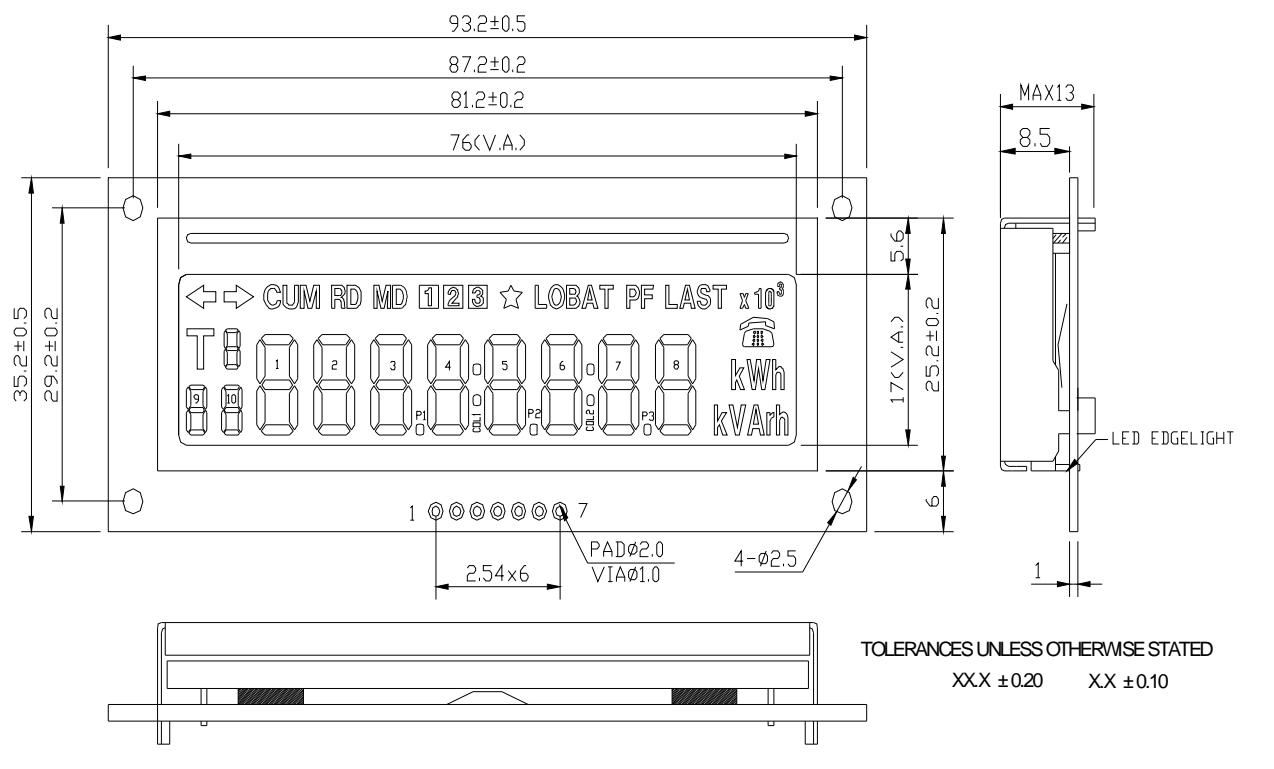


1. Features

1. Built-in controller (HT1621 or Equivalent)
2. +3.3 V power supply
3. 1/4 duty cycle
4. 3-wire serial interface
5. Display mode: TN, positive, transreflective
6. Viewing angle: 6:00 o'clock
7. LED sidelight(Yellow-green)

2. OUTLINE DIMENSION

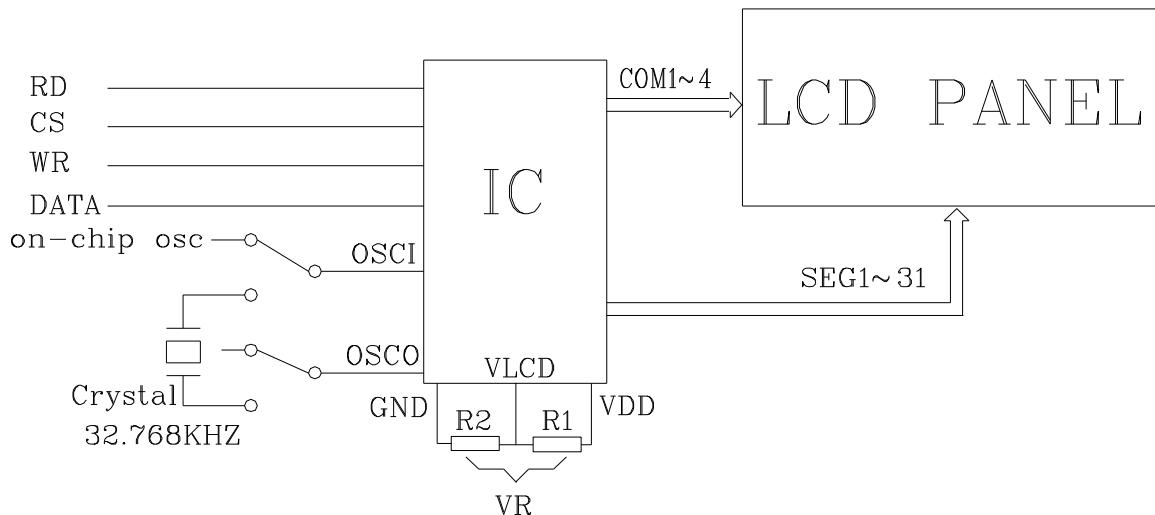


SEG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
COM1	1F	1A	2F	2A	3F	3A	4F	4A	5F	5A	6F	6A	7F	7A	8F	8A	9F	9A	10F	10A	11F	11A		3	★	KW	KV	
COM2	1G	1B	2G	2B	3G	3B	4G	4B	5G	5B	6G	6B	7G	7B	8G	8B	9G	9B	10G	10B	11G	11B	→			H1	A	
COM3	1E	1C	2E	2C	3E	3C	4E	4C	5E	5C	6E	6C	7E	7C	8E	8C	9E	9C	10E	10C	11E	11C	←	2	LOBAT	PF	→	
COM4	1D	RD	2D	MD	3D	P1	4D	call1	5D	P2	6D	call2	7D	P3	8D		9D		10D		11D	CUM	T	1	LAST	±10 ³	H2	

3. Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit
Power Voltage	V_{DD} - V_{SS}	-0.3	+5.5	V
Input Voltage	V_I	V_{SS} -0.3	V_{DD} +0.3	
Operating Temperature Range	V_{OP}	-20	+80	°C
Storage Temperature Range	T_{ST}	-30	+85	

4. Block diagram



*** Notes:**

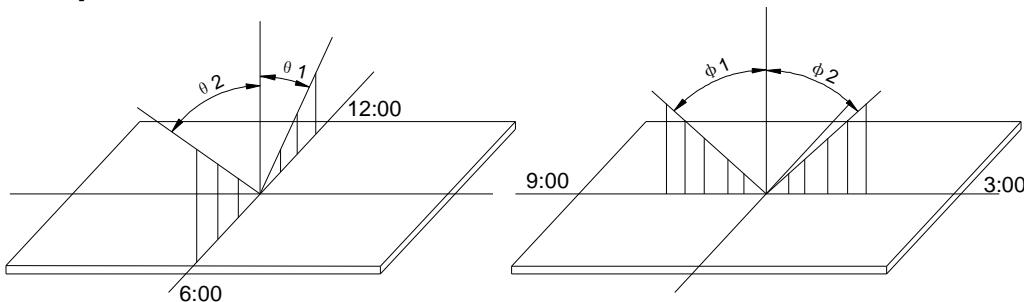
Adjust VR to fit LCD display, at $V_{DD} = 3.3V$, $V_{LCD} = 3V$, $R1 = 0$ ohm, $R2$ not mounted.
Adjust R (external pull-high resistance) to fit user's time base clock.

5. INTERFACE PIN DESCRIPTION

Pin No.	Pin Name	Input/Output	External Connection	Function
1	VSS	—	Power Supply	VSS: GND
2	VDD	—		VDD: +3.3V
3	DATA	—	MPU	Serial data input/output with pull-high resistor
4	WR	Input	MPU	WRITE clock input with pull-high resistor Data on the DATA line are latched into the HT1621 on the rising edge of the WR signal.
5	CS	Input	MPU	Chip selection input with pull-high resistor When the CS is logic high, the data and command read from or written to the HT1621 are disabled. The serial interface circuit is also reset. But if CS is at logic low level and is input to the CS pad, the data and command transmission between the host controller and the HT1621 are all enabled.
6	RD	Input	MPU	READ clock input with pull-high resistor Data in the RAM of the HT1621 are clocked out on the falling edge of the RD signal. The clocked out data will appear on the DATA line. The host controller can use the next rising edge to

				latch the clocked out data.
--	--	--	--	-----------------------------

6. Optical Characteristics

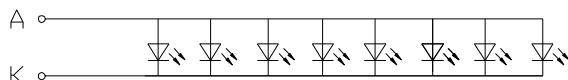


Ø For TN Type Display Module

 $(T_A=25^\circ\text{C}, V_{DD}=3.3\text{V} \pm 0.5\text{V})$

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Viewing angle	Θ 1	$C_R \geq 3$		10		DEG
	Θ 2			35		
	Φ 1			30		
	Φ 2			30		
Contrast ratio	C_R		—	20	—	—
Response time (rise)	T_R	—	—	100	150	ms
Response time (fall)	T_F	—	—	50	100	ms

7. Electrical Characteristics

LED Backlight circuit (color: Yellow-Green)

 $1*8=8$

LED RATINGS

ITEM	SYMBOL	MIN	TYP.	MAX	UNIT
FORWARD VOLTAGE	V_F	1.9	2.0	2.2	V
FORWARD CURRENT	I_F		80	120	MA
POWER	P			0.3	W
PEAK WAVE LENGTH	λ_P	570	573	575	NM
LUMINANCE	L_V	-	80	-	CD/M ²

Ø DC Characteristics

Parameter	Symbol	Conditions	Min.	Type	Max.	Unit
Supply voltage for LCD	$V_{DD}-V_O$	$T_A=25^\circ\text{C}$	—	3	—	V
Input voltage	V_{DD}		—	3.3	—	V
Supply current	I_{DD}	$V_{DD}=5.0\text{V}; T_A=25^\circ\text{C}$	—	0.4	0.7	mA

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Input leakage current	I_{LKG}		—	—	1.0	μA
“H” level input voltage	V_{IH}		2.2	—	V_{DD}	V
“L” level input voltage	V_{IL}	Twice initial value or less	0	—	0.6	V
“H” level output voltage	V_{OH}	$I_{OH} = -0.25mA$	2.4	—	—	V
“L” level output voltage	V_{OL}	$I_{OL} = 1.6mA$	—	—	—	V
Backlight supply voltage	V_F		—	2.0	—	V

Ø AC. Characteristics

Ta=25°C

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
f_{SYS1}	System clock	On-chip RC oscillator	—	256	—	KHZ
f_{SYS2}	System clock	Crystal oscillator	—	32.768	—	
f_{LCD}	LCD clock	On-chip RC oscillator	—	$f_{SYS1/1024}$	—	HZ
		Crystal oscillator	—	$f_{SYS2/128}$	—	
t_{COM}	LCD Common Period	N: Number of COM	—	n/f_{LCD}	—	S
f_{CLK1}	Serial Data Clock (WR pin)	Duty cycle 50%	—	—	300	KHZ
f_{CLK2}	Serial Data Clock (RD pin)	Duty cycle 50%	—	—	150	
f_{TONE}	Tone Frequency	On-chip RC oscillator	—	2 or 4	—	ns
t_{CS}	Serial Interface Reset Pulse Width (Figure 3)	/CS	—	250	—	
t_{CLK}	WR, RD Input Pulse Width (Figure 1)	Write mode	1.67	—	—	us
		Read mode	3.34	—	—	
$t_{r,tf}$	Rise/Fall Time Serial Data Clock Width (Figure 1)	—	—	120	—	ns
t_{su}	Setup Time for DATA to WR, RD Clock Width (Figure 2)	—	—	120	—	
t_h	Hold Time for DATA to WR, RD Clock Width (Figure 2)	—	—	120	—	
t_{su1}	Setup Time for CS to WR, RD Clock Width (Figure 3)	—	—	100	—	
t_{h1}	Hold Time for CS to WR, RD Clock Width (Figure 3)	—	—	100	—	

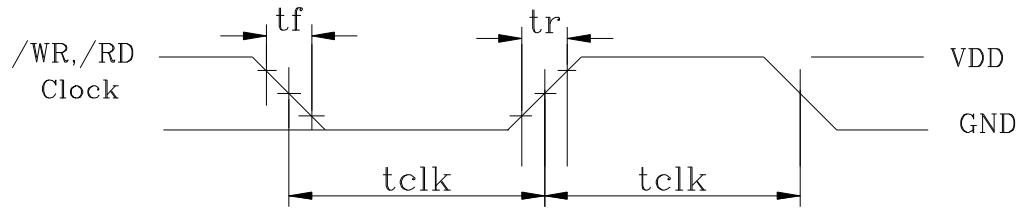


Figure 1

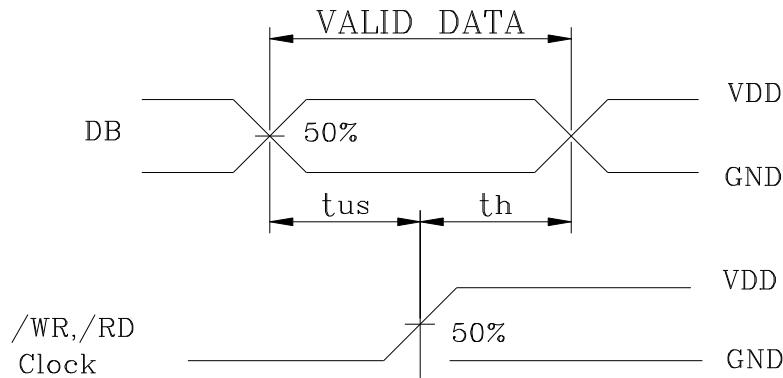


Figure 2

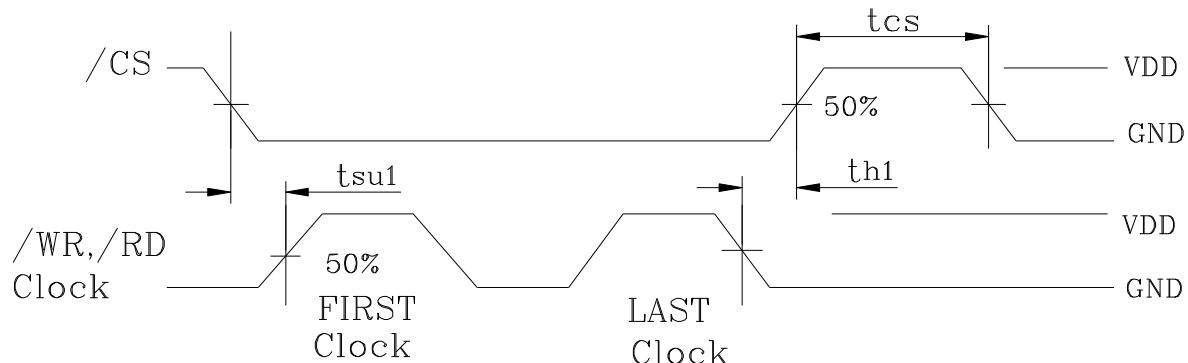
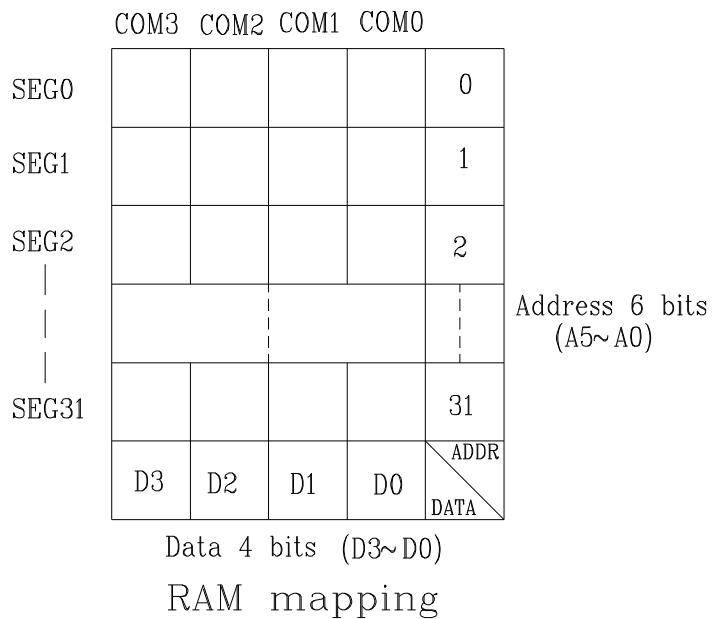


Figure 3

8. Functional Description

Display memory-RAM

The static display memory (RAM) is organized into 32x4 bits and stores the displayed data. The contents of the RAM are directly mapped to the contents of the LCD driver. Data in the RAM can be accessed by the READ, WRITE, and READ-MODIFY-WRITE commands. The following is a mapping from the RAM to the LCD pattern:



System oscillator

The HT1621 system clock is used to generate the time base/watchdog timer (WDT) clock frequency, LCD driving clock, and tone frequency. The source of the clock may be from an on-chip RC oscillator (256kHz), a crystal oscillator (32.768kHz), or an external 256kHz clock by the S/W setting. The configuration of the system oscillator is as shown. After the SYS DIS command is executed, the system clock will stop and the LCD bias generator will turn off. That command is, however, available only for the on-chip RC oscillator or for the crystal oscillator. Once the system clock stops, the LCD display will become blank, and the time base/WDT lose its function as well.

The LCD OFF command is used to turn the LCD bias generator off. After the LCD bias generator switches off by issuing the LCD OFF command, using the SYS DIS command reduces power consumption, serving as a system power down command. But if the external clock source is chosen as the system clock, using the SYS DIS command can neither turn the oscillator off nor carry out the power down mode. The crystal oscillator option can be applied to connect an external frequency source of 32kHz to the OSC1 pin. In this case, the system fails to enter the power down mode, similar to the case in the external 256kHz clock source operation. At the initial system power on, the HT1621 is at the SYS DIS state.

Name	Command Code	Function
LCD OFF	1 0 00 0 0 0 0 1 0 X	Turn off LCD outputs
LCD ON	1 0 00 0 0 0 0 0 1 1 X	Turn on LCD outputs
BIAS & COM	1 0 00 0 1 0 a b X c X	c=0: 1/2 bias option c=1: 1/3 bias option ab=00: 2 commons option ab=01: 3 commons option ab=10: 4 commons option

LCD driver

The HT1621 is a 128 (32x4) pattern LCD driver. It can be configured as 1/2 or 1/3 bias and 2 or 3 or 4 commons of LCD driver by the S/W configuration. This feature makes the HT1621 suitable for multiply LCD applications. The LCD driving clock is derived from the system clock. The value of the driving clock is always 256Hz even when it is at a 32.768kHz crystal oscillator frequency, an on-chip RC oscillator frequency, or an external frequency. The LCD corresponding commands are summarized in the table. The bold form of **1 0 0**, namely **1 0 0**, indicates the command mode ID. If successive commands have been issued, the command mode ID except for the first command will be omitted. The LCD OFF command turns the LCD display off by disabling the LCD bias generator. The LCD ON command, on the other hand, turns the LCD display on by enabling the LCD bias generator. The BIAS and COM are the LCD panel related commands. Using the LCD related commands; the HT1621 can be compatible with most types of LCD panels.

Command format

The HT1621 can be configured by the S/W setting. There are two mode commands to configure the HT1621 resources and to transfer the LCD display data. The configuration mode of the HT1621 is called command mode, and its command mode ID is **1 0 0**. The command mode consists of a system configuration command, a system frequency selection command, a LCD configuration command, a tone frequency selection command, a timer/WDT setting command, and an operating command. The data mode, on the other hand, includes READ, WRITE, and READ-MODIFY-WRITE operations. The following are the data mode IDs and the command mode ID:

Operation	Mode	ID
READ	Data	110
WRITE	Data	101
READ-MODIFY-WRITE	Data	101
COMMAND	Command	100

The mode command should be issued before the data or command is transferred. If successive commands have been issued, the command mode ID, namely **1 0 0**, can be omitted. While the system is operating in the non-successive command or the non-successive address data mode, the CS pin should be set to "1" and the previous operation mode will be reset also. Once the CS pin returns to "0" a new operation mode ID should be issued first.

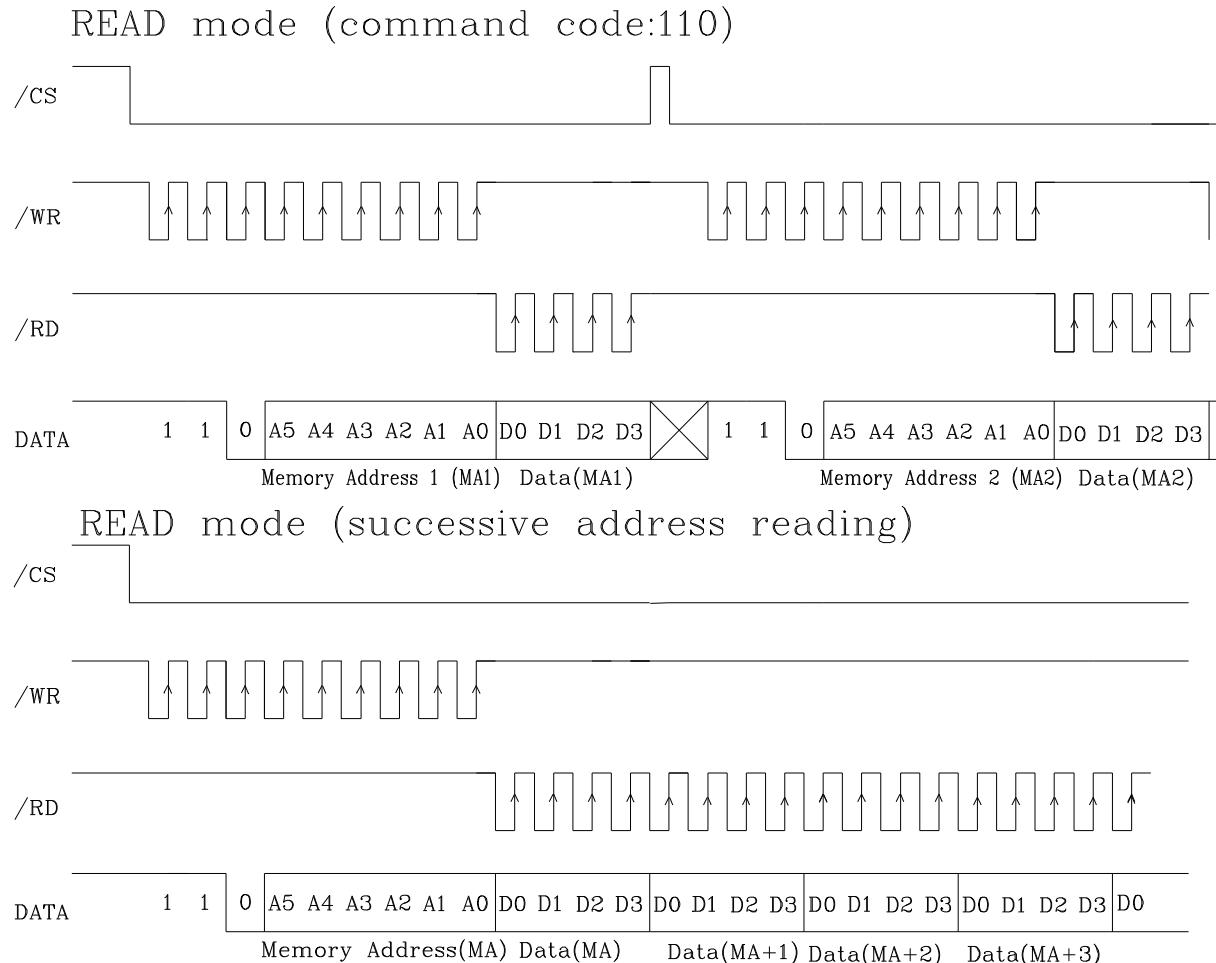
Interfacing

Only four lines are required to interface with the HT1621. The CS line is used to initialize the serial interface circuit and to terminate the communication between the host controller and the HT1621. If the CS pin is set to 1, the data and command issued between the host controller and the HT1621 are first disabled and then initialized. Before issuing a mode command or mode switching, a high level pulse is required to initialize the serial interface of the HT1621. The DATA line is the serial data input/output line. Data to be read or written or commands to be written have to be passed through the DATA line. The RD line is the READ clock input. Data in the RAM are clocked out on the falling edge of the RD signal, and the clocked out data will then appear on the

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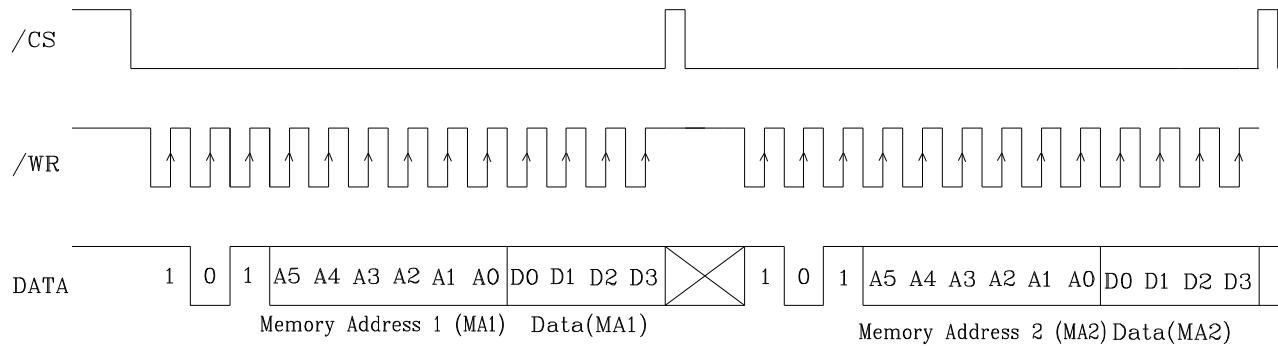
DATA line. It is recommended that the host controller read in correct data during the interval between the rising edge and the next falling edge of the RD signal. The WR line is the WRITE clock input. The data, address, and command on the DATA line are all clock-ed into the HT1621 on the rising edge of the WR signal. There is an optional IRQ line to be used as an interface between the host controller and the HT1621. The IRQ pin can be selected as a timer output or a WDT overflow flag output by the S/W setting. The host controller can perform the time base or the WDT function by being connected with the IRQ pin of the HT1621.

9. Timing Diagrams

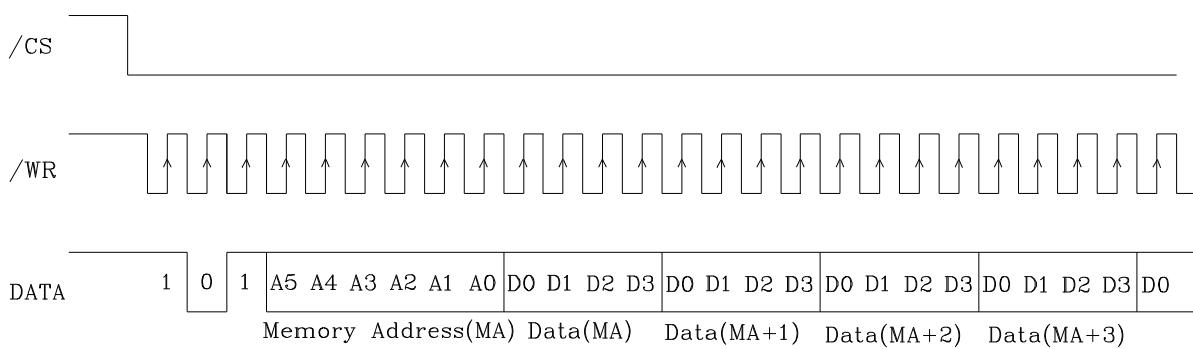


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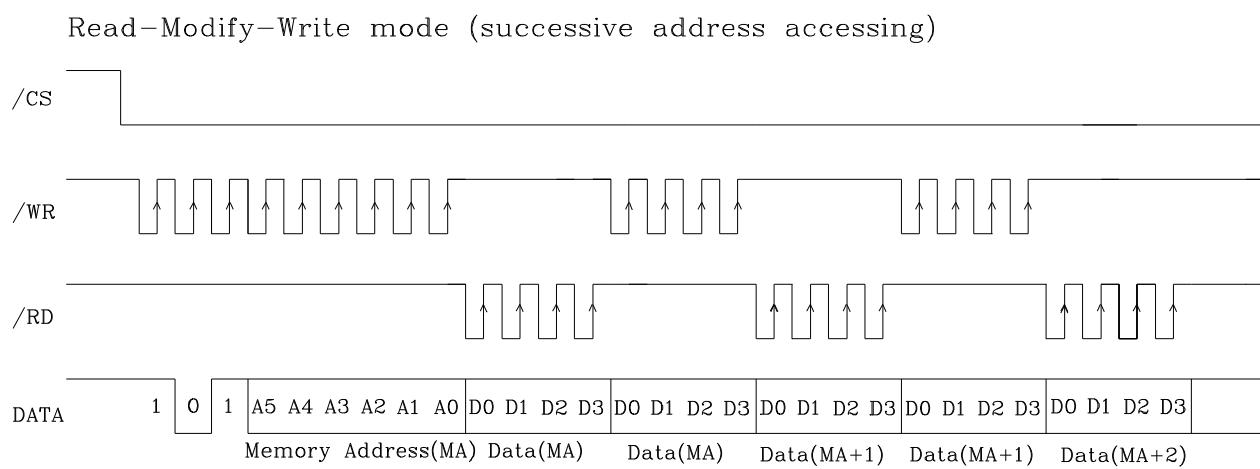
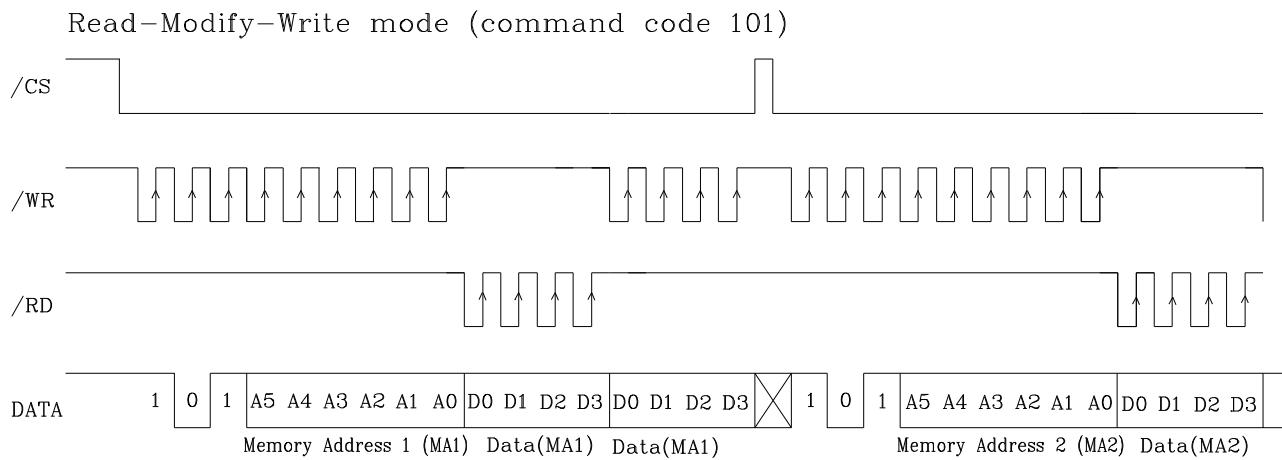
Write mode (command code 101)



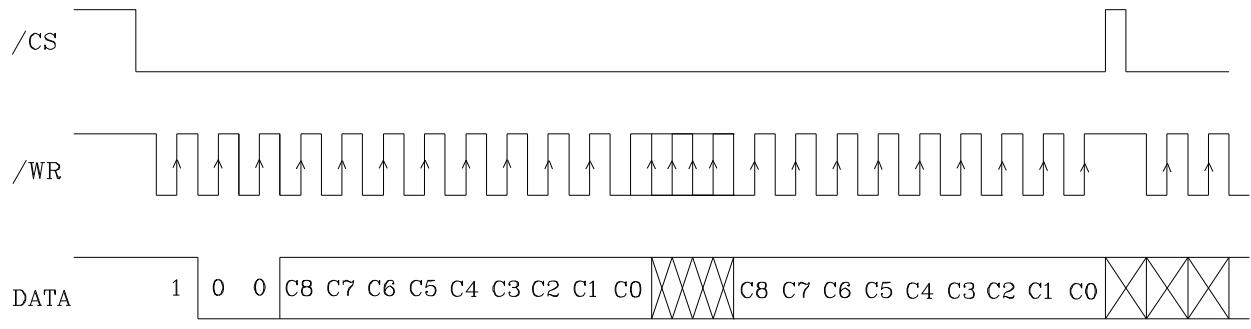
Write mode (successive address writing)



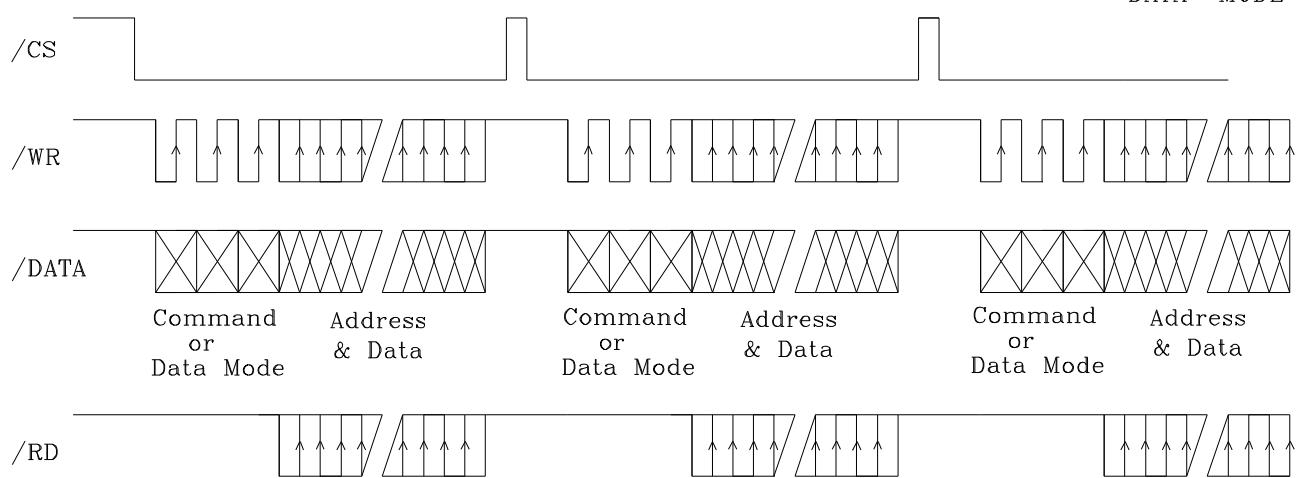
GDM060-FS(YG)-TBW/3.3V



Command mode (command code 100)



Mode (data and command mode)



Note:

It is recommended that the host controller should read in the data from the DATA line between the rising edge of the RD line and the falling edge of the next RD line.

10. Command Summary

Name	ID	Command Code	D/C	Function	Def.
READ	1 1 0	A5A4A3A2A1A0 D0D1D2D3	D	Read data from the RAM	
WRITE	1 0 1	A5A4A3A2A1A0 D0D1D2D3	D	Write data to the RAM	
READ-MODIFY-WRITE	1 0 1	A5A4A3A2A1A0 D0D1D2D3	D	READ and WRITE to the RAM	
SYS DIS	1 0 0	0000-0000-X	C	Turn off both system oscillator and LCD bias generator	Yes
SYS EN	1 0 0	0000-0001-X	C	Turn on system oscillator	
LCD OFF	1 0 0	0000-0010-X	C	Turn off LCD bias generator	Yes
LCD ON	1 0 0	0000-0011-X	C	Turn on LCD bias generator	
TIMER DIS	1 0 0	0000-0100-X	C	Disable time base output	
WDT DIS	1 0 0	0000-0101-X	C	Disable WDT time-out flag output	
TIMER EN	1 0 0	0000-0110-X	C	Enable time base output	
WDT EN	1 0 0	0000-0111-X	C	Enable WDT time-out flag output	
TONE OFF	1 0 0	0000-1000-X	C	Turn off tone outputs	Yes
TONE ON	1 0 0	0000-1001-X	C	Turn on tone outputs	
CLR TIMER	1 0 0	0000-11XX-X	C	Clear the contents of time base generator	
CLR WDT	1 0 0	0000-111X-X	C	Clear the contents of WDT stage	
XTAL 32K	1 0 0	0001-01XX-X	C	System clock source, crystal oscillator	
RC 256K	1 0 0	0001-10XX-X	C	System clock source, on-chip RC oscillator	Yes
EXT 256K	1 0 0	0001-11XX-X	C	System clock source, external clock source	
BIAS 1/2	1 0 0	0010-abX0-X	C	LCD 1/2 bias option ab=00: 2 commons option ab=01: 3 commons option ab=10: 4 commons option	
BIAS 1/3	1 0 0	0010-abX1-X	C	LCD 1/3 bias option ab=00: 2 commons option ab=01: 3 commons option ab=10: 4 commons option	
TONE 4K	1 0 0	010X-XXXX-X	C	Tone frequency, 4kHz	
TONE 2K	1 0 0	011X-XXXX-X	C	Tone frequency, 2kHz	
IRQ DIS	1 0 0	100X-0XXX-X	C	Disable IRQ output	Yes

Notes:

X : Don't care

A5~A0 : RAM addresses

D3~D0 : RAM data

D/C : Data/command mode

Def. : Power on reset default

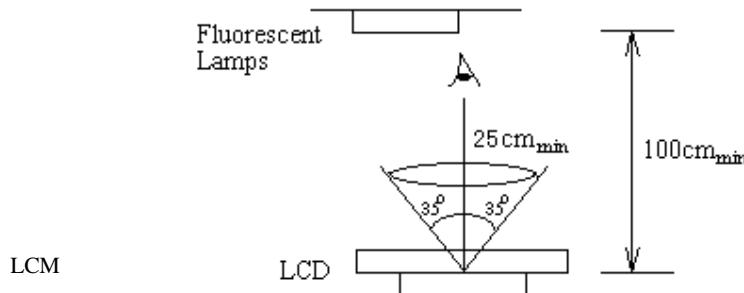
All the bold forms, namely **110**, **101**, and **100**, are mode commands. Of these, **100** indicates the command mode ID. If successive commands have been issued, the command mode ID except for the first command will be omitted. The source of the tone frequency and of the time base/WDT clock frequency can be derived from an on-chip 256kHz RC oscillator, a 32.768kHz crystal oscillator, or an external 256kHz clock. Calculation of the frequency is based on the system frequency sources as stated above. It is recommended that the host controller should initialize the HT1621 after power on reset, for power on reset may fail, which in turn leads to the malfunctioning of the HT1621.

11.Quality Specifications

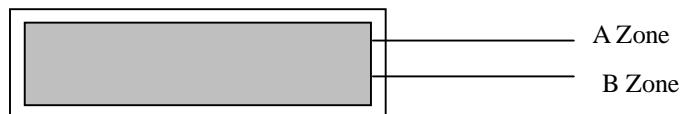
11.1 Standard of the product appearance test

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 25 cm or more.

Viewing direction for inspection is 35° from vertical against LCM.



Definition of zone:



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

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

11.2 Specification of quality assurance

AQL inspection standard

Sampling method: GB2828-87, Level II, single sampling

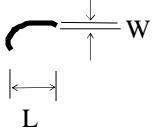
Defect classification (Note: * is not including)

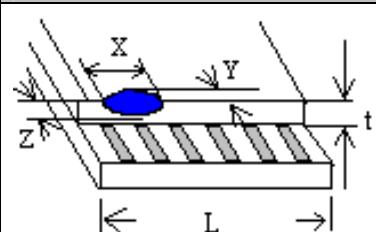
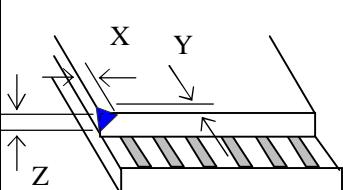
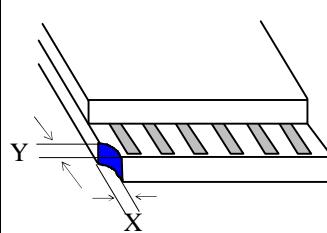
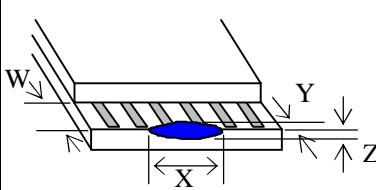
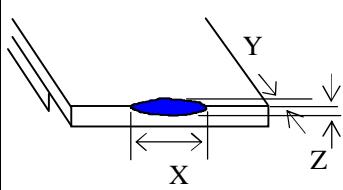
Classify		Item	Note	AQL
Major	Display state	Short or open circuit	1	0.65
		LC leakage		
		Flickering		
		No display		
		Wrong viewing direction		
		Contrast defect (dim, ghost)	2	
		Backlight		
	Non-display	Flat cable or pin reverse	10	

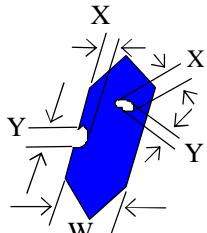
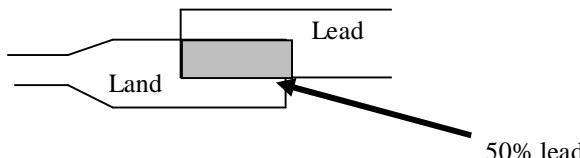
GDM060-FS(YG)-TBW/3.3V

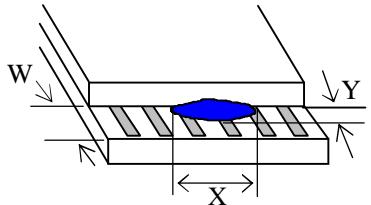
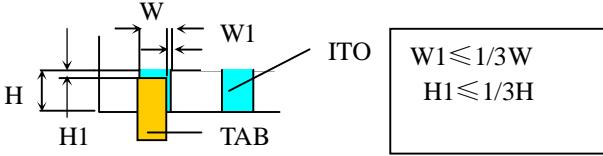
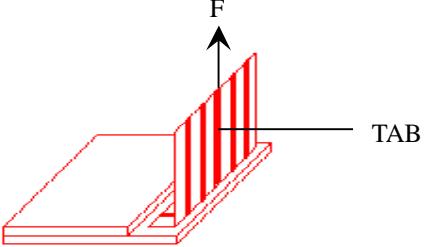
Minor	Display state	Wrong or missing component	11	1.0
		Background color deviation	2	
		Black spot and dust	3	
		Line defect, Scratch	4	
		Rainbow	5	
		Chip	6	
		Pin hole	7	
	Polarizer	Protruded	12	
		Bubble and foreign material	3	
	Soldering	Poor connection	9	
	Wire	Poor connection	10	
	TAB	Position, Bonding strength	13	

Note on defect classification

No.	Item	Criterion													
1	Short or open circuit	Not allow													
	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) $\phi = (X+Y)/2$	 <table border="1"> <thead> <tr> <th>Point Size</th> <th>Acceptable Qty.</th> </tr> </thead> <tbody> <tr> <td>$\phi \leq 0.10$</td> <td>Disregard</td> </tr> <tr> <td>$0.10 < \phi \leq 0.15$</td> <td>2</td> </tr> <tr> <td>$0.15 < \phi \leq 0.25$</td> <td>1</td> </tr> <tr> <td>$\phi > 0.25$</td> <td>0</td> </tr> </tbody> </table> <p>Unit: Inch²</p>	Point Size	Acceptable Qty.	$\phi \leq 0.10$	Disregard	$0.10 < \phi \leq 0.15$	2	$0.15 < \phi \leq 0.25$	1	$\phi > 0.25$	0			
Point Size	Acceptable Qty.														
$\phi \leq 0.10$	Disregard														
$0.10 < \phi \leq 0.15$	2														
$0.15 < \phi \leq 0.25$	1														
$\phi > 0.25$	0														
4	Line defect, Scratch	 <table border="1"> <thead> <tr> <th colspan="2">Line</th> <th>Acceptable Qty.</th> </tr> <tr> <th>L</th> <th>W</th> <td></td> </tr> </thead> <tbody> <tr> <td>---</td> <td>$0.05 > W$</td> <td rowspan="3">Disregard</td> </tr> <tr> <td>$3.0 > L$</td> <td>$0.1 > W > 0.05$</td> </tr> <tr> <td>$2.0 > L$</td> <td>$0.15 \geq W > 0.1$</td> </tr> </tbody> </table> <p>Unit: mm</p>	Line		Acceptable Qty.	L	W		---	$0.05 > W$	Disregard	$3.0 > L$	$0.1 > W > 0.05$	$2.0 > L$	$0.15 \geq W > 0.1$
Line		Acceptable Qty.													
L	W														
---	$0.05 > W$	Disregard													
$3.0 > L$	$0.1 > W > 0.05$														
$2.0 > L$	$0.15 \geq W > 0.1$														
5	Rainbow	Not more than two color changes across the viewing area.													

No	Item	Criterion																														
6	Chip	<p>Remark: X: Length direction Y: Short direction Z: Thickness direction t: Glass thickness W: Terminal width L: Glass length</p>  <p>Acceptable criterion</p> <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>$< L/8$</td> <td>0.5mm</td> <td>$\leq t/2$</td> </tr> </table>  <p>Acceptable criterion</p> <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤ 2</td> <td>0.5mm</td> <td>$\leq t$</td> </tr> </table>  <p>Acceptable criterion</p> <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤ 3</td> <td>≤ 2</td> <td>$\leq t$</td> </tr> </table> <p>shall not reach to ITO</p>  <p>Acceptable criterion</p> <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>Disregard</td> <td>≤ 0.2</td> <td>$\leq t$</td> </tr> </table>  <p>Acceptable criterion</p> <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤ 5</td> <td>≤ 2</td> <td>$\leq t/3$</td> </tr> </table>	X	Y	Z	$< L/8$	0.5mm	$\leq t/2$	X	Y	Z	≤ 2	0.5mm	$\leq t$	X	Y	Z	≤ 3	≤ 2	$\leq t$	X	Y	Z	Disregard	≤ 0.2	$\leq t$	X	Y	Z	≤ 5	≤ 2	$\leq t/3$
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No.	Item	Criterion								
7	Segment pattern W = Segment width $\phi = (X+Y)/2$	<p>(1) Pin hole $\phi < 0.10\text{mm}$ is acceptable.</p>  <table border="1" data-bbox="873 475 1297 623"> <thead> <tr> <th>Point Size</th><th>Acceptable Qty</th></tr> </thead> <tbody> <tr> <td>$\phi \leq 1/4W$</td><td>Disregard</td></tr> <tr> <td>$1/4W < \phi \leq 1/2W$</td><td>1</td></tr> <tr> <td>$\phi > 1/2W$</td><td>0</td></tr> </tbody> </table> <p>Unit: mm</p>	Point Size	Acceptable Qty	$\phi \leq 1/4W$	Disregard	$1/4W < \phi \leq 1/2W$	1	$\phi > 1/2W$	0
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8	Back-light	<p>(1) The color of backlight should be in match with the specification.</p> <p>(2) Not allow flickering</p>								
9	Soldering	<p>(1) Not allow heavy dirty and solder ball on PCB. (The size of dirty refer to point and dust defect)</p> <p>(2) Over 50% of lead should be soldered on Land.</p> 								
10	Wire	<p>(1) Copper wire should not be rusted</p> <p>(2) Not allow crack on copper wire connection.</p> <p>(3) Not allow reversing the position of the flat cable.</p> <p>(4) Not allow exposed copper wire inside the flat cable.</p>								
11*	PCB	<p>(1) Not allow screw rust or damage.</p> <p>(2) Not allow missing or wrong putting of component.</p>								

No	Item	Criterion
12	Protruded W: Terminal Width	 <p>Acceptable criteria: $Y \leq 0.4$</p>
13	TAB	<p>1. Position</p>  <p>$W_1 \leq 1/3W$ $H_1 \leq 1/3H$</p> <p>2 TAB bonding strength test</p>  <p>$P (=F/TAB \text{ bonding width}) \geq 650 \text{ gf/cm}$, (speed rate: 1mm/min) 5pcs per SOA (shipment)</p>
14	Total no. of acceptable Defect	<p>A. Zone</p> <p>Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm</p> <p>B. Zone</p> <p>It is acceptable when it is no trouble for quality and assembly in customer's end product.</p>

11.3 Reliability of LCM

Reliability test condition:

Item	Condition	Time (hrs)	Assessment
High temp. Storage	80°C	48	No abnormalities in functions and appearance
High temp. Operating	70°C	48	
Low temp. Storage	-30°C	48	
Low temp. Operating	-20°C	48	
Humidity	40°C/ 90%RH	48	
Temp. Cycle	0°C ← 25°C → 50°C (30 min ← 5 min → 30min)	10cycles	

Recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature ($20\pm8^\circ\text{C}$), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

11.4 Precaution for using LCD/LCM

LCD/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 trichlorotrifluoroethane, do not use water, ketone or aromatics and never scrub hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not make any modification on the PCB without consulting XIAMEM OCULAR
5. 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.
6. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
7. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal spreads 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 50-60% is recommended.

Soldering Precautions:

1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature: $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

Operation Precautions:

1. The viewing angle can be adjusted by varying the LCD driving voltage V_o .
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. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over 40°C is required, the relative humidity should be kept below 60%, and avoid direct sunlight.