



ELECTRONICS

Product Information

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MODEL : LTS220Q1-HE_x

Note : This Product information is subject to change without any notice.

PREPARED BY : AMLCD Application Engineering 1 Group

Samsung Electronics Co . , LTD.

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Revision History

Data	Rev. No.	Page	Summary
Mar.04. 2002	000		Rev.000 was issued.
May.07. 2002	001	27~32	Operating Sequences were changed.

General Description

* Description

LTS220Q1-HEX is a transfective type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching devices. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit. The resolution of a 2.2" contains 176 x 220 pixels and can display up to 262K colors.

* Features

- Transflective type and back-light with three LEDs are available.
- Line inversion mode.
- 18bit, 16bit or 6bit RGB Interface + Serial Peripheral Interface(SPI) with on-chip display RAM.
- Full, Still, Sleep & Stand-by mode are available.
- Low Power consumption.

* Applications

- Display terminals for HHP & PDA application products.

* General Information

Items	Specification	Unit	Note
Display area	34.848(H) x 43.560(V)	mm	-
Driver element	a-Si TFT active matrix	-	-
Display colors	262K	colors	-
Number of pixels	176(H) x 220(V)	pixel	-
Pixel arrangement	RGB vertical stripe	-	-
Pixel pitch	0.198(H) x 0.198(V)	mm	-
Display mode	Normally White	-	-
Viewing direction	TBD	o'clock	-
Surface Treatment	TBD	H	-

* Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal(H)	41.70	41.90	42.10	mm	(1)
	Vertical(V)	57.00	57.20	57.40	mm	(1)
	Depth(D)	3.17	3.37	3.57	mm	(1)
Weight		-	-	(16)	g	(1)

Note (1) Without FPC.

Refer to the Outline Dimension in the page 34 for further information.

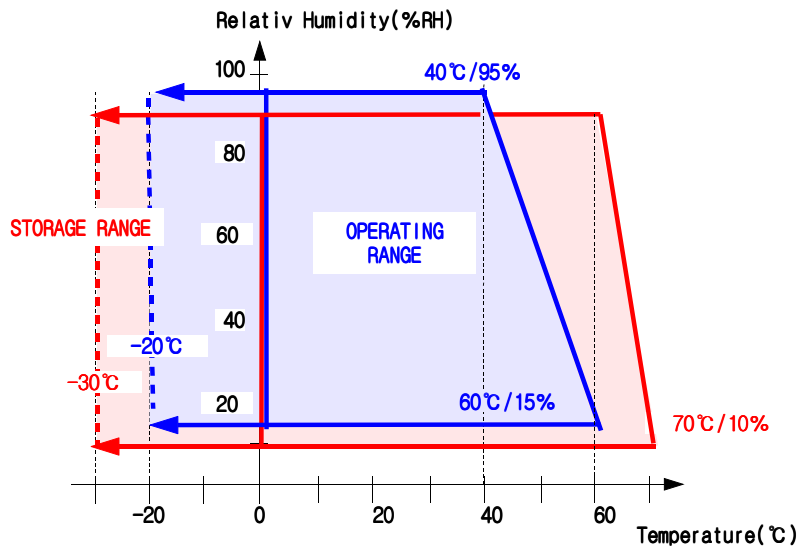
1. Absolute Maximum Ratings

1.1 Absolute Ratings of Environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T _{STG}	-30	70	°C	(1)
Operating temperature (Ambient temperature)	T _{OPR}	-20	60	°C	(1),(2)

Note (1) 95 % RH Max. (40 °C ≥ Ta)

Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.



- (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's characteristics.

1.2 Electrical Absolute Ratings

(1) TFT-LCD Module

(Ta = 25 ± 2°C, V_{ss}=GND=0)

Characteristics	Symbol	Min.	Max.	Unit	Note
Logic supply voltage	V _{CC}	-0.3	4.6	V	-
DC/DC supply voltage	V _{Cl}	-0.3	4.6	V	-

(2) Back-Light Unit

(Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Current	I _B	-	25	mA	(1)

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded.

Functional operation should be restricted to the conditions described under normal operating conditions.

2. Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (2).

Measuring equipment: LCD-7200, BM-5A, BM-7, PR-650, EZ-Contrast

($T_a = 25 \pm 2^\circ\text{C}$, $V_{CC} = V_{CI} = 3.3\text{V}$, $I_B = 15\text{mA}$)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note			
Reflectance	Rf	B/L Off	TBD	(7)	-	%	(3) LCD-7200			
Contrast ratio (Center point)	C/R1	B/L On	TBD	(130)	-	-	(4) BM-5A			
	C/R2	B/L Off	TBD	(50)	-	-	(4) LCD-7200			
Luminance of white (Center point)	YL	B/L On	TBD	(65)	-	cd/m2	(5) BM-5A			
Response time	Rising:Tr	Tr+Tf	-	(30)	TBD	msec	(6) BM-7			
	Falling:Tf									
Color chromaticity (CIE 1931)	White	Wx1	B/L On	TBD	(0.320)	TBD	-	(7) PR-650		
		Wy1		TBD	(0.350)	TBD				
	Red	Rx		TBD	(0.540)	TBD				
		Ry		TBD	(0.340)	TBD				
	Green	Gx		TBD	(0.320)	TBD				
		Gy		TBD	(0.470)	TBD				
	Blue	Bx		TBD	(0.150)	TBD				
		By		TBD	(0.160)	TBD				
	White	Wx1		B/L Off	TBD	(0.290)			TBD	(7) LCD-7200
		Wy1			TBD	(0.350)			TBD	
Viewing angle	Hor.	$\theta L1$	$C/R \geq 10$	TBD	(50)	-	Degrees	(8) Ez-Contrast		
		$\theta R1$		TBD	(50)	-				
	Ver.	$\phi H1$		B/L On	TBD	(20)			-	
		$\phi L1$			TBD	(30)			-	
	Hor.	$\theta L2$	$C/R \geq 2$	TBD	TBD	-	(8) LCD-7200			
		$\theta R2$		TBD	TBD	-				
	Ver.	$\phi H2$		B/L Off	TBD	TBD		-		
		$\phi L2$			TBD	TBD		-		

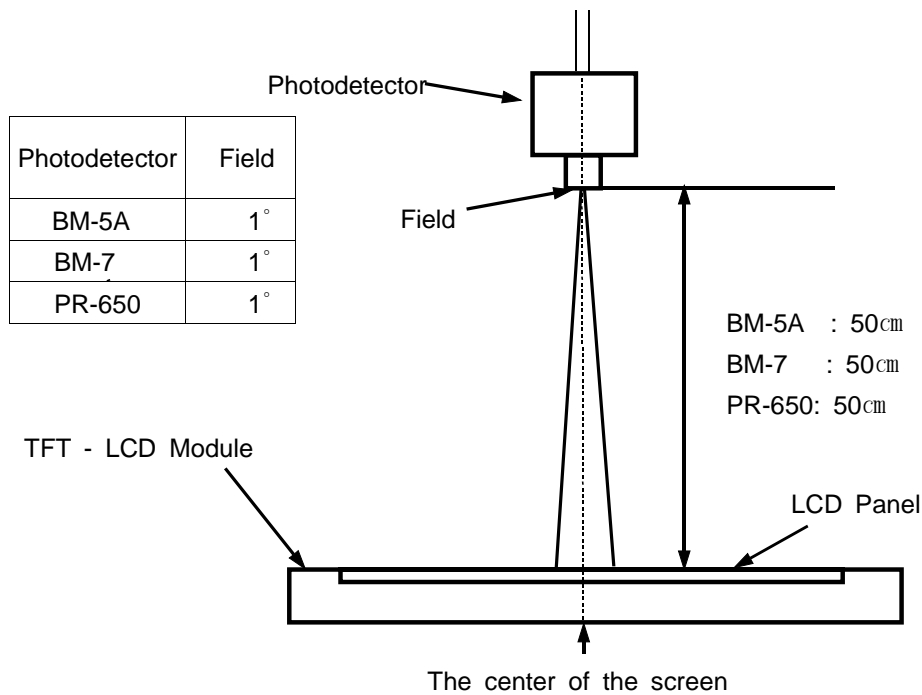
Note (1) If product is exposed to high temperatures for extended time, there is a possibility of the polarizer film damage which could degrade the optical characteristics.

Note (2) Test Equipment Setup

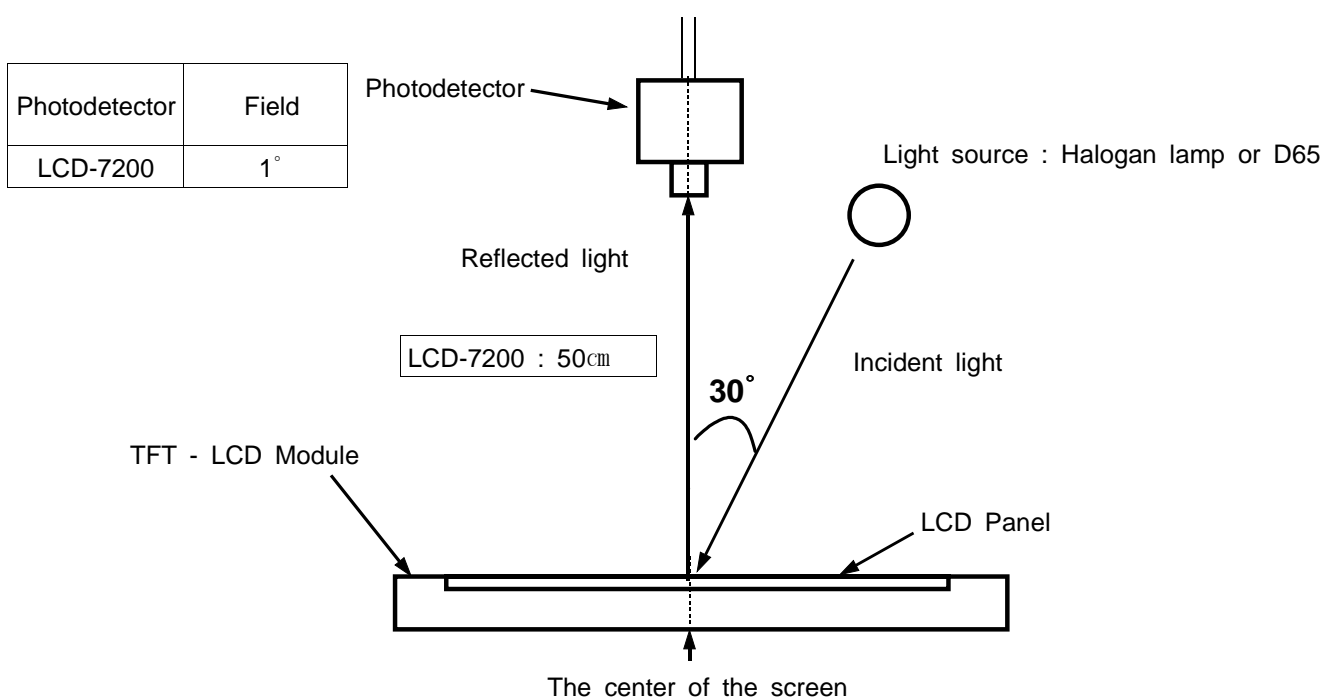
After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen.

Environment condition : $T_a = 25 \pm 2 \text{ } ^\circ\text{C}$

- Back-Light On condition



- Back-Light Off condition



Note (3) Definition of Reflectance : The reflectance is relative quantity to the standard white BaSO₄ or MgO plate that the reflectance of the standard white plate is the 100%.

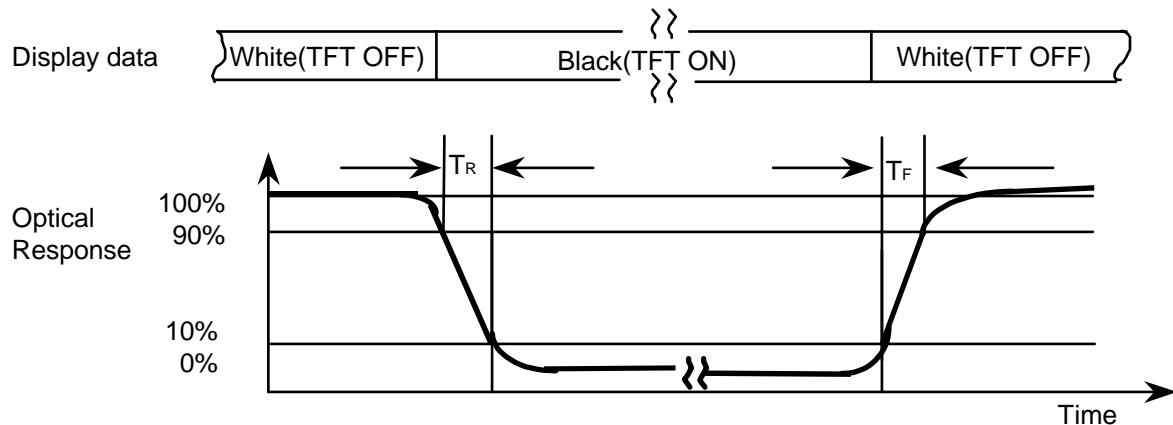
$$\text{Reflectance} = \frac{\frac{\text{Light intensity of the reflected light on LCD}}{\text{Input intensity of the reflected light on BaSO}_4 \text{ plate}}}{\frac{\text{Output intensity of the reflected light on BaSO}_4 \text{ plate}}{\text{Input intensity of the reflected light on BaSO}_4 \text{ plate}}} \times 100\%$$

Note (4) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point

$$CR = \frac{G \text{ max}}{G \text{ min}} \quad \begin{array}{l} * G_{\text{max}} : \text{Luminance with all pixels white} \\ * G_{\text{min}} : \text{Luminance with all pixels black} \end{array}$$

Note (5) Definition of Luminance of White : Luminance of white at the center point

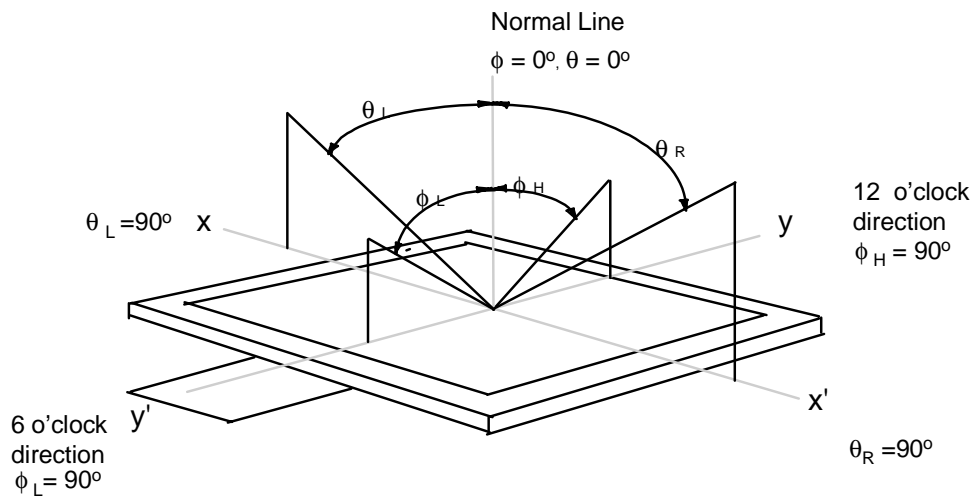
Note (6) Definition of Response time : Sum of Tr ,Tf



Note (7) Definition of Color Chromaticity (CIE 1931)

Color coordinate of white & red, green, blue at center point.

Note (8) Definition of Viewing Angle



3. Electrical Characteristics

3.1 TFT-LCD Module

(Ta = 25 ± 2°C)

Characteristics		Symbol	Min.	Typ.	Max.	Unit	Note
Logic supply voltage		V _{CC}	1.8	2.8	3.3	V	-
DC/DC supply voltage		V _{CI}	2.5	2.8	3.3	V	-
Dissipation Current	Stand-by	(I _{CC} +I _{CI}) _{STB}	-	-	(0.01)	mA	(1)
	Sleep	(I _{CC} +I _{CI}) _{SLP}	-	-	(0.04)		(2)
	Still	(I _{CC} +I _{CI}) _S	-	-	(4.5)		(3),(7)
	Full	(I _{CC} +I _{CI}) _F	-	-	(8.5)		(4),(5),(7)
Vsync frequency		f _{Vsync}	-	60	-	Hz	-
Frame rate		R _{frame}	-	-	f _{Vsync}	Frame	
Dot Clock		DOTCLK	-	3.0	-	MHz	(6)
Serial Clock		SCLK	-	-	16.7	MHz	-

* To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the Chapter 8. Power On/Off Sequence.

Note (1) V_{CC} = V_{CI} = 2.8V, Stand-by mode & No RGB I/F input signals

(2) V_{CC} = V_{CI} = 2.8V, Sleep mode & No RGB I/F input signals

(2) V_{CC} = V_{CI} = 2.8V, Internal mode & No RGB I/F input signals

(3) V_{CC} = V_{CI} = 2.8V, 18bit RGB I/F, f_{Vsync} = 60Hz, R_{frame} = 60Frame, DOTCLK = 3.0MHz

(4) Dissipation current in 6bit RGB I/F is a little bit higher than that in 18bit RGB I/F.

(5) In 6bit RGB I/F, DOTCLK = 3 x 3.0MHz = 9.0MHz

(6) Dissipation current check pattern

► Black Pattern



3.2 Back-Light unit

The back-light system is an edge-lighting type with three white LED(Light Emitting Diode)s.

(Ta=25 ± 2°C)

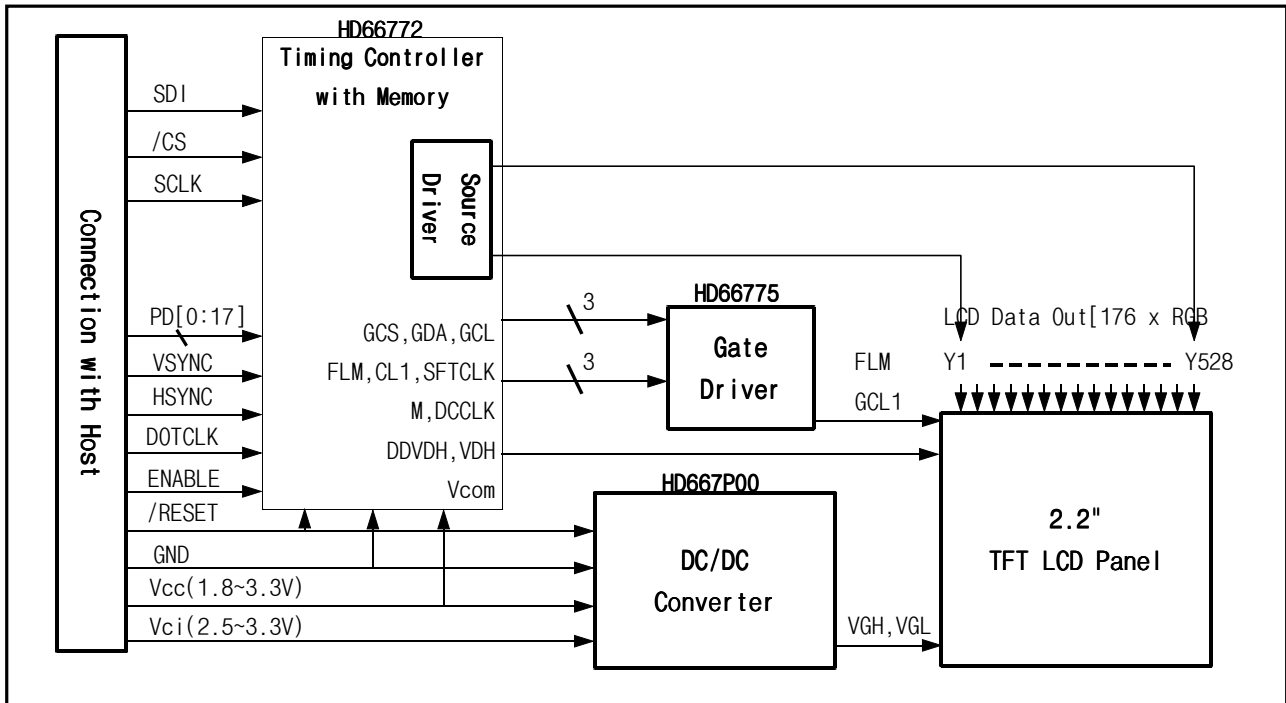
Item	Symbol	Min.	Typ.	Max.	Unit	Note
Current	I _B	-	15	-	mA	(1)
Power Consumption	P _{BL}	120	150	180	mW	(2)

Note (1) Three LEDs serial type.

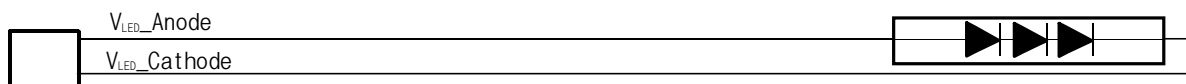
(2) Where $I_B = 15\text{mA}$, $V_B = P_{BL} / I_B$

4. Block Diagram

4.1 TFT-LCD Module (Interface System Structure)



4.2 Back-light Unit



5. Input Terminal Pin Assignment

5.1 Input Signal & Power (Connector : 32Pin FPC Hot-Bar type)

Pin No	Symbol	Description	Input/Output	Note
1	NC	No Connection	-	-
2	GND	Power Ground	-	-
3	GND	Power Ground	-	-
4	PD0	Data 0 (B0)	Input	-
5	PD1	Data 1 (B1)	Input	-
6	PD2	Data 2 (B2)	Input	-
7	PD3	Data 3 (B3)	Input	-
8	PD4	Data 4 (B4)	Input	-
9	PD5	Data 5 (B5)	Input	-
10	PD6	Data 6 (G0)	Input	-
11	PD7	Data 7 (G1)	Input	-
12	PD8	Data 8 (G2)	Input	-
13	PD9	Data 9 (G3)	Input	-
14	PD10	Data 10 (G4)	Input	-
15	PD11	Data 11 (G5)	Input	-
16	PD12	Data 12 (R0)	Input	-
17	PD13	Data 13 (R1)	Input	-
18	PD14	Data 14 (R2)	Input	-
19	PD15	Data 15 (R3)	Input	-
20	PD16	Data 16 (R4)	Input	-
21	PD17	Data 17 (R5)	Input	-
22	ENABLE	Data Enable	Input	-
23	DOTCLK	Dot Clock	Input	-
24	HSYNC	Horizontal Sync	Input	-
25	VSYNC	Vertical Sync	Input	-
26	/CS	Chip Select	Input	-
27	SCLK	Serial Clock	Input	-
28	SDI	Serial Data Input	Input	-
29	/RESET	System Reset	Input	-
30	V _{CC}	Logic Supply Voltage	-	-
31	V _{CI}	DC/DC Buffer Voltage	-	-
32	NC	No Connection	-	-

5.2 Back-Light Unit (Connector : 2Pin FPC Solder type)

Pin No.	Symbol	Fucntion
1	Anode	LED Input Terminal
2	Cathode	GND

5.3 Input Signal, Basic Display Colors and Gray Scale of Each Colors

COLOR	DISPLAY	DATA SIGNAL															GRAY SCALE LEVEL			
		RED					GREEN					BLUE								
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2		B3	B4	B5
BASIC COLOR	BLACK	0	0	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	0	1	1	1	1	1	1	-
	GREEN	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	-
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	-
	RED	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	-
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	-
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
GRAY SCALE OF RED	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0
	DARK ↑	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R60
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R61
		0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R62
	RED	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R63
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0
	DARK ↑	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	G1
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	G2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	G61
		0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	G62
	GREEN	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	G63
GRAY SCALE OF BLUE	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0
	DARK ↑	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	B1
		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	B2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B60
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	B61
		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B62
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B63

Note) Definition of Gray :

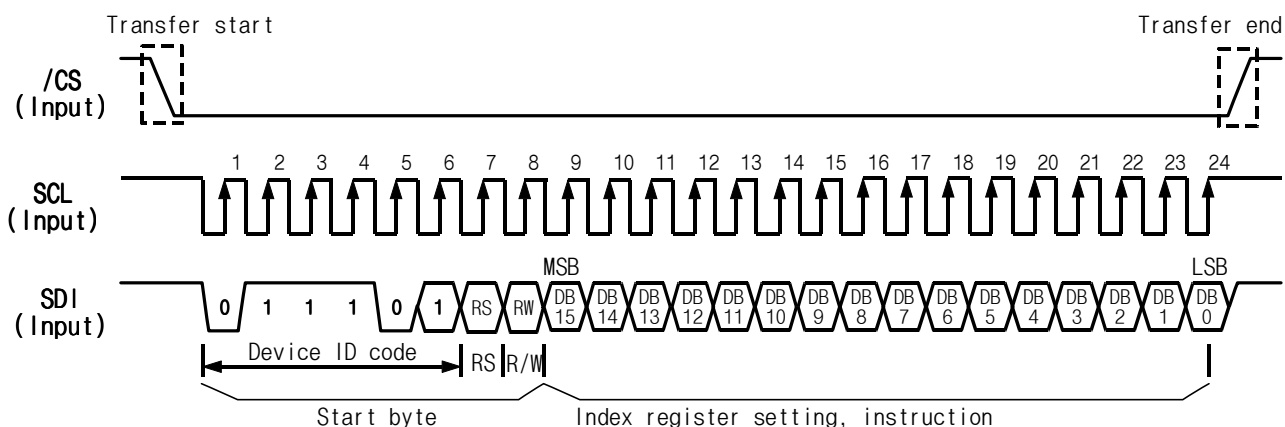
R_n : Red Gray, G_n : Green Gray, B_n : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

6. Interface Specifications

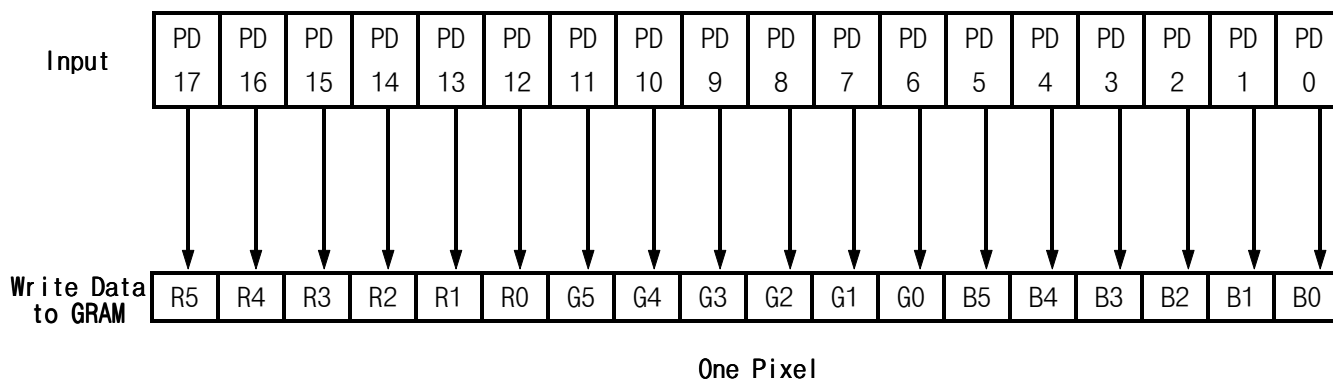
6.1 Serial Peripheral Interface

RS	R/W	Function
0	0	Sets Index Register
0	1	Read Status
1	0	Writes Instruction
1	1	Reads Instruction

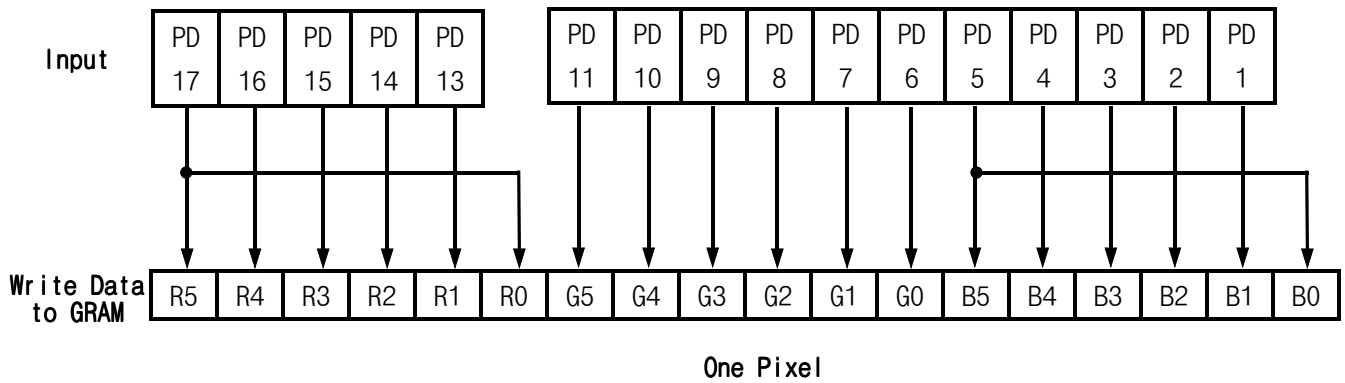


6.2 Data Format RGB Interface

1) 18bit RGB Interface

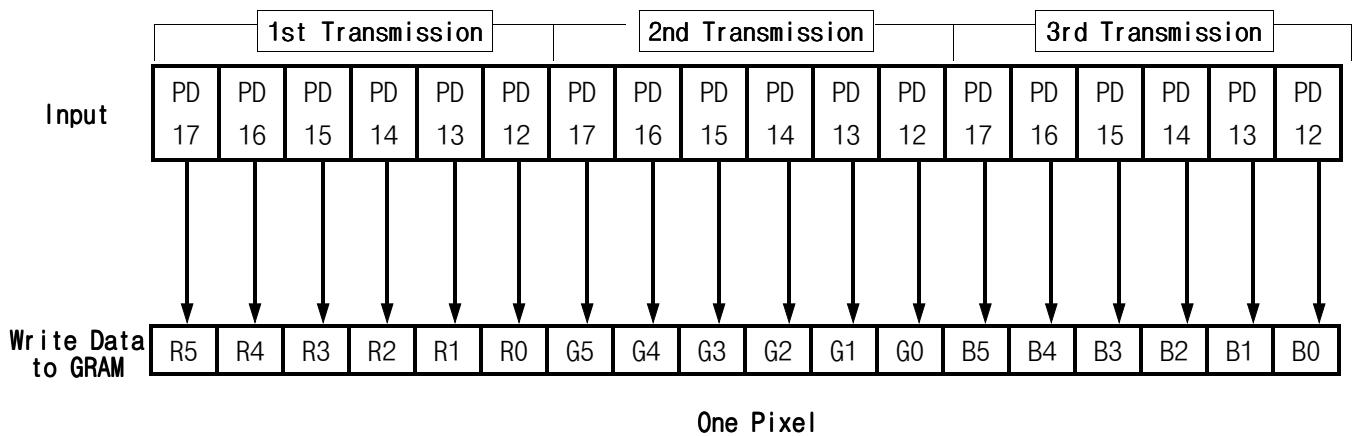


2) 16bit RGB Interface



Note(1) Connect PD12, PD0 to GND.

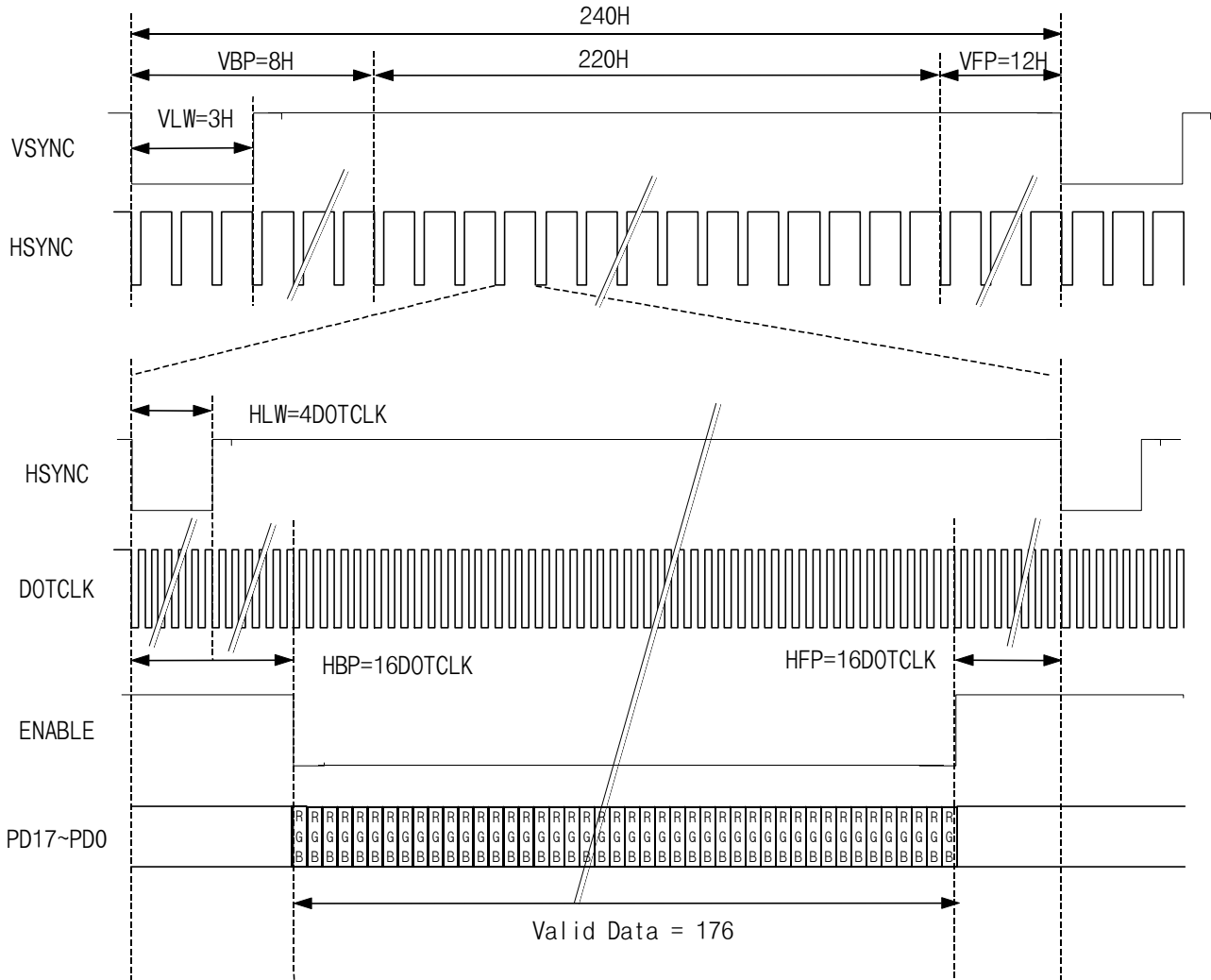
3) 6bit RGB Interface



Note(1) Connect PD11~PD0 to GND.

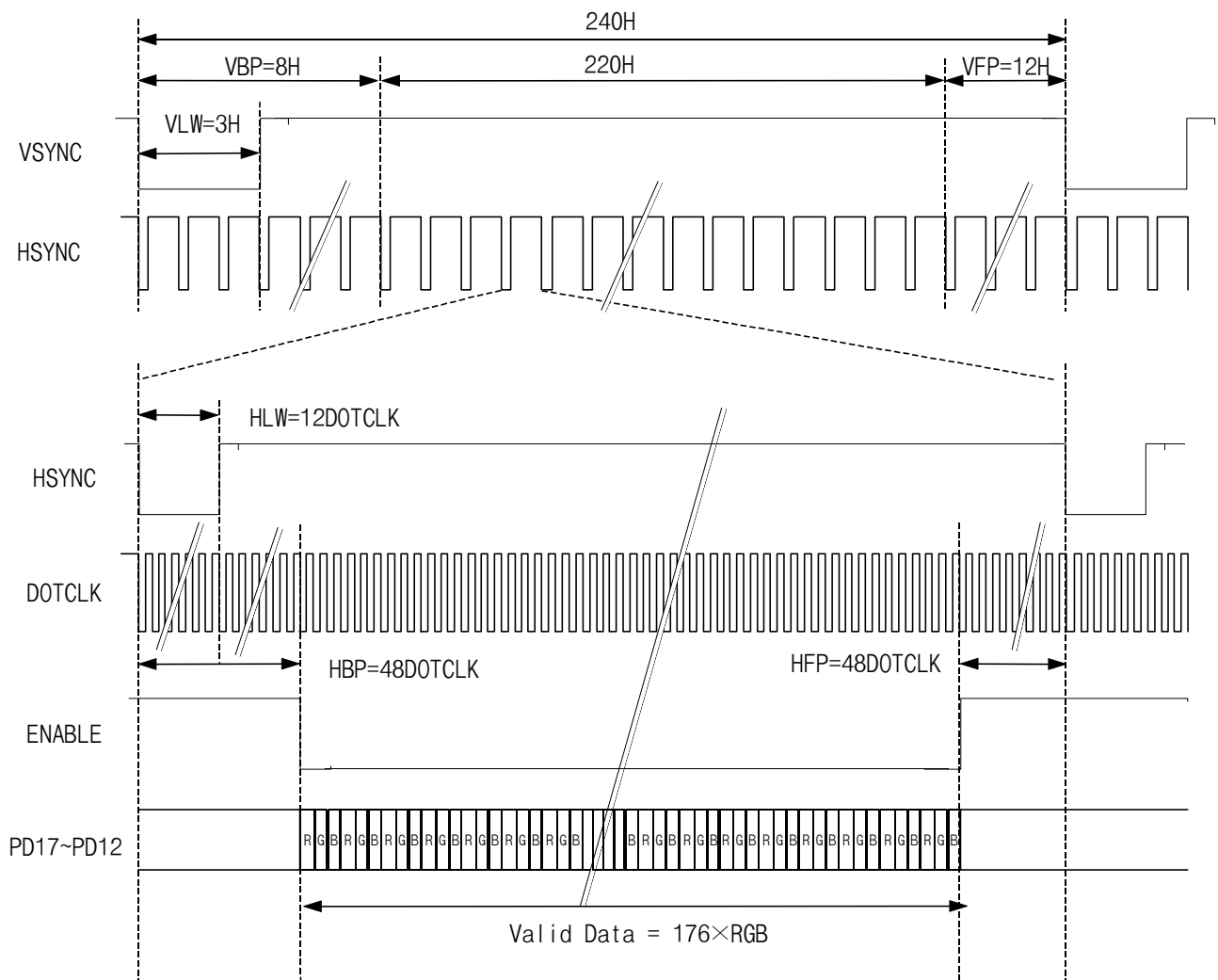
6.3 RGB Interface Timing

1) 18bit or 16bit RGB Interface



$$\begin{aligned}
 3.0\text{MHz} &= f_{\text{Frame}} \times 240 \times (176 + \text{HBP} + \text{HFP}) \\
 &= 60.096\text{Hz} \times 240 \times (176 + 16 + 16) \\
 &= 60.096\text{Hz} \times 240 \times 208
 \end{aligned}$$

2) 6bit RGB Interface



$$\begin{aligned}
 9.0\text{MHz} &= f_{\text{Frame}} \times 240 \times (176 \times 3 + \text{HBP} + \text{HFP}) \\
 &= 60.096\text{Hz} \times 240 \times (528 + 48 + 48) \\
 &= 60.096\text{Hz} \times 240 \times 624
 \end{aligned}$$

6.4 DC Characteristics

(Ta = -30 to + 70°C, V_{CC} = 1.8 to 3.3V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
High level input voltage	V _{IH}	0.8V _{CC}	-	V _{CC}	V
Low level input voltage	V _{IL}	0	-	0.2V _{CC}	

6.5 AC Characteristics

1) Serial Peripheral Interface

(Ta = -30 to + 70°C, V_{CC} = 1.8 to 2.4V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit	
Serial clock cycle time	Write (received)	tSCYC	0.1	-	20	us
	Read(transmitted)	tSCYC	0.5	-	20	us
Serial clock high-level pulse width	Write (received)	tSCH	40	-	-	ns
	Read(transmitted)	tSCH	230	-	-	ns
Serial clock low-level pulse width	Write (received)	tSCL	40	-	-	ns
	Read(transmitted)	tSCL	230	-	-	ns
Serial clock rise/fall time	tscr,scf	-	-	20	ns	
Chip select setup time	tCSU	20	-	-	ns	
Chip select hold time	tCH	60	-	-	ns	
Serial input data setup time	tSISU	30	-	-	ns	
Serial input data hold time	tSIH	30	-	-	ns	

(Ta = -30 to + 70°C, V_{CC} = 2.4 to 3.3V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit	
Serial clock cycle time	Write (received)	tSCYC	0.1	-	20	us
	Read(transmitted)	tSCYC	0.35	-	20	us
Serial clock high-level pulse width	Write (received)	tSCH	40	-	-	ns
	Read(transmitted)	tSCH	150	-	-	ns
Serial clock low-level pulse width	Write (received)	tSCL	40	-	-	ns
	Read(transmitted)	tSCL	150	-	-	ns
Serial clock rise/fall time	tscr,scf	-	-	20	ns	
Chip select setup time	tCSU	20	-	-	ns	
Chip select hold time	tCH	60	-	-	ns	
Serial input data setup time	tSISU	30	-	-	ns	
Serial input data hold time	tSIH	30	-	-	ns	

2) 18bit or 16bit RGB Interface

(Ta = -30 to + 70°C, V_{cc} = 1.8 to 2.4V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
VSYNC/HSYNC setup time	tSYNC	0	-	1	clock
ENABLE setup time	tENS	20	-	-	ns
ENABLE hold time	tENH	80	-	-	ns
DOTCLK "L" level pulse width	PW _{DL}	90	-	-	ns
DOTCLK "H" level pulse width	PW _{DH}	90	-	-	ns
DOTCLK cycle time	yCYCD	200	-	-	ns
Data setup time	tPDS	20	-	-	ns
Data hold time	tPDH	80	-	-	ns
DOTCLK,VSYNC,HSYNC, rise/fall time	trgbr,trgf	-	-	25	ns

(Ta = -30 to + 70°C, V_{cc} = 2.4 to 3.3V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
VSYNC/HSYNC setup time	tSYNC	0	-	1	clock
ENABLE setup time	tENS	10	-	-	ns
ENABLE hold time	tENH	20	-	-	ns
DOTCLK "L" level pulse width	PW _{DL}	40	-	-	ns
DOTCLK "H" level pulse width	PW _{DH}	40	-	-	ns
DOTCLK cycle time	yCYCD	100	-	-	ns
Data setup time	tPDS	10	-	-	ns
Data hold time	tPDH	40	-	-	ns
DOTCLK,VSYNC,HSYNC, rise/fall time	trgbr,trgf	-	-	25	ns

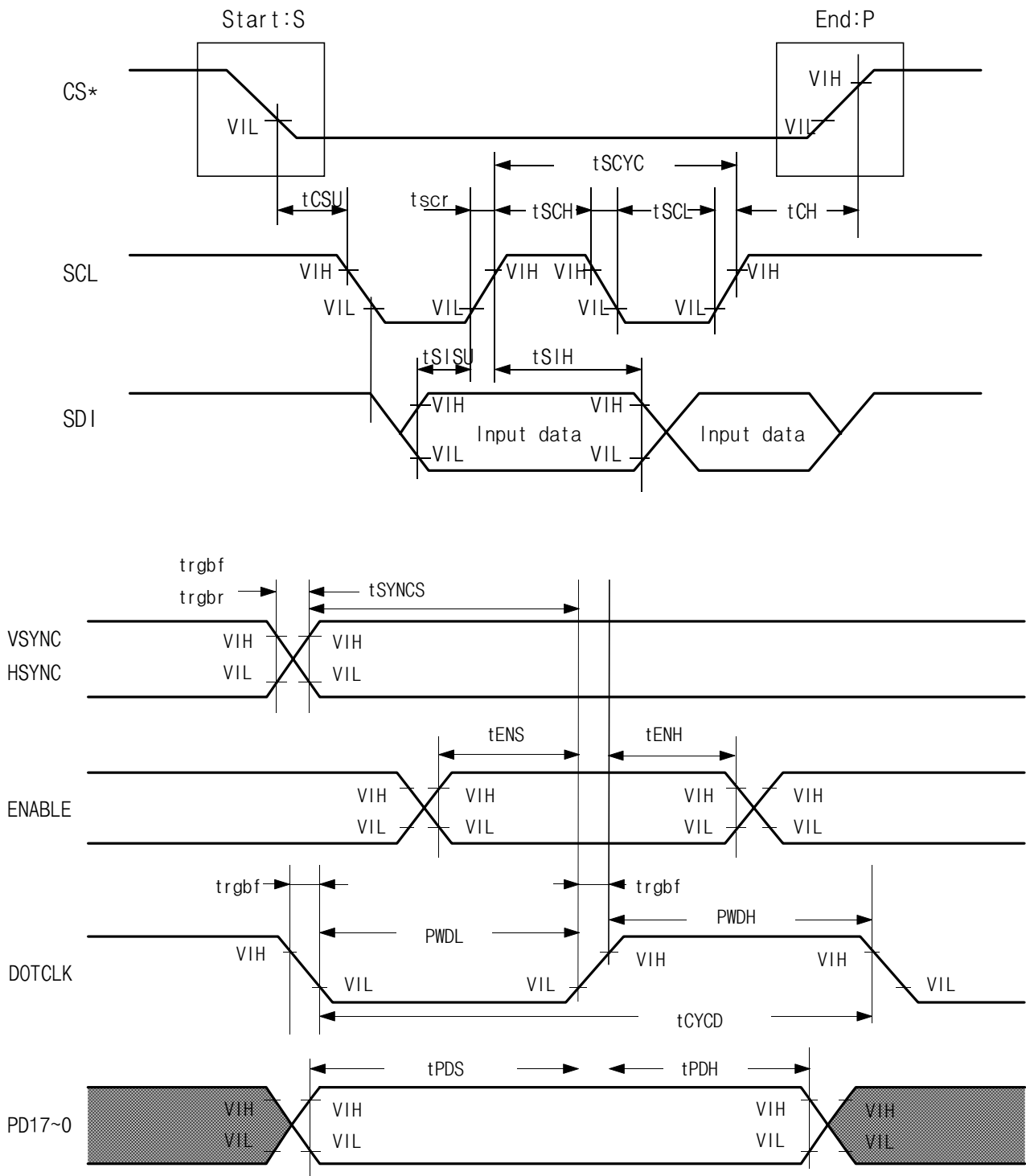
3) 6bit RGB Interface

(Ta = -30 to + 70°C, V_{CC} = 1.8 to 2.4V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
VSYNC/HSYNC setup time	tSYNC	0	-	1	clock
ENABLE setup time	tENS	20	-	-	ns
ENABLE hold time	tENH	50	-	-	ns
DOTCLK "L" level pulse width	PW _{DL}	50	-	-	ns
DOTCLK "H" level pulse width	PW _{DH}	50	-	-	ns
DOTCLK cycle time	yCYCD	120	-	-	ns
Data setup time	tPDS	20	-	-	ns
Data hold time	tPDH	65	-	-	ns
DOTCLK,VSYNC,HSYNC, rise/fall time	trgbr,trgf	-	-	25	ns

(Ta = -30 to + 70°C, V_{CC} = 2.4 to 3.3V, GND = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
VSYNC/HSYNC setup time	tSYNC	0	-	1	clock
ENABLE setup time	tENS	10	-	-	ns
ENABLE hold time	tENH	20	-	-	ns
DOTCLK "L" level pulse width	PW _{DL}	30	-	-	ns
DOTCLK "H" level pulse width	PW _{DH}	30	-	-	ns
DOTCLK cycle time	yCYCD	70	-	-	ns
Data setup time	tPDS	10	-	-	ns
Data hold time	V _{CC} = 2.4 to 2.7V	tPDH	40	-	ns
	V _{CC} = 2.7 to 3.3V	tPDH	30	-	ns
DOTCLK,VSYNC,HSYNC, rise/fall time	trgbr,trgf	-	-	25	ns



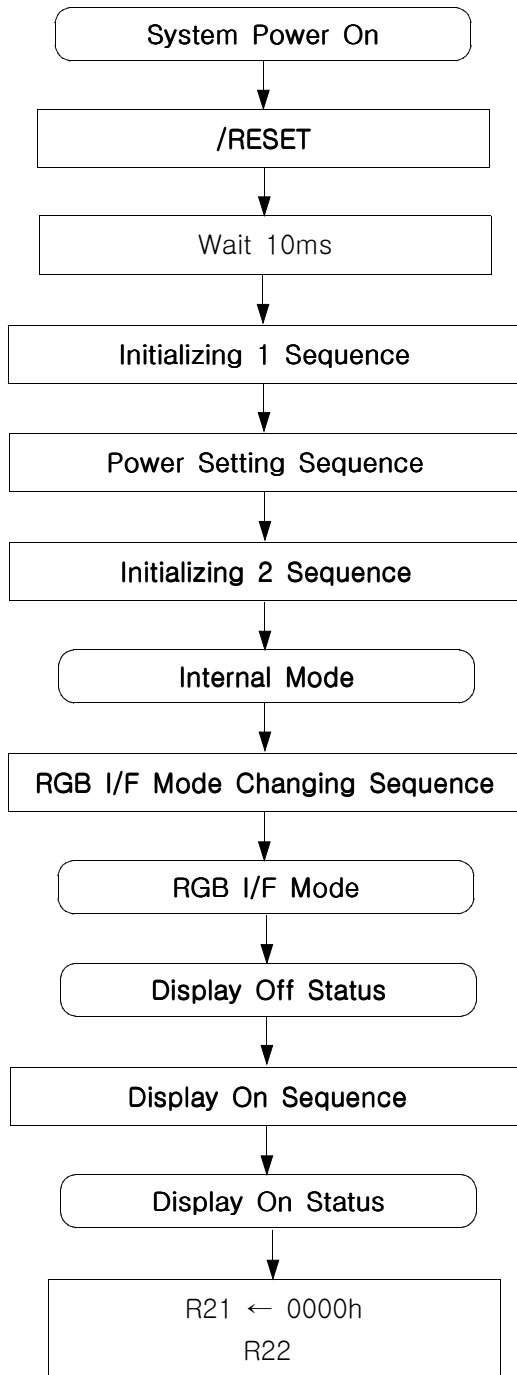
7. Reset

If the /RESET input becomes L or the reset command is input, the each register to its default value. These default values are listed in the table below.

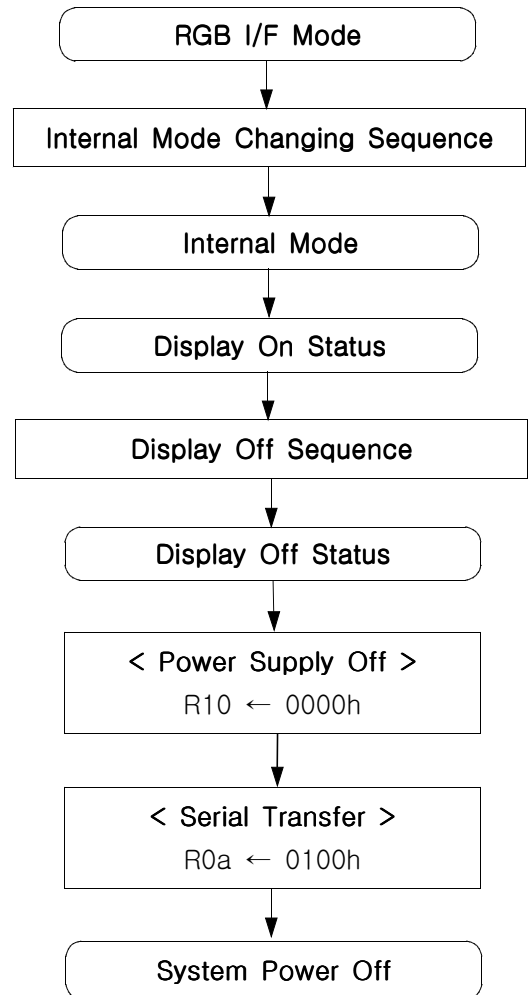
Register		Default	Note
Start Oscillation	R00	0000H	-
Driver output control	R01	001DH	-
LCD-driving-waveform	R02	0400H	-
Entry Mode	R03	0030H	-
Compare register 1	R04	0000H	-
Compare register 2	R05	0000H	-
Display control 1	R07	0000H	-
Display control 2	R08	0808H	-
Gate driver interface control	R0A	0000H	-
Frame cycle control	R0B	0000H	-
External display interface control	R0C	0000H	-
LTPS interface control	R0D	0700H	-
Power control 1	R10	0000H	-
Power control 2	R11	0000H	-
Power control 3	R12	0000H	-
Power control 4	R13	0000H	-
Power control 5	R14	0000H	-
RAM address set	R21	0000H	-
RAM data write/read	R22	0000H	-
RAM data write mask 1	R23	0000H	-
RAM data write mask 2	R24	0000H	-
γ Control 1	R30	0000H	-
γ Control 2	R31	0000H	-
γ Control 3	R32	0000H	-
γ Control 4	R33	0000H	-
γ Control 5	R34	0000H	-
γ Control 6	R35	0000H	-
γ Control 7	R36	0000H	-
γ Control 8	R37	0000H	-
γ Control 9	R3F	0000H	-
Gate scan start position	R40	0000H	-
Vertical scroll control	R41	0000H	-
1st screen driving position	R42	FF00H	-
2nd screen driving position	R43	FF00H	-
Horizontal RAM address position	R44	AF00H	-
Vertical RAM address position	R45	EF00H	-

8. Power On/Off Sequence

< Power On Sequence >



< Power Off Sequence >



9. Initializing & Power Setting Sequence

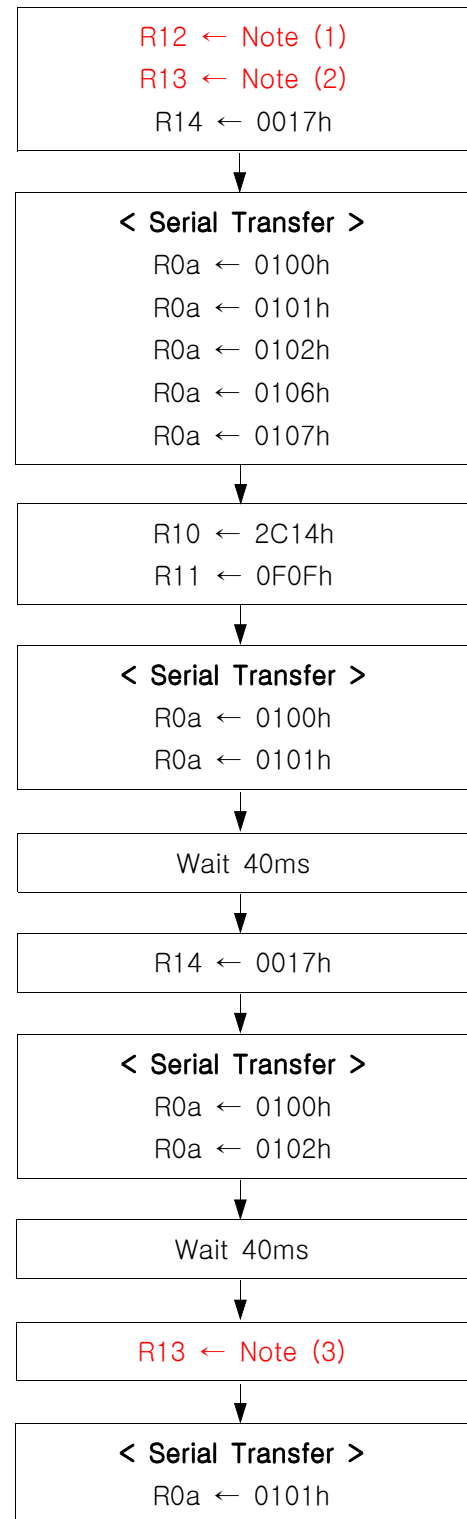
< Initializing 1 Sequence >

R01	←	011Bh
R02	←	0700h
R03	←	1230h
R04	←	0000h
R05	←	0000h
R07	←	0004h
R08	←	0808h
R0b	←	CC07h
R0c	←	0000h
R0d	←	0734h
R40	←	0000h

< Initializing 2 Sequence >

R30	←	0000h
R31	←	0000h
R32	←	0000h
R33	←	0000h
R34	←	0707h
R35	←	0707h
R36	←	0707h
R37	←	0000h
R3f	←	0000h
R41	←	0000h
R42	←	DB00h
R43	←	EFEDh
R44	←	AF00h
R45	←	DB00h

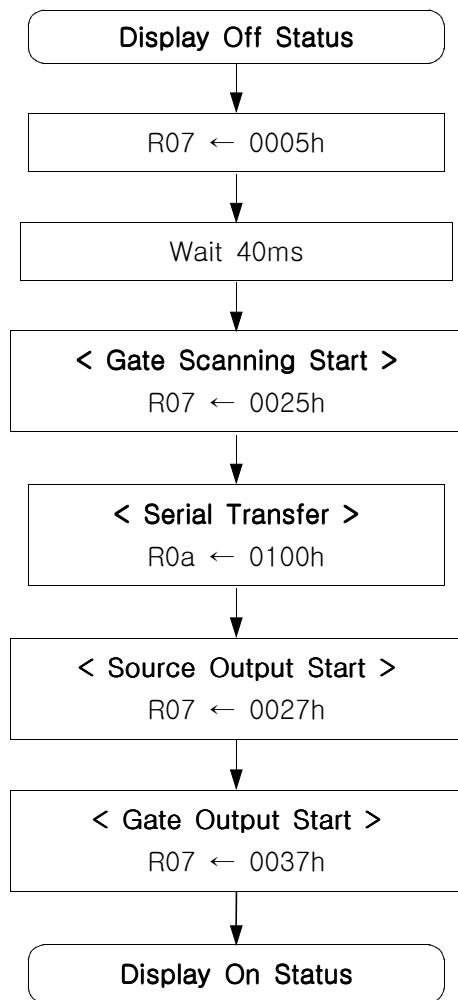
< Power Setting Sequence >



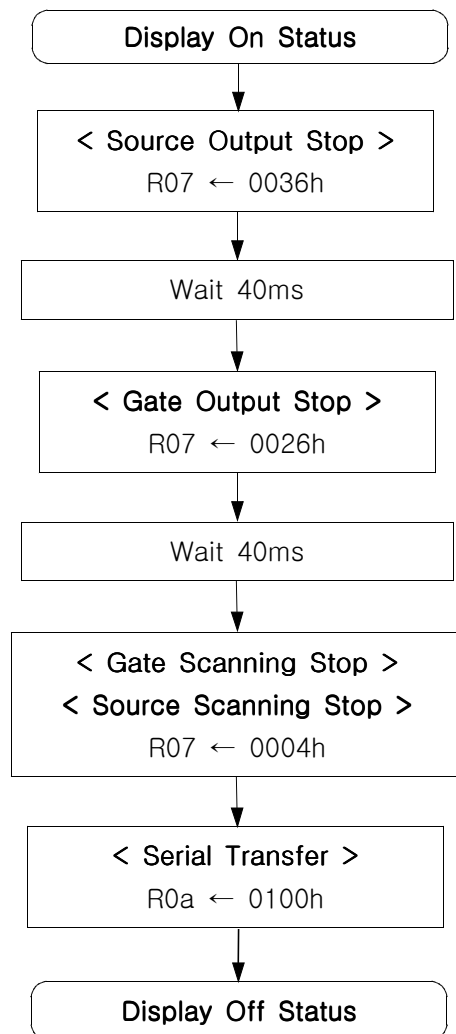
	Vci = 2.8V	Vci = 3.0V	Vci = 3.3V
Note (1)	R12 ← 0000h	R12 ← 0000h	R12 ← 0001h
Note (2)	R13 ← 0002h	R13 ← 0001h	R13 ← 0001h
Note (3)	R13 ← 0012h	R13 ← 0011h	R13 ← 0011h

10. Display On/Off Sequence

< Display On Sequence >

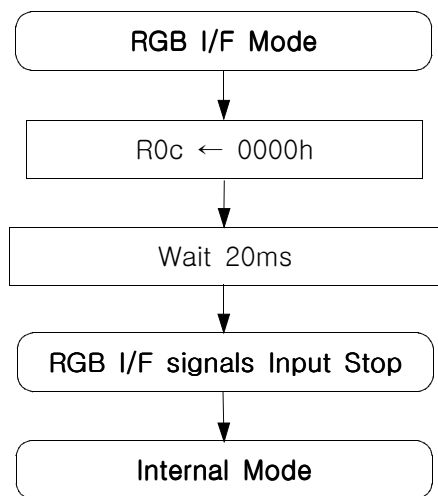


< Display Off Sequence >

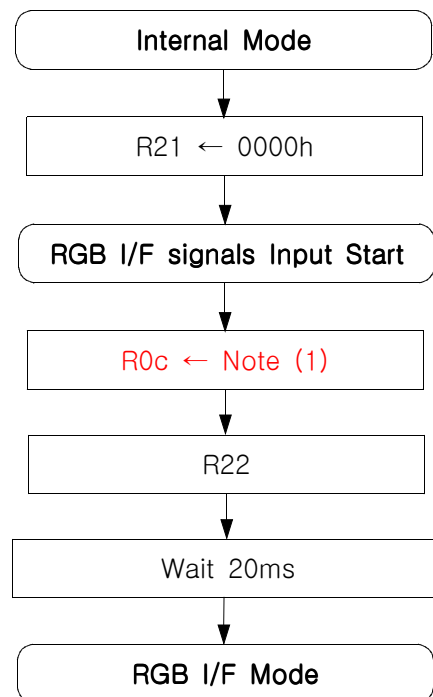


11. RGB I/F / Internal Mode Changing Sequence

< Internal Mode Changing Sequence >



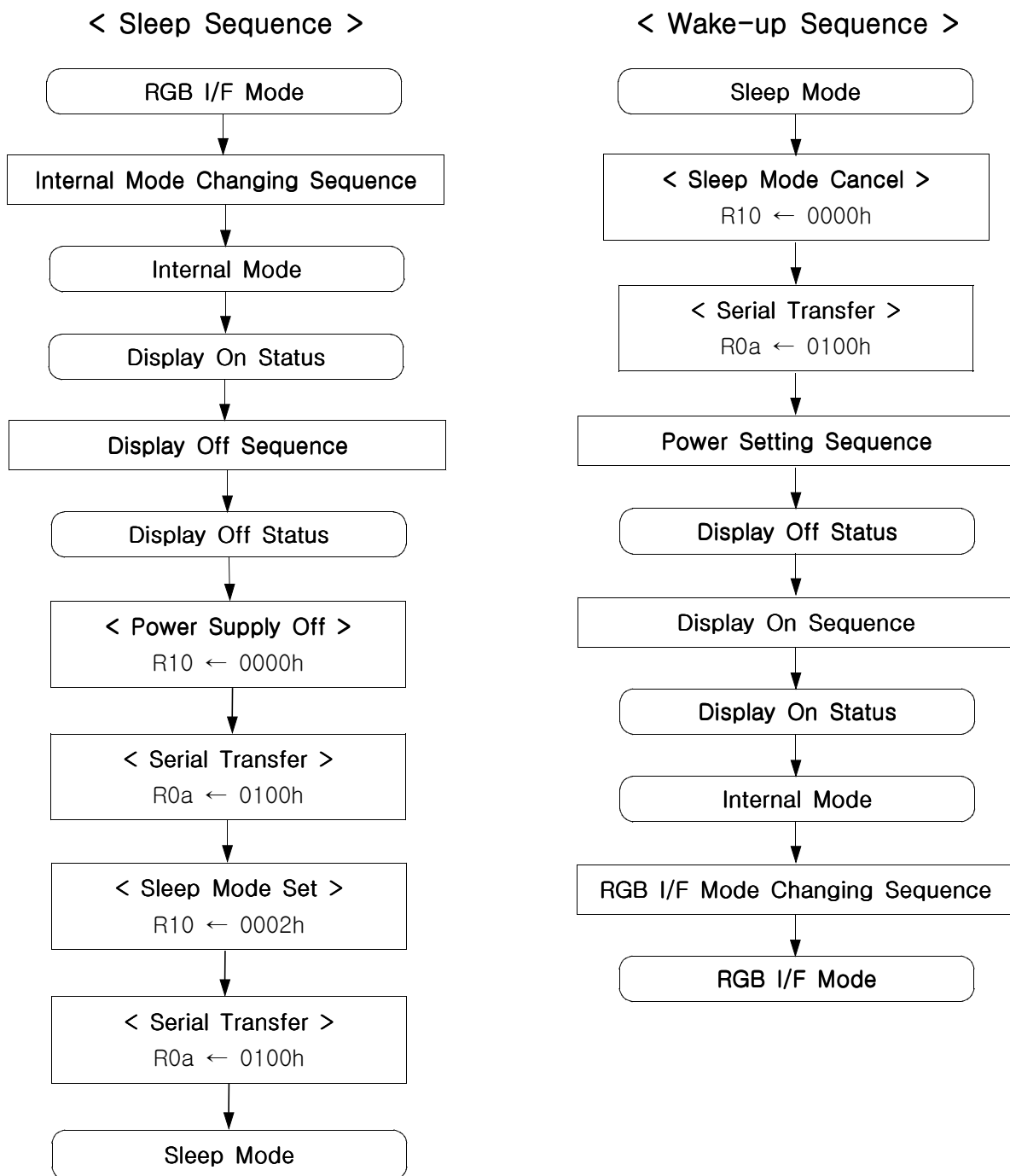
< RGB I/F Mode Changing Sequence >



	18bit RGB	16bit RGB	6bit RGB
Note (1)	R0c ← 0110h	R0c ← 0111h	R0c ← 0112h

Note (2) In the internal mode, the system must stop sending RGB I/F signals.

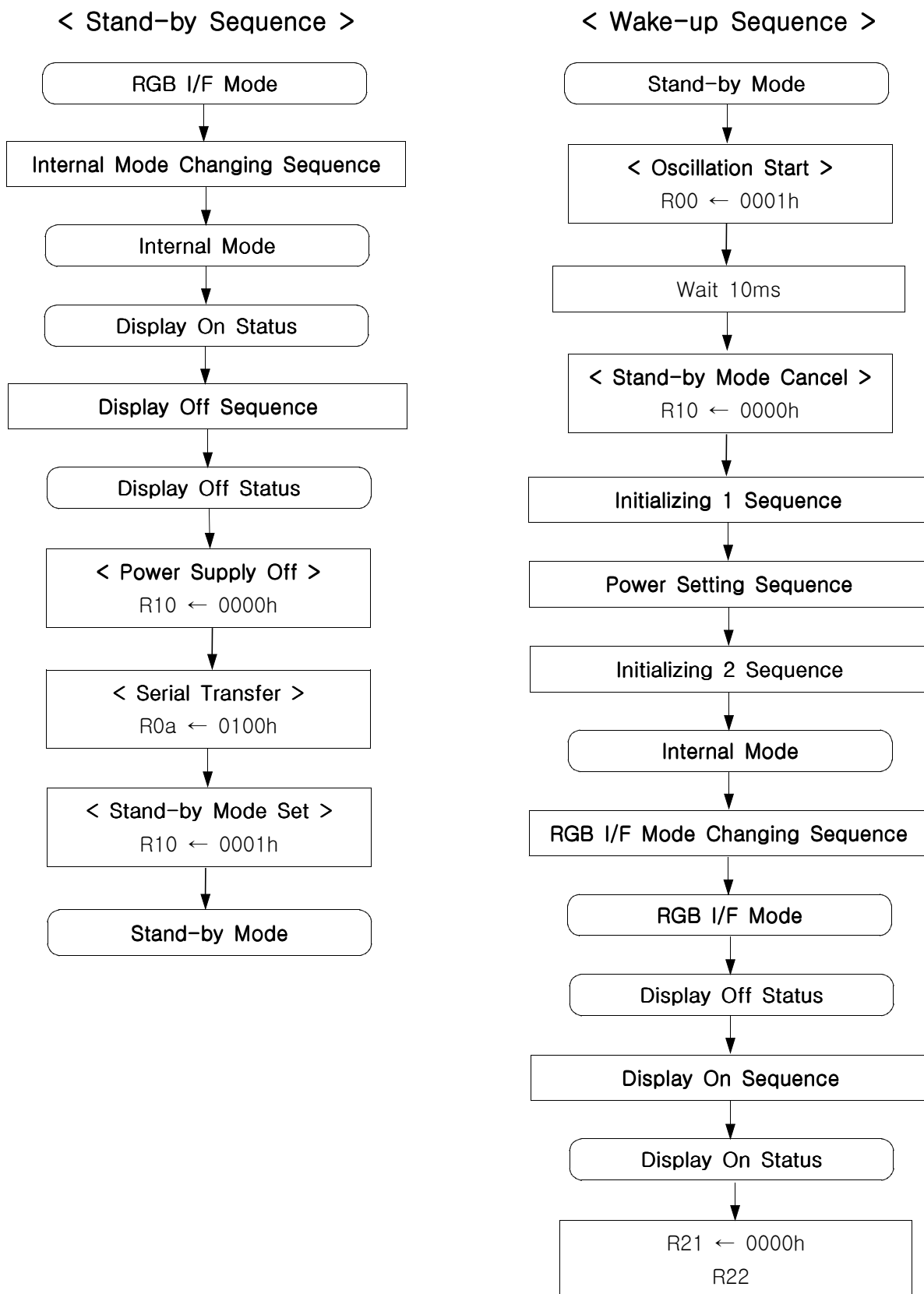
12. Sleep / Wake-up Sequence



Note (1) During sleep mode, GRAM data and instructions are retained.

Note (2) In the sleep mode, the system must stop sending RGB I/F signals.

13. Stand-by / Wake-up Sequence



Note (1) You can use Power On Sequence for Wake-up from Stand-by Mode.

Note (2) In the stand-by mode, the system must stop sending RGB I/F signals.

14. Frame Rate Control in RGB I/F Mode

14.1 Power Saving Method in RGB I/F Mode with frame rate control.

- 1) If the pixel data for display is not changed, you don't need to send the same data to the panel, because LTS220Q1-HEX has the internal frame memory.
- 2) The more you send the frame data, the more panel dissipates power.

14.2 Operating Method

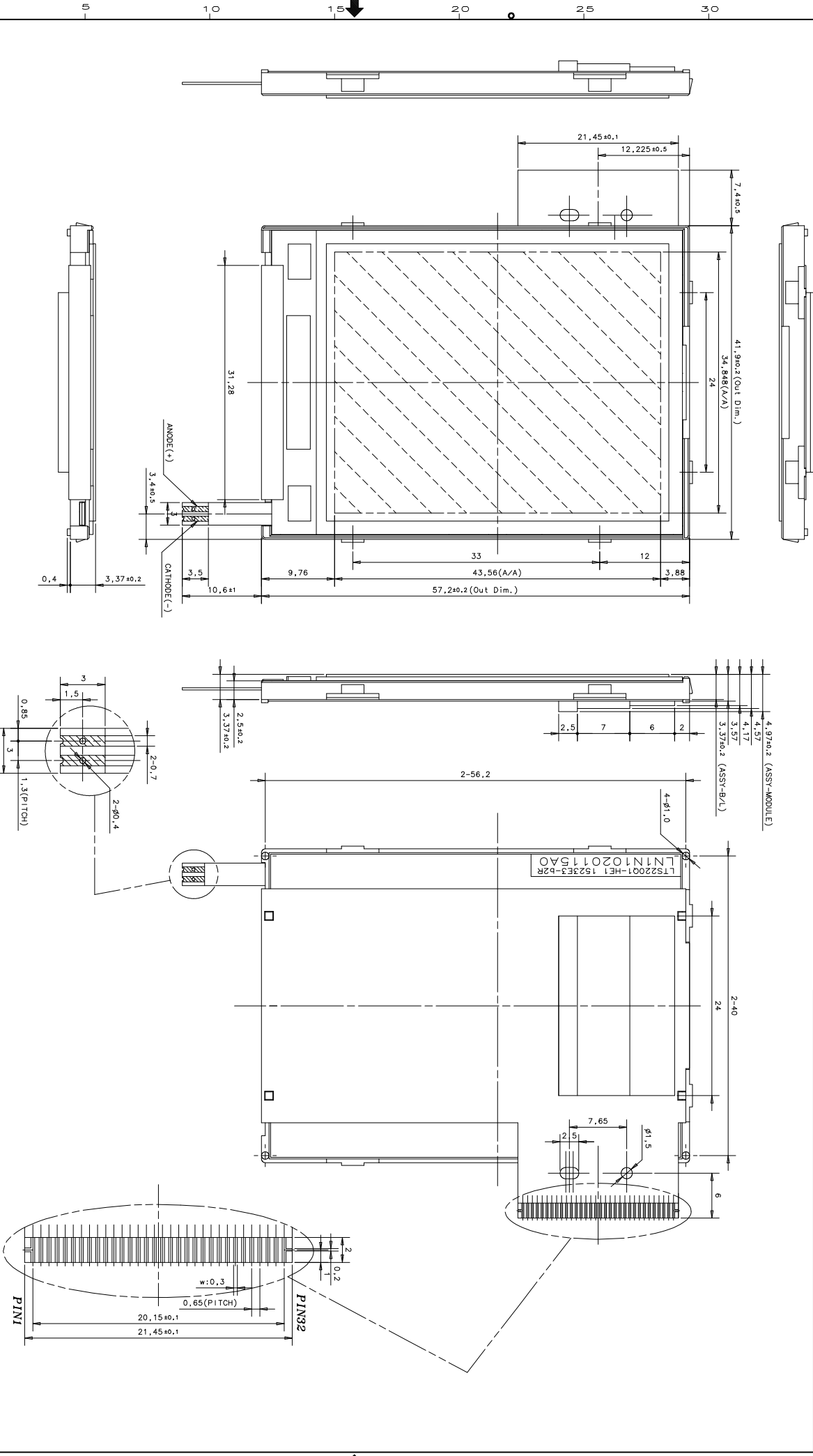
- 1) Set Vsync(60Hz), Hsync, DOTCLK, ENABLE signals timing according to the timing chart.
- 2) Don't change Vsync, Hsync, DOTCLK signals timing which was set in 1).
The internal refresh rate depends on the Vsync, Hsync, DOTCLK signals.
- 3) You can control the frame rate with ENABLE signal.
If ENABLE signal is in the active status, the internal RAM data is updated to the RGB input data level.
If ENABLE signal is in the inactive status, the internal RAM data is not updated.
- 4) If you set the ENABLE signal to the active status for 60frame, the power consumption is maximized.
- 5) If you set the ENABLE signal to the active status for just 15frame - MPEG4 standard frame rate, the power consumption is lower than case 4).
- 6) If you set the ENABLE signal to the inactive status, it is RGB I/F still mode and power consumption is minimized.
- 7) Please fix the RGB data level to low during the ENABLE signal is in the inactive status, if it is possible in your system.

15. Outline Dimension

Page 35 : LTS220Q1-HE1

Page 36 : LTS220Q1-HE2

FILE NO.	
NO	PART NAME
1	OUTLINE DIMENSION
	CODE NO
	LTSS220Q1-HB1
	SPECIFICATION
	QTY
	FINISH
	WEIGHT
	INTERNAL
	OF MATERIAL
	INTEGRATED DIM.
	REMARK



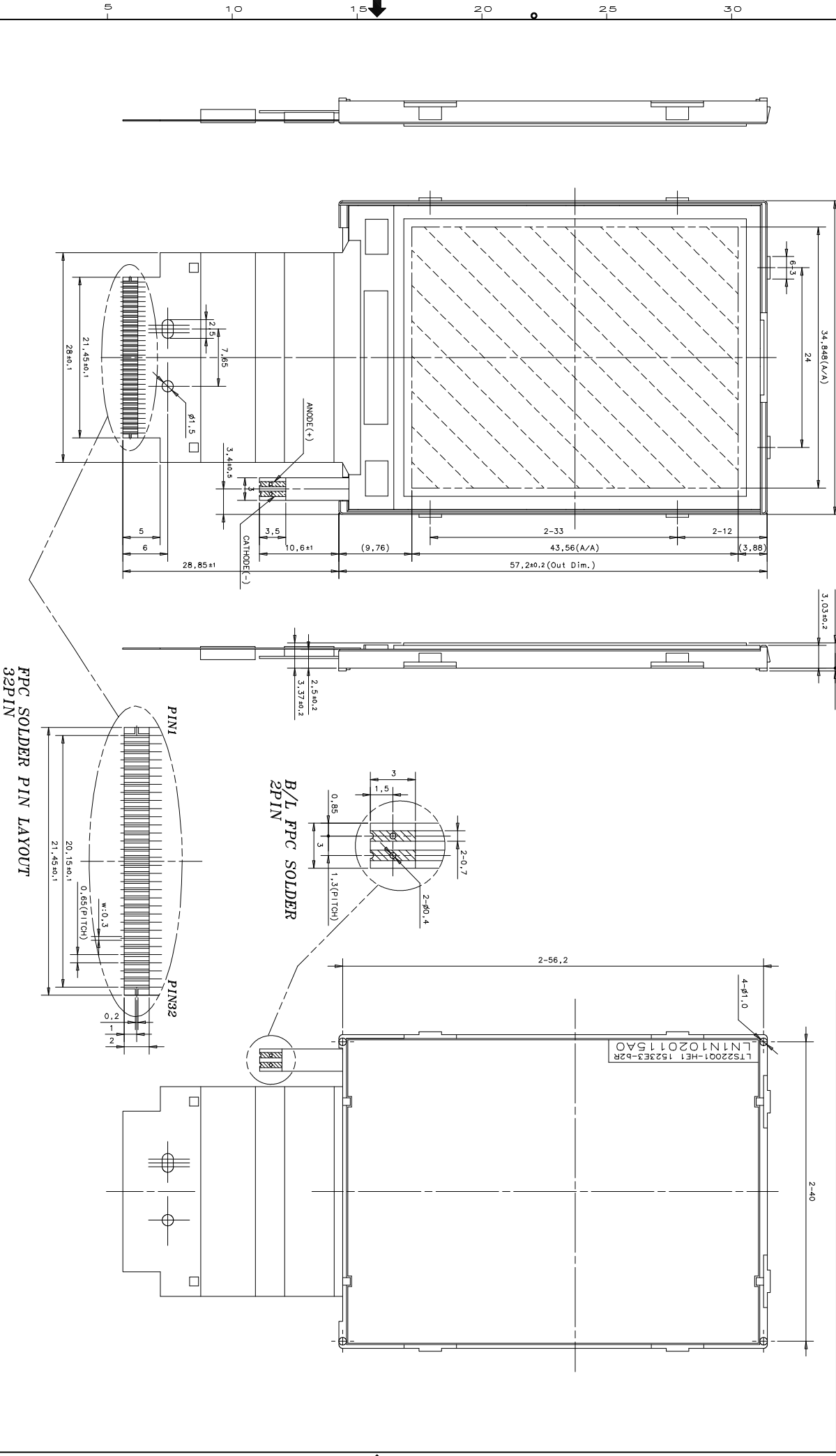
B/L FPC SOLDER 2PIN

FPC SOLDER PIN LAYOUT 32PIN

GENERAL TOLERANCE				REV		DATE		DESCRIPTION OF REVISION		REASON		CHK'D BY	
STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	SCALE	SCALE	SCALE	SCALE	SCALE	SCALE	SCALE	SCALE	SCALE
0 < X ≤ 4	±0.05	±0.1	±0.2	mm	3/1	S. M. KIM	I. S. LEE	LTSS220Q1-HB1	MODEL NAME	LTSS220Q1-HB1	OUTLINE DIMENSION SHEET 1 / 1	VER. 00	
4 < X ≤ 16	±0.08	±0.15	±0.3		LEVEL 2	.01	10.25		PART/SHEET				
16 < X ≤ 64	±0.12	±0.25	±0.5						NAME				
64 < X ≤ 256	±0.25	±0.4	±0.8						CODE NO.				

SAMSUNG ELECTRONICS

FILE NO.																				
NO	PART NAME	CODE NO	SPECIFICATION	QTY	WEIGHT	INTROD DTM	REMARK													
1	OUTLINE DIMENSION	-	LTSS220Q1-HB2	1	-	-	-													

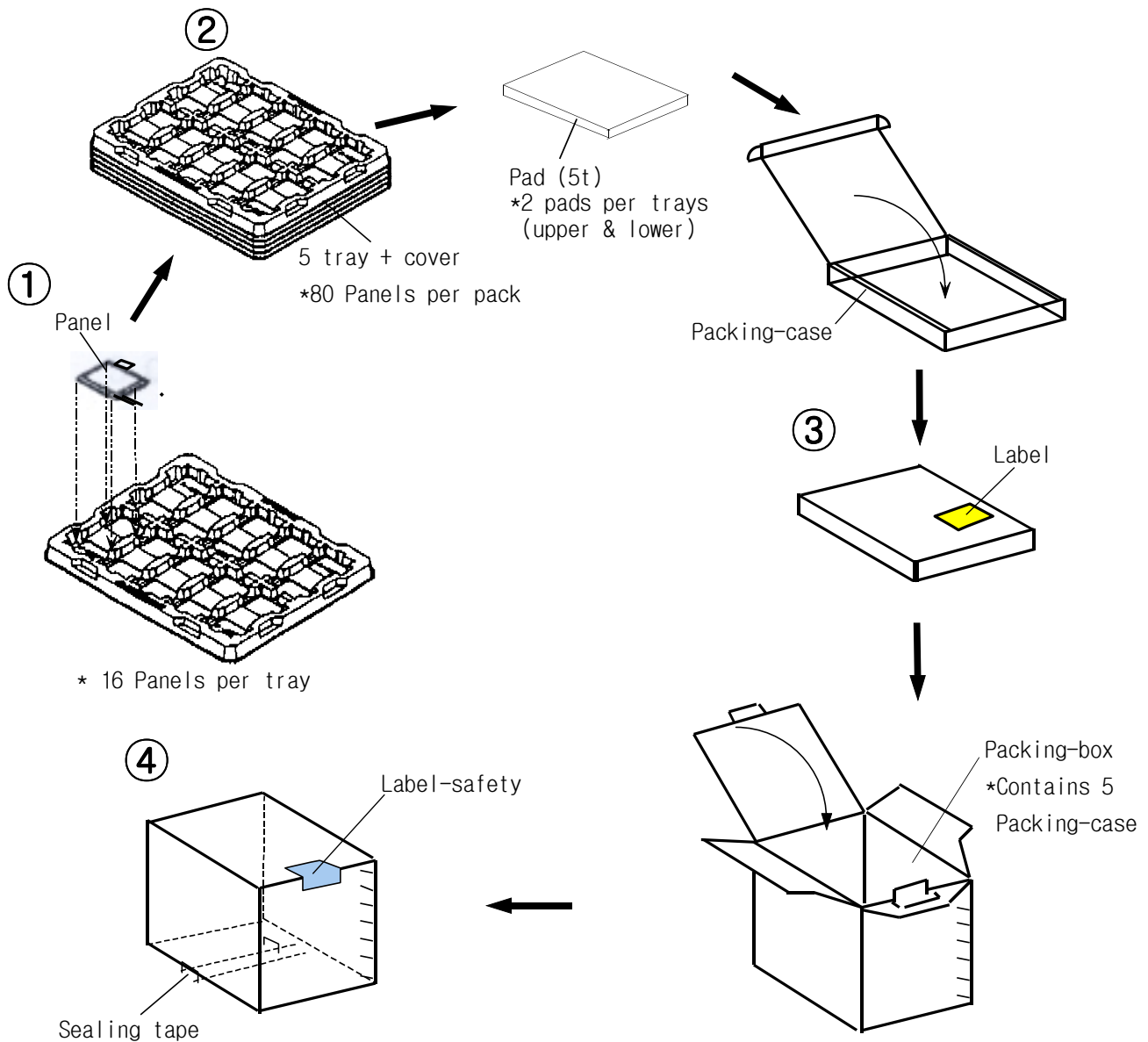


FPC SOLDER PIN LAYOUT
32PIN

GENERAL TOLERANCE				REV		DATE		DESCRIPTION OF REVISION				REASON		CHK'D BY	
STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	SCALE	SCALE	SCALE	DESIGN BY	DESIGN BY	CHK'D BY	APP'D BY	MODEL NAME	PART/SHEET	OUTLINE DIMENSION SHEET / 1	VER.
0 < X ≤ 4	±0.05	±0.1	±0.2	mm	3/1	3/1	3/1	S.M.KIM	S.M.KIM	I.S.LEB	I.S.LEB	LTSS220Q1-HB2	1/1	1/1	00
4 < X ≤ 16	±0.08	±0.15	±0.3												
16 < X ≤ 64	±0.12	±0.25	±0.5												
64 < X ≤ 256	±0.25	±0.4	±0.8												

REVISION

16. Packing



Note (1) Total : Case: Approx. **TBD** Kg

Box: Approx. **TBD** Kg

(2) Size : Case: 490(W) x 342(D) x 58(H)

Box: 505(W) x 355(D) x 312(H)

(3) Place the panels in the tray facing the direction shown in the figure.

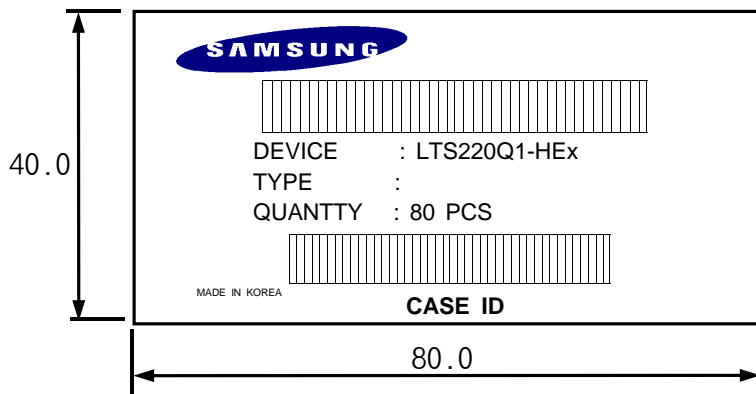
(4) Place 5 tray and cover(empty tray) and pads inside the packing-case.

(5) Place 5 packing-case inside the packing-box.(Affix the label)

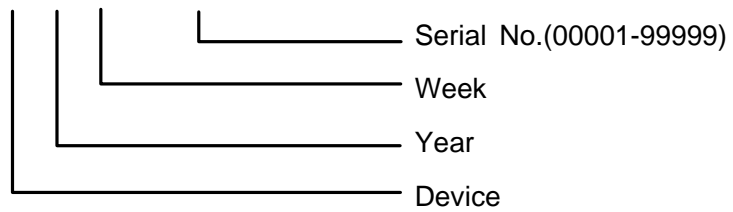
(6) Seal the packing-box. Affix the label-safety.

17. Marking & Others

(1) Packing case attach



CASE ID : V 00 00 00001



18. General Precautions

18.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly. Be careful not to twist and bend the module.
- (b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and back-light unit.
- (c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a B pencil lead.
- (d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.
- (e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (f) The desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane. Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (h) Protect the module from static , it may cause damage to the CMOS Gate Array IC.
- (i) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (j) Do not disassemble the module.
- (k) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (l) Pins of I/F connector shall not be touched directly with bare hands.

18.2 Storage

- (a) Do not leave the panel in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35°C and relative humidity of less than 70%.
- (b) Do not store the TFT-LCD module in direct sunlight.
- (c) The module shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

18.3 Operation

- (a) Do not connect, disconnect the module in the "Power On" condition.
- (b) Power supply should always be turned on/off by the chapter 8 "Power On/Off sequence"

18.4 Others

- (a) The Liquid crystal is deteriorated by ultraviolet, do not leave it in direct sunlight and strong ultraviolet ray for many hours.
- (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (c) Do not exceed the absolute maximum rating value. (the supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)
Otherwise the panel may be damaged.
- (d) If the panel displays the same pattern continuously for a long period of time, it can be the situation when the image "Sticks" to the screen.
- (e) This panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.