Project Size.	2.31 inch
Model No.	P023H005-V2
Samples No.	
Product type.	320xRGBx240 MCU mode
Signature by customer:	

Prepared	Checked	Approved

Email: 1553309801@qq.com

Mobile: 86-133 9284 8764

1.0 GENERAL DESCRIPTION

1.1 Introduction

Display model P023H005-V2 is a (TM)Transmissive type color active matrix thin Film transistor(TFT) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device.This model is composed of a TFT LCD panel, a driving circuit, a back light system. The resolution of a 2.31" contains 320_{RGB}x240 dots and can display up to 262k colors.

Item	Specification	Unit
Screen Size	2.31 inch	Diagonal
Number of Pixel	320RGB(H)x240(V)	Pixels
Display area	46.75(H)x35.06(V)	mm
Pixel pitch	0.1461(H)x0.1461(V)	mm
Outline Dimension	50.92x45.82x2.35	mm
Pixel arrangement	RGB Vertical Stripe	——
Display mode	Normally Black/Transmissive	——
Viewing Direction(eye)	6 0'CLOCK	——
Gray inversion direction	--	
Display Color	262K	——
Luminance(cd/m^2)	300	nit
Contrast Ratio	600:1	——
Surface treatment	——	——
Interface	8080 MCU 16bit	
Back-light	LED Side-light type	——
Drive IC	ILI9342C	
Operation Temperature	-20~70	℃
Storage Temperature	-30~80	℃
Weight	——	g

1.2 Features

n   MCU 16bit parallel interface.

1.3 Applications

n   MPOS Device.

n   Personal Navigation Device.

n   Other devices which require high quality displays.

2.0 INPUT INTERFACE PIN ASSIGNMENT

FPC connector is used for electronics interface.

PinNo.	Symbol	Function
1	LEDA	LED back light(Anode)
2-5	LEDK	LED back light(Cathode)
6	GND	Ground
7	RESET	External reset input.
8-23	DB15-DB0	MCU parallel interface data bus.
24	NC	NC
25	RD	Read enable in 8080 MCU parallel interface.
26	WR	Write enable in 8080 MCU parallel interface.
27	RS	Display data/command selection pin in parallel
28	CS	Chip select input pin (active low)
29	IOVCC	Power Supply. 1.8V
30	VCC	Power Supply. 2.8V
31	NC	NC
32	GND	Ground
33-40	NC	NC

3.0 ABSOLUTE MAXIMUM RATINGS

3.1 Electrical Absolute Rating

3.1.1 TFT LCD Module

Item	Symbol	Min	Max	Unit	Note
Digital supply voltage	VDDI	-0.3	+4.6	V	GND=0
Analog supply voltage	VCI	-0.3	+4.6	V	GND=0
Logic Signal Input Level	VIN	-0.3	VDDI+0.5	V	GND=0

3.1.2 Back-Light Unit

Item	Symbol	Min	Max	Unit	Note
LED current	I_{BL}	-	80	mA	-
LED voltage	V_{BL}	2.8	3.2	V	-

3.2 Environment Absolute Rating

Item	Symbol	Min	Max	Unit	Note
Operating temperature	TOPR	-20	70	°C	-
Storage temperature	TSTG	-30	80	°C	-

Note:

Permanent damage may occur to the LCD module if beyond this specification.

4.0 OPTICAL CHARACTERISTICS

4.1 Optical specification

Item		Symbol	Condition	Min	Type	Max	Unit	Note
White luminance (Center)		Lv	Θ=0 Normal Viewing Angle I_{BL}=80mA	--	250	--	cd/m²	(4)(5)(7)
Response time		Tr+Tf		--	35	45	ms	(3)
Contrast ratio		CR		--	600	--	--	(2)(4)
Color Chromaticity (CIE1931)	white	Wx		0.290	0.310	0.330		(6)
		Wy		0.316	0.336	0.356		
Viewing Angle	Hor	ΘL	CR≥10	--	80	--		(1)
		ΘR		--	80	--		
	Ver	ΘU		--	80	--		
		ΘD		--	80	--		
Brightness uniformity		Avg	Θ=0	80	90	--	%	(5)
Color Gamut		NTSC	Θ=0	--	70	--	%	(6)
Optima View Direction			Free					(1)

4.2 Measuring Condition
n Measuring surrounding: dark room
n LED current IL: 80mA
n Ambient temperature: 25±2℃
n 15min. warm-up time

4.3 Measuring Equipment
n FPM520 of Westar Display technologies, INC., which utilized SR-3 for Chromaticity and BM-7 for other optical characteristics.
n Measuring spot size：20 ~ 21 mm

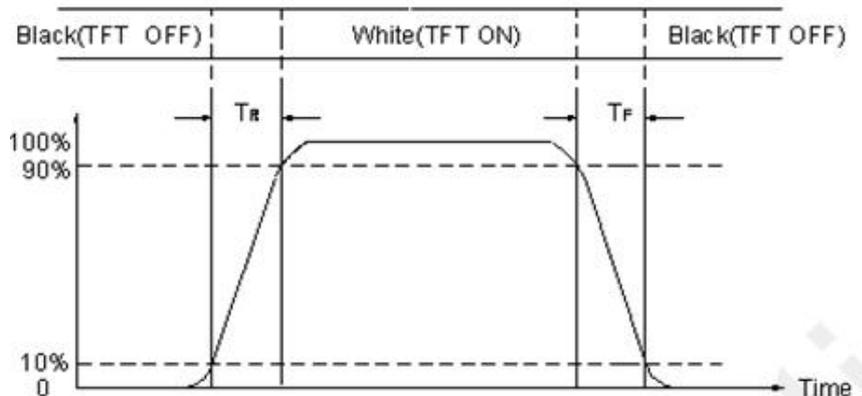## Note (1) Definition of Viewing Angle
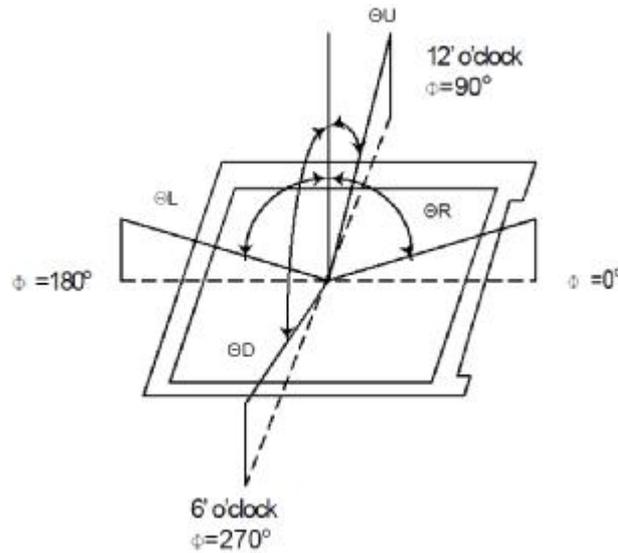
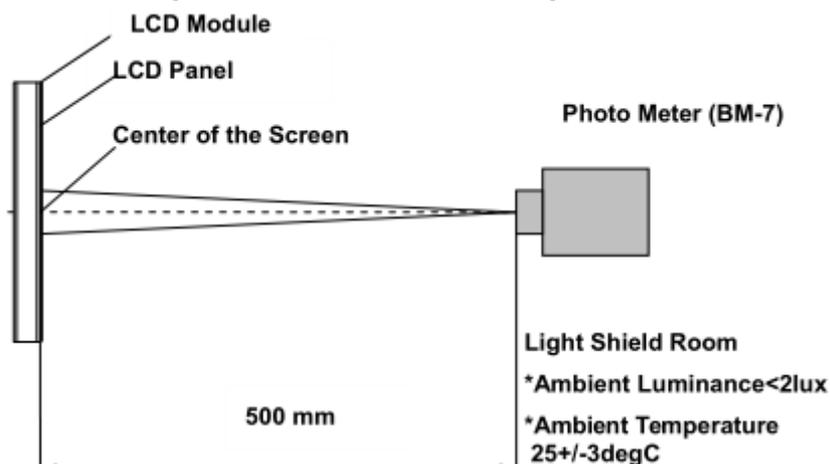## Note (2) Definition of Contrast Ratio(CR):
Measured at the center point of panel

$$CR= \frac{\text{Luminance with all pixels white}}{\text{Luminance with all pixels black}}$$

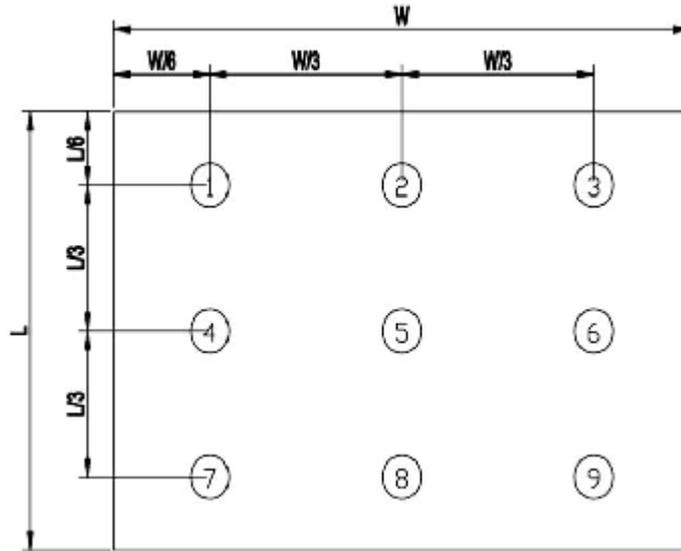## Note (3) Definition of Response Time: Sum of TR and TF

Note (4) Definition of optical measurement setup

Note (5) Definition of brightness uniformity

The luminance uniformity is calculated by using following formula.

$\triangle Bp = Bp\,(Min.)\,/\,Bp\,(Max.) \times 100\,(\%)$

Bp (Max.) = Maximum brightness in 9 measured spots

Bp (Min.) = Minimum brightness in 9 measured spots .

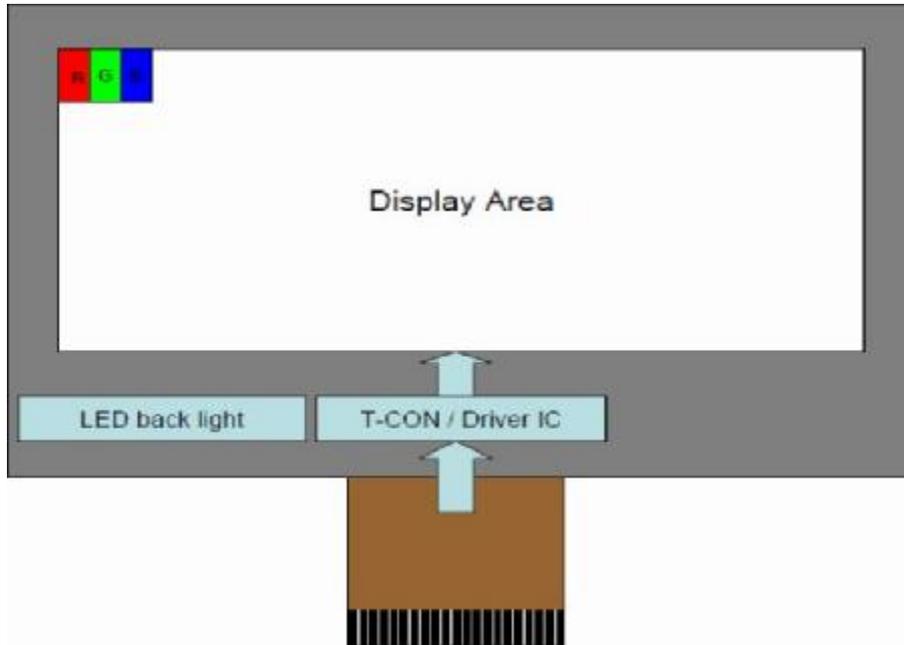**Note (6) Definition of Color of CIE1931 Coordinate and NTSC Ratio.**

Color gamut:

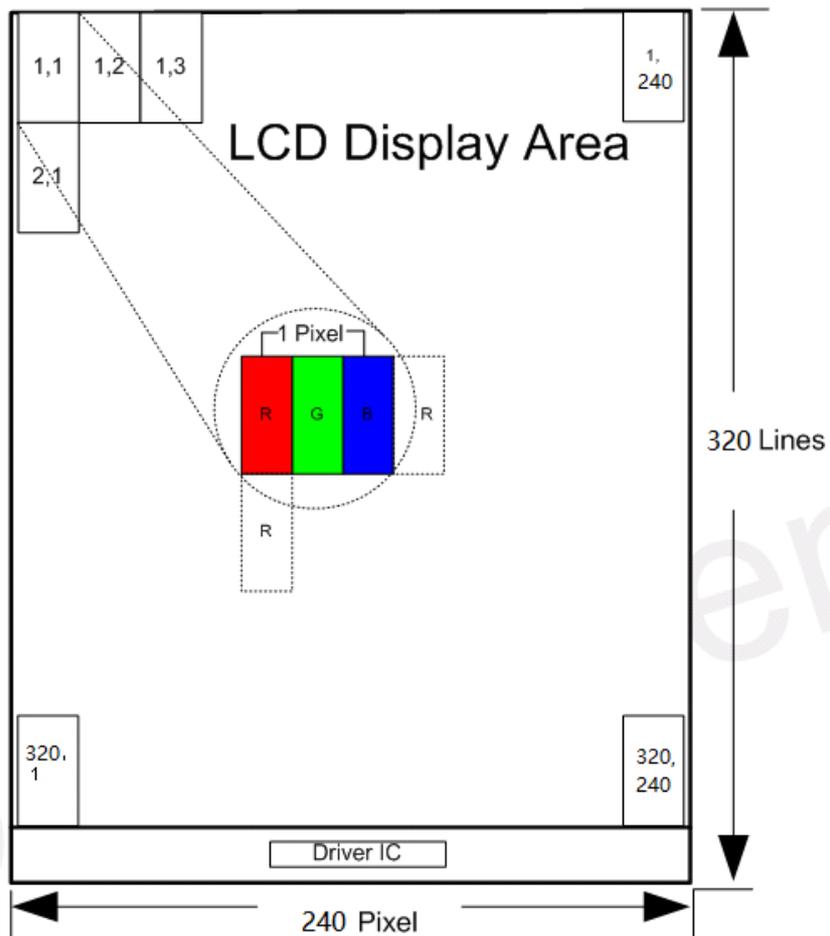$$S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$
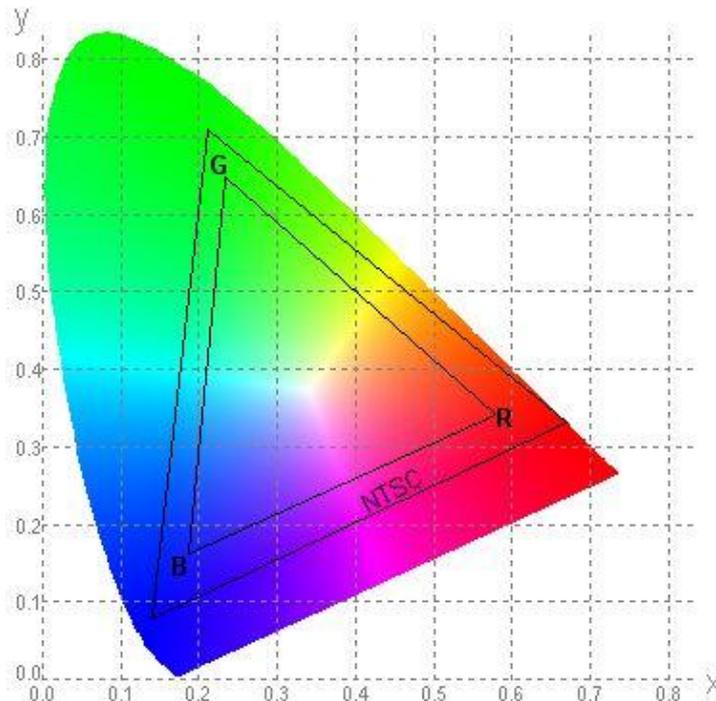
Note (7) Measured the luminance of white state at center point.

5.0 BLOCK DIAGRAM

5.1 TFT LCD Module

5.2 Pixel Format

6.0 ELECTRICAL CHARACTERISTICS

6.1 TFT LCD Module

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Analog supply voltage	VDD	2.4	2.8	3.3	V	
Digital supply voltage	VDDI	1.65	1.8	3.3		
Input signal Voltage	VIH	0.7VDDI	-	VDDI	V	
	VIL	GND	-	0.3VDDI	V	

6.2 Back-Light Unit

The backlight system is an edge-lighting type with 4 LED Dies.

The characteristics of the LED are shown in the following tables.

Item	Symbol	Min	Typ	Max	Unit	Note
LED current	IL	-	60	80	mA	(2)
LED voltage	VL	-	3.2	-	V	
Operating LED life time	Hr	-	4500	-	Hour	(1)(2)

Note (1) LED life time (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3 ℃, 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 Ta=25℃and IL=80mA. The LED lifetime could be decreased if operating IL is larger than 100mA. The constant current driving method is suggested.

Note (3) Suggested schematic of LED backlight driver

Typical Application Circuit
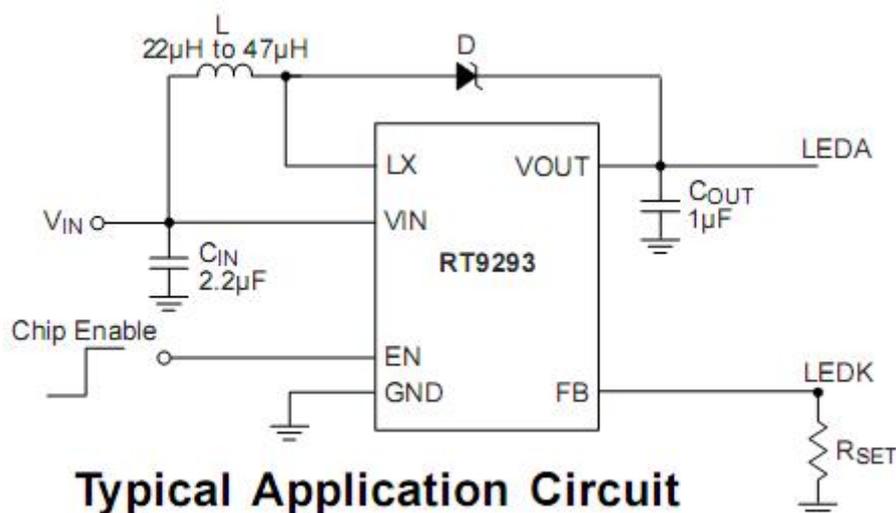
6.3 Interface Characteristics

8080 Series MCU Parallel Interface Characteristics: 16-bit Bus
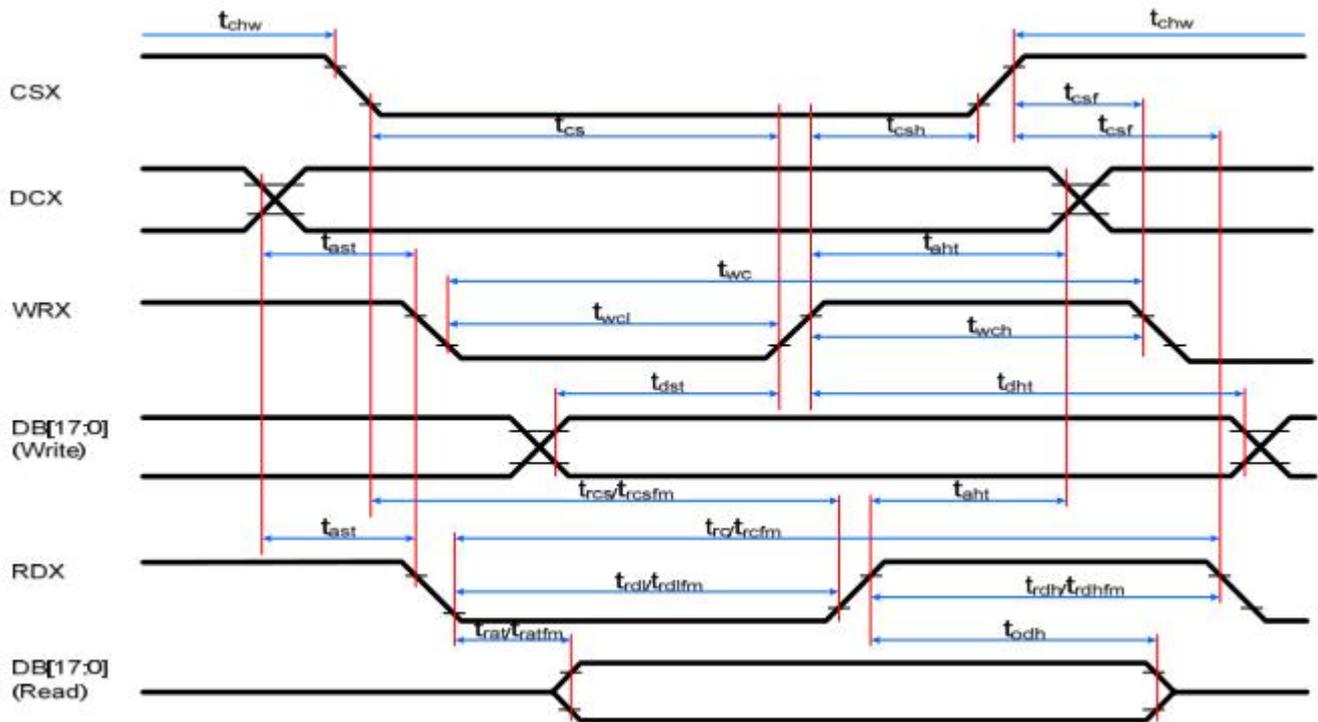
Signal	Symbol	Parameter	min	max	Unit	Description
DCX	tast	Address setup time	0	-	ns	
	taht	Address hold time (Write/Read)	10	-	ns	
CSX	tchw	CSX "H" pulse width	0	-	ns	
	tcs	Chip Select setup time (Write)	15	-	ns	
	trcs	Chip Select setup time (Read ID)	45	-	ns	
	trcsfm	Chip Select setup time (Read FM)	355	-	ns	
	tcsf	Chip Select Wait time (Write/Read)	10	-	ns	
WRX	twc	Write cycle	66	-	ns	
	twrh	Write Control pulse H duration	15	-	ns	
	twrl	Write Control pulse L duration	15	-	ns	
RDX (FM)	trcfm	Read Cycle (FM)	450	-	ns	
	trdhfm	Read Control H duration (FM)	90	-	ns	
	trdlfm	Read Control L duration (FM)	355	-	ns	
RDX (ID)	trc	Read cycle (ID)	160	-	ns	
	trdh	Read Control pulse H duration	90	-	ns	
	trdl	Read Control pulse L duration	45	-	ns	
D[17:0], D[17:10]&D[8:1], D[17:10], D[17:9]	tdst	Write data setup time	10	-	ns	For maximum CL=30pF For minimum CL=8pF
	tdht	Write data hold time	10	-	ns	
	trat	Read access time	-	40	ns	
	tratfm	Read access time	-	340	ns	
	trod	Read output disable time	20	80	ns	

Note: Ta = -30 to 70 ℃, IOVCC=1.65V to 2.8V, VCI=2.6V to 3.3V, GND=0V.

T$_{DHT}$	Data hold time	10		ns
T$_{RAT}$	Read access time (ID)		40	ns
T$_{RATFM}$	Read access time (FM)		340	ns
T$_{ODH}$	Output disable time	20	80	ns

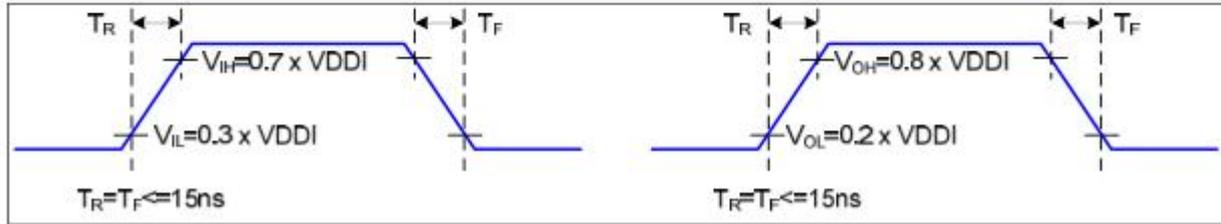**Table 4 8080 Parallel Interface Characteristics**

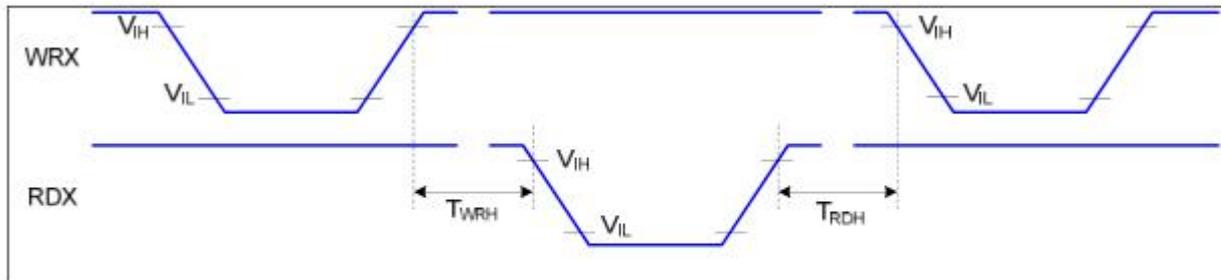
Figure 2 Rising and Falling Timing for I/O Signal

Figure 3 Write-to-Read and Read-to-Write Timing

Note: The rising time and falling time (Tr, Tf) of input signal and fall time are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.
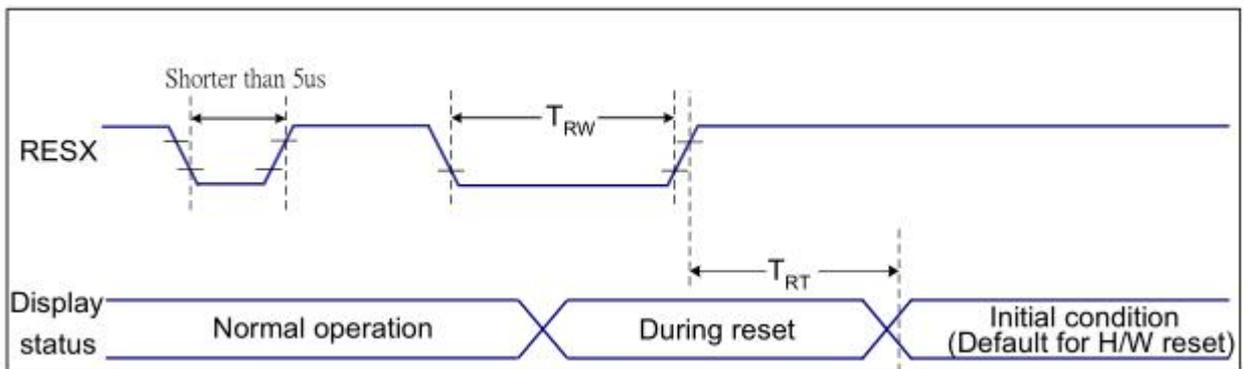
Figure 7 Reset Timing

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Table 9 Reset Timing

7.0 Reliability conditions

NO	Item	Conditions	Notes
1	High Temperature Storage	Ta=80℃±2℃, 72hrs	
2	Low Temperature Storage	Ta=-30℃±2℃, 72hrs	
3	High Temperature Operation	Ta=70℃±2℃, 72hrs(Operation state)	
4	Low Temperature Operation	Ta=-20℃±2℃, 72hrs(Operation state)	
5	High Temperature and High Humidity (Storage)	Ta=+60℃, 90%RH, 72hrs	
6	Thermal Cycling Test (non operation)	-20℃(30min) → +70℃(30min), 10cycles	
7	Electro static Discharge	Human Body Mode 100pF±10%/1500Ω±1% Air±8kV / contact±6kV Consecutive 10times/ Each discharge | DEVICE UNDER TEST	CLASS	STRESS LEVELS | | | CLASS I | 0-1999V | | | CLASS II | 2000-3999V | | | CLASS III | 4000-15999 V |	
8	Vibration test(with carton)	Total fixed amplitude:15mm Vibration Frequency :10~55Hz One cycle 60 seconds to 3 directions of X,Y,Z for Each 15 minutes	
9	Drop (with carton)	Height: 60cm 1 corner, 3 edges, 6 surfaces	
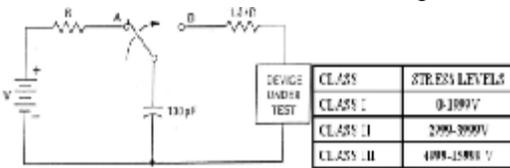
Note: There is no display function NG issue occurred, all the cosmetic specification is judged before the reliability stress.
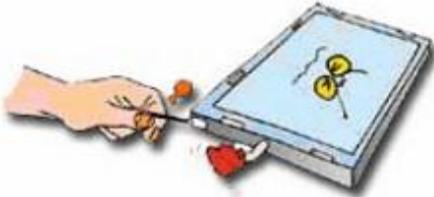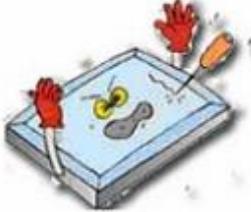
8.0 Precautions

8.1 Operation

Burn-in sometimes happens when the same character was displayed at along time. Therefore, to prevent Burn-in, it is recommended to set up a Screen-saver function.

8.2 Safety

The liquid crystal in the LCD is poisonous, DO NOT put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

8.3 Handling

	a. The LCD module shall be installed flat, without twisting or bending. b. COF or FPC has narrow pattern width, so easily become open circuit by external force. DO NOT apply pressure to COF or FPC especially in bending area.
	c. To avoid damage in appearance or malfunction, DO NOT subject the module to mechanical shock or to excessive force on its surface.
	d. The polarizer attached to the display is very easy to damage, handle it with care to avoid scratching.
	e. To avoid contamination on the display surface, DO NOT touch the display surface with bare hands. f. Provide a space so that the LCD module does not come into contact with other components.

8.4 Static Electricity

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge.
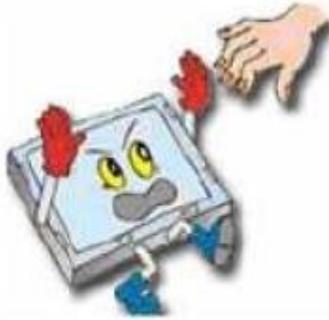
a. The LCD module shall be installed flat, without twisting or bending. Ground soldering iron tips, tools and testers when they operate.

b. Ground your body when handling the products.

c. DO NOT apply voltage to the input terminal without applying power supply.

d. DO NOT apply voltage that exceeds the absolute maximum rating.

e. Store the products in an anti-electrostatic container.

f. Peel off protect tape, attached to polarizer, slowly to minimize ESD damage.

8.5 Storage

Store the products in a dark place at +5 ~ +25 degree C, low humidity (50%RH or less).

DO NOT store the products in an atmosphere containing organic solvents or corrosive gases.

8.6 Cleaning

a. DO NOT wipe the polarizer with dry cloth, as it might cause scratch.

b. Wipe the polarizer with a soft cloth soaked with petroleum IPA, other chemical might damage.

8.7 Waste
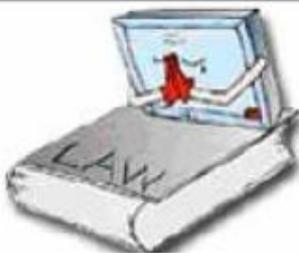
When dispose of LCD module, manage it at the production waste according to the relevant laws and regulations.

9.0 OUTINE DIMENSION

1 0.0 LOT MARK

10.1 Location of Lot Mark
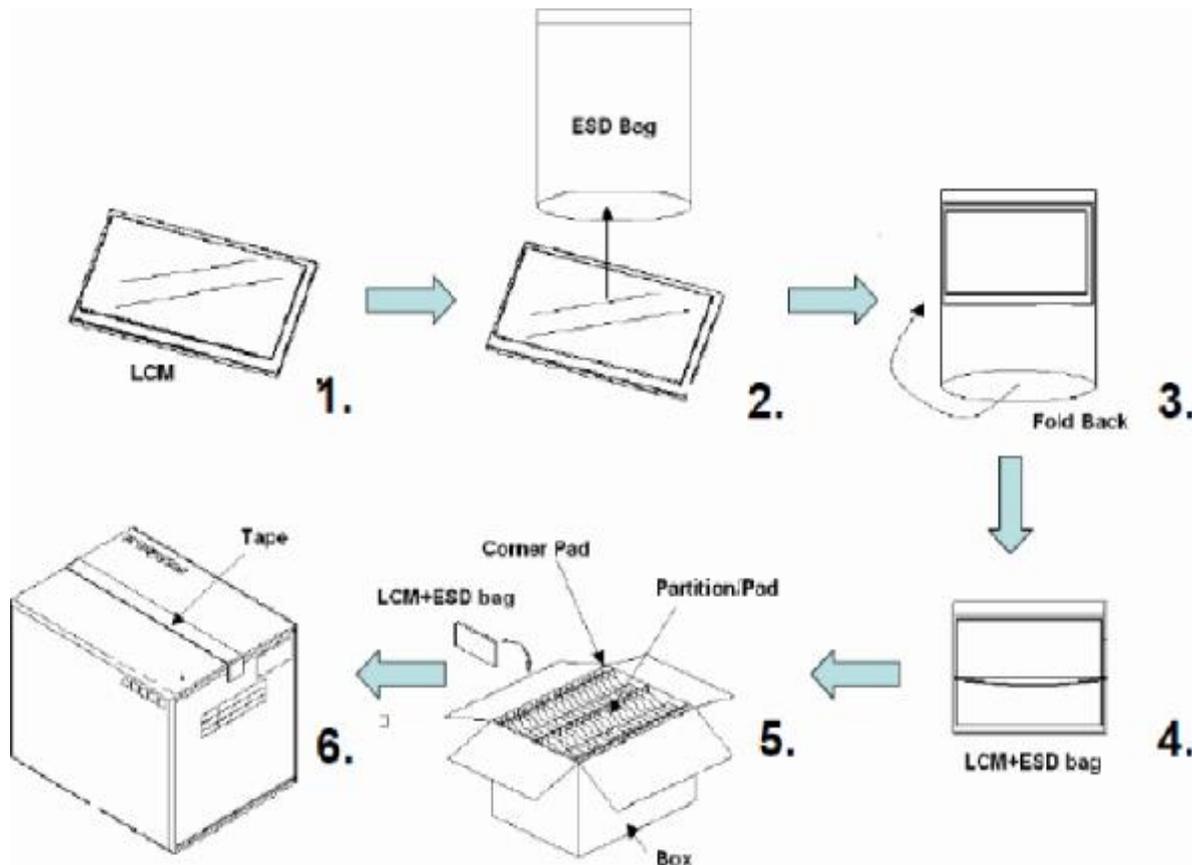
(1) Location: The label is attached to the backside of the LCD module.

(2) Detail of the Mark: as attached below.

(3) This is subject to change without prior notice.

11.0 PACKAGE SPECIFICATION

11.1 Packing form

LCM Model	LCM Qty. in the box	Inner Box Size (mm)	Notice
	TDB	TDB	

11.2 Packing assembly drawings11.2 Packing assembly drawings

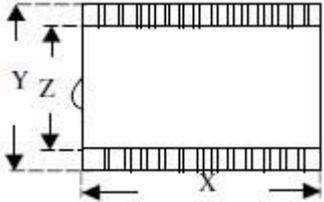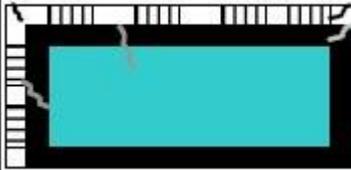| Items	Material	Notice
Box	Corrugated Paper Board	AB Flute
Partition/Pad	Corrugated Paper Board	A/B Flute
Corner Pad	Corrugated Paper Board	AB Flute
ESD bag	PE	

12.0 Items and Criteria：

12.1 Guarantee

APEX warrants the quality of our products for *1 year* (from the date of delivery).　If there are functional defects found during the period of warranty, the defective products would be replaced on a one-to-one ba... Apex would not be responsible for any direct /indirect liabilities consequential to any parties.
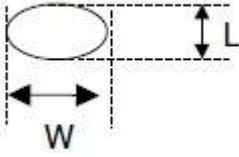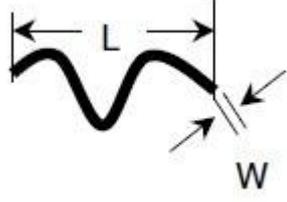
All the products should be stored or used as specified conditions described in these sheets. If module productions are not stored or used as specified conditions, herein, it will be void the *1 year* warranty(guarantee).

12.2 Visual inspection criterion in cosmetic

(1) Glass defect

Glass defect			
NO	Defect	Criteria	Remark
1	Dimension(Minor)	By engineering diagram	
2	Cracks(Major)	Extensive crack 【Reject】	

(2) LCM appearance defect

NO	Defect	Criteria		Remark
1	Round type(Minor)	Spec	Permissible Qty	1.ψ=(L+W)/2, L: Length, W: Width 2. Disregard if out of A.A.
		ψ≦0.10mm	Disregard	
		0.10mm<ψ≦0.20mm	**3**	
		0.20mm<ψ	**0**	
2	Line type(Minor)	Spec	Permissible Qty	1. L: Length, W: Width 2. Disregard if out of A.A.
		W≦0.03mm	Disregard	
		L≦3.0mm and 0.03mm<W≦0.05mm	2	
		L≦3.0mm and 0.05mm<W≦0.10mm	1	
		W>0.10mm orL>3.0mm	0	
3	Polarizer dent(Minor)	Spec.	Permissible Qty	1.ψ=(L+W)/2 , L: Length, W: Width 2.Disregard if out of A.A.
		ψ≦0.20mm	Disregard	
		0.20mm<ψ≦0.30mm	2	
		0.30mm<ψ≦0.50mm	1	

(3) FPC

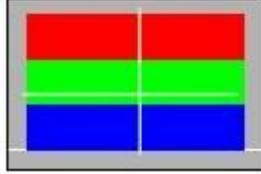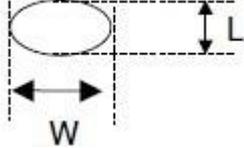| NO	Defect	Criteria	Remark
1	Copper peeling(Minor)	Copper peeling 【Reject】	
2	Golden finger	FPC golden finger broken, dead fold, indentation makes FPC surface broken 【Reject】 Tin plating layer(or gold plating) scratch, but not hurt circuit 【Accept】 Except circuit, other position scratch but not expose metal wire 【Accept】	
3	Pin	FPC PI layer delamination 【Reject】 Material and color are inconsistent with sample, FPC burrs 【Reject】 FPC Pin deformation but not affect function.【Accept】 FPC Pin area is dirty 【Reject】 Other than FPC Pin area is dirty but not affect function 【Accept】	
4	Golden finger	Golden finger edge has burrs,foreign material【Reject】 Golden finger oxidation (dark), uneven electroplating, pinhole, foreign material 【Reject】 Golden finger soldering pad crack exceeds 1/3 length of soldering pad, and soldering pad crack exceed 2 Pins【Reject】 Golden finger tin plating(or gold plating)scratch, but not hurt circuit 【Accept】 Other than golden finger area scratch but not expose metal circuit 【Accept】	
5	FPC Silk printing	Ghosting, incomplete silk printing, wrong printing 【Reject】	
6	FPC Circuit line width	Line width deviation exceed 1/3 line width【Reject】	

(4) Black tape

NO	Defect	Criteria	Remark
1	Shift(Minor)	IC exposed 【Reject】	
2	No black tape(Minor)	No black tape【Reject】	

(5) Silicon

NO	Defect	Criteria	Remark
1	Amount of silicon (Minor)	ITO exposed 【Reject】	

12.3 Visual inspection criterion in electrical display

NO	Defect	Criteria			Remark
1	No display (Major)	Not allowed			
2	Missing line (Major)	Not allowed			
3	Darker or lighter Line (Major)	Not allowed			
4	Weak line(Major)	By limited sample			
5	Bright / Dark point (Minor)	Spec.	Permissible Qty		1:1sub-pixel: 1R or 1G or1B 2:Point defect area≧1/2 sub pixel.
		Bright point	1		
		Dark point	2		
6	Round type (Minor)	Spec	Permissible Qty		1.ψ=(L+W)/2, L: Length, W: Width 2. Disregard if out of A.A.
		ψ≦0.10mm	Disregard		
		0.10mm<ψ≦ 0.20mm	3		
		0.20mm<ψ	0		
7	Line type (Minor)	Spec.	Permissible Qty		1. L: Length, W: Width 2. Disregard if out of A.A.
		W≦0.03mm	Disregard		
		L≦3.0mm and 0.03mm<W≦0.05mm	2		
		L≦3.0mm and 0.05mm<W≦0.10mm	1		
		W>0.10mm or L>3.0mm	0		
8	Mura (Minor)	By 5% ND filter invisible			

9.2.4. Others

1. Issues that are not defined in this document shall be discussed and agreed with both parties.
   (Customer and supplier)
2. Unless otherwise agreed upon in writing, the criteria shall be applied to both parties.
   (Customer and supplier)