



# DATA SHEET

( DOC No. HX8340-B(T)-DS )

## HX8340-B(T)

176RGB x 220 dot, 262k color,  
with internal GRAM,  
TFT Mobile Single Chip Driver

*Preliminary version 01 October, 2007*

# >> HX8340-B(T)

176RGB x 220 dot, 262K color, with internal GRAM, TFT Mobile Single Chip Driver



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# HX8340-B(T)

176RGB x 220 dot, 262K color, with internal GRAM, TFT Mobile Single Chip Driver



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*Preliminary Version 01*

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## 1. General Description

This document describes HX8340-B 176RGBx220 dots resolution driving controller. The HX8340-B is designed to provide a single-chip solution that combines a gate driver, a source driver, power supply circuit for 262,144 colors to drive a TFT panel with 176RGBx220 dots at maximum.

The HX8340-B can be operated in low-voltage (1.65V) condition for the interface and integrated internal boosters that produce the liquid crystal voltage, breeder resistance and the voltage follower circuit for liquid crystal driver. In addition, The HX8340-B also supports various functions to reduce the power consumption of a LCD system via software control.

The HX8340-B supports three interface groups: Command-Parameter interface group, Register-Content interface group and RGB interface mode. Command-Parameter interface mode and Register-Content interface mode are selected by the external pin IFSEL setting, and RGB interface mode is selected by external **RCM[1:0]** pins. This manual description focuses on Register-Content interface mode and RGB interface mode; about the Command-Parameter interface mode, please refer to the HX8340-B(N) datasheet for detail.

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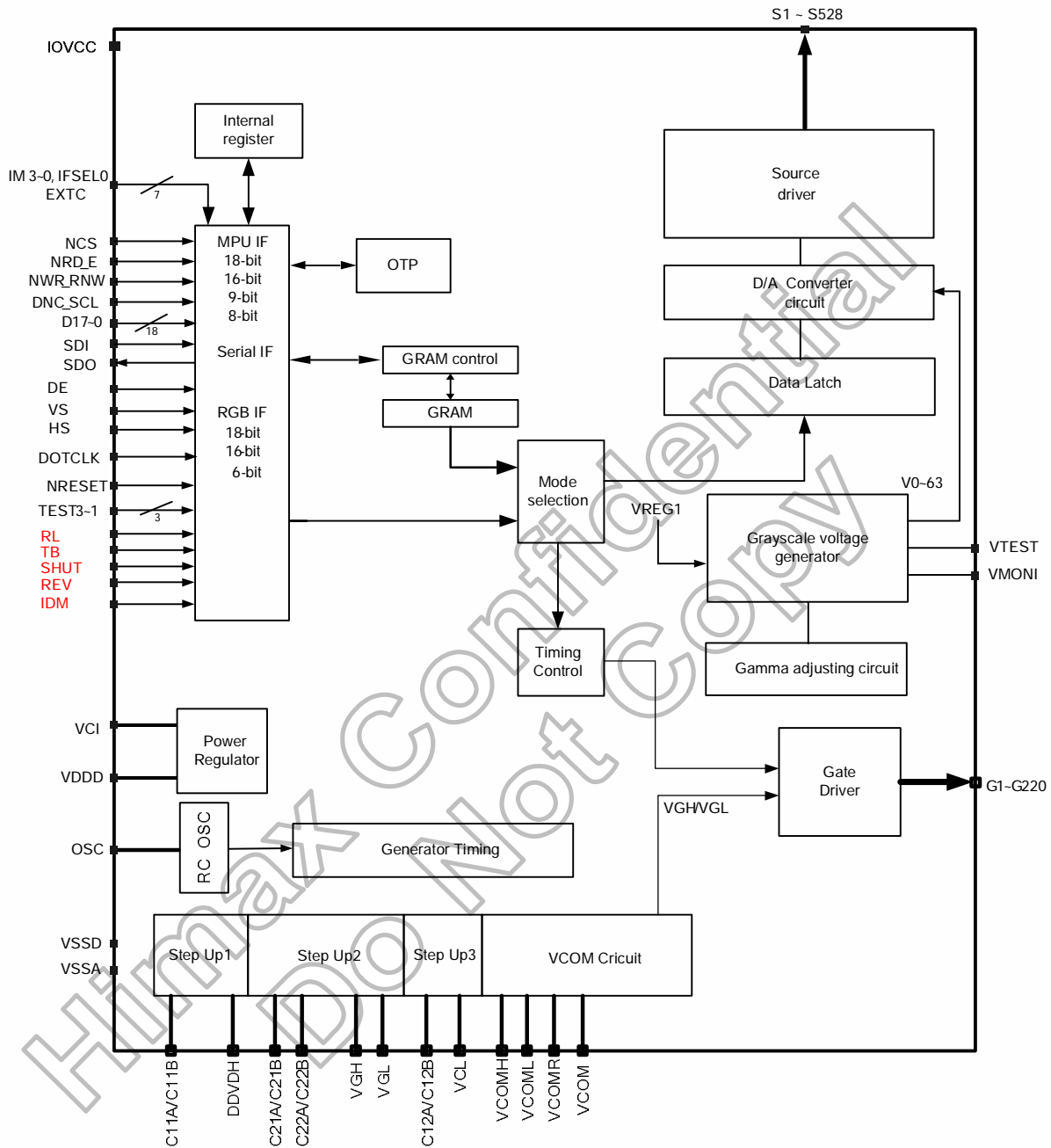
## 2. Features

- I Single chip solution to drive a a-TFT LCD panel
- I Display Resolution: 176(H) x RGB(H) x 220(V)
- I Display Color modes (Register-Content interface mode.( IFSEL= 'L' ) and RGB interface mode)
  - I Normal Display Mode On
    - a. System Interface Circuit
      - i. 4096(R(4),G(4),B(4)) colors
      - ii. 65,536(R(5),G(6),B(5)) colors
      - iii. 262,144(R(6),G(6),B(6)) color
    - b. RGB Interface Circuit
      - i. 65,536(R(5),G(6),B(5)) colors
      - ii. 262,144(R(6),G(6),B(6)) colors
  - I Idle Mode On
    - a. 8 (R(1),G(1),B(1)) colors.
- I Outputs
  - I Source outputs: 528 source lines.
  - I Selectable gate line control signal for glass 220 gate lines
  - I Adjusted source voltages ( V0p ~V63p, V0n ~V63n)
- I Display interface:
  - System interface:
    - a. 8-/9-/16-/18-bit parallel bus system interface
    - b. 3-wires serial bus system interface
  - RGB interface:
    - a. 6-/16-/18-bit RGB interface
- I Internal graphics RAM capacity: 176 x18x220 bit = 696960bits
- I Display features
  - I The vertical scroll display function in line units
  - I Partial area display mode.
  - I Software programmable color depth mode
- I On chip
  - I OTP memory to store initialization register settings
  - I Automatic malfunction recovery for default values (OTP table and other default values reloading after Sleep Out, HW / SW)
  - I Internal oscillator and hardware reset function
  - I DC/DC converter and charge bump circuit for source, glass gate driving voltage
  - I Adjust AC VCOM generation

- I LCD Driving Inversion Algorithm
  - Frame inversion AC liquid-crystal drive
  - 1~7 line inversion AC liquid-crystal drive
  
- I Input power supply
  - IOVCC = 1.65 to 3.3V (Logic IO power supply voltage range)
  - VCI = 2.5 to 3.3V (Driver power supply voltage range)
  
- I Output voltage levels
  - DDVDH = 5.2 V (Power supply for driver circuit range)
  - VREG1 = 3.3V to 4.8V (Source output voltage range)
  - VGH = +9.0 to +15.6V (Positive Gate output voltage range)
  - VGL = -6.0 to -13.5V (Negative Gate output voltage range)
  - VCOMH = 2.5V to 5.0V (Common electrode output high voltage)
  - VCOML = -2.5V to 0.0V (Common electrode output low voltage)
  
- I Low power consumption, suitable for battery operated systems
- I CMOS compatible inputs
- I Chip on Glass or Chip on Foil
- I Operating temperature range : -40°C ~ 85°C

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### 3. Block Diagram



## 4. Pin Description

### 4.1 Pin Description

Interface Logic Pin				
Signals	I/O	Pin Number	Connected with	Description
IM3, IM2, IM1, IM0	I	4	VSSD/ IOVCC	System interface select. Please refer to section 5.1.1 and 5.1.2 to detail. If not used, please fix this pin to IOVCC or VSSD level.
NRESET	I	1	MCU	Reset pin. Setting either pin low initializes the LSI. Must be reset after power is supplied.
NCS	I	1	MPU	Chip select input pin. Low: chip can be accessed; High: chip cannot be accessed.
DNC	I	1	MCU	Command / parameter or display data selection pin in parallel bus system interface. If not used, please fix this pin at IOVCC or GND level.
NRD(E)	I	1	MCU	(NRD) Read enable pin I80 parallel bus system interface. (E) Read/Write operation enable pin in M68 parallel bus system interface. If not used, please fix this pin at IOVCC or GND level
NWR(RNW)(SCL)	I	1	MCU	(NWR) Write enable pin I80 parallel bus system interface. (RNW) Read/Write select pin in M68 parallel bus system interface. (SCL) server as serial data clock in serial bus system interface. If not used, please fix this pin at IOVCC or GND level.
SDI	I	1	MCU	Serial data input pin in serial bus system interface. The data is inputted on the rising edge of the SCL signal. If not used, please fix this pin at IOVCC or GND level.
SDO	O	1	MCU	Serial data output pin in serial bus system interface. The data is outputted on the falling edge of SCL signal. SDI and SDO pins are possible to connect together outside of driver IC as one SDA line. If not used, please let this pin floating.
DB[17:0]	I/O	18	MCU	Input data bus If not used, please fix this pin at GND level.
VS	I	1	MCU	Vertical synchronizing signal in RGB interface. Has to be fixed to IOVCC level if it is not used.
HS	I	1	MCU	Horizontal synchronizing signal. Has to be fixed to IOVCC level if it is not used.
DE	I	1	MCU	Data enable signal in RGB interface. Has to be fixed to VSSD level if it is not used.
DOTCLK	I	1	MCU	Pixel clock signal in RGB interface. Has to be fixed to VSSD level if it is not used.
TE	O	1	MCU	Tearing effect output pin to synchronies MCU to frame writing, activated by S/W command. When this pin is not activated (TE function off), this pin is low.



Mode Select Pins												
Signals	I/O	Pin Number	Connected with	Description								
IFSEL	I	1	MPU	<p>Interface format select pin</p> <table border="1"> <thead> <tr> <th>IFSEL</th> <th>Interface Format Selection</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Register-content interface mode</td> </tr> <tr> <td>1</td> <td>Command-Parameter interface mode</td> </tr> </tbody> </table> <p>In this document, the IFSEL has to be connected to GND and Register-Content interface mode is select.</p>	IFSEL	Interface Format Selection	0	Register-content interface mode	1	Command-Parameter interface mode		
IFSEL	Interface Format Selection											
0	Register-content interface mode											
1	Command-Parameter interface mode											
EXTC	I	1	MPU	<p>Extended command set access enable bit pin In Register-content interface mode this pin is invalid. Internal pull low.</p>								
RCM1, RCM0	I	2	MCU	<p>RGB and System interface mode selection pin.</p> <table border="1"> <thead> <tr> <th>RCM1, RCM0</th> <th>MCU and RGB Interface Mode Select</th> </tr> </thead> <tbody> <tr> <td>0x</td> <td>System Interface (1)</td> </tr> <tr> <td>10</td> <td>RGB Interface (1) (VS+HS+DE)</td> </tr> <tr> <td>11</td> <td>RGB Interface (2) (VS+HS)</td> </tr> </tbody> </table> <p>As internal RCM[1:0] bits are written, the external pin RCM[1:0] control is invalid, and RGB and System interface mode selection is controlled by internal RCM[1:0] bits. If not used, please fix this pin to IOVCC or GND.</p>	RCM1, RCM0	MCU and RGB Interface Mode Select	0x	System Interface (1)	10	RGB Interface (1) (VS+HS+DE)	11	RGB Interface (2) (VS+HS)
RCM1, RCM0	MCU and RGB Interface Mode Select											
0x	System Interface (1)											
10	RGB Interface (1) (VS+HS+DE)											
11	RGB Interface (2) (VS+HS)											
SRGB	I	1	MCU	<p>RGB direction select H/W pin for Color filter default setting.</p> <table border="1"> <thead> <tr> <th>SRGB</th> <th>RGB Filter Order for Color Filter Default Setting</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>S1, S2, S3 filter order = 'B', 'G', 'R'</td> </tr> <tr> <td>1</td> <td>S1, S2, S3 filter order = 'R', 'G', 'B'</td> </tr> </tbody> </table> <p>If not used, please fix this pin to IOVCC or GND.</p>	SRGB	RGB Filter Order for Color Filter Default Setting	0	S1, S2, S3 filter order = 'B', 'G', 'R'	1	S1, S2, S3 filter order = 'R', 'G', 'B'		
SRGB	RGB Filter Order for Color Filter Default Setting											
0	S1, S2, S3 filter order = 'B', 'G', 'R'											
1	S1, S2, S3 filter order = 'R', 'G', 'B'											
SMX	I	1	MCU	<p>Module source output direction H/W select pin.</p> <table border="1"> <thead> <tr> <th>SMX</th> <th>Module Source Output Direction</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>S528 -&gt; S1</td> </tr> <tr> <td>1</td> <td>S1 -&gt; S528</td> </tr> </tbody> </table> <p>If not used, please fix this pin to IOVCC or GND.</p>	SMX	Module Source Output Direction	0	S528 -> S1	1	S1 -> S528		
SMX	Module Source Output Direction											
0	S528 -> S1											
1	S1 -> S528											
SMY	I	1	MCU	<p>Module Gate output direction H/W select pin.</p> <table border="1"> <thead> <tr> <th>SMY</th> <th>Module Gate Output Direction</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>G1 -&gt; G220</td> </tr> <tr> <td>1</td> <td>G220 -&gt; G1</td> </tr> </tbody> </table> <p>If not used, please fix this pin to IOVCC or GND.</p>	SMY	Module Gate Output Direction	0	G1 -> G220	1	G220 -> G1		
SMY	Module Gate Output Direction											
0	G1 -> G220											
1	G220 -> G1											
IDM	I	1	MCU	<p>Normal mode and Idle mode control pin in RGB I/F.</p> <table border="1"> <thead> <tr> <th>IDM</th> <th>Idle Mode H/W Controller</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Normal display (can be changed to Idle mode by S/W)</td> </tr> <tr> <td>1</td> <td>Into Idle mode</td> </tr> </tbody> </table> <p>As internal IDMON commands are written in RGB interface, the external pin IDM control is invalid, and normal and idle mode selection is controlled by internal IDMON commands. If not used, please fix this pin to IOVCC or GND.</p>	IDM	Idle Mode H/W Controller	0	Normal display (can be changed to Idle mode by S/W)	1	Into Idle mode		
IDM	Idle Mode H/W Controller											
0	Normal display (can be changed to Idle mode by S/W)											
1	Into Idle mode											
SHUT	I	1	MCU	<p>Chip On/ Off H/W control pin in RGB I/F.</p> <table border="1"> <thead> <tr> <th>SHUNT</th> <th>Display On/Off in RGB I/F</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Display On</td> </tr> <tr> <td>1</td> <td>Display Off</td> </tr> </tbody> </table> <p>As internal CSHUT commands be written in RGB interface, the external pin SHUT control is invalid, and chip on/off selection is controlled by internal CSHUT commands. If not used, please fix this pin to IOVCC or GND.</p>	SHUNT	Display On/Off in RGB I/F	0	Display On	1	Display Off		
SHUNT	Display On/Off in RGB I/F											
0	Display On											
1	Display Off											

Mode Select Pins					
Signals	I/O	Pin Number	Connected with	Description	
RL	I	1	MCU	Source output direction H/W select pin in RGB I/F.	
				<b>RL</b>	<b>Module Source Output Direction</b>
				0	Normal Direction
				1	Reverse Direction
As internal CRL bit be written in RGB interface, the external pin RL control is invalid, and CRL is operated based on external pin SMX setting. If not used, please fix this pin to IOVCC or GND.					
TB	I	1	MCU	Gate output direction H/W select pin in RGB I/F.	
				<b>TB</b>	<b>Module Gate Output Direction</b>
				0	Normal Direction
				1	Reverse Direction
As internal CTB bit be written in RGB interface, the external pin TB control is invalid, and CRL is operated based on external pin SMY setting. If not used, please fix this pin to IOVCC or GND.					
REV	I	1	MCU	Source output data polarity select H/W pin.	
				<b>REV</b>	<b>Source Output Data Polarity</b>
				0	Data not reverse
				1	Data reverse
As internal INVON commands are written, the external pin REV control is invalid, and INVON commands are operated based on internal NB bit setting. If not used, please fix this pin to IOVCC or GND.					

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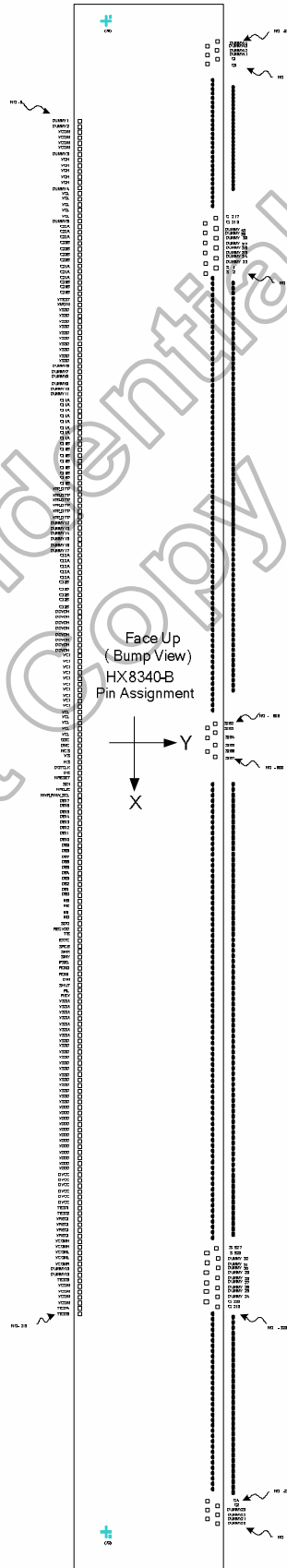
Driver Output Pins				
Signals	I/O	Pin Number	Connected with	Description
S1~S528	O	528	LCD	Source driver output pins.
G1~G220	O	220	LCD	Gate driver output pins.
IOVCC	P	1	Power Supply	Digital IO Pad power supply. IOVCC = 1.65 ~ 3.3V
VCI	P	1	Power Supply	Analog power supply. VCI = 2.5 ~ 3.3V
VSSD	P	1	Ground	Digital ground
VSSA	P	1	Ground	Analog ground
VPP_OTP	P	1	Power supply	Power supply pin used in OTP program mode and operates at 6.5V ± 0.2. If not in OTP program mode, please let it open.
C11A,C11B	I/O	2	Step-up Capacitor	Connect to the step-up capacitors for step up circuit 1 operation (DDVDH). Leave this pin open if the internal step-up circuit is not used.
C12A,C12B	I/O	2	Step-up Capacitor	Connect to the step-up capacitors for step up circuit 3 operation (VCL). Leave this pin open if the internal step-up circuit is not used.
C21A,C21B C22A,C22B	I/O	4	Step-up Capacitor	Connect to the step-up capacitors for step up circuit 2 operations (VGH, VGL). Leave this pin open if the internal step-up circuit is not used.
VDDD	O	1	Stabilizing Capacitor	Output from internal logic voltage (1.6V). Connect to a stabilizing capacitor
VREG1	O	1	Stabilizing Capacitor	Internal generated stable power for source driver unit.
VCOM	O	1	TFT common electrode	The power supply of common voltage in TFT driving. The voltage amplitude between VCOMH and VCOML is output. Connect this pin to the common electrode in TFT panel.
VCOMH	O	1	Stabilizing capacitor	Connect this pin to the capacitor for stabilization. This pin indicates a high level of VCOM amplitude generated in driving the VCOM alternation.
VCOML	O	1	Stabilizing capacitor	When the VCOM alternation is driven, this pin indicates a low level of VCOM amplitude. Connect this pin to a capacitor for stabilization.
VCOMR	I	1	Resistor or open	A VCOMH reference voltage input. When adjusting VCOMH externally, set registers to halt the VCOMH internal adjusting circuit and connect a variable resistor between VREG1 and GND for VCOMH adjusting.
VCL	O	1	Stabilizing capacitor	A negative voltage of VCI x (-1) output for VCOML circuit.
DDVDH	O	1	Stabilizing capacitor	A power output from the step-up circuit1. Connect to a stabilizing capacitor between GND and DDVDH. DDVDH =5.2V (typ.) when VCI = 2.8V.
VGH	O	1	Stabilizing capacitor	A positive power output from the step-up circuit 2 for the gate line drive circuit. The step-up rate is determined by BT3-0 bits. Connect to a stabilizing capacitor between GND and VGH. VGH=max 15.6V
VGL	O	1	Stabilizing capacitor	A negative power output from the step-up circuit 2 for the gate line drive circuit. The step-up rate is determined by BT(3-0) bits. Connect to a stabilizing capacitor between GND and VGL, and insert a schottkey barrier diode between GND and VGL. VGL=min -13.5V

Test pin and others				
Signals	I/O	Pin Number	Connected with	Description
OSC	I	1	External Clock / Open	External oscillator clock input with internal pull-low circuit. That input is valid in test mode enable. Left it opens in normal operation mode.
TEST5-1	I	5	GND	Test pin input (Internal pull low)
REGVDD	I	1	Open	Test pin. Left it opens in normal operation mode.
VMONI	O	1	Open	A test pin. Disconnect it.
VTEST	O	1	Open	Gamma voltage of Panel test pin output. Must be left open.
DUMMY1-44	-	32	Open	Dummy pads, Dummy 18 and Dummy 19 are connection pins

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### 4.2 Pin Assignment

Chip Size: 13880 um x 700 um  
 (Including Seal-ring 20 um \*2,  
 Scribe line 40 um \*2)  
 Chip Thickness: 300 um (typ.)  
 Pad Location: Pad center  
 Coordinate Origin: Chip center  
 Au Bump Size:  
 1. 40 um x 56 um  
 Input/Output  
 (No. 1~ No. 215)  
 2. 18 um x 100 um  
 Staggered LCD output side  
 (No. 216~ No. 988)













# >> HX8340-B(T)

176RGB x 220 dot, 262K color, TFT Mobile Single Chip Driver



DATA SHEET Preliminary V01

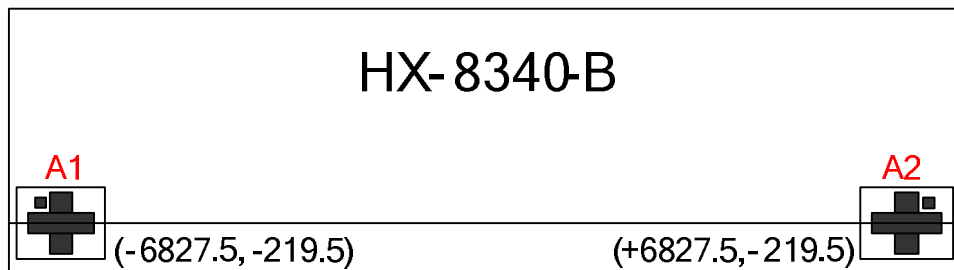
No.	Pad name	X	Y
961	G47	-6332	116
962	G45	-6348	236
963	G43	-6364	116
964	G41	-6380	236
965	G39	-6396	116
966	G37	-6412	236
967	G35	-6428	116
968	G33	-6444	236
969	G31	-6460	116
970	G29	-6476	236
971	G27	-6492	116
972	G25	-6508	236
973	G23	-6524	116
974	G21	-6540	236
975	G19	-6556	116
976	G17	-6572	236
977	G15	-6588	116
978	G13	-6604	236
979	G11	-6620	116
980	G9	-6636	236
981	G7	-6652	116
982	G5	-6668	236
983	G3	-6684	116
984	G1	-6700	236
985	Dummy41	-6716	116
986	Dummy42	-6732	236
987	Dummy43	-6748	116
988	Dummy44	-6764	236

Alignment	Mark	X	Y
	A1	-6827.5	-219.5
	A2	+6827.5	-219.5

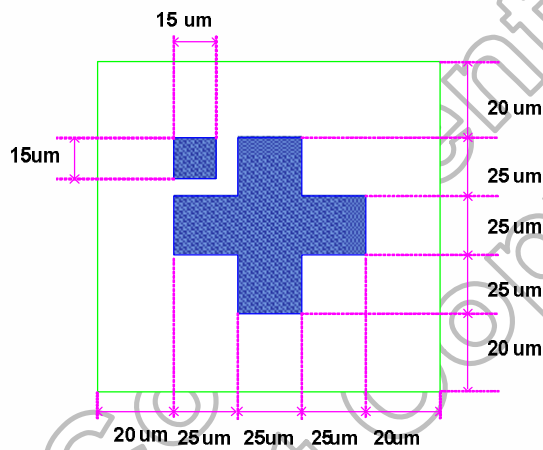
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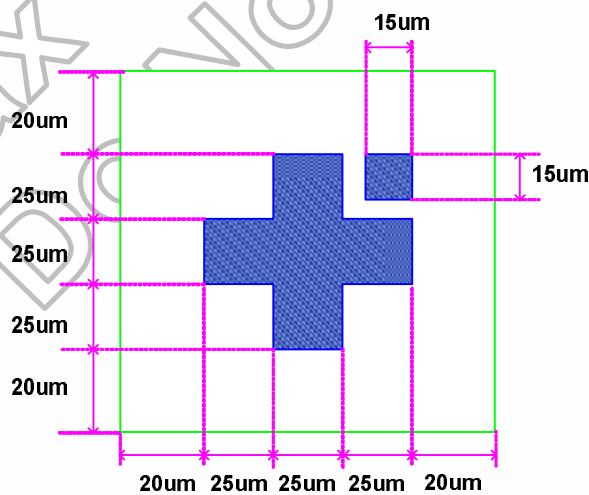
4.4 Alignment Mark



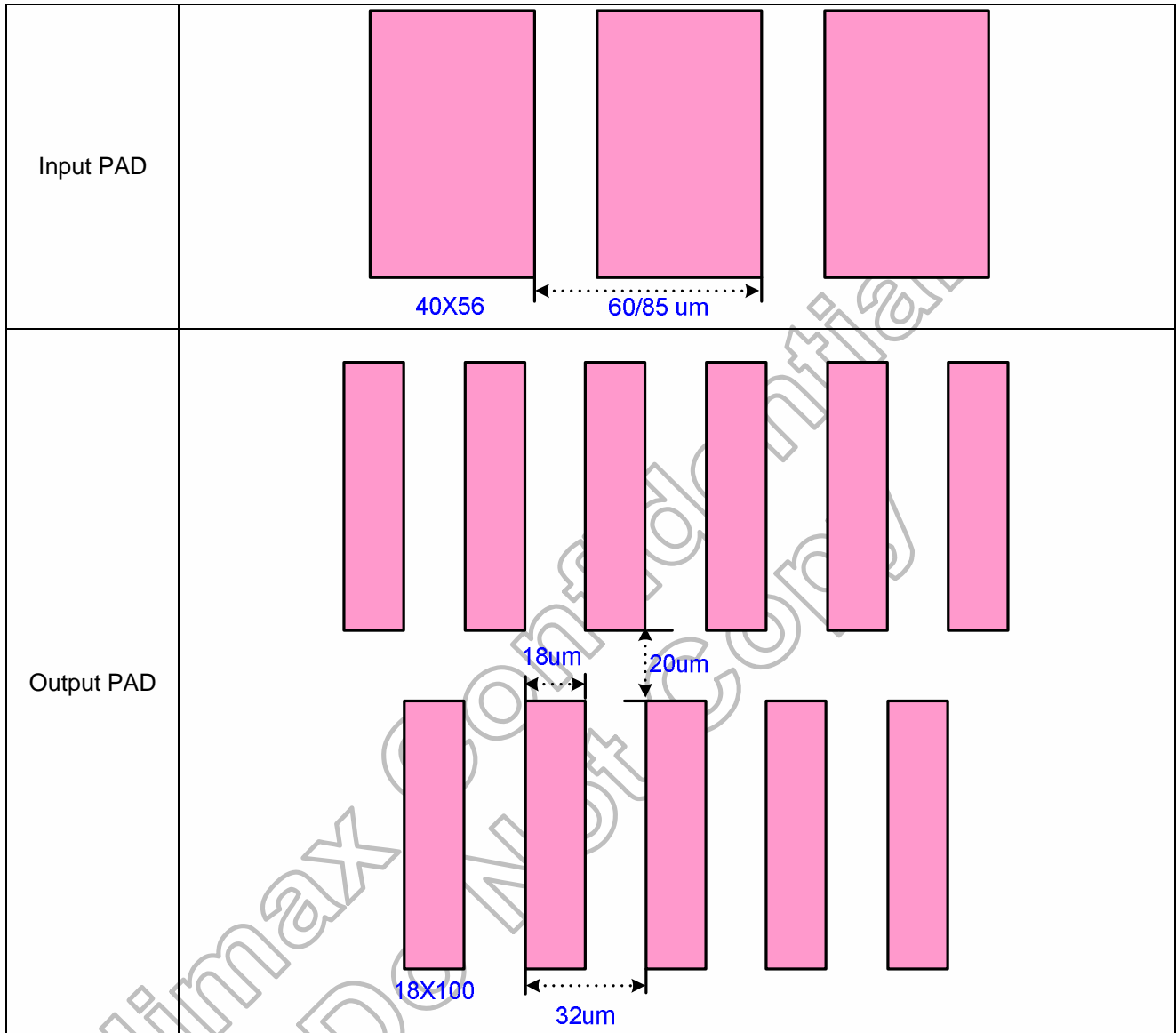
A\_MARK (A1)



A\_MARK (A2)



4.5 Bump Size



## 5. Interface

The HX8340-B supports two-type interface group: Command-Parameter interface mode, Register-Content interface mode.

This manual description focuses on Register-Content interface mode. About the Command-Parameter interface mode, please refer to the HX8340-B (N) datasheet for detail.

In Register-Content interface mode (IFSEL0='L'), the HX8340-B has a system interface circuit for command/parameter (include display data) transferring, and a RGB interface circuit for data transferring during animated display. The system interface circuit uses data bus pins (DB17-0). Since the data bus pins (DB17-0) can be used as input in RGB interface circuit, the HX8340-B shows animated display with less wiring.

System interface can be used to access internal command and internal 18-bit/pixel GRAM. The RGB interface is only used to access display data. Please make sure that in RGB interface mode, the input display data is not written to GRAM and is displayed directly.

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### 5.1 System Interface Circuit

The register-content interface circuit in HX8340-B supports 18-/16-/9-/8-bit bus width parallel bus system interface for I80 series and M68 series CPU, and a serial bus system interface for serial data input. When NCS = 'L', the parallel and serial bus system interface of the HX8340-B become active and data transfer through the interface circuit is available. The input bus width format of system interface circuit is selected by external pins IM3-0 setting. For selecting the input bus format, please refer to Table 5.1.

In register-content interface, it includes command code and the following parameter and GRAM data. The command code can be written through data bus by setting DNC = '0'. Then the parameter or GRAM data can be written to register at which that index pointer pointed by setting DNC='1'.

IM3	IM2	IM1	IM0	Interface	NRD_E	NWR_RNW_SCL	DNC	Data Bus use
0	0	0	0	6800 MCU 16-bits Parallel	E	RNW	DNC	DB0, DB9: Unused, DB17-B10, DB8-DB1: 16-bit data
0	0	0	1	6800 MCU 8-bits Parallel	E	RNW	DNC	DB9- DB0 Unused, DB17-DB10: 8-bits Data
0	0	1	0	8080 MCU 16-bits Parallel	NRD_E	NWR	DNC	DB0, DB9: Unused, DB17-10, DB8-DB1: 16-bit data
0	0	1	1	8080 MCU 8-bits Parallel	NRD_E	NWR	DNC	DB9- DB0: Unused, DB17-DB10: 8-bits Data
-	1	-	ID	Serial interface	Note <sup>(1)</sup>	SCL	Note <sup>(1)</sup>	SDI, SDO
1	0	0	0	6800 MCU 18-bits Parallel	E	RNW	DNC	DB17-DB0: 18-bits Data
1	0	0	1	6800 MCU 9-bits Parallel	E	RNW	DNC	DB8-DB0: Unused, DB17-DB9: 9-bits Data
1	0	1	0	8080 MCU 18-bits Parallel	NRD_E	NWR	DNC	DB17-DB0: 18-bits Data
1	0	1	1	8080 MCU 9-bits Parallel	NRD_E	NWR	DNC	DB8-DB0: Unused, DB17-DB9: 9-bits Data
Other Setting				Setting Invalid				

**Note:** (1) Can be connected to GND or IOVCC level.

(2) SDI and SDO can be tie together as SDA

**Table 5. 1 Pin connection According to MCU Interface Type Selection**

### 5.1.1 Parallel Bus System Interface

The input / output data from data pins (DB17-0) and signal operation of the I80/M68 series parallel bus interface are listed in Table 5.2 and Table 5.3.

IM3	IM2	IM1	IM0	Interface	DNC	NRD _E	NWR RNW _SCL	Function
0	0	1	0	16-bits Parallel	0	1	↑	Write 8-bits command (DB8 to DB1)
					1	1	↑	Write 8-bits parameter (DB8 to DB1)
					1	1	↑	Write 16-bits display data (DB17 to DB10, DB8 to DB1)
					1	↑	1	Read 8-bits command (DB8 to DB1)
					1	↑	1	Read 16-bits display data (DB17 to DB10, DB8 to DB1)
0	0	1	1	8-bits Parallel	0	1	↑	Write 8-bits command (DB17 to DB10)
					1	1	↑	Write 8-bits parameter (DB17 to DB10)
					1	1	↑	Write 8-bits display data (DB17 to DB10)
					1	↑	1	Read 8-bits parameter or status (DB17 to DB10)
					1	↑	1	Read 8-bits display data (DB17 to DB10)
1	0	1	0	18-bits Parallel	0	1	↑	Write 8-bits command (DB8 to DB1)
					1	1	↑	Write 8-bits parameter (DB8 to DB1)
					1	1	↑	Write 18-bits display data (DB17 to DB0)
					1	↑	1	Read 8-bits parameter or status (DB8 to DB1)
					1	↑	1	Read 18-bits display data (DB17 to DB0)
1	0	1	1	9-bits Parallel	0	1	↑	Write 8-bits command (DB17 to DB10)
					1	1	↑	Write 8-bits parameter (DB17 to DB10)
					1	1	↑	Write 9-bits display data (DB17 to DB9)
					1	↑	1	Read 8-bits command (DB17 to DB10)
					1	↑	1	Read 9-bits display data (DB17 to DB9)

Table 5. 2 Data Pin Function for I80 Series CPU

IM3	IM2	IM1	IM0	Interface	DNC	NWR RNW _SCL	NRD _E	Function
0	0	0	0	16-bits Parallel	0	0	↓	Write 8-bits command (DB8 to DB1)
					1	0	↓	Write 8-bits parameter (DB8 to DB1)
					1	0	↓	Write 16-bits display data (DB17 to DB10, DB8 to DB1)
					1	1	↓	Read 8-bits command (DB8 to DB1)
					1	1	↓	Read 16-bits display data (DB17 to DB10, DB8 to DB1)
0	0	0	1	8-bits Parallel	0	0	↓	Write 8-bits command (DB17 to DB10)
					1	0	↓	Write 8-bits parameter (DB17 to DB10)
					1	0	↓	Write 8-bits display data (DB17 to DB10)
					1	1	↓	Read 8-bits parameter or status (DB17 to DB10)
					1	1	↓	Read 8-bits display data (DB17 to DB10)
1	0	0	0	18-bits Parallel	0	0	↓	Write 8-bits command (DB8 to DB1)
					1	0	↓	Write 8-bits parameter (DB8 to DB1)
					1	0	↓	Write 18-bits display data (DB17 to DB0)
					1	1	↓	Read 8-bits parameter or status (DB8 to DB1)
					1	1	↓	Read 18-bits display data (DB17 to DB0)
1	0	0	1	9-bits Parallel	0	0	↓	Write 8-bits command (DB17 to DB10)
					1	0	↓	Write 8-bits parameter (DB17 to DB10)
					1	0	↓	Write 9-bits display data (DB17 to DB9)
					1	1	↓	Read 8-bits command (DB17 to DB10)
					1	1	↓	Read 9-bits display data (DB17 to DB9)

Table 5. 3 Data Pin Function for M68 Series CPU

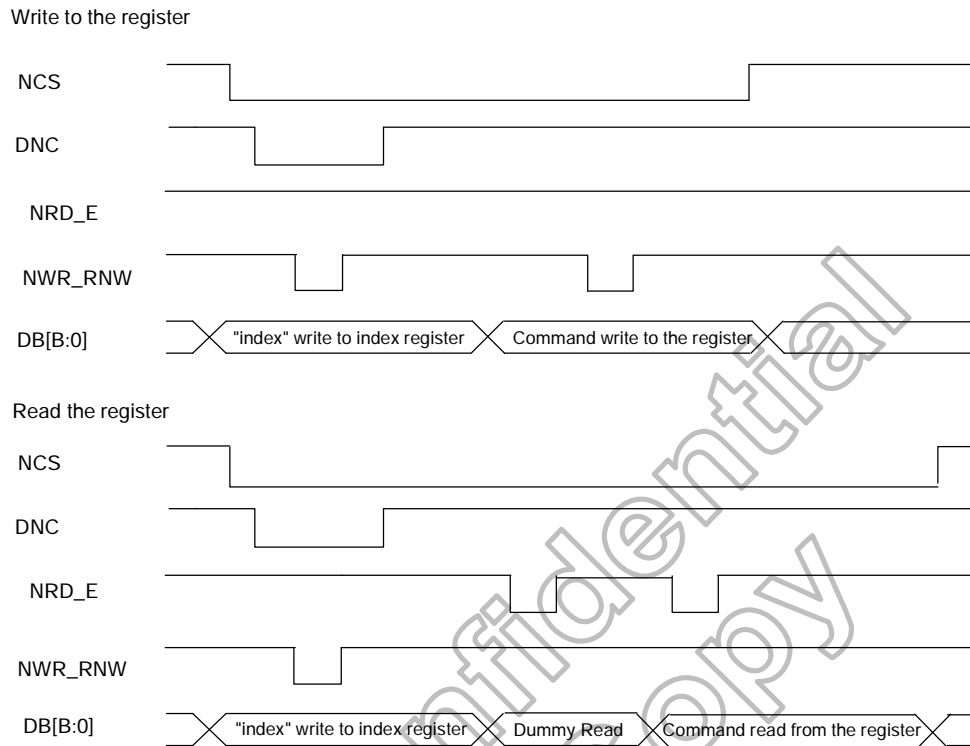


Figure 5. 1 Register Read/Write Timing in Parallel Bus System Interface (for I80 Series MPU)

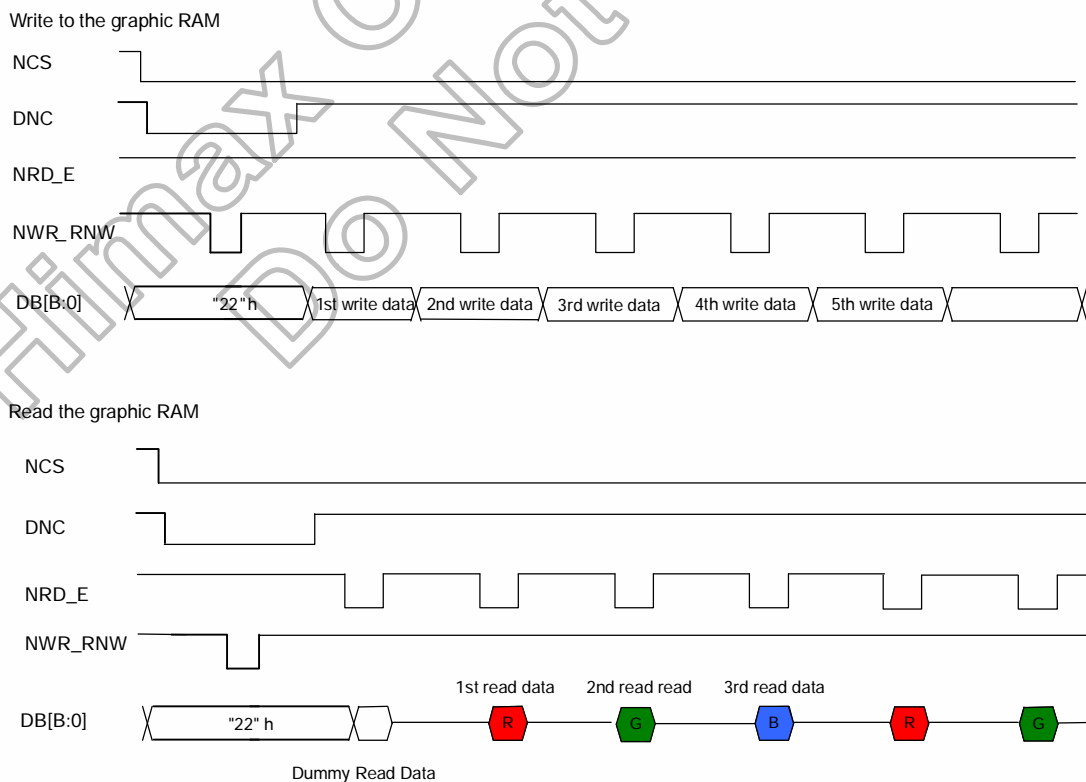
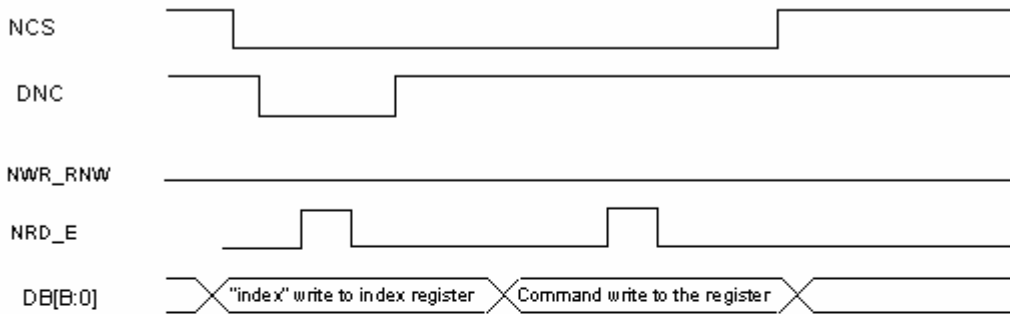


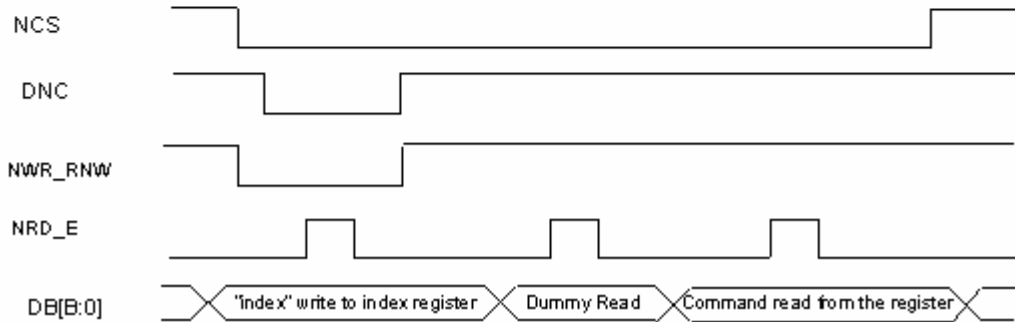
Figure 5. 2 GRAM Read/Write Timing in Bit Parallel Bus System Interface (for I80 Series MPU)



**Write to the register**

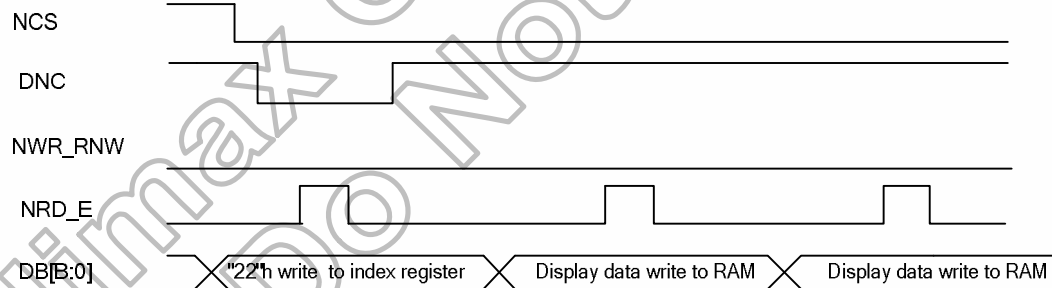


**Read the register**

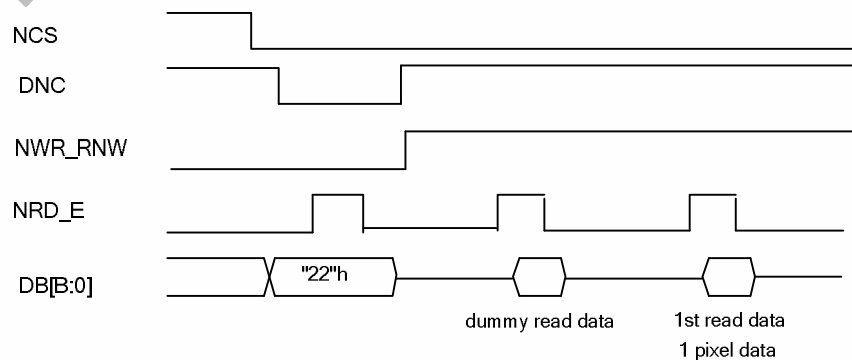


**Figure 5. 3 Register Read/Write Timing in Parallel Bus System Interface (for M68 Series MPU)**

**Write to the graphic RAM**



**Read the graphic RAM**



**Figure 5. 4 GRAM Read/Write Timing in Bit Parallel Bus System Interface (for M68 Series MPU)**

### 5.1.2 MCU Data Color Coding

MCU Data Color Coding for RAM data Write

- Parallel 8-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Command
0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	x	x	22H
17H	Color																		
03h	R3	R2	R1	R0	G3	G2	G1	G0	x	x	x	x	x	x	x	x	x	x	4K-Color (2-pixels/ 3-byyes)
	B3	B2	B1	B0	R3	R2	R1	R0	x	x	x	x	x	x	x	x	x	x	
05h	R4	R3	R2	R1	R0	G5	G4	G3	x	x	x	x	x	x	x	x	x	x	65K-Color (1-pixels/ 2-byyes)
	G2	G1	G0	B4	B3	B2	B1	B0	x	x	x	x	x	x	x	x	x	x	
06h	R5	R4	R3	R2	R1	R0	x	x	x	x	x	x	x	x	x	x	x	x	262K-Color (1-pixels/ 3byyes)
	G5	G4	G3	G2	G1	G0	x	x	x	x	x	x	x	x	x	x	x	x	
	B5	B4	B3	B2	B1	B0	x	x	x	x	x	x	x	x	x	x	x	x	

Table 5. 4 8-Bits Parallel Interface Set Table

- Parallel 16-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Command
x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	x	22H
17H	Color																		
03h	x	x	x	x	R3	R2	R1	R0	x	G3	G2	G1	G0	B3	B2	B1	B0	x	4K-Color
05h	R4	R3	R2	R1	R0	G5	G4	G3	x	G2	G1	G0	B4	B3	B2	B1	B0	x	65K-Color
06h	R5	R4	R3	R2	R1	R0	x	x	x	G5	G4	G3	G2	G1	G0	x	x	x	262K-Color (2-pixels/ 3byyes)
	B5	B4	B3	B2	B1	B0	x	x	x	R5	R4	R3	R2	R1	R0	x	x	x	
	G5	G4	G3	G2	G1	G0	x	x	x	B5	B4	B3	B2	B1	B0	x	x	x	

Table 5. 5 16-Bits Parallel Interface Set Table

- Parallel 9-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Register
0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	x	x	22H
17H	Color																		
06h	R5	R4	R3	R2	R1	R0	G5	G4	G3	x	x	x	x	x	x	x	x	x	262K-Color (1-pixels/ 2bytes)
	G2	G1	G0	B5	B4	B3	B2	B1	B0	x	x	x	x	x	x	x	x	x	

Table 5. 6 9-Bits Parallel Interface Set Table

- Parallel 18-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Register
x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	x	22H
17H	Color																		
03h	x	x	x	x	x	x	R3	R2	R1	R0	G3	G2	G1	G0	B3	B2	B1	B0	4K-Color
05h	x	x	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B4	B3	B2	B1	B0	65K-Color
06h	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0	262K-Color

Table 5. 7 18-Bits Parallel Interface Set Table

**Parallel 8-Bits Bus Interface for RAM Data Write**

Different display data formats are available for three colors depth supported by listed below.

- 4K-Colors, RGB 4, 4, 4-bits input data. (17H="03h")
- 65K-Colors, RGB 5, 6, 5-bits input data. (17H="05h")
- 262K-Colors, RGB 6, 6, 6-bits input data. (17H="06h")

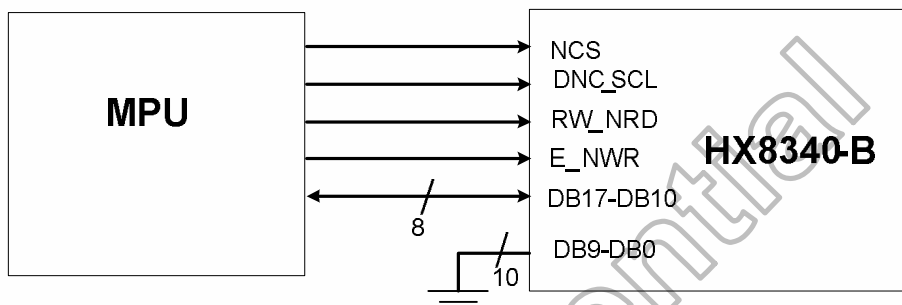


Figure 5. 5 Example of I80- / M68- System 8-Bit Parallel Bus Interface

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# >> HX8340-B(T)

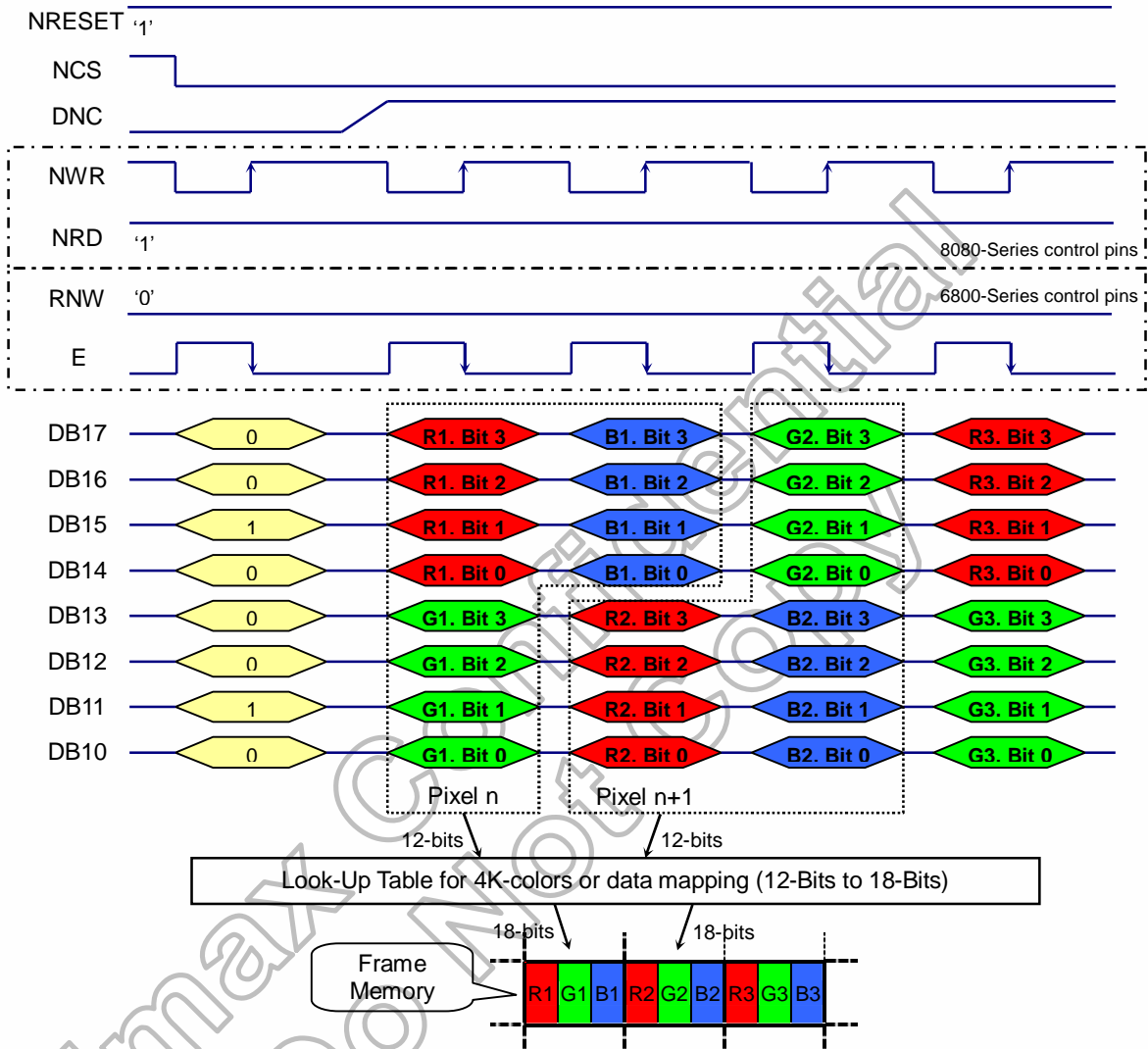
176RGB x 220 dot, 262K color, TFT Mobile Single Chip Driver



DATA SHEET Preliminary V01

8-bits data bus for 12-bits/pixel (RGB 4-4-4-bits input), 4K-colors, 17H="03h"

There are 2-pixels (6 sub-pixels) per 3-bytes.



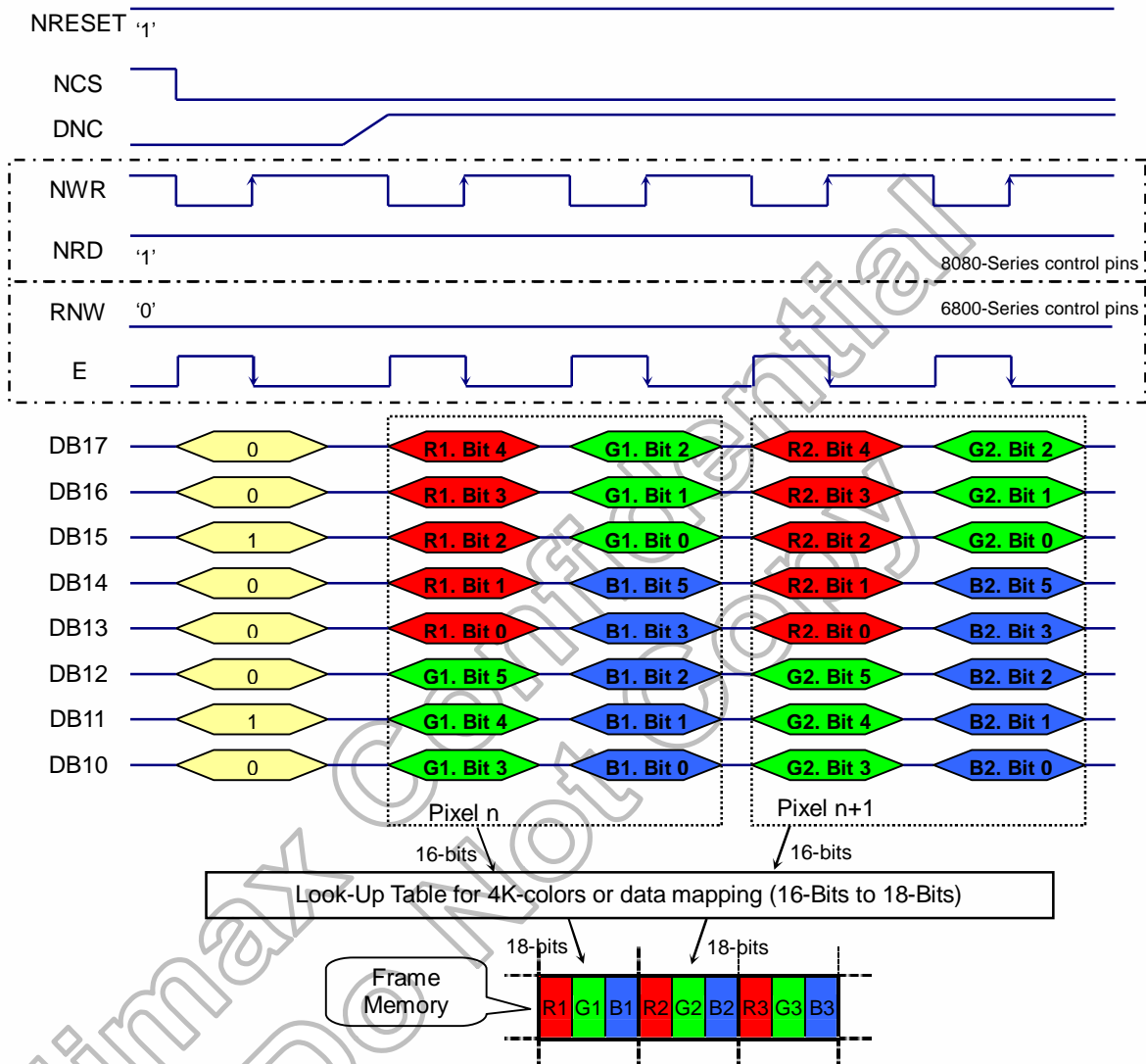
**Note:** (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 3, LSB=Bit 0 for Red, Green and Blue data.

(2) 3-times transfer is used to transmit 1 pixel data with the 12-bits color depth information.

(3) '-' = Don't care - Can be set to IOVCC or VSSD level.

8-bits data bus for 16-bits/pixel (RGB 5-6-5-bits input), 65K-colors, 17H="05h"

There is 1-pixel (3 sub-pixels) per 2-bytes.



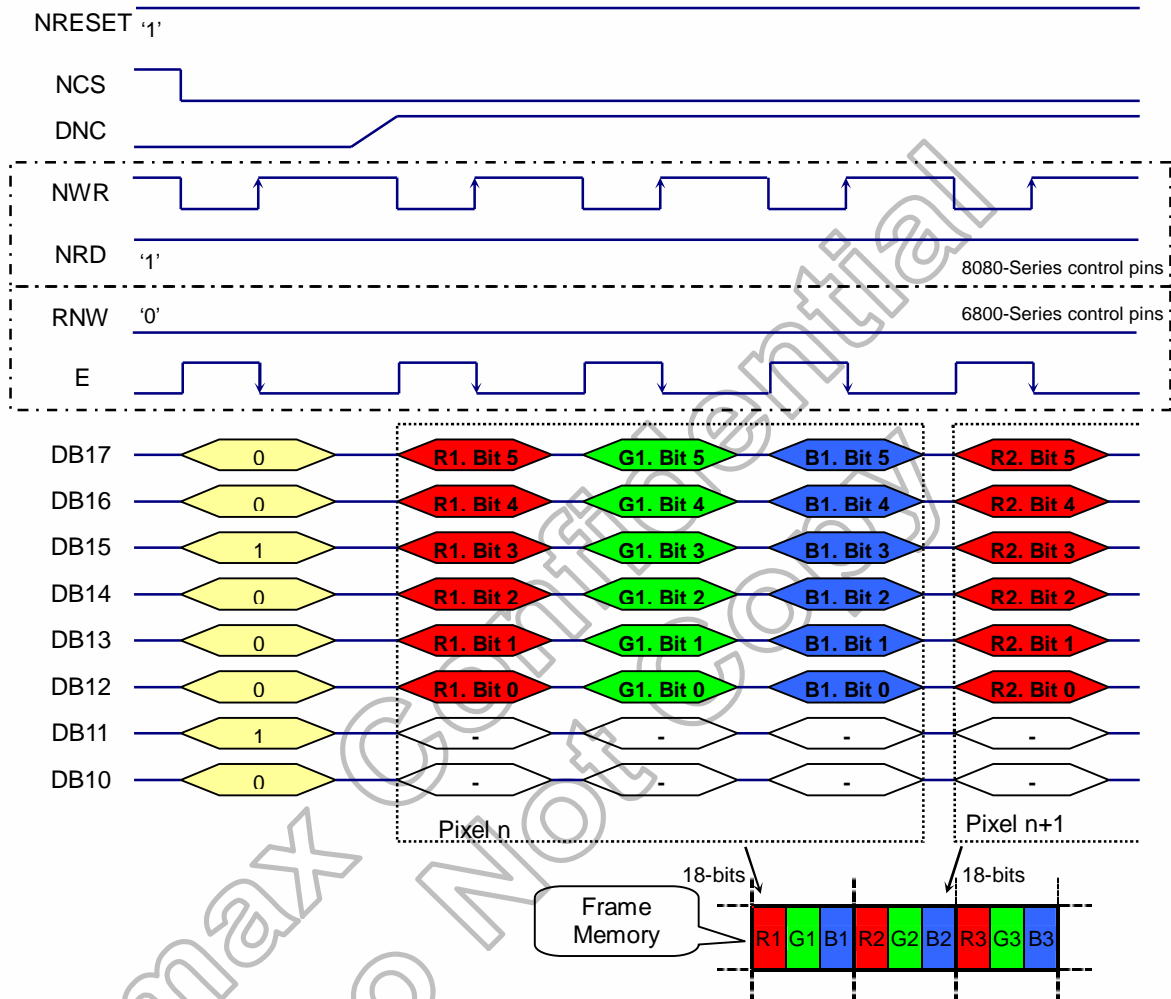
**Note:** (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Green and MSB=Bit 4, LSB=Bit 0 for Red and Blue data.

(2) 2-times transfer is used to transmit 1 pixel data with the 16-bits color depth information.

(3) 'x' = Don't care - Can be set to IOVCC or VSSD level.

8-bits data bus for 18-bits/pixel (RGB 6-6-6-bits input), 262K-colors, 17H="06h"

There is 1-pixel (3 sub-pixels) per 3-bytes.



**Note:** (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.

(2) 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.

(3) - = Don't care - Can be set to IOVCC or VSSD level.



**Parallel 16-Bits Bus Interface for RAM Data Write**

Different display data formats are available for three colors depth supported by listed below.

- 4K-Colors, RGB 4, 4, 4-bits input data. (17H="03h")
- 65K-Colors, RGB 5, 6, 5-bits input data. (17H="05h")
- 262K-Colors, RGB 6, 6, 6-bits input data. (17H="06h")

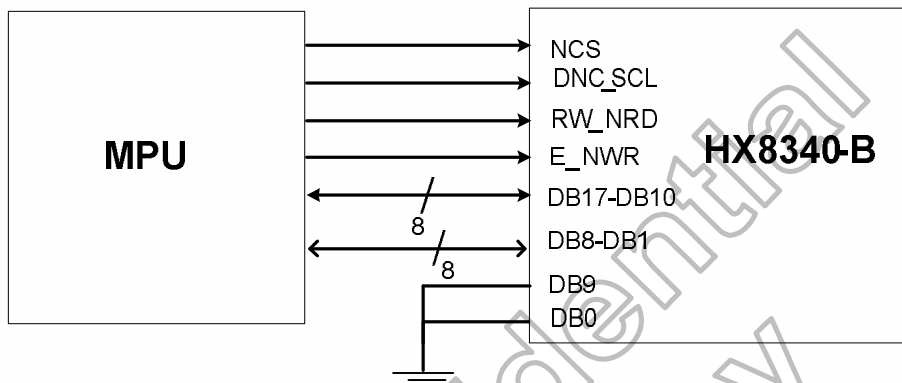
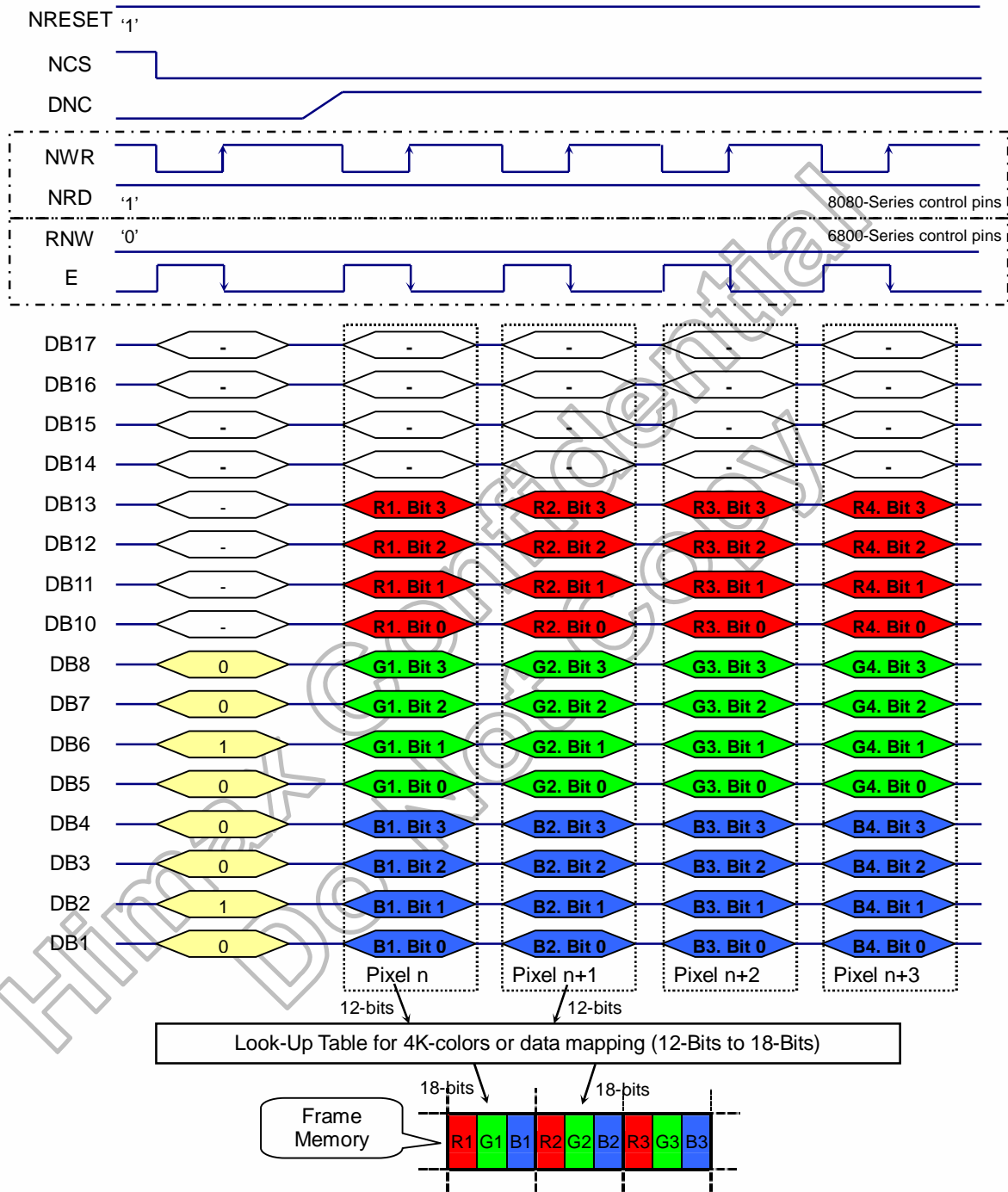


Figure 5. 6 Example of I80- / M68- System 16-Bit Parallel Bus Interface

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16-bits data bus for 12-bits/pixel (RGB 4-4-4-bits input), 4K-colors, 17H="03h"

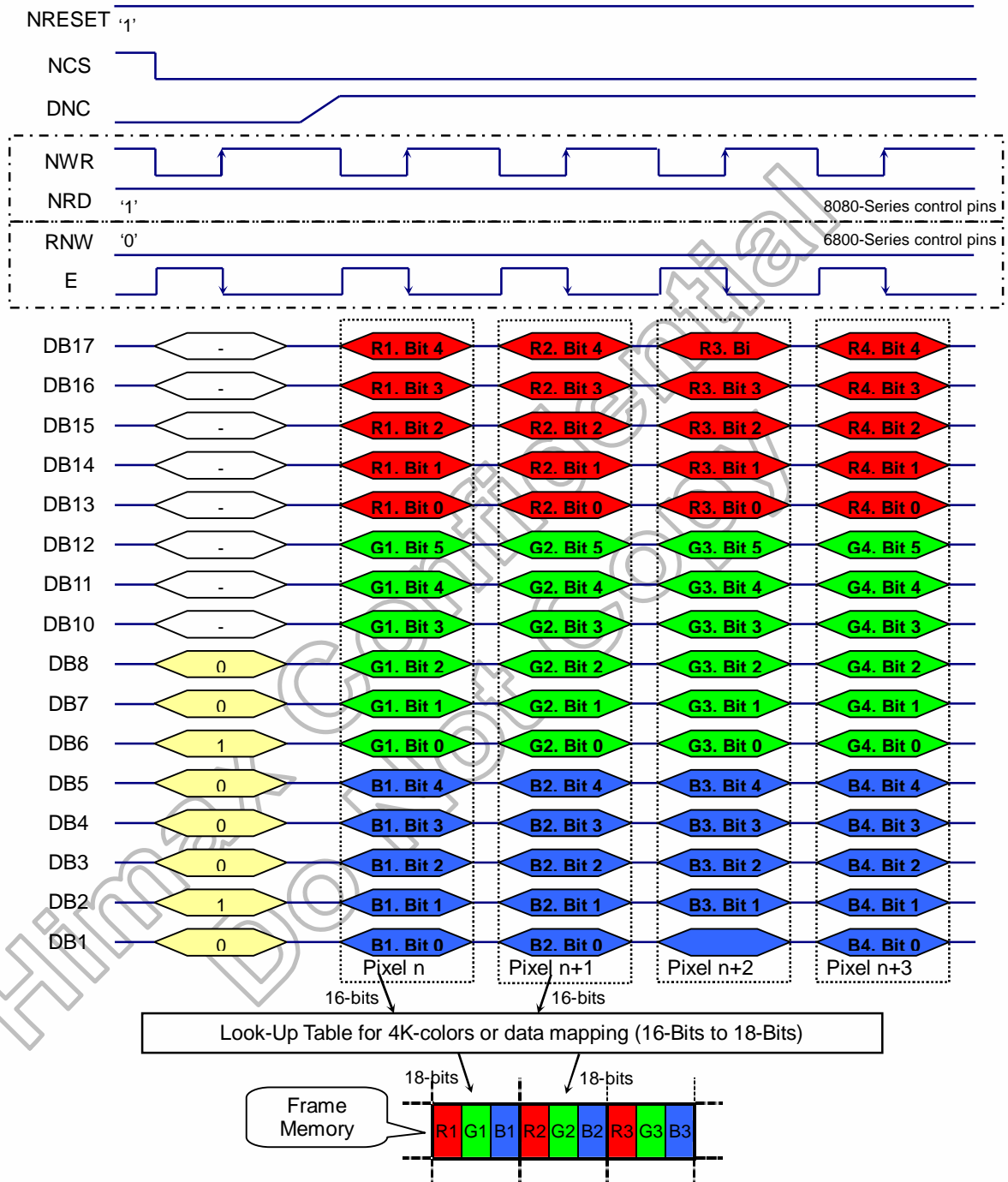
There is 1-pixel (3 sub-pixels) per 1-byte



- Note:** (1) The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 3, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 1-times transfer is used to transmit 1 pixel data with the 12-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

16-bits data bus for 16-bits/pixel (RGB 5-6-5-bits input), 65K-colors, 17H="05h"

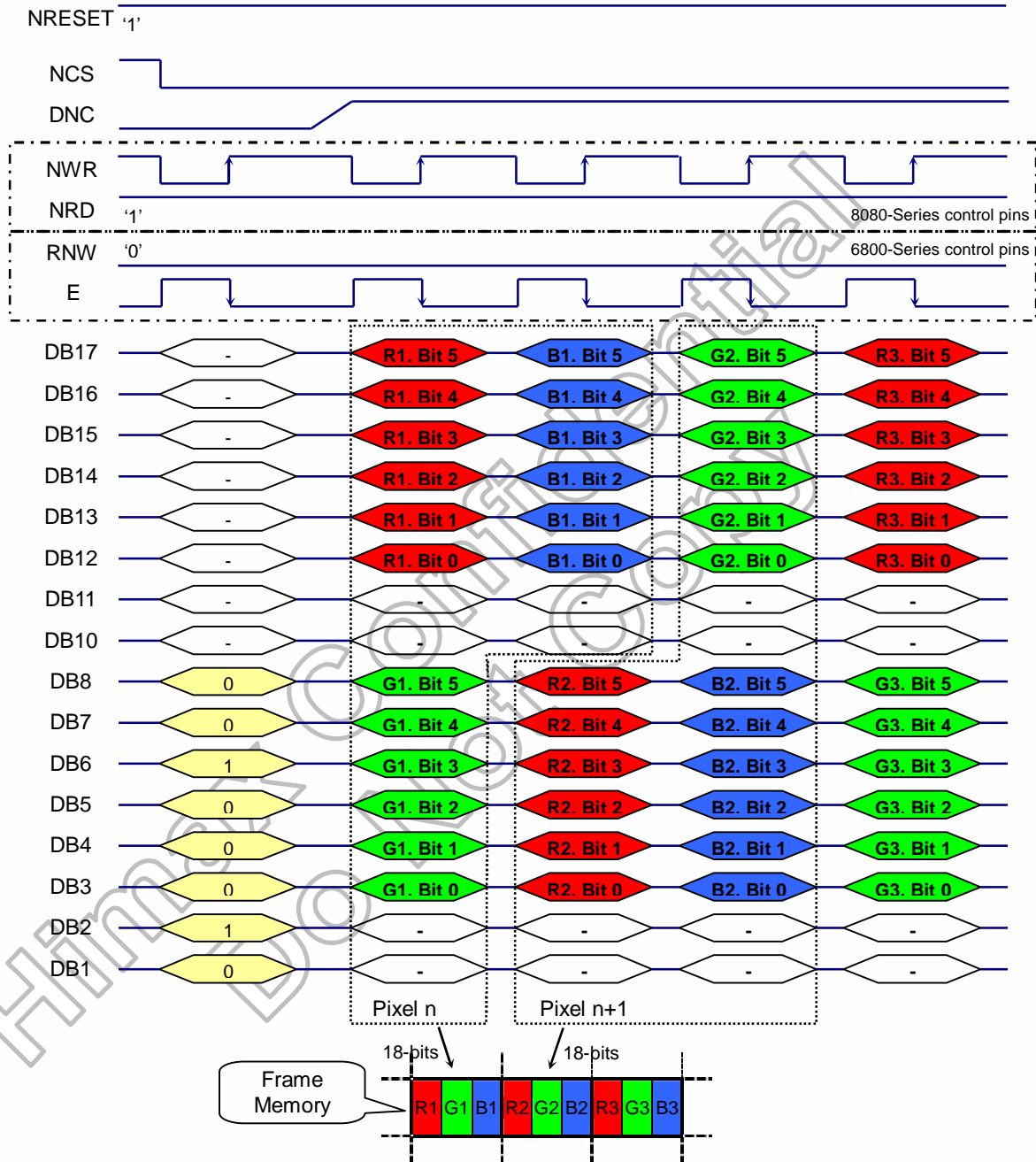
There is 1-pixel (3 sub-pixels) per 1-byte



- Note:** (1) The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Green, and MSB=Bit 4, LSB=Bit 0 for Red and Blue data.  
 (2) 1-times transfer is used to transmit 1 pixel data with the 16-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

16-bits data bus for 18-bits/pixel (RGB 6-6-6-bits input), 262K-colors, 17H="06h"

There are 2-pixels (6 sub-pixels) per 3-bytes



- Note:** (1) The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

**Parallel 9-Bits Bus Interface for RAM Data Write**

Different display data formats are available for three colors depth supported by listed below.

- 262K-Colors, RGB 6, 6, 6-bits input data. (17H="06h")

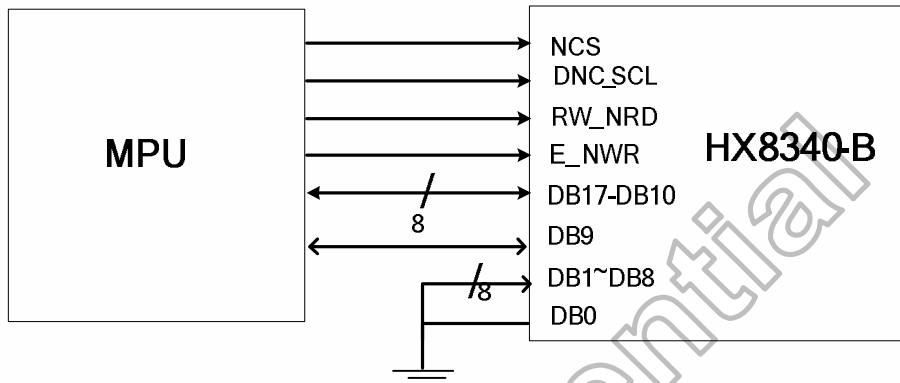
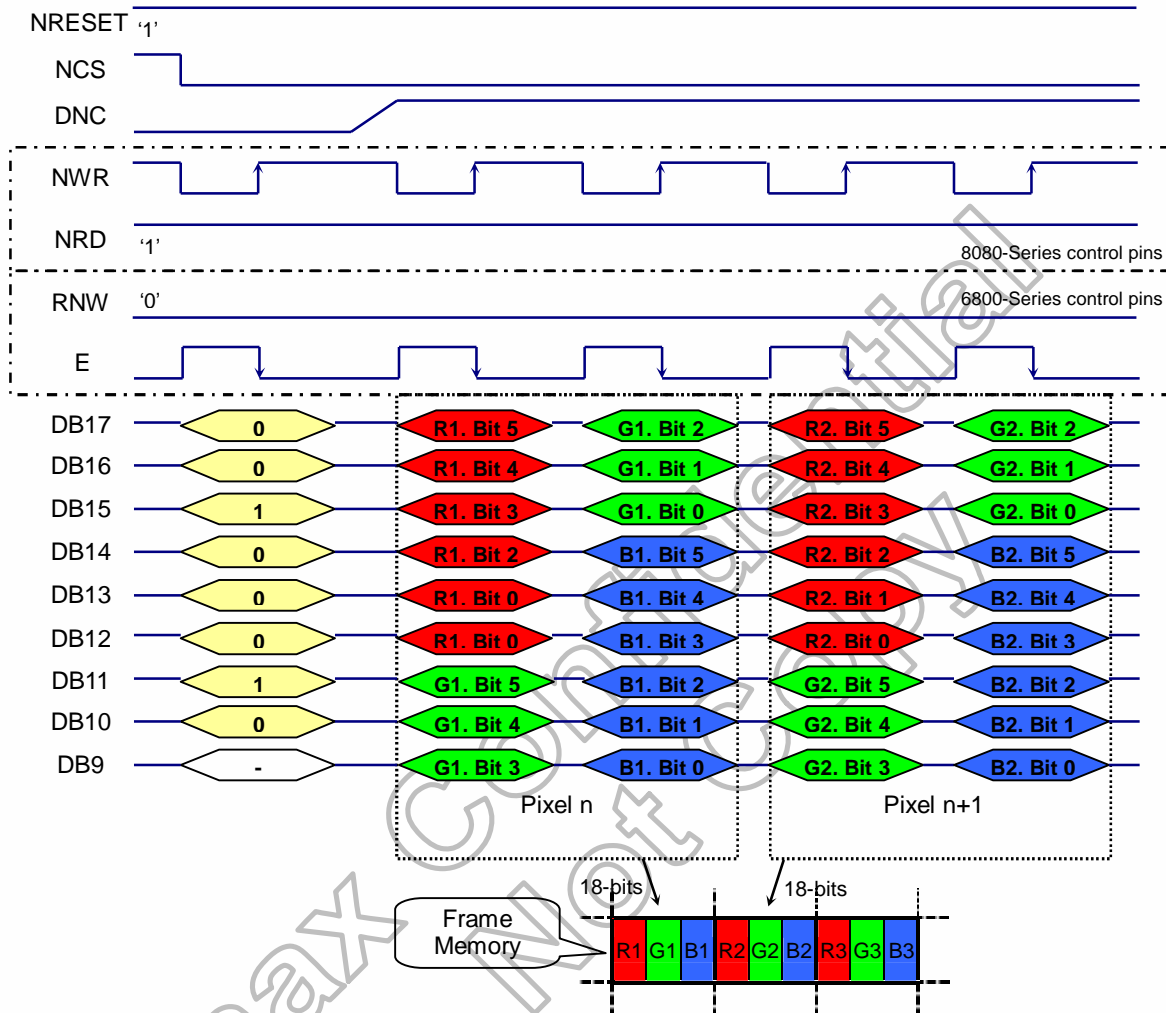


Figure 5. 7 Example of I80- / M68- System 9-Bit Parallel Bus Interface

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9-bits data bus for 18-bits/pixel (RGB 6-6-6-bits input), 262K-colors, 17H="06h"

There is 1-pixel (3 sub-pixels) per 2-bytes



- Note:** (1) The data order is as follows, MSB=D8, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 3-times transfer is used to transmit 1 pixel data with the 18-bit color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.



### Parallel 18-Bits Bus Interface for RAM Data Write

Different display data formats are available for three colors depth supported by listed below.

- 4K-Colors, RGB 4, 4, 4-bits input data. (17H="03h")
- 65K-Colors, RGB 5, 6, 5-bits input data. (17H="05h")
- 262K-Colors, RGB 6, 6, 6-bits input data. (17H="06h")

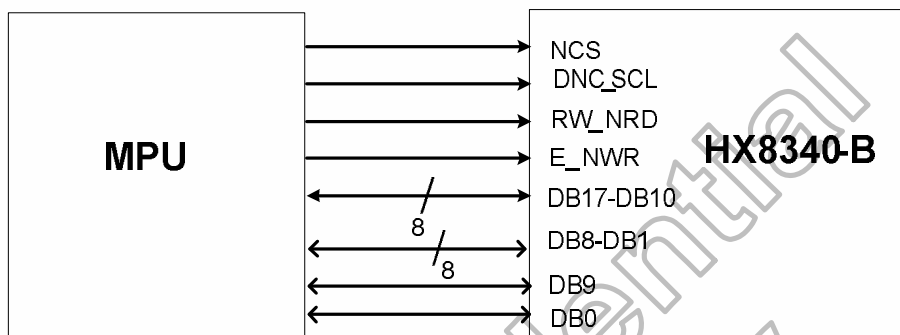
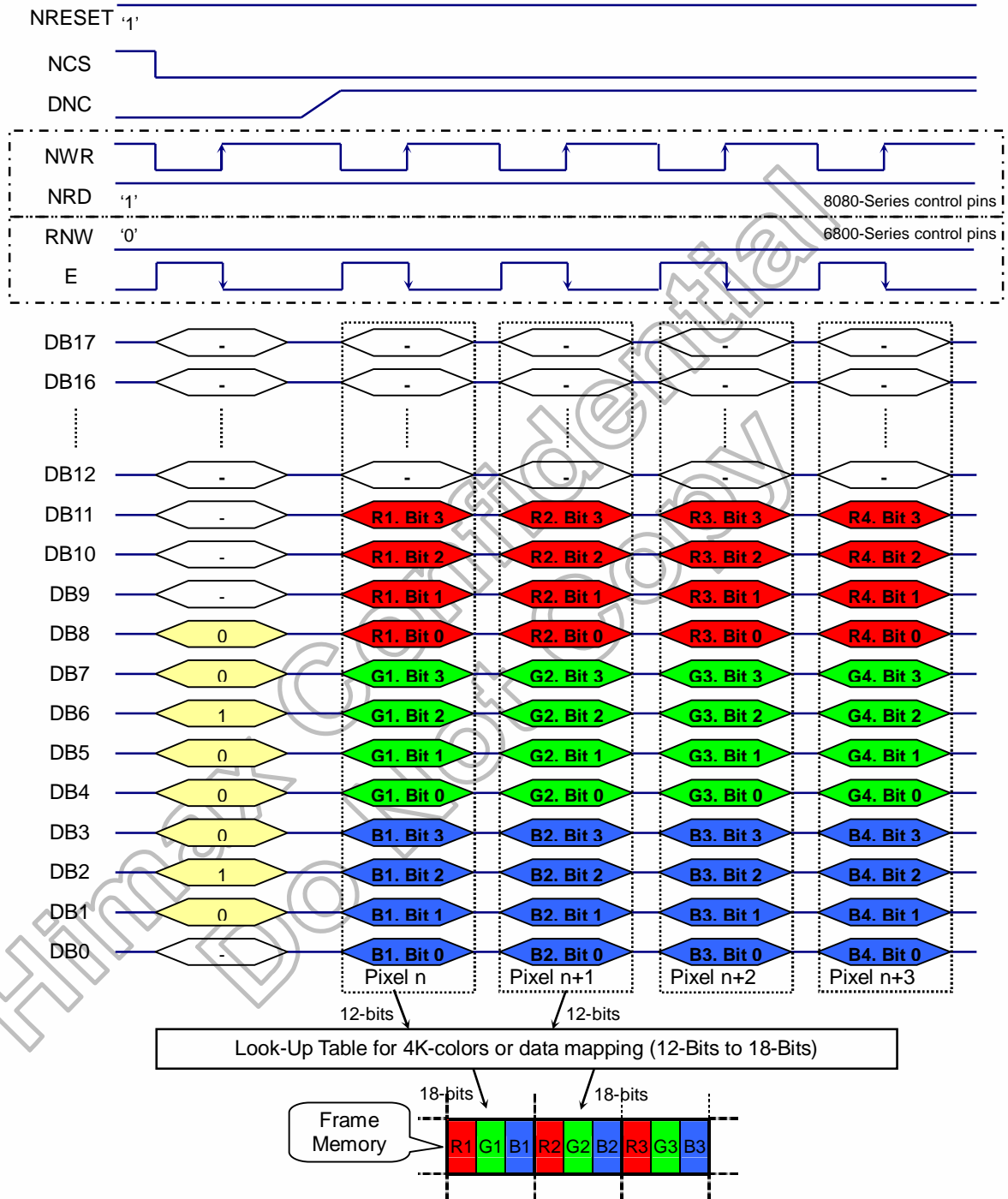


Figure 5. 8 Example of I80- / M68- System 18-Bit Parallel Bus Interface

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18-bits data bus for 12-bits/pixel (RGB 4-4-4-bits input), 4K-colors, 17H="03h"

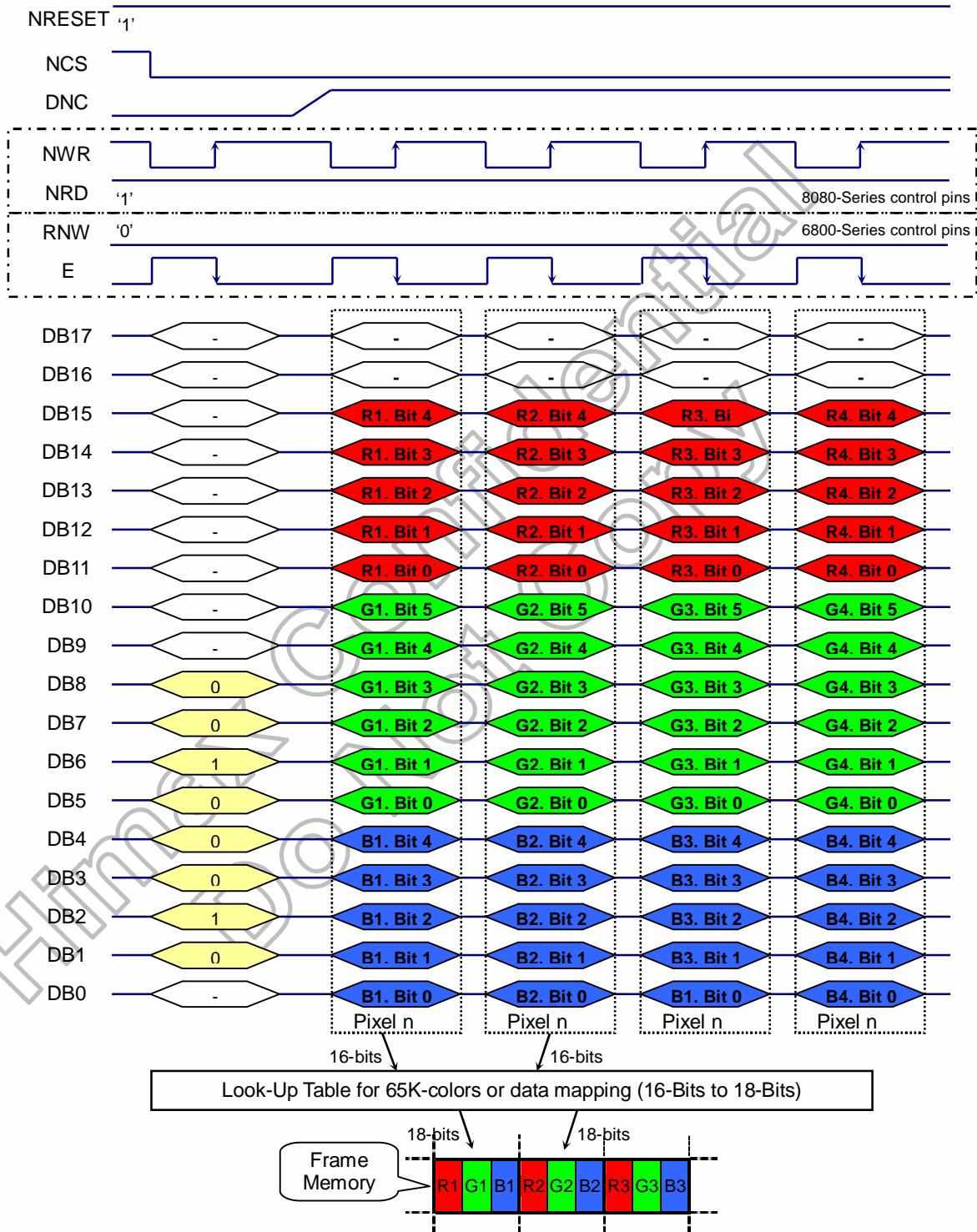
There is 1-pixel (3 sub-pixels) per 1-byte



- Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit 3, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 1-times transfer is used to transmit 1 pixel data with the 12-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

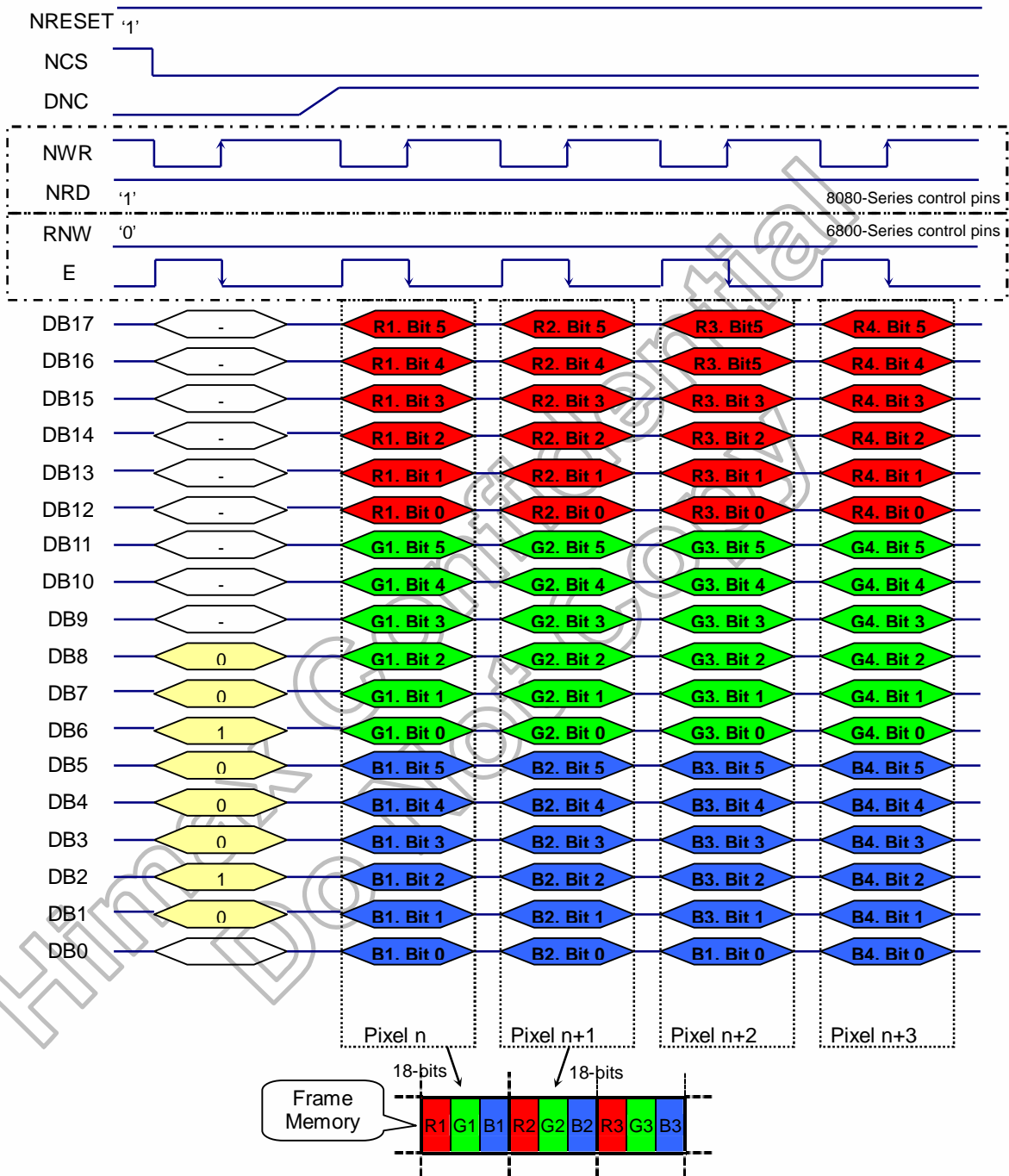
18-bits data bus for 16-bits/pixel (RGB 5-6-5-bits input), 65K-colors, 17H="05h"

There is 1-pixel (3 sub-pixels) per 1-bytes



- Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Green, and MSB=Bit 4, LSB=Bit 0 for Red and Blue data.  
 (2) 1-times transfer is used to transmit 1 pixel data with the 16-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

18-bits data bus for 18-bits/pixel (RGB 6-6-6-bits input), 262K-colors, 17H="06h"  
 There is 1-pixel (6 sub-pixels) per 1-byte



- Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 1-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

### 5.1.3 MCU Data Color Coding for RAM Data Read

- Parallel 8-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Command
	0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	x	<b>22H</b>
Read Data Format	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read
	R5	R4	R3	R2	R1	R0	x	x											262K-Color (1-pixels/ 3bytes)
	G5	G4	G3	G2	G1	G0	x	x	x	x	x	x	x	x	x	x	x	x	
B5	B4	B3	B2	B1	B0	x	x	x	x	x	x	x	x	x	x	x	x	x	

Table 5. 8 8-Bits Parallel Interface Set Table

- Parallel 16-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Command
	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	x	<b>22H</b>
Read Data Format	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	Dummy Read
	R5	R4	R3	R2	R1	R0	x	x	x	G5	G4	G3	G2	G1	G0	x	x	x	262K-Color (2-pixels/ 3bytes)
	B5	B4	B3	B2	B1	B0	x	x	x	R5	R4	R3	R2	R1	R0	x	x	x	
G5	G4	G3	G2	G1	G0	x	x	x	B5	B4	B3	B2	B1	B0	x	x	x		

Table 5. 9 16-Bits Parallel Interface Set Table

- Parallel 9-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Register
	0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	x	<b>22H</b>
Read Data Format	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read
	R5	R4	R3	R2	R1	R0	G5	G4	G3										262K-Color (1-pixels/ 2bytes)
	G2	G1	G0	B5	B4	B3	B2	B1	B0	x	x	x	x	x	x	x	x	x	

Table 5. 10 9-Bits Parallel Interface Set Table

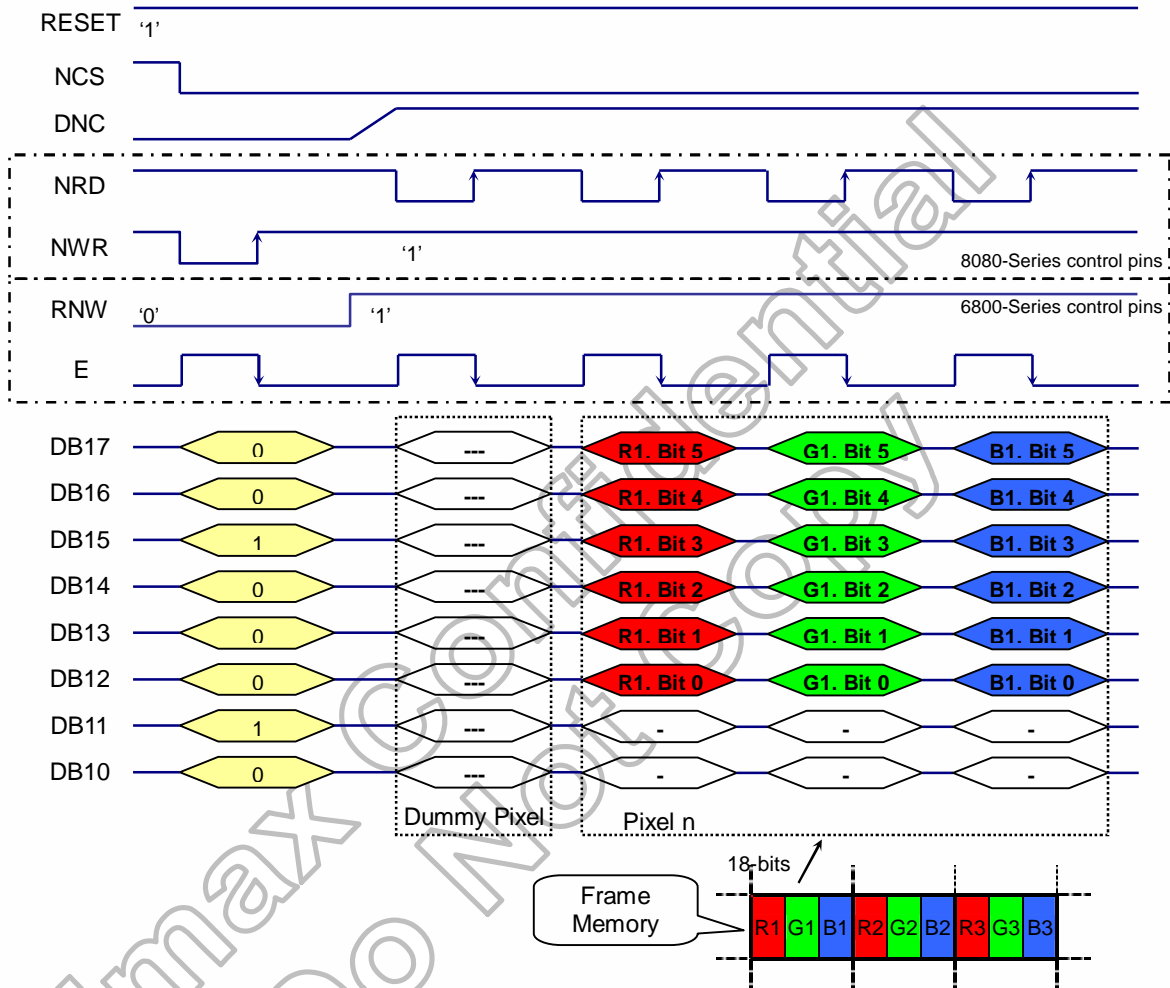
- Parallel 18-Bits Bus Interface

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Register
									x	0	0	1	0	0	0	1	0	x	<b>22H</b>
Read Data Format	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read
	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0	262K-Color (1-pixels/ 2bytes)

Table 5. 11 18-Bits Parallel Interface Set Table

**Parallel 8-Bits Bus Interface for RAM Data Read**

There is 1-pixel (3 sub-pixels) per 3-bytes. (RGB 6-6-6-bits output)



**Note:** (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.

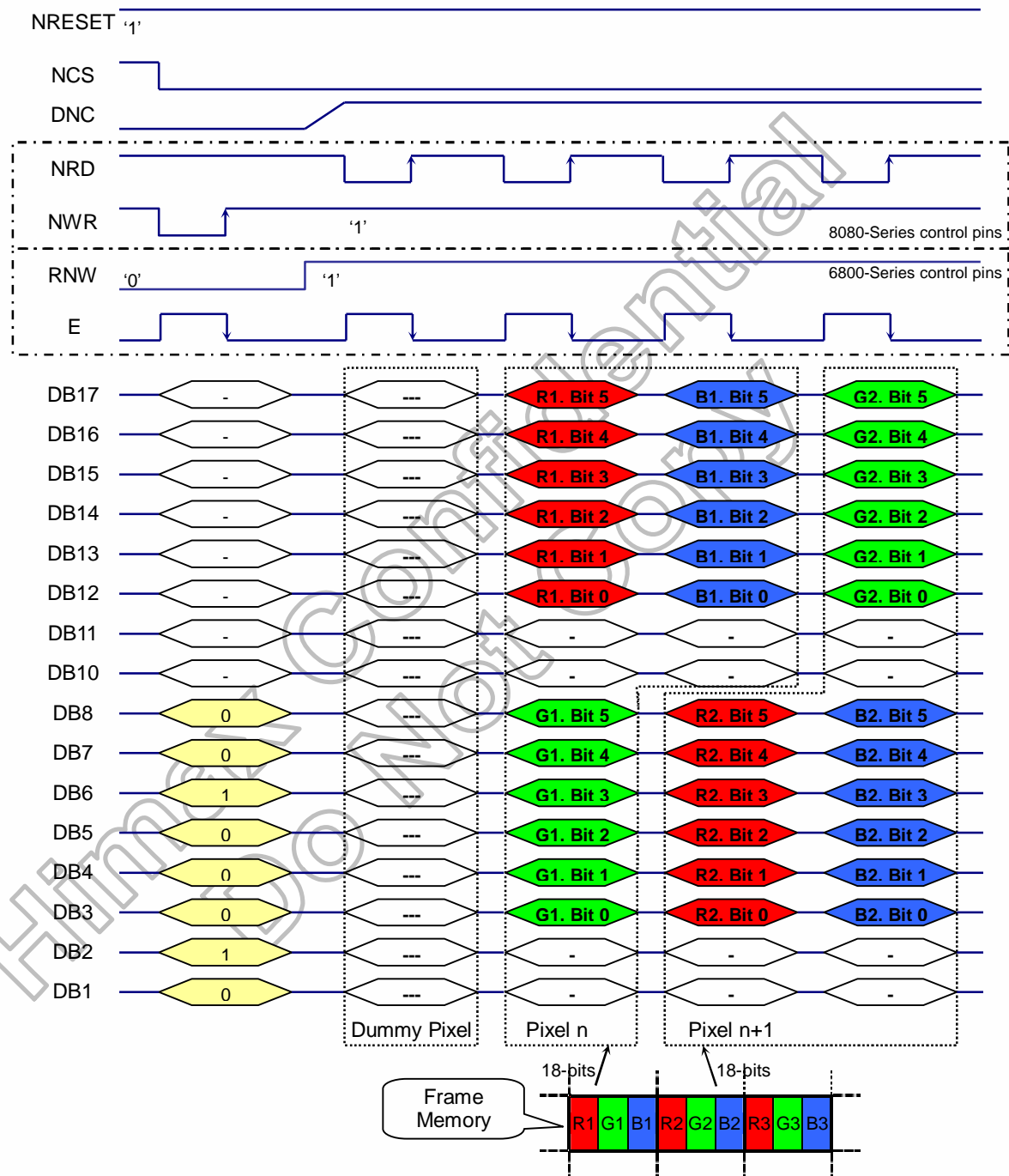
(2) 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.

(3) '-' = Don't care - Can be set to IOVCC or VSSD level.



## Parallel 16-Bits Bus Interface for RAM Data Read

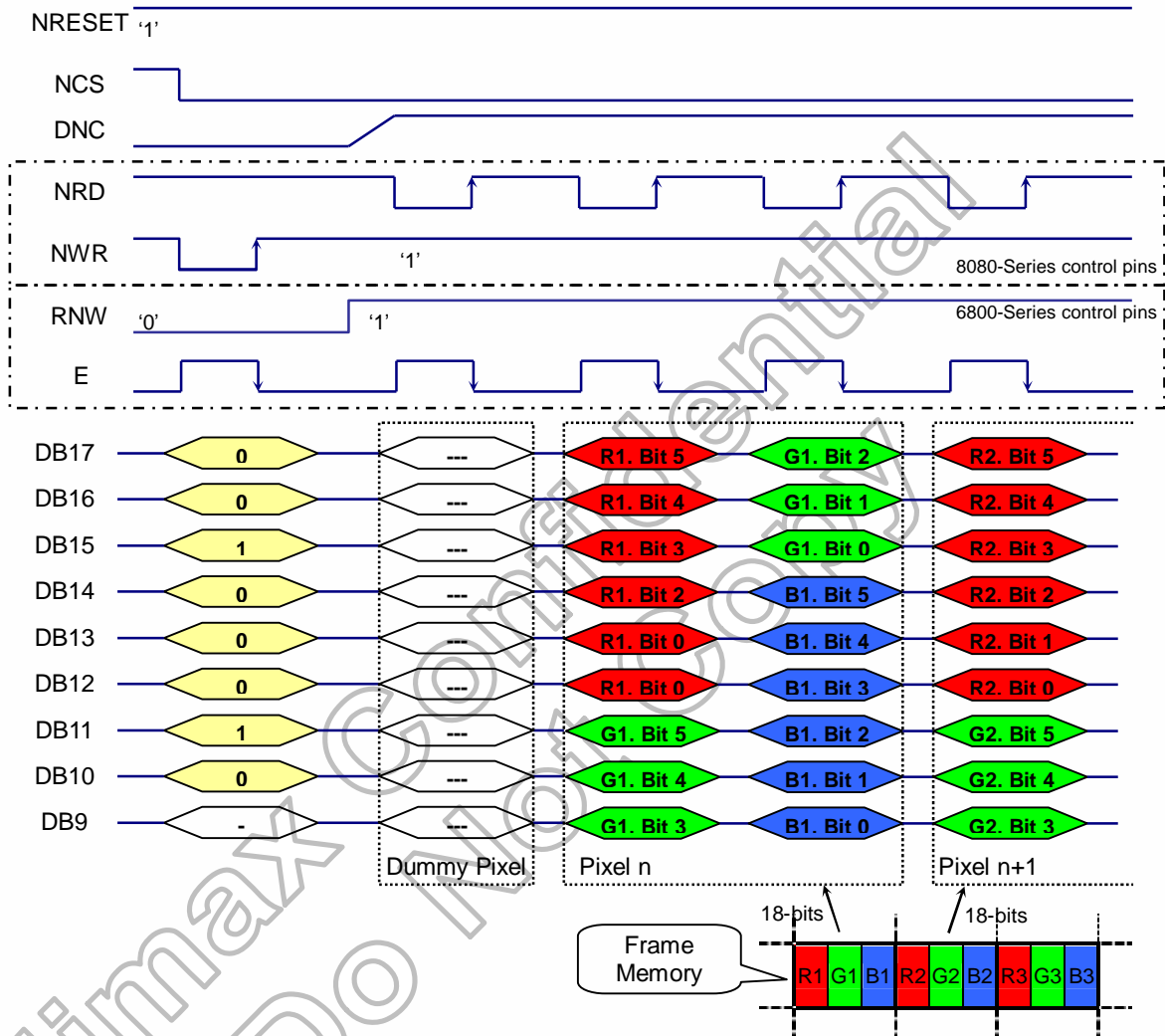
There are 2 pixel (6 sub-pixels) per 3 bytes (RGB 6-6-6-bits output)



- Note:**
- (1) The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.
  - (2) 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.
  - (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

**Parallel 9-Bits Bus Interface for RAM Data Read**

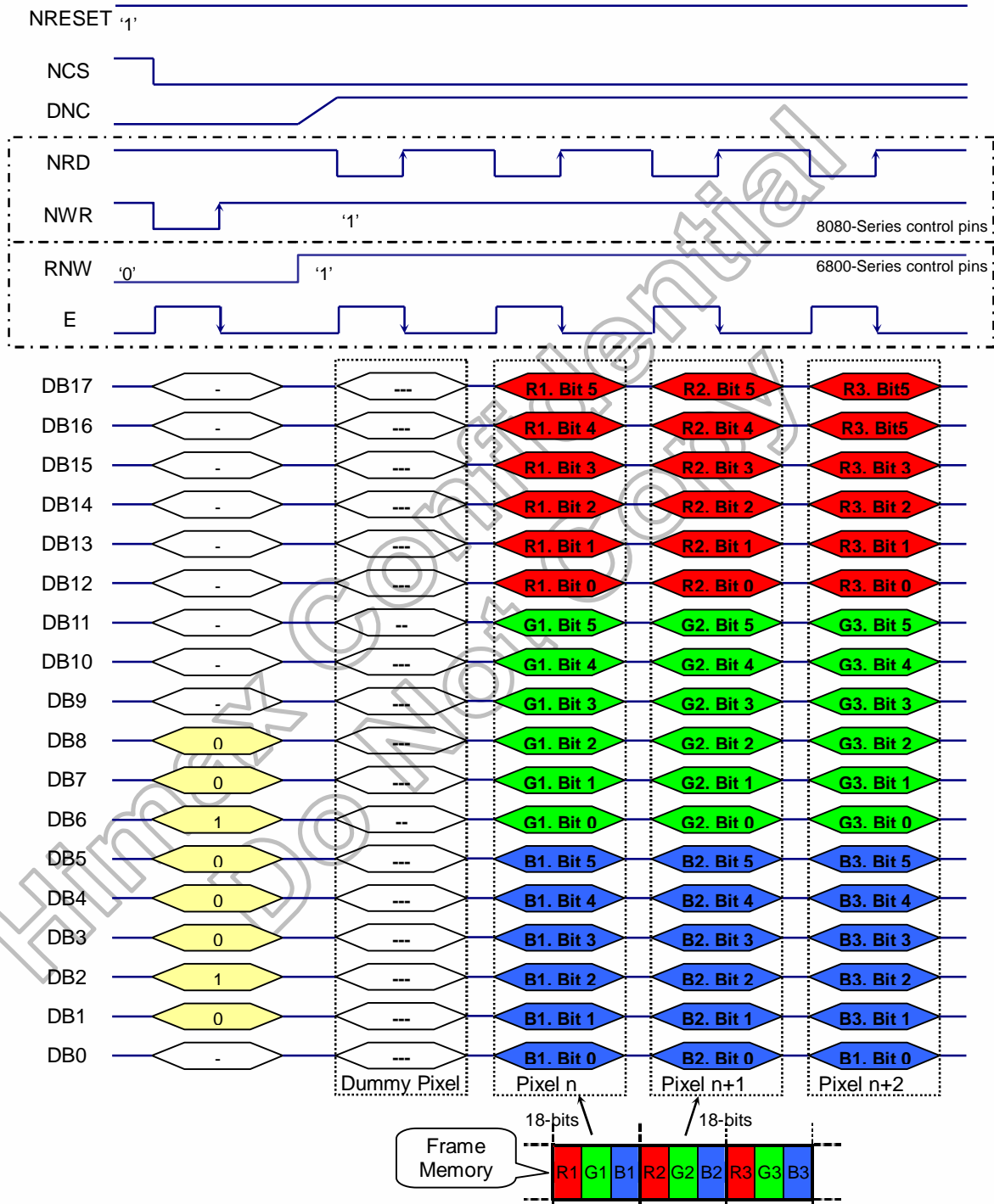
There are 1 pixel (3 sub-pixels) per 2 bytes (RGB 6-6-6-bits output)



- Note:** (1) The data order is as follows, MSB=D8, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.  
 (2) 3-times transfer is used to transmit 1 pixel data with the 18-bit color depth information.  
 (3) '-' = Don't care - Can be set to IOVCC or VSSD level.

## Parallel 18-Bits Bus Interface for RAM Data Read

There are 1 pixel (3 sub-pixels) per 1 bytes (RGB 6-6-6-bits output)



**Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.

(2) 1-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.

(3) '-' = Don't care - Can be set to IOVCC or VSSD level.

### 5.1.4 Serial Bus System Interface

The HX8340-B supports the serial bus interface in register-content mode by setting external pins “IM2” pins to “1”. The serial bus system interface mode is enabled through the chip select line (NCS), and it is accessed via a control consisting of the serial input data (SDI), serial output data (SDO) and the serial transfer clock signal (NWR\_RNW\_SCL).

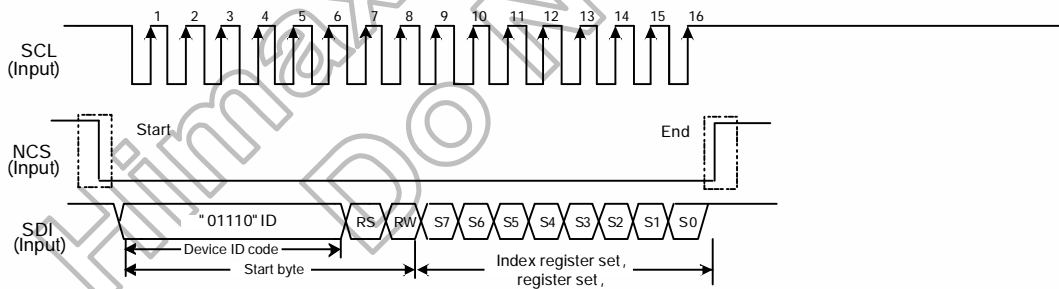
As the chip select signal (NCS) goes low, the start byte needs to be transferred first. The start byte is made up of 6-bit bus device identification code; register select (RS) bit and read/write operation (RW) bit. The five upper bits of 6-bit bus device identification code must be set to “01110”, and the least significant bit of the identification code must be set as the external pin IM0 input as “ID”.

The seventh bit (RS) of the start byte determines internal index register or register, GRAM accessing. RS must be set to “0” when writing data to the index register or reading the status and it must be set to “1” when writing or reading a command or GRAM data. The read or write operation is selected by the eighth bit (RW) of the start byte. The data is written to the chip when R/W = 0, and read from chip when RW = 1.

RS	R/W	Function
0	0	Writes Indexes into IR
1	0	Writes internal status and GRAM
1	1	Reads command into register or data into GRAM

Table 5. 12 The Function of RS and R/W Bit Bus

A) Transfer Timing Format in Serial Bus Interface for Index Register or Register Write



B) Transfer Timing Format in Serial Bus Interface for Index Register or Register Read

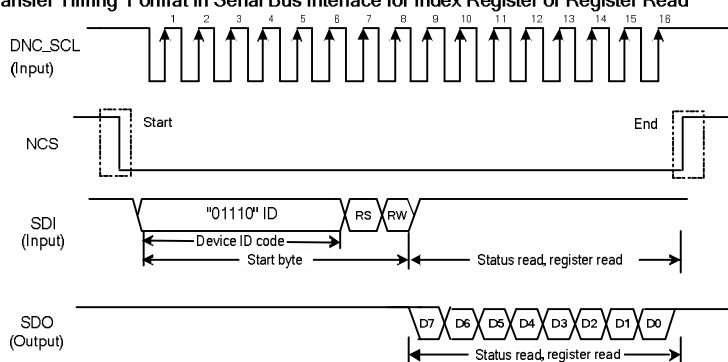
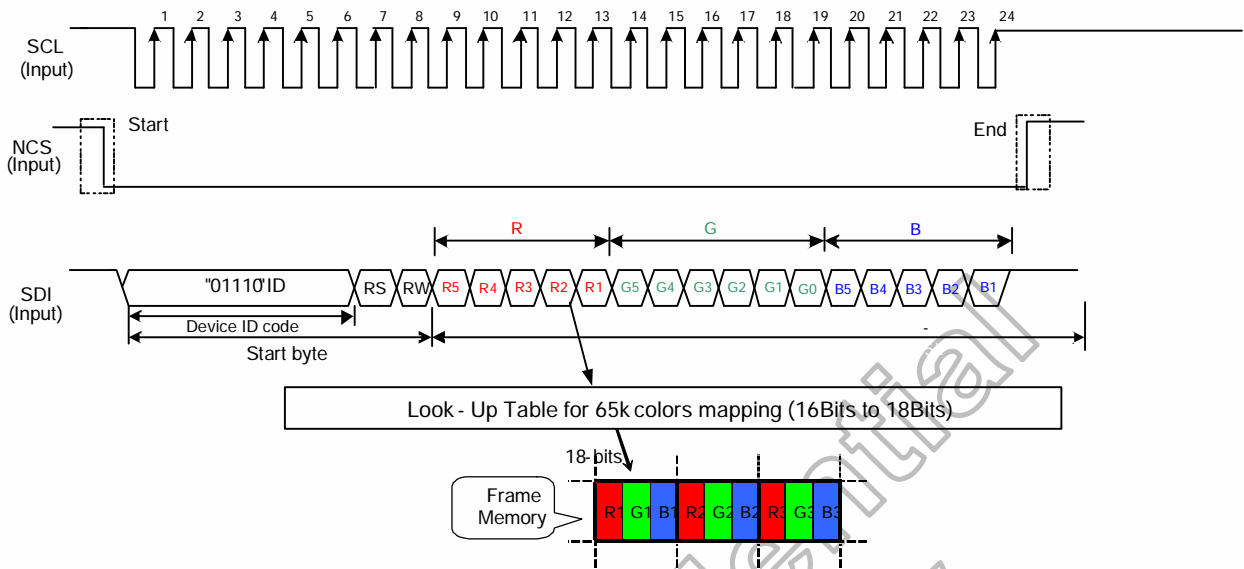


Figure 5. 9 Index Register Read/Write Timing in Serial Bus System Interface

A) 16-bit Data Transfer Timing Format in Serial Bus Interface for GRAM write (Index 17h= 05)



B) 18-bit Data Transfer Timing Format in Serial Bus Interface for GRAM write (Index 17H=06)

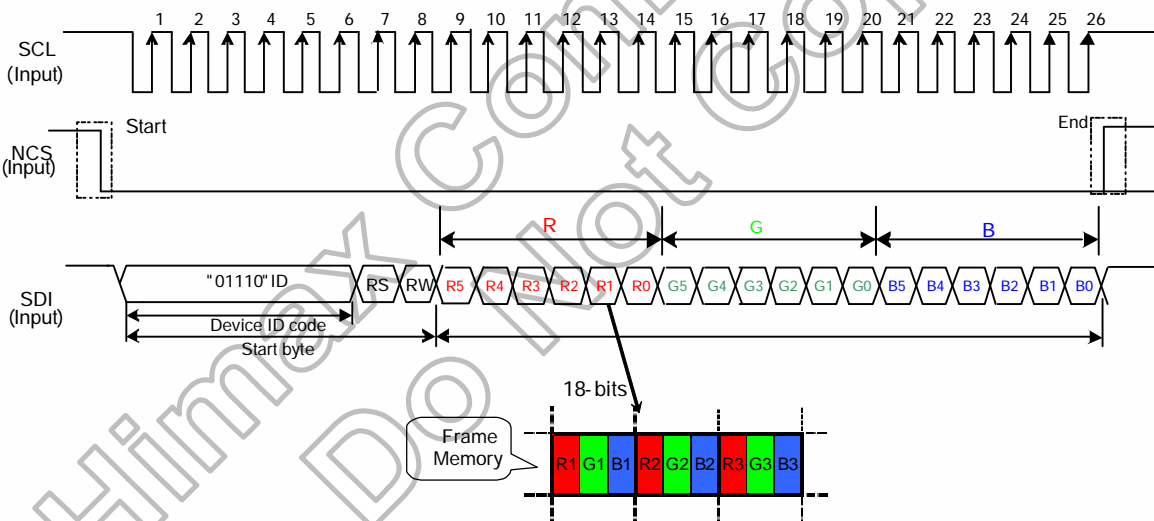


Figure 5. 10 Data Write Timing in Serial Bus System Interface

5.1.5 Color Depth Conversion Look-up Tables

Look Up Table Outputs Frame Memory Data (6-bit)	Default value after H/W Reset	RGBSET parameter	Look Up Table Input Data
			4k Color
R005R004 R003 R002 R001 R000 G005G004 G003 G002 G001 G000 B005B004 B003 B002 B001 B000	000000	1	0000
R105R104 R103 R102 R101 R100 G105G104 G103 G102 G101 G100 B105B104 B103 B102 B101 B100	000011	2	0001
R205R204 R203 R202 R201 R200 G205G204 G203 G202 G201 G200 B205B204 B203 B202 B201 B200	000101	3	0010
R305R304 R303 R302 R301 R300 G305G304 G303 G302 G301 G300 B305B304 B303 B302 B301 B300	000111	4	0011
R405R404 R403 R402 R401 R400 G405G404 G403 G402 G401 G400 B405B404 B403 B402 B401 B400	001001	5	0100
R505R504 R503 R502 R501 R500 G505G504 G503 G502 G501 G500 B505B504 B503 B502 B501 B500	001011	6	0101
R605R604 R603 R602 R601 R600 G605G604 G603 G602 G601 G600 B605B604 B603 B602 B601 B600	001101	7	0110
R705R704 R703 R702 R701 R700 G705G704 G703 G702 G701 G700 B705B704 B703 B702 B701 B700	001111	8	0111
R805R804 R803 R802 R801 R800 G805G804 G803 G802 G801 G800 B805B804 B803 B802 B801 B800	010001	9	1000
R905R904 R903 R902 R901 R900 G905G904 G903 G902 G901 G900 B905B904 B903 B902 B901 B900	010011	10	1001
R105R104 R103 R102 R101 R100 G105G104 G103 G102 G101 G100 B105B104 B103 B102 B101 B100	010101	11	1010
R115R114 R113 R112 R111 R110 G115G114 G113 G112 G111 G110 B115B114 B113 B112 B111 B110	010111	12	1011
R125R124 R123 R122 R121 R120 G125G124 G123 G122 G121 G120 B125B124 B123 B122 B121 B120	011001	13	1100
R135R134 R133 R132 R131 R130 G135G134 G133 G132 G131 G130 B135B134 B133 B132 B131 B130	011011	14	1101
R145R144 R143 R142 R141 R140 G145G144 G143 G142 G141 G140 B145B144 B143 B142 B141 B140	011101	15	1110
R155R154 R153 R152 R151 R150 G155G154 G153 G152 G151 G150 B155B154 B153 B152 B151 B150	011111	16	1111

Table 5. 13 Look-up Tables for 4k Color Mode

Look Up Table Outputs Frame Memory Data (6-bit)	Default value after H/W Reset	RGBSET parameter	Look Up Table Input Data
			65k Color
R005 R004 R003 R002 R001 R000 B005 B004 B003 B002 B001 B000	000000	1	00000
R105 R104 R103 R102 R101 R100 B105 B104 B103 B102 B101 B100	000011	2	00001
R205 R204 R203 R202 R201 R200 B205 B204 B203 B202 B201 B200	000101	3	00010
R305 R304 R303 R302 R301 R300 B305 B304 B303 B302 B301 B300	000111	4	00011
R405 R404 R403 R402 R401 R400 B405 B404 B403 B402 B401 B400	001001	5	00100
R505 R504 R503 R502 R501 R500 B505 B504 B503 B502 B501 B500	001011	6	00101
R605 R604 R603 R602 R601 R600 B605 B604 B603 B602 B601 B600	001101	7	00110
R705 R704 R703 R702 R701 R700 B705 B704 B703 B702 B701 B700	001111	8	00111
R805 R804 R803 R802 R801 R800 B805 B804 B803 B802 B801 B800	010001	9	01000
R905 R904 R903 R902 R901 R900 B905 B904 B903 B902 B901 B900	010011	10	01001
R105 R104 R103 R102 R101 R100 B105 B104 B103 B102 B101 B100	010101	11	01010
R115 R114 R113 R112 R111 R110 B115 B114 B113 B112 B111 B110	010111	12	01011
R125 R124 R123 R122 R121 R120 B125 B124 B123 B122 B121 B120	011001	13	01100
R135 R134 R133 R132 R131 R130 B135 B134 B133 B132 B131 B130	011011	14	01101
R145 R144 R143 R142 R141 R140 B145 B144 B143 B142 B141 B140	011101	15	01110
R155 R154 R153 R152 R151 R150 B155 B154 B153 B152 B151 B150	011111	16	01111
R165 R164 R163 R162 R161 R160 B165 B164 B163 B162 B161 B160	100001	17	10000
R175 R174 R173 R172 R171 R170 B175 B174 B173 B172 B171 B170	100011	18	10001
R185 R184 R183 R182 R181 R180 B185 B184 B183 B182 B181 B180	100101	19	10010
R195 R194 R193 R192 R191 R190 B195 B194 B193 B192 B191 B190	100111	20	10011
R205 R204 R203 R202 R201 R200 B205 B204 B203 B202 B201 B200	101001	21	10100
R215 R214 R213 R212 R211 R210 B215 B214 B213 B212 B211 B210	101011	22	10101
R225 R224 R223 R222 R221 R220 B225 B224 B223 B222 B221 B220	101101	23	10110
R235 R234 R233 R232 R231 R230 B235 B234 B233 B232 B231 B230	101111	24	10111
R245 R244 R243 R242 R241 R240 B245 B244 B243 B242 B241 B240	110001	25	11000
R255 R254 R253 R252 R251 R250 B255 B254 B253 B252 B251 B250	110011	26	11001
R265 R264 R263 R262 R261 R260 B265 B264 B263 B262 B261 B260	110101	27	11010
R275 R274 R273 R272 R271 R270 B275 B274 B273 B272 B271 B270	110111	28	11011
R285 R284 R283 R282 R281 R280 B285 B284 B283 B282 B281 B280	111001	29	11100
R295 R294 R293 R292 R291 R290 B295 B294 B293 B292 B291 B290	111011	30	11101
R305 R304 R303 R302 R301 R300 B305 B304 B303 B302 B301 B300	111101	31	11110
R315 R314 R313 R312 R311 R310 B315 B314 B313 B312 B311 B310	111111	32	11111

Note: Green color in 65k color mode is mapping directly.

Table 5. 14 Look-up Tables for 65k Color Mode



## 5.2 RGB Interface

The HX8340-B uses **RCM[1:0]='10' or '11' hardware setting to select RGB interface**. When after Power on Sequence, the RGB interface is activated. When RCM[1:0]='10' use VS, HS, DE, DOTCLK, DB17-0 parallel lines for the RGB interface (RGB mode 1). When RCM[1:0]='11' use VS, HS, DOTCLK, DB17-0 parallel lines for the RGB interface (RGB mode 2)

Pixel clock (DOTCLK) must be running all the time without stopping and it is used to entering VS, HS, DE and DB17-0 lines states when there is a rising edge of the DOTCLK.

In RGB interface mode 1, the valid display data is inputted in pixel unit via DB17-0 according to the high-level('H') of DE signal, and display operations are executed in synchronization with the frame synchronizing signal (VS), line synchronizing signal (HS) and pixel clock (DOTCLK). In RGB interface mode 2, the valid display data is inputted in pixel unit via DB17-0 according to the HBP setting of HS signal, and the VBP setting of VS. In these two RGB interface mode, the input display data is not written to GRAM and is displayed directly.

Vertical synchronization (VS) signal is used to tell when there is received a new frame of the display, and this is negative ('-', '0', low) active. Horizontal synchronization signal (HS) is used to tell when there is received a new line of the frame, and this is negative ('-', '0', low) active. Data enable (DE) is used to tell when there is received RGB information that should be transferred on the display, and this is positive ('+', '1', high) active. DB17-0 are used to tell what is the information of the image that is transferred on the display when DE='H'.

The pixel clock cycle is described in the following figure.

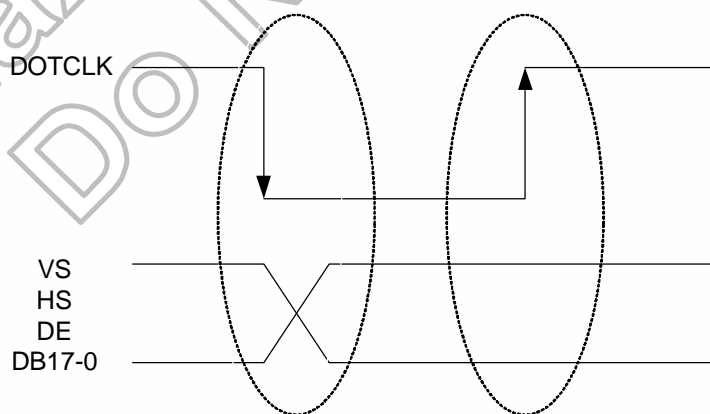


Figure 5. 11 DOTCLK Cycle

General timing diagram in RGB interface is as follow

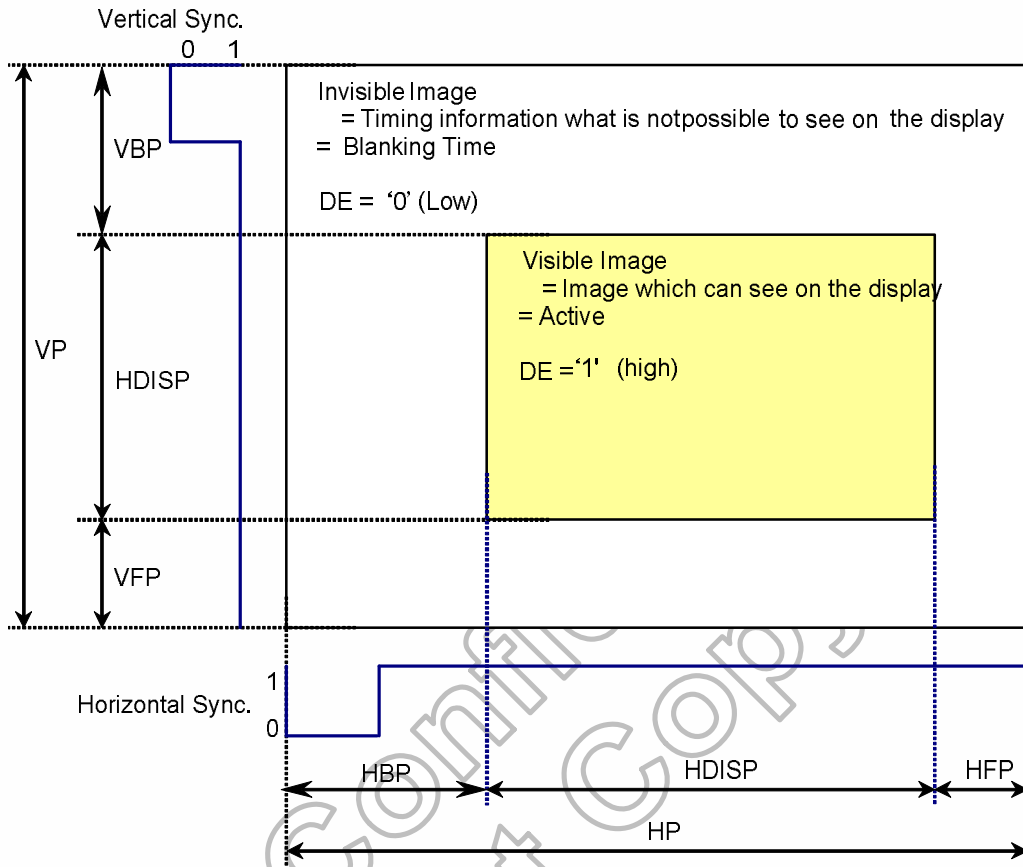
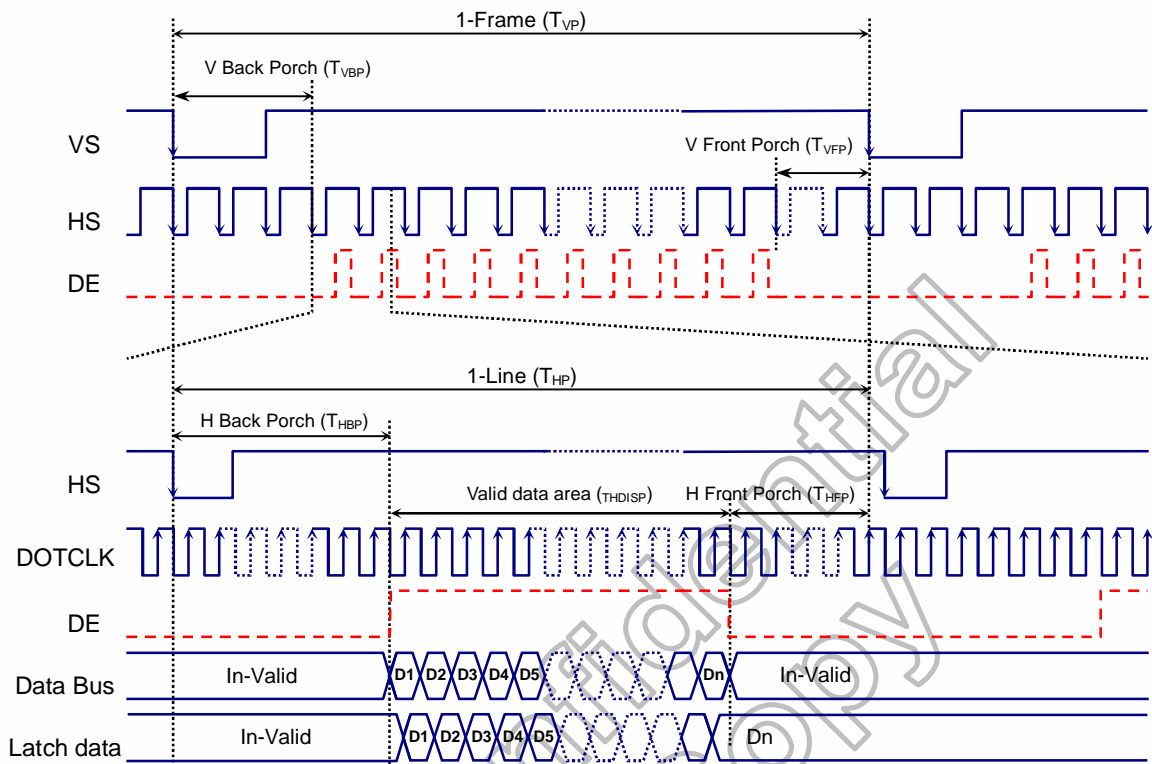


Figure 5. 12 RGB Interface Circuit Input Timing Diagram

The image information is correct on the display when the timings are in range on the interface. However, the image information will be incorrect on the display, when timings are out of the range on the RGB interface and the correct image information will be displayed automatically (by the display module) on the next frame (vertical sync.), when there is returned from out of the range to in range RGB interface timings.



**Note:** RGB mode 2 doesn't need DE signal

**Note:** EPL='0', VSPL='0', HSPL='0' and DPL='0' of SETRGBIF (33H) command.

Figure 5. 13 RGB Mode timing Diagram

All 3-kinds of bus width can be available during RGB interface mode (selected by COLMOD (17H) command for 6-bits, 16-bits and 18-bits data width)

17H	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Bus width
50h	R4	R3	R2	R1	R0	x	G5	G4	G3	G2	G1	G0	B4	B3	B2	B1	B0	x	16-bits data
60h	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0	18-bits data
17H	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Bus width
E0h	x	x	x	x	x	x	x	x	x	x	R5	R4	R3	R2	R1	R0	x	x	6-bits data
	x	x	x	x	x	x	x	x	x	x	G5	G4	G3	G2	G1	G0	x	x	
	x	x	x	x	x	x	x	x	x	x	x	B5	B4	B3	B2	B1	B0	x	

**Note:** (1) When 17H="E0h", 6-bits data width of 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.

(2) Only 17H= "50h","60h", "E0h" are valid on RGB I/F, Others are invalid.

(3) 'x' don't care, but need to set IOVCC or VSSD level.

**Table 5. 15 RGB interface Bus Width Set Table**

**RGB Interface Mode**

RGB I/F Mode	DOTCLK	DE	VS	HS	Video Data bus DB[B:0]	Register for Blanking Porch setting
RGB Mode 1	Used	Used	Used	Used	Used	Not Used
RGB Mode 2	Used	Not Used	Used	Used	Used	Used

There are 2-kinds of RGB mode which is selected by RCM1 & RCM0 hardware pins.

**In RGB Mode 1** (RCM1, RCM0 = "10"), writing data to display is done by DOTCLK and Video Data Bus (DB[B:0]), when DE is high state. The external synchronization signals (DOTCLK, VS and HS) are used for internal display signals. So, controller (host) must always transfer DOTCLK, VS, HS and DE signals to driver.

**In RGB Mode 2** (RCM1, RCM0 = "11"), blanking porch setting of VS and HS signals are defined by RGBBPCTR command. DE pin is not used.

### 5.2.1 Color Order on RGB Interface

The meaning of the pixel information, when there are used 3 components/pixel (Red, Green and Blue) on RGB interface, is describing on the following table:

Pixel Color	R Component	G Component	B Component
<b>Black</b>	All bits are 0	All bits are 0	All bits are 0
<b>Blue</b>	All bits are 0	All bits are 0	All bits are 1
<b>Green</b>	All bits are 0	All bits are 1	All bits are 0
<b>Cyan</b>	All bits are 0	All bits are 1	All bits are 1
<b>Red</b>	All bits are 1	All bits are 0	All bits are 0
<b>Magenta</b>	All bits are 1	All bits are 0	All bits are 1
<b>Yellow</b>	All bits are 1	All bits are 1	All bits are 0
<b>White</b>	All bits are 1	All bits are 1	All bits are 1

**Note:** There are only defined main colors on this table - Not all gray levels of colors.

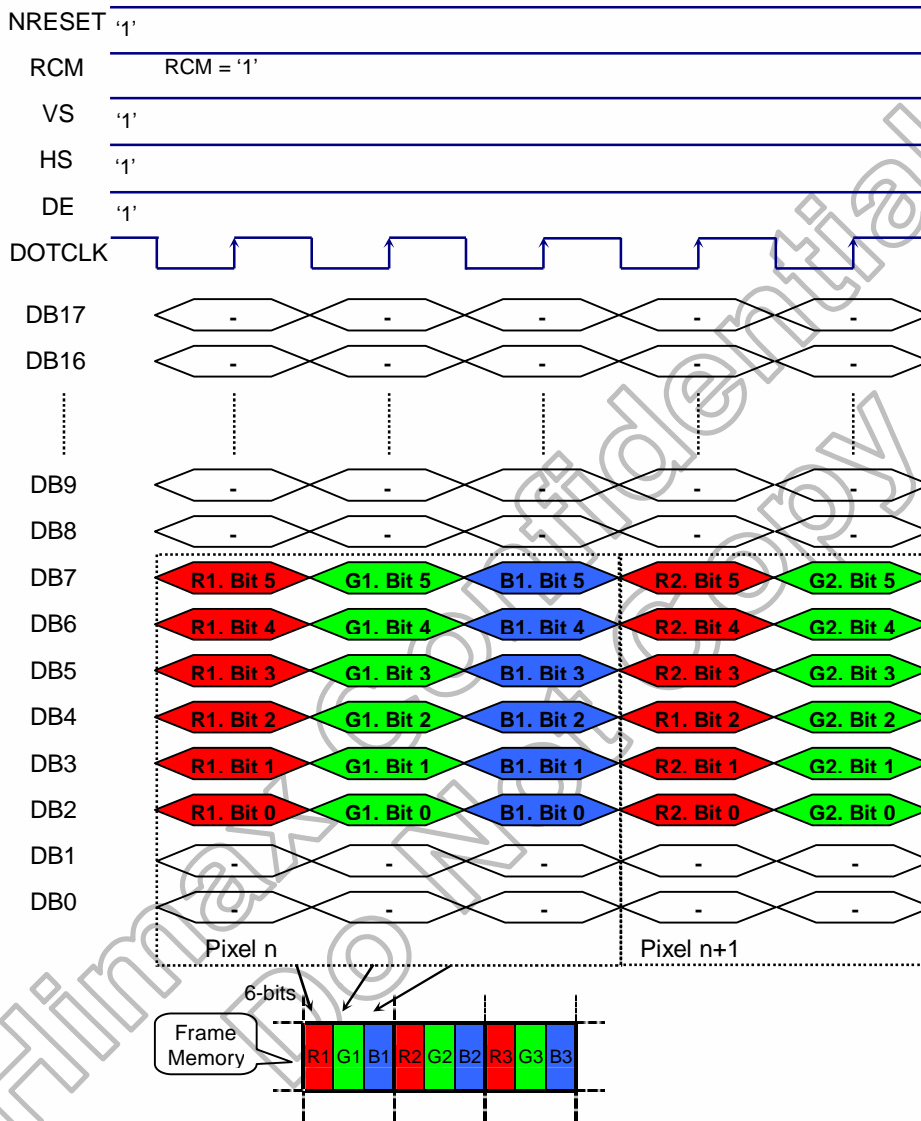
**Table 5. 16 Meaning of the Pixel Information for Main Colors on RGB Interface**

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### 5.2.2 RGB Data Color Coding

18-bits/pixel Colors Order on 6-bits Data width RGB Interface (RGB 6-6-6-bits input).

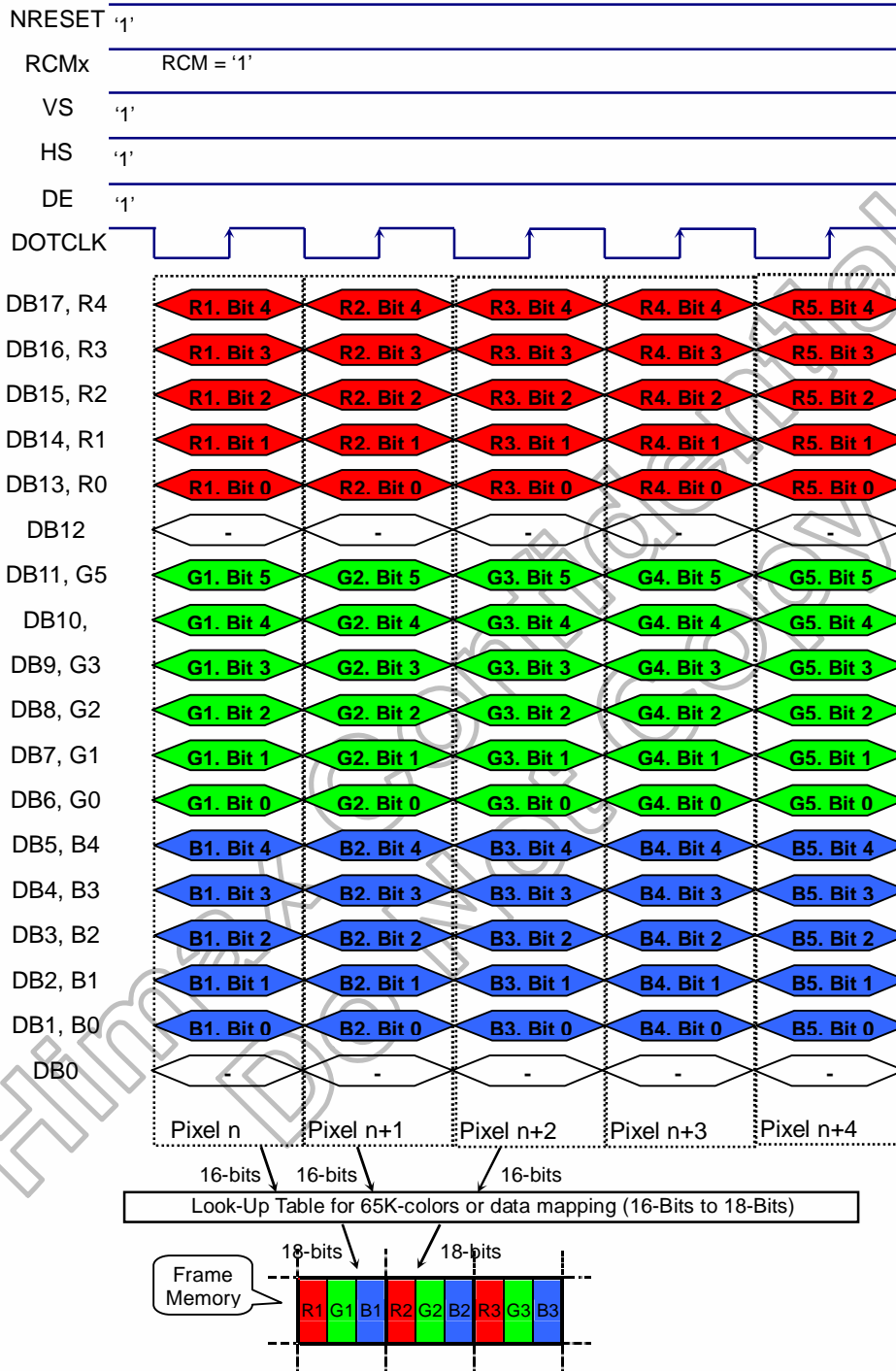
There are 1 pixel (3 sub-pixels) per 3 bytes, 262K-colors, 17H="E0h"



- Note:** (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit7, LSB=Bit0 for Red, Green and Blue data. (3-transfer data one pixel)  
 (2) '-' Don't care, but need to set IOVCC or VSSD level.

16-bits/pixel Colors Order on the 16-bits Data width RGB Interface (RGB 5-6-5-bits input).

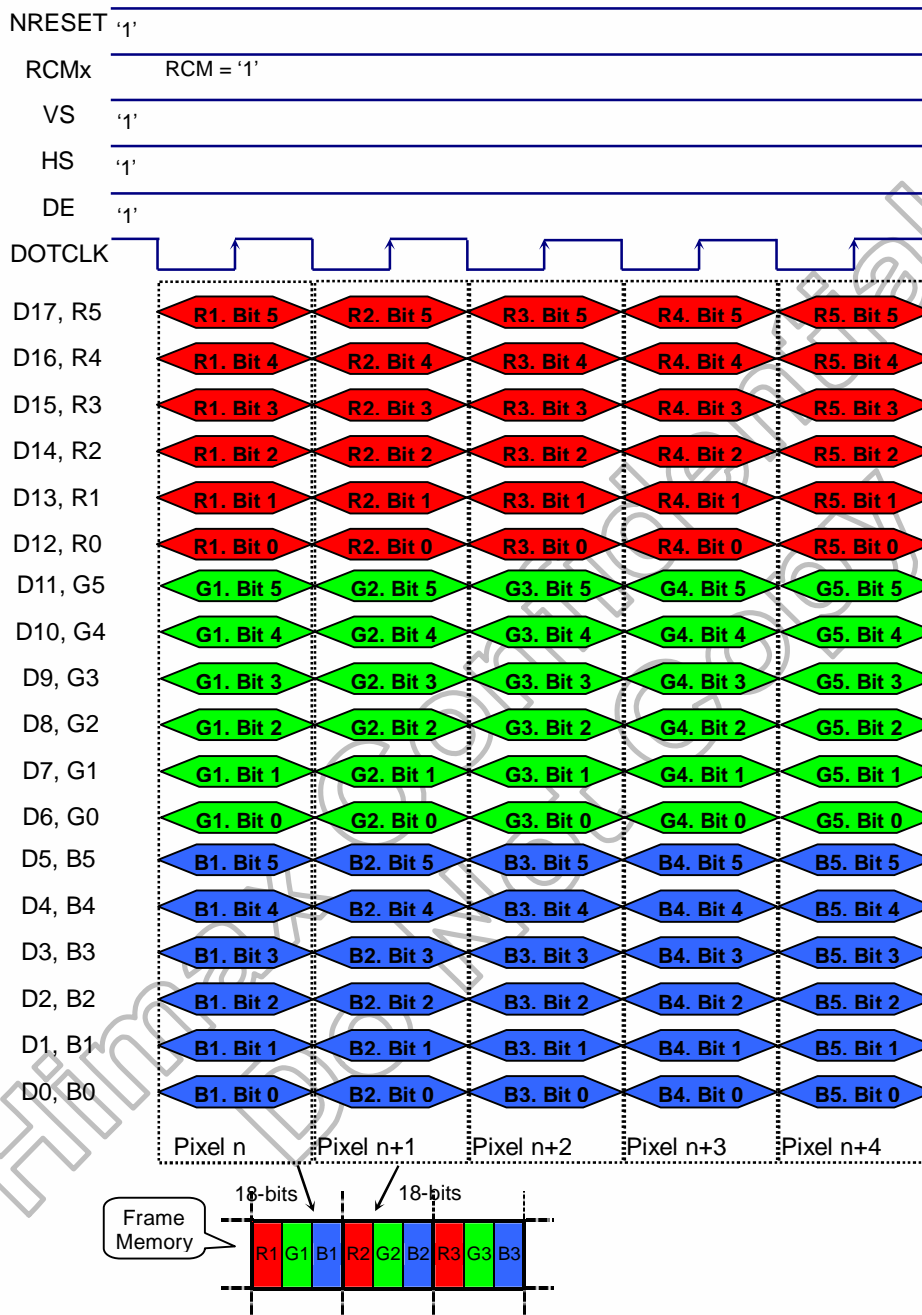
There are 1 pixel (3 sub-pixels) per 1 bytes, 65K-colors, 17H="50h"



- Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit5, LSB=Bit0 for Green data and MSB=Bit4, LSB=Bit0 for Red and Blue data.  
 (2) '-' Don't care, but need to set IOVCC or VSSD level.



18-bits/pixel Colors Order on the 18-bits Data width RGB Interface (RGB 6-6-6-bits input).  
 There are 1 pixel (3 sub-pixels) per 1 bytes, 262K-colors, 17H="60h"

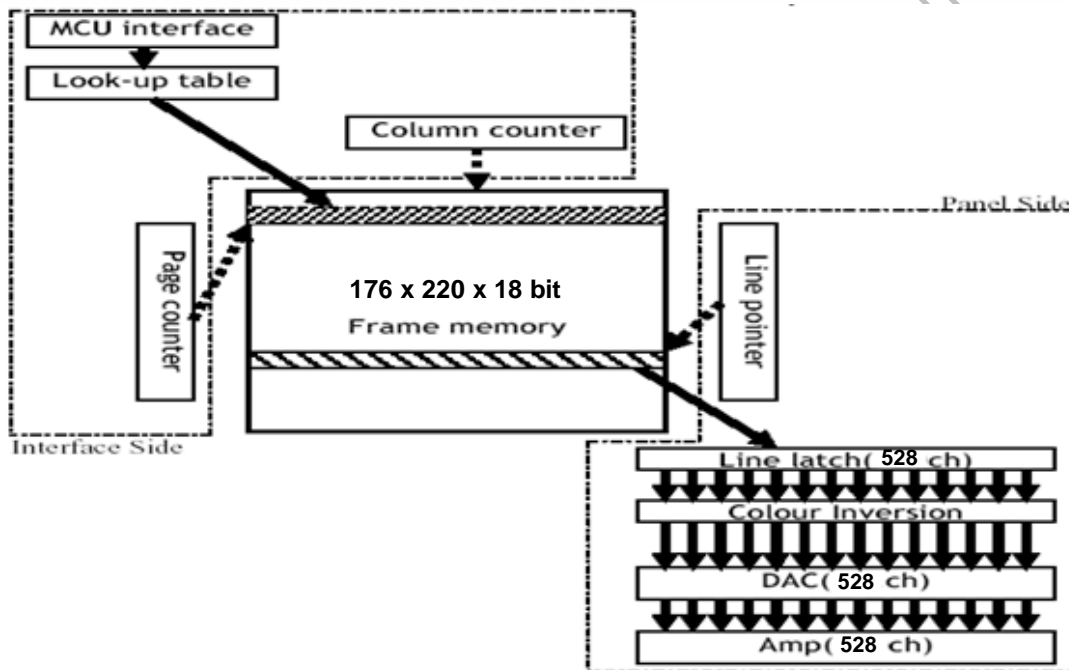


**Note:** (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit5, LSB=Bit0 for Red, Green and Blue data.

(2) '-' Don't care, but need to set IOVCC or VSSD level.

## 6. Display Data GRAM

The display data RAM stores display dots and consists of 696960 bits (176x18x220 bits). There is no restriction on access to the RAM even when the display data on the same address is loaded to DAC. There will be no abnormal visible effect on the display when there is a simultaneous Panel Read and Interface Read or Write to the same location of the Frame Memory.



### 6.1 Display Data GRAM Mapping

Every pixel (18-bit) data in GRAM is located by a (Page, Column) address (Y, X). By specifying the arbitrary window address **CASET's SC, EC** and **PASET's SP, EP**, it is possible to access the GRAM by setting RAMWR or RAMRD commands from start positions of the window address.

(00,00)H	(00,01)H	(00,02)H	-----	(00,AC)H	(00,AD)H	(00,AE)H	(00,AF)H
(01,00)H	(01,01)H	(01,02)H	-----	(01,AC)H	(01,AD)H	(01,AE)H	(01,AF)H
(02,00)H	(02,01)H	(02,02)H	-----	(02,AC)H	(02,AD)H	(02,AE)H	(02,AF)H
(03,00)H	(03,01)H	(03,02)H	-----	(03,AC)H	(03,AD)H	(03,AE)H	(03,AF)H
(04,00)H	(04,01)H	(04,02)H	-----	(04,AC)H	(04,AD)H	(04,AE)H	(04,AF)H
(05,00)H	(05,01)H	(05,02)H	-----	(05,AC)H	(05,AD)H	(05,AE)H	(05,AF)H
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
(D6,00)H	(D6,01)H	(D6,02)H	-----	(D6,AC)H	(D6,AD)H	(D6,AE)H	(D6,AF)H
(D7,00)H	(D7,01)H	(D7,02)H	-----	(D7,AC)H	(D7,AD)H	(D7,AE)H	(D7,AF)H
(D8,00)H	(D8,01)H	(D8,02)H	-----	(D8,AC)H	(D8,AD)H	(D8,AE)H	(D8,AF)H
(D9,00)H	(D9,01)H	(D9,02)H	-----	(D9,AC)H	(D9,AD)H	(D9,AE)H	(D9,AF)H
(DA,00)H	(DA,01)H	(DA,02)H	-----	(DA,AC)H	(DA,AD)H	(DA,AE)H	(DA,AF)H
(DB,00)H	(DB,01)H	(DB,02)H	-----	(DB,AC)H	(DB,AD)H	(DB,AE)H	(DB,AF)H

Table 6. 1 GRAM Address for Display Panel Position

## 6.2 Address Counter (AC) of GRAM

The HX8340-B contains an address counter (AC) which assigns address for writing/reading pixel data to/from GRAM. The address pointers set the position of GRAM. Every time when a pixel data is written into the GRAM, the X address or Y address of AC will be automatically increased by 1 (or decreased by 1), which is decided by the register (**MADTCL's MV(B5), MX(B6) and MY(B7)**) bits setting.

To simplify the address control of GRAM access, the window address function allows for writing data only to a window area of GRAM specified by registers. After data being written to the GRAM, the AC will be increased or decreased within setting window address-range which is specified by the **CASET** (start: **SC**, end: **EC**) and the **PASET** (start: **SP**, end: **EP**). Therefore, the data can be written consecutively without thinking a data wrap by those bit function.

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### 6.2.1 System Interface to GRAM Write Direction

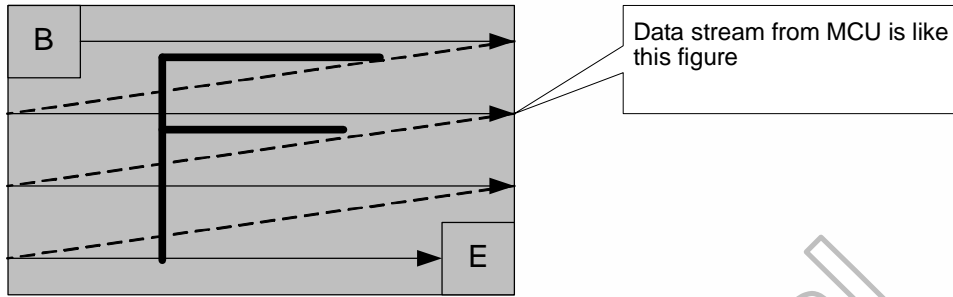


Figure 6. 1 Image Data Sending Order from the Host

The data is written in the order illustrated above. The counter which dictates where in the physical memory the data is to be written is controlled by MADCTL's MV(B5), MX(B6) and MY(B7) bits setting

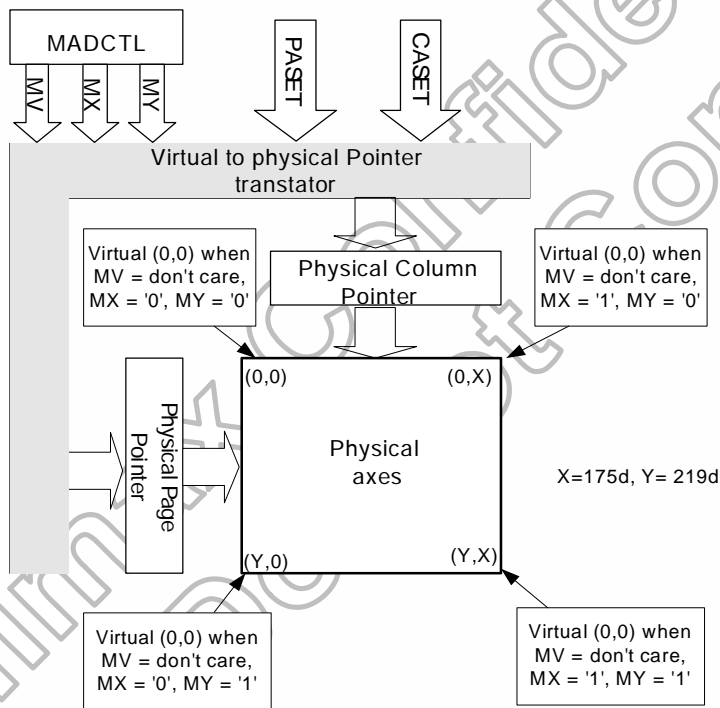


Figure 6. 2 Image Data Writing Control

MV	MX	MY	CASET	PASET
0	0	0	Direct to Physical Column Pointer	Direct to Physical Page Pointer
0	0	1	Direct to Physical Column Pointer	Direct to (Y - Physical Page Pointer)
0	1	0	Direct to (X-Physical Column Pointer)	Direct to Physical Page Pointer
0	1	1	Direct to (X - Physical Column Pointer)	Direct to (Y - Physical Page Pointer)
1	0	0	Direct to Physical Page Pointer	Direct to Physical Column Pointer
1	0	1	Direct to (Y - Physical Page Pointer)	Direct to Physical Column Pointer
1	1	0	Direct to Physical Page Pointer	Direct to (X-Physical Column Pointer)
1	1	1	Direct to (Y - Physical Page Pointer)	Direct to (X - Physical Column Pointer)

Table 6. 2 CASET and PASET Control for Physical Column/Page Pointers

For each image orientation, the controls for the column and page counters apply as below:

Condition	Column Counter	Page Counter
When RAMWR/RAMRD command is accepted.	Return to "Start Column"	Return to "Start Page"
Complete Pixel Pair Write/Read action	Increment by 1	No change
The Column counter value is larger than "End column."	Return to "Start Column"	Increment by 1
The Page counter value is larger than "End page".	Return to "Start Column"	Return to "Start Page"

**Note:** Data is always written to the Frame Memory in the same order, regardless of the Memory Write Direction set by MADCTL bits B7, B6 and B5.

**Table 6. 3 Rules for Updating GRAM Order**

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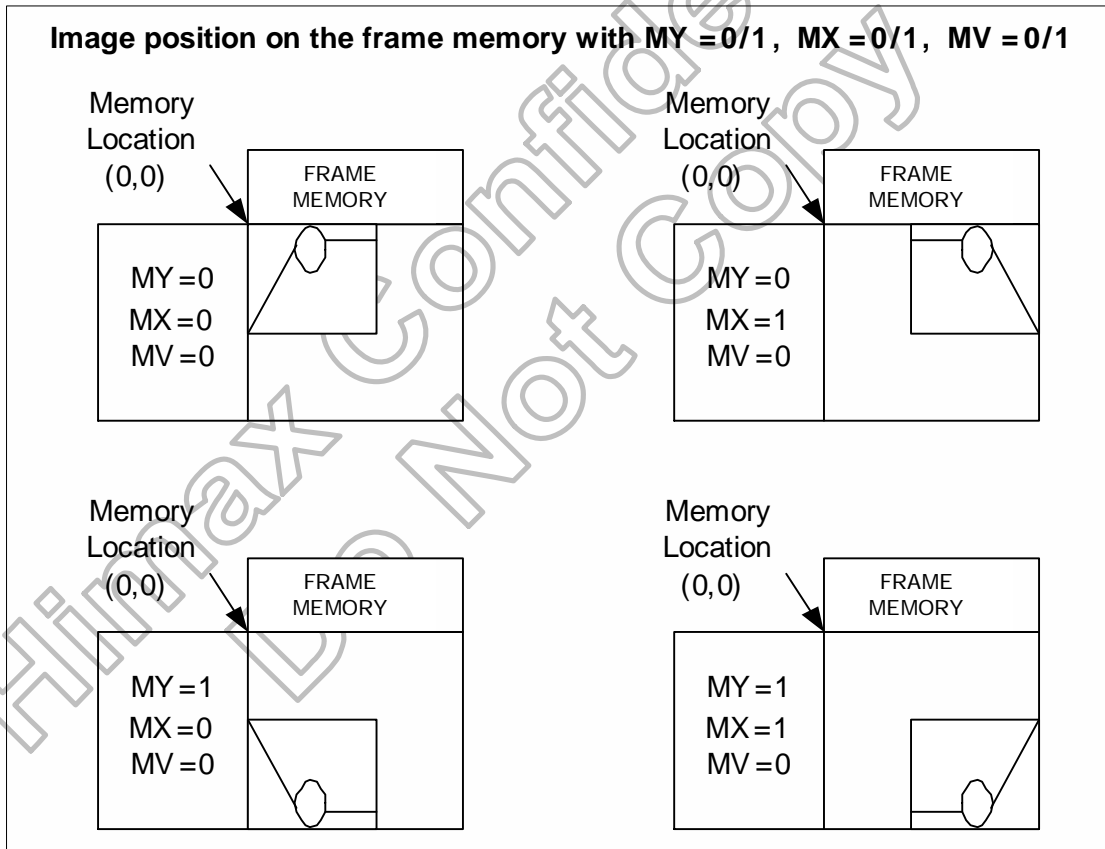
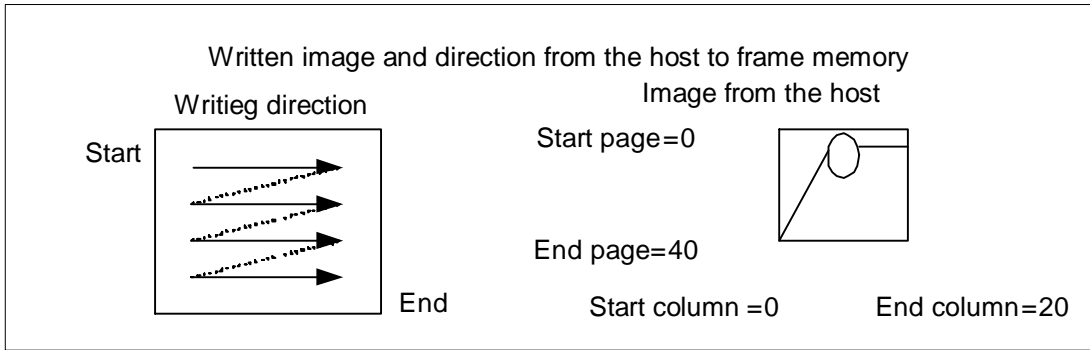
The following figure depicts the GRAM address update method with MV, MX and MY bit setting.

Display Data Direction	MADCTR parameter			Image in the Host	Image in the Driver (GRAM)
	MV	MX	MY		
Normal	0	0	0		
Y-Invert	0	0	1		
X-Invert	0	1	0		
X-Invert Y-Invert	0	1	1		
X-Y Exchange	1	0	0		
X-Y Exchange X-invert	1	0	1		
X-Y Exchange Y-invert	1	1	0		
X-Y Exchange X-invert Y-invert	1	1	1		

Table 6. 4 Address Direction Settings

**Example for rotation with MY, MX and MV**

This example is using following values: start page = 0, end page = 40, start column = 0 and end column = 20 => commands: page address set (0, 40) and column address set (0, 20). The sent figure is as follows and its sending order is as follows.



**Figure 6. 3 Example for Rotation with MY, MX and MV – 1**



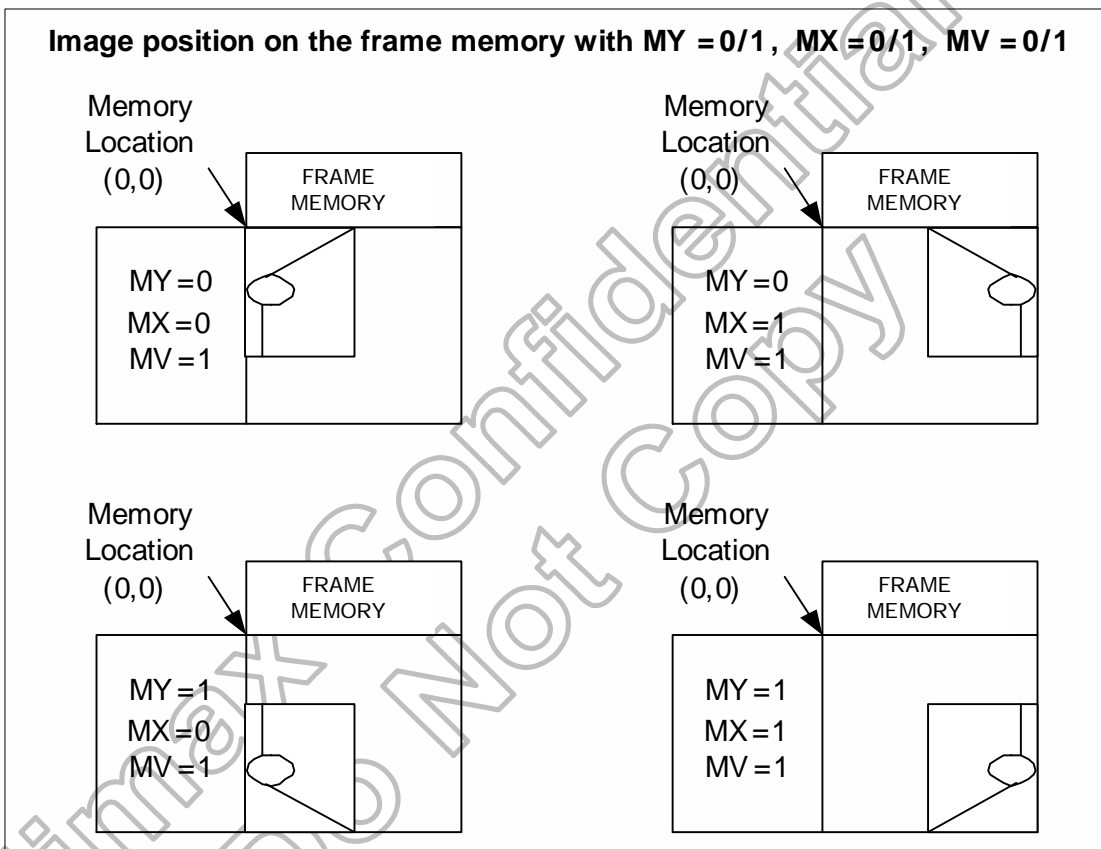
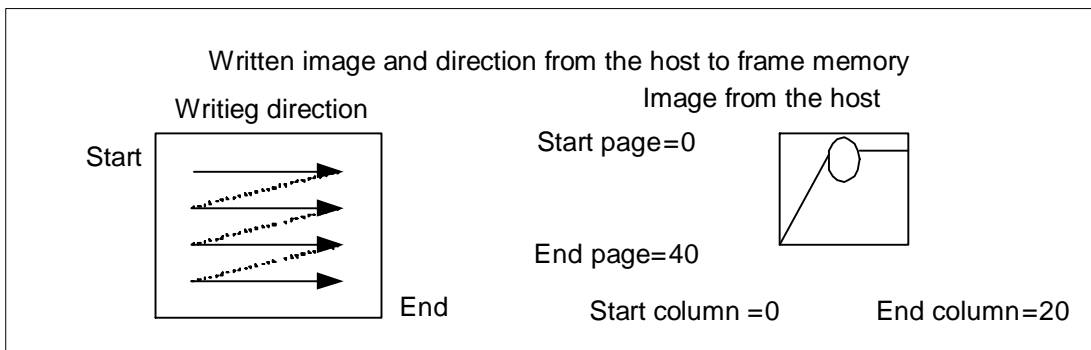


Figure 6. 4 Example for Rotation with MY, MX and MV - 2

### 6.3 GRAM to Display Address Mapping

By setting the external **SMX** pin, the relation between the source output channel and the GRAM address can be changed as reverse display. By setting the external **SMY** pin, the relation between the gate output channel and the GRAM address can be changed as reverse display. By setting the external **SRGB** pin, the relation between the source output channel and the <R>, <G>, <B> dot allocation can be reversed for different LCD color filter arrangement. Table 6.5, Table 6.6 and Table 6.7 show the relationship among the GRAM data allocation, the source output channel, and the R, G, B dot allocation.

SRGB = 'H'														
Source	SMX = 'H'	S1	S2	S3	S4	S5	S6	-----	S523	S524	S525	S526	S527	S528
Output	SMX = 'L'	S526	S527	S528	S523	S524	S525	-----	S4	S5	S6	S1	S2	S3
X Address		"00"h			"01"h			-----	"AE"h			"AF"h		
RGB data		R	G	B	R	G	B	-----	R	G	B	R	G	B
Pixel		Pixel 1			Pixel 2			-----	Pixel 175			Pixel 176		

SRGB = 'L'														
Source	SMX = 'H'	S3	S2	S1	S6	S5	S4	-----	S523	S524	S525	S526	S527	S528
Output	SMX = 'L'	S528	S527	S526	S525	S524	S523	-----	S6	S5	S4	S3	S2	S1
X Address		"00"h			"01"h			-----	"AE"h			"AF"h		
Bit Allocation		R	G	B	R	G	B	-----	R	G	B	R	G	B
Pixel		Pixel 1			Pixel 2			-----	Pixel 175			Pixel 176		

Table 6. 5 GRAM X Address and Display Panel Position

S/G pins	S1	S2	S3	S4	S5	S6	S7	S8	S9	-----	S517	S518	S519	S520	S521	S522	S523	S524	S525	S526	S527	S528	
G1	000h	001h	002h	003h	004h	005h	006h	007h	008h	-----	00ACh	00ADh	00AEh	00AFh									
G2	010h	011h	012h	013h	014h	015h	016h	017h	018h	-----	01ACh	01ADh	01AEh	01AFh									
G3	020h	021h	022h	023h	024h	025h	026h	027h	028h	-----	02ACh	02ADh	02AEh	02AFh									
G4	030h	031h	032h	033h	034h	035h	036h	037h	038h	-----	03ACh	03ADh	03AEh	03AFh									
G5	040h	041h	042h	043h	044h	045h	046h	047h	048h	-----	04ACh	04ADh	04AEh	04AFh									
G6	050h	051h	052h	053h	054h	055h	056h	057h	058h	-----	05ACh	05ADh	05AEh	05AFh									
G7	060h	061h	062h	063h	064h	065h	066h	067h	068h	-----	06ACh	06ADh	06AEh	06AFh									
G8	070h	071h	072h	073h	074h	075h	076h	077h	078h	-----	07ACh	07ADh	07AEh	07AFh									
G9	080h	081h	082h	083h	084h	085h	086h	087h	088h	-----	08ACh	08ADh	08AEh	08AFh									
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
G211	D200h	D201h	D202h	D203h	D204h	D205h	D206h	D207h	D208h	-----	D2ACh	D2ADh	D2AEh	D2AFh									
G212	D300h	D301h	D302h	D303h	D304h	D305h	D306h	D307h	D308h	-----	D3ACh	D3ADh	D3AEh	D3AFh									
G213	D400h	D401h	D402h	D403h	D404h	D405h	D406h	D407h	D408h	-----	D4ACh	D4ADh	D4AEh	D4AFh									
G214	D500h	D501h	D502h	D503h	D504h	D505h	D506h	D507h	D508h	-----	D5ACh	D5ADh	D5AEh	D5AFh									
G215	D600h	D601h	D602h	D603h	D604h	D605h	D606h	D607h	D608h	-----	D6ACh	D6ADh	D6AEh	D6AFh									
G216	D700h	D701h	D702h	D703h	D704h	D705h	D706h	D707h	D708h	-----	D7ACh	D7ADh	D7AEh	D7AFh									
G217	D800h	D801h	D802h	D803h	D804h	D805h	D806h	D807h	D808h	-----	D8ACh	D8ADh	D8AEh	D8AFh									
G218	D900h	D901h	D902h	D903h	D904h	D905h	D906h	D907h	D908h	-----	D9ACh	D9ADh	D9AEh	D9AFh									
G219	DA00h	DA01h	DA02h	DA03h	DA04h	DA05h	DA06h	DA07h	DA08h	-----	DAACH	DAADh	DAAEh	DAAFh									
G220	DB00h	DB01h	DB02h	DB03h	DB04h	DB05h	DB06h	DB07h	DB08h	-----	DBACH	DBADh	DBAEh	DBAFh									

Table 6. 6 GRAM Address and Display Panel Position (SMY = 'L')

S/G pins	S1	S2	S3	S4	S5	S6	S7	S8	S9	-----	S517	S518	S519	S520	S521	S522	S523	S524	S525	S526	S527	S528	
G220	000h	001h	002h	003h	004h	005h	006h	007h	008h	-----	00ECh	00EDh	00EEh	00EFh									
G219	010h	011h	012h	013h	014h	015h	016h	017h	018h	-----	01ECh	01EDh	01EEh	01EFh									
G218	020h	021h	022h	023h	024h	025h	026h	027h	028h	-----	02ECh	02EDh	02EEh	02EFh									
G217	030h	031h	032h	033h	034h	035h	036h	037h	038h	-----	03ECh	03EDh	03EEh	03EFh									
G216	040h	041h	042h	043h	044h	045h	046h	047h	048h	-----	04ECh	04EDh	04EEh	04EFh									
G215	050h	051h	052h	053h	054h	055h	056h	057h	058h	-----	05ECh	05EDh	05EEh	05EFh									
G214	060h	061h	062h	063h	064h	065h	066h	067h	068h	-----	06ECh	06EDh	06EEh	06EFh									
G213	070h	071h	072h	073h	074h	075h	076h	077h	078h	-----	07ECh	07EDh	07EEh	07EFh									
G212	080h	081h	082h	083h	084h	085h	086h	087h	088h	-----	08ECh	08EDh	08EEh	08EFh									
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
G10	D200h	D201h	D202h	D203h	D204h	D205h	D206h	D207h	D208h	-----	D2ACh	D2ADh	D2AEh	D2AFh									
G9	D300h	D301h	D302h	D303h	D304h	D305h	D306h	D307h	D308h	-----	D3ACh	D3ADh	D3AEh	D3AFh									
G8	D400h	D401h	D402h	D403h	D404h	D405h	D406h	D407h	D408h	-----	D4ACh	D4ADh	D4AEh	D4AFh									
G7	D500h	D501h	D502h	D503h	D504h	D505h	D506h	D507h	D508h	-----	D5ACh	D5ADh	D5AEh	D5AFh									
G6	D600h	D601h	D602h	D603h	D604h	D605h	D606h	D607h	D608h	-----	D6ACh	D6ADh	D6AEh	D6AFh									
G5	D700h	D701h	D702h	D703h	D704h	D705h	D706h	D707h	D708h	-----	D7ACh	D7ADh	D7AEh	D7AFh									
G4	D800h	D801h	D802h	D803h	D804h	D805h	D806h	D807h	D808h	-----	D8ACh	D8ADh	D8AEh	D8AFh									
G3	D900h	D901h	D902h	D903h	D904h	D905h	D906h	D907h	D908h	-----	D9ACh	D9ADh	D9AEh	D9AFh									
G2	DA00h	DA01h	DA02h	DA03h	DA04h	DA05h	DA06h	DA07h	DA08h	-----	DAACH	DAADh	DAAEh	DAAFh									
G1	DB00h	DB01h	DB02h	DB03h	DB04h	DB05h	DB06h	DB07h	DB08h	-----	DBACH	DBADh	DBAEh	DBAFh									

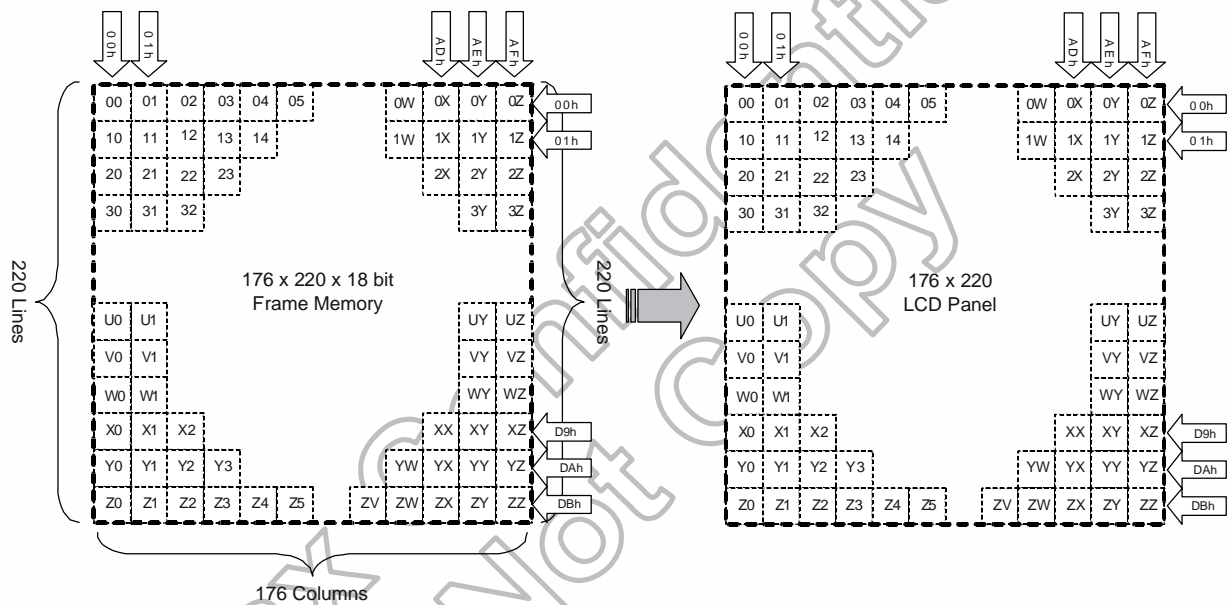
Table 6. 7 GRAM Address and Display Panel Position (SMY = 'H')

HX8340-B supports three kinds of display mode: one is Normal Display Mode, one is the other is Partial Display Mode, and Scrolling Display Mode.

When the **PLTON** is set '0', HX8340-B will be into Normal Display Mode. When the **PLTON** is set '1', HX8340-B will be into Partial Display Mode.

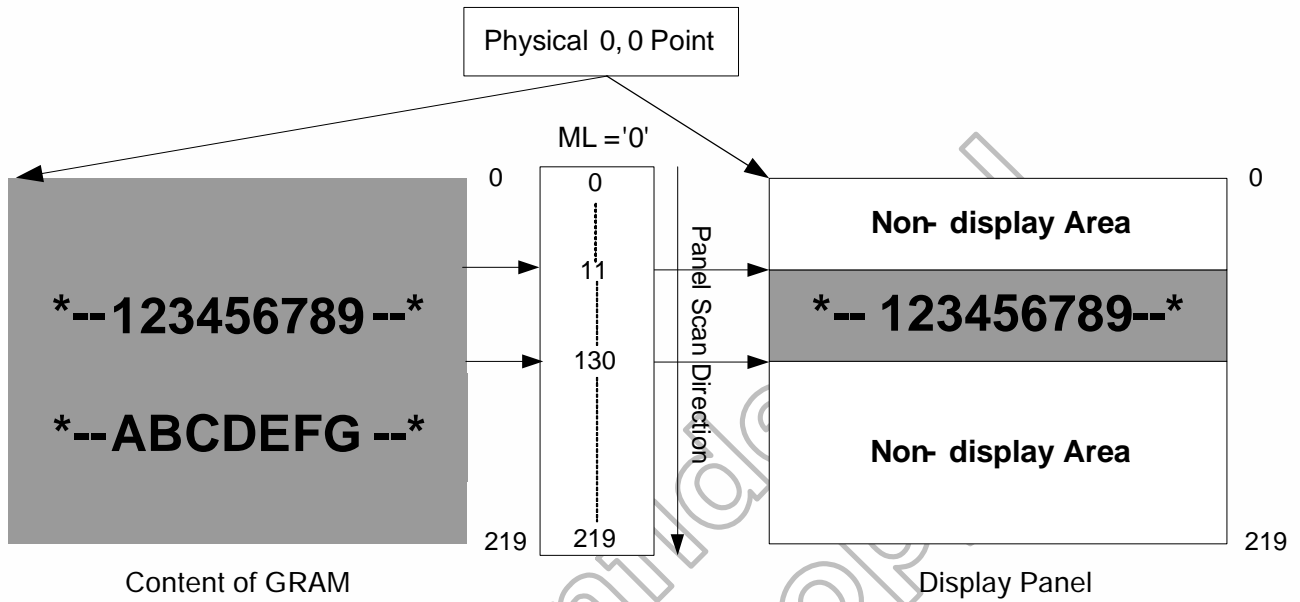
### 6.3.1 Normal Display On or Partial Mode On, Vertical Scroll Off

In this mode, content of the frame memory within an area where column pointer is 0000h to 00AFh and page pointer is 0000h to 00DBh is displayed. To display a dot on leftmost top corner, store the dot data at (column pointer, page pointer) = (0,0) (**SMX** = 'L', **SMY** = 'L').



**Example:**

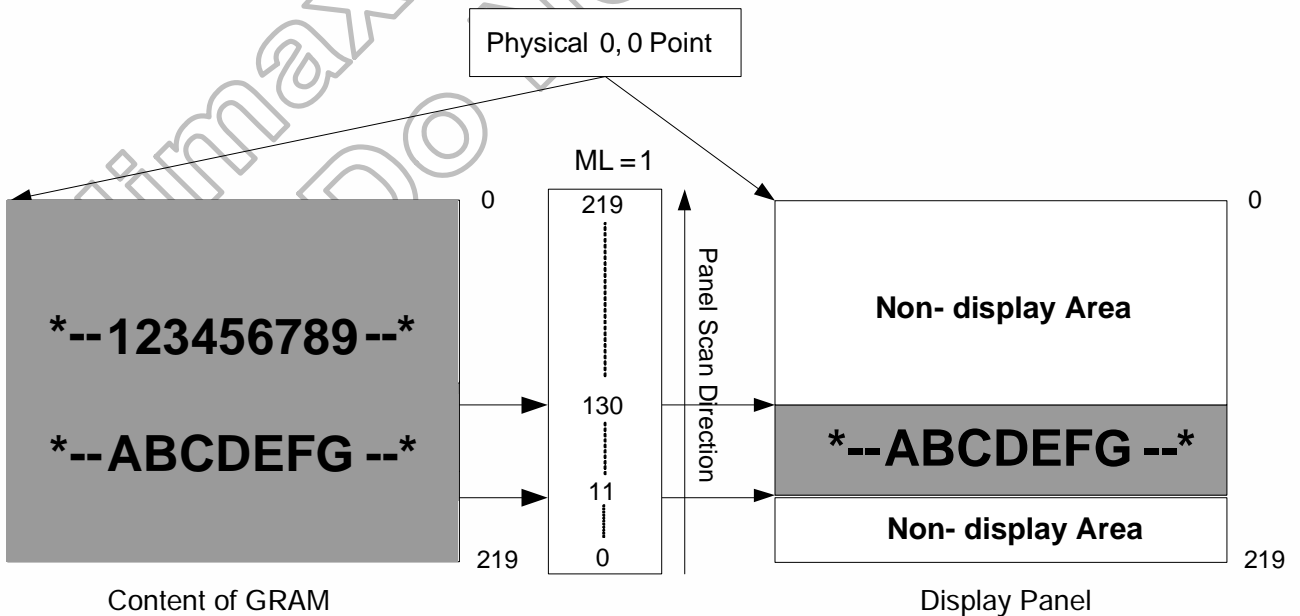
- (1) **PLTON** = '1',
- (2) R30h's **SR**=11<sub>DEC</sub>, **ER**=130<sub>DEC</sub>, **MADCTL**'s **B4(ML)**='0' (**SMY** = 'L').



**Figure 6. 5 Example of Partial Mode on (ML='0')**

**Example:**

- (1) **PLTON** = '1',
- (2) R30h's **SR**= 11<sub>DEC</sub>, **ER**=130<sub>DEC</sub>, **MADCTL**'s **B4(ML)**='1' (**SMY** = 'L').



**Figure 6. 6 Example of Partial Mode on (ML='1')**

The refresh gate scan cycle in the rest display area of the screen (non-display area) can be specified by **ISC[3:0]** bits. The scan cycle is set to an odd number from 0~13. The polarity is inverted every scan cycle.

ISC3	ISC2	ISC1	ISC0	Scan Cycle	f <sub>FLM</sub> = 60Hz
0	0	0	0	0 frame	-
0	0	0	1	3 frames	50 ms
0	0	1	0	5 frames	84 ms
0	0	1	1	7 frames	117 ms
0	1	0	0	9 frames	150 ms
0	1	0	1	11 frames	184 ms
0	1	1	0	13 frames	217 ms
0	1	1	1	15 frames	251 ms
1	0	0	0	17 frames	284 ms
1	0	0	1	19 frames	317 ms
1	0	1	0	21 frames	351 ms
1	0	1	1	23 frames	384 ms
1	1	0	0	25 frames	418 ms
1	1	0	1	27 frames	451 ms
1	1	1	0	29 frames	484 ms
1	1	1	1	31 frames	518 ms

Table 6. 8 ISC[3:0] Bits Definition

The rest display area (non-display area) will be the white display if the type of LCD is normally white (**NWB** = "1") and will be the black display if the type of LCD is normally black (**NWB** = "0") in refresh gate scan cycle.

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### 6.3.2 Vertical Scroll Display Mode

The vertical scrolling display is specified by VSCRDEF instruction (R0Eh~R13h) and VSCRADD instruction (R14h~R15h).

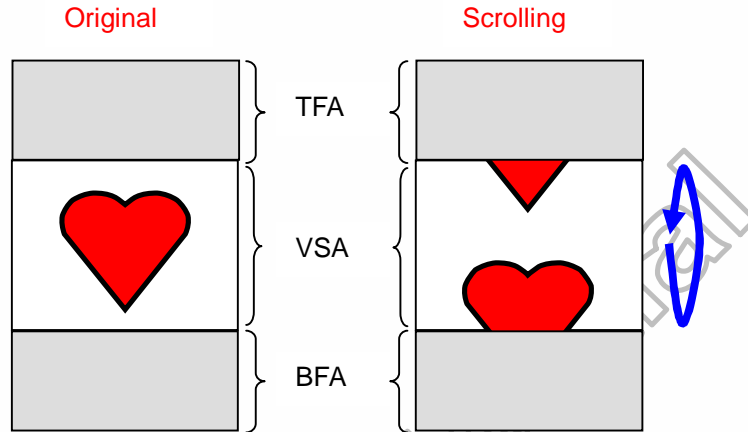


Figure 6.7 Vertical Scrolling

When Vertical Scrolling Definition Parameters (TFA+VSA+BFA)=220. In this case, scrolling is applied as shown below.

Example (1) TFA='2d', VSA='218d', BFA='0d', VSP='3d' when MADCTL B4 (ML)=0 (SMX = 'L', SMY = 'L').

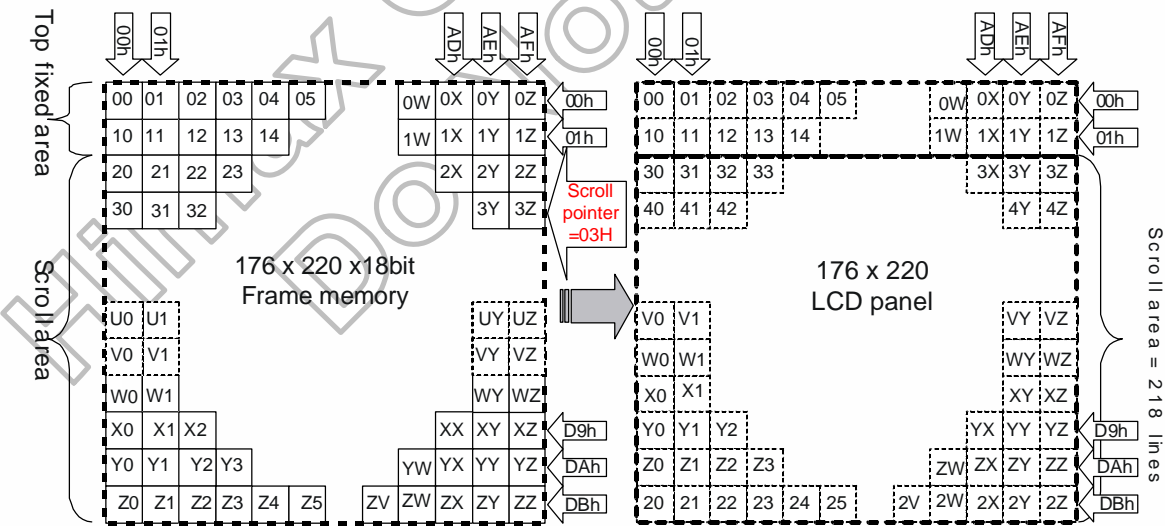


Figure 6.8 Memory Map of Vertical Scrolling I



Example (2) TFA='2d', VSA='216d', BFA='2d', VSP='3d' when MADCTL B4 (ML)=0  
(SMX = 'L', SMY = 'L').

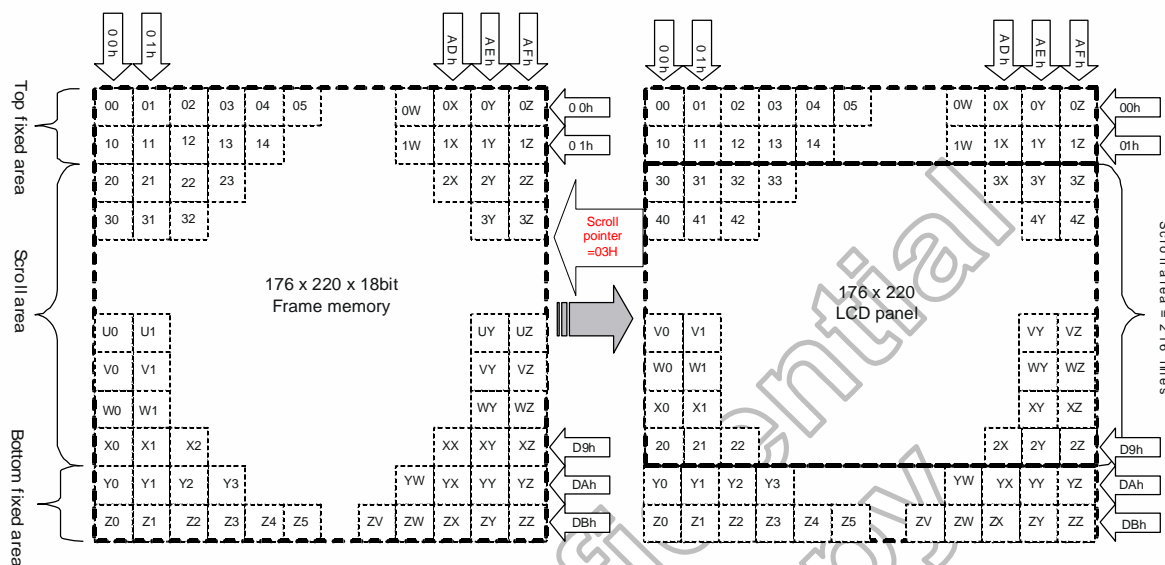


Figure 6.9 Memory Map of Vertical Scrolling II

Example (3) TFA='2d', VSA='216d', BFA='2d', VSP='5d' when MADCTL B4 (ML)=0  
(SMX = 'L', SMY = 'L').

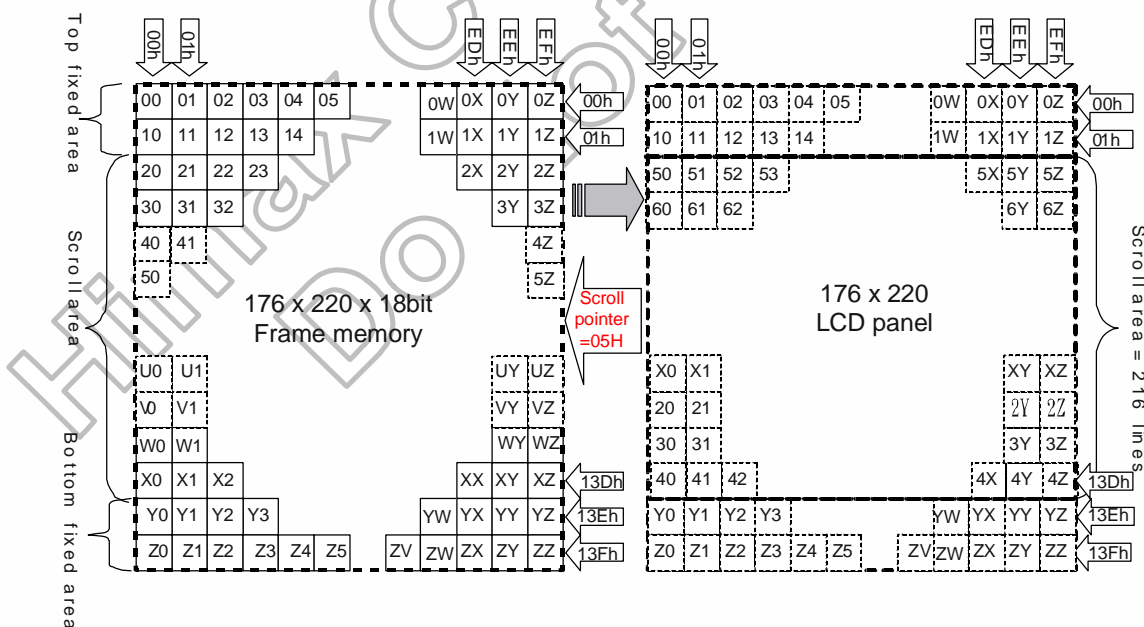


Figure 6.10 Memory Map of Vertical Scrolling III

**Vertical Scroll Example**

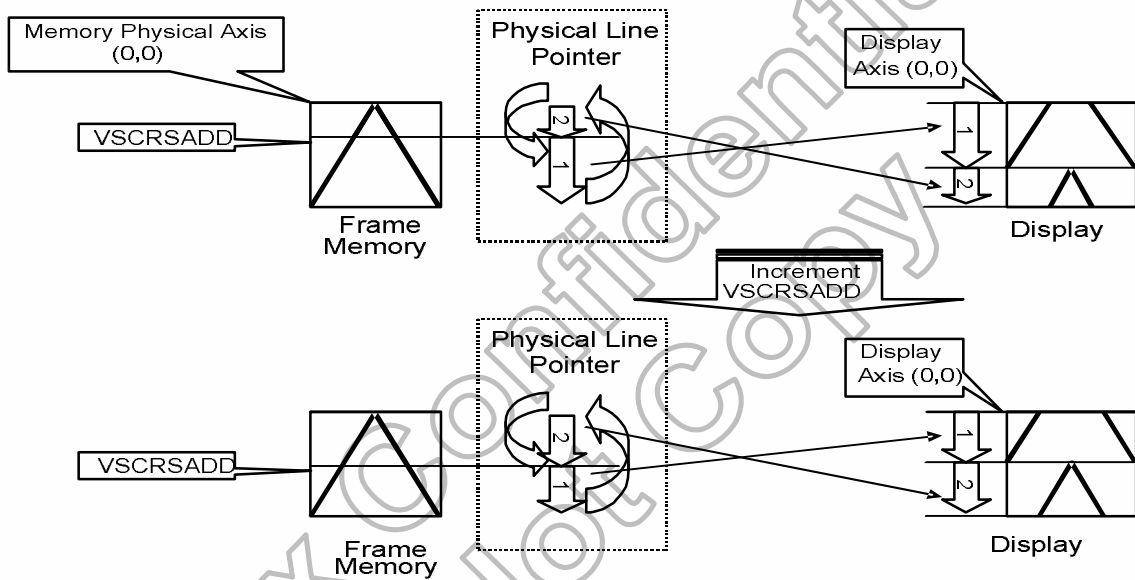
There are 2 types of vertical scrolling, which are determined by the commands “Vertical Scrolling Definition” (33h) and “Vertical Scrolling Start Address” (37h).

Case 1: TFA + VSA + BFA ≠ ‘220d’

N/A. Do not set TFA + VSA + BFA ≠ ‘220d’. In that case, unexpected picture will be shown.

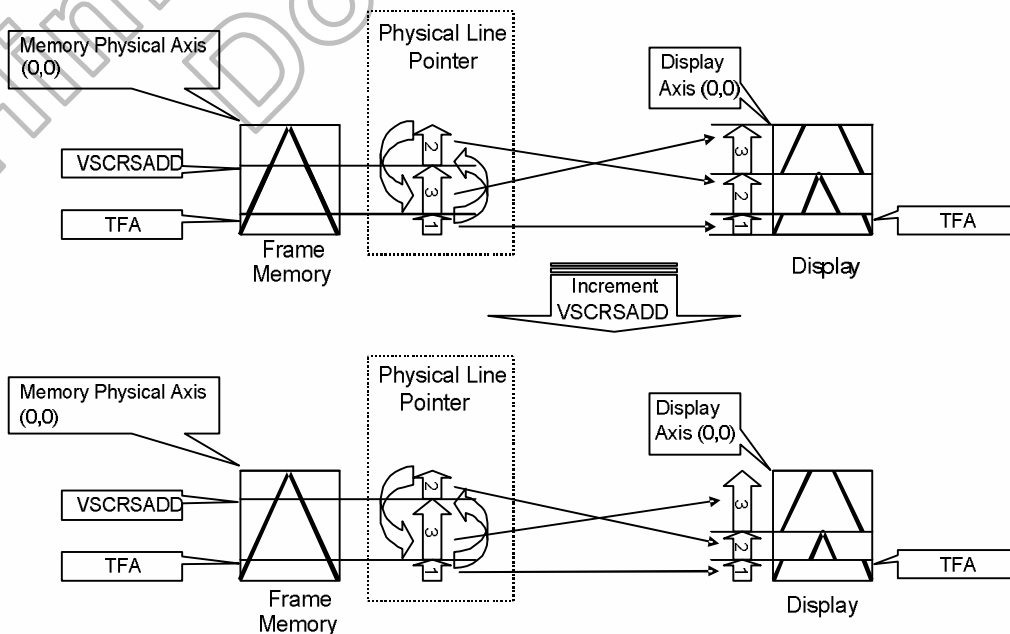
Case 2: TFA + VSA + BFA = ‘20d’ (Scrolling)

Example (1) When TFA=‘0d’, VSA=‘220d’, BFA=‘0d’ and VSP=‘40d’, MADCTRL parameter B4(ML)=‘0’



**Figure 6. 11 Vertical Scroll Example when ML=‘0’**

Example (2) TFA=‘30d’, VSA=‘190d’, BFA=‘0d’ and VSP=‘80d’, MADCTRL parameter B4(ML) = ‘1’



**Figure 6. 12 Vertical Scroll Example when ML=‘1’**

### 6.3.3 Updating Order on Display Active Area in RGB Interface Mode (Normal Mode On + Sleep Out)

There is defined different kind of updating orders for display in RGB interface mode (**RCM[1:0]** = '10' or '11'). These updating are controlled by external RL pin internal CRL bit based on external SMX pin setting and external TB pin/ internal CTB bit based on external SMY pin setting.

Please note that as internal CRL bit be written in RGB interface, the external pin RL control is invalid, and CRL is operated based on external pin SMX setting. As internal CTB bit be written in RGB interface, the external pin TB control is invalid, and CRL is operated based on external pin SMY setting.

Data streaming direction from the host to the display is described in the following figure.

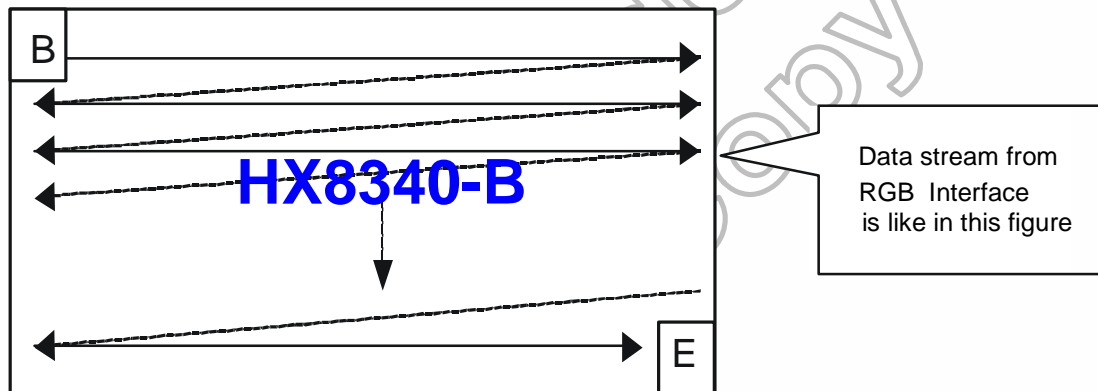


Figure 6. 13 Data Streaming Order in RGB I/F

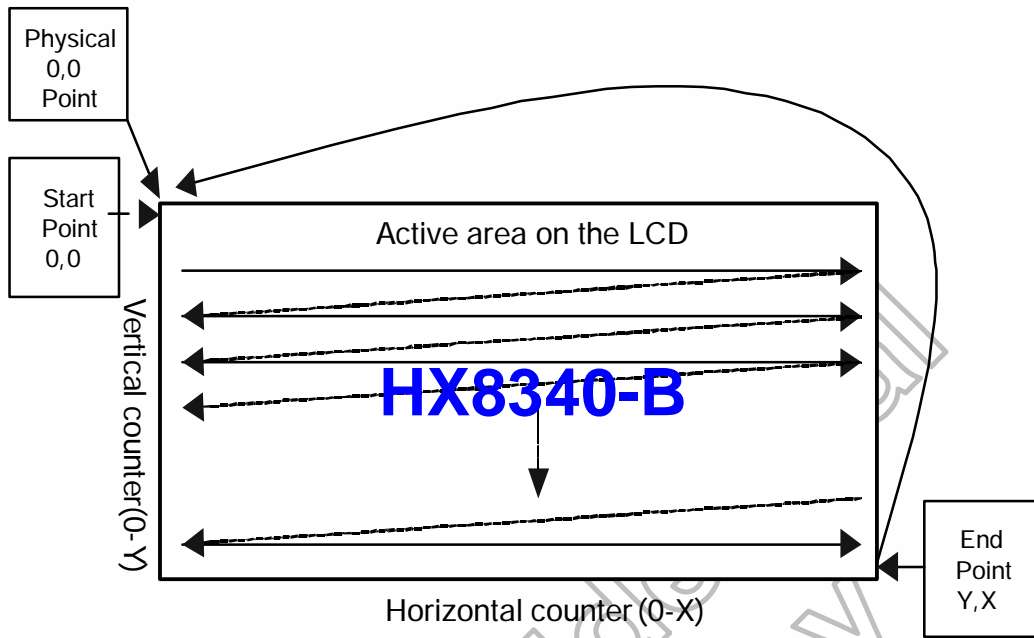


Figure 6. 14 Updating Order when TB = 'L' and RL = 'L'

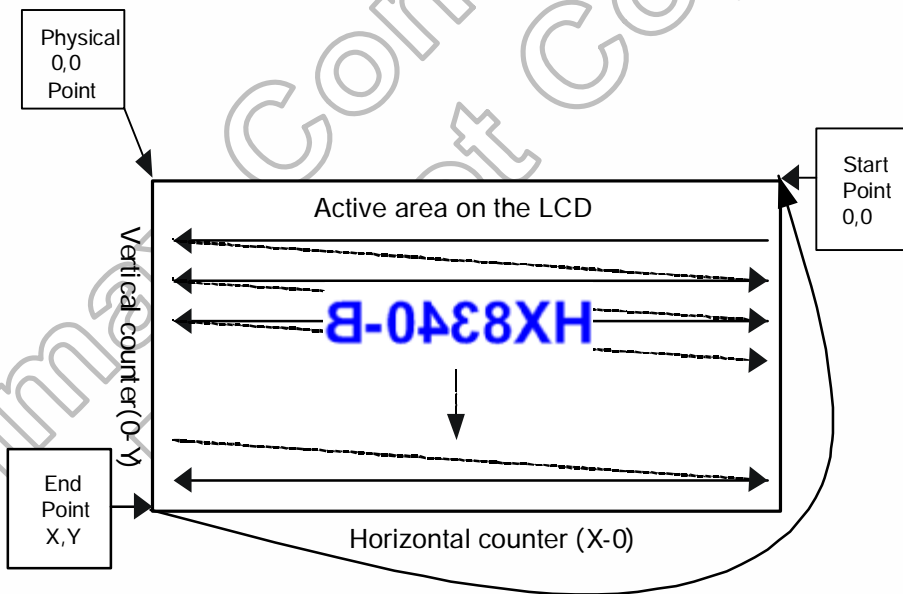


Figure 6. 15 Updating Order when TB = 'L' and RL = 'H'

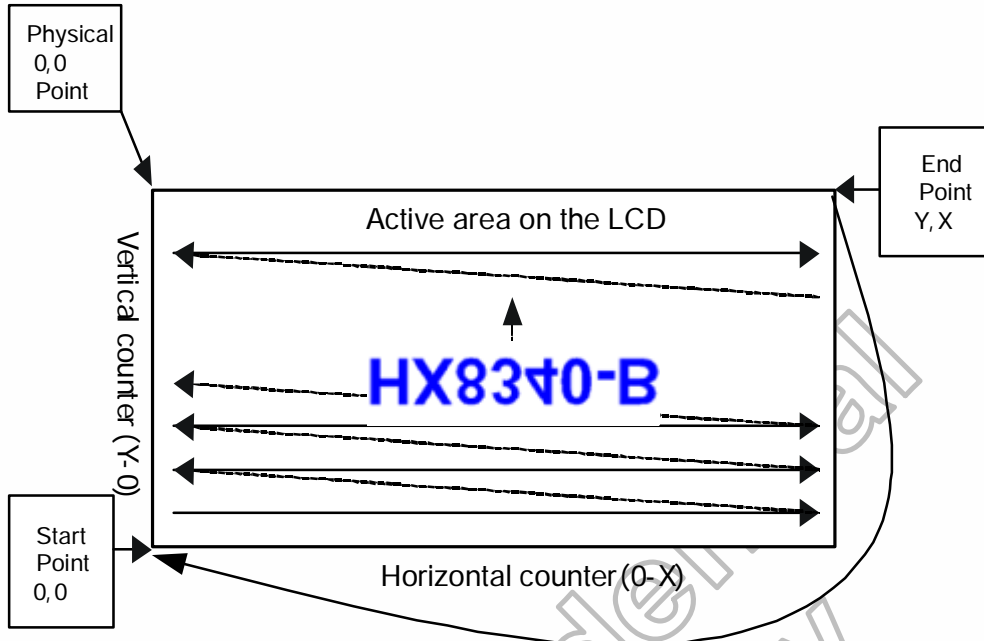


Figure 6. 16 Updating Order when TB = 'H' and RL = 'L'

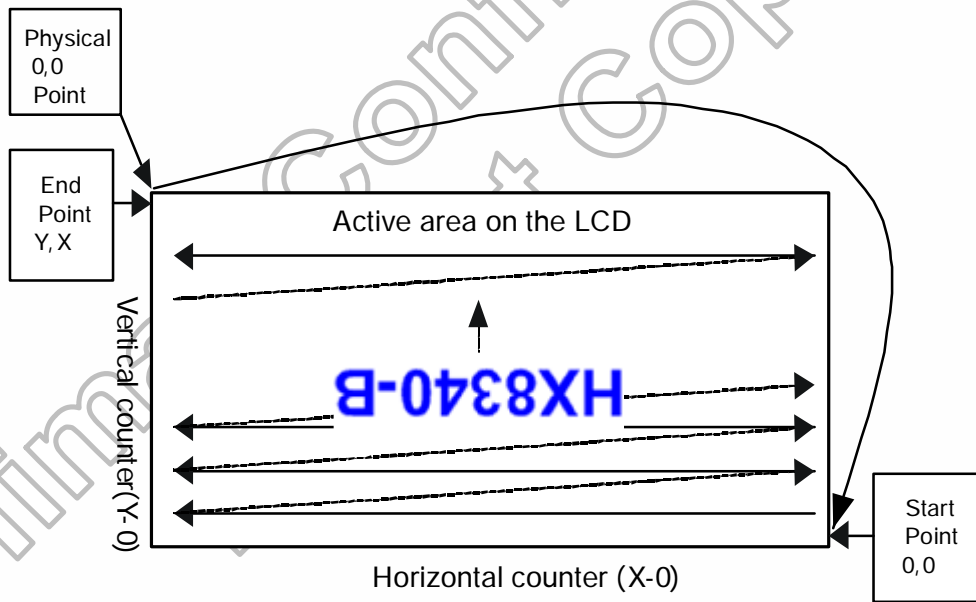


Figure 6. 17 Updating Order when TB = 'H' and RL = 'H'

Condition	Horizontal Counter	Vertical Counter
An active VS signal is received	Return to 0	Return to 0
Single Pixel information of the active area is received	Increment by 1	No change
An active HS signal between two active area lines	Return to 0	Increment by 1
The Horizontal counter value is larger than X and the Vertical counter value is larger than Y	Return to "Start Column"	Return to "Start Page"

Note: Pixel order is RGB on the display.

Table 6. 9 Rules for Updating Order on Display Active Area in RGB Interface Display Mode

## 7. Functional Description

### 7.1 Internal Oscillator

The HX8340-B can oscillate an internal R-C oscillator for internal operation. Because the tolerance of internal oscillator frequency is  $\pm 5\%$ , it can be adjusted for initial 2.52MHz internal clock generation. With other dividers setting, the 2.52MHz internal clock can be used to generate clock for other part of the chip using.

In RGB interface mode ( $RCM[1:0] = '10'$  or  $'11'$ ), external DOTCLK will be replace the internal clock for other part of the chip using.

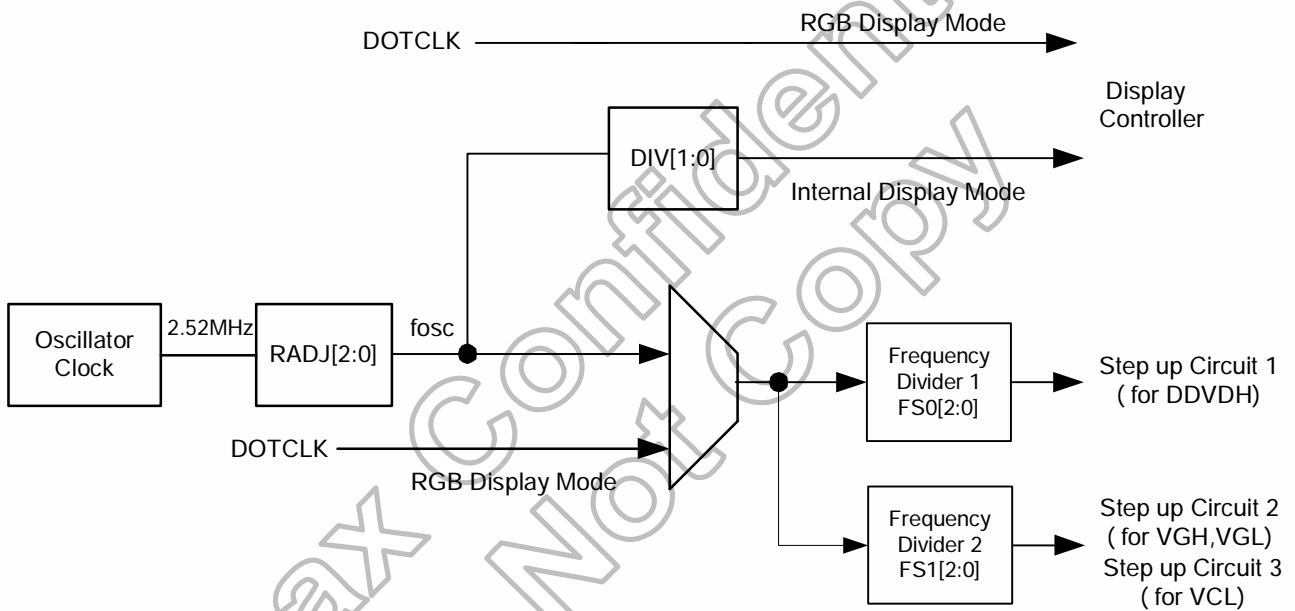


Figure 7. 1 HX8340-B Internal Clock Circuit

### 7.2 Gamma Characteristic Correction Function

The HX8340-B incorporates gamma adjustment function for the 262,144-color display (64 grayscale for each R, G and B color). Gamma adjustment operation is implemented by deciding the 8 grayscale levels firstly in gamma adjustment control registers to match the LCD panel. These registers are available both for positive polarities and negative polarities.

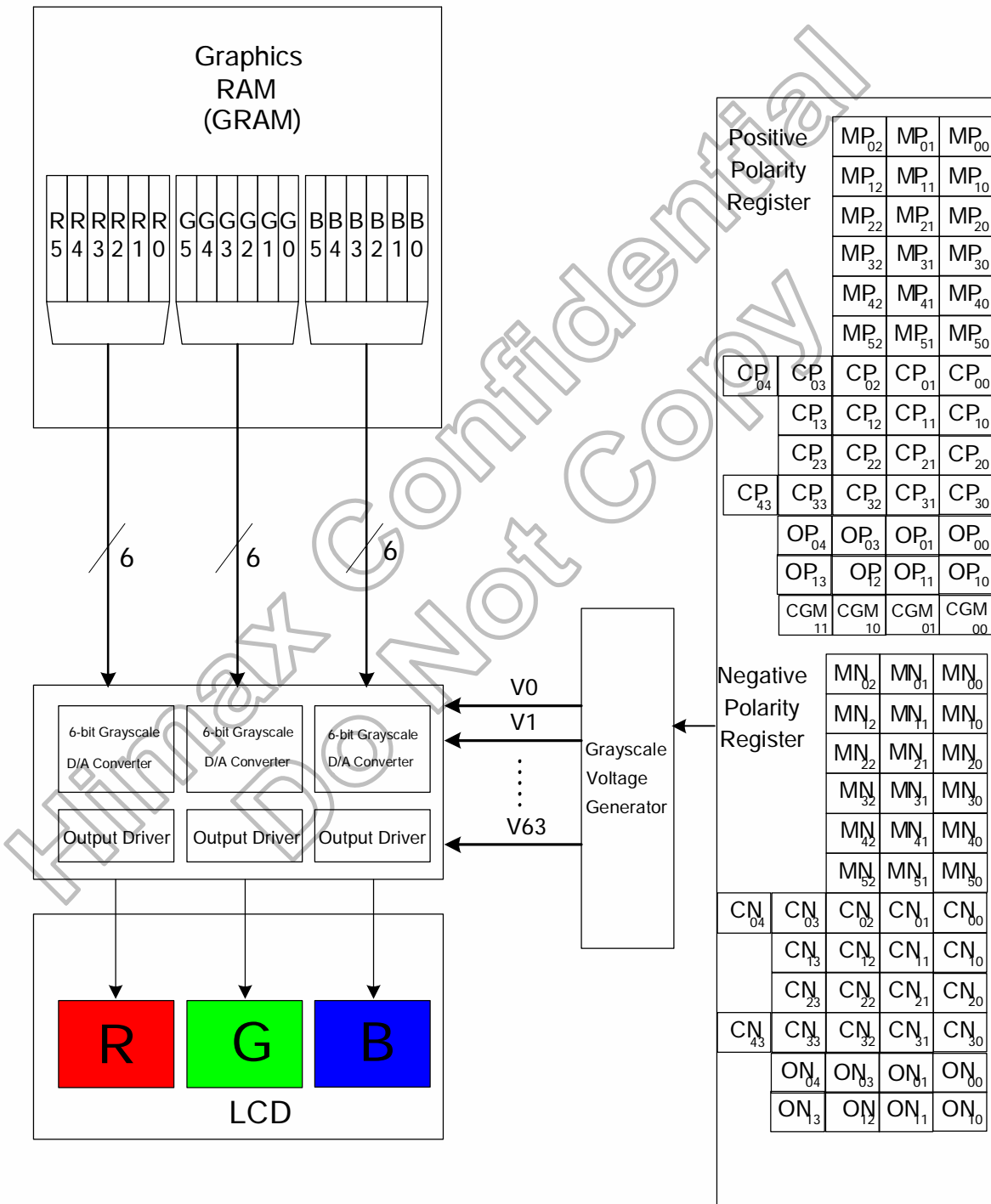
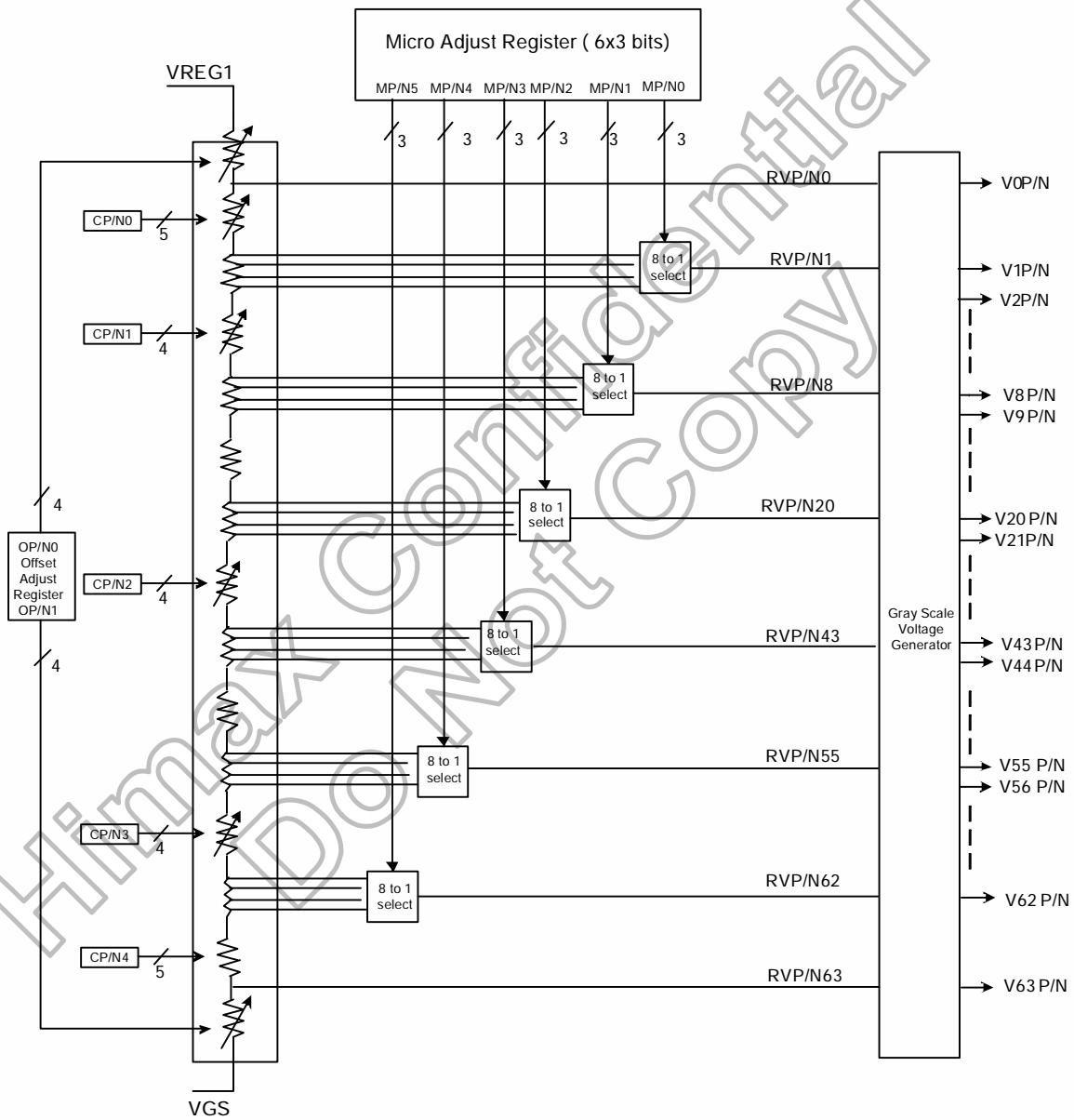


Figure 7. 2 Grayscale Control



**Structure of Grayscale Voltage Generator**

Eight reference gamma voltages (RVP 0, 1, 8, 20, 43, 55, 62 and 63). For positive and negative polarity are specified by the center adjustment, the micro adjustment and the offset adjustment registers firstly. With those eight voltages injected into specified node of grayscale voltage generator, total 64 grayscale voltages (V0-V63) can be generated from grayscale amplifier for LCD panel used.



**Figure 7. 3 Structure of Grayscale Voltage Generator**

**Gamma-Characteristics Adjustment Register**

This HX8343-B has register groups for specifying a series grayscale voltage that meets the Gamma-characteristics for the LCD panel used. These registers are divided into two groups, which correspond to the gradient, amplitude, and macro adjustment of the voltage for the grayscale characteristics.

**(1) Offset adjustment registers**

The offset adjustment variable registers are used to adjust the amplitude of the grayscale voltage. This function is implemented by controlling these variable resistors in the top and bottom of the gamma resistor stream for reference gamma voltage generation. These registers are available for both positive and negative polarities

**(2) Gamma center adjustment registers**

The gamma center adjustment registers are used to adjust the reference gamma voltage in the middle level of grayscale without changing the dynamic range. This function is implemented by choosing one input of 8 to 1 selector in the gamma resistor stream for reference gamma voltage generation. These registers are available for both positive and negative polarities.

**(3) Gamma macro adjustment registers**

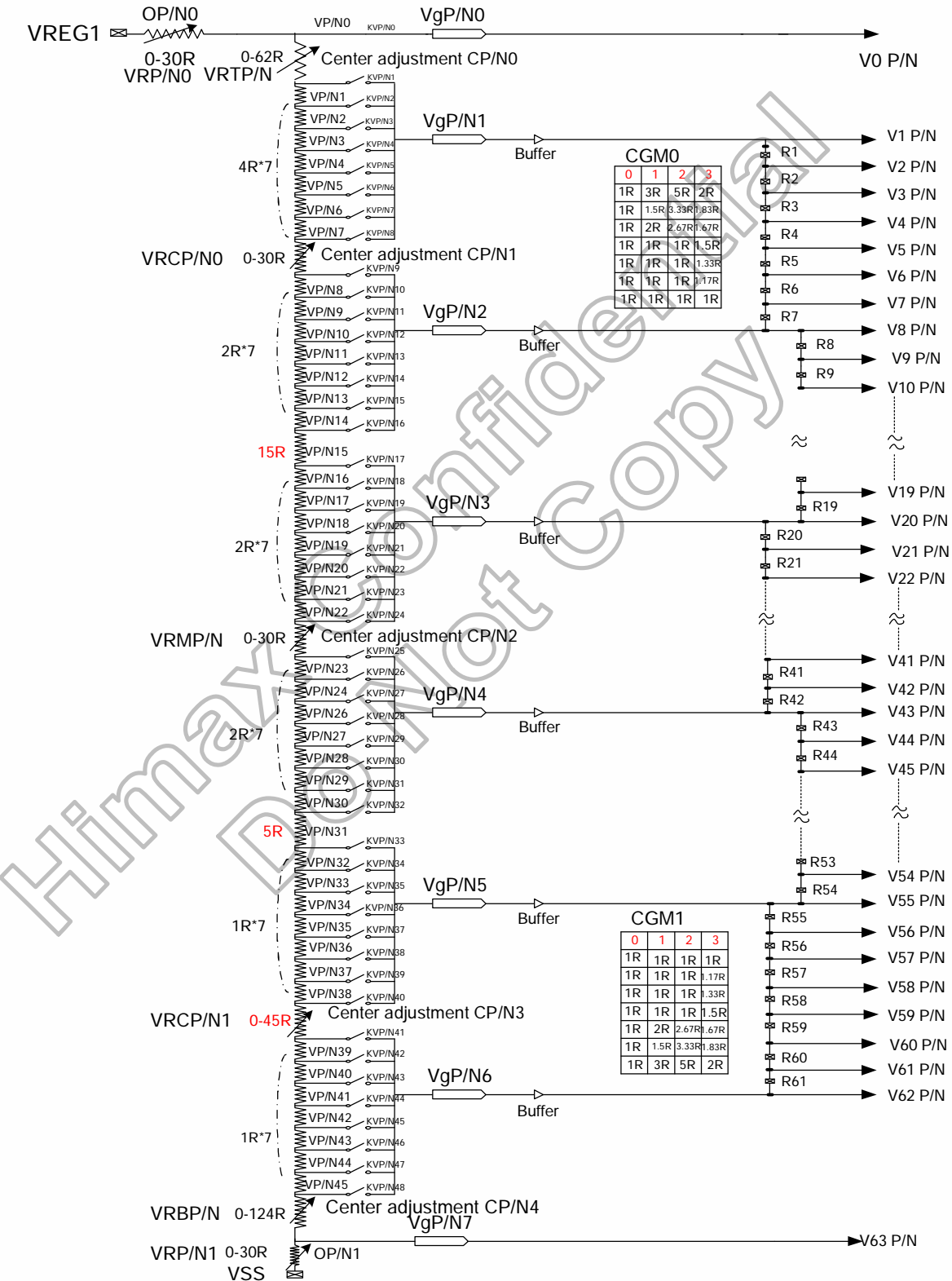
The gamma macro adjustment registers can be used for fine adjustment of the reference gamma voltage. This function is implemented by controlling the 8-to-1 selectors (MP/N0~5), each of which has 8 inputs and generate one reference voltage output (RVP/N 0, 1, 8, 20, 44, 56, 63, 64). These registers are available for both positive and negative polarities.

Register Groups	Positive Polarity	Description
Center Adjustment	CP/N0 4-0	Variable resistor (VRTP/N) for center adjustment
	CP/N1 3-0	Variable resistor (VRCP/N0)for center adjustment
	CP/N2 3-0	Variable resistor (VRMP/N) for center adjustment
	CP/N3 3-0	Variable resistor (VRCP/N1)for center adjustment
	CP/N4 4-0	Variable resistor (VRBP/N)for center adjustment
Macro Adjustment	MP/N0 2-0	8-to-1 selector (reference voltage level of grayscale 1)
	MP/N1 2-0	8-to-1 selector (reference voltage level of grayscale 8)
	MP/N2 2-0	8-to-1 selector (reference voltage level of grayscale 20)
	MP/N3 2-0	8-to-1 selector (reference voltage level of grayscale 43)
	MP/N4 2-0	8-to-1 selector (reference voltage level of grayscale 55)
	MP/N5 2-0	8-to-1 selector (reference voltage level of grayscale 62)
Offset Adjustment	OP/N0 3-0	Variable resistor (VROP/N0)for offset adjustment
	OP/N1 3-0	Variable resistor (VROP/N1)for offset adjustment

**Table 7. 1 Gamma-Adjustment Registers**

**Gamma resistor stream and 8 to 1 Selector**

The block consists of two gamma resistor streams one is for positive polarity and the other is for negative polarity, each one including eight gamma reference voltages. (RVP/N 0, 1, 8, 20, 43, 55, 62 63)



**Figure 7. 4 Gamma Resistor Stream and Gamma Reference Voltage**

**Variable resistor**

There are two types of variable resistors, one is for center adjustment and the other is for offset adjustment. The resistances are decided by setting values in the center adjustment, offset adjustment registers. Their relationships are shown below.

Value in Register OP/N0 3-0	Resistance VRP/N0
0000	0R
0001	2R
0010	4R
•	•
•	•
1101	26R
1110	28R
1111	30R

**Table 7. 2 Offset Adjustment 0**

Value in Register OP/N1 3-0	Resistance VRP/N1
0000	0R
0001	2R
0010	4R
•	•
•	•
1101	26R
1110	28R
1111	30R

**Table 7. 3 Offset Adjustment 1**

Value in Register CP/N0 4-0	Resistance VRTP/N0	Value in Register CP/N4 4-0	Resistance VRBP/N	Value in Register CP/N1(2) 3-0	Resistance VRCP/N0 VRMP/N
00000	0R	00000	0R	0000	0R
00001	2R	00001	4R	0001	2R
00010	4R	00010	8R	0010	4R
•	•	•	•	•	•
•	•	•	•	•	•
11100	56R	11100	112R	1100	24R
11101	58R	11101	116R	1101	26R
11110	60R	11110	120R	1110	28R
11111	62R	11111	124R	1111	30R

Value in Register CP/N3 3-0	Resistance VRCP/N1
0000	0R
0001	3R
0010	6R
•	•
•	•
1100	36R
1101	39R
1110	42R
1111	45R

**Table 7. 4 Center Adjustment**

**8 to 1 Selector**

The 8 to 1 selector has eight input voltages generated by gamma resister stream and outputs one reference voltages selected from inputs for gamma reference voltage generation by setting value in macro adjustment register. There are six 8 to 1 selectors and the relationships are shown below.

Value in Register MP/N 2-0	Voltage level					
	VgP/N 1	VgP/N 2	VgP/N 3	VgP/N 4	VP/N 5	VP/N 6
000	KVP/N1	KVP/N9	KVP/N17	KVP/N25	KVP/N33	KVP/N41
001	KVP/N 2	KVP/N10	KVP/N18	KVP/N26	KVP/N34	KVP/N42
010	KVP/N3	KVP/N11	KVP/N19	KVP/N27	KVP/N35	KVP/N43
011	KVP/N 4	KVP/N12	KVP/N20	KVP/N28	KVP/N36	KVP/N44
100	KVP/N 5	KVP/N13	KVP/N21	KVP/N29	KVP/N37	KVP/N45
101	KVP/N 6	KVP/N14	KVP/N22	KVP/N30	KVP/N38	KVP/N46
110	KVP/N 7	KVP/N15	KVP/N23	KVP/N31	KVP/N39	KVP/N47
111	KVP/N 8	KVP/N16	KVP/N24	KVP/N32	KVP/N40	KVP/N48

**Table 7. 5 Output Voltage of 8 to 1 Selector**

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The grayscale levels are determined by the following formulas.

Reference Voltage	Formula		Pin
VgP/N0	----	$VREG1 - VD * VRP/N0 / \text{sumRP/N}$	KVP/N0
VgP/N1	MP/N0 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N) / \text{sumRP/N})$	KVP/N1
	MP/N0 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + 4R) / \text{sumRP/N})$	KVP/N2
	MP/N0 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + 8R) / \text{sumRP/N})$	KVP/N3
	MP/N0 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + 12R) / \text{sumRP/N})$	KVP/N4
	MP/N0 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + 16R) / \text{sumRP/N})$	KVP/N5
	MP/N0 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + 20R) / \text{sumRP/N})$	KVP/N6
	MP/N0 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + 24R) / \text{sumRP/N})$	KVP/N7
	MP/N0 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + 28R) / \text{sumRP/N})$	KVP/N8
VgP/N2	MP/N1 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N + 28R + VRCP/N) / \text{sumRP/N})$	KVP/N9
	MP/N1 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + 30R + VRCP/N) / \text{sumRP/N})$	KVP/N10
	MP/N1 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + 32R + VRCP/N) / \text{sumRP/N})$	KVP/N11
	MP/N1 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + 34R + VRCP/N) / \text{sumRP/N})$	KVP/N12
	MP/N1 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + 36R + VRCP/N) / \text{sumRP/N})$	KVP/N13
	MP/N1 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + 38R + VRCP/N) / \text{sumRP/N})$	KVP/N14
	MP/N1 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + 40R + VRCP/N) / \text{sumRP/N})$	KVP/N15
	MP/N1 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + 42R + VRCP/N) / \text{sumRP/N})$	KVP/N16
VgP/N3	MP/N2 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N + 57R + VRCP/N) / \text{sumRP/N})$	KVP/N17
	MP/N2 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + 59R + VRCP/N) / \text{sumRP/N})$	KVP/N18
	MP/N2 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + 61R + VRCP/N) / \text{sumRP/N})$	KVP/N19
	MP/N2 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + 63R + VRCP/N) / \text{sumRP/N})$	KVP/N20
	MP/N2 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + 65R + VRCP/N) / \text{sumRP/N})$	KVP/N21
	MP/N2 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + 67R + VRCP/N) / \text{sumRP/N})$	KVP/N22
	MP/N2 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + 69R + VRCP/N) / \text{sumRP/N})$	KVP/N23
	MP/N2 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + 71R + VRCP/N) / \text{sumRP/N})$	KVP/N24
VgP/N4	MP/N3 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 71R + VRCP/N) / \text{sumRP/N})$	KVP/N25
	MP/N3 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 73R + VRCP/N) / \text{sumRP/N})$	KVP/N26
	MP/N3 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 75R + VRCP/N) / \text{sumRP/N})$	KVP/N27
	MP/N3 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 77R + VRCP/N) / \text{sumRP/N})$	KVP/N28
	MP/N3 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 89R + VRCP/N) / \text{sumRP/N})$	KVP/N29
	MP/N3 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 81R + VRCP/N) / \text{sumRP/N})$	KVP/N30
	MP/N3 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 83R + VRCP/N) / \text{sumRP/N})$	KVP/N31
	MP/N3 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 85R + VRCP/N) / \text{sumRP/N})$	KVP/N32
VgP/N5	MP/N4 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 90R + VRCP/N) / \text{sumRP/N})$	KVP/N33
	MP/N4 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 91R + VRCP/N) / \text{sumRP/N})$	KVP/N34
	MP/N4 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 92R + VRCP/N) / \text{sumRP/N})$	KVP/N35
	MP/N4 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 93R + VRCP/N) / \text{sumRP/N})$	KVP/N36
	MP/N4 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 94R + VRCP/N) / \text{sumRP/N})$	KVP/N37
	MP/N4 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 95R + VRCP/N) / \text{sumRP/N})$	KVP/N38
	MP/N4 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 96R + VRCP/N) / \text{sumRP/N})$	KVP/N39
	MP/N4 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 97R + VRCP/N) / \text{sumRP/N})$	KVP/N40
VgP/N6	MP/N5 2-0=000	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 97R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N41
	MP/N5 2-0=001	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 98R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N42
	MP/N5 2-0=010	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 99R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N43
	MP/N5 2-0=011	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 100R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N44
	MP/N5 2-0=100	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 101R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N45
	MP/N5 2-0=101	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 102R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N46
	MP/N5 2-0=110	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 103R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N47
	MP/N5 2-0=111	$VREG1 - VD((VRP/N0 + VRTP/N + VRMP/N + 104R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N48
VgP/N7	----	$VREG1 - VD((VRP/N0 + VRBP/N + VRTP/N + VRMP/N + 104R + VRCP/N0 + VRCP/N1) / \text{sumRP/N})$	KVP/N49

SumRP=104R+VRP0+ VRP1+ VRTP+ VRCP0+VRMP+VRCP1+VRBP  
 SumRN=104R+ VRP0+ VRP1+ VRTP+ VRCP0+VRMP+VRCP1+VRBP  
 VD=(VREG1-VSS)

Table 7. 6 Voltage Calculation Formula



Grayscale Voltage	Formula	Grayscale Voltage	Formula
V0P/N	VgP/N0	V32 P/N	VgP/N4+(VgP/N3-VgP/N4)*(11/23)
V1 P/N	VgP/N1	V33 P/N	VgP/N4+(VgP/N3-VgP/N4)*(10/23)
V2 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT1	V34 P/N	VgP/N4+(VgP/N3-VgP/N4)*(9/23)
V3 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT2	V35 P/N	VgP/N4+(VgP/N3-VgP/N4)*(8/23)
V4 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT3	V36 P/N	VgP/N4+(VgP/N3-VgP/N4)*(7/23)
V5 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT4	V37 P/N	VgP/N4+(VgP/N3-VgP/N4)*(6/23)
V6 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT5	V38 P/N	VgP/N4+(VgP/N3-VgP/N4)*(5/23)
V7 P/N	VgP/N2+(VgP/N1-VgP/N2)*CT6	V39 P/N	VgP/N4+(VgP/N3-VgP/N4)*(4/23)
V8 P/N	VgP/N2	V40 P/N	VgP/N4+(VgP/N3-VgP/N4)*(3/23)
V9 P/N	VgP/N3+(VgP/N2-VgP/N3)*(22/24)	V41 P/N	VgP/N4+(VgP/N3-VgP/N4)*(2/23)
V10 P/N	VgP/N3+(VgP/N2-VgP/N3)*(20/24)	V42 P/N	VgP/N4+(VgP/N3-VgP/N4)*(1/23)
V11 P/N	VgP/N3+(VgP/N2-VgP/N3)*(18/24)	V43 P/N	VgP/N4
V12 P/N	VgP/N3+(VgP/N2-VgP/N3)*(16/24)	V44 P/N	VgP/N5+(VgP/N4-VgP/N5)*(22/24)
V13 P/N	VgP/N3+(VgP/N2-VgP/N3)*(14/24)	V45 P/N	VgP/N5+(VgP/N4-VgP/N5)*(20/24)
V14 P/N	VgP/N3+(VgP/N2-VgP/N3)*(12/24)	V46 P/N	VgP/N5+(VgP/N4-VgP/N5)*(18/24)
V15 P/N	VgP/N3+(VgP/N2-VgP/N3)*(10/24)	V47 P/N	VgP/N5+(VgP/N4-VgP/N5)*(16/24)
V16 P/N	VgP/N3+(VgP/N2-VgP/N3)*(8/24)	V48 P/N	VgP/N5+(VgP/N4-VgP/N5)*(14/24)
V17 P/N	VgP/N3+(VgP/N2-VgP/N3)*(6/24)	V49 P/N	VgP/N5+(VgP/N4-VgP/N5)*(12/24)
V18 P/N	VgP/N3+(VgP/N2-VgP/N3)*(4/24)	V50 P/N	VgP/N5+(VgP/N4-VgP/N5)*(10/24)
V19 P/N	VgP/N3+(VgP/N2-VgP/N3)*(2/24)	V51 P/N	VgP/N5+(VgP/N4-VgP/N5)*(8/24)
V20 P/N	VgP/N3	V52 P/N	VgP/N5+(VgP/N4-VgP/N5)*(6/24)
V21 P/N	VgP/N4+(VgP/N3-VgP/N4)*(22/23)	V53 P/N	VgP/N5+(VgP/N4-VgP/N5)*(4/24)
V22 P/N	VgP/N4+(VgP/N3-VgP/N4)*(21/23)	V54 P/N	VgP/N5+(VgP/N4-VgP/N5)*(2/24)
V23 P/N	VgP/N4+(VgP/N3-VgP/N4)*(20/23)	V55 P/N	VgP/N5
V24 P/N	VgP/N4+(VgP/N3-VgP/N4)*(19/23)	V56 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB1
V25 P/N	VgP/N4+(VgP/N3-VgP/N4)*(18/23)	V57 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB2
V26 P/N	VgP/N4+(VgP/N3-VgP/N4)*(17/23)	V58 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB3
V27 P/N	VgP/N4+(VgP/N3-VgP/N4)*(16/23)	V59 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB4
V28 P/N	VgP/N4+(VgP/N3-VgP/N4)*(15/23)	V60 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB5
V29 P/N	VgP/N4+(VgP/N3-VgP/N4)*(14/23)	V61 P/N	VgP/N6+(VgP/N5-VgP/N6)*CB6
V30 P/N	VgP/N4+(VgP/N3-VgP/N4)*(13/23)	V62 P/N	VgP/N6
V31 P/N	VgP/N4+(VgP/N3-VgP/N4)*(12/23)	V63 P/N	VgP/N7

Table 7. 7 Voltage Calculation Formula of Grayscale Voltage

CGM0[1:0]	“00”	“01”	“10”	“11”	CGM1[1:0]	“00”	“01”	“10”	“11”
CT1	6/7	7.5/10.5	10/15	8.5/10.5	CB1	6/7	9.5/10.5	14/15	9.5/10.5
CT2	5/7	6/10.5	6.67/15	6.67/10.5	CB2	5/7	8.5/10.5	13/15	8.33/10.5
CT3	4/7	4/10.5	4/15	5.0/10.5	CB3	4/7	7.5/10.5	12/15	7.0/10.5
CT4	3/7	3/10.5	3/15	3.5/10.5	CB4	3/7	6.5/10.5	11/15	5.5/10.5
CT5	2/7	2/10.5	2/15	2.17/10.5	CB5	2/7	4.5/10.5	8.33/15	3.83/10.5
CT6	1/7	1/10.5	1/15	1/10.5	CB6	1/7	3.0/10.5	5/15	2.0/10.5

NOTE: Negative gamma don't have CGM0/CGM1 setting, the ratio V2~V7 and V56~V61 is automatically mapping from positive side.

Table 7. 8 Voltage Calculation Formula of Grayscale Voltage V2~V7 and V56~V61



Relationship between GRAM Data and Output Level

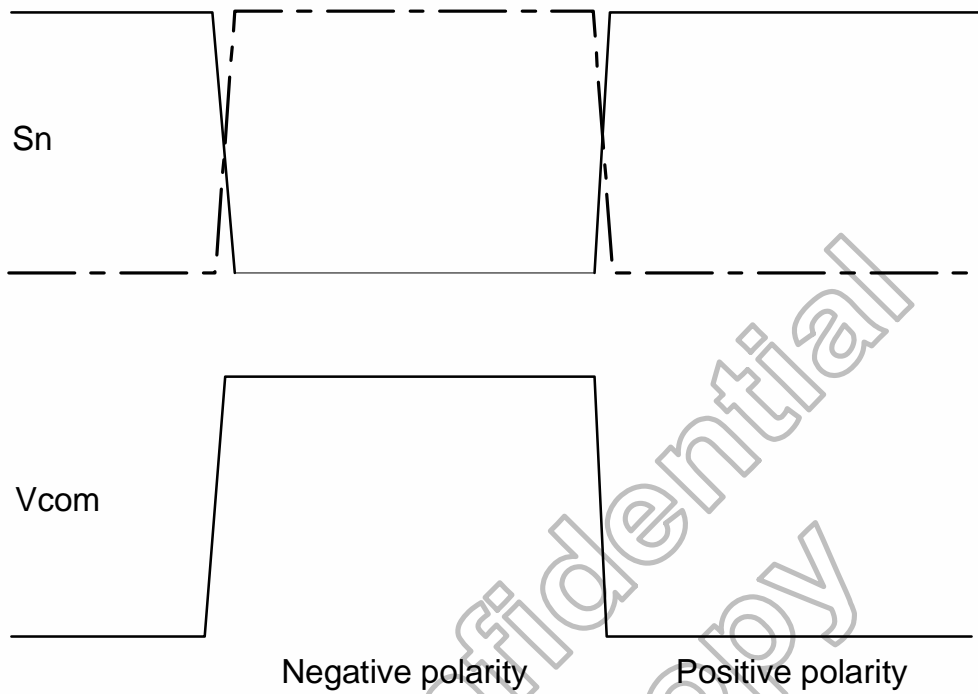
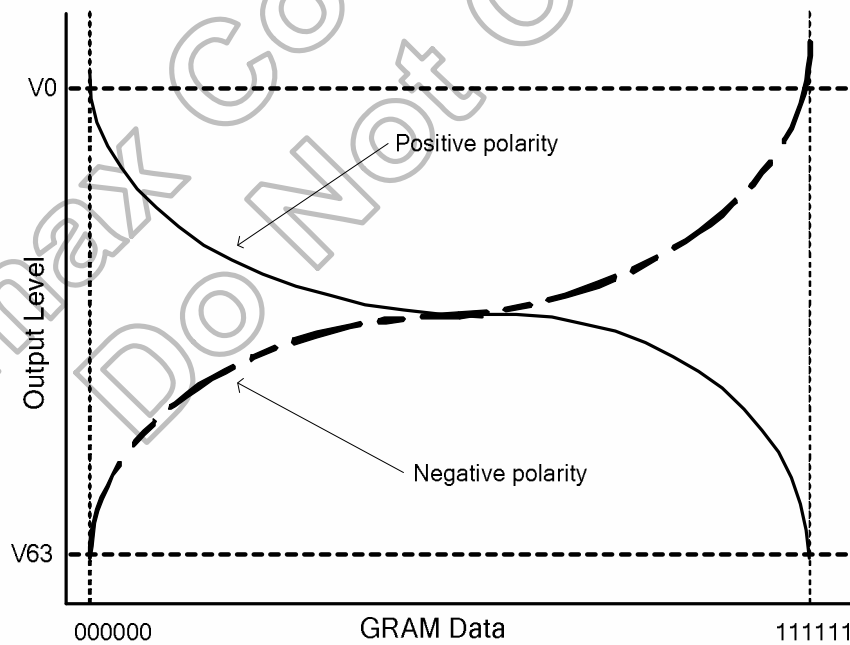


Figure 7.5 Relationship between Source Output and VCOM



(Same characteristic for each RGB)

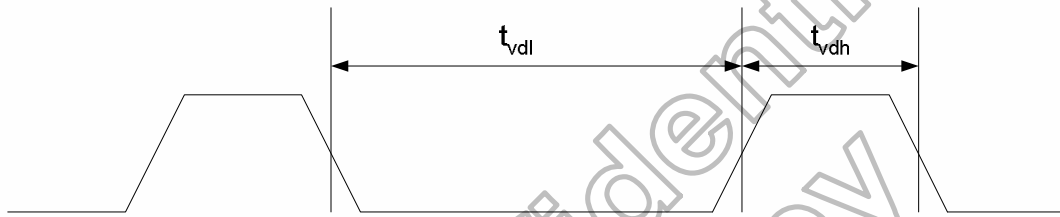
Figure 7.6 Relationship between GRAM Data and Output Level (Normal White Panel and INVON="0")

### 7.3 Tearing Effect Output Line

The Tearing Effect output line supplies to the MPU a Panel synchronization signal. This signal can be enabled or disabled by the Tearing Effect Line off & on commands. The mode of the Tearing Effect signal is defined by the parameter of the Tearing Effect Line On command. The signal can be used by the MPU to synchronize Frame Memory Writing when displaying video images.

#### 7.3.1 Tearing Effect Line Modes

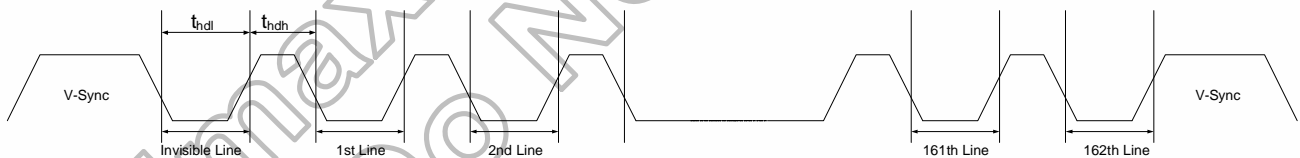
**Mode 1**, the Tearing Effect Output signal consists of V-Blanking Information only:



$t_{vdh}$  = The LCD display is not updated from the Frame Memory  
 $t_{vdl}$  = The LCD display is updated from the Frame Memory (except Invisible Line – see below)

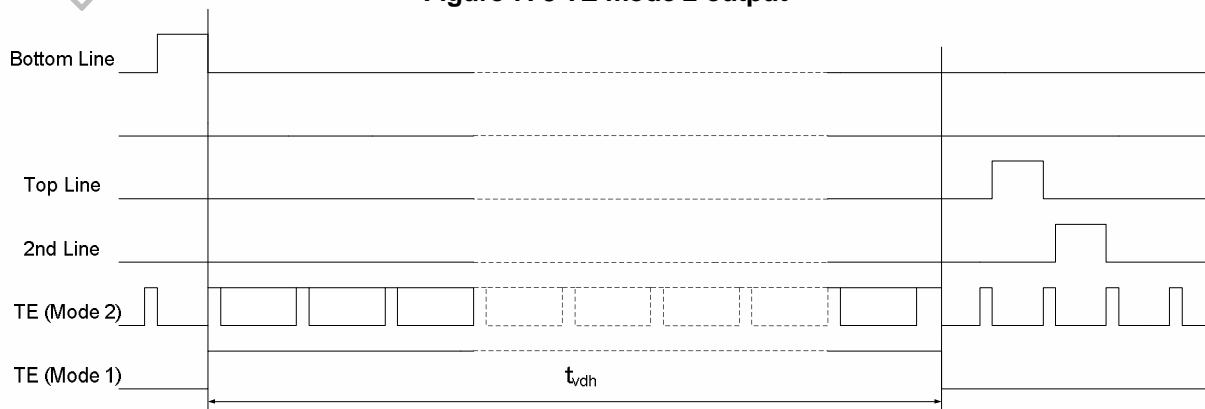
Figure 7. 7 TE mode 1 output

**Mode 2**, the Tearing Effect Output signal consists of V-Blanking and H-Blanking Information, there is one V-sync and 220 H-sync pulses per field.



$t_{hdh}$  = The LCD display is not updated from the Frame Memory  
 $t_{hdl}$  = The LCD display is updated from the Frame Memory (except Invisible Line – see above)

Figure 7. 8 TE mode 2 output



**Note:** During Sleep in Mode, the Tearing Output Pin is active Low

Figure 7. 9 TE output waveform

### 7.3.2 Tearing Effect Line Timing

The Tearing Effect signal is described below.

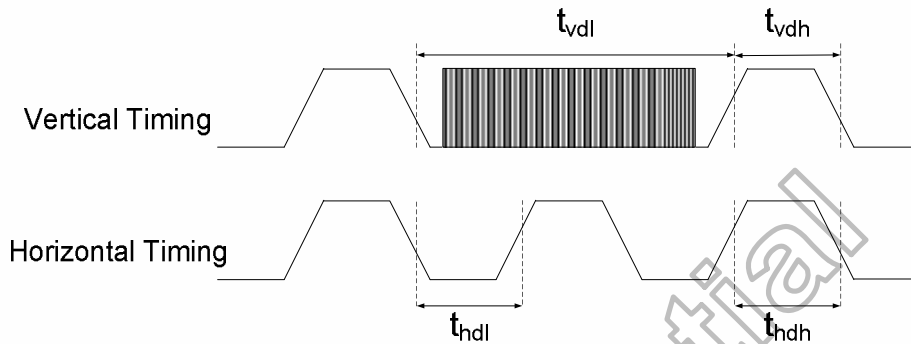


Figure 7.10 Waveform of Tearing Effect Signal

Idle Mode Off (Frame Rate = TBD Hz)

Symbol	Parameter	Min.	Max.	Unit	Description
tvdl	Vertical Timing Low Duration	TBD	-	ms	-
tvdh	Vertical Timing High Duration	BP+FP	-	us	-
thdl	Horizontal Timing Low Duration	TBD	-	us	-
thdh	Horizontal Timing High Duration	TBD	500	us	-

The signal's rise and fall times ( $t_f$ ,  $t_r$ ) are stipulated to be equal to or less than 15ns.

Table 7.9 AC characteristics of Tearing Effect Signal

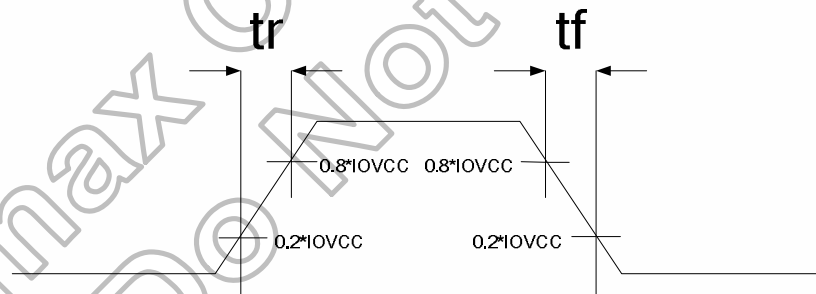
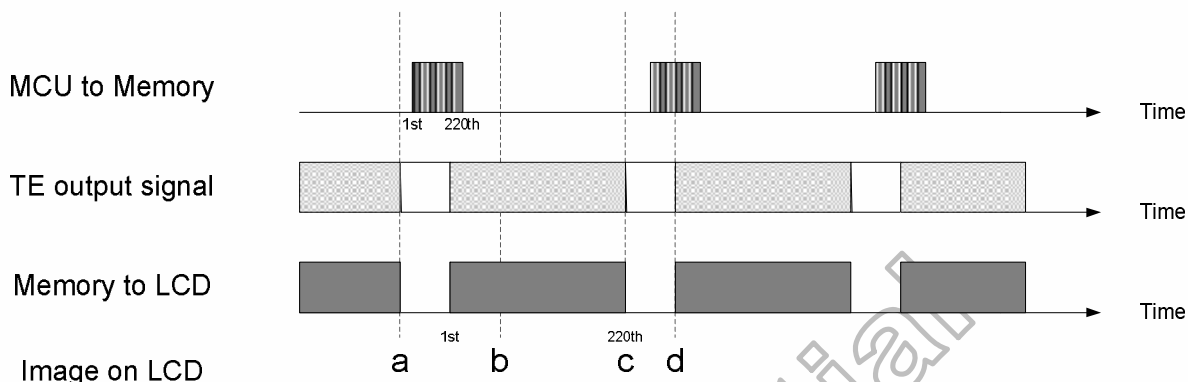


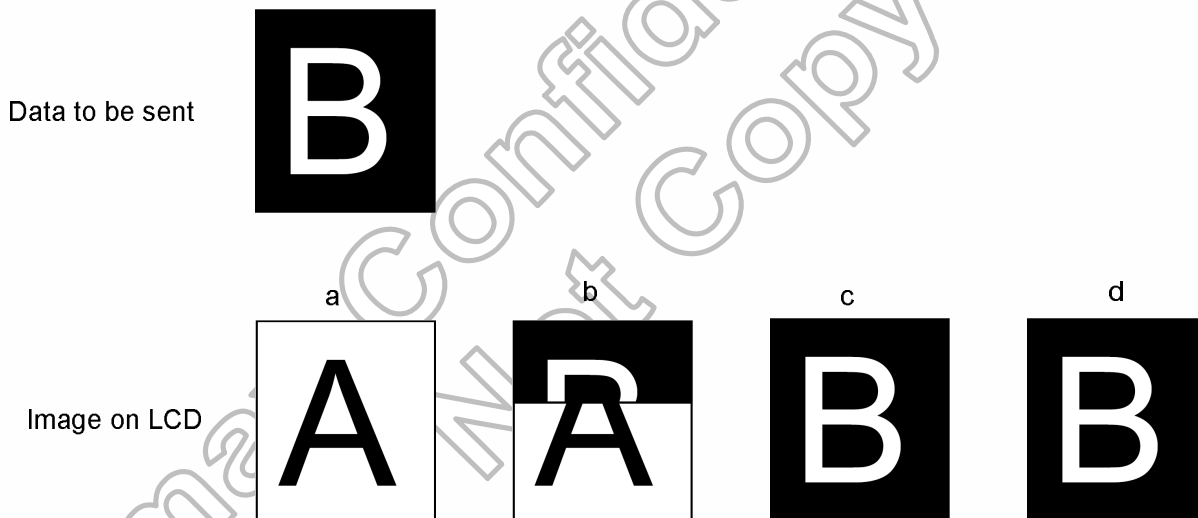
Figure 7.11 Timing of Tearing Effect Signal

The Tearing Effect Output Line is fed back to the MPU and should be used as shown below to avoid Tearing Effect:

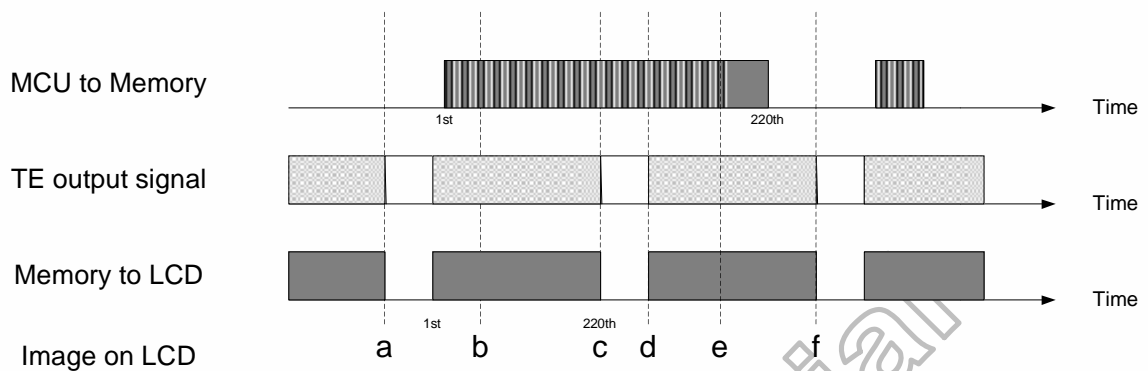
7.3.3 Example 1: MPU Write is faster than Panel Read



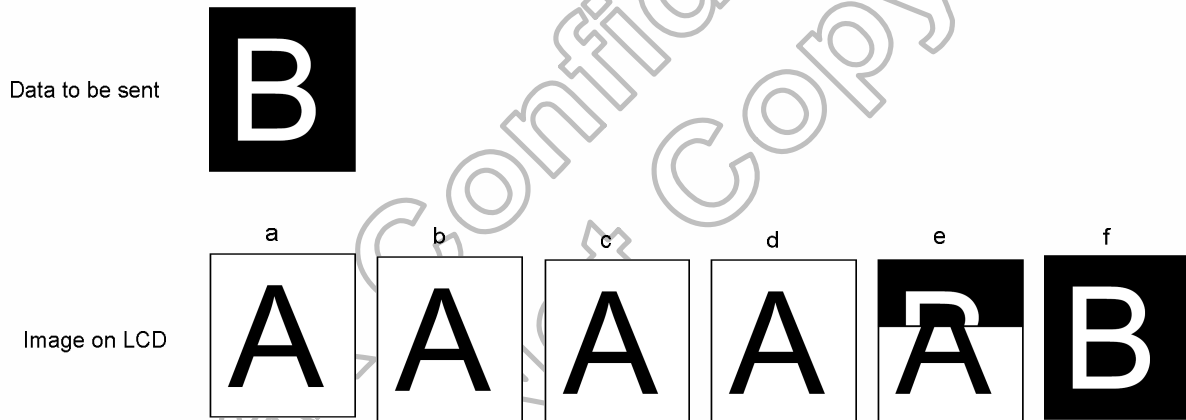
Data write to Frame Memory is now synchronized to the Panel Scan. It should be written during the vertical sync pulse of the Tearing Effect Output Line. This ensures that data is always written ahead of the panel scan and each Panel Frame refresh has a complete new image:



7.3.4 Example 2: MPU Write is slower than Panel Read



The MPU to Frame Memory write begins just after Panel Read has commenced i.e. after one horizontal sync pulse of the Tearing Effect Output Line. This allows time for the image to download behind the Panel Read pointer and finishing download during the subsequent Frame before the Read Pointer “catches” the MPU to Frame memory write position.



### 7.4 LCD Power Generation Circuit

#### 7.4.1 Power Supply Circuit

The power circuit of HX8340-B is used to generate supply voltages for LCD panel driving.

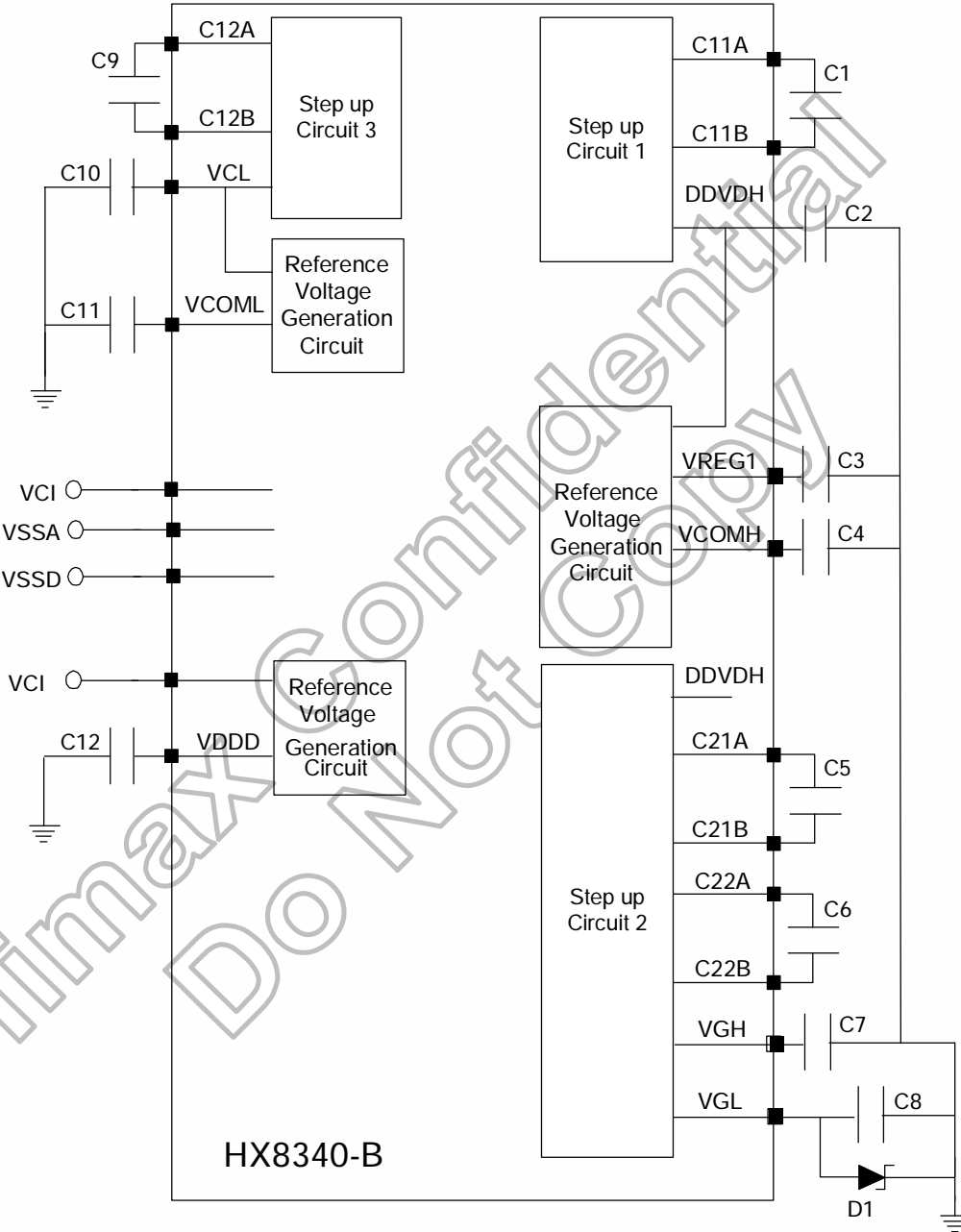


Figure 7. 12 The Block Diagram of HX8340-B Power Circuit

**Specification of Connected Passive Component**

Capacitor	Recommended voltage	Capacity
C1 (C11A/B)	6V	1 $\mu$ F (B characteristics)
C2 (DDVDH)	10V	1 $\mu$ F (B characteristics)
C3 (VREG1)	10V	1 $\mu$ F (B characteristics)
C4(VCOMH)	10V	1 $\mu$ F (B characteristics)
C5 (C21A/B)	10V	1 $\mu$ F (B characteristics)
C6 (C22A/B)	10V	1 $\mu$ F (B characteristics)
C7 (VGH)	25V	1 $\mu$ F (B characteristics)
C8 (VGL)	16V	1 $\mu$ F (B characteristics)
C9 (C12A/B)	6V	1 $\mu$ F (B characteristics)
C10 (VCL)	6V	1 $\mu$ F (B characteristics)
C11 (VCOML)	6V	1 $\mu$ F (B characteristics)
C12 (VDDD)	6V	1 $\mu$ F (B characteristics)

**Table 7. 10 The adoptability of Capacitor**

Diode	Feature
D1 (VGL-GND)	Schottkey Diode, $V_F < 0.4V / 20mA$ at $25^\circ C$ , $V_R \geq 30V$

**Table 7. 11 The adoptability of Diode**

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### 7.4.2 LCD Power Generation Scheme

The boost voltage generated is shown as below.

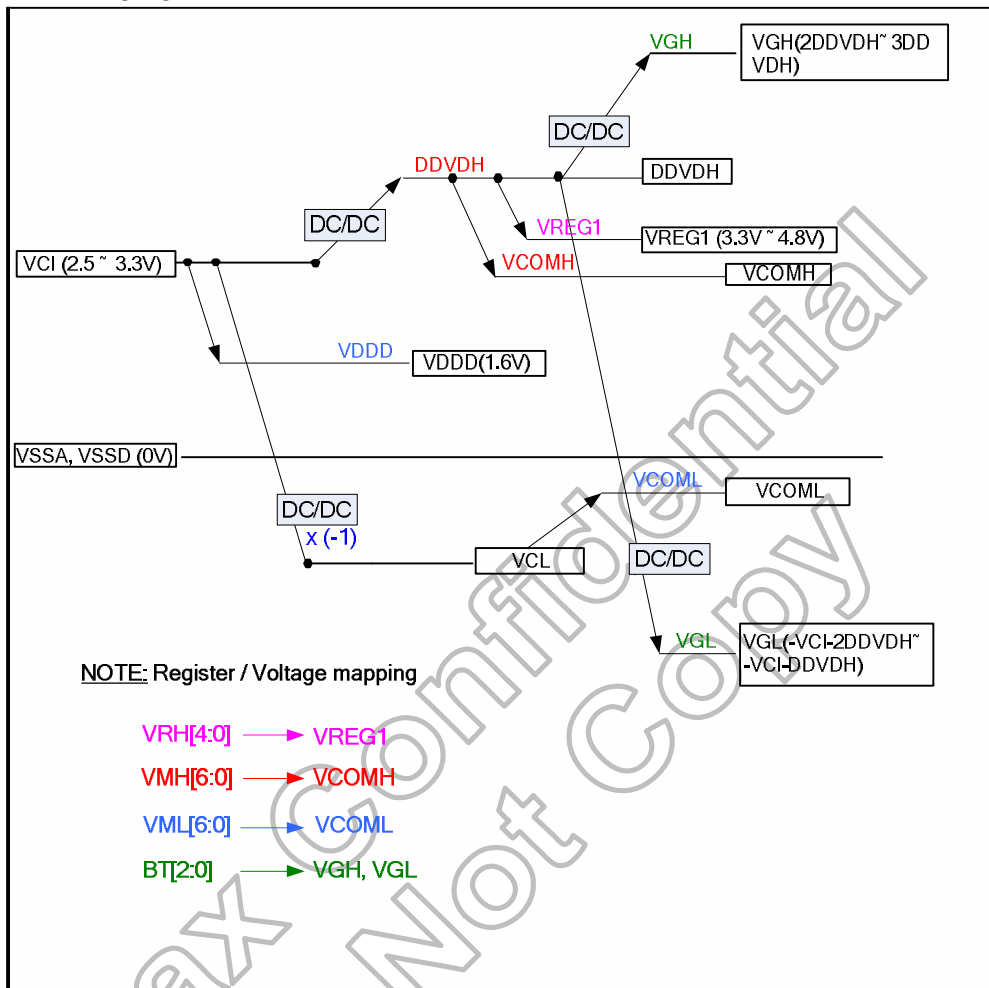


Figure 7. 13 LCD Power Generation Scheme

## 7.5 Power Function

### 7.5.1 System Interface Power On/Off Sequence

The following are the sequences of register setting flow that applied to this driver driving the TFT display, when operate in Register-Content interface mode.

#### Display On/Off Set flow

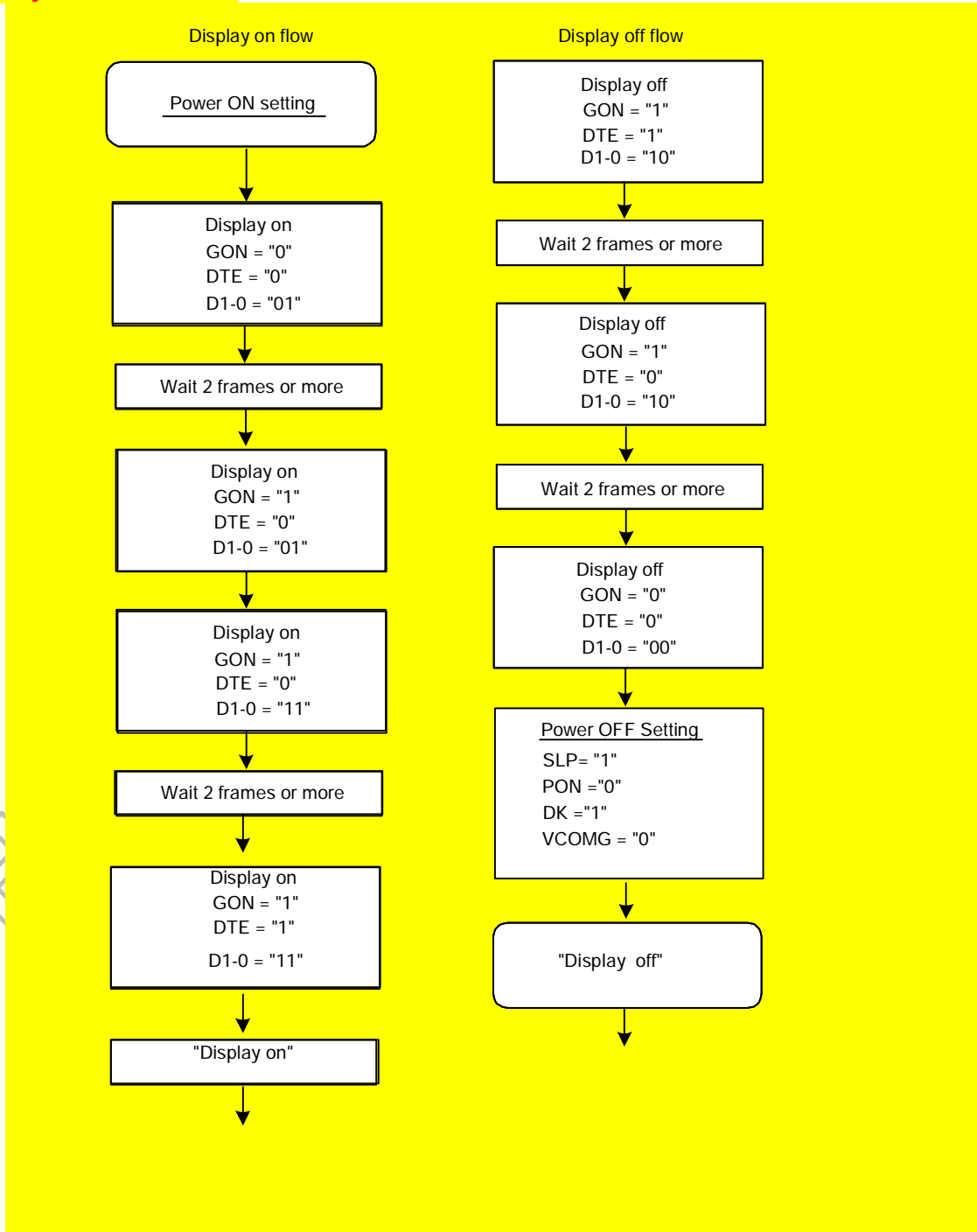
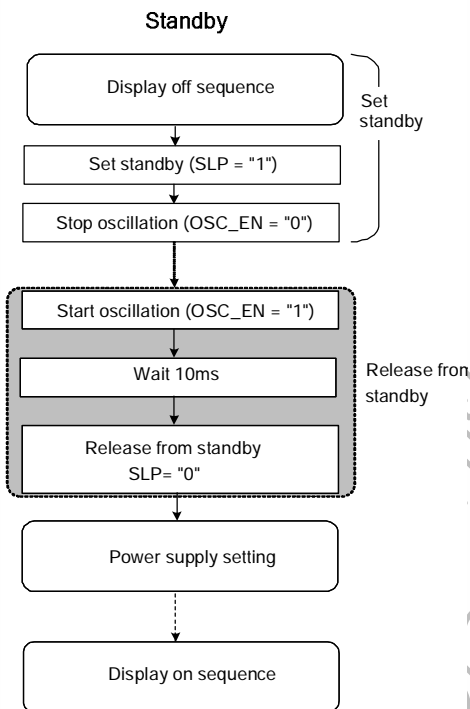


Figure 7. 14 Display On/Off Set Sequence

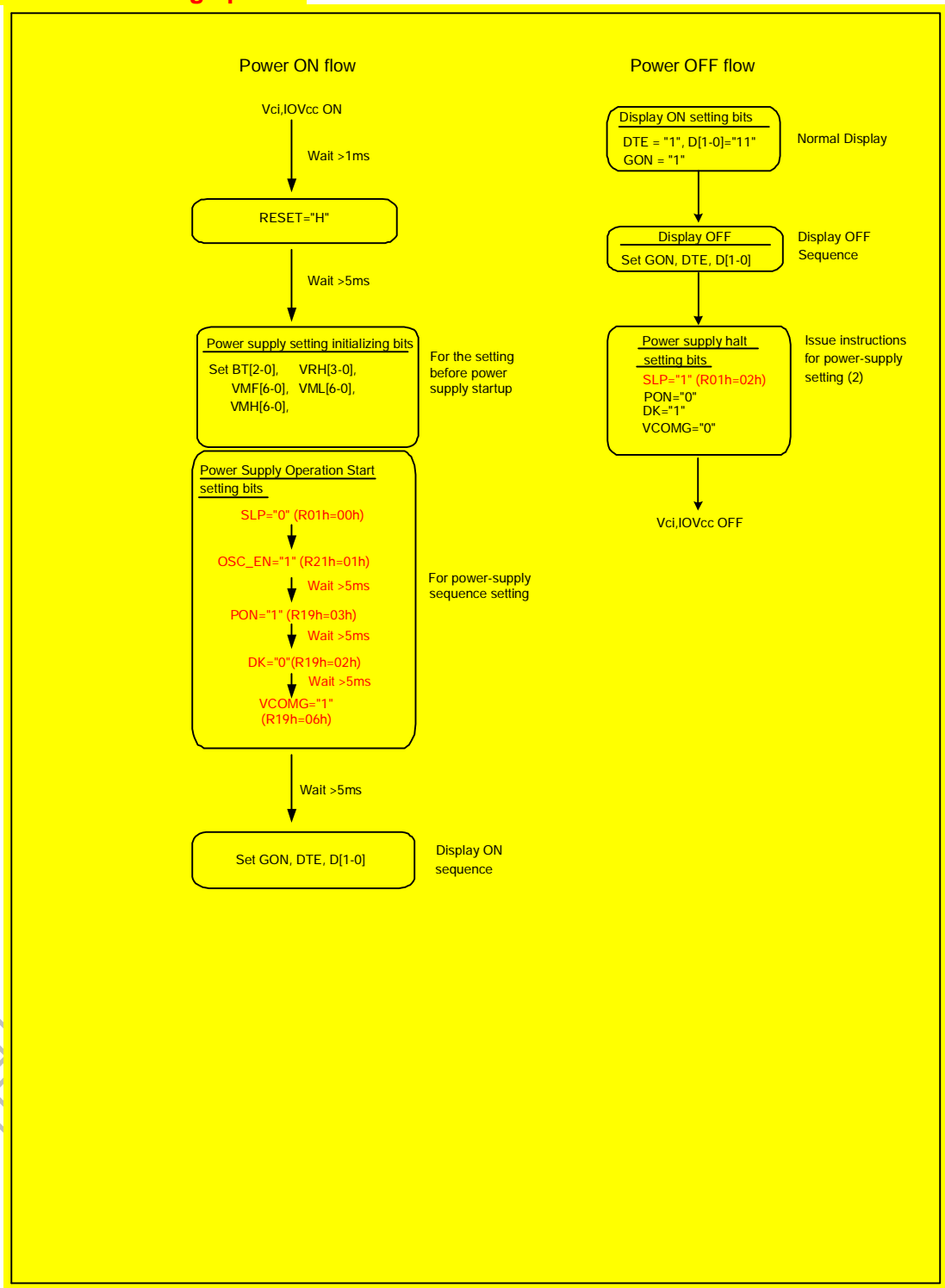
**Sleee Mode Set up Flow**



**Figure 7. 15 Standby Mode Setting Sequence**

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**Power On/Off Setting up Flow**



**Figure 7. 16 Power Supply Setting Flow**

### 7.5.2 RGB Interface Power On/Off

RGB mode Power on/off can be controlled by external pin SHUT or by internal CSHUT bit. As the internal CSHUT bit be written in RGB interface, the external pin SHUT control will be invalid

#### Power on Sequence

The Driver operates power up and display ON by IOVCC, VCII, SHUT, VS, HS, DE, DOTCLK on RGB mode as show as following figure.

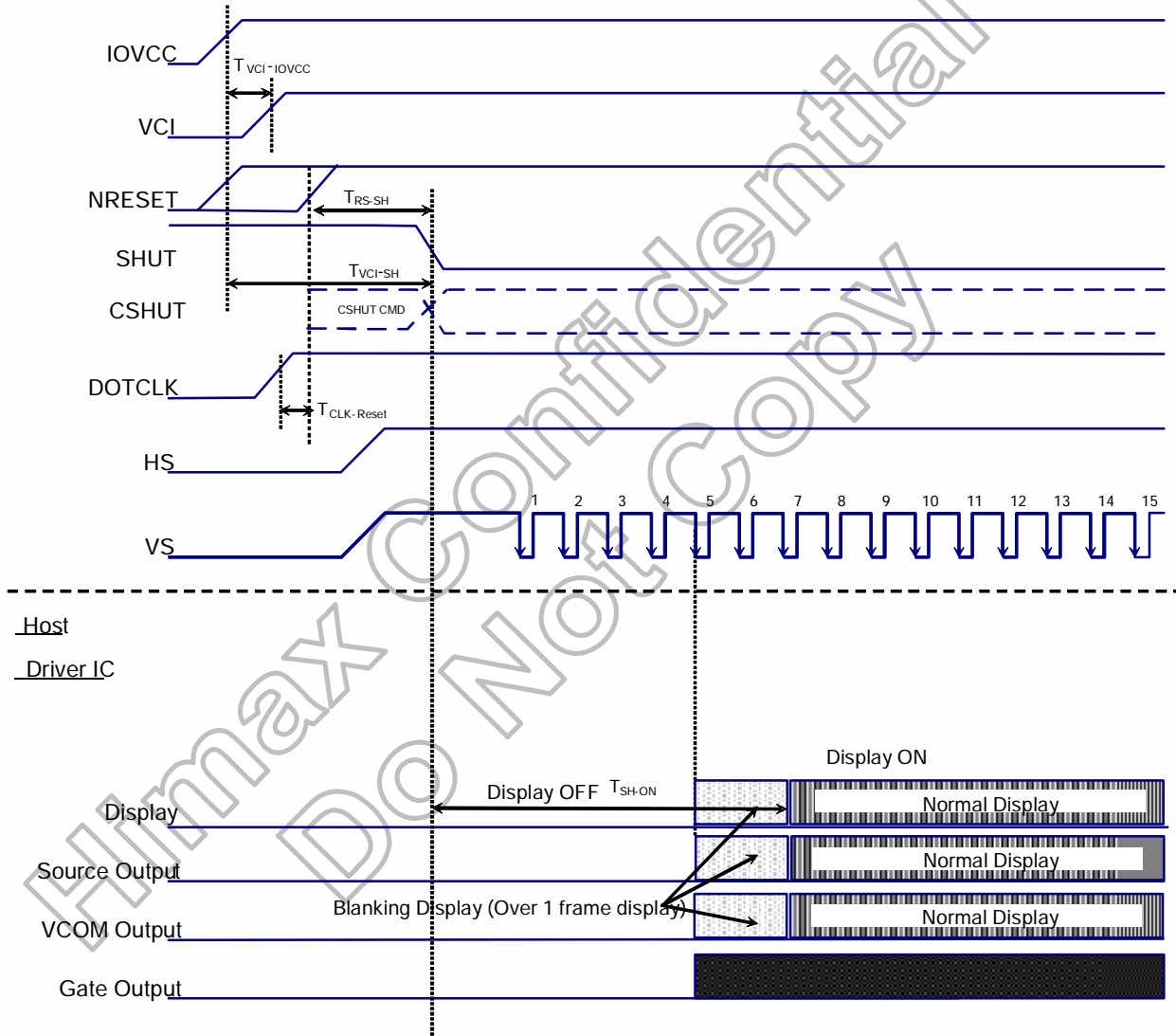


Figure 7. 17 Power On Sequence on RGB

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Remark
IOVCC On to VCI On	$T_{IOVCC-VCI}$	0		-	ns	Note <sup>(1)</sup>
IOVCC/VCI on to falling edge of SHUT	$T_{VCI-SH}$	2	10	-	ms	-
RESX to falling of SHUT	$T_{RS-SH}$	1	2	-	ms	-
DOTCLK to NRESET	$T_{CLK-Nreset}$	20	20	-	DOTCLK	-
Falling edge of SHUT to Display start	$T_{SH-ON}$	-	6	-	VS	-

**Note:** (1)  $T_{IOVCC-VCI}$  can be  $\leq 0ns$ ,  $> 0ns$ . In any case, IOVCC and VCI power up sequence should not have any impact on the driver / display functionalities / performance.

(2) EPL='0', VSPL='0', HSPL='0' and DPL='0' of SETRGBIF (33H) command.

Table 7. 12 Power ON AC Characteristics

### Power off Sequence Operate

The Driver operates power off and display OFF by VCI, IOVCC, SHUT, VS, HS and DE on RGB mode 2 as show as following figure.

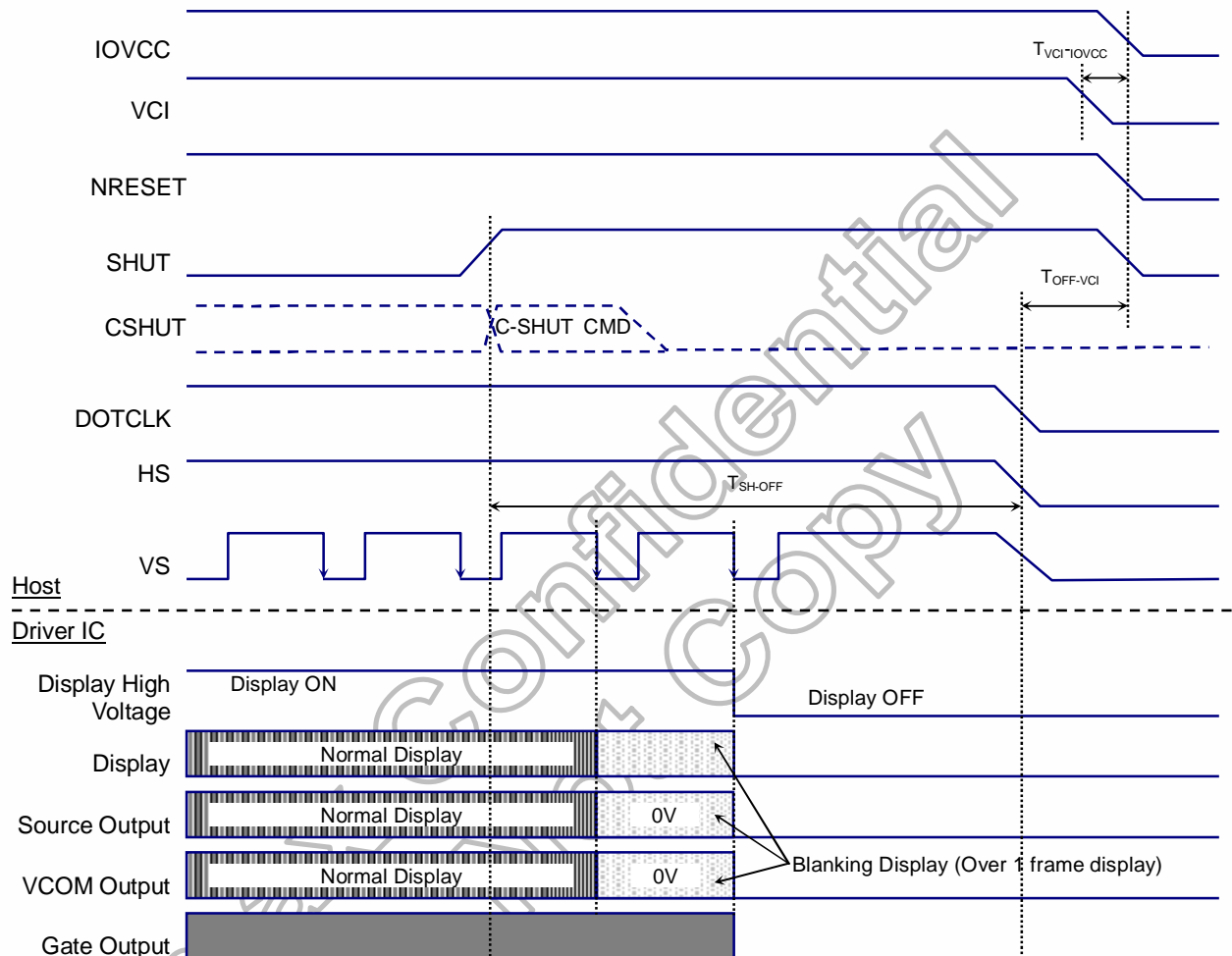


Figure 7. 18 Power off Sequence on RGB Mode

Characteristics	Symbol	Spec.			Unit	Remark
		Min.	Typ.	Max.		
IOVCC On to VCI On	$T_{iovcc-vci}$	0	-	-	ns	Note <sup>(1)</sup>
Signals Input to IOVCC/VCI Off	$T_{SH-OFF}$	1	-	-	us	Note <sup>(2)</sup>
Rising Edge of SHUT to Display Off	$T_{SH-OFF}$	2	-	-	VS	-

**Note:** (1)  $T_{iovcc-vci}$  can be  $\leq 0$ ns,  $> 0$ ns. In any case, IOVCC and VCI power up sequence should not have any impact on the driver / display functionalities / performance.

(2) Signals mean VS, HS, and DOTCLK signal.

(3) EPL='0', VSPL='0', HSPL='0' and DPL='0' of SETRGBIF (33H) command.

Table 7. 13 Power off AC Characteristics

## 7.6 Input / Output Pin State

### 7.6.1 Output Pins

Output or Bi-directional pins	After Power On	After Hardware Reset
DB17 to DB0 (Output driver)	High-Z (Inactive)	High-Z (Inactive)
SDO	High-Z (Inactive)	High-Z (Inactive)
TE	Low	Low

Table 7. 14 Characteristics of Output Pins

### 7.6.2 Input Pins

Input pins	During Power On Process	After Power On	After Hardware Reset	During Power Off Process
NRESET	Section 7.5.1	Input valid	Input valid	Section 7.5.1
NCS	Input invalid	Input valid	Input valid	Input invalid
NWR_RNW	Input invalid	Input valid	Input valid	Input invalid
NRD_E	Input invalid	Input valid	Input valid	Input invalid
DNC	Input invalid	Input valid	Input valid	Input invalid
SDI	Input invalid	Input valid	Input valid	Input invalid
VS	Input invalid	Input valid	Input valid	Input invalid
HS	Input invalid	Input valid	Input valid	Input invalid
DE	Input invalid	Input valid	Input valid	Input invalid
DOTCLK	Input invalid	Input valid	Input valid	Input invalid
DB[17:0]	Input invalid	Input valid	Input valid	Input invalid
OSC, M3, IM2, IM1, IM0,	Input invalid	Input valid	Input valid	Input invalid
EXTC	Input invalid	Input valid	Input valid	Input invalid

Table 7. 15 Characteristics of Input Pins



## 8. Command Set

### 8.1 Command Description

Register No.	Register	W/R	Upper Code	Lower Code								Comment
			D[17:8]	D7	D6	D5	D4	D3	D2	D1	D0	
R01h	Display Mode control	W/R	*	*	*	SCROL(0)		IDMON(0)	INVON(0)	SLP(1)	PTLON(0)	
R02h	Column address start 2	W/R	*	SC[15:8] (8'b0000_0000)								
R03h	Column address start 1	W/R	*	SC[7:0] (8'b0000_0000)								
R04h	Column address end 2	W/R	*	EC[15:8] (8'b0000_0000)								
R05h	Column address end 1	W/R	*	EC[7:0] (8'b1010_1111)								
R06h	Row address start 2	W/R	*	SP[15:8] (8'b0000_0000)								
R07h	Row address start 1	W/R	*	SP[7:0] (8'b0000_0000)								
R08h	Row address end 2	W/R	*	EP[15:8] (8'b0000_0000)								
R09h	Row address end 1	W/R	*	EP[7:0] (8'b1101_1011)								
R0Ah	Partial area start row 2	W/R	*	PSL[15:8] (8'b0000_0000)								
R0Bh	Partial area start row 1	W/R	*	PSL[7:0] (8'b0000_0000)								
R0Ch	Partial area end row 2	W/R	*	PEL[15:8] (8'b0000_0000)								
R0Dh	Partial area end row 1	W/R	*	PEL[7:0] (8'b1101_1011)								
R0Eh	Vertical Scroll Top fixed area 2	W/R	*	TFA[15:8] (8'b0000_0000)								
R0Fh	Vertical Scroll Top fixed area 1	W/R	*	TFA[7:0] (8'b0000_0000)								
R10h	Vertical Scroll height area 2	W/R	*	VSA[15:8] (8'b0000_0000)								
R11h	Vertical Scroll height area 1	W/R	*	VSA[7:0] (8'b1101_1100)								
R12h	Vertical Scroll Button area 2	W/R	*	BFA[15:8] (8'b0000_0000)								
R13h	Vertical Scroll Button area 1	W/R	*	BFA [7:0] (8'b0000_0000)								
R14h	Vertical Scroll Start address 2	W/R	*	VSP [15:8] (8b' 0000_0000)								
R15h	Vertical Scroll Start address 1	W/R	*	VSP [7:0] (8b' 0000_0000)								
R16h	Memory Access control	W/R	*	MY(0)	MX(0)	MV(0)	ML(0)	BGR(0)	*	*	*	
R17h	COLMOD	W/R	*	CSEL[3:0] (4b'0110)				*	IFPF[2:0] (3b'110)			
R18h	OSC Control	W/R	*	*	I/P_RADJ[2:0] (3b'101)			*	N/P_ADJ[2:0](3b'100)			
R19h	Power Control 1	W/R	*	*	*	*	*	VCOMG(0)	PON(0)	DK(1)		
R1Ah	Power Control 3	W/R	*	**	I/PI FS0[2:0] (100)			*	N/P FS0[2:0] (100)			
R1Bh	Power Control 4	W/R	*	*	I/PI FS1[2:0] (010)			*	N/P FS1[2:0] (010)			
R1Ch	Power Control 5	W/R	*	*	*	*	*	AP[2:0] (011)				
R1Dh	Power Control 6	W/R	*	N/P_SAP[7:0](8b'0011_0010)								
R1Eh	Power Control 7	W/R	*	I/PI_SAP[7:0](8b'0011_0010)								
R1Fh	Power Control 8	W/R	*	*	*	*	*	VRH[4:0] (5b'00011)				
R20h	Power Control 9	W/R	*					*	BT[2:0] (000)*			
R21h	OSC Control	W/R	*	*	*			*			OSC_EN(0)	
R22h	SRAM Write Control	W/R	SRAM Write									
R23h	VCOM Control 1	W/R	*	*	VMF[6:0] (7b'100_0000)							
R24h	VCOM Control 2	W/R	*	*	VMH[6:0] (7b'001_1100)							
R25h	VCOM Control 3	W/R	*	*	VML[6:0] (7b'011_0100)							

Register No.	Register	W/R	Upper Code	Lower Code								Comment
			D[17:8]	D7	D6	D5	D4	D3	D2	D1	D0	
R26h	Display Control 1	W/R	*	PT[1:0] (10)		GON(1)	DTE(0)	D[1:0] (00)		*	*	
R27h	Display Control 2	W/R	*	REF (1)	PTV[1:0](01)		PTG (1)	ISC[3:0] (0011)				
R28h	Frame Rate Control 1	W/R	*	*	*	IP/DIV[1:0] (00)		*	N/P_DIV[1:0] (00)			
R29h	Frame Rate control 2	W/R	*	I/PI_RTN[3:0] (4b'1000)				N/P_RTN[3:0] (4'b1000)				
R2Ah	Frame Rate Control 3	W/R	*	N/P_DUM[7:0] (8b'0000_1000)								
R2Bh	Frame Rate Control 4	W/R	*	I/PI_DUM[7:0] (8b'0000_1000)								
R2Ch	Cycle Control 1	W/R	*	SON[7:0] (8'b0011_1000)								
R2Dh	Cycle Control 2	W/R	*	GDON[7:0] (8'b0000_1111)								
R2Eh	Cycle Control 3	W/R	*	GDOF[7:0] (8'b1010_1000)								
R2Fh	Display inversion	W/R	*	*	I/PI_NW[2:0](3b'001)			*	N/P_NW[2:0] (3b'001)			
R31h	RGB interface control 1	W/R	*	*	*	HBP[5:0] (6b'00_0110)						
R32h	RGB interface control 2	W/R	*	VBP[7:0] (8b'0000_0110)								
R33h	RGB interface control 3	W/R	*	*	*	*	DPL (0)	HSPL (0)	VSPL (0)	EPL (0)		
R34h	RGB interface control 4	W/R	*	*	*	*	*	*	*	CSHU T(1)		
R35h	Outputs direction	W/R	*	*	*	*	*	*	CTB(0)	CRL(0)		
R36h	Interface mode	W/R	*	*	*	*	*	*	RCM1(0)	RCM0(0)		
R37h	NW/NB panel set	W/R	*	*	*	*	*	*	*	NWB(0)		
R38h	OTP Control 1	W/R	*	*	*	*	*	OTP_POR	OTP_OTPEN	OTP_PP ROG	OTP_P WE	
R39h	OTP Control 2	W/R	*	OTP_Y A2	OTP_YA1	OTP_YA0	*	OTP_XA2	OTP_XA1	OTP_XA0	*	
R3Ah	OTP Control 3	W/R	*	*	*	*	OTP_VARDJ1	OTP_VARDJ0	*	OTP_PTM1	OTP_PTM0	
R40h	Positive r1 Control (1)	W/R	*	*	MP12	MP11	MP10	*	MP02	MP01	MP00	
R41h	Positive r1 Control (2)	W/R	*	*	MP32	MP31	MP30	*	MP22	MP21	MP20	
R42h	Positive r1 Control (3)	W/R	*	*	MP52	MP51	MP50	*	MP42	MP41	MP40	
R43h	Positive r1 Control (4)	W/R	*	*	*	*	CP04	CP03	CP02	CP01	CP00	
R44h	Positive r1 Control (5)	W/R	*	CP23	CP22	CP21	CP20	CP13	CP12	CP11	CP10	
R45h	Positive r1 Control (6)	W/R	*	*	*	*	*	CP33	CP32	CP31	CP30	
R46h	Positive r1 Control (7)	W/R	*	*	*	*	CP44	CP43	CP42	CP41	CP40	
R47h	Positive r1 Control (8)	W/R	*	OP13	OP12	OP11	OP10	OP03	OP02	OP01	OP00	
R48h	Positive r1 Control (9)	W/R	*	*	*	*	*	CGM11	CGM10	CGM01	CGM00	
R50h	Negative r1 Control (1)	W/R	*	*	MN12	MN11	MN10	*	MN02	MN01	MN00	
R51h	Negative r1 Control (2)	W/R	*	*	MN32	MN31	MN30	*	MN22	MN21	MN20	
R52h	Negative r1 Control (3)	W/R	*	*	MN52	MN51	MN50	*	MN42	MN41	MN40	
R53h	Negative r1 Control (4)	W/R	*	*	*	*	CN04	CN03	CN02	CN01	CN00	
R54h	Negative r1 Control (5)	W/R	*	CN23	CN22	CN21	CN20	CN13	CN12	CN11	CN10	
R55h	Negative r1 Control (6)	W/R	*	*	*	*	*	CN33	CN32	CN31	CN30	
R56h	Negative r1 Control (7)	W/R	*	*	*	*	CN44	CN43	CN42	CN41	CN40	
R57h	Negative r1 Control (8)	W/R	*	ON13	ON12	ON11	ON10	ON03	ON02	ON01	ON00	

### 8.2 Index Register

R/W	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	0	*	*	*	*	*	*	*	*	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0

Figure 8. 1 Index Register

Index register (IR) specifies Index of the register from R00h to RFFh. It sets the register number (ID7-0) in the range from 000000b to 1111111b in binary form.

### 8.3 Display Mode Control Register (R01h)

R/W	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	SCR OLL	*	IDM ON	INV ON	SLP	PTL ON
R	1	*	*	*	*	*	*	*	*	*	*	SCR OLL	*	IDM ON	INV ON	SLP	PTL ON

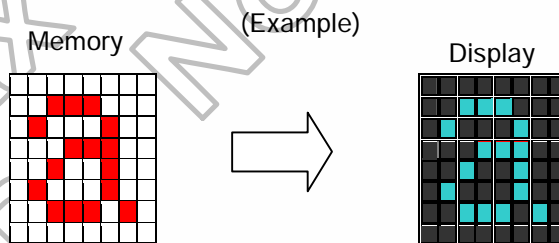
Figure 8. 2 Display Mode Control Register (R01h)

#### IDMON

This command is used for turning on/off IDLE (8-color display) mode by setting IDMON=1/0.

#### INVON

This command is used to enter into display inversion mode by setting INVON=1. Vice versa, it recovers from display inversion mode by setting INVON=0. This command makes no change of contents of frame memory. Every bit is inverted from the frame memory to the display. This command does not change any other status.



#### SLP

When SLP = '1', the driver into the sleep mode, where all display operation stops, suspend all the internal operations including the internal R-C oscillator. During the sleep mode, only the following process can be executed.

- a. Exit the Standby mode (SLP = "0")
- b. Start the oscillation

In the Sleep mode, the GRAM data and register content are retained.

#### PTLON

This command is used for turning on/off PARTIAL mode by setting PTLON=1/0.

#### SCROLL

This command is used for turning on/off SCROLL mode by setting SCROLL=1/0.

### 8.4 Column Address Start Register (R02~03h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	SC 15	SC 14	SC 13	SC 12	SC 11	SC 10	SC9	SC8
R	1	*	*	*	*	*	*	*	*	SC 15	SC 14	SC 13	SC 12	SC 11	SC 10	SC9	SC8

Figure 8. 3 Column Address Start Register Upper Byte (R02h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0
R	1	*	*	*	*	*	*	*	*	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0

Figure 8. 4 Column Address Start Register Low Byte (R03h)

### 8.5 Column Address End Register (R04~05h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	EC 15	EC 14	EC 13	EC 12	EC 11	EC 10	EC9	EC8
R	1	*	*	*	*	*	*	*	*	EC 15	EC 14	EC 13	EC 12	EC 11	EC 10	EC9	EC8

Figure 8. 5 Column Address End Register Upper Byte (R04h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0
R	1	*	*	*	*	*	*	*	*	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0

Figure 8. 6 Column Address End Register Low Byte (R05h)

### 8.6 Row Address Start Register (R06~07h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	SP 15	SP 14	SP 13	SP 12	SP 11	SP 10	SP9	SP8
R	1	*	*	*	*	*	*	*	*	SP 15	SP 14	SP 13	SP 12	SP 11	SP 10	SP9	SP8

Figure 8. 7 Row Address Start Register Upper Byte (R06h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0
R	1	*	*	*	*	*	*	*	*	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0

Figure 8. 8 Row Address Start Register Low Byte (R07h)

### 8.7 Row Address End Register (R08~09h)

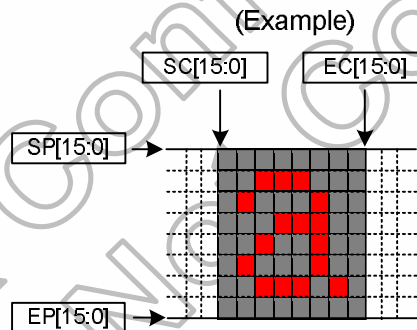
RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	EP 15	EP 14	EP 13	EP 12	EP 11	EP 10	EP9	EP8
R	1	*	*	*	*	*	*	*	*	EP 15	EP 14	EP 13	EP 12	EP 11	EP 10	EP9	EP8

Figure 8. 9 Row Address End Register Upper Byte (R08h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0
R	1	*	*	*	*	*	*	*	*	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0

Figure 8. 10 Row Address End Register Low Byte (R09h)

These commands (R02h~R09h) are used to define area of frame memory where MCU can access. These commands make no change on the other driver status. The values of SC[15:0], EC[15:0], SP[15:0] and EP[15:0] are referred when RAMWR command comes. Each value represents one Page line in the Frame Memory.



### 8.8 Partial Area Start Row Register (R0A~0Bh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	PSL 15	PSL 14	PSL 13	PSL 12	PSL 11	PSL 10	PSL 9	PSL 8
R	1	*	*	*	*	*	*	*	*	PSL 15	PSL 14	PSL 13	PSL 12	PSL 11	PSL 10	PSL 9	PSL 8

Figure 8. 11 Partial Area Start Row Register Upper Byte (R0Ah)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	PSL 7	PSL 6	PSL 5	PSL 4	PSL 3	PSL 2	PSL 1	PSL 0
R	1	*	*	*	*	*	*	*	*	PSL 7	PSL 6	PSL 5	PSL 4	PSL 3	PSL 2	PSL 1	PSL 0

Figure 8. 12 Partial Area Start Row Register Low Byte (R0Bh)

### 8.9 Partial Area End Row Register (R0C~0Dh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	PEL 15	PEL 14	PEL 13	PEL 12	PEL 11	PEL 10	PEL 9	PEL 8
R	1	*	*	*	*	*	*	*	*	PEL 15	PEL 14	PEL 13	PEL 12	PEL 11	PEL 10	PEL 9	PEL 8

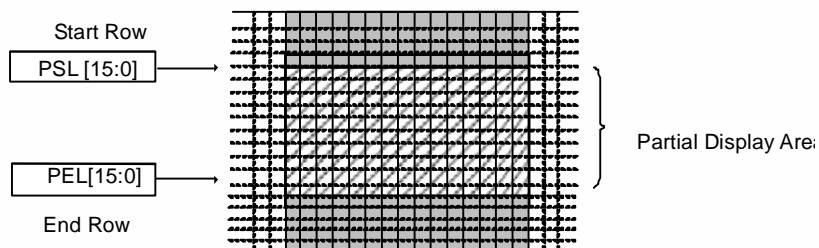
Figure 8. 13 Partial Area End Row Register Upper Byte (R0Ch)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	PEL 7	PEL 6	PEL 5	PEL 4	PEL 3	PEL 2	PEL 1	PEL 0
R	1	*	*	*	*	*	*	*	*	PEL 7	PEL 6	PEL 5	PEL 4	PEL 3	PEL 2	PEL 1	PEL 0

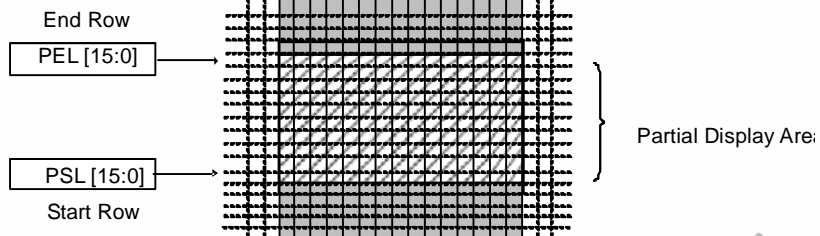
Figure 8. 14 Partial Area End Row Register Low Byte (R0Dh)

These commands (R0Ah~0Dh) define the partial mode's display area. There are 4 parameters associated with this command, PSL[15:0], PEL[15:0], as illustrated in the figures below. PSL and PEL refer to the Frame Memory Line Pointer.

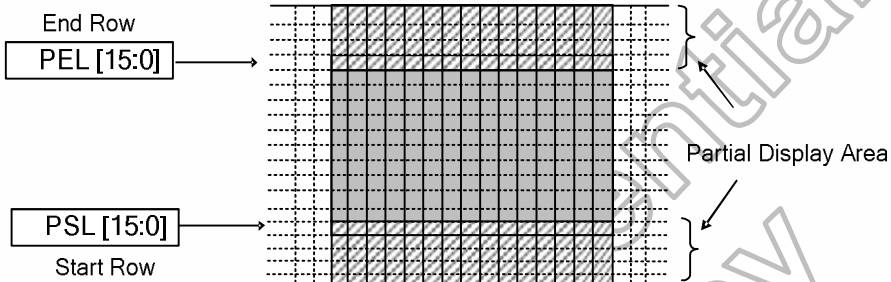
If End Row > Start Row when Memory Access Control ML=0



If End Row > Start Row when Memory Access Control ML=1



If End Row < Start Row when Memory Access Control ML=0



If End Row = Start Row then the Partial Area will be one row deep.

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### 8.10 Vertical Scroll Top Fixed Area Register (R0E~0Fh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	TFA 15	TFA 14	TFA 13	TFA 12	TFA 11	TFA 10	TFA 9	TFA 8
R	1	*	*	*	*	*	*	*	*	TFA 15	TFA 14	TFA 13	TFA 12	TFA 11	TFA 10	TFA 9	TFA 8

Figure 8. 15 Vertical Scroll Top Fixed Area Register Upper Byte (R0Eh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	TFA 7	TFA 6	TFA 5	TFA 4	TFA 3	TFA 2	TFA 1	TFA 0
R	1	*	*	*	*	*	*	*	*	TFA 7	TFA 6	TFA 5	TFA 4	TFA 3	TFA 2	TFA 1	TFA 0

Figure 8. 16 Vertical Scroll Top Fixed Area Register Low Byte (R0Fh)

### 8.11 Vertical Scroll Height Area Register (R10~11h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	VSA 15	VSA 14	VSA 13	VSA 12	VSA 11	VSA 10	VSA 9	VSA 8
R	1	*	*	*	*	*	*	*	*	VSA 15	VSA 14	VSA 13	VSA 12	VSA 11	VSA 10	VSA 9	VSA 8

Figure 8. 17 Vertical Scroll Height Area Register Upper Byte (R10h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	VSA 7	VSA 6	VSA 5	VSA 4	VSA 3	VSA 2	VSA 1	VSA 0
R	1	*	*	*	*	*	*	*	*	VSA 7	VSA 6	VSA 5	VSA 4	VSA 3	VSA 2	VSA 1	VSA 0

Figure 8. 18 Vertical Scroll Height Area Register Low Byte (R11h)

### 8.12 Vertical Scroll Button Fixed Area Register (R12~13h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	BFA 15	BFA 14	BFA 13	BFA 12	BFA 11	BFA 10	BFA 9	BFA 8
R	1	*	*	*	*	*	*	*	*	BFA 15	BFA 14	BFA 13	BFA 12	BFA 11	BFA 10	BFA 9	BFA 8

Figure 8. 19 Vertical Scroll Button Fixed Area Register Upper Byte (R12h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	BFA 7	BFA 6	BFA 5	BFA 4	BFA 3	BFA 2	BFA 1	BFA 0
R	1	*	*	*	*	*	*	*	*	BFA 7	BFA 6	BFA 5	BFA 4	BFA 3	BFA 2	BFA 1	BFA 0

Figure 8. 20 Vertical Scroll Button Fixed Area Register Low Byte (R13h)

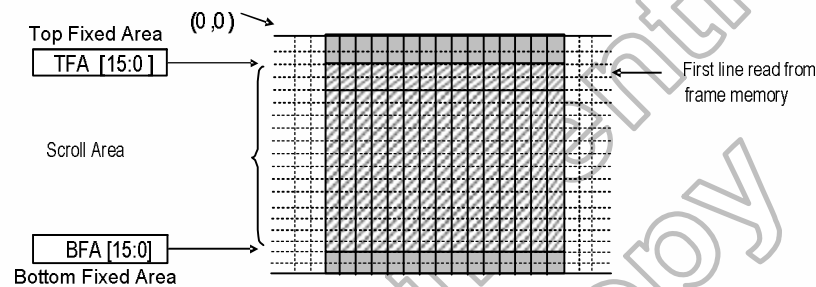
These commands (R0E~0Fh, R10~11h, R12~13h) define the Vertical Scrolling Area of the display. When Memory Access Control ML=0,

**TFA[15...0]** describes the Top Fixed Area (in No. of lines from Top of the Frame Memory and Display).

**VSA[15...0]** describes the height of the Vertical Scrolling Area (in No. of lines of the Frame Memory [not the display] from the Vertical Scrolling Start Address). The first line read from Frame Memory appears immediately after the bottom most line of the Top Fixed Area.

**BFA[15...0]** describes the Bottom Fixed Area (in No. of lines from Bottom of the Frame Memory and Display).

TFA, VSA and BFA refer to the Frame Memory Line Pointer.

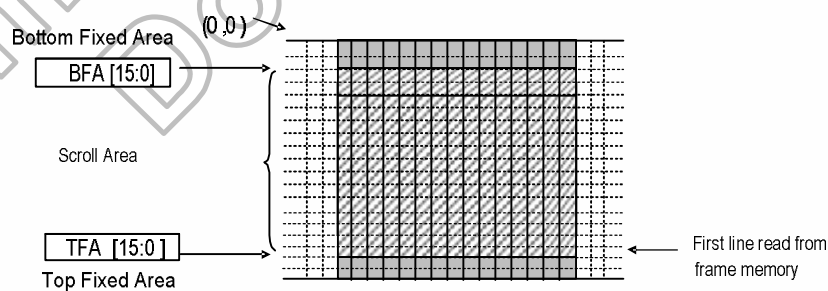


When Memory Access Control ML=1,

**TFA[15...0]** describes the Top Fixed Area (in No. of lines from Bottom of the Frame Memory and Display).

**VSA[15...0]** describes the height of the Vertical Scrolling Area (in No. of lines of the Frame Memory [not the display] from the Vertical Scrolling Start Address). The first line read from Frame Memory appears immediately after the top most line of the Top Fixed Area.

**BFA[15...0]** describes the Bottom Fixed Area (in No. of lines from Top of the Frame Memory and Display).



### 8.13 Vertical Scroll Start Address Register (R14~15h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	VSP 15	VSP 14	VSP 13	VSP 12	VSP 11	VSP 10	VSP 9	VSP 8
R	1	*	*	*	*	*	*	*	*	VSP 15	VSP 14	VSP 13	VSP 12	VSP 11	VSP 10	VSP 9	VSP 8

Figure 8. 21 Vertical Scroll Start Address Register Upper Byte (R14h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	VSP 7	VSP 6	VSP 5	VSP 4	VSP 3	VSP 2	VSP 1	VSP 0
R	1	*	*	*	*	*	*	*	*	VSP 7	VSP 6	VSP 5	VSP 4	VSP 3	VSP 2	VSP 1	VSP 0

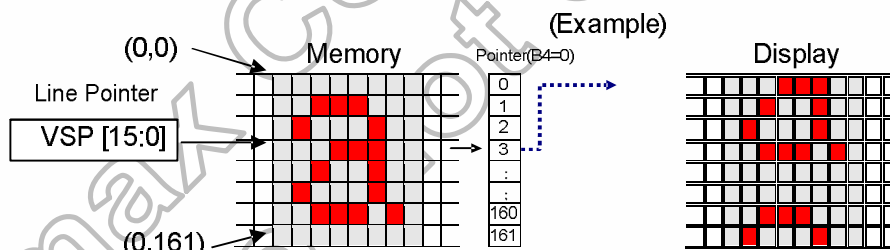
Figure 8. 22 Vertical Scroll Start Address Register Low Byte (R15h)

This command is used together with Vertical Scrolling Definition (18h). These two commands describe the scrolling area and the scrolling mode.

The Vertical Scrolling Start Address command has one parameter which describes the address of the line in the Frame Memory that will be written as the first line after the last line of the Top Fixed Area on the display as illustrated below: When Memory Access Control B4=0

Example:

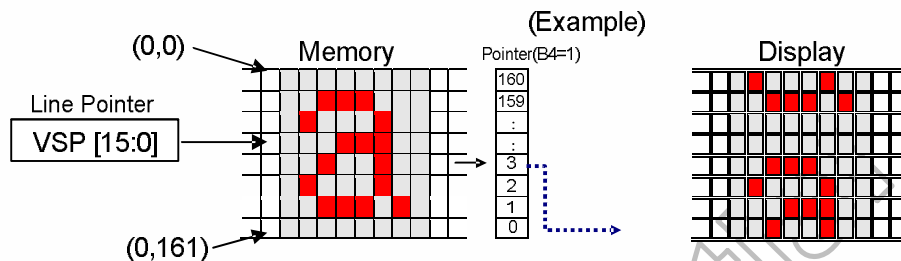
When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 162 and VSP=3



When Memory Access Control B4=1

Example:

When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 162 and VSP=3



When new Pointer position and Picture Data are sent, the result on the display will happen at the next Panel Scan to avoid tearing effect.

VSP refers to the Frame Memory line Pointer.

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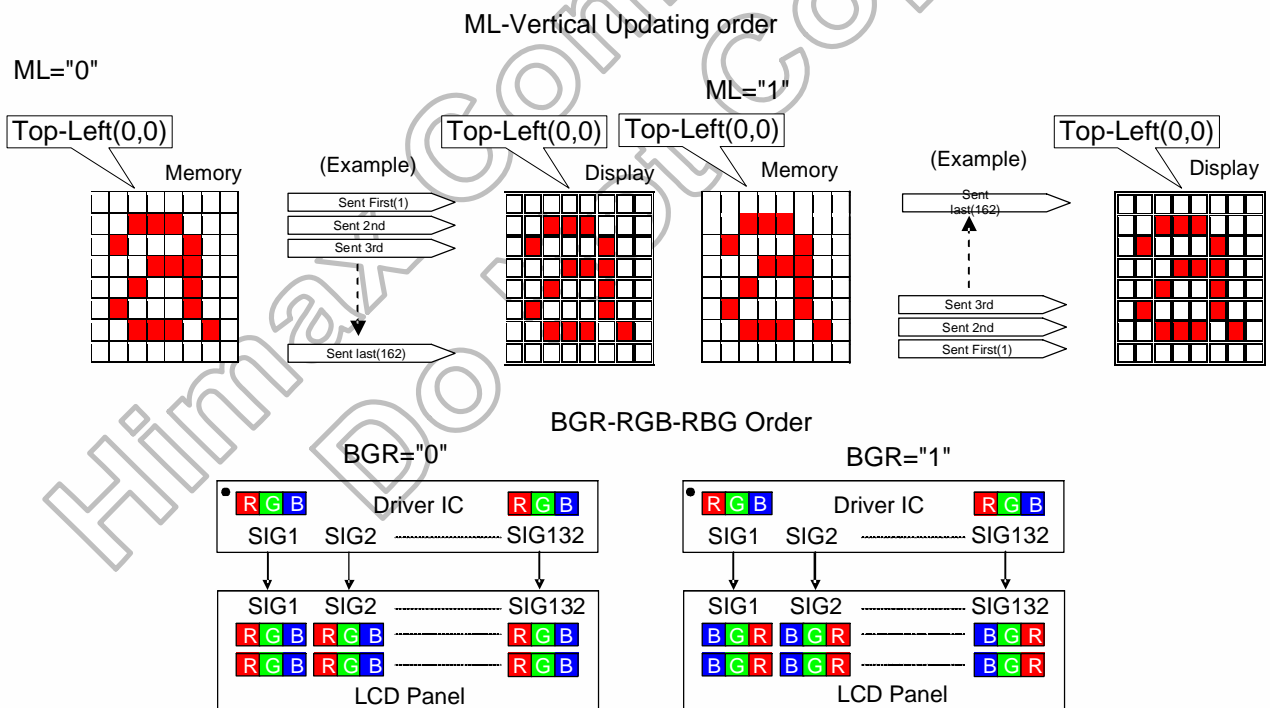
### 8.14 Memory Access Control Register (R16h)

<b>RW</b>	<b>KS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	MY	MX	MV	ML	BGR	*	*	*
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	MY	MX	MV	ML	BGR	*	*	*

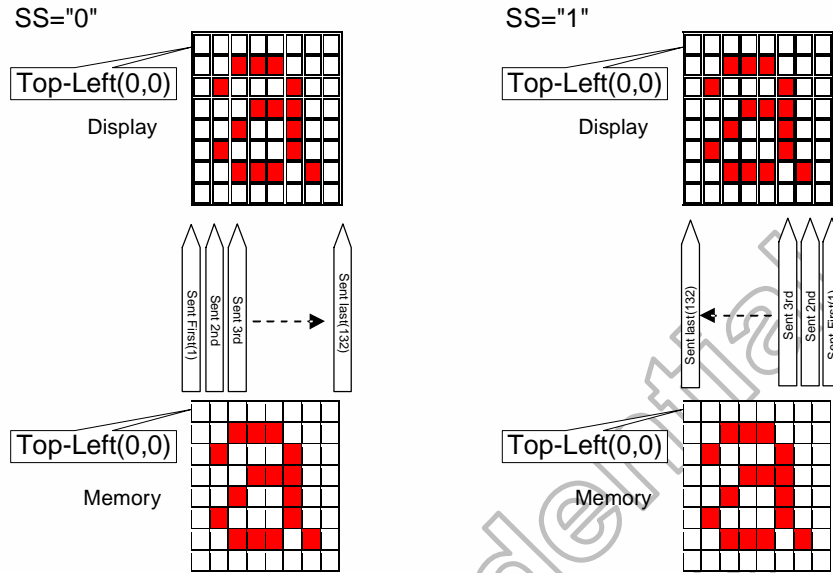
Figure 8. 23 Memory Access Control Register (R16h)

This command defines read/write scanning direction of frame memory. This command makes no change on the other driver status.

Bit	Name	Description
<b>MY</b>	PAGE ADDRESS ORDER	These 3 bits controls MCU to memory write/read direction. "MCU to memory write/read direction"
<b>MX</b>	COLUMN ADDRESS ORDER	
<b>MV</b>	PAGE/COLUMN SELECTION	
<b>ML</b>	Vertical ORDER	LCD vertical refresh direction control
<b>BGR</b>	RGB-BGR ORDER	Color selector switch control (0=RGB color filter panel, 1=BGR color filter panel)



SS-Horizontal Updating order



Note: Top-Left (0,0) means a physical memory location.

8.15 COLMOD Control Register (R17h)

		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	CSEL 3 (0)	CSEL 2 (1)	CSEL 1 (1)	CSEL 0 (0)	*	IFPF 2 (1)	IFPF 1 (1)	IFPF0 (0)
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	CSEL 3 (0)	CSEL 2 (1)	CSEL 1 (1)	CSEL 0 (0)	*	IFPF 2 (1)	IFPF 1 (1)	IFPF0 (0)

Figure 8. 24 COLMOD Control Register (R16h)

This command is used to define the format of RGB picture data, which is to be transfer via the system and RGB interface. The formats are shown in the table:

System interface

Interface Format	IFPF2	IFPF1	IFPF0
Not Defined	0	0	0
Not Defined	0	0	1
Not Defined	0	1	0
12 Bit/Pixel	0	1	1
Not Defined	1	0	0
16 Bit/Pixel	1	0	1
18 Bit/Pixel	1	1	0
Not Defined	1	1	1

RGB interface

Interface Format	CSEL3	CSEL2	CSEL1	CSEL0
16 Bit/Pixel	0	1	0	1
18 Bit/Pixel	0	1	1	0
6 Bit/Pixel	1	1	1	0
Not Defined	The Other Setting			

8.16 OSC Control Register (R18h & R21h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	I/P_A DJ2	I/P_A DJ1	I/P_A DJ0	*	N/P_A DJ2	N/P_A DJ1	N/P_A DJ0
R	1	*	*	*	*	*	*	*	*	*	I/P_A DJ2	I/P_A DJ1	I/P_A DJ0	*	N/P_A DJ2	N/P_A DJ1	N/P_A DJ0

Figure 8. 25 OSC Control 1 Register (R18h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	OSC_EN
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	OSC_EN

Figure 8. 26 OSC Control 2 Register (R21h)

These commands are used to set internal oscillator related setting

**OSC\_EN:** Enable internal oscillator, OSC\_EN = '1', internal oscillator start to oscillate. OSC\_EN = '0', internal oscillator stop. In RGB interface mode (RCM[1:0] = '10' or '11'), internal oscillator will be stop to oscillate and OSC\_EN bit control is invalid.

**N/P\_RADJ[2:0]:** Internal oscillator frequency adjusts in Normal / Partial mode.

**I/PI\_RADJ[2:0]:** Internal oscillator frequency adjusts in Idle(8-color) / Partial Idle mode.

For details, please refer to "7.1 Internal Oscillator" section.

RADJ2	RADJ1	RADJ0	Internal Oscillator Frequency
0	0	0	133% x 2.52MHz
0	0	1	125% x 2.52MHz
0	1	0	117% x 2.52MHz
0	1	1	108% x 2.52MHz
1	0	0	100% x 2.52MHz
1	0	1	85% x 2.52MHz
1	1	0	75% x 2.52MHz
1	1	1	50% x 2.52MHz



### 8.17 Power Control 1 Register (R19h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	VCO MG	PON	DK
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	VCO MG	PON	DK

Figure 8. 27 Power Control 1 Register (R19h)

**DK:** Specify on/off control of step-up circuit 1 for DDVDH voltage generation. For detail, see the Power Supply Setting Sequence.

DK	Operation of step-up circuit 1
0	ON
1	OFF

**PON:** Specify on/off control of step-up circuit 2 for VGH, VGL voltage generation. For detail, see the Power Supply Setting Sequence.

PON	Operation of step-up circuit 2
0	OFF
1	ON

**VCOMG:** Specify on/off control of step-up circuit 3 for VCL voltage generation. For detail, see the Power Supply Setting Sequence. When VCOMG = '0', VCOML = GND.

VCOMG	Operation of step-up circuit 3
0	OFF
1	ON

**8.18 Power Control 2 Register (R1Ah)**

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	I/PI FS02	I/PI FS01	I/PI FS00	*	N/P FS02	N/P FS01	N/P FS00
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	I/PI FS02	I/PI FS01	I/PI FS00	*	N/P FS02	N/P FS01	N/P FS00

**Figure 8. 28 Power Control 2 Register (R1Ah)**

**N/P\_FS0[2:0]:** Set the operating frequency of the step-up circuit 1 and extra step-up circuit 1 for DDVDH voltage generation in Normal / Partial mode.

FS02	FS01	FS00	Operation Frequency of Step-up Circuit 1 and Extra Step-up circuit 1
0	0	0	1/4 x H Line Frequency
0	0	1	1/2 x H Line Frequency
0	1	0	1 x H Line Frequency
0	1	1	1.5 x H Line Frequency
1	0	0	2 x H Line Frequency
1	0	1	3 x H Line Frequency
1	1	0	4 x H Line Frequency
1	1	1	8 x H Line Frequency

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### 8.19 Power Control 3 Register (R1Bh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	I/PI FS12	I/PI FS11	N/P FS10	*	N/P FS12	N/P FS11	N/P FS10
R	1	*	*	*	*	*	*	*	*	*	I/PI FS12	I/PI FS11	I/PI FS10	*	N/P FS12	N/P FS11	N/P FS10

Figure 8. 29 Power Control 3 Register (R1Bh)

**I/PI\_FS0[2:0]:** Set the operating frequency of the step-up circuit 1 and extra step-up circuit 1 for DDVDH voltage generation in Idle(8-color) / Partial Idle mode.  
For details, please refer to “7.1 Internal Oscillator” section.

**N/P\_FS1[2:0]:** Set the operating frequency of the step-up circuit 2 and 3 for VGH, VGL and VCL voltage generation in Normal / Partial mode.

**I/PI\_FS1[2:0]:** Set the operating frequency of the step-up circuit 2 and 3 for VGH, VGL and VCL voltage generation in Idle(8-color) / Partial Idle mode.  
For details, please refer to “7.1 Internal Oscillator” section.

FS12	FS11	FS10	Operation Frequency of Step-up Circuit 2, Step-up Circuit 3
0	0	0	¼ x H Line Frequency
0	0	1	½ x H Line Frequency
0	1	0	1 x H Line Frequency
0	1	1	1.5 x H Line Frequency
1	0	0	2 x H Line Frequency
1	0	1	3 x H Line Frequency
1	1	0	4 x H Line Frequency
1	1	1	8 x H Line Frequency

**Note:** Ensure that the operation frequency of step-up circuit 1  $\geq$  step-up circuit 2

### 8.20 Power Control 4 Register (R1Ch)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	AP2	AP1	AP0
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	AP2	AP1	AP0

Figure 8. 30 Power Control 4 Register (R1Ch)

**AP[2:0]:** Adjust the amount of current driving for the operational amplifier in the power supply circuit. When the amount of fixed current is increased, the LCD driving capacity and the display quality are high, but the current consumption is increased. Adjust the fixed current by considering both the display quality and the current consumption.

AP2	AP1	AP0	Constant Current of Operational Amplifier
0	0	0	Operation of the operational amplifier stops
0	0	1	Small
0	1	0	Medium Low
0	1	1	Medium
1	0	0	Medium High
1	0	1	Large
1	1	0	Setting Inhibited
1	1	1	Setting Inhibited

### 8.21 Power Control 5 Register (R1Dh)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	N/P_SAP7	N/P_SAP6	N/P_SAP5	N/P_SAP4	N/P_SAP3	N/P_SAP2	N/P_SAP1	N/P_SAP0
R	1	*	*	*	*	*	*	*	*	N/P_SAP7	N/P_SAP6	N/P_SAP5	N/P_SAP4	N/P_SAP3	N/P_SAP2	N/P_SAP1	N/P_SAP0

Figure 8. 31 Power Control 5 Register (R1Dh)

**N/P\_SAP[7:0]:** Internal use, not open.

### 8.22 Power Control 6 Register (R1Eh)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	I/PI_SAP7	I/PI_SAP6	I/PI_SAP5	I/PI_SAP4	I/PI_SAP3	I/PI_SAP2	I/PI_SAP1	I/PI_SAP0
R	1	*	*	*	*	*	*	*	*	I/PI_SAP7	I/PI_SAP6	I/PI_SAP5	I/PI_SAP4	I/PI_SAP3	I/PI_SAP2	I/PI_SAP1	I/PI_SAP0

Figure 8. 32 Power Control 6 Register (R1Eh)

**I/PI\_SAP[7:0]:** Internal use, not open.

8.23 Power Control 7 Register (R1Fh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	VRH 4	VRH 3	VRH 2	VRH 1	VRH 0
R	1	*	*	*	*	*	*	*	*	*	*	*	VRH 4	VRH 3	VRH 2	VRH 1	VRH 0

Figure 8. 33 Power Control 7 Register (R1Fh)

VRH[4:0]: Specify the VREG1 voltage adjusting. VREG1 voltage is for gamma voltage setting.

VRH4	VRH3	VRH2	VRH1	VRH0	VREG1
0	0	0	0	0	4.80
0	0	0	0	1	4.75
0	0	0	1	0	4.70
0	0	0	1	1	4.65
0	0	1	0	0	4.60
0	0	1	0	1	4.55
0	0	1	1	0	4.50
0	0	1	1	1	4.45
0	1	0	0	0	4.40
0	1	0	0	1	4.35
0	1	0	1	0	4.30
0	1	0	1	1	4.25
0	1	1	0	0	4.20
0	1	1	0	1	4.15
0	1	1	1	0	4.10
0	1	1	1	1	4.05
1	0	0	0	0	4.00
1	0	0	0	1	3.95
1	0	0	1	0	3.90
1	0	0	1	1	3.85
1	0	1	0	0	3.80
1	0	1	0	1	3.75
1	0	1	1	0	3.70
1	0	1	1	1	3.65
1	1	0	0	0	3.60
1	1	0	0	1	3.55
1	1	0	1	0	3.50
1	1	0	1	1	3.45
1	1	1	0	0	3.40
1	1	1	0	1	3.35
1	1	1	1	0	3.30
1	1	1	1	1	Internal circuit operations stop. The gamma voltage can be adjusted from external VREG1 input.

### 8.24 Power Control 8 Register (R20h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	BT2	BT1	BT0
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	BT2	BT1	BT0

Figure 8. 34 Power Control 8 Register (R20h)

**BT[2:0]:** Switch the output factor of step-up circuit 2 for VGH and VGL voltage generation. The LCD drive voltage level can be selected according to the characteristic of liquid crystal which panel used. Lower amplification of the step-up circuit consumes less current and then the power consumption can be reduced.

BT2	BT1	BT0	DDVDH	VCL	VGH	VGL
0	0	0	5.2V	2.65V	3DDVDH	-VCI-2DDVDH
0	0	1	5.2V	2.65V	3DDVDH	-2DDVDH
0	1	0	5.2V	2.65V	3DDVDH	-VCI-DDVDH
0	1	1	5.2V	2.65V	VCI+2DDVDH	-VCI-2DDVDH
1	0	0	5.2V	2.65V	VCI+2DDVDH	-2DDVDH
1	0	1	5.2V	2.65V	VCI+2DDVDH	-VCI-DDVDH
1	1	0	5.2V	2.65V	2DDVDH	-2DDVDH
1	1	1	5.2V	2.65V	2DDVDH	-VCI-DDVDH

Note: When VCI = 2.8V

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### 8.25 Write/Read Data Register (R22h)

R/W	RS	RB17	RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	WD 17	WD 16	WD 15	WD 14	WD 13	WD 12	WD 11	WD 10	WD 9	WD 8	WD 7	WD 6	WD 5	WD 4	WD 3	WD 2	WD 1	WD 0
R	1	RD 17	RD 16	RD 15	RD 14	RD 13	RD 12	RD 11	RD 10	RD 9	RD 8	RD 7	RD 6	RD 5	RD 4	RD 3	RD 2	RD 1	RD 0

Figure 8. 35 Read Data Register (R22h)

**WD[17:0]** : Transforms the data into 16-bit bus before written to GRAM through the write data register (WDR). After a write operation is issued, the address is automatically updated according to the AM and I/D bits.

**RD[17:0]**: Read 18-bit data from GRAM through the read data register (RDR). When the data is read by microcomputer, the first-word read immediately after the GRAM address setting is latched from the GRAM to the internal read-data latch. The data on the data bus (D17–0) becomes invalid and the second-word read is normal.

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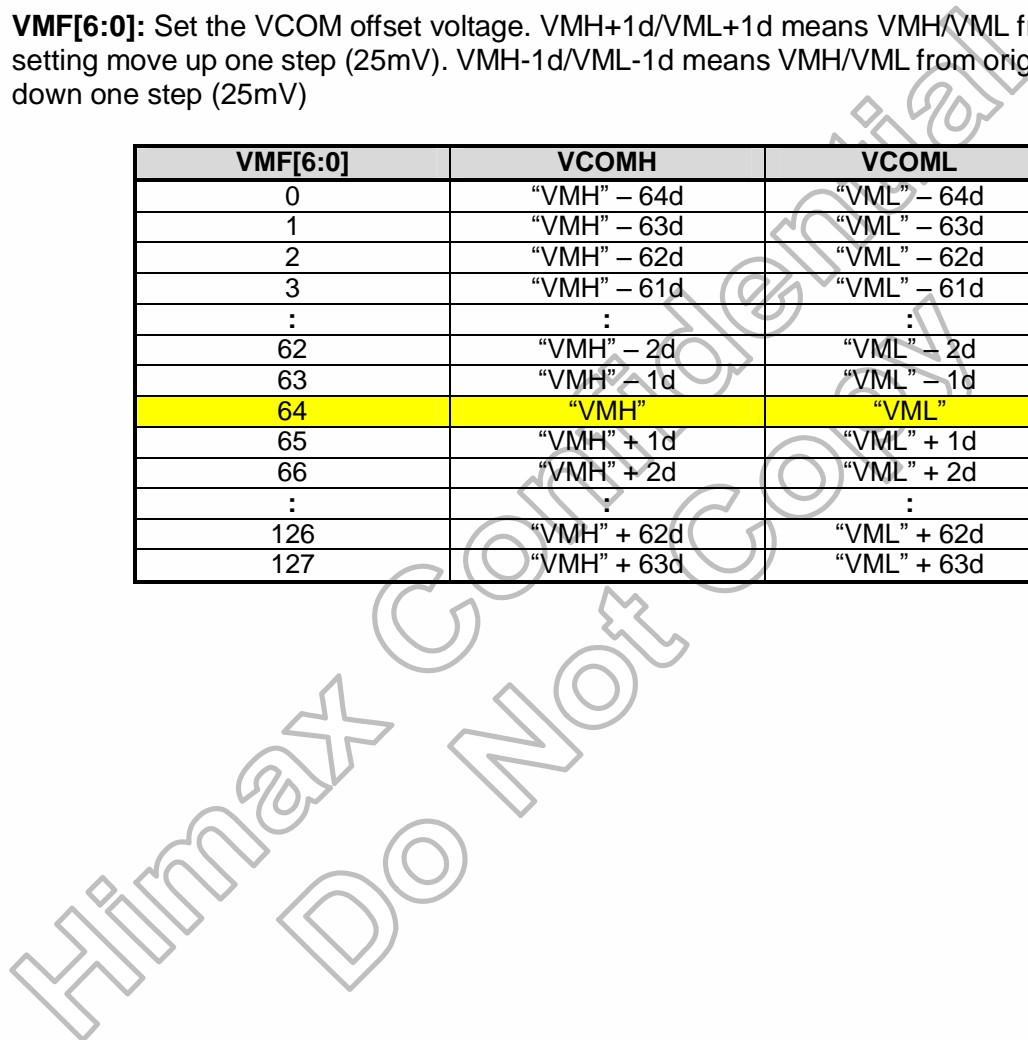
### 8.26 VCOM Offset Control Register (R23h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	VMF 6	VMF 5	VMF 4	VMF 3	VM F2	VMF 1	VMF 0
R	1	*	*	*	*	*	*	*	*	*	VMF 6	VMF 5	VMF 4	VMF 3	VM F2	VMF 1	VMF 0

Figure 8. 36 VCOM Offset Control Register (R23h)

**VMF[6:0]:** Set the VCOM offset voltage. VMH+1d/VML+1d means VMH/VML from original setting move up one step (25mV). VMH-1d/VML-1d means VMH/VML from original setting move down one step (25mV)

VMF[6:0]	VCOMH	VCOML
0	"VMH" - 64d	"VML" - 64d
1	"VMH" - 63d	"VML" - 63d
2	"VMH" - 62d	"VML" - 62d
3	"VMH" - 61d	"VML" - 61d
:	:	:
62	"VMH" - 2d	"VML" - 2d
63	"VMH" - 1d	"VML" - 1d
64	"VMH"	"VML"
65	"VMH" + 1d	"VML" + 1d
66	"VMH" + 2d	"VML" + 2d
:	:	:
126	"VMH" + 62d	"VML" + 62d
127	"VMH" + 63d	"VML" + 63d



8.27 VCOMH Control Register (R24h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	VMH 6	VMH 5	VMH 4	VMH 3	VMH 2	VMH 1	VMH 0
R	1	*	*	*	*	*	*	*	*	*	VMH 6	VMH 5	VMH 4	VMH 3	VMH 2	VMH 1	VMH 0

Figure 8. 37 VCOMH Control Register (R24h)

**VMH[6:0]:** Set the VCOMH voltage (High level voltage of VCOM). The default value is 1Ch(28x0.025+2.5=3.2V)

VMH6	VMH5	VMH4	VMH3	VMH2	VMH1	VMH0	VCOMH
0	0	0	0	0	0	0	2.500
0	0	0	0	0	0	1	2.525
0	0	0	0	0	1	0	2.550
0	0	0	0	0	1	1	2.575
0	0	0	0	1	0	0	2.600
0	0	0	0	1	0	1	2.625
:	:	:	:	:	:	:	:
0	1	1	1	0	0	1	3.925
0	1	1	1	0	1	0	3.950
0	1	1	1	0	1	1	3.975
0	1	1	1	1	0	0	4.000
0	1	1	1	1	0	1	4.025
0	1	1	1	1	1	0	4.050
0	1	1	1	1	1	1	4.075
1	0	0	0	0	0	0	4.100
1	0	0	0	0	0	1	4.125
1	0	0	0	0	1	0	4.150
1	0	0	0	0	1	1	4.175
1	0	0	0	1	0	0	4.200
1	0	0	0	1	0	1	
:	:	:	:	:	:	:	:
1	0	1	1	0	0	0	4700
1	0	1	1	0	0	1	4725
1	0	1	1	0	1	0	4750
1	0	1	1	0	1	1	4775
1	0	1	1	1	0	0	4800
:	:	:	:	:	:	:	4800
1	1	1	1	1	1	0	4800
1	1	1	1	1	1	1	VCOMH can be adjusted from VCOMR with a external VR (variable resister)

8.28 VCOML Control Register (R25h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	VML 6	VML 5	VML 4	VML 3	VML 2	VML 1	VML 0
R	1	*	*	*	*	*	*	*	*	*	VML 6	VML 5	VML 4	VML 3	VML 2	VML 1	VML 0

Figure 8. 38 VCOML Control Register (R25h)

**VML[6:0]:** Set the VCOML voltage (Low level voltage of VCOM). The default value is 34h(52x0.025-2.5=-1.2V)

VML6	VML5	VML4	VML3	VML2	VML1	VML0	VCOML
0	0	0	0	0	0	0	-2.500
0	0	0	0	0	0	1	-2.475
0	0	0	0	0	1	0	-2.450
0	0	0	0	0	1	1	-2.425
0	0	0	0	1	0	0	-2.400
0	0	0	0	1	0	1	-2.375
:	:	:	:	:	:	:	:
1	0	1	1	1	1	1	-0.125
1	1	0	0	0	0	0	-0.100
1	1	0	0	0	0	1	-0.075
1	1	0	0	0	1	0	-0.050
1	1	0	0	0	1	1	-0.025
1	1	0	0	1	0	0	0.000
1	1	0	0	1	0	1	Setting inhibit
:	:	:	:	:	:	:	:
1	1	1	1	1	1	1	Setting inhibit

### 8.29 Display Control 1 Register (R26h)

R/W	RS	D 15	D 14	D 13	D 12	D 11	D 10	D 9	D 8	D 7	D 6	D 5	D 4	D 3	D 2	D 1	D 0
W	1	*	*	*	*	*	*	*	*	PT1	PT0	GON	DTE	D1	D0	*	*
R	1	*	*	*	*	*	*	*	*	PT1	PT0	GON	DTE	D1	D0	*	*

Figure 8. 39 Display Control 1 Register (R26h)

**D[1:0]:** When D1=1, display is on; when D1 = 0, display is off. When display is off, the display data is retained in the GRAM, and can be instantly displayed by setting D1 = 1. When D1= 0, the display is off with the entire source outputs are set to the VSSD level. Because of this, the HX8340-B can control the charging current for the LCD with AC driving. When D1-0 = 01, the internal display of the HX8340-B is performed although the actual display is off. When D1-0 = 00, the internal display operation halts and the display is off.

**GON, DTE:**

GON	DTE	Gate Output
0	X	VGH
1	0	VGL
1	1	VGH/VGL

**PT[1:0] :** Non-display area source output control see follow table

INVON /REV_PANEL	GRAM Data	Source Output Level							
		Display area		Non-display Area					
		VCOM = "L"	VCOM = "H"	PT1-0=(0,*)		PT1-0=(1,0)		PT1-0=(1,1)	
		VCOM = "L"	VCOM = "H"	VCOM = "L"	VCOM = "H"	VCOM = "L"	VCOM = "H"	VCOM = "L"	VCOM = "H"
0	18'h00000	V63	V0	V63	V0	VSSD	VSSD	Hi-z	Hi-z
	18'h3FFFF	V0	V63						
1	18'h00000	V0	V63	V63	V0	VSSD	VSSD	Hi-z	Hi-z
	18'h3FFFF	V63	V0						

### 8.30 Display Control 2 Register (R27h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	REF	PTV <sub>1</sub>	PTV <sub>0</sub>	PTG	ISC <sub>3</sub>	ISC <sub>2</sub>	ISC <sub>1</sub>	ISC <sub>0</sub>
R	1	*	*	*	*	*	*	*	*	REF	PTV <sub>1</sub>	PTV <sub>0</sub>	PTG	ISC <sub>3</sub>	ISC <sub>2</sub>	ISC <sub>1</sub>	ISC <sub>0</sub>

Figure 8. 40 Display Control 2 Register (R27h)

**REF:** Refresh display in non-display area in Partial mode enable bit.

**REF = '0':** Refresh display operation is disabling.

**REF = '1':** Refresh display operation is enabling.

**PTG:** Specify the scan mode of gate driver in non-display area.

PTG	Gate Outputs in Non-display Area
0	Normal Drive
1	Fixed VGL

**PTV[1:0]:** Specify the scan mode of VCOM in non-display area.

PTV1	PTV0	VCOM Outputs in Non-display Area
0	0	Normal Drive
0	1	Fixed to VCOML
1	0	Fixed to GND
1	1	Setting Inhibited

**ISC[3:0]:** Specify the scan cycle of gate driver when **REF = '1'** in non-display area. Then scan cycle is set to an odd number from 0~31. The polarity is inverted every scan cycle.

ISC3	ISC2	ISC1	ISC0	Scan Cycle	f <sub>FLM</sub> = 60Hz
0	0	0	0	0 frame	-
0	0	0	1	3 frames	50 ms
0	0	1	0	5 frames	84 ms
0	0	1	1	7 frames	117 ms
0	1	0	0	9 frames	150 ms
0	1	0	1	11 frames	184 ms
0	1	1	0	13 frames	217 ms
0	1	1	1	15 frames	251 ms
1	0	0	0	17 frames	284 ms
1	0	0	1	19 frames	317 ms
1	0	1	0	21 frames	351 ms
1	0	1	1	23 frames	384 ms
1	1	0	0	25 frames	418 ms
1	1	0	1	27 frames	451 ms
1	1	1	0	29 frames	484 ms
1	1	1	1	31 frames	518 ms

PT1	PT0	REF	ISC[3:0]	Source Output	VCOM Output	Gate Output
0	x	x	--	Black Display ( NB = '0') White Display ( NB = '1')	Normal Driving	Normal Driving
1	0	0	--	GND	PTV[1:0]	PTG
		1	Non-refresh cycle	GND	PTV[1:0]	PTG
1	1	0	--	Hi-z	PTV[1:0]	PTG
		1	Refresh cycle	Black Display ( NB = '0') White Display ( NB = '1')	Normal Driving	Normal Driving
1	1	0	--	Hi-z	PTV[1:0]	PTG
		1	Refresh cycle	Black Display ( NB = '0') White Display ( NB = '1')	Normal Driving	Normal Driving

8.31 Frame Rate Control Register (R28h~R2Bh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	I/P_DIV1	I/P_DIV0	*	*	NP_DIV1	NP_DIV0
R	1	*	*	*	*	*	*	*	*	*	*	I/P_DIV1	I/P_DIV0	*	*	NP_DIV1	NP_DIV0

Figure 8. 41 Frame Control 1 Register (R28h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	I/P_RT3	I/P_RT2	I/P_RT1	I/P_RT0	NP_RT3	NP_RT2	NP_RT1	NP_RT0
R	1	*	*	*	*	*	*	*	*	I/P_RT3	I/P_RT2	I/P_RT1	I/P_RT0	NP_RT3	NP_RT2	NP_RT1	NP_RT0

Figure 8. 42 Frame Control 2 Register (R29h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	NP_DUM7	NP_DUM6	NP_DUM5	NP_DUM4	NP_DUM3	NP_DUM2	NP_DUM1	NP_DUM0
R	1	*	*	*	*	*	*	*	*	NP_DUM7	NP_DUM6	NP_DUM5	NP_DUM4	NP_DUM3	NP_DUM2	NP_DUM1	NP_DUM0

Figure 8. 43 Frame Control 3 Register (R2Ah)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	I/P_LDUM7	I/P_LDUM6	I/P_LDUM5	I/P_LDUM4	I/P_LDUM3	I/P_LDUM2	I/P_LDUM1	I/P_LDUM0
R	1	*	*	*	*	*	*	*	*	I/P_LDUM7	I/P_LDUM6	I/P_LDUM5	I/P_LDUM4	I/P_LDUM3	I/P_LDUM2	I/P_LDUM1	I/P_LDUM0

Figure 8. 44 Frame Control 4 Register (R2Bh)

**N/P\_DIV[1:0]:** Specify the division ratio of internal clocks in Normal / Partial mode for internal operation. When used internal clock for the display operation, frame frequency can be adjusted with the **N/P\_RTN[3:0]** bits (1H period clock cycle), **N/P\_DIV[1:0]**, and **N/P\_DUM[7:0]** bits.

**I/PI\_DIV[1:0]:** Specify the division ratio of internal clocks in Idle (8-color) / Partial Idle mode for internal operation. When used internal clock for the display operation, frame frequency can be adjusted with the **I/PI\_RTN[3:0]** bits(1H period clock cycle), **I/PI\_DIV[1:0]**, and **I/PI\_DUM[7:0]** bits.

DIV1	DIV0	Division Ratio	Internal Display Operation Clock Frequency
0	0	1	fosc / 1
0	1	2	fosc / 2
1	0	4	fosc / 4
1	1	8	fosc / 8

**N/P\_RTN[3:0]:** Specify clock number of one line period in Normal / Partial mode for internal operation.

**I/PI\_RTN[3:0]:** Specify clock number of one line period in Idle (8-color) / Partial Idle mode for internal operation.

Clock cycles=1/internal operation clock frequency(fosc)

RTN[3:0]	Clock number per Line
4'b0000	Setting Inhibited
4'b0001	Setting Inhibited
4'b0010	Setting Inhibited
4'b0011	Setting Inhibited
4'b0100	180
:	:
4'b1110	190
4'b1111	191

**N/P\_DUM[7:0]:** Specify dummy line number in blanking area of one frame in Normal / Partial mode for internal operation.

**I/PI\_DUM[7:0]:** Specify dummy line number in blanking area of one frame in Idle (8-color) / Partial Idle mode for internal operation.

DUM[7:0]	Line number in blanking period
000d	Setting Inhibited
001d	Setting Inhibited
002d	2
003d	3
004d	4
:	:
254d	254
255d	255

**Formula for the Frame Frequency during internal display mode:**

$$\text{Frame frequency} = \text{fosc} / (\text{RTN} \times \text{DIV} \times (220 + \text{DUM})) \text{ [Hz]}$$

fosc: RC oscillation frequency



### 8.32 Display Cycle Control Register (R2Ch~R2Eh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	SON 7	SON 6	SON 5	SON 4	SON 3	SON 2	SON 1	SON 0
R	1	*	*	*	*	*	*	*	*	SON 7	SON 6	SON 5	SON 4	SON 3	SON 2	SON 1	SON 0

Figure 8. 45 Display Cycle Control 1 Register (R2Ch)

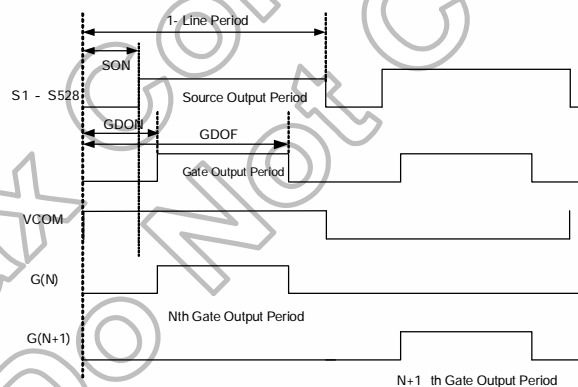
RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	GDO N7	GDO N6	GDO N5	GDO N4	GDO N3	GDO N2	GDO N1	GDO N0
R	1	*	*	*	*	*	*	*	*	GDO N7	GDO N6	GDO N5	GDO N4	GDO N3	GDO N2	GDO N1	GDO N0

Figure 8. 46 Display Cycle Control 2 Register (R2Dh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	GDO F7	GDO F6	GDO F5	GDO F4	GDO F3	GDO F2	GDO F1	GDO F0
R	1	*	*	*	*	*	*	*	*	GDO F7	GDO F6	GDO F5	GDO F4	GDO F3	GDO F2	GDO F1	GDO F0

Figure 8. 47 Display Cycle Control 1 Register (R2Eh)

The HX8340-B can control the display operation period time for LCD panel driving as follow:



**SON[7:0]:** Specify the valid source output start time in 1-line driving period. The period time value is defined as SYSCLK number in internal clock display mode. The period time value is defined as DOTCLK number in 18/16-bit bus width RGB display mode and is defined as DOTCLK/3 number in 6-bit bus width RGB display mode. (Please note that the setting “00h” and “01h” is inhibited).

**GDOF[7:0]:** Specify the valid gate output start time in 1-line driving period. The period time value is defined as SYSCLK number in internal clock display mode. The period time value is defined as DOTCLK number in 18/16-bit bus width RGB display mode and is defined as DOTCLK/3 number in 6-bit bus width RGB display mode. (Please note that the setting “00h”, “01h”, “02h” is inhibited).

**GDOF[7:0]:** Specify the gate output end time in 1-line driving period. The period time value is defined as SYSCLK number in internal clock display mode. The period time value is defined as DOTCLK number in 18/16-bit bus width RGB display mode and is defined as DOTCLK/3 number in 6-bit bus width RGB display mode. (Please note that the  $GDOF[7:0] + 1 \leq GDOF[7:0] \leq RTN-1$ ).

### 8.33 Display Inversion Control Register (R2Fh)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	I/PI_ NW2	I/PI_ NW1	I/PI_ NW0	*	N/P_ NW2	N/P_ NW1	N/P_ NW0
R	1	*	*	*	*	*	*	*	*	*	I/PI_ NW2	I/PI_ NW1	I/PI_ NW0	*	N/P_ NW2	N/P_ NW1	N/P_ NW0

Figure 8. 48 Display Inversion Control Register (R2Fh)

This command is used to set display inversion control

**N/P\_ NW[2:0]:** Specify LCD driving inversion type in Normal/ Partial mode.

**I/PI\_ NW[2:0]:** Specify LCD driving inversion type in Idle / Partial Idle mode.

NW[2:0]	LCD driving Inversion Type
0d	Frame inversion
1d	1-line inversion
2d	2-line inversion
3d	3-line inversion
:	:
6d	6-line inversion
7d	7-line inversion

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### 8.34 RGB Interface Control Register (R31h~R32h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	HBP 5	HBP 4	HBP 3	HBP 2	HBP 1	HBP 0
R	1	*	*	*	*	*	*	*	*	*	*	HBP 5	HBP 4	HBP 3	HBP 2	HBP 1	HBP 0

Figure 8. 49 RGB Interface HBP Control Register (R31h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	VBP 7	VBP 6	VBP 5	VBP 4	VBP 3	VBP 2	VBP 1	VBP 0
R	1	*	*	*	*	*	*	*	*	VBP 7	VBP 6	VBP 5	VBP 4	VBP 3	VBP 2	VBP 1	VBP 0

Figure 8. 50 RGB Interface VBP Control Register (R32h)

This command is used to set vertical and horizontal back porch control in RGB I/F mode 2 (RCM[1:0]= '11') (RGB I/F mode 1 is using DE signal as data enable signal)

**HBP[5:0]:** Set the delay period from falling edge of HSYNC signal to first valid data in RGB I/F mode 2

HBP[5:0]	No. of clock cycle of DOTCLK
00d	Setting Inhibited
01d	Setting Inhibited
02d	2
03d	3
04d	4
:	:
61d	61
62d	62
63d	63

**VBP[7:0]:** Set the delay period from falling edge of VSYNC signal to first valid line in RGB I/F mode 2

VBP[7:0]	No. of clock cycle of HSYNC
00d	Setting Inhibited
01d	Setting Inhibited
02d	2
03d	3
04d	4
:	:
253d	253
254d	254
255d	255

### 8.35 RGB Interface Signal Control Register (R33h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	DPL	HSP L	VSP L	EPL
R	1	*	*	*	*	*	*	*	*	*	*	*	*	DPL	HSP L	VSP L	EPL

Figure 8. 51 RGB Interface Signal Control Register (R33h)

**EPL:** Specify the polarity of Enable pin in RGB interface mode.

EPL	ENABLE pin	Display image	Operation
0	High	Enable	Write data to DB17-0
0	Low	Disable	Disable
1	High	Disable	Disable
1	Low	Enable	Write data to DB17-0

**VSPL:** The polarity of VSYNC pin. When VSPL=0, the VSYNC pin is Low active. When VSPL=1, the VSYNC pin is High active.

**HSPL:** The polarity of HSYNC pin. When HSPL=0, the HSYNC pin is Low active. When HSPL=1, the HSYNC pin is High active.

**DPL:** The polarity of DOTCLK pin. When DPL=0, the data is read on the rising edge of DOTCLK signal. When DPL=1, the data is read on the falling edge of DOTCLK signal.

### 8.36 RGB Interface Power on/off Control Register (R34h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	CSH UT
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	CSH UT

Figure 8. 52 RGB Interface Power On/Off Control Register (R34h)

This command is used to set chip on/ off control in RGB I/F.

CSHUT	Chip on/off in RGB I/F
0	Chip on
1	Chip off

As CSHUT command bit be written in RGB interface, the external pin SHUT control is invalid, and chip on/off selection is controlled by internal CSHUT command bit.

### 8.37 RGB Interface Output Direction Register (R35h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	CTB	CRL
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	CTB	CRL

Figure 8. 53 RGB Interface Output Direction Control Register (R35h)

This command is used to set driver output direction control in RGB interface.

**CRL:** Source output direction select register in RGB interface.

CRL	Module Source Output Direction
0	Normal Direction
1	Reverse Direction

**CTB:** Gate output direction select register in RGB interface.

CTB	Module Gate Output Direction
0	Normal Direction
1	Reverse Direction

**Note:** (1) As CRL bit be written in RGB interface, the external pin RL control is invalid, CRL is operated based on external pin SMX setting.

(2) As CTB bit be written in RGB interface, the external pin TB control is invalid, CTB is operated based on external pin SMY setting.

### 8.38 Interface Mode Selection Register (R36h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	RCM1	RCM0
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	RCM1	RCM0

Figure 8. 54 Interface Mode Selection Control Register (R36h)

This command is used to set interface mode.

**RCM[1:0]:** RGB and MCU interface select.

RCM1	RCM0	Interface Select
0	x	System Interface <sup>(1)</sup>
1	0	RGB Interface(1) (VS+HS+DE)
1	1	RGB Interface(2) (VS+HS)

**Note:** (1) As RCM[1:0] bit be written, the external pin RCM[1:0] control is invalid.

### 8.39 Normally White/Black Control Register (R37h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	NWB
R	1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	NWB

Figure 8. 55 Normally White/Black Control Register (R37h)

This command is used to set the characteristic of used panel.

NWB	Panel Type
0	Normally White Panel Used
1	Normally Black Panel Used

### 8.40 OTP Register (R38h ~ R3Ah)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	OTP_PO R	OTP_OT PEN	OTP_PP ROG	OTP_PW E
R	1	*	*	*	*	*	*	*	*	*	*	*	*	OTP_PO R	OTP_OT PEN	OTP_PP ROG	OTP_PW E

Figure 8. 56 OTP Command 1 (R38h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	OTP_YA2	OTP_YA1	OTP_YA0	*	OTP_XA2	OTP_XA1	OTP_XA0	*
R	1	*	*	*	*	*	*	*	*	OTP_YA2	OTP_YA1	OTP_YA0	*	OTP_XA2	OTP_XA1	OTP_XA0	*

Figure 8. 57 OTP Command 2 (R39h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	OTP_VR ADJ1	OTP_VR ADJ0	*	*	OTP_PT M1	OTP_PT M0	*	*
R	1	*	*	*	*	*	*	*	*	OTP_VR ADJ1	OTP_VR ADJ0	*	*	OTP_PT M1	OTP_PT M0	*	*

Figure 8. 58 OTP Command 3 (R3Ah)

This command is used to set the OTP related setting. Please see OTP flow for detail use.

**OTP\_POR:** for OTP read/write timing control

**OTP\_OTPEN:** 1'b1 to select 6.5V for OTP write operation.

**OTP\_PPROG :** 1'b1 to turn on OTP write mode.

**OTP\_PWE :** 1'b1 to write OTP.

**OTP\_XA[2:0]: OTP\_YA[2:0] :** Select OTP write address

**OTP\_TM[1:0] :** OTP Test mode register, In-house use.

**OTP\_VRADJ[1:0] :** OTP VPP2 adjust register, In-house use.

8.41 Positive Gamma Control (R40h~R48h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MP 12	MP 11	MP 10	*	MP 02	MP 01	MP 00
R	1	*	*	*	*	*	*	*	*	*	MP 12	MP 11	MP 10	*	MP 02	MP 01	MP 00

Figure 8. 59 Positive Gamma Control 1 Register (R40h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MP 32	MP 31	MP 30	*	MP 22	MP 21	MP 20
R	1	*	*	*	*	*	*	*	*	*	MP 32	MP 31	MP 30	*	MP 22	MP 21	MP 20

Figure 8. 60 Positive Gamma Control 2 Register (R41h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MP 52	MP 51	MP 50	*	MP 42	MP 41	MP 40
R	1	*	*	*	*	*	*	*	*	*	MP 52	MP 51	MP 50	*	MP 42	MP 41	MP 40

Figure 8. 61 Positive Gamma Control 3 Register (R42h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	CP 04	CP 03	CP 02	CP 01	CP 00
R	1	*	*	*	*	*	*	*	*	*	*	*	CP 04	CP 03	CP 02	CP 01	CP 00

Figure 8. 62 Positive Gamma Control 4 Register (R43h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	CP 23	CP 22	CP 21	CP 20	CP 13	CP 12	CP 11	CP 10
R	1	*	*	*	*	*	*	*	*	CP 23	CP 22	CP 21	CP 20	CP 13	CP 12	CP 11	CP 10

Figure 8. 63 Positive Gamma Control 5 Register (R44h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	CP 33	CP 32	CP 31	CP 30
R	1	*	*	*	*	*	*	*	*	*	*	*	*	CP 33	CP 32	CP 31	CP 30

Figure 8. 64 Positive Gamma Control 6 Register (R45h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	CP 44	CP 43	CP 42	CP 41	CP 40
R	1	*	*	*	*	*	*	*	*	*	*	*	CP 44	CP 43	CP 42	CP 41	CP 40

Figure 8. 65 Positive Gamma Control 7 Register (R46h)



RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	OP 23	OP 22	OP 21	OP 20	OP 13	OP 12	OP 11	OP 10
R	1	*	*	*	*	*	*	*	*	OP 23	OP 22	OP 21	OP 20	OP 13	OP 12	OP 11	OP 10

Figure 8. 66 Positive Gamma Control 8 Register (R47h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	*	*	*	CGM 11	CGM 10	CGM 01	CGM 00
R	1	*	*	*	*	*	*	*	*	*	*	*	*	CGM 11	CGM 10	CGM 01	CGM 00

Figure 8. 67 Positive Gamma Control 9 Register (R48h)

8.42 Negative Gamma Control (R50h~R57h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MN 12	MN 11	MN 10	*	MN 02	MN 01	MN 00
R	1	*	*	*	*	*	*	*	*	*	MN 12	MN 11	MN 10	*	MN 02	MN 01	MN 00

Figure 8. 68 Negative Gamma Control 1 Register (R50h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MN 32	MN 31	MN 30	*	MN 22	MN 21	MN 20
R	1	*	*	*	*	*	*	*	*	*	MN 32	MN 31	MN 30	*	MN 22	MN 21	MN 20

Figure 8. 69 Negative Gamma Control 2 Register (R51h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	*	MN 52	MN 51	MN 50	*	MN 42	MN 41	MN 40
R	1	*	*	*	*	*	*	*	*	*	MN 52	MN 51	MN 50	*	MN 42	MN 41	MN 40

Figure 8. 70 Negative Gamma Control 3 Register (R52h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
W	1	*	*	*	*	*	*	*	*	*	*	*	*	CN 04	CN 03	CN 02	CN 01	CN 00
R	1	*	*	*	*	*	*	*	*	*	*	*	*	CN 04	CN 03	CN 02	CN 01	CN 00

Figure 8. 71 Negative Gamma Control 4 Register (R53h)

RW	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	*	*	*	CN 23	CN 22	CN 21	CN 20	CN 13	CN 12	CN 11	CN 10
R	1	*	*	*	*	*	*	*	*	CN 23	CN 22	CN 21	CN 20	CN 13	CN 12	CN 11	CN 10

Figure 8. 72 Negative Gamma Control 5 Register (R54h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	*	*	*	CN 33	CN 32	CN 31	CN 30
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	*	*	*	CN 33	CN 32	CN 31	CN 30

Figure 8. 73 Negative Gamma Control 6 Register (R55h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	*	*	CN 44	CN 43	CN 42	CN 41	CN 40
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	*	*	*	CN 44	CN 43	CN 42	CN 41	CN 40

Figure 8. 74 Negative Gamma Control 7 Register (R56h)

<b>RW</b>	<b>RS</b>	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
<b>W</b>	<b>1</b>	*	*	*	*	*	*	*	*	ON 23	ON 22	ON 21	ON 20	ON 13	ON 12	ON 11	ON 10
<b>R</b>	<b>1</b>	*	*	*	*	*	*	*	*	ON 23	ON 22	ON 21	ON 20	ON 13	ON 12	ON 11	ON 10

Figure 8. 75 Negative Gamma Control 8 Register (R57h)

Register Groups	Positive Polarity	Description
Center Adjustment	CP/N0 4-0	Variable resistor (VRTP/N) for center adjustment
	CP/N1 3-0	Variable resistor (VRCP/N0) for center adjustment
	CP/N2 3-0	Variable resistor (VRMP/N) for center adjustment
	CP/N3 3-0	Variable resistor (VRCP/N1) for center adjustment
Macro Adjustment	CP/N4 4-0	Variable resistor (VRBP/N) for center adjustment
	MP/N0 2-0	8-to-1 selector (reference voltage level of grayscale 1)
	MP/N1 2-0	8-to-1 selector (reference voltage level of grayscale 8)
	MP/N2 2-0	8-to-1 selector (reference voltage level of grayscale 20)
	MP/N3 2-0	8-to-1 selector (reference voltage level of grayscale 43)
Offset Adjustment	MP/N4 2-0	8-to-1 selector (reference voltage level of grayscale 55)
	MP/N5 2-0	8-to-1 selector (reference voltage level of grayscale 62)
	OP/N0 3-0	Variable resistor (VROP/N0) for offset adjustment
	OP/N1 3-0	Variable resistor (VROP/N1) for offset adjustment

For details, please refer to 7.2 Gamma resistor stream and 8 to 1 Selector.

# 9. Layout Recommendation

## 9.1 Parallel Interface of Register-Content Mode

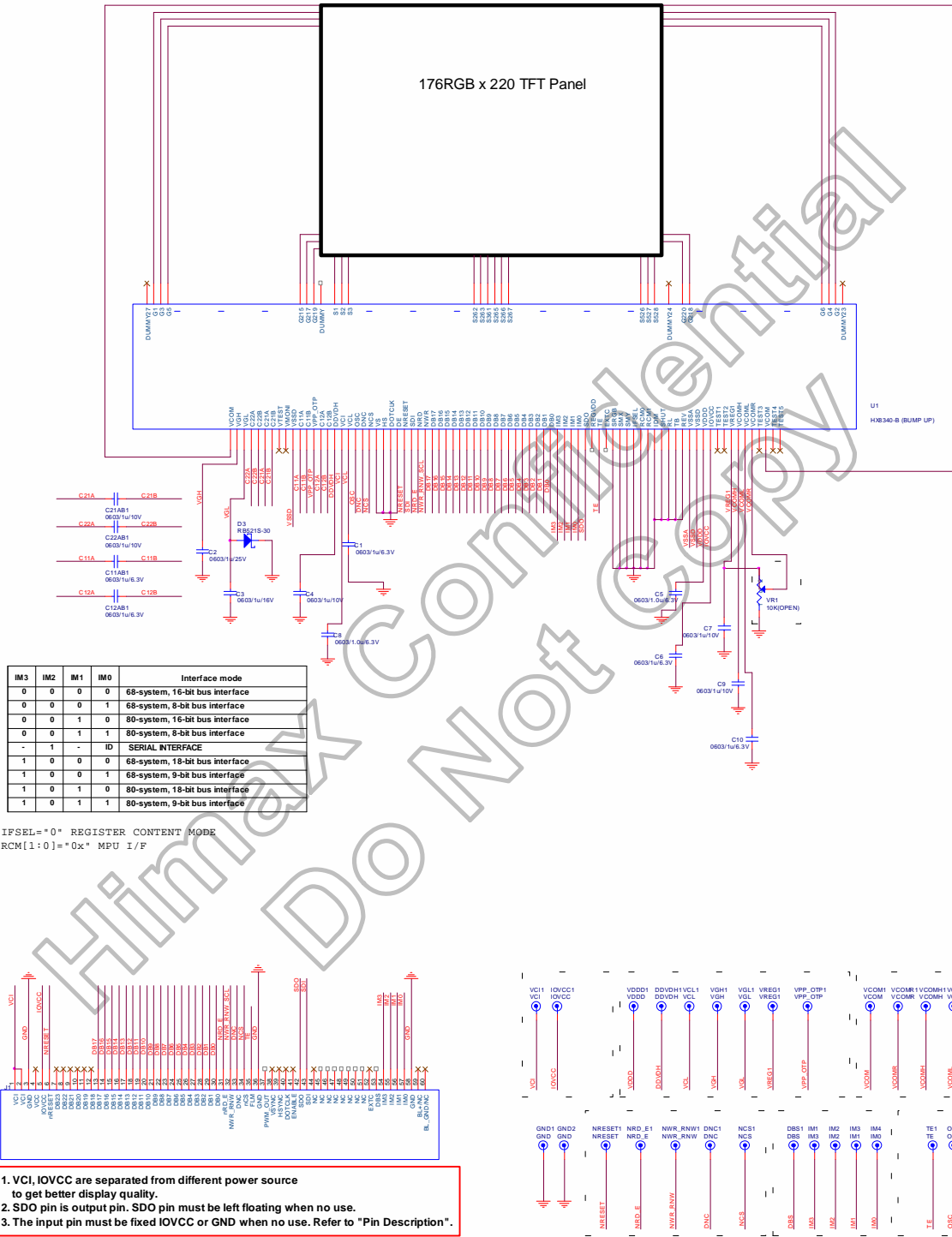


Figure 9. 1 Layout Recommendation of System Interface

### 9.2 RGB + SPI Interface of Register-Content

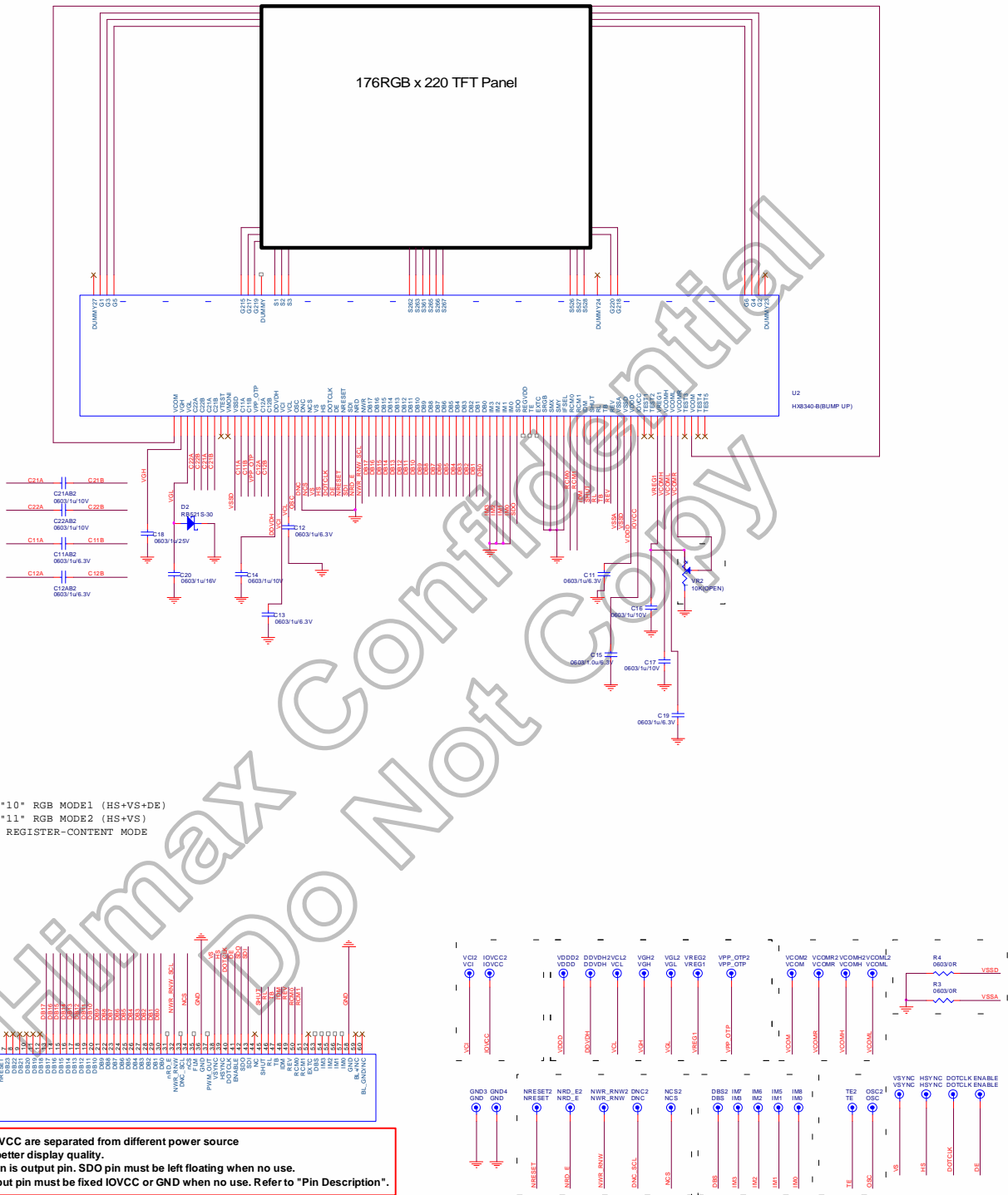


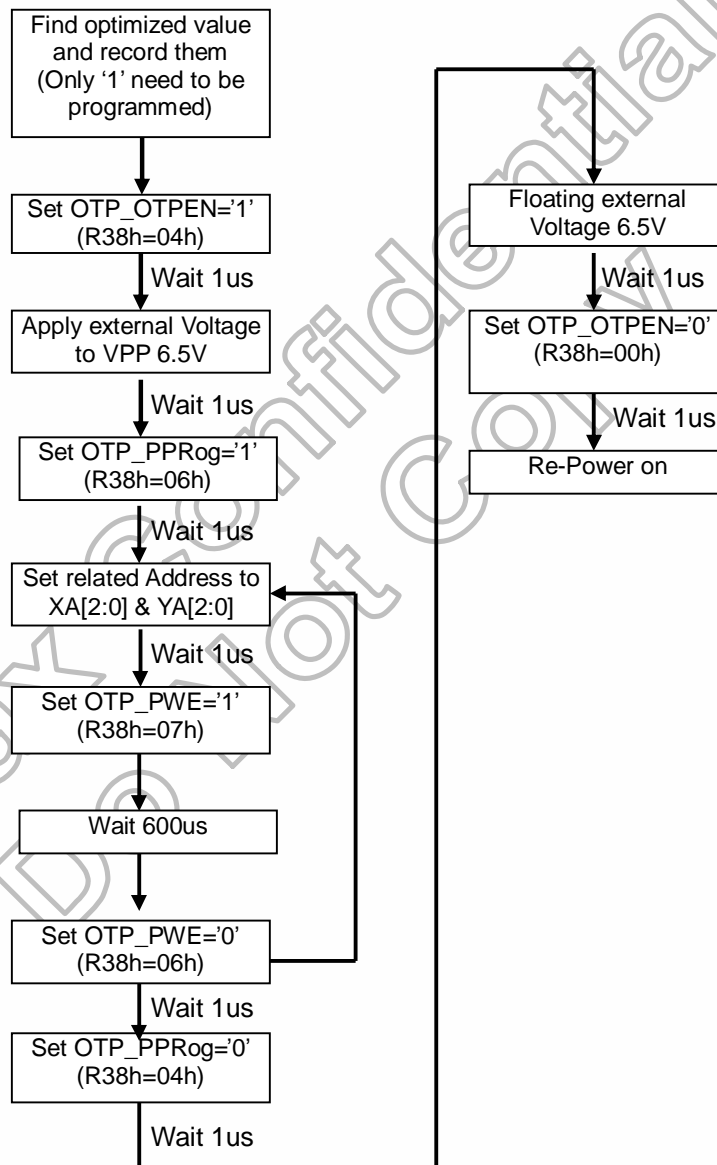
Figure 9. 2 Layout Recommendation of RGB Interface

## 10. OTP

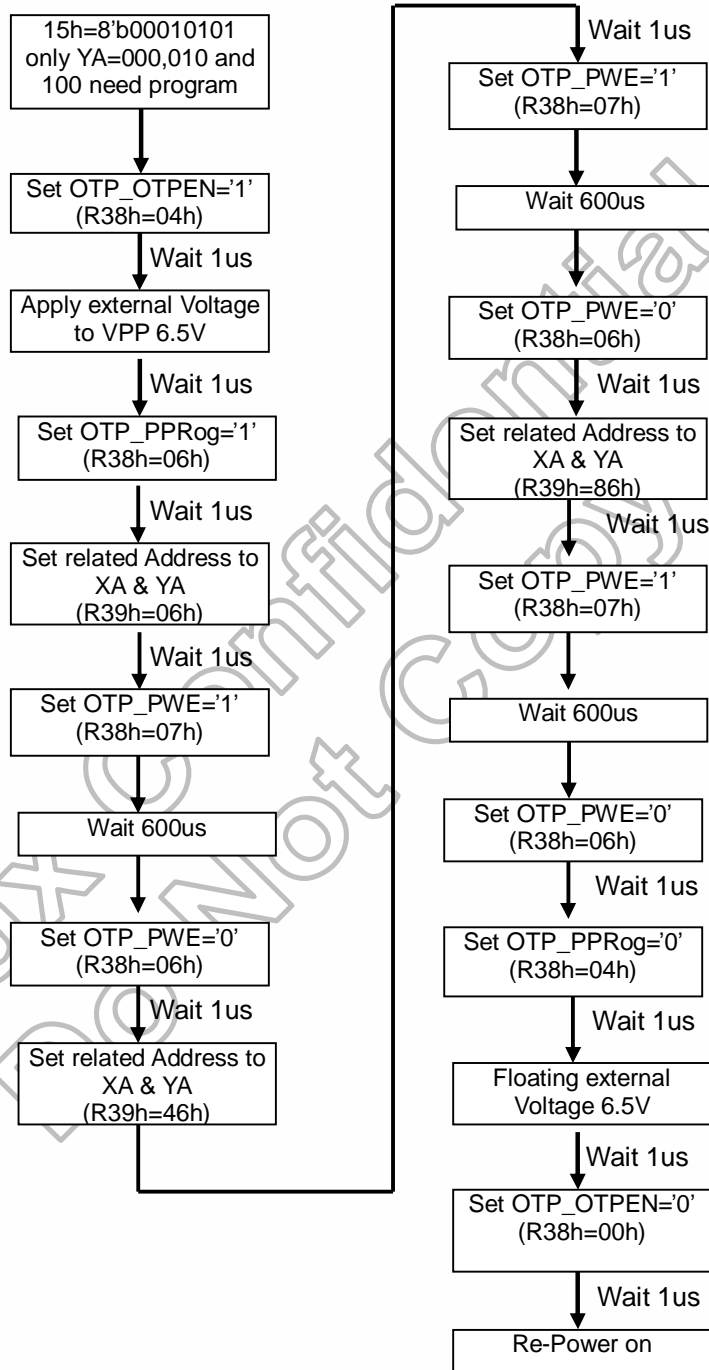
	YA[2:0]= 111	YA[2:0]= 110	YA[2:0]= 101	YA[2:0]= 100	YA[2:0]= 011	YA[2:0]= 010	YA[2:0]= 001	YA[2:0]= 000	Non-Program
XA[2:0]=011		VMF6	VMF5	VMF4	VMF3	VMF2	VMF1	VMF0	00h

**Table 10.1 OTP ADDRESS MAPPING**

### OTP Programming Flow



**OTP Programming Example (VMF=15h)**



## 11. Electrical Characteristic

### 11.1 Absolute Maximum Ratings

(VSS = 0V)

Item	Symbol	Value	Unit
Logic Supply voltage	IOVCC	-0.3~+3.6	V
Power Supply voltage	VCI	-0.3~+4.2	V
Logic input voltage range	Vin	-0.3~IOVCC+0.5	V
Logic Output voltage range	Vo	-0.3~IOVCC+0.5	V
Operating Temperature Range	TOPR	-20~+70	°C
Storage Temperature Range	TSTG	-40~+125	°C

Note: (1) IOVCC, VSSD must be maintained.

(2) To make sure IOVCC ≥ VSSD.

(3) To make sure VCI ≥ VSSA.

Table 11. 1 Absolute Maximum Ratings

### 11.2 ESD Protection Level

Item	Test Condition	Protection Level	Unit
Human Body Model	C = 100 pF, R = 1.5 kΩ	±2.5K	V
Machine Model	C = 200 pF, R = 0.0 Ω	±250	V

### 11.3 Latch-Up Protection Level

T.B.D

### 11.4 Light Sensitivity

T.B.D

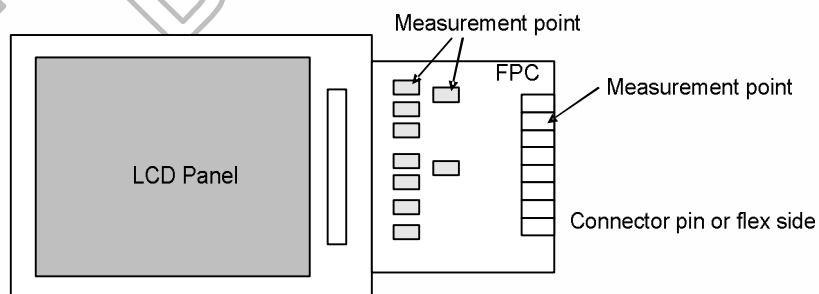


### 11.5 Maximum Layout Resistance

Name	Type	Maximum Resistance	Unit
IOVCC	Power supply	10	Ω
VCI	Power supply	10	Ω
VPP_OTP	Power supply	10	Ω
VSSA	Power supply	10	Ω
VSSD	Power supply	10	Ω
OSC	Input	100	Ω
DBS,IM[3:0], EXTC, IFSEL0,RCM[1:0]	Input	100	Ω
NRD_E, NWR_RNW, DNC_SCL, NCS, SDI	Input	100	Ω
NRESET,SMX,SMY,SRGB,	Input	100	Ω
IDM,SHUT,RL,TB,REV	Input	100	Ω
DB[17:0], DOTCLK, DE, VS, HS	Input	100	Ω
VGH	Capacitor connection	10	Ω
VGL	Capacitor connection	10	Ω
VCL	Capacitor connection	10	Ω
DDVDH	Capacitor connection	10	Ω
VDDD	Capacitor connection	10	Ω
VREG1	Capacitor connection	30	Ω
VCOMH, VCOML	Capacitor connection	30	Ω
C11A, C11B	Capacitor connection	10	Ω
C12A, C12B	Capacitor connection	10	Ω
C21A, C21B	Capacitor connection	15	Ω
C22A, C22B	Capacitor connection	15	Ω
VCOMR	Input	100	Ω
SDO, TE	Output	100	Ω

## 11.6 DC Characteristics

Parameter	Symbol	Conditions	Spec.			Unit
			Min.	Typ.	Max.	
<b>Power &amp; Operating Voltages</b>						
IO Operating voltage	IOVCC	I/O supply voltage	1.65	1.8	3.3	V
Driver Operating voltage	VCI	Operation voltage	2.5	2.8	3.3	
Source Drive Voltage	VREG1	-	TBD	TBD	TBD	
Gate Drive High Voltage	VGH	-	TBD	TBD	TBD	
Gate Drive Low Voltage	VGL	-				
Drive Supply Voltage	VGH-VGL	-	TBD	TBD	TBD	
<b>Input / Output</b>						
High level input voltage	VIH	-	TBD	TBD	TBD	V
Low level input voltage	VIL	-	TBD	TBD	TBD	
High level output voltage	VOH	IOH = -1.0mA	TBD	TBD	TBD	
Low level output voltage	VOL	IOL = +1.0mA	TBD	TBD	TBD	
Input leakage high current	IIH	-	TBD	TBD	TBD	μA
Input leakage current	IIL	-	TBD	TBD	TBD	μA
Oscillator frequency	fOSC	-	TBD	TBD	TBD	kHz
<b>Booster</b>						
AVDD boost voltage1	DDVDH	IAVDD=1mA	TBD	TBD	TBD	V
VCL boost voltage	VCL	ICL=-300uA	TBD	TBD	TBD	
VREG1 output voltage	VREG1	No load	TBD	TBD	TBD	
<b>VCOM Generator</b>						
VCOM amplitude	VCOM	No load	TBD	TBD	TBD	V
VCOM high level	VCOMH	No load	TBD	TBD	TBD	V
VCOM low level	VCOML	No load	TBD	TBD	TBD	V
<b>Source Driver</b>						
Output voltage deviation	DVOS	VSSD+1.0 ~ VREG1-1.0	TBD	TBD	TBD	mV
		VSSD+0.1V ~ VSSD+1.0 VREG1-1.0 ~ VREG1-0.1V	TBD	TBD	TBD	mV
Output voltage range	VOS	-	TBD	TBD	TBD	V
Output offset voltage	Voff	-				



## 11.6.1 Current Consumption

Host I/F	Mode of operation	Frame Frequency	Inversion Mode	Image	Memory Data Access Control (MY:MX:MV)	Current consumption	
						Typical	Worst case
						VCI (mA)	VCI (mA)
Host interface NOT active	- Normal Mode On - Partial Mode Off - Idle Mode Off - Sleep Out Mode	60Hz	TBD	Note <sup>(1)</sup>	X;X;X	TBD	TBD
					X;X;X	TBD	TBD
					X;X;X	TBD	TBD
					X;X;X	TBD	TBD
					X;X;X	TBD	TBD
	- Normal Mode On - Partial Mode Off - Idle Mode On - Sleep Out Mode	60Hz	TBD	Note <sup>(5)</sup>	X;X;X	TBD	TBD
					X;X;X	TBD	TBD
	- Normal Mode Off - Partial Mode On (32 lines) - Idle Mode Off - Sleep Out Mode	60Hz	TBD	Grey Levels	X;X;X	TBD	TBD
					X;X;X	TBD	TBD
	- Normal Mode Off - Partial Mode On (32 lines) - Idle Mode On - Sleep Out Mode	60Hz	TBD	Note <sup>(6)</sup>	X;X;X	TBD	TBD
X;X;X					TBD	TBD	
- Sleep In Mode	N/A	N/A	N/A	X;X;X	0.002	0.010	
				X;X;X	TBD	TBD	
Host interface active	- Normal Mode On - Partial Mode Off - Idle Mode Off - Sleep Out Mode	60Hz	TBD	262k Colors Note <sup>(8)</sup> CPU Access @ 15fps	0;0;0	TBD	TBD
					0;0;1	TBD	TBD
					0;1;0	TBD	TBD
					0;1;1	TBD	TBD
					1;0;0	TBD	TBD
					1;0;1	TBD	TBD
					1;1;0	TBD	TBD
					1;1;1	TBD	TBD
					0;0;0	TBD	TBD
					0;0;1	TBD	TBD
					0;1;0	TBD	TBD
					0;1;1	TBD	TBD
					1;0;0	TBD	TBD
					1;0;1	TBD	TBD
					1;1;0	TBD	TBD
1;1;1	TBD	TBD					

Typical Case:

T<sub>A</sub> = 25oC  
IOVCC=1.8V  
VCI = 2.8V

Worst Case:

T<sub>A</sub> = -30 to 70oC  
IOVCC = 1.65V to 1.95V  
VCI = 2.5V to 3.3V  
Includes Process Variance.

**Note:** X Do not care

- (1) All pixels black
- (2) Checker board one by one
- (3) Checker board 4 by 4
- (4) Grey-scale from top to bottom
- (5) 20% Black, 80%White
- (6) Black & White Checker board 8 by 8.
- (7) Absolute Worst Case Patterns: Defined by Display Supplier
- (8) Absolute Worst Case Patterns and Sequences: Defined by Display Supplier
- (9) Absolute worst case VCI current is less than TBD mA in the case of CPU access is inactive, Normal Mode On, Partial Mode Off, Idle Mode Off, Sleep Out mode.
- (10) Absolute worst case IOVCC current is less than TBD mA in the case of CPU access is inactive, Normal Mode On, Partial Mode Off, Idle Mode Off, Sleep Out mode.
- (11) Inrush currents are not included in current consumption values

### 11.7 AC Characteristics

#### 11.7.1 Parallel Interface Characteristics (8080-Series MPU)

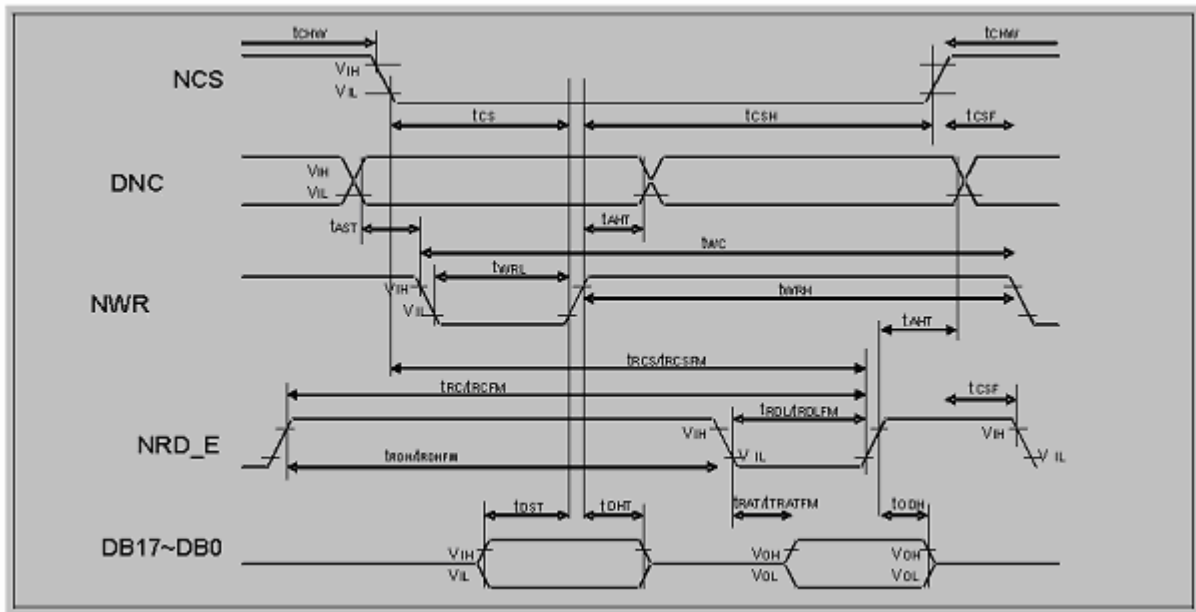


Figure 11. 1 Parallel Interface Characteristics (8080-Series MPU)

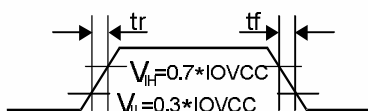
(VSSA=0V, IOVCC=1.65V to 1.95V, VCI=2.5V to 3.3V, Ta = -30 to 70° C)

Signal	Symbol	Parameter	Min.	Max.	Unit	Description
DNC	tAST	Address setup time	0	-	ns	-
	tAHT	Address hold time (Write/Read)	10	-	ns	-
NCS	tCHW	Chip select "H" pulse width	0	-	-	-
	tCS	Chip select setup time (Write)	15	-	-	-
	tRCS	Chip select setup time (Read ID)	45	-	ns	-
	tRCSFM	Chip select setup time (Read FM)	355	-	-	-
	tCSF	Chip select wait time (Write/Read)	10	-	-	-
	tCSH	Chip select hold time	10	-	-	-
NWR_RNW	tWC	Write cycle	66	-	-	-
	tWRH	Control pulse "H" duration	15	-	ns	-
	tWRL	Control pulse "L" duration	15	-	-	-
NRD_E (ID)	tRC	Read cycle (ID)	160	-	-	-
	tRDH	Control pulse "H" duration (ID)	90	-	ns	When read ID data
	tRDL	Control pulse "L" duration (ID)	45	-	-	-
NRD_E (FM)	tRCFM	Read cycle (FM)	450	-	-	-
	tRDHFM	Control pulse "H" duration (FM)	90	-	ns	When read from frame memory
	tRDLFM	Control pulse "L" duration (FM)	355	-	-	-
D15 to D0	tDST	Data setup time	10	-	-	-
	tDHT	Data hold time	10	-	-	-
	tRAT	Read access time (ID)	-	40	ns	For maximum CL=30pF
	tRATFM	Read access time (FM)	-	340	-	For minimum CL=8pF
	tODH	Output disable time	20	80	-	-

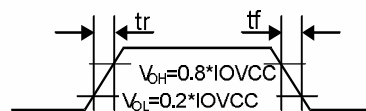
Note: The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.

Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.

Input Signal Slope



Output Signal Slope



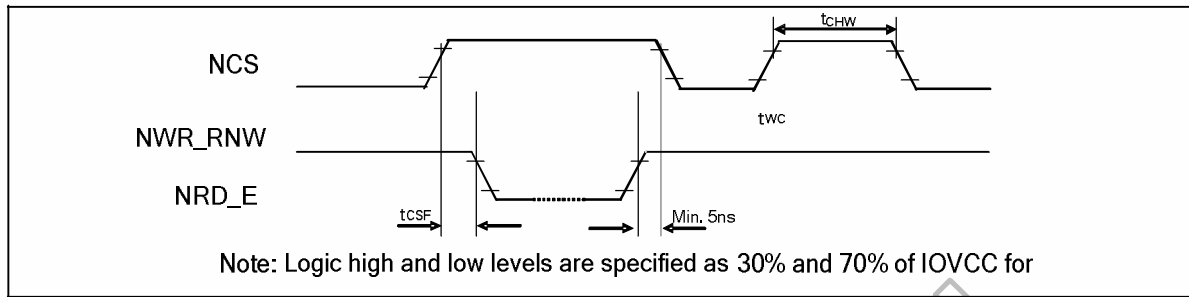


Figure 11. 2 Chip Select Timing

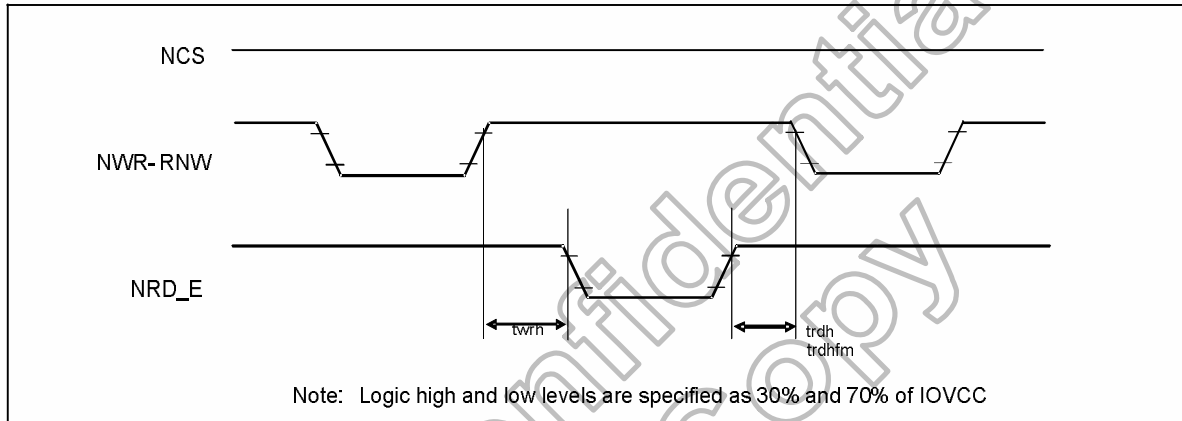


Figure 11. 3 Write to Read and Read to Write Timing

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11.7.2 Parallel Interface Characteristics (6800-Series MPU)

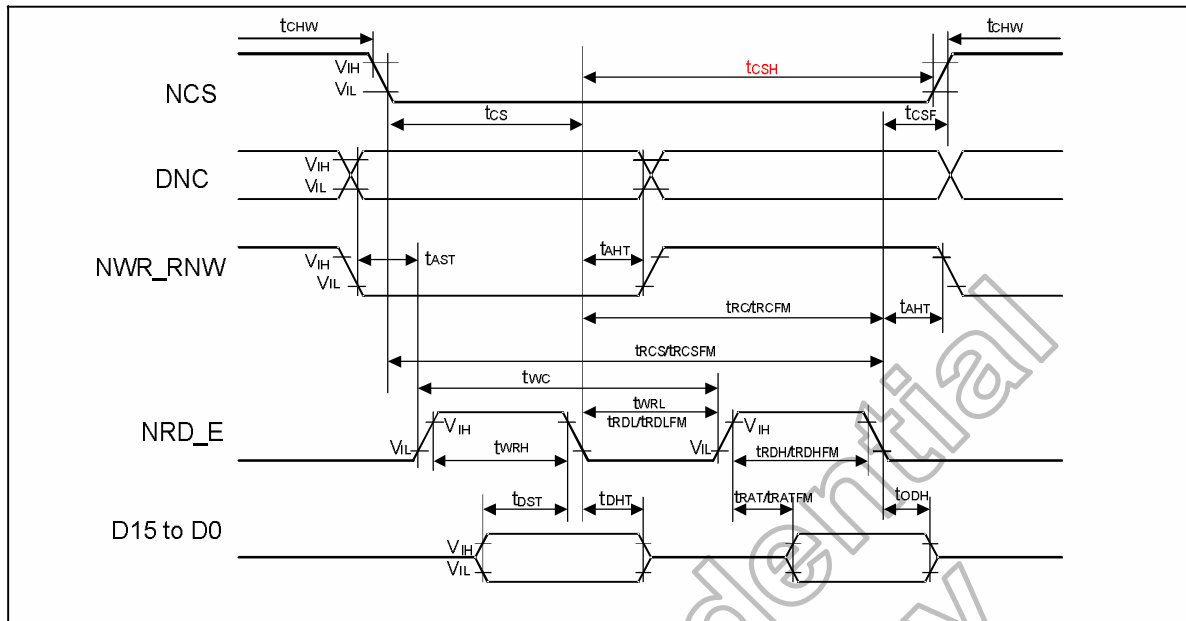


Figure 11. 4 Parallel Interface Characteristics (6800-Series MPU)

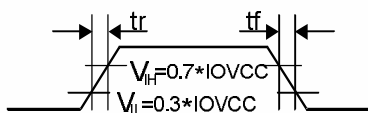
(VSSA=0V, IOVCC=1.65V to 1.95V, VCI=2.5V to 3.3V, Ta = -30 to 70° C)

Signal	Symbol	Parameter	Min.	Max.	Unit	Description
DNC	tAST	Address setup time	0	-		
	tAHT	Address hold time (Write/Read)	10	-	ns	-
NCS	tCHW	Chip select "H" pulse width	0	-		
	tCS	Chip select setup time (Write)	15	-		
	tRCS	Chip select setup time (Read ID)	45	-		
	tRCSFM	Chip select setup time (Read FM)	355	-	ns	-
	tCSF	Chip select wait time (Write/Read)	10	-		
NWR_RNW	tCST	Chip select hold time	10	-		
	tWC	Write cycle	66	-		
NRD_E (ID)	tWRH	Control pulse "H" duration	15	-	ns	-
	tWRL	Control pulse "L" duration	15	-		
	tRC	Read cycle (ID)	160	-		
NRD_E (FM)	tRDH	Control pulse "H" duration (ID)	90	-	ns	When read ID data
	tRD	Control pulse "L" duration (ID)	45	-		
	tRCFM	Read cycle (FM)	450	-		
D17 to D0	tRDHFM	Control pulse "H" duration (FM)	90	-	ns	When read from frame memory
	tRDLM	Control pulse "L" duration (FM)	355	-		
	tDST	Data setup time	10	-		
	tDHT	Data hold time	10	-		
	tRAT	Read access time (ID)	-	40	ns	For maximum CL=30pF
tRATFM	Read access time (FM)	-	340			
tODH	Output disable time	20	80		For minimum CL=8pF	

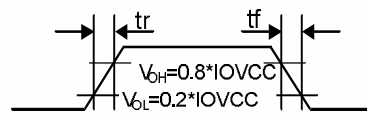
Note: The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.

Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.

Input Signal Slope



Output Signal Slope



11.7.3 Serial Interface Characteristics

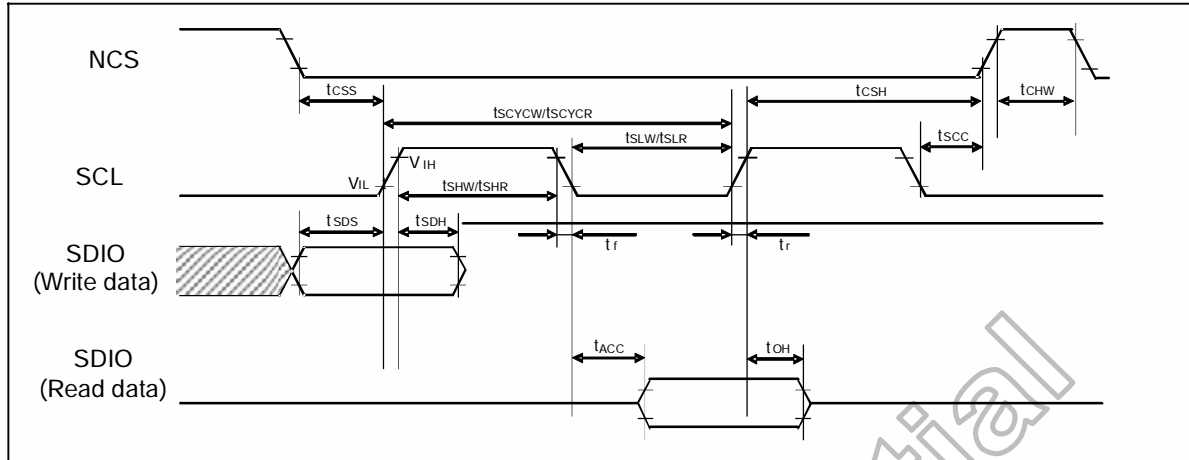
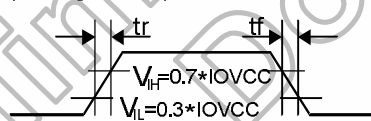


Figure 11. 5 Serial Interface Characteristics

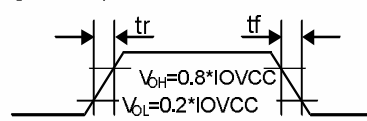
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Serial clock cycle (Write)	tscycw		66	-	-	
SCL "H" pulse width (Write)	tshw	SCL	15	-	-	ns
SCL "L" pulse width (Write)	tslw	SCL	15	-	-	
Data setup time (Write)	tsds	SDIO	10	-	-	ns
Data hold time (Write)	tsdh	SDIO	10	-	-	
Serial clock cycle (Read)	tscyrcr		150	-	-	
SCL "H" pulse width (Read)	tshr	SCL	60	-	-	ns
SCL "L" pulse width (Read)	tslr	SCL	60	-	-	
Access Time	tacc	SDI for maximum $C_L=30pF$ For minimum $C_L=8pF$	10	-	50	ns
Output disable time	toh	SDO For maximum $C_L=30pF$ For minimum $C_L=8pF$	15	-	50	ns
SCL to Chip select	tsccl	SCL, NCS	20	-	-	ns
NCS "H" pulse width	tchwl	NCS	40	-	-	ns
Chip select setup time	tcss	NCS	15	-	-	
Chip select hold time	tcsll	NCS	15	-	-	ns

**Note:** The input signal rise time and fall time ( $t_r$ ,  $t_f$ ) is specified at 15 ns or less.  
Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.

Input Signal Slope

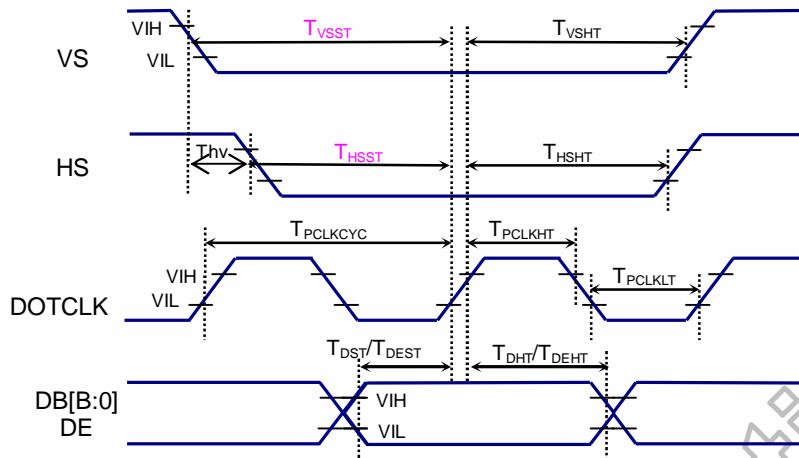


Output Signal Slope





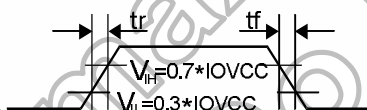
## 11.7.4 RGB Interface Characteristics



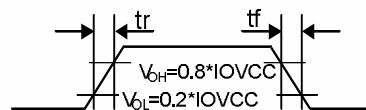
Item	Symbol	Condition	Spec.			Unit
			Min	Type.	Max	
Pixel low pulse width	$T_{CLKLT}$	-	15	-	-	ns
Pixel high pulse width	$T_{CLKHT}$	-	15	-	-	ns
Vertical Sync. set-up time	$T_{VSST}$	-	15	-	-	ns
Vertical Sync. hold time	$T_{VSHT}$	-	15	-	-	ns
Horizontal Sync. set-up time	$T_{HSST}$	-	15	-	-	ns
Horizontal Sync. hold time	$T_{HSHT}$	-	15	-	-	ns
Data Enable set-up time	$T_{DEST}$	-	15	-	-	ns
Data Enable hold time	$T_{DEHT}$	-	15	-	-	ns
Data set-up time	$T_{DST}$	-	15	-	-	ns
Data hold time	$T_{DHT}$	-	15	-	-	ns
Phase difference of sync signal falling edge	$T_{hv}$	-	0	-	176	Dotclk

**Note:** The input signal rise time and fall time ( $t_r$ ,  $t_f$ ) is specified at 15 ns or less.

Input Signal Slope

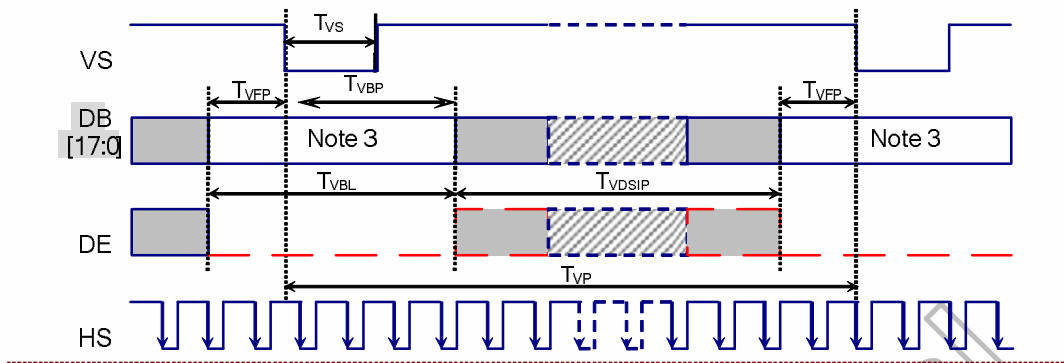


Output Signal Slope

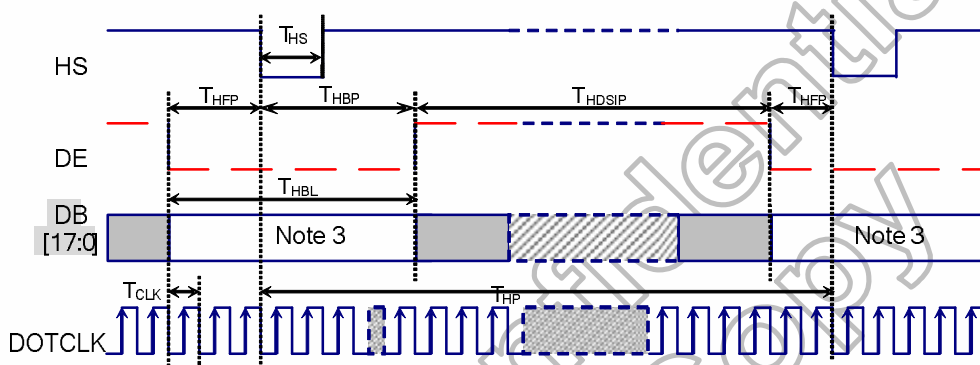




### Vertical Timing for RGB I/F



### Horizontal Timing for RGB I/F



Item	Symbol	Condition	Spec.			Unit
			Min	Type.	Max	
<b>Vertical Timing</b>						
Vertical cycle period	$T_{VP}$	-	224	228	511	HS
Vertical low pulse width	$T_{VS}$	-	2	2	-	HS
Vertical front porch	$T_{VFP}$	-	2	2	-	HS
Vertical back porch	$T_{VBP}$	-	2	6	255	HS
Vertical blanking period	$T_{VBL}$	$T_{VBP} + T_{VFP}$	4	8	-	HS
Vertical active area	$T_{VDISP}$	-	-	220	-	HS
			-		-	HS
			-		-	HS
Vertical refresh rate	TVRR	Frame rate	50	60	80	Hz
<b>Horizontal Timing</b>						
Horizontal cycle period	$T_{HP}$	-	180	184	255	DOTCLK
Horizontal low pulse width	$T_{HS}$	-	2	2	-	DOTCLK
Horizontal front porch	$T_{HFP}$	-	2	2	-	DOTCLK
Horizontal back porch	$T_{HBP}$	-	2	6	63	DOTCLK
Horizontal blanking period	$T_{HBL}$	$T_{HBP} + T_{HFP}$	4	8	-	DOTCLK
Horizontal active area	$T_{HDISP}$	-	-	176	-	DOTCLK
Pixel clock cycle TVRR=60Hz	$f_{CLKCYC}$	-	2.0	2.52	10.0	MHz

**Note:** (1) IOVCC=1.65 to 3.3V, VCI=2.5 to 3.3V, VSSA=VSSD=0V, Ta=-30 to 70°C (to +85°C no damage)

(2) Data lines can be set to "High" or "Low" during blanking time – Don't care.

(3) HP is multiples of DOTCLK.

### 11.7.5 Reset Input Timing

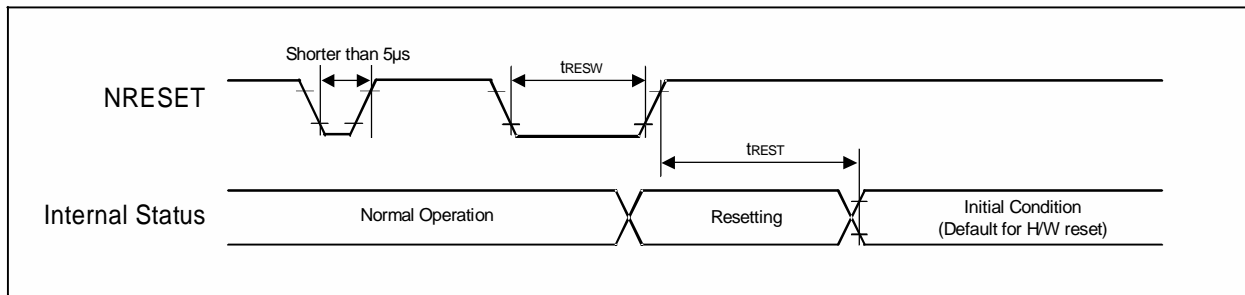


Figure 11. 6 Reset Input Timing

Symbol	Parameter	Related Pins	Min.	Typ.	Max.	Note	Unit
tRESW	Reset low pulse width <sup>(1)</sup>	NRESET	10	-	-		µs
tREST	Reset complete time <sup>(2)</sup>	-	-	-	5	When reset applied during Sleep In mode	ms
		-	-	-	120	When reset applied during Sleep Out mode	ms

**Note:**

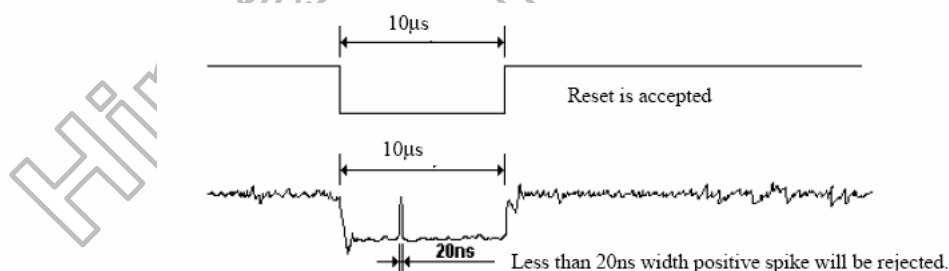
(1) Spike due to an electrostatic discharge on !RES line does not cause irregular system reset according to the following table.

NRESET Pulse	Action
Shorter than 5µs	Reset Rejected
Longer than 10µs	Reset
Between 5µs and 10µs	Reset Start

(2) During the resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep out –mode. The display remains the blank state in Sleep In –mode) and then return to Default condition for H/W reset.

(3) During Reset Complete Time, ID2 and VCOMOF value in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 5ms after a rising edge of RESET.

(4) Spike Rejection also applies during a valid reset pulse as shown as below:

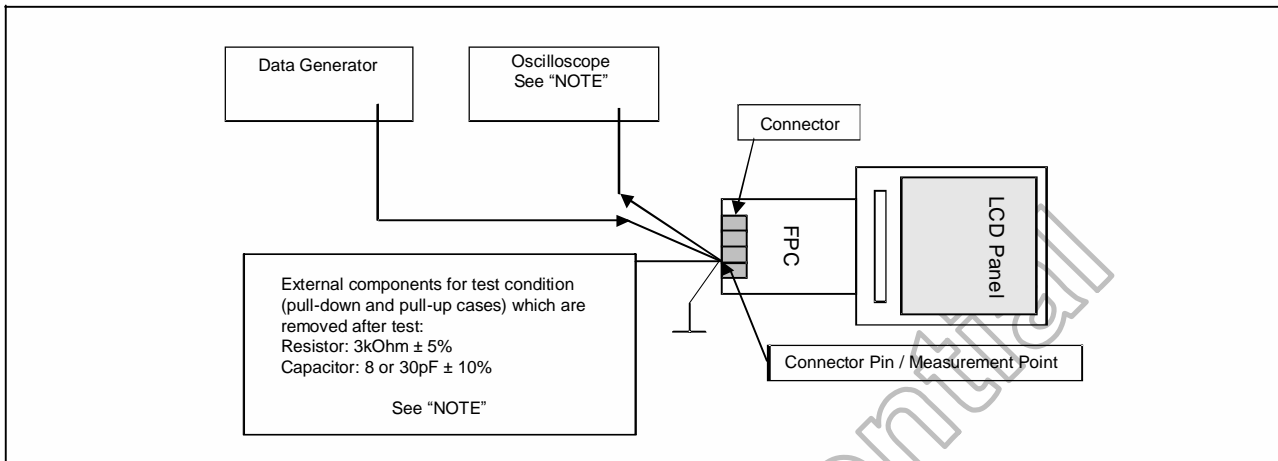


(5) It is necessary to wait 5msec after releasing RESET before sending commands. Also Sleep Out command cannot be sent for 120ms.

### 11.7.6 Measurement Conditions

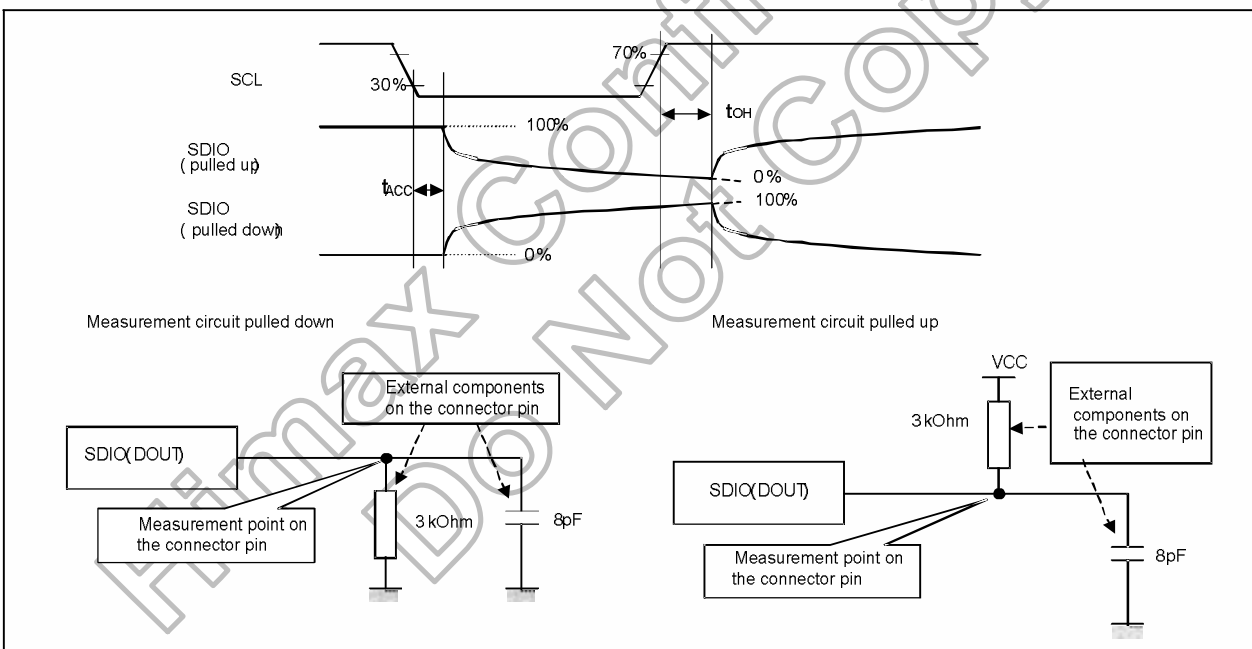
#### 11.7.6.1 tACC, tOH Measurement Condition

#### Measurement Condition Set-up

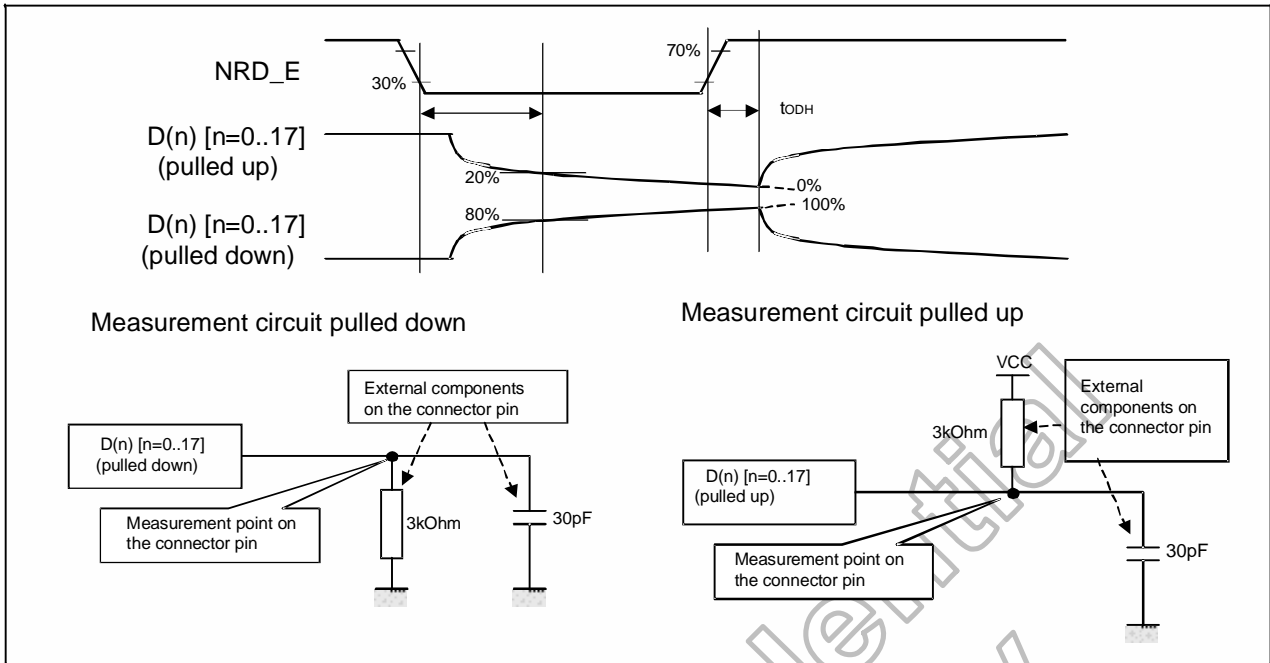


**Note:** Capacitances and resistances of the oscilloscope's probe must be included external components in these measurements

#### Minimum Value Measurement



**Maximum Value Measurement**



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## 12. Ordering Information

Part No.	Package
HX8340-B000 <u>PDxxx</u>	PD : mean COG xxx : mean chip thickness (μm), (default: 300μm)

## 13. Revision History

Version	Date	Description of Changes
01	2007/10/05	New setup
	2007/11/01	P9 Modify IFSEL= 'L' for Register-Content interface P10 Modify IOVCC =1.65~3.3V, VGH=+9.0~+15.6V P11 Modify Block Diagram add RL,TB,SHUT,REV,IDM pins P12 Modify DNC and NWR pin description. P15 Modify VGH max voltage =15.6V P29 Modify M68 read/write timing. P84. Modify Figure 7. 19 Gamma Resister Stream and Gamma Reference Voltage P85 Modify Table 7.4 Center Adjustment P87 Modify Table 7.6 Voltage Calculation Formula P97~P99 Modify System interface power on flow. P103 Update command R1Fh default to 03h. P104 Update command R38h~R3Ah OTP related register. P105 Update R01h command, remove DISP bit and modify SLP definition. P136 Update command R38h~R3Ah OTP related register. P140~P141 Modify Layout Recommendation P142 Update OTP table and OTP programming flow.
	2007/11/12	P85 Modify Gamma Table 7.4 Center Adjustment P85 Modify Gamma Table 7. 6 Voltage Calculation Formula
	2007/11/14	P27 Table 5. 2 Data Pin Function for I80 Series CPU P27 Table 5. 3 Data Pin Function for M68 Series CPU P50 Figure 5. 9 Index Register Read/Write Timing in Serial Bus System Interface P87 Table 7. 6 Voltage Calculation Formula P97~P99 7.5.1 System Interface Power On/Off Sequence P103 8.1 Command Table P105 8.3 Display Mode Control Register (R01h)

	2007/12/03	P13. Modify SHUT Pin description. P97~P99 7.5.1 System Interface Power On/Off Sequence P100. Modify RGB mode Power on AC timing P103. Modify Command Table. P105. Modify Display mode control Register R01h P139. Modify OTP command 2 R39h P142. Update Chapter 10. OTP programming
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