TIANMA

SPECIFICATION

FOR LCD MODULE

CUSTOMER:	TM Standard LCM
CUSTOMER NO.:	-----
PRODUCT NO.:	TM128128BBCWVBYA
PRODUCT TYPE:	Graphic Matrix STN
VERSION:	V1.0

□Preliminary specification

■Final specification

CUSTOMER APPROVED	

PREPARED BY	CHECKED BY	VERIFIED BY QA DEPT.	APPROVED BY

TIANMA CHINA:
TEL: (86-755) 83790774
FAX: (86-755) 83790431
www.tianma.com

TIANMA USA:
TEL: (86-755) 83790774
FAX: (86-755) 83790431
www.tianma.com.cn

TIANMA EUROPE:
TEL:+49-721-983110-0
FAX: +49-721-983110-20
www.tianma-europe.com

REVISION RECORD

Version	Page	Revision Items	Name	Date
0.0	-	First release	XieFei	2006.5.18
0.1	-	Add power supply circuit.	Pu Tang	2006.9.30
1.0	-	Remove power supply circuit, changed the name of module (TM128128BBCWVBYSA→TM128128BBCWVBYA)	XiaoRong Liu	2008.01.03

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1 Description

The TM128128BBCWVBYA, a Graphic LCM unit, consists of 128(segment)×128(common) dots dot-matrix LCD panel, LCD controller and drivers, and other circuits on a single PCB. The controller incorporating mask ROM-based character generator and display data RAM, it is easy to display characters and graphics with a microcontroller.

- Wide viewing angle.
- DC/DC and Temperature Compensation units.
- Requirements on environmental protection: ROHS.

2 Features

Item	Contents
LCD type	STN
	Positive
LCD Duty	1/128
LCD Bias	1/12
Polarizer	Transflective
LCD background color	Yellow-Green
Segment color	Blue-Black
Backlight	LED
Backlight type	Bottom
Backlight color	Yellow-Green
View direction	6:00
Operating temperature	-20℃~+70℃
Storage temperature	-30℃~+80℃
LCD Controller	T6963C
Frame	SPCC(Black)
Technology	COB
Data Transfer	8 Bit Parallel

3 Absolute maximum ratings

(VSS=0V, Ta=25℃)

Parameter	Symbol	Min	Max	Unit	Remark
Logic circuit supply voltage	VDD	-0.3	+7.0	V	-
Input voltage of logic control or data pins	V_I	-0.3	VDD+0.3	V	-
LCD driving voltage	V_{LCD}	6	28	V	Note [3-2]
Operating temperature range	T_{OP}	-20	+70	□	Note [3-3]
Storage temperature range	T_{ST}	-30	+80	□	

Note [3-1]: No parameter is allowed to exceed these maximum ratings.

Note [3-2]: LCD operating voltage is calculated as V_{LCD}=VDD –V_O–$V_{BE.}$ V_O is NC, if necessary, set R22=0ohm on the PCB.

Note [3-3]: 95% RH MAX (40 °C ≥ Ta);

Maximum wet-bulb temperature is 39°C or less. (Ta >40 °C) No dew condensation..

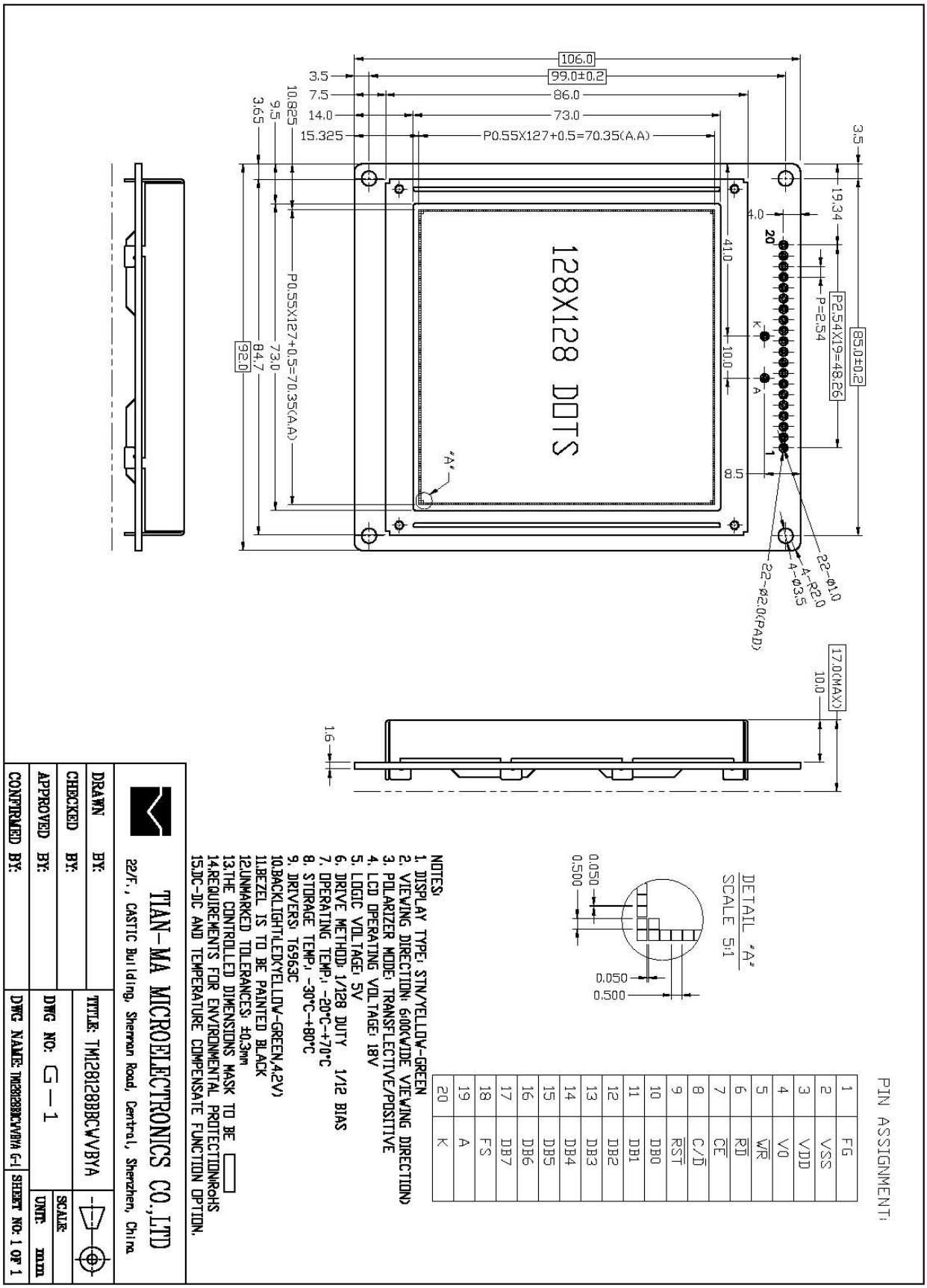
Note [3-4]: Only operation is guarantied at operating temperature. Contrast, response time and another display quality are evaluated at +25°C.

4 Mechanical Characteristics

4.1 Mechanical features

Parameter	Standard Value	Unit
Display type	Graphics Matrix LCM	-
Character size(W×H)	7×8 or 8×8 (selected by FS)	mm
Number of dots	128×128	-
View area (W×H)	73.0 × 73.0	mm
Active Area (W×H)	70.35 × 70.35	mm
Dot Size (W×H)	0.5 × 0.5	mm
Dot Pitch (W×H)	0.55 × 0.55	mm
Module size(W×H×D)	92.00 × 106.00 × 17.00(MAX)	mm
Module total weight (approx)	120	g

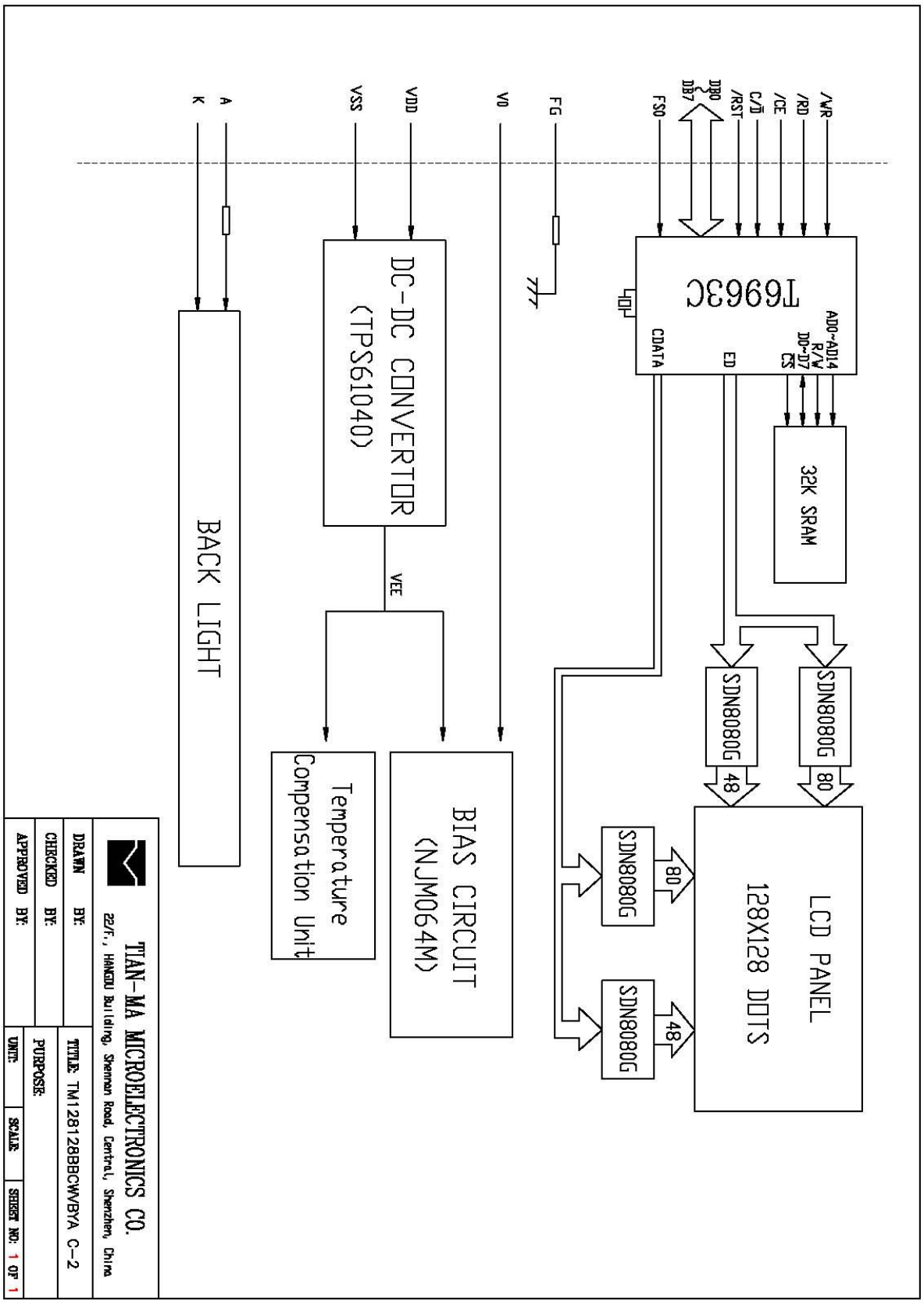
4.2 Mechanical drawing



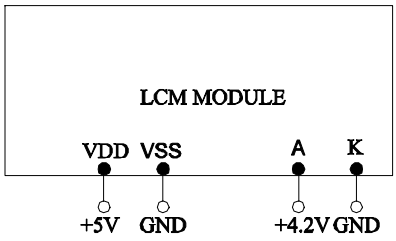
1	FG
2	VSS
3	VDD
4	V0
5	WR
6	RD
7	CE
8	C/D
9	RST
10	DB0
11	DB1
12	DB2
13	DB3
14	DB4
15	DB5
16	DB6
17	DB7
18	FS
19	A
20	K

5 Circuit

5.1 Block Diagram



5.2 Recommend power supply circuit



Note [5-1]: The module includes DC/DC and Temperature Compensation circuit. It can automatically adjust the contrast of the module according to the temperature.

6 Interface description

Pin No.	Symbol	I/O	Description
1	FG	I	Frame ground
2	VSS	P	Ground
3	VDD	P	Power supply voltage (+5V)
4	V_O	O	Test Point. LCD operating voltage is calculated as V_{LCD}=VDD $-V_O-V_{BE.}$ V_O is NC, if necessary, set R22=0ohm on the PCB.
5	/WR	I	Write enable signal. /WR=L, Data Write.
6	/RD	I	Read enable signal. /RD=L, Data Read.
7	/CE	I	Chip enable signal
8	C/D	I	H: Instruction; L: Data
9	/RST	I	Reset signal
10	DB0	I/O	Data bit0
11	DB1	I/O	Data bit1
12	DB2	I/O	Data bit2
13	DB3	I/O	Data bit3
14	DB4	I/O	Data bit4
15	DB5	I/O	Data bit5
16	DB6	I/O	Data bit6
17	DB7	I/O	Data bit7
18	FS	I	Pins for selection of font: FS=H, 7×8; FS=L, 8×8.
19	A	P	Power supply voltage for LED+(+4.2V)
20	K	P	Power supply voltage for LED-

7 Instruction Code & Timing characteristics

7.1 Command and initial code

The module TM128128BBCWVBYA uses LCD controller T6963C (0101). For more details, please refer to the datasheet of T6963C.

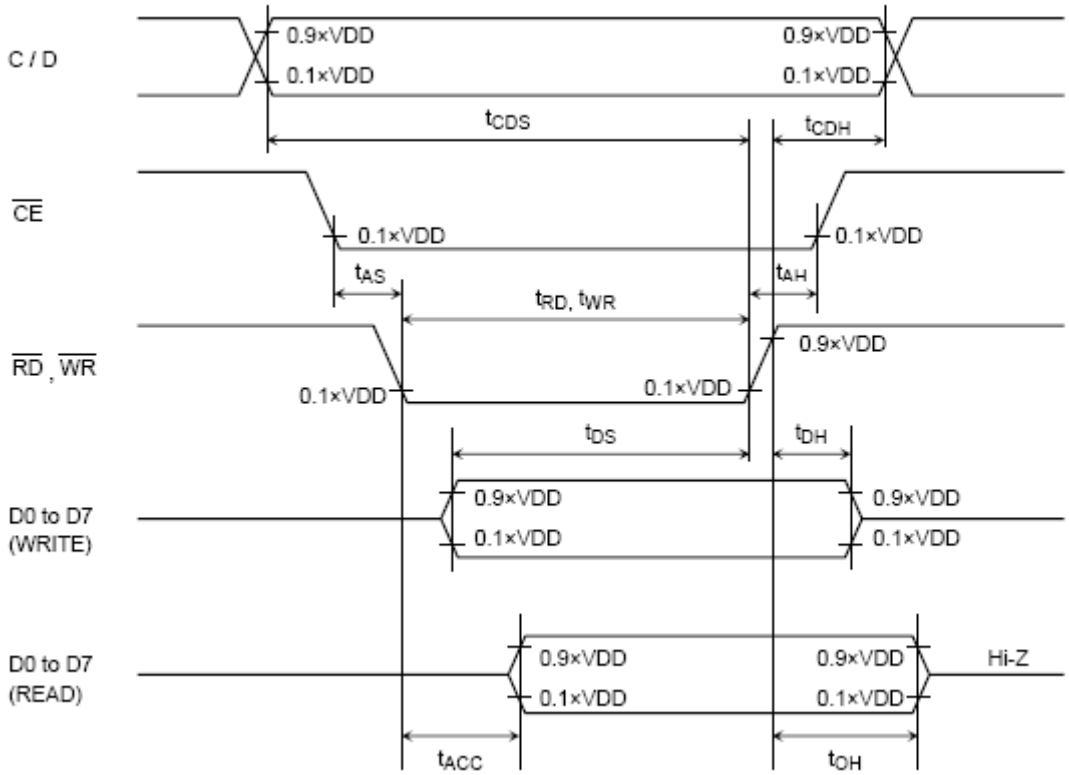
Command	Code	D1	D2	Function
REGISTERS SETTING	00100001 00100010 00100100	X address Data Low address	Y address 00H High address	Set Cursor Pointer Set Offset Register Set Address Pointer
SET CONTROL WORD	01000000 01000001 01000010 01000011	Low address Columns Low address Columns	High address 00H High address 00H	Set Text Home Address Set Text Area Set Graphic Home Address Set Graphic Area
MODE SET	1000X000 1000X001 1000X011 1000X100 10000XXX 10001XXX	— — — — — —	— — — — — —	OR mode EXOR mode AND mode Text Attribute mode Internal CG ROM mode External CG RAM mode
DISPLAY MODE	10010000 1001XX10 1001XX11 100101XX 100110XX 100111XX	— — — — — —	— — — — — —	Display off Cursor on, blink off Cursor on, blink on Text on, graphic off Text off, graphic on Text on, graphic on
CURSOR PATTERN SELECT	10100000 10100001 10100010 10100011 10100100 10100101 10100110 10100111	— — — — — — — —	— — — — — — — —	1–line cursor 2–line cursor 3–line cursor 4–line cursor 5–line cursor 6–line cursor 7–line cursor 8–line cursor
DATA AUTO READ / WRITE	10110000 10110001 10110010	— — —	— — —	Set Data Auto Write Set Data Auto Read Auto Reset
DATA READ / WRITE	11000000 11000001 11000010 11000011 11000100 11000101	Data — Data — Data —	— — — — — —	Data Write and Increment ADP Data Read and Increment ADP Data Write and Decrement ADP Data Read and Decrement ADP Data Write and Nonvariable ADP Data Read and Nonvariable ADP
SCREEN PEEK	11100000	—	—	Screen Peek
SCREEN COPY	11101000			Screen Copy

X: invalid

7.2 Interface Timing characteristics

Please refer to T6963C's datasheet for more details.

7.2.1 Bus Timing

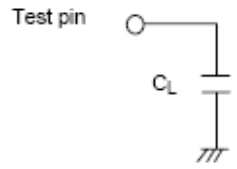


7.2.2 Timing Conditions

Item	Symbol	Test Conditions	Min	Max	Unit
C / D Set–up Time	t_{CDS}	—	100	—	ns
C / D Hold Time	t_{CDH}	—	10	—	ns
$\overline{RD}$, $\overline{WR}$ Pulse Width	t_{RD}, t_{WR}	—	80	—	ns
Address Set–up Time	t_{AS}	—	0	—	ns
Address Hold Time	t_{AH}	—	0	—	ns
Data Set–up Time	t_{DS}	—	80	—	ns
Data Hold Time	t_{DH}	(Note)	40	—	ns
Access Time	t_{ACC}	(Note)	—	150	ns
Output Hold Time	t_{OH}	(Note)	10	50	ns

Note: With the load circuit connected

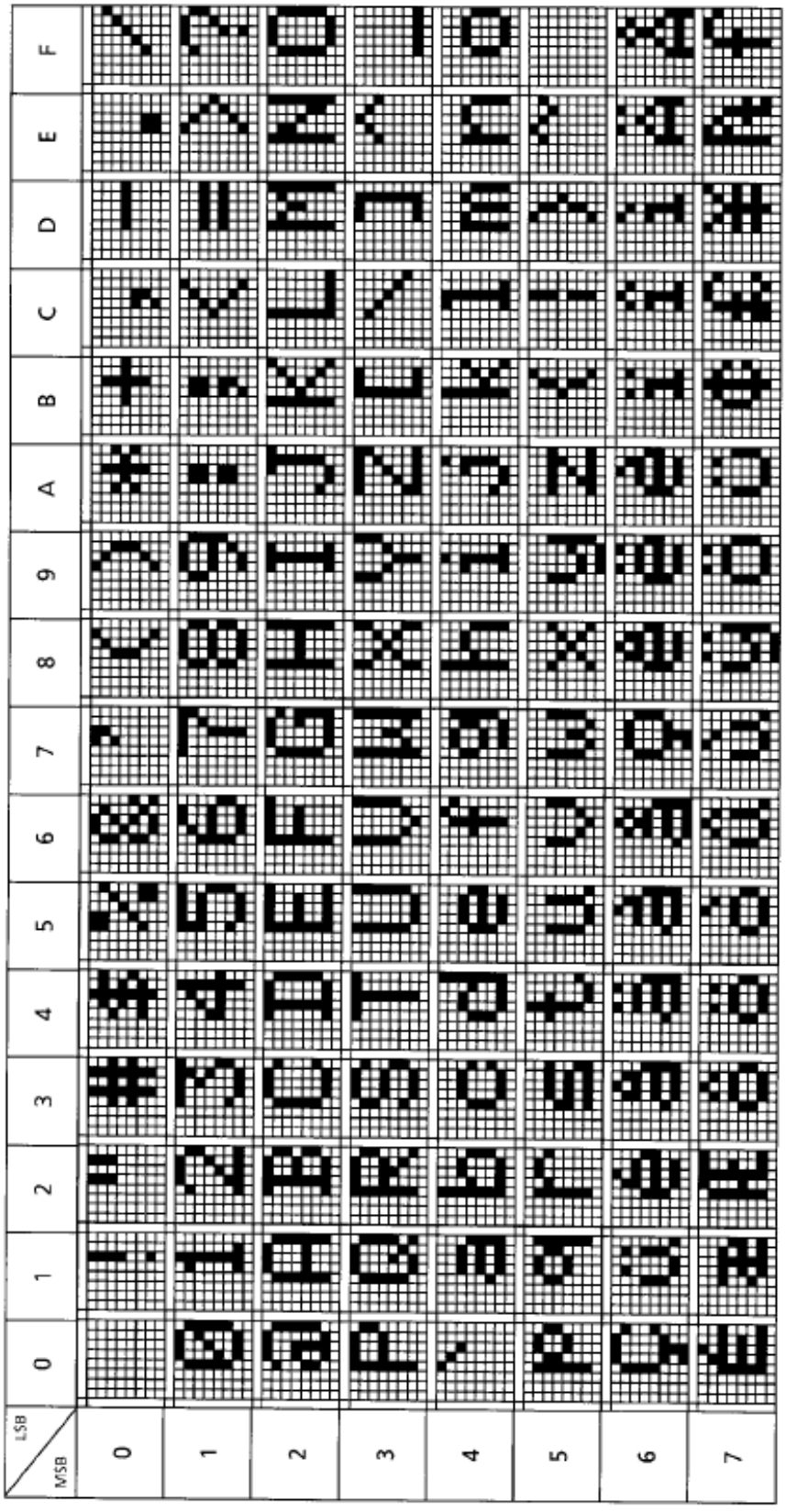
LOAD CIRCUIT



C_L =50pF (including wiring and probe capacitance)

7.3 Character Code Map

A 128−word character generator ROM (code 0101) T6963CFG−0101 is built in as standard. The relation between character codes and character pattern (CG ROM TYPE 0101) is as follow.

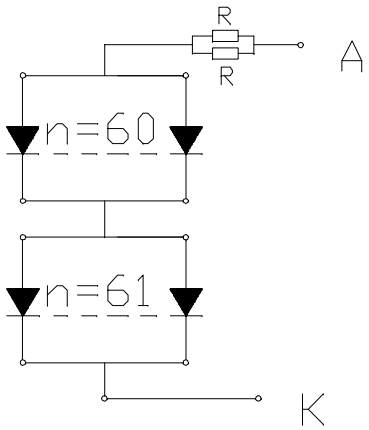


8 Electrical characteristics

Parameter		Symbol	Condition	MIN	TYP	MAX	UNIT
Logic circuit supply voltage		VDD	-	4.5	5.0	5.5	V
Power supply LCD		V_{LCD}	-	-	18	-	
Input voltage for logic circuit	"H" level	V_{IH}	VDD=5.0V	VDD-2.2	-	VDD	
	"L" level	V_{IL}		0	-	0.8	
Output voltage for logic circuit	"H" level	V_{OH}		VDD-0.3	-	VDD	
	"L" level	V_{OL}		0	-	0.3	
Logic power supply current (Without backlighting)		I_{VDD}		-	TBD	-	mA
Used driver IC		SDN8080G-D					

Note [8-1]**:** V_{LCD}=VDD –V_O–V_{BE}. It can be adjusted by RV1 on PCB according to the display.

9 LED backlight characteristics



Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Remark
Forward voltage	V_f	I_f=600mA	4.0	4.2	4.4	V	---
Forward current	I_f	V_f= 4.2V	--	600	-	mA	---
Wavelength	λ P	I_f=600mA	569	572	575	nm	Note [9-1,2]
Lifetime	t	-	-	TBD	-	hours	Note [9-3]

Note [9-1]**:** The wavelength is measured with the bare LED backlight unit.

Note [9-2]**:** If the backlight is used above its' driving voltage or current for a long time, its lifetime will reduce or it will cause poor reliability.

Note [9-3]**:** The backlight lifetime lasts until the luminance reduces to50% of its initial value.

10 Optical Characteristics

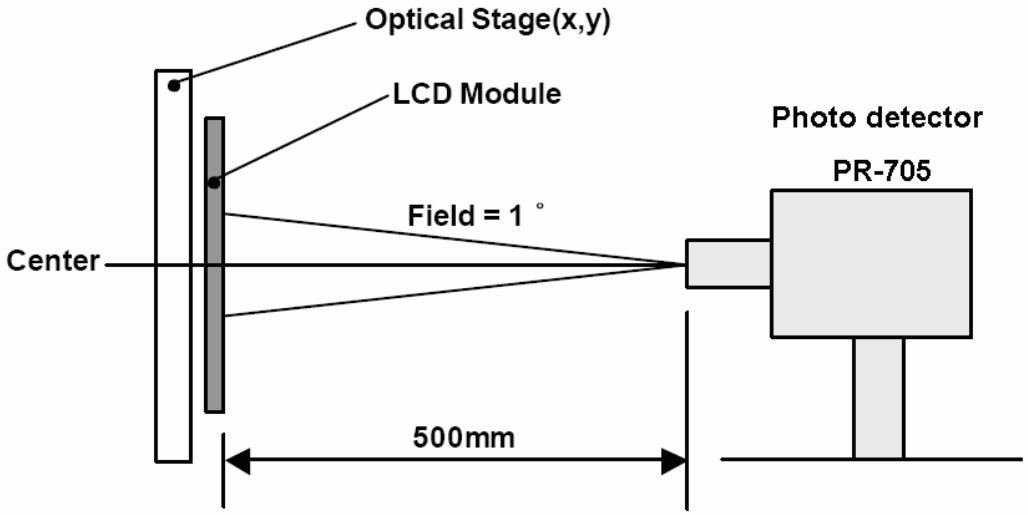
Ta=25□, 1/128Duty, 1/12Bias, V_{LCD}=18.0V(Note [10-2]), f=70Hz

Parameter		Symbol	Ratings			Unit	Measuring Temp.	Remark
			Min	Type	Max.			
Contrast ratio		Cr (θ=0°,Φ=0°)	---	2.5	---	---	25□	Note[10-1,3]
Response time	Turn on	t_{on}	---	100	---	ms	25□	Note[10-1,4]
			---	TBD	---		0□	
	Turn off	t_{off}	---	250	---	ms	25□	
			---	TBD	---		0□	
Viewing angle (Cr≥2)	Up-down	θ1 (Φ=0°)	---	40	---	deg	25□	Note[10-1,5]
			---	30	---			
	Left-right	θ2 (θ=0°)	---	30	---	deg	25□	
			---	30	---			
Luminance		Y_L (θ=0°,Φ=0°)	---	25	---	Cd/m^2	25□	Note[10-1] (I_f=600mA)
Luminance Uniformity		L_U (θ=0°,Φ=0°)	70	---	---	%	25□	Note[10-1,6]

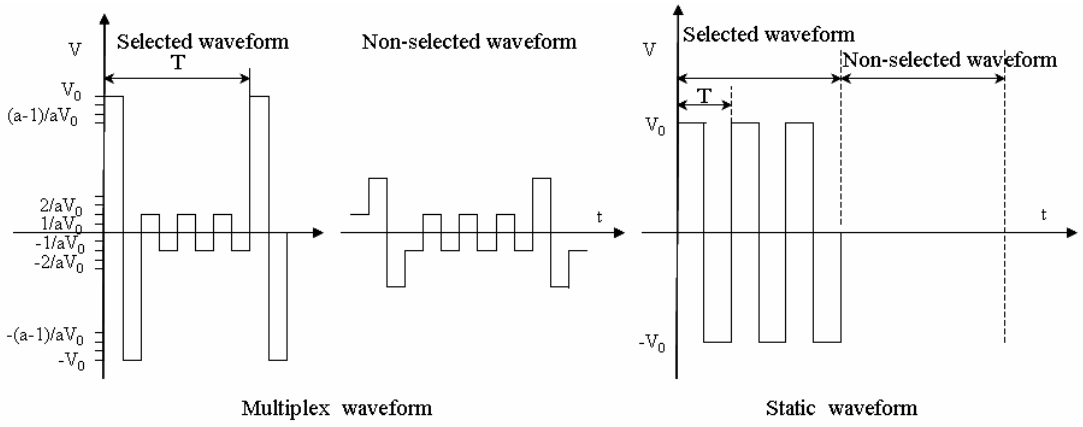
Note [10-1]: Measuring equipments: DMS-501, PR-705.

Measuring condition:

- After stabilizing and leaving the panel alone at a given temperature for 30 min, the measurement should be executed,
- Measuring surroundings: a stable, windless and dark room,
- Measuring temperature: Ta=25°C,
- 30 min after lighting the back-light.



Note [10-2]: The maximum and minimum ratings don't mean the LCD works well in the whole range of Vo. Vo must be adjusted to optimize the viewing angle and contrast. Refer to the following definition of drive voltage:



Operating voltage：V_{LCD}	Frame frequency: f=1/T
Duty: 1/N	Bias: 1/a

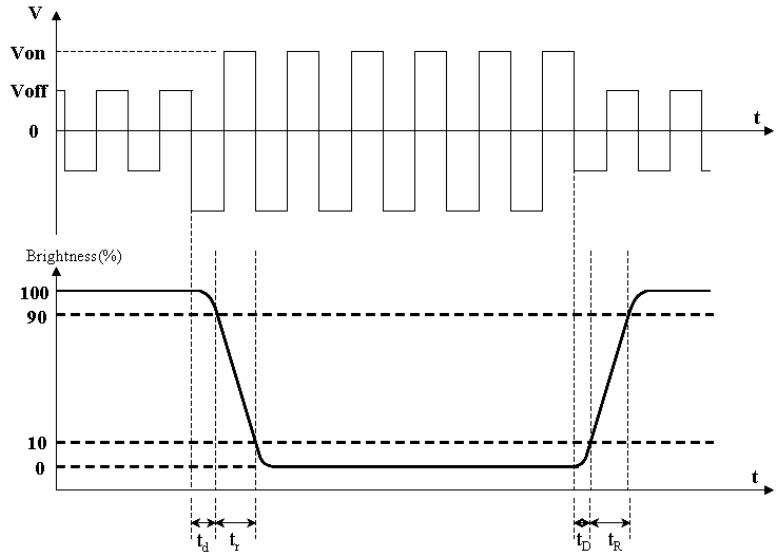
Note [10-3]: Contrast ratio(CR) is defined as follows:

$$CR = \frac{L_{ON}\ (\text{Luminance of the ON segments})}{L_{OFF}\ (\text{Luminance of the OFF segments})}$$

Note [10-4]: Definition of response time:

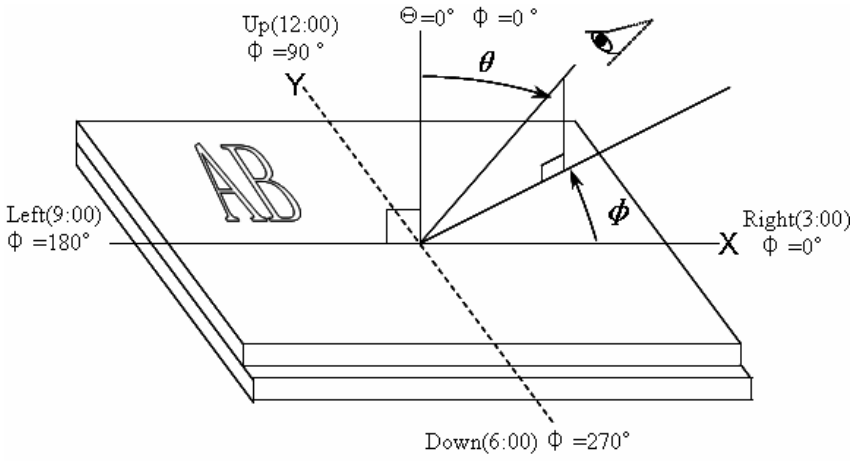
Turn on time (rise time): $t_{on} = t_d + t_r$ (The time that the luminance level reaches 90% of the saturation level from 0% when ON signal is applied)

Turn off time (fall time): $t_{off} = t_d + t_r$ (The time that the luminance level reaches 10% of the saturation level from 100% when OFF signal is applied)

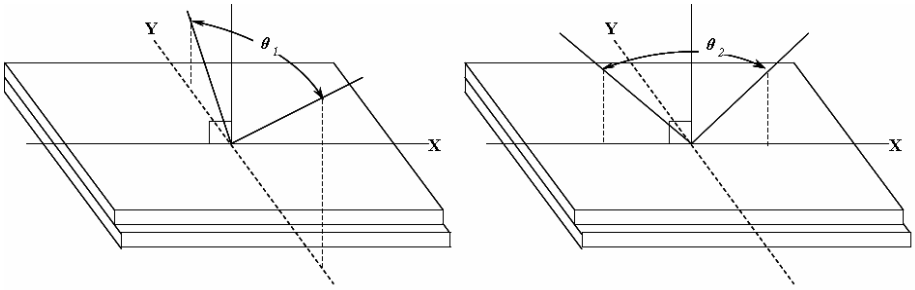


Note [10-5]: Definition of viewing direction

Refer to the picture below marked by θ and Φ



Definition of viewing angle



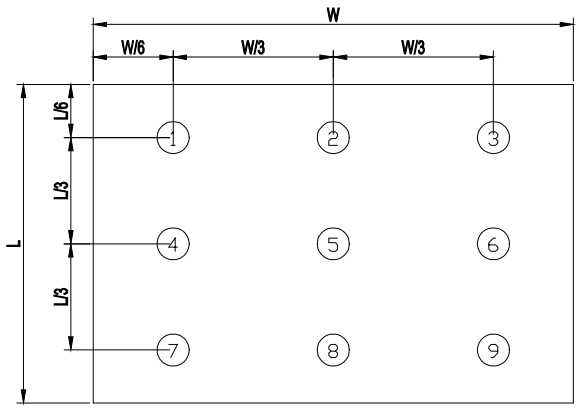
θ_1 ——range of viewing angle from up to down; θ_2 ——range of viewing angle from left to right.

Note [10-6]: The definition of luminance uniformity:

The luminance uniformity is calculated by using following formula.

$$\text{Luminance uniformity (Lu)} = \frac{\text{Minimum luminance from } \square \text{ to } \square}{\text{Maximum luminance from } \square \text{ to } \square}$$

The luminance is measured at near the 9 points shown below.



11 Reliability

11.1 Content of Reliability Test

No.	Test Item	Test condition	Remark	Criterion
1	High Temperature Storage	Ta=80□, 120H	-	Remark1 Remark2 Remake3 Remake4
2	Low Temperature Storage	Ta=-30□, 120H	Note[11-1]	
3	High Temperature Operation	Ta=+70□, 120H		
4	Low Temperature Operation	Ta=-20□, 120H	Note[11-1]	
5	High Temperature & High Humidity Operation	Ta=60□,90%RH,120H	Note[11-1]	
6	Temperature Cycle Test (Non-Operating)	-30 °C↔+25 °C↔+80 °C,100 Cycles 30min 5min 30min	Note[11-1]	
7	Vibration Test	Frequency: 10 ~150 Hz, Stroke: 1.5mm Sweep time: 11 min Test Period: 6 Cycles for each direction of X,Y,Z,120 min every direction	Note[11-2]	Remark1 Remark5 Remark6
8	Shock Test	Waveform : Half Sinusoidal Wave Shock Level:30 G, Pulse Width:18 ms, Direction: ±X, ±Y, ±Z, Cycle:3 times	Note[11-2]	

Notes:

1. No dew condensation to be observed.
2. Vibration test will be conducted to the product itself without putting it in a container.
3. The test sample is inspected after 2 hours or more storing at room temperature and room humidity after each test item is finished.
4. The criteria refer to 11.2.

11.2 Inspection of criteria

Remark NO.	Content
1	Function test is OK. Missing Segment, shorts, unclear segment, non-display, 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, the contrast ratio must be larger than 70% of its value before.
5	No glass crack, chipped glass, end seal loose frame crack and so on.
6	No structure looseness.

12 Package

TBD

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.	Refer to appendix A			II	Major 1.0 Minor 2.5
Display Defects	Under normal illumination and eyesight condition, display on inspection.	Refer to appendix 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.

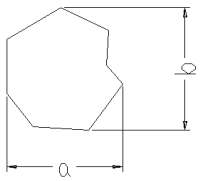
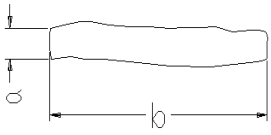
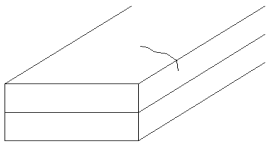
15. LCD Module Part Numbering System

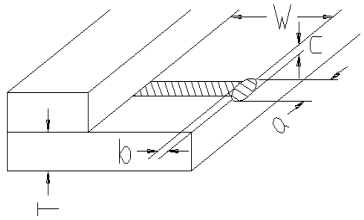
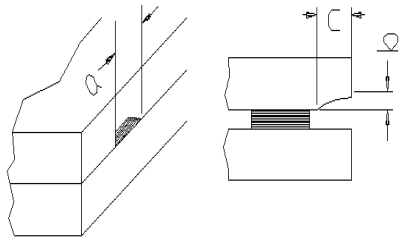
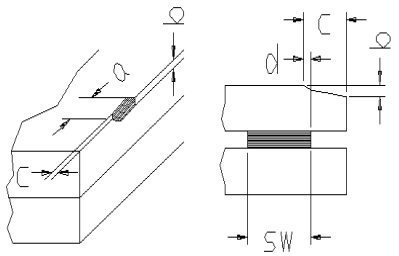
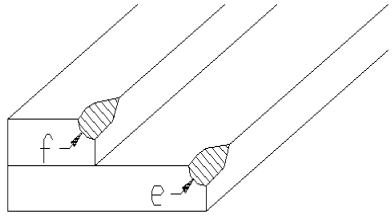
TM	128128	B	B	C	W	V	B	Y	A
□	□	□	□	□	□	□	□	□	□

NO.	Explanation	
□	**TIANMA module indicating**	
□	**Module type: 128 columns×128 rows**	
□	**TIANMA module series**	
□	**LCD type**	
	B	Positive, Yellow-Green mode, STN
□	**Backlight type**	
	C	Transflective, LED
□	**Temperature range**	
	W	Wide temperature
□	**Viewing Angle**	
	V	Wide viewing direction
□	**Technology**	
	B	COB (including SMT)
□	**The color of backlight**	
	Y	Yellow-green
□	**Module type**	
	A	Basic function

Appendix A

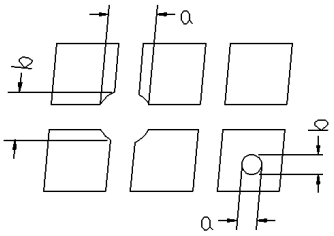
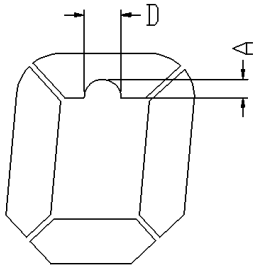
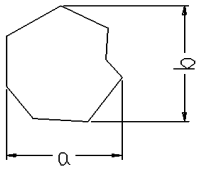
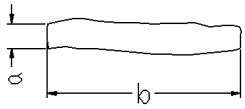
Inspection items and criteria for appearance defects

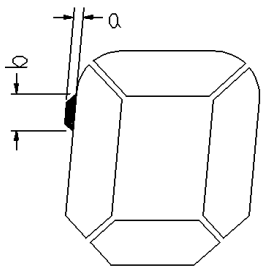
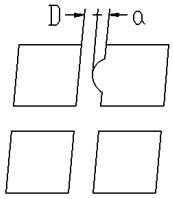
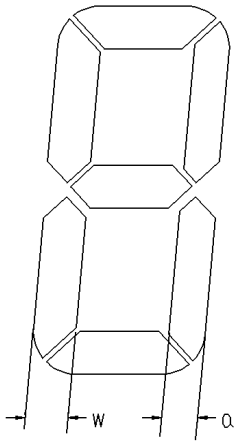
<table>
<tr><th>Items</th><th>Contents</th><th colspan="3">Criteria</th></tr>
<tr><td>Protective Glue</td><td></td><td colspan="3">No clear defects</td></tr>
<tr><td>Cover Tape</td><td></td><td colspan="3">Covering all of the chip and no clear crimple</td></tr>
<tr><td>Leakage</td><td></td><td colspan="3">Not 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>Not counted</td><td colspan="2">Max. 3 defects allowed</td></tr>
<tr><td>ϕ<0.3mm</td><td colspan="2">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>

<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></td><td>≤3mm</td><td>≤W/5</td><td>≤T/2</td></tr>
<tr><td></td><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>b</td><td rowspan="3">Max. 2 cracks allowed</td></tr>
<tr><td colspan="2">≤3mm</td><td>≤T/2</td></tr>
<tr><td colspan="2">≤2mm</td><td>T/2<b<T</td></tr>
<tr><td>Cracks on non-contact side
 
</td><td colspan="3">C shall be not reach the seal area</td><td colspan="2">Max. 2 cracks allowed</td></tr>
<tr><td colspan="2">a</td><td>b</td><td colspan="2" rowspan="4">Max. 2 cracks allowed</td></tr>
<tr><td colspan="2">≤3mm</td><td>≤T/2</td></tr>
<tr><td colspan="2">≤2mm</td><td>T/2<b<T</td></tr>
<tr><td colspan="3">C≤0.5mm</td></tr>
<tr><td>Corner cracks
 
</td><td colspan="3">d≤SW/3</td><td colspan="2">Max. 3 cracks allowed</td></tr>
<tr><td colspan="3">e<2.0mm^2
f<2.0mm^2</td><td colspan="2">Max. 3 cracks allowed</td></tr>
</table>

Appendix B

Inspection items and criteria for display defects

<table>
<tr><th>Items</th><th>Contents</th><th colspan="3">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>Black spot (in viewing area)</td><td>  </td><td>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>

<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="2">  </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>