

Product Specification

Model Name: HL017T03-01

Description: 1.78 AMOLED

Doc. Version:

☐ Approved for Preliminary Specification

☐ Approved for Final Specification

☒ Approved for Final Specification & Sample

Prepared	Checked	Approved

Customer's Approval

[illegible]

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1 Scope

This Specification defines AMOLED manufactured by HL Lighting Display, from here on refer as In the case of any unspecified item, it may require both party's designs this module into its product to work out as a solution.

2 Features

2.1 Product Applications

Smart Watch

2.2 Product Features

- 1) Display color: 16.7M (RGB x 8bits)
- 2) Display format: 1.78"(368*RGB*448)
- 3) Pixel arrangement: Real RGB arrangement
- 4) Interface: MIPI/SPI

3 Mechanical Specifications

Item	Specification	unit
LTPS Glass outline	30.6*37.99	mm
Encapsulation Glass outline	30.6*37.24	mm
Number of dots(W*H)	368* RGB * 448	dots
Active area	28.7*34.94	mm
Diagonal size	1.78	inch
Pixel pitch	78*78	μm
Glass thickness (LTPS/Encap. glass)	0.2 / 0.3	mm
Weight	2.10±10%	g

4 Maximum Rating

Parameter	Symbol	Spec			Unit	Note
		Min.	Typ.	Max.		
Analog/boost power voltage	VCI	-0.3	-	5.5	V	-
I/O voltage	VDDIO	-0.3	-	5.5	V	-
Operating temperature	Top	-20	-	70	°C	-
Storage temperature	Tstg	-40	-	80	°C	-

5 Electrical Specifications

5.1 Electrical Characteristics

Power Characteristic:

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Battery power Voltage	Vbat	2.9	3.7	4.8	V	-
Digital Power supply	VDDIO	1.65	1.8	1.95	V	Ref

1) Normal Mode

Power Supply: VDDIO=1.8V Vbat=3.7V

Frame Frequency: $F_{frame}=60\text{HZ}$ @ 25degC, Brightness 350 nits, Command Mode,

Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
100% Pixel On,350nits	Normal mode	-	186	210	mW	Ref

2) Idle Mode

Power Supply: VDDIO=1.8V Vbat=3.7V

Frame Frequency: $F_{frame}=15\text{HZ}$ @ 25degC, Brightness 30 nits,

Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
10% Pixel On,30nits	Idle mode	-	12	16	mW	Ref

3) Deep Standby Mode

Display Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
All Pixel Off,0nits/ Vci off/Vddio on	Standby mode	-	-	50	μW	-

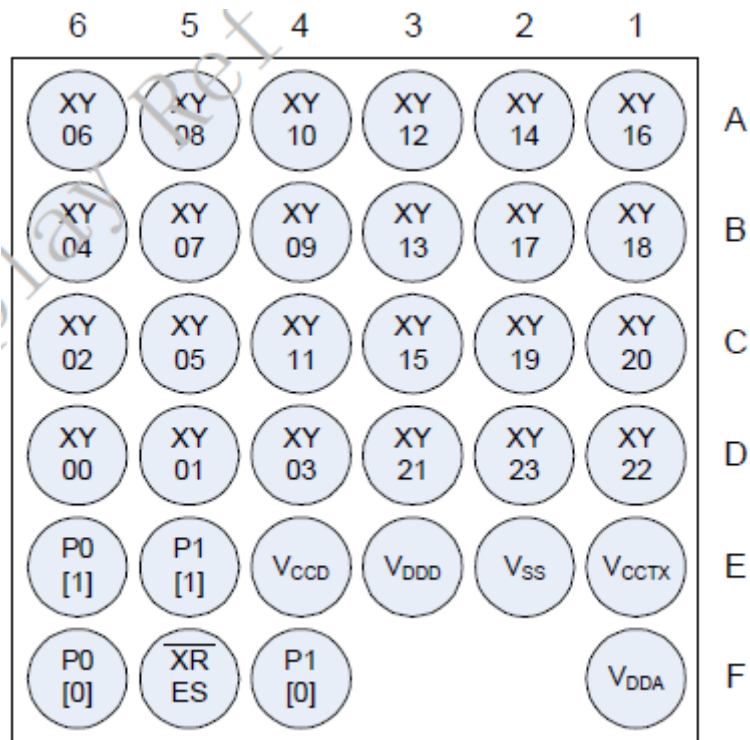
5.1.2 Driver IC

RM69090 (refer to the datasheet).

5.2 TP IC Recommended Operating Conditions

Touch IC: TMA525C (refer to the datasheet)

Symbol	Description	Min	TYP	MAX	UNIT
VCCA	Analog power supply voltage	2.7	2.8	3.6	V
V _{IN} (I2C)	Input voltage range	0	-	3.6	V
V _{OUT} (I2C)	Output voltage range	0	-	3.6	V
V _{IN} (INT)	Input voltage range	0	-	3.6	V
V _{OUT} (INT)	Output voltage range	0	-	3.6	V
V _{OUT} (TX)	Output voltage range	0	-	VCCA	V
V _{OUT} (RX)	Input voltage range	0	-	VCCA	V



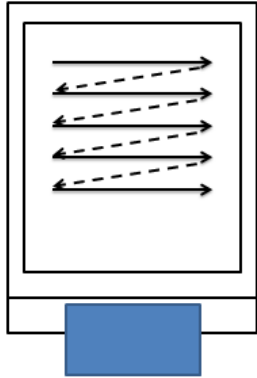
Item	Spec	Remark
Operating voltage	2.7-3.6V	
Operating current	2mA	
Linearity	Center part $\leq$ 1mm	Test tool: ϕ 7mm copper cylinder
	The peripheral position $\leq$ 2mm	
Sensitivity	No broken line	Lineation with 5mm/s&20mm/s respectively by Φ 7mm copper cylinder
Response time	$\leq$ 10ms	

5.3 I/O Connection

No.	Pin name	I/O	Description
1	VCI_EN	I	VCI enable signal for power ic
2	GND	Power	Ground
3	TP_I2C_SDA	I/O	Touch IC I2C data
4	TP_I2C_SCL	I/O	Touch IC I2C clock
5	TP_SWDIO(NC)	-	Serial Wire Debug Input/Output, leave the pin to open when not in use.
6	TP_RST	I	This signal will reset Touch IC.Signal is active low.
7	TP_INT	O	Touch IC's interrupt to Host
8	TP_VDD	Power	Power supply for Touch IC
9	GND	Power	Ground
10	LCD_RST	I	Driver IC reset signal (0 : enable ; 1 : Disable)
11	LCD_TE	O	Synchronous signal output from panel to avoid tearing effect
12	GND	Power	Ground
13	VIO18	Power	Power supply for interface system except MIPI interface
14	VIO18	Power	Power supply for interface system except MIPI interface
15	VPP(NC)	-	Power supply for OTP. Leave the pin to open when not in use.

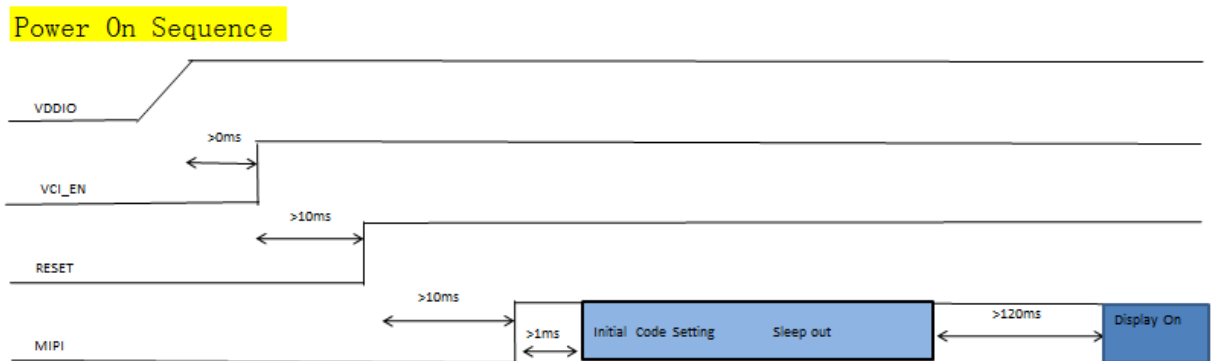
16	NFC_ANT2	I/O	Near Field Communication Antenna 2
17	NFC_ANT1	I/O	Near Field Communication Antenna 1
18	GND	Power	Ground
19	SPI_SDO	I/O	SPI interface, Serial output signal in SPI I/F. The data is output on the rising/falling edge of the SCL signal.
20	SPI_SDI	I/O	SPI interface, Serial input signal in SPI I/F. The data is input on the rising edge of the SCL signal.
21	SPI_DCX	I	SPI interface, Display data / command selection in 80-series MPU I/F and 4-wire SPI I/F. D/CX = "0" : Command D/CX = "1" : Display data or Parameter
22	SPI_CLK	I	SPI interface, A synchronous clock signal in SPI I/F.
23	SPI_CS	I	SPI interface, Chip select input pin ("Low" enable)
24	GND	Power	Ground
25	MIPI_CLKP	I	MIPI strobe positive signal
26	MIPI_CLKN	I	MIPI strobe negative signal
27	GND	Power	Ground
28	MIPI_D0P	I/O	MIPI data positive signal
29	MIPI_D0N	I/O	MIPI data negative signal
30	GND	Power	Ground
31	VPH_PWR	Power	AMOLED power
32	VPH_PWR	Power	AMOLED power
33	GND	Power	Ground
34	GND	Power	Ground

5.4 Graphic memory writing direction

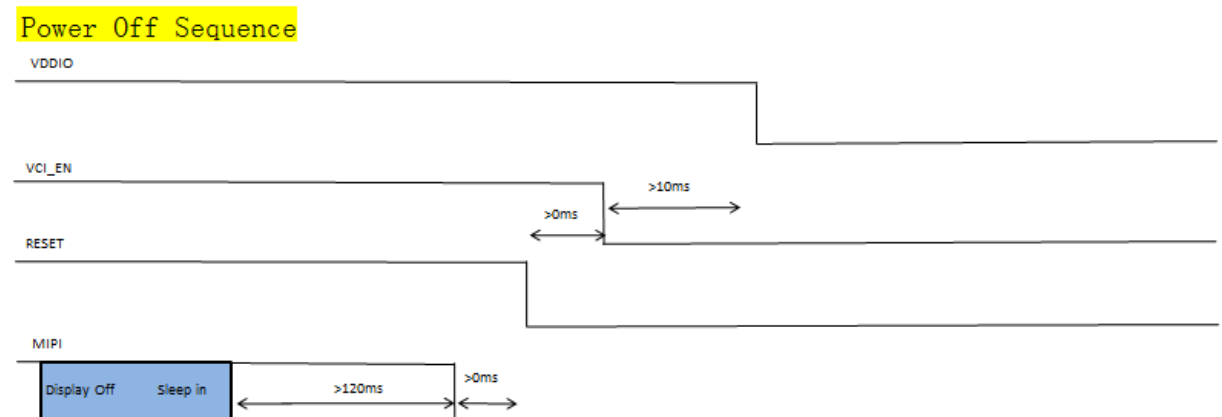


5.5 Recommended Operating Sequence

5.5.1 Power on sequence

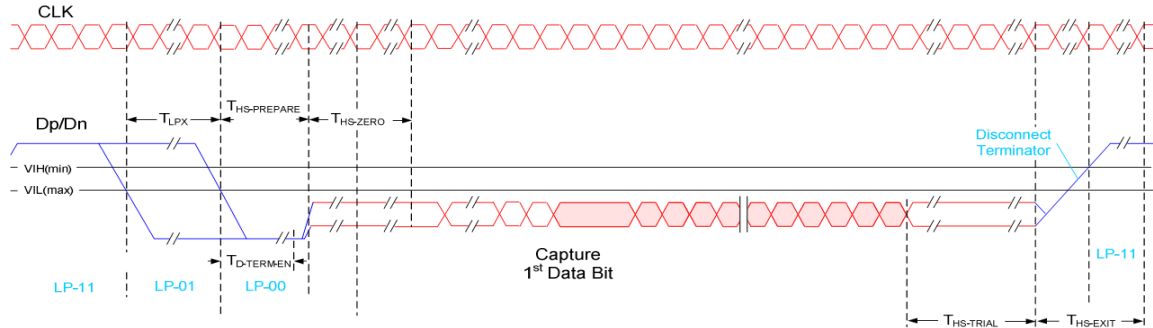


5.5.2 Power off sequence

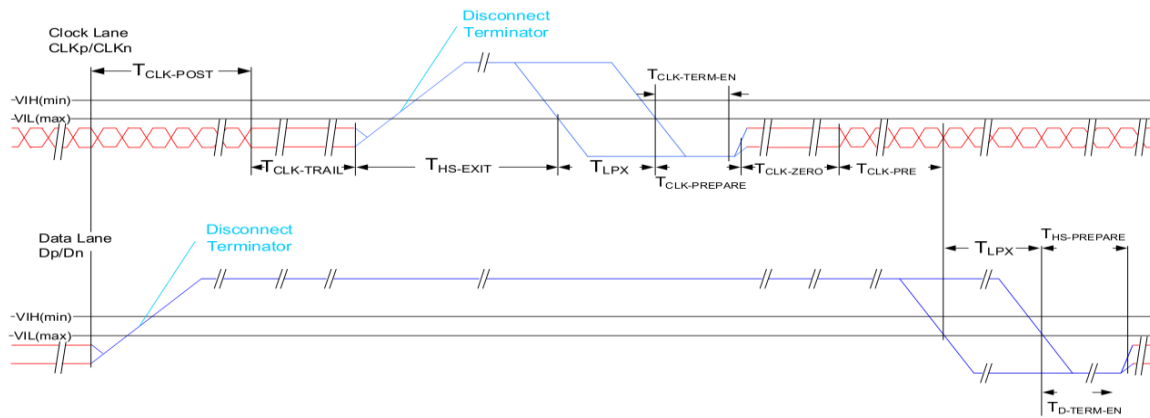


5.5.3 AC Characteristics (MIPI)

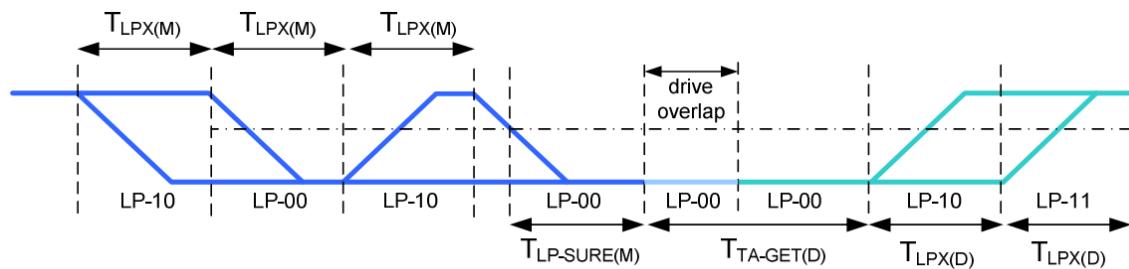
HS Data Transmission Burst



HS Clock Transmission



Turnaround Procedure



Timing Parameters

Symbol	Description	Min	Typ	Max	Unit
TREOT	30%-85% rise time and fall time	-	-	35	ns
TCLK-MISS	Timeout for receiver to detect absence of Clock transitions and disable the Clock Lane HS-RX.	-	-	60	ns

TCLK-POST*1	Time that the transmitter continues to send HS clock after the last associated Data Lane has transitioned to LP Mode. Interval is defined as the period from the end of THS-TRAIL to the beginning of TCLK-TRAIL.	60ns + 52*UI (For DCS)	-	-	ns
TCLK-PRE	Time that the HS clock shall be driven by the transmitter prior to any associated Data Lane beginning the transition from LP to HS mode.	8	-	-	ns
TCLK-SETTLE	Time interval during which the HS receiver shall ignore any Clock Lane HS transitions, starting from the beginning of TCLK-PRE.	95	-	300	ns
TCLK-TERM-EN	Time for the Clock Lane receiver to enable the HS line termination, starting from the time point when Dn crosses VIL, MAX.	Time for Dn to reach VTERM-EN		38	ns
THS-SETTLE	Time interval during which the HS receiver shall ignore any Data Lane HS transitions, starting from the beginning of THSPREPARE.	85 ns + 6*UI		145 ns + 10*UI	ns
TEOT	Time from start of THS-TRAIL or TCLK-TRAIL period to start of LP-11 state	-	-	105ns+48*UI	ns
THS-EXIT(1)	time to drive LP-11 after HS burst	100	-	-	ns
THS-PREPARE	Time to drive LP-00 to prepare for HS transmission	40ns + 4*UI	-	85ns+6*UI	ns
THS-PREPARE + THS-ZERO	THS-PREPARE + Time to drive HS-0 before the Sync	145ns + 10*UI	-	-	ns

	sequence				
THS-SKIP	Time-out at RX to ignore transition period of EoT	40	-	55ns+4*UI	ns
THS-TRAIL	Time to drive flipped differential state after last payload data bit of a HS transmission burst	60 + 4*UI	-	-	ns
TLPX	Length of any Low-Power state period	50	-	-	ns
Ratio TLPX	Ratio of TLPX(MASTER)/TLPS(SLAVE) between Master and Slave side	2/3	-	3/2	ns
TTA-GET	Time to drive LP-00 by new TX	5*TLPX	5*TLPX	5*TLPX	ns
TTA-GO	Time to drive LP-00 after Turnaround Request	4*TLPX	4*TLPX	4*TLPX	ns
TTA-SURE	Time-out before new TX side starts driving	TLPX	-	2*TLPX	ns

Timing requirements for RESETB

When RESETB of the reset pin equals to Low, it will be in the condition of reset. When it is in the condition of reset, it will make the device recover the initial set.

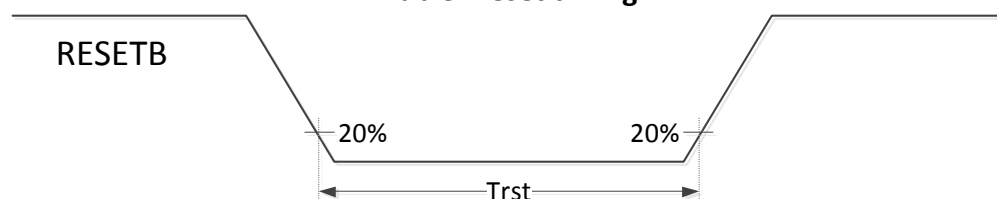
However, in order to avoid the reset noise cause reset, there is a mechanism to judge about whether the reset is needed or not.

The closed interval of Low can be shown as the following.

(Test condition: VDDIO=1.65V~3.6V, VSS=0V, TA=-20°C~+70°C)

Parameter	Symbol	Conditions	Spec			Unit
			Min.	Typ.	Max.	
Reset low pulse width	Trst	-	20	-	-	μs

Table: Reset timing



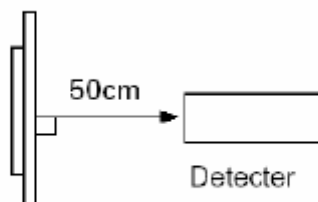
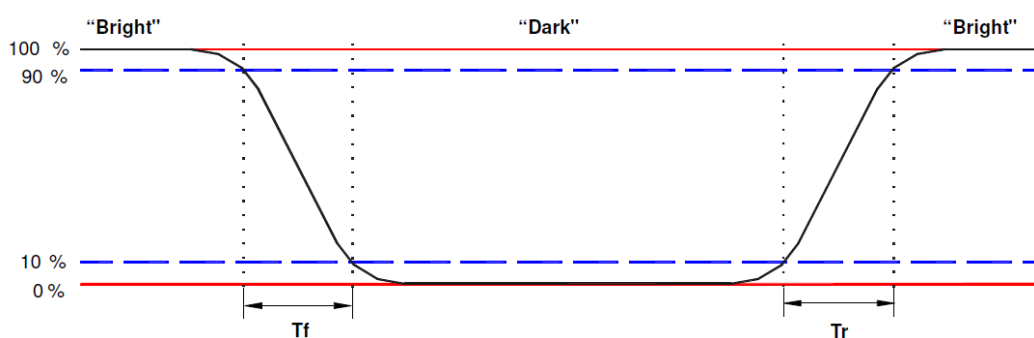
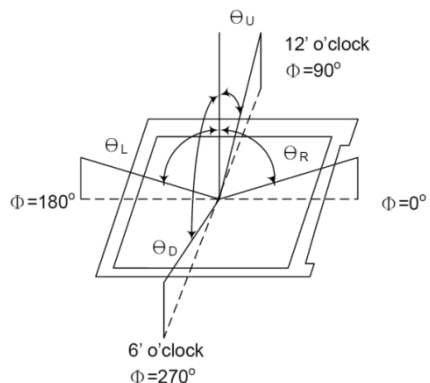
6 Electro-Optical Specification

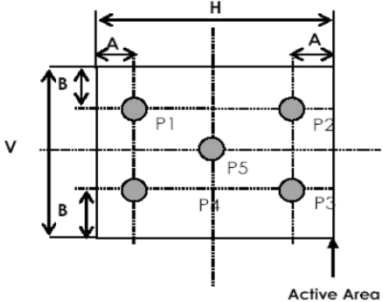
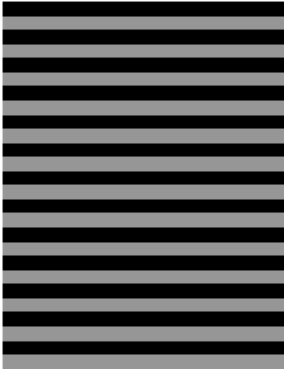
Test condition: 25℃±3℃, 65±20%RH, darkroom

No	Item		Symbol	Condition	Value			Unit	Remark
					Min.	Typ.	Max.		
1	Brightness		L	Full white Without CG	315	350	385	cd/m ²	Note1.
2	HBM		L	High brightness mode	900	1000	-	cd/m ²	Note1
3	Brightness Uniformity		UL	Full white	80	85	-	%	Note4
4	Contrast Ratio		CR	Normal Θ=Φ=0°	10000	100000	-	-	Note3.
5	Response time		Ton+Toff	Normal Θ=Φ=0°	-	2	4	ms	Note2.
6	Color Coordinate of CIE1931	White	X	Normal Θ=Φ=0°	0.28	0.30	0.32	-	Note1.
			Y		0.29	0.31	0.33		
		Red	X		0.668	0.688	0.708		
			Y		0.292	0.312	0.332		
		Green	X		0.18	0.22	0.26		
			Y		0.695	0.735	0.775		
		Blue	X		0.122	0.142	0.162		
			Y		0.022	0.042	0.062		
7	Color Gamut		NTSC	CIE1931	90	105	-	%	
8	Viewing Angle			Top/Bottom/Right/Left CR ratio ≥1000	80				Note3.
9	Gamma			Log(Lv- Lb)=log(V)+log(a) V(Gray)= 48,72,104,132, 164,192,224 Lum(gray255)=3 50nit	2.0	2.2	2.4	-	
10	Flicker			Normal Θ=Φ=0°	-	-35	-30	dB	Note6.
11	Crosstalk			-	-	-	3	%	Note7.
12	Color shift			θL=30°		5	5.5		
13	OLED Life Time			0.95*(TYP brightness) At 25℃,with white color	240			hrs	Note8.

		pattern					
14	Image Retention	With 8*8 black-white chess board test image, lighting on with maximum luminance for 10min	8*8 black-white chess board 10min,to G128,20s disappear				

See the note in the table below:

No	Item	Details
Note1	Brightness	
Note 2	Response time	
Note 3	Viewing Angle	Contrast Ratio:Dark Room C.R=LW/LB LW: full white brightness of display center P0; LB: full black brightness of display center P0. 

Note 4	Brightness Uniformity	 A: 1/4H B: 1/4V H.V: Active Area
Note 5	Luminance decrease ration	Definition of Luminance decrease ratio Test pattern : Full White The luminance decrease ratio is calculated by using following formula: $\text{Luminance decrease ration} = 1 - \frac{\text{Luminance test at left, right, top, bottom :}}{\text{Luminance test at left, right, top, bottom :}}$
Note 6	Flicker	Suggested Instruments: Konica Minolta CA-310 or Klein Instruments K-8  Odd row : L0 Black Even row : L186 gray level Flicker Test Pattern The flicker level is defined by Fast Fourier Transformation (FTT) as follows: $\text{Flicker} = 20 \log_{10} \left(2 \frac{f_{FFTC}(n)}{f_{FFTC}(0)} \right) + FS(Hz) \quad (\text{dB})$ Where fFFTC(n) is the n-th FFT coefficient. fFFTC(0) is the 0-th FFT coefficient which is DC component. FS(Hz) is the flicker sensitivity as a function of frequency. The peak flicker level shall be reported based on the calculation using above formula in which FS(Hz) is determined by the flicker weighing factor shown below.

		Flicker Weighing Factor <table border="1"> <caption>Flicker Weighing Factor Data</caption> <thead> <tr> <th>Frequency (Hz)</th> <th>Flicker Sensitivity (dB)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>10</td><td>0</td></tr> <tr><td>20</td><td>0</td></tr> <tr><td>30</td><td>-5</td></tr> <tr><td>40</td><td>-10</td></tr> <tr><td>50</td><td>-15</td></tr> <tr><td>60</td><td>-40</td></tr> </tbody> </table>	Frequency (Hz)	Flicker Sensitivity (dB)	0	0	10	0	20	0	30	-5	40	-10	50	-15	60	-40
Frequency (Hz)	Flicker Sensitivity (dB)																	
0	0																	
10	0																	
20	0																	
30	-5																	
40	-10																	
50	-15																	
60	-40																	
Note 7	Crosstalk	Crosstalk shall be calculated by the luminance of B1~B4 and G1~G4 in the patterns shown below. Box Pattern: L128 gray level background with a L255 White window in the central area. Gray Pattern: L128 gray level background only. 1/3 Width 1/3 Height B1 B2 B3 B4 G1 G2 G3 G4 Box Pattern Gray Pattern Crosstalk $\equiv \text{Maximum} : \left\{ \frac{ B1 - G1 }{G1}, \frac{ B2 - G2 }{G2}, \frac{ B3 - G3 }{G3}, \frac{ B4 - G4 }{G4} \right\} \times 100\%$																
Note 8	Life Time	OLED life time is defined by the Minimum Duration Time that the luminance is decayed to a specific ratio (ex. 92%) of initial state. Test Pattern under duration period: L255 White																

7 Reliability

7.1 Environmental Test

Item	Main spec	No. of failures / No. of examinations
High Temperature Operation	70°C / 240hrs	0/10
Low Temperature Operation	-20°C / 240hrs	0/10
High Temperature Storage	80°C / 240hrs	0/10
Low Temperature Storage	-40°C / 240hrs	0/10
High Temperature Humidity Operation	60°C/93%RH/ 240hrs	0/10
Thermal Shock	-40°C~85°C dwell time=0.5hr, 100 cycles.	0/10

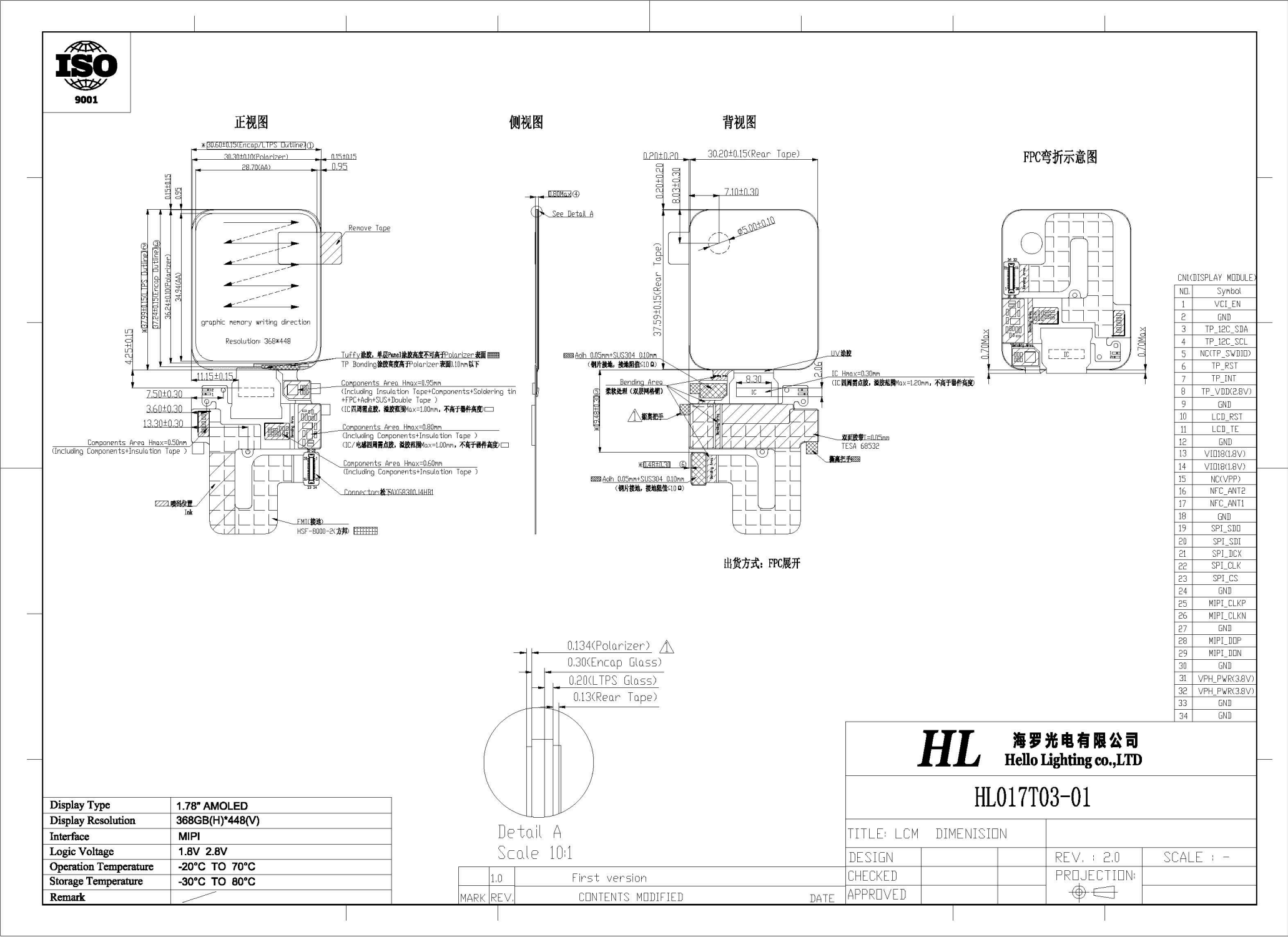
7.2 Electrical Test

Item	Main spec	Note
Air Discharge	±4/±6/±8kV 150pF/330Ω (Module level; without CG)	5Points, Each 10times. After one time discharge, panel and gun touch the ground, through the whole test, turn on ion fan. No degradation of OLED performance after this test.
Contact Discharge	±1/±2kV, 150pF/330Ω (Module level; without CG)	

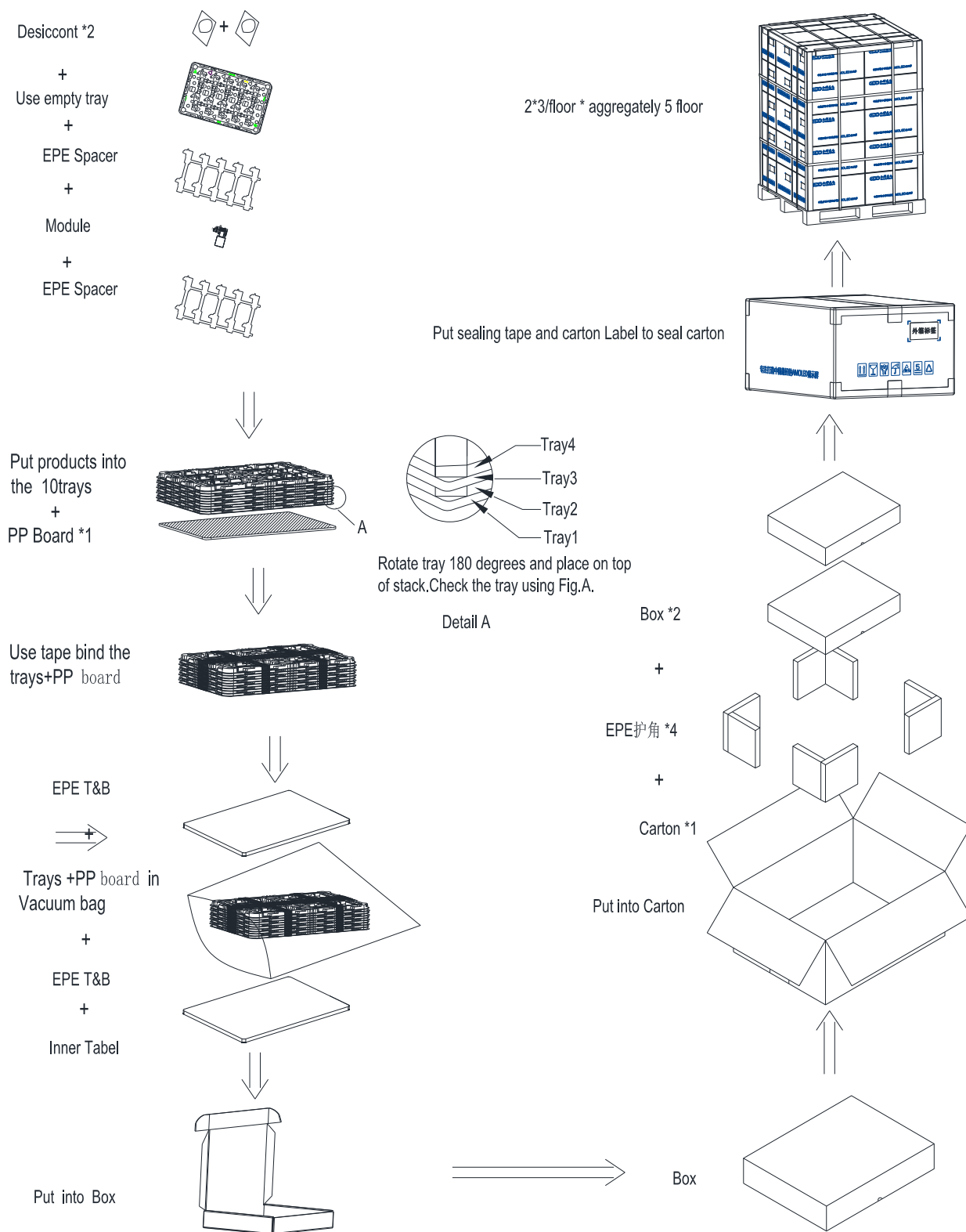
7.3 Mechanical Test

Test item	Test condition	Note
Packing vibration-proof test	2g, f=10->55->10Hz apply in each of X, Y, and Z direction for 30 min	Package
Packing Drop test	Drop the packing from 60cm height, 6-faces, 3-edges and 1-corner(one time for each)	Package

8 Outline Dimension Drawing



9 Packing Specification



(1) 内包装

NO	Item	材质	尺寸 (mm)	数量	模组数量	备注
1	纸盒	瓦楞纸	459*294*115	2	144PCS MDL/纸盒	
2	EPE填充物	EPE	457*294*10	4	2/纸盒	
3	吸塑盘	PET	455*290*14	22	16PCS MDL/吸塑盘, 下面9层吸塑盘放MDL产品, 最上面的吸塑为空	10 吸塑盘 / 盒
4	珍珠棉	EPE	386.58*206.82*1.00	40	2/吸塑盘	
5	防尘袋	Al	660*440*0.28	2	/	
6	纸盒标签	PET	52*100*0.075	2	/	
7	EPE护角	PET	120*244*100	4	/	
8	PP板	PP Board	457*292*5	2	/	
9	干燥剂	透明硅胶	55*75	4	2/纸盒	

(2) 外包装

NO	Item	材质	尺寸 (mm)	数量	模组数量	备注
1	外箱	瓦楞纸	516*338*248	1	288PCS MDL/纸箱	
2	外箱标签	铜版纸	52*100*0.1	1	/	

(3) 其它

环保产品在外包装箱上贴“ROHS”标签

10 The Control of Hazardous Substances

The control of Hazardous substances refer to EDO document 《有害物质管控标准书》 (Standard document for the Control of Hazardous substances) EDO-IS- 110, the latest version.