LIQUID CRYSTAL DISPLAY MODULE

Product Specification

CUSTOMER		
PRODUCT NUMBER	**LMR4145**	
CUSTOMER APPROVAL		**Date**

INTERNAL APPROVALS		
Product Mgr	Doc Control	Electr. Eng
Bruno Recaldini	**Anthony Perkins**	**Alan Wang**
Date: 11/03/2013	Date: 11/03/2013	Date: 11/03/2013

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REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
A	11/03/2013			First issue	

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1 MAIN FEATURES

ITEM	CONTENTS
Display Format	4-line 20-character display
Overall Dimensions	77.0 x 47.0 x 18.2 max. (Edge LED version)
Viewing Area	58.6(W) x 21.1(H)
LCD type	Transflective
Mode	Grey / Yellow-green
Viewing Direction	6 O'clock
Duty ratio	1/16
Controller / Driver IC	Sitronix ST7066 / ST7063
Backlight type	Edge LED
Backlight colour	Yellow-green
Operating temperature	Standard: 0 ℃~ 50 ℃ / Wide: -20 ℃~ 70 ℃
Storage temperature	Standard: -20 ℃~ 70 ℃ / Wide: -30 ℃ ~ 80 ℃

2 MECHANICAL SPECIFICATION

2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	4 line x 20 characters	-
Character Format	5 (W) x 8 (H) with attached cursor	dots
Overall Dimensions	77.0 x 47.0 x 18.2 max. (Edge LED version)	mm
Viewing Area	58.6 x 21.1	mm
Active Area	55.0 x 17.5	mm
Character Size	2.292 x 4.016	mm
Character Pitch	2.772 x 4.496	mm
Dot Size	0.42 x 0.46	mm
Dot Pitch	0.468 x 0.508	mm
Weight	-	g
Controller / Driver IC	Sitronix ST7066 / ST7063	

2.2 MECHANICAL DRAWING
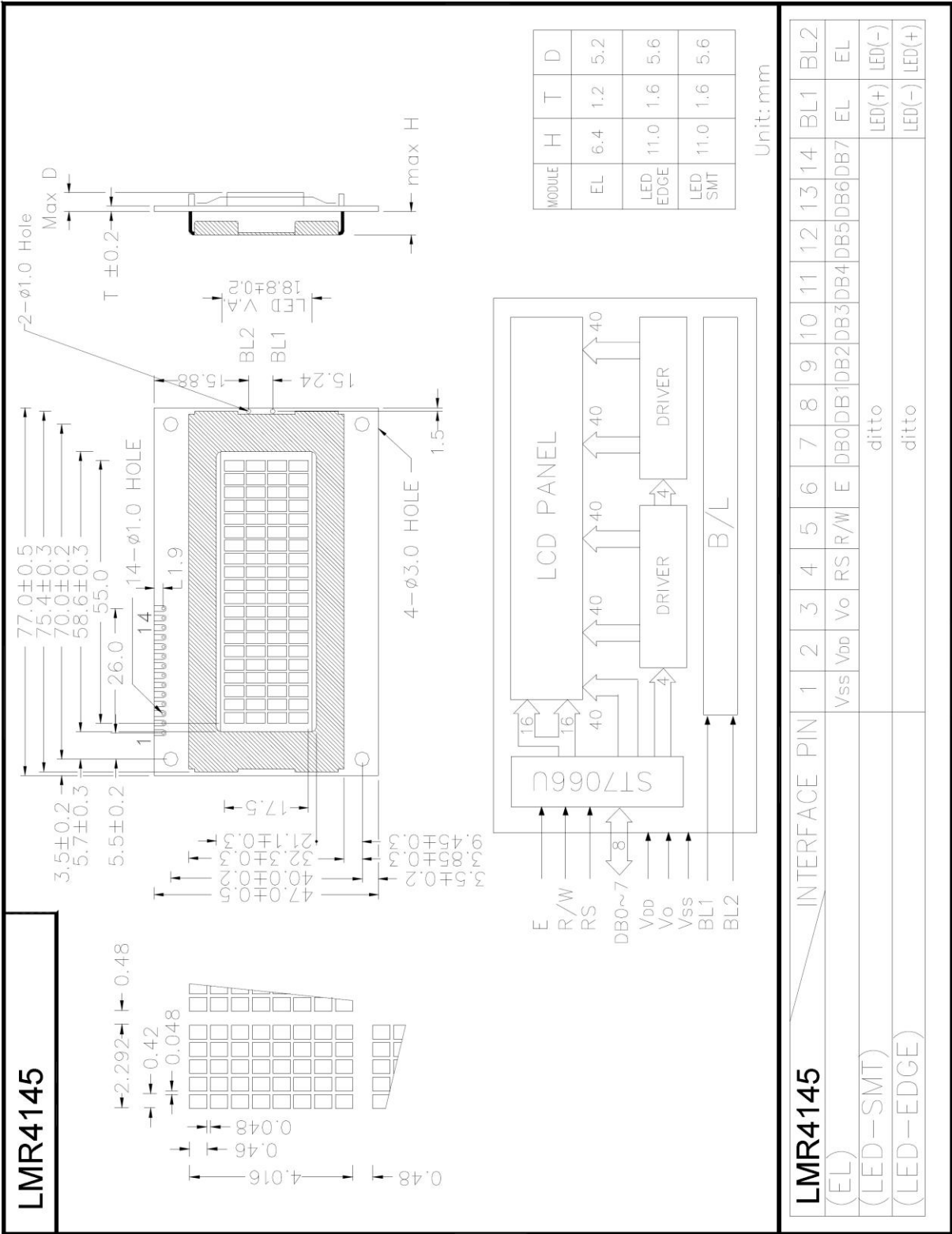
3 ELECTRICAL SPECIFICATION

3.1 ABSOLUTE MAXIMUM RATINGS

$VSS = 0$ V, $Ta = 25$ °C

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage	V_{DD}-V_{SS}	0	7.0	V	
Operating Temperature	Top	0	50	°C	Standard temperature range
Storage Temperature	Tst	-20	70	°C	
Operating Temperature	Top	-20	70	°C	Wide temperature range
Storage Temperature	Tst	-30	80	°C	
Static Electricity	Be sure that you are grounded when handling displays.				

3.2 ELECTRICAL CHARACTERISTICS

$VSS = 0$ V, $Ta = 25$ °C

Item	Symbol	Condition	Min	Typ	Max	Unit
Power Supply for Logic	V_{DD}-V_{SS}	$Ta = 25$ °C	4.75	5.0	5.25	V
Input Voltage	V_{IL}	$Ta = 25$ °C	0	-	0.6	V
	V_{IH}	$Ta = 25$ °C	$0.7V_{DD}$	-	V_{DD}	V
LCD Module Driving Voltage	V_{DD}-V_O	$Ta = 25$ °C	0	-	10.0	V
Current Consumption	* I_{DD}	$V_{DD} = V$ $V_{LCD} = V$	-	3	-	mA

* I_{DD} measurement condition is for all pattern ON

3.3 RECOMMENDED LC DRIVE VOLTAGE (V_{DD}-V_O)

$V_{DD} = 5.0\pm0.25V$

Temperature	Standard Temp. Range	Wide Temp. Range
Ta = -20 °C	-	5.8
Ta = 0 °C	4.5	5.2
Ta = 25 °C	4.2	4.8
Ta = 50 °C	3.9	4.5
Ta = 70 °C	-	4.2

3.4 INTERFACE PIN ASSIGNMENT

| No.	Symbol	I/O	Function
1	V_{SS}	-	Ground (0 V)
2	V_{DD}	-	Logic Supply Voltage (+5 V)
3	V_O	-	Voltage Level for LCD Control Adjustment
4	RS	I	Register Select 0: Instruction Register 1: Data Register
5	R/W	I	Read / Write 0: Data Write (Module-MPU) 1: Data Read (Module-MPU)
6	E	I	Enable Signal Active High (H-L)
7 ~ 14	DB0 ~ 7	I/O	Bi-directional data bus line 0~7
BL1	LED(-)	-	Cathode of LED B/L
BL2	LED(+)	-	Anode of LED B/L

3.5 BLOCK DIAGRAM
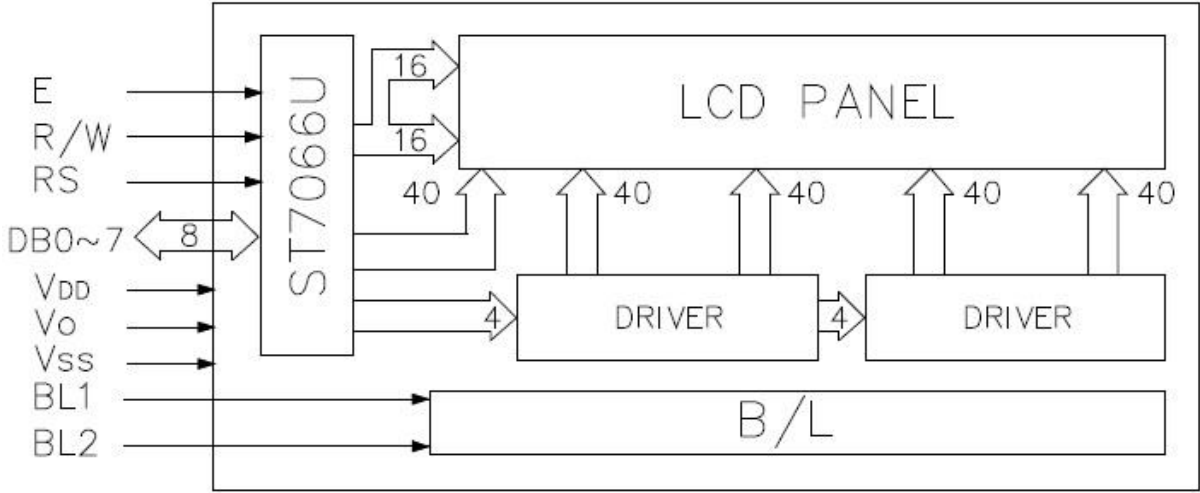
3.6 POWER SUPPLY CIRCUIT

Wide Temperature Range   Standard Temperature Range
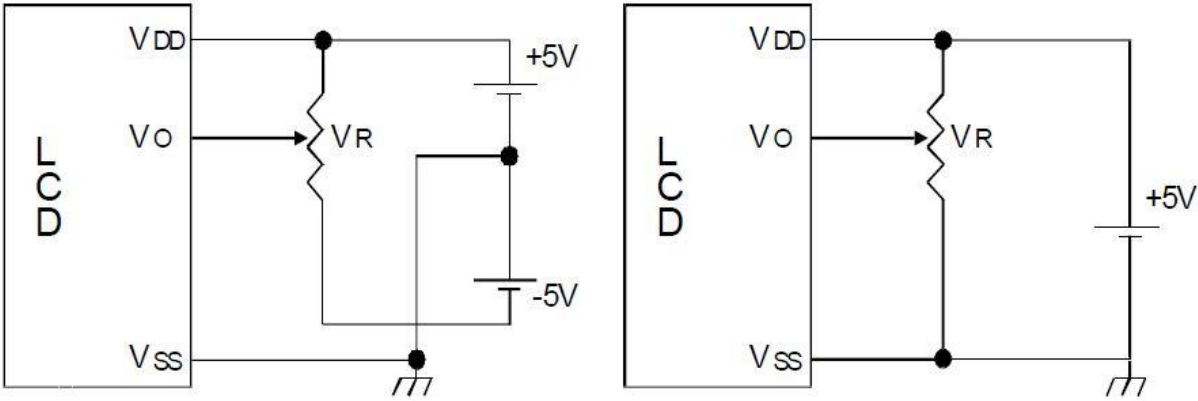
Recommended V_R: 10K~20K ohm

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3.7 CHARACTER GENERATOR ROM MAP

NO.7066-0A

3.8 TIMING CHARACTERISTICS

(Ta = 25 ºC, VDD = 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

● **Writing data from MPU to ST7066U**
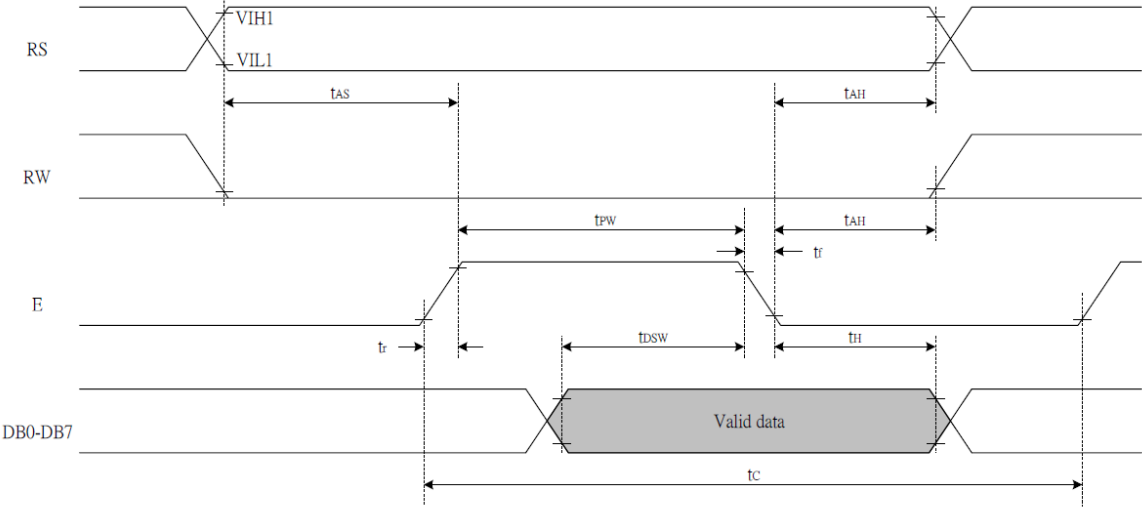
● **Reading data from ST7066U to MPU**
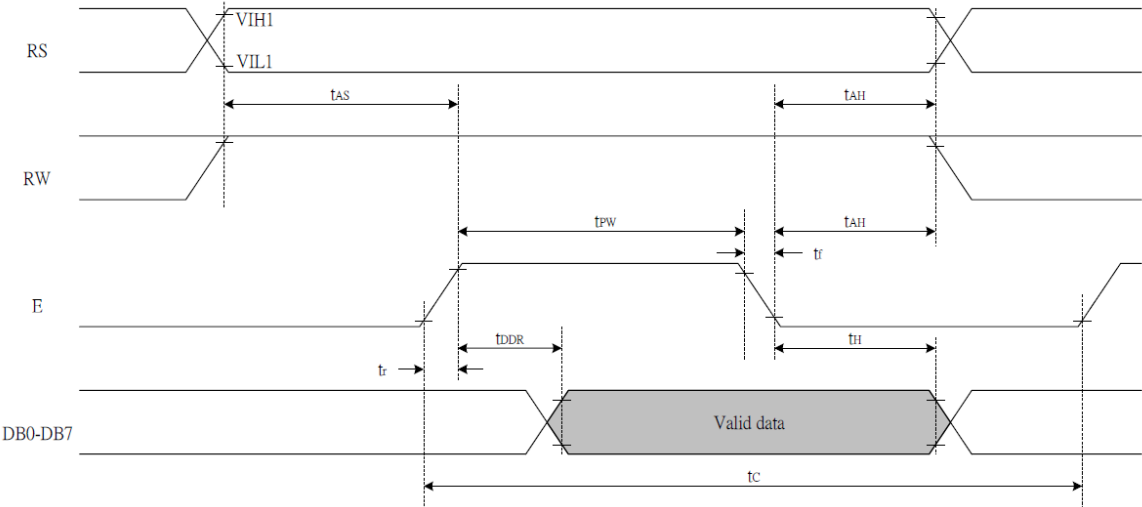
4 OPTICAL SPECIFICATION

4.1 OPTICAL CHARACTERISTICS

Ta = 25 °C

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Viewing Angle	θ1	CR≥2	-	40	-	deg	1
	θ2	CR≥2	-	40	-	deg	1
	θ3	CR≥2	-	30	-	deg	2
	θ4	CR≥2	-	30	-	deg	2
Contrast Ratio	CR	Ta = 25 °C	-	7	-	-	3
Response Time	Tr	Ta = 25 °C	-	140	220	ms	4
	Tf	Ta = 25 °C	-	210	340		
Driving Method	Duty	1/16					
	Bias	1/5					

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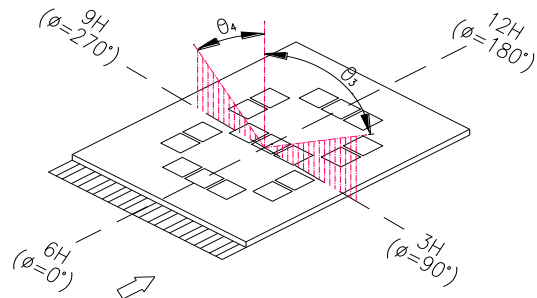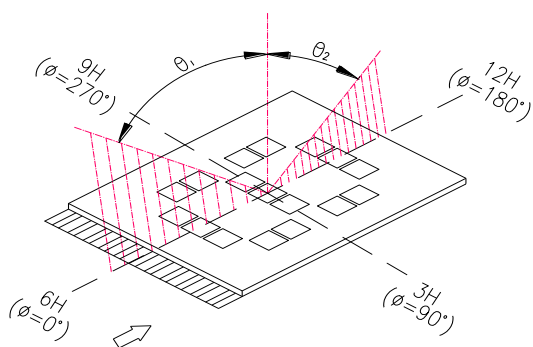
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Note 3: definition of contrast ratio (CR)

[positive type]

Intensity

100

Cr Max

Selected Wave

Non-selected Wave

$Cr = Loff / Lon$

Vop — Driving Voltage(V)

[Negative type]

Intensity

100%

Cr Max

Selected Wave

Non-selected Wave

$Cr = Lon / Loff$

Vop — Driving Voltage(V)
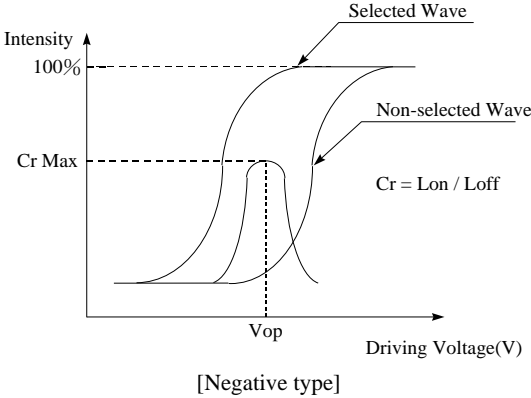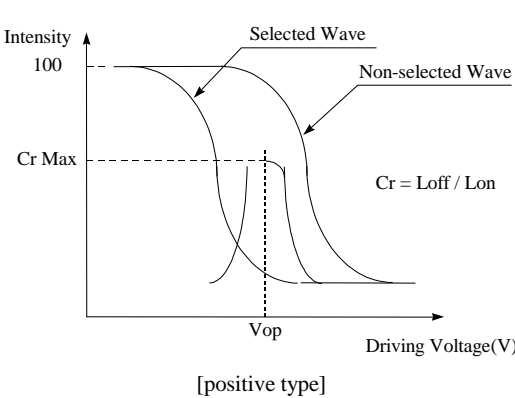
Note 4: definition of response time

Non-selected Condition — Selected Condition — Non-selected Condition

Intensity

100 %

90 %

10 %

Tr — Tf

[positive type]

Non-selected Condition — Selected Condition — Non-selected Condition

Intensity

100 %

90 %

10 %

Tr — Tf

[Negative type]

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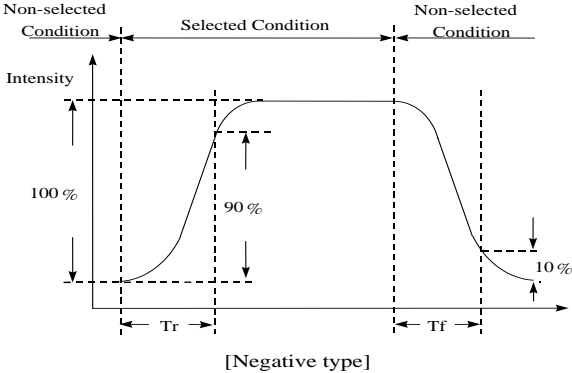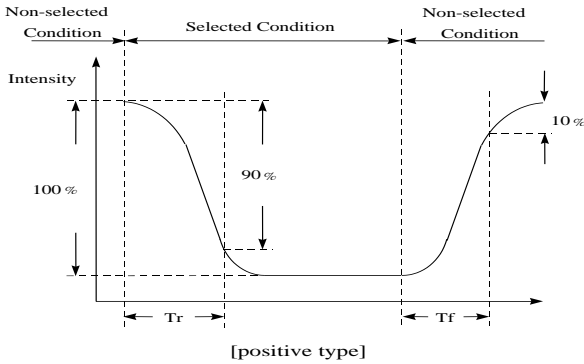
5 BACKLIGHT SPECIFICATION

5.1 BACKLIGHT CHARACTERISTICS

The backlight comprises of Edge LED

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
LED Input Voltage	V_{LED}	Ta = 25 ℃	-	5.0	-	V	-
LED Input Current	I_{LED}	Ta = 25 ℃	-	200	-	mA	-
Luminous Intensity	I_V	Test when connecting after 3 min Ta = 25 ℃ (max. contrast)	-	150	-	cd/m²	1
Brightness Uniformity	-	Ta = 25 ℃, I = 40.0 mA	80	-	-	%	2
Life time	-	Ta = 25 ℃, I = 40.0 mA Humidity: 30%RH ~ 85%RH	-	50,000	-	hr	3
Colour	Yellow-green						

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

![DENSITRON DISPLAYS]
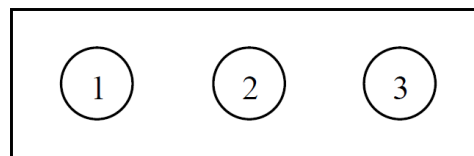
6 LABELLING & MARKING

```
DENSITRON
Product number
Country YYMM
```

7 QUALITY ASSURANCE SPECIFICATION

7.1 CONFORMITY

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

7.2 DELIVERY ASSURANCE

7.2.1 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%

7.2.2 Zone definition

A   Viewing area

B   Outside viewing area
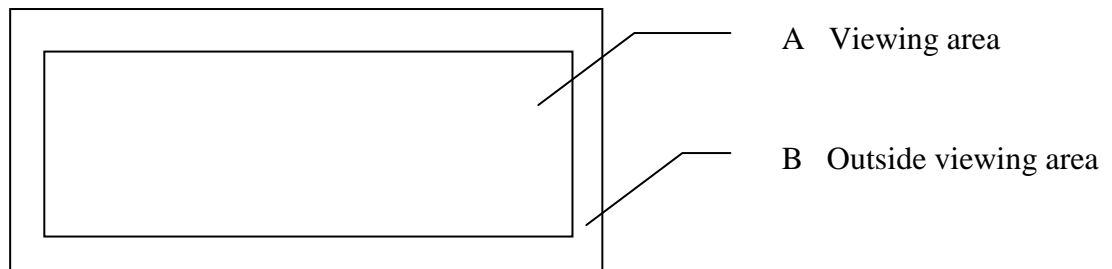
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7.2.3 Visual inspection

- 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.
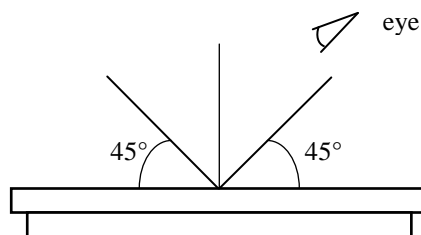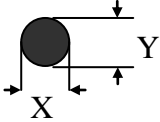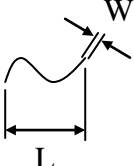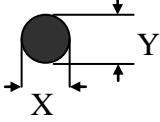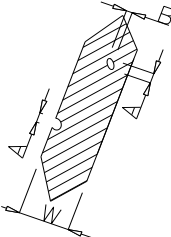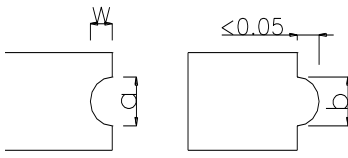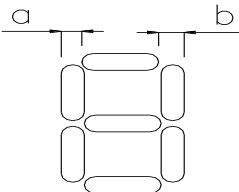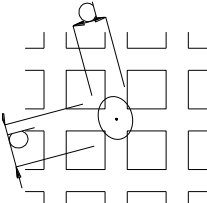
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7.2.3.1 Standard of appearance inspection
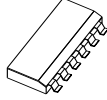
Units: mm

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 $\varnothing = (X+Y)/2$ **Acceptable quantity** | Size	Zone A	Zone B
---	---	---
$\varnothing < 0.1$	Any number	
$0.1 < \varnothing < 0.2$	2	
$0.2 < \varnothing < 0.25$	1	Any number
$0.25 < \varnothing$	0	| Line type: as per following drawing **Acceptable quantity** | Length	Width	Zone A	Zone B
---	---	---	---
- -	$W \leq 0.02$	Any number	
$L \leq 3.0$	$0.02 < W \leq 0.03$	2	Any number
$L \leq 2.5$	$0.03 < W \leq 0.05$		
- -	$0.05 < W$	As round type	| Total acceptable quantity: 3		
Minor	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1		
Minor	Polariser bubble	$\varnothing = (X+Y)/2$ **Acceptable quantity** | Size	Zone A	Zone B
---	---	---
$\varnothing < 0.2$	Any number	
$0.2 < \varnothing < 0.5$	2	
$0.5 < \varnothing < 1.0$	1	Any number
$1.0 < \varnothing$	0	| Total acceptable quantity: 3		

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

7.3 DEALING WITH CUSTOMER COMPLAINTS

7.3.1 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.

7.3.2 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.

8 RELIABILITY SPECIFICATION

8.1 RELIABILITY TESTS

Standard Temperature Range:

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

Wide Temperature Range:

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

* Current consumption < 2 times initial value
* Contrast > ½ initial value

8.1.1 MTBF of liquid crystal panel

50,000 hours, 90% Confidence Level at 25 ℃, 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

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8.2 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.

9 PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS

LMR4145①②4C20③④⑤

① **POLARIZER TYPE**
B = Transflective

② **BACKLIGHT COLOUR**
G = Yellow-green

③ **FLUID TYPE AND TEMPERATURE RANGE**
S = STN with +5V DC operation
H = STN-H with ±5V DC operation

④ **FLUID TYPE AND TEMPERATURE COMPENSATION**
N = STN

⑤ **BACKGROUND COLOUR FOR STN**
G = Grey Background
Y = Yellow Background

10 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).