DENSITRON®
DISPLAYS

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

CUSTOMER	Standard	
PRODUCT NUMBER	**LMR3287 / LMRD4287**	
CUSTOMER APPROVAL		**Date** **7th April 2014**

INTERNAL APPROVALS		
Product Mgr	Doc Control	Electr. Eng
Bruno Recaldini	**Anthony Perkins**	**Bazile Peter**
Date: 07/04/2014	Date: 07/04/2014	Date: 07/04/2014

☐ **Approval for Specification only**

☐ **Approval for Specification and Sample**

TABLE OF CONTENTS

Product No.	LMRD4287	REV. D	Page	2 / 28

REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
A	11/05/96			Product release	EO 0562
B	01/02/08			Change of line driver IC from OKI MSM5260 to Neotec NT7086	
C	07/12/10			Update VLCD	
D	01/04/14			Change of LCD Glass	

1 MAIN FEATURES

ITEM	CONTENTS
Display Format	240 x 64 dots
Overall Dimensions	154.0 x 57.0 x 17.2 mm LMRD4287 without NVTC
Viewing Area	112.0 x 31.5 mm
LCD type	STN
Mode	Reflective or Transflective
Viewing Angle	6 O clock
Duty ratio	1 / 64
Controller IC	T6963
Backlight type	LED
Backlight colour	Yellow Green LED
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

2 MECHANICAL SPECIFICATION

2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	240 x 64	
Overall Dimensions	154.0 x 57.0 x 17.2 LMRD4287 without NVTC	mm
Viewing Area	112.0 x 31.5	mm
Active Area	107.97 x 28.77	mm
Dot Size	0.42 x 0.42	mm
Dot Pitch	0.03	mm
IC Controller/Driver	T6963 / NT7086	

DENSITRON
DISPLAYS

2.2 MECHANICAL DRAWING

Unit: mm

MODULE	H
EL	4.7
LED SMT	10.7

INTERFACE PIN	1	2	3	4	5	6	7	~	14	15	16	17	18	19	20
	Vss	VDD	Vo	C/D	$\overline{RD}$	$\overline{WR}$	D0	~	D7	$\overline{CE}$	$\overline{RESET}$	VEE	MD2	FS1	N/A
								ditto							BL1	BL2
(EL)	*(NV)	**(NT)														EL
(LED-SMT)	*(NV)	**(NT)														LED(+)	LED(-)

*Negative Voltage Built in Pin 3;Pin 17 to External Contrast VR.
**Negative Voltage & Temperature Compensation Built in Both Pin 3 & Pin 17 N/C.

*Negative Voltage Built in Pin 3
**Negative Voltage & Temperature Compensation

NOTE 1		NOTE 2
NV (Negative Voltage Only)		8.6
NT (NV+Temperature Compensation)		8.6

Note :
1. The driver is Neotec. NT7086.

LCD PANEL

240 x 64 DOTS

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	$50 \pm 10\%$ RH
Input Voltage	Vin	0	V_{DD}	V	
Operating Temperature normal	Topr	0	50	°C	Note 1
Operating Temperature wide		-20	+70		
Storage Temperature normal	Tstg	-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	$V_{DD} - V_O$		8.0	--	25	V

3.2.1 Current Consumption & Driving Voltage

		FSTN		STN	
		Normal	Wide	Normal	Wide
Supply current, (I_{DD}) Max, mA		N/A	N/A	N/A	10
Supply current (I_{EE}) Typ, mA		N/A	N/A	N/A	3.5
Recommended LCD drive voltage					
LCD driving voltage	Ta = -20˚C	N/A	N/A	N/A	10.6
	Ta = 0˚C	N/A	N/A	N/A	10.0
	Ta = 25˚C	N/A	N/A	N/A	9.7
	Ta = 50˚C	N/A	N/A	N/A	9.5
	Ta = 70˚C	N/A	N/A	N/A	9.2

Note: 1. The Voltage tolerance is +/- 0.6V

3.3 INTERFACE PIN ASSIGNMENT LMRD3287 - Reflective

No.	Symbol	Function
1	V_{SS}	Ground
2	V_{DD}	Power supply for logic
3	Vo	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	DB0~DB7	Display Data 0~7
15	/CE	Chip Enable Signal
16	/RST	Reset Signal
17	Vee	Power supply for LCD drive
18	MD2	Terminals for selection for columns
19	FS1	Terminals for selection of font**
20	NC	No connection
BL1	LED+	Anode of LED B/L
BL2	LED -	Cathode of LED B/L

**

MD2	H	L	FS1	H	L
Columns	32	40	Font	6x8	8x8

3.4 INTERFACE PIN ASSIGNMENT LMRD4287 - Transflective

No.	Symbol	Function
1	V_{SS}	Ground
2	V_{DD}	Power supply for logic
3	Vo	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	DB0~DB7	Display Data 0~7
15	/CE	Chip Enable Signal
16	/RST	Reset Signal
17	Vee	Power supply for LCD drive
18	MD2	Terminals for selection for columns
19	FS1	Terminals for selection of font**
20	NC	No connection
BL1	LED(+)	Anode of LED backlight
BL2	LED(-)	Cathode of LED backlight

**

MD2	H	L	FS1	H	L
Columns	32	40	Font	6x8	8x8

4 BLOCK DIAGRAM
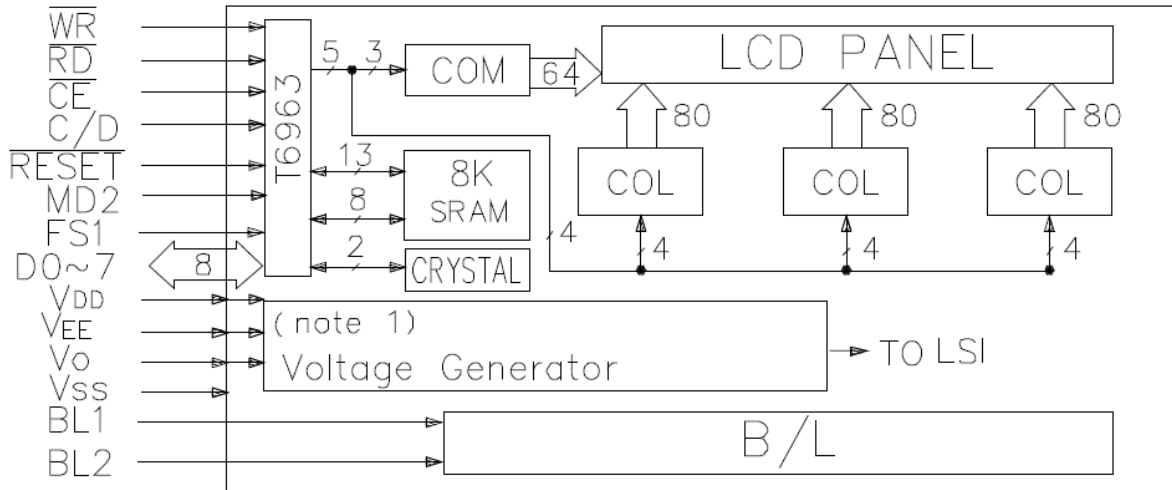
4.1 POWER SUPPLY CIRCUIT
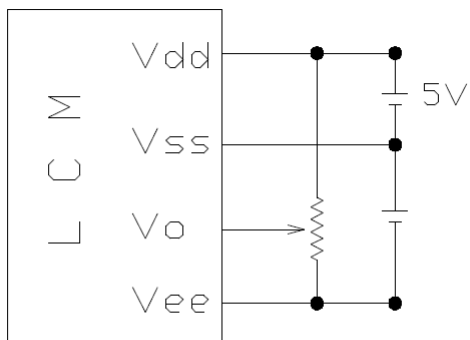
NEGATIVE VOLTAGE
NOT BUILD IN

4.2 CHARACTER GENERATOR ROM MAP

CHARACTER CODE MAP
ROM code 0101

CG ROM TYPE 0201

Product No.	LMRD4287	REV. D	Page	12 / 28

5 TIMING CHARECTERISTICS

5.1 Bus Timing
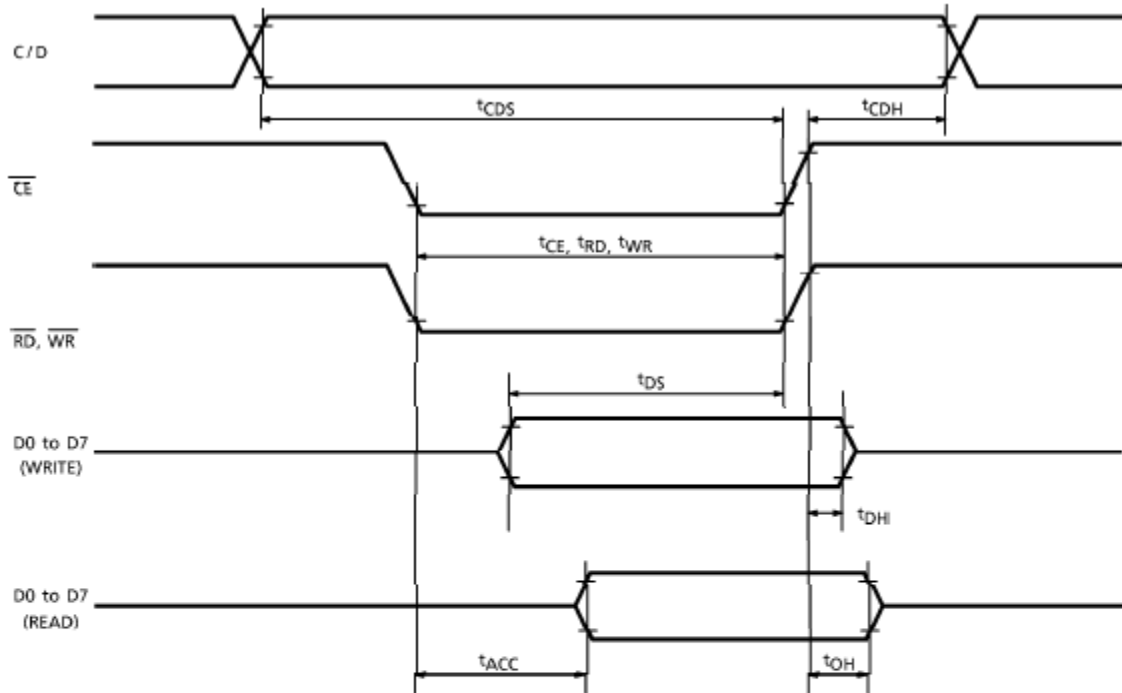
TEST CONDITIONS (Unless otherwise noted, V_{DD} = 5.0V ± 10%, V_{SS} = 0V, Ta = − 20 to 75°C)

| ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
C / D Set-up Time	t_{CDS}	—	100	—	ns
C / D Hold Time	t_{CDH}	—	10	—	ns
$\overline{CE}$, $\overline{RD}$, $\overline{WR}$ Pulse Width	t_{CE}, t_{RD}, t_{WR}	—	80	—	ns
Data Set-up Time	t_{DS}	—	80	—	ns
Data Hold Time	t_{DH}	—	40	—	ns
Access Time	t_{ACC}	—	—	150	ns
Output Hold Time	t_{OH}	—	10	50	ns

5.2 AC Characteristics
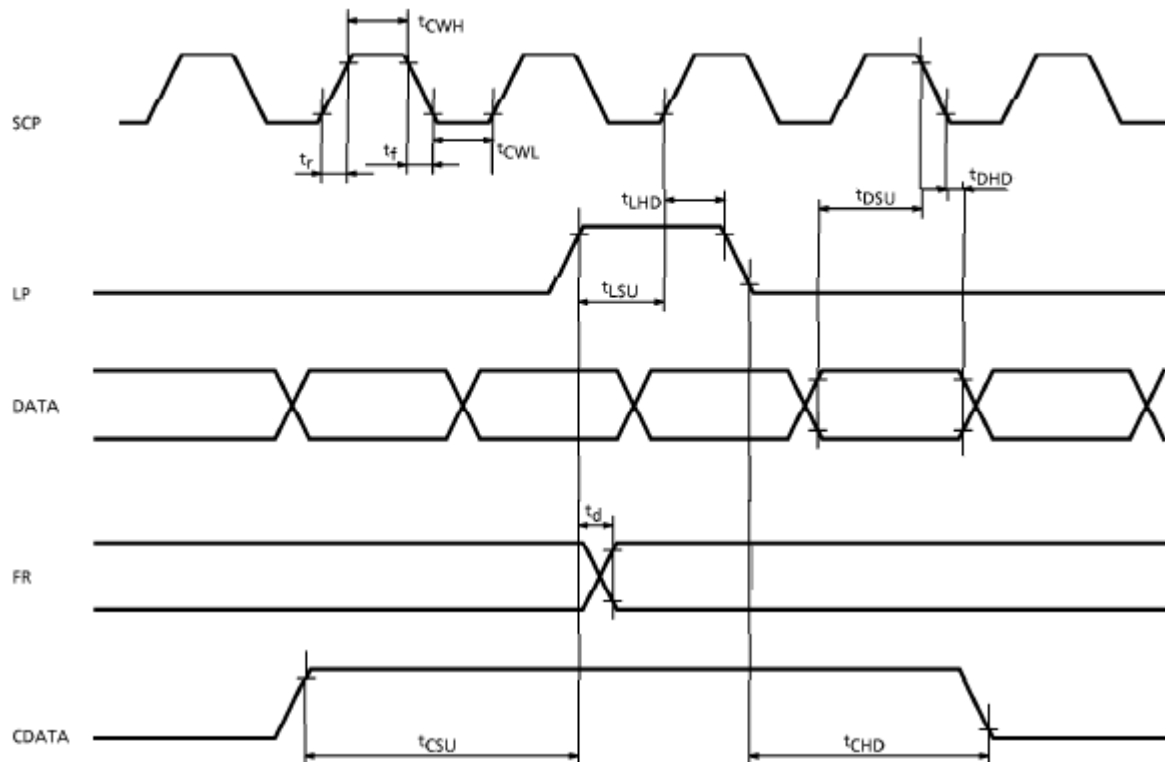
TEST CONDITIONS (Unless otherwise noted, V_{DD} = 5.0V ± 10%, V_{SS} = 0V, Ta = − 20 to 70°C)

ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Operating Frequency	f_{scp}	Ta = − 10~70°C	—	2.75	MHz
SCP Pulse Width	t_{CWH}, t_{CWL}	—	150	—	ns
SCP Rise / Fall Time	t_r, t_f	—	—	30	ns
LP Set-up Time	t_{LSU}	—	150	290	ns
LP Hold Time	t_{LHD}	—	5	40	ns
Data Set-up Time	t_{DSU}	—	170	—	ns
Data Hold Time	t_{DHD}	—	80	—	ns
FR Delay Time	t_d	—	0	90	ns
CDATA Set-up Time	t_{CSU}	—	450	850	ns
CDATA Hold Time	t_{CHD}	—	450	950	ns

	LMRD4287	REV. D		
Product No.			Page	14 / 28

5.3 Read/Write Timing
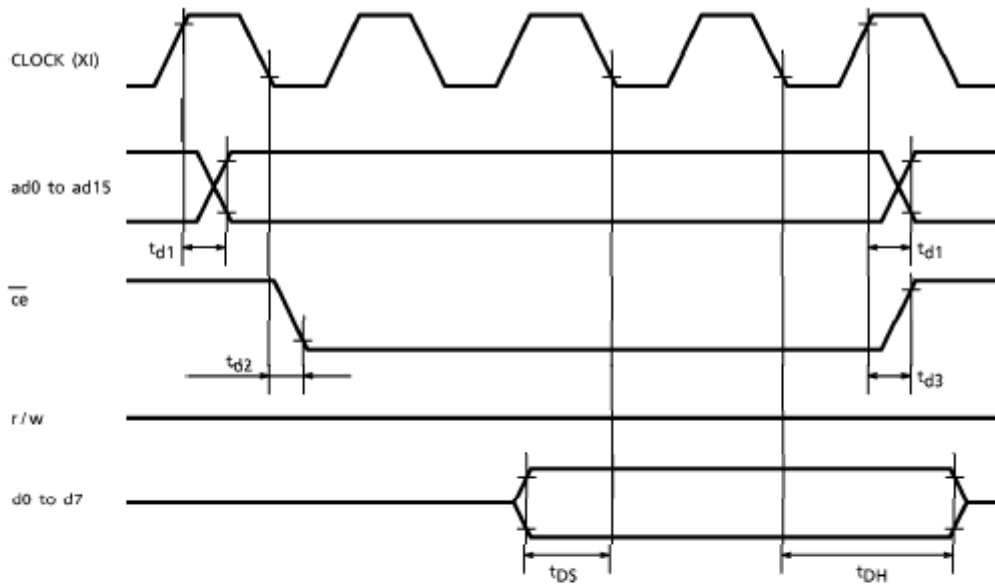
(2) External RAM Write mode
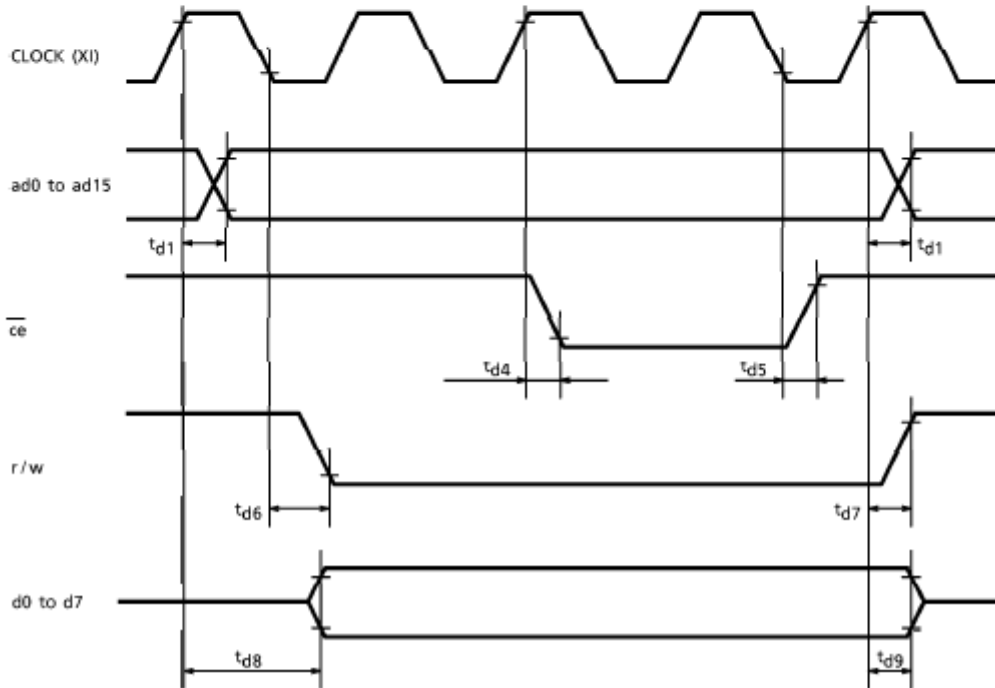
Product No.	LMRD4287	REV. D	Page	15 / 28

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		30		deg	1
	θ2	CR≥2		10		deg	1
	θ3	CR≥2		30		deg	2
	θ4	CR≥2		30		deg	2
Contrast Ratio	CR	Ta = 25 °C	2	4		-	3
Response Time	Tr	Ta = 25 °C		200		ms	4
	Tf	Ta = 25 °C		150			
Driving Method	Duty	1/64					
	Bias	1/9					
LCD Type	STN – Positive / Reflective / Transflective						
Viewing Direction	6 O'CLOCK						

Note 1: definition of viewing angle θ1 & θ2   Note 2: definition of viewing angle θ3 & θ4
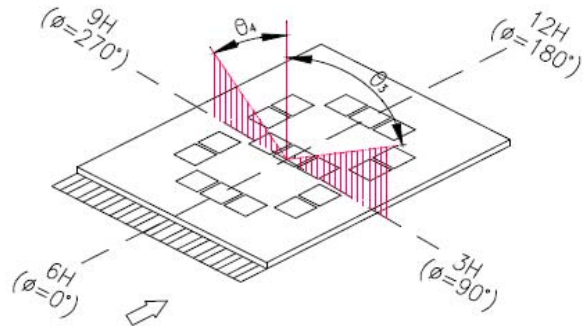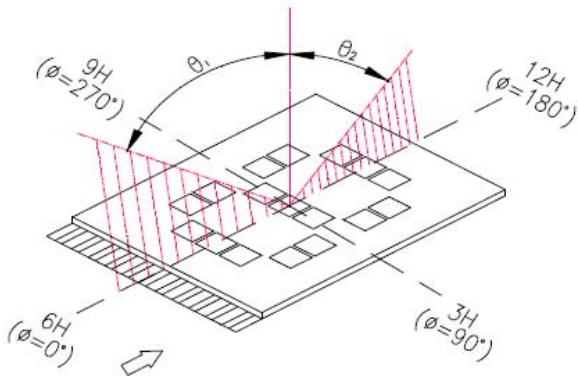
Note 3: definition of contrast ratio (CR)

$$Cr = Loff / Lon$$

[positive type]

$$Cr = Lon / Loff$$
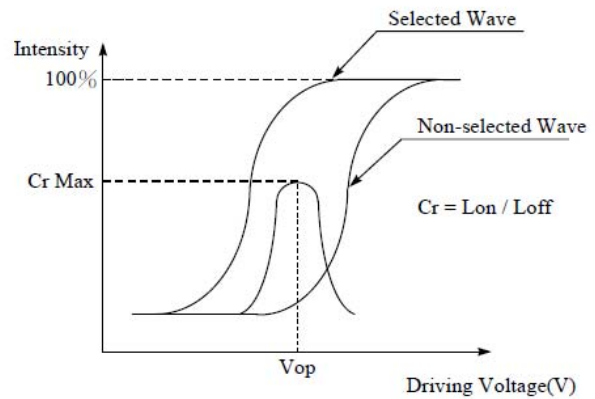
[Negative type]

Note 4: definition of response time
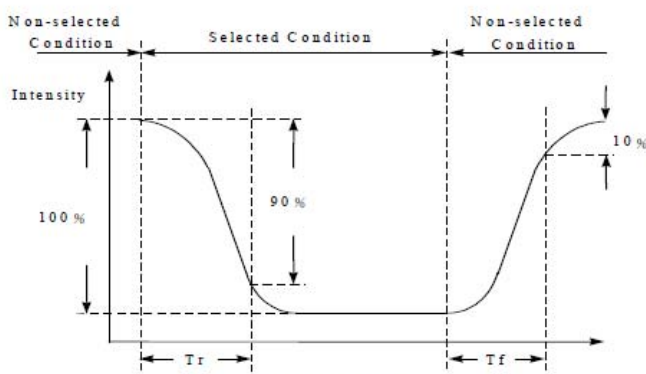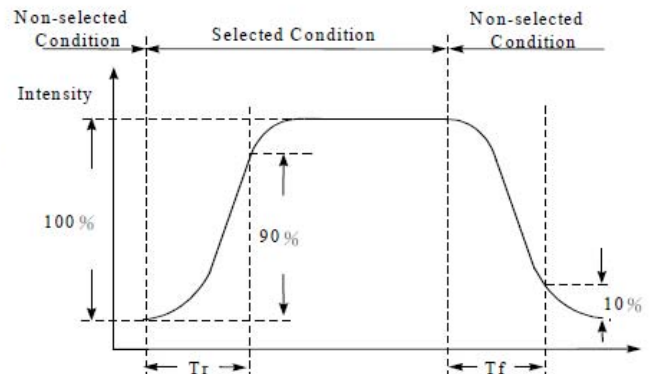
[positive type]   [Negative type]

Product No.	LMRD4287	REV. D		
			Page	17 / 28

7 BACKLIGHT SPECIFICATION

7.1 BACKLIGHT CHARACTERISTICS

7.1.1 LMRD4287 (Array LED)

Item	Condition	Min	Typ	Max	Unit
Input Voltage	Ta=25˚C		5.0		V(DC)
Current consumption	Ta=25˚C		500		mA
Average Brightness Ta=25˚C IL=380mA	Test when connecting after 3min. (max contrast) Ta=25˚C		170		cd/m² Note 1
Brightness Uniformity	Ta=25˚C, IL = 380mA	80			% Note 2
Life time	Ta=25˚C, IL= 380 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		2.0		OHM Note 4

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

$N = 50$, $I = 10$ mA
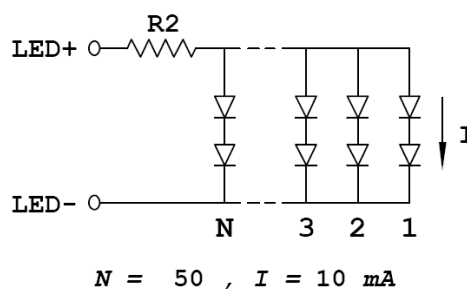
Product No.	LMRD4287	REV. D	Page	18 / 28
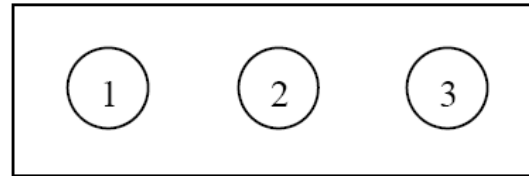
7.2 LABELLING & MARKING

```
DENSITRON
LMRD3287 or LMRD4287
Taiwan YYMM
```

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

A　Viewing area

B　Outside viewing area
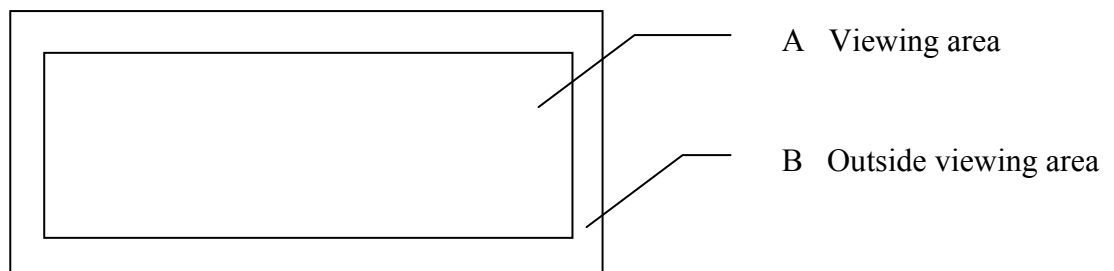
8.2.3 Visual inspection
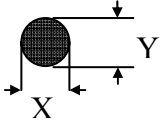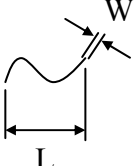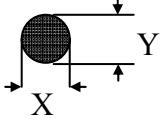
- Inspect under 2x20W or 40W fluorescent lamp (approximately 3000 lux) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye (measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted considering clearness and crosstalk on screen).
- Inspect the module at 45° right and left, top and bottom.
- Use the optimum viewing angle during the contrast inspection.
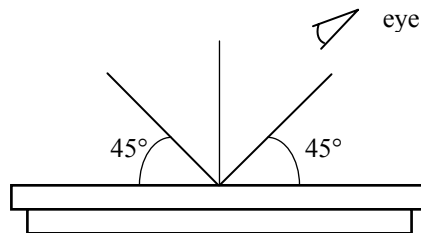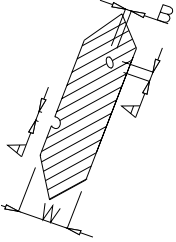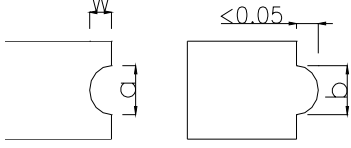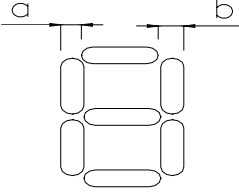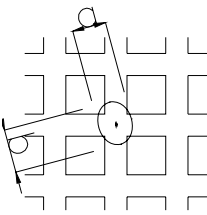
Product No.	LMRD4287	REV. D	Page	21 / 28

8.2.3.1 Standard of appearance inspection
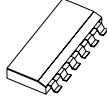
Units: mm

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	Round type: as per following drawing $\varnothing = (X+Y)/2$ Line type: as per following drawing Total acceptable quantity: 3		
Minor	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1		
Minor	Polariser bubble	$\varnothing = (X+Y)/2$ Total acceptable quantity: 3		

Round type table:

Acceptable quantity		
Size	Zone A	Zone B
$\varnothing<0.1$	Any number	
$0.1<\varnothing<0.2$	2	Any number
$0.2<\varnothing<0.25$	1	
$0.25<\varnothing$	0	

Line type table:

Acceptable quantity			
Length	Width	Zone A	Zone B
- -	$W\leq0.02$	Any number	
$L\leq3.0$	$0.02<W\leq0.03$	2	Any number
$L\leq2.5$	$0.03<W\leq0.05$		
- -	$0.05<W$	As round type	

Polariser bubble table:

Acceptable quantity		
Size	Zone A	Zone B
$\varnothing<0.2$	Any number	
$0.2<\varnothing<0.5$	2	Any number
$0.5<\varnothing<1.0$	1	
$1.0<\varnothing$	0	

Product No.	LMRD4287	REV. D	Page	22 / 28

Class	Item	Criteria
Minor	Segment deformation	1.a. Pin hole on segmented display W: segment width $\varnothing = (A+B)/2$ **Acceptable quantity** | Width	$\varnothing$
---	---
W≤0.4	$\varnothing≤0.2$ and $\varnothing≤1/2W$
W>0.4	$\varnothing≤0.25$ and $\varnothing≤1/3W$	 Total acceptable quantity: 1 defect per segment Pin holes with $\varnothing$ under 0.10 mm are acceptable
Minor	Segment deformation	1b. Pin hole on dot matrix display **Acceptable quantity** | Size	
---	---
a,b<0.1	Any number
(a+b)/2≤0.1	Any number
0.5<$\varnothing$<1.0	3 | Total acceptable quantity: 7 2. Segments / dots with different width **Acceptable** | a≥b	a/b≤4/3
---	---
a<b	a/b>4/3 | 3. Alignment layer defect $\varnothing = (a+b)/2$ **Acceptable quantity** | Size	
---	---
$\varnothing≤0.4$	Any number
0.4<$\varnothing$≤1.0	5
1.0<$\varnothing$≤1.5	3
1.5<$\varnothing$≤2.0	2	 Total acceptable quantity: 7
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

Class	Item	Criteria		
Major	PCB	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		Size	Quantity
		On tray	$\varnothing<0.2$	Any number
			$\varnothing>0.25$	4
		On display	$\varnothing\geq0.25$	2
			L = 3	1

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.

Product No.	LMRD4287	REV. D	Page	25 / 28

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.

10 PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS

LMR①287②③240G320④⑤⑥

①　　　3 = No backlit
4 = LED backlit version

②　　　**POLARIZER TYPE**
B = Transflective: light background with LED backlight
A = Reflective (LMRD3287)

③　　　**BACKLIGHT COLOUR**
G = Green Yellow (or left blank for LMRD3287)

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

Product No.	LMRD4287	REV. D	Page	27 / 28

10.1 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 Trichlorotriflorothane.
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).

Product No.	LMRD4287	REV. D	Page	28 / 28