PRODUCT SPECIFICATION

DESCRIPTION

TFT Module – 15.0”
1024x (RGB) x 768

PART NUMBER

LTTD1024768150-L5

VERSION

1.0

ROHS COMPLIANT

Revision Status

Revision	Revision Date	Page	Content	Notes
1.0	18.06.2012		Initial release	

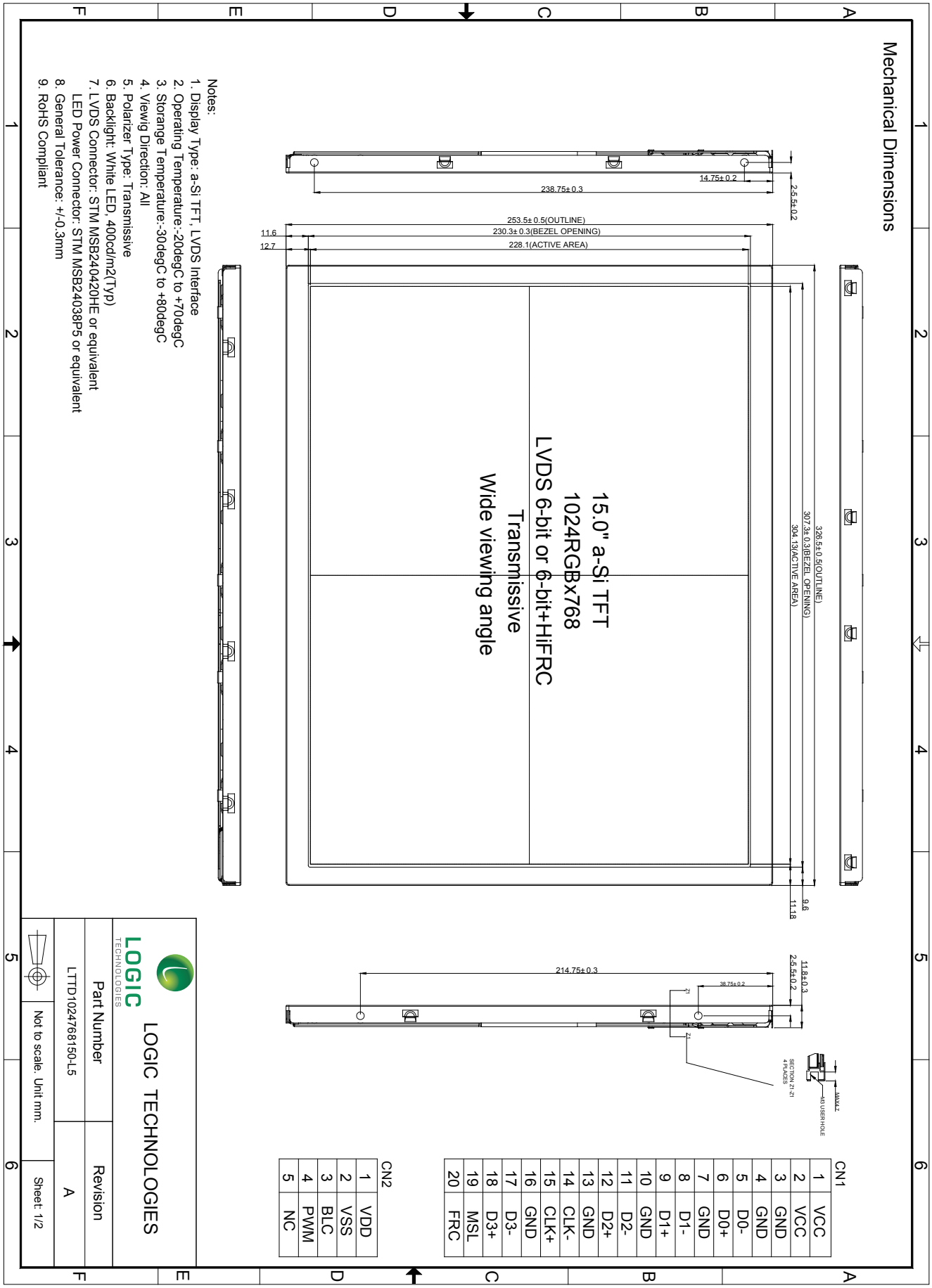
Table of Contents

- GENERAL INFORMATION

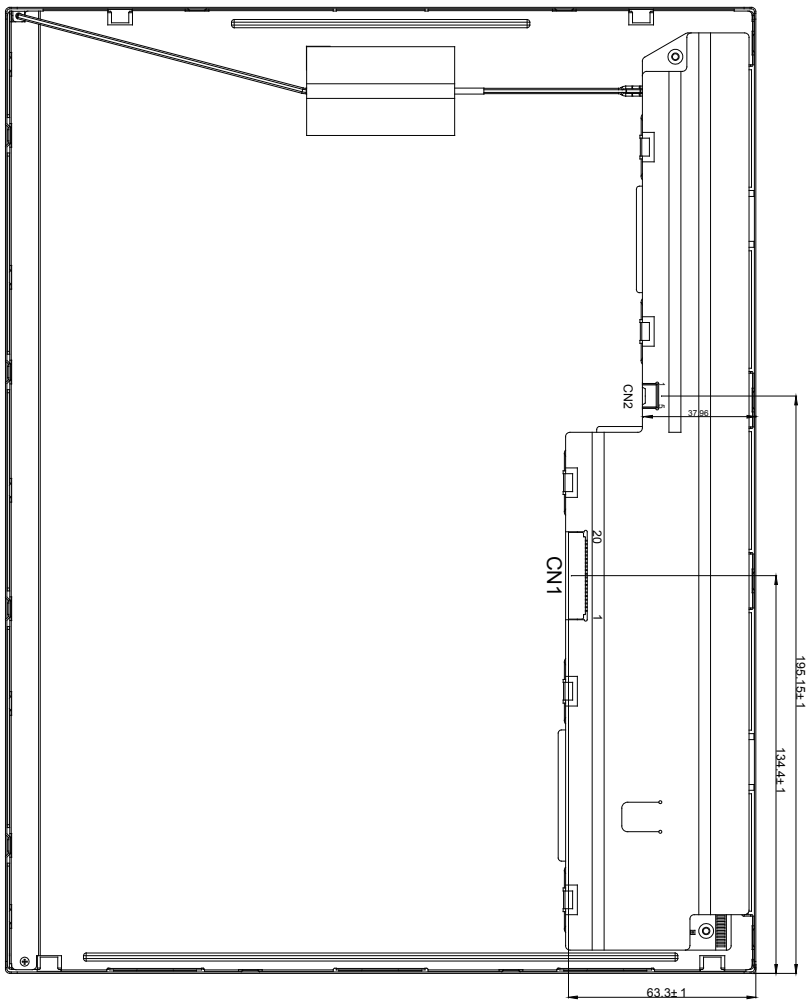
Item	Contents	Unit
LCD Type	TFT Transmissive	---
Technology	a-Si TFT	---
Viewing Angle	6:00 (Gray Scale Inversion Direction)	O'clock (Note 1)
Viewing Direction	12:00	O'clock
Module dimensions (W x H x T)	326.50 x 253.5 x 11.8 (Typical. Tolerance ±0.5)	mm
Active area (W x H)	304.13 x 228.1	mm
Number of pixels	1024 RGB x 768	---
Pixel pitch	0.297 x 0.297	mm
Pixel Configuration	R.G.B. Vertical Stripe	mm
Colours	262K/16.7M colors	---
Contrast ratio	600:1 (typical)	---
Backlight	White LEDs	---
Backlight Brightness	400 (typical)	cd/m^2
Color gamut	60 % (typ.)	---
Response time	8 (typ.)	ms
Surface Treatment	AG Type	
Interface	LVDS 1port	---
Power supply voltage	3.3 V(LCD digital voltage) 12V(LED backlight)	---
Power consumption	12 (Max.)	W
Operating temperature	-20 to +70	°C
Storage temperature	-30 to +80	°C
Weight	1000 (typ.)	g

Note： This is a wide viewing angle display. Just still a-Si TFT, the viewing direction for best image quality is different from TFT definition, there is a 180 degree shift.

- MECHANICAL DIMENSIONS



Mechanical Dimensions



Notes:

1. Display Type: a-Si TFT, LVDS Interface
2. Operating Temperature:-20degC to +70degC
3. Storange Temperature:-30degC to +80degC
4. Viewig Direction: All
5. Polarizer Type: Transmissive
6. Backlight: White LED, 400cd/m2(Typ)
7. LVDS Connector: STM MSB240420HE or equivalent
   LED Power Connector: STM MSB24038P5 or equivalent
8. General Tolerance: +/-0.3mm
9. RoHS Compliant

CN1

1	VCC
2	VCC
3	GND
4	GND
5	D0-
6	D0+
7	GND
8	D1-
9	D1+
10	GND
11	D2-
12	D2+
13	GND
14	CLK-
15	CLK+
16	GND
17	D3-
18	D3+
19	MSL
20	FRC

CN2

1	VDD
2	VSS
3	BLC
4	PWM
5	NC

LOGIC TECHNOLOGIES

Part Number	Revision
LTTD1024768150-L5	A

Not to scale. Unit:mm. Sheet: 2/2

- ABSOLUTE MAXIMUM RATINGS

.

Parameter	Symbol	Min.	Max.	Unit	Note
Supply Voltage	VCC/VCCIO	- 0.3	4.0	V	
Input Signal Voltage	D0+/-, D1+/-, D2+/-, D3+/- CLK+/-, MSL	- 0.3	4.0	V	
Operating Temperature	T_{OPR}	-20	70	°C	Note
Storage temperature	T_{ST}	- 30	80	°C	
Absolute humidity	AH		≤ 70	g/m3	Ta > 55℃
Operating altitude	-		≤4,850	m	0°C≤Ta≤ 55°C
Storage altitude	-		≤13,600	m	-20°C≤Ta≤ 60°C

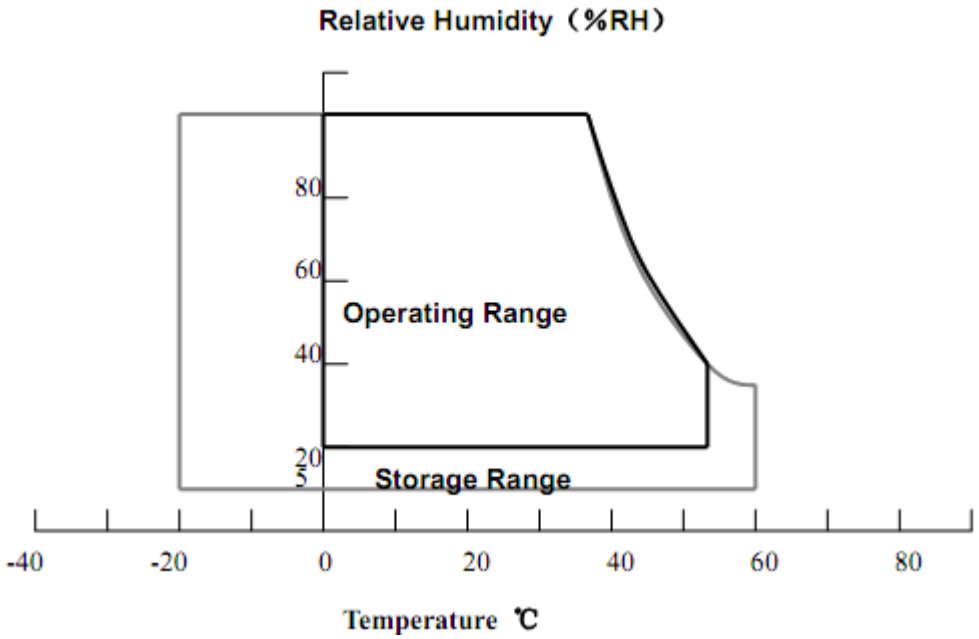
Note: Temperature and relative humidity range is shown in the figure below.

(a) 90%RH Max. (Ta ≤40℃)

(b)Web-bulb temperature should be39℃Max.(Ta＞40℃)

(c) No condensation.

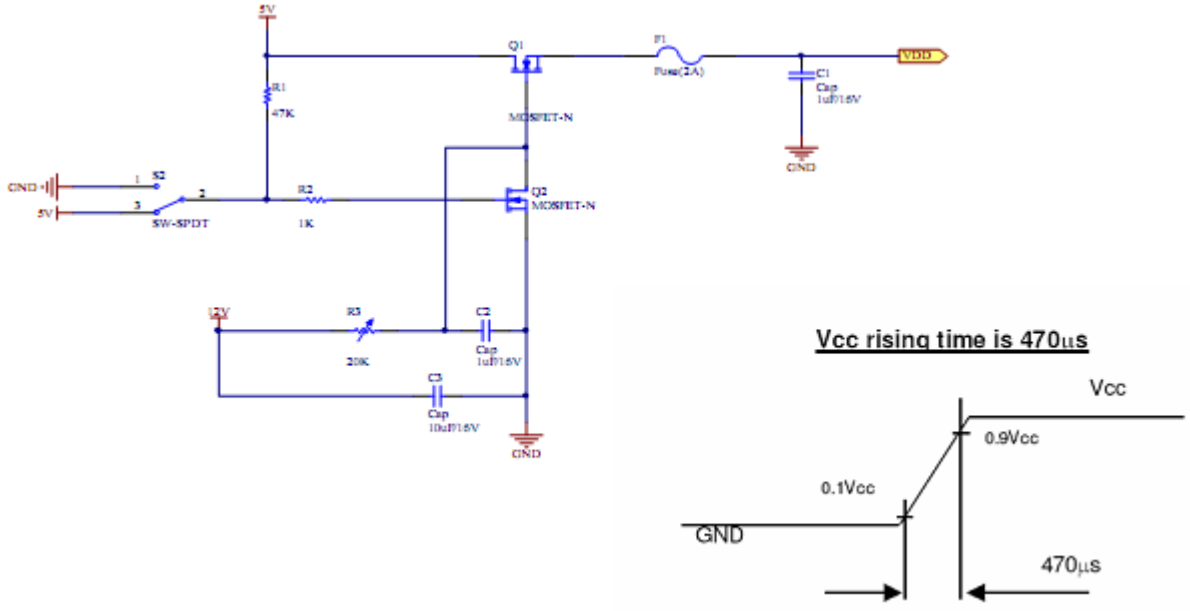
The temperature of panel display surface area should be 0℃Min and 65℃Max



- ELECTRICAL CHARACTERISTICS

Item		Symbol	Min.	Typ.	Max.	Unit	Remark
Supply Voltage		VCC - GND	3.0	3.3	3.6	V	
Supply Voltage current		ICC		500 Note1	700 Note2	mA	VCC=3.3V
Differential input threshold voltage for LVDS receiver	"H" Level	V_{TH}	-	-	100	mV	at VCM = 1.25V Note3
	"L" Level	V_{TL}	-100	-	-	mV	
Permissible ripple voltage		V_{RP}	-	-	100	mV	VCC
Differential input voltage		$\lvert V_{ID} \rvert$	200	-	600	mV	
Input voltage width for LVDS receiver -		V_I	0	-	2.4	V	
Terminating resistor		R_T	-	100	-	Ω	
Rush current		I_{RUSH}	-	-	1.5	A	Note4
Input voltage for MSL signal	"H" Level	V_{FH}	2.0		VCC	V	
	"L" Level	V_{FL}	0		0.4	V	

Note 1: Checkered flag pattern (EIAJ ED-2522);
Note 2: 2H1V dot inverse pattern
Note 3: Common mode voltage for LVDS receiver
Note4: Measurement Conditions:



- BACKLIGHT CHARACTERISTICS

Item		Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage		VDD	10.8	12.0	12.6	V	
Supply current		IDD		750	800	mA	250cd/ m2 (typ.)
Input voltage for PWM & BLC	"H" Level	V_H	2.0		5.0	V	
	"L" Level	V_L	0		0.4	V	
PWM frequency		F_{PWM}	200	---	20K	HZ	
PWM pulse width		T_{PWH}	10			us	
Operation life time		Hr	50,000			Hour	Ta = 25℃

NOTES:

Backlight drive conditions : constant current driving method.

- The LED driving condition is defined for total backlight consumption.
- Forward Voltage adjustment depends on the Forward Current setting.
- One LED : max IF = 25mA, VF = 3.3V
- The LED lifetime is typically 30,000 hours at 25degC
- If the LEDs are driven by high current, high ambient temperature & humidity condition the lifetime of the LEDs will be reduced.
- Operating lifetime means brightness reduces to 50% of initial brightness.
- Typical operating life time is estimated data.

- ELECTRO-OPTICAL CHARACTERISTICS

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Refer	Note
Response Time		T_{ON}	Ta=25°C	---	2	4	ms	Fig 1	4
		T_{OFF}		---	6	8			
Contrast ratio		Cr		400	600	---	---	Fig 2	1
Uniformity		U	---	70	80	---	%	Fig 2	3
NTSC		---	Backlight is on	50	60	---	%		
Surface Luminance		Lv		350	400	---	cd/m^2	Fig 2	2
Viewing angle ratio			∅=90°	70	80	---	deg	Fig 3	6
			∅=270°	70	80	---			
			∅=0°	70	80	---			
			∅=180°	70	80	---			
CIE (x,y) chromaticity	White	x		0.283	0.313	0.343	---	Fig 2.	5
		y		0.299	0.329	0.359			

Note1. Contrast ratio (CR) is defined mathematically in Figure 2.

$$\text{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Average Surface Luminance with all black pixels (P1, P2, P3, P4, P5)}}$$

Note 2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information see figure 2.

Lv = Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5…)

Note 3. Uniformity of surface luminance, White, is defined mathematically in figure 2.

$$\text{White} = \frac{\text{Minimum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Maximum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}$$

Note 4. Response time is the time required for the display to transition form white to black (rise time Tr) and from black to white (decay or fall time, Tf). The industry standard test equipment used is the Autronic-Melcher's Conoscope.

Note 5. Without backlight, CIE (x,y) chromaticity. The x,y value is determined by measuring luminance at each test position 1 through 5, then calculating the average value.

Note 6. The Viewing angle is the angle at which the contrast ratio is greater than 2. For a TFT module, the contrast ratio is greater than 10. The angles are determined for the horizontal or 'x' axis and the vertical or 'y' axis with respect to the 'z' axis, being the LCD surface reference. Also see figure 3.

Note 7. For viewing angle and response time testing, the testing data is based on Autronic-Melcher's BM-7A. For the contrast ratio, surface luminance, luminance uniformity and chromaticity (CIE), the test data is based on the industry's standard SR-3A photo detector.

Note 8. For TFT modules, grey scale reversing occurs in the opposite direction of the panel viewing angle.

Figure 1. Definition of response time

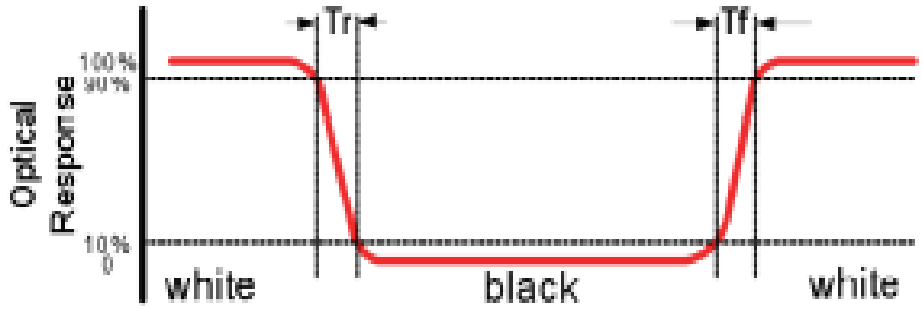


Figure 2. Measuring contrast ratio, surface luminance, luminance uniformity and CIE (chromaticity.)

A: 5mm. B: 5mm. H, V: Active area. Light spot size θ=7mm, 500mm distance from the LCD surface to the detector lens.
Measurement instrument is Topcon's luminance meter BM-7.

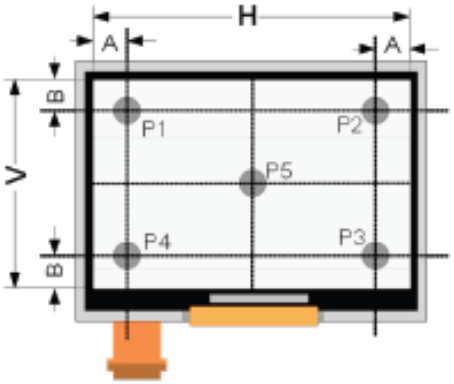


Figure 3. Definition of viewing angle

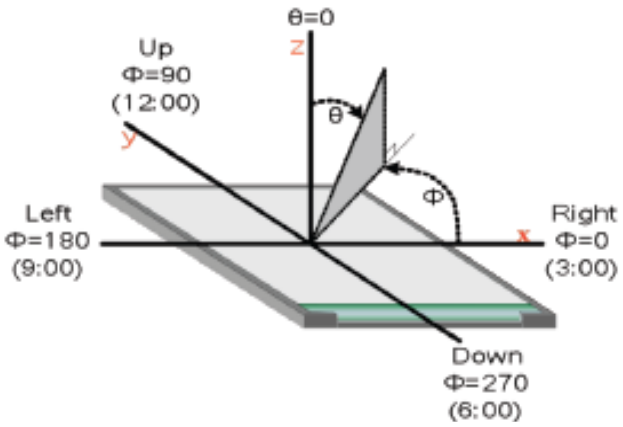
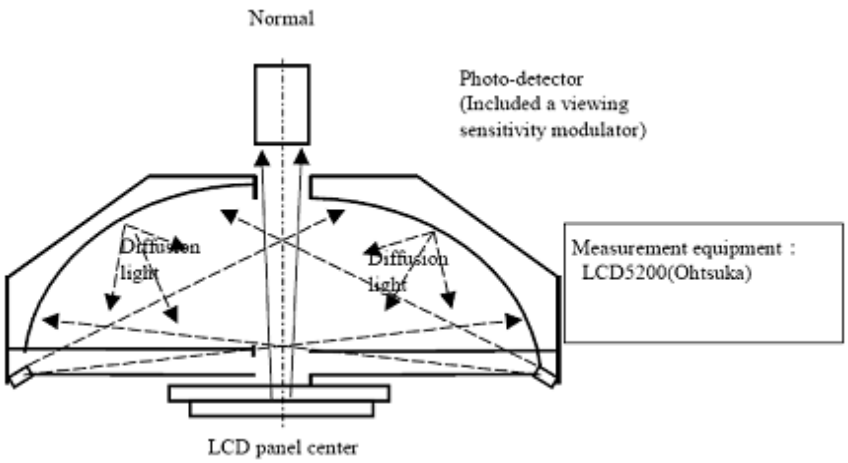


Figure 4. Definition of Reflectance measurement system



- **INTERFACE DESCRIPTION**

1. LCD panel signal processing board

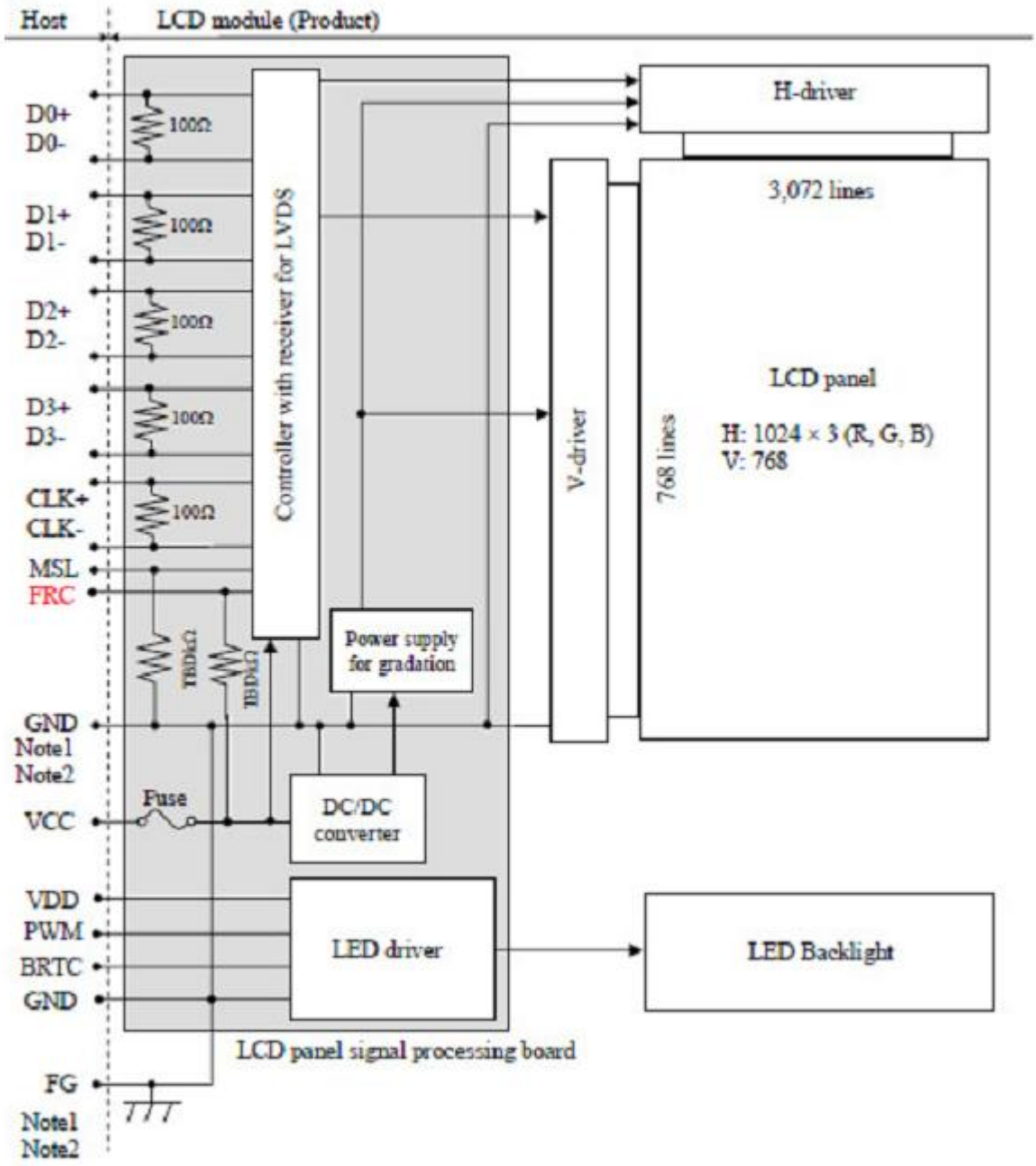
CN1 (Module side): 185083-20121 (P-Two Electric Technology CO., LTD.)						
Pin	**Symbol**	**Signal**	**Description**			**Note**
			6-bit	**8-bit (6-bit+HiFRC)**		
				Map A	**Map B**	
1	VCC	Power supply	Power supply			
2	VCC					
3	GND	Ground	Ground			
4	GND					
5	D0-	Pixel data	R0-R5,G0	R2-R7,G2	R0-R5,G0	Note1
6	D0+					
7	GND	Ground	Ground			
8	D1-	Pixel data	G1-G5,B0-B1	G3-G7,B2-B3	G1-G5,B0-B1	Note1
9	D1+					
10	GND	Ground	Ground			
11	D2-	Pixel data	B2-B5,DE	B4-B7,DE	B2-B5,DE	Note1
12	D2+					
13	GND	Ground	Ground			
14	CLK-	Pixel clock	Pixel clock			Note1
15	CLK+					
16	GND	Ground	Ground			
17	D3-	Pixel data	Ground	R0-R1, G0-G1, B0-B1	R6-R7, G6-G7, B6-B7	Note1
18	D3+					
19	MSL	Selection of LVDS Input data map	High	High	Low or NC	
20	FRC	Selection of the number of colors	High or NC	Low		

2. Backlight connector

CN2 (Module side): MSB24038P5 (Produced by STM) or equivalent			
Pin	**Symbol**	**Description**	**Note**
1	VDD	Power supply +12V	
2	VSS	Ground	
3	BLC	Backlight ON/OFF control: 5V-On / 0V-Off	
4	PWM	PWM: Luminance control	
5	NC	Not connection	

Note1：Twist pair wires with 100Ω (Characteristic impedance) should be connected between LCD panel signal processing board and LVDS transmitter.

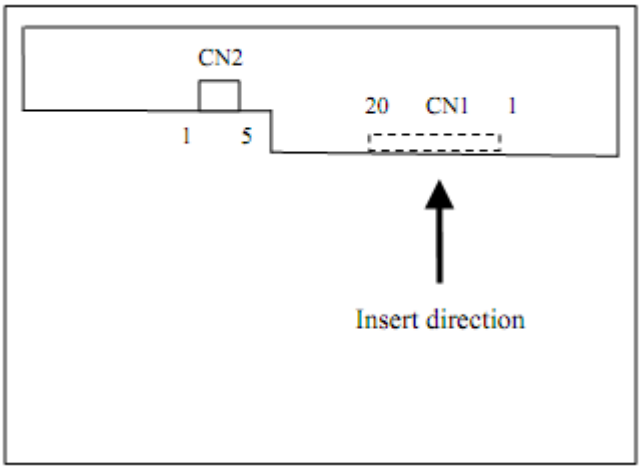
Note2：Block Diagram



*Note1: Relations between GND (Signal ground and LED driver ground) and FG (Frame ground)

*Note2: GND and FG must be connected to customer equipment's ground. All grounds be connected together to customer equipment is recommended.

Note3：Connector position



- **DISPLAY COLORS AND INPUT DATA INFORMATION**

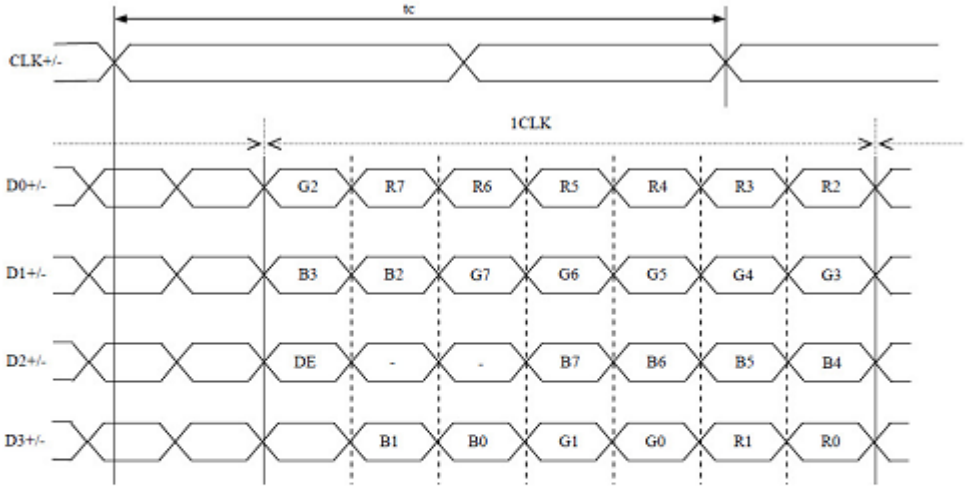
1. DISPLAY COLORS AND DATA SIGNAL

This product can display in equivalent to 16,777,216 colors in 256 scales. Also the relation between display colors and input data signals is as the following table. And it can display in equivalent to 262,144 colors in 64 scales, without data signals R7, R6, G7, G6, B7, B6 in the following table.

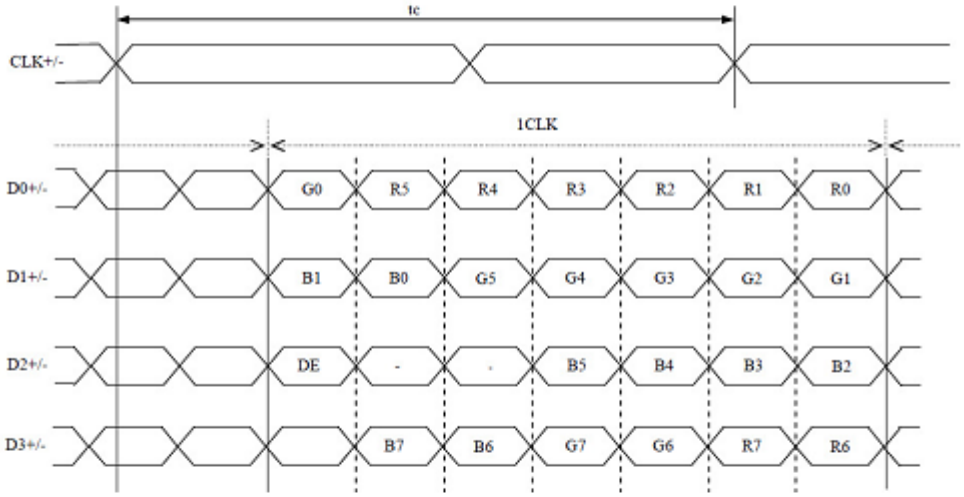
Display colors		Data signal （0:Low level，1:High Level）																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red grayscale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↕				:								:								:				
		1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bright	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green grayscale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↕				:								:								:				
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue grayscale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↕				:								:								:				
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

2 DATA MAP

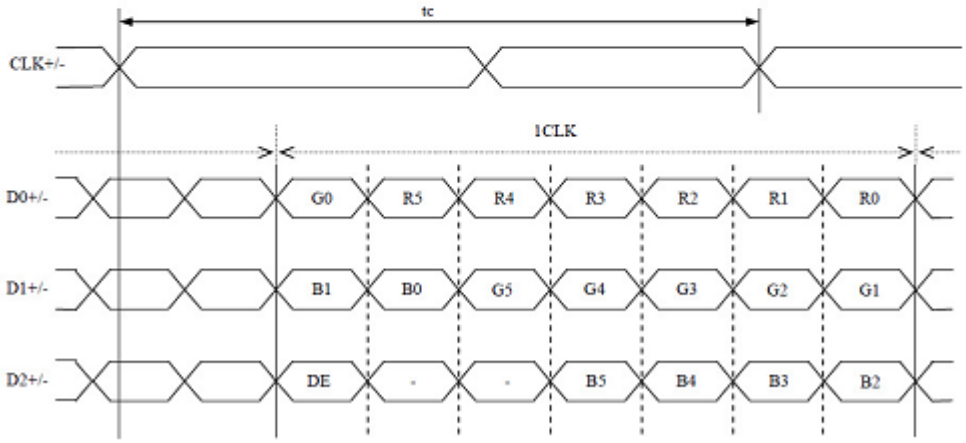
(1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low)



(2) LVDS Input data signal: 8bit, MAP B (MSL: Low or NC, FRC: Low)



(3) Input data signal: 6bit (MSL: High, FRC: High o



- **TIMING CHART and DATA**

1. Timing characteristics

(Note1)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	54	65.0	81	MHz	15.384ns（typ.）
	Duty		—	—			—	Note2
	Rise time, Fall time		—				ns	
DATA	CLK-DATA	Setup time	—	—			ns	Note2
		Hold time	—				ns	
	Rise time, Fall time		—				ns	
DE	Horizontal	Cycle	th	12.3	20.676	30.00	μs	48.363KHz(typ.)
				1050	1344	1800	CLK	Note3 Note4
		Display period	thd	1024				—
	Vertical (One frame)	Cycle	tv	13.1	16.666	20.0	ms	60.0Hz（typ.）
				770	806	1334	H	
		Display period	tvd	768			H	
	CLK-DE	Setup time	—	—			ns	Note2
		Hold time	—				ns	
	Rise time, Fall time		—				ns	

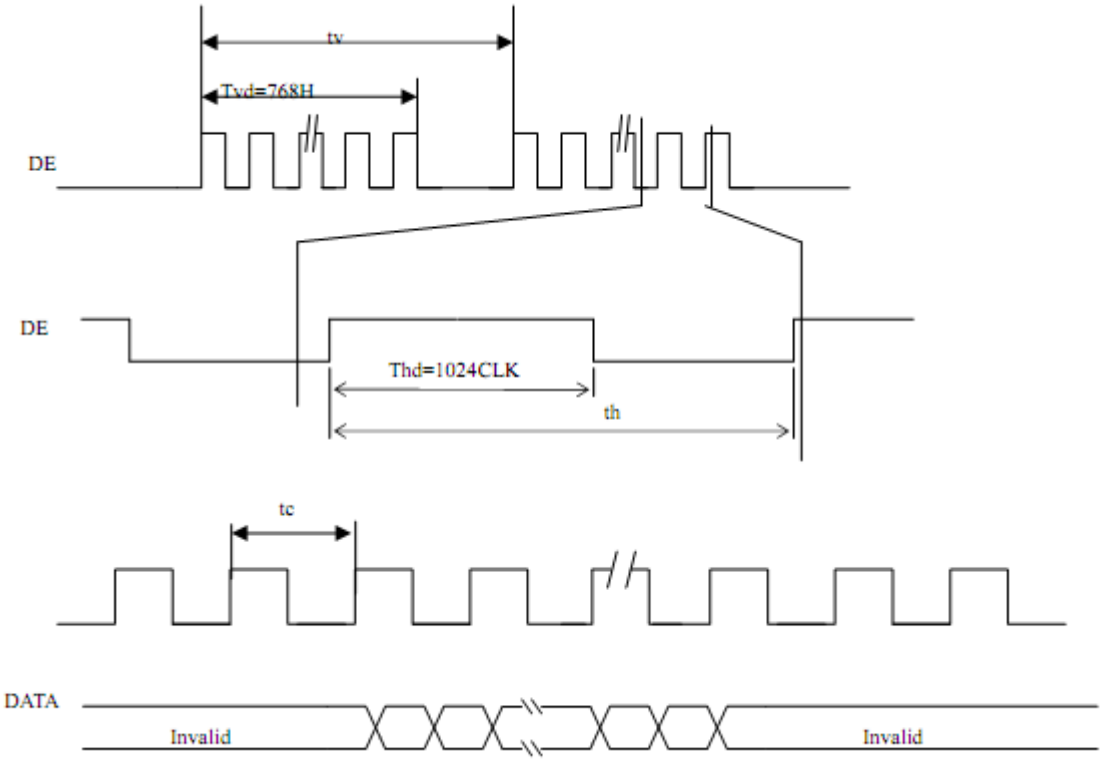
Note1： Definition of parameters is follows. tc=1CLK,Th=1H

Note 2：See the data sheet of LVDS transmitter.

Note 3：Both of “time” and “CLK number” of the “th” must keep the Minimum value of specifications.

Note 4：“th” must keep the fluctuation within ±1 CLK, because of avoidance of image sticking.

2. Input signal timing chart



3. Pixel DATA alignment of display image

The following table is the coordinates per pixel

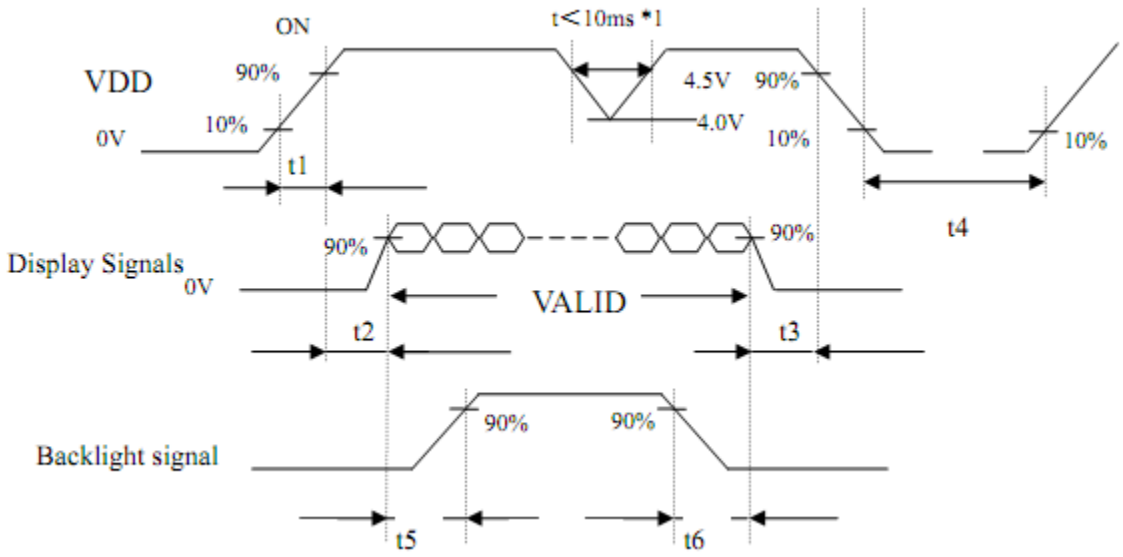
C（1，1）

R	G	B

C（1，1）	C（2，1）	•••	C（X，1）	•••	C（1023，1）	C（1024，1）
C（1，2）	C（2，2）	•••	C（X，Y）	•••	C（1023，2）	C（1024，2）
• • •	• • •	• ••• •	• • •	• ••• •	• • •	• • •
C（1，Y）	C（2，Y）	•••	C（X，Y）	•••	C（1023，Y）	C（1024，Y）
• • •	• • •	• ••• •	• • •	• ••• •	• • •	• • •
C（1，767）	C（2，767）	•••	C（X，767）	•••	C（1023，767）	C（1024，767）
C（1，768）	C（2，768）	•••	C（X，768）	•••	C（1023，767）	C（1024，768）

4. POWER SUPPLY VOLTAGE SEQUENCE

.4.1 The sequence of backlight and power



Timing Specifications:

0.47ms<t1 <10ms; 0.5 ms<t2 <50ms; 0ms<t3 <50ms;

t4 >1000ms; t5 >200ms; t6 >200ms;

*1: These signals should be measured at the terminal of 100Ω resistor.

[NOTE ITEM]

Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0 V, a protection circuit may work, and then this product may not work.

Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CK+/-) and function signal (MSL) must be “0” voltage,exclude the VALID period (See above sequence diagram). If these signals are higher than 0.3 V, the internal circuit is damaged.

If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If customer stops the display and function signals, they should be cut VCC.

Note3: The backlight power supply voltage should be inputted within the valid period of display and function signals, in order to avoid unstable data display.

Note4: In order to prevent unstable data displaying, suggest that, during display and function signal’s valid period, backlight power voltage should be input under the custom ’ condition as possible.

4.2 Power supply voltage ripple

This product works, even if the ripple voltage levels are beyond the permissible values as the following table, but there might be noise on the display image.

Parameter	Power supply voltage	Ripple voltage Note1(Measured at input	Unit
VCC	3.3 V	≤ 100	mVp-p

Note1: The permissible ripple voltage includes spike noise.

4.3 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	TF16SN2.50	KOA Corporation	1.5 A /32V	1.5 A	Note1

Note1: The power supply capacity should be more than the fusing current. If the power supply capacity is less than the fusing current, the fuse may not blow for a short time, and then nasty smell, smoking and so on may occur.

- RELIABILITY TESTING

NO.	Item	Condition	Criteria
1	High Temperature Operating	70°C +/-2°C, 240Hrs	IEC60068-2-1 GB2423.2
2	Low Temperature Operating	-20°C +/-2°C, 240Hrs	IEC60068-2-1 GB2423.1
3	High Temperature Storage	80°C +/-2°C, 240Hrs	IEC60068-2-1 GB2423.2
4	Low Temperature Storage	-30°C +/-2°C, 240Hrs	IEC60068-2-1 GB2423.2
5	High Temperature & High Humidity Storage	+50°C, 90% RH max,240 hours	IEC60068-2-3, GB/T2423.3
6	Thermal Shock (Non-operation)	-20°C 30 min~+60°C 30 min, Change time:5min, 20 Cycle	Start with cold temperature, End with high temperature, EC60068-2-14,GB2423.22—87
7	Vibration (non operating)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 1 hours for each direction of X.Y.Z. (3 hours for total)	IEC60068-2-6 GB/T2423.10
8	Shock (non-operation)	60G 6ms, ±X,±Y,±Z 3 times for each direction	IEC60068-2-27 GB/T2423.5
9	ESD (operation)	C=150pF, R=330Ω，5points/panel Air:± 8KV, 5times; Contact:± 4KV, 5 times; （Environment: 15°C～35°C, 30%～60%, 86Kpa～106Kpa）	IEC61000-4-2 GB/T17626.2—1998

Notes:

1. Test samples are applied to one test item.
2. Sample size for each test item is 2-10pcs.
3. For humidity testing, a pure water resistance of >10MW should be used.
4. (a) In the case of a malfunction caused by ESD damage, if the LCM returns to it's normal state after resetting, the item is considered to have passed the ESD test.

   (b) It is recommended to use an anti-static blower (ionizer) to reduce the electro-static voltage in the working area.

   (c) When removing the protection film from the LCM panel, peel off the film slowly (more than 1sec) while blowing the ioniser towards the peeling area to minimize ESD. This will reduce the risk of damaging the electrical circuitry.
5. If it is installed, please use the automatic test mode on the LCM &/or demonstration box when testing.

- INSPECTION CRITERIA

This specification is designed to be used as the standard acceptance/rejection criteria for normal LCM products.

1. Sampling plan.

The sampling plan according to GB/T 2828.1-2003 / ISO2859-16 1999 and ANSI/ASQC Z1.4 1993, normal level 2 and based on:

- Major defect: AQL 0.65
- Minor defect: AQL 1.5

2. Inspection condition

- The viewing distance for cosmetic inspection is approximately 30cm with the naked eye, and under an environment of 20-40W light intensity, in all directions, within 45° against a perpendicular line. (Normal temperature 20-25°C and normal humidity 60+/-15 RH.)
- Driving voltage - The Vop value from which the most optimal contrast can be obtained near the specified Vop in the specification (within +/-0.5V of the typical value at 25°C.)

3. Definition of inspection zone in LCD.

Zone A: active area
Zone B: viewing area except Zone A (Zone A + Zone B = Minimum viewing area)
Zone C: outside viewing area (invisible area after assembling customer's product.

Figure 4

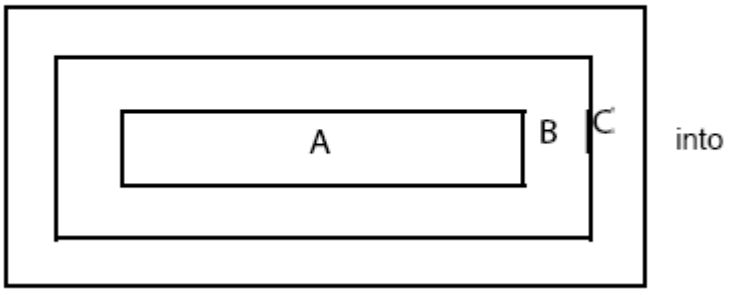


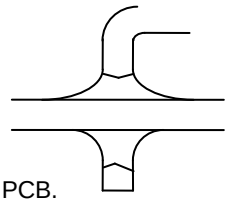
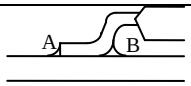
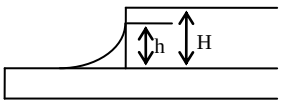
Figure 4 inspection zones in an LCD

Note: As a general rule visual defects in Zone C are permissible when there is no visual effect once assembled into the customer's product.

- INSPECTION STANDARD

No.	Item	Judgment Criteria	Partition
1	All functional defects	1) No display 2) Display abnormal 3) Missing vertical or horizontal segment 4) Short circuit 5) Backlight not working, flickering and abnormal light	Major
2	Missing	Missing component	Major
3	Outline dimension	Overall outline dimension beyond the drawing dimension is not allowed	Major

- **COSMETIC CRITERIA**

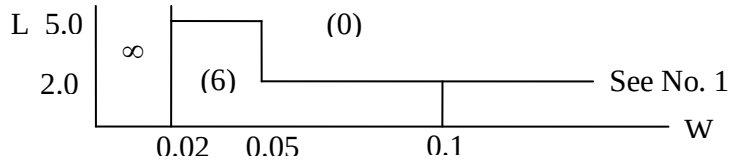
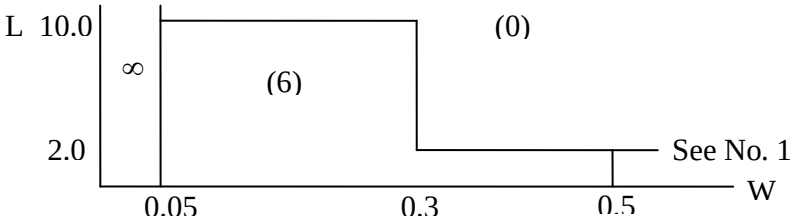
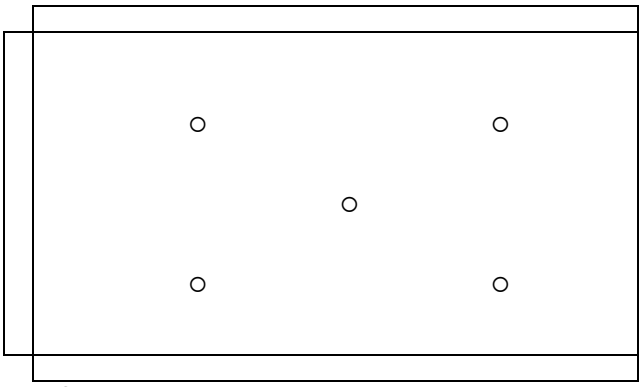
No.	Item	Judgment Criteria	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Major
4	Resist flaw on substrate	Invisible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. Lead parts	a. Soldering side of PCB Solder to form a 'Filet' all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of 'Through Hole PCB') Solder to reach the Components side of PCB. 	Minor
	2. Flat packages	Either 'toe' (A) or 'heal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder. 	Minor
	3. Chips	(3/2) H ≥ h ≥ (1/2) H 	Minor
9	Solder ball/solder splash	a) The spacing between solder ball and the conductor or solder pad h ≥ 0.13mm. The diameter of the solder ball d ≤ 0.15mm. b) The quantity of solder balls or solder splashes isn't more than 5 in 600mm2. c) Solder balls / splashes do not violate minimum electrical clearance d) Solder balls/splashes must be not be able to be dislodged with normal product usage	Minor Minor Major Minor

• COSMETIC CRITERIA (non-operating)

<table>
<tr><th>No.</th><th>Defect</th><th>Judgment Criteria</th><th>Classification</th></tr>
<tr><td>1</td><td>Spots</td><td>In accordance with Screen Cosmetic Criteria (Operating) No.1.</td><td>Minor</td></tr>
<tr><td>2</td><td>Lines</td><td>In accordance with Screen Cosmetic Criteria (Operating) No.2.</td><td>Minor</td></tr>
<tr><td>3</td><td>Bubbles in polarizer</td><td><table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr><tr><td>$d \leq 0.3$</td><td>Disregard</td></tr><tr><td>$0.3 < d \leq 1.0$</td><td>6</td></tr><tr><td>$1.0 < d \leq 1.5$</td><td>2</td></tr><tr><td>$1.5 < d$</td><td>0</td></tr></table></td><td>Minor</td></tr>
<tr><td>4</td><td>Scratch</td><td>In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.</td><td>Minor</td></tr>
<tr><td>5</td><td>Allowable density</td><td>Above defects should be separated more than 30mm each other.</td><td>Minor</td></tr>
<tr><td>6</td><td>Coloration</td><td>Not to be noticeable coloration in the viewing area of the LCD panels.
Back-lit type should be judged with back-lit on state only.</td><td>Minor</td></tr>
<tr><td>7</td><td>Contamination</td><td>Not to be noticeable.</td><td>Minor</td></tr>
</table>

• COSMETIC CRITERIA (operating)

<table>
<tr><th>No.</th><th>Defect</th><th>Judgment Criteria</th><th>Classification</th></tr>
<tr><td>1</td><td>Spots</td><td>A) Clear<table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr><tr><td>$d \leq 0.1$</td><td>Disregard</td></tr><tr><td>$0.1 < d \leq 0.2$</td><td>10</td></tr><tr><td>$0.2 < d \leq 0.3$</td><td>4</td></tr><tr><td>$0.3 < d$</td><td>0</td></tr></table>Note : Including pin holes and defective dots which must be within one pixel size.
B) Unclear<table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr><tr><td>$d \leq 0.2$</td><td>Disregard</td></tr><tr><td>$0.2 < d \leq 0.5$</td><td>10</td></tr><tr><td>$0.5 < d \leq 0.7$</td><td>4</td></tr><tr><td>$0.7 < d$</td><td>0</td></tr></table></td><td>Minor</td></tr>
</table>

2	Lines	A) Clear  Note :( ) - Acceptable Qty in active area L - Length (mm) W - Width (mm) ∞ - Disregard B) Unclear  	Minor
3	Rubbing line	Not to be noticeable.	
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as 'spot'. (see Screen Cosmetic Criteria (Operating) No.1)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.  ○ : Measuring points	Minor

Note :

(1) Size : d = (long length + short length) / 2

(2) The limit samples for each item have priority.

(3) Complex defects are defined item by item, but if the number of defects are defined in above table, the total number should not exceed 10.

(4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.

- 7 or over defects in circle of ∅5mm.
- 10 or over defects in circle of ∅10mm.
- 20 or over defects in circle of ∅20mm.

- PRECAUTIONS FOR USING LCD MODULES

  - HANDLING PRECAUTIONS

(1) The panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.
(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :
- Isopropyl alcohol
- Ethyl alcohol
(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.
- Water
- Ketone
- Aromatic solvents
(7) Exercise care to minimize corrosion of the electrode. Water droplets, moisture condensation or a current flow in a high-humidity environment, accelerate corrosion of the electrodes.
(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.
(9) Do not attempt to disassemble or process the LCD module.
(10) NC terminal should be open. Do not connect anything.
(11) If the logic circuit power is off, do not apply the input signals.
(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
- Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

  - STORAGE PRECAUTIONS

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below the stated storage temperature of the LCM specification).

  - OTHER

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.
If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

- USING LIQUID CRYSTAL DISPLAY MODULES

An LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarisers with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarisers and reflectors made of organic substances that may be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzene. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarisers. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

(9) Do not touch the display with bare hands. This will stain the display area and degrade the insulation between the terminals.

(10) As glass is fragile. It tends to become chipped during handling especially on the edges.

(11) Mounting Method

The panel of the LCD Module consists of two thin glass plates with polarizes, which easily get damaged. Since the Module is fixed by utilizing fitting holes in the printed circuit board.
Extreme care should be taken when handling the LCD Modules.

(12) Caution against static charge

The LCD Module use C-MOS LSI drivers, so we recommend that you connect any unused input terminal to VDD or VSS, do not input any signals before power is turned on. And ground your body, Work/assembly table. And assembly equipment to protect against static electricity.

- PRECAUTIONS FOR SOLDERING

	Manual Soldering	Machine Drag Soldering	Machine Pre-soldering
Non ROHS Product	290°C ~ 350°C Speed : 3 ~ 5 mm/s	330°C ~ 350°C Speed : 4 ~ 8mm/s	300°C ~ 330°C Time : 3 ~ 6S Pressure : 0.8 to 1.2Mpa
RoHS Product	340°C ~ 370°C Time : 3 ~ 5S.	350°C ~ 370°C Time : 4 ~ 8 mm/S.	330°C ~ 360°C Time : 3 ~ 6S. Pressure : 0.8 ~ 1.2Mpa.

(1) If solder flux is used, be sure to remove any remaining flux after finishing the soldering process. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during the soldering process to prevent any damage due to the flux sparks.

(2) When soldering a backlight panel and PCB, the panel and PCB should not be detached more than 3 times. The temperature determines this number and time conditions as mentioned in the above table, although there may be some variance depending on the actual temperature of the soldering iron.

(3) When removing a backlight panel from the PCB, ensure the solder has completely melted; otherwise the solder pads on the backlight panel and/or PCB may be damaged.

- CAUTIONS FOR OPERATION

(1) It is recommended to drive LCDs within their specified voltage limit since the higher voltage than the upper limit shortens the LCD life. An electrochemical reaction due to direct current causes the LCD to deteriorate. Therefore, avoid the use of direct current drive.

(2) Response time will be extremely delayed at lower temperatures than the operating temperature range. At higher temperatures LCD's will experience a dark color. However those phenomena do not mean a malfunction or the LCD's. Once the LCDs are returned to the specified operating temperature range, the response time and coloration should return to the normal state.

(3) If the display area is physically pressed hard during it's operation, some pixels may be abnormally displayed, but should return to their normal condition after resetting the LCM.

(4) Moisture sitting on the LCM terminals is a cause for an electro-chemical reaction resulting in a terminal open circuit. Usage under the relative condition of 40°C, 50%RH or less is therefore required.

- SAFETY

(1) It is recommended to crush any damaged or unnecessary LCDs into pieces and wash off the liquid crystal by using solvents such as acetone and ethanol, which should then be burned up later.

(2) When any liquid crystal has leaked out of a damaged glass cell and comes in contact with skin, please wash it off well with soap and water.

- WARRANTY

Unless otherwise agreed between Logic Technologies Ltd and the customer, Logic Technologies will replace or repair any of its products that are found to be functionally defective when inspected in accordance with Logic Technologies' acceptance criteria (copies available upon request) for a period of one year from date of shipment. Cosmetic/visual defects must be returned to Logic Technologies within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of Logic Technologies is limited to the repair and/or replacement on the terms set forth above. Logic Technologies will not be responsible for any subsequent or consequential losses and/or events.

Returning products under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are:

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Product repairs will be invoiced to the customer upon mutual agreement. Products must be returned with sufficient description of the failures and/or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet's, conductors and terminals.