

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

CUSTOMER	Standard	
PRODUCT NUMBER	LMRD4228	
CUSTOMER APPROVAL		Date 23rd June 2008

INTERNAL APPROVALS		
Product Mgr	Doc Control	Electr. Eng
Elijah Ebo	Anthony Perkins	Bazile Peter
Date: 23/06/08	Date: 23/06/08	Date: 23/06/08

- Approval for Specification only
- Approval for Specification and Sample

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REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
A				Product release	
B	23/06/08			Line Driver changed to Neotec NT7086	

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1 MAIN FEATURES

ITEM	CONTENTS
Display Format	128 x 164 dots
Overall Dimensions	87.0 x 71.0 x 11.0 mm (EL type without NVTC) 87.0 x 71.0 x 13.0 mm (EL type with NVTC) 87.0 x 71.0 x 15.6 mm (Array LED type without NVTC) 87.0 x 71.0 x 17.6 mm (Array LED type with NVTC)
Viewing Area	62.5 x 43.5 mm
LCD type	STN
Mode	Reflective or Transflective
Viewing Angle	6 O clock
Duty ratio	1 / 64
Driver IC	Toshiba 6963
Backlight type	EL / LED
Backlight colour	Array LED – Yellow Green EL – Blue Green
DC/DC converter	Optional
Operating temperature normal	0 ~ +50°C
Operating temperature wide	-20 ~ + +70°C
Storage temperature normal	-20 ~ + +70°C
Storage temperature wide	-30 ~ +80°C
RoHS status	Compliant

* NVTC: Negative voltage generator and temperature compensation

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2 MECHANICAL SPECIFICATION

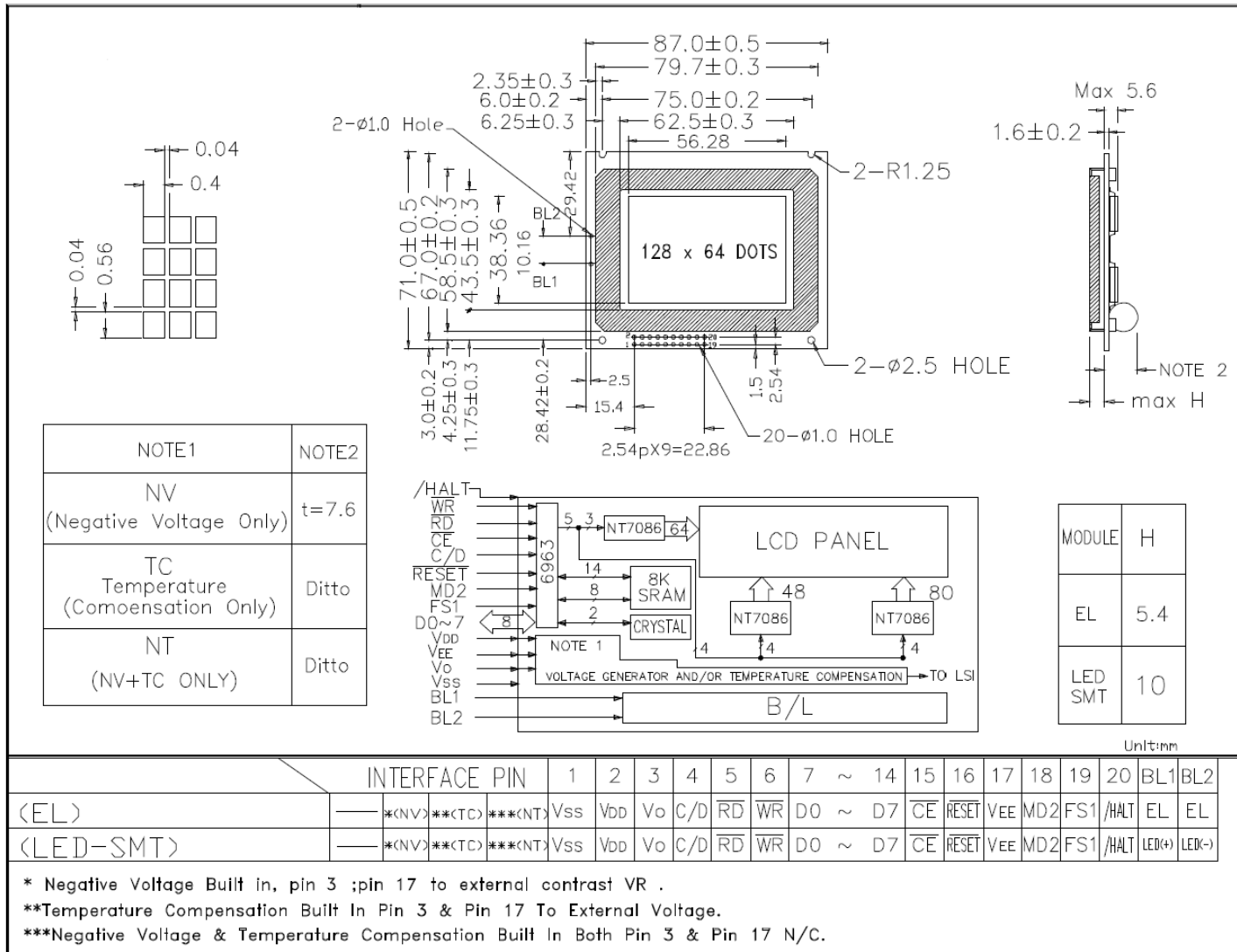
2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	128 x 164	
Overall Dimensions	87.0 x 71.0 x 11.0 (EL type without NVTC) 87.0 x 71.0 x 13.0 (EL type with NVTC) 87.0 x 71.0 x 15.6 (Array LED type without NVTC) 87.0 x 71.0 x 17.6 (Array LED type with NVTC)	mm
Viewing Area	62.5 x 43.5	mm
Active Area	56.28 x 38.36	mm
Dot Size	0.40 x 0.56	mm
Dot Pitch	0.04	mm
IC Controller/Driver	Toshiba 6963	

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2.2 MECHANICAL DRAWING



3 ELECTRICAL SPECIFICATION

3.1 ABSOLUTE MAXIMUM RATINGS

Ta = 25 °C

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage	V _{DD}	0	7	V	50 ± 10% RH
Operating Temperature normal	T _{opr}	0	50	°C	Note 1
Operating Temperature wide		-20	+70		
Storage Temperature normal	T _{stg}	-20	+70	°C	Note 2
Storage Temperature wide		-30	+80		
		20	90	%RH	<48 hrs
		20	65		< 1000 hrs
Static Electricity	Be sure that you are grounded when handling displays.				

Note 1: Background colour changes slightly depending on ambient temperature. This phenomenon is reversible. Ta ≤ 70 °C: 75% RH max

Note 2: Ta ≤ 80 °C: 75% RH max

3.2 ELECTRICAL CHARACTERISTICS

VSS = 0 V, Ta = 25 °C

Item	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage	V _{DD}		4.75	-	5.25	V
Input Voltage	Low V _{ILc}		0	-	0.2V _{DD}	V
	High V _{IHC}		0.8 V _{DD}	-	V _{DD}	V
LCD Driving Voltage	V _{DD} - V _O		8	V	28.0	V

3.2.1 Current Consumption & Driving Voltage

		FSTN		STN	
		Normal	Wide	Normal	Wide
Supply current, (I _{DD}) Max, mA		N/A	N/A	7	7
Supply current (I _{EE}) Typ, mA		N/A	N/A	2	2
Recommended LCD drive voltage					
LCD driving voltage	Ta = -20°C	N/A	N/A	N/A	17.8
	Ta = 0°C	N/A	N/A	16.2	16.2
	Ta = 25°C	N/A	N/A	14.6	14.6
	Ta = 50°C	N/A	N/A	13.5	13.5
	Ta = 70°C	N/A	N/A	N/A	12.4

Note: The I_{DD} is 90mA(typ.) if negative voltage or is built in

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3.3 INTERFACE PIN ASSIGNMENT LMRD3228

No.	Symbol	Function
1	V _{SS}	Ground
2	V _{DD}	Power supply for logic
3	V _O	Voltage Level for LCD Control Adjustment
4	C/D	WRITE MODE H: Command Write L: Data Write READ MODE H: Status Read L: Data Read
5	/RD	Data AND Status Read Signal
6	/WR	Command and Data Write Signal
7~14	D0~D7	Display Data 0~7
15	/CE	Chip Enable Signal
16	/RESET	Reset Signal
17	V _{ee}	Power supply for LCD drive
18	MD2	Terminals for selection for Columns
19	FS1	Terminals for selection of font **
20	/Halt	H: normal, L: Stops the oscillation of the clock
BL1	EL	EL
BL2	EL	EL

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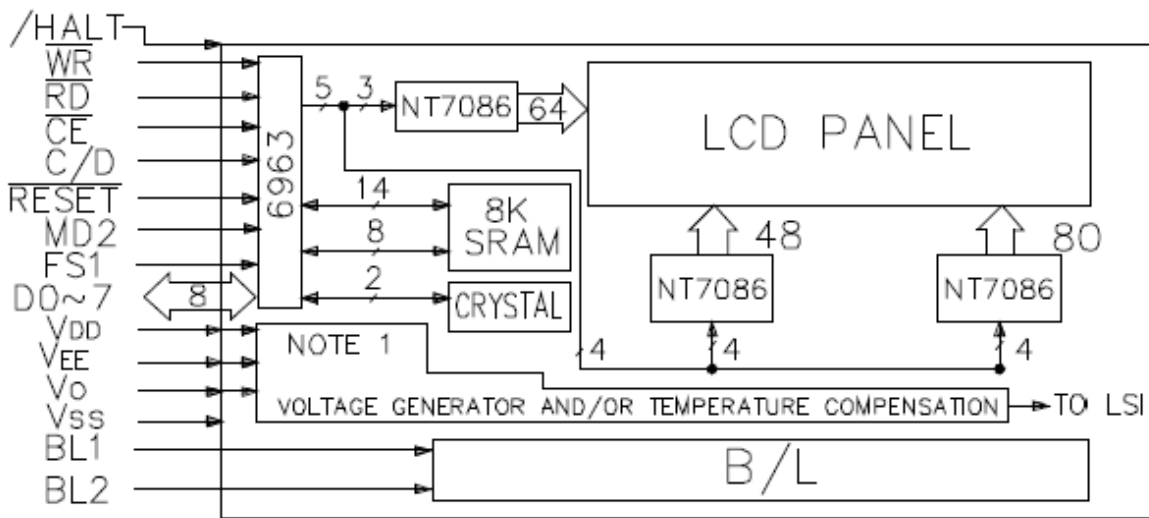
3.4 INTERFACE PIN ASSIGNMENT LMRD4228

No.	Symbol	Function
1	V _{SS}	Ground
2	V _{DD}	Power supply for logic
3	V _O	Voltage Level for LCD Control Adjustment
4	C/D	WRITE MODE H: Command Write L: Data Write READ MODE H: Status Read L: Data Read
5	/RD	Data AND Status Read Signal
6	/WR	Command and Data Write Signal
7~14	D0~D7	Display Data 0~7
15	/CE	Chip Enable Signal
16	/RESET	Reset Signal
17	V _{ee}	Power supply for LCD drive
18	MD2	Terminals for selection for Columns
19	FS1	Terminals for selection of font **
20	/Halt	H: normal, L: Stops the oscillation of the clock
BL1	LED(+)	Anode of LED backlight
BL2	LED(-)	Cathode of LED backlight

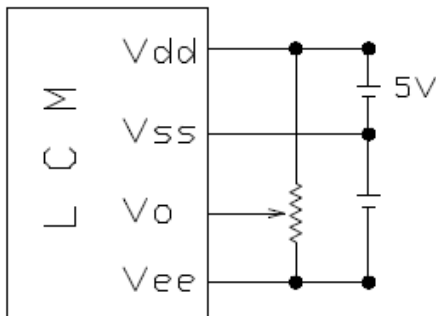
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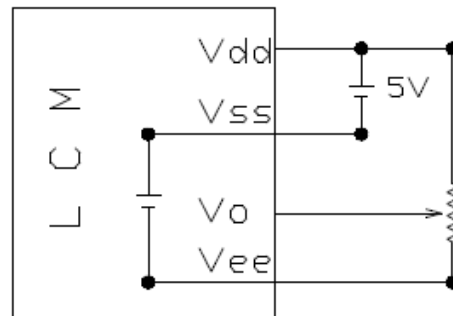
4 BLOCK DIAGRAM



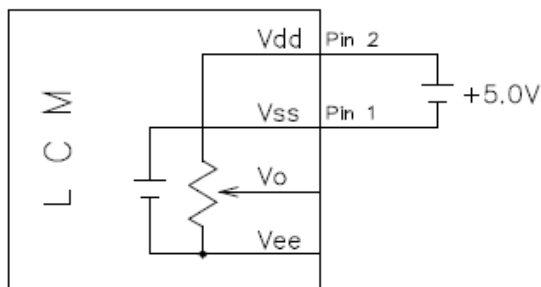
4.1 POWER SUPPLY CIRCUIT



NEGATIVE VOLTAGE
NOT BUILT IN



NEGATIVE VOLTAGE
BUILT IN



NEGATIVE VOLTAGE & TEMPERATURE
COMPENSATION BUILT IN

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4.2 CHARACTER GENERATOR ROM MAP

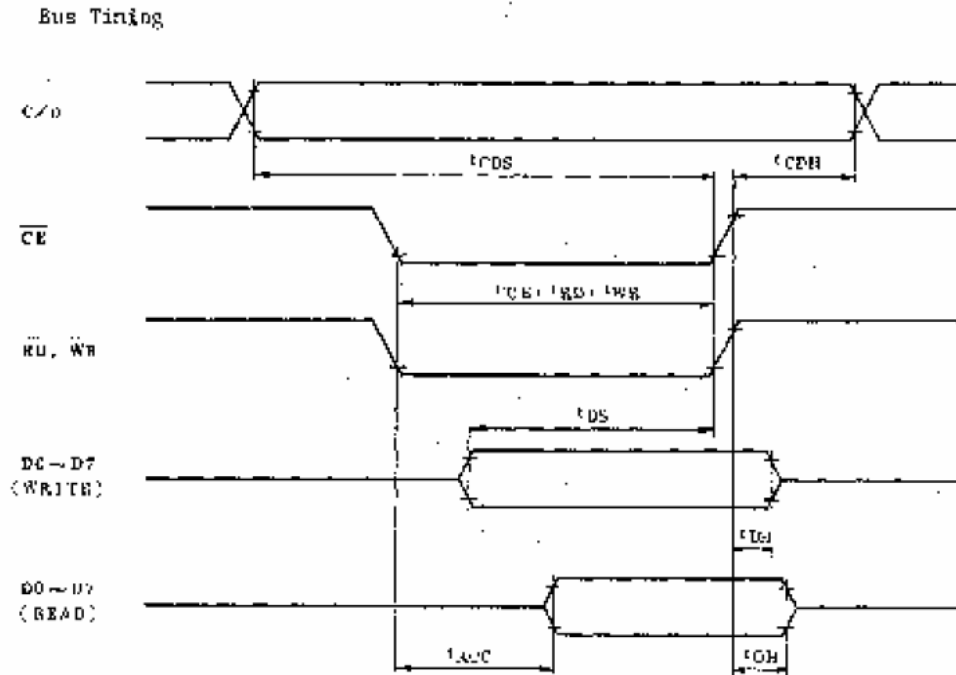
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E	8	9	A	B	C	D	E	F
D	G	H	I	J	K	L	M	N
C	O	P	Q	R	S	T	U	V
B	W	X	Y	Z	[]	^	_
A	`	a	b	c	d	e	f	g
M	h	i	j	k	l	m	n	o
K	p	q	r	s	t	u	v	w
7	x	y	z	{	}	~		
6								
5								
4								
3								
2								
1								
0								
3.5H MSB	0	1	2	3	4	5	6	7

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5 TIMING CHARACTERISTICS

5.1 Read/Write Timing



Unless otherwise specified, $V_{DD}=5.0V\pm10\%$, $V_{SS}=0V$, $T_a=-10-70^\circ C$

ITEM	SYMBOL	TEST CONDITION	MIN.	MAX.	UNIT
C/D Set Up Time	t_{CDS}		100	-	ns
C/D Hold Time	t_{CDH}		10	-	ns
CE, RD, WR Pulse Width	t_{CE}, t_{RD}, t_{WR}		80	-	ns
Data Set Up Time	t_{DS}		50	-	ns
Data Hold Time	t_{DH}		40	-	ns
Access Time	t_{ACC}		-	150	ns
Output Hold Time	t_{OH}		10	50	ns

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6 OPTICAL SPECIFICATION

6.1 OPTICAL CHARACTERISTICS

6.1.1 STN Type

Ta = 25 °C

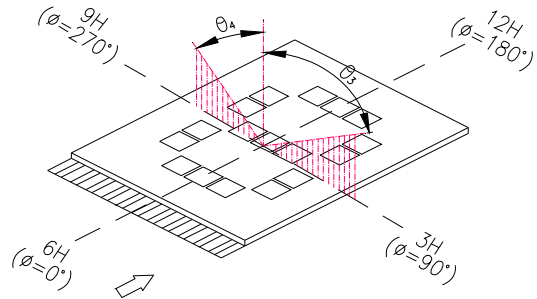
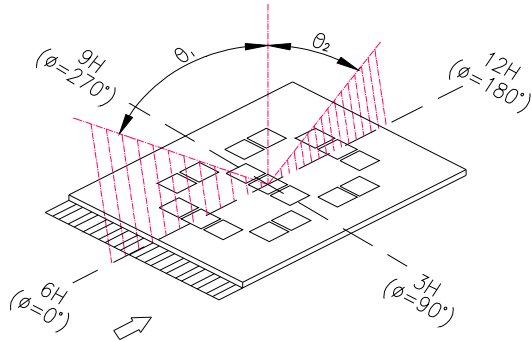
Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Viewing Angle	θ1	CR≥2	-	35	-	deg	1
	θ2	CR≥2	-	25	-	deg	1
	θ3	CR≥2	-	35	-	deg	2
	θ4	CR≥2	-	35	-	deg	2
Contrast Ratio	CR	Ta = 25 °C	4	-	-	-	3
Response Time	Tr	Ta = 25 °C	-	-	240	ms	4
	Tf	Ta = 25 °C	-	-	240		
Driving Method	Duty	1/164					
	Bias	1/9					
LCD Type	STN						
Viewing Direction	6 O'CLOCK						

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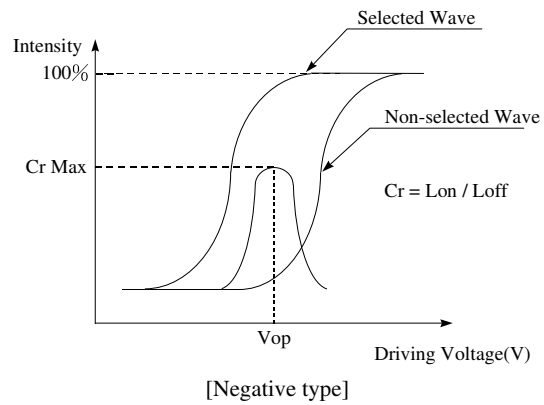
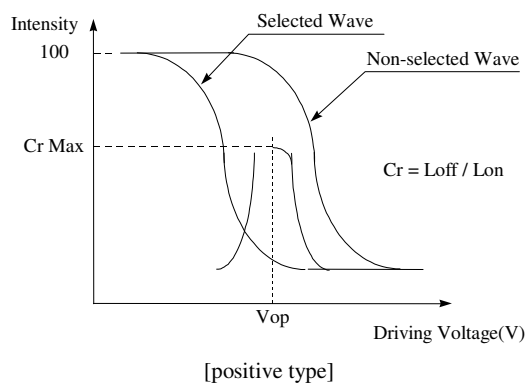
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Note 1: definition of viewing angle θ_1 & θ_2

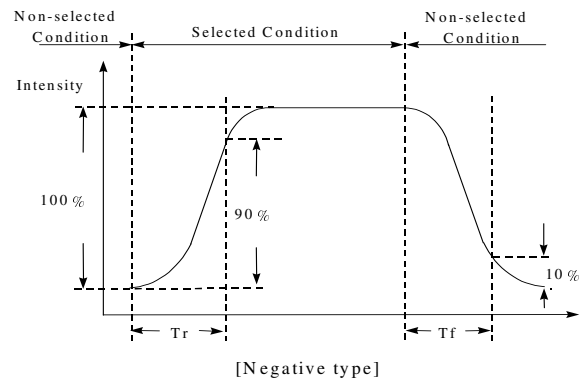
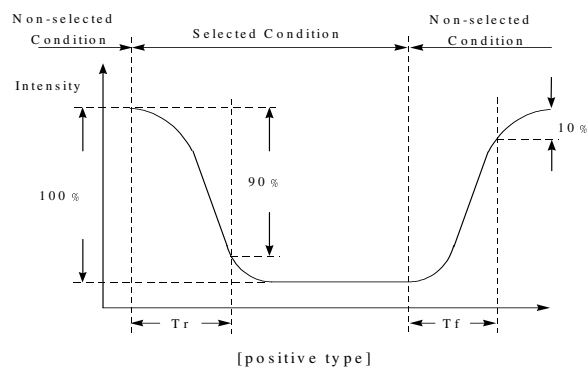
Note 2: definition of viewing angle θ_3 & θ_4



Note 3: definition of contrast ratio (CR)



Note 4: definition of response time



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7 BACKLIGHT SPECIFICATION

7.1 BACKLIGHT CHARACTERISTICS

7.1.1 LMRD3228 (EL)

Item	Condition	Min	Typ	Max	Unit
Input Voltage	Ta=25°C (400~800 Hz)		100		Vrms
Current consumption	Ta=25°C		12.0		mA
Average Brightness Ta=25°C I=12.0mA	Test when connecting after 3min. (max contrast) Ta=25°C		50		cd/m ² Note 1
Life time	Ta=25°C, I = 12.0 mA Humidity: 30% RH~85%RH		5000		Hrs Note 2
Operating temperature	Humidity: 30% RH~85% RH	-20		70	°C
Storage temperature	Humidity: 30% RH~85% RH	-30		80	°C

7.1.2 LMRD4228 (Array LED)

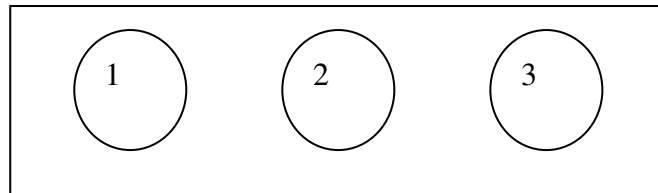
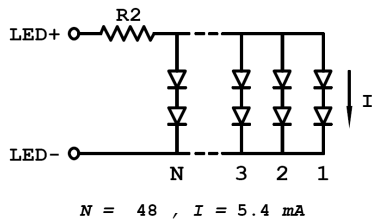
Item	Condition	Min	Typ	Max	Unit
Input Voltage	Ta=25°C		5.0		V(DC)
Current consumption	Ta=25°C		260		mA
Average Brightness Ta=25°C IL=260mA	Test when connecting after 3min. (max contrast) Ta=25°C		110		cd/m ² Note 1
Peak Emission Wavelength	Ta=25°C, IL = 260mA	565	570	575	nm
Brightness Uniformity	Ta=25°C, IL = 260mA	80			% Note 2
Life time	Ta=25°C, IL= 260 mA Humidity: 30% RH~85%RH		50000		Hrs Note 3
Operating temperature	Humidity: 30% RH~85% RH	-20		70	°C
Storage temperature	Humidity: 30% RH~85% RH	-30		80	°C
Limit Resistor	Ta=25°C		4.5		OHM Note 4

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Note:

1. Average brightness of 3 points when the B/L is used at the beginning.
2. Brightness uniformity = (MAX-MIN) / MAX x 100
3. Half of the original brightness
4. Suggested BL current limit resistor on customer board



7.2 LABELLING & MARKING

DENSITRON
LMRD3228 or LMRD4228
Taiwan YYMM

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8 QUALITY ASSURANCE SPECIFICATION

8.1 CONFORMITY

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

8.2 DELIVERY ASSURANCE

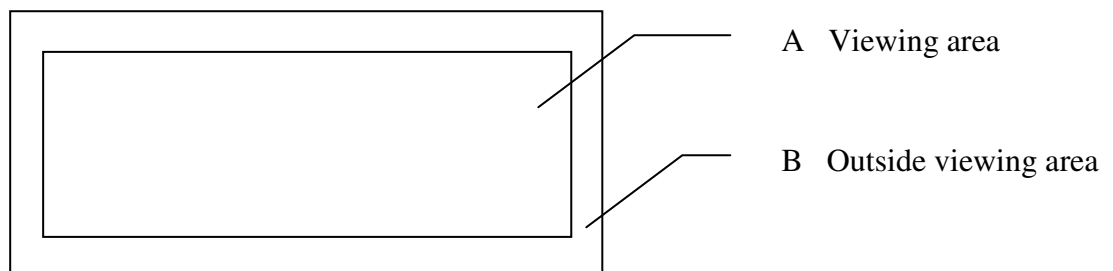
8.2.1 Delivery inspection standards

- MIL-STD-105E, general inspection level II, single sampling level;
- IPC-AA610 rev. C, class 2 electronic assemblies standard

The quality assurance levels are shown below:

Class	AQL (%)
Critical defect	0.65%
Major defect	1.0%
Minor defect	2.5%
TOTAL	2.5%

8.2.2 Zone definition

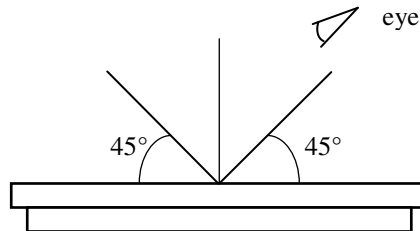


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8.2.3 Visual inspection

- 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.

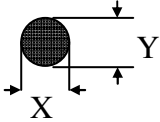
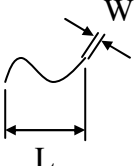
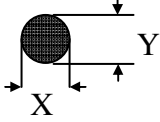


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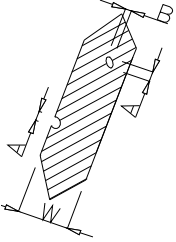
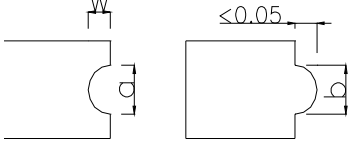
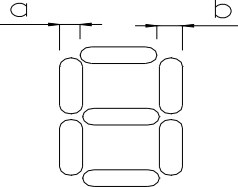
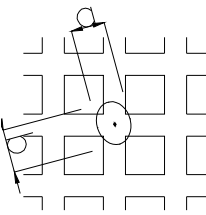
8.2.3.1 Standard of appearance inspection

Units: mm

Class	Item	Criteria																																				
Minor	Packing & Label	Outside & inside package Presence of product no., lot no., quantity																																				
Critical		Product must not be mixed with others and quantity must not be different from that indicated on the label																																				
Major	Dimension	Product dimensions must be according to specification and drawing																																				
Major	Electrical	Product electrical characteristics must be according to specification																																				
Critical	LCD Display	Missing lines or wrong patterns on LCD display are not allowed																																				
Minor	Black spot, white spot, dust	<p>Round type: as per following drawing $\varnothing = (X+Y)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <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>$\varnothing < 0.1$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.1 < \varnothing < 0.2$</td> <td>2</td> </tr> <tr> <td>$0.2 < \varnothing < 0.25$</td> <td>1</td> </tr> <tr> <td>$0.25 < \varnothing$</td> <td>0</td> </tr> </tbody> </table> <p>Line type: as per following drawing</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <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>$W \leq 0.02$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$L \leq 3.0$</td> <td>$0.02 < W \leq 0.03$</td> <td>2</td> </tr> <tr> <td>$L \leq 2.5$</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 style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.1$	Any number	Any number	$0.1 < \varnothing < 0.2$	2	$0.2 < \varnothing < 0.25$	1	$0.25 < \varnothing$	0	Acceptable quantity				Length	Width	Zone A	Zone B	--	$W \leq 0.02$	Any number	Any number	$L \leq 3.0$	$0.02 < W \leq 0.03$	2	$L \leq 2.5$	$0.03 < W \leq 0.05$		--	$0.05 < W$	As round type
Acceptable quantity																																						
Size	Zone A	Zone B																																				
$\varnothing < 0.1$	Any number	Any number																																				
$0.1 < \varnothing < 0.2$	2																																					
$0.2 < \varnothing < 0.25$	1																																					
$0.25 < \varnothing$	0																																					
Acceptable quantity																																						
Length	Width	Zone A	Zone B																																			
--	$W \leq 0.02$	Any number	Any number																																			
$L \leq 3.0$	$0.02 < W \leq 0.03$	2																																				
$L \leq 2.5$	$0.03 < W \leq 0.05$																																					
--	$0.05 < W$	As round type																																				
Minor	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1																																				
Minor	Polariser bubble	<p>$\varnothing = (X+Y)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <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>$\varnothing < 0.2$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.2 < \varnothing < 0.5$</td> <td>2</td> </tr> <tr> <td>$0.5 < \varnothing < 1.0$</td> <td>1</td> </tr> <tr> <td>$1.0 < \varnothing$</td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.2$	Any number	Any number	$0.2 < \varnothing < 0.5$	2	$0.5 < \varnothing < 1.0$	1	$1.0 < \varnothing$	0																					
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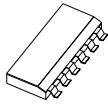
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Class	Item	Criteria																												
Minor	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width $\varnothing = (A+B)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th>Ø</th> </tr> </thead> <tbody> <tr> <td>W ≤ 0.4</td> <td>Ø ≤ 0.2 and Ø ≤ 1/2W</td> </tr> <tr> <td>W > 0.4</td> <td>Ø ≤ 0.25 and Ø ≤ 1/3W</td> </tr> </tbody> </table> <p>Total acceptable quantity: 1 defect per segment Pin holes with Ø under 0.10 mm are acceptable</p>	Acceptable quantity		Width	Ø	W ≤ 0.4	Ø ≤ 0.2 and Ø ≤ 1/2W	W > 0.4	Ø ≤ 0.25 and Ø ≤ 1/3W																				
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Minor	Colour uniformity	Level of sample for approval set as limit sample																												
Critical	Backlight	The backlight colour should correspond to the product specification																												
Critical		Flashing and or unlit backlight is not allowed																												
Minor		Dust larger than 0.25 mm is not allowed																												
Major	COB	Exposed wire bond pad is not allowed																												
Major		Insufficient covering with resin is not allowed (wire bond line exposed)																												
Minor		Dust or bubble on the resin are not allowed																												

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Class	Item	Criteria													
Major		No unmelted solder paste should be present on PCB													
Critical		Cold solder joints, missing solder connections, or oxidation are not allowed													
Minor		No residue or solder balls on PCB are allowed													
Critical		Short circuits on components are not allowed													
Minor	Tray particles	<table border="1"> <thead> <tr> <th></th> <th>Size</th> <th>Quantity</th> </tr> </thead> <tbody> <tr> <td rowspan="2">On tray</td> <td>$\varnothing < 0.2$</td> <td>Any number</td> </tr> <tr> <td>$\varnothing > 0.25$</td> <td>4</td> </tr> <tr> <td rowspan="2">On display</td> <td>$\varnothing \geq 0.25$</td> <td>2</td> </tr> <tr> <td>$L = 3$</td> <td>1</td> </tr> </tbody> </table>		Size	Quantity	On tray	$\varnothing < 0.2$	Any number	$\varnothing > 0.25$	4	On display	$\varnothing \geq 0.25$	2	$L = 3$	1
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8.3 DEALING WITH CUSTOMER COMPLAINTS

8.3.1 Non-conforming analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.

After accepting it, Densitron should complete the analysis in two weeks from receiving the sample.

If the analysis cannot be completed on time, Densitron must inform the purchaser.

8.3.2 Handling of non-conforming displays

If any non-conforming displays are found during customer acceptance inspection which Densitron is clearly responsible for, return them to Densitron.

Both Densitron and customer should analyse the reason and discuss the handling of non-conforming displays when the reason is not clear.

Equally, both sides should discuss and come to agreement for issues pertaining to modification of Densitron quality assurance standard.

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9 RELIABILITY SPECIFICATION

9.1 RELIABILITY TESTS

9.1.1 Normal Temperature Range

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	50°C ±2°C for 240 hours	No abnormalities in function* and appearance
Low Temperature Operation	0°C ±2°C for 240 hours	No abnormalities in function* and appearance
Thermal Shock Storage	-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	10Hz ~ 55Hz 0.3mm / 1 Octave 55Hz ~ 500Hz 3g / 1 Octave 20 cycle / per axis	No abnormalities in function* and appearance

9.1.2 Wide Temperature Range

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	70°C ±2°C for 240 hours	No abnormalities in function* and appearance
Low Temperature Operation	-20°C ±2°C for 240 hours	No abnormalities in function* and appearance
Thermal Shock Storage	-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	10Hz ~ 55Hz 0.3mm / 1 Octave 55Hz ~ 500Hz 3g / 1 Octave 20 cycle / per axis	No abnormalities in function* and appearance

9.2 LIFE TIME

Item	Description
1	Function, performance, appearance, etc. shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions of room temperature (25±10 °C), normal humidity (45±20% RH), and in area not exposed to direct sunlight.
2	Function, performance, appearance, etc. shall be free from remarkable deterioration within 5,000 hours under ordinary operating and storage conditions of 70 °C temperature, normal humidity (45±20% RH), and in area not exposed to direct sunlight.

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10 PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS

LMR①228②③240G320④⑤⑥

- ① 3 = EL backlight or no backlight option
4 = LED backlit version
- ② **POLARIZER TYPE**
B = Transflective: light background with LED backlight
A = Reflective (LMRD3228 only) No backlight
- ③ **BACKLIGHT COLOUR**
G = Green Yellow (or left blank for LMR3228)
- ④ **FLUID TYPE AND POWER SUPPLY**
D = Standard temperature range, negative supply voltage required
S = Standard temperature range, on board negative supply voltage generator
W = Wide temperature range; on-board negative supply voltage generator
H = Wide temperature range, negative supply voltage required
- ⑤ **TEMPERATURE COMPENSATION**
C = with on board temperature compensation circuitry
N = **No** on board temperature compensation and NTN Fluid
- ⑥ **Background Colour**
Y = Yellow mode
G = Grey mode

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10.1.1.1.1.1.1 *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 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).

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