

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

CUSTOMER	Standard	
PRODUCT NUMBER	LM6401	
CUSTOMER APPROVAL		Date

INTERNAL APPROVALS		
Product Mgr	Doc Control	Electr. Eng
Bruno Recaldini	Anthony Perkins	Bazile Peter
Date: 2 nd May 06	Date: 2 nd May 06	Date: 2 nd May 06

- Approval for Specification only
- Approval for Specification and Sample

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REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
A					
B	02 May 2006			Complete specification added	

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1 MAIN FEATURES

ITEM	CONTENTS
Display Format	640 x 480 dots
Overall Dimensions	186 x 121 x 5.5
Viewing Area	127 x 91.2
LCD type	FSTN
Mode	Transflective
Viewing Angle	6 O'Clock
Duty ratio	1/240
Driver IC	MSM6778BAV + MSM6779BAV
Backlight type	CCFL
Backlight colour	White
Operating temperature	0 ~ 50°C
Storage temperature	-20 ~ 60°C

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2 MECHANICAL SPECIFICATION

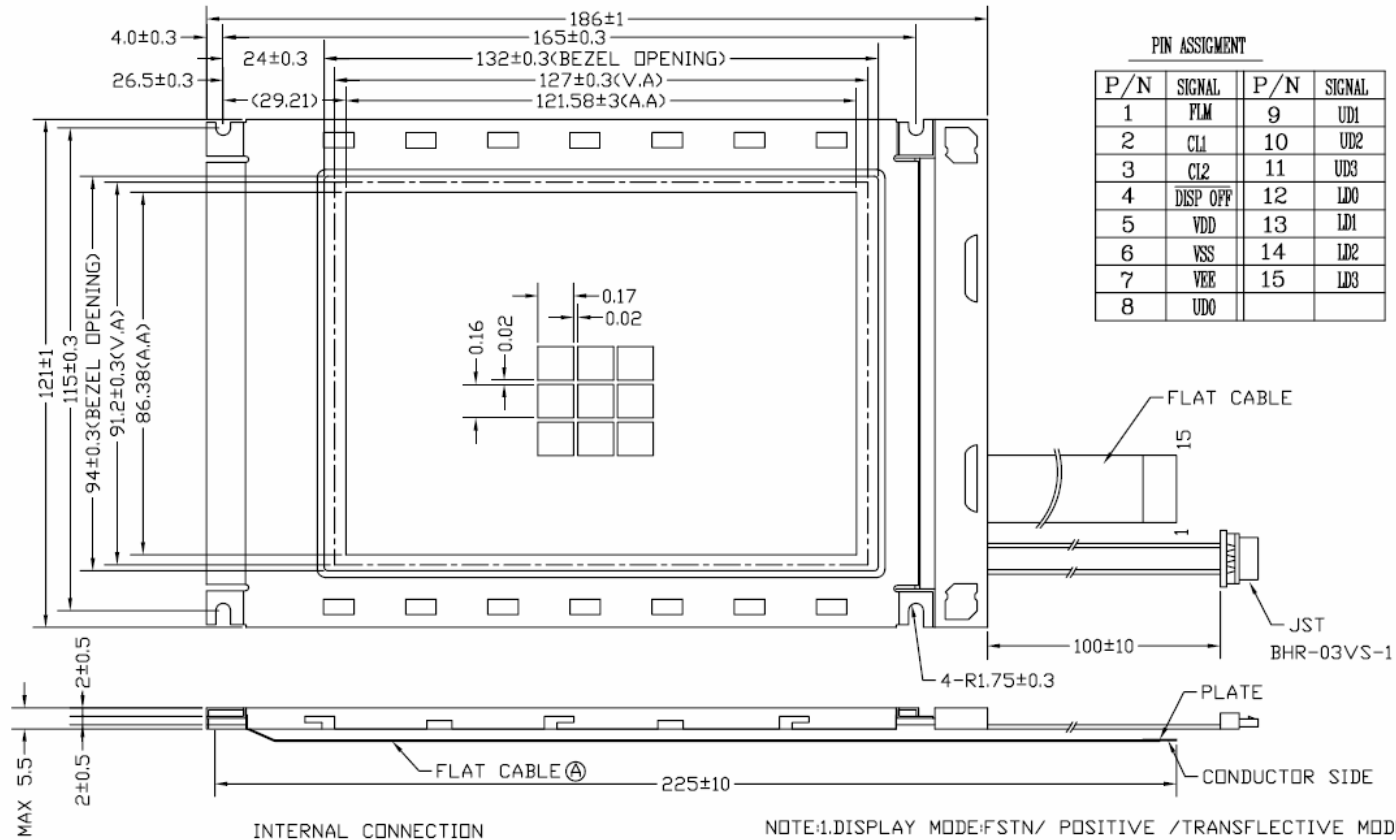
2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	640 x 480 dots	
Overall Dimensions	186 x 121 x 5.5	mm
Viewing Area	127 x 91.2	mm
Active Area	121.58 x 86.38	mm
Dot Size	0.17 x 0.16	mm
Dot Pitch	0.19 x 0.18	mm
Weight	150	g
IC Driver	MSM6778BAV + MSM6779BAV	

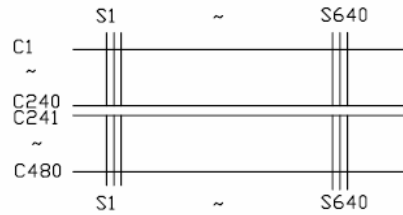
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2.2 MECHANICAL DRAWING



INTERNAL CONNECTION



- NOTE:1.DISPLAY MODE:FSTN/ POSITIVE /TRANSFLECTIVE MODE.
 2.DRIVING DUTY CYCLE:1/240D,1/14B.
 3.OPERATION TEMP:0 - 50 DEGREE.
 4.STORAGE TEMP:-20 - 60 DEGREE.
 5.VIEWING ANGLE: 6 HOUR.
 6.OTHER SPEC:ACCORDING TO SPECIFICATION.

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}	2.7	5.5	V	
Power Supply for LCD	V _{DD} -V _{EE}	14	28	V	
Operating Temperature	Top	0	50	°C	Note 1
Storage Temperature	Tst	-20	60	°C	Note 2
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 50 °C: 75% RH max

Note 2: Ta 60 °C: 75% RH max

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}		--	5	--	V
Input Voltage	V _{IL}		--	--	0.2 V _{DD}	V
	V _{IH}		0.8 V _{DD}	--	--	V
Output Voltage	V _{OL}	IO=0.2mA, V _{DD} =5V	--	--	0.4	V
	V _{OH}	IO=0.2mA, V _{DD} =5V	V _{DD} - 0.4	--	--	V
LCD Module Driving Voltage	V _{OP}	Ta = 25 °C	--	21.8	--	V
Current Consumption	I _{DD}	Fcp=4.0Mhz, V _{DD} =5.0V V _{DD} -V _{EE} =25V No load			3	mA
Frame Frequency	Ff			70		Hz

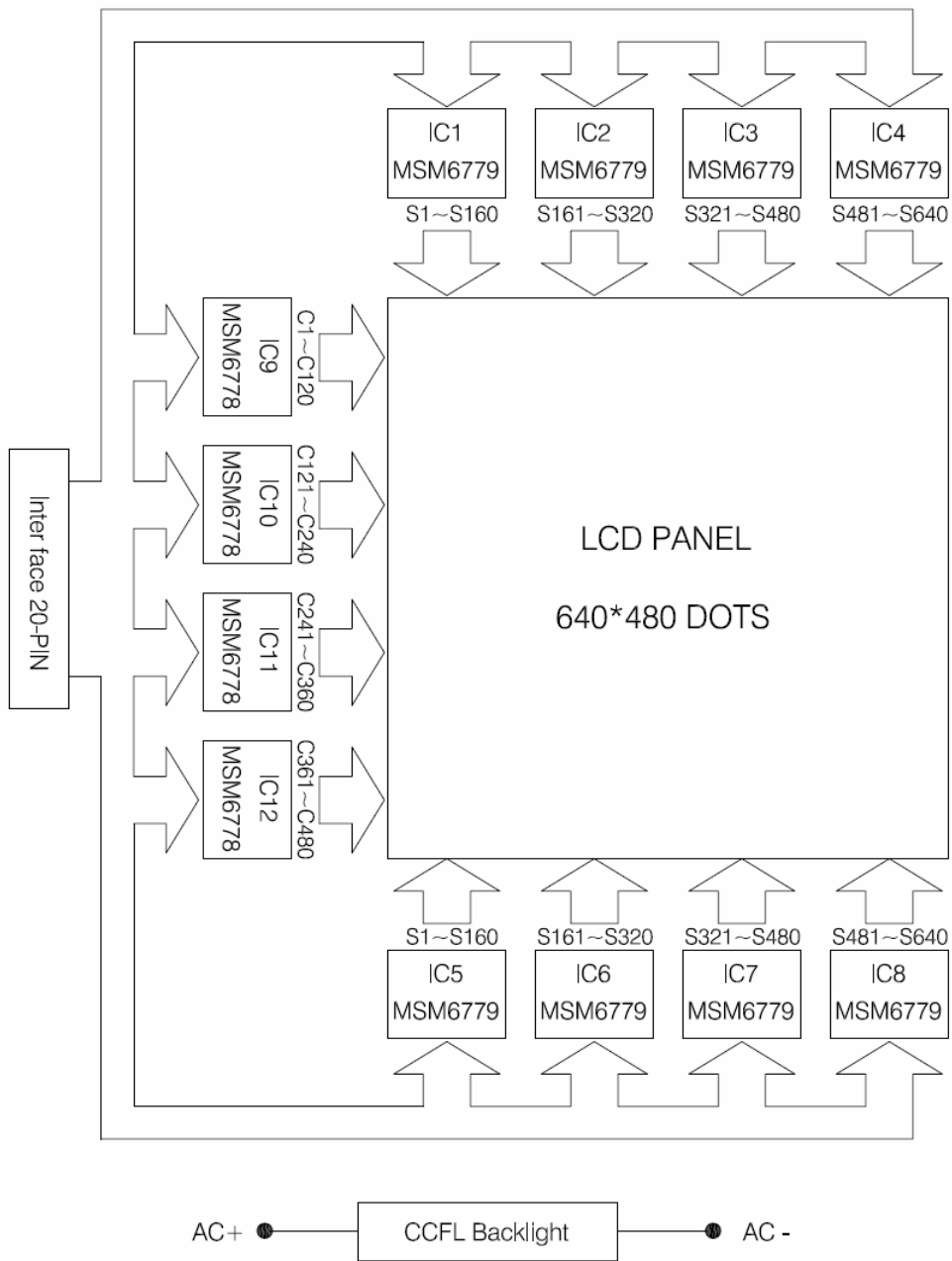
3.3 INTERFACE PIN ASSIGNMENT

No.	Symbol	I/O	Function
1	FLM	I	First line marker indicates the beginning of each display cycle
2	CL1	I	Column driver data latch signal
3	CL2	I	In column driver operation, used as a display data latch signal.
4	DISP OFF	I	Input for controlling the output level of O1 to O160. The V1 levels output from O1 to O160 pins during "L" level input. Refer to truth table
5	VDD	I	Power supply for the device VDD is set to 5V
6	VSS	I	Power supply for the device VSS is sent to 0
7	VEE	I	Negative voltage for LCD contrast adjustment
8~11	VD0 to VD3	I	The up-half display inputs (Line 1~240)
12~15	LD0 to LD3	I	The down-half display data inputs (Line 241~480)

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3.4 BLOCK DIAGRAM



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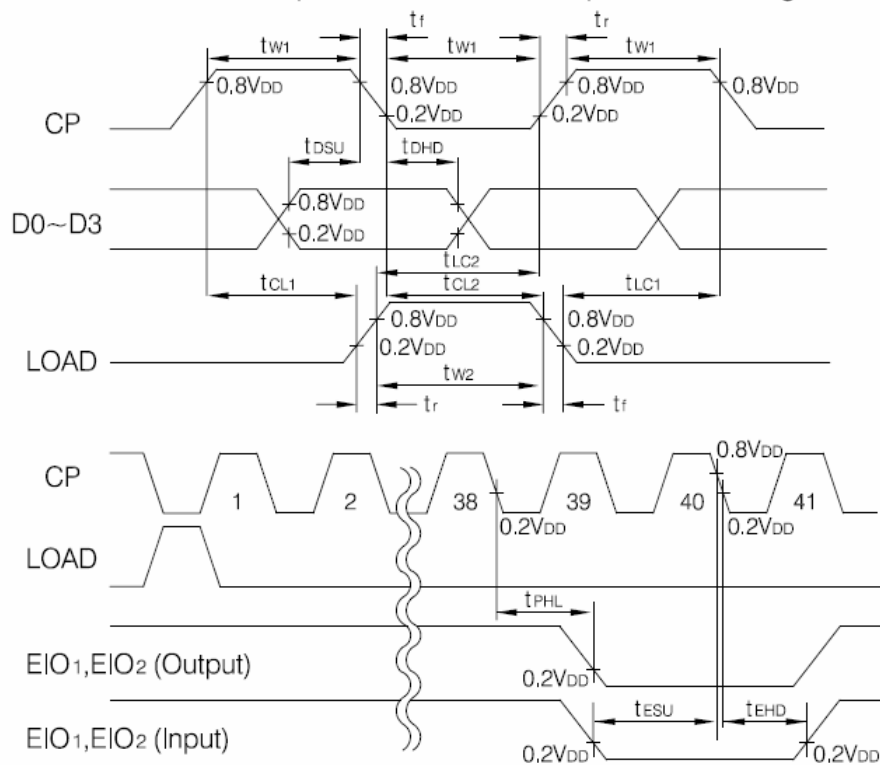
4 TIMING CHARACTERISTICS

4.1 Segment Drivers

($4.5 \leq V_{DD} < 4.5V$, $T_a = -20$ to $+75^\circ\text{C}$)

Signal	Symbol	Condition	Min.	Typ.	Max.	Unit
Clock Frequency	f_{CP}	DUTY=50%, $V_{DD} = 2.7V$			6.5	MHz
Clock Pulse Width	t_{w1}	—	56	—	—	ns
Load Pulse Width	t_{w2}	—	70	—	—	ns
Clock Pulse Rise/Fall Time	t_r, t_f	—	—	—	20	ns
Data Set-up Time	t_{DSU}	—	50	—	—	ns
Data Hold Time	t_{DHD}	—	40	—	—	ns
Clock Load Time 1	t_{CL1}	—	0	—	—	ns
Clock Load Time 2	t_{CL2}	—	65	—	—	ns
Load Clock Time 1	t_{LC1}	—	65	—	—	ns
Load Clock Time 2	t_{LC2}	—	65	—	—	ns
Propagation Delay Time	t_{PHL}	$C_L = 15\text{pF}$	—	—	236	ns
EIO_1, EIO_2 Set-up Time	t_{ESU}	—	50	—	—	ns
EIO_1, EIO_2 Hold Time	t_{EHD}	—	50	—	—	ns

Note: The above values are guaranteed when TCP is protected from light.



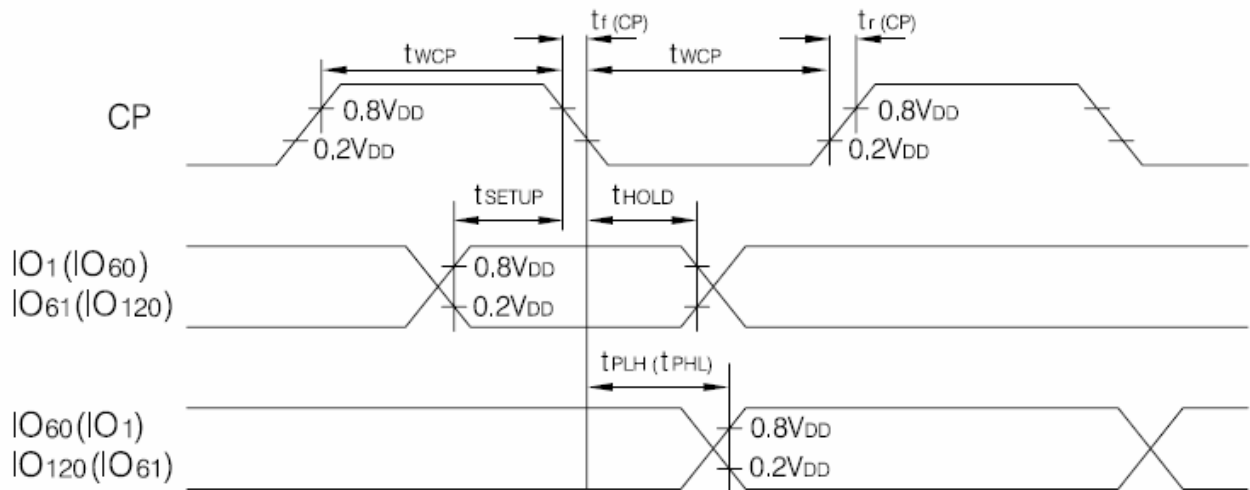
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4.2 Common Driver AC Characteristics

($V_{DD} = 2.7V$ to $5.5V$, $T_a = -20$ to $+75^\circ C$, $C_L = 15pF$)

Signal	Symbol	Condition	Min.	Typ.	Max.	Unit
IO ₁ , IO ₆₁ (IO ₆₀ , IO ₁₂₀) "H", "L" Propagation Delay Time	t _{PLH} t _{PHL}	—	—	—	3	μS
Clock Frequency	f _{CP}	—	—	—	1	MHz
CP Pulse Width	t _{WCP}	—	63	—	—	ns
Data Setup Time IO ₁ , IO ₆₁ → CP (IO ₆₀ , IO ₁₂₀ → CP)	t _{SETUP}	—	100	—	—	ns
Data Hold Time CP → IO ₁ , IO ₆₁ (CP → IO ₆₀ , IO ₁₂₀)	t _{HOLD}	—	100	—	—	ns
CP Rise, Fall Time	t _r (CP) t _f (CP)	—	—	—	20	ns



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5 OPTICAL SPECIFICATION

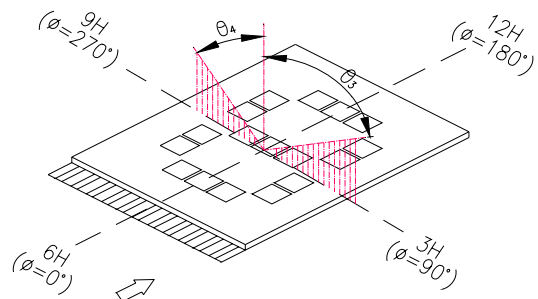
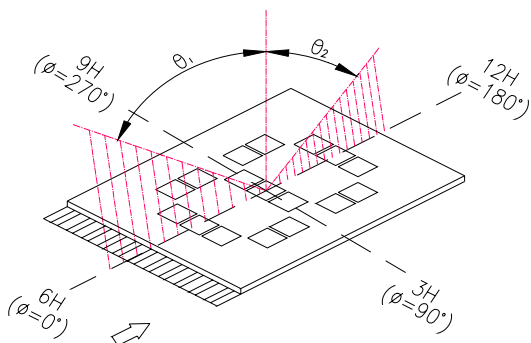
5.1 OPTICAL CHARACTERISTICS

Ta = 25 °C

Item	Symbol	Condition	Min	Typ	Max	Unit	Note	
Viewing Angle	θ_1	CR 2		31		deg	1	
	θ_2	CR 2		33		deg	1	
	θ_3	CR 2		33		deg	2	
	θ_4	CR 2		26		deg	2	
Contrast Ratio	CR	Ta = 25 °C		4.5		-	3	
Response Time	Tr	Ta = 25 °C		272		ms	4	
	Tf	Ta = 25 °C		157				
Driving Method	Duty	1/240						
	Bias	1/14						
LCD Type	FSTN – (Positive)							
Viewing Direction	6 O’CLOCK							

Note 1: definition of viewing angle θ_1 & θ_2

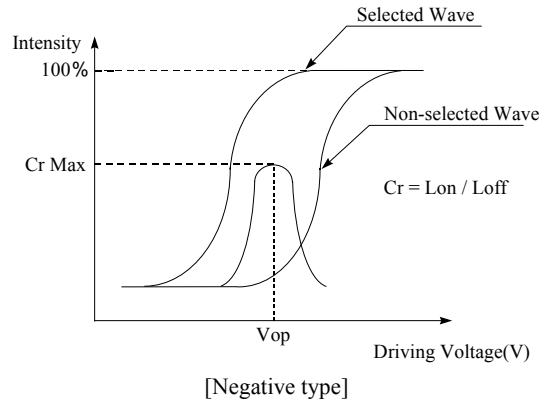
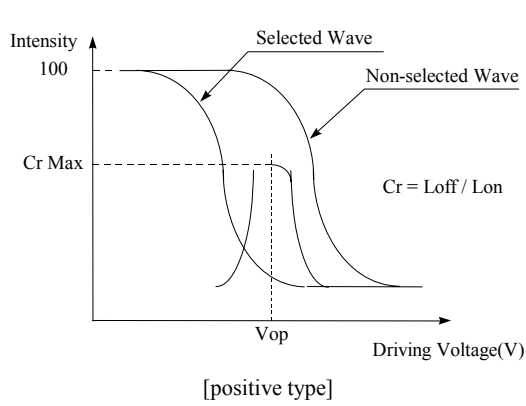
Note 2: definition of viewing angle θ_3 & θ_4



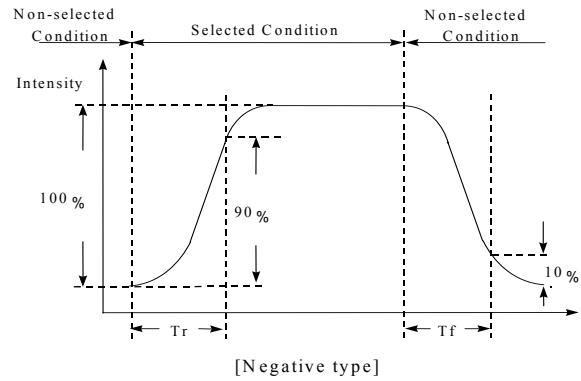
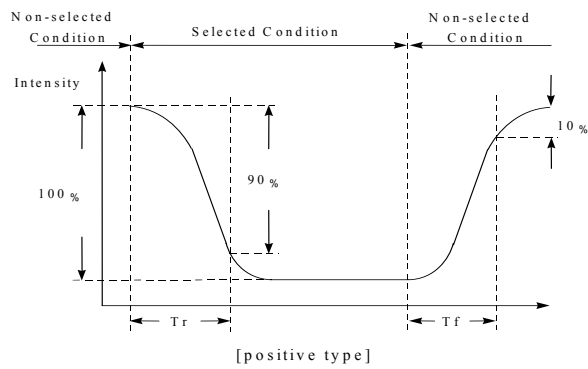
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Note 3: definition of contrast ratio (CR)



Note 4: definition of response time



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6 BACKLIGHT SPECIFICATION

6.1 BACKLIGHT CHARACTERISTICS

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Input Voltage	VCCFL			259±1 0%		Vrms	
Input Current	ICCFL			5		mA	
Luminous Intensity	I _v			350		cd/m ²	
Life time				15000		hrs	3
Colour	White						

6.2 LABELLING & MARKING

DENSITRON LM6401 Taiwan YYMM

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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

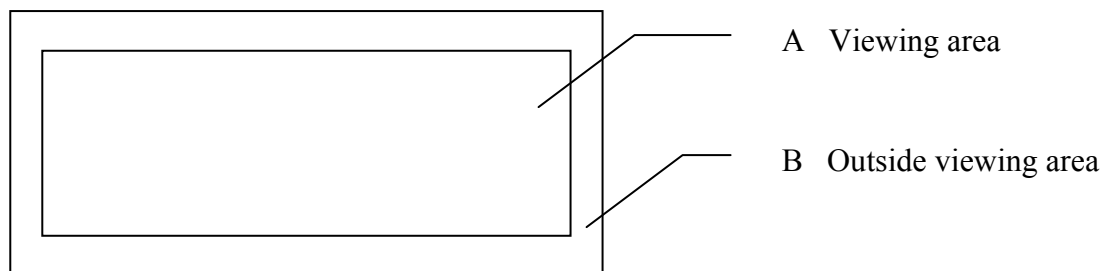
7.2.1 Delivery inspection standards

- 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

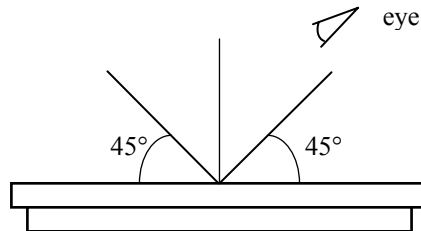


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7.2.3 Visual inspection

- 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.

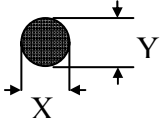
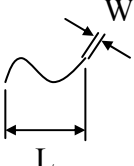
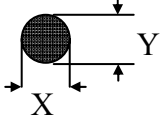


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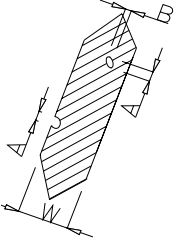
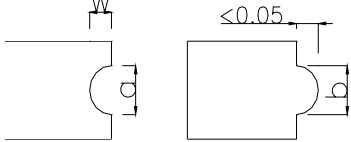
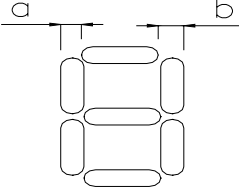
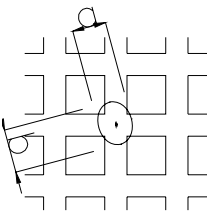
7.2.3.1 Standard of appearance inspection

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	<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 3.0</td> <td>$0.02 < W \leq 0.03$</td> <td rowspan="2">2</td> </tr> <tr> <td>L 2.5</td> <td>$0.03 < W \leq 0.05$</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 3.0	$0.02 < W \leq 0.03$	2	L 2.5	$0.03 < W \leq 0.05$	--	$0.05 < W$	As round type
Acceptable quantity																																					
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L 3.0	$0.02 < W \leq 0.03$	2																																			
L 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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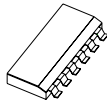
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Class	Item	Criteria																												
Minor	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width $\varnothing = (A+B)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th>\varnothing</th> </tr> </thead> <tbody> <tr> <td>W 0.4</td> <td>$\varnothing 0.2$ and $\varnothing 1/2W$</td> </tr> <tr> <td>W>0.4</td> <td>$\varnothing 0.25$ and $\varnothing 1/3W$</td> </tr> </tbody> </table> <p>Total acceptable quantity: 1 defect per segment Pin holes with \varnothing under 0.10 mm are acceptable</p>	Acceptable quantity		Width	\varnothing	W 0.4	$\varnothing 0.2$ and $\varnothing 1/2W$	W>0.4	$\varnothing 0.25$ and $\varnothing 1/3W$																				
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Width	\varnothing																													
W 0.4	$\varnothing 0.2$ and $\varnothing 1/2W$																													
W>0.4	$\varnothing 0.25$ and $\varnothing 1/3W$																													
Minor	Segment deformation	<p>1b. Pin hole on dot matrix display</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>a,b<0.1</td> <td>Any number</td> </tr> <tr> <td>(a+b)/2 0.1</td> <td>Any number</td> </tr> <tr> <td>0.5<\varnothing<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" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable</th> </tr> <tr> <th>a b</th> <th>a/b 4/3</th> </tr> </thead> <tbody> <tr> <td>a<b</td> <td>a/b>4/3</td> </tr> </tbody> </table> <p>3. Alignment layer defect</p> <p>$\varnothing = (a+b)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>$\varnothing 0.4$</td> <td>Any number</td> </tr> <tr> <td>0.4<\varnothing 1.0</td> <td>5</td> </tr> <tr> <td>1.0<\varnothing 1.5</td> <td>3</td> </tr> <tr> <td>1.5<\varnothing 2.0</td> <td>2</td> </tr> </tbody> </table> <p>Total acceptable quantity: 7</p>	Acceptable quantity		Size		a,b<0.1	Any number	(a+b)/2 0.1	Any number	0.5< \varnothing <1.0	3	Acceptable		a b	a/b 4/3	a<b	a/b>4/3	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
Acceptable quantity																														
Size																														
a,b<0.1	Any number																													
(a+b)/2 0.1	Any number																													
0.5< \varnothing <1.0	3																													
Acceptable																														
a b	a/b 4/3																													
a<b	a/b>4/3																													
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																													
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	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	<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
	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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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.

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8 RELIABILITY SPECIFICATION

8.1 RELIABILITY TESTS

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	50°C for 240 hours	No abnormalities in function* and appearance
Low Temperature Operation	0°C for 240 hours	No abnormalities in function* and appearance
High Temperature Storage	60°C for 240 hours	No abnormalities in function* and appearance
Low Temperature Storage	-20°C for 240 hours	No abnormalities in function* and appearance
High Temperature & High Humidity Storage	90% R.H 60°C for 240 hours	No abnormalities in function* and appearance
Vibration	10~55Hz at 5G for 1 minute cycle time. 15 minutes each direction.	No abnormalities in function* and appearance
Drop Shock packaging	0.7m drop to a wood board (30mm)	No abnormalities in function* and appearance

* Current consumption < 2 times initial value

* Contrast > ½ initial value

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.

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9 PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS

LM6401①②480G640③④

- ① **POLARIZER TYPE**
B = Transflective

- ② **BACKLIGHT COLOUR**
NA leave Blank

- ③ **FLUID TYPE AND TEMPERATURE RANGE**
D= Standard Temperature Range: Negative Voltage required

- ④ **FLUID TYPE**
F = FSTN

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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 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 $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and the humidity below 50%RH.

Store the display in a clean environment, free from dust, organic solvents and corrosive gases.

Do not crash, shake or jolt the display (including accessories).

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