



DATA DISPLAY GROUP

Datasheet

HLD1045AE2-600

HD-02-062

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1 Overview

1.1 Description

HLD1045AE2-600 is a 10.4-inch TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, and backlight. By applying 6 bit digital data 640 x 480, 262K – color images are displayed on the 10.4-inch diagonal screen. Input power voltage is single 3.3 for LCD driving. Both 3.3V- CMOS and 5.0V-CMOS voltage levels are acceptable for logic input voltage. Inverter for backlight is not included in this module.

1.2 General Features

ITEM	SPECIFICATION
Display Area (mm)	211.2 x 158.4 (10.39-inch diagonal)
Number of Pixels	640(H) x 480 (V)
Pixel Pitch (mm)	0.33 (H) x 0.33 (V)
Color Pixel Arrangement	RGB Vertical Stripe
Display Mode	Normally White
Number of Colors	262K
Wide Viewing Angle Technology	Optical Compensation Film
Optimum Viewing Angle (Contrast Ratio)	6 o'clock or 12 o'clock (reverse scan function through PIN31)
Brightness (cd/m ²)	600
Module Size (mm)	243.0 (W) x 181.6 (H) x 12.2 (D)
Module Weight (g)	570
Backlight Unit	CCFL, 2 tubes, edge-light, Replaceable
Surface treatment	Anti-glare and hard-coating 3H

Characteristic value without any note is typical value.

1.3 Product Disclaimer

The LCD products listed in this document are not suitable for safety related applications that do not have redundant back-up system(s). In other words, these LCD products are not designed for use as a single source safety related application, and therefore, are not recommended for applications in which human life and/or environment may be affected in the event of the failure of the LCD product. More specifically, if there is no back-up system or product in place that will continue operating the system, the LCD products should not be used in such things as:

- aircraft navigation or aerospace equipment
- nuclear reactor control systems
- any application where failure or inaccuracy might cause death or personal injury (e.g. life support systems) or
- military and submarine critical systems.

The LCD products are designed for typical industrial applications such as, but not are limited to the following: computers, office equipment, industrial controllers, audio and visual equipment, test and measurement devices, communication equipment, point of sale, medical imaging and automotive and various other consumer products.

2 Absolute maximum ratings

Item	Symbol	Min.	Max	Unit
Power Supply Voltage for LCD	V_{CC}	-0.3	4.0	V
Logic Input Voltage	V_I	-0.3	6.0	V
Lamp Voltage	V_L	0	2000	Vrms
Lamp Current	I_L	0	9.0	mArms
Lamp Frequency	F_L	40	100	kHz
Operating Temperature (panel surface)	$T_{op(Panel)}$	-30	+80	°C
Operating Temperature (Ambient)	$T_{op(Ambient)}$	-30	+80	°C
Storage Temperature (panel surface)	T_{stg}	-35	+80	°C

$T_{op}, T_{stg} \leq 40^\circ\text{C}$: 90% RH max. without condensation

$T_{op}, T_{stg} > 40^\circ\text{C}$: Absolute humidity shall be less than the value of 90% RH at 40°C without condensation

3 Electrical Characteristics

Conditions: TFT-LCD module ambient temperature is 25°C

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power Supply Voltage for LCD	V_{CC}	3.0	3.3	3.6	V	*1)
Power Supply Current for LCD	I_{CC}	-	200	300	mA	*2)
Permissible Input Ripple Voltage	V_{RP}	-	-	100	mV _{p-p}	
Logic Input Voltage	High	V_{IH}	2.0	-	5.5	V
	Low	V_{LL}	0.0	-	0.8	V

Notes:

*1) Power and signals sequence:

$$t1 \leq 10\text{ms}$$

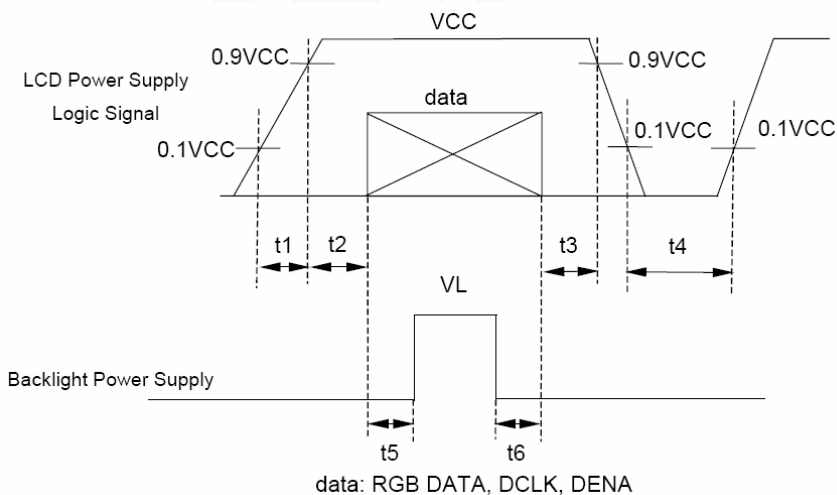
$$0 < t2 \leq 50\text{ms}$$

$$0 < t3 \leq 50\text{ms}$$

$$200\text{ms} \leq t4$$

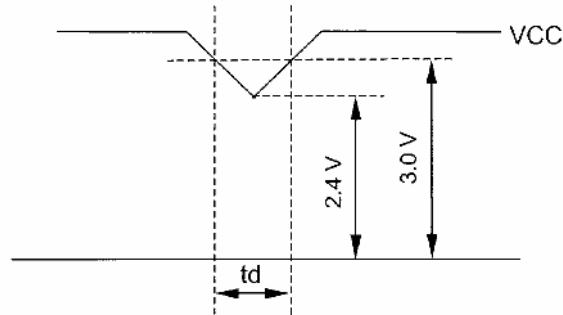
$$200\text{ms} \leq t5$$

$$0 \leq t6$$



VCC-dip conditions:

1. When $2.4\text{ V} \leq VCC < 3.0\text{ V}$, $t_d \leq 10\text{ms}$
 2. When $VCC < 2.4\text{ V}$
- VCC dip conditions should also follow the power and signals sequence



- *2) Typical current condition:
64 gray bar pattern
480 line mode
 $VCC = +3.3\text{ V}$, $f_h = 31.5\text{ kHz}$, $f_v = 60\text{ Hz}$, $f_{clk} = 25\text{ MHz}$

PRELIMINARY

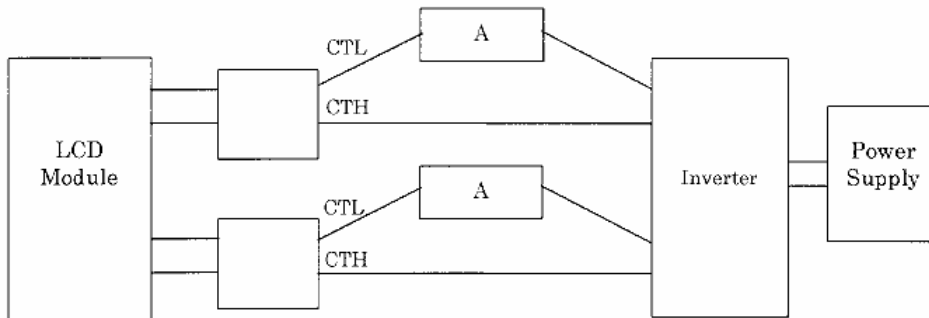
3.1 Backlight

Ta=25°C

Item	Symbol	Min.	Typ.	Max	Unit	Remarks	
Lamp Voltage	V_L		485		Vrms	IL=6.0 mArms	
Lamp Current	I_L	3.0	6.0	7.0	mArms	*1), *5)	
Lamp Frequency	F_L	40	-	100	kHz	*2)	
Lamp Starting Voltage	V_s	Ta=25°C	900	-	-	Vrms	
		Ta=0°C	1350	-	-	Vrms	
		Ta=-20°C	1440	-	-	Vrms	
Lamp Life Time	IL = 6.0mArms	LT	50000	-	-	h	*3), *4) continuous operation

Notes:

*1) Lamp Current measurement method (the current meter is inserted in low voltage line.



*2) Lamp frequency of inverter may produce interferences with horizontal synchronous frequency, and this may cause horizontal beat on the display. Therefore, please adjust lamp frequency, and keep inverter as far from module as possible or use electronic shielding between inverter and module to avoid the interference.

*3) Lamp life time is defined as the time either when the brightness becomes 50% of the initial value or when the starting lamp voltage does not meet the value specified in this table.

*4) The life time of the backlight depends on the ambient temperature. The life time will decrease under low/high temperature.

*5) Please use the inverter which has symmetrical current wave form as follows:

The degree of unbalance: less than 10%
The ratio of wave height: less than $\sqrt{2} \pm 10\%$



I_{PH} : High side peak

I_{PL} : Low side peak

The degree of unbalance = $|I_{PH} - I_{PL}| / I_{rms} \times 100(\%)$

The ratio of wave height = $I_{PH}(\text{or } I_{PL}) / I_{rms}$

CURRENT WAVE FORM

4 Interface connectors / Pin assignment

CN1 (interface signal)

Input connector CN1: DF9B-31P-1V(Hirose)

Input mating connector: DF9B-31S-1V(Hirose)

PIN	SYMBOL	FUNCTION
1	GND	
2	DCLK	Clock signal for sampling catchdata signal
3	HD	Horizontal sync signal *1)
4	VD	Vertical sync signal *1)
5	GND	
6	R0	Red data signal (LSB)
7	R1	Red data signal
8	R2	Red data signal
9	R3	Red data signal
10	R4	Red data signal
11	R5	Red data signal (MSB)
12	GND	
13	G0	Green data signal (LSB)
14	G1	Green data signal
15	G2	Green data signal
16	G3	Green data signal
17	G4	Green data signal
18	G5	Green data signal (MSB)
19	GND	
20	B0	Blue data signal (LSB)
21	B1	Blue data signal
22	B2	Blue data signal
23	B3	Blue data signal
24	B4	Blue data signal
25	B5	Blue data signal (MSB)
26	GND	
27	DENA	Data enable signal (to settle the viewing area)
28	V _{CC}	3.3 V Power Supply
29	V _{CC}	3.3 V Power Supply
30	GND	
31	SC	Scan direction Control (LOW=Normal, HIGH= Reverse)

*1) HD and VD are not being used for timing control

*2) The shielding case is connected with GND

CN2, CN3 (backlight)

Backlight side connector BHR-02(8.0)VS-1N (JST)

Inverter side connector: SM02(8.0)B-BHS(JST)

Pin Number	Symbol	Function
1	CTH	VBLH (High Voltage)
2	CTL	VBLL (Low Voltage)

VBLH – VBLL = VL

5 Interface timing

5.1 Timing Specifications

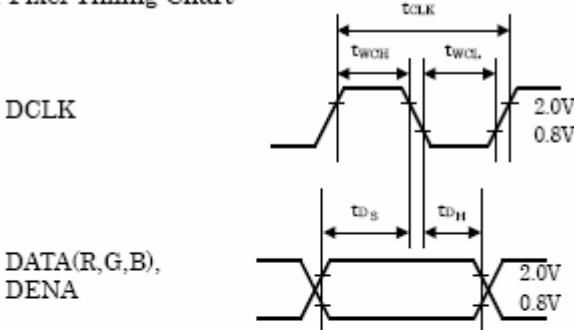
ITEM		SYMBOL	MIN	TYP	MAX	UNIT
DCLK	Frequency	f_{CLK}	20	25	30	MHz
	Period	t_{CLK}	33,3	40	50	ns
	Width-Low	tw_{CL}	10	-	-	ns
	Width-High	tw_{CH}	10	-	-	ns
DATA (R,G,B, DENA)	Set up time	T_{DS}	4	-	-	ns
	Hold time	T_{DH}	4	-	-	ns
DENA	Horizontal Active Time	t_{HA}	640	640	640	t_{CLK}
	Horizontal Blanking Time	t_{HB}	20	160	-	t_{CLK}
	Horizontal Frequency	f_H	27	31,5	38	kHz
	Horizontal Period	t_H	26.3	31.7	37.0	μs
	Vertical Active Time	t_{VA}	480	480	480	t_H
	Vertical Blanking Time	t_{VB}	3	45	-	t_H
	Vertical Frequency	f_V	55	60	70	Hz
Vertical Period	t_V	14.3	16.7	18.2	ms	

Notes:

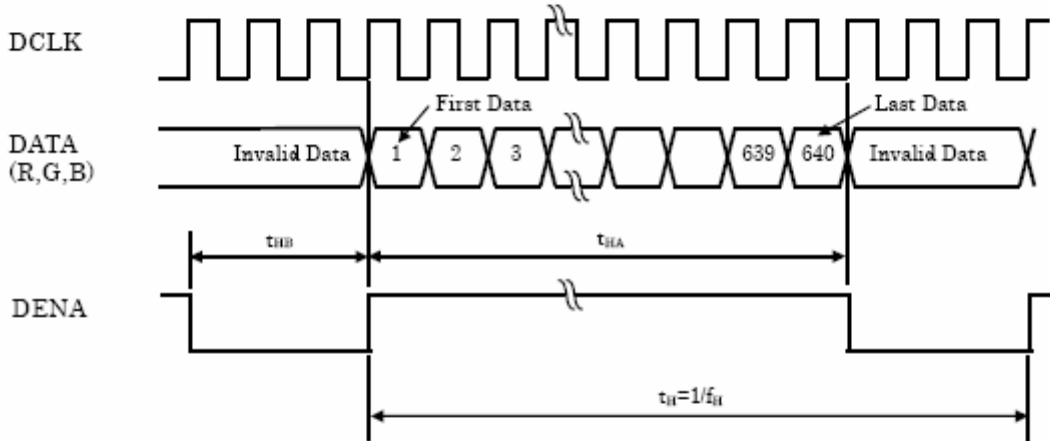
- *1) DATA is latched at fall edge of DCLK in this specification
- *2) DENA (Data Enable) should always be positive polarity as shown in the timing specification
- *3) DCLK should appear during all invalid period

Timing Charts

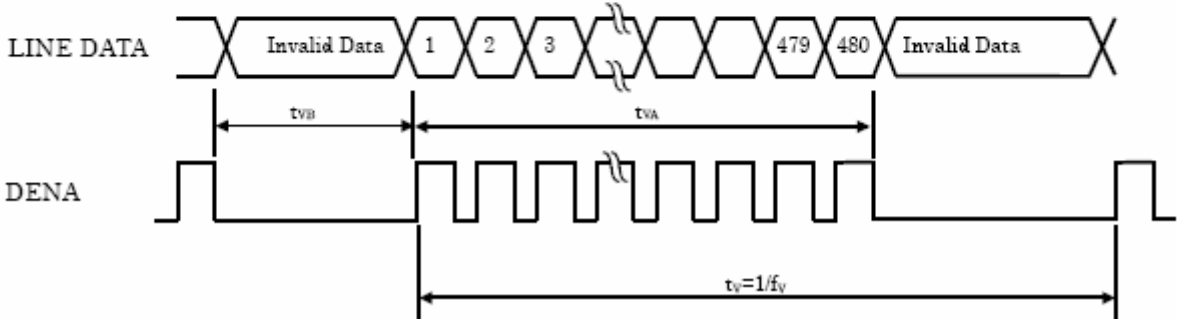
a. Pixel Timing Chart



b. Horizontal Timing Chart



c. Vertical Timing Chart



6 Color Data Assignment

COLOR	INPUT DATA	R DATA						G DATA						B DATA					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
		MSB			LSB			MSB			LSB			MSB			LSB		
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	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
RED	RED(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	RED(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	GREEN(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	GREEN(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE(0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BLUE(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	BLUE(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

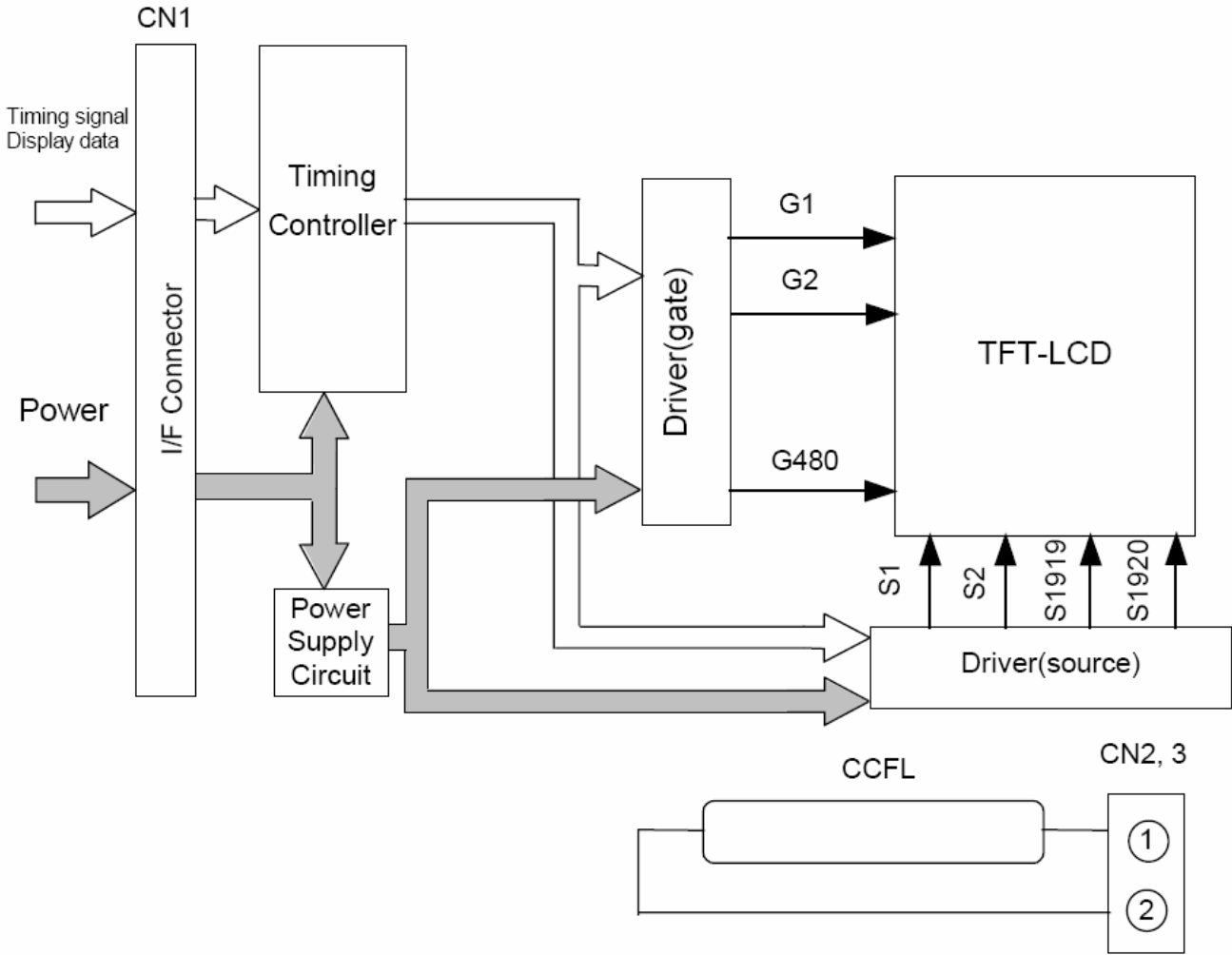
Definitions

Gray scale: Color (n) → n indicates gray scale level

Higher (n) means brighter level

Data: 1=High, 0=Low

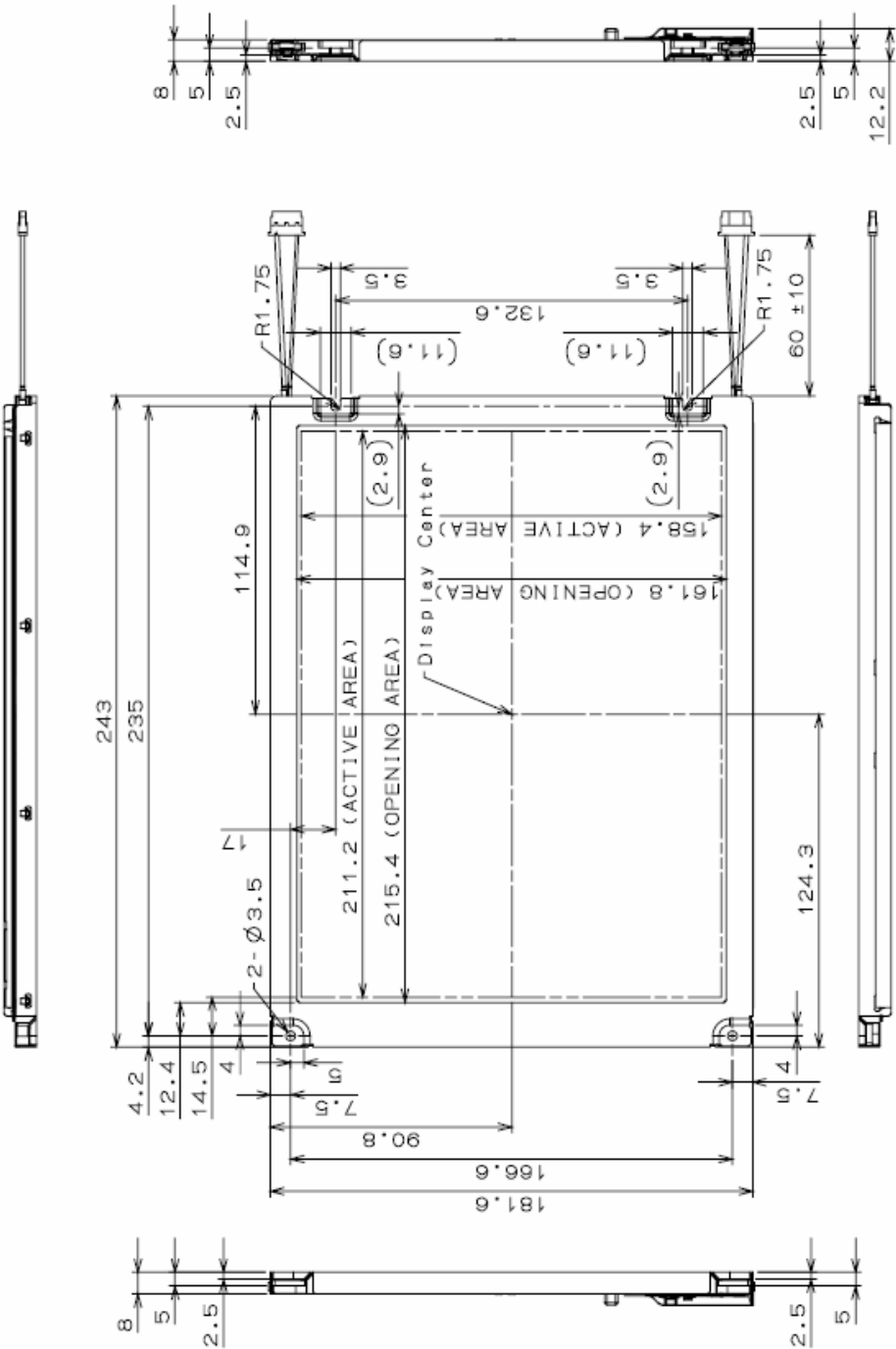
7 Block diagram



PRE

8 Mechanical Specification

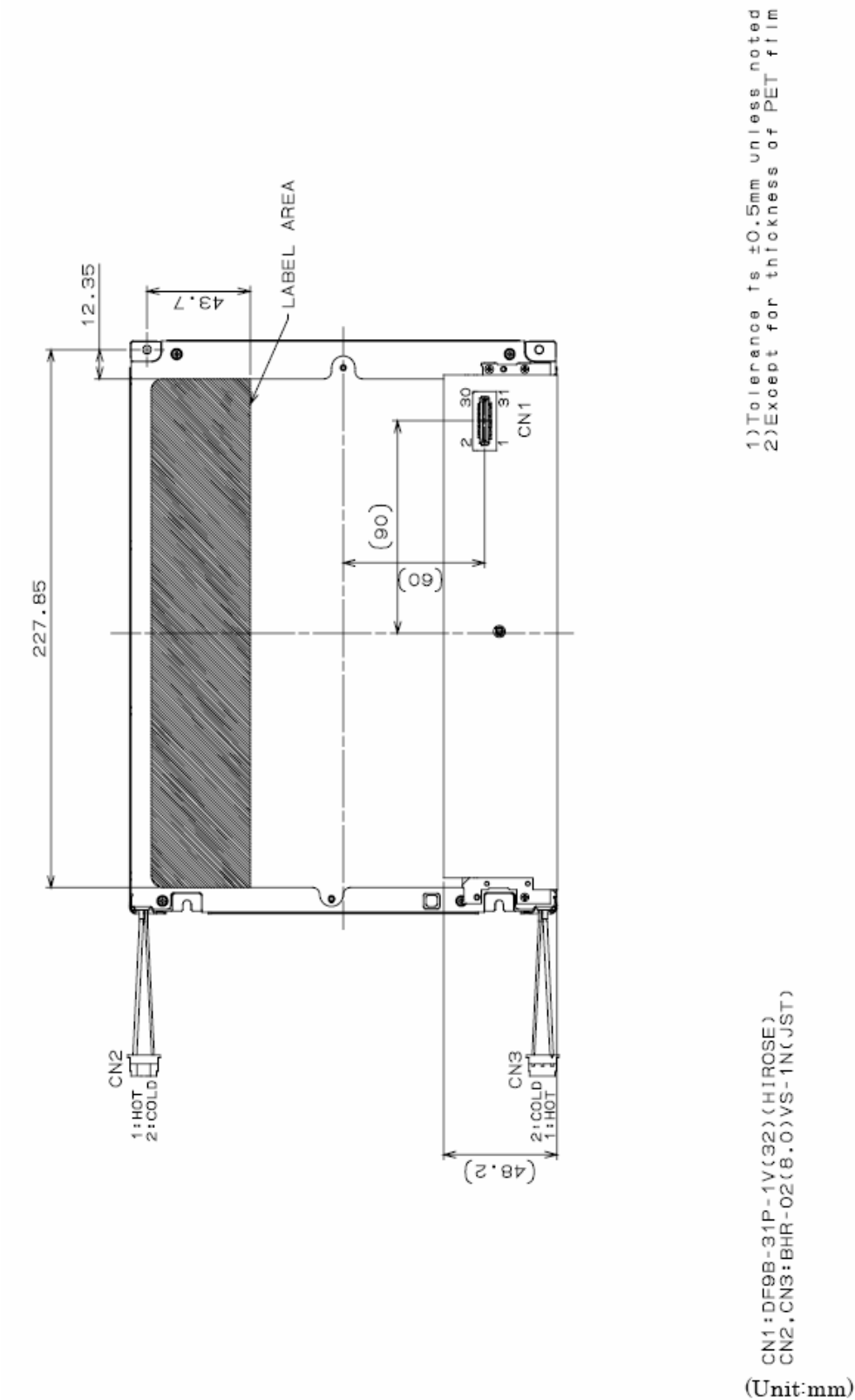
8.1 Front side Drawing



1)Tolerance is ±0.5mm unless noted
2)Except for thickness of PET film

(Unit:mm)

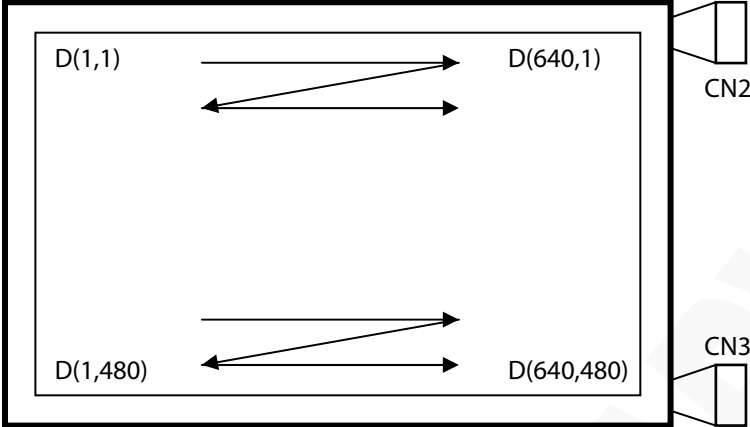
8.2 Rear side Drawing



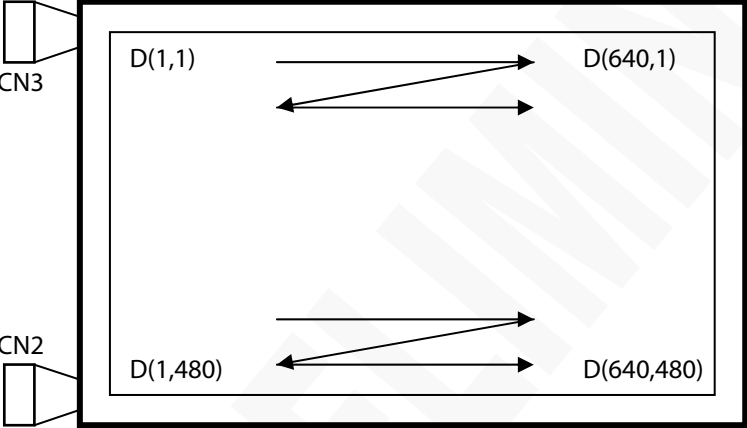
Note: We recommend you referring to the detailed drawing for your design. Please contact our company sales representative when you need the detailed drawing.

8.3 Scanning Direction

SC: High



SC: Low



9 Optical characteristics

Ta=25°C, Vcc=3.3V, Input signals: Typ. Values shown in section 5

ITEM	SYMB.	CONDITION	MIN	TYP	MAX	UNIT	Remarks	
Contrast Ratio	CR	$\theta_V=0^\circ, \theta_H=0^\circ$	350	500*	-	-	*1), *2), *6)	
Luminance	Lw	$\theta_V=0^\circ, \theta_H=0^\circ$	460	600*	-	cd/m ²	*1), *3), *6)	
Luminance Uniformity	ΔLw	$\theta_V=0^\circ, \theta_H=0^\circ$	-	-	30	%	*1), *4), *6)	
Response Time	tr	$\theta_V=0^\circ, \theta_H=0^\circ$	-	6*	-	ms	*1), *5), *6)	
	tf	$\theta_V=0^\circ, \theta_H=0^\circ$	-	19*	-	ms	*1), *5), *6)	
Viewing Angle	Horiz.	Θ_H	CR ≥ 10	-50~50	-65~65	-	°	*1), *6)
	Vert.	Θ_V		-40~30	-65~45	-	°	*1), *6)
	Horiz.	Θ_H	CR ≥ 5	-65~65	-80~80	-	°	*1), *6)
	Vert.	Θ_V		-50~40	-80~50	-	°	*1), *6)
Image Sticking	Tis	2 h	-	-	2	s	*7)	
Color Coordinates	Red	x	$\theta = \Phi = 0^\circ$	0.554	0.584	0.614	*1), *6)	
		y		0.301	0.331	0.361		
	Green	x		0.299	0.329	0.359		
		y		0.503	0.533	0.563		
	Blue	x		0.132	0.162	0.192		
		y		0.130	0.160	0.190		
	White	x		0.283	0.313	0.343		
		y		0.299	0.329	0.359		

* Contrast; Luminance and response time will be influenced in upper and lower temperature range

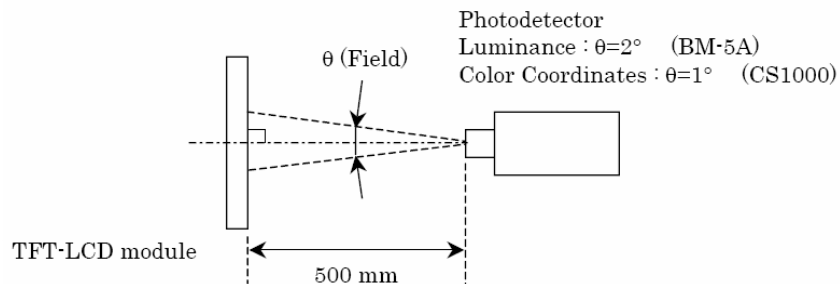
Notes:

These items are measured using CS1000(MINOLTA) for color coordinates, EZContrast(ELDIM) for viewing angle and CS1000 or BM-5A(TOPCON) for others under the dark room condition (no ambient light) after more than 30 minutes from turning on the lamp unless noted.

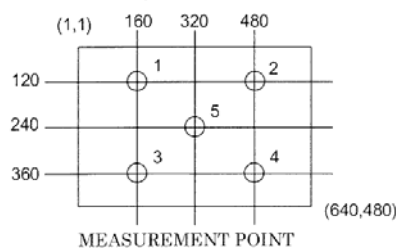
Condition: IL=6.0 mArms, FL=55 kHz

Measurement method for luminance and color coordinates is as follows:

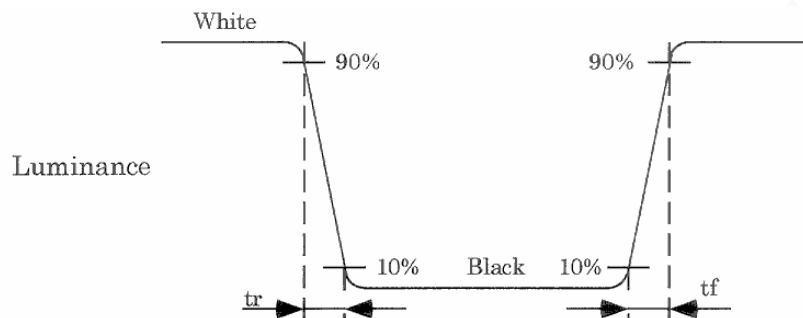
The luminance is measured according to Flat Panel Display Measurements Standard (VESA Standard)



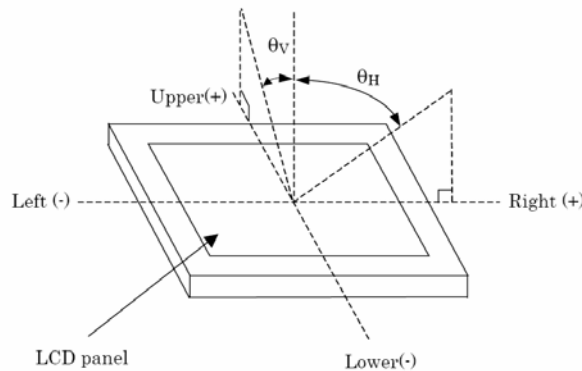
- *1) Measurement Point
Contrast Ratio, Luminance, Response Time, Viewing Angle, Color Coordinates: Display Center Luminance
Uniformity: point 1 ~ 5 shown in the figure below



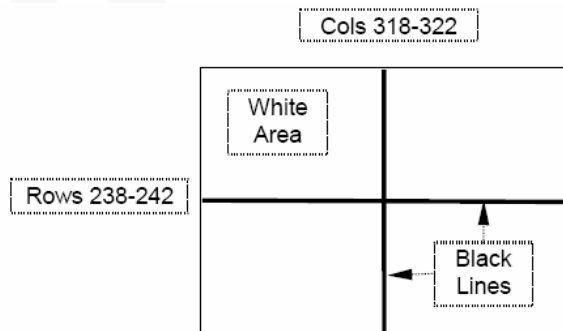
- *2) Definition of Contrast Ratio
CR = ON (white) luminance / OFF (black) luminance: average of 5 points
- *3) Definition of Luminance
Lw = ON (white) luminance: average of 5 points
- *4) Definition of Luminance Uniformity
 $\Delta[Lw]=[Lw(MAX)/Lw(MIN)-1] \times 100$
- *5) Definition of response time



- *6) Definition of viewing angle (θ_v , θ_H)



- *7) Image sticking
Continuously display the test pattern shown in the figure below for two-hours. Then display a completely white screen. The previous image shall not persist more than two seconds at 25°C.



TEST PATTERN FOR IMAGE STICKING TEST

10 Reliability test conditions

10.1 Temperature and Humidity

TEST ITEM	CONDITIONS
HIGH TEMPERATUREHIGH HUMIDITY OPERATION	40°C, 90%RH, 240 h (No condensation)
HIGH TEMPERATURE OPERATION	80°C, 240 h
LOW TEMPERATURE OPERATION	-30°C, 240 h
HIGH TEMPERATURE STORAGE	85°C, 240 h
LOW TEMPERATURE STORAGE	-35°C, 240 h
THERMAL SHOCK (NON-OPERATION)	Between -30°C (1h) and 80°C(1h),100 CYCLES

10.2 Shock and Vibration

TEST ITEM	CONDITIONS
Shock (non operating)	Shock level: 1470 m/s ² (150G) Waveform: half sinusoidal wave, 2ms Number of shocks: one shock input in each direction of three mutually perpendicular axis for a total of six shock input
Vibration (non operating)	Vibration level: 9,8 m/s ² (1.0G) Waveform: sinusoidal Frequency range: 5 to 500 Hz Frequency sweep rate: 0.5 octave/min. Duration: one sweep from 5 to 500 to 5Hz in each of three mutually perpendicular axis (total 3 hrs.)

10.3 Judgment standard

Pass/Fail criteria for reliability tests is defined as follows:

- Pass:** Normal display image, no damage of the display function. (ex. no line defect)
Partial transformation of the module parts should be ignored.
- Fail:** No display image, damage of the display function. (ex. line defect)

11 Inspection standards

Inspection condition is as follows:

Viewing distance is approximately 35 cm.
Viewing angle normal to the LCD panel $\pm 10^\circ$ horizontal and vertical.
Ambient temperature is approximately 25°C.
Ambient light is from 300 to 500 lx.

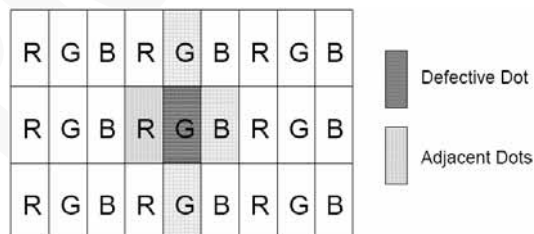
Bright dot is defined as follows:

Visible through 5% transmission ND filter under the condition that black image (color 0) is on the display.

Defect type		Limit	
Visual Defect	Scratch	0.01 mm < W ≤ 0.05 mm L ≤ 10 mm	N ≤ 4
		0.01 mm < W 10 mm < L	N = 0
		0.05 mm < W	N = 0
	Dent	0.2 mm < D ≤ 0.4 mm	N ≤ 4
		0.4 mm < D	N = 0
	Black Spot Bubble	0.2 mm < D ≤ 0.4 mm	N ≤ 5
		0.4 mm < D	N = 0
	Lint	L ≤ 3 mm W ≤ 0.1 mm	N ≤ 4
0.1 mm < W		According to Black Spot	
Electrical Defect	Bright Dot	N ≤ 5	
	Dark Dot	N ≤ 5	
	Total Dot	N ≤ 8	
	Two adjacent dots: Bright dot Dark dot	≤ 2 Pairs ≤ 2 Pairs	
	Three or more adjacent dot	Not allowed	
	Line Defect	Not allowed	

*1) W: width, L: length, D: diameter, N: number

*2) Definition of adjacent



The defects that are not defined above and considered to be problem shall be reviewed and discussed by both parties.

12 Handling precautions for TFT-LCD modules

12.1 Assembly precautions

Please use the mounting hole on the module corners for installation and avoid bending or wrenching LCD during assembly process. Do not drop, bend or twist the TFT-LCD module during handling.

Guidelines for designing the TFT-LCD module enclosure:

- Housing case must be designed carefully so as not to put stress on LCD all sides and not to wrench module. Mechanical stress to the TFT-LCD module may degrade the reliability and overall performances of the display (like brightness uniformity degradation...etc.).
- Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0 mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.
- When some parts, such as, FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is, especially to be reconsidered when additional parts are inserted for EMI countermeasures.
- Choose carefully the inverter location to avoid any stress to the lamp cable. The lamp cable also should not interfere with the module installation into the enclosure.
- Keep sufficient clearance between LCD module and the other components, such as inverter and speaker so as not to interfere with the LCD module. Approximately 1.0mm of the clearance in the design is recommended.
- To avoid local elevation/decrease of temperature, considering location of heating element, heat release, thermal design should be done.
- Do not apply pressure or scratch LCD panel surface with anything hard. Do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)
- Please do not push or scratch LCD panel surface with anything hard. And do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)
- Please do not press any parts on the rear side such as source TCP, gate TCP, control circuit board and FPCs during handling LCD module. If pressing rear part is unavoidable, handle the LCD module with care.
- Wipe out LCD panel surface with absorbent cotton or soft cloth to clean the surface.
- Wipe out immediately any liquids which may have accidentally being sprayed on LCD panel surface. Droplets on the LCD panel surface may alter the quality of the image.
- Please wipe off drops of adhesives like saliva and water on LCD panel surface immediately. They might cause panel surface variation and color change.
- Please do not take a LCD module to pieces and reconstruct it. Resolving and reconstructing modules may cause them not to work well.
- Please do not touch metal frames with bare hands and soiled gloves. A color change of the metal frames can happen during a long preservation of soiled LCD modules.
- Please handle metal frame carefully because edge of metal frame is very sharp.
- Please pay attention to handling lead wire of backlight so that it is not tugged in connecting with inverter.
- Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.
- Be sure to connect the cables and the connectors correctly.

12.2 Operating precautions

- Turn off the power supply before connecting and disconnecting signal input cable.
- Do not change the setting of the adjustable resistors on the TFT-LCD module subassemblies. The adjustable resistors are properly set at the factory and any deviation from the factory setting will compromise the performances on the TFT-LCD module.
- When evaluating the optical characteristics of the display please note that will take longer time for the backlight to stabilize if the ambient temperature is at the lower end of the temperature range.

- Sudden changes of the ambient temperature may cause condensation on various surfaces of the TFT-LCD module and degrade the overall performances until the surface becomes dry again.
- Follow up the general safety rules applying to generic electronic products.
- Please pay attention not to display the same pattern for very long time. Image might stick on LCD. Even if image sticking happens, it may disappear as the operation time proceeds.

12.3 Precautions with electronics

- This LCD module uses CMOS integrated circuits and other components subject to be affected by electrostatic discharges. Use ESD protection equipment and follow all ESD safety procedures when handling the TFT-LCD modules.
- Please remove protection film very slowly from the surface of LCD module to prevent from high level electrostatic discharges. It is recommended to lift the protection film starting from the corner of the glass in proximity of the source and gate PWB ending at the corner of the glass furthest away from the electronics.

12.4 Storage precautions

- When you store LCDs for a long time, it is recommended to keep the temperature between 0°C ~ 40°C without the exposure of sunlight and to keep the humidity less than 90%RH.
- Do not leave the LCDs in the environment of high humidity and high temperature such as 60°C 90%RH, 80°C with low humidity only.
- Do not expose the TFT-LCD modules to temperatures below -35°C.

12.5 Safety precautions

- When disposing LCDs it is recommended to break them into pieces. The broken pieces should be washed with solvents such as acetone and ethanol. The residual solvent from this process should be burned.
- If any liquid leaks out of damaged glass cell and corners in contact with the hands, wash it off thoroughly with soap and water.

12.6 Others

- Exposing the TFT-LCD module to strong incident light may negatively affect the display characteristics because of polarizer film, color filter and other materials degradation. Do not expose LCD module to direct sunlight or light with strong ultraviolet content.
- Avoid any contact of the TFT-LCD module front surface with other objects or materials.

12.7 Packaging and Shipping

- Packaging box and inner case for LCD are designed to protect the LCDs from the damage or scratching during transportation. Do not open the packaging box unnecessarily.
- Do not stack more than 5 boxes on top of each other because stack of 5 is minimum designed limit. Do not turn over the boxes.
- Avoid excessive shock, the shipping boxes are not designed to be thrown, Excessive vibrations can also damage the boxes and the TFT-LCD modules inside.
- Packaging box and inner structures of it are made of cardboard. Avoid to have the boxes in contact with water or in high humidity environment which may cause the carton to become soft, or to break, damaging the TFT-LCD modules.



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