



»» DATA SHEET

(DOC No. HX8347-D(T)-DS)

»» **HX8347-D(T)**

240RGB x 320 dot, 262K color,
with internal GRAM,
TFT Mobile Single Chip Driver

Preliminary version 01, October 2008

>> HX8347-D(T)

240RGB x 320 dot, 262K color, with internal
GRAM, TFT Mobile Single Chip Driver



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Preliminary Version 01

October, 2008

1. General Description

This document describes HX8347-D 240RGBx320 dots resolution driving controller. The HX8347-D 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 240RGBx320 dots at maximum.

The HX8347-D can be operated in low-voltage (1.4V) 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 HX8347-D also supports various functions to reduce the power consumption of a LCD system via software control.

The HX8347-D supports two interface groups: Command-Parameter interface group, Register-Content interface group. The interface groups are selected by the external pin IFSEL setting. This manual description focuses on Register-Content interface group. About the Command-Parameter interface group, please refer to the HX8347-D (N) datasheet for detail.

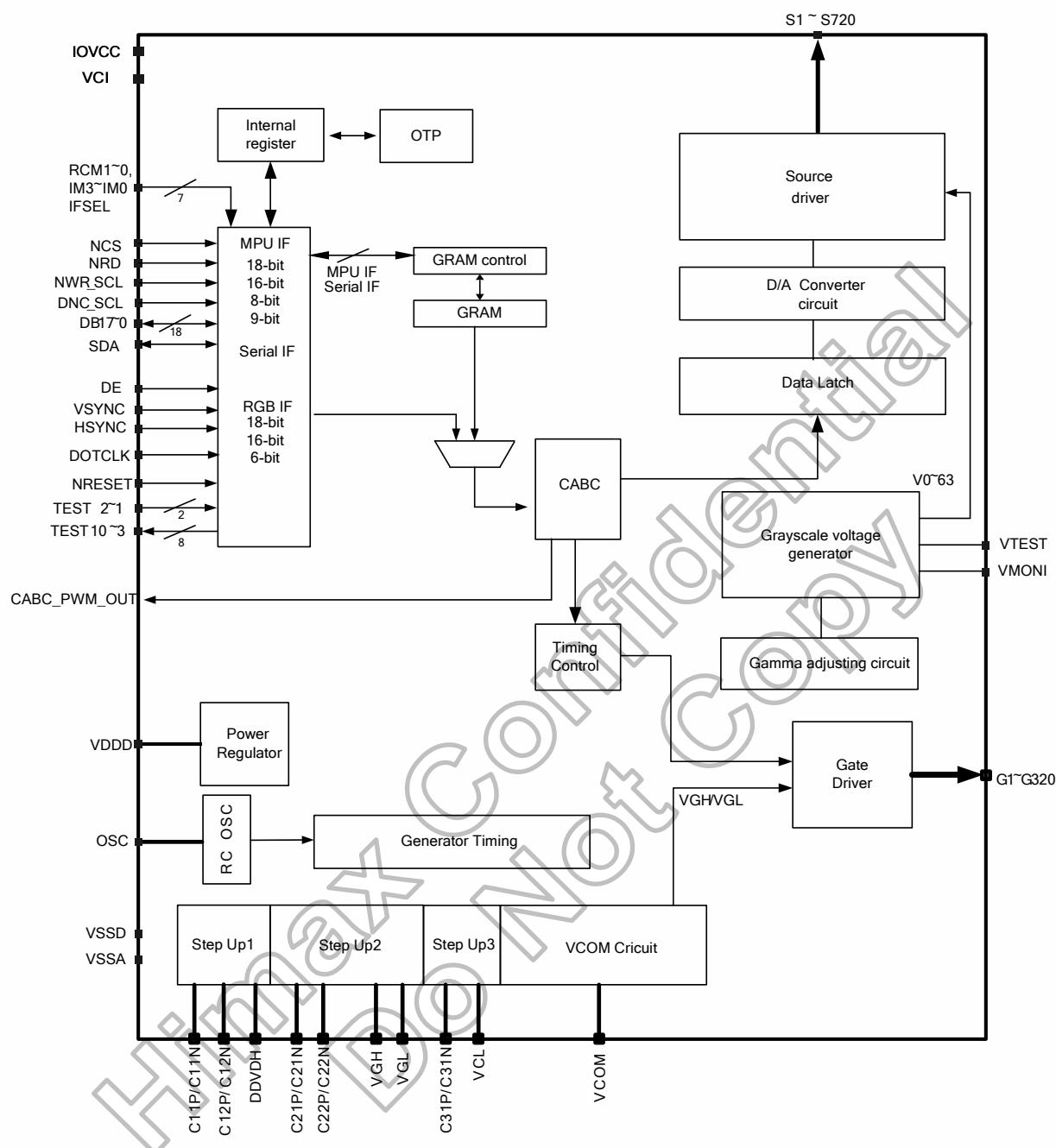
The HX8347-D is suitable for any small portable battery-driven and long-term driving products, such as small PDAs, digital cellular phones and bi-directional pagers.

2. Features

- Single chip solution to drive a a-TFT LCD panel
- Display Resolution: 240(H) x RGB(H) x 320(V)
- Display Color modes
 - 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)) colors
 - b. RGB Interface Circuit
 - i. 65,536(R(5),G(6),B(5)) colors
 - ii. 262,144(R(6),G(6),B(6)) colors
 - Idle Mode On
 - a. 8 (R (1), G (1), B (1)) colors.
 - Outputs
 - Source outputs: 720 source lines.
 - Selectable gate line control signal for glass 320 gate lines
 - Adjusted source voltages (V0p ~V63p, V0n ~V63n)
 - Display interface:
 - System interface:
 - a. 8-/9-/16-/18-bit parallel bus system interface
 - b. 3-/4-wire serial bus system interface
 - RGB interface:
 - a. 6-/16-/18-bit RGB interface
 - Internal graphics RAM capacity: 240 x18x320 bit = 1382400bits
 - Display features
 - The vertical scroll display function in line units
 - Partial area display mode.
 - Software programmable color depth mode
 - On chip
 - OTP memory to store initialization register settings
 - Automatic malfunction recovery for default values
 - Internal oscillator and hardware reset function
 - DC/DC converter and charge bump circuit for source, glass gate driving voltage
 - Adjust AC VCOM generation
 - LCD Driving Inversion Algorithm
 - Frame inversion AC liquid-crystal drive
 - 1~7 line inversion AC liquid-crystal drive

- Input power supply
 - IOVCC = 1.65 to 3.3V (Logic IO power supply voltage range)
 - VCI = 2.3 to 3.3V (Driver power supply voltage range)
- Output voltage levels
 - DDVDH = 5.0 V for two time pump (Power supply for driver circuit range)
 - DDVDH = 6.1 V for three time pump (Power supply for driver circuit range)
 - VREG1 = 3.3V to 5.8V (Source output voltage range)
 - VGH = +9.0 to +16.5V (Positive Gate output voltage range)
 - VGL = -6.0 to -13.5V (Negative Gate output voltage range)
 - VCOMH = 2.5V to 5.8V, 15mv/step (Common electrode output high voltage)
 - VCOML = -2.5V to 0.0V, 15mv/step (Common electrode output low voltage)
- Supply CABC function
- Low power consumption, suitable for battery operated systems
- CMOS compatible inputs
- Chip on Glass
- Operating temperature range : -40°C ~ 85°C

3. Block Diagram



4. Pin Description

4.1 Pin Description

Interface Logic Pin																																																												
Signals	I/O	Pin Number	Connected with	Description																																																								
IFSEL	I	1	MPU	Interface format select pin <table border="1"> <tr> <th>IFSEL</th><th>Interface Format Selection</th></tr> <tr> <td>0</td><td>Register-content interface mode</td></tr> <tr> <td>1</td><td>Command-Parameter interface mode</td></tr> </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																																																											
IM3, IM2, IM1, IM0	I	4	VSSD/ IOVCC	System interface select. <table border="1"> <tr> <th>IM3</th><th>IM2</th><th>IM1</th><th>IM0</th><th>Interface</th></tr> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>8080 MCU 16-bits Parallel type I</td></tr> <tr> <td>0</td><td>0</td><td>0</td><td>1</td><td>8080 MCU 8-bits Parallel type I</td></tr> <tr> <td>0</td><td>0</td><td>1</td><td>0</td><td>8080 MCU 16-bits Parallel type II</td></tr> <tr> <td>0</td><td>0</td><td>1</td><td>1</td><td>8080 MCU 8-bits Parallel type II</td></tr> <tr> <td>0</td><td>1</td><td>0</td><td>ID</td><td>3-wire Serial interface</td></tr> <tr> <td>0</td><td>1</td><td>1</td><td>-</td><td>4-wire Serial interface</td></tr> <tr> <td>1</td><td>0</td><td>0</td><td>0</td><td>8080 MCU 18-bits Parallel type I</td></tr> <tr> <td>1</td><td>0</td><td>0</td><td>1</td><td>8080 MCU 9-bits Parallel type I</td></tr> <tr> <td>1</td><td>0</td><td>1</td><td>0</td><td>8080 MCU 18-bits Parallel type II</td></tr> <tr> <td>1</td><td>0</td><td>1</td><td>1</td><td>8080 MCU 9-bits Parallel type II</td></tr> </table> <p>If not used, please fix this pin to IOVCC or VSSD level.</p>		IM3	IM2	IM1	IM0	Interface	0	0	0	0	8080 MCU 16-bits Parallel type I	0	0	0	1	8080 MCU 8-bits Parallel type I	0	0	1	0	8080 MCU 16-bits Parallel type II	0	0	1	1	8080 MCU 8-bits Parallel type II	0	1	0	ID	3-wire Serial interface	0	1	1	-	4-wire Serial interface	1	0	0	0	8080 MCU 18-bits Parallel type I	1	0	0	1	8080 MCU 9-bits Parallel type I	1	0	1	0	8080 MCU 18-bits Parallel type II	1	0	1	1	8080 MCU 9-bits Parallel type II
IM3	IM2	IM1	IM0	Interface																																																								
0	0	0	0	8080 MCU 16-bits Parallel type I																																																								
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1	0	0	0	8080 MCU 18-bits Parallel type I																																																								
1	0	0	1	8080 MCU 9-bits Parallel type I																																																								
1	0	1	0	8080 MCU 18-bits Parallel type II																																																								
1	0	1	1	8080 MCU 9-bits Parallel type II																																																								
NCS	I	1	MPU	Chip select signal. Low: chip can be accessed; High: chip cannot be accessed. Must be connected to VSSD if not in use.																																																								
NWR_SCL	I	1	MPU	(NWR) Write enable pin I80 parallel bus system interface. (SCL) server as serial data clock in serial bus system interface when IFSEL=0. Fix it to IOVCC or VSSD level when not used.																																																								
NRD	I	1	MPU	(NRD) Read enable pin I80 parallel bus system interface. If not used, please fix this pin at IOVCC or GND level																																																								
SDA	I/O	1	MCU	Serial data input pin and output pin in serial bus system interface. The data is inputted on the rising edge of the SCL signal. If not used, please let it open																																																								
DNC_SCL	I	1	MPU	(DNC) Command / parameter or display data selection pin. (SCL) server as serial data clock in serial bus system interface when IFSEL=1. If not used, please fix this pin at IOVCC or GND level.																																																								
VSYNC	I	1	MPU	Vertical synchronizing signal in RGB interface. Has to be fixed to VSSD level if it is not used.																																																								
HSYNC	I	1	MPU	Horizontal synchronizing signal in RGB interface. Has to be fixed to VSSD level if it is not used.																																																								
DE	I	1	MPU	A data ENABLE signal in RGB I/F mode. Has to be fixed to VSSD level if it is not used.																																																								
DOTCLK	I	1	MPU	Data enable signal in RGB interface. Has to be fixed to VSSD level if it is not used.																																																								
NRESET	I	1	MPU or reset circuit	Reset pin. Setting either pin low initializes the LSI. Must be reset after power is supplied.																																																								
DB17~0	I/O	18	MPU	18-bit bi-directional data bus. The unused pins let to open.																																																								

Interface Logic Pin

Signals	I/O	Pin Number	Connected with	Description								
RCM1, RCM0	I	2	MCU	RGB and System interface mode selection pin. <table border="1"> <tr> <td>RCM1, RCM0</td><td>MCU and RGB Interface Mode Select</td></tr> <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> </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.</p> <p>If not used, please fix this pin to 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	RGB direction select H/W pin for Color filter default setting. <table border="1"> <tr> <td>SRGB</td><td>RGB Filter Order for Color Filter Default Setting</td></tr> <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> </table> <p>If not used, please fix this pin to 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	Module source output direction H/W select pin. <table border="1"> <tr> <td>SMX</td><td>Module Source Output Direction</td></tr> <tr> <td>0</td><td>S720 -> S1</td></tr> <tr> <td>1</td><td>S1 -> S720</td></tr> </table> <p>If not used, please fix this pin to GND.</p>	SMX	Module Source Output Direction	0	S720 -> S1	1	S1 -> S720		
SMX	Module Source Output Direction											
0	S720 -> S1											
1	S1 -> S720											
SMY	I	1	MCU	Module Gate output direction H/W select pin. <table border="1"> <tr> <td>SMY</td><td>Module Gate Output Direction</td></tr> <tr> <td>0</td><td>G1 -> G320</td></tr> <tr> <td>1</td><td>G320 -> G1</td></tr> </table> <p>If not used, please fix this pin to GND.</p>	SMY	Module Gate Output Direction	0	G1 -> G320	1	G320 -> G1		
SMY	Module Gate Output Direction											
0	G1 -> G320											
1	G320 -> G1											

Output Part

Signals	I/O	Pin Number	Connected with	Description
S1~S720	O	720	LCD	Output voltages applied to the liquid crystal.
G1~G320	O	320	LCD	Gate driver output pins. These pins output VGH, VGL.(If not used, should be open)
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.
TE	O	1	MPU	Tearing effect output. If not used, please open this pin.
CABC_PWM_OUT	O	2	Backlight Circuit	CABC backlight control PWM signal output

Input/Output Part

Signals	I/O	Pin Number	Connected with	Description
C11P,C11N C12P, C12N	I/O	4	Step-up Capacitor	Connect to the step-up capacitors according to the step-up 1 factor. Leave this pin open if the internal step-up circuit is not used.
C31P,C31N	I/O	2	Step-up Capacitor	Connect to the step-up capacitors for step up circuit 3 operation. Leave this pin open if the internal step-up circuit is not used.
C21P,C21N C22P,C22N	I/O	4	Step-up Capacitor	Connect these pins to the capacitors for the step-up circuit 2. According to the step-up rate. When not using the step-up circuit2, disconnect them.

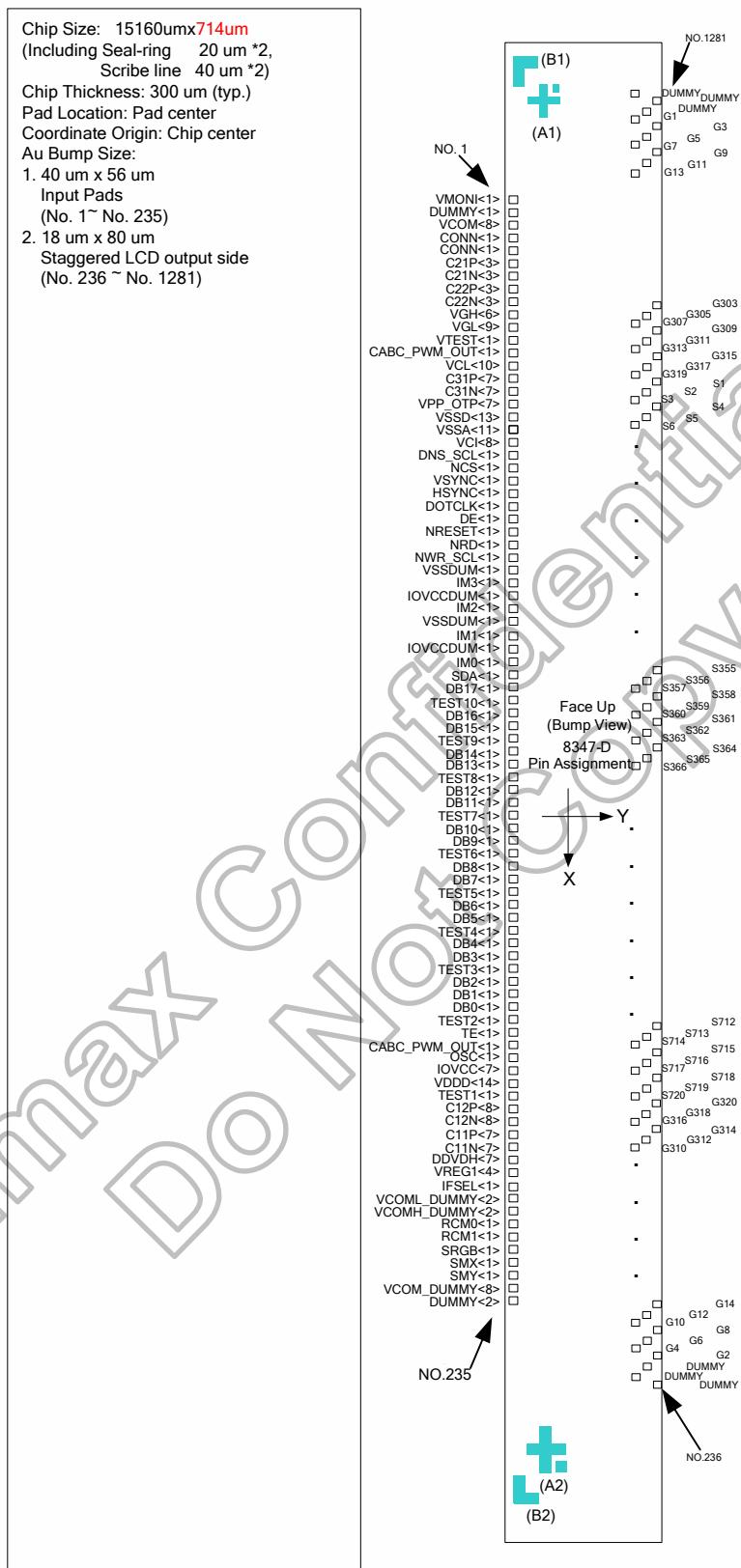
Power Part

Signals	I/O	Pin Number	Connected with	Description
IOVCC	P	7	Power Supply	Digital IO Pad power supply

Power Part				
Signals	I/O	Pin Number	Connected with	Description
VCI	P	8	Power Supply	Analog power supply
VSSD	P	13	Ground	Digital ground
VSSA	P	11	Ground	Analog ground
VDDD	O	14	Stabilizing capacitor	Output from internal logic voltage (1.4V). Connect to a stabilizing capacitor
VREG1	P	4		Internal generated stable power for source driver unit.
VCL	P	7	Stabilizing capacitor	An output from the step-up circuit3. A negative voltage for VCOML circuit, VCL=-VCI
DDVDH	P	7	Stabilizing capacitor	An output from the step-up circuit1. Connect to a stabilizing capacitor between VSSA and DDVDH.
VGH	P	6	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.
VGL	P	9	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.

Test pin and others				
Signals	I/O	Pin Number	Connected with	Description
TEST2-1	I	3	GND	Test pin input (Internal pull low). Disconnect it.
TEST10-3	O	8	Open	A test pin. Disconnect it.
VMONI	O	1	Open	A test pin. Disconnect it.
OSC	I	1	Open	A test pin. Disconnect it.
VTEST	O	1	Open	Gamma voltage of Panel test pin output. Must be left open.
CONN	-	2	Open	Dummy pads. Available for measuring the COG contact resistance. They are short-circuited within the chip.
IOVCCDUM	-	2	Neighbor-setting pins	This pin is connected to IOVCC internally. Use for input setting pins.
VSSDDUM	-	2	Neighbor-setting pins	This pin is connected to VSSDDUM internally. Use for input setting pins.
VCOMH_DUMMY	-	2	Open	Dummy pads
VCOML_DUMMY	-	2	Open	Dummy pads
VCOM_DUMMY	-	8	Open	Dummy pads
DUMMY	-	25	Open	Dummy pads

4.2 Pin Assignment



4.3 PAD Coordinates

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1	VMONI	-7307.5	-265	61	C31N	-3707.5	-265	121	IM0	-107.5	-265	181	C12P	4067.5	-265
2	DUMMY	-7247.5	-265	62	C31N	-3647.5	-265	122	SDA	-47.5	-265	182	C12P	4127.5	-265
3	VCOM	-7187.5	-265	63	C31N	-3587.5	-265	123	DB17	37.5	-265	183	C12N	4187.5	-265
4	VCOM	-7127.5	-265	64	C31N	-3527.5	-265	124	TEST10	122.5	-265	184	C12N	4247.5	-265
5	VCOM	-7067.5	-265	65	C31N	-3467.5	-265	125	DB16	182.5	-265	185	C12N	4307.5	-265
6	VCOM	-7007.5	-265	66	VPP OTP	-3407.5	-265	126	DB15	267.5	-265	186	C12N	4367.5	-265
7	VCOM	-6947.5	-265	67	VPP OTP	-3347.5	-265	127	TEST9	352.5	-265	187	C12N	4427.5	-265
8	VCOM	-6887.5	-265	68	VPP OTP	-3287.5	-265	128	DB14	412.5	-265	188	C12N	4487.5	-265
9	VCOM	-6827.5	-265	69	VPP OTP	-3227.5	-265	129	DB13	497.5	-265	189	C12N	4547.5	-265
10	VCOM	-6767.5	-265	70	VPP OTP	-3167.5	-265	130	TEST8	582.5	-265	190	C12N	4607.5	-265
11	CONN	-6707.5	-265	71	VPP OTP	-3107.5	-265	131	DB12	642.5	-265	191	C11P	4667.5	-265
12	CONN	-6647.5	-265	72	VPP OTP	-3047.5	-265	132	DB11	727.5	-265	192	C11P	4727.5	-265
13	C21P	-6587.5	-265	73	VSSD	-2987.5	-265	133	TEST7	812.5	-265	193	C11P	4787.5	-265
14	C21P	-6527.5	-265	74	VSSD	-2927.5	-265	134	DB10	872.5	-265	194	C11P	4847.5	-265
15	C21P	-6467.5	-265	75	VSSD	-2867.5	-265	135	DB9	957.5	-265	195	C11P	4907.5	-265
16	C21N	-6407.5	-265	76	VSSD	-2807.5	-265	136	TEST6	1042.5	-265	196	C11P	4967.5	-265
17	C21N	-6347.5	-265	77	VSSD	-2747.5	-265	137	DB8	1102.5	-265	197	C11P	5027.5	-265
18	C21N	-6287.5	-265	78	VSSD	-2687.5	-265	138	DB7	1187.5	-265	198	C11N	5087.5	-265
19	C22P	-6227.5	-265	79	VSSD	-2627.5	-265	139	TEST5	1272.5	-265	199	C11N	5147.5	-265
20	C22P	-6167.5	-265	80	VSSD	-2567.5	-265	140	DB6	1332.5	-265	200	C11N	5207.5	-265
21	C22P	-6107.5	-265	81	VSSD	-2507.5	-265	141	DB5	1417.5	-265	201	C11N	5267.5	-265
22	C22N	-6047.5	-265	82	VSSD	-2447.5	-265	142	TEST4	1502.5	-265	202	C11N	5327.5	-265
23	C22N	-5987.5	-265	83	VSSD	-2387.5	-265	143	DB4	1562.5	-265	203	C11N	5387.5	-265
24	C22N	-5927.5	-265	84	VSSD	-2327.5	-265	144	DB3	1647.5	-265	204	C11N	5447.5	-265
25	VGH	-5867.5	-265	85	VSSD	-2267.5	-265	145	TEST3	1732.5	-265	205	DDVDH	5507.5	-265
26	VGH	-5807.5	-265	86	VSSA	-2207.5	-265	146	DB2	1792.5	-265	206	DDVDH	5567.5	-265
27	VGH	-5747.5	-265	87	VSSA	-2147.5	-265	147	DB1	1877.5	-265	207	DDVDH	5627.5	-265
28	VGH	-5687.5	-265	88	VSSA	-2087.5	-265	148	DB0	1962.5	-265	208	DDVDH	5687.5	-265
29	VGH	-5627.5	-265	89	VSSA	-2027.5	-265	149	TEST2	2047.5	-265	209	DDVDH	5747.5	-265
30	VGH	-5567.5	-265	90	VSSA	-1967.5	-265	150	TE	2132.5	-265	210	DDVDH	5807.5	-265
31	VGL	-5507.5	-265	91	VSSA	-1907.5	-265	151	CABC_PWM_OUT	2217.5	-265	211	DDVDH	5867.5	-265
32	VGL	-5447.5	-265	92	VSSA	-1847.5	-265	152	OSC	2302.5	-265	212	VREG1	5927.5	-265
33	VGL	-5387.5	-265	93	VSSA	-1787.5	-265	153	IOVCC	2387.5	-265	213	VREG1	5987.5	-265
34	VGL	-5327.5	-265	94	VSSA	-1727.5	-265	154	IOVCC	2447.5	-265	214	VREG1	6047.5	-265
35	VGL	-5267.5	-265	95	VSSA	-1667.5	-265	155	IOVCC	2507.5	-265	215	VREG1	6107.5	-265
36	VGL	-5207.5	-265	96	VSSA	-1607.5	-265	156	IOVCC	2567.5	-265	216	IFSEL	6167.5	-265
37	VGL	-5147.5	-265	97	VCI	-1547.5	-265	157	IOVCC	2627.5	-265	217	VCOM_DUMMY	6227.5	-265
38	VGL	-5087.5	-265	98	VCI	-1487.5	-265	158	IOVCC	2687.5	-265	218	VCOML_DUMMY	6287.5	-265
39	VGL	-5027.5	-265	99	VCI	-1427.5	-265	159	IOVCC	2747.5	-265	219	VCOMH_DUMMY	6347.5	-265
40	VTEST	-4967.5	-265	100	VCI	-1367.5	-265	160	VDDD	2807.5	-265	220	VCOMH_DUMMY	6407.5	-265
41	CABC_PWM_OUT	-4907.5	-265	101	VCI	-1307.5	-265	161	VDDD	2867.5	-265	221	RCM0	6467.5	-265
42	VCL	-4847.5	-265	102	VCI	-1247.5	-265	162	VDDD	2927.5	-265	222	RCM1	6527.5	-265
43	VCL	-4787.5	-265	103	VCI	-1187.5	-265	163	VDDD	2987.5	-265	223	SRGB	6587.5	-265
44	VCL	-4727.5	-265	104	VCI	-1127.5	-265	164	VDDD	3047.5	-265	224	SMX	6647.5	-265
45	VCL	-4667.5	-265	105	DNC_SCL	-1067.5	-265	165	VDDD	3107.5	-265	225	SMY	6707.5	-265
46	VCL	-4607.5	-265	106	NCS	-1007.5	-265	166	VDDD	3167.5	-265	226	VCOM_DUMMY	6767.5	-265
47	VCL	-4547.5	-265	107	VSYNC	-947.5	-265	167	VDDD	3227.5	-265	227	VCOM_DUMMY	6827.5	-265
48	VCL	-4487.5	-265	108	HSYNC	-887.5	-265	168	VDDD	3287.5	-265	228	VCOM_DUMMY	6887.5	-265
49	VCL	-4427.5	-265	109	DOTCLK	-827.5	-265	169	VDDD	3347.5	-265	229	VCOM_DUMMY	6947.5	-265
50	VCL	-4367.5	-265	110	DE	-767.5	-265	170	VDDD	3407.5	-265	230	VCOM_DUMMY	7007.5	-265
51	VCL	-4307.5	-265	111	NRESET	-707.5	-265	171	VDDD	3467.5	-265	231	VCOM_DUMMY	7067.5	-265
52	C31P	-4247.5	-265	112	NRD	-647.5	-265	172	VDDD	3527.5	-265	232	VCOM_DUMMY	7127.5	-265
53	C31P	-4187.5	-265	113	NWR_SCL	-587.5	-265	173	VDDD	3587.5	-265	233	VCOM_DUMMY	7187.5	-265
54	C31P	-4127.5	-265	114	VSSDDUM	-527.5	-265	174	TEST1	3647.5	-265	234	DUMMY	7247.5	-265
55	C31P	-4067.5	-265	115	IM3	-467.5	-265	175	C12P	3707.5	-265	235	DUMMY	7307.5	-265
56	C31P	-4007.5	-265	116	IOVCCDUM	-407.5	-265	176	C12P	3767.5	-265	236	DUMMY	7399	253
57	C31P	-3947.5	-265	117	IM2	-347.5	-265	177	C12P	3827.5	-265	237	DUMMY	7385	61
58	C31P	-3887.5	-265	118	VSSDDUM	-287.5	-265	178	C12P	3887.5	-265	238	DUMMY	7371	157
59	C31N	-3827.5	-265	119	IM1	-227.5	-265	179	C12P	3947.5	-265	239	G2	7357	253
60	C31N	-3767.5	-265	120	IOVCCDUM	-167.5	-265	180	C12P	4007.5	-265	240	G4	7343	61

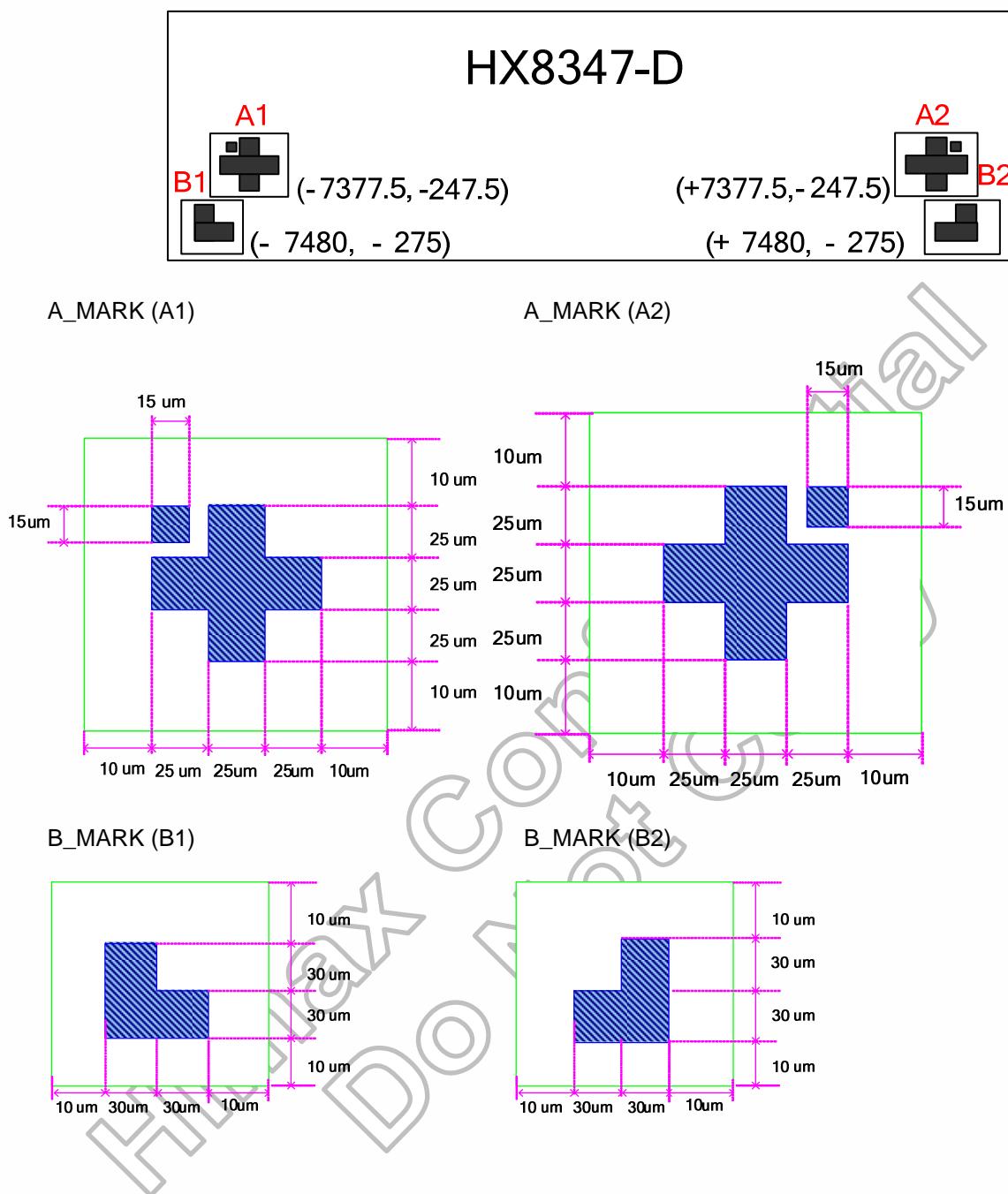
No.	Pad name	X	Y
241	G6	7329	157
242	G8	7315	253
243	G10	7301	61
244	G12	7287	157
245	G14	7273	253
246	G16	7259	61
247	G18	7245	157
248	G20	7231	253
249	G22	7217	61
250	G24	7203	157
251	G26	7189	253
252	G28	7175	61
253	G30	7161	157
254	G32	7147	253
255	G34	7133	61
256	G36	7119	157
257	G38	7105	253
258	G40	7091	61
259	G42	7077	157
260	G44	7063	253
261	G46	7049	61
262	G48	7035	157
263	G50	7021	253
264	G52	7007	61
265	G54	6993	157
266	G56	6979	253
267	G58	6965	61
268	G60	6951	157
269	G62	6937	253
270	G64	6923	61
271	G66	6909	157
272	G68	6895	253
273	G70	6881	61
274	G72	6867	157
275	G74	6853	253
276	G76	6839	61
277	G78	6825	157
278	G80	6811	253
279	G82	6797	61
280	G84	6783	157
281	G86	6769	253
282	G88	6755	61
283	G90	6741	157
284	G92	6727	253
285	G94	6713	61
286	G96	6699	157
287	G98	6685	253
288	G100	6671	61
289	G102	6657	157
290	G104	6643	253
291	G106	6629	61
292	G108	6615	157
293	G110	6601	253
294	G112	6587	61
295	G114	6573	157
296	G116	6559	253
297	G118	6545	61
298	G120	6531	157
299	G122	6517	253
300	G124	6503	61
301	G126	6489	157
302	G128	6475	253
303	G130	6461	61
304	G132	6447	157
305	G134	6433	253
306	G136	6419	61
307	G138	6405	157
308	G140	6391	253
309	G142	6377	61
310	G144	6363	157
311	G146	6349	253
312	G148	6335	61
313	G150	6321	157
314	G152	6307	253
315	G154	6293	61
316	G156	6279	157
317	G158	6265	253
318	G160	6251	61
319	G162	6237	157
320	G164	6223	253
321	G166	6209	61
322	G168	6195	157
323	G170	6181	253
324	G172	6167	61
325	G174	6153	157
326	G176	6139	253
327	G178	6125	61
328	G180	6111	157
329	G182	6097	253
330	G184	6083	61
331	G186	6069	157
332	G188	6055	253
333	G190	6041	61
334	G192	6027	157
335	G194	6013	253
336	G196	5999	61
337	G198	5985	157
338	G200	5971	253
339	G202	5957	61
340	G204	5943	157
341	G206	5929	253
342	G208	5915	61
343	G210	5901	157
344	G212	5887	253
345	G214	5873	61
346	G216	5859	157
347	G218	5845	253
348	G220	5831	61
349	G222	5817	157
350	G224	5803	253
351	G226	5789	61
352	G228	5775	157
353	G230	5761	253
354	G232	5747	61
355	G234	5733	157
356	G236	5719	253
357	G238	5705	61
358	G240	5691	157
359	G242	5677	253
360	G244	5663	61
361	G246	5649	157
362	G248	5635	253
363	G250	5621	61
364	G252	5607	157
365	G254	5593	253
366	G256	5579	61
367	G258	5565	157
368	G260	5551	253
369	G262	5537	61
370	G264	5523	157
371	G266	5509	253
372	G268	5495	61
373	G270	5481	157
374	G272	5467	253
375	G274	5453	61
376	G276	5439	157
377	G278	5425	253
378	G280	5411	61
379	G282	5397	157
380	G284	5383	253
381	G286	5369	61
382	G288	5355	157
383	G290	5341	253
384	G292	5327	61
385	G294	5313	157
386	G296	5299	253
387	G298	5285	61
388	G300	5271	157
389	G302	5257	253
390	G304	5243	61
391	G306	5229	157
392	G308	5215	253
393	G310	5201	61
394	G312	5187	157
395	G314	5173	253
396	G316	5159	61
397	G318	5145	157
398	G320	5131	253
399	S720	5075	61
400	S719	5061	157
401	S718	5047	253
402	S717	5033	61
403	S716	5019	157
404	S715	5005	253
405	S714	4991	61
406	S713	4977	157
407	S712	4963	253
408	S711	4949	61
409	S710	4935	157
410	S709	4921	253
411	S708	4907	61
412	S707	4893	157
413	S706	4879	253
414	S705	4865	61
415	S704	4851	157
416	S703	4837	253
417	S702	4823	61
418	S701	4809	157
419	S700	4795	253
420	S699	4781	61
421	S698	4767	157
422	S697	4753	253
423	S696	4739	61
424	S695	4725	157
425	S694	4711	253
426	S693	4697	61
427	S692	4683	157
428	S691	4669	253
429	S690	4655	61
430	S689	4641	157
431	S688	4627	253
432	S687	4613	61
433	S686	4599	157
434	S685	4585	253
435	S684	4571	61
436	S683	4557	157
437	S682	4543	253
438	S681	4529	61
439	S680	4515	157
440	S679	4501	253
441	S678	4487	61
442	S677	4473	157
443	S676	4459	253
444	S675	4445	61
445	S674	4431	157
446	S673	4417	253
447	S672	4403	61
448	S671	4389	157
449	S670	4375	253
450	S669	4361	61
451	S668	4347	157
452	S667	4333	253
453	S666	4319	61
454	S665	4305	157
455	S664	4291	253
456	S663	4277	61
457	S662	4263	157
458	S661	4249	253
459	S660	4235	61
460	S659	4221	157
461	S658	4207	253
462	S657	4193	61
463	S656	4179	157
464	S655	4165	253
465	S654	4151	61
466	S653	4137	157
467	S652	4123	253
468	S651	4109	61
469	S650	4095	157
470	S649	4081	253
471	S648	4067	61
472	S647	4053	157
473	S646	4039	253
474	S645	4025	61
475	S644	4011	157
476	S643	3997	253
477	S642	3983	61
478	S641	3969	157
479	S640	3955	253
480	S639	3941	61

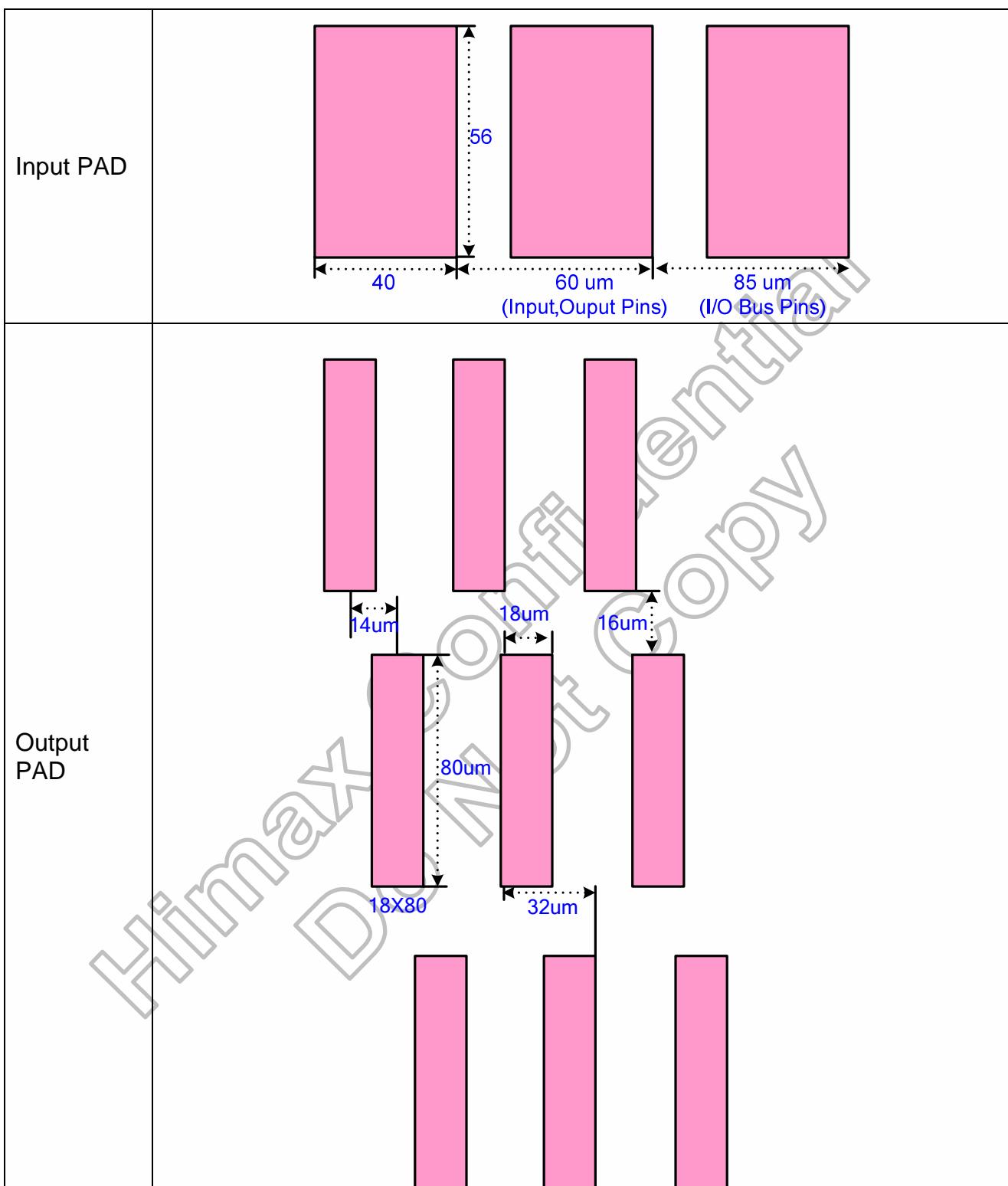
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481	S638	3927	157
482	S637	3913	253
483	S636	3899	61
484	S635	3885	157
485	S634	3871	253
486	S633	3857	61
487	S632	3843	157
488	S631	3829	253
489	S630	3815	61
490	S629	3801	157
491	S628	3787	253
492	S627	3773	61
493	S626	3759	157
494	S625	3745	253
495	S624	3731	61
496	S623	3717	157
497	S622	3703	253
498	S621	3689	61
499	S620	3675	157
500	S619	3661	253
501	S618	3647	61
502	S617	3633	157
503	S616	3619	253
504	S615	3605	61
505	S614	3591	157
506	S613	3577	253
507	S612	3563	61
508	S611	3549	157
509	S610	3535	253
510	S609	3521	61
511	S608	3507	157
512	S607	3493	253
513	S606	3479	61
514	S605	3465	157
515	S604	3451	253
516	S603	3437	61
517	S602	3423	157
518	S601	3409	253
519	S600	3395	61
520	S599	3381	157
521	S598	3367	253
522	S597	3353	61
523	S596	3339	157
524	S595	3325	253
525	S594	3311	61
526	S593	3297	157
527	S592	3283	253
528	S591	3269	61
529	S590	3255	157
530	S589	3241	253
531	S588	3227	61
532	S587	3213	157
533	S586	3199	253
534	S585	3185	61
535	S584	3171	157
536	S583	3157	253
537	S582	3143	61
538	S581	3129	157
539	S580	3115	253
540	S579	3101	61
541	S578	3087	157
542	S577	3073	253
543	S576	3059	61
544	S575	3045	157
545	S574	3031	253
546	S573	3017	61
547	S572	3003	157
548	S571	2989	253
549	S570	2975	61
550	S569	2961	157
551	S568	2947	253
552	S567	2933	61
553	S566	2919	157
554	S565	2905	253
555	S564	2891	61
556	S563	2877	157
557	S562	2863	253
558	S561	2849	61
559	S560	2835	157
560	S559	2821	253
561	S558	2807	61
562	S557	2793	157
563	S556	2779	253
564	S555	2765	61
565	S554	2751	157
566	S553	2737	253
567	S552	2723	61
568	S551	2709	157
569	S550	2695	253
570	S549	2681	61
571	S548	2667	157
572	S547	2653	253
573	S546	2639	61
574	S545	2625	157
575	S544	2611	253
576	S543	2597	61
577	S542	2583	157
578	S541	2569	253
579	S540	2555	61
580	S539	2541	157
581	S538	2527	253
582	S537	2513	61
583	S536	2499	157
584	S535	2485	253
585	S534	2471	61
586	S533	2457	157
587	S532	2443	253
588	S531	2429	61
589	S530	2415	157
590	S529	2401	253
591	S528	2387	61
592	S527	2373	157
593	S526	2359	253
594	S525	2345	61
595	S524	2331	157
596	S523	2317	253
597	S522	2303	61
598	S521	2289	157
599	S520	2275	253
600	S519	2261	61
601	S518	2247	157
602	S517	2233	253
603	S516	2219	61
604	S515	2205	157
605	S514	2191	253
606	S513	2177	61
607	S512	2163	157
608	S511	2149	253
609	S510	2135	61
610	S509	2121	157
611	S508	2107	253
612	S507	2093	61
613	S506	2079	157
614	S505	2065	253
615	S504	2051	61
616	S503	2037	157
617	S502	2023	253
618	S501	2009	61
619	S500	1995	157
620	S499	1981	253
621	S498	1967	61
622	S497	1953	157
623	S496	1939	253
624	S495	1925	61
625	S494	1911	157
626	S493	1897	253
627	S492	1883	61
628	S491	1869	157
629	S490	1855	253
630	S489	1841	61
631	S488	1827	157
632	S487	1813	253
633	S486	1799	61
634	S485	1785	157
635	S484	1771	253
636	S483	1757	61
637	S482	1743	157
638	S481	1729	253
639	S480	1715	61
640	S479	1701	157
641	S478	1687	253
642	S477	1673	61
643	S476	1659	157
644	S475	1645	253
645	S474	1631	61
646	S473	1617	157
647	S472	1603	253
648	S471	1589	61
649	S470	1575	157
650	S469	1561	253
651	S468	1547	61
652	S467	1533	157
653	S466	1519	253
654	S465	1505	61
655	S464	1491	157
656	S463	1477	253
657	S462	1463	61
658	S461	1449	157
659	S460	1435	253
660	S459	1421	61

No.	Pad name	X	Y
721	S398	567	157
722	S397	553	253
723	S396	539	61
724	S395	525	157
725	S394	511	253
726	S393	497	61
727	S392	483	157
728	S391	469	253
729	S390	455	61
730	S389	441	157
731	S388	427	253
732	S387	413	61
733	S386	399	157
734	S385	385	253
735	S384	371	61
736	S383	357	157
737	S382	343	253
738	S381	329	61
739	S380	315	157
740	S379	301	253
741	S378	287	61
742	S377	273	157
743	S376	259	253
744	S375	245	61
745	S374	231	157
746	S373	217	253
747	S372	203	61
748	S371	189	157
749	S370	175	253
750	S369	161	61
751	S368	147	157
752	S367	133	253
753	S366	119	61
754	S365	105	157
755	S364	91	253
756	S363	77	61
757	S362	63	157
758	S361	49	253
759	S360	-49	61
760	S359	-63	157
761	S358	-77	253
762	S357	-91	61
763	S356	-105	157
764	S355	-119	253
765	S354	-133	61
766	S353	-147	157
767	S352	-161	253
768	S351	-175	61
769	S350	-189	157
770	S349	-203	253
771	S348	-217	61
772	S347	-231	157
773	S346	-245	253
774	S345	-259	61
775	S344	-273	157
776	S343	-287	253
777	S342	-301	61
778	S341	-315	157
779	S340	-329	253
780	S339	-343	61
781	S338	-357	157
782	S337	-371	253
783	S336	-385	61
784	S335	-399	157
785	S334	-413	253
786	S333	-427	61
787	S332	-441	157
788	S331	-455	253
789	S330	-469	61
790	S329	-483	157
791	S328	-497	253
792	S327	-511	61
793	S326	-525	157
794	S325	-539	253
795	S324	-553	61
796	S323	-567	157
797	S322	-581	253
798	S321	-595	61
799	S320	-609	157
800	S319	-623	253
801	S318	-637	61
802	S317	-651	157
803	S316	-665	253
804	S315	-679	61
805	S314	-693	157
806	S313	-707	253
807	S312	-721	61
808	S311	-735	157
809	S310	-749	253
810	S309	-763	61
811	S308	-777	157
812	S307	-791	253
813	S306	-805	61
814	S305	-819	157
815	S304	-833	253
816	S303	-847	61
817	S302	-861	157
818	S301	-875	253
819	S300	-889	61
820	S299	-903	157
821	S298	-917	253
822	S297	-931	61
823	S296	-945	157
824	S295	-959	253
825	S294	-973	61
826	S293	-987	157
827	S292	-1001	253
828	S291	-1015	61
829	S290	-1029	157
830	S289	-1043	253
831	S288	-1057	61
832	S287	-1071	157
833	S286	-1085	253
834	S285	-1099	61
835	S284	-1113	157
836	S283	-1127	253
837	S282	-1141	61
838	S281	-1155	157
839	S280	-1169	253
840	S279	-1183	61
841	S278	-1197	157
842	S277	-1211	253
843	S276	-1225	61
844	S275	-1239	157
845	S274	-1253	253
846	S273	-1267	61
847	S272	-1281	157
848	S271	-1295	253
849	S270	-1309	61
850	S269	-1323	157
851	S268	-1337	253
852	S267	-1351	61
853	S266	-1365	157
854	S265	-1379	253
855	S264	-1393	61
856	S263	-1407	157
857	S262	-1421	253
858	S261	-1435	61
859	S260	-1449	157
860	S259	-1463	253
861	S258	-1477	61
862	S257	-1491	157
863	S256	-1505	253
864	S255	-1519	61
865	S254	-1533	157
866	S253	-1547	253
867	S252	-1561	61
868	S251	-1575	157
869	S250	-1589	253
870	S249	-1603	61
871	S248	-1617	157
872	S247	-1631	253
873	S246	-1645	61
874	S245	-1659	157
875	S244	-1673	253
876	S243	-1687	61
877	S242	-1701	157
878	S241	-1715	253
879	S240	-1729	61
880	S239	-1743	157
881	S238	-1757	253
882	S237	-1771	61
883	S236	-1785	157
884	S235	-1799	253
885	S234	-1813	61
886	S233	-1827	157
887	S232	-1841	253
888	S231	-1855	61
889	S230	-1869	157
890	S229	-1883	253
891	S228	-1897	61
892	S227	-1911	157
893	S226	-1925	253
894	S225	-1939	61
895	S224	-1953	157
896	S223	-1967	253
897	S222	-1981	61
898	S221	-1995	157
899	S220	-2009	253
900	S219	-2023	61

No.	Pad name	X	Y
1201	G155	-6279	157
1202	G153	-6293	253
1203	G151	-6307	61
1204	G149	-6321	157
1205	G147	-6335	253
1206	G145	-6349	61
1207	G143	-6363	157
1208	G141	-6377	253
1209	G139	-6391	61
1210	G137	-6405	157
1211	G135	-6419	253
1212	G133	-6433	61
1213	G131	-6447	157
1214	G129	-6461	253
1215	G127	-6475	61
1216	G125	-6489	157
1217	G123	-6503	253
1218	G121	-6517	61
1219	G119	-6531	157
1220	G117	-6545	253
1221	G115	-6559	61
1222	G113	-6573	157
1223	G111	-6587	253
1224	G109	-6601	61
1225	G107	-6615	157
1226	G105	-6629	253
1227	G103	-6643	61
1228	G101	-6657	157
1229	G99	-6671	253
1230	G97	-6685	61
1231	G95	-6699	157
1232	G93	-6713	253
1233	G91	-6727	61
1234	G89	-6741	157
1235	G87	-6755	253
1236	G85	-6769	61
1237	G83	-6783	157
1238	G81	-6797	253
1239	G79	-6811	61
1240	G77	-6825	157
1241	G75	-6839	253
1242	G73	-6853	61
1243	G71	-6867	157
1244	G69	-6881	253
1245	G67	-6895	61
1246	G65	-6909	157
1247	G63	-6923	253
1248	G61	-6937	61
1249	G59	-6951	157
1250	G57	-6965	253
1251	G55	-6979	61
1252	G53	-6993	157
1253	G51	-7007	253
1254	G49	-7021	61
1255	G47	-7035	157
1256	G45	-7049	253
1257	G43	-7063	61
1258	G41	-7077	157
1259	G39	-7091	253
1260	G37	-7105	61

4.4 Alignment Mark



4.5 Bump Size

5. Interface

The HX8347-D supports two-type interface group: Command-Parameter interface group, Register-Content interface group.

This manual description focuses on Register-Content interface group. About the Command-Parameter interface mode, please refer to the HX8347-D (N) datasheet for detail.

In Register-Content interface group (IFSEL = 'L'), the HX8347-D has a system interface circuit for register command/GRAM data transferring, and a RGB interface circuit for display 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 HX8347-D 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.

5.1 System Interface Circuit

The system interface circuit in HX8347-D supports, 18-/16-/9-/8-bit bus width parallel bus system interface for I80 series CPU, and 4-/3-wire serial bus system interface for serial data input. When NCS = "L", the parallel and serial bus system interface of the HX8347-D become active and data transfer through the interface circuit is available. The DNC_SCL pin specifies whether the system interface circuit access is to the register command or to the display data RAM. The input bus format of system interface circuit is selected by external pins setting. For selecting the input bus format, please refer to Table 5.1.

IM3	IM2	IM1	IM0	Interface	DNC_SCL	NWR_S CL	Data Bus use	
							Register/Content	GRAM
0	0	0	0	8080 MCU 16-bits Parallel type I	DNC	NWR	D7-D0	D15-D0: 16-bit data
0	0	0	1	8080 MCU 8-bits Parallel type I	DNC	NWR	D7-D0	D7-D0: 8-bits Data
0	0	1	0	8080 MCU 16-bits Parallel type II	DNC	NWR	D8-D1	D17-10, D8-D1: 16-bit data
0	0	1	1	8080 MCU 8-bits Parallel type II	DNC	NWR	D17-D10	D17-D10: 8-bits Data
0	1	0	ID	3-wire Serial interface	-	SCL		SDA
0	1	1	-	4-wire Serial interface	DNC	SCL		SDA
1	0	0	0	8080 MCU 18-bits Parallel type I	DNC	NWR	D7-D0	D17-D0: 18-bits Data
1	0	0	1	8080 MCU 9-bits Parallel type I	DNC	NWR	D7-D0	D8-D0: 9-bits Data
1	0	1	0	8080 MCU 18-bits Parallel type II	DNC	NWR	D8-D1	D17-D0: 18-bits Data
1	0	1	1	8080 MCU 9-bits Parallel type II	DNC	NWR	D17-D10	D17-D9: 9-bits Data
Other Setting				Setting Invalid				

Table 5. 1 Input Bus Format Selection of System Interface Circuit

It has an Index Register (IR) in HX8347-D to store index data of internal control register and GRAM. Therefore, the IR can be written with the index pointer of the control register through data bus by setting DNC_SCL=0. Then the command or GRAM data can be written to register at which that index pointer pointed by setting DNC_SCL=1.

Furthermore, there are two 18-bit bus control registers used to temporarily store the data written to or read from the GRAM. When the data is written into the GRAM from the MPU, it is first written into the write-data latch and then automatically written into the GRAM by internal operation. Data is read through the read-data latch when reading from the GRAM. Therefore, the first read data operation is invalid and the following read data operations are valid.

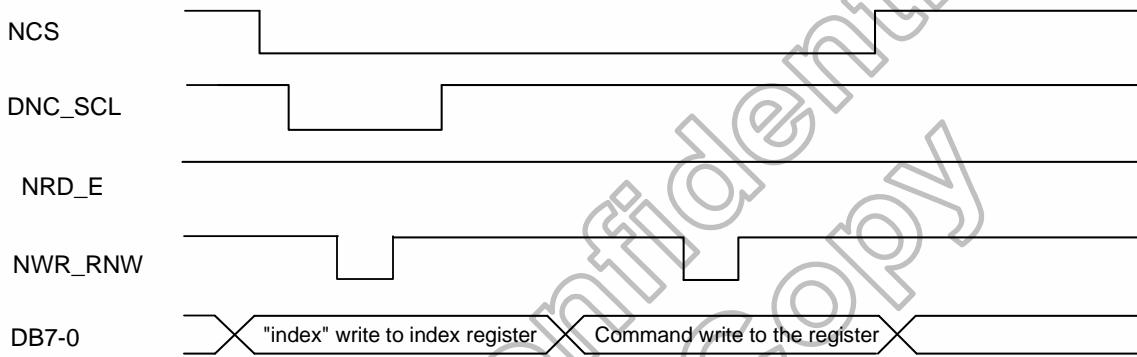
5.1.1 Parallel Bus System Interface

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

Operations	NWR_SCL	NRD	DNC_SCL
Writes Indexes into IR	0	1	0
Reads internal status	1	0	0
Writes command into register or data into GRAM	0	1	1
Reads command from register or data from GRAM	1	0	1

Table 5. 2 Data Pin Function for I80 Series CPU

Write to the register



Read the register

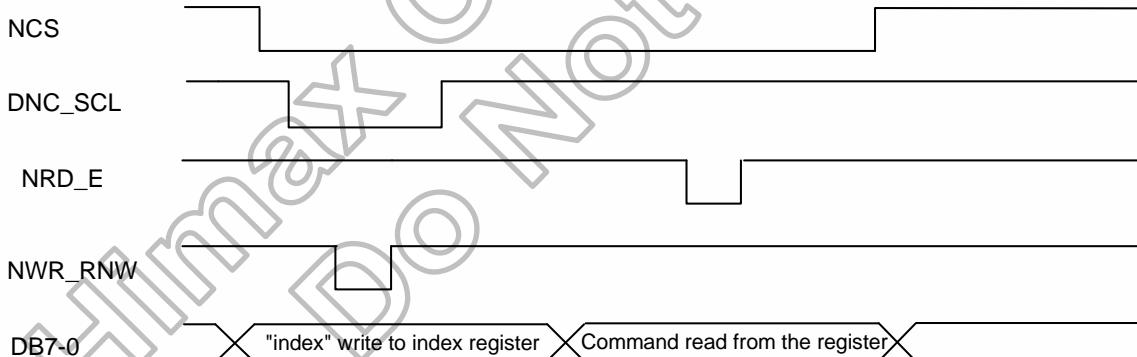


Figure 5. 1 Register Read/Write Timing in Parallel Bus System Interface (for I80 Series MPU)

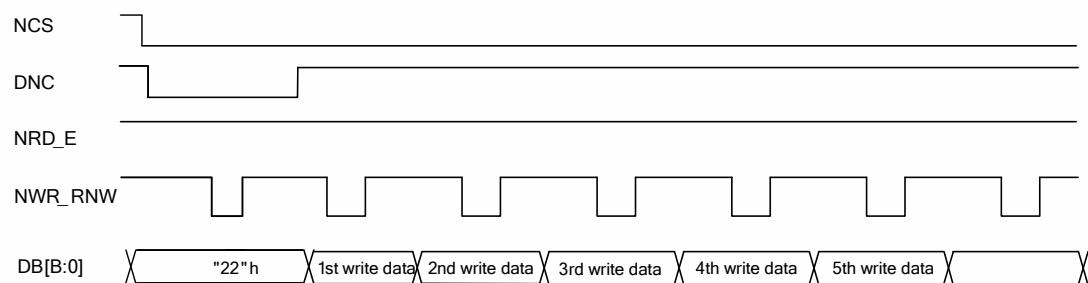
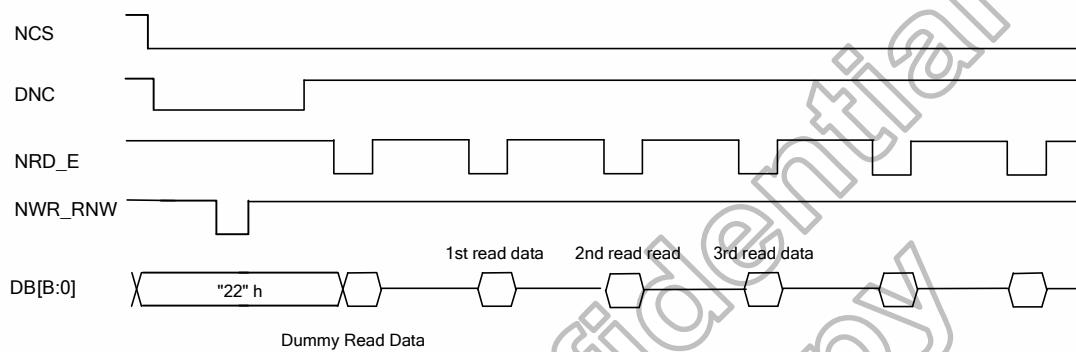
Write to the graphic RAM**Read the graphic RAM**

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

5.1.2 MCU Data Color Coding

MCU Data Color Coding for RAM data **Write**

- Parallel 8-Bits Bus Interface typeI (IM3,IM2,IM1,IM0="0001")

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

Table 5. 3 8-Bits Parallel Interface Type I GRAM Write Table

- Parallel 16-Bits Bus Interface typeI (IM3,IM2,IM1,IM0="0000")

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	22H
17H	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
03h											R3	R2	R1	R0	G3	G2	G1	G0	4K-Color
05h	x	x	R4	R3	R2	R1	R0				G5	G4	G3	G2	G1	G0	B5	B4	65K-Color
06h	x	x	R5	R4	R3	R2	R1	R0	x	x	G5	G4	G3	G2	G1	G0	x	x	262K-Color (2-pixels/ 3bytes)
	x	x	B5	B4	B3	B2	B1	B0	x	x	R5	R4	R3	R2	R1	R0	x	x	
07h	x	x	G5	G4	G3	G2	G1	G0	x	x	B5	B4	B3	B2	B1	B0	x	x	262K-Color (16+2)
	x	x	R5	R4	R3	R2	R1	R0			G5	G4	G3	G2	G1	G0	B5	B4	262K-Color (16+2)

Table 5. 4 16-Bits Parallel Interface Type I GRAM Write Table

- Parallel 9-Bits Bus Interface typeI (IM3,IM2,IM1,IM0="1001")

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	22H	
17H	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color	
06h	x	x	x	x	x	x	x	x	x	x	R5	R4	R3	R2	R1	R0	G5	G4	G3	262K-Color (1-pixels/ 2bytes)

Table 5. 5 9-Bits Parallel Interface Type I GRAM Write Table

- Parallel 18-Bits Bus Interface typeI (IM3,IM2,IM1,IM0="1000")

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

Table 5. 6 18-Bits Parallel Interface Type I GRAM Write Table

- Parallel 8-Bits Bus Interface typell (IM3,IM2,IM1,IM0="0011")

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	22H	
17H	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	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-bytes)
	B3	B2	B1	B0	R3	R2	R1	R0	x	x	x	x	x	x	x	x	x	x	
	G3	G2	G1	G0	B3	B2	B1	B0	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-bytes)
	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/ 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	

Table 5. 7 8-Bits Parallel Interface Type II GRAM Write Table

- Parallel 16-Bits Bus Interface typell (IM3,IM2,IM1,IM0="0010")

Register Command	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Command
									x	0	0	1	0	0	0	1	0	x	22H
17H	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	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	
07h	R5	R4	R3	R2	R1	R0	G5	G4	x	G3	G2	G1	G0	B5	B4	B3	B2	x	262K-Color (16+2)
	B1	B0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

Table 5. 8 16-Bits Parallel Interface Type II GRAM Write Set Table

- Parallel 9-Bits Bus Interface typell (IM3,IM2,IM1,IM0="1011")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Register
	0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	x	22H
17H	D8	D7	D6	D5	D4	D3	D2	D1	D0	D8	D7	D6	D5	D4	D3	D2	D1	D0	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. 9 9-Bits Parallel Interface Set Type II GRAM Write Table

- Parallel 18-Bits Bus Interface typell (IM3,IM2,IM1,IM0="1010")

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	0	0	1	0	0	0	1	0	x	22H
17H	DB17	DB16	DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Color
06h	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. 10 18-Bits Parallel Interface Type II GRAM Write Set Table

18-bit Parallel Bus System Interface

The I80-system 18-bit parallel bus interface **type I** in command-parameter interface mode can be used by setting external pins “IM3, IM2, IM1, IM0” pins to “1000”. And the I80-system 18-bit parallel bus interface **type II** in command-parameter interface mode can be used by setting “IM3, IM2, IM1, IM0” pins to “1010”. Figure 5.3 is the example of interface with I80 microcomputer system interface.

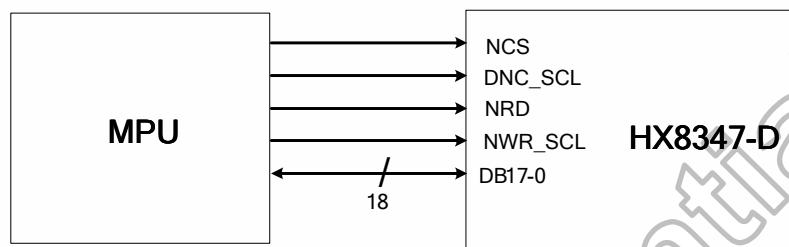


Figure 5. 3 Example of I80- System 18-bit Parallel Bus Interface

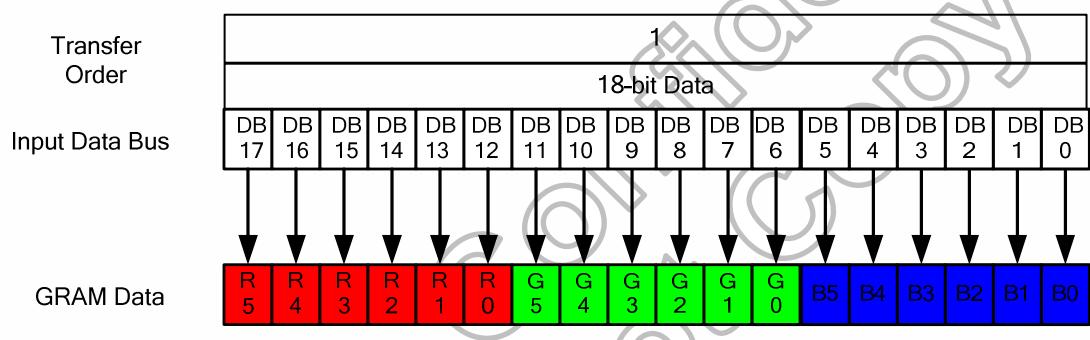


Figure 5. 4 Input Data Bus and GRAM Data Mapping in 18-Bit Bus System Interface with 18 Bit-Data Input (“IM3, IM2, IM1, IM0”=“1010” or “1000”)

16-bit Parallel Bus System Interface

The I80-system 16-bit parallel bus interface **type I** in command-parameter interface mode can be used by setting external pins “IM3, IM2, IM1, IM0” pins to “0000”. And I80-system 16-bit parallel bus interface **type II** in command-parameter interface mode can be used by setting “IM3, IM2, IM1, IM0” pins to “0010”. Figure 5.5 is the example of type I interface with I80 microcomputer system interface. And Figure 5.6 is the example of type II interface with I80 microcomputer system interface.

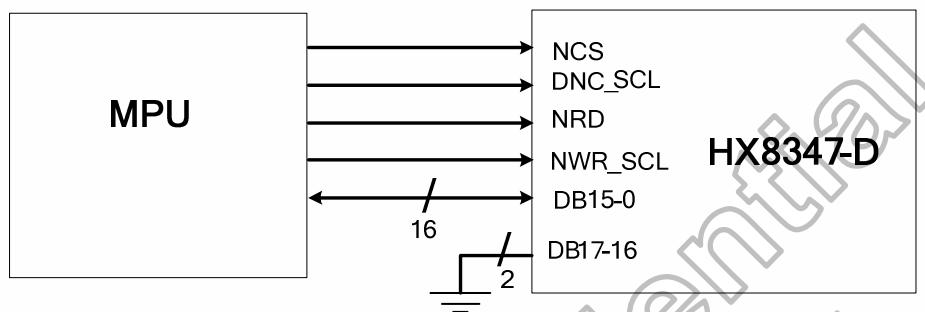


Figure 5.5 Example of I80 System 16-bit Parallel Bus Interface type I

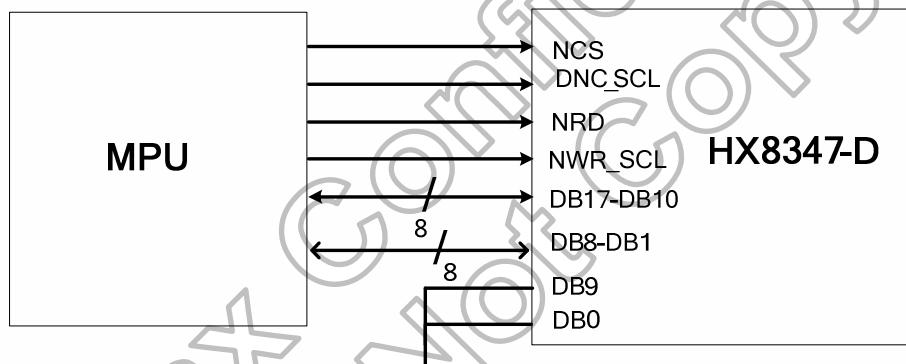


Figure 5.6 Example of I80 System 16-bit Parallel Bus Interface type II

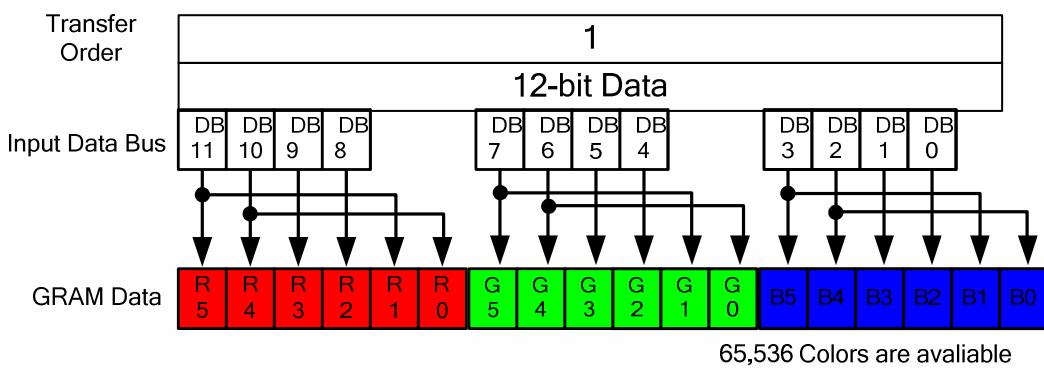


Figure 5.7 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 12 Bit-Data Input (R17H=03h and “IM3, IM2, IM1, IM0”=“0000”)

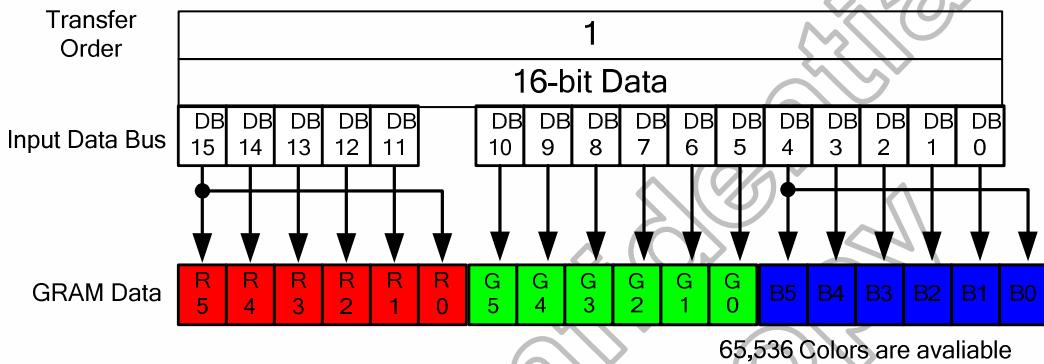


Figure 5.8 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 16 Bit-Data Input (R17H=05h and “IM3, IM2, IM1, IM0”=“0000”)

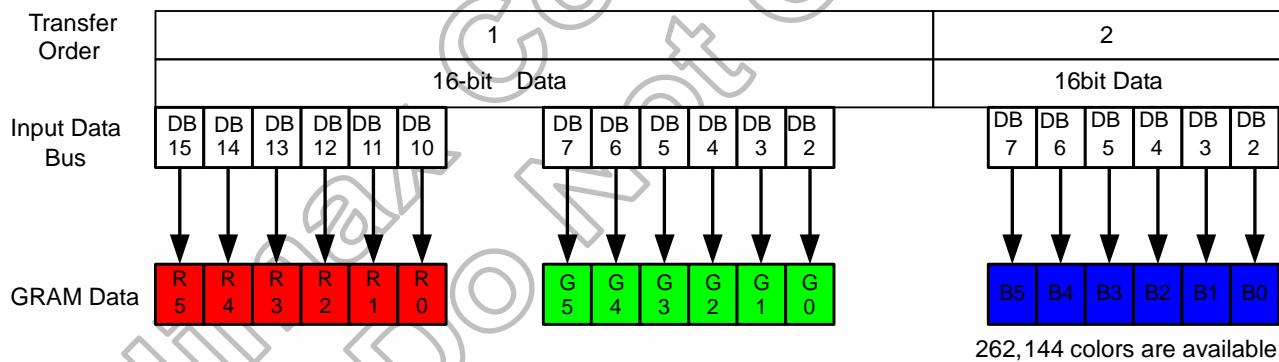


Figure 5.9 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 18(12+6) Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=“0000”)

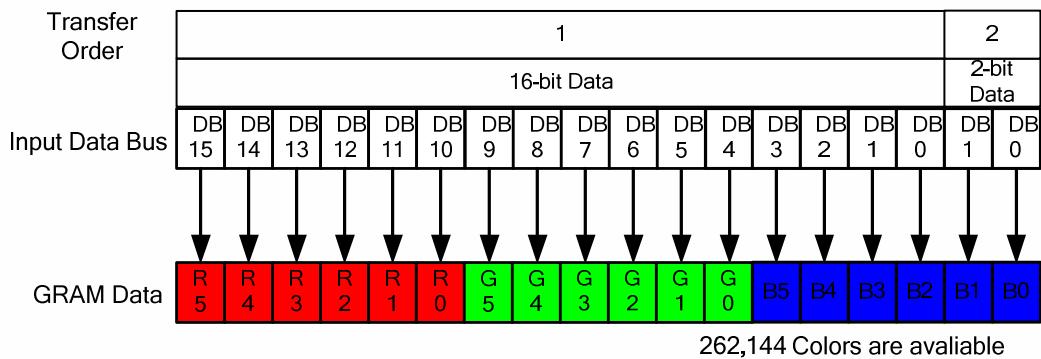


Figure 5.10 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 18(16+2) Bit-Data Input (R17H=07h and “IM3, IM2, IM1, IM0”=“0000”)

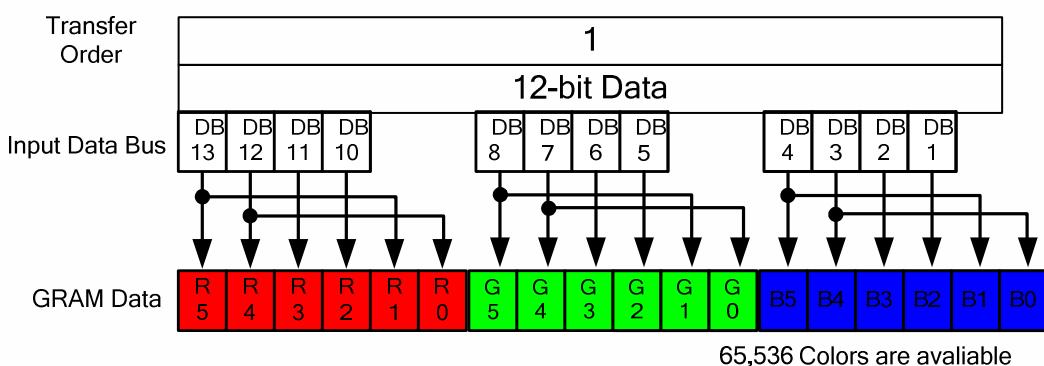


Figure 5. 11 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 12 Bit-Data Input (R17H=03h and “IM3, IM2, IM1, IM0”=“0010”)

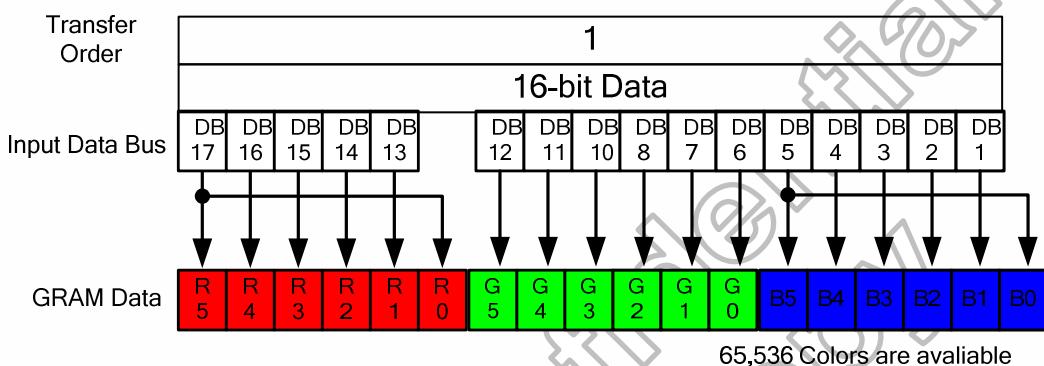


Figure 5. 12 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 16 Bit-Data Input (R17H=05h and “IM3, IM2, IM1, IM0”=“0010”)

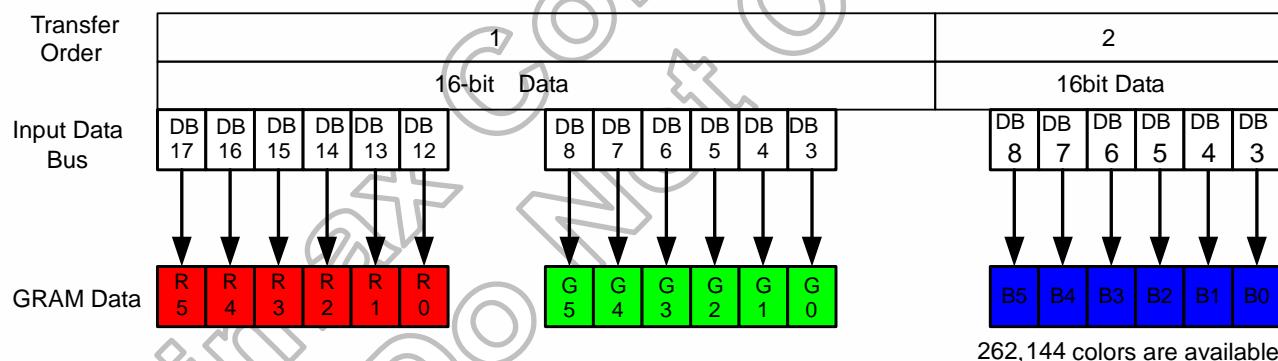


Figure 5. 13 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 18(12+6) Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=“0010”)

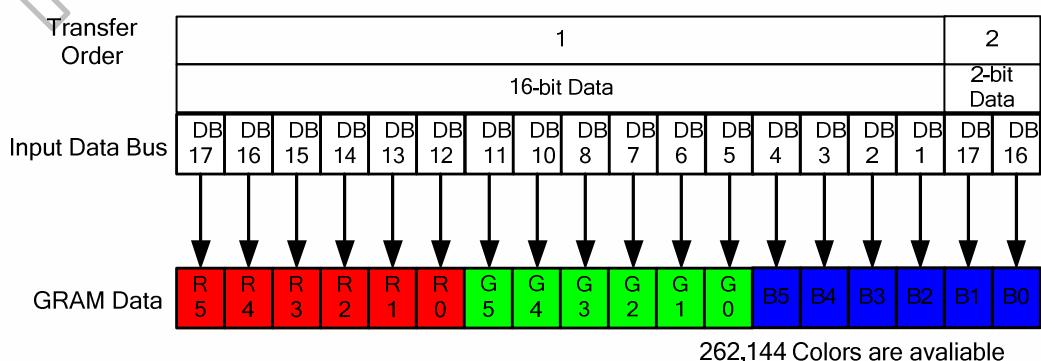


Figure 5. 14 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 18(16+2) Bit-Data Input (R17H=07h and “IM3, IM2, IM1, IM0”=“0010”)

9-bit Parallel Bus System Interface

The I80-system 9-bit parallel bus interface **type I** in command-parameter interface mode can be used by setting external pins ““IM3, IM2, IM1, IM0” pins to “1001”. And I80-system 9-bit parallel bus interface **type II** in command-parameter interface mode can be used by setting ““IM3, IM2, IM1, IM0” pins to “1011”. Figure 5.15 is the example of type I interface with I80 microcomputer system interface. And Figure 5.16 is the example of type II interface with I80 microcomputer system interface.

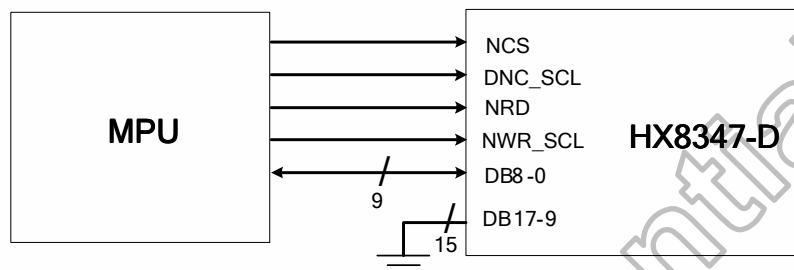


Figure 5. 15 Example of I80 System 9-bit Parallel Bus Interface type I

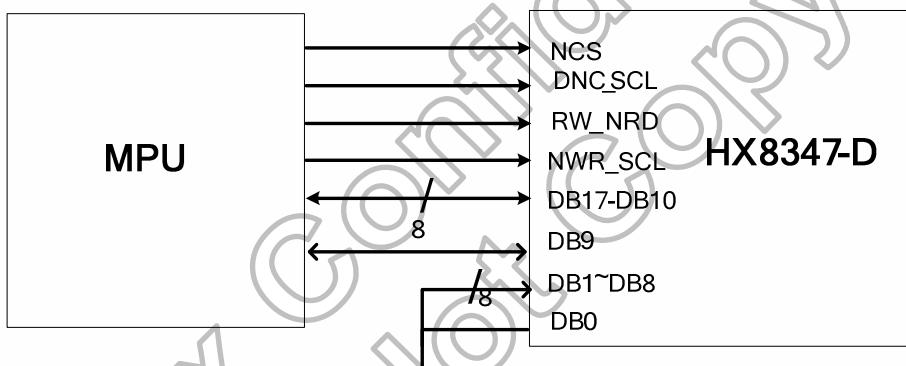


Figure 5. 16 Example of I80 System 9-bit Parallel Bus Interface type II

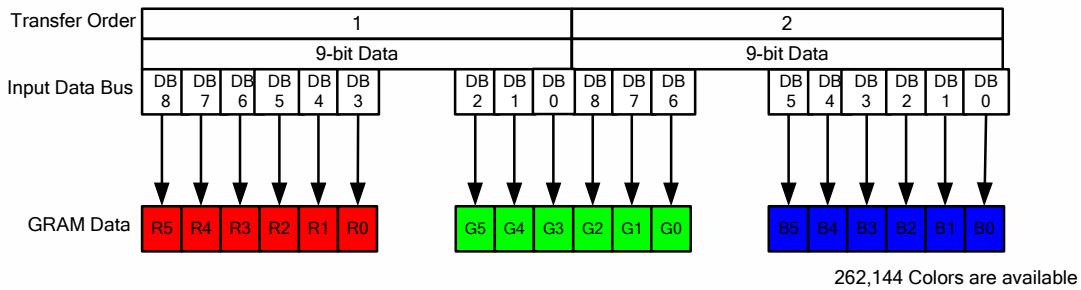


Figure 5. 17 Input Data Bus and GRAM Data Mapping in 9-Bit Bus System Interface with 18 Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=”1001”)

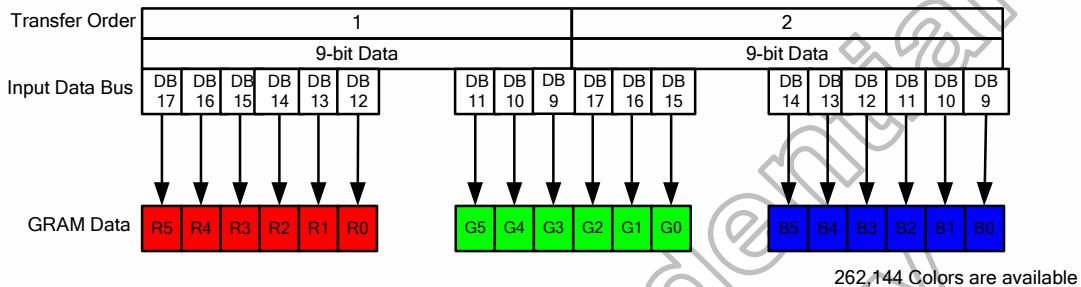


Figure 5. 18 Input Data Bus and GRAM Data Mapping in 9-Bit Bus System Interface with 18 Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=”1011”)

8-bit Parallel Bus System Interface

The I80-system 8-bit parallel bus interface **type I** in command-parameter interface mode can be used by setting external pins ““IM3, IM2, IM1, IM0” pins to “0001”. And I80-system 8-bit parallel bus interface **type II** in command-parameter interface mode can be used by setting ““IM3, IM2, IM1, IM0” pins to “0011”. Figure 5.19 is the example of type I interface with I80 microcomputer system interface. And Figure 5.20 is the example of type II interface with I80 microcomputer system interface.

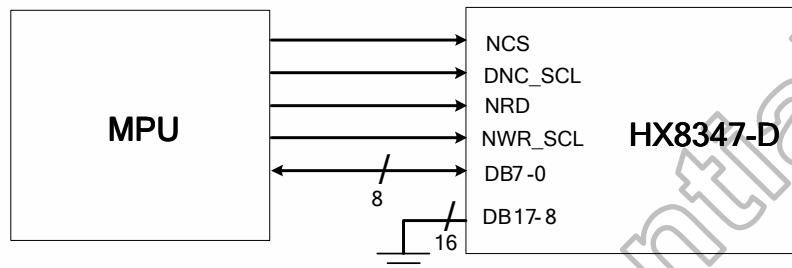


Figure 5. 19 Example of I80- System 8-bit Parallel Bus Interface type I

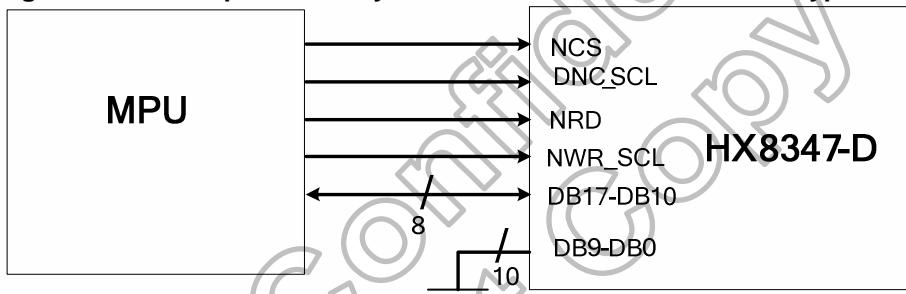


Figure 5. 20 Example of I80- System 8-bit Parallel Bus Interface type II

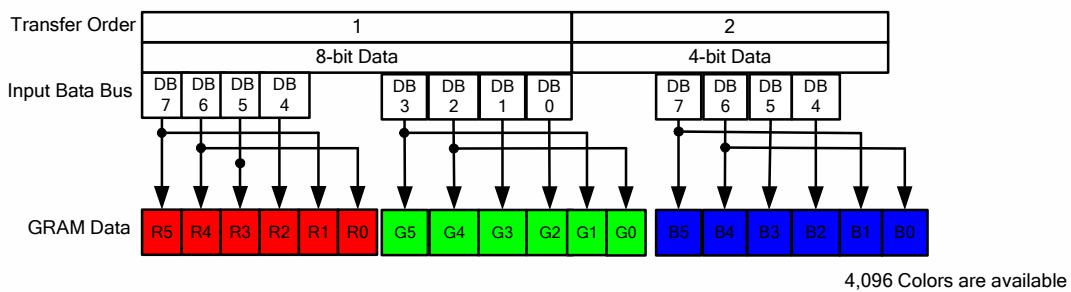


Figure 5.21 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 12 Bit-Data Input (R17H=03h and “IM3, IM2, IM1, IM0”=“0001”)

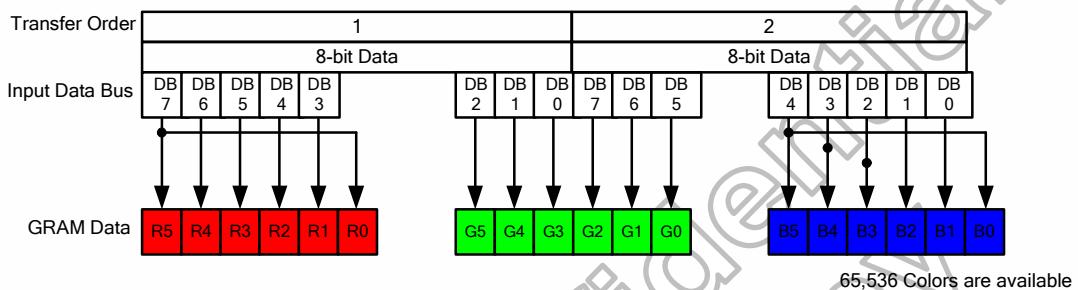


Figure 5.22 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 16 Bit-Data Input (R17H=05h and “IM3, IM2, IM1, IM0”=“0001”)

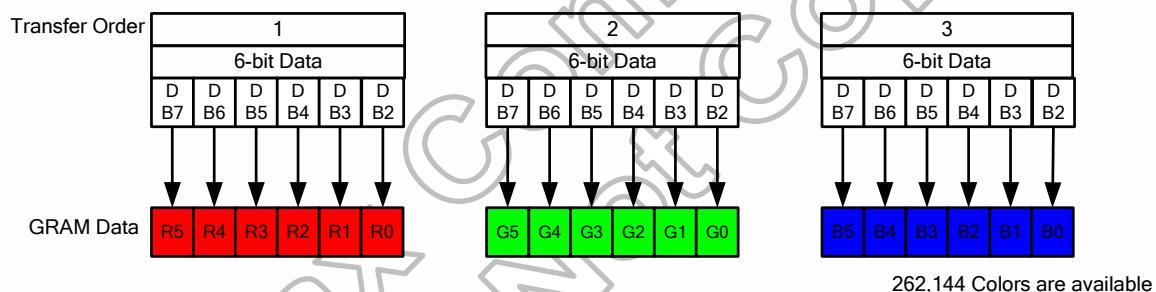


Figure 5.23 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 18 Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=“0001”)

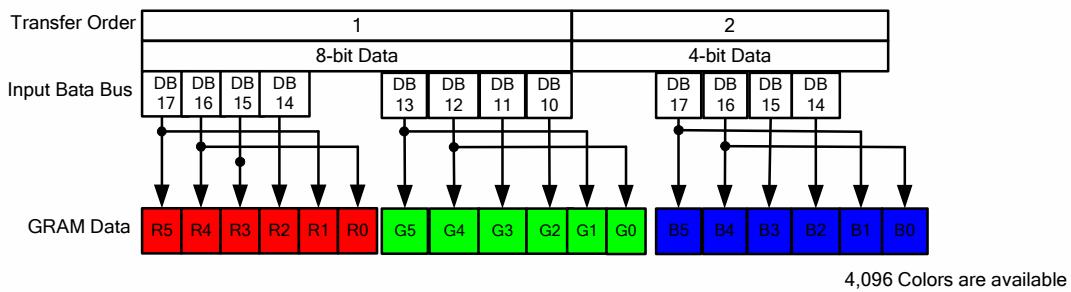


Figure 5. 24 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 12 Bit-Data Input (R17H=03h and “IM3, IM2, IM1, IM0”=“0011”)

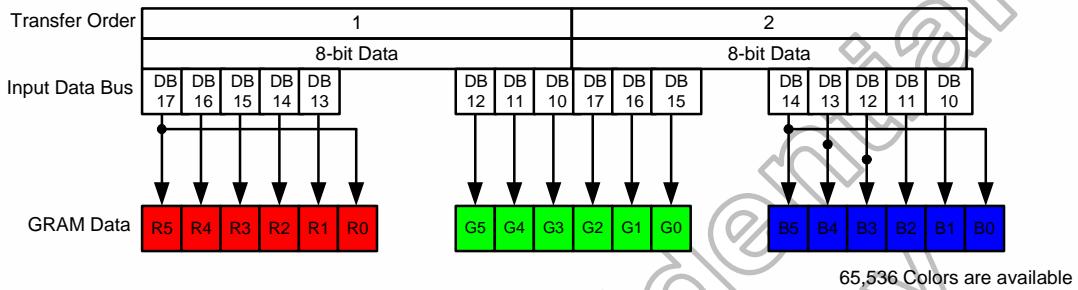


Figure 5. 25 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 16 Bit-Data Input (R17H=05h and “IM3, IM2, IM1, IM0”=“0011”)

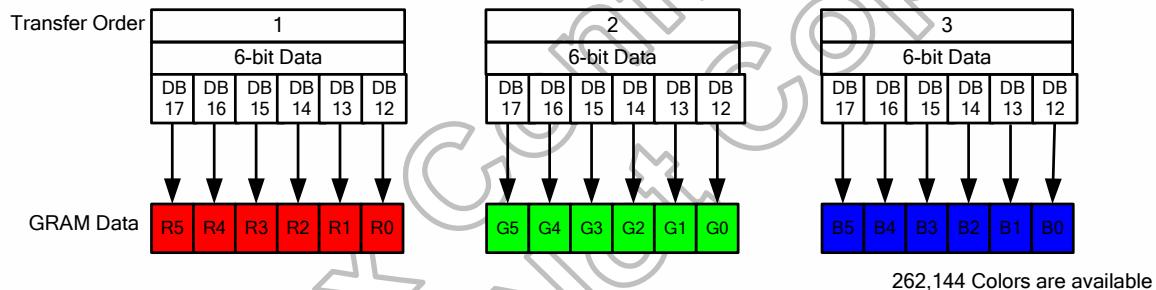


Figure 5. 26 Input Data Bus and GRAM Data Mapping in 8-Bit Bus System Interface with 18 Bit-Data Input (R17H=06h and “IM3, IM2, IM1, IM0”=“0011”)

MCU Data Color Coding for RAM data Read

- Parallel 8-Bits Bus Interface type I (IM3,IM2,IM1,IM0="0001")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Command
	x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	22H
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Color
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read
	x	x	x	x	x	x	x	x	x	x	R5	R4	R3	R2	R1	R0	x	x	262K-Color (1-pixels/ 3byyes)
	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	B5	B4	B3	B2	B1	B0	x	x	

Table 5. 11 8-Bits Parallel Interface type I GRAM Read Table

- Parallel 16-Bits Bus Interface type I (IM3,IM2,IM1,IM0="0000")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Command
	x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	22H
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Color
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read
	x	x	R5	R4	R3	R2	R1	R0	x	x	G5	G4	G3	G2	G1	G0	x	x	262K-Color (2-pixels/ 3byyes)
	x	x	B5	B4	B3	B2	B1	B0	x	x	R5	R4	R3	R2	R1	R0	x	x	
	x	x	G5	G4	G3	G2	G1	G0	x	x	B5	B4	B3	B2	B1	B0	x	x	

Table 5. 12 16-Bits Parallel Interface type I GRAM Read Table

- Parallel 9-Bits Bus Interface type I (IM3,IM2,IM1,IM0="1001")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Register	
	x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	22H	
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Color	
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Dummy Read	
	x	x	x	x	x	x	x	x	x	x	R5	R4	R3	R2	R1	R0	G5	G4	G3	262K-Color (1-pixels/ 2bytes)
	x	x	x	x	x	x	x	x	x	x	G2	G1	G0	B5	B4	B3	B2	B1	B0	
	x	x	x	x	x	x	x	x	x	x	B5	B4	B3	B2	B1	B0	x	x		

Table 5. 13 9-Bits Parallel Interface type I GRAM Read Table

- Parallel 18-Bits Bus Interface type I (IM3,IM2,IM1,IM0="1000")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Register
	x	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	22H
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	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
	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0	
	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0	

Table 5. 14 18-Bits Parallel Interface type I GRAM Read Table

- Parallel 8-Bits Bus Interface type II (IM3,IM2,IM1,IM0="0011")

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	22H	
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	Dummy Read	
	R5	R4	R3	R2	R1	R0													262K-Color (1-pixels/ 3bytes)
	G5	G4	G3	G2	G1	G0			x	x	x	x	x	x	x	x	x		
	B5	B4	B3	B2	B1	B0			x	x	x	x	x	x	x	x	x		

Table 5. 15 8-Bits Parallel Interface type II GRAM Read Table

- Parallel 16-Bits Bus Interface type II (IM3,IM2,IM1,IM0="0010")

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	22H
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				G5	G4	G3	G2	G1	G0				262K-Color (2-pixels/ 3bytes)
	B5	B4	B3	B2	B1	B0			x	x		R5	R4	R3	R2	R1	R0		
	G5	G4	G3	G2	G1	G0			x	x		B5	B4	B3	B2	B1	B0		

Table 5. 16 16-Bits Parallel Interface type II GRAM Read Table

- Parallel 9-Bits Bus Interface type II (IM3,IM2,IM1,IM0="1011")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Register
	0	0	1	0	0	0	1	0	x	x	x	x	x	x	x	x	x	22H	
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Color
	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	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		

Table 5. 17 9-Bits Parallel Interface type II GRAM Read Table

- Parallel 18-Bits Bus Interface type II (IM3,IM2,IM1,IM0="1010")

Register Command	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Register
	x	x	x	x	x	x	x	x	x	0	0	1	0	0	0	1	0	x	22H
Read Data Format	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Color
	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	x	x	x	x	x	x		262K-Color (1-pixels/ 2bytes)
	G5	G4	G3	G2	G1	G0			x	x	x	x	x	x	x	x	x		
	B5	B4	B3	B2	B1	B0													

Table 5. 18 18-Bits Parallel Interface type II GRAM Read Table

5.1.3 Serial Bus System Interface

The HX8347-D supports two kinds' serial bus interface in register-content mode by setting external pins "IM2, IM1" pins to "10" 3-wire serial interface and "IM2, IM1" pins to "11" 4-wire serial interface. 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 (SDA), and the serial transfer clock signal (NWR_SCL).

5.1.3.1 3-wire serial interface

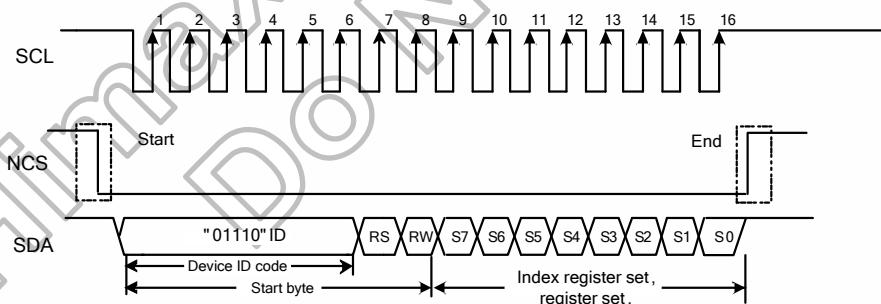
As the chip select signal (NCS) goes low, the start byte needs to be transferred first. The start byte is made up of 6-bit bus device identification code; register select (RS) bit and read/write operation (RW) bit. The five upper bits of 6-bit bus device identification code must be set to "01110", and 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	Set index register
1	0	Writes Instruction or GRAM data
1	1	Reads command (Not support GRAM read)

Table 5. 19 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

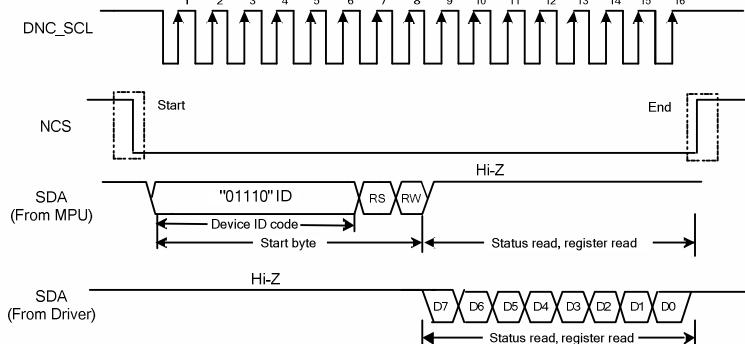


Figure 5. 27 Index Register Read/Write Timing in 3-wire Serial Bus System Interface

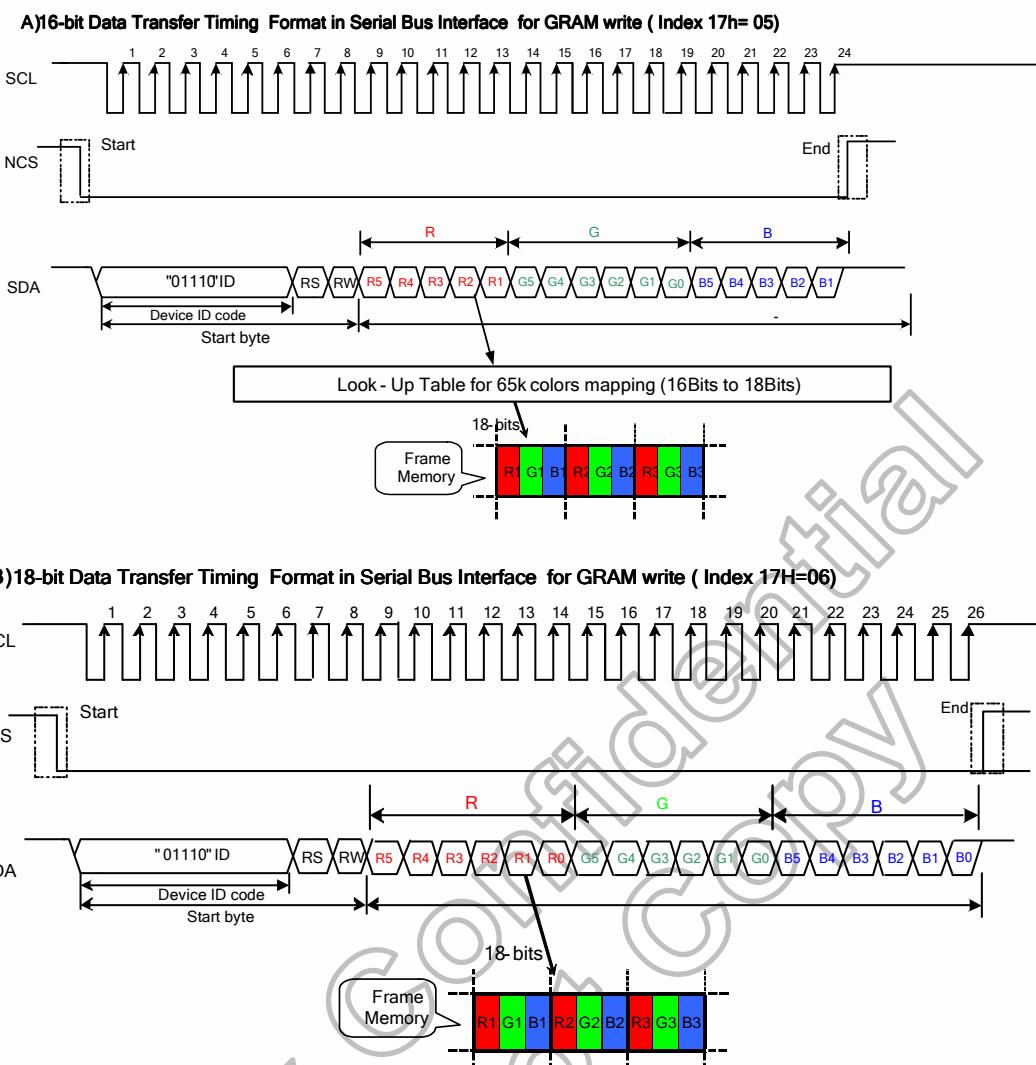


Figure 5. 28 Data Write Timing in 3-wire Serial Bus System Interface

5.1.3.2 4-wire serial interface

4-pin serial case, data packet contains just transmission byte and control bit DNC is transferred by DNC pin. If DNC is low, the transmission byte is command byte. If DNC is high, the transmission byte is stored to index register or GRAM. The MSB is transmitted first. The serial interface is initialized when NCS is high. In this state, NWR_SCL clock pulse or SDA data have no effect. A falling edge on NCS enables the serial interface and indicates the start of data transmission.

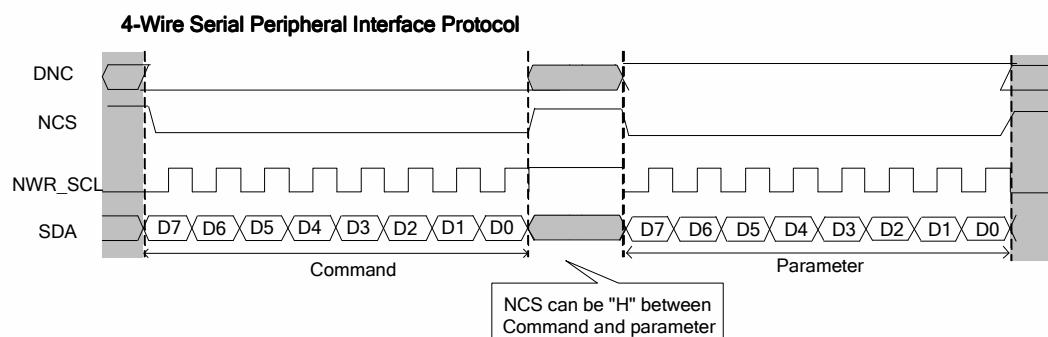
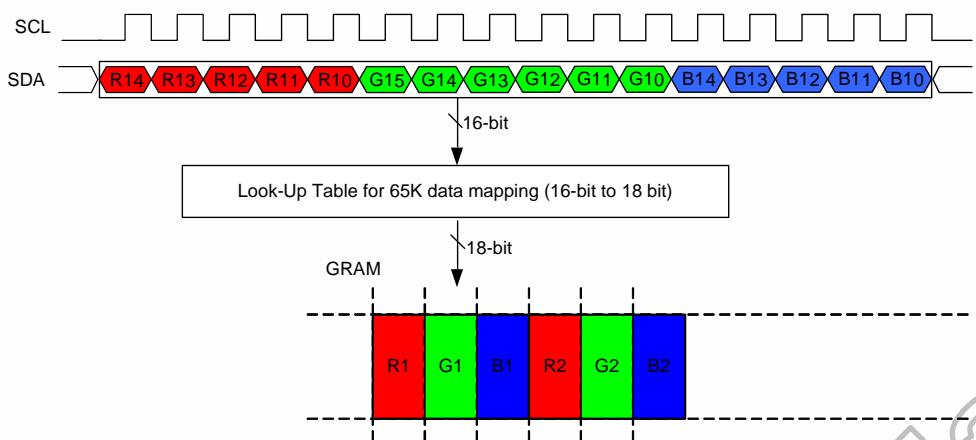


Figure 5. 29 Index Register Write Timing in 4-wire Serial Bus System Interface

16-bit Data Transfer Timing Format in 4-wire Serial Bus Interface for GRAM write (Index 17h= 05)



18-bit Data Transfer Timing Format in 4-wire Serial Bus Interface for GRAM write (Index 17h= 06)

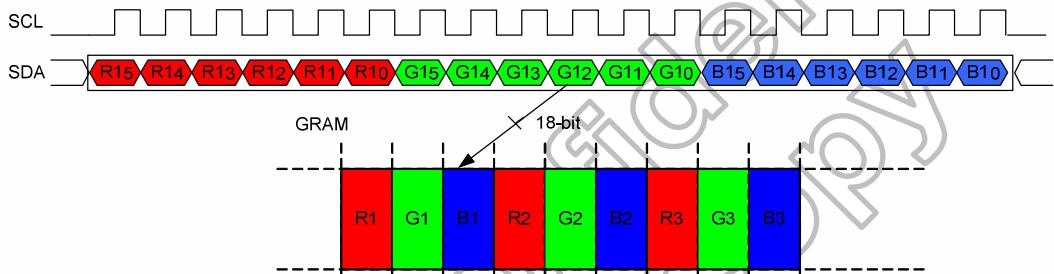


Figure 5. 30 Data Write Timing in 4-wire Serial Bus System Interface

5.2 RGB Interface

The HX8347-D 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 VSYNC, HSYNC, DE, DOTCLK, DB17-0 parallel lines for the RGB interface (RGB mode 1). When RCM [1:0] ='11' use VSYNC, HSYNC, 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 VSYNC, HSYNC, 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 (VSYNC), line synchronizing signal (HSYNC) 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 HSYNC signal, and the VBP setting of VSYNC. In these two RGB interface mode, the input display data is not written to GRAM and is displayed directly.

Vertical synchronization (VSYNC) 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 (HSYNC) 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.

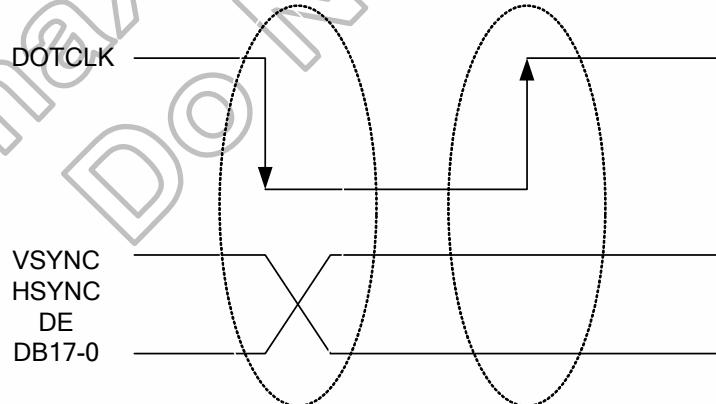


Figure 5. 31 DOTCLK Cycle

General timing diagram in RGB interface is as follow

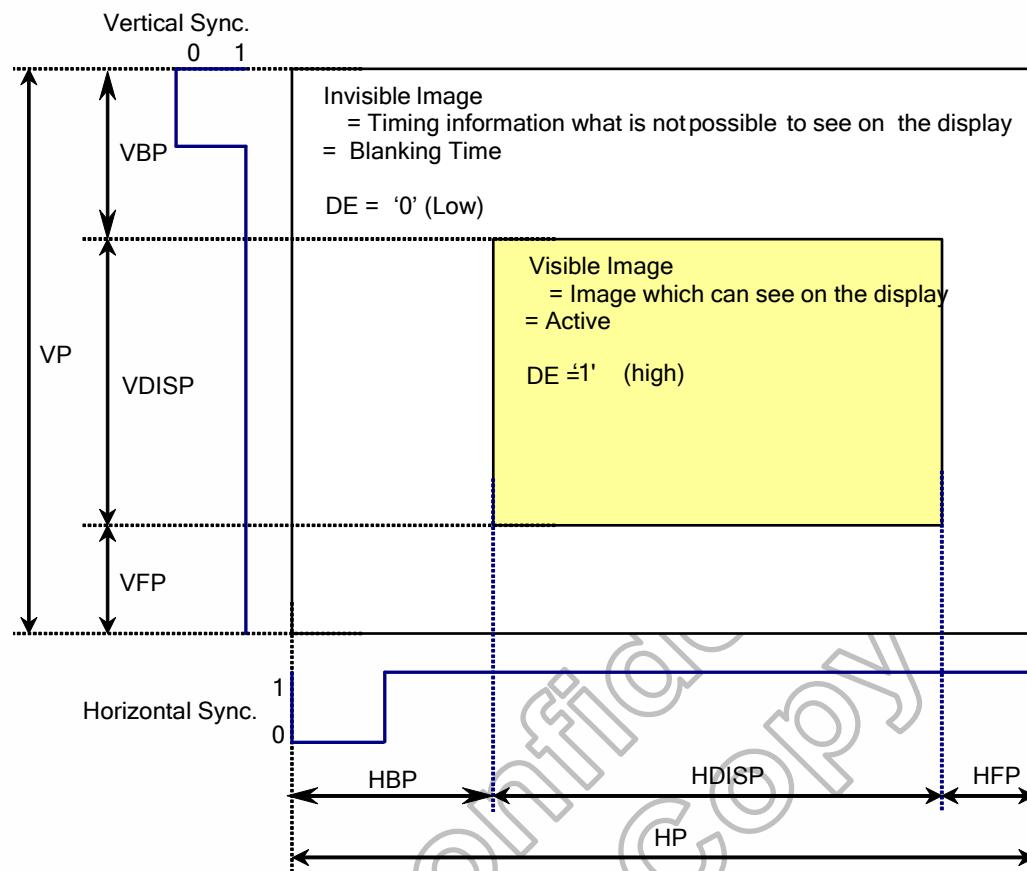
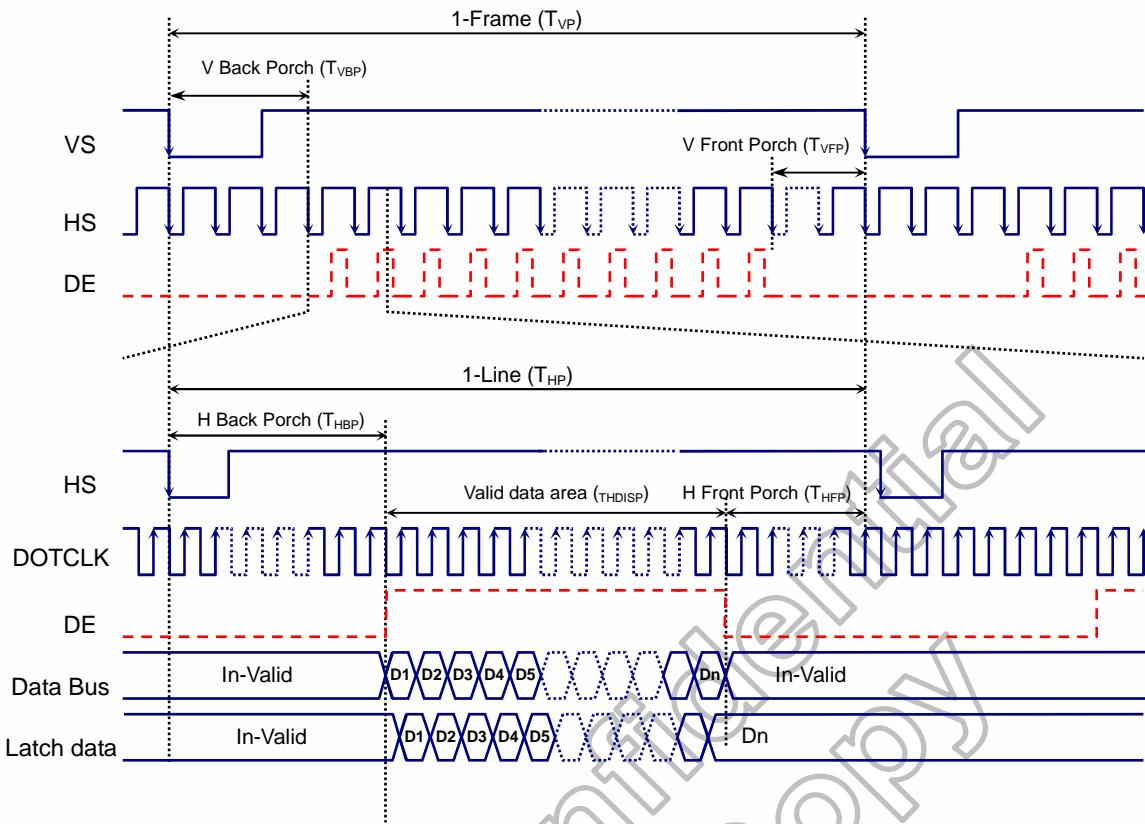


Figure 5. 32 RGB Interface Circuit Input Timing Diagram

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: (1) RGB mode 2 doesn't need DE signal
 (2) EPL='0', VSPL='0', HSPL='0' and DPL='0' of SETRGBIF (32H) command.

Figure 5. 33 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	B5	B4	B3	B2	B1	B0	x	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. 20 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 [17:0]), 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 R33h and R34h 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
Black	All bits are 0	All bits are 0	All bits are 0
Blue	All bits are 0	All bits are 0	All bits are 1
Green	All bits are 0	All bits are 1	All bits are 0
Cyan	All bits are 0	All bits are 1	All bits are 1
Red	All bits are 1	All bits are 0	All bits are 0
Magenta	All bits are 1	All bits are 0	All bits are 1
Yellow	All bits are 1	All bits are 1	All bits are 0
White	All bits are 1	All bits are 1	All bits are 1

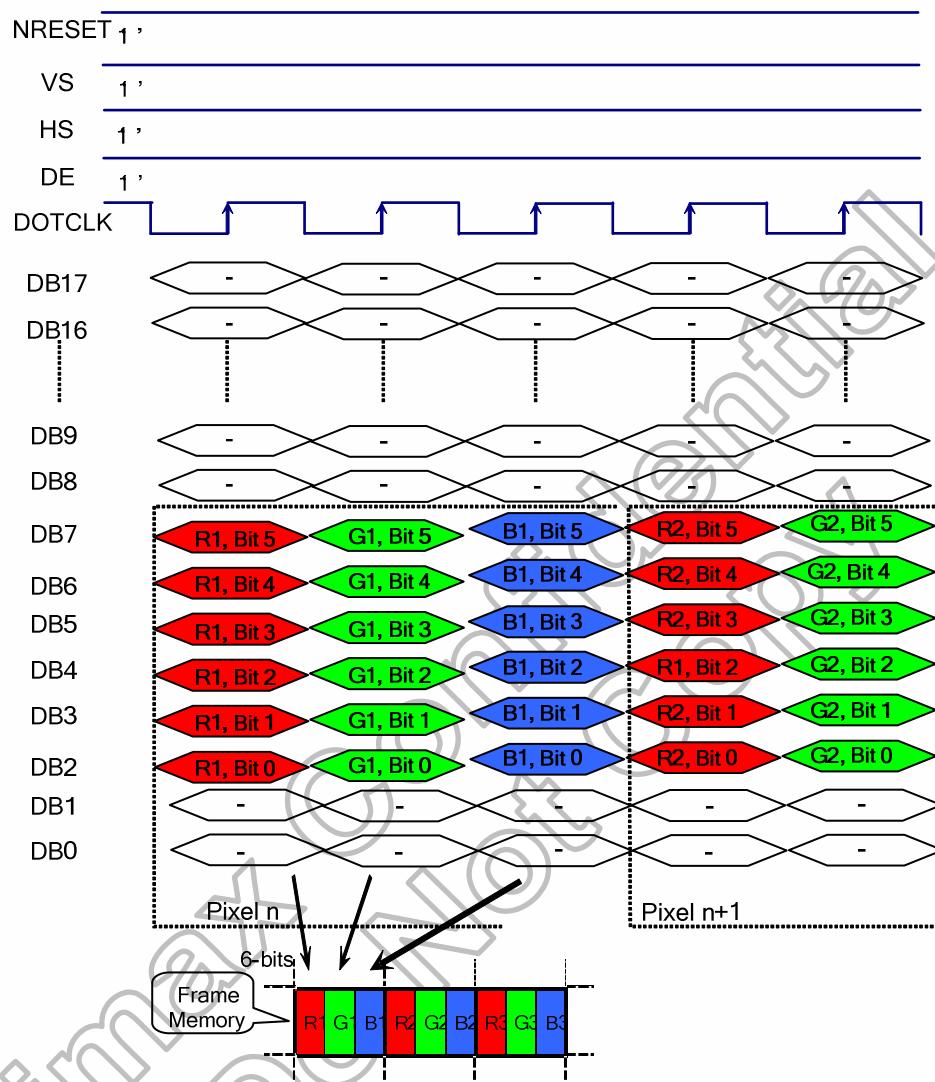
Note: There are only defined main colors on this table - Not all gray levels of colors.

Table 5. 21 Meaning of the Pixel Information for Main Colors on RGB Interface

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, $17H = "E0h"$



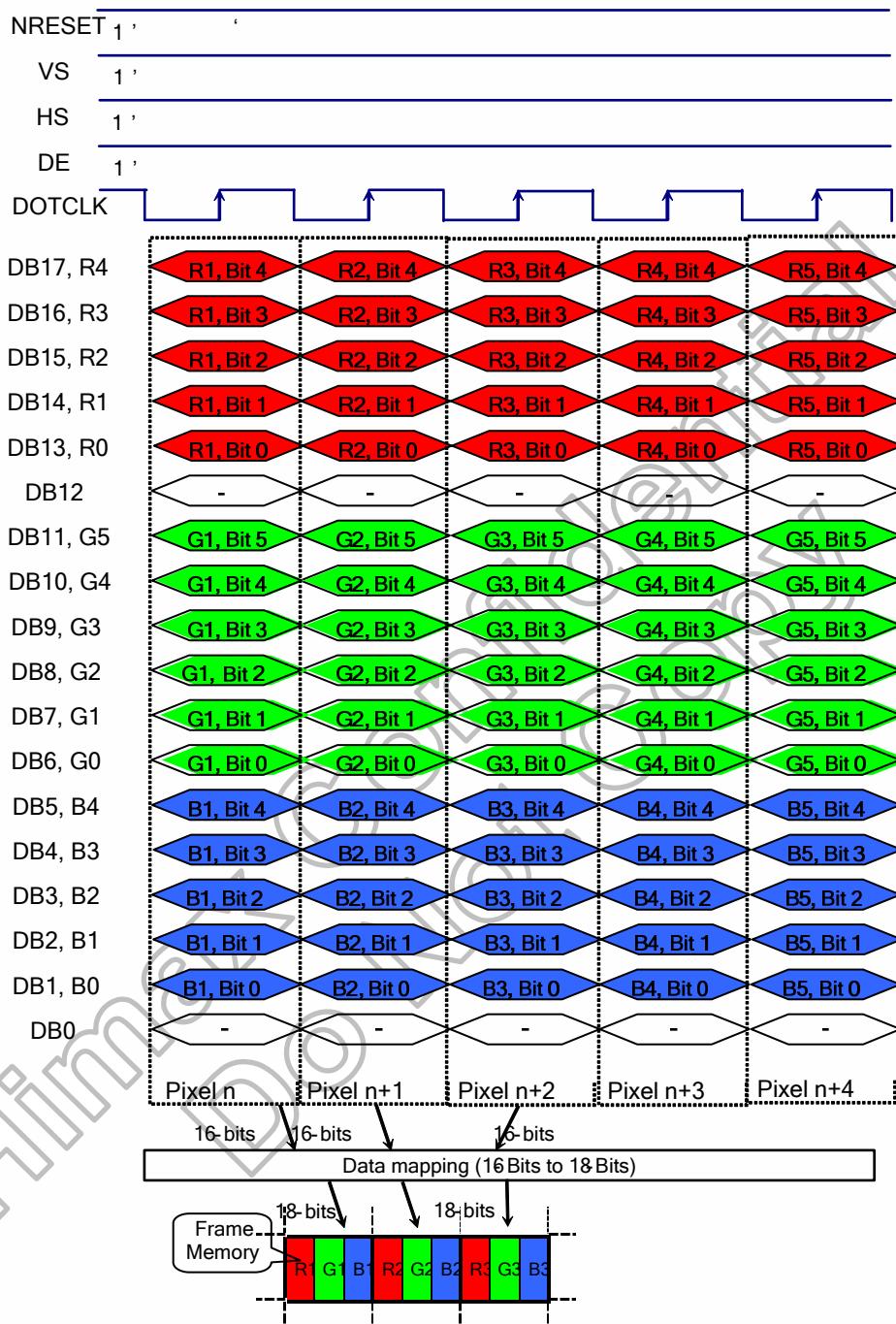
Note: (1) The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit7, LSB=Bit0 for Red, Green and Blue data. (3-transfer data one pixel)

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

Figure 5. 34 RGB 18-bits/pixel on 6-bits Data width

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"



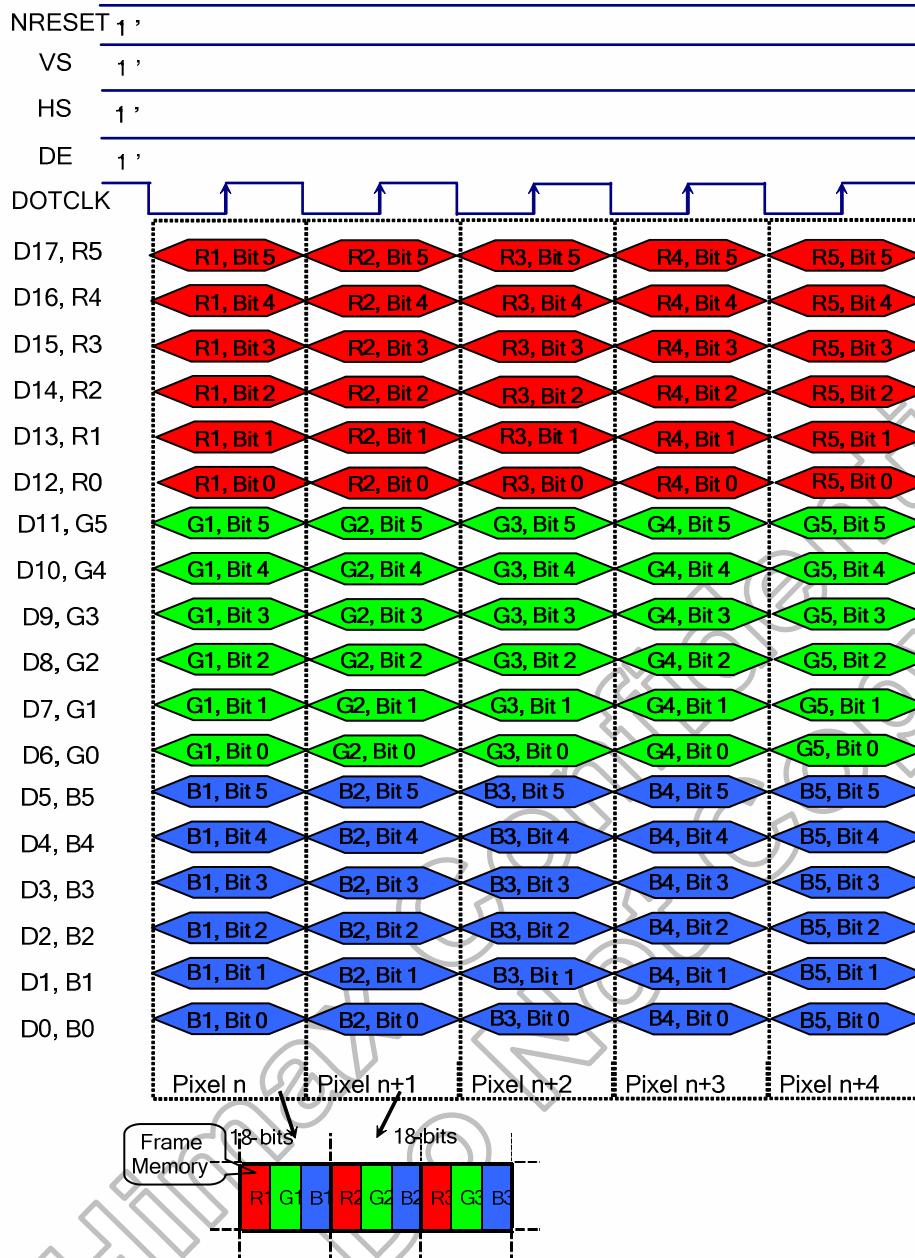
Note: (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit5, LSB=Bit0 for Green data and

MSB=Bit4, LSB=Bit0 for Red and Blue data.

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

Figure 5. 35 RGB 16-bits/pixel on 16-bits Data width

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, $17H=60h$



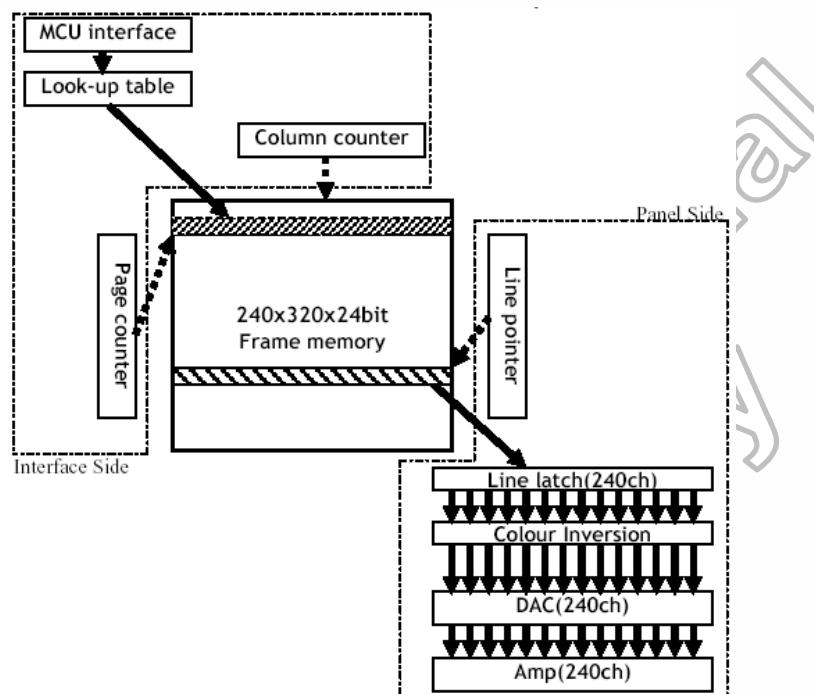
Note: (1) The data order is as follows, MSB=D17, LSB=D0 and picture data is MSB=Bit5, LSB=Bit0 for Red, Green and Blue data.

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

Figure 5. 36 RGB 18-bits/pixel on 18-bits Data width

6. Display Data GRAM

The display data RAM stores display dots and consists of 1,382,400 bits (240x18x320 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 **SC**, **EC** bits and **SP**, **EP** bits, 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,EC)H	(00,ED)H	(00,EE)H	(00,EF)H
(01,00)H	(01,01)H	(01,02)H	-----	(01,EC)H	(01,ED)H	(01,EE)H	(01,EF)H
(02,00)H	(02,01)H	(02,02)H	-----	(02,EC)H	(02,ED)H	(02,EE)H	(02,EF)H
(03,00)H	(03,01)H	(03,02)H	-----	(03,EC)H	(03,ED)H	(03,EE)H	(03,EF)H
(04,00)H	(04,01)H	(04,02)H	-----	(04,EC)H	(04,ED)H	(04,EE)H	(04,EF)H
(05,00)H	(05,01)H	(05,02)H	-----	(05,EC)H	(05,ED)H	(05,EE)H	(05,EF)H
(13A,00)H	(13A,01)H	(13A,02)H	-----	(13A,EC)H	(13A,ED)H	(13A,EE)H	(13A,EF)H
(13B,00)H	(13B,01)H	(13B,02)H	-----	(13B,EC)H	(13B,ED)H	(13B,EE)H	(13B,EF)H
(13C,00)H	(13C,01)H	(13C,02)H	-----	(13C,EC)H	(13C,ED)H	(13C,EE)H	(13C,EF)H
(13D,00)H	(13D,01)H	(13D,02)H	-----	(13D,EC)H	(13DED)H	(13D17E)H	(13D,EF)H
(13E,00)H	(13E,01)H	(13E,02)H	-----	(13E,EC)H	(13E,ED)H	(13E,EE)H	(13E,EF)H
(13F,00)H	(13F,01)H	(13F,02)H	-----	(13F,EC)H	(13F,ED)H	(13F,EE)H	(13F,EF)H

Table 6. 1 GRAM Address for Display Panel Position

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-P.54-

October, 2008

6.2 Address Counter (AC) of GRAM

The HX8347-D 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 (**MV**, **MX** and **MY** 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 (start: **SC**, end: **EC**) and the (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

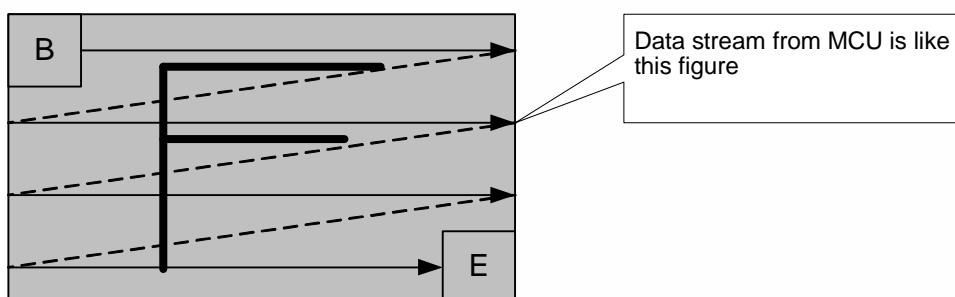


Figure 6.1 Image Data Sending Order from the Host

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 **MV**, **MX** and **MY** bits setting

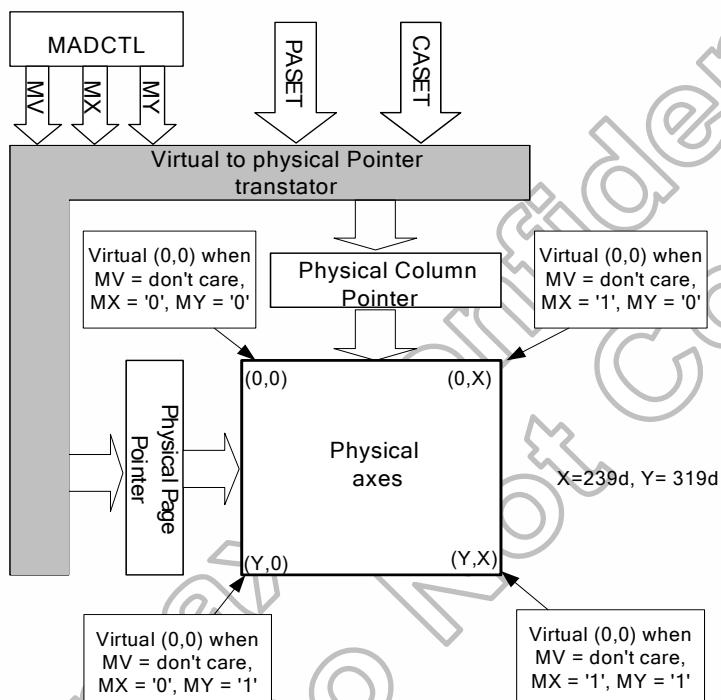


Figure 6.2 Image Data Writing Control

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 MX, MY, MV.

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.

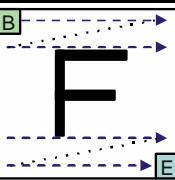
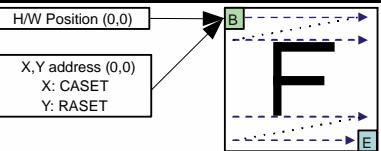
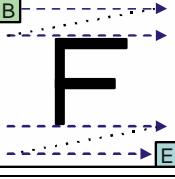
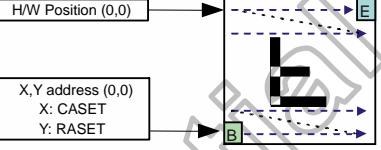
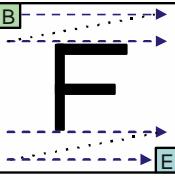
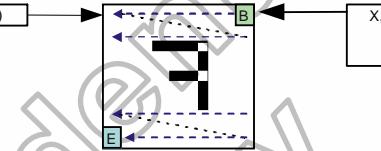
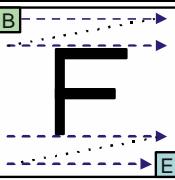
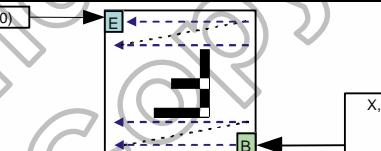
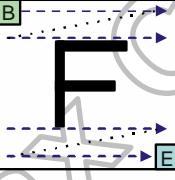
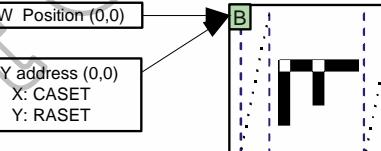
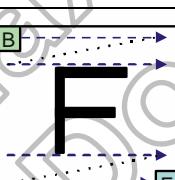
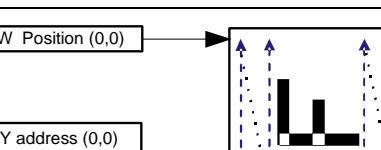
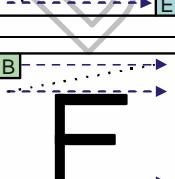
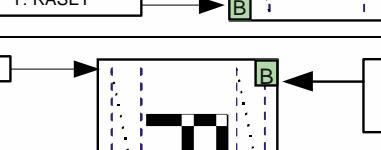
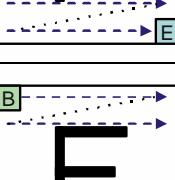
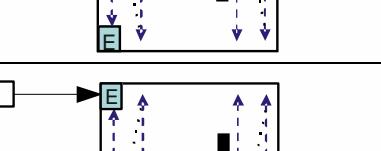
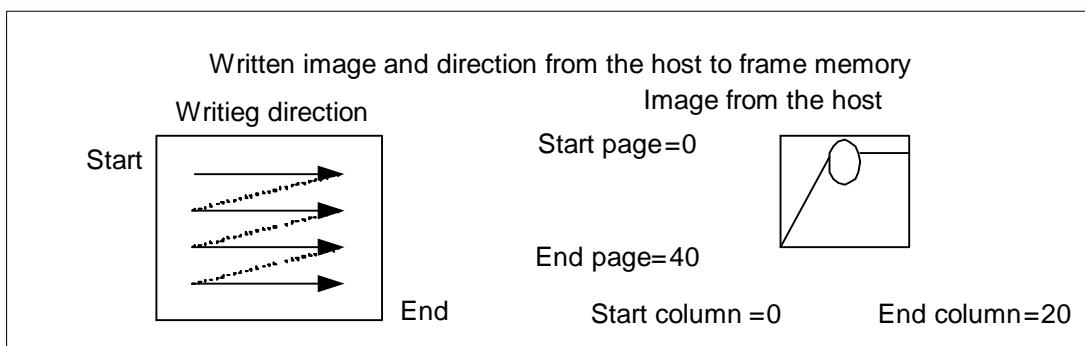
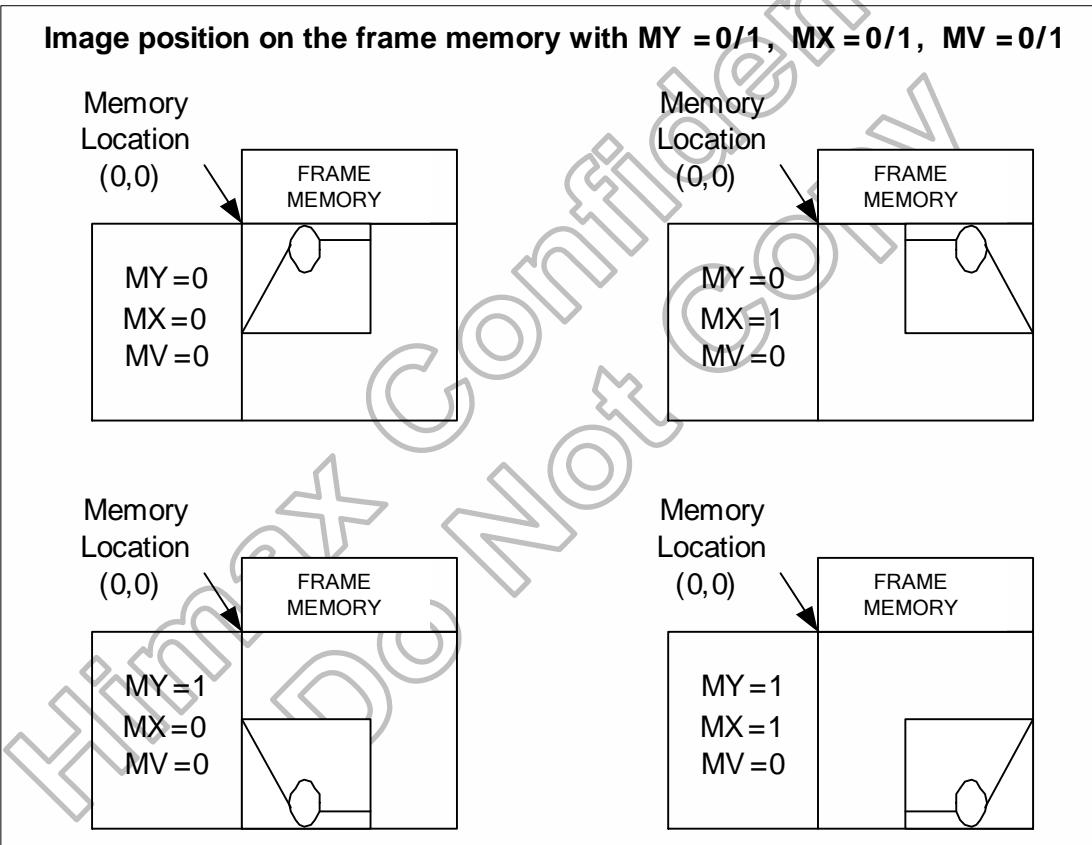
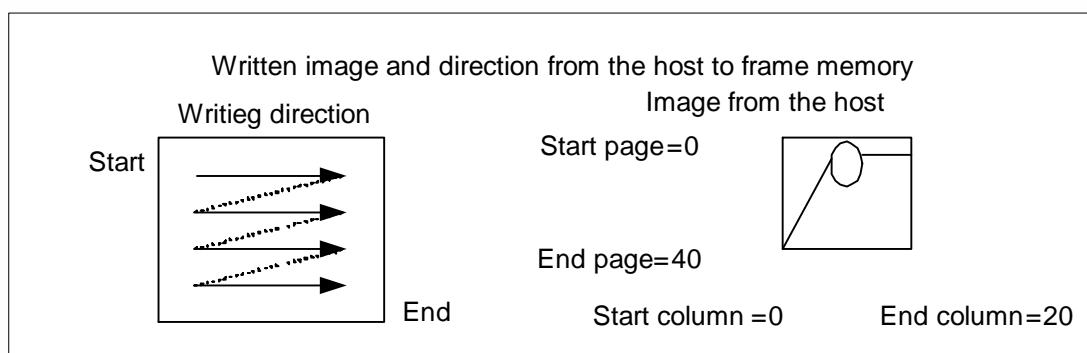
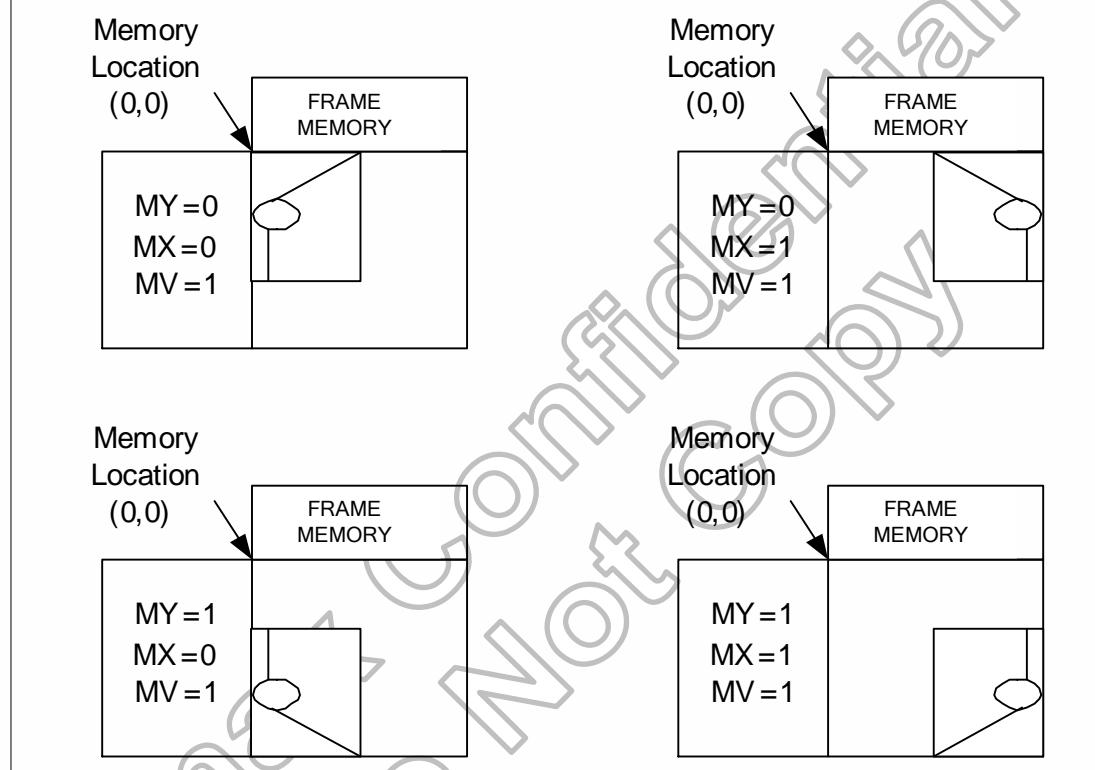
Display Data Direction	MV	MX	MY	Image in the Host	Image in the Driver (GRAM)
Normal	0	0	0		
Y-Invert	0	0	1		
X-Invert	0	1	0		
X-Invert Y-Invert	0	1	1		
X-Y Exchange	1	0	0		
X-Y Exchange X-invert	1	0	1		
X-Y Exchange Y-invert	1	1	0		
X-Y Exchange X-invert Y-invert	1	1	1		

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.

**Image position on the frame memory with MY = 0/1, MX = 0/1, MV = 0/1**

**Image position on the frame memory with MY =0/1, MX =0/1, MV =0/1****Figure 6. 4 Example for Rotation with MY, MX and MV - 2**

6.3 GRAM to Display Address Mapping

By setting the **SS** bit, the relation between the source output channel and the GRAM address can be changed as reverse display. By setting the **GS** bit, the relation between the gate output channel and the GRAM address can be changed as reverse display. By setting the **BGR** bit, the relation between the source output channel and the <R>, <G>, dot allocation can be reversed for different LCD color filter arrangement. Table 6.5, Table 6.6 and Table 6.7 show relations among the GRAM data allocation, the source output channel, and the R, G, B dot allocation.

SRGB = 'H'														
Source	SMX = '1'	S1	S2	S3	S4	S5	S6	-----	S715	S716	S717	S718	S719	S720
Output	SMX= '0'	S718	S719	S720	S715	S716	S717	-----	S4	S5	S6	S1	S2	S3
X Address	“00”h			“01”h			-----	“EE”h			“EF”h			
RGB data	R	G	B	R	G	B	-----	R	G	B	R	G	B	
Pixel	Pixel 1			Pixel 2			-----	Pixel 239			Pixel 240			

SRGB = 'L'														
Source	SMX = '1'	S3	S2	S1	S6	S5	S4	-----	S717	S716	S715	S720	S719	S718
Output	SMX = '0'	S720	S719	S718	S717	S716	S715	-----	S6	S5	S4	S3	S2	S1
X Address	“00”h			“01”h			-----	“EE”h			“EF”h			
Bit Allocation	R	G	B	R	G	B	-----	R	G	B	R	G	B	
Pixel	Pixel 1			Pixel 2			-----	Pixel 239			Pixel 240			

Note: (1) RGB direction default setting is defined by the hardware pin SRGB.

(2) Register R16h [3] (BGR) bit will override the hardware SRGB setting once software was sent to R16h [3] (BGR) bit. Hardware pin SRGB control is invalid, and RGB filter order is controlled by R16h [3] (BGR) bit.

Table 6. 5 GRAM X Address and Display Panel Position

S/G pins	S1	S2	S3	S4	S5	S6	S7	S8	S9	-----	S709	S710	S711	S712	S713	S714	S715	S716	S717	S718	S719	S720
G1	0000h	0001h	0002h	-----	-----	-----	-----	-----	-----	-----	00ECh	00EDh	00EEh	00EFh	-----	-----	-----	-----	-----	-----	-----	-----
G2	0100h	0101h	0102h	-----	-----	-----	-----	-----	-----	-----	01ECh	01EDh	01EEh	01EFh	-----	-----	-----	-----	-----	-----	-----	-----
G3	0200h	0201h	0202h	-----	-----	-----	-----	-----	-----	-----	02ECh	02EDh	02EEh	02EFh	-----	-----	-----	-----	-----	-----	-----	-----
G4	0300h	0301h	0302h	-----	-----	-----	-----	-----	-----	-----	03ECh	03EDh	03EEh	03EFh	-----	-----	-----	-----	-----	-----	-----	-----
G5	0400h	0401h	0402h	-----	-----	-----	-----	-----	-----	-----	04ECh	04EDh	04EEh	04EFh	-----	-----	-----	-----	-----	-----	-----	-----
G6	0500h	0501h	0502h	-----	-----	-----	-----	-----	-----	-----	05ECh	05EDh	05EEh	05EFh	-----	-----	-----	-----	-----	-----	-----	-----
G7	0600h	0601h	0602h	-----	-----	-----	-----	-----	-----	-----	06ECh	06EDh	06EEh	06EFh	-----	-----	-----	-----	-----	-----	-----	-----
G8	0700h	0701h	0702h	-----	-----	-----	-----	-----	-----	-----	07ECh	07EDh	07EEh	07EFh	-----	-----	-----	-----	-----	-----	-----	-----
G9	0800h	0801h	0802h	-----	-----	-----	-----	-----	-----	-----	08ECh	08EDh	08EEh	08EFh	-----	-----	-----	-----	-----	-----	-----	-----
---	---	---	---	---	---	---	---	---	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
G311	13600h	13601h	13602h	-----	-----	-----	-----	-----	-----	-----	136ECh	136EDh	136EEh	136EFh	-----	-----	-----	-----	-----	-----	-----	-----
G312	13700h	13701h	13702h	-----	-----	-----	-----	-----	-----	-----	137ECh	137EDh	137EEh	137EFh	-----	-----	-----	-----	-----	-----	-----	-----
G313	13800h	13801h	13802h	-----	-----	-----	-----	-----	-----	-----	138ECh	138EDh	138EEh	138EFh	-----	-----	-----	-----	-----	-----	-----	-----
G314	13900h	13901h	13902h	-----	-----	-----	-----	-----	-----	-----	139ECh	139EDh	139EEh	139EFh	-----	-----	-----	-----	-----	-----	-----	-----
G315	13A00h	13A01h	13A02h	-----	-----	-----	-----	-----	-----	-----	13AECh	13AEDh	13AEEh	13AEFh	-----	-----	-----	-----	-----	-----	-----	-----
G316	13B00h	13B01h	13B02h	-----	-----	-----	-----	-----	-----	-----	13BECh	13BEDh	13BEEh	13BEFh	-----	-----	-----	-----	-----	-----	-----	-----
G317	13C00h	13C01h	13C02h	-----	-----	-----	-----	-----	-----	-----	13CECh	13CEDh	13CEEh	13CEFh	-----	-----	-----	-----	-----	-----	-----	-----
G318	13D00h	13D01h	13D02h	-----	-----	-----	-----	-----	-----	-----	13DECh	13DEDh	13DEEH	13DEFh	-----	-----	-----	-----	-----	-----	-----	-----
G319	13E00h	13E01h	13E02h	-----	-----	-----	-----	-----	-----	-----	13EECh	13EEDh	13EEEh	13EEFh	-----	-----	-----	-----	-----	-----	-----	-----
G320	13F00h	13F01h	13F02h	-----	-----	-----	-----	-----	-----	-----	13FECh	13FEDh	13FE EH	13FEEh	-----	-----	-----	-----	-----	-----	-----	-----

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

S/G pins	S1	S2	S3	S4	S5	S6	S7	S8	S9	-----	S709	S710	S711	S712	S713	S714	S715	S716	S717	S718	S719	S720
G320	0000h	0001h	0002h	-----	-----	-----	-----	-----	-----	-----	00ECh	00EDh	00EEh	00EFh	-----	-----	-----	-----	-----	-----	-----	-----
G319	0100h	0101h	0102h	-----	-----	-----	-----	-----	-----	-----	01ECh	01EDh	01EEh	01EFh	-----	-----	-----	-----	-----	-----	-----	-----
G318	0200h	0201h	0202h	-----	-----	-----	-----	-----	-----	-----	02ECh	02EDh	02EEh	02EFh	-----	-----	-----	-----	-----	-----	-----	-----
G317	0300h	0301h	0302h	-----	-----	-----	-----	-----	-----	-----	03ECh	03EDh	03EEh	03EFh	-----	-----	-----	-----	-----	-----	-----	-----
G316	0400h	0401h	0402h	-----	-----	-----	-----	-----	-----	-----	04ECh	04EDh	04EEh	04EFh	-----	-----	-----	-----	-----	-----	-----	-----
G315	0500h	0501h	0502h	-----	-----	-----	-----	-----	-----	-----	05ECh	05EDh	05EEh	05EFh	-----	-----	-----	-----	-----	-----	-----	-----
G314	0600h	0601h	0602h	-----	-----	-----	-----	-----	-----	-----	06ECh	06EDh	06EEh	06EFh	-----	-----	-----	-----	-----	-----	-----	-----
G313	0700h	0701h	0702h	-----	-----	-----	-----	-----	-----	-----	07ECh	07EDh	07EEh	07EFh	-----	-----	-----	-----	-----	-----	-----	-----
G312	0800h	0801h	0802h	-----	-----	-----	-----	-----	-----	-----	08ECh	08EDh	08EEh	08EFh	-----	-----	-----	-----	-----	-----	-----	-----
---	---	---	---	---	---	---	---	---	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
G10	13600h	13601h	13602h	-----	-----	-----	-----	-----	-----	-----	136ECh	136EDh	136EEh	136EFh	-----	-----	-----	-----	-----	-----	-----	-----
G9	13700h	13701h	13702h	-----	-----	-----	-----	-----	-----	-----	137ECh	137EDh	137EEh	137EFh	-----	-----	-----	-----	-----	-----	-----	-----
G8	13800h	13801h	13802h	-----	-----	-----	-----	-----	-----	-----	138ECh	138EDh	138EEh	138EFh	-----	-----	-----	-----	-----	-----	-----	-----
G7	13900h	13901h	13902h	-----	-----	-----	-----	-----	-----	-----	139ECh	139EDh	139EEh	139EFh	-----	-----	-----	-----	-----	-----	-----	-----
G6	13A00h	13A01h	13A02h	-----	-----	-----	-----	-----	-----	-----	13AECh	13AEDh	13AEEh	13AEFh	-----	-----	-----	-----	-----	-----	-----	-----
G5	13B00h	13B01h	13B02h	-----	-----	-----	-----	-----	-----	-----	13BECh	13BEDh	13BEEh	13BEFh	-----	-----	-----	-----	-----	-----	-----	-----
G4	13C00h	13C01h	13C02h	-----	-----	-----	-----	-----	-----	-----	13CECh	13CEDh	13CEEh	13CEFh	-----	-----	-----	-----	-----	-----	-----	-----
G3	13D00h	13D01h	13D02h	-----	-----	-----	-----	-----	-----	-----	13DECh	13DEDh	13DEEH	13DEFh	-----	-----	-----	-----	-----	-----	-----	-----
G2	13E00h	13E01h	13E02h	-----	-----	-----	-----	-----	-----	-----	13EECh	13EEDh	13EEEh	13EEFh	-----	-----	-----	-----	-----	-----	-----	-----
G1	13F00h	13F01h	13F02h	-----	-----	-----	-----	-----	-----	-----	13FECh	13FEDh	13FE EH	13FEEh	-----	-----	-----	-----	-----	-----	-----	-----

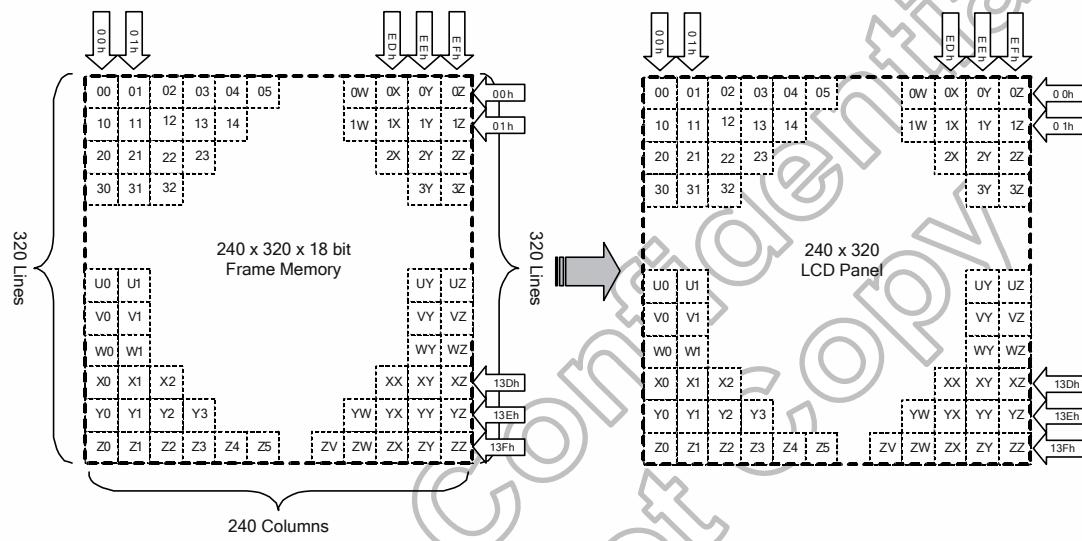
Table 6. 7 GRAM Address and Display Panel Position (SMY ='H')

HX8347-D 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** = '0' is set, HX8347-D will be into Normal Display Mode. When the **PLTON** = '1' is set, HX8347-D will be into Partial Display Mode. When the **SCROLL_ON** = '1' is set, HX8347-D will be into Scrolling 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 00EFh and page pointer is 0000h to 013Fh 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) **PSL [15:0]** = 11_{DEC} , **PEL [15:0]** = 130_{DEC} , **MADCTL's B4(ML)**='0' (**SMY** = 'L').

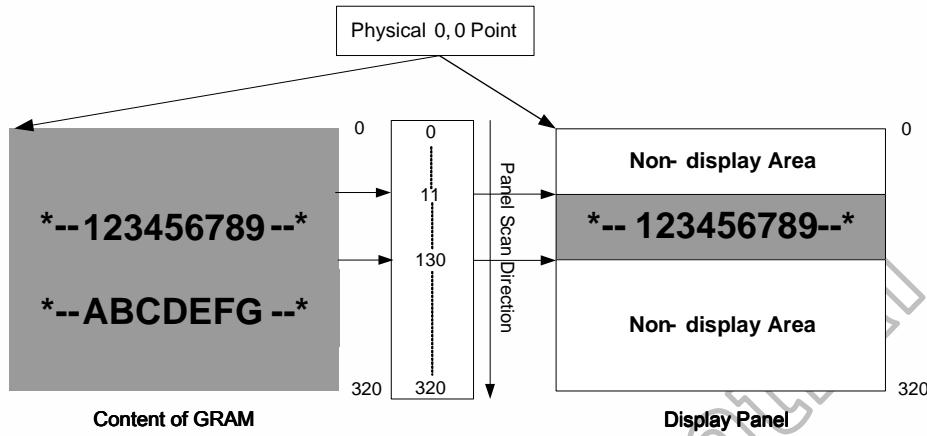


Figure 6. 5 Partial Display Area Setting (ML='0')

Example:

- (1) **PLTON** = '1',
- (2) **PSL [15:0]** = 11_{DEC} , **PEL [15:0]** = 130_{DEC} , **MADCTL's B4(ML)**='1' (**SMY** = 'L').

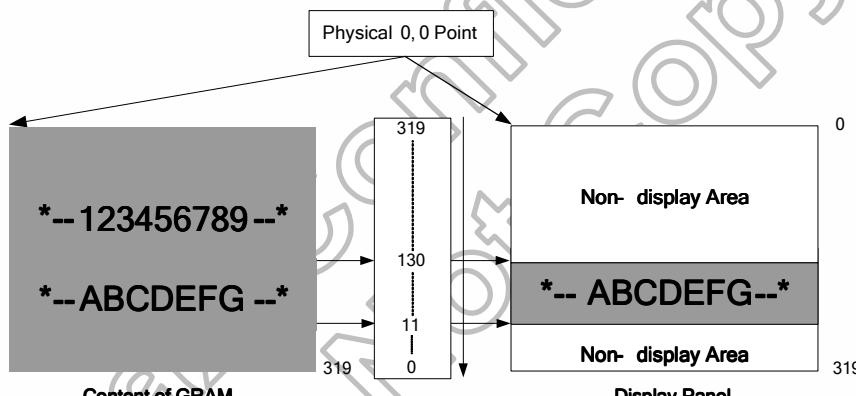


Figure 6. 6 Partial Display Area Setting (ML='1')

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	$f_{FLM} = 60Hz$
0	0	0	0	1 frame	17ms
0	0	0	1	5 frames	84ms
0	0	1	0	9 frames	150ms
:	:	:	:	:	
1	1	0	1	53 frames	880ms
1	1	1	0	57 frames	946ms
1	1	1	1	Setting Inhibited	-

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 (**REV_panel** = "0") and will be the black display if the type of LCD is normally black (**REV_panel** = "1") in refresh gate scan cycle.

6.3.2 Vertical Scroll Display Mode

When **SCROLL_ON** bit is set to '1', the scrolling display mode is active, and the vertical scrolling display is specified by **TFA**, **VSA**, **BFA** bits (R0Eh ~R13h) and **VSP** bits (R14~R15h).

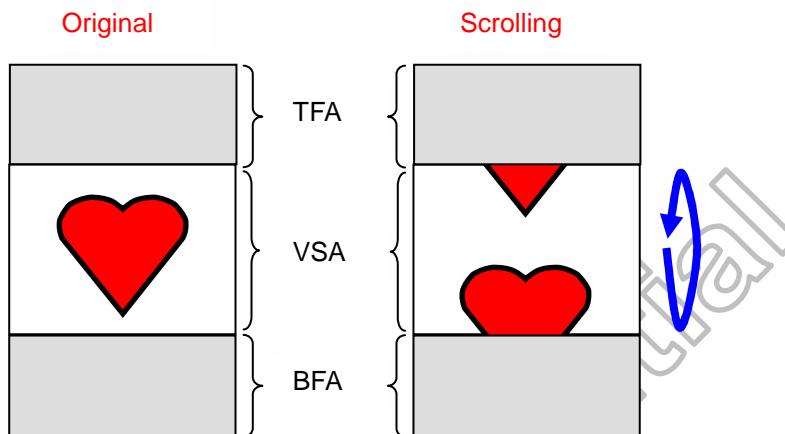


Figure 6. 7 Vertical Scrolling

When Vertical Scrolling Definition Parameters (**TFA+VSA+BFA**) =320. In this case, scrolling is applied as shown below.

Example (1) **TFA='2d'**, **VSA='318d'**, **BFA='0d'**, **VSP='3d'** (**SMX = 'L'**, **SMY = 'L'**)

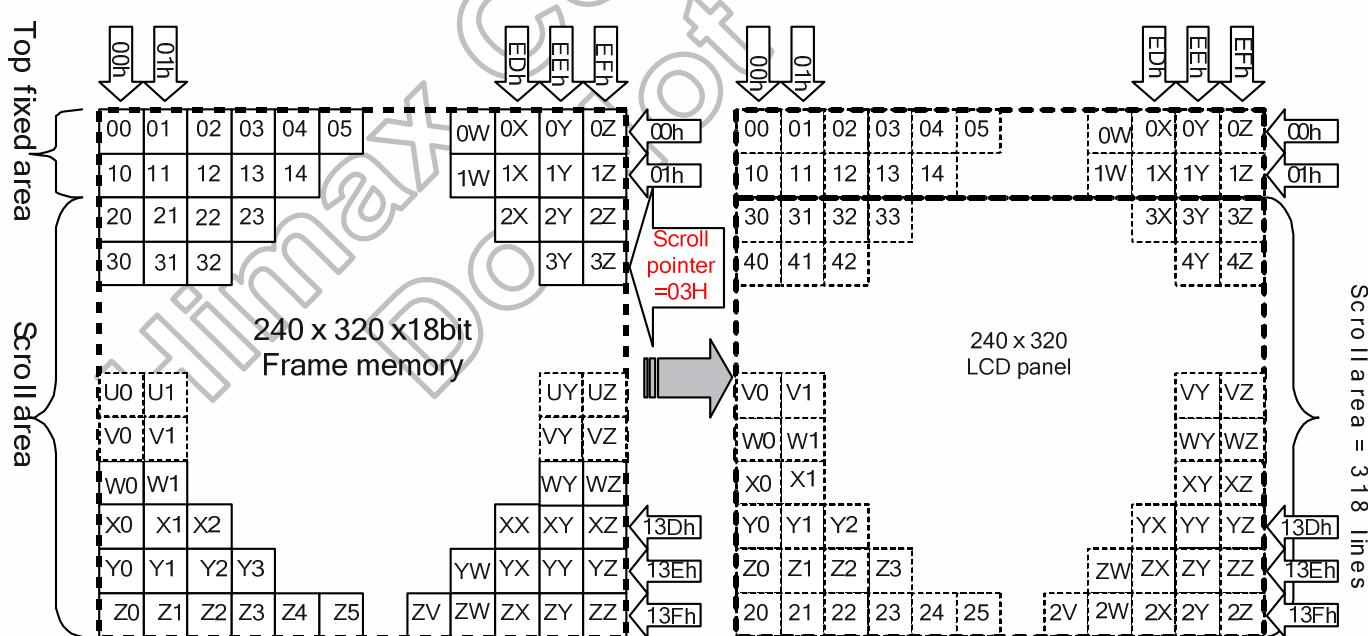


Figure 6. 8 Memory Map of Vertical Scrolling 1

Example (2) TFA='2d', VSA='316d', BFA='2d', VSP='3d' (**SMX = 'L'**, **SMY = 'L'**)

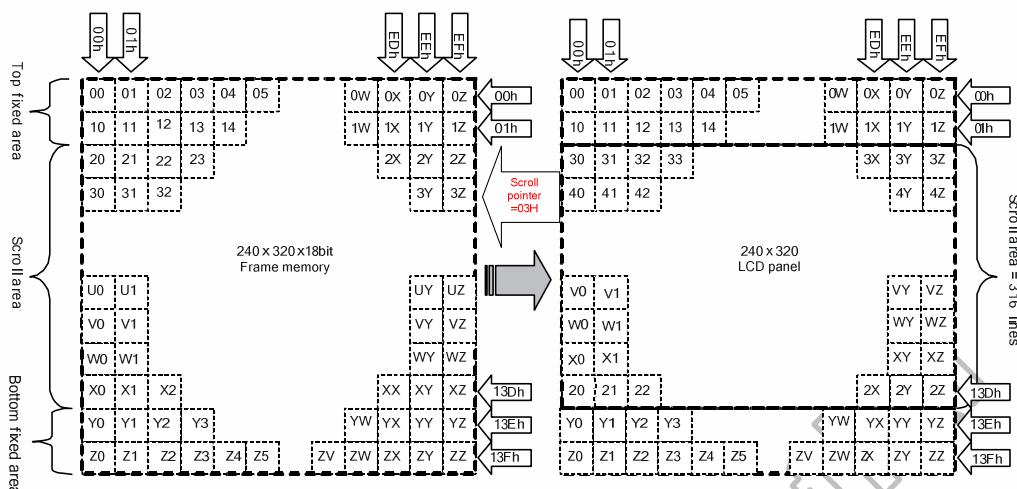


Figure 6.9 Memory Map of Vertical Scrolling 2

Example (3) TFA='2d', VSA='316d', BFA='2d', VSP='5d' (**SMX = 'L'**, **SMY = 'L'**).

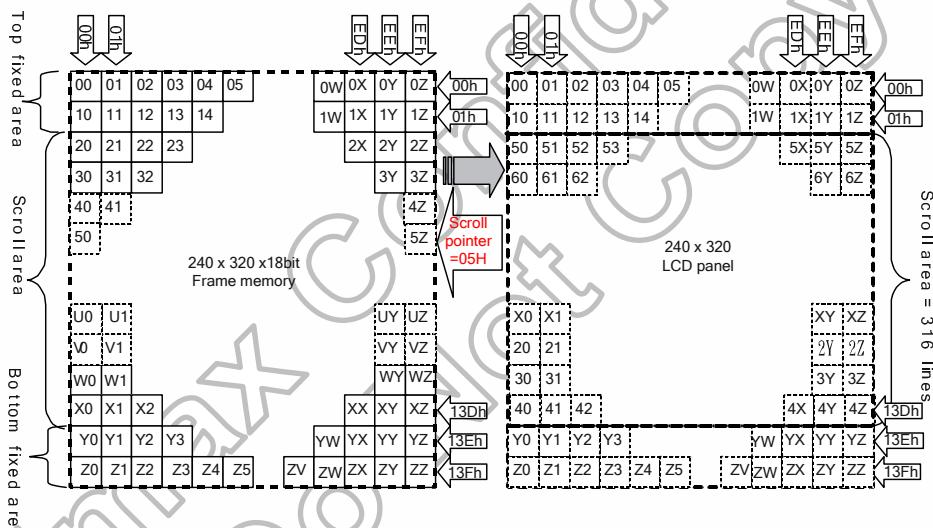


Figure 6.10 Memory Map of Vertical Scrolling 3

Vertical Scroll Example

There are 2 types of vertical scrolling, which are determined by the **TFA**, **VSA**, **BFA** bits (R0Eh ~R13h) and **VSP** bits (R14~R15h).

Case 1: TFA + VSA + BFA ≠ '320d'

N/A. Do not set TFA + VSA + BFA ≠ '320d'. In that case, unexpected picture will be shown.

Case 2: TFA + VSA + BFA = '320d' (Scrolling)

Example (1) When TFA='0d', VSA='320d', BFA='0d' and VSP='40d' (**SMX** = 'L', **SMY** = 'L')

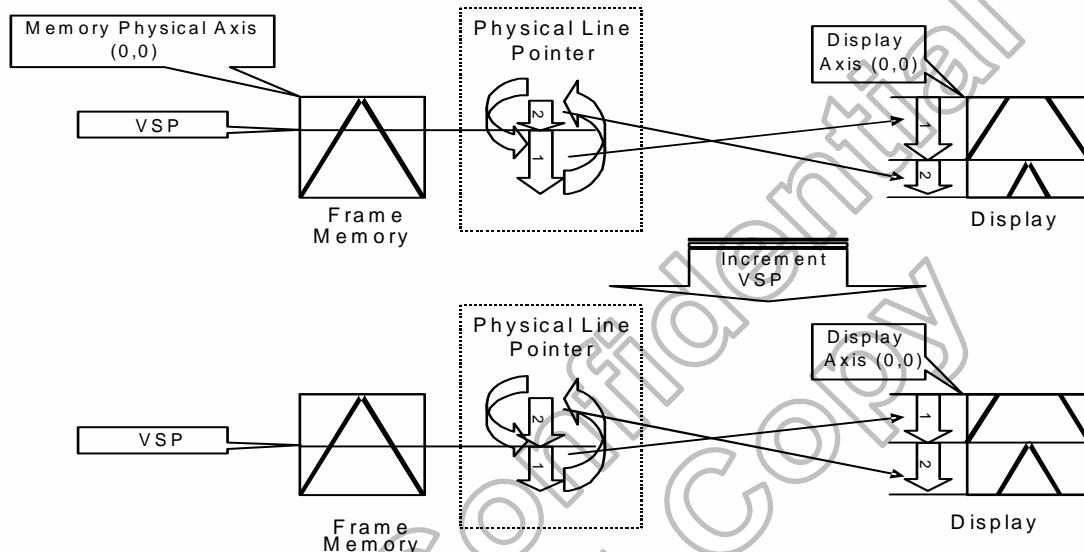


Figure 6. 11 Vertical Scrolling Example

6.3.3 Updating Order on Display Active Area in RGB Interface Mode

There is defined different kind of updating orders for display in RGB interface mode (**RCM [1:0]** = '1x'). These updating are controlled by **MY** and **MX** bits.

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

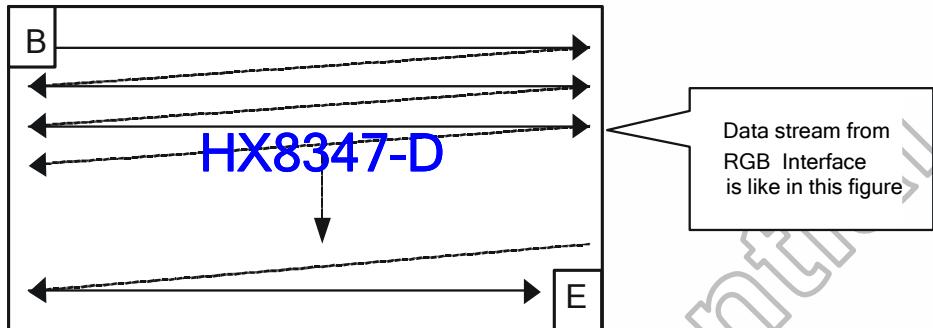


Figure 6. 12 Data Streaming Order in RGB I/F

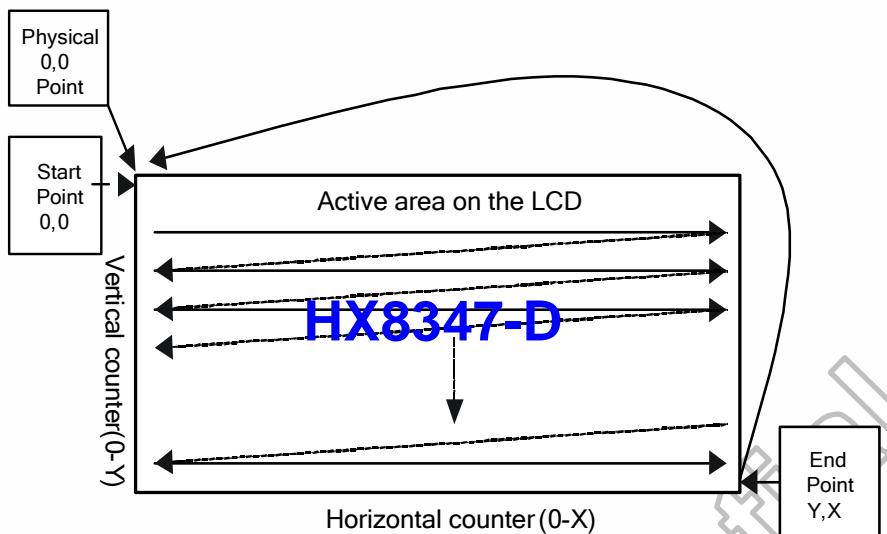


Figure 6. 13 Updating Order When MY = '0' and MX = '0'

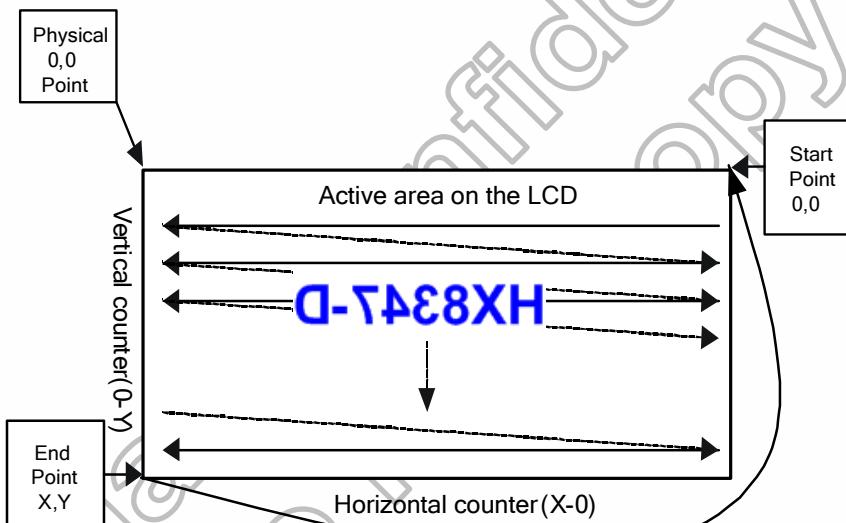
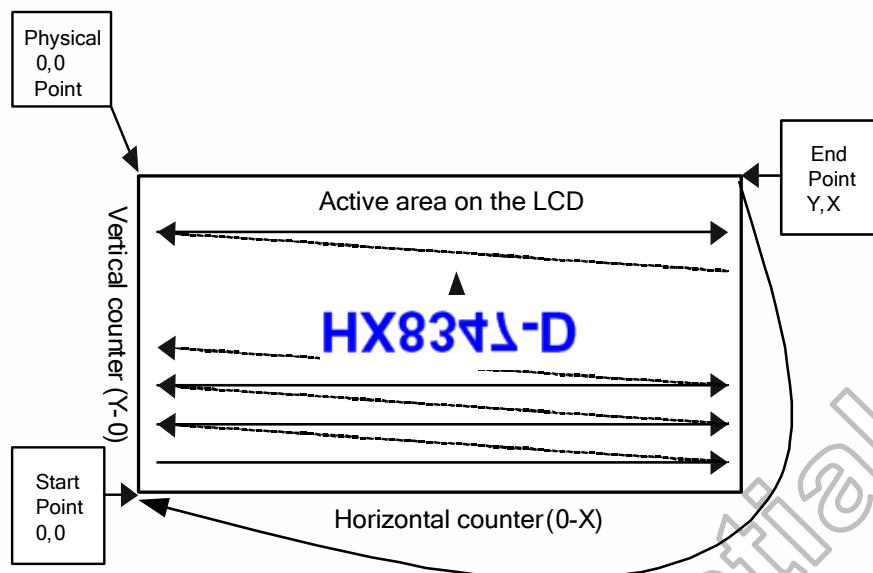
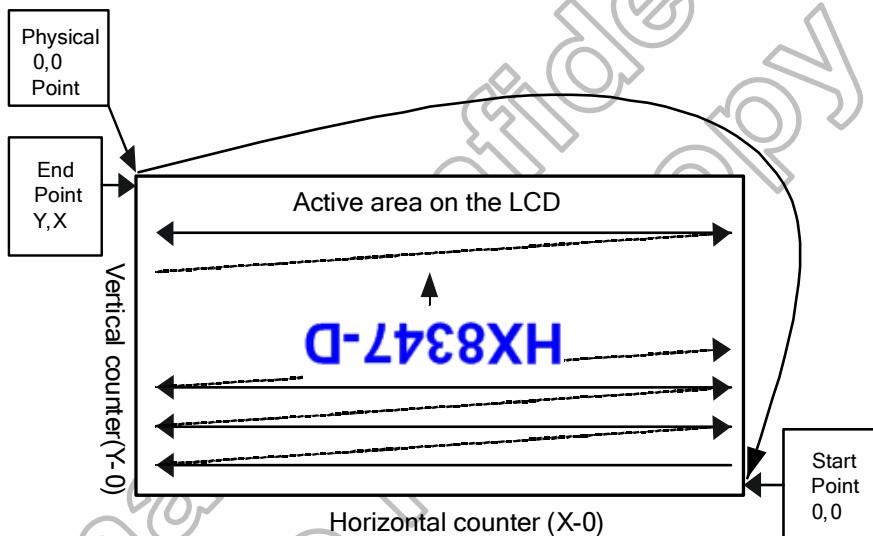


Figure 6. 14 Updating Order When MY = '0' and MX = '1'

Figure 6.15 Updating Order When $MY = '1'$ and $MX = '0'$ Figure 6.16 Updating Order When $MY = '1'$ and $MX = '1'$

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 HX8347-D can oscillate an internal R-C oscillator for internal operation. Because the tolerance of internal oscillator frequency is $\pm 5\%$, **RADJ [3:0]** bits for initial 2.85MHz internal clock generation. With other dividers setting, the 2.85MHz internal clock can be used to generate clock for other part of the chip using.

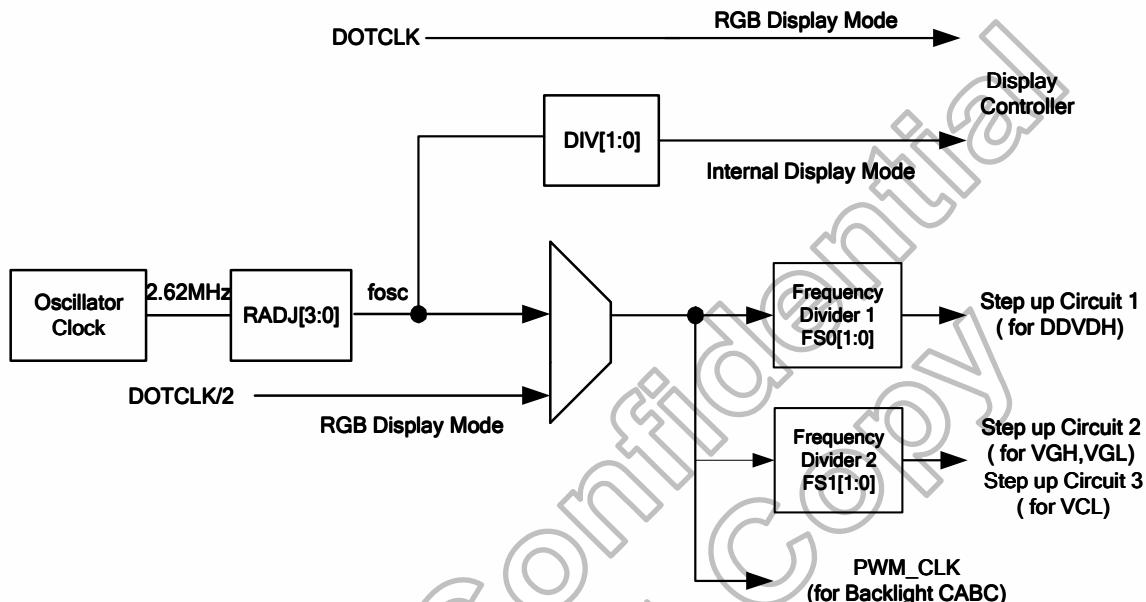


Figure 7.1 HX8347-D Internal Clock Circuit

7.2 Gamma Characteristic Correction Function

The HX8347-D 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.

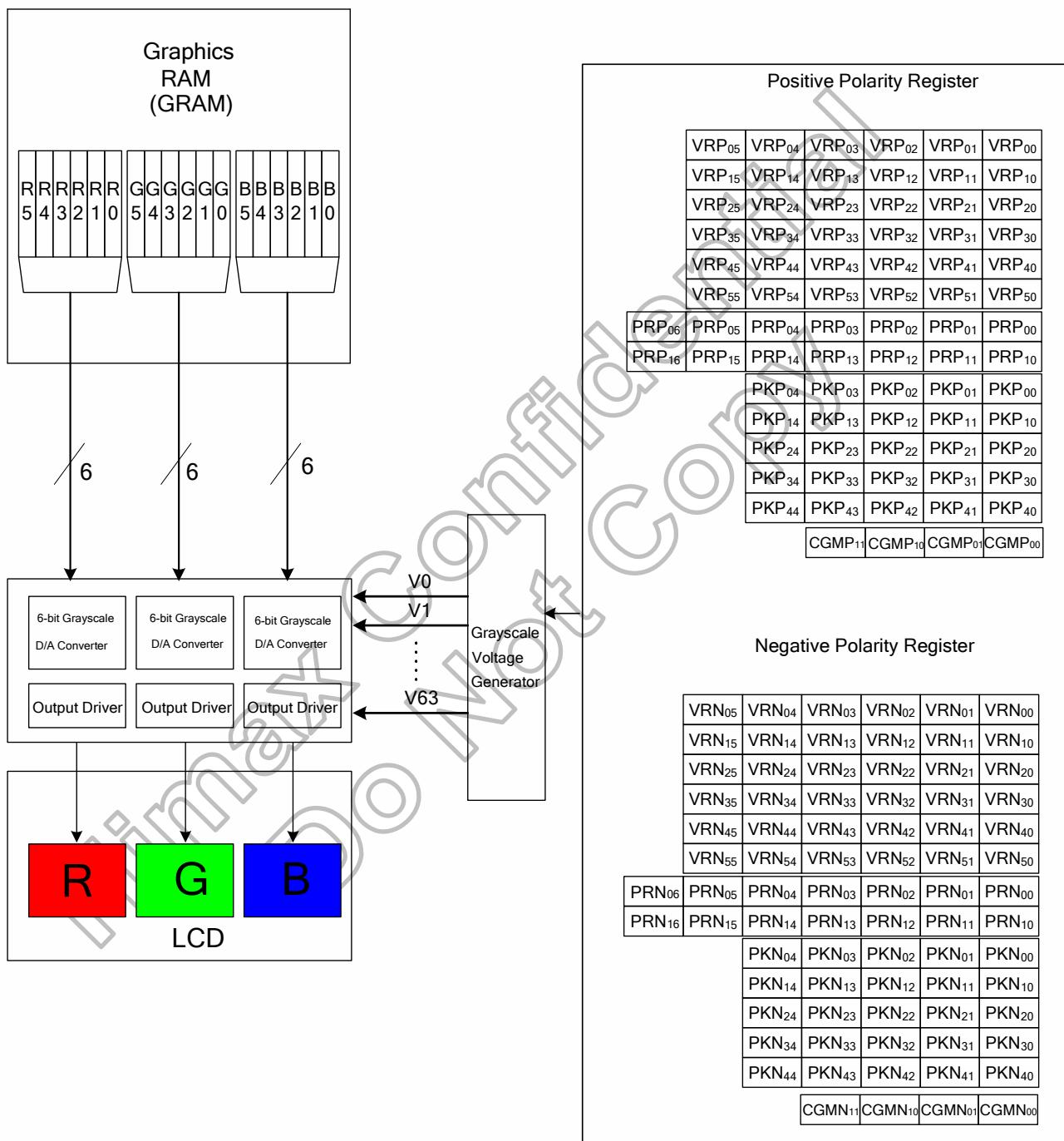


Figure 7. 2 Grayscale Control

Gamma-Characteristics Adjustment Register

This HX8347-D 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. The polarity of each register can be specified independently.

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

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 128-to-1 selector in the gamma resistor stream for reference gamma voltage generation. These registers are available for both positive and negative polarities.

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 32-to-1 selectors (PKP/N0~5), each of which has 5 inputs and generates one reference voltage output (Vg(P/N) 3, 20, 32(31), 43, 60).

Register Groups	Positive Polarity	Negative Polarity	Description
Center Adjustment	PRP0 6-0	PRN0 6-0	Variable resistor (PRP/N0) for center adjustment
	PRP1 6-0	PRN1 6-0	Variable resistor (PRP/N1) for center adjustment
Macro Adjustment	PKP0 4-0	PKN0 4-0	32-to-1 selector (voltage level of grayscale 3)
	PKP1 4-0	PKN1 4-0	32-to-1 selector (voltage level of grayscale 20)
	PKP2 4-0	PKN2 4-0	32-to-1 selector (voltage level of grayscale 32 for positive polarity and grayscale 31 for negative polarity)
	PKP3 4-0	PKN3 4-0	32-to-1 selector (voltage level of grayscale 43)
	PKP4 4-0	PKN4 4-0	32-to-1 selector (voltage level of grayscale 60)
Offset Adjustment	VRP0 5-0	VRN0 5-0	Variable resistor (VRP/N0) for offset adjustment
	VRP1 5-0	VRN1 5-0	Variable resistor (VRP/N1) for offset adjustment
	VRP2 5-0	VRN2 5-0	Variable resistor (VRP/N2) for offset adjustment
	VRP3 5-0	VRN3 5-0	Variable resistor (VRP/N3) for offset adjustment
	VRP4 5-0	VRN4 5-0	Variable resistor (VRP/N4) for offset adjustment
	VRP5 5-0	VRN5 5-0	Variable resistor (VRP/N5) for offset adjustment

Table 7. 1 Gamma-Adjustment Registers

Gamma Resister Stream

The block consists of two gamma register streams one is for positive polarity and the other is for negative polarity, each one including eight gamma reference voltages. VgP/N (0, 1, 2, 3, 8 20, 32(31), 43, 55, 60, 61, 62, 63). Furthermore, the block has a pin (VGS) to connect a variable resistor outside the chip for the variation between panels, if needed.

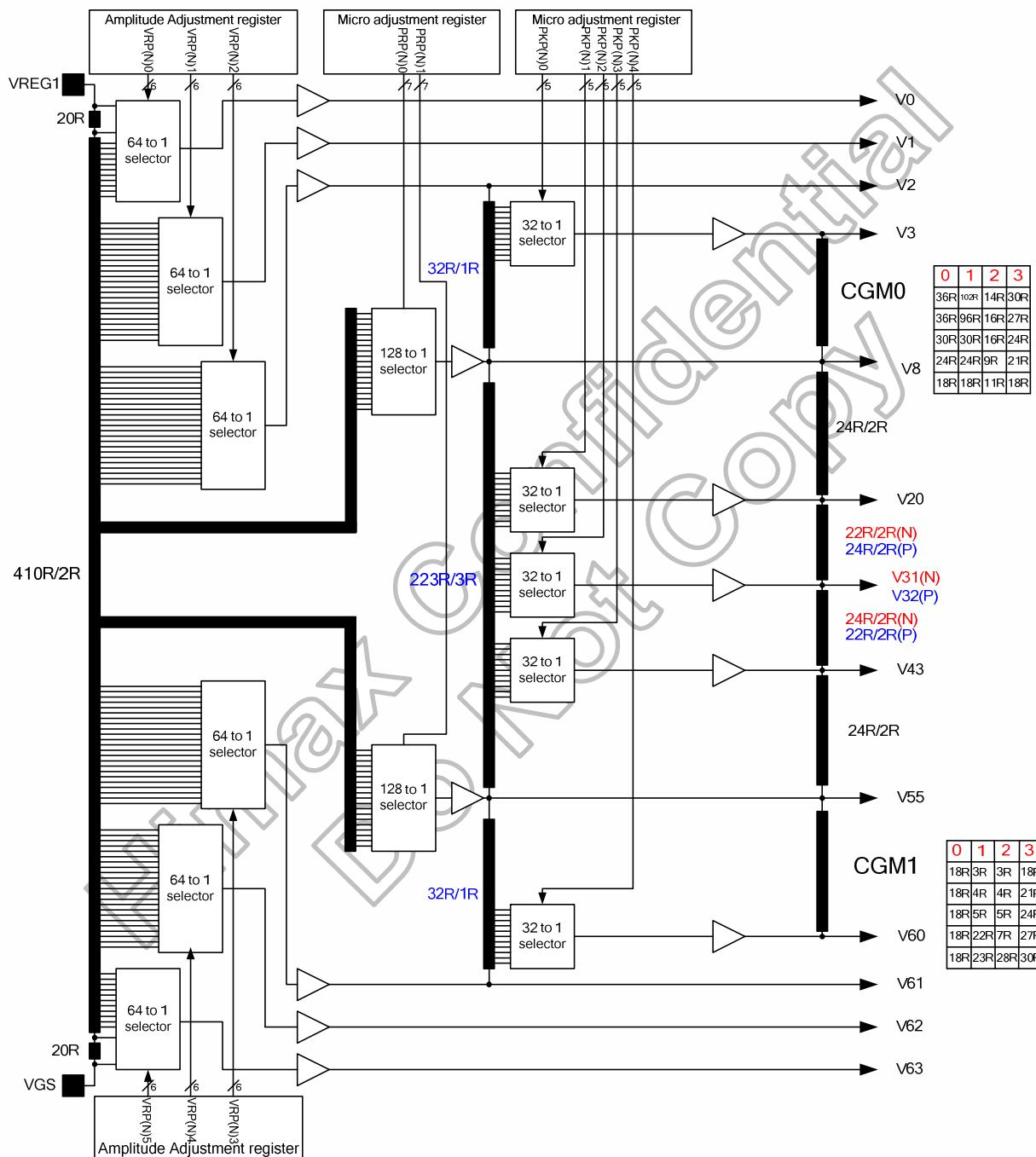


Figure 7. 3 Gamma Resister Stream and Gamma Reference Voltage

Variable Resister

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 VR(P/N)0 5-0	Resistance VR(P/N)0	Value in Register VR(P/N)1 5-0	Resistance VR(P/N)1	Value in Register VR(P/N)2 5-0	Resistance VR(P/N)2
000000	0R	000000	0R	000000	0R
000001	20R	000001	2R	000001	2R
000010	22R	000010	4R	000010	4R
000011	24R	000011	6R	000011	6R
•	•	•	•	•	•
•	•	•	•	•	•
011101	76R	011101	58R	011101	58R
011110	78R	011110	60R	011110	60R
011111	80R	011111	62R	011111	62R
100000	84R	100000	66R	100000	66R
100001	88R	100001	70R	100001	70R
100010	92R	100010	74R	100010	74R
•	•	•	•	•	•
•	•	•	•	•	•
111101	200R	111101	182R	111101	182R
111110	204R	111110	186R	111110	186R
111111	208R	111111	190R	111111	190R

Value in Register VR(P/N)3 5-0	Resistance VR(P/N)3	Value in Register VR(P/N)4 5-0	Resistance VR(P/N)4	Value in Register VR(P/N)5 5-0	Resistance VR(P/N)2
000000	0R	000000	0R	000000	0R
000001	4R	000001	4R	000001	4R
000010	8R	000010	8R	000010	8R
•	•	•	•	•	•
•	•	•	•	•	•
011101	116R	011101	116R	011101	116R
011110	120R	011110	120R	011110	120R
011111	124R	011111	124R	011111	124R
100000	128R	100000	128R	100000	128R
100001	130R	100001	130R	100001	130R
100010	132R	100010	132R	100010	132R
•	•	•	•	•	•
•	•	•	•	•	•
111100	184R	111100	184R	111100	184R
111101	186R	111101	186R	111101	186R
111110	188R	111110	188R	111110	188R
111111	190R	111111	190R	111111	190R

Table 7. 2 Offset Adjustment 0 ~ 5

Value in Register PR(P/N)0 6-0	Resistance PR(P/N)0	Value in Register PR(P/N)1 6-0	Resistance PR(P/N)1
0000000	0R	0000000	0R
0000001	2R	0000001	2R
0000010	4R	0000010	4R
•	•	•	•
•	•	•	•
1111101	250R	1010101	250R
1111110	252R	1111110	252R
1111111	254R	1111111	254R

Table 7. 3 Center Adjustment

The grayscale levels are determined by the following formulas:

Reference Voltage	Macro Adjustment Value	VinP/N0 Formula
VinP/N0	VRP/N0 5-0 = 000000	VREG1
	VRP/N0 5-0 = 000001	((450R - 20R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 000010	((450R - 22R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 000011	((450R - 24R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 0000100	((450R - 26R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 000101	((450R - 28R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 000110	((450R - 30R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 000111	((450R - 32R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001000	((450R - 34R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001001	((450R - 36R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001010	((450R - 38R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001011	((450R - 40R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001100	((450R - 42R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001101	((450R - 44R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001110	((450R - 46R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 001111	((450R - 48R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010000	((450R - 50R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010001	((450R - 52R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010010	((450R - 54R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010011	((450R - 56R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010100	((450R - 58R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010101	((450R - 60R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010110	((450R - 62R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 010111	((450R - 64R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011000	((450R - 66R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011001	((450R - 68R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011010	((450R - 70R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011011	((450R - 72R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011100	((450R - 74R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011101	((450R - 76R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011110	((450R - 78R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 011111	((450R - 80R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100000	((450R - 84R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100001	((450R - 88R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100010	((450R - 92R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100011	((450R - 96R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100100	((450R - 100R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100101	((450R - 104R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100110	((450R - 108R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 100111	((450R - 112R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101000	((450R - 116R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101001	((450R - 120R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101010	((450R - 124R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101011	((450R - 128R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101100	((450R - 132R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101101	((450R - 136R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101110	((450R - 140R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 101111	((450R - 144R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110000	((450R - 148R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110001	((450R - 152R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110010	((450R - 156R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110011	((450R - 160R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110100	((450R - 164R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110101	((450R - 168R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110110	((450R - 172R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 110111	((450R - 176R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111000	((450R - 180R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111001	((450R - 184R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111010	((450R - 188R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111011	((450R - 192R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111100	((450R - 196R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111101	((450R - 200R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111110	((450R - 204R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N0 5-0 = 111111	((450R - 208R) / 450R) * (VREG1 - VGS) + VGS

Table 7. 4 VinP/N 0

Reference Voltage	Macro Adjustment Value	VinP/N1 Formula
VinP/N1	VRP/N1 5-0 = 000000	((430R / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000001	((430R - 2R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000010	((430R - 4R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000011	((430R - 6R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000100	((430R - 8R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000101	((430R - 10R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000110	((430R - 12R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 000111	((430R - 14R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001000	((430R - 16R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001001	((430R - 18R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001010	((430R - 20R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001011	((430R - 22R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001100	((430R - 24R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001101	((430R - 26R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001110	((430R - 28R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 001111	((430R - 30R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010000	((430R - 32R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010001	((430R - 34R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010010	((430R - 36R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010011	((430R - 38R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010100	((430R - 40R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010101	((430R - 42R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010110	((430R - 44R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 010111	((430R - 46R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011000	((430R - 48R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011001	((430R - 50R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011010	((430R - 52R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011011	((430R - 54R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011100	((430R - 56R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011101	((430R - 58R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011110	((430R - 60R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 011111	((430R - 62R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100000	((430R - 66R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100001	((430R - 70R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100010	((430R - 74R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100011	((430R - 78R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100100	((430R - 82R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100101	((430R - 86R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100110	((430R - 90R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 100111	((430R - 94R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101000	((430R - 98R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101001	((430R - 102R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101010	((430R - 106R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101011	((430R - 110R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101100	((430R - 114R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101101	((430R - 118R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101110	((430R - 122R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 101111	((430R - 126R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110000	((430R - 130R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110001	((430R - 134R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110010	((430R - 138R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110011	((430R - 142R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110100	((430R - 146R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110101	((430R - 150R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110110	((430R - 154R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 110111	((430R - 158R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111000	((430R - 162R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111001	((430R - 166R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111010	((430R - 170R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111011	((430R - 174R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111100	((430R - 178R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111101	((430R - 182R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111110	((430R - 186R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N1 5-0 = 111111	((430R - 190R) / 450R) * (VREG1 - VGS) + VGS

Table 7. 5 VinP/N 1

Reference Voltage	Macro Adjustment Value	VinP/N2 Formula
VinP/N2	VRP/N2 5-0 = 000000	$(410R / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000001	$((410R - 2R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000010	$((410R - 4R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000011	$((410R - 6R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000100	$((410R - 8R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000101	$((410R - 10R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000110	$((410R - 12R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 000111	$((410R - 14R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001000	$((410R - 16R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001001	$((410R - 18R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001010	$((410R - 20R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001011	$((410R - 22R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001100	$((410R - 24R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001101	$((410R - 26R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001110	$((410R - 28R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 001111	$((410R - 30R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010000	$((410R - 32R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010001	$((410R - 34R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010010	$((410R - 36R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010011	$((410R - 38R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010100	$((410R - 40R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010101	$((410R - 42R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010110	$((410R - 44R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 010111	$((410R - 46R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011000	$((410R - 48R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011001	$((410R - 50R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011010	$((410R - 52R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011011	$((410R - 54R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011100	$((410R - 56R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011101	$((410R - 58R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011110	$((410R - 60R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 011111	$((410R - 62R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100000	$((410R - 66R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100001	$((410R - 70R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100010	$((410R - 74R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100011	$((410R - 78R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100100	$((410R - 82R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100101	$((410R - 86R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100110	$((410R - 90R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 100111	$((410R - 94R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101000	$((410R - 98R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101001	$((410R - 102R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101010	$((410R - 106R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101011	$((410R - 110R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101100	$((410R - 114R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101101	$((410R - 118R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101110	$((410R - 122R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 101111	$((410R - 126R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110000	$((410R - 130R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110001	$((410R - 134R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110010	$((410R - 138R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110011	$((410R - 142R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110100	$((410R - 146R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110101	$((410R - 150R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110110	$((410R - 154R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 110111	$((410R - 158R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111000	$((410R - 162R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111001	$((410R - 166R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111010	$((410R - 170R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111011	$((410R - 174R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111100	$((410R - 178R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111101	$((410R - 182R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111110	$((410R - 186R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N2 5-0 = 111111	$((410R - 190R) / 450R) * (VREG1 - VGS) + VGS$

Table 7. 6 VinP/N 2

Reference Voltage	Macro Adjustment Value	VinP/N10 Formula
VinP/N10	VRP/N3 5-0 = 000000	$((230R / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000001	$((230R - 4R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000010	$((230R - 8R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000011	$((230R - 12R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000100	$((230R - 16R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000101	$((230R - 20R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000110	$((230R - 24R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 000111	$((230R - 28R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001000	$((230R - 32R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001001	$((230R - 36R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001010	$((230R - 40R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001011	$((230R - 44R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001100	$((230R - 48R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001101	$((230R - 52R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001110	$((230R - 56R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 001111	$((230R - 60R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010000	$((230R - 64R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010001	$((230R - 68R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010010	$((230R - 72R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010011	$((230R - 76R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010100	$((230R - 80R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010101	$((230R - 84R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010110	$((230R - 88R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 010111	$((230R - 92R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011000	$((230R - 96R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011001	$((230R - 100R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011010	$((230R - 104R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011011	$((230R - 108R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011100	$((230R - 112R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011101	$((230R - 116R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011110	$((230R - 120R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 011111	$((230R - 124R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100000	$((230R - 128R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100001	$((230R - 130R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100010	$((230R - 132R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100011	$((230R - 134R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100100	$((230R - 136R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100101	$((230R - 138R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100110	$((230R - 140R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 100111	$((230R - 142R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101000	$((230R - 144R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101001	$((230R - 146R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101010	$((230R - 148R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101011	$((230R - 150R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101100	$((230R - 152R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101101	$((230R - 154R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101110	$((230R - 156R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 101111	$((230R - 158R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110000	$((230R - 160R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110001	$((230R - 162R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110010	$((230R - 164R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110011	$((230R - 166R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110100	$((230R - 168R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110101	$((230R - 170R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110110	$((230R - 172R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 110111	$((230R - 174R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111000	$((230R - 176R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111001	$((230R - 178R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111010	$((230R - 180R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111011	$((230R - 182R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111100	$((230R - 184R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111101	$((230R - 186R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111110	$((230R - 188R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N3 5-0 = 111111	$((230R - 190R) / 450R) * (VREG1 - VGS) + VGS$

Table 7. 7 VinP/N 10

Reference Voltage	Macro Adjustment Value	VinP/N11 Formula
VinP/N11	VRP/N4 5-0 = 000000	((210R / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000001	((210R - 4R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000010	((210R - 8R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000011	((210R - 12R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000100	((210R - 16R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000101	((210R - 20R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000110	((210R - 24R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 000111	((210R - 28R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001000	((210R - 32R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001001	((210R - 36R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001010	((210R - 40R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001011	((210R - 44R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001100	((210R - 48R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001101	((210R - 52R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001110	((210R - 56R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 001111	((210R - 60R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010000	((210R - 64R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010001	((210R - 68R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010010	((210R - 72R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010011	((210R - 76R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010100	((210R - 80R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010101	((210R - 84R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010110	((210R - 88R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 010111	((210R - 92R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011000	((210R - 96R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011001	((210R - 100R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011010	((210R - 104R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011011	((210R - 108R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011100	((210R - 112R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011101	((210R - 116R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011110	((210R - 120R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 011111	((210R - 124R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100000	((210R - 128R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100001	((210R - 130R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100010	((210R - 132R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100011	((210R - 134R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100100	((210R - 136R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100101	((210R - 138R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100110	((210R - 140R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 100111	((210R - 142R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101000	((210R - 144R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101001	((210R - 146R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101010	((210R - 148R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101011	((210R - 150R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101100	((210R - 152R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101101	((210R - 154R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101110	((210R - 156R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 101111	((210R - 158R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110000	((210R - 160R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110001	((210R - 162R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110010	((210R - 164R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110011	((210R - 166R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110100	((210R - 168R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110101	((210R - 170R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110110	((210R - 172R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 110111	((210R - 174R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111000	((210R - 176R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111001	((210R - 178R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111010	((210R - 180R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111011	((210R - 182R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111100	((210R - 184R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111101	((210R - 186R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111110	((210R - 188R) / 450R) * (VREG1 - VGS) + VGS
	VRP/N4 5-0 = 111111	((210R - 190R) / 450R) * (VREG1 - VGS) + VGS

Table 7. 8 VinP/N 11

Reference Voltage	Macro Adjustment Value	VinP/N12 Formula
VinP/N12	VRP/N5 5-0 = 000000	$(210R / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000001	$((208R - 4R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000010	$((208R - 8R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000011	$((208R - 12R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000100	$((208R - 16R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000101	$((208R - 20R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000110	$((208R - 24R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 000111	$((208R - 28R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001000	$((208R - 32R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001001	$((208R - 36R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001010	$((208R - 40R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001011	$((208R - 44R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001100	$((208R - 48R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001101	$((208R - 52R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001110	$((208R - 56R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 001111	$((208R - 60R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010000	$((208R - 64R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010001	$((208R - 68R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010010	$((208R - 72R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010011	$((208R - 76R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010100	$((208R - 80R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010101	$((208R - 84R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010110	$((208R - 88R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 010111	$((208R - 92R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011000	$((208R - 96R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011001	$((208R - 100R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011010	$((208R - 104R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011011	$((208R - 108R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011100	$((208R - 112R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011101	$((208R - 116R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011110	$((208R - 120R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 011111	$((208R - 124R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100000	$((208R - 128R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100001	$((208R - 130R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100010	$((208R - 132R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100011	$((208R - 134R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100100	$((208R - 136R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100101	$((208R - 138R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100110	$((208R - 140R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 100111	$((208R - 142R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101000	$((208R - 144R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101001	$((208R - 146R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101010	$((208R - 148R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101011	$((208R - 150R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101100	$((208R - 152R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101101	$((208R - 154R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101110	$((208R - 156R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 101111	$((208R - 158R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110000	$((208R - 160R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110001	$((208R - 162R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110010	$((208R - 164R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110011	$((208R - 166R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110100	$((208R - 168R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110101	$((208R - 170R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110110	$((208R - 172R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 110111	$((208R - 174R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111000	$((208R - 176R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111001	$((208R - 178R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111010	$((208R - 180R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111011	$((208R - 182R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111100	$((208R - 184R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111101	$((208R - 186R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111110	$((208R - 188R) / 450R) * (VREG1 - VGS) + VGS$
	VRP/N5 5-0 = 111111	VGS

Table 7. 9 VinP/N 12

Reference Voltage	Macro Adjustment Value	VinP/N4 Formula
VinP/N4	PRP/N0 6-0 = 0000000	$(350R / 450R) (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000001	$((350R - 2R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000010	$((350R - 4R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000011	$((350R - 6R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000100	$((350R - 8R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000101	$((350R - 10R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000110	$((350R - 12R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0000111	$((350R - 14R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001000	$((350R - 16R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001001	$((350R - 18R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001010	$((350R - 20R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001011	$((350R - 22R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001100	$((350R - 24R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001101	$((350R - 26R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001110	$((350R - 28R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0001111	$((350R - 30R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010000	$((350R - 32R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010001	$((350R - 34R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010010	$((350R - 36R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010011	$((350R - 38R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010100	$((350R - 40R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010101	$((350R - 42R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010110	$((350R - 44R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0010111	$((350R - 46R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011000	$((350R - 48R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011001	$((350R - 50R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011010	$((350R - 52R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011011	$((350R - 54R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011100	$((350R - 56R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011101	$((350R - 58R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011110	$((350R - 60R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0011111	$((350R - 62R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100000	$((350R - 64R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100001	$((350R - 66R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100010	$((350R - 68R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100011	$((350R - 70R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100100	$((350R - 72R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100101	$((350R - 74R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100110	$((350R - 76R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0100111	$((350R - 78R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101000	$((350R - 80R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101001	$((350R - 82R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101010	$((350R - 84R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101011	$((350R - 86R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101100	$((350R - 88R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101101	$((350R - 90R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101110	$((350R - 92R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0101111	$((350R - 94R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110000	$((350R - 96R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110001	$((350R - 98R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110010	$((350R - 100R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110011	$((350R - 102R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110100	$((350R - 104R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110101	$((350R - 106R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110110	$((350R - 108R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0110111	$((350R - 110R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111000	$((350R - 112R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111001	$((350R - 114R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111010	$((350R - 116R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111011	$((350R - 118R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111100	$((350R - 120R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111101	$((350R - 122R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111110	$((350R - 124R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 0111111	$((350R - 126R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 1000000	$((350R - 128R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 1000001	$((350R - 130R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 1000010	$((350R - 132R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 1000011	$((350R - 134R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N0 6-0 = 1000100	$((350R - 136R) / 450R) * (VREG1 - VGS) + VGS$

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PRP/N0 6-0 = 1000101	((350R – 138R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1000110	((350R – 140R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1000111	((350R – 142R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001000	((350R – 144R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001001	((350R – 146R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001010	((350R – 148R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001011	((350R – 150R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001100	((350R – 152R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001101	((350R – 154R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001110	((350R – 156R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1001111	((350R – 158R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010000	((350R – 160R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010001	((350R – 162R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010010	((350R – 164R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010011	((350R – 166R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010100	((350R – 168R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010101	((350R – 170R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010110	((350R – 172R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1010111	((350R – 174R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011000	((350R – 176R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011001	((350R – 178R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011010	((350R – 180R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011011	((350R – 182R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011100	((350R – 184R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011101	((350R – 186R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011110	((350R – 188R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1011111	((350R – 190R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100000	((350R – 192R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100001	((350R – 194R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100010	((350R – 196R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100011	((350R – 198R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100100	((350R – 200R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100101	((350R – 202R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100110	((350R – 204R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1100111	((350R – 206R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101000	((350R – 208R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101001	((350R – 210R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101010	((350R – 212R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101011	((350R – 214R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101100	((350R – 216R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101101	((350R – 218R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101110	((350R – 220R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1101111	((350R – 223R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110000	((350R – 224R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110001	((350R – 226R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110010	((350R – 228R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110011	((350R – 230R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110100	((350R – 232R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110101	((350R – 234R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110110	((350R – 236R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1110111	((350R – 238R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111000	((350R – 240R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111001	((350R – 243R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111010	((350R – 244R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111011	((350R – 246R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111100	((350R – 248R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111101	((350R – 250R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111110	((350R – 252R) / 450R) * (VREG1 - VGS) + VGS
PRP/N0 6-0 = 1111111	((350R – 254R) / 450R) * (VREG1 - VGS) + VGS

Table 7. 10 VinP/N4

Reference Voltage	Macro Adjustment Value	VinP/N8 Formula
VinP/N8	PRP/N1 6-0 = 0000000	$(354R / 450R) (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000001	$((354R - 2R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000010	$((354R - 4R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000011	$((354R - 6R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000100	$((354R - 8R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000101	$((354R - 10R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000110	$((354R - 12R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0000111	$((354R - 14R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001000	$((354R - 16R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001001	$((354R - 18R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001010	$((354R - 20R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001011	$((354R - 22R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001100	$((354R - 24R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001101	$((354R - 26R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001110	$((354R - 28R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0001111	$((354R - 30R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010000	$((354R - 32R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010001	$((354R - 34R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010010	$((354R - 36R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010011	$((354R - 38R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010100	$((354R - 40R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010101	$((354R - 42R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010110	$((354R - 44R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0010111	$((354R - 46R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011000	$((354R - 48R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011001	$((354R - 50R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011010	$((354R - 52R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011011	$((354R - 54R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011100	$((354R - 56R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011101	$((354R - 58R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011110	$((354R - 60R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0011111	$((354R - 62R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100000	$((354R - 64R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100001	$((354R - 66R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100010	$((354R - 68R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100011	$((354R - 70R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100100	$((354R - 72R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100101	$((354R - 74R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100110	$((354R - 76R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0100111	$((354R - 78R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101000	$((354R - 80R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101001	$((354R - 82R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101010	$((354R - 84R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101011	$((354R - 86R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101100	$((354R - 88R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101101	$((354R - 90R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101110	$((354R - 92R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0101111	$((354R - 94R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110000	$((354R - 96R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110001	$((354R - 98R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110010	$((354R - 100R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110011	$((354R - 102R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110100	$((354R - 104R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110101	$((354R - 106R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110110	$((354R - 108R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0110111	$((354R - 110R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111000	$((354R - 112R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111001	$((354R - 114R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111010	$((354R - 116R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111011	$((354R - 118R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111100	$((354R - 120R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111101	$((354R - 122R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111110	$((354R - 124R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 0111111	$((354R - 126R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 1000000	$((354R - 128R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 1000001	$((354R - 130R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 1000010	$((354R - 132R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 1000011	$((354R - 134R) / 450R) * (VREG1 - VGS) + VGS$
	PRP/N1 6-0 = 1000100	$((354R - 136R) / 450R) * (VREG1 - VGS) + VGS$

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PRP/N1 6-0 = 1000101	((354R - 138R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1000110	((354R - 140R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1000111	((354R - 142R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001000	((354R - 144R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001001	((354R - 146R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001010	((354R - 148R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001011	((354R - 150R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001100	((354R - 152R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001101	((354R - 154R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001110	((354R - 156R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1001111	((354R - 158R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010000	((354R - 160R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010001	((354R - 162R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010010	((354R - 164R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010011	((354R - 166R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010100	((354R - 168R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010101	((354R - 170R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010110	((354R - 172R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1010111	((354R - 174R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011000	((354R - 176R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011001	((354R - 178R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011010	((354R - 180R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011011	((354R - 182R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011100	((354R - 184R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011101	((354R - 186R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011110	((354R - 188R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1011111	((354R - 190R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100000	((354R - 192R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100001	((354R - 194R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100010	((354R - 196R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100011	((354R - 198R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100100	((354R - 200R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100101	((354R - 202R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100110	((354R - 204R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1100111	((354R - 206R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101000	((354R - 208R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101001	((354R - 210R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101010	((354R - 212R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101011	((354R - 214R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101100	((354R - 216R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101101	((354R - 218R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101110	((354R - 220R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1101111	((354R - 222R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110000	((354R - 224R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110001	((354R - 226R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110010	((354R - 228R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110011	((354R - 230R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110100	((354R - 232R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110101	((354R - 234R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110110	((354R - 236R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1110111	((354R - 238R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111000	((354R - 240R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111001	((354R - 242R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111010	((354R - 244R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111011	((354R - 246R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111100	((354R - 248R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111101	((354R - 250R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111110	((354R - 252R) / 450R) * (VREG1 - VGS) + VGS
PRP/N1 6-0 = 1111111	((354R - 254R) / 450R) * (VREG1 - VGS) + VGS

Table 7. 11 VinP/N 8

Reference Voltage	Macro Adjustment Value	VinP/N3 Formula
VinP/N3	PKP/N0 4-0 = 00000	$(31R / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00001	$((31R - 1R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00010	$((31R - 2R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00011	$((31R - 3R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00100	$((31R - 4R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00101	$((31R - 5R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00110	$((31R - 6R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 00111	$((31R - 7R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01000	$((31R - 8R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01001	$((31R - 9R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01010	$((31R - 10R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01011	$((31R - 11R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01100	$((31R - 12R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01101	$((31R - 13R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01110	$((31R - 14R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 01111	$((31R - 15R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10000	$((31R - 16R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10001	$((31R - 17R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10010	$((31R - 18R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10011	$((31R - 19R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10100	$((31R - 20R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10101	$((31R - 21R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10110	$((31R - 22R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 10111	$((31R - 23R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11000	$((31R - 24R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11001	$((31R - 25R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11010	$((31R - 26R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11011	$((31R - 27R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11100	$((31R - 28R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11101	$((31R - 29R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11110	$((31R - 30R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$
	PKP/N0 4-0 = 11111	$((31R - 31R) / 32R) * (VinP/N2 - VinP/N4) + VinP/N4$

Table 7. 12 VinP/N 3

Reference Voltage	Macro Adjustment Value	VinP/N5 Formula
VinP/N5	PKP/N1 4-0 = 00000	$(193R / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00001	$((193R - 3R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00010	$((193R - 6R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00011	$((193R - 9R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N14-0 = 00100	$((193R - 12R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00101	$((193R - 15R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00110	$((193R - 18R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 00111	$((193R - 21R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01000	$((193R - 24R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01001	$((193R - 27R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01010	$((193R - 30R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01011	$((193R - 33R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01100	$((193R - 36R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01101	$((193R - 39R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01110	$((193R - 42R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 01111	$((193R - 45R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10000	$((193R - 48R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10001	$((193R - 51R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10010	$((193R - 54R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10011	$((193R - 57R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10100	$((193R - 60R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10101	$((193R - 63R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10110	$((193R - 66R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 10111	$((193R - 69R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11000	$((193R - 72R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11001	$((193R - 75R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11010	$((193R - 78R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11011	$((193R - 81R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11100	$((193R - 84R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11101	$((193R - 87R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11110	$((193R - 90R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$
	PKP/N1 4-0 = 11111	$((193R - 93R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8$

Table 7. 13 VinP/N 5

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Reference Voltage	Macro Adjustment Value	VinP/N6 Formula
VinP/N6	PKP/N2 4-0 = 00000	(158R / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00001	((158R - 3R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00010	((158R - 6R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00011	((158R - 9R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00100	((158R - 12R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00101	((158R - 15R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00110	((158R - 18R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 00111	((158R - 21R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01000	((158R - 24R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01001	((158R - 27R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01010	((158R - 30R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01011	((158R - 33R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01100	((158R - 36R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01101	((158R - 39R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01110	((158R - 42R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 01111	((158R - 45R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10000	((158R - 48R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10001	((158R - 51R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10010	((158R - 54R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10011	((158R - 57R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10100	((158R - 60R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10101	((158R - 63R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10110	((158R - 66R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 10111	((158R - 69R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11000	((158R - 72R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11001	((158R - 75R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11010	((158R - 78R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11011	((158R - 81R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11100	((158R - 84R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11101	((158R - 87R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11110	((158R - 90R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N2 4-0 = 11111	((158R - 93R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8

Table 7. 14 VinP/N 6

Reference Voltage	Macro Adjustment Value	VinP/N7 Formula
VinP/N7	PKP/N3 4-0 = 00000	(123R / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00001	((123R - 3R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00010	((123R - 6R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00011	((123R - 9R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00100	((123R - 12R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00101	((123R - 15R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00110	((123R - 18R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 00111	((123R - 21R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01000	((123R - 24R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01001	((123R - 27R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01010	((123R - 30R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01011	((123R - 33R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01100	((123R - 36R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01101	((123R - 39R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01110	((123R - 42R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 01111	((123R - 45R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10000	((123R - 48R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10001	((123R - 51R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10010	((123R - 54R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10011	((123R - 57R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10100	((123R - 60R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10101	((123R - 63R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10110	((123R - 66R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 10111	((123R - 69R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11000	((123R - 72R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11001	((123R - 75R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11010	((123R - 78R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11011	((123R - 81R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11100	((123R - 84R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11101	((123R - 87R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11110	((123R - 90R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8
	PKP/N3 4-0 = 11111	((123R - 93R) / 223R) * (VinP/N4 - VinP/N8) + VinP/N8

Table 7. 15 VinP/N 7

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October, 2008

Reference Voltage	Macro Adjustment Value	VinP/N9 Formula
VinP/N9	PKP/N4 4-0 = 00000	$(31R / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00001	$((31R - 1R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00010	$((31R - 2R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00011	$((31R - 3R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00100	$((31R - 4R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00101	$((31R - 5R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00110	$((31R - 6R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 00111	$((31R - 7R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01000	$((31R - 8R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01001	$((31R - 9R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01010	$((31R - 10R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01011	$((31R - 11R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01100	$((31R - 12R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01101	$((31R - 13R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01110	$((31R - 14R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 01111	$((31R - 15R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10000	$((31R - 16R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10001	$((31R - 17R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10010	$((31R - 18R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10011	$((31R - 19R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10100	$((31R - 20R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10101	$((31R - 21R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10110	$((31R - 22R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 10111	$((31R - 23R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11000	$((31R - 24R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11001	$((31R - 25R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11010	$((31R - 26R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11011	$((31R - 27R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11100	$((31R - 28R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11101	$((31R - 29R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11110	$((31R - 30R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$
	PKP/N4 4-0 = 11111	$((31R - 31R) / 32R) * (VinP/N8 - VinP/N10) + VinP/N10$

Table 7. 16 VinP/N 9

Grayscale Voltage	Formula	Grayscale Voltage	Formula
V0	VinP0	V32	VinP6
V1	VinP1	V33	VinP7+(VinP6- VinP7)*(20R/22R)
V2	VinP2	V34	VinP7+(VinP6- VinP7)*(18R/22R)
V3	VinP3	V35	VinP7+(VinP6- VinP7)*(16R/22R)
V4	VinP4+ (VinP3 - VinP4)*CT1	V36	VinP7+(VinP6- VinP7)*(14R/22R)
V5	VinP4+ (VinP3 - VinP4)*CT2	V37	VinP7+(VinP6- VinP7)*(12R/22R)
V6	VinP4+ (VinP3 - VinP4)*CT3	V38	VinP7+(VinP6- VinP7)*(10R/22R)
V7	VinP4+ (VinP3 - VinP4)*CT4	V39	VinP7+(VinP6- VinP7)*(8R/22R)
V8	VinP4	V40	VinP7+(VinP6- VinP7)*(6R/22R)
V9	VinP5+(VinP4- VinP5)*(22R/24R)	V41	VinP7+(VinP6- VinP7)*(4R/22R)
V10	VinP5+(VinP4- VinP5)*(20R/24R)	V42	VinP7+(VinP6- VinP7)*(2R/22R)
V11	VinP5+(VinP4- VinP5)*(18R/24R)	V43	VinP7
V12	VinP5+(VinP4- VinP5)*(16R/24R)	V44	VinP8+(VinP7- VinP8)*(22R/24R)
V13	VinP5+(VinP4- VinP5)*(14R/24R)	V45	VinP8+(VinP7- VinP8)*(20R/24R)
V14	VinP5+(VinP4- VinP5)*(12R/24R)	V46	VinP8+(VinP7- VinP8)*(18R/24R)
V15	VinP5+(VinP4- VinP5)*(10R/24R)	V47	VinP8+(VinP7- VinP8)*(16R/24R)
V16	VinP5+(VinP4- VinP5)*(8R/24R)	V48	VinP8+(VinP7- VinP8)*(14R/24R)
V17	VinP5+(VinP4- VinP5)*(6R/24R)	V49	VinP8+(VinP7- VinP8)*(12R/24R)
V18	VinP5+(VinP4- VinP5)*(4R/24R)	V50	VinP8+(VinP7- VinP8)*(10R/24R)
V19	VinP5+(VinP4- VinP5)*(2R/24R)	V51	VinP8+(VinP7- VinP8)*(8R/24R)
V20	VinP5	V52	VinP8+(VinP7- VinP8)*(6R/24R)
V21	VinP6+(VinP5- VinP6)*(22R/24R)	V53	VinP8+(VinP7- VinP8)*(4R/24R)
V22	VinP6+(VinP5- VinP6)*(20R/24R)	V54	VinP8+(VinP7- VinP8)*(2R/24R)
V23	VinP6+(VinP5- VinP6)*(18R/24R)	V55	VinP8
V24	VinP6+(VinP5- VinP6)*(16R/24R)	V56	VinP9+ (VinP8 - VinP9)*CB1
V25	VinP6+(VinP5- VinP6)*(14R/24R)	V57	VinP9+ (VinP8 - VinP9)*CB2
V26	VinP6+(VinP5- VinP6)*(12R/24R)	V58	VinP9+ (VinP8 - VinP9)*CB3
V27	VinP6+(VinP5- VinP6)*(10R/24R)	V59	VinP9+ (VinP8 - VinP9)*CB4
V28	VinP6+(VinP5- VinP6)*(8R/24R)	V60	VinP9
V29	VinP6+(VinP5- VinP6)*(6R/24R)	V61	VinP10
V30	VinP6+(VinP5- VinP6)*(4R/24R)	V62	VinP11
V31	VinP6+(VinP5- VinP6)*(2R/24R)	V63	VinP12

Table 7. 17 Voltage Calculation Formula of 64-Grayscale Voltage (Positive Polarity)

CGMP0[1:0]	“00”	“01”	“10”	“11”
CT1	3/4	28/45	26/33	3/4
CT2	1/2	4/15	6/11	21/40
CT3	7/24	7/45	10/33	13/40
CT4	1/8	1/15	1/6	3/20

CGMP1[1:0]	“00”	“01”	“10”	“11”
CB1	4/5	18/19	44/47	17/20
CB2	3/5	50/57	40/47	27/40
CB3	2/5	15/19	35/47	19/40
CB4	1/5	23/57	28/47	1/4

Table 7. 18 Voltage Calculation Formula of Grayscale Voltage V4~V7 and V56~V59

Grayscale Voltage	Formula	Grayscale Voltage	Formula
V63	VinN0	V31	VinN7+(VinN6- VinN7)*(22R/24R)
V62	VinN1	V30	VinN7+(VinN6- VinN7)*(20R/24R)
V61	VinN2	V29	VinN7+(VinN6- VinN7)*(18R/24R)
V60	VinN3	V28	VinN7+(VinN6- VinN7)*(16R/24R)
V59	VinN4+ (VinN3 - VinN4)*CT1	V27	VinN7+(VinN6- VinN7)*(14R/24R)
V58	VinN4+ (VinN3 - VinN4)*CT2	V26	VinN7+(VinN6- VinN7)*(12R/24R)
V57	VinN4+ (VinN3 - VinN4)*CT3	V25	VinN7+(VinN6- VinN7)*(10R/24R)
V56	VinN4+ (VinN3 - VinN4)*CT4	V24	VinN7+(VinN6- VinN7)*(8R/24R)
V55	VinN4	V23	VinN7+(VinN6- VinN7)*(6R/24R)
V54	VinN5+(VinN4- VinN5)*(22R/24R)	V22	VinN7+(VinN6- VinN7)*(4R/24R)
V53	VinN5+(VinN4- VinN5)*(20R/24R)	V21	VinN7+(VinN6- VinN7)*(2R/24R)
V52	VinN5+(VinN4- VinN5)*(18R/24R)	V20	VinN7
V51	VinN5+(VinN4- VinN5)*(16R/24R)	V19	VinN8+(VinN7- VinN8)*(22R/24R)
V50	VinN5+(VinN4- VinN5)*(14R/24R)	V18	VinN8+(VinN7- VinN8)*(20R/24R)
V49	VinN5+(VinN4- VinN5)*(12R/24R)	V17	VinN8+(VinN7- VinN8)*(18R/24R)
V48	VinN5+(VinN4- VinN5)*(10R/24R)	V16	VinN8+(VinN7- VinN8)*(16R/24R)
V47	VinN5+(VinN4- VinN5)*(8R/24R)	V15	VinN8+(VinN7- VinN8)*(14R/24R)
V46	VinN5+(VinN4- VinN5)*(6R/24R)	V14	VinN8+(VinN7- VinN8)*(12R/24R)
V45	VinN5+(VinN4- VinN5)*(4R/24R)	V13	VinN8+(VinN7- VinN8)*(10R/24R)
V44	VinN5+(VinN4- VinN5)*(2R/24R)	V12	VinN8+(VinN7- VinN8)*(8R/24R)
V43	VinN5	V11	VinN8+(VinN7- VinN8)*(6R/24R)
V42	VinN6+(VinN5- VinN6)*(20R/22R)	V10	VinN8+(VinN7- VinN8)*(4R/24R)
V41	VinN6+(VinN5- VinN6)*(18R/22R)	V9	VinN8+(VinN7- VinN8)*(2R/24R)
V40	VinN6+(VinN5- VinN6)*(16R/22R)	V8	VinN8
V39	VinN6+(VinN5- VinN6)*(14R/22R)	V7	VinN9+ (VinN8 - VinN9)*CB1
V38	VinN6+(VinN5- VinN6)*(12R/22R)	V6	VinN9+ (VinN8 - VinN9)*CB2
V37	VinN6+(VinN5- VinN6)*(10R/22R)	V5	VinN9+ (VinN8 - VinN9)*CB3
V36	VinN6+(VinN5- VinN6)*(8R/22R)	V4	VinN9+ (VinN8 - VinN9)*CB4
V35	VinN6+(VinN5- VinN6)*(6R/22R)	V3	VinN9
V34	VinN6+(VinN5- VinN6)*(4R/22R)	V2	VinN10
V33	VinN6+(VinN5- VinN6)*(2R/22R)	V1	VinN11
V32	VinN6	V0	VinN12

Table 7. 19 Voltage Calculation Formula of 64-Grayscale Voltage (Negative Polarity)

CGMN1[1:0]	“00”	“01”	“10”	“11”
CT1	4/5	34/57	19/47	3/4
CT2	3/5	4/19	12/47	21/40
CT3	2/5	7/57	7/47	13/40
CT4	1/5	1/19	3/47	3/20

CGMN0[1:0]	“00”	“01”	“10”	“11”
CB1	7/8	14/15	5/6	17/20
CB2	17/24	38/45	23/33	27/40
CB3	1/2	11/15	5/11	19/40
CB4	1/4	17/45	7/33	1/4

Table 7. 20 Voltage Calculation Formula of Grayscale Voltage V59~V56 and V7~V4

Relationship between GRAM Data and Output Level ("Normally White Panel", GRAM data=0)

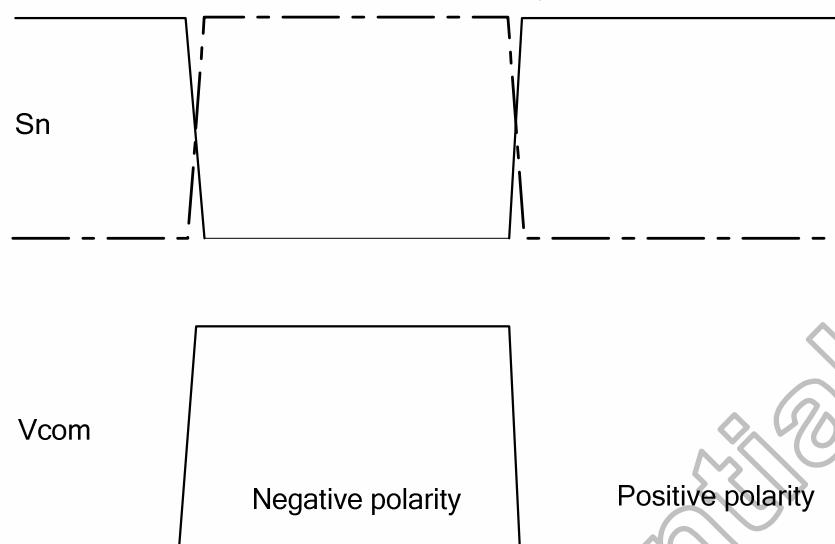


Figure 7. 4 Relationship between Source Output and Vcom

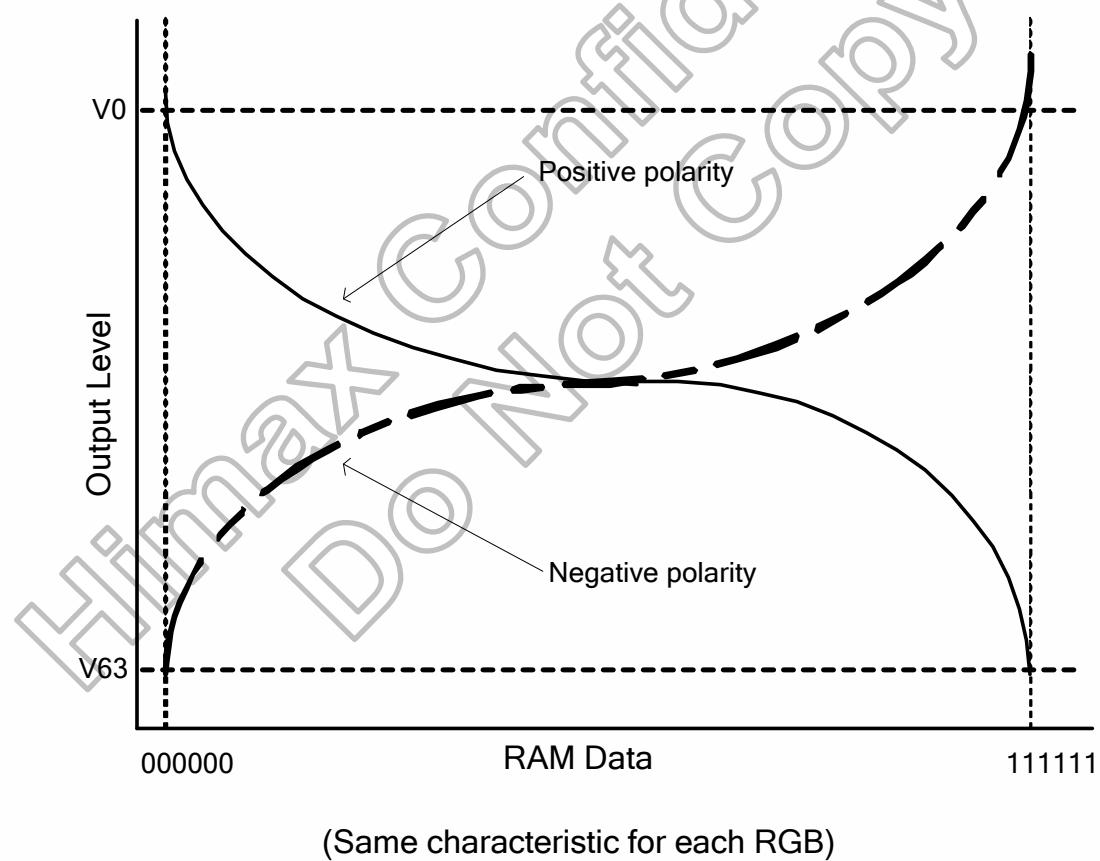


Figure 7. 5 Relationship between GRAM Data and Output Level (Normal White Panel REV_Panel="0")

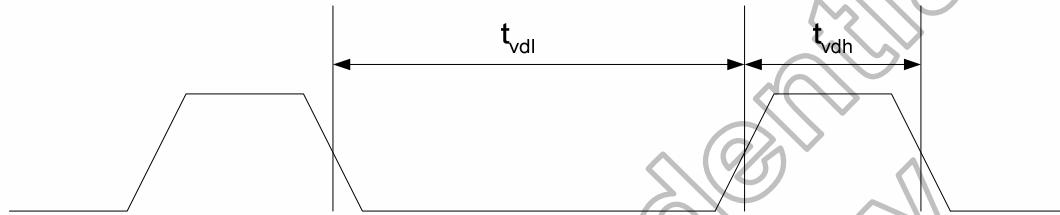
7.3 Tearing Effect Output Line

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.

Tearing effect function is not support when at RGB interface (RCM[1:0] = "1x").

7.3.1 Tearing Effect Line Modes

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

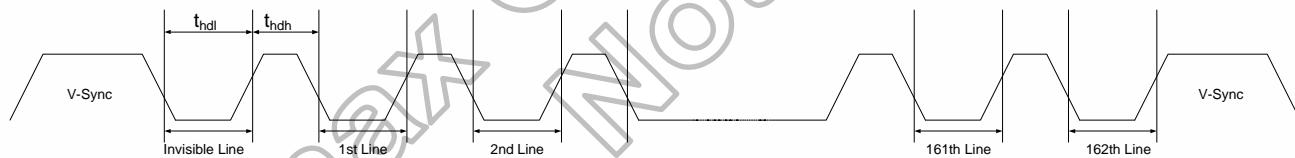


t_{vdh} = The LCD display is not updated from the Frame Memory

t_{vdl} = The LCD display is updated from the Frame Memory (except Invisible Line – see below)

Figure 7. 6 TE Mode 1 Output

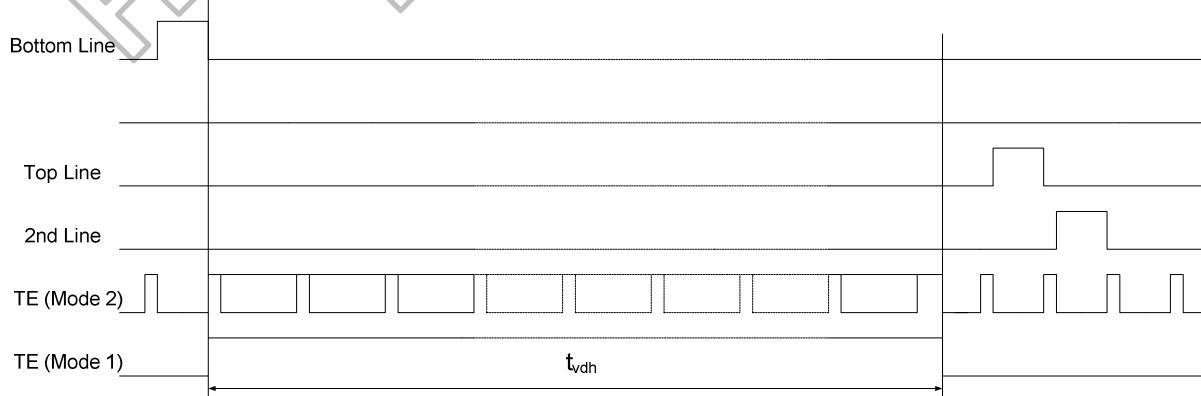
Mode 2, the Tearing Effect Output signal consists of V-Blanking and H-Blanking Information, there is one V-sync and 320 H-sync pulses per field.



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. 7 TE Mode 2 Output



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

Figure 7. 8 TE Output Waveform

7.3.2 Tearing Effect Line Timing

The Tearing Effect signal is described below.

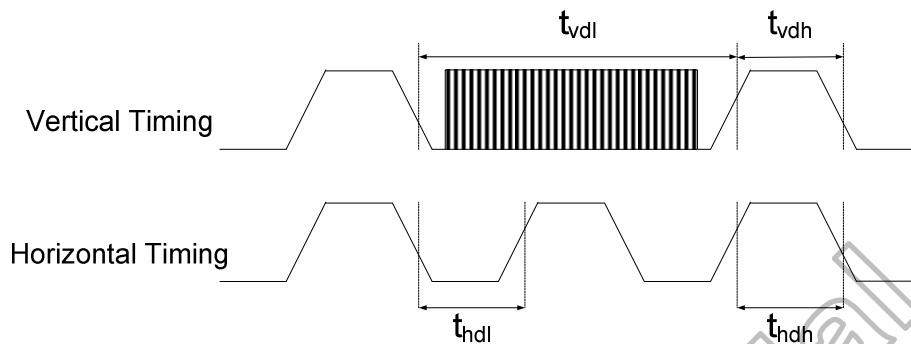


Figure 7. 9 Waveform of Tearing Effect Signal

Idle Mode Off (Frame Rate = 60 Hz)

Symbol	Parameter	Min.	Max.	Unit	Description
tvdl	Vertical Timing Low Duration	TBD	-	ms	-
tvdh	Vertical Timing High Duration	1000	-	us	-
thdl	Horizontal Timing Low Duration	TBD	-	us	-
thdh	Horizontal Timing High Duration	TBD	500	us	-

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

Table 7. 21 AC characteristics of Tearing Effect Signal

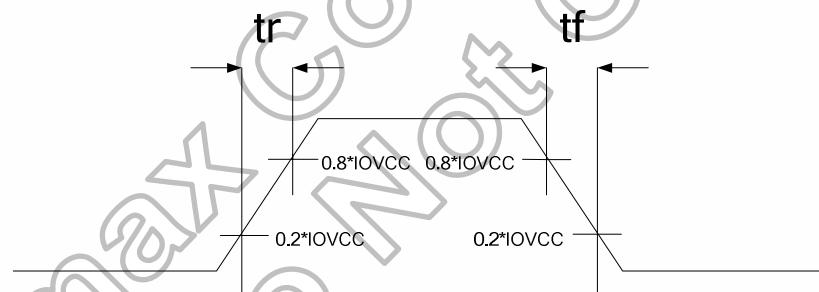


Figure 7. 10 Timing of Tearing Effect Signal

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

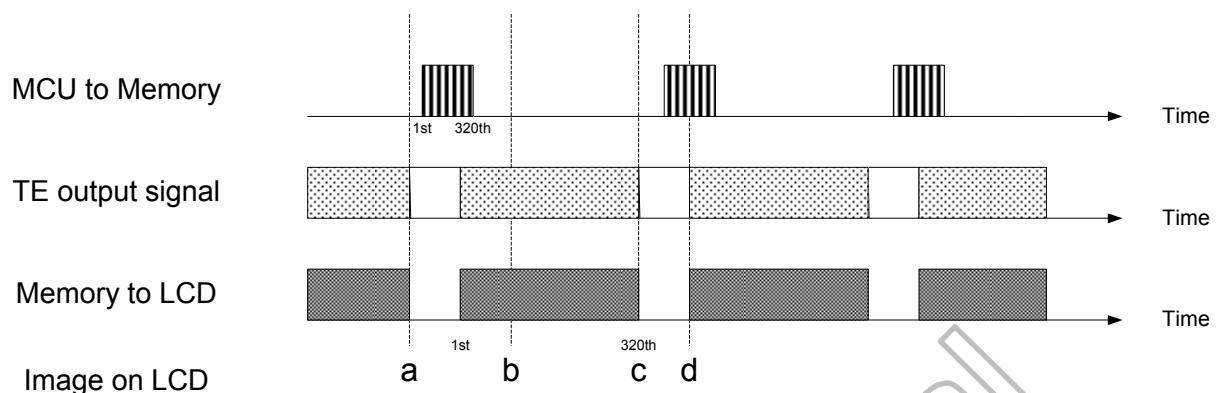


Figure 7. 11 Timing of MPU Write is faster than Panel Read

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.

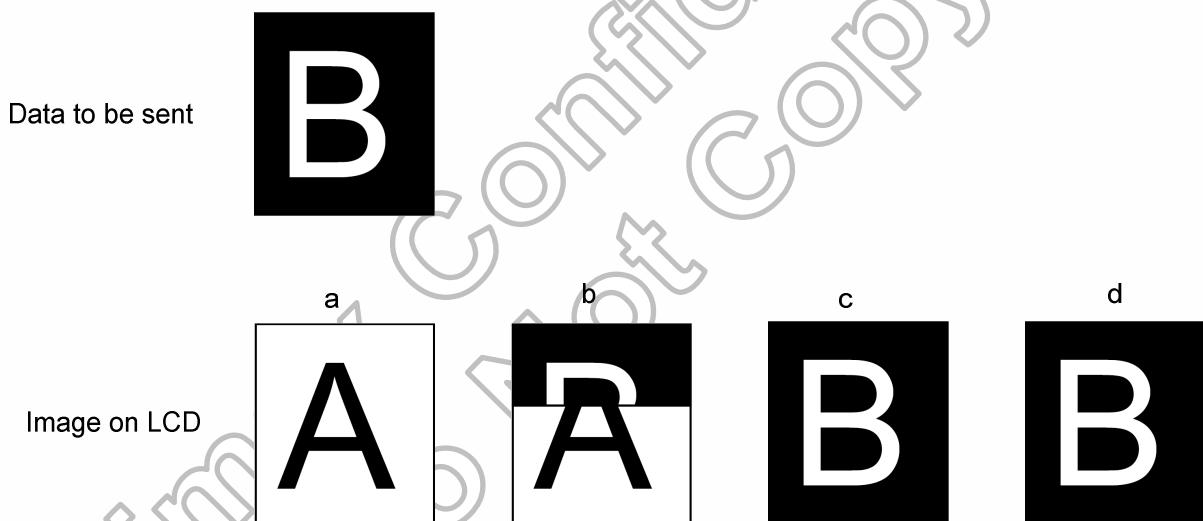
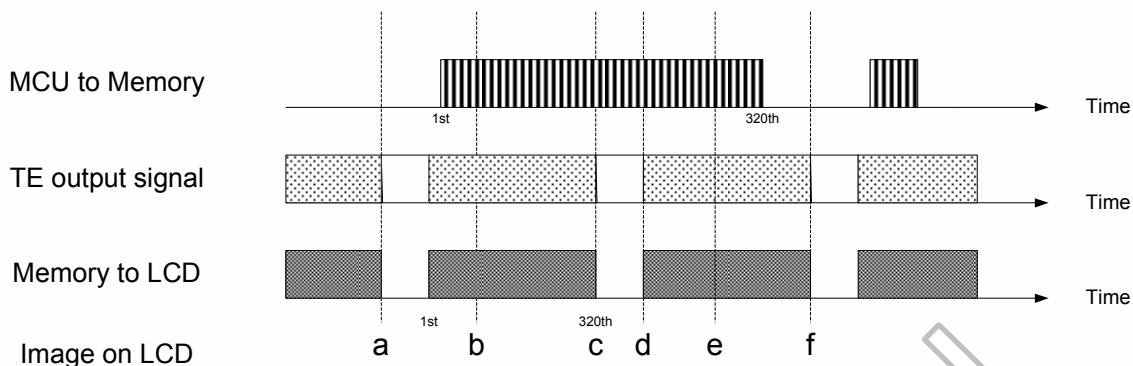
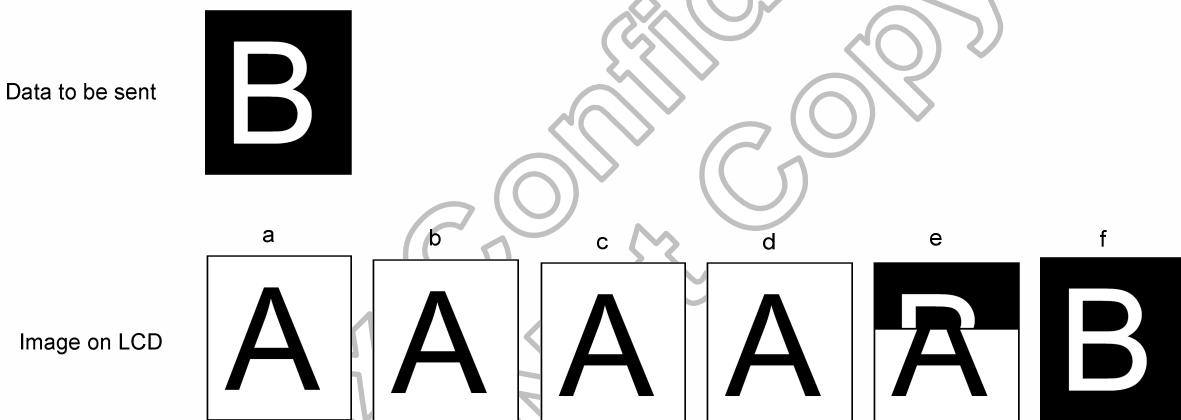


Figure 7. 12 Display of MPU Write is faster than Panel Read

7.3.4 Example 2: MPU Write is slower than Panel Read**Figure 7. 13 Timing of 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.

**Figure 7. 14 Display of MPU Write is slower than Panel Read**

7.4 Content Adaptive Brightness Control (CABC) Function

The HX8347-D has support Content Adaptive Brightness Control (CABC) Function and will output one PWM signal to external LED Driver IC. The PWM signal is automatically adjusted by display image for saving LED backlight power consumption.

Example:

- Image A: -20% brightness reduction
- Image B: -30% brightness reduction
- Image C: -10% brightness reduction

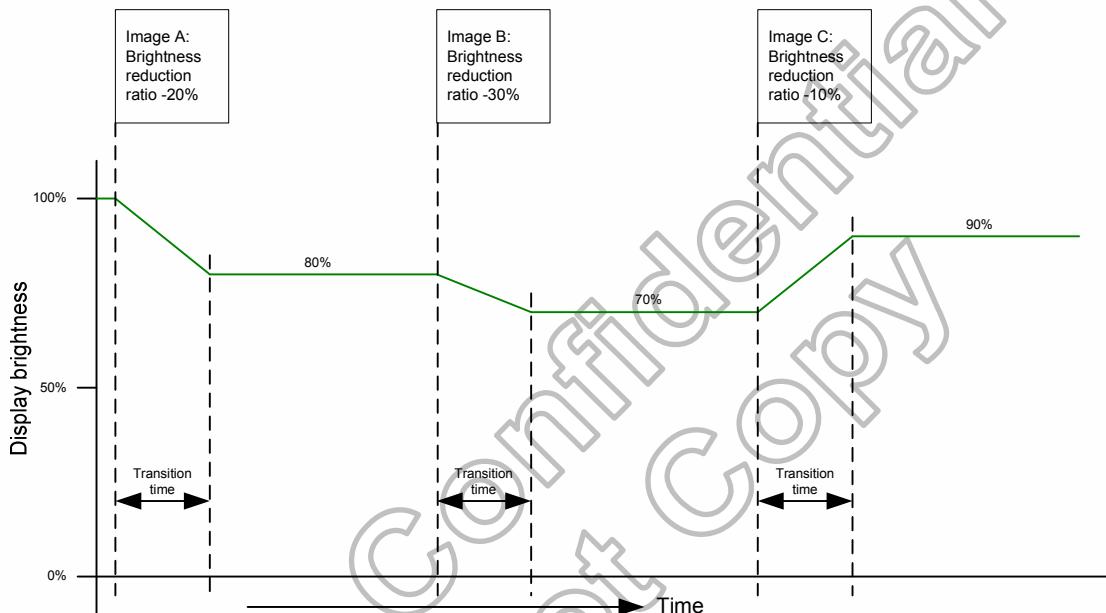


Figure 7. 15 Example of CABC Function

The general block diagram of the CABC and the brightness control is illustrated below:

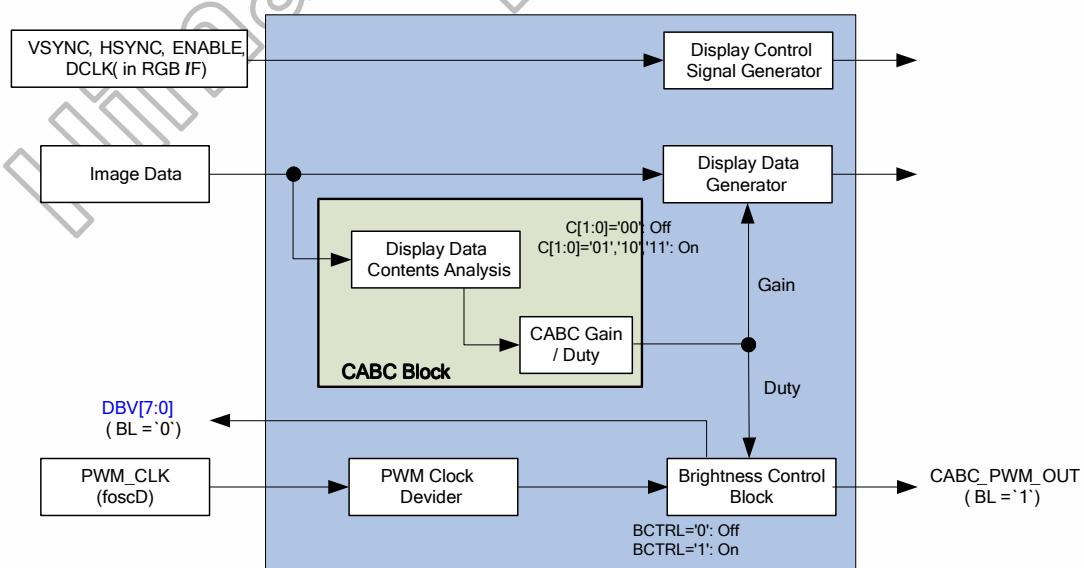
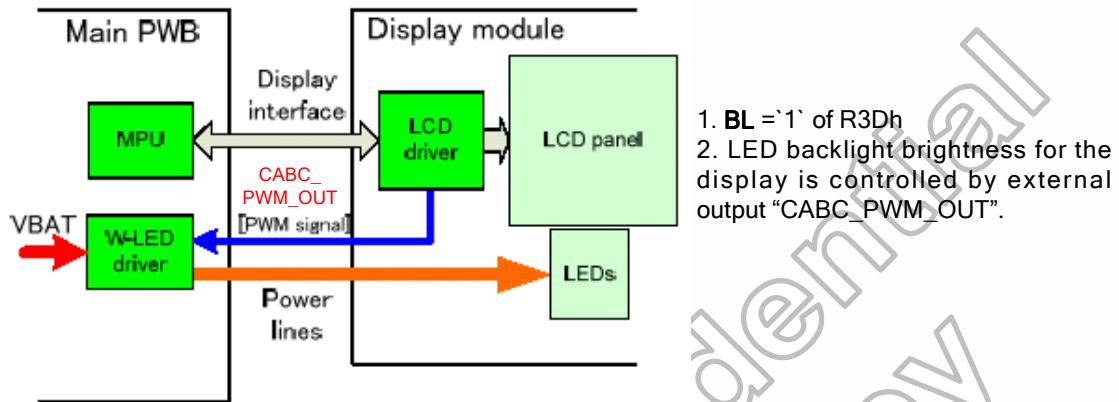


Figure 7. 16 CABC Block Diagram

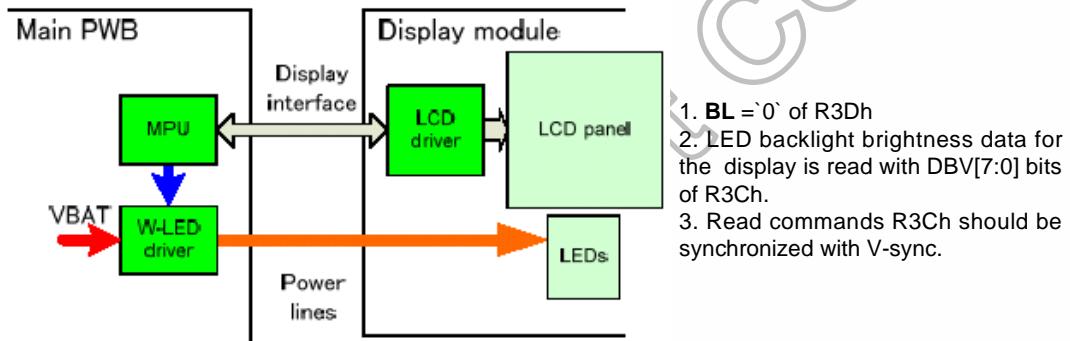
7.4.1 Module Architectures

HX8347-D can support two module architectures for CABC operation. The **BL** bit setting of R3Dh can be used to select used display module architecture. White LED driver circuit for display backlight is located on the main PWB, not in the display module both in architecture I and II.

- Architecture I



- Architecture II



7.4.2 Brightness Control Block

There is an external output signal from brightness block, CABC_PWM_OUT, to control the LED driver IC in order to control display brightness.

There are register bits, DBV[7:0] of R3Ch, for display brightness of manual brightness setting. The CABC_PWM_OUT duty is calculated as $DBV[7:0]/255 \times CABC\text{ duty}$ (generated after one-frame display data content analysis).

For ex: CABC_PWM_OUT period = 2.95 ms, and DBV[7:0](R3Ch) = '228_{DEC}' and CABC duty is 74%. Then CABC_PWM_OUT duty = $228 / 255 \times 74\% \equiv 65.90\%$. Correspond to the CABC_PWM_OUT period = 2.95 ms, the high-level of CABC_PWM_OUT (high effective) = 1.94ms, and the low-level of CABC_PWM_OUT = 1.01ms.

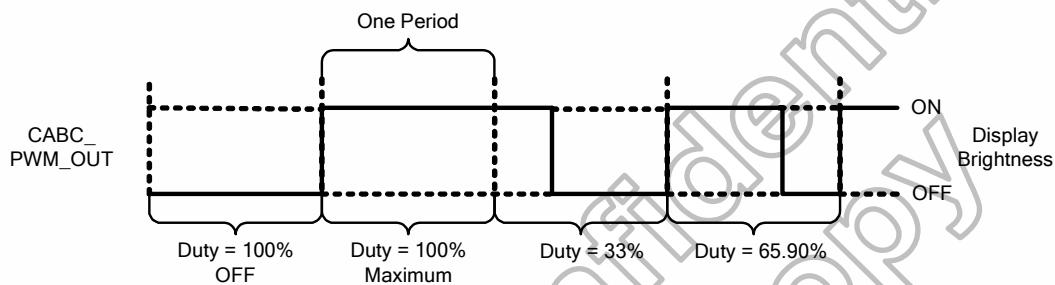


Figure 7.17 CABC_PWM_OUT Output Duty

When Architecture II module is used (**BL='0'**) with the example below, the CABC_PWM_OUT is always output low and the DBV[7:0](R3Ch) will be read a value as 169_{DEC} (169/255 \equiv 66.27%).

7.4.3 Minimum Brightness Setting of CABC Function

CABC function is automatically reduced backlight brightness based on image contents. In the case of the combination with the CABC or manual brightness setting, display brightness is too dark. It must affect to image quality degradation. CABC minimum brightness setting (**CMB[7:0]** bits of R3Fh) is to avoid too much brightness reduction.

When CABC is active, CABC can not reduce the display brightness to less than CABC minimum brightness setting. Image processing function is worked as normal, even if the brightness can not be changed.

This function does not affect to the other function, manual brightness setting. Manual brightness can be set the display brightness to less than CABC minimum brightness. Smooth transition and dimming function can be worked as normal.

When display brightness is turned off (**BCTRL='0'** of R3Dh), CABC minimum brightness setting is ignored. Read CABC minimum brightness **CMB[7:0]** (R3Fh) always read the setting value.

7.4.4 Display Dimming

A dimming function (how fast to change the brightness from old to new level and what are brightness levels during the change) is used when changing from one brightness level to another to avoid flicker in the actual display module. This dimming function curve is the same in increment and decrement directions.

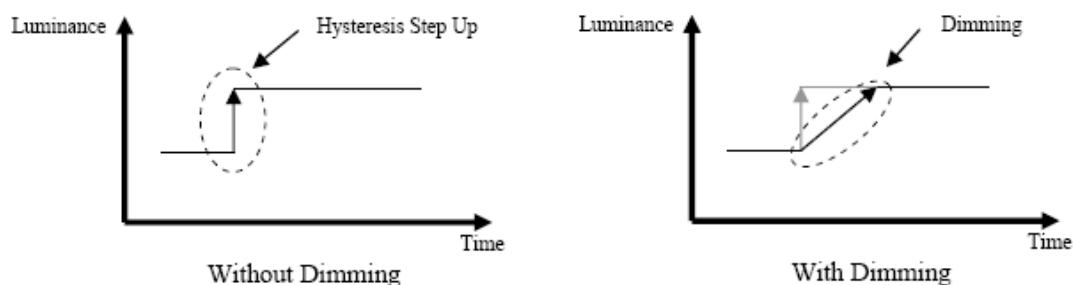


Figure 7.18 Dimming Function

7.5 LCD Power Generation Circuit

7.5.1 Power Supply Circuit

The power circuit of HX8347-D is used to generate supply voltages for LCD panel driving.

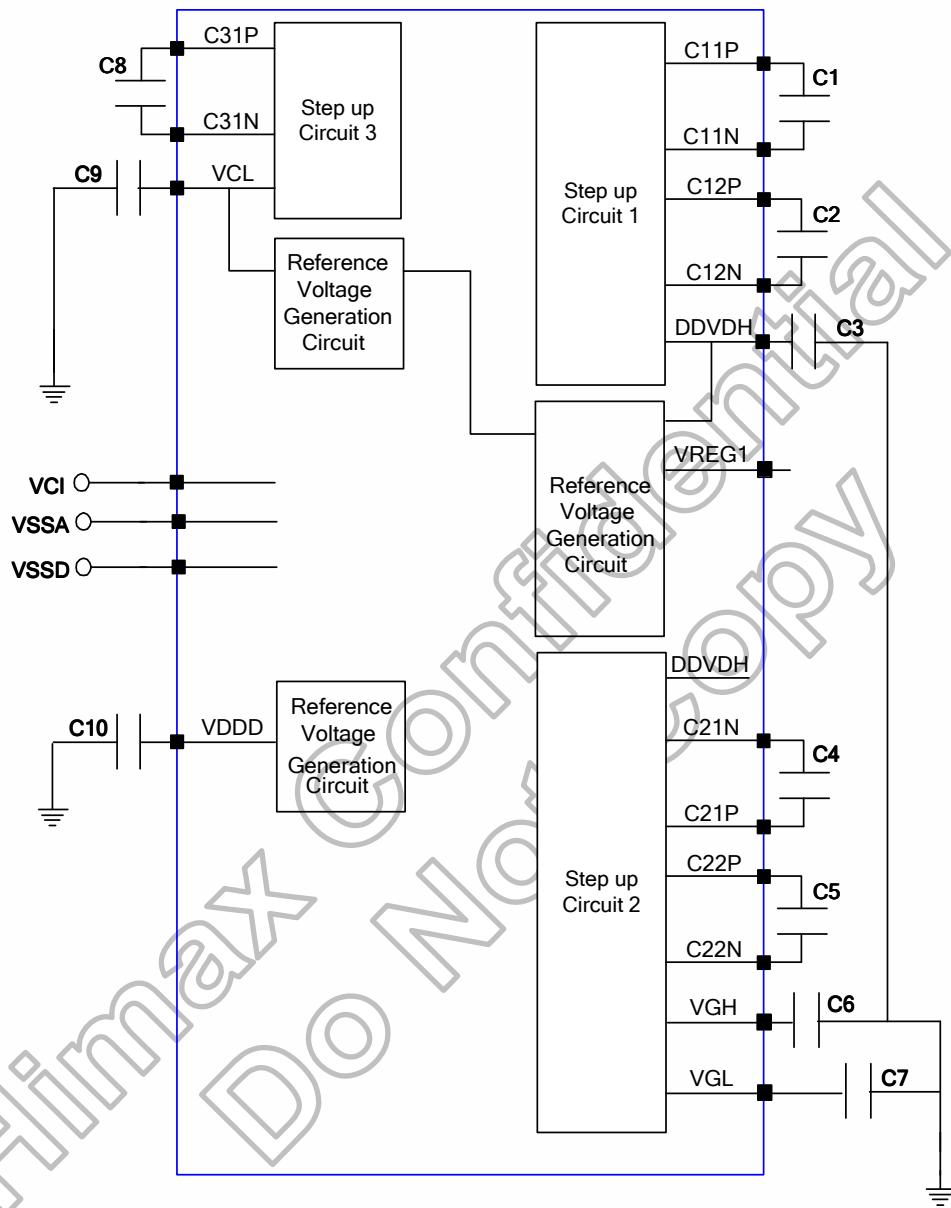


Figure 7. 19 The Block Diagram of HX8347-D Power Circuit

Specification of Connected Passive Component

Capacitor	Recommended voltage	Capacity
C1 (C11P/N)	6V	1 µF (B characteristics)
C2 (C12P/N)	6V	1 µF (B characteristics)
C3 (DDVDH)	10V	1 µF (B characteristics)
C4 (C21P/N)	10V	1 µF (B characteristics)
C5 (C22P/N)	10V	1 µF (B characteristics)
C6 (VGH)	25V	1 µF (B characteristics)
C7 (VGL)	16V	1 µF (B characteristics)
C8 (C31P/N)	6V	1 µF (B characteristics)
C9 (VCL)	6V	1 µF (B characteristics)
C10(VDDD)	6V	1 µF (B characteristics)

Table 7. 22 The adoptability of Capacitor

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7.5.2 LCD Power Generation Scheme

The boost voltage generated is shown as below.

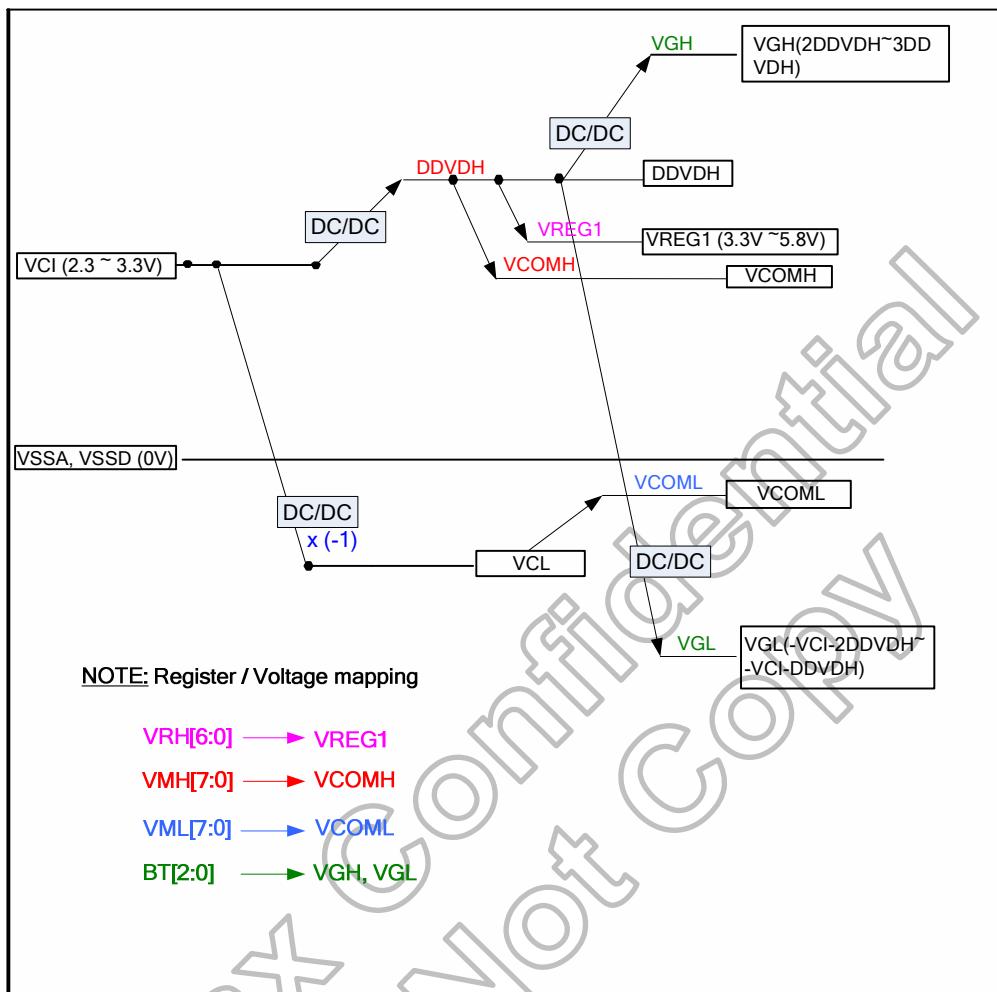


Figure 7. 20 LCD Power Generation Scheme

7.6 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

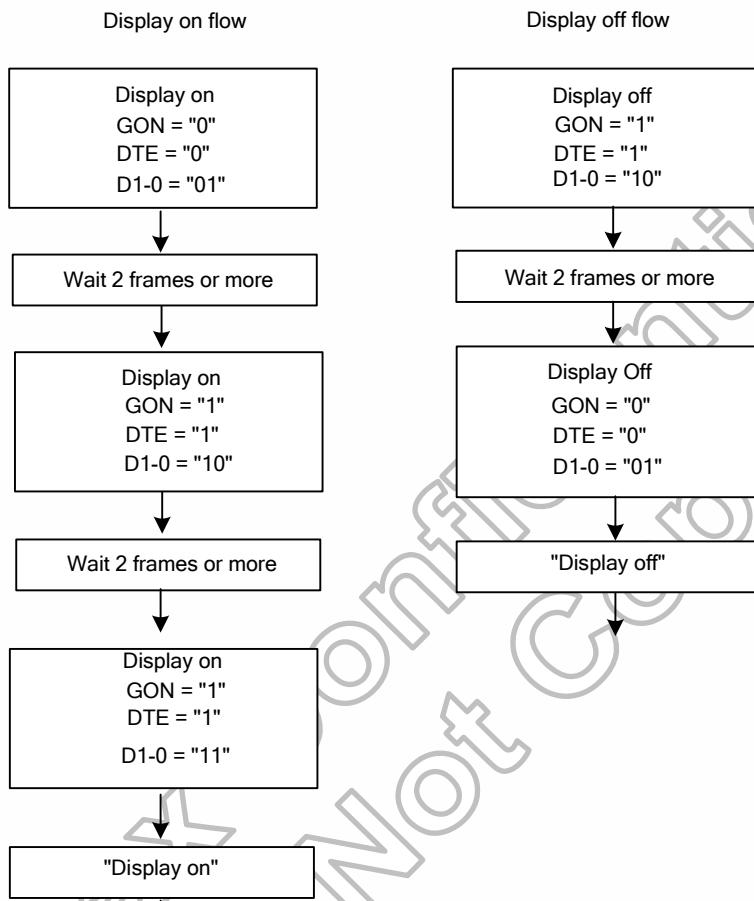
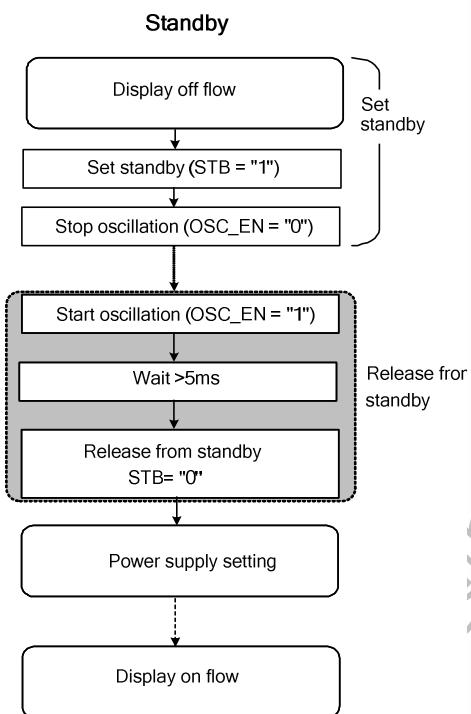
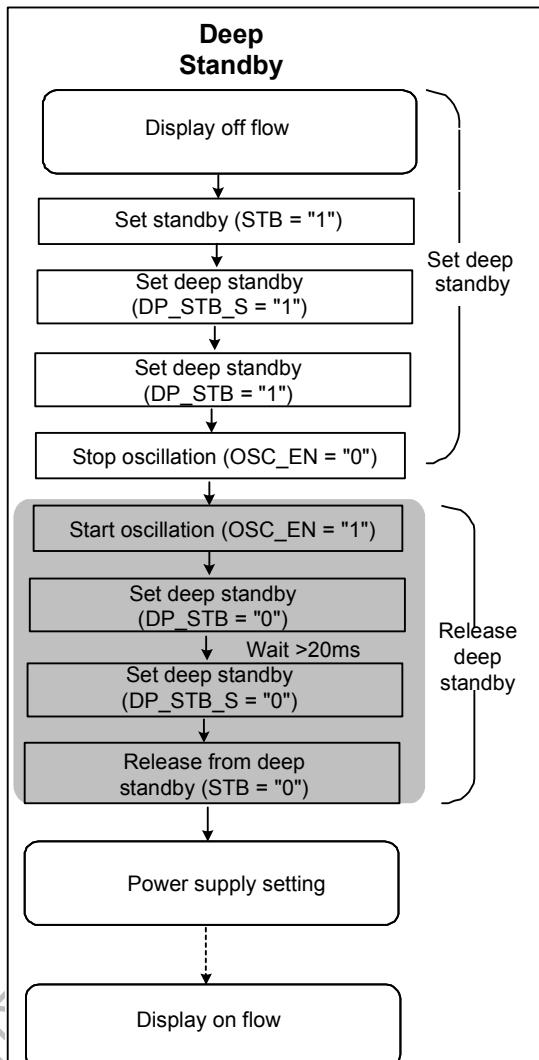
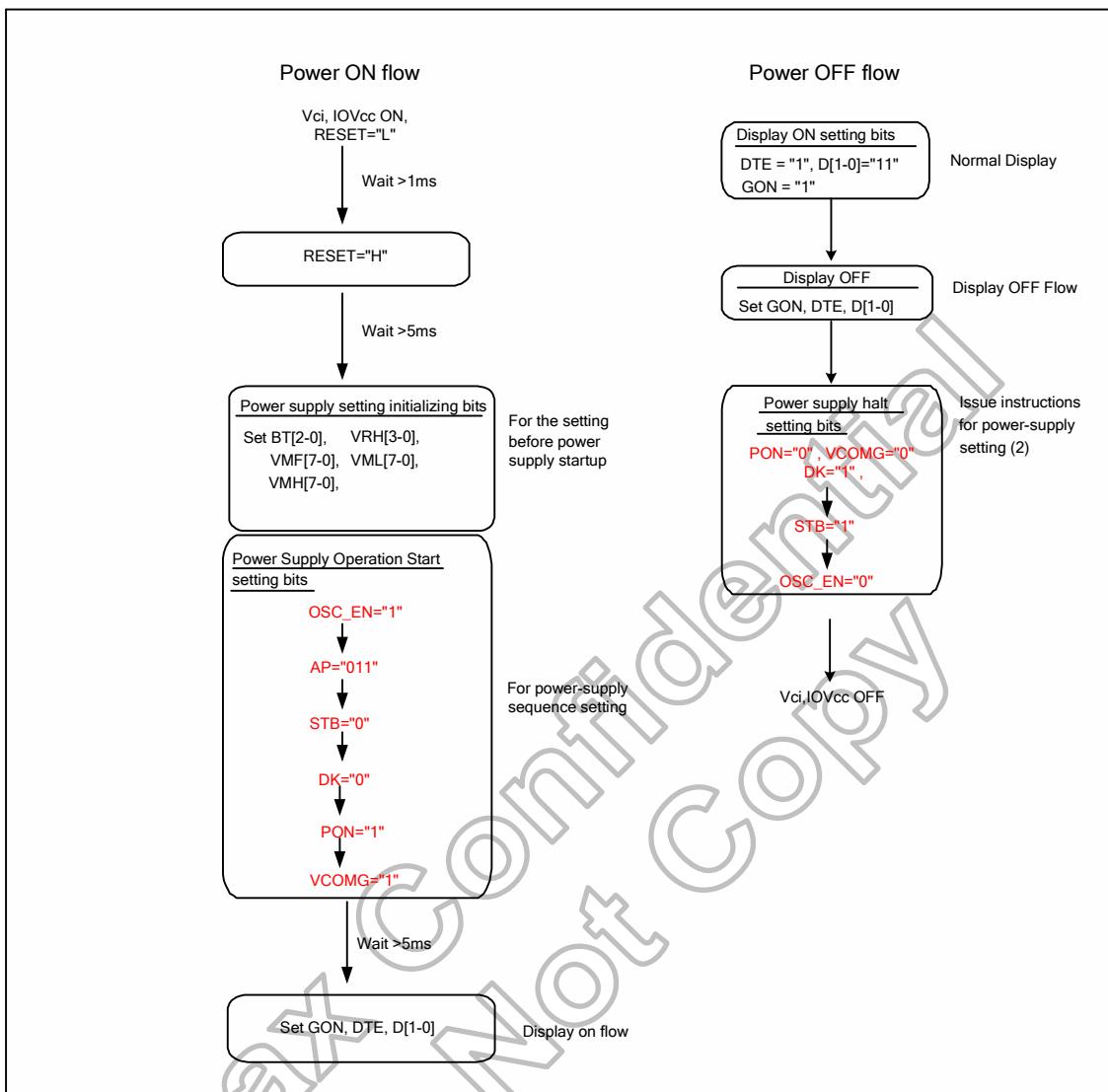


Figure 7. 21 Display On/Off Set flow

Standby Mode Set up Flow**Figure 7. 22 Standby Mode Setting flow**

Deep Standby Mode Set up Flow**Figure 7. 23 Deep Standby Mode Setting flow**

Power On/Off Setting up Flow**Figure 7. 24 Power Supply Setting Flow**

7.7 Input / Output Pin State

7.7.1 Output Pins

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

Table 7. 23 Characteristics of Output Pins

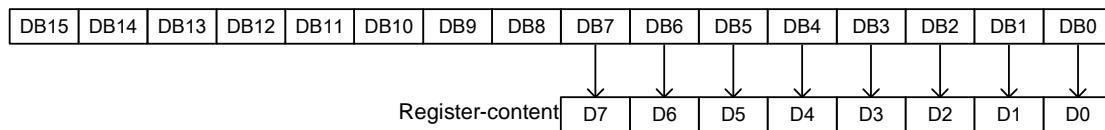
7.7.2 Input Pins

Input pins	During Power On Process	After Power On	After Hardware Reset	During Power Off Process
NRESET	Input valid	Input valid	Input valid	Input valid
NCS	Input invalid	Input valid	Input valid	Input invalid
NWR_SCL	Input invalid	Input valid	Input valid	Input invalid
NRD	Input invalid	Input valid	Input valid	Input invalid
DNC_SCL	Input invalid	Input valid	Input valid	Input invalid
SDA	Input invalid	Input valid	Input valid	Input invalid
VSYNC	Input invalid	Input valid	Input valid	Input invalid
HSYNC	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, IM3,IM2, IM1,IM0, IFSEL	Input invalid	Input valid	Input valid	Input invalid
TEST2-0	Input invalid	Input valid	Input valid	Input invalid

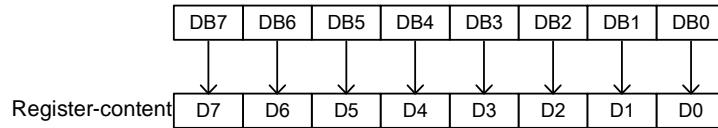
Table 7. 24 Characteristics of Input Pins

8. Command

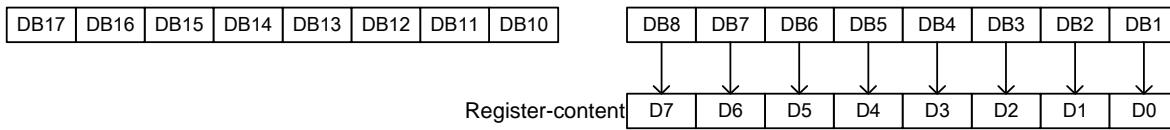
IM3~IM0 = "0000" 8080 MCU 16-bits Parallel type I



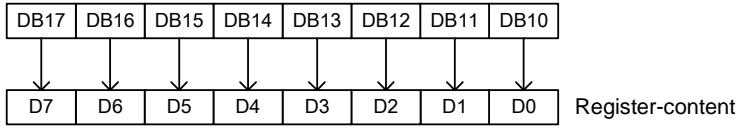
IM3~IM0 = "0001" 8080 MCU 8-bits Parallel type I



IM3~IM0 = "0010" 8080 MCU 16-bits Parallel type II



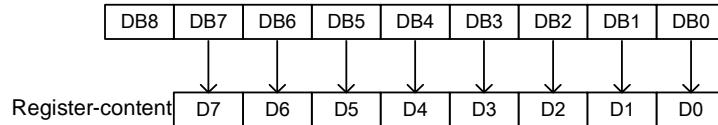
IM3~IM0 = "0011" 8080 MCU 8-bits Parallel type II



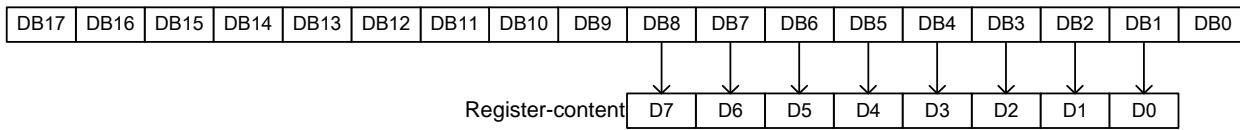
IM3~IM0 = "1000" 8080 MCU 18-bits Parallel type I



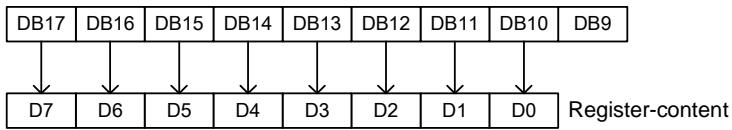
IM3~IM0 = "1001" 8080 MCU 9-bits Parallel type I



IM3~IM0 = "1010" 8080 MCU 18-bits Parallel type II



IM3~IM0 = "1011" 8080 MCU 9-bits Parallel type II



8.1 Command Set

Table 8. 1 List Table of Register Set

Register No.	Register	W/R	Upper Code	Lower Code								Comment
				D[17:8]	D7	D6	D5	D4	D3	D2	D1	D0
R00h	Himax ID	R	-	0	1	0	0	0	1	1	1	
R01h	Display Mode control	W/R	-	DP_S TB(0)	DP_S TB_S(0)	-	-	SCROL (0)	IDMON (0)	INVON (0)	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'b1110_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_0001)				
R09h	Row address end 1	W/R	-					EP[7:0] (8'b0011_1111)				
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_00000)				
R0Ch	Partial area end row 2	W/R	-					PEL[15:8] (8'b0000_0001)				
R0Dh	Partial area end row 1	W/R	-					PEL[7:0] (8'b0011_1111)				
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_0001)				
R11h	Vertical Scroll height area 1	W/R	-					VSA[7:0] (8'b0100_0000)				
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] (8'b0000_0000)				
R15h	Vertical Scroll Start address 1	W/R	-					VSP [7:0] (8'b0000_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 2	W/R	-	I/PI_RADJ1[3:0] (3b'0011)				N/P_RADJ0[3:0](4b'0100)				*
R19h	OSC Control 1	W/R	-	-	-	-	-	-	-	-	-	OSC_E N(0)
R1Ah	Power Control 1	W/R	-	-	-	-	-	-		BT[2:0] (001)		
R1Bh	Power Control 2	W/R	-	-	-			VRH[5:0] (01_1011)_4.8V				
R1Ch	Power Control 3	W/R	-	-	-	-	-	-		AP[2:0] (011)		
R1Dh	Power Control 4	W/R	-	-	I/PI_FS0[2:0](100)			-		N/P_FS0[2:0]](100)		
R1Eh	Power Control 5	W/R	-	-	I/PI_FS1[2:0]](100)			-		N/P_FS1[2:0]](100)		
R1Fh	Power Control 6	W/R	-	GASEN(1)	VCOMG(0)	-	PON(0)	DK(1)	XDK(0)	DDVDH_TRI(0)	STB(1)	
R22h	SRAM Write Control	W/R						SRAM Write				
R23h	VCOM Control 1	W/R	-					VMF[7:0](1000_0000)				
R24h	VCOM Control 2	W/R	-					VMH[7:0](0111_0001)				
R25h	VCOM Control 3	W/R	-					VML[7:0](0010_1111)				
R26h	Display Control 1	W/R	-	--	-	-	-			ISC[3:0](0001)		
R27h	Display Control 2	W/R	-	PT[1:0](10)		PTV[1:0](10)		-	-	PTG(1)	REF(1)	

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October, 2008

Register No.	Register	W/R	Upper Code	Lower Code								Comment	
				D[17:8]	D7	D6	D5	D4	D3	D2	D1	D0	
R28h	Display Control 3	W/R	-	-	-	GON(1)	DTE(0)	D[1:0] (00)	-	-	-	-	
R29h	Frame Rate control 1	W/R	-	I/PI_RTN[3:0](0010)				N/P_RTN[3:0](0010)					
R2Ah	Frame Rate Control 2	W/R	-	-	-	I/PI_DIV[1:0](00)	-	-	N/P_DIV[1:0](00)				
R2Bh	Frame Rate Control 3	W/R	-			N/P_DUM[7:0] (8b'0001_1100)							
R2Ch	Frame Rate Control 4	W/R	-			I/PI_DUM[7:0] (8b'0001_1100)							
R2Dh	Cycle Control 1	W/R	-			GDON[7:0] (8'b0000_1101)							
R2Eh	Cycle Control 2	W/R	-			GDOF[7:0] (8'b0111_0000)							
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	-	-	-	-	-	-	-	RCM[1:0](00)			
R32h	RGB interface control 2	W/R	-	-	-	-	-	DPL (0)	HSPL (0)	VSPL (0)	EPL (0)		
R33h	RGB interface control 3	W/R	-			HBP[7:0]							
R34h	RGB interface control 4	W/R	-		HBP[9:8]			VBP[5:0]					
R36h	Panel Characteristic	W/R	-	-	-	-	-	SS_Panel	GS_Pan el	REV_Panel	BGR_Panel		
R38h	OTP Control 1	W/R	-	OTP_PT[1:0]		OTP_VARDJ[1:0]		OTP_POR	OTP_OTPEN	OTP_PP ROG	OTP_PWE		
R39h	OTP Control 2	W/R	-	-	-	-	-	-	OTP_YA2	OTP_YA1	OTP_YA0		
R3Ah	OTP Control 3	W/R	-	-	-	-	OTP_XA4	OTP_XA3	OTP_XA2	OTP_XA1	OTP_XA0		
R3Ch	CABC Control 1	W/R	-			DBV[7:0](8'h00)							
R3Dh	CABC Control 2	W/R	-	-	-	BCTRL (0)	-	DD (0)	BL (0)	-	-		
R3Eh	CABC Control 3	W/R	-	-	-	-	-	-	-	C1 (0)	C0 (0)		
R3Fh	CABC Control 4	W/R	-			CMB[7:0](8'h00)							
R40h	r1 Control (1)	W/R	-	-	-			VRP0[5:0] (6'b00_0001)					
R41h	r1 Control (2)	W/R	-	-	-			VRP1[5:0] (6'b00_1110)					
R42h	r1 Control (3)	W/R	-	-	-			VRP2[5:0] (6'b01_0001)					
R43h	r1 Control (4)	W/R	-	-	-			VRP3[5:0] (6'b01_1010)					
R44h	r1 Control (5)	W/R	-	-	-			VRP4[5:0] (6'b01_1000)					
R45h	r1 Control (6)	W/R	-	-	-			VRP5[5:0] (6'b10_0100)					
R46h	r1 Control (7)	W/R	-	-	-			PRP0[6:0] (7'b001_0101)					
R47h	r1 Control (8)	W/R	-	-	-			PRP1[6:0] (7'b110_0101)					
R48h	r1 Control (9)	W/R	-	-	-	-		PKP0[4:0] (5'b0_1011)					
R49h	r1 Control (10)	W/R	-	-	-	-		PKP1[4:0] (5'b1_100)					
R4Ah	r1 Control (11)	W/R	-	-	-	-		PKP2[4:0] (5'b1_1001)					
R4Bh	r1 Control (12)	W/R	-	-	-	-		PKP3[4:0] (5'b1_1010)					
R4Ch	r1 Control (13)	W/R	-	-	-	-		PKP4[4:0] (5'b1_1000)					
R50h	r1 Control (18)	W/R	-	-	-			VRN0[5:0] (6'b01_1011)					
R51h	r1 Control (19)	W/R	-	-	-			VRN1[5:0] (6'b10_0111)					
R52h	r1 Control (20)	W/R	-	-	-			VRN2[5:0] (6'b10_0101)					
R53h	r1 Control (21)	W/R	-	-	-			VRN3[5:0] (6'b10_1110)					
R54h	r1 Control (22)	W/R	-	-	-			VRN4[5:0] (6'b11_0001)					
R55h	r1 Control (23)	W/R	-	-	-			VRN5[5:0] (6'b11_1110)					
R56h	r1 Control (24)	W/R	-	-	-			PRN0[6:0] (7'b001_1010)					
R57h	r1 Control (25)	W/R	-	-	-			PRN1[6:0] (7'b110_1010)					
R58h	r1 Control (26)	W/R	-	-	-			PKN0[4:0] (5'b0_0111)					
R59h	r1 Control (27)	W/R	-	-	-			PKN1[4:0] (5'b0_0101)					
R5Ah	r1 Control (28)	W/R	-	-	-			PKN2[4:0] (5'b0_0110)					
R5Bh	r1 Control (29)	W/R	-	-	-			PKN3[4:0] (5'b0_1011)					
R5Ch	r1 Control (30)	W/R	-	-	-			PKN4[4:0] (5'b1_0100)					
R5Dh	r1 Control (35)	W/R	-	CGMN1[1:0] (11)		CGMN0[1:0](00)		CGMP1[1:0](11)		CGMP0[1:0](00)			
R60h	TE Control	W/R	-	-	-		TE_m ode (0)	TEOE (0)	-	-	-		
RE4h	Power saving 1	W/R	-					EQ_S1[7:0]					
RE5h	Power saving 2	W/R	-					EQ_S2[7:0]					
RE6h	Power saving 3	W/R	-					EQ_S3[7:0]					
RE7h	Power saving 4	W/R	-					EQ_S4[7:0]					

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October, 2008

Register No.	Register	W/R	Upper Code D[17:8]	Lower Code								Comment
				D7	D6	D5	D4	D3	D2	D1	D0	
RE8h	Source OP control_Normal	W/R	-	OPON_N[7:0]								
RE9h	Source OP control_IDLE	W/R	-	OPON_I[7:0]								
REAh	Power control internal use (1)	W/R	-	STBA[15:8]								
REBh	Power control internal use (2)	W/R	-	STBA[7:0]								
RECh	Source control internal use (1)	W/R	-	PTBA[15:8]								
REDh	Source control internal use (2)	W/R	-	PTBA[7:0]								
RFFh	Page select	W/R	-	-	-	-	-	-	-	-	PAGE_SEL[1:0] (00)	

Table 8. 2 List Table of Command Set page 0

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Register No.	Register	W/R	Upper Code	Lower Code								Comment
				D[17:8]	D7	D6	D5	D4	D3	D2	D1	D0
RC3h	CABC Control 5	W/R	-	0	PWM DIV[2:0](000)			1	1	INPLUS(1)	1	
RC5h	CABC Control 6	W/R	-		PWM_PERIOD[7:0] (43d)							
RC7h	CABC Control 7	W/R	-	-		DIM_FRAME[6:0] (20)						
RCBh	Gain select register 0	W/R	-	-			DBG0[6:0](40)					
RCCh	Gain select register 1	W/R	-	-				DBG1[6:0](3C)				
RCDh	Gain select register 2	W/R	-	-					DBG2[6:0](38)			
RCEh	Gain select register 3	W/R	-	-					DBG3[6:0](34)			
RCFh	Gain select register 4	W/R	-	-					DBG4[6:0](33)			
RD0h	Gain select register 5	W/R	-	-					DBG5[6:0](32)			
RD1h	Gain select register 6	W/R	-	-					DBG6[6:0](2B)			
RD2h	Gain select register 7	W/R	-	-					DBG7[6:0](24)			
RD3h	Gain select register 8	W/R	-	-					DBG8[6:0](22)			
RFFh	Page select	W/R	-	-	-	-	-	-	-	-	PAGE_SEL[1:0] (00)	

Table 8. 2 List Table of Command Set page 1

8.2 Index Register

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	0	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
R	0	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0

Figure 8. 1 Index Register

Index register (IR) specifies the Index of register from R00h to RFFh. It sets the register number (ID7-0) in the range from 00000000b to 11111111b in binary form.

8.3 Himax ID Register (PAGE0 - R00h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
R	1	0	1	0	0	0	1	1	1

Figure 8. 2 Himax ID Register (PAGE0 -00h)

This command is used to read this IC's ID code. The ID code of this IC is 47h.

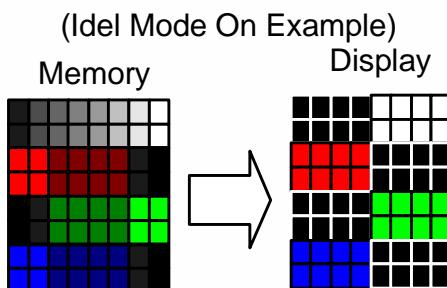
8.4 Display Mode Control Register (PAGE0 -01h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	DP_STB	DP_TB_S	*	*	SCR_OLL	IDMON	INVO_N	PLTON
R	1	DP_STB	DP_TB_S	0	0	SCR_OLL	IDMON	INVO_N	PLTON

Figure 8. 3 Display Mode Control Register (PAGE0 -01h)

DP_STB, DP_STB_S : These two bits can let the driver into the deep standby mode. And when into deep standby, all display operation stops, including the internal R-C oscillator. In the deep standby mode, the GRAM data and register content are NOT retained. For details, please refer to "7.7 Power On/Off Sequence" section for detail use.

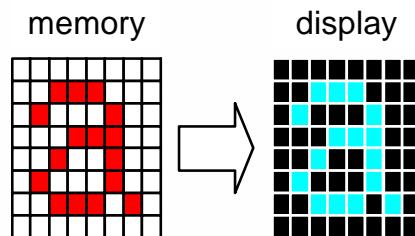
IDMON: This bit is Idle mode (8-color display mode) enable bit. **IDMON = '1'**, chip will be into idle mode, and color expression is reduced. The primary and the secondary colors using MSB of each R, G and B in the Frame Memory, 8 color depth data is displayed.



SCROLL : This bit turns on scroll mode by setting SCROLL = '1'. The scroll mode window is described by the Vertical Scroll Area command **TFA[15:0]**, **VSA[15:0]**, **BFA[15:0]** and **the Vertical start address VSP[15:0]** (R0Eh~R15h). To leave scroll mode to normal mode, the **SCROLL** bit should be set to '0'.

INVON: This bit is display inversion mode enable bit. **INVON** = '1', chip will be into display inversion mode, and makes no change of contents of frame memory. Every bit is inverted from the frame memory to the display.

(Example)



PTLON: This command is used for turning on/off SCROLL mode by setting SCROLL=1/0. The scrolling mode window is described by the Partial Area command **PSL[15:0]**, **PEL[15:0]** bits(R0Ah~R0Dh). To leave Partial mode to normal mode, the **PLTON** bit should be set to '0'.

8.5 Column Address Start Register (PAGE0 -02~03h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 4 Column Address Start Register Upper Byte (PAGE0 -02h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0
R	1	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0

Figure 8. 5 Column Address Start Register Low Byte (PAGE0 -03h)

8.6 Column Address End Register (PAGE0 -04~05h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 6 Column Address End Register Upper Byte (PAGE0 -04h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0
R	1	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0

Figure 8. 7 Column Address End Register Low Byte (PAGE0 -05h)

8.7 Row Address Start Register (PAGE0 -06~07h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 8 Row Address Start Register Upper Byte (PAGE0 -06h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0
R	1	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0

Figure 8. 9 Row Address Start Register Low Byte (PAGE0 -07h)

8.8 Row Address End Register (PAGE0 -08~09h)

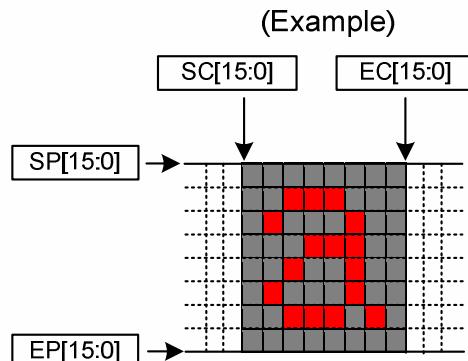
R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	EP 15	EP 14	EP 13	EP 12	EP 11	EP 10	EP9	EP8
R	1	EP 15	EP 14	EP 13	EP 12	EP 11	EP 10	EP9	EP8

Figure 8. 10 Row Address End Register Upper Byte (PAGE0 -08h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0
R	1	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0

Figure 8. 11 Row Address End Register Low Byte (PAGE0 -09h)

These commands (R02h~R09h) are used to define area of frame memory where MCU can access. The values of SC[15:0], EC[15:0], SP[15:0] and EP[15:0] are referred when RAMWR command comes. Each value of SC[15:0], EC[15:0] represents one column line in the Frame Memory. Each value of SP[15:0], EP[15:0] represents one page line in the Frame Memory.



8.9 Partial Area Start Row Register (PAGE0 -0A~0Bh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 12 Partial Area Start Row Register Upper Byte (PAGE0 -0Ah)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 13 Partial Area Start Row Register Low Byte (PAGE0 -0Bh)

8.10 Partial Area End Row Register (PAGE0 -0C~0Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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

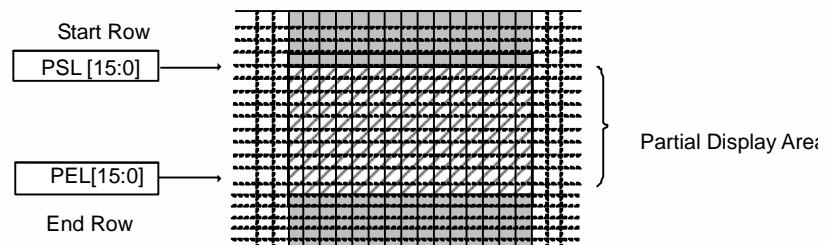
Figure 8. 14 Partial Area End Row Register Upper Byte (PAGE0 -0Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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

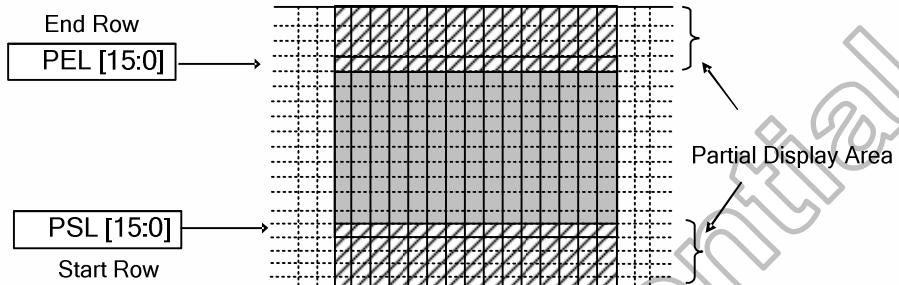
Figure 8. 15 Partial Area End Row Register Low Byte (PAGE0 -0Dh)

These commands (PAGE0 -0Ah~0Dh) define the partial mode's display area. The Start Row (PSL) and the second the End Row (PEL) are illustrated in the figures below. PSL and PEL refer to the Frame Memory Line Pointer.

If End Row > Start Row



If End Row < Start Row



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

8.11 Vertical Scroll Top Fixed Area Register (PAGE0 -0E~0Fh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 16 Vertical Scroll Top Fixed Area Register Upper Byte (PAGE0 -0Eh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 17 Vertical Scroll Top Fixed Area Register Low Byte (PAGE0 -0Fh)

8.12 Vertical Scroll Height Area Register (PAGE0 -10~11h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 18 Vertical Scroll Height Area Register Upper Byte (PAGE0 -10h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 19 Vertical Scroll Height Area Register Low Byte (PAGE0 -11h)

8.13 Vertical Scroll Button Fixed Area Register (PAGE0 -12~13h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 20 Vertical Scroll Button Fixed Area Register Upper Byte (PAGE0 -12h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 21 Vertical Scroll Button Fixed Area Register Low Byte (PAGE0 -13h)

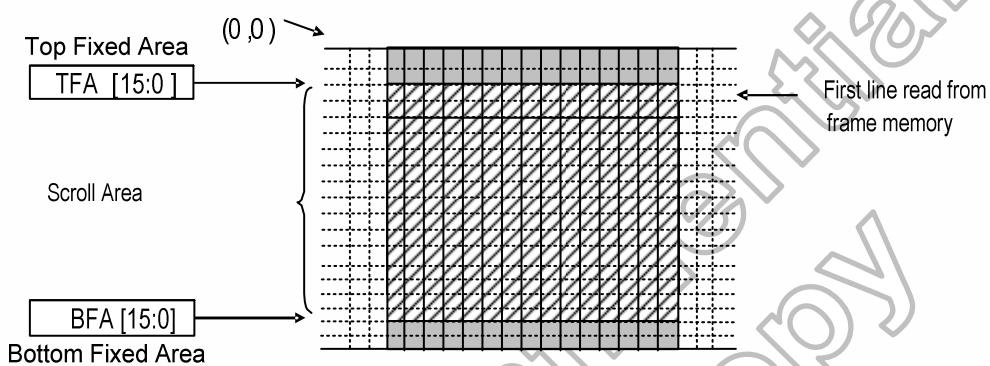
These commands (PAGE0 -0E~0Fh, R10~11h, R12~13h) define the Vertical Scrolling Area of the display.

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.



Please note that (TFA+VSA+BFA) must be set to '320d', otherwise Scrolling mode is undefined. In Vertical Scroll Mode, MV bit should be set to '0' – this only affects the Frame Memory Write.

8.14 Vertical Scroll Start Address Register (PAGE0 -14~15h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 22 Vertical Scroll Start Address Register Upper Byte (PAGE0 -14h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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

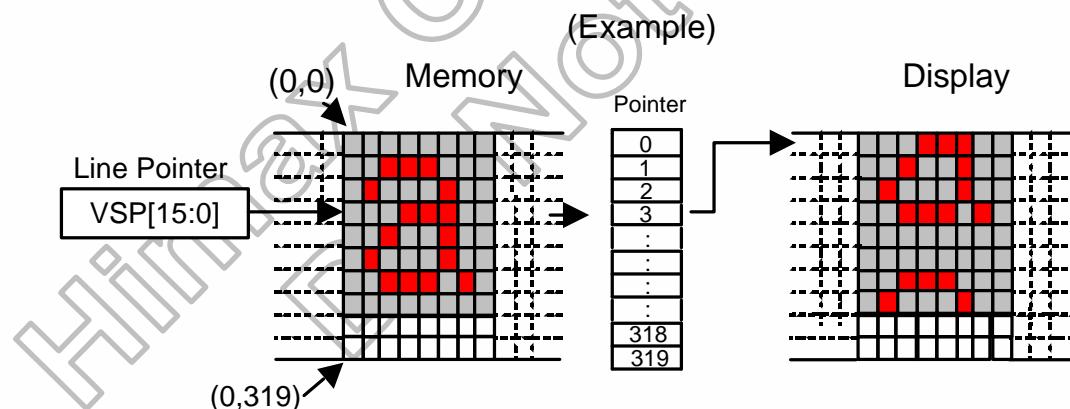
Figure 8. 23 Vertical Scroll Start Address Register Low Byte (PAGE0 -15h)

VSP[15:0] is used together with Vertical Scrolling Definition register (PAGE0 -0Eh~R13h), which describe the scrolling area and the scrolling mode.

VSP[15:0] refers to the Frame Memory line Pointer, and 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:

Example:

When Top Fixed Area TFA = '00d', Bottom Fixed Area BFA = '02'd, Vertical Scrolling Area VSA = '318'd and VSP = '3d' (**SMX** = 'L', **SMY** = 'L')



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.

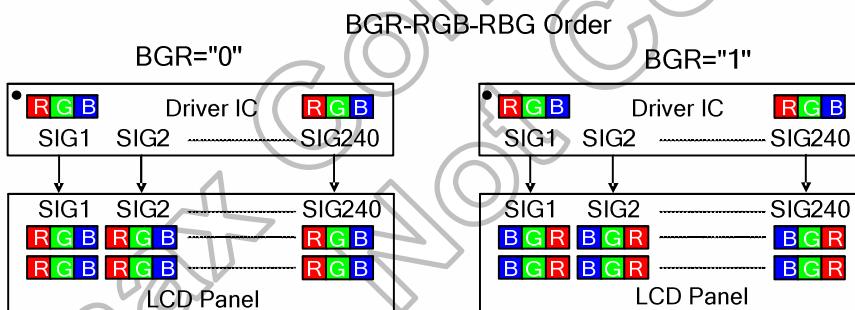
8.15 Memory Access Control Register (PAGE0 -16h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	MY	MX	MV	ML	BGR	*	*	*
R	1	MY	MX	MV	ML	BGR	0	0	0

Figure 8. 24 Memory Access Control Register (PAGE0 -16h)

This command defines read/write scanning direction of frame memory. **MX**, **MY** bits also define the display direction in the RGB interface. This command makes no change on the other driver status. For details, please refer to “6.2.1 System interface to GRAM Write Direction” section.

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



8.16 COLMOD Control Register (PAGE0 -17h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	CSEL3	CSEL2	CSEL1	CSEL0	*	IFPF2	IFPF1	IFPF0
R	1	CSEL3	CSEL2	CSEL1	CSEL0	*	IFPF2	IFPF1	IFPF0

Figure 8. 25 COLMOD Control Register (PAGE0 -17h)

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
18 Bit/Pixel at 16-bits data bus interface (16+2)	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			

8.17 OSC Control Register (PAGE0 -18h & R19h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	I/P_R ADJ3	I/P_R ADJ2	IP_RA DJ1	I/P_R ADJ0	N/P_R ADJ3	N/P_R ADJ2	N/P_R ADJ1	N/P_R ADJ0
R	1	I/P_R ADJ3	I/P_R ADJ2	IP_RA DJ1	I/P_R ADJ0	N/P_R ADJ3	N/P_R ADJ2	N/P_R ADJ1	N/P_R ADJ0

Figure 8. 26 OSC Control 1 Register (PAGE0 -18h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	*	*	OSC_EN
R	1	0	0	0	0	0	0	0	OSC_EN

Figure 8. 27 OSC Control 2 Register (PAGE0 -19h)

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 (PAGE0 -CM[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/P_RADJ[2:0]: Internal oscillator frequency adjusts in Idle(8-color) / Partial Idle mode.

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

RADJ3	RADJ2	RADJ1	RADJ0	Internal Oscillator Frequency	Display Frame rate
0	0	0	0	50% x 2.85MHz	35Hz
0	0	0	1	67% x 2.85MHz	45Hz
0	0	1	0	75% x 2.85MHz	50Hz
0	0	1	1	83% x 2.85MHz	55Hz
0	1	0	0	100% x 2.85MHz	65Hz
0	1	0	1	108% x 2.85MHz	70Hz
0	1	1	0	117% x 2.85MHz	75Hz
0	1	1	1	125% x 2.85MHz	80Hz
1	0	0	0	100% x 2.85MHz	70Hz
1	0	0	1	133% x 2.85MHz	90Hz
1	0	1	0	150% x 2.85MHz	100Hz
1	0	1	1	167% x 2.85MHz	110Hz
1	1	0	0	200% x 2.85MHz	130Hz
1	1	0	1	217% x 2.85MHz	140Hz
1	1	1	0	233% x 2.85MHz	150Hz
1	1	1	1	250% x 2.85MHz	160Hz

8.18 Power Control 1 Register (PAGE0 -1Ah)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	BT2	BT1	BT0
R	1	*	*	*	*	*	BT2	BT0	BT0

Figure 8. 28 Power Control 1 Register (PAGE0 -1Ah)

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	5.0V	-VCI	3DDVDH	-VCI-2DDVDH
0	0	1	5.0V	-VCI	3DDVDH	-2DDVDH
0	1	0	5.0V	-VCI	3DDVDH	VCI-2DDVDH
0	1	1	5.0V	-VCI	VCI+2DDVDH	-VCI-2DDVDH
1	0	0	5.0V	-VCI	VCI+2DDVDH	-2DDVDH
1	0	1	5.0V	-VCI	VCI+2DDVDH	VCI-2DDVDH
1	1	0	5.0V	-VCI	2DDVDH	-2DDVDH
1	1	1	5.0V	-VCI	2DDVDH	-VCI-DDVDH

Note: When VCI = 2.8V, DDVDH_TRI=0

BT2	BT1	BT0	DDVDH	VCL	VGH	VGL
0	0	0	6.1V	-VCI	Setting inhabited	Setting inhabited
0	0	1	6.1V	-VCI	3DDVDH	-2DDVDH
0	1	0	6.1V	-VCI	3DDVDH	VCI-2DDVDH
0	1	1	6.1V	-VCI	VCI+2DDVDH	-VCI-2DDVDH
1	0	0	6.1V	-VCI	VCI+2DDVDH	-2DDVDH
1	0	1	6.1V	-VCI	VCI+2DDVDH	VCI-2DDVDH
1	1	0	6.1V	-VCI	2DDVDH	-2DDVDH
1	1	1	6.1V	-VCI	2DDVDH	-VCI-DDVDH

Note: When VCI = 2.8V, DDVDH_TRI=1

8.19 Power Control 2 Register (PAGE0 -1Bh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRH5	VRH4	VRH3	VRH2	VRH1	VRH0
R	1	*	*	VRH5	VRH4	VRH3	VRH2	VRH1	VRH0

Figure 8. 29 Power Control 2 Register (PAGE0 -1Bh)

VRH[4:0]: Specify the VREG1 voltage adjusting. VREG1 voltage is for gamma voltage setting.
 $VREG1 = \text{Decimal}(VRH[5:0]) \times 0.05 + 3.3$.

VRH5	VRH4	VRH3	VRH2	VRH1	VRH0	VREG1 (DDVDH_TRI =0)	VREG1 (DDVDH_TRI =1)
0	0	0	0	0	0	3.30	3.30
0	0	0	0	0	1	3.35	3.35
0	0	0	0	1	0	3.40	3.40
0	0	0	0	1	1	3.45	3.45
0	0	0	1	0	0	3.50	3.50
0	0	0	1	0	1	3.55	3.55
0	0	0	1	1	0	3.60	3.60
0	0	0	1	1	1	3.65	3.65
0	0	1	0	0	0	3.70	3.70
:	:	:	:	:	:	:	:
0	1	1	1	0	1	4.75	4.75
0	1	1	1	1	0	4.80	4.80
0	1	1	1	1	1	STOP	4.85
1	0	0	0	0	0	STOP	4.90
1	0	0	0	0	1	STOP	4.95
:	:	:	:	:	:	:	:
1	1	0	0	0	0	STOP	5.70
1	1	0	0	0	1	STOP	5.75
1	1	0	0	1	0	STOP	5.80
1	1	0	0	1	1	STOP	STOP
1	1	1	0	1	1	STOP	STOP
:	:	:	:	:	:	:	:
1	1	1	1	1	0	STOP	STOP
1	1	1	1	1	1	Internal circuit operations stop. The gamma voltage can be adjusted from external VREG1 input.	

Note: Internal VREF can be modified by Custom's special request. default VREF=4.8 if DDVDH_TRI=0 and VREF=5.8 if DDVDH_TRI=1

VREG1={Decimal(VRH[5:0])x0.05+3.3 }*(VREF/4.8) if DDVDH_TRI=0.

VREG1={Decimal(VRH[5:0])x0.05+3.3 }*(VREF/5.8) if DDVDH_TRI=1.

8.20 Power Control 3 Register (PAGE0 -1Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	AP2	AP1	AP0
R	1	*	*	*	*	*	AP2	AP1	AP0

Figure 8. 30 Power Control 3 Register (PAGE0 -1Ch)

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	Small
0	1	1	Small
1	0	0	Medium
1	0	1	Medium High
1	1	0	Large
1	1	1	Setting Inhibited

8.21 Power Control 4 Register (PAGE0 -1Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	I/PI_F S02	I/PI_F S01	I/PI_F S00	*	N/P_ FS02	N/P_ FS01	N/P_ FS00
R	1	*	I/PI_F S02	I/PI_F S01	I/PI_F S00	*	N/P_ FS02	N/P_ FS01	N/P_ FS00

Figure 8. 31 Power Control 4 Register (PAGE0 -1Dh)

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.

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.

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

8.22 Power Control 5 Register (PAGE0 -1Eh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	I/PI_F S12	I/PI_F S11	I/PI_F S10	*	N/P_ FS12	N/P_ FS11	N/P_ FS10
R	1	*	I/PI_F S12	I/PI_F S11	I/PI_F S10	*	N/P_ FS12	N/P_ FS11	N/P_ FS10

Figure 8. 32 Power Control 5 Register (PAGE0 -1Eh)

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	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

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

8.23 Power Control 6 Register (PAGE0 -1Fh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	GAS EN	VCO MG	*	PON	DK	XDK	DDV DH_T RI	STB
R	1	GAS EN	VCO MG	*	PON	DK	XDK	DDV DH_T RI	STB

Figure 8. 33 Power Control 6 Register (PAGE0 -1Fh)

PON: Specify on/off control of step-up circuit 2 for VCL, VGL voltage generation.
For detail, see the Power On/Off Setting Flow.

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

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

STB: When **STB** = '1', the HX8347-D into the standby mode, where all display operation stops, suspend all the internal operations including the internal R-C oscillator. During the standby mode, only the following process can be executed. For details, please refer to STB mode flow.

- a. Start the oscillation
- b. Exit the Standby mode (**STB** = "0") ,

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

XDK, DDVDH_TRI: Specify the ratio of step-up circuit for DDVDH voltage generation.

DDVDH_TRI	XDK	Step up circuit 1	Capacitor connection pins used
0	0	2 x VCI	C11P, C11N
0	1	2 x VCI	C11P, C11N, C12P, C12N
1	0	3 x VCI	C11P, C11N, C12P, C12N
1	1	Setting inhabited	Setting inhabited

VCOMG: When **VCOMG** = '1', VCOML voltage can output to negative voltage (1.0V ~ VCL+0.5V). When **VCOMG** = '0', VCOML outputs GND and **VML[7:0]** setting are invalid. Then, low power consumption is accomplished.

GASEN: This stands for abnormal power-off monitor function when the power is off.

8.24 Read Data Register (PAGE0 -22h)

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. 34 Read Data Register (PAGE0 -22h)

WD[17:0] : Transforms the data into 18-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.

8.25 VCOM Control 1~3 Register (PAGE0 -23~25h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	VMF 7	VMF 6	VMF 5	VMF 4	VMF 3	VMF 2	VMF 1	VMF 0
R	1	VMF 7	VMF 6	VMF 5	VMF 4	VMF 3	VMF 2	VMF 1	VMF 0

Figure 8. 35 Vcom Control 1 Register (PAGE0 -23h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	VMH 7	VMH 6	VMH 5	VMH 4	VMH 3	VMH 2	VMH 1	VMH 0
R	1	VMH 7	VMH 6	VMH 5	VMH 4	VMH 3	VMH 2	VMH 1	VMH 0

Figure 8. 36 Vcom Control 2 Register (PAGE0 -24h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	VML 7	VML 6	VML 5	VML 4	VML 3	VML 2	VML 1	VML 0
R	1	VML 7	VML 6	VML 5	VML 4	VML 3	VML 2	VML 1	VML 0

Figure 8. 37 Vcom Control 3 Register (PAGE0 -25h)

This command is used to set VCOM Voltage include VCOM Low and VCOM High Voltage

VMH[7:0]: Set the VCOMH voltage (High level voltage of VCOM). VCOM High voltage = Decimal(VMH[7:0])x0.015+2.5.

VMH 7	VMH 6	VMH 5	VMH 4	VMH 3	VMH 2	VMH 1	VMH 0	VCOMH (DDVDH_TRI =0)	VCOMH (DDVDH_TRI =1)
0	0	0	0	0	0	0	0	2.500	2.500
0	0	0	0	0	0	0	1	2.515	2.515
0	0	0	0	0	0	1	0	2.530	2.530
0	0	0	0	0	0	1	1	2.545	2.545
0	0	0	0	0	1	0	0	2.560	2.560
0	0	0	0	0	1	0	1	2.575	2.575
:	:	:	:	:	:	:	:	:	:
1	0	0	1	0	0	1	1	4.705	4.705
1	0	0	1	0	1	0	0	4.720	4.720
1	0	0	1	0	1	0	1	4.735	4.735
1	0	0	1	0	1	1	0	4.750	4.750
1	0	0	1	0	1	1	1	4.765	4.765
1	0	0	1	1	0	0	0	4.780	4.780
1	0	0	1	1	0	0	1	4.795	4.795
1	0	0	1	1	0	1	0	4.800	4.810
1	0	0	1	1	0	1	1	4.800	4.825
1	0	0	1	1	1	0	0	4.800	4.840
1	0	0	1	1	1	0	1	4.800	4.855
:	:	:	:	:	:	:	:	4.800	:
1	1	0	0	1	0	0	0	4.800	5.800
:	:	:	:	:	:	:	:	4.800	5.800
1	1	1	1	1	1	1	0	4.800	5.800
1	1	1	1	1	1	1	1	Setting inhibited	

Note: internal VREF can be modified by customer's request. default VREF=4.8 if DDVDH_TRI=0 and VREF=5.8 if DDVDH_TRI=1

VCOMH= {Decimal(VMH[7:0])x0.015+2.5 }*(VREF/4.8) if DDVDH_TRI=0

VCOMH= {Decimal(VMH[7:0])x0.015+2.5 }*(VREF/5.8) if DDVDH_TRI=1

VML[7:0]: Set the VCOML voltage (Low level voltage of VCOM). VCOM Low voltage = Decimal(VML[7:0])x0.015-2.5.

VML7	VML6	VML5	VML4	VML3	VML2	VML1	VML0	VCOML
0	0	0	0	0	0	0	0	-2.500
0	0	0	0	0	0	0	1	-2.485
0	0	0	0	0	0	1	0	-2.470
0	0	0	0	0	1	0	1	-2.455
:	:	:	:	:	:	:	:	:
1	0	1	0	0	0	1	1	-0.055
1	0	1	0	0	1	0	0	-0.040
1	0	1	0	0	1	0	1	-0.025
1	0	1	0	0	1	1	0	-0.010
1	0	1	0	0	1	1	1	VSS
:	:	:	:	:	:	:	:	:
1	1	1	1	1	1	1	1	VSS

Note: internal VREF can be modified by customer's request. default VREF=4.8 if DDVDH_TRI=0 and VREF=5.8 if DDVDH_TRI=1

VCOML= { Decimal(VML[7:0])x0.015-2.5 }*(VREF/4.8) if DDVDH_TRI=0,

VCOML= { Decimal (VML[7:0])x0.015-2.5 }*(VREF/5.8) if DDVDH_TRI=1

VMF[7:0]: Set the VCOM offset voltage. VMH+1d/VML+1d means VMH/VML from original setting move up one step (15mV). VMH-1d/VML-1d means VMH/VML from original setting move down one step (15mV)

VMF[7:0]	VCOMH	VCOML
0	"VMH" - 128d	"VMH" - 128d
1	"VMH" - 127d	"VMH" - 127d
2	"VMH" - 126d	"VMH" - 126d
3	"VMH" - 125d	"VMH" - 125d
:	:	:
126	"VMH" - 2d	"VMH" - 2d
127	"VMH" - 1d	"VMH" - 1d
128	"VMH"	"VML"
129	"VMH" + 1d	"VMH" + 1d
130	"VMH" + 2d	"VMH" + 2d
:	:	:
254	"VMH" + 126d	"VMH" + 126d
255	"VMH" + 127d	"VMH" + 127d

Note: VMH[7:0]-128+VMF[7:0]>=0 and VML[7:0]-128+VMF[7:0]>=0

8.26 Display Control 1 Register (PAGE0 -26h~R28h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	ISC3	ISC2	ISC1	ISC0
R	1	*	*	*	*	ISC3	ISC2	ISC1	ISC0

Figure 8. 38 Display Control 1 Register (PAGE0 -26h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	PT1	PT0	PTV 1	PTV 0	*	*	PTG	REF
R	1	PT1	PT0	PTV 1	PTV 0	*	*	PTG	REF

Figure 8. 39 Display Control 2 Register (PAGE0 -27h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	GON	DTE	D1	D0	*	*
R	1	*	*	GON	DTE	D1	D0	0	0

Figure 8. 40 Display Control 3 Register (PAGE0 -28h)

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 _{FLM} = 60Hz	
0	0	0	0	1 frame	17ms	
0	0	0	1	5 frames	83ms	
0	0	1	0	9 frames	150ms	
0	0	1	1	13 frames	217ms	
0	1	0	0	17 frames	283ms	
0	1	0	1	21 frames	350ms	
0	1	1	0	25 frames	417ms	
0	1	1	1	29 frames	483ms	
1	0	0	0	33 frames	550ms	
1	0	0	1	37 frames	616ms	
1	0	1	0	41 frames	683ms	
1	0	1	1	45 frames	750ms	
1	1	0	0	49 frames	816ms	
1	1	0	1	53 frames	883ms	
1	1	1	0	57 frames	950ms	
1	1	1	1	Setting inhibited		

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

PT[1:0] : Specify the Non-display area source output in partial display mode.

REV_panel		Source Output Level								
		GRAM Data		Display area		Non-display Area				
				VCOM = "L"	VCOM = "H"	VCOM = "L"	VCOM = "H"	VCOM = "L"	VCOM = "H"	VCOM = "L"
1 (Normally Black Panel)	18'h0000	V63P	V0N	V63P	V0N	VSSD	VSSD	Hi-z	Hi-z	
	18'h3FFF	V0P	V63N							
0 (Normally White Panel)	18'h0000	V0P	V63N	V63P	V0N	VSSD	VSSD	Hi-z	Hi-z	
	18'h3FFF	V63P	V0N							

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 HX8347-D can control the charging current for the LCD with AC driving. Control the display on/off while control GON and DTE.

When D[1:0]= '01', the internal display of the HX8347-D is performed although the actual display is off. When D[1:0]= '00', the internal display operation halts and the display is off.

D1	D0	Source Output	HX8347-D Internal Display Operations	Gate-Driver Control Signals
0	0	VSSD	Halt	Halt
0	1	VSSD	Operate	Operate
1	0	=PT(0,0)	Operate	Operate
1	1	Display	Operate	Operate

GON, DTE:

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

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

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8.27 Frame Control Register (PAGE0 -29h~R2Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	I/P_R TN3	I/P_R TN2	I/P_R TN1	I/P_R TN0	N/P_ RTN3	N/P_ RTN2	N/P_ RTN1	N/P_ RTN0
R	1	I/P_R TN3	I/P_R TN2	I/P_R TN1	I/P_R TN0	N/P_ RTN3	N/P_ RTN2	N/P_ RTN1	N/P_ RTN0

Figure 8. 41 Frame Control 1 Register (PAGE0 -29h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	I/P_ DIV1	I/P_ DIV0	*	*	N/P_ DIV1	N/P_ DIV0
R	1	*	*	I/P_ DIV1	I/P_ DIV0	*	*	N/P_ DIV1	N/P_ DIV0

Figure 8. 42 Frame Control 2 Register (PAGE0 -2Ah)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	N/P_ DUM 7	N/P_ DUM 6	N/P_ DUM 5	N/P_ DU M4	N/P_ DUM 3	N/P_ DUM 2	N/P_ DUM 1	N/P_ DUM 0
R	1	N/P_ DUM 7	N/P_ DUM 6	N/P_ DUM 5	N/P_ DU M4	N/P_ DUM 3	N/P_ DUM 2	N/P_ DUM 1	N/P_ DUM 0

Figure 8. 43 Frame Control 3 Register (PAGE0 -2Bh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	I/PI_ DUM 7	I/PI_ DUM 6	I/PI_ DUM 5	I/PI_ DU M4	I/PI_ DUM 3	I/PI_ DUM 2	I/PI_ DUM 1	I/PI_ DUM 0
R	1	I/PI_ DUM 7	I/PI_ DUM 6	I/PI_ DUM 5	I/PI_ DU M4	I/PI_ DUM 3	I/PI_ DUM 2	I/PI_ DUM 1	I/PI_ DUM 0

Figure 8. 44 Frame Control 4 Register (PAGE0 -2Ch)

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

fosc = R-C oscillation frequency

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

IPI_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	124
4'b0001	125
4'b0010	126
4'b0011	127
4'b0100	128
:	:
4'b1110	134
4'b1111	135

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

IPI_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
:	:
190d	190
others	Setting Inhibited

Formula for the Frame Frequency during internal display mode:

Frame frequency = fosc/(RTN × DIV × (320+DUM)) [Hz]

fosc: RC oscillation frequency

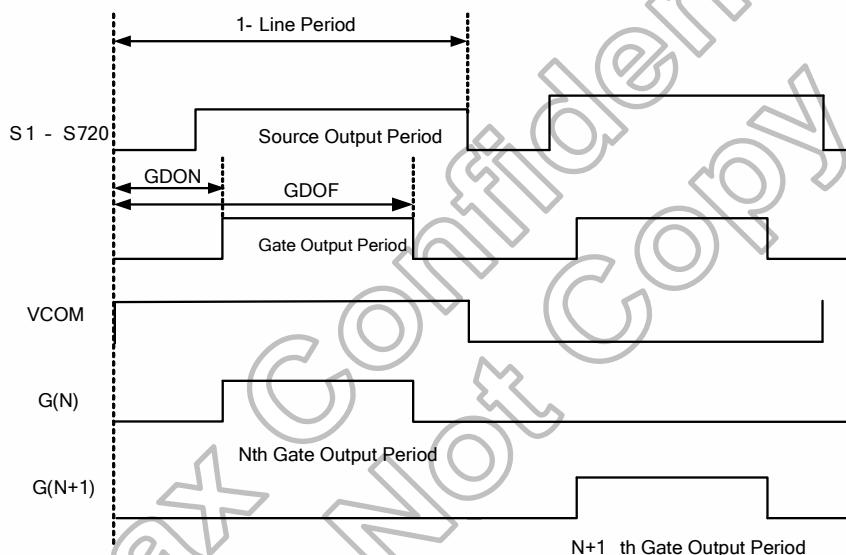
8.28 Cycle Control Register (PAGE0 -2Dh~R2Eh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 45 Cycle Control Register 1 (PAGE0 -2Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 46 Cycle Control Register 2 (PAGE0 -2Eh)



GDON[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 GDON[7:0] + 1 ≤ GDOF[7:0] ≤ RTN-1).

8.29 Display Inversion Register (PAGE0 -2Fh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
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. 47 Cycle Control Register (PAGE0 -2Fh)

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

8.30 RGB Interface Control Register (PAGE0 -31h~R34h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	*	RCM 1	RCM 0
R	1	0	0	0	0	0	0	RCM 1	RCM 0

Figure 8. 48 RGB Interface Control Register (PAGE0 -31h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	DPL	HSPL	VSPL	EPL
R	1	0	0	0	*	DPL	HSPL	VSPL	EPL

Figure 8. 49 RGB Interface Control Register (PAGE0 -32h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	HBP7	HBP6	HBP5	HBP4	HBP3	HBP2	HBP1	HBP0
R	1	HBP7	HBP6	HBP5	HBP4	HBP3	HBP2	HBP1	HBP0

Figure 8. 50 RGB Interface Control Register (PAGE0 -33h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	HBP9	HBP8	VBP5	VBP4	VBP3	VBP2	VBP1	VBP0
R	1	HBP9	HBP8	VBP5	VBP4	VBP3	VBP2	VBP1	VBP0

Figure 8. 51 RGB Interface Control Register (PAGE0 -34h)

This command is used to set RGB interface related register

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

RCM1	RCM0	Interface Select
0	x	System Interface ⁽¹⁾
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.

EPL: Specify the polarity of ENABLE signal in RGB interface mode. EPL='1', the ENABLE signal is High active; EPL=0, the ENABLE signal is Low active.

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

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

DPL: The polarity of DOTCLK pin. When DPL='0', the data is latched by the chip on the rising edge of DOTCLK signal. When DPL='1', the data is latched by the chip on the falling edge of DOTCLK signal.

HBP and **VBP** are 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[9:0]: Set the delay period from falling edge of HSYNC signal to first valid data in RGB I/F mode 2

HBP[9:0]	No. of clock cycle of DOTCLK
00d	Setting Inhibited
01d	Setting Inhibited
02d	2
03d	3
04d	4
:	:
1021d	1021
1022d	1022
1023d	Setting Inhibited

VBP[5:0]: Set the delay period from falling edge of VSYNC signal to first valid line in RGB I/F mode 2

VBP[5:0]	No. of clock cycle of HSYNC
00d	Setting Inhibited
01d	Setting Inhibited
02d	2
03d	3
04d	4
:	:
125d	125
126d	126
127d	Setting Inhibited

8.31 Panel Characteristic Control Register (PAGE0 -36h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	SS_PA NEL	GS_PA NEL	REV_P ANEL	BGR_P ANEL
R	1	*	*	*	*	SS_PA NEL	GS_PA NEL	REV_P ANEL	BGR_P ANEL

Figure 8. 52 Panel Characteristic Control Register (PAGE0 -36h)

This command is internal use for display panel setting.

REV_PANEL: The source output data polarity selected. When REV_PANEL=0, normally white panel is selected. When REV_P = 1, normally black panel is selected.

BGR_P: The color filter order direction selected. When BGR_PANEL=0, don't reverse the SRGB setting. When BGR_P = 1, the color filter order will be reversed.

GS_P: The gate driver output shift direction selected. When GS_P=0, the shift direction don't reverse. When GS_P = 1, the shift direction will be reversed.

SS_P: The source driver output shift direction selected. When SS_P=0, the shift direction don't reverse. When SS_P = 1, the shift direction will be reversed.

8.32 OTP Register (PAGE0 -38h ~ R3Ah)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	OTP _PT M0	OTP _PT M0	OTP _VR ADJ1	OTP _VR ADJ0	OTP _PO R	OTP _OT PEN	OTP _PP ROG	OTP _PW E
R	1	OTP _PT M1	OTP _PT M0	OTP _VR ADJ1	OTP _VR ADJ0	OTP _PO R	OTP _OT PEN	OTP _PP ROG	OTP _PW E

Figure 8. 53 OTP Command 1 (PAGE0 -38h)

R/W	RS	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	*	*	OTP _YA2	OTP _YA1	OTP _YA0
R	1	*	*	*	*	*	OTP _YA2	OTP _YA1	OTP _YA0

Figure 8. 54 OTP Command 2 (PAGE0 -39h)

R/W	RS	D7	D6	D5	D4	D3	D2	D1	D0
W	1	*	*	*	OTP _XA4	OTP _XA3	OTP _XA2	OTP _XA1	OTP _XA0
R	1	*	*	*	OTP _XA4	OTP _XA3	OTP _XA2	OTP _XA1	OTP _XA1

Figure 8. 55 OTP Command 3 (PAGE0 -3Ah)

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[4:0]; OTP_YA[2:0]: Select OTP writes address

OTP_TM[1:0]: OTP Test mode register, In-house use.

OTP_VRADJ[1:0]: OTP VPP2 adjusts register, In-house use.

8.33 CABC Control 1~4 Register (PAGE0 -3Ch~3Fh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	DBV 7	DBV 6	DBV 5	DBV 4	DBV 3	DBV 2	DBV 1	DBV 0
R	1	DBV 7	DBV 6	DBV 5	DBV 4	DBV 3	DBV 2	DBV 1	DBV 0

Figure 8. 56 CABC Control 1 Register (PAGE0 -3Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	BCT RL	*	DD	BL	*	*
R	1	0	0	BCT RL	0	DD	BL	0	0

Figure 8. 57 CABC Control 2 Register (PAGE0 -3Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	*	C1	C0
R	1	0	0	0	0	0	0	C1	C0

Figure 8. 58 CABC Control 3 Register (PAGE0 -3Eh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	CMB 7	CMB 6	CMB 5	CMB 4	CMB 3	CMB 2	CMB 1	CMB 0
R	1	CMB 7	CMB 6	CMB 5	CMB 4	CMB 3	CMB 2	CMB 1	CMB 0

Figure 8. 59 CABC Control 4 Register (PAGE0 -3Fh)

These commands are used to set CABC parameter

DBV[7:0]: The backlight PWM pulse output duty is equal to DBV[7:0]/255 x CABC_duty.

BCTRL: Backlight Control Block On/Off, This bit is always used to switch brightness for display.

‘0’ = Off (Equal to DBV[7:0] = ‘00h’)

‘1’ = On (Brightness registers are active.)

DD: Display Dimming (Only for manual brightness setting)

‘0’: Display Dimming is off.

‘1’: Display Dimming is on.

BL: Backlight Control On/Off

‘0’ = Off (Completely turn off backlight circuit. Control lines must be low.)

‘1’ = On

Dimming function is adapted to the brightness registers for display when bit BCTRL is changed at DD=1, e.g. BCTRL: 0 -> 1 or 1-> 0.

When BL bit change from “On” to “Off”, backlight is turned off without gradual dimming, even if dimming-on (**DD=1**) are selected.

C[1:0]: This command is used to set parameters for image content based adaptive brightness control functionality.

There is possible to use 4 different modes for content adaptive image functionality, which are defined on a table below.

C1	C0	Function	Note
0	0	Off	-
0	1	User Interface Image	-
1	0	Still Picture	-
1	1	Moving Image	-

CMB[7:0]: This command is used to set the minimum brightness value of the display for CABC function.

In principle relationship is that 00h value means the lowest brightness for CABC and FFh value means the highest brightness for CABC.

8.34 Gamma Control 1~35 Register (PAGE0 -40h~5Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 05	VRP 04	VRP 03	VRP 02	VRP 01	VRP 00
R	1	0	0	VRP 05	VRP 04	VRP 03	VRP 02	VRP 01	VRP 00

Figure 8. 60 Gamma Control 1 Register (PAGE0 -40h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 15	VRP 14	VRP 13	VRP 12	VRP 11	VRP 10
R	1	0	0	VRP 15	VRP 14	VRP 13	VRP 12	VRP 11	VRP 10

Figure 8. 61 Gamma Control 2 Register (PAGE0 -41h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 25	VRP 24	VRP 23	VRP 22	VRP 21	VRP 20
R	1	0	0	VRP 25	VRP 24	VRP 23	VRP 22	VRP 21	VRP 20

Figure 8. 62 Gamma Control 3 Register (PAGE0 -42h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 35	VRP 34	VRP 33	VRP 32	VRP 31	VRP 30
R	1	0	0	VRP 35	VRP 34	VRP 33	VRP 32	VRP 31	VRP 30

Figure 8. 63 Gamma Control 4 Register (PAGE0 -43h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 45	VRP 44	VRP 43	VRP 42	VRP 41	VRP 40
R	1	0	0	VRP 45	VRP 44	VRP 43	VRP 42	VRP 41	VRP 40

Figure 8. 64 Gamma Control 5 Register (PAGE0 -44h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRP 55	VRP 54	VRP 53	VRP 52	VRP 51	VRP 50
R	1	0	0	VRP 55	VRP 54	VRP 53	VRP 52	VRP 51	VRP 50

Figure 8. 65 Gamma Control 6 Register (PAGE0 -45h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	PRP 06	PRP 05	PRP 04	PRP 03	PRP 02	PRP 01	PRP 00
R	1	0	PRP 06	PRP 05	PRP 04	PRP 03	PRP 02	PRP 01	PRP 00

Figure 8. 66 Gamma Control 7 Register (PAGE0 -46h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	PRP 16	PRP 15	PRP 14	PRP 13	PRP 12	PRP 11	PRP 10
R	1	0	PRP 16	PRP 15	PRP 14	PRP 13	PRP 12	PRP 11	PRP 10

Figure 8. 67 Gamma Control 8 Register (PAGE0 -47h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 04	PKP 03	PKP 02	PKP 01	PKP 00
R	1	0	0	0	PKP 04	PKP 03	PKP 02	PKP 01	PKP 00

Figure 8. 68 Gamma Control 9 Register (PAGE0 -48h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 14	PKP 13	PKP 12	PKP 11	PKP 10
R	1	0	0	0	PKP 14	PKP 13	PKP 12	PKP 11	PKP 10

Figure 8. 69 Gamma Control 10 Register (PAGE0 -49h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 24	PKP 23	PKP 22	PKP 21	PKP 20
R	1	0	0	0	PKP 24	PKP 23	PKP 22	PKP 21	PKP 20

Figure 8. 70 Gamma Control 11 Register (PAGE0 -4Ah)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 34	PKP 33	PKP 32	PKP 31	PKP 30
R	1	0	0	0	PKP 34	PKP 33	PKP 32	PKP 31	PKP 30

Figure 8. 71 Gamma Control 12 Register (PAGE0 -4Bh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 44	PKP 43	PKP 42	PKP 41	PKP 40
R	1	0	0	0	PKP 44	PKP 43	PKP 42	PKP 41	PKP 40

Figure 8. 72 Gamma Control 13 Register (PAGE0 -4Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKP 84	PKP 83	PKP 82	PKP 81	PKP 80
R	1	0	0	0	PKP 84	PKP 83	PKP 82	PKP 81	PKP 80

Figure 8. 73 Gamma Control 14 Register (PAGE0 -50h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 05	VRN 04	VRN 03	VRN 02	VRN 01	VRN 00
R	1	0	0	VRN 05	VRN 04	VRN 03	VRN 02	VRN 01	VRN 00

Figure 8. 74 Gamma Control 15 Register (PAGE0 -51h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 15	VRN 14	VRN 13	VRN 12	VRN 11	VRN 10
R	1	0	0	VRN 15	VRN 14	VRN 13	VRN 12	VRN 11	VRN 10

Figure 8. 75 Gamma Control 16 Register (PAGE0 -52h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 25	VRN 24	VRN 23	VRN 22	VRN 21	VRN 20
R	1	0	0	VRN 25	VRN 24	VRN 23	VRN 22	VRN 21	VRN 20

Figure 8. 76 Gamma Control 17 Register (PAGE0 -53h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 35	VRN 34	VRN 33	VRN 32	VRN 31	VRN 30
R	1	0	0	VRN 35	VRN 34	VRN 33	VRN 32	VRN 31	VRN 30

Figure 8. 77 Gamma Control 18 Register (PAGE0 -54h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 45	VRN 44	VRN 43	VRN 42	VRN 41	VRN 40
R	1	0	0	VRN 45	VRN 44	VRN 43	VRN 42	VRN 41	VRN 40

Figure 8. 78 Gamma Control 19 Register (PAGE0 -55h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	VRN 55	VRN 54	VRN 53	VRN 52	VRN 51	VRN 50
R	1	0	0	VRN 55	VRN 54	VRN 53	VRN 52	VRN 51	VRN 50

Figure 8. 79 Gamma Control 20 Register (PAGE0 -56h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	PRN 06	PRN 05	PRN 04	PRN 03	PRN 02	PRN 01	PRN 00
R	1	0	PRN 06	PRN 05	PRN 04	PRN 03	PRN 02	PRN 01	PRN 00

Figure 8. 80 Gamma Control 21 Register (PAGE0 -57h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	PRN 16	PRN 15	PRN 14	PRN 13	PRN 12	PRN 11	PRN 10
R	1	0	PRN 16	PRN 15	PRN 14	PRN 13	PRN 12	PRN 11	PRN 10

Figure 8. 81 gamma Control 22 Register (PAGE0 -58h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKN 04	PKN 03	PKN 02	PKN 01	PKN 00
R	1	0	0	0	PKN 04	PKN 03	PKN 02	PKN 01	PKN 00

Figure 8. 82 Gamma Control 23 Register (PAGE0 -59h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKN 14	PKN 13	PKN 12	PKN 11	PKN 10
R	1	0	0	0	PKN 14	PKN 13	PKN 12	PKN 11	PKN 10

Figure 8. 83 Gamma Control 24 Register (PAGE0 -5Ah)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKN 24	PKN 23	PKN 22	PKN 21	PKN 20
R	1	0	0	0	PKN 24	PKN 23	PKN 22	PKN 21	PKN 20

Figure 8. 84 Gamma Control 25 Register (PAGE0 -5Bh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKN 34	PKN 33	PKN 32	PKN 31	PKN 30
R	1	0	0	0	PKN 34	PKN 33	PKN 32	PKN 31	PKN 30

Figure 8. 85 Gamma Control 26 Register (PAGE0 -5Ch)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	PKN 44	PKN 43	PKN 42	PKN 41	PKN 40
R	1	0	0	0	PKN 44	PKN 43	PKN 42	PKN 41	PKN 40

Figure 8. 86 Gamma Control 27 Register (PAGE0 -5Dh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	CGM N11	CGM N10	CGM N01	CGM N00	CGM P11	CGM P10	CGM P01	CGM P00
R	1	CGM N11	CGM N10	CGM N01	CGM N00	CGM P11	CGM P10	CGM P01	CGM P00

Figure 8. 87 Gamma Control 28 Register (PAGE0 -5Eh)

VRP5-0[5:0]: Gamma Offset adjustment registers for positive polarity output

VRN5-0[5:0]: Gamma Offset adjustment registers for negative polarity output

PRP1-0[6:0]: Gamma Center adjustment registers for positive polarity output

PRN1-0[6:0]: Gamma Center adjustment registers for negative polarity output

PKP8-0[4:0]: Gamma Macro adjustment registers for positive polarity output

PKN8-0[4:0]: Gamma Macro adjustment registers for negative polarity output

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

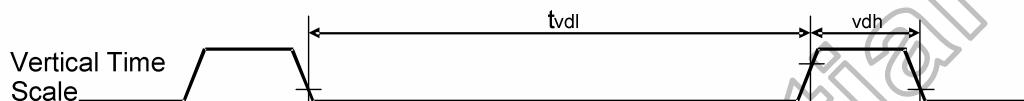
8.35 Mode Control Register (PAGE0 -60h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	TEM ODE	TEON	*	*	*
R	1	0	0	0	TEM ODE	TEON	0	0	0

Figure 8. 88 Mode Control Register (PAGE0 -60h)

TEMODE: Specify the Tearing-Effect mode.

When **TEMODE** = '0': The Tearing Effect Output line (TE) consists of V-Blanking information only.



When **TEMODE** = '1': The Tearing Effect Output Line (TE) consists of both V-Blanking and H-Blanking information



Note: During Stand by Mode with Tearing Effect Line On, Tearing Effect Output pin active low

TEON: This command is used to turn ON the Tearing Effect output signal from the TE signal line.

8.36 Power saving internal control register (PAGE0 -RE4h~RE7h)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	EQ_ S17	EQ_ S16	EQ_ S15	EQ_ S14	EQ_ S13	EQ_ S12	EQ_ S11	EQ_ S10
R	1	EQ_ S17	EQ_ S16	EQ_ S15	EQ_ S14	EQ_ S13	EQ_ S12	EQ_ S11	EQ_ S10

Figure 8. 89 Power Saving Internal Control Register (R68h)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	EQ_ S27	EQ_ S26	EQ_ S25	EQ_ S24	EQ_ S23	EQ_ S22	EQ_ S21	EQ_ S20
R	1	EQ_ S27	EQ_ S26	EQ_ S25	EQ_ S24	EQ_ S23	EQ_ S22	EQ_ S21	EQ_ S20

Figure 8. 90 Power Saving Internal Control Register (R69h)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	EQ_ S37	EQ_ S36	EQ_ S35	EQ_ S34	EQ_ S33	EQ_ S32	EQ_ S31	EQ_ S30
R	1	EQ_ S37	EQ_ S36	EQ_ S35	EQ_ S34	EQ_ S33	EQ_ S32	EQ_ S31	EQ_ S30

Figure 8. 91 Power Saving Internal Control Register (R70h)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	EQ_S47	EQ_S46	EQ_S45	EQ_S44	EQ_S43	EQ_S42	EQ_S41	EQ_S40
R	1	EQ_S47	EQ_S46	EQ_S45	EQ_S44	EQ_S43	EQ_S42	EQ_S41	EQ_S40

Figure 8. 92 Power Saving Internal Control Register (R71h)

These commands are internal used.

EQ_S1[7:0]: Power Saving control internal used.

EQ_S2[7:0]: Power Saving control internal used.

EQ_S3[7:0]: Power Saving control internal used.

EQ_S4[7:0]: Power Saving control internal used.

8.37 Source OP control (PAGE0 -RE8h-E9h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	OPON_N(7)	OPON_N(6)	OPON_N(5)	OPON_N(4)	OPON_N(3)	OPON_N(2)	OPON_N(1)	OPON_N(0)
R	1	OPON_N(7)	OPON_N(6)	OPON_N(5)	OPON_N(4)	OPON_N(3)	OPON_N(2)	OPON_N(1)	OPON_N(0)

Figure 8. 93 Source OP Control Register (PAGE0 -RE8h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	OPON_N(7)	OPON_N(6)	OPON_N(5)	OPON_N(4)	OPON_N(3)	OPON_N(2)	OPON_N(1)	OPON_N(0)
R	1	OPON_N(7)	OPON_N(6)	OPON_N(5)	OPON_N(4)	OPON_N(3)	OPON_N(2)	OPON_N(1)	OPON_N(0)

Figure 8. 94 Source OP Control Register (PAGE0 -RE9h)

This command is used to set the Source OP output period. It will increase the driving ability of the source driver. For example, if the user has crosstalk issue, user can adjust this command for more driving ability, the ability is more when the setting is bigger.

OPON_N[7:0]: Specify the Normal mode valid source OP output period in 1-line driving period.

OPON_I[7:0]: Specify the IDLE mode valid source OP output period in 1-line driving period.

8.38 Power control internal used (PAGE0 -REAh-ECh)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	PTB A15	PTB A14	PTB A13	PTB A12	PTB A11	PTB A10	PTA B9	PTB A8
R	1	PTB A15	PTB A14	PTB A13	PTB A12	PTB A11	PTB A10	PTA B9	PTB A8

Figure 8. 95 Power Control Internal used (1) Register (PAGE0 -REAh)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	PTB A7	PTB A6	PTB A5	PTB A4	PTB A3	PTB A2	PTB A1	PTB A0
R	1	PTB A7	PTB A6	PTB A5	PTB A4	PTB A3	PTB A2	PTB A1	PTB A0

Figure 8. 96 Power Control Internal used (2) Register (PAGE0 -REBh)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	STB A15	STB A14	STB A13	STB A12	STB A11	STB A10	STA B9	STB A8
R	1	STB A15	STB A14	STB A13	STB A12	STB A11	STB A10	STA B9	STB A8

Figure 8. 97 Source Control Internal used (1) Register (PAGE0 -RECh)

R/W	DNC	D7	D6	D5	D4	D3	D2	D1	D0
W	1	STB A7	STB A6	STB A5	STB A4	STB A3	STB A2	STB A1	STB A0
R	1	STB A7	STB A6	STB A5	STB A4	STB A3	STB A2	STB A1	STB A0

Figure 8. 98 Source Control Internal used (2) Register (PAGE0 -REDh)

These commands are internal used.

PTBA[15:0]: Power control internal used.

STBA[15:0]: Source Power control internal used.

8.39 Command page select register (RFFh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	*	*	*	*	*	PAGE_SEL_1	PAGE_SEL_0
R	1	0	0	0	0	0	0	PAGE_SEL_1	PAGE_SEL_0

Figure 8. 99 Command Page select Register (RFFh)

PAGE_SEL[1:0]: Command set page select.

PAGE_SEL1	PAGE_SEL0	Command Page
0	0	Page 0
0	1	Page 1

8.40 CABC control 5~7 register (PAGE1 – RC3h, RC5h, RC7h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	0	PWM DIV2	PWM DIV1	PWM DIV0	1	1	INPL US	1
R	1	0	PWM DIV2	PWM DIV1	PWM DIV0	1	1	INPL US	1

Figure 8. 100 CABC control 5 (PAGE1 – RC3h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	PWM PERIO D7	PWM PERIO D6	PWM PERIO D5	PWM PERIO D4	PWM PERIO D3	PWM PERIO D2	PWM PERIO D1	PWM PERIO D0
R	1	PWM PERIO D7	PWM PERIO D6	PWM PERIO D5	PWM PERIO D4	PWM PERIO D3	PWM PERIO D2	PWM PERIO D1	PWM PERIO D0

Figure 8. 101 CABC control 6 (PAGE1 – RC5h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	0	DIM_F RAME 6	DIM_F RAME5	DIM_F RAME4	DIM_F RAME3	DIM_F RAME2	DIM_F RAME1	DIM_F RAME0
R	1	0	DIM_F RAME 6	DIM_F RAME5	DIM_F RAME4	DIM_F RAME3	DIM_F RAME2	DIM_F RAME1	DIM_F RAME0

Figure 8. 102 CABC control 7 (PAGE1 – RC7h)

PWM_DIV[2:0]: Internal PWM_CLK divider for CABC clock.

PWM_DIV[2:0]	Divider
0	PWM_CLK/1
1	PWM_CLK/2
2	PWM_CLK/4
3	PWM_CLK/8
4	PWM_CLK/16
5	PWM_CLK/32
6	PWM_CLK/64
7	PWM_CLK/128

Note:1. PWM_CLK is OSC frequency in system interface and DOTCLK in RGB interface.

INVPULS: The backlight PWM output polarity select.

'0', The backlight PWM output is low level active.

'1', The backlight PWM output is high level active.

PWM_PERIOD[7:0] : The backlight PWM output period setting.

Backlight PWM output period = 1 / (PWM_CLK / clock divider (PWMDIV)) x
(255x(PWM_PERIOD[7:0]+1))

DIM_FRAME[6:0] : Manual brightness setting dimming period.

8.41 Gain select register 0~8 (PAGE1 – RCBh~D3h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 06	DBG 05	DBG 04	DBG 03	DBG 02	DBG 01	DBG 00
R	1	0	DBG 06	DBG 05	DBG 04	DBG 03	DBG 02	DBG 01	DBG 00

Figure 8. 103 Gain select register 0 (PAGE1 – RCBh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 16	DBG 15	DBG 14	DBG 13	DBG 12	DBG 11	DBG 10
R	1	0	DBG 16	DBG 15	DBG 14	DBG 13	DBG 12	DBG 11	DBG 10

Figure 8. 104 Gain select register 1 (PAGE1 – RCCh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 26	DBG 25	DBG 24	DBG 23	DBG 22	DBG 21	DBG 20
R	1	0	DBG 26	DBG 25	DBG 24	DBG 23	DBG 22	DBG 21	DBG 20

Figure 8. 105 Gain select register 2 (PAGE1 – RCDh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 36	DBG 35	DBG 34	DBG 33	DBG 32	DBG 31	DBG 30
R	1	0	DBG 36	DBG 35	DBG 34	DBG 33	DBG 32	DBG 31	DBG 30

Figure 8. 106 Gain select register 3 (PAGE1 – RCEh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 46	DBG 45	DBG 44	DBG 43	DBG 42	DBG 41	DBG 40
R	1	0	DBG 46	DBG 45	DBG 44	DBG 43	DBG 42	DBG 41	DBG 40

Figure 8. 107 Gain select register 4 (PAGE1 – RCFh)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 56	DBG 55	DBG 54	DBG 53	DBG 52	DBG 51	DBG 50
R	1	0	DBG 56	DBG 55	DBG 54	DBG 53	DBG 52	DBG 51	DBG 50

Figure 8. 108 Gain select register 5 (PAGE1 – RD0h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 66	DBG 65	DBG 64	DBG 63	DBG 62	DBG 61	DBG 60
R	1	0	DBG 66	DBG 65	DBG 64	DBG 63	DBG 62	DBG 61	DBG 60

Figure 8. 109 Gain select register 6 (PAGE1 – RD1h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 76	DBG 75	DBG 74	DBG 73	DBG 72	DBG 71	DBG 70
R	1	0	DBG 76	DBG 75	DBG 74	DBG 73	DBG 72	DBG 71	DBG 70

Figure 8. 110 Gain select register 7 (PAGE1 – RD2h)

R/W	DNC	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
W	1	*	DBG 86	DBG 85	DBG 84	DBG 83	DBG 82	DBG 81	DBG 80
R	1	0	DBG 86	DBG 85	DBG 84	DBG 83	DBG 82	DBG 81	DBG 80

Figure 8. 111 Gain select register 8 (PAGE1 – RD3h)

DBG0~8[6:0] : Gain select register 0~8

DBGX	Duty	DBGX	Duty	DBGX	Duty
20	100.00%	30	66.67%	40	49.80%
21	96.86%	31	65.10%		
22	94.12%	32	63.92%		
23	91.37%	33	62.75%		
24	89.02%	34	61.57%		
25	86.27%	35	60.39%		
26	84.31%	36	59.22%		
27	81.96%	37	58.04%		
28	80.00%	38	56.86%		
29	78.04%	39	56.08%		
2A	76.08%	3A	54.90%		
2B	74.51%	3B	54.12%		
2C	72.55%	3C	53.33%		
2D	70.98%	3D	52.16%		
2E	69.41%	3E	51.37%		
2F	67.84%	3F	50.59%		

	UI	ST	MV
DBG0	24	40	40
DBG1	24	3C	3C
DBG2	24	38	38
DBG3	23	34	34
DBG4	23	33	33
DBG5	23	32	32
DBG6	22	2B	2D
DBG7	22	24	2B
DBG8	22	22	28

9. Layout Recommendation

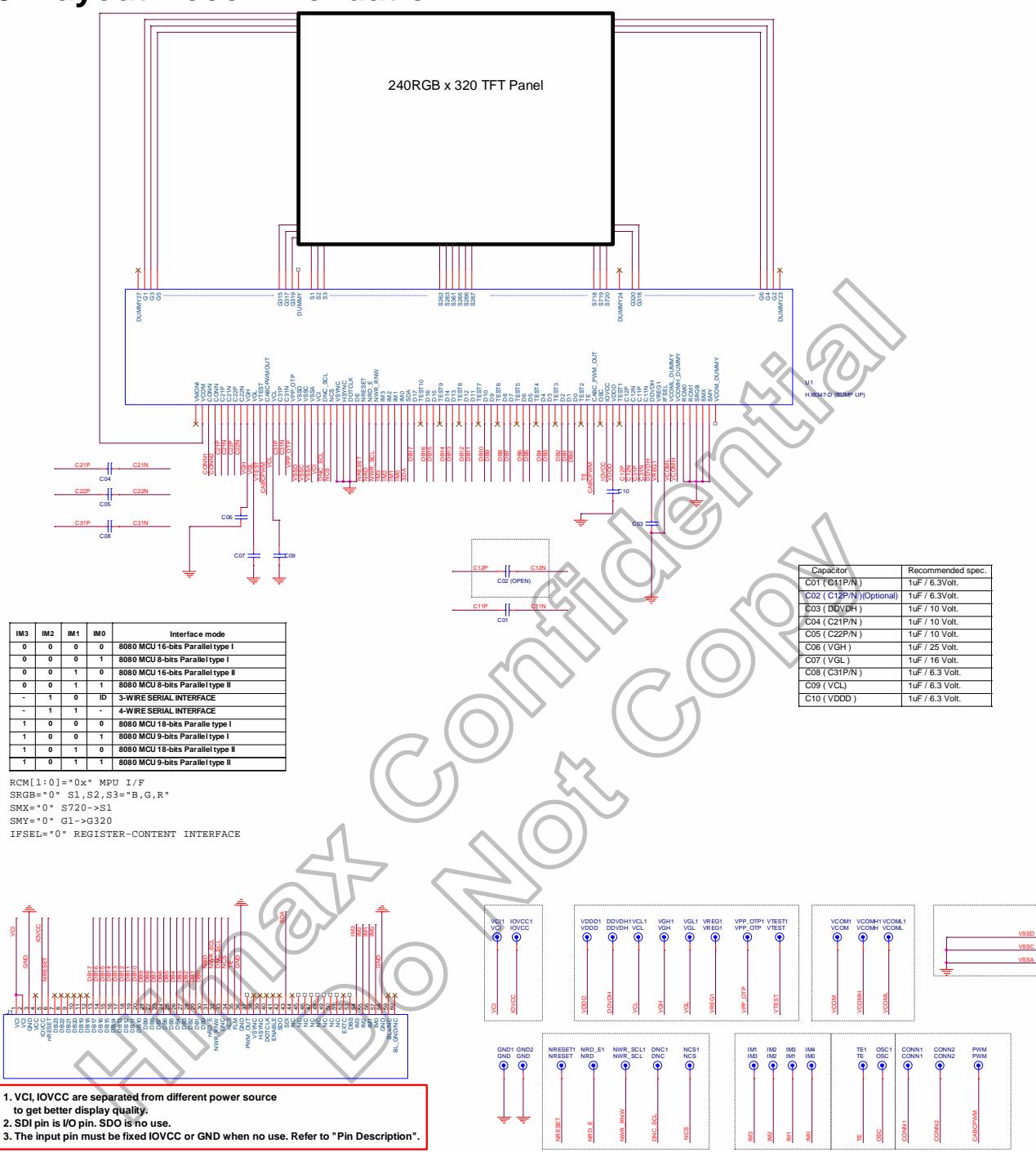
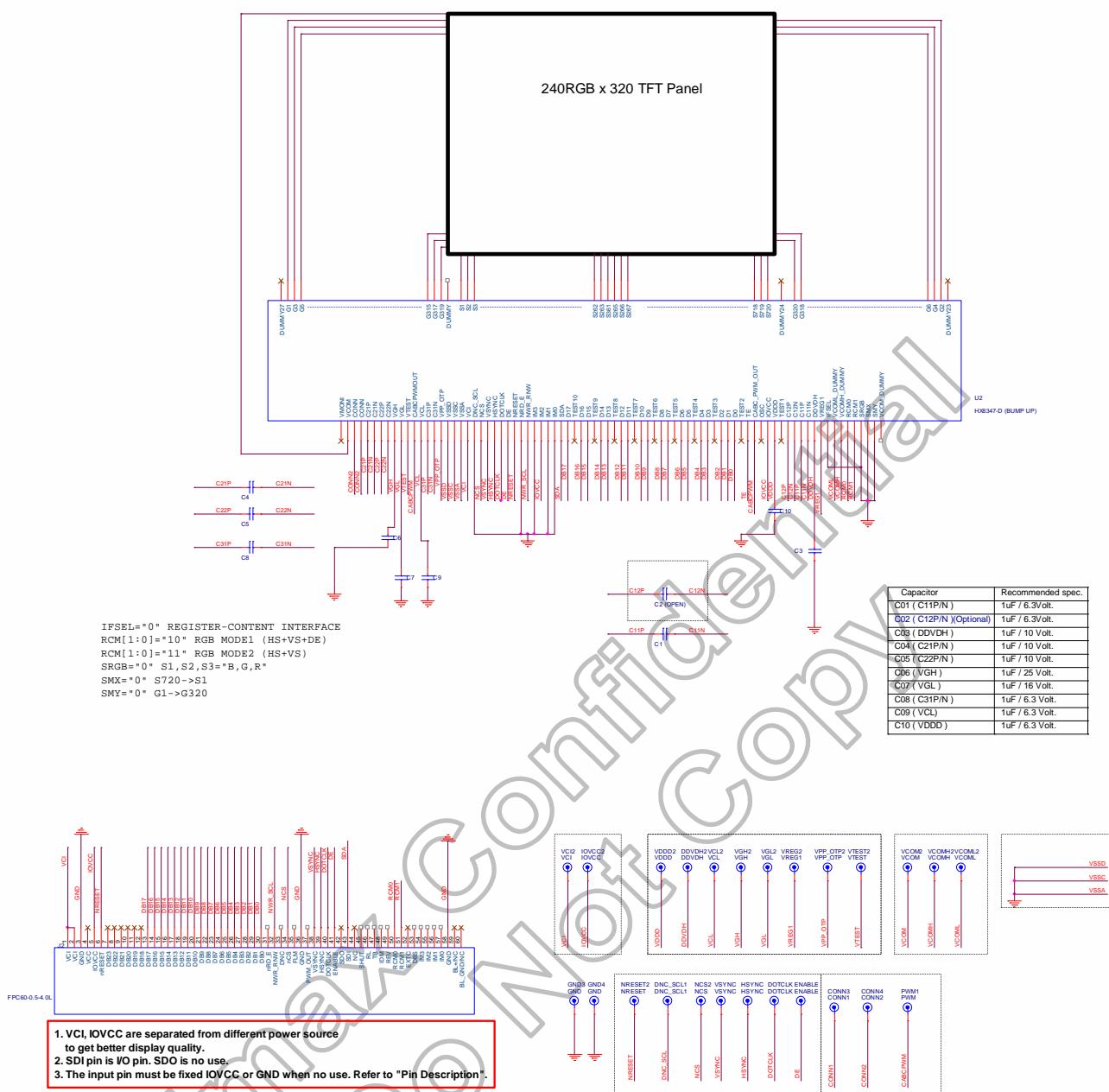


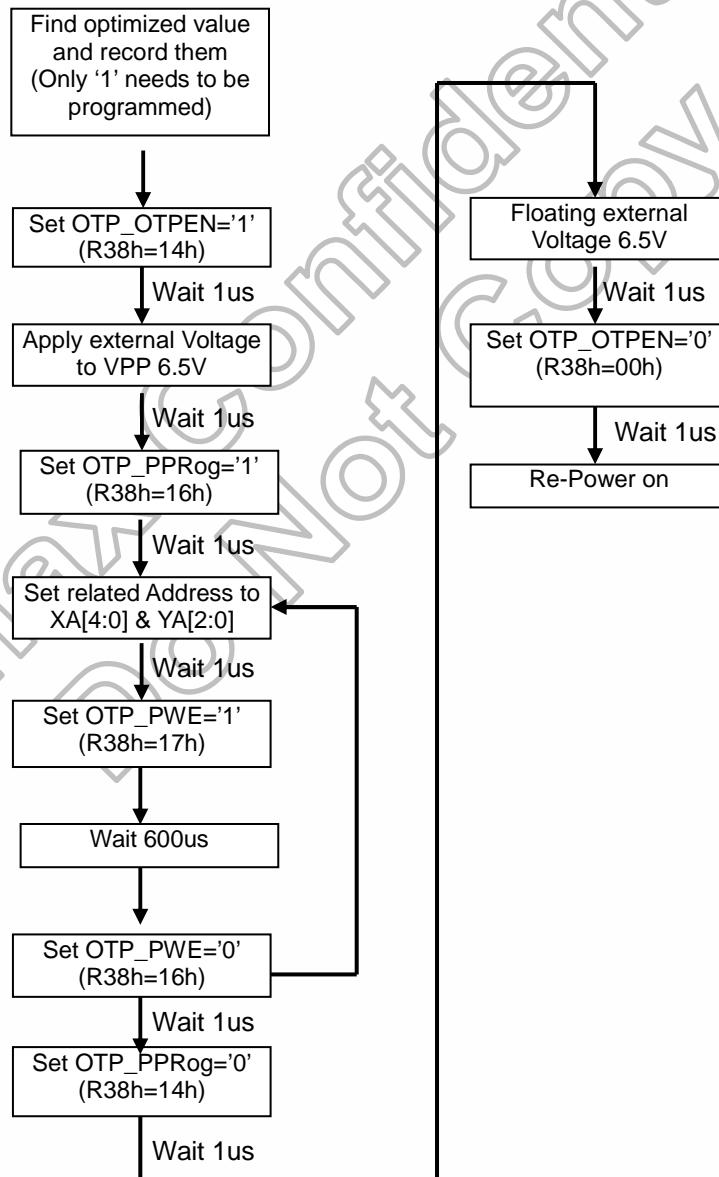
Figure 9.1 Layout Recommendation of HX8347-D MPU Mode



10. OTP Table

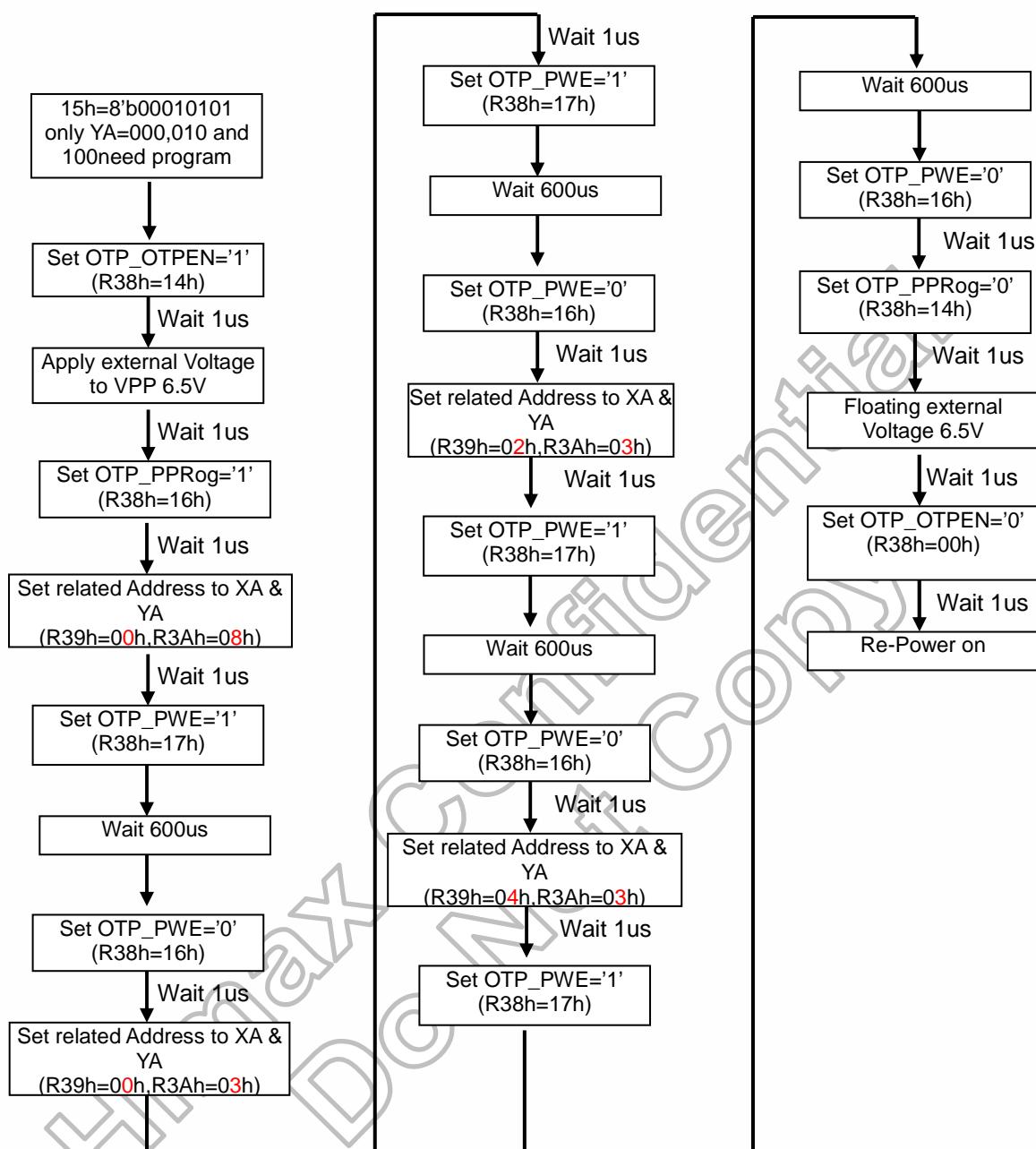
	YA[2:0]=1 11	YA[2:0]=1 10	YA[2:0]= 101	YA[2:0]= 100	YA[2:0]= 011	YA[2:0]= 010	YA[2:0]= 001	YA[2:0]= 000	Non-Pro gram
XA[4:0]=00011	VMF17	VMF16	VMF15	VMF14	VMF13	VMF12	VMF11	VMF10	00h
XA[4:0]=00100	VMF27	VMF26	VMF25	VMF24	VMF23	VMF22	VMF21	VMF20	00h
XA[4:0]=00101	VMF37	VMF36	VMF35	VMF34	VMF33	VMF32	VMF31	VMF30	00h
XA[4:0]=00110	VMH6	VMH6	VMH5	VMH4	VMH3	VMH2	VMH1	VMH0	00h
XA[4:0]=00111	VML6	VML6	VML5	VML4	VML3	VML2	VML1	VML0	00h
XA[4:0]=01000				Valid_VM L	Valid_VM H	Valid_VM F3	Valid_VM F2	Valid_VM F1	00h
XA[4:0]=01001	Valid_pa nel		DDVDH_ TRI		SS_Pane l	GS_Pan el	REV_Pa nel	BGR_Pa nel	00h

10.1 OTP Programming Flow



Note: Valid bit must program if user want use this OTP function

OTP Programming Example (VMF=15h)



11. Electrical Characteristic

11.1 Absolute Maximum Ratings

Item	Symbol	Unit	Value	Note
Power Supply Voltage 1	IOVCC~VSSD	V	-0.3 to +4.6	Note ^{(1),(2)}
Power Supply Voltage 2	VCI ~ VSSA	V	-0.3 to +4.6	Note ⁽³⁾
Power Supply Voltage 3	DDVDH ~ VSSA	V	-0.3 to +6.6	Note ⁽⁴⁾
Power Supply Voltage 4	VSSA ~ VCL	V	-0.3 to +4.6	Note ⁽⁵⁾
Power Supply Voltage 5	DDVDH ~ VCL	V	-0.3 to +9	Note ⁽⁶⁾
Power Supply Voltage 6	VGH ~ VSSA	V	-0.3 to +18.5	Note ⁽⁷⁾
Power Supply Voltage 7	VSSA ~ VGL	V	0 to -16.5	Note ⁽⁸⁾
Logic Input Voltage	V _{IN}	V	-0.3 to IOVCC+0.5	-
Logic Output Voltage	V _O	V	-0.3 to IOVCC+0.5	-
Operating Temperature	T _{opr}	°C	-40 to +85	Note ^{(9),(10)}
Storage Temperature	T _{stg}	°C	-55 to +110	Note ^{(9),(10)}

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

(2) To make sure IOVCC ≥ VSSD.

(3) To make sure VCI ≥ VSSA.

(4) To make sure DDVDH ≥ VSSA.

(5) To make sure VSSA ≥ VCL.

(6) To make sure DDVDH ≥ VCL.

(7) To make sure VGH ≥ VSSA.

(8) To make sure VSSA ≥ VGL

VGH +|VGL| < 32V

(9) For die and wafer products, specified up to +85°C.

(10) This temperature specifications apply to the TCP package.

Table 11. 1 Absolute Maximum Ratings

11.2 ESD Protection Level

Mode	Test Condition	Protection Level	Unit
Human Body Model	C=100 pF, R=1.5 kΩ	±2.0K	V
Machine Model	C=200 pF, R=0.0 Ω	±200	V

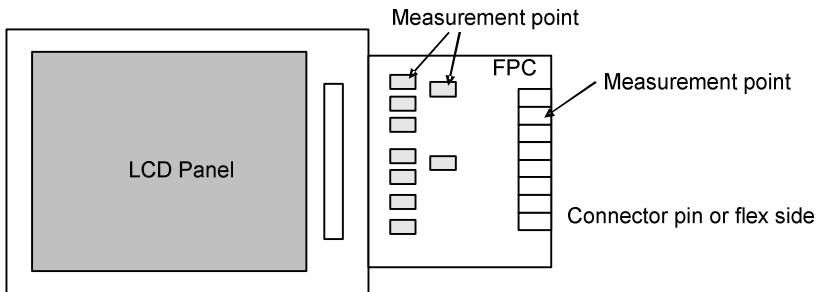
Table 11. 2 ESD Protection Level

11.3 Maximum Layout Resistance

Name	Type	Maximum Series Resistance	Unit
IOVCC	Power supply	10	Ω
VCI	Power supply	10	Ω
VSSA,VSSC	Power supply	10	Ω
VSSD	Power supply	10	Ω
VPP OTP	Power supply	10	Ω
OSC	Input	100	Ω
IM[3:0], SMX,SMY,SRGB,RCM0,RCM1,IFSEL	Input	100	Ω
NRD_E, NWR_RNW, DNC_SCL, NCS, SDA	Input	100	Ω
NRESET	Input	100	Ω
TE, CABC_PWM_OUT	Output	100	Ω
DB[17:0],	I/O	100	Ω
DOTCLK, DE, VSYNC, HSYNC	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
C11P, C11N, C12P, C12N	Capacitor connection	10	Ω
C31P, C12N	Capacitor connection	10	Ω
C21P, C21N	Capacitor connection	15	Ω
C22P, C22N	Capacitor connection	15	Ω
TEST[10:1]	Input	100	Ω
VCOMH_DUMMY, VCOML_DUMMY,DUMMY	Dummy	100	Ω
VTEST,VMONI	Test Pin	100	Ω

11.4 DC Characteristics

Parameter	Symbol	Conditions	Spec.			Unit
			Min.	Typ.	Max.	
Power & Operating Voltages						
IO Operating voltage	IOVCC	I/O supply voltage	1.65	1.8	3.3	V
Driver Operating voltage	VCI	Operation voltage	2.3	2.8	3.3	
Source Drive Voltage	VREG1	Triple Pump	3.3	4.65	4.8	
	VREG1	Dual Pump	3.3	4.65	5.8	
Gate Drive High Voltage	VGH	IVGH=100uA (Typ:BT=001) VCl=2.8 Dual Pump	9.5	14.25	-	
		IVGH=100uA (Typ:BT=001) VCl=2.8 Triple Pump	11.6	17.39	-	
Gate Drive Low Voltage	VGL	IVGL=100uA (Typ:BT=001) VCl=2.8 Dual Pump	-6.85	-9.5	-	
		IVGL=100uA (Typ:BT=001) VCl=2.8 Triple Pump	-8.46	-11.59	-	
Drive Supply Voltage	VGH-VGL	-	-	-	30	
Input / Output						
High level input voltage	VIH	-	0.7IOVCC	-	IOVCC	V
Low level input voltage	VIL	-	VSSD	-	0.3IOVCC	
High level output voltage	VOH	IOH = -1.0mA	0.8IOVCC	-	IOVCC	
Low level output voltage	VOL	IOL = +1.0mA	VSSD	-	0.2IOVCC	
Input leakage current	IIL	-	-1	-	1	µA
Oscillator frequency	fOSC	Frame rate at 65hz, default Vs and Hs setting Ta=25°C	2.76	2.85	2.94	MHz
Booster(VCI=2.8V)						
DDVDH boost voltage1	DDVDH	Dual Pump IDDVDH=1mA	4.8	5.0	5.2	V
		Triple Pump IDDVDH=1mA	5.9	6.1	6.3	
VCL boost voltage	VCL	ICL=-300uA	-2.5	-2.65	2.75	
VCOM Generator(VCI=2.8V)						
VCOM amplitude	VCOM	No load, Dual Pump	2.5	4.4	7.3	V
		No load Triple Pump	2.5	4.4	8.3	V
VCOM high level	VCOMH	No load Dual Pump	2.5	3.205	4.8	V
		No load Triple Pump	2.5	3.205	5.8	V
VCOM low level	VCOML	No load	-2.5	-1.195	VSSD	V
Source Driver(Typ:Ta=25°C VCI=2.8v)						
Output voltage deviation (mean value)	DVOS	VSSD+1.0 ~ VREG1-1.0	-	+/- 10	+/- 20	mV
		VSSD+0.1V ~ VSSD+1.0 VREG1-1.0 ~ VREG1-0.1V	-	+/- 30	+/- 50	mV
Output voltage range	VOS	-	0.1	-	DDVDH-0. 1	V
Output offset voltage	Voff	-		+/-30	+/-50	mV



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11.4.1 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)	IOVCC (mA)	VCI (mA)	IOVCC (mA)
Host interface NOT active	Normal Mode On	60Hz	1-line	Black	X;X;X	3.48	0.21	3.85	0.33
			1-line	1x1 checker board	X;X;X	2.82	0.21	3.06	0.33
			1-line	4x4 checker board	X;X;X	2.76	0.33	3.12	0.42
			1-line	Gray_Scale Top to Bottom	X;X;X	2.57	0.22	3.00	0.33
			1-line	20B80W	X;X;X	3.05	0.21	3.50	0.32
	Idle Mode On	60Hz	1-line	20B80W	X;X;X	2.40	0.17	2.74	0.25
	Partial Mode On (48 lines)	60Hz	1-line	Grey Levels	X;X;X	0.86	0.11	1.35	0.18
	Partial Mode On (48 lines) Idle Mode On	60Hz	1-line	8x8 checker board	X;X;X	0.99	0.09	1.12	0.15
			1-line	Worst pattern	X;X;X	1.01	0.09	1.20	0.15
	Sleep Mode	N/A	N/A	N/A	X;X;X	0.00059	0.00452	0.010	0.080
Host interface active	Normal Mode On	60Hz	1-line	262k Colors Worst pattern CPU Access @ 15fps	0;0;0	3.29	0.98	3.89	1.30
					0;0;1	3.29	0.98	3.89	1.30
					0;1;0	3.29	0.98	3.89	1.30
					0;1;1	3.29	0.98	3.89	1.30
					1;0;0	3.29	0.98	3.89	1.30
					1;0;1	3.29	0.98	3.89	1.30
					1;1;0	3.29	0.98	3.89	1.30
					1;1;1	3.29	0.98	3.89	1.30
					0;0;0	3.28	1.54	3.88	1.88
				262k Colors Worst pattern CPU Access @ 25fps	0;0;1	3.28	1.54	3.88	1.88
					0;1;0	3.28	1.54	3.88	1.88
					0;1;1	3.28	1.54	3.88	1.88
					1;0;0	3.28	1.54	3.88	1.88
					1;0;1	3.28	1.54	3.88	1.88
					1;1;0	3.28	1.54	3.88	1.88
					1;1;1	3.28	1.54	3.88	1.88

Table 11. 3 Current Consumption

Typical Case:

TA = 25oC
IOVCC=1.8V
VCI = 2.8V
CMO 2.6" panel

Worst Case:

TA = -30 to 70oC
IOVCC = 1.65V to 1.95V
VCI = 2.3V to 3.3V
Includes Process Variance.

11.5 AC Characteristics

11.5.1 Parallel Interface Characteristics (8080-series MPU)

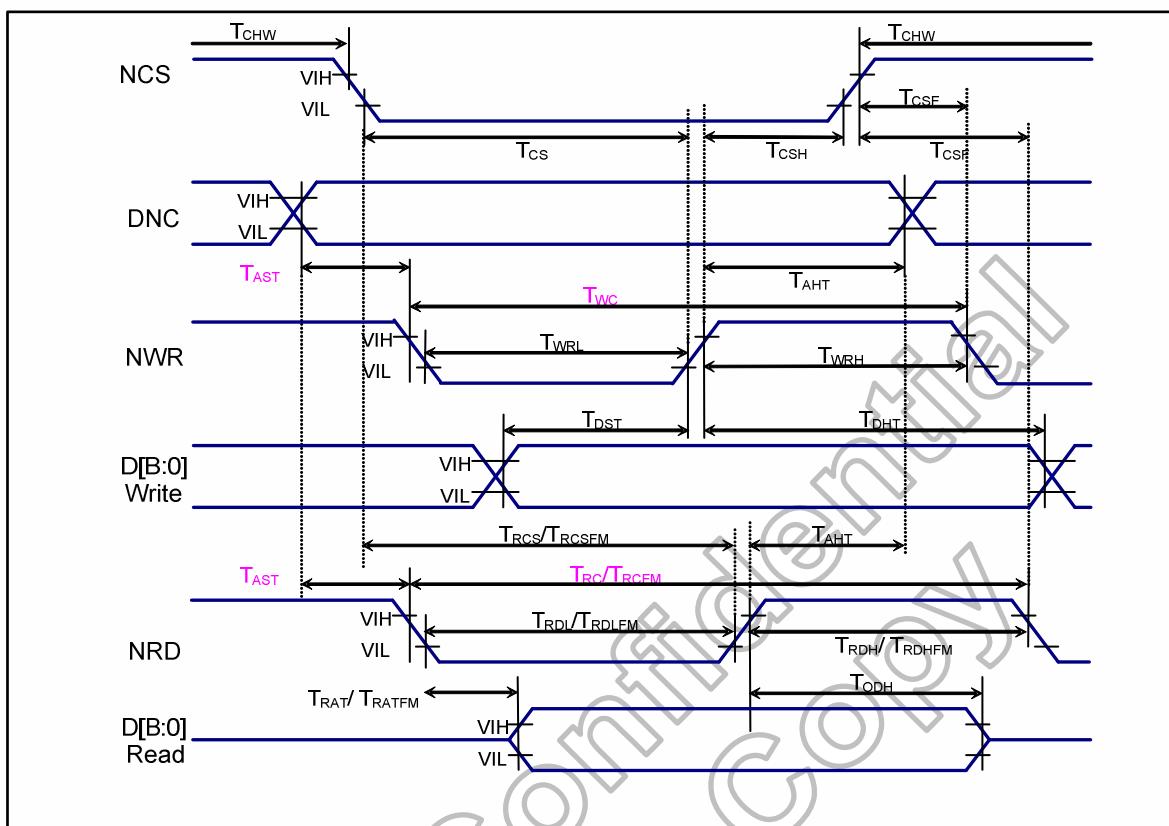


Figure 11. 1 Parallel Interface Characteristics (8080-Series MPU)

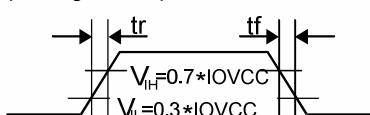
(V_{SSA}=0V, IOVCC=1.65V to 3.3V, VCI=2.3V to 3.3V, Ta = -30 to 70° C)

Signal	Symbol	Parameter	Min.	Max.	Unit	Description
NCS_SCL	t_{AST}	Address setup time	0	-	ns	-
	t_{AHT}	Address hold time (Write/Read)	10	-	ns	-
	t_{CHW}	Chip select "H" pulse width	0	-	ns	-
	t_{CS}	Chip select setup time (Write)	15	-	ns	-
	t_{RCSS}	Chip select setup time (Read ID)	45	-	ns	-
	t_{RCSEM}	Chip select setup time (Read FM)	355	-	ns	-
NWR_SCL	t_{CSF}	Chip select wait time (Write/Read)	10	-	ns	-
	t_{CSH}	Chip select hold time	10	-	ns	-
	t_{WC}	Write cycle	66	-	ns	-
NRD(ID)	t_{WRU}	Control pulse "H" duration	15	-	ns	-
	t_{WRH}	Control pulse "L" duration	15	-	ns	-
	t_{DST}	Data setup time	10	-	ns	-
NRD(FM)	t_{DHT}	Data hold time	10	-	ns	-
	t_{RDH}	Control pulse "H" duration (ID)	90	-	ns	When read ID data
	t_{RDH}	Control pulse "L" duration (ID)	45	-	ns	When read from frame memory
DB17 to DB0	t_{RC}	Read cycle (ID)	160	-	ns	-
	t_{RDHF}	Control pulse "H" duration (FM)	90	-	ns	-
	t_{RDLFM}	Control pulse "L" duration (FM)	355	-	ns	-
	t_{TRAT}	Read access time (ID)	-	40	ns	For maximum $C_L=30\text{pF}$
	t_{TRATFM}	Read access time (FM)	-	340	ns	For minimum $C_L=8\text{pF}$
DB17 to DB0	t_{TODH}	Output disable time	20	80	ns	-

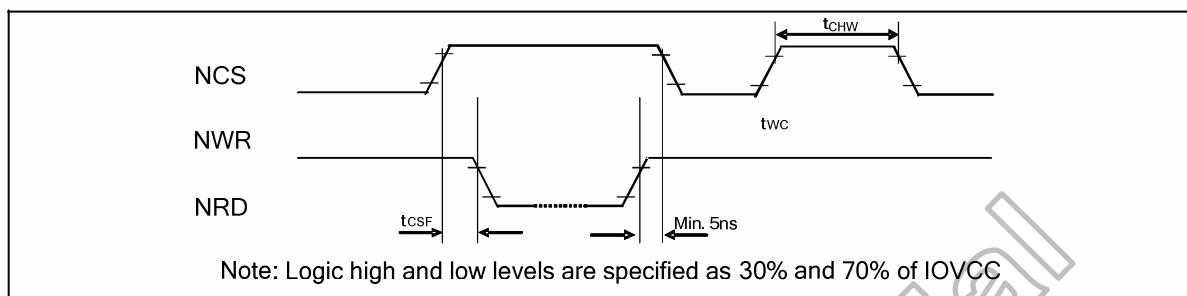
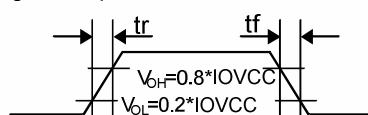
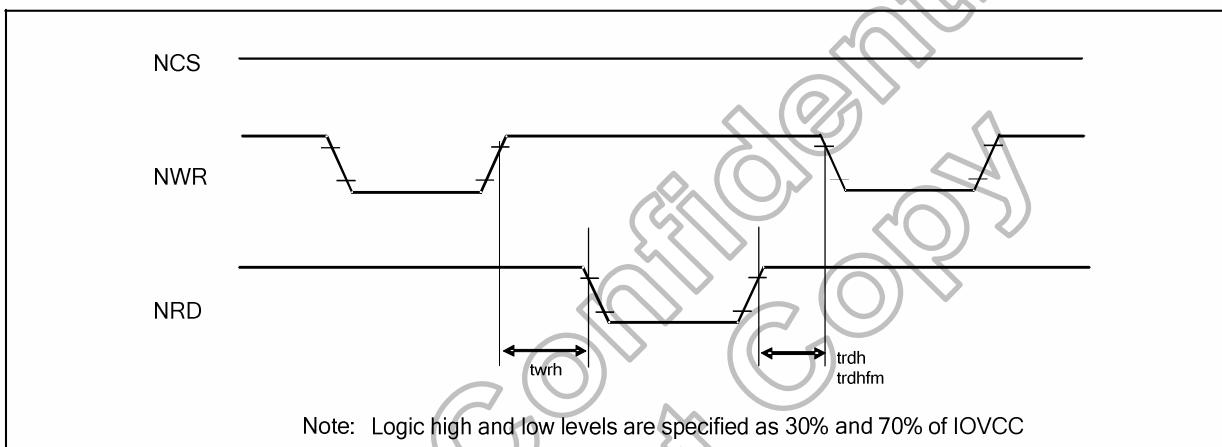
Note: The input signal rise time and fall time (t_r , t_f) is specified at 15 ns or less.

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

Input Signal Slope



Output Signal Slope

**Figure 11. 2 Chip Select Timing****Figure 11. 3 Write to Read and Read to Write Timing**

11.5.2 Serial Interface Characteristics

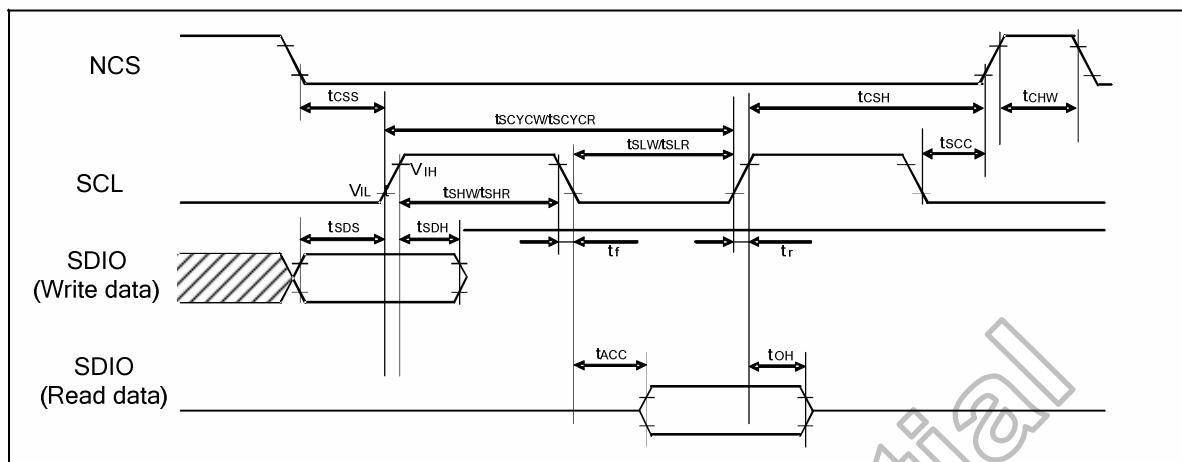


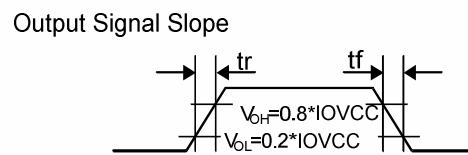
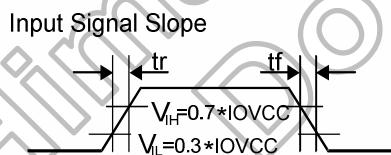
Figure 11.4 Serial Interface Characteristics

(V_{SSA}=0V, IOVCC=1.65V to 3.3V, V_{CI}=2.3V to 3.3V, Ta = -30 to 70° C)

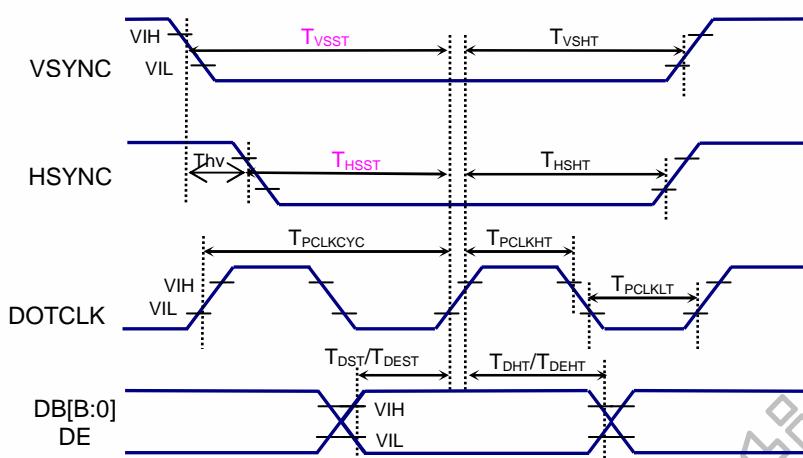
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Serial clock cycle (Write)	t _{scycw}		20	-	-	
SCL "H" pulse width (Write)	t _{shw}	SCL	8	-	-	ns
SCL "L" pulse width (Write)	t _{slw}		8	-	-	
Data setup time (Write)	t _{dsd}	SDIO	10	-	-	ns
Data hold time (Write)	t _{sdh}	SDIO	10	-	-	ns
Serial clock cycle (Read)	t _{scycr}		150	-	-	
SCL "H" pulse width (Read)	t _{shr}	SCL	60	-	-	ns
SCL "L" pulse width (Read)	t _{tslr}		60	-	-	
Access Time	t _{acc}	SDI for maximum C _L =30pF For minimum C _L =8pF	10	-	50	ns
Output disable time	t _{oh}	SDO For maximum C _L =30pF For minimum C _L =8pF	15	-	50	ns
SCL to Chip select	t _{scs}	SCL, NCS	20	-	-	ns
NCS "H" pulse width	t _{chw}	NCS	40	-	-	ns
Chip select setup time	t _{css}	NCS	15	-	-	ns
Chip select hold time	t _{csh}	NCS	15	-	-	ns

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.



11.5.3 RGB Interface Characteristics

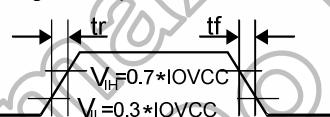


(VSSA=0V, IOVCC=1.65V to 3.3V, VCI=2.3V to 3.3V, Ta = -30 to 70° C)

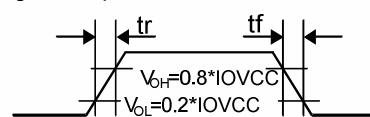
Item	Symbol	Condition	Spec.			Unit
			Min	Type.	Max	
Pixel low pulse width	T_{CLKLT}	-	15	-	-	ns
Pixel high pulse width	T_{CLKHT}	-	15	-	-	ns
Vertical Sync. set-up time	T_{VSST}	-	15	-	-	ns
Vertical Sync. hold time	T_{VSSHT}	-	15	-	-	ns
Horizontal Sync. set-up time	T_{HSST}	-	15	-	-	ns
Horizontal Sync. hold time	T_{VSSHT}	-	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	Thv	-	0	-	240	Dotclk

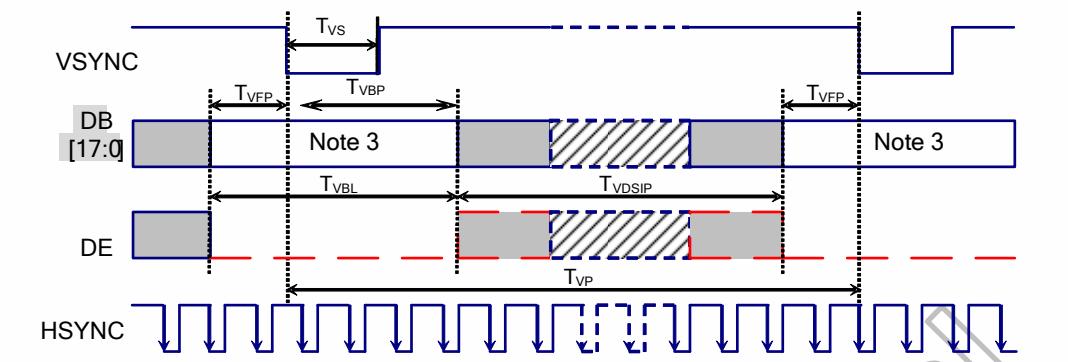
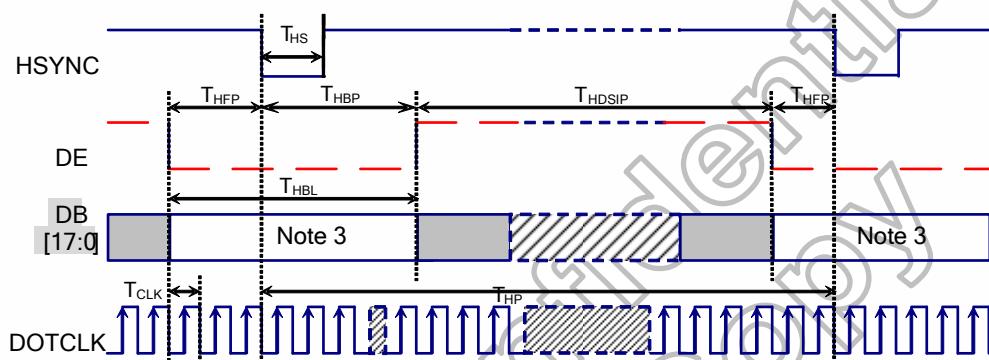
Note: The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.

Input Signal Slope



Output Signal Slope



Vertical Timing for RGB I/FHorizontal Timing for RGB I/F

Item	Symbol	Condition	Specification			Unit
			Min	Type.	Max	
Vertical Timing						
Vertical cycle period	T_{VP}		324	326	452	HS
Vertical low pulse width	T_{VS}		2	2	-	HS
Vertical front porch	T_{VFP}		2	2	6	HS
Vertical back porch	T_{VBP}		2	4	126	HS
Vertical blanking period	T_{VBL}	$T_{VBP} + T_{VFP}$	4	6	132	HS
Vertical active area	T_{VDISP}		320			HS
						HS
						HS
Vertical refresh rate	$TVRR$	Frame rate	50	60	80	Hz
Horizontal Timing						
Horizontal cycle period	T_{HP}		244	252	1008	DOTCLK
Horizontal low pulse width	T_{HS}		2	2	256	DOTCLK
Horizontal front porch	T_{HFP}		2	4	256	DOTCLK
Horizontal back porch	T_{HBP}		2	8	256	DOTCLK
Horizontal blanking period	T_{HBL}	$T_{HBP} + T_{HFP}$	4	12	256	DOTCLK
Horizontal active area	T_{HDISP}		240			DOTCLK
Pixel clock cycle $TVRR=60\text{Hz}$	f_{CLKCYC}		3.9		16.6	MHz

Note: (1) IOVCC=1.65 to 3.3V, VCI=2.3 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.

11.6.4 Reset Input Timing

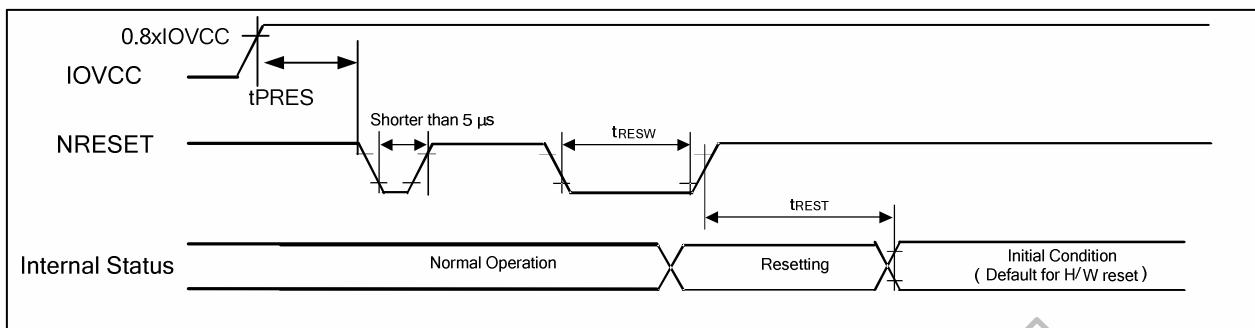


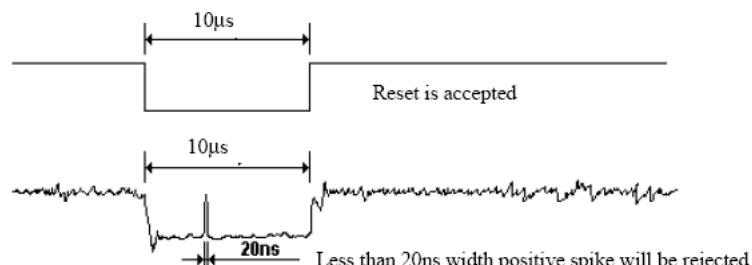
Figure 11. 5 Reset Input Timing

Symbol	Parameter	Related Pins	Spec.			Note	Unit
			Min.	Typ.	Max.		
tRESW	Reset low pulse width ⁽¹⁾	NRESET	10	-	-	-	μs
tREST	Reset complete time ⁽²⁾	-	-	-	5	When reset applied during STB mode	ms
		-	-	-	120	When reset applied during STB mode	ms
tPRES	Reset goes high level after Power on time	NRESET & IOVCC	1	-	-	Reset goes high level after Power on	ms

Note: (1) Spike due to an electrostatic discharge on NRESET line does not cause irregular system reset according to the table below.

NRESET Pulse	Action
Shorter than 5 μs	Reset Rejected
Longer than 10 μs	Reset
Between 5 μs and 10 μs	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 STB Out –mode. The display remains the blank state in STB –mode) and then return to Default condition for H/W reset.
- (3) During Reset Complete Time, VMF 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 NRESET.
- (4) Spike Rejection also applies during a valid reset pulse as shown below:



- (5) It is necessary to wait 5msec after releasing !RES before sending commands. Also STB Out

12. Ordering Information

Part No.	Package
HX8347-D000 PD_{xxx}	PD : mean COG xxx : mean chip thickness (μm), (default: 300 μm)

13. Revision History

Version	Date	Description of Changes
01	2008/04/17	New setup
	2008/05/21	P18 modify Pin 211 DDVDH P18~23 update Y coordinates
	2008/06/24	<ul style="list-style-type: none"> 1. P11 modify the operation voltage of VCI and IOVCC 2. P23 add the alignment mark B1& B2 3. P70 modify the OSC frequency 2.62MHz 4. P89 modify the Table 7. 25 Voltage Calculation Formula of Grayscale Voltage V59~V56 and V7~V4 5. P104 add the deep standby flow 6. P105 modify the power on/off flow 7. P110 modify the register R01h, add DP_STB_S bit. 8. P133 modify the register R29h RTN. 9. P150 update chapter 10. OTP
	2008/09/17	<ul style="list-style-type: none"> 1. P30 modify Table 5. 8 16-Bits Parallel Interface Type II GRAM Write Set Table 2. P34 modify Figure 5. 14 Input Data Bus and GRAM Data Mapping in 16-Bit Bus System Interface with 18(16+2) 3. P102 modify Figure 7. 21 Display On/Off Set flow 4. P121 modify 8.18 Power Control 1 Register (R1Ah) 5. P122 modify 8.19 Power Control 2 Register (R1Bh) 6. P128 modify 8.25 VCOM Control 1~3 Register (R23~25h) 7. P137 modify 8.30 RGB Interface Control Register (R31h~R34h) 8. P148 modify Figure 9. 1 Layout Recommendation of HX8347-D MPU Mode 9. P149 modify Figure 9. 2 Layout Recommendation of HX8347-D (SPI+RGB) 10. P150 modify 10. OTP table 11. P154 modify 11.4 DC Characteristics 12. P156 modify 11.5.1 Current Consumption 13. P161 modify RGB max timing
	2008/09/30	<ul style="list-style-type: none"> 1. P15 modify Pin Description VSSD 2. P17 modify PAD Coordinates VSSD 3. P60 modify Table 6. 5 GRAM X Address and Display Panel Position 4. P70 modify OSC to 2.85Mhz 5. P120 modify RADJ internal oscillator related setting
	2008/10/27	<ul style="list-style-type: none"> 1. P13 modify Pin Description SDA 2. P15 add Pin Description IOVCCDUM and VSSDDUM 3. P16 modify Pin assignment figure 4. P128 add note for register VMF (R23h) setting 5. P139 Remove OTP control register 4 R3Bh.

Version	Date	Description of Changes
01	2008/10/29	1. P16 modify Pin assignment figure (Chip Size)
	2008/11/29	1. P111, add register RE4h~REDh and RFFh to register table 2. P112, add register RC3h~RD3h and RFFh to register table 3. P150 add Power saving internal control register 4. P151 add Source OP control register 5. P152 add Power control internal used register 6. P152 add Command page select register register 7. P153 add CABC control 5~7 register register 8. P154 add Gain select register 0~8 register

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