P-TEC

PRODUCT SPECIFICATION

Part Number

PCOG12864P-O Series

CUSTOMER	
CUSTOMER PART NUMBER	
DESCRIPTION	
APPROVED BY	
DATE	

Table of Contents

Record of Revisions

Rev.	Comments	Page	Date
1	Preliminary Specification was first issued.	All	8/8'14

1. Part number breakdown

P_ __ - _ __ _ _ - _ _ _
1 2   3 4 5 6   7 8 9
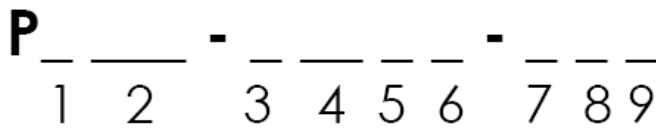
Replace each Space (_) with the following letters and or numbers

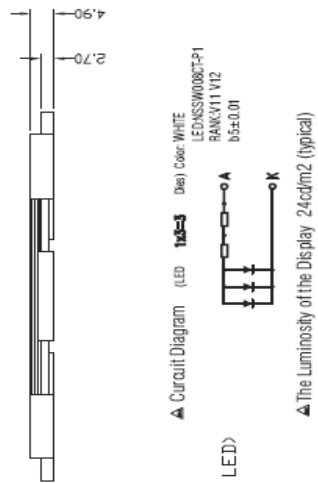|		
1. P-tec LCD Type	**C** = Character **G** = Graphic **COG** = Chip On Glass	**COF** = Chip On Flex **TAB** = Tape Automated Bonding **TFT** = Thin-film Transistor
2. LCD Model	Example for Character: **2002A** = 20 Characters x 2 Lines w/ Pins on Left side and 116mm x 37 x 12.7mm overall size Example 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	**S** = Yellow/Green **O** = Orange **W** = White
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 General Specifications

Item	☑Standard Value	Unit
Display Pattern	☑Graphic ☐Character ☐Segment ☐_____ ☐with ICON	
Color	☑Mono. ☐Grayscale ☐_____	
Module Dimension (W x H x T)	72.4(W)X87.6(H)X(5.9)(T)	mm
Viewing Area (W x H)	70(W)X37(H)	mm
Active Area (W x H)	65.265(W)X32.625(H)	mm
Character Size (W x H)	\	mm
Character Pitch (W x H)	\	mm
DOT Size (W x H)	0.495(W)• 0.495(H)	mm
DOT Pitch (W x H)	0.51(W)• 0.51(H)	mm
LCD Type	☐TN, Positive ☐TN, Negative ☐HTN, Positive ☐HTN, Negative ☐STN, Yellow-Green ☐STN, Gray ☑STN, Blue ☐FSTN, Positive ☐FSTN, Negative ☐_____ ☐FM LCD ☐Color STN	
Polarizer Type	☐Transflective ☑Transmissive ☐Reflective ☐Anti-Glare	
View Direction	☐6H ☑12H ☐_____	
LCD Controller & Driver	ST7565P (or Equivalent)	
LCD Driving Method	1/65duty, 1/9bias	
Interface Type	Serial ☐I^{2}C ☑4-line SPI ☐3-line SPI ☐_____ Parallel ☑6800 ☑8080 ☐4-bit ☐_____	
Backlight Type	☑LED ☐Bottom ☑Single Side ☐Dual Side ☐_____ ☐EL ☐CCFL	
Backlight Color	☐Yellow-Green ☑White ☐Amber ☐Blue ☐Red ☐_____	
EL/CCFL Driver type	☐Build-in ☐External	
DC-DC Converter	☑Build-in ☐External	
Operation Temperature	T_{OPL} = -20 T_{OPH} =+70	℃
Storage Temperature	T_{STL} = -30 T_{STH} = +80	℃

3 Mechanical Diagram
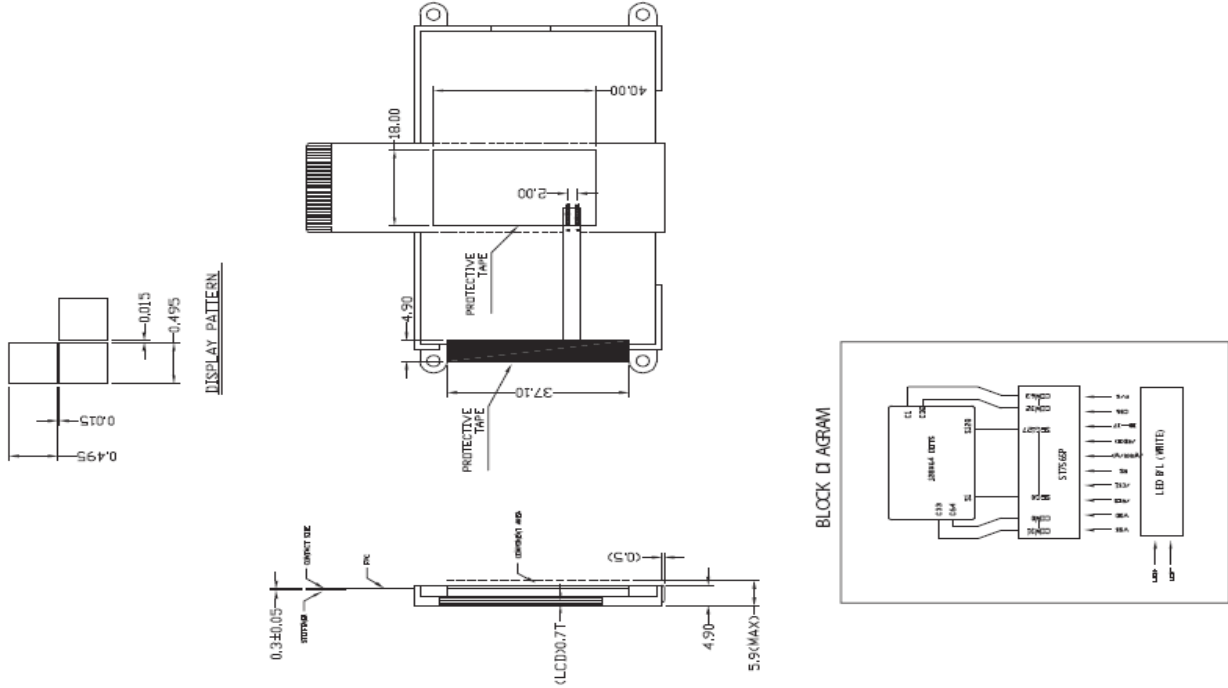
NO	SYMBOL
1	VSS
2	VDD
3	NC
4	/RES
5	/CS1
6	RS
7	/WR(R/W)
8	/RD(E)
9	D0
10	D1
11	D2
12	D3
13	D4
14	D5
15	D6
16	D7
17	C86
18	P/S
19	LED+
20	LED-

△Display Type : BLUE/NEGATIVE
△Display Mode : TRANSMISSIVE
△Viewing Direction : 12:00
Driver IC: ST7565P
Logical Voltage (VDD) : 3.0V (3.5V MAX) ; 10.3V
LCD Driver Voltage (Vlcd) : 5.0V (5.2V MAX)(WHITE LED)
△LED Driver Voltage (Vled) : 5.0V (5.2V MAX)(WHITE LED)
△LED Durrent(If) : If=45mA (60mA MAX)
Driving Method : 1/65 DUTY 1/9 BIAS
Operating Temperature : -20°~ +70°C
Storage Temperature : -30°~ +80°C
Interface Connector : FPC
All unmarked tolerances: ±0.2mm

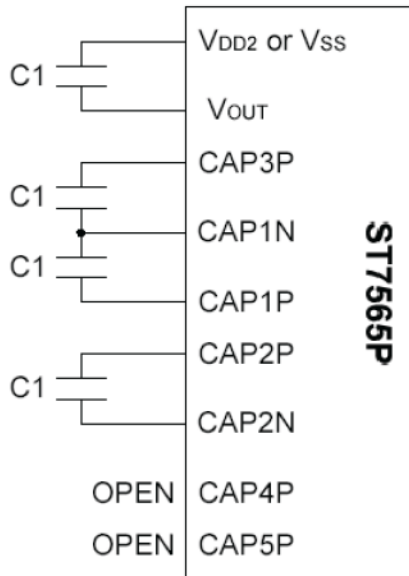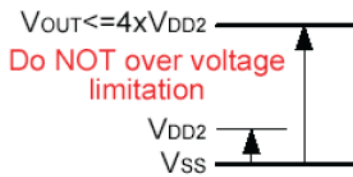△Curcuit Diagram (LED)   Die) Color: WHITE
LED:NSSW008CT-P1
RANK:V11 V12
b5±0.01

△The Luminoshty of the Display 24cd/m2 (typical)

4 I/O Terminal

4.1 Pin Description

| Pin NO.••	Symbol••	Function Description••
1	VSS	Ground
2	VDD	Power supply.
3	NC	Not connect
4	/RES	When /RES is set to "L," the settings are initialized. The reset operation is performed by the /RES signal level.
5	/CS1	This is the chip select signal.
6	RS	This is connect to the least significant bit of the normal and it determines whether the data bits are data or a RS = "H": Indicates that D0 to D7 are display data. RS = "L": Indicates that D0 to D7 are control data.
7	R/W	• When connected to an 8080 MPU, this is active LOW. (R/W) This terminal connects to the 8080 MPU /WR signal. The signals on the data bus are latched at the rising edge of the /WR signal. • When connected to a 6800 Series MPU: This is the read/write control signal input terminal. When R/W = "H": Read. When R/W = "L": Write.
8	E	• When connected to a 6800 Series MPU, this is active HIGH. This is the 6800 Series MPU enable clock input terminal.
9~16	D0~D7	This is an 8-bit bi-directional data bus that connects to an 8-bit or 16-bit standard MPU data bus.
17	C86	This is the MPU interface switch terminal. C86 = "H": 6800 Series MPU interface. C86 = "L": 8080 MPU interface.
18	P/S	This is the parallel data input/serial data input switch terminal. P/S = "H": Parallel data input. P/S = "L": Serial data input. The following applies depending on the P/S status: When P/S = "L", D0 to D5 fixed "H". /RD (E) and /WR (R/W) are fixed to either "H" or "L". With serial data input, It is impossible read data from RAM . P/S Data/Command Data Read/Write Serial Clock "H" A0 D0 to D7 /RD, /WR X "L" A0 SI (D7) Write only SCL (D6)
19	LED+	+5V
20	LED-	Ground

4.2 Block Diagram and Application Circuit

4x voltage booster circuit

$V_{OUT} <= 4 \times V_{DD2}$

Do NOT over voltage limitation

4x boost voltage relationship
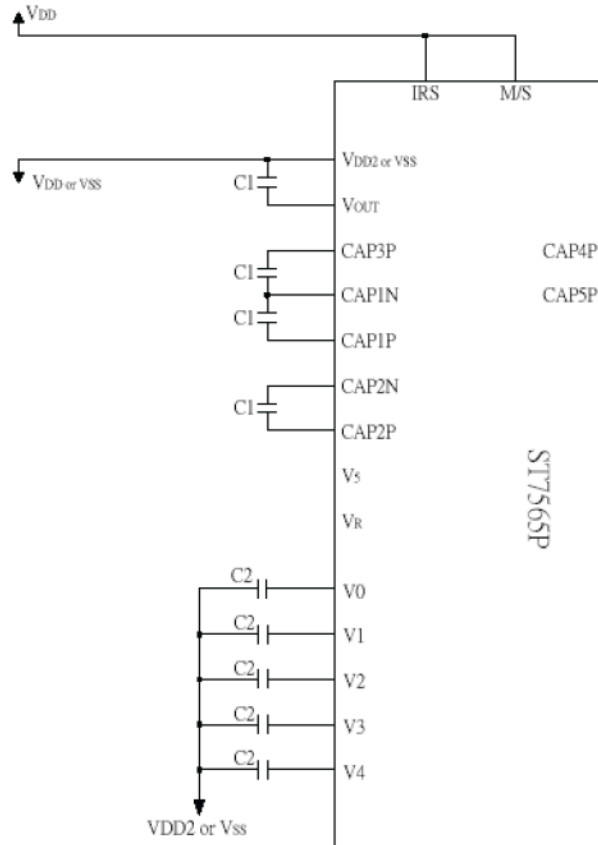
5 Electro-optical Specifications

5.1 Absolute Maximum Ratings

No	Item	Symbol	Min.	Max.	Unit
1	Supply Voltage For Logic	$V_{DD} - V_{SS}$	0.3	3.6	V
2	Supply Voltage For LCD Driver	V_{LCD}	0.3	14.5	V
3	Input Voltage	V_{IN}	0.3	3.6	V

Note: Operating Temperature and Storage Temperature can be found in *1.General Specifications.*

5.2 Optical Characteristics[1]

No	Item		Symbol	Condition	Min.	Typ.	Max.	Unit
1	Contrast Ratio		Cr	$Ta=23\pm3^oC$ V_{LCD} = Typ. [2]	8.4	9.08	-	-
2	Response time		T_{ON}	$Ta=23\pm3^oC$	-	223	330	ms
3	Response time		T_{OFF}	$Ta=23\pm3^oC$	-	102	200	ms
4	Viewing Angle	3H	Θ1	Cr = 2 $Ta=23\pm3^oC$	43	48	-	Deg.
5		9H	Θ2		45	49	-	Deg.
6		6H	Θ3		39	44	-	Deg.
7		12H	Θ4		26	31	-	Deg.

Note:

(1) See Appendix Definition of Optical Characteristics for detail.

(2) V_{LCD} can be found in 4.2 Electrical Characteristics *Supply Voltage for LCD Driver*

5.3 Electrical Characteristics

No	Item	Symbol	Condition	Min.	Typ.	Max.	Unit
1	Supply Voltage for Logic	$V_{DD}-V_{SS}$	-	2.9	3.0	3.1	V
2	Supply Voltage for LCD Driver	V_{LCD}	$Ta=25^oC$	10.1	10.3	10.5	V
3	Supply Current for Logic	I_{DD}	-….	-	-	1.0	mA
4	Frame Frequency	f_M	$Ta=25^oC$	17	20	24	KHz
5	Input High Voltage	V_{IH}	-	$0.8\ V_{DD}$	-	V_{DD}	V
6	Input Low Voltage	V_{IL}	-	VSS	-	$0.2\ V_{DD}$	V
7	Output High Voltage	V_{OH}	-	$0.8\ V_{DD}$	-	V_{DD}	V
8	Output Low Voltage	V_{OL}	-	VSS	-	$0.2V_{DD}$	V
9	Supply Current for LED Backlight	I_{LED}	V_{LED} = Typ. $Ta=23\pm3^oC$	-	45	-	mA
10	Supply Voltage for LED Backlight	V_{LED}	I_{LED} = Typ. $Ta=23\pm3^oC$	4.8	5.0	5.2	V

5.4 Timing Characteristics

System Bus Read/Write Characteristics 1 (For the 8080 Series MPU)

Figure 37
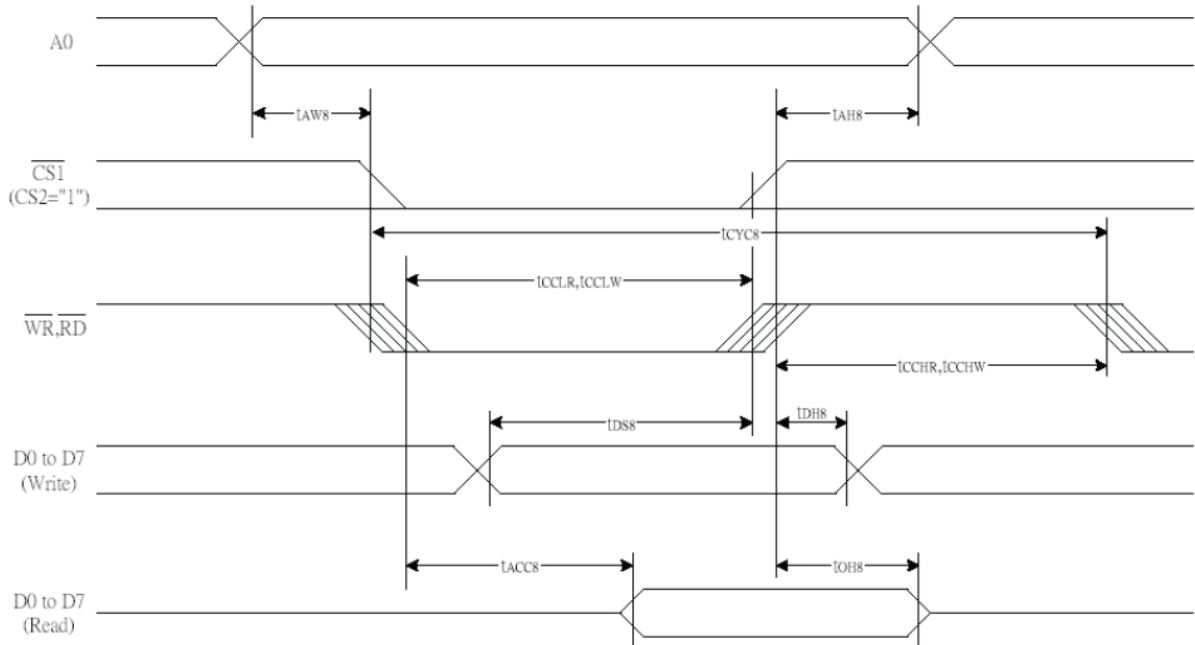
Table 24

(VDD = 3.3V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Address hold time	A0	tAH8		0	—	Ns
Address setup time	A0	tAW8		0	—	
System cycle time		tCYC8		240	—	
Enable L pulse width (WRITE)	WR	tCCLW		80	—	
Enable H pulse width (WRITE)	WR	tCCHW		80	—	
Enable L pulse width (READ)	RD	tCCLR		140	—	
Enable H pulse width (READ)	RD	tCCHR		80	—	
WRITE Data setup time	D0 to D7	tDS8		40	—	
WRITE Address hold time	D0 to D7	tDH8		0	—	
READ access time	D0 to D7	tACC8	CL = 100 pF	—	70	
READ Output disable time	D0 to D7	tOH8	CL = 100 pF	5	50	

(V_DD = 2.7V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Address hold time	A0	t_{AH8}		0	—	ns
Address setup time		t_{AW8}		0	—	
System cycle time		t_{CYC8}		400	—	
Enable L pulse width (WRITE)	WR	t_{CCLW}		220	—	
Enable H pulse width (WRITE)		t_{CCHW}		180	—	
Enable L pulse width (READ)	RD	t_{CCLR}		220	—	
Enable H pulse width (READ)		t_{CCHR}		180	—	
WRITE Data setup time	D0 to D7	t_{DS8}		40	—	
WRITE Address hold time		t_{DH8}		0	—	
READ access time		t_{ACC8}	$C_L = 100$ pF	—	140	
READ Output disable time		t_{OH8}	$C_L = 100$ pF	10	100	

Table 26

(V_DD = 1.8V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Address hold time	A0	t_{AH8}		0	—	ns
Address setup time		t_{AW8}		0	—	
System cycle time		t_{CYC8}		640	—	
Enable L pulse width (WRITE)	WR	t_{CCLW}		360	—	
Enable H pulse width (WRITE)		t_{CCHW}		280	—	
Enable L pulse width (READ)	RD	t_{CCLR}		360	—	
Enable H pulse width (READ)		t_{CCHR}		280	—	
WRITE Data setup time	D0 to D7	t_{DS8}		80	—	
WRITE Address hold time		t_{DH8}		0	—	
READ access time		t_{ACC8}	$C_L = 100$ pF	—	240	
READ Output disable time		t_{OH8}	$C_L = 100$ pF	10	200	

The input signal rise time and fall time (t_r, t_f) is specified at 15 ns or less. When the system cycle time is extremely fast, $t_r + t_f \leq (t_{CYC8} - t_{CCLW} - t_{CCHW})$ for $(t_r + t_f) \leq (t_{CYC8} - t_{CCLR} - t_{CCHR})$ are specified.
All timing is specified using 20% and 80% of V_DD as the reference.
t_{CCLW} and t_{CCLR} are specified as the overlap between /CS1 being "L" (CS2 = "H") and /WR and /RD being at the "L" level.
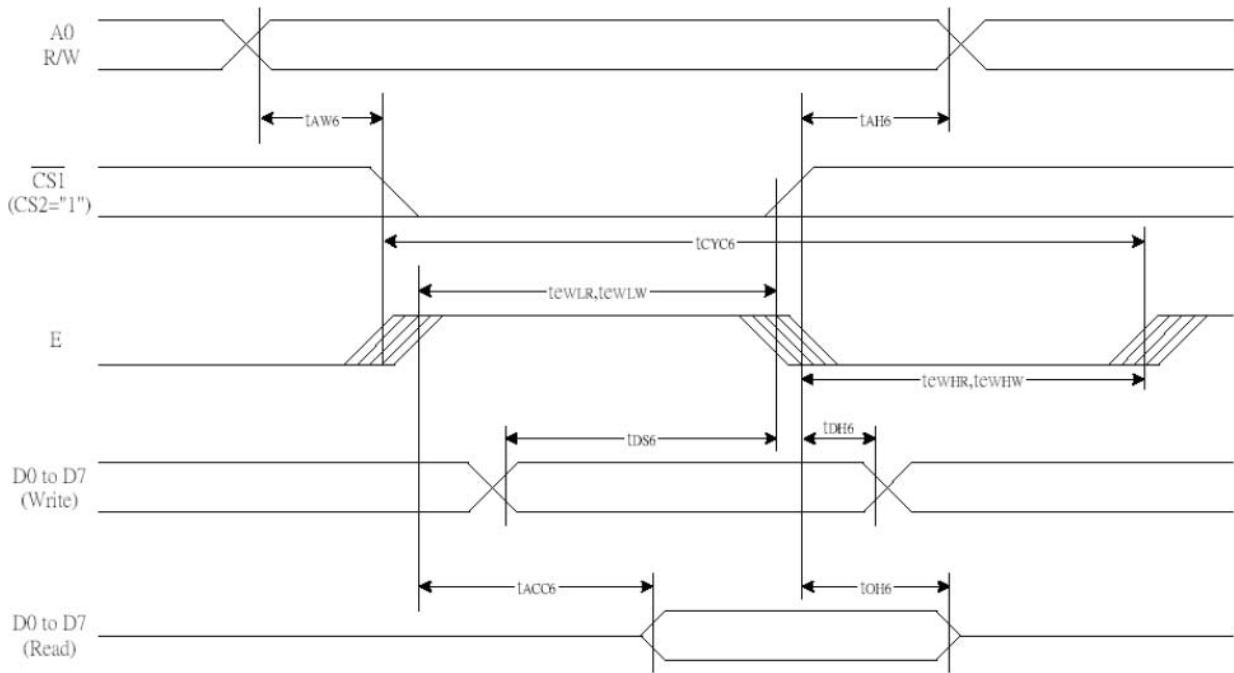
System Bus Read/Write Characteristics 2 (For the 6800 Series MPU)

Figure 38

Table 27

(V$_{DD}$ = 3.3V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Address hold time	A0	t$_{AH6}$		0	—	
Address setup time		t$_{AW6}$		0	—	
System cycle time		t$_{CYC6}$		240	—	
Enable L pulse width (WRITE)	WR	t$_{EWLW}$		80	—	
Enable H pulse width (WRITE)		t$_{EWHW}$		80	—	
Enable L pulse width (READ)	RD	t$_{EWLR}$		80	—	ns
Enable H pulse width (READ)		t$_{EWHR}$		140		
WRITE Data setup time	D0 to D7	t$_{DS6}$		40	—	
WRITE Address hold time		t$_{DH6}$		0	—	
READ access time		t$_{ACC6}$	C$_L$ = 100 pF	—	70	
READ Output disable time		t$_{OH6}$	C$_L$ = 100 pF	5	50	

(V$_{DD}$ = 2.7V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	t$_{AH6}$		0	—	ns
Address setup time		t$_{AW6}$		0	—	
System cycle time		t$_{CYC6}$		400	—	
Enable L pulse width (WRITE)	WR	t$_{EWLW}$		220	—	
Enable H pulse width (WRITE)		t$_{EWHW}$		180	—	
Enable L pulse width (READ)	RD	t$_{EWLR}$		220	—	
Enable H pulse width (READ)		t$_{EWHR}$		180	—	
WRITE Data setup time	D0 to D7	t$_{DS6}$		40	—	
WRITE Address hold time		t$_{DH6}$		0	—	
READ access time		t$_{ACC6}$	C$_L$ = 100 pF	—	140	
READ Output disable time		t$_{OH6}$	C$_L$ = 100 pF	10	100	

Table 29

(V$_{DD}$ = 1.8V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	t$_{AH6}$		0	—	ns
Address setup time		t$_{AW6}$		0	—	
System cycle time		t$_{CYC6}$		640	—	
Enable L pulse width (WRITE)	WR	t$_{EWLW}$		360	—	
Enable H pulse width (WRITE)		t$_{EWHW}$		280	—	
Enable L pulse width (READ)	RD	t$_{EWLR}$		360	—	
Enable H pulse width (READ)		t$_{EWHR}$		280	—	
WRITE Data setup time	D0 to D7	t$_{DS6}$		80	—	
WRITE Address hold time		t$_{DH6}$		0	—	
READ access time		t$_{ACC6}$	C$_L$ = 100 pF	—	240	
READ Output disable time		t$_{OH6}$	C$_L$ = 100 pF	10	200	

1 The input signal rise time and fall time (t$_r$, t$_f$) is specified at 15 ns or less. When the system cycle time is extremely fast, (t$_r$ +t$_f$) $\leq$ (t$_{CYC6}$ − t$_{EWLW}$ − t$_{EWHW}$) for (t$_r$ + t$_f$) $\leq$ (t$_{CYC6}$ − t$_{EWLR}$ − t$_{EWHR}$) are specified.

2 All timing is specified using 20% and 80% of V$_{DD}$ as the reference.

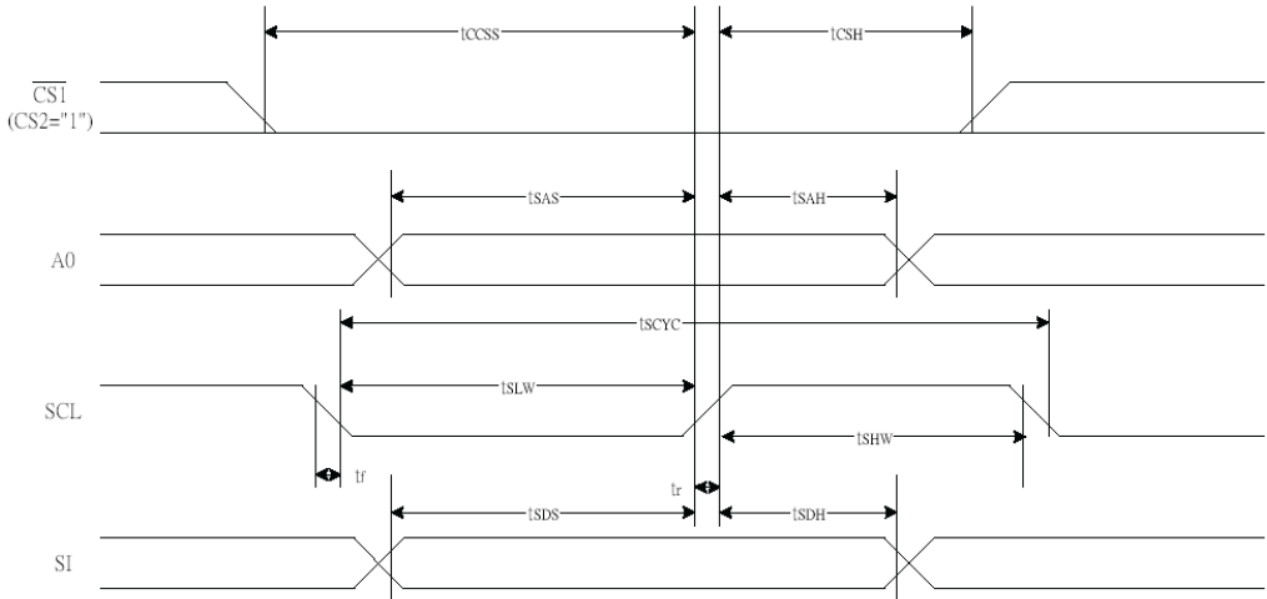3 t$_{EWLW}$ and t$_{EWLR}$ are specified as the overlap between $\overline{CS1}$ being "L" (CS2 = "H") and E.

The Serial Interface

Figure 39

Table 30

(V$_{DD}$ = 3.3V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Serial Clock Period	SCL	T$_{scyc}$		50	—	
SCL "H" pulse width		T$_{shw}$		25	—	
SCL "L" pulse width		T$_{SLW}$		25	—	
Address setup time	A0	T$_{SAS}$		20	—	
Address hold time		T$_{sah}$		10	—	ns
Data setup time	SI	T$_{sds}$		20	—	
Data hold time		T$_{SDH}$		10	—	
CS-SCL time	CS	T$_{css}$		20	—	
CS-SCL time		T$_{csh}$		40	—	

Table 31

(V$_{DD}$ = 2.7V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating Min.	Rating Max.	Units
Serial Clock Period	SCL	T$_{scyc}$		100	—	
SCL "H" pulse width		T$_{SHW}$		50	—	
SCL "L" pulse width		T$_{SLW}$		50	—	
Address setup time	A0	T$_{SAS}$		30	—	
Address hold time		T$_{SAH}$		20	—	ns
Data setup time	SI	T$_{SDS}$		30	—	
Data hold time		T$_{SDH}$		20	—	
CS-SCL time	CS	T$_{CSS}$		30	—	
CS-SCL time		T$_{CSH}$		60	—	

(V_{DD} = 1.8V, Ta = −30 to 85°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	T_{SCYC}		200	—	ns
SCL "H" pulse width		T_{SHW}		80	—	
SCL "L" pulse width		T_{SLW}		80	—	
Address setup time	A0	T_{SAS}		60	—	
Address hold time		T_{SAH}		30	—	
Data setup time	SI	T_{SDS}		60	—	
Data hold time		T_{SDH}		30	—	
CS-SCL time	CS	T_{CSS}		40	—	
CS-SCL time		T_{CSH}		100	—	

*1 The input signal rise and fall time (tr, tf) are specified at 15 ns or less.
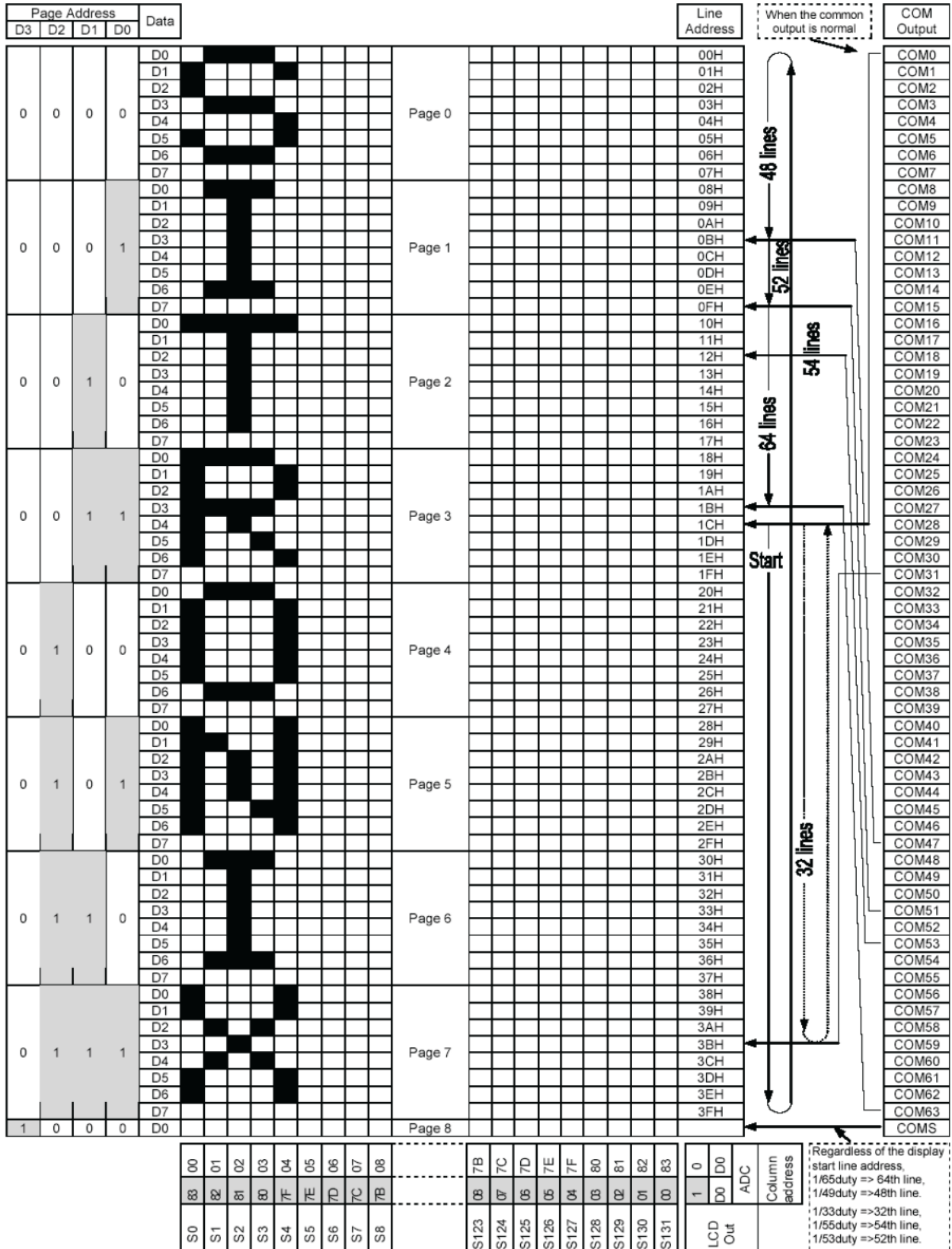*2 All timing is specified using 20% and 80% of V_{DD} as the standard.

6 Programming

6.1 Instruction Table

Command	Command Code												Function
	A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0		
(1) Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0/1		LCD display ON/OFF 0: OFF, 1: ON
(2) Display start line set	0	1	0	0	1	Display start address							Sets the display RAM display start line address
(3) Page address set	0	1	0	1	0	1	1	Page address					Sets the display RAM page address
(4) Column address set upper bit	0	1	0	0	0	0	1	Most significant column address					Sets the most significant 4 bits of the display RAM column address.
Column address set lower bit	0	1	0	0	0	0	0	Least significant column address					Sets the least significant 4 bits of the display RAM column address.
(5) Status read	0	0	1	Status				0	0	0	0		Reads the status data
(6) Display data write	1	1	0	Write data									Writes to the display RAM
(7) Display data read	1	0	1	Read data									Reads from the display RAM
(8) ADC select	0	1	0	1	0	1	0	0	0	0	0/1		Sets the display RAM address SEG output correspondence 0: normal, 1: reverse
(9) Display normal/ reverse	0	1	0	1	0	1	0	0	1	1	0/1		Sets the LCD display normal/ reverse 0: normal, 1: reverse
(10) Display all points ON/OFF	0	1	0	1	0	1	0	0	1	0	0/1		Display all points 0: normal display 1: all points ON
(11) LCD bias set	0	1	0	1	0	1	0	0	0	1	0/1		Sets the LCD drive voltage bias ratio 0: 1/9 bias, 1: 1/7 bias (ST7565P)
(12) Read/modify/write	0	1	0	1	1	1	0	0	0	0	0		Column address increment At write: +1 At read: 0
(13) End	0	1	0	1	1	1	0	1	1	1	0		Clear read/modify/write
(14) Reset	0	1	0	1	1	1	0	0	0	1	0		Internal reset
(15) Common output mode select	0	1	0	1	1	0	0	0/1	*	*	*		Select COM output scan direction 0: normal direction 1: reverse direction
(16) Power control set	0	1	0	0	0	1	0	1	Operating mode				Select internal power supply operating mode
(17) V0 voltage regulator internal resistor ratio set	0	1	0	0	0	1	0	0	Resistor ratio				Select internal resistor ratio(Rb/Ra) mode
(18) Electronic volume mode set	0	1	0	1	0	0	0	0	0	0	1		Set the V0 output voltage electronic volume register
Electronic volume register set				0	0	Electronic volume value							
(19) Static indicator ON/OFF	0	1	0	1	0	1	0	1	1	0	0/1		0: OFF, 1: ON
Static indicator register set				0	0	0	0	0	0	0	Mode		Set the flashing mode
(20) Booster ratio set	0	1	0	1	1	1	1	1	0	0	0		select booster ratio 00: 2x,3x,4x 01: 5x 11: 6x
				0	0	0	0	0	0	step-up value			
(21) Power saver													Display OFF and display all points ON compound command
(22) NOP	0	1	0	1	1	1	0	0	0	1	1		Command for non-operation
(23) Test	0	1	0	1	1	1	1	*	*	*	*		Command for IC test. Do not use this command

6.2 Display Data RAM

Relationship between display pattern and Display Data RAM show as below:

Page Address (D3 D2 D1 D0)	Data	Page	Line Address	When the common output is normal	COM Output
0 0 0 0	D0–D7	Page 0	00H–07H		COM0–COM7
0 0 0 1	D0–D7	Page 1	08H–0FH	48 lines / 52 lines	COM8–COM15
0 0 1 0	D0–D7	Page 2	10H–17H	54 lines	COM16–COM23
0 0 1 1	D0–D7	Page 3	18H–1FH	64 lines / Start	COM24–COM31
0 1 0 0	D0–D7	Page 4	20H–27H		COM32–COM39
0 1 0 1	D0–D7	Page 5	28H–2FH	32 lines	COM40–COM47
0 1 1 0	D0–D7	Page 6	30H–37H		COM48–COM55
0 1 1 1	D0–D7	Page 7	38H–3FH		COM56–COM63
1 0 0 0	D0	Page 8			COMS

Column address (S0–S131):

	00	01	02	03	04	05	06	07	08	...	7B	7C	7D	7E	7F	80	81	82	83
ADC=0	83	82	81	80	7F	7E	7D	7C	7B	...	08	07	06	05	04	03	02	01	00
LCD Out	S0	S1	S2	S3	S4	S5	S6	S7	S8	...	S123	S124	S125	S126	S127	S128	S129	S130	S131

		ADC
0	D0	Column address
1	D0	

Regardless of the display start line address,
1/65duty => 64th line,
1/49duty =>48th line.
1/33duty =>32th line,
1/55duty =>54th line,
1/53duty =>52th line.

Appendix

1 Packing Method

□Method 1

ESD Bag + Product Box + Plastic Bag + Carton

1. Quantity

| QUANTITY	UNIT
1	PCS / ESD Bag
108	PCS / Box
2	Box / Carton
216	PCS / Carton

2. Material

Material	Size (LXWXH) mm
ESD Bag	
Product Box	
Carton	

3. Label

PRODUCT ID:
PART NO:
QUANTITY:
GROSS WEIGHT:
MEASUREMENTS:

4. Packing Method
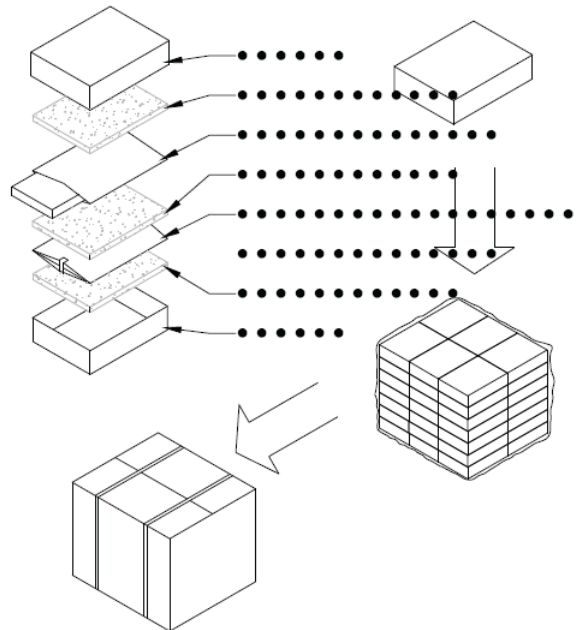
Note: see *table 1. Quantity* for detail.

□Method 2

ESD Tray + Plastic Bag + Carton

1. Quantity

QUANTITY	UNIT
	PCS / Tray
	Tray / Carton
	PCS / Carton

2. Material

Material	Size (LXWXH) mm
ESD Tray	
Carton	

3. Label

PRODUCT ID:
PART NO:
QUANTITY:
GROSS WEIGHT:
MEASUREMENTS:

4. Packing Method
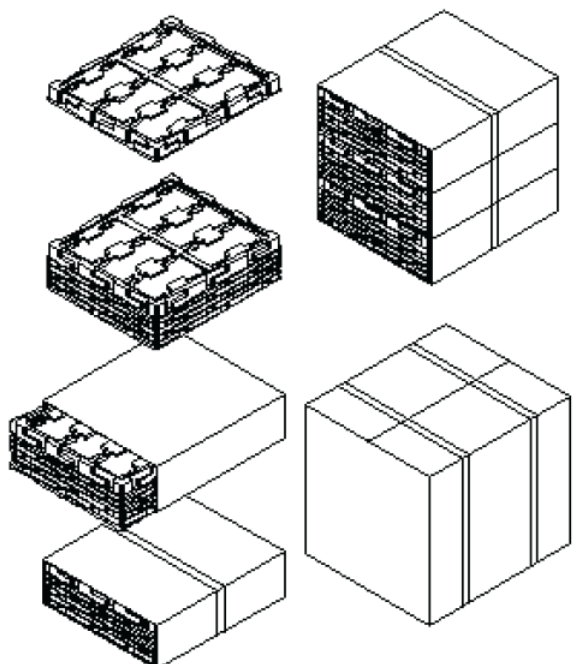
Note: see *table 1. Quantity* for detail.

2 Definitions of Optical Characteristic

2.1 Contrast Ratio Test

A) Contrast ratio is calculated by the following formula when the output voltage is obtained from the electro-optical test system.

B) Test Condition: Accord to the LCD's driving method and operating voltage (V_{LCD}).

C) Formula:

$$\frac{Contrast \quad Ratio}{(Positive \quad type)} = \frac{Photometer \quad output \quad voltage \quad when \quad non-select \quad waveform \quad is \quad applying}{Photometer \quad output \quad voltage \quad when \quad select \quad waveform \quad is \quad applying}$$

$$\frac{Contrast \quad Ratio}{(Negative \quad type)} = \frac{Photometer \quad output \quad voltage \quad when \quad select \quad waveform \quad is \quad applying}{Photometer \quad output \quad voltage \quad when \quad non-select \quad waveform \quad is \quad applying}$$

D) Test system:
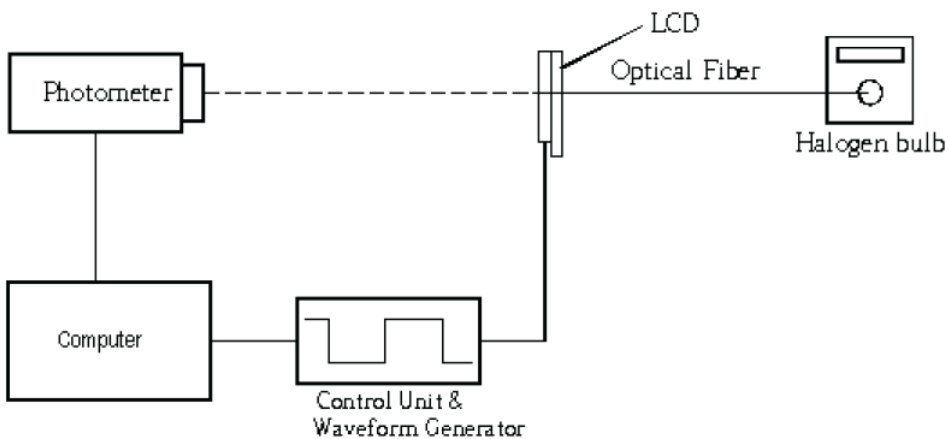
2.2 Response time

2.2.1 Positive type

A) Rise time is defined as the time required for the transmission to change from 90% to 10%.
B) Fall time is defined as the time required for the transmission to change from 10% to 90%.
C) On time is defined as the time required for the transmission to change from 100% to 10%.
D) Off time is defined as the time required for the transmission to change from 0% to 90%.
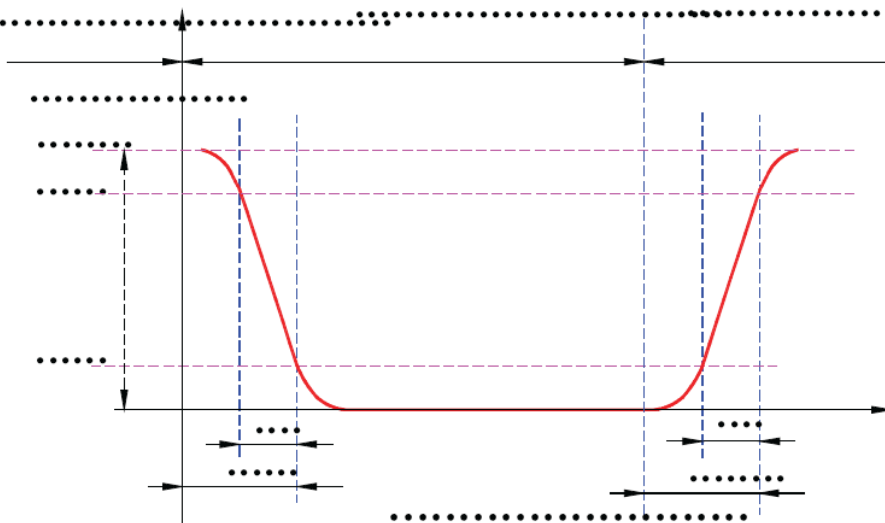
2.2.1 Negative type

A) Rise time is defined as the time required for the transmission to change from 10% to 90%.
B) Fall time is defined as the time required for the transmission to change from 90% to 10%.
C) On time is defined as the time required for the transmission to change from 0% to 90%.
D) Off time is defined as the time required for the transmission to change from 100% to 10%.
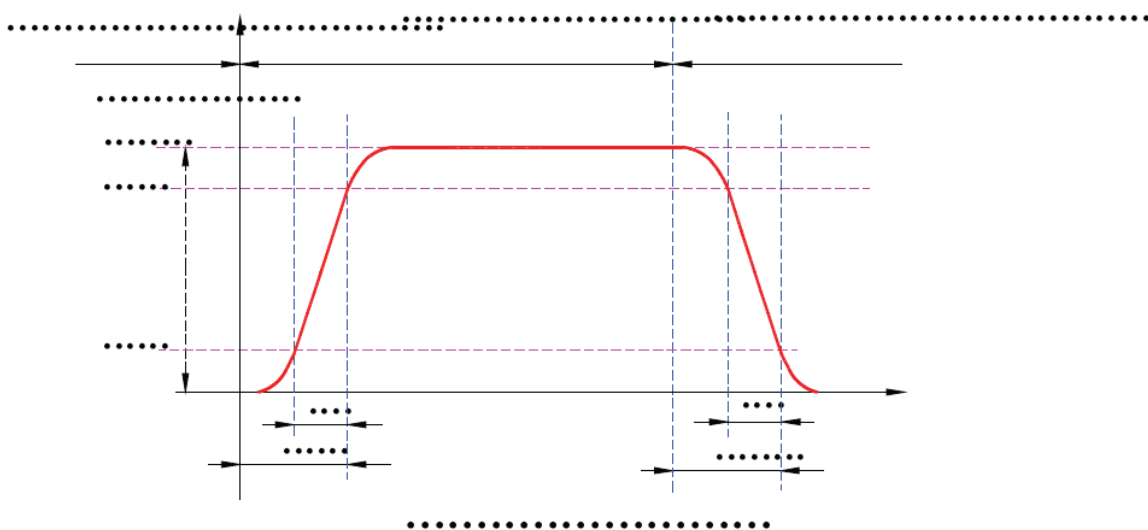
2.3 Viewing Angle

A) Viewing angle is definition
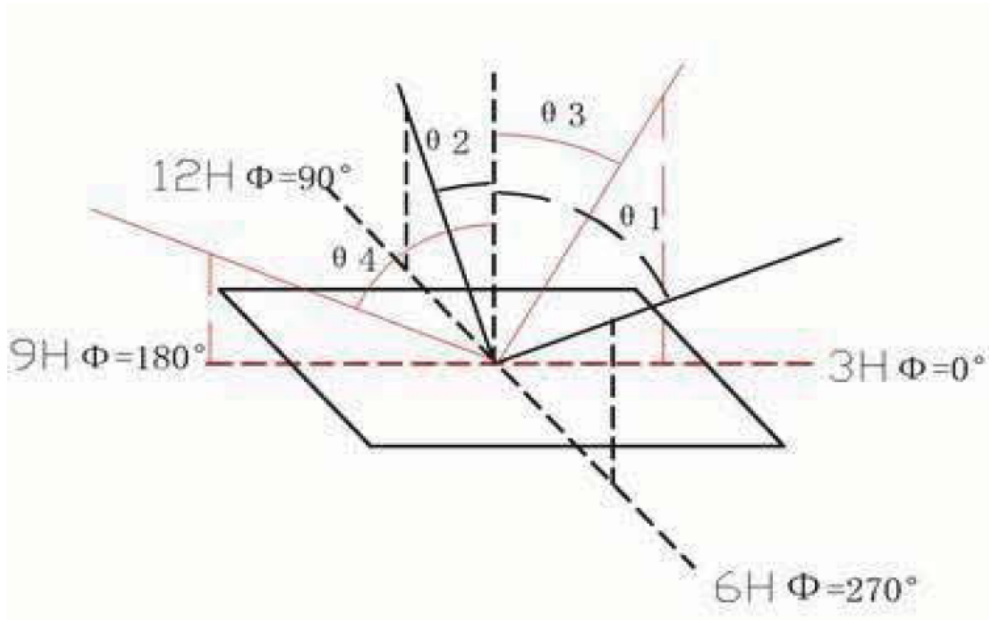
B) System Block Diagram
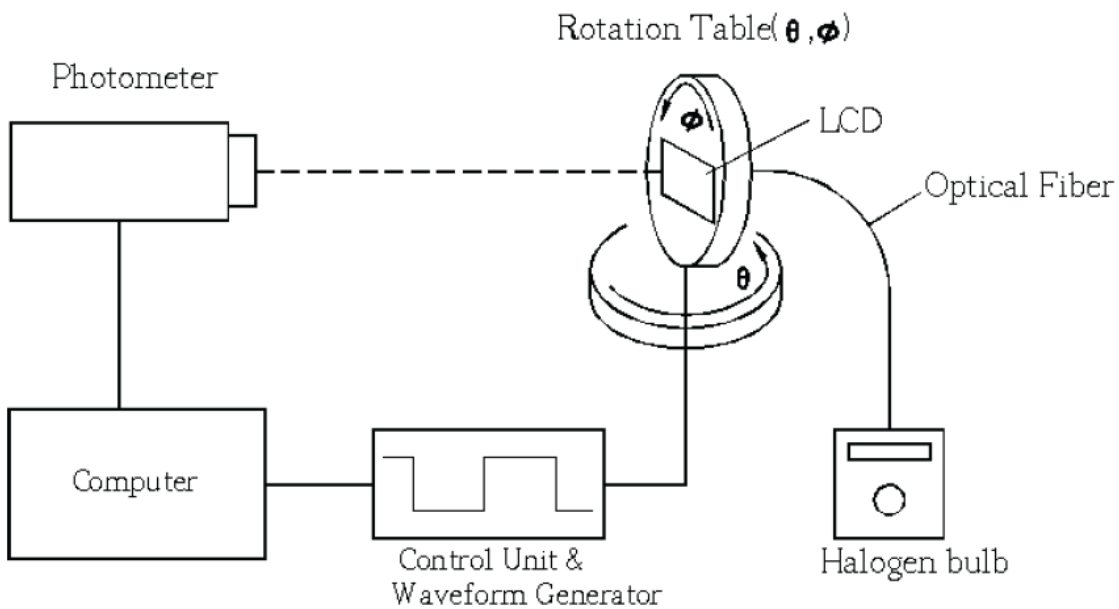
3 Quality Units

3.1 Visual and Technological Inspection

- Visual inspection must be performed with naked eye on display.
- Distance between observer and display should be about 30 cm.
- Perform inspection at OFF state and ON state
- Ambient lighting should be 1000 lux
- Transmissive, transflective and negative type specimens should be inspected in backlight
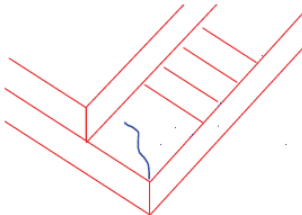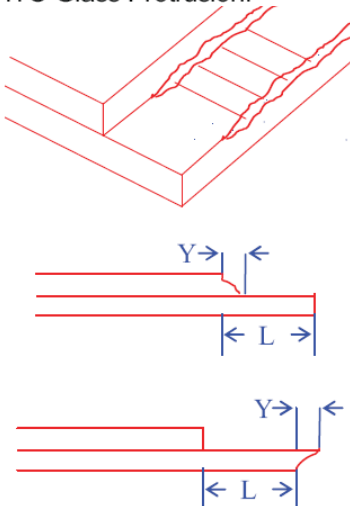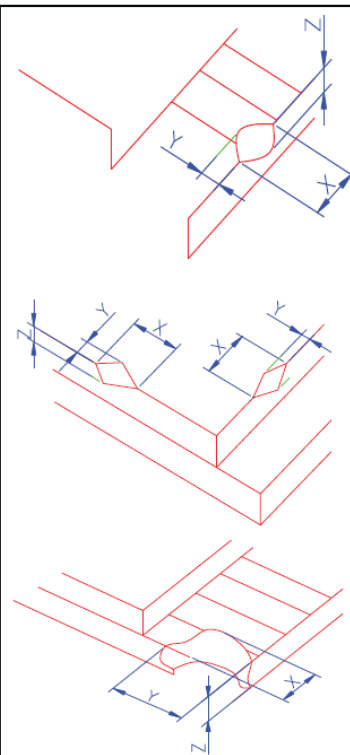 (i) Inspecting method:
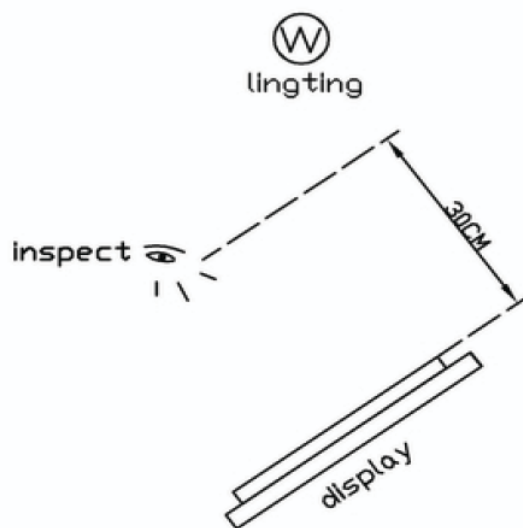
(ii) Definition of area:
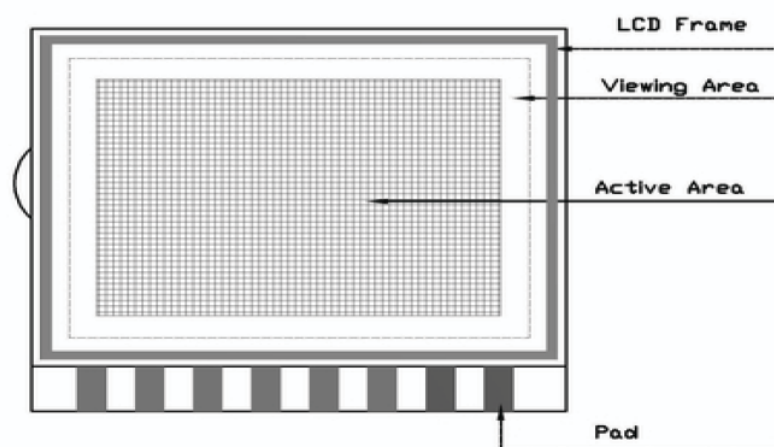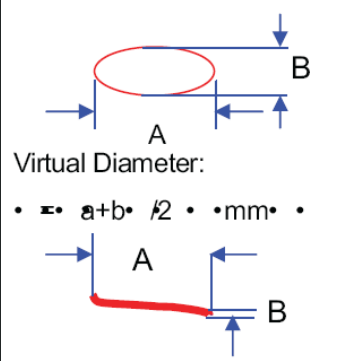
Note: The drawing is a general sketch map only. If want to see the product outline detail, please see the product outline drawing.

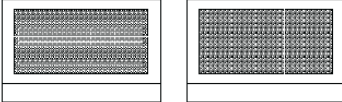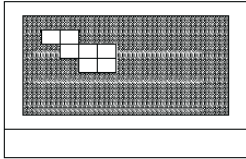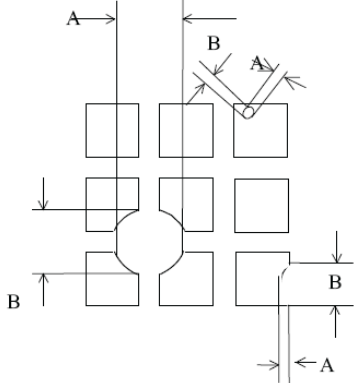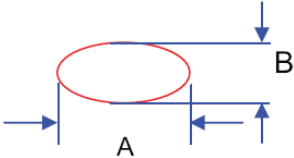## 3.2 Visual Inspection Standard:

Table1

(Unit: mm)
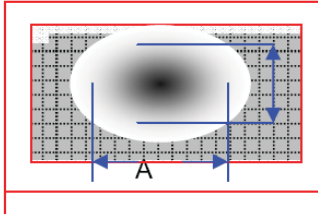
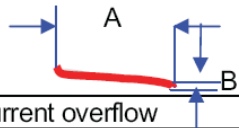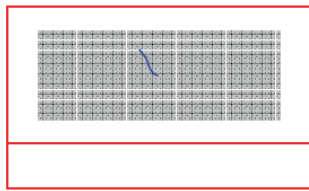| No	Defect Item			Criterion	
	Defect describe	Position	classify	Section	Acceptable Number(N)(*3)
1	Liquid Crystal Leakage				Not acceptable
2	Bubble in Liquid Crystal				Not acceptable
3	Rainbow		Slight• ※1• •		Acceptable
			Obvious• ※2• ▶		Not acceptable
4	ITO Glass Crackle Pic 1		Slight	Pic 1: Enter into the glass	Not acceptable
	Pic 2		Slight	Pic 2: not Enter into the glass	2
5• ※4•	• ITO Glass Protrusion: Y→ ← ←L→ Y→ ← ←L→		Slight	1• smaller glass edge: Y• ≤L/6 , X ignore, Z• t 2: larger glass edge: no influence upon no influence upon outline dimension• ▶ assemble,display funtion	1
6• ※4•	• Chipped Glass:	pad Edge	Slight	X• ≤.5, Y• ≤/3L,Z • t •or chip don't touch one third of Pad width.	2

		Non-Pad Edge	Slight	X• 2,Y• 1,Z• 1,Y cann't t enter into active area and cann't touch the sealant	2
		Corner	Slight	X• 1.5, Y• 1.5 , Z • 1	2

7	Black/White Spots (Include LCD and Backlight): Virtual Diameter: • ⊏• a+b• /2 • •mm• •	Circular Type	Slight	• • 0.1	Acceptable
				0.10<• • 0.2	2
				0.2<• • 0.25	1
		Linear Type	Slight	B • 0.05 A • 2	Acceptable
				0.05<B• 0.1 A• 2	2
				B>0.1	According to the spot's standard
8	Polarizer Bubble			• • 0.2	Acceptable
				0.2• • • 0.3 •	2
				0.3• • • 0.5 •	1
Note	1. Slight rainbow: rainbow outside of Viewing Area, or concolorous rainbow inside of ViewingArea but don't go beyond the limited sample which affirmed by purchaser. 2. Obvious rainbow: double color rainbow in Viewing area and go beyond the limited sample which affirmed by puchaser. 3. Acceptable Number(N) is the defects number in the LCD that will be defined acoording to the defects distributing density. In this table,the acceptable number is • 1/1(cm)^2. If purchaser has different suggest, please discuss with GW.				

3.3 Display Inspection Standard:

Table2
(Unit: mm)

No	Defect Item		Criterion	
	Defect describe		**Section**	**Acceptable Number(N) (*1)**
1	Non display			Not acceptable
2	Display missing			Not acceptable
3	Short Circuit			Not acceptable
4	Abnormal display			Not acceptable
5	Pin Hole &Gap in displaying segment or Dot Matrix: Virtual Diameter: φ＝ a+b／2 ・ ・mm・ ・		φ ・ 0.1	Acceptable
			0.1＜ φ ・ 0.2 ・	2
			0.2＜ φ ・ 0.25・	1
			φ ＞0.25	Not acceptable
6	Display Black/White Spots φ＝(A+B)/2 mm		The spot's dimension and color don't alter with the voltage alteration	
			φ ・ 0.10	acceptable
			0.10<φ ・ 0.2	3
			0.2<φ ・ 0.25	1
			φ ＞0.25	Not acceptable
			The spot's dimension and color alter with the voltage alteration	
			φ ・ 0.3	acceptable
			0.3<φ ・ 0.5	3
			0.5<φ ・ 0.8	1
			φ ＞0.8	Not acceptable
7	Display Black/White lines		The Line"s dimension and color don't alter with the voltage alteration	
			B ・ 0.05 A ・ 2	acceptable
			0.05<B ・ 0.1 A・ 2	3
			B>0.1	According to the spot's standard

		The Line''s dimension and color alter with the voltage alteration	
	A B	B・0.07 A・5	acceptable
		0.07<B•0.15 A 5	3
		0.15<B•0.3 A•5	1
		B>0.3	According to the spot's standard
8	The current overflow		Not acceptable
Note	1.when the width value of Segment or Dot Matrix is less than 3.0 mm, no defaut is acceptable 2.No more than 5 defauts are acceptable in 1cm^2 area.		

4 Reliability-TEST

4.1. Standard Specifications for Reliability

4.1-1Test method

There should be no existing conspicuous failure of functions and appearance in LCD after the following tests.

NO	Item	Description
1	Low Temperature Operating	The sample should be allowed to stand at (-20•2)••for 96 Hours under driving condition.
2	High Temperature Operating	The sample should be allowed to stand at (+70•2)••for 96 Hours under driving condition.
3	Low Temperature Storage	The sample should be allowed to stand at (-30•3)••for 96 Hours under no-load condition, and then returning it to normal temperature condition, and allowing it stand for 24 hours
4	High Temperature Storage	The sample should be allowed to stand at (+80•2)••for 96Hours under no-load condition, and then returning it to normal temperature condition, and allowing it stand for 24 hours
5	Moisture resistance	The sample should be allowed to stand at (40±2)•,(95±2)%RH for 96Hours under no-load condition excluding the polarizer, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours
6	Thermal Shock Resistance	The sample should be allowed to stand the following 5 cycles of operation: T_{STL} * for 30 minutes -> normal temperature for 5 minutes -> T_{STH} * for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours

4.1-2 Testing Conditions and Inspection Criteria:

For the final test, the testing sample must be stored at room temperature for 24 hours, after the tests listed above; Standard specifications for Reliability have been executed in order to ensure stability.

NO	Item	Inspection Criteria
1	Current Consumption	The current consumption should be under double of initial test.
2	Contrast	The contrast must be larger than half of initial test.
3	Appearance	Appearance defects should not happen.

4.2 Life Time:

Functions, performance, appearance, etc. shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature ($25\pm10^{o}C$), normal humidity ($45\pm20\%RH$), and in area not exposed to direct sunlight.