

# LIQUID CRYSTAL DISPLAY MODULE

## Product Specification

<b>PRODUCT NUMBER</b>	<b>LMR4022</b>
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INTERNAL APPROVALS		
Product Manager	Engineering	Document Control

## TABLE OF CONTENTS

1	MAIN FEATURES .....	4
2	MECHANICAL DRAWING .....	5
3	ABSOLUTE MAXIMUM RATINGS .....	6
4	ELECTRONICAL CHARACTERISTICS .....	6
5	OPTICAL CHARACTERISTICS .....	6
6	BACKLIGHT CHARACTERISTICS .....	8
7	OPERATING INSTRUCTIONS .....	9
7.1	<i>I/O PIN FUNCTION</i> .....	9
7.2	<i>AC CHARACTERISTICS</i> .....	9
7.3	<i>TIMING CHARACTERISTICS</i> .....	10
7.4	<i>CHARACTER FONT</i> .....	11
8	BLOCK DIAGRAM.....	12
9	POWER SUPPLY.....	12
10	RELIABILITY TEST .....	13
10.1	<i>RELIABILITY NORMAL TEMPERATURE</i> .....	13
10.2	<i>RELIABILITY WIDE TEMPERATURE</i> .....	13
11	STANDARD OF APPEARANCE INSPECTION .....	14
12	PART NUMBER DESCRIPTION .....	16
13	HANDLING PRECAUTIONS .....	17

**REVISION RECORD**

<b>Rev.</b>	<b>Date</b>	<b>Page</b>	<b>Par.</b>	<b>Comment</b>	<b>ECN no.</b>
A	03/18/08	--	--	Initial DCA Release	E3661

## 1 MAIN FEATURES

ITEM	CONTENTS	UNIT
Outline Dimension	85.0 (W) x 36.0 (H) x 12.5 (D)	mm
Display Format	16 characters x 2 lines	dot
Active Area	56.2 (W) x 11.5 (H)	mm
Viewing Area	63.5 (W) x 15.8 (H)	mm
Character Dimensions	2.95 x 5.55	mm
Character Pitch	3.55 x 5.95	mm
Backlight Type	Edge LED	--
Backlight Color	Yellow-Green	--
View Angle	6:00	O'clock
Duty Ratio	1/16	Duty
Bias	1/4	Bias
Controller	Sitronix ST7066	--
Driver	Sitronix ST7065	--
RoHS Complaint	Yes	-



### 3 ABSOLUTE MAXIMUM RATINGS

(Ta=25°C, VSS=0V)

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

### 4 ELECTRONICAL CHARACTERISTICS

(Vss = 0V, Ta =25°C)

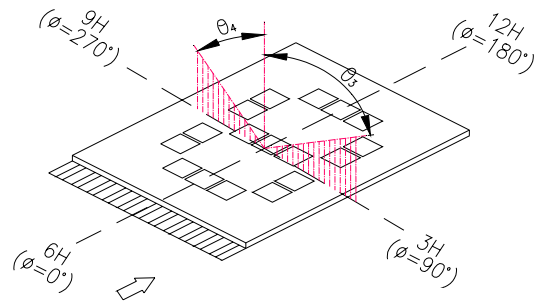
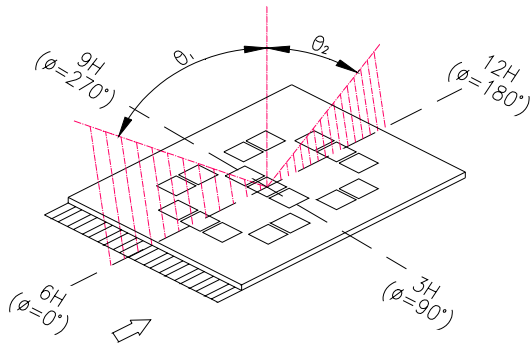
Item	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage	V <sub>DD</sub>	-	4.75	--	5.25	V
Input Voltage	V <sub>ILC</sub>	Low	0	--	0.55	V
	V <sub>IHC</sub>	High	0.7 V <sub>DD</sub>	--	V <sub>DD</sub>	
LCD Driving Voltage	V <sub>DD</sub> - V <sub>O</sub>	--	3.0	V	10.0	V

### 5 OPTICAL CHARACTERISTICS

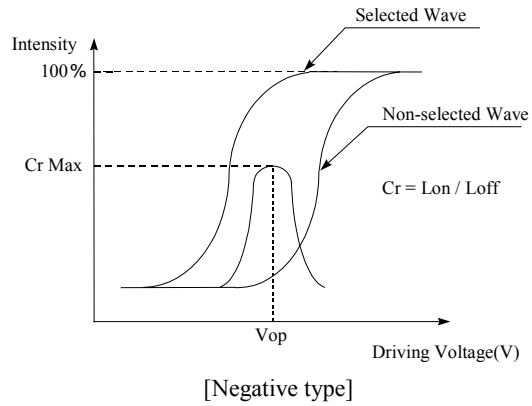
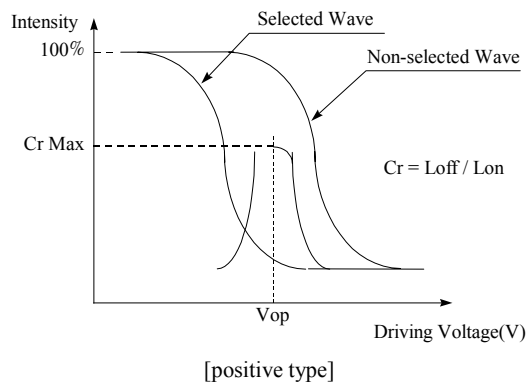
Ta = 25°C

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Viewing Angle	Θ1 (down)	CR≥2	--	40	--	deg	5.1
	Θ2 (up)	CR≥2	--	30	--	deg	5.1
	Θ3 (right)	CR≥2	--	30	--	deg	5.2
	Θ4 (left)	CR≥2	--	30	--	deg	5.2
Contrast Ratio	Cr	Ta = 25°C	2	4	--	--	5.3
Response Time	Tr	Ta = 25°C	--	120	250	ms	5.4
	Tf	Ta = 25°C	--	160	300		
Driving Method	Duty	1/16					
	Bias	1/5					
Viewing Direction	6:00 O'clock						

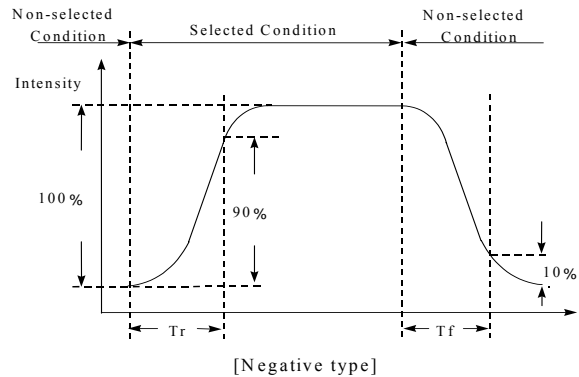
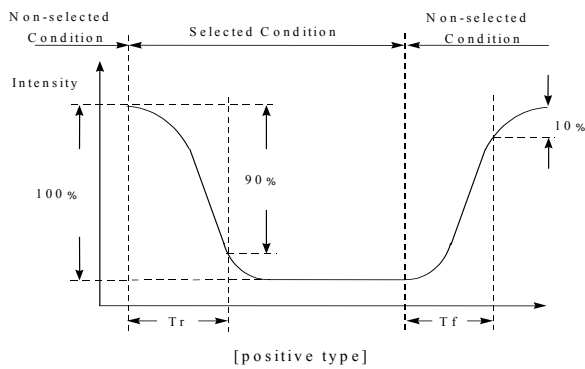
Note 5.1: Definition of viewing angle  $\theta_1$  &  $\theta_2$     Note 5.2: Definition of viewing angle  $\theta_3$  &  $\theta_4$



Note 5.3: Definition of contrast ratio (CR)



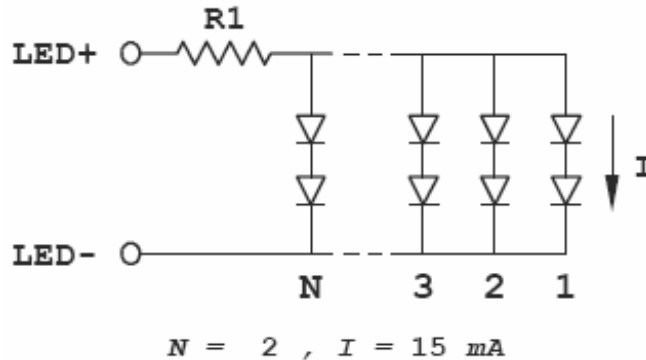
Note 5.4: Definition of response time



## 6 BACKLIGHT CHARACTERISTICS

Item	Conditions	Min	Typ	Max	Unit
Input Voltage	Ta = 25°C	--	5.0	--	V(DC)
Current Consumption	Ta = 25°C	--	30	--	mA
Average brightness (B/L only) (Ta=25°C, IL=30mA)	Test when connecting after 3 min. Ta = 25 C (max. contrast)				cd/m <sup>2</sup> (note 2)
	Yellow-green B/L	--	12	--	
Brightness Uniformity	Ta = 25°C, IL = 30mA	70	--	--	% (note 3)
Lamp Life	Ta = 25°C , IL = 30mA Humidity: 30%RH~85%RH	--	50,000	--	Hrs (note 4)
Operating Temp.	Humidity: 30%RH~85%RH	-20	--	70	°C
Storage Temp.	Humidity: 30%RH~85%RH	-30	--	80	°C
Limit Resistor (R1)	Ta = 25°C	--	27	--	OHM (note 1)

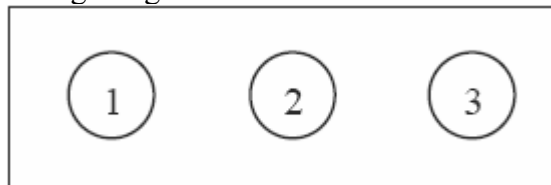
Note 1: R1: Built-in BL current limit resistor On LCD.



Note 2: Average brightness of 3 points when B/L is used at the beginning.

Note 3: Brightness uniformity = (MIN / MAX) x 100 %.

Note 4: Half of the original average brightness.





## 7 OPERATING INSTRUCTIONS

### 7.1 I/O PIN FUNCTION

Pin No.	Function	Level	Description
1	V <sub>SS</sub>	--	Ground (0V)
2	V <sub>DD</sub>	--	Logic Supply Voltage (+5V)
3	V <sub>O</sub>	--	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 ~ DB7	I/O	Bi-directional data bus line 0 ~ 7
BL1	LED (+)	--	Anode of LED B/L
BL2	LED (-)	--	Cathode of LED B/L

### 7.2 AC CHARACTERISTICS

(T<sub>a</sub> = 25°C, V<sub>CC</sub> = 5V)

Symbol	Characteristics	Test Condition	Min	Typ	Max	Unit
Internal Clock Operation						
f <sub>OSC</sub>	OSC Frequency	R = 91KΩ	190	270	350	KHz
External Clock Operation						
f <sub>EX</sub>	External Frequency	--	125	270	410	KHz
--	Duty Cycle	--	45	50	55	%
T <sub>R</sub> , T <sub>F</sub>	Rise / Fall Time	--	--	--	0.2	μs
Write Mode (Writing data from MPU to ST7066U)						
T <sub>C</sub>	Enable Cycle Time	Pin E	1200	--	--	ns
T <sub>PW</sub>	Enable Pulse Width	Pin E	140	--	--	ns
T <sub>R</sub> , T <sub>F</sub>	Enable Rise / Fall Time	Pin E	--	--	25	ns
T <sub>AS</sub>	Address Setup Time	Pins: RS, RW, E	0	--	--	ns
T <sub>AH</sub>	Address Hold Time	Pins: RS, RW, E	10	--	--	ns
T <sub>DSW</sub>	Data Setup Time	Pins: DB0 – DB7	40	--	--	ns
T <sub>H</sub>	Data Hold Time	Pins: DB0 – DB7	10	--	--	ns
Read Mode (Reading data from ST7066U to MPU)						
T <sub>C</sub>	Enable Cycle Time	Pin E	1200	--	--	ns
T <sub>PW</sub>	Enable Pulse Width	Pin E	140	--	--	ns
T <sub>R</sub> , T <sub>F</sub>	Enable Rise / Fall Time	Pin E	--	--	25	ns
T <sub>AS</sub>	Address Setup Time	Pins: RS, RW, E	0	--	--	ns
T <sub>AH</sub>	Address Hold Time	Pins: RS, RW, E	10	--	--	ns
T <sub>DDR</sub>	Data Setup Time	Pins: DB0 – DB7	--	--	100	ns
T <sub>H</sub>	Data Hold Time	Pins: DB0 – DB7	10	--	--	ns

Product No.	LMR4022	REV. A
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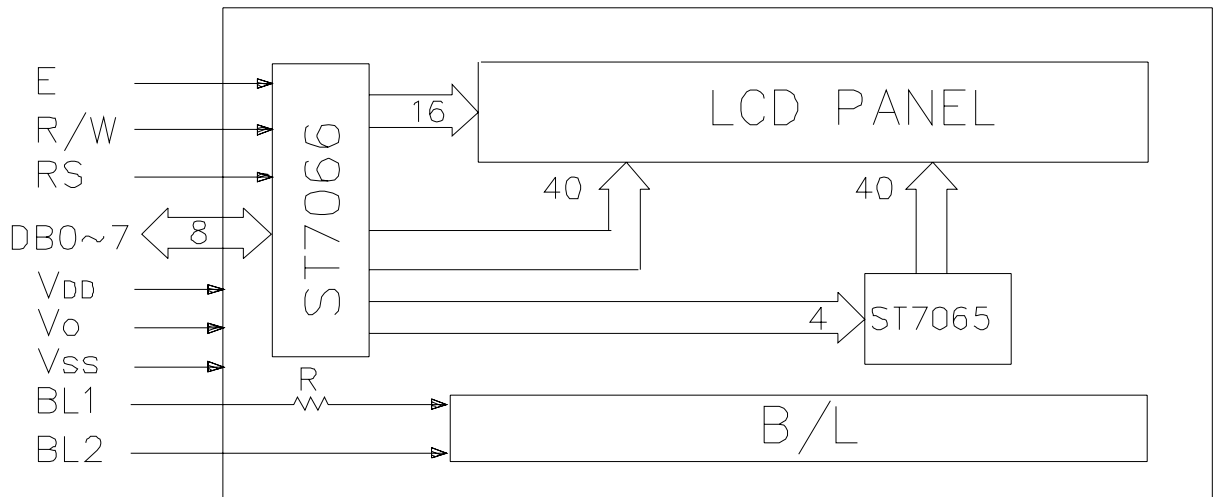
Page	9 / 17
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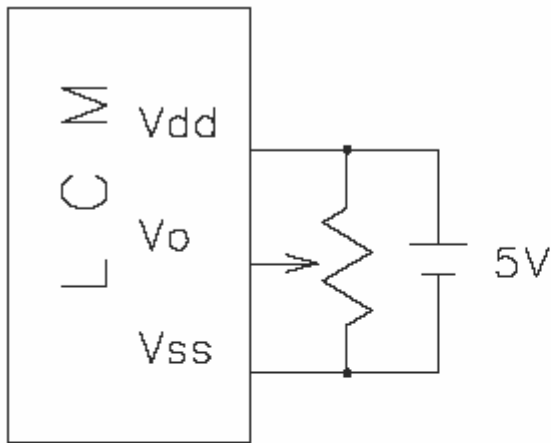
7.4 CHARACTER FONT

b7-b4 b5-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)		0	a	P	\	P				-	3	E	&	P	
0001	(2)	.	1	A	D	a	%			•	7	*	4	a	9	
0010	(3)	"	2	B	R	b	r			"	4	9	x	p	0	
0011	(4)	#	3	C	S	c	s			u	7	7	E	E	&	
0100	(5)	\$	4	D	T	d	t			\	E	T	h	h	0	
0101	(6)	%	5	E	U	e	u			•	•	•	1	0	0	
0110	(7)	&	6	F	V	f	v			7	h	2	0	p	Σ	
0111	(8)	'	7	G	W	g	w			7	*	7	7	g	π	
1000	(1)	<	8	H	X	h	x			4	7	*	7	7	7	
1001	(2)	>	9	I	Y	i	y			7	7	7	7	7	7	
1010	(3)	*	:	J	Z	j	z			E	0	0	7	j	7	
1011	(4)	+	:	K	E	k	e			*	7	E	0	*	7	
1100	(5)	.	<	L	#	l	l			7	7	7	7	7	7	
1101	(6)	-	=	M	J	m	j			7	7	7	7	7	7	
1110	(7)	•	>	N	^	n	+			7	7	7	7	7	7	
1111	(8)	/	?	O	_	o	←			7	7	7	7	7	7	7

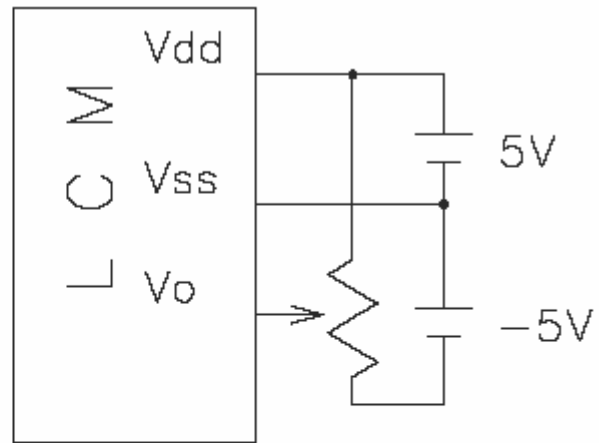
## 8 BLOCK DIAGRAM



## 9 POWER SUPPLY



Normal temp.



Wide temp.

RECOMMENDED  $V_R$  : 10K ohm ~ 20K ohm

## 10 RELIABILITY TEST

### 10.1 RELIABILITY NORMAL TEMPERATURE

Test Item	Test Condition	Note
High Temperature Operation	240 HR , 50 °C +/- 2 °C	No abnormalities in function* and appearance**
Low Temperature Operation	240 HR , 0 °C +/- 2 °C	
Thermal Shock Storage (non operational)	-20°C (30 min.) -> 25°C (5 min.) -> 70°C (30 min.) ->25 °C (5 min.) 5 cycle	
Vibration (non operational)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycle / per axis	

### 10.2 RELIABILITY WIDE TEMPERATURE

Test Item	Test Condition	Note
High Temperature Operation	240 HR , 70 °C +/- 2 °C	No abnormalities in function* and appearance**
Low Temperature Operation	240 HR , -20 °C +/- 2 °C	
Thermal Shock Storage (non operational)	-30°C (30 min.) -> 25°C (5 min.) -> 80°C (30 min.) ->25 °C (5 min.) 5 cycle	
Vibration (non operational)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycle / per axis	

#### MTBF of liquid crystal panel

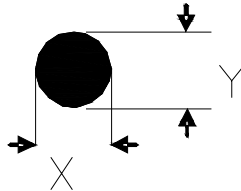
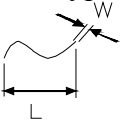
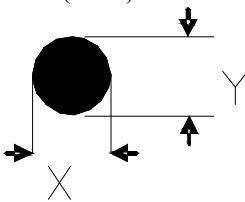
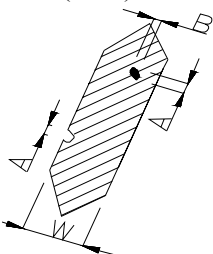
50,000 hours, 90% Confidence Level at 25 °C , 65% RH Max.

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

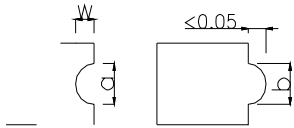
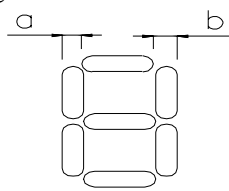
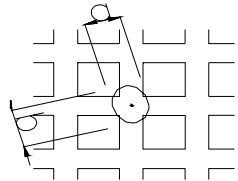
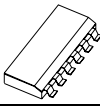
- Current consumption increase three times than initial value
- Damaged glass plug and/or polarizer on the LCD glass
- Non-operational display

## 11 STANDARD OF APPEARANCE INSPECTION

units: mm

No.	Item	Criteria																																			
1	Black spot, White spot, dust	<p>Round type: as per following drawing  <math>\Phi = (X+Y)/2</math></p>  <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.1</math></td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td><math>0.1 &lt; \Phi &lt; 0.2</math></td> <td>2</td> </tr> <tr> <td><math>0.2 &lt; \Phi &lt; 0.25</math></td> <td>1</td> </tr> <tr> <td><math>0.25 &lt; \Phi</math></td> <td>0</td> </tr> </tbody> </table> <p>Line type: as per following drawing</p>  <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="4">Acceptable quantity</th> </tr> <tr> <th>Length</th> <th>Width</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>-</td> <td><math>W \leq 0.02</math></td> <td rowspan="2">Any number</td> <td rowspan="3">Any number</td> </tr> <tr> <td><math>L \leq 3.0</math></td> <td><math>0.02 &lt; W \leq 0.03</math></td> </tr> <tr> <td><math>L \leq 2.5</math></td> <td><math>0.03 &lt; W \leq 0.05</math></td> <td>2</td> </tr> <tr> <td>-</td> <td><math>0.05 &lt; W</math></td> <td>as round type</td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			size	Zone A	Zone B	$\Phi < 0.1$	Any number	Any number	$0.1 < \Phi < 0.2$	2	$0.2 < \Phi < 0.25$	1	$0.25 < \Phi$	0	Acceptable quantity				Length	Width	Zone A	Zone B	-	$W \leq 0.02$	Any number	Any number	$L \leq 3.0$	$0.02 < W \leq 0.03$	$L \leq 2.5$	$0.03 < W \leq 0.05$	2	-	$0.05 < W$	as round type
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$L \leq 2.5$	$0.03 < W \leq 0.05$	2																																			
-	$0.05 < W$	as round type																																			
2	Polariser scratch	<p>Scratch on protective film is permitted  Scratch on polariser: same as No. 1</p>																																			
3	Polariser bubble	<p><math>\Phi = (X+Y)/2</math></p>  <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.2</math></td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td><math>0.2 &lt; \Phi &lt; 0.5</math></td> <td>2</td> </tr> <tr> <td><math>0.5 &lt; \Phi &lt; 1.0</math></td> <td>1</td> </tr> <tr> <td><math>1.0 &lt; \Phi</math></td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\Phi < 0.2$	Any number	Any number	$0.2 < \Phi < 0.5$	2	$0.5 < \Phi < 1.0$	1	$1.0 < \Phi$	0																				
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$0.5 < \Phi < 1.0$	1																																				
$1.0 < \Phi$	0																																				
4	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width  <math>\Phi = (A+B)/2</math></p>  <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th><math>\Phi</math></th> </tr> </thead> <tbody> <tr> <td><math>W \leq 0.4</math></td> <td><math>\Phi \leq 0.2</math> and <math>\Phi \leq 1/2W</math></td> </tr> <tr> <td><math>W &gt; 0.4</math></td> <td><math>\Phi \leq 0.25</math> and <math>\Phi \leq 1/3W</math></td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 1 defect per segment  Pin holes with <math>\Phi</math> under 0.10 mm are acceptable.</p>	Acceptable quantity		Width	$\Phi$	$W \leq 0.4$	$\Phi \leq 0.2$ and $\Phi \leq 1/2W$	$W > 0.4$	$\Phi \leq 0.25$ and $\Phi \leq 1/3W$																											
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$W > 0.4$	$\Phi \leq 0.25$ and $\Phi \leq 1/3W$																																				



No.	Item	Criteria																												
5	Black spot, White spot, dust	<p>1b. Pin hole on dot matrix display</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td><math>a, b &lt; 0.1</math></td> <td>Any number</td> </tr> <tr> <td><math>(a+b)/2 \le 0.1</math></td> <td>Any number</td> </tr> <tr> <td><math>0.5 &lt; \Phi &lt; 1.0</math></td> <td>3</td> </tr> </tbody> </table> <p>2. Segments / dots with different width</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable</th> </tr> </thead> <tbody> <tr> <td><math>a &gt; b</math></td> <td><math>a/b \le 4/3</math></td> </tr> <tr> <td><math>a &lt; b</math></td> <td><math>a/b &gt; 4/3</math></td> </tr> </tbody> </table> <p>3. Alignment layer defect</p> <p><math>\Phi = (a+b)/2</math></p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td><math>\Phi \le 0.4</math></td> <td>Any number</td> </tr> <tr> <td><math>0.4 &lt; \Phi \le 1.0</math></td> <td>5</td> </tr> <tr> <td><math>1.0 &lt; \Phi \le 1.5</math></td> <td>3</td> </tr> <tr> <td><math>1.5 &lt; \Phi \le 2.0</math></td> <td>2</td> </tr> </tbody> </table>	Acceptable quantity		Size		$a, b < 0.1$	Any number	$(a+b)/2 \le 0.1$	Any number	$0.5 < \Phi < 1.0$	3	Acceptable		$a > b$	$a/b \le 4/3$	$a < b$	$a/b > 4/3$	Acceptable quantity		Size		$\Phi \le 0.4$	Any number	$0.4 < \Phi \le 1.0$	5	$1.0 < \Phi \le 1.5$	3	$1.5 < \Phi \le 2.0$	2
Acceptable quantity																														
Size																														
$a, b < 0.1$	Any number																													
$(a+b)/2 \le 0.1$	Any number																													
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$0.4 < \Phi \le 1.0$	5																													
$1.0 < \Phi \le 1.5$	3																													
$1.5 < \Phi \le 2.0$	2																													
6	Colour uniformity	Level of sample for approval set as limit sample																												
7	Backlight	The backlight colour should correspond to the product specification Flashing and or unlit backlight is not allowed Dust larger than 0.25 mm is not allowed																												
8	COB	Exposed wire bond pad is not allowed Insufficient covering with resin is not allowed (wire bond line exposed) Dust or bubble on the resin are not allowed																												
9	PCB 	No unmelted solder paste should be present on PCB Cold solder joints, missing solder connections, or oxidation are not allowed No residue or solder balls on PCB are allowed Short circuits on components are not allowed																												
10	Tray particles	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Size</th> <th>Quantity</th> </tr> </thead> <tbody> <tr> <td rowspan="2">On tray</td> <td><math>\Phi &lt; 0.2</math></td> <td>Any number</td> </tr> <tr> <td><math>\Phi &gt; 0.25</math></td> <td>4</td> </tr> <tr> <td rowspan="2">On display</td> <td><math>\Phi \ge 0.25</math></td> <td>2</td> </tr> <tr> <td><math>L = 3</math></td> <td>1</td> </tr> </tbody> </table>		Size	Quantity	On tray	$\Phi < 0.2$	Any number	$\Phi > 0.25$	4	On display	$\Phi \ge 0.25$	2	$L = 3$	1															
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	$L = 3$	1																												

12 PART NUMBER DESCRIPTION

**LMR4022**①②**2C16**③④⑤

①

**Polarizer Type**

B = Transflective: light background with LED backlight

E = Transmissive: dark background with LED backlight

F = Transmissive: light background with LED backlight

A = Reflective: No backlight

②

**Backlight Color**

G = Yellow-green (standard)

③

**Fluid Type and Power Supply**

S = NTN with +5VDC operation

H = NTN-H with ±5VDC operation

④

**Fluid Type/TN Viewing Direction**

N = NTN, NTN-H

⑤

**Background Color for NTN or TN Temperature Range**

B = Blue background

G = Gray background

Y = Yellow background



## 13 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 polariser 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 terminal 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 sunshine 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 electrochemical 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  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$  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).

Product No.	LMR4022	REV. A
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Page	17 / 17
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