



TIANMA

SPECIFICATION

FOR LCD MODULE

Version 0.1

CUSTOMER	:	
CUSTOMER NO.	:	
PRODUCT TYPE	:	Graphics LCM
MODULEL NO.	:	TM320240ACCWVGWSA

CUSTOMER APPROVED	
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RoHS

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1. LCD Module Part Numbering System

TM	320240	A	C	C	W	V	G	W	S	A
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	

NO.	Explanation	
①	TIANMA module indicating	
②	Module type: 320 columns×240 rows, 6 DIGITS	
③	TIANMA module series (A,B,C,D...)	
④	LCD type	
	C	Positive, FSTN
⑤	Backlight type	
	C	Transflective, LED
⑥	Temperature range	
	W	Wide temperature
⑦	Viewing Angle	
	V	Wide viewing direction
⑧	Technology	
	G	COG
⑨	The color of backlight	
	W	White
⑩	Module type	
	S	Standard
	Function choice	
	A	Without any function

2 Basic specification

Item	Contents			
LCD type	<input type="checkbox"/> TN	<input type="checkbox"/> STN	<input checked="" type="checkbox"/> FSTN	<input type="checkbox"/>
	<input checked="" type="checkbox"/> positive	<input type="checkbox"/> negative		
LCD Duty	<input type="checkbox"/> 64	<input type="checkbox"/> 128	<input checked="" type="checkbox"/> 240	<input type="checkbox"/> 16
LCD Bias	<input type="checkbox"/> 1/9	<input type="checkbox"/> 1/12	<input checked="" type="checkbox"/> 1/16	<input type="checkbox"/> 1/5
Polarizer	<input type="checkbox"/> reflective	<input checked="" type="checkbox"/> transflective	<input type="checkbox"/> transmissive	
LCD background color	<input type="checkbox"/> grey	<input type="checkbox"/> yellow/green	<input type="checkbox"/> blue-black	<input checked="" type="checkbox"/> white
Segment color	<input type="checkbox"/> white	<input checked="" type="checkbox"/> blue-black	<input type="checkbox"/>	
Backlighting	<input checked="" type="checkbox"/> LED	<input type="checkbox"/> EL	<input type="checkbox"/> CFL	<input type="checkbox"/>
LED type	<input checked="" type="checkbox"/> edge	<input type="checkbox"/> area	<input type="checkbox"/>	<input type="checkbox"/>
Backlighting color	<input checked="" type="checkbox"/> white	<input type="checkbox"/> yellow/green	<input type="checkbox"/> blue	<input type="checkbox"/>
View direction	<input type="checkbox"/> 6:00	<input type="checkbox"/> 12:00	<input type="checkbox"/> 9:00	<input checked="" type="checkbox"/> Wide View
Operating temperature	<input type="checkbox"/> 0°C~50°C	<input checked="" type="checkbox"/> -20°C~70°C	<input type="checkbox"/>	
Storage temperature	<input type="checkbox"/> -20°C~60°C	<input checked="" type="checkbox"/> -30°C~80°C	<input type="checkbox"/>	
Controller	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Frame	<input type="checkbox"/> SPCC(black)	<input type="checkbox"/> Zinc plated	<input type="checkbox"/> stainless steel	<input checked="" type="checkbox"/> Without
Technology	<input type="checkbox"/> SMT	<input type="checkbox"/> COB	<input checked="" type="checkbox"/> COG	<input type="checkbox"/>
Power supply	<input type="checkbox"/> single +3.3V	<input checked="" type="checkbox"/> single +5.0V	<input type="checkbox"/> dual	<input type="checkbox"/> triplex
Data Transfer	<input checked="" type="checkbox"/> 8 Bit Parallel	<input type="checkbox"/> 4 Bit Parallel	<input type="checkbox"/> Serial	<input type="checkbox"/>

2.1 General

The TM320240ACCWVGWSA, Graphics LCM unit consists of 320 columns(segment)×240 rows(common) dot-matrix LCD panel, LCD driver on a single PCB without controller LSI.

2.2 Features

- ◆ Wide viewing direction. Wide Operating temperature.
- ◆ Requirements on environmental protection: RoHS.
- ◆ The contrast can be control by add a VR outside. Refer to page 8-“circuit” .

Notes:

- Color tone can slightly change with temperature and driving voltage.
- Color tone will be changed by backlight.

3 Mechanical data

Parameter	Standard Value	Unit
Display type	Dot-matrix module	--
Number of dots (W×H)	320×240	--
View area (W×H)	79.8 × 60.6	mm
Active Area (W×H)	76.785 × 57.585	mm
Dot Size (W×H)	0.225 × 0.225	mm
Dot Pitch (W×H)	0.24 × 0.24	mm
Module size(W×H×D)	91.5 × 75.0 × 6.6	mm
Module total weight (approx)	45	g
Module outline dimensions	Refer to page 6-“Outline drawing”	--

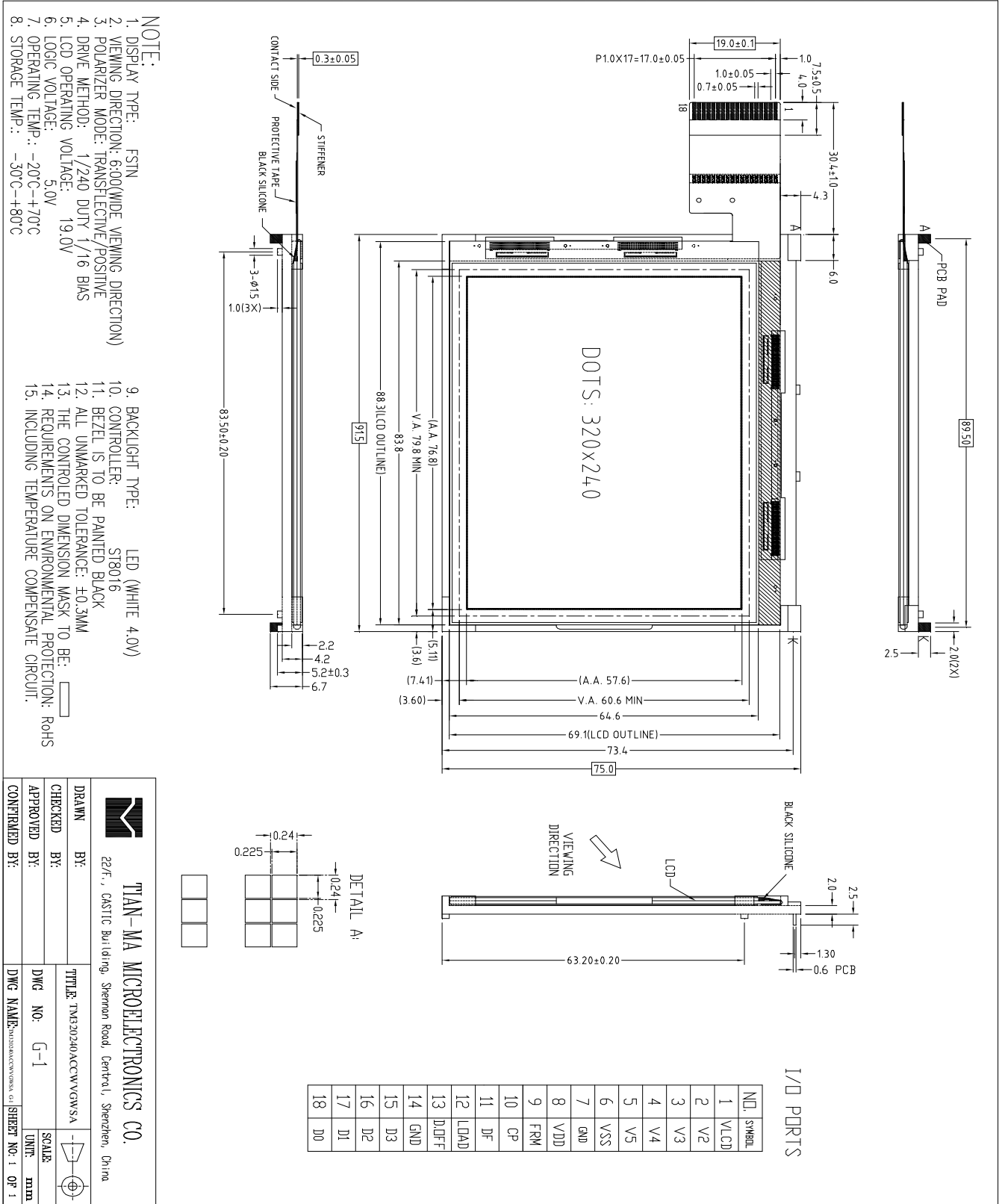
4 Absolute maximum ratings

(Without LED backlighting ,Ta=25℃)

Parameter	Symbol	Min	Max	Unit	Remark
Logic circuit supply voltage	V _{DD}	-0.3	7.0	V	
LCD driving voltage	V _{LCD}	-0.3	19.0	V	
Operating temperature range	Top	-20	+70	℃	No Condensation
Storage temperature range	Tst	-30	+80	℃	

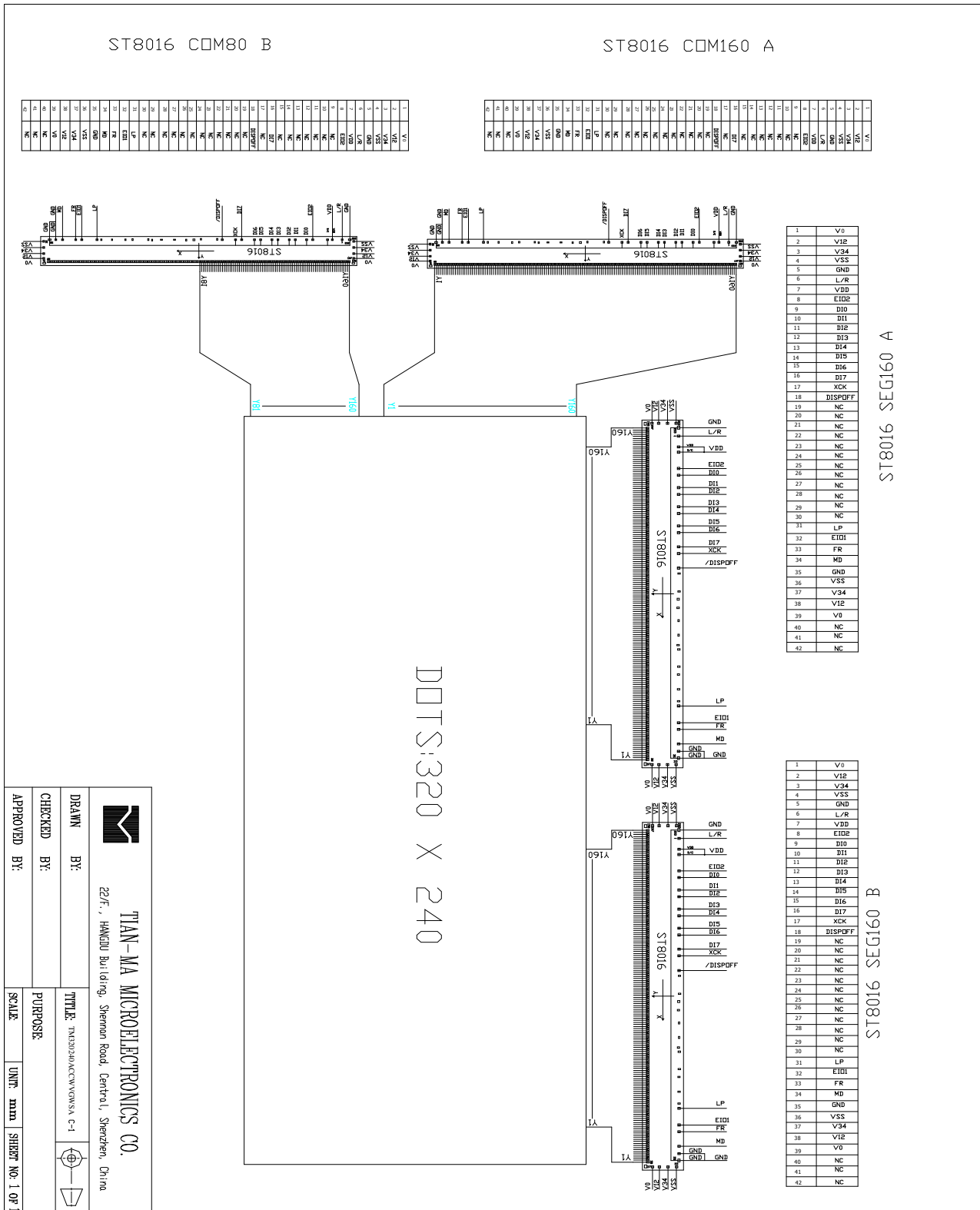
Notes:

- LCD operating voltage $V_{OP}=V_{LCD}-V_{SS}$.
- If the module is above these absolute maximum ratings. It may become permanently damaged. Using the module within the following electrical characteristic conditions are also exceeded, the module will malfunction and cause poor reliability, and its service life will reduce.
- $V_{LCD} > V_{SS}$ must be maintained.

5. Outline Drawing


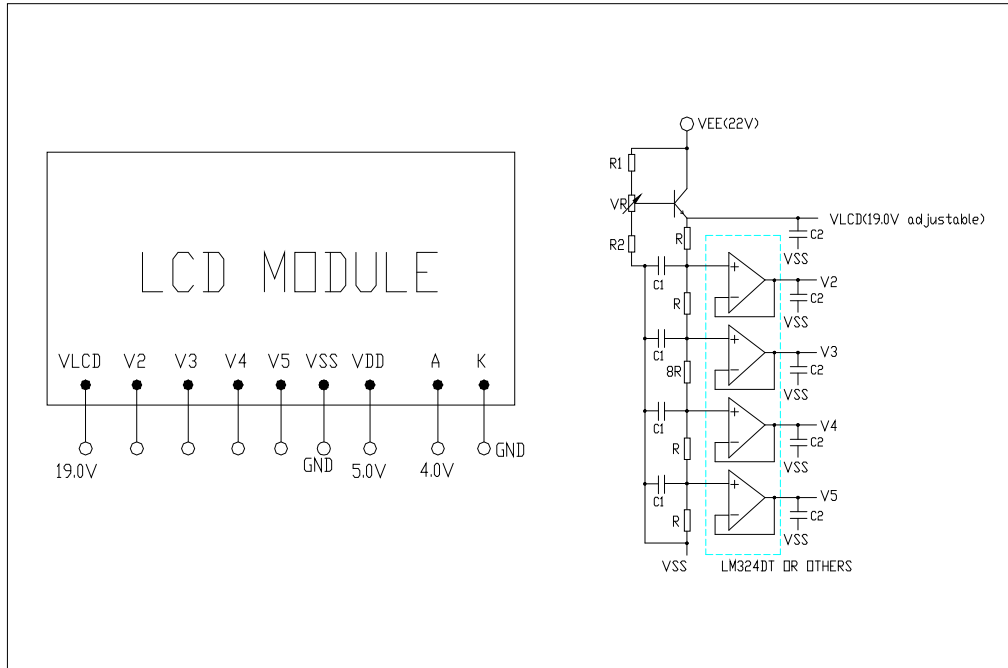
6. Circuit

6.1 Block Diagram



6.2 Recommend power supply circuit

Only for reference.



Note:

- If you want to control the module contrast outside, please add the VR and its circuit.

7 Pin connections

Pin No.	Symbol	Level	Description
1	VLCD	--	Bias power supply pins for LCD drive voltage. Ensure that the voltages are set such that: VLCD > V2 > V3 > V4 > V5 > VSS
2	V2	-	
3	V3	-	
4	V4	-	
5	V5	-	
6	VSS	0V	Ground pin
7	GND	0V	Ground pin
8	VDD	5V	Logic system power supply pin
9	FRM	H/L	Input/output pins for chip selection
10	CP	H/L	Clock input pin for taking display data
11	DF	H/L	AC signal input pin for LCD drive waveform
12	LOAD	H/L	Latch pulse input pin for display data
13	D.OFF	H/L	Control input pin for output of non-select level
14	GND	0V	Ground pin
15	D3	H/L	Data bit3
16	D2	H/L	Data bit2
17	D1	H/L	Data bit1
18	D0	H/L	Data bit0

8. Timing characteristics

8.1 COMMAND

The module TM320240ACCWVGWSA do not include the controller LSI, so there do not offer the code of command definition, it depend on the controller you choose. Please refer the SPEC. of controller you use.

8.2 Interface Timing characteristics

Note: Please refer to IC: ST8016 data sheet for more details.

AC Characteristics

(Segment Mode 2) ($V_{SS} = 0\text{ V}$, $V_{DD} = +5.0 \pm 0.5\text{ V}$, $V_0 = +15.0\text{ to }+30.0\text{ V}$, $T_{OPR} = -25\text{ to }+85\text{ }^\circ\text{C}$)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	NOTE
Shift clock period	t _{WCK}	t _r , t _f = 10ns	66			ns	1
Shift clock "H" pulse width	t _{WCKH}		23			ns	
Shift clock "L" pulse width	t _{WCKL}		23			ns	
Data setup time	t _{DS}		15			ns	
Data hold time	t _{DH}		23			ns	
Latch pulse "H" pulse width	t _{WLPH}		30			ns	
Shift clock rise to latch pulse rise time	t _{LD}		0			ns	
Shift clock fall to latch pulse fall time	t _{SL}		50			ns	
Latch pulse rise to shift clock rise time	t _{LS}		30			ns	
Latch pulse fall to shift clock fall time	t _{LH}		30			ns	
Latch pulse fall to shift clock rise time	t _{LSW}		50			ns	
Enable setup time	t _S		15			ns	
Input signal rise time	t _R				50	ns	2
Input signal fall time	t _F				50	ns	2
DISPOFF removal time	t _{SD}		100			ns	
DISPOFF "L" pulse width	t _{WDL}		1.2			μs	
Output delay time (1)	t _D	CL = 15 pF			41	ns	
Output delay time (2)	t _{PD1} , t _{PD2}	CL = 15 pF			1.2	μs	
Output delay time (3)	t _{PD3}	CL = 15 pF			1.2	μs	

NOTES:

1. Takes the cascade connection into consideration.
2. (t_{WCK} - t_{WCKH} - t_{WCKL})/2 is maximum in the case of high speed operation.

(Common Mode) ($V_{SS} = 0\text{ V}$, $V_{DD} = +2.5\text{ to }+5.5\text{ V}$, $V_0 = +15.0\text{ to }+30.0\text{ V}$, $T_{OPR} = -25\text{ to }+85\text{ }^\circ\text{C}$)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Shift clock period	t _{WLP}	t _r , t _f = 20ns	250			ns
Shift clock "H" pulse width	t _{WLPH}	V _{DD} = +5.0 ± 0.5V	15			ns
		V _{DD} = +2.5 + 4.5V	30			ns
Data setup time	t _{SU}		30			ns
Data hold time	t _H		50			ns
Input signal rise time	t _R				50	ns
Input signal fall time	t _F				50	ns
DISPOFF removal time	t _{SD}		100			ns
DISPOFF "L" pulse width	t _{WDL}		1.2			μs
Output delay time (1)	t _D	CL = 15 pF			200	ns
Output delay time (2)	t _{PD1} , t _{PD2}	CL = 15 pF			1.2	μs
Output delay time (3)	t _{PD3}	CL = 15 pF			1.2	μs

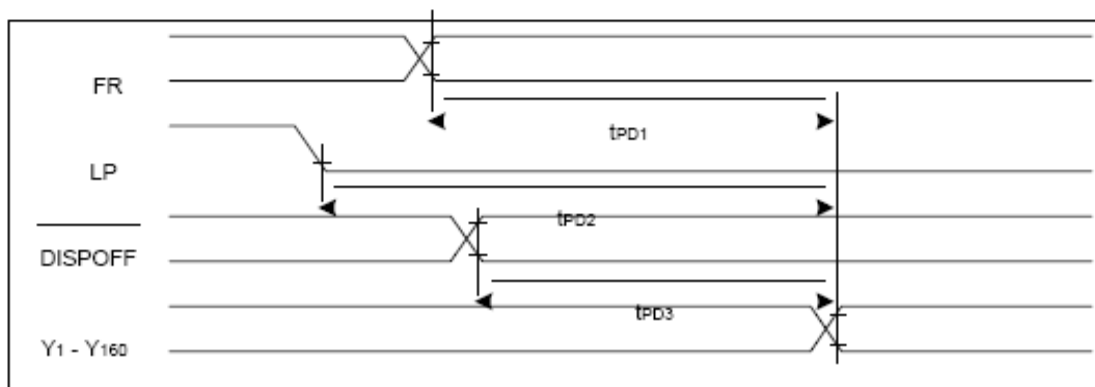
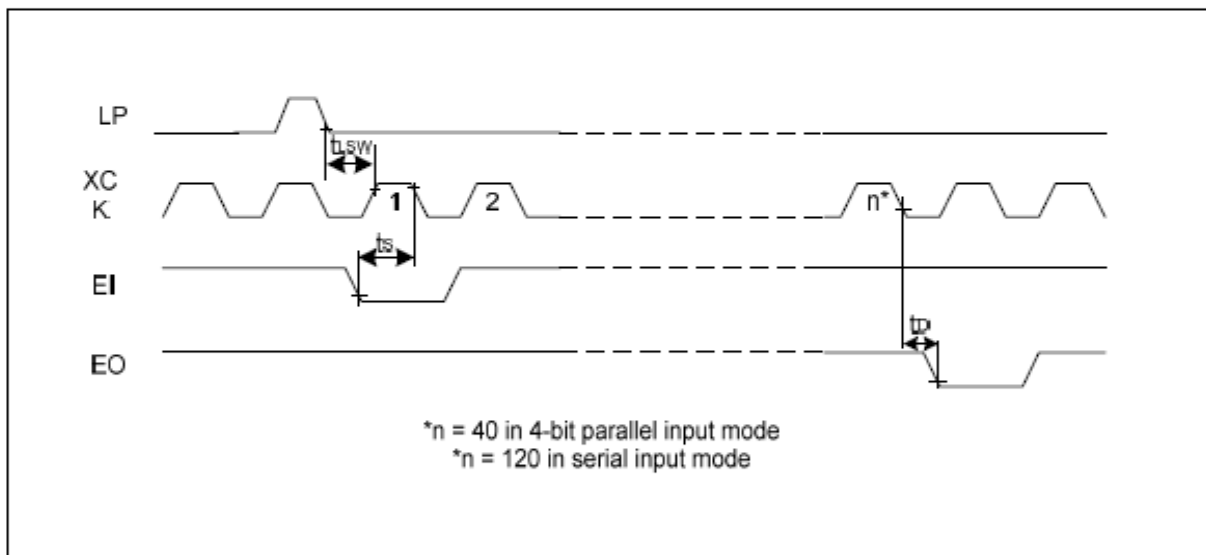
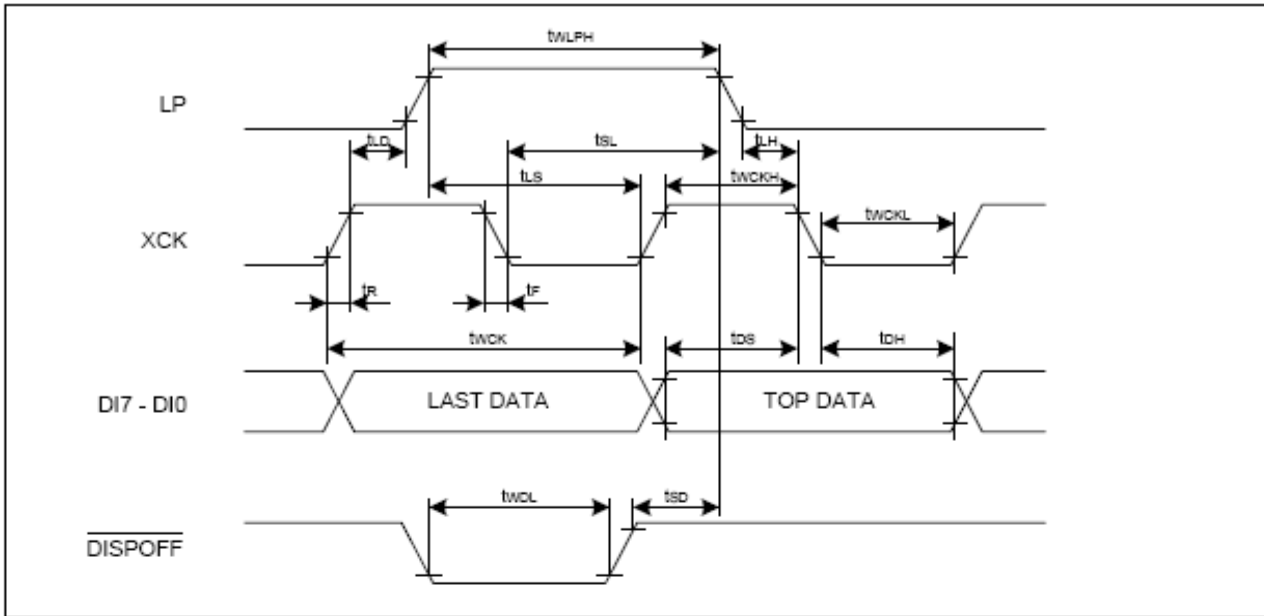


Figure1. Timing Chart of Segment Mode

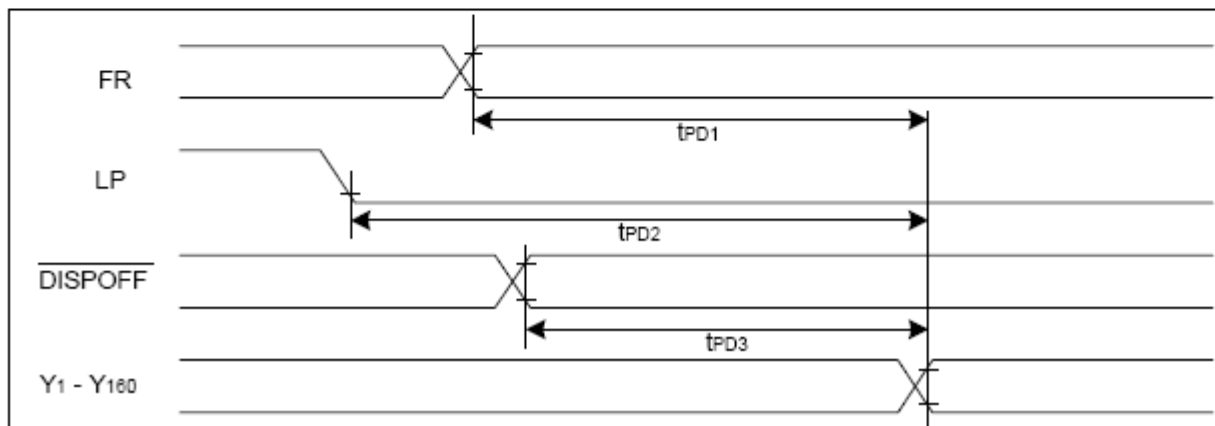
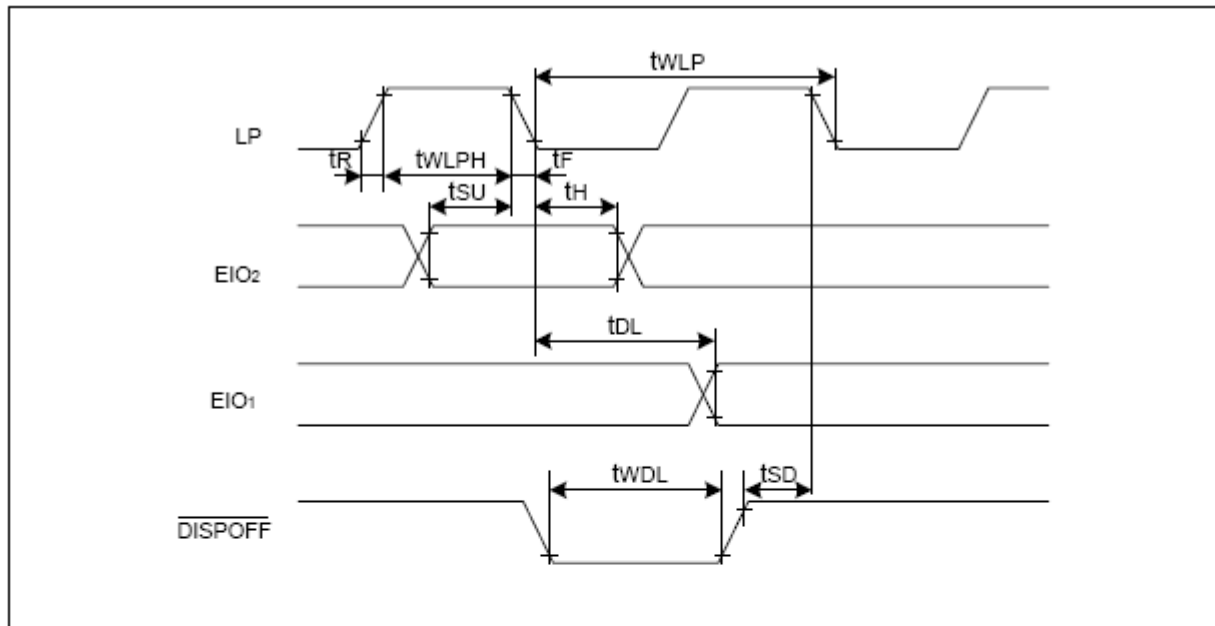


Figure2. Timing Chart of Common Mode

8.3 character generator code map

Please refer the SPEC of controller.

9 Electrical characteristics

$V_{SS}=0V$, $T_a=25^\circ C$

Item	Symbol	Condition	MIN	TYP	MAX	UNIT
Logic circuit supply voltage	V_{DD}	--	4.5	5.0	5.5	V

LCD operation voltage		V_{op}	-20°C	-	TBD	-		
			0°C	19.1	19.3	19.5		
			25°C	18.8	19.0	19.2		
			40°C	18.5	18.7	18.9		
			70°C	-	TBD			
Input voltage for logic circuit	“H”level	V_{IH}	$V_{DD}=5.0V$	$0.8V_{DD}$	--	--		
	“L”level	V_{IL}		--	--	$0.2V_{DD}$		
Output voltage for logic circuit	“H”level	V_{OH}		$V_{DD}-0.4$	--	--		
	“L”level	V_{OL}		--	--	0.4		
Logic power supply current (Without backlighting and Display character)		I_{CC} ($F_{OSC}=270KHz$)		--	30	35		mA
Used driver IC		ST8016 of Sitronix						

10 LED backlight characteristics

 $T_a=25^{\circ}C$

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Forward voltage	V_f	$I_f=75mA$	--	4.0	4.2	V
Forward current	I_f	$V_f=4.0V$	--	75	100	mA
Reverse voltage	V_r	--	--	--	10	V
Reverse Current	I_r	--	--	45	60	uA
Luminous intensity*	B_p	$I_f=75mA$	250	--	--	cd/m ²
Luminous Uniformity*	ΔB_p		75	--	--	%
Color coordinate*	X		0.283	--	0.330	--
	Y		0.276	--	0.339	--

Note:

- Measured at the bare LED backlight unit.
- If the backlight is above these maximum ratings for long time, the service life of the LED backlight will reduce or it will cause poor reliability.

11 Optical Characteristics

11.1 Optical Characteristics

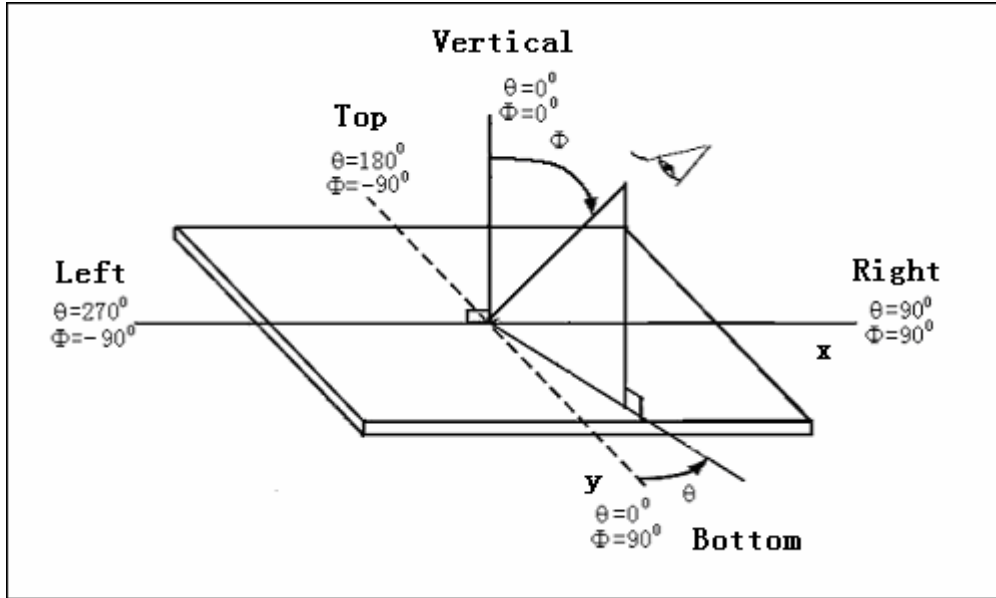
 $T_a=25^{\circ}C$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
------	--------	-----------	------	------	------	------

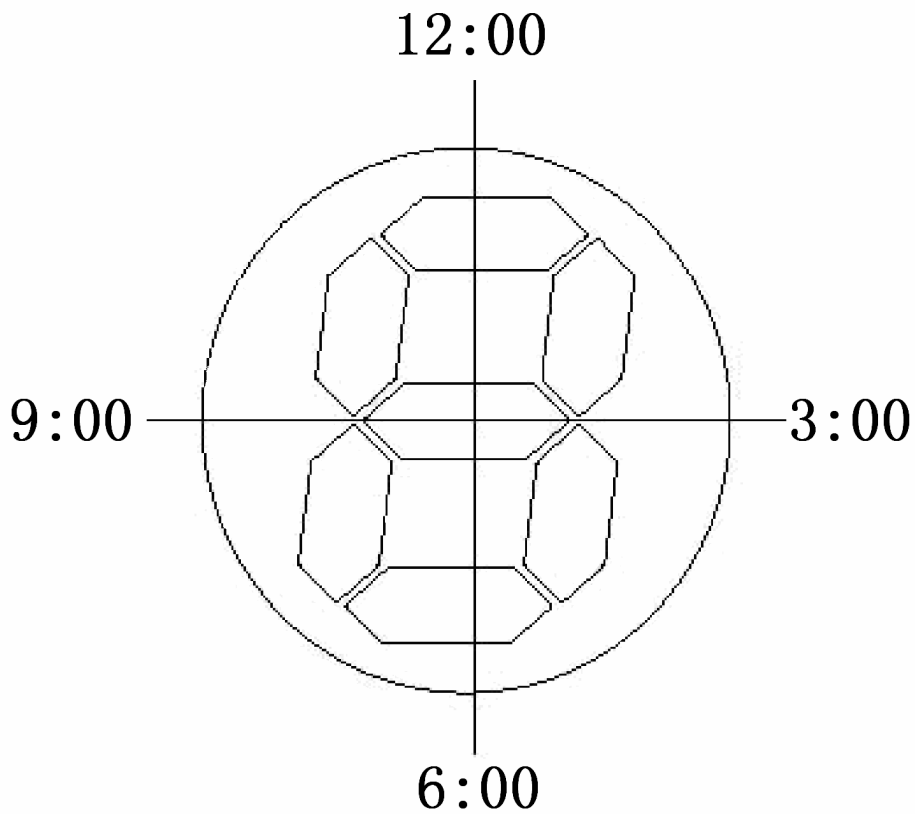
Transmission		T	--	10%	16%	--	--	
Viewing Angle		θ_x	Cr \geq 2	$\theta_y = 0^\circ$	-45 -- 60		Deg	
		θ_y		$\theta_x = 0^\circ$	-30 -- 30			
Viewing Angle		θ_x	Cr \geq 5	$\theta_y = 0^\circ$	--		Deg	
		θ_y		$\theta_x = 0^\circ$	--			
Contrast Ratio		Cr	$\theta_x = 0^\circ$ $\theta_y = 0^\circ$	--	10.0	--		
Response Time	Turn on	Ton	$\theta_x = 0^\circ$ $\theta_y = 0^\circ$ A wave, f=70Hz	Tamb= +22°C	--	--	250	ms
				0°C	--	--	--	
				-10°C	--	--	--	
				-20°C	--	--	--	
	Turn off	Toff		$\theta_x = 0^\circ$ $\theta_y = 0^\circ$	--	--	200	
					--	--	--	
					--	--	--	
					--	--	--	

11.2 Definition of Optical Characteristics

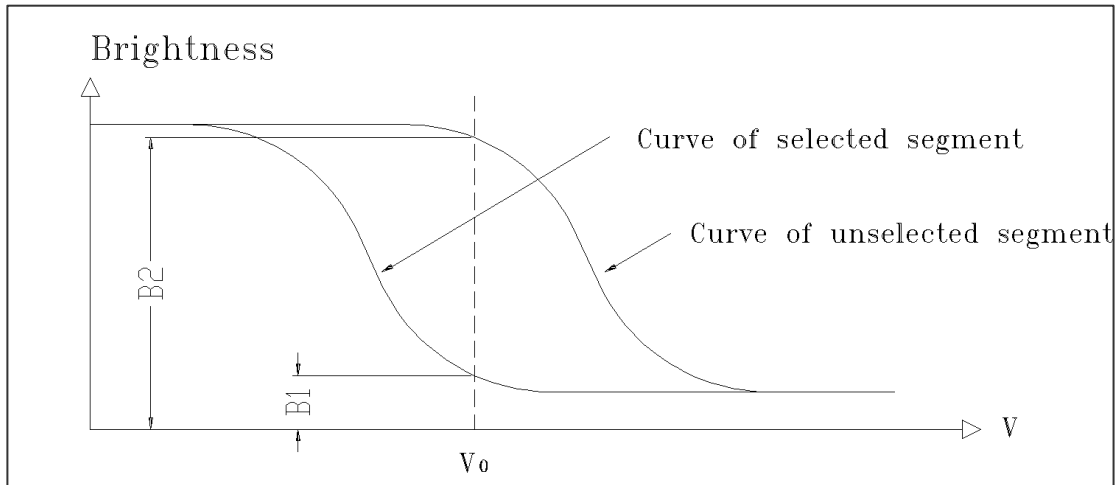
11.2.1 Definition of Viewing Angle



11.2.2 Indication of Viewing Angle



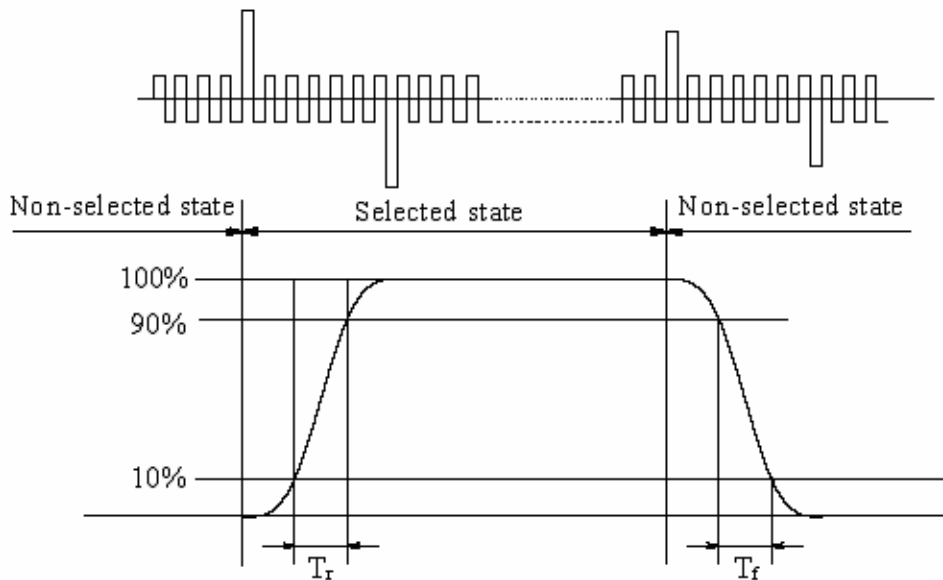
11.2.2 Definition of Contrast Ratio



$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

- Measuring Conditions:
- 1) Ambient Temperature: 25°C
 - 2) Frame frequency: 70Hz
 - 3) Operating voltage: $V_{op}=19V$
 - 4) Applying waveform: 1/240 duty 1/16 bias
 - 5) View angle (θ , ϕ): (0° , 0°)

11.2.3 Definition of Response time Test (LCD using DMS501)



Turn on time: $t_{on} = t_r$ Turn off time: $t_{off} = t_f$

- Measuring Condition:
- 1) Operating Voltage: $V_{op}=19V$
 - 2) Frame frequency: 70Hz
 - 3) Applying waveform: 1/240duty 1/16bias
 - 4) View angle (θ , ϕ): (0° , 0°)

12 Reliability

12.1 Content of Reliability Test

Ta=25°C

No.	Test Item	Content of Test	Test condition	Criterion
1	High Temperature Storage	Endurance test applying the high storage temperature for a long time	80°C 240H	Remark1 Remark2 Remake3 Remake4
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-30°C 240H	
3	High Temperature Operation	Endurance test applying the electric stress (voltage and current) and the thermal stress to the element for a long time	70°C 240H	
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time	-20°C 240H	
5	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	40°C 90%RH 240H	
6	Temperature Cycle	Endurance test applying the low and high temperature cycle $ \begin{array}{c} -30^{\circ}\text{C} \longleftrightarrow 25^{\circ}\text{C} \longleftrightarrow 80^{\circ}\text{C} \longleftrightarrow 25^{\circ}\text{C} \\ \begin{array}{cccc} 30\text{min} & 5\text{min} & 30\text{min} & 5\text{min} \end{array} \\ \longleftarrow \hspace{10em} \longrightarrow \\ \text{1 cycle} \end{array} $	-30°C/80°C 10 cycles	
7	Vibration Test (package state)	Endurance test applying the vibration during transportation	10Hz~150Hz, 100m/s ² , 120min	Remark1 Remark5 Remark6
8	Shock Test (package state)	Endurance test applying the shock during transportation	Half- sine wave, 300m/s ² ,18ms	
9	Atmospheric Pressure Test	Endurance test applying the atmospheric pressure during transportation by air	25kPa 16H Restore 2H	

Notes:

- Each test item applies for a test sample only once, The test sample can not be used again in any other test item.
- The test sample is inspected after 2 hours or more storing at room temperature and room humidity after each test item is finished.
- The criteria refer to 12.2.

12.2 Inspection of criteria

Remark NO.	Content
1	Functional test is OK. Missing Segment, shorts, unclear segment, nondisplay, display abnormally, liquid crystal leak are unallowable.
2	After testing, cosmetic defects should not happen, no low temperature bubbles, seal loose and fall, frame rainbow, ACF bubble growing are unallowable in the appearance test.
3	Total current consumption should not be over 10% of initial value.
4	After tests being executed, Contrast must be larger than 70% of its initial value prior to the tests.
5	No glass crack, chipped glass, end seal loose frame crack and so on.
6	No structure loose and fall.

12.3 LCD module service life

Functions, performance, appearance, etc. shall be free from remarkable deterioration within 100,000 hours under ordinary operating and storage conditions room temperature ($25^{\circ}\text{C} \pm 10^{\circ}\text{C}$).

12.4 Definition of module service life

- Contrast becomes 30% of initial value.
- Current consumption becomes three times higher than initial value.
- Remarkable alignment deterioration occurs in LCD cell layer.
- Unusual operation occurs in display functions

13 Quality level

Examination or Test	At T _a =25°C (Unless otherwise stated)	Inspection				
		Min.	Max.	Unit	IL	AQL
External Visual Inspection	Under normal illumination and eyesight condition, the distance between eyes and LCD is 25cm.	See annex A			II	Major 1.0 Minor 2.5
Display Defects	Under normal illumination and eyesight condition, display on inspection.	See annex B			II	Major 1.0 Minor 2.5
Note: Major defects: Open segment or common, Short, Serious damages, Leakage Minor defects: Others Sampling standard conforms to GB2828						

14 Precautions for Use of LCD Modules

14.1 Handling Precautions

14.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

14.1.2 Liquid in LCD is hazardous substance, if the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, thoroughly and promptly wash it off using soap and water.

14.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

14.1.4 Don't touch, push or rub the exposed polarizer covering the display surface of the LCD module with anything harder than an HB pencil lead, the polarizer is soft and easily scratched, handle it carefully.

14.1.5 Don't put or attach anything on the display area to avoid leaving any marks on.

14.1.6 If the display surface is contaminated or becomes dusty, breathe on the surface and gently wipe it with a soft dry cloth. do not scrub hard to avoid damage the surface. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Water
- Ketone
- Aromatic solvents

14.1.7 Do not attempt to disassemble the LCD Module.

14.1.8 If the logic circuit power is off, do not apply the input signals.

14.1.9 Avoid using the same display pattern long time (continuous ON segment).Software must be prepared so that the pattern will be changed

14.1.10 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- a. Be sure to ground the body and electric appliances when handling the LCD Modules. It is preferable to use conductive mat on table and wear cotton clothes or conductive processed fibre. Synthetic fibre is not recommended.
- b. Tools required for assembly, such as soldering irons, must be properly ground.
- c. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
- d. The LCD Module is coated with a film to protect the display surface. Be careful and slow when peeling off this protective film since static electricity may be generated. It is recommended to use ionic fan or machine when operating. It is recommended to remove the protection foil slowly (> 3 sec.).
- e. It is preferable to wear gloves etc, to avoid damaging the LCD. Please do not touch electrodes with bare hands or avoid any other contamination.

14.2 Storage precautions

14.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

14.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : 5°C ~ 40°C

Relatively humidity: ≤80%

14.2.3 The LCD modules should be stored in a clean environment or room, free from acid, alkali and harmful gas.

14.2.4 Store the module in anti-static electricity container and without any physical load.

14.3 Transportation precautions

The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

14.4 Soldering

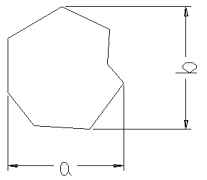
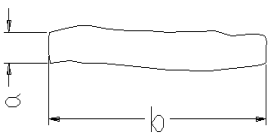
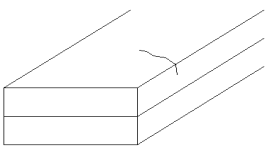
14.4.1 Use the high quality solders, only solder the I/O terminals.

14.4.2 No higher than 280°C and time less than 3-4 second during soldering.

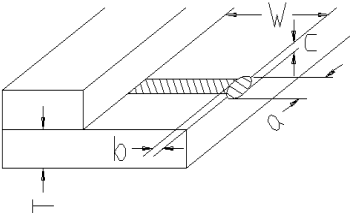
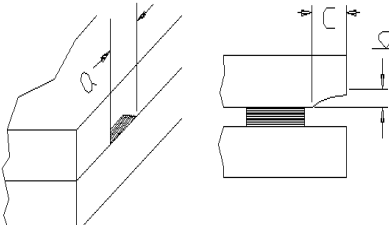
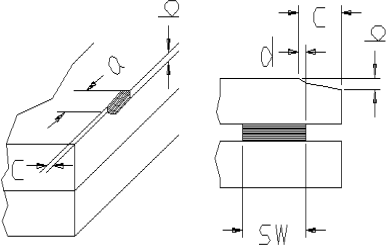
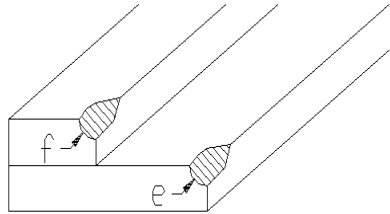
14.4.3 Rewiring: no more than 3 times.

14.4.4 when you remove connector or cable soldered to I/O terminals, please confirm that solder is fully melted. If you remove by force, electrodes at I/O terminals may be damaged (or stripped off). It is recommended to use solder suction machine.

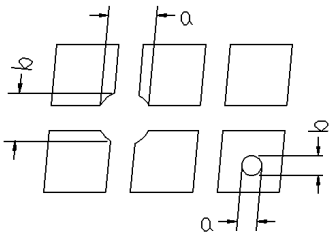
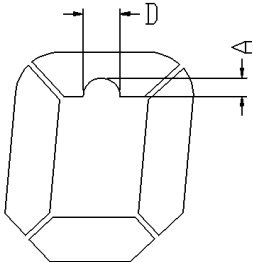
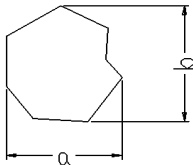
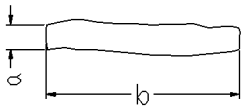
Appendix A
Inspection items and criteria for appearance defects

Items	Contents	Criteria		
Protective Glue		No clear defects		
Cover Tape		Covering all of the chip and no clear crimple		
Leakage		Not permitted		
Rainbow		According to the limit specimen		
Polarizer	Wrong polarizer attachment	Not permitted		
	Bubble between polarizer and glass	Not counted	Max. 3 defects allowed	
		$\phi < 0.3\text{mm}$	$0.3\text{mm} \leq \phi \leq 0.5\text{mm}$	
	Scratches of polarizer	According to the limit specimen		
Black spot (in viewing area)		Not counted	Max. 3 spots allowed	
		$X < 0.20\text{mm}$	$0.20\text{mm} \leq X \leq 0.5\text{mm}$	
		$X = (a+b)/2$		
Black line (in viewing area)		Not counted	Max. 3 lines allowed	
		$a < 0.02\text{mm}$	$0.02\text{mm} \leq a \leq 0.05\text{mm}$ $b \leq 2.0\text{mm}$	
Progressive cracks		Not permitted		

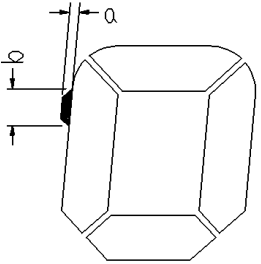
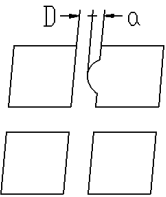
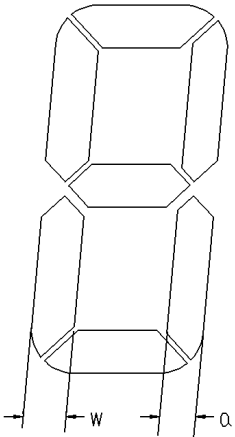
Appendix A (continued)

Item	Contents	Criteria					
Glass Cracks	Cracks on pads 	a	b	c	Max. 2 Cracks allowed	Max. 5 cracks allowed	
	$\leq 3\text{mm}$	$\leq W/5$	$\leq T/2$				
	$\leq 2\text{mm}$	$\leq W/5$	$T/2 < C < T$				
	Cracks on contact side 	a	b		Max. 2 cracks allowed		
	$\leq 3\text{mm}$	$\leq T/2$					
	$\leq 2\text{mm}$	$T/2 < b < T$					
	C shall be not reach the seal area						
	Cracks on non-contact side 	a	b		Max. 2 cracks allowed		
	$\leq 3\text{mm}$	$\leq T/2$					
	$\leq 2\text{mm}$	$T/2 < b < T$					
$C \leq 0.5\text{mm}$							
$d \leq SW/3$							
Corner cracks 	$e < 2.0\text{mm}^2$ $f < 2.0\text{mm}^2$			Max. 3 cracks allowed			

Appendix B
Inspection items and criteria for display defects

Items	Contents	Criteria		
Open segment or open common		Not permitted		
Short		Not permitted		
Wrong viewing angle		Not permitted		
Contrast ratio uneven		According to the limit specimen		
Crosstalk		According to the limit specimen		
Pin holes and cracks in segment (DOT)		Not counted	Max.3 dots allowed	Max.3 dots allowed
		$X < 0.1\text{mm}$	$0.1\text{mm} \leq X \leq 0.2\text{mm}$	
		$X = (a+b)/2$		
		Not counted	Max.2 dots allowed	
$A < 0.1\text{mm}$	$0.1\text{mm} \leq A \leq 0.2\text{mm}$ $D < 0.25\text{mm}$			
Black spot (in viewing area)		Not counted	Max.3 spots allowed	Max.3 spots (lines) allowed
		$X < 0.1\text{mm}$	$0.1\text{mm} \leq X \leq 0.2\text{mm}$	
		$X = (a+b)/2$		
Black line (in viewing area)		Not counted	Max.3 lines allowed	
		$a < 0.02\text{mm}$	$0.02\text{mm} \leq a \leq 0.05\text{mm}$ $b \leq 0.5\text{mm}$	

Appendix B (continued)

Items	Content	Criteria		
Transformation of segment		Not counted	Max. 2 defects allowed	
		$x < 0.1\text{mm}$	$0.1\text{mm} \leq x \leq 0.2\text{mm}$	
		$x = (a+b)/2$		
		Not counted	Max. 1 defects allowed	
		$a < 0.1\text{mm}$	$0.1\text{mm} \leq a \leq 0.2\text{mm}$ $D > 0$	
		Max.2 defects allowed $0.8W \leq a \leq 1.2W$ a = measured value of width W = nominal value of width		

Max.3 defects allowed