

SPECIFICATION FOR LCM Module

MODULE No:	KD035WVFPD122
CUSTOMER:	

STARTEK	INITIAL	DATE
PREPARED BY		
CHECKED BY		
APPROVED BY		

CUSTOMER	INITIAL	DATE
APPROVED BY		

Part. No	KD035WVFPD122	REV	V1.0	Page 1 of 28
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Part. No	KD035WVFPD122	REV	V1.0	Page 2 of 28
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Contents

1. Block Diagram.....	5
2. Outline dimension.....	6
3. Input terminal Pin Assignment.....	7
4. LCD Optical Characteristics.....	9
4.1 Optical specification.....	9
4.2 Measuring Condition.....	9
4.3 Note.....	10
5. Electrical Characteristics.....	12
5.1 Absolute Maximum Rating.....	12
5.2 DC Electrical Characteristics.....	12
5.3 LED Backlight Characteristics.....	13
6. AC Characteristics.....	15
6.1 Serial Interface Characteristics (3-line serial):.....	15
6.2 RGB Interface Characteristics :.....	16
6.3 Reset timing.....	17
7. LCD Module Out-Going Quality Level.....	19
7.1 VISUAL & FUNCTION INSPECTION STANDARD.....	19
7.1.1 Inspection conditions.....	19
7.1.2 Definition.....	19
7.1.3 Sampling Plan.....	20
7.1.4 Criteria (Visual).....	21
8. Reliability Test Result.....	24
9. Cautions and Handling Precautions.....	25
9.1 Handling and Operating the Module.....	25
9.2 Storage and Transportation.....	25
10. Packing.....	27

Part. No	KD035WVFPD122	REV	V1.0	Page 3 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

* Description

This is a color active matrix TFT (Thin Film Transistor) LCD (liquid crystal display) that uses amorphous silicon TFT as a switching device. This model is composed of a Transmissive type TFT-LCD Panel, driver circuit, back-light unit. The resolution of a 3.5" TFT-LCD contains 480x800 pixels, and can display up to 16.7M colors.

* Features

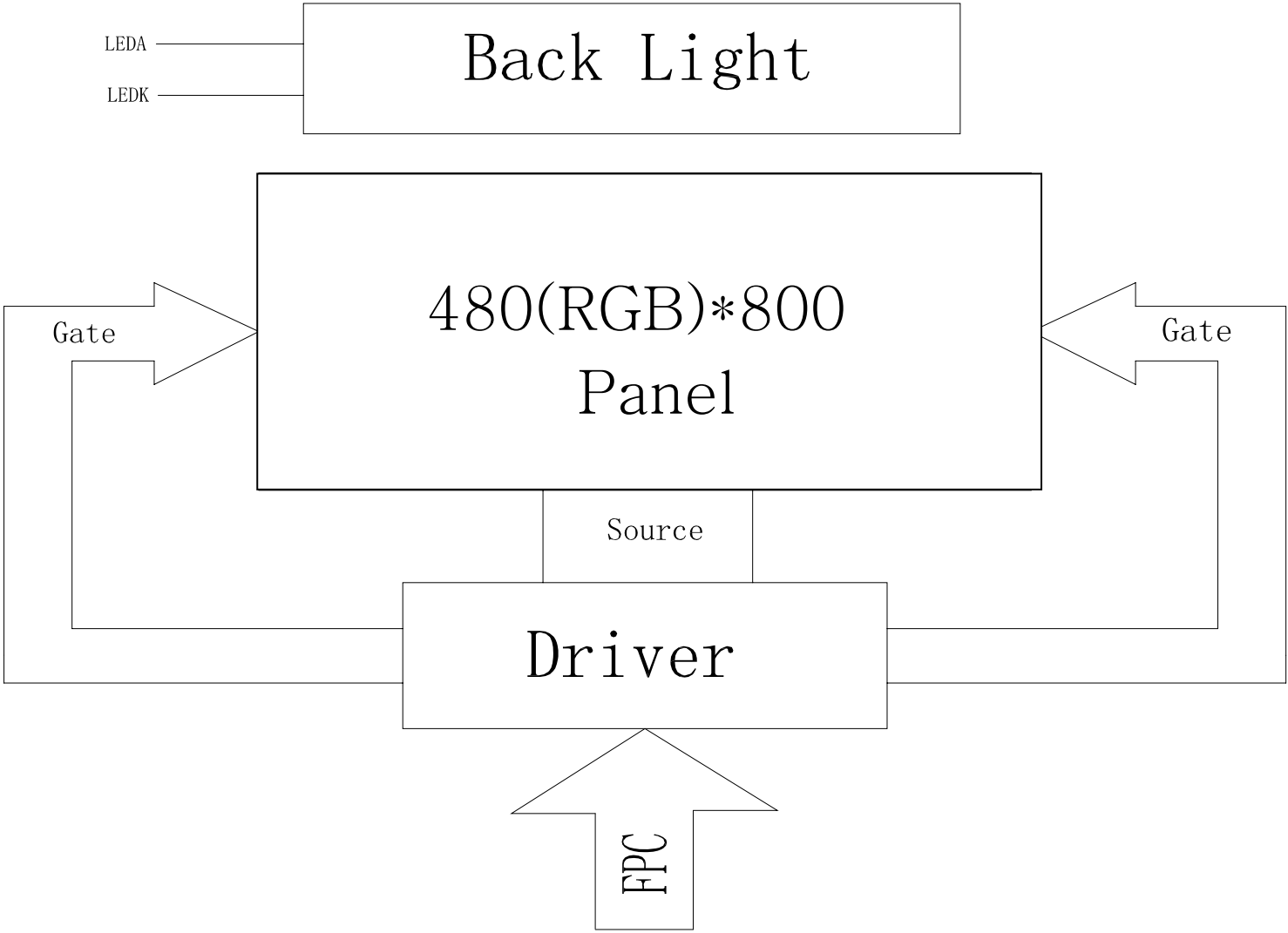
General Information Items	Specification	Unit	Note
	Main Panel		
Display area(AA)	45.36(H)*75.6(V) (3.5inch)	mm	
Driver element	TFT active matrix	-	
Display colors	16.7M	colors	
Number of pixels	480(RGB)*800	dots	
Pixel arrangement	RGB vertical stripe	-	
Pixel pitch	0.0945(H)*0.0945(V)	mm	
Viewing angle	ALL	o'clock	
Controller IC	ST7701S	-	
LCM Interface	3SPI+RGB	-	
Display mode	Transmissive /Normally black	-	
Operating temperature	-20 ~ +70	℃	
Storage temperature	-30 ~ +80	℃	

* Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal(H)	-	50.16	-	mm	
	Vertical(V)	-	86.3	-	mm	
	Depth(D)	-	2.3	-	mm	
Weight		-	15	-	g	

Part. No	KD035WVFPD122	REV	V1.0	Page 4 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

1. Block Diagram





Technical drawing of a 3.5 inch TFT LCD module. The drawing includes a top view with dimensions: 50.16±0.2 (BL 00), 48.96±0.15 (CD 00), 48.36±0.2 (UP POL), 46.36±0.2 (CD AA), 25.08, 0.60±0.15, 0.90±0.3, 2.40±0.3, 40.20, 86.30±0.2 (BL 00), 83.20±0.15 (CD 00), 79.10±0.2 (UP POL), 75.60±0.2 (CD AA), 46.65±0.5, 12.00±0.2, 13.58±0.5, 3.50±0.3, 23.08±0.1, 22.00±0.2, 23.08±0.1, 2.40±0.3, 0.90±0.3, 0.60±0.15. A side view shows a height of 2.30±0.2 (LOM). A detail view shows a 20.00 x 21.26 area with a 0.13±0.03 (PPC) dimension. A note indicates 'LCD左右兩側 接點孔位置' (Contact hole positions on both sides of the LCD). A table lists 45 pins with their functions: 1. XSRING, 2. Y0VNC, 3. X1VNC, 4. Y0VNC, 5. GND, 6. GND, 7. VCI, 8. IOVCC, 9. SDO, 10. SUI, 11. SCL, 12. CS, 13. RESET, 14. DB2(R7), 15. DB2(R8), 16. DB2(R5), 17. DB2(R4), 18. DB1(R3), 19. DB1(R2), 20. DB1(R1), 21. DB1(R0), 22. DB1(S7), 23. DB1(S5), 24. DB1(S5), 25. DB1(S5), 26. DB1(S3), 27. DB1(S2), 28. DB1(S1), 29. DB1(S0), 30. DB1(R7), 31. DB1(R6), 32. DB1(R5), 33. DB1(R4), 34. DB1(S3), 35. DB1(S2), 36. DB1(S1), 37. DB1(S0), 38. DE, 39. PCLK, 40. HSYNC, 41. VSYNC, 42. NC, 43. LERK, 44. NC, 45. LEDA.

Notes:

1. DISPLAY TYPE: 3.5" TFT, 16.7M Colors
2. DISPLAY MODE: NORMALLY BLACK
3. VIEWING DIRECTION: ALL
4. DRIVER IC: ST7701S (COG)
5. VCI: 3.3V
6. LCM Interface: RGB
7. OPERATING TEMP: -20°C TO 70°C
8. STORAGE TEMP: -30°C TO 80°C
9. BACK LIGHT: LED WHITE, 7 LED, 20mA, 21V±0.3V
10. RoHS COMPLIANT.

K. B/L Circuit

SHENZHEN STARTEK ELECTRONICS CO.,LTD

Part. No	KD035WVFPD122	REV	V1.0	Page 6 of 28
常 备 库 存 Stock For Sale	长 期 供 货 Long Time supply	支持小量 NO MOQ	品 种 齐 全 In Full Range	



3. Input terminal Pin Assignment

NO.	SYMBOL	DISCRIPTION	I/O
1	XR(NC)	--	--
2	YD(NC)	--	--
3	XL(NC)	--	--
4	YU(NC)	--	--
5	GND	Ground	P
6	GND	Ground	P
7	VCI	Power supply(3.3V)	P
8	IOVCC	Power supply for I/O block(1.8-3.3V)	
9	SDO	Serial data output pin used for the SPI Interface. Leave the pin open when not in use.	O
10	SDI	SDI: Serial data input/output bidirectional pin for SPI Interface. Fix to GND level when not in use.	I
11	SCL	SCL: Serial clock input for SPI interface. Fix to IOVCC or GND level when not in use.	I
12	CS	- A chip select signal Low: the chip is selected and accessible High: the chip is not selected and not accessible Fix to IOVCC or GND level when not in use.	I
13	RESET	- The external reset input - Initializes the chip with a low input. Be sure to execute a power -on reset after supplying power.	I



14-37	DB23(R7)-DB0 (B0)	A 24-bit parallel data bus for RGB Interface. 24-bit/pixel: D[23:16]=R,D[15:8]=G,D[7:0]=B 18-bit/pixel: MDT=0:D[21:16]=R,D[13:8]=G,D[5:0]=B MDT=1:D[17:12]=R,D[11:6]=G,D[5:0]=B 16-bit/pixel: D[20:16]=R,D[13:8]=G,[4:0]=B Fix to IOVCC or GND level when not in use.	I/O
38	DE	Data enable signal for RGB interface operation Low: access enabled High: access inhibited Fix to IOVCC or GND level when not in use.	P
39	PCLK	Dot clock signal for RGB interface operation Fix to IOVCC or GND level when not in use.	I
40	HSYNC	Line synchronizing signal for RGB interface operation Fix to IOVCC or GND level when not in use.	I
41	VSYNC	Frame synchronizing signal for RGB interface operation Fix to IOVCC or GND level when not in use.	I
42	NC	--	--
43	LEDK	Cathode pin OF backlight	P
44	NC	--	--
45	LED A	Anode pin of backlight	P

4. LCD Optical Characteristics

4.1 Optical specification

Item		Symbol	Condition	Min.	Typ.	Max.	Unit.	Note
Contrast Ratio		CR	$\Theta=0$ Normal viewing angle	550	650	--		(2)
Response time	Rising	T_R+T_F		--	--	35	msec	(5)
	Falling							
Uniformity		S(%)		64	69	--	%	C-light
Color Filter Chromaticity	White	W_X		0.256	0.296	0.336		(4) CF glass C-light
		W_Y		0.292	0.332	0.372		
	Red	R_X		0.580	0.620	0.660		
		R_Y		0.311	0.351	0.391		
	Green	G_X		0.268	0.308	0.348		
		G_Y		0.528	0.568	0.608		
	Blue	B_X		0.109	0.149	0.189		
		B_Y		0.022	0.062	0.102		
Viewing angle	Hor.	Θ_L	CR>10	80	85	--		(1)
		Θ_R		80	85	--		
	Ver.	Θ_U		80	85	--		
		Θ_D		80	85	--		
Option View Direction		Free						

4.2 Measuring Condition

- Measuring surrounding : dark room
- Ambient temperature : $25\pm 2^{\circ}\text{C}$
- 15min. warm-up time.

Part. No	KD035WVFPD122	REV	V1.0	Page 9 of 28
常备库存 Stock For Sale		长期供货 Long Time supply		品种齐全 In Full Range

支持小量
NO MOQ

4.3 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.1). Viewing angle measuring is based on WV Pol attached.
2. Contrast measurements shall be made at viewing angle of $\Theta = 0^\circ$ 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. 1) Luminance Contrast Ratio (CR) is defined mathematically.

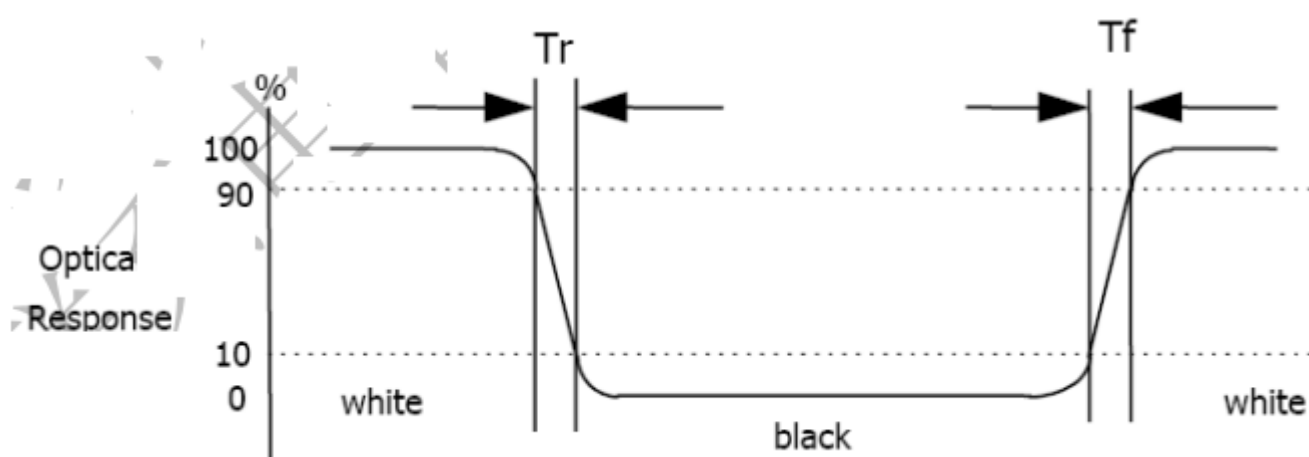
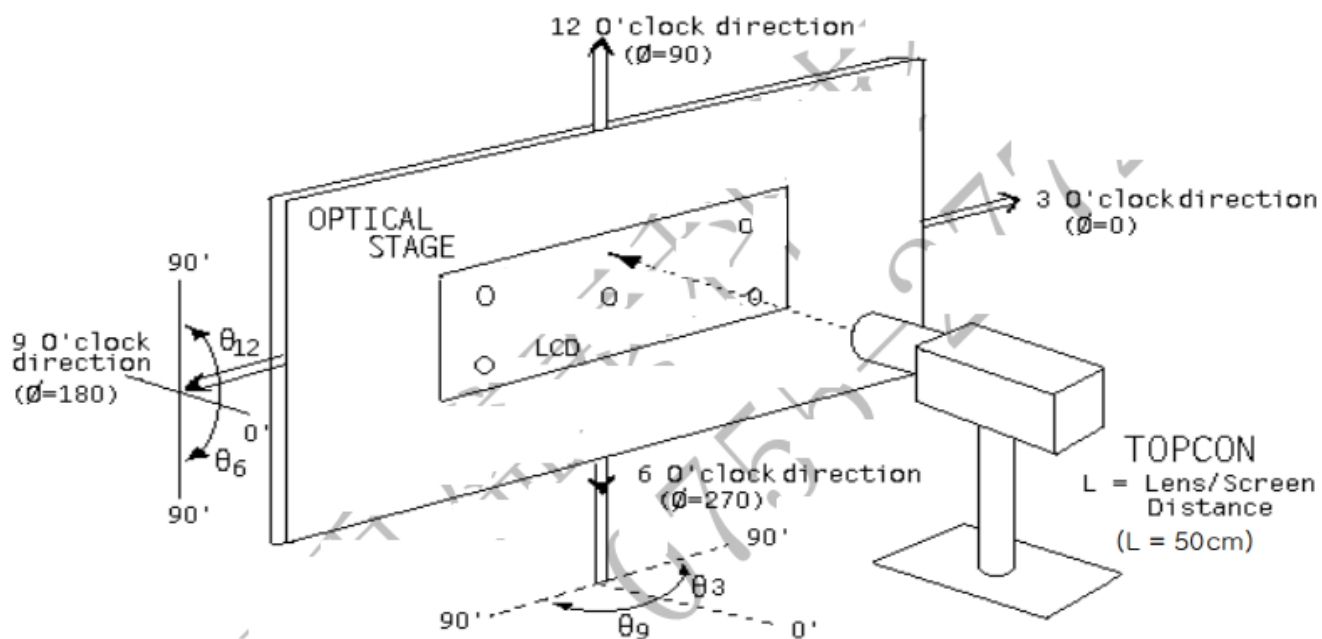
$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Transmittance is the value without APF.
4. 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 C/F.
Measurement condition is C - light source & Halogen Lamp
5. The electro-optical response time measurements shall be made as FIG.2 b g the "data" input signal ON and OFF.
The times needed for the luminance to change from 10% to 90% is Tf, and 90% to 10% is Tr.

Part. No	KD035WVFPD122	REV	V1.0	Page 10 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	



Figure 1. Measurement Set Up



Part. No	KD035WVFPD122	REV	V1.0	Page 11 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

5. Electrical Characteristics

5.1 Absolute Maximum Rating

Characteristics	Symbol	Min.	Max.	Unit	Note
Supply Voltage	V _{CI}	-0.3	4.6	V	Note1
Supply Voltage (Logic)	IOVCC	-0.3	4.6	V	
Operating temperature	T _{OP}	-20	+70	°C	
Storage temperature	T _{ST}	-30	+80	°C	

NOTE1: 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.

5.2 DC Electrical Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
System Voltage	V _{CI}	2.5	3.3	3.6	V	
Interface Operation Voltage	IOVCC	1.65	1.8	3.3	V	
Normal mode Current	IDD	--	30	--	mA	
Level input voltage	V _{IH}	0.7IOVCC	--	IOVCC	V	
	V _{IL}	GND	--	0.3 IOVCC	V	
Level output voltage	V _{OH}	0.8IOVCC	--	IOVCC	V	
	V _{OL}	GND	--	0.2IOVCC	V	

5.3 LED Backlight Characteristics

The back-light system is edge-lighting type with 7 chips LED

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Forward Current	I_F	15	20	--	mA	
Forward Voltage	V_F	--	21	--	V	
LCM Luminance ($I_F = 20\text{mA}$)	LV	400	450	--	cd/m ²	Note3
LED life time	Hr	--	50000	--	Hour	Note1,2
Uniformity	Avg	80	--	--	%	Note3

Note1: LED life time (Hr) can be defined as the time in which it continues to operate under the condition:

$T_a = 25 \pm 3^\circ\text{C}$, typical IL value indicated in the above table until the brightness becomes less than 50%.

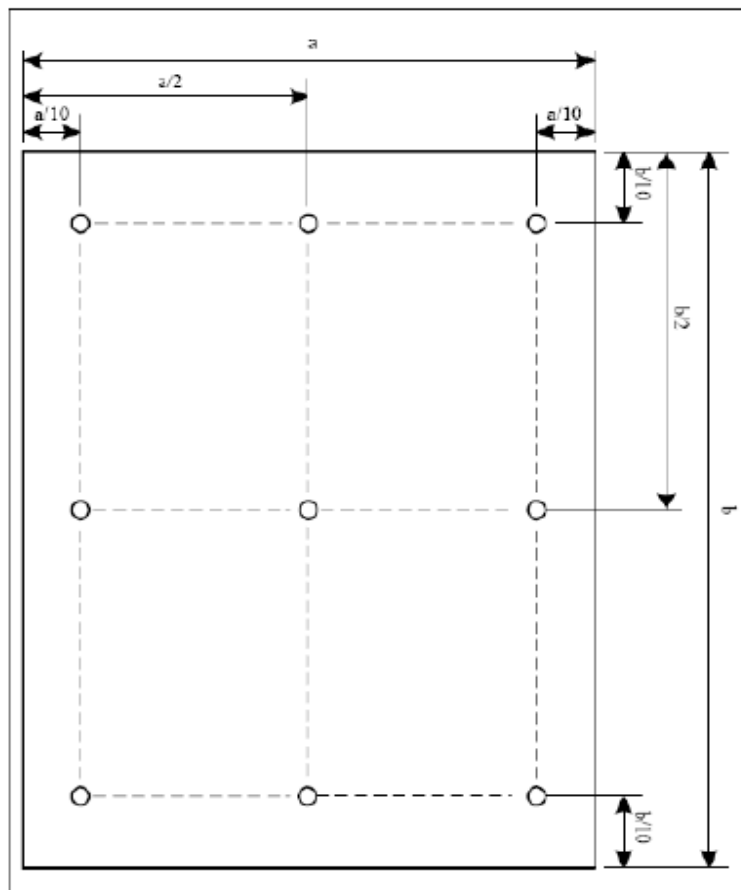
Note 2: The “LED life time” is defined as the module brightness decrease to 50% original brightness at

$T_a = 25^\circ\text{C}$ and $I_L = 20\text{ mA}$. The LED lifetime could be decreased if operating I_L is larger than 20mA. The constant current driving method is suggested.





Note (3) Luminance Uniformity of these 9 points is defined as below:



$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$$

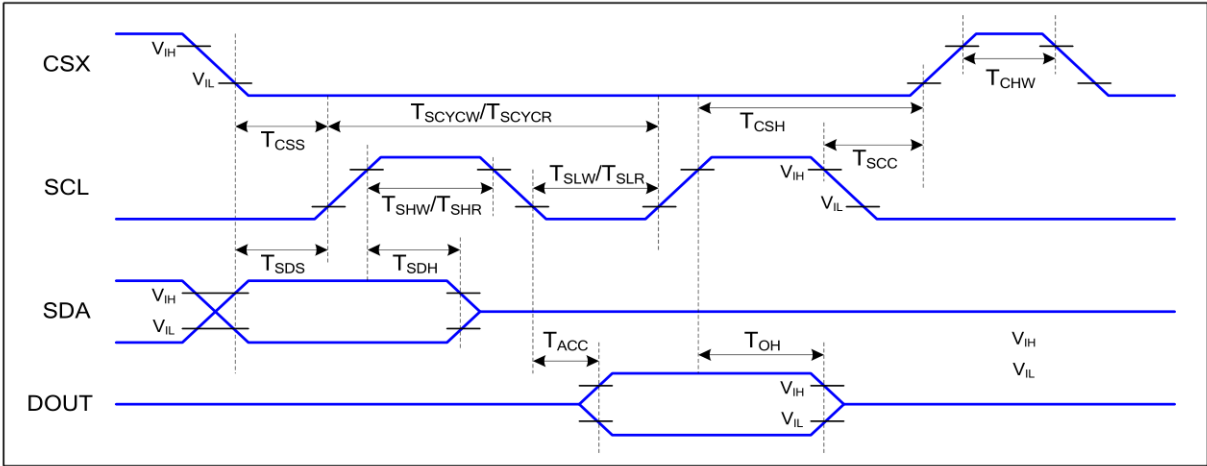
$$\text{Luminance} = \frac{\text{Total Luminance of 9 points}}{9}$$

Part. No	KD035WVFPD122	REV	V1.0	Page 14 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	



6. AC Characteristics

6.1 Serial Interface Characteristics (3-line serial):



3-line serial Interface Timing Characteristics

IOVCC=1.8V,VCI=3.3V, GND=0V, Ta=25 °C

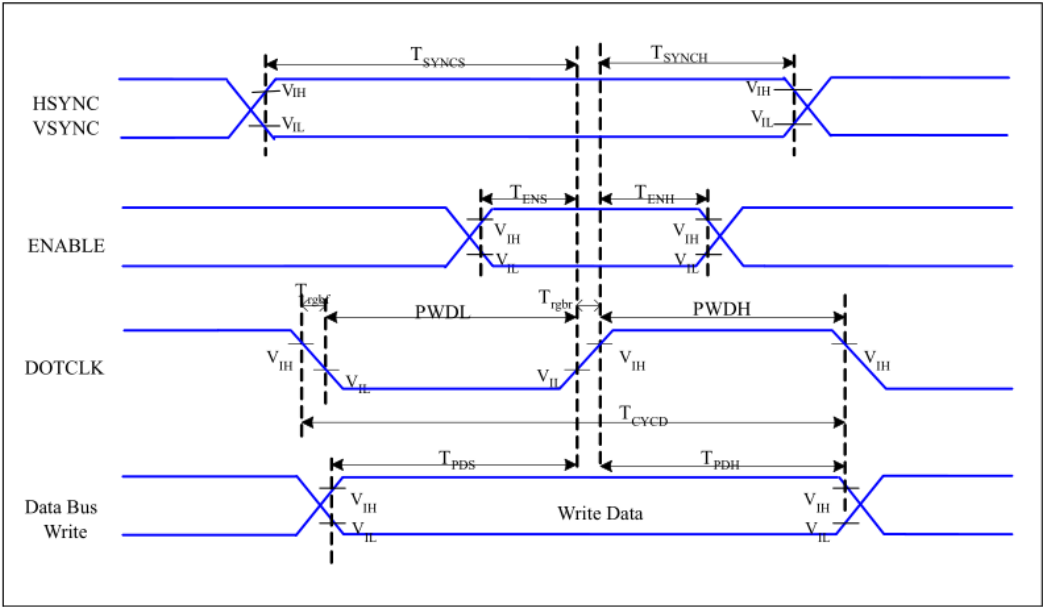
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T _{CSS}	Chip select setup time (write)	15		ns	
	T _{CSH}	Chip select hold time (write)	15		ns	
	T _{CSS}	Chip select setup time (read)	60		ns	
	T _{SCC}	Chip select hold time (read)	60		ns	
	T _{CHW}	Chip select "H" pulse width	40		ns	
SCL	T _{SCYCW}	Serial clock cycle (Write)	66		ns	
	T _{SHW}	SCL "H" pulse width (Write)	15		ns	
	T _{SLW}	SCL "L" pulse width (Write)	15		ns	
	T _{SCYCR}	Serial clock cycle (Read)	150		ns	
	T _{SHR}	SCL "H" pulse width (Read)	60		ns	
	T _{SLR}	SCL "L" pulse width (Read)	60		ns	
SDA (DIN)	T _{SDS}	Data setup time	10		ns	
	T _{SDH}	Data hold time	10		ns	

serial Interface Characteristics

Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

Part. No	KD035WVFPD122	REV	V1.0	Page 15 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

6.2 RGB Interface Characteristics :



RGB Interface Timing Characteristics

IOVCC=1.8V,VCI=3.3V, GND=0V, Ta=25 °C

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
HSYNC, VSYNC	T_{SYNCS}	VSYNC, HSYNC Setup Time	5	-	ns	
ENABLE	T_{ENS}	Enable Setup Time	5	-	ns	
	T_{ENH}	Enable Hold Time	5	-	ns	
DOTCLK	PWDH	DOTCLK High-level Pulse Width	15	-	ns	
	PWDL	DOTCLK Low-level Pulse Width	15	-	ns	
	T_{CYCD}	DOTCLK Cycle Time	33	-	ns	
	Trghr, Trghf	DOTCLK Rise/Fall time	-	15	ns	
DB	T_{PDS}	PD Data Setup Time	5	-	ns	
	T_{PDH}	PD Data Hold Time	5	-	ns	

18/16 Bits RGB Interface Timing Characteristics



6.3 Reset timing

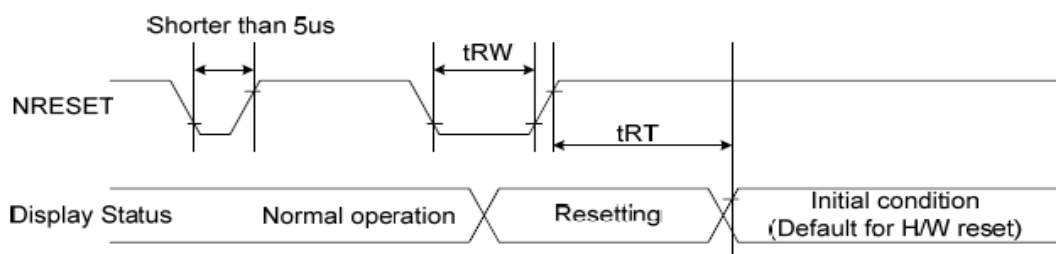


Figure 102 Reset Timing

Table 41 Reset Timing

Signal	Symbol	Parameter	Min	Max	Unit
RESX	t_{RW}	Reset pulse duration	10		us
	t_{RT}	Reset cancel		5(note 1,5)	ms
				120 (note 1,6,7)	ms

Note:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from OTP to registers. This loading is done every time when there is H/W reset cancel time (t_{RT}) within 5 ms after a rising edge of RESX.
2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the Table 43.



Table 42 Reset Descript

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

- During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out mode. The display remains the blank state in Sleep In mode.) and then return to Default condition for Hardware Reset.
- Spike Rejection also applies during a valid reset pulse as shown below:

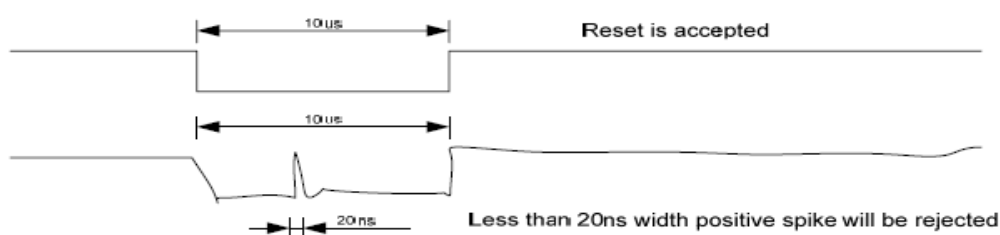


Figure 103 Positive Noise Pulse during Reset Low

- When Reset applied during Sleep In Mode.
- When Reset applied during Sleep Out Mode.
- It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

7. LCD Module Out-Going Quality Level

7.1 VISUAL & FUNCTION INSPECTION STANDARD

7.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

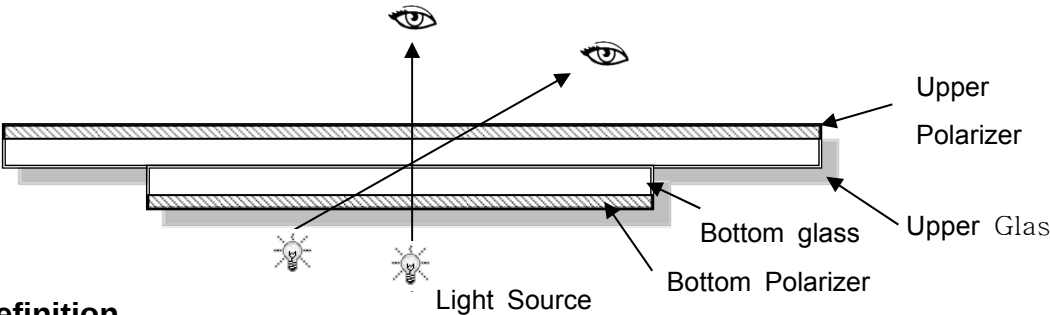
Temperature : 25±5℃

Humidity : 65%±10%RH

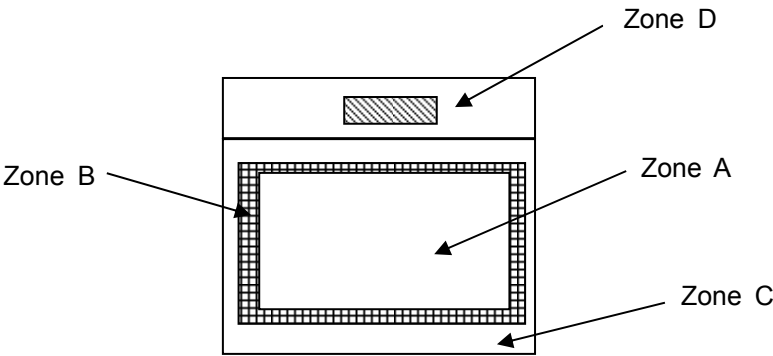
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance:30-50cm



7.1.2 Definition



Zone A : Effective Viewing Area(Character or Digit can be seen)

Zone B : Viewing Area except Zone A

Zone C : Outside (Zone A+Zone B) which can not be seen after assembly by customer .)

Zone D : IC Bonding Area

Note:

As a general rule ,visual defects in Zone C can be ignored when it doesn't effect product function or

Part. No	KD035WVFPD122	REV	V1.0	Page 19 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	



appearance after assembly by customer

7.1.3 Sampling Plan

According to GB/T 2828-2003 ; , normal inspection, Class II

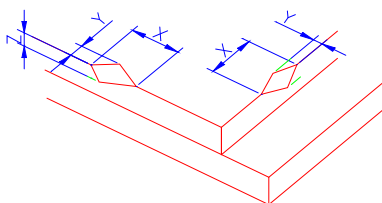
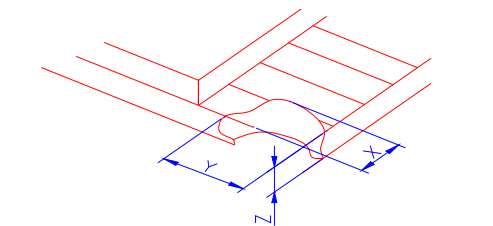
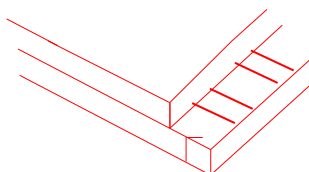
AQL:

Major defect	Minor defect
0.65	1.5

LCD: Liquid Crystal Display , TP: Touch Panel , LCM: Liquid Crystal Module

No	Items to be inspected	Criteria	Classification of defects
1	Functional defects	1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed	
4	Color tone	Color unevenness, refer to limited sample	Minor
5	Spot Line defect	Light dot, Dim spot,Polarizer Bubble ; Polarizer accidented spot.	
6	Soldering appearance	Good soldering , Peeling off is not allowed.	
7	LCD/Polarizer/TP	Black/White spot/line, scratch, crack, etc.	

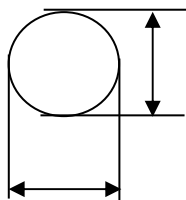
7.1.4 Criteria (Visual)

Number	Items	Criteria(mm)						
1.0 LCD Crack/Broken NOTE: X: Length Y: Width Z: Height L: Length of IT O, T: Height of LCD	(1) The edge of LCD broken	 <table><tr><td>X</td><td>Y</td><td>Z</td></tr><tr><td>≤3.0mm</td><td><Inner border line of the seal</td><td>≤T</td></tr></table>	X	Y	Z	≤3.0mm	<Inner border line of the seal	≤T
	X	Y	Z					
	≤3.0mm	<Inner border line of the seal	≤T					
(2)LCD corner broken	 <table><tr><td>X</td><td>Y</td><td>Z</td></tr><tr><td>≤3.0mm</td><td>≤L</td><td>≤T</td></tr></table>	X	Y	Z	≤3.0mm	≤L	≤T	
X	Y	Z						
≤3.0mm	≤L	≤T						
(3) LCD crack	 Crack Not allowed							



2.0

Spot defect



Y

X

$$\Phi = (X + Y) / 2$$

① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain)

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.10$	Ignore		Ignore
$0.10 < \Phi \leq 0.25$	3(distance $\geq 10\text{mm}$)		
$0.25 < \Phi \leq 0.3$	2		
$\Phi > 0.35$	0		

② Dim spot (LCD/TP/Polarizer dim dot, light leakage, dark spot)

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.1$	Ignore		Ignore
$0.10 < \Phi \leq 0.25$	3(distance $\geq 10\text{mm}$)		
$0.25 < \Phi \leq 0.3$	2		
$\Phi > 0.35$	0		

③ Polarizer accidented spot

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.2$	Ignore		Ignore
$0.3 < \Phi \leq 0.5$	2(distance $\geq 10\text{mm}$)		
$\Phi > 0.5$	0		

④ Pixel bad points (light dot, Dim dot, color dot)

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.1$	Ignore	Ignore	
$0.15 < \Phi \leq 0.25$	2(distance $\geq 10\text{mm}$)		
$\Phi > 0.3$	0		

⑤ Polarizer Bubble

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.2$	Ignore		

Part. No

KD035WVFPD122

REV

V1.0

Page 22 of 28

常备库存
Stock For Sale

长期供货
Long Time supply

支持小量
NO MOQ

品种齐全
In Full Range



3.0	Line defect (LCD/TP /Polarizer backlight black/white line, scratch, stain)					
		Width(mm)	Length(m m)	Acceptable Qty		
				A	B	C
		$\Phi \leq 0.05$	Ignore	Ignore		Ignore
		$0.05 < W \leq 0.06$	$L \leq 3.0$	$N \leq 2$		
$0.07 < W \leq 0.08$	$L \leq 2.0$	$N \leq 1$				
		$0.08 < W$	Define as spot defect			
4.0	Electronic Components SMT	Not allow missing parts, solderless connection, cold solder joint, mismatch, The positive and negative polarity opposite				
5.0	Display color& Brightness	1. Color : Measuring the color coordinates, The measurement standard according to the datasheet or samples. 2. Brightness : Measuring the brightness of White screen, The measurement standard according to the datasheet or Samples.				
6.0	LCD Mura	By 5% ND filter invisible.				

Criteria (functional items)

Number	Items	Criteria (mm)
1	No display	Not allowed
2	Missing segment	Not allowed
3	Short	Not allowed
4	Backlight no lighting	Not allowed
5	TP no function	Not allowed



8. Reliability Test Result

Item	Condition	Inspection after test
High Temperature Operating	70°C,96H	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Non-display; 3.Missing segments/line; 4.Glass crack; 5.Current IDD is twice higher than initial value.
Low Temperature Operating	-20°C, 96HR	
High Temperature Storage	80°C, 96HR	
Low Temperature Storage	-30°C, 96HR	
High Temperature & High	+60°C, 90% RH ,96 hours.	
Thermal Shock (Non-operation)	-30°C,30 min ↔ +80°C,30 min, Change time:5min 20CYC.	
ESD test	C=150pF, R=330,5points/panel Air:±8KV, 5times; Contact:±6KV, 5 times; (Environment: 15°C~35°C, 30%~60%).	
Vibration (Non-operation)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z. (6 hours for total) (Package condition).	
Box Drop Test	1 Corner 3 Edges 6 faces,80 _{cm} (MEDIUM BOX)	

Remark:

- 1.The test samples should be applied to only one test item.
- 2.Sample size for each test item is 5~10pcs.
- 3.For Damp Proof Test, Pure water(Resistance > 10MΩ) should be used.
- 4.In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judged as a good part.
- 5.Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

Part. No	KD035WVFPD122	REV	V1.0	Page 24 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

9. Cautions and Handling Precautions

9.1 Handling and Operating the Module

(1) When the module is assembled, it should be attached to the system firmly.

Do not warp or twist the module during assembly work.

(2) Protect the module from physical shock or any force. In addition to damage, this may cause improper operation or damage to the module and back-light unit.

(3) Note that polarizer is very fragile and could be easily damaged. Do not press or scratch the surface.

(4) Do not allow drops of water or chemicals to remain on the display surface.

If you have the droplets for a long time, staining and discoloration may occur.

(5) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(6) The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane.

Do not use ketene type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.

(7) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs, or clothes, it must be washed away thoroughly with soap.

(8) Protect the module from static; it may cause damage to the CMOS ICs.

(9) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(10) Do not disassemble the module.

(11) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.

(12) Pins of I/F connector shall not be touched directly with bare hands.

(13) Do not connect, disconnect the module in the "Power ON" condition.

(14) Power supply should always be turned on/off by the item 6.1 Power On Sequence & 6.2 Power Off Sequence

9.2 Storage and Transportation.

(1) Do not leave the panel in high temperature, and high humidity for a long time.

It is highly recommended to store the module with temperature from 0 to 35 °C and relative humidity of less than 70%

(2) Do not store the TFT-LCD module in direct sunlight.

(3) The module shall be stored in a dark place. When storing the modules for a long time, be sure to adopt effective measures for protecting the modules from strong ultraviolet radiation, sunlight, or fluorescent light.

(4) It is recommended that the modules should be stored under a condition where no condensation is allowed. Formation of dewdrops may cause an abnormal operation or a failure of the module.

Part. No	KD035WVFPD122	REV	V1.0	Page 25 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

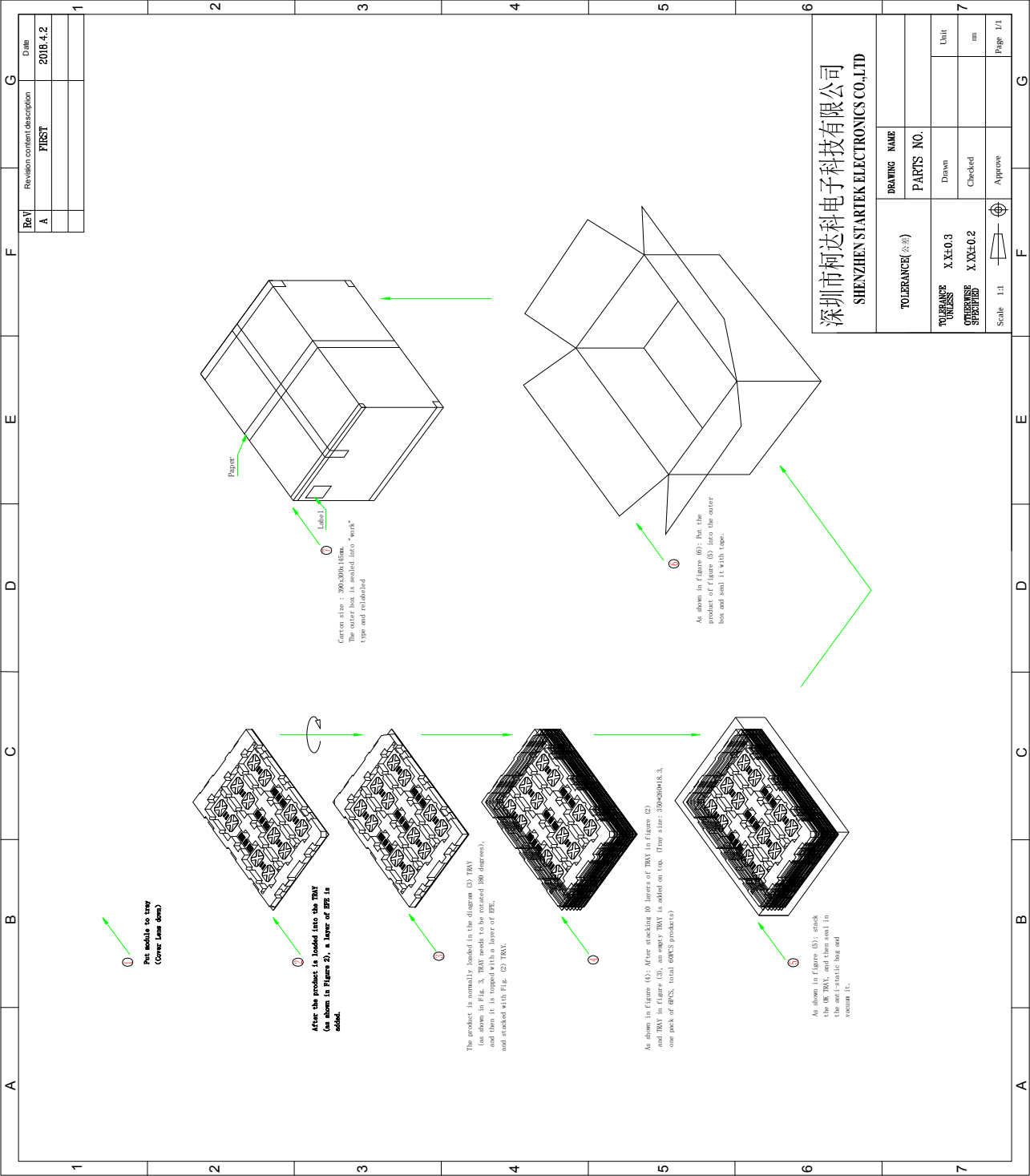
In particular, the greatest possible care should be taken to prevent any module from being operated where condensation has occurred inside.

(5) This panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.

Part. No	KD035WVFPD122	REV	V1.0	Page 26 of 28
常 备 库 存 Stock For Sale	长 期 供 货 Long Time supply	支持小量 NO MOQ	品 种 齐 全 In Full Range	



10. Packing



Part. No	KD035WVFPD122	REV	V1.0	Page 27 of 28
常备库存 Stock For Sale	长期供货 Long Time supply	支持小量 NO MOQ	品种齐全 In Full Range	

Part. No	KD035WVFPD122	REV	V1.0	Page 28 of 28
	常 备 库 存 Stock For Sale	长 期 供 货 Long Time supply	支持少量 NO MOQ	品 种 齐 全 In Full Range