

SHARP

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DATE	May . 29 . 1996

TECHNICAL LITERATURE
FOR
TFT - LCD module

MODEL No. L Q 1 0 D 3 6 ?

TENTATIVE

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SHARP CORPORATION
LIQUID CRYSTAL DISPLAY GROUP
LCD PRODUCTS DEVELOPMENT CENTER

1. Application

This **specification** applies to color **TFT-LCD module**, LQ10D36X.

2. Overview

This module is a color active matrix LCD module incorporating amorphous silicon TFT (Thin Film Transistor). It is composed of a color TFT-LCD panel, driver ICS, control circuit and power supply circuit and a backlight unit. Graphics and texts can be displayed on a 640X3X 480 dots panel with 262,144 colors by supplying 18 bit data signal (**6bit/color**), four timing signals, +5V DC supply voltage for TFT-LCD panel driving and supply voltage for backlight.

The TFT-LCD panel used for this module is a low-reflection and higher-color-saturation type. Therefore, this **module** is also suitable for the **multimedia** use.

This **module** is the type of wide viewing angle.

Optimum viewing direction is 6 o'clock.

Backlight-driving DC/AC inverter is not built in this module.

3. Mechanical Specifications

Parameter	Specifications	Unit
Display size	26 (10.4") Diagonal	cm
Active area	211.2(H) × 158.4(V)	mm
Pixel format	640(H) × 480(V)	pixel
	(1 pixel = R + G + B dots)	—
Pixel pitch	0.330(H) × 0.330(V)	mm
Pixel configuration	R,G,B vertical stripe	·
Display mode	Normally white	·
Unit outline dimensions *1	246.5(W) × 179.4(H) x9,5(D)	mm
Mass	500 (+10, -30)	g
Surface treatment	Anti-glare and hard-coating 2H Haze value = TBD 28%	—

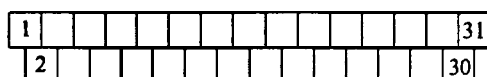
* 1.Note: excluding backlight cables.

Outline dimensions is shown in Fig. 1

4. Input Terminals

4-1. TFT-LCD panel driving

CN1 Used connector:DF9BA-3 1P-1V (Hirose Electric Co., Ltd.)



Corresponding connector: DF9 -3 1S-1V (//)

DF9A-3 1S-1V

DF9B-31S-1V

CN1 pin arrangement from module surface

(Transparent view)

Pin No.	Symbol	Function	Remark
1	GND	—	
2	CK	Clock signal for sampling each data signal	
3	Hsync	Horizontal synchronous signal	[Note1]
4	Vsync	Vertical synchronous signal	[Note1]
5	GND	—	—
6	R0	R E D data signal(LSB)	—
7	R1	R E D data signal	—
8	R2	R E D data signal	—
9	R3	R E D data signal	—
10	R4	R E D data signal	—
11	R5	R E D data signal(MSB)	—
12	GND	—	—
13	G0	G R E E N data signal(LSB)	—
14	G1	G R E E N data signal	—
15	G2	G R E E N data signal	—
16	G3	G R E E N data signal	—
17	G4	G R E E N data signal	—
18	G5	G R E E N data signal(MSB)	—
19	GND	—	—
20	B0	B L U E data signal(LSB)	—
21	B1	B L U E data signal	—
22	B2	B L U E data signal	—
23	B3	B L U E data signal	—
24	B4	B L U E data signal	—
25	B5	B L U E data signal(MSB)	—
26	GND	—	—
27	ENAB	Signal to settle the horizontal display position	[Note2]
28	Vcc	+5.0V power supply	—
29	Vcc	+5.0V power supply	—
30	TST	This should be electrically opened during operation	—
31	TST	This should be electrically opened during operation	—

※The shielding case is connected with GND.

[Note1] 480 line, 400 line or 350 line mode

is selected by the polarity combination of the both synchronous signals.

Mode	480 lines	400 lines	350 lines
Hsync	negative	negative	positive
Vsync	negative	positive	negative

[Note2] The horizontal display start timing is settled in accordance with a rising timing of ENAB signal. In case ENAB is fixed "Low", the horizontal start timing is determined as described in

7-2. Don't keep ENAB "High" during operation.

4-2. Backlight driving

Used connector : BHR-03VS-1(JST)

CN2 Corresponding connector :SM02(8.0)B-BHS(JST)

Pin no.	symbol	fiction
1	V_{HIGH}	Power supply for lamp (High voltage side)
2	NC	This is electrically opened.
3	V_{LOW}	Power supply for lamp (Low voltage side)

5. Absolute Maximum Ratings

Parameter	Symbol	Condition	Ratings	unit	Remark
Input voltage	V_I	$T_a=25^\circ\text{C}$	$-0.3 \sim V_{CC}+0.3$	V	[Note 11]
+5V supply voltage	V_{CC}	$T_a=25^\circ\text{C}$	$0 \sim +7$	v	-
Storage temperature	T_{stg}	'	$-25 \sim +60$	"C	【Note2】
Operating temperature (Ambient)	T_{opa}	-	$0 \sim +50$	"c	

【Note 1】 CK,R0~R5,G0~G5,B0~B5,Hsync,Vsync,ENAB

【Note2】 Humidity : 95%RH Max. at $T_a \leq 40^\circ\text{C}$.Maximum wet-bulb temperature at 39°C or less at $T_a > 40^\circ\text{C}$.

No condensation.

6. Electrical Characteristics

6-1. TFT-LCD panel driving

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

Parameter		Symbol	Min.	Typ.	Max.	unit	Remark
+5V	Supply voltage	V_{CC}	+4.5	+5.0	+5.5	V	【Note 1】
	Current dissipation	I_{CC}	-	180	300	mA	【Note2】
Permissible input ripple voltage		V_{RP}	-	-	100	mVp-p	$V_{CC}=+5V$
Input voltage (Low)		V_{IL}	-	-	$0.3V_{CC}$	V	[Note31]
Input voltage (High)		V_{IH}	$0.7V_{CC}$	-	-	V	
Input current (low)		I_{OL}	-	-	1.0	μA	$V_I=0V$ [Note3]
input current (High)		I_{OH1}	-	-	1.0	μA	$V_I=V_{CC}$ 【Note4】
		I_{OH2}	-	-	60.0	μA	$V_I=V_{CC}$ [Note51]

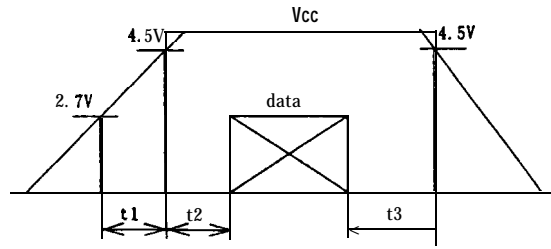
【Note1】

Vcc-turn-on conditions

$t1 \leq 10ms$

$0 < t2 \leq 10ms$

$0 < t3 \leq 1s$



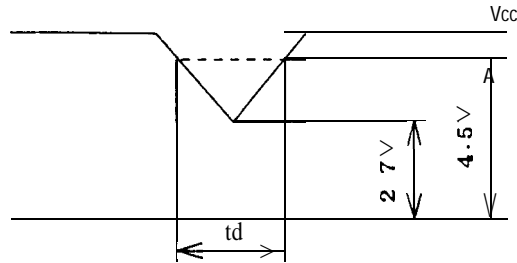
Vcc-dip conditions

1) $2.7V \leq Vcc < 4.5V$

$td \leq 10ms$

2) $Vcc < 2.7V$

Vcc-dip conditions should also follow the Vcc-turn-on conditions



【Note2】 Typical current situation: 16-gray-bar pattern.

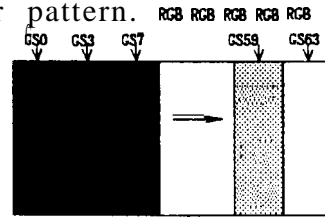
480 line mode

Vcc=+5.0V

[Note31] CK,R0~R5,G0~G5,B0~B5,Hsync,Vsync,ENAB

[Note4] CK,R0~R5,G0~G5,B0~B5, Hsync,Vsync

【Note5】 ENAB



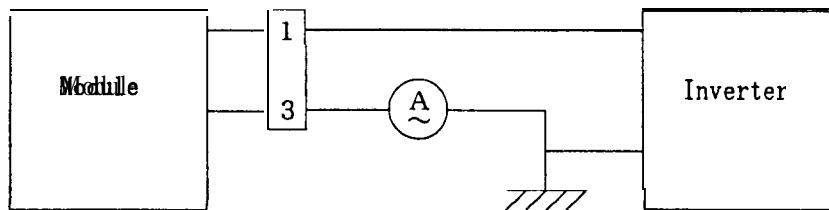
6-2. Backlight driving

The backlight system is an edge-lighting type with single CCFT (Cold Cathode Fluorescent Tube). The characteristics of single lamp are shown in the following table.

Ta=25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Lamp current	I_L	TBD	(6.0)	TBD	mArms	【Note1】
Lamp power consumption	P_L	-	TBD	-	W	【Note2】
Lamp frequency	F_L	20	35	60	KHz	[Note3]
Kick-off voltage	V_s	-	-	TBD	Vrms	Ta=25°C
		-	-	TBD	Vrms	Ta=0°C [Note4]
Lamp life time	LL		(25,000)	-	hour	[Note5]

【Note1】 Lamp current is measured with current meter for high frequency as shown below.



* 3pin is V_{LOW}

【Note2】 At the condition of $Y_L = TBD \text{ cd/m}^2$

[Note31] Lamp frequency may produce interference with horizontal synchronous frequency, and this may cause beat on the display. Therefore lamp frequency shall be detached as much as possible from the horizontal synchronous frequency and from the harmonics of horizontal synchronous to avoid interference.

【Note4】The open output voltage of the inverter shall be maintained for more than 1sec; otherwise the lamp may not be turned on.

【Note5】Lamp lifetime is defined that it applied either ① or ② under this condition
(Continuous turning on at $T_a=25^{\circ}\text{C}$, $I_L = \text{TBD mA rms}$)

@Brightness becomes 50% of the original value under standard condition.

② Kick-off voltage at $T_a=0^{\circ}\text{C}$ exceeds maximum value, TBD V_{rms} .

Note) The performance of the backlight, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the backlight and the inverter (miss-lighting, flicker, etc.) never occur. when you confirm it, the module should be operated in the same condition as it is installed in your instrument.

7. Timing Characteristics of input signals

Timing diagrams of input signal are shown in Fig.2 - ①~③.

1. Timing characteristics

Parameter		Symbol	Mode	Min.	Typ.	Max.	unit	Remark
Clock	Frequency	$1/T_c$	all	-	25,18	32.00	MHz	-
	High time	T_{ch}	//	5	-	-	ns	-
	Low time	T_{cl}	//	10	-	-	ns	-
Data	Setup time	T_{ds}	//	5	-	-	ns	-
	Hold time	T_{dh}	//	10	-	-	ns	-
Horizontal sync. signal	Cycle	T_H	//	30.00	31.78	-	μs	-
			//	770	800	900	clock	-
	Pulse width	T_{Hp}	//	2	96	200	clock	-
Vertical sync. signal	Cycle	T_v	480	515	525	560	line	-
			400	445	449	480	line	-
			350	447	449	510	line	-
	Pulse width	T_{Vp}	all	1	-	34	line	-
Horizontal display period		T_{Hd}	//	640	640	640	clock	-
Hsync-Clock phase difference		T_{Hc}	//	10	-	$T_c - 10$	ns	-
Hsync-Vsync phase difference		T_{Vh}	//	0	-	$T_H - T_{Hp}$	clock	-

Note) In case of lower frequency, the deterioration of display quality, flicker etc., may be occurred.

7-2. Horizontal display position

The horizontal display position is determined by ENAB signal and the input data corresponding to the rising edge of ENAB signal is displayed at the left end of the active area.

Parameter		symbol	Min.	Typ.	Ma...	unit	Remark
Enable signal	Setup time	Tes	5	—	Tc-10	ns	-
	Pulse width	Tep	2	640	640	clock	-
Hsync-Enable signal phase difference		The	44	-	164	clock	-

Note) When ENAB is fixed "Low", the display starts from the data of C 104(clock) as shown in Fig.2-①~③. Be careful that the module does not work when ENAB is fixed "High".

7-3, Vertical display position

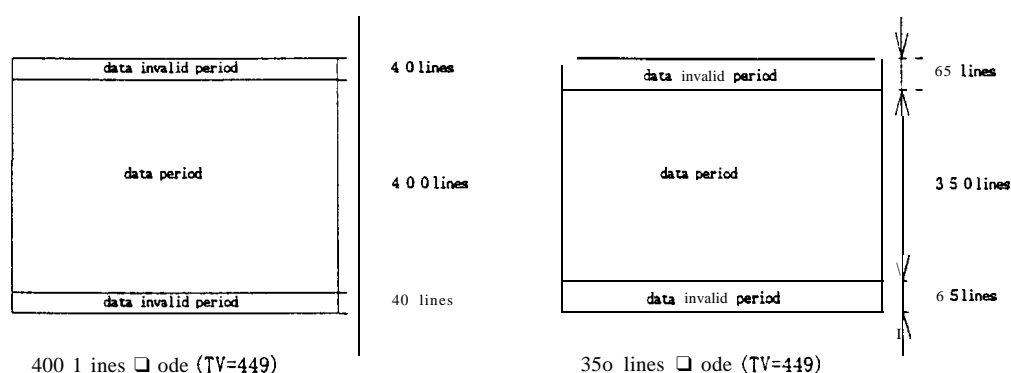
The vertical display position is automatically centered in the active area at each mode of VGA ,480 -,400 -,and 350-line mode Each mode is selected depending on the polarity of the synchronous signals described in 4-1(Note1).

In each mode ,the data of TVn is displayed at the top line of the active area. And the display position will be centered on the screen like the following figure when the period of vertical synchronous signal,TV,is typical value.

In 400-, and 350-line mode, the data in the vertical data invalid period is also displayed, So ,inputting all data "O" is recommended during vertical data invalid period.

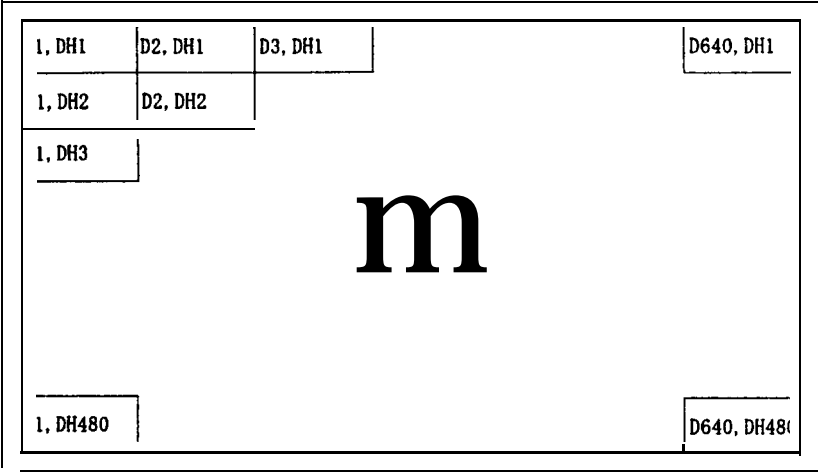
ENAB signal has no relation to the vertical display position.

mode	v-data start(TVs)	V-data period(TVd)	V-display start(TVn)	V-display period	unit	Remark
480	34	480	34	480	line	-
400	34	400	443--Iv	480	line	-
350	61	350	445-TV	480	line	-



7-4. Input Data Signals and Display Position on the screen

Display position of input data (480 lines mode)
(H, V)



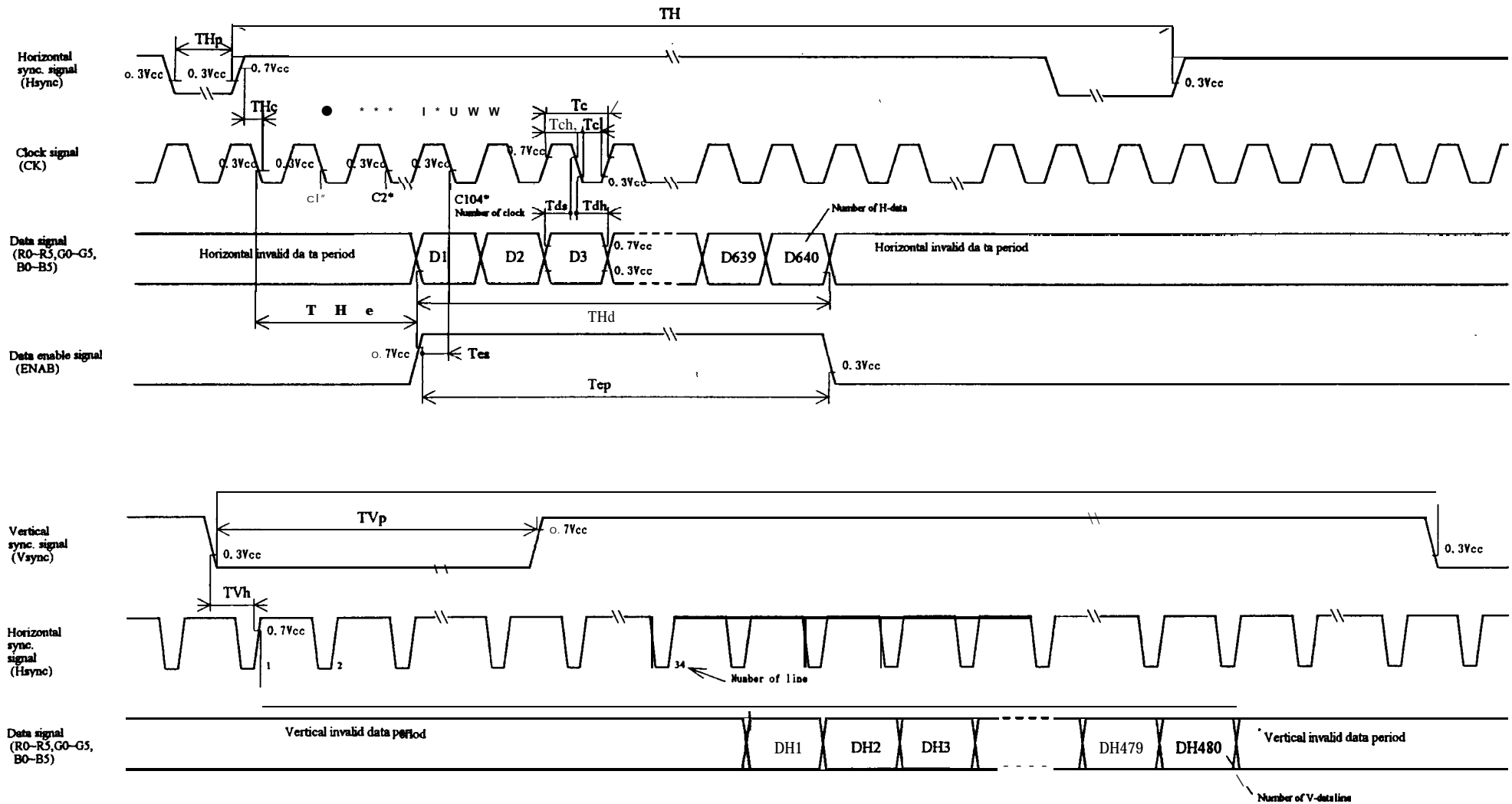


Fig 2-1 Input signal waveforms (480 line mode)

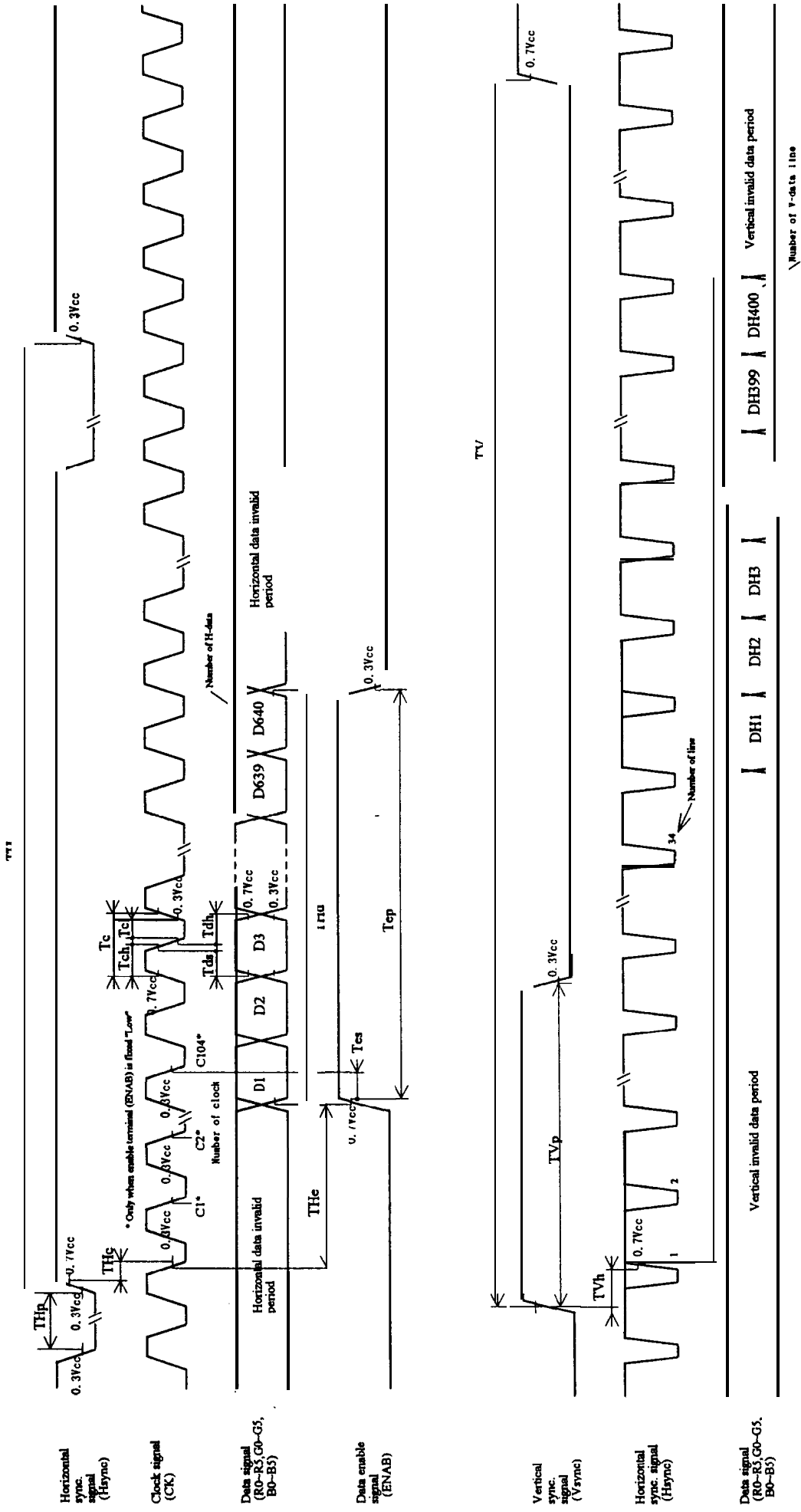


Fig.2-2 Input signal waveforms (400 line mode)

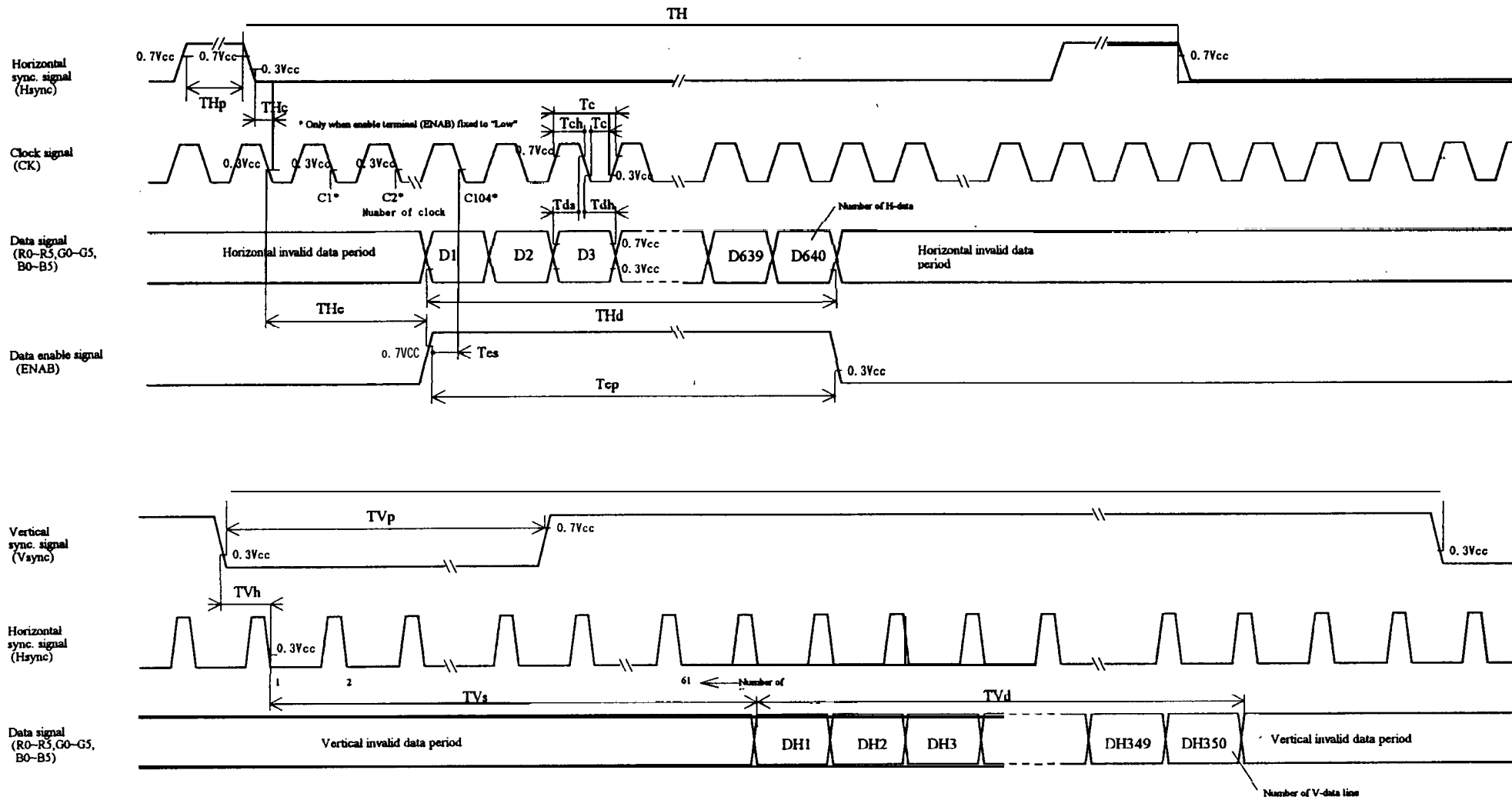


Fig.2-3 Input signal waveforms (350 line mode)

8. Input Signals, Basic Display Colors and Gray Scale of Each Color

Colors & Gray scale	Data signal																				
	GrayScale	RO	R1	R2	R3	R4	R5	GO	G1	G2	G3	G4	G5	BO	B1	B2	B3	B4	B5		
Black	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Blue	-	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
Green	-	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	
Cyan	-	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	
Red	-	1	1	1	1	1	1	0	0	0	0	0	0	()	()	()	()	()	()	()	
Magenta	-	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	
Yellow	-	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
White	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
R	Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↑	GS1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Darker	GS2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↑	↓				↓					↓							↓			
	u	↓				↓					↓							↓			
	Brighter	GS61	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
	0	GS62	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
	Red	GS63	1	1	1	1	1	1	()	()	()	()	()	()	0	0	0	0	0	0	
	G	Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		↑	GS1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Darker		GS2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
↑		↓				↓					↓							↓			
↓		↓				↓					↓							↓			
Brighter		GS61	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	
↓		GS62	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	
Green		GS63	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	
B		Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		↑	GS1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Darker	GS210	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
	↑	↓				↓					↓							↓			
	↓	↓				↓					↓							↓			
	Brighter	GS61	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	
	↓	GS62	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	
	Blue	GS63	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	

0 : Low level voltage, 1: High level voltage

Each basic color can be displayed in 64 gray scales from 6 bit data signals. According to the combination of total 18 bit data signals, the 262, 144-color display can be achieved on the screen.

9. Optical Characteristics

Parameter		Symbol	Condition	Min.	Typ.	Max.	unit	Remark
Viewing angle range	Horizontal	021.022	CR>5	60	—	—	Deg.	【Note1,4】
	Vertical	$\theta 11$		55	—	—	Deg.	
		$\theta 12$		35	—	—	Deg.	
Contrast ratio		C R	$\theta = 0^\circ$	100	—	—		【Note2,4】
Response time	Rise	τr		—	30	—	m s	【Note3,4】
	Decay	τd		—	50	—	m s	
Chromaticity of white		x		0.263	0.313	0.363		【Note4】
		y		0.279	0.329	0.379		
Luminance of white		Y_L		TBD	(120)	—	cd/m ²	【Note4】
White Uniformity		δw		—	—	1.45		【Note5】

Ta=25°C, c=+5V

※The measurement shall be executed 30 minutes after lighting at rating. (typical condition: $I_L = \text{TBD mArms}$)
The optical characteristics shall be measured in a dark room or equivalent state with the method shown in Fig.3 below.

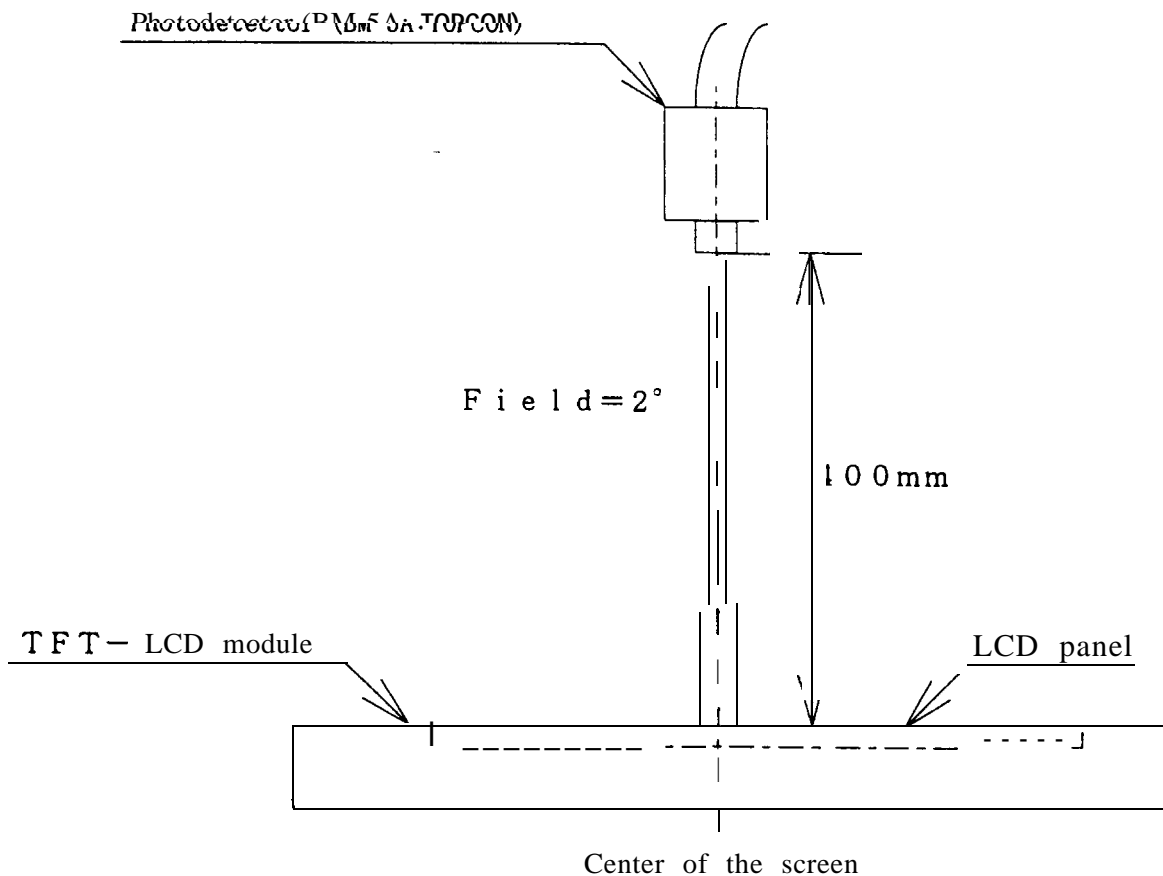
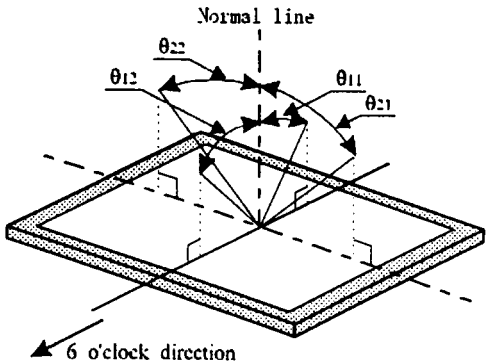


Fig. 3 Optical characteristics measurement method

[Note1] Definitions of viewing angle range:



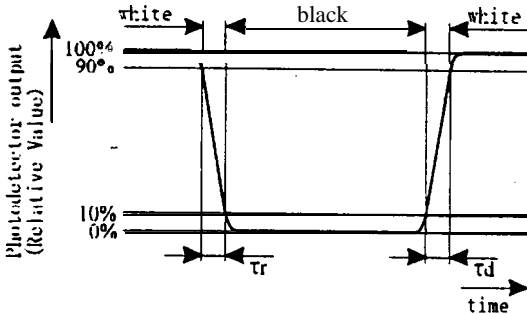
[Note2] Definition of contrast ratio:

The contrast ratio is defined as the following.

$$\text{Contrast Ratio (CR)} = \frac{\text{Luminance (brightness) with all pixels white}}{\text{Luminance (brightness) with all pixels black}}$$

[Note3] Definition of response time:

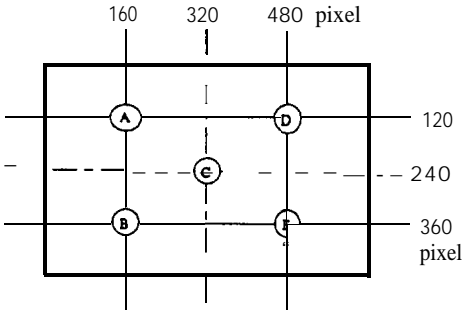
The response time is defined as the following figure and shall be measured by switching the input signal for “black” and “white” .



[Note4] This shall be measured at center of the screen.

[Note5] Definition of white uniformity:

White uniformity is defined as the following with five measurements (A~E).



$$\delta_w = \frac{\text{Maximum Luminance of five points (brightness)}}{\text{Minimum Luminance of five points (brightness)}}$$

10. Display Quantity

The display quality of the color TFT-LCD module shall be in compliance with the **Incoming** Inspection Standard.

11. Handling Precautions

- a) Be **sure** to turn off the power supply when inserting or disconnecting the cable.
- b) Be sure to design the cabinet so that the module can be installed without any extra stress such as **warp** or **twist**.
- c) Since the front polarizer is easily damaged, pay attention not to scratch it.
- d) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
- e) When the panel surface is soiled, wipe it with absorbent cotton or other **soft** cloth.
- f) Since the panel is made of glass, it may break or crack if dropped or bumped on hard surface. Handle with care.
- g) Since CMOS LSI is used in this **module**, take care of static electricity and injure the human earth when handling,
- h) Observe all other precautionary requirements in handling components.
- i) This **module** has its circuitry PCBS on the rear side and should be **carefully** handled in order not to be stressed.
- j) Laminated film is attached to the module surface to prevent it from being scratched Peel the film off slowly , just before the use, with strict attention to electrostatic charges. Ionized air shall be blown over during the action. Blow off 'dust' on the polarizer by using an ionized nitrogen gun, etc.

12. Packing form

- a) Piling number of cartons : **MAX.7**
- b) Package quantity in one carton: **10pcs**
- c) Carton size : 298(W) × 295(H) × **362(D)mm**
- d) Total mass of 1 carton filled **with full modules** : 6800g

Packing form is shown in Fig.4

3. Reliability test items

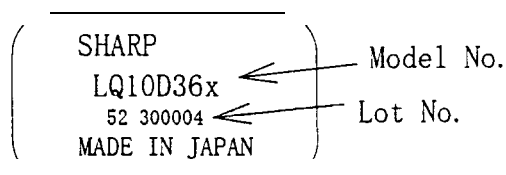
No.	Test item	Conditions
1	High temperature storage test	Ta=60°C 240h
2	Low temperature storage test	Ta=-25°C 240h
3	High temperature & high humidity operation test	Ta=40°C ; 95%RH 240h (No condensation)
4	High temperature operation test	Ta=50°C 240h
5	Low temperature operation test	Ta=0°C 240h
6	Vibration test (non- operating)	Frequency : 10~57Hz/Vibration width (one side) : 0.075mm : 58~500Hz/Gravity: 9.8m/s ² Sweep time: 11 minutes Test period: 3 hours (1 hour for each direction of X,Y,Z)
7	Shock test (non- operating)	Max. gravity : 490m/s ² Pulse width : 1 ms, half sine wave Direction : ±X, ±Y, ±Z once for each direction.

【Result Evaluation Criteria】

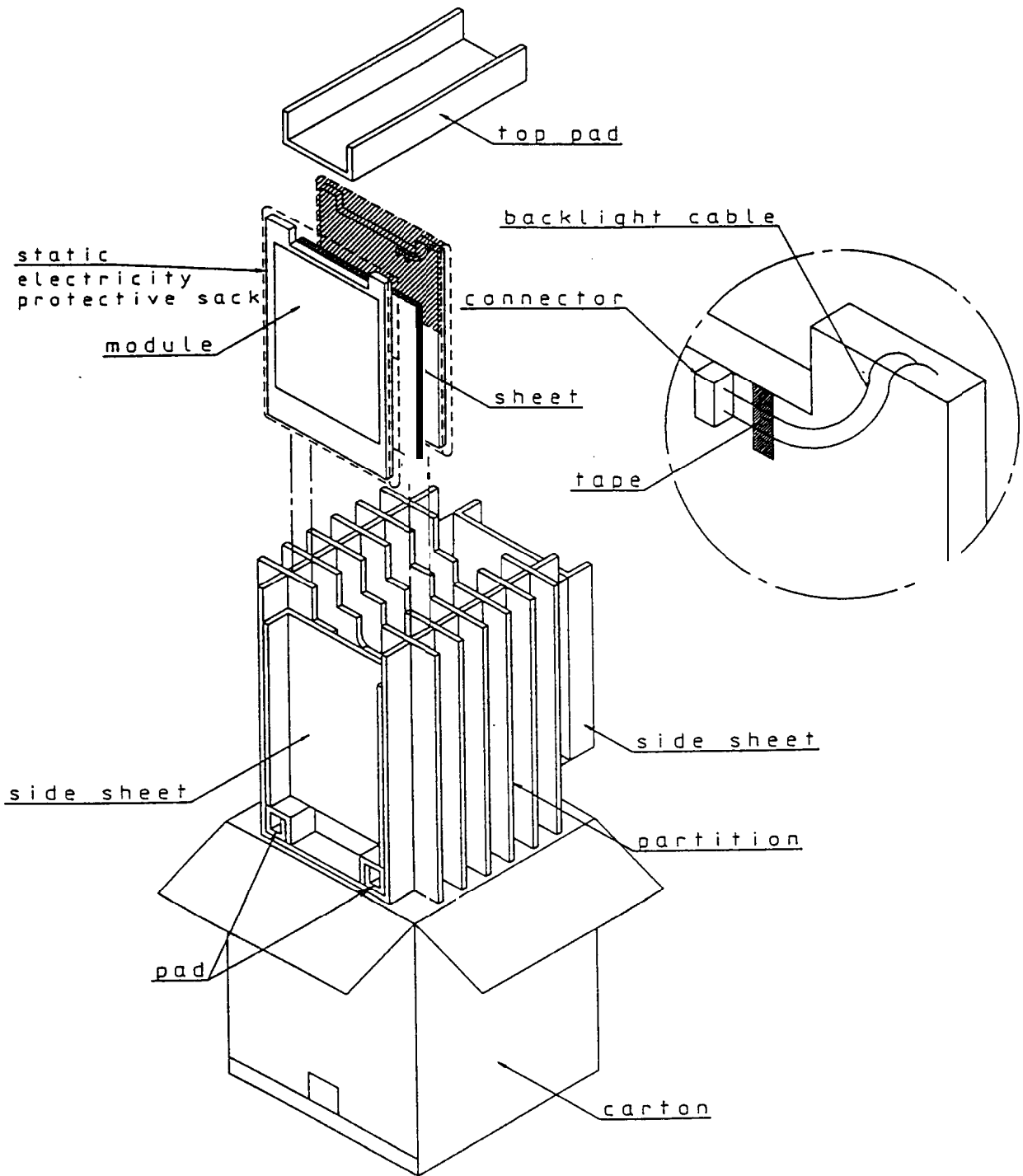
Under the display **quality** test conditions with normal operation state, these shall be no change which may affect practical display function.

14. Others

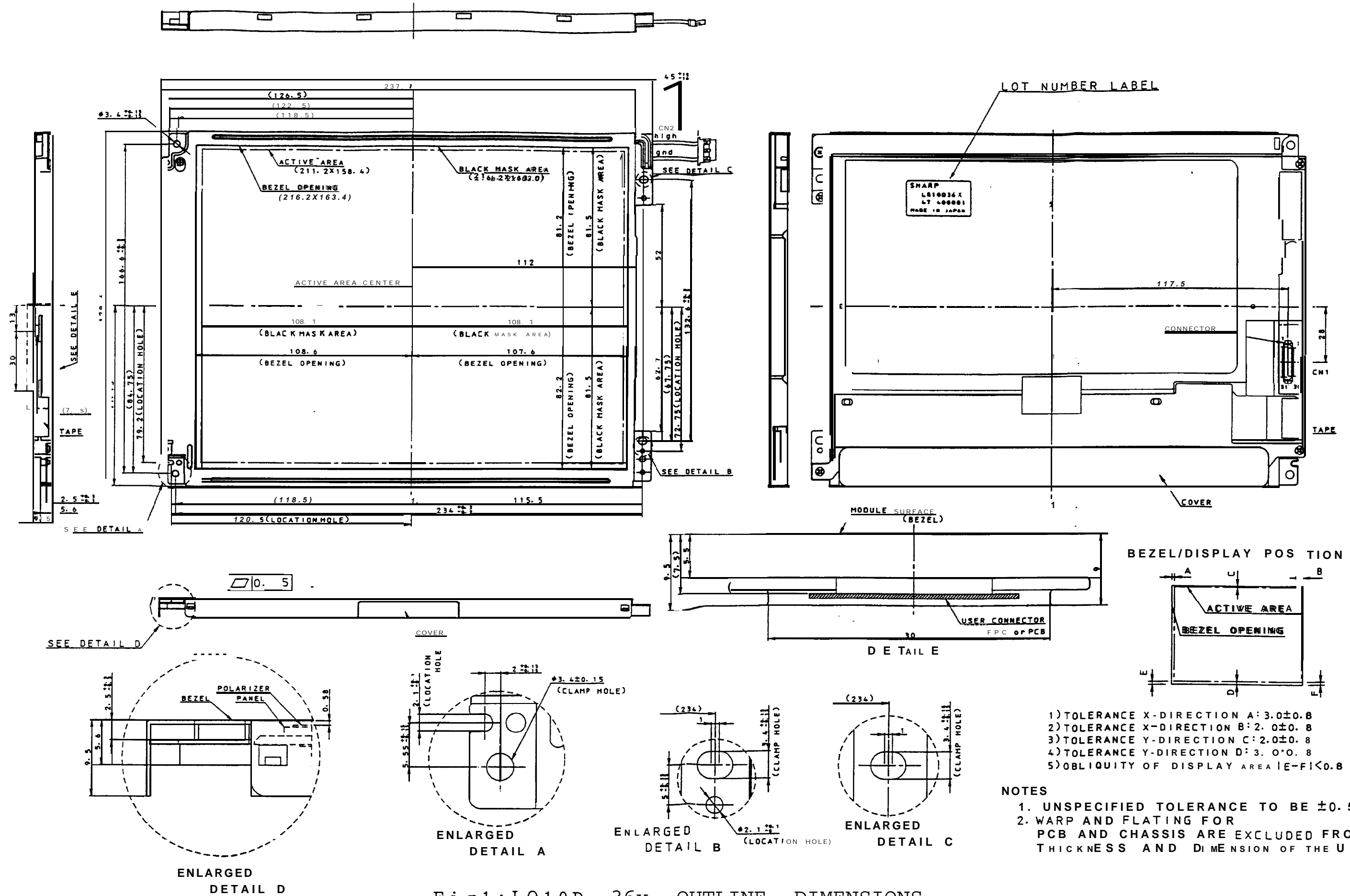
1) Lot No. Label:



- 2) Adjusting volume have been set optimally before shipment, so do not change **any** adjusted value.
If adjusted value is changed, the **specification** may not be satisfied.
- 3) Disassembling the module can cause permanent damage and should be strictly avoided.
- 4) Please be careful since image retention may occur **when** a fixed pattern is displayed for a long time
- 5) If **any** problem occurs in relation to the description of this **specification**, it shall be resolved through discussion **with** spirit of cooperation.



packing form



- NOTES
- 1) TOLERANCE X-DIRECTION A: 3.0 ± 0.8
 - 2) TOLERANCE X-DIRECTION B: 2.0 ± 0.8
 - 3) TOLERANCE Y-DIRECTION C: 2.0 ± 0.8
 - 4) TOLERANCE Y-DIRECTION D: 3.0 ± 0.8
 - 5) OBLIQUITY OF DISPLAY AREA |E-F| < 0.8

- NOTES
1. UNSPECIFIED TOLERANCE TO BE ± 0.5
 2. WARP AND FLATING FOR PCB AND CHASSIS ARE EXCLUDED FROM THICKNESS AND DIMENSION OF THE UNIT.

Fig1:LQ10D 36x OUTLINE DIMENSIONS