

# SPECIFICATION FOR LCD MODULE

Model No. TM162AAA6-1

<b>Prepared by:</b>	<b>Date:</b>
<b>Checked by :</b>	<b>Date:</b>
<b>Verified by :</b>	<b>Date:</b>
<b>Approved by:</b>	<b>Date:</b>

**TIANMA MICROELECTRONICS CO., LTD**

**REVISION RECORD**

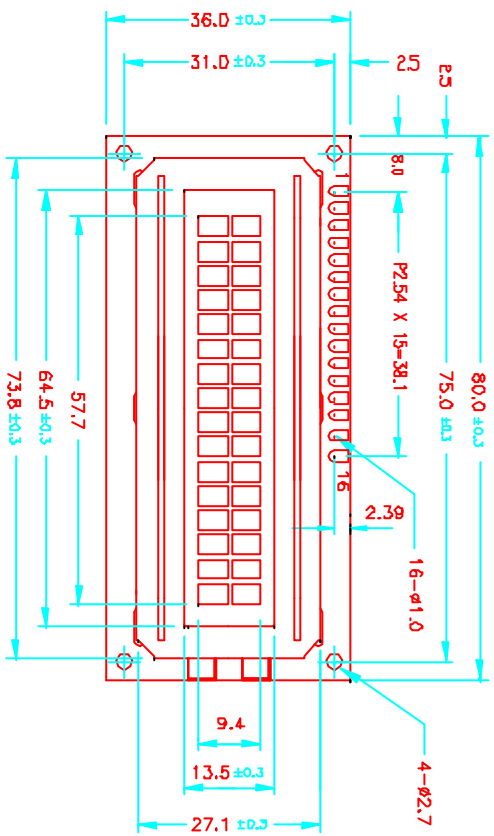
<b>Date</b>	<b>Ref. Page</b>	<b>Revision No.</b>	<b>Revision Items</b>	<b>Check &amp; Approval</b>

## 1. General Specifications:

- 1.1 Display type: TN
- 1.2 Display color\*:
  - 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 Backlight: None
- 1.7 Display Fonts: 5 x 7 dots + Cursor (1 Character)
- 1.8 Controller: HCD66701A00
- 1.9 Data Transfer: 8 Bit Parallel
- 1.10 Operating Temperature: 0----+50°C
  - Storage Temperature: -20----+60°C
- 1.11 Outline Dimensions: Refer to outline drawing on next page
- 1.12 Dot Matrix: 16 Characters X 2 Lines
- 1.13 Dot Size: 0.55X0.50(mm)
- 1.14 Dot Pitch: 0.60X0.55 (mm)
- 1.15 Weight: 20g
- 1.16 PCB edition: TM162AD P1-2

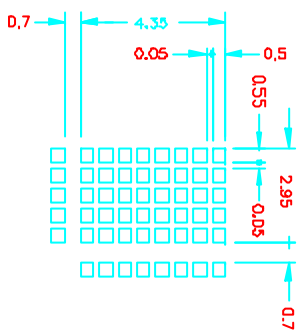
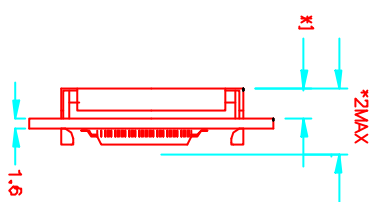
\* Color tone is slightly changed by temperature and driving voltage.

## 2. Outline Drawing

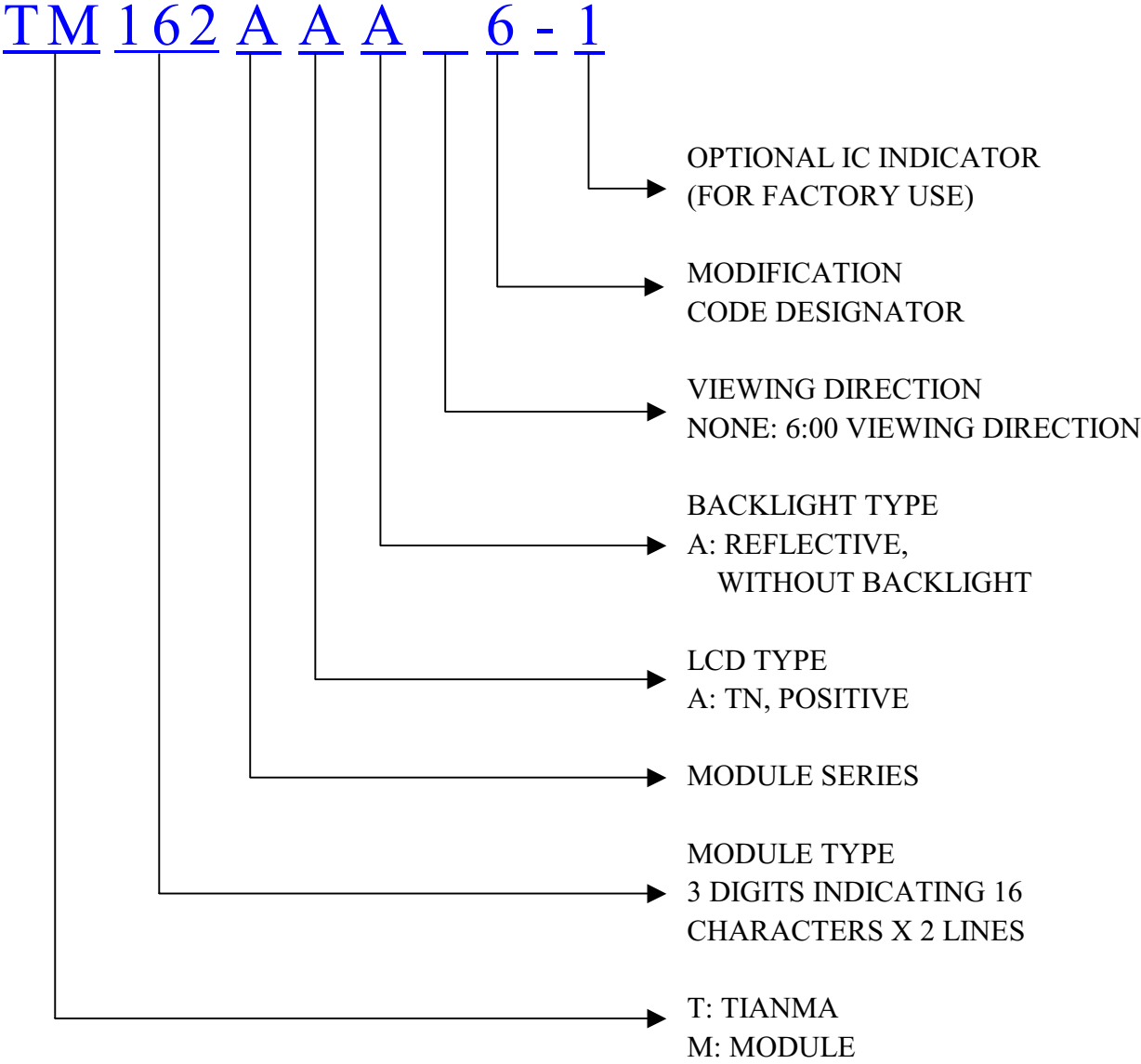


1	VSS	2	VCC	3	VDD	4	RS	5	R/W	6	E	7	DB0	8	DB1	9	DB2	10	DB3	11	DB4	12	DB5	13	DB6	14	DB7	15	LED+	16	LED-
---	-----	---	-----	---	-----	---	----	---	-----	---	---	---	-----	---	-----	---	-----	----	-----	----	-----	----	-----	----	-----	----	-----	----	------	----	------

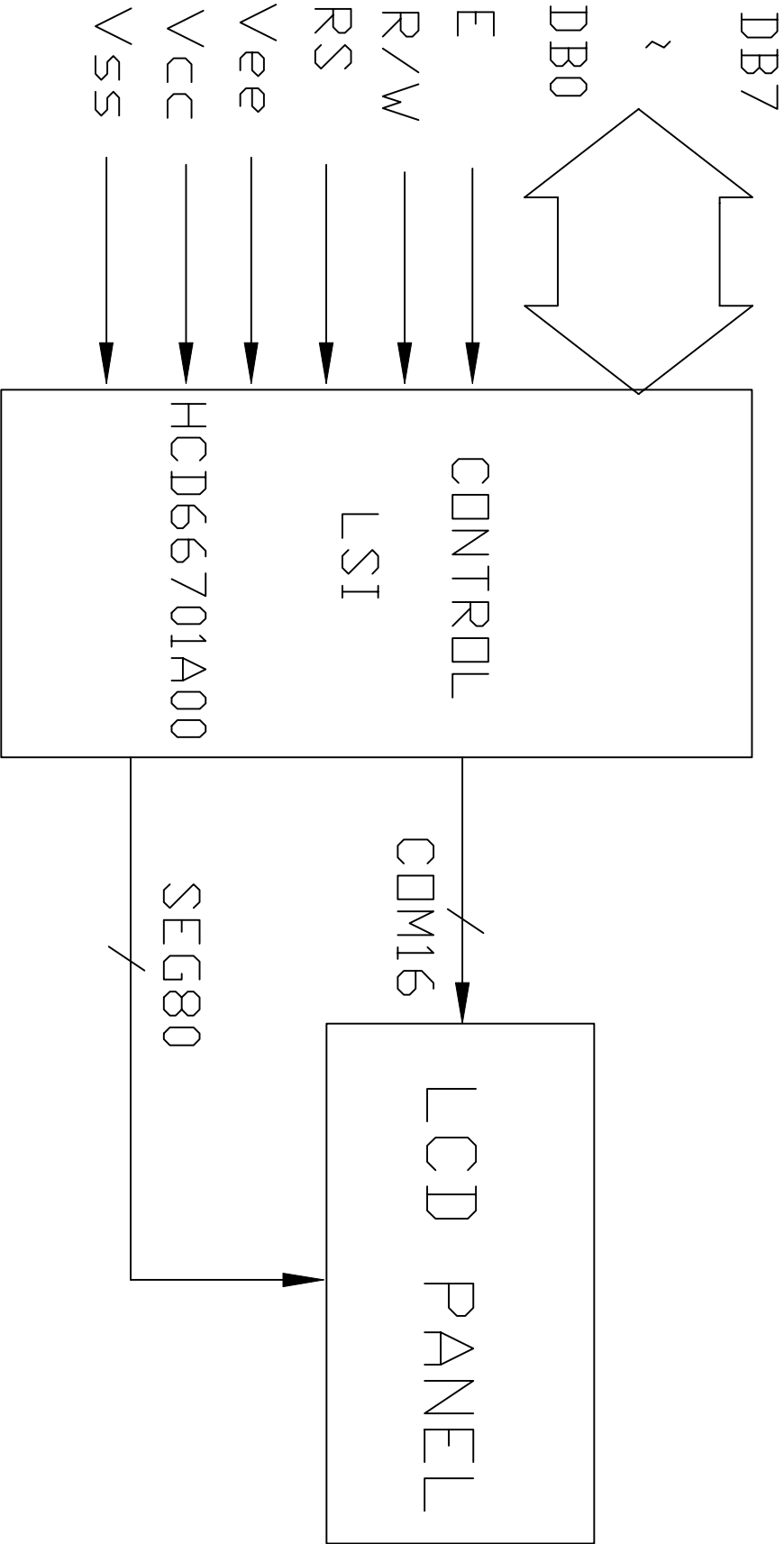
TYPE	*1	*2
R&EL	4.5	11.0
LED	7.5	15.0



### 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	°C	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)		$V_{DD}-V_{SS}$	4.5	5.0	5.5	V
Supply Voltage (LCD Drive)		$V_{LCD}$	-	4.7	-	V
Input Signal Voltage	High	$V_{IH}$ ( $V_{DD}=5.0$ )	$0.7V_{DD}$	-	$V_{DD}+0.3$	V
	Low	$V_{IL}$ ( $V_{DD}=5.0$ )	-0.3	-	$0.2 V_{DD}$	V
Supply current (Logic)		$I_{DD}$ ( $V_{DD}-V_{SS}=5.0$ )	-	1.5	2.0	mA
Supply current (LCD Drive)		$I_{EE}$	-	0.40	0.6	mA



## 6.2 Interface Signals

Pin No.	Symbol	Level	Description
1	Vss	0V	Ground
2	Vcc	5.0V	Power supply voltage for logic and LCD(+)
3	Vee	0.3V	Power supply voltage for LCD(-)
4	RS	H/L	Selects registers
5	R/W	H/L	Selects read or write
6	E	H/L	Starts data read/write
7	DB0	H/L	Data bit0
8	DB1	H/L	Data bit1
9	DB2	H/L	Data bit2
10	DB3	H/L	Data bit3
11	DB4	H/L	Data bit4
12	DB5	H/L	Data bit5
13	DB6	H/L	Data bit6
14	DB7	H/L	Data bit7
15	NC	-	No signal
16	NC	-	No signal

## 6.3 Interface Timing Chart

**AC Characteristics ( $V_{CC} = 2.7$  to  $5.5V$ ,  $T_a = -30$  to  $+75^{\circ}C^{*3}$ )**

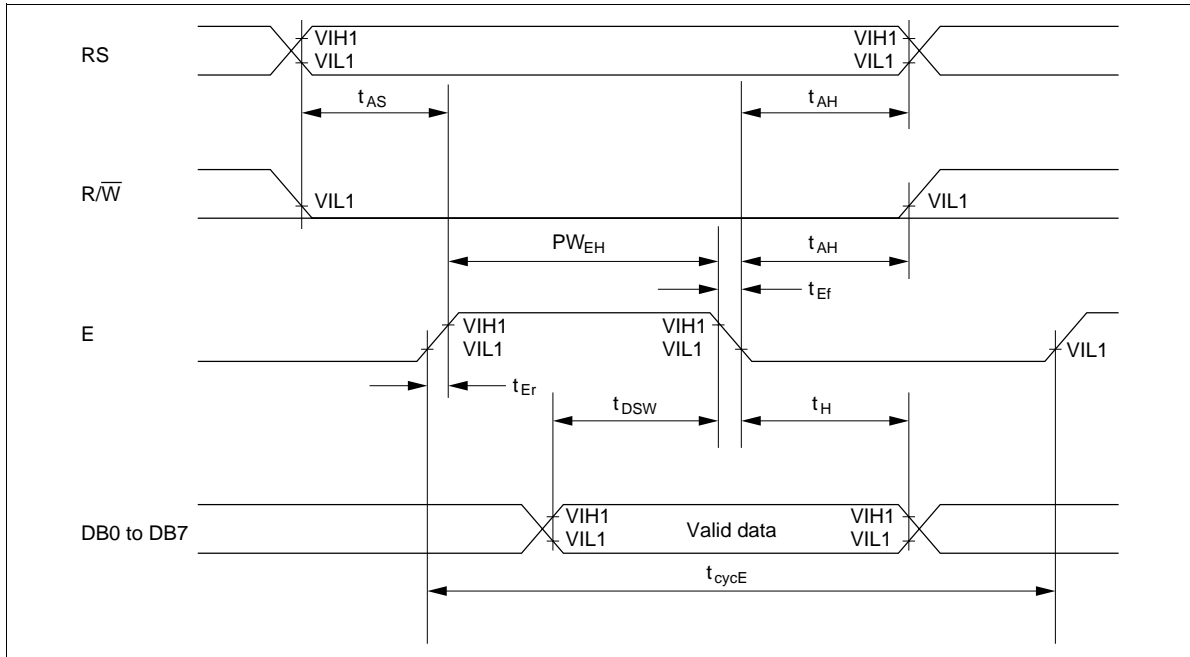
### Write Operation

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Enable cycle time	$t_{cycE}$	1000	—	—	ns	
Enable pulse width (high level)	$PW_{EH}$	450	—	—		
Enable rise/fall time	$t_{Er}, t_{Ef}$	—	—	25		
Address set-up time (RS, R/W to E)	$t_{AS}$	40	—	—		
Address hold time	$t_{AH}$	20	—	—		
Data set-up time	$t_{DSW}$	195	—	—		
Data hold time	$t_H$	10	—	—		

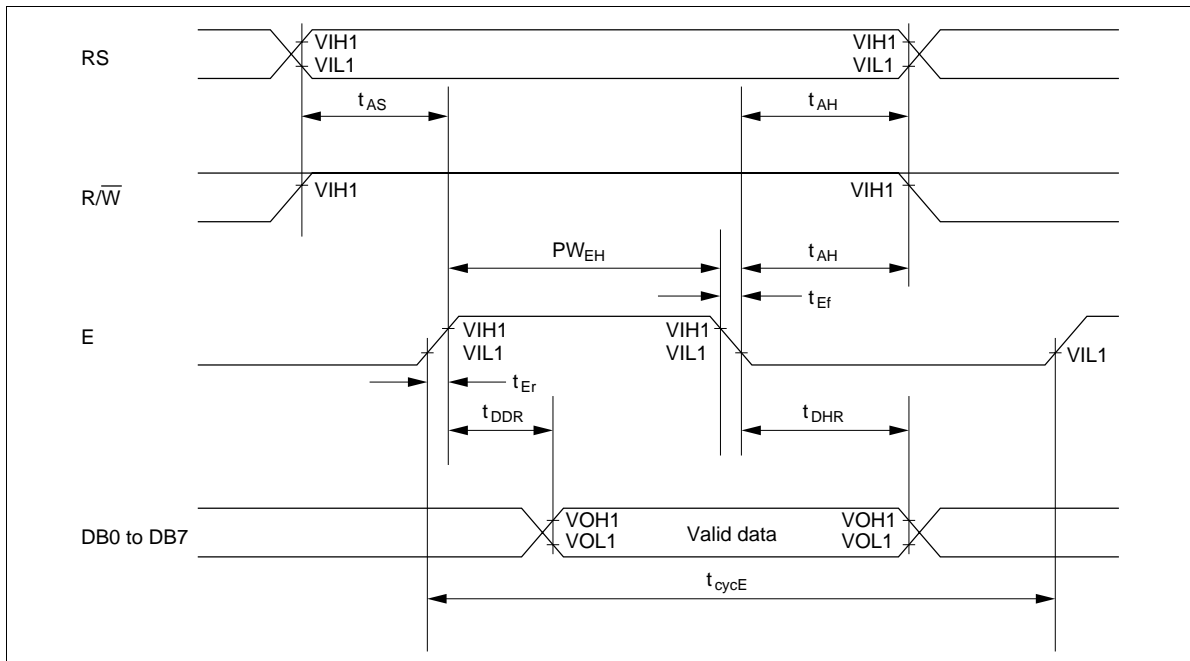
### Read Operation

Item	Symbol	Min	Typ	Max	Unit	Test Condition
Enable cycle time	$t_{cycE}$	1000	—	—	ns	
Enable pulse width (high level)	$PW_{EH}$	450	—	—		
Enable rise/fall time	$t_{Er}, t_{Ef}$	—	—	25		
Address set-up time (RS, R/W to E)	$t_{AS}$	40	—	—		
Address hold time	$t_{AH}$	20	—	—		
Data delay time	$t_{DDR}$	—	—	350		
Data hold time	$t_{DHR}$	10	—	—		

## Timing Characteristics



**Write Operation**



**Read Operation**

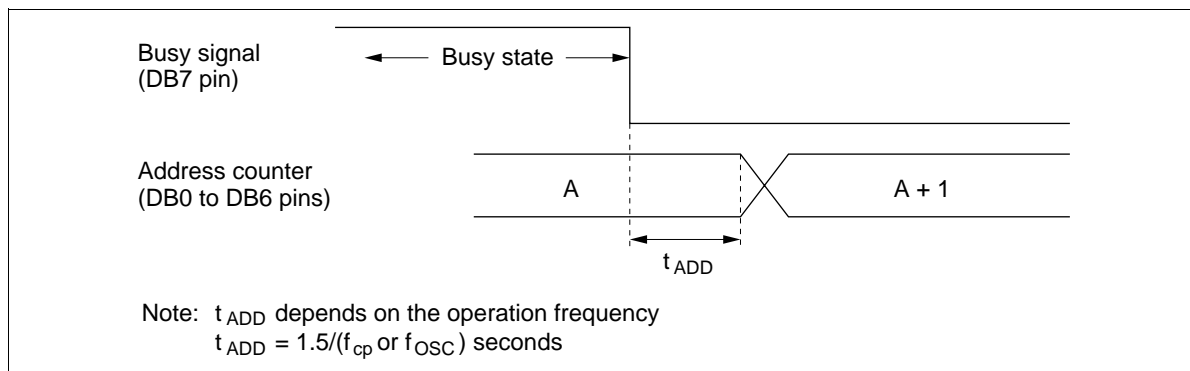
## 6.4 Instruction Code

Instruction	Code										Description	Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 320 kHz)	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	1.28 ms	
Return home	0	0	0	0	0	0	0	0	0	1	—	Sets DDRAM address 0 in address counter. Also returns display from being shifted to original position. DDRAM contents remain unchanged.	1.28 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	31 $\mu$ s	
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, cursor on/off (C), and blinking of cursor position character (B).	31 $\mu$ s	
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	—	—	Moves cursor and shifts display without changing DDRAM contents.	31 $\mu$ s	
Function set	0	0	0	0	1	DL	N	F	—	—	Sets interface data length (DL), number of display lines (L), and character font (F).	31 $\mu$ s	
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	31 $\mu$ s	
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. DDRAM data is sent and received after this setting.	31 $\mu$ s	
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 $\mu$ s	

Instruction	RS	R/W	Code								Description	Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 320 kHz)
			DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Write data to CG or DDRAM	1	0	Write data								Writes data into DDRAM or CGRAM.	31 $\mu$ s $t_{ADD} = 4.7 \mu$ s*
Read data from CG or DDRAM	1	1	Read data								Reads data from DDRAM or CGRAM.	31 $\mu$ s $t_{ADD} = 4.7 \mu$ s*
			I/D = 1:	Increment						DDRAM: Display data RAM	Execution time changes when frequency changes	
			I/D = 0:	Decrement						CGRAM: Character generator RAM	Example:	
			S = 1:	Accompanies display shift						ACG: CGRAM address	When $f_{cp}$ or $f_{osc}$ is 270 kHz,	
			S/C = 1:	Display shift						ADD: DDRAM address (corresponds to cursor address)	$31 \mu$ s $\times \frac{320}{270} = 37 \mu$ s	
			S/C = 0:	Cursor move						AC: Address counter used for both DD and CGRAM addresses		
			R/L = 1:	Shift to the right								
			R/L = 0:	Shift to the left								
			DL = 1:	8 bits, DL = 0: 4 bits								
			N = 1:	2 lines, N = 0: 1 line								
			F = 1:	$5 \times 10$ dots, F = 0: $5 \times 7$ dots								
			BF = 1:	Internally operating								
			BF = 0:	Instructions acceptable								

Note: — indicates no effect.

- \* After execution of the CGRAM/DDRAM data write or read instruction, the RAM address counter is incremented or decremented by 1. The RAM address counter is updated after the busy flag turns off. In Figure 10,  $t_{ADD}$  is the time elapsed after the busy flag turns off until the address counter is updated.



**Figure 10 Address Counter Update**

## 6.5 Character generator ROM(HCD66701A00)

Lower 4 Bits \ Upper 4 Bits	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	a	P	`	F		-	9	E	a	P
xxxx0001	(2)	!	1	A	Q	a	9	a	7	7	4	ä	q
xxxx0010	(3)	"	2	B	R	b	r	「	イ	ツ	×	ß	ø
xxxx0011	(4)	#	3	C	S	c	s	」	ウ	テ	E	ε	ø
xxxx0100	(5)	\$	4	D	T	d	t	、	エ	ト	ト	μ	Ω
xxxx0101	(6)	%	5	E	U	e	u	、	オ	ナ	ユ	ε	Ü
xxxx0110	(7)	&	6	F	V	f	v	ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)	'	7	G	W	g	w	ヲ	キ	ヌ	ウ	g	π
xxxx1000	(1)	(	8	H	X	h	x	イ	ウ	本	リ	ρ	×
xxxx1001	(2)	)	9	I	Y	i	y	ウ	ク	ル	ル	ı	ı
xxxx1010	(3)	*	:	J	Z	j	z	エ	コ	ン	ク	j	ı
xxxx1011	(4)	+	;	K	C	k	c	(	オ	サ	ヒ	ı	ı
xxxx1100	(5)	,	<	L	¥	ı	ı	カ	シ	フ	ワ	φ	ı
xxxx1101	(6)	-	=	M	I	m	)	ユ	ズ	ノ	コ	ı	ı
xxxx1110	(7)	.	>	N	^	n	→	ヨ	セ	ホ	°	ı	ı
xxxx1111	(8)	/	?	O	_	o	+	ウ	リ	マ	°	ö	ı

Note: The user can specify any pattern for character-generator RAM.

## 7. Optical Characteristics

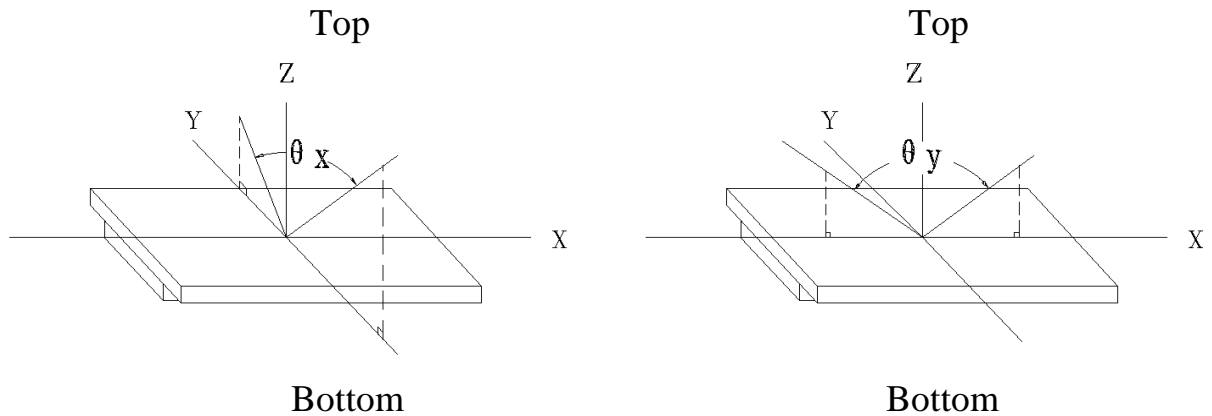
### 7.1 Optical Characteristics

Ta=25°C

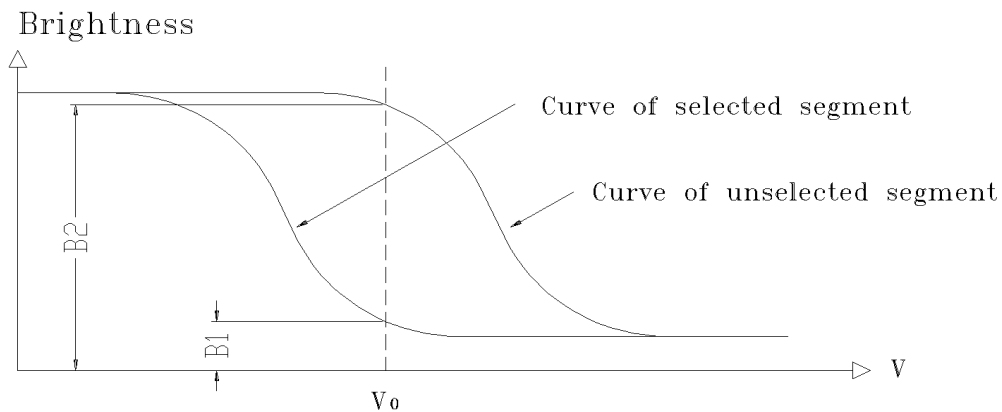
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
Viewing Angle	$\theta_x$	$C_r \geq 2$	$\theta_y = 0^\circ$	35	--	10	Deg
	$\theta_y$			$\theta_x = 0^\circ$	-30	--	
Contrast Ratio	$C_r$	$\theta_x = 20^\circ$ $\theta_y = 0^\circ$	3.0	-	-		
Response Time	Turn on	$\theta_x = 20^\circ$ $\theta_y = 0^\circ$	-	-	150	ms	
	Turn off		-	-	150		

## 7.2 Definition of Optical Characteristics

### 7.2.1 Definition of Viewing Angle



### 7.2.2 Definition of Contrast Ratio

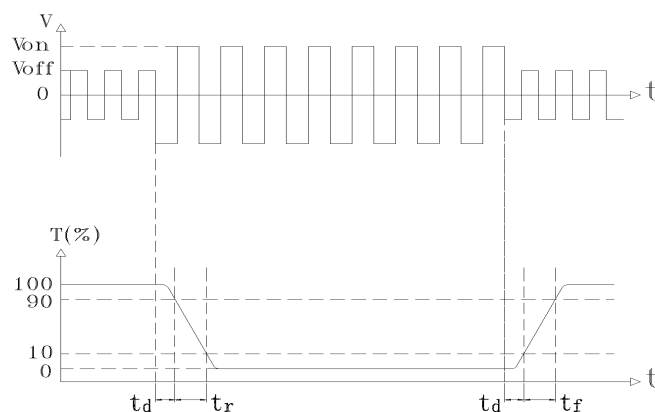


$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

Measuring Conditions:

- 1) Ambient Temperature: 25°C;
- 2) Frame frequency: 64Hz

### 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: 4.7V
- 2) Frame frequency: 64Hz



## 8. Reliability

### 8.1 Content of Reliability Test

Ta=25°C

No.	Test Item	Content of Test	Test condition
1	High Temperature Storage	Endurance test applying the high storage temperature for a long time	60°C 96H
2	Low Temperature Storage	Endurance test applying the low storage temperature for a long time	-20°C 96H
3	High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the thermal stress to the element for a long time	50°C 96H
4	Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time	0°C 96H
5	High Temperature /Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time	40°C 90%RH 96H
6	Temperature Cycle	Endurance test applying the low and high temperature cycle $-20^{\circ}\text{C} \longleftrightarrow 25^{\circ}\text{C} \longleftrightarrow 60^{\circ}\text{C} \longleftrightarrow 25^{\circ}\text{C}$ $\begin{array}{cccc} 30\text{min} & 5\text{min} & 30\text{min} & 5\text{min} \end{array}$ <p style="text-align: center;">1 cycle</p>	-20°C/60°C 10 cycles
7	Vibration Test (package state)	Endurance test applying the vibration during transportation	10Hz~150Hz, 50m/s <sup>2</sup> , 40min
8	Shock Test (package state)	Endurance test applying the shock during transportation	Half- sine wave, 100m/s <sup>2</sup> , 11ms
9	Atmospheric Pressure Test	Endurance test applying the atmospheric pressure during transportation by air	40kPa 16H

## 8.2 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									

## 9. QUALITY LEVEL

Examination or Test	At Ta=25°C (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
<p>Note: Major defects: Open segment or common, Short, Serious damages, Leakage            Miner defects: Others            Sampling standard conforms to GB2828</p>						

## 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 :  $0^{\circ}\text{C} \sim 40^{\circ}\text{C}$

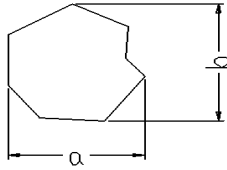
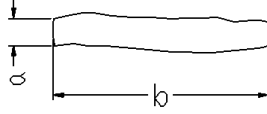
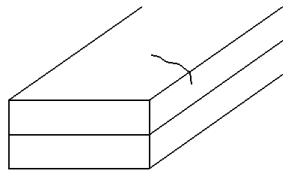
Relatively humidity:  $\leq 80\%$

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

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