



Specifications Approval Sheet

Product Description: 2.2”TFT+1.2” TFT Dual-Panel			
AU Model Name: H022QL04 V0 (version 0.7)			
Customer Part No:			
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Product Specification

2.2”TFT+1.2”TFT Dual-Panel

MODEL NAME: H022QL04 V0

(◆) Preliminary Specification

Note: The content of this specification is subject to change.

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Record of Revision

Version	Revise Date	Page	Content
0.0	2005/6/6		First draft
0.1	2005/6/8	3	Update Sub-panel mode from TM to TMR
		5	Modify pin10, pin30 remark
		7	Modify power supply spec. in main panel 2.7/Min.,3.0/Max.
			Remove Version 0 page 12
		16	Add NTSC 65%
		17	Add NTSC 40%
		21	Update No.4 LTO Ta=-20℃,remove version 0 No.7
0.2	2005/9/9	5	Pin assignment
		7, 10	Electrical char., power consumption
		15	Optical spec for both main and sub display
		25	Outline dimension
0.3	2005/9/15	5	Change view angle (o'clock) to gray scale inversion
		9	Change Electrical typical operating for main and sub from Vdd3=>Vcc and Vcc=>Vdd3
0.4	2005/10/19	10	Update 8 colors display power consumption
		12	Change RGB interface latch setting for PCLK
0.5	2005/10/25		Correct wrong edge of PCLK to latch data
0.6	2006/2/9	9	Update power supply (main and sub panel) to 2.7(min.), 3.3(max) from 2.6(min.), 3.0(max)
		10	Update power consumption (sub panel)
		18	Update optical specification (main panel) and add conditions for CR and viewing angle measurement : VDC=2.85V
		19	Update optical specification (sub panel)
0.7	2006/3/27	5	Update Weight=14.5g typ.
		10	Update Backlight driving condition VL=12.8V typ., 14.0V max.
		18	Update Brightness Main=310nits typ., 250nits min.
		19	Update Brightness Sub=140nits typ., 110nits min.
		26	Update outline dimension of TFT LCD drawing



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A. General Specification

Physical specifications

	Main Display	Sub Display
Screen Size (inch)	2.2"	1.2"
Driving Method	TFT	TFT
Display Mode	Transmissive	Transmissive
Display Resolution (dot)	240RGBx320	128RGBx128
Active Area (mm)	33.84x45.12	21.504 x 21.504
Pixel Pitch (um)	0.141X0.141	0.168x0.168
Pixel Configuration	R.G.B. Vertical Strip	
Display Color	262K/65K	262K/65K
Driver IC	Sunplus SPFD5403A	Samsung S6D0117
Interface	RGB I/F 18 bits	RGB I/F 18 bits
Backlight (IF=20mA)	4 pcs white LED	Common
Gray Scale Inversion	12 o'clock	12 o'clock
Overall Dimension (mm)	56.5x40.25x3.8 (typical)	
Weight (g)	14.5	

TFT Key features

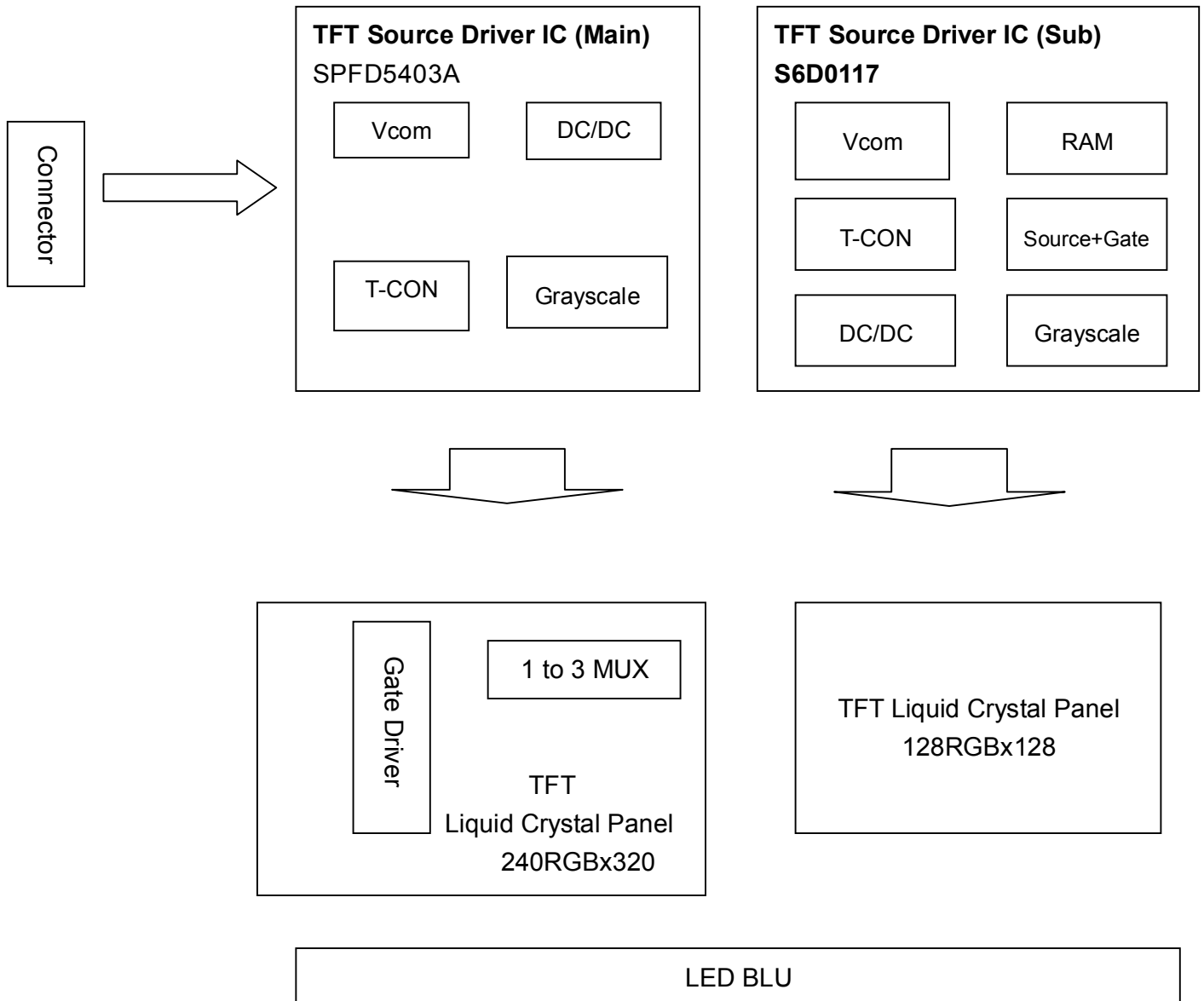
Main

- A. Data input as 6-bit x 3-dot digital data is output as 64 γ -corrected values using an internal D/A converter, achieving 262,144-color (full-color) display.
- B. Can support SPI and RGB interface
- C. On-chip 8-bit serial interface (applied to SPI)

Sub

- A. Allows direct RAM data display (RAM is included in the source driver):
A single pixel consists of three dots (RGB), Built-in RAM capacity are 132x3x132x6=313 632 bits
- B. Can support SPI and RGB interface
- C. Low power consumption and single chip driver solution

Block diagram





B. Electrical specifications

Pin Assignment

(Connector: AXK8L50115B)

This LCD connector is 50-pins. (50-pin connector is shown in FPC control drawing)

PIN No.	P/I/O	Pin Name	Signal level	Descriptions	Remark
1	P	V_LCD_2 V85	2.85V	LCD Power	
2	P	GND	GND	Ground	
3	I	Vsync	2.85V	LCD VSYNC	
4	I	PCLK	2.85V	LCD pixel clock	
5	I	Hsync	2.85V	LCD HSYNC	
6	P	GND	GND	Ground	
7	I	SPI_SCLK	2.85V	LCD SPI clock	Main/sub SPI_SCLK
8	I	DE	2.85V	LCD Data Enable	
9	I	SPI_SDA	2.85V	LCD SPI Data	Main/Sub SPI_Data
10	I	MLCD_CS#	2.85V	Main LCD Selection; Low: main LCD controller is selected	This pin will select main LCD SPI only
11	I	LCD_R0	2.85V	LCD_R0	
12	I	LCD_R1	2.85V	LCD_R1	
13	I	LCD_R2	2.85V	LCD_R2	
14	I	LCD_R3	2.85V	LCD_R3	
15	I	LCD_R4	2.85V	LCD_R4	
16	I	LCD_R5	2.85V	LCD_R5	
17	I	LCD_G0	2.85V	LCD_G0	Data and ID0
18	I	LCD_G1	2.85V	LCD_G1	Data and ID1
19	I	LCD_G2	2.85V	LCD_G2	
20	I	LCD_G3	2.85V	LCD_G3	
21	I	LCD_G4	2.85V	LCD_G4	
22	I	LCD_G5	2.85V	LCD_G5	
23	I	LCD_PD/NC	2.85V	Main LCD power down active: high If LCD module doesn't need this function, please put this pin to NC.	Note 1
24	I	LCD_B0	2.85V	LCD_B0	
25	I	LCD_B1	2.85V	LCD_B1	
26	I	LCD_B2	2.85V	LCD_B2	
27	I	LCD_B3	2.85V	LCD_B3	
28	I	LCD_B4	2.85V	LCD_B4	
29	I	LCD_B5	2.85V	LCD_B5	
30	I	SLCD_CS#	2.85V	Sub LCD selection, Low: Sub LCD controller is selected	This pin will select Sub LCD SPI only
31	I	MLCD_RST#	2.85V	Main LCD RESET, Low: Reset	Reset main LCD
32	P	V_LCD_2 V85	2.85V	LCD Power	

33	I	SLCD_RST#	2.85V	Sub LCD RESET, Low: Reset	Reset Sub LCD
34	O	KBR3	2.85V	KBR3	
35	O	KBR2	2.85V	KBR2	
36	I	KBC0	2.85V	KBC0	
37	P	FL_POS	Power	Back Light LED Power (+)	
38	I	KBC1	2.85V	KBC1	
39	P	FL_NEG	Power	Back Light LED Power (-)	
40	P	V_LED	Power	Status LED power for Blue and Red LED	
41	P	V_2V85	Power	Status LED power for Green LED	
42	O	LPG_BT#		Control Signal on Blue LED	
43	O	LED_RED#		Control Signal on Red LED	
44	O	LED_GREEN#		Control Signal on Green LED	
45	I	KBC2	2.85V	KBC2	
46	P	GND	GND	Ground	
47	O	SPK+		Speaker +	
48	O	REC+		Receiver +	
49	O	SPK-		Speaker -	
50	O	REC-		Receiver -	

Note 1: this pin will be NC pin.

Absolute maximum ratings

($V_{SS}=0V$) (Note 1)

Main

Item	Symbol	Min.	Max.	Unit	Remark
Power supply for Logic (M)	V_{DC}	-0.3	3.6	V	
Supply voltage for DC (M)	V_{CC}	-0.3	3.6	V	
TFT-LCD supply voltage	$ V_{GH}-V_{GL} $	-	33	V	
Operating temperature	T_{ope}	-20	70	°C	
Storage temperature	T_{stg}	-30	80	°C	

Note 1: If the module exceeds the absolute maximum ratings, it may be damaged permanently.

Also, if the module operated with the absolute maximum

Sub

Item	Symbol	Min	Max	Unit	Remark
Supply voltage	VDD3	-0.3	+5.0	V	
Supply voltage for step-up	VCI	-0.3	+5.0	V	
LCD supply voltage range	VGH-VGL	-	33	V	
Input Voltage range	V _{in}	-0.3	VDD+0.5	V	
Operating temperature	T _{opr}	-20	+70	°C	
Storage temperature	T _{stg}	-30	+80	°C	

Electrical characteristics
Typical operating condition
Main

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply	V _{DC} , V _{CC} V _{DD} , V _{CI}	2.7	2.85	3.3	V	Note 1
Input Signal Voltage	H Level	V _{IH}	0.7 x V _{CC}	-	V _{CC}	Note 2
	L Level	V _{IL}	0	-	0.3 x V _{CC}	

Note 1: The operations are guaranteed under the recommended operating conditions only. These operations are not guaranteed if a quick voltage change occurs during operation. To prevent noise, a bypass capacitor must be inserted into the line close to power pin.

Note 2: SPI, DATA, Chip_sel, VSYNC, HSYNC, DOTCLK, RESET

Sub

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply	VDD3, VCI	2.7	2.85	3.3	V	Note 1
Input Signal Voltage	H Level	V _{IH}	0.7xV _{DD3}		V _{DD3}	Note 2
	L Level	V _{IL}	0		0.3x V _{DD3}	

Note 1: The operations are guaranteed under the recommended operating conditions only. These operations are not guaranteed if a quick voltage change occurs during operation. To prevent noise, a bypass capacitor must be inserted into the line close to power pin.

Note 2: CS, DB0 to DB17, SDI, SCL, ENABLE, VSYNC, HSYNC, DOTCLK, RESET

Power consumption (Note 1)

Main

Mode	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Normal	P_N	$V_{CC} = 2.85V$	-	19	22.8	mW	Note 1
Stand-by	P_S		-	0.72	1.0	mW	Note 2
8-color	P_8		-	8.0	11.0	mW	Note 3

Note 1: Full black screen with 262k colors(Line inversion)

Note 2: Display off. Display operation completely stops, halting all the internal operations which is included R-C oscillator.

Note 3: 8 colors display (Frame inversion)

Sub

Mode	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Full	P_N	$V_{CC} = 2.85V$	-	5.8	6.5	mW	Note 1
Stand-by	P_S		-	0.36	0.41	mW	Note 2
Still	P_P		-	5.2	5.8	mW	Note 3

Note 1: RGB I/F with full black screen with 262k colors (Line inversion)

Note 2: Display off. Display operation completely stops, halting all the internal operations which is included R-C oscillator.

Note 3: CPU I/F with full black screen with 65k color (Line inversion)

Backlight driving conditions

Parameter	Symbol	Min.	Typ.	Max.	Units	Remark
LED voltage	V_L	-	12.8	14.0	V	
LED current	I_L	-	20	-	mA	
Power consumption	W_L	-	256	-	mW	Note 1
LED life time	L_L	5000	10000	-	hr	Note 2

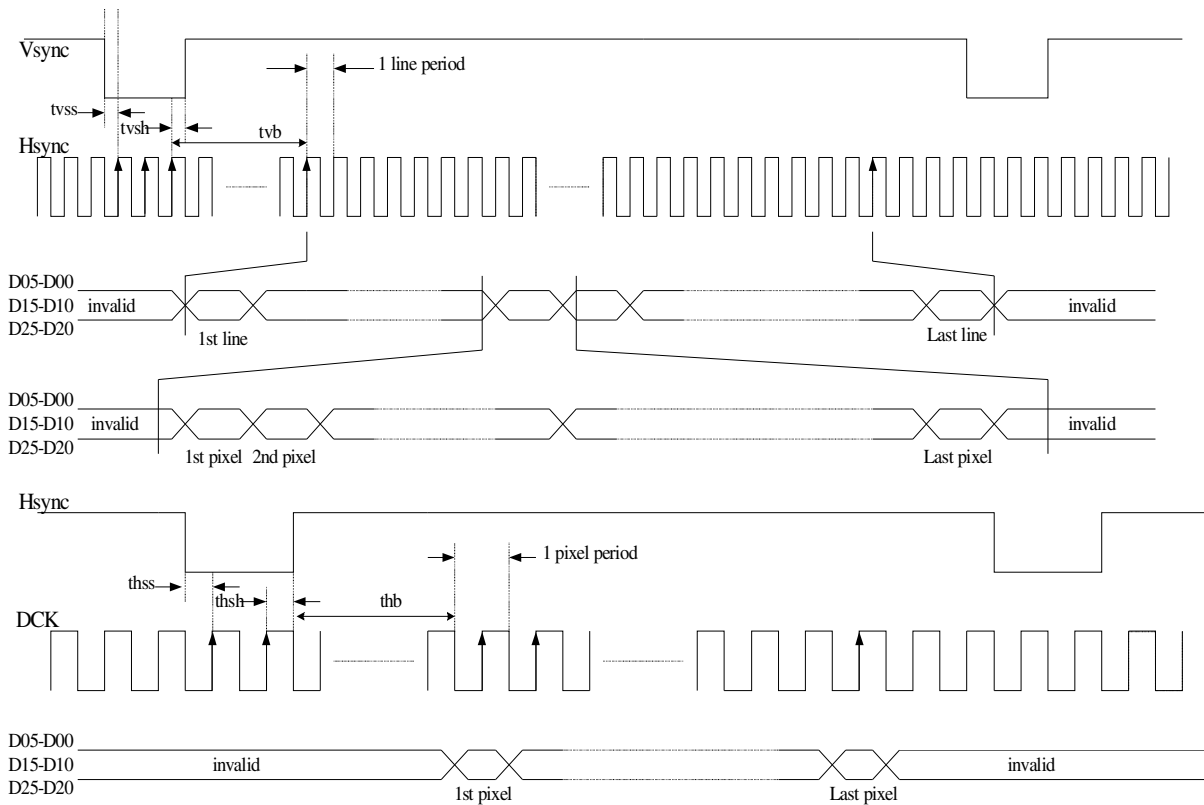
Note 1: $T = 25^{\circ}\text{C}$, $I_L = 20\text{mA}$, with serial LED circuit

Note 2: Brightness ($I_L = 20\text{mA}$) to be decreased to 50% of the initial value.

AC Characteristics

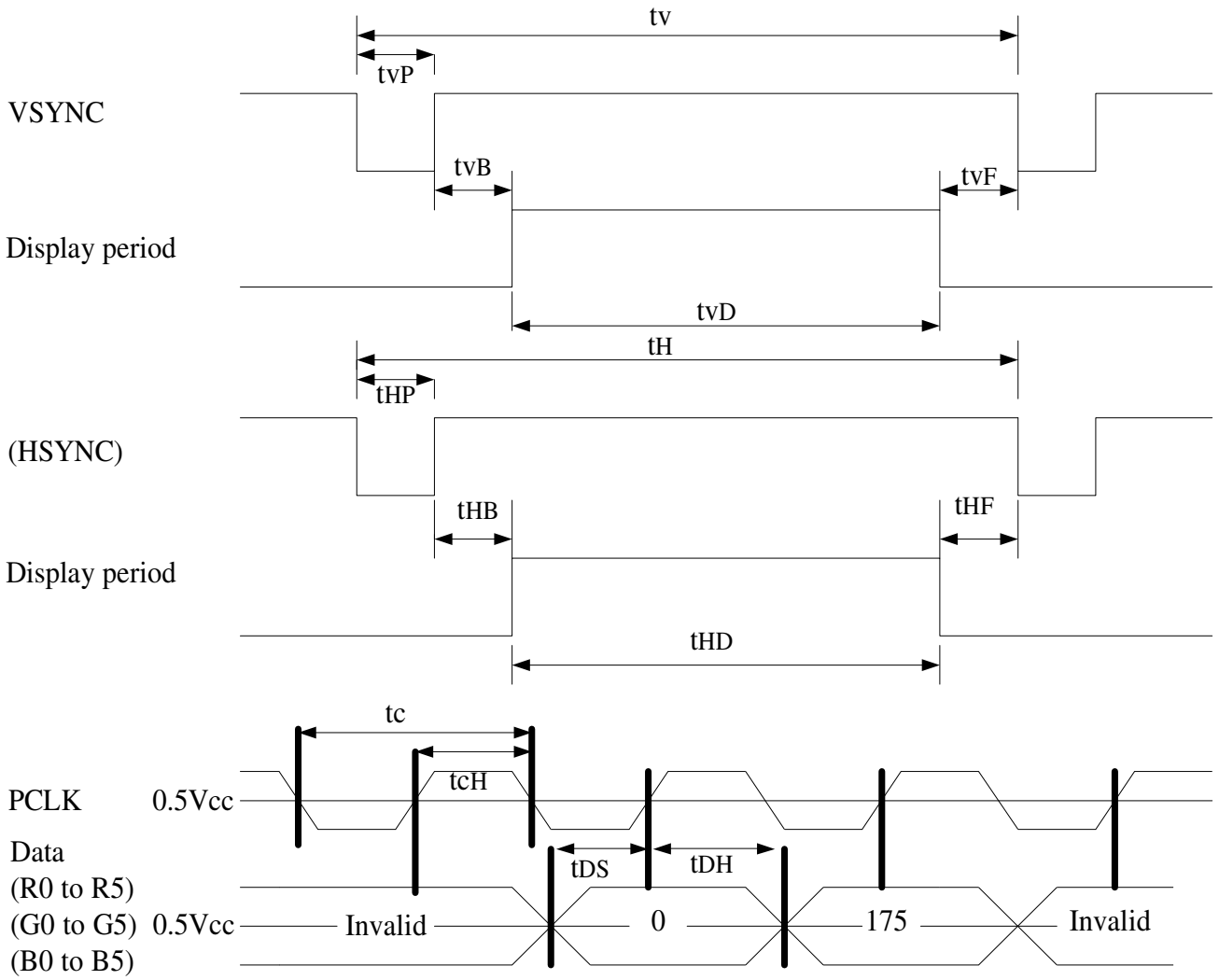
Main

RGB interface (when CKS=H, HSEG=L, VSEG=L)



tv_b = vertical back porch period

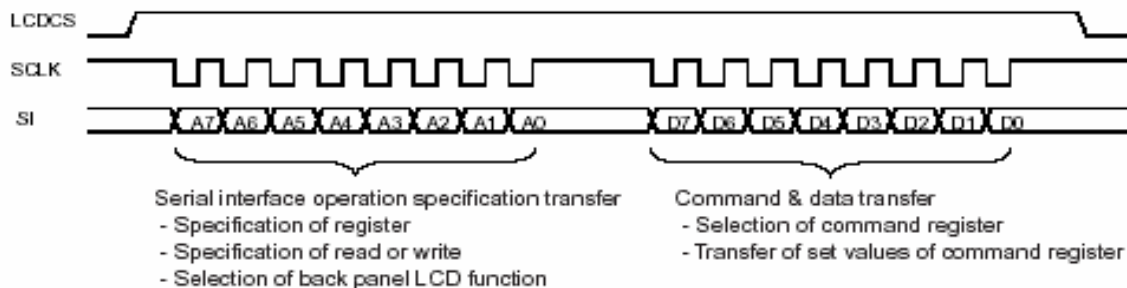
th_b = horizontal back porch period

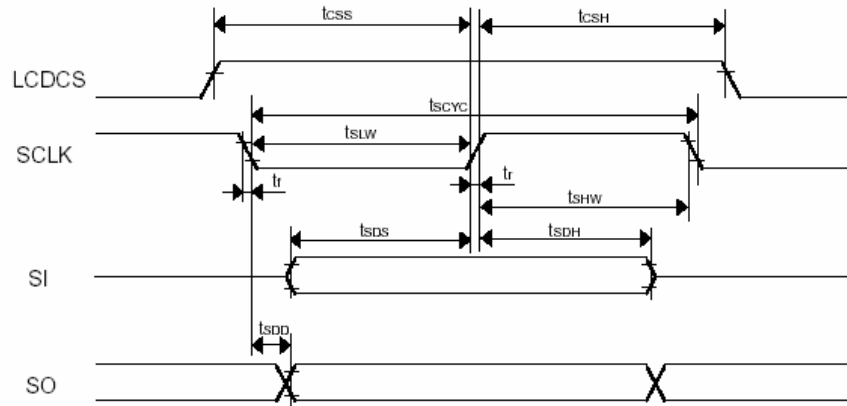


TA = -40 to +85°C, VDDIO = 2.2 to 3.6 V, VS = 5.0 V ± 0.5 V, VSS = 0 V

Name		Symbol	Min.	Typ.	Max.	Unit	Remark	
Clock	Frequency	VDDIO ≥ 2.5 V	1/fo	5.0	10.0	MHz	200 ns (TYP.)	
		VDDIO ≥ 2.2 V	1/fo	5.0	8.0	MHz	200 ns (TYP.)	
		VDDIO ≥ 1.7 V	1/fo	5.0	6.0	MHz	200 ns (TYP.)	
	Duty	t _{ch} /t _c	0.4	0.5	0.6	-	-	
Horizontal signal	Cycle	t _H	-	50.51	-	μs	19.8 kHz (TYP.)	
			-	252	-	CLK		
	Display period	t _{HD}		240		CLK	-	
	Front porch	t _{HF}	1.0	3.0	-	CLK	-	
	Pulse width	t _{HP}	2.0	5.0	-	CLK	-	
	Back porch	t _{HB}	2.0	4.0	-	CLK	-	
	t _{HP} + t _{HB} (Quarter data function not used)			5.0	10	255	CLK	-
	t _{HP} + t _{HB} (Quarter data function used)			10.0	10	255	CLK	-
	HSYNC setup time	t _{HSS}	20	-	-	ns	-	
	HSYNC hold time	t _{HSH}	20	-	-	ns	-	
Vertical signal	Cycle	t _V	-	16.67	-	ms	60.0 Hz (TYP.)	
			5	330	-	H		
	Front porch	t _{VF}	1.0	2.0	-	H	-	
	Pulse width	t _{VP}	1.0	5.0	-	H	-	
	Back porch	t _{VB}	1.0	3.0	-	H	-	
	t _{VF} + t _{VP} + t _{VB}			4.0	10.0	-	H	-
	VS _{YNC} setup time	t _{VSS}	40	-	-	ns	-	
	VS _{YNC} hold time	t _{VSH}	40	-	-	ns	-	
Data	Clock - data timing	t _{CH}	20	-	-	ns	-	
	Data - clock timing	t _{CS}	20	-	-	ns	-	

SPI Interface





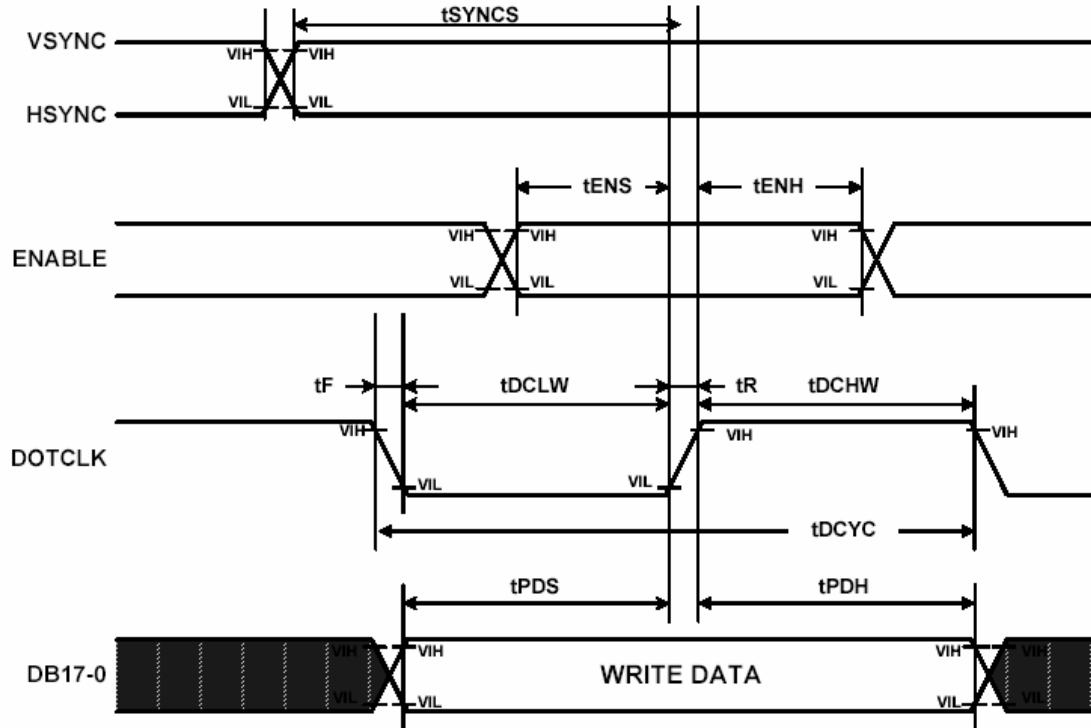
($T_A = -40$ to $+85^\circ\text{C}$, $V_{DDIO} = 1.7$ to V_{DC} , $V_{DC} = 2.5$ to 3.0 ($V_{DC2} = 1$)/ 3.6 ($V_{DC2} = 0$) V, $V_S = 5.0$ V \pm 0.5 V, $V_{SS} = 0$ V)

Parameter	Symbol	Condition	MIN.	TYP. ^{Note}	MAX.	Unit
Serial clock cycle	t_{scyc}		150			ns
SCLK high-level pulse width	t_{shw}		60			ns
SCLK low-level pulse width	t_{slw}		60			ns
Data setup time	t_{sds}		60			ns
Data hold time	t_{sdH}		60			ns
LCDCS-SCLK time	t_{css}		90			ns
	t_{csH}		90			ns
SCLK \downarrow \rightarrow SO output delay time	t_{sdp}		100			ns

Note TYP. values are reference values when $T_A = 25^\circ\text{C}$.

Remarks 1. The input signal's rise/fall times (t_r and t_f) are rated as 15 ns or less.

2. All timing is rated based on 20 to 80% of V_{DDIO} .

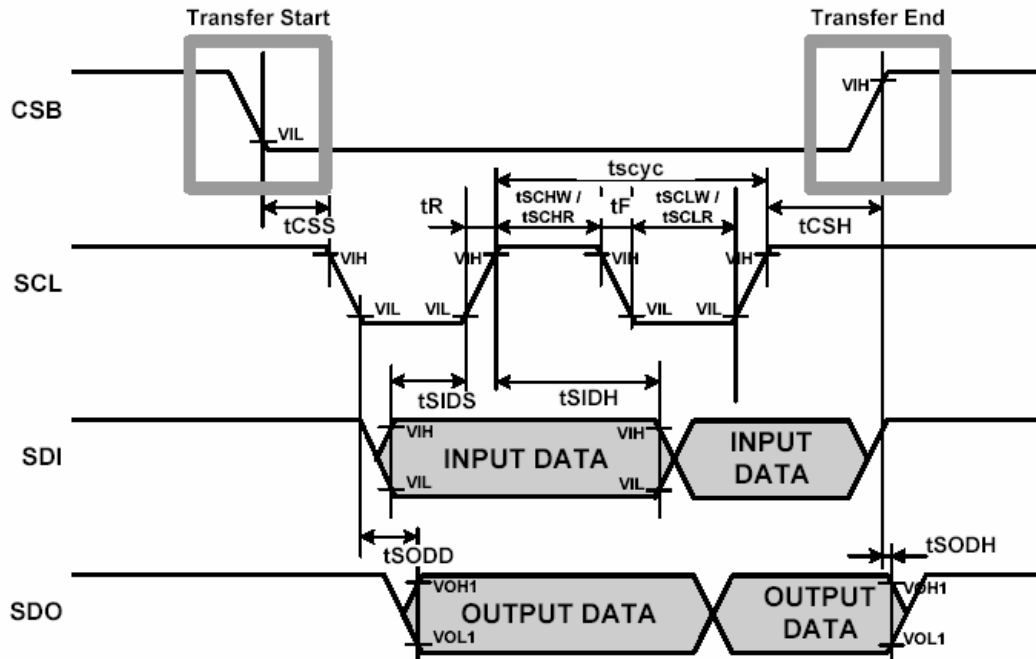
Sub
RGB interface Characteristics


(VDD3 = 2.7 to 3.0V, TA = - 40 to + 85°C)

Characteristic	Symbol	Specification			Unit
		Min	Typ	Max	
DOTCLK cycle time(Note.1)	t_{DCYC}	-	833	-	ns
DOTCLK rise/fall time	t_R, t_F	-		25	
DOTCLK high level pulse width	t_{DCHW}	40		-	
DOTCLK low level pulse width	t_{DCLW}	40		-	
ENABLE setup time	t_{ENS}	30		-	
ENABLE hold time	t_{ENH}	20		-	
Data setup time	t_{PDS}	30		-	
Data hold time	t_{PDH}	20		-	
VSYNC/HSYNC setup time	t_{SYNCS}	0		1	clock

Note.1: 60Hz frame rate

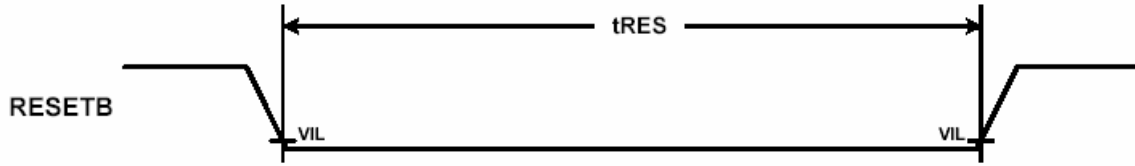
SPI interface characteristic



(VDD3 = 2.7 to 3.0V, TA = - 40 to + 85°C)

Characteristic	Symbol	Specification		Unit
		Min	Max	
Serial clock cycle time	tSCYC	250	-	ns
Serial clock rise/ fall time	tR, tF	-	25	
Pulse width high for write	tSCHW	40	-	
Pulse width high for read	tSCHR	230	-	
Pulse width low for write	tSCLW	60	-	
Pulse width low for read	tSCLR	230	-	
Chip Select setup time	tCSS	20	-	
Chip Select hold time	tCSH	60	-	
Serial input data setup time	tSIDS	30	1	
Serial input data hold time	tSIDH	30		
Serial output data delay time	tSODD	-	130	
Serial output data hold time	tSODH	5		

Reset Timing Characteristics



(VDD3 = 2.7 to 3.0V, TA = -40 to +85°C)

Characteristic	Symbol	Specification		Unit
		Min	Max	
Reset low pulse width	tRES	1	-	us

C. Optical specification

(Note 1, Note 2, Note 3, Note 4)

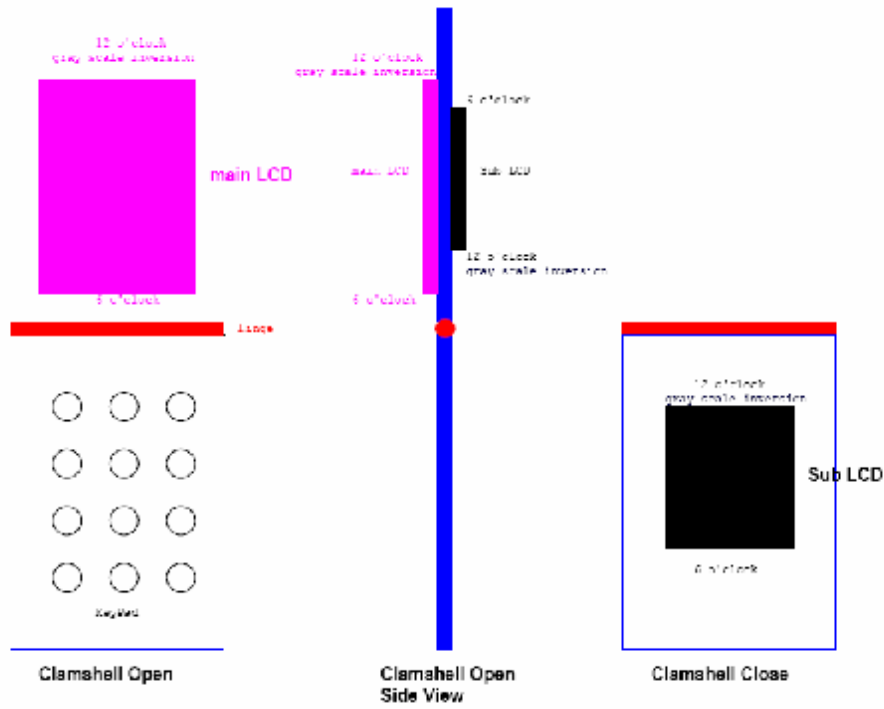
Main

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response time	Rise	Tr	$\theta = 0^\circ$	-	15	25	ms	Note 5, 6
	Fall	Tf		-	20	30	ms	
Contrast ratio		CR	At optimized Viewing angle (VDC=2.85V)	200	300	-		Note 6, 7
NTSC		%		55	60			
Viewing angle	Top		CR ≥ 10 (VDC=2.85V)	50	60	-	deg.	Note 6, 8
	Bottom			30	40	-		
	Left			45	55	-		
	Right			45	55	-		
Brightness		Y_L	$\theta = 0^\circ$	250	310	-	cd/m ²	Note 4, IF=20mA
Luminance Uniformity		Y_L	Display: White	70	80	-	%	Note 9
Display color		W_x		0.29	0.33	0.37		It will be updated on modified sample
		W_y		0.31	0.35	0.39		
		R_x		0.61	0.65	0.69		
		R_y		0.30	0.34	0.38		
		G_x		0.28	0.32	0.36		
		G_y		0.55	0.59	0.63		
		B_x		0.10	0.14	0.18		
		B_y		0.07	0.11	0.15		

Sub

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response time	Rise	Tr	$\theta = 0^\circ$	-	15	25	ms	Note 6, 7
	Fall	Tf		-	20	30	ms	
Contrast ratio		CR		150	250	-		Note 7, 8,11
NTSC		%		35	40	-		
Viewing angle	Top		$CR \geq 10$	50	55	-	deg.	Note 7, 9
	Bottom			10	15	-		
	Left			35	40	-		
	Right			35	40	-		
Brightness		Y_L	$\theta = 0^\circ$	110	140	-	cd/m ²	IF=20mA
Luminance Uniformity			Display: White	70	80	-	%	Note 10
Display color		W_x		0.30	0.34	0.38		It will be updated on modified sample
		W_y		0.32	0.36	0.40		
		R_x		0.56	0.60	0.64		
		R_y		0.30	0.34	0.38		
		G_x		0.32	0.36	0.40		
		G_y		0.49	0.53	0.57		
		B_x		0.10	0.14	0.18		
		B_y		0.12	0.16	0.20		

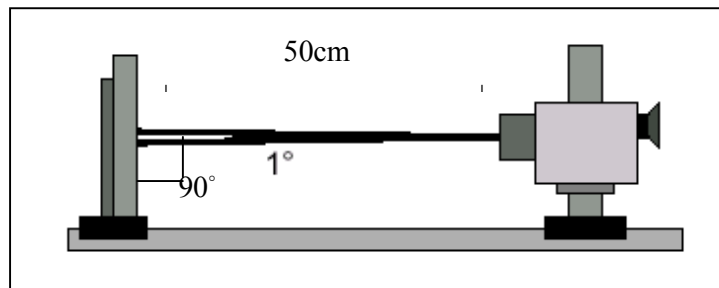
Note 1: Optical spec for Main and Sub LCD are base on direction of gray scale inversion as below drawing.



Note 2: Ambient temperature = $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

Note 3: To be measured in the dark room.

Note 4: To be measured at the center area of panel with a viewing cone of 1° by Topcon luminance meter BM-7, after 10 minutes operation (module).

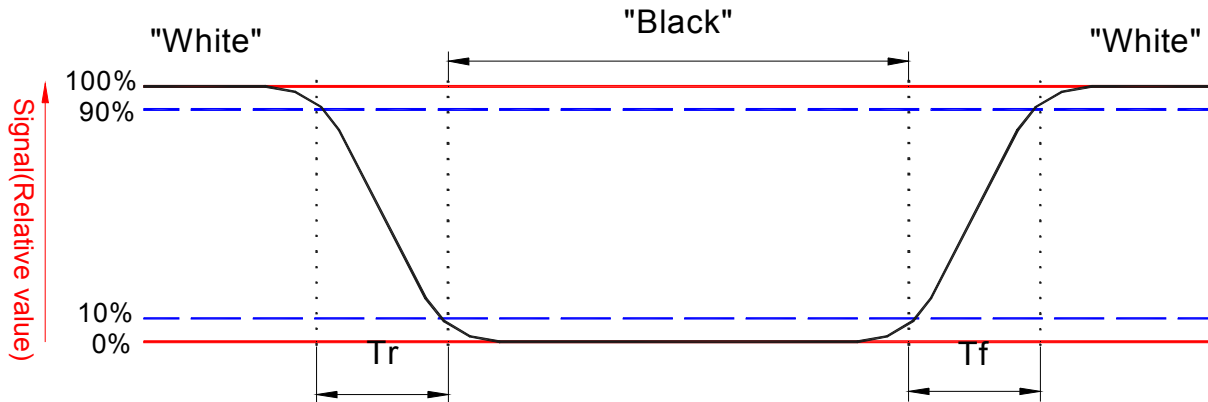


Note 5: Definition of response time:

The output signals of photo detector are measured when the input signals are changed from “black” to “white”(falling time) and from “white” to “black”(rising time), respectively.

The response time is defined as the time interval between the 10% and 90% of amplitudes.

Refer to figure as below:



Note 6. White Vi=0.9V

Black Vi=4.5V

The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

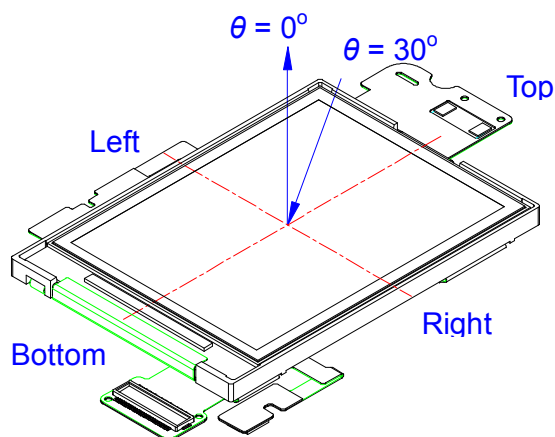
Note 7. Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

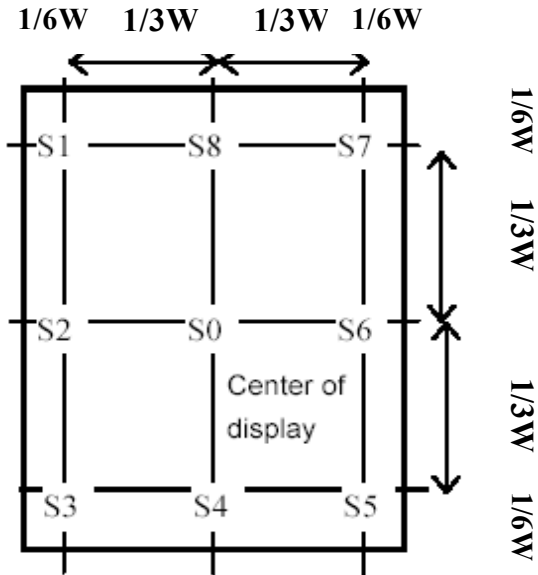
$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output when LCD is at "White" state}}{\text{Photo detector output when LCD is at "Black" state}}$$

Note 8. Definition of viewing angle:

Refer to the figure as below.



Note 9. Definition of Luminance Uniformity:



$$\text{Luminance uniformity} = \frac{\text{Minimum value from S0 to S8}}{\text{Maximum value from S0 to S8}} \times 100(\%)$$

$$\frac{(\text{Max brightness or Min brightness}) - (\text{Average brightness})}{(\text{Average brightness})}$$

D. Reliability test items

No.	Test items	Conditions	Remark
1	High temperature storage	Ta= 80°C 240H	
2	Low temperature storage	Ta= -40°C 240H	
3	High temperature operation	Ta= 70°C 240H	
4	Low temperature operation	Ta= -20°C 240H	
5	High temperature and high humidity	Ta= 60°C. 90% RH 240H	Operation
6	Heat shock	-30°C~80°C/50 cycles, 2H/cycle	Non-operation
7	Shock Test (package state)	Height: 80cm 1 corner, 3 edges, 6 surfaces	Each direction 1 time
8	Glass stress		Samples size: 30, follow AUO's criteria for glass stress
9	Dust	IEC 60529, Level IP5X	No dust or particle should enter the LCD
10	FPC bending	Connector side: 0->90->0 degree, 50times R=1mm	Display should be normal
11	Board to Board connector	Plug / unplug connector, 20 times	Display should be normal
12	Image stick	5*5 checkerboard pattern in 60°C for 36hrs and -20°C for 36hrs (TBC for Sub LCD)	Residual Image should not be found on full-white and full-black after 30 minutes at room temp.
13	Altitude (non-operating)	303 hpa (40,000ft), Room Temp, 48hours	
14	Flicker	Display horizontal stripe lines pattern (width: 1 Pixel) with middle gray background (Backlight on and off), dark room	No flicker should be found
15	MTBF	Provide the MTBF	
16	Screen durability	Provide the polarizer spec (meet 3H)	
17	Deflection Force	4kg weight load for 72hrs on the center of LCM using R=5 mm Silicon Rubber	No observable Mura after removing the weight load on LCM.

Note: Ta: Ambient temperature.

Failure Judgment Criterion for 1~7:

After finish the above-mentioned RA , leave the samples under room temperature for 2H and conduct the failure check under 25°C 40RH environments.

1. Neither abnormality nor significant deterioration should be found with display quality and appearance. (Discoloration of the polarizer can be exempted)
2. The contrast ratio and Brightness should be more than 50% of the initial value.

3. The functions should be normal.

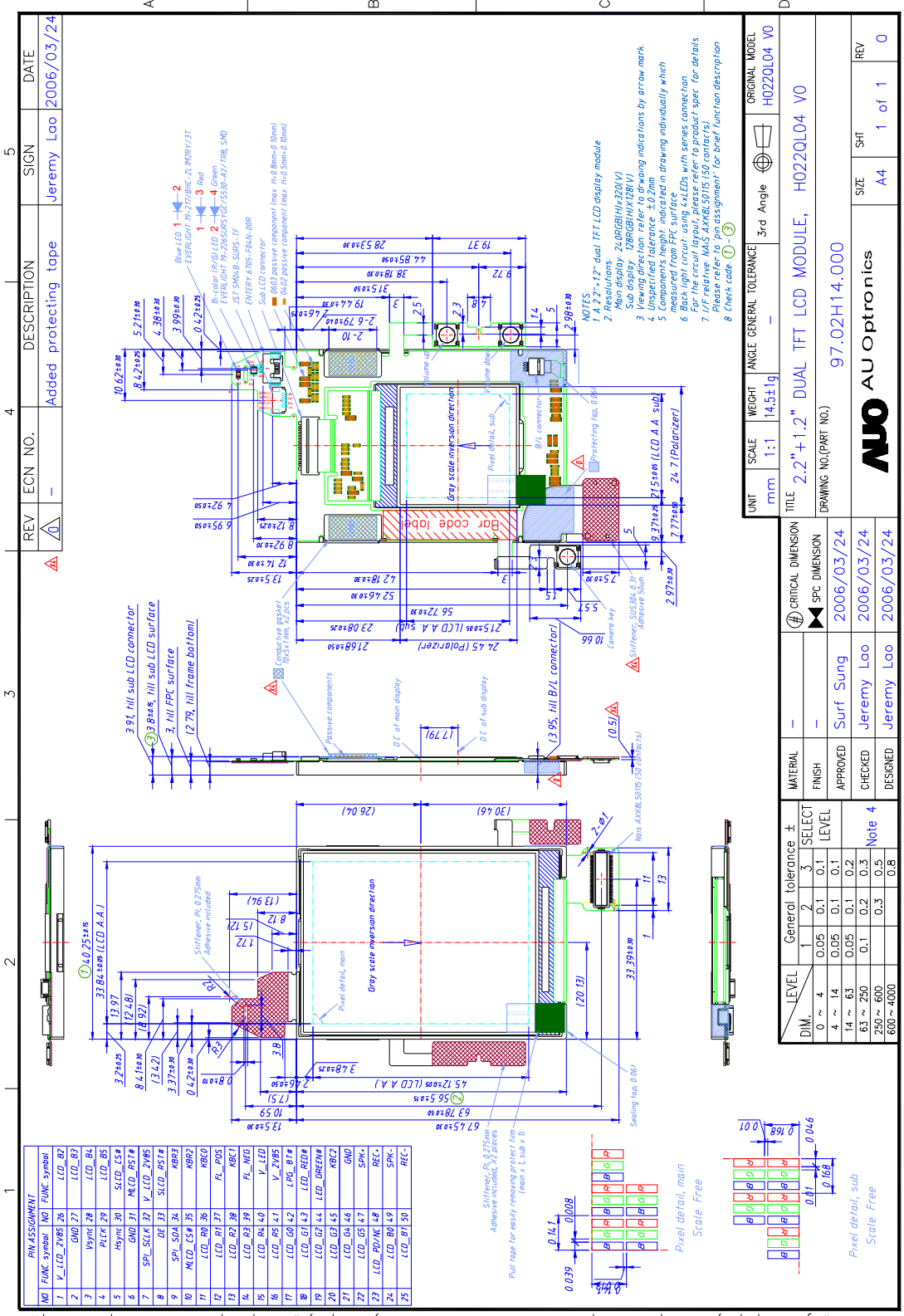
ESD and Grounding Requirement

Items	Test condition	Notes
ESD(air discharge on the ground of mobile phone)	IEC 61000-4-2 Air Discharge +-8KV Contact Discharge +-4KV	There is no degradation of LCD performance after this test.
	IEC 61000-4-2 Air Discharge +-15KV Contact Discharge +-8KV	There is no LCD damage after this test. (function ok after reset)
Metal frame grounding	The resistance between FPC grounding pin and metal frame should be less than 1 Ohm before/after all reliability test	TBC



E. Packing form (Reference)
(TBD)

Appendix 1: Outline dimension of TFT LCD drawing



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