Ver.: 1.0

TFT LCD Specification

Model Name: TD022SHEB2

Customer Signature
Date

This technical specification is subjected to change without notice

Table of Contents

Record of Revision

Rev	Issued Date	Description
1.0	Nov 12, 2004	New Create

1. FEATURES

The 2.2”(5.6 cm) LCD module is a trans-flective active matrix color TFT LCD module. LTPS (Low Temperature Poly Silicon) TFT technology is used. Vertical and horizontal drivers are built on the panel.

2. GENERAL SPECIFICATIONS

Item	Description	Unit
Display Size (Diagonal)	2.2 (5.6)	Inch(cm)
Display Type	Trans-flective	
Active Area (HxV)	34.848 x 43.56	mm
Number of Dots (HxV)	176 x RGB x 220	dot
Dot Pitch (HxV)	0.066 x 0.198	mm
Color Arrangement	RGB Stripe	
Color Numbers	65536 (bit: R=5, G=6, B=5)	
Outline Dimension (HxVxT)	41.0 x 54.4 x 4.6	mm
Weight	13.89 (Approx.)	g

* Exclude COF and protrusions.

3. INPUT/OUTPUT TERMINALS

Pin	Symbol	I/O	Description	Remarks
1	RESETB	I	System Control IC Rest	
2	LOAD	I	LOAD Input For Serial Bus	
3	SCLK	I	Clock Input For Serial Bus	
4	DATA	I	DATA For Serial Bus	
5	GND	-	GND	
6	CLK	I	Clock Signal For Sampling Each Data Signal	
7	GND	-	GND	
8	GND	-	GND	
9	GND	-	GND	
10	D1	I	BLUE Data Signal B1	
11	D2	I	BLUE Data Signal B2	
12	D3	I	BLUE Data Signal B3	
13	D4	I	BLUE Data Signal B4	
14	D5	I	BLUE Data Signal B5 (MSB)	
15	GND	-	GND	
16	D6	I	GREEN data signal G0 (LSB)	
17	D7	I	GREEN Data Signal G1	
18	D8	I	GREEN Data Signal G2	
19	D9	I	GREEN Data Signal G3	
20	D10	I	GREEN Data Signal G4	
21	D11	I	GREEN Data Signal G5 (MSB)	
22	GND	-	GND	
23	D13	I	RED Data Signal R1	
24	D14	I	RED Data Signal R2	
25	D15	I	RED Data Signal R3	
26	D16	I	RED Data Signal R4	
27	D17	I	RED Data Signal R5 (MSB)	
28	GND	-	GND	
29	HS	I	Horizontal Synchronous Signal	
30	VS	I	Vertical Synchronous Signal	
31	GND	-	GND	
32	GND	-	GND	
33	DVCC	I	Power supply (+2.8V)	
34	DVCC	I	Power supply (+2.8V)	
35	LED+	I	LED +	

36	LED+	I	LED +	
37	LED-	I	LED -	
38	LED-	I	LED -	
39	GND	-	GND	

4. ABSOLUTE MAXIMUM RATINGS

VSS=0V

Item	Symbol	Min	MAX	Unit	Remark
Input voltage	VI	0	4.6	V	Note 4-1
Supply voltage	DVCC	0	4.6	V	
Back light forward current(Ta=25℃)	If	--	23	mA	
Operating temperature	Topr	-20	+70	℃	
Storage temperature	Tstg	-40	+80	℃	

Note 4-1 :VI：HS,VS,D0~D17, SCK, SDT

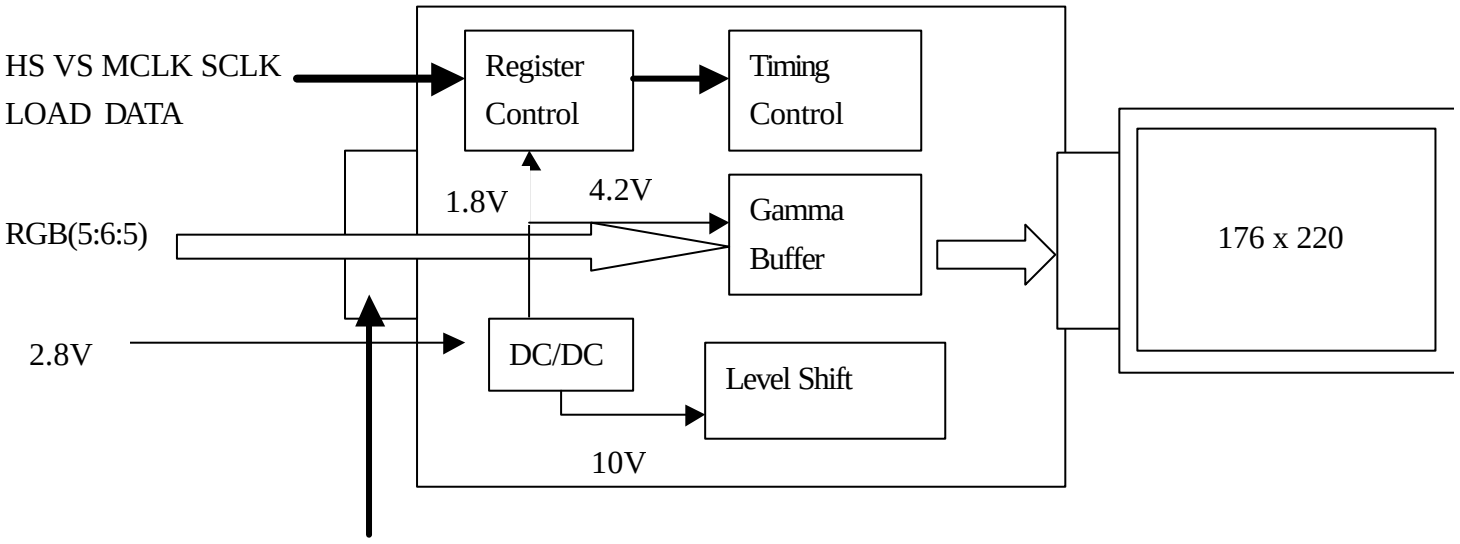
5. ELECTRICAL CHARACTERISTICS

Ta=25℃

Item		Symbol	MIN	TYP	MAX	Unit	Remark
Power Supply Voltage		DVCC	2.7	2.8	3.0	V	
Logic Input High Level		VIH	2.25	--	3.0	V	Note 5-1
Logic Input Low Level		VIL	0	--	0.42	V	Note 5-1
Back light Forward Current		Ib	--	18	23	mA	
Back light Forward Voltage (Fix Current: 18mA)		Vb	--	3.6	--	V/Unit	
Panel Power Consumption		Wp	--	--	--	mW	
System Power Consumption	Moving	W_M	--	7.84	8.8	mW	
	8 color/partial (32 lines)	W_8	--	2.632	3.08	mW	
	Sleeping	W_S	--	0.28	0.56	mW	
Back light Power Consumption		Wbl	--	194.4	248.4	mW	

Note 5-1 :VIH, VIL：HS,VS,D0~D17, SCK, SDT

5.1 Driving TFT LCD panel block diagram



39 pin
0.3 pitch

5.2 Driving Backlight

Ta=25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Forward Current	I_F	--	18	23	mA	Note 5-2
Forward Current Voltage	V_F	--	10.8	--	V	
Backlight Power Consumption	W_{BL}	--	194.4	248.4	mW	

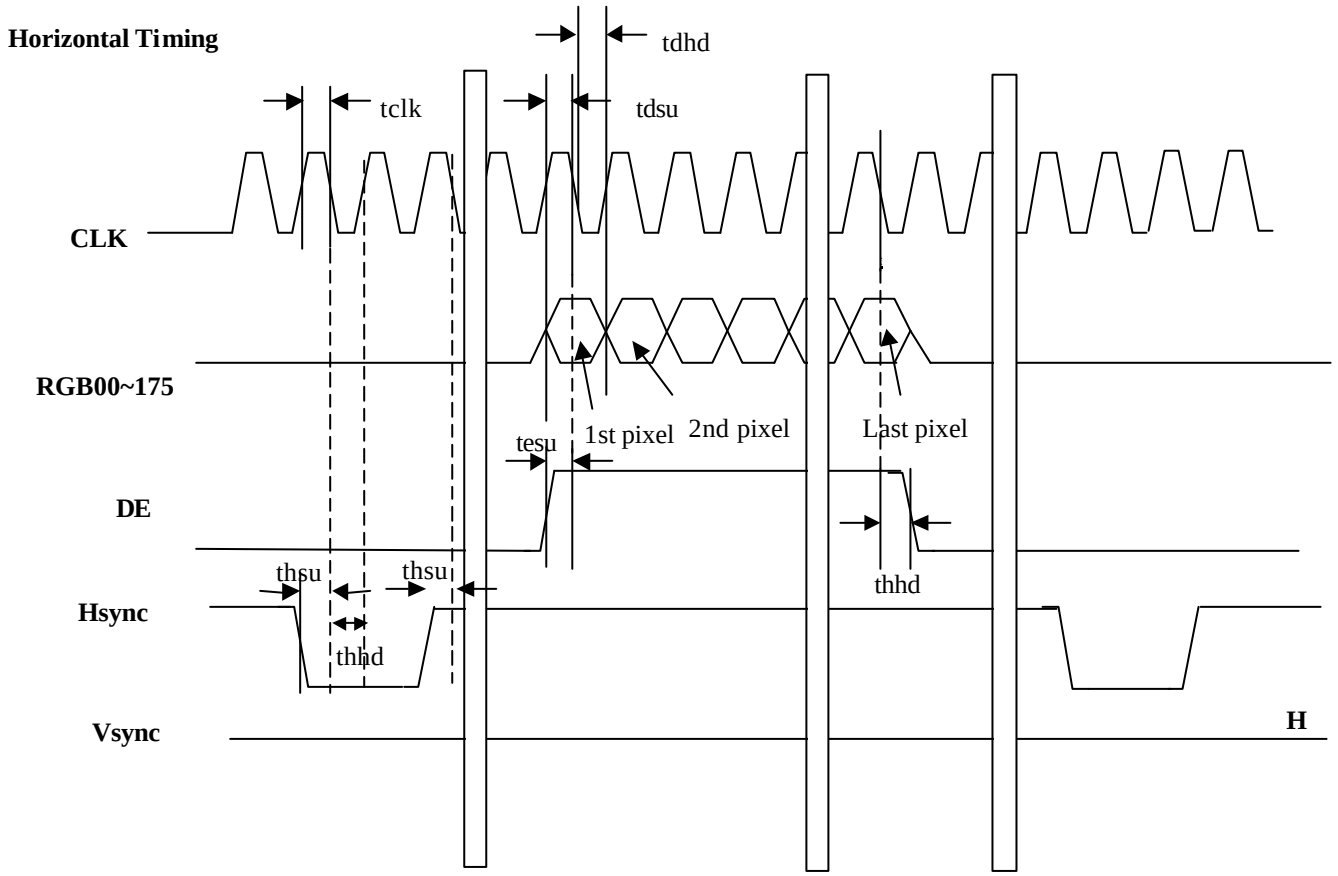
Note 5-2: LEDx3

6. TIMING CHART

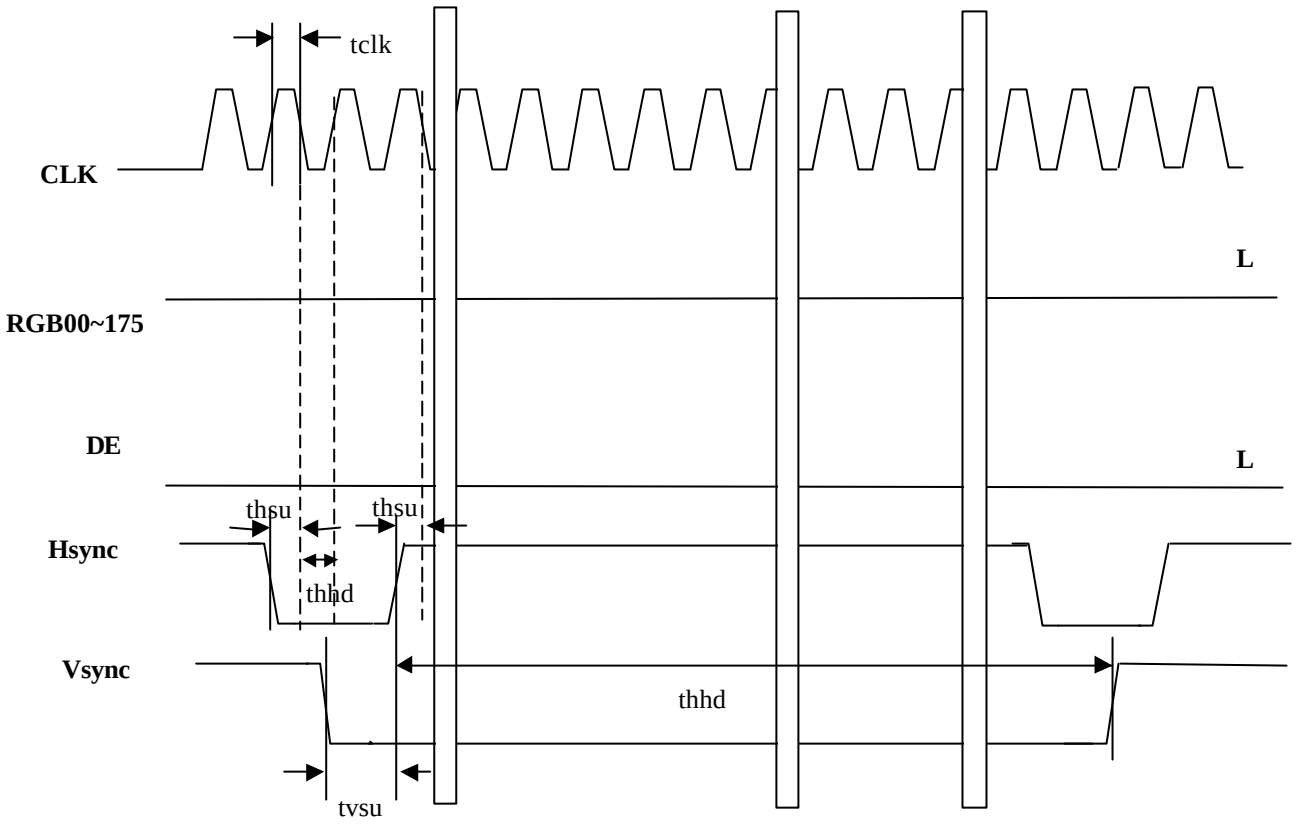
6.1 Timing Characteristics of Input Signals

176X220

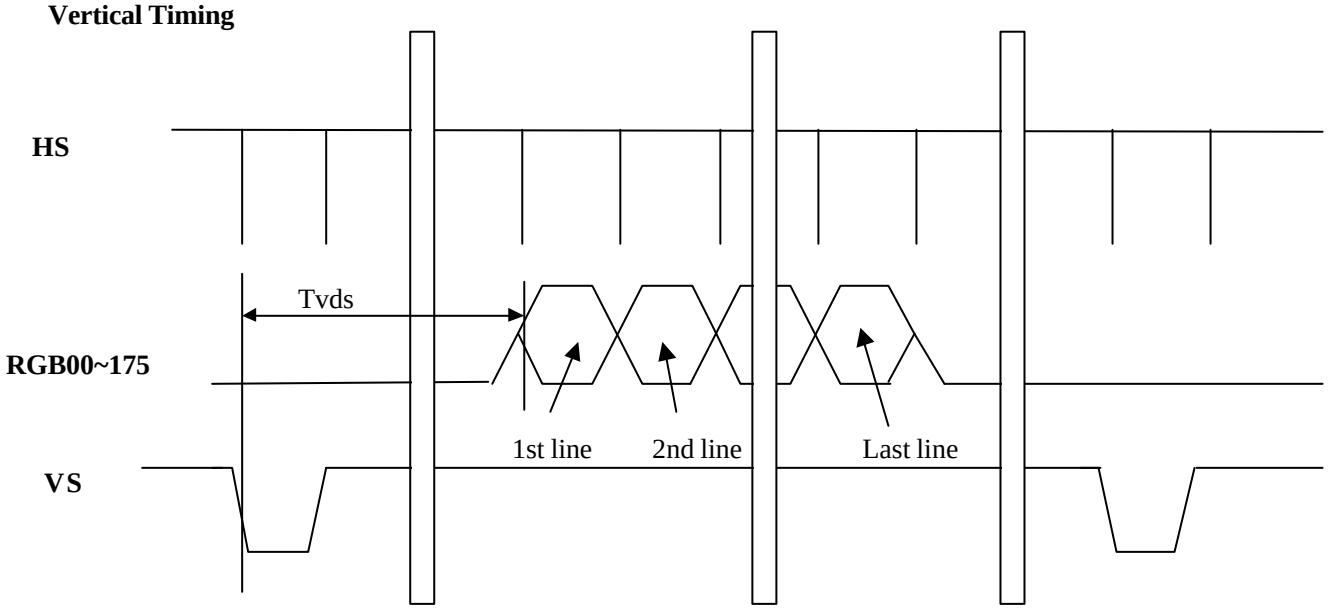
Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Clock	Frequency	f_{clk}		3.3	3.85	5	MHz
	Clock time	t_{clk}		—	260.0	—	ns
	High time	t_{clk_H}		—	0.5 t_{clk}	—	ns
	Low time	t_{clk_L}		—	0.5 t_{clk}	—	ns
Data Enable	Setup time	t_{esu}		20	—	—	ns
	Hold Time	t_{hhd}		20	—	—	ns
Hsync	Setup time	t_{hsu}		20	—	—	ns
	Hold Time	t_{hhd}		20	—	—	ns
Vsync	Setup time	t_{vsu}		20	—	—	ns
	Hold Time	t_{hhd}		20	—	—	ns
data	Setup time	t_{dsu}		20	—	—	ns
	Hold time	t_{dhd}		20	—	—	ns



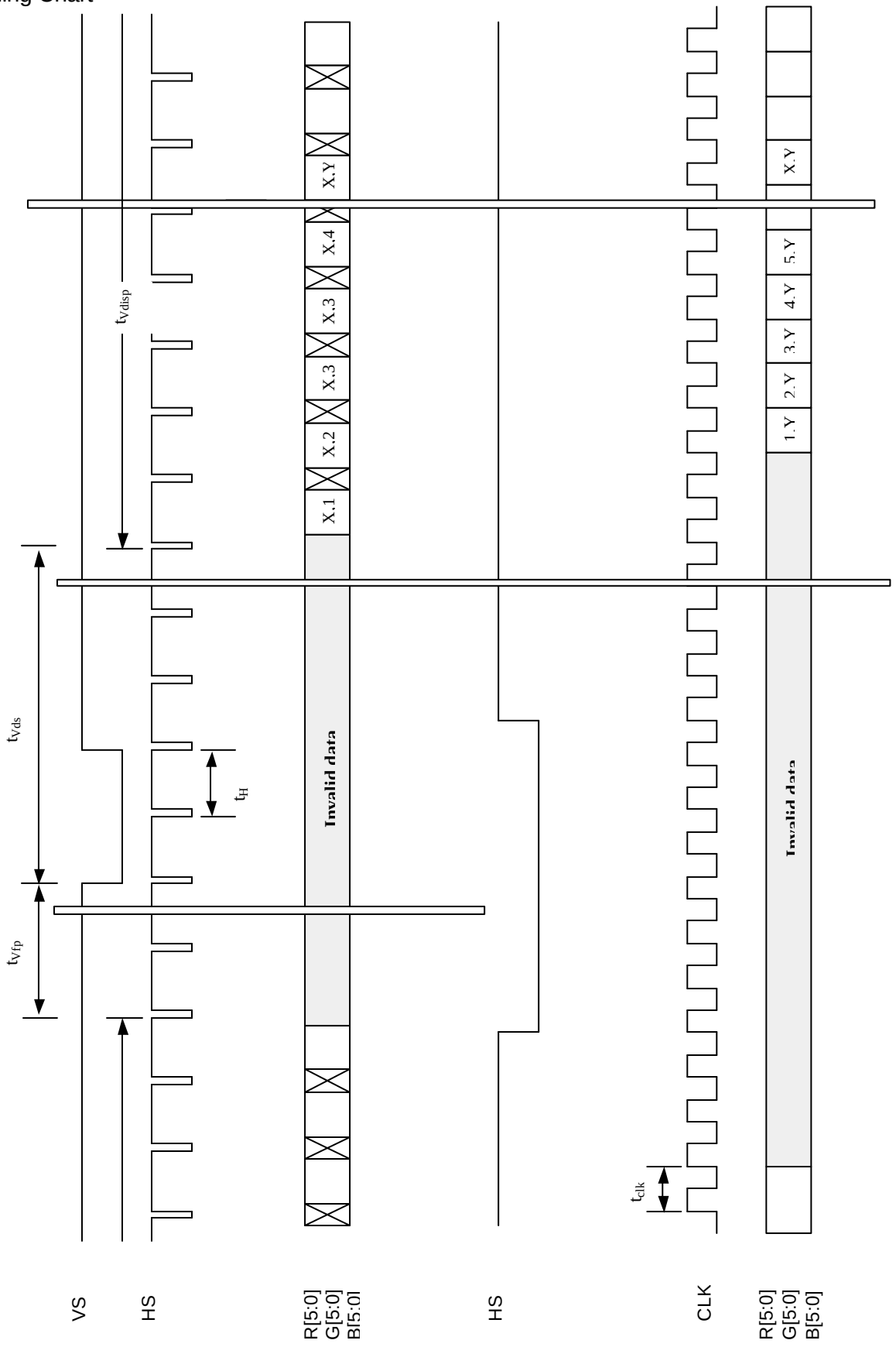
Horizontal Timing



Vertical Timing



6.2 Timing Chart



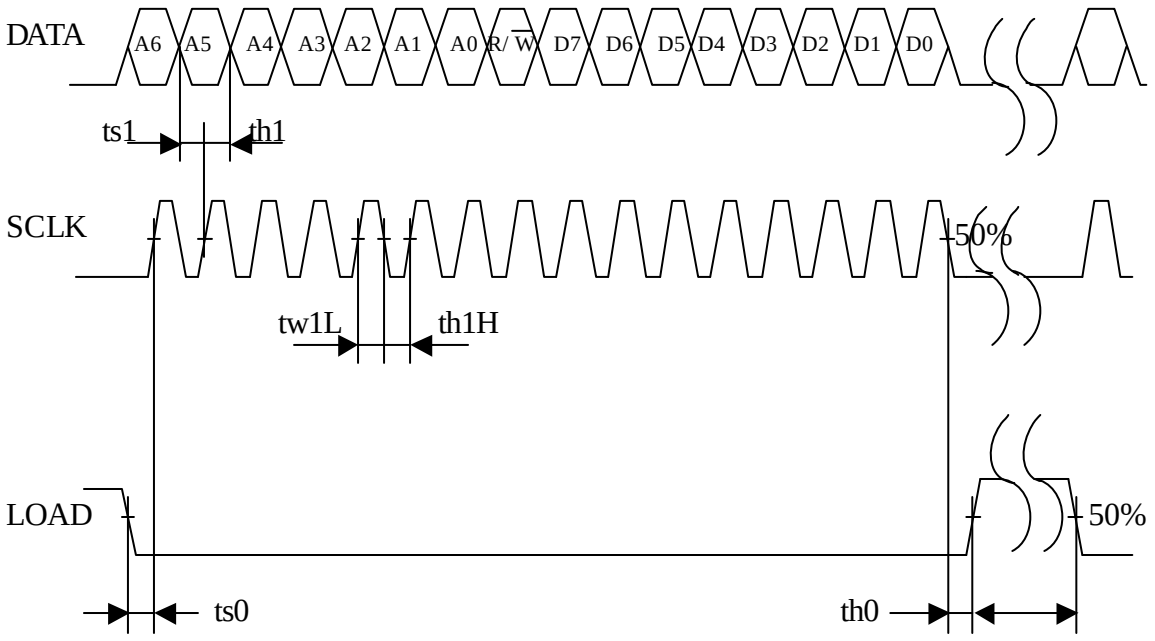
6.3 Timing Characteristics of Output Signals (HS+VS mode)

Item		Symbol	Conditions	Min.	Typ.	Max.	unit
Horizontal	Period	t_H		233	240	250	t_{clk}
	Active	t_{Hdisp}		176	176	176	t_{clk}
	Display start	t_{Hds}		Note1	20	—	t_{clk}
	Front porch	t_{Hfp}		20	—	—	t_{clk}
Vertical	Period	t_V		227	229	240	t_H
	Active	t_{Vdsip}		220	220	220	t_H
	Display start	t_{Vds}		Note2	6	—	t_H
	Front porch	t_{vfp}		1	—	—	t_H

Note1: t_{Hds} > the number of MCLK during HS low period

Note2: t_{Vds} > the number of Line during VS low period

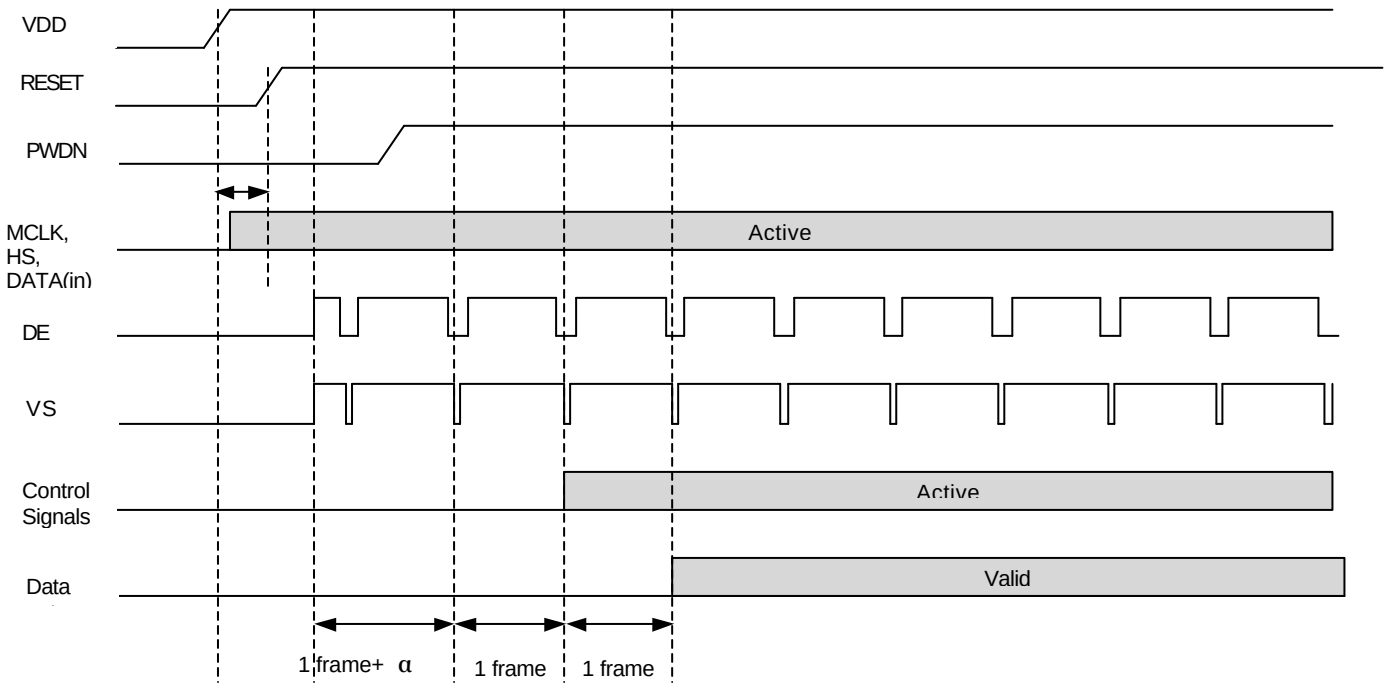
6.4 3-wire Serial Interface Timing



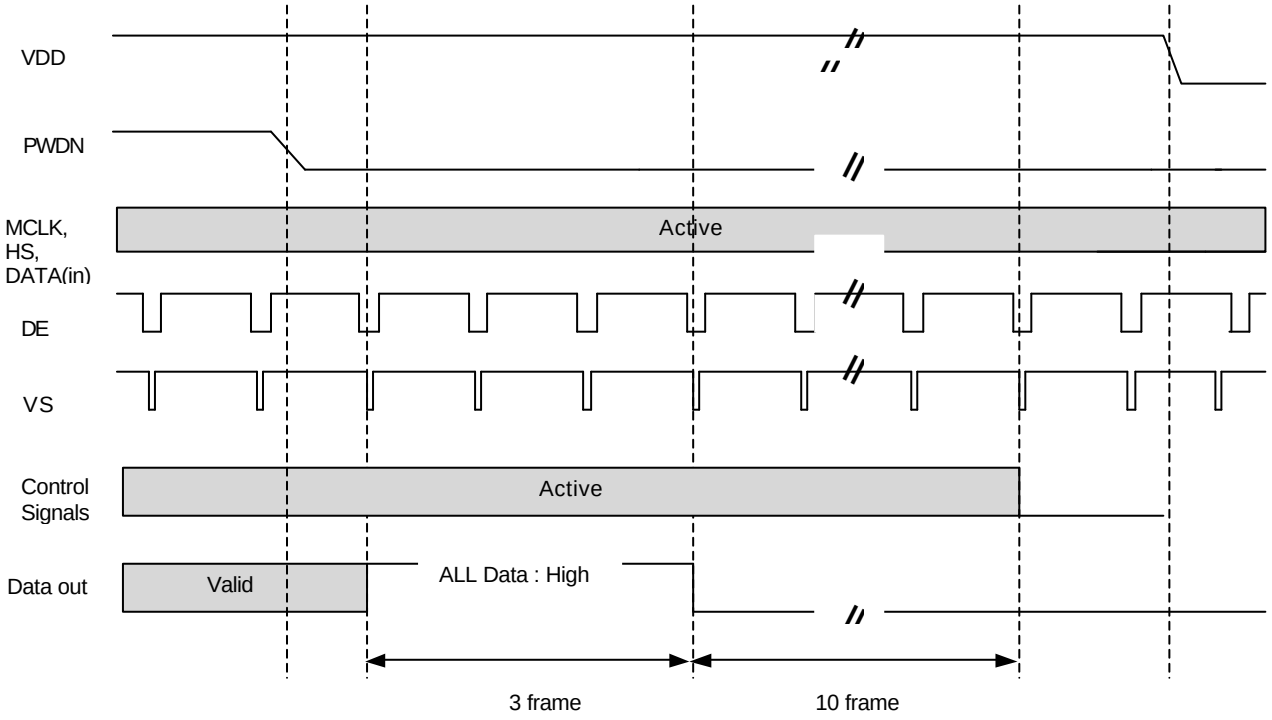
Item	Symbol	Conditions	Min	Typ.	Max	Unit
Data Setup Time	ts0	LOAD to SCLK	150			ns
	ts1	DATA to SCLK	150			ns
Data Hold Time	th0	LOAD to SCLK	150			ns
	th1	DATA to SCLK	150			ns
Pulse Width	tw1L	SCLK pulse width	160			ns
	tw1H	SCLK pulse width	160			ns
	tw2	LOAD pulse width	1.0			us

6.5 Power On and Power Off Sequence:

6.5.1 Power On Sequence



6.5.2 Power Off Sequence



6.6 Input Signals, Basic Display Color and Gray Scale of Each Color

Color & Gray scale		Digital Signal																	
		R0	R1	R2	R3	R4	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	B4
Black		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue		0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Green		0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
Cyan		0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
Red		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Magenta		1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1
Yellow		1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
White		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Black	GS0(R)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
↓		↓					↓						↓				
		0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Red	GS31(R)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Black	GS0(G)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
↓		↓					↓						↓				
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
Green	GS63(G)	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
Black	GS0(B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
↓		↓					↓						↓				
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Blue	GS31(B)	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1

6.7 Setup data (ASIC Register Table)

Address	Register/Bit Name	Reset Value	Meaning
0x00	CHIPID	xx00-1001	[5:3] : REVID (read only) [2:0] : CHIPID (read only)
0x01	MODE_SEL1	0000-0000	[7:6] Panel resolution select 00: 176 x 220 (Default) 01: 128 x 160 [5:4] Scan direction [5] 0: CSH=1(H normal scan) (Default) 1: CSH=0 (H reverse scan) [4] 0 : CSV=1(V normal scan) (Default) 1: CSV=0(V reverse scan) [3] SYNC polarity 0: negative (Default) 1: positive [2] Input mode selection 0: DE (Default) 1: HS/VS [1] Input data selection 0: 18 bits (Default) 1: 16 bits
0x02	MODE_SEL2	0100-0000	[7] Select 8color / full color 0: 8 color mode 1: full color mode (65K/262K) [6:5] Select Display mode 00:moving mode (Default) 01: still mode 1x: Power saving mode (Default) [4] Out of window data select enable 0: Disable (Default, Normal Display) 1: Enable (Display B/W) [3] Select Line/Frame inversion 0: Line inversion (Default) 1: Frame inversion [2] Out of range data select 0: White (Default) 1: Black

			[1] Vcom output selection 0: Vcom output from OP driver (Default) 1: Vcom output from Inveter(2.8V) [0] Dithering mode ON/OFF 0: dithering OFF (Default) 1: Dithering ON
0x03	VCO_Mode	xxxx-0100	[3] : Turbo Bias select ; 1: ON, 0: OFF [2] : Gating PUMPfreq when Sample/Hold 0 : OFF 1 : ON (Default) [1] : OSC select ; 1: always ON, 0: Automatic [0] : VCO frequency 0 : 475 KHz (Default) 1 : 475/ 2 KHz
0x04	DAC_OP_CTRL2	00100001	[7] Sample/Hold Disable 0: Enable (Default) 1: Disable (Always ON) [6:4] OP bias select 000 : 60% 001 : 80% 010 : 100% (Default) 011 : 120% 100 : 140% 101 : 180% 110 : 240% 111 : 360% [2] PUMPFreq select 0 : controlled by 0x38,39 (Default) 1 : Test mode
0x05	VCOMH_CTRL	xx000101	[5:0] VCOM_H output Voltage control (Default = 4.0V) (000000)=4.1V, (000101)=4.0V, (1111111)=2.84V, 20mV/step
0x06	VCOML_CTRL	xx000101	[5:0] VCOM_L output Voltage control (Default = 0.2V) (000000)=0.1V, (000101)=0.2V, (111111)=1.36V, 20mV/step
0x14	Window Start- X	0000-0000	[7:0] Window Left-UP X point
0x15	Window Start- Y	0000-0000	[7:0] Window Left-UP Y point
0x16	Window End- X	1010-1111	[7:0] Window Right-Down X point

0x17	Window End- Y	1101-1011	[[7:0] Window Right-Down Y point
0x19	Number of Line Invertion	xxxx-xx00	This mode is enable when line inversion is chosen 00 : 1 Line Inversion (Default) 01 : 2 Line Inversion 10 : 4 Line Inversion 11 : 8 Line Inversion
0x21	Th	0001-0100	[7:0] Thds (min to max) : 1clk / step [0 ~ 255]
0x22	Tv	0000-0110	[4:0] Tvds (min to max) : 1 TH / step [0 ~ 31]
0x23	MODE_SW	1xxx-xxxx	[7] Still mode write data into SRAM 0: write NG 1: write data into SRAM (Default)
0x26	V0H_CTRL	Xx01-1001	When VCOM=L [5:0] V0H output Voltage control (Default = 3.7V) (000000)=4.2V, (011001)=3.7V, (111111)=2.94V, 20mV/step
0x27	V0L_CTRL	Xx01-1110	When VCOM=H [5:0] V0L output Voltage control (Default = 0.9V) (000000)=0.3V, (011110)=0.9V, (111111)=1.56V, 20mV/step
0x28	V63H_CTRL	Xx01-1001	When VCOM=H [5:0] V0H output Voltage control (Default = 3.7V) (000000)=4.2V, (011001)=3.7V, (111111)=2.94V, 20mV/step
0x29	V63L_CTRL	Xx01-1110	When VCOM=L [5:0] V0L output Voltage control (Default = 0.9V) (000000)=0.3V, (011110)=0.9V, (111111)=1.56V, 20mV/step
0x30	PWMDUTY	1000-0000	[7:0]: PWM output duty (duty cycle adjustment) 0000-0000: LEDPWM output GND level 1111-1111: LEDPWM output 99% duty cycle Duty cycle = PWMDUTY/256
0x31	LEDCNTR	11xx-x101	[7:0]: LED current control setup [7]: LEDPWDN 0: LED driver normal output 1: LED driver power OFF [6]: LEDSEL 1: Controlled by LEDC2~LEDC0 (LEDPWM output HIGH level)

			0: PWM output (LEDPWM AC output) [5:3]: Reserved [2]: LEDC2 [1]: LEDC1 [0]: LEDC0
0x32	PWMFREQ	1100-1000	[7:0]: PWM frequency divider PWM freq = MCLK / PWMFREQ
0x33	GPO	xxxx_xx00	[1:0]: General purpose output
0x34	FLAGSET	xxxx-xxx0	[0]: Set to all flags which individually control each source driver channel
0x35	STV	xxxx-xx11	[1]: STV1; 1: ON, 0:OFF [0]: STV0; 1: ON, 0:OFF
0x36	SRAM_OFF	xxxx-xxx0	[0]: SRAMPWROFF; 1: Enable(SRAM POWER OFF) , 0: Disable (Normal , Default)

7. OPTICAL CHARACTERISTICS

7.1 Optical Specification

(1) Transmissive Mode (Back Light On, LED current = 18mA)

Ta=25℃

Item		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Viewing angles		Θ11	CR = 2	35	45	--	Degree	Note 7-1
		Θ12		35	45	--		
		Θ21		35	45	--		
		Θ22		45	60	--		
Contrast ratio		CR	Θ=0°	60	80	--		Note 7-2
Response time		Tr+Tf		--	35	60		Note 7-3
Chromaticity	White	x		0.275	0.310	0.345		Note 7-4
		y		0.290	0.330	0.370		
	Red	x		0.46	0.51	0.56		
		Y		0.28	0.33	0.38		
	Green	x		0.27	0.32	0.37		
		Y		0.47	0.52	0.57		
	Bule	x		0.11	0.16	0.21		
		Y		0.11	0.16	0.21		
NTSC		(x,y)		28	30	--	%	
Luminance		L		80	110	--	cd/m^2	Note 7-5
Uniformity		Lu		60	70	--	%	Note 7-9

(2) Reflective Mode (Back Light Off)

Ta=25℃

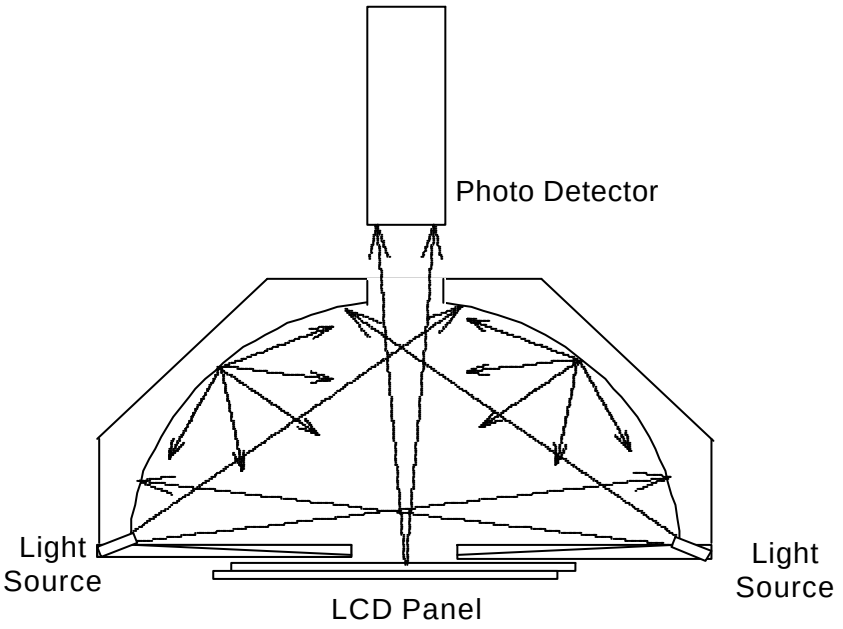
Item		Symbol	Condition	MIN	TYP	MAX	Unit	Remarks
Viewing angles		Θ11	CR = 2	35	45	--	Degree	Note 7-1
		Θ12		35	45	--		
		Θ21		35	45	--		
		Θ22		45	60	--		
Contrast ratio		CR	Θ=10°	8	15	--		Note 7-6
Chromaticity	White	x	Θ=0°	0.28	0.33	0.38		Note 7-7
		y		0.30	0.35	0.40		
	Red	x		0.38	0.43	0.48		
		Y		0.29	0.34	0.39		
	Green	x		0.24	0.29	0.34		
		Y		0.36	0.41	0.46		
	Blue	x		0.14	0.19	0.24		
		Y		0.18	0.23	0.28		
Reflection ratio		R	Θ=10°	10	15	--	%	Note 7-8

7.2 Basic measure condition

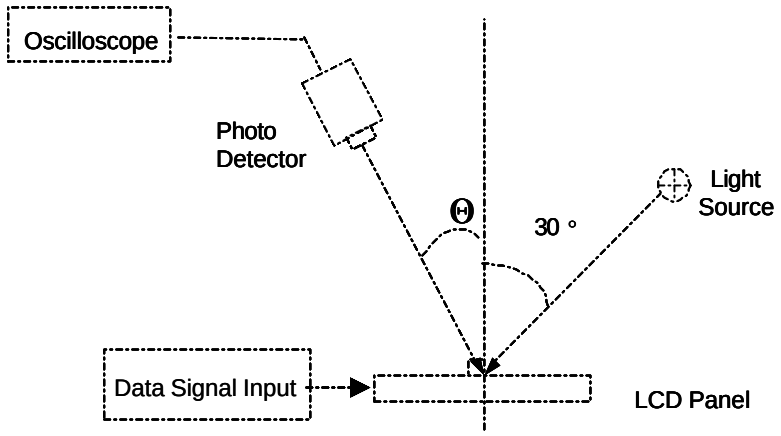
(1) Ambient temperature: Ta=25℃

(2) Measure System

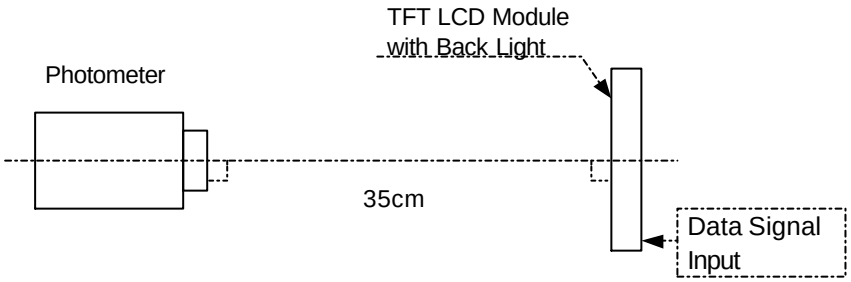
a. System A



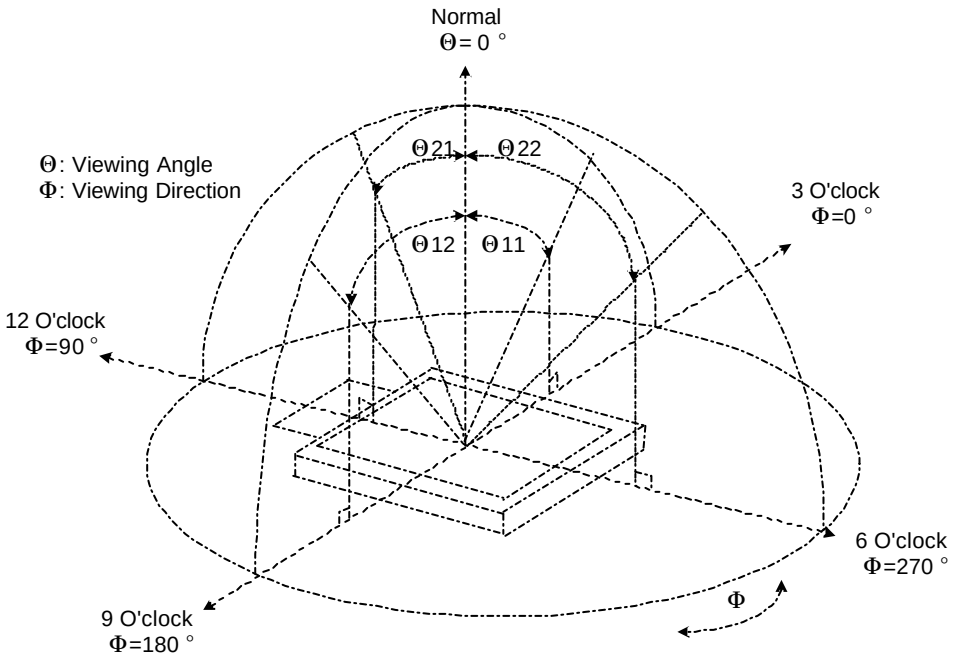
b. System B



c. System C



Note 7-1: Viewing angle diagrams:

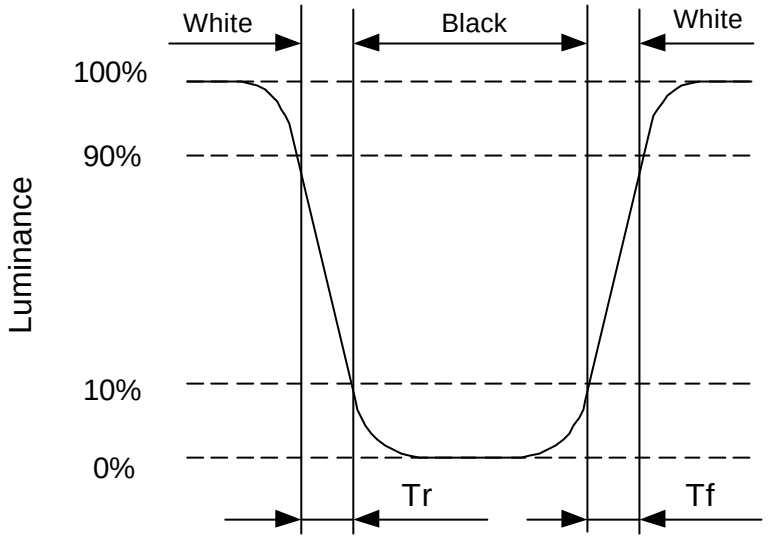


Note 7-2: Contrast ratio in back light on (Measure System C)

Contrast ratio is measured in optimum common electrode voltage.

$$CR = \frac{\text{Luminance with all white pixels}}{\text{Luminance with all black pixels}}$$

Note 7-3: Definition of response time: (Measure System C)



Note 7-4: White chromaticity as back light on: (Measure System C)

Note 7-5: Luminance: (Measure System C)

Test Point: Display Center

LED Current I_F = 18 mA

Note 7-6: Contrast ratio in back light off (Measure System B)

Contrast ratio is measured in optimum common electrode voltage.

$$CR = \frac{\text{Luminance with white image}}{\text{Luminance with black image}}$$

Note 7-7: White chromaticity as back light off: (Measure System A)

Note 7-8: Reflection ratio (R) (Measure System B)

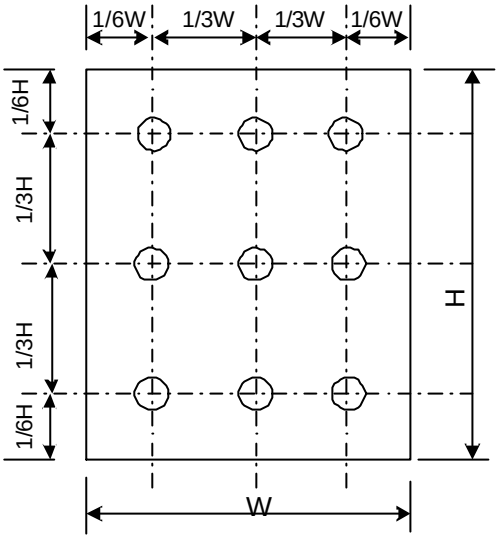
In the measuring system B, calculate the reflection ratio by the following formula.

$$\text{Reflection ratio(R)} = \frac{\text{Light detected level of refection by the LCD module}}{\text{Light detected level of refection by the standard white}}$$

Notes 7-9: Definition of uniformity: Light on backlight 5 minutes before test.

$$\text{Uniformity (Lu)} = \frac{\text{Minimum Luminance of 9 test points}}{\text{Center Luminance of 9 test points}} \text{X100\%}$$

The definition of 9 test points:



8. RELIABILITY

No	Test Item	Condition
1	High Temperature Operation	Ta=+70°C, 240hrs
2	High Temperature & High Humidity Operation	Ta=+40°C, 95% RH, 240hrs
3	Low Temperature Operation	Ta=-20°C, 240hrs
4	High Temperature Storage	Ta=+80°C, 240hrs
5	Low Temperature Storage	Ta=-40°C, 240hrs
6	Thermal Shock (non-operation)	-30°C←→80°C, 50 cycles 30 min 30 min
7	Resistance to Static Electricity Discharge (non-operation)	C=200pF, R=0Ω; Discharge: ±150V 3 times / Terminal
8	Surface Discharge (non-operation)	C=150pF, R=330Ω; Discharge: Air: ±15kV; Contact: ±8kV 5 times / Point; 5 Points / Panel
9	Vibration (non-operation)	Frequency: 10~55Hz; Amplitude: 1.5mm Sweep Time: 11min Test Time: 2 hrs for each direction of X, Y, Z
10	Shock (non-operation)	Acceleration: 100G; Period: 6ms Directions: ±X, ±Y, ±Z; Cycles: Twice

Ta: Ambient Temperature

9. HANDLING CAUTIONS

9.1 ESD (Electrical Static Discharge) Strategy

ESD will cause serious damage of the panel, ESD strategy is very important in handling. Following items are the recommended ESD strategy

(1) In handling LCD panel, please wear non-charged material gloves. Connector the wrist conduction ring to the earth and the conducting shoes to the earth is necessary.

(2) The machine and working table for the panel should have ESD protection strategy.

(3) In handling the panel, using ionized air to decrease the charge in the environment is necessary.

(4) In the process of assembly the module, shield case should connect to the ground.

9.2 Environment

(1) Working environment of the panel should be in the clean room.

(2) The front polarizer is easy damaged. Handle it carefully and do not scratch it by sharp material.

(3) Panel has polarizer protective film in the surface. Please remove the protection film of polarizer slowly with ionized air to prevent the electrostatic discharge.

9.3 Others

(1) Turn off the power supply before connecting and disconnecting signal input cable.

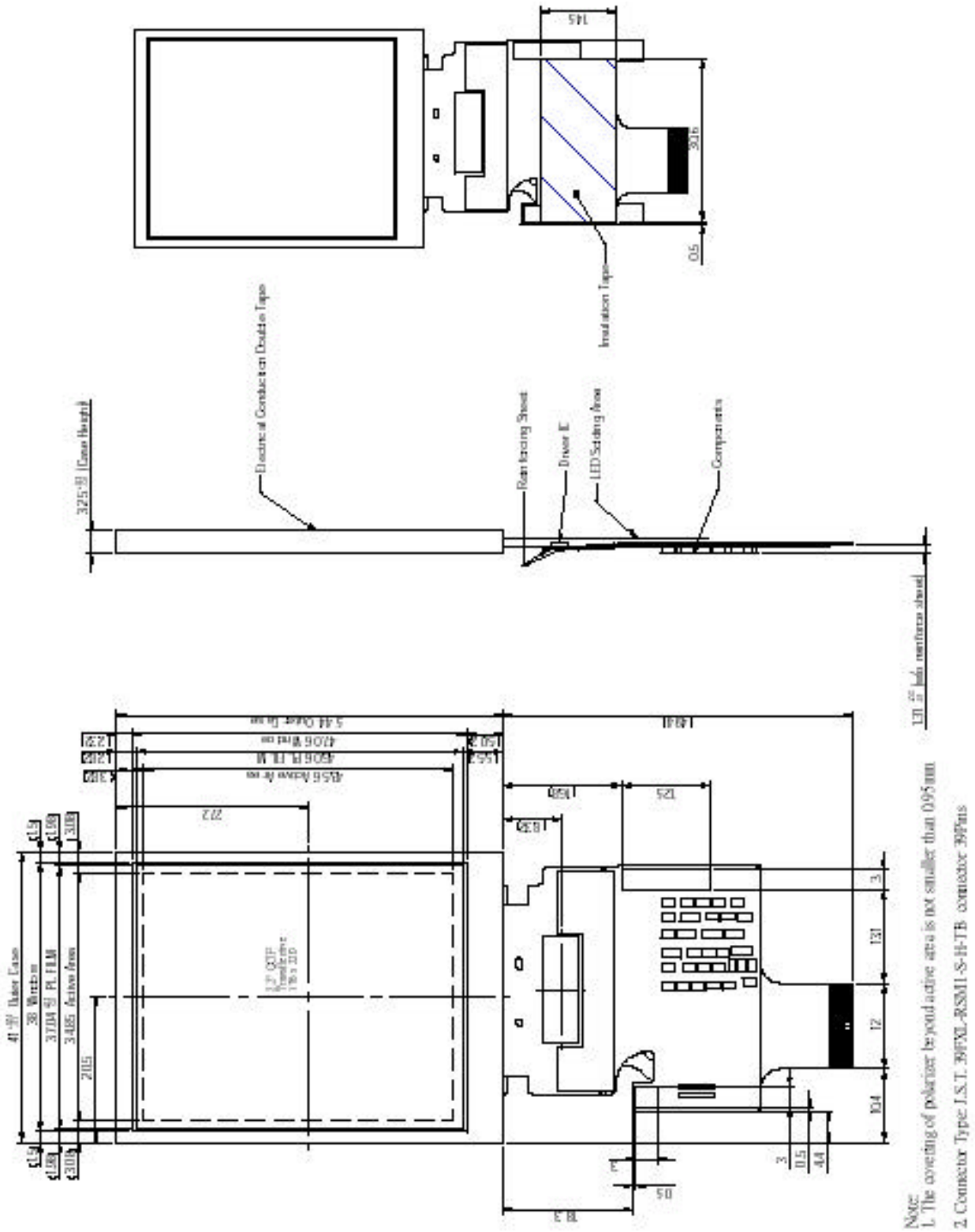
(2) The connection area of FPC and panel is very weak, do not handle panel only by FPC or bend FPC.

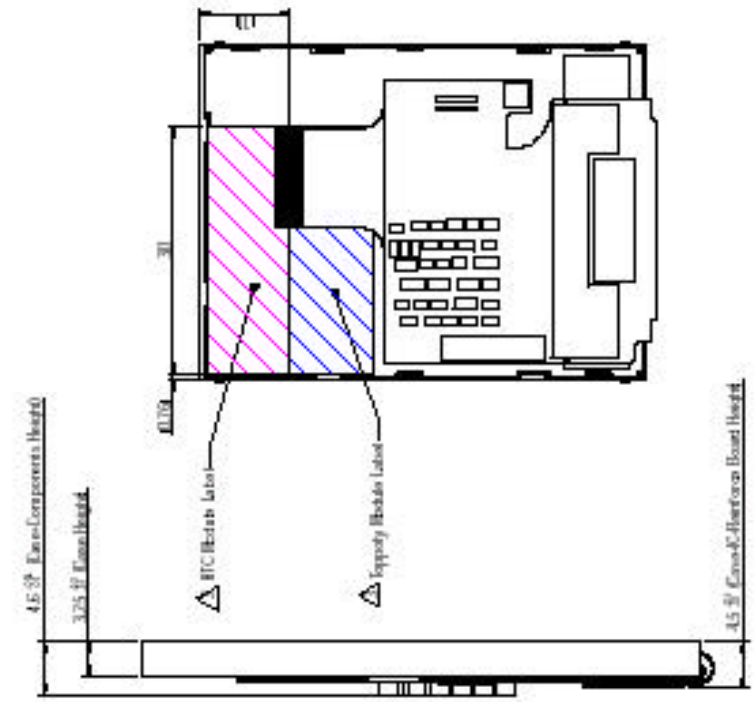
(3) Water drop on the surface or condensation as panel power on will corrode panel electrode.

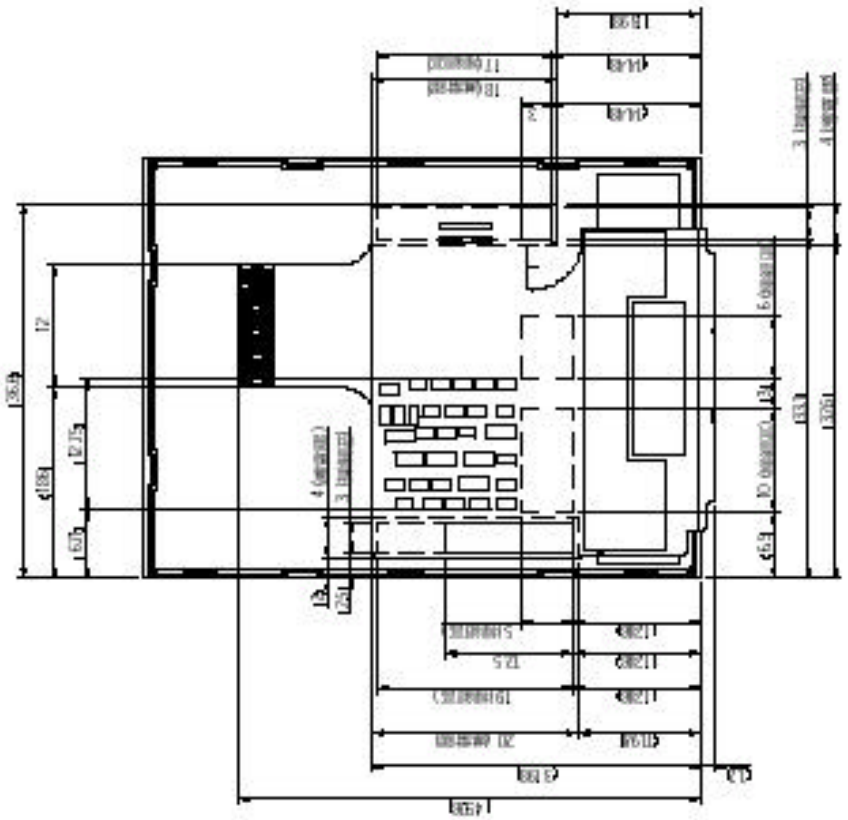
(4) As the packing bag open, watch out the environment of the panel storage. High temperature and high humidity environment is prohibited.

(5) When the TFT LCD module is broken, please watch out whether liquid crystal leaks out or not. If your hand touches liquid crystal, wash your hand cleanly by water and soap as soon as possible.

10.MECHANICAL DRAWING



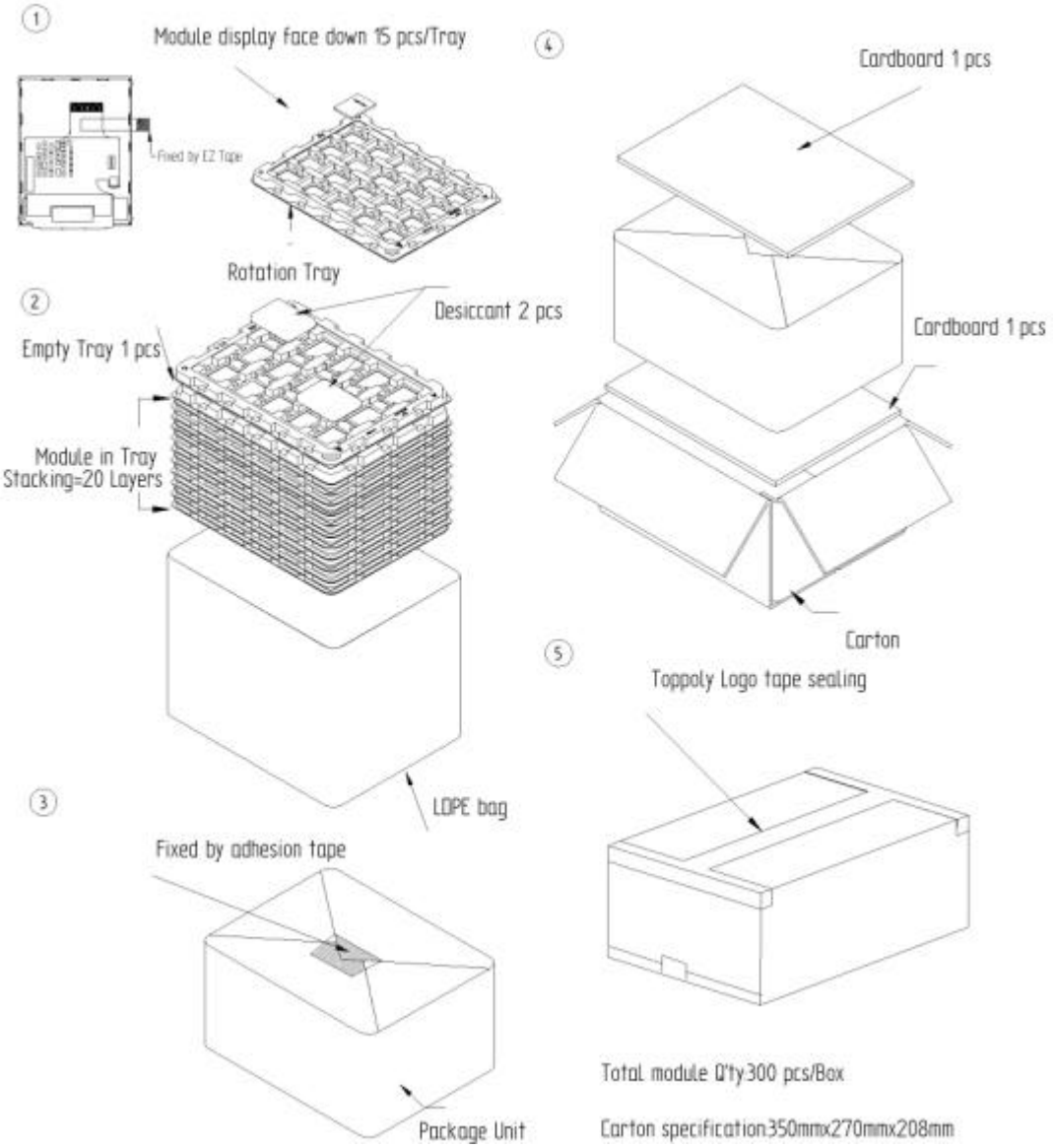




(Bottom Side)

11. PACKING DRAWING

11.1 Packing Drawing



TD022SHEB2 Module delivery packing method

(1). Use EZ tape to fix the FPC on the backlight bezel.Module packed into tray cavity (with Module display face down), and stacking tray of reverse 180 degree in order.

(2). Stacking the production on tray with 20 layers and with 1 empty tray above the stacking tray unit, and put 2 Desiccant on the empty tray.

(3). Stacking tray unit put into the LDPE bag and fix by adhesive tape.

(4). Put 1 pcs cardboard inside the carton bottom, then pack the package unit into the carton, finally put 1 pcs cardboard above the package unit

(5) Sealing the Carton with Toppoly Logo adhesive tape.

11.2 Key Component Label Plan

(1) Key component label ----- LCD / LCM / Battery/Adapter

Dimension : 30mm * 10mm * 0.1mm (T.B.D)

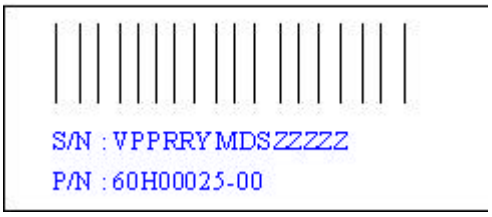
Material : Hi Fi printing paper (T.B.D)

Color : Pantone White (T.B.D)

Barcode Serial number requirement (14 digital)

Barcode symbology use Code 128

SAMPLE



(2) For S/N : **VPPRRYMDSZZZZZ**

V: Vendor code (Assist by CE or R.D) for Toppoly is "B"

PP: Part number code for Typhoon project is " CD "

RR: Revision Code

2 characters	Combination				
	1'st Char	Material Related		2'nd Char	Process or Customer related
		B/L	COF		
X1	X			1	Before MP
A1	A	FJK	Career	1	HTC
A2	A	FJK	Career	2	Not Used
A3	A	FJK	Career	3	New Career COF(FPC Modify)
A4	A	FJK	Career	4	Not Used
B1	B	FJK	SMMD	1	HTC
B2	B	FJK	SMMD	2	Not Used
B3	B	FJK	SMMD	3	Not Used
B4	B	FJK	SMMD	4	Not Used
C1	C	Radiant	Career	1	HTC
C2	C	Radiant	Career	2	Radiant's New B/L FPC (Add 2.8mm)
C3	C	Radiant	Career	3	New Career COF(FPC Modify)
C4	C	Radiant	Career	4	Radiant's B/L LED Change to 008T
D1	D	Radiant	SMMD	1	HTC
D2	D	Radiant	SMMD	2	Radiant's New B/L FPC (Add 2.8mm)
D3	D	Radiant	SMMD	3	Not Used
D4	D	Radiant	SMMD	4	Radiant's B/L LED Change to 008T

Y: Manufacture year

Lowest one digit of A.D

example : 2002 = 2

M: Manufacture month

Jan. : 1	May. : 5	Sep. : 9
Feb. : 2	Jun. : 6	Oct. : A
Mar. : 3	Jul. : 7	Nov. : B
Apr. : 4	Aug. : 8	Dec. : C

D: Manufacture day

1st dight of serial number and represent the DAY

Use base 31 (ex : 1,2,3……..9,A,B,C……. Z , exclude I , O , Q , U , please note day start from 1)

S: Manufacture place: T : Taiwan ChuNan, N : China NanJing

Z: Remaining 5 digital of serial number (reset by every day)

Use base decimalism(00001 ~ 99999)