Preliminary

Ver 0.2

TFT LCD Specification

Model NO.: TD0028TTEE1

Customer Signature
Date

Table of Contents

Record of Reversion

Rev	Issued Date	Description
0.0	20, Jun, 2007	New Create
0.1	28, Apr, 2008	1. Add connector: FH23-39S-0.3SHW and update pin14 in 3.1 TFT LCD module 2. Update backlight and touch panel voltage in 4.ABSOLUTE MAXIMUM RATINGS 3. Update power consumption to TBD.in 5.1 Driving TFT LCD Panel 4. Update Forward Current voltage in 5.2 Driving backlight 5. Update 5.3 Driving touch panel (Analog resistance type) 6. Update 10.1 Optical Specification 7. Update 14. MECHANICAL DRAWING
0.2	16, May, 2008	1. Revise Power consumption(LCD Panel + System) in 2.GENERAL SPECIFICATION and 5.1 Driving TFT LCD Panel 2. Update 14. MECHANICAL DRAWING (add AG paste area)

1. FEATURES

The 2.8 inch (real 2.83 inch) LCD module is the Transmissive active matrix color TFT LCD module. LTPS (Low Temperature Poly Silicon) TFT technology is used and COG design are built on the panel. Highly integrated LCD module includes backlight and TFT LCD panel with minimal external circuits and components required.

2. GENERAL SPECIFICATION

Item		Description	Unit
Display Size (Diagonal)		2.8 inch (real 2.83 inch)	-
Display Type		Transmissive	-
Active Area (HxV)		43.2 X 57.6	mm
Number of Dots (HxV)		480 x RGB x 640	dot
Dot Pitch (HxV)		0.03 X 0.09	mm
Color Arrangement		RGB Stripe	-
Color Numbers		262,144 (18 bits)	-
Outline Dimension (HxVxT)		52.9 X 71.7X4.1(TYP, FPC excluded)	mm
Shipment Type		COG	
Brightness		250	nits
NTSC		50	%
White Chromaticity (x,y) (Light On)		(0.31,0.33)	
Response Time		20	msec
Viewing Angle (Light On) (R/U/L/D)		55/55/55/50 @CR>10	
Gray Scale Inversion Direction		12 o'clock	
Contrast Ratio (Light On)		300:1	
Operation Temperature		-20~60	℃
Storage Temperature		-30~70	℃
Interface		Parallel RGB	
Weight		TBD	g
Power consumption	LCD Panel + System	150 (TYP.)	mW
	Backlight	264 (Typ, I_F= 20mA)	

3. INPUT/OUTPUT TERMINALS

3.1 TFT LCD module

Connector: FH23-39S-0.3SHW

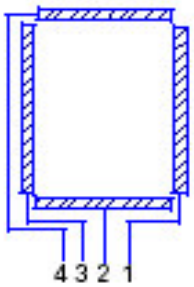
PIN No.	P/I/O	Symbol	Descriptions	Remark
1	P	LED+	B/L LED Anode	
2	P	LED-	B/L LED Cathode	
3	P	VDDIO	Power supply for I/O logic	
4	P	VDC	Power supply for analog	
5	P	VSS	GND	
6	O	YU	T/P terminal (Y-Upper)	
7	O	XL	T/P terminal (X-Left)	
8	O	YL	T/P terminal (Y-Lower)	
9	O	XR	T/P terminal (X-Right)	
10	I	XCS	Serial interface chip select	
11	I/O	DIN	Serial interface data input/output	
12	P	VSS	GND	
13	I	SCL	Serial interface clock input	
14	I	SD	Auto power on/of sequence enable input	
15	I	XRES	Reset (low active)	
16	I	B0	BLUE signal 0(LSB)	
17	I	B1	BLUE signal 1	
18	I	B2	BLUE signal 2	
19	I	B3	BLUE signal 3	
20	I	B4	BLUE signal 4	
21	I	B5	BLUE signal 5 (MSB)	
22	I	G0	GREEN signal 0(LSB)	
23	I	G1	GREEN signal 1	
24	I	G2	GREEN signal 2	
25	I	G3	GREEN signal 3	
26	I	G4	GREEN signal 4	
27	I	G5	GREEN signal 5 (MSB)	
28	I	R0	RED signal 0 (LSB)	
29	I	R1	RED signal 1	
30	I	R2	RED signal 2	
31	I	R3	RED signal 3	
32	I	R4	RED signal 4	

33	I	R5	RED signal 5 (MSB)	
34	P	VSS	GND	
35	I	PCLK	Clock signal for Display Data	
36	P	VSS	GND	
37	I	VSYNC	Vertical synchronous for Display DATA	
38	I	HSYNC	Horizontal synchronous for Display DATA	
39	I	DE	Enable signal for Display	

3.2 Touch panel Pin

Touch Panel Pin	Module Pin	Symbol	Description	Remark
1	9	XR	Touch Panel Right Side	
2	8	YL	Touch Panel Lower Side	
3	7	XL	Touch Panel Left Side	
4	6	YU	Touch Panel Upper Side	

Pin assignment for touch panel:

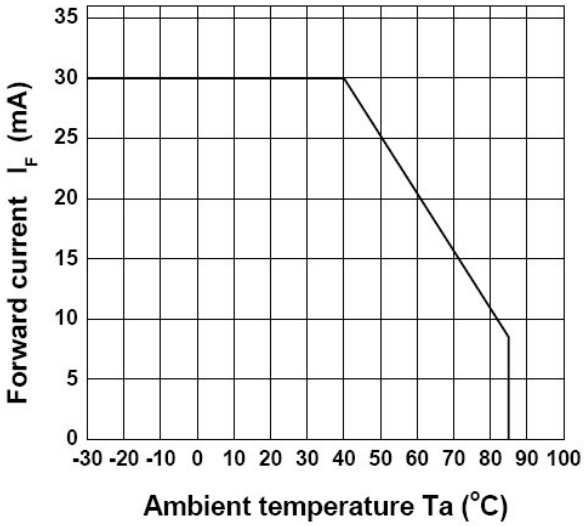


4. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	MIN	MAX	Unit	Remark
Logic Supply Voltage	VDDIO	+1.6	+3.6	V	
Analog Supply Voltage	VDC	+2.7	+3.6	V	
Touch Panel Operation Voltage	V_{Touch}	-	5	V	
Backlight LED forward Voltage	V_F	3.0	3.3	V	
Backlight LED reverse Voltage	V_R	-	5	V	
Backlight LED forward current (Ta=25℃)	I_F	-	--	mA	Note 2
Operating Temperature	Topr	-20	60	℃	
Storage Temperature	Tstg	-30	70	℃	

Note 1. Reference voltages must satisfy the following relationship: VDC ≧ VDDIO.

Note 2. Relation between maximum LED forward current and ambient temperature is showed as bellow.



5. ELECTRICAL CHARACTERISTICS

5.1 Driving TFT LCD Panel

Ta=25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Supply Voltage	VDDIO	+1.6	+2.8	+3.6	V	
	VDC	+2.7	+2.8	+3.6	V	
Input Voltage	VIL	VSS	—	0.2VDDIO	V	Note 1
	VIH	0.8VDDIO	—	VDDIO	V	
Output Voltage	VOL	VSS	—	0.3VDDIO	V	DIN/DOUT
	VOH	0.7VDDIO	—	VDDIO	V	
Power consumption	Power	—	150	—	mW	Note 2

Note 1: Related pins: VSYNC, HSYNC, DE, PCLK, XRES, XCS, SCL, DIN, and PD0-17

Note 2: The supply current specification is measured at the line inversion test pattern (Color bar vertical as the diagram shown below).

5.2 Driving backlight

Ta=25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Forward Current	I_F	-	20	-	mA	LED/Part
LED Life Time	-	-	10000	-	Hr	I_F: 20mA
Forward Current Voltage	V_F	12	-	13.2	V	I_F: 20mA, LED/Part

Note : Backlight driving circuit is recommend as the fix current circuit.

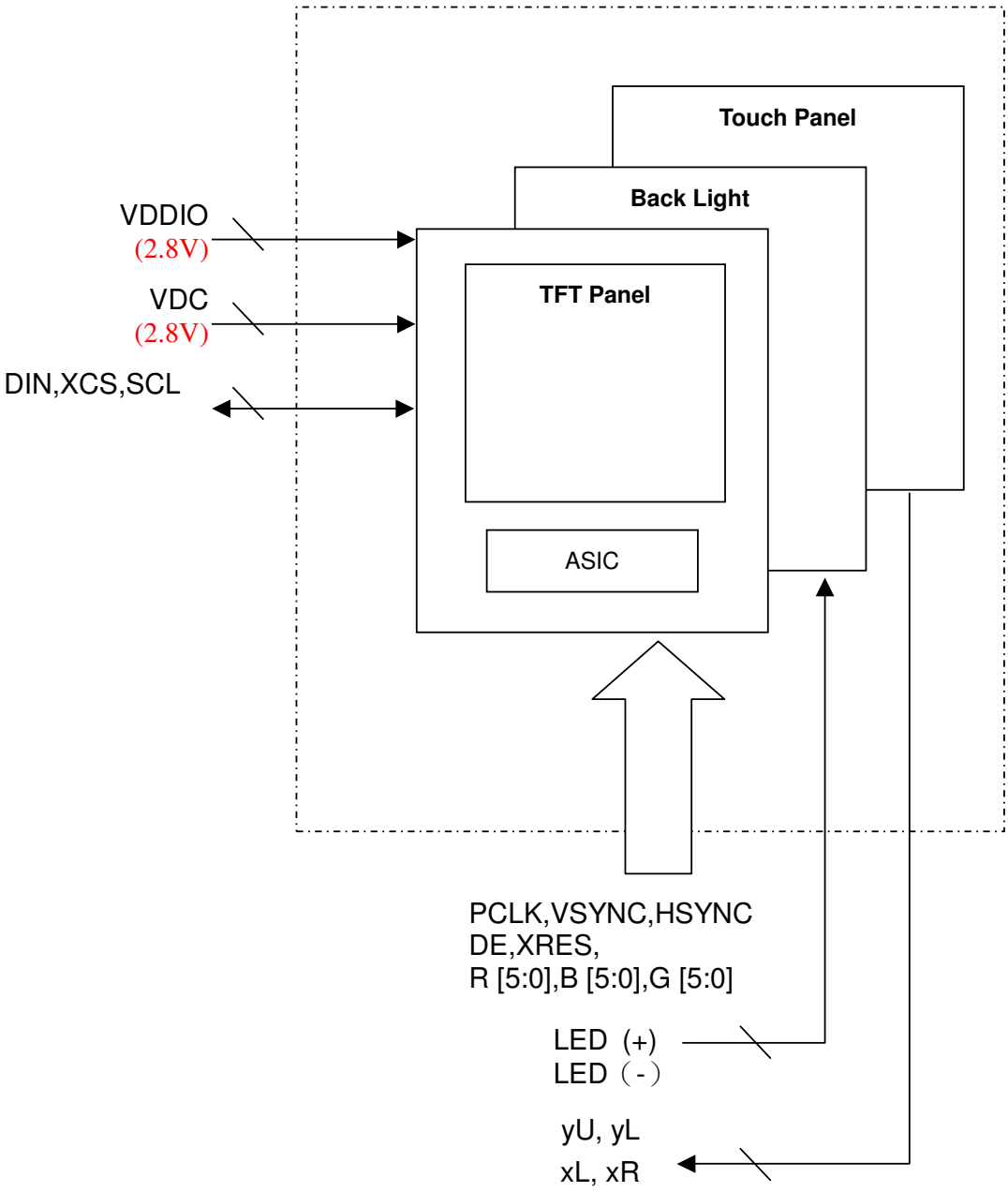
5.3 Driving touch panel (Analog resistance type)

Ta=25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Resistor between terminals (XR-XL)	Rx	250	-	950	Ω	Note 2
Resistor between terminals (YU-YL)	Ry	250	-	950	Ω	
Operation Voltage	V_{Touch}	-	5.0		V	DC
Line Linearity (X direction)	-	-1.5	-	+1.5	%	
Line Linearity (Y direction)	-	-1.5	-	+1.5	%	
Chattering	-	-	-	10	ms	
Surface Hardness	-	3	-	-	H	JIS K 5600
Minimum tension for detecting	-	-	-	80	g	
Insulation Resistance	Ri	20	-	-	MΩ	At DC 25V

Note: The maximum test force is 80 g.

6. BLOCK DIAGRAM



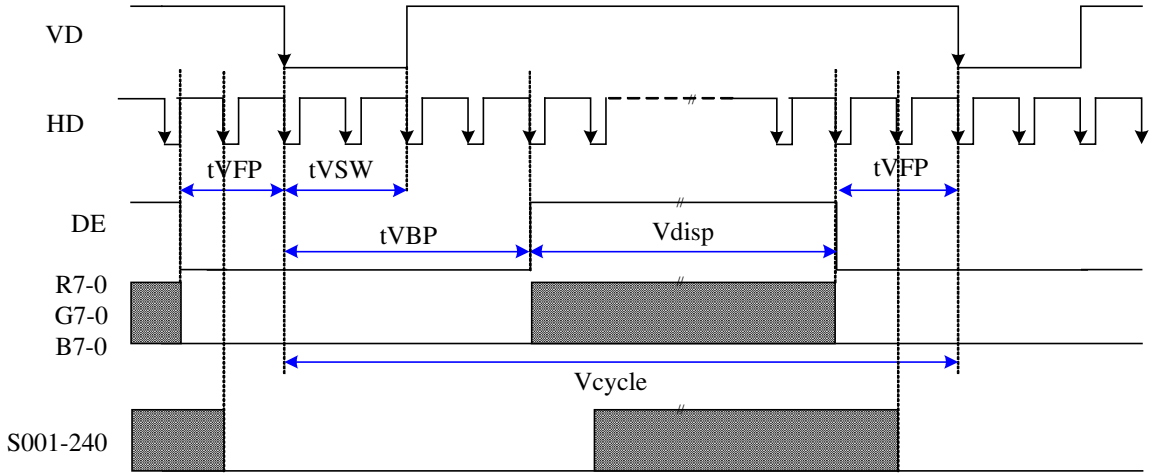
7. TIMING CHART

7.1 Display timing

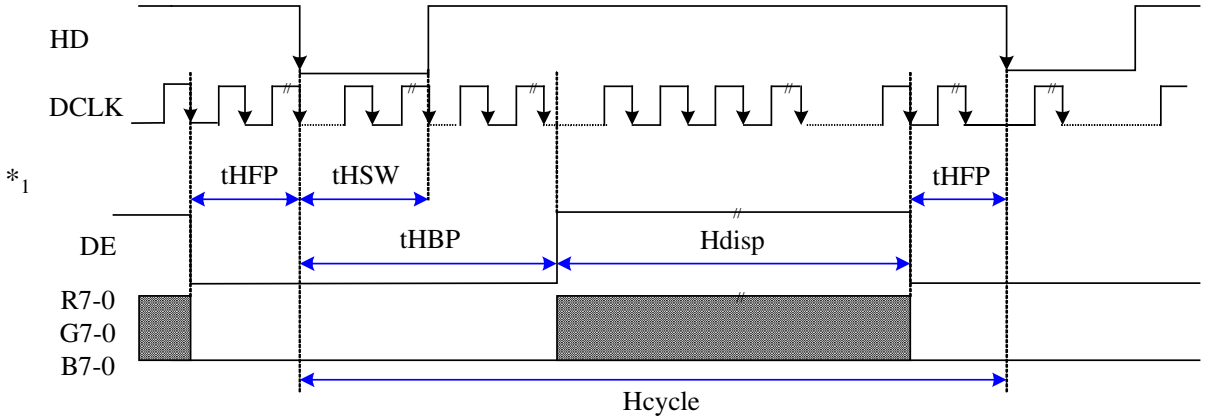
Display Mode	Parameter	Symbol	Conditions	Ratings			Unit
				MIN	TYP	MAX	
Normal	Vertical cycle	Vcycle		--	646	--	Line
	Vertical Sync Pulse width	tVSW		--	2	--	Line
	Vertical front porch	tVFP		--	2	--	Line
	Vertical Back porch	tVBP		--	4	--	Line
	Vertical active area	Vdisp		--	640	--	Line
	Horizontal cycle	Hcycle		--	520	--	dot
	Horizontal front porch	tHFP		--	20	--	dot
	Horizontal Sync Pulse width	tHSW		--	10	--	dot
	Horizontal Back porch	tHBP		--	10	--	dot
	Horizontal active area	Hdisp		--	480	--	dot
	Clock frequency	fclk		--	20	30	MHz
		tclk		--	50	33.3	nS

7.2 Input timing chart

＜Vertical Timing chart＞



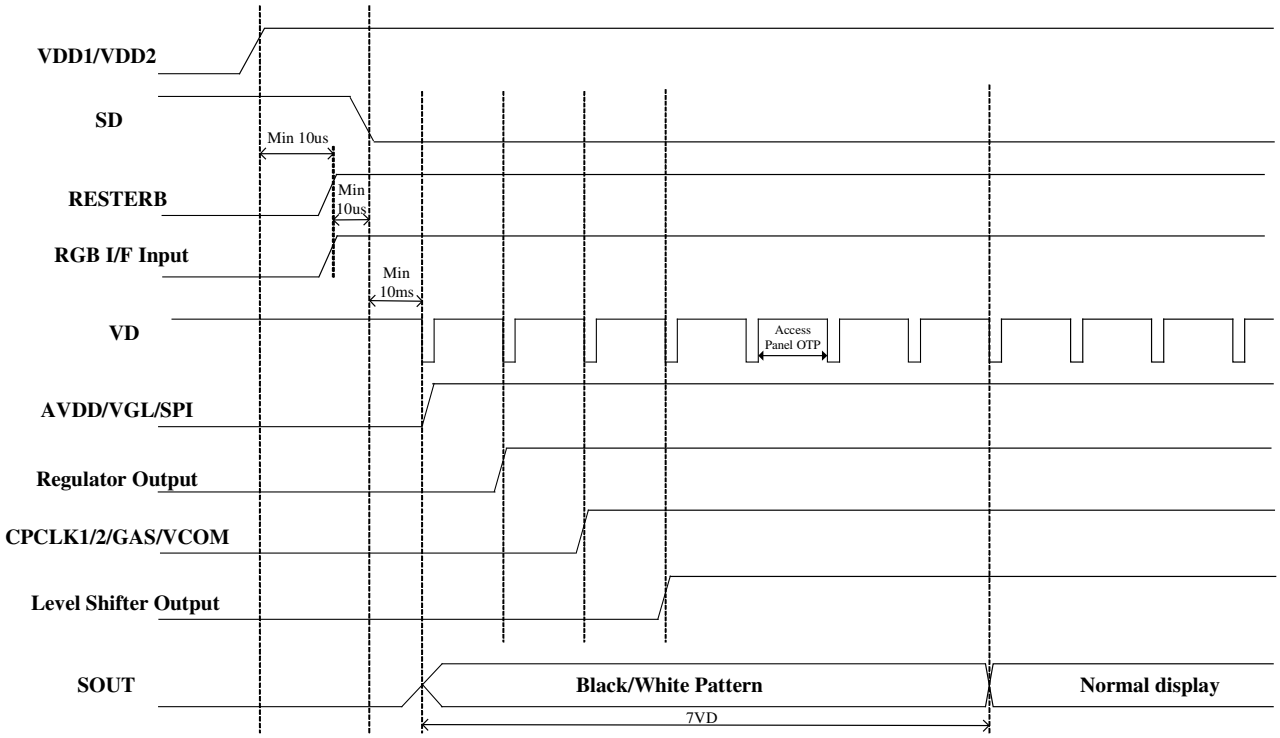
＜Horizontal Timing chart＞



Note: The frequency of CLK should be continued whether in display or blank region to ensure IC operating normally.

8. POWER ON/OFF SEQUENCE

8.1 Power on sequence

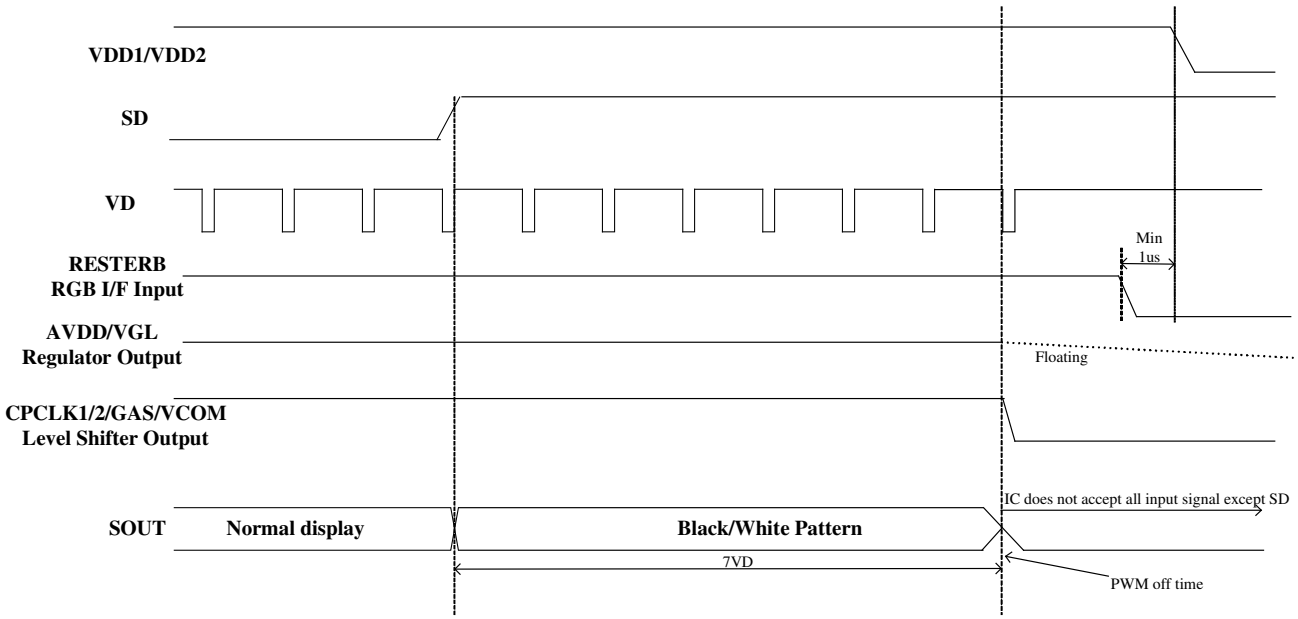


NOTE 1: RGB I/F Input → HD, DCLK, DE, R[7:0], G[7:0], B[7:0]

NOTE 2: Regulator Output → VREGP, VDDP, VR, VREGN, VDDN, VMN

NOTE 3: Level shifter output → STV, CKV1/2, CKH1/2/3/4/5/6, XCKH1/2/3/4/5/6, ENBV, XENBV

8.2 Power off sequence



NOTE 1: RGB I/F Input → HD, DCLK, DE, R[7:0], G[7:0], B[7:0]

NOTE 2: Regulator Output → VREGP, VDDP, VR, VREGN, VDDN, VMN

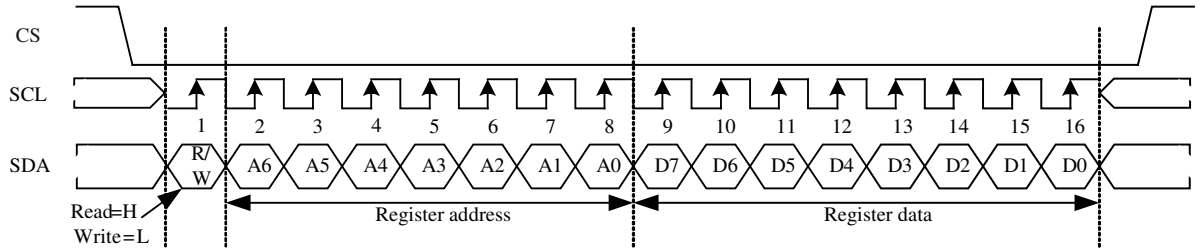
NOTE 3: Level shifter output → STV, CKV1/2, CKH1/2/3/4/5/6, XCKH1/2/3/4/5/6, ENBV, XENBV

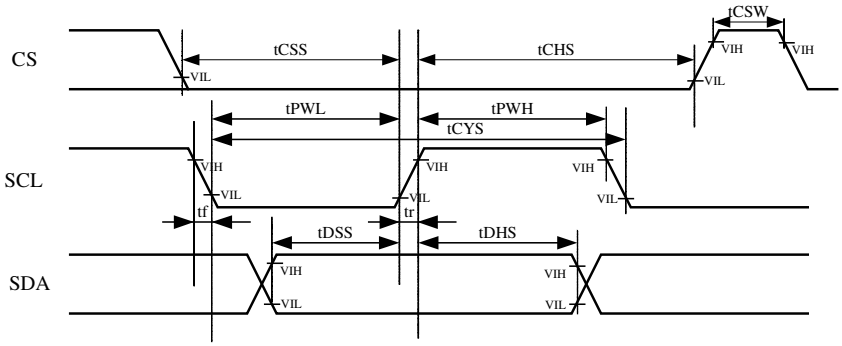
9. SERIAL INTERFACE

The LCM support the 3-Wire serial interface to set internal register. Read/Write bit D/C, Serial address D7 to D0 (DIN) and serial data D7 to D0 (DOUT) are read at the rising edge of the serial clock, via the serial input pin. This data is synchronized on the rising edge of eighth serial clock and is then converted to parallel data. The serial interface signal timing chart is shown below.

9.1 Serial Interface Signal Timing Chart

L1K0-02 Support the 3-pin serial peripheral interface (SPI) to set internal register. Read/Write bit RW, Serial address A6 to A0 and serial data D7 to D0 are read at the rising edge of the serial clock, via the serial input pin. This data is synchronized on the rising edge of eighth serial clock and is then converted to parallel data. The serial interface signal timing chart is shown below.





Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Clock cycle	tCYS	-	150	-	-	ns
Clock high period	tPWH	-	60	-	-	ns
Clock low period	tPWL	-	60	-	-	ns
Data set-up time	tDSS	-	60	-	-	ns
Data hold tome	tDHS	-	60	-	-	ns
CS high width	tCSW	-	1	-	-	us
CS set-up time	tCSS	-	60	-	-	ns
CS hold time	tCHS	-	70	-	-	ns

Note 1: Every SPI command data length must meet 16 SCL

Note 2: SPI command will be erased when RESTB is active

10. OPTICAL CHARACTERISTICS

10.1 Optical Specification

Back Light On /w Touch panel

Ta=25℃

Item	Symbol		Condition	MIN	TYP	MAX	Unit	Remarks
Viewing Angles	Θ11(R)		CR ≥ 10	50	55	-	Degree	Note 10-1
	Θ12(L)			50	55	-		
	Θ21(U)			50	55	-		
	Θ22(D)			45	50	-		
Response Time	Tr+Tf		Θ=0°	-	20	30	ms	Note 10-5
Contrast Ratio	CR		Θ=0°	180:1	300:1	-	-	Note 10-6
Luminance	L		Θ=0° I_F =20	160	230	-	nits	Note 10-7
NTSC	-		-	40	50	-	%	Note 10-7
Uniformity	-		-	75	80	-	%	Note 10-8
Chromaticity	White	x	Θ=0°	0.26	0.31	0.36		Note 10-9
		y		0.28	0.33	0.38		

10.2 Basic measure condition

10.2.1 Driving voltage

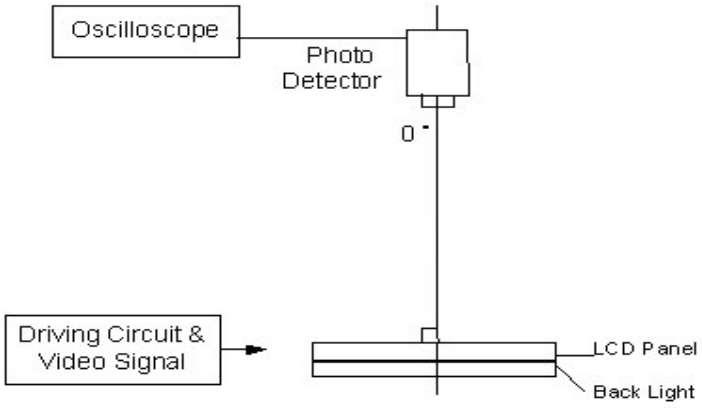
VDD= 12.0V, VEE=-6.5V

10.2.2 Ambient temperature: Ta=25℃

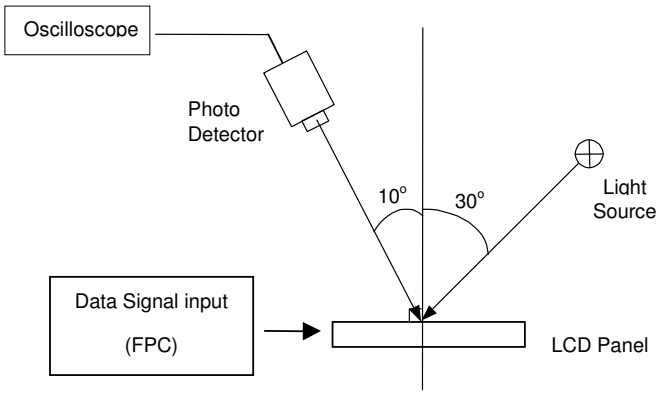
10.2.3 Testing point: measure in the display center point and the test angle Θ=0°

10.2.4 Testing Facility: Environmental illumination: ≦1 Lux

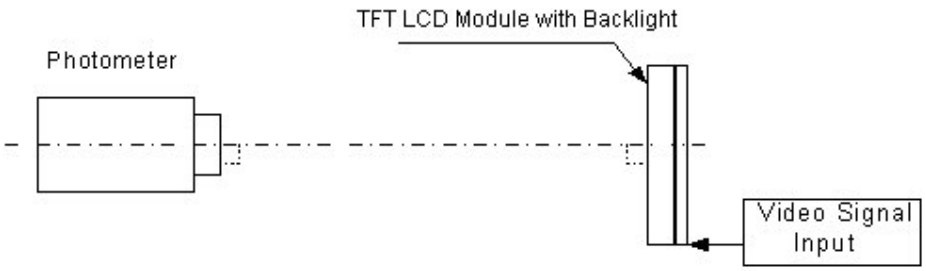
a. System A (DMS900 series)



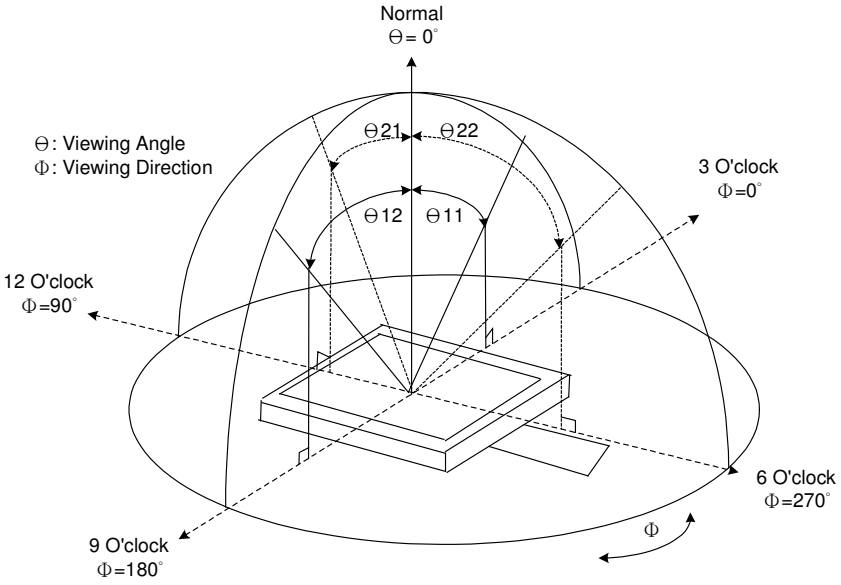
b. System B (DMS900 series)



c. System C (BM5A)



Note 10-1: Viewing angle diagrams (Measure System A)



Note 10-2: Contrast ratio in back light off (Measure System A)

Contrast Ration is measured in optimum common electrode voltage.

$$CR = \frac{\text{Luminance with white image}}{\text{Luminance with black image}}$$

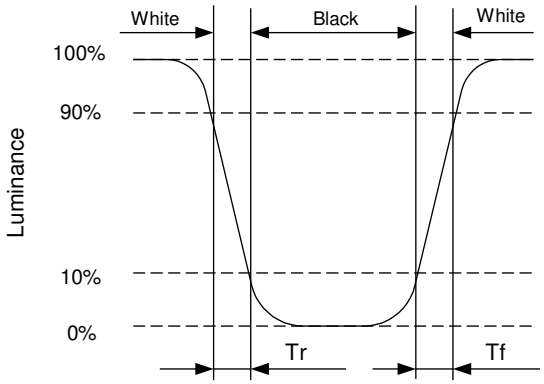
Note 10-3: White chromaticity as back light off: (Measure System A),

Note 10-4: Reflectivity (R%) (Measure System B)

In the measuring system A. calculate the reflectance by the following formula.

$$\text{Reflectivity(R)} = \frac{\text{Output from the white display panel}}{\text{Output from the reflectance standard}} \text{ X } \text{Reflectance factor of reflectance standard}$$

Note 10-5: Definition of response time: (Measure System C)



Note 10-6: Contrast Ratio in back light On (Measure System A)

Contrast Ration is measured in optimum common electrode voltage.

$$CR = \frac{\text{Luminance with white image}}{\text{Luminance with black image}}$$

Note 10-7: Luminance: (Measure System A_ Spectrum meter)

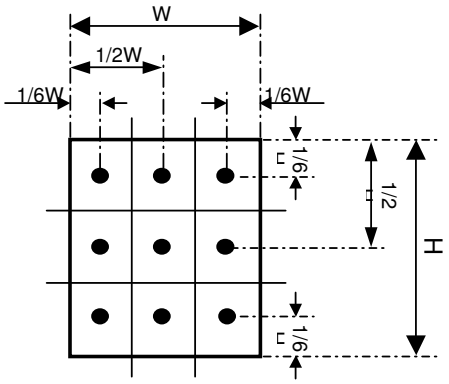
Test Point: Display Center

Note 10-8: Uniformity (Measure System C)

The luminance of 9 points as the black dot in the figure shown below are measured and the uniformity is defined as the formula:

$$\text{Uniformity} = \frac{\text{The minimum luminance among 9 points}}{\text{The maximum luminance among 9 points}}$$

Note 10-9: White chromaticity as back light on and NTSC (Measure System A_Spectrum)



Active Area (W x H)

11. RELIABILITY

No	Test Item	Condition
1	High Temperature Operation	Ta=+60℃, 240hrs
2	High Temperature & High Humidity Operation	Ta=+40℃, 95% RH, 240hrs
3	Low Temperature Operation	Ta= -20℃, 240hrs
4	High Temperature Storage (non-operation)	Ta=+70℃, 240hrs
5	Low Temperature Storage (non-operation)	Ta= -30℃, 240hrs
6	Thermal Shock (non-operation)	-30℃ ← → 70℃, 50 cycles 30 min 30 min
7	Vibration (non-operation)	Frequency: 10~55Hz; Amplitude: 1.5mm Sweep Time: 11min Test Time: 2 hrs for each direction of X, Y, Z
8	Shock (non-operation)	Acceleration: 100G; Period: 6ms Directions: ±X, ±Y, ±Z; Cycles: Three times
9	Pin Activation Test (Touch Panel)	Hit 1,000,000 times with a silicon rubber of R8 HS 60. Hitting Force: 250g Hitting Speed: 3 time/sec
10	Writing Friction Resistance Test (Touch Panel)	Pen: 0.8R Polyacetal stylus Load: 250g Speed: 3 Strokes/sec Stroke: 35mm 100000 times

12. HANDING CAUTIONS

12.1 ESD (Electrical Static Discharge) strategy

ESD will cause serious damage of the panel, ESD strategy is very important in handling. Following items are the recommended ESD strategy

12.1.1 In handling LCD panel, please wear gloves with non-charged material. Using the conduction ring connect wrist to the earth and the conducting shoes to the earth is necessary.

12.1.2 The machine and working table for the panel should have ESD protection strategy.

12.1.3 In handling the panel, ionized air flowing decrease the charge in the environment is necessary.

12.1.4 In the process of assemble the module, shield case should connect to the ground.

12.2 Environment

12.2.1 Working environment should be clean room.

12.2.2 Because touch panel has protective film on the surface, please remove the protection film slowly with ionizer to prevent the electrostatic discharge.

12.3 Touch panel

12.3.1 The front touch panel is vulnerable to heavy weight, so any input must be done by special stylus or by a finger. Do not put any heavy stuff on it.

12.3.2 When any dust or stain is observed on a film surface, clean it using a lens cleaner for glasses or something similar.

12.4 Others

12.4.1 Turn off the power supply before connecting and disconnecting signal input cable.

12.4.2 Because the connection area of FPC and panel is not so strong, do not handle panel only by FPC or bend FPC.

12.4.3 Water drop on the surface when panel is powered on will corrode panel electrode.

12.4.4 Before opening up the packing bag, watch out the environment for the panel storage. High temperature and high humidity environment is prohibited.

12.4.5 In the case the TFT LCD module is broken, please watch out whether liquid crystal leaks out or not. If your hand touches liquid crystal, wash your hands cleanly with water and soap as soon as possible

13. APPLICATION NOTE

13.1 Design notes on touch panel

13.1.1 Explanation of each boundary of touch panel

A. Boundary of Double-sided adhesive

a. Electrically detectable within this zone.

When holding the touch panel by housing, it needs to be held at outside of this zone.

b. Film is supported by double-sided adhesive tape.

B. Viewing area

a. Cosmetic inspection to be done for this area.

This area is set as inside of boundary of double-sided adhesive with tolerance.

b. Boundary of transparent insulation

c. Purpose is to "Help" to secure insulation.

d. Electrical insulation on this area is not guaranteed.

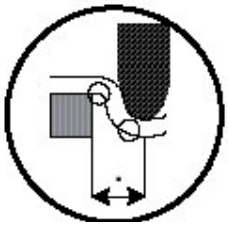
e. We do recommend not to hold this area by something like housing or gasket.

C. Active area

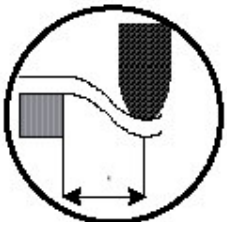
a. This area is where the performance is guaranteed.

This area set as some distance inside from the boundary area of double-sided adhesive tape since its neighboring area is less durable to writing friction.

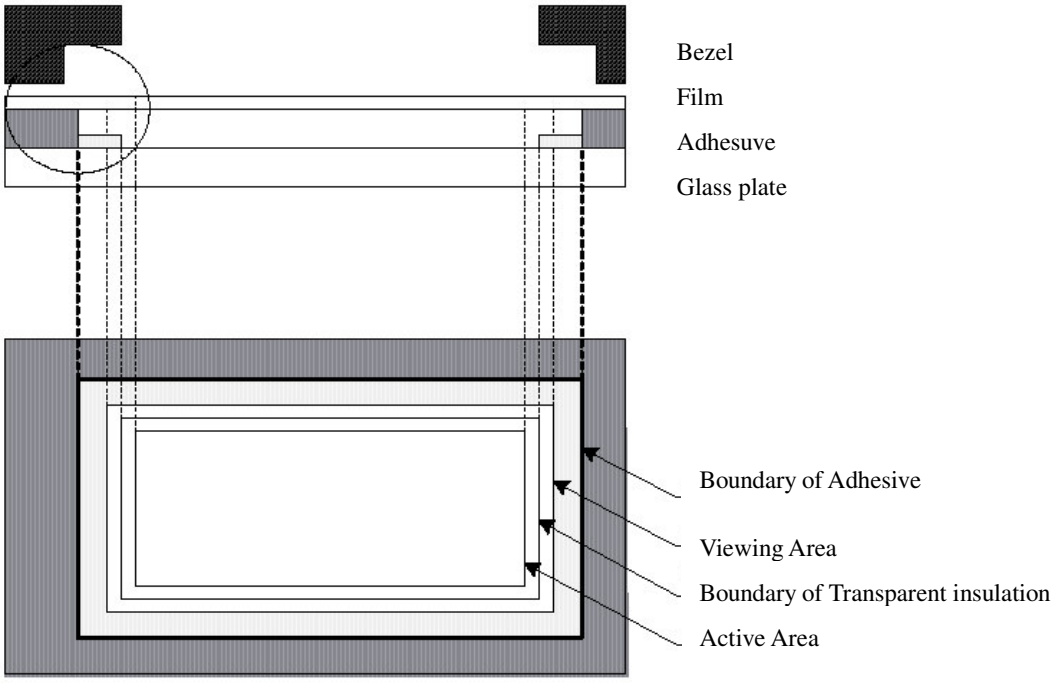
b. Please refer to the attached module drawing for the bezel opening and window size design.



There is some possibility to damage ITO



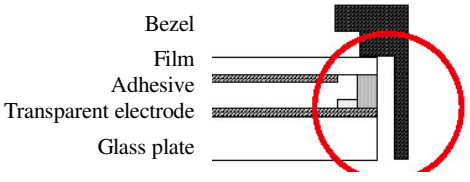
No Damage to ITO



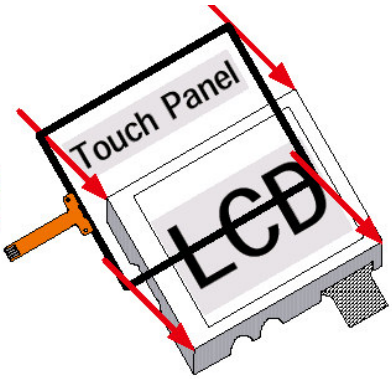
13.1.2 Housing and touch panel

A. Please have clearance between the side of touch panel, and any conductive material such as metal frame.(drawing.1) Transparent electrode exists on glass of touch panel from end to end.

B. It is recommended to fix a touch panel on the LCD module chassis rather than the touch panel housing. Clinging at conductive material and side of touch panel might cause malfunction.

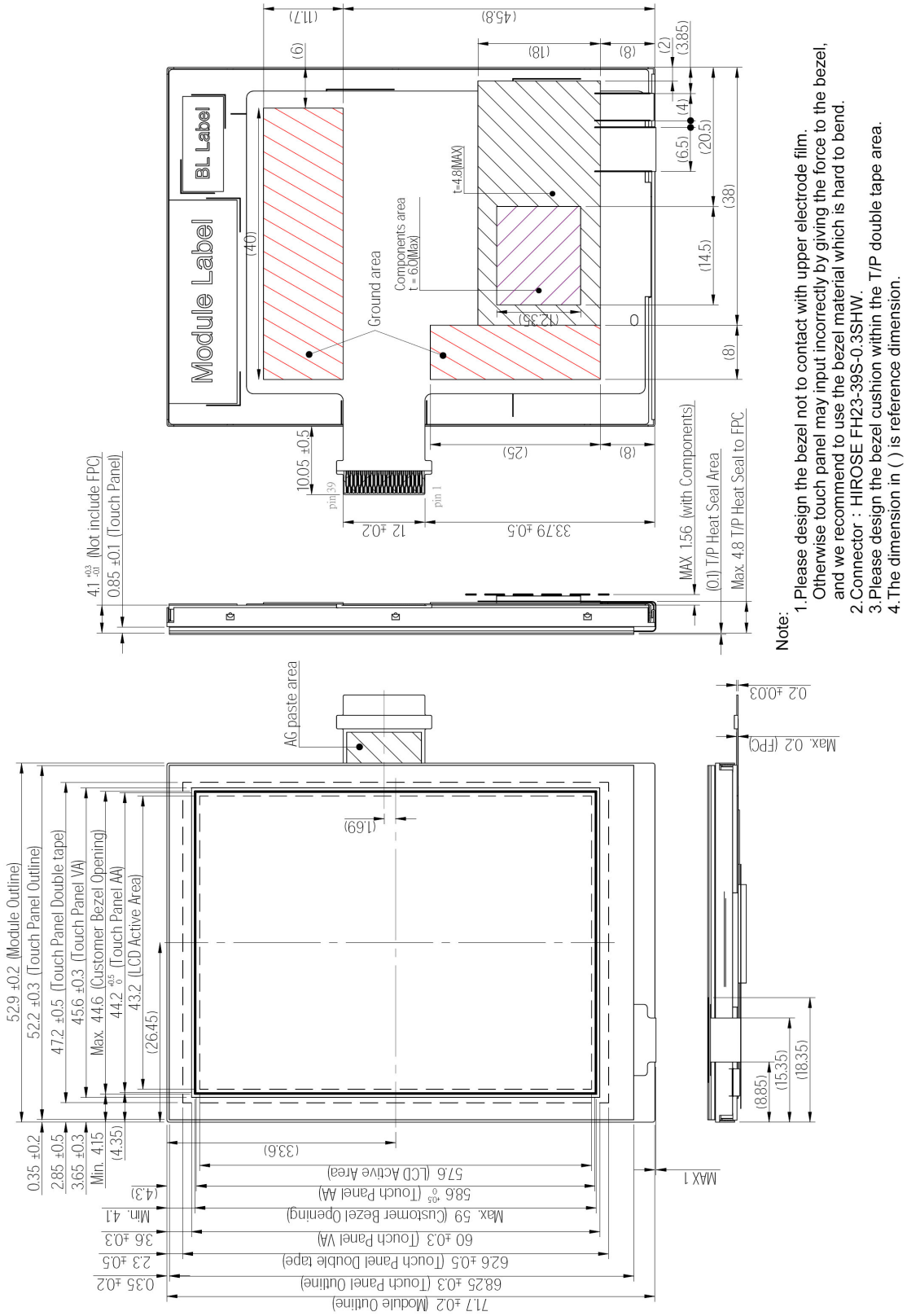


Drawing 1

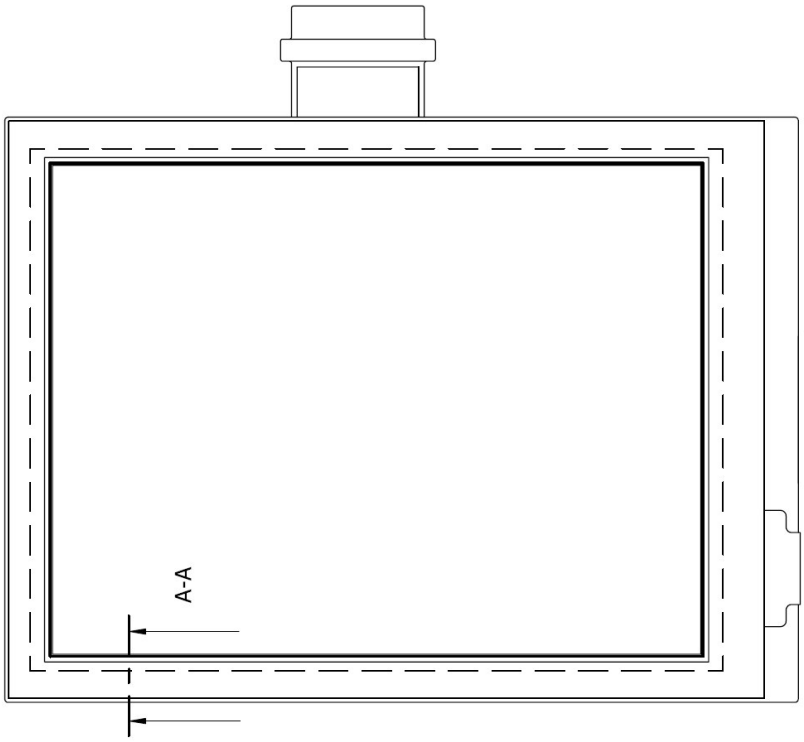


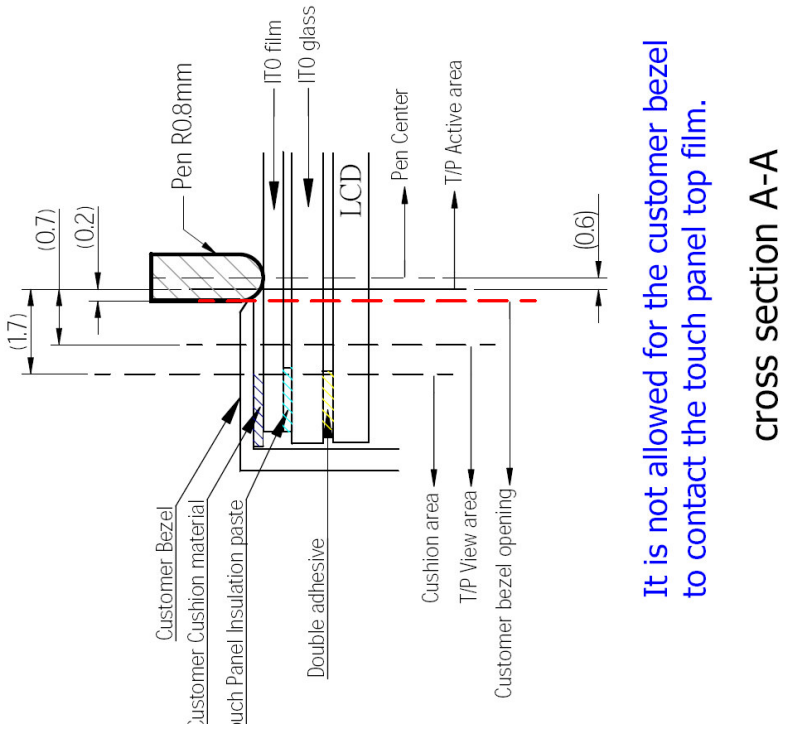
Drawing 2

14. MECHANICAL DRAWING

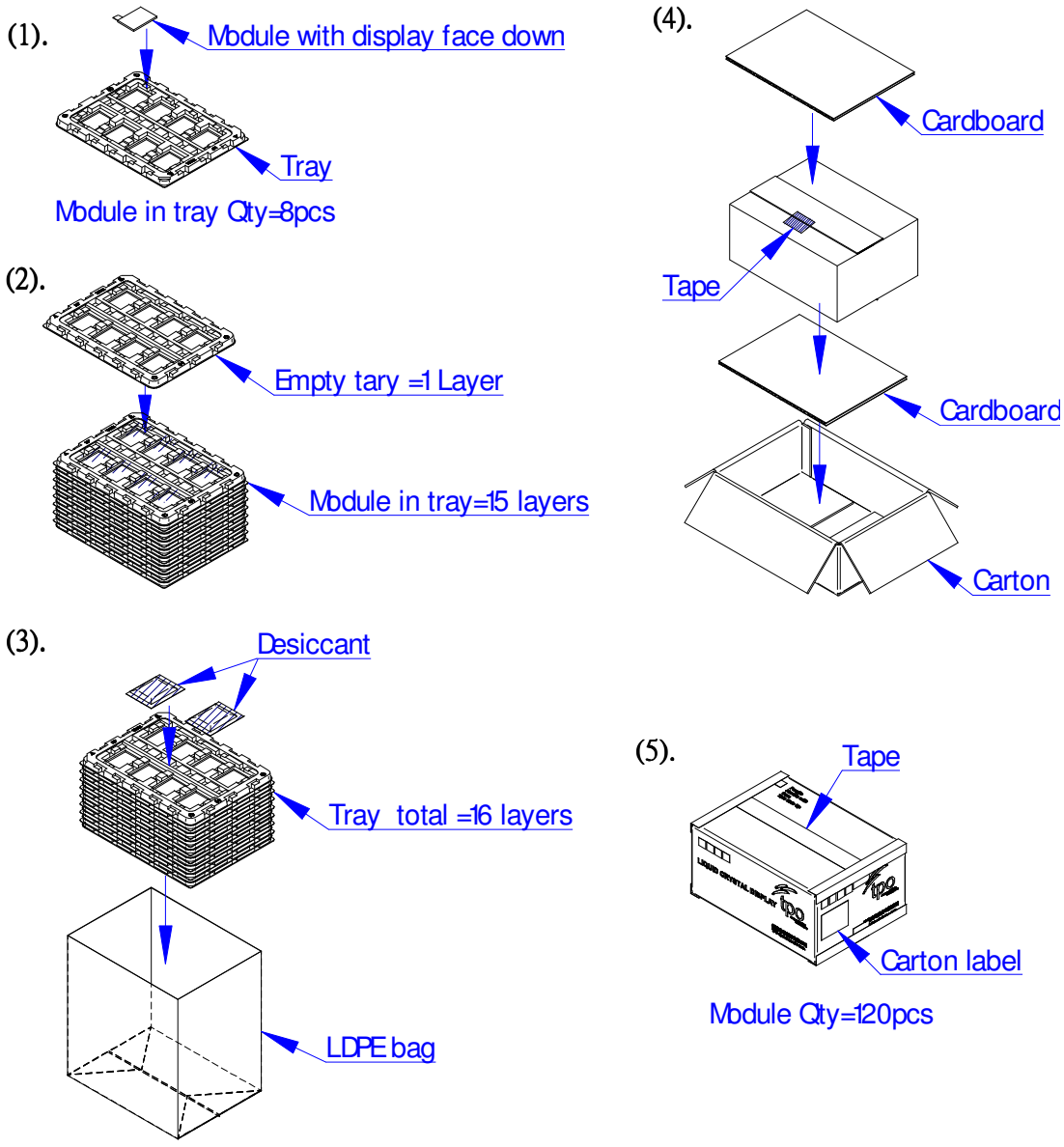


Note:
1. Please design the bezel not to contact with upper electrode film. Otherwise touch panel may input incorrectly by giving the force to the bezel, and we recommend to use the bezel material which is hard to bend.
2. Connector : HIROSE FH23-39S-0.3SHW.
3. Please design the bezel cushion within the T/P double tape area.
4. The dimension in ( ) is reference dimension.





15. PACKING DRAWING



2.8" module (TD028TTEE1) delivery packing method

15.1 Module packed into tray cavity (with module display face down).

15.2 Tray stacking with 15 layers and with 1 empty tray above the stacking tray unit.
2pcs desiccant put above the empty tray

15.3 Stacking tray unit put into the LDPE bag and fix by adhesive tape.

15.4 Put 1pc cardboard inside the carton bottom, and then pack the package unit into the carton. Put 1pc cardboard above the package unit.

15.5 Carton tapping with adhesive tape.