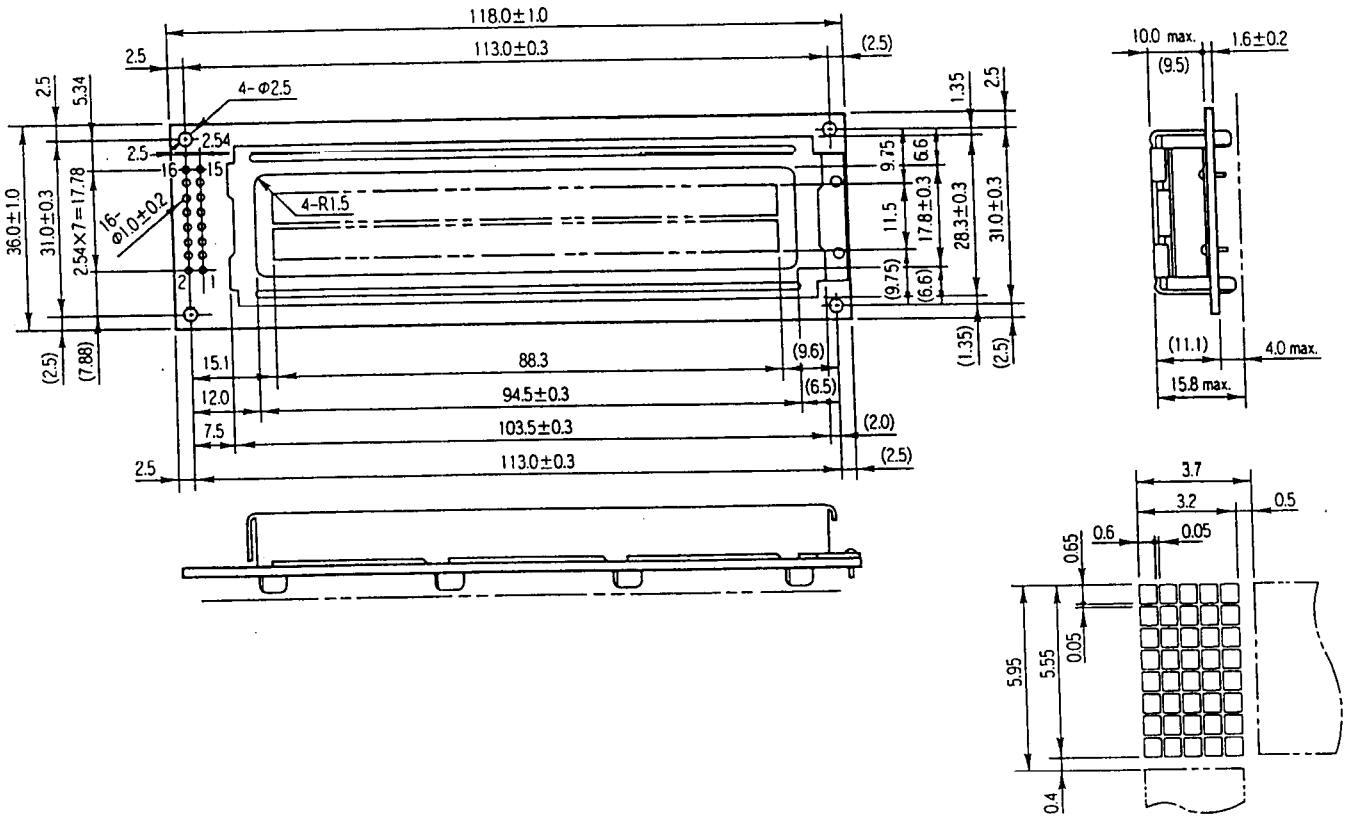
G-1 Power Supply



G-2 Dimensions

Unit : mm

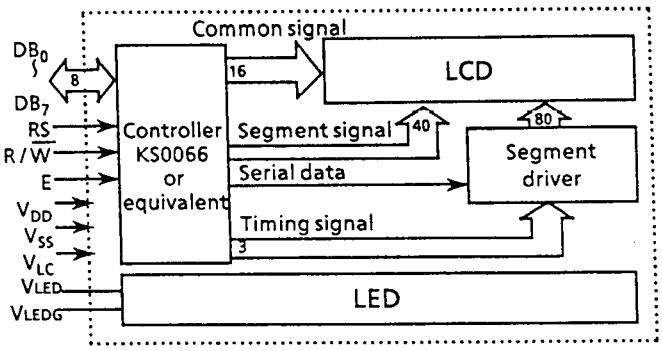
General tolerance : ±0.5



G-3 Pin Functions

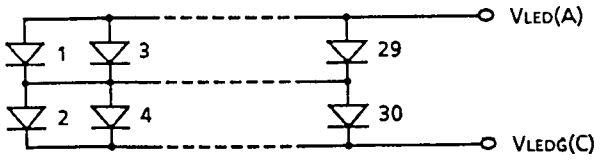
No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input H: Data input
5	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line
15	V_{LED}	Anode
16	V_{LEDG}	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

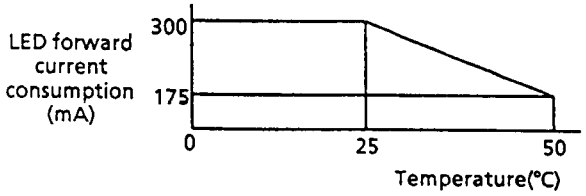


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	300	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.3	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 150 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	1.5	mA

G-5-4 Optical Characteristics

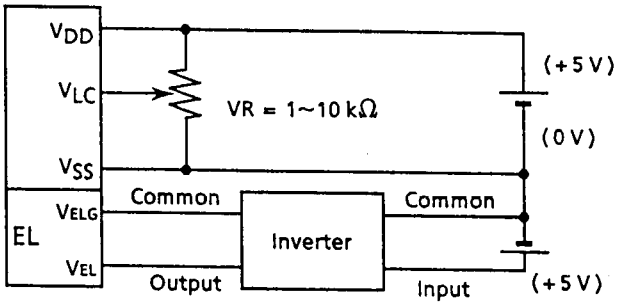
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 150 mA, V_{OPT} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 150 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L246221J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

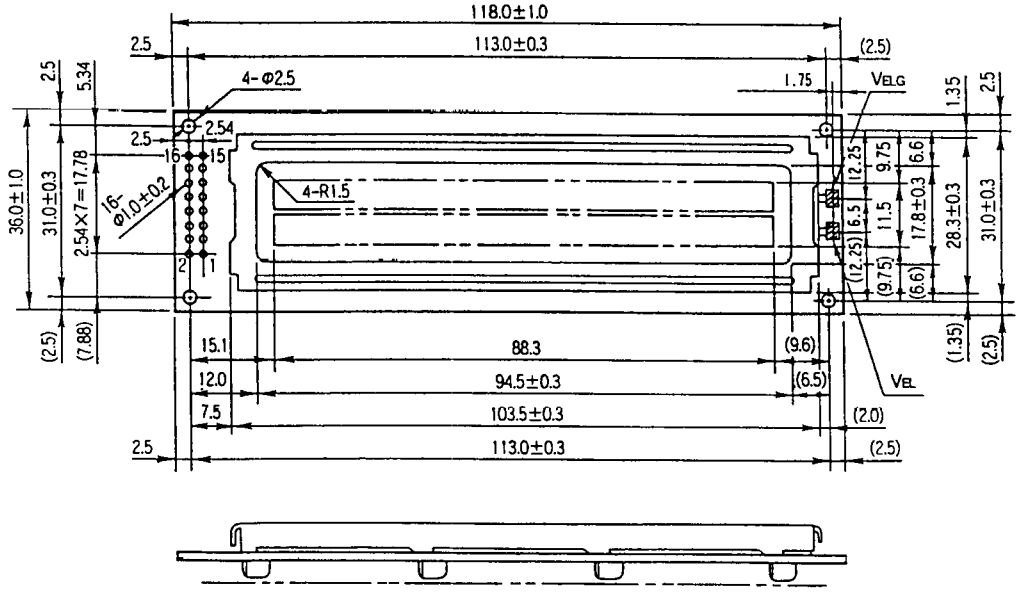
H-1 Power Supply

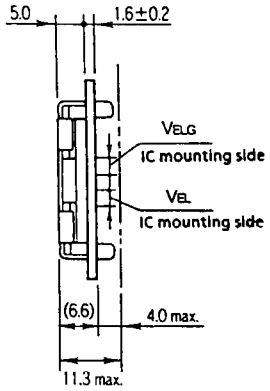


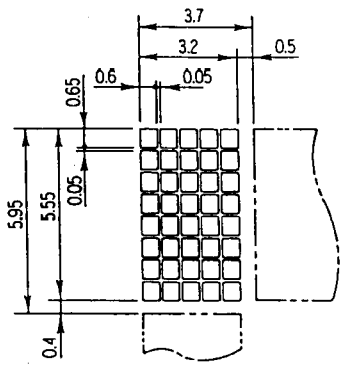
H-2 Dimensions

Unit : mm

General tolerance : ±0.5



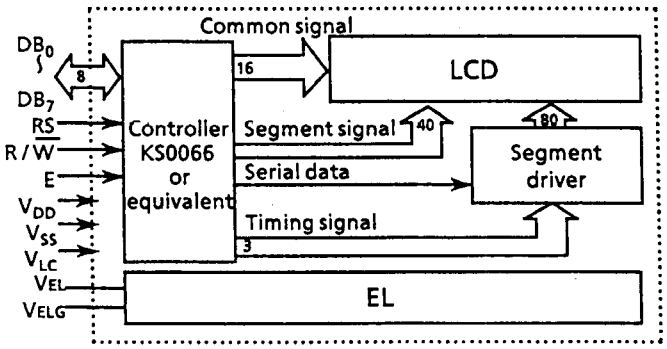




H-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input H: Data input
5	R/W	L:Data write (LCM←MPU) H:Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line
15	NC	–
16	NC	–

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ + 60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	5.5 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	3.0 max. 2.2 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m^2
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5A

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	350 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	95 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	1.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	45 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	35 typ.	cd/m^2
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	7 typ.	cd/m^2

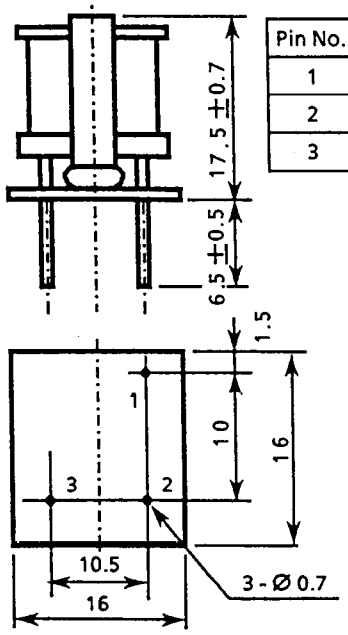
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	5 to 20	cm^2

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	25	cm^2
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD} − 7.0	V_{DD} + 0.3	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	−	6.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	2.5	4.0	mA
		I_{LC}		−	0.5	1.0	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

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

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L246200P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L2462B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

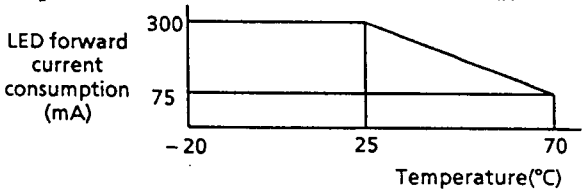
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	300	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	1.3	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 150 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 150 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L4051 Series

- 40 characters × 1 line
- STN LCD is used
- 5×10 dot matrix + cursor
- 1/11 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective type)	182.0×33.5×11.3	mm
Viewing area (H×V)	154.4×15.8	mm
Character size (5×7 dot, H×V)	3.15×7.90	mm
Dot size (H×V)	0.55×0.70	mm
Dot space	0.10	mm
Center to center dimension of mounting holes (H×V)	175.0×26.5	mm
Weight (Reflective type)	70	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD}−7.0	V_{DD}+0.3	V
Input voltage	V_{IN}		−0.3	V_{DD}+0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	–	6.0	V
Input* voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$=0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL}=1.2 mA	–	–	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.4 V	–	3.0	4.5	mA
		I_{LC}		–	1.0	1.5	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

- Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.6 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−15	deg.
	θ_2		55	–	–	
	$\theta_2-\theta_1$		70	–	–	
Contrast	C	θ = 20°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	130	200	ms
Response time(fall)	t_{off}		–	80	120	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	220	330	ms
Response time(fall)	t_{off}		–	360	550	

E. Recommended Operating Voltage (STN gray type)

The recommended value of (V_{opr}) for an ambient temperature is as follows.

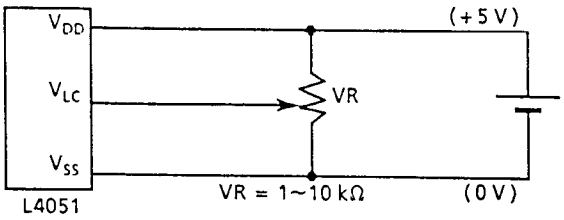
$V_{opr} = V_{DD} - V_{LC}$

Temperature(℃)	0	25	50
V_{opr} (V)	4.9	4.6	4.2

■ STN Reflective type

Item	L405100J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D
Recommended Operating Voltage	E

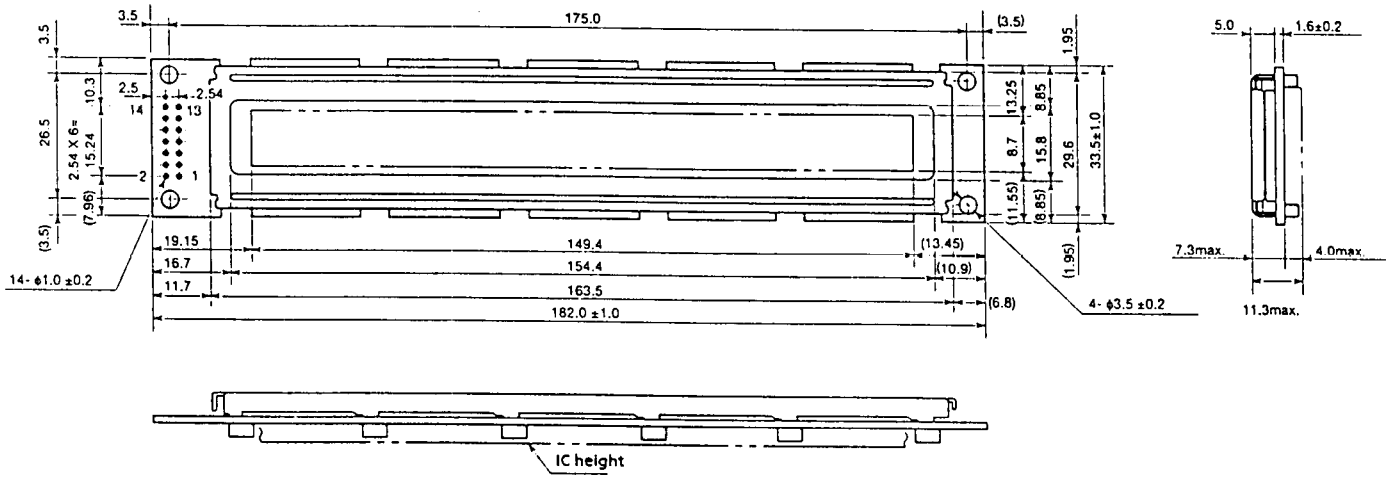
F-1 Power Supply

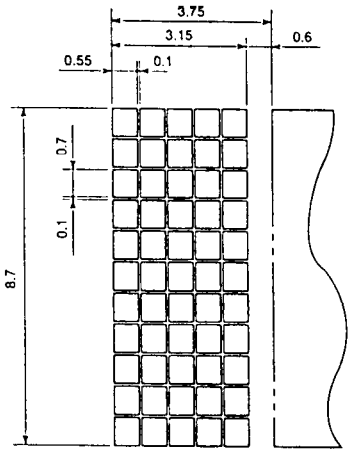


F-2 Dimensions

Unit : mm

General tolerance : ±0.5

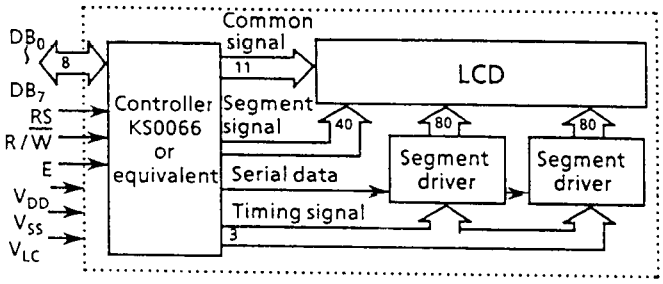




F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

F-4 Block Diagram



■ Features of L4052 Series

- 40 characters × 2 lines
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective / built-in EL backlight type)	182.0×33.5×11.3	mm
Module size (H×V×T) (Built-in LED backlight type)	182.0×33.5×16.3	mm
Viewing area (H×V)	154.4×15.8	mm
Character size (5×7 dot , H×V)	3.20×4.85	mm
Dot size (H×V)	0.60×0.65	mm
Dot space	0.05	mm
Center to center dimension of mounting holes (H×V)	175.0×26.5	mm
Weight (Reflective type)	70	g
Weight (Built-in LED backlight type)	95	g
Weight (Built-in EL backlight type)	75	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD}−7.0	V_{DD}+0.3	V
Input voltage	V_{IN}		−0.3	V_{DD}+0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	–	6.0	V
Input* voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$=0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL}=1.2 mA	–	–	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC}***	–	3.0	4.5	mA
		I_{LC}		–	1.0	1.5	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7
*** TN LCD module : V_{LC} = 0.4 V , STN LCD module: V_{LC} = 0.25 V

D. Optical Characteristics

D-1 TN LCD module (reflective type)

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.6 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	10	deg.
	θ_2		45	–	–	
	$\theta_2-\theta_1$		35	–	–	
Contrast	C	θ = 30°, ø = 0°	5	8	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	40	80	ms
Response time(fall)	t_{off}		–	120	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.8 V	–	240	330	ms
Response time(fall)	t_{off}		–	425	650	

D-2 STN LCD module (gray)

D-2-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−15	deg.
	θ_2		55	–	–	
	$\theta_2-\theta_1$		70	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

D-2-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	−10	deg.
	θ_2		50	–	–	
	$\theta_2-\theta_1$		60	–	–	
Contrast	C	θ = 25°, ø = 0°	2	4	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	270	400	ms
Response time(fall)	t_{off}		–	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	–	720	1100	ms
Response time(fall)	t_{off}		–	170	350	

E. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

E-1 TN LCD module

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	4.8	4.6	4.1

E-2 STN LCD module (gray)

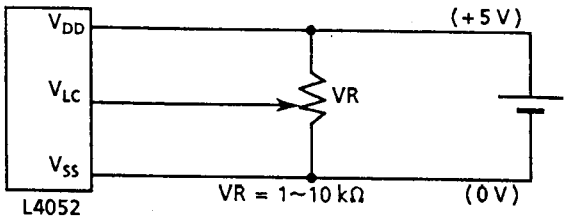
V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	0	25	50
V_{opr} (V)	5.0	4.75	4.5

■ TN/STN Reflective type

Item	L4052000000	L405200J000
Mechanical Characteristics	A	A
Absolute Maximum Ratings	B	B
Electrical Characteristics	C	C
Optical Characteristics	D-1	D-2-1
Recommended Operating Voltage	E-1	E-2

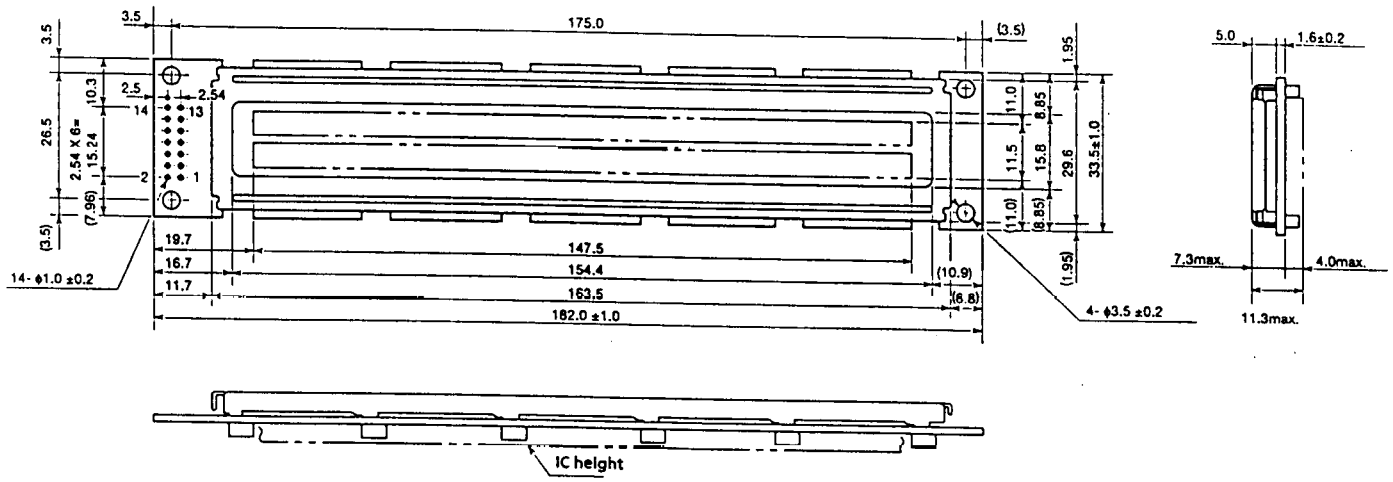
F-1 Power Supply

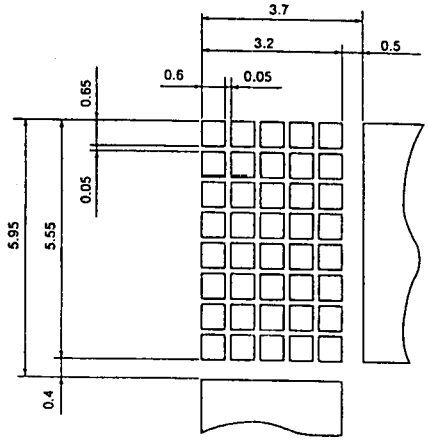


F-2 Dimensions

Unit : mm

General tolerance : ± 0.5

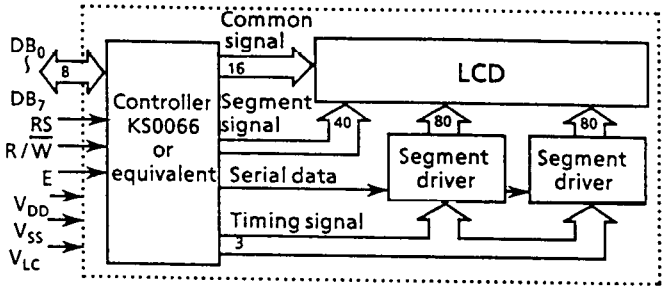




F-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

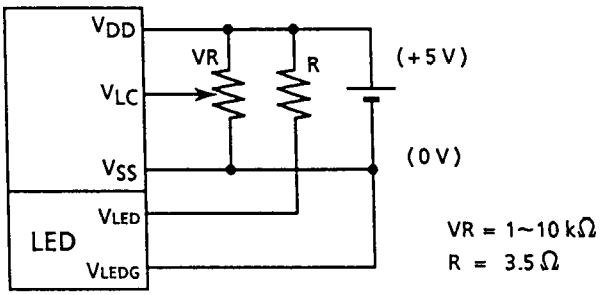
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

Item	L4052B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

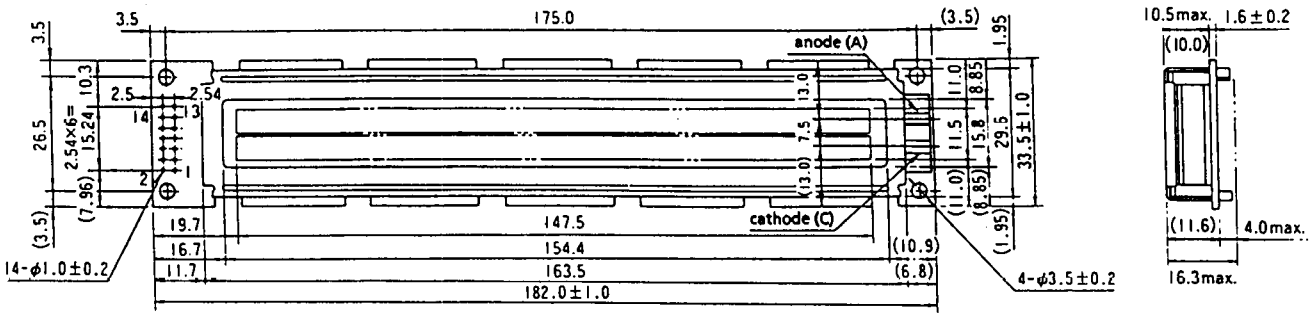
G-1 Power Supply

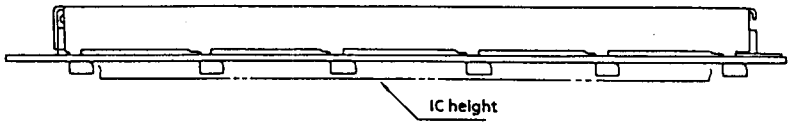


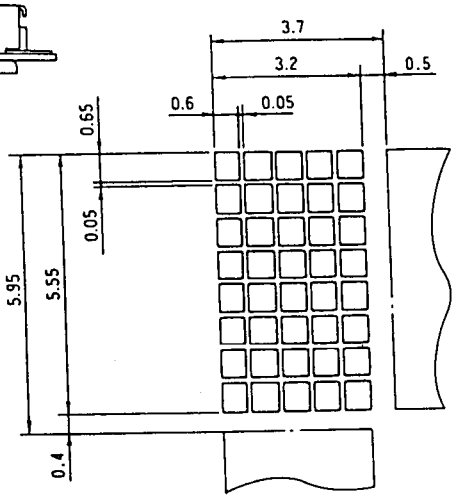
Unit : mm

General tolerance : ± 0.5

G-2 Dimensions



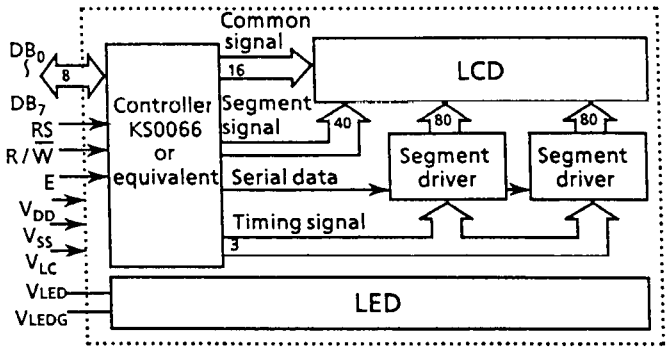




G-3 Pin Functions

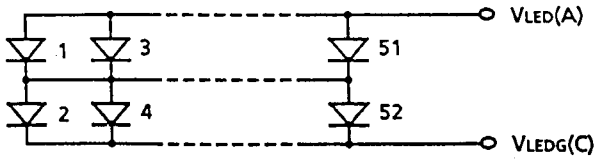
No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

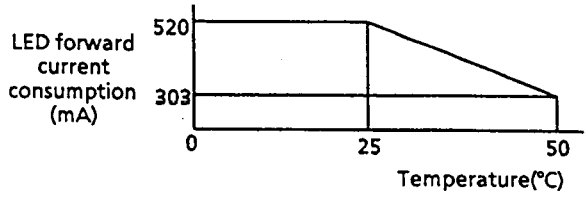


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	520	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.24	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 260 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	2.6	mA

G-5-4 Optical Characteristics

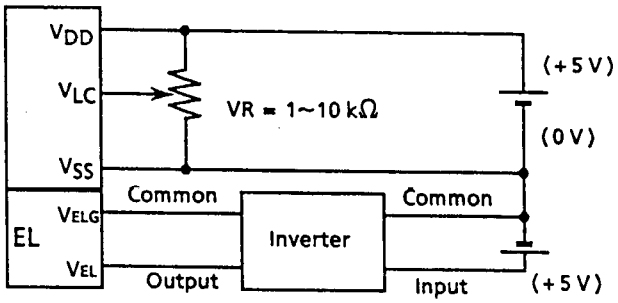
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 260 mA V_{opr} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 260 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

Item	L405221J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2-2
Recommended Operating Voltage	E-2

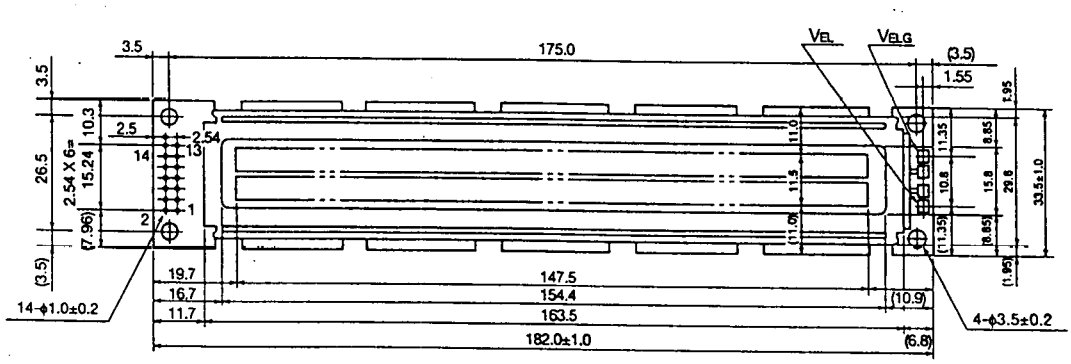
H-1 Power Supply

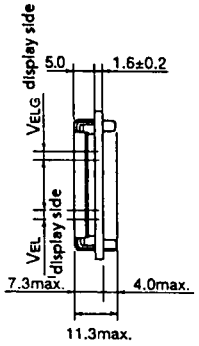


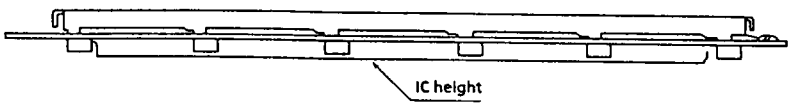
H-2 Dimensions

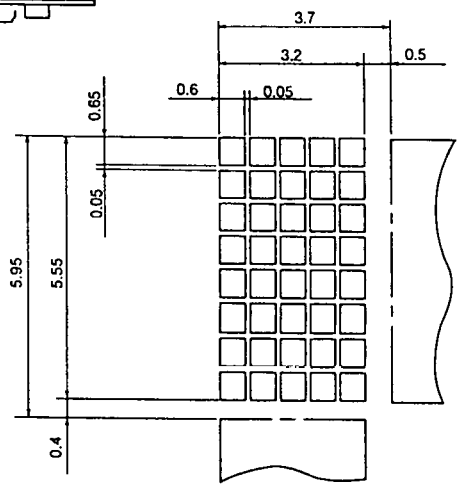
Unit : mm

General tolerance : ±0.5





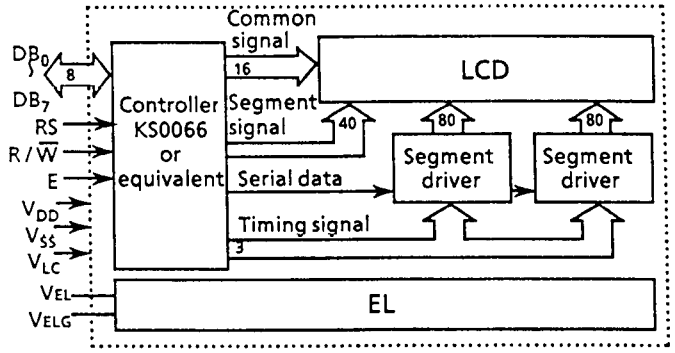




H-3 Pin Functions

No.	Name	Function
1	V_{SS}	GND
2	V_{DD}	Power supply voltage + 5 V
3	V_{LC}	Liquid crystal driving voltage
4	RS	L:Instruction code input, H: Data input
5	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
6	E	Enable
7	DB_0	Data bus line
8	DB_1	Data bus line
9	DB_2	Data bus line
10	DB_3	Data bus line
11	DB_4	Data bus line
12	DB_5	Data bus line
13	DB_6	Data bus line
14	DB_7	Data bus line

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	8.8 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	5.0 max. 3.5 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m²
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	–
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	–

H-6 Suitable Inverter 5C

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	480 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	105 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	3.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	25 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	40 typ.	cd/m²
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	8 typ.	cd/m²

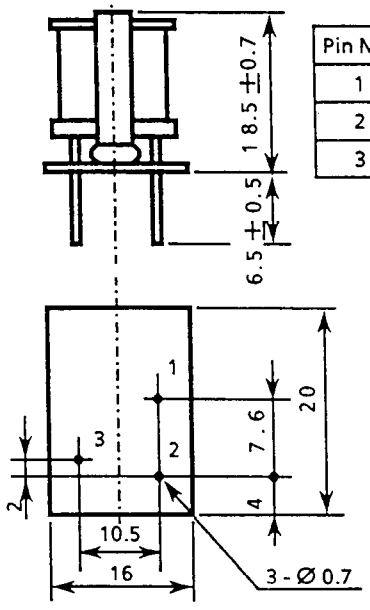
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	25 to 40	cm²

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	50	cm²
Operating temperature range	– 10 to + 60	°C
Storage temperature range	– 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	7.0	V
	V_{LC}		V_{DD}−7.0	V_{DD}+0.3	V
Input voltage	V_{IN}		−0.3	V_{DD}+0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		3.0	–	6.0	V
* Input voltage	High	V_{IH1}		2.2	–	V_{DD}	V
	Low	V_{IL1}		0	–	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$=0.205 mA	2.4	–	–	V
	Low	V_{OL1}	I_{OL}=1.2 mA	–	–	0.4	V
Current consump tion		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	–	3.0	4.5	mA
		I_{LC}		–	1.0	1.5	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	140	220	300	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	–	–	0	deg.
	θ_2		50	–	–	
	$\theta_2-\theta_1$		50	–	–	
Contrast	C	θ = 20°, ø = 0°	2	3	–	–
Response time(rise)	t_{on}	θ = 0°, ø = 0°	–	50	80	ms
Response time(fall)	t_{off}		–	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	–	200	320	ms
Response time(fall)	t_{off}		–	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	–	1500	2400	ms
Response time(fall)	t_{off}		–	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L405200P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L4052B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

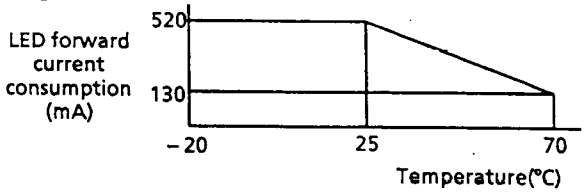
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	520	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	2.24	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 260 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 260 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

■ Features of L4044 Series

- 40 characters × 4 lines
- STN LCD is used
- 5×7 dot matrix + cursor
- 1/16 duty
- 5V single power supply

■ Specification

A. Mechanical Characteristics

Item	Specifications	Unit
Module size (H×V×T) (Reflective type)	190.0×54.0×10.1	mm
Module size (H×V×T) (Built-in LED backlight type)	190.0×54.0×16.3	mm
Module size (H×V×T) (Built-in EL backlight type)	190.0×54.0×11.3	mm
Viewing area (H×V)	147.0×29.5	mm
Character size (5×7 dot, H×V)	2.78×4.27	mm
Dot size (H×V)	0.50×0.55	mm
Dot space	0.07	mm
Center to center dimension of mounting holes (H×V)	183.0×47.0	mm
Weight (Reflective type)	90	g
Weight (Built-in LED backlight type)	140	g
Weight (Built-in EL backlight type)	105	g

H:Horizontal, V:Vertical, T:Thickness (max.)

B. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		0	+50	°C
Storage temp.	T_{stg}		−20	+60	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

C. Electrical Characteristics

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		$V_{DD}-V_{LC}$		4.0	−	11.0	V
Input* voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
Output** voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.25 V	−	8.0	12.0	mA
		I_{LC}		−	3.8	4.5	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS
** Applied to DB_0~DB_7

D. Optical Characteristics (STN gray type)

D-1 Reflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C
V_{opr} = 4.75 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−15	deg.
	θ_2		55	−	−	
	$\theta_2-\theta_1$		70	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

D-2 Transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C,
V_{opr} = 4.75 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	−10	deg.
	θ_2		50	−	−	
	$\theta_2-\theta_1$		60	−	−	
Contrast	C	θ = 25°, ø = 0°	2	4	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	270	400	ms
Response time(fall)	t_{off}		−	60	100	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 5.0 V	−	720	1100	ms
Response time(fall)	t_{off}		−	170	350	

E. Recommended Operating Voltage (STN gray type)

The recommended value of (V_{opr}) for an ambient temperature is as follows.

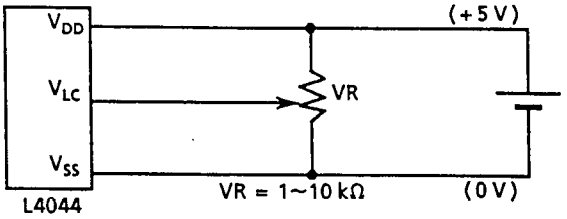
$V_{opr} = V_{DD} - V_{LC}$

Temperature(°C)	0	25	50
V_{opr} (V)	5.00	4.75	4.50

■ STN Reflective type

Item	L404400J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-1
Recommended Operating Voltage	E

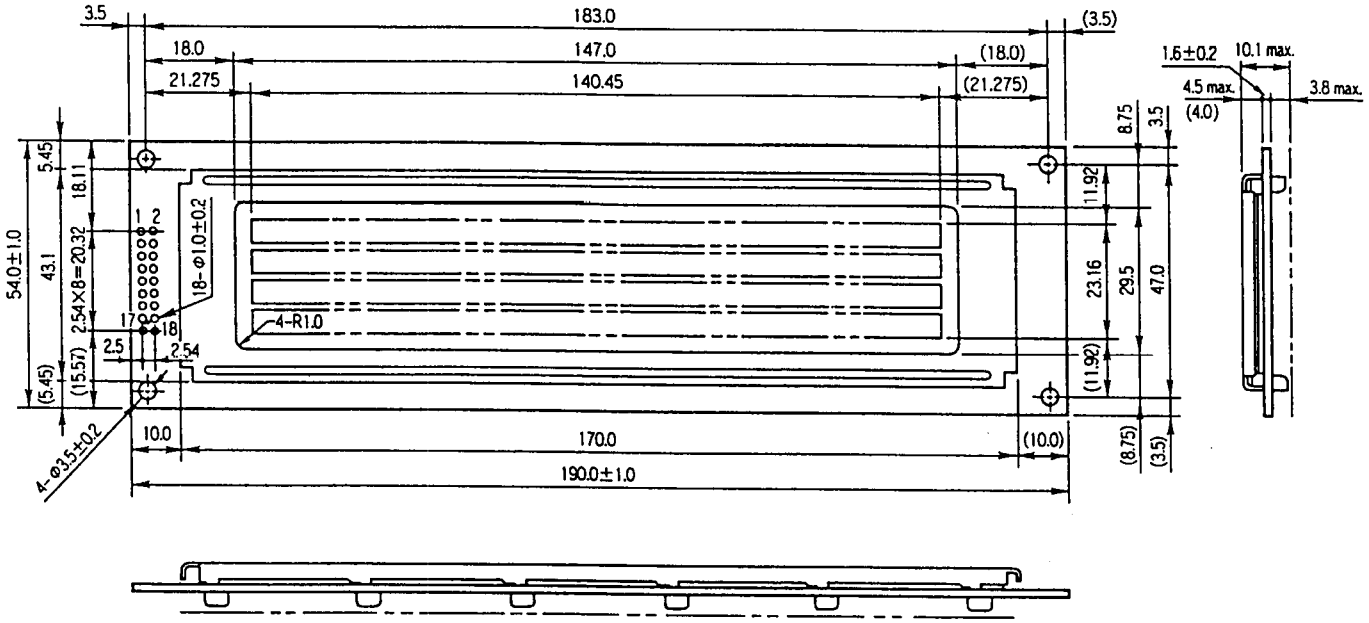
F-1 Power Supply

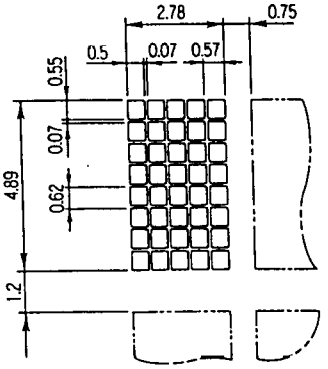


F-2 Dimensions

Unit : mm

General tolerance : ±0.5

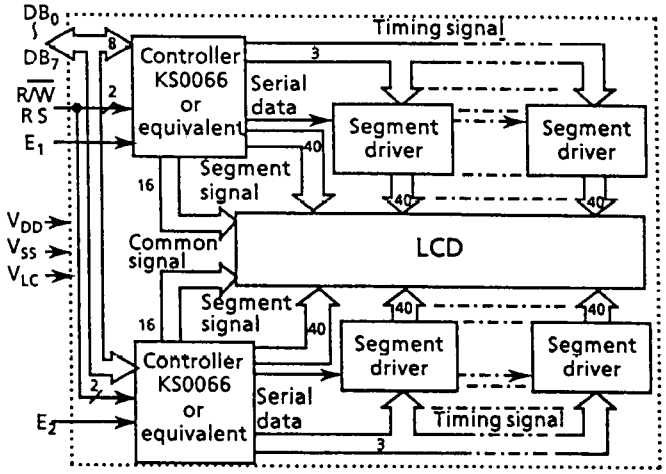




F-3 Pin Functions

No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E_1	Enable (for upper 2 lines)
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V
15	E_2	Enable (for lower 2 lines)
16	NC	—
17	NC	—
18	NC	—

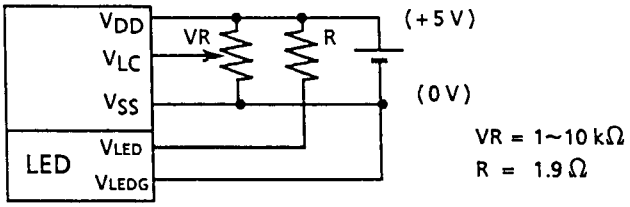
F-4 Block Diagram



■ STN Transflective, Built-in LED Backlight type

Item	L4044B1J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

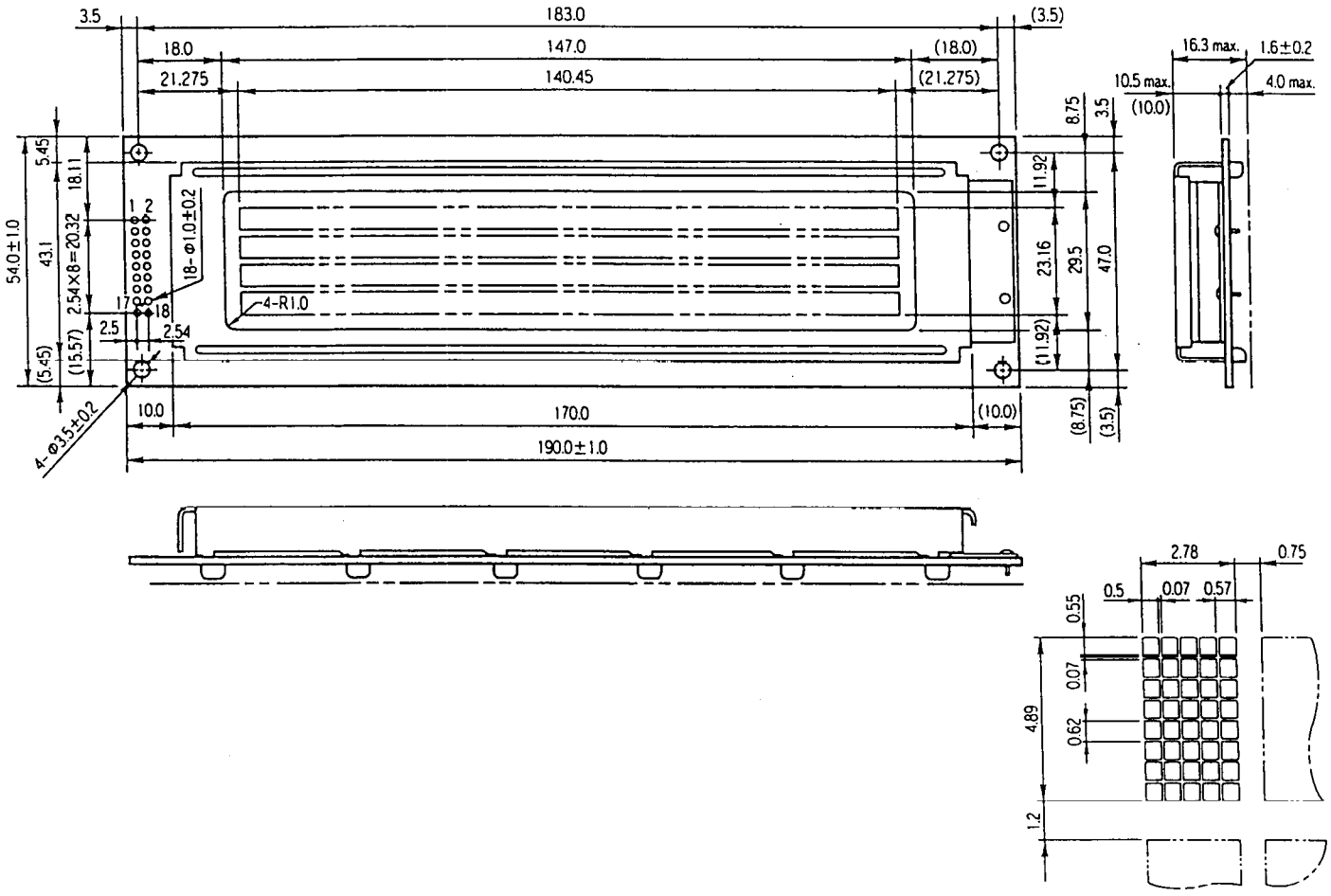
G-1 Power Supply



G-2 Dimensions

Unit : mm

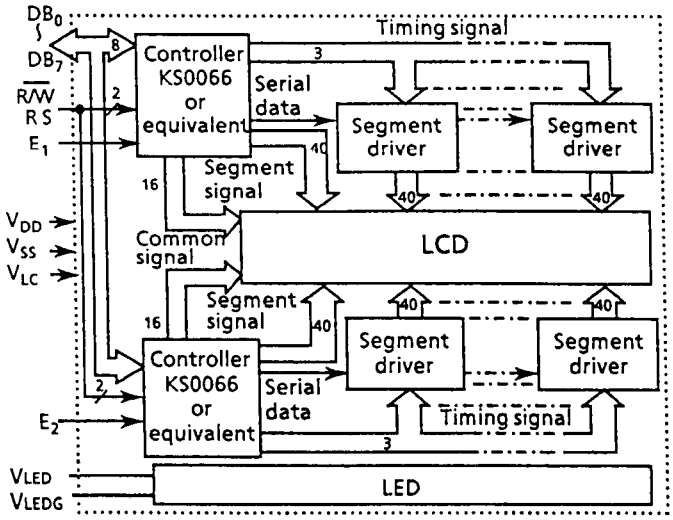
General tolerance : ± 0.5



G-3 Pin Functions

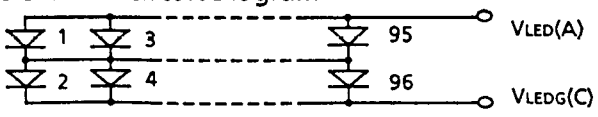
No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E_1	Enable (for upper 2 lines)
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V
15	E_2	Enable (for lower 2 lines)
16	NC	—
17	VLED	Anode
18	VLEDG	Cathode

G-4 Block Diagram



G-5 LED Backlight

G-5-1 LED Circuit Diagram

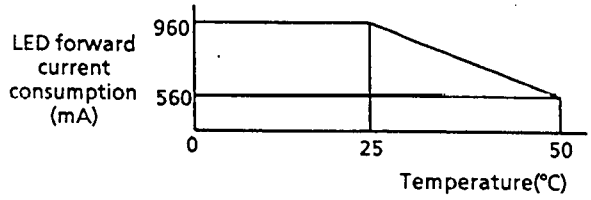


G-5-2 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	960	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	4.16	W

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



G-5-3 Electrical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
LED forward input voltage	V_F	I_F = 480 mA	3.8	4.1	4.4	V
LED reverse current	I_R	V_R = 8 V	–	–	4.8	mA

G-5-4 Optical Characteristics

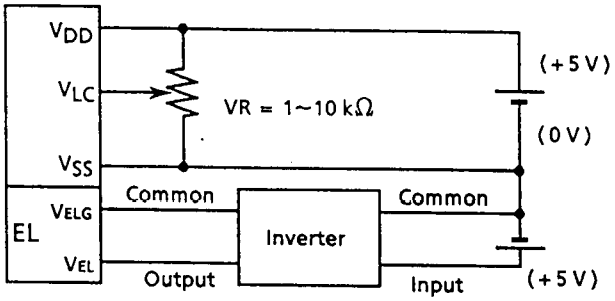
Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 480 mA, V_{opr} = 0 V	8 min. 10 typ.	cd/m²
LED brightness	L	I_F = 480 mA	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

■ STN Transflective, Built-in EL Backlight type

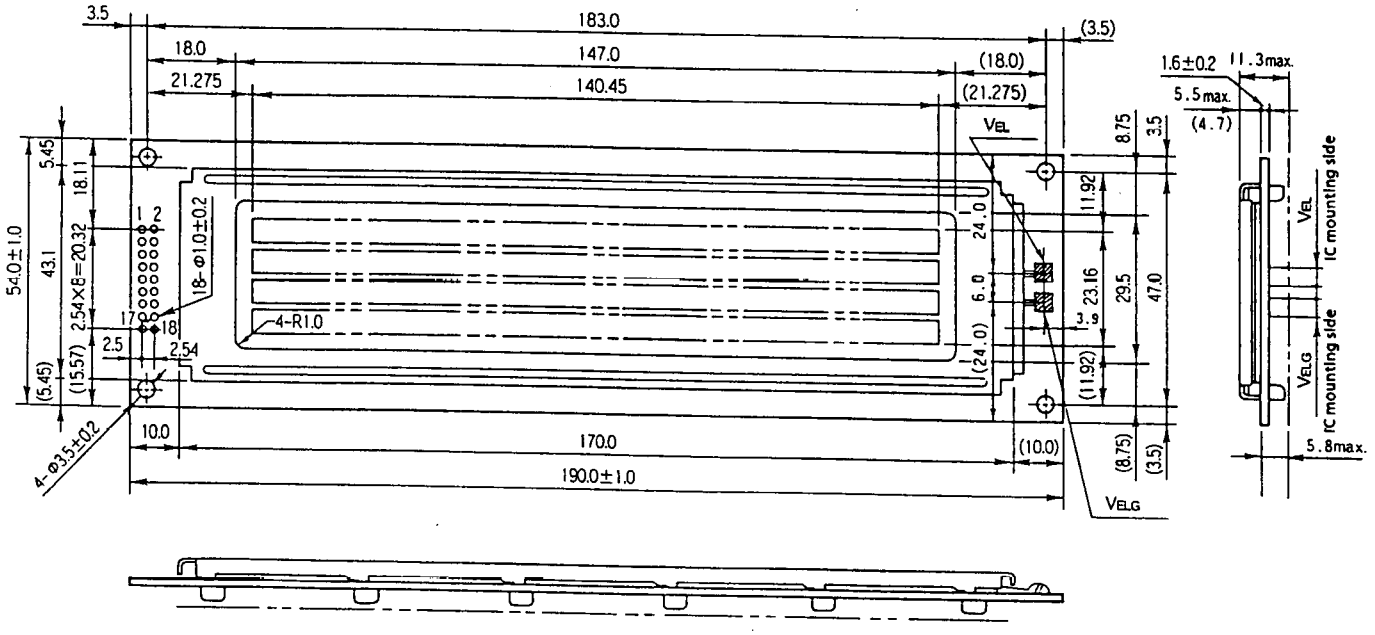
Item	L404421J000
Mechanical Characteristics	A
Absolute Maximum Ratings	B
Electrical Characteristics	C
Optical Characteristics	D-2
Recommended Operating Voltage	E

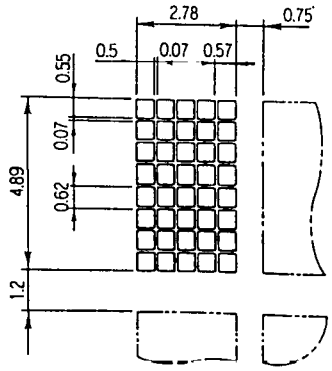
H-1 Power Supply



H-2 Dimensions

Unit : mm
General tolerance : ±0.5

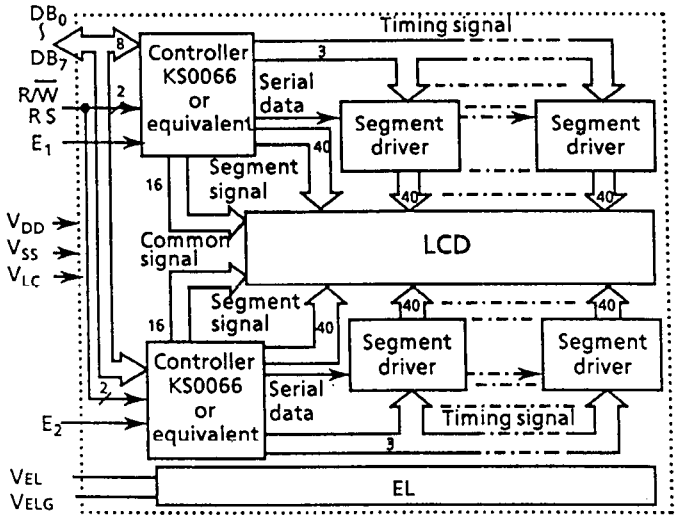




H-3 Pin Functions

No.	Name	Function
1	DB_7	Data bus line
2	DB_6	Data bus line
3	DB_5	Data bus line
4	DB_4	Data bus line
5	DB_3	Data bus line
6	DB_2	Data bus line
7	DB_1	Data bus line
8	DB_0	Data bus line
9	E_1	Enable (for upper 2 lines)
10	R/W	L:Data write (LCM←MPU), H: Data read (LCM→MPU)
11	RS	L:Instruction code input, H: Data input
12	V_{LC}	Liquid crystal driving voltage
13	V_{SS}	GND
14	V_{DD}	Power supply voltage + 5 V
15	E_2	Enable (for lower 2 lines)
16	NC	—
17	NC	—
18	NC	—

H-4 Block Diagram



H-5 EL Lamp (white)

H-5-1 Environmental Characteristics

Item	Symbol	Conditions	Specifications
Operating temperature range	T_{opr}		-20°C to + 50°C
Storage temperature range	T_{stg}		-20°C to + 60°C
Soldering heat-resistance		270°C ± 5°C, 3 s max.	No terminal abnormality
Thermal shock		-20°C 30min. ⇆ +60°C 30 min. 5 cycles	No defect on appearance

H-5-2 Electrical Characteristics

Item	Symbol	Conditions	Spec.	Unit
Electrostatic capacity	C_{EL}	f = 1 kHz(in darkroom) 2 VAC	14.0 typ.	nF
Current	I_{EL}	When applying rated voltage, 20°C, 70%RH	8.0 max. 5.8 typ.	mA
Maximum rated voltage	V_{EL1}	Sine wave, 1 kHz	150	Vrms
Rated voltage	V_{EL2}	Sine wave, 400 Hz	100	Vrms
Isolation voltage		Between lead and film Sine wave ,50 Hz,1 min.	1500	Vrms

H-5-3 Emission Characteristics

Item	Conditions	Specifications	Unit
Initial brightness(B)	When applying rated voltage 20°C,70%RH (in darkroom)	30 min. 35 typ.	cd/m²
Service life when applying rated voltage	Used continuously down to half of initial brightness 20°C, 70%RH	1500	h
Service life when used with an inverter	Used continuously down to half of initial brightness 20°C, 70%RH	4000	h
Color of light		White	—
Chromaticity coordinates	When applying rated voltage 20°C, 70%RH (in darkroom)	x = 0.315 typ. y = 0.375 typ. x = 0.285 min. y = 0.345 min. x = 0.355 max. y = 0.415 max.	—

H-6 Suitable Inverter 5D

H-6-1 Electrical Characteristics (when combined with EL lamp)

Item	Symbol	Conditions	Specifications	Unit
Oscillating frequency	f_{INV}	Ta = 25°C, V_{IN} = 5 VDC	350 typ.	Hz
Output voltage	V_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	130 typ.	V
Output current	I_{OUT}	Ta = 25°C, V_{IN} = 5 VDC	5.5 typ.	mA
Input current	I_{IN}	Ta = 25°C, V_{IN} = 5 VDC	80 typ.	mA
Input voltage	V_{IN}		5 typ.	V DC
Initial brightness	B	Ta = 25°C, V_{IN} = 5 VDC	45 typ.	cd/m²
Surface brightness (panel upper side)	B_P	Ta = 25°C, V_{IN} = 5 VDC V_{opr} = 0 V	9 typ.	cd/m²

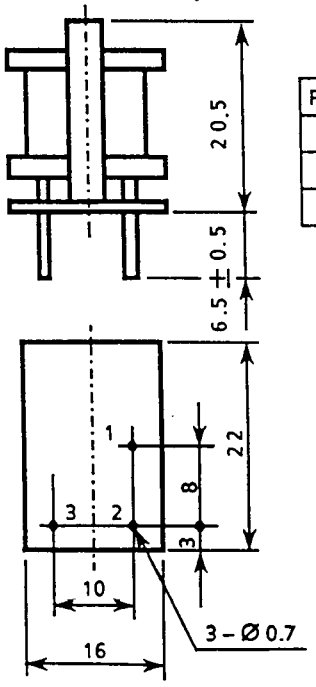
H-6-2 Tolerance (inverter only)

Item	Specifications	Unit
Input voltage	3.0 to 6.0	V
Load range	35 to 60	cm²

H-6-3 Maximum ratings (inverter only)

Item	Specifications	Unit
Input voltage	7.0	V
Load range	70	cm²
Operating temperature range	- 10 to + 60	°C
Storage temperature range	- 20 to + 70	°C

H-6-4 Dimensions (Unit: mm)



Pin No.	Functions
1	Input :5V DC
2	Common :GND
3	Output

■ Specification

J. Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}		V_{DD} − 12.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temp.	T_{opr}		−20	+70	°C
Storage temp.	T_{stg}		−30	+80	°C
Storage humidity		≤ 48 hrs	+20	+85	%RH
		≤ 1000 hrs	+20	+65	%RH

K. Electrical Characteristics

V_{DD} = 5 V ± 5% V_{SS} = 0 V Ta = −20°C to +70°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
		V_{DD} − V_{LC}		4.0	−	11.0	V
* Input voltage	High	V_{IH1}		2.2	−	V_{DD}	V
	Low	V_{IL1}		0	−	0.6	V
** Output voltage	High	V_{OH1}	$-I_{OH}$ = 0.205 mA	2.4	−	−	V
	Low	V_{OL1}	I_{OL} = 1.2 mA	−	−	0.4	V
Current consumption		I_{DD}	Ta = 25°C, V_{DD} = 5 V, V_{LC} = 0.2 V	−	8.0	12.0	mA
		I_{LC}		−	3.8	4.5	mA
Clock oscillation frequency		f_{osc}	Resistance oscillation	190	270	350	kHz

* Applied to DB_0~DB_7, E, R/W, RS

** Applied to DB_0~DB_7

L. Optical Characteristics

The background color is affected by ambient temperature, and the response characteritics deteriorates at low temperature.

· Reflective/transflective type

Viewing angle: 6 o'clock(ø = 0°), Ta = 25°C, V_{opr} = 4.8 V, Backlight OFF

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	C ≧ 2.0, ø = 0°	−	−	0	deg.
	θ_2		50	−	−	
	$\theta_2 - \theta_1$		50	−	−	
Contrast	C	θ = 20°, ø = 0°	2	3	−	−
Response time(rise)	t_{on}	θ = 0°, ø = 0°	−	50	80	ms
Response time(fall)	t_{off}		−	100	160	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = 0°C, V_{opr} = 4.9 V	−	200	320	ms
Response time(fall)	t_{off}		−	450	720	
Response time(rise)	t_{on}	θ = 0°, ø = 0°, Ta = −20°C, V_{opr} = 5.0 V	−	1500	2400	ms
Response time(fall)	t_{off}		−	1500	2400	

M. Recommended Operating Voltage

The recommended value of (V_{opr}) for an ambient temperature is as follows.

V_{opr} = V_{DD} − V_{LC}

Temperature(°C)	−20	0	25	70
V_{opr} (V)	5.0	4.9	4.8	4.2

■ Reflective type

Item	L404400P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Reflective type	
Power Supply	F-1
Dimensions	F-2
Pin Functions	F-3
Block Diagram	F-4

■ Built-in LED Backlight type

Item	L4044B1P000
Mechanical Characteristics	A
Absolute Maximum Ratings	J
Electrical Characteristics	K
Optical Characteristics	L
Recommended Operating Voltage	M
Transflective Built-in LED Backlight type	
Dimensions	G-2
Pin Functions	G-3
Block Diagram	G-4
LED Circuit Diagram	G-5-1
Electrical Characteristics (LED)	G-5-3

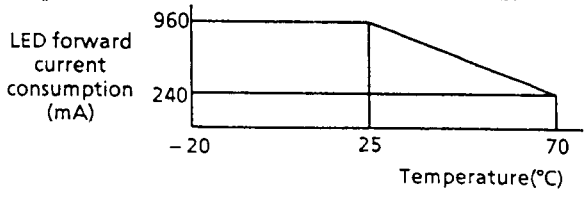
P. LED Backlight

P-1 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Specifications	Unit
LED forward current consumption*	I_F	960	mA
LED reverse voltage	V_R	8	V
LED allowable dissipation	P_D	4.16	W

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



P-2 Optical Characteristics

Ta = 25°C

Item	Symbol	Conditions	Specifications	Unit
Surface brightness (panel upper side)	B_P	I_F = 480 mA*, V_{opr} = 0 V	4 min. 5 typ.	cd/m²
LED brightness	L	I_F = 480 mA*	40 min. 50 typ.	cd/m²
LED service life			50,000 typ.	h
LED color			Yellowgreen	

* The forward current depends upon the temperature. Especially, it must be decreased at high temperature. For temperature dependence, refer to forward current reduction characteristics.

Table 2 Terminal functions

Signal name	No. of terminals	I/O	Destination	Function
DB_0 to DB_3	4	I/O	MPU	Tristate bidirectional lower four data buses: Data is read from the module to the MPU or written to the module from the MPU through the buses. If the interface data is 4 bits, the signals are not used.
DB_4 to DB_7	4	I/O	MPU	Tristate bidirectional upper four data buses: Data is read from the module to the MPU or written to the module from the MPU through the buses. DB_7 is also used as a busy flag.
E	1	Input	MPU	Operation start signal: The signal activates data write or read.
(E1, E2)	(2)	(Input)	(MPU)	L4044: E1 for the upper 2 lines, and E2 for the lower 2 lines.
R/W	1	Input	MPU	Read (R) and Write (W) selection signals 0 : Write 1 : Read
RS	1	Input	MPU	Register selection signals 0 : Instruction register (Write) Busy flag and address counter (Read) 1 : Data register (Write and Read)
V_{LC}	1	–	Power supply	Power supply terminal for driving liquid crystal display: The screen contrast can be varied by changing V_{LC}.
V_{DD}	1	–	Power supply	+5 V
V_{SS}	1	–	Power supply	Ground terminal: 0 V

7. TIMING CHARACTERISTICS

(1) Write operation

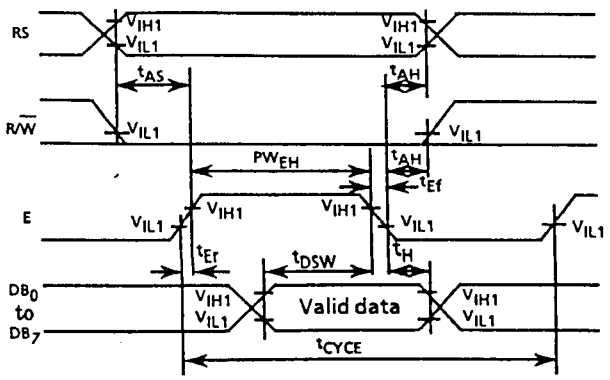
V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

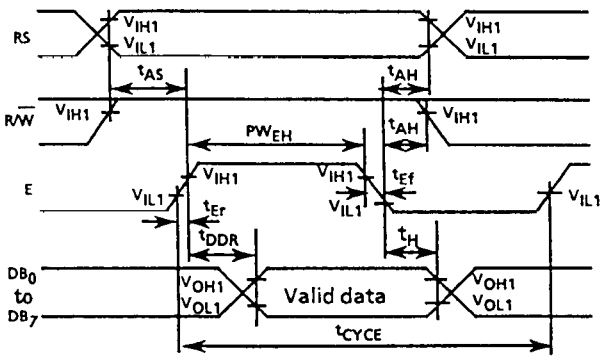
Item	Symbol	Min.	Max.	Unit
Enable cycle time	t_{CYCE}	500	–	ns
Enable pulse width "High" level	PW_{EH}	220	–	ns
Enable rise and fall times	t_{Er},t_{Ef}	–	25	ns
Setup time RS, R/W → E	t_{AS}	40	–	ns
Address hold time	t_{AH}	10	–	ns
Data setup time	t_{DSW}	60	–	ns
Data hold time	t_H	10	–	ns

(2) Read operation

V_{DD} = 5 V ± 5%, V_{SS} = 0 V, Ta = 0°C to 50°C

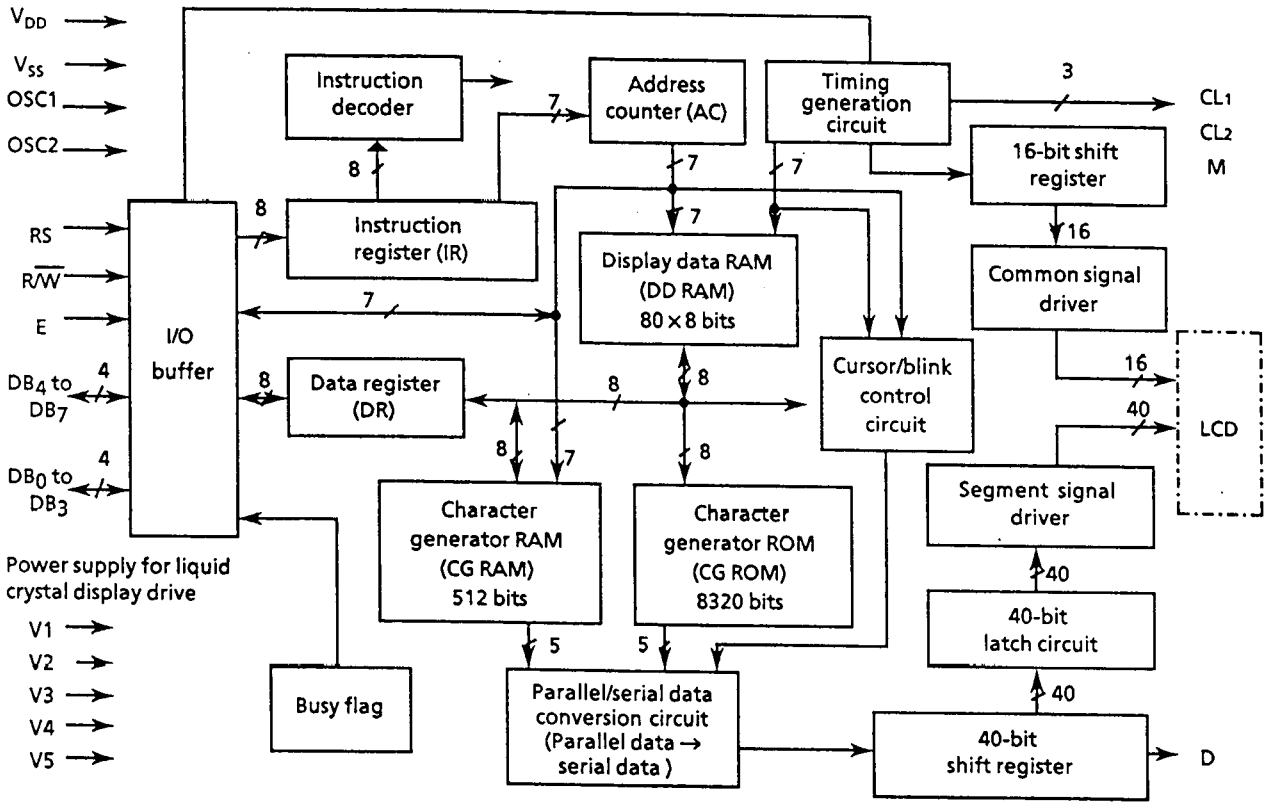
Item	Symbol	Min.	Max.	Unit
Enable cycle time	t_{CYCE}	500	–	ns
Enable pulse width "High" level	PW_{EH}	220	–	ns
Enable rise and fall times	t_{Er},t_{Ef}	–	25	ns
Setup time RS, R/W → E	t_{AS}	40	–	ns
Address hold time	t_{AH}	10	–	ns
Data delay time	t_{DDR}	60	120	ns
Data hold time	t_H	20	–	ns





8. BASIC OPERATIONS

8.1 Block Diagram of the Controller



8.2 Registers

The controller 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 in Table 3.

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 cannot 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 3 Register selection

RS	R/W	Operation
0	0	IR selection, IR write. Internal operation : Display Clear, Cursor Home, etc.
0	1	Busy flag (DB_7) and address counter (DB_0 to DB_6) 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

8.3 Busy flag (BF)

The busy flag indicates whether the module is ready to accept the next instruction. As shown in Table 3, the signal is output to DB_7 if RS = 0 and R/W = 1. If the busy flag is 1, the module is working internally and the instruction cannot be accepted. 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 4.9 , "Instruction Outline".

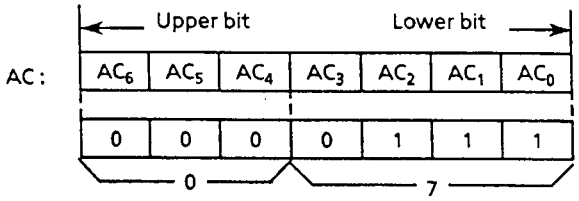
8.4 Address counter (AC)

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 in the 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 DB_0 to DB_6 if
RS = 0 and R/W = 1 as shown in Table 3.

8.5 Display data RAM (DD RAM)

DD RAM has a capacity of up to 80 × 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 following.

- One line display (N = 0, 1/8 duty or 1/11 duty)

The DD RAM address and the display digit of the LCD panel correspond as follows.

1	2	3			23	24	25			39	40	41			78	79	80	Display digit
00	01	02	-----		16	17	18	-----		26	27	28	-----		4D	4E	4F	DDRAM address (HEX)

When the display digits are less than 80, the display begins at the head position.
(1) L4051

1	2	3	4	5											36	37	38	39	40	Display digit
00	01	02	03	04	-	-	-	-	-	-	-	-	-	-	23	24	25	26	27	DD RAM address (HEX)

When the Display Shift instruction is executed, the DD RAM address and the display shift as follows. The DD RAM addresses 00_H to $4F_H$ are displayed by executing Display Shift.

* Left shift

1	2	3	4	5											36	37	38	39	40	Display digit
01	02	03	04	05	-	-	-	-	-	-	-	-	-	-	24	25	26	27	28	DD RAM address (HEX)

* Right shift

1	2	3	4	5											36	37	38	39	40	Display digit
4F	00	01	02	03	-	-	-	-	-	-	-	-	-	-	22	23	24	25	26	DD RAM address (HEX)

- Two line display (N = 1, 1/16 duty)

The DD RAM address and the display digit of the LCD panel correspond as follows.

	1	2	3					15	16	17	18	19	20	21				38	39	40	Display digit
Line 1	00	01	02	-	-	-	-	0E	0F	10	11	12	13	14	-	-	-	25	26	27	DDRAM
Line 2	40	41	42	-	-	-	-	4E	4F	50	51	52	53	54	-	-	-	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, the first line end address and the second line start address are not consecutive.

(1) L1672, L1682, L1692

	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)

The DD RAM addresses 00_H to $0F_H$ are displayed in line 1 and 40_H to $4F_H$ in line 2.
When the Display Shift instruction is executed, the DD RAM address and the display shift as follows. The DD RAM addresses 00_H to 27_H are displayed in line 1 and 40_H to 67_H in line 2 by executing Display Shift.

* Left shift

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

* Right shift

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	27	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	DD RAM address
Line 2	67	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	(HEX)

(2) L4052

	1	2	3	4	5	6	----------	38	39	40	Display digit
Line 1	00	01	02	03	04	05	----------	25	26	27	DD RAM address
Line 2	40	41	42	43	44	45	----------	65	66	67	(HEX)

The DD RAM addresses 00_H to 27_H are displayed in line 1 and 40_H to 67_H in line 2. When the Display Shift instruction is executed, the DD RAM address and the display shift as follows.

* Left shift

	1	2	3	4	5	6	----------	38	39	40	Display digit
Line 1	01	02	03	04	05	06	----------	26	27	00	DD RAM address
Line 2	41	42	43	44	45	46	----------	66	67	40	(HEX)

* Right shift

	1	2	3	4	5	6	----------	38	39	40	Display digit
Line 1	27	00	01	02	03	04	----------	24	25	26	DD RAM address
Line 2	67	40	41	42	43	44	----------	64	65	66	(HEX)

(3) L2032, L2462

In L2032, the DD RAM addresses 00_H to 13_H are displayed in line 1 and 40_H to 53_H are displayed in line 2. In L2462, the DD RAM addresses 00_H to 17_H are displayed in line 1 and 40_H to 57_H in line 2 . The DD RAM addresses 00_H to 27_H are displayed in line 1 and 40_H to 67_H in line 2 by executing Display Shift.

- L1671 and L1681 (N=1, 1/16 duty)

L1671 and L1681 are 16 characters ×1 line display and they are driven at 1/16 duty. Eight characters ×2 lines in the LCD controller are converted into 16 characters ×1 line on the LCD panel.

In the LCD controller

	1	2	3	4	5	6	7	8	------	25	26	27	Display digit
Line 1	00	01	02	03	04	05	06	07	08	09	------	25	26	27	DD RAM
Line 2	40	41	42	43	44	45	46	47	48	49	------	65	66	67	address (HEX)
	9	10	11	12	13	14	15	16					Display digit				

On the LCD panel

	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)

Consequently, the address at digit 8 and the address at digit 9 are not consecutive. When the Display Shift instruction is executed, the DD RAM address and the display shift as follows . The DD RAM addresses 00_H to 27_H are displayed at the 1st to 8th digits and 40_H to 67_H are displayed at the 9th to 16th digits by executing Display Shift.

* Left shift

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	01	02	03	04	05	06	07	08	41	42	43	44	45	46	47	48	DD RAM address (HEX)

* Right shift

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Display digit
Line 1	27	00	01	02	03	04	05	06	67	40	41	42	43	44	45	46	DD RAM address (HEX)

- L1634 (N = 1, 1/16 duty)

L1634 is 16 characters × 4 line display and is driven at 1/16 duty. 32 characters × 2 lines in the LCD controller are converted into 16 characters × 4 lines on the LCD panel.

In the LCD controller

1 2 3 ------ 14 15 16 (Line 1)	1 2 3 ------ 14 15 16 (Line 3)	Display digit
00 01 02 ------ 0D 0E 0F	10 11 12 ------ 1D 1E 1F	20 ------ 27	DD RAM address (HEX)
40 41 42 ------ 4D 4E 4F	50 51 52 ------ 5D 5E 5F	60 ------ 67	
Line 2	Line 4	

On the LCD panel

	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	
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	DD RAM address (HEX)
Line 3	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	
Line 4	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	

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. When the Display Shift instruction is executed, the DD RAM address and the display shift as follows. The DD RAM address 00_H to 27_H are displayed in line 1 and line 3 and 40_H to 67_H in line 2 and line 4 by executing Display Shift.

* Left shift

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

* Right shift

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

- L2034 (N = 1, 1/16 duty)

L2034 is 20 characters × 4 line display and is driven at 1/16 duty. 40 characters × 2 lines in the LCD controller are converted into 20 characters × 4 lines on the LCD panel.

In the LCD controller

	1	2	3	------	18	19	20	1	2	3	------	18	19	20	Display digit
	Line 1							Line 3							
	00	01	02	------	11	12	13	14	15	16	------	25	26	27	DD RAM address (HEX)
	40	41	42	------	51	52	53	54	55	56	------	65	66	67	
	Line 2							Line 4							

On the LCD panel

	1	2	3	4	5	----------	15	16	17	18	19	20	Display digit
Line 1	00	01	02	03	04	----------	0E	0F	10	11	12	13	
Line 2	40	41	42	43	44	----------	4E	4F	50	51	52	53	DD RAM address (HEX)
Line 3	14	15	16	17	18	----------	22	23	24	25	26	27	
Line 4	54	55	56	57	58	----------	62	63	64	65	66	67	

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. When the Display Shift instruction is executed, the DD RAM address and the display shift as follows.

* Left shift

	1	2	3	4	5	----------	15	16	17	18	19	20	Display digit
Line 1	01	02	03	04	05	----------	0F	10	11	12	13	14	
Line 2	41	42	43	44	45	----------	4F	50	51	52	53	54	DD RAM address (HEX)
Line 3	15	16	17	18	19	----------	23	24	25	26	27	00	
Line 4	55	56	57	58	59	----------	63	64	65	66	67	40	

* Right shift

	1	2	3	4	5	----------	15	16	17	18	19	20	Display digit
Line 1	27	00	01	02	03	----------	0D	0E	0F	10	11	12	
Line 2	67	40	41	42	43	----------	4D	4E	4F	50	51	52	DD RAM address (HEX)
Line 3	13	14	15	16	17	----------	21	22	23	24	25	26	
Line 4	53	54	55	56	57	----------	61	62	63	64	65	66	

- L4044 (N = 1, 1/16 duty)

L4044 has two LCD controllers. Since the capacity for each is 80 characters (40 characters × 2 lines), L4044 can display 160 characters (40 characters × 4 lines) by using two LCD controllers. Line 1 and line 2 are activated by E1. Line 3 and line 4 are activated by E2.

On the LCD panel

	1	2	3	4	5	----------	35	36	37	38	39	40	Display digit
Line 1	00	01	02	03	04	----------	22	23	24	25	26	27	
Line 2	40	41	42	43	44	----------	62	63	64	65	66	67	DD RAM address (HEX)
Line 3	00	01	02	03	04	----------	22	23	24	25	26	27	
Line 4	40	41	42	43	44	----------	62	63	64	65	66	67	

When E1 is activated and the Display Shift instruction is executed, the DD RAM address and the display for upper two lines shift as follows.

* E1 activation and left shift

	1	2	3	4	5	----------	35	36	37	38	39	40	Display digit
Line 1	01	02	03	04	05	----------	23	24	25	26	27	00	
Line 2	41	42	43	44	45	----------	63	64	65	66	67	40	DD RAM address (HEX)
Line 3	00	01	02	03	04	----------	22	23	24	25	26	27	
Line 4	40	41	42	43	44	----------	62	63	64	65	66	67	

When E2 is activated and the Display Shift instruction is executed, the DD RAM address and the display shift for lower two lines as follows.

* E2 activation and right shift

	1	2	3	4	5	----------	35	36	37	38	39	40	Display digit
Line 1	00	01	02	03	04	----------	22	23	24	25	26	27	
Line 2	40	41	42	43	44	----------	62	63	64	65	66	67	DD RAM address (HEX)
Line 3	27	00	01	02	03	----------	21	22	23	24	25	26	
Line 4	67	40	41	42	43	----------	61	62	63	64	65	66	

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.

8.6 Character generator ROM (CG ROM)

CG ROM generates 5 x 7 dot-matrix or 5x10 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, and in LCD modules of 5x10 dot-matrix character pattern (L4051), CG generates 160 types of 5x7 dot-matrix characters and 32 types of 5x10 dot-matrix characters.
Table 4 and Table 5 show the correspondence between the CG ROM character codes and character patterns of 5x7 and 5x10 respectively.

8.7 Character generator RAM (CG RAM)

CG RAM is used to create character patterns freely by programming. Eight types of 5x7 dot matrix character patterns or four types of 5x10 dot matrix character patterns can be written into a CG RAM. Table 6 and Table 7 show 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.

8.8 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 08_H, a cursor or blink position is in the 9th digit in line 1 as shown below.

	AC_6	AC_5	AC_4	AC_3	AC_2	AC_1	AC_0
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 address (HEX)
Line 2	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

Note: 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.

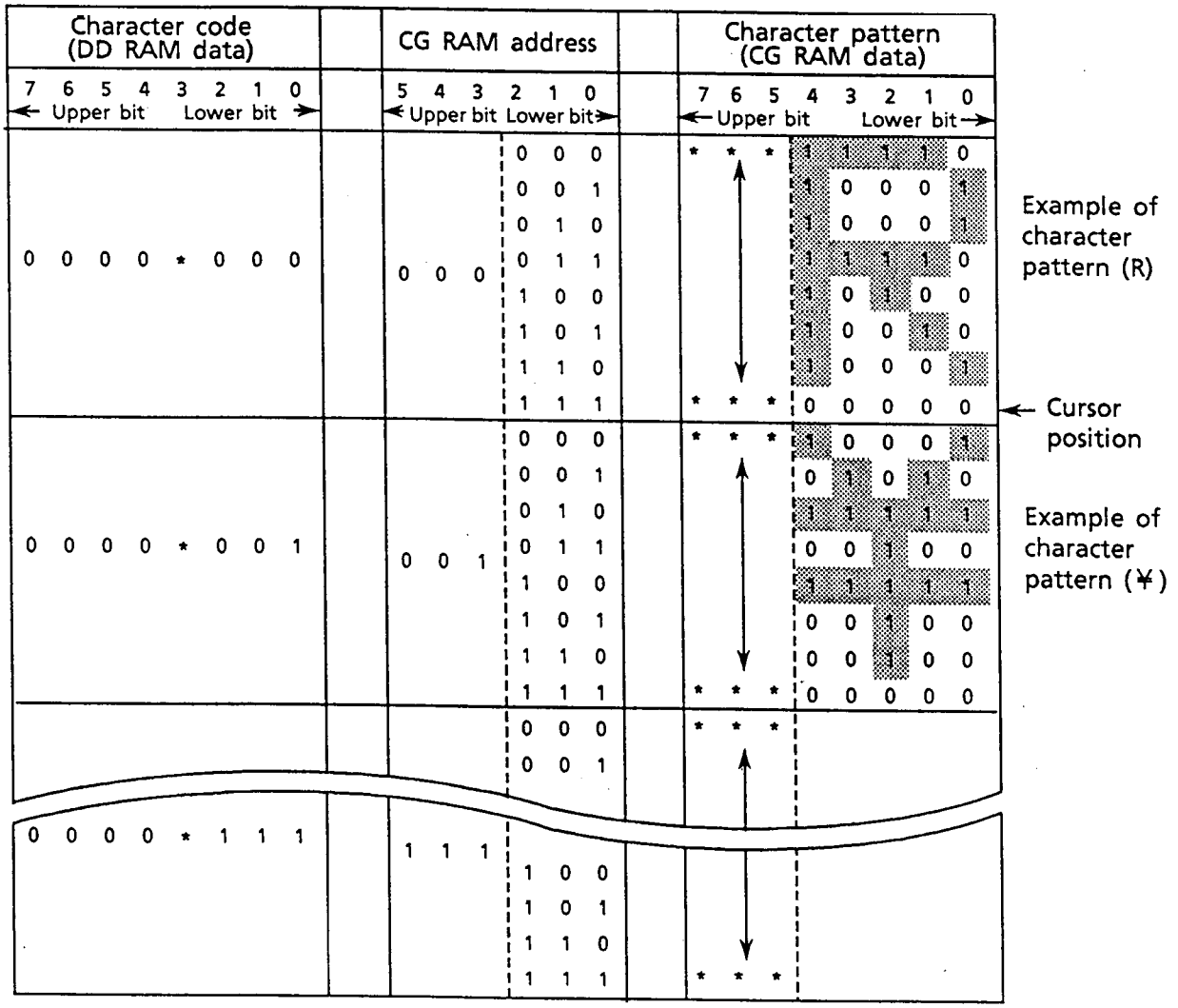
Table 4 Correspondence between character codes and character patterns (5 × 7 dot matrix)

Lower 4 bits \ Upper 4 bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)															
XXXX0001	(2)															
XXXX0010	(3)															
XXXX0011	(4)															
XXXX0100	(5)															
XXXX0101	(6)															
XXXX0110	(7)															
XXXX0111	(8)															
XXXX1000	(1)															
XXXX1001	(2)															
XXXX1010	(3)															
XXXX1011	(4)															
XXXX1100	(5)															
XXXX1101	(6)															
XXXX1110	(7)															
XXXX1111	(8)															

Table 5 Correspondence between character codes and character patterns (5 × 10 dot matrix)

Lower 4 bits \ Upper 4 bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)															
XXXX0001	(2)															
XXXX0010	(3)															
XXXX0011	(4)															
XXXX0100	(5)															
XXXX0101	(6)															
XXXX0110	(7)															
XXXX0111	(8)															
XXXX1000	(1)															
XXXX1001	(2)															
XXXX1010	(3)															
XXXX1011	(4)															
XXXX1100	(5)															
XXXX1101	(6)															
XXXX1110	(7)															
XXXX1111	(8)															

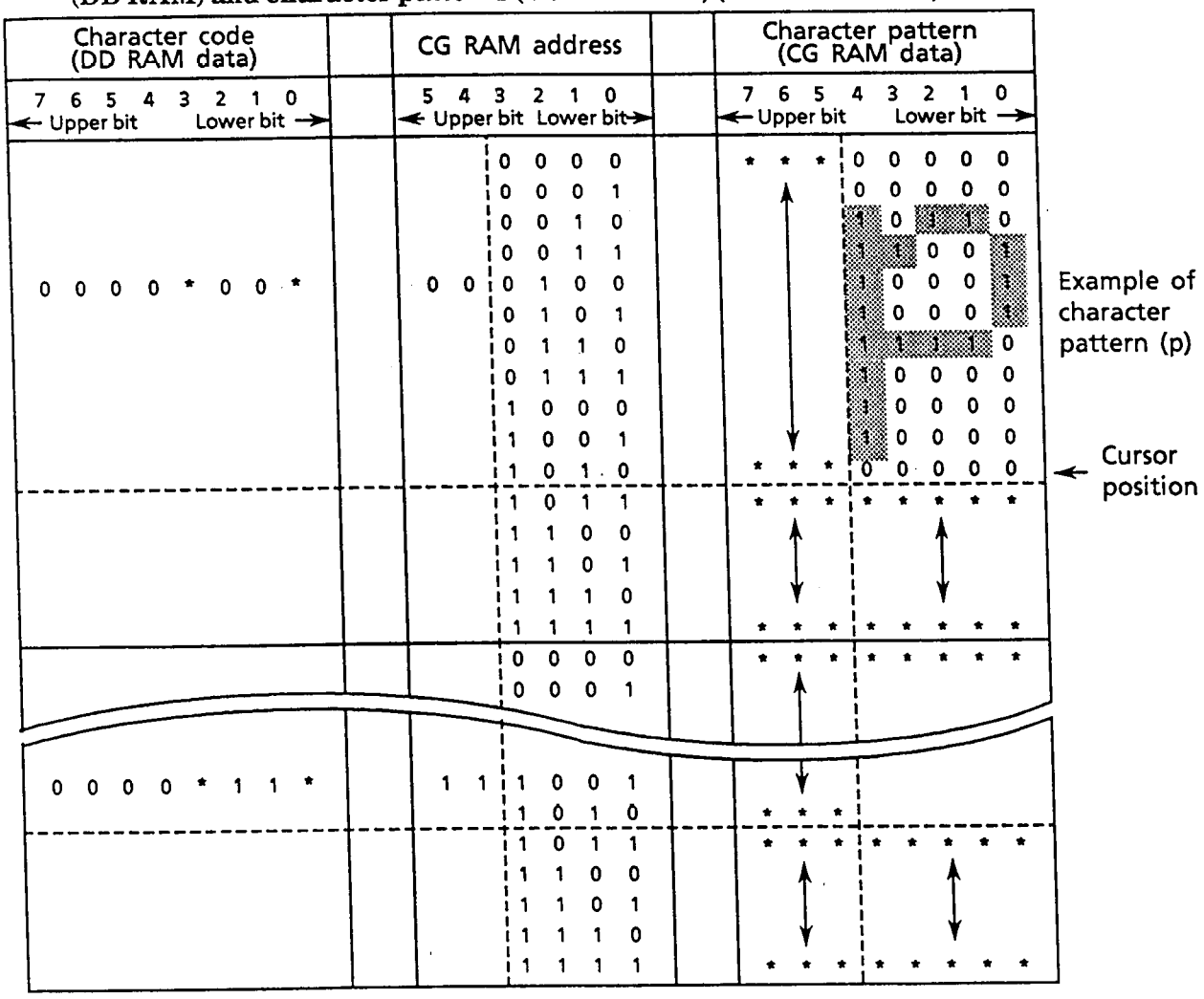
Table 6 Relationship between CG RAM addresses and character codes (DD RAM) and character patterns (CG RAM data) (5 × 7 dot matrix)



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 types).
- 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 reading 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, 00_H and 08_H select the same character.

Table 7 Relationship between CG RAM addresses and character codes (DD RAM) and character patterns (CG RAM data) (5 × 10 dot matrix)



* : Don't care bit

Notes : · In CG RAM data, "1" corresponds to Selection and "0" to Non-selection on the display.

- Character code bits 1 to 2 and CG RAM address bits 4 to 5 correspond to each other (two bits, four types).
- CG RAM address bits 0 to 3 specify a line position for a character pattern. Line 11 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 11 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 reading a character pattern from CG RAM, set to "0" all of character code bits between 4 and 7. Bits 0 to 3 determine which pattern will be read out. Since bit 0 and 3 are not valid, 00_H, 01_H, 08_H, and 09_H select the same character.

9. INSTRUCTION OUTLINE

When MPU controls LCD controller on the LCD module, MPU directly controls only two registers of the controller : 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.

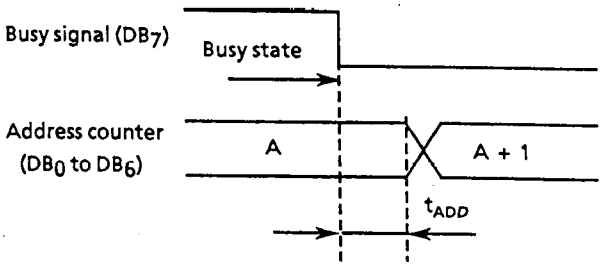
Table 8 shows the instructions and their execution time.

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 decremented 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}).

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

Table 8 List of instructions

Instruction	Code										Function	Execution time **
	RS	R/$\overline{W}$	DB_7	DB_6	DB_5	DB_4	DB_3	DB_2	DB_1	DB_0		
(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 μs
(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 μs
(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 μs
(6) Function Set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), the duty (N), and character fonts (F).	40 μs
(7) CG RAM Address Set	0	0	0	1	A_{CG}						Sets CG RAM address to start transmitting or receiving CG RAM data.	40 μs
(8) DD RAM Address Set	0	0	1	A_{DD}							Sets DD RAM address to start transmitting or receiving DD RAM data.	40 μs
(9) BF/Address Read	0	1	BF	AC							Reads BF indicating module in internal operation and AC contents (used for both CG RAM and DD RAM).	0 μs
(10) Data Write to CG RAM or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	40 μs t_{ADD} = 6 μs
(11) Data Read from CG RAM or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	40 μs t_{ADD} = 6 μs

* : Don't care bit
A_{CG} : CG RAM address
A_{DD} : DD RAM address
AC : Address counter

I/D = 1 : Increment
I/D = 0 : Decrement

S = 1 : Display shift
S = 0 : No display shift

D = 1 : Display ON
D = 0 : Display OFF

C = 1 : Cursor ON
C = 0 : Cursor OFF

B = 1 : Blink ON
B = 0 : Blink OFF

S/C = 1 : Display shift
S/C = 0 : Cursor movement

R/L = 1 : Right shift
R/L = 0 : Left shift

DL = 1 : 8 bits
DL = 0 : 4 bits

N = 1 : 1/16 duty
N = 0 : 1/8 duty or 1/11 duty

F = 1 : 5×10 dot matrix
F = 0 : 5×7 dot matrix

BF = 1 : Internal operation in progress
BF = 0 : Instruction can be accepted

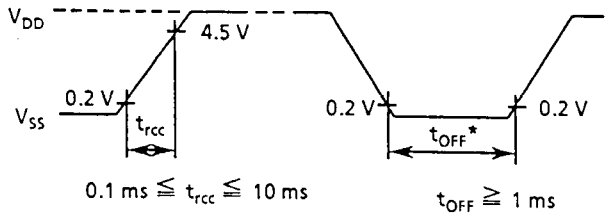
** Execution time in the above Table indicates the maximum value when f_{osc} is 250 kHz. It changes when f_{osc} changes.

When f_{osc} = 270 kHz : $40\ \mu s \times \frac{250}{270} = 37\ \mu s$

10. INITIALIZATION

10.1 Automatic initialization

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



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

In automatic initialization, 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: 5×7 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

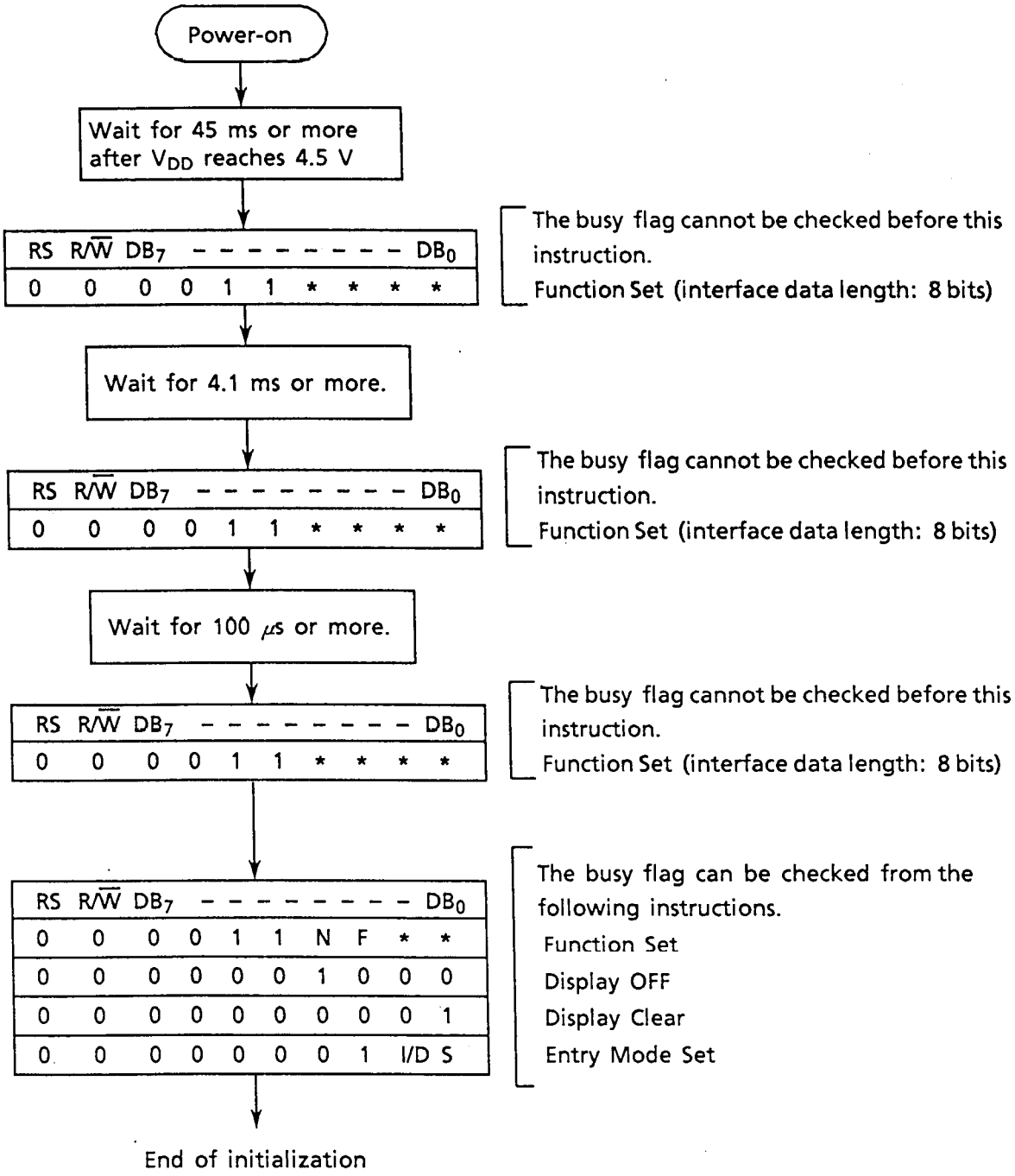
Since some conditions set by initialization may not be suitable for the LCD module, execute further Function Set instruction.

The busy flag (BF) is kept busy until initialization ends. The busy state remains for 20 ms after V_{DD} reaches 4.5 V.

If the power supply conditions are not satisfied and automatic initialization is not executed. Execute initialization using instructions according to section 10.2, "Initialization by instruction".

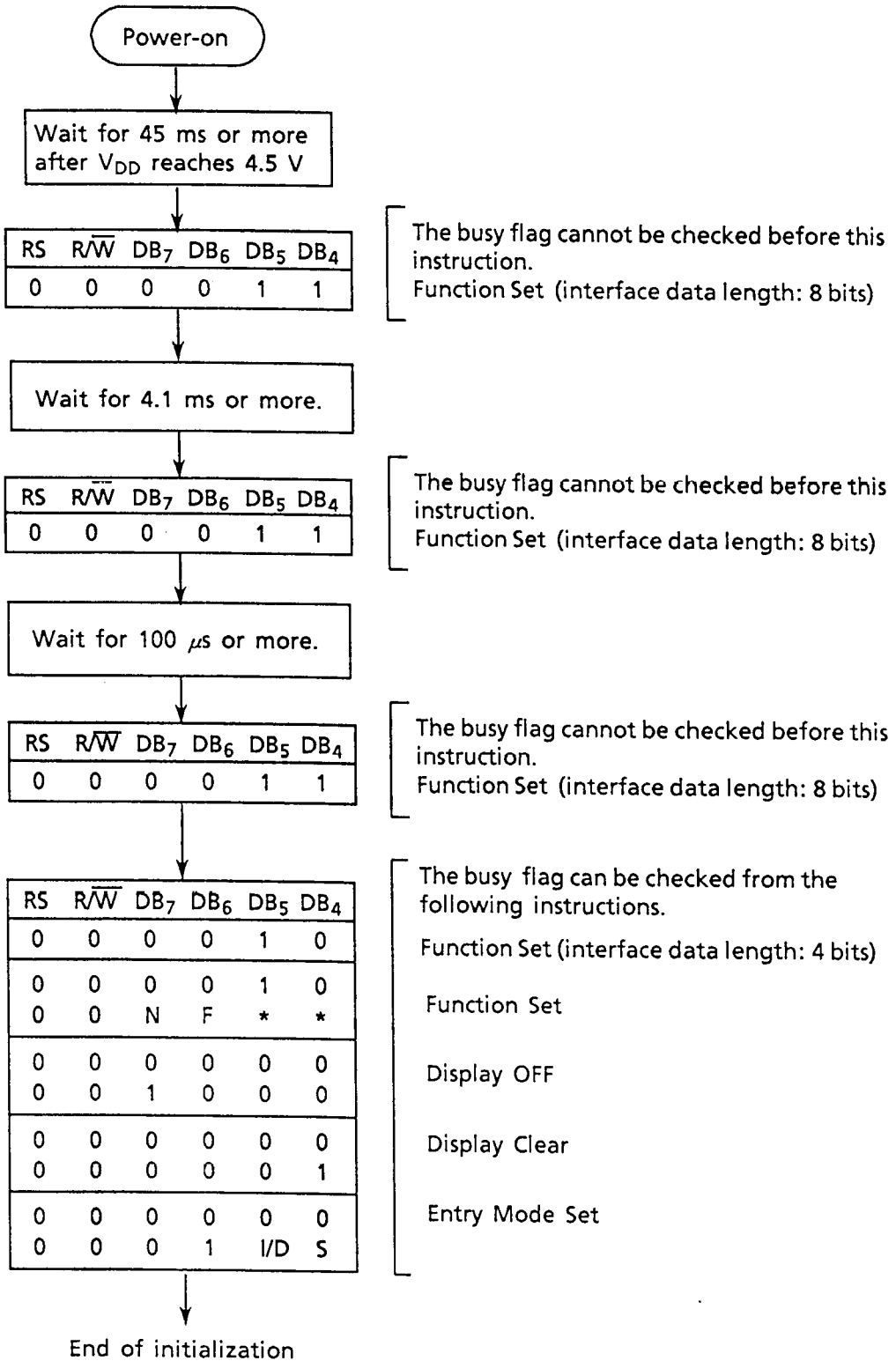
If automatic initialization is not executed because the power supply conditions are not satisfied,use the following instructions to initialize.
Since it is unknown whether the interface data length is set to eight bits or four bits at power on, execute Function Set twice to set the interface data length to eight bits. And then set the required interface data length by executing further Function Set instruction.

(a) Interface data length : Eight bits



Note: In L4044, execute initialization on E1 and E2 respectively.

(b) Interface data length: Four bits



Note: In L4044, execute initialization on E1 and E2 respectively.

11. INSTRUCTION DETAILES

(1) Display Clear

	RS	R/W	DB7						DB0
Code	0	0	0	0	0	0	0	0	1

Display Clear clears all display and returns cursor to home position (address 0).
Space code 20 (hexadecimal) 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 L4044. In L4044, 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) Cursor Home

	RS	R/W	DB7							DB0
Code	0	0	0	0	0	0	0	0	1	*

* : Don't care bit

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 L4044. In L4044, if the cursor or blink is on line 3 or line 4, it returns to the left end of line 3.

(3) Entry Mode Set

	RS	R/W	DB7							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 change, only the display moves. There is no display shift for reading from 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.

(4) Display ON/OFF Control

	RS	R/W	DB7							DB0
Code	0	0	0	0	0	0	1	D	C	B

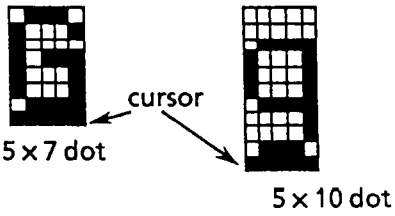
Display ON/OFF Control turns the total display and the cursor ON and OFF, and makes the character on the cursor position start blinking. Cursor ON/OFF and blinking is done at the digit indicated by the DD RAM address specified by the AC.

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.

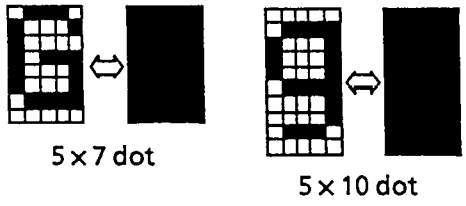
C : When C = 1, the cursor is displayed.
When C = 0, the cursor is not displayed.
The cursor is displayed in the dot line below the character fonts.

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 f_{osc} is 250 kHz. The cursor and blinking can be set at the same time.

• C = 1 (cursor display)



• B = 1 (blink)



(5) Cursor/Display Shift

	RS	R/W	DB7							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 (DDRAM 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 the display pattern of line 1 is not shifted to line 2.

Note: L1671 and L1681 operates internally as 8 char. × 2 line-display, L1634 as 32 chars. ×2 line-display, L2034 as 40 chars. ×2 line-display, and L4044 as two displays of 40 chars. × 2 lines. See section 8.5, "Display data RAM".

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.

Note: If only display shift is done, the AC contents do not change.

(6) Function Set

	RS	R/W	DB_7							DB_0
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 (DB_7 to DB_0).
When DL = 0, the data length is set at four bits (DB_7 to DB_4). 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 5×10 dot matrix.
When F = 0, the character font is set to 5×7 dot matrix.
If N is set to 1, F becomes "Don't care bit".

N	F	Number of display lines	Character font (dot matrix)	Duty	LCD module
0	0	1	5×7	1/8	-
0	1	1	5×10	1/11	L4051
1	*	2	5×7	1/16	L1671, L1681, L1672 L1682, L1692, L1634 L2032, L2034, L2462 L4052, L4044

* Don't care bit

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

(7) CG RAM Address Set

	RS	R/W	DB_7							DB_0
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. Then data written from or read to the MPU is for the CG RAM.

(8) DD RAM Address Set

	RS	R/W	DB_7							DB_0
Code	0	0	1	A	A	A	A	A	A	A

← Upper bit Lower bit →

DD RAM addresses expressed as binary AAAAAAA 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: L4051), the addresses are 00_H to $4F_H$. When N = 1 (two-line display: L1672, L1682, L1692, L2032, L2462, L4052), the addresses used for display in line 1 (AAAAAAA) are 00_H to 27_H and those for line 2 (AAAAAAA) are 40_H to 67_H. As for L1671, L1681, L1634, L2034 and L4044, see section 8.5, "Display Data RAM".

(9) Busy Flag/Address Read

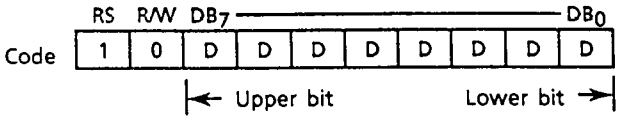
	RS	R/W	DB_7							DB_0
Code	0	1	BF	A	A	A	A	A	A	A

← Upper bit Lower bit →

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

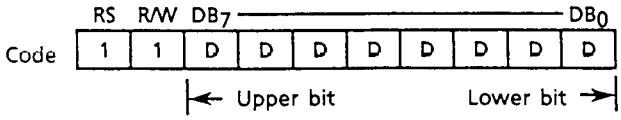
When BF = 1, the module is working internally and the next instruction cannot be accepted until the BF value becomes 0.
When BF = 0, the next instruction can be accepted. Therefore, make sure that BF = 0 before writing the next instruction.
The AC values binary AAAAAAA are read out at the same time as 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 CG RAM or DD RAM.

(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.

(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 is not shifted regardless of Entry Mode Set.

Note : The AC is automatically incremented or decremented 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.

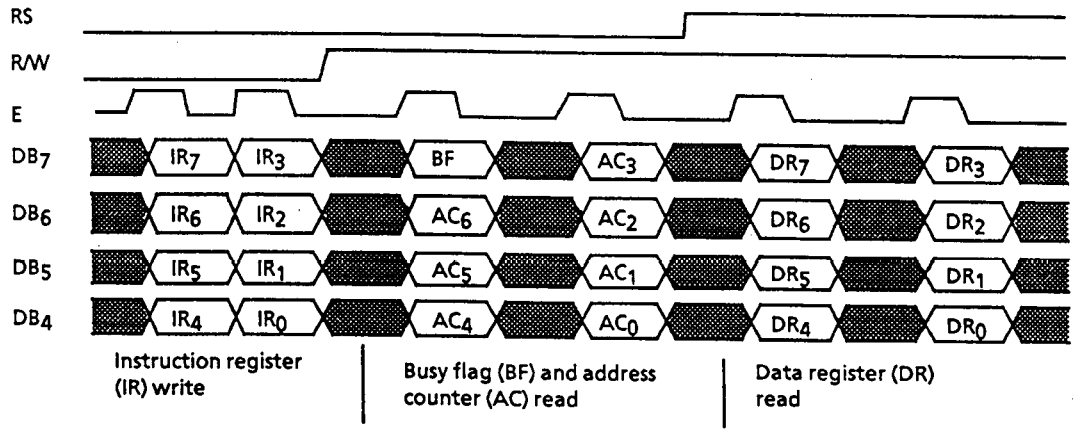
- An Address Set instruction is executed immediately before a read instruction
- For DD RAM, the Cursor Shift instruction is executed immediately before a read instruction
- The second, or later, instruction is executed in consecutive execution of read instructions.

12. INTERFACING TO MPU

LCD modules containing controller can interface to both 4 bit and 8 bit MPUs.

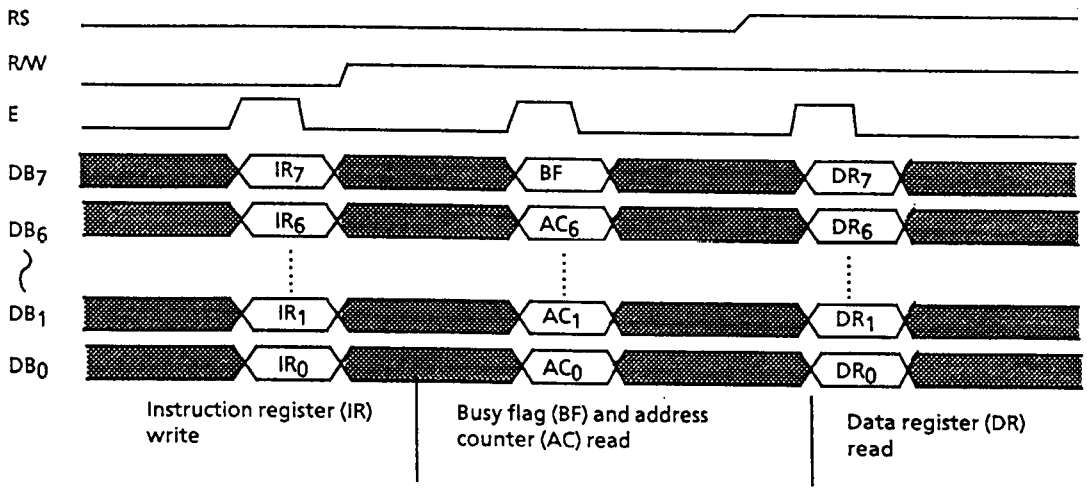
12.1 Interface in 4-bit operation

When interface data is 4 bits long, data is transferred using only four buses: DB_4 to DB_7. DB_0 to DB_3 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 DB_4 to DB_7 when interface data is 8 bits long) are transferred first, then lower order 4 bits (content of DB_0 to DB_3 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.



12.2 Interface in 8-bit operation

When interface data is 8 bits long, data is transferred using the 8 data buses of DB_0 to DB_7.



13. EXAMPLES OF INSTRUCTION USE

13.1 L1671

(1) Interface data length : 8 bits

	Instruction	Display	Operation
1	Power on RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 – – – – – – – – – –		The built-in reset circuit initializes the module.
2	Function Set RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 0 0 0 0 1 1 1 * * *		The interface data length 8-bit, 5 x 7 dot-matrix character font and 1/16 duty cycle are selected.
3	Display ON/OFF Control RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 0 0 0 0 0 0 1 1 1 0	_	The display and cursor are turned ON. No display appears.
4	Entry Mode Set RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 0 0 0 0 0 0 0 1 1 0	_	Entry Mode is set : the address is incremented by one and the cursor shifts to the right in a write operation to internal RAM. The display is not shifted.
5	Write to CG RAM or DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 1 0 0 1 0 0 1 1 0 0	L_	L is written. The AC is incremented by one and the cursor shifts to the right.
6	Write to CG RAM/DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 1 0 0 1 0 0 0 0 1 1	LC_	C is written.
7	⋮	⋮	
8	Write to CG RAM/DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 1 0 0 1 0 1 0 1 0 1	LCD MODU	U is written in digit 8. Cursor disappears.
9	DD RAM Address Set RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 0 0 1 1 0 0 0 0 0 0	LCD MODU_	The DD RAM address is set so that the cursor position is at digit 9.
10	Write to CG RAM/DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 1 0 0 1 0 0 1 1 0 0	LCD MODUL_	L is written.
11	⋮	⋮	
12	Write to CG RAM/DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0 1 0 0 0 1 1 0 0 0 1	LCD MODULE L1671	1 is written.

(2) Interface data length : 4 bits

	Instruction	Display	Operation
1	Power on RS R/W DB_7 DB_6 DB_5 DB_4 – – – – – – – – – – – –		The built-in reset circuit initializes the module.
2	Function Set RS R/W DB_7 DB_6 DB_5 DB_4 0 0 0 0 1 0 – – – – – –		4-bit operation mode is set. Since 8-bit operation mode has been set by initialization, the instruction is executed only once.
3	Function Set RS R/W DB_7 DB_6 DB_5 DB_4 0 0 0 0 1 0 0 0 1 * * *		The 4-bit operation mode, 1/16 duty cycle, and 5 x 7 dot-matrix character font are selected. Then 4-bit operation mode starts.
4	Display ON/OFF Control RS R/W DB_7 DB_6 DB_5 DB_4 0 0 0 0 0 0 0 0 1 1 1 0	_	The display and the cursor are turned ON. No display appears.
5	Entry Mode Set RS R/W DB_7 DB_6 DB_5 DB_4 0 0 0 0 0 0 0 0 0 1 1 0	_	Entry mode is set: the address is incremented by one and the cursor shifts to the right in a write operation to internal RAM. The display is not shifted.
6	Write to CG RAM/DD RAM RS R/W DB_7 DB_6 DB_5 DB_4 1 0 0 1 0 0 1 0 1 1 0 0	L_	L is written. The AC is incremented by one and the cursor shifts to the right.
7	⋮	⋮	

13.2 L4044

(1) Interface data length : 8 bits

	Instruction	Display	Operation
1	Power on E: – RS: – R/W: – DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: – – – – – – – –		The built-in reset circuit initializes the module.
2	Function Set E: E_1 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 1 1 1 * * *		The interface data length 8 bit, 5 x 7 dot-matrix character font and 1/16 duty cycle are selected for the upper 2 lines.
3	Function Set E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 1 1 1 * * *		The interface data length 8 bit, 5 x 7 dot-matrix character font and 1/16 duty cycle are selected for the lower 2 lines.
4	Display ON/OFF Control E: E_1 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 1 0	_	The display and the cursor are turned ON for the upper 2 lines. No display appears.
5	Display ON/OFF Control E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 0 0	_	The display is turned ON and the cursor is turned OFF for the lower 2 lines . No display appears.
6	Entry Mode Set E: E_1 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 0 1 1 0	_	The address is incremented by one and the cursor shifts to the right in a write operation to internal RAM for the upper 2 lines. The display is not shifted.
7	Entry Mode Set E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 0 1 1 0	_	The same entry mode is set for the lower 2 lines.
8	Write to CG RAM/DD RAM E: E_1 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 0 1 1 0 0	L_	L is written. The AC is incremented by one and the cursor shifts to the right.
9	⋮	⋮	
10	Write to CG RAM/DD RAM E: E_1 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 1 1 0 1 0 0	LCD MODULE L4044_	4 is written.
11	DD RAM Address Set E: E_1 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 1 1 0 0 0 0 0 0	LCD MODULE L4044 _	The DD RAM address is set so that the cursor position is at digit 1 of line 2.
12	Write to CG RAM/DD RAM E: E_1 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 1 1 0 1 0 0	LCD MODULE L4044 4_	4 is written.

	Instruction	Display	Operation
13			
14	Write to CG RAM/ DD RAM E: E_1 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 1 0 0 1 1	LCD MODULE L4044 40DIGITS,4LINES_	S is written.
15	Display ON/OFF Control E: E_1 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 0 0	LCD MODULE L4044 40DIGITS,4LINES	The cursor for the upper 2 lines is turned OFF.
16	DD RAM Address Set E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 1 0 0 0 0 0 0 0	LCD MODULE L4044 40DIGITS,4LINES	The DD RAM address is set so that the cursor position is at digit 1 of line 3.
17	Display ON/OFF Control E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 1 0	LCD MODULE L4044 40DIGITS,4LINES _	The cursor is turned ON at digit 1 of line 3.
18	Write to CG RAM/DD RAM E: E_2 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 0 1 0 0 0	LCD MODULE L4044 40DIGITS,4LINES H_	H is written.
19	Write to CG RAM/DD RAM E: E_2 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 0 1 0 0 1	LCD MODULE L4044 40DIGITS,4LINES HI_	I is written.
20			
21	Write to CG RAM/DD RAM E: E_2 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 1 0 1 0 0	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST_	T is written.
22	DD RAM Address Set E: E_2 RS: 0 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 1 1 0 0 0 0 0 0	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST _	The DD RAM address is set so that the cursor position is at digit 1 of line 4.
23	Write to CG RAM/DD RAM E: E_2 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 1 0 1 1 1	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST W_	W is written.
24	Write to CG RAM/DD RAM E: E_2 RS: 1 R/W: 0 DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 0 1 0 0 1	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST WI_	I is written.

	Instruction	Display	Operation
25			
26	Write to CG RAM/DD RAM E: 1, RS: 0, R/W: 0, DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 1 0 0 0 1 0 1	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST WIDE VIEWING ANGLE_	E is written.
27	Display ON/OFF Control E: 0, RS: 0, R/W: 0, DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 0 0	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST WIDE VIEWING ANGLE	The cursor is turned OFF.
28	DD RAM Address Set E: 0, RS: 0, R/W: 1, DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 0 0 0 0	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST WIDE VIEWING ANGLE	The DD RAM address is set at line 1.
29	Display ON/OFF Control E: 0, RS: 0, R/W: 0, DB_7 DB_6 DB_5 DB_4 DB_3 DB_2 DB_1 DB_0: 0 0 0 0 1 1 1 0	LCD MODULE L4044 40DIGITS,4LINES HIGH CONTRAST WIDE VIEWING ANGLE	The cursor is turned ON at digit 1 of line 1.
30			

(2) Interface data length : 4 bits

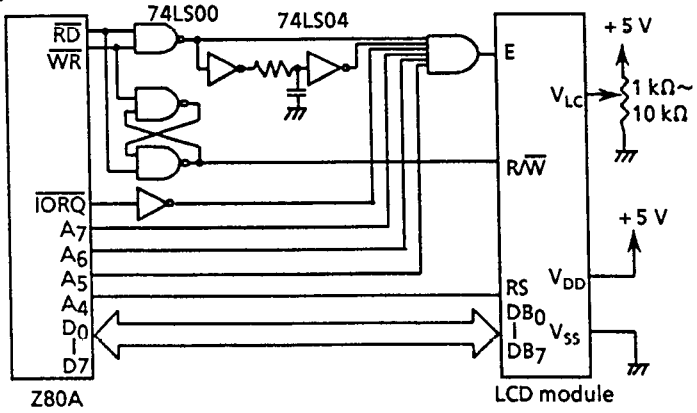
	Instruction	Display	Operation
1	Power on E: –, RS: –, R/W: –, DB_7: –, DB_6: –, DB_5: –, DB_4: – E: –, RS: –, R/W: –, DB_7: –, DB_6: –, DB_5: –, DB_4: –		The built-in reset circuit initializes the module.
2	Function Set E: E_1, RS: 0, R/W: 0, DB_7: 0, DB_6: 0, DB_5: 1, DB_4: 0 E: –, RS: –, R/W: –, DB_7: –, DB_6: –, DB_5: –, DB_4: –		4-bit operation mode is set for the upper 2 lines. Since 8-bit operation mode has been set by initialization, the instruction is executed only once.
3	Function Set E: E_1, RS: 0, R/W: 0, DB_7: 0, DB_6: 0, DB_5: 1, DB_4: 0 E: E_1, RS: 0, R/W: 0, DB_7: 1, DB_6: *, DB_5: *, DB_4: *		4-bit operation mode, 1/16 duty cycle, and 5 x 7 dot-matrix character font are selected. Then 4-bit operation mode starts.
4	Function Set E: E_2, RS: 0, R/W: 0, DB_7: 0, DB_6: 0, DB_5: 1, DB_4: 0 E: –, RS: –, R/W: –, DB_7: –, DB_6: –, DB_5: –, DB_4: –		4-bit operation mode is set for the lower 2 lines. Since 8-bit operation mode has been set by initialization, the instruction is executed only once.

	Instruction	Display	Operation
5	Function Set E: E_2 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 1 DB_4: 0 E: E_2 RS: 0 R/W: 0 DB_7: 1 DB_6: * DB_5: * DB_4: *		4-bit operation mode, 1/16 duty cycle, and 5 x 7 dot-matrix character font are selected. Then 4-bit operation mode starts.
6	Display ON/OFF control E: E_1 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 0 DB_4: 0 E: E_1 RS: 0 R/W: 0 DB_7: 1 DB_6: 1 DB_5: 1 DB_4: 0	_	The display and the cursor are turned ON for the upper 2 lines. No display appears.
7	Display ON/OFF control E: E_2 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 0 DB_4: 0 E: E_2 RS: 0 R/W: 0 DB_7: 1 DB_6: 1 DB_5: 0 DB_4: 0	_	The display is turned ON and the cursor is turned OFF for the lower 2 lines. No display appears.
8	Entry Mode Set E: E_1 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 0 DB_4: 0 E: E_1 RS: 0 R/W: 0 DB_7: 0 DB_6: 1 DB_5: 1 DB_4: 0	_	The address is incremented by one and the cursor shifts to the right in a write operation to internal RAM for the upper 2 lines. No display appears.
9	Entry Mode Set E: E_2 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 0 DB_4: 0 E: E_2 RS: 0 R/W: 0 DB_7: 0 DB_6: 1 DB_5: 1 DB_4: 0	_	The same entry mode is set for the lower 2 lines.
10	Write to CG RAM/DD RAM E: E_1 RS: 1 R/W: 0 DB_7: 0 DB_6: 1 DB_5: 0 DB_4: 0 E: E_1 RS: 1 R/W: 0 DB_7: 1 DB_6: 1 DB_5: 0 DB_4: 0	L_	L is written. The AC is incremented by one and the cursor shifts to the right.
11	⋮	⋮	
12	Display ON/OFF control E: E_2 RS: 0 R/W: 0 DB_7: 0 DB_6: 0 DB_5: 0 DB_4: 0 E: E_2 RS: 0 R/W: 0 DB_7: 1 DB_6: 1 DB_5: 1 DB_4: 0	LCM 40X4 SII _	The display and the cursor are turned ON for the lower 2 lines. No display appears.

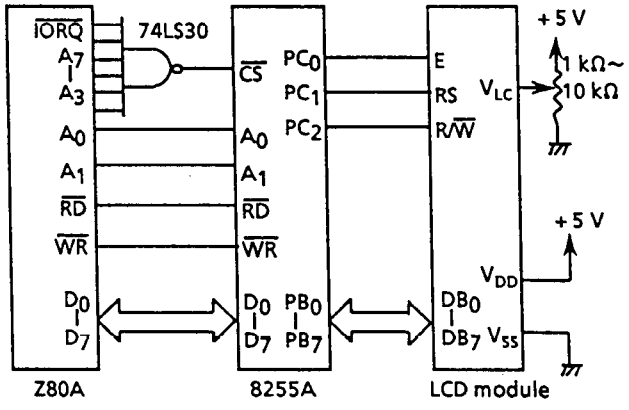
14. INTERFACE WITH MPU

14.1 L1671, L1681, L1672, L1682, L1692, L1634, L2032, L2034, L2462, L4051, L4052

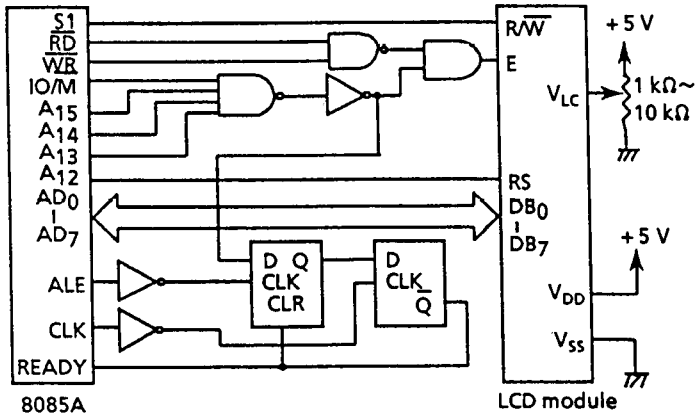
(1) Z80A



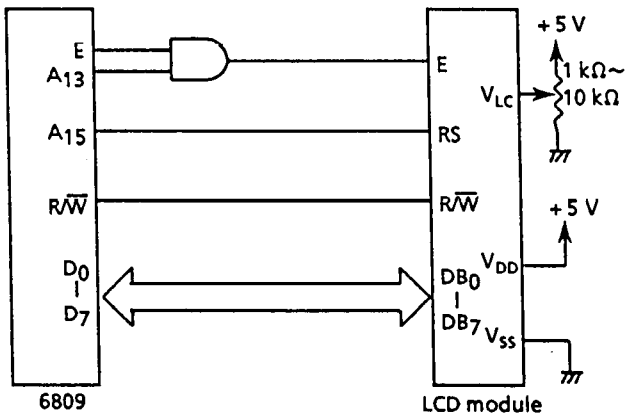
(2) Z80A and 8255A



(3) 8085A

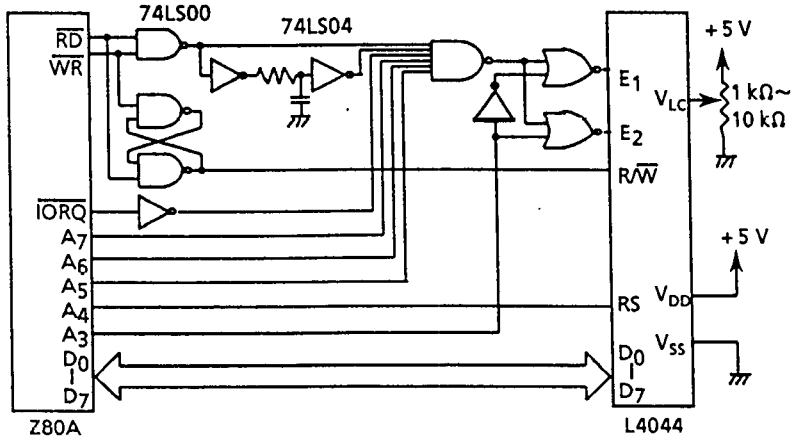


(4) 6809

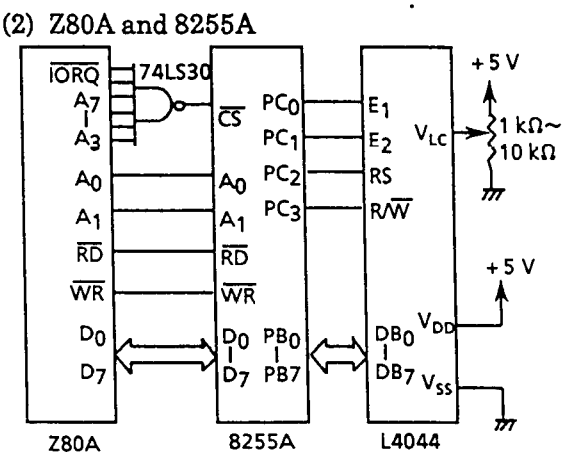


14.2 L4044

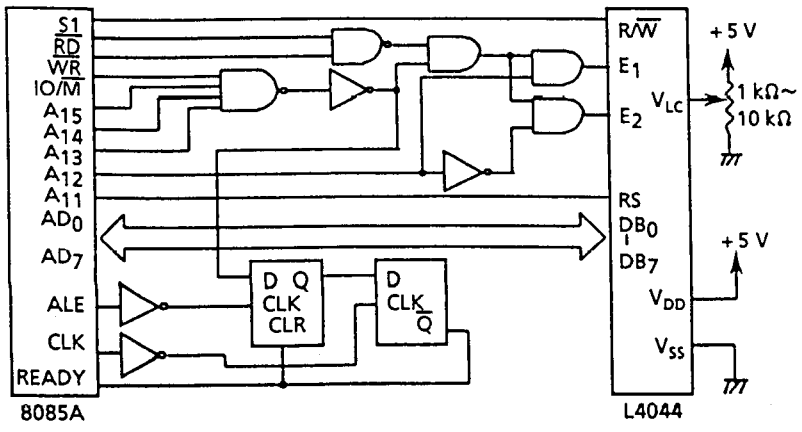
(1) Z80A



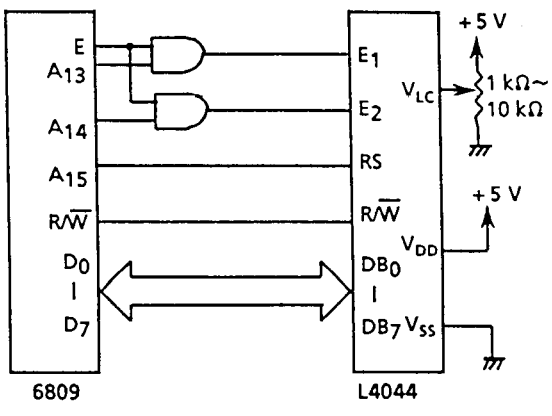
(2) Z80A and 8255A



(3) 8085A



(4) 6809



15. INTERFACE PROBLEMS AND CHECK POINTS

15.1 Phenomena

(1) Display is blank after power-on and initialization.
◎ See Causes and check: ① to ⑦

(2) Wrong display or missing display
◎ See Causes and check: ③ to ⑩

(3) ICs become hot.
◎ See Causes and check: ①, ⑪, ⑫, ⑬

(4) Input data is not displayed in correct order.

- In L1671 and L1681, display at digit 8 does not shift to digit 9.
- In 2-line module except L4052, display at the last digit of line 1 does not shift to the first digit of line 2.
- In L1634 and L2034, display at the last digit of line 1 does not shift t to the first digit of line 2, but shifts to the first digit of line 3.
- In L4044, display at the last digit of line 2 does not shift to line 3.

◎ See Causes and Check: ⑤, ⑭, ⑮

15.2 Causes and check

① Check that the power supplies (V_{DD} = 5 V, V_{SS} = 0 V) are connected.

② Check that adequate voltage is being applied to V_{LC} terminal. See "Power Supply" in section 5, "Specifications" of individual LCD modules.

③ Check that input/output pins are set in correct order.

④ Check that data is not being transmitted too fast.

- Is busy being checked on operation ?
- If busy check is not performed, is there sufficient interval between instructions?

⑤ Check that initialization has been properly performed. See section 10, "Initialization".

⑥ Check that enable fall time is 25 ns or less.

⑦ Check that enable pulse width is 220 ns or more.

⑧ Check that other peripheral equipment is not in contention with the data bus (chip select problem).

⑨ Check that signal levels (TTL level) are not too low.

⑩ Check that all data bus components have TTL type outputs.

⑪ Check that V_{DD} and V_{SS} are not connected inversely.

⑫ Check that too much voltage is not applied to V_{DD}.

⑬ Check that no input signal is applied when the power source of V_{DD} terminal is off.

⑭ Check the relation between the DD RAM address and the display digit, and execute correct DD RAM Address Set instruction. See section 8.5, "Display Data RAM".

⑮ Check that initialization has been performed for E1 and E2 respectively in L4044, which has two controllers and requires E1 for lines 1 and 2, and E2 for lines 3 and 4.

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