



PRODUCT SPECIFICATION

Part Number

PCOG128128PR-O Series

CUSTOMER	
CUSTOMER PART NUMBER	
DESCRIPTION	
APPROVED BY	
DATE	

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[illegible]

**P-TEC****MODEL NO.**

PCOG128128PR-O series

SPEC ONLY

PAGE

4

1. Part number breakdown

P _ _ - _ _ - _ _ - _ _

1 2 3 4 5 6 7 8 9

Replace each Space (_) with the following letters and or numbers

1. P-tec LCD Type	C = Character G = Graphic COG = Chip On Glass	COF = Chip On Flex TAB = Tape Automated Bonding TFT = Thin-film Transistor
2. LCD Model	Example for Character: 2002A = 20 Characters x 2 Lines w/ Pins on Left side and 116mm x 37 x 12.7mm overall size Example for Graphic: 12864B = 128 Dots per row x 64 Dots per Column w/ Pins on lower side and 93mm x 70 x 8.8mm overall size	
3. Fluid Type	T = TN/Grey Y = STN/Yellow Green G = STN/ Grey	B = STN/ Blue F = FSTN/ White N = FSTN/ Black
4. Backlight/polorizer	NF = None/Transflective NM = None/Transmissive NR = None/Reflective EF = EL/Transflective EM = EL/Transmissive	LF = LED/Transflective LM = LED/Transmissive CF = CCFL/Transflective CM = CCFL=Transmissive
5. Backlight Color	(If no backlight provided move on to viewing angle [6.]) B = Blue/Green Y = Yellow G = Green	
6. Viewing Angle	D = 6:00 U = 12:00	R = 3:00 L = 9:00
7. Internal Number	Single Letter for internal purposes	
8. Extended Temperature	This space is blank if operating temperature is standard 0°C to 50°C An X will be visible if the LCD is Extended operating temperature	
9. Customer Specials or List of Value-added items	Usually blank unless customer requests some modifications. Can be several Letters long.	

2. FUNCTIONS & FEATURES

- | | |
|--|--------------------------------------|
| 1.1. Format | : 128x128dots |
| 1.2. LCD mode | : FSTN / Positive/ transfective mode |
| 1.3. Viewing direction | : 12 o'clock |
| 1.4. Driving scheme | : 1/128Duty cycle, 1/11Bias |
| 1.5. Power supply voltage range (V_{DD}) | : 3.0V |
| 1.6. LCD driving voltage | : 12.0V |
| 1.7. Operation temp | : -20~70°C |
| 1.8. Storage temp | : -30~85°C |
| 1.9. Backlight color | : Side White |
| 1.10. RoHS standard. | |

3. MECHANICAL SPECIFICATIONS

- | | |
|-------------------|------------------------------------|
| 2.1. Module size | : 48.0mm(L)*52.8mm(W)*4.3mm(H)Max. |
| 2.2. Viewing area | : 44.0mm(L)*40.5mm(W) |
| 2.3. Dot pitch | : 0.297mm(L)*0.297m(W) |
| 2.4. Dot size | : 0.282mm(L)*0.282mm(W) |
| 2.5. Weight | : Approx. |

4. BLOCK DIAGRAM AND ICON TABLE

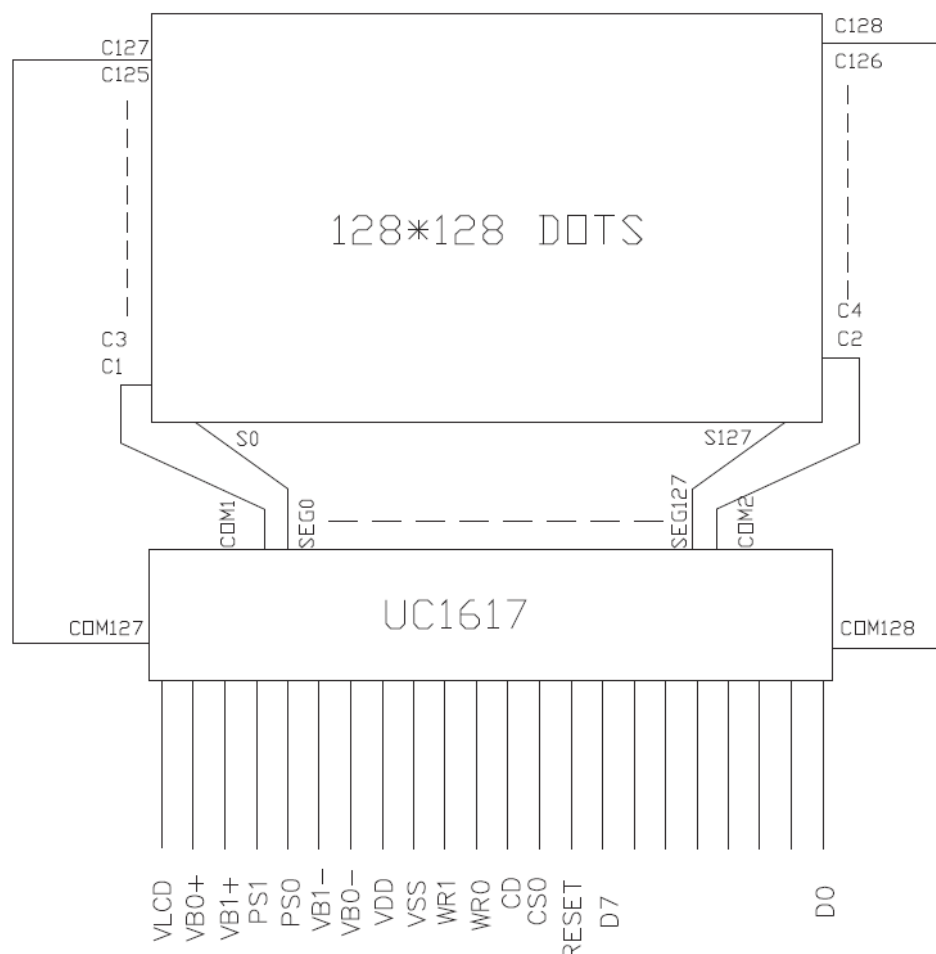


Figure 1. Block diagram

5. DIMENSIONAL OUTLINE

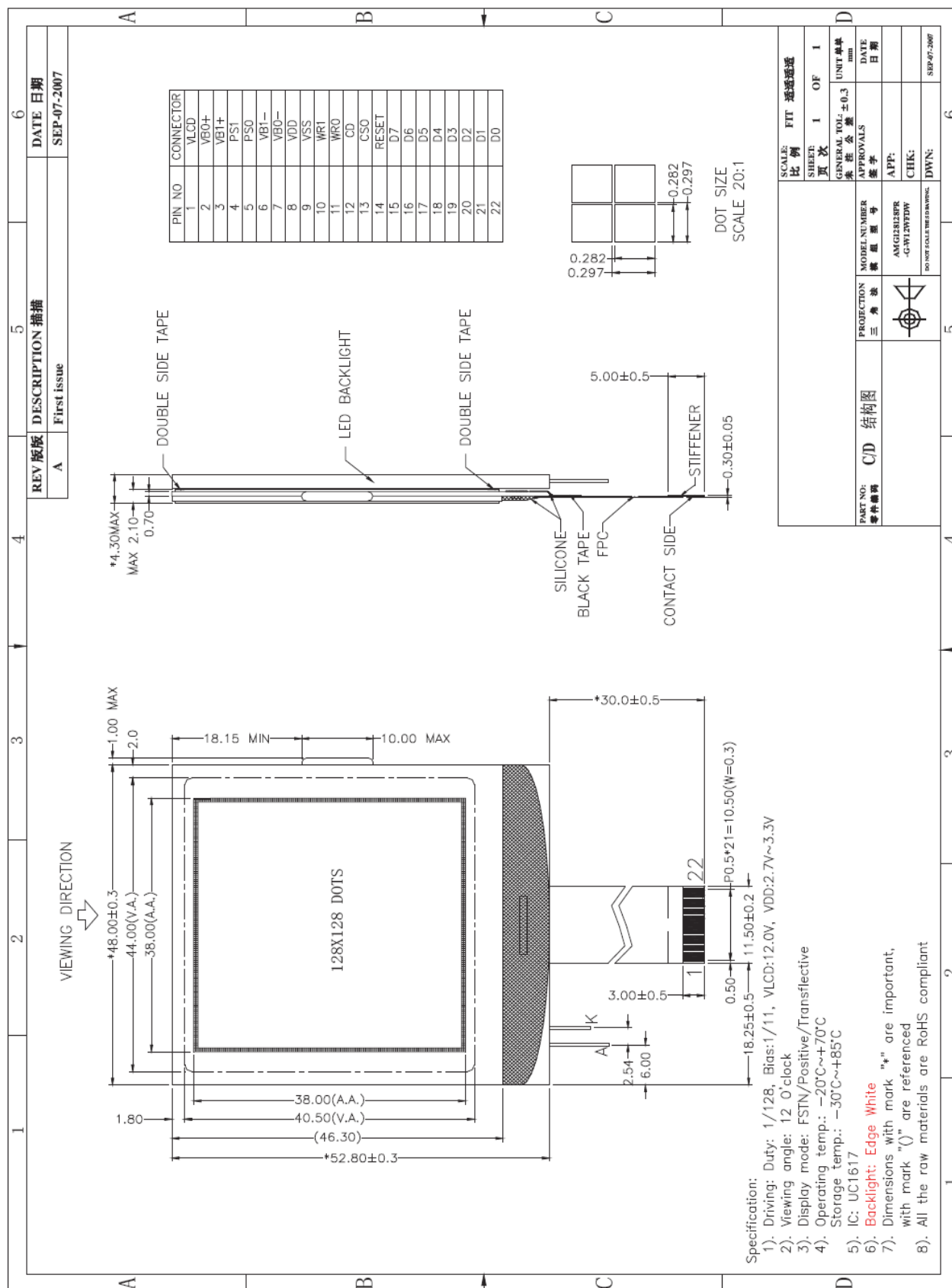


Figure 2. Dimensional outline

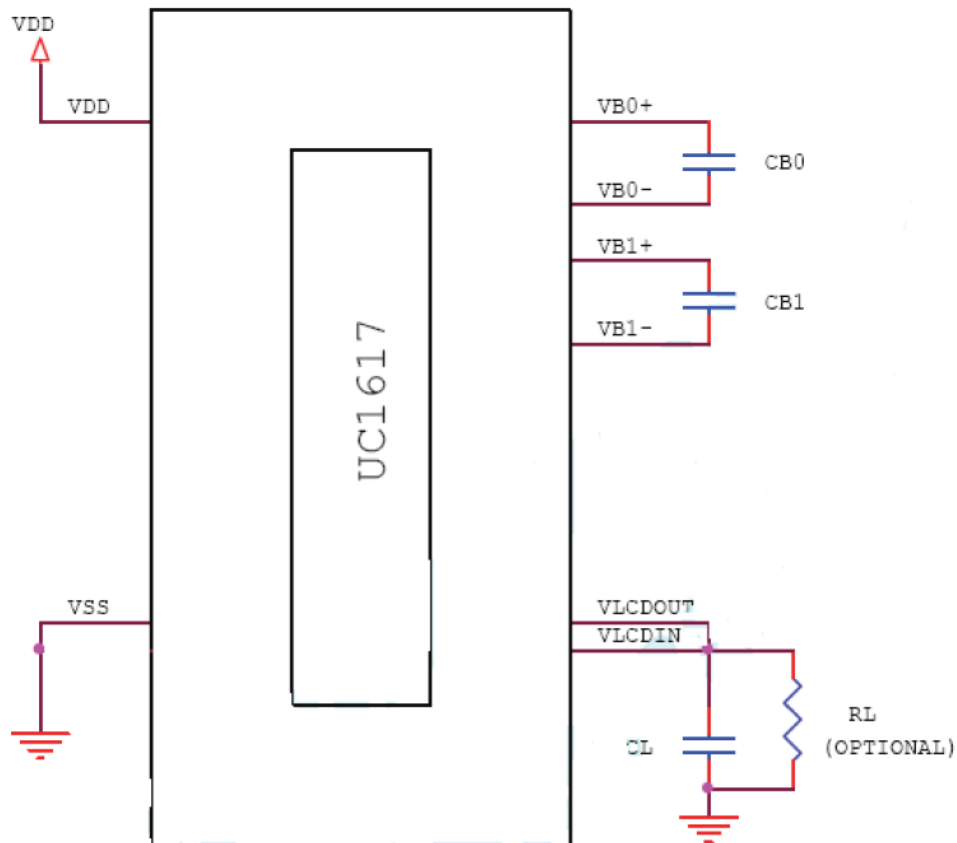
6. PIN DESCRIPTION

No.	Symbol	Function
1	VLCD	High voltage LCD power supply
2	VB0+	LCD bias voltage
3	VB1+	LCD bias voltage
4	PS1	Bus mode. PS1:PS0 (1:1 6800 series interface) (1:0 8080 series interface)
5	PS0	
6	VB1-	LCD bias voltage
7	VB0-	LCD bias voltage
8	VDD	Power supply
9	VSS	Ground
10	WR1	Controls the read/write operation of the host interface.(In 6800 series WR1:EN,WR0:R/W. In 8080 series WR1:/RD,WR0:/WR)
11	WR0	
12	CD	Register selection(L: Control data H: Display data)
13	CS0	Chip select(When CS0=L chip is select)
14	RESET	Reset signal
15-22	D7-D0	Data bus

7. MAXIMUM ABSOLUTE LIMIT

Symbol	Parameter	Min.	Max.	Unit
V _{DD}	Logic Supply voltage	-0.3	+4.0	V
V _{DD2}	LCD Generator Supply voltage	-0.3	+4.0	V
V _{DD3}	Analog Circuit Supply voltage	-0.3	+4.0	V
V _{DD2/3} -V _{DD}	Voltage difference between V _{DD} and V _{DD2/3}	--	1.6	V
V _{LCD}	LCD Generated voltage (-30°C ~ +80°C)	-0.3	+18.0	V
V _{IN}	Digital input signal	-0.4	V _{DD} + 0.5	V
T _{OPR}	Operating temperature range	-30	+85	°C
T _{STR}	Storage temperature	-55	+125	°C

8. REFERENCE CIRCUIT



Reference circuit using internal Hi-V generator circuit

9. ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Supply for digital circuit		1.65		3.3	V
$V_{DD2/3}$	Supply for bias & pump		2.5		3.3	V
V_{LCD}	Charge pump output	$V_{DD2/3} \geq 2.6V, 25^{\circ}C$		14	15	V
V_D	LCD data voltage	$V_{DD2/3} \geq 2.6V, 25^{\circ}C$	0.89		1.78	V
V_{IL}	Input logic LOW				$0.2V_{DD}$	V
V_{IH}	Input logic HIGH		$0.8V_{DD}$			V
V_{OL}	Output logic LOW				$0.2V_{DD}$	V
V_{OH}	Output logic HIGH		$0.8V_{DD}$			V
I_{IL}	Input leakage current				1.5	μA
C_{IN}	Input capacitance			5	10	pF
C_{OUT}	Output capacitance			5	10	pF
$R_{ON(SEG)}$	SEG output impedance	$V_{LCD} = 15V$		1.5	2.0	$k\Omega$
$R_{ON(COM)}$	COM output impedance	$V_{LCD} = 15V$		1.5	2.0	$k\Omega$
f_{LINE}	Average Line rate	LC[4:3] = 00b	-10%	14.2	+10%	kHz

10. TIMING CHARACTERISTICS

AC CHARACTERISTICS

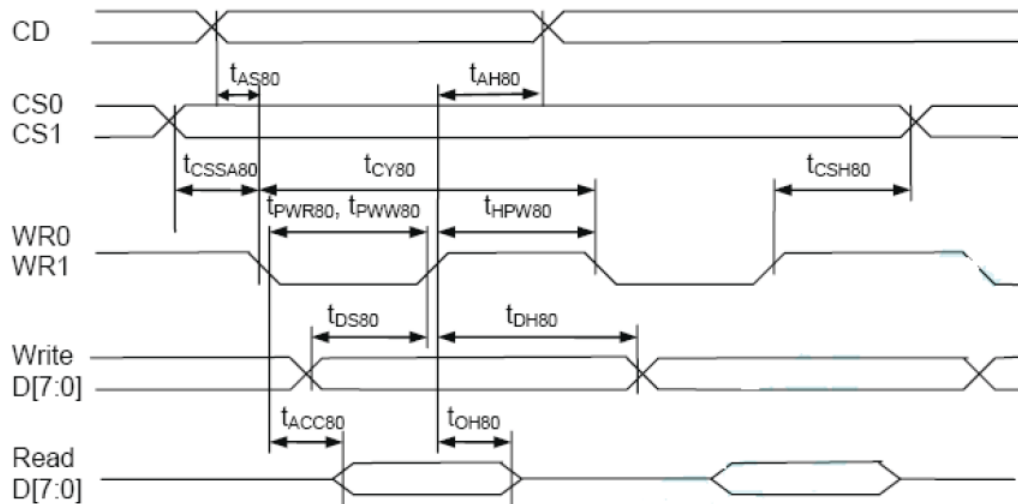
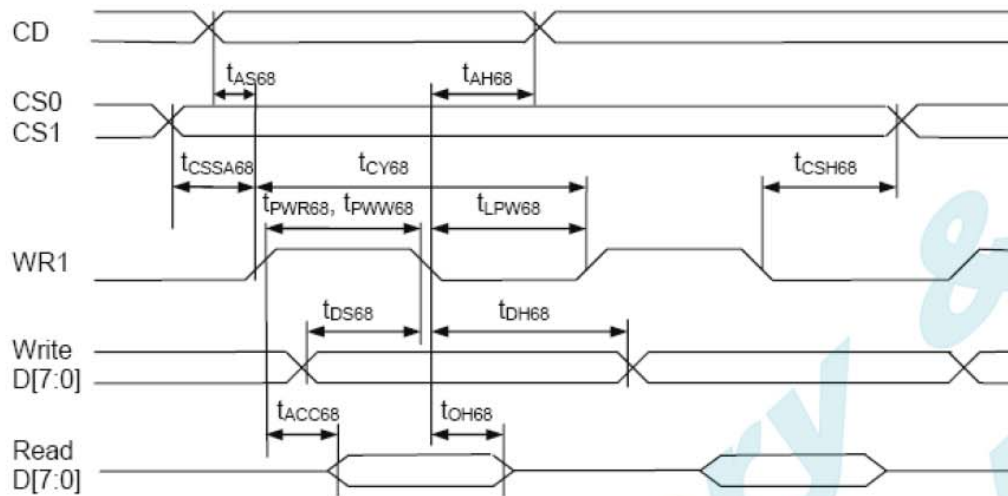


FIGURE 13: Parallel Bus Timing Characteristics (for 8080 MCU)

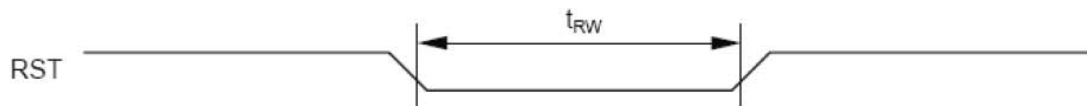
($2.5V \leq V_{DD} < 3.3V$, $T_a = -30$ to $+85^\circ C$)

Symbol	Signal	Description	Condition	Min.	Max.	Units
t_{AS80}	CD	Address setup time		0	–	nS
t_{AH80}		Address hold time		0	–	nS
t_{CY80}		System cycle time (read) (write)		170 130	–	nS
t_{PWR80}	WR1	Pulse width (read)		70	–	nS
t_{PWW80}	WR0	Pulse width (write)		70	–	nS
t_{HPW80}	WR0, WR1	High pulse width (read) (write)		100 60	–	nS
t_{DS80}	D0~D7	Data setup time		30	–	nS
t_{DH80}		Data hold time		0	–	nS
t_{ACC80}		Read access time	$C_L = 100pF$	–	60	nS
t_{OH80}		Output hold time		–	25	nS
t_{CSSA80}	CS1/CS0	Chip select setup time		5	–	nS
t_{CSH80}				5	–	nS


FIGURE 14: Parallel Bus Timing Characteristics (for 6800 MCU)
 $(2.5V \leq V_{DD} < 3.3V, T_a = -30 \text{ to } +85^\circ\text{C})$

Symbol	Signal	Description	Condition	Min.	Max.	Units
t_{AS68}	CD	Address setup time		0	–	nS
t_{AH68}	CD	Address hold time		0	–	nS
t_{CY68}		System cycle time (read) (write)		170 130	–	nS
t_{PWR68}	WR1	Pulse width (read)		70	–	nS
t_{PWW68}		Pulse width (write)		70	–	nS
t_{LPW68}		Low pulse width (read) (write)		100 60	–	nS
t_{DS68}	D0~D7	Data setup time		30	–	nS
t_{DH68}	D0~D7	Data hold time		0	–	nS
t_{ACC68}		Read access time	$C_L = 100\text{pF}$	–	60	nS
t_{OH68}		Output hold time		–	25	nS
t_{CSSA68}	CS1/CS0	Chip select setup time		5	–	nS
t_{CSH68}	CS1/CS0	Chip select hold time		5	–	nS

11. Reset Timing


 $(1.65V \leq V_{DD} < 3.3V, T_a = -30 \text{ to } +85^\circ\text{C})$

Symbol	Signal	Description	Condition	Min.	Max.	Units
t_{RW}	RST	Reset low pulse width		3	–	μS
t_{RD}	RST, WR	Reset to WR pulse delay		10	–	mS

12. CONTROL AND DISPLAY INSTRUCTION

	Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action	Default
1	Write Data Byte	1	0	#	#	#	#	#	#	#	#	Write 1 byte	N/A
2	Read Data Byte	1	1	#	#	#	#	#	#	#	#	Read 1 byte	N/A
3	Get Status	0	1	1	MX	MY	WA	DE	WS	MD	MS	Get {Status, Ver, PMO, Product Code, PID, MID}	N/A
4	Set Page_C Address	0	0	0	0	0	#	#	#	#	#	Set CA[4:0]	0H
5	Set Temp. Compensation	0	0	0	0	1	0	0	1	#	#	Set TC[1:0]	00b
6	Set Panel Loading	0	0	0	0	1	0	1	0	#	#	Set PC[1:0]	10b
7	Set Pump Control	0	0	0	0	1	0	1	1	#	#	Set PC[3:2]	11b
8	Set Adv. Program Control (double-byte command)	0	0	0	0	1	1	0	0	R	R	Set APC[R][7:0], R = 0, 1 or 2	N/A
9	Set Scroll Line LSB	0	0	0	1	0	0	#	#	#	#	Set SL[3:0]	0H
9	Set Scroll Line MSB	0	0	0	1	0	1	-	#	#	#	Set SL[6:4]	0H
10	Set Row Address LSB	0	0	0	1	1	0	#	#	#	#	Set RA[3:0]	00H
10	Set Row Address MSB	0	0	0	1	1	1	-	#	#	#	Set RA[6:4]	00H
11	Set V _{BIAS} Potentiometer (double-byte command)	0	0	1	0	0	0	0	0	0	1	Set PM[7:0]	4EH
12	Set Partial Display Control	0	0	1	0	0	0	0	1	#	#	Set LC[9:8]	00b: Disable
13	Set RAM Address Control	0	0	1	0	0	0	1	#	#	#	Set AC[2:0]	001b
14	Set Fixed Lines	0	0	1	0	0	1	0	0	0	0	Set {FLT, FLB}	0
15	Set Line Rate	0	0	1	0	1	0	0	0	#	#	Set LC[4:3]	00b
16	Set All-Pixel-ON	0	0	1	0	1	0	0	1	0	#	Set DC[1]	0b
17	Set Inverse Display	0	0	1	0	1	0	0	1	1	#	Set DC[0]	0b
18	Set Display Enable	0	0	1	0	1	0	1	1	#	#	Set DC[3:2]	10b
19	Set LCD Mapping Control	0	0	1	1	0	0	0	#	#	#	Set LC[2:0]	000b
20	Set N-Line Inversion	0	0	1	1	0	0	1	0	0	0	Set NIV[3:0]	6H
21	Set LCD Gray Shade	0	0	1	1	0	1	0	#	#	#	Set LC[7:5]	001b
22	System Reset	0	0	1	1	1	0	0	0	1	0	System Reset	N/A
23	NOP	0	0	1	1	1	0	0	0	1	1	No operation	N/A
24	Set Test Control (double-byte command)	0	0	1	1	1	0	0	1	TT		For testing only. Do not use.	N/A
25	Set LCD Bias Ratio	0	0	1	1	1	0	1	0	#	#	Set BR[1:0]	11b: 11
26	Reset Cursor Update Mode	0	0	1	1	1	0	1	1	1	0	AC[3]=0, CA=CR	AC[3]=0
27	Set Cursor Update Mode	0	0	1	1	1	0	1	1	1	1	AC[3]=1, CR=CA	AC[3]=1
28	Set COM End	0	0	1	1	1	1	0	0	0	1	Set CEN[6:0]	127
29	Set Partial Display Start	0	0	1	1	1	1	0	0	1	0	Set DST[6:0]	0
30	Set Partial Display End	0	0	1	1	1	1	0	0	1	1	Set DEN[6:0]	127
31	Set Window Program Starting Page_C Address	0	0	1	1	1	1	0	1	0	0	Set WPC0[4:0]	0
32	Set Window Programming Starting Row Address	0	0	1	1	1	1	0	1	0	1	Set WPP0[6:0]	0
33	Set Window Programming Ending Page_C Address	0	0	1	1	1	1	0	1	1	0	Set WPC1[4:0]	31

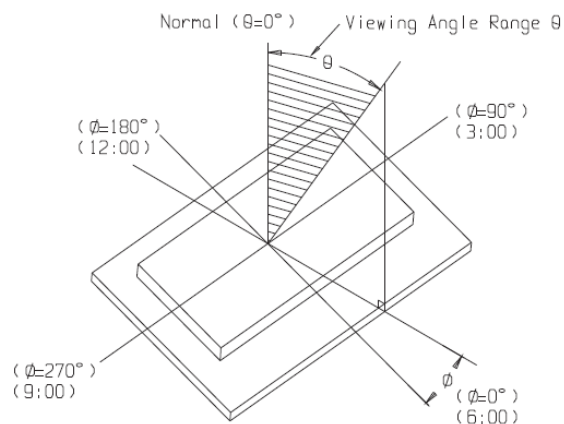
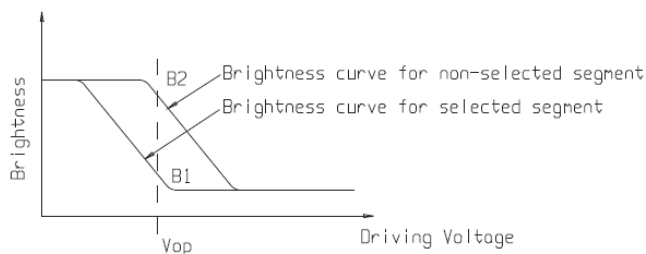
	Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action	Default
34	Set Window Programming Ending Row Address	0 0	0 0	1 -	1 #	1 #	1 #	0 #	1 #	1 #	1 #	Set WPP1[6:0]	127
35	Enable window program	0 0	0 0	1 -	1 -	1 -	1 -	1 -	0 -	0 -	#	Set AC[4]	0: Disable
36	Set MTP Operation control	0 0	0 0	1 -	0 -	1 -	1 -	1 -	0 -	0 -	0 -	Set MTPC[5:0]	10H
37	Set MTP Write Mask	0 0	0 0	1 #	0 #	1 #	1 #	1 #	0 #	0 #	1 #	Set MTPM[7:0]	0
38	Set V _{MTP1} Potentiometer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	0 #	0 #	Shared with Window Programming commands	N/A
39	Set V _{MTP2} Potentiometer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	0 #	1 #		
40	Set MTP Write Timer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	1 #	0 #		
41	Set MTP Read Timer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	1 #	1 #		

13.ELECTRO-OPTICAL CHARACTERISTICS

(V_{DD} = 3.0V, Ta = 25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage of LCD	V _{op}	Ta = -20°C	12.4	12.6	12.8	V
		Ta = 25°C	11.8	12.0	12.4	
		Ta = 70°C	11.2	11.4	11.6	
Response time	Tr	Ta = 25°C	---	250	---	ms
	Tf		---	300	---	ms
Contrast	Cr	Ta = 25°C	---	4	---	---
Viewing angle range	θ	Cr ≥ 2	-40	---	+40	deg
	Φ		-40	---	+40	deg

$$Cr = \frac{\text{Brightness of non-selected segment}(B2)}{\text{Brightness of selected segment}(B1)}$$



14.BACK LIGHT CHARACTERISTICS

LCD Module with side LED Backlight

ELECTRICAL RATINGS

Ta = 25°C

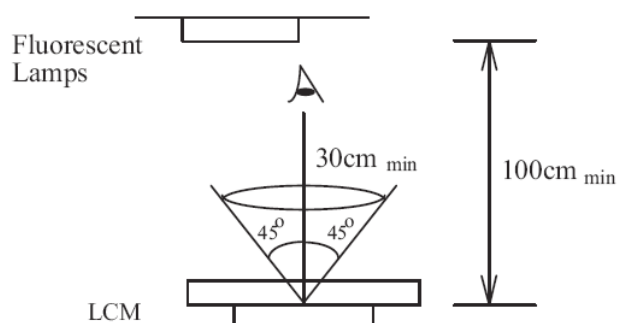
Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage	VF	IF=45mA	3.0	3.1	3.3	V
Reverse Current	IR	VR=5V	---	---	100	uA
Color	White					

15.Quality Specifications

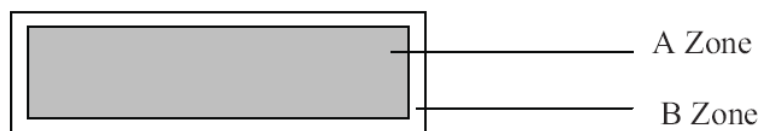
15.1 Standard of the product appearance test

Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.



Definition of zone:



A Zone: Active display area (minimum viewing area).

B Zone: Non-active display area (outside viewing area).

15.2 Specification of quality assurance

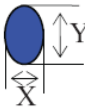
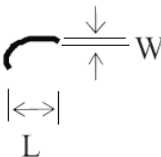
AQL inspection standard

Sampling method: MIL-STD-105E, Level II, single sampling

Defect classification **(Note: * is not including)**

Classify	Item		Note	AQL
Major	Display state	Short or open circuit	1	0.65
		LC leakage		
		Flickering		
		No display		
		Wrong viewing direction		
		Contrast defect (dim, ghost)	2	
		Back-light	1,8	
	Non-display	Flat cable or pin reverse	10	
		Wrong or missing component	11	
Minor	Display state	Background color deviation	2	1.0
		Black spot and dust	3	
		Line defect, Scratch	4	
		Rainbow	5	
		Chip	6	
		Pin hole	7	
		Protruded	12	
		Bubble and foreign material	3	
	Soldering	Poor connection	9	
	Wire	Poor connection	10	
	TAB	Position, Bonding strength	13	

Note on defect classification

No.	Item	Criterion																				
1	Short or open circuit	Not allow																				
	LC leakage																					
	Flickering																					
	No display																					
	Wrong viewing direction																					
	Wrong Back-light																					
2	Contrast defect	Refer to approval sample																				
	Background color deviation																					
3	Point defect, Black spot, dust (including Polarizer)	 <table><thead><tr><th>Point Size</th><th>Acceptable Qty.</th></tr></thead><tbody><tr><td>$\phi \leq 0.10$</td><td>Disregard</td></tr><tr><td>$0.10 < \phi \leq 0.20$</td><td>3</td></tr><tr><td>$0.20 < \phi \leq 0.25$</td><td>2</td></tr><tr><td>$0.25 < \phi \leq 0.30$</td><td>1</td></tr><tr><td>$\phi > 0.30$</td><td>0</td></tr></tbody></table> $\phi = (X+Y)/2$	Point Size	Acceptable Qty.	$\phi \leq 0.10$	Disregard	$0.10 < \phi \leq 0.20$	3	$0.20 < \phi \leq 0.25$	2	$0.25 < \phi \leq 0.30$	1	$\phi > 0.30$	0								
	Point Size	Acceptable Qty.																				
$\phi \leq 0.10$	Disregard																					
$0.10 < \phi \leq 0.20$	3																					
$0.20 < \phi \leq 0.25$	2																					
$0.25 < \phi \leq 0.30$	1																					
$\phi > 0.30$	0																					
	Unit: mm																					
4	Line defect, Scratch	 <table><thead><tr><th colspan="2">Line</th><th>Acceptable Qty.</th></tr><tr><th>L</th><th>W</th><th></th></tr></thead><tbody><tr><td>---</td><td>$0.015 \geq W$</td><td>Disregard</td></tr><tr><td>$3.0 \geq L$</td><td>$0.03 \geq W$</td><td rowspan="2">2</td></tr><tr><td>$2.0 \geq L$</td><td>$0.05 \geq W$</td></tr><tr><td>$1.0 \geq L$</td><td>$0.1 > W$</td><td>1</td></tr><tr><td>---</td><td>$0.05 < W$</td><td>Applied as point defect</td></tr></tbody></table>	Line		Acceptable Qty.	L	W		---	$0.015 \geq W$	Disregard	$3.0 \geq L$	$0.03 \geq W$	2	$2.0 \geq L$	$0.05 \geq W$	$1.0 \geq L$	$0.1 > W$	1	---	$0.05 < W$	Applied as point defect
	Line		Acceptable Qty.																			
L	W																					
---	$0.015 \geq W$	Disregard																				
$3.0 \geq L$	$0.03 \geq W$	2																				
$2.0 \geq L$	$0.05 \geq W$																					
$1.0 \geq L$	$0.1 > W$	1																				
---	$0.05 < W$	Applied as point defect																				
	Unit: mm																					
5	Rainbow	Not more than two color changes across the viewing area.																				

No

Item

Criterion

6

Chip

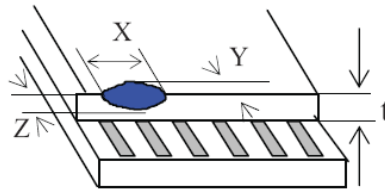
Remark:

X: Length
direction

Y: Short
direction

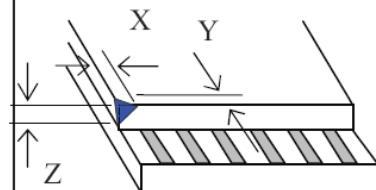
Z: Thickness
direction

t: Glass
thickness

W: Terminal
Width


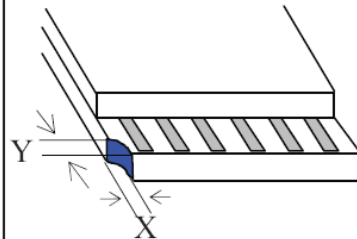
Acceptable criterion

X	Y	Z
≤ 2	0.5mm	$\leq t/2$



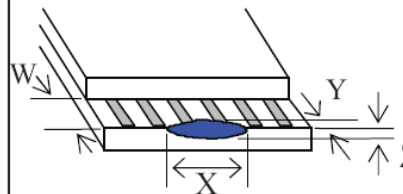
Acceptable criterion

X	Y	Z
≤ 2	0.5mm	$\leq t$



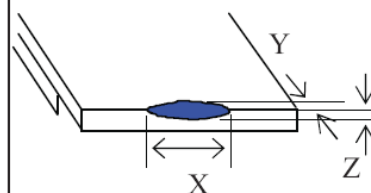
Acceptable criterion

X	Y	Z
≤ 3	≤ 2	$\leq t$
shall not reach to ITO		



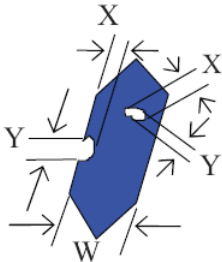
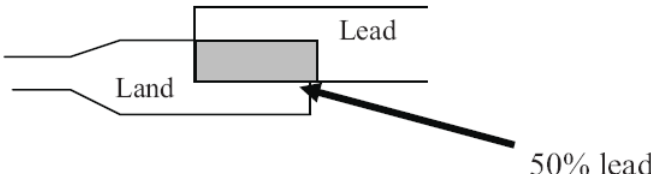
Acceptable criterion

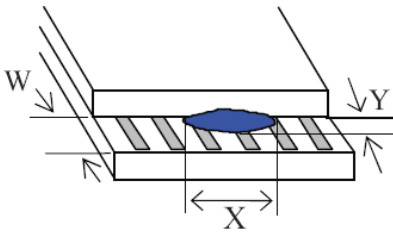
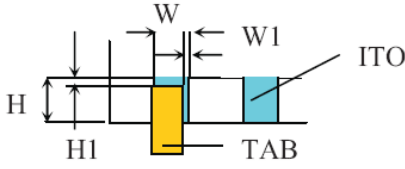
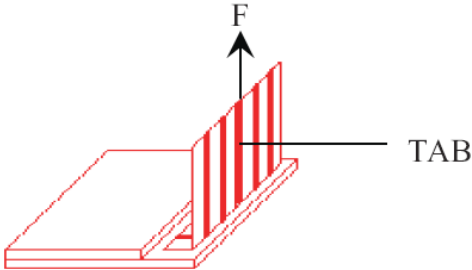
X	Y	Z
Disregard	≤ 0.2	$\leq t$



Acceptable criterion

X	Y	Z
≤ 5	≤ 2	$\leq t/3$

No.	Item	Criterion								
7	Segment pattern W = Segment width $\phi = (X+Y)/2$	(1) Pin hole $\phi < 0.10\text{mm}$ is acceptable. <table><tr><th>Point Size</th><th>Acceptable Qty</th></tr><tr><td>$\phi \leq 1/4W$</td><td>Disregard</td></tr><tr><td>$1/4W < \phi \leq 1/2W$</td><td>1</td></tr><tr><td>$\phi > 1/2W$</td><td>0</td></tr></table> Unit: mm	Point Size	Acceptable Qty	$\phi \leq 1/4W$	Disregard	$1/4W < \phi \leq 1/2W$	1	$\phi > 1/2W$	0
Point Size	Acceptable Qty									
$\phi \leq 1/4W$	Disregard									
$1/4W < \phi \leq 1/2W$	1									
$\phi > 1/2W$	0									
8	Back-light	(1) The color of backlight should correspond its specification. (2) Not allow flickering								
9	Soldering	(1) Not allow heavy dirty and solder ball on PCB. (The size of dirty refer to point and dust defect) (2) Over 50% of lead should be soldered on Land. 								
10	Wire	(1) Copper wire should not be rusted (2) Not allow crack on copper wire connection. (3) Not allow reversing the position of the flat cable. (4) Not allow exposed copper wire inside the flat cable.								
11*	PCB	(1) Not allow screw rust or damage. (2) Not allow missing or wrong putting of component.								

No	Item	Criterion
12	Protruded W: Terminal Width	 Acceptable criteria: $Y \leq 0.4$
13	TAB	1. Position  $W1 \leq 1/3W$ $H1 \leq 1/3H$ 2 TAB bonding strength test  $P (=F/\text{TAB bonding width}) \geq 650\text{gf/cm}$,(speed rate: 1mm/min) 5pcs per SOA (shipment)
14	Total no. of acceptable Defect	A. Zone Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm B. Zone It is acceptable when it is no trouble for quality and assembly in customer's end product.

15.3 Reliability of LCM

Reliability test condition:

Item	Condition	Time (hrs)	Assessment
High temp. Storage	85°C	48	No abnormalities in functions and appearance
High temp. Operating	70°C	48	
Low temp. Storage	-30°C	48	
Low temp. Operating	-20°C	48	
Humidity	40°C/ 90%RH	48	
Temp. Cycle	-20°C ← 25°C → 70°C (30 min ← 5 min → 30min)	10cycles	

Recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature (20±8°C), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

15.4 Precaution for using LCD/LCM

LCD/LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

General Precautions:

1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol, ethyl alcohol or trichlorotrifluoroethane, do not use water, ketone or aromatics and never scrub hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not make any modification on the PCB without consulting P-tec Corp.
5. When mounting a LCM, make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight

Static Electricity Precautions:

1. CMOS-LSI is used for the module circuit; therefore operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
5. Only properly grounded soldering irons should be used.
6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
7. The normal static prevention measures should be observed for work clothes and working benches.
8. Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

Soldering Precautions:

1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature: $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

Operation Precautions:

1. The viewing angle can be adjusted by varying the LCD driving voltage V_o .
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over 40°C is required, the relative humidity should be kept below 60%, and avoid direct sunlight.

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Limited Warranty

P-tec Corp LCDs and modules are not consumer products, but may be incorporated by P-tec Corp's customers into consumer products or components thereof, P-tec Corp does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of P-tec Corp is limited to repair or replacement on the terms set forth below. P-tec Corp will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between P-tec Corp and the customer, P-tec Corp will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with P-tec Corp general LCD inspection standard. (Copies available on request)
2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.
3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.