APEX DISPLAY LIMITED

SPECIFICATION
FOR
LCM MODULE

MODULE NO.: AX06002

DOC.REVISION :A00

SAMPLE REVISION: A(061109)

Customer Approval:

	SIGNATURE
PREPARED BY (LCM ENGINEER)	
CHECKED BY (QA ENGINEER)	
CHECKED BY	
VERIFIED BY	
APPROVED BY	

APEX DISPLAY LIMITED

DOCUMENT REVISION HISTORY

Version	DATE	DESCRIPTION	CHEEKED BY
A00	Nov-26-2006	First issue	

CONTENTS

APEX DISPLAY LIMITED

1. FUNCTIONS & FEATURES

1-1. Format	: 128*64 dots
1-2. LCD mode	: STN, Yellow-Green, Transflective mode
1-3. Viewing direction	: 6 o' clock
1-4. Driving scheme	: 1/65 Duty cycle, 1/9 Bias,Vlcd=9.3V
1-5. Single Supply Voltage	: Power supply voltage range (V_{DD}): 3V
1-6.8080 Interface Series	

2. MECHANICAL SPECIFICATIONS

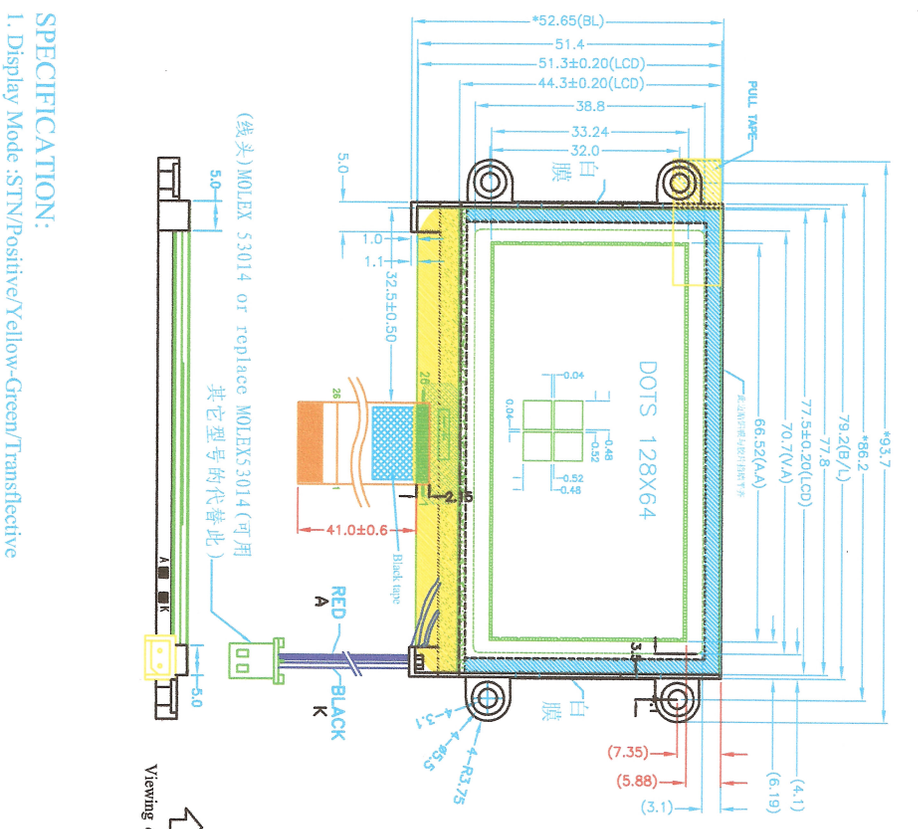
2-1. Module size	: 93.70mm(L)*52.65mm(W) NO IQFOXGIQJ)3&
2-2. Viewing area	: 70.70mm(L)*38.80mm(W)
2-3. Active area	: 66.52mm(L)*33.24mm(W)
2-4. Dot pitch	: 0.52mm(L)*0.52mm(W)
2-5. Dot size	: 0.48mm(L)*0.48mm(W)
2-6. Weight	: TBD

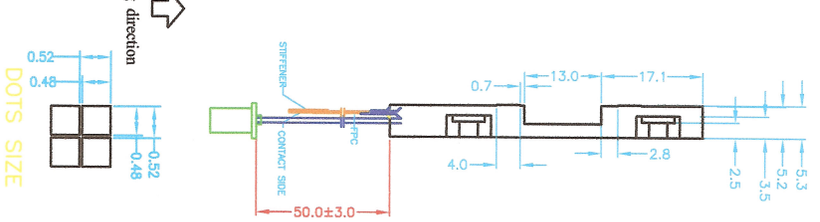
APEX DISPLAY LIMITED

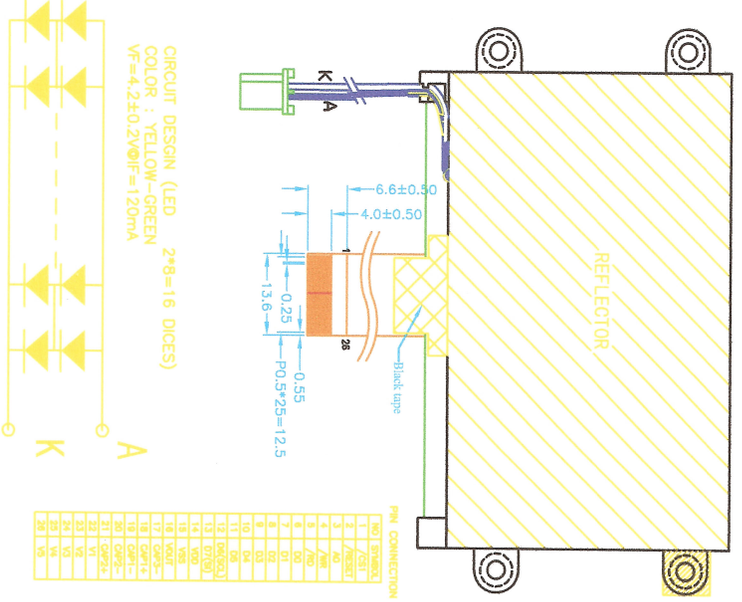
CUSTOMER'S APPROVED:	DATE:	PAGE:1/1

SPECIFICATION:

1. Display Mode :STN/Positive/Yellow-Green/Transflective
2. Drive Condition :1/65 Duty,1/9 Bias.Vop=9.3V ,Vdd:3.0V
3. Viewing angle: 6 O'clock
4. Operating temp. : -20~70°
   Storage temp. : -30~80°
5. Using IC : SPLC501C 8080 Interface Series
6. Backlight color: Yellow-green
7. Dimensions with mark "*"are important .with mark"()"are referenced.



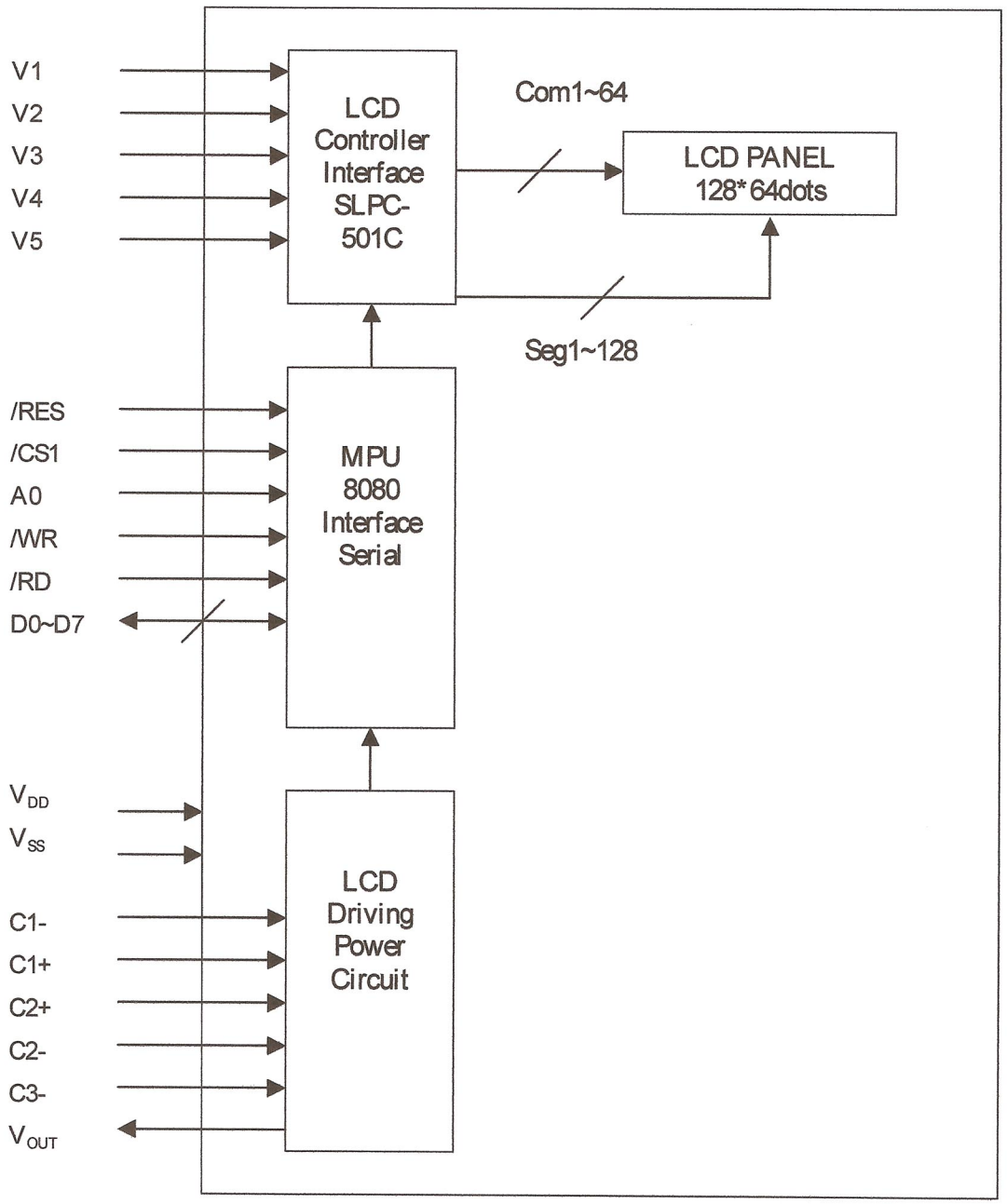




REV	DESCRIPTION:	DATE
A00	First issue	Auge-27-2006

DESCRIPTION: C / D	APEX DISPLAY LIMITED	
GENERAL TOL: ± 0.3		
DO NOT SCALE THIS DRAWING.	Unit: mm	Model No : AX06002

4. BLOCK DIAGRAM



5. POWER SUPPLY

The power supply circuits are low-power consumption power supply circuits that generate the voltage levels required for the LCD drivers. They are Booster circuits, voltage regulator circuits, and voltage follower circuits. They are only enabled in master operation. The power supply circuits can turn the Booster circuits, the voltage regulator circuits, and the voltage follower circuits ON or OFF independently through the use of the Power Control Set command. Consequently, it is possible to make an external power supply and the internal power supply function somewhat in parallel. The following tables show the Power Control Set Command 3-bit data control function, and reference combinations.

The control details of each bit of the power control set command

Bit	Function	Status "1"	Status "0"
D2	Booster circuit control bit	ON	OFF
D1	Voltage regulator circuit control bit (V/R circuit)	ON	OFF
D0	Voltage follower circuit control bit (V/F circuit)	ON	OFF

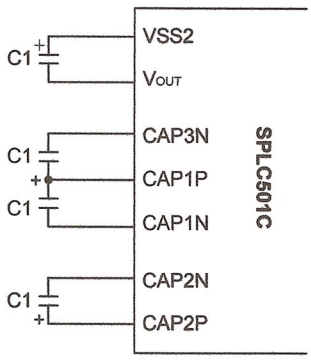
Reference combinations

Use Settings	D2 D1 D0	Voltage booster	Voltage regulator	Voltage follower	External voltage input	Step-up voltage
Only the internal power supply is used	1 1 1	On	On	On	V_{SS2}	Used
Only the voltage regulator circuit and the voltage follower circuit are used	0 1 1	Off	On	On	V_{OUT}, V_{SS2}	Open
Only the V/F circuit is used	0 0 1	Off	Off	On	V5, V_{SS2}	Open
Only the external power supply is used	0 0 0	Off	Off	Off	V1 to V5	Open

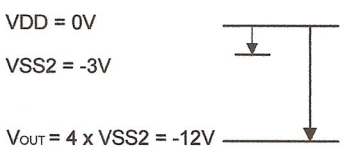
* The "step-up system terminals" refer CAP1+, CAP1-, CAP2+, CAP2-, and CAP3-.
* While other combinations, not shown above, are also possible, these combinations are not recommended because they have no practical use.

5-1. Voltage Converter Circuits

Using the step-up voltage circuits equipped within the SPLC501C chips it is possible to product a 2X,3X,4X,5X or 6X step-up of the $V_{DD} - V_{SS2}$ voltage levels.

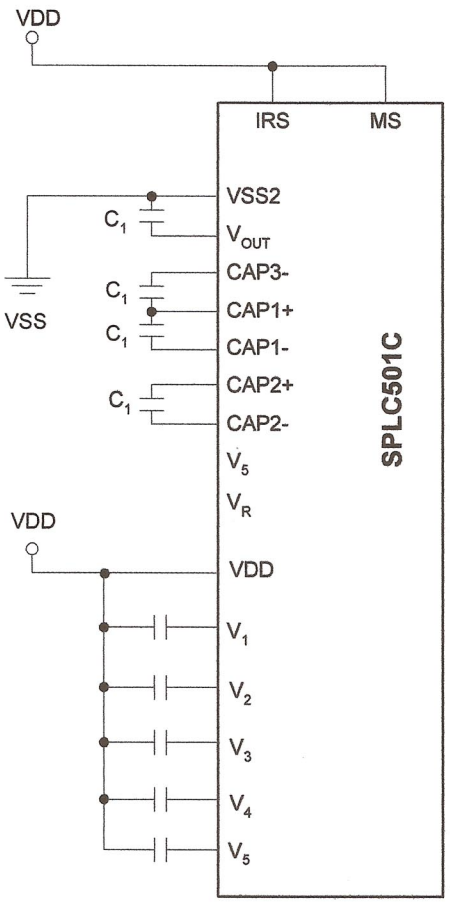


4 x step-up voltage circuit



4 x step-up voltage relationships

[C1 = 1.0 to 4.7 µF, C2 = 0.1 to 4.7 µF]



A. When the voltage regulator internal resistor is used.
Example where VSS2 = VSS, with 4x step-up

5-2. Voltage Regulator Circuits

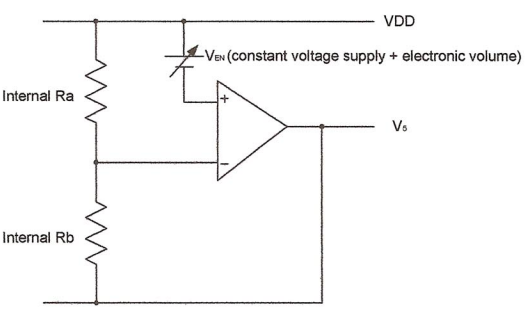
The step-up voltage generated at V_{OUT} outputs the LCD driver voltage V5 through the voltage regulator circuit. Because the SPLC501C chips have an internal high-accuracy fixed voltage power supply with a 64-level electronic volume function and internal resistors for the V5 voltage regulator, systems can be constructed without having to include high-accuracy voltage regulator circuit components. (V_{REG} thermal gradients approximate -0.05%/°C)

$$V_5 = \left\{1 + \frac{Rb}{Ra}\right\} \bullet V_{EN}$$

$$= \left\{1 + \frac{Rb}{Ra}\right\} \bullet \left\{1 - \frac{a}{162}\right\} \bullet V_{REG}$$

$$[\ V_{EN} = (1 - a/162) \bullet V_{REG}]$$

Equation A-1



6. PIN DESCRIPTION

Pin no.	Symbol	Function
1	/CS1	This is the chip select signal. When /CS1 = "L" and CS2 = "H", then the chip select becomes active, and data/command I/O is enabled.
2	/RESET	When /RES is set to "L," the settings are initialized. The reset operation is performed by the /RES signal level.
3	A0	This is connected to the least significant bit of the normal MPU address bus, and it determines whether the data bits are data or a command. A0 = "H": Indicates that D0 to D7 are display data. A0 = "L": Indicates that D0 to D7 are control data.
4	/WR	When connected to an 8080 MPU, this s LOW active. This terminal connects to the MPU /WR signal.The signals on the data bus are latched at the rising edge of the /WR signal. When connected to a 6800 Series MPU, this is the read/write control signal input terminal. When /WR = "H": Read; When /WR = "L": Write.
5	/RD	• When connected to an 8080 MPU, this is active LOW. This pin is connected to the /RD signal of the 8080 MPU, and the SPLC501C data bus is in an output status when this signal is "L". • When connected to a 6800 Series MPU, this is active HIGH. This is the 6800 Series MPU enable clock input terminal.
6 ~ 13	D5 to D0 D6(SCL) D7(SI)	This is an 8-bit bi-directional data bus that connects to an 8-bit or 16-bit standard MPU data bus. When the serial interface is selected (P/S = "L"): D7: serial data input (SI); D6: the serial clock input (SCL). D0 to D5 are set to high impedance. When the chip select is not active, D0 to D7 are set to high impedance.
14	V_{DD}	Shared with the MPU power supply terminal V_{CC}.
15	V_{SS}	This is a 0V terminal connected to the system GND.
16	V_{OUT}	DC/DC voltage converter. Connect a capacitor between this terminal and V_{SS}.
17	C3-	DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1+ terminal.
18	C1+	DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1- terminal.
19	C1-	DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1+ terminal.
20	C2-	DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2+ terminal.
21	C2+	DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2- terminal.

<table>
<tr><td>22</td><td>V1</td><td rowspan="6">This is a multi-level power supply for the liquid crystal drive. The voltage Supply applied is determined by the liquid crystal cell, and is changed through the use of a resistive voltage divided or through changing the impedance using an op. amp. Voltage levels are determined based on V_{DD}, and must maintain the relative magnitudes: V_{DD} (= V0) ≥ V1 ≥ V2 ≥ V3 ≥ V4 ≥ V5
When the power supply turns ON, the internal power supply circuits produce the V1 to V4 voltages shown below. The voltage settings are selected using the LCD bias set command.

<table><tr><td></td><td>SPLC501C</td></tr><tr><td>V_1</td><td>1/9 . V_5</td></tr><tr><td>V_2</td><td>2/9 . V_5</td></tr><tr><td>V_3</td><td>7/9 . V_5</td></tr><tr><td>V_4</td><td>8/9 . V_5</td></tr></table></td></tr>
<tr><td>23</td><td>V2</td></tr>
<tr><td>24</td><td>V3</td></tr>
<tr><td>25</td><td>V4</td></tr>
<tr><td>26</td><td>V5</td></tr>
</table>

7. ABSOLUTE MAXIMUM RATINGS

Unless otherwise noted, V_{SS} = 0V

Parameter		Symbol	Conditions	Unit
Power Supply Voltage		V_{DD}	-0.3 ~ +5.0	V
Power supply voltage (V_{DD} standard)		V_5, V_{OUT}	-12.0 ~ +0.3	V
Power supply voltage (V_{DD} standard)		V1, V2, V3, V4,	V5 ~ +0.3	V
Output voltage		V_O	-0.3to VDD +0.3	V
Operating temperature		T_{OPR}	–20 ~ +70	°C
Storage temperature	TCP Bare chip	T_{STR}	-30 ~ +80	°C

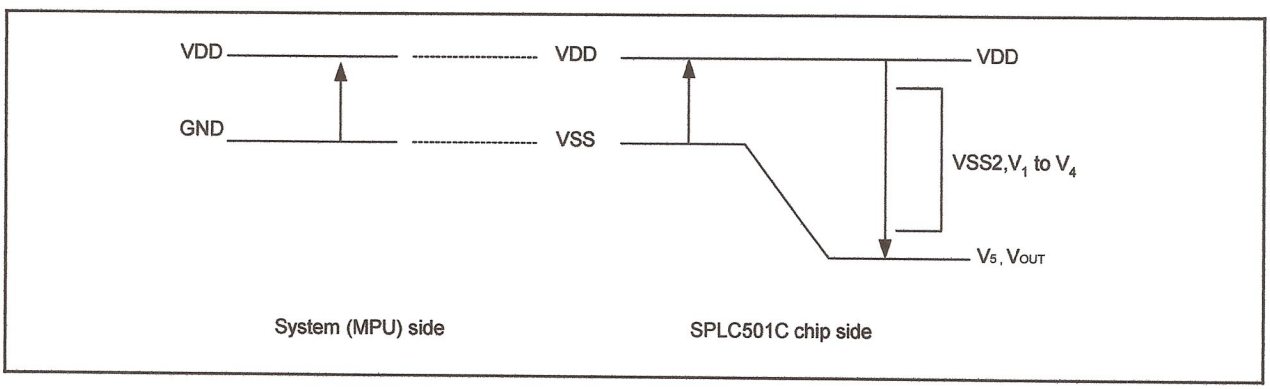


Figure 25

Notes and Cautions

1. The V_{SS2}, V1 to V5 and V_{OUT} are relative to the V_{DD} = 0V reference.
2. Insure that the voltage levels of V1 ~ V4 are always such that $V_{DD} \geqslant V1 \geqslant V2 \geqslant V3 \geqslant V4 \geqslant V5$.
3. Permanent damage to the LSI may result if the LSI is used outside of the absolute maximum ratings. Moreover, it is recommended that in normal operation the chip be used at the electrical characteristic conditions, and use of the LSI outside of these conditions may not only result in malfunctions of the LSI, but may have a negative impact on the LSI reliability as well.

8. ELECTRICAL CHARACTERISTICS

8-1. DC Characteristics

(Unless otherwise specified, VSS = 0V, VDD = 3.0V±10%, T_A = 25℃)

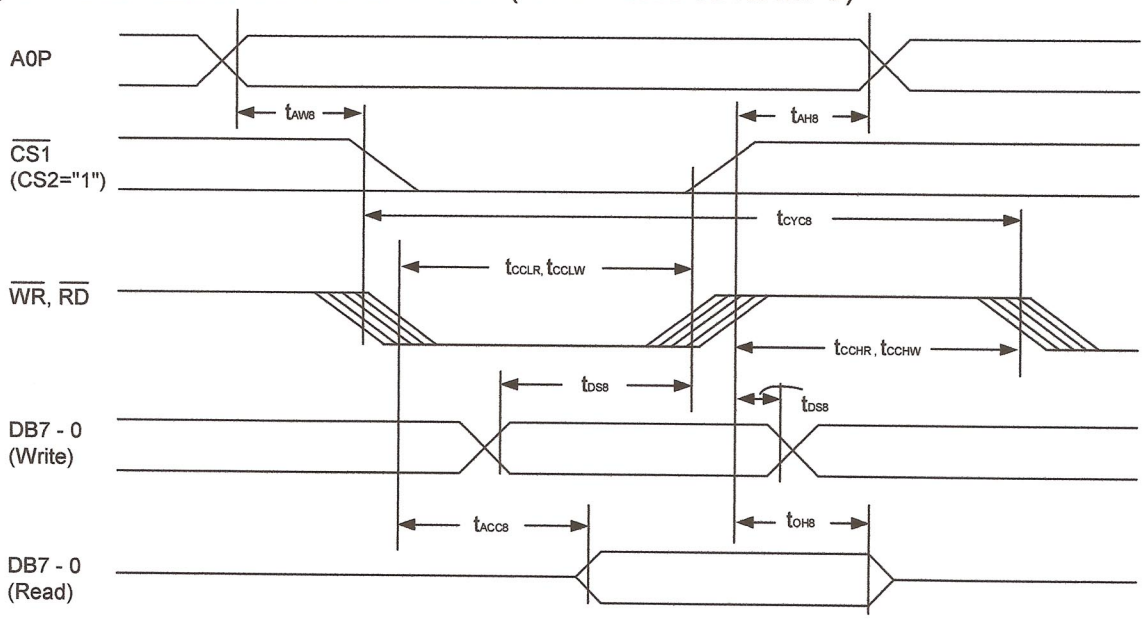
Item		Symbol	Condition		Rating Min.	Rating Typ.	Rating Max.	Units	Applicable PIN
Operating Voltage (1)	Possible Operating Voltage (1A)	VDD			2.8	-	3.0	V	VDD*1
	Possible Operating Voltage (1B)				3.0	-	5.5	V	VDD*1
Operating Voltage (2)	Recommended Voltage	VSS2	(Relative to VDD)		-3.3	-	-2.7	V	VSS2
	Possible Operating Voltage	VSS2	(Relative to VDD)		-6.0	-	-1.8	V	VSS2
Operating Voltage (3)	Possible Operating Voltage (3A)	V_5	(Relative to VDD)		-10	-	-4.5	V	V_5*2
	Possible Operating Voltage (3B)				-12	-	-4.5	V	V_5*2
	Possible Operating Voltage	V_1, V_2	(Relative to VDD)		0.4 x V_5	-	VDD	V	V_1, V_2
	Possible Operating Voltage	V_3, V_4	(Relative to VDD)		V_5	-	0.6 x V_5	V	V_3, V_4
High-level Input Voltage		V_{IHC}			0.8 x VDD	-	VDD	V	*3
Low-level Input Voltage		V_{ILC}			VSS	-	0.2 x VDD	V	*3
High-level Input Voltage		V_{OHC}	I_{OH} = -0.5mA		0.8 x VDD	-	VDD	V	*4
Low-level Input Voltage		V_{OLC}	I_{OL} = 0.5mA		VSS	-	0.2 x VDD	V	*4
Input leakage current		I_{LI}	V_{IN} = VDD or VSS		-1.0	-	1.0	μA	*5
Output leakage current		I_{LO}			-3.0	-	3.0	μA	*6
Liquid Crystal Driver ON Resistance		R_{ON}	T_A = 25℃ (Relative To VDD)	V_5 = -12V	-	2.0	3.5	KΩ	SEGn
				V_5 = -8.0V	-	3.2	5.4	KΩ	COMn*7
Static Consumption Current		I_{SSQ}			-	0.01	5.0	μA	VSS, VSS2
Output Leakage Current		I_{5Q}	V_5 = -12V (Relative to VDD)		-	0.01	15	μA	V_5
Input Terminal Capacitance		C_{IN}	T_A = 25℃ f = 1.0MHz		-	5.0	8.0	pF	
Oscillator Frequency	Internal Oscillator	f_{OSC}	T_A = 25℃		18	22	26	KHz	*8
	External Input	f_{CL}	SPLC501C		18	22	26	KHz	CL
Internal Power	Input Voltage	VSS2	With Triple (Relative to VDD)		-4.0	-	-2.4	V	VSS2
		VSS2	With Quad (Relative to VDD)		-3.0	-	-2.4	V	VSS2
	Supply Setup-up output voltage Circuit	V_{OUT}	(Relative to VDD)		-12	-	-	V	V_{OUT}
	Voltage regulator Circuit Operating Voltage	V_{OUT}	(Relative to VDD)		-12	-	-6.0	V	V_{OUT}
	Voltage Follower Circuit Operating Voltage	V_5	(Relative to VDD)		-12	-	-4.5	V	V_5 *9
	Base Voltage	V_{REG0}	T_A = 25℃ (Relative to VDD)	-0.05%/℃	-2.28	-2.22	-2.16	V	*10

*Possible operating voltage (1A) is applied for possible operating voltage (3A)

*Possible operating voltage (1B) is applied for possible operating voltage (3B)

8-2. Timing Characteristics

System Bus Read/Write Characteristics (For the 8080 Series MPU)



(VDD = 2.7V to 4.5V, T_A = 25℃)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0P	t_{AH8}		0	-	ns
Address setup time		t_{AW8}		0	-	ns
System cycle time	A0P	t_{CYC8}		300	-	ns
Control L pulse width ($\overline{WR}$)	$\overline{WR}$	t_{CCLW}		60	-	ns
Control L pulse width ($\overline{RD}$)	$\overline{RD}$	t_{CCLR}		120	-	ns
Control H pulse width ($\overline{WR}$)	$\overline{WR}$	t_{CCHW}		60	-	ns
Control H pulse width ($\overline{RD}$)	$\overline{RD}$	t_{CCHR}		60	-	ns
Data setup time	DB7 - 0	t_{DS8}		40	-	ns
Address hold time		t_{DH8}		15	-	ns
$\overline{RD}$ access time		t_{ACC8}	C_L = 100pF	-	140	ns
Output disable time		t_{OH8}		10	100	ns

*1 The input signal rise time and fall time (tr, tf) is specified at 15 ns or less. When the system cycle time is extremely fast, $(tr + tf) \leqslant (t_{CYC6} - t_{EWLW} - t_{EWHW})$ for $(tr + tf) \leqslant (t_{CYC6} - t_{EWLR} - t_{EWHR})$ are specified.
*2 All timing is specified using 20% and 80% of V_{DD} as the reference.
*3 t_{EWLW} and t_{EWLR} are specified as the overlap between CS1 being "L" (CS2 = "H") and E.

8-3. Electro-Optical characteristics

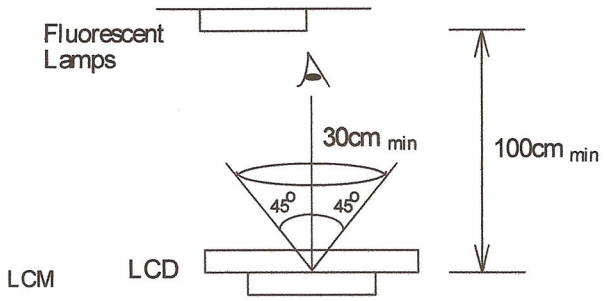
Item		Temp	Unit	Standard value		
				Min	Typ	Max
Operating voltage	Vop	25°C	V8	9.2	9.3	9.5
		0°C		9.3	9.5	9.7
Frame frequency	f	25°C	Hz	64	-----	200
Response time	Ton	25°C	msec	150	-----	250
	Toff	25°C		150	-----	250
Dissipation current	Iop	25°C	uA/cm^2	-----	-----	3
Contrast ratio (θ= 30°)	CR	25°C	-----	3	-----	-----
Viewing angle (CR>2)	θ	25°C	Deg	- 45	-----	+ 45
	ϕ	25°C	Deg	- 45	-----	+ 45

9.QUALITY SPECIFICATIONS9

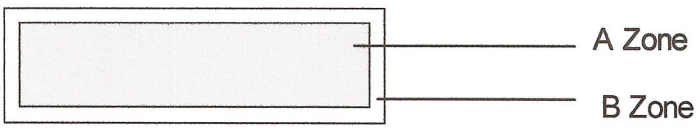
9.1. Standard of the product appearance test

Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.



Definition of zone:



A Zone: Active display area (minimum viewing area).

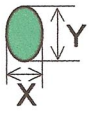
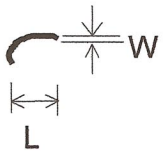
B Zone: Non-active display area (outside viewing area).

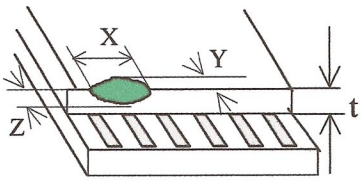
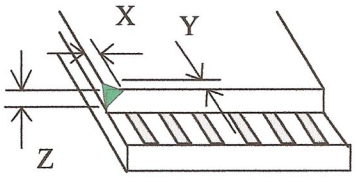
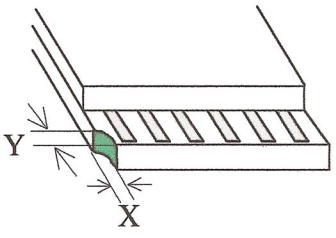
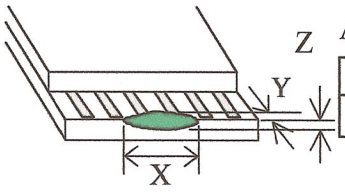
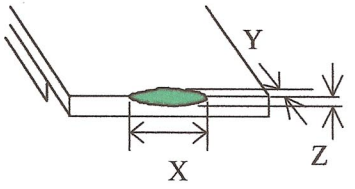
9.2. Specification of quality assurance

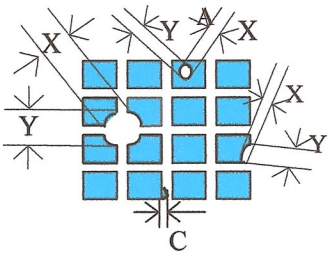
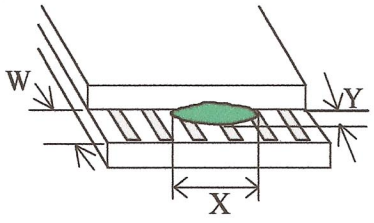
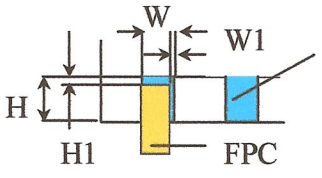
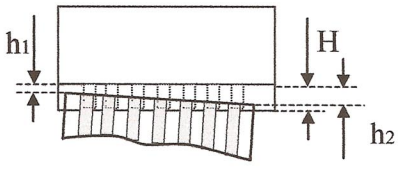
AQL inspection standard
Sampling method: MIL-STD-105E, Level II, single sampling
Defect classification :

Classify	Item	Note	AQL
Major	Short or open circuit	1	0.65 (C=0)
	LC leakage		
	Flickering		
	No display		
	Wrong viewing direction		
	Contrast defect (dim, ghost)	2	
	Wrong or missing component	10	
Minor	Background color deviation	2	1.0
	Black spot and dust	3	
	Line defect, Scratch	4	
	Rainbow	5	
	Chip	6	
	Pin hole	7	
	Protruded glass	8	
	Polarizer bubble and foreign material	3	
	FPC Position	9	
	Cross talk	Refer to limited sample	

Note on defect classification

No.	Item	Criterion
1	Short or open circuit	Not allowed
	LC leakage	
	Flickering	
	No display	
	Wrong viewing direction	
	Wrong Back-light	
2	Contrast defect	Refer to approval sample
	Background color deviation	
3	Point defect, Black spot, dust (including Polarizer) $\phi = (X+Y)/2$	 Point Size / Acceptable Qty. $\phi \leq 0.10$: Disregard $0.10 < \phi \leq 0.20$: 2 $0.20 < \phi \leq 0.25$: 1 $\phi > 0.25$: 0 Unit: mm
4	Line defect, Scratch	 Line: L / W; Acceptable Qty. --- / $W \leq 0.015$: Disregard $L \leq 3.0$ / $W \leq 0.03$: 2 $L \leq 2.0$ / $W \leq 0.05$: 2 $L \leq 1.0$ / $W < 0.1$: 1 --- / $W > 0.05$: Applied as point defect Unit: mm
5	Rainbow	Not more than two colors change across the viewing area.

No	Item	Criterion
6	Chip Remark: X: Length direction Y: Short direction Z: Thickness direction t: Glass thickness	 Acceptable criterion X: ≤2 mm; Y: 0.5mm; Z: ≤t/2  Acceptable criterion X: ≤2 mm; Y: 0.5mm; Z: ≤t  Acceptable criterion X: ≤3 mm; Y: ≤2 mm; Z: ≤t shall not reach to ITO  Acceptable criterion X: Disregard; Y: ≤0.2 mm; Z: ≤t  Acceptable criterion X: ≤5 mm; Y: ≤2 mm; Z: ≤t/3

No.	Item	Criterion
7	Dot-matrix pattern $\phi = (X+Y)/2$	Pin hole  Size / Acceptable Qty. ϕ<0.1 : Disregard 0.10≤ϕ≤0.20 : 1 ϕ>0.20 : 0 C: Shall not touch other dot(s).
8	Protruded W: Terminal width	 Acceptable criteria: Y ≤ 0.4
9	FPC	Position  ITO W1≤1/3W H1≤1/3H  Acceptable: | h2 — h1|≤ 1/8H
10	Total no. of acceptable Defect	A. Zone Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm B. Zone It is acceptable when it is no trouble for quality and assembly in customer's end product.

9.3. Reliability of LCM

Reliability test condition:

Item	Condition	Time (hrs)	Assessment
High temp. Storage	80°C	240	No abnormalities in functions and appearance
High temp. Operating	70°C	240	
Low temp. Storage	-30°C	240	
Low temp. Operating	-20°C	240	
Humidity	40°C/ 90%RH	240	
Temp. Cycle(no operating)	-30°C ← 25°C →+80°C (30 min ← 5 min → 30min)	10cycles	
ESD test	Contact Discharges: ±4KV; Air Discharges: ±8KV	2pcs	When turning on power again, No abnormalities in functions

9.4. Precaution For Using LCM

LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

General Precautions:

1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol, ethyl alcohol or trichlorotriflorothane, do not use water, ketone or aromatics and never scrub hard.
3. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal adheres to skin or clothes, wash it off immediately with soap and water.

Static Electricity Precautions:

1. CMOS-LSI is used for the module circuit; therefore, operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
5. Only properly grounded soldering irons should be used.
6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
7. The normal static prevention measures should be observed for work clothes and working benches.
8. Since dry air is inductive to static, a relative humidity of 65±15% is recommended.

Operation Precautions:

1. The viewing angle can be adjusted by varying the LCD driving voltage Vo.
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. The LCM could only withstand upto 45,000 Lux light intensity. Therefore it advisable to avoid direct sunlight exposure on the LCM. If direct sunlight is unavoidable, proper housing is necessary to protect the LCM.
7. Operating humidity should be within 65±15%RH.

Storage Precautions:

1. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
2. For long-term storage over 25±3°C is required, the relative humidity should be kept below 65±15%, and avoid direct sunlight.

Limited Warranty

LCDs and modules are not consumer products, but may be incorporated by WILY's customers into consumer products or components thereof, WILY does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of WILY is limited to repair or replacement on the terms set forth below. WILY will not be Responsible for any subsequent or consequential events, injury, or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between WILY and the customer, WILY will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with WILY GENERAL LCD INSPECTION STANDARD. (Copies available on request)
2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.
3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.