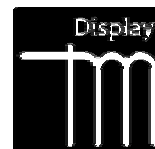


To: HYUNDAI MOBIS Corporation



APPROVAL SIGNATURE

SPECIFICATION(DRAFT)

FOR

TOSHIBA MATSUSHITA DISPLAY TECHNOLOGY

TFT-LCD MODULE

TFD65W50C

SPECIFICATION No. : _____
TFD65W50C-01

DATE OF ISSUE : 2005-05-10

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Revision History

Date	Sheet (New)	Item	Old	New	Reason

Caution and Handling Precaution

For your end user's safety, it is strongly advised that the items with "*" should be included in the instruction manual of the system which may be issued by your organization.

Toshiba Matsushita Display Technology always endeavor to maintain sufficient quality of the LCD module in process of designing and manufacturing, however, to avoid causing extended damages such as Accidents resulting injury or death, fire accidents, or social damages if the LCD module fails, please adopt safe design as a whole set, by adopting redundant design, taking measure in set design to prevent fire-spreading, over-current, or incorrect operation, etc..

For Safety

Warning

- (1) Toshiba Matsushita Display Technology's Standard LCD modules have not been customized for operation in extreme environments or for use in applications where performance failures could be life-threatening or otherwise catastrophic.

Since they must never be installed in aircraft navigation control systems (such as, but not limited to Traffic Collision System and Air Traffic Indicator), in military defense or weapons systems, in critical industrial process-control systems (e.g., those involved in the production of nuclear energy), or in critical medical device or patient life-support systems.

- (2) DISCONNECT POWER SUPPLY before handling LCD module.

DO NOT TOUCH the parts inside LCD module and the fluorescent lamp's (hereinafter called "FL") connector or cable in order to prevent electric shock, because high voltage is supplied to these parts from the inverter unit while power supply is turned on.

- (3) Make sure to insert the module FL connector to the inverter connector in correct position. If incorrect, this may cause smoke or burn of electrical parts by high voltage of FL circuit. If there is a possibility that the connector has been inserted incorrectly, please re-insert the connector only after you confirm the module and FL power is completely off.

DO NOT USE the mating FL connector which Toshiba Matsushita Display Technology does not specify. Otherwise, Toshiba Matsushita Display Technology shall not be liable for any damages caused by the connector.

Caution

- (1) DO NOT DISASSEMBLE OR MODIFY the module.

Sensitive parts inside LCD module may be damaged, and dusts or scratches may mar the displays. Toshiba Matsushita Display Technology does not warrant the module, if customer disassembled or modified them.

- * (2) DO NOT INGEST liquid crystal material, DO NOT INHALE this material, and DO NOT PERMIT this material to contact the skin, if glass of LCD panel is broken and liquid crystal material spills out. If liquid crystal material contacts the skin, mouth or clothing, take the following actions immediately. In case contact to the eye or mouth, rise with large amount of running water for more than 15 minutes. In case contact to the skin or clothing, wipe it off immediately and wash with soap and large amount of running water for more than 15 minutes. The skin or closing may be damaged if liquid crystal material left adhered. In case ingestion, rise out the mouth well with water. After spewing up by drinking large amount of water, get medical.
- * (3) BE CAREFUL WITH CHIPS OF GLASS that may cause injuring fingers or skin, when the glass is broken. Since FL is also made of glass, when FL is built in, handle with due cations as well.
- (4) DO NOT EXCEED the absolute maximum rating values under the worst probable conditions caused by the supply voltage variation, input voltage variation, variation in parts constants, ambient- temperature, etc., otherwise LCD module may be damaged.
- (5) RECOMMENDED OPERATING CONDITIONS
Don't exceed the recommended operation conditions in this specification. (The LCD module should be used within the recommended operation conditions when use it in a room temeperature.)
We Toshiba Matsushita Display Technology don't confirm the performance and quality of the LCD over it, although within the absolute maximum rating. Please don't exceed the recommended operation conditions when use it in a room temperature.
To use the LCD module over "the recommended operation conditions" may have bad influence on the characteristics and reliability of the LCD module and may shorten the life of the LCD module.
Therefore, when designing the whole set, not to be over "the recommended operation conditions", you should fully take care of supply voltage change, characteristic of connection parts, serge of input-and-output line , and surrounding temperature.
- (6) Suitable protection circuit should be applied for each system design.
A fuse is not fitted to this module. Therefore, without a suitable power-supply protection device, dust or partial circuit failure may cause overheating and/or burning , which may lead to injury.
- (7) Be sure that power supply output from the system should be limited to smaller values than listed shown below.
It is because this LCD module explained in this specification has a current limiter, with such function at power input lines. But it may be some possibility of overheat and/or burning of LCD module and its peripheral devices before current limiter of the module when open-short test of the module is performed by using power supply higher than following recommended value.

Power supply	Recommended maximum output current of power supply
V_{DD1}	$\leq 0.5A$
V_{DD2}	$\leq 1.0A$
V_{GH}	$\leq 0.5A$
V_{GL}	$\leq 0.5A$

- (8) Always comply all applicable environmental regulations, when disposing of LCD module.

(9) EDGES OF PARTS

Be careful with handling the metal frame (bezel) of a module. Even though burr disposal treatment is performed, it may cause injuring. Be careful with edges of glass parts and touch panel identically. For designing the system, give special consideration that the wiring and parts do not touch those edges.

***(10) LUMINANCE DECREASE OF FL**

When FL becomes extremely dark and its color changes from white to pink, stop the use of the module immediately. FL, at the end of its life with its discharge color turns into pink as the characteristics of FL, may adversely affect the module at the end part of FL due to temperature raising caused by depletion of the mercury which is contained in FL tube, or may have a possibility of breakage.

For Designing the System**DESIGNING ENCLOSURE**

(1) LCD module should be assembled to the system by using all mounting holes specified in the this specification and with the specified screws.

(2) GASES FROM SETTING MATERIAL

Some plastic materials and shock absorbing materials (rubber) used in the system may generate gases that may cause the deterioration of the polarizer laminated on LCD's panel or internal parts of the module. Prior confirmation is required.

(3) GASES FROM PACKAGING MATERIAL

Some materials used for packaging (for which sulfuric acid is used in the recycling process) generate gases that may cause the deterioration of the polarizer laminated on LCD's panel or internal parts of the module. Prior confirmation is required.

DESIGNING POWER SUPPLIES AND INPUT SIGNALS TO LCD MODULE

(4) Power supply lines should be designed as follows.

Power supplies should always be turned on before the input signals are supplied to LCD module, and the input signals should be disconnected before power supplies are turned off.

(5) Make sure to connect correctly high-voltage wire and low-voltage wire between FL tube and inverter unit. If high-voltage wire and low-voltage wire are connected incorrectly it may cause insufficient brightness or unstable operation of FL, and smoke or burn of the parts.

DESIGNING FOR BETTER VISIBILITY

(6) Input FL starting voltage should be longer than two seconds. If it were not, it may cause unstable operation of FL. Inverter should be design to stop output when the inverter is no-load to FL tubes (due to breakage of FL, etc.) to prevent high-voltage generation.

When high voltage is applied to FL continuously without normal operation of FL (due to output leakage within FL wiring circuit, etc.) it may cause smoke or burn. To prevent excess current design the inverter with a protection circuit such as a current limiter (excess current detection) to stop inverter output.

(7) In case of severe environmental condition like outdoor usage, a proper transparent protective cover over LCD module is recommended to apply in order to prevent scratches, and invasion of dusts, water, etc., from the system's window onto LCD module.

Ultra-violet ray cut filter is recommended to apply onto LCD module for outdoor operation. Strong ultra-violet ray may cause damage the panel. However, in that case, transmittance-luminance will decrease. Careful selection of material is required.

For Installation in Assembly

ESD(ELECTRO-STATIC DISCHARGE)PREVENTION

- (1) The C-MOS LSIs used in LCD module are very sensitive to ESD (electro-static Discharge). Ambient humidity of working area is recommended to be higher than 50%RH.

Person handling LCD modules should be grounded with wrist band. Tools like soldering iron and screw driver, and working benches should be grounded.

The grounding should be done through a resistor of 0.5-1M ohms in order to prevent spark of ESD.

- (2) When remove protection film from LCD panel, peel off the film slowly (more than three seconds) from the edge of the panel, using a soft-pointed tweezers covered by teflon or adherent tape.

DUST AND STAIN PREVENTION

- (3) Reduce dust level in working area. Especially the level of metal particle should be decreased.

Use finger stalls or soft and dust-free gloves in order to keep clean appearance of LCD module when handled for incoming inspection and assembly.

- *(4) When LCD panel becomes dirty, wipe off the panel surface softly with absorbent cotton or another soft cloth.

If necessary, breathe upon the panel surface and then wipe off immediately and softly again.

If the dirt can not be wiped off, follow the instructions described in individual specification.

Be careful not to spill organic solvents into the inside of LCD module. The solvents may damage driver IC and PCB area used inside module. The polarizer laminated to LCD panel and adhesives may be damaged by the solvents, so do not use any organic solvents for wiping off LCD panel.

- *(5) AVOID THE DEWING OF WATER CONDENSATION.

Wipe off a spot or spots of water or mist on LCD panel softly with absorbent cotton or another cloth as soon as possible if happened, otherwise discoloration or stain may be caused. If water invade into LCD module, it may cause LCD module damages.

BENDING / TWISTING OF LCD MODULE DURING ASSEMBLY

- *(6) DO NOT APPLY MECHANICAL FORCES.

Do not bend or twist LCD module even momentary when LCD module is installed an enclosure of the system. Bending or twisting LCD module may cause its damages. Make sure to design the enclosure that bending/twisting forces are not applied to LCD module when it is installed in the system.

Refrain from strong mechanical shock like dropping from the working bench or knocking against hard object. These may cause the panel crack, damage of FL or other mis-operation.

- (7) INTERFACE / FL CABLES

Do not fasten screws, with catching interface cables or FL cables between LCD module and the enclosure.

This may cause bending of LCD module, or become the cause of a failure by damaging cables.

MECHANICAL FORCES

- *(8) Refrain from excessive force like pushing the surface of LCD panel. This may cause scratches or breakage of the panel, or a failure of the module.

- *(9) Do not put heavy object such as tools, books, etc., and do not pile up LCD modules.

Be careful not to touch surface of the polarizer laminated to the panel with any hard and sharp object. The polarizer is so soft that it can be easily scratched, even the protect film covers it.

- (10) When inserting or disconnecting the connectors to LCD module, be sure not to apply force against PCB, not connecting cables, otherwise internal connection of PCB and TAB drivers may be damages.
Do not fasten screws with catching interface cables or FL cables between LCD module and the enclosure. These may cause bending of LCD module, or damaging cable insulating cover.
- (11) Be careful not to pull the FL cables in order to avoid mechanical damage in FL lamp and soldering area.
While mounting, do not bind or twist the FL cables, or the Lamp current may not be applied as designed.

OPERATION

- (12) Power supplies should always be turned off in assembling process.
Do not connect or disconnect the power cables and connectors with power applied to LCD module.
This may cause damage of module circuit.
The signal should be applied after power supplies are turned on. And the signal should be removed before power supplies are turned off.

For Transportation and Storage

- (1) Do not store LCD module in high temperature, especially in high humidity for a long time approximately more than one month).
It is recommended to store LCD module where the temperature is in the range of 0 to 35 degrees Celsius and the relative humidity is lower than 70%.
- (2) Low temperature
Liquis crystal material may be coagulates and LCD panel may be damaged at the lower temperature than storage teperaturerange described in individual specification.
- (3) Store LCD module without exposure to direct sunlight or fluorescent lamps in order to prevent the module from strong ultra violet ray.
- * (4) Avoid condensation of water on LCD module, otherwise it may cause mis-operation or defects.
Keep away LCD module from such ambient.
- (5) In case of transportation of storage after opening the original packing. LCD module are recommended to be repacked into the original packaging with the same method, especially with same kind of desiccant.

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1. Scope

This specification(DRAFT) is applicable to Toshiba Matsushita Display Technology's Full Color TFT-LCD module "TFD65W50C" designed for Car Navigation and TV monitor use.

2. Specifications

2.1 General specifications

Items	Specifications	Note
Screen size	16.4cm (6.5-inch) diagonal screen	
Display mode	TN full color, Transmissive type	Normally white
Contents	a-Si TFT active matrix panel(COG) Backlight-unit, Case	
Input signal	Supply	4 Supply voltage(V_{DD1} , V_{DD2} , V_{GH} , V_{GL})
	Sync.	Horizontal/Vertical start puls and clock Negative 5.0Vp-p C-MOS
	Signal	Specified Analog RGB Signals(H-Line inverted)
	Common	H-line alternate signal
Number of pixels	480(W) x 234(H)	Note 1
Number of sub-pixels	1440(W) x 234(H)	Note 1
Pixel pitch	0.3015(W) x 0.3295(H)	[unit:mm]
Pixel arrangement	RGB stripe	Note 1
Dimensional outline	155.54(W) x 89.2(H) x 6.09(D) max.	[unit:mm]
Sampling mode	RGB simultaneous sampling	
Backlight	FL side light(L type 1 lamp)	
Viewing direction	12 o'clock (in direction of maximum CR)	Refer to figure A (Next sheet)
Weight	143 (typ.)	g
Surface treatment	Anti-glare coating on LCD panel surface. wide view film	

Note 1 : Pixel arrangement

	1	2	3	4	5		1437	1438	1439	1440
1	R	G	B	R	G		B	R	G	B
2	R	G	B	R	G		B	R	G	B
233	R	G	B	R	G		B	R	G	B
234	R	G	B	R	G		B	R	G	B

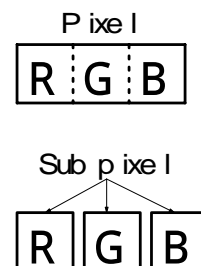
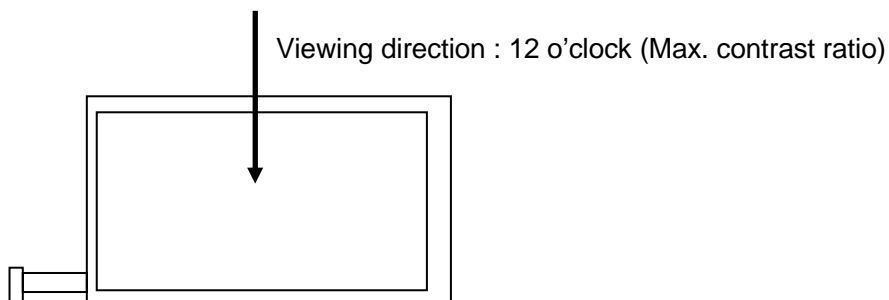


Figure A : Viewing direction



2.2 Absolute maximum ratings

Items		Symbol	Conditions	Absolute maximum ratings		Unit	Remarks
				Min.	Max.		
Supply Voltage		V_{DD1}	$T_a=25 \pm 5^{\circ}\text{C}$	- 0.3	+6.5	V	
		V_{DD2}		- 0.3	+6.5		
		V_{GH}		+15.0	+29.0	V	
		V_{GL}		-17.0	V_{SS}	V	
		$V_{GH}-V_{GL}$		15.0	45.0	V	
Input signal voltage	Video	V_R, V_G, V_B	$V_{SS}=0\text{V}$	$V_{SS}+0.2$	$V_{DD2}-0.3$	V	
	Sync.	STH1, STV1, CPH, CPV		$V_{SS}-0.3$	$V_{DD1}+0.3$	V	
	Common	V_{com}		-10.0	13.0	V	
Input FL current		I_{FL}		—	10	mA	Note 4
Operating temperature		T_{op}	—	-30	85	$^{\circ}\text{C}$	Note 2,3
Storage temperature		T_{stg}	—	-40	85	$^{\circ}\text{C}$	Note 2

Note 1 : Do not exceed the maximum rating values under the worst probable conditions taking into account the supply voltage variation, input voltage variation, variation in part constants, and ambient temperature and so on. Otherwise the module may be damaged.

Note 2 : The temperature on TFT-LCD panel surface.

Note 3 : The temperature of the module rises under the influence of the backlight.

Please design that all parts for this module do not exceed 85°

2.3 Mechanical specifications

2.3.1 Weight : 143 (typ.)

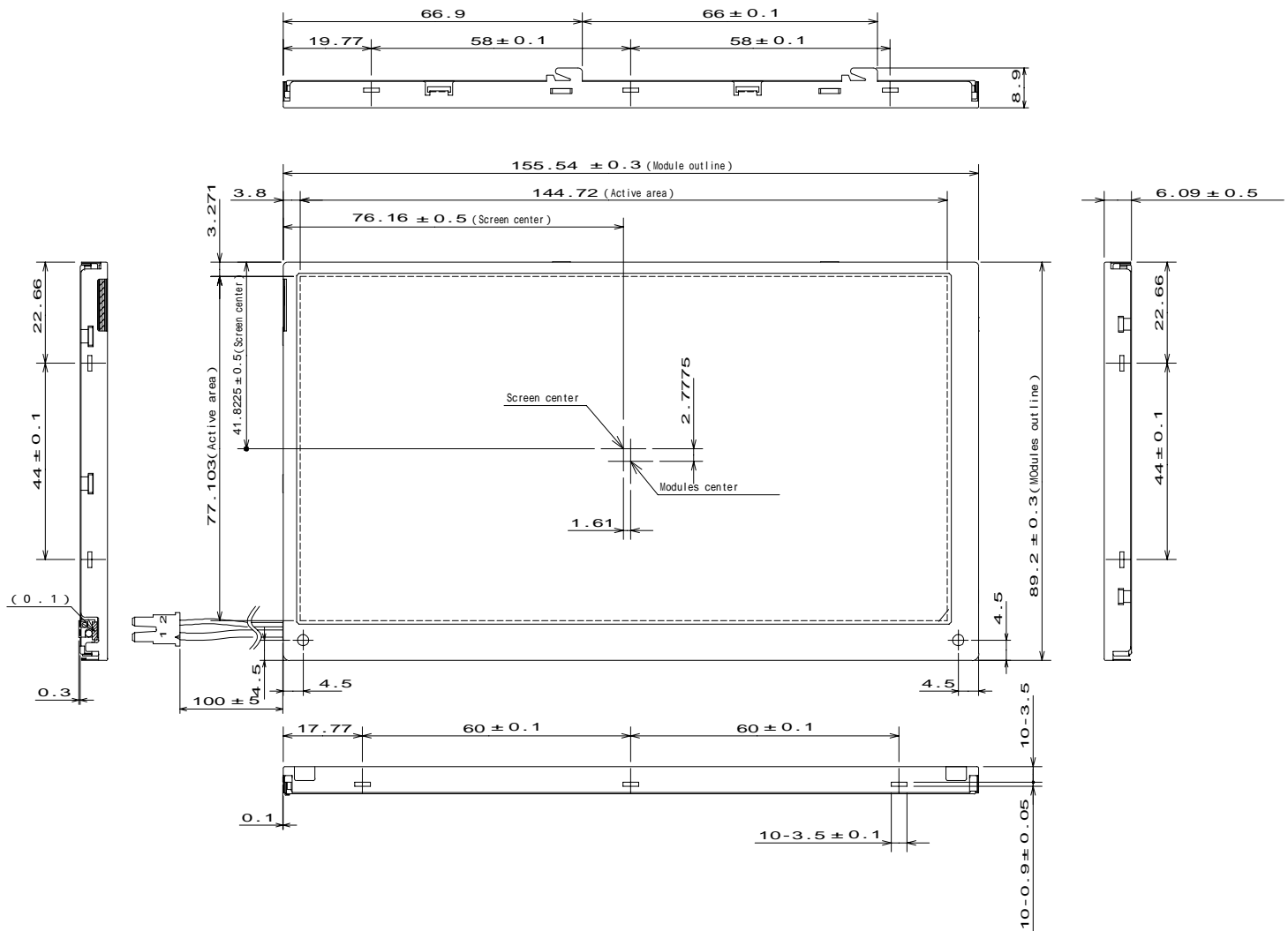
2.3.2 Dimensional outline and label indication

(a) Dimensional outline

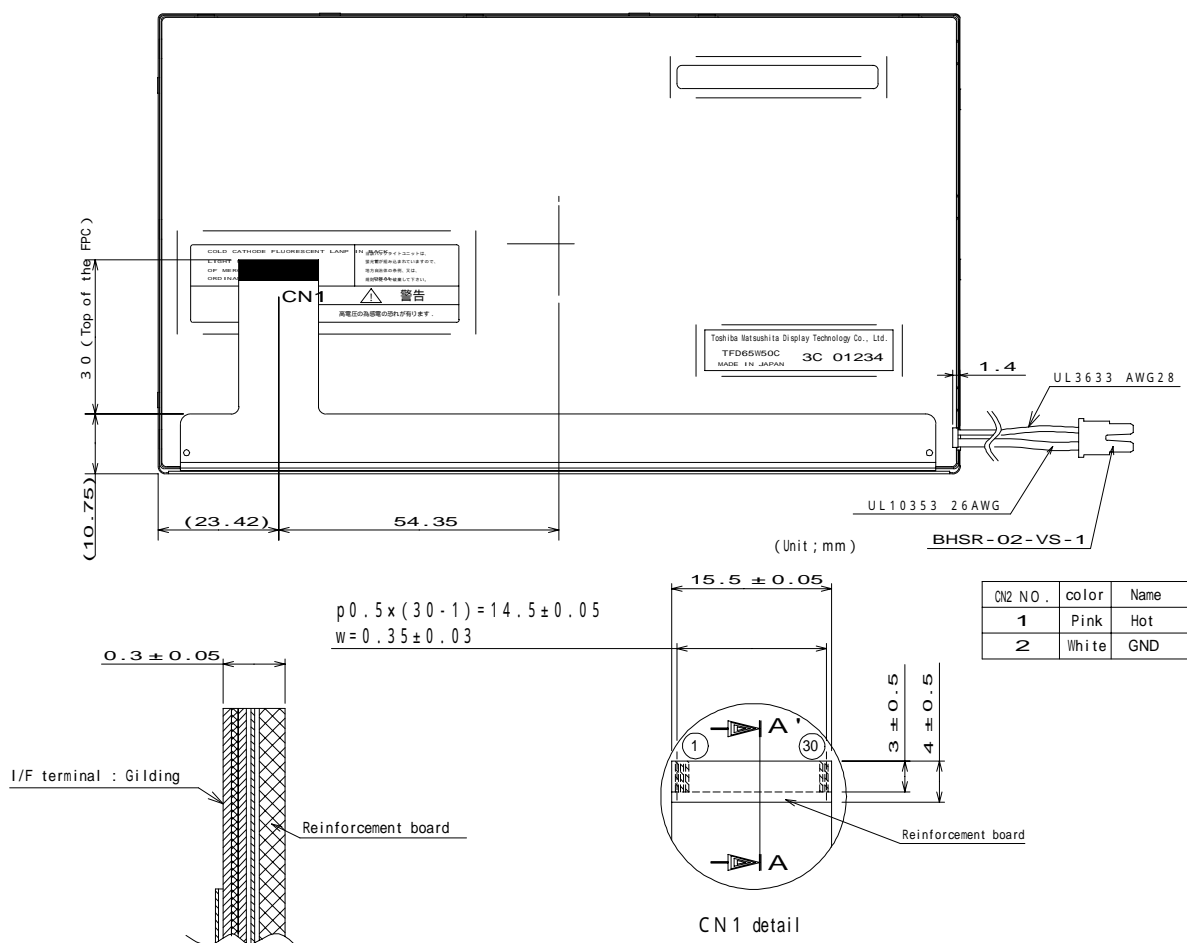
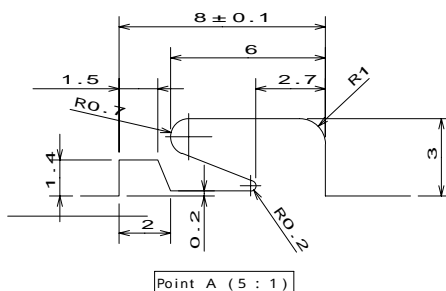
155.54(W) × 89.2(H) × 6.09(D)

Active area

144.72(W) × 77.103(H)



Unit : mm



Unit : mm

(b)Label indications

Items		Contents
(1)	Product number	"TFD65W50C"
(2)	Lot number	Example : "0I01234" Year (0='00), Month (I=september) Serial number (01234)
(3)	Brand name	"Toshiba Matsushita Display Technology"
(4)	Country of origin	"MADE IN JAPAN"
(5)	Caution label	"WARNING" ("High Voltage")

Product Label



Toshiba Matsushita Display Technology Co., Ltd.

TFD65W50C

MADE IN JAPAN

3C 01234

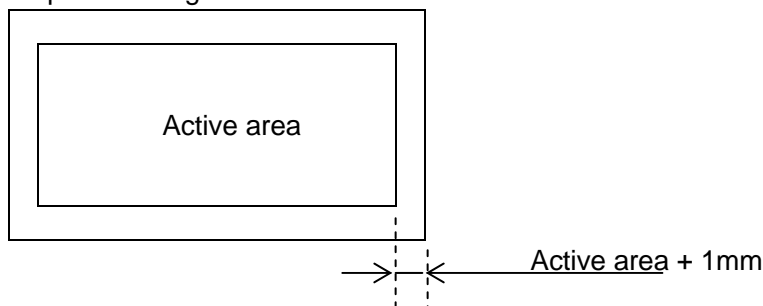
Caution label

COLD CATHODE FLUORESCENT LAMP IN BACK LIGHT UNIT CONTAINS A SMALL AMOUNT OF MERCURY. PLEASE FOLLOW LOCAL ORDINANCES OR REGULATIONS FOR DISPOSAL.		当該バックライトユニットは、 蛍光管が組み込まれていますので、 地方自治体の条例、又は、 規則に従って破棄して下さい。	
			 警告
		高電圧の為感電の恐れがあります。	

2.3.3 Appearance

Inspection parts	Items		Standard		Remarks
Cell	Front side scratch	Line	Line width (mm)	Acceptable count / length	Note 1
			$W < 0.05$	neglect	
			$0.05 \leq W < 0.15$	total length $\leq 50\text{mm}$	
			$0.15 \leq W$	NG	
		Spot	Size (sub pixel)	Judgement	
			$D < 1$	neglect	
			$1 \leq D < 3$	1 dark sub pixel	
			$3 \leq D$	NG	
	Rear side scratch		Same as front scratch standard. (Condition : front view)		
Flaw		Display of the module should be maintained.			
Dirt		No dirt which can not be cleaned easily.			
Discoloration		No conspicuous discoloration.			
Shield case (Black front shield case)	Scratch	Line	Line width (mm)	Acceptable count / length	
			$W < 3.0$	neglect	
			$3.0 \leq W$	total length $\leq 90\text{mm}$	
		Spot	Diameter (mm)	Acceptable count / length	
			$D < \phi 3.0$	$n \leq 3$	
			$\phi 3.0 \leq D$	NG	
	Dirt		No dirt which can not be cleaned easily.		
	Burr		No injurious burrs.		
Interface connector and backlight cable	Scratch		No scratch.		
	Distortion		No distortion.		

Note 1 : Inspection range : Active area + 1mm



2.4 Interface

[CN1] LCD FPC Cable

Mating connector:SFR30-1STE1/Japan FCI

No.	Symbol	Functions	I/O	Remarks
1	NC	No Connect	-	
2	V _{GL}	Power Supply -12.0V	INPUT	Note2
3	NC	No Connect	-	
4	VSS	Ground (0V)	-	
5	STV1	Vertical start pulse 1	INPUT	Note3
6	U/D	Scanning Direction Switch	INPUT	Note3
7	CPV	Vertical clock pulse	INPUT	Note3
8	OE3	Vertical(gate) enable 3	INPUT	Note3
9	OE2	Vertical(gate) enable 2	INPUT	Note3
10	OE1	Vertical(gate) enable 1	INPUT	Note3
11	STV2	Vertical start pulse 2	INPUT	Note3
12	V _{DD1}	Power Supply +3.3V	INPUT	Note2
13	V _{DD2}	Power Supply +5.0V	INPUT	Note2
14	NC	No Connect	-	
15	V _{GH}	Power Supply +18.5V	INPUT	Note2
16	NC	No Connect	-	
17	Vcom	Common Voltage	INPUT	Note3
18	VSS	Ground (0V)	-	
19	VSS	Ground (0V)	-	
20	CPH	Horizontal clock pulse	INPUT	Note3
21	VSS	Ground (0V)	-	
22	CX	Column driver latch channel control	INPUT	Note3
23	L/R	Scanning Direction Switch	INPUT	Note3
24	STH1	Horizontal start pulse 1	INPUT	Note3
25	VSS	Ground (0V)	-	
26	VB	Video Input B	INPUT	Note3
27	VG	Video Input G	INPUT	Note3
28	VR	Video Input R	INPUT	Note3
29	STH2	Horizontal start pulse 2	INPUT	Note3
30	NC	No Connect	-	

[CN2],CCFL SOURCE Connector (BHSR-02VS-1/JAPAN SOLDERLESS TERMINAL MFG CO.,LTD)

No.	Symbol	Functions	I/O	Remarks
1	VFLH	Power Supply for Backlight(HOT)	Input	Note4
2	VFLH	Power Supply for Backlight(GND)	Input	Note4

Mating Connector : SM02B-BHSS-1-TB / JAPAN SOLDERLESS TERMINAL MFG CO.,LTD

Note 1 : Timing controller will be recommended [TC200G02AF-0104 (TOSHIBA)].

Note 2 : Power supply sequence

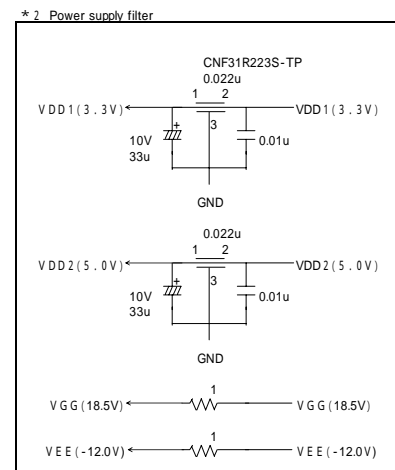
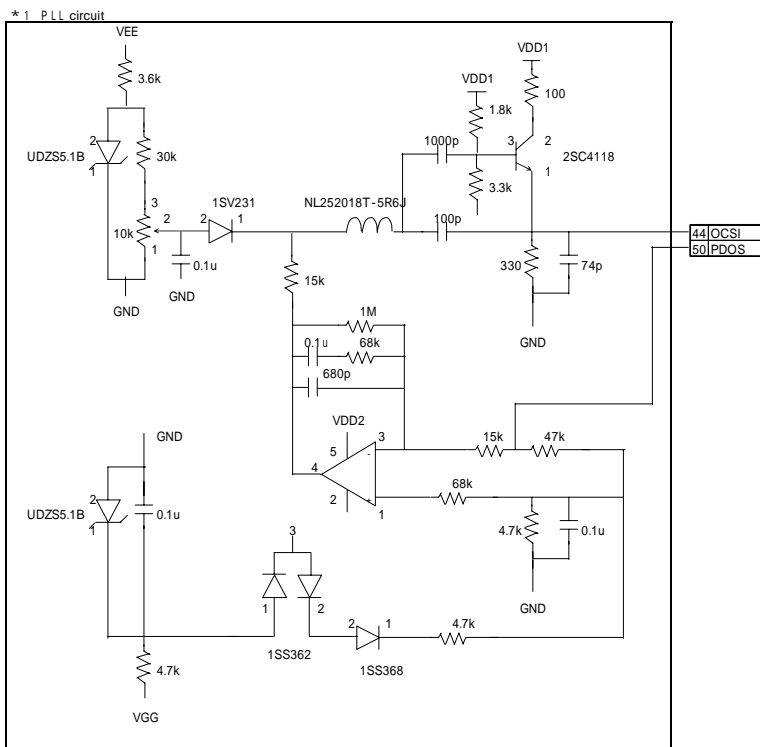
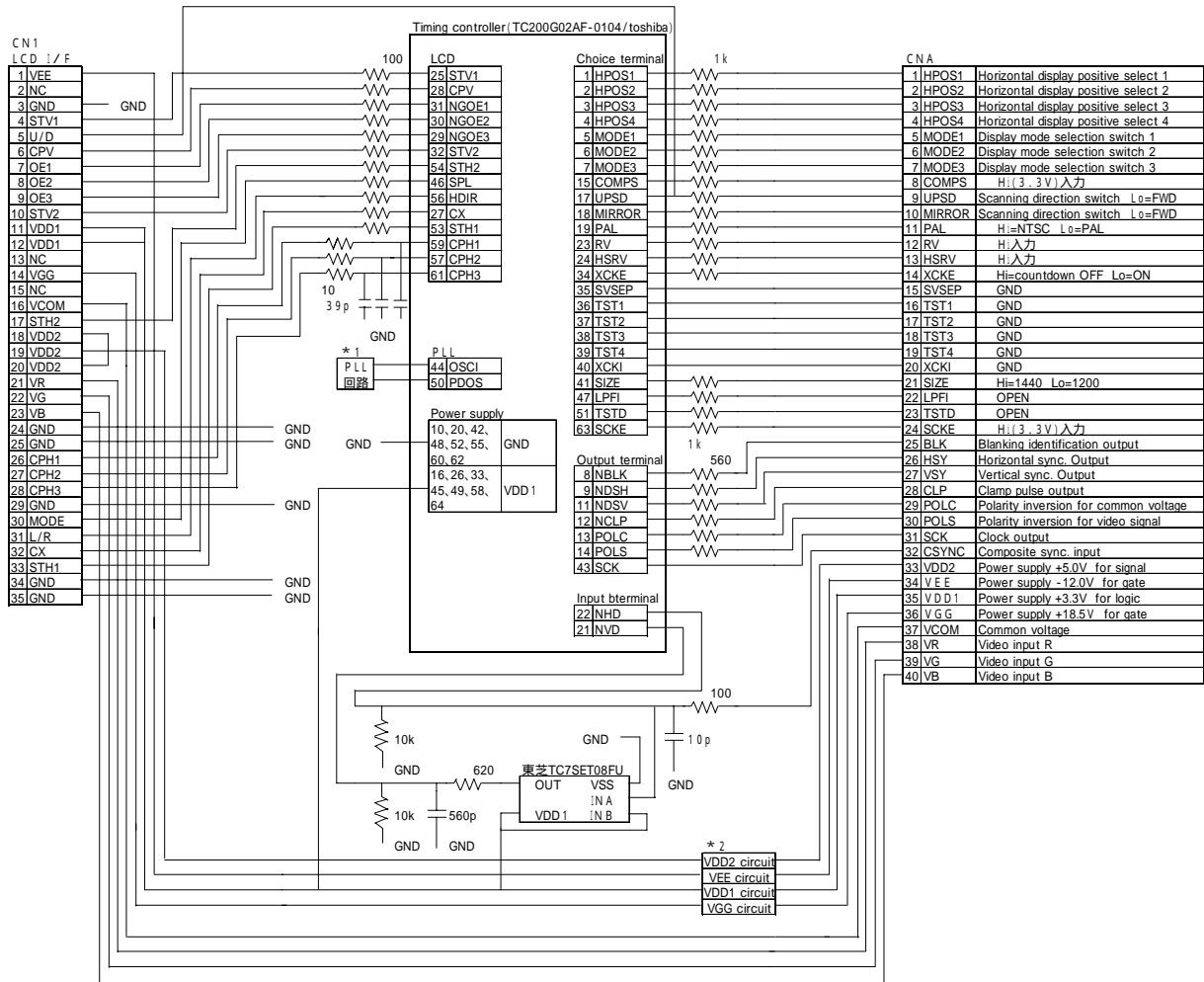
Power ON	V _{DD1}	V _{GL}	V _{DD2}	V _{GH}
Power OFF	V _{GH}	V _{DD2}	V _{GL}	V _{DD1}

Note 3 : Refer to "2.6.2 Indication timing diagram"

Note 4 : Push-pull inverter will be recommended as high voltage (1000) required.

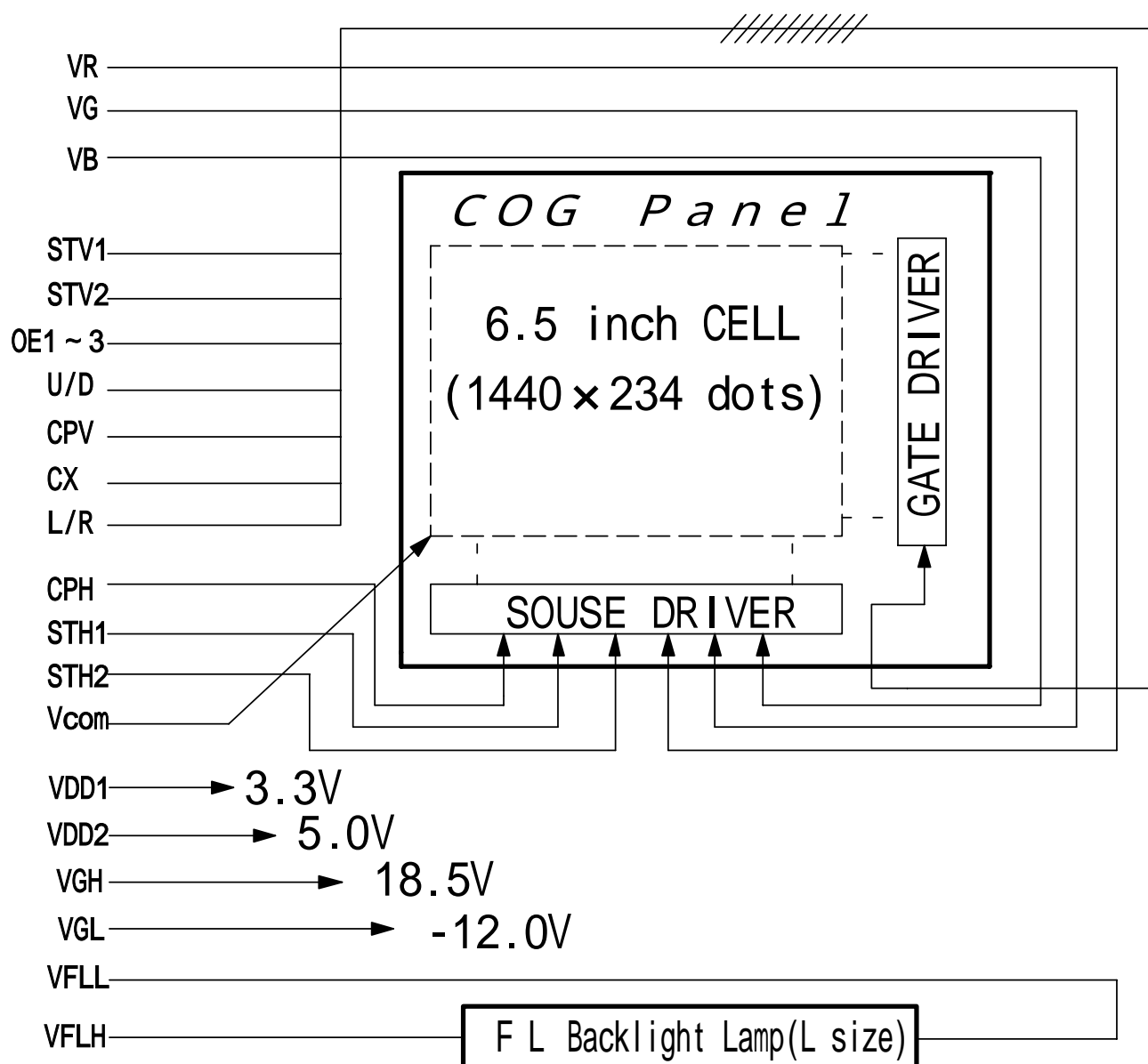
2.5 APPLICATION

Connection between this module and timing controller is recommended as follows:



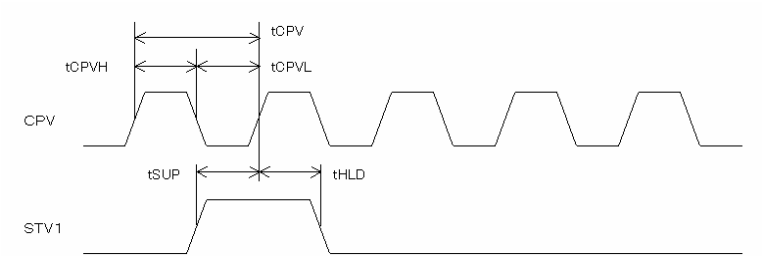
2.6 Electrical specifications

2.6.1 Circuit block diagram



2.6.2 Indication timing diagram

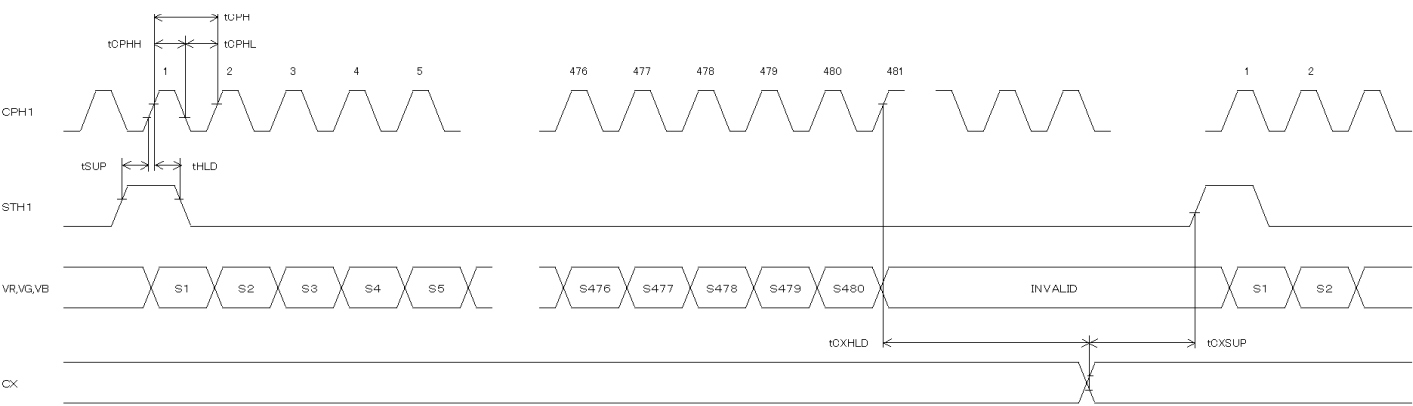
Vertical Timing



Horizontal Timing

RGB simultaneous sampling

Sampling(MODE=Hi)

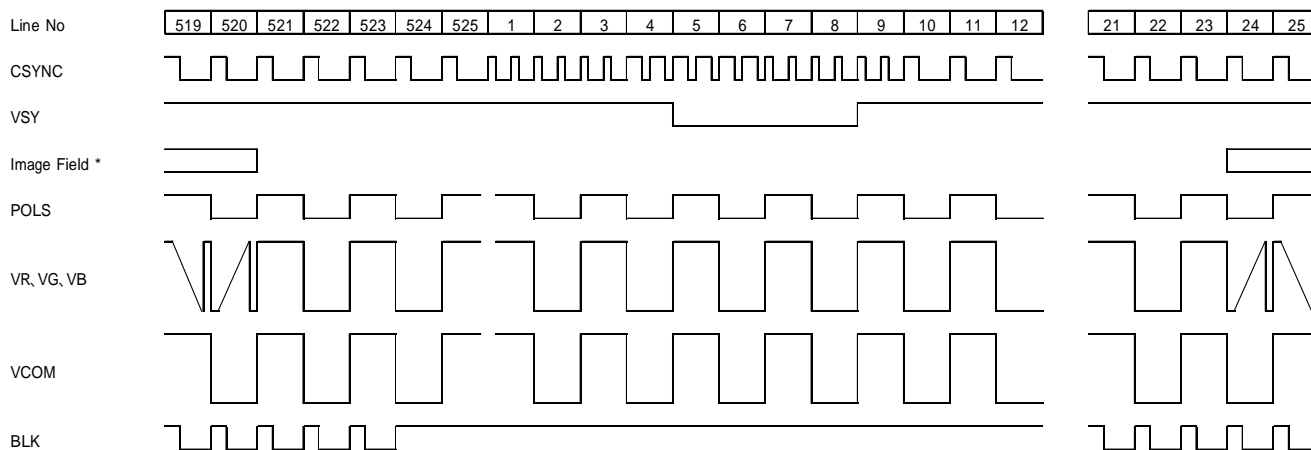


Timing example for use timing controller[TC200G02AF-0104(TOSHIBA)]

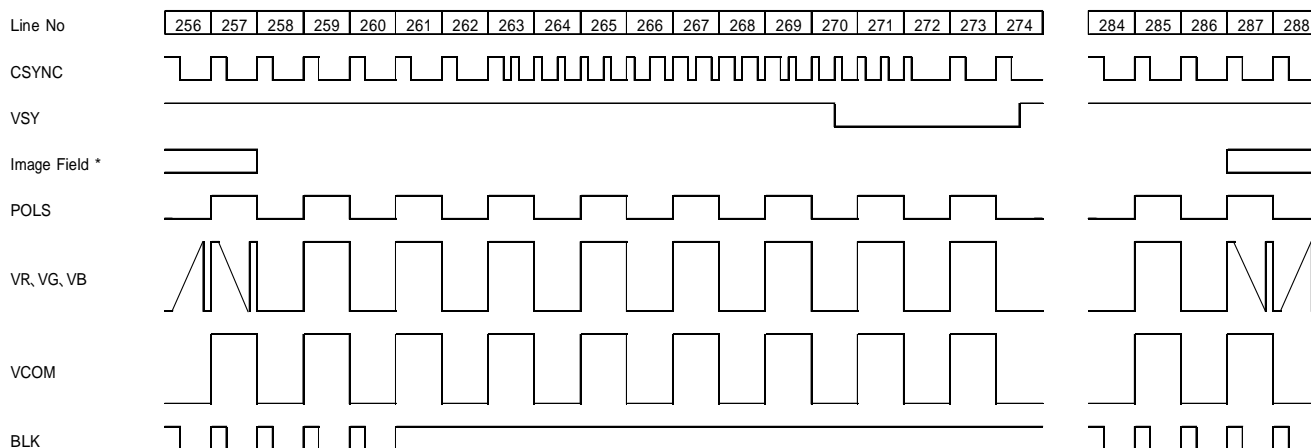
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NTSC

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< EVEN FIELD >



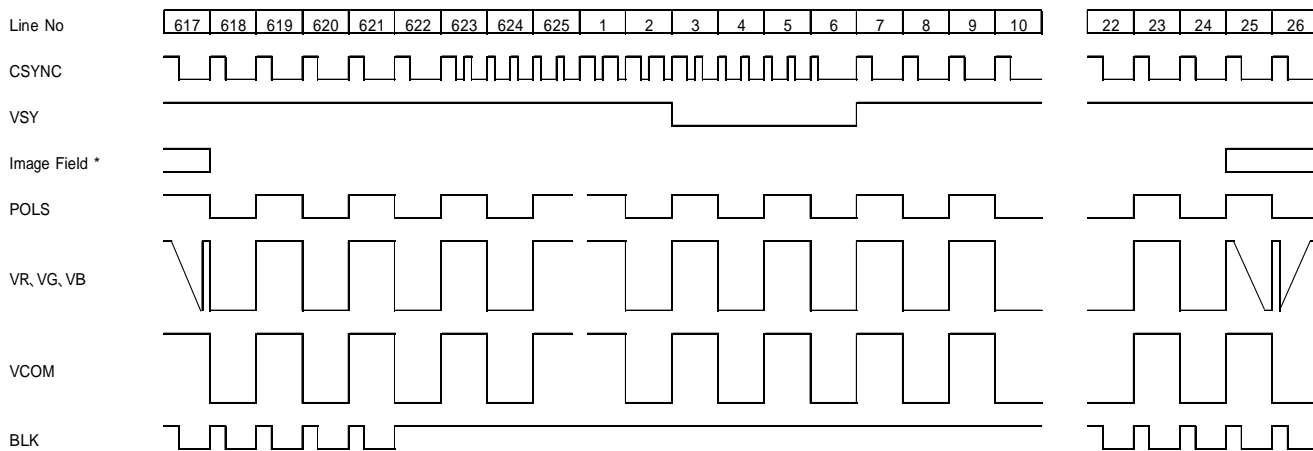
* Display differs by a selection of display mode.(Refer to Right table)
An aforementioned timing chart shows position around FULL-MODE..

Display Mode	Image Field(Line No.)	
	ODD	EVEN
FULL	24 ~ 257	287 ~ 520
NORMAL-CENTER		
NORMAL-LEFT		
NORMAL-RIGHT		
WIDE	53 ~ 228	316 ~ 491
ZOOM1		
ZOOM2		

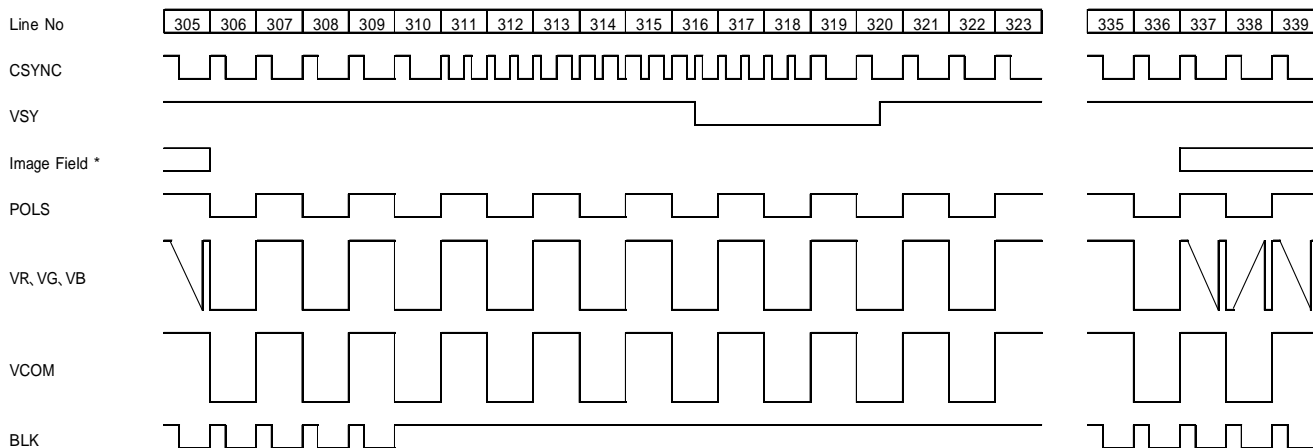
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PAL

< ODD FIELD >



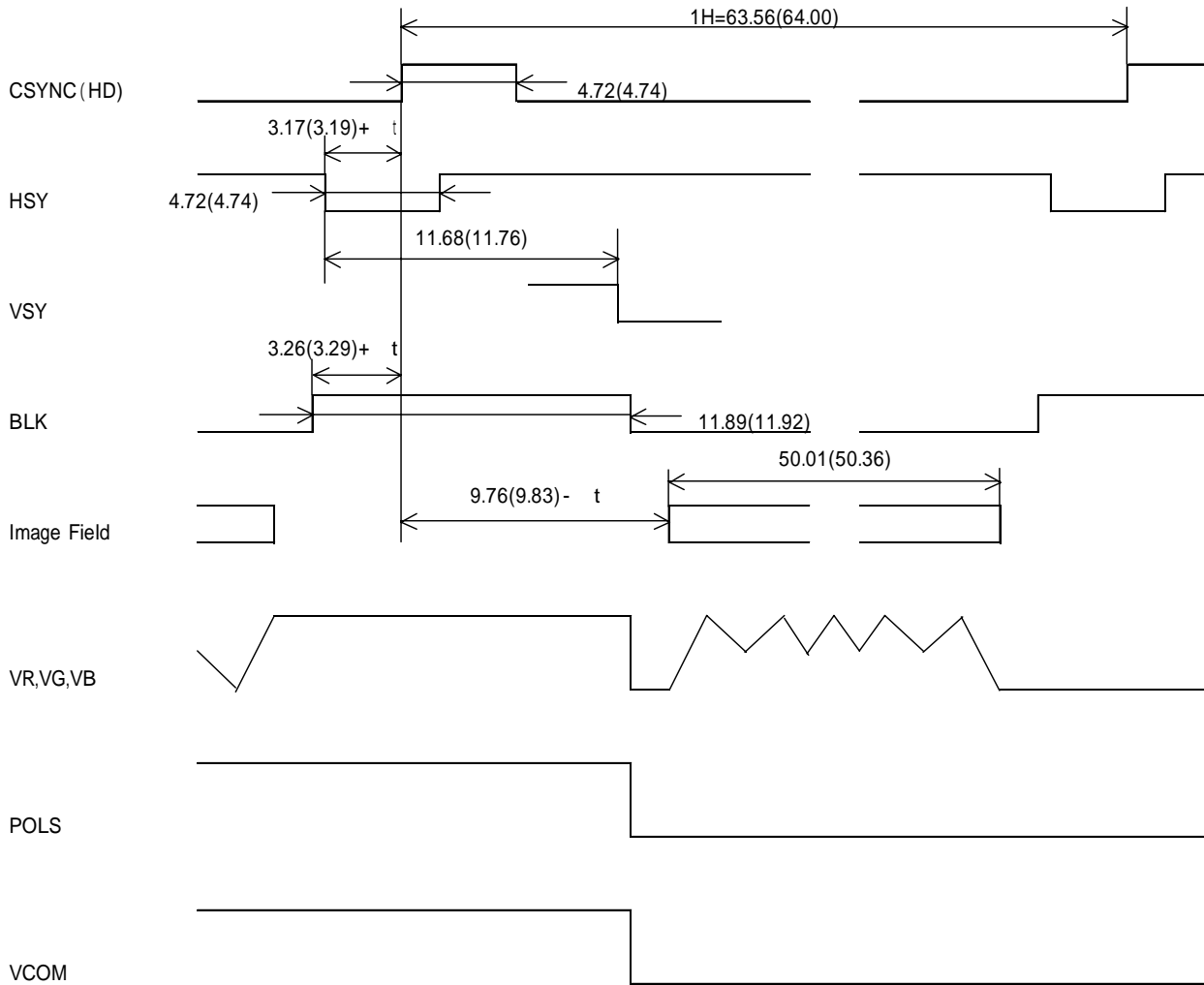
< EVEN FIELD >



* Display differs by a selection of display mode.(Refer to Right table)
An aforementioned timing chart shows display position around FULL MODE..

Display Mode	Image Field(Line No.)	
	ODD	EVEN
FULL		
NORMAL-CENTER		
NORMAL-LEFT	25 ~ 305	337 ~ 617
NORMAL-RIGHT		
WIDE	48 ~ 281	361 ~ 594
ZOOM1	60 ~ 269	373 ~ 582
ZOOM2	48 ~ 281	361 ~ 594

<Horizontal> (NTSC / PAL)

Unit: μs

Note 1: Refer to "2.6 Recommended operating condition".

Note 2: Value in brackets correspond to PAL mode.

Note 3: $f_{HDN} = 15.734\text{kHz}$, $f_{HDP} = 15.625\text{kHz}$ Note 4: $t = 0.208(0.210)\mu s \times n$

pin No.10	HPOS4	pin No.9	HPOS3	pin No.8	HPOS2	pin No.7	HPOS1	n
Hi		Lo		Lo		Lo		+8
Hi		Lo		Lo		Hi		+7
Hi		Lo		Hi		Lo		+6
Hi		Lo		Hi		Hi		+5
Hi		Hi		Lo		Lo		+4
Hi		Hi		Lo		Hi		+3
Hi		Hi		Hi		Lo		+2
Hi		Hi		Hi		Hi		+1
Lo		Lo		Lo		Lo		0
Lo		Lo		Lo		Hi		-1
Lo		Lo		Hi		Lo		-2
Lo		Lo		Hi		Hi		-3
Lo		Hi		Lo		Lo		-4
Lo		Hi		Lo		Hi		-5
Lo		Hi		Hi		Lo		-6
Lo		Hi		Hi		Hi		-7

2.7 Recommended operating conditions

(Ta=25°C,VSS=0V)

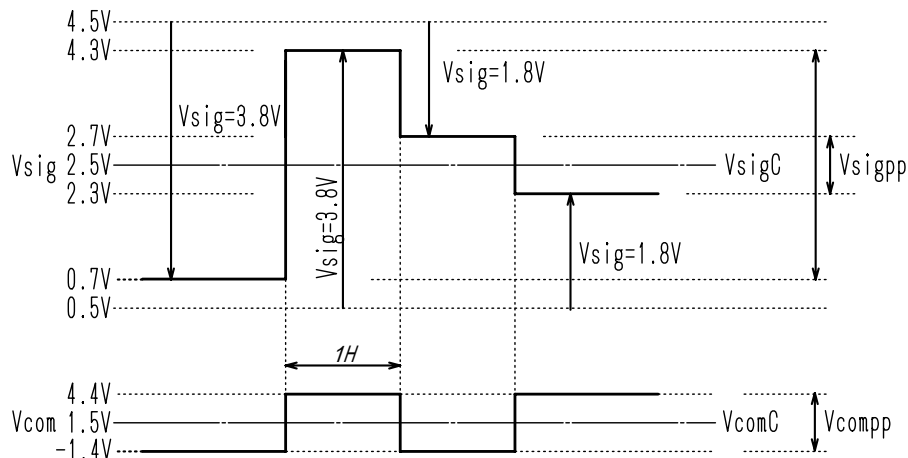
ITEMS	SYMBOL	CONDITONS	SPECIFICATIONS (Note 1)			UNIT	Remarks
			MIN.	TYP.	MAX.		
SUPPLY POWER VOLTAGE	V_{DD1}	3.3V input	+3.00	+3.30	+3.60	V	
		5.0V input	+4.5	+5.0	+5.5		
	V_{DD2}	-	+4.75	+5.00	+5.25		
	V_{GH}		+17.5	+18.5	+19.5		
	V_{GL}		-13.0	-12.0	-11.0		
INPUT VIDEO VOLTAGE	V_{sigC}	-	+2.4	+2.5	+2.6	V	Note 2
	V_{sigpp}	$V_{sigC}=2.5V$	3.7	4.0	4.3	V(p-p)	
COMMON SIGNAL AMPLITUDE	V_{comC}	-	-	(+1.8)	-	V	
	V_{compP}	-	5.5	5.8	7.0	V(p-p)	
INPUT SIGNAL (C-MOS)	V_{IH}	H LEVEL	$0.8V_{DD1}$	-	V_{DD1}	V	
	V_{IL}	L LEVEL	V_{SS}	-	$0.2V_{DD1}$		
Frame frequency	f_{CLK}	CPH	9.20	9.59	9.95	MHz	
		CPV	15.00	15.734	16.50	KHz	
	f_{ST}	STH	15.00	15.734	16.50	KHz	
		STV	57.143	59.939	62.852	Hz	
BACKLIGHT VOLTAGE	VL	IL=6mA(rms)	-	500	-	V(rms)	Refernce
BACKLIGHT CURRENT	IL	-	5.0	6.0	7.0	mA(rms)	
FL DRIVING FREQUENCY	FL	-	-	(51.1)	-	kHz	
DISCHARGE STARTING VOLTAGE	VS	Ta=25°C	850	-	-	V(rms)	
		Ta=-20°C	1000	-	-		

Note 1: The recommended operating conditions show the ranges in which the device can operate normally.

Operation beyond the limit of the recommended operating conditions is not assured, even though operating conditions are within the limit of the absolute maximum ratings.

Note 2: Input signal timing.(V_{sig} , V_{com})

[Example Timing]



Optimization of input Voltage on viewing angle is necessary.

Adjust for mininum flicker.

2.8 Electrical characteristics

Common Test Conditions: $T_a=25\pm5^{\circ}\text{C}$, $V_{DD1}=+3.3\text{V}$, $V_{DD2}=+5.0\text{V}$, $V_{GH}=+18.5\text{V}$, $V_{GL}=-12.0\text{V}$, $V_{SS}=0\text{V}$, $V_{sigC}=+2.5\text{V}$, $V_{comp}=5.8\text{V(p-p)}$, $I_{FL}=6.0\text{mA}_{rms}$, Measured after 30 minutes operation.

ITEMS	SYMBOL	CONDITIONS	SPECIFICATIONS			UNIT	REMARKS
			MIN.	TYP.	MAX.		
INPUT CAPACITY	C_{IN}	-	-	-	50	pF	Note1
	C_{VI}	-	-	-	200	pF	VR,VG.VB
	C_{com}	$f=f_{HD}/2$	-	-	300	nF	Vcom
SUPPLY CURRENT	I_{DD1}	-	1.4	2.1	2.6	mA	Note2
	I_{DD2}	-	10	24	37	mA	
	I_{GH}	$V_{sigpp}=4.0\text{V(p-p)}$	28	70	92	μA	
	I_{GL}	-	175	274	355	μA	
INPUT TIMING	t_{CPV}		-	-	100	KHz	
	t_{CPVH}		500	-	-	ns	
	t_{CPVL}		500	-	-	ns	
	t_{CPH}		-	-	20	KHz	
	t_{CPHH}		15	-	-	ns	
	t_{CPHL}		15	-	-	ns	
	t_{SUP}		7	-	-	ns	
	t_{HLD}		7	-	-	ns	
	t_{CXSUP}		1.0	-	-	μs	
	t_{CXHLD}		50	-	-	ns	

Note 1:STV1,STV2,CPV,OE1,OE2,OE3,CPH,STH1,STH2,CX

Note 2:Timing controller current is not include.

2.9 Optical characteristics

Common test conditions : $T_a=25 \pm 5^\circ\text{C}$, $\text{RH}=65 \pm 5\%$, $V_{\text{DD1}}=+3.3\text{V}$, $V_{\text{DD2}}=5.0\text{V}$, $V_{\text{GH}}=18.5\text{V}$, $V_{\text{GL}}=-12.0\text{V}$,
 $V_{\text{SS}}=0\text{V}$, $V_{\text{sigc}}=2.5\text{V}$, $V_{\text{compp}}=5.8\text{V}$,
 $V_{\text{comc}}=\text{Adjust for minimum flicker.}$, $I_{\text{FL}}=6.0\text{mA(rms)}$ Measured after 30 minutes operation.

ITEM		SYMBOL	CONDITIONS	SPECIFICATIONS			UNIT	REMARKS
				MIN.	TYP.	MAX.		
RESPONSE TIME		t_{ON}	$V_{\text{sig}}=4 \rightarrow 0\text{V}$	-	-	100	ms	
		T_{OFF}	$V_{\text{sig}}=0 \rightarrow 4\text{V}$	-	-	50		
CONTRAST RATIO		CR	$V_{\text{sig}}=0/4$	150	250	-	-	Note1,2
VIEWING ANGLE	L/R	θ_{10}	$V_{\text{sig}}=0/4\text{V}$ $\text{CR} \geq 10$	45/45	55/55	-	°	Note 6
	U/D	ϕ_{10}		45/15	60/30	-		
LUMINANCE		L	$V_{\text{sig}}=0\text{V}$	340	400	-	cd/m ²	Note 2,5
V-L THRESHOLD		V_{th}	90% LT	-	1.0	1.5	V	
WHITE CHROMATICITY (Reference)		x	$V_{\text{sig}}=0\text{V}$	-	(0.334)	-	-	Note 5
		y		-	(0.345)	-		
UNIFORMITY		DLUM	$V_{\text{sig}}=0\text{V}$	70	-	-	%	
BACKLIGHT LIFE (Reference)		-	$I_{\text{FL}}=6.5\text{mA(rms)}$	(10,000)	-	-	h	Note 3,4

Note 1:100% brightness.

Note 2:These values vary with brightness input.

Note 3:MTTF(Mean Time to Failure), time to become 50% brightness.

Note 4:Reference Value.

Note 5:This spec is spectroradiometer [BM-7] of TMD.

Note 6:The viewng direction of this product is 12 o'clock(up side). It is in direction of maximum CR, and shows darker tint.

2.10 Display quality

2.10.1 Display quality (Room temperature)

Common test conditions : $T_a=25 \pm 5^\circ\text{C}$, $\text{RH}=65 \pm 5\%$, $V_{DD1}=3.3\text{V}$, $V_{DD2}=5.0\text{V}$, $V_{GH}=18.5\text{V}$,

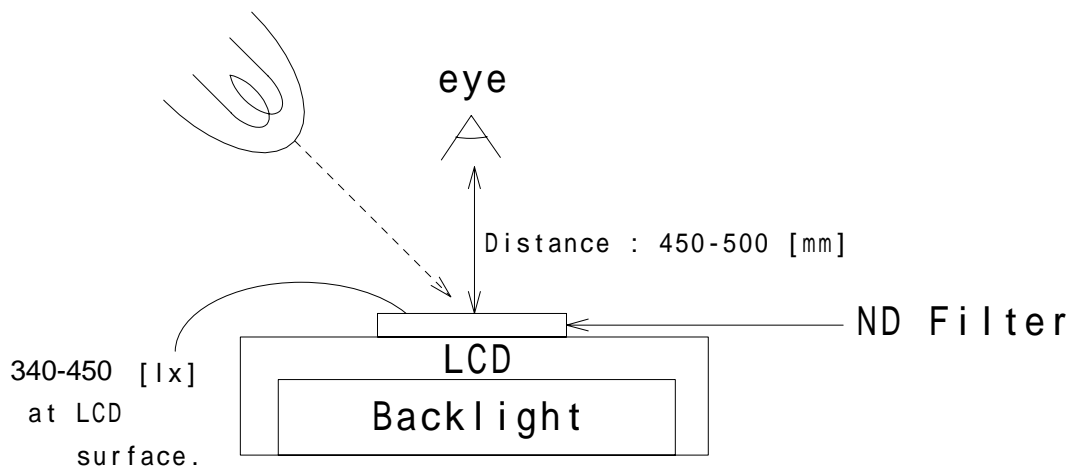
$V_{GL}=-12.0\text{V}$, $V_{SS}=0\text{V}$, $V_{sig}=2.5\text{V}$, $V_{comp}=5.8\text{V}$, $V_{comc}=\text{Adjust for minimum flicker}$. $I_{FL}=6\text{mA(rms)}$,

Measured after 30 minutes operation.

Items		Definition	Standards
Display defect	Line	Black, white, color line. Horizontal or vertical line missing.	No defect
	Sub-pixel	1) Bright sub-pixel Bright defect (Black background : $V_{sig}=4.0\text{V}$) 2) Dark sub-pixel Dark defect (White Background : $V_{sig}=0\text{V}$)	Note 1
Screen quality	Smear	Spot defect whose luminance isn't uniform.	Note 2 (next sheet)
	Unevenness	Partial luminance or chromatic non-uniformity.	
	Non-uniformity streak	Streak shaped luminance or chromatic non-uniformity.	
	Reverse	Concentrated unevenness (sub-pixel unit).	
	Others	Trash between LCD and backlight. ,etc.	

Note 1 : Sub-pixel defect specifications

Inspection condition of sub-pixel defects



Observation time : 5 [sec.]

Bright sub-pixels are classified into the following three category using appropriate Neutral Density (ND) Filter.

Bright sub-pixel (which are) not visible through 2.5% ND Filter are not counted as bright sub-pixel.

(1) Sub-pixel defect

Items	Maximum count	Specifications		
Bright sub-pixel	-	0.3% ND	1.0% ND	2.5% ND
Level 1	0	Visible	Visible	Visible
Level 1,2	3	Invisible	Visible	Visible
Level 1 to 3	5	Invisible	Invisible	Visible
Dark sub-pixel	6	Dark defect (Vsig=0V)		
Total	7	[Bright defect(Level 1+2+3) +Dark defect]		

(2) Cluster : (Bright sub-pixel density)

The maximum permissible sub-pixel defects number per specified area one as follows.

Bright sub-pixel (Level 2 + Level 2)	2 defects in $\phi 10\text{mm}$ area
Bright sub-pixel (Level 2 + Level 3)	2 defects in $\phi 10\text{mm}$ area
Bright sub-pixel (Level 3 + Level 3)	2 defects in $\phi 10\text{mm}$ area
Dark sub-pixel	2 defects in $\phi 10\text{mm}$ area
Total (Bright and dark defects)	2 defects in $\phi 10\text{mm}$ area

(3) Linked sub-pixel defects

A) Three linked sub-pixel defects are not permissible.

B) Two linked sub-pixel defects ;

Bright + Bright : Regarded as one bright defect and classified into Level 1, 2 or 3.

Dark + Dark : Regarded as two dark defects.

Dark + Bright : Regarded as one dark defect and one bright defect (classified into Level).

(4) If any sub-pixel is counted as bright sub-pixel and dark sub-pixel, the sub-pixel is regarded as bright sub-pixel.

(5) Dusts (in Cell)

	Size	Judgement
1	3 sub-pixels $\leq x$	NG
2	2 sub-pixels $\leq x < 3$ sub-pixels	Regarded as two linked dark defects.
3	1 sub-pixel $\leq x < 2$ sub-pixels	Regarded as one dark defect.
4	$\leq x < 1$ sub-pixel	Uncounted.

(6) Dusts (in Backlight)

	Criterion	Judgement
1	$0.2\text{mm}^2 \leq x$ *	Count is dark dot defects.
2	$0.2\text{mm}^2 < x$	No count

* 0.2mm^2 criterion : based on [], Japanese Mint Bureau

Note 2 : Screen quality defects (smear etc.), which can not be found by using 2.5% ND filter, shall not be counted as defects.

Inspection condition : Same as sub-pixel defect condition.

2.11 Reliability test

2.11.1 Environmental & life test

Items	Conditions	Judgement time
High temperature operation	$T_a=65 \pm 2^\circ\text{C}$, $\text{RH} \leq 45\%$	192h
High temperature and high humidity operation	$T_a=65 \pm 2^\circ\text{C}$, $\text{RH}=90$ to 95%	192h
Low temperature operation	$T_a= -30 \pm 3^\circ\text{C}$	192h
High temperature storage	$T_a=85 \pm 2^\circ\text{C}$	192h
Low temperature storage	$T_a= -40 \pm 3^\circ\text{C}$	192h
Light stability non-operating	Sun shine carbon arc, $T_a=63 \pm 2^\circ\text{C}$	360h
Thermal shock non-operating	$-30^\circ\text{C}(30\text{min.}) \longleftrightarrow 80^\circ\text{C}(30\text{min.})$	300 cycle
Condensation test	$-30^\circ\text{C}(30\text{min. non-operation}) \longleftrightarrow 25^\circ\text{C}/95\%(10\text{min. operation})$	10 cycle
Temperature and humidity cycling (non-operating)	<p>1 cycle = 48h(25 to 65°C : 90 to 95%)</p>	5 cycle
Static discharge durability	$C=200\text{pF}$, $R=0\Omega$, $V= \pm 200\text{V}$ Electric discharge between power supply terminals and other terminals [non-operating]	each terminals 3 times
Surface electric Discharge durability	$C=150\text{pF}$, $R=150\Omega$, $V= \pm 15\text{kV}$ Electric discharge between LCD panel and ground. (positive and negative) [non-operating]	positive and negative 5 times each
Mechanical vibration	<p>5 to 10Hz : Amplitude 25mm 10 to 30Hz : $3.7 \times 9.8\text{m/s}^2$ 30 to 50Hz : $1.6 \times 9.8\text{m/s}^2$ 50 to 80Hz : $0.7 \times 9.8\text{m/s}^2$ 80 to 100Hz : $0.3 \times 9.8\text{m/s}^2$ XYZ directions, 8min x 2 = 1 sweep [non-operating]</p>	each directions 96h
Mechanical shock	$100 \times 9.8\text{m/s}^2$, $t=6\text{ms}$, XYZ directions, sin curve (positive only) [non-operating]	each directions 2 times
Front force test	Push-pull head : $\phi 12.7\text{mm}$, $5 \times 9.8\text{N}$ [non-operating]	a time
Atmospheric pressure stability	$5.06 \times 10^4 \text{ Pa}$ [non-operating]	2h

2.11.2 Reliability test criteria

Items	Specification (Note 1)				Remark
	Contrast	Luminance	Supply current	Screen quality	
High temperature operation	$30 \leq CR$	$\leq \pm 20\%$	$\leq \pm 30\%$	Note 2	Note 3
High temperature and high humidity operation	$25 \leq CR$	"	"	"	Note 3,4
Low temperature operation	$30 \leq CR$	"	"	"	Note 3
High temperature storage	"	"	"	"	Note 3
Low temperature storage	"	"	"	"	Note 3
Light stability non-operating	"	"	"	"	Note 3
Thermal shock non-operating	"	"	"	"	Note 3
Condensation test	$25 \leq CR$	"	"	"	Note 5
Temperature and humidity cycling non-operating	"	"	"	"	Note 5
Static discharge durability non-operating	No abnormal function or indication				
Surface electric discharge durability non-operating	"				
Mechanical vibration non-operating	"				Note 6
Mechanical shock non-operating	"				Note 6
Front force test	"				
Atmospheric pressure stability non-operating	"				

Note 1 : The Change quantity for initial value.

Note 2 : Screen quality should not have distinguished unevenness.

Note 3 : Measured after 2 hours storage in room temperature.

Note 4 : Degradation due to the degradation of polarizer is excluded.

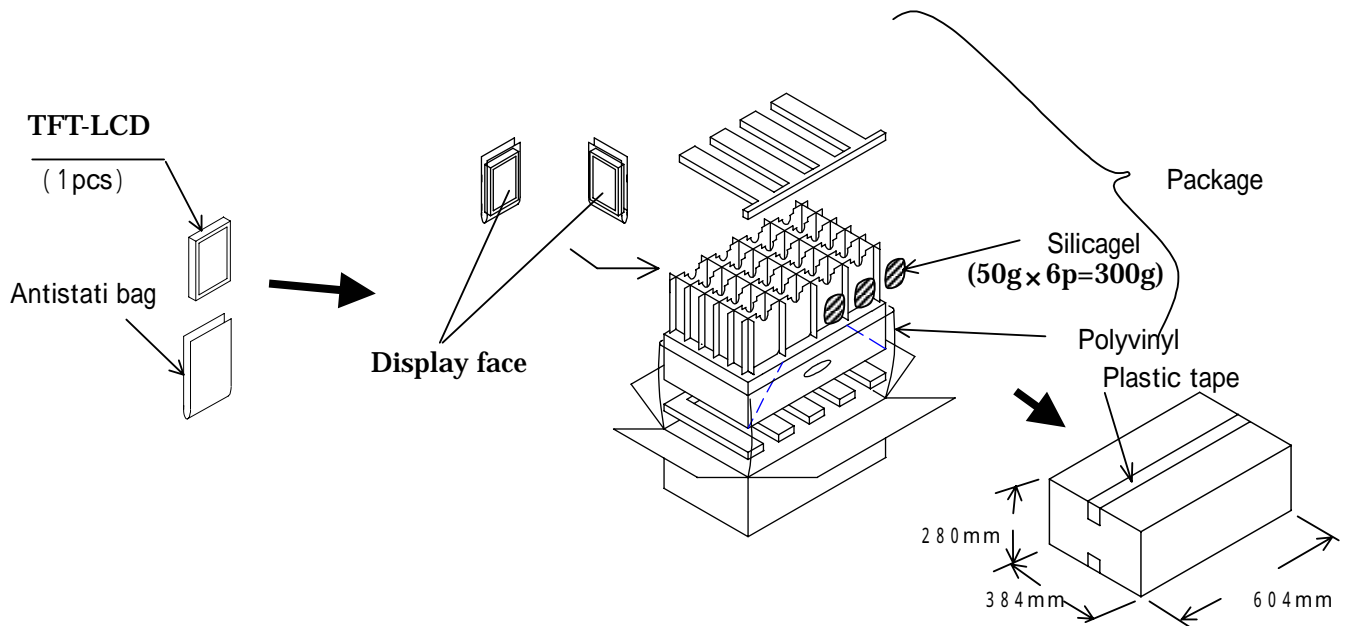
Note 5 : Measured after 24 hours storage in room temperature.

Note 6 : Mechanical shock and vibration tests are performed with all mounting holes tightened and fixed to test jig.

3. Packaging

3.1 Packaging form

* Capacity carrying is 40pcs.(total) : 20pcs. from upper, 20pcs. from under.



3.2 Packaging materials

Number	Quantity	Contents / Materials
(1)	40p	Antistatic bag
(2)	6p	Silica gel
(3)	1set	Package
(4)	1p	Polyvinyl
(5)	-	Plastic tape
(6)	-	Product label (Refer to figure A)
(7)	-	Handling caution label (Refer to figure B)

Figure A

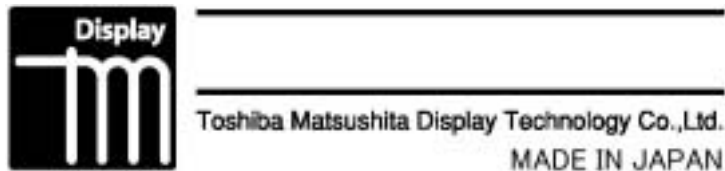


Figure B



3.3 Packaging specifications

Items	Contents
Packaging form	Corrugated cardboard
Outline dimension (box)	604(Width) x 384 (High) x 280(Depth) [unit :mm]
Capacity carrying	40 pcs.
Total weight	7.5 kg (typ.)
Maximum allowed pile	10 tiers
Volume	0.065 m ³

4. Measuring Method

4.1 Mechanical & electrical items

Inspection or test items	Measuring systems or definition
1.Mechanical	
A)Critical dimensions	Vernier caliper
B)Marking	Visual
C)Appearance	Visual
2.Electrical	
1)Supply current	Ampere meter
2)Input capacitance	Capacitance meter

4.2 Optical items

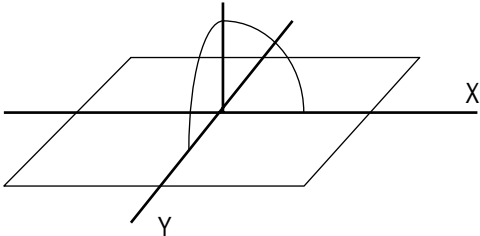
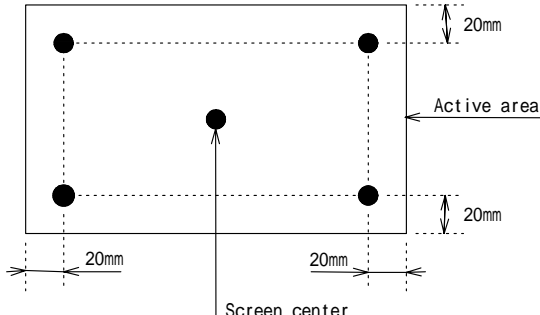
4.2.1 Standard measuring conditions

Measure on the following conditions.

Operating voltage : $V_{DD1}=3.3V$, $V_{DD2}=5.0V$, $V_{GH}=18.5V$, $V_{GL}= -12.0V$, $V_{SS}=0V$, $V_{sigc}=2.5V$,
 $V_{comp}=5.8V$, V_{comc} =Adjust for minimum flicker., (Measured after 30 minutes operation),
 $I_{FL}=6mA(rms)$, Measurement temperature : $T_a=25 \pm 5^{\circ}C$

The Measurement point : Measuring one point of the screen center.

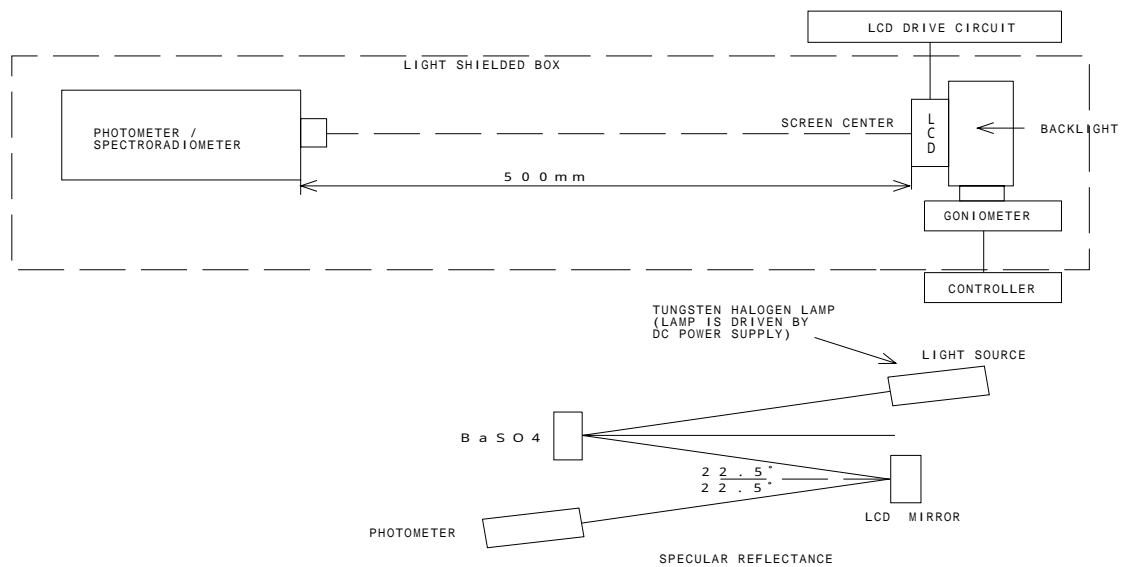
Set the luminance meter above the normal line of the LCD module.

Inspection or test items	Measuring systems or definition	System
1. Contrast ratio	$CR= L1 / L2$ $L1 : V_{sig}=0V$, $L2 : V_{sig}=4V$	method A (Next sheet)
2. Luminance (L) & White chromaticity	Measurement point is screen center Raster pattern ($V_{sig}=0V$)	method A
3. Viewing angle	CR is larger than 10 = Left and Right viewing angle = Up and Down viewing angle 	method A
4. V-L threshold (V_{th})	$L = V_{sig} 0 \text{ to } 4V$ (step : $0.2V$) $V_{th}= L (90\%)$	method A
5. Uniformity (5 point)	$L = V_{sig}(0V)$, Screen center= $L(max.)$ Uniformity = $L (min.) / L (max.) \times 100$ [unit : %] 	method A

6. Specular reflectance	$\rho_{SP} = L_3 / L_4$ L_3 : Non-operating LCD luminance L_4 : Mirror luminance	method A
7. Display defect and screen quality	Inspection shall be performed right above the module, apart 500mm from the module to eyes. (Vsig=0 to 4V)	Visual inspection

4.2.2 Measuring systems

Method A (distant method)



LCD drive circuit : Supplies raster pattern to LCD.

Photometer : BM-8 or BM-5A or BM-3 (made in TOPCON). [Aperture 2 °]

Spectroradiometer : BM-5A (made in TOPCON). [Aperture 1 °]

Standard diffuse reflector : WS-2 (made in TOPCON).

5. Other

5.1 Produce factory

This product is made in TFPD Co.,ltd. and our factory at Himeji.