

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

PRODUCT NUMBER	84-0041-001
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INTERNAL APPROVALS		
Product Manager	Engineering	Document Control

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REVISION RECORD

Rev.	Date	Page	Par.	Comment	ECN no.
A	09/29/08	--	--	New DCA Specification	E3858

1 GENERAL SPECIFICATIONS

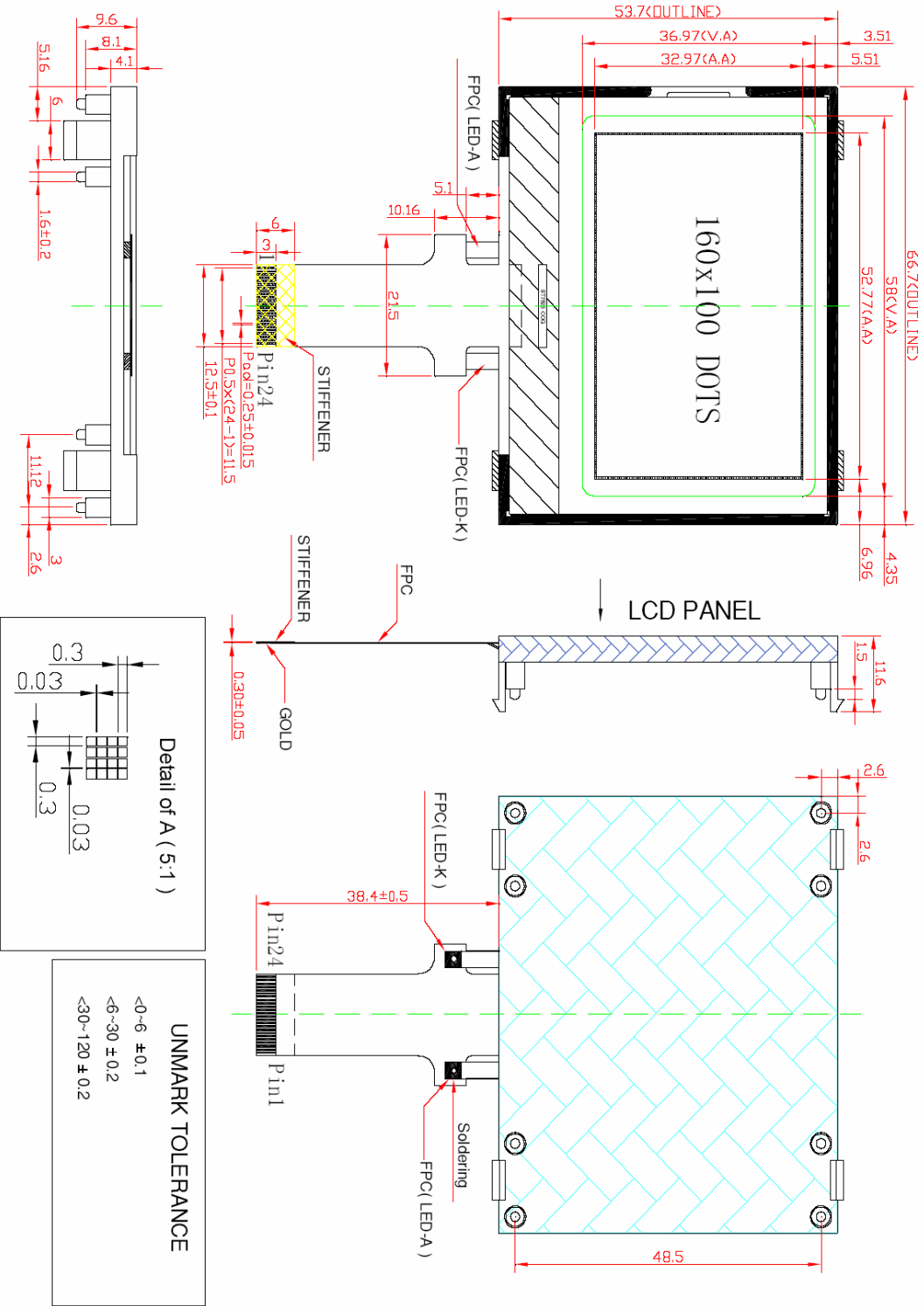
ITEM	CONTENTS	UNIT
Outline Dimension	66.7 (W) x 53.7 (H) x 11.6 (D) (Not Including FPC)	mm
Viewing Area	58.0 (W) x 36.97 (H)	mm
Active Area	52.77 (W) x 32.97 (H)	mm
Display Format	160 x 100	Pixels
Dot Size	0.30 x 0.30	mm
Dot Pitch	0.33 x 0.33	mm
Viewing Angle	6:00	O'clock
LCD Type	FSTN / Gray / Transflective / Positive	--
IC Controller	ST7528 (COG)	--
Backlight Type	LED Edge / White / 4 Pieces Chip / Polycarbonate Housing	--
Operating Temperature	20 ~ 70	°C
Storage Temperature	-30 ~ 80	°C
Drive Method	1/100 Duty, 1/11 Bias	--
Approx. Weight	60	g
RoHS Complaint	Yes	--

2 MAIN FEATURES

The 84-0041-001 is a graphic dot-matrix liquid crystal display module with a built-in COG LCD controller / driver ST7528. It has a display capacity of 160 x 100 dots. This COG Module is connected directly to a micro-processor, accepts 8-bit parallel display data and stores in an on-chip display data RAM of 160 x 129 x 4 bits. It performs display data RAM read/write operation with no external operating clock to minimize power consumption. In addition, because it contains power supply circuits necessary to drive liquid crystal, it is possible to make a display system with the fewest components. The following are some of the features.

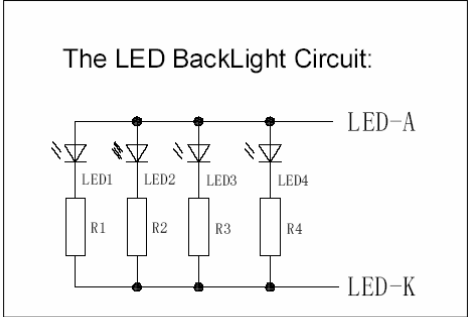
- (1) Support display capacity: 160 x 100 Dots, Two Color
- (2) On-Chip Display Data RAM, Capacity 160 x 129 x 4 = 82,560 Bits
- (3) 8-Bit parallel bi-directional interface with 8080-series
- (4) On-chip oscillator circuit and voltage converter (x3, x4, x5 or x6)
- (5) On-chip electronic contrast control function (64 steps x 8)
- (6) Abundant instruction set including clear display, cursor on/off, and character blinking.
- (7) Compact and lightweight for easy assembly to the host instrument.
- (8) Operable on single power supply, $V_{DD} - V_{SS}$: 2.7 to 3.3 V
- (9) Low power consumption: 550 μ A
- (10) Includes a White LED Backlight
- (11) Small and very thin outline package

3 MECHANICAL DRAWING



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★ Requirements:

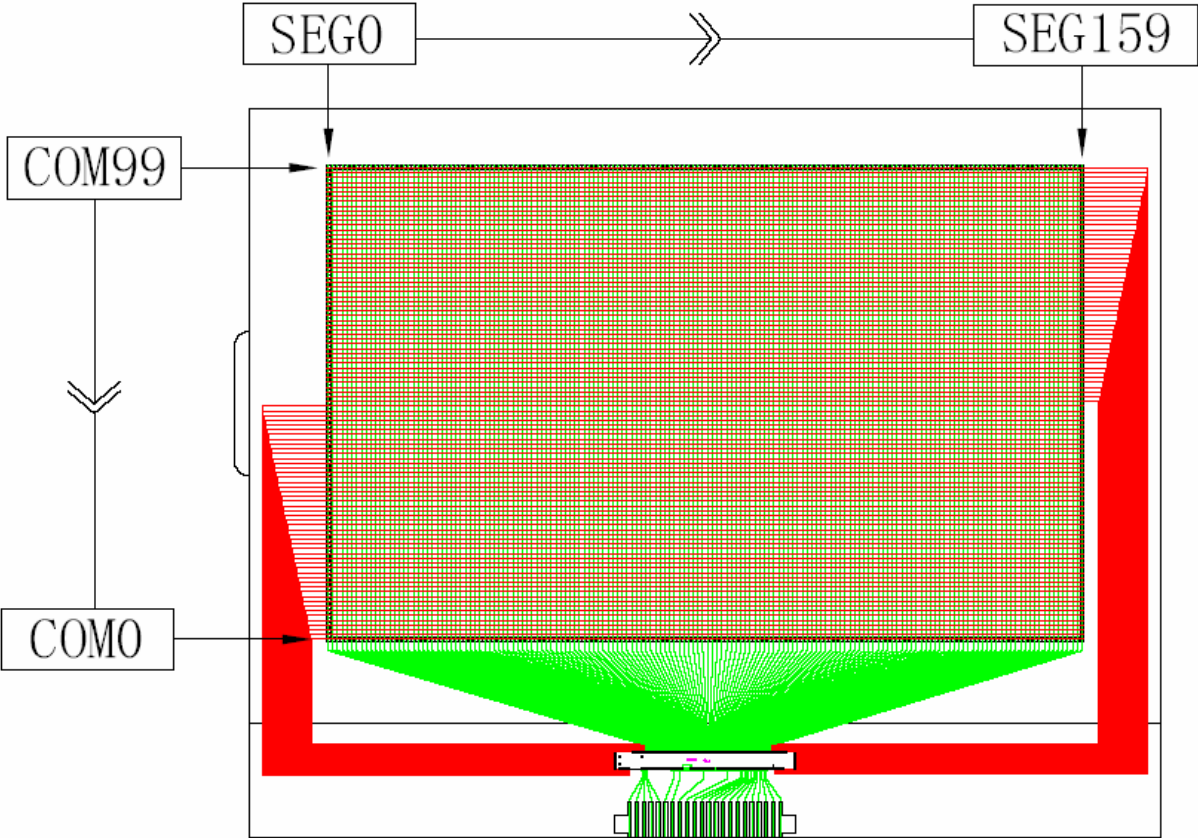
- Silverback high contrast polarizer
- ITO 15 ohm
- 60 mA backlight
- RoHS compliant

PIN DESCRIPTION:

PIN No.	SYMBOL
1	LED-A
2	V0
3	V1
4	V2
5	V3
6	V4
7	VOUT-IN
8	VOUT-OUT
9	VSS
10	VDD
11	D7
12	D6
13	D5
14	D4
15	D3

PIN No.	SYMBOL
16	D2
17	D1
18	D0
19	/RD
20	/WR
21	A0
22	/RST
23	/CSB
24	LED-K

LCD LAYOUT MAP (TOP VIEW)



4 ABSOLUTE MAXIMUM RATINGS

(Ta = 25°C)

Item	Symbol	Min	Max	Unit
Power Voltage for Logics	$V_{DD} - V_{SS}$	-0.5	3.6	V
External Voltage for LCD	V_{OUT-IN}	-0.3	20.0	V
Input Voltage	V_{IN}	-0.3	$V_{DD} + 0.5$	V
Operating Temperature	Topr	-10	70	°C
Storage Temperature	Tstg	-25	80	°C
Power Voltage for LED Backlight	LED-A & LED-K	-0.5	4.5	V
Static Electricity	Make sure that you are grounded when handling the LCD Module			

5 ELECTRICAL CHARACTERISTICS

(V_{DD} = 3.0V, Ta = 25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
Logic Power Voltage	$V_{DD} - V_{SS}$	--	2.7	3.0	3.3	V
LCD Driving Voltage	V_{LCD}	--	11.3	11.5	11.7	V
External Voltage	V_{OUT-IN}	Relative V_{SS}	0	--	18	V
Voltage Output	$V_{OUT-OUT}$	Relative V_{SS}	0	--	18	V
“H” Input Voltage	V_{IH}	--	$0.7V_{DD}$	--	V_{DD}	V
“L” Input Voltage	V_{IL}	--	V_{SS}	--	$0.3V_{DD}$	V
“H” Output Voltage	V_{OH}	--	$0.7V_{DD}$	--	--	V
“L” Output Voltage	V_{OL}	--	V_{SS}	--	$0.3V_{DD}$	V
Current Consumption	I_{DD}	When all pixels are on	--	550	650	μA
Power voltage for LED	LED-A/K	--	3.0	3.2	3.4	V
LED Current Supply	I_{LED}	3.2V	--	15x4	--	mA
Used LCD Controller	ST7528					

6 OPTICAL CHARACTERISTICS

(Ta = 25°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
LED Backlight Luminance	Lv	100	--	--	Cd/m ²	ILED = 15x4 mA
LED Backlight Uniformity	a	80%	--	--	--	--
Response Time 1 (Note 1)	tr	--	--	350	ms	$\Phi = 0^\circ, \theta = 10^\circ$
Response Time 2 (Note 2)	td	--	--	350	ms	$\Phi = 0^\circ, \theta = 10^\circ$
Contrast Ratio (Note 3)	K	--	3.0	--	--	$\Phi = 0^\circ, \theta = 10^\circ$
Viewing Angle	θ_1	-25	--	35	deg	$\Phi = 0^\circ, K \geq 3.0$
	θ_2	-25	--	35	deg	

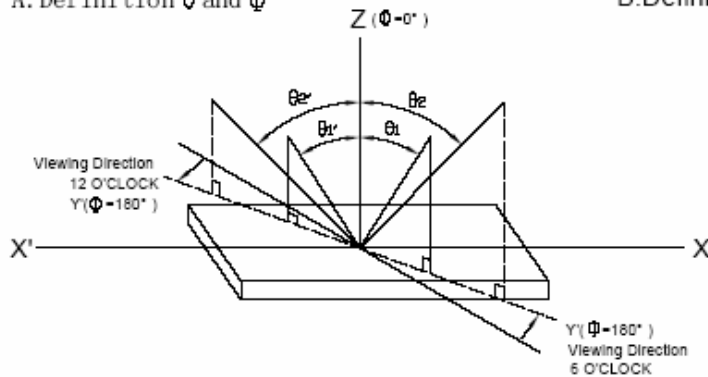
Note 1: Contrast Ratio is defined as follows:

$$K = B2/B1 \text{ (} B1: \text{Luminance of the ON Segments; } B2: \text{Luminance of the OFF segments)}$$

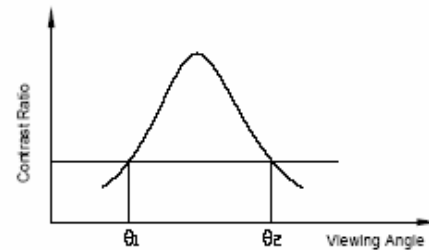
Note 2: The time that the luminance level reaches 90% of the saturation from 0% when ON signal is applied.

Note 3: The time that the luminance level reaches 10% of the saturation level from 100% when OFF signal is applied.

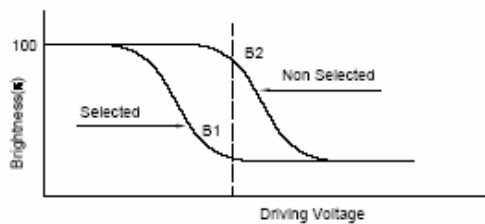
A. Definition θ and Φ



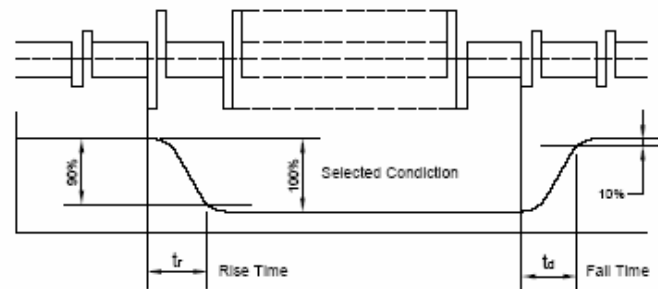
B. Definition of Viewing angles θ_1 and θ_2



C. Definition Contrast Ratio (K=B2/B1)



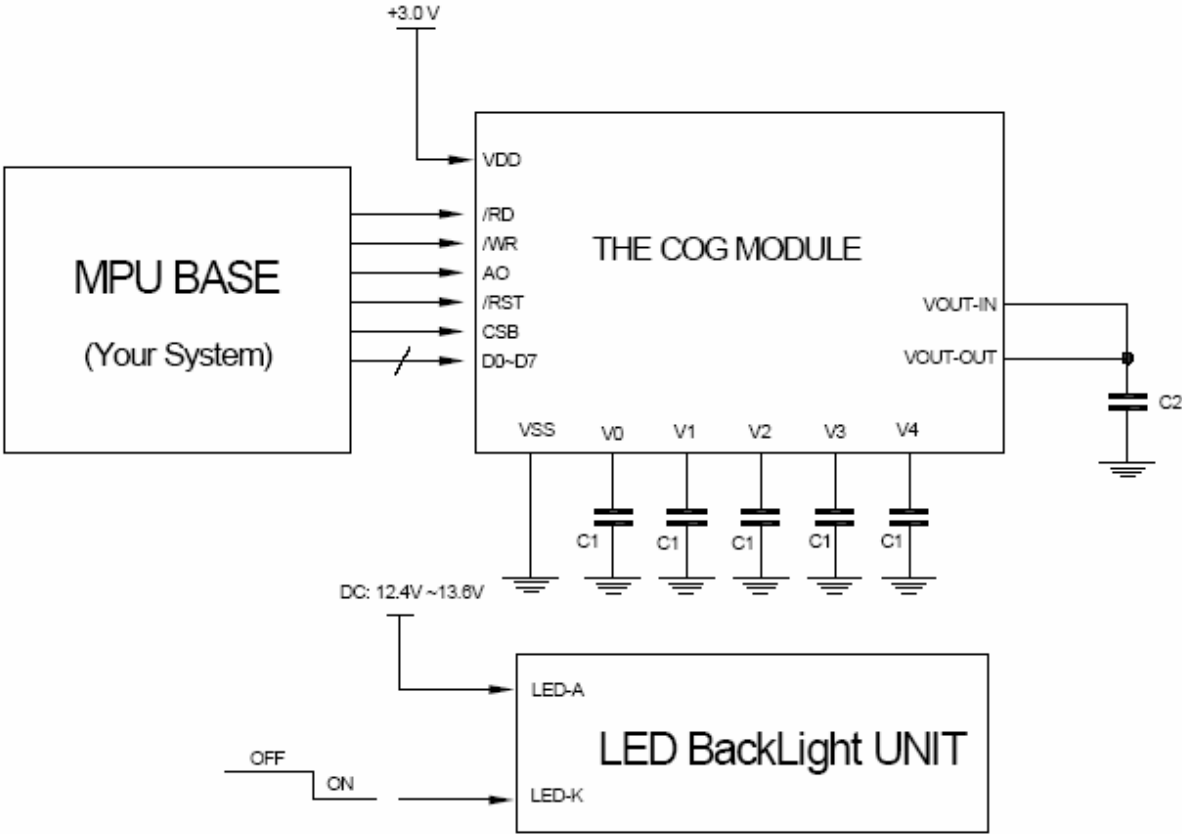
D. Definition of Optical Response



7 INTERFACE PIN ASSIGNMENT

Pin No.	Symbol	Function
1	LED-A	The Anode of White LED Backlight.
2~6	V0-V4	LCD Driver supply voltages. The voltage determined by LCD pixel is impedance-converted by an operational amplifier for application. Voltages should have the following relationship; $V0 \geq V1 \geq V2 \geq V3 \geq V4 \geq VSS$
7	VOUT_IN	An external V_{OUT} supply voltage can be supplied using the VOUT_IN pad. In this case, VOUT_OUT has to be left open, and the internal voltage generator has to be programmed to zero. (SET register VC = 0)
8	VOUT_OUT	If the internal V_{OUT} voltage generator is used, the VOUT_IN & VOUT_OUT must be connected together. If an external supply is used, this pin must be left open.
9	VSS	Ground
10	VDD	Power Supply (3.0V±10%)
11~18	D7~D0	8-bit bi-directional data bus When chip select is not active (CSB=H), D0 to D7 may be high impedance.
19	/RD	Read Signal, when /RD is "L", D0 to D7 are in a output status.
20	/WR	Write Signal, The data on D0 to D7 are latched at the rising edge of the /WR signal.
21	AO	Register select input pin, When AO = "H": D0 to D7 are display data. While AO = "L": DB0 to DB7 are control data.
22	/RST	Reset input pin. When /RST is "L", initialization is executed
23	CSB	Chip select input pins Data/Instruction I/O is enabled only when CSB is "L". When chip select is non-active, D0 to D7 may be high impedance.
24	LED-K	The Cathode of white LED backlight

8 BLOCK DIAGRAM

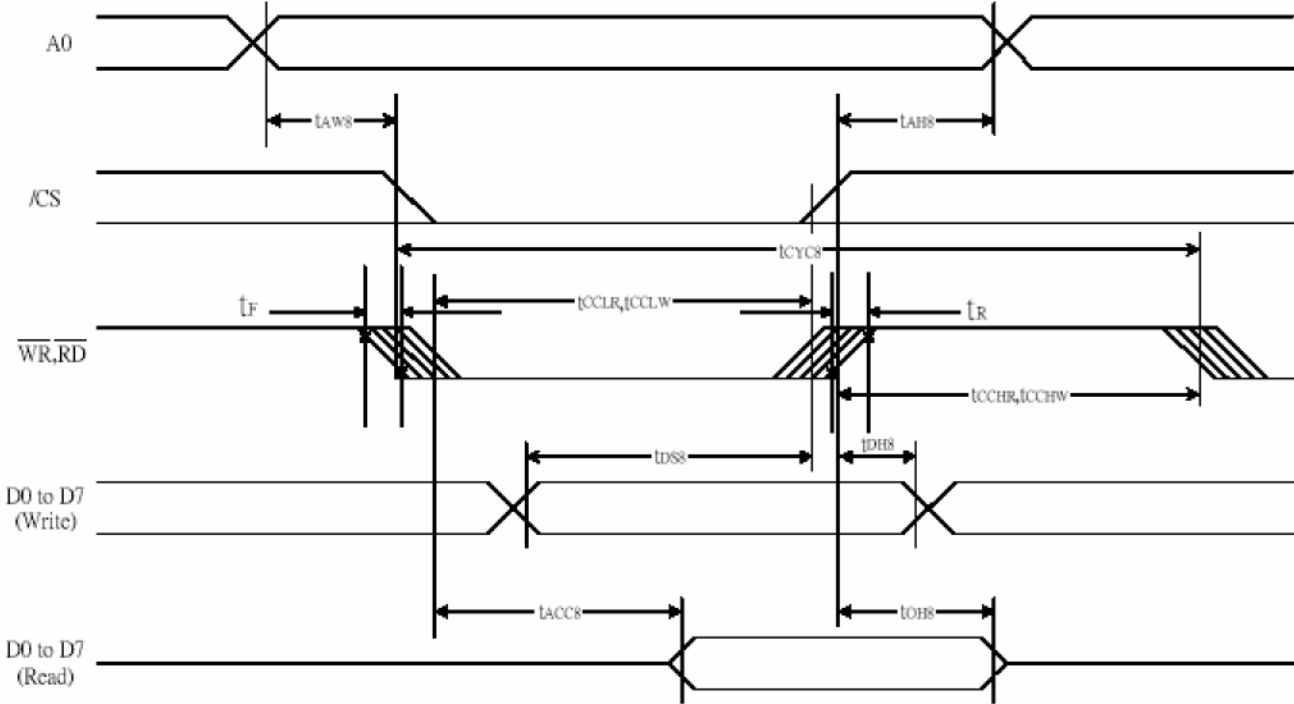


//----- Recommend Value:

- C1: 0.1uF ~ 2.2uF/25V
- C2: 2.2uF ~ 10uF/35V

9 TIMING CHARACTERISTICS

(V_{DD} = 3.3V, T_a = 0~50°C)



Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	t _{AH8}		0	—	ns
Address setup time		t _{AW8}		0	—	
System cycle time		t _{CYC8}		240	—	
Enable L pulse width (WRITE)	WR	t _{CCLW}		80	—	
Enable H pulse width (WRITE)		t _{CCHW}		80	—	
Enable L pulse width (READ)	RD	t _{CCLR}		140	—	
Enable H pulse width (READ)		t _{CCHR}		80	—	
WRITE Data setup time	D0 to D7	t _{DS8}		40	—	
WRITE Data hold time		t _{DH8}		10	—	
READ access time		t _{ACC8}	CL = 100 pF	—	70	
READ Output disable time		t _{OH8}	CL = 100 pF	5	50	
t _F				—	10	
t _R				—	10	

10 INSTRUCTION SUMMARY (ST7528)

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
EXT=0 or 1											
Mode Set	0	0	0	0	1	1	1	0	0	0	2-byte instruction to set Mode and
	0	0	FR3	FR2	FR1	FR0	0	BE	x'	EXT	FR(Frame frequency control) BE(Booster efficiency control)
EXT=0											
Read display data	1	1	Read data								Read data into DDRAM
Write display data	1	0	Write data								Write data into DDRAM
Read status	0	1	BUSY	ON	RES	MF2	MF1	MF0	DS1	DS0	Read the internal status
ICON control register ON/OFF	0	0	1	0	1	0	0	0	1	ICON	ICON=0: ICON disable(default) ICON=1: ICON enable & set the page address to 16
Set page address	0	0	1	0	1	1	P3	P2	P1	P0	Set page address
Set column address MSB	0	0	0	0	0	1	Y9	Y8	Y7	Y6	Set column address MSB
Set column address LSB	0	0	0	0	0	0	Y5	Y4	Y3	Y2	Set column address LSB
Set modify-read	0	0	1	1	1	0	0	0	0	0	Set modify-read mode
Reset modify-read	0	0	1	1	1	0	1	1	1	0	release modify-read mode
Display ON/OFF	0	0	1	0	1	0	1	1	1	D	D=0: Display OFF D=1: Display ON
Set initial display line register	0	0	0	1	0	0	0	0	x'	x'	2-byte instruction to specify the initial display line to realize vertical scrolling
	0	0	x'	S6	S5	S4	S3	S2	S1	S0	
Set initial COM0 register	0	0	0	1	0	0	0	1	x'	x'	2-byte instruction to specify the initial COM0 to realize window scrolling
	0	0	x'	C6	C5	C4	C3	C2	C1	C0	
Select partial display line	0	0	0	1	0	0	1	0	x'	x'	2-byte instruction to set partial display duty ratio
	0	0	D7	D6	D5	D4	D3	D2	D1	D0	
Set N-line inversion	0	0	0	1	0	0	1	1	x'	x'	2-byte instruction to set N-line inversion register
	0	0	x'	x'	x'	N4	N3	N2	N1	N0	
Release N-line inversion	0	0	1	1	1	0	0	1	0	0	Release N-line inversion mode
Reverse display ON/OFF	0	0	1	0	1	0	0	1	1	REV	REV=0: normal display REV=1: reverse display
Entire display ON/OFF	0	0	1	0	1	0	0	1	0	EON	EON=0: normal display EON=1: entire display ON

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Ext=0											
Power control	0	0	0	0	1	0	1	VC	VR	VF	Control power circuit operation
Select DC-DC step-up	0	0	0	1	1	0	0	1	DC1	DC0	Select the step-up of internal voltage converter
Select regulator register	0	0	0	0	1	0	0	R2	R1	R0	Select the internal resistance ratio of the regulator resistor
Select electronic volumn register	0	0	1	0	0	0	0	0	0	1	2-byte instruction to specify the reference voltage
	0	0	x'	x'	EV5	EV4	EV3	EV2	EV1	EV0	
Select LCD bias	0	0	0	1	0	1	0	B2	B1	B0	Select LCD bias
Set Bias Power Save Mode	0	0	1	1	1	1	0	0	1	1	Bias Power save Save the Bias current consumption
	0	0	0	0	0	0	0	0	0	0	
Release Bias Power Save Mode	0	0	1	1	1	1	0	0	1	1	Bias Power save release set the Bias power to normal
	0	0	0	0	0	0	0	1	0	0	
SHL select	0	0	1	1	0	0	SHL	x'	x'	x'	COM bi-direction selection SHL=0: normal direction SHL=1: reverse direction
ADC select	0	0	1	0	1	0	0	0	0	ADC	SEG bi-direction selection ADC=0: normal direction ADC=1: reverse direction
Oscillator on start	0	0	1	0	1	0	1	0	1	1	Start the built-in oscillator
Set power save mode	0	0	1	0	1	0	1	0	0	P	P=0: normal mode P=1: sleep mode
Release power save mode	0	0	1	1	1	0	0	0	0	1	release power save mode
Reset	0	0	1	1	1	0	0	0	1	0	initial the internal function
Set data direction & display data length(DDL)	x'	x'	1	1	1	0	1	0	0	0	2-byte instruction to specify the number of data bytes. (SPI mode)
	x'	x'	D7	D6	D5	D4	D3	D2	D1	D0	
Select FRC and PWM mode	0	0	1	0	0	1	0	FRC	PWM1	PWM0	FRC(1:3FRC, 0:4FRC) PWM1 PWM0 0 0 45PWM 0 1 45 PWM 1 0 60PWM 1 1 ---
NOP	0	0	1	1	1	0	0	0	1	1	<u>No operation</u>
Test Instruction	0	0	1	1	1	1	x'	x'	x'	x'	<u>Don't use this instruction</u>

Instruction	A0	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
EXT=1											
Set white mode and 1 st frame, set pulse width	0	0	1	0	0	0	0	0	0	0	Set white mode and 1st frame
	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 2 nd frame, set pulse width	0	0	1	0	0	0	0	0	0	1	Set white mode and 2nd frame
	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 3 rd frame, set pulse width	0	0	1	0	0	0	0	0	1	0	Set white mode and 3rd frame
	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set white mode and 4 th frame, set pulse width	0	0	1	0	0	0	0	0	1	1	Set white mode and 4th frame
	0	0	X'	X'	GA05	GA04	GA03	GA02	GA01	GA00	
Set gray level 1 mode	0	0	84H~87H (4 bytes)								Set gray level1
Set gray level 2 mode	0	0	88H~8BH (4 bytes)								Set gray level2
Set gray level 3 mode	0	0	8CH~8FH (4bytes)								Set gray level3
Set gray level 4 mode	0	0	90H~93H (4bytes)								Set gray level4
Set gray level 5 mode	0	0	94H~97H (4bytes)								Set gray level5
Set gray level 6 mode	0	0	98H~9BH (4 bytes)								Set gray level6
Set gray level 7 mode	0	0	9CH~9FH (4 bytes)								Set gray level7
Set gray level 8 mode	0	0	A0H~A3H (4 bytes)								Set gray level8
Set gray level 9 mode	0	0	A4H~A7H (4 bytes)								Set gray level9
Set gray level 10 mode	0	0	A8H~ABH (4 bytes)								Set gray level10
Set gray level 11mode	0	0	ACH~AFH (4 bytes)								Set gray level11
Set gray level 12 mode	0	0	B0H~B3H (4 bytes)								Set gray level12
Set gray level 13 mode	0	0	B4H~B7H (4 bytes)								Set gray level13
Set gray level 14 mode	0	0	B8H~BBH (4 bytes)								Set gray level14
Set Dark mode and 1st frame, set pulse width	0	0	1	0	1	1	1	1	0	0	Set Dark mode and 1st frame, set pulse width
	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 2nd frame, set pulse width	0	0	1	0	1	1	1	1	0	1	Set Dark mode and 2nd frame, set pulse width
	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 3rd frame, set pulse width	0	0	1	0	1	1	1	1	1	0	Set Dark mode and 3rd frame, set pulse width
	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	
Set Dark mode and 4th frame, set pulse width	0	0	1	0	1	1	1	1	1	1	Set Dark mode and 4th frame, set pulse width
	0	0	X'	X'	GAF5	GAF4	GAF3	GAF2	GAF1	GAF0	

11 RELIABILITY TEST

11.1 ENVIRONMENTAL TEST

Test Item	Test Condition	Test Time	Note
Low Temperature Storage	-30°C	72H	--
High Temperature Storage	80°C	72H	--
Low Temperature Operation	-10°C	100H	--
High Temperature Operation	60°C	100H	--
High Temperature/ Humidity Storage	70°C, 90%RH	72H	Without Dewing
Temperature Cycle	-20 ~ 70°C 	10 Cycles	--

11.2 MECHANICAL TEST

Test Item	Test Condition	Note
Vibration Test	10~22 Hz, 1.5mmp-p, 22~500 Hz, 1.5 G, Total of 0.5 Hrs	Non operation state
Shock Test	50G half sign wave, 11 msdc, 3 times in each direction	Non operation state
Atmospheric pressure test	115 mbar, 40 hrs	--
Static Electricity test	VS = 1000V, RS = 1.5k, CS = 100pF, 1 time	--

11.3 LIFE TIME

Item	Description
1	Functions, performance, appearance should be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature (25±10°C), normal humidity (45±20%RH), and in area not exposed to direct sun light.(Except backlight).

12 QUALITY ASSURANCE SPECIFICATION

12.1 CONFORMITY

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

12.2 DELIVERY ASSURANCE

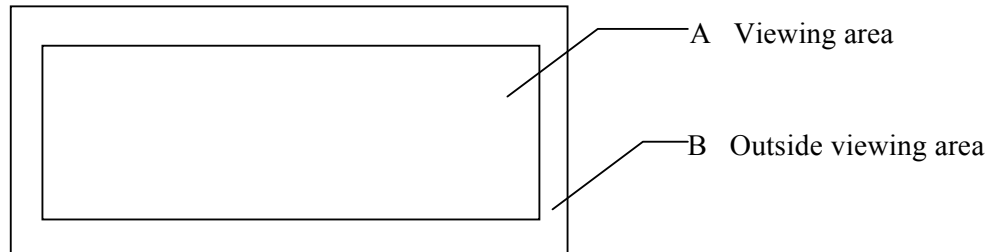
10.2.1 Delivery inspection standards

- IPC-AA610, class 2 electronic assemblies standard

The quality assurance levels are shown below:

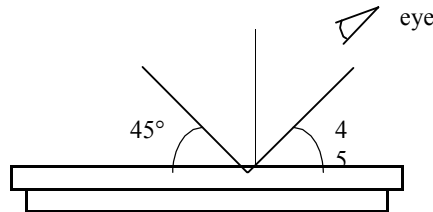
Rank	Item Inspected	Defect type	AQL	Remark
Major defect	Display	Non display	0.25%	Fit/Function defect
		Over current		
		Missing segment		
		Wrong viewing direction		
		Incorrect operating		
		Backlight OFF		
	Backlight flashing			
Dimension	PCB and bezel out of specification			
Minor defect	LCD	Black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

10.2.2 Zone definition



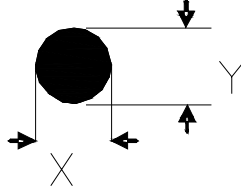
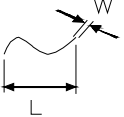
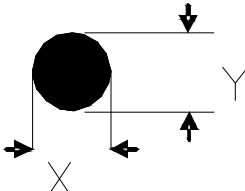
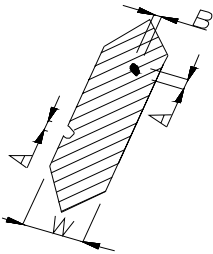
10.2.3 Visual inspection

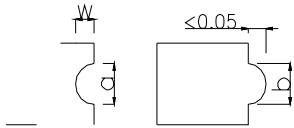
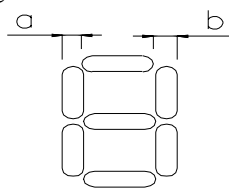
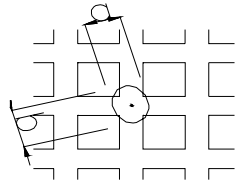
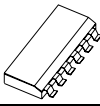
- Inspect under 2x20W or 40W fluorescent lamp (approximately 3000 lux) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye (measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted considering clearness and crosstalk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



10.2.3.1 Standard of appearance inspection

units: mm

No.	Item	Criteria																																						
1	Black spot, White spot, dust	<p>Round type: as per following drawing $\Phi = (X+Y)/2$</p>  <table border="1" data-bbox="781 415 1268 632"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>$\Phi < 0.1$</td> <td>Any number</td> <td rowspan="3">Any number</td> </tr> <tr> <td>$0.1 < \Phi < 0.2$</td> <td>2</td> </tr> <tr> <td>$0.2 < \Phi < 0.25$</td> <td>1</td> </tr> <tr> <td>$0.25 < \Phi$</td> <td>0</td> <td></td> </tr> </tbody> </table> <p>Line type: as per following drawing</p>  <table border="1" data-bbox="662 720 1333 930"> <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 rowspan="2">Any number</td> <td rowspan="2">Any number</td> </tr> <tr> <td>$L \leq 3.0$</td> <td>$0.02 < W \leq 0.03$</td> </tr> <tr> <td>$L \leq 2.5$</td> <td>$0.03 < W \leq 0.05$</td> <td>2</td> <td></td> </tr> <tr> <td>-</td> <td>$0.05 < W$</td> <td>as round type</td> <td></td> </tr> </tbody> </table> <p>Total acceptable quantity: 3</p>	Acceptable quantity			size	Zone A	Zone B	$\Phi < 0.1$	Any number	Any number	$0.1 < \Phi < 0.2$	2	$0.2 < \Phi < 0.25$	1	$0.25 < \Phi$	0		Acceptable quantity				Length	Width	Zone A	Zone B	-	$W \leq 0.02$	Any number	Any number	$L \leq 3.0$	$0.02 < W \leq 0.03$	$L \leq 2.5$	$0.03 < W \leq 0.05$	2		-	$0.05 < W$	as round type	
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2	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1																																						
3	Polariser bubble	<p>$\Phi = (X+Y)/2$</p>  <table border="1" data-bbox="808 1060 1268 1276"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>$\Phi < 0.2$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.2 < \Phi < 0.5$</td> <td>2</td> </tr> <tr> <td>$0.5 < \Phi < 1.0$</td> <td>1</td> </tr> <tr> <td>$1.0 < \Phi$</td> <td>0</td> </tr> </tbody> </table> <p>Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\Phi < 0.2$	Any number	Any number	$0.2 < \Phi < 0.5$	2	$0.5 < \Phi < 1.0$	1	$1.0 < \Phi$	0																							
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4	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width $\Phi = (A+B)/2$</p>  <table border="1" data-bbox="735 1434 1287 1665"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th>Φ</th> </tr> </thead> <tbody> <tr> <td>$W \leq 0.4$</td> <td>$\Phi \leq 0.2$ and $\Phi \leq 1/2W$</td> </tr> <tr> <td>$W > 0.4$</td> <td>$\Phi \leq 0.25$ and $\Phi \leq 1/3W$</td> </tr> </tbody> </table> <p>Total acceptable quantity: 1 defect per segment Pin holes with Φ under 0.10 mm are acceptable.</p>	Acceptable quantity		Width	Φ	$W \leq 0.4$	$\Phi \leq 0.2$ and $\Phi \leq 1/2W$	$W > 0.4$	$\Phi \leq 0.25$ and $\Phi \leq 1/3W$																														
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No.	Item	Criteria																												
5	Black spot, White spot, dust	<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>$(a+b)/2 \le 0.1$</td> <td>Any number</td> </tr> <tr> <td>$0.5 < \Phi < 1.0$</td> <td>3</td> </tr> </tbody> </table> <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> </thead> <tbody> <tr> <td>$a > b$</td> <td>$a/b \le 4/3$</td> </tr> <tr> <td>$a < b$</td> <td>$a/b > 4/3$</td> </tr> </tbody> </table> <p>3. Alignment layer defect $\Phi = (a+b)/2$</p>  <table border="1" 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>$\Phi \le 0.4$</td> <td>Any number</td> </tr> <tr> <td>$0.4 < \Phi \le 1.0$</td> <td>5</td> </tr> <tr> <td>$1.0 < \Phi \le 1.5$</td> <td>3</td> </tr> <tr> <td>$1.5 < \Phi \le 2.0$</td> <td>2</td> </tr> </tbody> </table>	Acceptable quantity		Size		$a, b < 0.1$	Any number	$(a+b)/2 \le 0.1$	Any number	$0.5 < \Phi < 1.0$	3	Acceptable		$a > b$	$a/b \le 4/3$	$a < b$	$a/b > 4/3$	Acceptable quantity		Size		$\Phi \le 0.4$	Any number	$0.4 < \Phi \le 1.0$	5	$1.0 < \Phi \le 1.5$	3	$1.5 < \Phi \le 2.0$	2
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$1.5 < \Phi \le 2.0$	2																													
6	Colour uniformity	Level of sample for approval set as limit sample																												
7	Backlight	The backlight colour should correspond to the product specification Flashing and or unlit backlight is not allowed Dust larger than 0.25 mm is not allowed																												
8	COB	Exposed wire bond pad is not allowed Insufficient covering with resin is not allowed (wire bond line exposed) Dust or bubble on the resin are not allowed																												
9	PCB 	No unmelted solder paste should be present on PCB Cold solder joints, missing solder connections, or oxidation are not allowed No residue or solder balls on PCB are allowed Short circuits on components are not allowed																												
10	Tray particles	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Size</th> <th>Quantity</th> </tr> </thead> <tbody> <tr> <td rowspan="2">On tray</td> <td>$\Phi < 0.2$</td> <td>Any number</td> </tr> <tr> <td>$\Phi > 0.25$</td> <td>4</td> </tr> <tr> <td rowspan="2">On display</td> <td>$\Phi \ge 0.25$</td> <td>2</td> </tr> <tr> <td>$L = 3$</td> <td>1</td> </tr> </tbody> </table>		Size	Quantity	On tray	$\Phi < 0.2$	Any number	$\Phi > 0.25$	4	On display	$\Phi \ge 0.25$	2	$L = 3$	1															
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13 HANDLING PRECAUTIONS

Safety

If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes.
If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design

Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.
When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean. Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning

Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotrifluoroethane. Do not wipe the display surface with dry or hard materials that will damage the polariser surface. Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge

As the display uses C-MOS LSI drivers, connect any unused input terminal to VDD or VSS. Do not input any signals before power is turned on. Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging

Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height.
To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation

It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life. Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation.
Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged. If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once. Even a small amount of condensation on the contact pads (terminals) can cause an electrochemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage

Store the display in a dark place where the temperature is $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ 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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