General Description

The K6484L-FF BabyVGA™ is a 8,4" STN color VGA LCD display module. It can be ordered with or without a backlight power supply.

The K-series range of passive color STN displays feature dual scan display addressing which doubles the refresh rate of single scan panels. The K6484L has pixel format of full 640 x 3 (RGB) x 480 individually addressable graphic matrix. In the K6484L display, the use of "Slim-Tab" technology connects the control lines to the display in the most compact and efficient manner.

Features

- Dual scanning : effectively doubles the usal refresh rate of pasive color displays
- high contrast image giving a high color depth
- Clearer, brighter colors with excellent picture definition
- Fast response time and more color shades
- Ultra Thin
- Lightweight

Applications

- Portable Instruments
- PDA
- Ultra compact-size PCs
- Industrial Controls
- Lan/Cable Testers
- Handy Terminals

K6484L-FF BabyVGA™

Made by Citizen Watch Co., Ltd. Tokyo, Japan

Specificationc

1. Application

This specification shall be applied to Dot Matrix LCD Module K6484L-FF.

2. Composition

Display type	: Color STN display
Dot structure	: 640 x 3 (RGB) x 480 dot graphic display
Driving method	: 1/240 duty multiplex drive
Backlight	: Cold cathod fluoresent tube (CCFT)
Surface texture	: Non-Glare

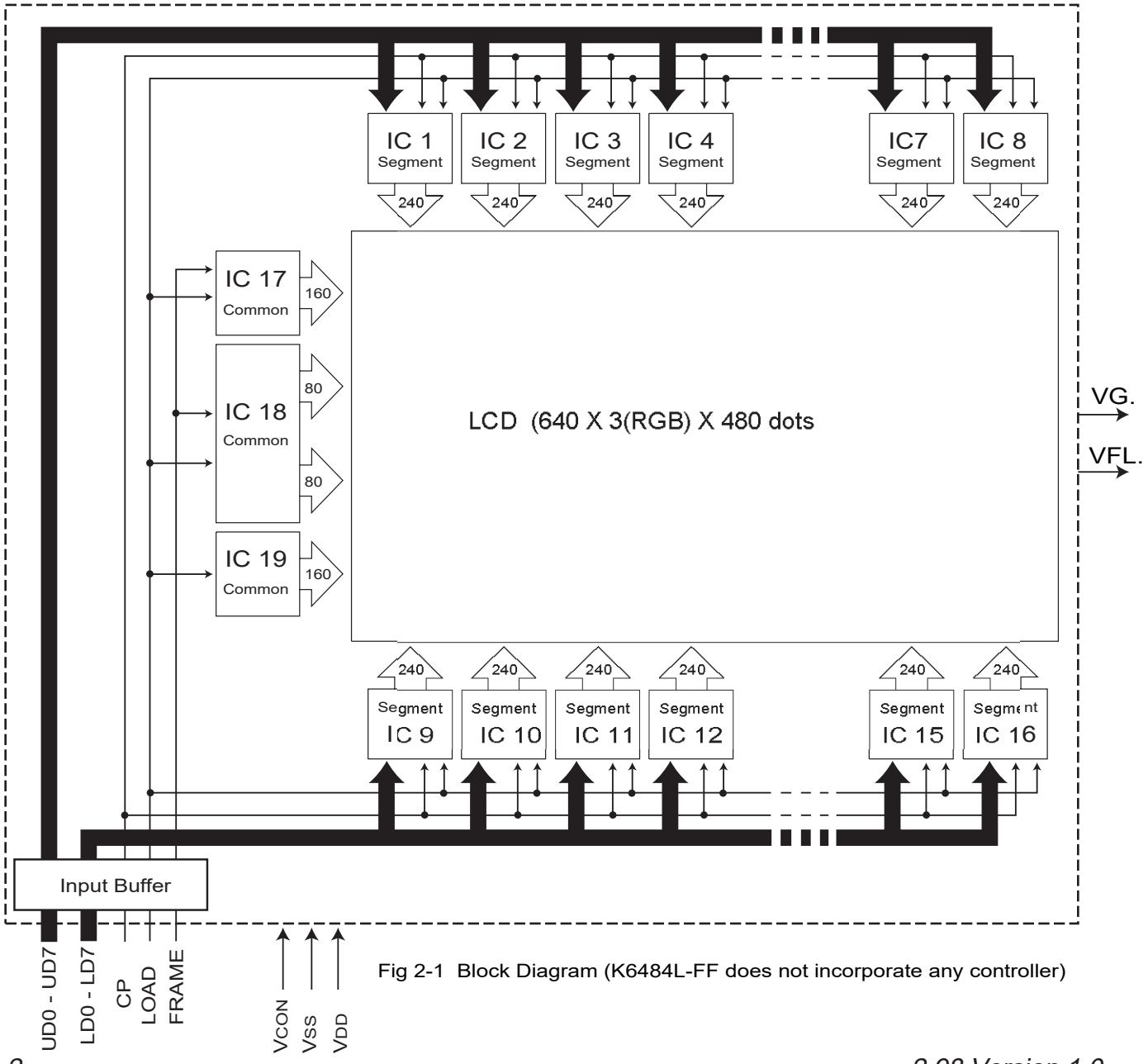


Fig 2-1 Block Diagram (K6484L-FF does not incorporate any controller)

3. Mechanical Specifications

3-1 Dimentions and weights

Module size : 216 (W) x 152.4 (H) x 7.5 (D) mm Typ.
Effective viewing area : 174 (W) x 131 (H) mm
Weight : Approx. 260 g

3-2 Dot dimentional drawing

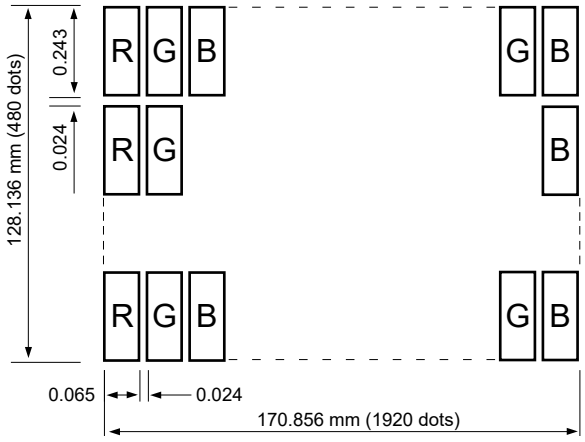


Fig 3-1

3-3 Input connector

Manufacturer : Hirose
Parts number : DF9B-31P-1V
Compatible PCB connector: DF9-31S-1V

3-4 Backlight connector

Manufacturer : JST
Parts number : BHR-03VS-1
Compatible PCB connector: SM02(8.0)B-BHS

4. Absolute maximum ratings

4-1 Electrical absolute maximum ratings

Item	Symbol	Min.	Max.	Unit	Remarks
Supply voltage for logic circuit	V_{DD} - V_{SS}	-0.3	+6.0	V	
Supply voltage for LCD driving	V_{CON} - V_{SS}	0	+3.0	V	
Input voltage	V_{IN}	-0.3	V_{DD}+0.3	V	Note 1

Note 1 : Shall applied to FRAME, LOAD, CP, UD0~UD7, LD0~LD7.

4-2 Environmental absolute maximum ratings

Item	Specification	Remarks
Storage temperature	Max. +60°C Min. -20°C	Note 1 No condensation
Operating temperature	Max. +45°C Min. 0°C	Note1 No condensation
Vibration	Frequency : 15~55Hz Acceleration : 1.5G Sweep : 2.5 octave/min.	X, Y, Z directions
Shock	Acceletation : 50G Acting time : 11msec.	X, Y, Z directions

(Note) Ta ≤ +40°C .....85% RH Max.
Ta > +40°C .....Absolute humidity must be lower than the humidity of 85% RH at +40°C

5. Electrical specifications

5-1 Electrical characteristics

(V_{SS} =0V)

Item		Symbol	Test Condition	Min	Typ	Max	Unit	Remarks
Supply Voltage for Logic Circuit		V_{DD}-V_{SS}		3.15	5.0	5.25	V	
Supply voltage for LCD driving		V_{CON}-V_{SS}		0.8		2.8	V	
Frame Frequency		f_{FRAME}			—	120	Hz	
Input Voltage	H level	V_{IH}	V_{DD}-V_{SS} = 5.0V±5%	0.8V_{DD}	—	V_{DD}	V	(Note)
	L level	V_{IL}		0		0.2V_{DD}	V	
Current Consumption		I_{DD}	Ta = 25 °C V_{DD} - V_{SS} = 5.0V V_{CON} - V_{SS} = 1.6V f_{FRAME} = 120Hz		90	1206	mA	
		I_{DD}	Ta = 25 °C V_{DD} - V_{SS} = 3.3V V_{CON} - V_{SS} = 1.6V f_{FRAME} = 120Hz		110	270	mA	

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

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

The contrast of the liquid crystal display depends on viewing angle, ambient temperature, and operating voltage, etc. Adjust the contrast by varying VCON as necessary.

Ta = 0°C .....1.3 Vtyp θ =0° , Ø = 0°
Ta = 25°C .....1.6 Vtyp f_{FRAME} = 120Hz
Ta = 40°C .....1.8 Vtyp

5-3 V_{CON} adjusting circuit

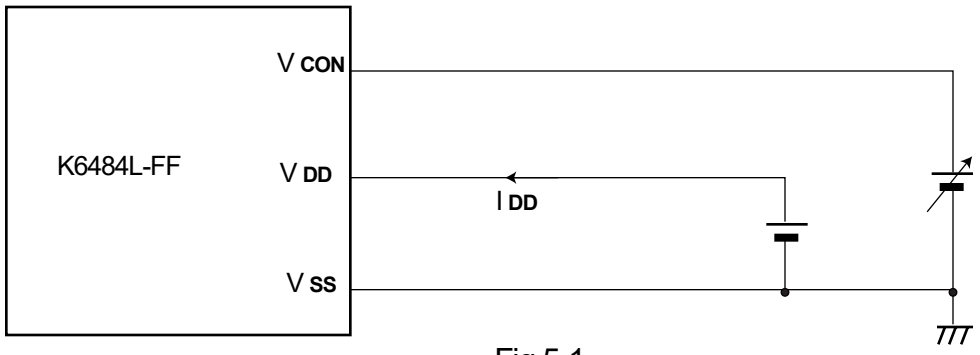


Fig 5-1

6. Interface specifications

6-1 Terminal pin assignment

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

Others : 2 lead wires for FL backlight - V_{FL}, V_G(GND)

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

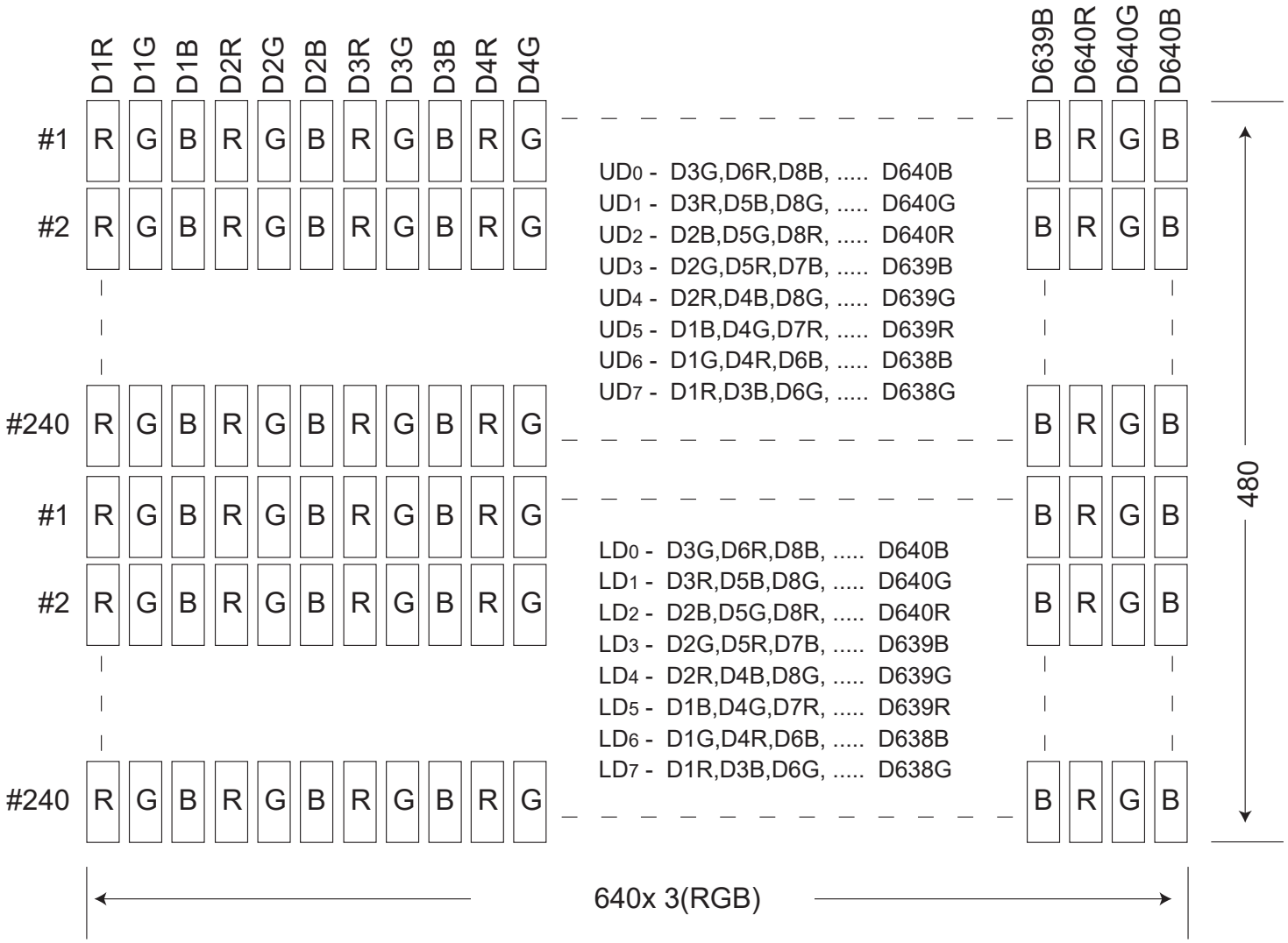


Fig 6-1

6-3 Timing chart

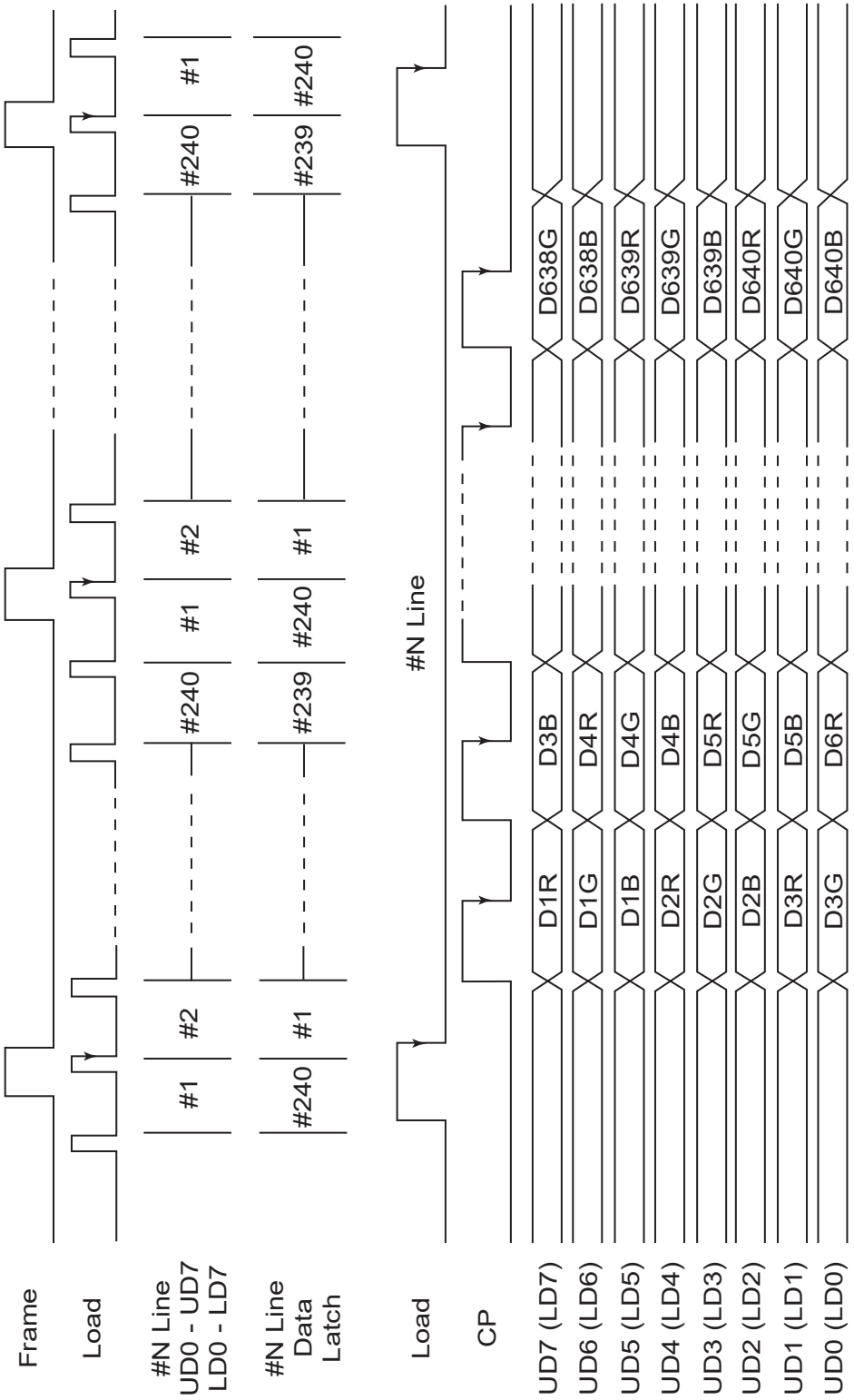


Fig 6-2

6-4 Switching characteristics

V_{DD}-V_{SS}=3.15V~4.75V

Item	Symbol	Min	Typ	Max	Unit
Top Clock Cycle Time		110			ns
CP Pulse Width	tw(CH)	41			ns
	tw(CL)	41			ns
Load Pulse Width	tw(LH)	110			ns
	tw(LL)	440			ns
Load ⟶ CP	t_{LC}	110			ns
CP ⟶ Load	t_{CL}	110			ns
Data Setup Time UD7-UD0, LD7-LD0 ⟶ CP	t_{OSU}	39			ns
Data Hold Time CP ⟶ UD7-UD0, LD7-LD0	t_{DHD}	39			ns
Frame Setup Time Frame ⟶ Load	t_{SU}(FR)	143			ns
Frame Hold Time Load ⟶Frame	t_{HD}(FR) 10			ns	
CP Rise/Fall Time	t_R(CP)			45	ns
	t_F(CP)			45	ns
Load Rise/Fall Time	t_R(L)			18	ns
	t_F(L)			18	ns

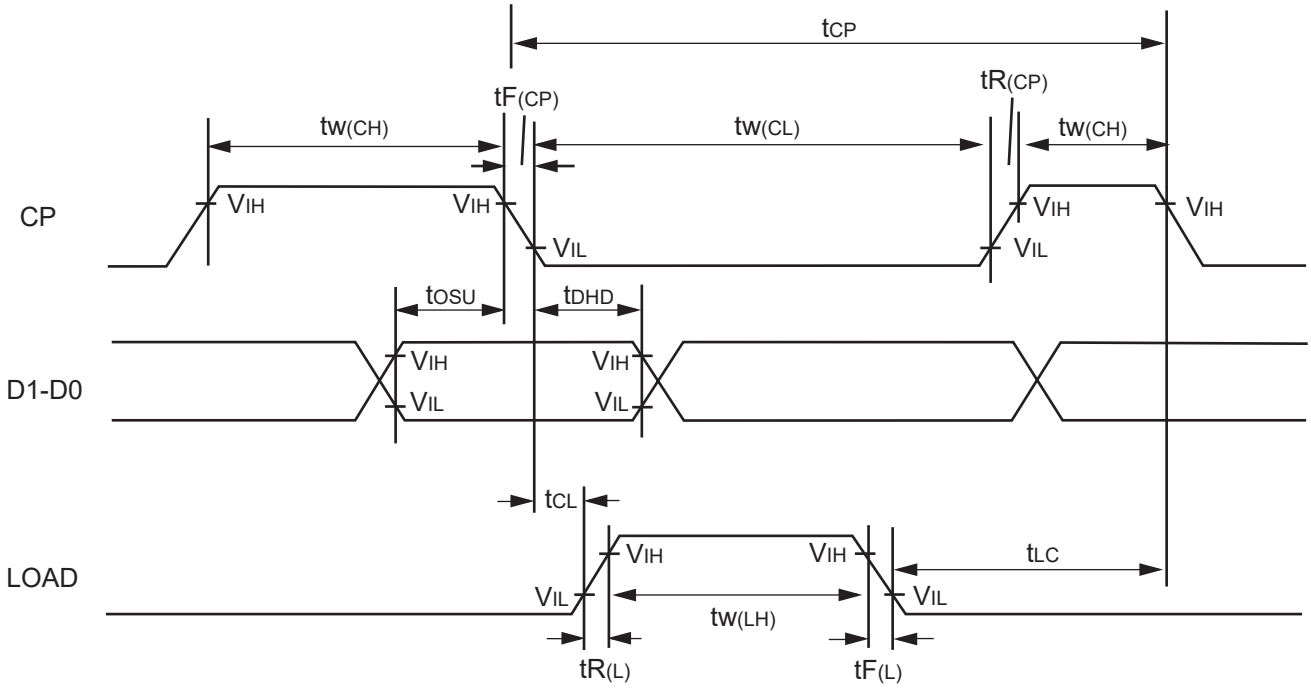
(Note) 1. Load signal should be inputted at the same interval.
2. CP signal should be inputted 20 times or more between LOAD signal.

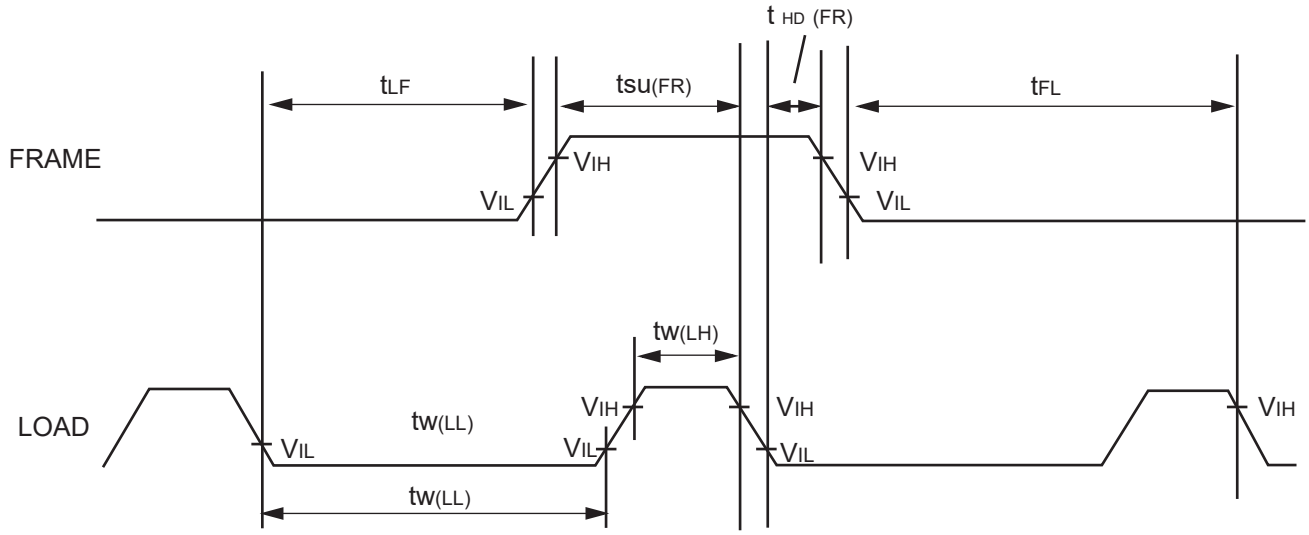
V_{DD}-V_{SS} = 5V ± 5%

Item	Symbol	Min	Typ	Max	Unit
Top Clock Cycle Time		65			ns
CP Pulse Width	tw(CH)	20			ns
	tw(CL)	20			ns
Load Pulse Width	tw(LH)	39			ns
	tw(LL)	254			ns
Load ⟶ CP	t_{LC}	110			ns
CP ⟶ Load	t_{CL}	110			ns
Data Setup Time UD7-UD0, LD7-LD0 ⟶ CP	t_{OSU}	7			ns
Data Hold Time CP ⟶ UD7-UD0, LD7-LD0	t_{DHD}	20			ns
Frame Setup Time Frame ⟶ Load	t_{SU}(FR)	104			ns
Frame Hold Time Load ⟶Frame	t_{HD}(FR) 10			ns	
CP Rise/Fall Time	t_R(CP)			45	ns
	t_F(CP)			45	ns
Load Rise/Fall Time	t_R(L)			18	ns
	t_F(L)			18	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.

6-5 Switching Timing Chart





7. Optical characteristics

7-1 Optical characteristics (1) (Refer to Note 1 ~ Note 5)

Item	Symbol	Min	Typ	Max	Unit	Condition
Turn On Time Turn Off Time	t_{ON} t_{OFF}	– –	150 100	– –	ms ms	θ= 0 ° , ø=0 °
Contrast Ratio	CR		30	–		θ= 0 ° , ø=0 °
Visual Angle Range	θ_1	-40 ≤θ_1≤20			deg.	ø= 0 °, CR≥3
	θ_2	-40 ≤θ_1≤40			deg.	ø= 0 °, CR≥3
Viewing Direction		12:00				

(Note 1) Optical characteristics measurement system

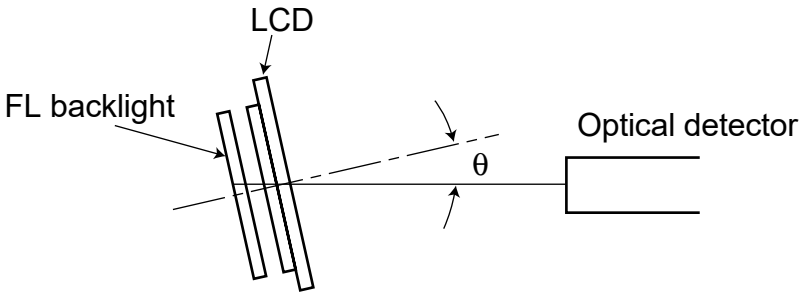


Fig 7-1

(Note 2) Definition of response time

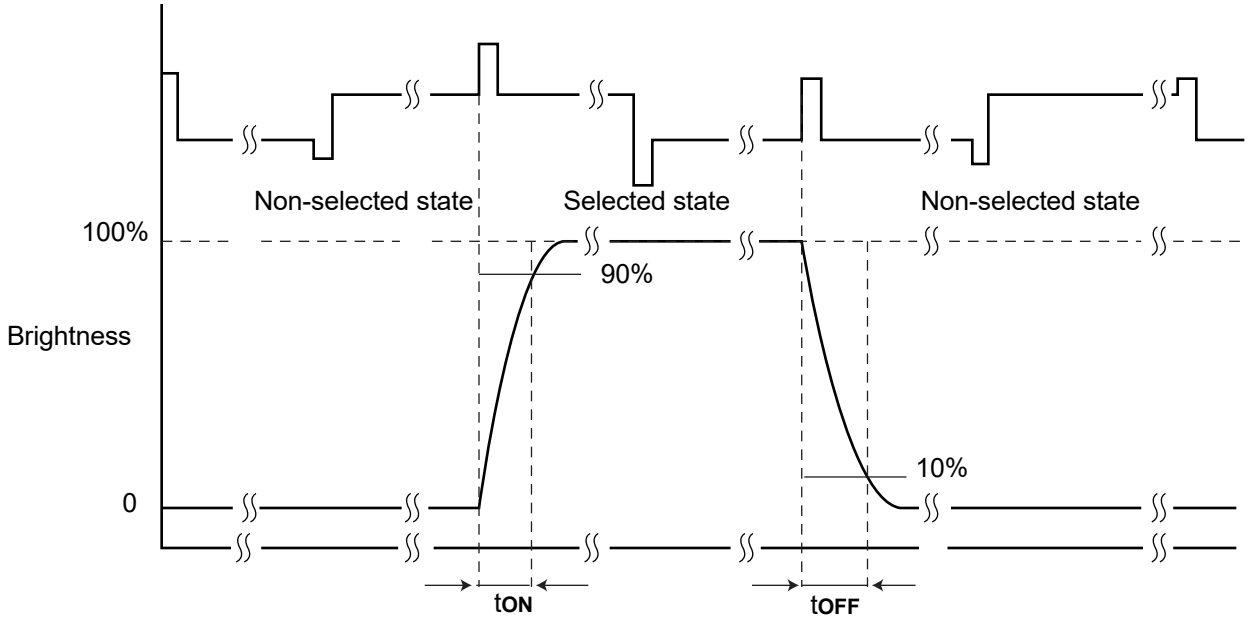


Fig 7-2

(Note 3) Definition of θ and Ø

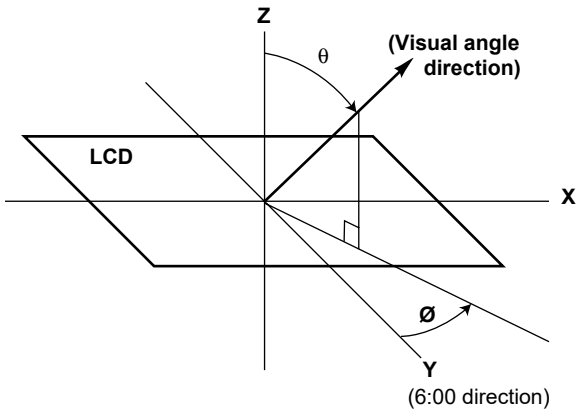


Fig 7-3

(Note 4) Definition of contrast ratio

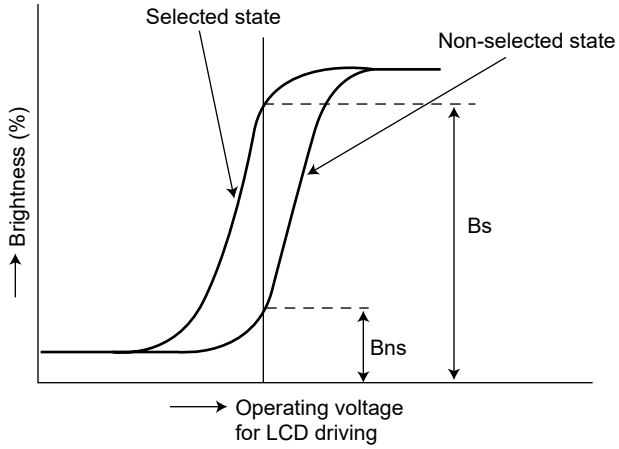


Fig 7-4

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

(Note 5) Definition of visual field enlarging direction

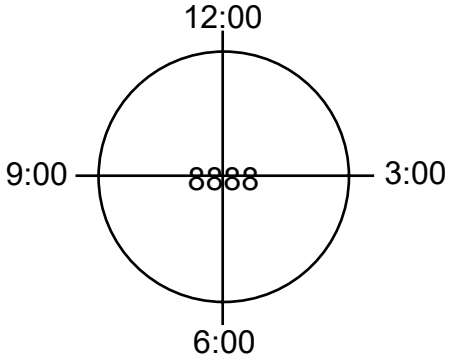


Fig 7-5

7-2 Optical characteristics (2)

CIE (X, Y) color chart

Item	Symbol	Min	Typ.	Max.	Test condition
Red	X	—	0.53	—	θ = 0° , Ø = 0°
	Y	—	0.34	—	
Green	X	—	0.32	—	θ = 0° , Ø = 0°
	Y	—	0.54	—	
Blue	X	—	0.17	—	θ = 0° , Ø = 0°
	Y	—	0.16	—	
White	X	—	0.33	—	θ = 0° , Ø = 0°
	Y	—	0.39	—	

8. Backlight specifications

8-1 Electrical characteristics

Item	Condition	Min.	Typ.	Max.	Unit
Lamp current	Ta = 25 °C			5	mArms
Lamp voltage	Ta = 25 °C	342	380	418	V rms
Frequency			40 - 60		kHz
Starting discharge voltage	Ta = 0°C			920	V rms

8-1 Electrical characteristics

Item	Condition	Min.	Typ.	Max.	Unit
Brightness	Frequency = 40kHz, Sin wave Lamp current = 5mA		70		cd / m ^{2}
Rise time	80% brightness		3	5	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 of whole screen white.

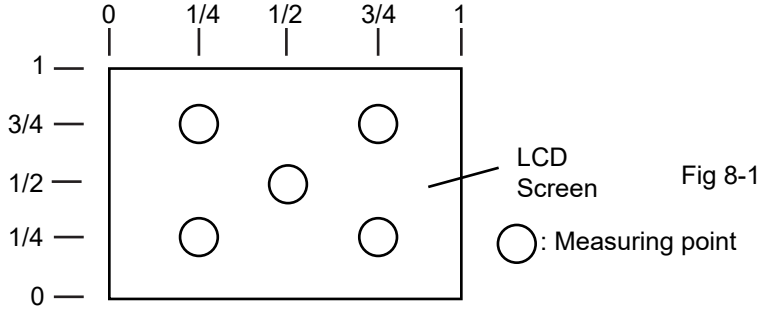


Fig 8-1

8-3 Life time *

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 life time is the period until the brightness becomes 1/2.

** : 1 cycle = 30sec. ON → 30sec. OFF.

9. Precautions

9-1 Precautions for use

(1) Before using the LCD module, peel off the protective plastic sheet, otherwise the displayed picture will be fuzzy or cloudy.
(2) Before applying the supply voltage or video signal, make sure the power supply and the video signal are connected correctly. Improper connections may damage the unit.
(3) Do not touch the semi-fix resistor mounted on PCB which was preadjusted in the factory for optimum display result, readjustment will need a special instrument.
(4) Do not use this LCD module in a high humidity environment, otherwise the unit may be damaged.

9-2 Precautions in handling

(1) Take great care to handle the LCD, since the surface of the LCD is covered by a layer of plastic, called polarizer which is very easy to be scratched.
(2) Be careful not to touch the polarizer with the bare hand. Clean only with an absorbent cotton swab or a soft cloth by wiping gently with petroleum benzine. Do not use such chemicals as acetone, ethanol, toluene, isopropyl alcohol for cleaning, otherwise the polarizer may be deteriorated.
(3) Also, saliva or water droplets should be removed right away or the LCD may become deformed or discolored if it was left on the polarizer surface for a long time.
(4) If the LCD panel has been broken and the liquid crystal substance has leaked out, avoid inhaling or touching it. If the liquid crystal has contacted the skin or clothes, wash it immediately.

9-3 Installation

(1) The circuit substrate with ICs mounted is a static sensitive element . Handle the substrate with utmost care.
(2) Do not bend or twist the unit, LCD panel or circuit board may crack.
(3) To protect LCD panel, especially the polarizer surface, put a transparent protective board (for example, acrylic or glass board) on the product case.

9-4 Storage

(1) Avoid high humidity and temperature.
(2) Do not expose the unit to direct sunlight.
(3) Take precautions to avoid any unnecessary pressure on the unit.

9-5 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) To prevent IC latch-up and DC voltage on the LCD panel, power on by the following timing (Fig 9-1).

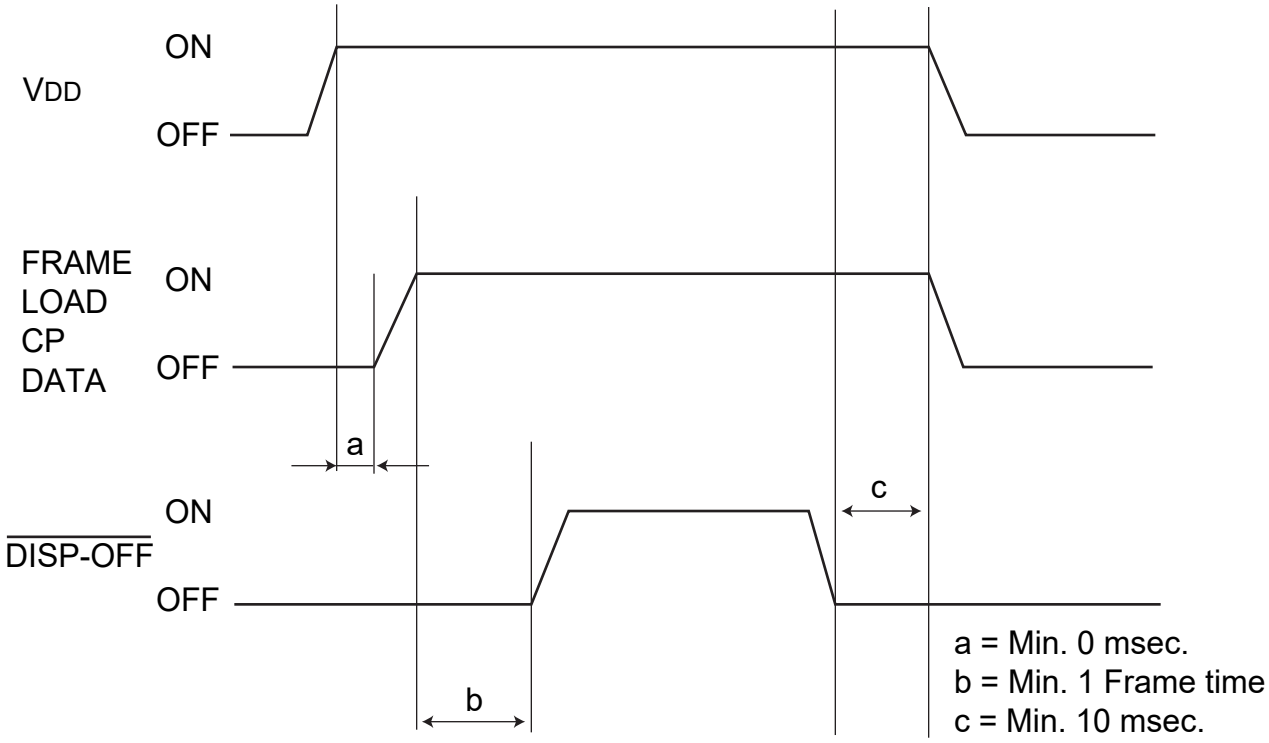


Fig 9-1

(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 0.2V_{DD} and H level : more than 0.8V_{DD}). If the noise level is beyond that specified figure, there is possibility to occur operational error statistically.
Moreover, be sure to measure the noise level with the module kept connected.

(7) As IC on the module, CMOS 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}, Vo 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 "Manual for use".

(9) The metal frame is not connected 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 displayed, 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.

10. Reliability evaluation standard of Dot Matrix LCD Module

10-1 Scope

This reliability evaluation standard applies to Dot Matrix LCD module K6484L-FF.

10-2 Reliability test items and criteria[

Test items	Test conditions	Time	Criteria *1, 2
Operation at high temperature	+45 ± 2°C, RH ≤ 30% Operation with standard voltage	240 H	No noticeable change in operating performance
Operation at low temperature	0 ± 2°C, RH ≤ 60% Operation with standard voltage (non-condensing)	240 H	↑
Leaving in high temperature	+60 ± 2°C, RH ≤ 30%	240 H	↑
Leaving in low temperature	-20 ± 2°C, RH ≤ 60% (non-condensing)	240 H	↑
Leaving in high temperature	+40 ± 2°C, 90 ~ 95% RH (non-condensing)	240 H	↑
Temperature cycling	-20 ± 2°C, 30 min. ↓ 25 ± 2°C, 10 min. ↓ 60 ± 2°C, 30 min. ↓ 25 ± 2°C, 10 min. 1 cycle non-condensing	10 cycle	↑
Vibration	Vibration frequency : 15 ~ 55 Acceleration : 1.5 G Sweep : 2.5 octave/min. X, Y and Z directions.	15 min/cycle in each direction 1 cycle	↑
Shock I	Gravity drop onto lauan board of 3 cm thick from height of 70 cm (in packaged condition) X, Y and Z directions.	One time each in X, Y and Z directions	↑
Shock II	Acceleration : 50 G Acting times : 11 msec X, Y and Z directions	↑	

* 1 The test measurement shall be made at ambient temperature of 25 ± 5°C
* 2 The number of samples shall be : n = 5.

11. Inspection standard of Dot Matrix LCD Module

11-1 Scope

this inspection standard applies to dot matrix LCD module K6484L-FF.

11-2 Delivery inspection

(1) Inspection conditions

The inspection conditions shall be in accordance with the conditions in this spec. sheet. Also as the environmental conditions, the inspection shall be made at ordinary temperature (20 to 25°C) and ordinary humidity (65 ± 5% RH) and the appearance shall be inspected visually at a distance of more than 30 cm between product and eyes and besides from a vertical direction of the display unit under illumination of one fluorescent lamp of 20W.
(However, excluded when there is the provision)
Defects shall be inspected at maximum contrast.

(2) Inspection lot

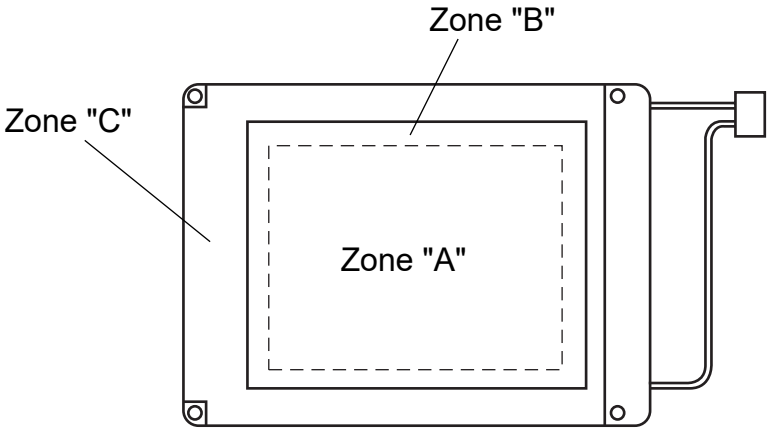
One lot shall comprise the quantity products delivered at one time.

(3) Inspection method

A sampling inspection shall be made according to the following provisions to judge the acceptability.

Applicable standard	: MIL - STD - 105D		
	Normal one - time sampling method		
	Level II		
	A Q L Major defect	1.0%	
	Minor defect	2.5%	To be evaluated by overall items.
Major defect	: Defect to miss proper function		
Minor defect	: Defect does not miss proper function but depreciates the value of the products.		

(4) Definition of applicable zone



Zone "A" : Display area
Zone "B" : Viewing area exclude Zone "A"
Zone "C" : Outside viewing area

11-3 Inspection standard

11-3-1 Visual defects classification

Section of defects	Inspection item	A Q L
Major defect	• Defect to miss specified display function (For all and specified dots) (E.g. disconnection, short - circuit, etc.) • Malfunction Electrical characteristics	1.0%
Minor defect	• Current consumption 0utward appearance • Dimension • Display part appearance when LCD turn ON Pinholes, dot chipping, white spot, black spot, thick dot., thin dot, deformation, center line, uneven display, etc. • Display part appearance when LCD turn OFF (Scope having no effect on function) Bubbles, flaws, stains, and foreign article • Outward appearance excluding display part (Scope having no effect on function) Flaws, stains, solder, identification marking, assembly and deformation of metallic frame.	2.5%

11-3-2 Visual inspection standard of display unit

<table>
<tr><th>Classification</th><th>Inspection items</th><th>Criteria</th><th colspan="2">Section of defects</th></tr>
<tr><td rowspan="2">Display part appearance when LCD turn ON</td><td>(1) Display</td><td>
(a) Defect to miss specified display function
(b) Turn ON area is different from specified area
(c) Backlight doesn't light

A defect that size which can be seen does not very even though voltage applied to LCD display element is changed.

Circular spot and foreign matters
<table>
<tr><th rowspan="2">Zone
Size
Ø d (mm)</th><th colspan="2">Allowable q'ty</th></tr>
<tr><th>Zone "A"</th><th>Zone "B"</th></tr>
<tr><td>d≤ 0.2</td><td>Ignore</td><td>Ignore</td></tr>
<tr><td>0.2 < d ≤ 0.5</td><td>4</td><td>5</td></tr>
<tr><td>0.5 < d ≤ o.6</td><td>0</td><td>1</td></tr>
<tr><td>0.6 < d</td><td>0</td><td>0</td></tr>
</table>
a special shape shall be estimated with (Longer side + Shorter side) /2 = d .

The number of defects must be within 5 pcs.

Quantity of defects having diameter of zone A and B : Within 1 pc.

Linear spot and foreign article
<table>
<tr><th rowspan="2">Zone
Thickness (mm)
Length (mm)</th><th colspan="2">Allowed q'ty</th></tr>
<tr><th>Zone "A"</th><th>Zone "B"</th></tr>
<tr><td></td><td>W<0.025</td><td>Ignore</td><td>Ignore</td></tr>
<tr><td>L<1.0</td><td>W<o.1</td><td>Ignore</td><td>Ignore</td></tr>
<tr><td>1.0≤L≤10.0</td><td>0.025≤W ≤0.05</td><td>3</td><td>3</td></tr>
<tr><td>1.0≤L≤5.0</td><td>0.05≤W≤0.1</td><td>1</td><td>3</td></tr>
<tr><td>L ≤ 1.0</td><td>0.1 ≤ W</td><td colspan="2">In accordance with inspection item (2)</td></tr>
</table>
The number of defects must be within 5 pcs.
</td><td>Major defect
Major defect
Major defect</td><td>Minor defect</td></tr>
<tr><td></td><td></td><td></td><td>Minor defect</td></tr>
</table>

Classification	Inspection items	Criteria	Section of defects	
Display part appearance when LCD turn ON	(4) White spot II, Black spot II , Red spot II , Blue spot II , Green spot II	A defect that size which can be seen varies according to change in voltage applied to LCD display element. Size d = Ømm • A part seen clearly : Ø0.2 < d ≤ Ø0.4 A part of which size is Ø0.2 ≥ d is not counted as defect. • A part seen clearly in the vicinity of thick spot : Ø0.7 < d ≤ Ø1.0 A part of which size is Ø0.7 ≥ d is not counted as defect. • A part seen unclearly not accompanied by a thick spot must be judged : Ø0.8 < d ≤ Ø1.2 The number of defects must be within 5 pcs.		Minor defect
	(5) White line II, Black line II	A defect that line condition varies according to change in voltage applied to LCD display element. • Defect mustn't be conspicuous at the display front (θ = 0° and Ø = 0°) in the most suitable contrast voltage.		Minor defect
	(6) Thick dot, Thin dot, deformation dot	Less than ± 15% of dots width		Minor defect
	(7) Center line	Not more than 36 μm *-marked objects denote an overlapping dislocation of liquid crystal cells.		Minor defect
	(8) Uneven display	No conspicuous unevenness		Minor defect
	(9) Uneven color	No conspicuous unevenness		Minor defect
Display part appearance when LCD turn OFF	(10) White spot I, Black spot I	In accordance with lighting appearance inspection item (2).		Minor defect
	(11) White line I, Black line I	In accordance with lighting appearance inspection item (3).		Minor defect