PREPARED BY: DATE	SHARP	SPEC No. LD-2902F
		FILE No.
APPROVED BY: DATE		ISSUE: Sep. 5. 1990
		PAGE : 34 pages
	LIQUID CRYSTAL DISPLAY GROUP SHARP CORPORATION	APPLICABLE GROUP Liquid Crystal Display Group
	SPECIFICATION	

DEVICE SPECIFICATION FOR

TFT-LCD module

MODEL No. LQ 4N C O 1

LQ 4 N C O 2

❑ CUSTOMER'S APPROVAL

DATE

BY

PRESENTED

BY

S. YASUDA

Department General Manager

Engineering Department 3

TFT Development Center

LIQUID CRYSTAL DISPLAY GROUP

SHARP CORPORATION

RECORDS OF REVISION

SPEC No.	DATE	REVISED No.	PAGE	SUMMARY	NOTE
,D-2902	–	–		—	1st Issue
,D-2902A	Jan. 10.'91	Al	7	Table 7 Optical characteristics	2nd Issue
				Kick-off voltage MIN 600	
				→Kick-off voltage MAX 600 [Correction]	
		A2	18, 27	Deletion of COCOM Information.	
,D-2902B	Nov. 29.'91	B1	2	234Vx479H(total 112, 086)dots	3rd Issue
				→37, 440 pixels [Correction]	
		B2	3	Table 1 Module geometry	
				Parameter Display format 37,440 pixels	
				[Addition]	
		B3		Display format unit dots→dot [Correction]	
,D-2902D	May. 14.'93	D1	4	【Note5-1】	4th Issue
				① (Pin No. 13)	
				→(Pin No. 13) [Correction]	
		D 2		③ When RGB signal is superimposed ~,	
				"Low" or ~ synchronizing RGB signal.	
				[Addition]	
,D-2902E	Nov. 19.'93	El		[Correction] 4 inches →10cm(4 type), H →h	5th Issue
				nt →cd/m², kg-f →N, μsec →μs	
				Degree →°(Degree)	
		E2	11	After 20 minutes operation [Addition]	
		E3	14	11-2)B)a)The electricity ~ [Correction]	
		E4		20cm→The optimum ~ [Correction]	
		E5	16	⑤Static image should - [Addition]	
		E6		⑥V_{CDC} must be -- [Addition]	
		E7	- -	10 layers Max →12 layers Max [Correction]	
		E8	17	100G →980m/s² [Correction]	
		E9		Cover [Correction]	
,D2902F	Feb. 4.'94	F1	3	4 type→4" [Correction]	6th Issue
		F2	2, 3	Weight→Mass [Correction]	

CONTENTS

(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
- "37,440 pixels (delta configuration)
- Slim, lightweight and compact

①Active-area / Outline-area=53% ②Thickness=20.7mm ③Mass =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 signais 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	37.440 479(W)x234(H)	pixels dots	
Active area	81.9(W)x61.8(H)	mm	
Screen size(diagonal)	10 (4")	cm	
Dot pitch	0.171(W)x0.264(H)	mm	
Dot configuration	R.G.B Delta configuration	–	
Outline dimension	11O.2(W)X85.8(H)X2O.7(D)	mm	Note 4-1
Mass	180±20	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	$\overline{VSY}$	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 operational	
5	TST	-	This shall be electrically opened during operational	
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_{SH} "and "Low" means "GND".

【Note5-1】 Selects input signals, composite or RGB

① When VSW is "High" or open, composite video signal (Pin No.11) is selected.

② When VSW is "Low". RGB signal set (pin No.17 through 19) is selected.

③ When RGB signal is superimposed on the screen of composite signal, "Low" or "High" should be input into this terminal by synchronizing RGB signal.

【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_{CDC}) is adjusted to the optimum value with V_{SH} and V_{SL} 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_{CDC}) 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 avalable 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 avalable 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	0	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.)

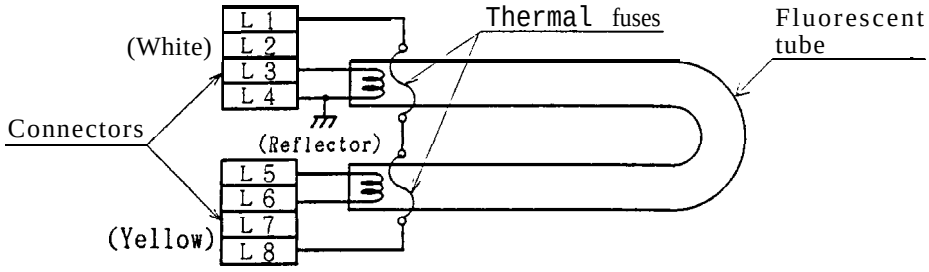


Fig.(i) Wiring diagram of backlight unit

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℃

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		Vi_1	–	2.0	Vp-p	【Note6-1】
Video input signal 2		Vi_2	–	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 drivingsignal		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	℃	【Note6-5】
Operating temperature	Panel temp.	Topp	o	60	℃	
	Ambient temp.	Topa	o	40	℃	

【Note6-1】 VBS terminal (composite video signal)

【Note6-2】 VRI VGI,VBI terminals (RGB signals)

【Note6-3】 HSY VSY,VSW terminals

【Note6-4】 BRT CNT,COL,TIN terminals

【Note6-5】 Max: mum wet-bulb temperature 38℃ or less.

No dew condensation.

6-2) Backlight driving section

Table 5 Ta=25℃

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=OV Ta=25℃

Parameter		Symbol	MIN	TYP	MAX	Unit	Remarks
Positive power supply voltage		V_S "	+4.8	+5.0	+5.2	V	
Negative power supply voltage		V_{SL}	-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		Vi_{DC}	-1.0	0	+1.0	V	【Note7-4】
Digital input voltage	High level	V_{IH}	+3.5	—	V_{SH}	V	【Note7-5】
	Low level	V_{IL}	0	-	+1.5	V	
Digital output voltage	High level	V_{OH}	+3.5	—	V_{SH}	V	【Note7-6】
	Low level	V_{OL}	0	-	+1.5	V	
DC bias voltage of common electrode driving signal		V_{CDC}	-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℃

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	mArms	
Filament voltage	V_F	6.0	6.5	7.0	Vrms	
Filament current	I_F	58	66	74	mArms	
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.": LQ0J06) is optionally available.

7-2) Power consumption

Table 8 Ta=25℃

Parameter		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Power consumption by the panel section	Positive supply cut-rent	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 x 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=15.7kHz,fv=60Hz

Parameter		Symbol	MIN	TYP	MAX	Unit	Remarks
Horizontal sync.	Input pulse width	τ_{Hs1}	4.2	4.7	5.7	μs	
	Output pulse width	τ_{Hs2}	2.3	4.7	7.1	μs	f=f_H 【Note7-11】
Horizontal sync.phase difference		τ pd	-0.1		2.7	μs	【Note7-12】
Vertical sync.output pulse width		τ Vs	243	256	269	μs	4/f_H
Vertical sync. phase difference		r pv	121/90	127/9	133/100	μs	【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 HSY proceeds VBS.)

Adjusted value : τ pd= 1.3 ± 0.7 μs

【Note7-13】 Odd field/Even field (2/f_H／1.5/f_H)

7-6) Display time range

(a) Horizontally

12.0-61.9 μs from the falling edge of HSY.

(b) Vertically

19～252H from the falling edge of VSY.

(8)-Optical characteristics

Parameter		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Viewing angle range		Δθ11	CR210	30(10)	—	—	°(Degree)	LQ4NC01
		Δθ12	CR210	10(30)	—	—	°(Degree)	(LQ4NC02)
		Δθ2	CR≥10	45	-	-	°(Degree)	【Note 8-1, 2】
Contrast ratio		CRmax	θ=0°	30	—	—		【Note 8-2,3】
Response time	Rise	τr	θ=15°		30	—	ms	【Note 8-2】
	Decay	τd		—	50	-	ms	[Note 8-4]
Brightness		Y_L		100	120	-	cd/m²	[Note 8-5]
Color temperature		K_L	θ=0°		7900	-	K	【Note 8-5】
White chromaticity		x		0.247	0.297	0.347		
		y		0.262	0.312	0.362		

【Note8-1】 Viewing angle range is defined as follows.

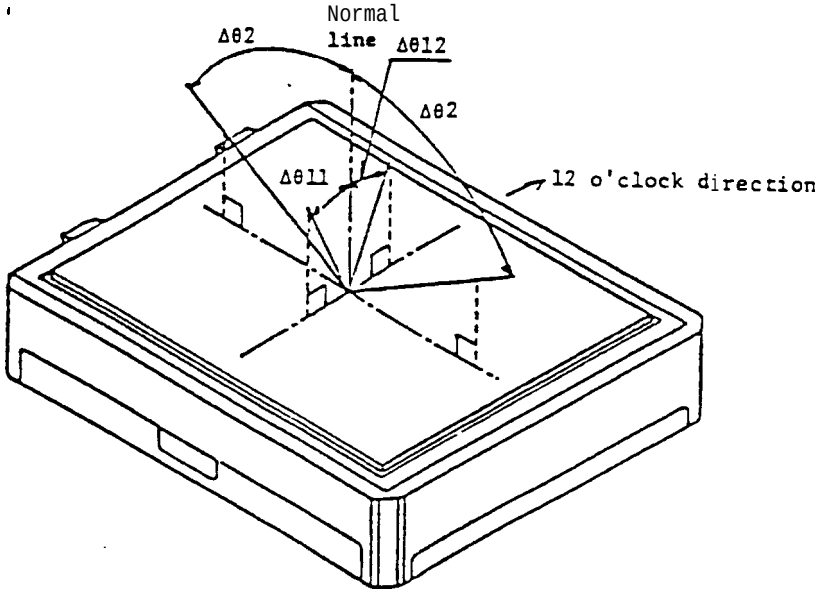


Fig. (ii) Definition of viewing angle range

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

a) V_{CDC} 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.

$$\text{Contrast ratio (CR)} = \frac{\text{Photodetector output with LCD being "white"}}{\text{Photodetector output with LCD being "black"}}$$

[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.

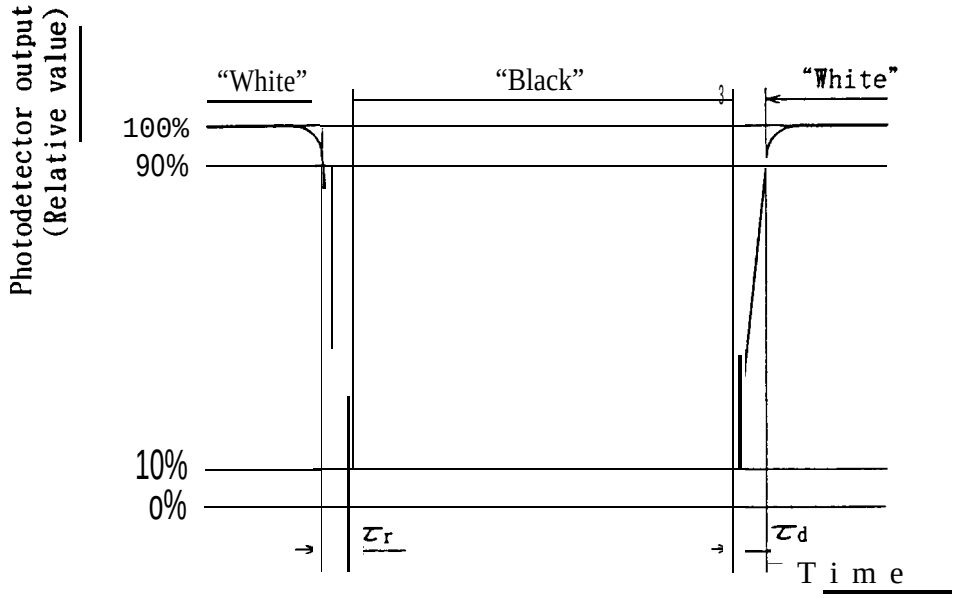


Fig. (iii)

[Note 8-5] Measured on the center area of the panel at a viewing cone 1° by TOPCON luminance meter BM-7. (After 20 minutes operation)

(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 sheilding case.

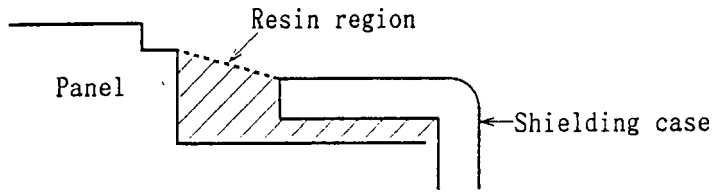


Fig. (iv)

9-4) 1/0 connector performance

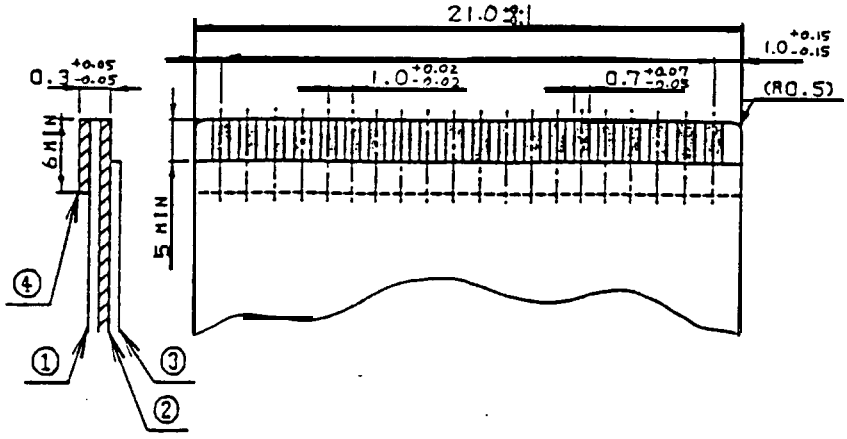
A) 1/0 connector of LCD panel driving circuit (FPC connector 20 pins)

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

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

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

iii) 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 μm thick)
②	Copper foil	Copper foil (35 μm thick), solder plated in 2 to 12 μm thickness
③	Coverlay	Polyimide or equivalent material
④	Reinforcing plate	Polyester polyimide or equivalent material (188 μm thick)

Fig. (i) Applicable FPC for 1/0 connector (1.0 mm pitch)

B) 1/0 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/see.)

i) 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 0.5 through 0.6 N) 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 dirts. 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 adhensive 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) The electricity removing blower must face downward slightly sothat the module is exposed to wind. (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 seconds.

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

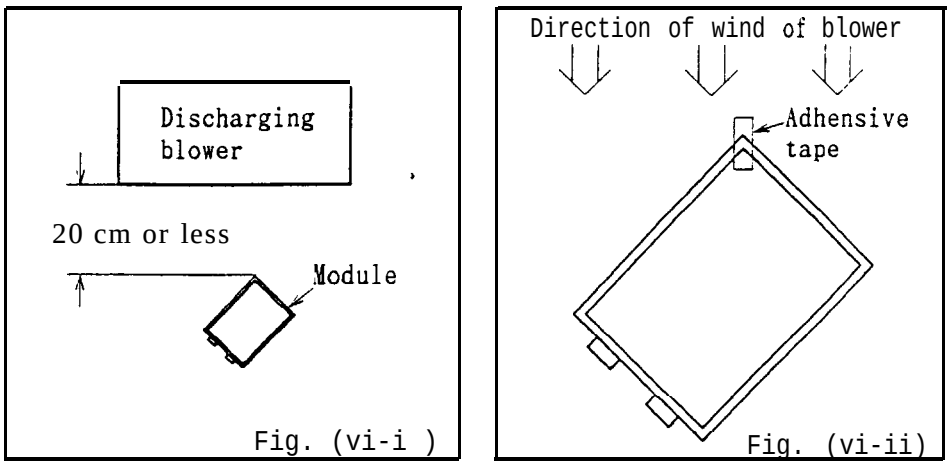


Fig. (vi)

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 dirts, 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.

1 1-3) 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.

Q 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.

⑤ Static image should not be displayed more than 5 minutes in order to prevent from occurrence of residual image.

⑥ V_{CDC} must be adjusted according to Appendix-3 "Adjusting method of optimum common electrode DC bias voltage". No adjustment causes the deterioration for display quality.

(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 : 12 layers Max.

② Environmental condition :

⁰Temperature	0 ℃ to 40 ℃
⁰Humidity	60 %RH or less (at 40 ℃) No dew condition even at a low temperature and high humidity
⁰Atmosphere	Harmful gases such as acid and alkali which corrode electronic components and wires must not be detected.
⁰Storage period	About 3 months
⁰Opening 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.

Reliability Test Items for TFT-LCD Module

Table 11

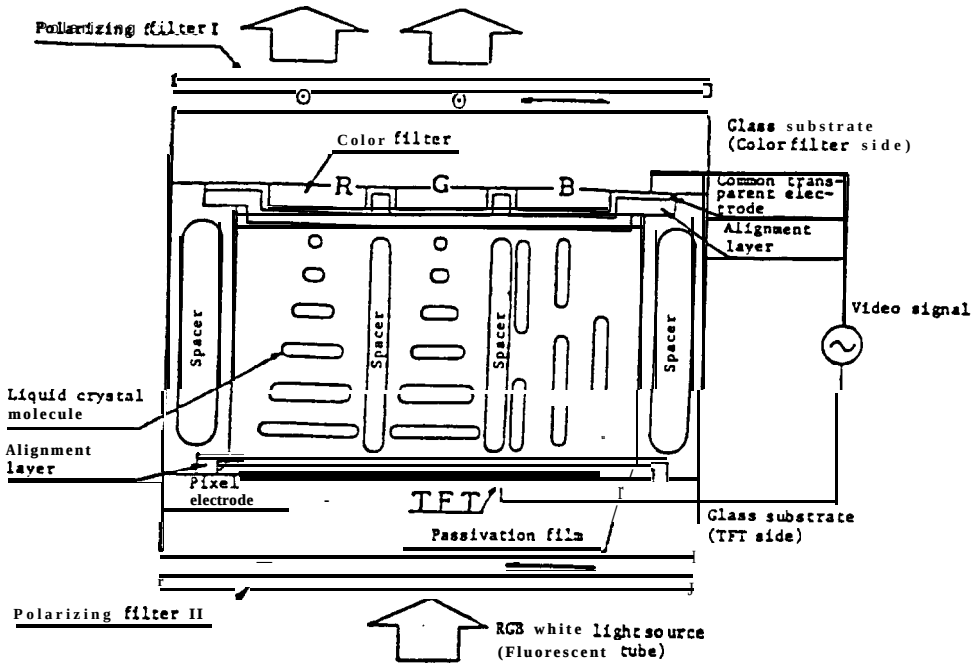
No.	Test items	Conditions	
1	High temperature storage test	Ta = 60℃	240 h
2	Low temperature storage test	Ta = −25℃	240 h
3	High temperature and high humidity operation test	Ta = 40℃・95%RH	240 h
4	High temperature operation test	Ta = 40℃	240 h
5	Low temperature operation test	Ta= O°C	240 h
6	Electrostatic discharge test	±200V・200pF (0Ω)	Once for each terminal
7	Shock test	980 m/s²・6 ms, ±X;±Y;±Z	3 times for each direction (JIS C7021, A-7 Condition C)
8	Vibration test	Frequency range : 10～55 Hz Stroke : 1.5 mm Sweep : 10 Hz～55 Hz～10 Hz	2 hours for each direction of X,Y,Z (6 hours in total (JIS C7021, A-10 Condition A)
9	Heat shock test	−25℃～+60℃／5 cycles (1 b) (1 b)	(2 hours/cycle)

[Result Evaluation Criteria]

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

(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.



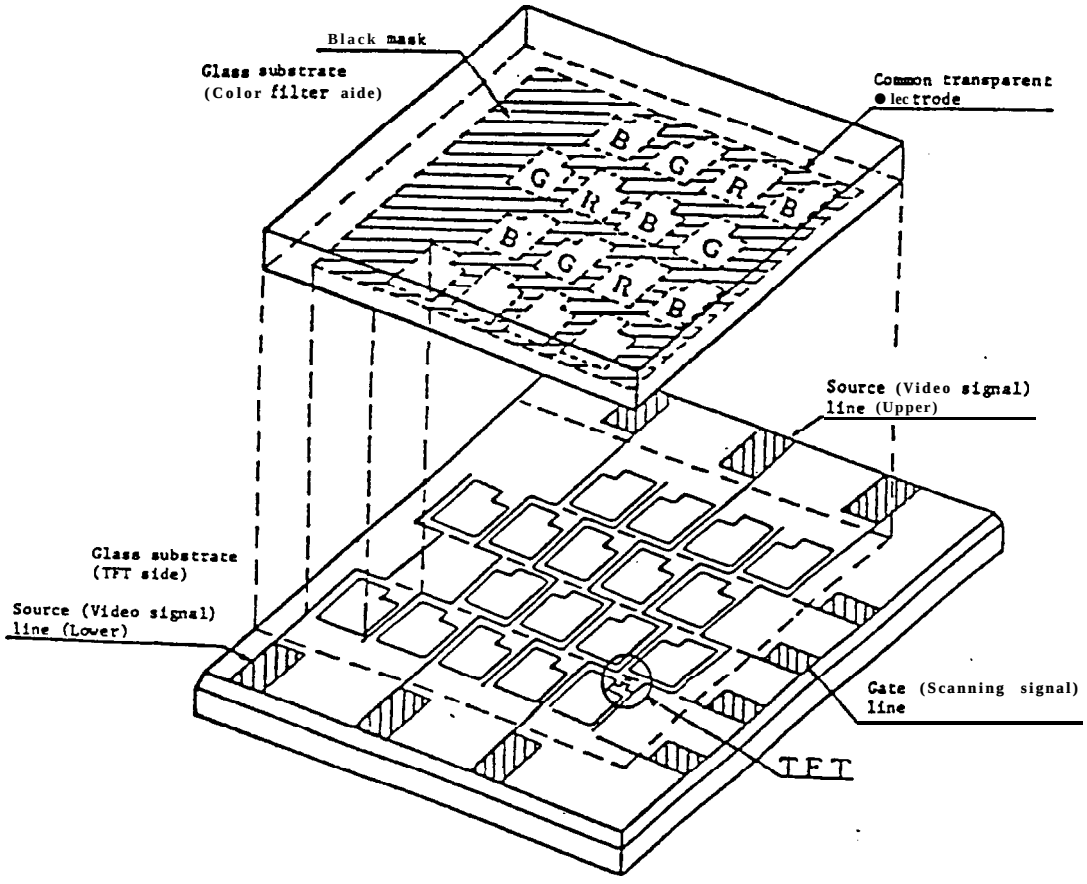


Fig. 1 Illustration of TFT-LCD panel

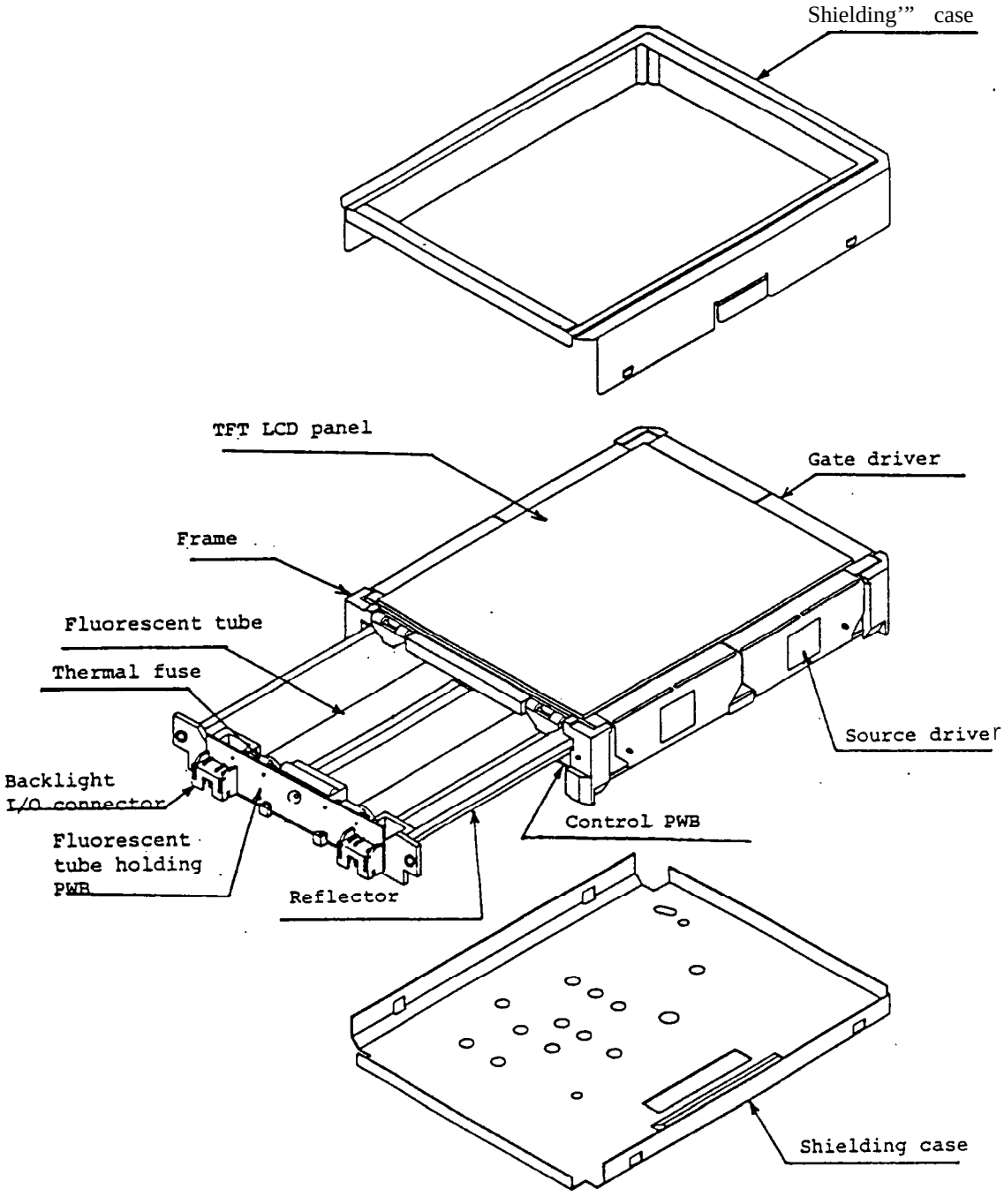
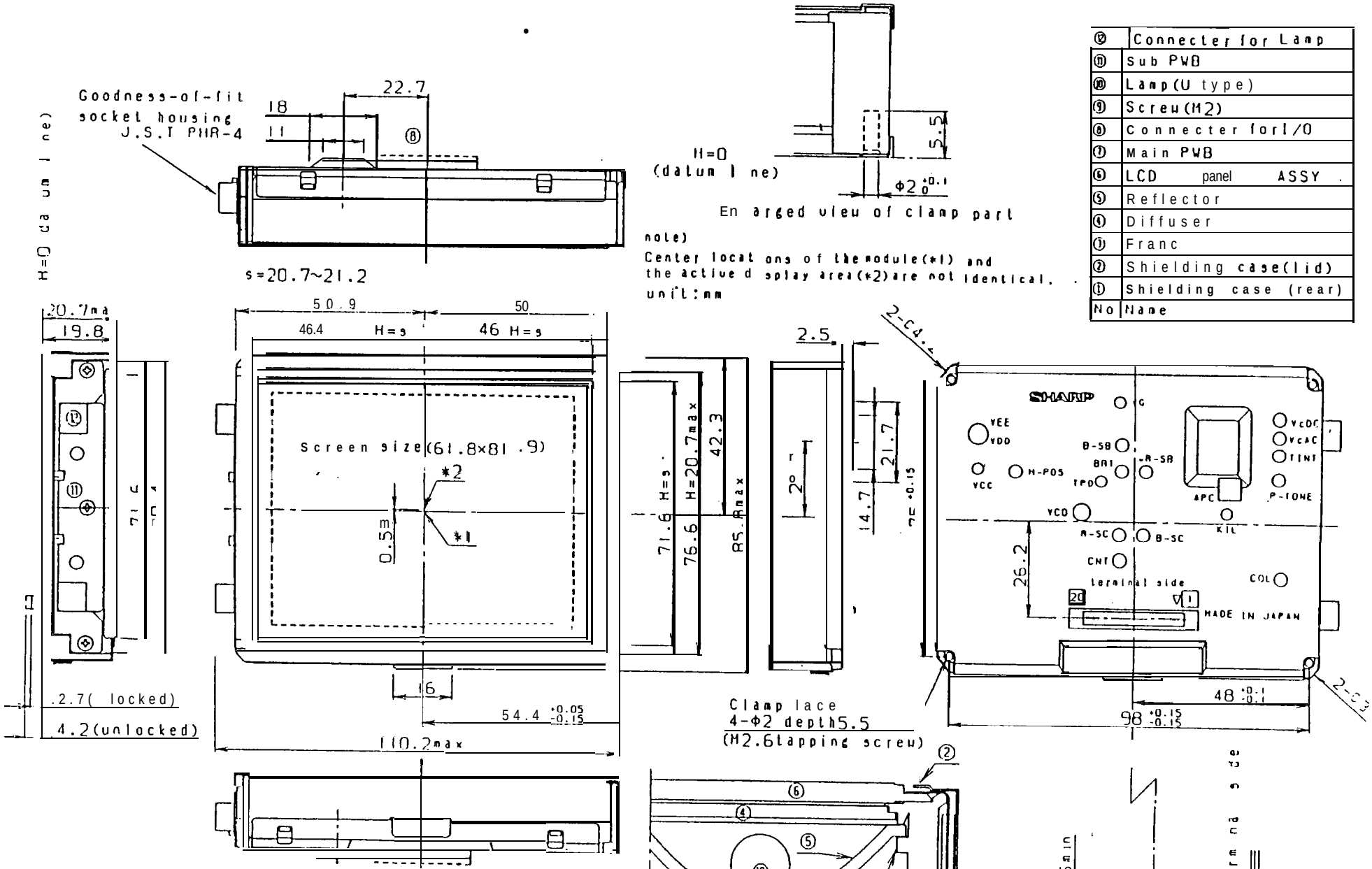


Fig. 2 Construction of TFT-LCD module



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

*This shall be electrically opened during operation.

1	HSY	2	VSY	3	TST*	4	NC*	5	TST*
6	GND	7	VSW	8	GND	9	VCDC	10	VSH
11	VBS	12	BRT	13	CNT	14	COL	15	TIN
16	VSL	17	RIN	18	GIN	19	BIN	20	GND

Fig. 3 Outline dimensions of TFT-LCD module

LD2902-2

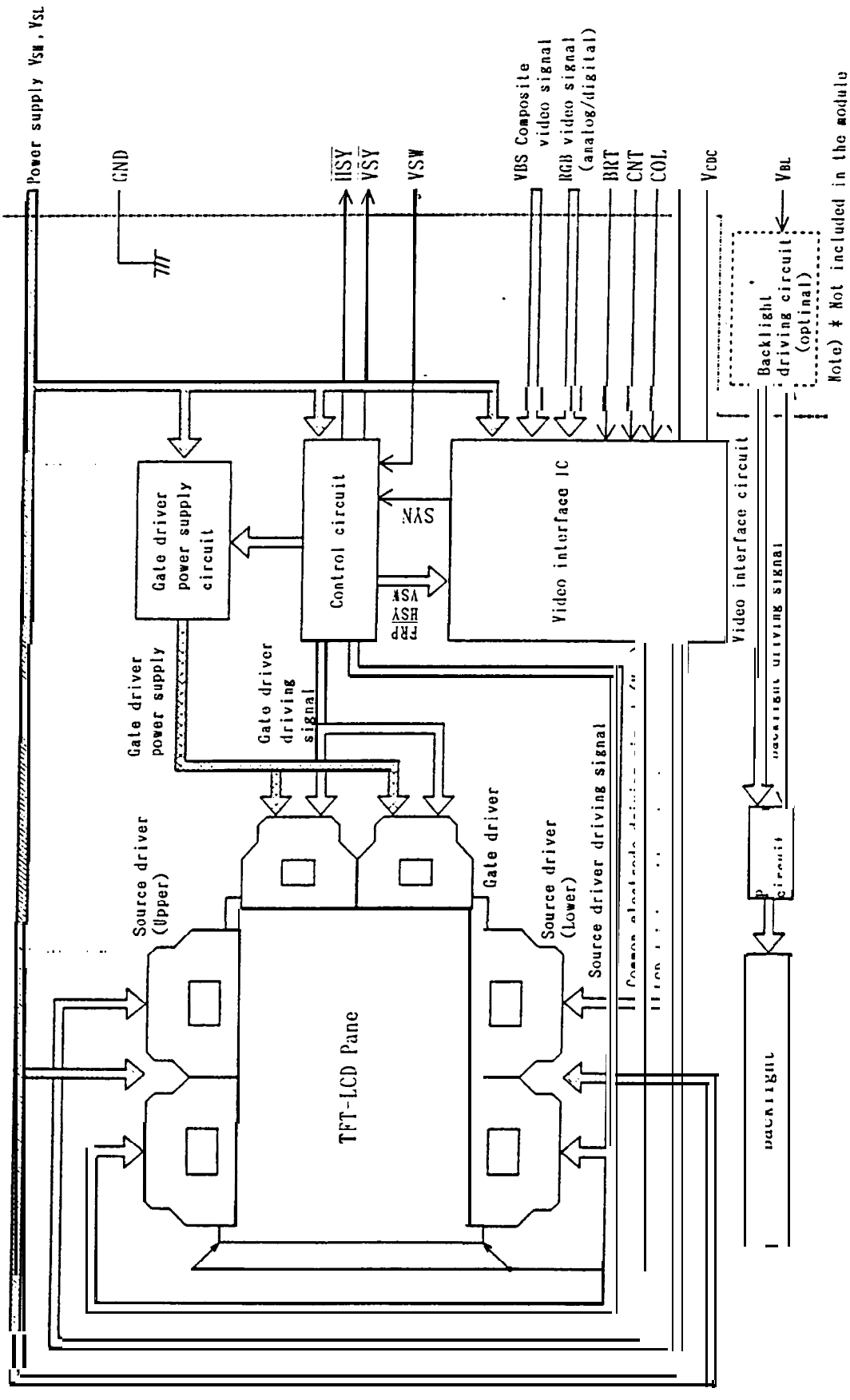


Fig. 4 Circuit block diagram of TFT-LCD module

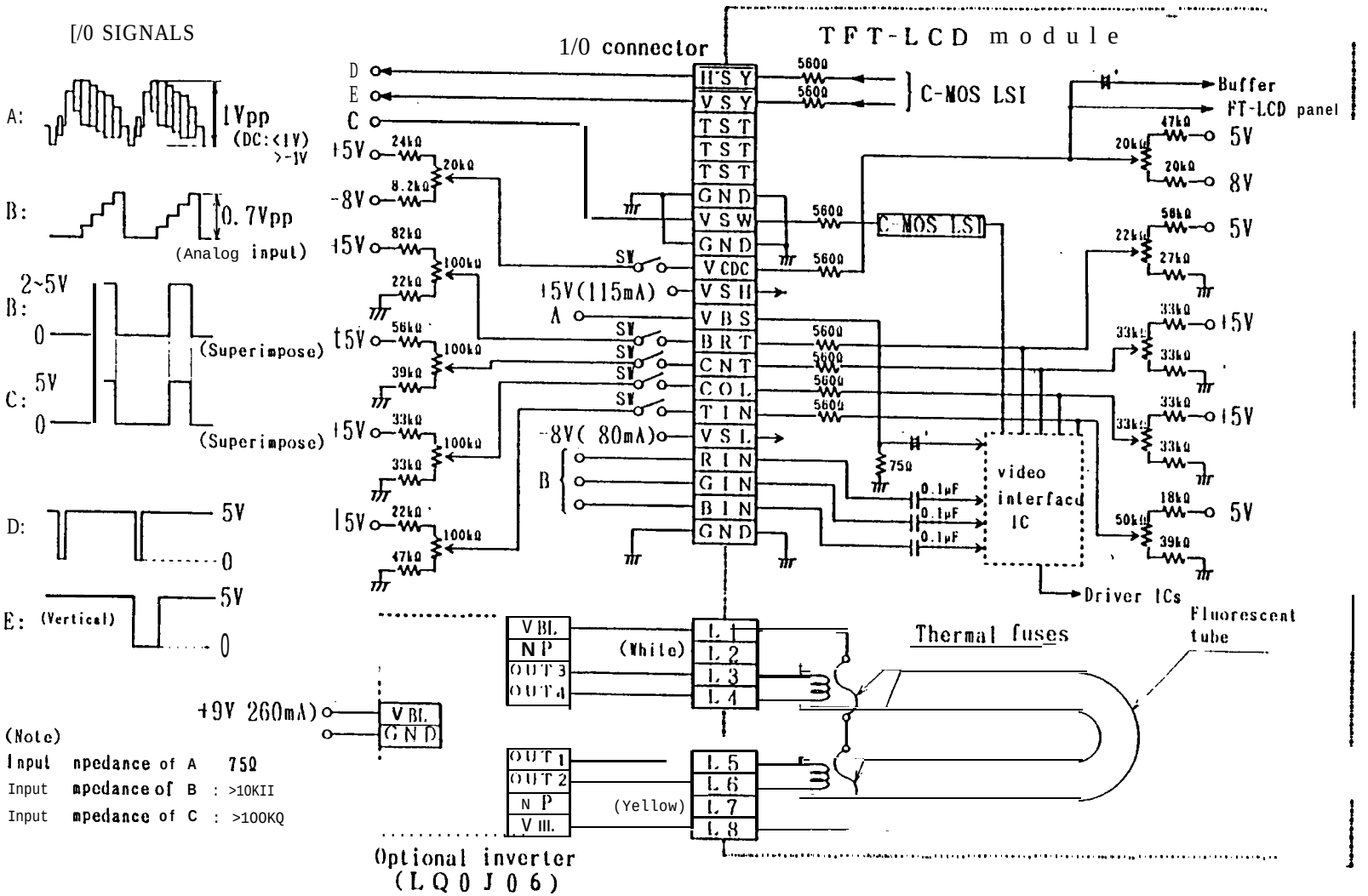


Fig. 5 Recommended circuit for TFT-LCD module

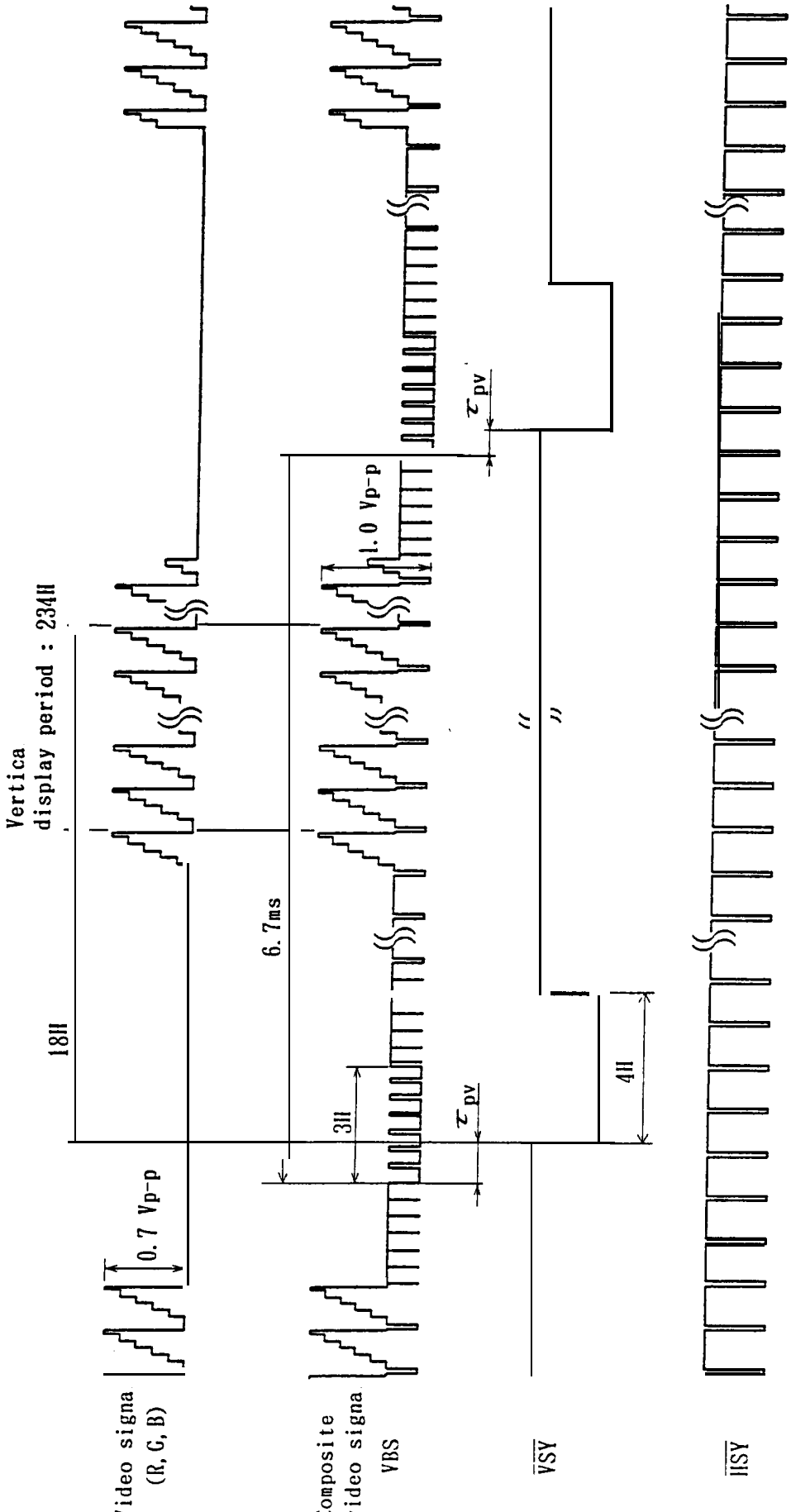


Fig. 6 Input/output signa waveforms

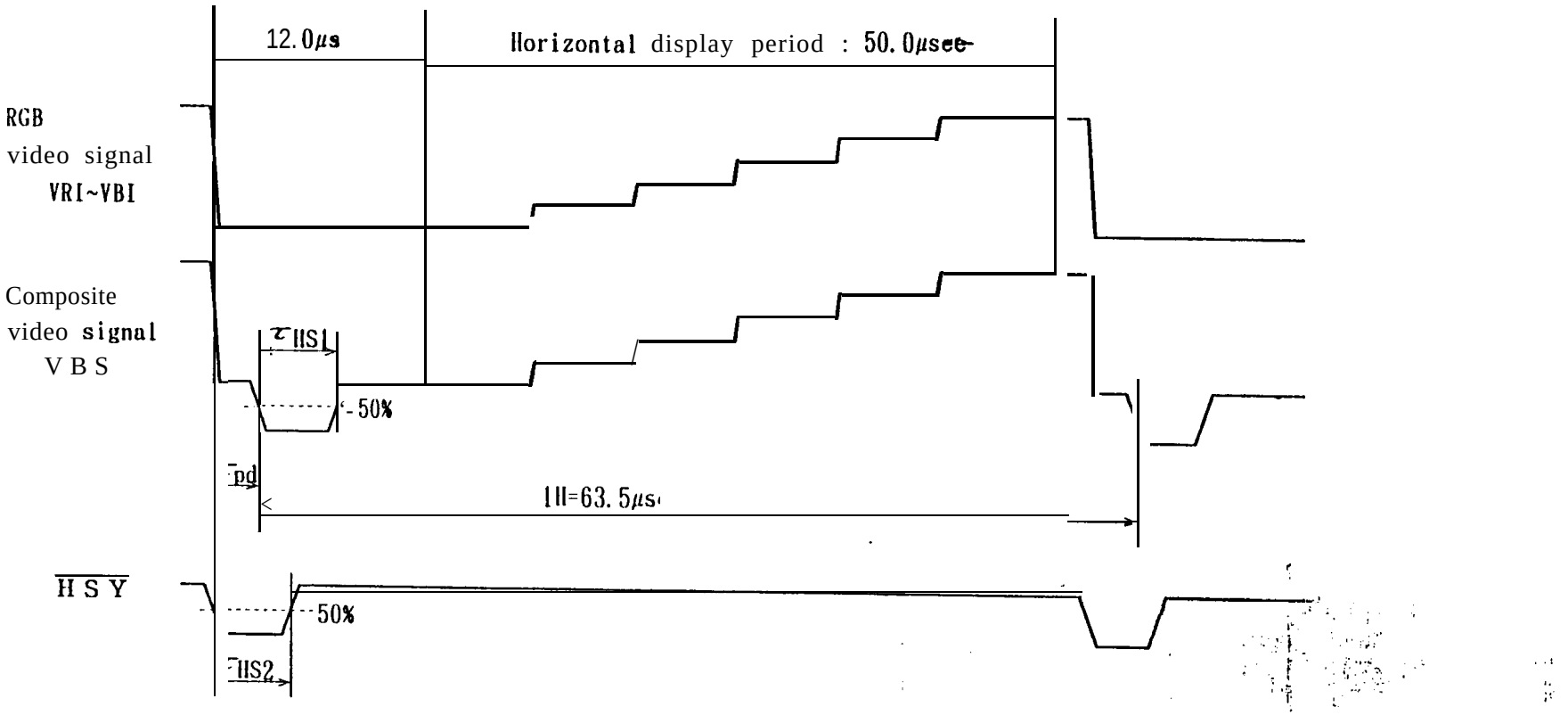


Fig.7 Input/output signal timing chart

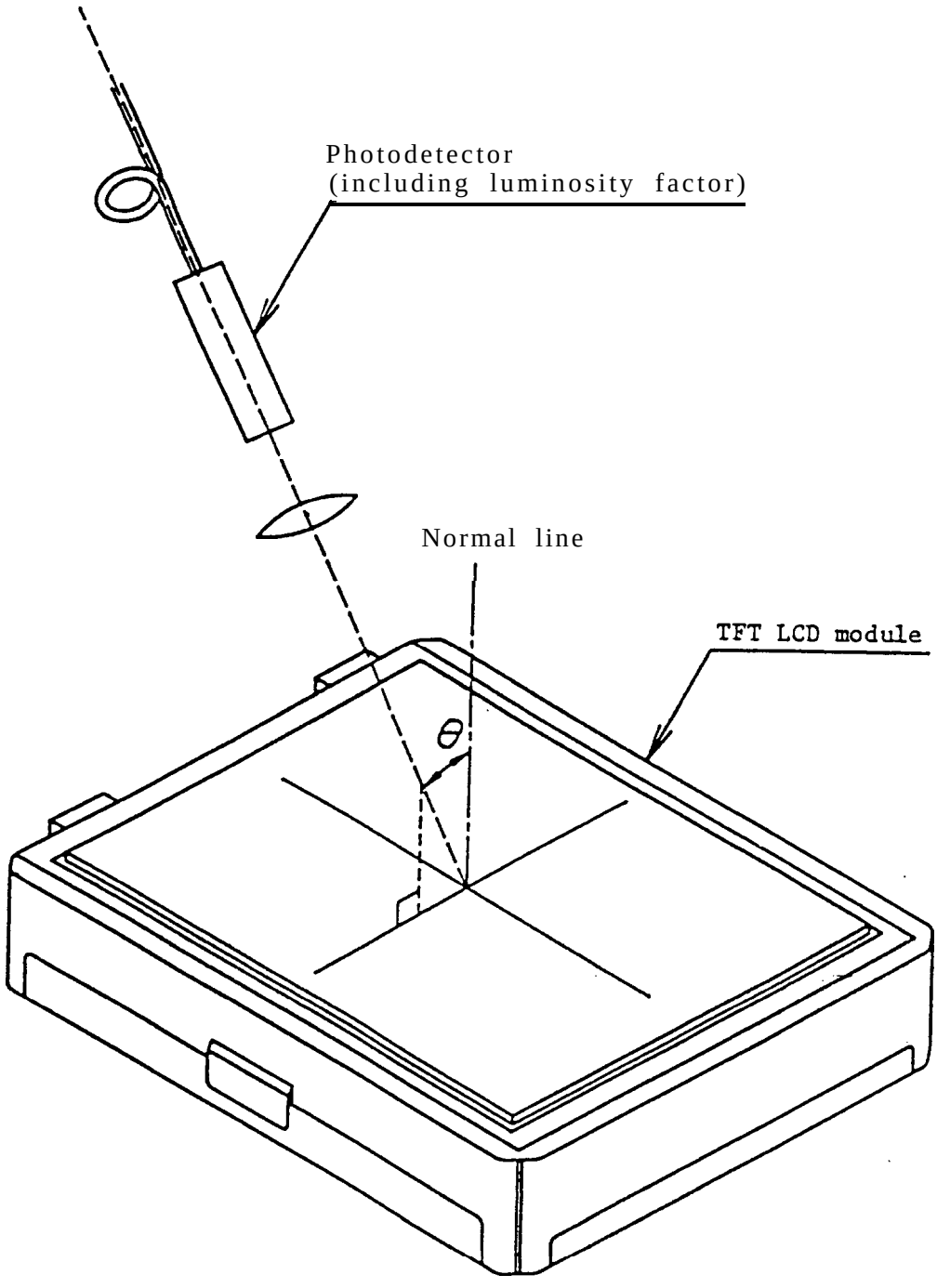


Fig. 8 Optical characteristics measuring method

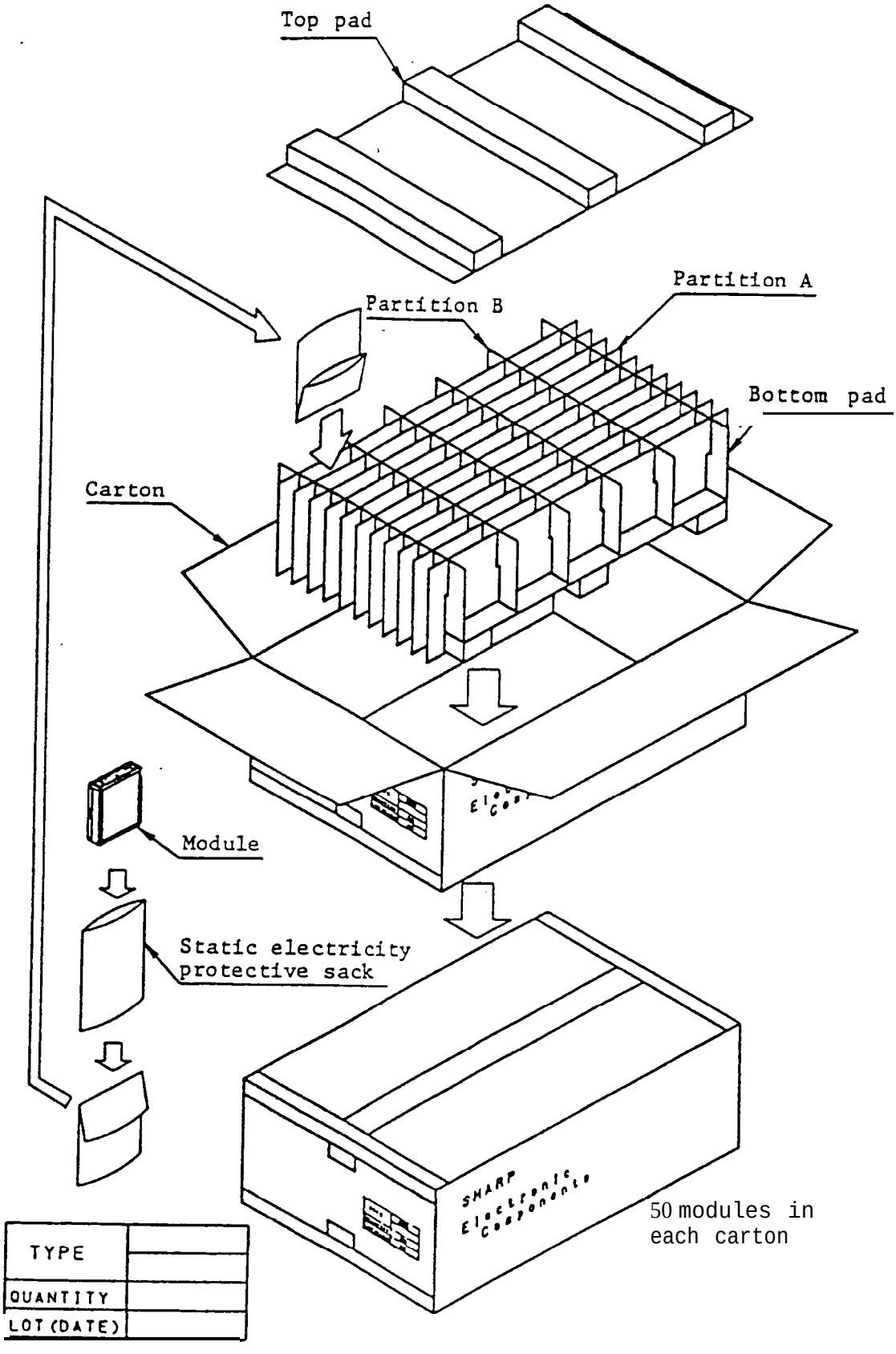


Fig. 9 Packing form

(Appendix-1)

《 Construction of TFT-LCD module 》

TFT-LCD module is composed of an LCD panel, driver ICS for the LCD panel, a control circuit for the driver ICs, a video signal processing circuit (video interface circuit) peculiar to LCD, and a backlight.

The driver ICs are divided into two types: a source driver (data driver) which receives R•G•B signals and sends them sequentially by one horizontal line of the LCD panel, and a gate driver (scan driver) which scans 240 gate lines of the LCD panel.

The circuit diagram is shown in Fig.4.

The module displays an image on LCD panel as it receives power supplies (V_{SH},V_{SL}), composite video signal, R•G•B video signals, DC bias voltage of common electrode driving signal (V_{CDC}), selection signal of composite and R•G•B video signals (VSW), brightness adjusting DC voltage (BRT), color gain adjusting DC voltage (CDL), tint adjusting DC voltage (TIN), and contrast adjusting DC voltage (CNT),from the exterior.

The composite video signal is subject to synchronous separation in the module and used to write a video signal accurately on each pixel on the module.

The control circuit receives composite synchronizing signal separated in the video interface circuit, generates clock pulses synchronized with the composite synchronizing signal and gate and source drivers-driving signals, and outputs internal horizontal synchronizing signal ($\overline{HSY}$), internal vertical synchronizing signal ($\overline{VSY}$) and polarity inversion signal (FRP).

The voltage level of R•G•B video signals applied to the liquid crystal layer of each pixel through the source driver IC and TFT is about 3.7 Vp–p from black to white level. In order to prevent the electro-chemical decomposition of the liquid crystal, it is necessary to apply AC voltage to the liquid crystal.
For this purpose, the polarity of the video signals must be alternated.
Since the amplification and polarity inversion of the video signals are performed in the video interface circuit in the module using the polarity inversion signal (FRP), composite video signal of 1.0 Vp-p or standard analog R•G•B signals of 0.7 Vp-p may be used for both of the inputs to the module."

Power supplies to this module are ① 5 V (V_{SH}), ② O V (GND), and ③ -8 V (V_{SL}). Control IC operates on O to 5 V line so that it outputs $\overline{HSY}$ and $\overline{VSY}$ at O to 5 V level. Power supplies to the video interface circuit are V_{SH} and V_{SL}.

VSW is used to select composite or R•G•B video signals.

VSW selects composite video signal when it is “High” or open, and selects R•G•B signals when it is “Low”,

BRT, COL, TIN, CNT, and V_{cpc} are adjusted to the optimum value on shipping,

The module contains backlight (hot cathode fluorescent tubes) but not a driving circuit for the backlight. Therefore, it is necessary to install a DC/AC inverter for driving the fluorescent tubes.

Standard DC/AC inverter (Model name: LQOJ06) is available as an option.

In addition, the backlight of the module is designed to be replaceable, and backlight unit (Model name: LQ0B01) is available as a service part for the replacement.

(Appendix-2)

《 Example of TFT-LCD TV 》

Fig.A shows a block diagram example of the TFT-LCD module applied to a TV set.
The block enclosed by [ ] is the TFT-LCD module.
Other signal processing systems are the same as those in ordinary CRT-TVS.

The following seven signals must be supplied to this module from the exterior:

① Composite video signal: VBS
② Standard analog R•G•B video signals
③ Signal for selecting input video signals: VSW
④ DC bias voltage of common electrode driving signal: V_{CDC}
⑤ Brightness adjusting DC voltage: BRT
⑥ Color gain adjusting DC voltage: COL
⑦ Tint adjusting DC voltage: TIN

The following two signals are output from this module to the exterior.

① Internal horizontal synchronizing signal: $\overline{HSY}$
② Internal vertical synchronizing signal: VSY

When this module is applied to a TV set, for example, HSY and VSY are used to display selected channel number and characters on the screen.

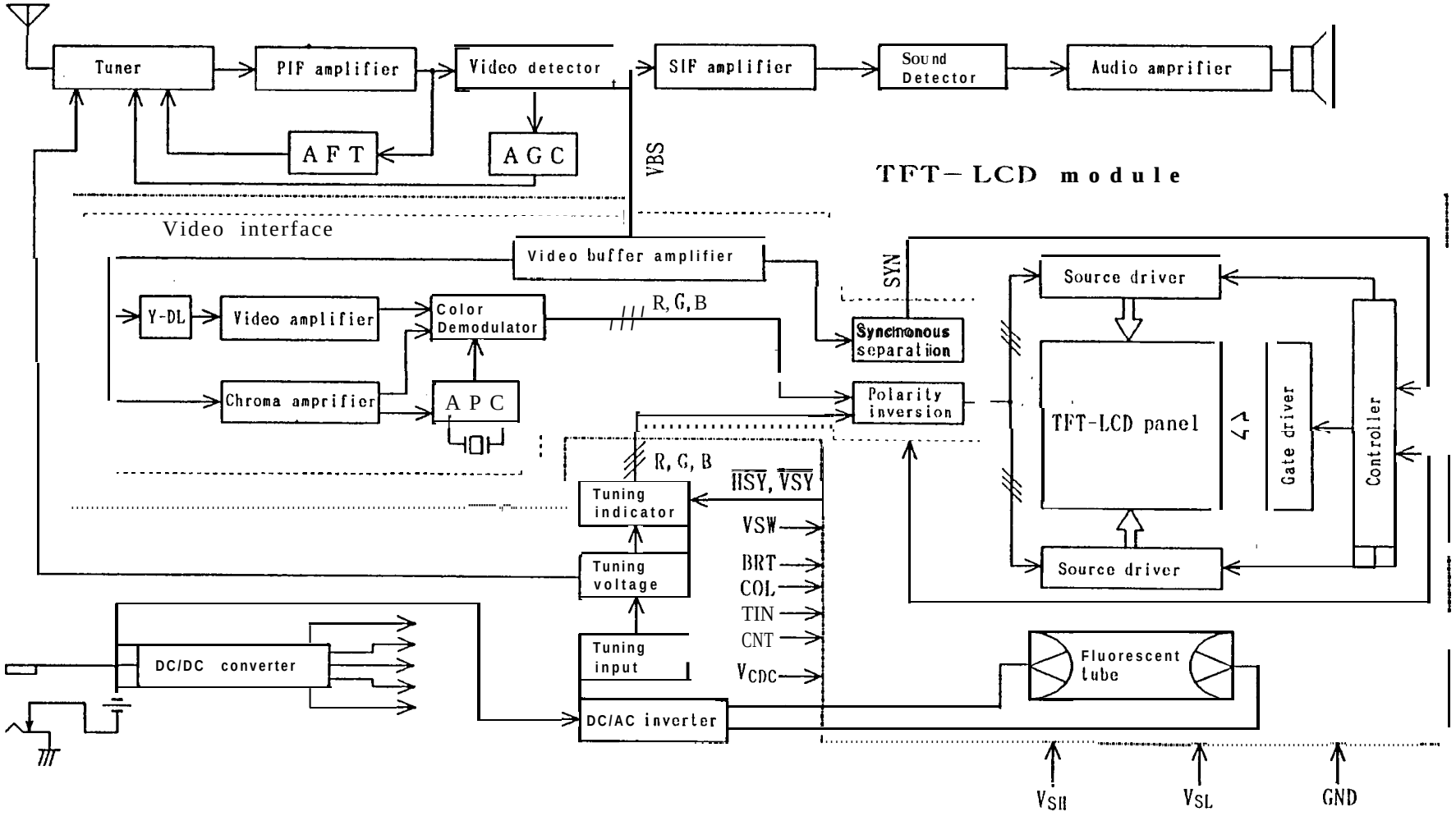


Fig. A B ock diagram of TFT-LCD TV set

(Appendix-3)

Adjusting method of optimum common electrode DC bias voltage

To obtain optimum DC bias voltage of common electrode driving signal (V_{CDC}), photo-electric devices are very effective, and the accuracy is within 0.IV. (In visual examination method, the accuracy is about 0.5V because of the difference among individuals.),

To gain optimum common electrode DC bias voltage, there are two methods which use photo-electric devices. The value of optimum DC bias voltage is the same in both methods.

① Measurement of flicker

DC bias voltage is adjusted so as to minimize 60Hz(30Hz) flicker.

② Measurement of contrast

DC bias voltage is adjusted so as to minimize the photo-electric output voltage.

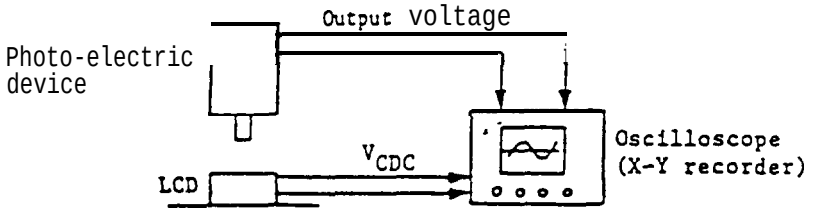


Fig. B Measurement system

(1) Measurement of flicker

Photo-electric output voltage is measured by an oscilloscope at, a system shown in Fig.B.

- DC bias voltage must be adjusted so as to minimize the 60Hz(30Hz) flicker with DC bias voltage changing slowly. (Fig,C)

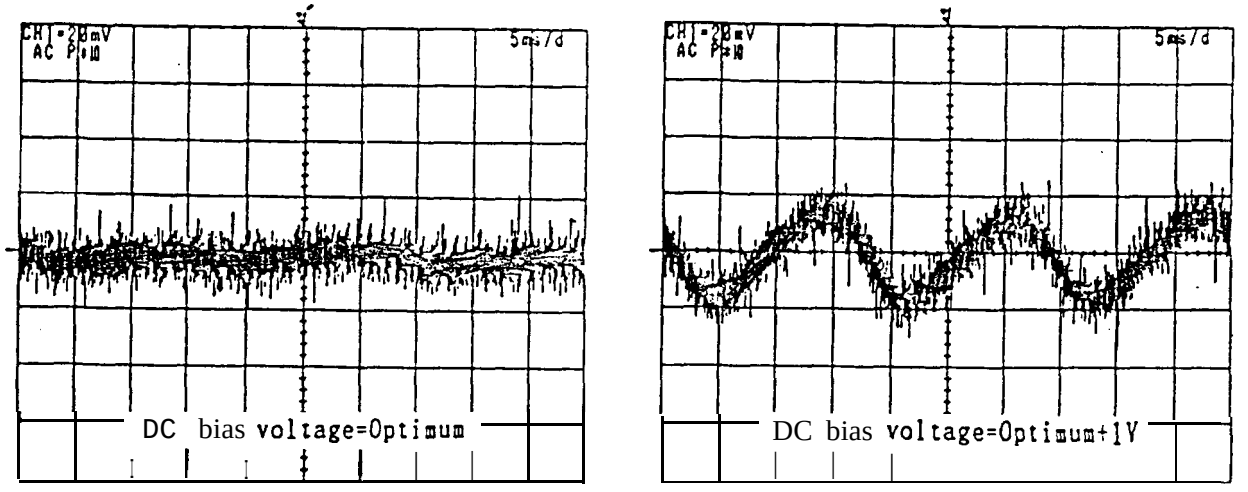


Fig.C Waveforms of flicker

(2) Measurement of contrast

Photo-electric output voltage is measured by oscilloscope or X-Y recorder by using the system in Fig.A. Common electrode DC bias voltage must be adjusted so as to minimize the photo-electric output voltage with DC bias voltage changing slowly. (Fig.D)

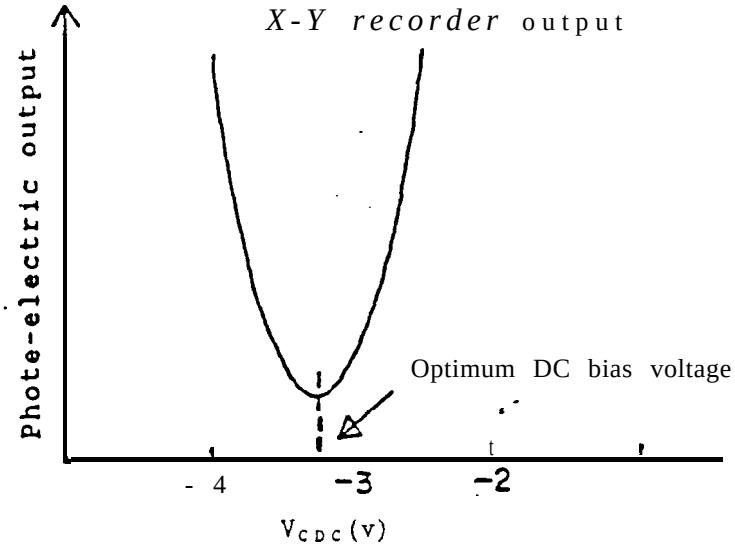


Fig.D Optimum common electrode DC bias voltage by measurement of contrast

(3) Notes

① Measurement is more accurate at half tone as compared with other gradation level.
(Change of photo-electric output is small at black level.) see Fig.E.

② DC bias voltage must be adjusted slowly. The value of optimum common electrode DC bias voltage changing fast is different from that with changing slowly.
Because DC response is slow. see Fig.F.

③ The final adjustment of DC bias voltage must be made by changing from positive to negative.

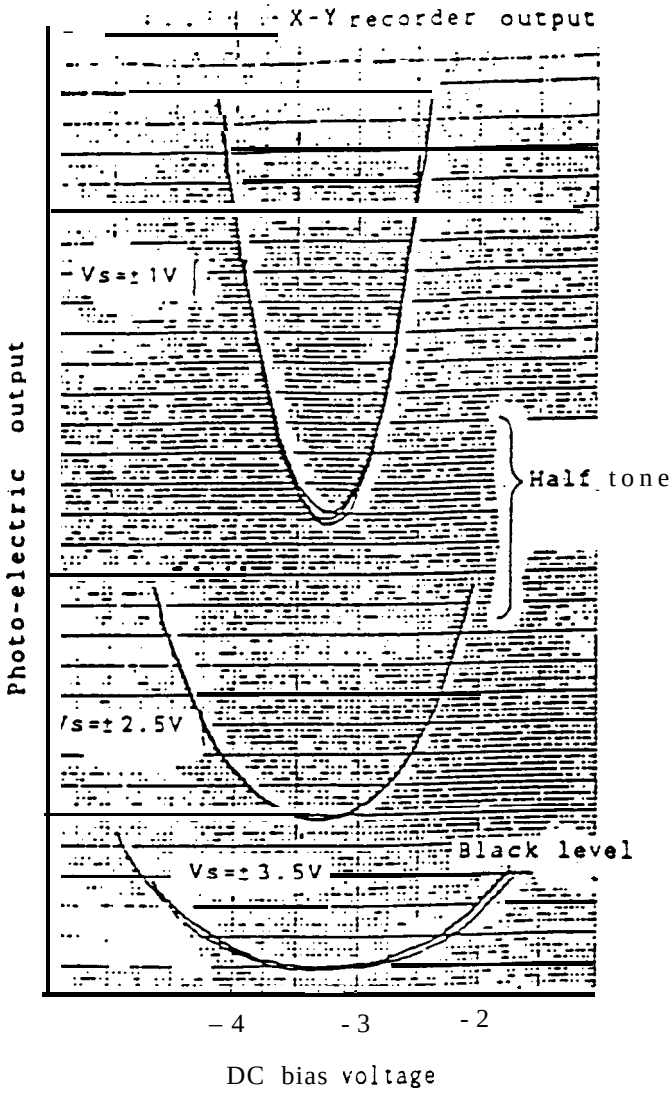


Fig. E Relation between gradation level and DC bias voltage

Optimum common electrode DC bias voltage is almost equal between half tone and black level,
But it is difficult to deside the optimum point at black level.

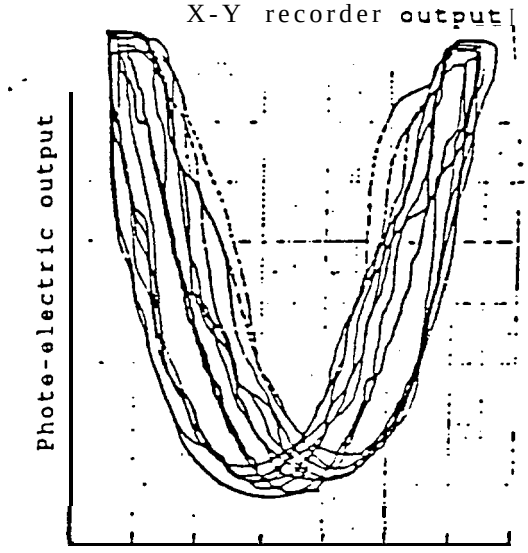


Fig.F Output voltage with DC bias voltage changing fast

The value of minimum point is not definite because DC response is slow. And optimum point cannot be attained.