

SPECIFICATION FOR LCD MODULE

Model No. TM0210AKFW

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

TIANMA MICROELECTRONICS CO., LTD

REVISION RECORD

Date	Ver.	Ref. Page	Revision No.	Revision Items

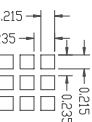
1 General Specifications:

ITEM	CONTENTS		UNIT
	MAIN LCD	SUB LCD	
LCD TYPE	COLOR STN	FSTN	---
LCD DUTY	1/160	1/64	---
LCD BIAS	1/5	1/9	---
VIEWING DIRECTION	6:00	6:00	O'CLOCK
GLASS AREA(WXH)	38.5X48.0	28.2X27.6	MM
VIEWING AREA(WXH)	34.5X39.3	25.5X18.2	MM
NUMBER OF DOTS	128(R+G+B)X160	96X64	MM
MODULE SIZE(WXHXT)	38.5X(51.9+33.4)X5.0(MAX)		MM
DOT SIZE(WXH)	0.069X0.215	0.215X0.215	MM
DOT PITCH(WXH)	0.079X0.225	0.235X0.235	MM
CONTROLLER	S6B33B0A-B0CY	SSD1828Z	---
VDD	3.0		V
LCD OPERATING VOLTAGE	16.8	9	V
OUTLINE DIMENSIONS	REFER TO OUTLINE DRAWING ON NEXT PAGE		
BACKLIGHT	LED(WHITE)	LED(WHITE)	---
OPERATING TEMPERAT	-20---+70	-20---+70	---
STORAGE TEMPERATURE	-30---+80	-30---+80	---
WEIGHT	TBD		---
DATA TRANSFER	8 BIT PARALLEL		---
POLARIZER MODE	TRANSMISSIVE /NEGATIVE	TRANSFLECTIVE/ POSITIVE	---



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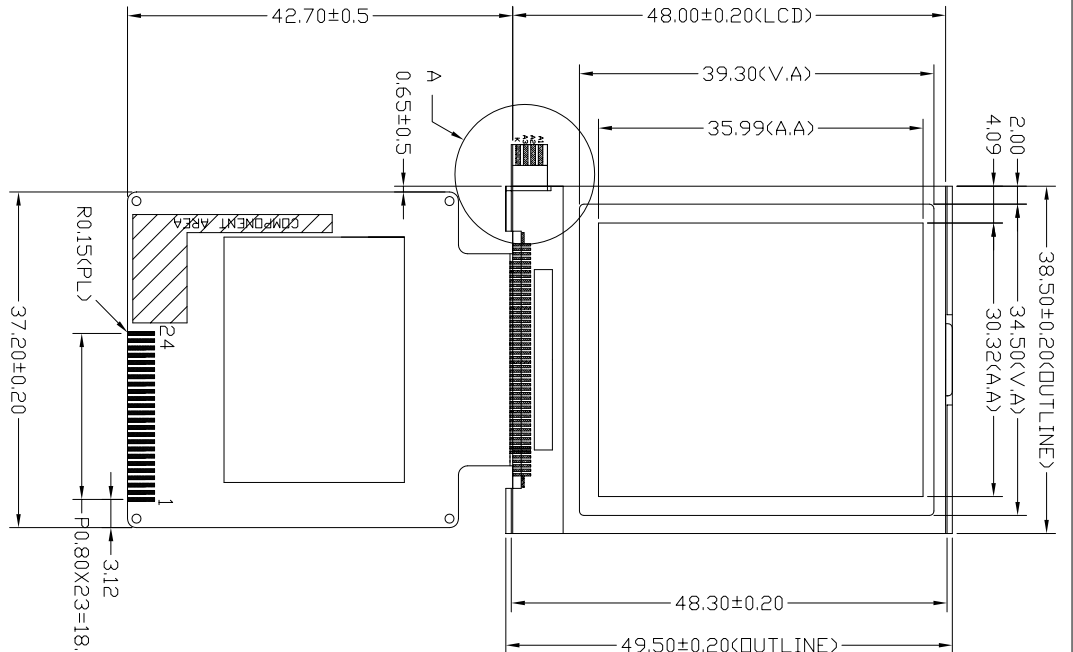
NOTES:
1.DISPLAY TYPE:
2.VIEWING DIRECTION:
3.MAIN LCD DRIVE IC:
SUB LCD DRIVE IC:
4.POLARIZER MODE:
5.DRIVE METHOD:
6.VBAT:
7.BACKLIGHT:
8.OPERATING TEMP:
9.STORAGE TEMP:
10.UNMARKED TOLERANCE:
11.① IS REMOVE TAPE
12.CONNECTOR TYPE:AKK830145J
MAIN LCD CSTN.SUB LCD FSTN
6:00
S6B33B0A-B0CY
SSD1828Z
MAIN LCD TRANSMISSIVE/NEGATIVE
SUB LCD TRANSLFLECTIVE/POSITIVE
MAIN LCD 1/160 DUTY 1/5 BIAS
SUB LCD 1/64 DUTY 1/9 BIAS
3.2~5.5V
MAIN VLCD=16.8V SUB VLCD=12.0V
MAIN & SUB LCD (3CHP-WHITE LED)
-20°C -- 70°C
-30°C -- 80°C

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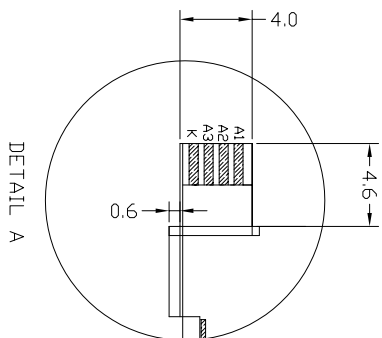
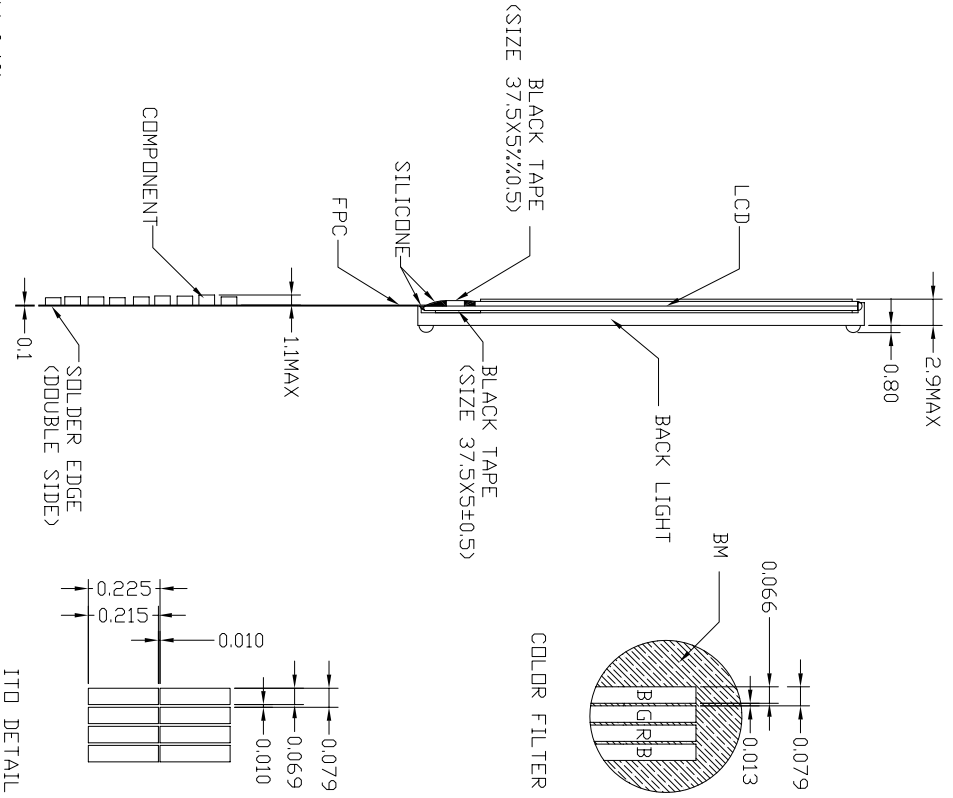


NO.	SYMBOL
1	VBAT
2	VBAT
3	GND
4	LED-G
5	LED-B
6	LED-R
7	DISP-CS-SUB
8	RD
9	VBAT
10	DN-OFF
11	DISP-RST
12	LED-MAIN-EN
13	VIBRATOR
14	WR
15	DISP-CS-MAIN
16	DB0
17	DB1
18	DB2
19	DB3
20	DB4
21	DB5
22	DB6
23	DB7
24	RS
25	GND
26	GND
27	REC+
28	REC-
29	SP+
30	SP-

		TIAN-MA MICROELECTRONICS CO. 6/F., CASTLE Building, Sherman Road, Central, Shenzhen, China	
DRAWN BY:	TITLE: TM0210AKFW		
CHECKED BY:			
APPROVED BY:	DWG NO: G-2	SCALE:	
CONFIRMED BY:	DWG NAME: TM0210AKFW-G-2	SHEET NO. 1 OF 1	UNIT: mm



NOTE:
 1. OPERATION TEMPERATURE: -20°C TO 70°C
 2. STORAGE TEMPERATURE: -30°C TO 80°C
 3. DRIVE IC: S6B3B0A01-B0CY
 4. LCD: TSF6216
 5. FPC: TSF6302
 6. BACK LIGHT: GG1022
 7. GENERAL TOLERANCE: ±0.2



PIN	SYMBOL	PIN DESCRIPTION
1	GND	
2	VDD	
3	MPU0	
4	DISP-CS-MAIN	
5	DISP-RST	
6	RS	
7	WR	
8	RD	
9	DB0	
10	DB1	
11	DB2	
12	DB3	
13	DB4	
14	DB5	
15	DB6	
16	DB7	
17	DB8	
18	DB9	
19	DB10	
20	DB11	
21	DB12	
22	DB13	
23	DB14	
24	DB15	

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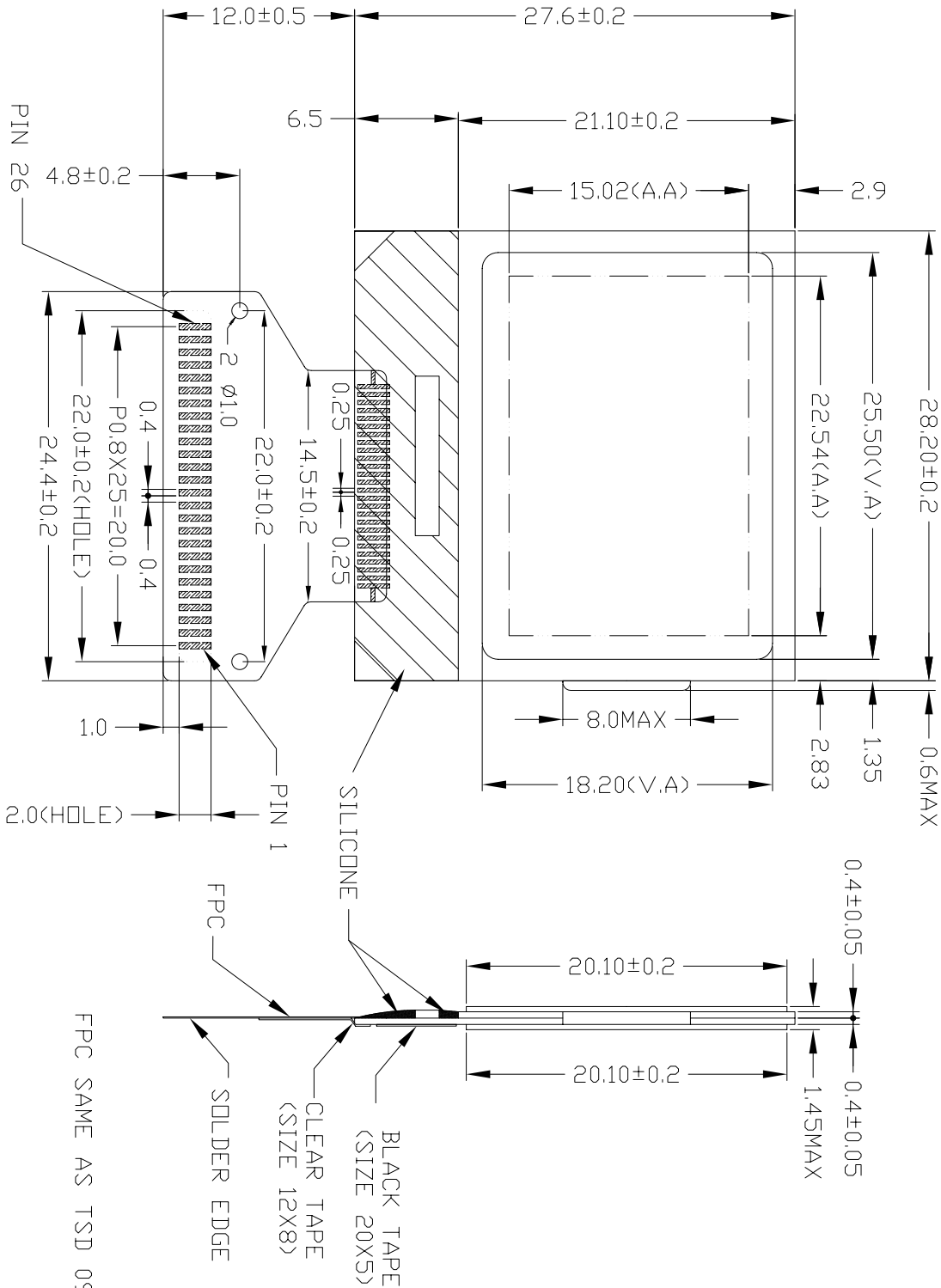
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DRAWN BY:	TITLE:
CHECKED BY:	DWG NO:
APPROVED BY:	DWG NAME:
CONFIRMED BY:	SHEET NO: 1 OF 1

SCALE:

UNIT: mm

1:1



1	PS0
2	PS1
3	/CS
4	/RES
5	D/C
6	R/W
7	E
8	D0
9	D1
10	D2
11	D3
12	D4
13	D5
14	D6
15	D7
16	VDD
17	VDD
18	VSS
19	VSS
20	VOUT
21	VOUT
22	NC
23	NC
24	NC
25	NC
26	NC

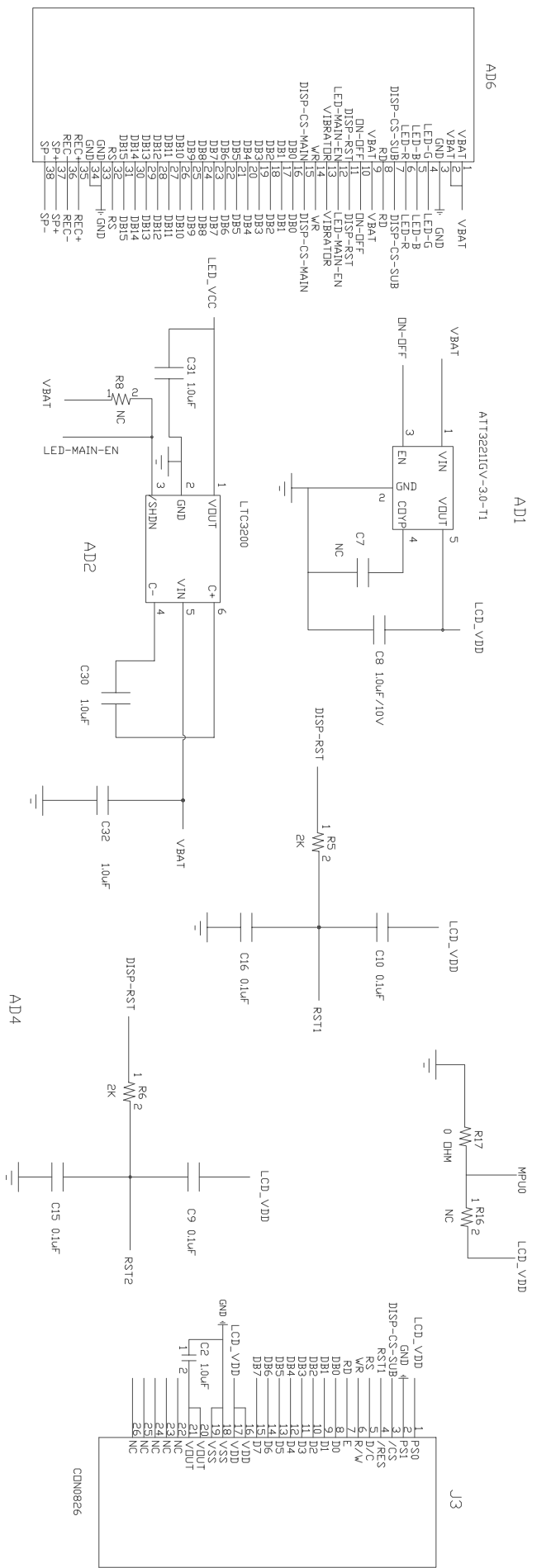




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DRAWN BY:	TITLE:	SCALE:	SHEET NO: 1 OF 1
CHECKED BY:		UNIT: mm	
APPROVED BY:	DWG NO:		
CONFIRMED BY:	DWG NAME:		

3. Circuit Block Diagram



		TIAN-MA MICROELECTRONICS CO. 22/F., CASTIC Building, Shennan Road, Central, Shenzhen, China	
DRAWN BY:	TITLE: TM0210AKFW		
CHECKED BY:	DWG NO: DC-1	SCALE:	
APPROVED BY:	DWG NAME: TM0210AKFW DC-1	UNIT: mm	SHEET NO. 1 OF 1

4 Absolute Maximum Ratings(Ta=25)

ITEM	SYMBOL	MIN	MAX	UNIT
Power supply voltage(1)	VBAT	3.0	5.0	V
Power supply voltage(2)	LCD_VCC	-0.3	4.0	V
Power supply Voltage for main LCD	VLCD-GND	-0.3	20	V
Logic signal Input voltage	Vt	-0.3	LCD_VCC+0.3	V
Operating temperature	Topr	-20	+70	
Storage temperature	Tst	-30	+80	

Notes:

1. If the module is used 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.
2. LCD_VCC>GND must be maintained.

5. Electrical Specifications and Instruction Code (V_{SS}=0V, T_a=25)

5.1 Electrical characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for logic	VBAT	---	3.2	3.8	4.5	V
Operating voltage for LCD(main LCD)	VLCD1	25	2.4	3.0	3.3	V
Operating voltage for LCD(Sub LCD)	VLCD2	25	2.4	3.0	3.3	V
Input voltage'H'level	V _{IH}	LCD_VCC=3.0V	0.7LCD_VCC	---	LCD_VCC	V
Input voltage'L'level	V _{IL}	LCD_VCC=3.0V	0	---	0.15LCD_VCC	V
Output voltage'H'level	V _{OH}	---	0.75LCD_VCC	---	LCD_VCC	V
Output voltage'L'level	V _{OL}	---	0	---	0.15LCD_VCC	V
Current consumption for MAIN LCD normal operation	IDD1	LCD-VCC-GND=3.0V; 1/160DUTY	---	1.2	2.0	mA
Current consumption for SUB LCD normal operation	IDD2	LCD-VCC-GND=3.0V; 1/64DUTY	---	0.15	0.35	mA

5.2 Interface Signals

Pin NO.	Symbol	Function
1	VBAT	Power supply pin
2	VBAT	Power supply pin
3	GND	Ground pin
4	LED-G	Indication LED(GREEN)ON
5	LED-B	Indication LED(BLUE)ON
6	LED-R	Indication LED(RED)ON
7	CS-SUB	SUB chip selection input pin:Active”L”
8	RD	E is read enable clock input pin.When E=”L”,DB0~DB7 are in output status.
9	VBAT	Power supply pin.
10	ON-OFF	LDO ON/OFF
11	RST	Chip reset signal input pin:Active”L”
12	LED-MAIN-EN	LED backlight enable pin.when”H”the LED backlight is turn on.
13	VIBRTOR	Motor control pin.
14	WR	WR is write enable clock input pin.DB0~DB7 are latched at the rising edge of the RW signal.
15	CS-MAIN	Main LCD(CSTN)chip selection input pin:Active”L”.
16	D0	8bit Bi-directional data bus.
17	D1	
18	D2	
19	D3	
20	D4	
21	D5	
22	D6	
23	D7	
24	RS	Command/data select input pin. RS=”L” input DB7~DB0 is control data;RS=”L” input DB7~DB0 is display data.
25	GND	Ground pin.
26	GND	Ground pin.
27	REC+	Connect to REC.
28	REC-	Connect to REC.
29	SPK+	Connect to speaker.
30	SPK-	Connect to speaker.

5.3 Interface Timing Chart

Note: Please refer to SAMSUNG's S6B33B0A / SOLOMON SSD1828Z data sheet for more details.

SAMSUNG S6B33B0A INTERFACE PROTOCOL

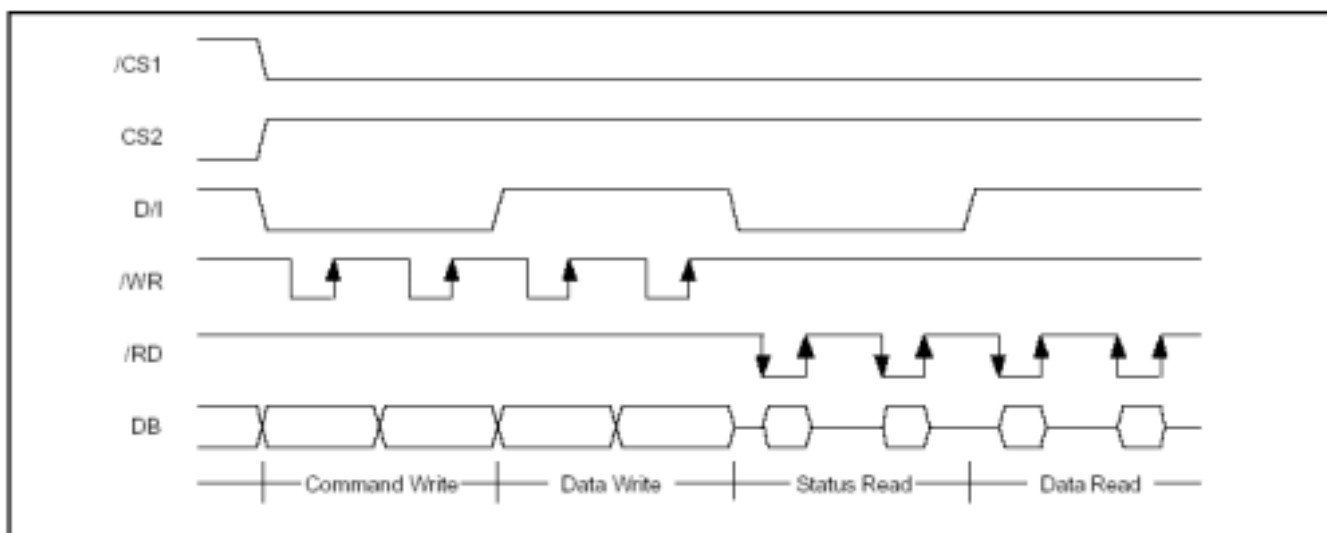


Figure 7. 8080-Series MPU Interface Protocol (MPU[1]="L")

Table 17. AC Characteristics (8080-series Parallel Mode)

(VDD3 = 1.8 to 3.3V, Ta = -30 to +70°C)

Item	Signal	Symbol	Condition	Min.		Max. (3.3V/1.8V)	Unit
				3.3V	1.8V		
Address setup time	D/I	t _{AS80}		0	0	-	ns
Address hold time		t _{AH80}		0	0	-	
System cycle time		t _{CY80}		150	360	-	ns
Pulse width low for write	WRB (WRB)	t _{PWLW}		50	100	-	ns
Pulse width High for write		t _{PWHW}		30	75	-	
Pulse width low for read	RDB (RDB)	t _{PWLr}		50	100	-	ns
Pulse width high for read		t _{PWHR}		30	75	-	
Data setup time	DB0 to DB15	t _{DS80}		5	10	-	ns
Data hold time		t _{DH80}		8	14	-	
Read access time		t _{ACC80}	CL = 100 pF	-		60 / 120	ns
Output disable time		t _{OD80}		t _{EWHR}			

NOTE: *1. The input signal rise time and fall time (t_r , t_f) is specified at 10 ns or less.

($t_r + t_f$) < ($t_{CY80} - t_{PWLW} - t_{PWHW}$) for write, ($t_r + t_f$) < ($t_{CY80} - t_{PWLr} - t_{PWHr}$) for read

INSTRUCTION DESCRIPTION (S6B33B0)

Instruction Name	D/I	WRB	RDB	DB15 ~DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Hex.	Parameter
Non Operation	0	0	1	*	0	0	0	0	0	0	0	0	00	
Oscillation Mode Set	0	0	1	*	0	0	0	0	0	0	1	0	02	1Byte
Driver Output Mode Set	0	0	1	*	0	0	0	1	0	0	0	0	10	1Byte
DC-DC Select	0	0	1	*	0	0	1	0	0	0	0	0	20	1Byte
Driving current & Bias Set	0	0	1	*	0	0	1	0	0	0	1	0	22	1Byte
DCDC Clock Division Set	0	0	1	*	0	0	1	0	0	1	0	0	24	1Byte
DCDC and AMP ON/OFF set	0	0	1	*	0	0	1	0	0	1	1	0	26	1Byte
Temperature Compensation Set	0	0	1	*	0	0	1	0	1	0	0	0	28	1Byte
Contrast Control(1)	0	0	1	*	0	0	1	0	1	0	1	0	2A	1Byte
Contrast Control(2)	0	0	1	*	0	0	1	0	1	0	1	1	2B	1Byte
Standby Mode OFF	0	0	1	*	0	0	1	0	1	1	0	0	2C	-
Standby Mode ON	0	0	1	*	0	0	1	0	1	1	0	1	2D	-
DDRAM Burst Mode OFF	0	0	1	*	0	0	1	0	1	1	1	0	2E	-
DDRAM Burst Mode ON	0	0	1	*	0	0	1	0	1	1	1	1	2F	-
Addressing Mode Set	0	0	1	*	0	0	1	1	0	0	0	0	30	1Byte
ROW Vector Mode Set	0	0	1	*	0	0	1	1	0	0	1	0	32	1Byte
N-line Inversion Set	0	0	1	*	0	0	1	1	0	1	0	0	34	1Byte
Entry Mode Set	0	0	1	*	0	1	0	0	0	0	0	0	40	1Byte
X-address Area Set	0	0	1	*	0	1	0	0	0	0	1	0	42	2Byte
Y-address Area Set	0	0	1	*	0	1	0	0	0	0	1	1	43	2Byte
RAM Skip Area Set	0	0	1	*	0	1	0	0	0	1	0	1	45	1Byte
Display OFF	0	0	1	*	0	1	0	1	0	0	0	0	50	-
Display ON	0	0	1	*	0	1	0	1	0	0	0	1	51	-
Specified Display Pattern Set	0	0	1	*	0	1	0	1	0	0	1	1	53	1Byte
Partial Display Mode Set	0	0	1	*	0	1	0	1	0	1	0	1	55	1Byte
Partial Display Start Line Set	0	0	1	*	0	1	0	1	0	1	1	0	56	1Byte
Partial Display End Line Set	0	0	1	*	0	1	0	1	0	1	1	1	57	1Byte
Area Scroll Mode Set	0	0	1	*	0	1	0	1	1	0	0	1	59	4Byte
Scroll Start Line Set	0	0	1	*	0	1	0	1	1	0	1	0	5A	1Byte
Set Display Data Length	X	X	X	*	1	1	1	1	1	1	0	0	FC	1Byte
Display Data Write	1	0	1	Display Data Write									-	-
Display Data Read	1	1	0	Display Data Read									-	-
Status Read	0	1	0	0	Status Data Read								-	-
Test Mode1	0	0	1	*	1	1	1	1	1	1	1	1	FF	-
Test Mode2	0	0	1	*	1	1	1	1	1	1	1	0	FE	-
Test Mode3	0	0	1	*	1	1	1	1	1	1	0	1	FD	-
Test Mode4	0	0	1	*	1	1	1	1	1	0	1	1	FB	-
Test Mode5	0	0	1	*	1	1	1	1	1	0	1	0	FA	-
Test Mode6	0	0	1	*	1	1	1	1	1	0	0	1	F9	-

*: Don' t care

Parameter: The number of parameter bytes that follows instruction data.

SOLOMON SSD1828Z INTERFACE PROTOCOL

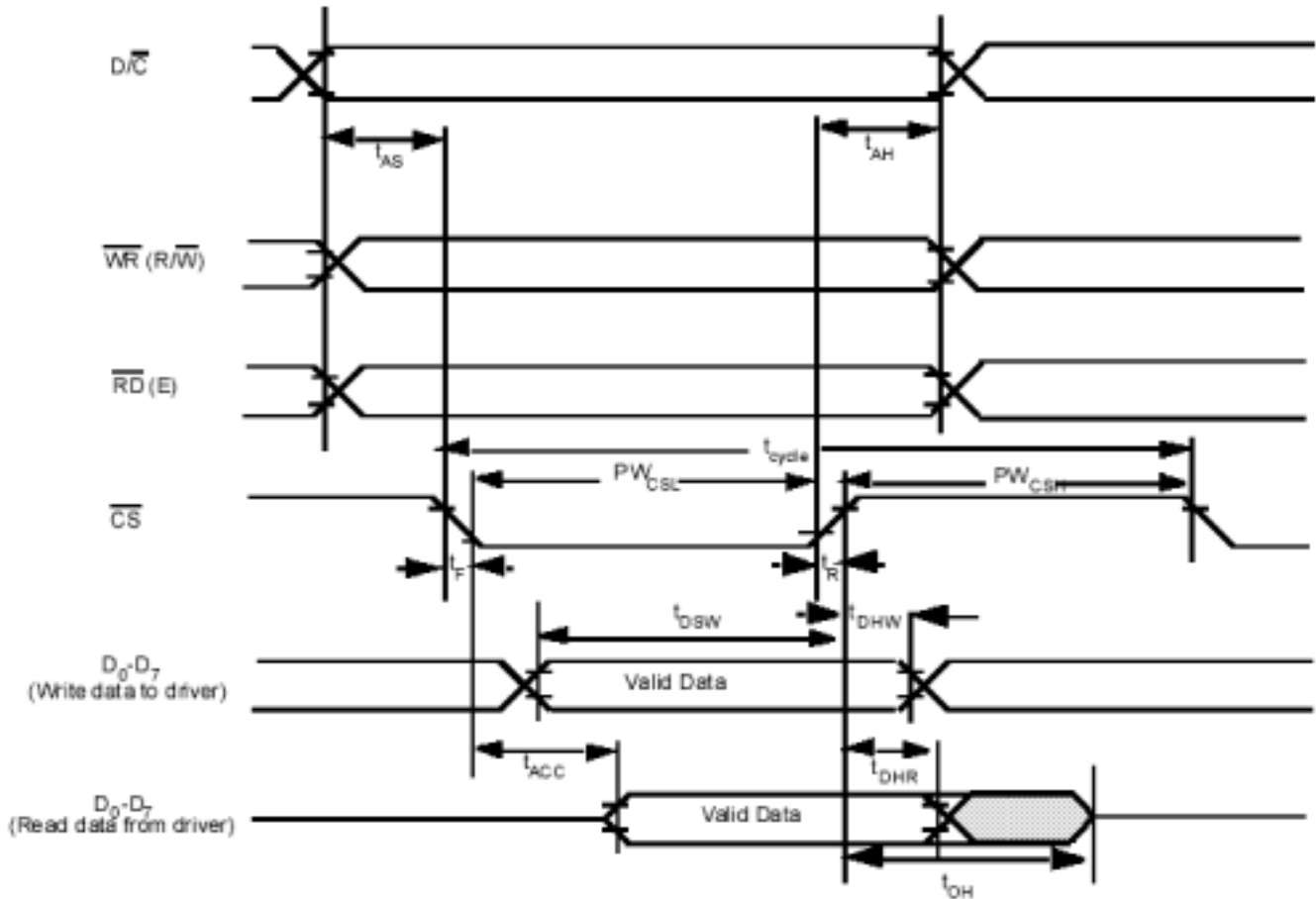


Figure 12 - Parallel 8080-series Interface Timing Characteristics (PS0 = H, PS1 = L)

Table 16 - Parallel Timing Characteristics ($T_A = -40$ to 85°C , $V_{DD} = 1.8\text{V}$, $V_{SS} = 0\text{V}$)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time (write cycle)	200	1000	-	ns
t_{AS}	Address Setup Time	0	-	25	ns
t_{AH}	Address Hold Time	0	-	-	ns
t_{DSW}	Write Data Setup Time	40	-	-	ns
t_{DHW}	Write Data Hold Time	10	-	-	ns
t_{DHR}	Read Data Hold Time	10	-	50	ns
t_{OH}	Output Disable Time	-	-	40	ns
t_{ACC}	Access Time (RAM)	15	-	-	ns
t_{ACC}	Access Time (command)	15	-	-	ns
PW_{CSL}	Chip Select Low Pulse Width (read RAM)	500	-	-	ns
	Chip Select Low Pulse Width (read Command)	500	-	-	ns
	Chip Select Low Pulse Width (write)	100	-	-	ns
PW_{CSH}	Chip Select High Pulse Width (read)	200	-	-	ns
	Chip Select High Pulse Width (write)	200	-	-	ns
t_R	Rise Time	-	-	10	ns
t_F	Fall Time	-	-	10	ns

COMMAND TABLE (SSD1828)

Bit Pattern	Command	Description
0000 $C_3C_2C_1C_0$	Set Column LSB	Set the lower nibble of the column address pointer for RAM access. The pointer is reset to 0 after reset.
0001 $0C_6C_5C_4$	Set Column MSB	Set the upper nibble of the column address pointer for RAM access. The pointer is reset to 0 after reset.
0010 $0R_2R_1R_0$	Set Internal Resistor Ratio	The internal regulator gain $(1+R_2/R_1)$ Vout increases as $R_2R_1R_0$ is increased from 000b to 111b. The factor, $1+R_2/R_1$, is given by: $R_2R_1R_0 = 000$: 2.3 (POR) $R_2R_1R_0 = 001$: 3.0 $R_2R_1R_0 = 010$: 3.7 $R_2R_1R_0 = 011$: 4.4 $R_2R_1R_0 = 100$: 5.1 $R_2R_1R_0 = 101$: 5.8 $R_2R_1R_0 = 110$: Reserved $R_2R_1R_0 = 111$: Reserved (Refer to 8.14)
0010 1VC VR VF	Set Voltage Control	VC VR = 00: turn OFF the internal voltage booster & regulator (POR) VC VR = 01,10,11: turn ON the internal voltage booster & regulator VF=0: turn OFF the output op-amp buffer (POR) VF=1: turn ON the output op-amp buffer
0011 $1T_2T_1T_0$	Set TC value	This command set the Temperature Coefficient $T_2T_1T_0$: 001: -0.035%/°C 010: -0.035%/°C 011: -0.05%/°C (POR) 100: -0.083%/°C
0100 00XX $XL_6L_5L_4L_3L_2L_1L_0$	Set Initial Display Line	The second command specifies the row address pointer (0-63) of the RAM data to be displayed in COM0. This command has no effect on ICONS. The pointer is set to 0 after reset.
0100 01XX $XXC_5C_4C_3C_2C_1C_0$	Set Initial COM0	The second command specifies the mapping of first display line (COM0) to one of ROW0~63. This command has no effect on ICONS. COM0 is mapped to ROW0 after reset.

Bit Pattern	Command	Description																																				
0100 10XX XD ₆ D ₅ D ₄ D ₃ D ₂ D ₁ D ₀	Set Multiplex Ratio (partial display)	<p>The second command specifies the number of lines, excluding ICONS, to be displayed. With Icon is disabled (POR), 16~64 mux could be selected. With Icon enabled, the available mux are 17~ 65.</p> <table> <tr> <th>D6 – D0</th><th>Mux (Icon disable)</th><th>Mux (Icon enable)</th></tr> <tr> <td>000000</td><td>invalid</td><td>invalid</td></tr> <tr> <td>...</td><td></td><td></td></tr> <tr> <td>0001111</td><td>invalid</td><td>invalid</td></tr> <tr> <td>0010000</td><td>16</td><td>17</td></tr> <tr> <td>0010001</td><td>17</td><td>18</td></tr> <tr> <td>...</td><td></td><td></td></tr> <tr> <td>1000000</td><td>64</td><td>65</td></tr> <tr> <td>1000001</td><td>invalid</td><td>invalid</td></tr> <tr> <td>1000010</td><td>invalid</td><td>invalid</td></tr> <tr> <td>...</td><td></td><td></td></tr> <tr> <td>1111111</td><td>invalid</td><td>invalid</td></tr> </table>	D6 – D0	Mux (Icon disable)	Mux (Icon enable)	000000	invalid	invalid	...			0001111	invalid	invalid	0010000	16	17	0010001	17	18	...			1000000	64	65	1000001	invalid	invalid	1000010	invalid	invalid	...			1111111	invalid	invalid
D6 – D0	Mux (Icon disable)	Mux (Icon enable)																																				
000000	invalid	invalid																																				
...																																						
0001111	invalid	invalid																																				
0010000	16	17																																				
0010001	17	18																																				
...																																						
1000000	64	65																																				
1000001	invalid	invalid																																				
1000010	invalid	invalid																																				
...																																						
1111111	invalid	invalid																																				
0100 11XX XXXN ₄ N ₃ N ₂ N ₁ N ₀	Set N-line Inversion	<p>The second command sets the n-line inversion register from 3 to 33 lines to reduce display crosstalk. Register values from 00001b to 11111b are mapped to 3 lines to 33 lines respectively. Value 00000b disables the N-line inversion, which is the POR value.</p> <p>To avoid a fix polarity at some lines, it should be noted that the total number of mux (including the icon line) should NOT be a multiple of the lines of inversion (n).</p>																																				
0101 0B ₂ B ₁ B ₀	Set LCD Bias	<p>Sets the LCD bias from 1/4 ~ 1/9 according to B₂B₁B₀:</p> <p>000: 1/4 bias 001: 1/5 bias 010: 1/6 bias 011: 1/7 bias 100: 1/8 bias 101: 1/9 bias (POR) 110: 1/9 bias 111: 1/9 bias</p>																																				
0110 01B ₁ B ₀	Set Boost Level	<p>Set the DC-DC multiplying factor from 2X to 5X</p> <p>B₁B₀: 00: 3X 01: 4X 10: 5X 11: 2X (POR)</p>																																				
1000 0001 XXC ₅ C ₄ C ₃ C ₂ C ₁ C ₀	Set Contrast Level	<p>The second command sets one of the 64 contrast levels. The darkness increase as the contrast level increase.</p>																																				
1010 000S ₀	Set Segment Re-map	<p>S₀=0: column address 00H is mapped to SEG0 (POR) S₀=1: column address 5FH is mapped to SEG0</p>																																				
1010 001C ₀	Icon Control Register ON/OFF	<p>C₀=0: Disable icon row (Mux = 16 to 64, POR) C₀=1: Enable icon row (Mux = 17 to 65)</p>																																				
1010 010E ₀	Entire Display Select	<p>E₀=0: Normal display (display according to RAM contents, POR) E₀=1: All pixels are ON regardless of the RAM contents *Note: This command will override the effect of "Set Normal/Invert Display"</p>																																				
1010 011R ₀	Invert Display Select	<p>R₀=0: Normal display (display according to RAM contents, POR) R₀=1: Invert display (ON and OFF pixels are inverted) *Note: This command will not affect the display of the icon lines</p>																																				

Bit Pattern	Command	Description																		
1010 1000	NOP	No operation																		
1010 1001	Power Save Mode	Sleep Mode: Oscillator: OFF LCD Power Supply: OFF COM/SEG Outputs: V _{SS}																		
1010 1011	Start Internal Oscillator	This command starts the internal oscillator. Note that the oscillator is OFF after reset, so this instruction must be executed for initialization																		
1010 111D ₀	Display On/Off	Turn the display on and off without modifying the content of the RAM. (0: off, 1: on) This command has priority over Entire Display On/Off and Invert Display On/Off. Commands are accepted while the display is off, but the visual state of the display does not change.																		
1011 P ₃ P ₂ P ₁ P ₀	Set Page Address	Set GDDRAM page address (0~8) using P ₃ P ₂ P ₁ P ₀ for RAM access. The page address is sets to 0 after reset.																		
1100 S ₀ XXX	Set COM Scan Direction	Set the COM (row) scanning direction. (0: COM0 →COM63, 1: COM63 →COM0)																		
1101 1F ₂ F ₁ F ₀	Set Frame Frequency	This command is used to set the frame frequency. <table><tr><td>F₂F₁F₀</td><td>Frame Frequency</td></tr><tr><td>000</td><td>68</td></tr><tr><td>001</td><td>73</td></tr><tr><td>010</td><td>75 (POR)</td></tr><tr><td>011</td><td>80</td></tr><tr><td>100</td><td>80</td></tr><tr><td>101</td><td>86</td></tr><tr><td>110</td><td>90</td></tr><tr><td>111</td><td>100</td></tr></table>	F ₂ F ₁ F ₀	Frame Frequency	000	68	001	73	010	75 (POR)	011	80	100	80	101	86	110	90	111	100
F ₂ F ₁ F ₀	Frame Frequency																			
000	68																			
001	73																			
010	75 (POR)																			
011	80																			
100	80																			
101	86																			
110	90																			
111	100																			
1110 0001	Exit Power-save Mode	DC-DC converter, regulator and divider status before entering the power-save mode is restored. At POR, Power-save Mode is released.																		
1110 0010	Software Reset	Reset some functions of the driver/controller. See Reset Section below for more details.																		
1110 0100	Release N-line Inversion Mode	Release the driver/controller from N-line inversion mode. The frame will be inverted once per frame																		
1110 1000 D ₇ D ₆ D ₅ D ₄ D ₃ D ₂ D ₁ D ₀	Display Data Length	This command is used in 3-line SPI mode (without D/C line) to specify that the controller is about to send display data to the display RAM. Eight bits are used to specify the number of bytes to be sent (1 to 256 bytes). The second command received after the display data is transmitted is assumed to be command data.																		

Bit Pattern	Command	Comment
1111 0010 0000 X ₀ 000	Enable external oscillator input	Select external oscillator input form CL pin. X ₀ = 0 : (POR) internal RC oscillator X ₀ = 1 : external square wave
Other than above	Reserved	

6. Optical Characteristics

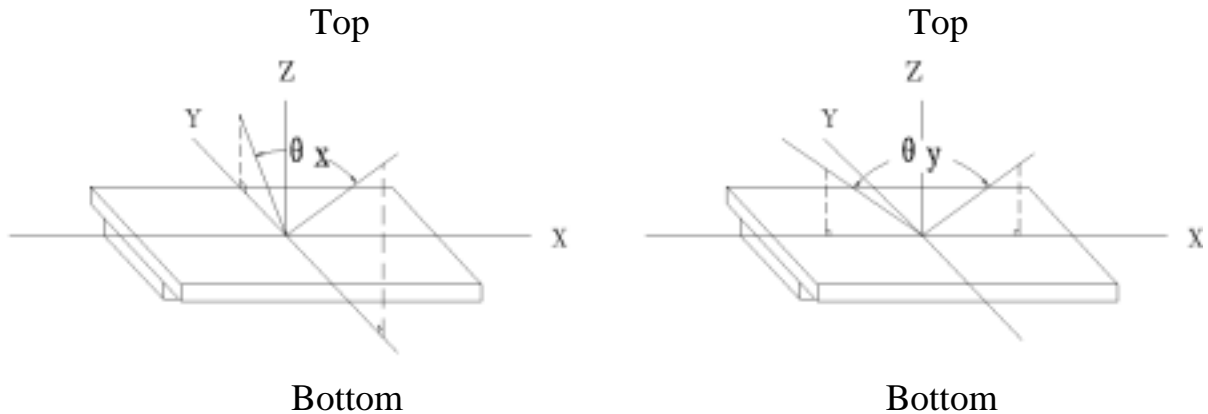
6.1 Optical Characteristics

$V_{LCD}=16.8V$ $T_a=25$

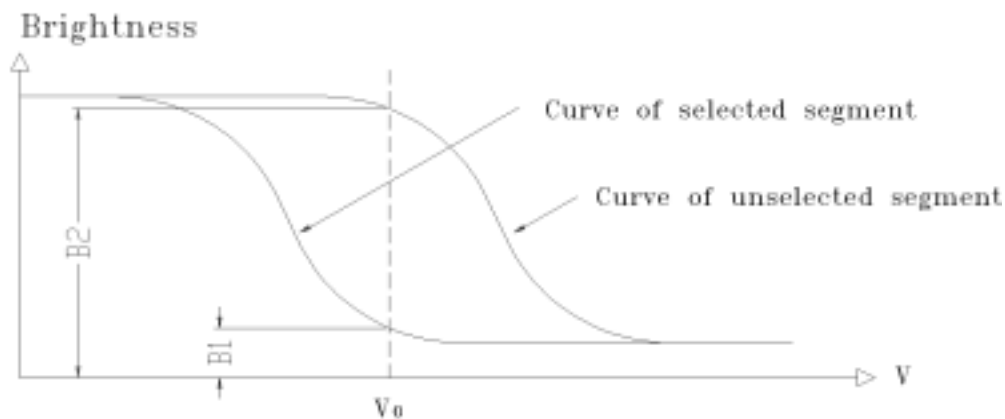
Item		Symbol	Condition			Min.	Typ.	Max.	Unit
Viewing Angle		x	Cr≥2	y=0 °	MAIN	-40--+35			Deg
					SUB	-60--+36			
		y		x=0 °	MAIN	-30--+30			
					SUB	-42--+40			
Contrast Ratio		Cr	x=0 ° y=0 °			30	50	60	--
Response Time	Turn on	Ton	x=0 ° y=0 °			-	-	150	ms
	Turn off	Toff				-	-	100	
Color Of CIE Coord-Inate	Red	x	x=0 ° y=0 °			-	0.43	-	-
		y				-	0.35	-	-
	Green	x	x=0 ° y=0 °			-	0.32	-	-
		y				-	0.46	-	-
	Blue	x	x=0 ° y=0 °			-	0.22	-	-
		y				-	0.26	-	-

6.2 Definition of Optical Characteristics

6.2.1 Definition of Viewing Angle



6.2.2 Definition of Contrast Ratio

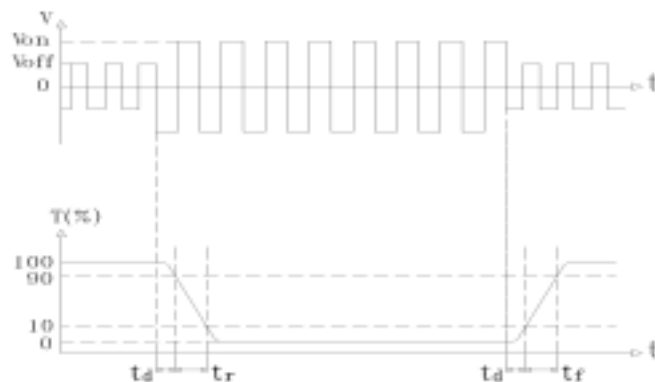


$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

Measuring Conditions:

- 1) Ambient Temperature: 25 ;
- 2) Frame frequency: 70.0Hz

6.2.3 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: MAIN-LCD 16.8V SUB-LCD 9V
- 2) Frame frequency: 70.0Hz

6.3 Brightness Characteristic

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Brightness	Bp	Ta=25 ±3	100	-	-	cd/m ²
Uniformity	Bp	30-80%RH	-	-	60	%

Note:

1. The data is measured after LED are turned on for 5 minutes.
2. Testing conditions LED: VLED =5.0 V (DC)
 LCD: All dots are on (White color)
3. Brightness in the center of the LCD panel.
4. Definition of Uniformity (Bp)
 $Bp = Bp \text{ (Min.)} / Bp \text{ (Max.)} \times 100 \text{ (\%)}$
 Bp (Max.) = Maximum brightness in 9 measurement spots
 Bp (Min.) = Minimum brightness in 9 measurement spots

7. Reliability

7.1 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	80 ±2 240H Restore 4H at 25
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-30 ±2 240H Restore 4H at 25
3	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	70 ±2 90%RH 240H Restore 4H at 25
4	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 Restore 4H at 25
5	Vibration Test (package state)	Endurance test applying the vibration during transportation	10Hz~150Hz, 100m/s ² , 120min
6	Shock Test (package state)	Endurance test applying the shock during transportation	Half- sine wave, 300m/s ² , 18ms
7	Atmospheric Pressure Test	Endurance test applying the atmospheric pressure during transportation by air	25kPa 16H Restore 2H

7.2 Failure Judgment Criterion

Criterion Item	Test Item No.									Failure Judgement Criterion
	1	2	3	4	5	6	7	8	9	
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									

8. 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 Appendix A			II	Major 1.0 Minor 2.5
Display Defects	Under normal illumination and eyesight condition, display on inspection.	See 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						

9. Precautions for Use of LCD Modules

9.1 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.

9.1.2 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.

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

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

9.1.5 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

9.1.6 Do not attempt to disassemble the LCD Module.

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

9.1.8 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.

9.2 Storage precautions

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

9.2.2 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

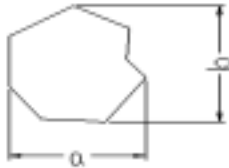

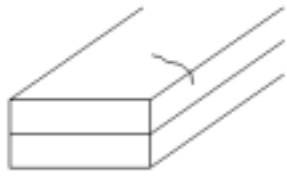
Relatively humidity: 80%

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

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

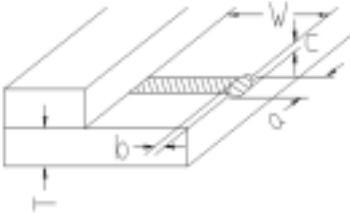
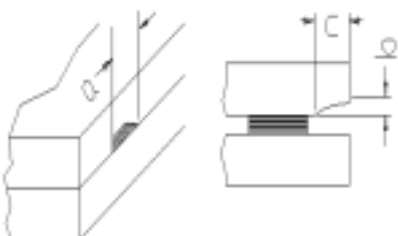
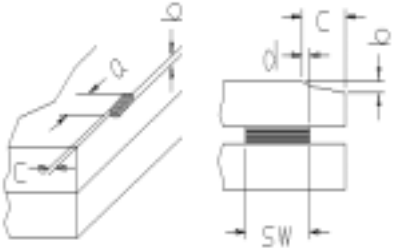
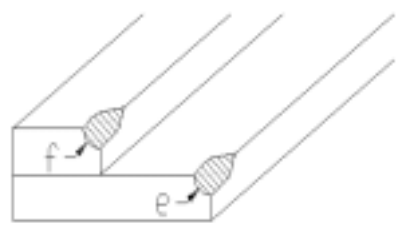
Appendix A

Inspection items and criteria for appearance defects

Items	Contents	Criteria		
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	Max. 3 spots (lines) allowed
		$X < 0.2\text{mm}$	$0.2\text{mm} \leq X \leq 0.5\text{mm}$	
		$X = (a+b)/2$		
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		

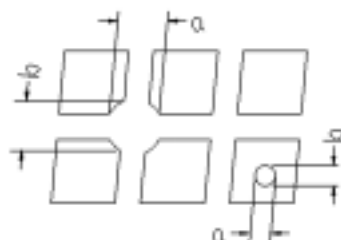
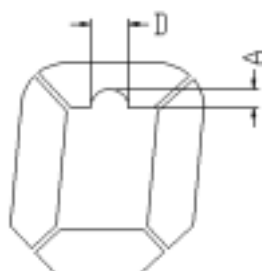
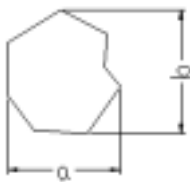
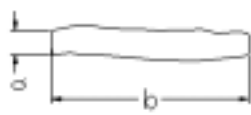
Appendix A

Inspection item and criteria for appearance defects (continued)

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

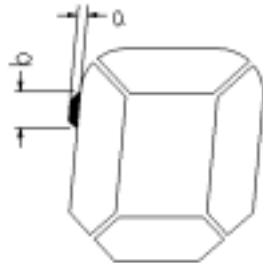
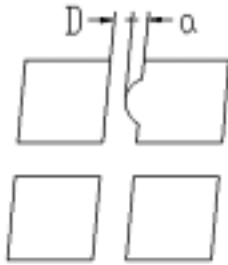
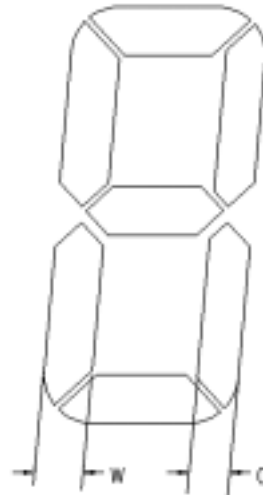
Appendix B

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 radio 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<0.1mm	0.1mm X 0.2mm		
		X=(a+b)/2			
		Not counted	Max.2 dots allowed		
		A<0.1mm	0.1mm A 0.2mm D<0.25mm		
Black spot (in viewing area)		Not counted	Max.3 spots allowed		Max.3 spots (lines) allowed
		X<0.1mm	0.1mm X 0.2mm		
		X=(a+b)/2			
Black line (in viewing area)		Not counted	Max.3 lines allowed		
		a<0.02mm	0.02mm a 0.05mm b 0.5mm		

Appendix B

Inspection items and criteria for display defects (continued)

Items	Content	Criteria		
Transformation of segment		Not counted	Max. 2 defects allowed	Max.3 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	Max.3 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		