

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

PRODUCT NUMBER	LR2227
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INTERNAL APPROVALS		
Product Manager	Engineering	Document Control

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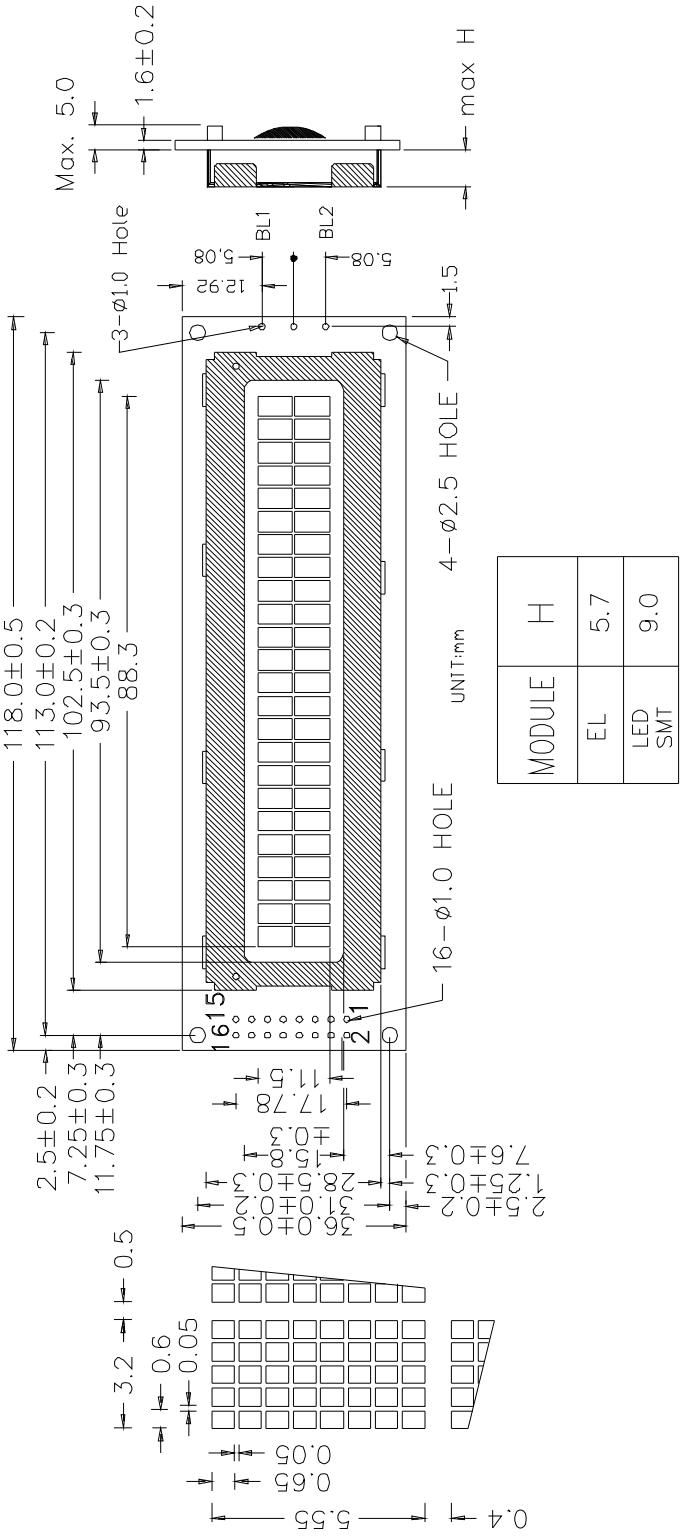
REVISION RECORD

Rev.	Date	Page	Par.	Comment	ECN no.
A	09/05/08	--	--	New DCA Specification	E3834
B	2/27/2012	20	--	PN description updated	E4593

1 MAIN FEATURES

ITEM	CONTENTS	UNIT
Outline Dimension	118.0 (W) x 36.0 (H) x 10.7 Max. (D)	mm
Active Area	88.3 (W) x 11.5 (H)	mm
Viewing Area	93.5 (W) x 15.8 (H)	mm
LCM Configuration	24 Characters x 2 Lines	--
Character Dimensions	3.20 x 5.55	mm
Character Pitch	3.70 x 5.95	mm
Backlight Type	EL Type	--
Backlight Color	Blue-Green/White	--
IC	ST7066U	--
RoHS Complaint	Yes	--

2 MECHANICAL DRAWING



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3 ABSOLUTE MAXIMUM RATINGS

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

4 ELECTRICAL CHARACTERISTICS

4.1 DC CHARACTERISTICS

(V_{SS} = 0V, Ta = 25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Voltage	V _{DD}	--	4.75	--	5.25	V
Input Voltage	High	V _{ihc}	--	0.7 V _{DD}	--	V _{DD}
	Low	V _{ilc}	--	0	--	0.6
LCD Driving Voltage	V _{DD} - V _O	--	0	V	10.0	V

4.2 LCD CURRENT CONSUMPTION & DRIVING VOLTAGE

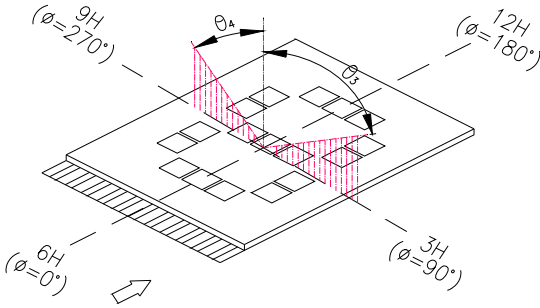
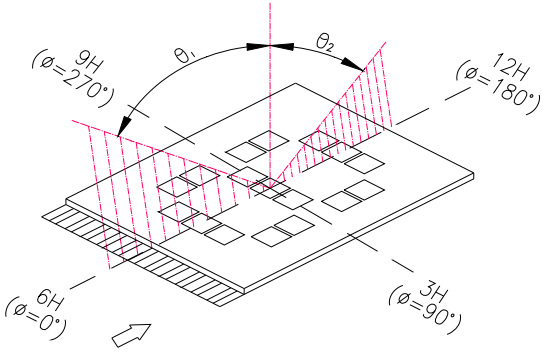
(V_{dd} - V_{SS} = 5.0V)

		STN TEMPERATURE		
		NORMAL	WIDE	
Supply Current, (I _{dd}) Typ. ,mA		3.0	3.0	
Supply Current, (I _{ee}) Typ. ,mA		N/A	N/A	
Supply Voltage (V _{ee}) Max.		N/A	N/A	
Recommend LCD Drive Voltage				
LCD driving voltage (V _{dd} - V _o)	Ta = -20 °C		N/A	4.6
	Ta = 0 °C		4.4	4.4
	Ta = 25 °C		4.2	4.2
	Ta = 50 °C		4.0	4.0
	Ta = 70 °C		N/A	3.8

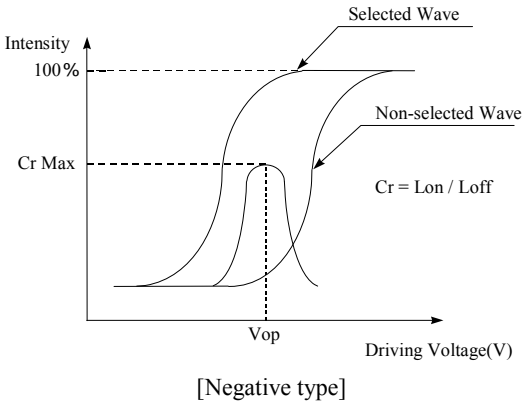
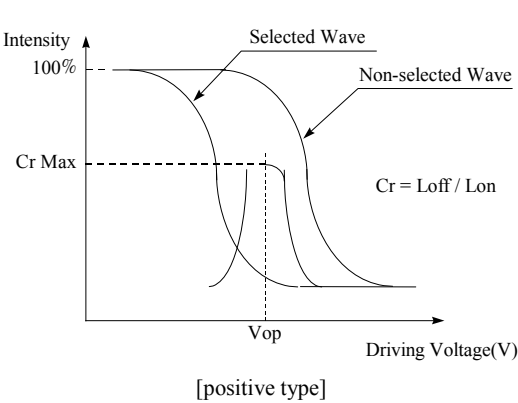
5 OPTICAL CHARACTERISTICS

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note	
Viewing Angle	$\Theta 1(\text{down})$	$CR \geq 2$	--	40	--	deg.	5.1	
	$\Theta 2(\text{up})$	$CR \geq 2$	--	30	--	deg.	5.1	
	$\Theta 3(\text{right})$	$CR \geq 2$	--	40	--	deg.	5.2	
	$\Theta 4(\text{left})$	$CR \geq 2$	--	40	--	deg.	5.2	
Contrast Ratio	CR	$T_a = 25\text{ }^\circ\text{C}$	2	4.3	4.36	--	5.3	
Response Time	Tr	$T_a = 25\text{ }^\circ\text{C}$	--	70	300	ms	5.4	
	Tf	$T_a = 25\text{ }^\circ\text{C}$	--	85	300			
Driving Method	Duty	1/16						
	Bias	1/5						

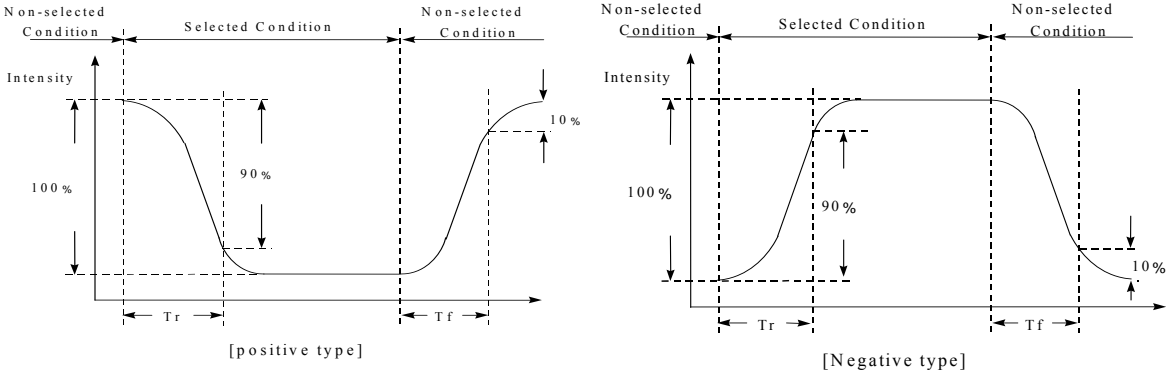
Note 5.1: Definition of viewing angle $\theta 1$ & $\theta 2$ Note 5.2: Definition of viewing angle $\theta 3$ & $\theta 4$



Note 5.3: Definition of contrast ratio (CR)



Note 5.4: Definition of response time



6 BACKLIGHT CHARACTERISTICS

EL B/L OPERATING RANGE

Item	Conditions	Min.	Typ.	Max.	Unit
Input voltage	Ta = 25 °C (400~800 Hz)	--	100	--	Vrms
Current consumption	Ta = 25 °C	--	2.7	--	mA
Average brightness (B/L only) (Ta=25°C, I=2.7 mA)	Test when connecting after 3 min. Ta=25°C (max. contrast)				cd/m ² (Note 1)
		--	50	--	
Lamp life	Ta=25°C, I=2.7 mA Humidity: 30%RH~85%RH	--	3,000	--	Hrs (Note 2)
Operating Temp.	Humidity: 30%RH~85%RH	-20	--	70	°C
Storage Temp.	Humidity: 30%RH~85%RH	-30	--	80	°C

Note 1: Average brightness of 3 points when B/L is used at the beginning.

Note 2: Half of the original average brightness.



7 OPERATING INSTRUCTIONS

7.1 I/O PIN FUNCTION (EL Type)

Pin No.	Function	Level	Description
1	Vss	--	Ground (0V)
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 1 Active High (H - L)
7 ~ 14	DB0 ~ DB7	I/O	Bi-directional data bus line 0 ~ 7
15	N/A		--
16	N/A		--
BL1	EL	--	EL B/L
BL2	EL	--	EL B/L

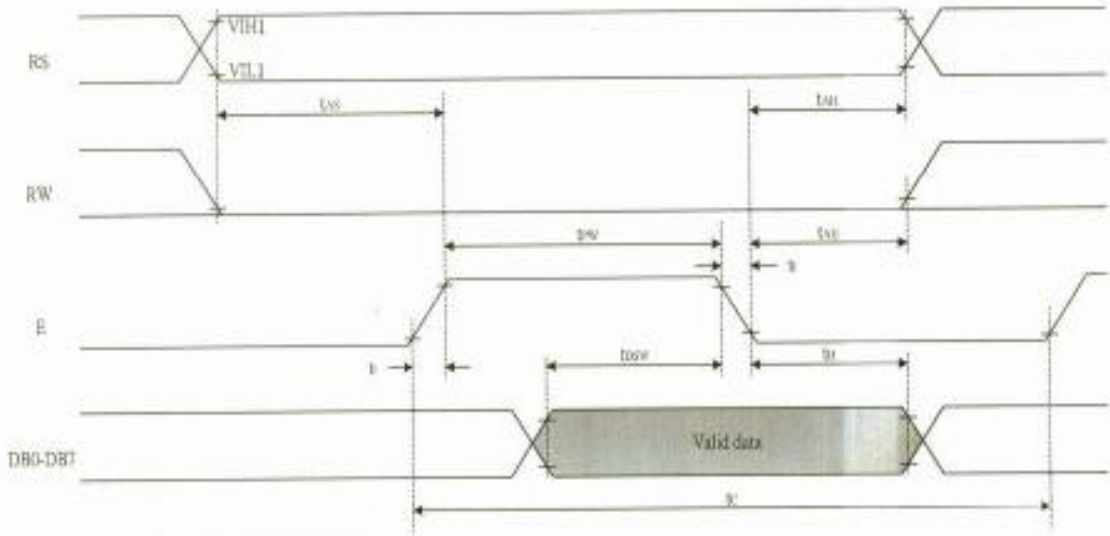
7.2 AC CHARACTERISTICS

(Ta = 25°, VCC = 5V)

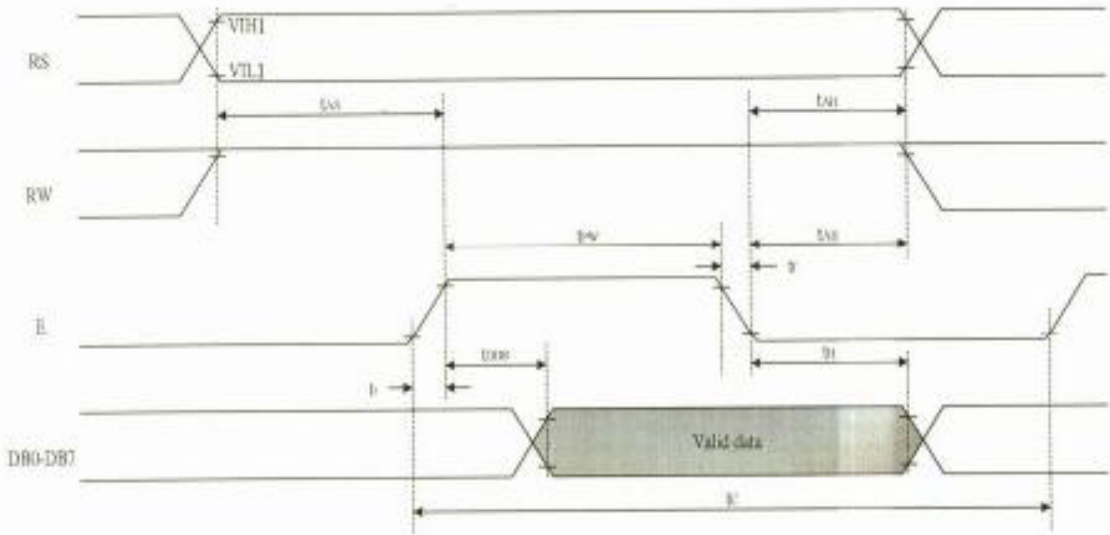
Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
INTERNAL CLOCK OPERATION						
f _{OSC}	OSC Frequency	R=91KΩ	190	270	350	KHz
EXTERNAL CLOCK OPERATION						
f _{EX}	External Frequency	--	125	270	410	KHz
	Duty Cycle	--	45	50	55	%
T _R , T _F	Rise/Fall Time	--	--	--	0.2	μs
WRITE MODE (Writing 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

7.3 TIMING CHARACTERISTICS

● Writing data from MPU to ST7066U



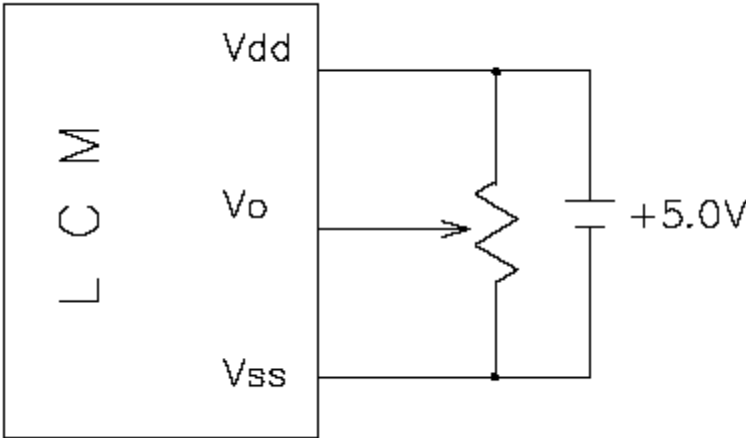
● Reading data from ST7066U to MPU



7.4 CHARACTERISTIC FONT

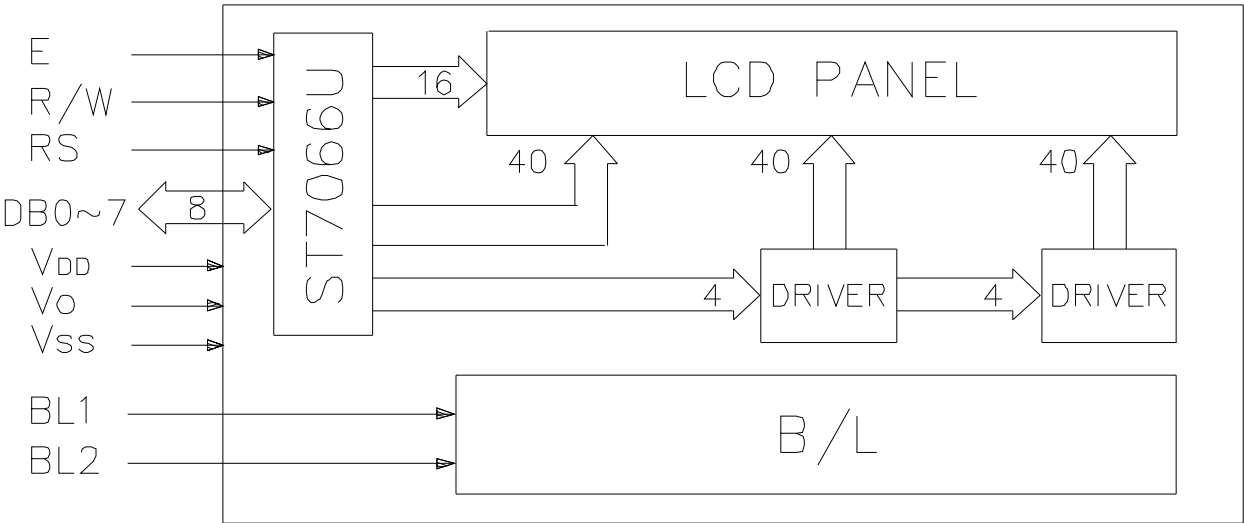
b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)		0	1	2	3	4	5				6	7	8	9	A
0001	(2)	!	1	A	Q	a	q				2	3	4	5	6	7
0010	(3)	"	2	B	R	b	r				4	5	6	7	8	9
0011	(4)	#	3	C	S	c	s				6	7	8	9	0	1
0100	(5)	\$	4	D	T	d	t				8	9	0	1	2	3
0101	(6)	%	5	E	U	e	u				0	1	2	3	4	5
0110	(7)	&	6	F	V	f	v				2	3	4	5	6	7
0111	(8)	'	7	G	W	g	w				4	5	6	7	8	9
1000	(1)	<	8	H	X	h	x				6	7	8	9	0	1
1001	(2)	>	9	I	Y	i	y				8	9	0	1	2	3
1010	(3)	*	:	J	Z	j	z				0	1	2	3	4	5
1011	(4)	+	;	K	[	k	[				2	3	4	5	6	7
1100	(5)	,	<	L	*	l	l				4	5	6	7	8	9
1101	(6)	-	=	M	]	m	]				6	7	8	9	0	1
1110	(7)	.	>	N	^	n	^				8	9	0	1	2	3
1111	(8)	/	?	O	_	o	+				0	1	2	3	4	5

8 POWER SUPPLY



RECOMMENDED V_R: 10K ohm ~ 20K ohm

9 BLOCK DIAGRAM



10 RELIABILITY TEST

10.1 RELIABILITY (Normal Temp. LCM)

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	No abnormalities in function* and appearance**
Thermal Shock Storage (None operation)	-20°C (30 min.)→ 25°C (5 min.) → 70°C (30 min.) → 25°C (5 min.) 5 cycle	No abnormalities in function* and appearance**
Vibration (None operation)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycle / per axis	No abnormalities in function* and appearance**

10.2 RELIABILITY (Wide Temp. LCM)

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	No abnormalities in function* and appearance**
Thermal Shock Storage (None operation)	-30°C (30 min.)→ 25°C (5 min.) → 80°C (30 min.) → 25°C (5 min.) 5 cycle	No abnormalities in function* and appearance**
Vibration (None operation)	10 Hz ~ 55 Hz 0.3 mm / 1 Octave 55 Hz ~ 500 Hz 3g / 1 Octave 20 cycle / per axis	No abnormalities in function* and appearance**

10.3 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 QUALITY ASSURANCE SPECIFICATION

11.1 CONFORMITY

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

11.2 DELIVERY ASSURANCE

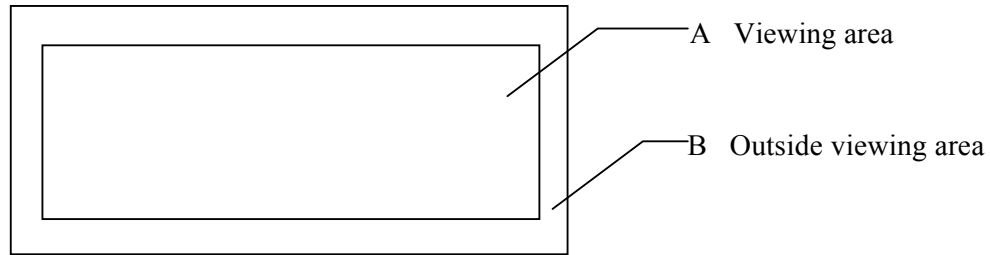
11.2.1 Delivery inspection standards

- IPC-AA610, class 2 electronic assemblies standard

The quality assurance levels are shown below:

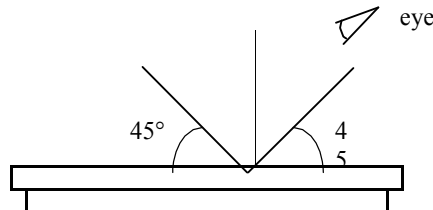
Rank	Item Inspected	Defect type	AQL	Remark
Major defect	Display	Non display	0.25%	Fit/Function defect
		Over current		
		Missing segment		
		Wrong viewing direction		
		Incorrect operating		
		Backlight OFF		
	Backlight flashing			
Dimension	PCB and bezel out of specification			
Minor defect	LCD	Black and white spot	1.0%	Appearance defect
		Black and white lines		
		Polariser scratch		
		Bubbles in polariser		
		Segment deformation, pin hole		
		Colour uniformity		
		Glass chip		
	COB	Wire bond pad exposed		
		Insufficient covering with resin (wire bond line exposed)		
		Bubble, dust on COB		
	PCB	Dust, solder ball on PCB		
		Pad scratch		
Tray	Particles	Every tray		
Total			1.0%	

11.2.2 Zone definition



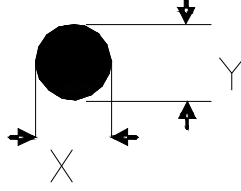
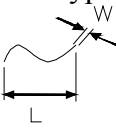
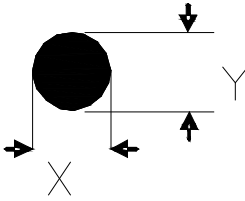
11.2.3 Visual inspection

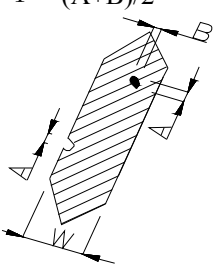
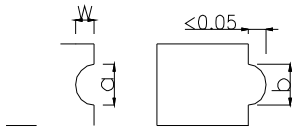
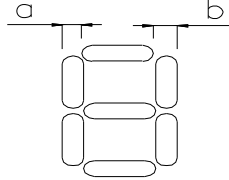
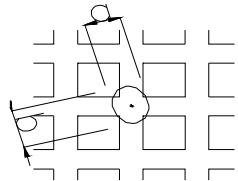
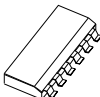
- Inspect under 2x20W or 40W fluorescent lamp (approximately 3000 lux) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye (measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted considering clearness and crosstalk on screen).
- Inspect the module at 45° right and left, top and bottom.
- Use the optimum viewing angle during the contrast inspection.



11.2.3.1 Standard of appearance inspection

units: mm

No.	Item	Criteria																															
1	Black spot, White spot, dust	<p>Round type: as per following drawing $\Phi = (X+Y)/2$</p>  <table border="1" data-bbox="781 474 1268 653"> <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>$\Phi < 0.2$</td> <td>Any number</td> <td rowspan="3">Any number</td> </tr> <tr> <td>$0.2 < \Phi < 0.25$</td> <td>3</td> </tr> <tr> <td>$0.25 < \Phi$</td> <td>0</td> </tr> </tbody> </table> <p>Line type: as per following drawing</p>  <table border="1" data-bbox="660 779 1333 963"> <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>$W \leq 0.03$</td> <td>Any number</td> <td rowspan="3">Any number</td> </tr> <tr> <td>$L \leq 3$</td> <td>$0.03 < W \leq 0.05$</td> <td></td> </tr> <tr> <td>-</td> <td>$0.05 < W$</td> <td>As round type</td> </tr> </tbody> </table> <p>Total acceptable quantity: 5 Note : Zone A means viewing area and Zone B means other area except viewing area.</p>	Acceptable quantity			size	Zone A	Zone B	$\Phi < 0.2$	Any number	Any number	$0.2 < \Phi < 0.25$	3	$0.25 < \Phi$	0	Acceptable quantity				Length	Width	Zone A	Zone B	-	$W \leq 0.03$	Any number	Any number	$L \leq 3$	$0.03 < W \leq 0.05$		-	$0.05 < W$	As round type
Acceptable quantity																																	
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$0.25 < \Phi$	0																																
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$L \leq 3$	$0.03 < W \leq 0.05$																																
-	$0.05 < W$	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>$\Phi = (X+Y)/2$</p>  <table border="1" data-bbox="805 1215 1268 1434"> <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>$\Phi < 0.2$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.2 < \Phi < 0.5$</td> <td>3</td> </tr> <tr> <td>$0.5 < \Phi < 1.0$</td> <td>1</td> </tr> <tr> <td>$1.0 < \Phi$</td> <td>0</td> </tr> </tbody> </table> <p>Total acceptable quantity: 4 Note : Zone A means viewing area and Zone B means other area except viewing area.</p>	Acceptable quantity			Size	Zone A	Zone B	$\Phi < 0.2$	Any number	Any number	$0.2 < \Phi < 0.5$	3	$0.5 < \Phi < 1.0$	1	$1.0 < \Phi$	0																
Acceptable quantity																																	
Size	Zone A	Zone B																															
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$0.2 < \Phi < 0.5$	3																																
$0.5 < \Phi < 1.0$	1																																
$1.0 < \Phi$	0																																

4	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width $\Phi = (A+B)/2$</p>  <table border="1" data-bbox="738 315 1291 556"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th>Φ</th> </tr> </thead> <tbody> <tr> <td>$W \leq 0.4$</td> <td>$\Phi \leq 0.2$ and $\Phi \leq 1/2W$</td> </tr> <tr> <td>$W > 0.4$</td> <td>$\Phi \leq 0.25$ and $\Phi \leq 1/3W$</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> </tbody> </table>	Acceptable quantity		Width	Φ	$W \leq 0.4$	$\Phi \leq 0.2$ and $\Phi \leq 1/2W$	$W > 0.4$	$\Phi \leq 0.25$ and $\Phi \leq 1/3W$	Total acceptable quantity: 1 defect per segment Pin holes with Φ under 0.10 mm are acceptable.																			
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$W > 0.4$	$\Phi \leq 0.25$ and $\Phi \leq 1/3W$																													
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5	Black spot, White spot, dust	<p>1b. Pin hole on dot matrix display</p>  <table border="1" data-bbox="876 651 1307 829"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>$a, b < 0.1$</td> <td>Any number</td> </tr> <tr> <td>$(a+b)/2 \leq 0.1$</td> <td>Any number</td> </tr> <tr> <td>$0.5 < \Phi < 1.0$</td> <td>3</td> </tr> </tbody> </table> <p>Total acceptable quantity: 7</p> <p>2. Segments / dots with different width</p>  <table border="1" data-bbox="876 997 1307 1102"> <thead> <tr> <th colspan="2">Acceptable</th> </tr> </thead> <tbody> <tr> <td>$a \geq b$</td> <td>$a/b \leq 4/3$</td> </tr> <tr> <td>$a < b$</td> <td>$a/b > 4/3$</td> </tr> </tbody> </table> <p>3. Alignment layer defect $\Phi = (a+b)/2$</p>  <table border="1" data-bbox="876 1176 1307 1386"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.4$</td> <td>Any number</td> </tr> <tr> <td>$0.4 < \Phi \leq 1.0$</td> <td>5</td> </tr> <tr> <td>$1.0 < \Phi \leq 1.5$</td> <td>3</td> </tr> <tr> <td>$1.5 < \Phi \leq 2.0$</td> <td>2</td> </tr> </tbody> </table>	Acceptable quantity		Size		$a, b < 0.1$	Any number	$(a+b)/2 \leq 0.1$	Any number	$0.5 < \Phi < 1.0$	3	Acceptable		$a \geq b$	$a/b \leq 4/3$	$a < b$	$a/b > 4/3$	Acceptable quantity		Size		$\Phi \leq 0.4$	Any number	$0.4 < \Phi \leq 1.0$	5	$1.0 < \Phi \leq 1.5$	3	$1.5 < \Phi \leq 2.0$	2
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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																												

12 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LR2227①②2C24③④⑤

①

Polarizer Type

A = Reflective
B = Transflective
E = Transmissive Negative
F = Transmissive Positive

②

Backlight Color

B = Blue-Green
W = White

③

Fluid Type and Temperature Range

S = Standard temperature range
H = Wide temperature range

④

Fluid Type and Temperature Compensation

N = STN

⑤

Background Color

Y = Yellow mode STN
G = Gray mode STN
B = Blue Mode STN

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°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).

Product No.	LR2227	REV. A
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