DENSITRON DISPLAYS

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

PRODUCT NUMBER	LR4301

INTERNAL APPROVALS		
Product Manager	Engineering	Document Control
	Vivek Premkumar Digitally signed by Vivek Premkumar DN: cn=Vivek Premkumar, o=Densitron Corporation, ou=Densitron Displays, email=vivek.premkumar@densitron.com, c=US Date: 2009.06.02 10:23:19 -07'00'	Vivek Premkumar Digitally signed by Vivek Premkumar DN: cn=Vivek Premkumar, o=Densitron Corporation, ou=Densitron Displays, email=vivek.premkumar@densitron.com, c=US Date: 2009.06.02 10:23:07 -07'00'
Date:	Date:	Date:

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REVISION RECORD

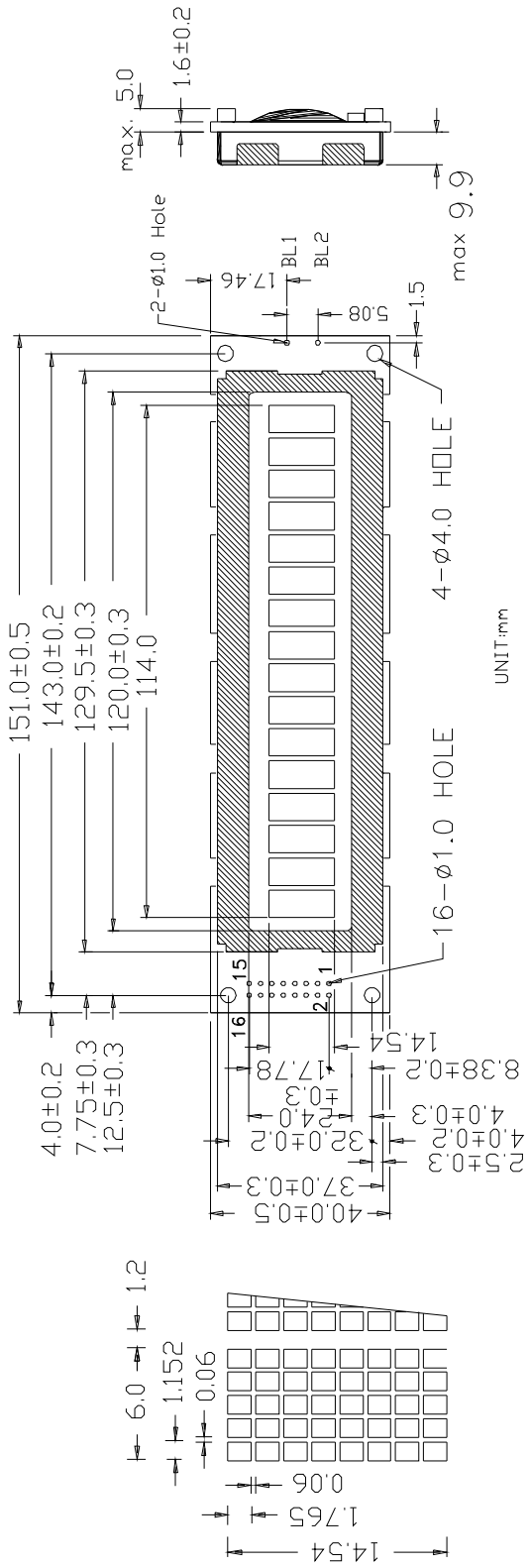
Rev.	Date	Page	Par.	Comment	ECN no.
A	06/02/09	--	--	Initial DCA Release	E4094

1 GENERAL SPECIFICATIONS

ITEM	DESCRIPTION	UNIT
Module Outline Dimensions	151.0 (W) x 40.0 (H) x 14.9 Max (D) (Without NVTC)	mm
Viewing Area	120.0 (W) x 24.0 (H)	mm
Active Display Area	114.0 (W) x 14.54 (H)	mm
Configuration Format	16 Characters (W) x 1 Line (H)	--
Character Dimensions	6.0 (W) x 14.54 (H)	mm
Character Pitch	7.2	mm
LCD Type	STN / Transflective / Positive	--
Backlight Type	Array LED / Yellow-Green	--
Duty Ratio	1/8	--
Bias Drive	1/4	--
Controller / Interface	Sitronix ST7066 / 8-bit Parallel interface	--
Power Supply	Vdd (+5)	V
RoHS Complaint	Yes	--

- Without Negative voltage (NV) and Temperature compensation (TC)

2 MECHANICAL DRAWING



3 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Conditions	Min.	Max.	Unit
Power Supply Voltage	Vdd	Ta = 25°C, 50 ± 10% RH	0	7.0	V
Operating Temperature	Topr	< 65% RH (Normal Temp.)	0	50	°C
		< 65% RH (Wide Temp.)	-20	70	
Storage Temperature	Tstg	< 65% RH (Normal Temp.)	-20	70	°C
		< 65% RH (Wide Temp.)	-30	80	
		< 48 hrs	20	90	% RH
		< 1000 hrs	20	65	% RH

4 ELECTRONIC CHARACTERISTICS

4.1 DC CHARACTERISTICS

(Vss = 0 V, Ta = 25°C)

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Voltage		Vdd	--	4.75	--	5.25	V
Input Voltage	High	Vihc		0.7Vdd	--	Vdd	V
	Low	Vilc		0	--	0.55	
LCD Driving Voltage		Vdd - Vo		3.0	--	10.0	V

4.2 LCD CURRENT CONSUMPTION & DRIVING VOLTAGE

(Vdd – Vss = 5.0 V)

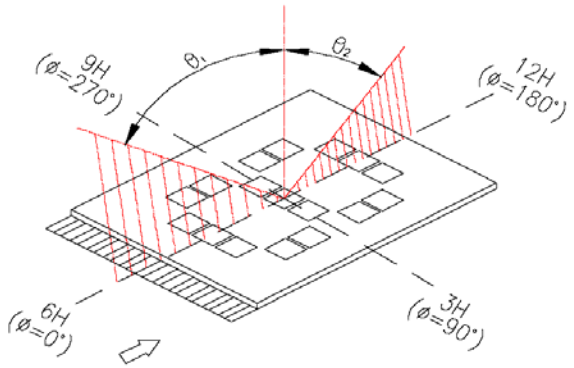
			STN TEMPERATURE	
			Normal Temp.	Wide Temp.
Supply Current, (Idd) Typ., mA			2.3	2.3
Supply Current, (Iee) Typ., mA			N/A	N/A
Recommended LCD Driving voltage				
LCD Driving Voltage (Vdd – Vo)	Ta = -20 °C		N/A	7.7
	Ta = 0 °C		4.9	7.4
	Ta = 25 °C		4.7	7.1
	Ta = 50 °C		4.5	6.9
	Ta = 70 °C		N/A	6.7

5 OPTOELECTRONIC CHARACTERISTICS

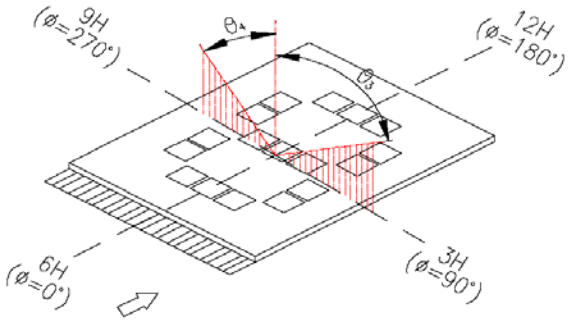
(Ta = 25°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note
Viewing Angle	θ1 (down)	CR ≥ 1.4	--	40	--	deg.	6.1
	θ2 (up)	CR ≥ 1.4	--	40	--	deg.	6.1
	θ3 (right)	CR ≥ 1.4	--	30	--	deg.	6.2
	θ4 (left)	CR ≥ 1.4	--	30	--	deg.	6.2
Contrast Ratio	CR	Ta = 25°C	4.0	7.0	--	--	6.3
Response Time	Tr	Ta = 25°C	--	140	220	ms	6.4
	Tf	Ta = 25°C	--	210	340		

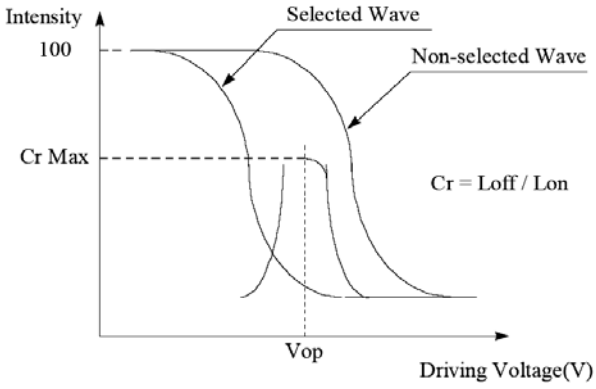
Note 6.1: Definition of Viewing angle, θ1 & θ2



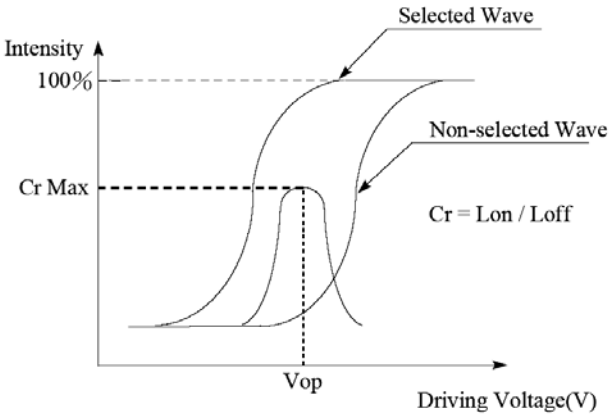
Note 6.2: Definition of Viewing angle, θ3 & θ4



Note 6.3: Definition of Contrast Ratio (CR)

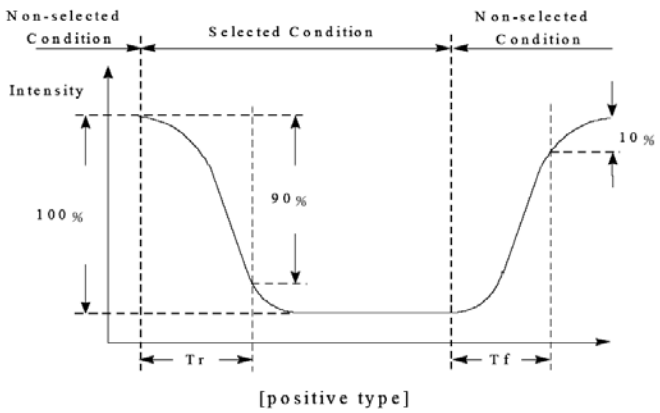


[positive type]

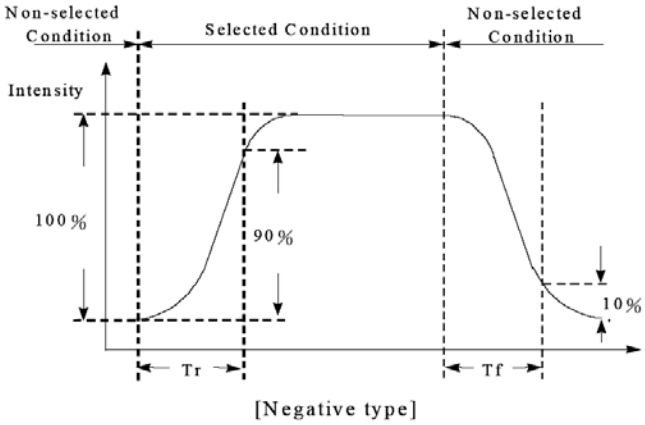


[Negative type]

Note 6.4: Definition of Response Time



[positive type]



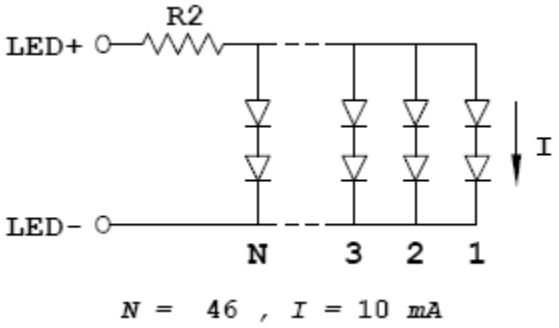
[Negative type]

6 ARRAY LED BACKLIGHT ELECTRICAL CHARACTERISTICS

Item	Conditions	Min.	Typ.	Max.	Unit
Input voltage	Ta = 25°C	--	5.0	--	V(DC)
Current consumption	Ta = 25°C	--	460	--	mA
Average brightness (B/L only)(Ta = 25°C, IL = 460 mA)	Test when connected for 3 min., Ta = 25 °C				cd/m² (Note 7.1)
	Yellow-Green Array LED B/L	--	285	--	
Brightness uniformity	Ta = 25°C , IL = 460 mA	80	--	--	% (Note 7.2)
Lamp life	Ta = 25°C , IL = 460 mA Humidity: 30% RH ~ 85% RH	--	50,000	--	Hrs (Note 7.3)
Operating Temp.	Humidity: 30% RH ~ 85% RH	-20	--	70	°C
Storage Temp.	Humidity: 30% RH ~ 85% RH	-30	--	80	°C
Limit Resistor (R2)	Ta = 25°C	--	1.8	--	Ohm (Note 7.4)

Note 7.1: Average brightness of 3 points when B/L is used at the beginning.
Note 7.2: Brightness uniformity = (MIN / MAX) x 100 %.
Note 7.3: Half of the original average brightness.

Note 7.4: The limit resistor R2 of LED Backlight is built-in to the LED board.



7 RELIABILITY TEST

7.1 RELIABILITY CHARACTERISTICS (NORMAL TEMP.)

Test Item	Test Condition	Remarks
High Temperature Operation	240 HR , 50°C ± 2°C	No abnormalities in function and appearance
Low Temperature Operation	240 HR , 0°C ± 2°C	No abnormalities in function and appearance
Thermal Shock Storage (NO operation state)	-20 °C (30 min.) → 25 °C (5 min.) → 70 °C (30 min.) → 25 °C (5 min.) 5 cycles	No abnormalities in function and appearance
Vibration (No operation state)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycles per axis	No abnormalities in function and appearance

7.2 RELIABILITY CHARACTERISTICS (WIDE TEMP.)

Test Item	Test Condition	Remarks
High Temperature Operation	240 HR , 70°C ± 2°C	No abnormalities in function and appearance
Low Temperature Operation	240 HR , -20°C ± 2°C	No abnormalities in function and appearance
Thermal Shock Storage (NO operation state)	-30 °C (30 min.) → 25 °C (5 min.) → 80 °C (30 min.) → 25 °C (5 min.) 5 cycles	No abnormalities in function and appearance
Vibration (No operation state)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycles per axis	No abnormalities in function and appearance

7.3 MTBF OF LIQUID CRYSTAL PANEL

50,000 hours, 90% Confidence Level at 25 °C and 65% RH Max.

If any of the following occurs after the MTBF test, the LCD is deemed to be failed:

- Current consumption increases three times the initial value.
- Damaged glass, plug and/or polarizer of the LCD.
- Non-operational display.

8 OPERATING INSTRUCTIONS

8.1 I/O PIN FUNCTION (ARRAY LED B/L)

Pin No.	Function	Level	Description
1	Vss/LED(-)	-	Ground (0V) and cathode of LED B/L
2	Vdd	-	Logic Supply Voltage (+5V)
3	Vo	-	Voltage Level for LCD Control Adjustment
4	RS	I	Register Select 0: Instruction Register 1: Data Register
5	R/W	I	Read / Write 0: Data Write (Module-MPU) 1: Data Read (Module-MPU)
6	E	I	Enable Signal Active High (H - L)
7 ~ 14	DB0 ~ 7	I/O	Bi-directional data bus line 0 ~ 7
15	NC		No connection
16	LED(+)		Anode of LED B/L
BL1	LED(+)		Anode of LED B/L
BL2	LED(-)		Cathode of LED B/L

8.2 AC CHARACTERISTICS

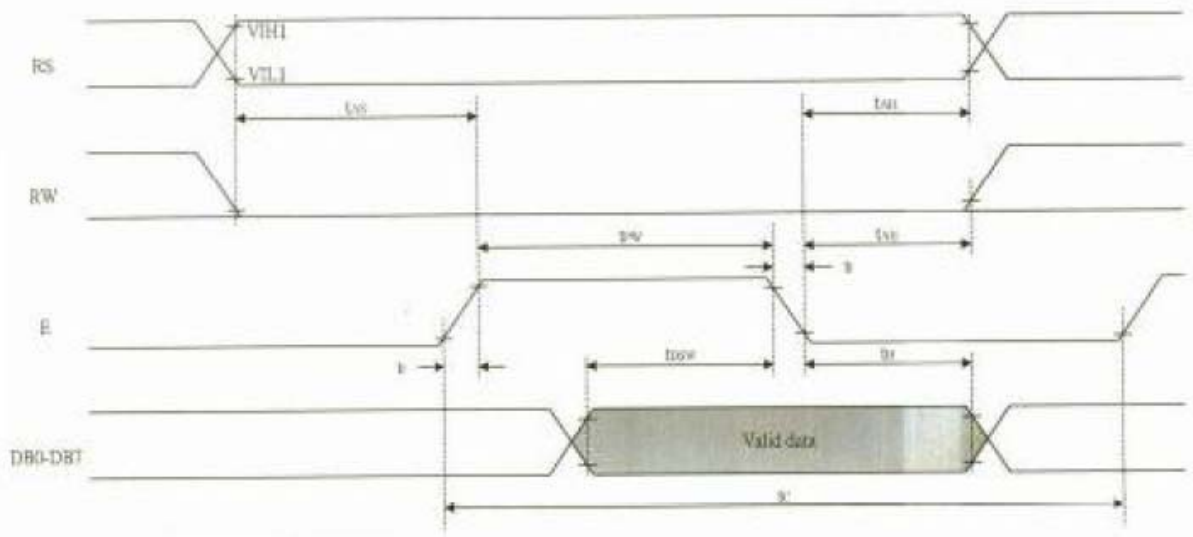
■ AC Characteristics

(TA = 25℃, VCC = 5V)

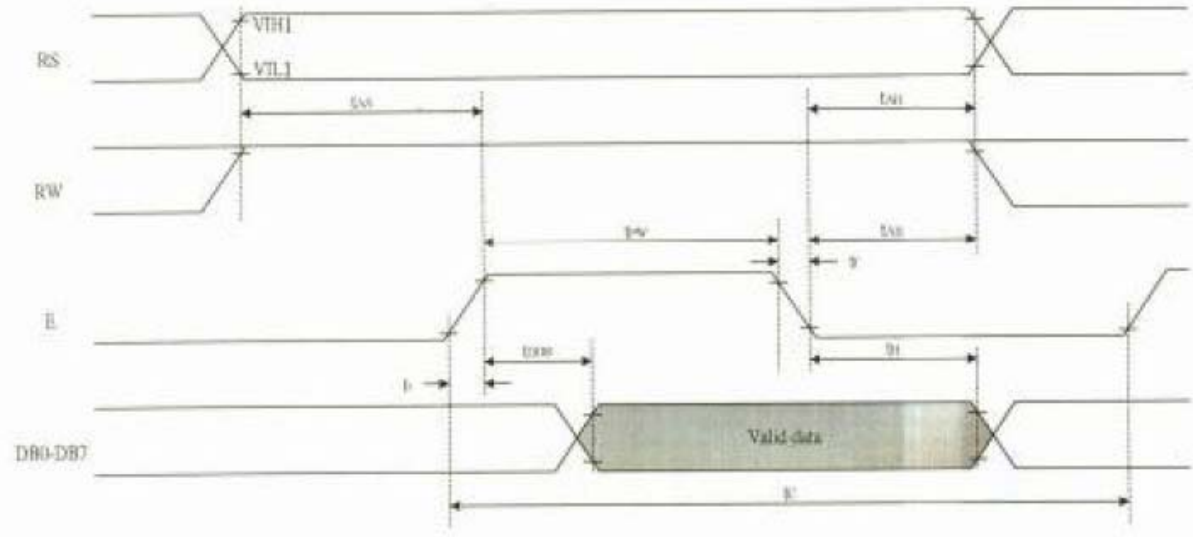
Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
Internal Clock Operation						
f_{OSC}	OSC Frequency	R = 91KΩ	190	270	350	KHz
External Clock Operation						
f_{EX}	External Frequency	-	125	270	410	KHz
	Duty Cycle	-	45	50	55	%
T_R,T_F	Rise/Fall Time	-	-	-	0.2	µs
Write Mode (Writing data from MPU to ST7066U)						
T_C	Enable Cycle Time	Pin E	1200	-	-	ns
T_{PW}	Enable Pulse Width	Pin E	140	-	-	ns
T_R,T_F	Enable Rise/Fall Time	Pin E	-	-	25	ns
T_{AS}	Address Setup Time	Pins: RS,RW,E	0	-	-	ns
T_{AH}	Address Hold Time	Pins: RS,RW,E	10	-	-	ns
T_{DSW}	Data Setup Time	Pins: DB0 - DB7	40	-	-	ns
T_H	Data Hold Time	Pins: DB0 - DB7	10	-	-	ns
Read Mode (Reading Data from ST7066U to MPU)						
T_C	Enable Cycle Time	Pin E	1200	-	-	ns
T_{PW}	Enable Pulse Width	Pin E	140	-	-	ns
T_R,T_F	Enable Rise/Fall Time	Pin E	-	-	25	ns
T_{AS}	Address Setup Time	Pins: RS,RW,E	0	-	-	ns
T_{AH}	Address Hold Time	Pins: RS,RW,E	10	-	-	ns
T_{DDR}	Data Setup Time	Pins: DB0 - DB7	-	-	100	ns
T_H	Data Hold Time	Pins: DB0 - DB7	10	-	-	ns
Interface Mode with LCD Driver(ST7065)						
T_{CWH}	Clock Pulse with High	Pins: CL1, CL2	800	-	-	ns
T_{CWL}	Clock Pulse with Low	Pins: CL1, CL2	800	-	-	ns
T_{CST}	Clock Setup Time	Pins: CL1, CL2	500	-	-	ns
T_{SU}	Data Setup Time	Pin: D	300	-	-	ns
T_{DH}	Data Hold Time	Pin: D	300	-	-	ns
T_{DM}	M Delay Time	Pin: M	0	-	2000	ns

■ Timing Characteristics

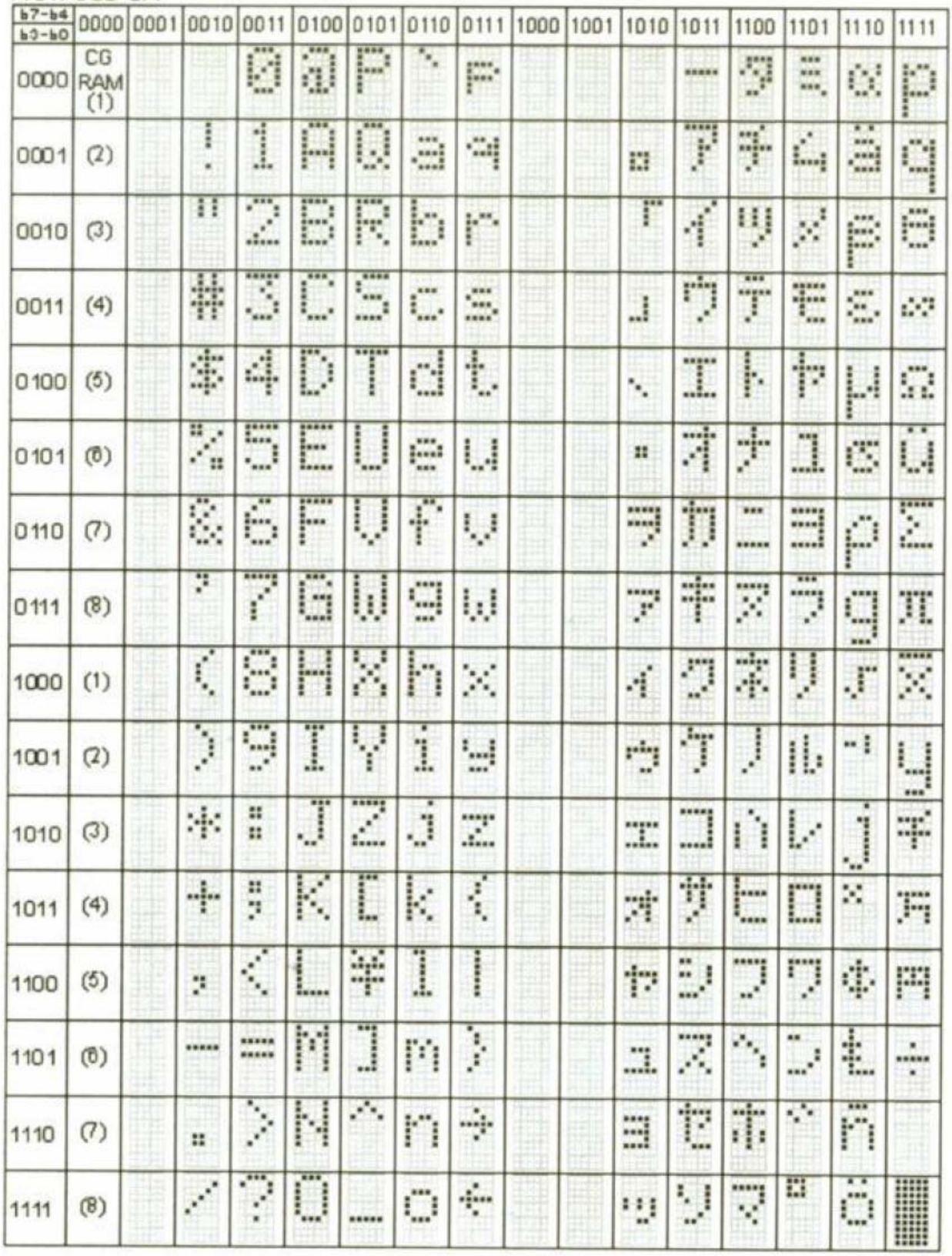
- **Writing data from MPU to ST7066U**



- **Reading data from ST7066U to MPU**



NO.7066-0A



9 LABELING DESCRIPTION

9.1 Gray Mode

9.1.1 Normal Temp.

DENSITRONLR
4301BG-SNG
TAIWAN YYMM

9.1.2 Wide Temp.

DENSITRONLR
4301BG-HNG
TAIWAN YYMM

9.2 Yellow Mode

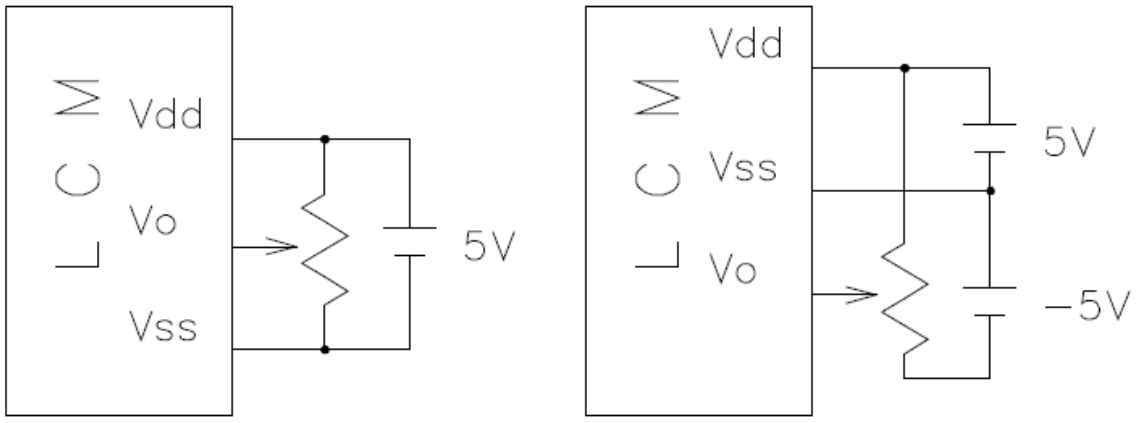
9.2.1 Normal Temp.

DENSITRONLR
4301BG-SNY
TAIWAN YYMM

9.2.2 Wide Temp.

DENSITRONLR
4301BG-HNY
TAIWAN YYMM

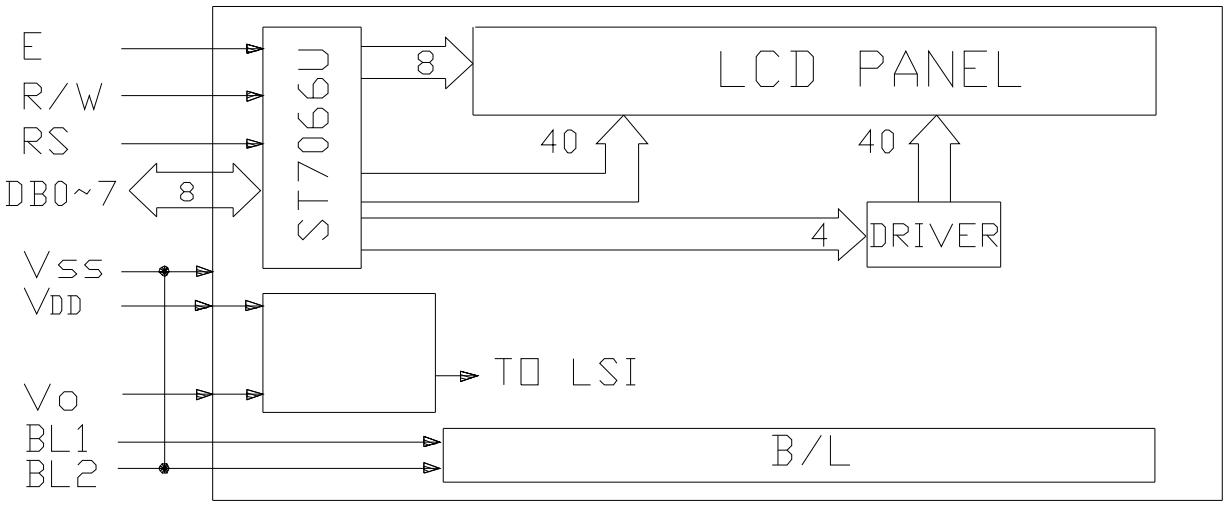
10 POWER SUPPLY



Normal Temp. Wide Temp.

RECOMMENDED V_R : 10K ohm ~ 20K ohm

11 BLOCK DIAGRAM



12 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LR4301①②1C16③④⑤

①

Polarizer Type

B = Transflective Positive Mode

②

Backlight Color

G = Yellow-Green

③

Fluid Type and Temperature Range

D = Standard temp. range; negative supply voltage required
H = Wide temp. range; negative supply voltage required

④

Fluid Type and Temperature Compensation

N = STN

⑤

Background Color

Y = Yellow mode STN
G = Gray mode STN

13 QUALITY ASSURANCE SPECIFICATION

13.1 CONFORMITY

The performance, function and reliability of the shipped products conform to the Product Specification.

13.2 DELIVERY ASSURANCE

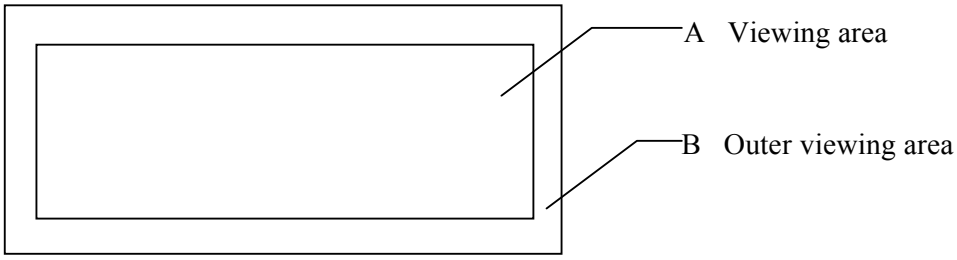
13.2.1 Delivery Inspection Standards

- IPC-AA610, Class 2 Electronic assemblies' standard.

The Quality assurance levels are shown below:

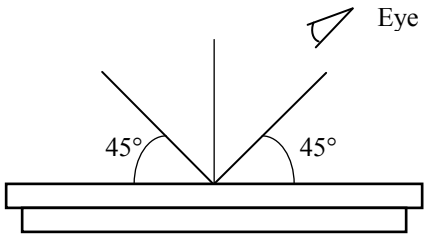
Rank	Item Inspected	Defect type	AQL	Remark
Major defect	Display	No display	0.25%	Fit/Function defect
		Over current		
		Missing segment		
		Wrong Viewing direction		
		Incorrect operation		
		No Backlight		
		Flickering Backlight		
	Dimensions	PCB and/or Bezel out of Specifications		
Minor defect	LCD	Black and White spots	1.0%	Appearance defect
		Black and White lines		
		Polarizer Scratches		
		Bubbles in Polarizer		
		Segment deformations, Pin holes		
		Color Defect		
		Glass Chips		
	COB	Wire Bonding Pad exposed		
		Insufficient covering with Resin (Wire Bonding line exposed)		
		Bubbles or Dust on COB		
	PCB	Dust or Solder balls on PCB		
		Pad Scratches		
	Tray	Particles	Every Tray	
		Total	1.0%	

13.2.2 Zone Definition



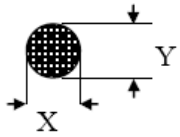
13.2.3 Visual Inspection

- Inspect under 2 x 20 W or one 40 W fluorescent lamp (approximately 3000 lux.) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye. (Measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted by considering clarity and crosstalk on the screen).
- Inspect the module at 45° right and left, top and bottom.
- Use the optimum viewing angle during the contrast inspection.



13.2.3.1 Standard of Appearance Inspection

Unit: mm

<table>
<tr><th>No.</th><th>Item</th><th>Criteria</th></tr>
<tr><td>1</td><td>Black spot,
White spot,
Dust</td><td>
Round type as shown:
Φ = (X+Y)/2


<table>
<tr><th colspan="3">Acceptable quantity</th></tr>
<tr><th>Size</th><th>Zone A</th><th>Zone B</th></tr>
<tr><td>Φ < 0.2</td><td>Any number</td><td rowspan="3">Any number</td></tr>
<tr><td>0.2 < Φ < 0.25</td><td>2</td></tr>
<tr><td>0.25 < Φ</td><td>0</td></tr>
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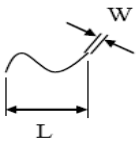
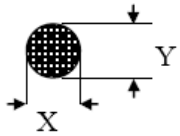
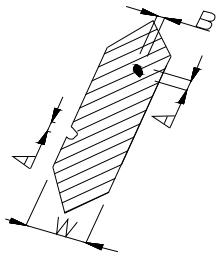
Line type as shown:


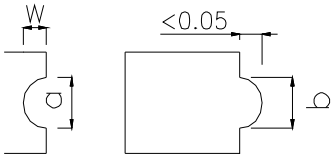
<table>
<tr><th colspan="4">Acceptable quantity</th></tr>
<tr><th>Length</th><th>Width</th><th>Zone A</th><th>Zone B</th></tr>
<tr><td>-</td><td>W ≤ 0.03</td><td>Any number</td><td rowspan="3">Any number</td></tr>
<tr><td>L ≤ 3</td><td>0.03 < W ≤ 0.05</td><td>2</td></tr>
<tr><td>-</td><td>0.05 < W</td><td>As round type</td></tr>
</table>
Total acceptable quantity: 5
</td></tr>
<tr><td>2</td><td>Polarizer Scratch</td><td>Scratch on Protective film is permitted.
Scratch on Polarizer: Same as 1.</td></tr>
<tr><td>3</td><td>Polarizer Bubble</td><td>
Φ = (X+Y)/2


<table>
<tr><th colspan="3">Acceptable quantity</th></tr>
<tr><th>Size</th><th>Zone A</th><th>Zone B</th></tr>
<tr><td>Φ < 0.2</td><td>Any number</td><td rowspan="4">Any number</td></tr>
<tr><td>0.2 < Φ < 0.5</td><td>3</td></tr>
<tr><td>0.5 < Φ < 1.0</td><td>1</td></tr>
<tr><td>1.0 < Φ</td><td>0</td></tr>
</table>
Total acceptable quantity: 4
</td></tr>
<tr><td>4</td><td>Segment Deformation</td><td>
1.a. Pin hole on segmented display:

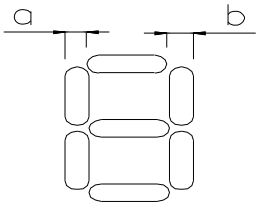
W: Segment Width

Φ = (A+B)/2


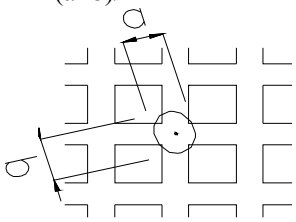
<table>
<tr><th colspan="2">Acceptable quantity</th></tr>
<tr><th>Width</th><th>Φ</th></tr>
<tr><td>W ≤ 0.4</td><td>Φ ≤ 0.2 and Φ ≤ ½W</td></tr>
<tr><td>W > 0.4</td><td>Φ ≤ 0.25 and Φ ≤ (1/3)W</td></tr>
<tr><td colspan="2">Total acceptable quantity: 1 Defect per segment.
Pin holes with Φ under 0.10 mm are acceptable.</td></tr>
</table>
</td></tr>
</table>

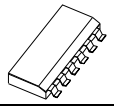
<table>
<tr><th>No.</th><th>Item</th><th>Criteria</th></tr>
<tr><td>4</td><td>Segment Deformation</td><td>
1.b. Pin hole on dot matrix display:


<table>
<tr><td colspan="2">Acceptable quantity</td></tr>
<tr><td>Size</td><td>-</td></tr>
<tr><td>a, b < 0.1</td><td>Any number</td></tr>
<tr><td>(a+b)/2 ≤ 0.1</td><td>Any number</td></tr>
<tr><td>0.5 < Φ <1.0</td><td>3</td></tr>
</table>
Total acceptable quantity: 7

2. Segments / dots with different width:


<table>
<tr><td colspan="2">Acceptable limits</td></tr>
<tr><td>a ≥ b</td><td>a/b ≤ 4/3</td></tr>
<tr><td>a < b</td><td>a/b > 4/3</td></tr>
</table>
3. Alignment layer defect:

Φ = (a+b)/2


<table>
<tr><td colspan="2">Acceptable quantity</td></tr>
<tr><td>Size</td><td>-</td></tr>
<tr><td>Φ ≤ 0.4</td><td>Any number</td></tr>
<tr><td>0.4 < Φ ≤ 1.0</td><td>5</td></tr>
<tr><td>1.0 < Φ ≤ 1.5</td><td>3</td></tr>
<tr><td>1.5 < Φ ≤ 2.0</td><td>2</td></tr>
</table>
</td></tr>
<tr><td>5</td><td>Color Uniformity</td><td>Level of samples for approval is set as the limit.</td></tr>
<tr><td>6</td><td>Backlight</td><td>The backlight color should correspond to the product specification.
Flashing / flickering and / or non-functioning backlight is not allowed.
Dust larger than 0.25 mm is not allowed.</td></tr>
<tr><td>7</td><td>COB</td><td>Exposed wire bonding pad is not allowed.
Insufficient covering with resin is not allowed. (Exposed Wire bonding line)
Dust or bubbles on the resin are not allowed.</td></tr>
<tr><td>8</td><td>PCB
  </td><td>Non-melted solder paste should not be present on the PCB.
Cold solder joints, missing solder connections, or oxidation is not allowed.
Residue or solder balls on the PCB are not allowed.
Short circuits on components are not allowed.</td></tr>
</table>

14 HANDLING PRECAUTIONS

Safety
If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes.
If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design
Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.
When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean. Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning
Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotrifluoroethane. Do not wipe the display surface with dry or hard materials that will damage the polarizer surface. Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge
As the display uses C-MOS LSI drivers, connect any unused input terminals to VDD or VSS. Do not input any signals before power is turned on. Also, ground your body, work / assembly table and assembly equipment to protect against static electricity.

Packaging
Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height.
To prevent displays from degradation, do not operate or store them exposed directly to sunlight or high temperature / humidity.

Caution during operation
It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life. Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation.
Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged. If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once. Even a small amount of condensation on the contact pads (terminals) can cause an electro-chemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage
Store the display in a dark place where the temperature is 25°C ± 10°C and the humidity below 50% RH.
Store the display in a clean environment, free from dust, organic solvents and corrosive gases.
Do not crash, shake or jolt the display (including accessories).