2. General Description

2.1. General Feature

No	Item	Specification	Remark
1	Display Method	Active Matrix TFT	
2	Display Mode	Tranmissive Type	
3	Display Resolution	720RGB(H) × 1,280(V)	
4	Active Area [mm]	55.512(H) × 98.688(V)	
5	Screen Size [inch]	4.46”	
6	Pixel Pitch [mm]	0.0257 × RGB(H) × 0.0771(V)	
7	Display Color	16.7M color	
8	Surface Treatment	Anti-Reflection	
9	Outside Dimension [mm]	59.61(H) × 108.47(V) × 1.58(D)	
10	Viewing Angle	Wide view(80˚/80˚/80˚8/0˚)	
11	Weight [g]	15.0 ± 10%	
12	Driver IC	LG4591	28.08mm(H) × 1.23mm(V) × 0.20mm(D)
13	Inversion Method	Column inversion	

2.2. Optical Characteristic

Item		Symbol	Condition	Unit	Min.	Typ.	Max.	Note
Response Time	Rise	Tr	25˚C	ms	-	17	-	
	Fall	Tf	25˚C	ms	-	18	-	
Luminance		Bp	Θ = 0˚	cd/m²	400	500	-	
Luminance Uniformity		ΔL	Θ = 0˚	%	80	85	-	
Contrast Ratio		C/R	Θ = 0˚		800	1,000	-	
Crosstalk		C/T	Θ = 0˚	%	-	3	5	
Flicker		F/K	Θ = 0˚	dB	-	-52	-	
Viewing Angle		Top	CR>10˚	Degree	-	80	-	
		Bottom			-	80	-	
		Right			-	80	-	
		Left			-	80	-	
Color Coordination (CIE 1931)		Rx	Θ = 0˚	NTSC (x.y)	0.605	0.645	0.685	
		Ry			0.290	0.330	0.370	
		Gx			0.265	0.305	0.345	
		Gy			0.565	0.605	0.645	
		Bx			0.105	0.145	0.185	
		By			0.020	0.060	0.100	
		Wx			0.275	0.315	0.355	
		Wy			0.315	0.355	0.395	
Color Gamut (CIE 1931)		NTSC	Θ = 0˚	%	65	70		
Color Temperature		CCT	Θ = 0˚	K	5,000		9,000	

2.3. Optical Specification (Note)

[Note 1] Optical Test Equipment Setup

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 5 minutes in a dark environment at 25°C. The values specified are at an approximate distance 50cm from the LCD surface. And backlight LED current is 20mA.

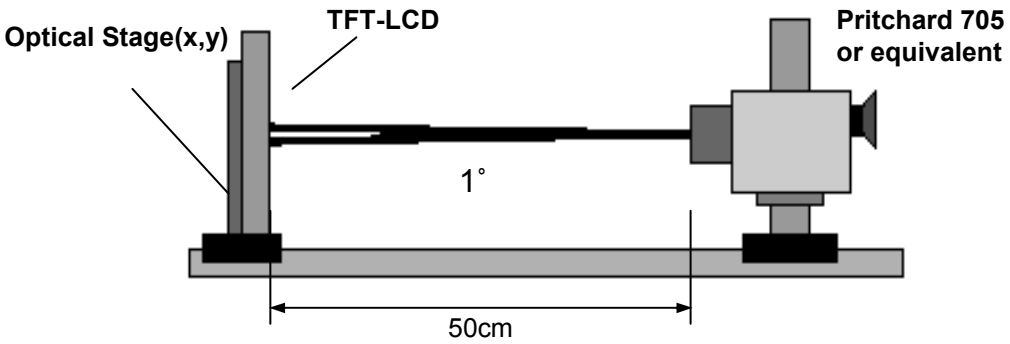


Fig 2-1. Optical Characteristic Measurement Equipment and Method

※ Measuring Condition:
- Measuring surroundings : Dark Room
- Measuring temperature : T_a=25°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 5 minutes while backlight turning on.

[Note 2] Viewing Angle

Viewing angle range is defined as follows;

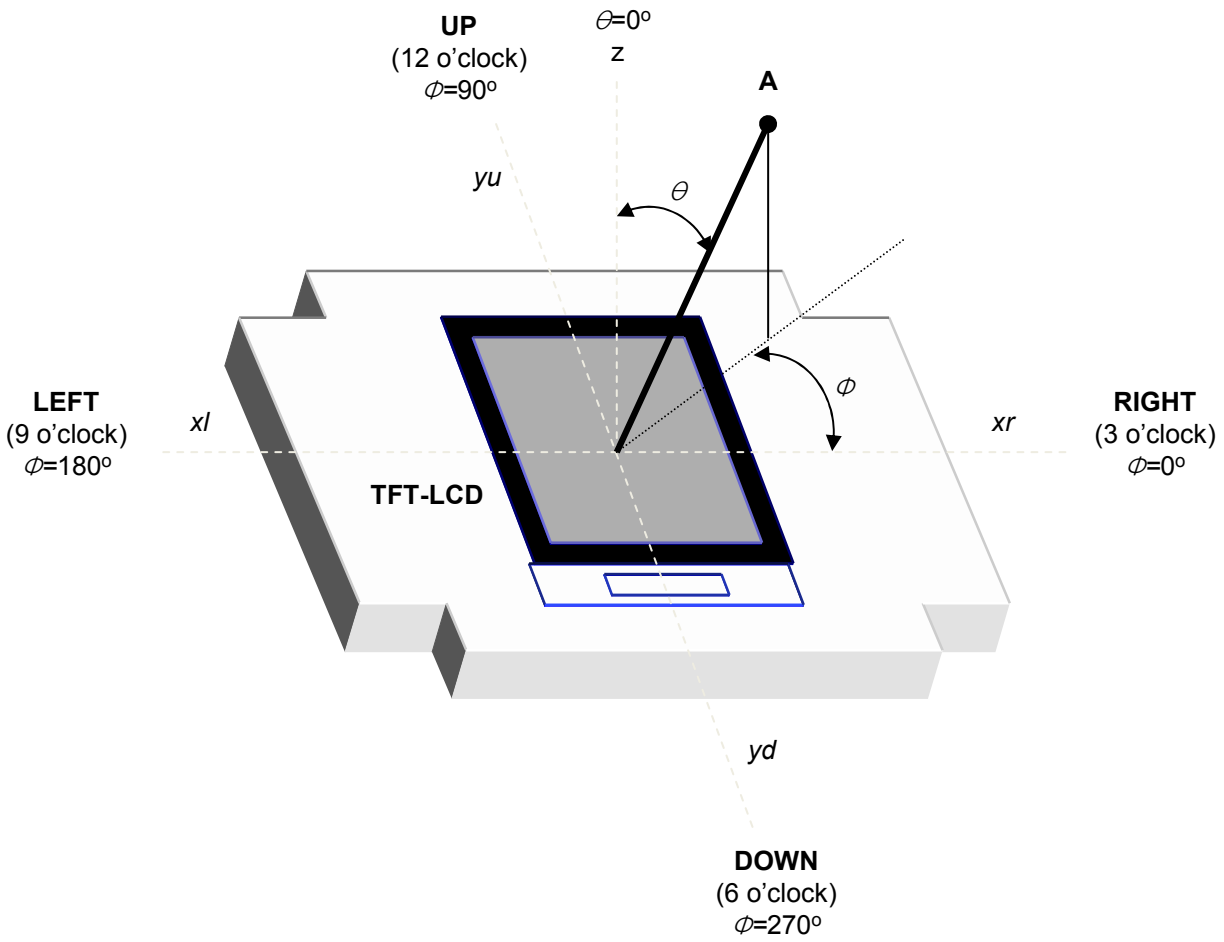


Fig 2-2. Viewing angle

[Note 3] Contrast Ratio

Contrast ratio is defined as follows;

$$\text{Contrast Ratio (CR)} = \frac{\text{Photodetector output with LCD being "WHITE"}}{\text{Photodetector output with LCD being "BLACK"}}$$

[Note 4] Luminance

The luminance measurement is taken at point P5.

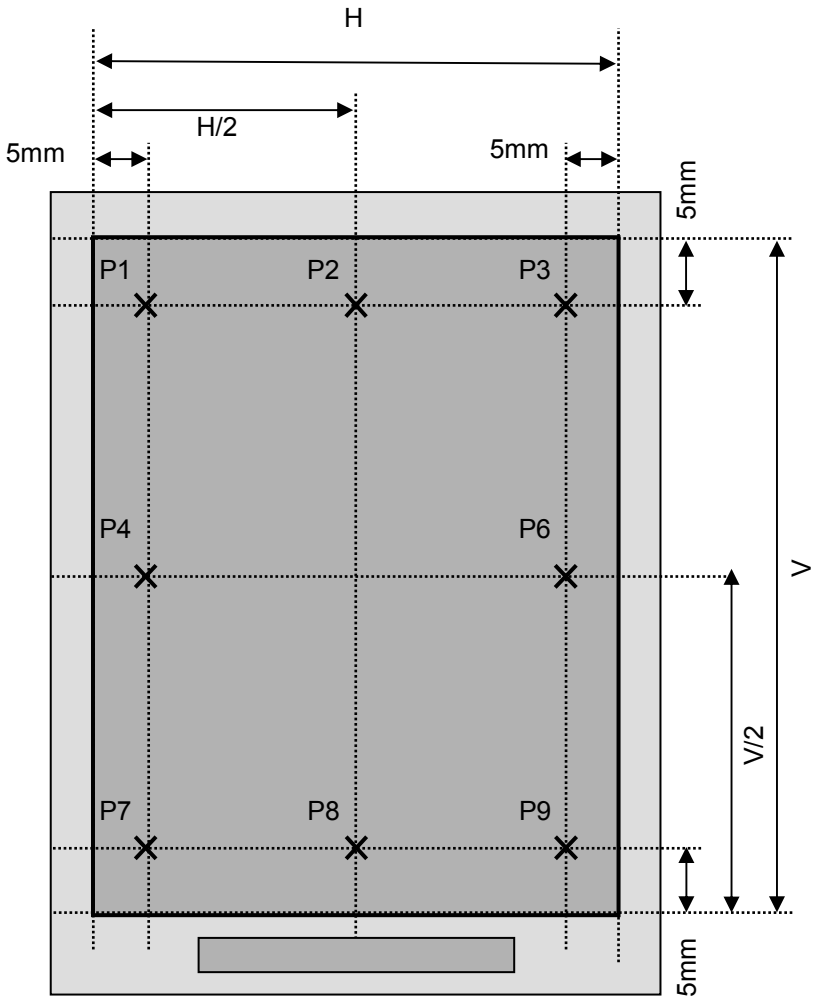


Fig 2-3. Luminance measurement points

[Note 5] Luminance Uniformity

$$\text{Luminance Uniformity} = \frac{\text{Minimum Luminance for P1 ~ P9 with all white pixels}}{\text{Maximum Luminance for P1 ~ P9 with all white pixels}}$$

[Note 6] Response Time

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”.

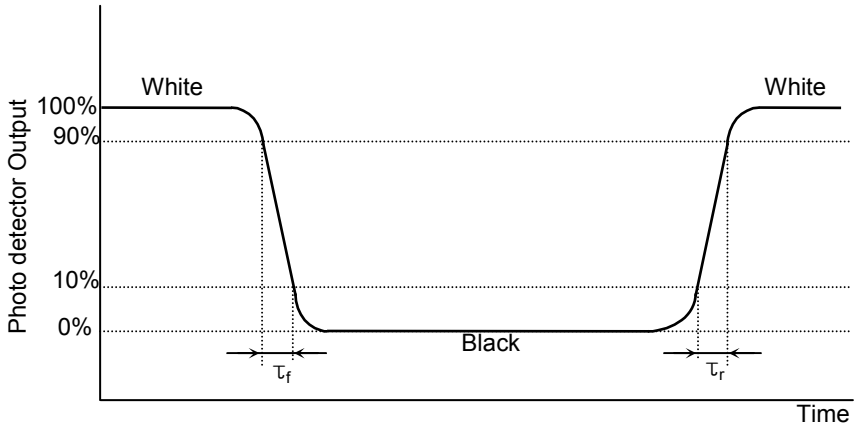
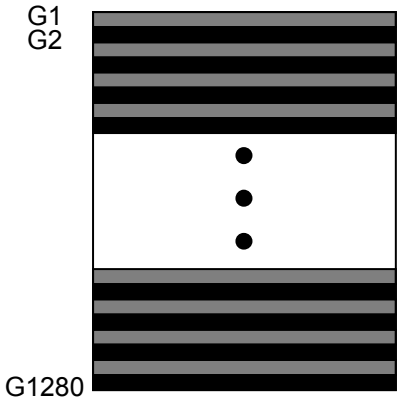


Fig 2-4. Response Time

[Note 7] Flicker

The flicker level should be measured with horizontal gray/black stripes. The flicker is essentially a ratio of the powers in the frequency spectrum at 30 Hz (P_X) and 0 Hz (P_{0-} DC level).

$$F = 20 \text{ Log } (P_X / P_0)$$



[Note 8] Crosstalk

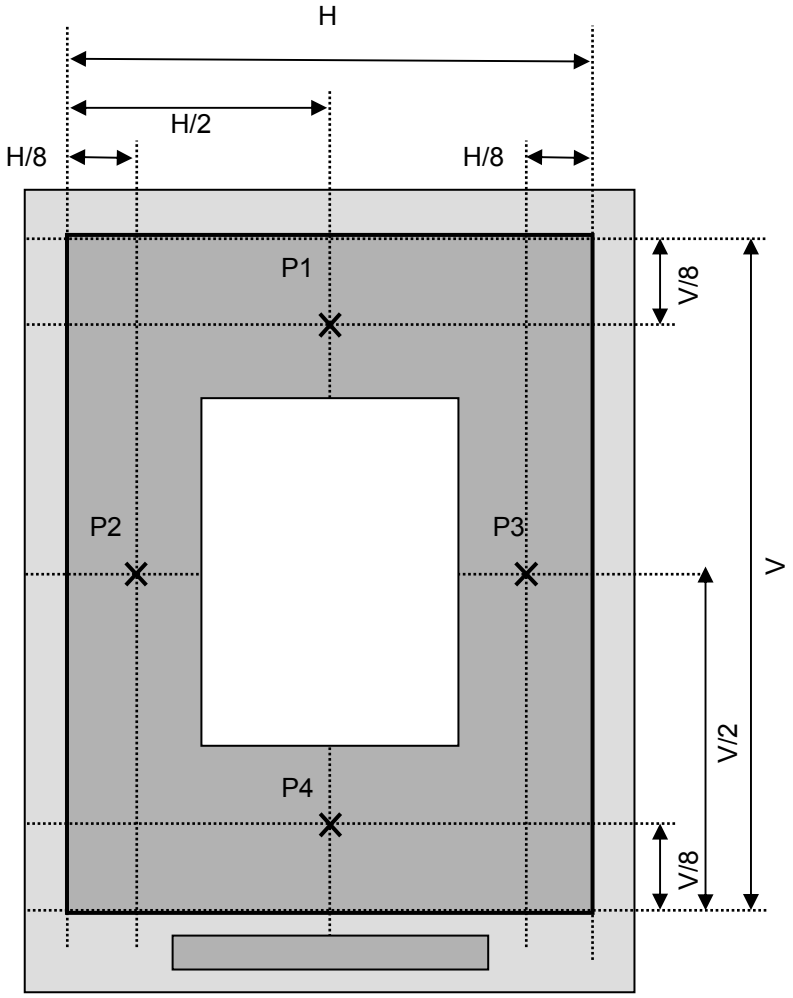


Fig 2-5. Crosstalk measurement points

A: Luminance for P1 ~ P4 with all 127gray pixels

B: Luminance for P1 ~ P4 with 127gray pixels when the white box is applied

$$\text{Crosstalk [\%]} = \text{Maximum}\left[\text{Absolute}\left(\frac{A - B}{A}\right)\right]$$

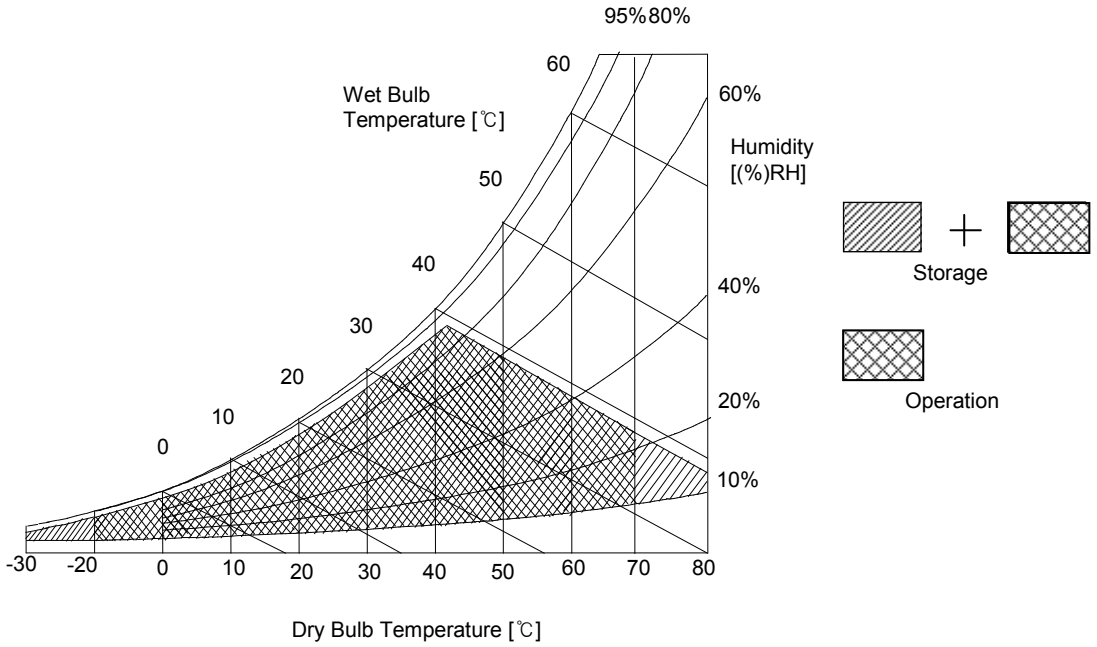
3. Electrical Characteristic

3.1. Maximum Rating

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power for Analog Circuit	VCI	-0.3	3.0	4.5	V	
Power for Logic Circuit	VCC	-0.3	3.0	4.5	V	
Power for Interface Circuit	IOVCC	-0.3	1.8	4.5	V	
Storage Humidity	Hstg	10	-	90	%RH	Note 1), 2)
Storage Temperature	T_{STG}	-30	-	80	°C	Note 1), 2)
Operating Ambient Humidity	H_{OP}	10	-	90	%RH	Note 1), 2)
Operating Ambient Temperature	T_{OP}	-20	-	70	°C	Note 1), 2)

Note 1) Temp. ≤ 60℃ , 90% RH MAX.
Temp. ＞60℃ , Absolute humidity shall be less than 90% RH at 60℃.

Note 2) The diagram below indicates the peripheral environment of the module.
The wet bulb temperature should be kept under 39 °C and there should be no compensation.
If the LSI is used above these absolute maximum ratings, it may become permanently damaged.

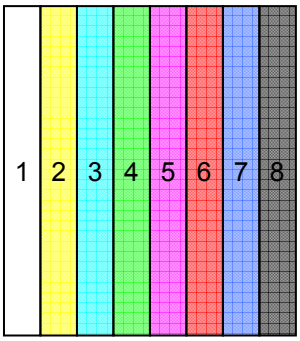


3.2. Electrical Characteristic

Ta + 25˚C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Power for Analog Circuit		VCI	2.6	3.0	3.3	V	
Power for Logic Circuit		VCC	2.6	3.0	3.3	V	
Power for Interface Circuit		IOVCC	1.65	1.8	3.3	V	
Power for BLU Driving		IBAT	-	20	-	mA	9LEDs serial
Input High Voltage		VIH	0.8×IOVCC	-	IOVCC	V	
Input Low Voltage		VIL	-0.3	-	0.2×IOVCC	V	
Output High Voltage		VOH	0.8×IOVCC	-	-	V	
Output Low Voltage		VOL	-	-	0.2×IOVCC	V	
I/O Leakage Current		ILi	-1	-	1	uA	
Frame Frequency		Ff	-	60	-	Hz	
Power Consumption	Normal Display	Pci	-	140	-	mW	
	Standby Mode	P_{Dstb}	-	-	100	uW	
	BLU Driving	Pbat	-	540	-	mW	20mA/LED

* All kinds of specifications and functions are optimized with VCI/VCC 3.0V.
** The power consumption is measured at the below test pattern (color bar, column inversion)



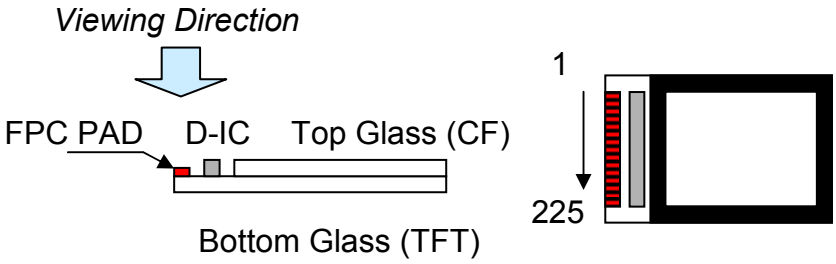
1. White
2. Yellow
3. Light blue
4. Green
5. Purple
6. Red
7. Blue
8. Black

3.3. FPC PAD Pin Assignment (Panel)

No.	Symbol	Description	No.	Symbol	Description
1~2	Dummy		87	VSS_SH	
3~5	VCOM		88~89	CLKP	MIPI Clock+
6~9	VGL		90~91	CLKN	MIPI Clock-
10~14	VGH		92	VSS_SH	
15~17	VCOM		93~94	DATA_1P	MIPI Data1+
18~20	VPP		95~96	DATA_1N	MIPI Data1-
21	VCOMR		97	VSS_SH	
22~27	DDVDL		98~99	DATA_0P	MIPI Data0+
28~32	VDDOUT		100~101	DATA_0N	MIPI Data0-
33~37	VDD		102	VSS_SH	
38~42	VCC		103	HSYNC	
43~49	VCI		104	VSYNC	
50	VCIREF		105	SDO	This pad should be opened at FPC side.
51~52	LSW_RSD		106	SDI	This pad should be connected VSS at FPC side.
53~54	LSW_OUT		107	CS	This pad should be connected IOVCC at FPC side.
55	VSSREF		108	SCK	These pads should be connected VSS at FPC side.
56~64	VSS		109	RD	
65~73	DDVDH		110~115	Dummy	
74~75	DUM_DATA		116	RESET	
76	CREG		117~120	IM3~0	These pads should be connected IOVCC at FPC side.
77	VSS_SH		121	BLU_EN	
78~79	DATA_3P	MIPI Data3+	122	BLU_PWM	
80~81	DATA_3N	MIPI Data3-	123~125	IOVCC	
82	VSS_SH		126~129	VDD	
83~84	DATA_2P	MIPI Data2+	130~135	DDVDL	
85~86	DATA_2N	MIPI Data2-	136	VGS_N	

3.3. FPC PAD Pin Assignment (Panel) *continued*

No.	Symbol	Description	No.	Symbol	Description
137	VREG2OUT		184~188	C22P	
138	VGS		189~193	C22N	
139	VREG1OUT		194~198	C21P	
140~145	VCI		199~203	C21N	
146~153	VSS		204~208	VSS	
154~160	DDVDH		209~211	VCOM	
161~163	VCL		212~216	VGH	
164~168	C24P		217~220	VGL	
169~173	C24N		221~223	VCOM	
174~178	C23P		224	Dummy	These pads should be connected GND at FPC side.
179~183	C23N		225	Dummy	



3.4. Pin Description (FPCB Connector)

No.	Symbol	Description	No.	Symbol	Description
1	GND	Ground (0V)	16	D3+	MIPI Data3+
2	VCI	Analog Power	17	D3-	MIPI Data3-
3	VCC	Logic Power	18	GND	Ground (0V)
4	IOVCC	Interface Power	19	D2+	MIPI Data2+
5	Maker ID_Low	Ground (0V)	20	D2-	MIPI Data2-
6	PWM(B/C)	BLU LED PWM Control	21	GND	Ground (0V)
7	GND	Ground (0V)	22	CLK+	MIPI Clock+
8	/RES	Reset	23	CLK-	MIPI Clock-
9	VSYNC_OUT	Sync. Signal Output	24	GND	Ground (0V)
10	GND	Ground (0V)	25	D1+	MIPI Data1+
11	OTP	OTP Power (OPEN)	26	D1-	MIPI Data1-
12	GND	Ground (0V)	27	GND	Ground (0V)
13	LED_C	LED Cathode	28	D0+	MIPI Data0+
14	LED_A	LED Anode	29	D0-	MIPI Data0-
15	GND	Ground (0V)	30	GND	Ground (0V)

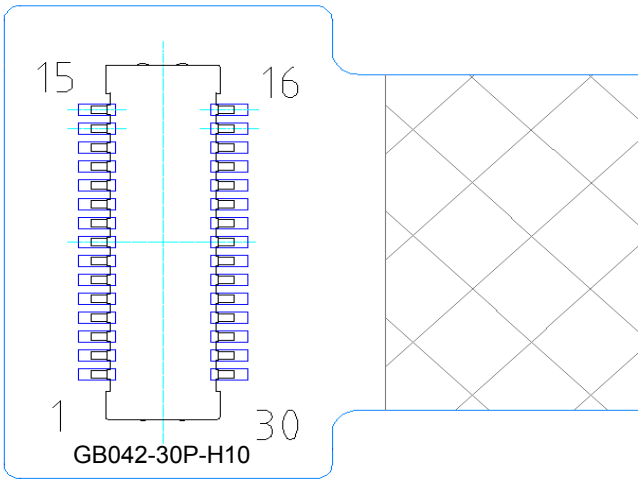
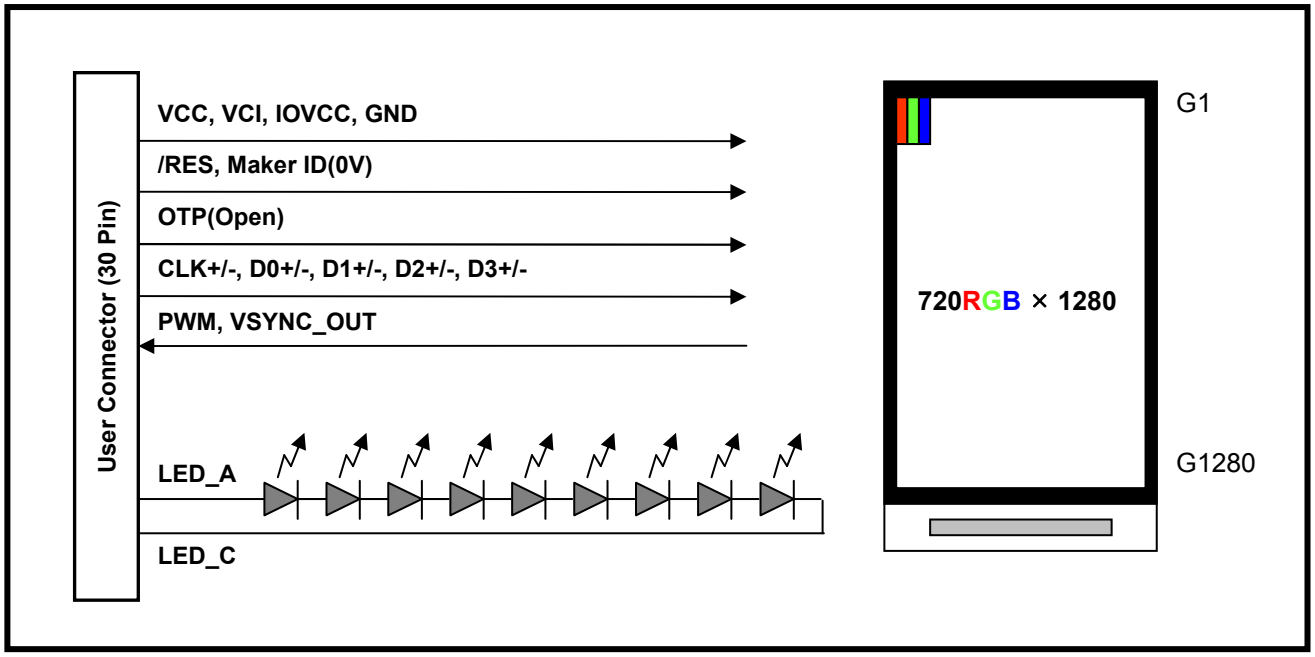


Fig 1. FPC Connector Top View

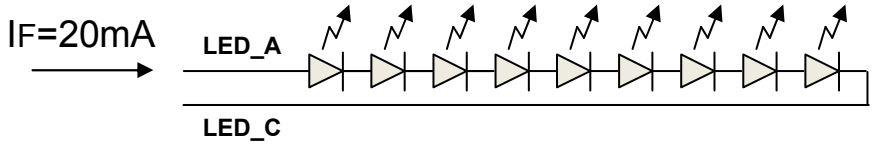
3.5. Block Diagram



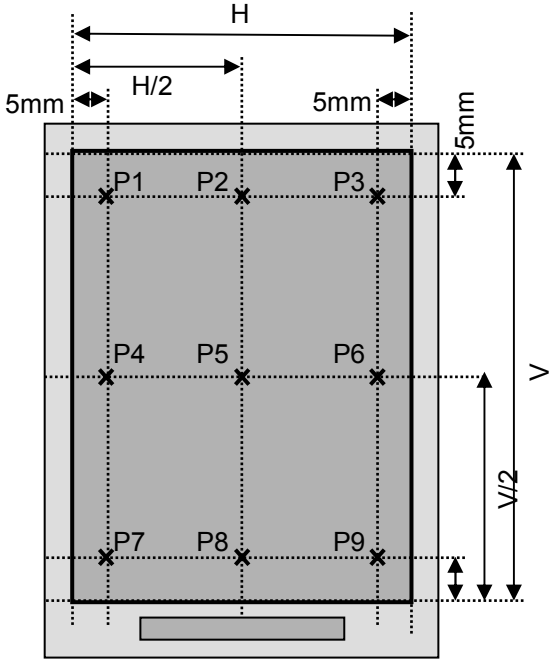
3.6. Backlight Unit

Item	Symbol	Min.	Typ.	Max.	Units
Surface Luminance			12,000		cd/m^2
Surface Brightness Uniformity			85		%
LED Voltage			27		V
LED Current			20		mA

Note 1)
LED Maker : Nichia
LED Part name : NSSW206A



Note 2) Uniformity measure condition



3.7. LED Specification

1) Absolute Maximum Ratings

Item	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	35	mA
Pulse Forward Current	I_{FP}	100	mA
Reverse Voltage	V_R	5	V
Power Dissipation	P_D	115	mW
Operating Temp.	T_{OPR}	-30 to 85	˚C
Storage Temp.	T_{STG}	-40 to 100	˚C
Soldering Temp.	T_{SLD}	Reflow Soldering: 260 ˚C for 10sec Hand Soldering: 350 ˚C for 3sec	

2) Initial Electrical/Optical Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward Voltage	V_{F1}	I_F = 20mA			3.3	V
Reverse Current	I_R	V_R = 5V			50	uA
Luminous Flux	Φ_V	I_F = 20mA	7.25		8.00	lm
Chromaticity Coordinate	C_X	I_F = 20mA	0.291		0.312	-
	C_Y		0.287		0.315	-

3.8. Timing Characteristics

3.8.1. MIPI HS Receiver Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit	Note
VCMRX(DC)	Common-mode voltage HS receive mode	70		330	mV	
VIDTH	Differential input high threshold			100	mV	
VIDTL	Differential input low threshold	-100			mV	
VIHHS	Single-ended input high voltage			460	mV	
VILHS	Single-ended input low voltage	-40			mV	
VTERM-EN	Single-ended threshold for HS termination enable			450	mV	
ZID	Differential input impedance	80	100	125	ohm	

Table 3-1. DC Characteristics of MIPI HS Receiver

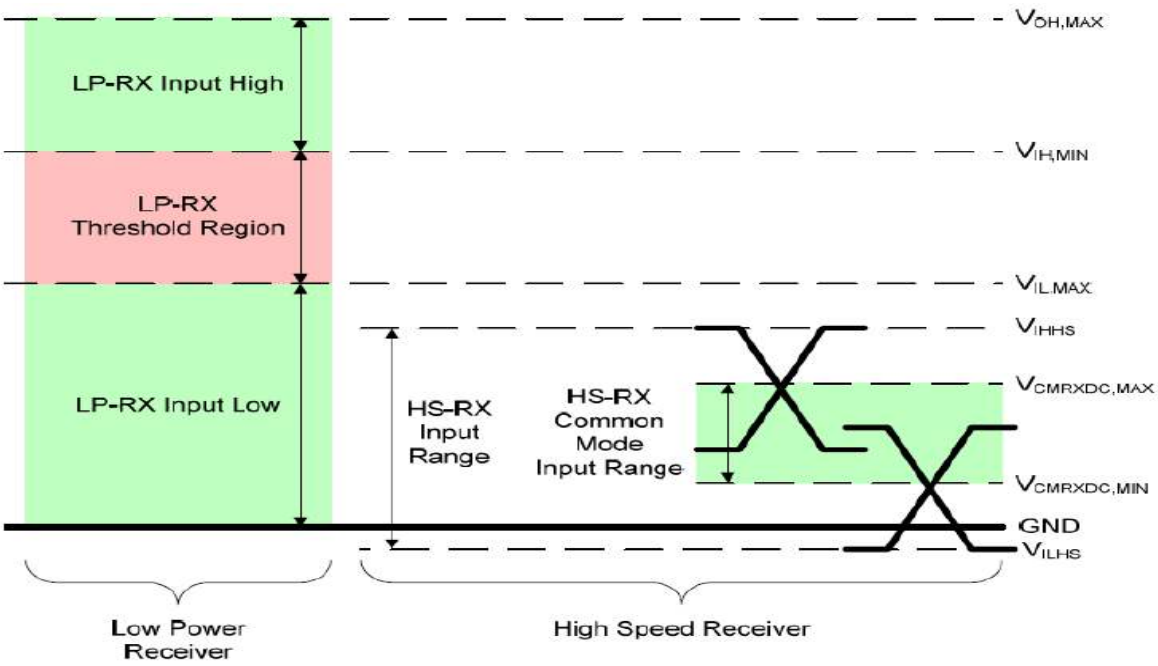


Figure 3-1. Signaling Voltage Levels

Parameter	Description	Min.	Typ.	Max.	Unit	Note
UIINST	Data Rate (UI instantaneous)	2.0			ns	
TSETUP	Data to Clock Setup Time	0.15			UIINST	1
TSHOLD	Clock to Data Hold Time	0.15			UIINST	1
TSKEW	Data to Clock Skew	-0.15		0.15	UIINST	

Notes 1: Total setup and hold window for receiver of 0.3*UIINST

Table 3-2. AC Characteristics of MIPI HS Receiver

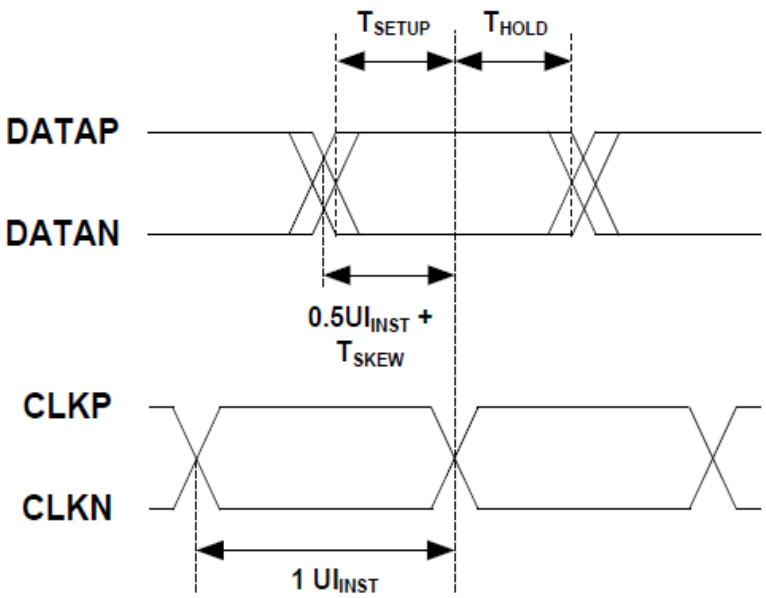


Figure 3-2. AC Timing Waveform for HS Mode MIPI Operation

3.8.2. MIPI LP Receiver Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit	Note
VIH	Logic 1 input voltage	880			mV	
VIL	Logic 0 input voltage			550	mV	
VIL-ULPS	Logic 0 input voltage, ULP State			300	mV	
VHYST	Input Hysteresis	25			mV	

Table 3-3. DC Characteristics of MIPI LP Receiver

Parameter	Description	Min.	Typ.	Max.	Unit	Note
eSPIKE	Input pulse rejection			300	Vp-s	1, 2
TMIN-RX	Minimum pulse width response	20			ns	3
VINT	Peak interference amplitude			200	mV	
fINT	Interference frequency	450			MHz	

Notes 1: Time-voltage integration of a spike above VIL when being in LP-0 state or below VIH when being in LP-1 state.
Notes 2: An impulse less than this will not change the receiver state.
Notes 3: An input pulse greater than this shall toggle the output.

Table 3-4. AC Characteristics of MIPI LP Receiver

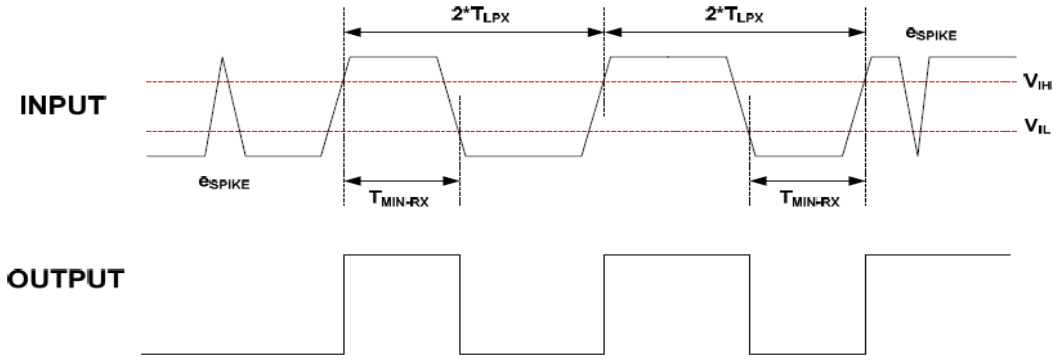


Figure 3-3. AC Timing Waveform for LP Mode MIPI Operation

3.8.3. MIPI LP Transmitter Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit	Note
VOH	Thevenin output high level	1.1	1.2	1.3	V	
VOL	Thevenin output low level	-50		50	mV	
ZOLP	Output impedance of LP transmitter	110			ohm	1

Notes 1: Though no maximum value for ZOLP is specified, the LP transmitter output impedance shall ensure the TRLP/TFLP specification is met.

Table 3-5. DC Characteristics of MIPI LP Transmitter

Parameter	Description		Min.	Typ.	Max.	Unit	Note
TRLP/TFLP	15%-85% rise time and fall time				25	ns	1
TREOT	Thevenin output low level				35	ns	1, 5, 6
TLP-PULSE-TX	Pulse width of the LP XOR clock	First LP XOR clock pulse after Stop state or last pulse before Stop state	40			ns	4
		All other pulses	20			ns	4
TLP-PER-TX	Period of the LP XOR clock		90			ns	
δV/δtSR	Slew rate @ CLOAD = 0pF		30		500	mV/ns	1, 2, 3
	Slew rate @ CLOAD = 5pF		30		200	mV/ns	1, 2, 3
	Slew rate @ CLOAD = 20pF		30		150	mV/ns	1, 2, 3
	Slew rate @ CLOAD = 70pF		30		100	mV/ns	1, 2, 3
CLOAD	Load capacitance		0		70	pF	1

Notes 1: CLOAD includes the low-frequency equivalent transmission line capacitance.
The capacitance of TX and RX are assumed to always be <10pF.
The distributed line capacitance can be up to 50pF for a transmission line with 2ns delay.
Notes 2: When the output voltage is between 15% and below 85% of the fully settled LP signal levels.
Notes 3: Measured as average across any 50 mV segment of the output signal transition.
Notes 4: This parameter value can be lower then TLPX due to differences in rise vs. fall signal slopes and trip levels and mismatches between Dp and Dn LP transmitters.
Notes 5: The rise-time of TREOT starts from the HS common-level at the moment the differential amplitude drops below 70mV, due to stopping the differential drive.
Notes 6: With an additional load capacitance CCM between 0-60pF on the termination center tap at RX side of the Lane

Table 3-6. AC Characteristics of MIPI LP Transmitter

3.8.4. Reset Characteristics

Parameter	Description	Min.	Typ.	Max.	Unit	Note
tRES	Reset “Low” level width	1			ms	
trRES	Reset rise time			10	us	

Condition: IOVCC = 1.65 to 3.30V, VCC = 2.60 to 3.30V

Figure 3-4. Reset Operation

3.9. Operation Flow Chart

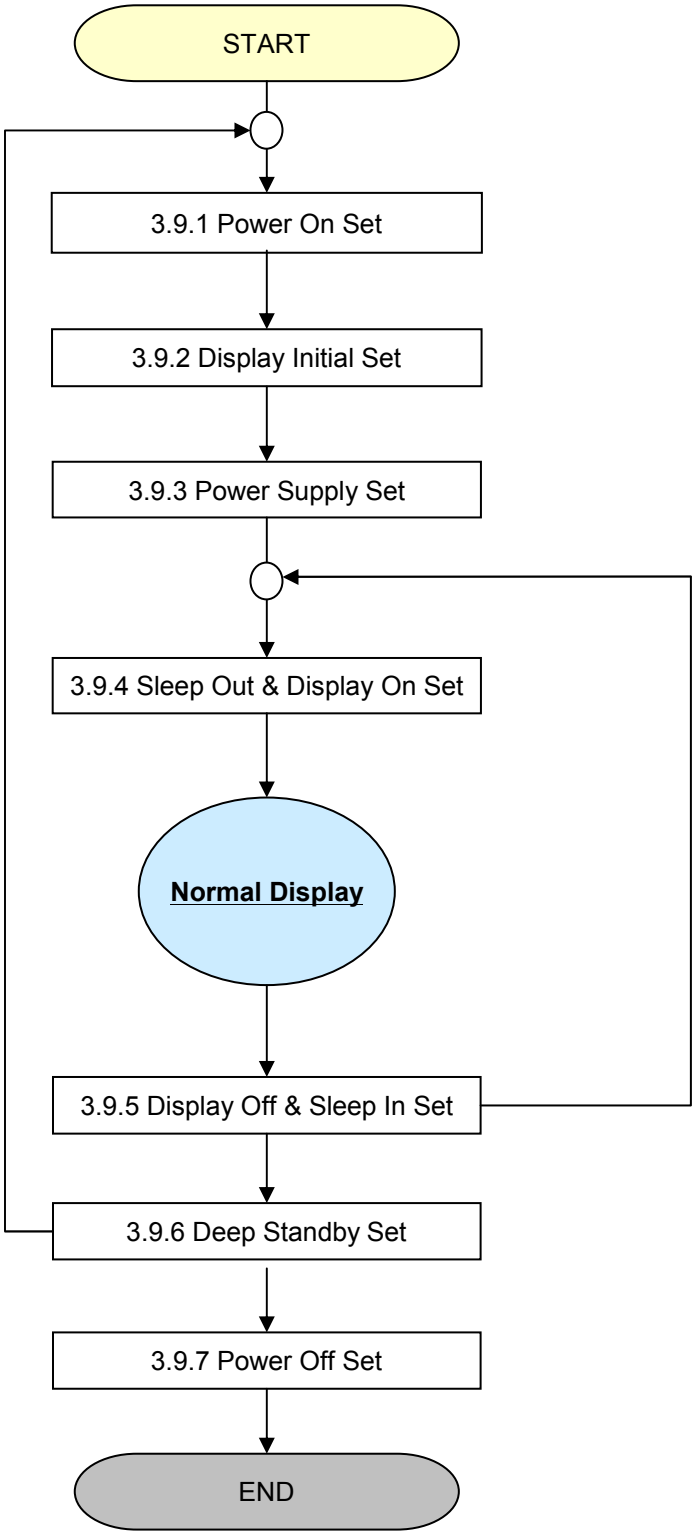


Table 3.9.1. Power On Set

Step	Register Setting		Operation
	Register	Data	
1	/RES = LOW		
2	Power (VCC, IOVCC, VCI) ON VCC→100us→IOVCC→100us→VCI or simultaneously ON		
3	1ms or more		
4	/RES = HIGH		
5	10ms or more		

Table 3.9.2. Display Initial Set

Step	Register Setting		Operation
	Register	Data	
1	E0	43	MIPI DSI Configuration
		00	
		80	
		00	
		00	
2	B5	29	Display Control 1
		20	
		40	
		00	
		00	
3	B6	01	Display Control 2
		14	
		0F	
		16	
		13	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
4	D0	00	Positive Gamma Curve for Red
		11	
		77	
		23	
		16	
		06	
		62	
		41	
		03	
5	D1	00	Negative Gamma Curve for Red
		14	
		63	
		23	
		08	
		06	
		41	
		33	
		04	
6	D2	00	Positive Gamma Curve for Green
		11	
		77	
		23	
		16	
		06	
		62	
		41	
		03	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
7	D3	00	Negative Gamma Curve for Green
		14	
		63	
		23	
		08	
		06	
		41	
		33	
		04	
8	D4	00	Positive Gamma Curve for Blue
		11	
		77	
		23	
		16	
		06	
		62	
		41	
		03	
9	D5	00	Negative Gamma Curve for Blue
		14	
		63	
		23	
		08	
		06	
		41	
		33	
		04	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
10	70	0F	Image Enhancement
11	71	00	
		00	
		01	
		01	
12	72	01	
		0F	
13	73	34	
		52	
		00	
14	74	04	
		01	
		07	
15	75	03	
		0F	
		07	
16	76	07	
		00	
		05	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
17	77	40	Image Enhancement
		40	
		40	
		40	
		40	
		40	
		40	
		40	
18	78	3E	
		3E	
		3E	
		3E	
		3E	
		3E	
		3E	
		3E	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
19	79	40	Image Enhancement
		40	
		40	
		40	
		40	
		40	
		40	
		40	
20	7A	00	
		00	
		00	
		00	
		00	
		00	
		00	
		00	

Table 3.9.2. ***continued***

Step	Register Setting		Operation
	Register	Data	
21	7B	00	Image Enhancement
		00	
		00	
		00	
		00	
		00	
		00	
		00	
22	7C	00	
		00	
		00	
		00	
		00	
		00	
		00	
		00	

Table 3.9.3. Power Supply Set

Step	Register Setting		Operation
	Register	Data	
1	C0	01	Internal Oscillator Setting
		04	
2	C3	00	Power Control 3
		09	
		10	
		12	
		00	
		66	
		20	
		31	
		00	
3	C4	22	Power Control 4
		24	
		18	
		18	
		47	
4	C7	10	Power Control 5
		00	
		14	
5	F9	00	OTP2
6	C1	00	Power Control 1
7	C2	02	Power Control 2
8	10ms delay		
9	C2	06	Power Control 2
10	10ms delay		
11	C2	4E	Power Control 2
12	10ms delay		

Table 3.9.4. Sleep Out & Display On Set

Step`	Register Setting		Operation
	Register	Data	
1	11	None	Sleep out
2	10ms delay		
3	F9	80	OTP2
4	10ms delay		
5	29	None	Display On

Table 3.9.5. Display Off & Sleep In Set

Step	Register Setting		Operation
	Register	Data	
1	28	None	Display Off
2	10	None	Sleep In

Table 3.9.6. Deep Standby Set

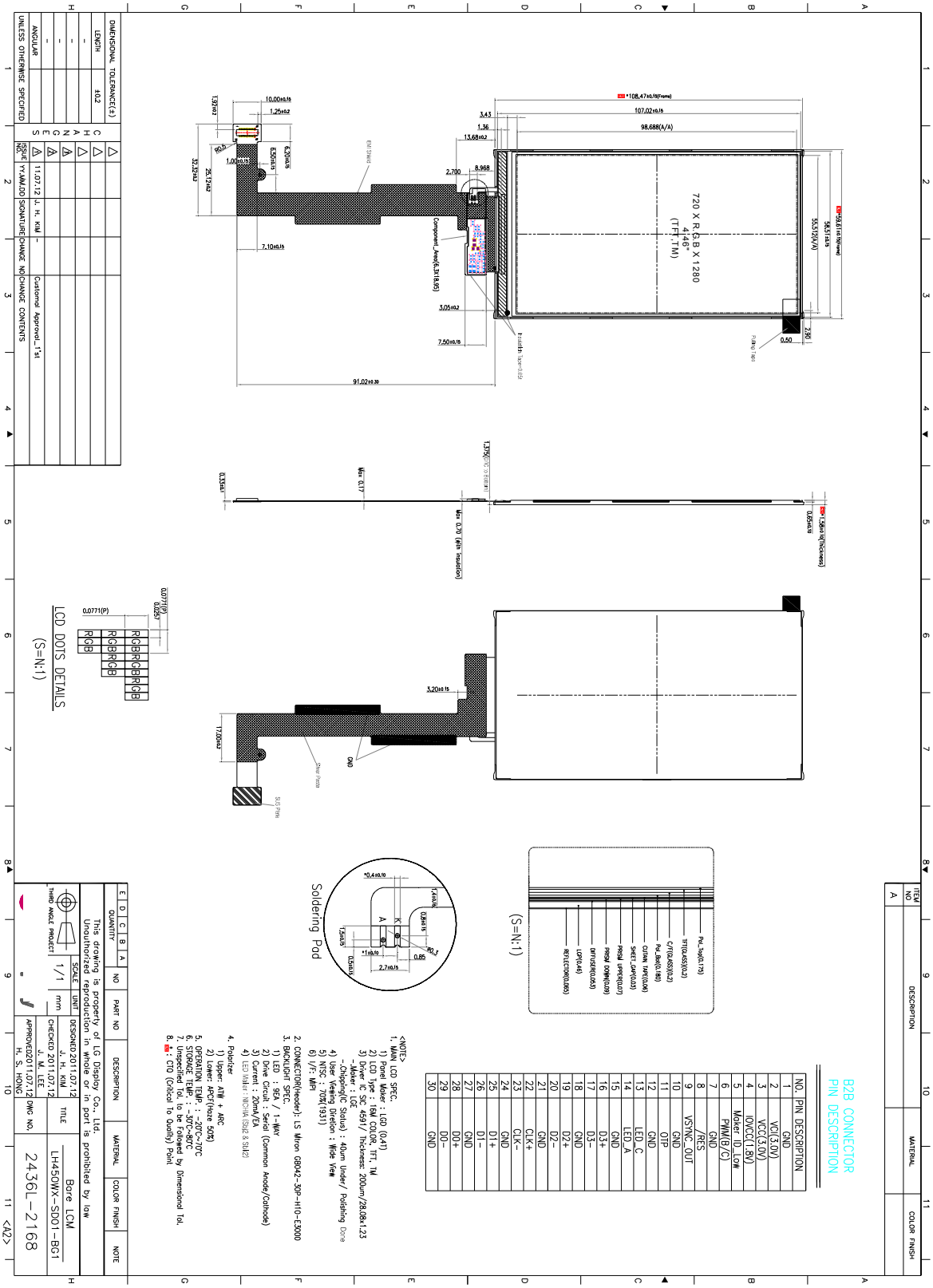
Step	Register Setting		Operation
	Register	Data	
1	C2	00	Power Control 2
2	C4	00	Power Control 4
		00	
		00	
		00	
		00	
3	10ms or more		
4	C1	02	Standby
5	10ms or more		
6	C1	03	Deep Standby
7	10ms or more		

Table 3.9.7. Power Off Set

Step	Register Setting		Operation
	Register	Data	
1	10ms or more		
2	Power (VCC, IOVCC, VCI) OFF VCI→100us→IOVCC→100us→VCC or simultaneously OFF		

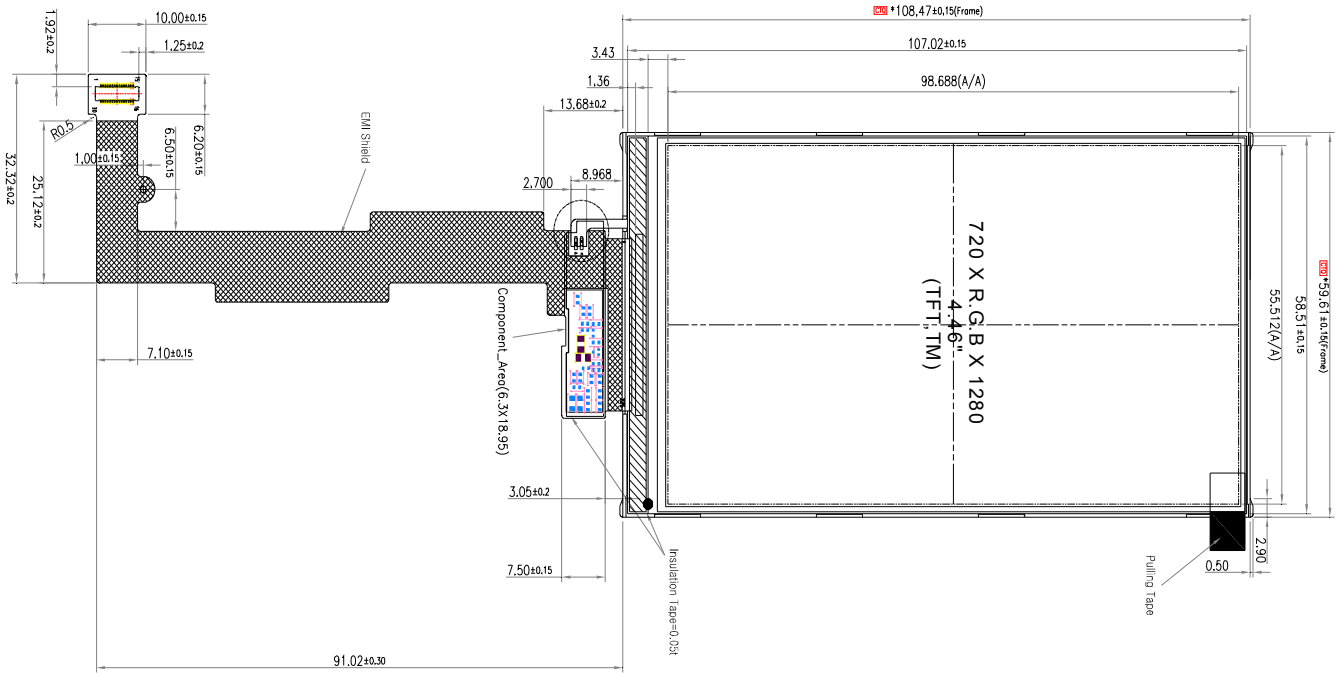
4. Mechanical Drawing

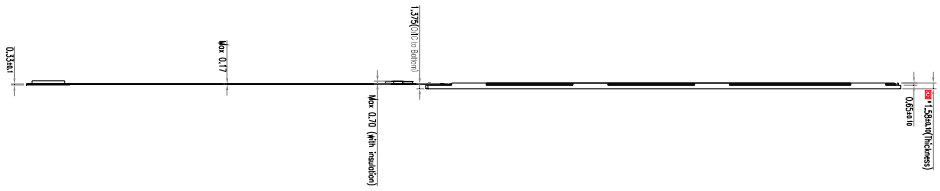
4.1 Module Layout

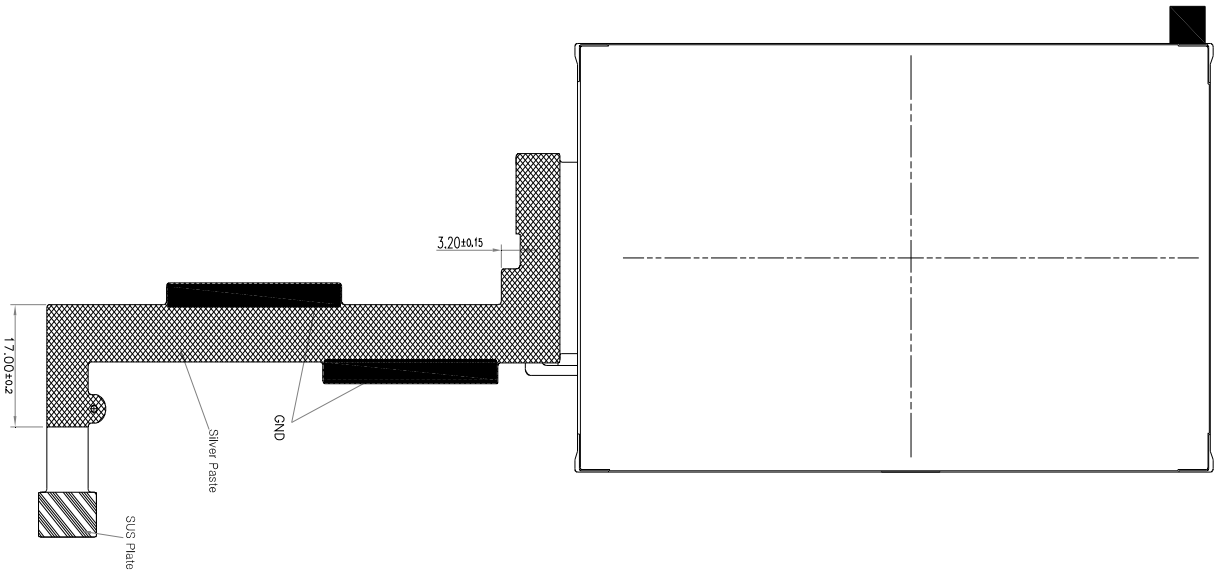


4. Mechanical Drawing

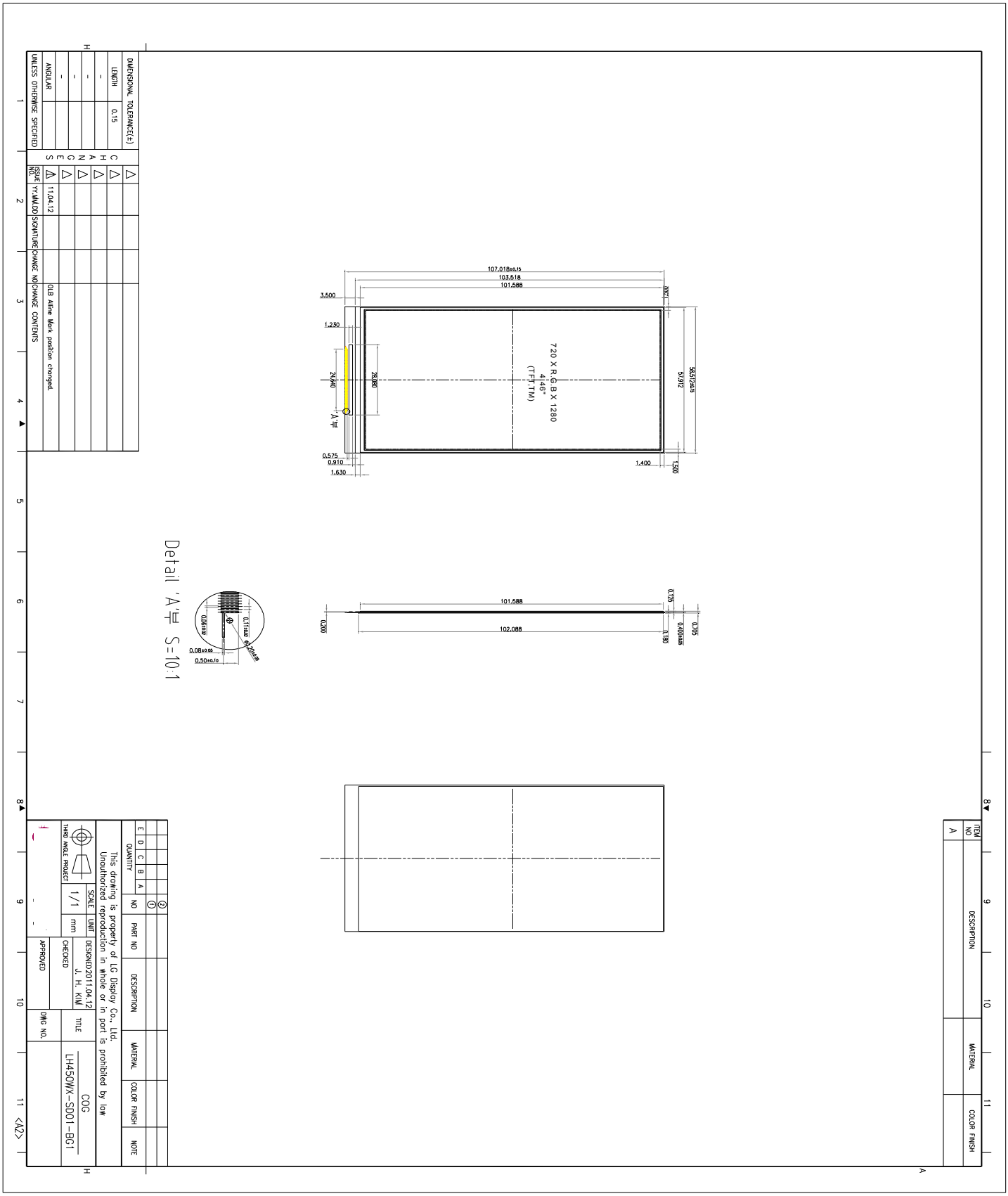
4.1 Module Layout



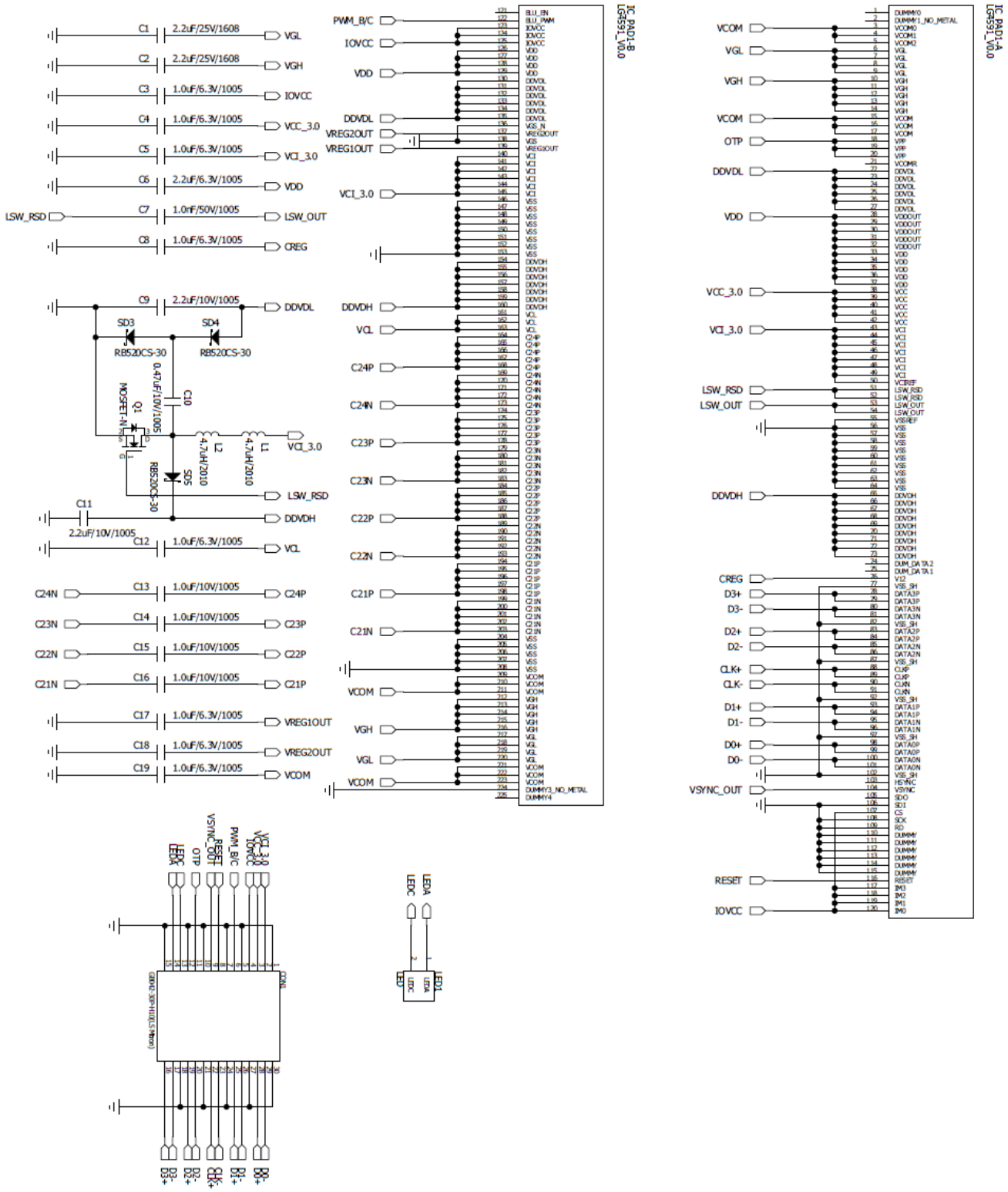




4.2. Panel Layout

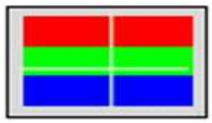
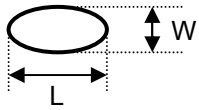
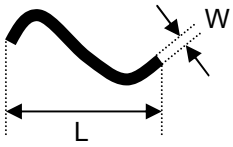


4.3. FPCB Schematic

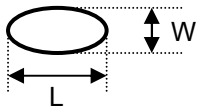
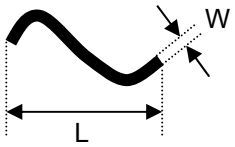
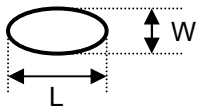


5. Incoming Inspection Specification

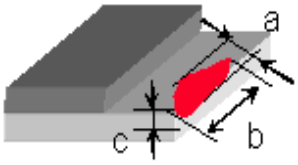
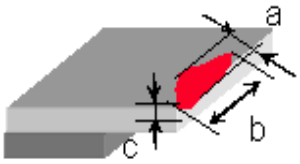
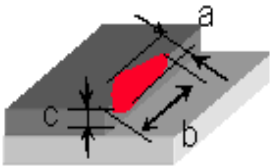
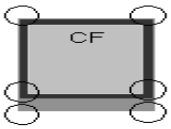
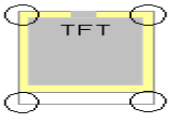
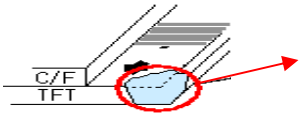
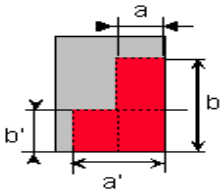
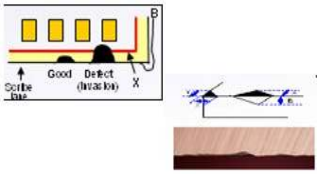
5.1. Display Quality Specification

No	Defect	Criteria		Remark
1	No Display (Major)	Not allowed		
2	Missing Line (Major)	Not allowed		
3	Darker or Lighter Line (Major)	Not allowed		
4	Bright / Dark Point (Minor)	Spec.	Permissible Qty	1: If blue sub-pixel number is 1 or 2ea, it is OK. But if 2ea in diameter 20mm, it is NG. 2. If particle bright dot size is under 0.2mm, 2ea is OK. But if 2ea in diameter 20mm, it is NG.
		Bright Point	0	
		Dark Point	2	
5	Round Type (Minor)	Spec.	Permissible Qty	1: Φ=(L+W)/2, L=Length W=Width 2: Disregard if out of A/A 
		Φ ≤ 0.10mm	Disregard	
		0.10mm < Φ ≤ 0.20mm	1	
		0.20mm < Φ	0	
6	Line Type (Minor)	Spec.	Permissible Qty	1: L=Length, W=Width 2: Disregard if out of A/A 
		W ≤ 0.03mm	Disregard	
		0.03mm < W ≤ 0.05mm , L ≤ 2.0mm	1	
		W > 0.05mm or L > 2.0mm	0	

5.2. Scratches, Dent and Extraneous Substances

No	Defect	Criteria		Remark
1	Round Type (Minor)	Spec.	Permissible Qty	1: Φ=(L+W)/2, L=Length W=Width 2: Disregard if out of A/A 
		Φ ≤ 0.10mm	Disregard	
		0.10mm < Φ ≤ 0.20mm	1	
		0.20mm < Φ	0	
2	Line Type (Minor)	Spec.	Permissible Qty	1: L=Length, W=Width 2: Disregard if out of A/A 
		W ≤ 0.03mm	Disregard	
		0.03mm < W ≤ 0.05mm , L ≤ 1.0mm	1	
		W > 0.05mm or L > 1.0mm	0	
3	Polarizer Dent (Minor)	Spec.	Permissible Qty	1: Φ=(L+W)/2, L=Length W=Width 2: Disregard if out of A/A 
		Φ ≤ 0.10mm	Disregard	
		0.10mm < Φ ≤ 0.20mm	1	
		0.20mm < Φ	0	

5.3 Chipping and Broken

No`	Item	Criterion for Defects	Defect Type	Remark
1	Glass Chipping [Pad Area]	 Size [mm] a ≤ 0.3 b ≤ 5.0 c ≤ t	Minor	
2	Glass Chipping [Rear of Pad Area]	 Size [mm] a ≤ 0.5 b ≤ 5.0 c ≤ t	Minor	
3	Glass Chipping [Except Pad Area]	 Size [mm] a ≤ 0.5 b ≤ 5.0 c ≤ t	Minor	
4	Glass Chipping [Corner]	 Size [mm] a ≤ 0.5 b ≤ 3.0 Size [mm] a' ≤ 3.0 b' ≤ 0.5   	Minor	
5	D-IC Chipping [Top/Back side]	 Scribe Line 침범 없을것 (Red Line) X,Y(모서리)≤50um A,B(중앙) ≤40um	Minor	

6. Precautions for Use

6.1. Safety

1) DISASSEMBLING OR MODIFICATION

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

2) BREAKAGE OF LCD PANEL

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. If liquid crystal material contacts the skin, mouth or clothing, take the following actions immediately.

In case contact to the eye or mouth, rinse 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 is left adhered. In case ingestion, rinse out the mouth well with water. After spewing up by drinking large amount of water, get medical treatment.

3) GLASS OF LCD PANEL

Be careful with chips of Grass that may cause injuring fingers or skin, when the glass is broken.

4) ABSOLUTE MAXIMUM RATINGS

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, environmental temperature, etc., otherwise LCD module may be damaged.

5) POWER PROTECTION CIRCUIT

Employ protection circuit for power supply, whenever the specification specifies it.
A suitable protection circuit should be applied, based on 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.

6) DISPOSAL

Always comply with all applicable environmental regulations, when disposing of the LCD.

7) EDGES OF PARTS

Be careful with edges of glass parts and metal frame, it may cause injuring.
For designing the system, give special consideration that the wiring and parts do not touch those edges.

8) RECOMMENDED OPERATING CONDITIONS

Don't exceed “the recommended operation conditions” in this specification. The performance and quality of the LCD module are warranted only when the LCD module is used within “the recommended operation conditions”. 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.

6.2. Installation in Assembly

1. ESD (ELECTRO-STATIC DISCHARGE) PREVENTION

The circuit used in LCD module is very sensitive to ESD. The following caution should be taken when installing LCD module to an enclosure of the system in order to prevent damage of circuit used in LCD module.

1) HUMIDITY

Ambient humidity of working area is recommended to be higher than 50%(RH) in order to avoid ESD.

2) GROUNDING

- Person handling LCD modules should be grounded with wrist band.
- Tools like soldering iron and screw drivers and working benches should be grounded.
- Grounded electro-conductive mats are recommended to be cover`ed on the floor of working area and surface of working benches.
- The grounding should be done through a resister of 0.5~1Mohms in order to prevent spark of ESD.

3) Be careful with touching metal portion of testing instruments in order to prevent unnecessary ESD.

4) Do not touch the electrode area of PCB and electrical parts like LSI, capacitor, connector pin, etc.

5) IONIZER

Using ionizer (an antistatic blower) is recommended at working area in order to reduce electro-static voltage.

6) REMOVING PROTECTION FILM

When removing protection film from LCD panel, peel off the tag slowly (more than one second) while blowing with ionizer toward the peeling face to minimize ESD which may damage electrical circuit.

2. DUST AND STAIN PREVENTION

1) WORKING AREA

Reduce dust level in working area. Especially the level of metal particle should be decreased, otherwise electrical circuit in LCD module may be damaged due to short circuit by metal particles.

2) FINGER PRINT

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.

3) PROTECTION FILM

LCD module may be shipped with "protection film" on LCD panel in order to prevent from scratches and dust. It is recommended to remove the film at later process of assembling.

4) WIPING OFF DUST ON THE PANEL

When LCD panel becomes dirty, wipe the panel surface off softly with absorbent cotton or another soft cloth. If necessary, breathe upon the panel surface and then wipe off immediately and softly again. 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) ADHESIVE ON LCD PANEL

Be careful not to attach adhesive, grease, etc., on LCD panel, because it is difficult to remove them without any damages on LCD panel.

6) WATER SPOTS ON THE PANEL

Avoid the dewing or 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. And, damage may occur if water penetrates the inside.

3. INSTALLING LCD MODULE TO THE ENCLOSURE

1) INSTALLING LCD MODULE TO THE ENCLOSURE

Do not bend or twist LCD module even momentarily when the LCD module is installed into the system. Bending or twisting the LCD module may cause permanent damage.
When the FPC is bent, the radius of FPC curvature must be more than value of recommendation to prevent bending and twisting forces from affecting the connection of FPC.
Even temporary bending or twisting sometimes causes damage.

2) INTERFACE

Do not fasten screws, with catching interface FPC between LCD module and the enclosure.
This may cause bending of LCD module, or become the cause of a failure by damaging FPC.

4. MECHANICAL FORCES

1) CARRY
Hold the side of the plastic frame when you carry an LCD module by hand. If an LCD is carried using the FPC, it is likely to be damaged and the LCD will then malfunction. If you turn on the LCD with a broken FPC, it may cause smoke or burning.
Protection (eg gloves) for fingers and hands is recommended to avoid injury by broken glass.

2) STRONG MECHANICAL SHOCK
Avoid strong mechanical shock, such as dropping the LCD from the work bench, or knocking it against a hard object.
These may cause the glass panel to crack, or cause other mis-operation.

3) EXCESSIVE FORCE
Avoid applying excessive force, like pushing the surface of LCD panel. This may cause scratches or breakage of the panel, or a failure of the module.

4) SCRATCHES ON THE PANEL
Do not put heavy object such as tools, books, etc., and do not pile up LCD modules.
Be careful not to touch the surface of the polarizer with any hard and sharp object. These parts are so sensitive and can easily be scratched, even if protected by a film.

5)Connector
When inserting or disconnecting the connector into a connector of the LCD module, care should be taken to ensure that no strong external force is applied to the connector on the LCD module side.
A strong external force applied to the connector or the FPC may damage their connections.
When assembling a module into a system, pay extra attention to ensure that no part such as the FPC etc. should be caught between the case of the system and the module. Make sure that the input signal connector of a module is securely and correctly connected to the connector on the system, not skewed, or incompletely connected.
Inputting a signal etc. into the module with connectors incorrectly inserted may cause a circuit component or components to malfunction.

6) FPC
When inserting or disconnecting the connector of the LCD module into a connector of the system, care should be taken to ensure that no strong external force is applied to the FPC on the LCD module side. A strong external force applied to the FPC may damage their connections.
When assembling a module into a system, pay extra attention to ensure that no part such as the FPC etc. should be caught between the case of the system and the module.
Make sure that the input signal connector of a module is securely and correctly connected to the connector on the system, not skewed, or incompletely connected. Inputting a signal etc. into the module with connectors incorrectly inserted may cause a circuit component or components to malfunction. Be careful not to pull or damage the FPC cables, to avoid mechanical damage in FPC and connection part of FPC and cell.

5. OPERATION

1) POWER SUPPLY
Power supplies should always be turned off during the assembly process.
Do not connect or disconnect the power cables and connectors with power applied to LCD module. This may cause damage to the LCD module circuit.
In operating module at the inspection process, and so on, the supply voltage and signals of driving device must satisfy the sequence of power supplies and signals described in this specifications.

2) GAS
Do not expose the LCD module to any gas which is not normally contained in the atmosphere, it may cause mis-operation or defects.

3) USED FOR LONG TERM
When a LCD module is used for a long term, the characteristics of LCD module might be changed and it may be out of the standard of “4.3 Optical Specifications” due to LED discoloration.
LED has the characteristics of shifting optical characteristics by the long term use.

6.3. Transportation and Storage

1) TEMPERATURE

Do not store LCD modules in a high temperature and high humidity condition, higher than 35ºC and 70%(RH) for a long term, meaning about one month or more, otherwise this may deteriorate the quality of the display. When you unavoidably store LCD modules for a long time, store between 0 and 35ºC, with a relative humidity 70% or lower.

2) LOW TEMPERATURE

Be careful not to leave it where the temperature is below specified storage temperature because the liquid crystal of the display panel may be damaged.

3) ULTRA VIOLET RAY

Store LCD module without exposure to direct sunlight or fluorescent lamps in order to prevent the module from strong ultra violet ray.

4) CLEANLINESS

Keep the LCD module in clean place, because any dust, hard particle may damage the polarizer, or dust invades the inside of the LCD module.

5) CONDENSATION OF WATER

The modules should be stored under a condition where no condensation of water is allowed. It may cause mis-operation or defects. Be especially careful not to make a module work under the condition that condensation of water appears.

6) PACKAGING

When you must re-package a LCD module after it has been removed from the original packaging, it is recommended to re-pack using the original package box and package material.

7. Package

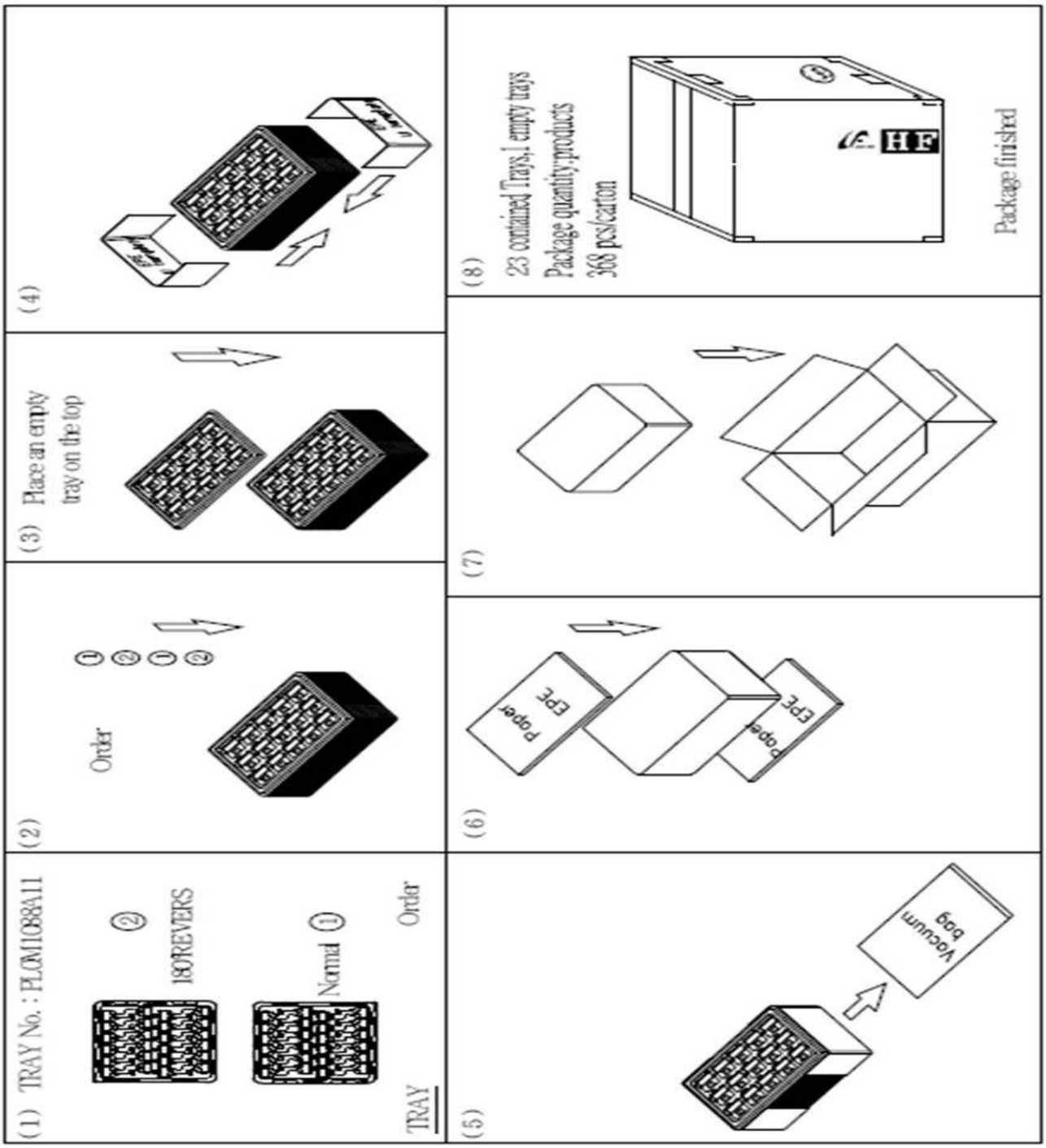
7.1. Packing Description

Packing Condition	Contents
Packing Type	PET packing type
PET material model	PET (10^9~10^{12} Ω)
PET packing type	See the picture 1
Number of panels per PET	8 pieces
Number of PET per carton	20+1(empty) units
Number of panels per carton	160 pieces

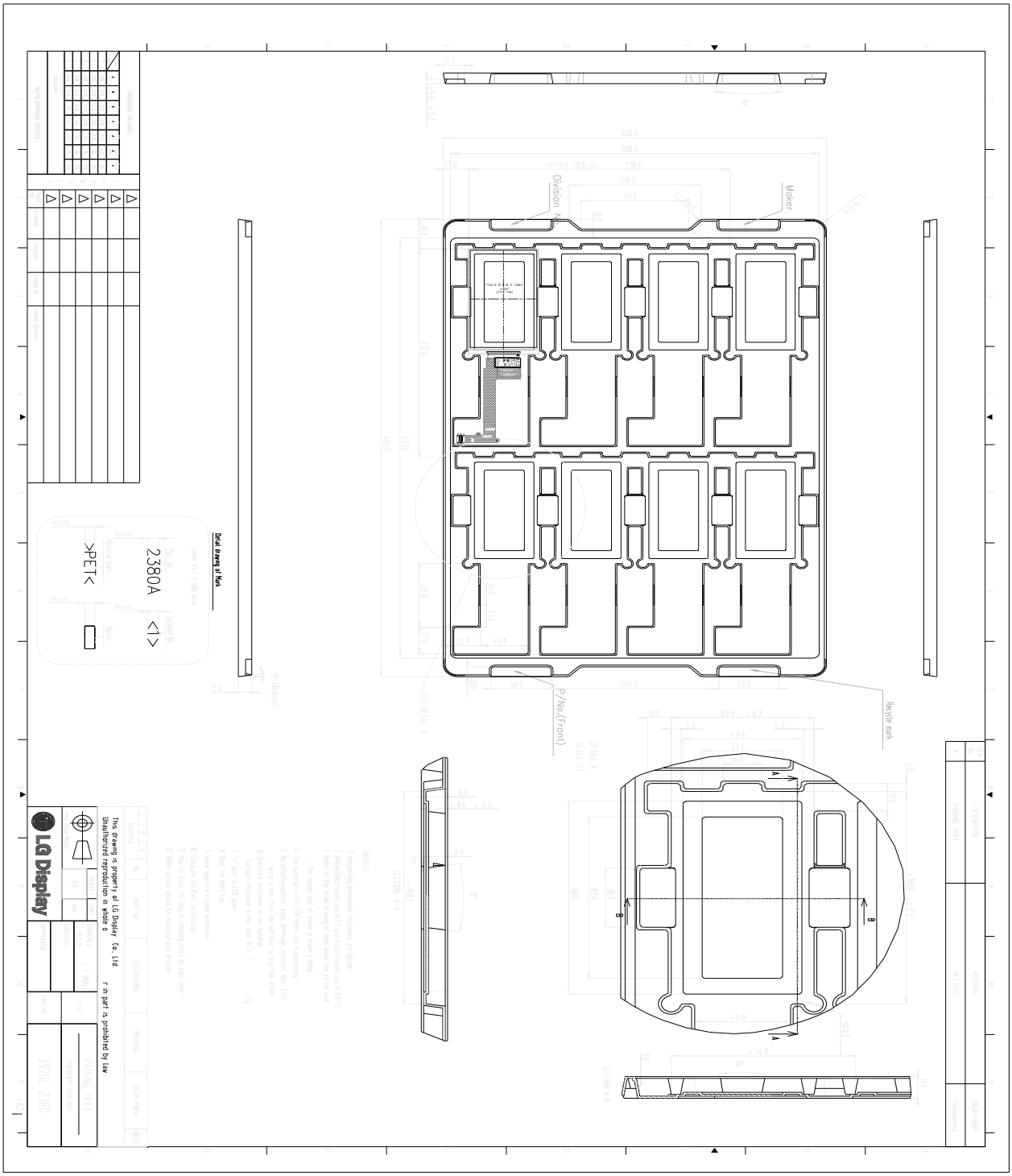
7.2. Description of Carton Material Composed

No.	1	2	3	4	5
Description	LCD Module	PET Tray	Packing Carton	Vacuum Bag	Carton
Quantity	160	21	1	1	1

7.3. Description of Packing Procedure



7.4. Description of Packing Tray



7.5. Designation of Lot Mark

Byte	1	2	3	4	5	6	7	8	9	10

1. Factory Code

Byte	1	2

Mark		Description
M	4	Gumi OLED Fab
X	C	KR EMS
X	W	육일 C&S

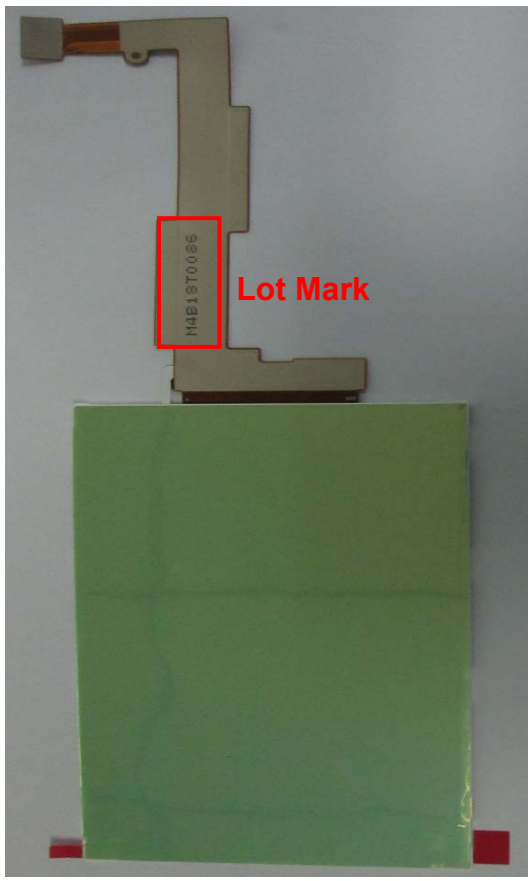
2. Lot Type

Byte	3

Mark	Desc.
A	CP Line
B	Ass'y Line
R	Rework
G	GIB
P	Packing

3. Year/Month/Data of Production

Byte	4	→	Year : 0~9
Byte	5	→	Month : 1~C (Except I/O)
Byte	6	→	Date : 1~X (Except I/O)

4. Serial Number : 0001 ~ Z999 (Except I/O)

Byte	7	→	1~Z (Except I/O)
Byte	8	→	0~9
Byte	9	→	0~9
Byte	10	→	0~9