SPECIFICATION FOR LCD MODULE

Model No. TM162ICAG

Prepared by:	**Date:**
Checked by :	**Date:**
Verified by :	**Date:**
Approved by:	**Date:**

TIANMA MICROELECTRONICS CO., LTD

Ver 1.0

REVISION RECORD

Date	Ver.	Ref. Page	Revision No.	Revision Items
2003/7/21	**Ver1.0**			

1. General Specifications:

1.1 Display type: FSTN

1.2 Display color*[1]:

Display color: Blue-Black

Background: White

1.3 Polarizer mode: Reflective/Positive

1.4 Viewing Angle: 6:00

1.5 Driving Method: 1/16 Duty 1/5 Bias

1.6 LCD Operating Voltage: 3.3V

1.7 Logic Voltage: 3.3V

1.8 Without Backlight

1.9 Controller: S6A0032X01-B0CY

1.10 Data Transfer: 8 Bit Parallel

1.11 Operating Temperature: 0----+50℃

Storage Temperature: -20----+60℃

1.12Outline Dimensions: Refer to outline drawing on next page

1.13 Dot Matrix: 16 Characters × 2 Line

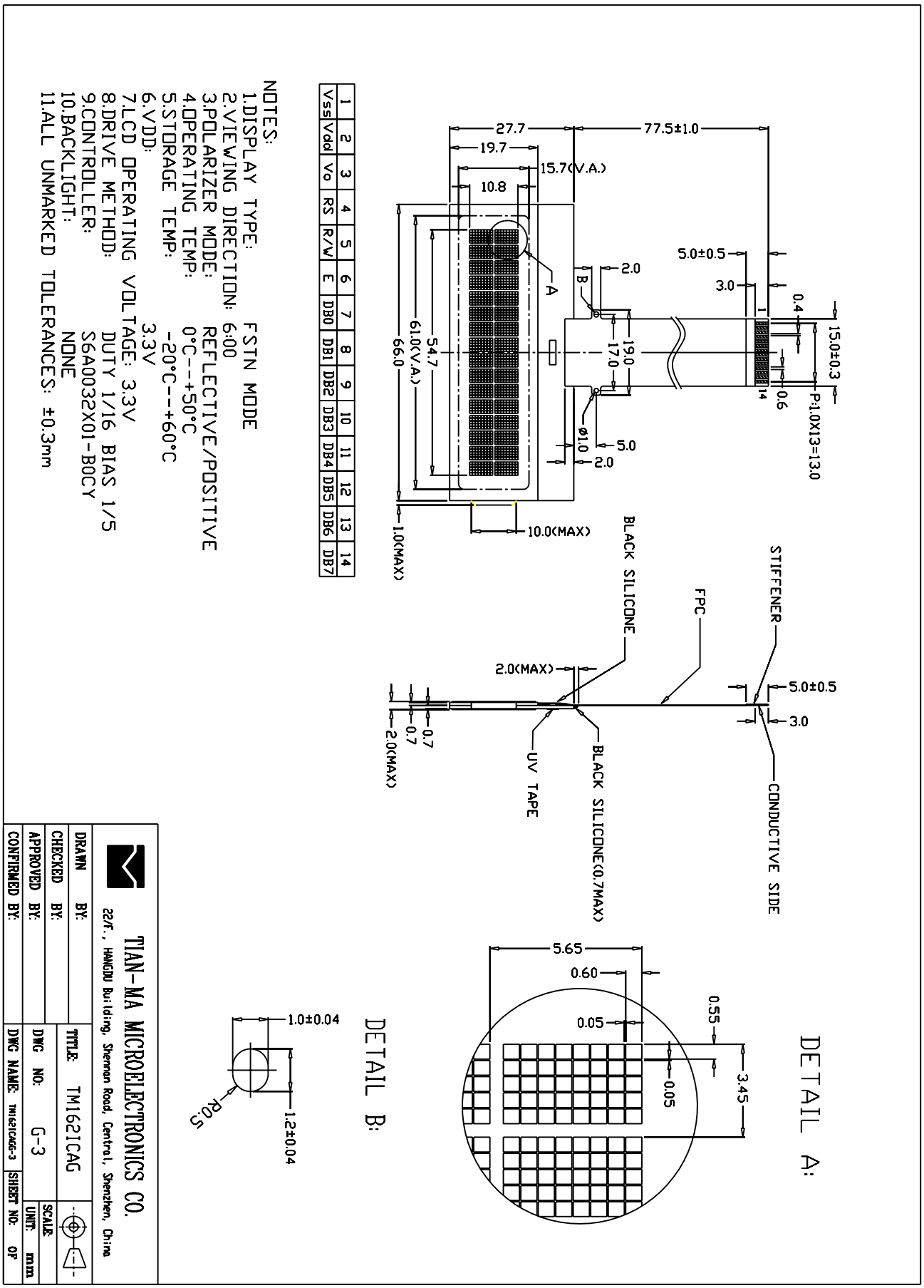
1.14 Dot Size: 0.55×0.60 (mm)

1.15 Dot Pitch: 0.60×0.65 (mm)

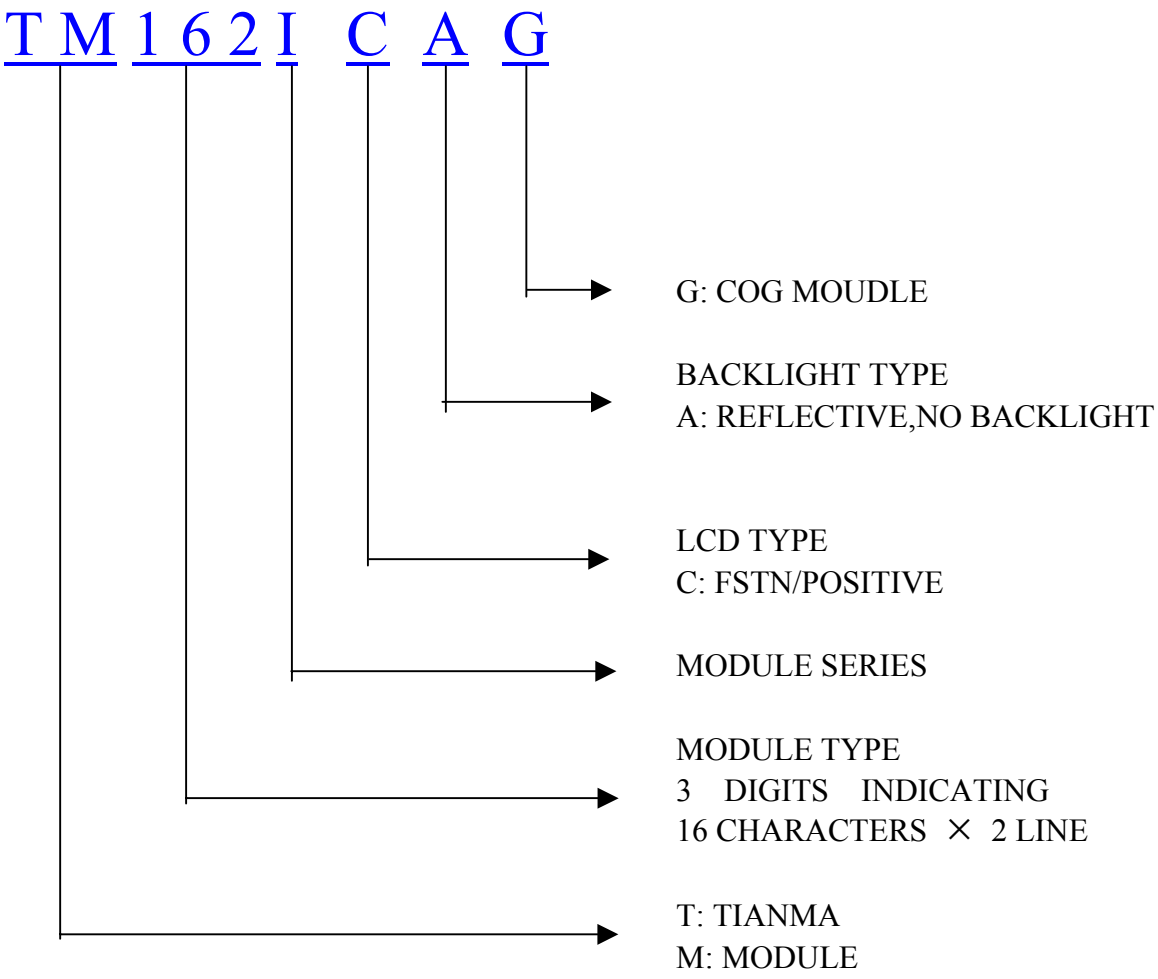
1.16 Weight: 10g (Approx)

*[1] Color tone is slightly changed by temperature and driving voltage.

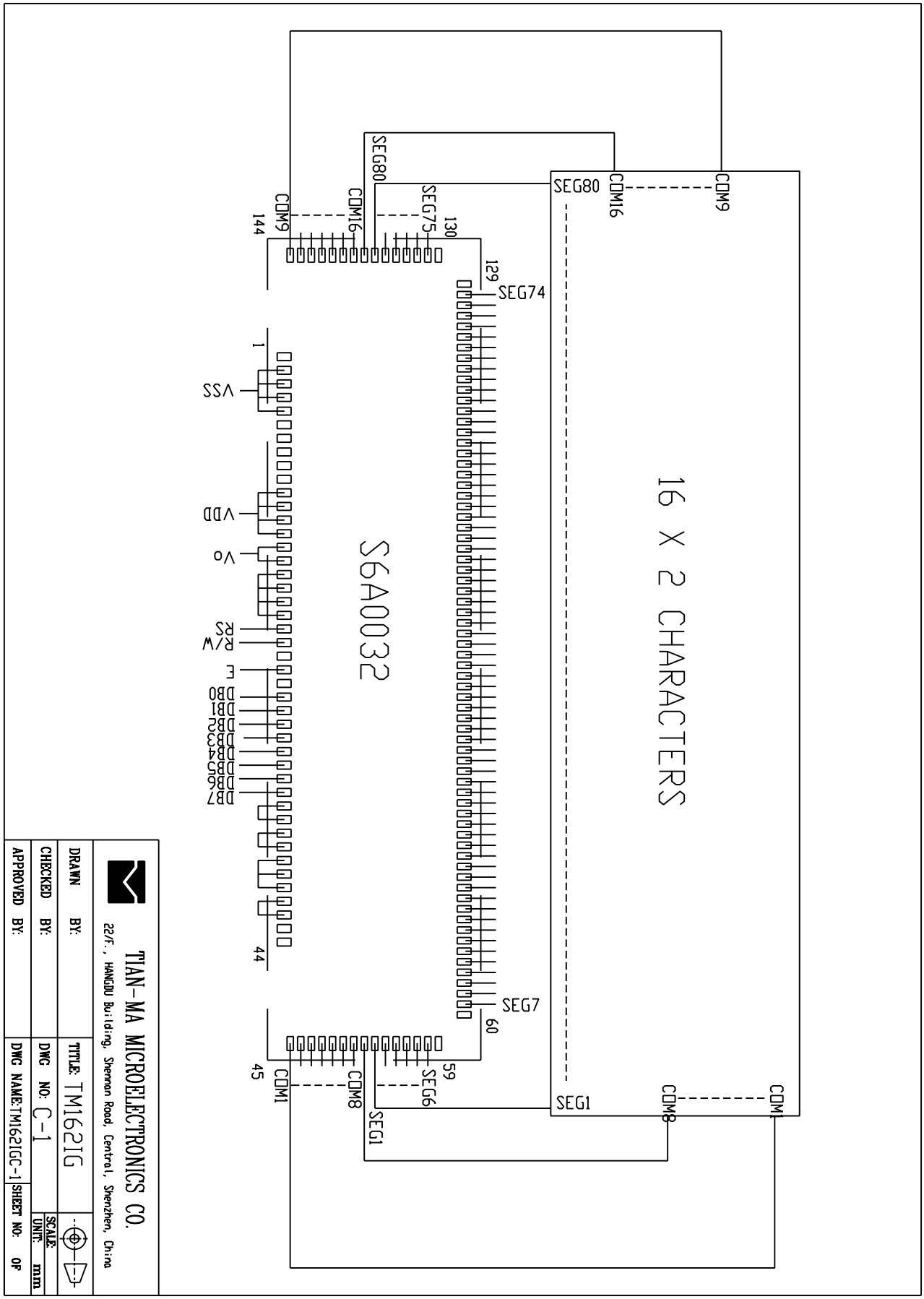
2. Outline Drawing



3. LCD Module Part Numbering System



4. Circuit Block Diagram



5. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Remark
Power Supply Voltage	$V_{DD}-V_{SS}$	-0.3	7.0	V	
LCD Driving Voltage	V_{LCD}	-0.3	13.0		
Operating Temperature Range	T_{OP}	0	+50	℃	No Condensation
Storage Temperature Range	T_{ST}	-20	+60		

6. Electrical Specifications and Instruction Code

6.1 Electrical characteristics

Item		Symbol	Min.	Typ.	Max.	Unit
Supply Voltage (Logic)		$V_{DD}-V_{SS}$	-	3.3	-	V
Supply Voltage (LCD Drive)		V_{LCD}	-	3.3	-	V
Input Signal Voltage	High	V_{IH} (V_{DD}=3.3)	$0.7V_{DD}$	-	V_{DD}+0.3	V
	Low	V_{IL} (V_{DD}=3.3)	-0.3	-	$0.2V_{DD}$	V
Supply current (Logic)		I_{DD} (V_{DD} -V_{SS} =3.3)	-	-	500	uA

6.2 Interface Signals

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground
2	VDD	3.3V	Power supply voltage
3	V0	3.3V	Power supply voltage for LCD
4	RS	H/L	Register selection input(H: data L: instruction)
5	R/W	H/L	Read or write selection input(H: read L: write)
6	E	H/L	Read or write enable signal
7	D0	H/L	Data bit 0
8	D1	H/L	Data bit 1
9	D2	H/L	Data bit 2
10	D3	H/L	Data bit 3
11	D4	H/L	Data bit 4
12	D5	H/L	Data bit 5
13	D6	H/L	Data bit 6
14	D7	H/L	Data bit 7

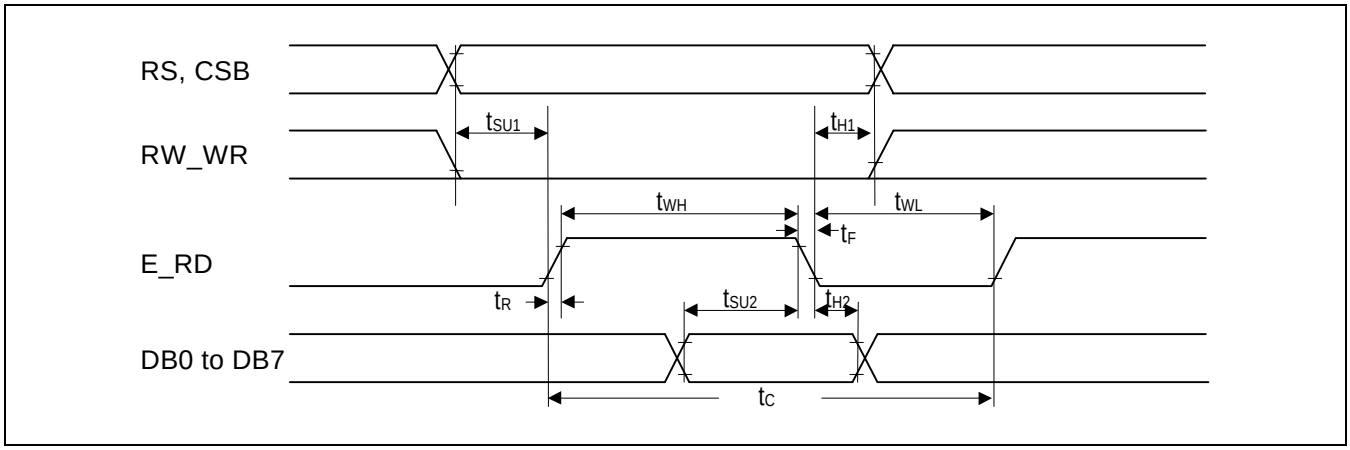
6.3 Interface Timing Chart

AC Characteristics(V_{DD}=2.4V~5.5V,Ta=-30~+85℃)

6800-series MPU Interface & Write Instruction

AC Characteristics (6800-series Write Instruction)

Condition	Characteristic	Symbol	Min.	Typ.	Max.	Unit
V_{DD} = 2.4V to 3.6V, Ta = -30 to +85 °C	E cycle time	t_C	650		-	ns
	Pulse rise / fall time	t_R, t_F	-	-	25	
	E pulse width high	t_{WH}	450	-	-	
	E pulse width low	t_{WL}	150	-	-	
	RS and CSB setup time	t_{SU1}	60	-	-	
	RS and CSB hold time	t_{H1}	30	-	-	
	DB setup time	t_{SU2}	100	-	-	
	DB hold time	t_{H2}	50	-	-	
V_{DD} = 3.6V to 5.5V, Ta = -30 to +85 °C	E cycle time	t_C	350		-	ns
	Pulse rise / fall time	t_R, t_F	-	-	25	
	E pulse width high	t_{WH}	250	-	-	
	E pulse width low	t_{WL}	100	-	-	
	RS and CSB setup time	t_{SU1}	40	-	-	
	RS and CSB hold time	t_{H1}	10	-	-	
	DB setup time	t_{SU2}	40	-	-	
	DB hold time	t_{H2}	10	-	-	

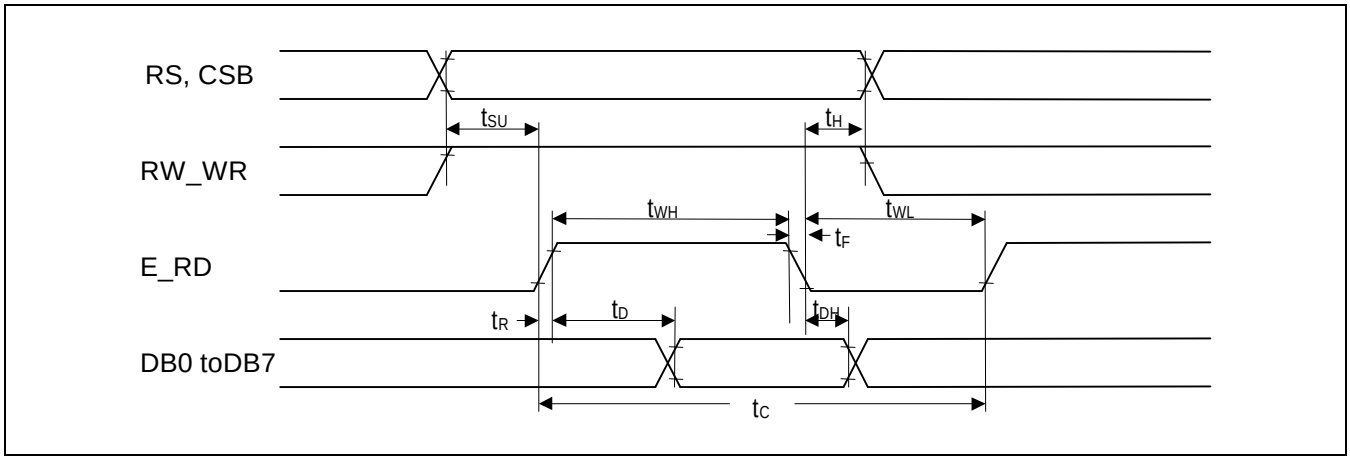


Write Bus Mode Timing (6800-series MPU Interface)

6800-series MPU Interface & Read Instruction

AC Characteristics (6800-series Read Instruction)

Condition	Characteristic	Symbol	Min.	Typ.	Max.	Unit
V_{DD} = 2.4V to 3.6V, Ta = -30 to +85 °C	E cycle time	t_C	650		-	ns
	Pulse rise / fall time	t_R,t_F	-	-	25	
	E pulse width high	t_{WH}	450	-	-	
	E pulse width low	t_{WL}	150	-	-	
	RS and CSB setup time	t_{SU}	60	-	-	
	RS and CSB hold time	t_H	30	-	-	
	DB output delay time	t_D	-	-	360	
	DB output hold time	t_{DH}	20	-	-	
V_{DD} = 3.6V to 5.5V, Ta = -30 to +85 °C	E cycle time	t_C	350		-	ns
	Pulse rise / fall time	t_R,t_F	-	-	25	
	E pulse width high	t_{WH}	250	-	-	
	E pulse width low	t_{WL}	100	-	-	
	RS and CSB setup time	t_{SU}	40	-	-	
	RS and CSB hold time	t_H	10	-	-	
	DB output delay time	t_D	-	-	120	
	DB output hold time	t_{DH}	10	-	-	



Read Bus Mode Timing (6800-series MPU Interface)

6.4 Instruction Code

INSTRUCTION DESCRIPTION

Instruction Table

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
*Clear display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC
Return home	0	0	0	0	0	0	0	0	1	-	DDRAM address is set to 00h from AC and the cursor returns to 00h position. The contents of DDRAM are not changed.
Entry mode set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display
Display ON / OFF control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and blinking of cursor (B) ON / OFF control
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data
Function set	0	0	0	0	1	DL	-	-	-	-	Set interface data length (DL: 4-bit / 8-bit) instruction
CGRAM address set	0	0	0	1	0	0	A3	A2	A1	A0	Set CGRAM address in address counter.
DDRAM address set	0	0	1	A6	A5	A4	A3	A2	A1	A0	Set DDRAM address in address counter.
Read busy flag and address	0	1	BF	A6	A5	A4	A3	A2	A1	A0	Whether in internal operation or not can be known by reading BF, The contents of address counter can also be read
Write data	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into DDRAM / CGRAM
Read data	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from DDRAM / CGRAM

("-": Don't care)

NOTES:

1. Instruction execution time depends on the internal process time of KS0032, therefore it is necessary to provide a time larger than one MPU interface cycle time (tc) between execution of two successive instructions.
2. "Clear Display" instruction has 850μs execution time (when fosc = 40.0kHz), so check the Busy flag or wait for more than 850μs after using "Clear Display" instruction.

6.5 Character generator ROM(S6A0032)

CHARACTER GENERATOR ROM (CGROM)

CGROM has 5 x 8-dot 254 characters. The CGROM character code 00h and 01h are CGRAM character data area.

CGROM Character Code (00)

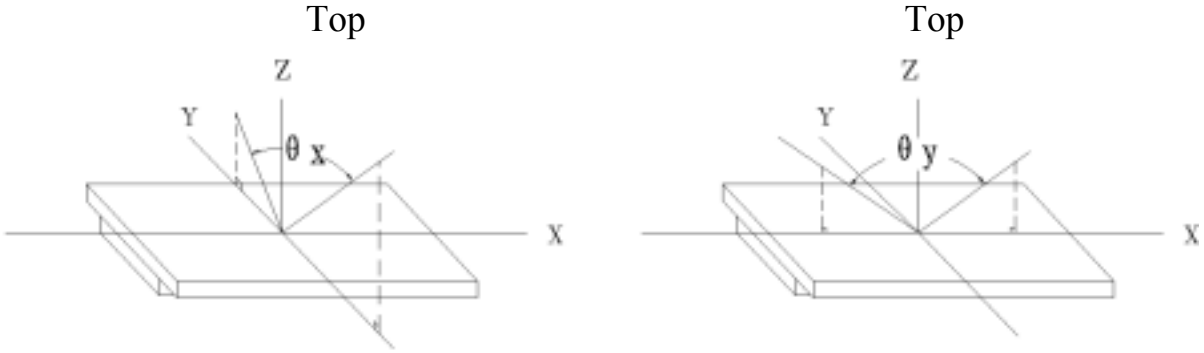
7. Optical Characteristics

7.1 Optical Characteristics Ta=25℃

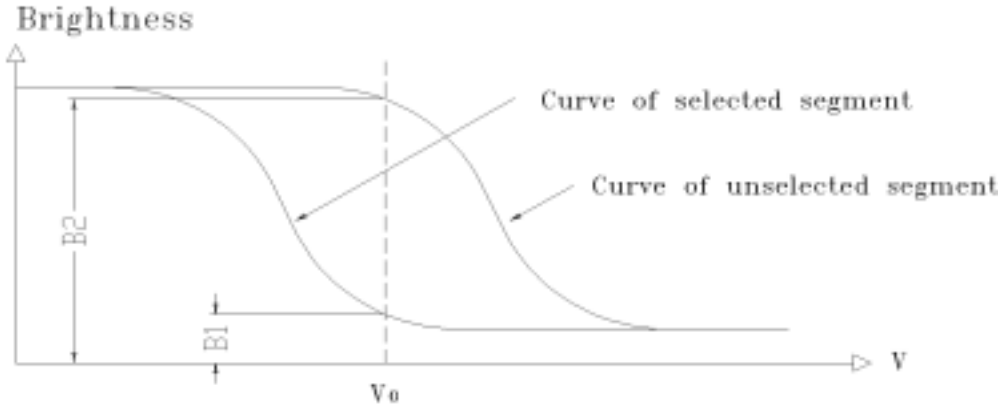
Item		Symbol	Condition		Min.	Typ.	Max.	Unit
Viewing Angle		θ_x	$C_r \geq 2$	$\theta_y=0°$	-35	--	20	Deg
		θ_y		$\theta_x=0°$	-30	--	30	
Contrast Ratio		C_r	$\theta_x=0°$ $\theta_y=0°$		4.0	-	-	
Response Time	Turn on	T_{on}	$\theta_x=0°$ $\theta_y=0°$		-	-	250	ms
	Turn off	T_{off}			-	-	250	

7.2 Definition of Optical Characteristics

7.2.1 Definition of Viewing Angle



7.2.2 Definition of Contrast Ratio

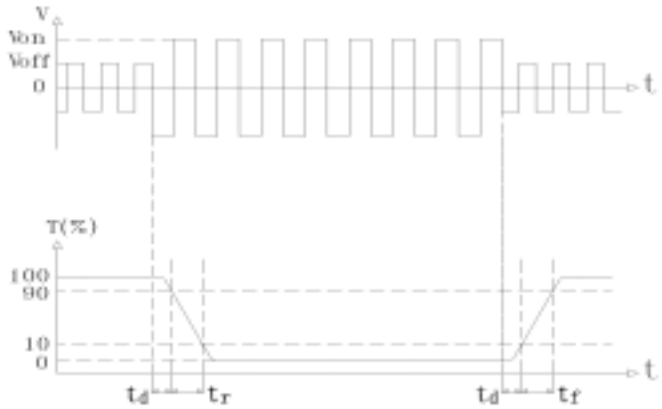


$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

Measuring Conditions:

1) Ambient Temperature: 25℃; 2) Frame frequency: 78Hz

7.2.3 Definition of Response time



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

Measuring Condition:

1) Operating Voltage: 3.3V 2) Frame frequency:78Hz

8. Reliability

8.1 Content of Reliability Test Ta=25℃

No.	Test Item	Content of Test	Test condition
1	High Temperature Storage	Endurance test applying the high storage temperature for a long time	60℃ 96H Restore 4H at 25℃
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-20℃ 96H Restore 4H at 25℃
3	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	40℃ 90%RH 96H Restore 4H at 25℃
4	Temperature Cycle	Endurance test applying the low and high temperature cycle -20℃←→25℃←→60℃←→25℃ 30min 5min 30min 5min ←——————————→ 1 cycle	-20℃/60℃ 10 cycles Restore 4H at 25℃
5	Vibration Test (package state)	Endurance test applying the vibration during transportation	10Hz~150Hz, 50m/s^2, 40min
6	Shock Test (package state)	Endurance test applying the shock during transportation	Half- sine wave, 100m/s^2, 11ms
7	Atmospheric Pressure Test	Endurance test applying the atmospheric pressure during transportation by air	40kPa 16H Restore 2H

8.2 Failure Judgment Criterion

Criterion Item	Test Item No.							Failure Judgement Criterion
	1	2	3	4	5	6	7	
Basic Specification	√	√	√	√	√	√	√	Out of the basic Specification
Electrical specification	√	√	√					Out of the electrical specification
Mechanical Specification					√	√		Out of the mechanical specification
Optical Characteristic	√	√	√	√			√	Out of the optical specification
Note	For test item refer to 8.1							
Remark	Basic specification = Optical specification + Mechanical specification							

9. QUALITY LEVEL

Examination or Test	At Ta=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 Appendix A			II	Major 0.65 Minor 1.5
Display Defects	Under normal illumination and eyesight condition, display on inspection.	See Appendix B			II	Major 0.65 Minor 1.5
Note: Major defects: Open segment or common, Short, Serious damages, Leakage Miner defects: Others Sampling standard conforms to GB2828						

10. Precautions for Use of LCD Modules

10.1 Handling Precautions

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

10.1.2 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, promptly wash it off using soap and water.

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

10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

10.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. 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

10.1.6 Do not attempt to disassemble the LCD Module.

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

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

a. Be sure to ground the body when handling the LCD Modules.

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 care when peeling off this protective film since static electricity may be generated.

10.2 Storage precautions

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

10.2.2 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 : 0℃ ～ 40℃

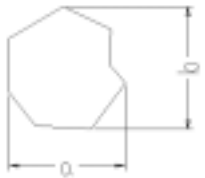
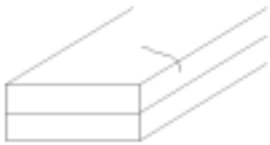
Relatively humidity: ≤80%

10.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

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

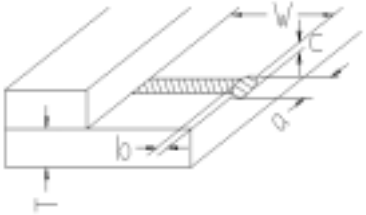
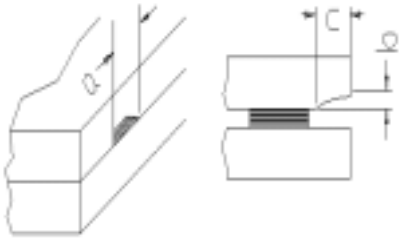
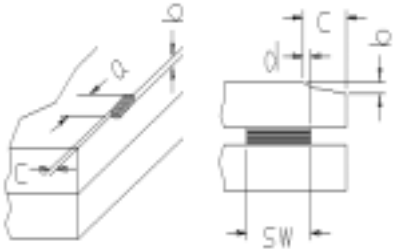
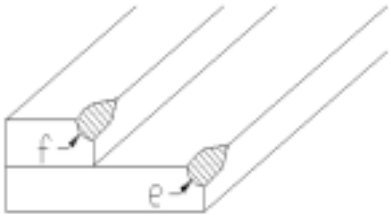
Appendix A

Inspection items and criteria for appearance defects

<table>
<tr><th>Items</th><th>Contents</th><th colspan="3">Criteria</th></tr>
<tr><td colspan="2">Protective Glue</td><td colspan="3">No clear defects</td></tr>
<tr><td colspan="2">Cover Tape</td><td colspan="3">Covering all of the chip and no clear crimple</td></tr>
<tr><td colspan="2">Leakage</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="2">Rainbow</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="5">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>

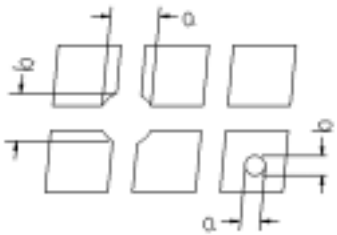
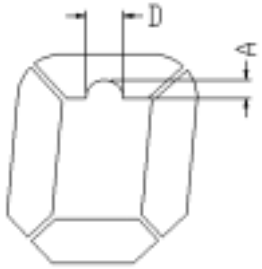
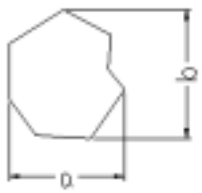
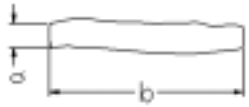
Appendix A

Inspection item and criteria for appearance defects (continued)

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

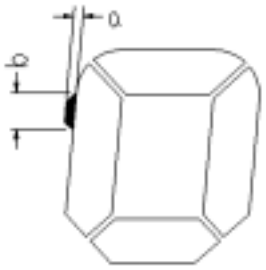
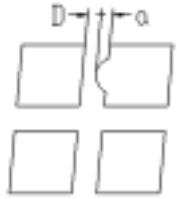
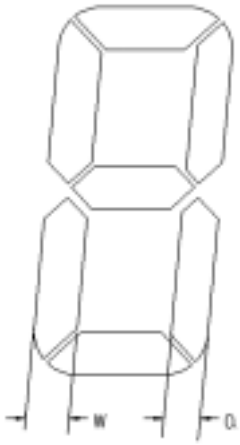
Appendix B

Inspection items and criteria for display defects

<table>
<tr><td colspan="2">Items</td><td>Contents</td><td colspan="3">Criteria</td></tr>
<tr><td colspan="3">Open segment or open common</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="3">Short</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="3">Wrong viewing angle</td><td colspan="3">Not permitted</td></tr>
<tr><td colspan="3">Contrast radio uneven</td><td colspan="3">According to the limit specimen</td></tr>
<tr><td colspan="3">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="2">  </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 rowspan="2">  </td><td>Not counted</td><td>Max.2 dots allowed</td></tr>
<tr><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. 02m≤a≤0.05mm
b≤0. 5mm</td></tr>
</table>

Appendix B

Inspection items and criteria for display defects (continued)

<table>
<tr><th>Items</th><th>Content</th><th colspan="3">Criteria</th></tr>
<tr><td rowspan="3">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
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. 1 defects allowed</td><td rowspan="2">Max.3
defects
allowed</td></tr>
<tr><td>a＜0.1mm</td><td>0.1mm≤a≤0.2mm
D>0</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>