

PREPARED BY: _____ DATE _____

APPROVED BY: _____ DATE _____

S H A R P

LIQUID CRYSTAL DISPLAY GROUP
SHARP CORPORATION

SPECIFICATION

SPEC No. LCD-2902

FILE No. _____

ISSUE: Sep. 5, 1990

PAGE : 14 pages

APPLICABLE GROUP

Liquid Crystal Display
Group

DEVICE SPECIFICATION FOR

TFT-LCD module

MODEL No. LQ4NC01
LQ4NC02

*Received from
Jeff Brown
Hughes-Avionics
6/3/91*

CUSTOMER'S APPROVAL

DATE _____

BY _____

Represented by
PLUSTRONICS

O.C. (714) 476-8009

L.A. (818) 833-3304

S.B. (805) 968-8181

PRESENTED

BY *T. Takehota*

T. TAKEHOTA

Department General Manager

Engineering Department

TENRI FACTORY

LIQUID CRYSTAL DISPLAY GROUP

SHARP CORPORATION

C O N T E N T S

(1)	Introduction	- 2-
(2)	Features	- 2-
(3)	Construction and Outline	- 2-
(4)	Module geometry	- 3-
(5)	Input / Output terminals	- 3-
(6)	Absolute maximum ratings	- 6-
(7)	Electrical characteristics	- 7-
(8)	Optical characteristics	-10-
(9)	Mechanical characteristics	-12-
(10)	Display quality	-13-
(11)	Handling instructions	-14-
(12)	Sipping requirements	-16-
(13)	Reliability test items	-16-
(14)	Others	-18-

Attached drawings

Fig. 1	Illustration of TFT-LCD panel	-19-
Fig. 2	Construction of TFT-LCD module	-20-
Fig. 3	Outline dimensions of TFT-LCD module	-21-
Fig. 4	Circuit block diagram of TFT-LCD module	-22-
Fig. 5	Recommended circuit of TFT-LCD module	-23-
Fig. 6	Input/Output signal waveforms	-24-
Fig. 7	Input/Output signal timing chart	-25-
Fig. 8	Optical characteristics measuring method	-26-
Fig. 9	Packing form	-27-

Attached sheets

(Appendix-1)	Construction of TFT-LCD module	-28-
(Appendix-2)	Example of TFT-LCD TV	-30-
(Appendix-3)	Adjusting method of optimum common electrode DC bias voltage	-32-

(1) Introduction

Sharp Color TFT-LCD module is the active matrix LCD (Liquid Crystal Display) produced by making the most of Sharp's expertise in liquid-crystal and semiconductor technologies.

The active device is amorphous silicon TFT (Thin Film Transistor). The module accepts full color video signals (composite video and analog RGB) conforming to the NTSC(M) system standard.

When additionally provided with the backlight-driving DC/AC inverter, it is applicable to pocket TVs and various display monitors.

(2) Features

- TFT-active matrix-LCD drive system
- 234V x 479H (total 112,086) dots (delta configuration)
- Slim, lightweight and compact
 - ① Active-area / Outline-area=53% ② Thickness=20.7mm ③ Weight=180g
- Built-in video interface circuit (including chroma demodulator, picture tone, video AGC circuit) and control circuit responsive to composite video signal
- Also responsive to standard analog RGB video signals
- Further RGB signals can be superimposed on composite video signal
(In this case, RGB signals shall be digital input signal for 8 colors display)
- High quality full color rendition with backlight source incorporated.
- Viewing angle: 6 o'clock direction. (LQ4NC01)
12 o'clock direction. (LQ4NC02)

(3) Construction and Outline

The module consists of a TFT-LCD panel, driver ICs, control PWB mounted with electronic circuits, fluorescent tube, reflector, frame, front and rear shielding cases.

(Backlight-driving DC/AC inverter is not built in the module.)

- * Illustration of TFT-LCD panel : See Fig. 1.
- * Construction of TFT-LCD module : See Fig. 2.
- * Outline dimensions of TFT-LCD module : See Fig. 3.

(4) Module geometry

Table 1

Parameter	Specifications	Unit	Remarks
Display format	479(W)x234(H)	dots	
Active area	81.9(W)x61.8(H)	mm	
Screen size	4(diagonal)	inch	
Dot pitch	0.171(W)x0.264(H)	mm	
Dot configuration	R.G.B Delta configuration	-	
Outline dimension	110.2(W)x85.8(H)x20.7(D)	mm	[Note 4-1]
Weight	180±10	g	

[Note 4-1] Excluding protrusions /

(5) Input / Output terminals

5-1) TFT-LCD panel driving section

Table 2

PinNo.	Symbol	i/o	Description	Remarks
1	HSY	o	Internal horizontal sync. signal(In phase with VBS)	
2	VSX	o	Internal vertical sync. signal(In phase with VBS)	
3	TST	-	This shall be electrically opened during operation.	
4	NC	-	This shall be electrically opened during operation.	
5	TST	-	This shall be electrically opened during operation.	
6	GND	i	Ground	
7	VSW	i	Selection signal of two sets of video signals	[Note5-1]
8	GND	i	Ground	
9	V _{cdc}	i	DC bias voltage adjusting terminal of common electrode driving signal	[Note5-2]
10	VSH	i	Positive power supply voltage	
11	VBS	i	Composite video signal	[Note5-3]
12	BRT	i	Brightness adjusting terminal	[Note5-4]
13	CNT	i	Contrast adjusting terminal	'
14	COL	i	Color gain adjusting terminal	'
15	TIN	i	Tint adjusting terminal	'
16	VSL	i	Negative power supply voltage	
17	VRI	i	Color video signal (Red)	[Note5-5]
18	VGI	i	' (Green)	'
19	VBI	i	' (Blue)	'
20	GND	i	Ground	

In the following descriptions, "High" means V_{1H} and "Low" means "GND".

[Note5-1] Selects input signals, composite or RGB

- ① When VSW is "High" or open, composite video signal (Pin No.13) is selected.
- ② When VSW is "Low", RGB signal set (Pin No.17 through 19) is selected.

[Note5-2] Common electrode driving signal (V_{COM}) generated in the module is observed on the pin. Should be opened during operation, as the DC component of V_{COM} (V_{CBC}) is adjusted to the optimum value with V_{1H} and V_{1L} being the typical values on shipping.

But, in case of change of the optimum value (for example, lowering of the power source), it should be re-adjusted by the built-in variable resistor (V_{CBC}) or external circuit shown in Fig.5.

Refer to (Appendix-3) "Adjusting method of optimum DC bias voltage" for re-adjusting.

[Note5-3] Similary in case of RGB input, apply composite video signal or composite sync. signal (with negative polarity) for sync. separator.

[Note5-4] Brightness, Contrast, Color gain and Tint are adjusted by the DC voltage supplied to each pin. (Contrast, color gain, and tint are not available for RGB signal input)

They are adjusted to the optimum value on shipping, but, they can be re-adjusted by the built-in variable resistor (BRT,CNT,COL,TIN) or external circuit shown in Fig.5.

(However, as the contrast is adjusted to maximize display characteristics, it is recommended not to readjust it and to remain outer adjustment terminals open.)

[Note5-5] ① Responsive to 0~0.7Vpp analog RGB signal when VSW is fixed to "Low"

- ② In case of superimposing on composite video signal as on screen display (ref; Note 5-1), RGB signals shall be digital signal (Low:0Vp-p High:>2Vp-p available for 8 colors display)

5-2) Backlight driving section

Table 3

PinNo.	Symbol	i/o	Description	Remarks
L1	VBL 1	i	Input for thermal fuses	[Note5-6]
L2	NC	-	No connection	
L3	VF 1	i	Power supply for fluorescent tube filament (1)	
L4	VF 2	i		[Note5-7]
L5	VF 3	i	Power supply for fluorescent tube filament (2)	
L6	VF 4	i		
L7	NC	-	No connection	
L8	VBL 2	o	Output from thermal fuses	[Note5-6]

[Note5-6] Thermal fuses are connected between the L1 and L8 terminals in the backlight unit. When connected with input power line of DC/AC inverter for backlight, the terminals can protect the backlight unit against excessive temperature rise at the lamp electrodes.

[Note5-7] Should be grounded by the backlight driving DC/AC inverter, as the L4 terminal is connected with the reflector.

It will be grounded by the optional DC/AC inverter.

(For internal electrical connection of backlight unit, see Fig.(i) below.)

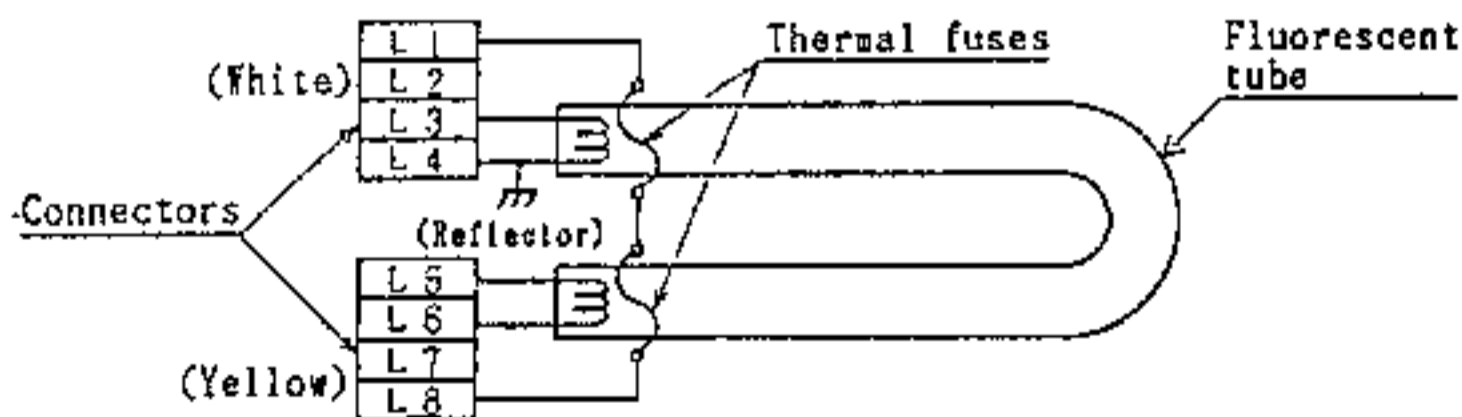


Fig. (i) Wiring diagram of backlight unit

Caution: Shielding case is separated from GND terminal and electrically open.

(6) Absolute maximum ratings

6-1) TFT-LCD panel driving section

Table 4

GND=0V Ta=25°C

Parameter	Symbol	MIN	MAX	Unit	Remarks	
Positive power supply voltage	V_{SH}	-0.3	+6.0	V		
Negative power supply voltage	V_{SL}	-9.0	+0.3	V		
Video input signal 1	V_{i1}	—	2.0	Vp-p	[Note6-1]	
Video input signal 2	V_{i2}	—	$V_{SH}-0.3$	Vp-p	[Note6-2]	
Digital input/output signals	VI	-0.3	$V_{SH}+0.3$	V	[Note6-3]	
DC bias voltage of common electrode driving signal	V_{cDC}	$V_{SL}-0.3$	-1.5	V		
Picture adjusting terminal voltage	V_{pic}	-0.3	$V_{SH}-0.3$	V	[Note6-4]	
Storage temperature	Tstg	-25	60	°C	[Note6-5]	
Operating temperature	Panel temp.	Topp	0	60		°C
	Ambient temp.	Topa	0	40		°C

[Note6-1] VBS terminal (composite video signal)

[Note6-2] VRI,VGI,VBI terminals (RGB signals)

[Note6-3] \overline{HSY} , \overline{VSY} , VSW terminals

[Note6-4] BRT,CNT,COL,TIN terminals

[Note6-5] Maximum wet-bulb temperature 38°C or less.

No dew condensation.

6-2) Backlight driving section

Table 5

Ta=25°C

Parameter	Symbol	MIN	MAX	Unit	Remarks
Filament voltage	V_f	—	8.5	Vrms	

(7) Electrical characteristics

7-1) Recommended operating conditions

A) TFT-LCD panel section

Table 6

GND=0V Ta=25°C

Parameter	Symbol	MIN	TYP	MAX	Unit	Remarks	
Positive power supply voltage	V_{DH}	+4.8	+5.0	+5.2	V		
Negative power supply voltage	V_{DL}	-7.6	-8.0	-8.4	V		
Video input signal amplitude (peak level)	VBS	0.7	1.0	1.3	Vp-p	[Note7-1]	
	$V_{RGB}(1)$	—	0.7	—	Vp-p	[Note7-2]	
	$V_{RGB}(2)$	2.0	—	4.0	Vp-p	[Note7-3]	
Video input signal DC component	V_{DC}	-1.0	0	+1.0	V	[Note7-4]	
Digital input voltage	High level	V_{IH}	+3.5	—	V_{DH}	V	[Note7-5]
	Low level	V_{IL}	0	—	+1.5	V	
Digital output voltage	High level	V_{OH}	+3.5	—	V_{DH}	V	[Note7-6]
	Low level	V_{OL}	0	—	+1.5	V	
DC bias voltage of common electrode driving signal	V_{CC}	-4.5	-3.5	-2.5	V	[Note7-7]	

[Note7-1] VBS (composite video signal) Input impedance : 75Ω

Amplitude of sync. signal : >0.2Vp-p

[Note7-2] VRI, VGI, VBI terminals (RGB signals for analog display)

Input impedance : >10kΩ

[Note7-3] VRI, VGI, VBI terminals (RGB signals for superimposing)

Input impedance : >10kΩ

[Note7-4] VBS, VRI, VGI, VBI terminals

[Note7-5] VSW terminal

Input impedance : >50kΩ

[Note7-6] HSY, VSY terminals (Internal sync. signals).

Load resistance : >20kΩ

[Note7-7] Adjusted for each module so as to attain maximum contrast ratio.

Refer to Appendix-3 for adjusting.

B) Backlight driving section

Table 7

Ta=25°C

Parameter	Symbol	MIN	TYP	MAX	Unit	Remarks
Lamp voltage	V_L	95	110	125	Vrms	(just for reference)
Lamp current	I_L	13	15	18	mA rms	
Filament voltage	V_f	6.0	6.5	7.0	Vrms	
Filament current	I_f	58	66	74	mA rms	
Frequency	f_L	20		50	kHz	
Kick-off voltage	V_s	600	/ -	-	Vrms	[Note7-8]

[Note7-8] The reflector should be grounded.

※ DC/AC inverter for driving hot cathode fluorescent tube (HCFT) is not built in the module.

DC/AC inverter for external connection (Model No.: LQOJ06) is optionally available.

7-2) Power consumption

Table 8

Ta=25°C

Parameter		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Power consumption by the panel section	Positive supply current	I_{sH}	$V_{sH} = +5.0V$	-	+90	+115	mA	
	Negative supply current	I_{sL}	$V_{sL} = -8.0V$	-	-55	-80	mA	
	Total	W_s		-	0.89	1.22	W	[Note7-9]
Power consumption by the fluorescent tube section		W_L	On rated lighting	-	1.7	2.3	W	[Note7-10]

[Note7-9] Excluding power consumption by the backlight.

[Note7-10] Calculated reference value ($I_L \times V_L$).

7-3) Circuit diagram

The circuit block diagram of TFT-LCD module is shown in Fig.4.

(For detail, refer to (Appendix-1) and (Appendix-2).)

The recommended external circuit for TFT-LCD module is shown in Fig.5.

Caution: Turn on or off the power supply (V_{sH} and V_{sL}) at the same time.

Be sure to supply all power voltages before inputting input signals.

7-4) Input/Output signal waveforms

Shown in Fig. 6

Caution: Input standard composite video (or sync.) signal matching for NTSC(M) system in VBS.

A long time input of non-standard sync. signal may cause flicker or degradation of display quality.

7-5) Input/Output signal timing chart

Shown in Fig. 7

Table 9 shows the timing specifications.

Table 9

 $f_H = 15.7\text{kHz}, f_V = 60\text{Hz}$

Parameter		Symbol	MIN	TYP	MAX	Unit	Remarks
Horizontal sync.	Input pulse width	τ_{H1}	4.2	4.7	5.7	μsec	
	Output pulse width	τ_{H2}	2.3	4.7	7.1	μsec	$f = f_H$ [Note7-11]
Horizontal sync. phase difference		τ_{pd}	-0.1		2.7	μsec	[Note7-12]
Vertical sync. output pulse width		τ_{vs}	243	256	269	μsec	$4/f_H$
Vertical sync. phase difference		τ_{pv}	121/90	127/95	133/100	μsec	[Note7-13]

(Supply voltage condition: $V_{SH} = +5V, V_{SL} = -8V$)

[Note7-11] Adjusted by variable resistor (H-POS).

[Note7-12] Variable range by variable resistor (H-POS)

(Positive when \overline{HSY} proceeds VBS.)

Adjusted value : $\tau_{pd} = 1.3 \pm 0.7 \mu\text{sec}$

[Note7-13] Odd field/Even field ($2/f_H / 1.5/f_H$)

7-6) Display time range

(a) Horizontally

12.0~61.9 μsec from the falling edge of \overline{HSY} .

(b) Vertically

19~252K from the falling edge of \overline{VSY} .

(B) Optical characteristics

Parameter		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Viewing angle range		$\Delta\theta 11$	CR \geq 10	30 (10)	—	—	Degree	LQ4HC01
		$\Delta\theta 12$	CR \geq 10	10 (30)	—	—	Degree	(LQ4HC02)
		$\Delta\theta 2$	CR \geq 10	45	—	—	Degree	[Note 8-1, 2]
Contrast ratio		CRmax	$\theta = 0^\circ$	30	—	—		[Note 8-2, 3]
Response time	Rise	τr	$\theta = 15^\circ$	—	30	—	ms	[Note 8-2]
	Decay	τd		—	50	—	ms	[Note 8-4]
Brightness		Y_L		100	120	—	nt	[Note 8-5]
Color temperature		K_L	$\theta = 0^\circ$	—	7900	—	K	[Note 8-5]
White chromaticity		x		0.247	0.297	0.347		
		y		0.262	0.312	0.362		

[Note 8-1] Viewing angle range is defined as follows.

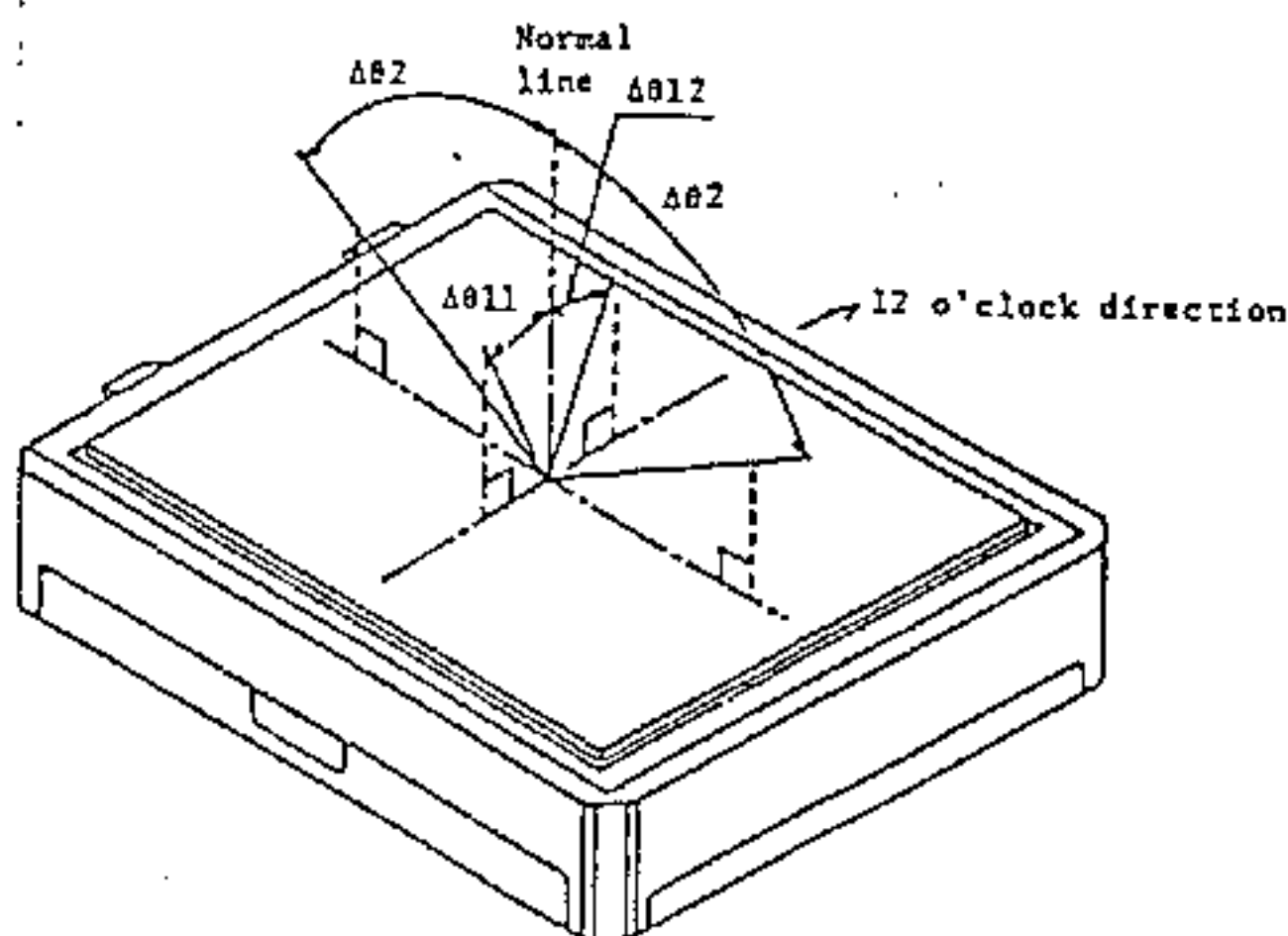


Fig.(j) Definition of viewing angle range

[Note 8-2] Applied voltage for measuring optical characteristics

- a) V_{cac} must be adjusted by the (1) Flicker measuring method or the (2) Contrast measuring method described in the (Appendix-3) "Adjusting method of optimum common electrode DC bias voltage".
- b) Brightness adjusting terminal (BRT) should be opened.
- c) Video signal of reference black level and 100% white level must be input.

[Note 8-3] Contrast ratio is defined as follows.

Contrast ratio is calculated with the following formula in the optical characteristics measuring method shown in Fig. 8.

Contrast ratio (CR)

$$= \frac{\text{Photodetector output with LCD being "white"}}{\text{Photodetector output with LCD being "black"}}$$

[Note 8-4] Input signals are applied to the area measured to make the area "white" and "black" respectively, and change with time in the photodetector output is measured in the optical characteristics measuring method shown in Fig. 8.

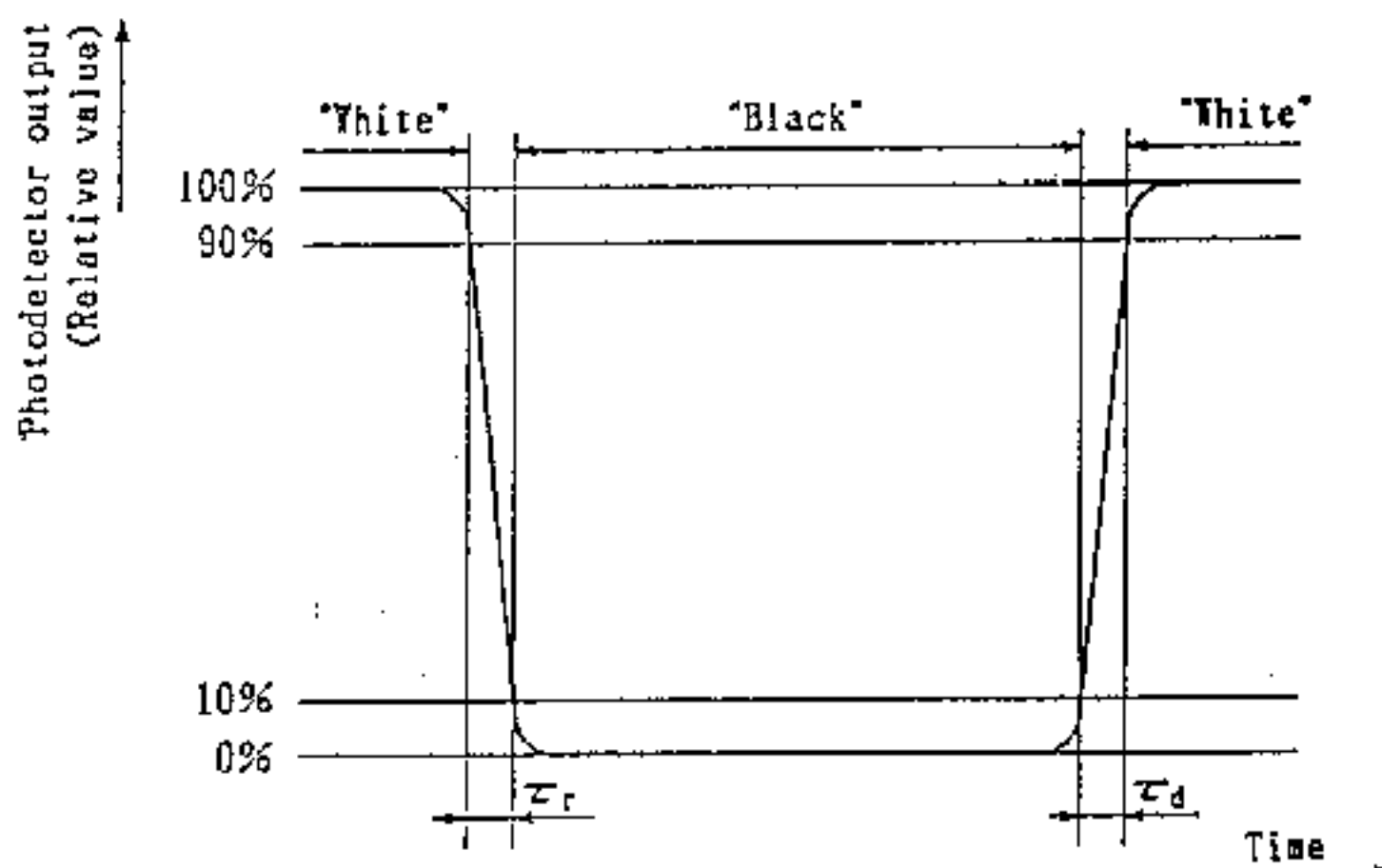


Fig. (iii)

[Note 8-5] Measured on the center area of the panel at a viewing cone 1° by TOPCON luminance meter BM-7.

(9) Mechanical characteristics

9-1) External appearance

There shall not be any conspicuous defects. (See Fig. 3. "Outline dimensions of TFT-LCD module".)

9-2) Panel toughness

The panel shall not break when the panel center is pressed with 2 kg force by 15 mm dia. smooth flat surface.

(Caution): The least force can cause functional troubles if it is applied on the active area for a long time.

9-3) Maximum resin region

As shown in the illustration below, resin may fill up to the same level as a line connecting the upper ridges of a panel and a shielding case.

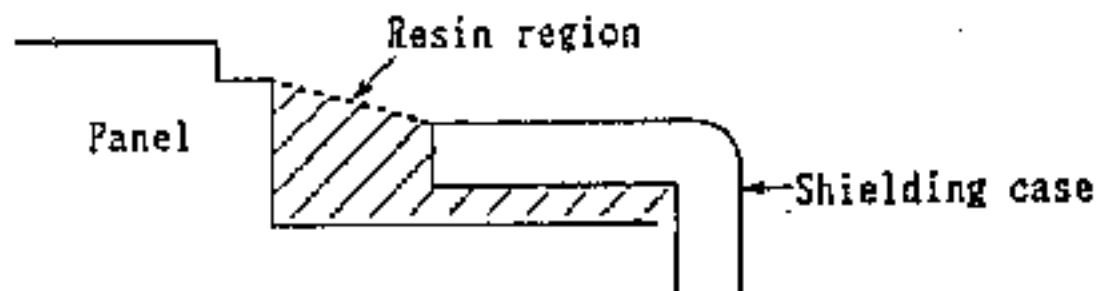


Fig. (iv)

9-4) I/O connector performance

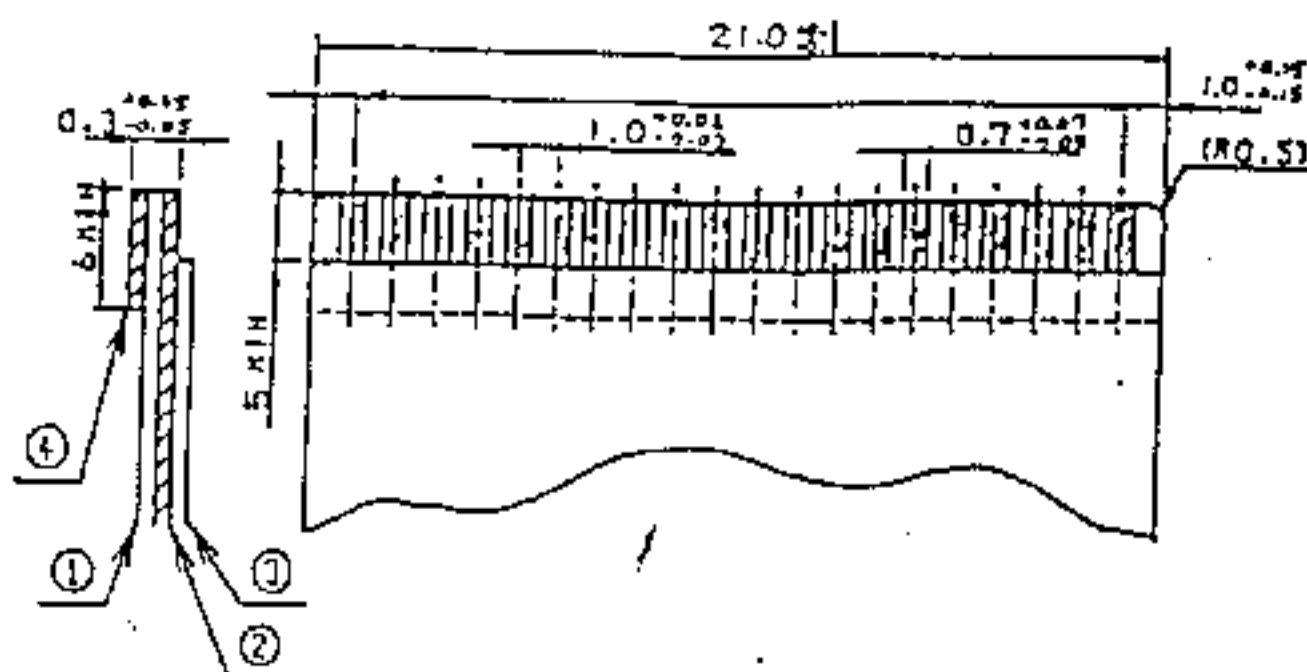
A) I/O connector of LCD panel driving circuit (FPC connector 20 pins)

1) Applicable FPC: Shown in Fig. (v).

2) Terminal holding force: 100 g or larger/pin

(Each terminal is pulled out at a rate of 25 ± 3 mm/min.)

3) Insertion/pulling durability: Contact resistance not larger than double the initial value after applicable FPC is inserted and pulled out 20 times.



Ref. No	Name	Material
①	Base material	Polyimide or equivalent material (25 μ m thick)
②	Copper foil	Copper foil (35 μ m thick), solder plated in 2 to 12 μ m thickness
③	Coverlay	Polyimide or equivalent material
④	Reinforcing plate	Polyester polyimide or equivalent material (188 μ m thick)

Fig. (k) Applicable FPC for I/O connector (1.0 mm pitch)

- B) I/O connector of backlight driving circuit (PH connector 4 pins x2 pcs.)
- i) Applicable connector housing: PHR-4 (produced by Japan Solderless Terminal)
 - ii) Terminal holding force: 100 g or more/pin
(Pulled out at a rate of 1 through 5 mm/sec.)
 - iii) Insertion/pulling durability: Contact resistance not larger than double the initial value after connectors are inserted and pulled out 20 times.

(10) Display quality

The display quality of the color TFT-LCD module shall be in compliance with the Delivery Inspection Standard (Separate Sheet LDI-89901).

(11) Handling instructions

11-1) Mounting of module

The TFT-LCD module is designed to be mounted on equipment using the mounting tabs in the four corners of the module rear face.

On mounting the module, as the M2.6 tapping screw (fastening torque is 5 through 6 kg·cm) is recommended, be sure to fix the module on the same plane, taking care not to warp or twist the module.

11-2) Precautions in mounting

① Polarizer which is made of soft material and susceptible to flaw must be handled carefully. Protective film (laminator) is applied on the surface to protect it against scratches and dirt. It is recommended to peel off the laminator immediately before the use, taking care of static electricity.

② Precautions in peeling off the laminator

A) Working environment

When the laminator is peeled off, static electricity may cause dust to stick to the polarizer surface. To avoid this, the following working environment is desirable.

a) Floor: Conductive treatment of 1 MΩ or more on the tile

(Conductive mat or conductive paint on the tile)

b) Clean room free from dust and with an adhesive mat on the doorway

c) Humidity: 50 % to 70 % RH

d) Workers shall wear conductive shoes, conductive work clothes, conductive gloves and an earth band.

B) Working procedures

a) Direct the wind of discharging blower somewhat downward to ensure that module is blown sufficiently. Keep the distance between module and discharging blower within 20 cm. (See Fig. (vi-i).)

b) Attach adhesive tape to the laminator part near discharging blower so as to protect polarizer against flaw. (See Fig. (vi-ii).)

c) Peel off laminator, pulling adhesive tape slowly to your side taking 5 or more second.

d) On peeling off the laminator, pass the module to the next work process to prevent the module to get dust.

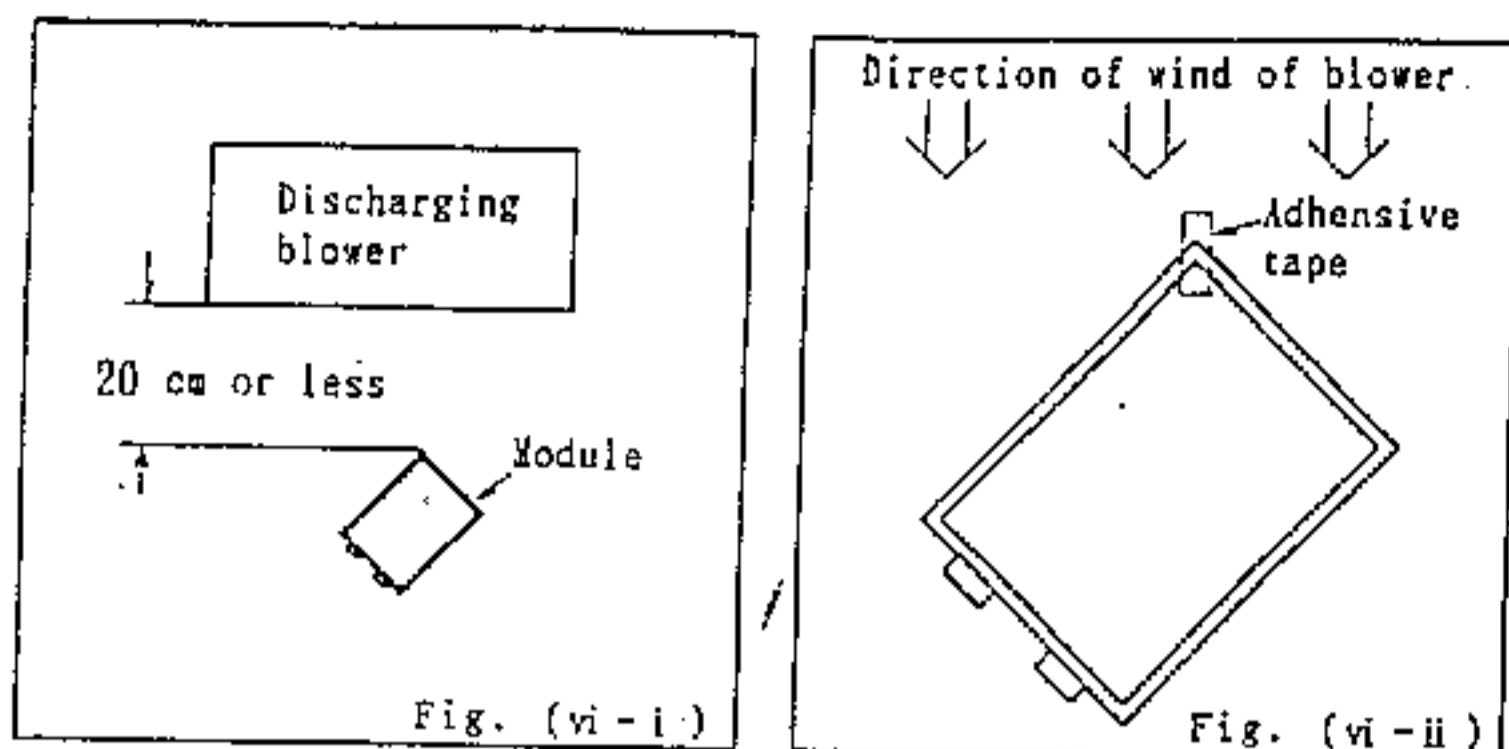


Fig. (vi)

e) Method of removing dust from polarizer

- Blow off dust with N_2 blower for which static electricity preventive measure has been taken. Ionized air gun (Hugle Electronics Co.) is recommended.
- Since polarizer is vulnerable, wiping should be avoided. If wiping is unavoidable, wipe it carefully with lens cleaning cloth, breathing on it. "Belleseime" (Kanebo, Ltd.) is desirable.

- ③ When metal part of the TFT-LCD module (shielding lid and rear case) is soiled, wipe it with soft dry cloth. For stubborn dirt, wipe the part, breathing on it.
- ④ Wipe off water drop or finger grease immediately. Long contact with water may cause discoloration or spots.
- ⑤ TFT-LCD module uses glass which breaks or cracks easily if dropped or bumped on hard surface. Handle with care.
- ⑥ Since CMOS LSI is used in this module, take care of static electricity and earth your body when handling.

11-3) Precautions in adjusting module

Adjusting volumes on the rear face of the module have been set optimally before shipment. Therefore, do not change any adjusted values. If adjusted values are changed, the specifications described here may not be satisfied.

11-4) Others

- ① Do not expose the module to direct sunlight or intensive ultraviolet rays for many hours; liquid crystal is deteriorated by ultraviolet rays.
- ② Store the module at a temperature near the room temperature. At lower than the rated storage temperature, liquid crystal solidifies, causing the panel to be damaged. At higher than the rated storage temperature, liquid crystal turns into isotropic liquid and may not recover.
- ③ If LCD panel breaks, there may be a possibility that the liquid crystal escapes from the panel. Since the liquid crystal is injurious, do not put it into the eyes or mouth. When liquid crystal sticks to hands, feet or clothes, wash it out immediately with soap.
- ④ Observe all other precautionary requirements in handling general electronic components.

(12) Shipping requirements

12-1) Packing form is shown in Fig. 9.

12-2) Carton storage condition

- ① Number of layers of cartons in pile : 10 layers Max.
- ② Environmental condition :
 - Temperature 0 °C to 40 °C
 - Humidity 60 %RH or less (at 40 °C)
No dew condition even at a low temperature and high humidity
 - Atmosphere Harmful gases such as acid and alkali which corrode electronic components and wires must not be detected.
 - Storage period About 3 months
 - Opening of package To prevent TFT-LCD module from being damaged by static electricity, adjust the room humidity to 50 %RH or higher and provide an appropriate measure for electrostatic earthing before opening the package.

(13) Reliability test items

Reliability test items for the TFT-LCD module are shown in Table 11.

(14) Others

If any problem occurs in relation to the description in the present specifications or other relevant items, it shall be eliminated in all sincerity through discussion.

COCOM

This product falls under "strategic product" according to the export trade control ordinance in force. And export of the item requests an export license issued by the related authorities.

Please confirm us whether the license is necessary since the ordinance may be revised by the authorities.

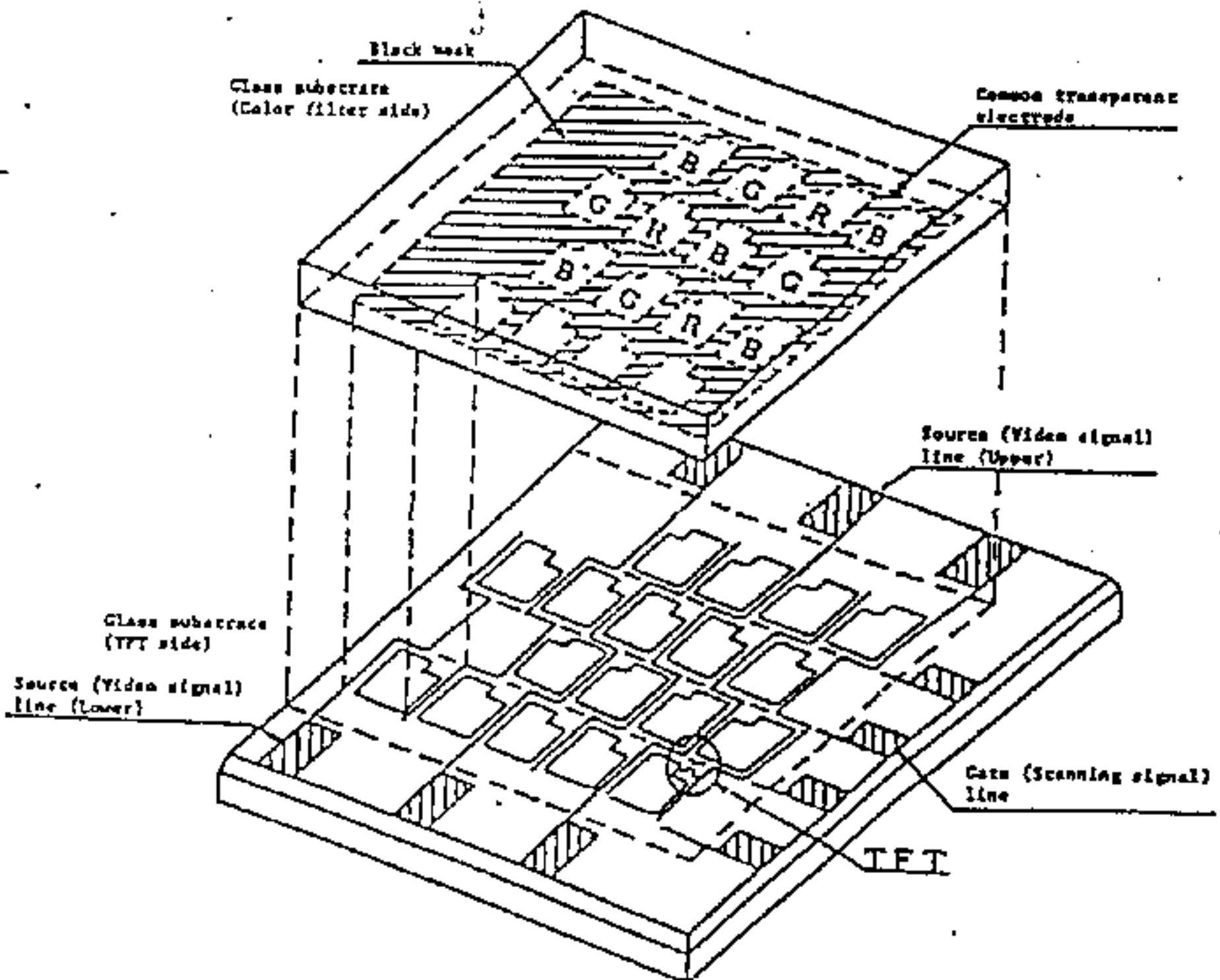
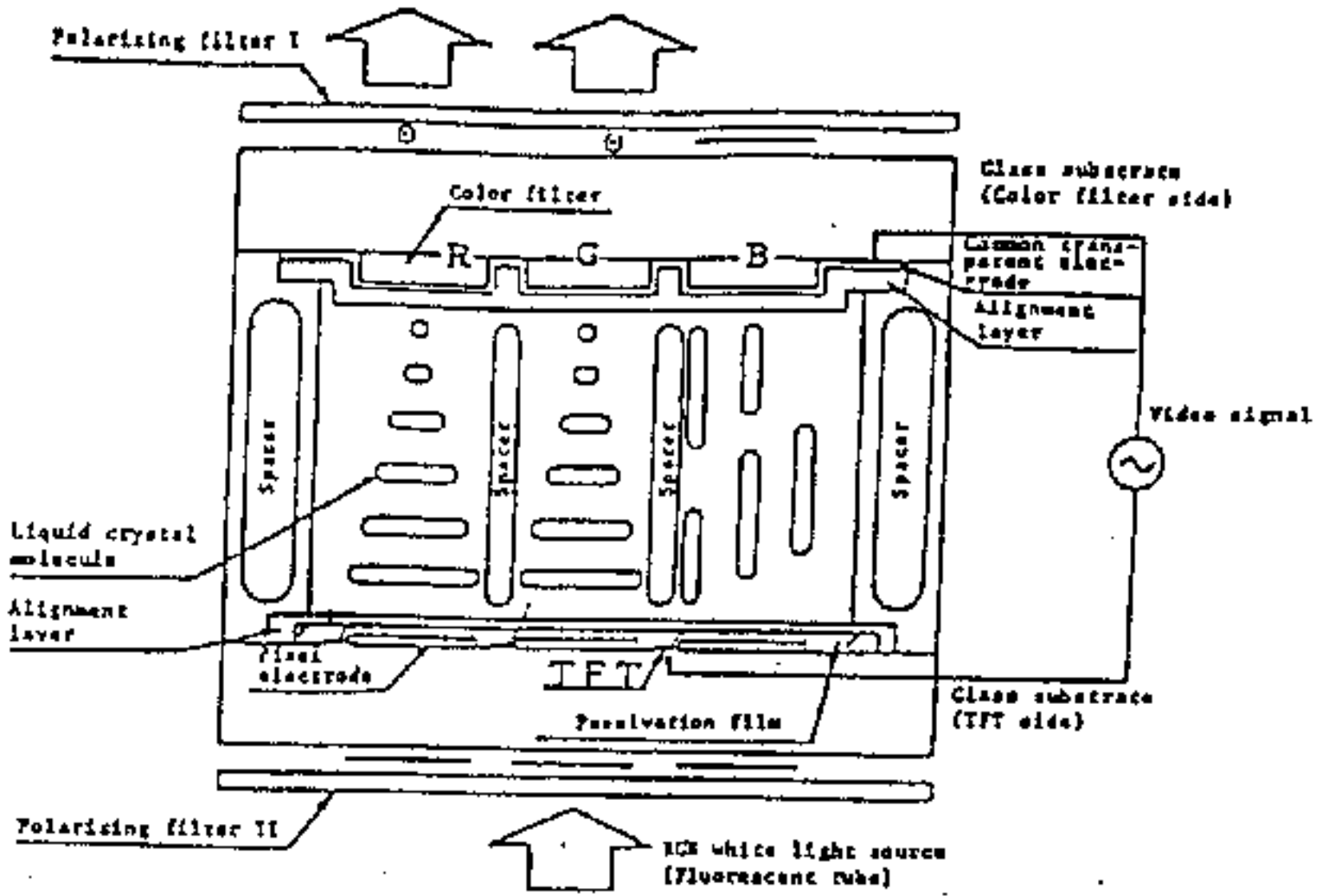


Fig. 1 Illustration of TFT-LCD panel

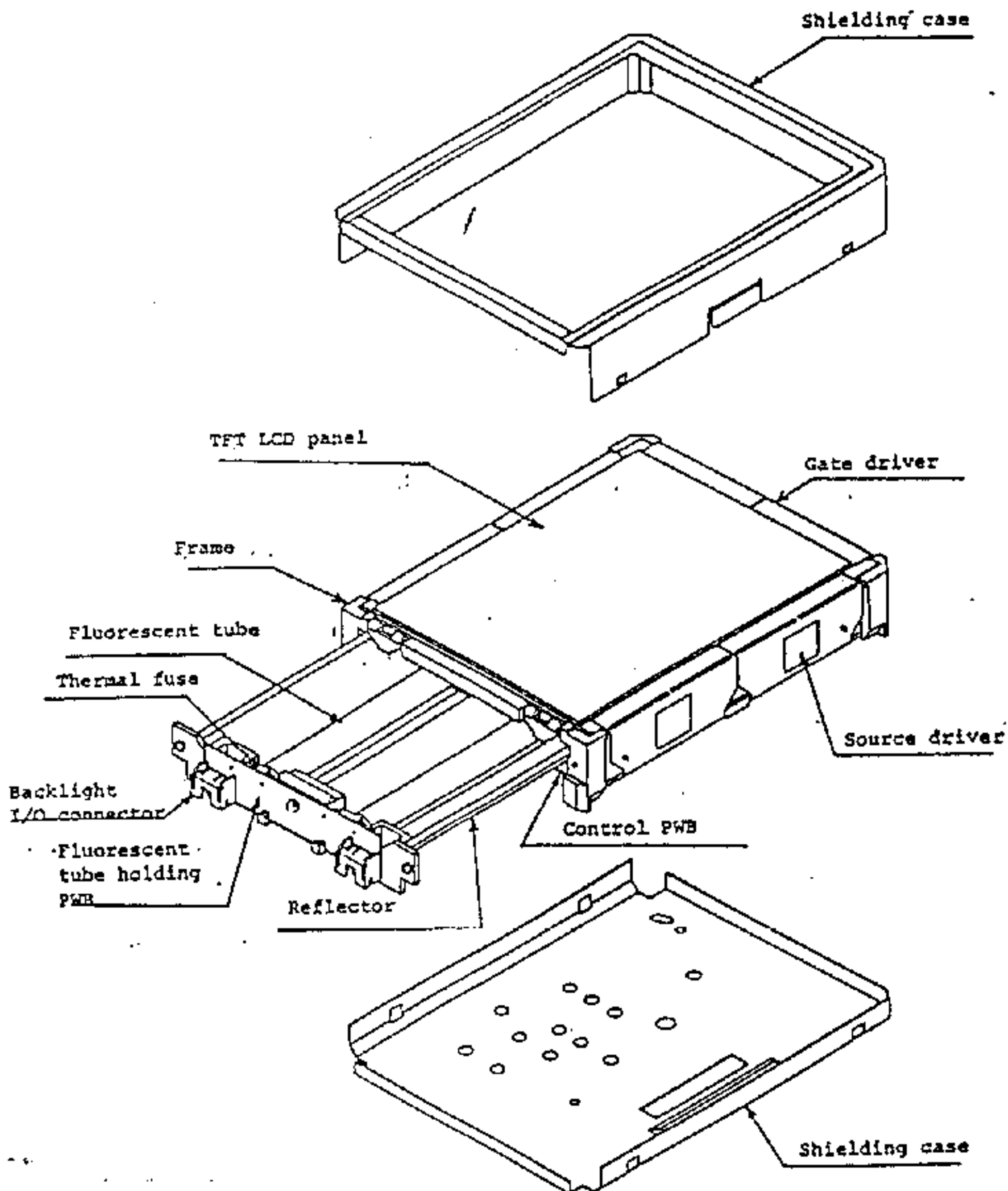
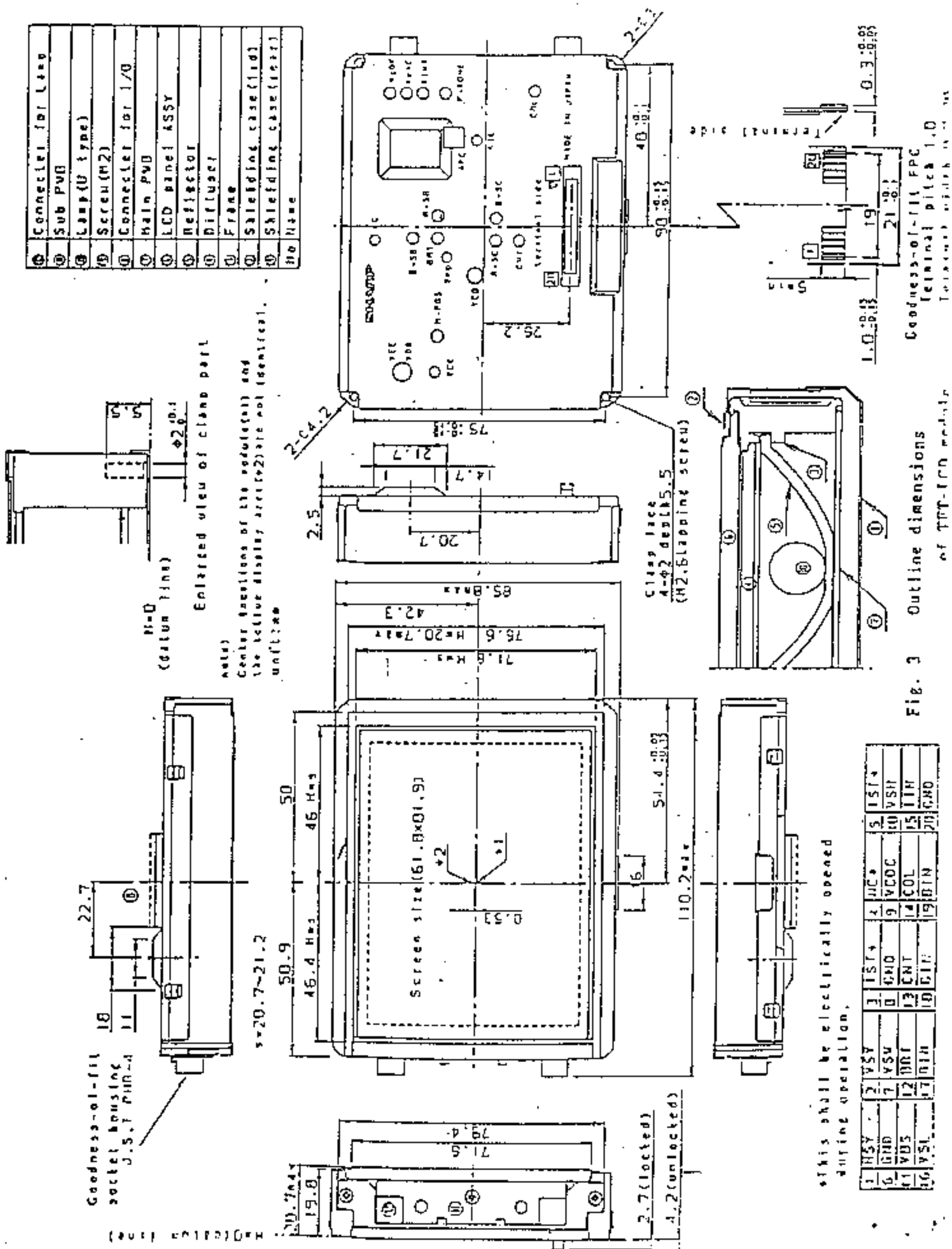


Fig. 2 Construction of TFT-LCD module



①	Connector for Lamp
②	Sub PVD
③	Lamp (U type)
④	Screw (M2)
⑤	Connector for I/O
⑥	Main PVD
⑦	LCD panel ASSY
⑧	Reflector
⑨	Diffuser
⑩	Frame
⑪	Shielding case (lid)
⑫	Shielding case (rear)
No	Name

Fig. 3 Outline dimensions of TFT-LCD module

This shall be electrically opened during operation.

1	VSY	2	VSV	3	IST+	4	UC+	5	IST+
6	GND	7	VSM	8	GND	9	VCOC	10	VSH
11	VDS	12	INT	13	CNT	14	COL	15	TH
16	VSL	17	DN	18	DN	19	DN	20	GND

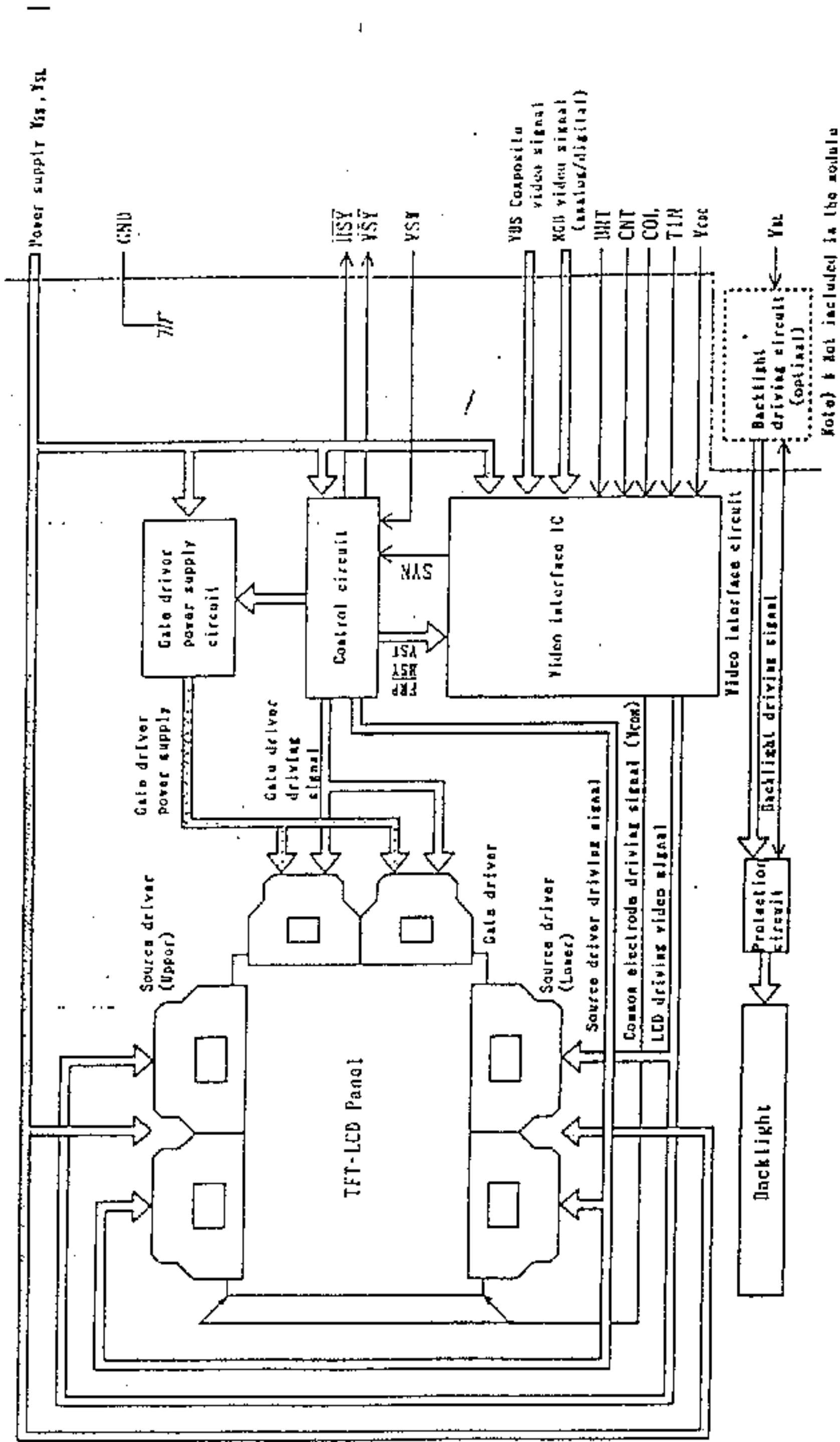


Fig. 4 Circuit block diagram of TFT-LCD module

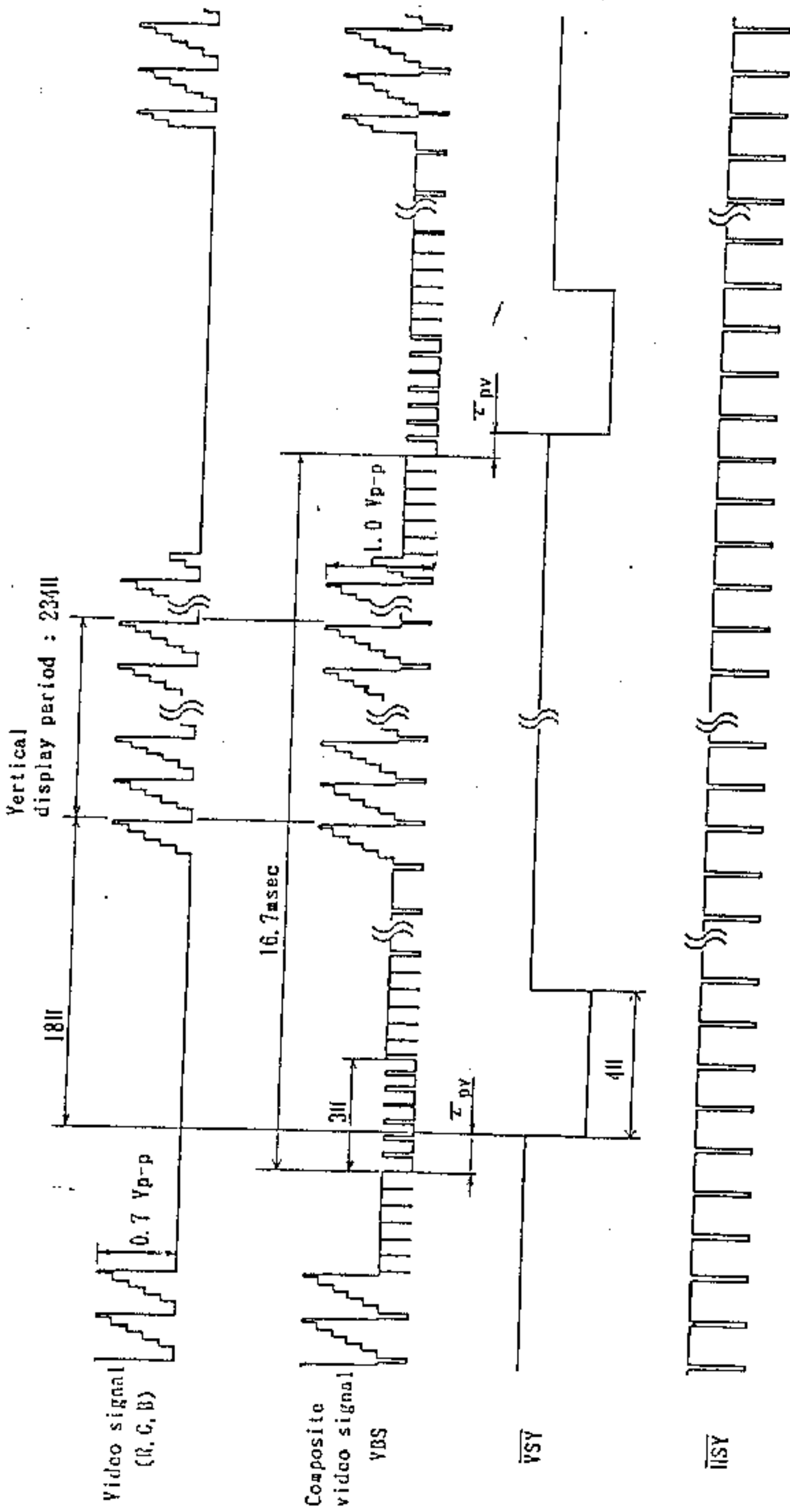


Fig. 6 Input/output signal waveforms

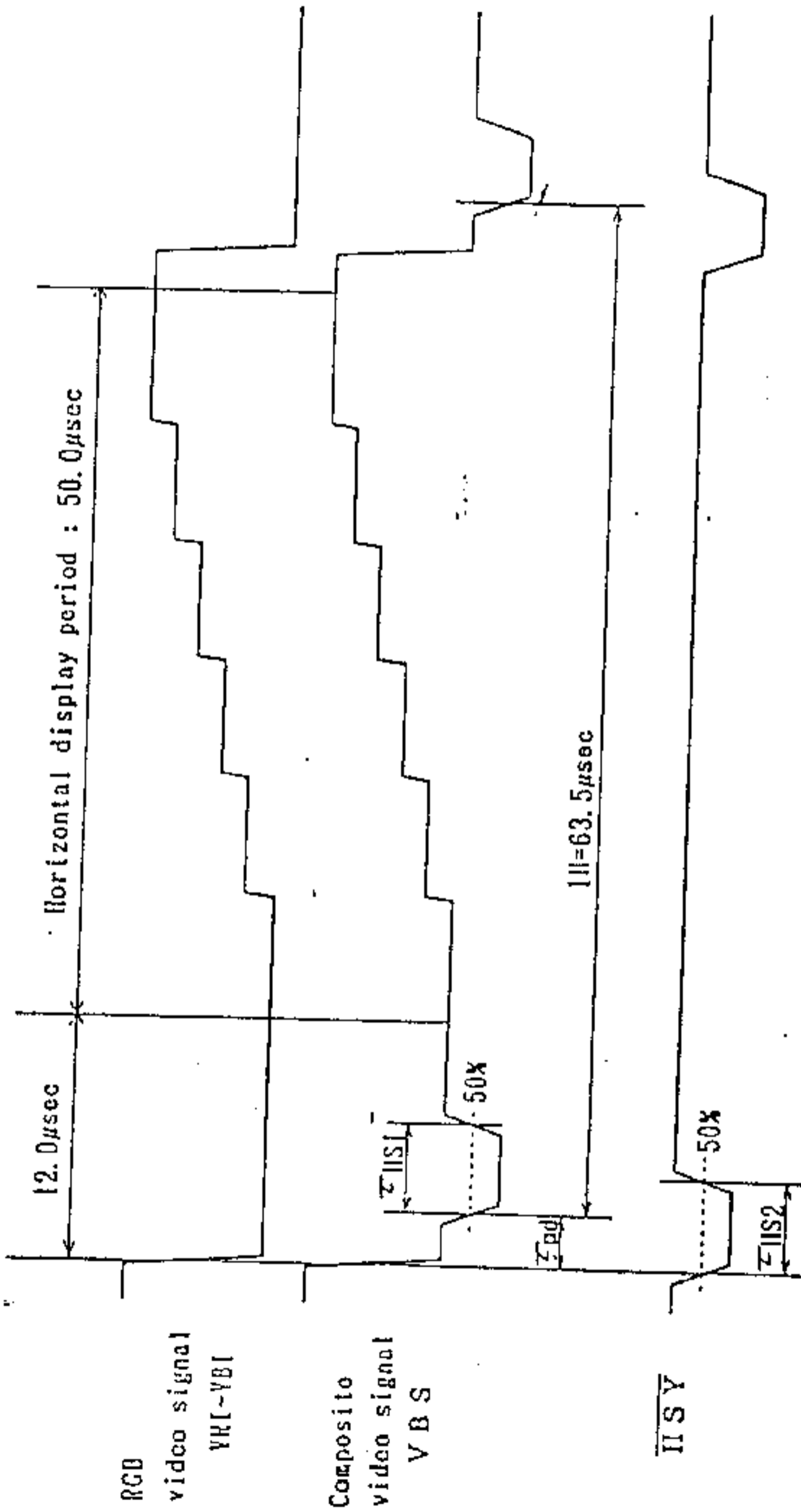


Fig. 7 Input/output signal timing chart