MULTI-INNO TECHNOLOGY CO., LTD.

LCD MODULE SPECIFICATION

Model : MI320240I-1

Revision	
Engineering	
Date	
Our Reference	

REVISION RECORD

Version	Revision Items	Name	Date
0.0	First release		2006.3.14
0.1	Add power supply circuit		2006.9.30

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1. LCD Module Part Numbering System

MI	320240	I	-1
①	②	③	④

NO.	Explanation	
①	MULTIHNNO TECHNOLOGY CO.,LTD. module indicating	
②	Module type: 320 columns X 240 rows, 6 DIGITS	
③	MULTIHNNO module series	
④	LCM PART NUMBER	
	1	

2 Basic specification

Item	Contents			
LCD type	☐TN	☐STN	■FSTN	☐
	■positive	☐negative		
LCD Duty	☐64	☐128	■240	☐
LCD Bias	☐1/9	☐1/12	■1/16	☐
Polarizer	☐reflective	■transflective	☐transmissive	
LCD background color	☐grey	☐yellow/green	☐blue-black	■White
Segment color	☐white	■blue-black	☐	
Backlighting	■LED	☐EL	☐CFL	☐
LED type	■edge	☐area	☐	☐
Backlighting color	■white	☐yellow/green	☐blue	☐
View direction	☐6:00	☐12:00	☐9:00	■Wide View
Operating temperature	☐0℃~50℃	■-20℃~70℃	☐	
Storage temperature	☐-20℃~60℃	■-30℃~80℃	☐	
Controller	☐T6963C	☐S1D13305	■S1D13700	☐
Frame	☐SPCC(black)	☐Zinc plated	☐stainless steel	■SUS430
Technology	■SMT	☐COB	☐COG	☐
Power supply	☐single +3.3V	☐single +5.0V	■dual	☐triplex
Data Transfer	■8 Bit Parallel	☐4 Bit Parallel	☐Serial	☐

2.1 General

The MI320240I-1, Graphics LCM unit consists of 320(segment) x 240(common) dots dot-matrix LCD panel, LCD driver, controller LSI on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the unit can efficiently display the desired character under microprocessor control.

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” .
- Including DC-DC and Temperature Compensate Circuit. The function of DC-DC Circuit and Temperature Compensate Circuit is optional, the default of the function is enabled.
- LED serial resistor:R40//R41= 2.2Ω//2.2Ω .

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	Graphics module	--
Number of dots/characters (W×H)	320 x 240	--
View area (W×H)	119.80 x 90.6	mm
Active Area (W×H)	115.17 x 86.37	mm
Dot Size (W×H)	0.33 x 0.33	mm
Dot Pitch (W×H)	0.36 x 0.36	mm
Module size(W×H×D)	160.0 x 109.0 x 14.0(MAX)	mm
Module total weight (approx)	230	g
Module outline dimensions	Refer to page 6-"Outline drawing"	--

4 Absolute maximum ratings

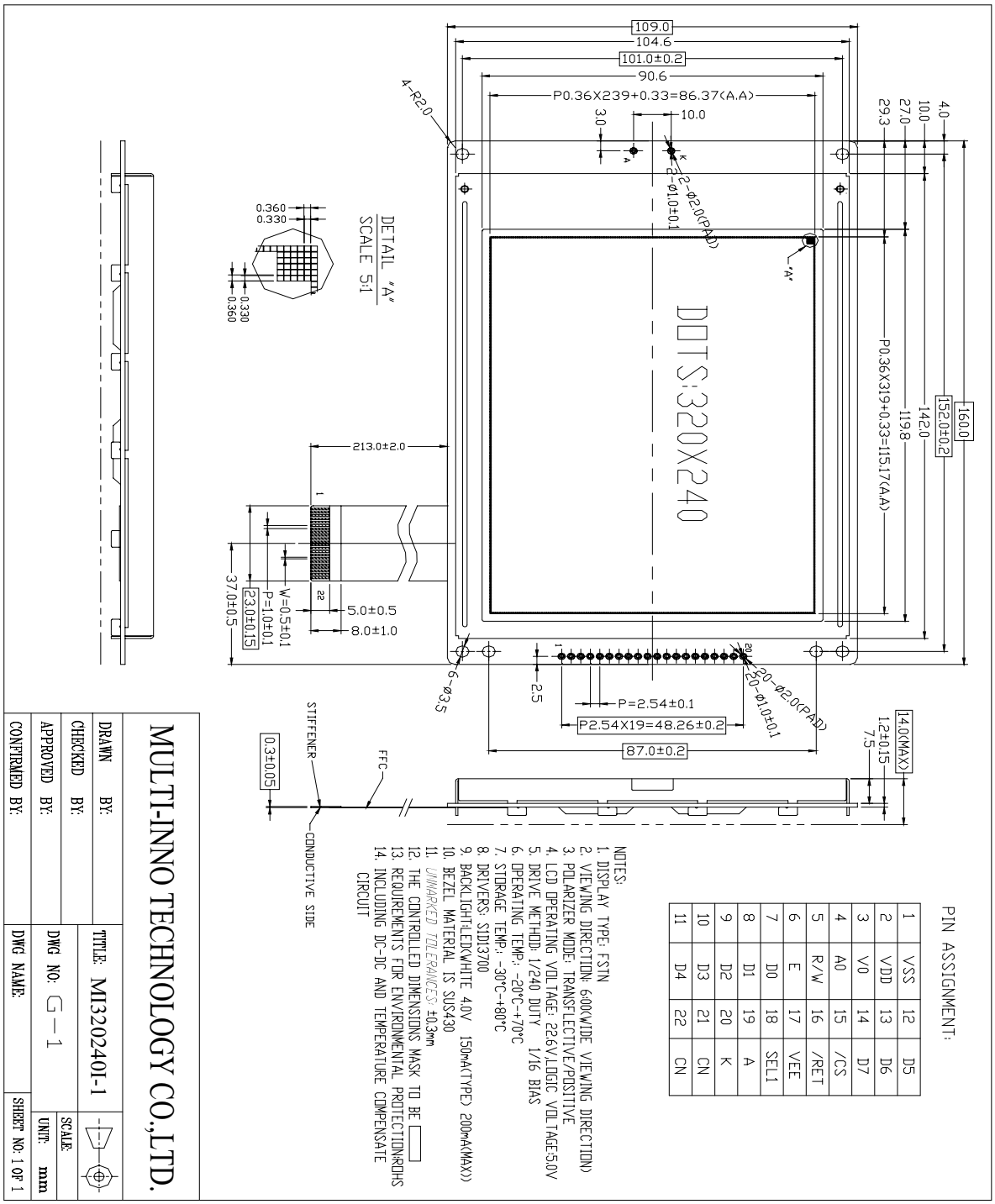
(Without LED backlighting ,Ta=25℃)

Parameter	Symbol	Min	Max	Unit	Remark
Logic circuit supply voltage	V_{DD}	-0.3	+6.0	V	
Logic circuit supply negative voltage	V_{EE}	-24.0	0	V	
LCD driving voltage	V_{LCD}	-0.3	+28.5	V	
Operating temperature range	Top	-20	+70	℃	No Condensation
Storage temperature range	Tst	-30	+80	℃	

Note :

- LCD operating voltage $V_{LCD}=V_{DD}-V_{0.}$
- 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.
- $V_{DD}>V_{SS}$ must be maintained.

5. Outline Drawing



NOTES:
1. DISPLAY TYPE: FSTN
2. VIEWING DIRECTION: 6:00(WIDE VIEWING DIRECTION)
3. POLARIZER MODE: TRANSFLECTIVE/POSITIVE
4. LCD OPERATING VOLTAGE: 22.6V,LOGIC VOLTAGE:5.0V
5. DRIVE METHOD: 1/240 DUTY 1/16 BIAS
6. OPERATING TEMP.: -20°C~+70°C
7. STORAGE TEMP.: -30°C~+80°C
8. DRIVERS: SIDI3700
9. BACKLIGHT:LED(WHITE 4.0V 150mA(TYPE) 200mA(MAX))
10. BEZEL MATERIAL IS SUS430
11. UNMARKED TOLERANCES: ±0.3mm
12. THE CONTROLLED DIMENSIONS MASK TO BE □
13. REQUIREMENTS FOR ENVIRONMENTAL PROTECTION:ROHS
14. INCLUDING DC-DC AND TEMPERATURE COMPENSATE CIRCUIT

PIN ASSIGNMENT:

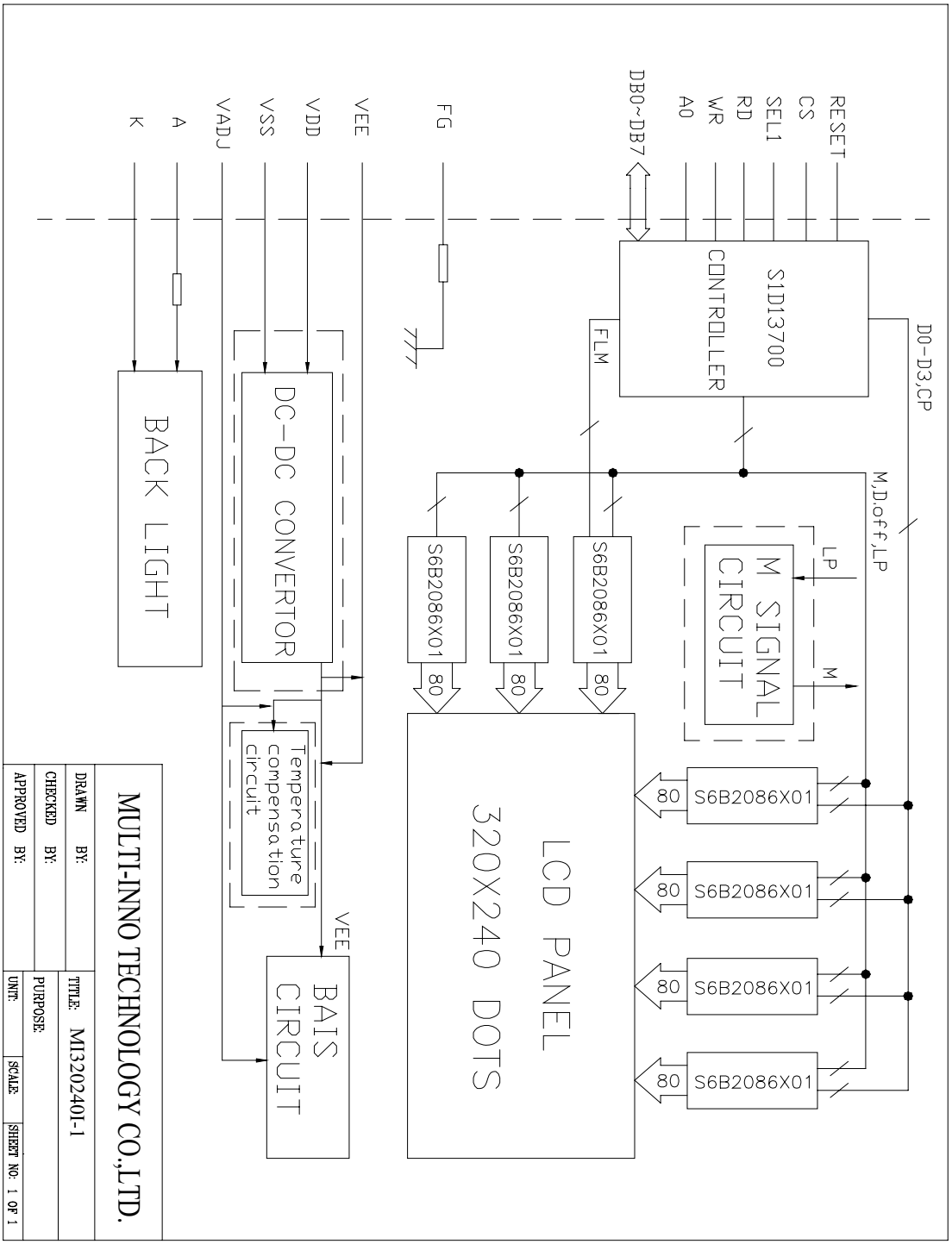
1	VSS	12	D5
2	VDD	13	D6
3	V0	14	D7
4	A0	15	/CS
5	R/W	16	/RET
6	E	17	VEE
7	D0	18	SEL1
8	D1	19	A
9	D2	20	K
10	D3	21	CN
11	D4	22	CN

MULTI-INNO TECHNOLOGY CO.,LTD.

DRAWN BY:		TITLE: MI320240I-1	
CHECKED BY:			
APPROVED BY:		DWG NO: G-1	SCALE:
CONFIRMED BY:		DWG NAME:	UNIT: mm
			SHEET NO: 1 OF 1

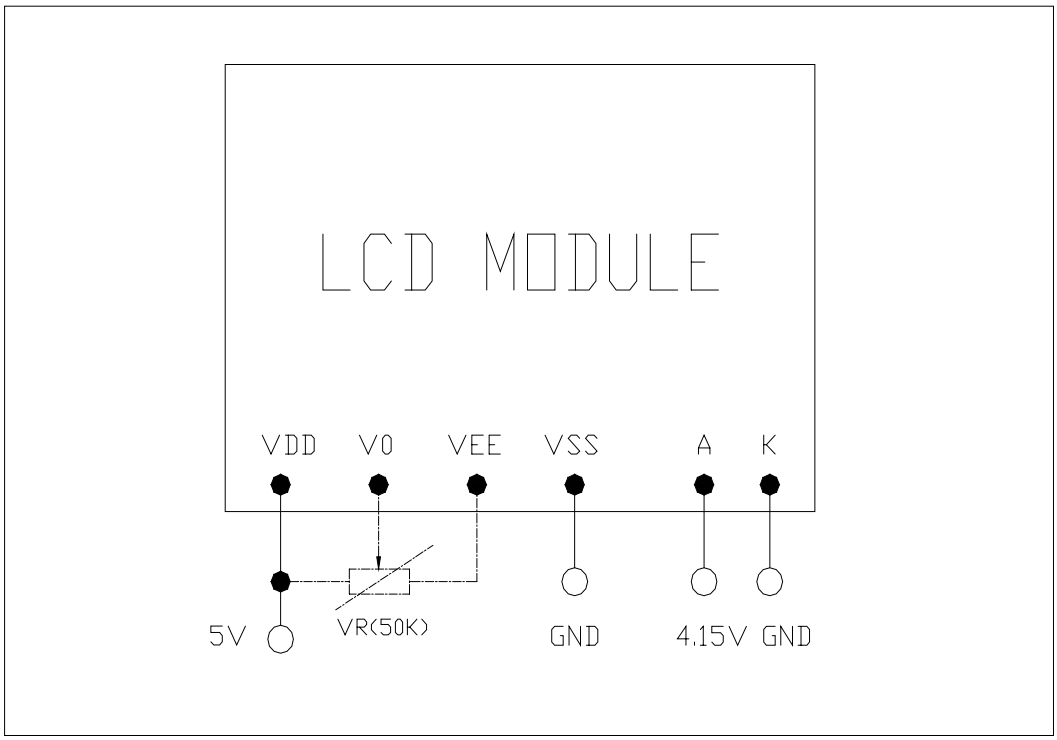
6. Circuit

6.1 Block Diagram



6.2 Recommend power supply circuit

Only for reference.



Note:

- The V_{EE} comes form V_{DD} by DC-DC circuit, if you do not want to control the contrast of module outside, please don't add the VR.
- The Temp. Compensate circuit can offer the function of adjusting contrast.
- If you want to input V_{EE} direct from external power and don't need the DC-DC circuit, please remove the resistance R28/R29 on the PCB board.

7 Pin connections

Pin No.	Symbol	Level	Description
1	V_{SS}	0V	Ground
2	V_{DD}	5.0V	Power supply voltage for logic and LCD(+)
3	V_0	--	Adjustable operating voltage for LCD(-)
4	A0	H/L	AC signal for LCD driver output
5	R/W	H/L	Selects read or write
6	E	H/L	Data read/write enable signal
7	D0	H/L	Data bit0
8	D1	H/L	Data bit1
9	D2	H/L	Data bit2
10	D3	H/L	Data bit3
11	D4	H/L	Data bit4
12	D5	H/L	Data bit5
13	D6	H/L	Data bit6
14	D7	H/L	Data bit7
15	/CS	H/L	Chip Enable Signal (active at low)
16	/RET	H/L	Reset Signal (Initialize at low)
17	VEE	--	Power supply voltage for LCD(-)
18	SEL1	H/L	Select the host bus interface. (H:6800 series L:8080 series)
19	A	4.0V	Power supply voltage for LED(+)
20	K	0	Power supply voltage for LED(-)
21	NC	-	No signal
22	NC	-	No signal

8 Instruction Code & Timing characteristics

8.1 COMMAND

The module MI320240I-1 include the controller-S1D13700. When indirect mode is selected for the system interface, use commands to set up the display. The table below lists the types of commands, including the code of each command. more details refer to S1D13700 data sheet please.

Purpose	Command	Code									Command description	No. of para.	Remarks
		WR/RD/AB0	DB BIN 7	6	5	4	3	2	1	0	DB HEX			
Operation control	SYSTM SET	1 0 1	0	1	0	0	0	0	0	0	40	Sets initial operation and window size.	8	
	SLEEP IN	1 0 1	0	1	0	1	0	0	1	1	53	Sleep operation.	0	Note
Display control	DISPON/OFF	1 0 1	0	1	0	1	1	0	0	D	58 • 59	Instructs to turn display on or off and make the screen flash on and off.	1	Note
	SCROLL	1 0 1	0	1	0	0	0	1	0	0	44	Sets the display start address and display area.	10	
	CSRFORM	1 0 1	0	1	0	1	1	1	0	1	5D	Sets the cursor shape, etc.	2	
	CSRDIR	1 0 1	0	1	0	0	1	1	CD 1	CD 0	4C – 4F	Sets the direction of cursor movement.	0	
	OVLAY	1 0 1	0	1	0	1	1	0	1	1	5B	Instructs screen overlay mode.	1	
	CGRAM ADR	1 0 1	0	1	0	1	1	1	0	0	5C	Sets the start address of CG RAM.	2	
	HDOT SCR	1 0 1	0	1	0	1	1	0	1	0	5A	Sets the horizontal direction dot unit and scroll position.	1	
	GRAY SCALE	1 0 1	0	1	1	0	0	0	0	0	60	Sets grayscale mode.	0	
Drawing control	CSRW	1 0 1	0	1	0	0	0	1	1	0	46	Sets the cursor address.	2	Note
	CSRR	1 0 1	0	1	0	0	0	1	1	1	47	Instructs to read the cursor address.	2	Note
Memory control	MWRITE	1 0 1	0	1	0	0	0	0	1	0	42	Instructs to write to display memory.	—	Note
	MREAD	1 0 1	0	1	0	0	0	0	1	1	43	Instructs to read display memory data.	—	

As a rule, each command is executed every time a parameter for the command is input to the S1D13700, and completed before the next parameter (P) or command (C) is input. Therefore, the MPU can stop sending parameters in the middle and send the next command. In this case, the parameters that have already been sent are effective and other parameters not input to the S1D13700 retain their original values. However, two-byte parameters are handled as described below.

Note :

- CSRW and CSRR commands: The parameter is executed one byte at a time. Therefore, the MPU can only alter or check the low-order byte.
- Commands other than CSRW and CSRR: The parameter is not executed until its second byte is input
  SYSTEM SET SCROLL CGRAM ADR
- Two-byte parameters consist of two bytes of data (as in the case of APL and APH).
- Because the value of each register after power-on is indeterminate, make sure all command parameters are set.

8.2 Interface Timing characteristics

Note: Please refer to IC: S1D13700 data sheet for more details.

Conditions:

IOVDD=5.0V± 10%

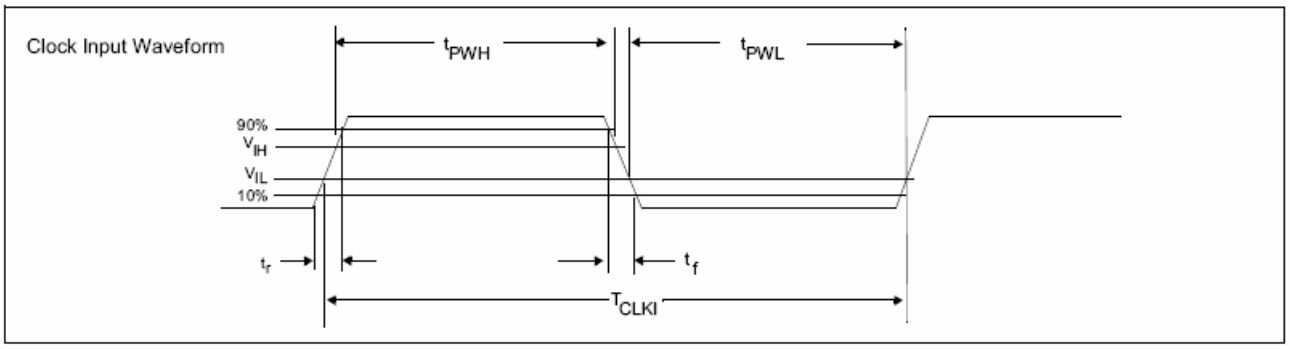
T_{OPR} = -40° C to 85° CT_{rise} and T_{fall} for all inputs must be < 5 nsec (10% ~ 90%)

C_L = 30pF (Bus/MPU Interface)

C_L = 30pF (LCD Panel Interface)

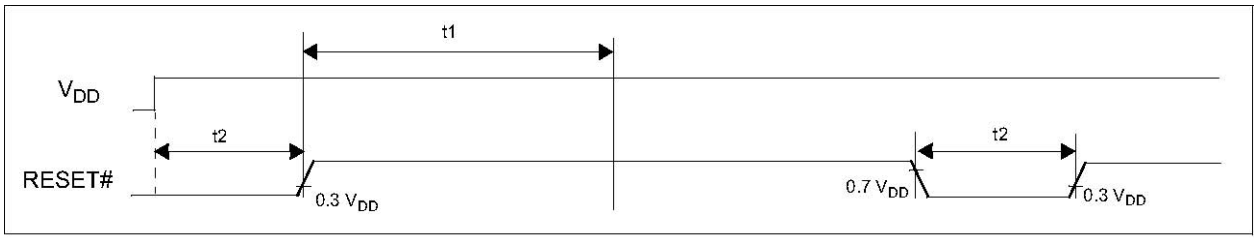
8.2.1 Clock timing

Input clock

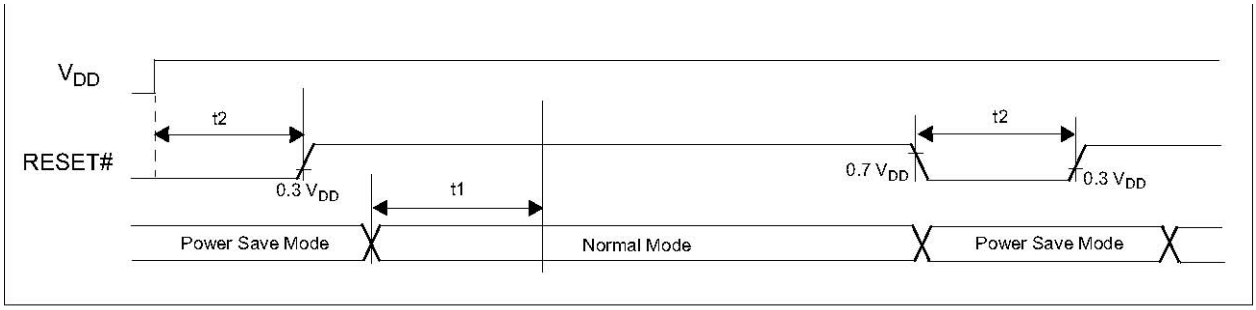


Symble	Parameter	Min	Max	Units
f_{CLKI}	Input Clock Frequency (CLKI)	--	60	MHz
T_{CLKI}	Input Clock period (CLKI)	$1/f_{OSC}$	--	ns
t_{PWH}	Input Clock Pulse Width High (CLKI)	0.4 T_{CLKI}	--	ns
t_{PWL}	Input Clock Pulse Width Low (CLKI)	0.4 T_{CLKI}	--	ns
t_f	Input Clock Fall Time (10% - 90%)	--	2	ns
t_r	Input Clock Rise Time (10% - 90%)	--	2	ns

8.2.2 Reset timing



Reset timing when using an external oscillator



Reset timing when using an internal oscillator with external crystal

Symbol	Parameter	Min	Max	Units
t1	Oscillator stable delay (Note 1)	3	--	ms
t2	Reset pulse duration (Note 2)	1	--	ms

Note1:

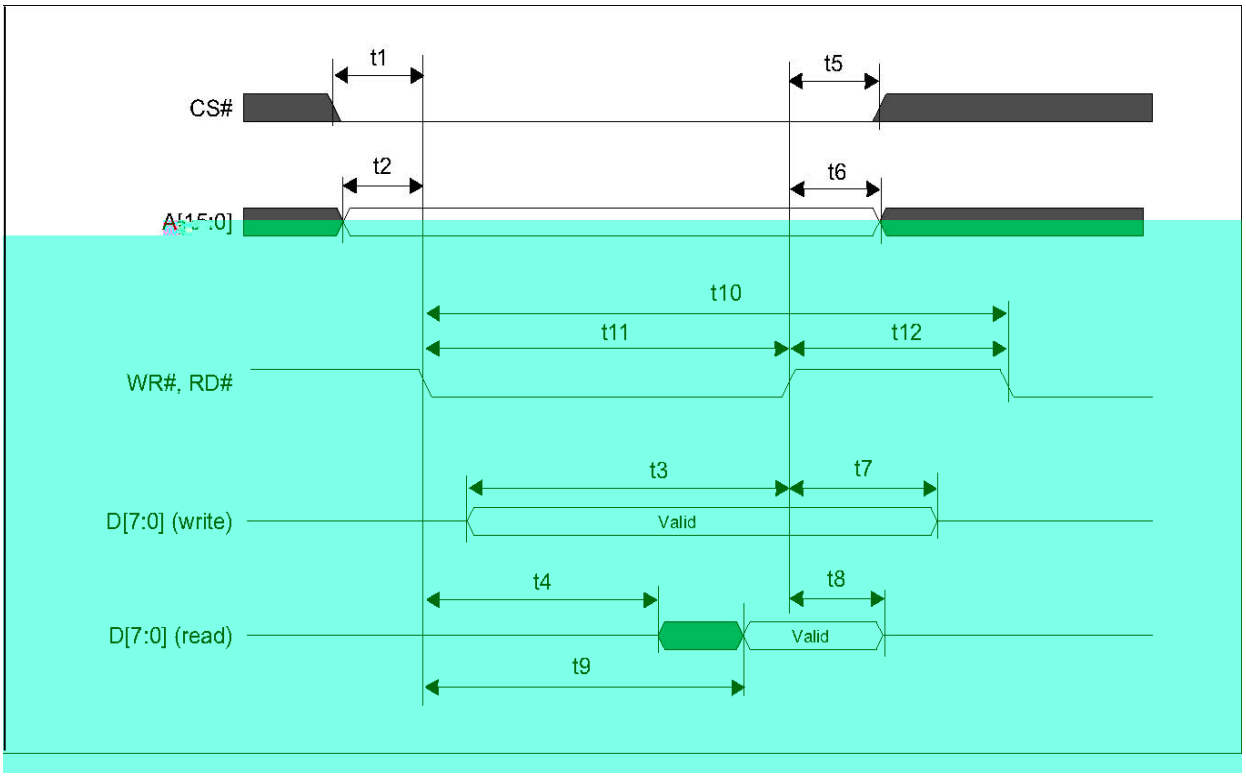
- *When using an external oscillator*, a delay is required following the rising edges of both RESET# and VDD to allow for system stabilization. This delay allows the clock used by the internal oscillator circuit to become stable before use. The LCDC must not be accessed before the oscillation circuit is stable.
- *When using the internal oscillator with an external crystal*, a delay is required after exiting power save mode.For direct mode, writing REG[08h] bit 0 will exit power save mode and start the internal oscillator.For indirect mode, writing the SYSTEM SET command will exit power save mode and start the internal oscillator.

Note2:

- The S1D13700F01 requires a reset pulse of at least 1 ms after power-on in order to re-initialize its internal state. For maximum reliability, it is not recommended to apply a DC voltage to the LCD panel while the S1D13700F01 is reset. Turn off the LCD power supplies for at least one frame period after the start of the reset pulse.
- Note that during the reset period the S1D13700F01 cannot receive commands. Commands to initialize the internal registers should be issued soon after a reset. During reset, the LCD drive signals FPDAT, FPLINE and FR are halted.

8.2.3 CPU interface timing

Generic Bus Direct/Indirect Interface without WAIT# Timing

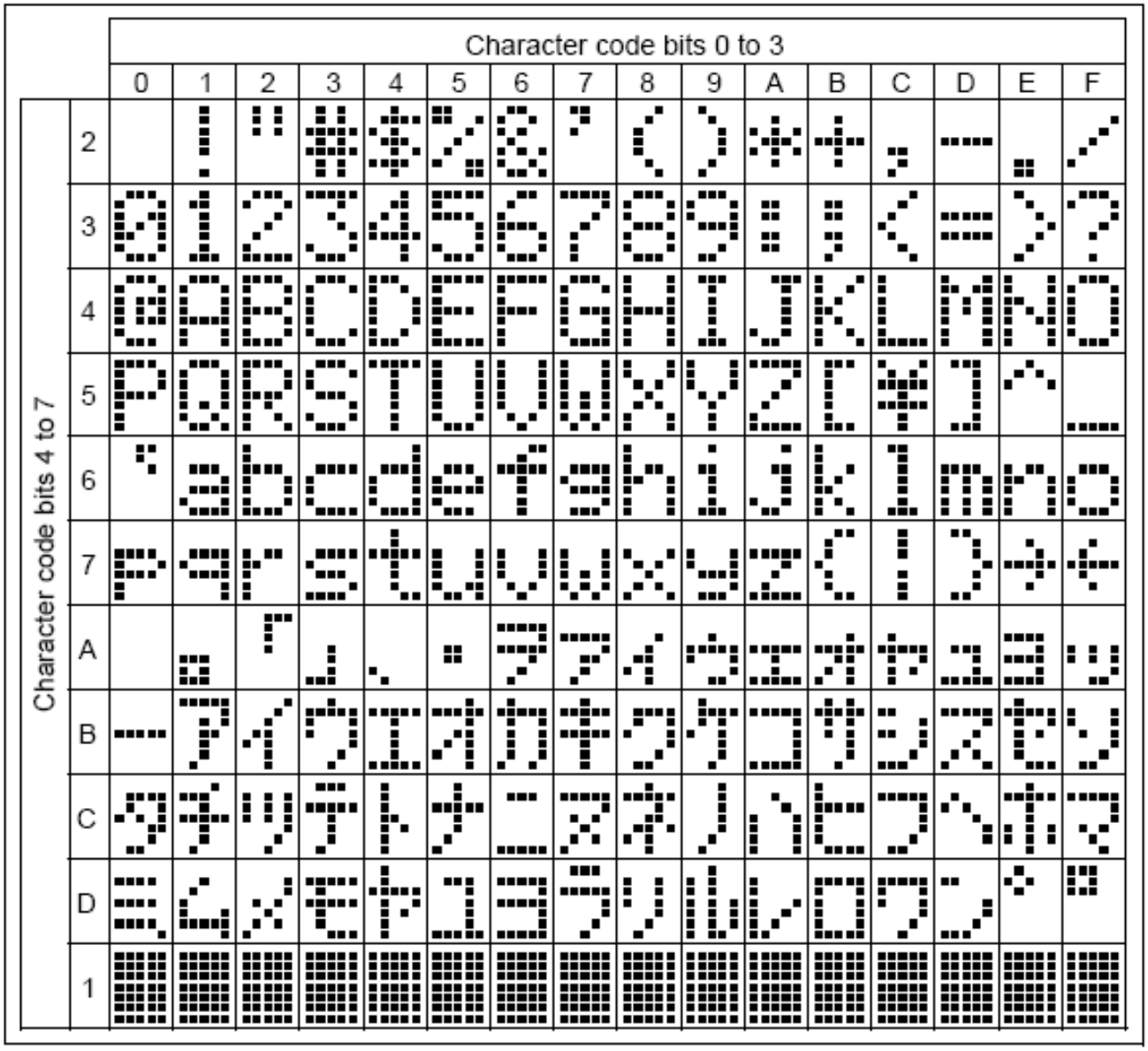


Symbol	Parameter	Min	Max	Units
t1	CS# setup time	5	--	ns
t2	A[15:0] setup time	5	--	ns
t3	D[7:0] setup time to WR# rising edge (write cycle)	Note 2	--	ns
t4	RD# falling edge to D[7:0] driven (read cycle)	3	--	ns
t5	CS# hold time	7	--	ns
t6	A[15:0] hold time	7	--	ns
t7	D[7:0] hold time from WR# rising edge (write cycle)	5	--	ns
t8	D[7:0] hold time from RD# rising edge (read cycle)	3	14	ns
t9	RD# falling edge to valid Data (read cycle)	--	Note 3	ns
t10	RD#, WR# cycle time	Note 4	--	ns
t11	RD#, WR# pulse active time	5	--	Ts
t12	RD#, WR# pulse inactive time	Note 5	--	ns

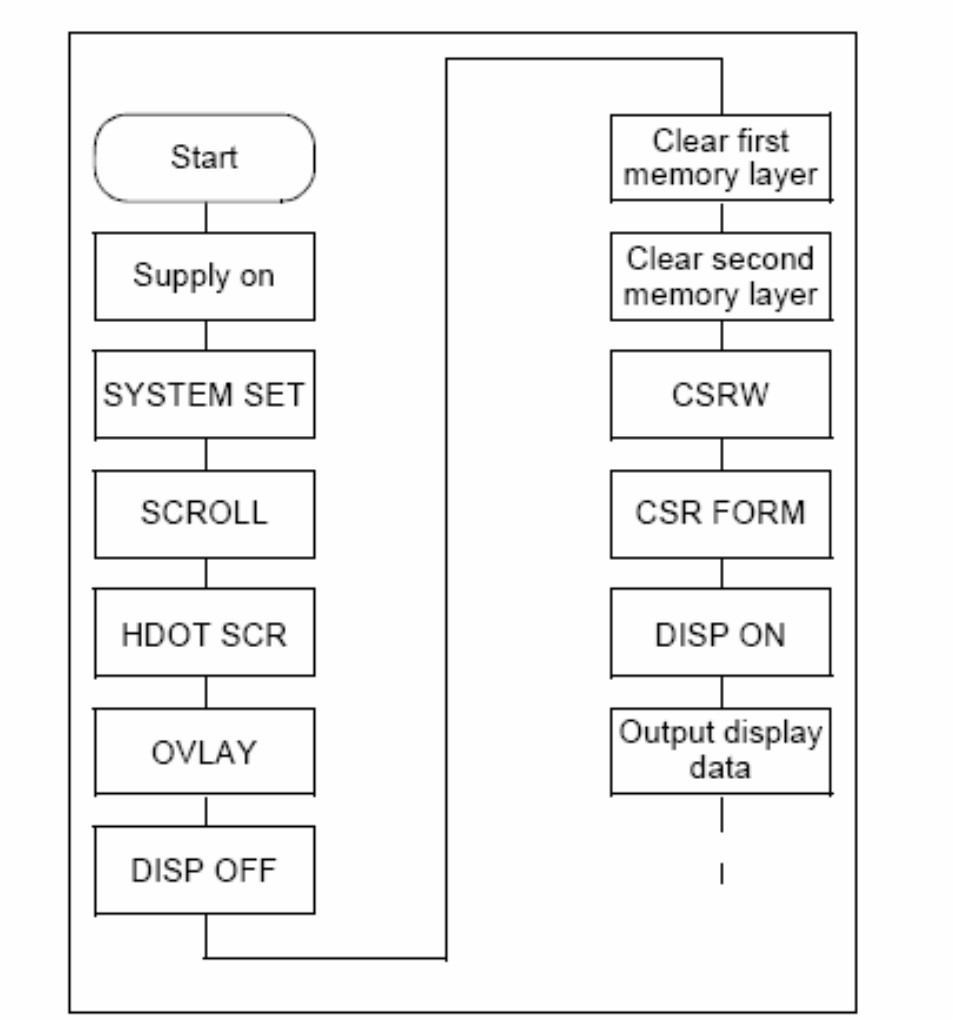
Note:

1 Ts = System clock period
2 t3min = 2Ts +5
3 t9max = 4Ts + 20 (for 5.0V)
4 t10min = 6Ts (for a read cycle followed by a read or write cycle)
= 7Ts + 2 (for a write cycle followed by a write cycle)
= 10Ts + 2 (for a write cycle followed by a read cycle)
5 t12min = 1Ts (for a read cycle followed by a read or write cycle)
= 2Ts + 2 (for a write cycle followed by a write cycle)
= 5Ts + 2 (for a write cycle followed by a read cycle)

8.3 character generator code map



8.4 Initialization flow map



9 Electrical characteristics

V_{SS}=0V, Ta=25℃

Parameter		Symbol	Condition	MIN	TYP	MAX	UNIT
Logic circuit supply voltage		V_{DD}	--	4.5	5.0	5.5	V
LCD driving voltage		V_{LCD}	-20℃	25.9	26.2	26.5	
			0℃	24.2	24.5	24.8	
			22℃	23.7	24.0	24.3	
			40℃	23.3	23.6	23.9	
			70℃	21.6	21.9	22.2	
Input voltage for logic circuit	"H"level	V_{IH}	V_{DD}=5.0V	2.0	--	--	
	"L"level	V_{IL}		--	--	0.8	
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}		--	--	150.0	mA
Used driver IC		S6B0086 of SAMSUNG					

10 LED backlight characteristics

Ta=25℃

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Forward voltage	V_f	I_f=150mA	--	4.0	4.2	V
Forward current	I_f	V_f= 4.0V	--	150	200	mA
Reverse voltage	V_r	--	--	--	10	V
Reverse Current	I_r	--	--	--	240	mA
Luminous intensity*	Bp	I_f=150mA	200	--	--	cd/m^2
Luminous Uniformity*	△Bp		70	--	--	%
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.
- When LED serial resistor R40 and R41 are 0Ω, the input voltage 4.0V is enough, but if R40 and R41 are changed to 2.2Ω , please make the input voltage increase to 4.15V.

11 Optical Characteristics

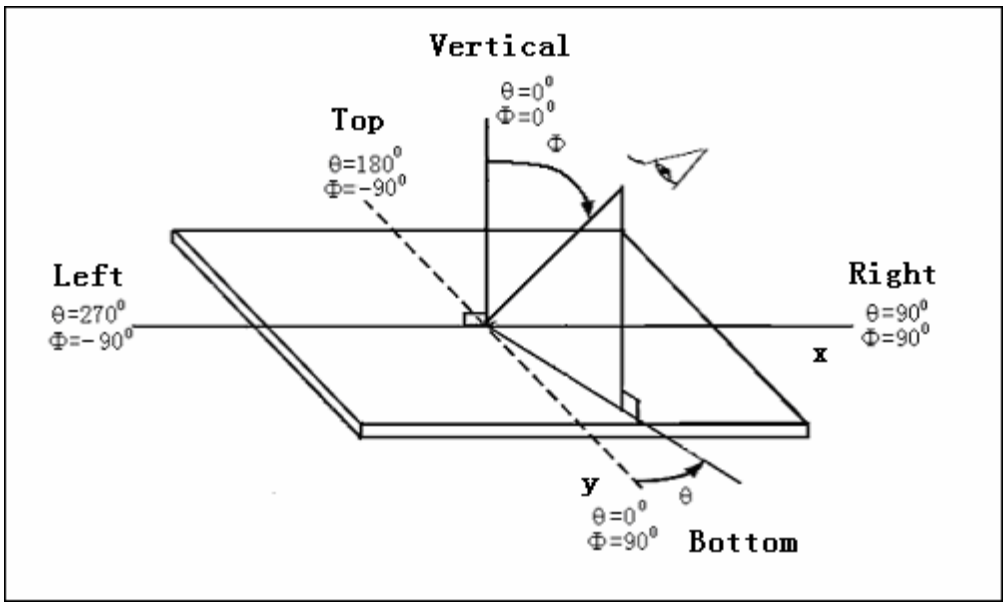
11.1 Optical Characteristics

Ta=25℃

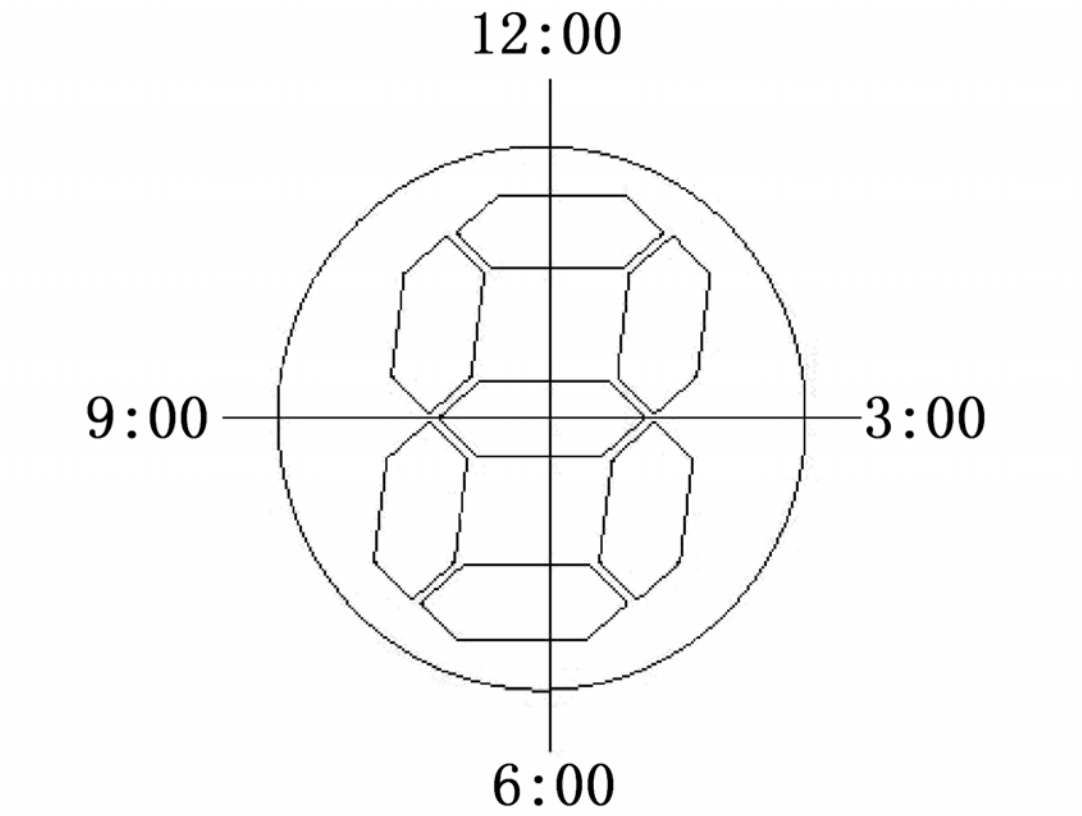
Item		Symbol	Condition		Min.	Typ.	Max.	Unit
Transmission		T	--		10%	16%	--	--
Viewing Angle		θ_x	Cr≥2	θ_y =0°	-45 -- 60			Deg
		θ_y		θ_x =0°	-30 -- 30			
Viewing Angle		θ_x	Cr≥5	θ_y =0°	--			Deg
		θ_y		θ_x =0°	--			
Contrast Ratio		Cr	θ_x =0° θ_y =0°		3.0	--	--	
Response Time	Turn on	Ton	Tamb= +22℃		--	--	350	ms
			0℃		--	--	--	
			-10℃		--	--	--	
			-20℃		--	--	--	
	Turn off	Toff	θ_x =0° θ_y =0°		--	--	350	
			A wave, f=70Hz		--	--	--	
					--	--	--	
					--	--	--	

11.2 Definition of Optical Characteristics

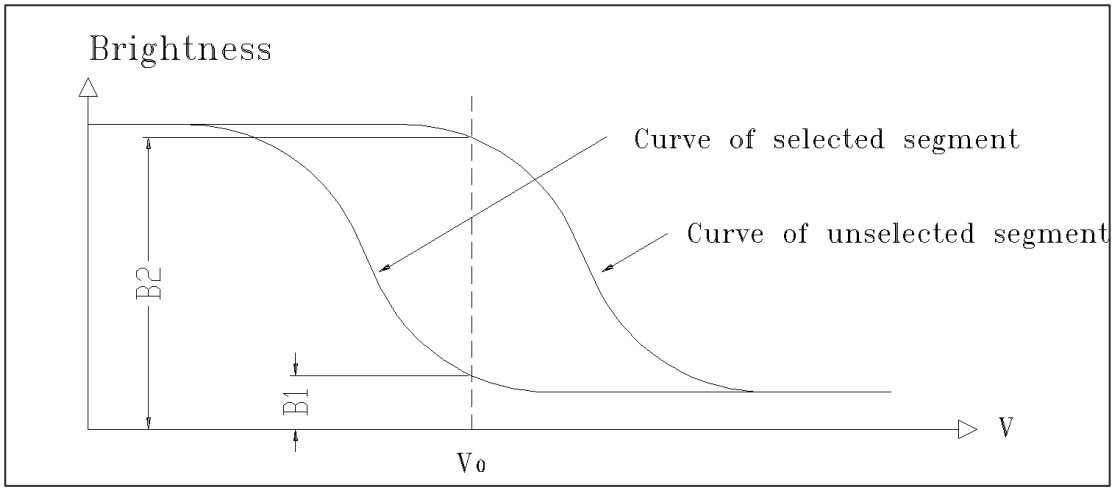
11.2.1 Definition of Viewing Angle



11.2.2 Indication of Viewing Angle



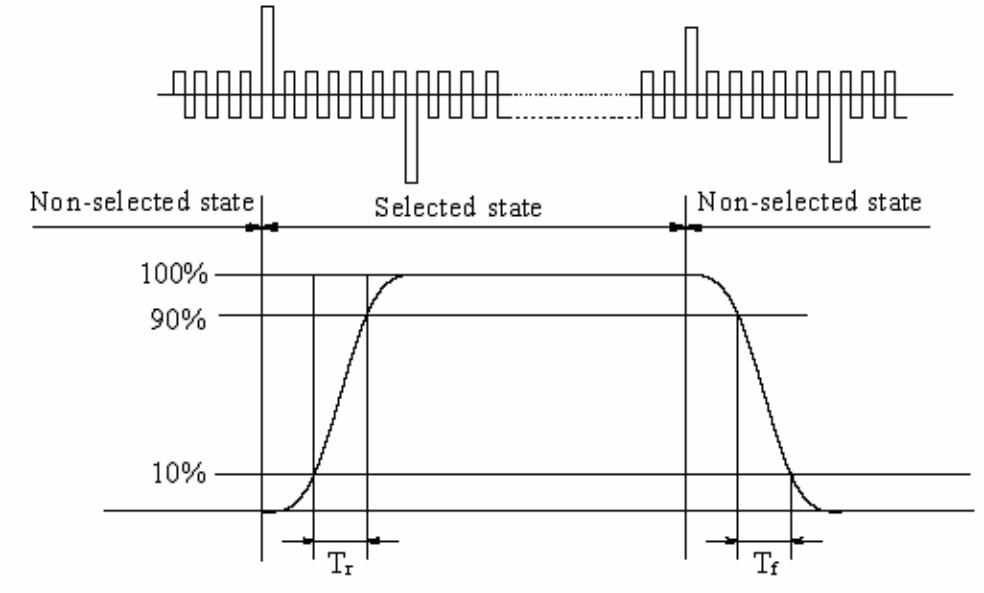
11.2.2 Definition of Contrast Ratio



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

Measuring Conditions:
1) Ambient Temperature: 25℃
2) Frame frequency: 70Hz
3) Operating voltage: Vop=22.6V
4) Appling waveform: 1/240 duty 1/16 bias
5) View angle (θ , ϕ): (0^o, 0^o)

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: Vop=22.6V
2) Frame frequency: 70Hz
3) Appling waveform: 1/240 duty 1/16 bias
4) View angle (θ , ϕ): (0^o, 0^o)

12 Reliability

12.1 Content of Reliability Test

Ta=25℃

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℃ 240H	Remark1 Remark2 Remake3 Remake4
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-30℃ 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℃ 240H	
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time	-20℃ 240H	
5	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	60℃ 90%RH 240H	
6	Temperature Cycle	Endurance test applying the low and high temperature cycle -30℃←→25℃←→80℃←→25℃ 30min 5min 30min 5min ←——————————→ 1 cycle	-30℃/80℃ 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:

1. Each test item applies for a test sample only once, The test sample can not be used again in any other test item.
2. The test sample is inspected after 2 hours or more storing at room temperature and room humidity after each test item is finished.
3. 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℃±10℃).

12.4 Definition of module service life

- Contrast becomes 30% of initial value.
- Current consumption becomes threes 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℃ (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 **Miner 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 (continous 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℃ ～ 40℃

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.

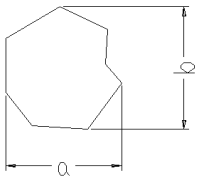
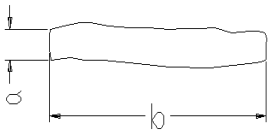
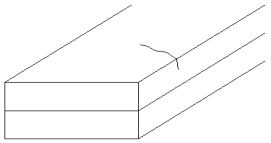
14.4.2 No higher than 280℃ and time less than 3-4 second during soldering.

14.4.3 Rewiring: no more than 3 times.

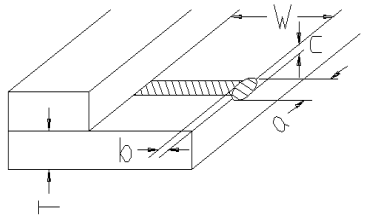
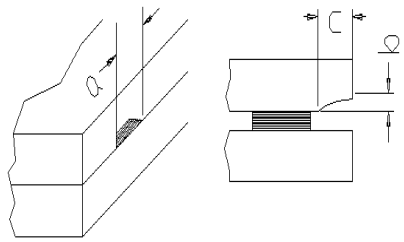
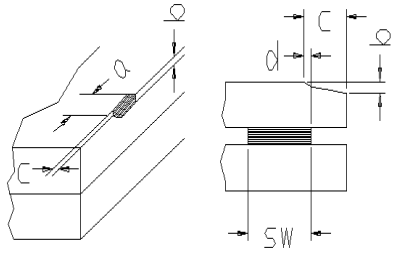
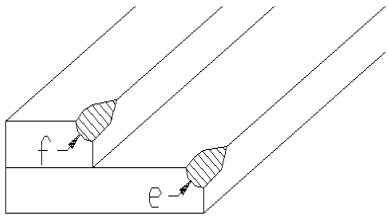
14.4.4 when you remove connector or cable soldered to I/O terminals, please confirm that solder is fully melted. If you remove by force, electrodes at I/O terminals may be damaged (or stripped off). It is recommended to use solder suction machine.

Appendix A

Inspection items and criteria for appearance defects

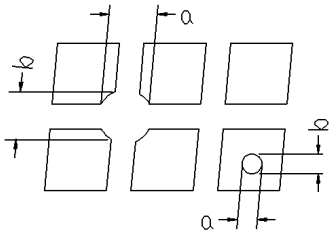
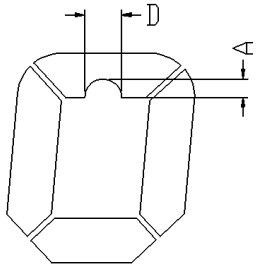
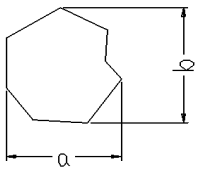
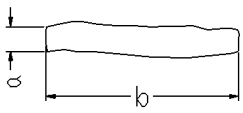
<table>
<tr><th>Items</th><th>Contents</th><th colspan="3">Criteria</th></tr>
<tr><td>Protective Glue</td><td></td><td colspan="3">No clear defects</td></tr>
<tr><td>Cover Tape</td><td></td><td colspan="3">Covering all of the chip and no clear crimple</td></tr>
<tr><td>Leakage</td><td></td><td colspan="3">Not permitted</td></tr>
<tr><td>Rainbow</td><td></td><td colspan="3">According to the limit specimen</td></tr>
<tr><td rowspan="4">Polarizer</td><td>Wrong polarizer attachment</td><td colspan="3">Not permitted</td></tr>
<tr><td rowspan="2">Bubble between polarizer and glass</td><td colspan="2">Not counted</td><td>Max. 3 defects allowed</td></tr>
<tr><td colspan="2">ϕ<0.3mm</td><td>0.3mm≤ϕ≤0.5mm</td></tr>
<tr><td>Scratches of polarizer</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td rowspan="3">Black spot (in viewing area)</td><td rowspan="3">  </td><td>Not counted</td><td>Max. 3 spots allowed</td><td rowspan="4">Max. 3 spots (lines) allowed</td></tr>
<tr><td>X<0.20mm</td><td>0.20mm≤X≤0.5mm</td></tr>
<tr><td colspan="2">X=(a+b)/2</td></tr>
<tr><td rowspan="2">Black line (in viewing area)</td><td rowspan="2">  </td><td>Not counted</td><td>Max. 3 lines allowed</td></tr>
<tr><td>a<0.02mm</td><td>0.02mm≤a≤0.05mm
b≤2.0mm</td></tr>
<tr><td>Progressive cracks</td><td>  </td><td colspan="2">Not permitted</td><td></td></tr>
</table>

Appendix A (continued)

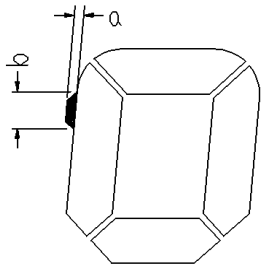
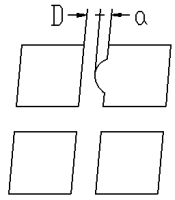
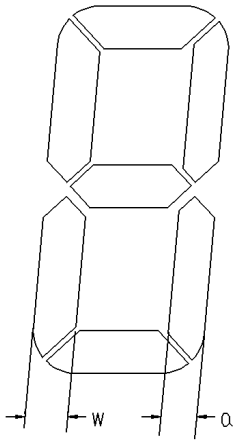
<table>
<tr><th>Item</th><th>Contents</th><th colspan="5">Criteria</th></tr>
<tr><td rowspan="4">Glass Cracks</td><td>Cracks on pads
 
</td><td>a</td><td>b</td><td>c</td><td rowspan="3">Max. 2 Cracks allowed</td><td rowspan="4">Max. 5 cracks allowed</td></tr>
<tr><td>≤3mm</td><td>≤W/5</td><td>≤T/2</td></tr>
<tr><td>≤2mm</td><td>≤W/5</td><td>T/2<C<T</td></tr>
<tr><td>Cracks on contact side
 
</td><td colspan="2">a</td><td colspan="2">b</td><td rowspan="3">Max. 2 cracks allowed</td></tr>
<tr><td colspan="2">≤3mm</td><td colspan="2">≤T/2</td></tr>
<tr><td colspan="2">≤2mm</td><td colspan="2">T/2<b<T</td></tr>
<tr><td>Cracks on non-contact side
 
</td><td colspan="4">C shall be not reach the seal area</td></tr>
<tr><td>Corner cracks
 
</td><td colspan="4">e<2.0mm^2
f<2.0mm^2</td><td>Max. 3 cracks allowed</td></tr>
</table>

Appendix B

Inspection items and criteria for display defects

<table>
<tr><th colspan="2">Items</th><th colspan="2">Contents</th><th colspan="2">Critera</th></tr>
<tr><td colspan="2">Open segment or open common</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Short</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Wrong viewing angle</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Contrast radio uneven</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td colspan="2">Crosstalk</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td rowspan="4">Pin holes and cracks in segment (DOT)</td><td rowspan="3">  </td><td>Not counted</td><td>Max.3 dots allowed</td><td rowspan="4">Max.3 dots allowed</td></tr>
<tr><td>X<0.1mm</td><td>0.1mm≤X≤0.2mm</td></tr>
<tr><td colspan="2">X=(a+b)/2</td></tr>
<tr><td>  </td><td>Not counted</td><td>Max.2 dots allowed</td></tr>
<tr><td colspan="2">A<0.1mm</td><td>0.1mm≤A≤0.2mm
D<0.25mm</td></tr>
<tr><td rowspan="3">Black spot (in viewing area)</td><td rowspan="3">  </td><td>Not counted</td><td>Max.3 spots allowed</td><td rowspan="4">Max.3 spots (lines) allowed</td></tr>
<tr><td>X<0.1mm</td><td>0.1mm≤X≤0.2mm</td></tr>
<tr><td colspan="2">X=(a+b)/2</td></tr>
<tr><td rowspan="2">Black line (in viewing area)</td><td rowspan="2">  </td><td>Not counted</td><td>Max.3 lines allowed</td></tr>
<tr><td>a<0.02mm</td><td>0.02mm≤a≤0.05mm
b≤0.5mm</td></tr>
</table>

Appendix B (continued)

<table>
<tr><th>Items</th><th>Content</th><th colspan="3">Critera</th></tr>
<tr><td rowspan="4">Transfor-
mation
of segment</td><td rowspan="3">  </td><td>Not counted</td><td>Max. 2 defects allowed</td><td rowspan="3">Max.3
defects
allowe
d</td></tr>
<tr><td>x＜0.1mm</td><td>0.1mm≤x≤0.2mm</td></tr>
<tr><td colspan="2">x=(a+b)/2</td></tr>
<tr><td rowspan="2">  </td><td>Not counted</td><td>Max. 1 defects allowed</td></tr>
<tr><td>a＜0.1mm</td><td>0.1mm≤a≤0.2mm
D>0</td><td></td></tr>
<tr><td>  </td><td colspan="3">Max.2 defects allowed
0.8W≤a≤1.2W

a = measured value of width
W = nominal value of width</td></tr>
</table>