CITIZEN

OEM DIVISION

Liquid Crystal Displays

K6481L-FF

features:

- 4.7 inch diagonal screen
- Full "VGA" 640 x 480 resolution
- Colour STN passive matrix
- CCFT Backlight
- Dual Scan: $^{1}/_{240}$ duty multiplex

A full VGA screen in a quarter-VGA footprint

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1. Application

This specification shall be applied to Dot Matrix LCD MODULE K6481L-FF.

2. Composition

Display type	: Color STN display
Dot structure	: 640 × 3 (RGB) × 480 Dot's Graphic display
Driving method	: 1/240 duty Multiplex drive
Back light	: Cold Cathod Fluorescent Tube (CCFT)
Surface texture	: Non-Glare

Block Diagram

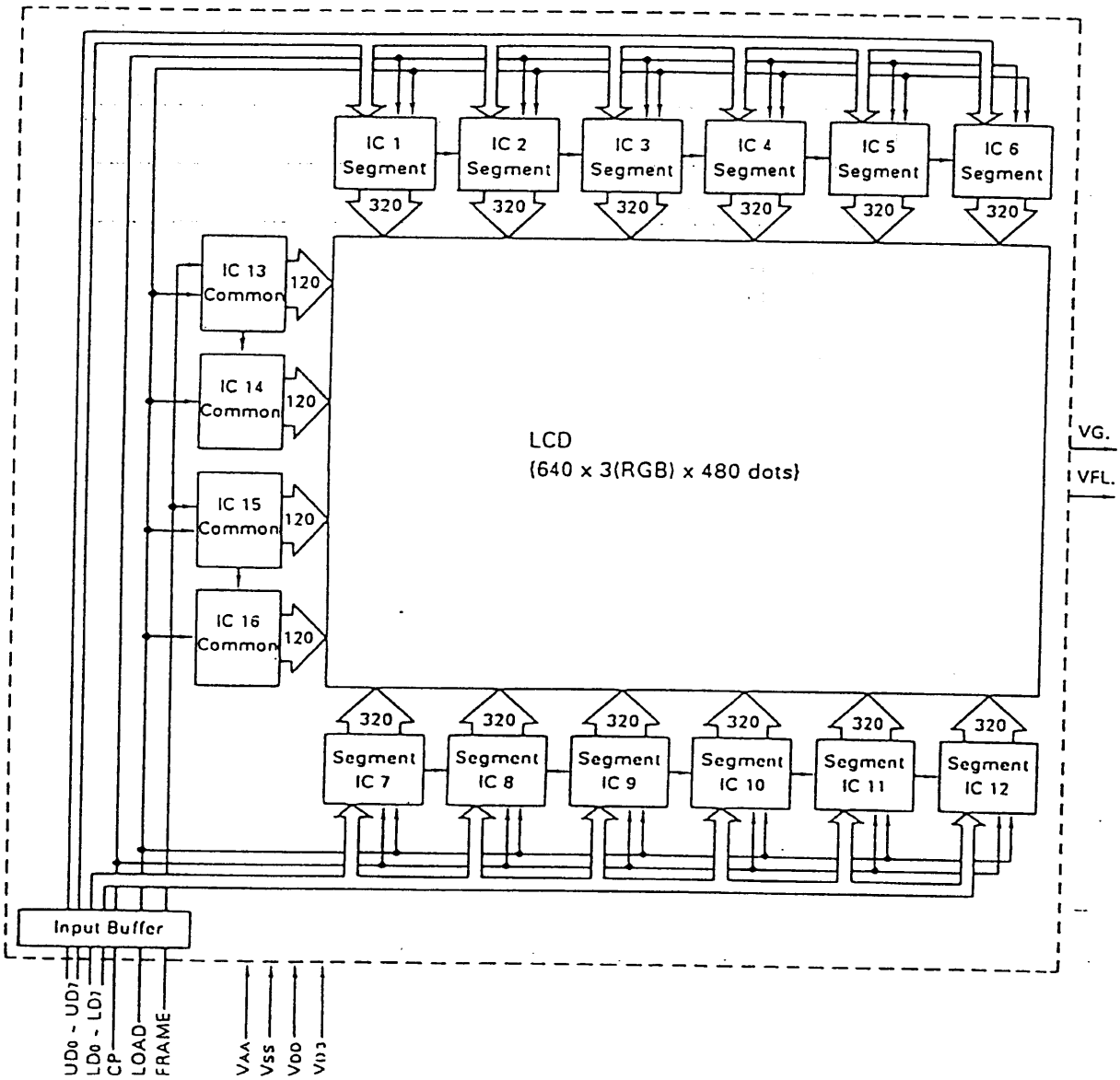

Fig 2-1

(Notes) · K648 L-FF does not incorporate any controller.

3. Mechanical Specifications

3-1 Dimentions and weights

Item	Dimensions	Unit
Module size	140(W) × 98(H) × 7(D) max.	mm
Effective viewing area	98(W) × 74(H)	mm
Weight	Approx. 116	g

3-2 Dot Dimensional Drawing

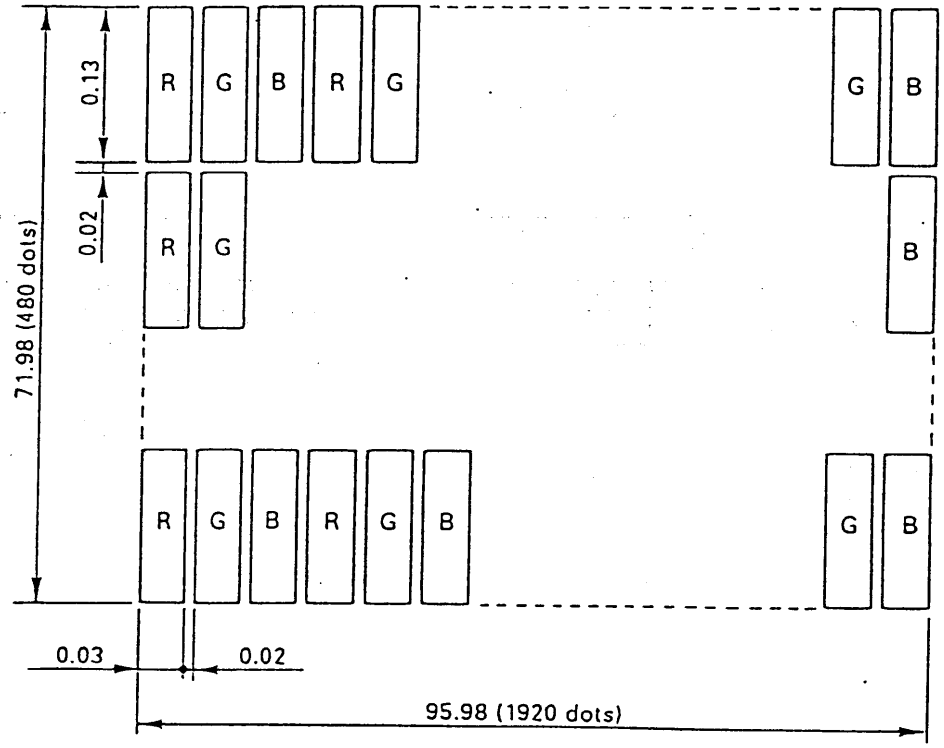

Fig 3-1

3-3 Input connector

Manufacturer HOLEX
Parts NO. 52437-30

3-4 Input FPC, FFC specification (Reference drawing)

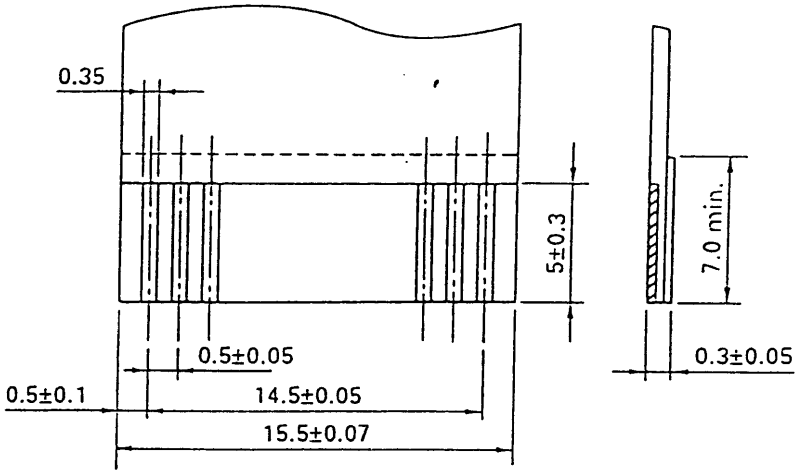

Fig 3-2

3-5 Backlight connector

Manufacturer JST
Parts NO. BHR-03VS-1
Compatible PCB connector SM02(8.0)B-BHS

4. Absolute Haximum Ratings

4-1 Electrical absolute maximum ratings

(V_{SS}=0V)

Item	Symbol	Hin.	Hax.	Unit	Remarks
Supply voltage for logic circuit 1	$V_{DD}-V_{SS}$	- 0.3	+ 6.0	V	
Supply voltage for logic circuit 2	$V_{D3}-V_{SS}$	- 0.3	+ 6.0	V	
Supply voltage for LCD driving	$V_{AA}-V_{SS}$	0	+30.0	V	
Input voltage	V_{IN}	- 0.3	V_{D3}+0.3	V	Note 1

Note 1 : Shall be applied to FRAME, LOAD, CP, UD_0 ~UD_7 , LD_0 ~LD_7 .

4-2 Environmental absolute maximum ratings

Item	Specification	Remarks
Storage temperature	Max. + 60℃ Hin. - 20℃	Note 1 No condensation
Operating temperature	Max. + 45℃ Hin. 0℃	Note 1 No condensation
Vibration	Frequency : 15 ~ 55Hz Acceletation : 1.5G Sweep : 2.5 octave/min.	X, Y, Z directions
Shock	Acceletation : 50G Acting time : 11 msec.	X, Y, Z directions

Note 1 : Ta ≦ + 40℃ ····· 85% RH Max.
Ta > + 40℃ ····· Absolute humidity must be lower than the humidity of 85% RH at + 40℃

5. Electrical Specifications

5-1 Electrical Characteristics

(V_{SS}=0V)

Item		Symbol	Test condition	Min.	Typ.	Max.	Unit	Remarks
Supply voltage for logic circuit 1		$V_{DD}-V_{SS}$		4.75	5.0	5.25	V	
Supply voltage for logic circuit 2		$V_{D3}-V_{SS}$		3.0	V_{DD}	V_{DD}+0.5	V	
Supply voltage for LCD driving		$V_{AA}-V_{SS}$		15.0		27.0	V	
FRAME frequency		f_{FRAME}		—	120	—	Hz	
Input voltage	H level	VIH	$V_{DD}-V_{SS}$ =5.0V ± 5%	0.7V_{D3}	—	V_{D3}	V	(Note)
	L level	VIL		0	—	0.3V_{D3}	V	
Current consumption		I_{DD}	Ta=25 °C $V_{DD}-V_{SS}$= 5.0V $V_{D3}-V_{SS}$= 3.0V $V_{AA}-V_{SS}$=23.8V f_{FRAME}=120HZ	—	63.6	127.4	mA	
		I_{D3}		—	0.3	1.6	mA	
		I_{AA}		—	3.5	6.1	mA	

※ $V_{AA}>V_{DD}>V_{SS}$

(Note) Shall be applied to FRAME, LOAD, CP, UD_0 ~UD_7 , LD_0 ~LD_7 .

5-2 Supply voltage for LCD driving ($V_{AA}-V_{SS}$)

The contrast of the liquid crystal display depends on viewing angle, ambient temperature, and operating voltage, etc. Adjust the contrast by varying V_{AA} as necessary.
The following values are recommended.

Ta= 0 °C ..... 26.2Vtyp θ= 0 °, ϕ= 0 °
Ta=25 °C ..... 23.8Vtyp f_{FRAME}=120HZ
Ta=40 °C 22.7Vtyp

5-3 V_{AA} adjusting circuit

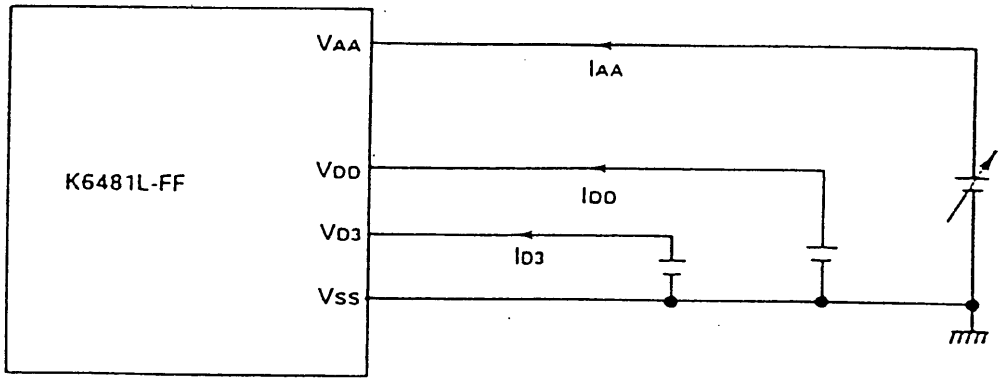

Fig 5-1

6. Interface Specifications

6-1 Terminal Pin Assignment

Pin No.	Symbol	Function
1	V_{SS}	GND
2	V_{D3}	3.0 ~ V_{DD}+0.5V (Supply voltage [2] for logic circuit) ※
3	V_{AA}	+V (Variable power supply for LCD drive circuit)
4	V_{DD}	+5.0V (Supply voltage [1] for logic circuit) ※
5	$\overline{DISP \cdot OFF}$	GND level : LCD becomes non-visual V_{DD} level : LCD becomes normal operation
6	NC	No connection
7	V_{SS}	GND
8	UD_7	Display data of upper screen (Fig 6-1)
9	UD_6	
10	UD_5	
11	UD_4	
12	UD_3	
13	UD_2	
14	UD_1	
15	UD_0	
16	V_{SS}	GND
17	LD_7	Display data of lower screen (Fig 6-1)
18	LD_6	
19	LD_5	
20	LD_4	
21	LD_3	
22	LD_2	
23	LD_1	
24	LD_0	
25	V_{SS}	GND
26	FRAME	Scanning data (Start signal of each display cycle)
27	LOAD	Clock pulse for scanning data shift Latch pulse for output of display data
28	V_{SS}	GND
29	CP	Clock pulse for input of display data
30	V_{SS}	GND

Others : 2 lead wires for FL back ligh (V_{FL}, VG(GND))

※ Supply voltage [1] for logic circuit
··· Supply voltage for operating logic circuit in LCD module.

※ Supply voltage [2] for logic circuit
··· Supply voltage for operating IC of interface.
Supply the voltage in accordance with logic level of input signal.

6-2 Relationships of DATA input signal and LCD Screen division

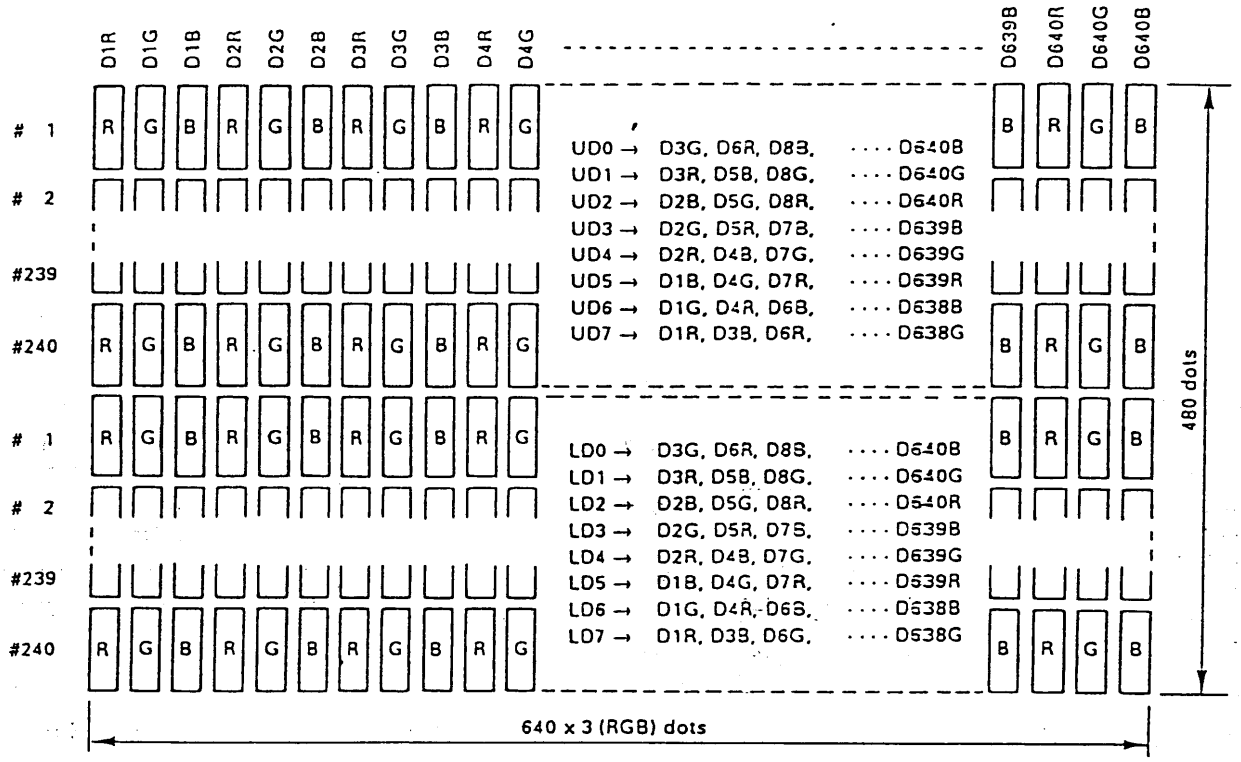

Fig 6-1 LCD screen

6-3 Timing Chart

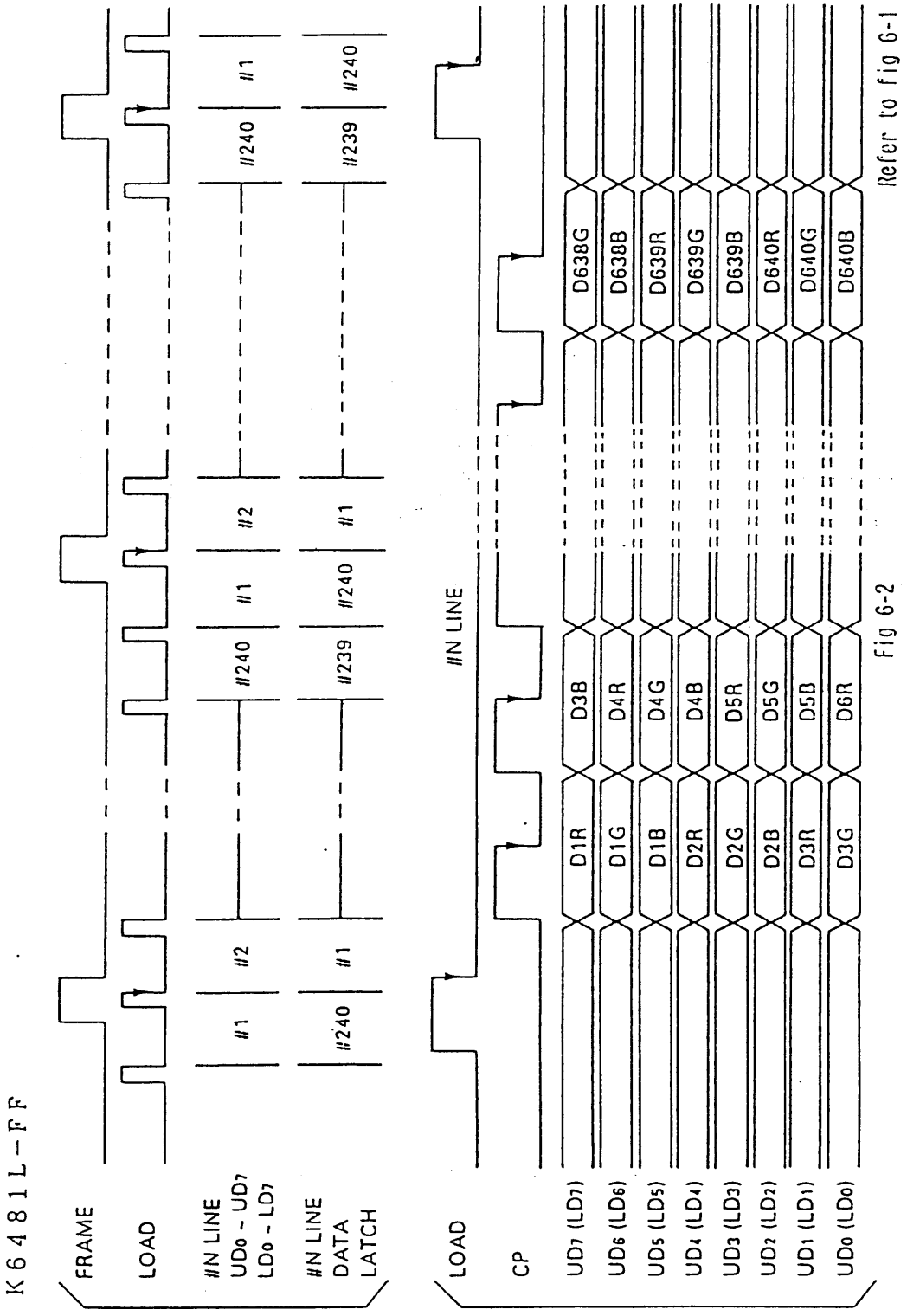

Fig 6-2

6-4 Switching Characteristics

$V_{DD} - V_{SS} = 5V \pm 5\%$

Item	Symbol	Min.	Typ.	Max.	Unit
tcp clockcycle time		80			nS
CP pulse width	$t_{W(CH)}$	30			nS
	$t_{W(CL)}$	30			nS
LOAD pulse width	$t_{W(LH)}$	100			nS
	$t_{W(LL)}$	10			μs
LOAD → CP time	t_{LC}	300			nS
CP → LOAD time	t_{CL}	100			nS
DATA set up time $UD_7 \sim UD_0$, $LD_7 \sim LD_0$ → CP	t_{DSU}	20			nS
DATA hold time CP → $UD_7 \sim UD_0$, $LD_7 \sim LD_0$	t_{DHD}	40			nS
LOAD → FRAME time	t_{LF}	150			nS
FRAME → LOAD time	t_{FL}	150			nS
FRAME set up time FRAME → LOAD	$t_{SU(FR)}$	350			nS
FRAME hold time LOAD → FRAME	$t_{HD(FR)}$	150			nS
CP rise & fall time	$t_{R(CP)}$			30	nS
	$t_{F(CP)}$				nS
LOAD rise & fall time	$t_{R(L)}$			30	nS
	$t_{F(L)}$				nS

Note) 1. LOAD signal should be inputted at the same interval.
2. CP signal should be inputted 20 times or more between LOAD signal.

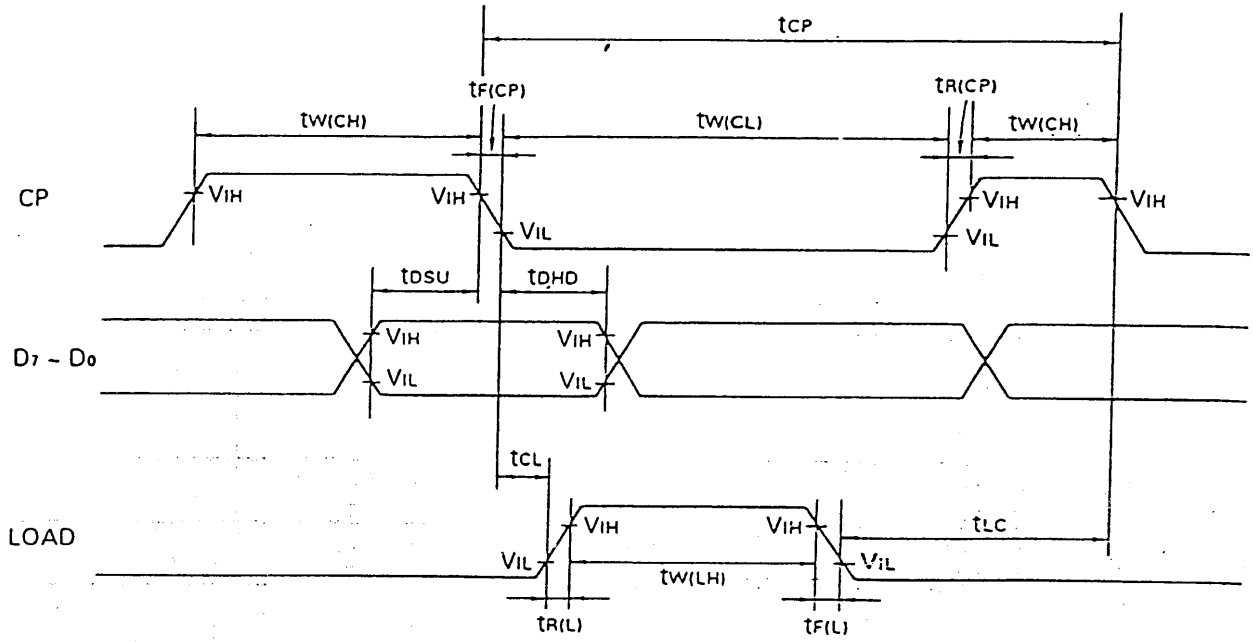
tCP
tF(CP)
tR(CP)
tW(CH)
tW(CL)
tW(CH)
CP
VIH
VIL
tDSU
tDHD
D7 ~ D0
tCL
LOAD
tLC
tW(LH)
tR(L)
tF(L)

Fig 6-3

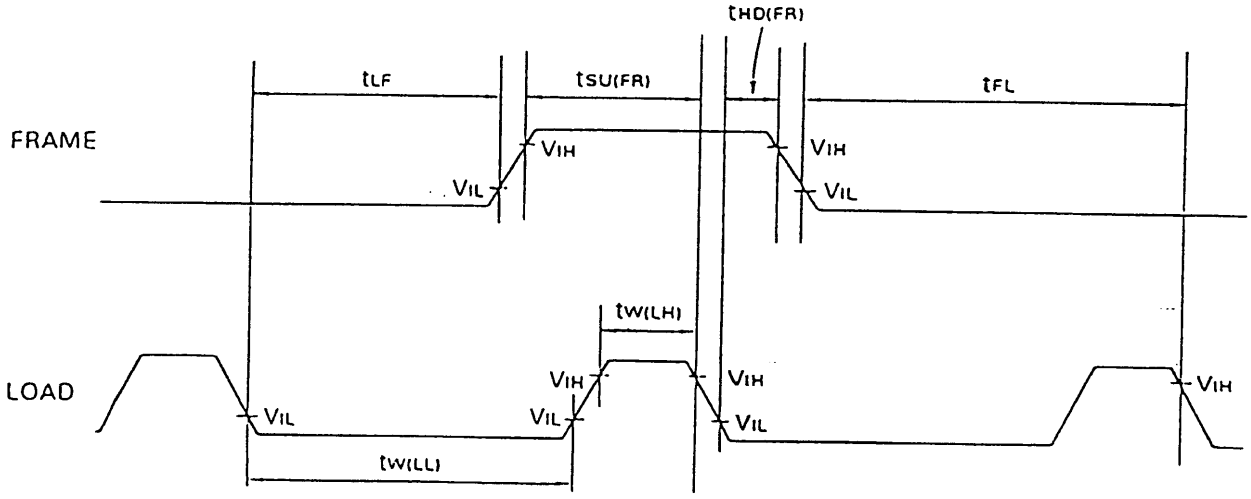
tHD(FR)
tLF
tSU(FR)
tFL
FRAME
VIH
VIL
tW(LH)
LOAD
tW(LL)

Fig 6-4

7. Optical Characteristics

7-1 Optical Characteristics (1) (Refer to Note 1~Note 4)

Ta=25 ℃

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
Turn on time	t_{ON}	—	150		ms	θ= 0°, ϕ= 0°
Turn off time	t_{OFF}	—	100		ms	
Contrast ratio	CR		30	—		θ= 0°, ϕ= 0°
Visual angle range	θ_1	$-40 \leqq \theta_1 \leqq 20$			deg.	ϕ= 0°, CR≧ 3
	θ_2	$-40 \leqq \theta_2 \leqq 40$			deg.	ϕ= 90°, CR≧ 3

(Note 1) Optical Characteristics measurement system

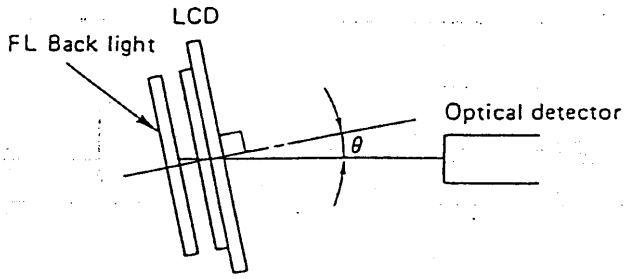

Fig 7-1

(Note 2) Definition of response time

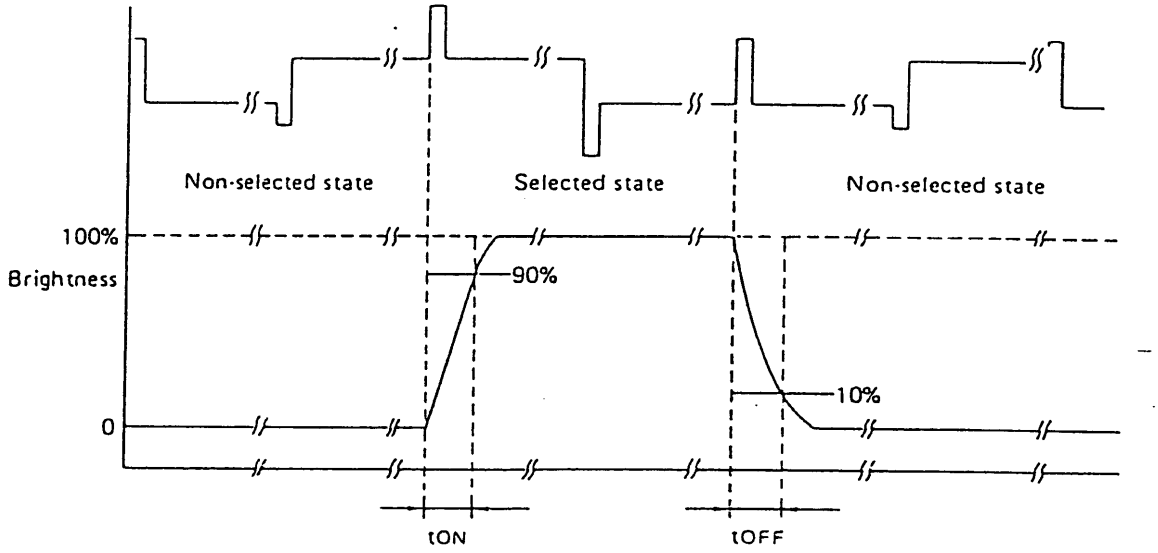

Fig 7-2

(Note 3) Definition of θ and ϕ

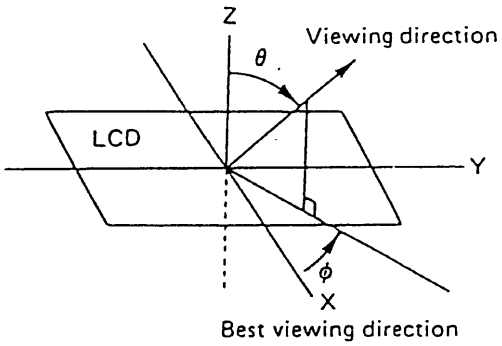

Fig 7-3

(Note 4) Definition of contrast ratio

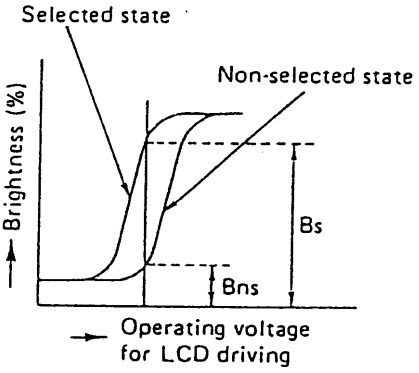

Fig 7-4

$$CR = \frac{\text{Brightness at selected state} \quad (Bs)}{\text{Brightness at non-selected state} \quad (Bns)}$$

7-2 Optical Characteristics (2)

CIE (x, y) color chart

Ta=25°C

Item	Symbol	Min.	Typ.	Max.	Test condition
Red	x	—	0.45	—	$\theta = 0°$, $\phi = 0°$
	y	—	0.29	—	
Green	x	—	0.30	—	$\theta = 0°$, $\phi = 0°$
	y	—	0.47	—	
Blue	x	—	0.17	—	$\theta = 0°$, $\phi = 0°$
	y	—	0.14	—	
White	x	—	0.32	—	$\theta = 0°$, $\phi = 0°$
	y	—	0.35	—	

8. Backlight Specifications

8-1 Electrical Characteristics

Item	Condition	Min.	Typ.	Max.	Unit
Lamp current	Ta = 25 ℃		5.0		mA rms
Lamp voltage	Ta = 25 ℃		310		V rms
Frequency			40~60		kHz
Starting discharge voltage	Ta = 0 ℃			530	V rms

8-2 Optical Characteristics

Item	Condition	Min.	Typ.	Max.	Unit
Brightness	Frequency = 40kHz, Sin wave Lamp current = 5mA		150 *		cd/㎡
	Frequency = 40kHz, Sin wave Lamp current = 3mA		90		cd/㎡
Rise time	80% brightness		5	8	Minutes
Brightness uniformity				±20% **	

* : Windless condition at room temperature, average value of 5 points below.
** : (Max. or Min. brightness - Ave. brightness) / Ave. brightness.
Measured at 5 points below with the fittest contrast in the condition whole screen white.

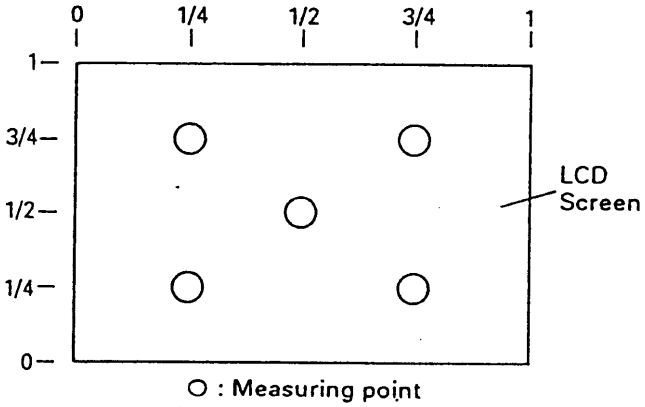

Fig 8-1

8-3 Lifetime *

Ta=25 ℃

Item	Condition	Min.	Typ.	Unit
Continuous driving	Lamp current = 5mA	10,000		hrs.
ON OFF cycle	Lamp current = 5mA	100,000		Cycles **

* : The definition of lifetime is the period until the brightness becomes 1/2.
** : 1 cycle =30 sec. ON → 30 sec. OFF.

9. Precautions in use

9-1 Precautions for handling

(1) The polarizer is quite susceptible to scratches. Handle it very carefully. Do not handle it with metallic tweezers nor press nor rub it.
(2) Do not contact the display face by nor get it stained.
If the surface is dirty, wipe it off lightly with a cotton swab or a piece of soft cloth or chamois which is soaked with petroleum or benzine. Never use organic solvents including acetone, toluene, ethanol, and isopropyl alcohol: they would damage the surface.
(3) Do not allow saliva or water to remain on the surface for long; it might cause a local deformation or discoloration.
(4) When the LCD has broken and the liquid crystal has come out, never allow it in your mouth. If it sticks to the skin or clothes, wash it off immediately by using a soap.

9-2 Installation

(1) The ICs mounted on the PCB are very susceptible to static electricity. To protect them from static electricity which your body and clothing collect, connect your body to the ground via a resistor of some 1M ohms so that the electricity should discharge. Connect the resistor close to your body in the grounding line and protect yourself from electric shock hazard. Keep the fact in mind that static electricity is liable to be generated in a dry environment. It is recommended to do the work in the environment where humidity is 60% or more. Whenever such tool as a soldering iron is used for assembly, be sure to ground it.
(2) Neither bend nor twist the module excessively when installing it. Otherwise the device might break or the circuits fail.
In particular, be careful not to allow pressure to work on the CCFT.
Don't put undue stress on a part where the CCFT and cable have been connected ;otherwise, the cold cathode tube fails to come on as the case may be.
(3) Protect the LCD , particularly the surface of polarizer, with a transparent plate (such acrylic or glass plate) on the cabinet.

9-3 Storage

(1) Avoid high temperature and high humidity. The temperature should be 0-35 ℃ and humidity be under 60%.
(2) Store the module in a dark place, out of direct sunlight and fluorescent lamp,etc.
(3) Keep the polarizer from any external forces.
(4) Store the module, keeping it in the box as it is in delivery or in the same conditions.

9-4 Operational precautions

(1) The ICs would break down if the drive voltage exceeds the limit. Make sure of electrical specifications, particularly the supply voltage.
Moreover, if the input connector of LCD module is joined/disjoined with the power of LCD module kept ON, the internal circuit of LCD module might break down. So, be sure to join/disjoin the input connector with the power turned OFF.
(2) The response of the display is slow when the ambient temperature is below the lower limit, and the display becomes unusual when the ambient temperature is above the upper limit. In any case, it does not mean failure. It operates properly in the normal operating temperature range.
(3) The contrast of the liquid crystal display varies with the viewing angle, ambient temperature, and drive voltage. Adjust the drive voltage for the best contrast by installing external variable switch.

(4) If you move the module from a cold storage into the room as during test, moisture would condense on the module and it might fail.
(5) In order to prevent IC Latch-up and DC voltage on the LCD panel, please power on by the following Fig. 9-1.

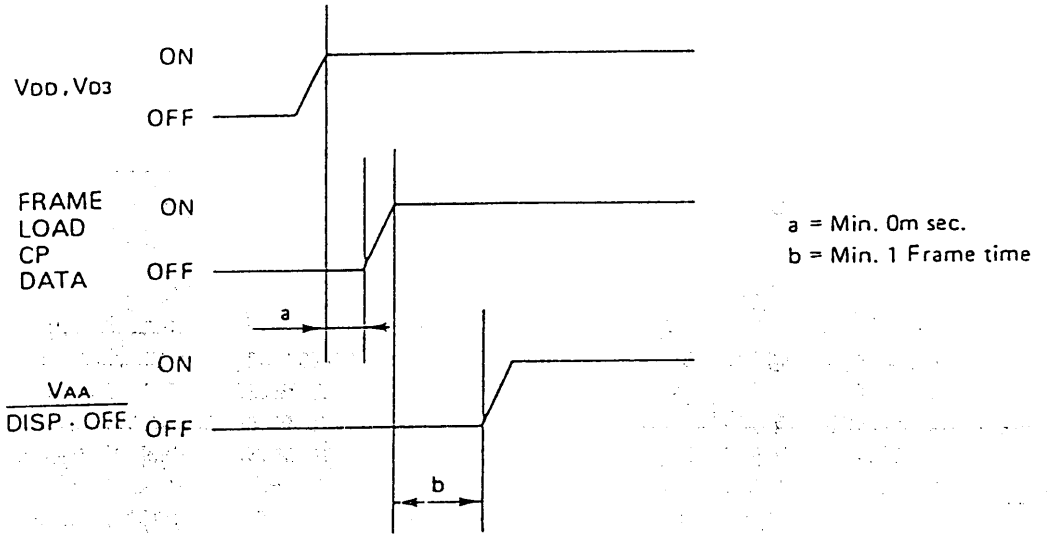

Fig 9-1

(6) Even when the module has worked normally, be sure to check if a noise level on each signal is within the specification (L level : less than $0.3V_{D3}$ and H level : more than $0.7V_{D3}$). If the noise level is beyond that specified figure, there is possibility to occure operational error statistically.
Moreover, be sure to measure the noise level with the module kept connected.
(7) As IC on the module, CHOS IC has been used and the input terminals do not incorporate a pull-up/pull-down function. So, avoid to keep the input terminals OPEN state during power ON condition.
(8) Application of DC voltage to a liquid crystal results in debasement of the characteristics. Though the original characteristics can be recovered so long as the application time is short, e.g., up to 1 second maximum, a long-time application would bring a permanent deterioration in the characteristics.
If a control signal, especially LOAD signal is not applied correctly in a condition where the liquid crystal driving voltage V_{AA} being applied to the liquid crystal, DC voltage is applied to liquid crystal.
It is suggested before use to prevent such application of DC voltage by studying "Hunual for use".
(9) The metal frame is not connceted to GND electrically. After the module has been built in your equipment, don't fail to connect the metal frame to GND. Otherwise, the internal IC is prone to latch up and could break down.
For lighting LCD module in a condition where it is not built in the equipment, be sure to connect the metal frame to GND and thereafter, turn the power ON.

9-5 Others

(1) Don't disassemble nor dismantle LCD module. As to any LCD module which has ever been disassembled or dismantled at the user's side, WARRANTY provided by CITIZEN won't be applied.
(2) In such a case where the same display pattern is left ON for a long time, there may be a slight residual image coming on. This residual image should disappear when any other display pattern is given or turn the power OFF and left the module as it is for a while. There is no problem in the reliability.
(3) When a grey scale is displayed, a poor-looking display, e.g., a crosstalk or flicker may come on according to the type of controller outputting a grey scale signal. For displaying the grey scale, check beforehand if any poor-looking display comes on for every grey scales.

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