PALM TECHNOLOGY CO., LTD.

The LCD(M) Specialist

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PART NO. :   PFG38A-SCF-1

FOR MESSRS. :

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ACCEPTED BY :   PROPOSED BY :

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RECORD OF REVISION

DATE	PAGE	SUMMARY

1. Scope

This approval document defines the product specifications and inspection criteria for the Liquid Crystal Display (LCD) supplied by Palm Technology Co., Ltd.

2. Purpose

This approval document is only valid when signed by customer representative and by Palm Technology Co., Ltd. QA department.

By signing this document, the parties accept to acknowledge and to comply with the product specifications and the quality level as stipulated in this document.

3. Basic Specifications

3.1 Display Specifications

No.	Item	Specifications
1	Display Mode	Transmissive Color Active Matrix LCD Panel TN Mode
2	Viewing Angle	6 O'clock Direction
3	Color Mode	4096 Colors
4	Driver IC	STLC563(COG)×3 STLC564(TAB)×1
5	Back Light	White CCFL

3.2 Mechanical Specifications

No.	Item	Specifications	Unit
1	Outline Dimensions	Refer to attachment A (Out-line Dimensions)	-
2	Dot Format	320 RGB x 240	Dots
3	Active Area	76.785(W)×57.585(H)	mm
4	Dot Size	0.065 (W) x 0.225 (H)	mm
5	Dot Pitch	0.08 (W) x 0.24 (H)	mm
6	Pixel Pitch	0.24 (W) X 0.24 (H)	mm
7	Weight	Approx. 8	g

3.3 Block Diagram
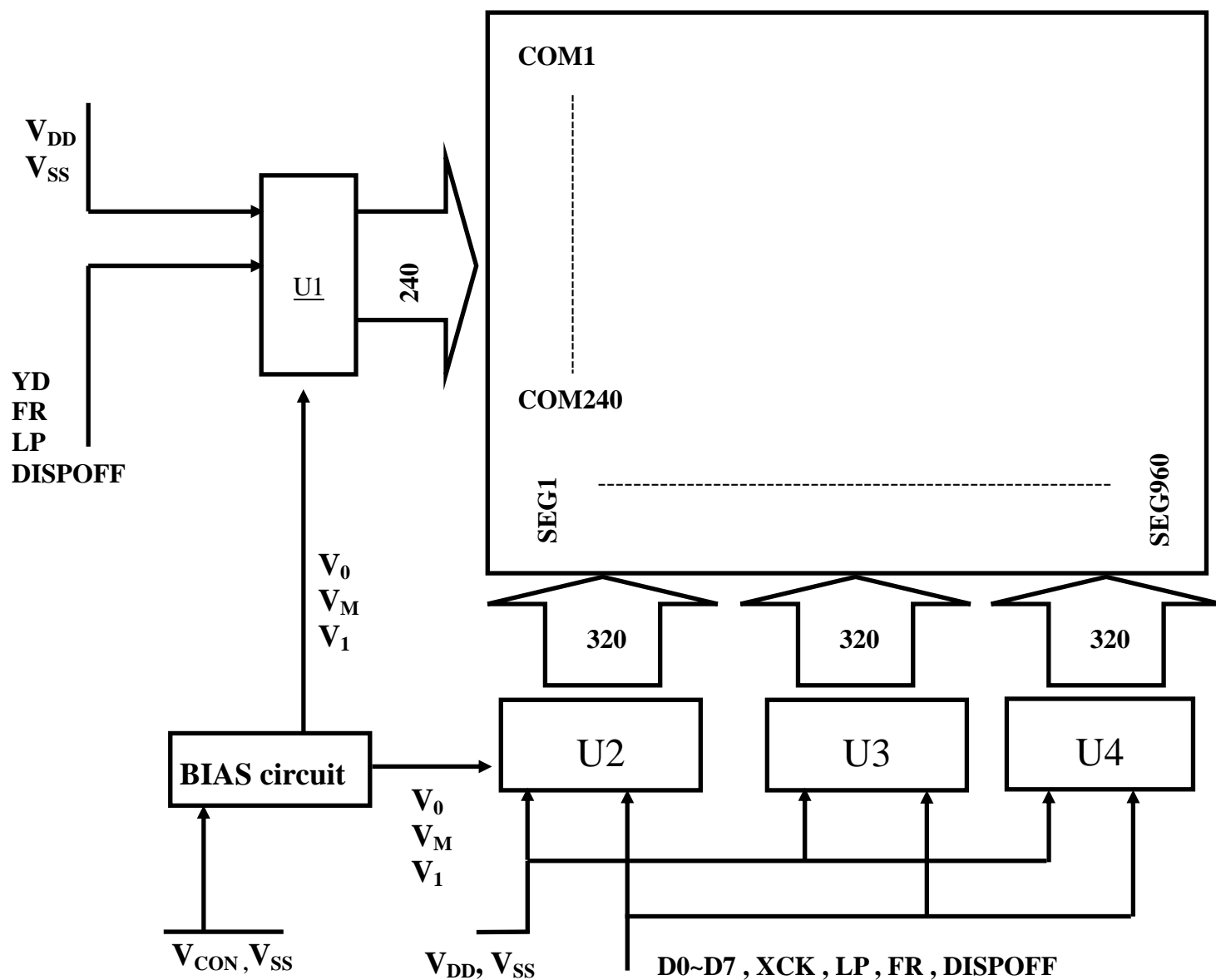
3.4 Terminal Functions
3.4.1 LCD Terminal

Interface: 0.5 mm Pitch 17 pins FPC

Pin No.	Symbol	I/O	Function
1	Vcon	I	Power supply for LCD
2	FR	I	Reserved for external switch signal to convert waveform
3	YD	I	Frame start signal
4	LP	I	Latch pulse of display data
5	XCK	I	Clock pulse for segment shift register
6	DISPOFF	I	H: display on L: display off
7	VDD	I	Logic power supply
8	VSS	I	Power ground
9	D0	I/O	Display data line
10	D1	I/O	Display data line
11	D2	I/O	Display data line
12	D3	I/O	Display data line
13	D4	I/O	Display data line
14	D5	I/O	Display data line
15	D6	I/O	Display data line
16	D7	I/O	Display data line

3.4.2 CCFL Back-Light Terminal

Interface:

No.	Symbol	I/O	Function
1	CCFL/H	I	CCFL backlight Anode input (268V(rms)/5mA)
2	CCFL/L	I	CCFL backlight Cathode input (0V)

4. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Note
Supply voltage	V_{DD}	-0.3	7.0	V	T_A=25
Input Voltage	V_{IN}	-0.3	V_{DD}+0.3	V	
Operating temperature	T_{OPR}	0	50		
Storage temperature	T_{STR}	-10	60		
Humidity	-	-	90	%RH	

5. Electrical Characteristics
5.1 DC Characteristics

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	Logic	V_{DD}	25	2.5	3.3	5.5	V
Input Voltage	H level	V_{IH}	25	$0.8V_{DD}$	-	-	V
	L level	V_{IL}		-	-	$0.2V_{DD}$	
Supply current for logic		I_{DD}	25 . V_{DD}=3.0 V	-		0.4	mA
Supply current for LCD		I_{EE}	V_{LCD}=20V	-		4	mA
LCD Driving Voltage (V_{LCD}-V_{SS})		V_{LCD}	25 V_{DD}=3.3 V 1/12 bias	18.1	19.0	19.9	V

5.2 AC Characteristics

OF SEGMENT
AC CHARACTERISTICS 1

(VCC = 2.5V to 4.5V, V0 - GND = 2.6V to 5.5V, T_A = -30°C to +75°C)

Item	Symbol	Pins	Min.	Max.	Unit
Clock cycle time	t_{CYC}	CL2	152	-	ns
Clock high pulse width 1	t_{CWH2}	CL2	65	-	ns
Clock low pulse width 1	t_{CWL2}	CL2	65	-	ns
Clock high pulse width 2	t_{CWH1}	CL1	65	-	ns
Clock setup time	t_{SCL}	CL1, CL2	80	-	ns
Clock hold time	t_{HCL}	CL1, CL2	80	-	ns
Clock rise time	t_r	CL1, CL2	-	30	ns
Clock fall time	t_f	CL1, CL2	-	30	ns
Data setup time	t_{DS}	D0 to D7, CL2	50	-	ns
Data hold time	t_{DH}	D0 to D7, CL2	50	-	ns
M setup time	t_{MS}	M, CL1	20	-	ns
M hold time	t_{MH}	M, CL1	20	-	ns
Output delay time 1	t_{d1}	CL1, Y0 to Y319	-	1000	ns

AC CHARACTERISTICS 2

(VCC = 4.5V to 5.5V, V0 - GND = 2.6V to 5.5V, T_A = -30°C to +75°C)

Item	Symbol	Pins	Min.	Max.	Unit
Clock cycle time	t_{CYC}	CL2	125	-	ns
Clock high pulse width 1	t_{CWH2}	CL2	45	-	ns
Clock low pulse width 1	t_{CWL2}	CL2	45	-	ns
Clock high pulse width 2	t_{CWH1}	CL1	45	-	ns
Clock setup time	t_{SCL}	CL1, CL2	80	-	ns
Clock hold time	t_{HCL}	CL1, CL2	80	-	ns
Clock rise time	t_r	CL1, CL2	-	20	ns
Clock fall time	t_f	CL1, CL2	-	20	ns
Data setup time	t_{DS}	D0 to D7, CL2	20	-	ns
Data hold time	t_{DH}	D0 to D7, CL2	20	-	ns
M setup time	t_{MS}	M, CL1	20	-	ns
M hold time	t_{MH}	M, CL1	20	-	ns
Output delay time 1	t_{d1}	CL1, Y0 to Y319	-	1000	ns

Note1: A load must be 10pF or less for EI/O connection between drivers.

Note2: For output delay time 1 and 2, connect the load circuit shown below.

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OF COMMON
AC CHARACTERISTICS 1

(VCC = 2.5V to 5.5V, GND = 0V, VLCD - VEE = 15V to 43V, T_A = -30°C to +75°C)

Item	Symbol	PINs	Min.	Max.	Unit	Note
Clock cycle time	tCYC	CL	400	-	ns	
Clock high-level width	tCWH	CL	25	-	ns	
Clock low-level width	tCWL	CL	370	-	ns	
CL rising time	tr	CL	-	30	ns	
CL falling time	tf	CL	-	30	ns	
Data setup time	tDS	DIO1, DIO2, CL	100	-	ns	
Data hold time	tDH	DIO1, DIO2, CL	10	-	ns	
Data output delay time	tDD	DIO1, DIO2, CL	-	200	ns	*1
M output delay time	tMD	M, CL	-	200	ns	*1
M setup time	tMS	M, CL	20	-	ns	
M hold time	tMH	M, CL	20	-	ns	
DOC delay time 1	tDOC1	DISPOFF, DOC	-	300	ns	*2
DOC delay time 2	tDOC2	DIO1, DIO2, DOC	-	300	ns	*2

AC CHARACTERISTICS 2

(VCC = 2.5V to 4.5V, GND = 0V, VLCD - VEE = 43V, T_A = -30°C to +75°C)

Item	Symbol	PINs	Min.	Max.	Unit	Note
Output delay time 1	t_{ec1}	X (n), M	-	1.2	μs	*2

AC CHARACTERISTICS 3

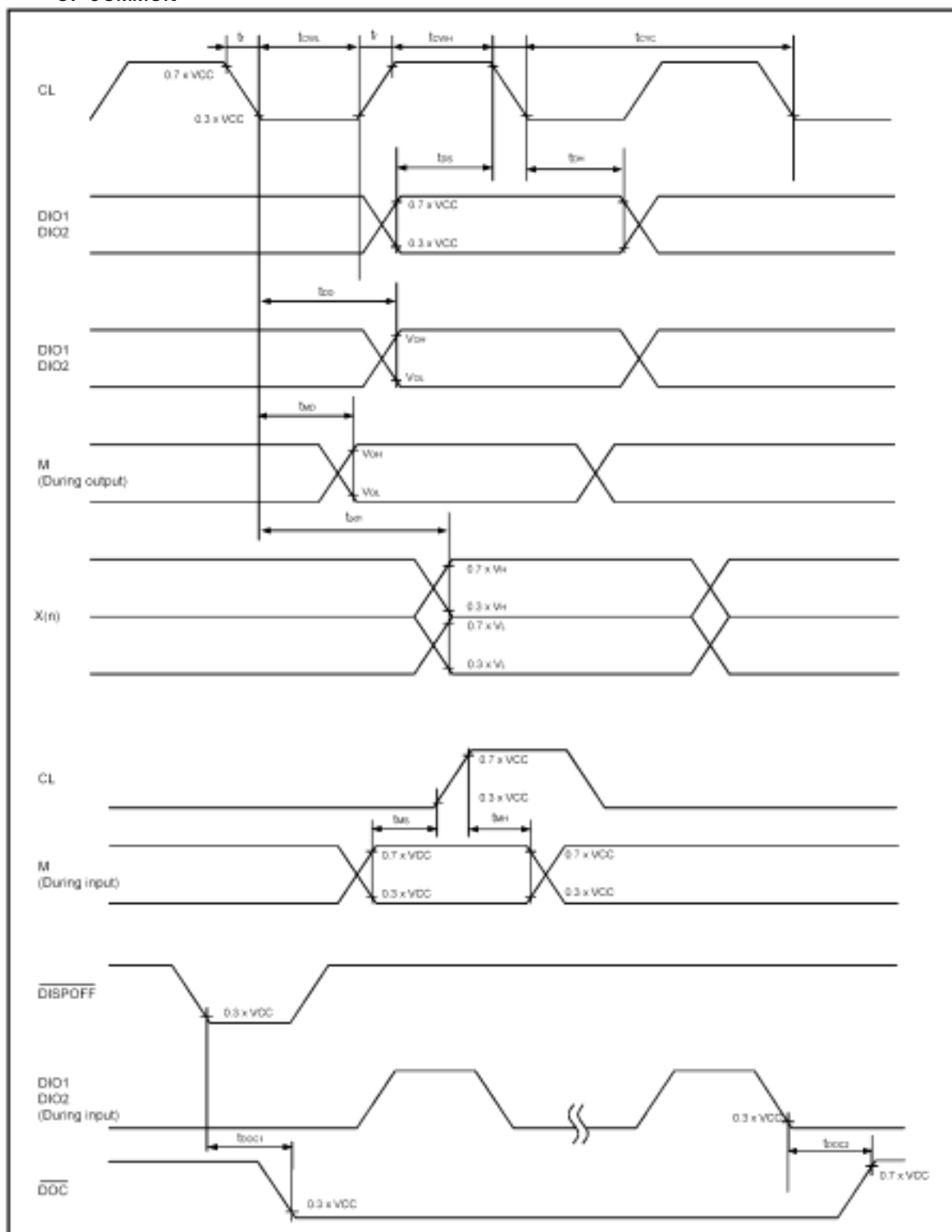(VCC = 4.5V to 5.5V, GND = 0V, VLCD - VEE = 43V, T_A = -30°C to +75°C)

Item	Symbol	PINs	Min.	Max.	Unit	Note
Output delay time 1	t_{ec1}	X (n), M	-	0.7	μs	*2

5.3 Timing Diagram

OF SEGMENT
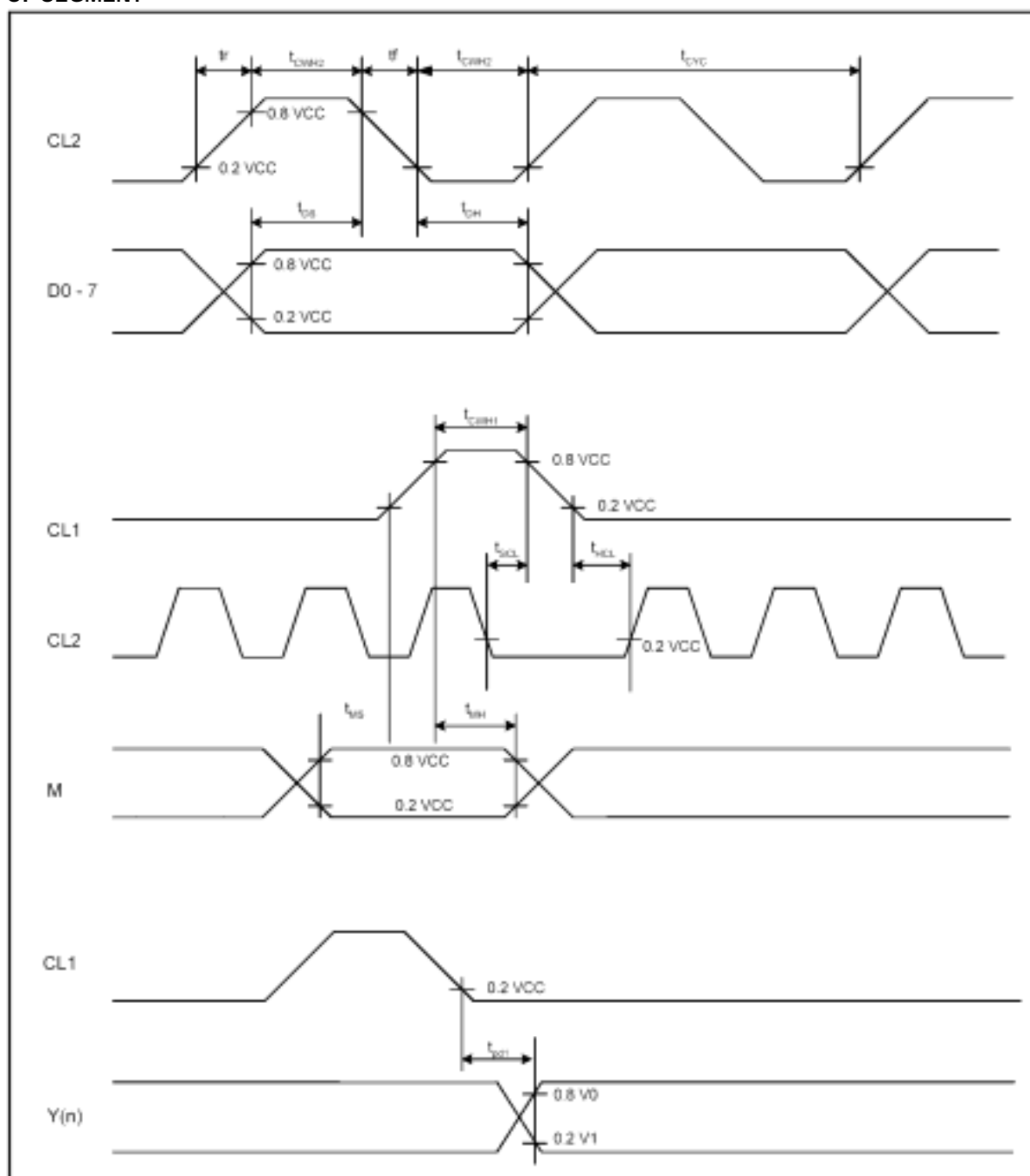
OF COMMON

5.4 Explanation of Commands

For details of command explanation, please refer to the data sheet of driver IC:
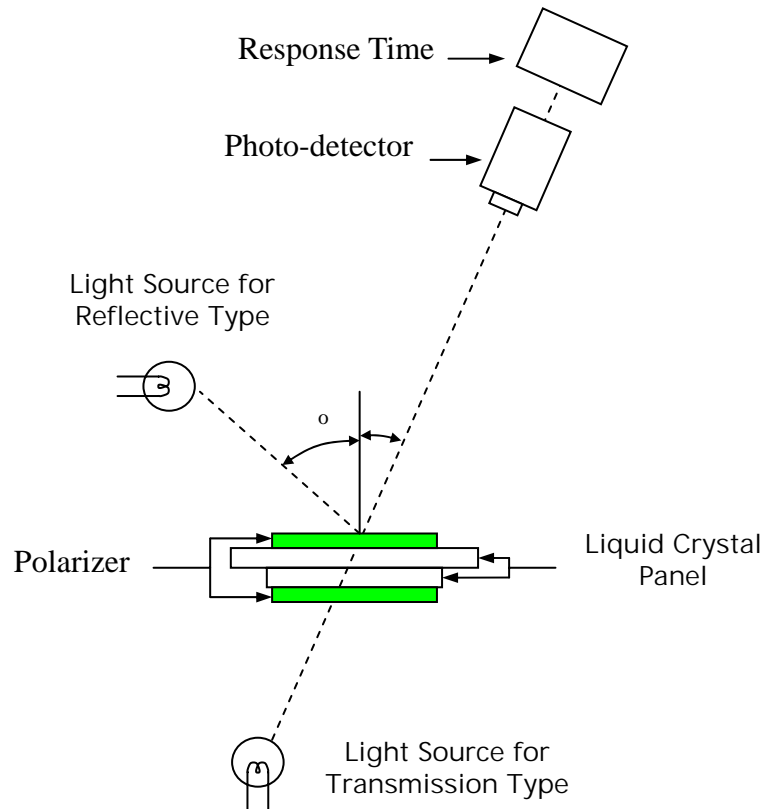STLC563(SEG) STLC564(COM).

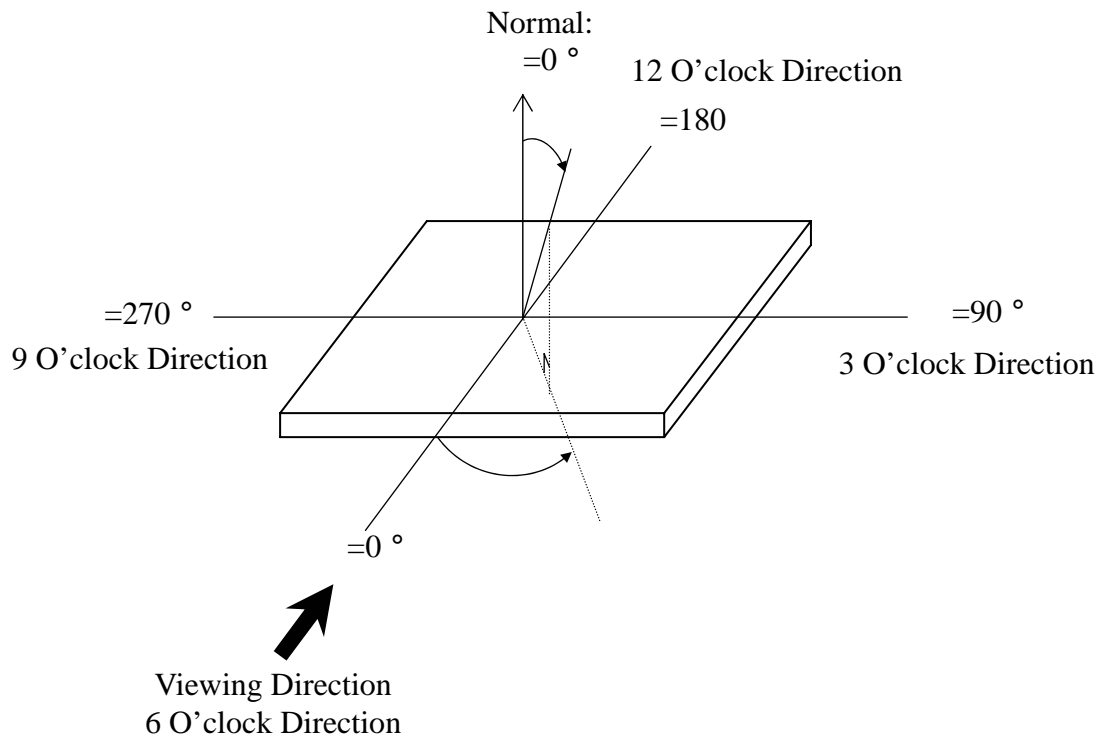## 6. Optical Characteristics
6.1 Optical Characteristics

Electro-Optical Characteristics								
Item	Symbol	Condition	Temp.	Min.	Typ.	Max.	Units	Note
LCD driving Voltage(recommended voltage)	V_{LCD}	$= = 0°$ $_0 = 25°$	0	----	----	----	V	Note 1, 3
			25	----	19.98*	----		
			50	----	----	----		
Response Time	Rise Time (Tr)	$= = 0°$ $_0 = 25°$	0	----	----	----	ms	Note 1, 4
	Decay Time (Td)			----	----	----		
	Rise Time (Tr)		25	----	170	----		
	Decay Time (Td)			----	200	----		
	Rise Time (Tr)		50	----	----	----		
	Decay Time (Td)			----	----	----		
Module Chromaticity	White x	$= = 0°$ $_0 = 25°$	25	----	TDB	----	---	----
	White y			----	TDB	----		
	Red x			----	TDB	----		
	Red y			----	TDB	----		
	Green x			----	TDB	----		
	Green y			----	TDB	----		
	Blue x			----	TDB	----		
	Blue y			----	TDB	----		
Contrast Ratio	Transmissive	$= = 0°$ $_0 = 180°$	25	----	----	30	---	Note 1, 5

6.2 Definition of Optical Characteristics
6.2.1 Electro-Optical Characteristics Test Method.

Response Time

Photo-detector

Light Source for
Reflective Type

o

Polarizer

Liquid Crystal
Panel

Light Source for
Transmission Type

6.2.2 Definition of Viewing Angle

Normal:
=0°

12 O'clock Direction
=180

=270°
9 O'clock Direction

=90°
3 O'clock Direction

=0°

Viewing Direction
6 O'clock Direction

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6.2.3 Definition of Optical Response Time
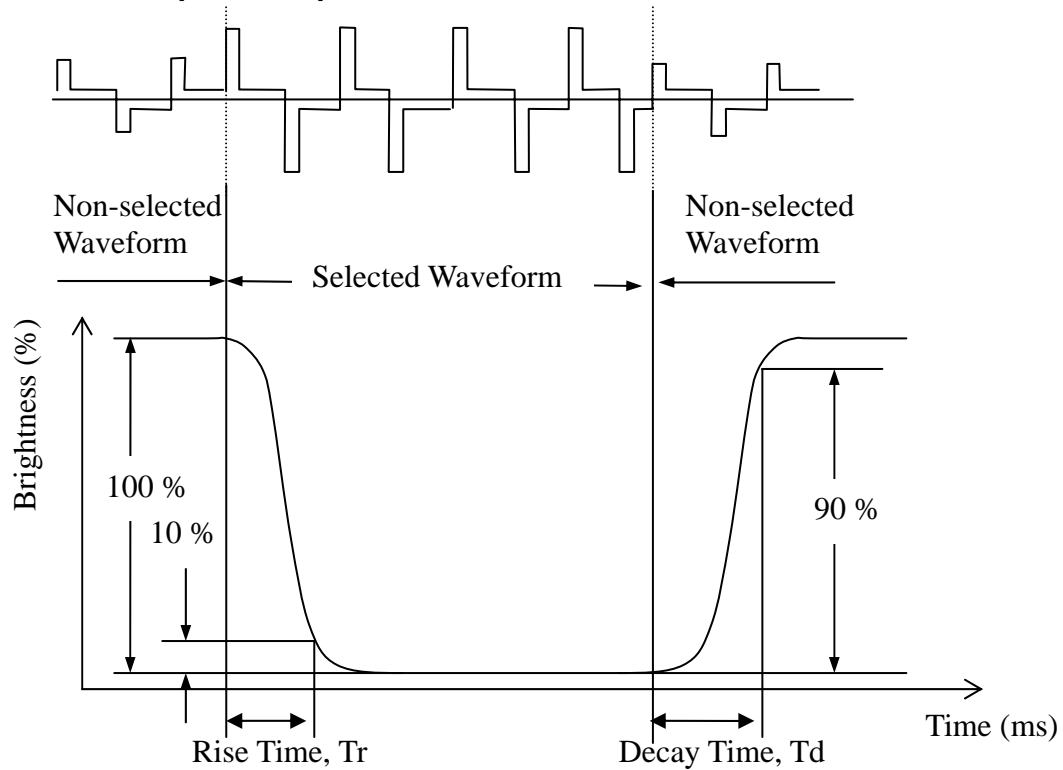
(Positive Type)

(Negative Type)

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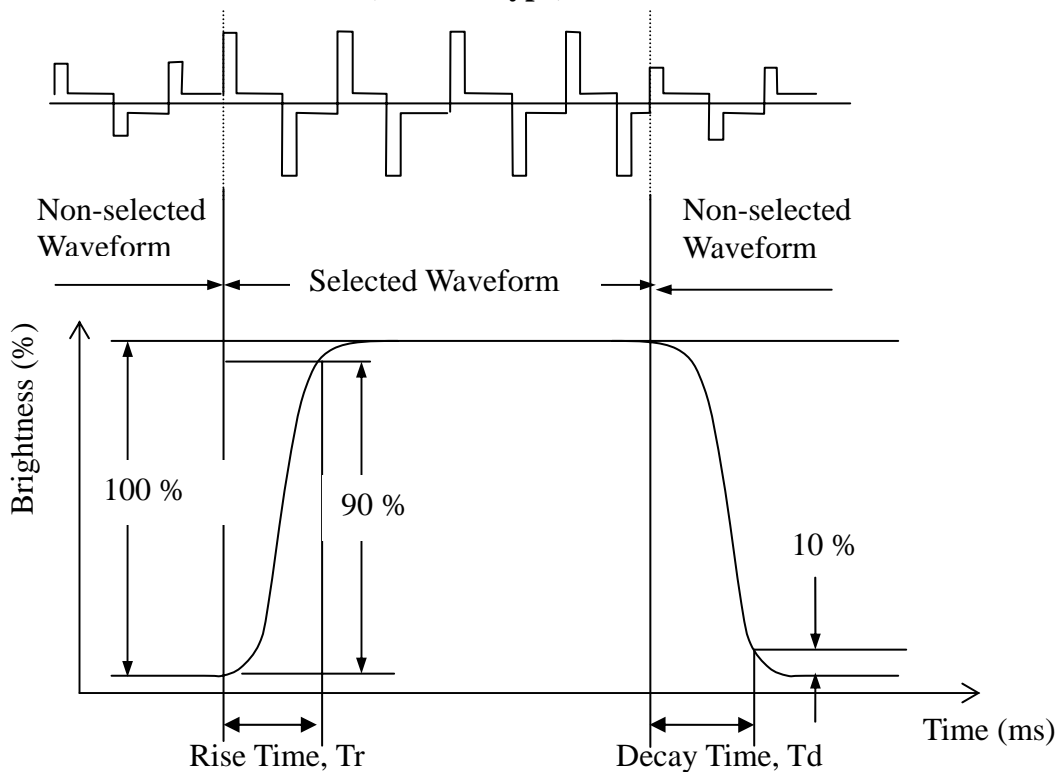
6.2.4 Definition of Contrast Ratio (CR).

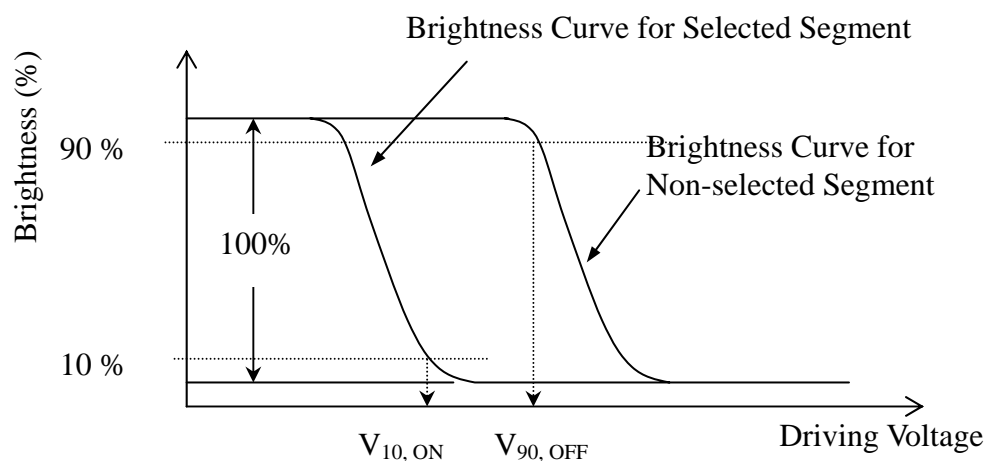$$CR = \frac{\text{Brightness of Non-selected Segment (B2)}}{\text{Brightness of Selected Segment (B1)}}$$
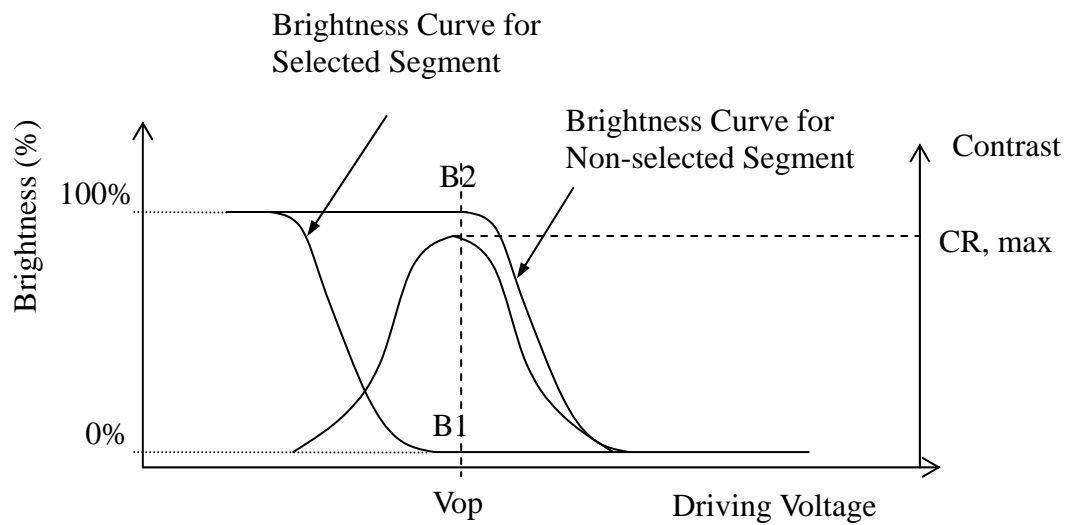
(Positive Type)

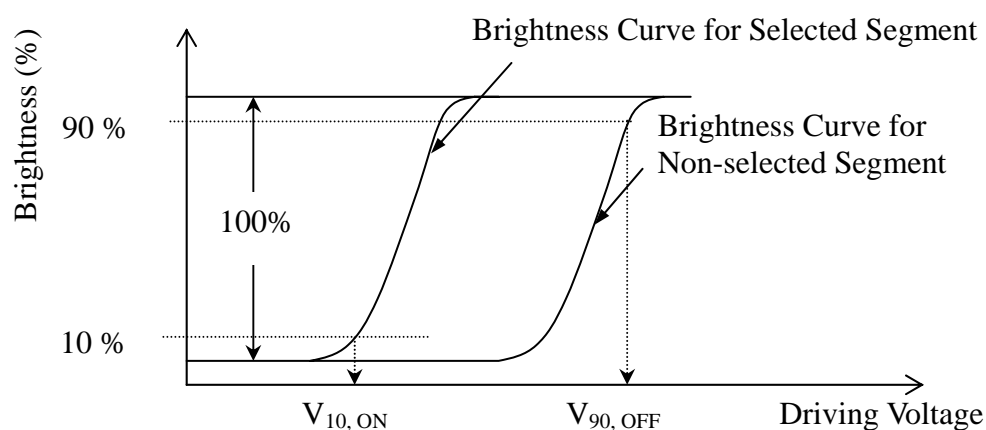$$CR = \frac{\text{Brightness of Selected Segment (B2)}}{\text{Brightness of Non-selected Segment (B1)}}$$

(Negative Type)

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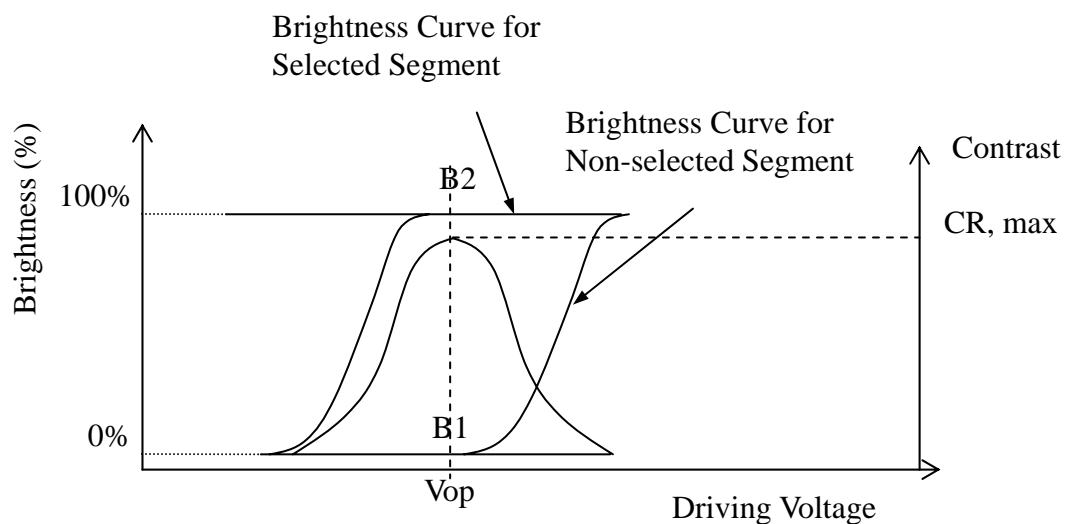
6.2.5 *Definition of Driving Voltage, $V_{LCD} = (V_{10, ON} + V_{90, OFF}) / 2$.*

Brightness Curve for Selected Segment

Brightness Curve for Non-selected Segment

Brightness (%)

90 %

100%

10 %

$V_{10, ON}$ $V_{90, OFF}$ Driving Voltage

(Positive Type)

Brightness Curve for Selected Segment

Brightness Curve for Non-selected Segment

Brightness (%)

90 %

100%

10 %

$V_{10, ON}$ $V_{90, OFF}$ Driving Voltage

(Negative Type)

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7. Reliability

7.1 MTTF (Mean-Time-To-Fail)
The LCD is designed to meet the MTTF by 60,000 hours under normal room conditions
(25 °C, 65% RH, without sun-shine)

7.2 Content of Reliability Test

Categories	No	Item	Conditions	Duration
Initial	1	Initial measurement	1. Out-line dimensions 2. Cosmetic inspection 3. Power consumption	
Environmental Reliability	1	High Temp / Storage	70	240 hrs
	2	High Temp / Operation	60	120 hrs
	3	Low Temp / Storage	-30	240 hrs
	4	Low Temp / Operation	-20	120 hrs
	5	High Temp. & High Humidity / Storage	50 / 95% R.H.	240 hrs
	6	High Temp. & High Humidity / Operation	50 / 95% R.H.	120 hrs
	7	Thermal Shock	-30 / 0.5 hr <=> 70 / 0.5 hr	50 Cycles
Mechanical effects (package state)	1	Vibration	Sinusoidal vibration: 9~200 Hz 2.0mm p-p 2.0 Gmax Random vibration: 10~200 Hz 0.02 g/Hz 200~500 Hz 0.0004 g/Hz	1 hr, 3 axis each
	2	Free Fall	1. Height: 80cm 2. 1 corner / 3 lines / 6 surfaces	

1) During the Reliability Test the LCD Module is without package except for mechanical effects
2) Vibration & Free Fall is the endurance test applying vibration & shock that might occur during transportation. The testing unit is one packing carton.
3) No condensation may occur during the test.

7.3 Failure judgment criteria
After the above-mentioned test:
1. The current consumption must be below or equal to the initial value.
2. There should be no abnormal function.
No cosmetic failures are allowed.

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8. Inspection Criteria

8.1 Quality level

Defect	Classification of Defects		AQL ( )	References
Major Defect	Electrical Characteristic	Electrical Function	0.25	A major defect refers to a defect that may substantially degrade the usability of product applications
		Electrical Defect	0.40	
Minor Defect	Appearance	Glass Chip / Crack	0.65	A minor defect refers to a defect that is not considered to substantially degrade the product application or a defect that deviates from existing standards almost unrelated to the effective use of the products or it's operation.
		Polarizer / Reflector (Scratch / Particle / Bubble / Peeling)		

Sampling planning is following MIL-STD-105E Normal Inspection Level   , single sampling.

8.2 Conditions for Visual Inspection

Visual Inspection shall be carried out at a distance of more than 30 cm from the naked eye to the display surface, and under a light source of 800~1200 LUX table light.

The inspection shall be performed within an angle of 30° from Z-axis to X and Y.

Visual Inspection is only for the Viewing Area. Refer to attachment A (Out-line drawing)
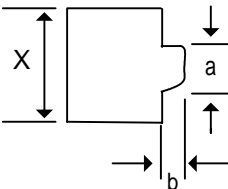
Vertical Direction

800~1200Table Light

60°

Polarizer

Glass

Reflector

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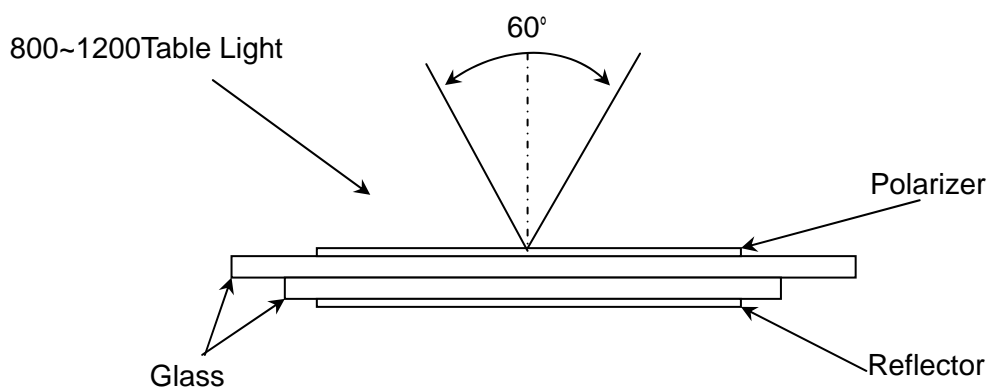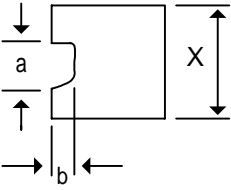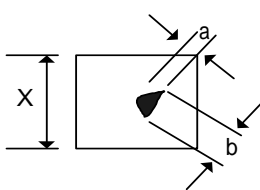
8.3 Quality Judgment Criteria
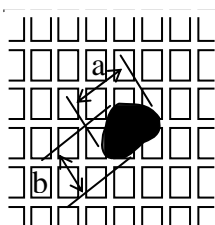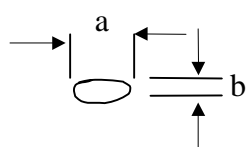
8.3.1 Electric Characteristics

8.3.1.1 Electric Function

No	Item	Judgment Criteria
1	Abnormal Light On	Not allowed
2	Miss Operation	Not allowed
3	Open, Short	Not allowed
4	Cross Short Line	Not allowed
5	Half Tone	Not allowed
6	Response Time	Same time in whole active area
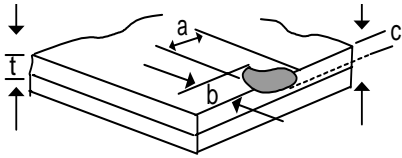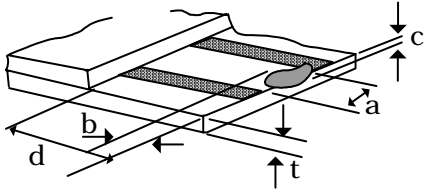
8.3.1.2 Electric Defects
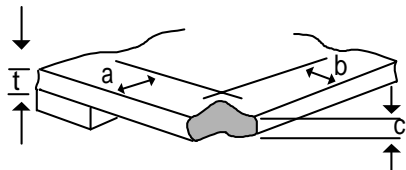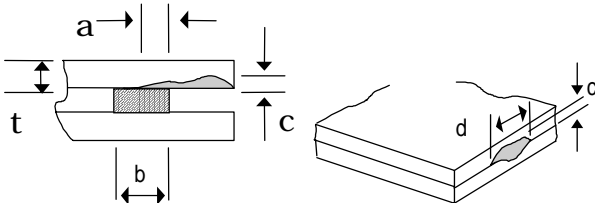
No	Item	Judgment Criteria
1	Electrical Defect	 ( )Circle Spots **Grain Size (mm)** / **Tolerance Dots** When the width is over 0.05 mm, according to the ( ) Circle Spots. ( ) a X/2 and b X/2, but not be allowed short. Follow the above defect quantity 2 Defects.

( )Circle Spots

Grain Size (mm)		Tolerance Dots
	0.10	Neglect
0.10	0.20	2
0.20		0

( ) Defect Line

Grain Size (mm)		Length (mm)	Tolerance Dots
	0.03	—	Neglect
0.03	0.05	1.0 L 2.0	2
0.05		—	0

When the width is over 0.05 mm, according to the (   ) Circle Spots.

(   ) a X/2 and b X/2, but not be allowed short.

Follow the above defect quantity 2 Defects.

No	Item	Judgment Criteria
1	Bubble (Polarizer, Reflector)	 Grain Size (mm) / Tolerance Dots: 0.15 → Neglect 0.15 0.30 → 2 0.30 → 0 ( ) Grain Size Average Diameter ( ) Allowed Dots: 2 Dots
2	Aligning Defect	 Grain Size (mm) / Tolerance Dots: 0.5 → Neglect 0.5 1.0 → 2 1.0 1.5 → 1 1.5 2.0 → 1 ( ) Grain Size showed by (a+b)/2 ( ) Allowed Dots: 4 Dots
3	Panel (Including Polarizer, Reflector) Black Spots, White Spots, Fiber, Scratch	( ) Circle Spots Definition: Grain size is (a+ b)/2 Grain Size (mm) / Tolerance Dots: 0.10 → Neglect 0.10 0.20 → 2 0.20 → 0 ( ) Defect Line Grain Size (mm) / Length (mm) / Tolerance Dots: 0.03 / — / Neglect 0.03 0.05 / 1.0 L 4.0 / 2 0.05 / — / 0

Item 1 — Bubble (Polarizer, Reflector):

Grain Size (mm)		Tolerance Dots
	0.15	Neglect
0.15	0.30	2
0.30		0

( ) Grain Size Average Diameter
( ) Allowed Dots: 2 Dots

Item 2 — Aligning Defect:

Grain Size (mm)		Tolerance Dots
	0.5	Neglect
0.5	1.0	2
1.0	1.5	1
1.5	2.0	1

( ) Grain Size showed by (a+b)/2
( ) Allowed Dots: 4 Dots

Item 3 — Panel (Including Polarizer, Reflector) Black Spots, White Spots, Fiber, Scratch:

( ) Circle Spots

Definition: Grain size is (a+ b)/2

Grain Size (mm)		Tolerance Dots
	0.10	Neglect
0.10	0.20	2
0.20		0

( ) Defect Line

Grain Size (mm)		Length (mm)	Tolerance Dots
	0.03	—	Neglect
0.03	0.05	1.0 L 4.0	2
0.05		—	0

		When the width is over 0.05 mm, according to the ( ) Circle Spots. Follow the above defect quantity 2 Defects.

8.3.3 LCD Panel Appearance

No.	Item	Judgement Criteria
1	Glass Chip (Not Terminal)	( ) a, b 0.5 mm neglect ( ) a 5.5(L),5.5(W) and b 1.5, c t; N 3,(L:Length ; W:Width) ( ) Follow the above, The allowed chip 3 chips unit mm
2	Glass Chip at ITO Terminal	( ) a 5.5(L),and b d/3, c t, d is the length of the ITO ( ) Follow the above, The allowed chip 3 chips ( ) 3 continuous chips at the panel are not allowed unit mm

3	Glass Chip at Corner	( ) a 4.5(L),4.5(W), and b 2.0, c t; N 3 ( ) If length broken to ITO line ,Reference No.2 Glass Chip at ITO Terminal ( ) 3 continuous chips at the panel are not allowed unit mm
4	Glass Chip at Seal Sid	( ) a b/3 and d 7.5(L),7.5(W), c t, b is the width of seal ( ) Follow the above, The allowed chip 3 chips unit mm
5	Glass Crack	Any crack out side sealed area is accepted, provided it is not expandable

8.4 Provision for Settlement of Disputes

In case of any inconsistency in above criteria, the Contract duly signed by both parties takes priority over the Approval Document.

Limit-sample: Some inspection criteria cannot be shown in this document, so the parties might agree on limit sample, which will then be basis for the approval of the actual product.

9. Precautions for use of LCD Modules
9.1. Handling procedures

A) The display panel is made of glass. Do not subject it to a mechanical shock.

B) If the display panel is damaged, the liquid crystal substance inside may leak out. Avoid contact with the mouth. If the substance comes into contact with the your skin or clothes, promptly wash the area thoroughly using soap and water.

C) Do not touch or apply excessive force on the surface of the display or the adjoining area of the LCD module since this may cause the color tone/contrast ratio to vary.

D) Under the protective film the polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully and keep in a dust free environment.

E) If the display surface of the LCD module 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 following solvents, either Isopropyl or Ethyl Alcohol
Solvents other than those mentioned above may damage the polarizer.
Do not use water, acetone, and aromatic solvents.

F) When positioning the LCD module, ensure that it is free of twisting, warping, and tension. Strain has a great influence upon display quality. Also, ensure that enough room is left for possible shifting of the outer case/housing.

G) When installing the LCD module, do not forcibly pull or bend the I/O cable.

H) Do not touch the IC of the LCD module, as this may cause abnormal readings that cannot be corrected.

I) Do not attempt to disassemble or modify the LCD module.

J) No Connection terminals should be left open. Do not connect anything.

K) If the logic circuit power is off, do not try to apply input signals.

L) To prevent damage to the various components of the display from static electricity, normal anti static techniques must be used.
Tools required for assembly, such as soldering irons, must be properly earthed to minimize the amount of static electricity generated. Try to avoid assembly and other work under very 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.

M) Avoid handling the LCD glass, as the edges are sharp.

9.2 Storage precautions

A) Exercise care to minimize possible corrosion or contamination of the electrical contacts. Moisture condensation or a current flow in a high humidity environment accelerates corrosion of the contacts.

B) When storing the LCD module, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the LCD module in bags designed to prevent static electricity build up under low ambient temperature/normal humidity conditions.
Avoid high temperature /high humidity and low temperatures, below 0 ºC.
Whenever possible, the LCD module should be stored in the same packaging in which they were

shipped from our company.

9.3 Design precautions

A) The absolute maximum ratings represent the rated value beyond which the LCD module must not be used. If the LCD module is used in excess of the rated values, their operation characteristics may be adversely affected permanently.

B) To prevent the occurrence of erroneous or poor operation caused by electromagnetic noise, attention must be paid to the VIL, VIH specification values, including taking the precaution of using short signal cables whenever possible.

C) The liquid crystal display characteristics are temperature dependent. Viewing clarity of the display becomes poorer when the LCD is used outside its designated operating temperature range. It is therefore recommended that the LCD be used within this range.

D) We recommend that power supply lines (VDD or Vcc) have over-current protection precautions. (Fuse etc.)

E) To minimize Electro Magnetic Interference, designs using LCD Modules should recognize the effect of components elsewhere, especially from adjacent peripheral devices.

F) The Tape Carrier Package fixes the LCD module, consisting of a glass panel, inside the housing. If the PCB is fixed, it could be disconnected when subjected to stress.

9.4. COG Precautions

A) Although these modules have a built-in protection terminal against static electricity for all pins, this may not be sufficient if higher levels of static electricity are encountered, possibly leading to a short circuit. Therefore, care in anti static handling is very important, including using earthen straps for the operators

B) Generally, irradiating it with a strong light will change the characteristics of a semiconductor device. This may adversely affect the operational characteristics of the IC in the modules. We recommend whenever possible that:

> Handling, preparation, assembly, and testing involving LCD are carried out in the lowest possible lighting conditions, consistent with Operator comfort.

9.5. Other considerations

A) Liquid crystal material solidifies at low temperatures (below the storage temperature range) leading to defective orientation of the liquid crystal or the generation of air bubbles.
Air bubbles may also be generated if the LCD module is subjected to a strong shock at a low temperature.

B) If the LCD module has been operating for a long time showing the same display patterns, there may be retention of the display pattern on the screen as ghost images and a slight contrast irregularity may also appear. Normal operating status can be regained by suspending use for some time to rest the display if possible. It should be noted that this phenomenon does not adversely affect the performance reliability.

C) To minimize performance reduction of the LCD modules resulting from the adverse effects of static electricity, avoid touching the following areas when handling the modules:
   - Terminal connections
   - Parts of pattern wiring on TCP

9.6. Warranty

A) Acceptance Inspection Period
The period is one month after the arrival of contracted commodity at the customer's factory site.

B) General Warranty Period
The General Warranty period is one year from the date when the product was shipped out from Palm Technology Co., Ltd However, the warranty is applicable only when the product has been handled and/or stored under normal conditions that at no time violate above-mentioned precautions.

C) The warranty liability of Palm Techology Co., Ltd. is limited to repair and/or replacement.
The disregard of any one of above precautions invalidates the warranty in its entirety.

D) Palm Technology Co., Ltd.is not to be held responsible for any subsequent or consequential events.

DOTS 320X3X240

↑
Viewing Direction

"A" Scale 40:1

Scale 40:1

"C" Scale 2.5:1

"B" Scale 2.5:1

NOTES

1) DISPLAY MODE   Color-STN, NEGATIVE
2) DRIVING METHOD 1/240 DUTY 1/12BIAS
3) OPERATING TEMPERATURE   0~50°C
4) STORAGE TEMPERATURE   -10~60°C
5) IF NO TOLERANCE SPECIFICATION,
   COMMON TOLERANCE IS ±0.05

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
-	A	First Issue	2004.07.26	Watt

Palm Technology Co., Ltd.		
MODEL	FC4012A1	
DWG.NAME	Outline Drawing	
DWG.NO	FC4012A1ODA	
SCALE 1:1	UNIT mm	TOL. ±0.2	DATE 2004.07.26
APPROVED	CHECKED	DESIGN	DRAWN Watt