Crystal Clear Technology

Product Specification

C216x10 series

Crystal Clear Technology sdn. bhd.
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1.0 Table of Contents

2.0 Record of revision

Rev	Date	Item	Page	Comment	Originator	Checked By
1.0	21/07/09			Initial Release	Khairiah	Azhar

3.0 General specification

Display format: Characters 2 x 16

Character size: 5 x 8

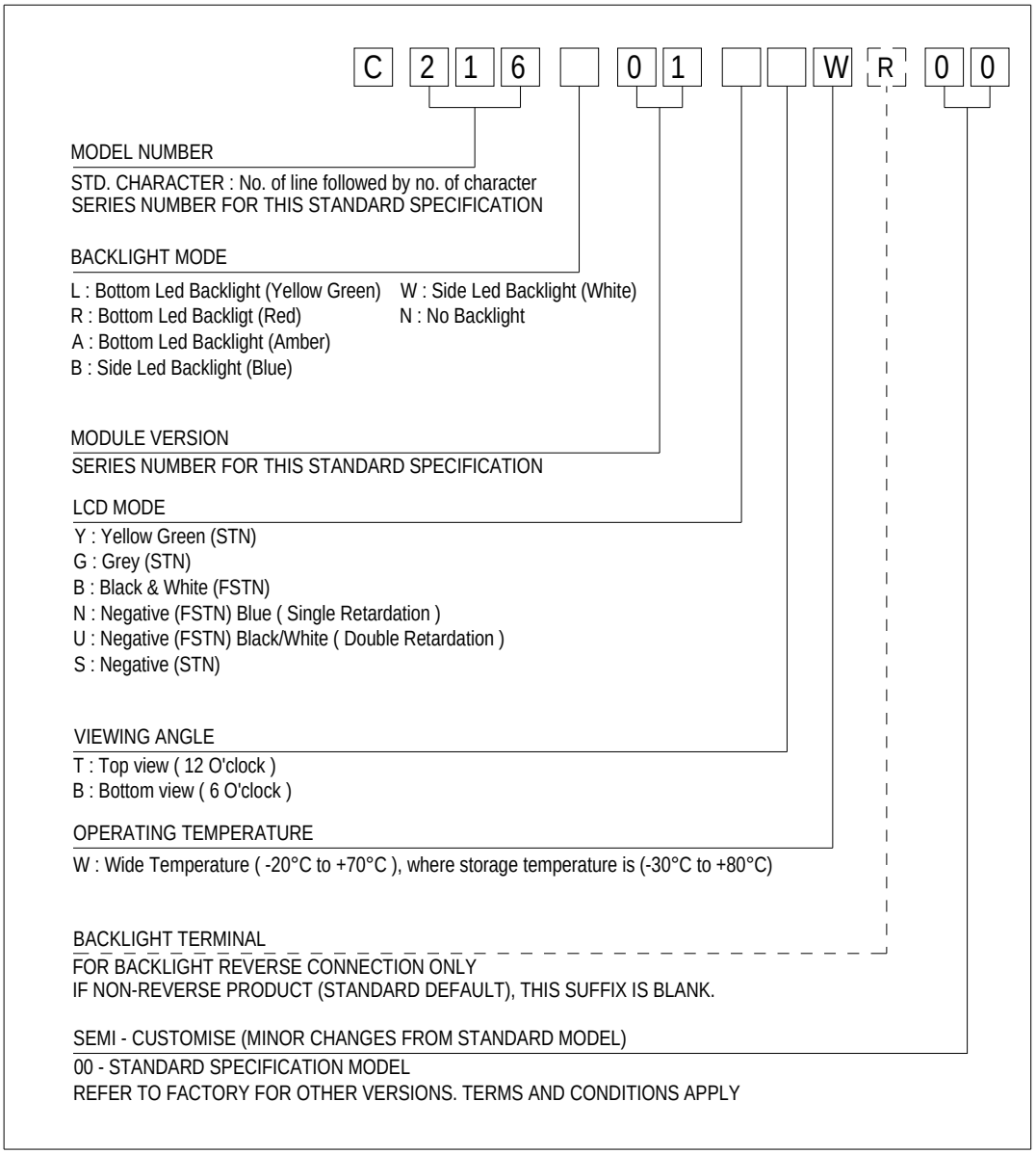
Character size: 2.95mm x 5.55mm

View area: 61.0mm x 15.8mm

Active area: 56.2mm x 11.5mm

General dimensions: 80.0mm x 36.0mm

Controller/Driver: SPLC783A or equivalent



4.0 Absolute maximum rating (at Vss = 0V, ambient temperature = 25°C)

NO	ITEM	SIMBOL	MIN	MAX	UNIT
1.	Power Supply voltage (Logic)	$V_{DD} - V_{SS}$	0	7	V
2.	Power Supply voltage (LCD Driver)	$V_{DD} - V_0$	-	12	V
3.	Operating Temperature	T_{op}	Refer page 3		°C
4.	Storage Temperature	T_{st}	Refer page 3		°C

5.0 Electrical characteristics

NO	ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
1.	Power Supply voltage (Logic)	$V_{DD} - V_{SS}$	-	4.5	5.0	5.5	V
2.	Power Supply voltage (V_{LCD})	V_{DD}-V_0	25°C	4.5±5%			V
3.	Input Voltage (except OSC1)	V_{IH}	-	0.7Vdd	-	Vdd	V
		V_{IL}	-	-0.3	-	0.6	V
4.	Current Supply	I_{DD}	$V_{DD} - V_{SS} = 5V$	-	1.0	2.0	mA

5.1 Backlight Options

NO	COLOR	FORWARD VOLTAGE (V)			FORWARD CURRENT (mA)			MIN BRIGHTNESS (cd/m2) *
		Min	Typ.	Max	Min	Typ.	Max	
1.	Yellow Green	-	5.0	-	-	100	150	60
2.	White	-	4.5	-	-	30	40	160
3.	Blue	-	5.0	-	-	30	40	70
4.	Amber	-	5.0	-	-	100	150	170
5.	Red	-	5.0	-	-	100	150	170

*Note : 1. Brightness measured at backlight surface.
2. On LCD surface, brightness is only about 10% to 15% of backlight brightness.
3. Lifetime of backlight: For YG, Amber, Red = 50K hrs. For White, Blue = 20K hrs

6.0 Environmental requirements

NO	ITEM	CONDITION
1.	Operating Temperature	Refer page 3
2.	Storage Temperature	Refer page 3
3.	Operating Humidity	5% to 95%RH
4.	Cycle Test	0 C @ 30 min to 50 C @ 30min for 1 cycle run for 10 cycles
5.	Lifetime	50000 HOURS (excluding backlight)

Note: The background on LCD has the possibility to be changed in different temperature range.

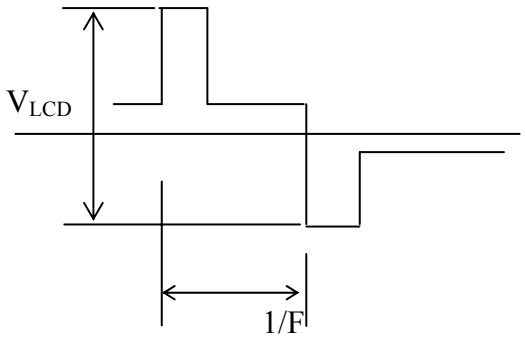
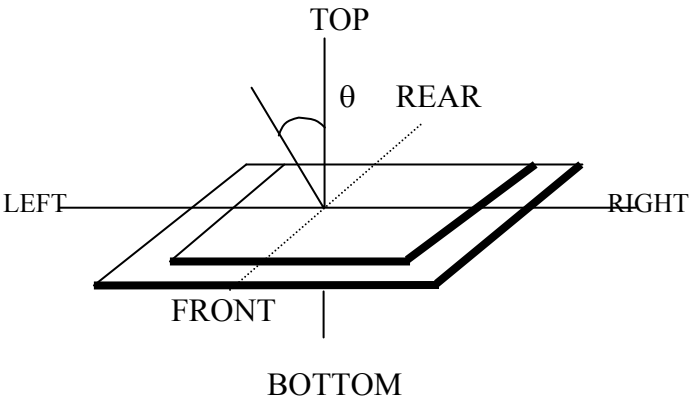
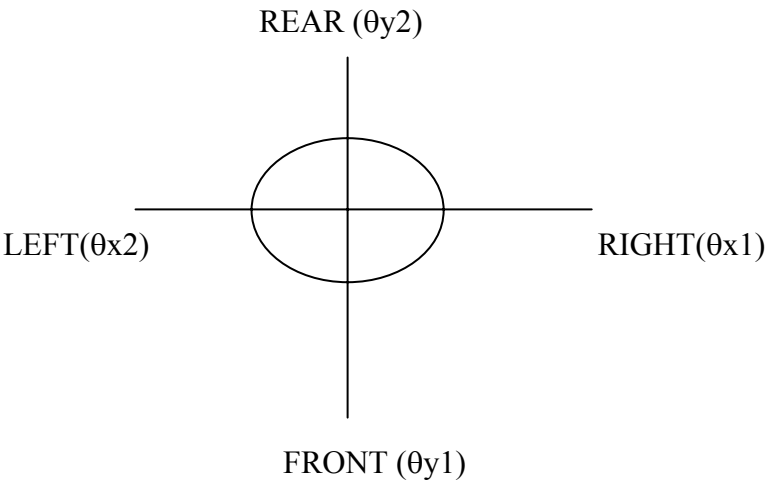
7.0 LCD specification

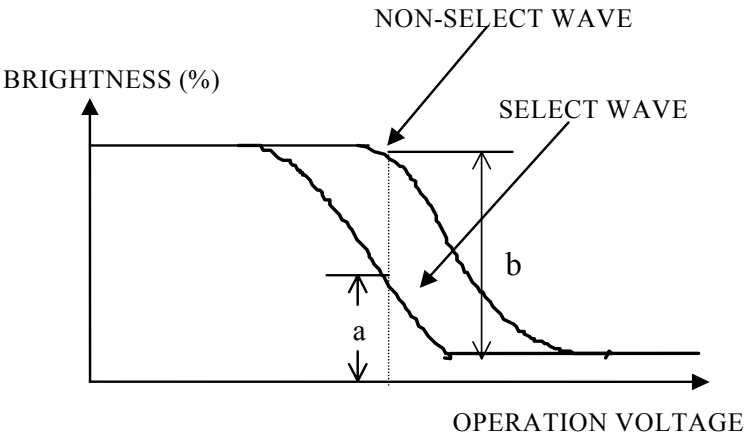
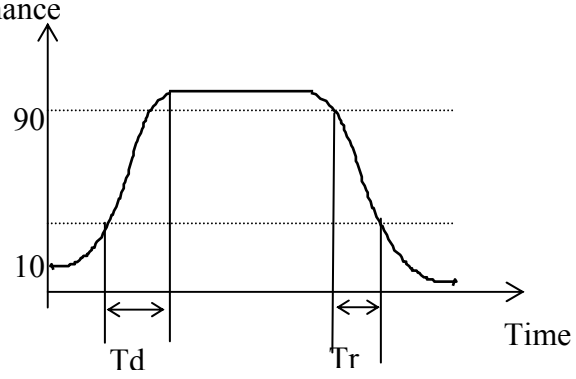
7.1 Electro-optical characteristics (at ambient temperature = 25°C)

NO	ITEM	SYMBOL	CONDITION	LCD TYPE						REF.
				STN YG	STN GREY	STN -VE BLUE	FSTN +VE B/W	FSTN –VE BLUE	FSTN -VE TRUE B/W	
1	Operating Voltage (Volt)	V_{LCD}	θ = 0 Cr = max	4.5 ± 5%						7.1.1
2	Viewing Angle (Deg)	θ x 1	CR ≥ 2 V_{LCD} = 4.5V	+25	+20	+35	+25	+35	+35	7.1.2
		θ x 2		-25	-20	-35	-25	-35	-40	
		θ y 1		-30	-25	-35	-30	-35	-35	
		θ y 2		+30	+25	+35	+30	+35	+35	
3	Contrast Ratio	CR	θ = 0^0 V_{LCD} =4.5V	3.0	2.3	6.0	3.0	6.0	20	7.1.3
4	Response Time (msec)	Rise Time (Tr)	θ = 0^0	200						7.1.4
		Decay Time (Td)	θ = 0^0	250						

Note:

1. Viewing angle data is based on bottom view product by default. Should it be a top view product, values are then swap.
2. Contrast ratio is based on typical data when using white colour as backlight.
3. Equipment Used Eldim; Ez Contrast 120R , Spot Size = 2mm

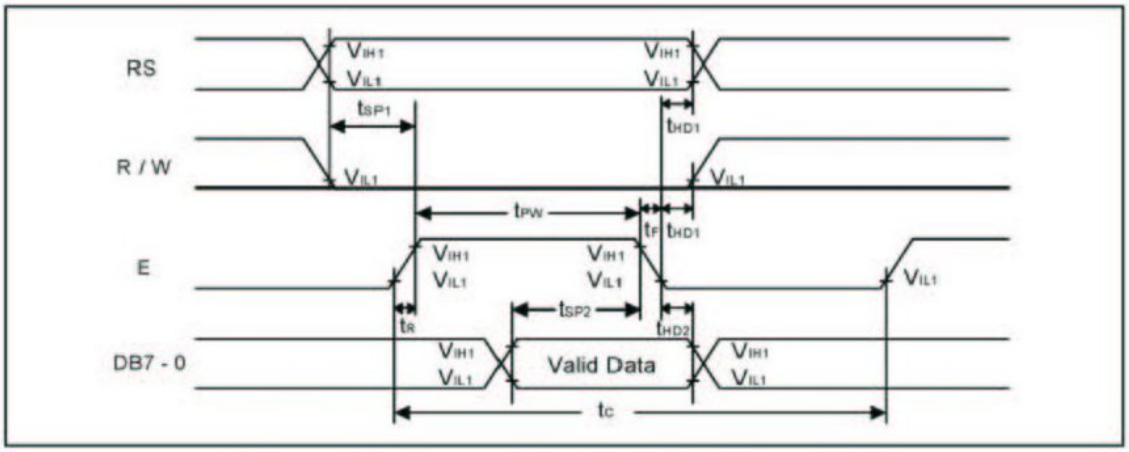
NO	CHARACTERISTICS	DEFINITIONS
7.1.1	***Definition of Operating Voltage (V_{LCD})***	 V_{LCD} : Operating Voltage F : Frame Frequency
7.1.2	***Definition of Viewing Angle***	 

7.1.3	***Definition of Contrast Ratio***	 Contrast Ratio = Brightness of non-selected state (b) / Brightness of selected state (a) ***Conditions*** (a) Operating Voltage: V_{LCD} (b) Temperature: 25°C (c) Viewing Angle, $\theta = 0^o$
7.1.4	*Response Time*	Luminance (%)  Tr: Measured between 10% and 90% of LCD segment maximum response with $V_{ON.}$ Td: With voltage switches to zero and the instant LCD segment reaches 10% of its maximum response.

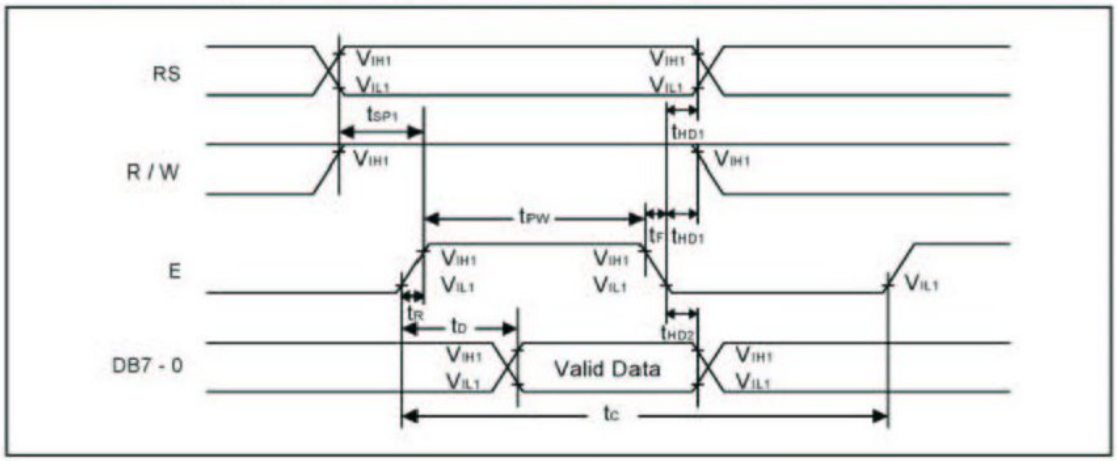
8.0 Interface

8.1	***Display Driver***	SPLC783A	
8.2	***Duty Cycle***	1/16	
8.3	***Pin-out Assignments***		
	Pin No	**Symbol**	**Description**
	1	V_{SS}	Ground terminal of module
	2	V_{DD}	Supply terminal of module
	3	V_O	Power supply for Liquid Crystal Drive
	4	RS	Register Select: RS = 0 …. Instruction Register RS = 1 …. Data Register
	5	R/W	Read/Write: High = Read Low = Write
	6	E	Enable
	7 to 14	D0 to D7	Bi-directional Data Bus. Data Transfer is performed once, thru D0 to D7, in the case of interface data length is 8-bits.
	15	(BL -)	N/A
	16	(BL +)	N/A

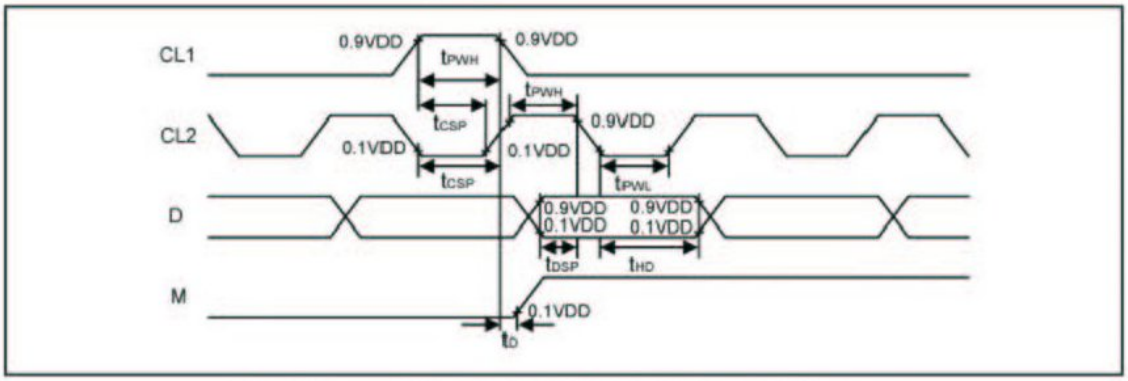
9.0 Timing characteristics / Timing diagrams



Write mode (Writing data from SPLC783 to MPU)



Read mode (Reading data from SPLC783 to MPU)



Interface mode with SPLC100A1 timing Diagram

9.1 AC Characteristic (VDD = 4.5V to 5.5V, Ta = 25°C

9.1.1 Internal clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
OSC Frequency	F_{OSC1}	190	270	350	KHz	VDD = 5.0V, Rf = 91KΩ±2%

9.1.2 Eternal clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
External Frequency	F_{OSC2}	125	250	350	KHz	
Duty Cycle		45	50	55	%	
Rise/Fall Time	tr, tf	-	-	0.2	μs	

9.1.3 Write mode (Writing data from MPU to SPLC783)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_{PW}	220	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Setup Time	t_{SP2}	60	-	-	ns	Pins: DB0 - DB7
Data Hold Time	t_{HD2}	10	-	-	ns	Pins: DB0 - DB7

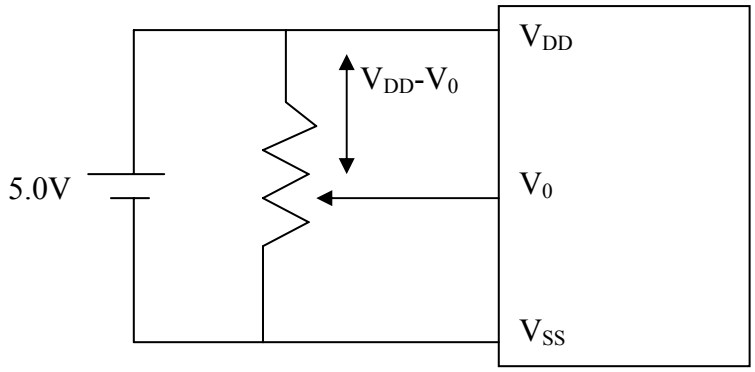
9.1.4 Read mode (Reading data from SPLC783 to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_W	220	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Output Delay Time	t_D	-	-	120	ns	Pins: DB0 - DB7
Data hold time	t_{HD2}	20	-	-	ns	Pin DB0 - DB7

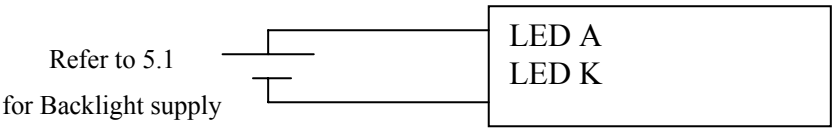
9.1.5 Interface mode with LCD Driver (SPLC100A1)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Clock pulse width high	t_{PWH}	800	-	-	ns	Pins: CLK1, CLK2
Clock pulse width low	t_{PWL}	800	-	-	ns	Pins: CLK1, CLK2
Clock setup time	t_{CSP}	500	-	-	ns	Pins: CLK1, CLK2
Data setup time	t_{DSP}	300	-	-	ns	Pins: D
Data hold time	t_{HD}	300	-	-	ns	Pins: D
M delay time	t_D	-1000	-	1000	ns	Pins: M

10. Power Supply

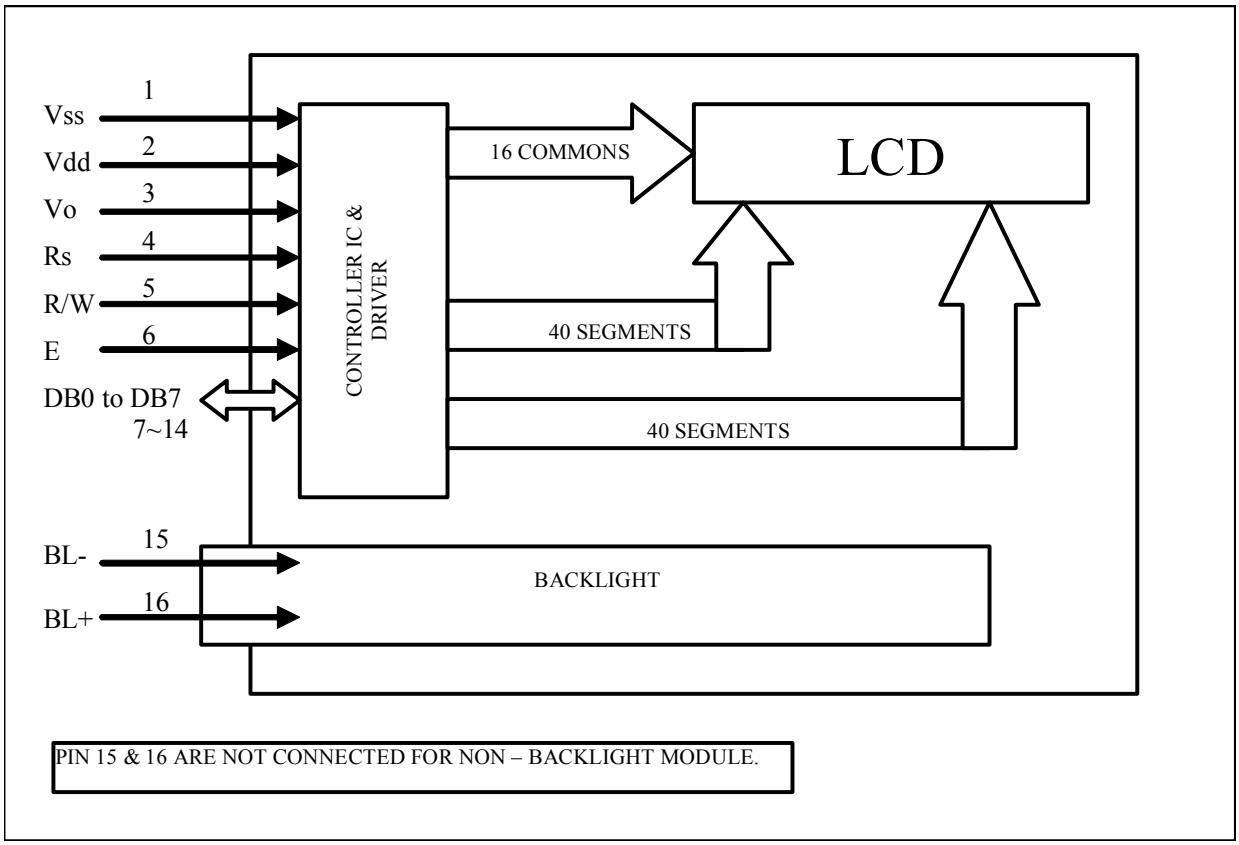


Where V_{DD}-V_0 = LCD Driving voltage



For backlight version only

11. Block Diagram



12. Instructions

Instruction	Instruction Code										Description	Execution time (fosc=270KHz)
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC	1.52ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.52ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Assign cursor moving direction and enable the shift of entire display	38μs
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 bit.	38μs
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.	38μs
Function Set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5x10 dots/5x8 dots)	38μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	38μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in counter	38μs
Read Busy Flag and Address Counter	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	38μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	38μs

Note: "-": don't care

8 bit operation example.

No.	Instruction	Display	Operation
1	Power on. (SPLC783A starts initializing)		Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 0 0 0 0 1 1 0 0 X X		Set to 8-bit operation and select 1-line display line and character font.
3	Display on / off control 0 0 0 0 0 0 1 1 1 0	_	Display on. Cursor appear.
4	Entry mode set 0 0 0 0 0 0 0 1 1 0	_	Increase address by one. It will shift the cursor to the right when writing to the DD RAM/CG RAM. Now the display has no shift.
5	Write data to CG RAM / DD RAM 1 0 0 1 0 1 0 1 1 1	W_	Write " W ". The cursor is incremented by one and shifted to the right.
6	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 1 0 1	WE_	Write " E ". The cursor is incremented by one and shifted to the right.
7	:	:	
8	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 1 0 1	WELCOME_	Write " E ". The cursor is incremented by one and shifted to the right.
9	Entry mode set 0 0 0 0 0 0 0 1 1 1	WELCOME_	Set mode for display shift when writing
10	Write data to CG RAM / DD RAM 1 0 0 0 1 0 0 0 0 0	ELCOME _	Write " "(space). The cursor is incremented by one and shifted to the right.
11	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 0 1 1	LCOME C_	Write " C ". The cursor is incremented by one and shifted to the right.
12	:	:	
13	Write data to CG RAM / DD RAM 1 0 0 1 0 1 1 0 0 1	COMPAMY_	Write " Y ". The cursor is incremented by one and shifted to the right.
14	Cursor or display shift 0 0 0 0 0 1 0 0 X X	COMPAMY_	Only shift the cursor's position to the left (Y).
15	Cursor or display shift 0 0 0 0 0 1 0 0 X X	COMPAMY_	Only shift the cursor's position to the left (M).
16	Write data to CG RAM / DD RAM 1 0 0 1 0 0 1 1 1 0	OMPANY_	Write " N ". The display moves to the left.
17	Cursor or display shift 0 0 0 0 0 1 1 1 X X	COMPAMY_	Shift the display and the cursor's position to the right.
18	Cursor or display shift 0 0 0 0 0 1 0 1 X X	OMPANY_	Shift the display and the cursor's position to the right.
19	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 0 0 0	COMPAMY_	Write " " (space). The cursor is incremented by one and shifted to the right.
20	:	:	:
21	Return home 0 0 0 0 0 0 0 0 1 0	WELCOME_	Both the display and the cursor return to the original position (address 0).

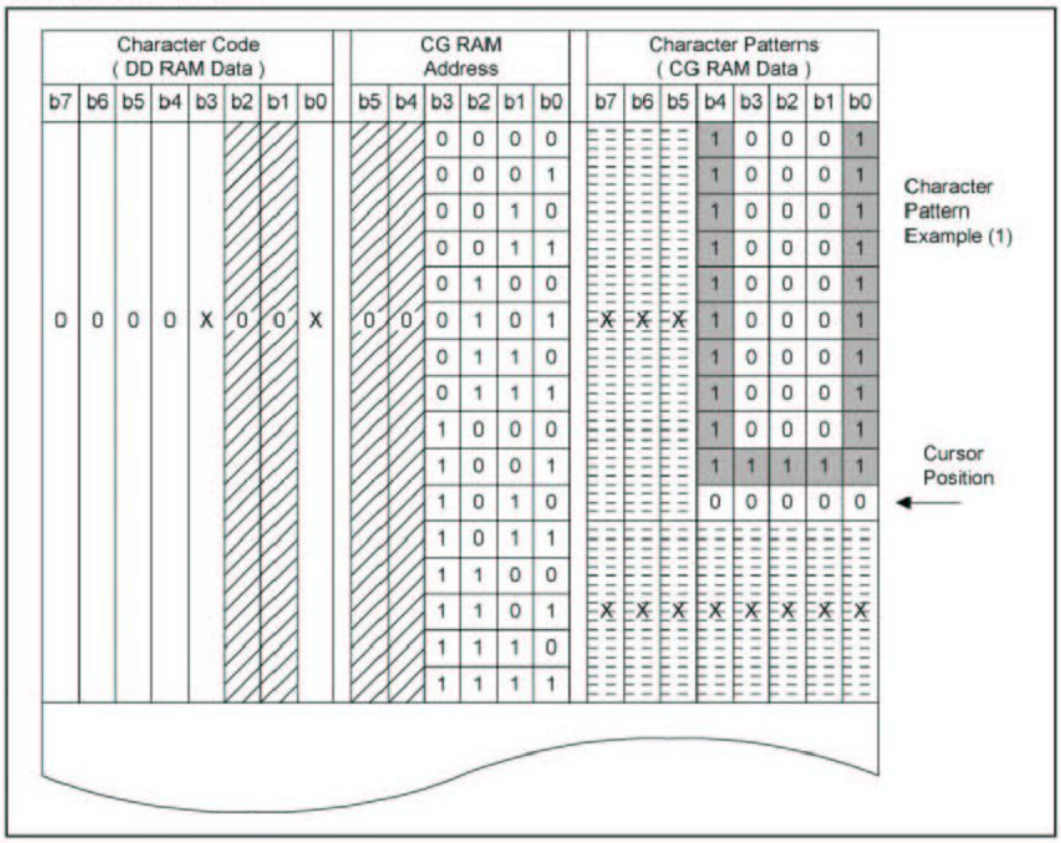
Relationship between character code (DDRAM) and character pattern (CGRAM)

1). 5 x 8 dot character patterns

Character Code (DD RAM Data)								CG RAM Address						Character Patterns (CG RAM Data)								
b7	b6	b5	b4	b3	b2	b1	b0	b5	b4	b3	b2	b1	b0	b7	b6	b5	b4	b3	b2	b1	b0	
0	0	0	0	X	0	0	0	0	0	0	0	0	0	X	X	X	1	1	1	1	1	Character Pattern Example (1)
											0	0	1				0	0	1	0	0	
											0	1	0				0	0	1	0	0	
											0	1	1				0	0	1	0	0	
											1	0	0				0	0	1	0	0	
											1	0	1				0	0	1	0	0	
											1	1	0				0	0	1	0	0	
											1	1	1				0	0	0	0	0	Cursor Position
0	0	0	0	X	0	0	1	0	0	1	0	0	0	X	X	X	0	1	1	1	0	Character Pattern Example (2)
											0	0	1				0	0	1	0	0	
											0	1	0				0	0	1	0	0	
											0	1	1				0	0	1	0	0	
											1	0	0				0	0	1	0	0	
											1	0	1				0	0	1	0	0	
											1	1	0				0	1	1	1	0	
											1	1	1				0	0	0	0	0	

Note1: It means that the bit0~2 of the character code correspond to the bit3~5 of the CG RAM address.
Note2: These areas are not used for display, but can be used for the general data RAM.
Note3: When all of the bit4-7 of the character code are 0, CG RAM character patterns are selected.
Note4: " 1 ": Selected , " 0 " : No selected , " X " : Do not care (0 or 1).
Note5: For example (1), set character code (b2 = b1 = b0 = 0, b3 = 0 or 1, b7-b4 = 0) to display " T ". That means character code (00) 16,and (08) 16 can display " T " character.
Note6: The bits 0-2 of the character code RAM is the character pattern line position. The 8th line is the cursor position and display is formed by logical OR with the cursor.

2). 5 X 10 dot character patterns



Note1: It means that the bit1~2 of the character code correspond to the bit4~5 of the CG RAM address.

Note2: These areas are not used for display, but can be used for the general data RAM.

Note3: When all of the bit4-7 of the character code are 0, CG RAM character patterns are selected.

Note4: " 1 ": Selected, " 0 ": No selected, " X ": Do not care (0 or 1).

Note5: For example (1), set character code (b2 = b1 = 0, b3 = b0 = 0 or 1, b7-b4 = 0) to display " U ". That means all of the character codes (00) 16, (01) 16, (08) 16,and (09) 16 can display " U " character.

Note6: The bits 0-3 of the character code RAM is the character pattern line position. The 11th line is the cursor position and display is formed by logical OR with the cursor.

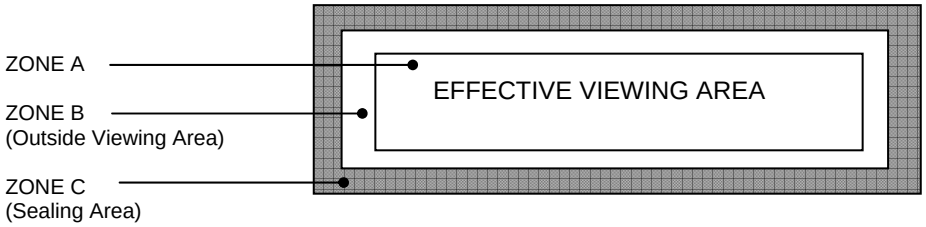
Character Generator ROM (SPLC783A)

Correspondence between Character Codes and Character Patterns.

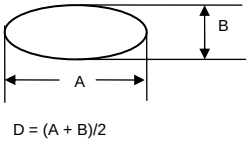
Lower 4-bit (D0 to D3) of Character Code (Hexadecimal)	Higher 4-bit (D4 to D7) of Character Code (Hexadecimal)															
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	CG RAM (1)															
1	CG RAM (2)															
2	CG RAM (3)															
3	CG RAM (4)															
4	CG RAM (5)															
5	CG RAM (6)															
6	CG RAM (7)															
7	CG RAM (8)															
8	CG RAM (1)															
9	CG RAM (2)															
A	CG RAM (3)															
B	CG RAM (4)															
C	CG RAM (5)															
D	CG RAM (6)															
E	CG RAM (7)															
F	CG RAM (8)															

13.0 Quality Assurance

13.1 ZONE DEFINITION



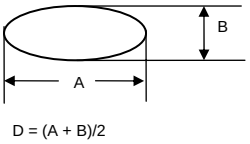
13.1.1 Black Spot, White Spot and Foreign Material

Defect Category	Defect Description	Criterion				Drawing Specification
Black Spot, White Spot and Foreign Material	Black Spot, White Spot and Foreign Material	Zone / Dimension	Acceptable No.			
			A	B	C	
		D ≤ 0.10mm	NC	NC	NC	
		0.10<D ≤ 0.20mm	3	3	NC	
		0.20 < D ≤ 0.30mm	1	2	NC	
		D > 0.30 mm	0	0	NC	
		NC: No count D: Mean Diameter of Defect				

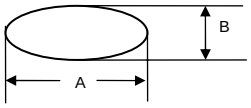
13.1.2 Line Shape and Scratches

Defect Category	Defect Description	Criterion					Drawing Specification
Line shape and scratches	Line shape and scratches	Zone /Dimension		Acceptable No.			
		X	Y	A	B	C	
		-	<0.01mm	NC	NC	NC	
		< 2 mm	< 0.02mm	1	1	NC	
		<1 mm	< 0.0 2mm	1	2	NC	

13.1.3 Pin Hole

Defect Category	Defect Description	Criterion	Drawing Specification
Pin Hole	Pin hole / void at light up segment	D ≤ 0.20mm within 1 part/segment	

13.1.4 Polarizer Bubble/Foreign Material

<table>
<tr><th>Defect Category</th><th>Defect Description</th><th>Criterion</th><th>Drawing Specification</th></tr>
<tr><td></td><td>Polarizer bubble / Foreign material</td><td>
<table>
<tr><td rowspan="2">Zone / Dimension</td><td colspan="3">Acceptable No.</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>D ≤ 0.15mm</td><td>NC</td><td>NC</td><td>NC</td></tr>
<tr><td>0.15 < D ≤ 0.30mm</td><td>3</td><td>5</td><td>NC</td></tr>
<tr><td>0.30 < D ≤ 0.50mm</td><td>2</td><td>3</td><td>NC</td></tr>
<tr><td>0.50 < D ≤ 1.0mm</td><td>0</td><td>1</td><td>NC</td></tr>
<tr><td colspan="4">NC: No count
D: Mean Diameter of Defect
Accept - if air bubble at the seal area does not propagate into effective viewing area</td></tr>
</table>
</td><td> 

D = (A + B)/2</td></tr>
</table>

Note: Total defects shall not exceed five

14. Precaution for using LCM

1. Liquid Crystal Display (LCD)

LCD is made up of glass, organic sealant, organic fluid and polymer based polarizers. The following precautions should be taken when handling.

b) Keep the temperature within the range of use and storage. Excessive temperature and humidity could cause polarization degredation, polarizer peel off or bubble.

c) Do not contact the exposed polarizer with anything harder than HB pencil lead. To clean dust off the display surface, wipe gently with cotton, chamois or other soft material soaked in petroleum benzin.

d) Wipe off saliva or water drops immediately. Contact with water over a long period of time may cause polarizer deformation or colour fading, while an active LCD with water condensation on its surface will cause corrosion of ITO electrodes.

e) Glass can be easily chipped or cracked from rough handling, especially at corners and edges.

f) Do not drive LCD with DC voltage.

2. Liquid Crystal Display Modules.

2.1 Mechanical Considerations

LCM are assembled and adjusted with a high degree of precision. Avoid excessive shocks and do not make any alterations or modification. The following should be noted.

a) Do not tamper in any way with the tabs on the metal frame.

b) Do not modify the PCB by drilling extra holes, changing its outline, moving its component or modifying its pattern.

c) Do not touch the elastomer connector, especially insert a backlight panel (for example, EL)

d) When mounting a LCM make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.

a) Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels.

2.2 Static Electricity

LCM contains CMOS LSI's and the same precaution for such devices should apply, namely

a) The operator should be grounded whenever he/she comes into contact with the module. Never 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.

b) The modules should be kept in antistatic bags or other containers to static for storage.

c) Only properly grounded soldering irons should be used.

d) If an electric screwdriver is used, it should be well grounded and shielded from commutator spark.

e) The normal static prevention measures should be observed for work clothes and working benches, the latter conductive (rubber) mat is recommended.

f) Since dry air is inductive to statics, a relative humidity of 50-60% is recommended.

2.3 Soldering

a) Solder only to the I/O terminals.

b) Use only soldering irons with proper grounding and no leakage.

c) Soldering temperature: 280 °C

d) Soldering time: 3 to 4 sec

e) Use eutectic solder with resin flux fill.

f) If flux is used, the LCD surface should be covered to avoid flux spatters. Flux residue should be removed afterwards.

2.4 Operation

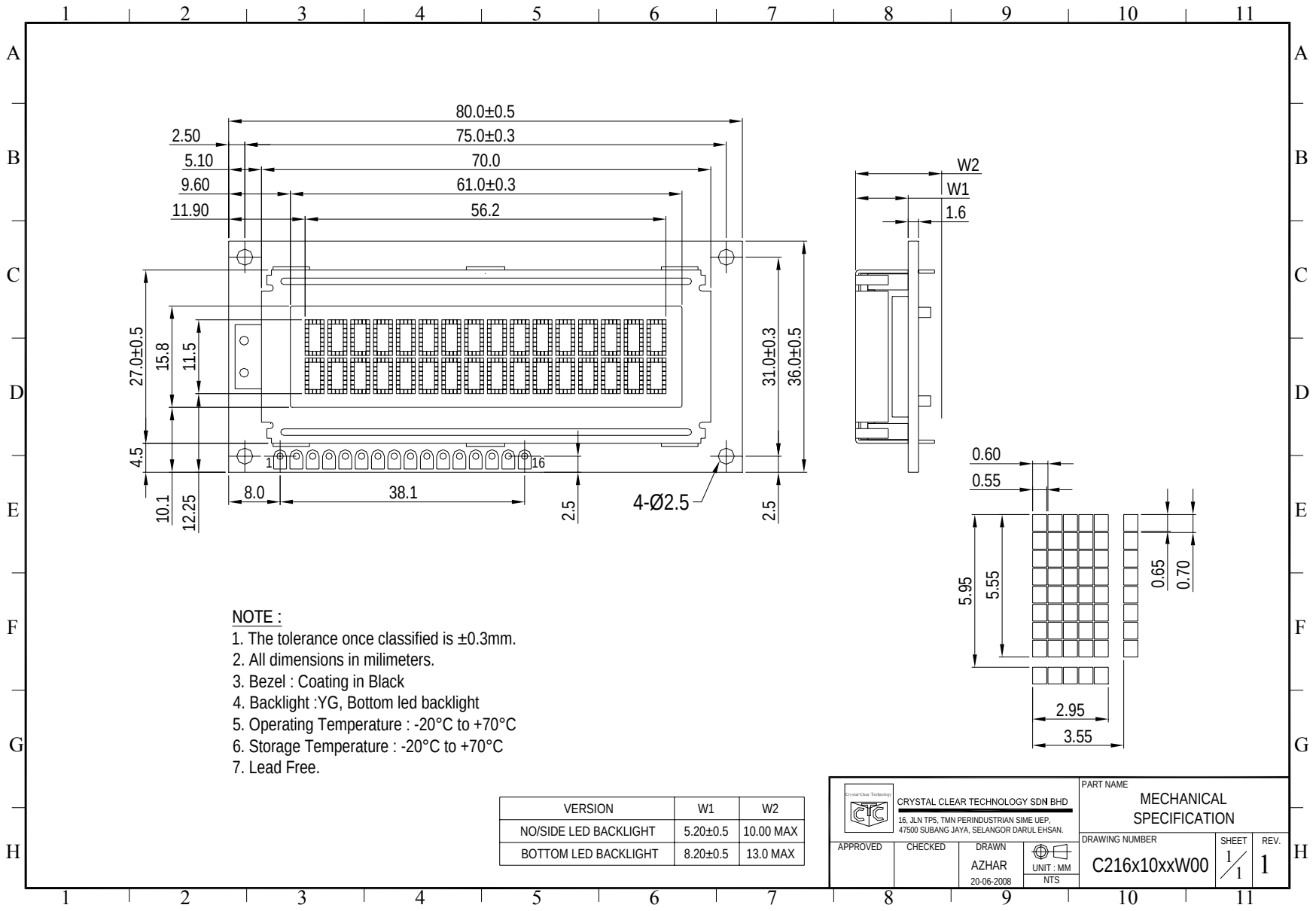
a) The contras can be adjusted by varying the LCD driving voltage V0
b) Driving voltage should be kept within specified range, excess voltage shortens display life.
c) Response time increases with decrease in temperature.
d) Display may turn black or dark blue at temperature above its operational range, this is (however not pressing on the viewing area) may cause the segments to appear "fractured".
e) Mechanical disturbance during operation (such as pressing on the viewing area) may cause the segments to appear "fractured".

2.5 Storage

If any fluid leaks out of the damage glass cell, wash off any human part that comes into contact with soap and water. Never swallow the fluid. The toxicity is extremely low but caution should be exercised at all the time.

2.6 Limited Warranty

Unless otherwise agreed between Crystal Clear Technology and customer, Crystal Clear Technology will replace or repair any of its LCD and LCM which is found to be defective electrically and visually when inspected in accordance with Crystal Clear Technology acceptance standards, for a period of one year from date of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of Crystal Clear Technology is limited to repair and/or replacement on the terms set forth above. Crystal Clear Technology will not responsible for any subsequent or consequential events.



NOTE :

1. The tolerance once classified is ±0.3mm.
2. All dimensions in milimeters.
3. Bezel : Coating in Black
4. Backlight :YG, Bottom led backlight
5. Operating Temperature : -20°C to +70°C
6. Storage Temperature : -20°C to +70°C
7. Lead Free.

VERSION	W1	W2
NO/SIDE LED BACKLIGHT	5.20±0.5	10.00 MAX
BOTTOM LED BACKLIGHT	8.20±0.5	13.0 MAX

CRYSTAL CLEAR TECHNOLOGY SDN BHD
16, JLN TP5, TMN PERINDUSTRIAN SIME UEP,
47500 SUBANG JAYA, SELANGOR DARUL EHSAN.

PART NAME					
MECHANICAL SPECIFICATION					
APPROVED	CHECKED	DRAWN	UNIT : MM	DRAWING NUMBER	SHEET / REV.
		AZHAR 20-06-2008	NTS	C216x10xxW00	1/1 / 1

Crystal Clear Technology
16 Jalan TP5—Taman Perindustrian Sime UEP
47600 Subang Jaya—Selangor DE
Malaysia