

Product Specification

SPECIFICATION FOR APPROVAL




() Preliminary Specification
(●) Final Specification

Title	3.5" (320 X RGB X 240) TFT- LCD
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BUYER	RoyalTek
MODEL	

SUPPLIER	LG.Philips LCD CO.,Ltd.
MODEL	LB035Q02
SUFFIX	TD03

SIGNATURE	DATE
/	
/	
/	

APPROVED BY S. D. Jung / G. Manager  _____	DATE 2008. 3. 14
REVIEWED BY W. C. Lee / Manager  _____	08. 03. 14
PREPARED BY S. H. Kim / Engineer  _____	08. 03. 14
Product Engineering Dept. LG. Phillips LCD Co., Ltd	

Product Specification**Contents**

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Product Specification

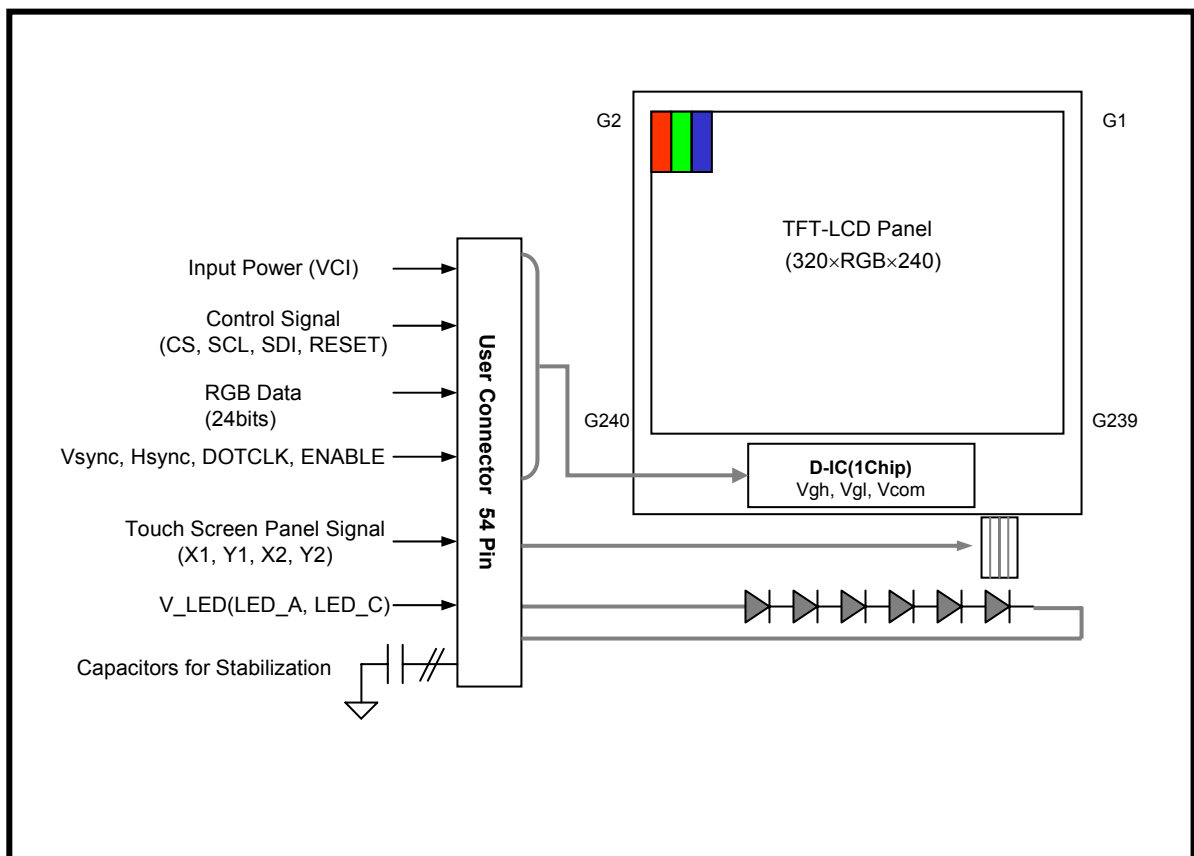
1. General Description

1-1. Description

The LB035Q02 is a Color Active Matrix Liquid Crystal Display with a white LED backlight assembly. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. This module is a diagonal 3.5 inch with the Landscape typed qVGA resolution.

The LB035Q02 is intended to support displays. [PND(Portable Navigation Device), PMP(Portable Multimedia Player) and others]

1-2. Block Diagram



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1-3. Features

PARAMETER	SPECIFICATION	REMARK
Active Screen Size	3.5 inches	Diagonal
Outline Dimension	76.9[H] x 63.9[V] x 4.25t[D](with Touch Panel)	[mm]
Active Area	70.08[H] x 52.56[V]	[mm]
Number of dots	320[H] x RGB x 240[V]	-
Dot Pitch	0.073 x 0.219	[mm]
Pixel Arrangement	Stripe type	-
Display Mode	Transmissive	-
Display Color	Pseudo-16M	colors
Viewing Direction	6 o'clock	12 o'clock (good viewing)
Color Filter Array	RGB Vertical Stripe	-
Signal Interface	Digital RGB + SPI Interface	-
Weight	41g	-
Backlight	6 LEDs	Serial Type

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2. Interface Connections

This LCD employs one interface connection for the operation of module, LED B/L and TSP.
 The pin configuration for the connector is shown in the table below.

(LCD Connector: FPC(54Pin 0.5mm pitch), Mating Connector: LD09T4-54NB(Sumiko) or equivalent)

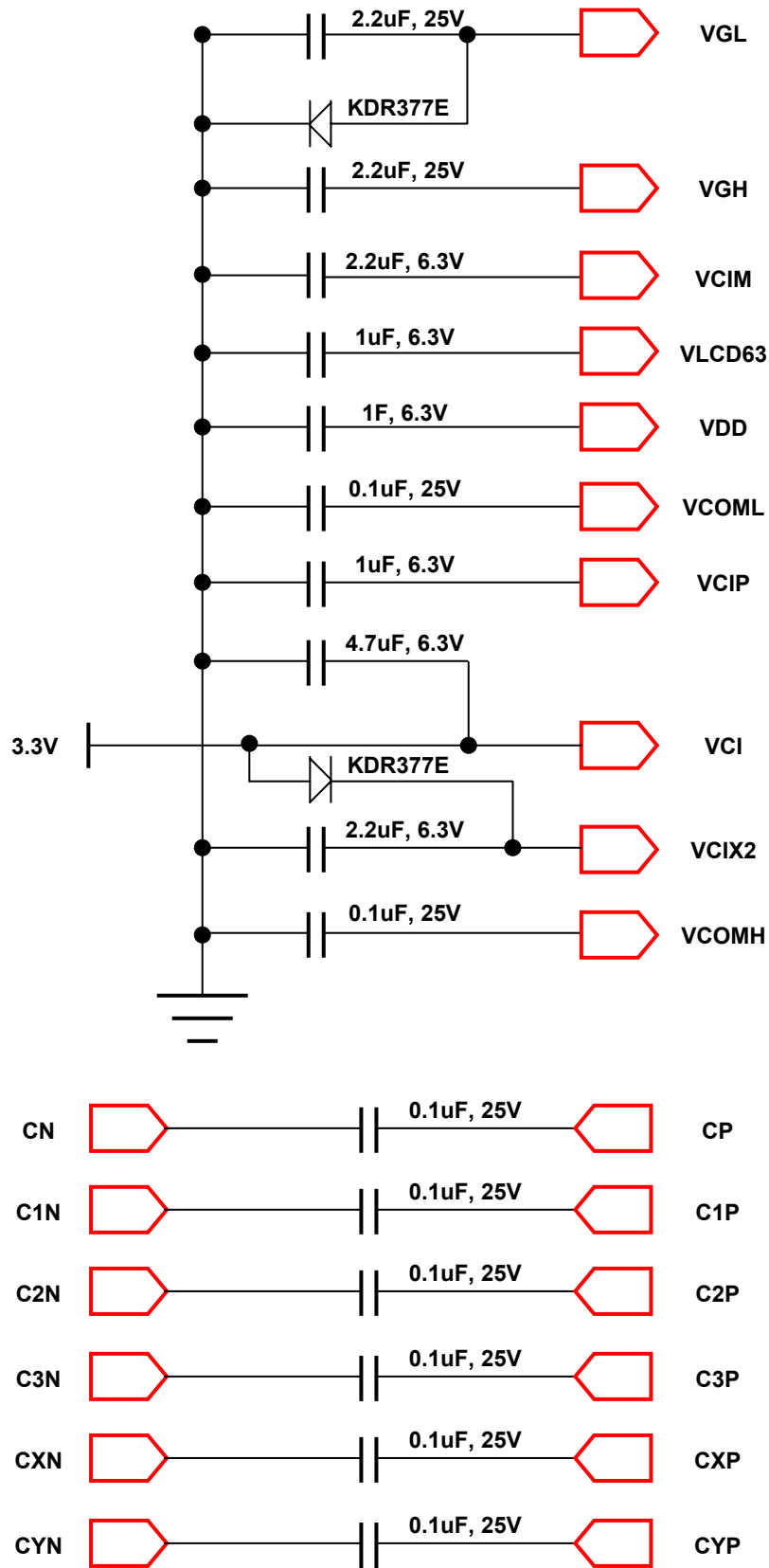
Pin	Symbol	Description	I/O	Remark
1	LED_C	LED_Cathode	I	
2	LED_C	LED_Cathode	I	
3	LED_A	LED_Anode	I	
4	LED_A	LED_Anode	I	
5	NC	No Connect	-	
6	NC	No Connect	-	
7	NC	No Connect	-	
8	RESET	System Reset	I	
9	CS	Chip Select	I	
10	SCL	Serial Clock Line	I	
11	SDI	Serial Data Input	I	
12	PD0	BB0, Blue Data [LSB]	I	
13	PD1	BB1, Blue Data	I	
14	PD2	BB2, Blue Data	I	
15	PD3	BB3, Blue Data	I	
16	PD4	BB4, Blue Data	I	
17	PD5	BB5, Blue Data	I	
18	PD6	BB6, Blue Data	I	
19	PD7	BB7, Blue Data [MSB]	I	
20	PD8	GG0, Green Data [LSB]	I	
21	PD9	GG1, Green Data	I	
22	PD10	GG2, Green Data	I	
23	PD11	GG3, Green Data	I	
24	PD12	GG4, Green Data	I	
25	PD13	GG5, Green Data	I	
26	PD14	GG6, Green Data	I	
27	PD15	GG7, Green Data [MSB]	I	
28	PD16	RR0, Red Data [LSB]	I	
29	PD17	RR1, Red Data	I	
30	PD18	RR2, Red Data	I	
31	PD19	RR3, Red Data	I	
32	PD20	RR4, Red Data	I	
33	PD21	RR5, Red Data	I	

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Pin	Symbol	Description	I/O	Remark
34	PD22	RR6, Red Data	I	
35	PD23	RR7, Red Data [MSB]	I	
36	HSYNC	Horizontal Sync Signal	I	
37	VSYNC	Vertical Sync Signal	I	
38	DOTCLK	Dot Clock	I	
39	Y2	Top-electrode-differential analog	I	
40	X1	Right-electrode-differential analog	I	
41	VCI	Power	I	
42	VCI	Power	I	
43	Y1	Bottom-electrode-differential analog	I	
44	X2	Left-electrode-differential analog	I	
45	Dummy	Dummy	-	
46	SDO	Serial Data Output	O	
47	Dummy	Dummy	-	
48	NC	No Connect	-	
49	NC	No Connect	-	
50	NC	No Connect	-	
51	Dummy	Dummy	-	
52	ENABLE	Data Enable	I	
53	GND	Ground	I	
54	GND	Ground	I	

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2-1. FPC



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3. Absolute Maximum Ratings

If used the beyond absolute maximum ratings, this device can permanently be damaged.
It is strongly recommended to use this device at a condition for normal operation.

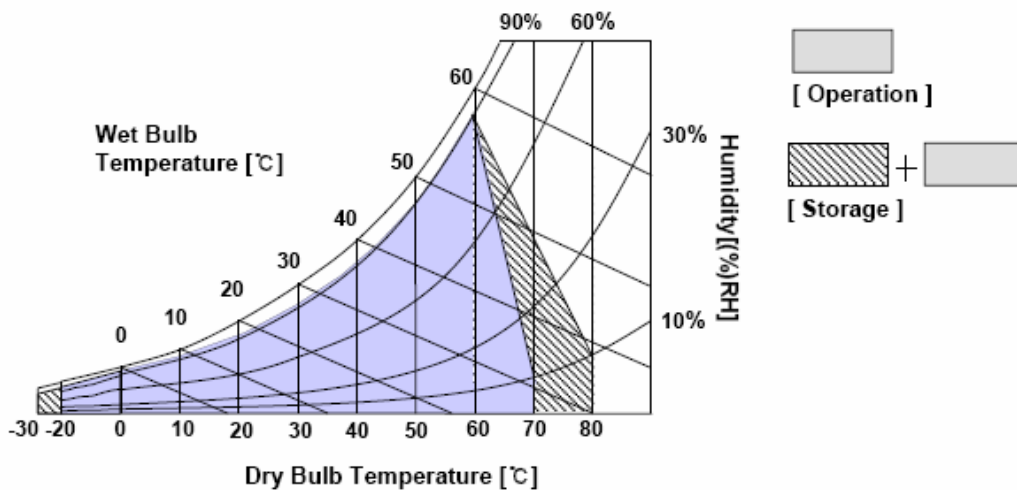
PARAMETER	SYMBOL	CONDITION	MIN.	MAX.	UNIT	REMARK
Power Supply Voltage	V _{CI}	T _a =25℃	-0.3	5.0	V	-
LED Forward Current	I _f	T _a =25℃	-	25	mA	[Note 3-1]
Operating Temperature	T _{OP}	-	-20	70	℃	[Note 3-2, 3]
Storage Temperature	T _{ST}	-	-30	80	℃	[Note 3-2, 3]

[Note 3-1] Applies for each LED individually

[Note 3-2] If fixed pattern is displayed for a minute, image sticking may appear.

[Note 3-3] Temp. ≤ 60℃ , Humidity 90% RH Max

Temp. > 60℃ , absolute humidity shall be less than 90% RH at 60℃ .
No condensation > 40℃



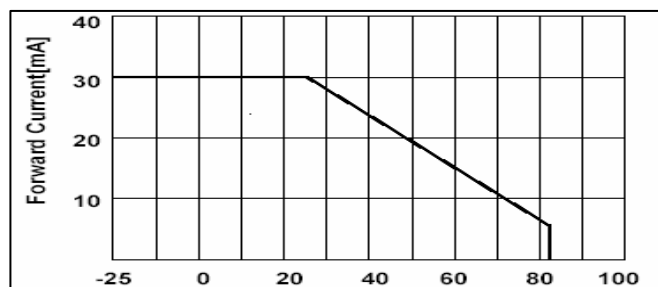
Product Specification
4. Electrical Characteristics
4-1. TFT LCD Module
 $T_a = 25^{\circ}C$

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	REMARK
Power Supply Voltage	VCI	3.0	3.3	3.6	V	
Gate On Voltage	V_{GH}	10	13	15	V	
Gate Off Voltage	V_{GL}	-11	-9	-7	V	
Frame Frequency	f_{FRAME}	-	70		Hz	
Dot Clock	DOTCLK	-	6.5	10	MHz	
Serial Clock	SCL	100	-	-	ns	See. 7-2-2
Input Leakage Current	I_{IL}	-1.0	-	3.0	uA	
Output Leakage Current	I_{OL}	3.0	-	4.5	uA	
Power Consumption	-		60	70	mW	@White
			90	100	mW	@Black

4-2. Backlight Unit
 $T_a = 25^{\circ}C$

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	REMARK
LED forward Current	I_f	-	20	-	mA	[Note4-1]
Power Consumption	P_{BL}	-	400	-	mW	

[Note4-1] The permissible forward current of LED vary with environmental temperature.



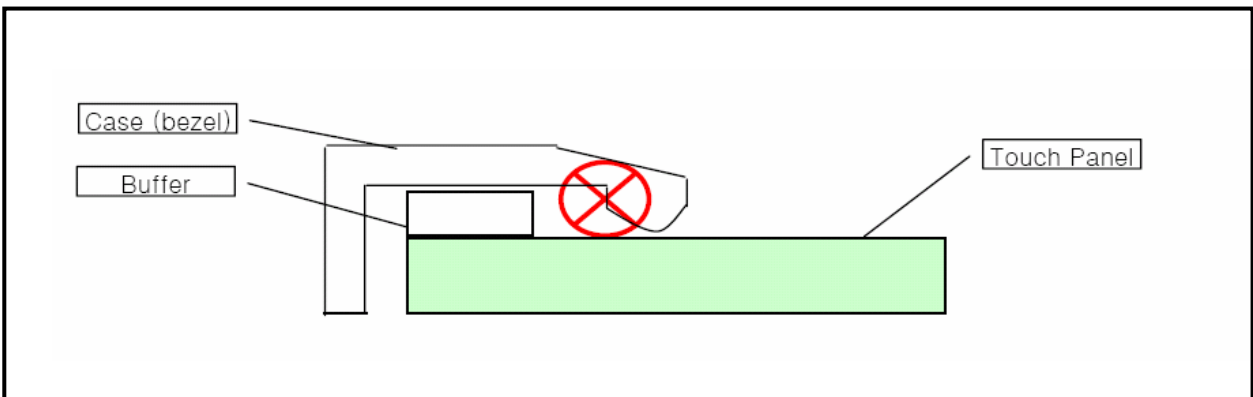
Environmental temperature(°C)

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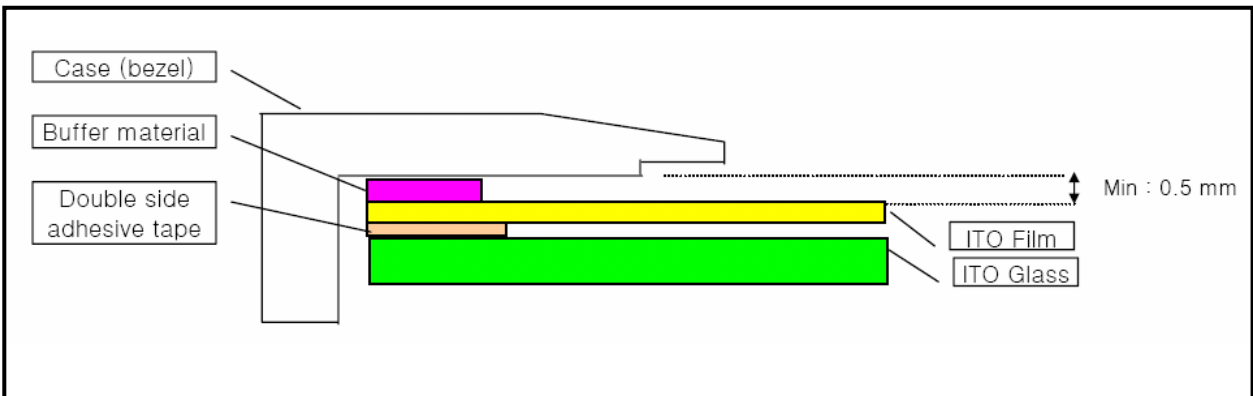
5. Touch Screen Panel Specifications

5-1. TSP Design Guide

- Avoid the bezel design as below. Because it can press the 'Active Area' of the touch panel



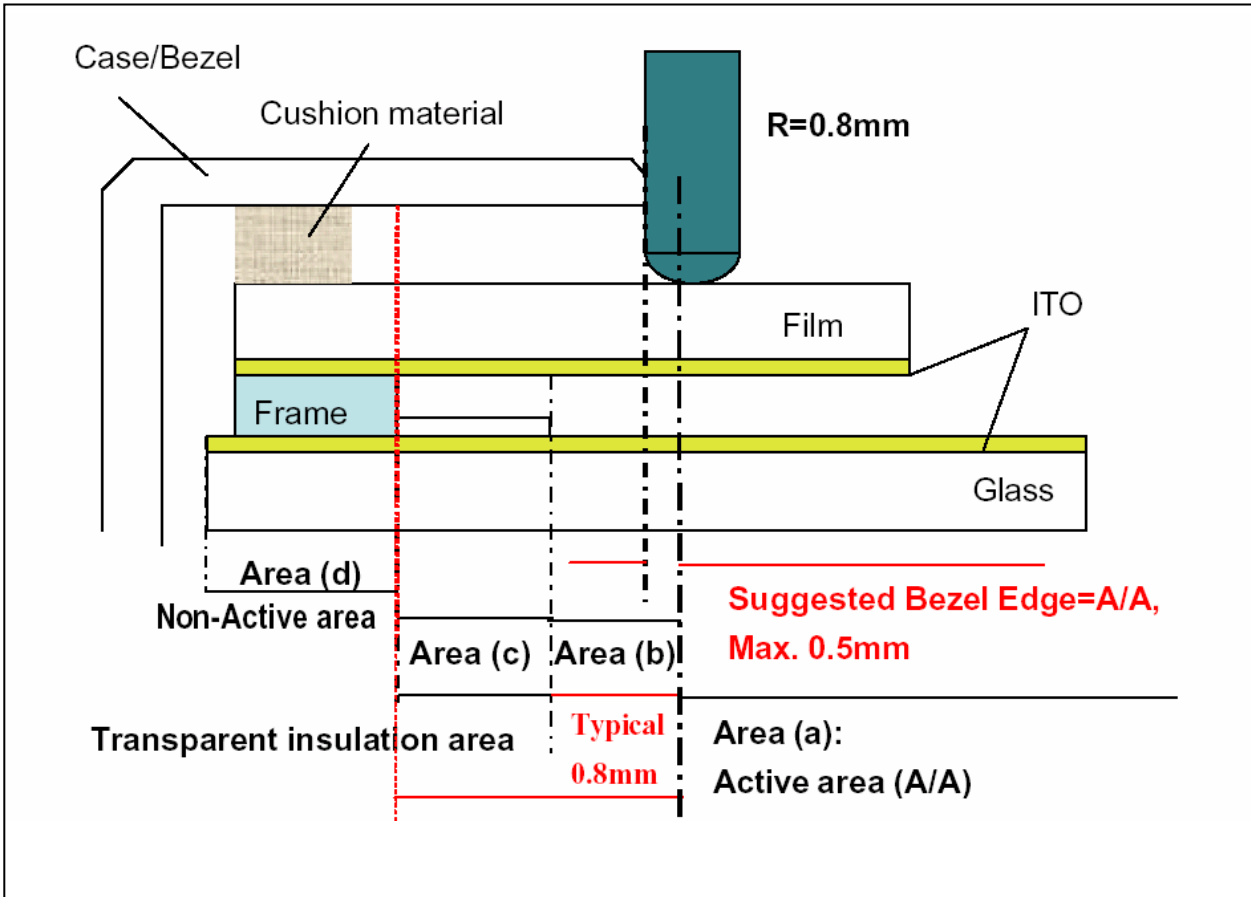
- We recommend the use of a buffer material between the touch panel and the bezel, and buffer material should be limited only on the adhesive tape area. If it is out of adhesive tape area, Touch Panel may occur a short.



<Prohibition & Operation>

1. Do not attach bezel inside of panel viewing area.
2. Prevent excessive force on the touch panel.
3. Do not use sharp things except finger or R0.8 stylus pen when operating.
This may cause scratches to the surface of touch panel.

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- Use a cushion material between the touch panel and the bezel.
- Do not overlap and contact between the Case/Bezel and the TSP active area

[Note]

Area(a): Active area

The active area is guaranteed the position data detectable precision, operation force and other operations. It is strongly recommended to place the operation button or menu keys within the active area.

Area(b): Operation non-guaranteed area

This area does not guarantee a touch panel operation and its function. When this area is pressed, touch panel shows degradation of its performance and durability such as a pen sliding durability.

Area(c): Pressing prohibition area

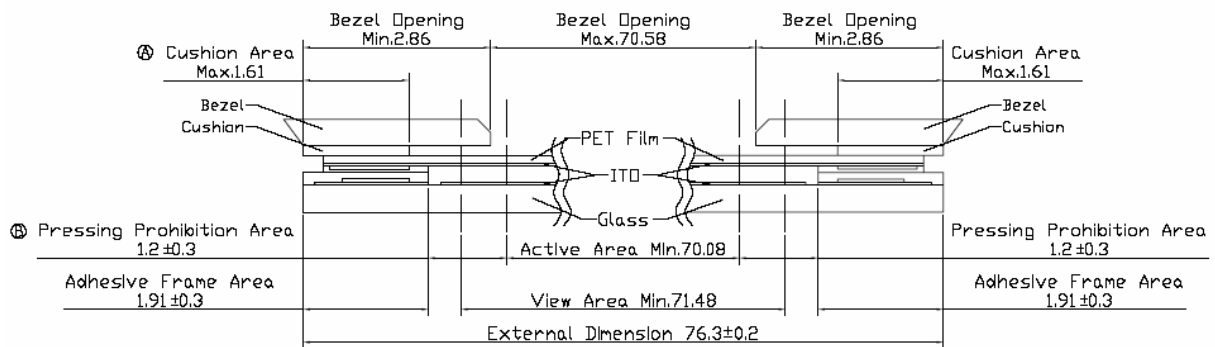
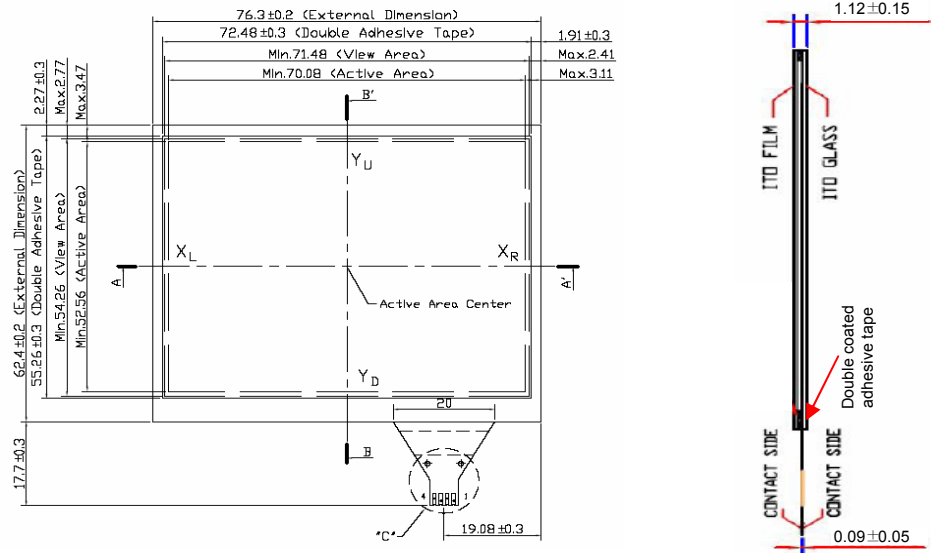
The area which forbids pressing, because an excessive load is applied to a transparent electrode(ITO) and a serious damage is given to a touch panel function by pressing

Area(d): Non-Active area

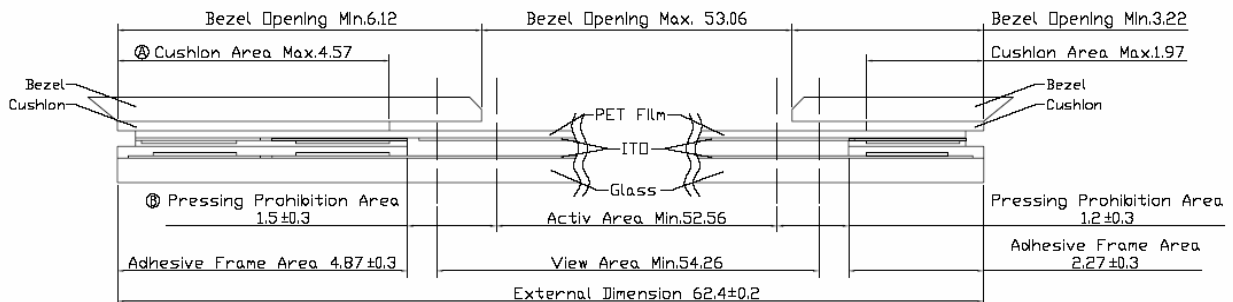
The area does not activate even if pressed

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5-2. TSP Dimensions



A-A' CROSS SECTION



B-B' CROSS SECTION

Product Specification
5-3. Electrical Characteristics
 $(T_a = 25^\circ C)$

PARAMETER	MIN.	TYP.	MAX.	UNIT	REMARK
Linearity	1.5	-	1.5	%	Analog X & Y Directions
Terminal Resistance	200	-	900	Ω	X-axis
	200	-	900	Ω	Y-axis
Insulation Resistance	25	-	-	M Ω	DC 25V
Voltage	-	-	7	V	DC
Chattering	-	-	10	ms	
Transparency	-	80	-	%	

5-4. Mechanical & Reliability Characteristics

PARAMETER	MIN.	TYP.	MAX.	UNIT	REMARK
Activation force	-	-	100	g	R0.8mm polyacetal Pen or Finger
Durability (Surface scratching)	Write 100,000			Characters	[Note 1]
Durability (Surface pitting)	1,000,000			Touches	[Note 2]
Surface hardness	3	-	-	H	Judgment ref.JIS-K5600

[Note 1]

Measurement for Surface area

- Force : 250gf
- Speed : 60m/sec
- Stylus : R0.8 polyacetal tip

[Note 2]

Pit 1,000,000 times on the Film with a R8.0 silicon rubber

- Force : 250gf
- Speed : 2times/sec

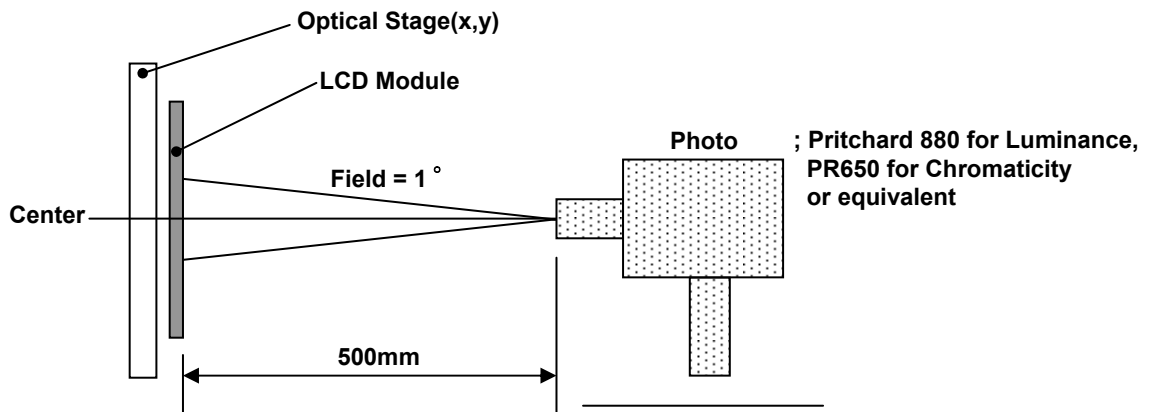
Product Specification
6. Optical Characteristics
6-1. TFT LCD Module
 $T_a = 25^{\circ}C$

PARAMETER		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	REMARK
Luminance (with Touch Panel)		Y	$I_{BL} = 20mA$	250	300	-	Cd/m ₂	[Note6-1]
Contrast Ratio		CR	Center Point	300	400	-	-	[Note6-2]
White color Chromaticity		Wx	$I_{BL} = 20mA$	0.26	0.31	0.36	-	[Note6-1] PR-650
		Wy		0.28	0.33	0.38	-	
Red color Chromaticity		Wx	$I_{BL} = 20mA$	0.532	0.582	0.632	-	[Note6-1] PR-650
		Wy		0.300	0.350	0.400	-	
Green color Chromaticity		Wx	$I_{BL} = 20mA$	0.307	0.357	0.407	-	[Note6-1] PR-650
		Wy		0.533	0.583	0.633	-	
Blue color Chromaticity		Wx	$I_{BL} = 20mA$	0.108	0.158	0.208	-	[Note6-1] PR-650
		Wy		0.068	0.118	0.168	-	
Viewing Angle	Hor.	θ_L	CR > 10	-	65	-	Degrees	[Note6-2] [Note6-3] PR-880
		θ_R		-	65	-		
	Ver.	θ_U		-	50	-		
		θ_D		-	60	-		
Response Time	Rising	$T_r + T_f$	$\theta = 0^{\circ}$	-	25	30	msec	[Note6-4] PR-880
	Falling							
Luminance Uniformity		U	$I_{BL} = 20mA$	-	1.20	1.40	-	[Note6-5]
				71.4	83.4	-	%	

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- Measurement condition : Refer to the below “Test Equipment Set Up” and next two pages

[Test Equipment Set Up]



- Measuring Condition ;
 - Measuring surroundings : Dark Room
 - Measuring temperature : $T_a=25^{\circ}\text{C}$
 - Adjust operating voltage to get optimum contrast at the center of the display.
 - Measured value at the center point of LCD panel after more than 10 minutes while backlight turning on.

[Note 6-1]

Measured on the center area of the panel by PHOTO RESEARCH photometer PR-880&PR650 or Equivalent

[Note 6-2]

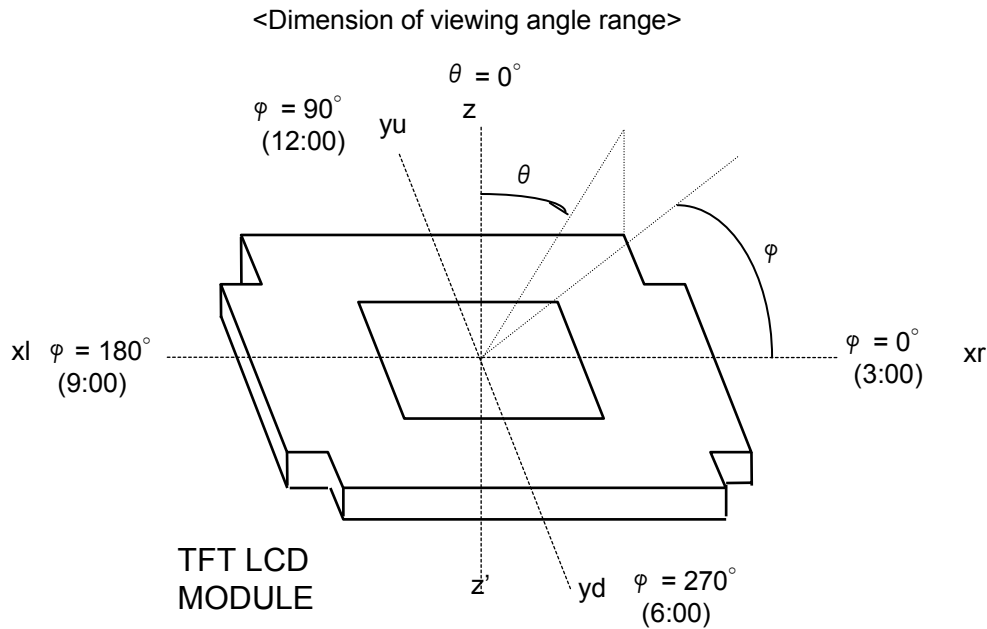
Contrast ratio is defined as follows ;

$$\text{Contrast Ratio(CR)} = \frac{\text{Photo detector output with LCD being "white"}}{\text{Photo detector output with LCD being "black"}}$$

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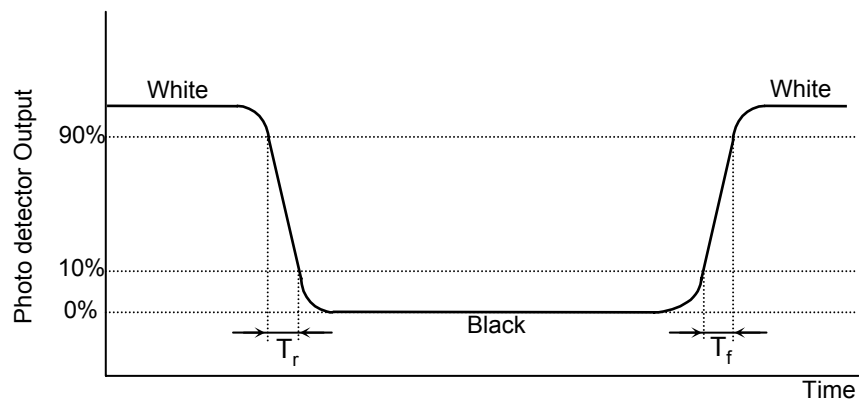
[Note 6-3]

Viewing angle range is defined as follows [PR-880];



[Note 6-4]

Response time is obtained by measuring the transition time of photo detector output, when input signals are applied so as to make the area "black" to and from "white".

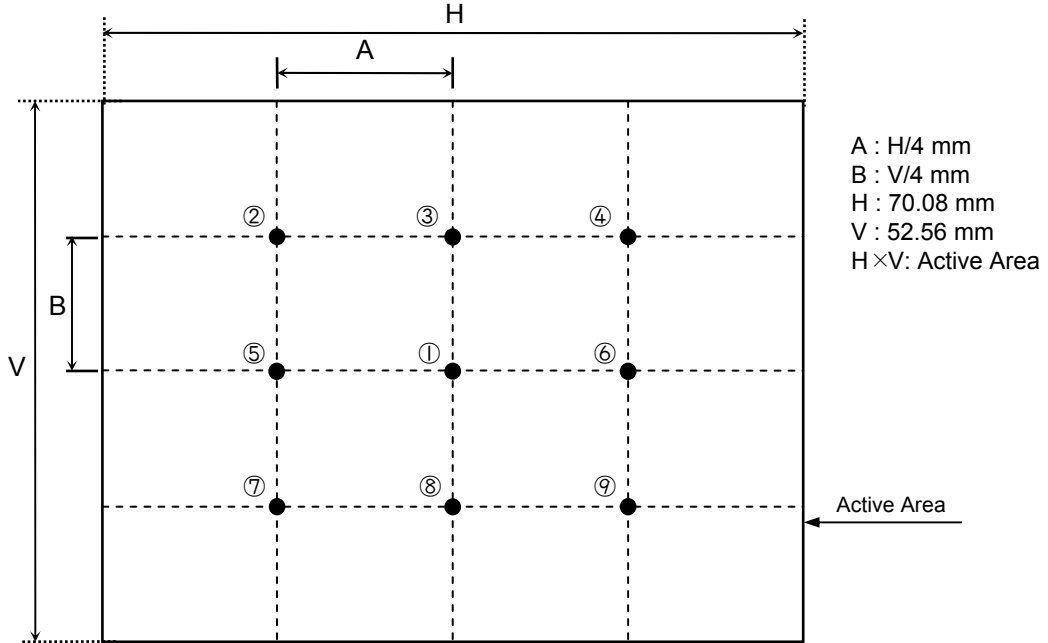


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[Note 6-5]

Luminance Uniformity= Maximum of 9points (①~⑨) / Minimum of 9points (①~⑨)

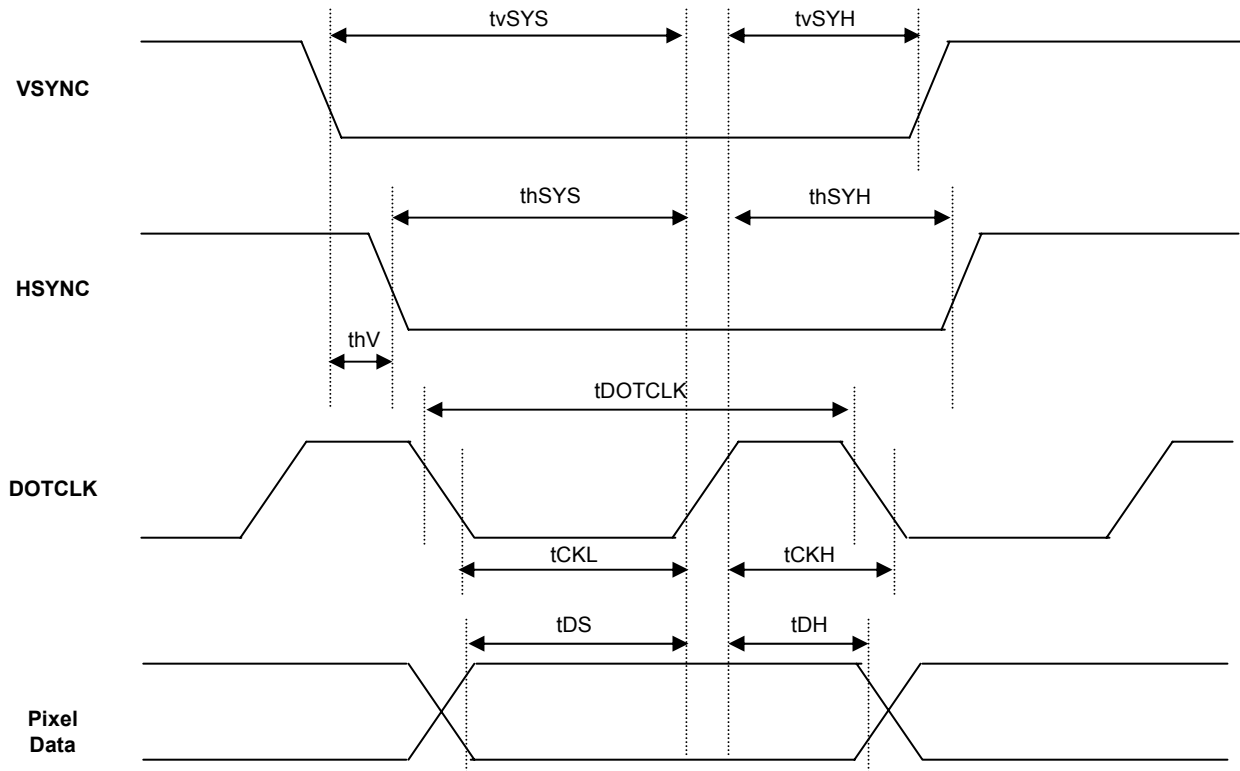
Luminance Uniformity(%) = Minimum of 9points (①~⑨) / Maximum of 9points (①~⑨) x 100



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7. Mechanical Characteristics

PARAMETER	SPECIFICATION		UNIT	REMARK
Outline Dimension	Width	76.9	mm	-
	Height	63.9	mm	
	Depth	3.15 (without TSP) 4.25 (with TSP)	mm	
Bezel Area	Width	72.48	mm	
	Height	55.26	mm	
Weight	41 (Typ.)		g	
Surface Treatment	Anti glare & Anti Newton's ring Coating(3H) Treatment (TSP film side)			

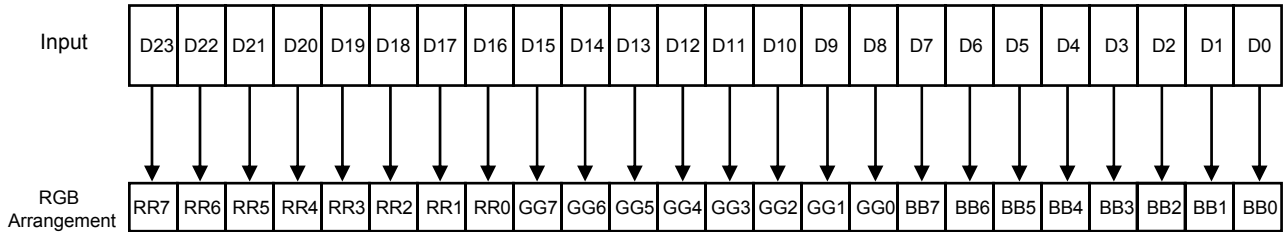
Product Specification
8. Operation Specifications
8-1. RGB Data Interface
8-1-1. RGB Data Interface Timing Characteristics


PARAMETER	SYMBOL	24bit Interface		8 bit Interface		Unit
		Min.	Max.	Min.	Max.	
DOTCLK Period	tDOTCLK	100	-	33.3	-	ns
DOTCLK Low Period	tCKL	50	-	15	-	ns
DOTCLK High Period	tCKH	50	-	15	-	ns
DOTCLK Frequency	tDOTCLK	10	-	30	-	MHz
Vertical Sync Setup Time	tvSYS	20	-	10	-	ns
Vertical Sync Hold Time	tvSYH	20	-	10	-	ns
Horizontal Sync Setup Time	thSYS	20	-	10	-	ns
Horizontal Sync Hold Time	thSYH	20	-	10	-	ns
Data Setup Time	tDS	12	-	10	-	ns
Data Hold Time	tDH	12	-	10	-	ns

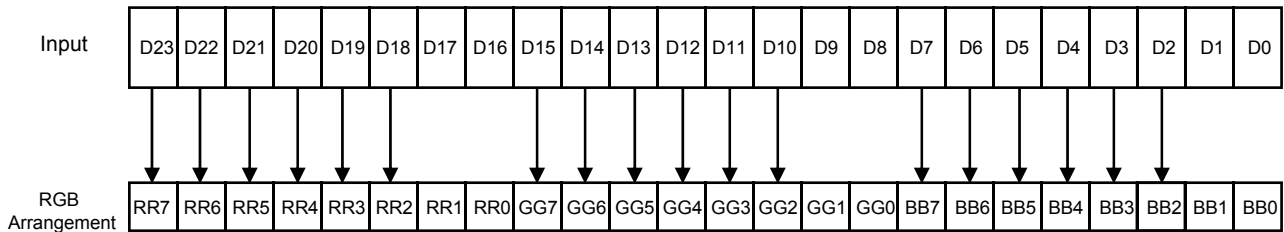
[Note] External clock source must be provided to LCM.
 The LCM will not operate if absent of the clocking signal.

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8-1-2. Data Format for 24 bit RGB Data Interface

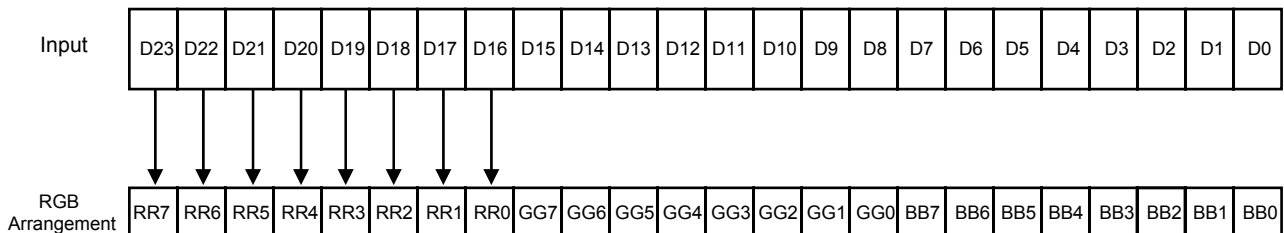


8-1-3. Data Format for 18 bit RGB Data Interface



[Note] LSB 2bits are connected to VSS or floating.

8-1-4. Data Format for 8 bit RGB Data Interface

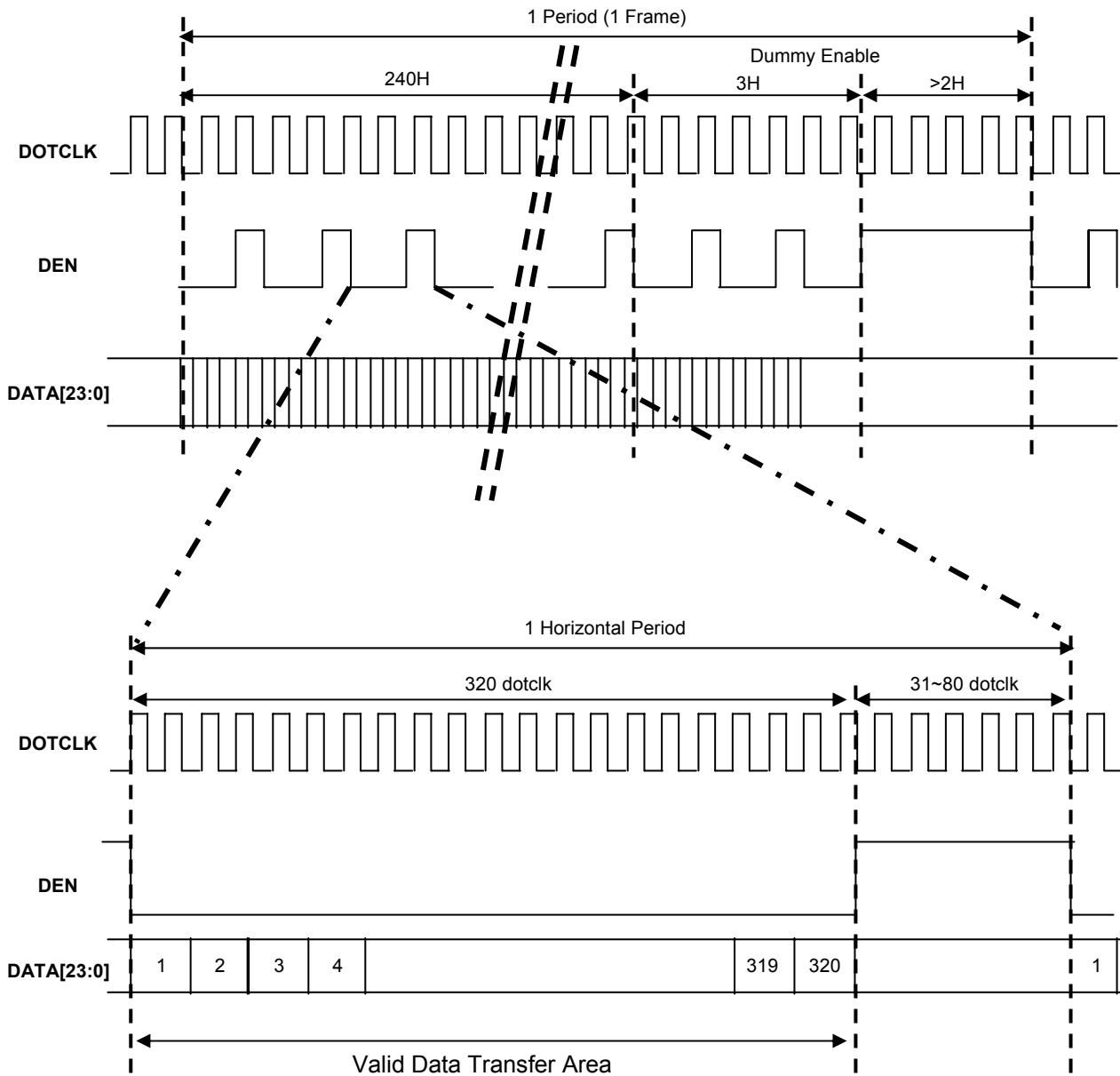


[Note] For 8 bit interface, only RR[7:0] are used.
For unused pins, please connect to GND or floating.

Product Specification

8-1-3. 24 Bit RGB Interface Timing

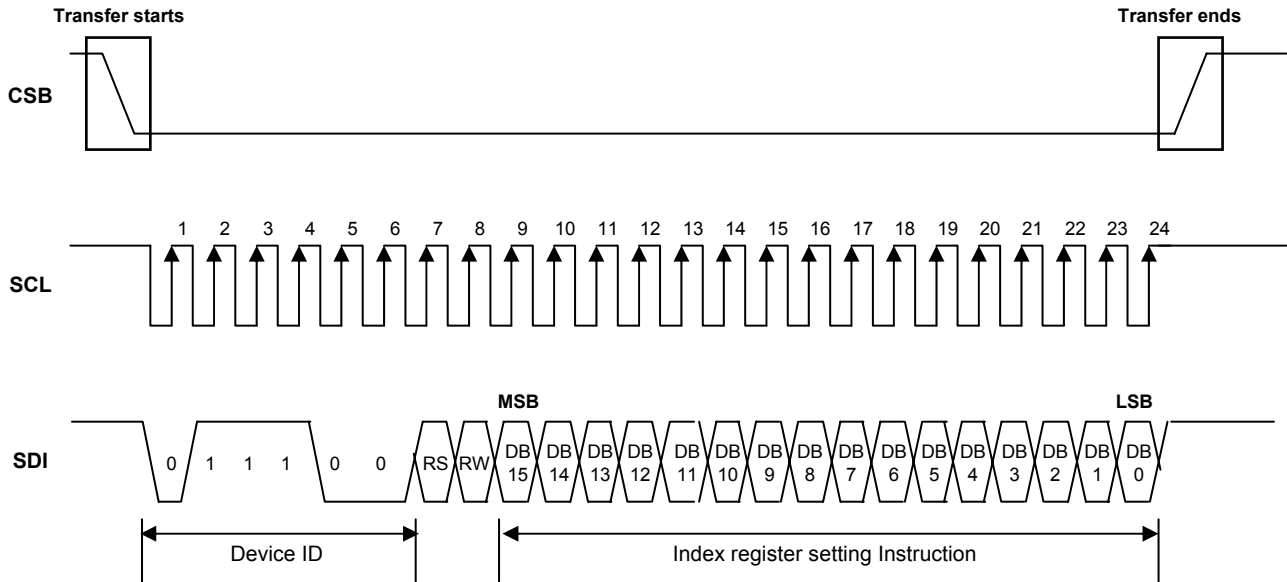
8-1-3-2. DE Mode



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8-2. Serial Peripheral Interface

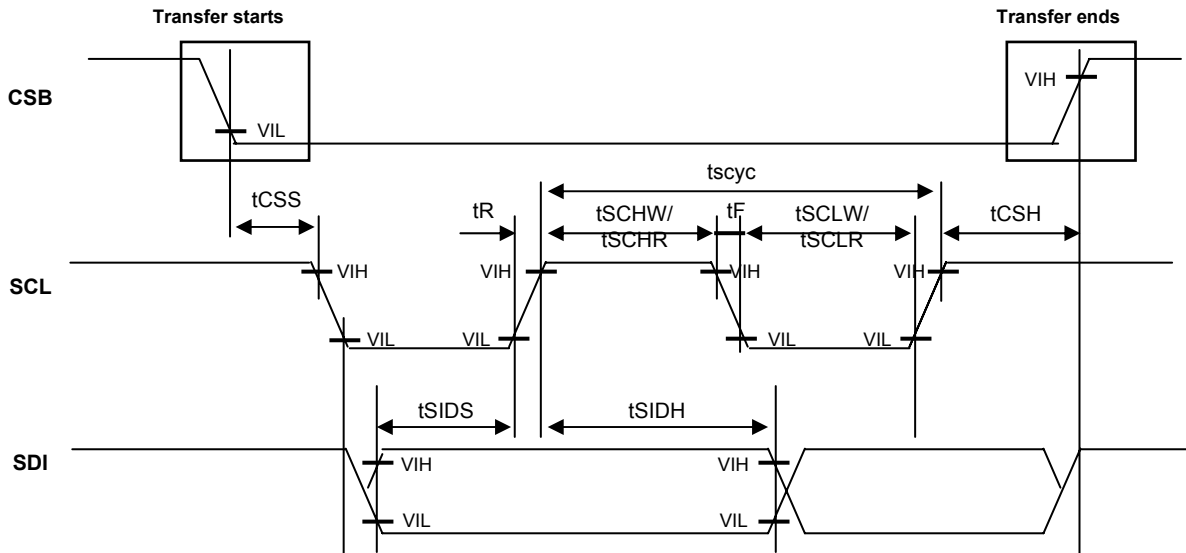
8-2-1. Serial Peripheral Interface Timing



[Note] RS="0" [Index], RS="1" [Instruction]

Product Specification

8-2-2. Clock Synchronized Serial Mode Characteristics

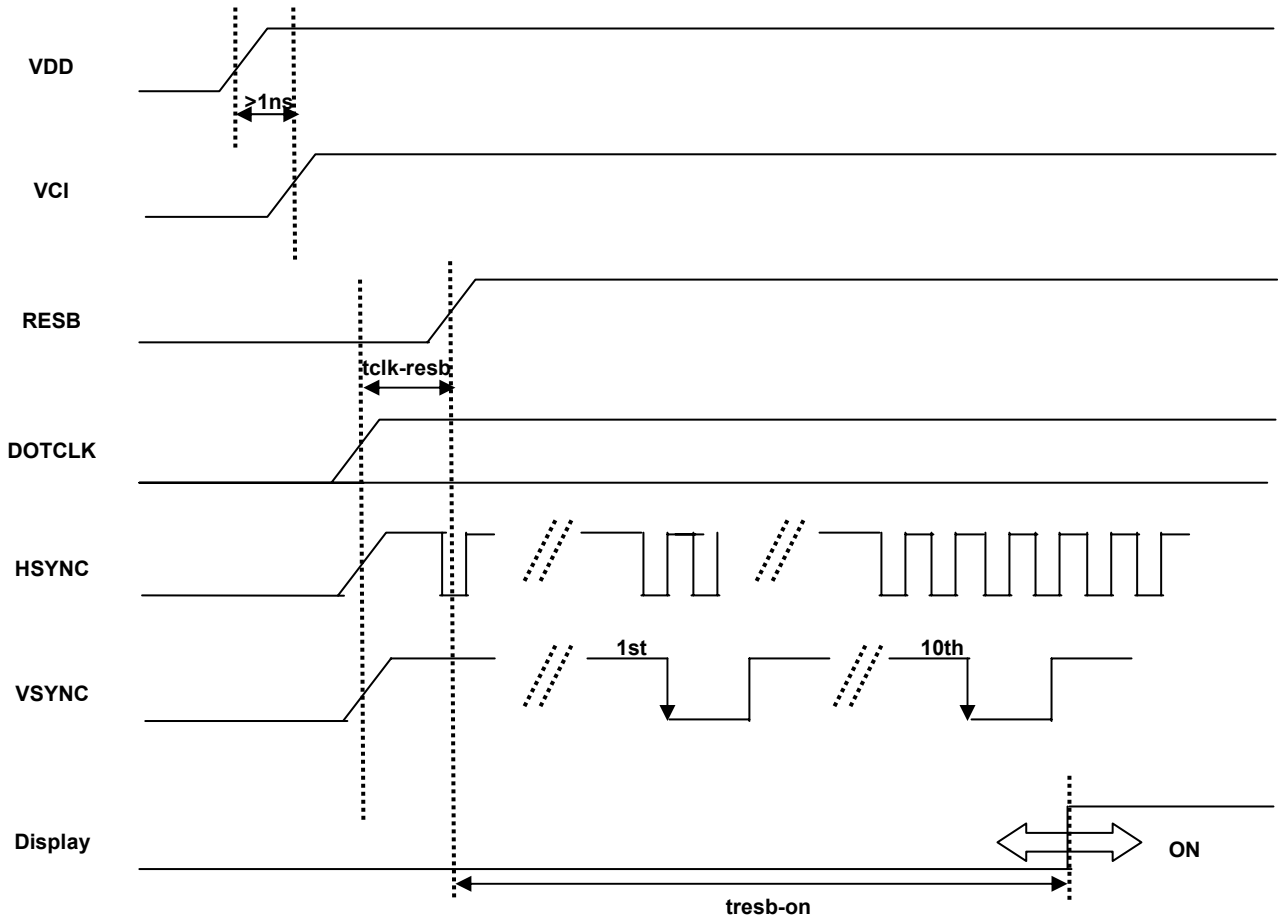


PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Serial Clock Cycle Time	tscyc	100	-	ns
Serial Clock Rise/Fall Time	tR,tF	-	2	
Pulse Width High For Write	tSCHW	30	-	
Pulse Width High For Read	tSCHR	50	-	
Pulse Width Low For Write	tSCLW	30	-	
Pulse Width Low For Read	tSCLR	50	-	
Chip Select Setup Time	tCSS	20	-	
Chip Select Hold Time	tCSH	50	-	
Serial Input Data Setup Time	tSIDS	30	-	
Serial Input Data Hold Time	tSIDH	30	-	

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9. Power On/Off Sequence

9-1. Power On Sequence



Characteristics	SYMBOL	MIN.	Typ.	MAX.	Units
DOTCLK to rising edge of RESB	$t_{clk-resb}$ (Note)	10	-	-	us
Rising edge of RESB to display start - 1 line : 408 clk - 1 frame : 262 line - DOTCLK = 6.5MHz	$t_{resb-on}$	-	-	11	frame

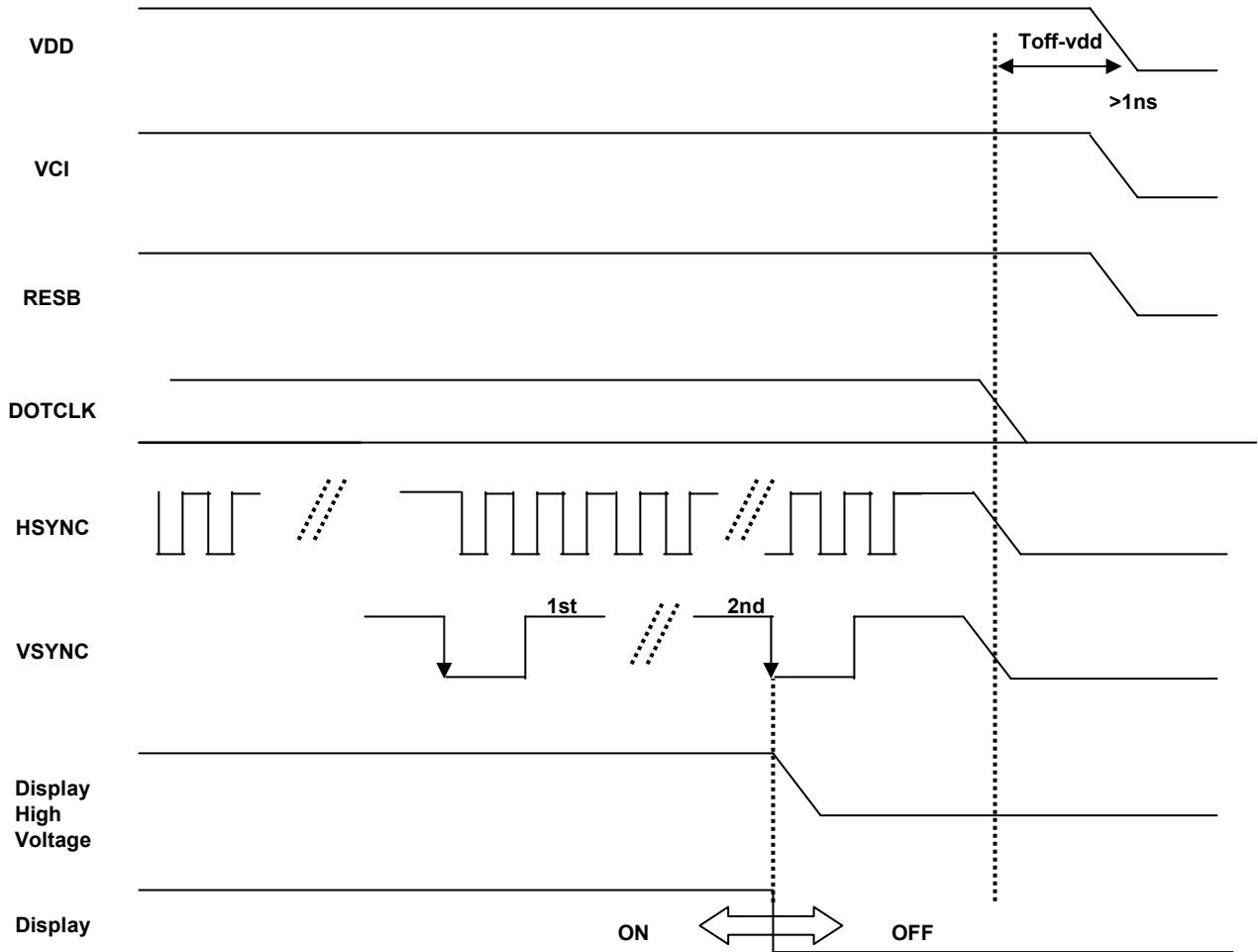
[Note] It is necessary to input DOTCLK before the rising edge of RESB.

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9-2. Initial Code

No.	Register	Value	Contents
1	H01	6300	Driver Output
2	H02	0200	LCD Driving Waveform Control
3	H03	0117	Power Control 1
4	H04	04C7	Input Data & C/F Control
5	H05	FFC0	Function Control
6	H06	E806	-
7	H0A	4008	Contrast / Brightness Control
8	H0B	0000	Frame Cycle Control
9	H0D	0030	Power Control 2
10	H0E	2800	Power Control 3
11	H0F	0000	Gate Scan Position
Porch			
12	H16	9F80	Horizon Porch
13	H17	0A0F	Vertical Porch
14	H1E	00C1	Power Control 4
Gamma Collection			
15	H30	0300	-
16	H31	0007	-
17	H32	0000	-
18	H33	0000	-
19	H34	0707	-
20	H35	0004	-
21	H36	0302	-
22	H37	0202	-
23	H3A	0A0D	-
24	H3B	0806	-

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9-3. Power Off Sequence



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10. Reliability Test

NO	TEST ITEMS	CONDITION	REMARK
1	High Temperature Storage Test	Ta = 80℃ 240h	-
2	Low Temperature Storage Test	Ta = -30℃ 240h	-
3	High Temperature Operation Test	Ta = 70℃ 240h	-
4	Low Temperature Operation Test	Ta = -20℃ 240h	-
5	High Temperature and High Humidity Operation Test	Ta = 60℃ 90%RH 240h	-
6	Shock Test (operating)	Operation, 180G, 2msecm Half sine ±X, ±Y, ±Z per 1time	-
7	Vibration Test (operating)	Random Operation 10~200~10Hz, 0.37Oct/min, 2.0G X/Y/Z direction, Per 1Hour	-
8	Thermal Shock Test	-30℃ (0.5h) ~ 80℃ (0.5h) / 10cycle	-

[Note]

T_a = Ambient Temperature

In the standard condition, there shall be no practical problems that may affect the display function.

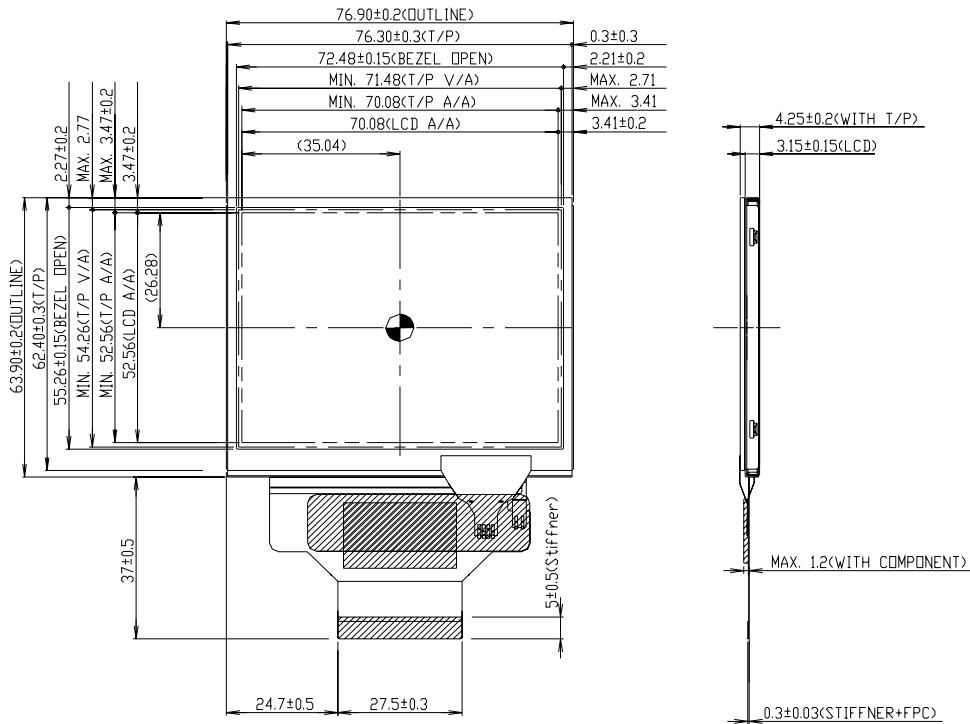
Result Evaluation Criteria

TFT- LCD Module should be at room temperature for 2 hours when the display quality test is over. There should be no particular change which might affect the practical display function and the display quality test should be conducted under normal operating condition.

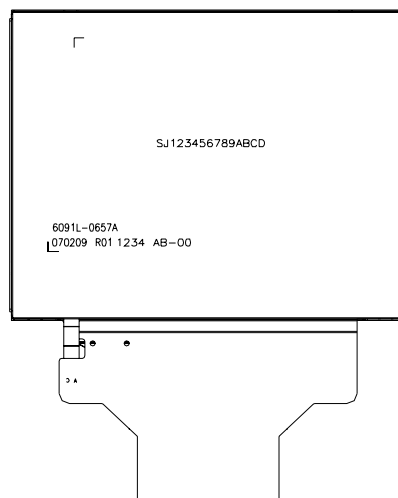
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11. Outline Dimension

11-1. Front View



11-2. Rear View

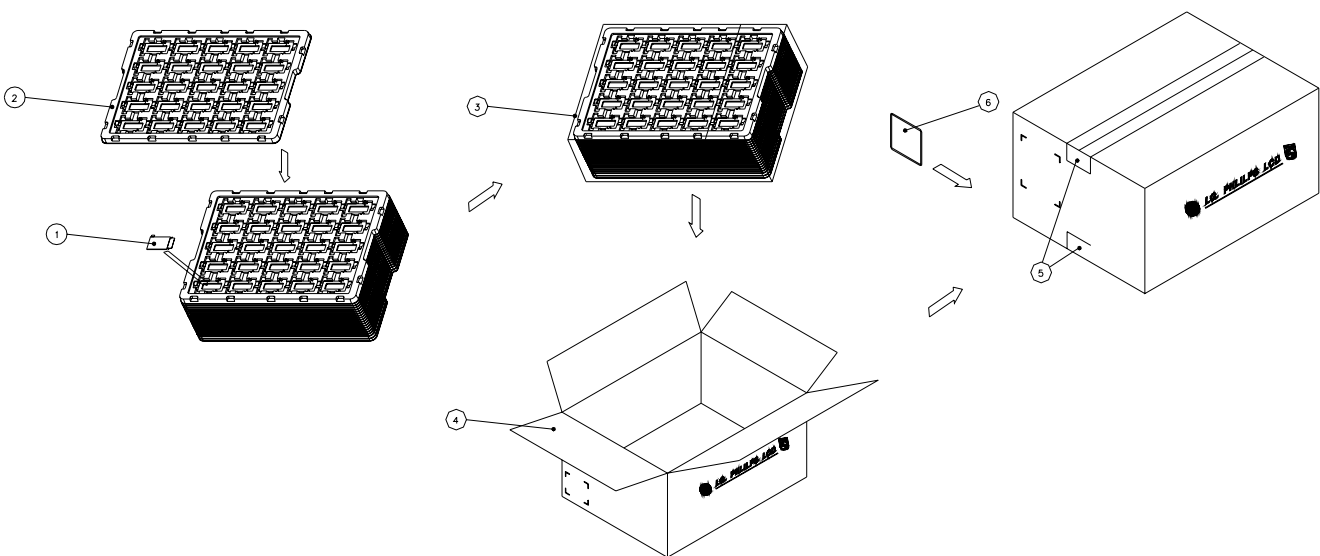


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12. Packing

12-1. Packing Form

- a) Package quantity in one box : 135 pcs
- b) Box Size : 475mm × 348mm × 210mm
- c) 1Box = tray 15 + 1 tray(dummy , top) = 16 tray



NO.	Description	Material
1	Module	
2	Packing, Tray	PET(0.8t)
3	Bag	PE 560x 830
4	Box	SWR4 378x324x112
5	Tape	OPP 70MMx300m
6	Label	Art Paper 100x70

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13. Precautions

Please pay attention to the following when you use this TFT LCD module.

13-1. Mounting Precautions

- <1> You may mount a module using four corner sides.
- <2> You should consider the mounting structure so that uneven force(ex. Twisted stress) is not applied to the module.
And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- <3> Please attach a transparent protective plate to the surface in order to protect the polarizer.
Transparent protective plate should have sufficient strength in order to resist external force.
- <4> You should adopt radiation structure to satisfy the temperature specification.
- <5> Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- <6> Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics deteriorate the polarizer.)
- <7> When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone and toluene because they cause chemical damage to the polarizer.
- <7> Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- <8> Do not open the case because inside circuits do not have sufficient strength.
- <9> The metal case of a module should be contacted to electrical ground of your system.

13-2. Operating Precautions

- <1> The spike noise causes the disoperation of circuits. It should be lower than following voltage
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- <2> Response time depends on the temperature.(In lower temperature, it becomes longer.)
- <3> Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
- <4> Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- <5> When fixed patterns are displayed for a long time, remnant image is likely to occur.
- <6> Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.

Product Specification

13-3. Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

13-4. Precautions For Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

13-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

- <1> Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- <2> The polarizer surface should not come in contact with any other object.
- <3> The warranty for storage of the color TFT-LCD module shall be in compliance with the Incoming Inspection standard.

13-6. Handling Precautions For Protection Film

- <1> When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- <2> The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt to remain on the polarizer.
Please carefully peel off the protection film without rubbing it against the polarizer.
- <3> When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
- <4> You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.