



# DATA SHEET

(DOC No. HX8312-A-DS)

## HX8312-A

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

*Version 05 March, 2006*

# >> HX8312-A

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



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*Version 04*

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### General Description

This manual describes the Himax's HX8312-A 240RGB\*320 dots resolution driving controller. The HX8312-A is designed to provide a single-chip solution that combined a gate driver, a source driver, power supply circuit, and internal graphics SRAM for 262,144 colors to drive a TFT panel with 240RGB\*320 dots at maximum.

The HX8312-A can be operated in low-voltage (1.65V) condition to 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 HX8312-A also supports various functions to reduce the power consumption of a LCD system via software control, such as an standby mode and 8-color display mode. The HX8312-A has five system interfaces: an I80-system and M68-system 18-/16-/9-/8-bit bus interface, VSYNC interface(internal clock, DB17-0) , serial data transfer interface and RGB18-/16-/6-bit bus interface(DOTCLK, VSYNC, HSYNC, ENABLE). In RGB interface and VSYNC interface mode, the combined use widow address function enables to display data in a moving picture area and data in internal RAM at once, which makes it possible to transfer display data only when rewriting a screen and minimize data transfers.

The HX8312-A is suitable for any small portable battery-driven product and requiring long-term driving capabilities, such as small PDAs, digital cellular phones and bi-directional pagers

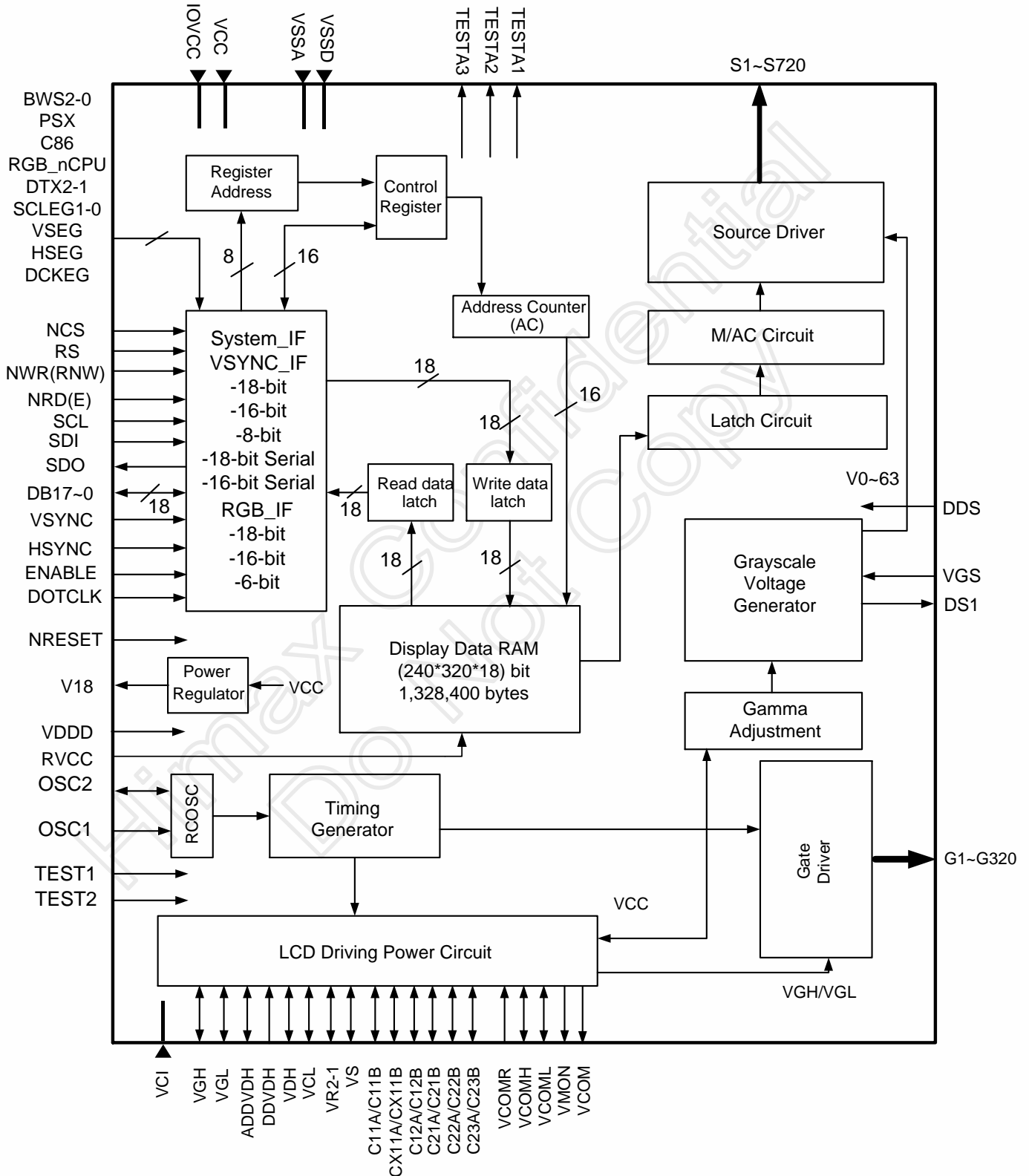
## Features

- ~ Single chip solution to drive a TFT panel
- ~ 240RGB x 320-dot graphics display LCD controller/driver and 262,144 TFT colors
- ~ Support interface:
  - System interface
    - (I80 / M68) parallel bus system interface
    - Serial bus system interface
  - RGB interface
  - VSYNC interface
- ~ Internal graphics RAM capacity: 1,328,400 bytes
- ~ The 262,144 colors can be displayed at the same time with gamma correction
- ~ The vertical scroll display function in line units
- ~ Internal operation circuit of liquid crystal display:
  - Source channel: 720
  - Gate line: 320
- ~ To write data in a window-RAM address area by using a window address area access function
- ~ Low-power consumption architecture supports:
  - VCI = 2.5 to 3.3 V (internal reference voltage)
  - VCC = 2.2 to 3.3 V (corresponding low-voltage operation)
  - IOVCC = 1.65 to 3.3 V (Interface I/O operation)
  - VLCD=4.5~5.5V
  - Power-saving functions
    - 8-color mode
    - standby mode
- ~ N-line inversion AC liquid-crystal drive
- ~ Partial liquid crystal drive to display two screens at arbitrary positions
- ~ Internal oscillator and hardware / software reset function



## 1. Device Overview

### 1.1 Block Diagram



## 1.2 Pin Description

Input Parts				
Signals	I/O	Pin Number	Connected with	Description
BWS2	I	1	MPU	The bus width selection in RGB interface circuit. 0: 18-bit, 1: 16-bit
BWS1-0		2	MPU	The bus width selection in system interface circuit. (see Table 2. 1)
PSX	I	1	MPU	The parallel and serial bus interface selection in system interface circuit. 0: Parallel bus interface, 1: Serial bus interface
NCS	I	1	MPU	Chip select signal. 0: chip can be accessed; 1: chip cannot be accessed.
NRESET	I	1	MPU	Reset pin. Setting either pin low initializes the LSI. Must be reset the chop after power being supplied.
NRD (E)	I	1	MPU	I80 system: Serves as a read signal and reads data at the low level. M68 system: 0: Read/Write disable ; 1: Read/Write enable Fix it to IOVCC or VSSD level when using serial buss interface.
NWR (RNW)	I	1	MPU	I80 system : serves as a write signal and writes data at the rising edge. M68 system: 0: Write ; 1: Read Serial bus interface: 0: Write ; 1: Read
C86	I	1	MPU	MPU selection 0: i80 series MPU; 1: M68 series MPU. Fix it to IOVCC or VSSD level when using serial bus interface.
SDI	I	1	MPU	Serial bus interface data input pin. Fix it to IOVCC or VSSD level when using parallel bus interface.
SCL	I	1	MPU	Serial bus interface clock input pin Fix it to IOVCC or VSSD level when using parallel bus interface.
RGB_nCPU	I	1	MPU	0: System interface can be accessed. 1: System interface can not be accessed.
RS	I	1	MPU	Command/display Data Selection 0: Command, 1: Display data
DTX2-1	I	2	MPU	Specify the transferring method of one pixel data in system interface. (see Table 2. 3)
SCLEG1-0	I	1	MPU	Determine the effective edge operation of SCLK for SDI data latch and SDO data output. (see Table 2. 6)
VSYNC	I	1	MPU	Vertical synchronization signal input pin. Must be connected to IOVCC if not in use.
HSYNC	I	1	MPU	Horizontal synchronization signal input pin. Must be connected to IOVCC if not in use.
DOTCLK	I	1	MPU	Dot clock signal input used in the RGB interface circuit. Must be connected to IOVCC if not in use.
ENABLE	I	1	MPU	Enable signal pin used in RGB interface circuit. 0: disable, 1: enable when EPL (D1 bit of R157) = 0. 0: enable, 1: disable when EPL (D1 bit of R157) = 1. Must be connected to IOVCC if not in use.
VSEG	I	1	MPU	Valid VSYNC polarity selection pin 0: Start in the low level, 1: Start in the high level Fix it to IOVCC or VSSD level when only using system interface.
HSEG	I	1	MPU	Valid HSYNC polarity selection pin 0: Start in the low level, 1: Start in the high level. Fix it to IOVCC or VSSD level when only using system interface.
DCKEG	I	1	MPU	Valid DOTCLK polarity selection pin 0: chip latch data at falling edge. 1: Chip latch data at rising edge. Fix it to IOVCC or VSSD level when only using system interface.
DDS	I	1	MPU	Selection the position of dummy line (321st line). 0: the end of the frame, 1: the beginning of the frame

Output Part				
Signals	I/O	Pin Number	Connected with	Description
SDO	O	1	MPU	Serial bus interface data output pin. Keep it open while using parallel bus interface
CSTB	O	1	MPU	Frame synchronization signal output pin. Keep it open if not in use.
S1~S720	O	720	LCD	Source driver output pin. Output voltages to the liquid crystal.
G1~G321	O	321	LCD	Output signals to panel gate lines. VGH: the level to select the gate lines VGL: the level not to select the gate lines
VCOM1~4	O	4	LCD	VCOM output pin. They are short-circuited inside HX8312-A.

Input/Output Part				
Signals	I/O	Pin Number	Connected with	Description
DB17-0	I/O	18	MPU	Operates liked an 18-bit bi-directional data bus. Fix it to IOVCC or VSSD level when using serial bus interface. Don't set MPU output as Hi-Z when MPU has no output.
OSC2-1	I/O	2	Oscillation Resistor	Connect an external resistor for generating internal clock by internal R-C oscillation. Or an external clock signal is supplied through OSC1 with OSC2 open.
C11A , C11B CX11A , CX11B	I/O	4	Step up Capacitor	Connect to the step-up capacitors for step up circuit 1 operation. Leave this pin open if the internal step-up circuit is not used.
C21A , C21B C22A , C22B C23A , C23B	I/O	6	Step up Capacitor	Connect to the step-up capacitors for step up circuit 2 operation. Leave this pin open if the internal step-up circuit is not used.
C12A , C12B	I/O	2	Step up Capacitor	Connect to the step-up capacitors for step up circuit 3 operation. Leave this pin open if the internal step-up circuit is not used.

Power Part				
Signals	I/O	Pin Number	Connected with	Description
VCC	I	1	Power supply	A power supply for the internal logic circuit. VCC = 2.2 ~ 3.3V
VCI	I	1	Power supply	A Power supply for step-up circuit and power supply circuit. VCI = 2.5 ~ 3.3V
IOVCC	I	1	Power supply	Power supply for I/O circuit. IOVCC = 1.65 ~ 3.3V
V18	O	1	Bypass capacitor and VDDD, RVCC	1.8V regulator output. V18, VDDD and RVCC must have the same voltage level. Connect to VDDD and RVCC on the FPC.
RVCC	I	1	V18 and VDDD	Power supply for RAM circuit.
VDDD	I	1	V18 and RVCC	Power supply for logic circuit.
VSSD	I	1	System Ground	Ground for digital circuit.
VSSD2	I	1	System Ground	Ground for internal circuit.
VSSA	I	1	System Ground	Ground for analog circuit.
VGH	O	1	Bypass Capacitor	A positive power supply for the gate line drive circuit.
VGL	O	1	Bypass Capacitor Schottky Diode	A negative power supply for the gate line drive circuit. Insert a schottky diode in a forward direction to VSSA.
ADDVDH	I	1	DDVDH	Power supply pins for VS and COMH regulators. Connected to DDVDH on FPC
DDVDH	O	1	ADDVDH and Bypass Capacitor	Output supply pin. Connected to ADVDDH on FPC.
VCL	O	1	Bypass Capacitor	The voltage of Vci x (-1) output
VR2-1	O	2	Bypass Capacitor	Reference voltage output for the step-up circuit 2.
VS	O	1	Bypass Capacitor	Power supply for the source drive unit.
VGLDMY	O	1	-	A negative power supply for the gate line drive circuit.

Power Part				
Signals	I/O	Pin Number	Connected with	Description
VCOMH	O	1	Bypass Capacitor	The high level voltage output of VCOM AC voltage output.
VCOML	O	1	Bypass Capacitor	The low level voltage output of VCOM AC voltage output. When VCOML is fixed to GND level (VCOMG=0), capacitor connection is not necessary.
VGS	I	1	GND or External R	A reference level for the grayscale voltage generating circuit.
VCOMR	I	1	Variable Resistor	Adjusting VCOMH level with an variable resistor between VDH and VSSA.
IOVCCDUM1~8	O	8	-	Pull-up pin for mode setting. These pins are connected to IOVCC inside the chip.
IOGNDDUM1~9	O	9	-	Pull-down pin for mode setting. These pins are connected to VSSD inside the chip.

Test Pin and Others				
Signals	I/O	Pin Number	Connected with	Description
TEST2-1	I	2	GND	Test pin input. Must connect to VSSD.
DS1	O	1	-	Pin for gamma voltage output
VMON	O	1	-	Test pin output. Must be left open.
TESTA1, 2, 4	O	3	-	Test pin output. Must be left open.
THROUGH1	-	1	-	Dummy pads. Used to measure the COG contact resistance.
THROUGH8	-	1	-	THROUGH1 and THROUGH8 are short-circuited within the chip.
THROUGH2	-	1	-	Dummy pads. Used to measure the COG contact resistance.
THROUGH7	-	1	-	THROUGH2 and THROUGH7 are short-circuited within the chip.
THROUGH3	-	1	-	Dummy pads. Used to measure the COG contact resistance.
THROUGH6	-	1	-	THROUGH3 and THROUGH6 are short-circuited within the chip.
THROUGH4	-	1	-	Dummy pads. Used to measure the COG contact resistance.
THROUGH5	-	1	-	THROUGH4 and THROUGH5 are short-circuited within the chip.
DUMMYR1	-	1	-	Dummy pads. Used to measure the COG contact resistance.
DUMMYR2	-	1	-	DUMMYR1 and DUMMYR2 are short-circuited within the chip.
DUMMY 1-14, 16, 18, 20-50	-	47	-	Dummy pin. ( There is no gold bumper on DUMMY 7,9,11, 23, 25 ,27)

Note : 1. The layout of VSSA , VSSD , VSSD2 need to be separated in panel, and short together in FPC.

2. The short connection of TEST1, TEST2 and VSSD must be located in FPC, not in panel.
3. Input pin must be fixed to VCC or VSSD when no use.
4. The output pin must be left floating when no use.
5. SDO is a output pin. It must be left floating when no use.
6. TEST2 , 1 are test pin inputs. It must be connected to VSSD
7. DS1, MON, TESTA1, 2, 4 are test pin outputs. It must be left floating.

## PAD Coordinate

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1	DUMMY1	-11928	-547.5	66	VGH	-9945	-701.5	131	VSYNC	-4420	-701.5	196	VDDD	1105	-701.5
2	DUMMY2	-11904	-702.5	67	VGH	-9860	-701.5	132	HSYNC	-4335	-701.5	197	VDDD	1190	-701.5
3	DUMMY3	-11880	-547.5	68	VGH	-9775	-701.5	133	HXSYNC	-4250	-701.5	198	RVCC	1275	-701.5
4	DUMMY4	-11856	-702.5	69	VGH	-9690	-701.5	134	DOTCLK	-4165	-701.5	199	RVCC	1360	-701.5
5	DUMMY5	-11832	-547.5	70	C23A	-9605	-701.5	135	DOTCLK	-4080	-701.5	200	RVCC	1445	-701.5
6	DUMMY6	-11808	-702.5	71	C23A	-9520	-701.5	136	ENABLE	-3995	-701.5	201	RVCC	1530	-701.5
7	DUMMY7	-11784	-547.5	72	C23B	-9435	-701.5	137	ENABLE	-3910	-701.5	202	V18	1615	-701.5
8	DUMMY8	-11760	-702.5	73	C23B	-9350	-701.5	138	DB17	-3825	-701.5	203	V18	1700	-701.5
9	DUMMY9	-11736	-547.5	74	C22A	-9265	-701.5	139	DB17	-3740	-701.5	204	V18	1785	-701.5
10	DUMMY10	-11712	-702.5	75	C22A	-9180	-701.5	140	DB16	-3655	-701.5	205	V18	1870	-701.5
11	DUMMY11	-11688	-547.5	76	C22B	-9095	-701.5	141	DB16	-3570	-701.5	206	DUMMYR1	1955	-701.5
12	DUMMY12	-11664	-702.5	77	C22B	-9010	-701.5	142	DB15	-3485	-701.5	207	DUMMYR2	2040	-701.5
13	THROUGH1	-11640	-547.5	78	C21A	-8925	-701.5	143	DB15	-3400	-701.5	208	OSC1	2125	-701.5
14	THROUGH2	-11616	-702.5	79	C21A	-8840	-701.5	144	DB14	-3315	-701.5	209	OSC1	2210	-701.5
15	G278	-11592	-547.5	80	C21B	-8755	-701.5	145	DB14	-3230	-701.5	210	OSC2	2295	-701.5
16	G279	-11568	-702.5	81	C21B	-8670	-701.5	146	DB13	-3145	-701.5	211	OSC2	2380	-701.5
17	G280	-11544	-547.5	82	C12A	-8585	-701.5	147	DB13	-3060	-701.5	212	VSSD	2465	-701.5
18	G281	-11520	-702.5	83	C12A	-8500	-701.5	148	DB12	-2975	-701.5	213	VSSD	2550	-701.5
19	G282	-11496	-547.5	84	C12A	-8415	-701.5	149	DB12	-2890	-701.5	214	VSSD	2635	-701.5
20	G283	-11472	-702.5	85	C12A	-8330	-701.5	150	DB11	-2805	-701.5	215	VSSD	2720	-701.5
21	G284	-11448	-547.5	86	C12B	-8245	-701.5	151	DB11	-2720	-701.5	216	VSSD2	2805	-701.5
22	G285	-11424	-702.5	87	C12B	-8160	-701.5	152	DB10	-2635	-701.5	217	VSSD2	2890	-701.5
23	G286	-11400	-547.5	88	C12B	-8075	-701.5	153	DB10	-2550	-701.5	218	VSSD2	2975	-701.5
24	G287	-11376	-702.5	89	C12B	-7990	-701.5	154	DB9	-2465	-701.5	219	VSSD2	3060	-701.5
25	G288	-11352	-547.5	90	VR2	-7905	-701.5	155	DB9	-2380	-701.5	220	VSSA	3145	-701.5
26	G289	-11328	-702.5	91	VR2	-7820	-701.5	156	DB8	-2295	-701.5	221	VSSA	3230	-701.5
27	G290	-11304	-547.5	92	VR2	-7735	-701.5	157	DB8	-2210	-701.5	222	VSSA	3315	-701.5
28	G291	-11280	-702.5	93	VR2	-7650	-701.5	158	DB7	-2125	-701.5	223	VSSA	3400	-701.5
29	G292	-11256	-547.5	94	VGL	-7565	-701.5	159	DB7	-2040	-701.5	224	VSSA	3485	-701.5
30	G293	-11232	-702.5	95	VGL	-7480	-701.5	160	DB6	-1955	-701.5	225	VSSA	3570	-701.5
31	G294	-11208	-547.5	96	VGL	-7395	-701.5	161	DB6	-1870	-701.5	226	IOVCC	3655	-701.5
32	G295	-11184	-702.5	97	VGL	-7310	-701.5	162	DB5	-1785	-701.5	227	IOVCC	3740	-701.5
33	G296	-11160	-547.5	98	VGL	-7225	-701.5	163	DB5	-1700	-701.5	228	IOVCC	3825	-701.5
34	G297	-11136	-702.5	99	IOVCCDUM1	-7140	-701.5	164	DB4	-1615	-701.5	229	IOVCC	3910	-701.5
35	G298	-11112	-547.5	100	DDS	-7055	-701.5	165	DB4	-1530	-701.5	230	VCI	3995	-701.5
36	G299	-11088	-702.5	101	IOGNDDUM1	-6970	-701.5	166	DB3	-1445	-701.5	231	VCI	4080	-701.5
37	G300	-11064	-547.5	102	SCLEG1	-6885	-701.5	167	DB3	-1360	-701.5	232	VCI	4165	-701.5
38	G301	-11040	-702.5	103	IOVCCDUM2	-6800	-701.5	168	DB2	-1275	-701.5	233	VCI	4250	-701.5
39	G302	-11016	-547.5	104	SCLEG0	-6715	-701.5	169	DB2	-1190	-701.5	234	VCI	4335	-701.5
40	G303	-10992	-702.5	105	IOGNDDUM2	-6630	-701.5	170	DB1	-1105	-701.5	235	VCI	4420	-701.5
41	G304	-10968	-547.5	106	HSEG	-6545	-701.5	171	DB1	-1020	-701.5	236	VCC	4505	-701.5
42	G305	-10944	-702.5	107	IOVCCDUM3	-6460	-701.5	172	DB0	-935	-701.5	237	VCC	4590	-701.5
43	G306	-10920	-547.5	108	VSEG	-6375	-701.5	173	DB0	-850	-701.5	238	VCC	4675	-701.5
44	G307	-10896	-702.5	109	IOGNDDUM3	-6290	-701.5	174	NRD(E)	-765	-701.5	239	VCC	4760	-701.5
45	G308	-10872	-547.5	110	DCKEG	-6205	-701.5	175	NRD(E)	-680	-701.5	240	VGS	4845	-701.5
46	G309	-10848	-702.5	111	IOVCCDUM4	-6120	-701.5	176	NWR(RNW)	-595	-701.5	241	VGS	4930	-701.5
47	G310	-10824	-547.5	112	PSX	-6035	-701.5	177	NWR(RNW)	-510	-701.5	242	VCOMR	5015	-701.5
48	G311	-10800	-702.5	113	IOGNDDUM4	-5950	-701.5	178	RS	-425	-701.5	243	VCOMR	5100	-701.5
49	G312	-10776	-547.5	114	C86	-5865	-701.5	179	RS	-340	-701.5	244	VS	5185	-701.5
50	G313	-10752	-702.5	115	IOVCCDUM5	-5780	-701.5	180	SDO	-255	-701.5	245	VS	5270	-701.5
51	G314	-10728	-547.5	116	DTX1	-5695	-701.5	181	SDO	-170	-701.5	246	VS	5355	-701.5
52	G315	-10704	-702.5	117	IOGNDDUM5	-5610	-701.5	182	SDI	-85	-701.5	247	VS	5440	-701.5
53	G316	-10680	-547.5	118	DTX2	-5525	-701.5	183	SDI	0	-701.5	248	VCOML	5525	-701.5
54	G317	-10656	-702.5	119	IOVCCDUM6	-5440	-701.5	184	SCL	85	-701.5	249	VCOML	5610	-701.5
55	G318	-10632	-547.5	120	BWS0	-5355	-701.5	185	SCL	170	-701.5	250	VCOML	5695	-701.5
56	G319	-10608	-702.5	121	IOGNDDUM6	-5270	-701.5	186	NCS	255	-701.5	251	VCOML	5780	-701.5
57	G320	-10584	-547.5	122	BWS1	-5185	-701.5	187	NCS	340	-701.5	252	VCOMH	5865	-701.5
58	G321	-10560	-702.5	123	IOVCCDUM7	-5100	-701.5	188	CSTB	425	-701.5	253	VCOMH	5950	-701.5
59	DUMMY13	-10536	-547.5	124	BWS2	-5015	-701.5	189	CSTB	510	-701.5	254	VCOMH	6035	-701.5
60	DUMMY14	-10512	-702.5	125	IOGNDDUM7	-4930	-701.5	190	TEST1	595	-701.5	255	VCOMH	6120	-701.5
61	VMON	-10488	-547.5	126	RGBNCPU	-4845	-701.5	191	IOGNDDUM8	680	-701.5	256	VCL	6205	-701.5
62	DUMMY16	-10285	-701.5	127	IOVCCDUM8	-4760	-701.5	192	TEST2	765	-701.5	257	VCL	6290	-701.5
63	VCOM1	-10200	-701.5	128	NRESET	-4675	-701.5	193	IOGNDDUM9	850	-701.5	258	VCL	6375	-701.5
64	VCOM1	-10115	-701.5	129	NRESET	-4590	-701.5	194	VDDD	935	-701.5	259	VCL	6460	-701.5
65	DS1	-10030	-701.5	130	VSYNC	-4505	-701.5	195	VDDD	1020	-701.5	260	TESTA1	6545	-701.5

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
261	TESTA1	6630	-701.5	326	G20	10992	-702.5	391	G65	11136	547.5	456	G130	9576	702.5
262	VR1	6715	-701.5	327	G21	11016	-547.5	392	G66	11112	702.5	457	G131	9552	547.5
263	VR1	6800	-701.5	328	G22	11040	-702.5	393	G67	11088	547.5	458	G132	9528	702.5
264	VR1	6885	-701.5	329	G23	11064	-547.5	394	G68	11064	702.5	459	G133	9504	547.5
265	VR1	6970	-701.5	330	G24	11088	-702.5	395	G69	11040	547.5	460	G134	9480	702.5
266	ADDVDH	7055	-701.5	331	G25	11112	-547.5	396	G70	11016	702.5	461	G135	9456	547.5
267	ADDVDH	7140	-701.5	332	G26	11136	-702.5	397	G71	10992	547.5	462	G136	9432	702.5
268	ADDVDH	7225	-701.5	333	G27	11160	-547.5	398	G72	10968	702.5	463	G137	9408	547.5
269	ADDVDH	7310	-701.5	334	G28	11184	-702.5	399	G73	10944	547.5	464	G138	9384	702.5
270	DDVDH	7395	-701.5	335	G29	11208	-547.5	400	G74	10920	702.5	465	G139	9360	547.5
271	DDVDH	7480	-701.5	336	G30	11232	-702.5	401	G75	10896	547.5	466	G140	9336	702.5
272	DDVDH	7565	-701.5	337	G31	11256	-547.5	402	G76	10872	702.5	467	G141	9312	547.5
273	DDVDH	7650	-701.5	338	G32	11280	-702.5	403	G77	10848	547.5	468	G142	9288	702.5
274	CX11B	7735	-701.5	339	G33	11304	-547.5	404	G78	10824	702.5	469	G143	9264	547.5
275	CX11B	7820	-701.5	340	G34	11328	-702.5	405	G79	10800	547.5	470	G144	9240	702.5
276	CX11B	7905	-701.5	341	G35	11352	-547.5	406	G80	10776	702.5	471	G145	9216	547.5
277	CX11B	7990	-701.5	342	G36	11376	-702.5	407	G81	10752	547.5	472	G146	9192	702.5
278	CX11B	8075	-701.5	343	G37	11400	-547.5	408	G82	10728	702.5	473	G148	9168	547.5
279	CX11B	8160	-701.5	344	G38	11424	-702.5	409	G83	10704	547.5	474	G148	9144	702.5
280	CX11A	8245	-701.5	345	G39	11448	-547.5	410	G84	10680	702.5	475	G149	9120	547.5
281	CX11A	8330	-701.5	346	G40	11472	-702.5	411	G85	10656	547.5	476	G150	9096	702.5
282	CX11A	8415	-701.5	347	G41	11496	-547.5	412	G86	10632	702.5	477	G151	9072	547.5
283	CX11A	8500	-701.5	348	G42	11520	-702.5	413	G87	10608	547.5	478	G152	9048	702.5
284	CX11A	8585	-701.5	349	G43	11544	-547.5	414	G88	10584	702.5	479	G153	9024	547.5
285	CX11A	8670	-701.5	350	G44	11568	-702.5	415	G89	10560	547.5	480	G154	9000	702.5
286	C11B	8755	-701.5	351	G45	11592	-547.5	416	G90	10536	702.5	481	G155	8976	547.5
287	C11B	8840	-701.5	352	THROUGH3	11616	-702.5	417	G91	10512	547.5	482	G156	8952	702.5
288	C11B	8925	-701.5	353	THROUGH4	11640	-547.5	418	G92	10488	702.5	483	G157	8928	547.5
289	C11B	9010	-701.5	354	DUMMY22	11664	-702.5	419	G93	10464	547.5	484	G158	8904	702.5
290	C11B	9095	-701.5	355	DUMMY23	11688	-547.5	420	G94	10440	702.5	485	G159	8880	547.5
291	C11B	9180	-701.5	356	DUMMY24	11712	-702.5	421	G95	10416	547.5	486	G160	8856	702.5
292	C11A	9265	-701.5	357	DUMMY25	11736	-547.5	422	G96	10392	702.5	487	G161	8832	547.5
293	C11A	9350	-701.5	358	DUMMY26	11760	-702.5	423	G97	10368	547.5	488	DUMMY37	8808	702.5
294	C11A	9435	-701.5	359	DUMMY27	11784	-547.5	424	G98	10344	702.5	489	DUMMY38	8784	547.5
295	C11A	9520	-701.5	360	DUMMY28	11808	-702.5	425	G99	10320	547.5	490	VCOM3	8760	702.5
296	C11A	9605	-701.5	361	DUMMY29	11832	-547.5	426	G100	10296	702.5	491	VCOM3	8736	547.5
297	C11A	9690	-701.5	362	DUMMY30	11856	-702.5	427	G101	10272	547.5	492	DUMMY39	8712	702.5
298	TESTA2	9775	-701.5	363	DUMMY31	11880	-547.5	428	G102	10248	702.5	493	DUMMY40	8688	547.5
299	DUMMY18	9860	-701.5	364	DUMMY32	11904	-702.5	429	G103	10224	547.5	494	DUMMY41	8664	702.5
300	VCOM2	9945	-701.5	365	DUMMY33	11928	-547.5	430	G104	10200	702.5	495	S720	8640	547.5
301	VCOM2	10030	-701.5	366	DUMMY34	11736	702.5	431	G105	10176	547.5	496	S719	8616	702.5
302	VCOM2	10115	-701.5	367	VGLDMY	11712	547.5	432	G106	10152	702.5	497	S718	8592	547.5
303	VCOM2	10200	-701.5	368	DUMMY35	11688	702.5	433	G107	10128	547.5	498	S717	8568	702.5
304	TESTA4	10285	-701.5	369	DUMMY36	11664	547.5	434	G108	10104	702.5	499	S716	8544	547.5
305	DUMMY20	10488	-547.5	370	THROUGH5	11640	702.5	435	G109	10080	547.5	500	S715	8520	702.5
306	DUMMY21	10512	-702.5	371	THROUGH6	11616	547.5	436	G110	10056	702.5	501	S714	8496	547.5
307	G1	10536	-547.5	372	G46	11592	702.5	437	G111	10032	547.5	502	S713	8472	702.5
308	G2	10560	-702.5	373	G47	11568	547.5	438	G112	10008	702.5	503	S712	8448	547.5
309	G3	10584	-547.5	374	G48	11544	702.5	439	G113	9984	547.5	504	S711	8424	702.5
310	G4	10608	-702.5	375	G49	11520	547.5	440	G114	9960	702.5	505	S710	8400	547.5
311	G5	10632	-547.5	376	G50	11496	702.5	441	G115	9936	547.5	506	S709	8376	702.5
312	G6	10656	-702.5	377	G51	11472	547.5	442	G116	9912	702.5	507	S708	8352	547.5
313	G7	10680	-547.5	378	G52	11448	702.5	443	G117	9888	547.5	508	S707	8328	702.5
314	G8	10704	-702.5	379	G53	11424	547.5	444	G118	9864	702.5	509	S706	8304	547.5
315	G9	10728	-547.5	380	G54	11400	702.5	445	G119	9840	547.5	510	S705	8280	702.5
316	G10	10752	-702.5	381	G55	11376	547.5	446	G120	9816	702.5	511	S704	8256	547.5
317	G11	10776	-547.5	382	G56	11352	702.5	447	G121	9792	547.5	512	S703	8232	702.5
318	G12	10800	-702.5	383	G57	11328	547.5	448	G122	9768	702.5	513	S702	8208	547.5
319	G13	10824	-547.5	384	G58	11304	702.5	449	G123	9744	547.5	514	S701	8184	702.5
320	G14	10848	-702.5	385	G59	11280	547.5	450	G124	9720	702.5	515	S700	8160	547.5
321	G15	10872	-547.5	386	G60	11256	702.5	451	G125	9696	547.5	516	S699	8136	702.5
322	G16	10896	-702.5	387	G61	11232	547.5	452	G126	9672	702.5	517	S698	8112	547.5
323	G17	10920	-547.5	388	G62	11208	702.5	453	G127	9648	547.5	518	S697	8088	702.5
324	G18	10944	-702.5	389	G63	11184	547.5	454	G128	9624	702.5	519	S696	8064	547.5
325	G19	10968	-547.5	390	G64	11160	702.5	455	G129	9600	547.5	520	S695	8040	702.5

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
521	S694	8016	547.5	586	S629	6456	702.5	651	S564	4896	547.5	716	S499	3336	702.5
522	S693	7992	702.5	587	S628	6432	547.5	652	S563	4872	702.5	717	S498	3312	547.5
523	S692	7968	547.5	588	S627	6408	702.5	653	S562	4848	547.5	718	S497	3288	702.5
524	S691	7944	702.5	589	S626	6384	547.5	654	S561	4824	702.5	719	S496	3264	547.5
525	S690	7920	547.5	590	S625	6360	702.5	655	S560	4800	547.5	720	S495	3240	702.5
526	S689	7896	702.5	591	S624	6336	547.5	656	S559	4776	702.5	721	S494	3216	547.5
527	S688	7872	547.5	592	S623	6312	702.5	657	S558	4752	547.5	722	S493	3192	702.5
528	S687	7848	702.5	593	S622	6288	547.5	658	S557	4728	702.5	723	S492	3168	547.5
529	S686	7824	547.5	594	S621	6264	702.5	659	S556	4704	547.5	724	S491	3144	702.5
530	S685	7800	702.5	595	S620	6240	547.5	660	S555	4680	702.5	725	S490	3120	547.5
531	S684	7776	547.5	596	S619	6216	702.5	661	S554	4656	547.5	726	S489	3096	702.5
532	S683	7752	702.5	597	S618	6192	547.5	662	S553	4632	702.5	727	S488	3072	547.5
533	S682	7728	547.5	598	S617	6168	702.5	663	S552	4608	547.5	728	S487	3048	702.5
534	S681	7704	702.5	599	S616	6144	547.5	664	S551	4584	702.5	729	S486	3024	547.5
535	S680	7680	547.5	600	S615	6120	702.5	665	S550	4560	547.5	730	S485	3000	702.5
536	S679	7656	702.5	601	S614	6096	547.5	666	S549	4536	702.5	731	S484	2976	547.5
537	S678	7632	547.5	602	S613	6072	702.5	667	S548	4512	547.5	732	S483	2952	702.5
538	S677	7608	702.5	603	S612	6048	547.5	668	S547	4488	702.5	733	S482	2928	547.5
539	S676	7584	547.5	604	S611	6024	702.5	669	S546	4464	547.5	734	S481	2904	702.5
540	S675	7560	702.5	605	S610	6000	547.5	670	S545	4440	702.5	735	S480	2880	547.5
541	S674	7536	547.5	606	S609	5976	702.5	671	S544	4416	547.5	736	S479	2856	702.5
542	S673	7512	702.5	607	S608	5952	547.5	672	S543	4392	702.5	737	S478	2832	547.5
543	S672	7488	547.5	608	S607	5928	702.5	673	S542	4368	547.5	738	S477	2808	702.5
544	S671	7464	702.5	609	S606	5904	547.5	674	S541	4344	702.5	739	S476	2784	547.5
545	S670	7440	547.5	610	S605	5880	702.5	675	S540	4320	547.5	740	S475	2760	702.5
546	S669	7416	702.5	611	S604	5856	547.5	676	S539	4296	702.5	741	S474	2736	547.5
547	S668	7392	547.5	612	S603	5832	702.5	677	S538	4272	547.5	742	S473	2712	702.5
548	S667	7368	702.5	613	S602	5808	547.5	678	S537	4248	702.5	743	S472	2688	547.5
549	S666	7344	547.5	614	S601	5784	702.5	679	S536	4224	547.5	744	S471	2664	702.5
550	S665	7320	702.5	615	S600	5760	547.5	680	S535	4200	702.5	745	S470	2640	547.5
551	S664	7296	547.5	616	S599	5736	702.5	681	S534	4176	547.5	746	S469	2616	702.5
552	S663	7272	702.5	617	S598	5712	547.5	682	S533	4152	702.5	747	S468	2592	547.5
553	S662	7248	547.5	618	S597	5688	702.5	683	S532	4128	547.5	748	S467	2568	702.5
554	S661	7224	702.5	619	S596	5664	547.5	684	S531	4104	702.5	749	S466	2544	547.5
555	S660	7200	547.5	620	S595	5640	702.5	685	S530	4080	547.5	750	S465	2520	702.5
556	S659	7176	702.5	621	S594	5616	547.5	686	S529	4056	702.5	751	S464	2496	547.5
557	S658	7152	547.5	622	S593	5592	702.5	687	S528	4032	547.5	752	S463	2472	702.5
558	S657	7128	702.5	623	S592	5568	547.5	688	S527	4008	702.5	753	S462	2448	547.5
559	S656	7104	547.5	624	S591	5544	702.5	689	S526	3984	547.5	754	S461	2424	702.5
560	S655	7080	702.5	625	S590	5520	547.5	690	S525	3960	702.5	755	S460	2400	547.5
561	S654	7056	547.5	626	S589	5496	702.5	691	S524	3936	547.5	756	S459	2376	702.5
562	S653	7032	702.5	627	S588	5472	547.5	692	S523	3912	702.5	757	S458	2352	547.5
563	S652	7008	547.5	628	S587	5448	702.5	693	S522	3888	547.5	758	S457	2328	702.5
564	S651	6984	702.5	629	S586	5424	547.5	694	S521	3864	702.5	759	S456	2304	547.5
565	S650	6960	547.5	630	S585	5400	702.5	695	S520	3840	547.5	760	S455	2280	702.5
566	S649	6936	702.5	631	S584	5376	547.5	696	S519	3816	702.5	761	S454	2256	547.5
567	S648	6912	547.5	632	S583	5352	702.5	697	S518	3792	547.5	762	S453	2232	702.5
568	S647	6888	702.5	633	S582	5328	547.5	698	S517	3768	702.5	763	S452	2208	547.5
569	S646	6864	547.5	634	S581	5304	702.5	699	S516	3744	547.5	764	S451	2184	702.5
570	S645	6840	702.5	635	S580	5280	547.5	700	S515	3720	702.5	765	S450	2160	547.5
571	S644	6816	547.5	636	S579	5256	702.5	701	S514	3696	547.5	766	S449	2136	702.5
572	S643	6792	702.5	637	S578	5232	547.5	702	S513	3672	702.5	767	S448	2112	547.5
573	S642	6768	547.5	638	S577	5208	702.5	703	S512	3648	547.5	768	S447	2088	702.5
574	S641	6744	702.5	639	S576	5184	547.5	704	S511	3624	702.5	769	S446	2064	547.5
575	S640	6720	547.5	640	S575	5160	702.5	705	S510	3600	547.5	770	S445	2040	702.5
576	S639	6696	702.5	641	S574	5136	547.5	706	S509	3576	702.5	771	S444	2016	547.5
577	S638	6672	547.5	642	S573	5112	702.5	707	S508	3552	547.5	772	S443	1992	702.5
578	S637	6648	702.5	643	S572	5088	547.5	708	S507	3528	702.5	773	S442	1968	547.5
579	S636	6624	547.5	644	S571	5064	702.5	709	S506	3504	547.5	774	S441	1944	702.5
580	S635	6600	702.5	645	S570	5040	547.5	710	S505	3480	702.5	775	S440	1920	547.5
581	S634	6576	547.5	646	S569	5016	702.5	711	S504	3456	547.5	776	S439	1896	702.5
582	S633	6552	702.5	647	S568	4992	547.5	712	S503	3432	702.5	777	S438	1872	547.5
583	S632	6528	547.5	648	S567	4968	702.5	713	S502	3408	547.5	778	S437	1848	702.5
584	S631	6504	702.5	649	S566	4944	547.5	714	S501	3384	702.5	779	S436	1824	547.5
585	S630	6480	547.5	650	S565	4920	702.5	715	S500	3360	547.5	780	S435	1800	702.5

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
781	S434	1776	547.5	846	S369	216	702.5	911	S305	-1344	547.5	976	S240	-2904	702.5
782	S433	1752	702.5	847	S368	192	547.5	912	S304	-1368	702.5	977	S239	-2928	547.5
783	S432	1728	547.5	848	S367	168	702.5	913	S303	-1392	547.5	978	S238	-2952	702.5
784	S431	1704	702.5	849	S366	144	547.5	914	S302	-1416	702.5	979	S237	-2976	547.5
785	S430	1680	547.5	850	S365	120	702.5	915	S301	-1440	547.5	980	S236	-3000	702.5
786	S429	1656	702.5	851	S364	96	547.5	916	S300	-1464	702.5	981	S235	-3024	547.5
787	S428	1632	547.5	852	S363	72	702.5	917	S299	-1488	547.5	982	S234	-3048	702.5
788	S427	1608	702.5	853	S362	48	547.5	918	S298	-1512	702.5	983	S233	-3072	547.5
789	S426	1584	547.5	854	S361	24	702.5	919	S297	-1536	547.5	984	S232	-3096	702.5
790	S425	1560	702.5	855	DUMMY42	0	547.5	920	S296	-1560	702.5	985	S231	-3120	547.5
791	S424	1536	547.5	856	S360	-24	702.5	921	S295	-1584	547.5	986	S230	-3144	702.5
792	S423	1512	702.5	857	S359	-48	547.5	922	S294	-1608	702.5	987	S229	-3168	547.5
793	S422	1488	547.5	858	S358	-72	702.5	923	S293	-1632	547.5	988	S228	-3192	702.5
794	S421	1464	702.5	859	S357	-96	547.5	924	S292	-1656	702.5	989	S227	-3216	547.5
795	S420	1440	547.5	860	S356	-120	702.5	925	S291	-1680	547.5	990	S226	-3240	702.5
796	S419	1416	702.5	861	S355	-144	547.5	926	S290	-1704	702.5	991	S225	-3264	547.5
797	S418	1392	547.5	862	S354	-168	702.5	927	S289	-1728	547.5	992	S224	-3288	702.5
798	S417	1368	702.5	863	S353	-192	547.5	928	S288	-1752	702.5	993	S223	-3312	547.5
799	S416	1344	547.5	864	S352	-216	702.5	929	S287	-1776	547.5	994	S222	-3336	702.5
800	S415	1320	702.5	865	S351	-240	547.5	930	S286	-1800	702.5	995	S221	-3360	547.5
801	S414	1296	547.5	866	S350	-264	702.5	931	S285	-1824	547.5	996	S220	-3384	702.5
802	S413	1272	702.5	867	S349	-288	547.5	932	S284	-1848	702.5	997	S219	-3408	547.5
803	S412	1248	547.5	868	S348	-312	702.5	933	S283	-1872	547.5	998	S218	-3432	702.5
804	S411	1224	702.5	869	S347	-336	547.5	934	S282	-1896	702.5	999	S217	-3456	547.5
805	S410	1200	547.5	870	S346	-360	702.5	935	S281	-1920	547.5	1000	S216	-3480	702.5
806	S409	1176	702.5	871	S345	-384	547.5	936	S280	-1944	702.5	1001	S215	-3504	547.5
807	S408	1152	547.5	872	S344	-408	702.5	937	S279	-1968	547.5	1002	S214	-3528	702.5
808	S407	1128	702.5	873	S343	-432	547.5	938	S278	-1992	702.5	1003	S213	-3552	547.5
809	S406	1104	547.5	874	S342	-456	702.5	939	S277	-2016	547.5	1004	S212	-3576	702.5
810	S405	1080	702.5	875	S341	-480	547.5	940	S276	-2040	702.5	1005	S211	-3600	547.5
811	S404	1056	547.5	876	S340	-504	702.5	941	S275	-2064	547.5	1006	S210	-3624	702.5
812	S403	1032	702.5	877	S339	-528	547.5	942	S274	-2088	702.5	1007	S209	-3648	547.5
813	S402	1008	547.5	878	S338	-552	702.5	943	S273	-2112	547.5	1008	S208	-3672	702.5
814	S401	984	702.5	879	S337	-576	547.5	944	S272	-2136	702.5	1009	S207	-3696	547.5
815	S400	960	547.5	880	S336	-600	702.5	945	S271	-2160	547.5	1010	S206	-3720	702.5
816	S399	936	702.5	881	S335	-624	547.5	946	S270	-2184	702.5	1011	S205	-3744	547.5
817	S398	912	547.5	882	S334	-648	702.5	947	S269	-2208	547.5	1012	S204	-3768	702.5
818	S397	888	702.5	883	S333	-672	547.5	948	S268	-2232	702.5	1013	S203	-3792	547.5
819	S396	864	547.5	884	S332	-696	702.5	949	S267	-2256	547.5	1014	S202	-3816	702.5
820	S395	840	702.5	885	S331	-720	547.5	950	S266	-2280	702.5	1015	S201	-3840	547.5
821	S394	816	547.5	886	S330	-744	702.5	951	S265	-2304	547.5	1016	S200	-3864	702.5
822	S393	792	702.5	887	S329	-768	547.5	952	S264	-2328	702.5	1017	S199	-3888	547.5
823	S392	768	547.5	888	S328	-792	702.5	953	S263	-2352	547.5	1018	S198	-3912	702.5
824	S391	744	702.5	889	S327	-816	547.5	954	S262	-2376	702.5	1019	S197	-3936	547.5
825	S390	720	547.5	890	S326	-840	702.5	955	S261	-2400	547.5	1020	S196	-3960	702.5
826	S389	696	702.5	891	S325	-864	547.5	956	S260	-2424	702.5	1021	S195	-3984	547.5
827	S388	672	547.5	892	S224	-888	702.5	957	S259	-2448	547.5	1022	S194	-4008	702.5
828	S387	648	702.5	893	S223	-912	547.5	958	S258	-2472	702.5	1023	S193	-4032	547.5
829	S386	624	547.5	894	S322	-936	702.5	959	S257	-2496	547.5	1024	S192	-4056	702.5
830	S385	600	702.5	895	S321	-960	547.5	960	S256	-2520	702.5	1025	S191	-4080	547.5
831	S384	576	547.5	896	S320	-984	702.5	961	S255	-2544	547.5	1026	S190	-4104	702.5
832	S383	552	702.5	897	S319	-1008	547.5	962	S254	-2568	702.5	1027	S189	-4128	547.5
833	S382	528	547.5	898	S318	-1032	702.5	963	S253	-2592	547.5	1028	S188	-4152	702.5
834	S381	504	702.5	899	S317	-1056	547.5	964	S252	-2616	702.5	1029	S187	-4176	547.5
835	S380	480	547.5	900	S316	-1080	702.5	965	S251	-2640	547.5	1030	S186	-4200	702.5
836	S379	456	702.5	901	S315	-1104	547.5	966	S250	-2664	702.5	1031	S185	-4224	547.5
837	S378	432	547.5	902	S314	-1128	702.5	967	S249	-2688	547.5	1032	S184	-4248	702.5
838	S377	408	702.5	903	S313	-1152	547.5	968	S248	-2712	702.5	1033	S183	-4272	547.5
839	S376	384	547.5	904	S312	-1176	702.5	969	S247	-2736	547.5	1034	S182	-4296	702.5
840	S375	360	702.5	905	S311	-1200	547.5	970	S246	-2760	702.5	1035	S181	-4320	547.5
841	S374	336	547.5	906	S310	-1224	702.5	971	S245	-2784	547.5	1036	S180	-4344	702.5
842	S373	312	702.5	907	S309	-1248	547.5	972	S244	-2808	702.5	1037	S179	-4368	547.5
843	S372	288	547.5	908	S308	-1272	702.5	973	S243	-2832	547.5	1038	S178	-4392	702.5
844	S371	264	702.5	909	S307	-1296	547.5	974	S242	-2856	702.5	1039	S177	-4416	547.5
845	S370	240	547.5	910	S306	-1320	702.5	975	S241	-2880	547.5	1040	S176	-4440	702.5

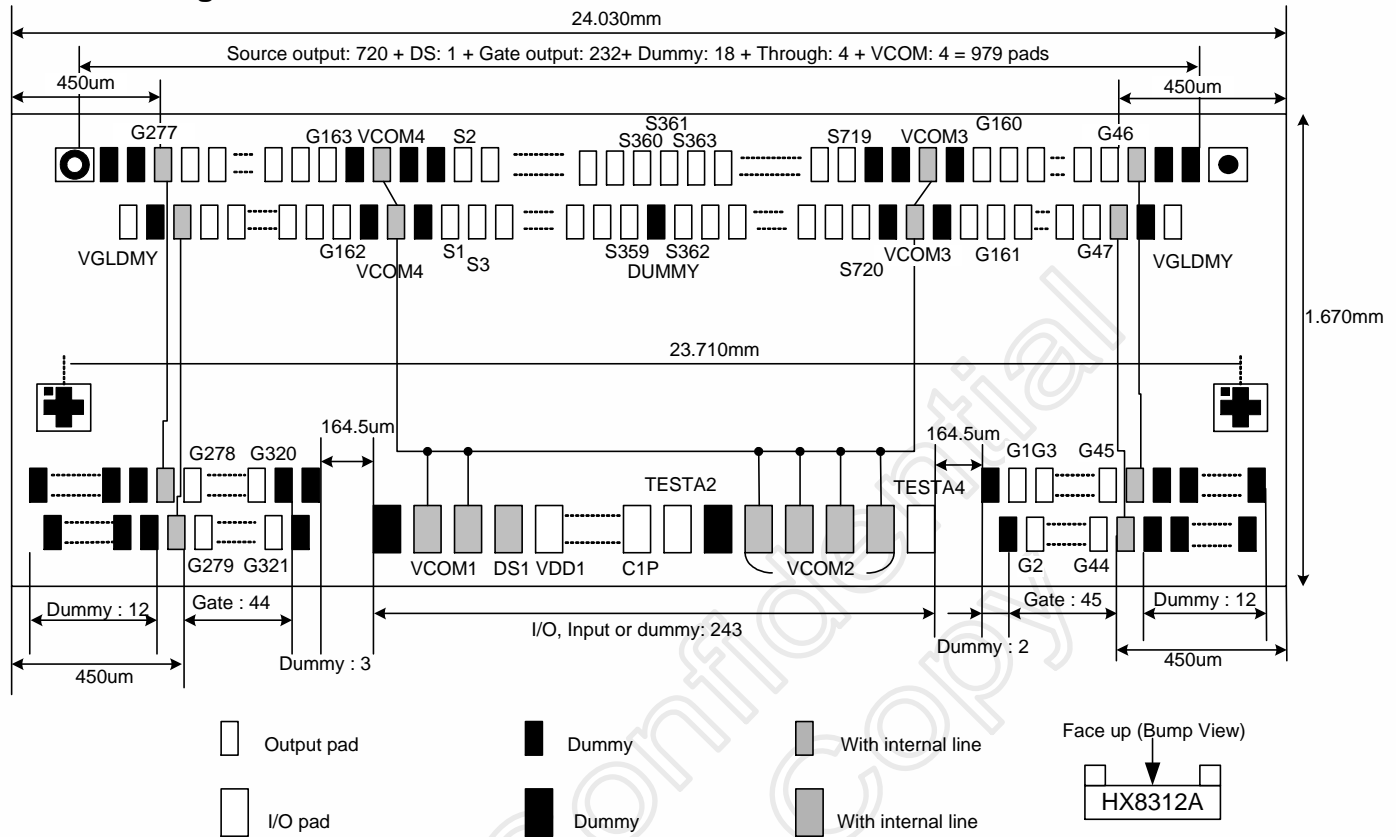


No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1041	S175	-4464	547.5	1106	S110	-6024	702.5	1171	S45	-7584	547.5	1236	G175	-9144	702.5
1042	S174	-4488	702.5	1107	S109	-6048	547.5	1172	S44	-7608	702.5	1237	G176	-9168	547.5
1043	S173	-4512	547.5	1108	S108	-6072	702.5	1173	S43	-7632	547.5	1238	G177	-9192	702.5
1044	S172	-4536	702.5	1109	S107	-6096	547.5	1174	S42	-7656	702.5	1239	G178	-9216	547.5
1045	S171	-4560	547.5	1110	S106	-6120	702.5	1175	S41	-7680	547.5	1240	G179	-9240	702.5
1046	S170	-4584	702.5	1111	S105	-6144	547.5	1176	S40	-7704	702.5	1241	G180	-9264	547.5
1047	S169	-4608	547.5	1112	S104	-6168	702.5	1177	S39	-7728	547.5	1242	G181	-9288	702.5
1048	S168	-4632	702.5	1113	S103	-6192	547.5	1178	S38	-7752	702.5	1243	G182	-9312	547.5
1049	S167	-4656	547.5	1114	S102	-6216	702.5	1179	S37	-7776	547.5	1244	G183	-9336	702.5
1050	S166	-4680	702.5	1115	S101	-6240	547.5	1180	S36	-7800	702.5	1245	G184	-9360	547.5
1051	S165	-4704	547.5	1116	S100	-6264	702.5	1181	S35	-7824	547.5	1246	G185	-9384	702.5
1052	S164	-4728	702.5	1117	S99	-6288	547.5	1182	S34	-7848	702.5	1247	G186	-9408	547.5
1053	S163	-4752	547.5	1118	S98	-6312	702.5	1183	S33	-7872	547.5	1248	G187	-9432	702.5
1054	S162	-4776	702.5	1119	S97	-6336	547.5	1184	S32	-7896	702.5	1249	G188	-9456	547.5
1055	S161	-4800	547.5	1120	S96	-6360	702.5	1185	S31	-7920	547.5	1250	G189	-9480	702.5
1056	S160	-4824	702.5	1121	S95	-6384	547.5	1186	S30	-7944	702.5	1251	G190	-9504	547.5
1057	S159	-4848	547.5	1122	S94	-6408	702.5	1187	S29	-7968	547.5	1252	G191	-9528	702.5
1058	S158	-4872	702.5	1123	S93	-6432	547.5	1188	S28	-7992	702.5	1253	G192	-9552	547.5
1059	S157	-4896	547.5	1124	S92	-6456	702.5	1189	S27	-8016	547.5	1254	G193	-9576	702.5
1060	S156	-4920	702.5	1125	S91	-6480	547.5	1190	S26	-8040	702.5	1255	G194	-9600	547.5
1061	S155	-4944	547.5	1126	S90	-6504	702.5	1191	S25	-8064	547.5	1256	G195	-9624	702.5
1062	S154	-4968	702.5	1127	S89	-6528	547.5	1192	S24	-8088	702.5	1257	G196	-9648	547.5
1063	S153	-4992	547.5	1128	S88	-6552	702.5	1193	S23	-8112	547.5	1258	G197	-9672	702.5
1064	S152	-5016	702.5	1129	S87	-6576	547.5	1194	S22	-8136	702.5	1259	G198	-9696	547.5
1065	S151	-5040	547.5	1130	S86	-6600	702.5	1195	S21	-8160	547.5	1260	G199	-9720	702.5
1066	S150	-5064	702.5	1131	S85	-6624	547.5	1196	S20	-8184	702.5	1261	G200	-9744	547.5
1067	S149	-5088	547.5	1132	S84	-6648	702.5	1197	S19	-8208	547.5	1262	G201	-9768	702.5
1068	S148	-5112	702.5	1133	S83	-6672	547.5	1198	S18	-8232	702.5	1263	G202	-9792	547.5
1069	S147	-5136	547.5	1134	S82	-6696	702.5	1199	S17	-8256	547.5	1264	G203	-9816	702.5
1070	S146	-5160	702.5	1135	S81	-6720	547.5	1200	S16	-8280	702.5	1265	G204	-9840	547.5
1071	S145	-5184	547.5	1136	S80	-6744	702.5	1201	S15	-8304	547.5	1266	G205	-9864	702.5
1072	S144	-5208	702.5	1137	S79	-6768	547.5	1202	S14	-8328	702.5	1267	G206	-9888	547.5
1073	S143	-5232	547.5	1138	S78	-6792	702.5	1203	S13	-8352	547.5	1268	G207	-9912	702.5
1074	S142	-5256	702.5	1139	S77	-6816	547.5	1204	S12	-8376	702.5	1269	G208	-9936	547.5
1075	S141	-5280	547.5	1140	S76	-6840	702.5	1205	S11	-8400	547.5	1270	G209	-9960	702.5
1076	S140	-5304	702.5	1141	S75	-6864	547.5	1206	S10	-8424	702.5	1271	G210	-9984	547.5
1077	S139	-5328	547.5	1142	S74	-6888	702.5	1207	S9	-8448	547.5	1272	G211	-10008	702.5
1078	S138	-5352	702.5	1143	S73	-6912	547.5	1208	S8	-8472	702.5	1273	G212	-10032	547.5
1079	S137	-5376	547.5	1144	S72	-6936	702.5	1209	S7	-8496	547.5	1274	G213	-10056	702.5
1080	S136	-5400	702.5	1145	S71	-6960	547.5	1210	S6	-8520	702.5	1275	G214	-10080	547.5
1081	S135	-5424	547.5	1146	S70	-6984	702.5	1211	S5	-8544	547.5	1276	G215	-10104	702.5
1082	S134	-5448	702.5	1147	S69	-7008	547.5	1212	S4	-8568	702.5	1277	G216	-10128	547.5
1083	S133	-5472	547.5	1148	S68	-7032	702.5	1213	S3	-8592	547.5	1278	G217	-10152	702.5
1084	S132	-5496	702.5	1149	S67	-7056	547.5	1214	S2	-8616	702.5	1279	G218	-10176	547.5
1085	S131	-5520	547.5	1150	S66	-7080	702.5	1215	S1	-8640	547.5	1280	G219	-10200	702.5
1086	S130	-5544	702.5	1151	S65	-7104	547.5	1216	DUMMY43	-8664	702.5	1281	G220	-10224	547.5
1087	S129	-5568	547.5	1152	S64	-7128	702.5	1217	DUMMY44	-8688	547.5	1282	G221	-10248	702.5
1088	S128	-5592	702.5	1153	S63	-7152	547.5	1218	DUMMY45	-8712	702.5	1283	G222	-10272	547.5
1089	S127	-5616	547.5	1154	S62	-7176	702.5	1219	VCOM4	-8736	547.5	1284	G223	-10296	702.5
1090	S126	-5640	702.5	1155	S61	-7200	547.5	1220	VCOM4	-8760	702.5	1285	G224	-10320	547.5
1091	S125	-5664	547.5	1156	S60	-7224	702.5	1221	DUMMY46	-8784	547.5	1286	G225	-10344	702.5
1092	S124	-5688	702.5	1157	S59	-7248	547.5	1222	DUMMY47	-8808	702.5	1287	G226	-10368	547.5
1093	S123	-5712	547.5	1158	S58	-7272	702.5	1223	G162	-8832	547.5	1288	G227	-10392	702.5
1094	S122	-5736	702.5	1159	S57	-7296	547.5	1224	G163	-8856	702.5	1289	G228	-10416	547.5
1095	S121	-5760	547.5	1160	S56	-7320	702.5	1225	G164	-8880	547.5	1290	G229	-10440	702.5
1096	S120	-5784	702.5	1161	S55	-7344	547.5	1226	G165	-8904	702.5	1291	G230	-10464	547.5
1097	S119	-5808	547.5	1162	S54	-7368	702.5	1227	G166	-8928	547.5	1292	G231	-10488	702.5
1098	S118	-5832	702.5	1163	S53	-7392	547.5	1228	G167	-8952	702.5	1293	G232	-10512	547.5
1099	S117	-5856	547.5	1164	S52	-7416	702.5	1229	G168	-8976	547.5	1294	G233	-10536	702.5
1100	S116	-5880	702.5	1165	S51	-7440	547.5	1230	G169	-9000	702.5	1295	G234	-10560	547.5
1101	S115	-5904	547.5	1166	S50	-7464	702.5	1231	G170	-9024	547.5	1296	G235	-10584	702.5
1102	S114	-5928	702.5	1167	S49	-7488	547.5	1232	G171	-9048	702.5	1297	G236	-10608	547.5
1103	S113	-5952	547.5	1168	S48	-7512	702.5	1233	G172	-9072	547.5	1298	G237	-10632	702.5
1104	S112	-5976	702.5	1169	S47	-7536	547.5	1234	G173	-9096	702.5	1299	G238	-10656	547.5
1105	S111	-6000	547.5	1170	S46	-7560	702.5	1235	G174	-9120	547.5	1300	G239	-10680	702.5

No.	Pad name	X	Y
1301	G240	-10704	547.5
1302	G241	-10728	702.5
1303	G242	-10752	547.5
1304	G243	-10776	702.5
1305	G244	-10800	547.5
1306	G245	-10824	702.5
1307	G246	-10848	547.5
1308	G247	-10872	702.5
1309	G248	-10896	547.5
1310	G249	-10920	702.5
1311	G250	-10944	547.5
1312	G251	-10968	702.5
1313	G252	-10992	547.5
1314	G253	-11016	702.5
1315	G254	-11040	547.5
1316	G255	-11064	702.5
1317	G256	-11088	547.5
1318	G257	-11112	702.5
1319	G258	-11136	547.5
1320	G259	-11160	702.5
1321	G260	-11184	547.5
1322	G261	-11208	702.5
1323	G262	-11232	547.5
1324	G263	-11256	702.5
1325	G264	-11280	547.5
1326	G265	-11304	702.5
1327	G266	-11328	547.5
1328	G267	-11352	702.5
1329	G268	-11376	547.5
1330	G269	-11400	702.5
1331	G270	-11424	547.5
1332	G271	-11448	702.5
1333	G272	-11472	547.5
1334	G273	-11496	702.5
1335	G274	-11520	547.5
1336	G275	-11544	702.5
1337	G276	-11568	547.5
1338	G277	-11592	702.5
1339	THROUGH7	-11616	547.5
1340	THROUGH8	-11640	702.5
1341	DUMMY48	-11664	547.5
1342	DUMMY49	-11688	702.5
1343	VGLDMY	-11712	547.5
1344	DUMMY50	-11736	702.5

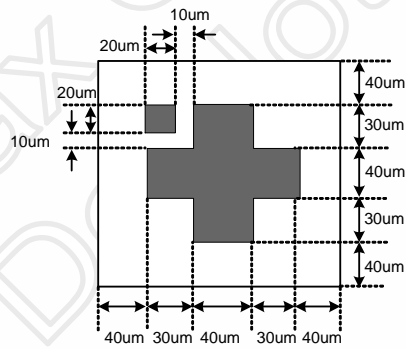
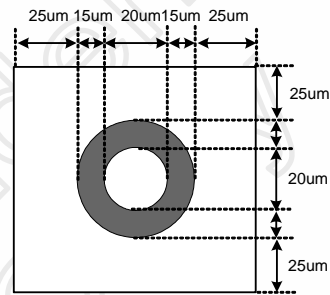
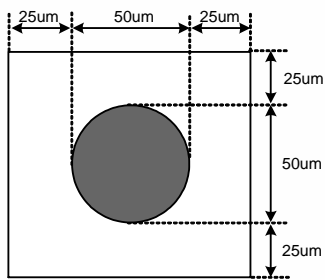
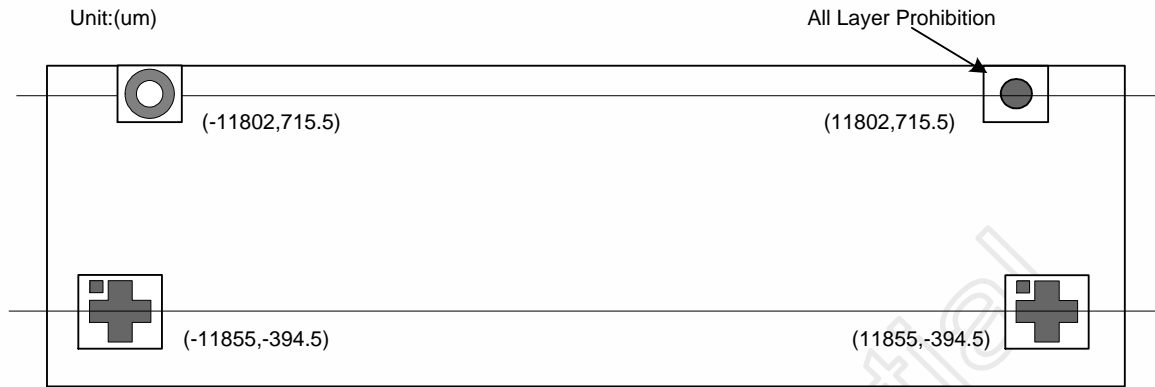
Alignment mark	X	Y
(1-a)	-11855	-394.5
(1-b)	11855	-394.5
(2-a)	-11802	715.5
(2-b)	11802	715.5

## BUMP Arrangement



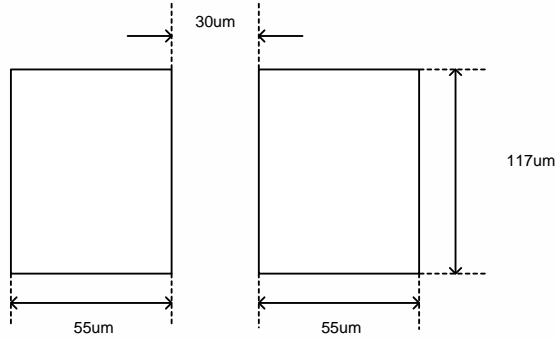
**Note:** There is no gold bumper on DUMMY 7,9,11, 23, 25, 27 pins.

## Alignment mark

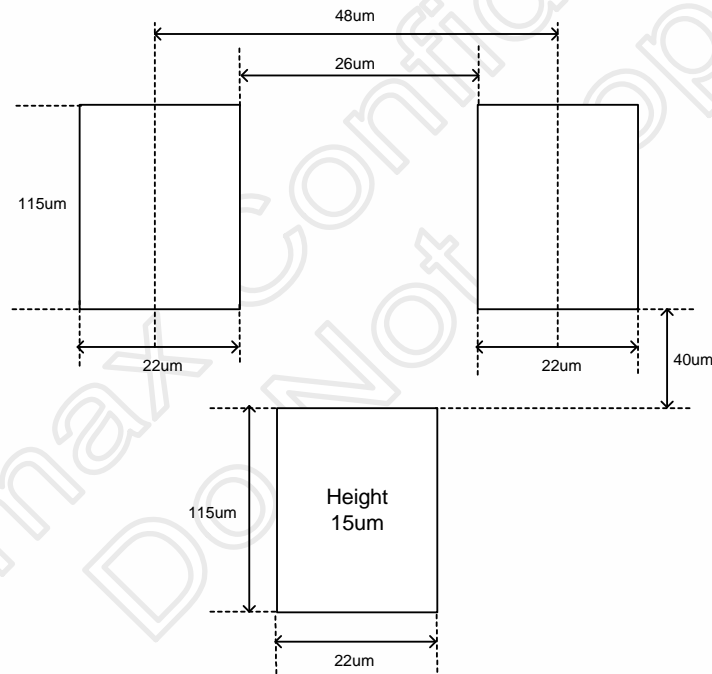


**Bump size**

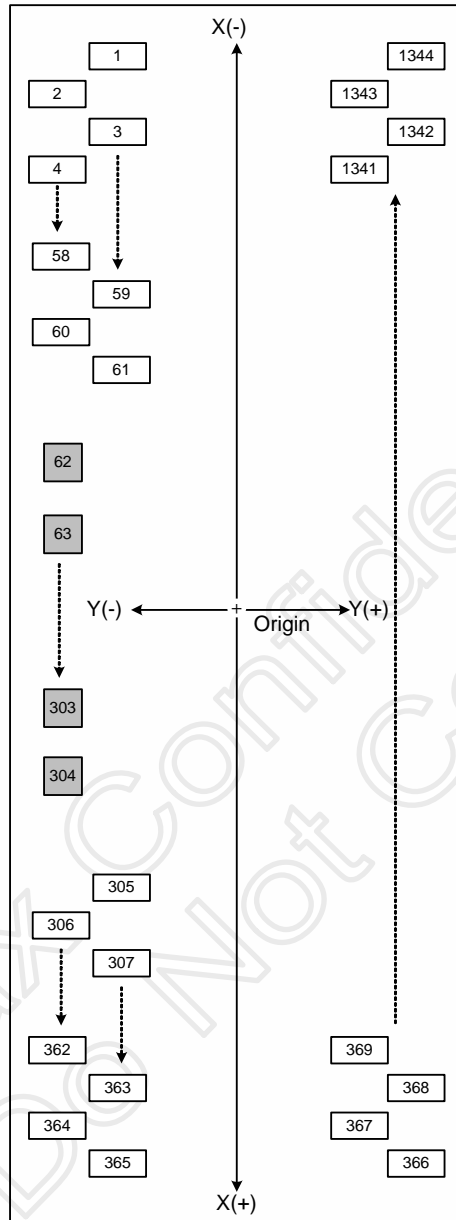
Input Bump size (type A) (pad 62~pad 304)



Output Bump size (type B) (pad 1 ~ pad 61; pad 305 ~ pad 1344)



Pad Coordinate



## 2. Interface

The HX8312-A has a system interface circuit for data / command transferring, and a RGB interface circuit for data transferring during animated display. The system interface circuit uses data bus pins (DB17-0) defined as (R5-0, G5-0, B5-0) bits. Since the data bus pins (DB17-0) can be used as input in RGB interface circuit, the HX8312-A shows animated display with less wiring. Table 2.1 shows the bus pin used in every interface circuit with different external setting pin setting.

When HX8312-A is set up for unique interface mode, the input data bus pins which are not used must be fixed at IOVCC or VSSD.

External Setting Pin				Interface Mode	
NWRGB	PSX	RS	VSYNC, HSYNC, DENA, DOTCLK	Command transfer	Display Data Transfer
0	0	0	Fixed	System Interface Circuit ( Parallel Bus )	-
0	0	1	Fixed	-	System Interface Circuit ( Parallel Bus )
0	1	0	Fixed	System Interface Circuit ( Serial Bus )	-
0	1	1	Fixed	-	System Interface Circuit ( Serial Bus )
1	0	0	Input	System Interface Circuit ( Parallel Bus )	-
1	0	1	Input	-	RGB Interface Circuit
1	1	0	Input	System Interface Circuit ( Serial Bus )	RGB Interface Circuit
1	1	1	Input	-	RGB Interface Circuit

**Table 2. 1 Interface Type**

**Note:**

1. The NWRGB is the D0 bit of R02h register.
2. System interface (parallel and serial bus) circuit is not available when external pin RGB\_nCPU = "1". All operation from system interface input are not available.
3. Please make sure that RGB interface circuit is only used for display data RAM accessed, and can not be used for register accessed.

## 2.1 System Interface Circuit

The system interface circuit in HX8312-A supports 18-/16-/8-bit bus width parallel bus system interface for I80 series and M68 series CPU, and 18-/16-bit serial bus system interface for serial data input. When NCS = "L" and RGB\_nCPU="L", the parallel and serial bus system interface of the HX8312-A become active and data transfer through the interface circuit is available. The RS 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 2.2 and Table 2.3.

C86	Input signal format selection
0	Format for I80 series MPU
1	Format for M68 series MPU

Table 2. 2 MPU selection

Interface Type	External Setting Pin					Bus Width	Bit number in a pixel	Transferring Method of RAM data	Transferring Method of Command
	PSX	BWS1	BWS0	DTX2	DTX1				
MPU1	0	0	0	x	x	18-bit parallel	18-bits	18-bit collective	16-bit collective
MPU2	0	1	0	0	1	16-bit parallel	18-bits	9-bit twice	
MPU3	0	1	0	1	1		16-bits	16-bit + 2-bit	
MPU4	0	1	0	0	0	8-bit parallel	18-bits	16-bit collective	8-bit twice
MPU5	0	1	1	0	1		18-bits	6-bit 3 times	
MPU6	0	1	1	1	1		16-bits	8-bit+8-bit+2-bit	
MPU7	0	1	1	1	0		18-bit serial	18-bit serial	
MPU8	1	0	1	x	x	16-bit serial	16-bits	16-bit serial	16-bit serial
MPU9	1	1	1	x	x				

Table 2. 3 Input bus format selection of system interface circuit

### 2.1.1 Parallel Bus System Interface

The input / output data from data pins (DB17-0) and signal operation of the I80/M68 series parallel bus interface as listed in Table 2.4 and Table 2.5.

Operations	NWR(RNW)	NRD(E)	RS
Write command to register	0	1	0
Read command from register	1	0	0
Write display data to RAM	0	1	1
Read display data from RAM	1	0	1

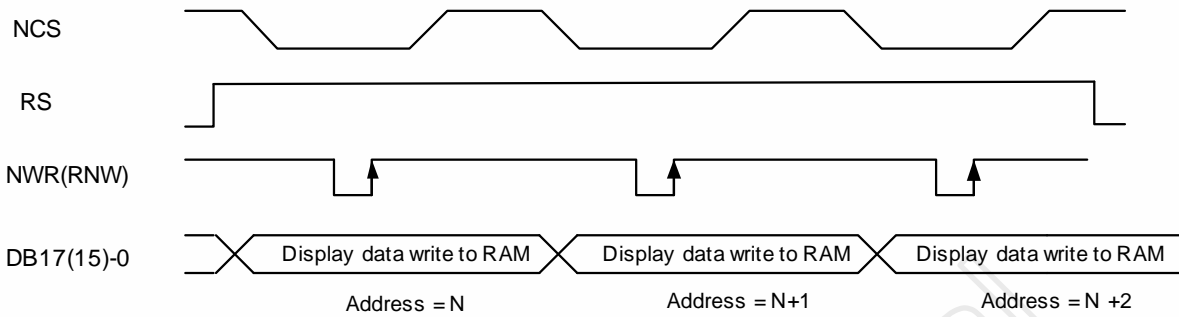
Table 2. 4 Data pin function for I80 series CPU

Operations	NWR(RNW)	NRD(E)	RS
Write command to register	0	1	0
Read command from register	1	1	0
Write display data to RAM	0	1	1
Read display data from RAM	1	1	1

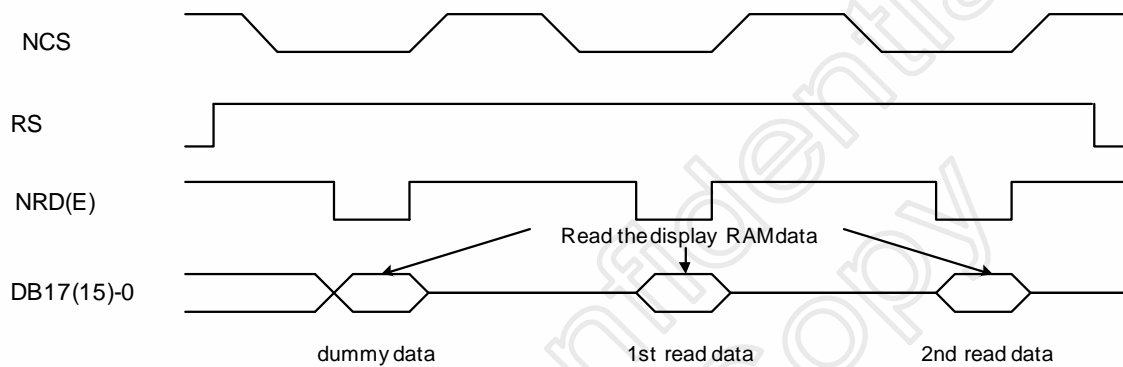
Table 2. 5 Data pin function for M68 series CPU



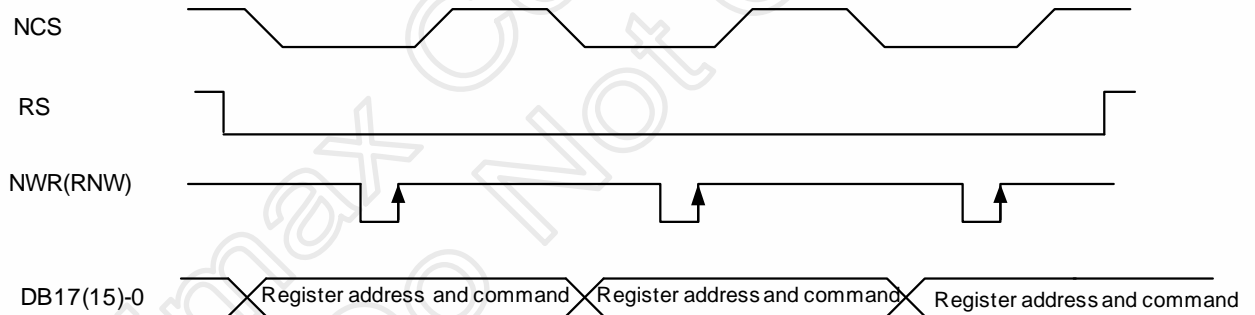
**Write to the display data RAM (MPU1 , MPU4 )**



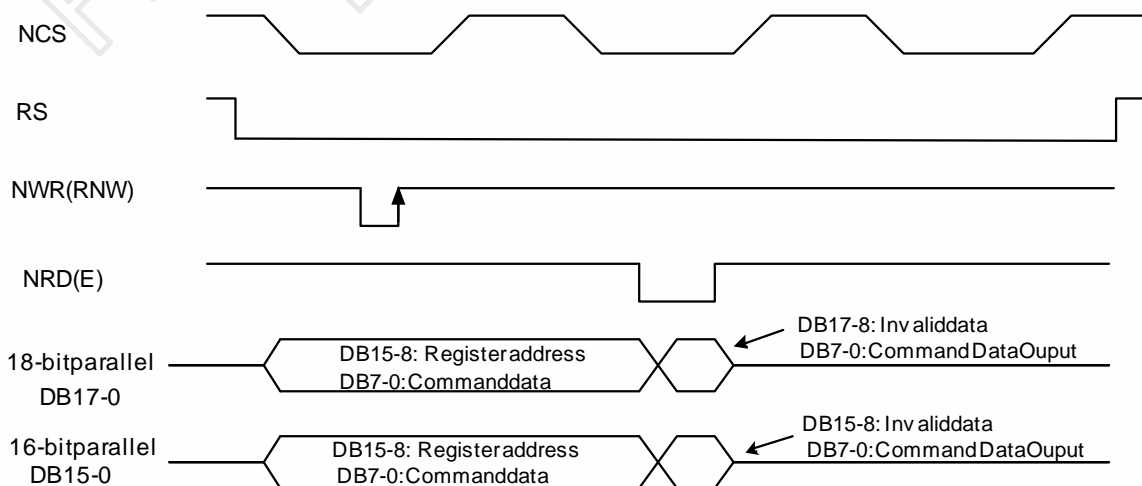
**Read the display data RAM (MPU1 , MPU4)**



**Write to the register (MPU1~ MPU4)**



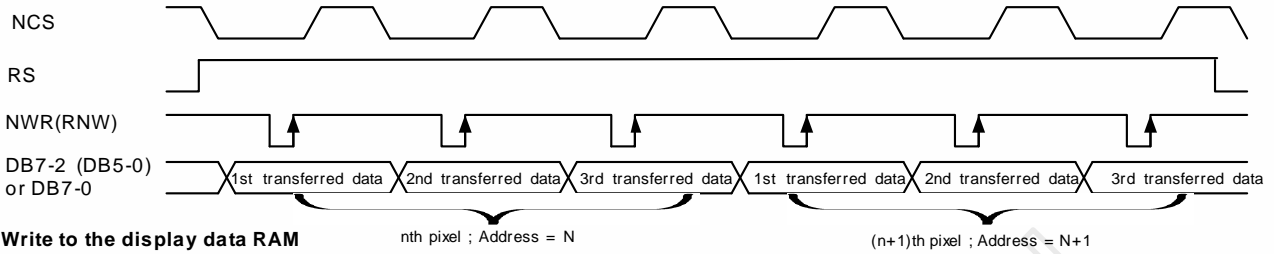
**Read the register (MPU1~MPU4)**



**Figure 2. 1 18 / 16-bit Bus Width Parallel Bus Interface Timing (for I80 series MPU)**

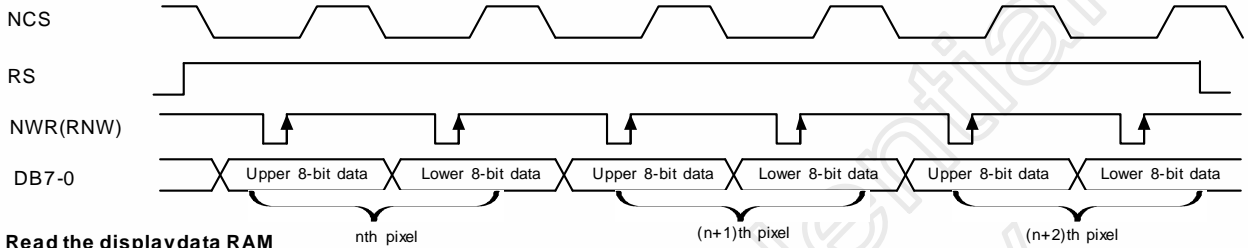
### Write to the display data RAM

18-bit display data (6-bit x 3 transfers/ 8-bit + 8-bit + 2-bit transfers)



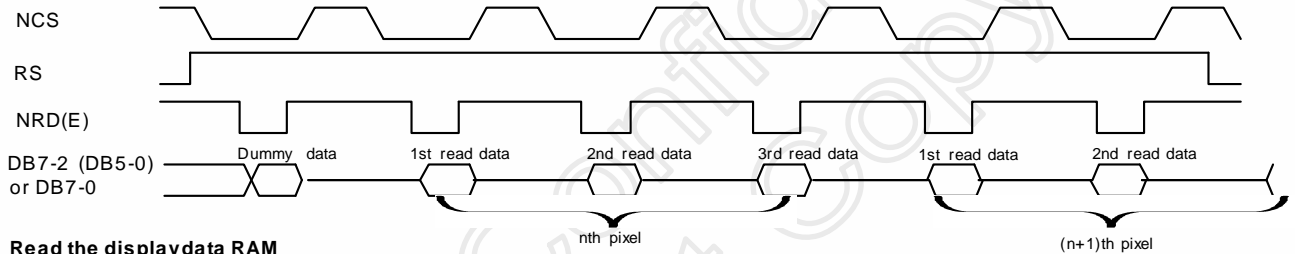
### Write to the display data RAM

16-bit display data (8-bit x 2 transfers)



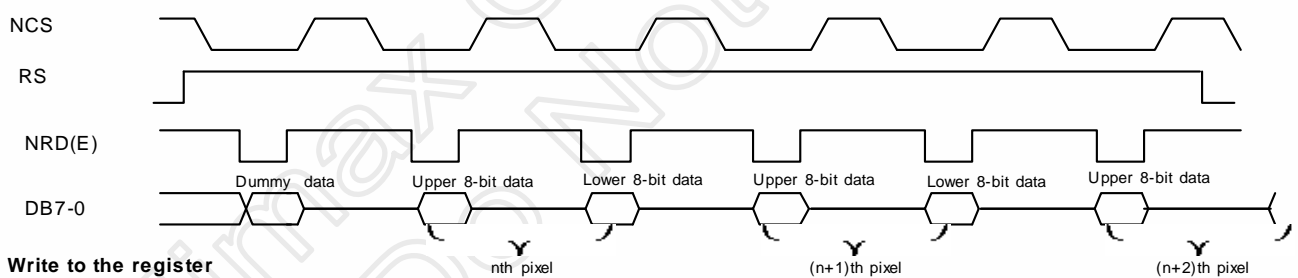
### Read the display data RAM

18-bit display data (6-bit x 3 transfers/ 8-bit + 8-bit + 2-bit transfers)

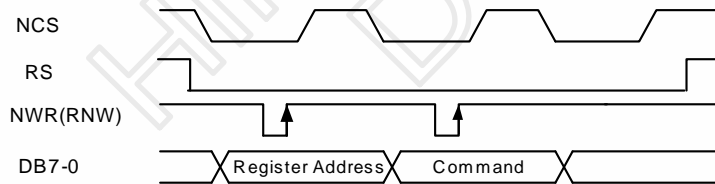


### Read the display data RAM

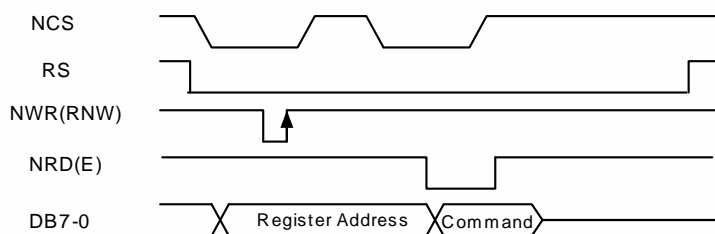
16-bit display data (8-bit x 2 transfers)



### Write to the register



### Read the register



DB7-2 or DB5-0 selection in 6-bit x 3 input mode is decided by MSBF (D0 bit) of R157

Figure 2. 2 8-bit Bus Width Parallel Bus Interface Timing (for I80 series MPU)

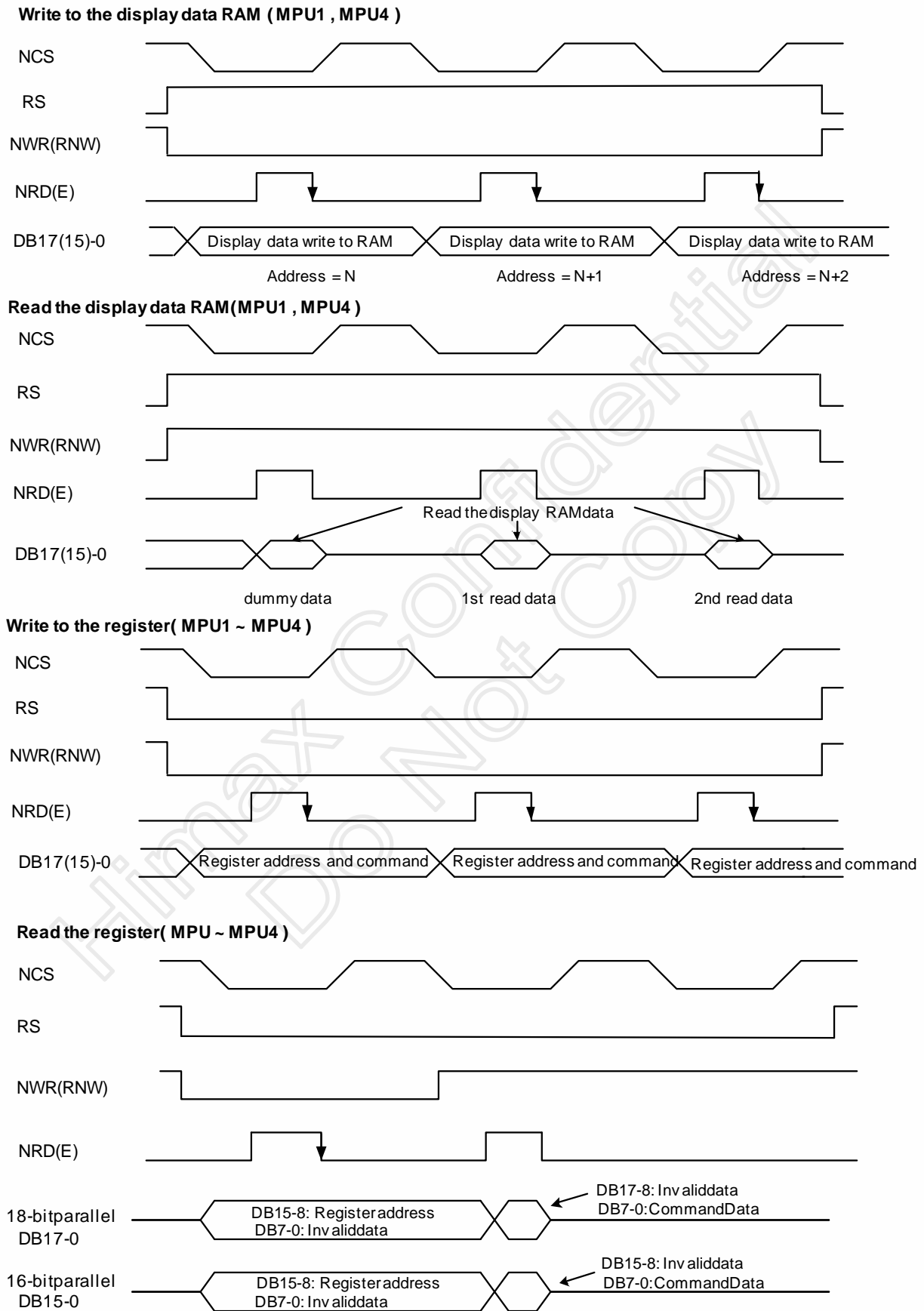
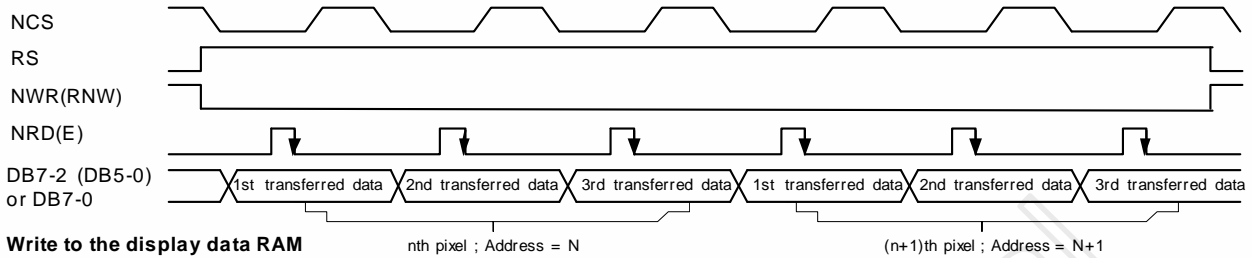


Figure 2. 3 18 / 16-bit Bus Width Parallel Bus Interface Timing (for M68 series MPU)

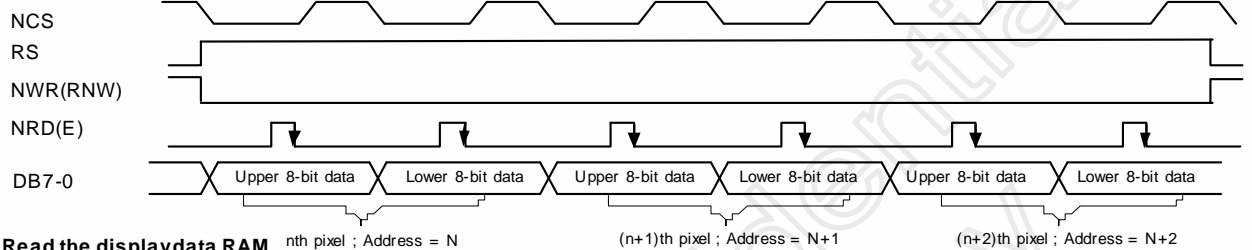
### Write to the display data RAM

18-bit display data (6-bit x 3 transfers/ 8-bit + 8-bit + 2-bit transfers)



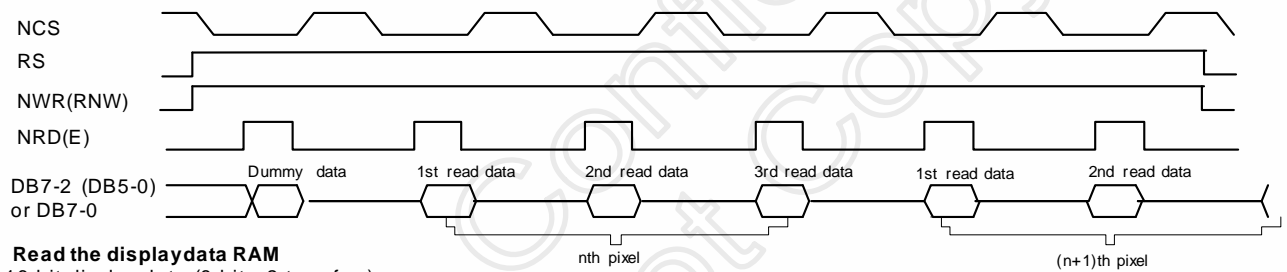
### Write to the display data RAM

16-bit display data (8-bit x 2 transfers)



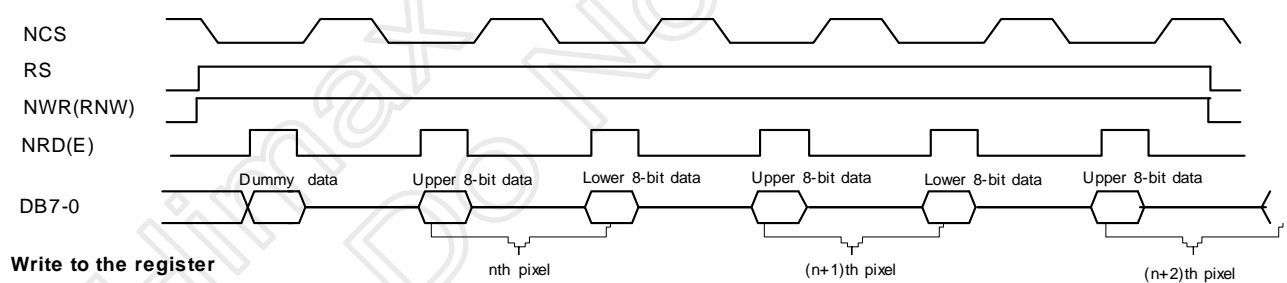
### Read the display data RAM

18-bit display data (6-bit x 3 transfers/ 8-bit + 8-bit + 2-bit transfers)

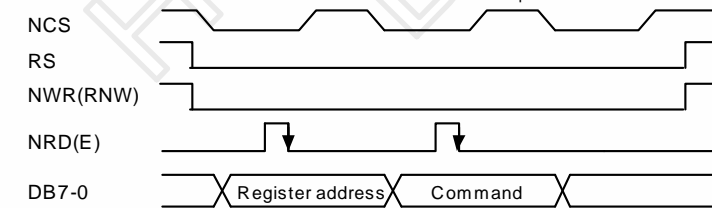


### Read the display data RAM

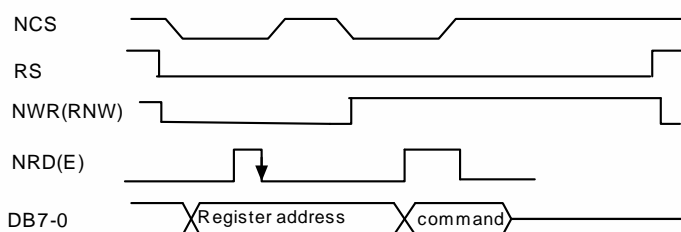
16-bit display data (8-bit x 2 transfers)



### Write to the register



### Read the register



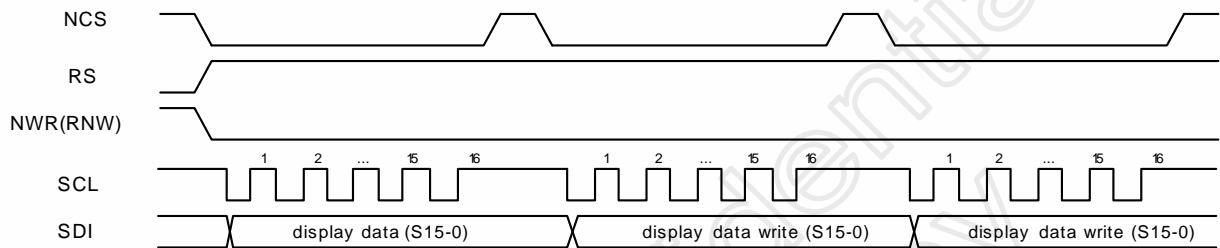
DB7-2 or DB5-0 used in 6-bit x 3 input mode is decided by MSBF ( D0 bit) of R157

Figure 2. 4 8-bit Bus Width Parallel Bus Interface Timing (for M68 series MPU)

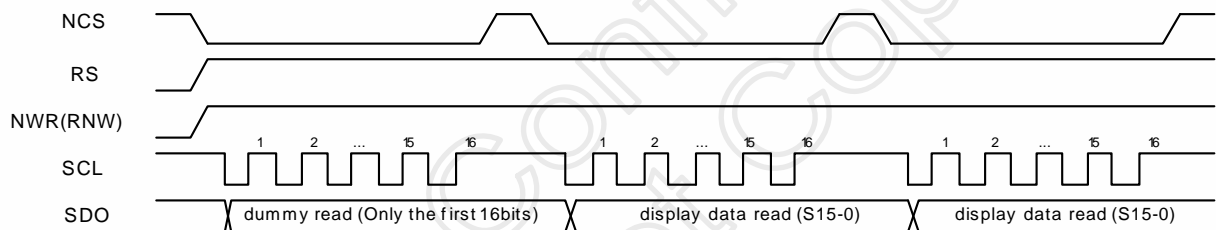
### 2.1.2 Serial Bus System Interface

The HX8312-A supports the 18/16-bit serial bus system interface. The serial bus interface mode is enabled through the chip select input (NCS), and accessed via a three-wire control pin consisting of the serial input data (SDI), serial output data (SDO), and the serial transfer clock (SCL). The selection of read / write operation is made by NWR(RNW) pin, and the RS pin specifies whether the access is to the register command or to the display data RAM. Please remember to complete one data transfer operation by the 16-clock SCLK input when the 16-bit serial interface is in use, and by the 18-clock SCLK input when 18-bit serial interface is in use.

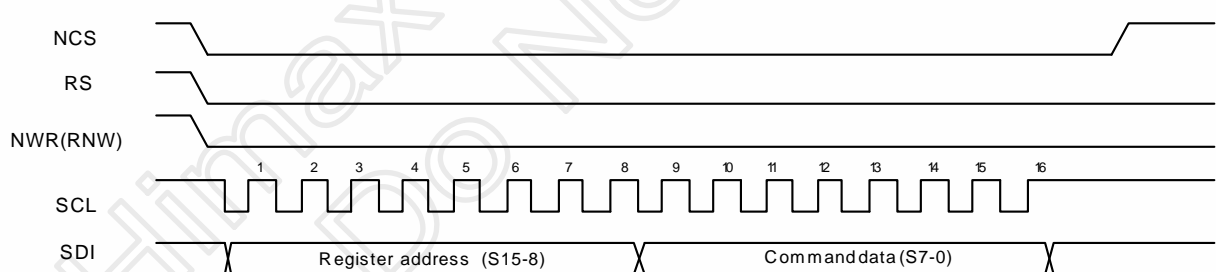
#### Write to the display data RAM



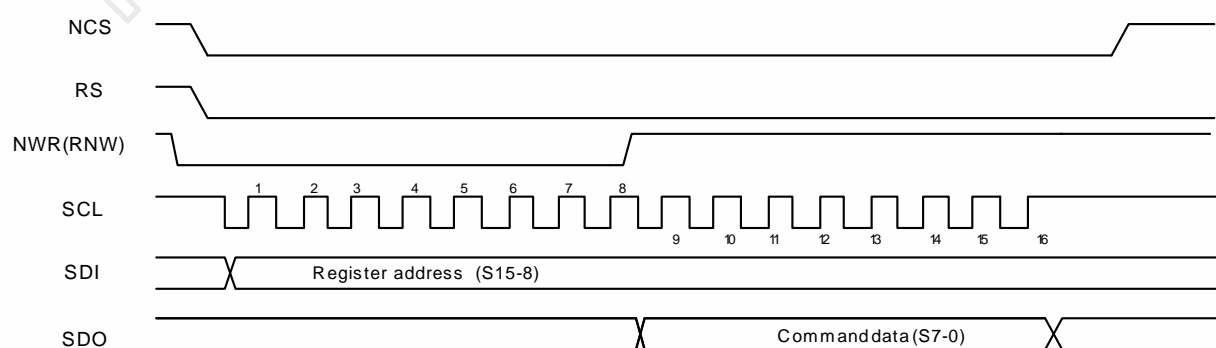
#### Read the display data RAM



#### Write to the register



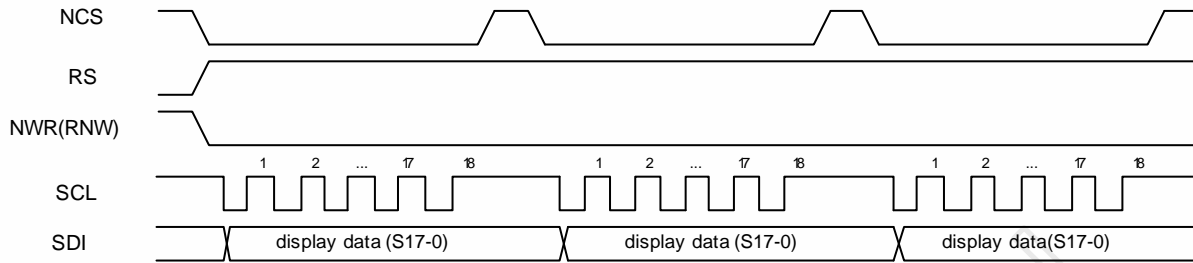
#### Read the register



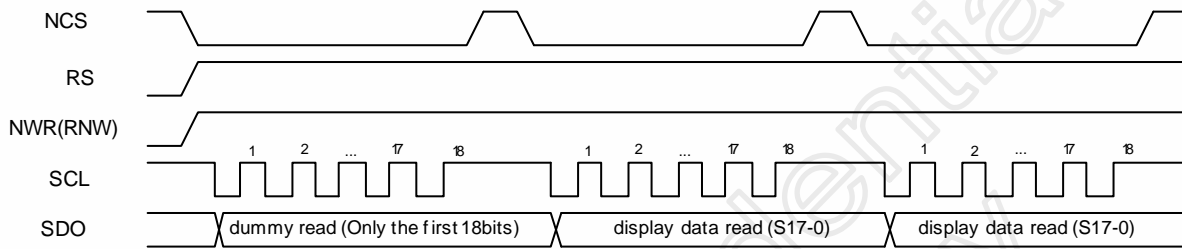
After sending a command and display data in an 16-bit unit, set nCS as "H", and then send the next command and display data.

Figure 2. 5 16-bit Serial Bus Interface Timing (SCLEG1=SCLEG2=0)

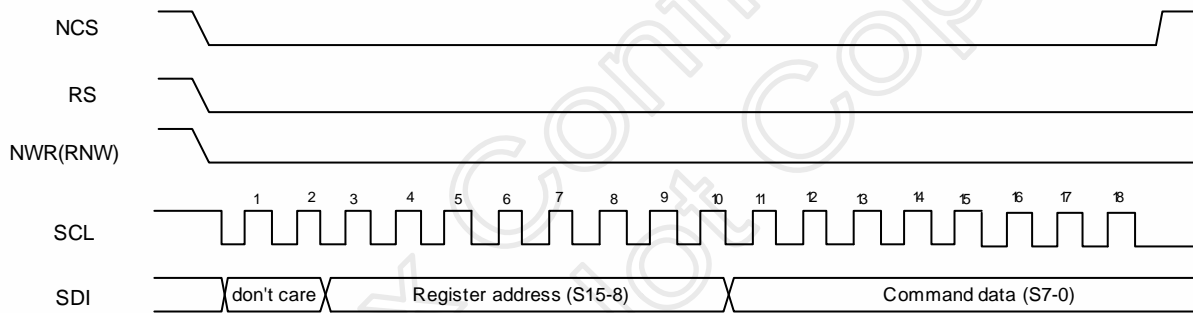
**Write to the display data RAM**



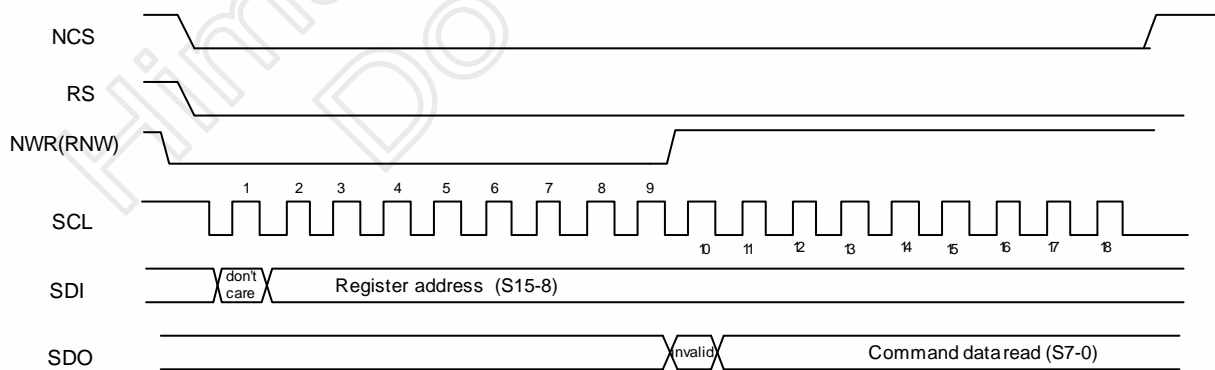
**Read the display data RAM**



**Write to the registers**



**Read the registers**



After sending a command and display data in an 18-bit unit, set nCS as "H", and then send the next command and display data.

**Figure 2. 6 18-bit Serial Bus Interface Timing (SCLEG1=SCLEG2=0)**

When the serial bus interface is in use, the external pins SCLEG1-0 setting determine the effective edge operation of SCLK for SDI data latch and SDO data output. Please refer to Table 2.6 and Figure 2.7.

SCLEG1	SCLEG0	Active level of SCLK	Latch Timing of SDI	Output Timing of SDO
0	0	Low Level	Rising edge of SCLK	Falling edge of SCLK
0	1	Low Level	Falling edge of SCLK	Rising edge of SCLK
1	0	High Level	Falling edge of SCLK	Rising edge of SCLK
1	1	High Level	Rising edge of SCLK	Falling edge of SCLK

Table 2. 6 Relation between SCLEG1-0 setting and effective edge operation of SCLK

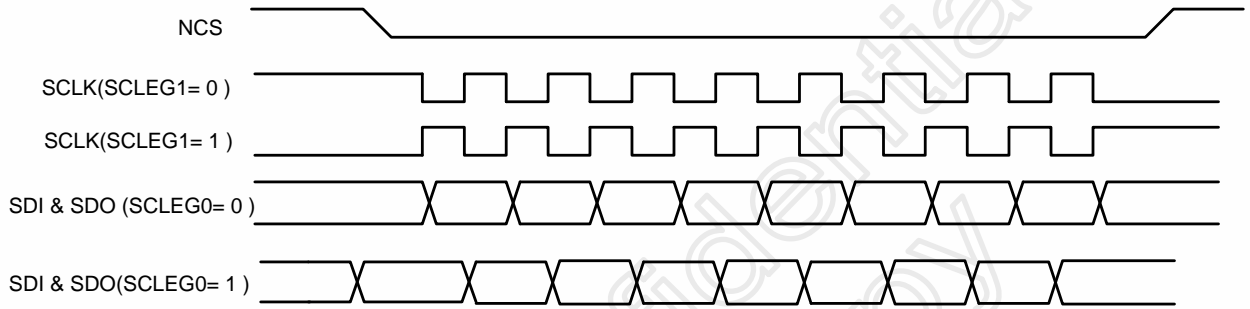


Figure 2. 7 The effective edge of SCLK with SCLEG1-0 setting

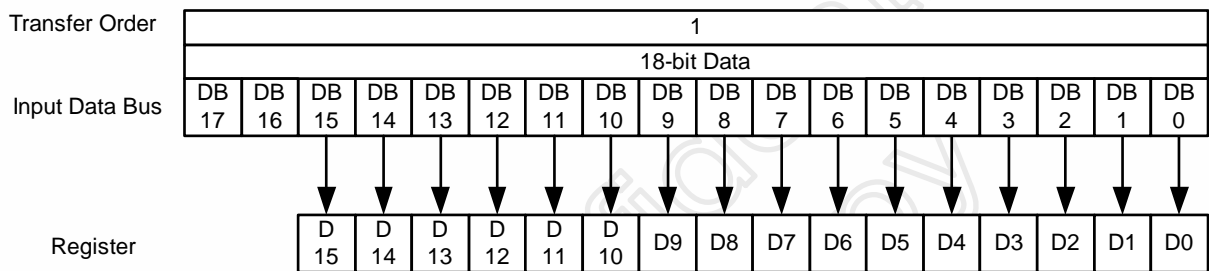
### 2.1.3 Relation between Register Command Data Format and Input Bus

The RS pin specifies whether the access is to the register command or to the display data RAM. The input data for register command is consist of 16 bits. The upper 8 bits ( D15-8) are address and the lower 8 bits (D7-0) are data.

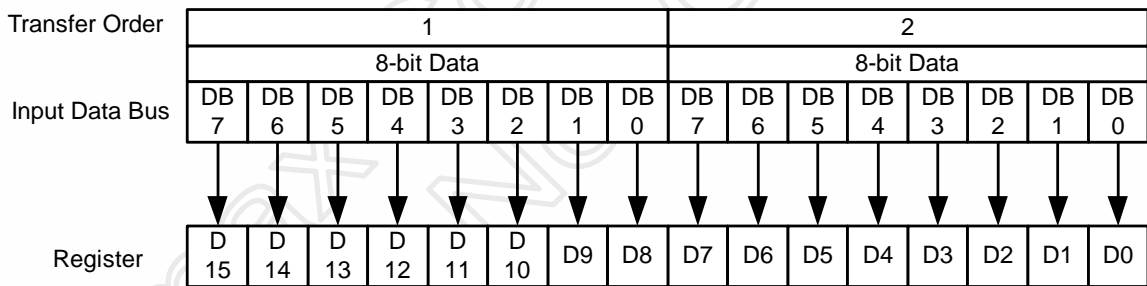
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Register Address								Command							

The following shows the relation between register command allocation and input data bus in different MPU type input data format.

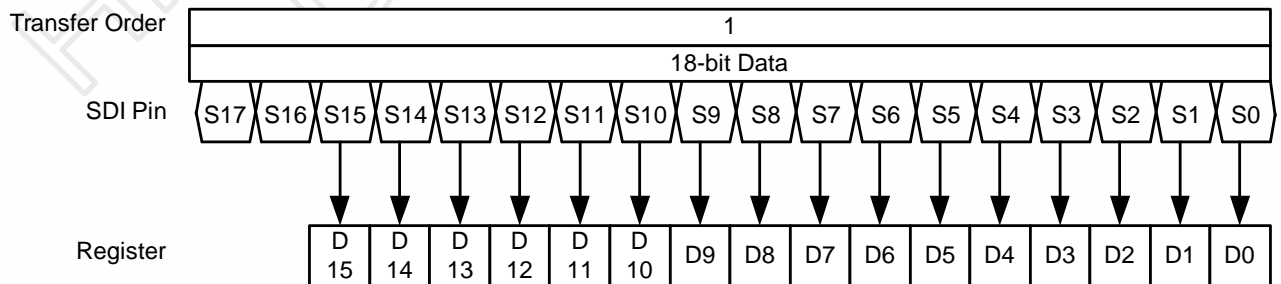
#### (1) MPU1, MPU2, MPU3, MPU4 Type



#### (2) MPU5, MPU6, MPU7 Type

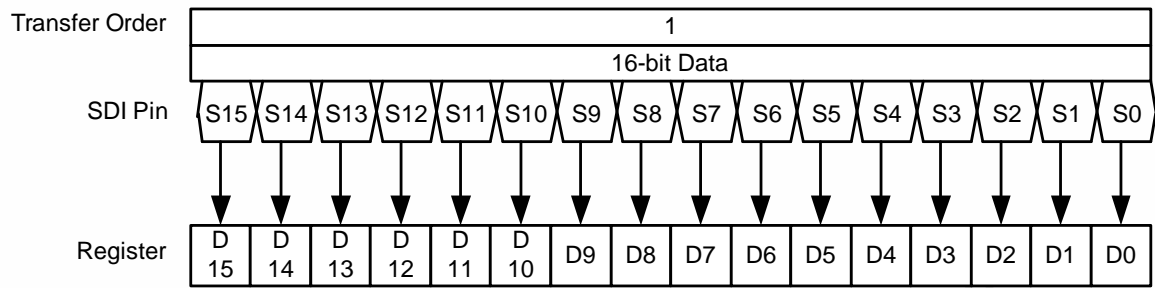


#### (3) MPU8 Type





(4) MPU9 Type



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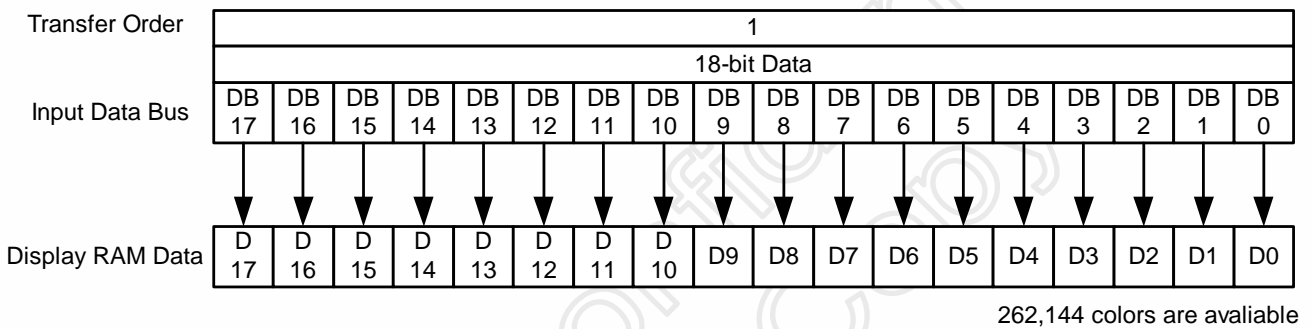
**2.1.4 Relation between Display RAM Data Format and Input Bus in System Interface**

The display RAM data is consist of 18 bits which include R-, G-, B-dot display level information. The (D17-12) bits are R-dot display level (D17 is MSB); (D11-6) bits are G-dot display level (D11 is MSB) ; (D5-0) bits are B-dot display level (D5 is MSB).

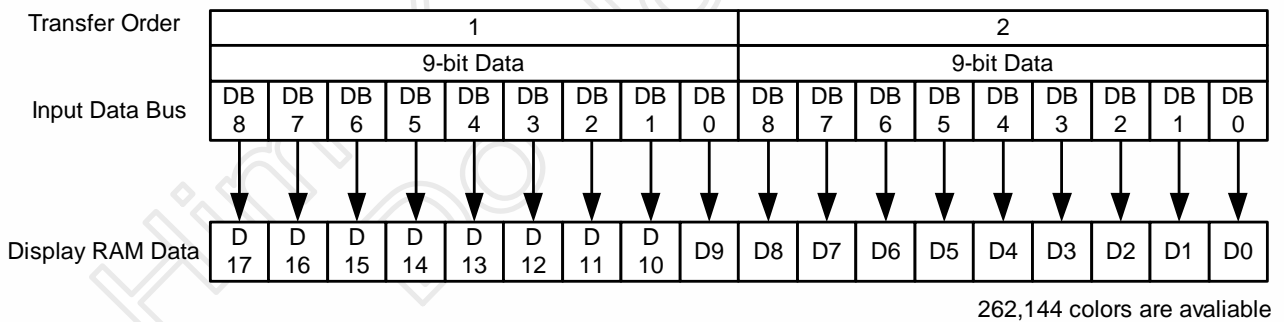
D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0

The following shows the relation between display RAM data allocation and input data bus in different MPU type input data format.

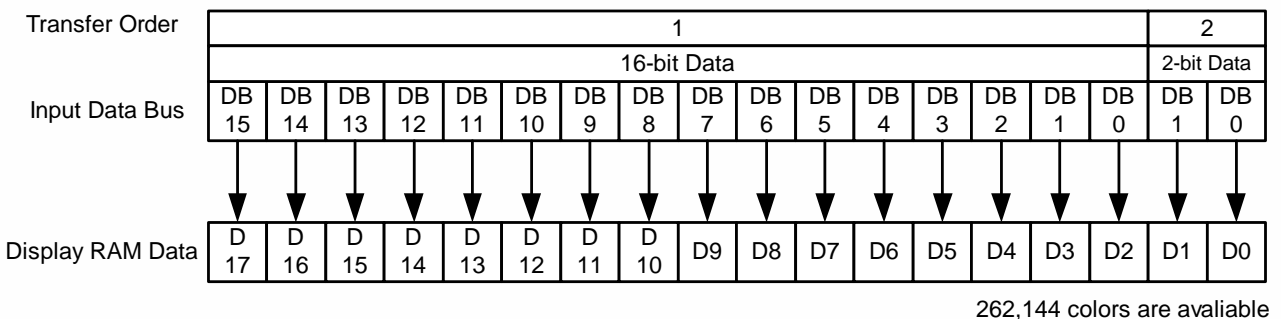
**(1) MPU1 Type**



**(2) MPU2 Type (9-bit + 2)**

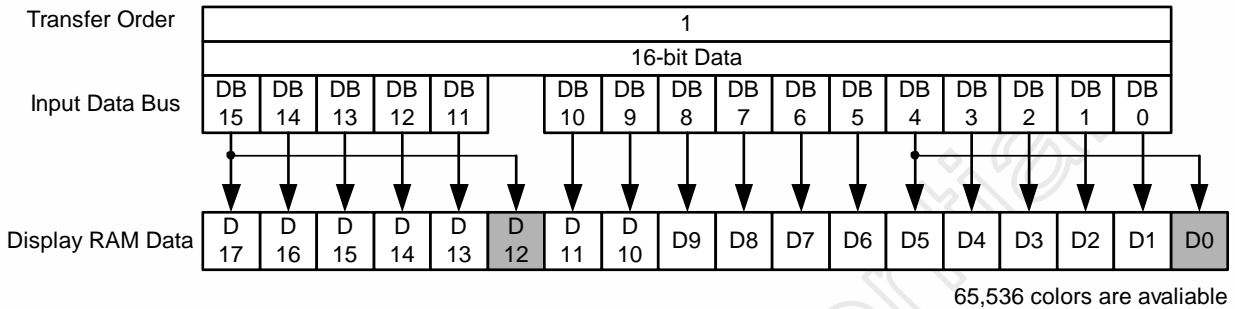


**(3) MPU3 Type (16-bit + 2-bit)**

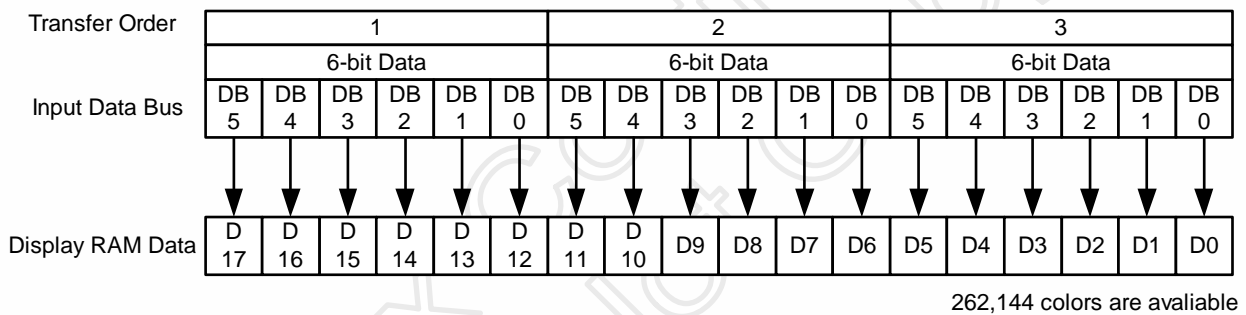


**(4) MPU4 Type (16-bit × 1)**

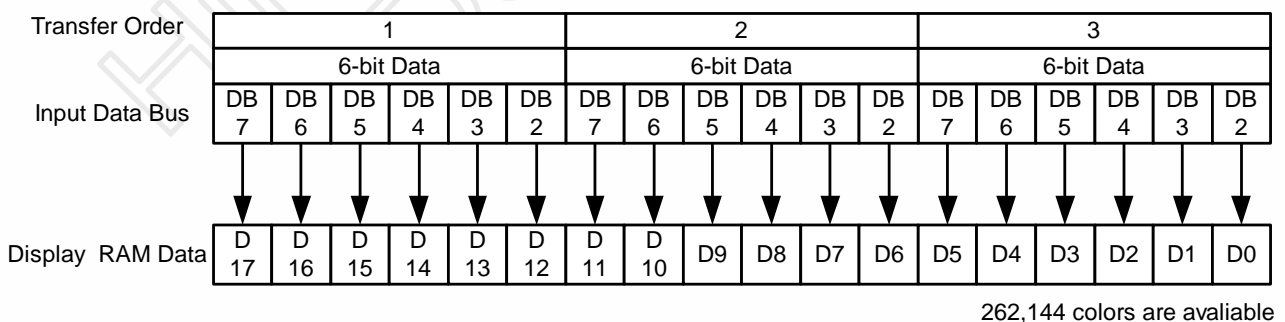
In the MPU4 type, The 16-bit data written to display RAM is expanded to 18-bit bus data automatically in the LSI. D12 of the display data RAM is compensated by the data from DB15 and D0 of the display data RAM is compensated by the data from DB4 in the transfer.



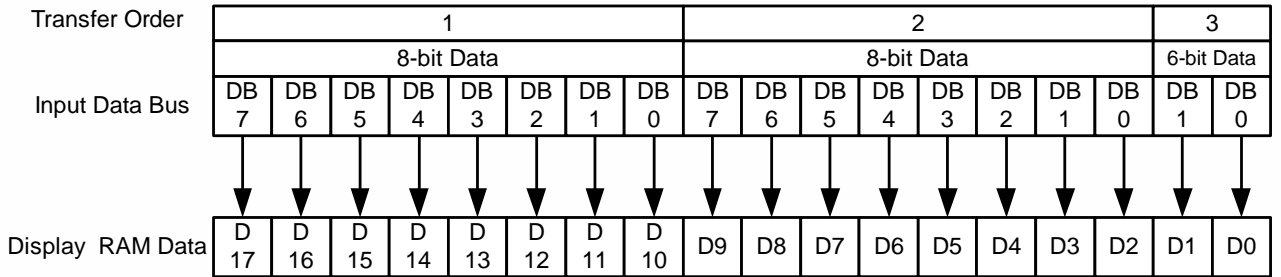
**(5-1) MPU5 Type A (6-bit × 3) with (MSBF=0 ; D0 bit of R157)**



**(5-2) MPU5 Type B (6-bit × 3) with (MSBF=1; D0 bit of R157)**



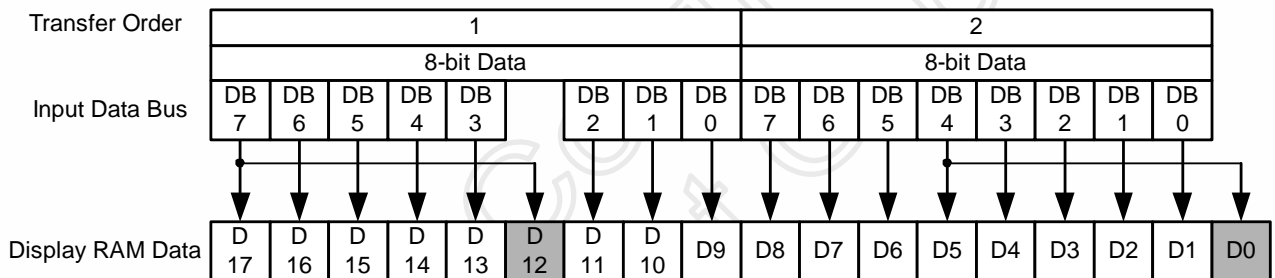
### (6) MPU6 Type (8-bit + 8-bit + 2-bit)



262,144 colors are available

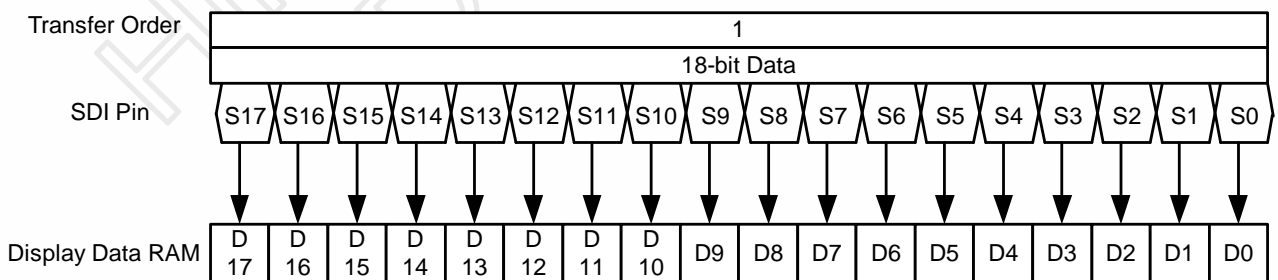
### (7) MPU7 Type (8-bit + 2)

In the MPU7 type, The 16-bit data written to display RAM is expanded to 18-bit bus data automatically in the LSI. D12 of the display data RAM is compensated by the data from DB7 in the first transfer and D0 of the display data RAM is compensated by the data from DB4 in the second transfer.



65,536 colors are available

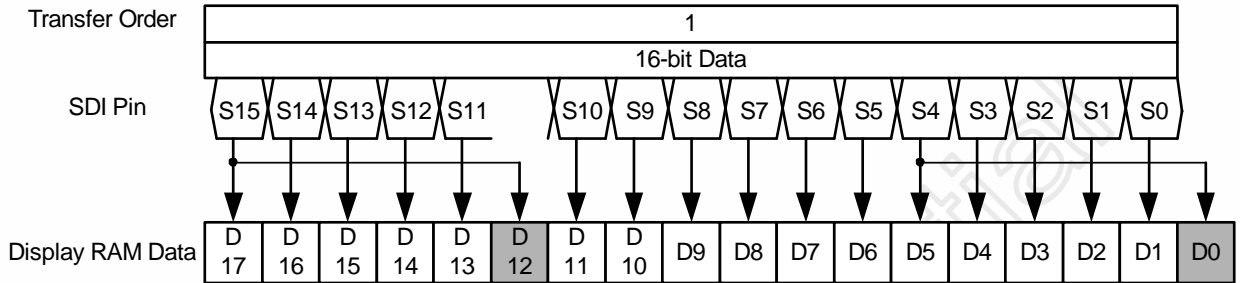
### (8) MPU8 Type (18-bit serial)



262,144 colors are available

**(9) MPU9 Type (16-bit serial)**

In the MPU9 type, The 16-bit data written to display RAM is expanded to 18-bit bus data automatically in the LSI. D12 of the display data RAM is compensated by the data from S15 and D0 of the display data RAM is compensated by the data from S4 in the transfer.



65,536 colors are available

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### 2.1.5 Synchronous Transfer Function in System Interface

The HX8312-A supports the synchronous transfer function which resets the internal counter to count data transfer time in the system interface. When using some-type interface which needs two or three-time data writing for one complete display data or register command, noise causing transfer mismatch between the adjacent bits can be corrected by a reset triggered by consecutively writing a FFh instruction four times with RS=0 , NCS=0. The next transfer starts from the first transfer data bits. Executing synchronization function periodically can recover any runaway in the display system.

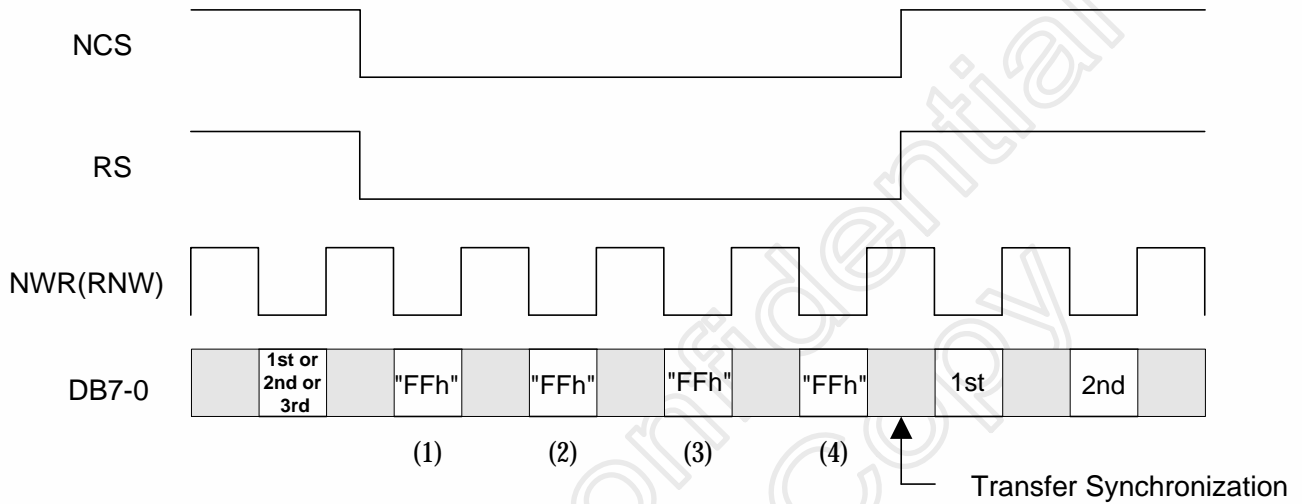


Figure 2. 8 The synchronous transfer function in I80 system interface

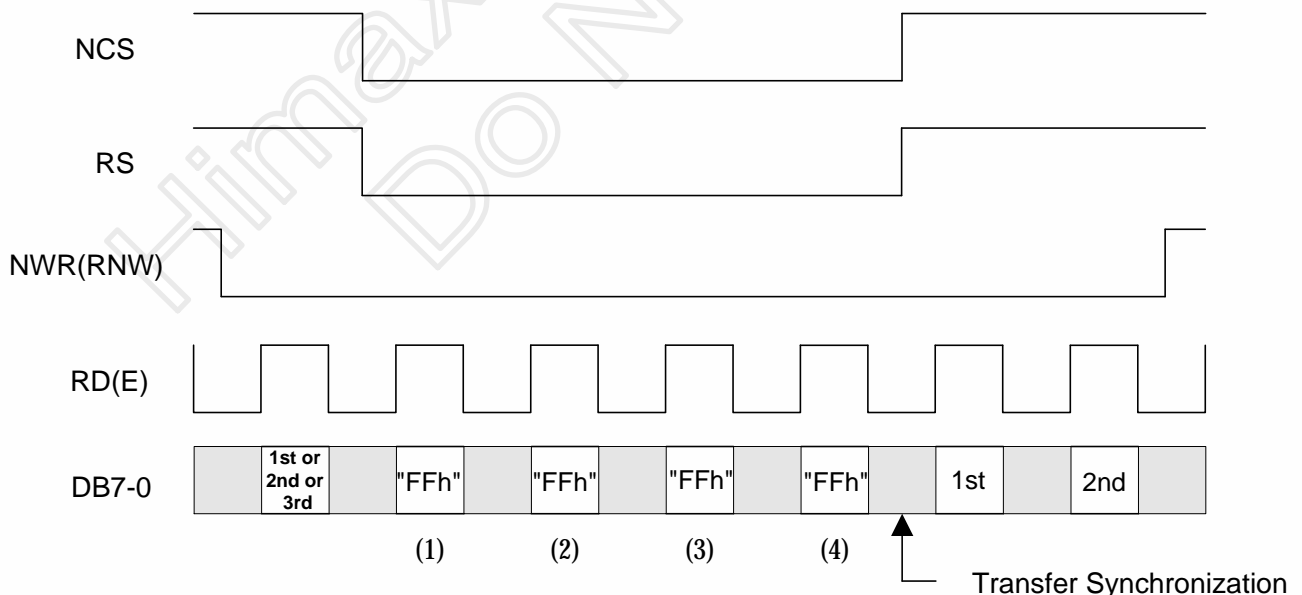


Figure 2. 9 The synchronous transfer function in M68 system interface

## 2.2 RGB Interface Circuit

The HX8312-A has the RGB interface circuit for animated display data written. RGB25-20, RGB15-10, RGB05-00 input pins are used for RGB interface circuit via data pins (DB17-0). When using the RGB interface circuit to update display RAM, please make sure to set NWRGB (D0 bit of R2) as "1". Please make sure that register of LSI can not be accessed via RGB interface circuit.

When the data pins (DB17-0) are used for the RGB interface circuit, the bit allocation is as below.

Data Pins	RGB Pins
DB17-12	RGB25-20
DB11-6	RGB15-10
DB5-0	RGB05-00

Table 2. 7 Bit allocation when DB17-0 used for RGB interface circuit

The input bus format of RGB interface circuit is selected by external pin BWS2 and MSBF ( D0 bit of R157 ) setting. For selecting the input bus format, please refer to Table 2. 8.

Interface Type	External Pin	Register	Interface Mode	Number of data per pixel	Transferring method of one pixel data
	BWS2	MSBF (D0 : R157)			
RGB1	0	0	18-bit	18 bits	18-bit collective
RGB2	1	0	16-bit	16 bits	16-bit collective
RGB3	0 or 1	1	6-bit	18 bits	6-bit x 3

Table 2. 8 RGB Interface Mode Selection

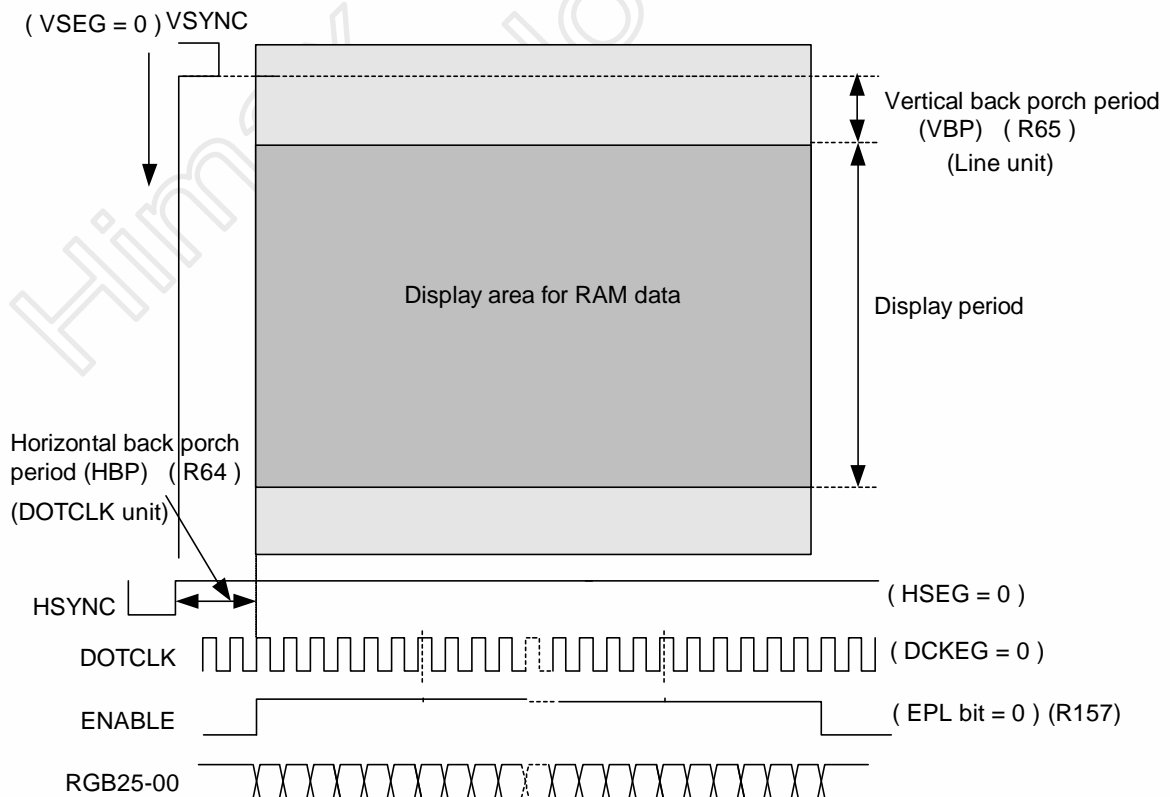


Figure 2. 10 RGB Interface Circuit Input Timing

Figure 2.11 shows the input timings of the RGB3 type input format.

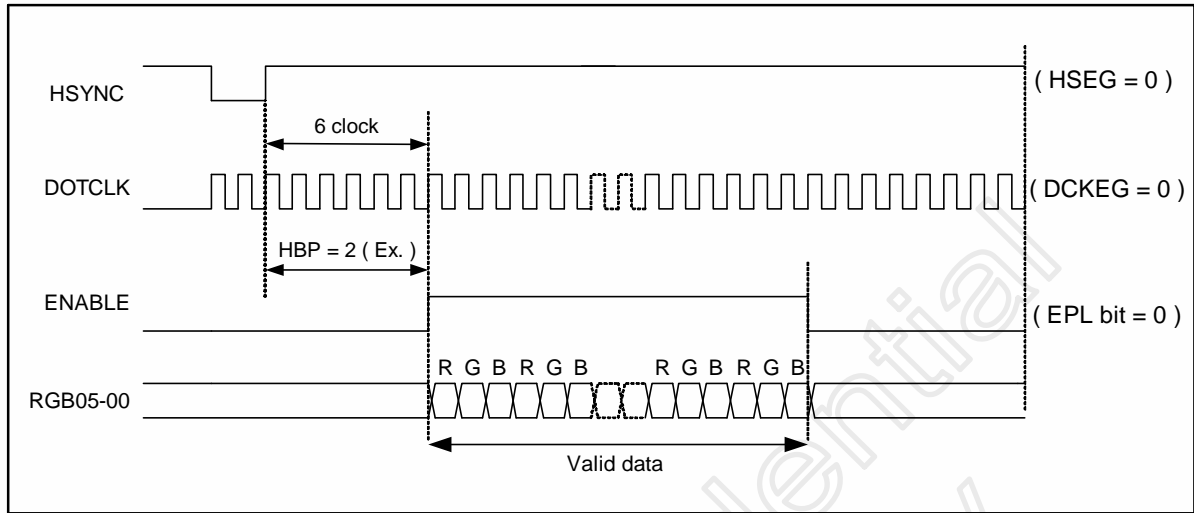


Figure 2. 11 RGB3 Type (6-bit Interface Mode) Input Timing

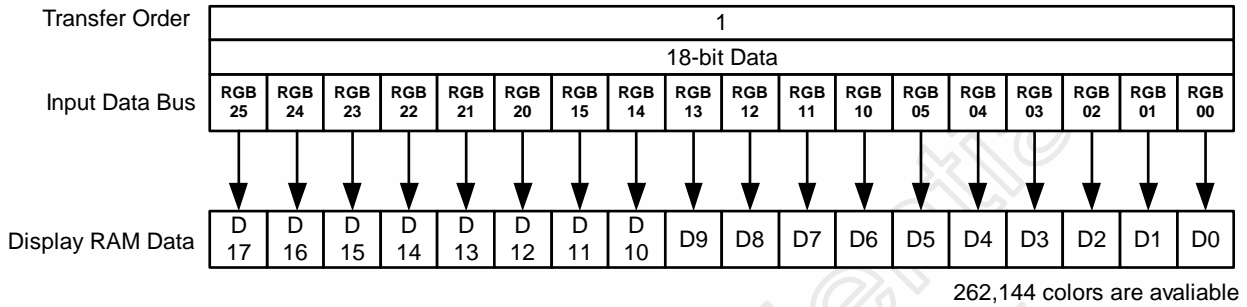
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### 2.2.1 Relation between Display RAM Data Format and Input Bus

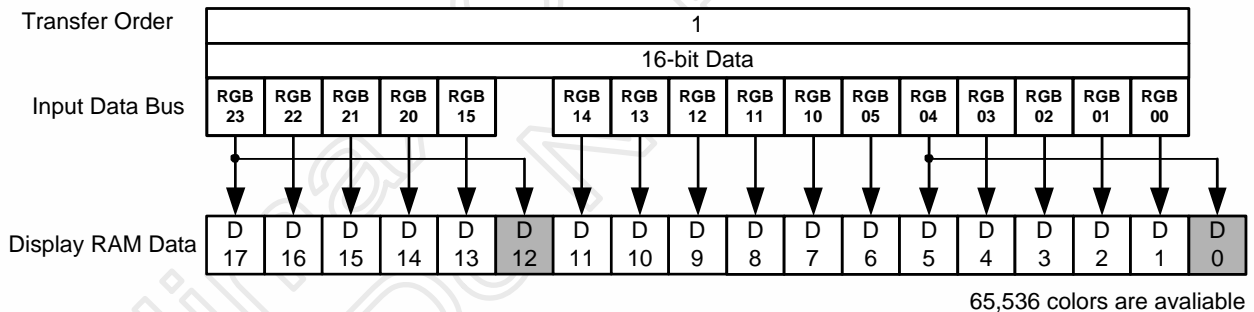
The following shows the relation between display RAM data allocation and input data bus in different RGB type input data format.

#### (1)RGB1 Type

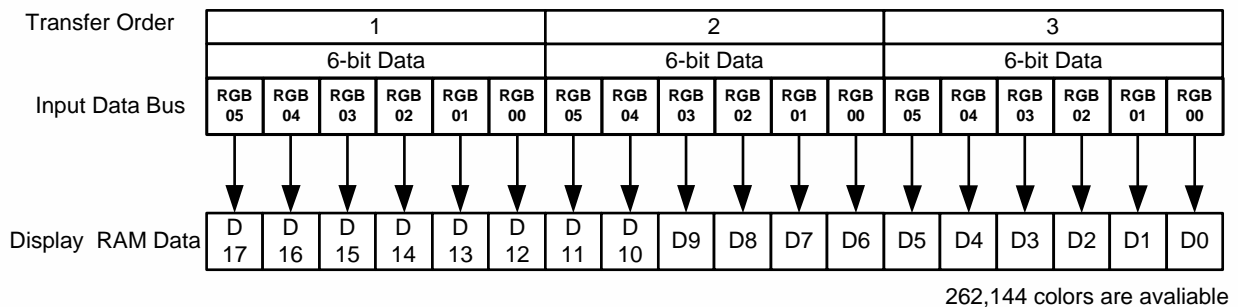


#### (2)RGB2 Type

In the RGB2 type, The 16-bit data written to display RAM is expanded to 18-bit bus data automatically in the LSI. D12 of the display data RAM is compensated by the data from RGB23 and RGB04 of the display data RAM is compensated by the data from DB4 in the transfer.



#### (3)RGB3 Type



### 3. Input and Synchronized Display Modes

The HX8312-A has three writing mode for display data input. Three writing modes are as follow :

- (1)**Through Mode:** In through mode, input display data via RGB interface circuit is not written to display RAM and is displayed directly.
- (2)**Capture Mode:** In capture mode, display data is written to display RAM via RGB interface circuit and displayed.
- (3)**Override Mode:** In override mode, RGB pins are not available, and input display data via system interface circuit is written to display RAM and display.

Also, the HX8312-A has three synchronized display modes as listed below :

- (1)**Internally Synchronized Display Mode:**  
Display operation is synchronized with SYSCLK generated by internal oscillator.
- (2)**Externally Synchronized Display Mode:**  
Display operation is synchronized with external VSYNC, HSYNC, DOTCLK signal input.
- (3)**VSYNC Interface Display Mode:**  
Display operation is synchronized with SYSCLK and external VSYNC signal input.

Table 3. 1 shows the combinations of these modes. One out of these six modes is available by setting D4, D2, D1, D0 bits of the RGB interface register (R2). See the sections (3.1 - 3.3) for more details. When a mode is changed to another mode, HX8312-A can display correct pictures after finishing displaying the present frame.

Register R2				RGB Mode	Used Interface Circuit	Signal used to display RAM write	Display Operation	
D4	D2	D1	D0				Mode Name	Signal used to display
VMODE	RGBS	DISPCLK	NWRGB					
0	1	1	1	Through Mode	RGB Interface Circuit	No write operation	Externally Synchronized Display mode	VSYNC, HSYNC, DOTCLK
0	0	1	1	Capture Mode	RGB Interface Circuit	VSYNC, HSYNC, DOTCLK	Externally Synchronized Display mode	VSYNC, HSYNC, DOTCLK
0	X	0	1	Capture Mode	RGB Interface Circuit	VSYNC, HSYNC, DOTCLK	Internally Synchronized Display mode	SYSCLK (*1)
0	X	0	0	Override Mode	System Interface Circuit	NCS, NRD(E), NWR(RNW) (*3)	Internally Synchronized Display mode	SYSCLK (*1)
0	X	1	0	Override Mode	System Interface Circuit	NCS, NRD(E), NWR(RNW) (*2)	Externally Synchronized Display mode	VSYNC, HSYNC, DOTCLK
1	0	0	0	-	System Interface Circuit	NCS, NRD(E), NWR(RNW) (*2)	VSYNC interface mode	VSYNC, SYSCLK

**Table 3. 1 Display Mode Set up**

- Note:**1: SYSCLK: system clock signal generated by internal oscillator.  
 2: Serial bus interface pins are also available.  
 3: X ="1" or "0" (optional)

### 3.1 The Operation of Each Mode

#### 3.1.1 Externally synchronized display mode + through mode

As Table 3.1 shows, the HX8312-A enters "externally synchronized mode + through mode" by setting D4, D2, D1 and D0 bits of the RGB interface register (R2) as "0111". In this mode, display data is displayed in synchronization with VSYNC, HSYNC and DOTCLK, and the display data of display area defined by RGB start register 1 (R60), RGB start register 2 (R61), RGB end register 1 (R62) and RGB end register 2 (R63), is inputted via RGB interface circuit without being written to the display RAM and display directly. The display data in the display RAM outside the display area defined by R60-R63 is not updated in this mode so the same display data is displayed. NWRGB(D0 bit of R2) must be set to "0" when it is necessary to update display RAM data outside the display area defined by R60-R63, and then display data must be inputted via system interface pins.

In this mode, the vertical back porch register VBP4-0 (D4-0 of R65) needs to be set the value the same as vertical back porch of input signal. The horizontal back porch register HBP4-0 (D4-0 of R64) needs to be set the value the same as (horizontal back porch-2) of input signal. See Figure 3. 1.

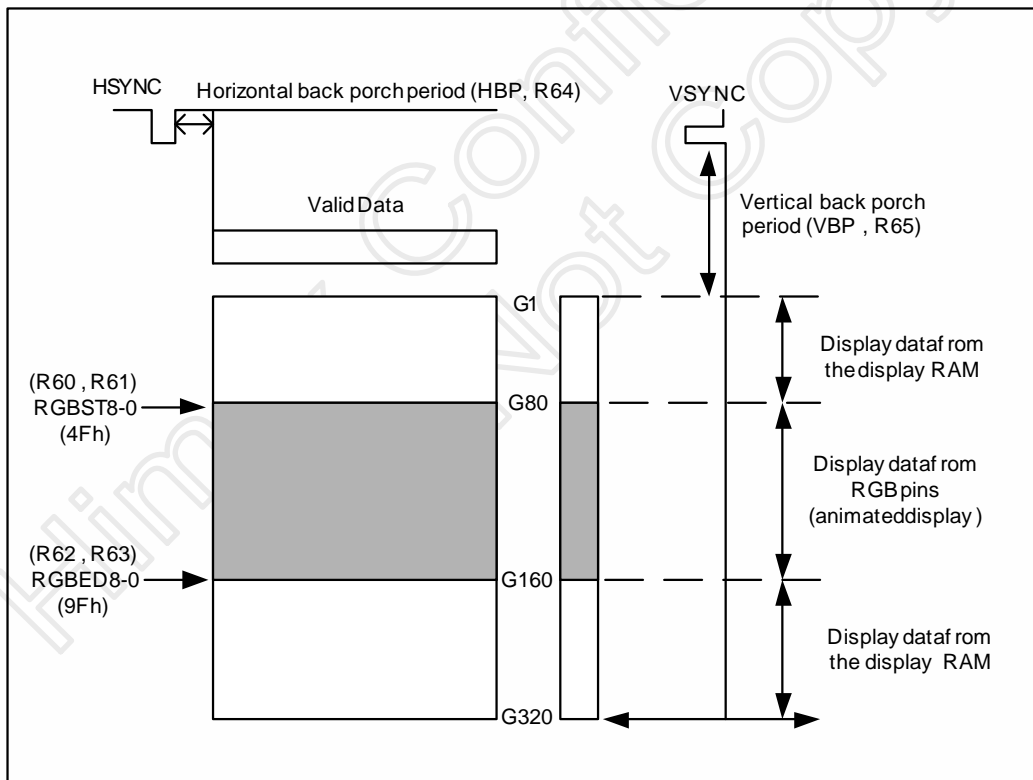
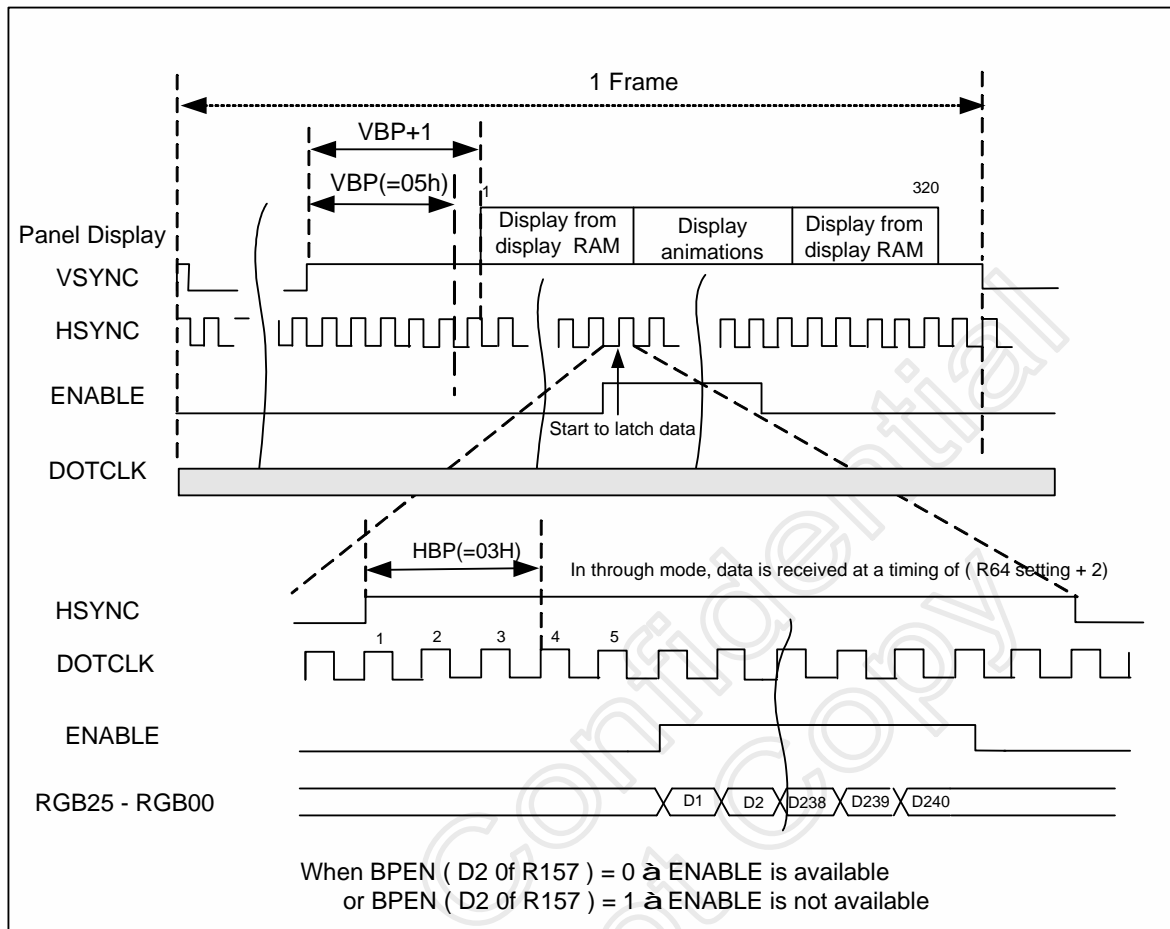


Figure 3. 1 Display example in the externally synchronized display mode + through mode



**Figure 3. 2 Display and Input Timing of the externally synchronized display mode + through Mode (VSEG = "0", HSEG = "0", DCKEG = "0", EPL = "0")**

### 3.1.2 Externally synchronized display mode + capture mode

As Table 3.1 shows, by setting D4, D2, D1 and D0 bits of the RGB interface register (R2) as "0011", the HX8312-A enters "externally synchronized mode + capture mode". In this mode, display data is written to the display RAM via RGB interface first and then displayed in synchronization with VSYNC, HSYNC and DOTCLK by reading the display data from the display RAM in the same frame. As in Figure 3.3, the captured area can be determined by the window area access mode. (See the "4.3 Window Address Area Access" section.) or full screen display. The display data in the display RAM outside the display area defined by window access register is not updated in this mode so the same display data is displayed. When it is necessary to update display RAM data outside the window access area, it needs to change window access area register.

In this mode, the vertical back porch register VBP4-0 (D4-0 of R65) needs to be set the value the same as vertical back porch of input signal. The horizontal back porch register HBP4-0 (D4-0 of R64) needs to be set the value the same as horizontal back porch of input signal. See Figure 3. 3.

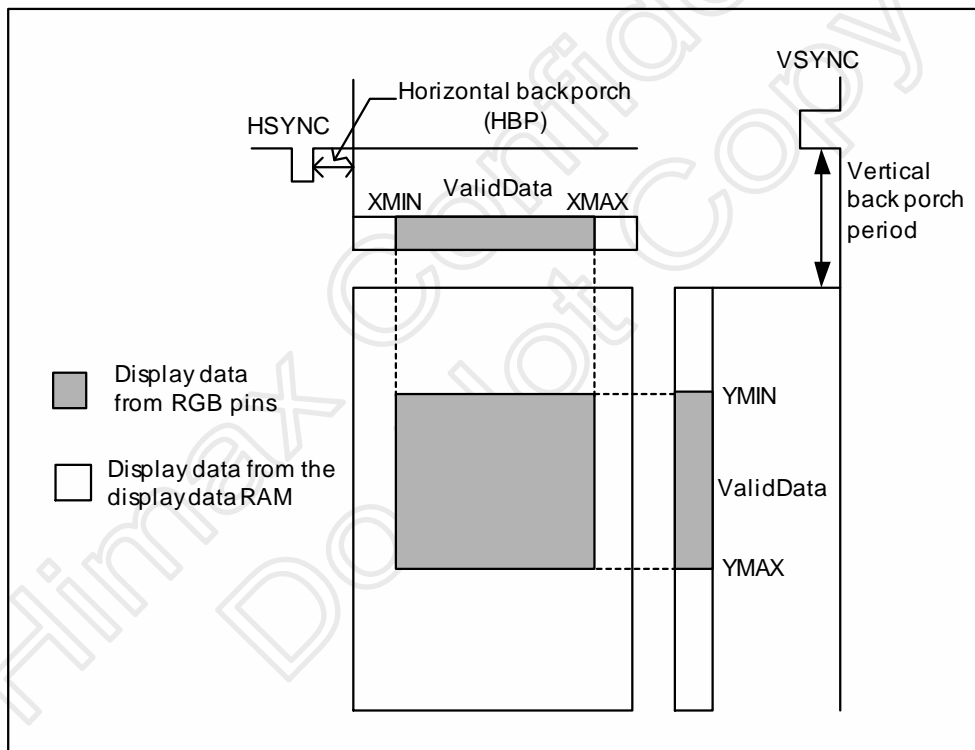


Figure 3. 3 Display example in the externally synchronized display mode + capture mode

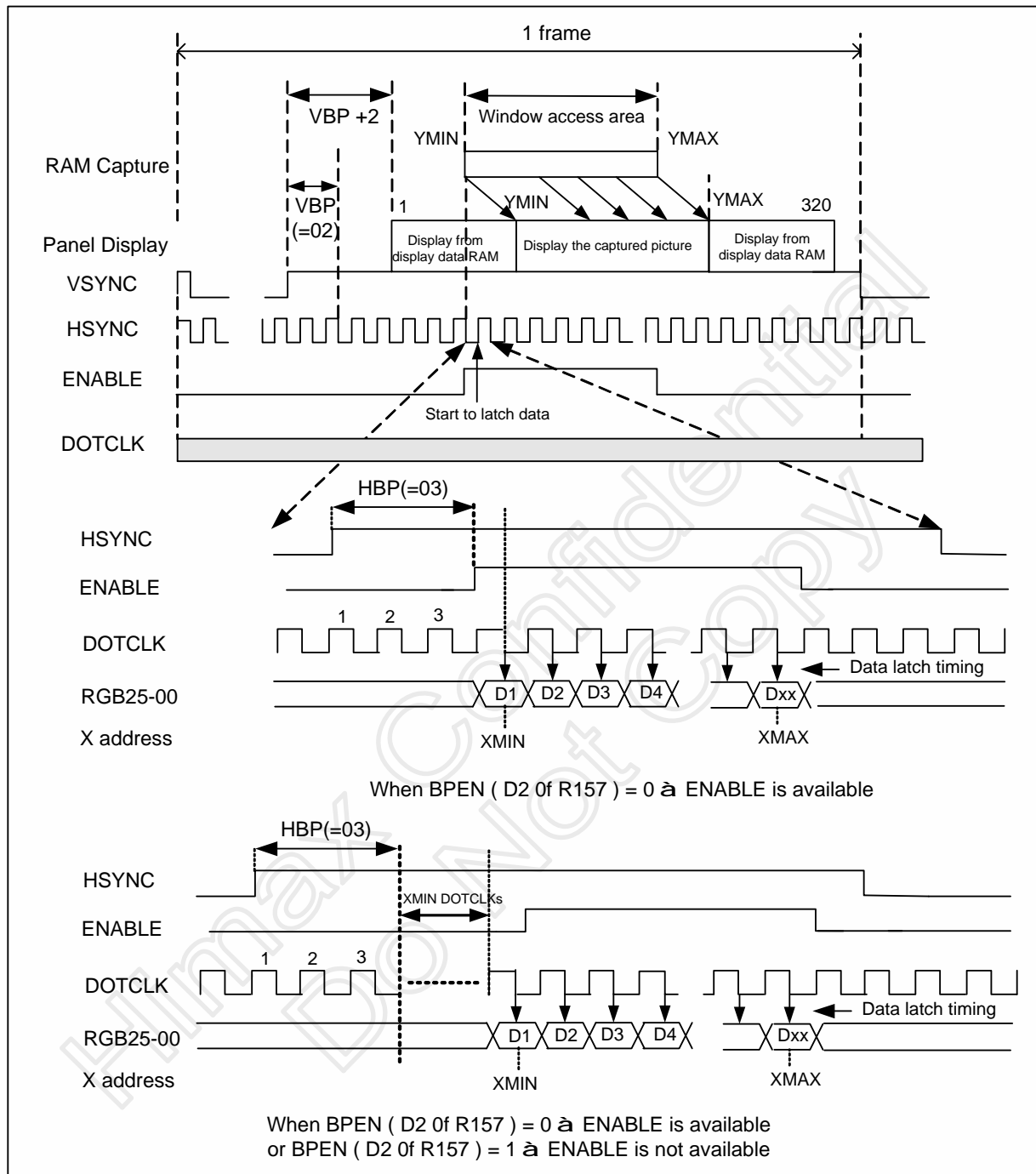


Figure 3. 4 Display and Input Timing of the externally synchronized display mode + capture mode (VSEG = "0", HSEG = "0", DCKEG = "0", EPL = "0")

### 3.1.3 Internally synchronized display mode + capture mode

As Table 3.1 shows, by setting D4, D2, D1 and D0 bits of the RGB interface register (R2) as "0001", the HX8312-A enters "internally synchronized mode + capture mode". In this mode, display data is written to the display data RAM via RGB interface circuit first and then displayed in synchronization with SYSCLK (system clock signal generated by internal oscillator ) by reading the display data from the display RAM to the panel. As in Figure 3.3, the captured area is determined by the window access mode. (See the "4.3 Window Address Area Access Mode") The display data in the display RAM outside the display area defined by window access register is not updated in this mode so the same display data is displayed. When it is necessary to update display RAM data outside the window access area, it needs to change window access area register.

In this mode, 1-frame and 1-line period of display timing must be defined by internal SYSCLK instead of VSYNC and HSYNC. In this mode, the vertical back porch register VBP4-0 (D4-0 of R65) needs to be set the value the same as vertical back porch of input signal. The horizontal back porch register HBP4-0 (D4-0 of R64) needs to be set the value the same as horizontal back porch of input signal.

### 3.1.4 Internally synchronized display mode + override mode

As Table 3.1 shows, by setting D4, D2, D1 and D0 bits of the RGB interface register (R2) as "0000", the HX8312-A enters "internally synchronized mode + override mode". In this mode, display data is written to the display data RAM via system interface circuit first and then displayed in synchronization with SYSCLK by reading the display data from the display RAM to panel.

In this mode, 1-frame and 1-line period of display timing must be defined by internal SYSCLK instead of VSYNC and HSYNC.

### 3.1.5 Externally synchronized display mode + override mode

As Table 3.1 shows, by setting D4, D2, D1 and D0 bits of the RGB interface register (R2) as "0010", the HX8312-A enters "Externally synchronized mode + override mode". In this mode, display data is written to the display data RAM via system interface circuit first and then displayed in synchronization with VSYNC, HSYNC, DOTCLK

In this mode, the display blanking period is determined by the settings of the horizontal back porch register (R64) and the vertical back porch register (R65).

When the HX8312-A make the transition with system interface mode and RGB interface mode, the sequence of switching process must be follow as Figure3.5.

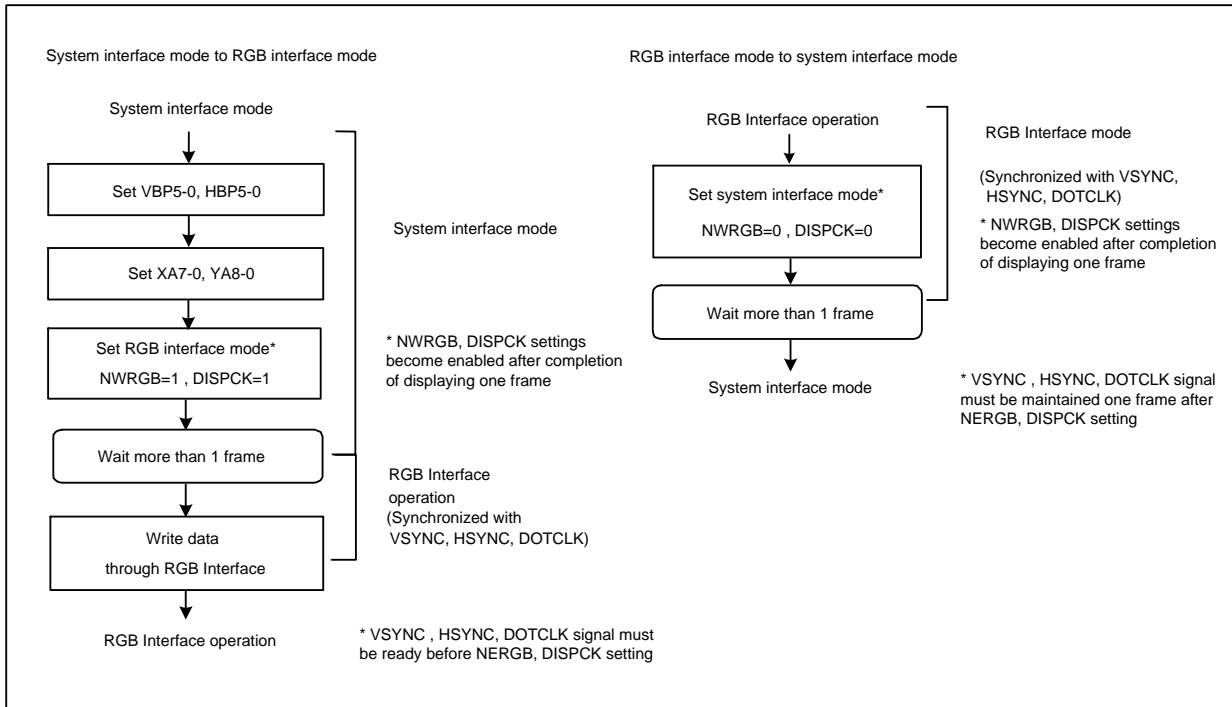


Figure 3. 5 RGB Interface Mode and Internally Synchronized Mode Transition



### 3.2 VSYNC Interface Mode

The HX8312-A supports the VSYNC interface mode, which can display animated displays with the system interface circuit and the frame synchronization signal VSYNC.

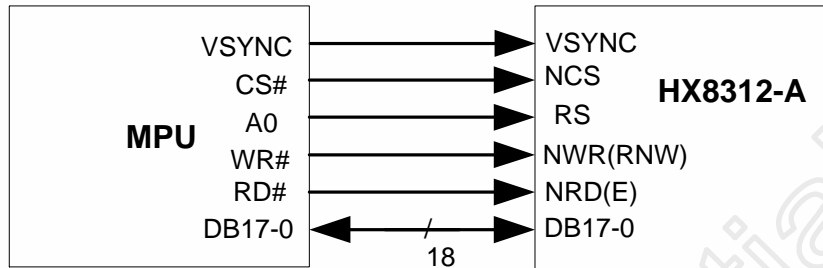


Figure 3. 6 VSYNC Interface to MPU

By setting D4 = "1" (VMODE) and D3-D0="0000" of the RGB interface register (R2), the VSYNC interface becomes available. In the VSYNC interface mode, the internal display operation is synchronized with SYSCLK, however, the frame starting of display operation is determined by VSYNC. (Therefore, VSYNC signal needs always exist.)

In the VSYNC interface mode, writing of display data to the display RAM must be performed before outputting that pixel data in the same allocation of RAM for smooth animation display. Therefore, the VSYNC interface has some constraints in the internal clock and the RAM write speed via the system interface circuit. It requires display RAM write speed more than the minimum value that system processed and displayed. The system clock (SYSCLK) in VSYNC interfaces mode can be computed by the following formula that used some parameters with VFP, VBP and display lines duration (320 line):

$$SYSCLK \text{ frequency}(fs) = \text{Frame Frequency} \times [\text{Display Lines}(321) + VBP + VFP] \times HCK \times \text{frequency fluctuation}$$

VBP ( Vertical Back porch ) : set by R65

VFP ( Vertical Front porch ) : defined automatically (Min. 1 line is necessary)

HCK : The clock number of SYSCLK specifies the horizontal line period (1H), which is set by R139

The parameter of frequency fluctuation is ascribed to the external resistor or voltage variation, fabrication process condition, external temperature and humidity condition etc.

Then the minimum speed for display RAM write can be computed by the following formula:

$$The\ Min.\ RAM\ Write\ Speed\ [Hz] \geq \frac{240(pixel) \times DisplayLines(321) \times fs}{[VBP + DisplyLines(NL) - margin\ lines] \times HCK}$$

The margin line means when operate in VSYNC interface mode, it must be remained the several lines in advance for protection between the actual line of the display operation and the line address for the RAM write data operation.

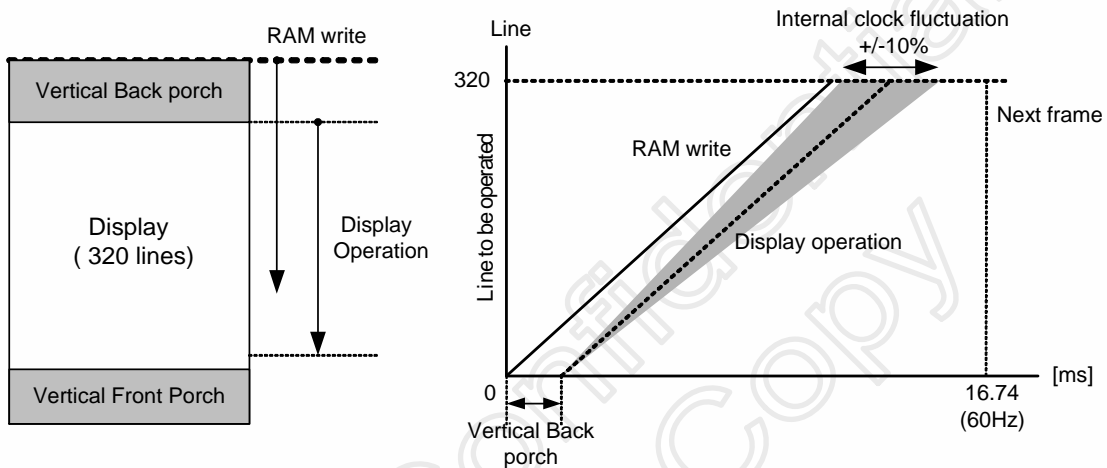


Figure 3. 7 VSYNC Interface Mode Operation

The mode transition flow between internally synchronized display mode and VSYNC interface mode is as Figure 3. 8.

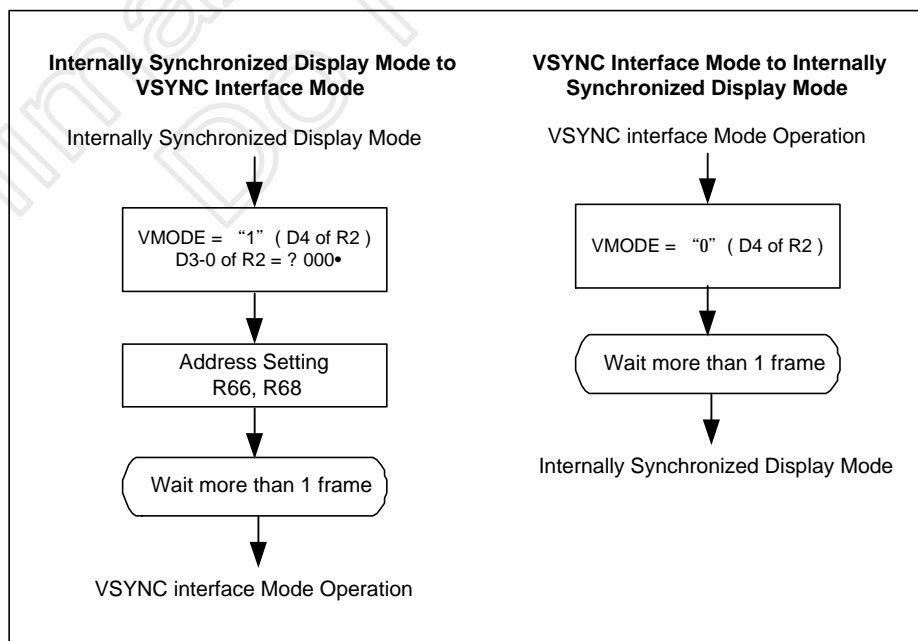


Figure 3. 8 VSYNC Interface Mode and Internally Synchronized Mode Transition

### 3.3 Internal Clock Mode

The clock number of SYSCLK which is stored in the line clock register (R139) is used to specify the one horizontal line period (1H) in the internally synchronized display mode. The one horizontal line period (1H) can be adjusted by two ways. One is by calibration and another is by setting the clock number of one horizontal line period (1H) in a register. The horizontal cycle adjustment mode is defined by CLKM (D0 bit of the line cycle adjustment mode register, R141). Clock numbers will be stored into line clock register (R139) in both cases. In case of calibration, the value will be stored automatically. In case of register set up, the value will be set from MPU.

D0=CLKM	Setting Method
0	Calibration Mode
1	Register Setup Mode

Table 3. 2 Line Frequency Adjustment

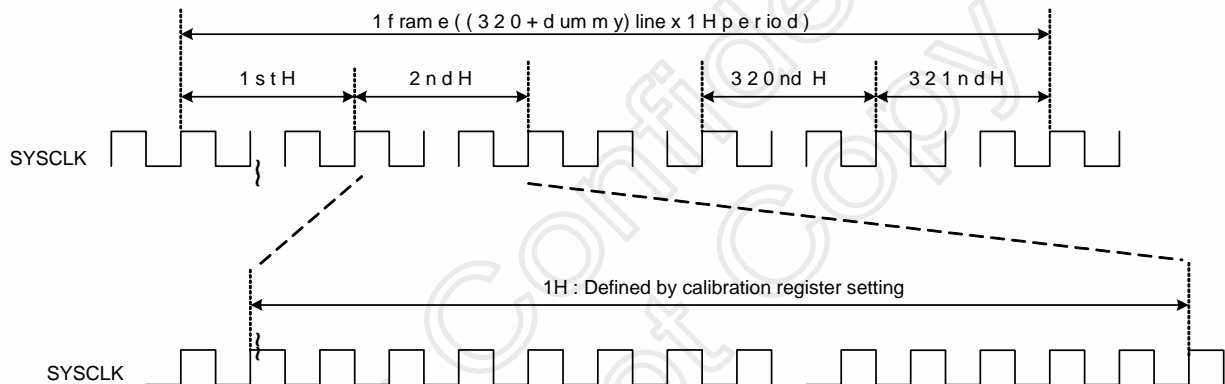


Figure 3. 9 One Line Clock Number in Internal Clock Mode

#### 3.3.1 Adjusting the one horizontal line period (1H) by calibration

Setting OC (D0 bit of the calibration register, R45) as "0" starts calibration. The calibration starts from the first positive edge of SYSCLK after D0=OC is set as "0". The HX8312-A counts the number of positive edges of SYSCLK until OC becomes "1". Then the HX8312-A writes the number of positive edges of SYSCLK (tcal) in the line clock register (R139). When LTS (D1 bit of the R1) is "1", the double number of the counted positive edges (tcalx2) will be set to R139.

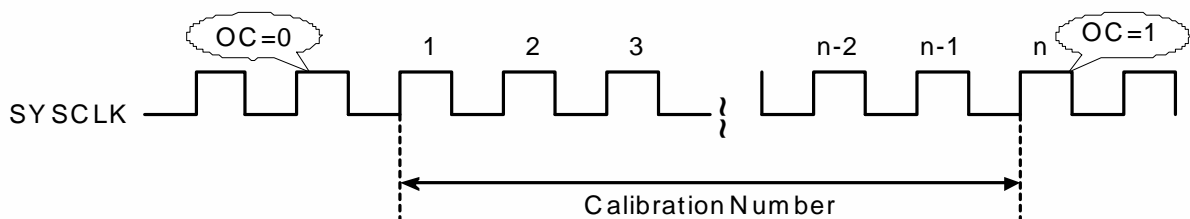


Figure 3. 10 Adjust by Calibration

### 3.3.2 Adjusting the one horizontal line period by register set-up

First users need to specify the target frame frequency, which will drive the LCD (60 Hz commonly.) Next using the formula below, calculate the integer of HCK, so that it is close to the target frame frequency.

$$\text{Frame Frequency} = \frac{\text{SYSCLK}}{\text{HCK} \times (\text{GL} + 1)}$$

- SYSCLK : System clock frequency
- HCK : Raster-row clock number
- GL+1 : Gate drive number (320) + 1 (dummy output)

Example:

$$60 \text{ Hz} = \frac{1200000 \text{ Hz}}{\text{HCK} \times (320 + 1)}$$

$$\text{HCK} = \frac{1200000}{60 \times 321} = 62.3$$

Please determine a value around HCK = 62 or 63 while drive the LCD with frame rate 60Hz. Remind that the setting in R139 can not be setting without the setting CLKM = "1", therefore the default setting of HCK="25" stays valid.

Please note that the value in R139 must be ≥ "20".

## 4. Display RAM

The HX8312-A have an internal graphics RAM that stores 1,382,400-bits data, where one pixel is expressed by 18 bits. By specifying arbitrary X and Y address, it is possible to access the display RAM.

The bit allocation of a pixel in the display RAM is as below.

Bit	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Allocation	R-Dot						G-Dot						B-Dot					
	One Pixel																	

Figure 4. 1 Bit Allocation of a Pixel in the display RAM

### 4.1 Relation between the Display RAM Address and the Source Output Channel

The X size of display can be changed by setting NSO1-0 ( D2-1 bits of R13).

R13		X Size
NSO1	NSO0	
0	0	240
0	1	208
1	0	180
1	1	Inhibited

Table 4. 1 X Size of Display Setting

When the X size is set as 208, the valid X addresses of the display RAM are from "00"h to "CF"h. Addresses "D0"h to "EF"h are invalid. Source outputs S313 to S408 are also invalid. When the X size is set as 180, the valid X addresses of the display data RAM are from "00"h to "B3"h. Addresses "B4"h to "EF"h are invalid. Source outputs S271 to S450 are also invalid.

By the ADC bit (D5 bit of R0) , the relation between the source output channel and the display data RAM address can be changed as reverse display. By setting the BGR bit (D0 bit of R193), the relation between the source output channel and the <R>, <G>, <B> dot allocation can be reversed for different LCD color filter arrangement. Table 4.2, Table 4.3 and Table 4.4 show relation between the display RAM data allocation, the R, G, B dot allocation and the source output channel.

BGR = 0														
Source	ADC = 0	S1	S2	S3	S4	S5	S6	-----	S715	S716	S717	S718	S719	S720
Output	ADC = 1	S718	S719	S720	S715	S716	S717	-----	S4	S5	S6	S1	S2	S3
X Address		"00"h			"01"h			-----	"EE"h			"EF"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 239			Pixel 240		

BGR = 1														
Source	ADC = 0	S3	S2	S1	S6	S5	S4	-----	S717	S716	S715	S720	S719	S718
Output	ADC = 1	S720	S719	S718	S717	S716	S715	-----	S6	S5	S4	S3	S2	S1
X Address		"00"h			"01"h			-----	"EE"h			"EF"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 239			Pixel 240		

Table 4. 2 Display RAM X Address and Display Panel Position ( X Size = 240 )

BGR = 0														
Source	ADC = 0	S1	S2	S3	S4	S5	S6	-----	S715	S716	S717	S718	S719	S720
Output	ADC = 1	S718	S719	S720	S715	S716	S717	-----	S4	S5	S6	S1	S2	S3
X Address		"00"h			"01"h			-----	"CE"h			"CF"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 207			Pixel 208		

BGR = 1														
Source	ADC = 0	S3	S2	S1	S6	S5	S4	-----	S717	S716	S715	S720	S719	S718
Output	ADC = 1	S720	S719	S718	S717	S716	S715	-----	S6	S5	S4	S3	S2	S1
X Address		"00"h			"01"h			-----	"CE"h			"CF"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 207			Pixel 208		

S313 to S408 are invalid

Table 4. 3 Display RAM X Address and Display Panel Position (X Size = 208)

BGR = 0														
Source	ADC = 0	S1	S2	S3	S4	S5	S6	-----	S715	S716	S717	S718	S719	S720
Output	ADC = 1	S718	S719	S720	S715	S716	S717	-----	S4	S5	S6	S1	S2	S3
X Address		"00"h			"01"h			-----	"B2"h			"B3"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 179			Pixel 180		

BGR = 1														
Source	ADC = 0	S3	S2	S1	S6	S5	S4	-----	S717	S716	S715	S720	S719	S718
Output	ADC = 1	S720	S719	S718	S717	S716	S715	-----	S6	S5	S4	S3	S2	S1
X Address		"00"h			"01"h			-----	"B2"h			"B3"h		
Bit Allocation		17-12	11-6	5-0	17-12	11-6	5-0	-----	17-12	11-6	5-0	17-12	11-6	5-0
Pixel		Pixel 1			Pixel 2			-----	Pixel 179			Pixel 180		

S271 to S450 are invalid

Table 4. 4 Display RAM X Address and Display Panel Position (X Size = 180)

S/G pins	S1	S2	S3	S4	S5	S6	S7	S8	S9	-----	S709	S710	S711	S712	S713	S714	S715	S716	S717	S718	S719	S720
	17-----0			17-----0			17-----0			-----	17-----0			17-----0			17-----0			17-----0		
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														
G10	0900h	0901h	0902h	-----	09ECh	09EDh	09EEh	09EFh														
G11	0A00h	0A01h	0A02h	-----	0AECh	0AEDh	0AEEh	0AEFh														
G12	0B00h	0B01h	0B02h	-----	0BECh	0BEDh	0BEEh	0BEFh														
G13	0C00h	0C01h	0C02h	-----	0CECh	0CEDh	0CEEh	0CEFh														
G14	0D00h	0D01h	0D01h		0DECh	0DEDh	0DEEh	0DEFh														
G15	0E00h	0E01h	0E01h		0EECh	0EEDh	0EEEh	0EEFh														
⋮	⋮	⋮	⋮	-----	⋮	⋮	⋮	⋮														
G231	13600h	13601h	13602h	-----	136ECh	136EDh	136EEh	136EFh														
G232	13700h	13701h	13702h	-----	137ECh	137EDh	137EEh	137EFh														
G233	13800h	13801h	13802h	-----	138ECh	138EDh	138EEh	138EFh														
G234	13900h	13901h	13902h	-----	139ECh	139EDh	139EEh	139EFh														
G235	13A00h	13A01h	13A02h	-----	13AECh	13AEDh	13AEEh	13AEFh														
G236	13B00h	13B01h	13B02h	-----	13BECh	13BEDh	13BEEh	13BEFh														
G237	13C00h	13C01h	13C02h	-----	13CECh	13CEDh	13CEEh	13CEFh														
G238	13D00h	13D01h	13D02h	-----	13DECh	13DEDh	13DEEh	13DEFh														
G239	13E00h	13E01h	13E02h	-----	13EECh	13EEDh	13EEEh	13EEFh														
G240	13F00h	13F01h	13F02h	-----	13FECh	13FEDh	13FEEh	13FEFh														

Table 4. 5 Display RAM Address and Display Panel Position (X Size = 240, ADX = 0)

### 4.2 Display RAM Access

The HX8312-A contains a display RAM bus address counter (AC) which assigns X (pixel), Y(line) address for writing pixel data to display RAM. One X address equals to one pixel allocation. The display data will be written at a pixel which address is specified by X address register (R66) and Y address register 1, 2 (R67, R68). Every time when a pixel data is written into or read from the display RAM, the X address or Y address of AC will be automatically increased by 1 (or decreased by 1), which is decided by the register bits AM( D2 bit of R5), ADX(D7 bit of R1) and ADR(D6 bit of R1) setting.

ADX	X Address Direction		
	X Size = 180	X Size = 208	X Size = 240
0	X0 à X179 à X0	X0 à X207 à X0	X0 à X239 à X0
1	X179 à X0 à X179	X207 à X0 à X207	X239 à X0 à X239

ADR	Y Address Direction
0	Y0 à Y319 à Y0
1	Y319 à Y0 à Y319

Table 4. 6 X Address and Y Address Update Direction Setting

AM	ADR	ADX	Description Figure	AM	ADR	ADX	Description Figure
0	0	0		1	0	0	
		1				1	
	1	0		1	1	0	
		1				1	

Figure 4. 2 Address Update Direction Settings



### 4.3 Window Address Area Access Mode

To simplify the address control of display RAM access, the window area address function allows for writing data only within a window area of display RAM specified by registers. Setting WAS (D4 bit of data access control register R5) as "1" starts the window area access mode. After writing data to the display RAM, the AC will be increased or decreased within setting window address-range which is specified by the MIN X address (R69) and MAX X address register (R70) or the MIN Y address 1, 2(R71, R72) and MAX Y address 1, 2(R73, R74) register. Therefore, data can be written consecutively without thinking a data wrap by those bit function. When use window access mode, please make sure the following address setting restriction:

$$\begin{aligned}
 & \text{"00"}\text{h} \leq \text{MIN X address} \leq \text{X address} \leq \text{MAX X address} \leq \text{"EF"}\text{h} \\
 & \text{"00"}\text{h} \leq \text{MIN Y address} \leq \text{Y address} \leq \text{MAX Y address} \leq \text{"13F"}\text{h}
 \end{aligned}$$

The display RAM access address direction control still work in window access mode. In window access mode, the display RAM access X address boundary is restricted by R69 and R70 instead of X0 and X239 ; Y address boundary is restricted by R71,R72 and R73,R74 instead of Y0 and Y319.

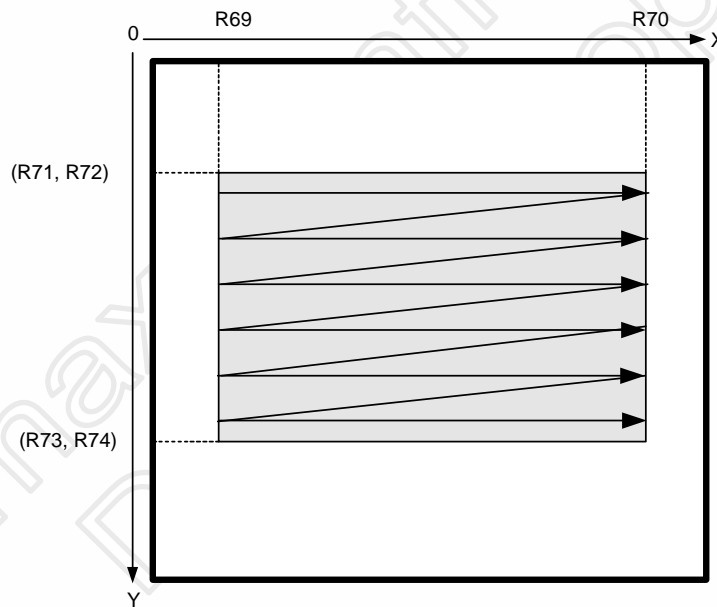
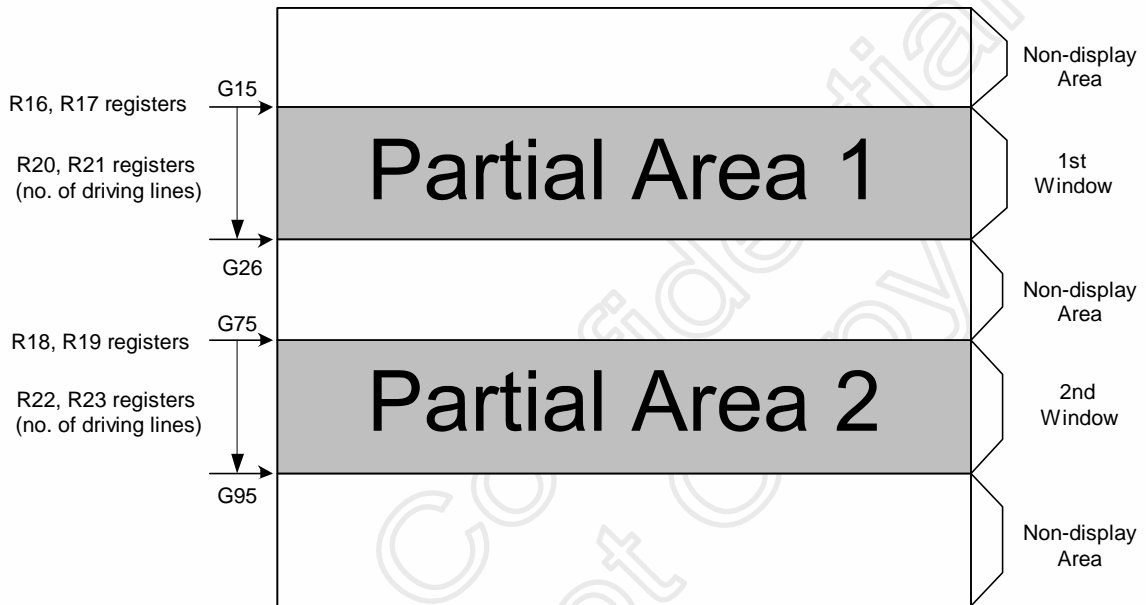


Figure 4. 3 Display RAM Access in Window Area Access Mode (AM=0, ADX=0, ADR=0)

## 5. Partial Display Mode

The HX8312-A enters a partial display mode when DTY (D4 bit of the control register 1 (R0)) is set as "1". The HX8312-A has one or two display window driving functions in partial display mode. The position of display screen register (R16-R23) can display at any line position of the whole screen. The numbers of display lines that display on the first and second display window must be less than total LCD-driving lines (320 lines). The number of the total selection driving lines included the 1st and 2nd display window must be equal to or less than the LCD Drive Line (320 lines).



Number of Scan Line: 320 lines

Ex: 1<sup>st</sup> Screen Setting: (R16, R17) = "0E"h, (R20, R21) = "0B"h  
 2<sup>nd</sup> Screen Setting: (R18, R19) = "4A"h, (R22, R23) = "14"h

**Figure 5. 1 Partial Screen Display Example in 2-Windows Driving**

- Note:**
1. The start driving line of partial areas are ( (R16, R17) + 1 ) line for the first display window and ( (R18, R19) + 1 ) for second display window.
  2. Please make sure the conditions. (R16, R17 + R20, R21) < 320 , (R18, R19 + R22, R23) < 320.
  3. For only one display window display operation, it can be set the same value in (R16,R17) , (R18,R19) and (R20,R21) , (R22,R23).
  4. That incorrect display may occur if the condition setting is not matched the spec.

The following table shows the register for first and second display window area setting in partial display mode.

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	P1SL8

Table 5. 1 First display window area starting register 1 (R16)

D7	D6	D5	D4	D3	D2	D1	D0
P1SL7	P1SL6	P1SL5	P1SL4	P1SL3	P1SL2	P1SL1	P1SL0

Table 5. 2 First display window area starting register 2 (R17)

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	P2SL8

Table 5. 3 Second display window area starting register 1 (R18)

D7	D6	D5	D4	D3	D2	D1	D0
P2SL7	P2SL6	P2SL5	P2SL4	P2SL3	P2SL2	P2SL1	P2SL0

Table 5. 4 Second display window starting register 2 (R19)

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	P1AW8

Table 5. 5 First display window area driving line number register 1 (R20)

D7	D6	D5	D4	D3	D2	D1	D0
P1AW7	P1AW6	P1AW5	P1AW4	P1AW3	P1AW2	P1AW1	P1AW0

Table 5. 6 First display window area display line number register 2 (R21)

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	P2AW8

Table 5. 7 Second display window area display line number register 1 (R22)

D7	D6	D5	D4	D3	D2	D1	D0
P2AW7	P2AW6	P2AW5	P2AW4	P2AW3	P2AW2	P2AW1	P2AW0

Table 5. 8 Second display window area display line number register 2 (R23)

### 5.1 Display Color Selection and Gate Scan Method in Partial Non-Display Areas

The color of non-display areas is specified by the partial non-display area color register 1 (R14) and the partial non-display area color register 2 (R15).

PSEL ( D0 bit of R14 )	PGR, PGG, PGB ( D2-0 bits of R15 )	Display Color in non-Display Area
0	"000"	Black
	"001"	Red
	"010"	Green
	"011"	Yellow
	"100"	Blue
	"101"	Purple
	"110"	Cyan
	"111"	White
1	-	Display the most significant bit of each display data in display RAM.

**Table 5. 9 Display Color in non-Display Areas of Partial Display Mode**

The gate scan method in of partial non-display areas can be selected by setting PNFRM ( D0 bit of R53) as follow.

Gate Scan of Display Area	Gate Scan of Partial non-Display Area	
	PNFRM = 0	PNFRM = 1
Frame Inversion Driving	Frame Inversion Driving	Frame Inversion Driving
N-Line Inversion Driving	N-Line Inversion Driving.	Frame Inversion Driving
3-field Interlaced Driving	3-field Interlaced Driving	

**Table 5. 10 Gate Scan Method in non-Display Areas of Partial Display Mode**

#### Arbitrary frame refresh scan: (Inhibited to use)

Arbitrary frame refresh scan can be available in partial non-display area when frame inversion or N-line inversion driving scan is selected in display areas of partial display mode. By setting GSM (D0 bit of the control register 1, R0) as "1" and GSMLN7-0 ( D7-0 bits of the partial gate register 1 , R52) are used to define the number of frame which gate scan will be performed in partial non-display area.

Please note that when GSMLN7-0 is set as "00h", no gate scan will be performed in the partial non-display areas.

GSMLN7	GSMLN6	GSMLN5	GSMLN4	GSMLN3	GSMLN2	GSMLN1	GSMLN0	Refresh frame number
0	0	0	0	0	0	0	0	Gate scan always stop
0	0	0	0	0	0	0	1	Every 1 frame
0	0	0	0	0	0	1	0	Every 2 frame
⋮								
1	1	1	1	1	1	1	0	Every 254 frame
1	1	1	1	1	1	1	1	Every 255 frame

**Table 5. 11 Partial gate register 1 (R52)**

## 6. Vertical Scroll Function

The HX8312-A incorporates a scroll display function, which performs a scroll display operation without repudiating display RAM for reducing chip RAM access. Since this scroll function is not automatic, please follow the instructions below to operate this function manually.

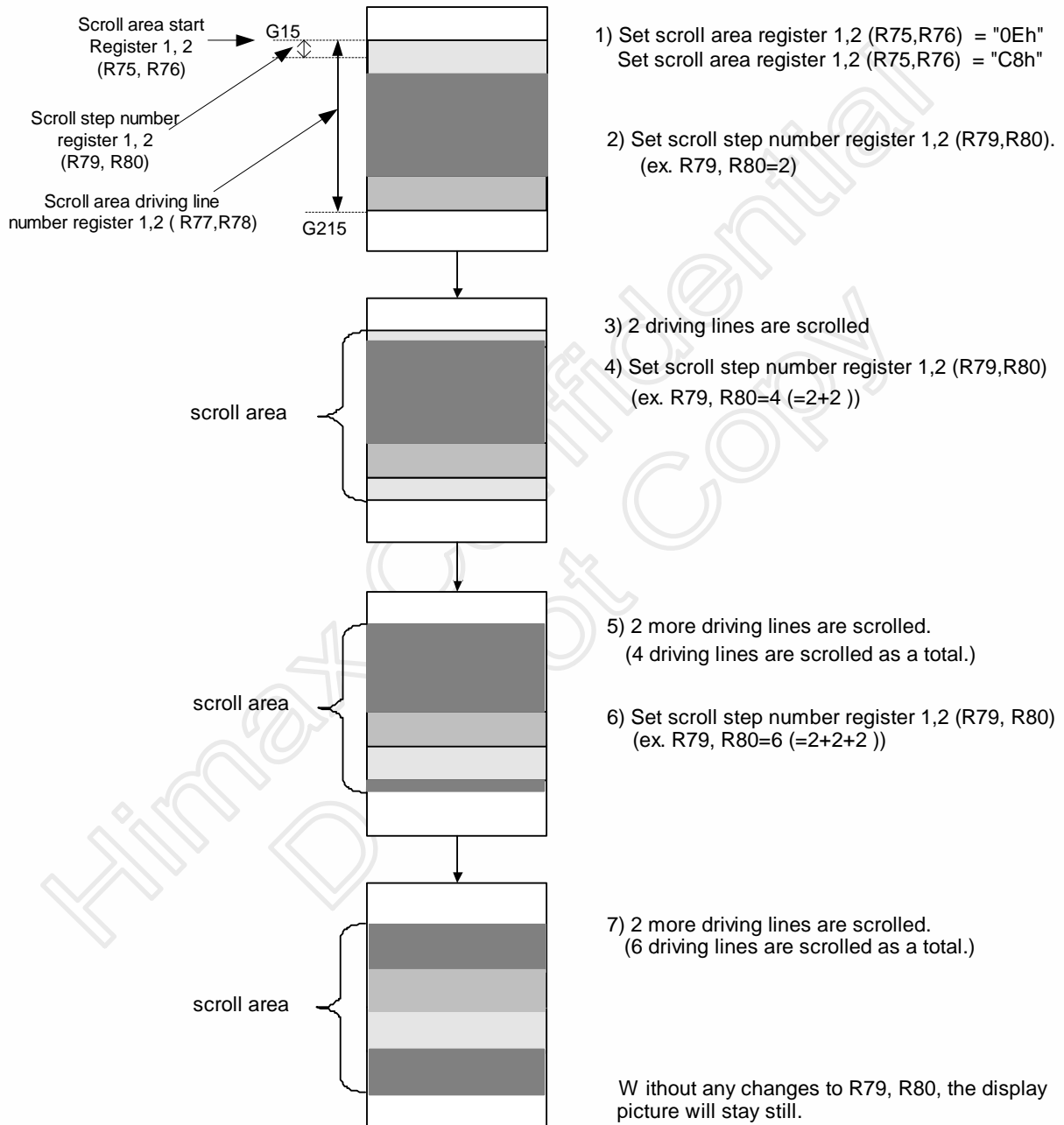


Figure 6. 1 Scroll Function Driving

To go back to the display before scrolling, please set the scroll step number register1,2 (R79, R80) as "000"h. Please make sure to set the number of driving lines to be scrolled (set value of R79 and R80) less than the line number of the scroll area. When the value of R79, R80 exceeds the value of R77 and R78, please set new value which is less than R77 and R78 again to R79 and R80.

SSL8	SSL7	SSL6	SSL5	SSL4	SSL3	SSL2	SSL1	SSL0	Raster-row start address
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	0	1	1	3
.									.
.									.
1	0	0	1	1	1	1	0	1	317
1	0	0	1	1	1	1	1	0	318
1	0	0	1	1	1	1	1	1	319

Table 6. 1 Scroll Area Start Register 1, 2 (R75, R76)

SAW8	SAW7	SAW6	SAW5	SAW4	SAW3	SAW2	SAW1	SAW0	Scroll area driving line number
0	0	0	0	0	0	0	0	0	Setting Inhibited
0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	0	1	1	3
.									.
.									.
1	0	0	1	1	1	1	0	1	317
1	0	0	1	1	1	1	1	0	318
1	0	0	1	1	1	1	1	1	319

Table 6. 2 Scroll Area Driving Line Number Register 1, 2 (R77, R78)

SST8	SST7	SST6	SST5	SST4	SST3	SST2	SST1	SST0	Scroll step number
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	0	1	1	3
.									.
.									.
1	0	0	1	1	1	1	0	1	317
1	0	0	1	1	1	1	1	0	318
1	0	0	1	1	1	1	1	1	319

Table 6. 3 Scroll Step Number Register 1, 2 (R79, R80)

## 7. Gate Line Driving Function

Table 7.1 shows the available gate line driving modes of the HX8312-A. Please set it up according to users' panel's characteristics.

LCD driving mode	GSCAN2 R55:D2	GSCAN1 R55:D1	GSCAN0 R55:D0	Description
Frame Inversion	0	0	0	The polarity of VCOM output is alternated once every frame.
N Line Inversion	0	0	1	The polarity of VCOM output is alternated once N line which N is defined by R51.
3-field Interlaced	1	1	0	Divided one frame scan into 3-field scan, and the polarity of VCOM output is alternated once every field.

Table 7. 1 Gate Line Driving Mode

The HX8312-A has an interlaced driving function that divided one frame scan into 3 fields scan for flicker-free display. As following Figure, by setting GSCAN2-0 = "111" ( D2-0 bits of R55 ) the gate scan order of one frame is changed to G1 à G4 à G7 à ..... à G319 à G2 à G5 à G8 à .....à G320 à G3 à G6 à G9 à .....à G321 ( 3-field interlaced driving )

GSCAN2-0	111		
	Field 1	Field 2	Field 3
Gate			
G1	.		
G2		.	
G3			.
G4	.		
G5		.	
G6			.
G7	.		
G8		.	
G9			.
:	:	:	:
G318			.
G319	.		
G320		.	
G321			.

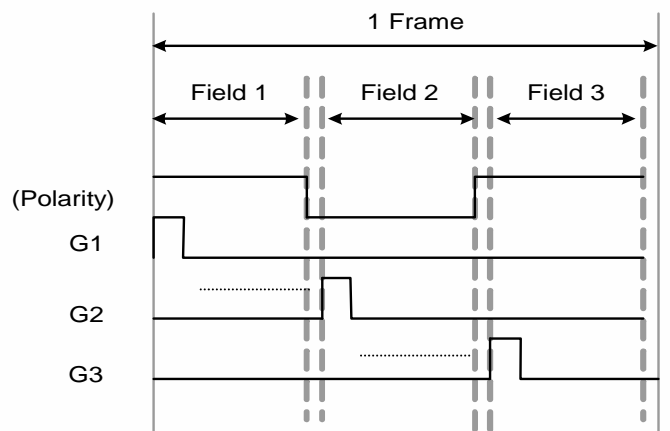
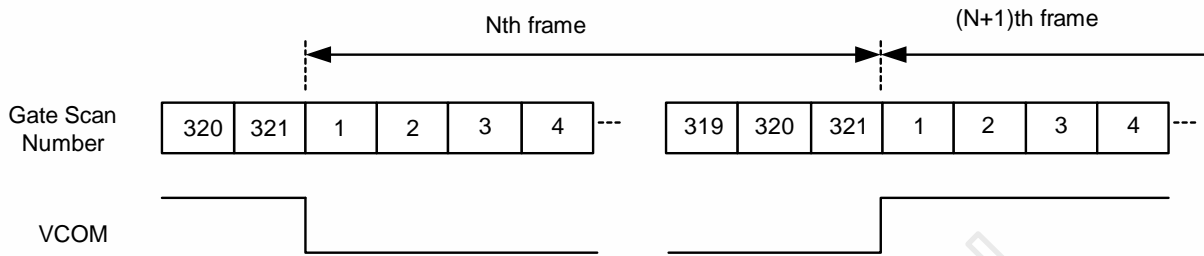
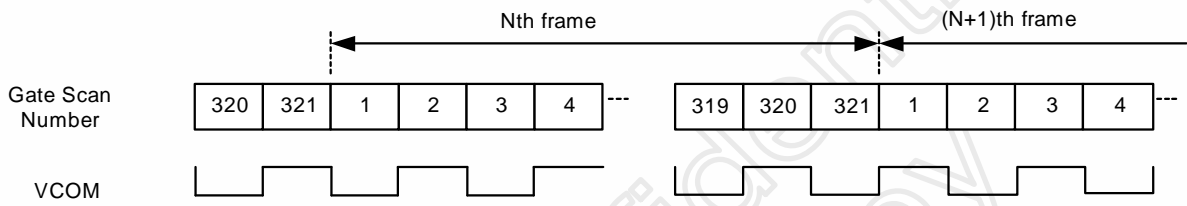


Figure 7. 1 Output Timing for Interlaced Gate Signals (Three-Field is selected)

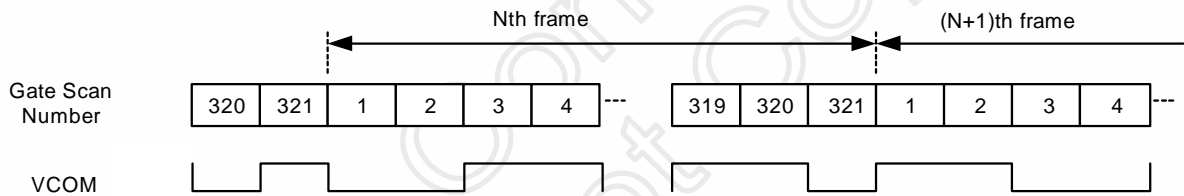
The polarity of VCOM output in every driving mode is as follow:



**Figure 7. 2 Frame inversion LCD Driving**

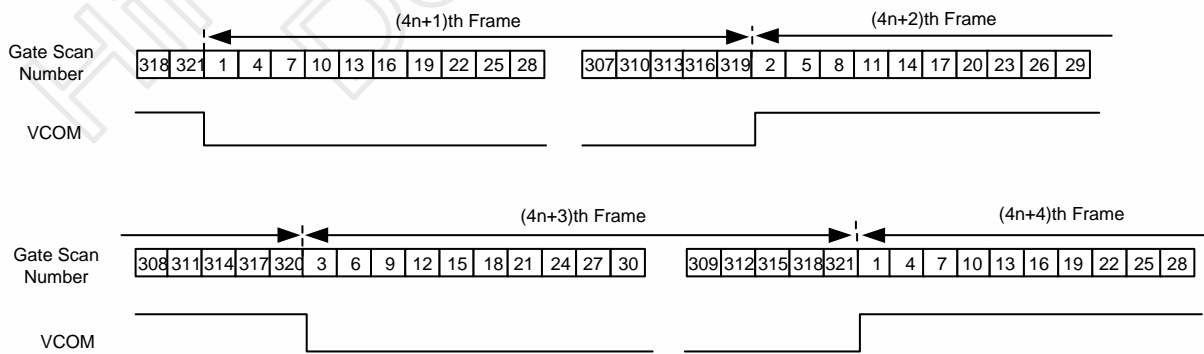


**1-line Inversion Driving**



**2-line Inversion Driving**

**Figure 7. 3 N-line inversion LCD Driving**



**Figure 7. 4 3-field Interlaced LCD Driving**



## 8. Gamma Adjustment Function

The HX8312-A incorporates gamma adjustment function for the 262,144-color display (64 grayscale for each R, G, B color). Gamma adjustment operation is implemented by deciding the 8 grayscale levels firstly in gamma adjustment control registers to match the LCD panel. Then total 64 grayscale levels are generated in grayscale voltage generator. These registers are available for both polarities. However, R, G, B can not be adjusted individually.

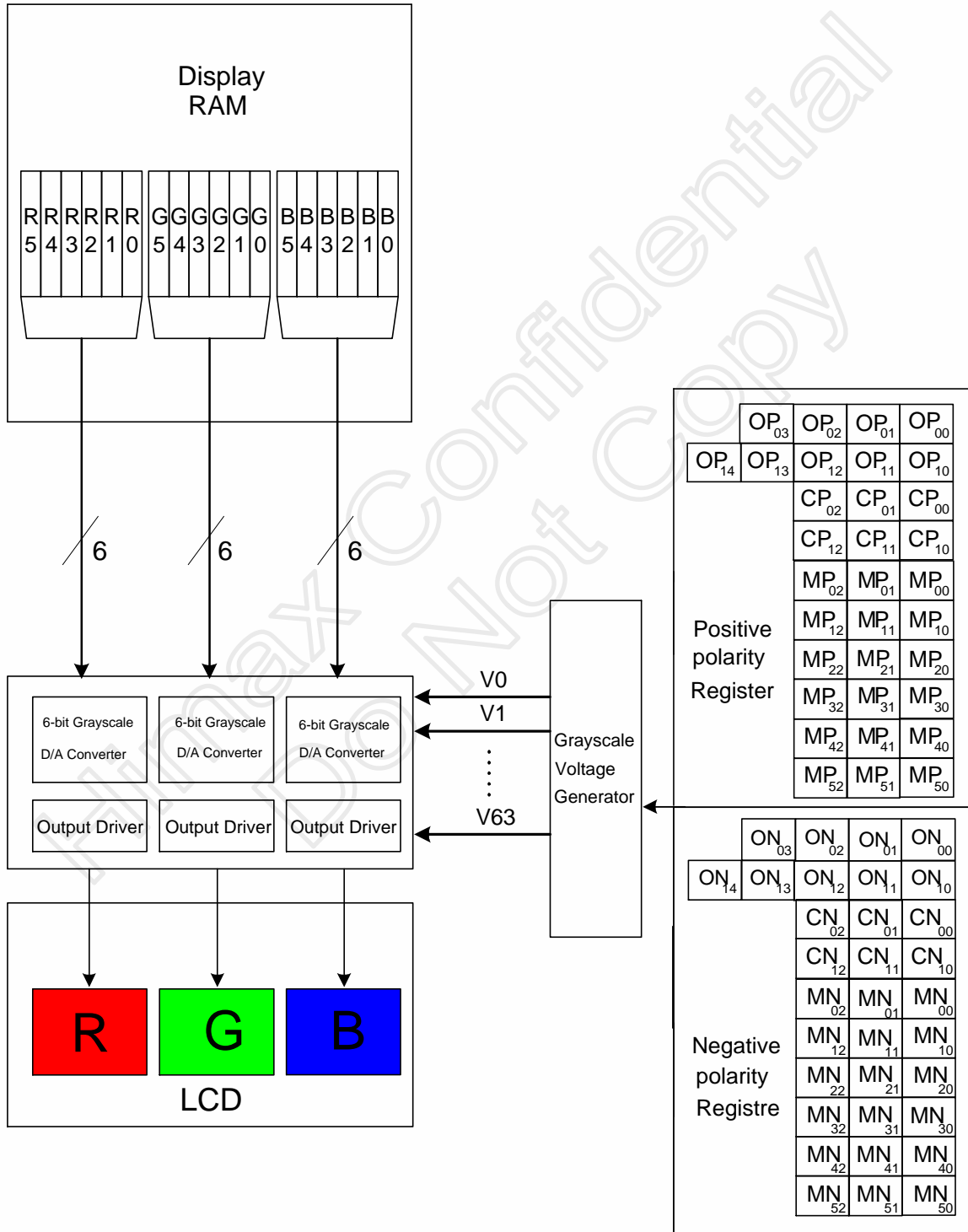


Figure 8. 1 Grayscale Control

### 8.1 Structure of Grayscale Voltage Generator

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

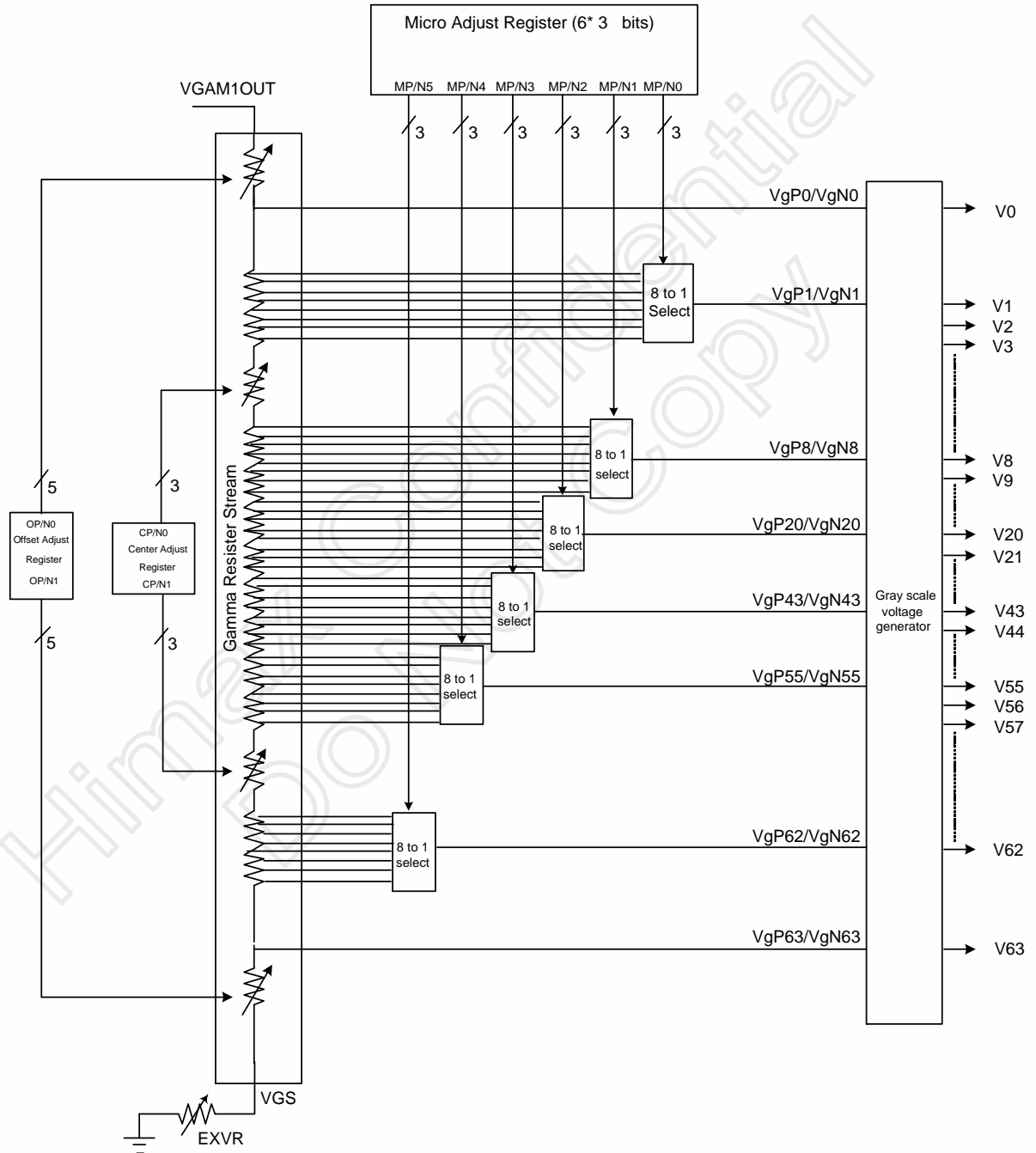


Figure 8. 2 Structure of Grayscale Voltage Generator

## 8.2 Gamma-Characteristics Adjustment Register

This HX8312-A 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. (R, G, and B are common.)

### (1) Gamma offset adjustment registers (R151, R152, R153, R154)

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

### (2) Gamma center adjustment registers (R146, R150)

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

### (3) Gamma macro adjustment registers (R143, R144, R145, R147, R148, R149)

The gamma macro adjustment registers can be used for fine adjustment of the reference gamma voltage. This function is implemented by controlling the 8-to-1 selectors (MP/N0~5), each of which has 8 inputs and generate one reference voltage output (VgP/N) 1, 8, 20, 43, 55, 62). These registers are available for both positive and negative polarities.

Register Groups	Positive Polarity	Negative Polarity	Description
Center Adjustment	CP0 2-0	CN0 2-0	Variable resistor (VRCP/N0) for center adjustment
	CP1 2-0	CN1 2-0	Variable resistor (VRCP/N1) for center adjustment
Macro Adjustment	MP0 2-0	MN0 2-0	8-to-1 selector (voltage level of grayscale 1)
	MP1 2-0	MN1 2-0	8-to-1 selector (voltage level of grayscale 8)
	MP2 2-0	MN2 2-0	8-to-1 selector (voltage level of grayscale 20)
	MP3 2-0	MN3 2-0	8-to-1 selector (voltage level of grayscale 43)
	MP4 2-0	MN4 2-0	8-to-1 selector (voltage level of grayscale 55)
	MP5 2-0	MN5 2-0	8-to-1 selector (voltage level of grayscale 62)
Offset Adjustment	OP0 3-0	ON0 3-0	Variable resistor (VROP/N0) for offset adjustment
	OP1 4-0	ON1 4-0	Variable resistor (VROP/N1) for offset adjustment

Table 8. 1 Gamma-Adjustment Registers

### 8.3 Gamma Voltage Calculation Formula

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

#### 8.3.1 Gamma Curve Adjustment Circuit

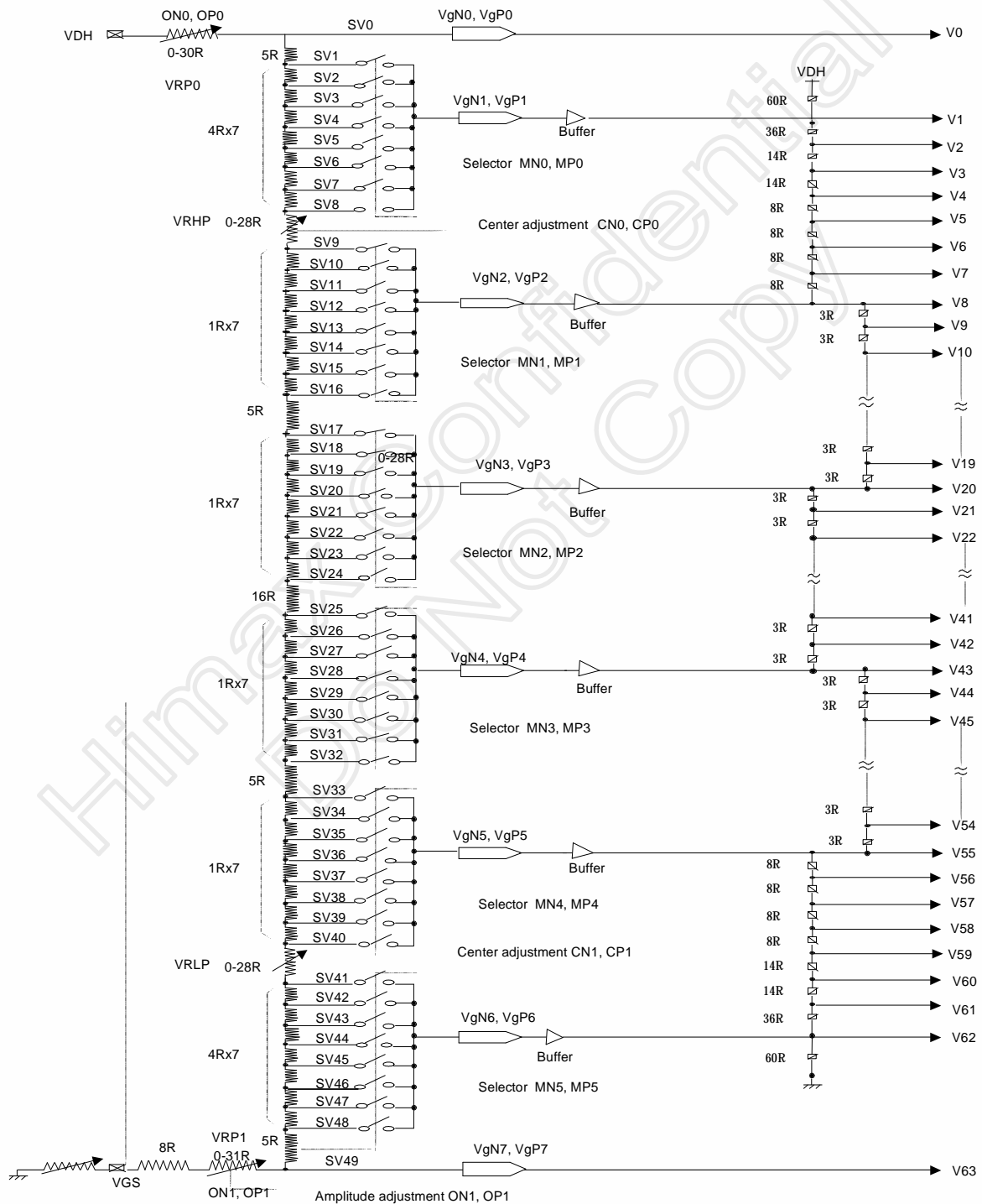


Figure 8. 3 Gamma Correction Circuit

### 8.3.2 Variable Resister

There are two types of variable resistors in gamma adjustment circuit, 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 O(P/N)0 3-0	Resistance	Value in Register O(P/N)1 4-0	Resistance	Value in Register C(P/N)0/1 2-0	Resistance
0000	0R	00000	0R	000	0R
0001	2R	00001	1R	001	4R
0010	4R	00010	2R	010	8R
⋮	⋮	⋮	⋮	011	12R
1101	26R	11101	29R	100	16R
1110	28R	11110	30R	101	20R
1111	30R	11111	31R	110	24R
				111	28R

Table 8. 2 Offset, Center, Adjustment Registers

### 8 to 1 Selector

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

Value in Register M(P/N) 2-0	Voltage level					
	Vg(N/P) 1	Vg(N/P) 8	Vg(N/P) 20	Vg(N/P) 43	Vg(N/P) 55	Vg(N/P) 62
000	SV1	SV9	SV17	SV25	SV33	SV41
001	SV2	SV10	SV18	SV26	SV34	SV42
010	SV3	SV11	SV19	SV27	SV35	SV43
011	SV4	SV12	SV20	SV28	SV36	SV44
100	SV5	SV13	SV21	SV29	SV37	SV45
101	SV6	SV14	SV22	SV30	SV38	SV46
110	SV7	SV15	SV23	SV31	SV39	SV47
111	SV8	SV16	SV24	SV32	SV40	SV48

Table 8. 3 Output Voltage of 8 to 1 Selector

8.3.3 The grayscale levels are determined by the following formulas

Reference Voltage	Adjustment Register -- Positive	Adjustment Register -- Negative	Formula	Voltage
VgN/P0	---	---	$VDH - DV \times VR0 / SUMR$	SV0
VgN/P1	MP0 2-0=000	MN0 2-0=000	$VDH - DV \times (VR0 + 5R) / SUMR$	SV1
	MP0 2-0=001	MN0 2-0=001	$VDH - DV \times (VR0 + 9R) / SUMR$	SV2
	MP0 2-0=010	MN0 2-0=010	$VDH - DV \times (VR0 + 13R) / SUMR$	SV3
	MP0 2-0=011	MN0 2-0=011	$VDH - DV \times (VR0 + 17R) / SUMR$	SV4
	MP0 2-0=100	MN0 2-0=100	$VDH - DV \times (VR0 + 21R) / SUMR$	SV5
	MP0 2-0=101	MN0 2-0=101	$VDH - DV \times (VR0 + 25R) / SUMR$	SV6
	MP0 2-0=110	MN0 2-0=110	$VDH - DV \times (VR0 + 29R) / SUMR$	SV7
	MP0 2-0=111	MN0 2-0=111	$VDH - DV \times (VR0 + 33R) / SUMR$	SV8
VgN/P8	MP1 2-0=000	MN1 2-0=000	$VDH - DV \times (VR0 + 33R + VRH) / SUMR$	SV9
	MP1 2-0=001	MN1 2-0=001	$VDH - DV \times (VR0 + 34R + VRH) / SUMR$	SV10
	MP1 2-0=010	MN1 2-0=010	$VDH - DV \times (VR0 + 35R + VRH) / SUMR$	SV11
	MP1 2-0=011	MN1 2-0=011	$VDH - DV \times (VR0 + 36R + VRH) / SUMR$	SV12
	MP1 2-0=100	MN1 2-0=100	$VDH - DV \times (VR0 + 37R + VRH) / SUMR$	SV13
	MP1 2-0=101	MN1 2-0=101	$VDH - DV \times (VR0 + 38R + VRH) / SUMR$	SV14
	MP1 2-0=110	MN1 2-0=110	$VDH - DV \times (VR0 + 39R + VRH) / SUMR$	SV15
	MP1 2-0=111	MN1 2-0=111	$VDH - DV \times (VR0 + 40R + VRH) / SUMR$	SV16
VgN/P20	MP2 2-0=000	MN2 2-0=000	$VDH - DV \times (VR0 + 45R + VRH) / SUMR$	SV17
	MP2 2-0=001	MN2 2-0=001	$VDH - DV \times (VR0 + 46R + VRH) / SUMR$	SV18
	MP2 2-0=010	MN2 2-0=010	$VDH - DV \times (VR0 + 47R + VRH) / SUMR$	SV19
	MP2 2-0=011	MN2 2-0=011	$VDH - DV \times (VR0 + 48R + VRH) / SUMR$	SV20
	MP2 2-0=100	MN2 2-0=100	$VDH - DV \times (VR0 + 49R + VRH) / SUMR$	SV21
	MP2 2-0=101	MN2 2-0=101	$VDH - DV \times (VR0 + 50R + VRH) / SUMR$	SV22
	MP2 2-0=110	MN2 2-0=110	$VDH - DV \times (VR0 + 51R + VRH) / SUMR$	SV23
	MP2 2-0=111	MN2 2-0=111	$VDH - DV \times (VR0 + 52R + VRH) / SUMR$	SV24
VgN/P43	MP3 2-0=000	MN3 2-0=000	$VDH - DV \times (VR0 + 68R + VRH) / SUMR$	SV25
	MP3 2-0=001	MN3 2-0=001	$VDH - DV \times (VR0 + 69R + VRH) / SUMR$	SV26
	MP3 2-0=010	MN3 2-0=010	$VDH - DV \times (VR0 + 70R + VRH) / SUMR$	SV27
	MP3 2-0=011	MN3 2-0=011	$VDH - DV \times (VR0 + 71R + VRH) / SUMR$	SV28
	MP3 2-0=100	MN3 2-0=100	$VDH - DV \times (VR0 + 72R + VRH) / SUMR$	SV29
	MP3 2-0=101	MN3 2-0=101	$VDH - DV \times (VR0 + 73R + VRH) / SUMR$	SV30
	MP3 2-0=110	MN3 2-0=110	$VDH - DV \times (VR0 + 74R + VRH) / SUMR$	SV31
	MP3 2-0=111	MN3 2-0=111	$VDH - DV \times (VR0 + 75R + VRH) / SUMR$	SV32
VgN/P55	MP4 2-0=000	MN4 2-0=000	$VDH - DV \times (VR0 + 80R + VRH) / SUMR$	SV33
	MP4 2-0=001	MN4 2-0=001	$VDH - DV \times (VR0 + 81R + VRH) / SUMR$	SV34
	MP4 2-0=010	MN4 2-0=010	$VDH - DV \times (VR0 + 82R + VRH) / SUMR$	SV35
	MP4 2-0=011	MN4 2-0=011	$VDH - DV \times (VR0 + 83R + VRH) / SUMR$	SV36
	MP4 2-0=100	MN4 2-0=100	$VDH - DV \times (VR0 + 84R + VRH) / SUMR$	SV37
	MP4 2-0=101	MN4 2-0=101	$VDH - DV \times (VR0 + 85R + VRH) / SUMR$	SV38
	MP4 2-0=110	MN4 2-0=110	$VDH - DV \times (VR0 + 86R + VRH) / SUMR$	SV39
	MP4 2-0=111	MN4 2-0=111	$VDH - DV \times (VR0 + 87R + VRH) / SUMR$	SV40
VgN/P62	MP5 2-0=000	MN5 2-0=000	$VDH - DV \times (VR0 + 87R + VRH + VRL) / SUMR$	SV41
	MP5 2-0=001	MN5 2-0=001	$VDH - DV \times (VR0 + 91R + VRH + VRL) / SUMR$	SV42
	MP5 2-0=010	MN5 2-0=010	$VDH - DV \times (VR0 + 95R + VRH + VRL) / SUMR$	SV43
	MP5 2-0=011	MN5 2-0=011	$VDH - DV \times (VR0 + 99R + VRH + VRL) / SUMR$	SV44
	MP5 2-0=100	MN5 2-0=100	$VDH - DV \times (VR0 + 103R + VRH + VRL) / SUMR$	SV45
	MP5 2-0=101	MN5 2-0=101	$VDH - DV \times (VR0 + 107R + VRH + VRL) / SUMR$	SV46
	MP5 2-0=110	MN5 2-0=110	$VDH - DV \times (VR0 + 111R + VRH + VRL) / SUMR$	SV47
	MP5 2-0=111	MN5 2-0=111	$VDH - DV \times (VR0 + 115R + VRH + VRL) / SUMR$	SV48
VgN/P63	---	---	$VDH - DV \times (VR0 + 120R + VRH + VRL) / SUMR$	SV49

Table 8. 4 Voltage Calculation Formula

**Note:** SUMR: Sum of ladder resistors = 128R + VRH + VRL + VR0 + VR1  
 DV: Voltage difference between VDH and VGS.

Grayscale Voltage	Formula	Grayscale Voltage	Formula
V0	VgN/P0	V32	V43+(V20-V43)*(11/23)
V1	VgN/P1	V33	V43+(V20-V43)*(10/23)
V2	V8+(V1-V8)*(30/48)	V34	V43+(V20-V43)*(9/23)
V3	V8+(V1-V8)*(23/48)	V35	V43+(V20-V43)*(8/23)
V4	V8+(V1-V8)*(16/48)	V36	V43+(V20-V43)*(7/23)
V5	V8+(V1-V8)*(12/48)	V37	V43+(V20-V43)*(6/23)
V6	V8+(V1-V8)*(8/48)	V38	V43+(V20-V43)*(5/23)
V7	V8+(V1-V8)*(4/48)	V39	V43+(V20-V43)*(4/23)
V8	VgN/P8	V40	V43+(V20-V43)*(3/23)
V9	V20+(V8-V20)*(22/24)	V41	V43+(V20-V43)*(2/23)
V10	V20+(V8-V20)*(20/24)	V42	V43+(V20-V43)*(1/23)
V11	V20+(V8-V20)*(18/24)	V43	VgN/P43
V12	V20+(V8-V20)*(16/24)	V44	V55+(V43-V55)*(22/24)
V13	V20+(V8-V20)*(14/24)	V45	V55+(V43-V55)*(20/24)
V14	V20+(V8-V20)*(12/24)	V46	V55+(V43-V55)*(18/24)
V15	V20+(V8-V20)*(10/24)	V47	V55+(V43-V55)*(16/24)
V16	V20+(V8-V20)*(8/24)	V48	V55+(V43-V55)*(14/24)
V17	V20+(V8-V20)*(6/24)	V49	V55+(V43-V55)*(12/24)
V18	V20+(V8-V20)*(4/24)	V50	V55+(V43-V55)*(10/24)
V19	V20+(V8-V20)*(2/24)	V51	V55+(V43-V55)*(8/24)
V20	VgN/P20	V52	V55+(V43-V55)*(6/24)
V21	V43+(V20-V43)*(22/23)	V53	V55+(V43-V55)*(4/24)
V22	V43+(V20-V43)*(21/23)	V54	V55+(V43-V55)*(2/24)
V23	V43+(V20-V43)*(20/23)	V55	VgN/P55
V24	V43+(V20-V43)*(19/23)	V56	V62+(V55-V62)*(44/48)
V25	V43+(V20-V43)*(18/23)	V57	V62+(V55-V62)*(40/48)
V26	V43+(V20-V43)*(17/23)	V58	V62+(V55-V62)*(36/48)
V27	V43+(V20-V43)*(16/23)	V59	V62+(V55-V62)*(32/48)
V28	V43+(V20-V43)*(15/23)	V60	V62+(V55-V62)*(25/48)
V29	V43+(V20-V43)*(14/23)	V61	V62+(V55-V62)*(18/48)
V30	V43+(V20-V43)*(13/23)	V62	VgN/P62
V31	V43+(V20-V43)*(12/23)	V63	VgN/P63

**Table 8. 5 Voltage Calculation Formula of Grayscale Voltage**

**Note:** The following relationship should be retained.  
VgN/P63 – GND > 0.3V

GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale	
	P	N		P	N		P	N		P	N
000000	V0	V63	010000	V16	V47	100000	V32	V31	110000	V48	V15
000001	V1	V62	010001	V17	V46	100001	V33	V30	110001	V49	V14
000010	V2	V61	010010	V18	V45	100010	V34	V29	110010	V50	V13
000011	V3	V60	010011	V19	V44	100011	V35	V28	110011	V51	V12
000100	V4	V59	010100	V20	V43	100100	V36	V27	110100	V52	V11
000101	V5	V58	010101	V21	V42	100101	V37	V26	110101	V53	V10
000110	V6	V57	010110	V22	V41	100110	V38	V25	110110	V54	V9
000111	V7	V56	010111	V23	V40	100111	V39	V24	110111	V55	V8
001000	V8	V55	011000	V24	V39	101000	V40	V23	111000	V56	V7
001001	V9	V54	011001	V25	V38	101001	V41	V22	111001	V57	V6
001010	V10	V53	011010	V26	V37	101010	V42	V21	111010	V58	V5
001011	V11	V52	011011	V27	V36	101011	V43	V20	111011	V59	V4
001100	V12	V51	011100	V28	V35	101100	V44	V19	111100	V60	V3
001101	V13	V50	011101	V29	V34	101101	V45	V18	111101	V61	V2
001110	V14	V49	011110	V30	V33	101110	V46	V17	111110	V62	V1
001111	V15	V48	011111	V31	V32	101111	V47	V16	111111	V63	V0

**Table 8. 6 Display RAM Data and Grayscale Voltage Mapping (REV = 0 D0 bit of R6)**

GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale		GRAM Data Set-up RGB	Selected Grayscale	
	P	N		P	N		P	N		P	N
000000	V63	V0	010000	V47	V16	100000	V31	V32	110000	V15	V48
000001	V62	V1	010001	V46	V17	100001	V30	V33	110001	V14	V49
000010	V61	V2	010010	V45	V18	100010	V29	V34	110010	V13	V50
000011	V60	V3	010011	V44	V19	100011	V28	V35	110011	V12	V51
000100	V59	V4	010100	V43	V20	100100	V27	V36	110100	V11	V52
000101	V58	V5	010101	V42	V21	100101	V26	V37	110101	V10	V53
000110	V57	V6	010110	V41	V22	100110	V25	V38	110110	V9	V54
000111	V56	V7	010111	V40	V23	100111	V24	V39	110111	V8	V55
001000	V55	V8	011000	V39	V24	101000	V23	V40	111000	V7	V56
001001	V54	V9	011001	V38	V25	101001	V22	V41	111001	V6	V57
001010	V53	V10	011010	V37	V26	101010	V21	V42	111010	V5	V58
001011	V52	V11	011011	V36	V27	101011	V20	V43	111011	V4	V59
001100	V51	V12	011100	V35	V28	101100	V19	V44	111100	V3	V60
001101	V50	V13	011101	V34	V29	101101	V18	V45	111101	V2	V61
001110	V49	V14	011110	V33	V30	101110	V17	V46	111110	V1	V62
001111	V48	V15	011111	V32	V31	101111	V16	V47	111111	V0	V63

**Table 8. 7 Display RAM Data and Grayscale Voltage Mapping (REV = 1)**



8.3.4 Relationship between GRAM Data and Output Level

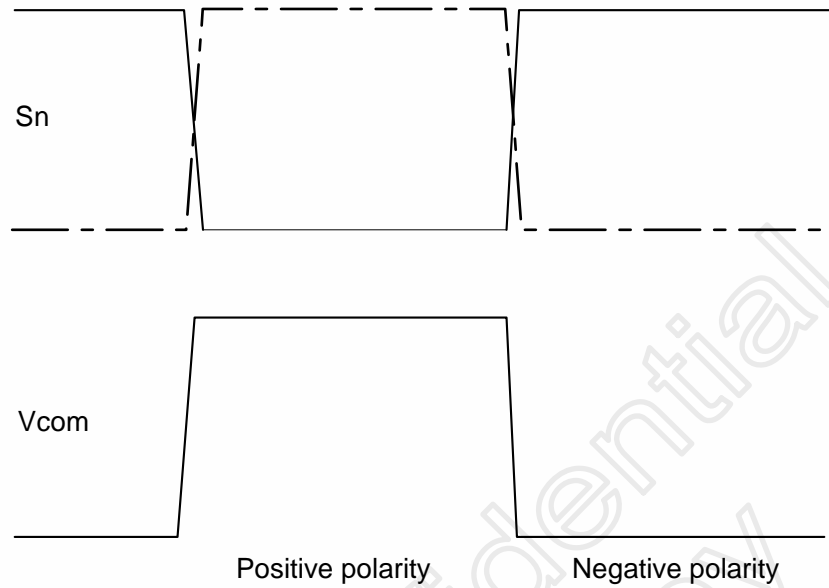
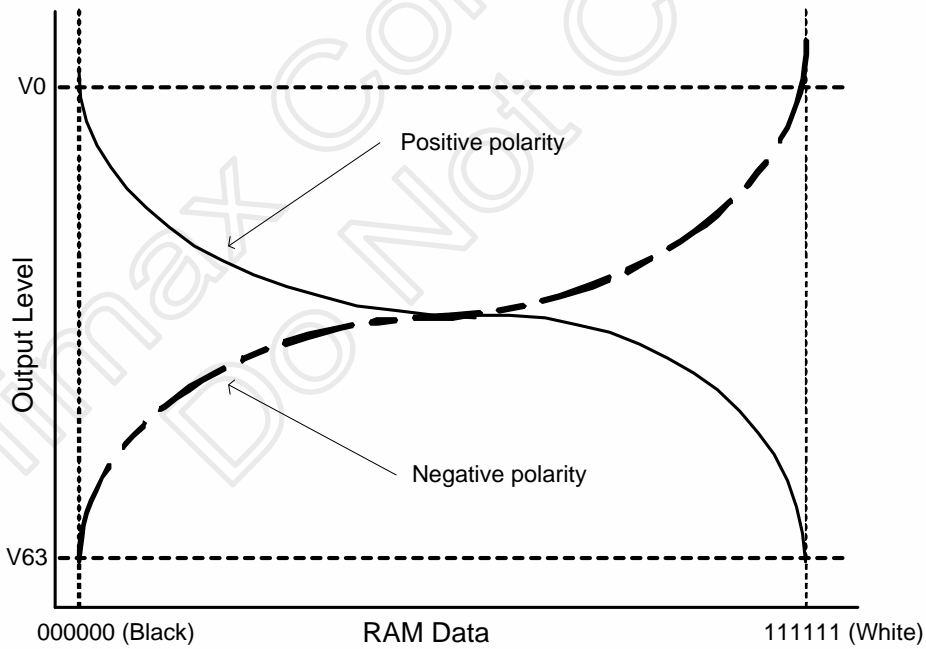


Figure 8. 4 Relationship between Source Output and Vcom



(Same characteristic for each RGB)

Figure 8. 5 Relationship between GRAM Data and Output Level (REV = 1)

## 9. 8-Color Display Mode Function

The HX8312-A supports an 8-color display mode by setting COLOR (D2 bit of R0) as "1". The grayscale level to be used is V0 and V63 with R5, G5, B5 decoding, and the other levels (V1-V62) are halted to reduce power consumption in 8-color display mode. In 8-color display mode, the Gamma-micro-adjustment registers are invalid and only the upper bits of RGB are used for display.

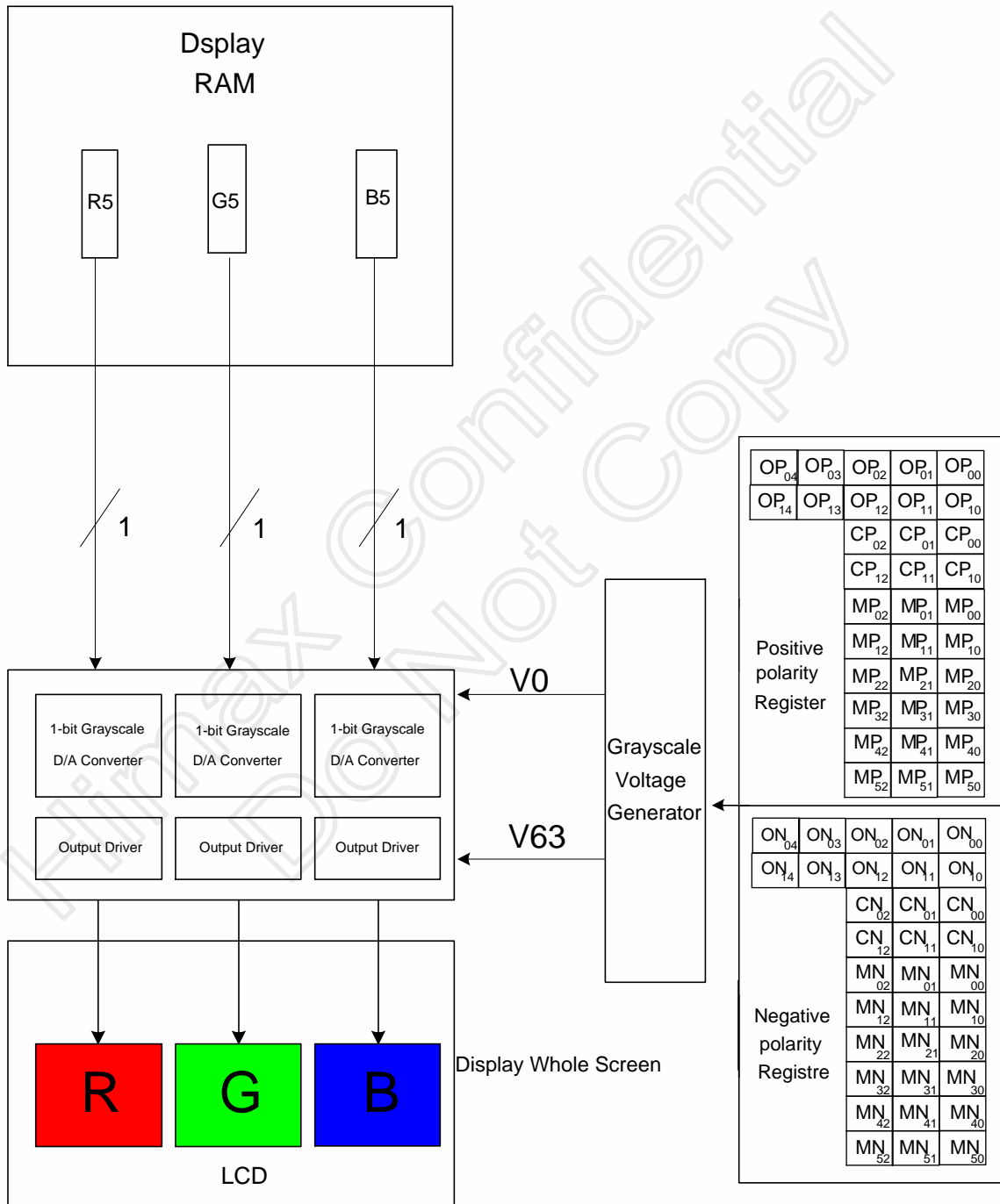


Figure 9. 1 Grayscale Control in 8-Color Display Mode

## 10. Display Operation Control

### 10.1 Display Driving Period Time Control

The HX8312-A can control the display operation period time for LCD panel driving as follow:

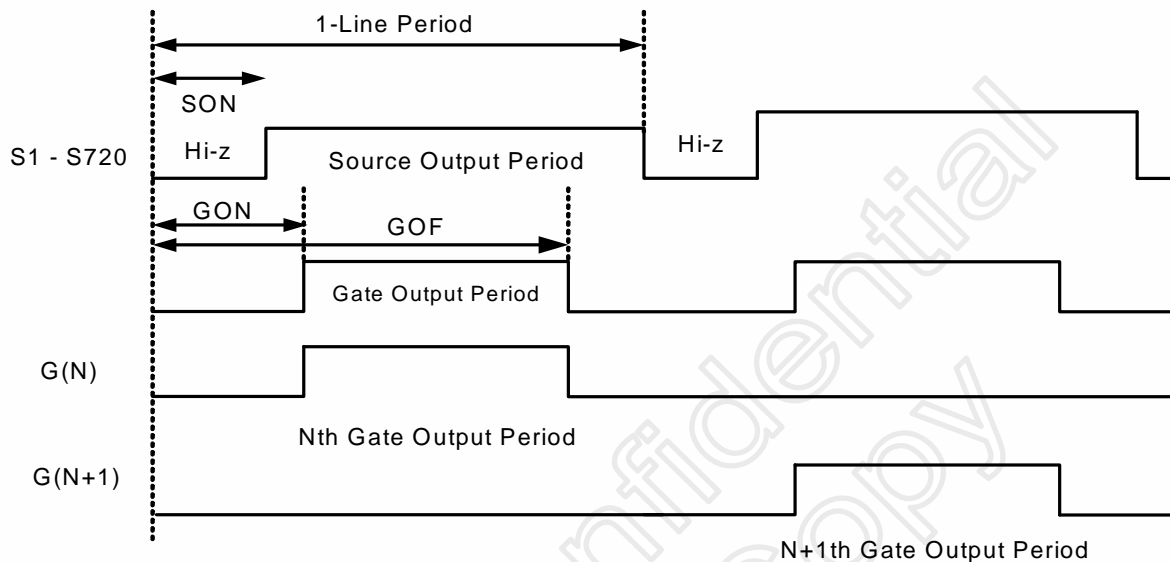


Figure 10. 1 Display Driving Period Time Setting

D7	D6	D5	D4	D3	D2	D1	D0
SON7	SON6	SON5	SON4	SON3	SON2	SON1	SON0

Table 10. 1 Source on register (R136)

**SON7-0:** Specify the valid source output start time in 1-line driving period. The period time is defined as SYSCLK clock number.

Please note that the setting “00h” and “01h” is inhibited.

D7	D6	D5	D4	D3	D2	D1	D0
GON7	GON6	GON5	GON4	GON3	GON2	GON1	GON0

Table 10. 2 Gate on register (R137)

**SON7-0:** Specify the valid gate output start time in 1-line driving period.

The period time is defined as SYSCLK clock number in internal clock display mode.

The period time is defined as setting value x 8 DOTCLK clock number in external clock display mode.

Please note that the setting “00h”, “01h”, “02h” is inhibited.

**Gate off register 1 (R134)**

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	GOF8

**Gate off register 2 (R135)**

D7	D6	D5	D4	D3	D2	D1	D0
GOF7	GOF6	GOF5	GOF4	GOF3	GOF2	GOF1	GOF0

**Table 10. 3 Gate off register**

**GOF8-0:** Specify the gate output end time in 1-line driving period.  
 The period time is defined as SYSCLK clock number in internal clock display mode.  
 The period time is defined as setting value x 8 DOTCLK clock number in external clock display mode.

Please note that the  $GOF8-0 \leq HCK-1$

**10.2 All “0” or “1” Source Output Display**

By setting DISP1 and DISP0 (D7-6 bits of R0), HX8312-A can display data “0” or “1” on the whole LCD regardless of display RAM data and the data in the display RAM is not changed.

D7	D6	D5	D4	D3	D2	D1	D0
DISP1	DISP0	ADC	DTY	STBY	COLOR	-	GSM

**Table 10. 4 Control register 1 (R0)**

**DISP1-0:**

DISP1	DISP0	Display
0	0	Output display data from display RAM
0	1	All Output “0” regardless of the display data in display RAM
1	0	All output “1” regardless of the display data in display RAM
1	1	All output “1” regardless of the display data in display RAM

**10.3 Gate Scanning Stop Control**

Gate scanning can be stopped by setting DISPTMG (D0 bit of R59) as "0" All gate scans will be stopped if DISPTMG = “0”, however, the frame frequency doesn’t change.  
 GOE 1 output control register (R59)

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	DISPTMG

**Table 10. 5 Gate output control register (R59)**

# 11. Scan Mode Setting

## 11.1 Scan Pattern

The number of gate-drive lines can be set by NSO1-0 (D2-1 bits of R13). Refer to "4.1 Relation between Display Data RAM and the LCD Panel".

The HX8312-A can set R/L (D3 bit of R29) and SCN[2:0] (D2-0 bits of R29) bits to determine the shift direction of gate outputs for different panel layout. And the DDS pin is used to set the position of dummy output pin in each mode. (Refer to "11.2. Blanking Period and Dummy Line Location")

R/L	SCN[2:0]	Scan direction	DDS pin
1	XX 0	<p>HX8312-A MODE5R mode</p>	0 G1, G321, G2, G320, ..., G159, G163, G160, G162, (G161 dummy)
			1 (G1 dummy), G321, G2, G320, ..., G159, G163, G160, G162, G161
0	XX 0	<p>HX8312-A MODE5R mode</p>	0 G161, G162, G160, G163, ..., G3, G320, G2, G321, (G1 dummy)
			1 (G161 dummy), G162, G160, G163, ..., G3, G320, G2, G321, G1
1	01 1	<p>HX8312-A MODE2R mode</p>	0 G1, G2, ..., G160, G161, G321, G320, G319, ..., G163, (G162 dummy)
			1 (G1 dummy), G2, ..., G160, G161, G321, G320, ..., G163, G162
0	01 1	<p>HX8312-A MODE2L mode</p>	0 G162, G163, G164, ..., G320, G321, G161, G160, ..., G3, G2, (G1 dummy)
			1 (G162 dummy), G163, G164, ..., G321, G161, G160, ..., G3, G2, G1

Figure 11. 1 SCAN Mode Setting

Scan pattern mode	R/L R29:D3	SCN2 R29:D2	SCN1 R29:D1	SCN0 R29:D0	DDS pin	Dummy pin	Scan Order
MODE5R	1	X	X	0	0	G161	G1, G321, G2, G320, ..., G159, G163, G160, G162, (dummy)
					1	G1	(dummy), G321, G2, G320, ..., G159, G163, G160, G162, G161
MODE5L	0	X	X	0	0	G1	G161, G162, G160, G163, ..., G3, G320, G2, G321, (dummy)
					1	G161	(dummy), G162, G160, G163, ..., G3, G320, G2, G321, G1
MODE2R	1	0	1	1	0	G162	G1, G2, ..., G160, G161, G321, G320, G319, ..., G163, (dummy)
					1	G1	(dummy), G2, ..., G160, G161, G321, G320, ..., G163, G162
MODE2L	0	0	1	1	0	G1	G162, G163, G164, ..., G320, G321, G161, G160, ..., G3, G2, (dummy)
					1	G162	(dummy), G163, G164, ..., G321, G161, G160, ..., G3, G2, G1

Table 11. 1 Scan Mode Setting

### 11.2 Blanking Period and Dummy Line Location

The dummy line number selection register (R118) is used for setting the blanking period between two frame scan. The external DDS pin of HX8312-A determines to put the blanking period and a dummy line whether at the head or the end of a frame.

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	-	-	-	DMYSEL

Table 11. 2 Dummy line number selection register (R118)

DMYSEL: sets dummy line number of the blanking period

“0”: one dummy line scan

“1”: one dummy line scan + 7-line blanking period

(In blanking period, LC AC alternated source drive and the gate output OFF)

DDS pin	Blanking Period Location
0	End: 1 frame scan + dummy ( +7 blanking)
1	Head: (7 blanking + ) dummy + 1 frame scan

Table 11. 3 DDS pin set-up

**Note:**1.Please set R118:D0=DMYSEL as “0” when 3-field interlaced driving mode is selected.

(DMYSEL=“1” is not available when Skip 2B is selected)

2. R118 is not valid when the LCD displays operation is in synchronization with an external clock

## 12. Oscillation Circuit

The HX8312-A can oscillate between the OSC1 and OSC2 pins using an internal R-C oscillator with an external oscillation resistor (Rf) or internal oscillation resistor 100Kohm(select by ROSC setting, D0 bit of R43). The oscillation frequency is changed according to the external resistance value, wiring length, or operating power-supply voltage. If Rf is increased or power supply voltage is decreased, the oscillation frequency decreases.

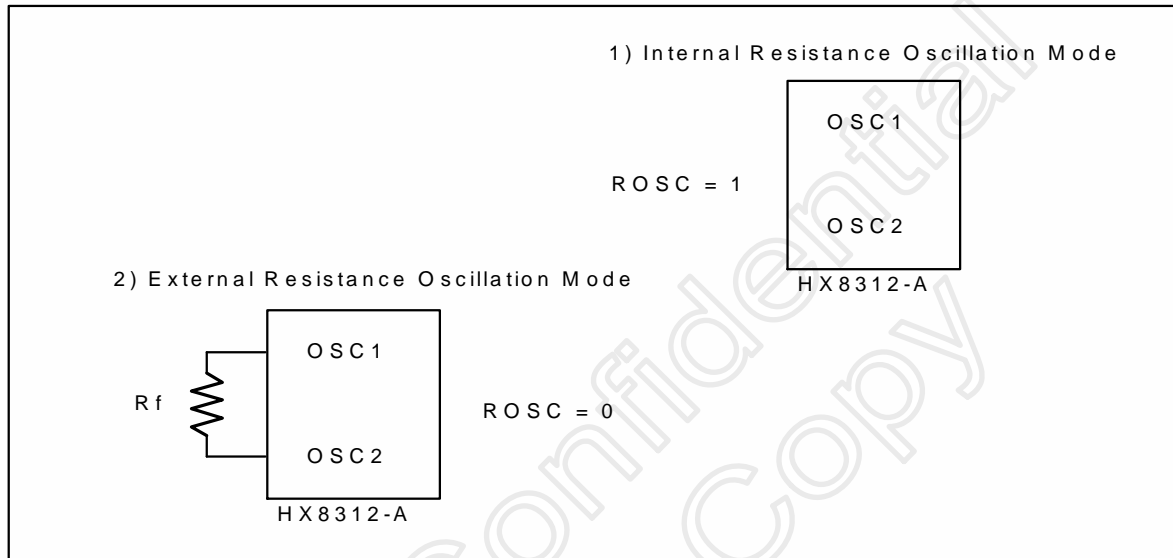


Figure 12. 1 Oscillation Circuit

The oscillation frequency can be adjust finely by setting RADJ2-0 (D3-1 bits of R43) as follow:

Internal R: 100 K ohm		RC oscillation frequency (MHz)		
RADJ[2:0]	correction	Vcc=2.5V	Vcc=2.8V	Vcc=3.3V
000	No	1.561	1.820	2.215
001	-10%	1.434	1.640	1.953
010	-20%	1.313	1.480	1.718
011	-30%	1.181	1.310	1.495
100	+10%	1.677	1.990	2.444
101	+20%	1.788	2.153	2.688
110	+30%	1.898	2.305	2.943
111	+40%	2.023	2.482	3.25

Table 12. 1 Frequency Adjustment (ROSC = 1)

The oscillation circuit on / off control can be defined by the OSCSTBY setting (D0 bit of R1), When OSCSTBY = "0", the oscillation circuit start to oscillate; when OSCSTBY = "1", the oscillation circuit stop to oscillate.



## 13. Power Generation

### 13.1 Power Supply Set up

HX8312-A has an internal power supply circuit to drive TFT LCD panel. Please set up each voltage output according to the LCD panel.

Name	Function	Set up Value	Note
VR1	Reference voltage for VR2 / DDVDH / VS / VDH generation	$V_{ci} \times A$ (*1)	$VR1 \leq V_{ci} - 0.15$
VR2	Reference voltage for VGH generation	$VR1 \times B$ (*2)	$VR2 \leq V_{ci} - 0.15$
DDVDH	Step-up circuit 1 output Power supply for VS/VR/VDH/VCOM	$VR1 \times 2$	Do not exceed 5.5V
VGH	( Step-up circuit 2 output ) Gate on voltage	$VR1 \times C$ (*3)	Do not exceed 16.5V
VGL	( Step-up circuit 2 output ) Gate off voltage	$VR2 \times D$ $- VR1 \times E$ (*3)	Do not lower than -16.5V
VCL	( Step-up circuit 3 output ) Power supply for VCOML generation	$V_{ci} \times (-1)$	-
VS	Power supply for the source circuit output driving	$VR1 \times F$ (*4)	3.5V – 5.25V
VDH	Reference voltage for gamma circuit	$VR1 \times F$ (*4)	
VCOMH	VCOM high voltage	$VS \times G$ (*5)	-
VCOML	VCOM low voltage	$VCOMH - VS \times H$ (*6)	-
VCOM	VCOM voltage	-	Output VCOMH and VCOML voltage alternately.
V18	Logic power supply	1.8V	-

**Table 13. 1 Power Supply Voltage Configuration**

- Note :**
1. The value of A is determined by VR1SEL2-0 bits ( D4-2 bits of register R25 ).
  2. The value of B is determined by VR2SEL2-0 bits ( D7-5 bits of register R25 ).
  3. The value of C , D and E is determined by BT3-0 bits ( D3-0 bits of register R37 ) setting and C21+ , C21- pin connection.
  4. The value of F is determined by VSEL2-0 bits ( D3-1 bits of register R27 ).
  5. The value of F is determined by VCM4-0 bits ( D4-0 bits of register R32 ).
  6. The value of G is determined by VDV4-0 bits ( D4-0 bits of register R31 ).

The voltage setting diagram of power output for LCD panel driving setup diagram is as follow:

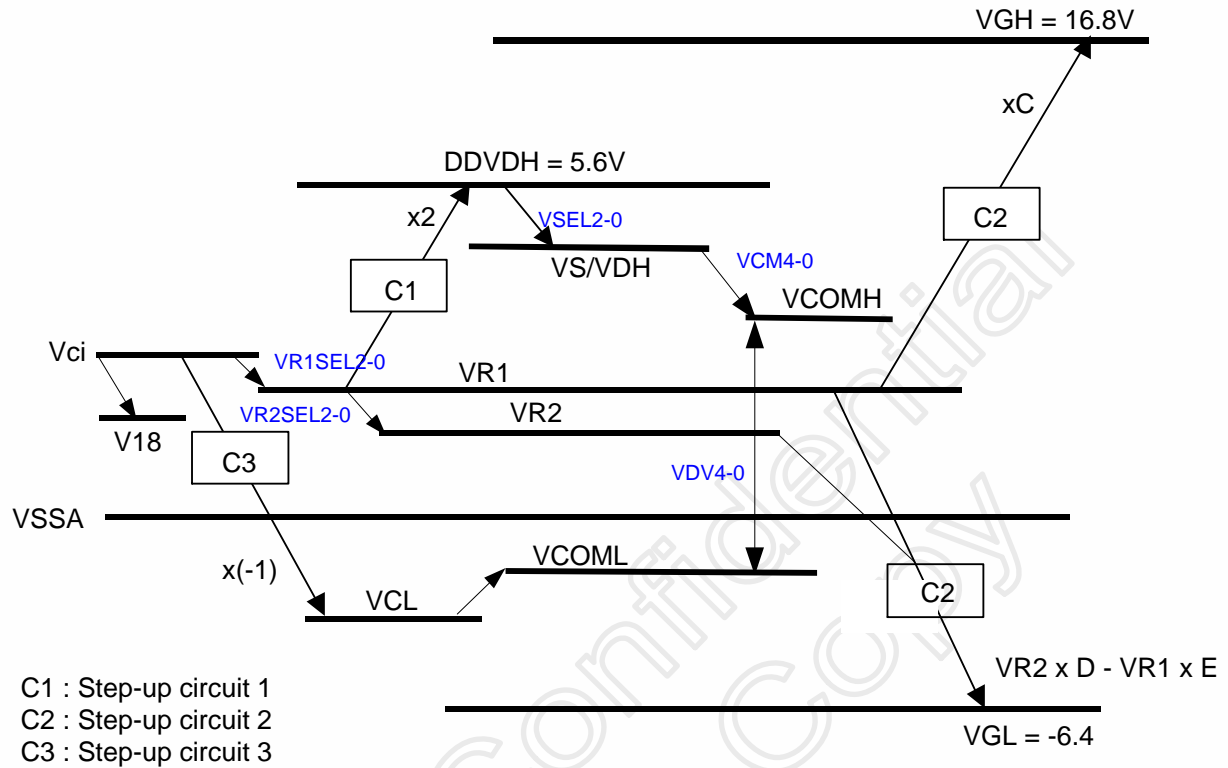


Figure 13. 1 Voltage setting diagram

### 13.2 Power Supply Register

The on/off control of each power output is defined by power supply system control register 1 (R24)

D7	D6	D5	D4	D3	D2	D1	D0
VR2ON	VR1ON	VCLON	VGON	-	DDVDHON	-	DCON

Table 13. 2 Power supply system control register 1 (R24)

**VR2ON:** VR2 regulator output control.  
 “0”: VR2 regulator off, VR2 output = Hi-z.  
 “1”: VR2 regulator on.

**VR1ON:** VR1 regulator output control.  
 “0”: VR regulator off, VR2 output = VSSA.  
 “1”: VR1 regulator on.

**VCLON:** Step up circuit 3 output control

Register			Step up Circuit	Output
DCON ( D0 bit of R24 )	STBY ( D3 bit of R0 )	VS4ON ( D5 bit of R24 )	C3	VCL
0	X	X	Stop	VSSA
1	1	X	Stop	VSSA
1	0	0	Stop	VSSA
1	0	1	ON	Active

**VGON:** Step up circuit 2 output control

Register			Step up Circuit	Output	
DCON ( D0 bit of R24 )	STBY ( D3 bit of R0 )	VGON ( D4 bit of R24 )	C2	VGH	VGL
0	X	X	Stop	DDVDH	VSSA
1	1	X	Stop	DDVDH	VSSA
1	0	0	Stop	DDVDH	VSSA
1	0	1	ON	Active	Active

**DDVDHON:** Step up circuit 1 output control

Register			Step up Circuit	Output
DCON ( D0 bit of R24 )	STBY ( D3 bit of R0 )	DDVDHON ( D2 bit of R24 )	C1	DDVDH
0	X	X	Stop	VR1
1	1	X	Stop	VR1
1	0	0	Stop	VR1
1	0	1	ON	Active

**VDCON:** DC/DC Converter output control  
 “0”: DC/DC Converter off.  
 “1”: DC/DC Converter on.

D7	D6	D5	D4	D3	D2	D1	D0
VR2SEL2	VR2SEL1	VR2SEL0	VR1SEL2	VR1SEL1	VR1SEL0	-	-

**Table 13. 3 Power supply system control register 2 (R25)**

**VR2SEL2-0** specify the output voltage of the VR2regulator. ( $VR2 \leq V_{ci} - 0.15V$ )

VR2SEL2	VR2SEL1	VR2SEL0	VR2
0	0	0	VR1
0	0	1	VR1 x 0.9
0	1	0	VR1 x 0.8
0	1	1	VR1 x 0.7
1	0	0	VR1 x 0.6
1	0	1	VR1 x 0.5
1	1	0	Hi-Z
1	1	1	Hi-Z

**VR1SEL2-0** specify the output voltage of the VR1regulator. ( $VR1 \leq V_{ci} - 0.15V$ )

VR1SEL2	VR1SEL1	VR1SEL0	VR1
0	0	0	V <sub>ci</sub>
0	0	1	V <sub>ci</sub> x 0.93
0	1	0	V <sub>ci</sub> x 0.88
0	1	1	V <sub>ci</sub> x 0.82
1	0	0	V <sub>ci</sub> x 0.78
1	0	1	V <sub>ci</sub> x 0.74
1	1	0	Setting Disable
1	1	1	Setting Disable

D7	D6	D5	D4	D3	D2	D1	D0
DCCLK7	DCCLK6	DCCLK5	DCCLK4	DCCLK3	DCCLK2	DCCLK1	DCCLK0

**Table 13. 4 Power supply system control register 3 (R40)**

**DCCLK7-0** : specify the clock frequency for DC/DC converter operating.

DCCLK7	DCCLK6	DCCLK5	DCCLK4	DCCLK3	DCCLK2	DCCLK1	DCCLK0	DCDCf
0	0	0	0	0	0	0	0	Inhibited
0	0	0	0	0	0	0	1	SYSCLK
0	0	0	0	0	0	1	0	SYSCLK / 2
1	1	1	1	1	1	1	0	SYSCLK / 254
1	1	1	1	1	1	1	1	SYSCLK / 255

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	DC3	DC2	DC1	DC0

Table 13. 5 Power supply system control register 3 (R26)

DC3-2 : specify the operating frequency for step up circuit 2 and 3

DC3	DC2	Frequency for step up 2 and 3
0	0	DCDCf / 1
0	1	DCDCf / 2
1	0	DCDCf / 4
1	1	DCDCf / 8

DC1-0 : specify the operating frequency for step up circuit 1

DC1	DC0	Frequency for step up 1
0	0	DCDCf / 1
0	1	DCDCf / 2
1	0	DCDCf / 4
1	1	DCDCf / 8

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	VSEL2	VSEL1	VSEL0	RGON

Table 13. 6 Power supply system control register 4 (R27)

VSEL2-0 specify the output voltage of the VS and VDH regulator.

VSEL2	VSEL1	VSEL0	VS / VDH
0	0	0	VR1 x 1.38
0	0	1	VR1 x 1.45
0	1	0	VR1 x 1.53
0	1	1	VR1 x 1.6
1	0	0	VR1 x 1.68
1	0	1	VR1 x 1.75
1	1	0	VR1 x 1.83
1	1	1	Setting Disable

Note: Make sure  $VS / VDH \leq DDVDH - 0.15$ .

RGON control the output on/off of the VS and VDH regulator.

“0”: Off, The VS output is Hi-Z and the VDH output is VSSA.

“1”: On.

D7	D6	D5	D4	D3	D2	D1	D0
VCOMEN	-	VCOMFX	VCOMHI	XVCOMG	-	-	DDVDHXON

Table 13. 7 Power supply system control register 8 (R30)

VCOMEN, VCOMFX, VCOMHI specify the VCOM circuit operation.

VCOMEN	VCOMFX	VCOMHI	VCOM Circuit	VCOM Output
0	X	X	Stand-by	VSSA
1	X	1	Operation	Hi-Z
1	1	0	Operation	VSSA
1	0	0	Operation	Normal Operation

DDVDHXON specify whether or not to use an extra step-up circuit capacitor CX11 for stronger DDVDH generation.

“0” : Doesn’t use the extra step-up circuit CX11.

“1” : Use the extra step-up circuit C!x.

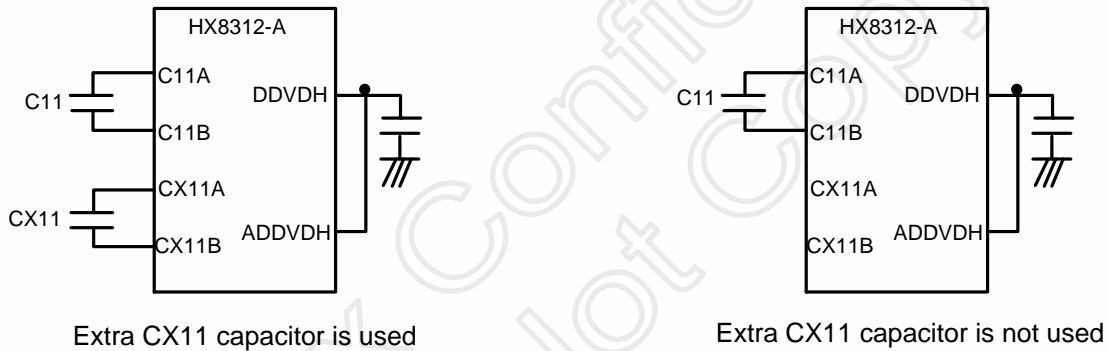


Figure 13. 2 Configuration of the Step up Circuit 1

XVCOMG specify VCOML output level.

“0” : Specified by register R31 and R32.

“1” : VSSA.

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	VDV4	VDV3	VDV2	VDV1	VDV0

Table 13. 8 Power supply system control register 9 (R31)

VDV4-0 specify the amplitude of VCOM output alternating voltage.

VDV4	VDV3	VDV2	VDV1	VDV0	VCOM Amplitude
0	0	0	0	0	VS x 0.60
0	0	0	0	1	VS x 0.63
0	0	0	1	0	VS x 0.66
•					
0	1	1	0	1	VS x 0.99
0	1	1	1	0	VS x 0.102
0	1	1	1	1	Setting Disable
1	0	0	0	0	VS x 1.05
1	0	0	0	1	VS x 1.08
1	0	0	1	0	VS x 1.11
1	0	0	1	1	VS x 1.14
1	0	1	0	0	VS x 1.17
1	0	1	0	1	VS x 1.20
1	0	1	1	0	VS x 1.23
1	0	1	1	1	Setting Disable
1	1	x	x	x	Setting Disable

D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	VCM4	VCM3	VCM2	VCM1	VCM0

Table 13. 9 Power supply system control register 9 (R32)

VCM4-0 specify the high level of VCOM output alternating voltage (VCOMH).

VCM4	VCM3	VCM2	VCM1	VCM0	VCOMH
0	0	0	0	0	VS x 0.40
0	0	0	0	1	VS x 0.42
0	0	0	1	0	VS x 0.44
⋮					
0	1	1	0	1	VS x 0.66
0	1	1	1	0	VS x 0.68
0	1	1	1	1	Internal adjustment halt VCOMH = External pin VcomR input.
1	0	0	0	0	VS x 0.70
1	0	0	1	0	VS x 0.72
1	0	0	1	1	VS x 0.74
⋮					
1	1	1	0	0	VS x 0.94
1	1	1	0	1	VS x 0.96
1	1	1	1	0	VS x 0.98
1	1	1	1	1	Internal adjustment halt VCOMH = External pin VcomR input.



D7	D6	D5	D4	D3	D2	D1	D0
-	-	-	-	BT3	BT2	BT1	BT0

Table 13. 10 Power supply system control register 12 (R37)

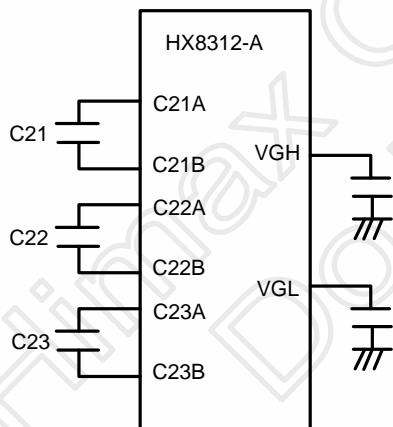
BT2-0 specify the DDVDH, VGH and VGL output voltage level.

C21 capacitor is used

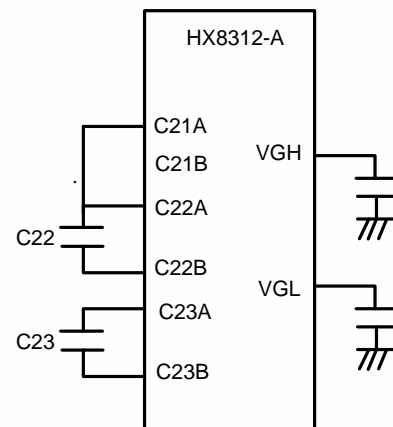
BT3	BT2	BT1	BT0	VGH	VGL
0	0	0	0	VR1 x 8	-VR1 x 7
0	0	0	1	VR1 x 8	-VR1 x 6
0	0	1	0	VR1 x 8	VR2- VR1 x 6
0	0	1	1	VR1 x 7	-VR1 x 7
0	1	0	0	VR1 x 7	-VR1 x 6
0	1	0	1	VR1 x 7	VR2- VR1 x 6
0	1	1	0	VR1 x 6	-VR1 x 6
0	1	1	1	VR1 x 6	VR2- VR1 x 6
1	0	0	0	VR1 x 6	-VR1 x 4
1	0	0	1	VR1 x 6	VR2- VR1 x 4
1	0	1	0	VR1 x 6	-VR1 x 3
1	0	1	1	VR1 x 6	VR2- VR1 x 3
1	1	0	0	VR1 x 5	-VR1 x 5
1	1	0	1	VR1 x 5	-VR1 x 4
1	1	1	0	VR1 x 5	-VR1 x 3
1	1	1	1	VR1 x 5	VR2- VR1 x 3

C21 capacitor is not used

BT3	BT2	BT1	BT0	VGH	VGL
0	0	0	0	VR1 x 6	-VR1 x 5
0	0	0	1	VR1 x 6	-VR1 x 4
0	0	1	0	VR1 x 6	VR2- VR1 x 4
0	0	1	1	VR1 x 5	-VR1 x 5
0	1	0	0	VR1 x 5	-VR1 x 4
0	1	0	1	VR1 x 5	VR2- VR1 x 4
0	1	1	0	VR1 x 4	-VR1 x 4
0	1	1	1	VR1 x 4	VR2- VR1 x 4
1	0	0	0	VR1 x 4	-VR1 x 2
1	0	0	1	VR1 x 4	VR2- VR1 x 2
1	0	1	0	VR1 x 4	-VR1 x 1
1	0	1	1		Inhibit
1	1	0	0	VR1 x 3	-VR1 x 3
1	1	0	1	VR1 x 3	-VR1 x 2
1	1	1	0	VR1 x 3	-VR1 x 1
1	1	1	1		Inhibit



C21 capacitor is used



C21 capacitor is not used

Figure 13. 3 Configuration of the Step up Circuit 2

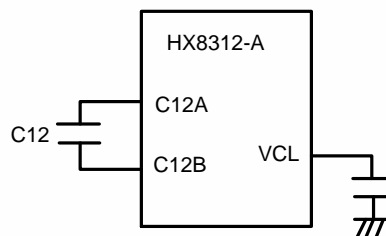


Figure 13. 4 Configuration of the Step up Circuit 3

## 14. Set up Sequence

### 14.1 On / Off Sequence

Register	Setting Value	D7	D6	D5	D4	D3	D2	D1	D0	Operation
VCC, VCI, IOVCC On										
R1	"xx" h	x	x	0	0	0	0	x	0	Start oscillation.
R0	"xx" h	x	x	x	x	0	x	0	x	Stand by mode cancel.
R3	"01" h	0	0	0	0	0	0	0	1	Software reset operation.
Wait for 10ms										
R3	"00" h	0	0	0	0	0	0	0	0	Software reset cancel.
R43	"0x" h	0	0	0	0	x	x	x	x	Oscillation frequency adjust.
R40	"xx" h	x	x	x	x	x	x	x	x	DCDCf setting.
R26	"0x" h	0	0	0	0	x	x	x	x	Step up circuit frequency setting.
R37	"0x" h	0	0	0	0	x	x	x	x	Step up circuit 2 factor setting.
R28	"3x" h	0	0	1	1	0	x	x	x	Set the step-up circuit operating current.
R30	"0x" h	0	0	0	0	x	0	0	1	Set extra CP1 available.
R25	"xx" h	x	x	x	x	x	x	0	0	Set the VR1, VR2 regulator to fit to LCD module.
R24	"C1" h	1	1	0	0	0	0	0	1	Set VR1 and VR2 regulator on.
Wait for 10ms										
R24	"E1" h	1	1	1	0	0	0	0	1	VCL turn on.
R24	"F1" h	1	1	1	1	0	1	0	1	VGH / VGL turn on.
Wait for 60ms										
R24	"F5" h	1	1	1	1	0	1	0	1	DDVDH turn on.
Wait for 60ms										
R27	"0x" h	0	0	0	0	x	x	x	1	VS / VDH set and VS / VDH turn on.
Wait for 10ms										
R32	"xx" h	0	0	0	x	x	x	x	x	Set VCOMH voltage.
R31	"xx" h	0	0	0	x	x	x	x	x	Set VCOM amplitude.
R30	"8x" h	1	0	0	0	x	0	0	1	VCOM start
Wait for 10ms										

**Table 14. 1 Power On Sequence**

Note : "x" means that set the value to meet LCD module characteristic.

Register	Setting Value	D7	D6	D5	D4	D3	D2	D1	D0	Operation
R30	"0x" h	0	0	0	0	x	0	0	1	VCOM stop
R27	"0x" h	0	0	0	0	x	x	x	0	VS / VDH turn off.
R24	"C0" h	1	1	0	0	0	0	0	0	CP1, CP2, CP3 turn off.
Wait for 10ms										
R24	"00" h	0	0	0	0	0	0	0	0	VR1 / VR2 Off.
R28	"30" h	0	0	1	1	0	0	0	0	Step up circuit operating current stop.
VCC, VCI, IOVCC Off										

**Table 14. 2 Power Off Sequence**

Register	Setting Value	D7	D6	D5	D4	D3	D2	D1	D0	Operation
R0	"xx" h	1	0	x	x	0	x	0	x	White display mode setting.
R59	"01" h	0	0	0	0	0	0	0	1	Gate scan start.
Wait for 2 frame scan										
R0	"xx" h	0	0	x	x	0	x	0	x	Normal display operation start.

**Table 14. 3 Display On Sequence**

Register	Setting Value	D7	D6	D5	D4	D3	D2	D1	D0	Operation
R0	"xx" h	1	0	x	x	0	x	0	x	White display mode setting.
Wait for 2 frame scan										
R59	"00" h	0	0	0	0	0	0	0	0	Gate scan stop.

**Table 14. 4 Display Off Sequence**

### 14.2 Operation Sequence

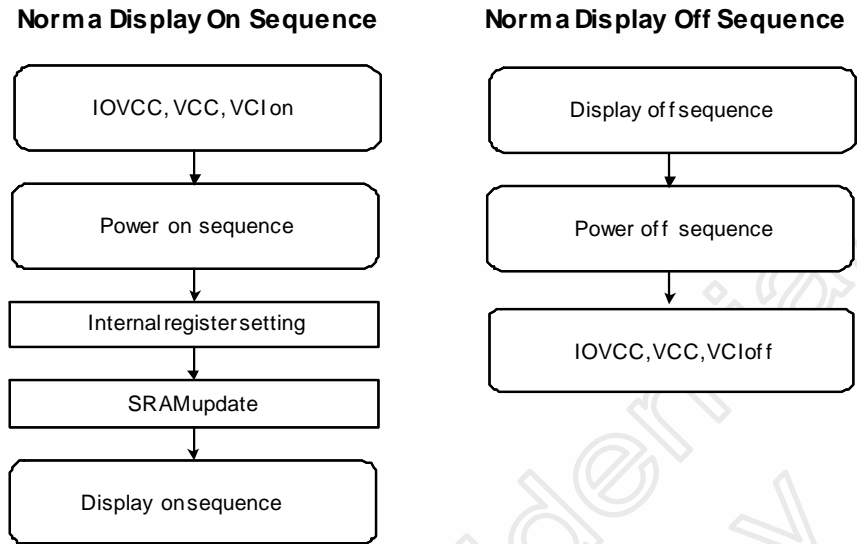
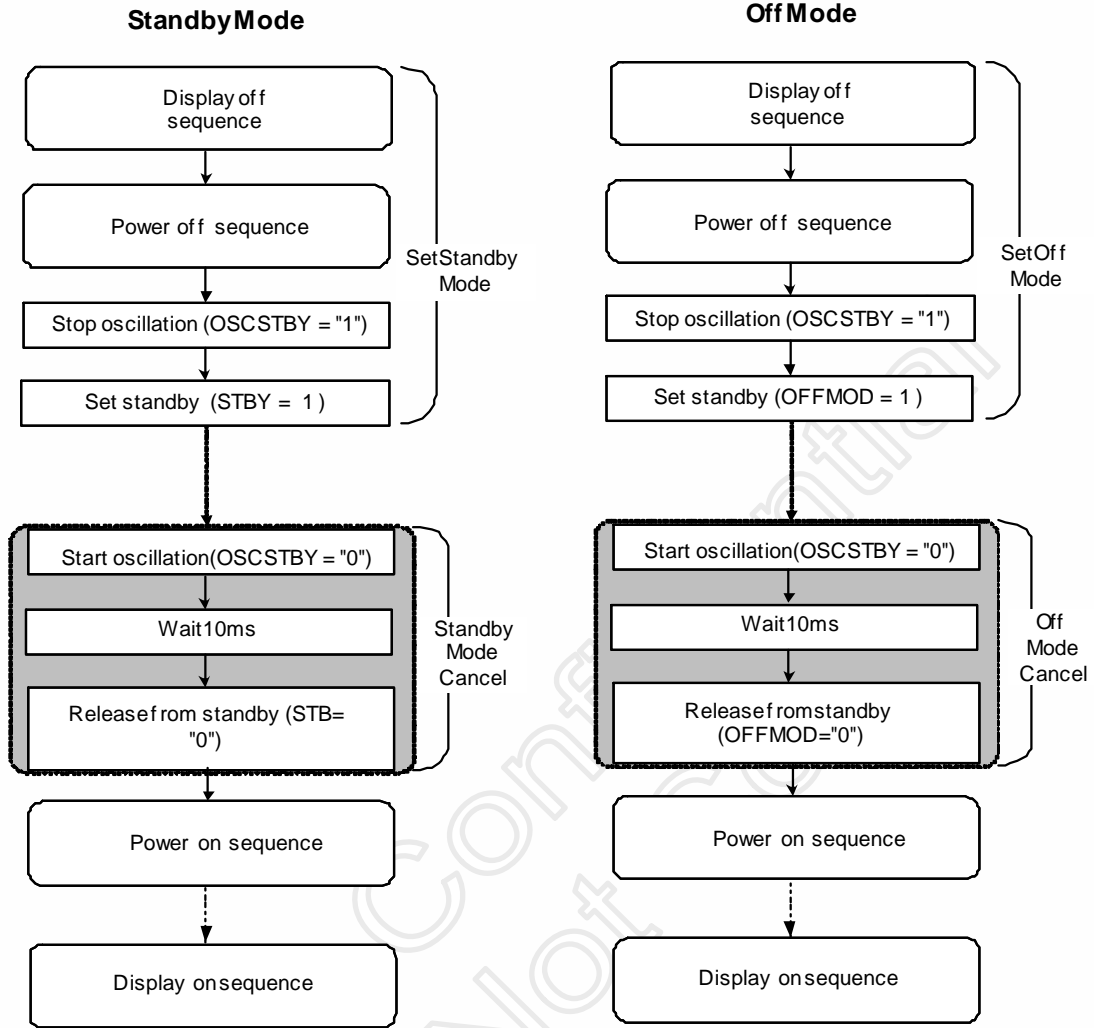


Figure 14. 1 Normal Display On / Off Sequence



Note : In off mode, only OFFMOD bit (D7 bit of R192) can be updated. Other register and the display RAM can not be updated. The display RAM data may not be retained in off mode, and need to rewrite after off mode canceling.

Figure 14. 2 Standby Mode and OFF Mode Sequence

# 15. System Configuration

## 15.1 System Diagram

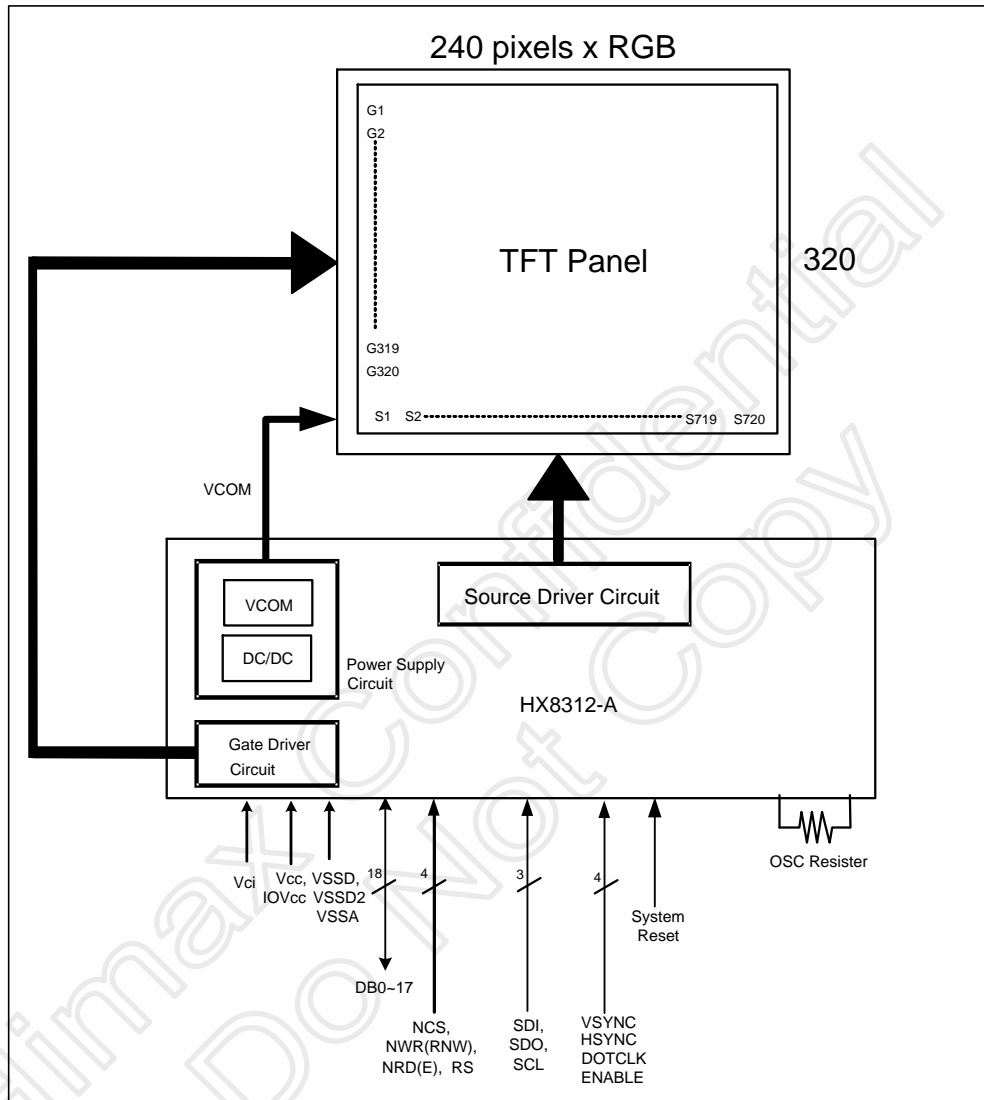


Figure15. 1 System Diagram of HX8312-A

## 15.2 Layout Recommendation

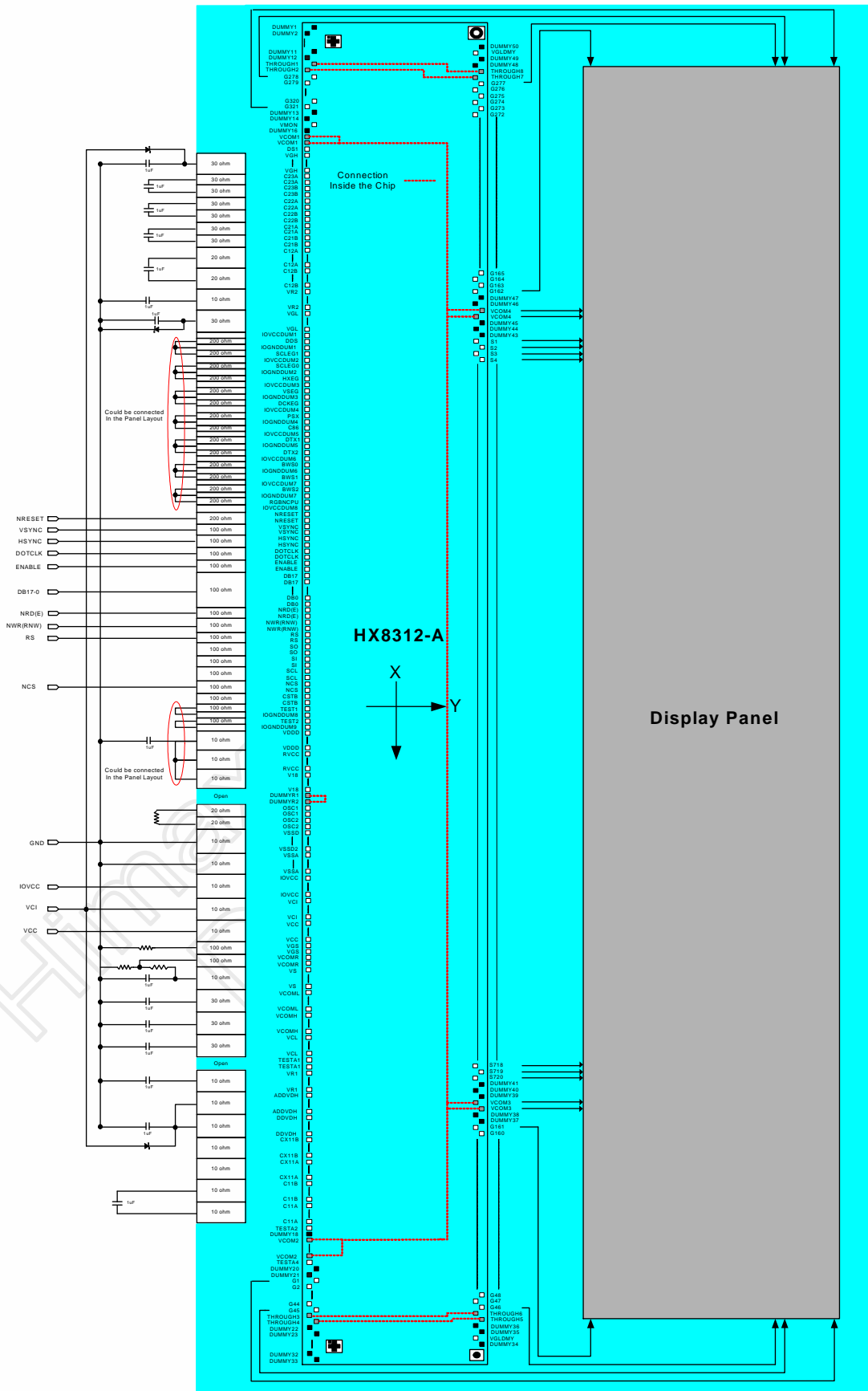


Figure15. 2 Layout Recommendation of HX8312-A

### 15.3 Recommended Passive Components for the Step-up circuits and Others

The specification of recommended passive components used for the step up circuits and others are listed as following table.

Pins connection	Recommended voltage	Capacity
VDDD	6V	1 μF (B characteristics)
C11A/B, CX11A/B, C12A/B, VCL, VR1, VR2, VS, VCOMH, VCOML, DDVDH	10V	1 μF (B characteristics)
C21A/B, C22A/B, C23A/B, VGH, VGL	25V	1 μF (B characteristics)

Table 15. 1 The adoptability of Capacitor

Pins connection	Feature
(VSSA – VGL) (VCI – VGH) (VCI – DDVDH)	VF < 0.4V / 20mA at 25°C, VR ≥30V

Table 15. 2 The adoptability of Schottkey diode

Pins connection	Feature
VcomR	> 200 kΩ

Table 15. 3 The adoptability of Variable resistor



## 16. Register Description

Register	Bit	Symbol	Function	Configuration
<b>Control register 1</b>				
R0 (R00h)  default "A0"h	D7	DISP1	Source output data selection.	All source output as "0" or "1" selection Refer to "10.2 " All "0" or "1" Source Output Display "
	D6	DISP0	Source output data selection.	All source output as "0" or "1" selection Refer to "10.2 " All "0" or "1" Source Output Display "
	D5	ADC	Specifies source output and display RAM address mapping.	Refer to 4.1 "Relation between the Display RAM Address and the Source Output Channel"
	D4	DTY	Specifies partial display mode.	"0" : Normal display mode. "1" : Partial display mode. Refer to "5. Partial Display Mode".
	D3	STBY	Specifies stand-by mode.	"0" : Normal operation. "1" : Stand-by mode.
	D2	COLOR	Specifies color mode.	"0" : 262,144 color mode. "1" : 8 color mode. Refer to "9 8-color Display Mode".
	D1	-	-	-
	D0	GSM	Gate scan selection in partial-off display areas.	"0" : Normal scan in non-display area "1" : Configures the scanning cycle in non-display area by the number of the R52 register.
<b>Control register 2</b>				
R1 (R01h)  default "00"h	D7	ADX	RAM X address increment direction after one write or read operation .	"0" : From X0 to X239 Refer to "4.2. Display RAM Access" "1" : From X239 to X0 *Note : ADX = "1" setting is prohibited when RGB interface circuit is in use.
	D6	ADR	RAM Y address increment direction after one write or read operation .	"0" : Y0 to Y319 Refer to "4.2. Display RAM Access" "1" : Y319 to Y0 *Note : ADR = "1" setting is prohibited when RGB interface circuit is in use.
	D5	-	-	-
	D4	GSEL	Specifies voltage level of V0 and V63	"0" : V0=VDH, V63 = VSSA. "1" : Depends on the OP0/1 and CP0/1 register setting. Refer to "8 Gamma Adjustment Function".
	D3	-	-	-
	D2	-	-	-
	D1	LTS	Specifies setting period of calibration.	"0" : 1line period = tcal "1" : 1 line period = tcal x 2 Refer to "3.3 Internal Clock Mode".
	D0	OSCSTB Y	Oscillation control.	"0" : Starts oscillation. "1" : Stops oscillation.
<b>RGB interface register 2</b>				
R2 (R02h)  default "00"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	VMODE	VSYNC interface selection.	"0" : Normal Refer to "Table 9. 1". "1" : Uses VSYNC interface.
	D3	-	-	-
	D2	RGBS	RGB interface writing mode selection.	"0" : Capture mode. Refer to "Table 9. 1". "1" : Through mode.
	D1	DISPCK	Specifies display timing at RGB interface circuit.	"0" : Internally synchronized display mode by SYSCLK. "1" : Externally synchronized display mode by VSYNC and HSYNC. Refer to "Table 9. 1".
	D0	NWRGB	RGB interface pin control.	"0" : Writes to the display data RAM via the system interface circuit. "1" : Writes to the display data RAM via the RGB interface circuit. Refer to "Table 9. 1".

Reset register 1					
R3 (R03h)	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	D2	-	-	-	
	D1	-	-	-	
	default "00"h	D0	RES	Reset command for the HX8312-A	"0" : Normal operation. "1" : Reset Operation.
RAM access control register					
R5 (R05h)	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	WAS	Specifies window area access mode.	"0" : Normal writing mode. "1" : Window area access mode. Refer to "4.3. Window Area Access Mode".	
	D3	-	-	-	
	default "00"h	D2	AM	Specifies the address increment direction.	"0" : X address increment, then Y address increment. "1" : Y address increment, then X address increment, *Note: This setting is invalid when RGB interface circuit is in use. Refer to "4.2. Access to the Display Data RAM".
	D1	-	-	-	
	D0	-	-	-	
Data reverse register					
R6 (R06h)	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	default "00"h	D2	-	-	-
	D1	-	-	-	
	D0	REV	Reverse the source output data voltage	"0": Data "0000"h; Source output: V0 at VCOML "1": Data "0000"h; Source output V63 at VCOML	
Display size control register					
R13 (R0Dh)	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	default "00"h	D2	NSO1	Specify source output size.	Refer to "4.1 Relation between the Display RAM Address and the Source Output Channel".
	D1	NSO0			
	D0	-	-	-	
Partial non-display area color register 1					
R14 (R0Eh)	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	D2	-	-	-	
	default "00"h	D1	-	-	-
	D0	PSEL	Specifies the color of the partial non-display area	"0" : Displays the color specified in the R15 register. "1" : Displays the most significant bit of the display RAM data. Refer to "5.2 Display Color Selection and Gate Scan Method in Partial Non-Display Areas".	

Partial non-display area color register 2				
R15 ("0F" h)  default "00" h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	PGR	Specifies display data for pixel R.	"0" : Displays "0". "1" : Displays "1".
	D1	PGG	Specifies display data for pixel G.	"0" : Displays "0". "1" : Displays "1".
	D0	PGB	Specifies display data for pixel B.	"0" : Displays "0". "1" : Displays "1".
First display window area starting register 1 , 2				
R16 (R10h)  default "00" h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P1SL8	Specify the starting line number of the first display window area.	Set within the range of "000" h - "13F" h.
R17 (R11h)  default "00" h	D7	P1SL7		
	D6	P1SL6		
	D5	P1SL5		
	D4	P1SL4		
	D3	P1SL3		
	D2	P1SL2		
	D1	P1SL1		
	D0	P1SL0		
Second display window area starting register 1 , 2				
R18 (R12h)  default "00" h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P2SL8	Specify the starting line number of the second display window area.	Set within the range of "000" h - "13F" h.
R19 (R13h)  default "00" h	D7	P2SL7		
	D6	P2SL6		
	D5	P2SL5		
	D4	P2SL4		
	D3	P2SL3		
	D2	P2SL2		
	D1	P2SL1		
	D0	P2SL0		
First display window area display line number 1 , 2				
R20 (R14h)  default "00" h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P1AW8	Specify the display line number of the first display window area.	Set within the range of "001" h - "140" h.
R21 (R15h)  default "00" h	D7	P1AW7		
	D6	P1AW6		
	D5	P1AW5		
	D4	P1AW4		
	D3	P1AW3		
	D2	P1AW2		
	D1	P1AW1		
	D0	P1AW0		

Second display window area display line number 1 , 2				
R22 (R16h)  default "00"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P2AW8		
R23 (R17h)  default "00"h	D7	P2AW7	Specify the display line number of the second display window area.	Set within the range of 000"h - "13F"h.
	D6	P2AW6		
	D5	P2AW5		
	D4	P2AW4		
	D3	P2AW3		
	D2	P2AW2		
	D1	P2AW1		
	D0	P2AW0		
Power Supply System Control Register 1				
R24 (R18h)  default "00"h	D7	VR2ON	Controls the VR2 regulator.	"0" : VR2 regulator off. "1" : VR2 regulator on.
	D6	VR1ON	Controls the VR1 regulator.	"0" : VR1 regulator off. "1" : VR1 regulator on.
	D5	VCLON	Controls the step-up circuit 3 for VCL..	"0" : VCL step-up circuit off. "1" : VCL step-up circuit on.
	D4	VGON	Controls the step-up circuit 2.	"0" : Step-up circuit 2 off. "1" : Step up circuit 2 on.
	D3	-	-	-
	D2	DDVDHON	Controls the step-up circuit 1 for DDVDH.	"0" : DDVDH step-up circuit off. "1" : DDVDH step-up circuit on.
	D1	-	-	-
	D0	DCON	Controls the DC/DC converter.	"0" : DC/DC converter off. "1" : DC/DC converter on.
Power Supply System Control Register 2				
R25 (R19h)  default "00"h	D7	VR2SEL2	Specify the output voltage of the VR2 regulator.	-
	D6	VR2SEL1		
	D5	VR2SEL0		
	D4	VR1SEL2	Specify the output voltage of the VR1 regulator.	-
	D3	VR1SEL1		
	D2	VR1SEL0		
	D1	-	-	-
	D0	-	-	-
Power Supply System Control Register 3				
R26 (R1Ah)  default "05"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	DC3	Specify the step-up circuit 2 and 3 frequency	-
	D2	DC2		
	D1	DC1	Specify the step-up circuit 1 frequency	-
	D0	DC0		
Power Supply System Control Register 4				
R27 (R1Bh)  default "0A"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	VSEL2	Specify the output voltage of the VS and VDH regulator.	-
	D2	VSEL1		
	D1	VSEL0		
	D0	RGON	Controls the VS and VDH regulator.	"0" : VS and VDH regulator off. "1" : VS and VDH regulator on.

Power Supply System Control Register 5				
R28 (R1Ch)  default "33"h	D7	-	-	-
	D6	SAP2	Source driver circuit operating current control	(SAP2, SAP1, SAP0) = "000": Halt (SAP2, SAP1, SAP0) = "001": 0.5(fixed) (SAP2, SAP1, SAP0) = "010": 0.75(fixed) (SAP2, SAP1, SAP0) = "011": 1.0(fixed) (SAP2, SAP1, SAP0) = "100": 1.25(fixed) (SAP2, SAP1, SAP0) = "101": 1.5(fixed) (SAP2, SAP1, SAP0) = "110": 1.5(fixed) (SAP2, SAP1, SAP0) = "111": Setting disable
	D5	SAP1		
	D4	SAP0		
	D3	-		
	D2	AP2	Step-up circuit operating current control	(AP2, AP1, AP0) = "000": Halt (AP2, AP1, AP0) = "001": Setting disable (AP2, AP1, AP0) = "010": 0.5(fixed) (AP2, AP1, AP0) = "011": 0.75(fixed) (AP2, AP1, AP0) = "100": 1.0(fixed) (AP2, AP1, AP0) = "101": 1.25(fixed) (AP2, AP1, AP0) = "110": 1.5(fixed) (AP2, AP1, AP0) = "111": Setting disable
	D1	AP1		
	D0	AP0		
Power Supply System Control Register 6				
R29 (R1Dh)  default "03"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	R/L	Specifies the gate scan direction.	-
	D2	SCN2	Specify gate scan mode.	(SCN2, SCN1, SCN0) = "XX0" : MODE5 (SCN2, SCN1, SCN0) = "011" : MODE2
	D1	SCN1		
	D0	SCN0		
Power Supply System Control Register 8				
R30 (R1Eh)  default "00"h	D7	VCOMEN	Specify the VCOM1 operation.	-
	D6	-		
	D5	VCOMFX		
	D4	VCOMHI		
	D3	XVCOMG	VCOML output control	"0": VCOML is setting by VDV and VCM bits "1": VCOML = VSSA
	D2	-	-	-
	D1	-	-	-
	D0	DDVDHXON	Specifies whether to use or not to use the extra step-up circuit 1 for DDVDH.	"0" : Doesn't use the extra step-up circuit 1. "1" : Uses the extra step-up circuit 1.
Power Supply System Control Register 9				
R31 (R1Fh)  default "00"h	D7	-	Specify the VCOM amplitude.	-
	D6	-		
	D5	-		
	D4	VDV4		
	D3	VDV3		
	D2	VDV2		
	D1	VDV1		
	D0	VDV0		
Power Supply System Control Register 10				
R32 (R20h)  default "00"h	D7	-	Specify the VCOMH voltage level	-
	D6	-		
	D5	-		
	D4	VCM4		
	D3	VCM3		
	D2	VCM2		
	D1	VCM1		
	D0	VCM0		

Power Supply System Control Register 11						
R36 (R24h)  default "73" h	D7	-	-	-		
	D6	IBV2	Specify the constant current source of V18 regulator.	(IBV2, IBV1, IBV0) = "000": 0.2		
	D5	IBV1		(IBV2, IBV1, IBV0) = "001": 0.4		
	D4	IBV0		(IBV2, IBV1, IBV0) = "010": 0.6		
				(IBV2, IBV1, IBV0) = "011": 0.8		
	D3	-	-	(IBV2, IBV1, IBV0) = "100": Setting disable		
				(IBV2, IBV1, IBV0) = "101": Setting disable		
	D2	BIAS2	Specify the constant current source of VCOM regulator	(IBV2, IBV1, IBV0) = "110": Setting disable		
(IBV2, IBV1, IBV0) = "111": 1						
D1	BIAS1	(BIAS2, BIAS1, BIAS0) = "000": Halt				
D0	BIAS0	(BIAS2, BIAS1, BIAS0) = "001": Setting disable				
		(BIAS2, BIAS1, BIAS0) = "010": 0.5				
		(BIAS2, BIAS1, BIAS0) = "011": 0.75				
		(BIAS2, BIAS1, BIAS0) = "100": 1				
		(BIAS2, BIAS1, BIAS0) = "101": 1.25				
Power Supply System Control Register 12						
R37 (R25h)  default "00" h	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	D3	BT3	Specify the step-up factor in step up circuit 2.	-		
					D2	BT2
					D1	BT1
					D0	BT0
Power Supply System Control Register 14						
R40 (R28h)  default "25" h	D7	DCCLK7	Specify the frequency for the DC/DC converter (DCDCf)	DCDCf = SYSClk / DCCLK		
	D6	DCCLK6				
	D5	DCCLK5				
	D4	DCCLK4				
	D3	DCCLK3				
	D2	DCCLK2				
	D1	DCCLK1				
	D0	DCCLK0				
OSC resistance control						
R43 (R2Bh)  default "00" h	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	D3	RADJ2	Internal oscillator frequency correction function	(RADJ2, RADJ1, RADJ0) = "000": No correction		
				(RADJ2, RADJ1, RADJ0) = "001": -10%		
	D2	RADJ1		(RADJ2, RADJ1, RADJ0) = "010": -20%		
				(RADJ2, RADJ1, RADJ0) = "011": -30%		
D1	RADJ0	(RADJ2, RADJ1, RADJ0) = "100": +10%				
		(RADJ2, RADJ1, RADJ0) = "101": +20%				
		(RADJ2, RADJ1, RADJ0) = "110": +30%				
D0	ROSC	(RADJ2, RADJ1, RADJ0) = "111": +40%				
R45 (R2Dh)  default "01" h	Calibration register					
	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	D3	-	-	-		
	D2	-	-	-		
	D1	-	-	-		
D0	OC	Execute calibration.	"0" : Starts calibration "1" : Stops calibration. Refer to "3.3 Internal Clock Mode"			

ID code register 1				
R49 (R31h)  default "01" h	D7	MCOD3	Manufacturer code.	
	D6	MCOD2		
	D5	MCOD1		
	D4	MCOD0		
	D3	VCOD3	The version of this LSI.	
	D2	VCOD2		
	D1	VCOD1		
	D0	VCOD0		
			-	
ID code register 2				
R50 (R32h)  default "0C" h	D7	DCOD7	Device code of this LSI.	
	D6	DCOD6		
	D5	DCOD5		
	D4	DCOD4		
	D3	DCOD3		
	D2	DCOD2		
	D1	DCOD1		
	D0	DCOD0		
N line inversion register				
R51 (R33h)  default "01" h	D7	NLINE6	Specify the number of lines for N line inversion.	
	D6	NLINE5		
	D5	NLINE4		
	D4	NLINE3		
	D3	NLINE2		
	D2	NLINE1		
	D1	NLINE0		
	D0	NLINE0		
Partial gate register 1				
R52 (R34h)  default "01" h	D7	GSMLN7	Specify the gate scanning cycle of the non-display area	
	D6	GSMLN6		
	D5	GSMLN5		
	D4	GSMLN4		
	D3	GSMLN3		
	D2	GSMLN2		
	D1	GSMLN1		
	D0	GSMLN0		
Partial gate register 2				
R53 (R35h)  default "00" h	D7	-	-	
	D6	-	-	
	D5	-	-	
	D4	-	-	
	D3	-	-	
	D2	-	-	
	D1	-	-	
	D0	PNFRM	Configures the driving method of the partial non-display area.	"0" : The partial non-display area is driven as that in the partial display area. "1" : The partial non-display area is driven by the frame inversion.
Gate scan selection register				
R55 (R37h)  default "00" h	D7	-	-	
	D6	-	-	
	D5	-	-	
	D4	-	-	
	D3	-	-	
	D2	GSCAN2	Select the method of gate scanning.	-
	D1	GSCAN1		
	D0	GSCAN0		
Gate output control register				
R59 (R3Bh)  default "00" h	D7	-	-	
	D6	-	-	
	D5	-	-	
	D4	-	-	
	D3	-	-	
	D2	-	-	
	D1	-	-	
	D0	DISPTMG	Controls the gate output	"0" : Fix all gate outputs to VGL level. "1" : Gate scanning normal operation.

RGB start line register 1 , 2						
R60 (R3Ch)	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	D3	-	-	-		
	D2	-	-	-		
	D1	-	-	-		
	D0	RGBST8				
R61 (R3Dh)	D7	RGBST7	Specify the display start line in the RGB interface circuit.	-		
	D6	RGBST6				
	D5	RGBST5				
	D4	RGBST4				
	D3	RGBST3				
	D2	RGBST2				
	D1	RGBST1				
	D0	RGBST0				
RGB end line register 1 , 2						
R62 (R3Eh)	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	D3	-	-	-		
	D2	-	-	-		
	D1	-	-	-		
	D0	RGBED8				
R63 (R3Fh)	D7	RGBED7	Specify the display end line in the RGB interface circuit.	-		
	D6	RGBED6				
	D5	RGBED5				
	D4	RGBED4				
	D3	RGBED3				
	D2	RGBED2				
	D1	RGBED1				
	D0	RGBED0				
Horizontal back porch setting register						
R64 (R40h)	D7	-	-	-		
	D6	-	-	-		
	D5	HBP5	Specify the horizontal back porch period in the RGB interface circuit.	-		
	D4	HBP4				
	D3	HBP3				
	D2	HBP2				
	D1	HBP1				
	D0	HBP0				
Vertical back porch setting register						
R65 (R41h)	D7	-			-	-
	D6	-	-	-		
	D5	VBP5	Specify the vertical back porch period in the RGB interface circuit			
	D4	VBP4				
	D3	VBP3				
	D2	VBP2				
	D1	VBP1				
	D0	VBP0				
X address register						
R66 (R42h)	D7	XA7			Specify the X-starting address of the display RAM.	Set within the range of "00"h - "EF"h.
	D6	XA6				
	D5	XA5				
	D4	XA4				
	D3	XA3				
	D2	XA2				
	D1	XA1				
	D0	XA0				



Y address register				
R67 (R43h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	YA8		
R68 (R44h)	D7	YA7	Specify the Y-starting address of the display RAM	Set within the range of "000"h - "13F"h.
	D6	YA6		
	D5	YA5		
	D4	YA4		
	D3	YA3		
	D2	YA2		
	D1	YA1		
	D0	YA0		
MIN X address register				
R69 (R45h)	D7	XMIN7	Specify X start address for the window area access mode.	Set within the range of "00"h - "EF"h.
	D6	XMIN6		
	D5	XMIN5		
	D4	XMIN4		
	D3	XMIN3		
	D2	XMIN2		
	D1	XMIN1		
	D0	XMIN0		
MAX X address register				
R70 (R46h)	D7	XXM7	Specify X end address for the window area access mode.	Set within the range of "00"h - "EF"h.
	D6	XXM6		
	D5	XXM5		
	D4	XXM4		
	D3	XXM3		
	D2	XXM2		
	D1	XXM1		
	D0	XXM0		
MIN Y address register				
R71 (R47h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	YMIN8		
R72 (R48h)	D7	YMIN7	Specify the Y start address for the window area access mode	Set within the range of "000"h - "13F"h
	D6	YMIN6		
	D5	YMIN5		
	D4	YMIN4		
	D3	YMIN3		
	D2	YMIN2		
	D1	YMIN1		
	D0	YMIN0		

MAX Y address register						
R73 (R49h)	D7	-	-	-		
	D6	-	-	-		
	D5	-	-	-		
	D4	-	-	-		
	default "00"h	D3	-	-	-	
		D2	-	-	-	
		D1	-	-	-	
		D0	YMX8	Specify the Y end address for the window area access mode	Set within the range of "000"h -"13F"h	
R74 (R4Ah)	D7	YMX7				
	D6	YMX6				
	D5	YMX5				
	D4	YMX4				
	D3	YMX3				
	D2	YMX2				
	D1	YMX1				
default "00"h	D0	YMX0				
	Scroll area start register 1, 2					
	R75 (R4Bh)	D7	-	-	-	
		D6	-	-	-	
		D5	-	-	-	
		D4	-	-	-	
		default "00"h	D3	-	-	-
			D2	-	-	-
D1			-	-	-	
D0			SSL8	Specify the scroll start line address	Set within the range of "000"h -"13F"h	
R76 (R4Ch)	D7	SSL7				
	D6	SSL6				
	D5	SSL5				
	D4	SSL4				
	D3	SSL3				
	D2	SSL2				
	D1	SSL1				
default "00"h	D0	SSL0				
	Scroll area line number register 1, 2					
	R77 (R4Dh)	D7	-	-	-	
		D6	-	-	-	
		D5	-	-	-	
		D4	-	-	-	
		default "00"h	D3	-	-	-
			D2	-	-	-
D1			-	-	-	
D0			SAW8	Specify the scroll area line number	Set within the range of "000"h -"13F"h	
R78 (R4Eh)	D7	SAW7				
	D6	SAW6				
	D5	SAW5				
	D4	SAW4				
	D3	SAW3				
	D2	SAW2				
	D1	SAW1				
default "00"h	D0	SAW0				

Scroll area step number register 1, 2					
R79 (R4Fh)  default "00"h	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	D2	-	-	-	
	D1	-	-	-	
	D0	SST8	Specify the number of lines to be scrolled (amount of scrolling)	Set within the range of "000"h-"13F"h.	
R80 (R50h)  default "00"h	D7	SST7			
	D6	SST6			
	D5	SST5			
	D4	SST4			
	D3	SST3			
	D2	SST2			
	D1	SST1			
	D0	SST0			
R118 (R76h)  default "00"h	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	D2	-	-	-	
	D1	-	-	-	
	D0	DMYSEL	Specify the number of dummy lines	"0" : 1 line refer to "11.2 Blanking Period and Dummy Line Location"	"1" : 8 line
Gate on interval control register					
R134 (R86h)  default "00"h	D7	-	-	-	
	D6	-	-	-	
	D5	-	-	-	
	D4	-	-	-	
	D3	-	-	-	
	D2	-	-	-	
	D1	-	-	-	
	D0	GOF8	Specify the gate line output off timing.	GOF = GON + Gate output period 1) Set GOF by the SYSCLK number in the internally synchronized display mode. 2) Set GOF by the Dotclk number / 8 in the externally synchronized display mode.	
R135 (R87h)  default "20"h	D7	GOF7			
	D6	GOF6			
	D5	GOF5			
	D4	GOF4			
	D3	GOF3			
	D2	GOF2			
	D1	GOF1			
	D0	GOF0			
Source on interval control register					
R136 (R88h)  default "02"h	D7	SON7	Specify the source line output on timing.	Set the time from the horizontal period by the SYSCLK number.	
	D6	SON6			
	D5	SON5			
	D4	SON4			
	D3	SON3			
	D2	SON2			
	D1	SON1			
	D0	SON0			
Gate on interval control register					
R137 (R89h)  default "03"h	D7	GON7	Specify the gate line output off timing.	GON is the time from the starting of the horizontal scan. 1) Set GON by the SYSCLK number in the internally synchronized display mode. 2) Set GON by the Dotclk number / 8 in the externally synchronized display mode.	
	D6	GON6			
	D5	GON5			
	D4	GON4			
	D3	GON3			
	D2	GON2			
	D1	GON1			
	D0	GON0			

Line clock register 1				
R139 (R8Bh)  default "25"h	D7	HCK7	Specify the period for the number of 1 horizontal period.	R141: CLKM=0 => a calibrated clock number is written. R141: CLKM=1 => Set a raster-row clock number; the integer of HCK close to a target frame frequency calculated with SYSCLK number. *Note: This HCK setting is invalid when CLKM=0.
	D6	HCK6		
	D5	HCK5		
	D4	HCK4		
	D3	HCK3		
	D2	HCK2		
	D1	HCK1		
	D0	HCK0		
Line clock register 2				
R140 (R8Ch)  default "25"h	D7	HCK7	A register to read the R139 data.	The data of R139 is copied to this register automatically. The MPU can read the same data as R139.
	D6	HCK6		
	D5	HCK5		
	D4	HCK4		
	D3	HCK3		
	D2	HCK2		
	D1	HCK1		
	D0	HCK0		
Line frequency control register				
R141 (R8Dh)  default "00"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	CLKM	Specifies the line frequency control mode.	"0" : Calibration mode. "1" : Register set-up mode.
Gamma control register 1				
R143 (R8Fh)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MP12		
	D5	MP11		
	D4	MP10		
	D3	-		
	D2	MP02		
	D1	MP01		
	D0	MP00		
Gamma control register 2				
R144 (R90h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MP32		
	D5	MP31		
	D4	MP30		
	D3	-		
	D2	MP22		
	D1	MP21		
	D0	MP20		
Gamma control register 3				
R145 (R91h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MP52		
	D5	MP51		
	D4	MP50		
	D3	-		
	D2	MP42		
	D1	MP41		
	D0	MP40		
Gamma control register 4				
R146 (R92h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	CP12		
	D5	CP11		
	D4	CP10		
	D3	-		
	D2	CP02		
	D1	CP01		
	D0	CP00		

Gamma control register 5				
R147 (R93h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MN12		
	D5	MN11		
	D4	MN10		
	D3	-		
	D2	MN02		
	D1	MN01		
	D0	MN00		
Gamma control register 6				
R148 (R94h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MN32		
	D5	MN31		
	D4	MN30		
	D3	-		
	D2	MN22		
	D1	MN21		
	D0	MN20		
Gamma control register 7				
R149 (R95h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	MN52		
	D5	MN51		
	D4	MN50		
	D3	-		
	D2	MN42		
	D1	MN41		
	D0	MN40		
Gamma control register 8				
R150 (R96h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	CN12		
	D5	CN11		
	D4	CN10		
	D3	-		
	D2	CN02		
	D1	CN01		
	D0	CN00		
Gamma control register 9				
R151 (R97h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	-		
	D5	-		
	D4	-		
	D3	OP03		
	D2	OP02		
	D1	OP01		
	D0	OP00		
Gamma control register 10				
R152 (R98h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	-		
	D5	-		
	D4	OP14		
	D3	OP13		
	D2	OP12		
	D1	OP11		
	D0	OP10		
Gamma control register 11				
R153 (R99h)  default "00"h	D7	-	Gamma adjustment register	-
	D6	-		
	D5	-		
	D4	-		
	D3	ON03		
	D2	ON02		
	D1	ON01		
	D0	ON00		

Gamma control register 12				
R154 (R9Ah)  default "00" h	D7	-	Gamma adjustment register	-
	D6	-		
	D5	-		
	D4	ON14		
	D3	ON13		
	D2	ON12		
	D1	ON11		
	D0	ON10		
Extend mode register				
R157 (R9Dh)  default "00" h	D7	-	-	-
	D6	-	-	-
	D5	MON_EN	Specify the V0 and V63 monitor function	"0": V0 and V63 output monitor is disable. "1": V0 and V63 output monitor is enable.
	D4	MON_SEL	V0 and V63 monitor selection	"0": V0 outputs at DS1 pin. "1": V63 outputs at DS1 pin
	D3	-	-	-
	D2	BPEN	Specify the Enable operation	"0": Enable control is available. "1": VBP/HBP control is enable
	D1	EPL	Specify the Enable polarity	"0": High active "1": Low active
	D0	MSBF	NWRGB (R2:D0) = "1"	"0": 18-bit x 1transfer ( BWS2="L" ). RGB interface type RGB1 "0": 16-bit x 1transfer ( BWS2="H" ). RGB interface type RGB2 "1": 6-bit x 3 transfer ( BWS2=x ). RGB interface type RGB3
	NWRGB (R2:D0) = "0"		"0": MPU5 mode A ( use lower 6bits ). MPU interface type "1": MPU5 mode B ( use upper 6bits ). MPU interface type This bit is invalid in other modes.	
Off mode register				
R192 (C0 h)  default "00" h	D7	OFFMOD	Specify the Off mode	"0": Normal mode "1": Off mode In off mode, only OFFMOD bit can be updated. Other register and the display RAM can not be updated. The display RAM data may not be retained in off mode, and need to rewrite after off mode canceling.
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	-	-	-
RGB mode register				
R193 (C1 h)  default "01" h	D7			
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	BGR	Specify the order of <R><G><B> dot color in one pixel stored in display RAM.	When BGR = 1, the order sent from the MPU with expanding to 18 bits are reversed bit order from <R><G><B> order to <B><G><R> order.

## 17. Electrical Characteristic

### 17.1 Absolute Maximum Ratings

The absolute maximum ratings are list on Table 17.1. When used out of the absolute maximum ratings, the LSI may be permanently damaged. Using the LSI within the following electrical characteristics limit is strongly recommended for normal operation. If these electrical characteristic conditions are exceeded during normal operation, the LSI will malfunction and cause poor reliability.

Item	Symbol	Unit	Value	Note
Power Supply Voltage (1)	VCC,IOVCC	V	-0.3 to +4.6	1,2
Power Supply Voltage (2)	VCI ~ VSSA	V	-0.3 to +4.6	1,2
Power Supply Voltage (3)	VLCD ~ VSSA	V	-0.3 to +6.0	3
Power Supply Voltage (4)	VSSA ~ VCL	V	-0.3 to +4.6	4
Power Supply Voltage (5)	VLCD ~ VCL	V	-0.3 to +9	5
Power Supply Voltage (6)	VGH ~ VSSA	V	-0.3 to +18.5	6
Power Supply Voltage (7)	VSSA ~ VGL	V	0 to -16.5	7
Input Voltage	Vi	V	-0.3 to VCC+0.3	-
Operating Temperature	Topr	°C	-40 to +85	8,9
Storage Temperature	Tstg	°C	-55 to +110	8,9

Table 17. 1 Absolute maximum rating

Note:

- 1.VCC, VSSD must be maintained.
- 2.To make sure IOVCC ≥ VSSD.
- 3.To make sure VCI ≥ VSSA.
- 4.To make sure VLCD ≥ VSSA.
- 5.To make sure VLCD ≥ VCL.
- 6.To make sure VGH ≥ VSSA.
- 7.To make sure VSSA ≥ VGL  
VGH +|VGL| < 32V
- 8.For die and wafer products, specified up to +85°C.
- 9.This temperature specifications apply to the TCP package.

## 17.2 AC Characteristic

### Clock Characteristics (VCC = 2.2 ~ 3.3V)

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
External clock frequency	f <sub>cp</sub>	MHz	-	1.2	-	VCC= 2.4 ~ 3.3V
External clock duty ratio	Duty	%	45	50	55	VCC= 2.4 ~ 3.3V
External clock rise time	Trcp	μs	-	-	0.2	VCC= 2.4 ~ 3.3V
External clock fall time	Tfcp	μs	-	-	0.2	VCC= 2.4 ~ 3.3V
R-C oscillation clock	f <sub>OSC</sub>	MHz	-	1.2	-	Rf = 100K Ω , VCC=2.8V

### 80-system Bus Interface Timing Characteristics

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition	
Bus cycle time	Write	t <sub>CYCW</sub>	ns	200	-	-	Figure 17.1
	Read	t <sub>CYCR</sub>	ns	300	-	-	Figure 17.1
Write low-level pulse width	PW <sub>LW</sub>	ns	40	-	-	Figure 17.1	
Read low-level pulse width	PW <sub>LR</sub>	ns	150	-	-	Figure 17.1	
Write high-level pulse width	PW <sub>HW</sub>	ns	70	-	-	Figure 17.1	
Read high-level pulse width	PW <sub>HR</sub>	ns	150	-	-	Figure 17.1	
Write / Read rise / fall time	t <sub>WRr</sub> , t <sub>WRf</sub>	ns	-	-	25	Figure 17.1	
RS Setup time ( RS to NCS, NWR )	t <sub>AS</sub>	ns	5	-	-	Figure 17.1	
RS hold time ( NCS, NWR to RS )	t <sub>AH</sub>	ns	5	-	-	Figure 17.1	
Write data set up time	t <sub>DSW</sub>	ns	20	-	-	Figure 17.1	
Write data hold time	t <sub>H</sub>	ns	15	-	-	Figure 17.1	
Read data delay time	t <sub>DDR</sub>	ns	-	-	100	Figure 17.1	
Read data hold time	t <sub>DHR</sub>	ns	5	-	-	Figure 17.1	

Table 17. 2 Normal Write Mode (IOVCC = 1.65 ~ 2.4V) / (VCC = 2.4V~3.3V)

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition	
Bus cycle time	Write	t <sub>CYCW</sub>	ns	125	-	-	Figure 17.1
	Read	t <sub>CYCR</sub>	ns	300	-	-	Figure 17.1
Write low-level pulse width	PW <sub>LW</sub>	ns	40	-	-	Figure 17.1	
Read low-level pulse width	PW <sub>LR</sub>	ns	150	-	-	Figure 17.1	
Write high-level pulse width	PW <sub>HW</sub>	ns	70	-	-	Figure 17.1	
Read high-level pulse width	PW <sub>HR</sub>	ns	150	-	-	Figure 17.1	
Write / Read rise / fall time	t <sub>WRr</sub> , t <sub>WRf</sub>	ns	-	-	25	Figure 17.1	
RS Setup time ( RS to NCS, NWR )	t <sub>AS</sub>	ns	5	-	-	Figure 17.1	
RS hold time ( NCS, NWR to RS )	t <sub>AH</sub>	ns	5	-	-	Figure 17.1	
Write data set up time	t <sub>DSW</sub>	ns	20	-	-	Figure 17.1	
Write data hold time	t <sub>H</sub>	ns	15	-	-	Figure 17.1	
Read data delay time	t <sub>DDR</sub>	ns	-	-	100	Figure 17.1	
Read data hold time	t <sub>DHR</sub>	ns	5	-	-	Figure 17.1	

Table 17. 3 Normal Write Mode (IOVCC = 2.4 ~ 3.3V) / (VCC = 2.4V~3.3V)



**68-system Bus Interface Timing Characteristics**

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition	
Bus cycle time	Write	t <sub>CYCEW</sub>	ns	200	-	-	Figure 17.2
	Read	t <sub>CYCER</sub>	ns	300	-	-	Figure 17.2
Write low-level pulse width	PWE <sub>LR</sub>	ns	70	-	-	Figure 17.2	
Read low-level pulse width	PWE <sub>LR</sub>	ns	150	-	-	Figure 17.2	
Write high-level pulse width	PWE <sub>HW</sub>	ns	40	-	-	Figure 17.2	
Read high-level pulse width	PWE <sub>HR</sub>	ns	150	-	-	Figure 17.2	
Write / Read rise / fall time	t <sub>WRr</sub> , t <sub>WRf</sub>	ns	-	-	25	Figure 17.2	
RS setup time	( RS to NCS, E )	t <sub>ASE</sub>	ns	5	-	-	Figure 17.2
RS hold time	( NCS, E to RS )	t <sub>AHE</sub>	ns	5	-	-	Figure 17.2
Write data set up time		t <sub>DSWE</sub>	ns	20	-	-	Figure 17.2
Write data hold time		t <sub>HE</sub>	ns	15	-	-	Figure 17.2
Read data delay time		t <sub>DDR</sub>	ns	-	-	100	Figure 17.2
Read data hold time		t <sub>DHR</sub>	ns	5	-	-	Figure 17.2

Table 17. 4 Normal Write Mode (IOVCC = 1.65 ~ 2.4V) / (VCC = 2.4V~3.3V)

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition	
Bus cycle time	Write	t <sub>CYCEW</sub>	ns	125	-	-	Figure 17.2
	Read	t <sub>CYCER</sub>	ns	300	-	-	Figure 17.2
Write low-level pulse width	PWE <sub>LR</sub>	ns	70	-	-	Figure 17.2	
Read low-level pulse width	PWE <sub>LR</sub>	ns	200	-	-	Figure 17.2	
Write high-level pulse width	PWE <sub>HW</sub>	ns	40	-	-	Figure 17.2	
Read high-level pulse width	PWE <sub>HR</sub>	ns	200	-	-	Figure 17.2	
Write / Read rise / fall time	t <sub>WRr</sub> , t <sub>WRf</sub>	ns	-	-	25	Figure 17.2	
Setup time	Write ( RS to NCS, E_NWR )	t <sub>ASE</sub>	ns	10	-	-	Figure 17.2
	Read ( RS to NCS , RW_NRD )			10	-	-	Figure 17.2
Address hold time	t <sub>AHE</sub>	ns	5	-	-	Figure 17.2	
Write data set up time	t <sub>DSWE</sub>	ns	60	-	-	Figure 17.2	
Write data hold time	t <sub>HE</sub>	ns	15	-	-	Figure 17.2	
Read data delay time	t <sub>DDR</sub>	ns	-	-	100	Figure 17.2	
Read data hold time	t <sub>DHR</sub>	ns	5	-	-	Figure 17.2	

Table 17. 5 Normal Write Mode (IOVCC = 2.4 ~ 3.3V) / (VCC = 2.4V~3.3V)

## Serial Data Transfer Interface Timing Characteristics

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition	
Serial clock cycle time	Write ( received )	$t_{SCYC}$	ns	100	-	-	Figure 17.3
	Read ( transmitted )	$t_{SCYC}$	ns	200	-	-	Figure 17.3
Serial clock high – level pulse width	Write ( received )	$t_{SCH}$	ns	40	-	-	Figure 17.3
	Read ( transmitted )	$t_{SCH}$	ns	150	-	-	Figure 17.3
Serial clock low – level pulse width	Write ( received )	$t_{SCL}$	ns	40	-	-	Figure 17.3
	Read ( transmitted )	$t_{SCL}$	ns	150	-	-	Figure 17.3
Serial clock rise / fall time	$t_{scr}, t_{scf}$	ns	-	-	20	Figure 17.3	
Chip select (NCS) set up time	$t_{CSU}$	ns	20	-	-	Figure 17.3	
Chip select (NCS) hold time	$t_{CH}$	ns	60	-	-	Figure 17.3	
RS set up time	$t_{RSU}$	ns	10			Figure 17.3	
RS hold time	$t_{RSH}$	ns	10			Figure 17.3	
Read/write select (RNW) set up time	$t_{WRU}$	ns	10			Figure 17.3	
Read/write select (RNW) hold time	$t_{WRH}$	ns	10			Figure 17.3	
Read clock set up time	$t_{SCSR}$	ns	10			Figure 17.3	
Read clock hold time	$t_{SCHR}$	ns	10			Figure 17.3	
Serial input data set up time	$t_{SISU}$	ns	30	-	-	Figure 17.3	
Serial input data hold time	$t_{SIH}$	ns	30	-	-	Figure 17.3	
Serial output data delay time	$t_{SOD}$	ns	-	-	100	Figure 17.3	
Serial output data hold time	$t_{SOH}$	ns	5	-	-	Figure 17.3	

Table 17. 6 (IOVCC=1.65~3.3V) / (VCC = 2.4V~3.3V)

**RGB Interface Timing Characteristics**

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
VSYNC / HSYNC set up time	tsynCS	ns	10	-	-	Figure 17.4
ENABLE set up time	tENS	ns	10	-	-	Figure 17.4
ENABLE hold time	tENH	ns	10	-	-	Figure 17.4
DOTCLK "low" level pulse width	PWDL	ns	40	-	-	Figure17.4
DOTCLK "high" level pulse width	PWDH	ns	40	-	-	Figure17.4
DOTCLK cycle time	tCYCD	ns	200	-	-	Figure17.4
DATA set up time	tpDS	ns	20	-	-	Figure17.4
DATA hold time	tpDH	ns	20	-	-	Figure17.4
DOTCLK , VSYNC , HSYNC rising and falling time	trgbr , trgbf	ns	-	-	25	Figure17.4

**Table 17. 7 RGB interface mode, Normal Write Mode (IOVCC=1.65~2.4V) / (VCC = 2.4V~3.3V)**

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
VSYNC / HSYNC set up time	tsynCS	ns	10	-	-	Figure 17.4
ENABLE set up time	tENS	ns	10	-	-	Figure 17.4
ENABLE hold time	tENH	ns	10	-	-	Figure 17.4
DOTCLK "low" level pulse width	PWDL	ns	40	-	-	Figure 17.4
DOTCLK "high" level pulse width	PWDH	ns	40	-	-	Figure 17.4
DOTCLK cycle time	tCYCD	ns	150	-	-	Figure 17.4
DATA set up time	tpDS	ns	20	-	-	Figure 17.4
DATA hold time	tpDH	ns	20	-	-	Figure 17.4
DOTCLK , VSYNC , HSYNC rising and falling time	trgbr , trgbf	ns	-	-	25	Figure 17.4

**Table 17. 8 RGB interface mode, Normal Write Mode (IOVCC=2.4~3.3V) / (VCC = 2.4V~3.3V)**

**17.3 LCD driver output Characteristics**

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
Driver output delay timing	t <sub>DD</sub>	us	-	25	-	<b>Figure 17.5</b> VCI=IOVCC=VCC=2.8V , Ta=25°C , fOSC = 930KHz, (320 Line) VBP=02h , VFP =02h, Black Image, Frame rate = 60Hz, SAP=111,AP=011,HCK=30h,DCCLK=18h, DC=0101,NLINE=000001, VR1SEL=000, VR2SEL=000, VSEL=100, BT=0101, VRH=0011, VCM=10000, VDV=10001, XVCOMG=0, DDVDHXON=1, COLOR=0.

Table 17.7 Driver output delay timing

**17.4 Reset Timing Characteristics**

Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
Reset low level width	t <sub>RES</sub>	ms	1	-	-	Figure17.5
Reset rise time	t <sub>rRES</sub>	ns	-	-	10	Figure17.5

Table 17.8 (IOVCC=1.65~3.3V) / (VCC = 2.4V~3.3V)

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## 17.5 DC Characteristic

Item	Symbol	Unit	Test Condition	Min.	Typ.	Max.	Note
Input high voltage	V <sub>IH</sub>	V	Note <sup>(1)</sup>	0.8xIOVCC	-	IOVCC	-
Input low voltage	V <sub>IL</sub>	V	Note <sup>(1)</sup>	-0.3V	-	0.2xIOVCC	-
Output high voltage(1) (DB17-0, SDO Pins)	V <sub>OH1</sub>	V	I <sub>OH</sub> = -0.1mA	0.8xIOVCC	-	-	-
Output low voltage (DB17-0, SDO Pins)	V <sub>OL1</sub>	V	IOVCC= 1.65 ~ 3.3V I <sub>OL</sub> = 0.1mA	-	-	0.2xIOVCC	-
I/O leakage current	I <sub>LI</sub>	μA	V <sub>in</sub> = 0 ~ VCC	-1	-	1	-
Current consumption during normal operation (VCC - VSSD) + (IOVCC-VSSD)	I <sub>OP(VCC)</sub>	μA	V <sub>CI</sub> =IOVCC=VCC=2.8V, T <sub>a</sub> =25°C, f <sub>OSC</sub> = 930KHZ, (320 Line) VBP=02h, VFP =02h, Black Image, Frame rate = 60Hz, SAP=111,AP=011,HCK=30h, DCCLK=18h, DC=0101, NLINE=000001, VR1SEL=000, VR2SEL=000, VSEL=100, BT=0101, VRH=0011,VCM=10000, VDV=10001, XVCOMG=0, DDVDHXON=1, COLOR=0. No panel load	-	450	700	-
Current consumption during normal operation (VCI - VSSD)	I <sub>OP(VCI)</sub>	mA			2.2	2.7	
Current consumption during standby mode (VCC - VSSD) + (IOVCC-VSSD)	I <sub>ST(VCC)</sub>	μA	VCC=VCI=2.8V, T <sub>a</sub> =25°C	-	5	10	-
Current consumption during standby mode (VCI - VSSD)	I <sub>ST(VCI)</sub>	μA			0.5	1	
Current consumption during OFF mode (VCC - VSSD) + (IOVCC-VSSD)	I <sub>ST(VCC)</sub>	μA	VCC=VCI=2.8V, T <sub>a</sub> =25°C		1	5	
Current consumption during OFF mode (VCI - VSSD)	I <sub>ST(VCI)</sub>	μA			0.5	1	
Output voltage deviation	-	mV	-	-	5	-	-
Dispersion of the Average Output Voltage	V	mV	-	-	-	35	-

Table 17. 9 DC Characteristic (VCC = 2.4 ~ 3.3V, IOVCC = 1.65 ~3.3V, T<sub>a</sub> = -40 ~ 85 °C)

Note: (1) Test Condition: IOVCC= 1.8 ~ 3.3V

### 17.6 Timing Characteristic

#### 80-system Bus Operation

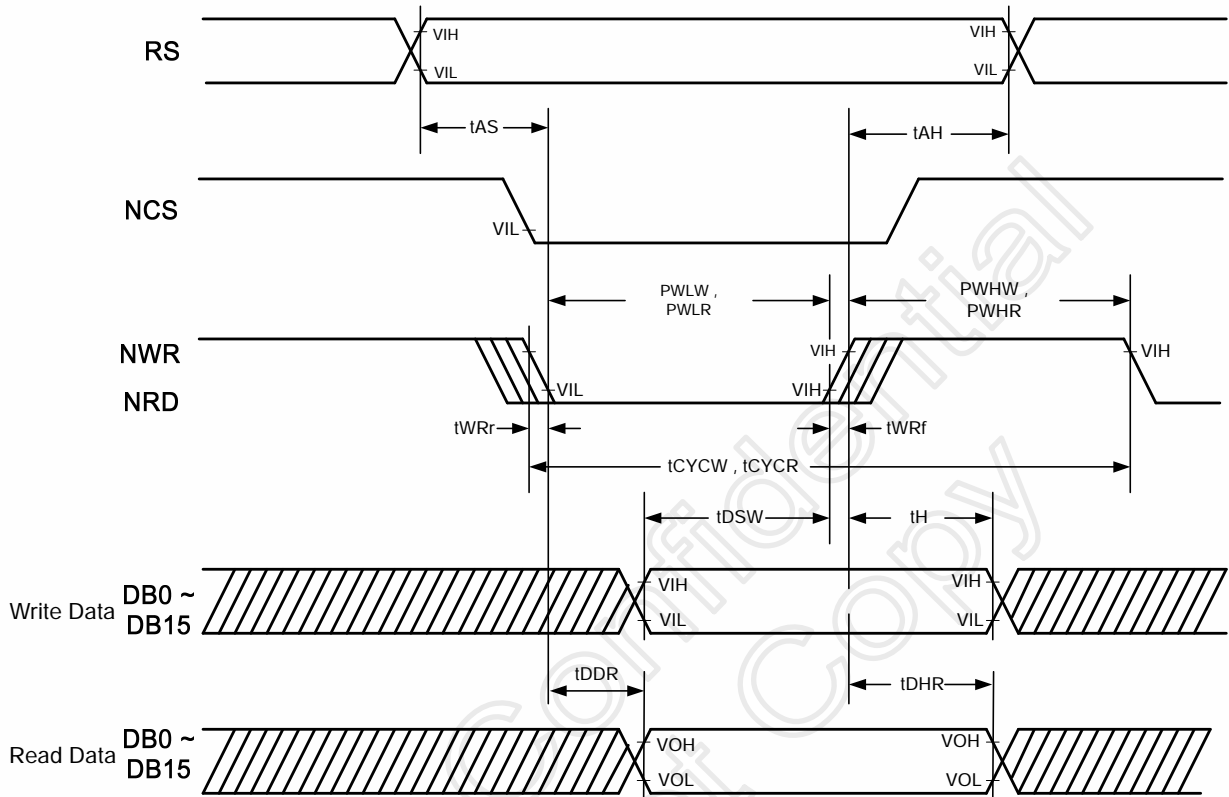


Figure 17. 1 80-system Bus Timing

68-system Bus Operation

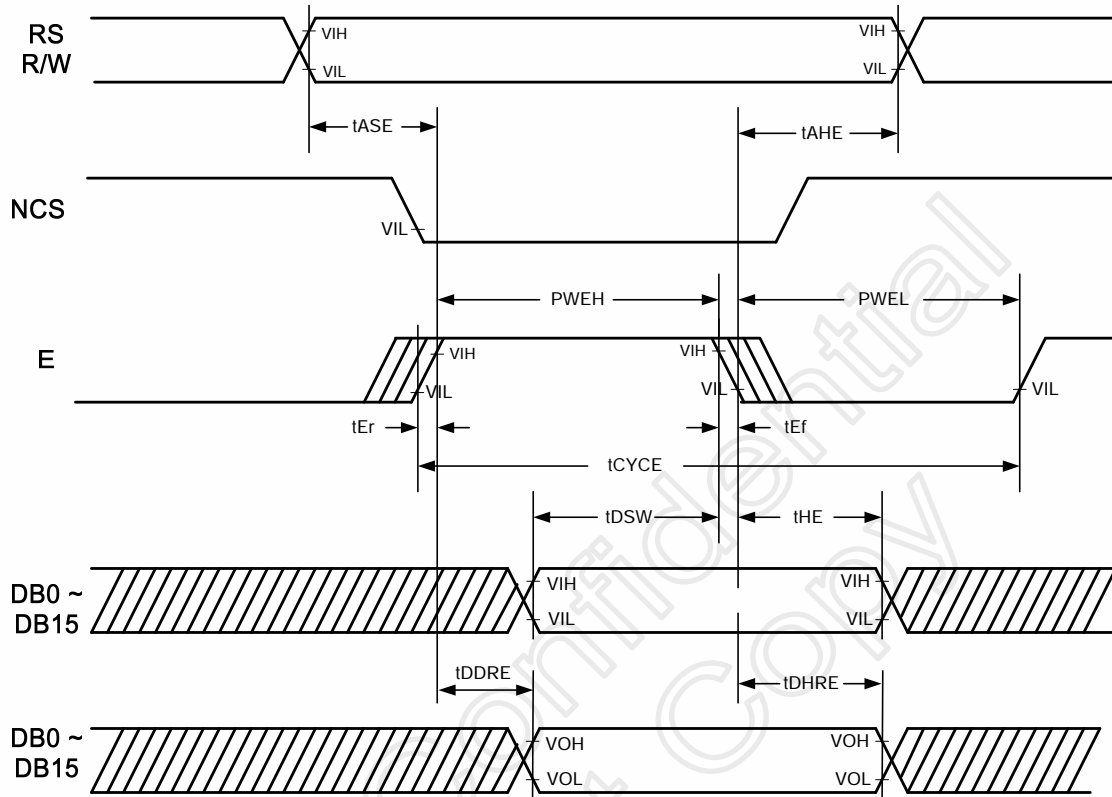
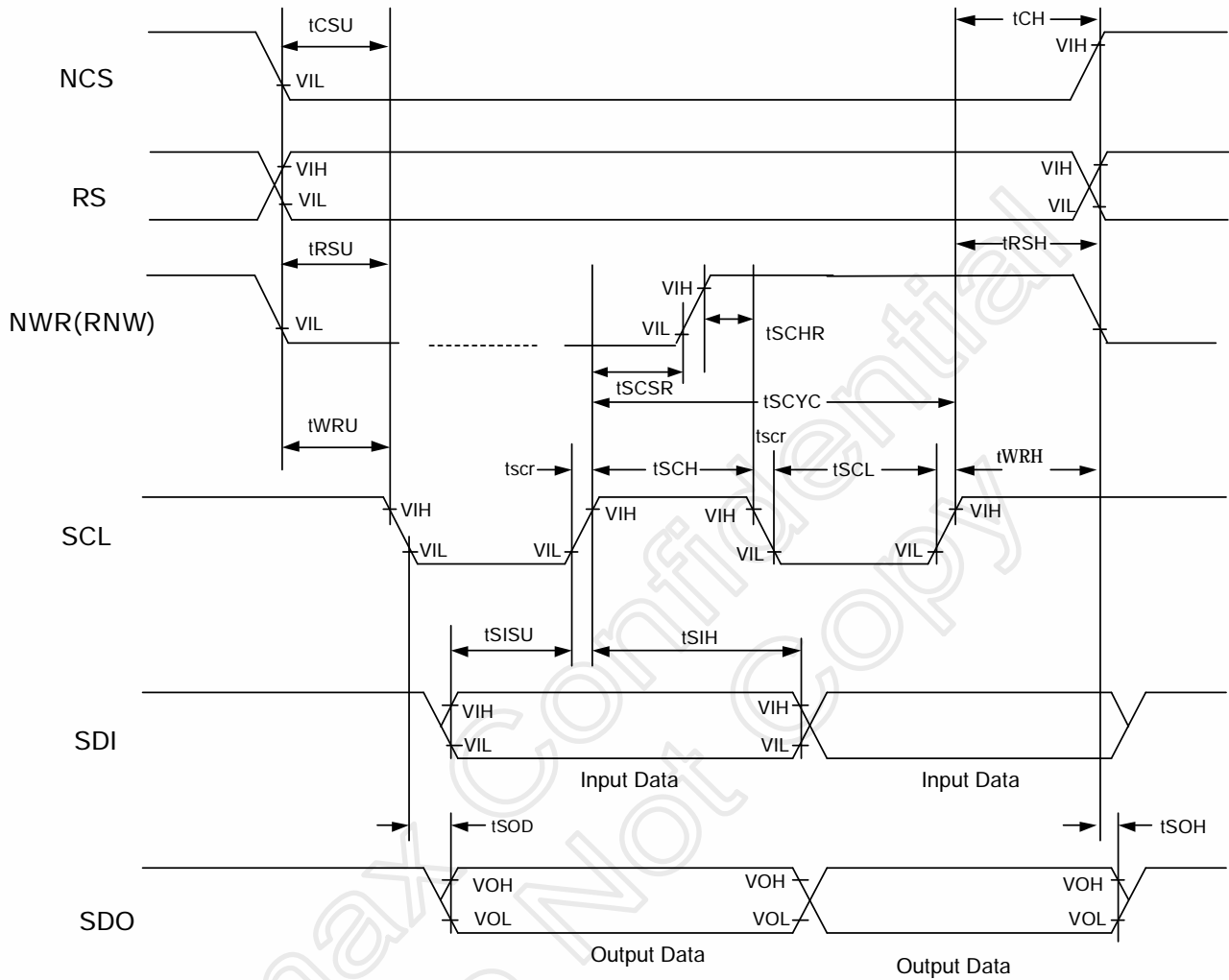


Figure 17. 2 68-System Bus Timing

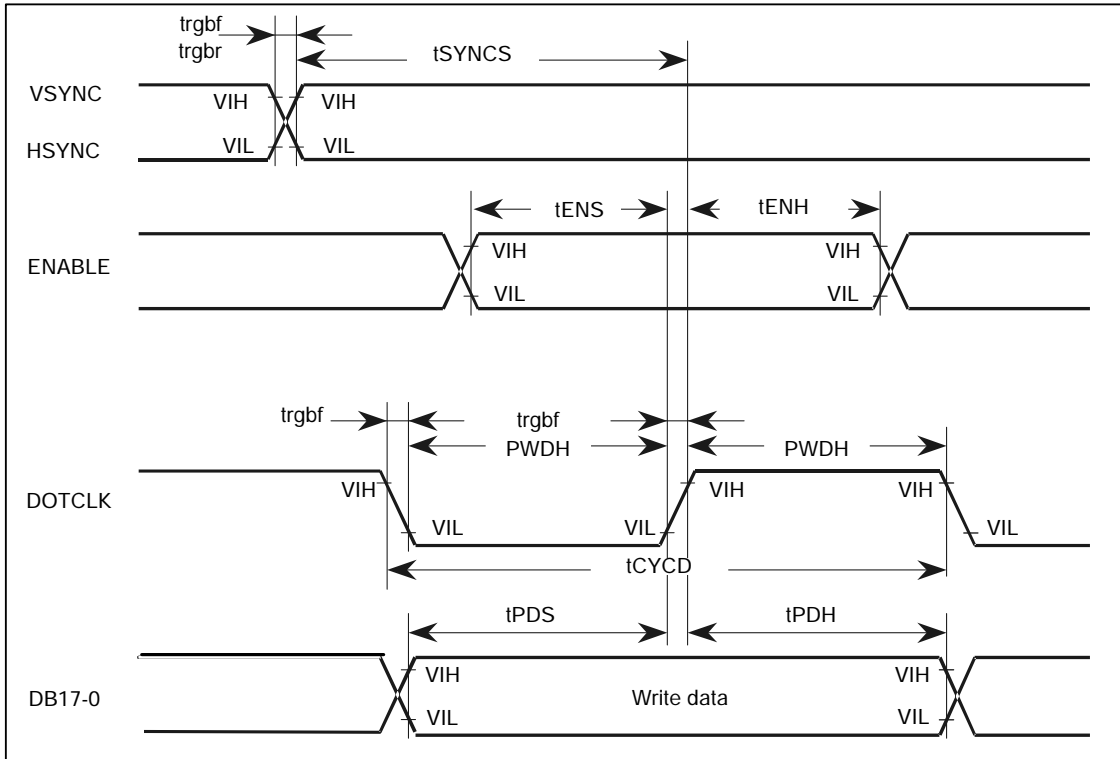
**Clock Synchronized Serial Data Transfer Interface Operation**



**Figure 17. 3 Clock Synchronized Serial Data Transfer Interface Timing**



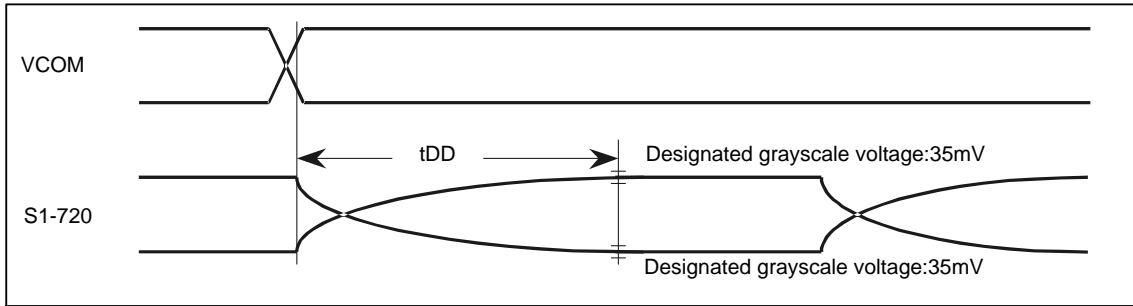
**RGB Interface Operation**



**Figure 17. 4 RGB Interface Operation**

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**LCD Driving Output**



**Figure 17. 5 LCD Driving Output**

**Reset Operation**



**Figure 17. 6 Reset Timing**

## 18. Ordering Information

Part NO.	Package
HX8312-A000PDxxx	PD: means COG xxx: means chip thickness (µm), default 400 µm

## 19. Revision History

Version	EFF.DATE	DESCRIPTION OF CHANGES
01	2005/05/06	New setup
02	2005/07/11	<ol style="list-style-type: none"> <li>1. Add note in p.11.</li> <li>2. Change Pin 216 ~ Pin 219 from VSSD to VSSD2 in p.11 and p.12.</li> <li>3. RGB interface description and drawing correction in p.37 ~ p.45</li> <li>4. Add "Please note that the value in R139 must be ≥ "20" in p.49.</li> <li>5. Add BGR bit function in p.50, p.51 and p.107.</li> <li>6. Add "Inhibited to use" in p.52.</li> <li>7. Delete note in p.53</li> <li>8. Change note and setting value in example in p.55.</li> <li>9. Change the color definition (Table.5.9) for PSEL bit setting in p.57.</li> <li>10. Define SAW6-0 = "00h" in Table 6.2 as "setting inhibited" in p.59.</li> <li>11. Delete WNRGB (D3 bit of R2) function in p.94.</li> <li>12. Change: XVCOMG = 0 ⇒ VCOML level is decided by VCM and VDV bits in p.83 and p.98.</li> <li>13. Change device ID default value to "0C" in R50 in p.100.</li> </ol>
	2005/08/23	1. Add the "Ordering Information" section, page 120.
03	2005/10/04	<ol style="list-style-type: none"> <li>1. Delete "VDH pin description in p.11.</li> <li>2. Correct the X address mapping in Table. 4.2 ~4.4 in p.51~ p.52.</li> <li>3. Correct the width of chip from 1.670um to 1.670mm in p.18.</li> <li>4. Correct the alignment mark circle diameter from 50um to 20um in p.19.</li> </ol>
04	2005/11/08	<ol style="list-style-type: none"> <li>1. Add AC and DC characteristic parameter in p.108~p.119.</li> <li>2. Redrawing the on/off flow in p.89 and p.90</li> <li>3. Change the power on / off flow in p.87</li> </ol>
	2006/01/02	<ol style="list-style-type: none"> <li>1. Remove "preliminary".</li> <li>2. Add "Synchronous Transfer Function" in p.38.</li> <li>3. Add RGB Interface Mode and Internally Synchronized Mode Transition in p.48.</li> </ol>
05	2006/03/13	<ol style="list-style-type: none"> <li>1. Correct the RGB2 type (16 bit collective) data mapping in p.41.</li> <li>2. Correct the RGB interface through mode display and input timing in figure 3.2 in p.44.</li> <li>3. Correct the RGB interface capture mode display and input timing in figure 3.4 in p.46.</li> <li>4. Revise V<sub>IH</sub> &amp; V<sub>IL</sub> test condition.</li> </ol>