Specification
For
Approval

■ Preliminary specification
□ Final specification

Title	6.0WQHD LTPS TFT-LCD (Module)

Buyer	
Model	

Supplier	Cheng Du BOE Optoelectronics Technology CO., LTD
Model	BL060WHMM001

TITLE/SIGNATURE	DATE
_____	_____
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Please return one copy confirmation with signature and your comments

ITEM	SIGNATURE/DATE
Approved	_____
Reviewed	_____
Reviewed	_____
Prepared	_____

BOE CHENG DU
Optoelectronics Technology CO., LTD

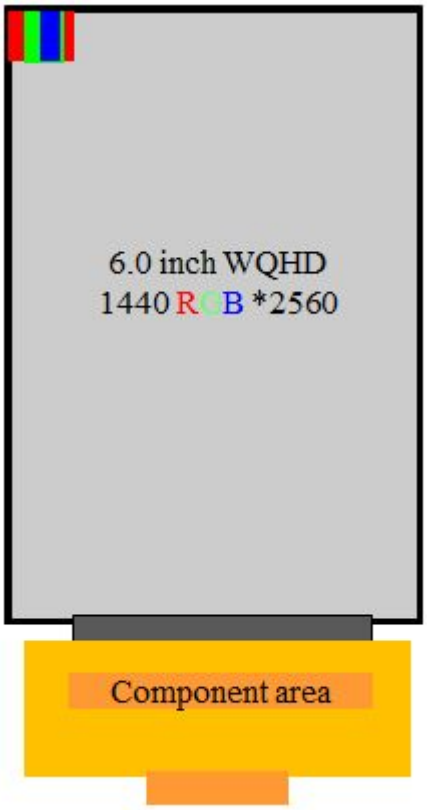
CONTENT LIST

Record of Revisions				
Revision	Date	Page	Description	Released by
Pre.0	2015.1.06		Initial Released	wanghengruo

1.0 GENERAL DESCRIPTION

1.1 Introduction

BL060WHMM001 is a color active matrix TFT-LCD Module using Low Temperature Poly Silicon Thin Film Transistors' (LTPS TFT) as an active switching devices. This model is composed of a TFT-LCD Panel, a driving circuit and a back light system. It is a transmissive type display operating in the normal black. This TFT-LCD has a 6.0 inch diagonally measured active area with WQHD resolutions (1440 horizontal by 2560 vertical pixel array). Each pixel is divided into Red, Green, Blue dots which are arranged in vertical stripe and this panel can display 16.7M colors.



1.2 Features

- 0.15t single glass
- Module Design
- Low power consumption
- Display 16.7M colors

● Incorporated edge type back-light (14 lamps)

(two group parallel connection, 7 lights per group)

● LTPS, GOA, Narrow boarder, Fine Pattern, High contrast ratio, High speed

Interface, and Ultrathin, wide viewing angle, Forward/Backward Scan

● RoHS Compliant

1.3 Application

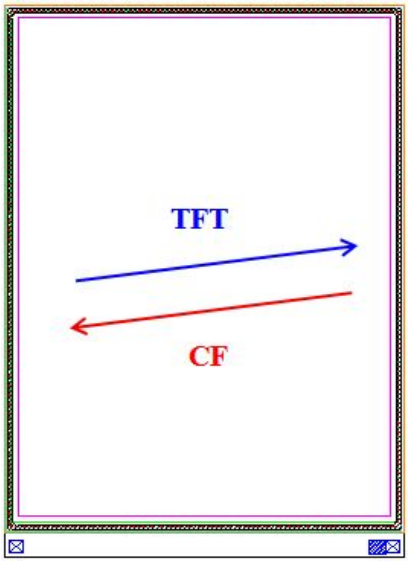
● Mobile

1.4 General Specifications (H: horizontal length, V: vertical length)

1.4.1 Physical Specifications

Parameter	Specification	Unit	Remark
Active Area	74.52(H) × 132.48(V)	mm	
Number of Pixels	1440(H) RGB × 2560(V)	pixels	
Pixel Pitch	51.75(H) × 51.75(V)	um	
Pixel Arrangement	RGB Vertical stripe		
Display Colors	16.7 M	colors	
Color Gamut	70%(typ.)		
Display Mode	Normally Black, Transmissive mode		
Dimensional Outline	77.72±0.15(H)×140.9±0.15(V)×1.42±0.1(D)	mm	Module
Back-light	LED Side-light type		
Polarizer Surface treatment	Hard-coating		
Polarizer compensation type	Up: Positive B + Negative B		
Viewing Direction(Human Eye)	U/D/L/R free viewing direction		Note 1
D-IC	NT35598H-DP		Note 2
Weight	TBD	gram	

Note:
1.At the U/D/L/R direction, the viewing angle is same
2.The TFT and CF LC Align Direction



3.Up pol absorption axis is vertical with C/F Rubbing direction, Down Pol absorption axis is parallel with TFT Rubbing direction, shown in lower left quarter;
4.These data of Product Specification were based on NT35598H-DP, we only gained Product Qualification in NT35598H-DP, if Customer want to use compatible IC, Please contact our technic personnel.

1.4.2 Part List

Item		Supplier	Type	Remark
Panel part	Glass (TFT/CF)	ASAHI	LTPS glass AN100 (t=0.5)	
	LC	Merck	MAT-13-1936 (Negative)	
	Polarizer (Up/Down)	Nitto	Up: 75.82±0.10(H) × 134.73±0.10(V) Down: 75.82±0.10(H) × 135.33±0.10(V)	Total THK (Up + Down = 0.214)
	ACF (FPCA)	Sony	CP34531	
	UV	Henkel Loctite	UV glue (3318)	
FPC part	FPC	Leader-Tech		
	EMI film	TOYO INK		
	Insulation Tape 1	3M		
	Insulation Tape 2	3M		
	Connector	Panasonic		
	Stiffener 1			
	Stiffener 2			
	Pulling tape			
BLU part	B/W Tape	TAPEX	T236SBB	BLU supplier is
	Prism Up	3M	BEF4-GM-95v2 (t=0.095)	

	Prism Down	3M	BEF4-GT-90(24) (t=0.09)	MINEBEA
	Diffuser	LMS	DLAS-38D (t=0.053)	
	LGP	MITSUBISHI	IUPILON HL-7002 (t=0.5)	
	Mold frame	MITSUBISHI	IUPILON URZ2501	
	Double Stick Tape	Soken	SK-65BW(t=0.03)	
	Reflector	3M	ESR-80 (t=0.082)	
	LED	LEXTAR	PS06W12 E(t=0.6)	
	LED FPC	-	PI + Cu (t=0.12)	

2.0 ELECTRICAL SPECIFICATION

2.1 Absolute Maximum Ratings

The absolute maximum ratings are list on table as follows. When used out of the absolute maximum ratings, the LSI may be permanently damaged. Using the LSI within the following electrical characteristics limit is strongly recommended for normal operation. If these electrical characteristic conditions are exceeded during normal operation, the LSI will malfunction and cause poor reliability.

Parameter	Symbol	Value	Unit
Supply Voltage (Logic)	VDDI	-0.3 ~ +5.5	V
Supply Voltage	VCI	-0.3 ~ +5.5	V
Supply Voltage (MV)	AVDD	-0.3 ~ +6.6	V
	AVEE	+0.3 ~ -6.6	V
Supply Voltage (HV)	VGH	-0.3 ~ +22	V
	VGLX	+0.3 ~ -18	
	VGH - VGLX	-0.3 ~ +33	
Logic Input Voltage Range	VIN	-0.3 ~ VDDI +0.3	V
Logic Output Voltage Range	VO	-0.3 ~ VDDI +0.3	V
Differential Input Voltage	DSIA/B_CLK_P/N DSIA/B_DATA0__P/N DSIA/B_DATA1__P/N DSIA/B_DATA2__P/N DSIA/B_DATA3__P/N	-0.3 ~ +1.8	V
Operating Temperature Range	TOPR	-40 ~ +85	℃
Storage Temperature Range	TSTG	-55 ~ +125	℃

Note:

1. If the absolute maximum rating of even is one of the above parameters is exceeded even momentarily, the quality of the product may be degraded. Absolute maximum ratings, therefore, specify the values exceeding which the product may be physically damaged. Be sure to use the product within the range of the absolute maximum ratings.
2. VCI means VDDA/VDDR/VDDB when BTM[2:0]= "000".
   VCI means VDDA/VDDR and AVDD means AVDD/VDDB when BTM[2:0]= "101", or "110".
   AVDD means AVDD/VDDB/VDDR when BTM[2:0]= "010", or "100".

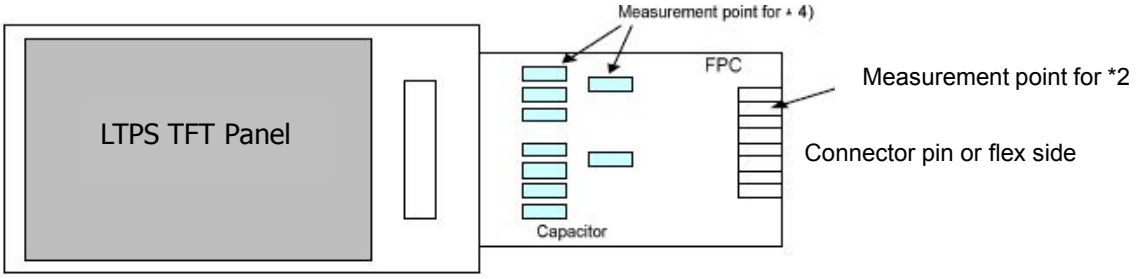
2.2 DC characteristics

Parameter	Symbol	Condition	Specification			Unit	Related Pins
			Min.	Typ.	Max.		
Power & Operation Voltage							
Analog Operating Voltage	VDD	Operating Voltage	2.5	3.3	3.6	V	Note 1,2
Logic Operating Voltage	VDDI	I/O Supply Voltage	1.65	1.8	3.6	V	Note 1,2
Input / Output							
Logic High Level Input Voltage	VIH	VDDI=1.65~3.6	0.7 VDDI	-	VDDI	V	Note 1,2,3
Logic Low Level Input Voltage	VIL		VSSI	-	0.3 VDDI	V	Note 1,2,3
Logic High level Output Voltage	VOH	VDDI=1.65~3.6 IOH=-1.0mA	0.8 VDDI	-	VDDI	V	Note 1,2,5
Logic Low level Output Voltage	VOL	VDDI=1.65~3.6 IOH=+1.0mA	VSSI	-	0.2 VDDI	V	Note 1,2,5
Logic High level leakage (Except MIPI)	ILIH	Vin=0~VDDI	-	-	1	uA	Note 1,2,3
Logic Low level leakage (Except MIPI)	ILIL	Vin=0~VDDI	-1	-	-	uA	Note 1,2,3
Logic High level leakage (MIPI)	ILIH	Vin=0~VDDA	-	-	1	uA	Note 2,8
Logic Low level leakage (MIPI)	ILIL	Vin=0~VDDA	-1	-	-	uA	Note 2,8
DC / DC Converter Operation							
AVDD Booster Voltage	AVDD	-	4.5	5	6.0	V	Note 2,7
AVEE Booster Voltage	AVEE	-	-6.0	-5	-4.5	V	Note 2,7
VCL Booster Voltage	VCL	-	-2.0	-	-3.0	V	Note 2,7
VGH Booster Voltage	VGH	-	AVDD -VCL	-	2AVDD-2AVEE	V	Note 2,6
VGLX Booster Voltage	VGLX	-	AVEE +VCL	-	2AVEE-AVDD	V	Note 2,6
Voltage difference between VGH & VGLX	VGHL	|VGH-VGLX|	-	-	30	V	Note 2

Oscillator tolerance	ΔOSC	25℃	-5	-	5	%	
Source Driver							
Gamma Reference Voltage	VGMP	–	3.05	-	5.6	V	Note 2
	VGSP	-	0	-	1.3	V	Note 2
	VGMN	-	-5.6	-	-3.05	V	Note 2
	VGSN	-	-1.3	-	0	V	Note 2
Output offset voltage	Voffset	-	-	-	45	mV	Note 4
Output deviation voltage	Vdev	VGMP-0.2V ≥Sout≥4.0V (0.2-VGMN ≥Sout≥4.0V) 0.2V≤Sout≤1.0V	-	20	30	mV	
		1.0V < Sout < 4.0V	-	10	15	mV	

Note:

1. VDDI=1.65 to 3.6V, VDD=2.5 to 3.6V, VSSI=VSS=DVSS=0V, Ta=-30 to 70℃(to +85℃ no damage). VDD means VDDA, VDDR, VDDB and VSS means VSSR, VSSB, AVSS, VSSAM. VDDB, VDDA and VDDR should be larger than VDDI voltage.
2. When the measurements are performed with module, measurement points are like below.
3. RESX, DSWAPA[2:0], PSWAPA, DSWAPB[2:0], PSWAPB, LANSEL[1:0], IM[1:0], PORTSWAP, BTM[2:0], GPI[1:0], BIST_EN, BIST_PAUSE pins.
4. Channel loading=40pF / channel, Ta=25℃.
5. SDO, GPO[7:0] pins.
6. VDDB=3.3V/Ta=25℃, no load on panel & load=2mA, |Output voltage-Target voltage| < 100mV
7. VDDB=3.3V/Ta=25℃, no load on panel & load=TBD mA, power pad serial resistor is smaller than maximum value.
8. Vin=0 to VDDA, VDD=2.5 to 3.6V, VDDI=1.65 to 3.6V, VSSAM=VSS=0V, Ta=-30 to 70℃(to +85℃ no damage).



Measurement Points for All Characteristics

-When 4.0≤Sout≤VGMP-0.2V (4.0≤Sout≤0.2V-VGMN), 0.2V≤Sout≤1.0V
|(S1,S2,S3,……S1600)-Average (S1,S2,S3,……S1600) |≤30mV
-When 1.0V < Sout < 4.0V
|(S1,S2,S3,……S1600)-Average (S1,S2,S3,……S1600) |≤15mV
-Sout=V0~V255, |STarget-Average (S1,S2,S3,……S1600) |≤45mV

2.3 Power Consumption

Test condition: 3 power mode, VDDI=1.8V,AVDD=5V,AVEE=-5V

Parameter	Symbol	Typ	Max	Unit	Remark
Normal mode	I_{VDDI}	40	60	mA	Note
	I_{AVDD}	12	15	mA	Note
	I_{AVEE}	12	15	mA	Note
Sleep mode	I_{VDDI}	20	30	uA	
	I_{AVDD}	50	100	uA	
	I_{AVEE}	50	100	uA	

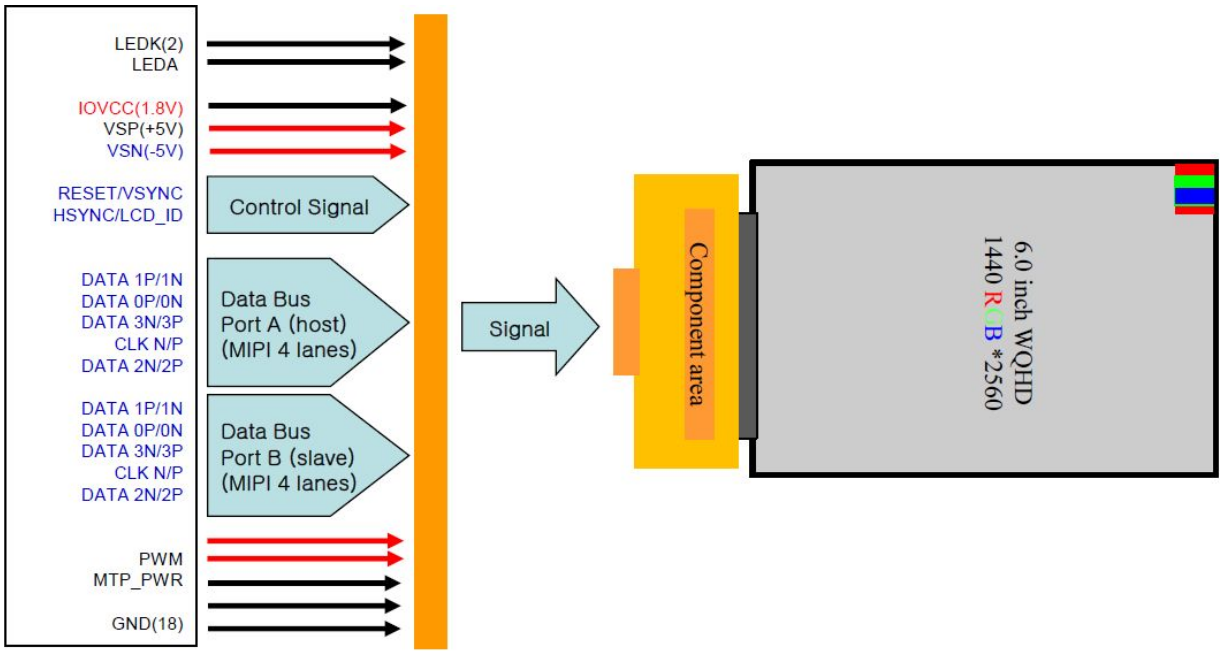
Note:

Frame rate=60HZ, White pattern, 25℃

2.4 Backlight Driving Conditions

Parameter	Symbol	Min	Typ	Max	Unit	Remark
Current	I_B	-	40	-	mA	
Power Consumption	P_{BL}	-	924	-	mW	

2.5 Block Diagram



Input Signal: MIPI Dual 4 lanes 1Gbps/Lane
Connector type: AXE650124 Panasonic

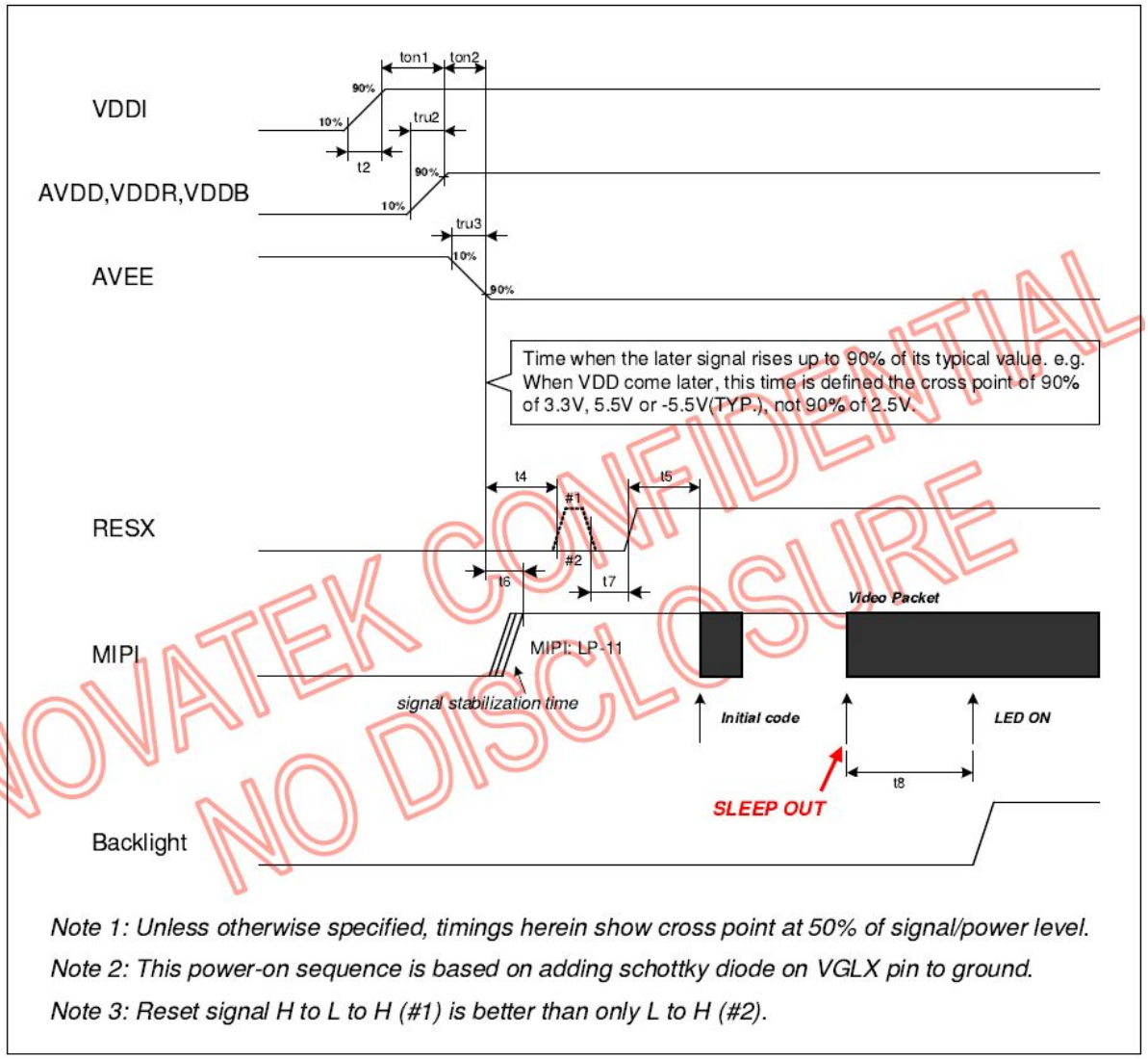
2.6 Power ON/OFF Sequence

Power ON Sequence

If RESX line is held High or unstable by the host during Power on, then a Hardware Reset must be applied after both VDD and VDDI have been applied – otherwise correct functionality is not guaranteed. There is no timing restriction upon this hardware reset.
If RESX line is held Low (and stable) by the host during Power on, then the RESX must be held low for minimum 10usec after both VDD and VDDI have been applied.
The power on sequence for different power input modes are shown below figures.

Symbol	Value			Unit	Remark
	Min.	Typ.	Max.		
ton1	0	-	-	ms	Schottky diode should add on VGLX
ton2	2	-	-	ms	
ton3	2	-	-	ms	
ton4	0	-	-	ms	
t2	-	-	150	us	
tru1	-	-	150	us	
tru2	-	-	150	us	
tru3	-	-	150	us	
tru4	-	-	150	us	
t4	40	-	-	ms	
t5	120	-	-	ms	
t6	0	-	t4	ms	
t7	10	-	-	us	
t8	8	-	-	VS	Keep data more than 8 frames(VS)

3 Input power (BTM[2:0]= "100"):
VDDI=1.65~3.6V, AVDD=VDDR=VDDB=4.5~6.0V, AVEE= -4.5~-6.0V



Note 1: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

Note 2: This power-on sequence is based on adding schottky diode on VGLX pin to ground.

Note 3: Reset signal H to L to H (#1) is better than only L to H (#2).

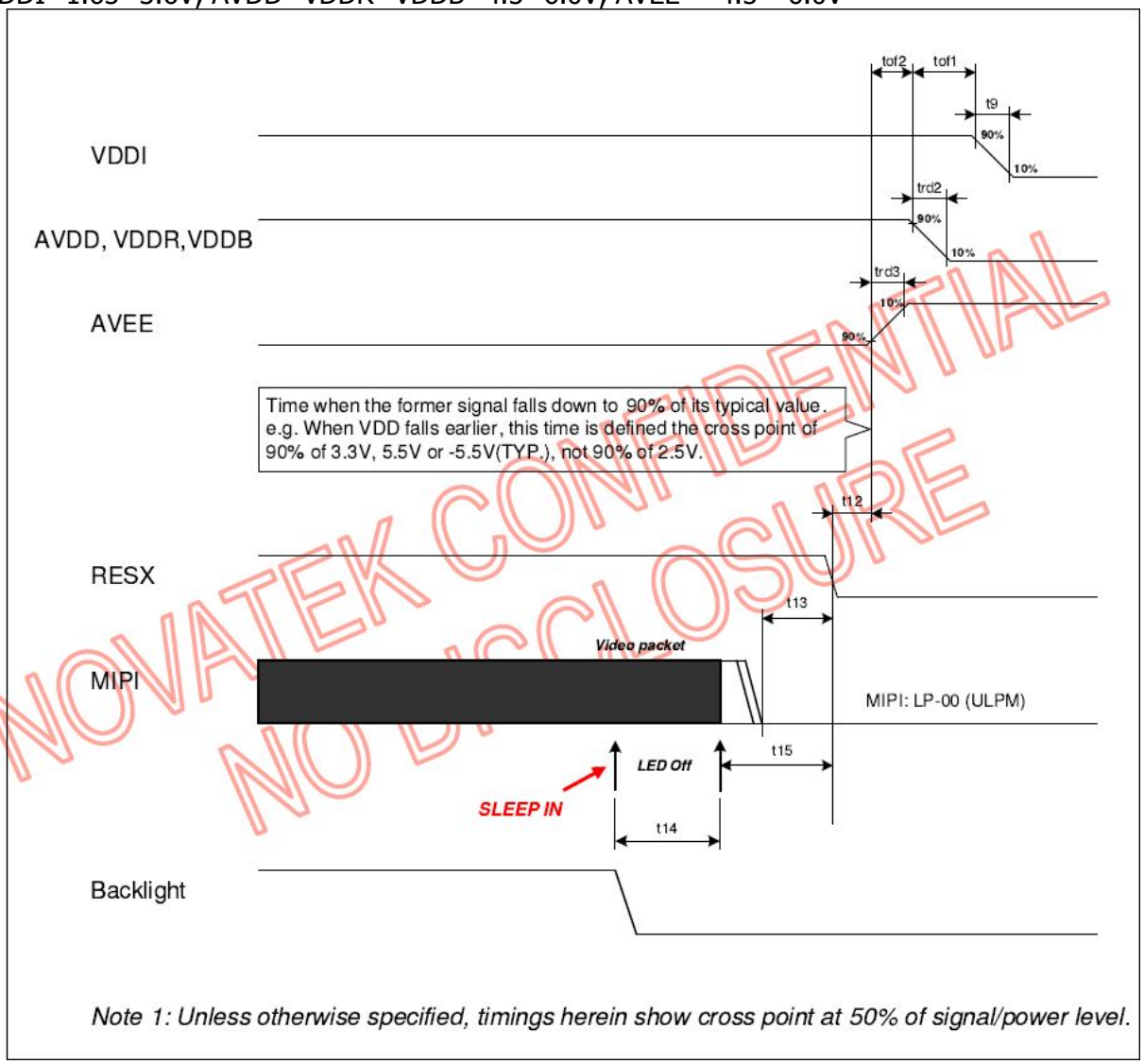
Power OFF Sequence

The power off sequence for different power input modes are shown below figures.

Symbol	Value			Unit	Remark
	Min.	Typ.	Max.		
t9	150	-	-	us	
tof1	0	-	-	ms	
tof2	2	-	-	ms	
tof3	2	-	-	ms	
tof4	0	-	-	ms	
trd1	150	-	-	us	
trd2	150	-	-	us	

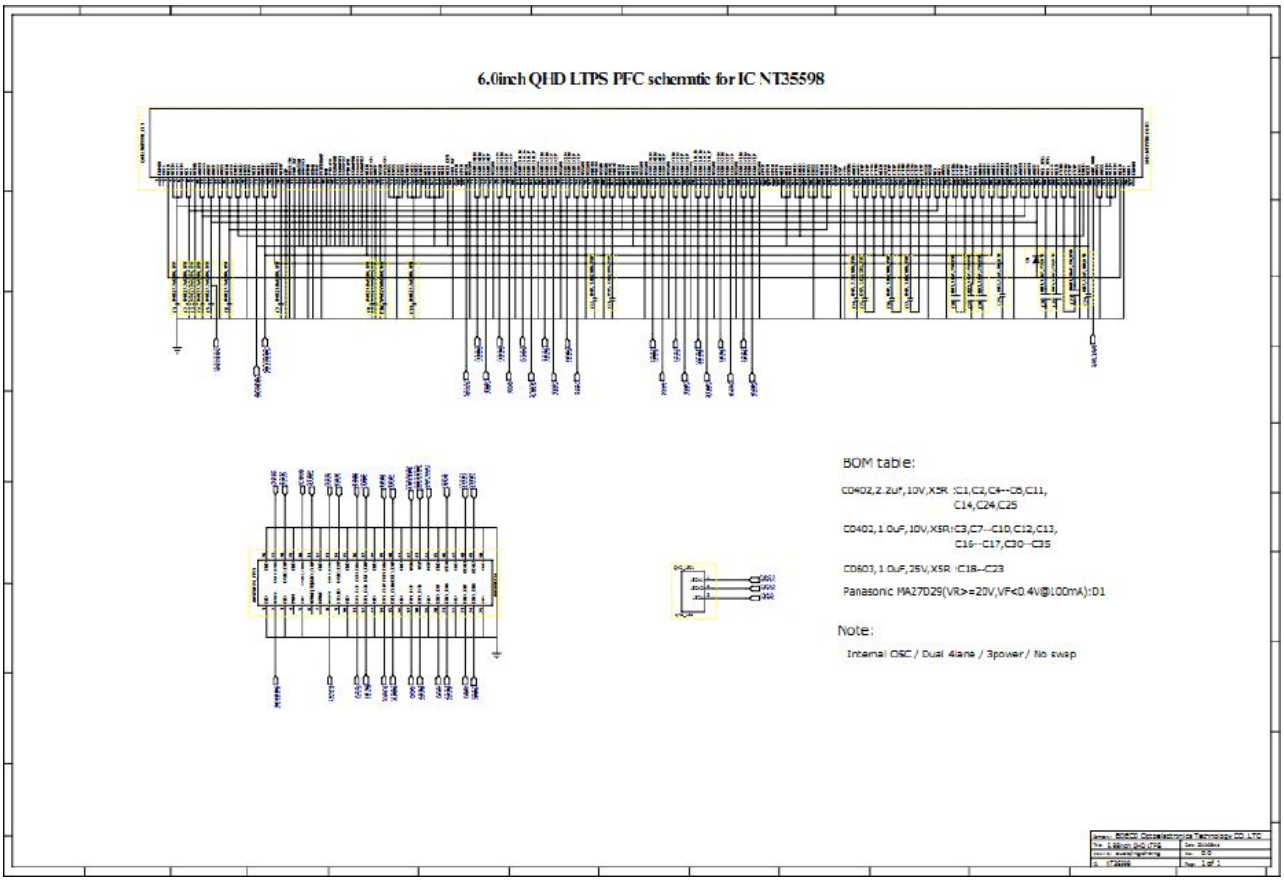
trd3	150	-	-	us	
trd4	150	-	-	us	
t12	0	-	-	ms	
t13	0	-	-	ms	
t14	0	-	-	ms	
t15	100	-	-	ms	

- 3 Input power (BTM[2:0]= "100"):
VDDI=1.65~3.6V, AVDD=VDDR=VDDB=4.5~6.0V, AVEE= -4.5~-6.0V



Note 1: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

2.8 FPC Schematic



2.9 Connector Pin Assignment

Pin No.	Symbol	Remark	Pin No.	Symbol	Remark
1	GND	Ground	26	GND	Ground
2	IOVCC	Logic power 1.8V	27	LEDK1	LED 1-
3	GND	Ground	28	LEDK2	LED 2-
4	LCD_ID	Pull high on FPC	29	GND	Ground
5	GND	Ground	30	LEDA	LED +
6	DSI1_D2P	MIPI B port D2P	31	GND	Ground
7	DSI1_D2N	MIPI B port D2N	32	DSI0_D3N	MIPI A port D3N
8	GND	Ground	33	DSI0_D3P	MIPI A port D3P
9	DSI1_CLKP	MIPI B port CLKP	34	GND	Ground
10	DSI1_CLKN	MIPI B port CLKN	35	DSI0_CLKN	MIPI A port CLKN
11	GND	Ground	36	DSI0_CLKP	MIPI A port CLKP
12	DSI1_D3P	MIPI B port D3P	37	GND	Ground
13	DSI1_D3N	MIPI B port D3N	38	DSI0_D2N	MIPI A port D2P
14	GND	Ground	39	DSI0_D2P	MIPI A port D2N
15	DSI0_D1P	MIPI A port D1P	40	GND	Ground
16	DSI0_D1N	MIPI A port D1N	41	DSI1_D0N	MIPI B port D0P
17	GND	Ground	42	DSI1_D0P	MIPI B port D0N
18	DSI0_D0P	MIPI A port D0P	43	GND	Ground
19	DSI0_D0N	MIPI A port D0N	44	DSI1_D1N	MIPI B port D1P
20	GND	Ground	45	DSI1_D1P	MIPI B port D1N
21	RESET	Globle reset signal	46	GND	Ground
22	TE	TE signal	47	VSN	Negitive analog power
23	HSYNC	Hsync signal	48	VSP	Positive analog power
24	PWM	LED PWM control	49	MTP	Internal use NC
25	GND	Ground	50	GND	Ground

Connector type:AXE650124 Vendor: Panasonic

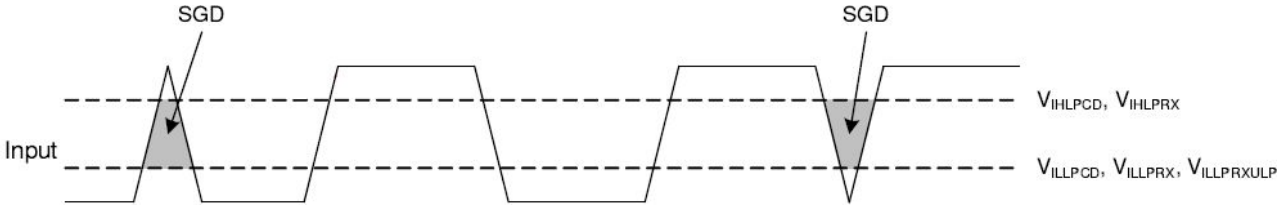
3.0 SIGNAL TIMING SPECIFICATION

3.1 DC Characteristics for DSI LP Mode

Parameter	Symbol	Conditions	Specification			Unit
			Min.	Typ.	Max.	
Logic high level input voltage	VIHLPCD	LP-CD	450	-	1350	mV
Logic low level input voltage	VILLPCD	LP-CD	0	-	200	mV
Logic high level input voltage	VIHLPRX	LP-RX (CLK,D0,D1)	880	-	1350	mV
Logic low level input voltage	VILLPRX	LP-RX (CLK,D0,D1)	0	-	550	mV
Logic low level input voltage	VILLPRXULP	LP-RX (CLK ULP mode)	0	-	300	mV
Logic high level input voltage	VOHLPTX	LP-TX (D0)	1.1	-	1.3	V
Logic low level input voltage	VOLLPTX	LP-TX (D0)	-50	-	50	mV
Logic high level input current	IIH	LP-CD, LP-RX	-	-	10	uA
Logic low level input current	IIL	LP-CD, LP-RX	-10	-	-	uA
Input pulse rejection	SGD	DSI-CLK+/-, DSI-Dn+/-(Note 3)	-	-	300	Vps

Note:

1. VDDI=1.65~3.6V, VDD=2.5 to 3.6V, VSSI=VSS=VSSAM=0V, Ta=-30 to 70℃(to +85℃ no damage). VDD means VDDA, VDDR, VDDB and VSS means VSSAM, VSSR, VSSB, AVSS.
2. DSI high speed is off.
3. Peak interference amplitude max. 200mV and interference frequency min. 450MHz.



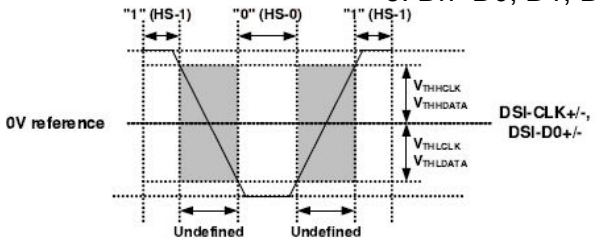
Spike/Glitch rejection-DSI

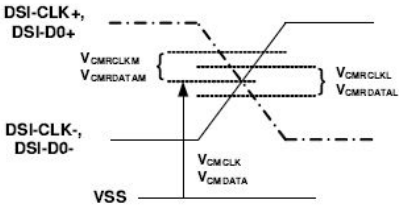
3.2 DC Characteristics for DSI HS Mode

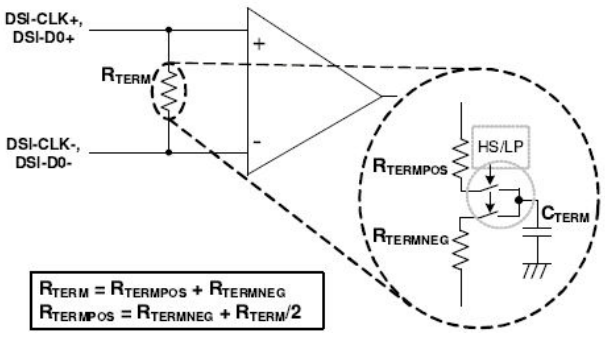
Parameter	Symbol	Conditions	Specification			Unit
			Min.	Typ.	Max.	
Input voltage common mode range	VCMCLK VCMDATA	DSI-CLK+/-, DSI-Dn+/- (Note2,3)	70	-	330	mV
Input voltage common mode variation(≤450MHz)	VCMRCLKL VCMRDATAL	DSI-CLK+/-, DSI-Dn+/- (Note4)	-50	-	50	mV
Input voltage common mode variation(≥450MHz)	VCMRCLKM VCMRDATAM	DSI-CLK+/-, DSI-Dn+/-	-	-	100	mV
Low-level differential input voltage threshold	VTHLCLK VTHLDATA	DSI-CLK+/-, DSI-Dn+/-	-70	-	-	mV
High-level differential input voltage threshold	VTHHCLK VTHHDATA	DSI-CLK+/-, DSI-Dn+/-	-	-	70	mV
Single-ended input low voltage	VILHS	DSI-CLK+/-, DSI-Dn+/- (Note3)	-40	-	-	V
Single-ended input high voltage	VIHHS	DSI-CLK+/-, DSI-Dn+/- (Note3)	-	-	460	mV
Differential input termination resistor	RTERM	DSI-CLK+/-, DSI-Dn+/-	80	100	125	uA
Single-ended threshold voltage for termination enable	VTERM-EN	DSI-CLK+/-, DSI-Dn+/-	-	-	450	uA
Termination capacitor	CTERM	DSI-CLK+/-, DSI-Dn+/-	-	-	14	Vps

Note:

1. VDDI=1.65~3.6V, VDD=2.5 to 3.6V, VSSI=VSS=VSSAM=0V, Ta=-30 to 70℃(to +85℃ no damage). VDD means VDDA, VDDR, VDDB and VSS means VSSAM, VSSR, VSSB, AVSS.
2. Includes 50mV (-50mV to 50mV) ground difference.
3. Without VCMRCLKM/ VCMRDATAM.
4. Without 50mV (-50mV to 50mV) ground difference.
5. Dn=D0, D1, D2 and D3.

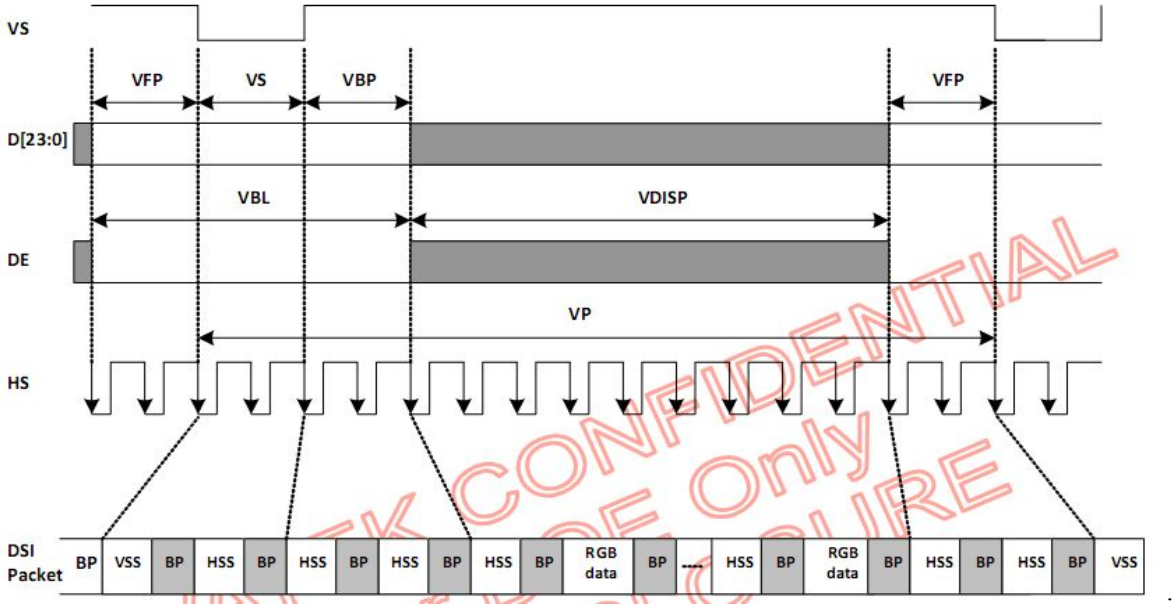






Differential voltage range, termination resistor and common mode voltage

3.3 MIPI video mode AC Characteristics



Condition

- DSI 4Lane, 2port
- 850Mbps/Lane

Vertical Display Timing

Item	Symbol	Unit	Value
Vertical cycle	VP	Line	2600
Vertical low pulse width	VS	Line	1
Vertical front porch	VFP	Line	20
Vertical back porch	VBP	Line	20
Vertical data start point	–	Line	20
vertical blanking period	VBL	Line	40
Vertical active area	Vadr	Line	2560

Horizontal Display Timing

Item	Symbol	Unit	Value
Horizontal front porch	HFP	ByteClock	20
Horizontal data start point	–	ByteClock	100
Horizontal active area	Hadr	Pixel	1440

4.0 INTERFACE CONNECTION

4.1 Electrical Interface Connection (Pin Assignment)

Pin No.	Symbol	Pin No.	Symbol	Pin No.	Symbol	Pin No.	Symbol
1	DUMMY	46	DSWAPB2	103~104	VDDA	161~162	VDDB
2	NULL	47	VDDR	105~107	VDDI	163~164	C31P
3	VGLX	48	VEQP_SD	108~109	VSSAM	165~166	C31N
4~6	VCOM	49	VREF	110~111	DSIA_D0_N	167~168	C32N
7~8	VCL	50	VSSR	112~113	DSIA_D0_P	169~170	C32P
9	VGMN	51	VEQN_SD	114	VSSAM	171~172	VSSB
10~11	AVEER	52~55	DVSS	115~116	DSIA_D1_N	173~174	VCL
12~13	AVEE	56~59	DVDD	117~118	DSIA_D1_P	175~176	AVSS
14~15	AVSS	60~64	VDDI	119	VSSAM	177~178	C41N
16~17	VDDA	65	VDDI_DET	120~121	DSIA_CLK_N	179~180	C41P
18~19	DVDD	66	EXT_OSC	122~123	DSIA_CLK_P	181~182	VGH
20~21	DVSS	67	GPO0	124	VSSAM	183~184	VRGH
22~23	VDDI	68	GPO1	125~126	DSIA_D2_N	185~186	AVDD
24~25	AVDD	69	RESX	127~128	DSIA_D2_P	187~189	AVDDR
26~27	AVDDR	70	VSSAM	129	VSSAM	190~191	VSSB
28	VGMP	71~72	DSIB_D0_N	130~131	DSIA_D3_N	192~194	AVEER
29	GIP	73~74	DSIB_D0_P	132~133	DSIA_D3_P	195~196	AVEE
30	BIST_EN	75	VSSAM	134	VSSAM	197~198	VGL_REG
31	ENB_OSC	76~77	DSIB_D1_N	135	GPO2	199~200	VGLX
32	LANSEL0	78~79	DSIB_D1_P	136	GPO3	201~202	C51N
33	LANSEL1	80	VSSAM	137	GPO4	203~204	C51P
34	BTM0	81~82	DSIB_CLK_N	138	GPO5	205	DVSS
35	BTM1	83~84	DSIB_CLK_P	139~141	VDDI	206	DVDD
36	BTM2	85	VSSAM	142~144	DVDD	207	VDDI
37	PORTSWAP	86~87	DSIB_D2_N	145~147	DVSS	208	MTP_PWR
38	IM0	88~89	DSIB_D2_P	148~150	VDDA	209~210	AVSS
39	PSWAPA	90	VSSAM	151	EXTP	211~213	VCOM
40	DSWAPA0	91~92	DSIB_D3_N	152	CSP	214	VGLX
41	DSWAPA1	93~94	DSIB_D3_P	153	CSN	215	GND
42	DSWAPA2	95~96	VSSAM	154	EXTN	216	NULL
43	PSWAPB	97~98	MVDDA	155~156	AVDD	217	DUMMY
44	DSWAPB0	99~100	VSSIM	157~158	C11P		

5.0 OPTICAL SPECIFICATIONS

5.1 Overview

The test of Optical specifications shall be measured in a dark room(ambient luminance≤ 1 lux and temperature = 25±2℃) with the equipment of Luminance meter system (Topcon SR-UL1R and Westar TRD-100A) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of θ and Φ equal to 0°.The center of the measuring spot on the Display surface shall stay fixed.

The backlight should be operating for 30 minutes prior to measurement.

5.2 Optical Specifications

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Threshold Voltage		Vsat		4.1	4.3	4.5	V	Fig.1
		Vth		1.6	1.8	2.0	V	
Viewing Angle	Horizontal	Θ3	CR>10	70	80		°	Note 1
		Θ9		70	80		°	
	Vertical	Θ12		70	80		°	
		Θ6		70	80		°	
Contrast Ratio		CR	Θ= 0°	1000	1300			Note 2
Luminance		lm	Θ= 0°	400			cd/m2	Note 3
Uniformity		%	Θ= 0°	80				Note 4
NTSC		%	Θ= 0°	65	70			
Reproduction Of color	Red	Rx	Θ= 0°		TBD			Note 4 *Module
		Ry			TBD			
	Green	Gx			TBD			
		Gy			TBD			
	Blue	Bx			TBD			
		By			TBD			
White		Wx	Θ= 0°		TBD			
		Wy			TBD			
Response Time		Tr+Tf	Θ= 0°		32	35	ms	Note 5
Flicker		Amount	-		TBD	TBD		
Crosstalk		△CT	-		TBD	TBD		

Note:

1. Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (See FIG.2).
2. Contrast measurements shall be made at viewing angle of Θ= 0° and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state. (See FIG. 2) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Surface luminance is the center point across the LCD surface 50cm from the surface with all pixels displaying white. This measurement shall be taken at the locations shown in FIG. 2.

4. Uniformity measurement shall be taken at the locations shown in FIG. 2&3, for a total of the measurements per display, measure surface luminance of these nine points across the LCD surface 50cm from the surface with all pixels displaying white.

$$\text{Uniformity} = \frac{\text{Min Luminance of 9 points}}{\text{Max Luminance of 9 points}} \times 100\%$$

5. The color chromaticity coordinates specified in Table1 shall be calculated from The spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the Module.

6. The electro-optical response time measurements shall be made as FIG.4 by switching the "data" input signal ON and OFF.

The times needed for the luminance to change from 10% to 90% is Tr and 90% to 10% is Tf.

Figure 1. The definition of Vth & Vsat

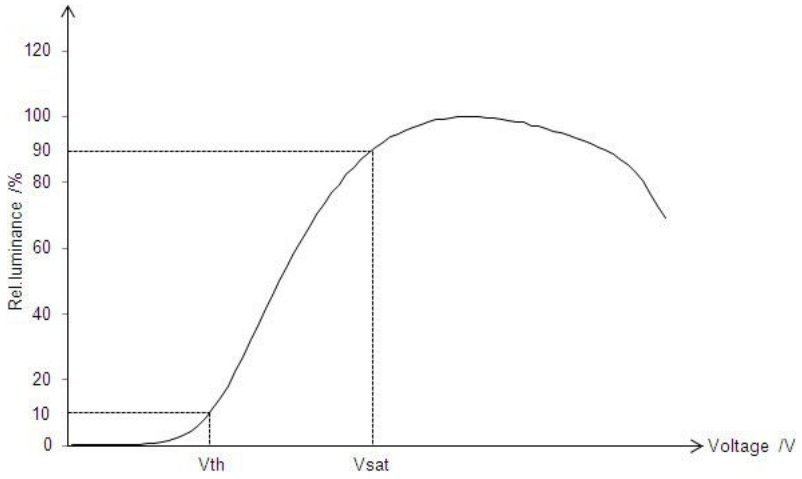


Figure 2. Measurement Set Up

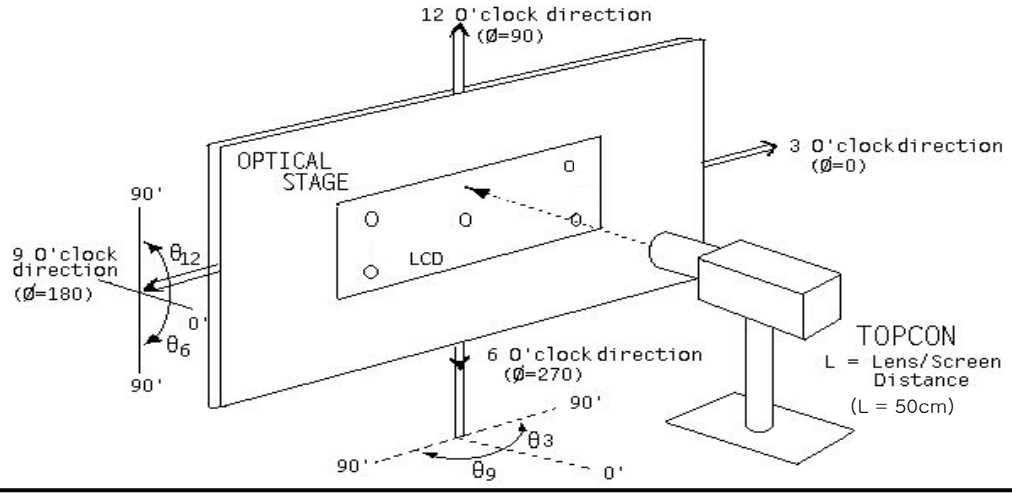


Figure 3. Uniformity Measurement Locations

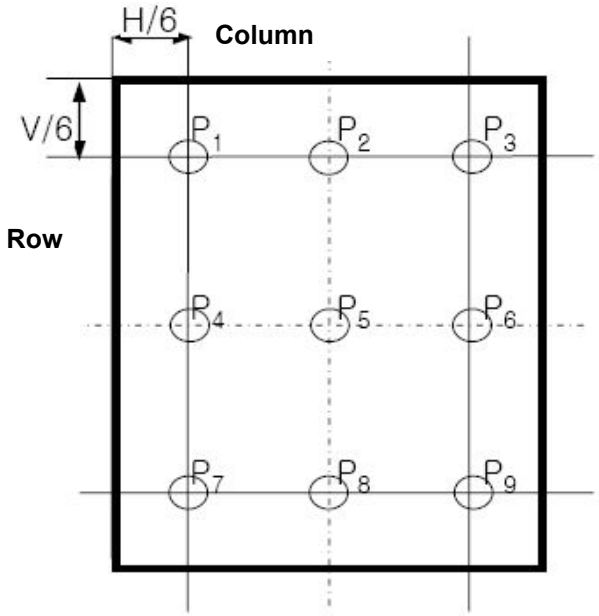
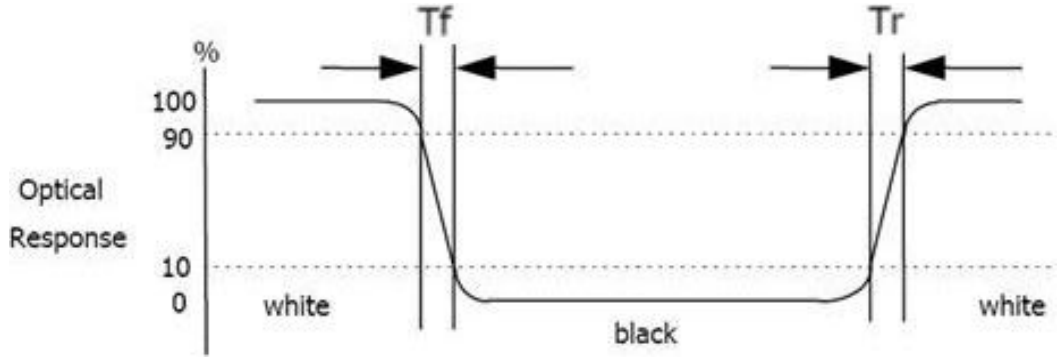


Figure 4. Response Time Testing



6.0 MECHANICAL CHARACTERISTICS

6.1 Dimension Requirements

Parameter	Specification	Unit	Remark
Panel size	76.32(H) × 138.88(V)	mm	
CF size	76.32(H) × 135.88(V)	mm	
Active area	74.52(H) × 132.48(V)	mm	
Dimensional outline	77.72±0.15(H)×140.9±0.15(V)×1.42±0.1(D)	mm	Module

Figure 5. LCM Outline Dimension (unit:mm)

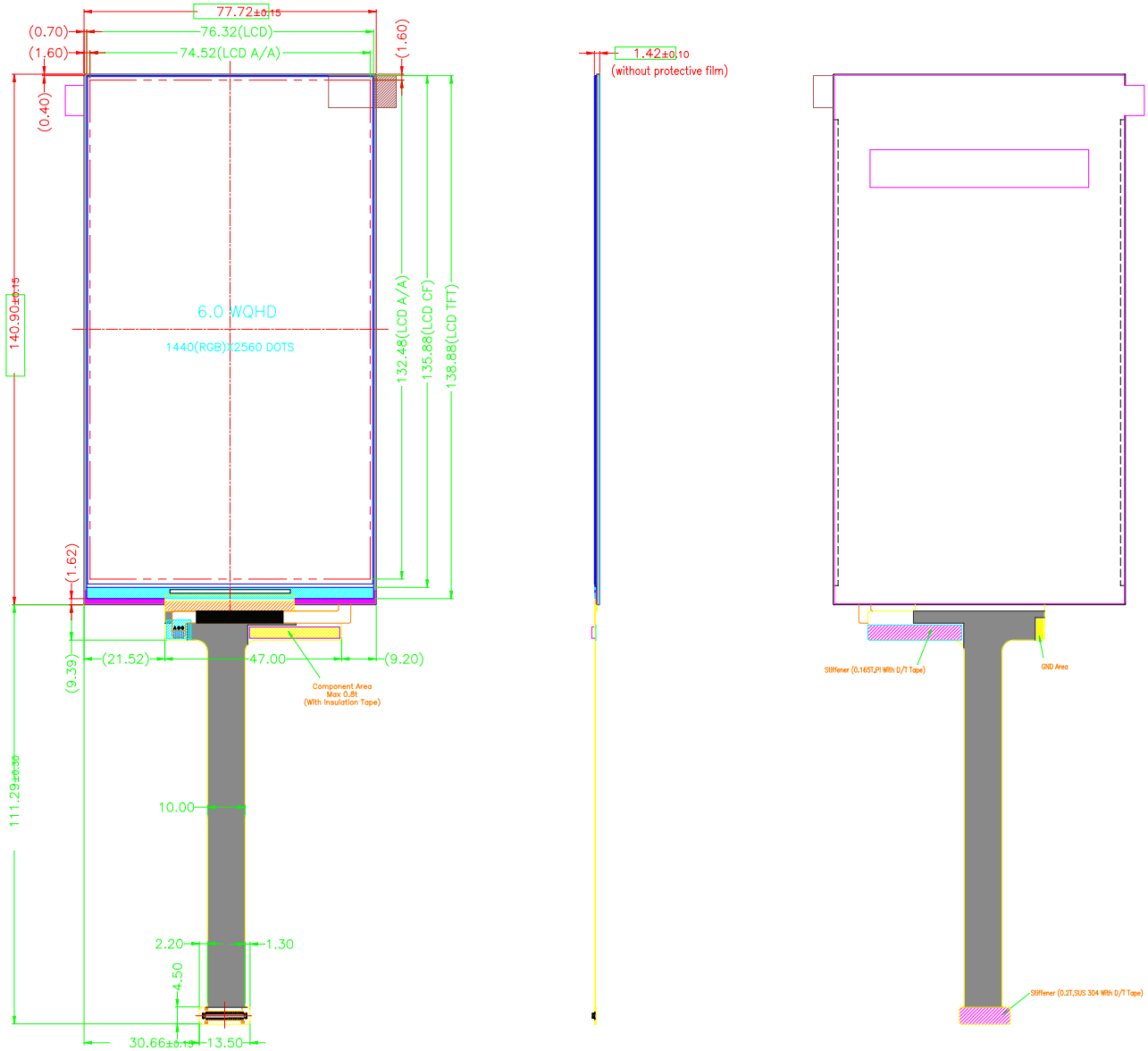


Figure 6. BLU Outline Dimension (unit:mm)

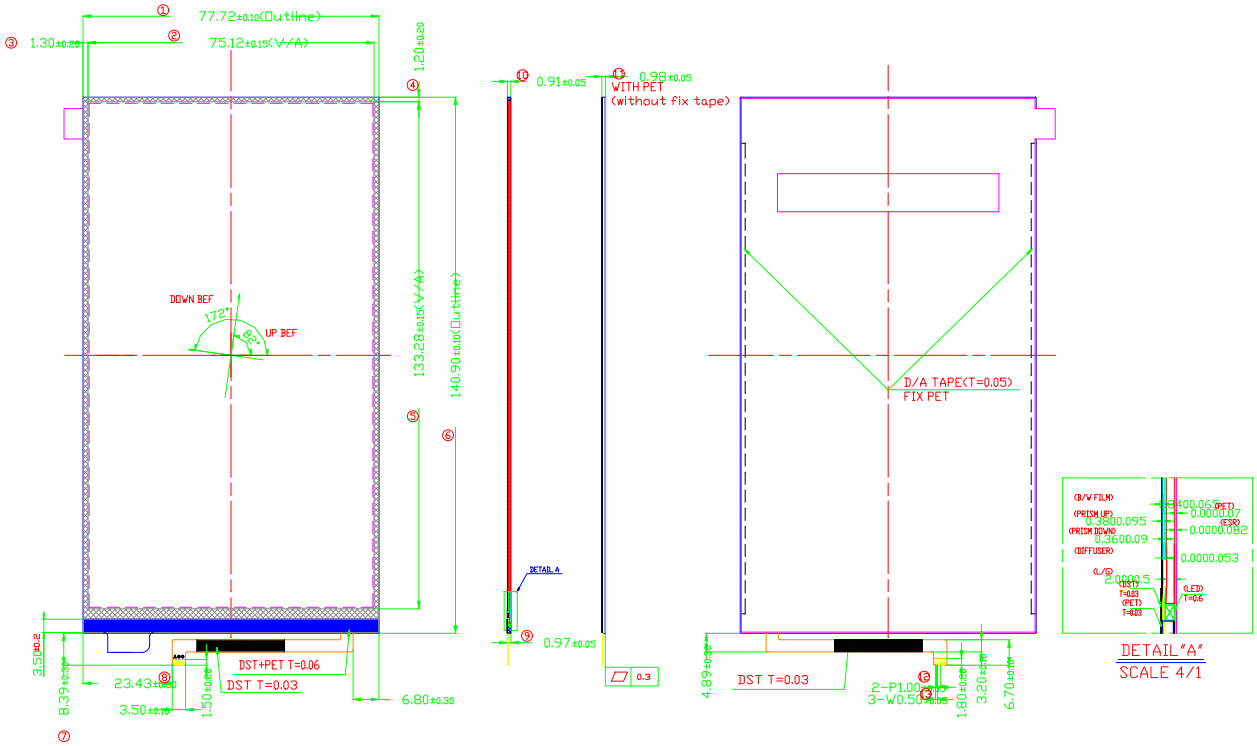
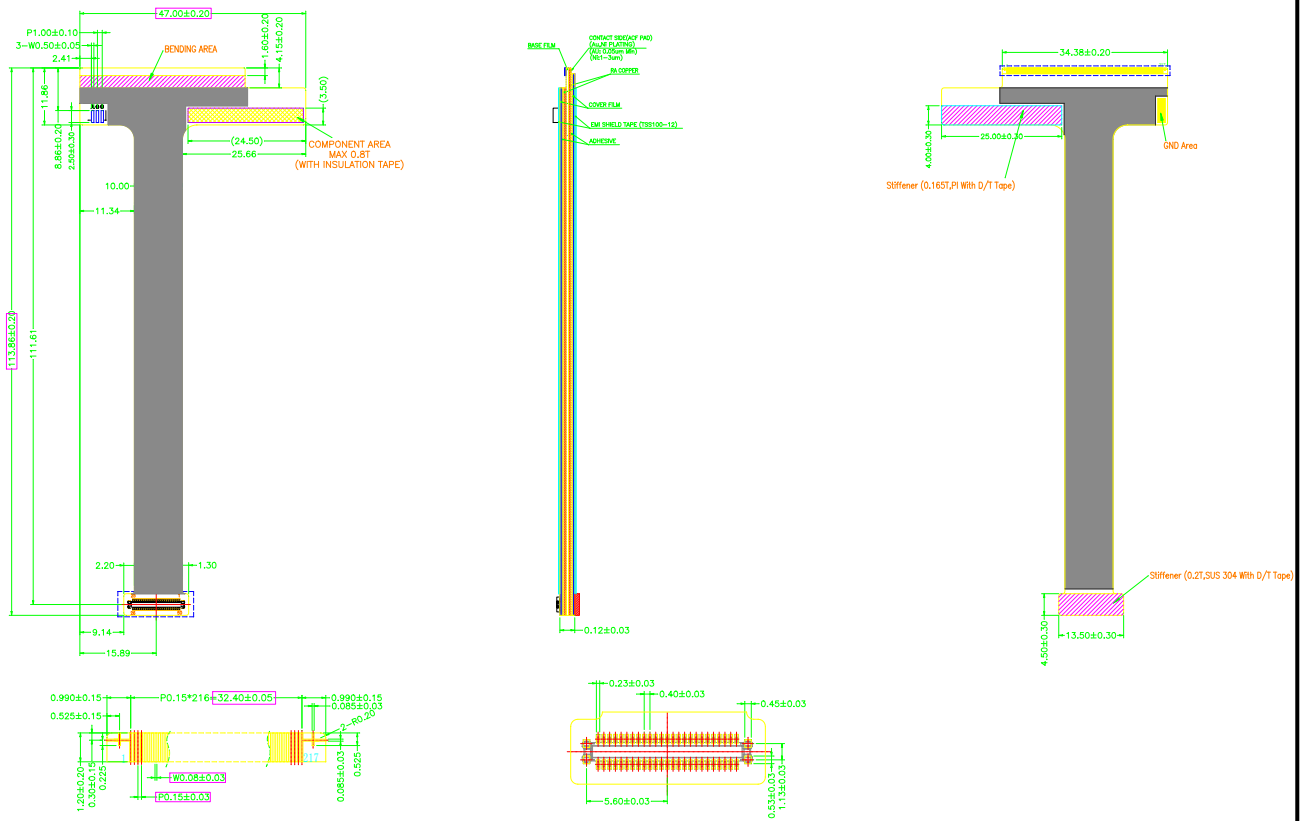


Figure 7. FPC main structure (unit:mm)



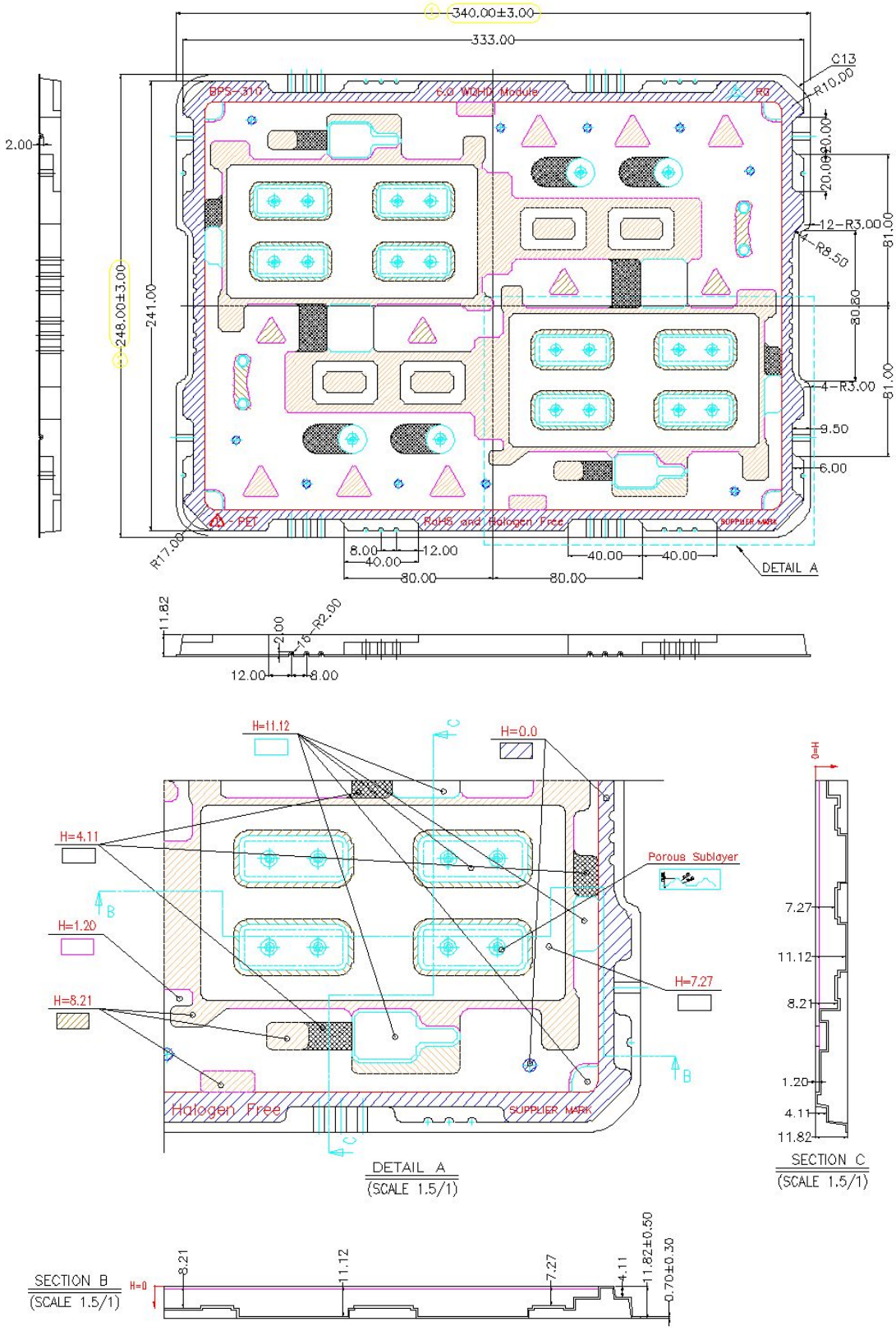
7.0 RELIABILITY TEST

NO.	Test Item	Test Condition	Duration
1	High temperature, high humidity operation test(THO)	60℃, 90%RH	120hrs
2	Low temperature operation test(LTO)	-20 ℃	240hrs
3	High temperature operation test(HTO)	60 ℃	120hrs
4	High temperature storage test(HTS)	60℃	240hrs
5	Low temperature storage test(LTS)	-30℃	240hrs
6	Thermal shock test (TST)	-30 ℃ →80 ℃ (Per 30min)	100hrs
7	ESD	150pF 330Ω ±8KV(Air) / ±4KV(Contact)	20points (Module)
8	Vibration	1.5G,10/500/10,Sine,X/Y/ Z Direction	Total:30min

8.0 PACKING METHOD

8.1 Packing Tray

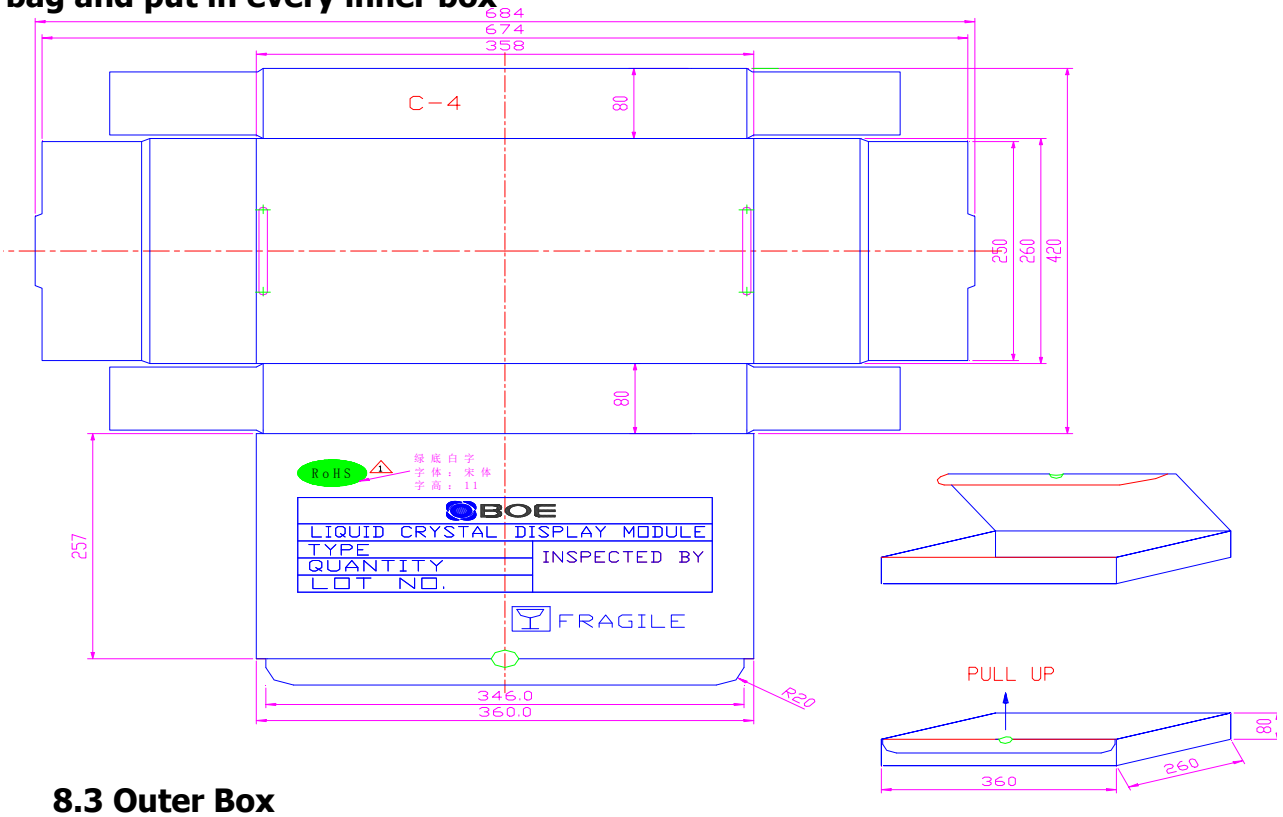
<Tray Size> L: 340 mm; W: 248 mm; 2 Pcs/tray



8.2 Inner Box

<Inner Box Size> L: 360mm; W: 260mm; H:80mm

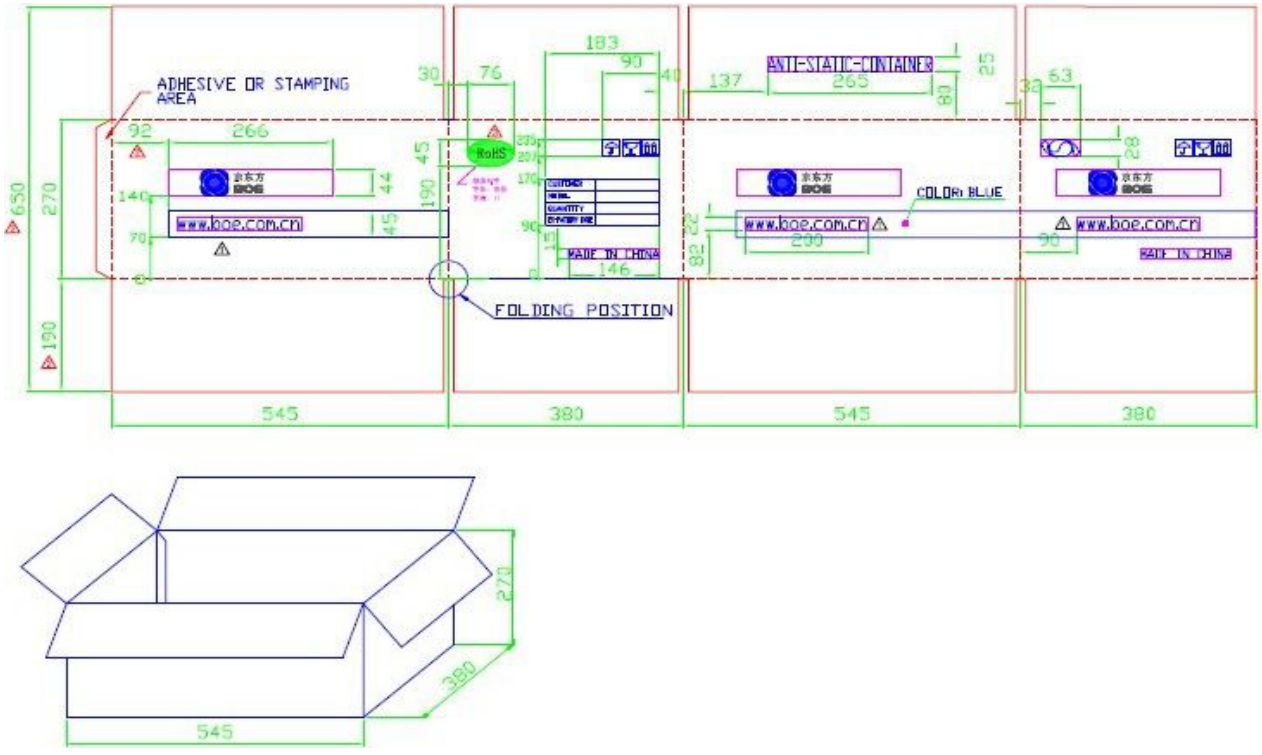
*** 8 tray (with cell) plus 1 Tray (without Cell) are packed in a vacuum with PE bag and put in every inner box**



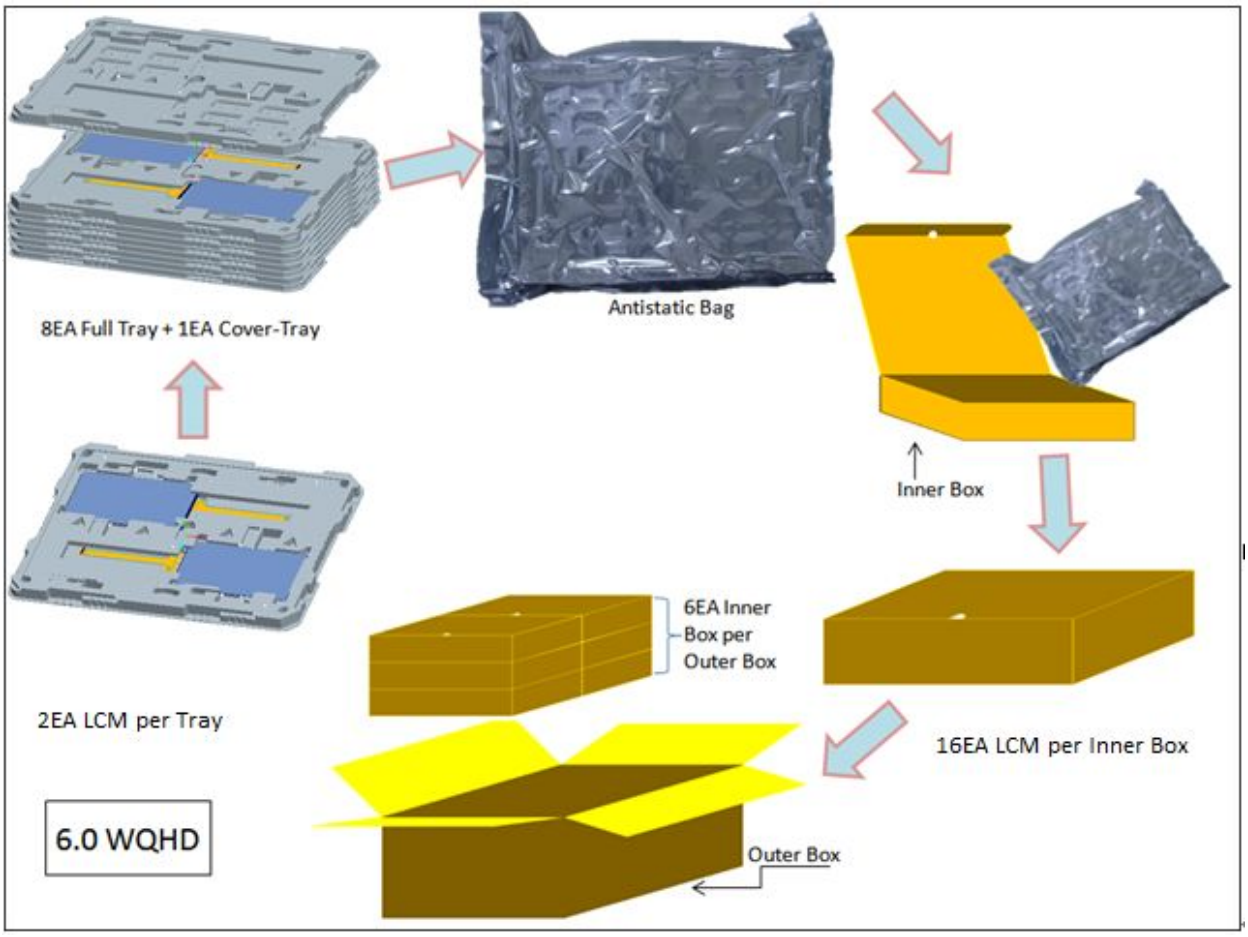
8.3 Outer Box

<Outer box size> L:545mm; W:380mm; H:270mm

6pcs inner box /Outer Box



8.4 Packing Process



8.5 Packing Notice

- Panel should be placed upwardly while in the tray.
- Every eight full trays with a blank one while twining twice on both sides by adhesive tape.
- Every tray should be put crossly.
- Panels should be packed in a vacuum with PE (anti-ESD) bag.

9.0 PRODUCT ID RULE

B L 060 WH M M 001
1 2 3 4 5 6 7

1 <Company>

Code	Description
B	BOE

2 <Mode>

Code	Description
L	LTPS
F	FFS
T	TN

3 <Size>

Code	Description
060	6.0"
024	2.4"
101	10.1"

4 <Resolution>

Code	Description
WH	WQHD
QV	QVGA
WV	WVGA

5 <Application area>

Code	Description
M	Mobile
A	Application

6 <Production type>

Code	Description
M	Module
E	CELL
Q	Q-Panel
E	CELL (w/o POL) / CELL Slimming (w/o Pol)
P	CELL (With Pol)
G	COGA
B	FOG
G	COGA

7 <Other information>

2nd /3rd digit	
Code	Description
01	First Mode
02	Second Mode

10.0 HANDDLING & CAUTIONS

10.1 Mounting Method

● The panel of the LCM consists of two thin glasses with polarizer which easily get damaged. So extreme care should be taken when handling the LCM.

● Excessive stress or pressure on the glass of the LCM should be avoided. Care must be taken to insure that no torsional or compressive forces are applied to the LCM unit when it is mounted.

● If the customer's set presses the main parts of the LCM, the LCM may show the abnormal display. But this phenomenon does not mean the malfunction of the LCM and should be pressed by the way of mutual agreement.

● To determine the optimum mounting angle, refer to the viewing angle range in the specification for each model.

● Mount a LCM with the specified mounting parts.

10.2 Caution of LCM Handling and Cleaning

● Since the LCM is made of glass, do not apply strong mechanical impact or static load onto it. Handling with care since shock, vibration, and careless handling may seriously affect the product. If it falls from a high place or receives a strong shock, the glass maybe broken.

● The polarizer on the surface of panel are made from organic substances. Be very careful for chemicals not to touch the polarizer or it leads the polarizer to be deteriorated.

● If the use of a chemical is unavoidable, use soft cloth with solvent recommended below to clean the LCM's surface with wipe lightly.

-IPA (Isopropyl Alcohol), Ethyl Alcohol, Tri-chloro, tri-florothane.

● Do not wipe the LCM's surface with dry or hard materials that will damage the polarizer and others. Do not use the following solvent—Water, acetone, Aromatics.

● It is recommended that the LCM be handled with soft gloves during assembly, etc.

The polarizer on the LCM's surface are vulnerable to scratch and thus to be damaged by shape particles.

● Do not drop water or any chemicals onto the LCM's surface.

● A protective film is supplied on the LCM and should be left in place until the LCM is required for operation.

● The ITO pad area needs special careful caution because it could be easily corroded. Do not contact the ITO pad area with HCFC, Soldering flux, Chlorine, Sulfur, saliva or fingerprint. To prevent from the ITO corrosion, customers are recommended that the ITO area would be covered by UV or silicon.

● Handle FPC with care.

10.3 Caution Against Static Charge

- The LCM use C-MOS LSI drivers, so customers are recommended that any unused input terminal would be connected to Vdd or Vss, do not input any signals before power is turn on, and ground you body, work/assembly area, assembly equipments to protect against static electricity.
- Remove the protective film slowly, keeping the removing direction approximate 30-degree not vertical from panel surface, if possible, under ESD control device like ion blower, and the humidity of working room should be kept over 50%RH to reduce the risk of static charge.
- Avoid the use work clothing made of synthetic fibers. We recommend cotton clothing or other conductivity-treated fibers.
- In handling the LCM, wear non-charged material gloves. And the conducting wrist to the earth and the conducting shoes to the earth are necessary.

10.4 Caution For Operation

- It is indispensable to drive the LCM within the specified voltage limit since the higher voltage than the limit causes LCM's life shorter. An electro-chemical reaction due to DC causes undesirable deterioration of the LCM so that the use of DC drive should avoid.
- Do not connect or disconnect the LCM to or from the system when power is on.
- Never use the LCM under abnormal conditions of high temperature and high humidity.
- When expose to drastic fluctuation of temperature(hot to cold or cold to hot), the LCM may be affected; specifically, drastic temperature fluctuation from cold to hot, produces dew on the LCM's surface which may affect the operation of the polarizer on the LCM.
- Response time will be extremely delay at lower temperature than the operating temperature range and on the other hand LCM may turn black at temperature above its operational range. However those phenomenon do not mean malfunction or out of order with the LCM. The LCM will revert to normal operation once the temperature returns to the recommended temperature range for normal operation.
- Do not display the fixed pattern for a long time because it may develop image sticking due to the LCM structure. If the screen is displayed with fixed pattern, use a screen saver.
- Do not disassemble and/or re-assemble LCM module

10.5 Packaging

- Modules use LCM element, and must be treated as such.

-Avoid intense shock and falls from a height.

-To prevent modules from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity for long periods.

10.6 Storage

- A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Relative humidity of the environment should therefore be kept below 60%RH.
- Original protective film should be used on LCM's surface (polarizer). Adhesive type protective film should be avoided, because it may change color and/or properties of the polarizer.
- Do not store the LCM near organic solvents or corrosive gasses.
- Keep the LCM safe from vibration, shock and pressure.
- Black or white air-bubbles may be produced if the LCM is stored for long time in the lower temperature or mechanical shocks are applied onto the LCM.
- In the case of storing for a long period of time for the purpose or replacement use, the following ways are recommended.

-Store in a polyethylene bag with sealed so as not to enter fresh air outside in it.
-Store in a dark place where neither exposure to direct sunlight nor light is.
-Keep temperature in the specified storage temperature range.
-Store with no touch on polarizer surface by the anything else. If possible, store the LCM in the packaging situation when it was delivered.

10.7 Safety

- For the crash damaged or unnecessary LCM, it is recommended to wash off liquid crystal by either of solvents such as acetone and ethanol an should be burned up later.
- In the case of LCM is broken, watch out whether liquid crystal leaks out or not. If your hands touch the liquid crystal, wash your hands cleanly with water and soap as soon as possible.
- If you should swallow the liquid crystal, first, wash your mouth thoroughly with water, then drink a lot of water and induce vomiting, and then, consult a physician.
- If the liquid crystal get in your eyes, flush your eyes with running water for at least fifteen minutes.
- If the liquid crystal touches your skin or clothes, remove it and wash the affected part of your skin or clothes with soap and running water.

11.0 Applicable Scope

- This product specification only applies to the products manufactured and sold by our company.
- Any specification, quality etc. about other parts mentioned in this product spec are no concern of our company.