US Micro Products

Electronic Products for the OEM

LCD PRODUCT SPECIFICATION

PART NUMBER:	**USMPG-TQ12864C-TZWFH-P1**
DESCRIPTION:	128x64 Graphic LCD; FSTN Display Mode; Transflective, Positive with White LED Sidelight and 6 O'Clock Viewing Direction.

ISSUE DATE	APPROVED BY (Customer Use Only)	CHECKED BY	PREPARED BY
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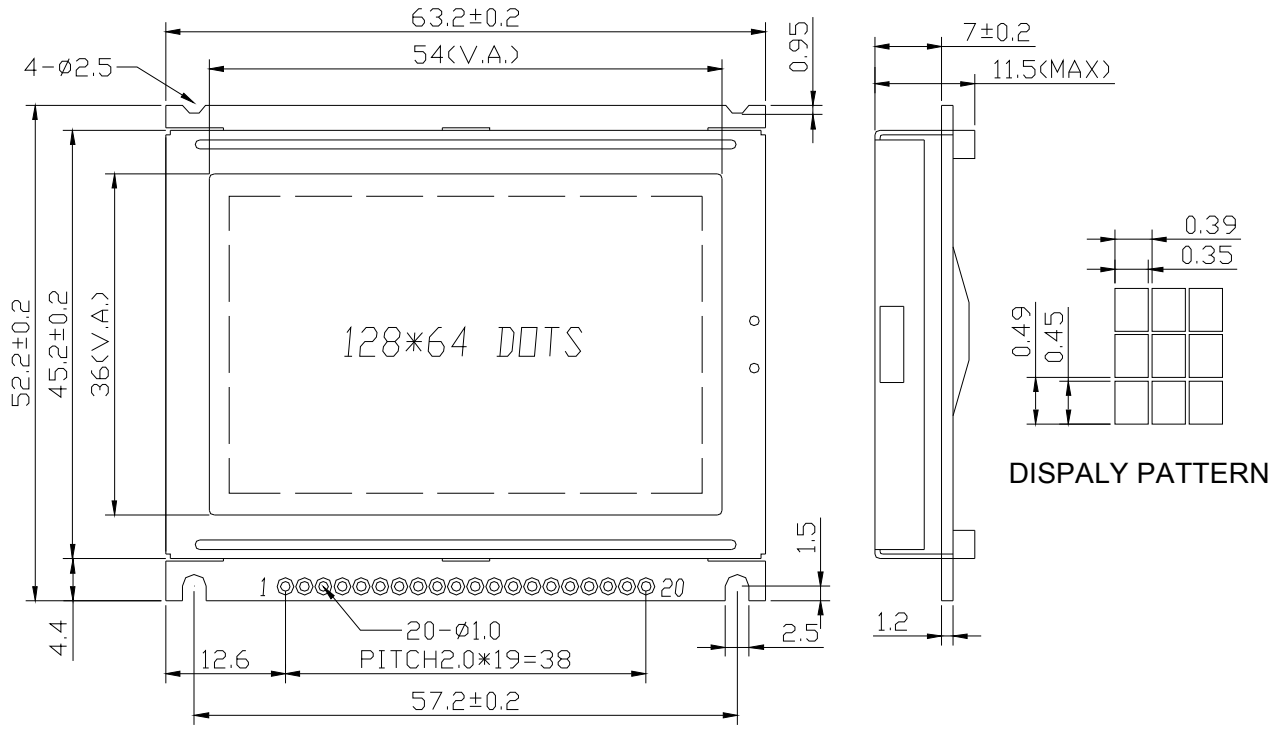
Features

- Display format: 128*64 dots matrix graphic
- STN (Yellow-Green) mode, transflective
- Easy interface with 8-bit MPU
- Low power consumption
- LED back-light (yellow-green)
- Viewing angle: 6 O'clock
- Driving method: 1/64 duty, 1/9 bias
- LCD driver IC:NT7108C、NT7107C
- Connector: zebra

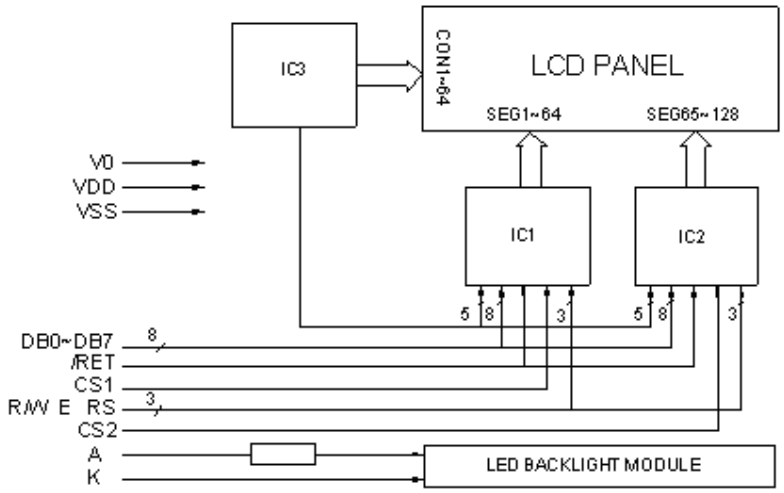
Outline dimension



Absolute maximum ratings

Item	Symbol	Standard			Unit
Power voltage	V_{DD}-V_{SS}	0	-	7.0	V
Input voltage	VIN	VSS	-	VDD	
Operating temperature range	VOP	0	-	+50	℃
Storage temperature range	VST	-20	-	+60	

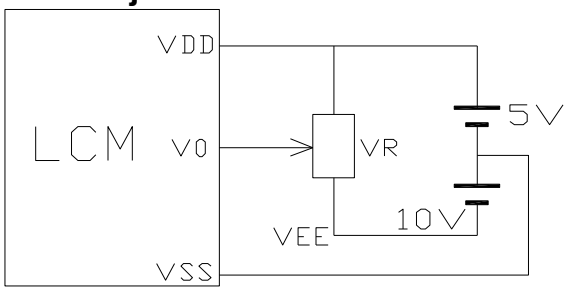
Block diagram



Interface pin description

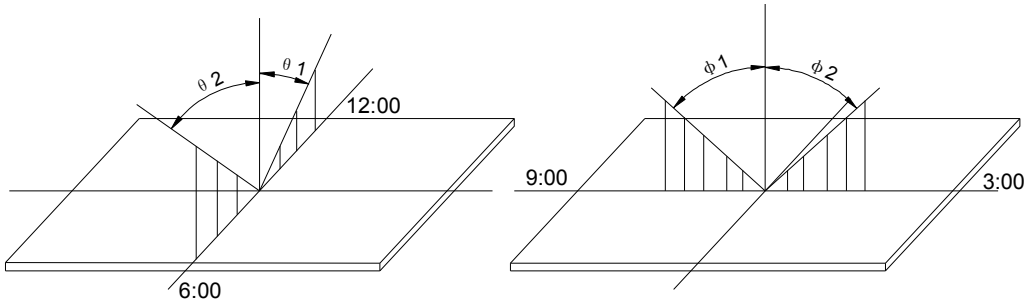
Pin no.	Symbol	External connection	Function
1	V_{DD}	Power supply	Power supply for logic (+5V) for LCM
2	V_{SS}		Signal ground for LCM (GND)
3	V_0		Contrast adjust
4~11	DB0~DB7	MPU	Data bus [0~7] Bi-directional data bus
12	CS2	MPU	Chip selection: When CS1=H,CS2=L, select IC1 When CS1=L,CS2=H, select IC2
13	CS1	MPU	
14	RST	MPU	Reset signal. When RSTB=L
15	R/W	MPU	Read/write select signal
16	D/I		Register select signal
17	E		Operation (data read/write) enable signal
18	VSS		Signal ground for LCM (GND)
19	A	LED BKL Power supply	Power supply for BKL (+5.0V)
20	K		Power supply for BKL (GND)

Contrast adjust



V_{DD}~V_0: LCD Driving voltage
VR: 10k~20k

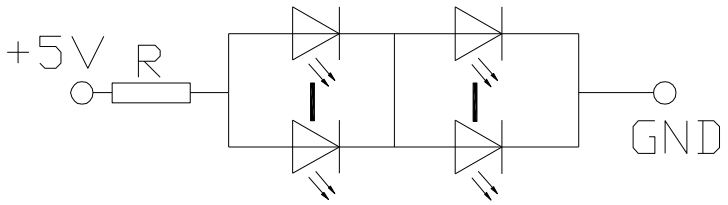
Optical characteristics



STN type display module (Ta=25℃, VDD=5.0V)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	θ 1	$C_r \geqslant 3$		20		deg
	θ 2			40		
	Φ 1			35		
	Φ 2			35		
Contrast ratio	C_r		-	6	-	-
Response time (rise)	T_r	-	-	200	250	ms
Response time (fall)	T_r	-	-	300	350	

Backlight circuit diagram(light 2X30)



LED ratings

(voltage= 5V,R=6.8Ω)

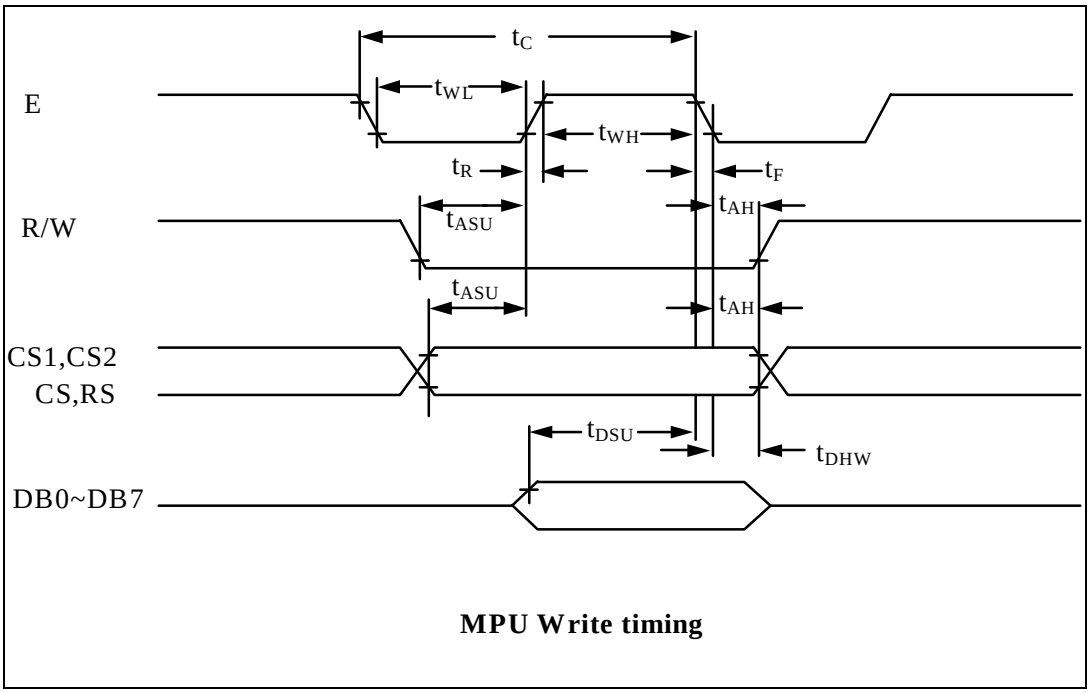
Item	Symbol	Min	Typ.	Max	Unit
Forward Voltage	V_F	3.8	4.2	4.4	V
Forward current	IF	-	120		mA
Power	P		504		mW
Peak wave length	λp		570		nm
Luminance	Lv		200		Cd/m^2

DC Electrical Characteristics

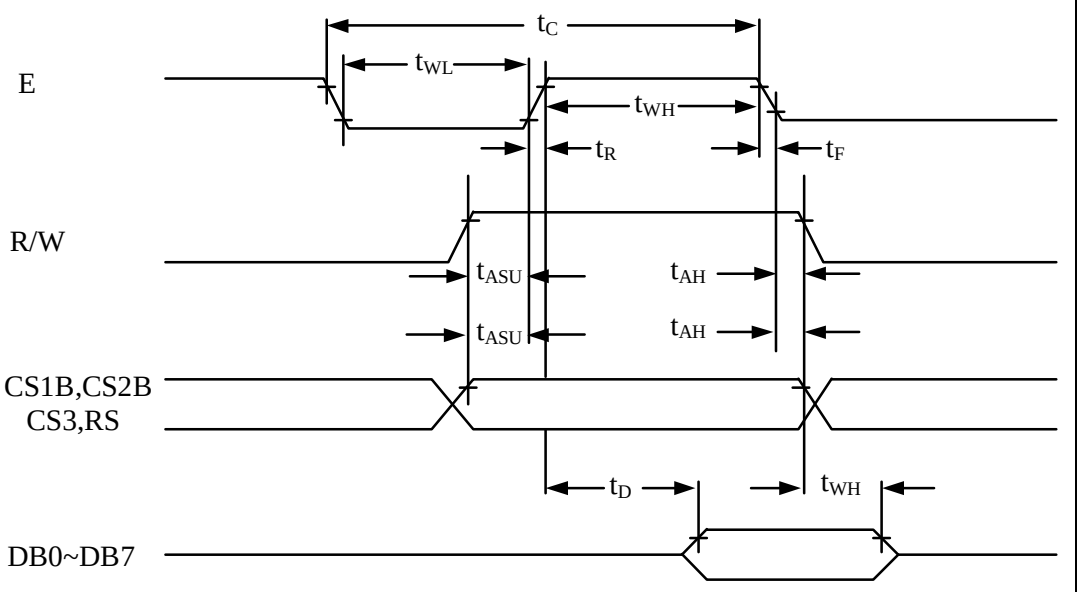
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	V_{DD}-V_0	Ta =25℃	8.0	8.3	8.6	V
Input voltage	V_{DD}		4.7	5.0	5.5	
Supply current	I_{DD}	Ta=25℃, V_{DD}=5.0V	-	2.0	3.5	mA
Input leakage current	I_{LKG}		-	-	5.0	uA
“H” level input voltage	V_H		2.2	-	V_{DD}	V
“L” level input voltage	V_L	Twice initial value or less	0	-	0.6	
“H” level output voltage	V_{OH}	LOH=-0.25mA	2.4	-	-	
“L” level output voltage	V_{OL}	LOH=1.6mA	-	-	0.4	

MPU Interface

Characteristic	Symbol	Min	Typ	Max	Unit
E Cycle	t_C	1000	-	-	ns
E High Level Width	t_{WH}	450	-	-	
E Low Level Width	t_{WL}	450	-	-	
E Rise Time	t_R	-	-	25	
E Fall Time	t_F	-	-	25	
Address Set-Up Time	t_{ASU}	140	-	-	
Address Hold Time	t_{AH}	10	-	-	
Data Set-Up Time	t_{SU}	200	-	-	
Data Delay Time	t_D	-	-	320	
Data Hold Time (Write)	t_{DHW}	10	-	-	
Data Hold Time (Read)	t_{DHR}	20	-	-	



MPU Write timing



MPU Read timing

OPERATING PRINCIPLES & METHODS

1. **I/O Buffer**
   Input buffer controls the status between the enable and disable of chip. Unless the CS1B to CS3 is in active mode, Input or output of data and instruction does not execute. Therefore internal state is not change. But RSTB and ADC can operate regardless CS!B-CS3.

2. **Input register**
   Input register is provided to interface with MPU which is different operating frequency. Input register stores the data temporarily before writing it into display RAM.
   When CS1B to CS3 are in the active mode, R/W and RS select the input register. The data from MPU is written into input register. Then writing it into display RAM. Data latched for falling of the E signal and write automatically into the display data RAM by internal operation.

3. **Output register**
   Output register stores the data temporarily from display data RAM when CS1B, CS2B and CS3 are in active mode and R/W and RS=H, stored data in display data RAM is latched in output register. When CS1B to CS3 is in active mode and R/W=H , RS=L, status data (busy check) can read out.
   To read the contents of display data RAM, twice access of read instruction is needed. In first access, data in display data RAM is latched into output register. In second access, MPU can read data which is latched. That is to read the data in display data RAM, it needs dummy read. But status read is not needed dummy read.

4.

RS	R/W	Function
L	L	Instruction
	H	Status read (busy check)
H	L	Data write (from input register to display data RAM)

	H	Data read (from display data RAM to output register)

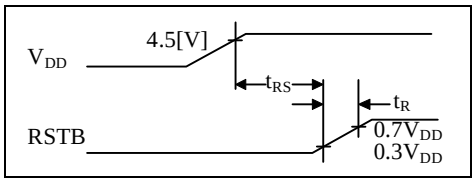
4. Reset

The system can be initialized by setting RSTB terminal at low level when turning power on, receiving instruction from MPU. When RSTB becomes low, following procedure is occurred.
1. Display off
2. Display start line register become set by 0.(Z-address 0)

While RSTB is low, No instruction except status read can by accepted. Therefore, execute other instructions after making sure that DB4= (clear RSTB) and DB7=0 (ready) by status read instruction.
The conditions of power supply at initial power up are shown in table 1.

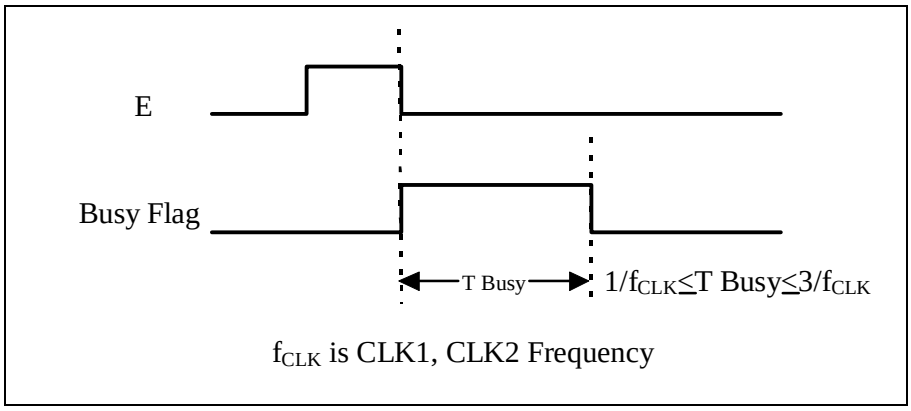
Table 1. Power Supply Initial Conditions

Item	Symbol	Min	Typ	Max	Unit
Reset Time	t_{RS}	1.0	-	-	us
Rise Time	t_R	-	-	200	ns



5. Busy flag

Busy flag indicates that NT7108CB is operating or no operating. When busy flag is high, NT7108CB is in internal operating .
When busy flag is low, NT7108CB can accept the data or instruction.
DB7indicates busy flag of the NT7108CB.



6. Display On/Off Flip-Flop

The display on/off flip-flop makes on/off the liquid crystal display. When flip-flop is reset (logical low), selective voltage or non selective voltage appears on segment output terminals. When flip-flop is set (logic high), non selective voltage appears on segment output terminals regardless of display RAM data. The display on/off flip-flop can changes status by instruction. The display data at all segment disappear while RSTB is low.
The status of the flip-flop is output to DB5 by status read instruction.
The display on/off flip-flop synchronized by CL signal.

7. X Page Register

X page register designates pages of the internal display data RAM.
Count function is not available. An address is set by instruction.

8. Y address counter

Y address counter designates address of the internal display data RAM. An address is set by instruction and is increased by 1 automatically by read or write operations of display data.

9. Display Data RAM

Display data RAM stores a display data for liquid crystal display. To indicate on state dot matrix of liquid crystal display , write datra1. The other way , off state, writes 0.
Display data RAM address and segment output can be controlled by ADC signal.
ADC=H => Y-address 0: S1~Y address 63: S64
ADC=L => Y-address 0: S64~Yaddress 63: S1
ADC terminal connect the V_{DD} or V_{SS}.

10. Display Start Line Register

The display start line register indicates of display data RAM to display top line of liquid crystal display. Bit data (DB<0.5>) of the display start line set instruction is latched in display start line register. Latched data is transferred to the Z address counter while FRM is high, presetting the Z address counter.
It is used for scrolling of the liquid crystal display screen.

Display Control Instruction

The display control instructions control the internal state of the NT7108CB. Instruction is received from MPU to NT7108CB for the display control. The following table shows various instructions.

Instruction	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Function
Read Display Date	1	1	Read data								Reads data (DB[7:0]) from display data RAM to the data bus.
Write Display Date	1	0	Write data								Writes data (DB[7:0]) into the DDRAM. After writing instruction, Y address is incriminated by 1 automatically
Status Read	0	1	Busy	0	ON/OFF	Re-set	0	0	0	0	Reads the internal status BUSY 0: Ready 1: In operation ON/OFF 0: Display ON 1: Display OFF RESET 0: Normal 1: Reset
Set Address (Y address)	0	0	0	1	Y address (0~63)						Sets the Y address at the column address counter
Set Display Start Line	0	0	1	1	Display start line (0~63)						Indicates the Display Data RAM displayed at the top of the screen.
Set Address (X address)	0	0	1	0	1	1	1	Page (0~7)			Sets the X address at the X address register.
Display On/off	0	0	0	0	1	1	1	1	1	0/1	Controls the display ON or OFF. The internal status and the DDRAM data is not affected. 0: OFF, 1: ON

1. Display On/Off

The display data appears when D is 1 and disappears when D is 0.
Though the data is not on the screen with D=0, it remains in the display data RAM.
Therefore, you can make it appear by changing D=0 into D=1.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	1	1	1	D

2. Set Address (Y Address)

Y address (AC0~AC5) of the display data RAM is set in the Y address counter.
An address is set by instruction and increased by 1 automatically by read or write operations of display data.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

3. Set Page (X Address)

X address (AC0~AC2) of the display data RAM is set in the X address register.
Writing or reading to or from MPU is executed in this specified page until the next page is set.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	1	1	AC2	AC1	AC0

4. Display Start Line (Z Address)

Z address (AC0~AC5) of the display data RAM is set in the display start line register and displayed at the top of the screen.
When the display duty cycle is 1/64 or others (1/32~1/64), the data of total line number of LCD screen, from the line specified by display start line instruction, is displayed.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	AC5	AC4	AC3	AC2	AC1	AC0

5. Status Read

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	BUSY	0	ON/OFF	RESET	0	0	0	0

- BUSY
  When BUSY is 1, the Chip is executing internal operation and no instructions are accepted.
  When BUSY is 0, the Chip is ready to accept any instructions.
- ON/OFF
  When ON/OFF is 1, the display is on.
  When ON/OFF is 0, the display is off.
- RESET
  When RESET is 1, the system is being initialized.
  In this condition, no instructions except status read can be accepted.
  When RESET is 0, initializing has finished and the system is in the usual operation condition.

6. Write Display Data

Writes data (D0~D7) into the display data RAM.
After writing instruction, Y address is increased by 1 automatically.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

7. Read Display Data

Reads data (D0~D7) from the display data RAM.
After reading instruction, Y address is increased by 1 automatically.

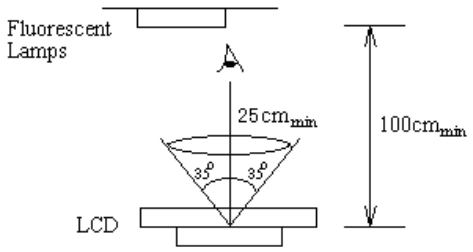
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

.Quality Specifications

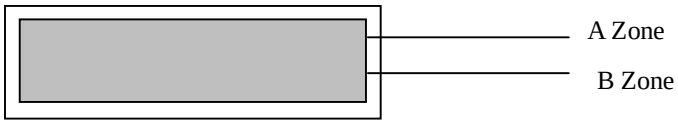
1 Standard of the product appearance test

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 : LCM



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

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

2 Specification of quality assurance

AQL inspection standard

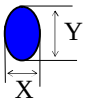
Sampling method: GB2828-87, Level II, single sampling

Defect classification **(Note: * is not including)**

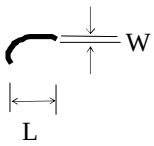
Classify		Item	Note	AQL
Major	Display state	Short or open circuit	1	0.65
		LC leakage		
		Flickering		
		No display		
		Wrong viewing direction		
		Contrast defect (dim, ghost)	2	
		Backlight	1,8	
	Non-display	Flat cable or pin reverse	10	
		Wrong or missing component	11	
Minor	Display state	Background color deviation	2	1.0
		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

<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td rowspan="6">1</td><td>Short or open circuit</td><td rowspan="6">Not allow</td></tr>
<tr><td>LC leakage</td></tr>
<tr><td>Flickering</td></tr>
<tr><td>No display</td></tr>
<tr><td>Wrong viewing direction</td></tr>
<tr><td>Wrong Back-light</td></tr>
<tr><td rowspan="2">2</td><td>Contrast defect</td><td rowspan="2">Refer to approval sample</td></tr>
<tr><td>Background color deviation</td></tr>
<tr><td>3</td><td>Point defect,
Black spot, dust
(including Polarizer)

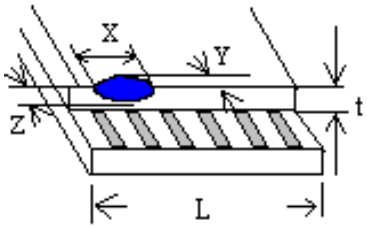
ϕ = (X+Y)/2</td><td> 

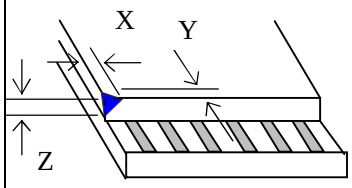
<table>
<tr><th>Point Size</th><th>Acceptable Qty.</th></tr>
<tr><td>ϕ≤0.10</td><td>Disregard</td></tr>
<tr><td>0.10<ϕ≤0.15</td><td>2</td></tr>
<tr><td>0.15<ϕ≤0.25</td><td>1</td></tr>
<tr><td>ϕ>0.25</td><td>0</td></tr>
</table>
Unit： Inch^2</td></tr>
<tr><td>4</td><td>Line defect,

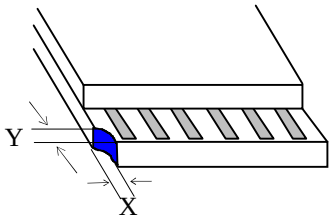
Scratch</td><td> 

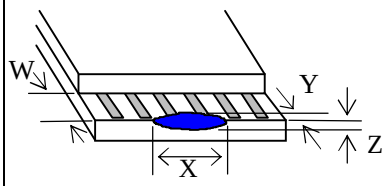
<table>
<tr><th colspan="2">Line</th><th>Acceptable Qty.</th></tr>
<tr><td>L</td><td>W</td><td></td></tr>
<tr><td>---</td><td>0.05>W</td><td rowspan="3">Disregard</td></tr>
<tr><td>3.0>L</td><td>0.1>W>0.05</td></tr>
<tr><td>2.0>L</td><td>0.15≥W>0.1</td></tr>
</table>
Unit: mm</td></tr>
<tr><td>5</td><td>Rainbow</td><td>Not more than two color changes across the viewing area.</td></tr>
</table>

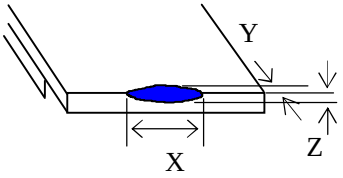
<table>
<tr><th>No</th><th>Item</th><th>Criterion</th></tr>
<tr><td>6</td><td>Chip

Remark:
X: Length direction
Y: Short direction
Z: Thickness direction
t: Glass thickness
W: Terminal width
L: Glass length</td><td>


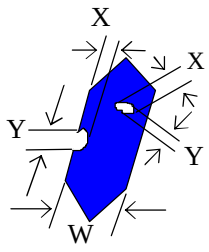
Acceptable criterion
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>< L /8</td><td>0.5mm</td><td>≤t/2</td></tr>
</table>


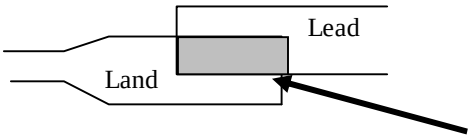
Acceptable criterion
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>≤2</td><td>0.5mm</td><td>≤t</td></tr>
</table>


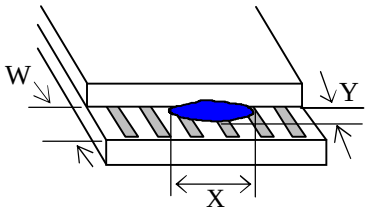
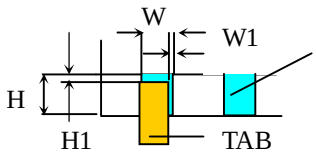
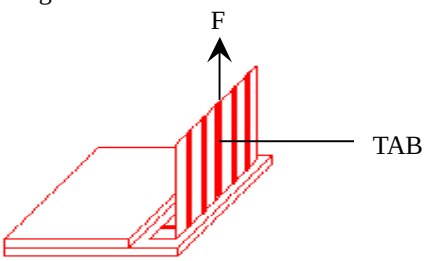
Acceptable criterion
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>≤3</td><td>≤2</td><td rowspan="2">≤t</td></tr>
<tr><td colspan="2">shall not reach to ITO</td></tr>
</table>


Acceptable criterion
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>Disregard</td><td>≤0.2</td><td>≤t</td></tr>
</table>


Acceptable criterion
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>≤5</td><td>≤2</td><td>≤t/3</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td>7</td><td>Segment
pattern
W = Segment width
ϕ = (X+Y)/2</td><td>(1) Pin hole
ϕ < 0.10mm is acceptable.
 

<table>
<tr><th>Point Size</th><th>Acceptable Qty</th></tr>
<tr><td>ϕ≤1/4W</td><td>Disregard</td></tr>
<tr><td>1/4W< ϕ≤1/2W</td><td>1</td></tr>
<tr><td>ϕ>1/2W</td><td>0</td></tr>
</table>
Unit: mm</td></tr>
<tr><td>8</td><td>Back-light</td><td>(1) The color of backlight should be in match with the specification.
(2) Not allow flickering</td></tr>
<tr><td>9</td><td>Soldering</td><td>(1) Not allow heavy dirty and solder ball on PCB.
(The size of dirty refer to point and dust defect)
(2) Over 50% of lead should be soldered on Land.
 
</td></tr>
<tr><td>10</td><td>Wire</td><td>(1) Copper wire should not be rusted
(2) Not allow crack on copper wire connection.
(3) Not allow reversing the position of the flat cable.
(4) Not allow exposed copper wire inside the flat cable.</td></tr>
<tr><td>11*</td><td>PCB</td><td>(1) Not allow screw rust or damage.
(2) Not allow missing or wrong putting of component.</td></tr>
</table>

No	Item	Criterion
12	Protruded W: Terminal Width	 Acceptable criteria: Y ≤ 0.4
13	TAB	1. Position  W1≤1/3W H1≤1/3H 2 TAB bonding strength test  P (=F/TAB bonding width) ≥650gf/cm ,(speed rate: 1mm/min) 5pcs per SOA (shipment)
14	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.

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±8°C), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

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 isoproply alcohol, ethyl alcohol or trichlorotriflorothane, 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 USMP
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°C±10°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 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. 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.

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