Laurel Electronics Co., Ltd.

SPECIFICATION FOR TFT LCD MODULE

MODEL NO.: LT035A-02A

3.5”, 320(RGB) x 240 PIXELS TFT LCD MODULE

REVISION	PREPARED	CHECKED	APPROVED
0.2	Y.D.Y.	L.Y.J.	L.Y.

RECORD OF REVISION

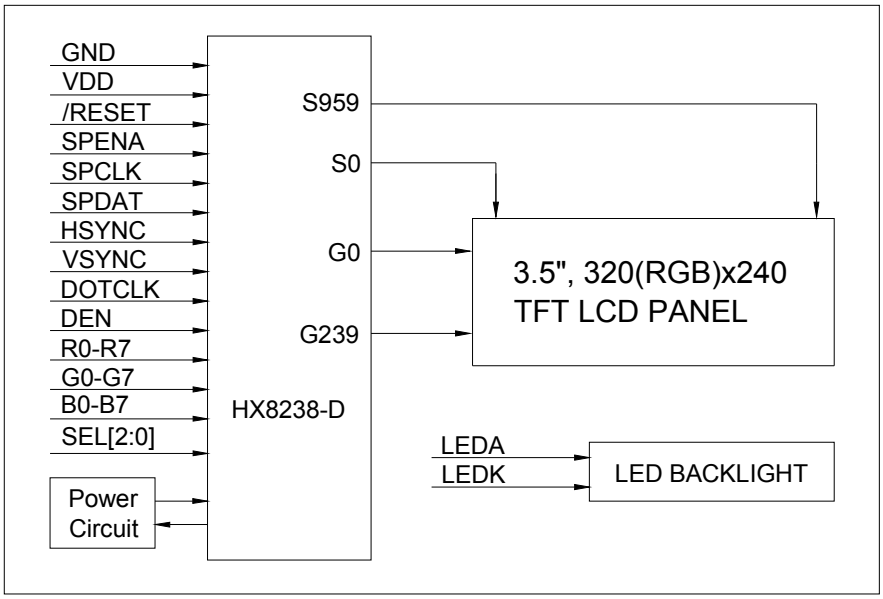
Date	Revision	Page	Revision Items
2010-05-20	0.1	-	New release
2016-02-16	0.2	All pages	Update 3. Interface Specifications; 5. Electrical Characteristics; 7. Outline Dimension

CONTENTS

1. General Description

Item	Specifications	Unit
LCD Type	TFT, Transmissive, Normally White	-
Number of Dots	320x3(RGB)×240	dot
Display Color	16.7M	-
Color Configuration	RGB-Stripe	-
Screen Size	3.5(Diagonal)	inch
Active Area (W×H)	70.08×52.56	mm
Dot Pitch (W×H)	0.073×0.219	mm
Outline Dimensions (W×H×T)	76.9×63.9×3.3	mm
Viewing Direction	6:00	O'clock
Controller	HX8238-D	-
VDD	3.3	V
Interface Mode	Parallel 24-bit RGB/Serial 8-BIT RGB/ CCIR656/CCIR601	-
Backlight	White LED	-
Touch Panel	None	-
Operating Temperature	-20 to +70	°C
Storage Temperature	-30 to +80	°C
Weight	32	g

2. Block Diagram



3. Interface Specification

PIN NO.	SYMBOL	DESCRIPTION
1	LEDK	Backlight cathode
2	LEDK	Backlight cathode
3	LEDA	Backlight anode
4	LEDA	Backlight anode
5 - 7	NC	No connection
8	/RESET	Reset signal, active low. The minimum pulse width for completing reset sequence is 10us. The TFT controller is built with power on reset circuitry. Connect /RESET terminal to VDD when not used.
9	SPENA	SPI chip selection. Connect to VDD when not used.
10	SPCLK	SPI serial clock input. Connect to VDD when not used.
11	SPDAT	SPI serial data input. Connect to VDD when not used.
12	B0(D0)	Blue data (LSB)
13	B1(D1)	Blue data
14	B2(D2)	Blue data
15	B3(D3)	Blue data
16	B4(D4)	Blue data
17	B5(D5)	Blue data
18	B6(D6)	Blue data
19	B7(D7)	Blue data (MSB)
20	G0(D8)	Green data (LSB)
21	G1(D9)	Green data
22	G2(D10)	Green data
23	G3(D11)	Green data
24	G4(D12)	Green data
25	G5(D13)	Green data
26	G6(D14)	Green data
27	G7(D15)	Green data (MSB)
28	R0(D16)	Red data (LSB)
29	R1(D17)	Red data
30	R2(D18)	Red data
31	R3(D19)	Red data
32	R4(D20)	Red data
33	R5(D21)	Red data
34	R6(D22)	Red data
35	R7(D23)	Red data (MSB)
36	HSYNC	Horizontal synchronous signal
37	VSYNC	Vertical synchronous signal
38	DOTCLK	Dot data clock
39 - 40	NC	No connection

PIN NO.	SYMBOL	DESCRIPTION
41	VDD	Power supply
42	VDD	Power supply
43 - 47	NC	No connection
48	SEL2	Input data format selection
49	SEL1	Input data format selection
50	SEL0	Input data format selection
51	NC	No connection
52	DEN	Data enable signal
53	GND	Ground
54	GND	Ground

Note:

1. For digital RGB input data format, both SYNC mode and DEN mode are supported. If DEN signal is fixed low, SYNC mode is used. Otherwise, DEN mode is used. Suggest pull DEN low to use SYNC mode.
2. If serial RGB or CCIR601/CCIR656 input mode is selected, only R0-R7(D0-D7) is used. Connect unused pins D8-D23 to GND or floating.
3. SEL2-SEL0 defines the input data format.

SEL2	SEL1	SEL0	Data Format	Operating Frequency
0	0	0	Parallel 24-bit RGB data format	6.5MHz
0	0	1	Serial 8-bit RGB data format	19.5MHz
0	1	0	CCIR 656 data format (640RGB)	24.54MHz
0	1	1	CCIR 656 data format (720RGB)	27MHz
1	0	0	YUV mode A data format (Cr-Y-Cb-Y)	24.54MHz
1	0	1	YUV mode A data format (Cr-Y-Cb-Y)	27MHz
1	1	0	YUV mode B data format (Cb-Y-Cr-Y)	27MHz
1	1	1	YUV mode B data format (Cb-Y-Cr-Y)	24.54MHz

Input format	DOTCLK Frequency (MHZ)	Display Data	Active Area (DOTCLK)
YUV mode	24.54	640	1280
	27	720	1440

Mode	D[23:16]	D[15:8]	D[7:0]	HSYNC	VSYNC	DEN
ITU-R BT 656	D[23:16]	GND	GND	NC	NC	NC
ITU-R BT 601	D[23:16]	GND	GND	HSYNC	VSYNC	NC
8-bit RGB	D[23:16]	GND	GND	HSYNC	VSYNC	NC for HV Mode
						DEN for DEN Mode
24-bit RGB	R[7:0]	G[7:0]	B[7:0]	HSYNC	VSYNC	NC for HV Mode
						DEN for DEN Mode

4. Absolute Maximum Ratings (Note 1)

Item	Symbol	Min.	Max.	Unit	Remark
Supply Voltage (Logic)	V_{DD}	-0.3	4.5	V	
Input Signal Voltage	V_I	-0.3	V_{DD}+0.3	V	
Supply Voltage (LED)	If	-	25	mA	
Operating Temperature	Top	-20	70	°C	Note 2, 3
Storage Temperature	Tstg	-30	80	°C	Note 2, 3

Note 1: The absolute maximum rating values of this product are not allowed to be exceeded at any times. A module should be used with any of the absolute maximum ratings exceeded, the characteristics of the module may not be recovered, or in an extreme condition, the module may be permanently destroyed.

Note 2: 90% RH Max. (Max. wet-bulb temperature is 60°C)
Max. wet-bulb temperature is at 60°C or less. No condensation (no drops of dew).

Note 3: In case of temperature below 0°C, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one.

5. Electrical Characteristics

5.1 DC Characteristics

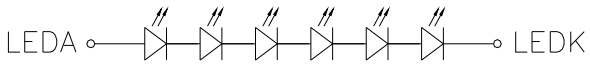
Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power Voltage	V_{DD}	3.0	3.3	3.6	V	-
Input Logic High Voltage	V_{IH}	0.7V_{DD}	-	V_{DD}	V	-
Input Logic Low Voltage	V_{IL}	0	-	0.3V_{DD}	V	-
Current for LCD	I_{DD}	-	9.0	15	mA	V_{DD}=3.3V

5.2 LED Backlight Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
LED Current	I_L	-	20.0	22.0	mA	
LED Voltage	V_L	17.4	18.6	19.8	V	Note 1
LED Life time	-	20,000	-	-	Hr	Note 2

Note 1: The LED voltage is defined by the number of LED at Ta=25°C and I_L=20mA.

Note 2: The LED life time is defined as the module brightness decrease to 50% original brightness at Ta=25°C and I_L=20mA. The LED life time could be decreased if operating I_L is larger than 20mA.



LED Backlight: 6 LED

5.3 AC Characteristics (VDD=3.3V, Ta=25°C)

5.3.1 Parallel 24-bit RGB Interface

Signal	Item	Symbol	Min.	Typ.	Max.	Unit
DCLK	Period	T_{CLK}	-	156	-	ns
	High Time	T_{CH}	-	78	-	ns
	Low Time	T_{CL}	-	78	-	ns
Data	Setup Time	T_{DS}	12	-	-	ns
	Hold Time	T_{DH}	12	-	-	ns
HSYNC	Period	T_H	-	408	-	T_{CLK}
	Pulse Width	T_{HS}	5	30	-	T_{CLK}
	Back Porch	T_{HB}	-	38	-	T_{CLK}
	Display Period	T_{EP}	-	320	-	T_{CLK}
	Front Porch	T_{HF}	-	20	-	T_{CLK}
VSYNC	Period	Tv	-	262	-	T_H
	Pulse Width	T_{VS}	1	3	5	T_H
	Back Porch	T_{VB}	-	15	-	T_H
	Display Period	T_{VD}	-	240	-	T_H
	Front Porch	T_{VF}	2	4	-	T_H

Note 1: $T_{HS}+T_{HB}$=68TCLK.

2. $T_V=T_{VS}+T_{VB}+T_{VD}+T_{VF}$

3. When SYNC mode is used, 1st data start from 68th DCLK after Hsync falling.

5.3.2 Serial 8-bit RGB Interface

Signal	Item	Symbol	Min.	Typ.	Max.	Unit
DCLK	Period	T_{CLK}	-	52	-	ns
	High Time	T_{CH}	-	78	-	ns
	Low Time	T_{CL}	-	78	-	ns
Data	Setup Time	T_{DS}	12	-	-	ns
	Hold Time	T_{DH}	12	-	-	ns
HSYNC	Period	T_H	-	1224	-	T_{CLK}
	Pulse Width	T_{HS}	5	90	-	T_{CLK}
	Back Porch	T_{HB}		114		T_{CLK}
	Display Period	T_{EP}	-	960	-	T_{CLK}
	Front Porch	T_{HF}	-	60	-	T_{CLK}
VSYNC	Period	Tv	-	262	-	T_H
	Pulse Width	T_{VS}	1	3	5	T_H
	Back Porch	T_{VB}	-	15	-	T_H
	Display Period	T_{VD}	-	240	-	T_H
	Front Porch	T_{VF}	2	4	-	T_H

Note 1: $T_{HS}+T_{HB}$=204TCLK

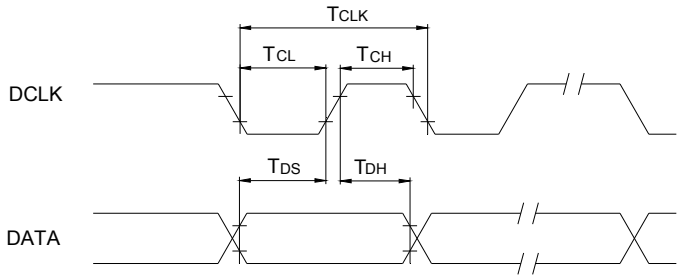
2. $T_V=T_{VS}+T_{VB}+T_{VD}+T_{VF}$

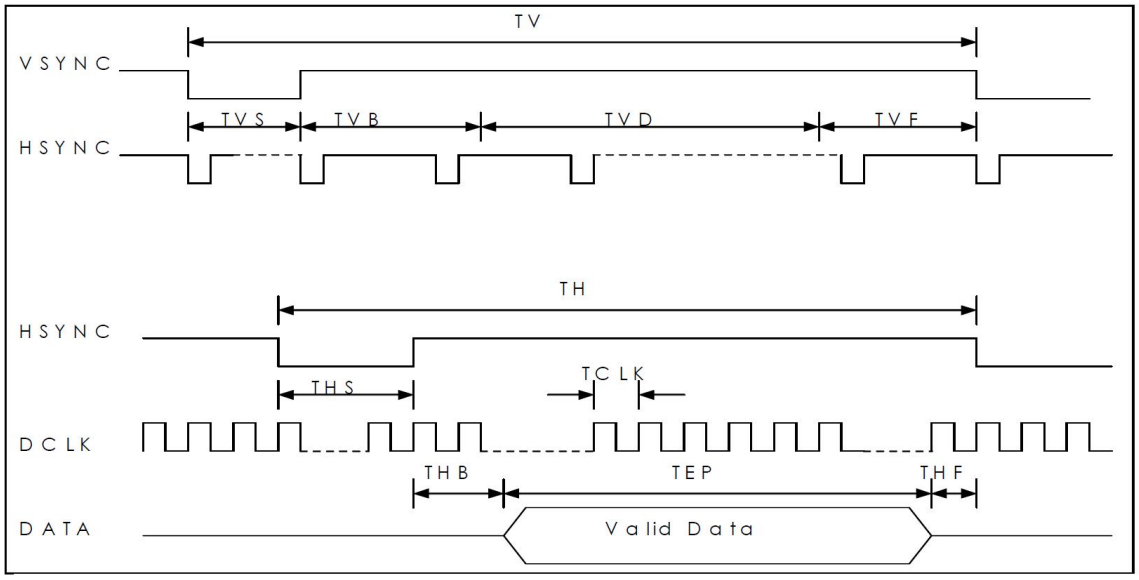
3. When SYNC mode is used, 1st data start from 204th DCLK after Hsync falling.

5.3.3 CCIR601/656 Interface

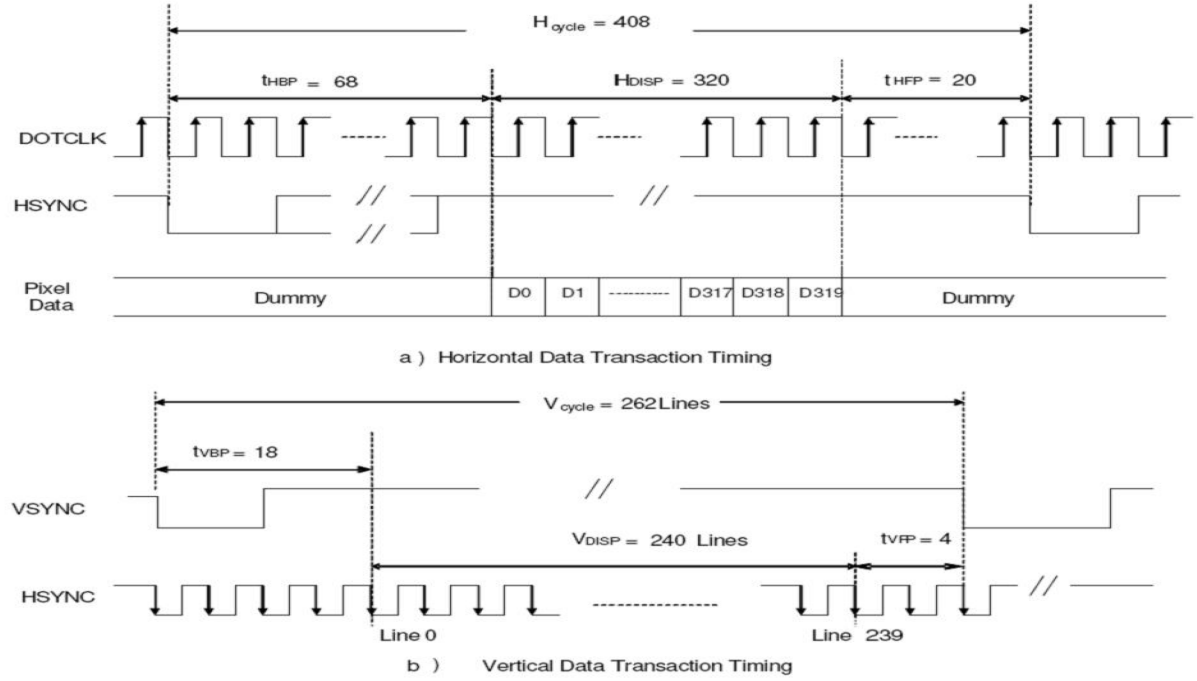
Signal	Item	Symbol	Min.	Typ.	Max.	Unit
DCLK	Period	T_{CLK}	-	37	-	ns
	High Time	T_{CH}	-	78	-	ns
	Low Time	T_{CL}	-	78	-	ns
Data	Setup Time	T_{DS}	12	-	-	ns
	Hold Time	T_{DH}	12	-	-	ns

5.3.4 Clock and Sync Timing Waveforms

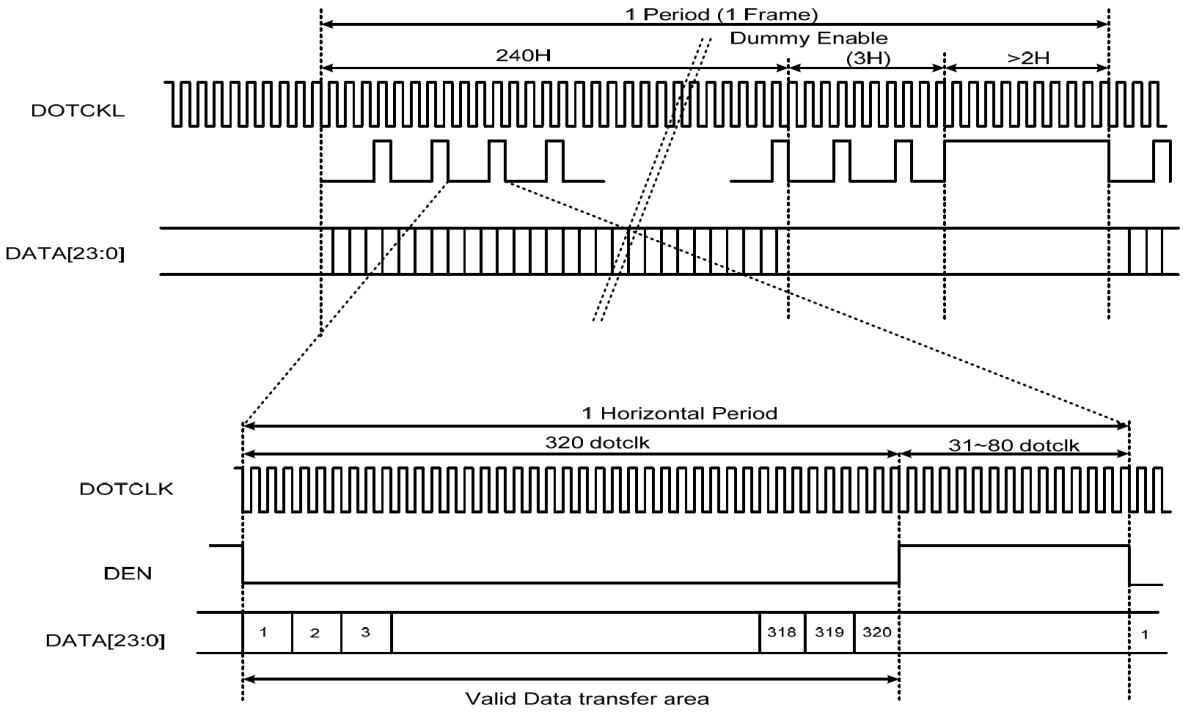




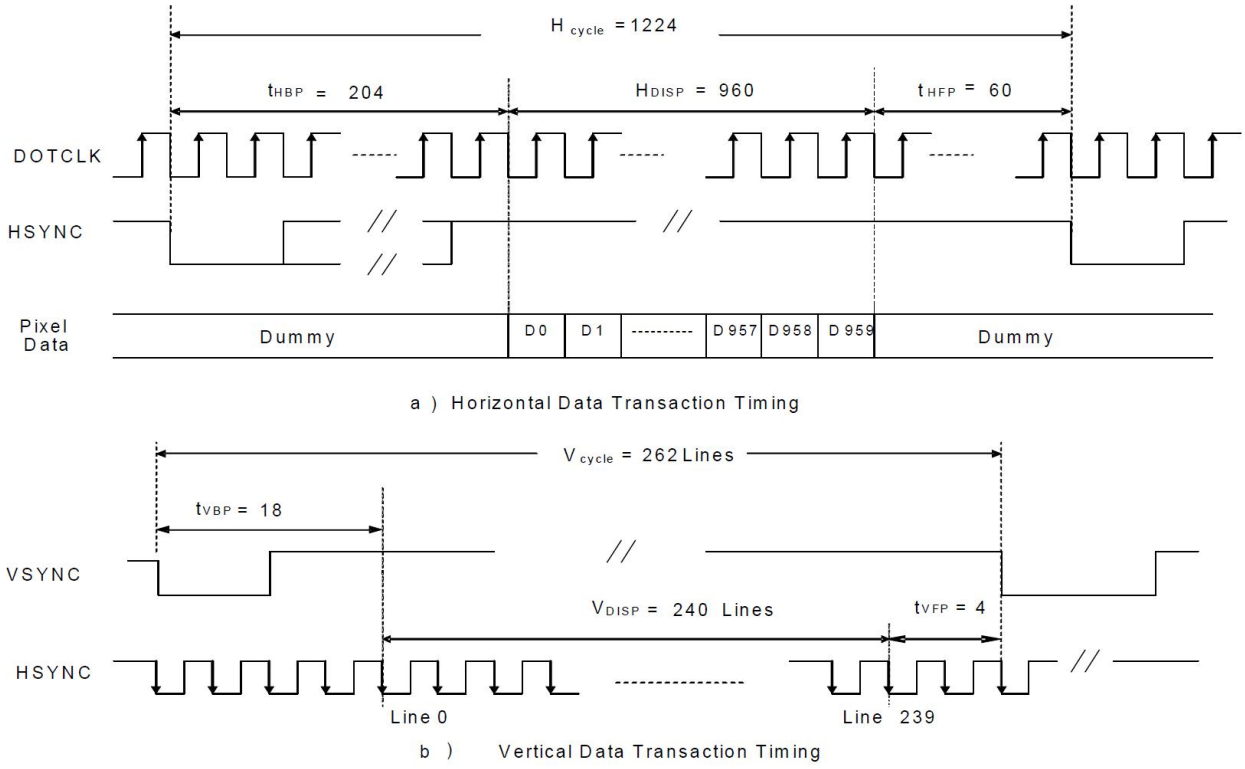
5.3.5 Parallel 24-bit RGB Timing Diagram (SYNC Mode)



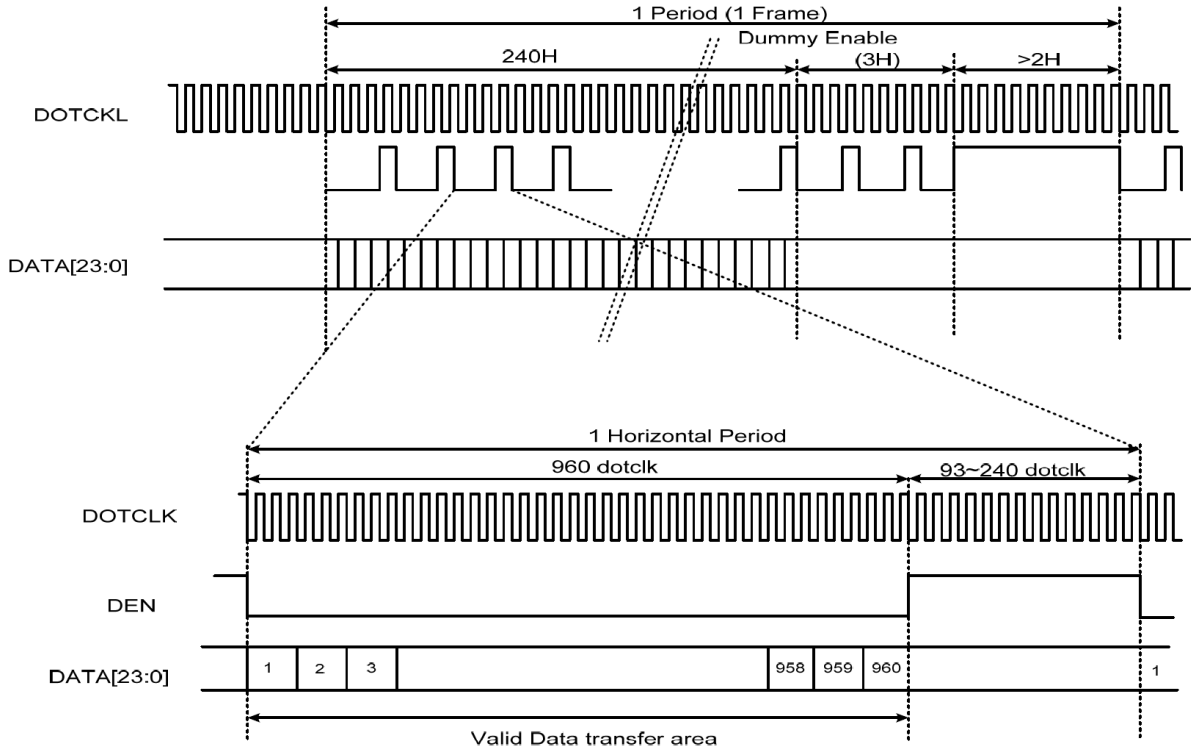
5.3.6 Parallel 24-bit RGB Timing Diagram (DE Mode)



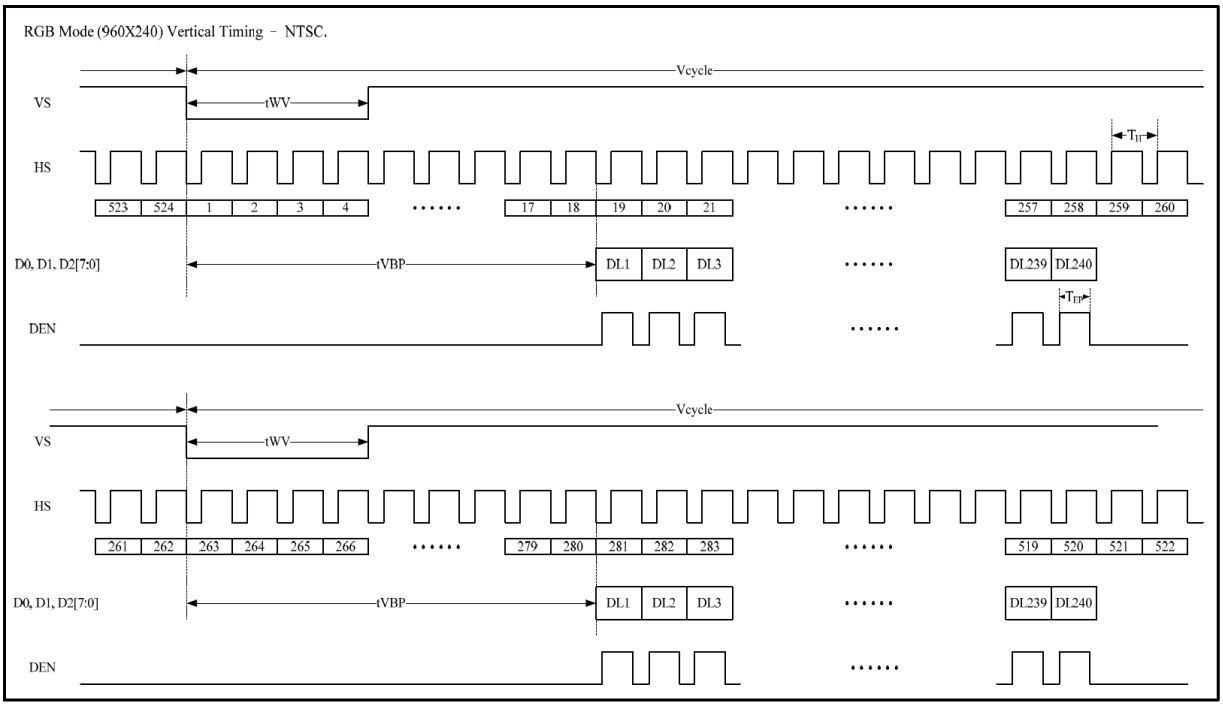
5.3.7 Serial 8-bit RGB Timing Diagram (SYNC Mode)



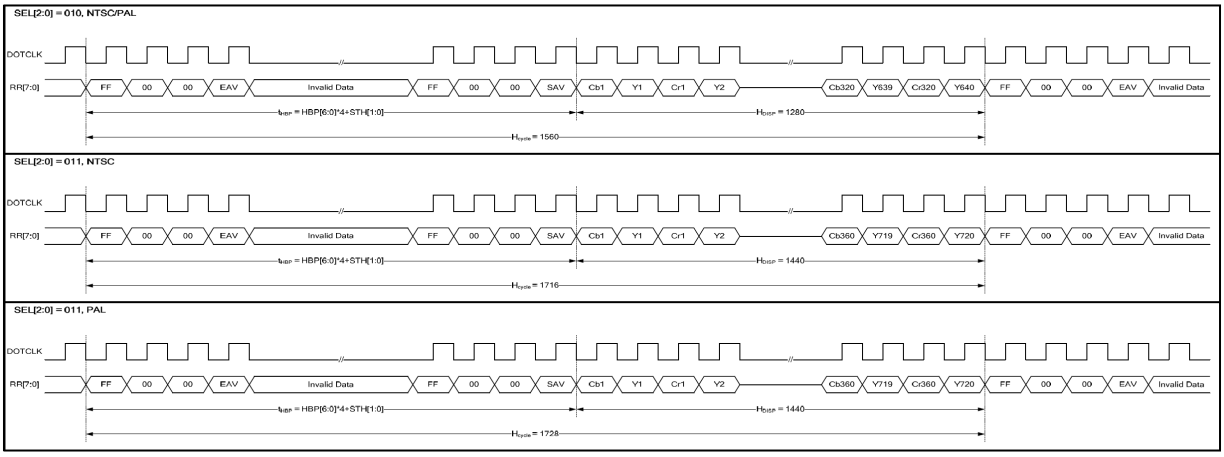
5.4.8 Serial 8-bit RGB Timing Diagram (DE Mode)



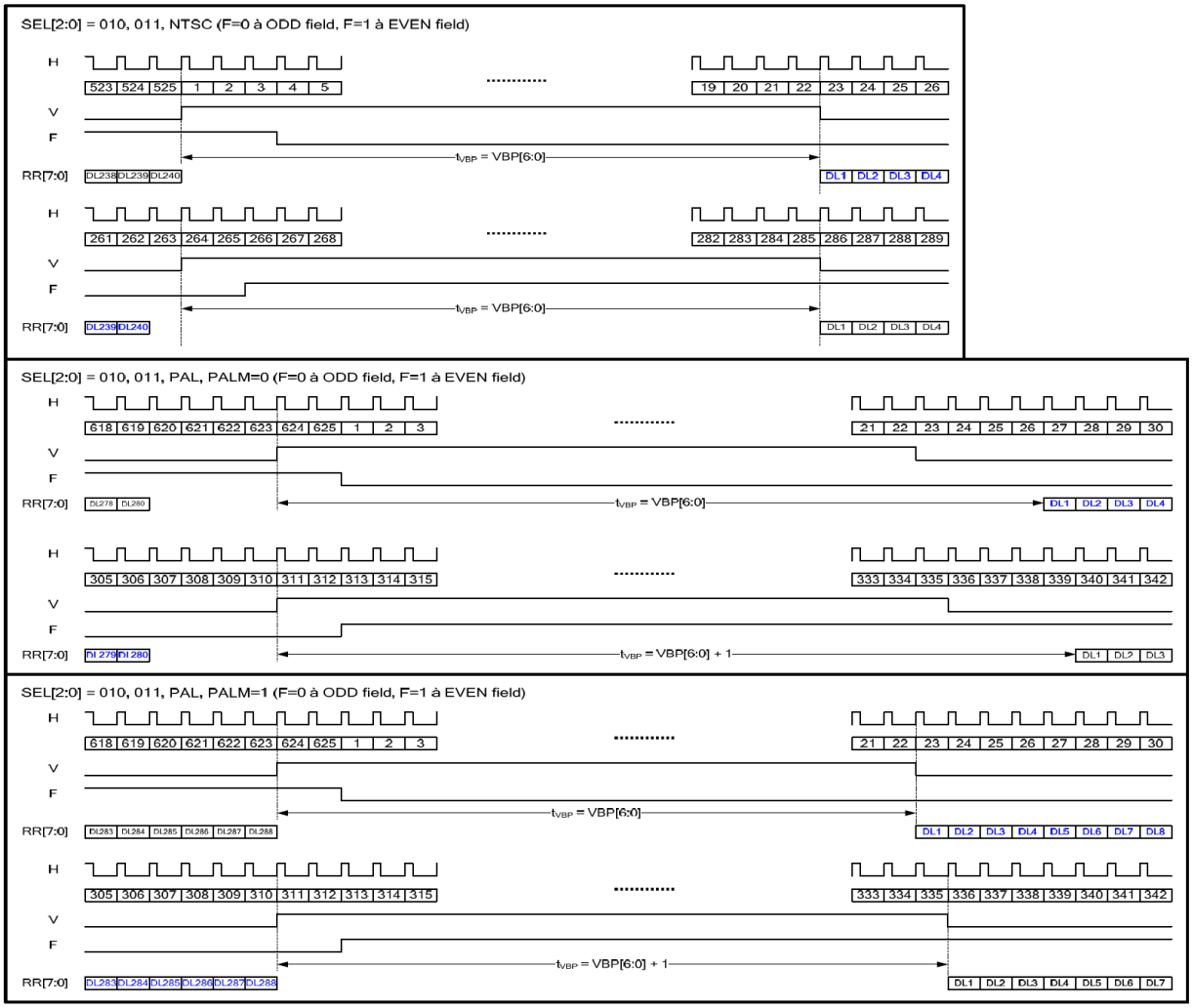
5.3.9 Digital RGB NTSC mode Vertical Data Format for $262T_H$



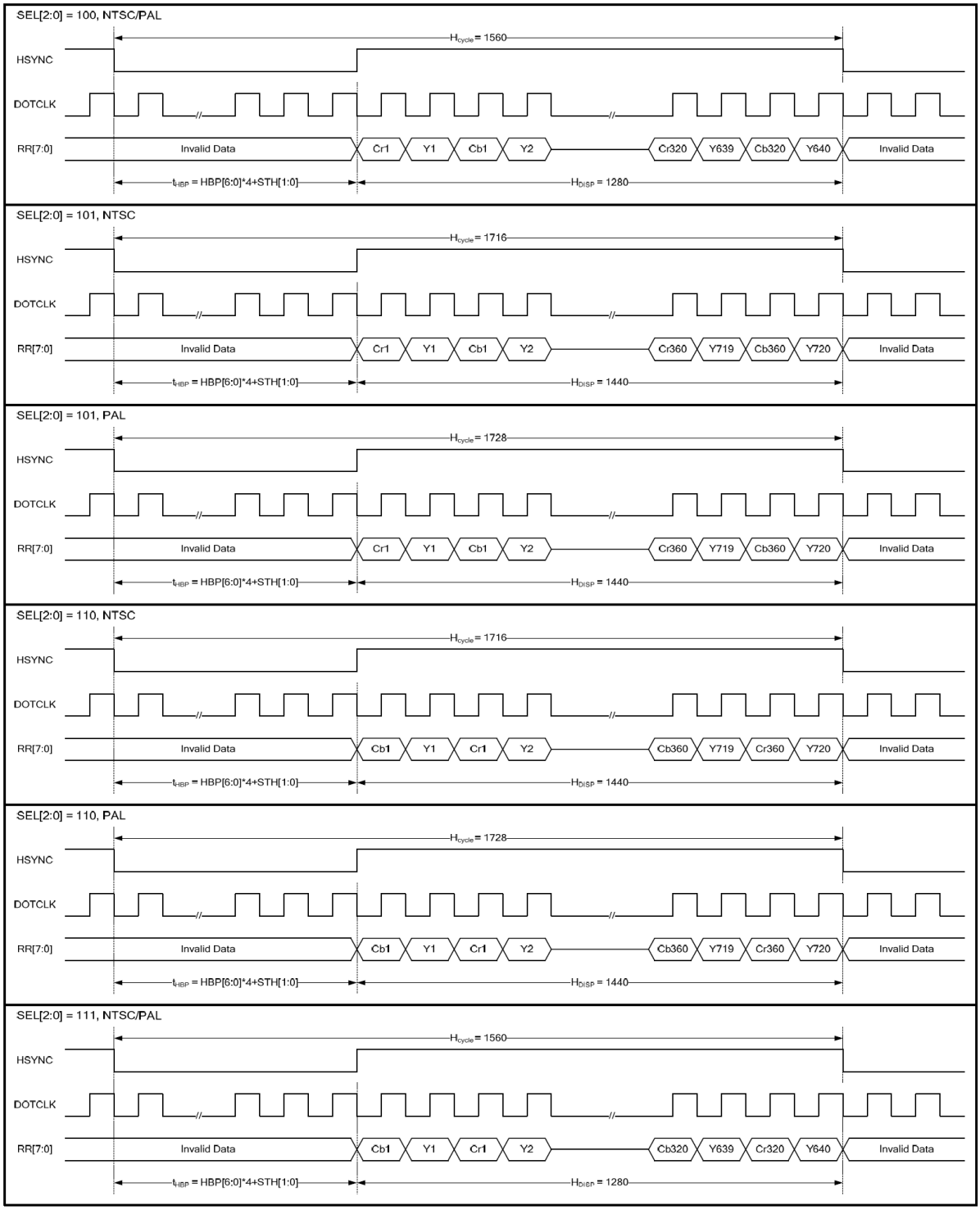
5.3.10 CCIR656 Horizontal Timing



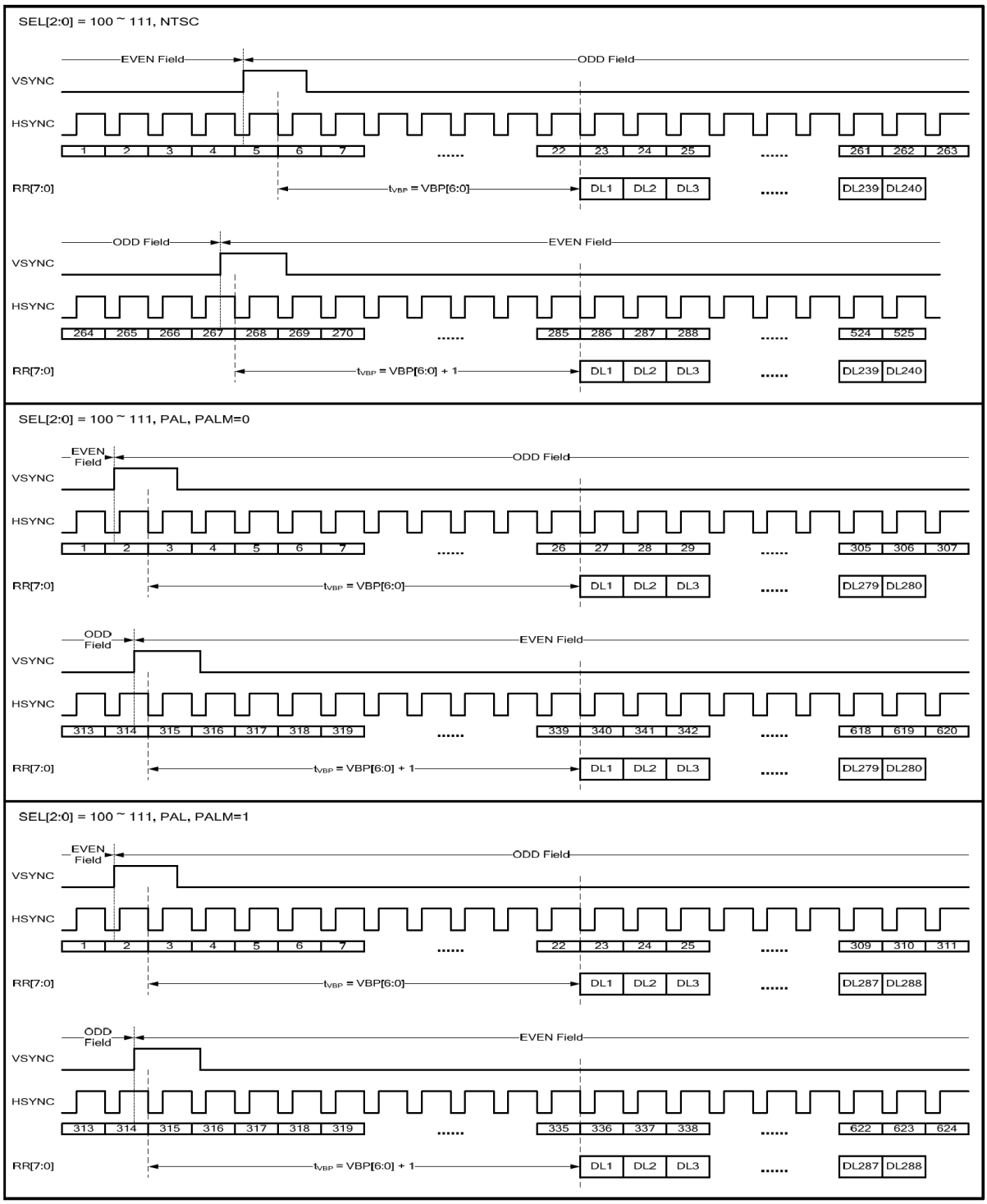
5.3.11 CCIR656 Vertical Timing



5.3.12 CCIR601 Horizontal Timing



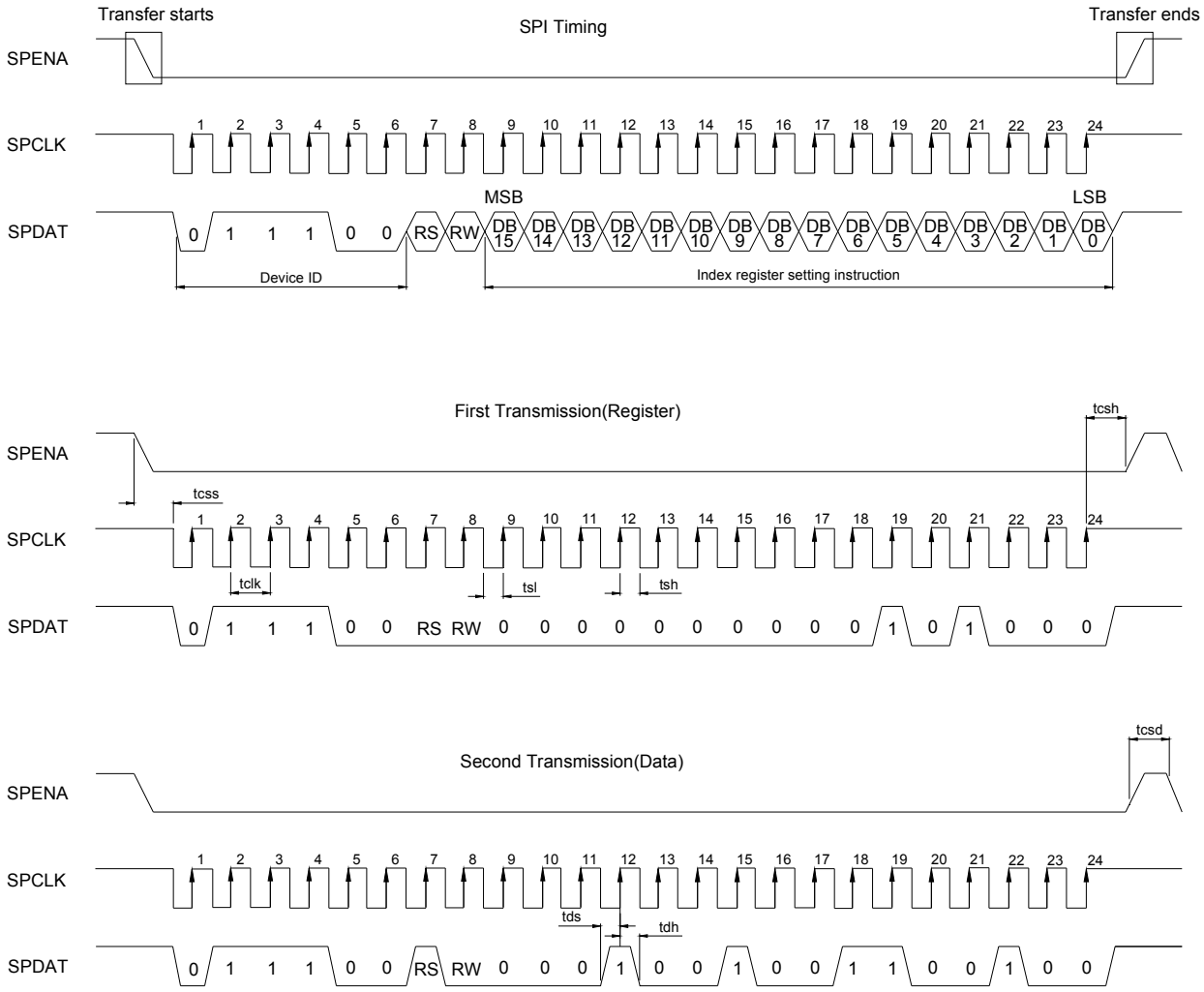
5.3.13 CCIR601 Vertical Timing



5.3.14 SPI Timing Characteristics

The SPI interface of the lcm is used to receive commands to adjust the TFT to the best display result. Please refer to HX8238-D datasheet for details.

Item	Symbol	Min.	Typ.	Max.	Unit
SPCLK Period	tclk	60	-	-	ns
SPCLK High Width	tsh	30	-	-	ns
SPCLK Low Width	tsl	30	-	-	ns
Data Setup Time	tds	12	-	-	ns
Data Hold Time	tdh	12	-	-	ns
SPENA to SPCLK Setup Time	tcss	20	-	-	ns
SPENA to SPDA Hold Time	tcsh	20	-	-	ns
SPENA High Delay Time	tcsd	50	-	-	ns



Note: The example writes "0X1264h" to register R28h

5.4 Basic Display Colors and Gray Scale

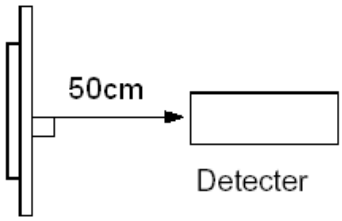
Color		Input Color Data																									
		Red								Green								Blue									
		MSB							LSB	MSB							LSB	MSB							LSB		
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0		
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0		
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1		
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1		
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	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	1	1	1	1	1	1		
Gray Scale of Red	Red(0) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Red(253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(255) Bright	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Gray Scale of Green	Green(0) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		
	Green(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0		
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0		
	Green(255) Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0		
Gray Scale of Blue	Blue(0) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1		
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0		
	Blue(255) Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1		

6. Optical Specification

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note
Brightness	Bp		Θ=0° Φ=0°	-	250	-	cd/m^2	1
Uniformity	△Bp			70%	-	-	-	1, 2
Viewing Angle	Hor	ΘR	Cr≥10	-	55	-	degree	3
		ΘL		-	55	-		
	Ver	ΘU		-	40	-		
		ΘD		-	50	-		
Contrast Ratio	Cr		Θ=0° Φ=0°	225	300	-	-	4
Response Time	Tr + Tf			-	25	-	ms	5
Color Coordinate	Wx		Θ=0° Φ=0°	0.26	0.31	0.36	-	1, 6
	Wy			0.28	0.33	0.38	-	

Test conditions: V_{DD}=3.3V, I_L=20mA (LED backlight current), the ambient temperature is 25°C.

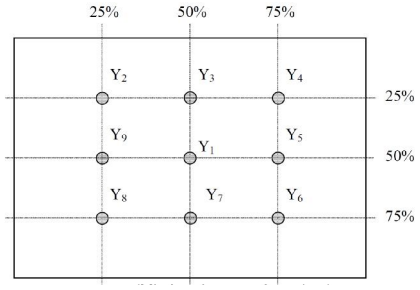
Note 1: The optical characteristics should be measured in dark room after 15 minutes operation. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment BM-7.



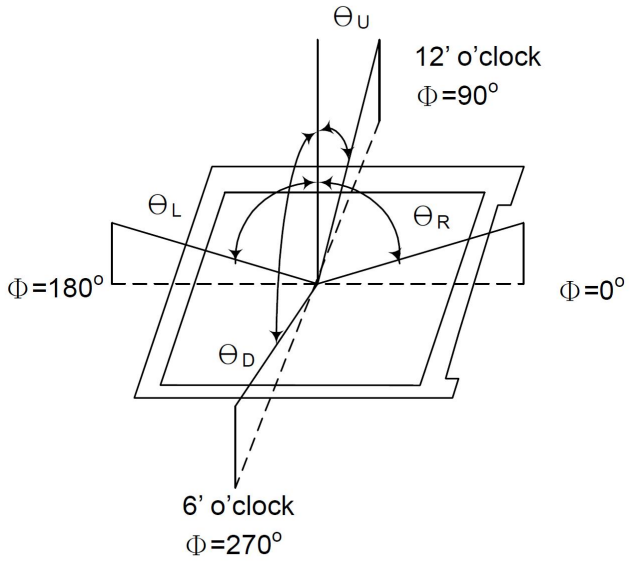
Note 2: △ Bp = Bp (Min.) / Bp (Max.)×100 (%)

Bp (Max.) = Maximum brightness in 9 measured spots

Bp (Min.) = Minimum brightness in 9 measured spots.



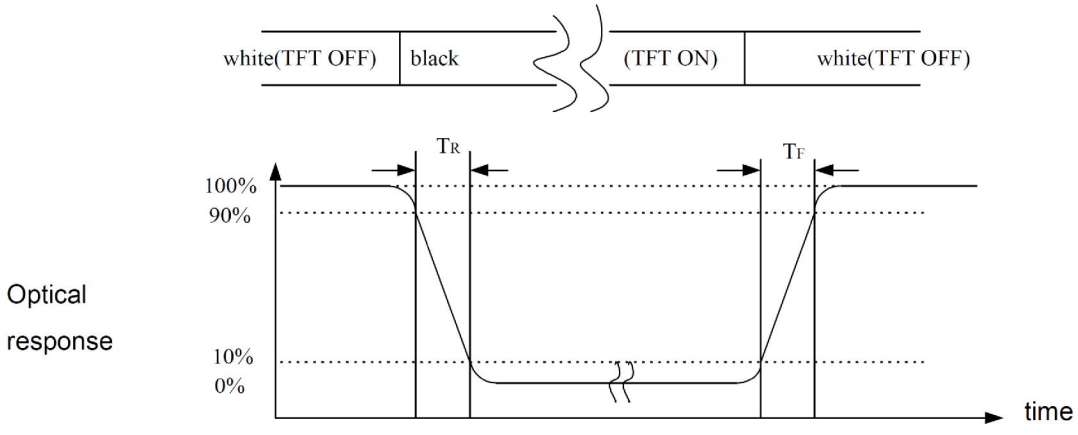
Note 3: Definition of Viewing Angle



Note 4: Definition of Contrast Ratio

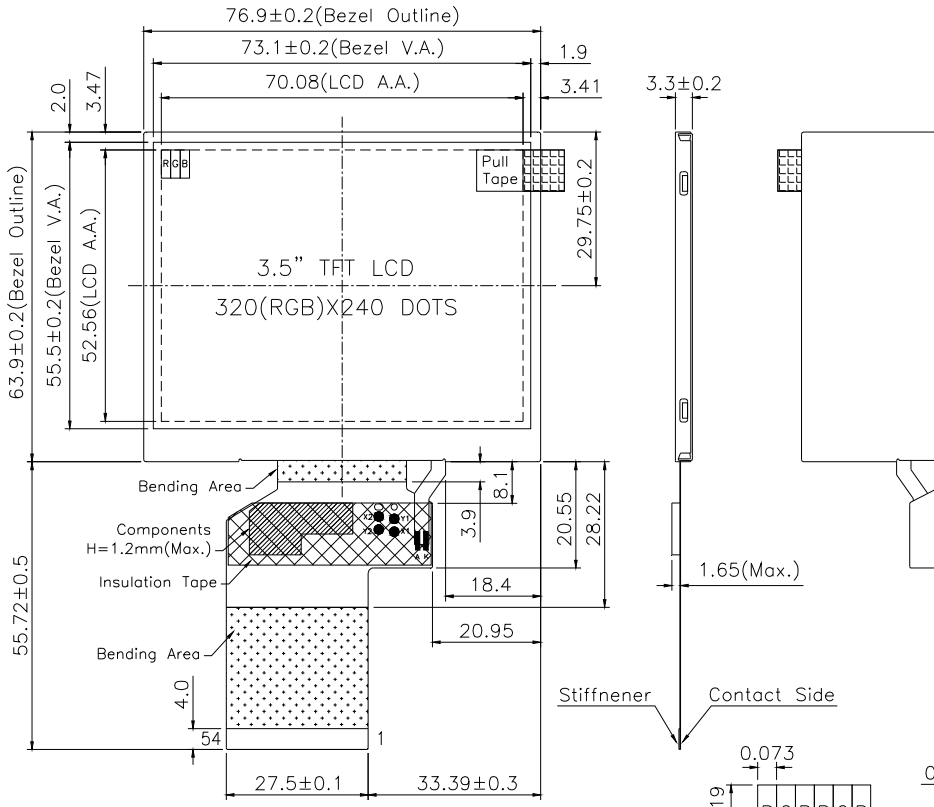
$$\text{Contrast Ratio (Cr)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$

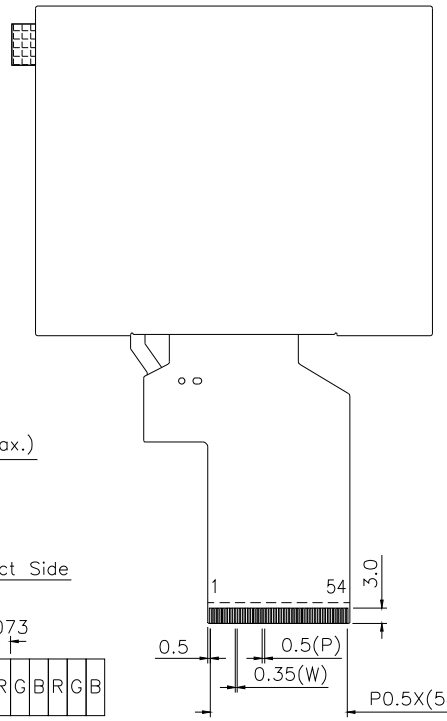
Note 5: Definition of Response Time



Note 6: Definition of color chromaticity (CIE1931)
Color coordinates measured at center point of LCD.

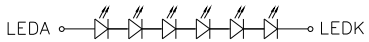
7. Outline Dimension





PIN	SYMBOL	PIN	SYMBOL
1	LEDK	28	R0
2	LEDK	29	R1
3	LEDA	30	R2
4	LEDA	31	R3
5	NC	32	R4
6	NC	33	R5
7	NC	34	R6
8	/RESET	35	R7
9	SPENA	36	HSYNC
10	SPCLK	37	VSYNC
11	SPDAT	38	DOTCLK
12	B0	39	NC
13	B1	40	NC
14	B2	41	VDD
15	B3	42	VDD
16	B4	43	NC
17	B5	44	NC
18	B6	45	NC
19	B7	46	NC
20	G0	47	NC
21	G1	48	SEL2
22	G2	49	SEL1
23	G3	50	SEL0
24	G4	51	NC
25	G5	52	DEN
26	G6	53	GND
27	G7	54	GND

Notes:
1. 3.5" Transmissive, Normally-White TFT LCD Module
2. View Direction: 6:00
3. LCD Drivers: HX8238-D
4. Interface: 24-Bit RGB/8-BIT RGB/CCIR656/CCIR601
5. Operation Temp.: -20°C~70°C
6. Storage Temp.: -30°C~80°C
7. VDD=3.0V to 3.6V



LED Backlight Digram

DWN.	YDY	TITLE	LCM OUTLINE DIMENSION		
CHK.	LYJ	PART NO.	LT035A-02A		
APPD.	LY	DWG. NO.	LT035A-02A-WXB		
REV.	B	UNIT	mm	PROJECTION	
DATE	2016.02.15	SCALE	NTS	SHEET	1 OF 1

8. PRECAUTIONS FOR USE OF LCD MODULE

8.1 Handing Precautions

1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

2) If the display panel is damaged and the liquid crystal substance inside it leaks out,be sure not to get any in your mouth. If the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

3) Do not apply excessive force on the surface of display or the adjoining areas of LCD module since this may cause the color tone to vary.

4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

5) If the display surface of LCD module becomes contaminated, blow on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents.

· Isopropyl alcohol

· Ethyl alcohol Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

· Water

· Ketone

· Aromatic Solvents

6) When mounting the LCD module make sure that it is free of twisting, warping, and distortion. Distortion has great influence upon display quality. Also keep the stiffness enough regarding the outer case.

7) Be sure to avoid any solvent such as flux for soldering never stick to Heat-Seal. Such solvent on Heat-Seal may cause connection problem of heat-Seal and TAB.

8) Do not forcibly pull or bend the TAB I/O terminals.

9) Do not attempt to disassemble or process the LCD module.

10) NC terminal should be open. Do not connect anything.

11) If the logic circuit power is off, do not apply the input signals.

12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

· Be sure to ground the body when handling the LCD module.

· Tools required for assembly, such as soldering irons, must be properly grounded.

· To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

· The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

8.2 Storage Precautions

1) When storing the LCD module, avoid exposure to direct sunlight or to the light of fluorescent lamps and high temperature/high humidity. Whenever possible, the LCD module should be stored in the same conditions in which they were shipped from our company.

2) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets or a current flow in a high humidity environment.

8.3 Design Precautions

1) The absolute maximum ratings represent the rated value beyond which LCD module can not exceed. When the LCD modules are used in excess of this rated value, their operating characteristics may be adversely affected.
2) To prevent the occurrence of erroneous operation caused by noise, attention must be paid to satisfy VIL, VIH specification values, including taking the precaution of using signal cables that are short.
3) The liquid crystal display exhibits temperature dependency characteristics. Since recognition of the display becomes difficult when the LCD is used outside its designated operating temperature range, be sure to use the LCD within this range.Also, keep in mind that the LCD driving voltage levels necessary for clear displays will vary according to temperature.
4) Sufficiently notice the mutual noise interference occurred by peripheral devices.
5) To cope with EMI, take measures basically on outputting side.
6) If DC is impressed on the liquid crystal display panel, display definition is rapidly deteriorated by the electrochemical reaction that occurs inside the liquid crystal display panel. To eliminate the opportunity of DC impressing, be sure to maintain the AC characteristics of the input signals sent to the LCD Module.

8.4 Others

1) Liquid crystals solidify under low temperatures (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white).Air bubbles may also be generated if the LCD module is subjected to a strong shock at a low temperature.
2) If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and aslight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
3) To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity, etc., exercise care to avoid touching the following sections when handling the module:
· Terminal electrode sections.
· Part of pattern wiring on TAB,