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ILI9163

a-Si TFT LCD Single Chip Driver 132RGBx162 Resolution and 262K color

Datasheet

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1. Introduction

ILI9163 is a 262,144-color one-chip SoC driver for a-TFT liquid crystal display with resolution of 132RGBx162 dots, comprising a 396-channel source driver, a 162-channel gate driver, 48,114bytes GRAM for graphic data of 132RGBx162 dots, and power supply circuit.

The ILI9163 supports 18-/16-/9-/8-bit data bus interface and serial peripheral interfaces (SPI). The moving picture area can be specified in internal GRAM by window address function. The specified window area can be updated selectively, so that moving picture can be displayed simultaneously independent of still picture area.
ILI9163 can operate with 1.65V I/O interface voltage, and an incorporated voltage follower circuit to generate voltage levels for driving an LCD. The ILI9163 also supports a function to display in 8 colors and a sleep mode, allowing for precise power control by software and these features make the ILI9163 an ideal LCD driver for medium or small size portable products such as digital cellular phones, smart phone, MP3 and PMP where long battery life is a major concern.

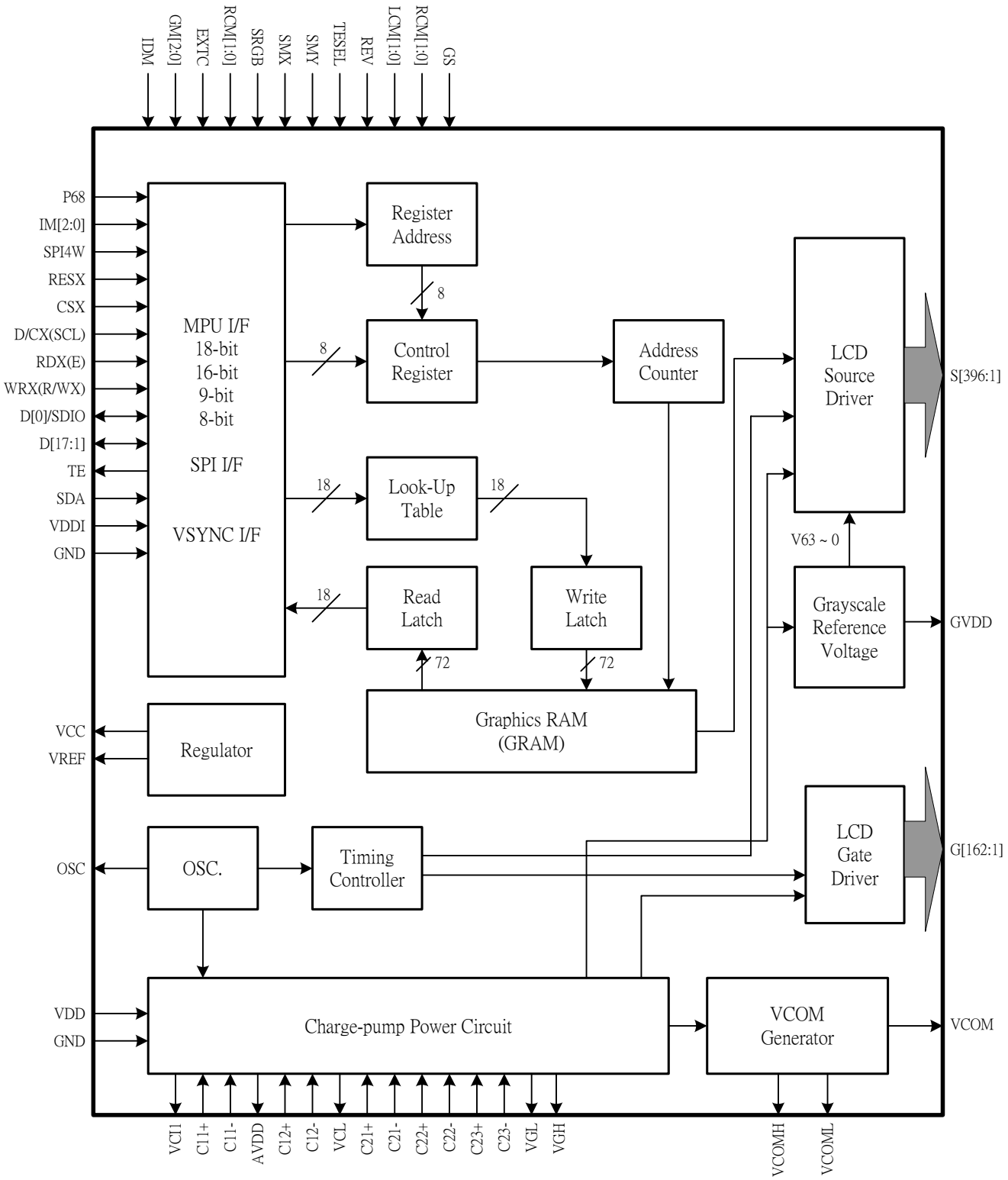
2. Features

- Display resolution: [132xRGB](H) x 162(V)
- Output:
  - 396 source outputs
  - 162 gate outputs
  - Common electrode output
- AM-LCD driver with on-chip full display RAM: 48,114 bytes
- MCU Interface
  - 8-bits, 9-bits, 16-bits, 18-bits interface with 8080-series MCU
  - 8-bits, 9-bits, 16-bits, 18-bits interface with 6800-series MCU
  - 3-pin/4-pin serial interface
- Display mode:
  - Full color mode (idle mode off): 262K-colors
  - Reduced color mode (idle mode on): 8-colors (3-bits MSB bits mode)
- On chip functions:
  - VCOM generator and adjustment
  - Timing generator
  - Oscillator
  - DC/DC converter
  - 8 preset gamma curve selectable
  - Line/frame inversion
  - MTP to store initialization register setting
  - Factory default value(Contrast, Module ID, Module version, etc) are stored on the display module
- MTP:
  - 7-bits for ID2

- 8-bits for ID3
- 7-bits for VCOM adjustment

- Low –power consumption architecture
  - Low operating power supplies:
    - VDDI = 1.65V ~ 3.3 V (interface I/O)
    - VDD = 2.6V ~ 3.3 V (analog)
- LCD Voltage drive:
  - Source/VCOM power supply voltage
    - AVDD – GND = 4.5V ~ 6.0
    - VCL – GND = -1.0V ~ -3.0V
    - VDD – VCL ≦ 6.0V
  - Gate driver output voltage
    - VGH – GND = 10V ~ 16V
    - VGL – GND = -9V ~ -16V
    - VGH – VGL ≦ 32V
  - VCOM driver output voltage
    - VCOMH = 2.5V ~5V
    - VCOML = -2.5V ~ 0V
    - VCOMH-VCOML ≦ 6.0V
- Operate temperature range: -40℃ to 85℃

3. Block Diagram



4. Pin Descriptions

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Descriptions</th></tr>
<tr><td>P68</td><td>I</td><td>8080/6800 MCU Interface mode selection.

P68='1': select 6800-MCU parallel interface
P68='0': select 8080-MCU parallel interface

If not used, please fix this pin at GND level.</td></tr>
<tr><td>IM2</td><td>I</td><td>MCU Parallel interface bus and Serial interface select
- IM2='1';Parallel Interface
- IM2='0';Serial Interface</td></tr>
<tr><td>IM1, IM0</td><td>I</td><td>MCU parallel interface type selection

<table><tr><th>IM1</th><th>IM0</th><th>Parallel interface</th></tr><tr><td>0</td><td>0</td><td>MCU 8-bit Parallel</td></tr><tr><td>0</td><td>1</td><td>MCU 16-bit Parallel</td></tr><tr><td>1</td><td>0</td><td>MCU 9-bit Parallel</td></tr><tr><td>1</td><td>1</td><td>MCU 18-bit Parallel</td></tr></table></td></tr>
<tr><td>SPI4W</td><td>I</td><td>SPI interface selection pin
SPI4W='0': 3-wire SPI. (default)
SPI4W='1': 4-wire SPI.
This pin is internal pull low.</td></tr>
<tr><td>RESX</td><td>I</td><td>Chip reset pin ("Low Active").
This signal low will reset the device and must be applied to properly initialize the chip.</td></tr>
<tr><td>CSX</td><td>I</td><td>Chip select input pin ("Low" enable).
This pin can be permanently fixed "Low" in MCU interface mode only.</td></tr>
<tr><td>D/CX
(SCL)</td><td>I</td><td>Display data / Command selection pin in parallel and SCL in 3-pin SPI interface.
D/CX='1': Display data.
D/CX='0': Command data.
If not used, please connect this pin to GND.</td></tr>
<tr><td>RDX
(E)</td><td>I</td><td>Read enable in 8080-parallel interface and Read/ Write operation enable pin in 6800-parallel interface.
If not used, please connect this pin to GND.</td></tr>
<tr><td>WRX
(R/Wx)(D/CX)</td><td>I</td><td>Write enable in parallel interface.
WRX: for 8080 MCU
R/WX: for 6800 MCU
D/CX: for 4-wire SPI
If not used, please connect to ground or VDDI this pin.</td></tr>
<tr><td>D[17:1]
D[0]/SDIO</td><td>I/O</td><td>When– RCM='0' (MCU I/F), D[17:0] are used to MCU parallel interface data bus, and D0 is also the serial input/ output signal in SPI interface mode.
In serial interface, D[17:1] are not used and should be connected to ground.</td></tr>
<tr><td>TE</td><td>O</td><td>Tearing effect output pin to synchronies MCU to frame writing, activated by S/W command. When this pin is not activated, this pin is low.</td></tr>
</table>

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Descriptions</th></tr>
<tr><td></td><td></td><td>If not used, please open this pin.</td></tr>
<tr><td>SDA</td><td>I/O</td><td>When RCM[1:0]= ’0X’ (MCU I/F), This pin is not used, and fix at GND level.
-If it’s not used, please fix this pin at GND level.</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>OSC</td><td>O</td><td>Oscillator output or test purpose.</td></tr>
<tr><td>EXTC</td><td>I</td><td>To use extended command set, please connect this pin to VDDI. During normal operation, please open this pin. (It has an internal pull low resistor.)
EXTC=’1’, all the command can be used.
EXTC=’0’, only Command (00h~3Ah, Dah~DCh) can be used</td></tr>
<tr><td>IDM</td><td>I</td><td>Normal mode and Idle mode control pin
<table>
<tr><th>IDM</th><th>Idle mode H/W controller</th></tr>
<tr><td>0</td><td>Normal display (can be changed to Idle mode by S/W)</td></tr>
<tr><td>1</td><td>Into Idle mode</td></tr>
</table></td></tr>
<tr><td>GM2,GM1,GM0</td><td>I</td><td>Panel Resolution selection pins
<table>
<tr><th>GM2</th><th>GM1</th><th>GM0</th><th>Resolution selection</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>132RGB x 162(S1~396 and G1~ G162 output)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>128RGB x 128(S7~390 and G2~ G129 output)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>120RGB x 160(S7~366 and G2~ G161 output)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>128RGB x 160(S7~390 and G2~ G161 output)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>130RGB x 130(S7~396 and G2~ G131 output)</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>132RGB x 132(S1~396 and G2~ G133 output)</td></tr>
</table></td></tr>
<tr><td>RCM[1:0]</td><td>I</td><td>MCU interface mode selection pin
<table>
<tr><th>RCM1</th><th>RCM0</th><th>Resolution selection</th></tr>
<tr><td>0</td><td>0</td><td>MCU interface mode</td></tr>
<tr><td>0</td><td>1</td><td>MCU interface mode</td></tr>
<tr><td>1</td><td>0</td><td>Setting prohibited</td></tr>
<tr><td>1</td><td>1</td><td>Setting prohibited</td></tr>
</table></td></tr>
<tr><td>SRGB</td><td>I</td><td>RGB direction select H/W pin for Color filter default setting.
<table>
<tr><th>SRGB</th><th>Color mapping selection</th></tr>
<tr><td>0</td><td>S1, S2, S3 filter order = ’R’, ‘G’, ‘B’</td></tr>
<tr><td>1</td><td>S1, S2, S3 filter order = ’B’, ‘G’, ‘R’</td></tr>
</table>
If the register is not changed, this H/W pin is always valid. If the register be changed, should be following registers setting.
When Power On or H/W reset, this function follow H/W pins setting first.</td></tr>
<tr><td>SMX</td><td>I</td><td>Source output direction H/W select pin
<table>
<tr><th rowspan="2">SMX</th><th colspan="6">Source Output Direction</th></tr>
<tr><th>GM=’101’</th><th>GM=’100’</th><th>GM=’011’</th><th>GM=’010’</th><th>GM=’001’</th><th>GM=’000’</th></tr>
<tr><td>0</td><td>S1 → S396</td><td>S7 → S396</td><td>S7 → S390</td><td>S7 → S366</td><td>S7 → S390</td><td>S1 → S396</td></tr>
<tr><td>1</td><td>S396 → S1</td><td>S396 → S7</td><td>S390 → S7</td><td>S366 → S7</td><td>S390 → S7</td><td>S396 → S1</td></tr>
</table>
If the register is not changed, this H/W pin is always valid. If the register be</td></tr>
</table>

<table>
<tr><th>Pin Name</th><th>I/O</th><th>Descriptions</th></tr>
<tr><td></td><td></td><td>changed, should be following registers setting. When Power On or H/W reset,</td></tr>
<tr><td>SMY</td><td>I</td><td>Gate output direction H/W select pin
<table>
<tr><th rowspan="2">SMY</th><th colspan="5">Gate Output Direction</th></tr>
<tr><th>GM=’101’</th><th>GM=’100’</th><th>GM=’011’,’010’</th><th>GM=’001’</th><th>GM=’000’</th></tr>
<tr><td>0</td><td>G2 → G133</td><td>G2 → G131</td><td>G2 → G161</td><td>G2 → G129</td><td>G1 → G162</td></tr>
<tr><td>1</td><td>G133 → G2</td><td>G131 → G2</td><td>G161 → G2</td><td>G129 → G2</td><td>G162 → G1</td></tr>
</table>
If the register is not changed, this H/W pin is always valid. If the register be changed, should be following registers setting.
When Power On or H/W reset, this function follow H/W pins setting first.</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>REV</td><td>I</td><td>Source output data polarity select H/W pin.
<table>
<tr><th>REV</th><th>Source output data polarity</th></tr>
<tr><td>0</td><td>Data not reverse</td></tr>
<tr><td>1</td><td>Data reverse</td></tr>
</table>
If the register is not changed, this H/W pin is always valid. If the register be changed, should be following registers setting.
When Power On or H/W reset, this function follow H/W pins setting first.</td></tr>
<tr><td>LCM[1:0]</td><td>I</td><td>Different Liquid Crystal type selection pins.
There is a pull-low resistor only in LCM1 pin
<table>
<tr><td>LCM1</td><td>LCM0</td><td>LC Type Selection</td></tr>
<tr><td>0</td><td>0</td><td>TR (Transflective) LC Type</td></tr>
<tr><td>0</td><td>1</td><td>TM (Transmission) LC Type1</td></tr>
<tr><td>1</td><td>0</td><td>TM (Transmission) LC Type2</td></tr>
<tr><td>1</td><td>1</td><td>MVA-TM/TR LC type</td></tr>
</table></td></tr>
<tr><td>GS</td><td>I</td><td>Input pin to select the gamma curve order
Connect to VDDI for GC0(2,0), GC1(1.8), GC2(2.5), GC3(1.0)
Connect to GND for GC0(1,0), GC1(2.5), GC2(2.2), GC3(1.8)</td></tr>
<tr><td>TESEL</td><td>I</td><td>There is a pull-high resistor in the pin.
This pin is only for GM[2:0]=’000’ mode
Connect to VDDI (Disable scroll function)
Connect to GND (Enable scroll function)</td></tr>
<tr><td>S1 ~ S396</td><td>O</td><td>Source driver output pins.</td></tr>
<tr><td>G1 ~ G162</td><td>O</td><td>Gate driver output pins.</td></tr>
<tr><td>VDD</td><td>P</td><td>Power supply to liquid crystal power supply analog circuit.
Connect to external power supply (VDD=2.5~3.3V).</td></tr>
<tr><td>VDDI</td><td>P</td><td>VDDI voltage level for interface control pins.</td></tr>
<tr><td>VCC</td><td>P</td><td>Power supply for internal logic regulator.</td></tr>
<tr><td>GND</td><td>P</td><td>GND voltage output level for control pins.</td></tr>
</table>

Pin Name	I/O	Descriptions
VDDIO	P	VDDI voltage output level for control pins using.
GNDO	P	GND voltage output level for control pins using.
VCI1	I/O	A reference voltage in step-up circuit 1 Connect a capacitor for stabilization
AVDD	P	A power output pin for source driver block that is generated from power block. Output of booster 1 circuit (output of 2-times output of VCI1) Connect a capacitor for stabilization.
VCL	P	A power supply pin for generating VCOML Connect a capacitor for stabilization
VREF	-	Floating pin. Leave this pin as open.
GVDD	P	A standard level for grayscale voltage generator. Connect a capacitor for stabilization.
VGH	P	Positive voltage of the Booster circuit Connect a capacitor for stabilization
VGL	P	Negative voltage of the Booster circuit 3 Connect a capacitor for stabilization
VCL	P	Power supply to drive VCOML. Connect a capacitor for stabilization
C11+, C11-, C12+, C12-	O	Make sure to connect to capacitor that is used in internal step-up circuit 1.
C21+, C21-, C22+, C22-, C23+, C23-	O	Make sure to connect to capacitor that is used in internal step-up circuit 2. Connect to capacitors according to the step-up factors in use.
VCOM	O	TFT display common electrode power supply. Alternates between voltage levels between VCOMH-VCOML. Registers set the alternating cycle. Registers set the alternating cycle and operate or halt VCOM.
VCOMH	O	Positive voltage output of VCOM Connect a capacitor for stabilization
VCOML	O	Negative voltage output of VCOM Connect a capacitor for stabilization
DUMMY_TEST DUMMY_TESTOSC	I	These test pins for Driver vender test used. Please open these pins or fix to GND.
DUMMY_TESTDA[6:0] DUMMY_VPRER_OUT	O	These test pins for Driver vendor test used. Please open these pins.
DUMMYR1-DUMMYR2	-	DUMMYR1 and DUMMYR2 are short-circuited within the chip for COG contact resistance measurement. Please leave them open when not used.
DUMMY1-DUMMY18	-	-These pins are dummy (not have any function inside) -Can have signal traces pass through on TFT glass under the PAD

Liquid crystal power supply specifications Table 1

No.	Item		Description
1	TFT Source Driver		396 pins (132 x RGB)
2	TFT Gate Driver		162 pins
3	TFT Display's Capacitor Structure		Cst structure only (Common VCOM)
4	Liquid Crystal Drive Output	S1 ~ S396	V0 ~ V63 grayscales
		G1 ~ G162	VGH – VGL
		VCOM	VCOMH – VCOML: Amplitude = electronic volumes
5	Input Voltage	VDDI	1.65 ~ 3.30V
		VDD	2.60 ~ 3.30V
6	Liquid Crystal Drive Voltages	AVDD	4.5V ~ 6.0V
		VGH	10V ~ 16V
		VGL	-9V ~ -16V
		VCL	-1.7V ~ -2.7V
		VGH – VGL	Max. 32V
		VDD – VCL	Max. 6.0V
7	Internal Step-up Circuits	AVDD	VCI1 x2
		VGH	VCI1 x4, x5, x6
		VGL	VCI1 x-3, x-4, x-5
		VCL	VCI1 x-1

5. Pad Arrangement and Coordination

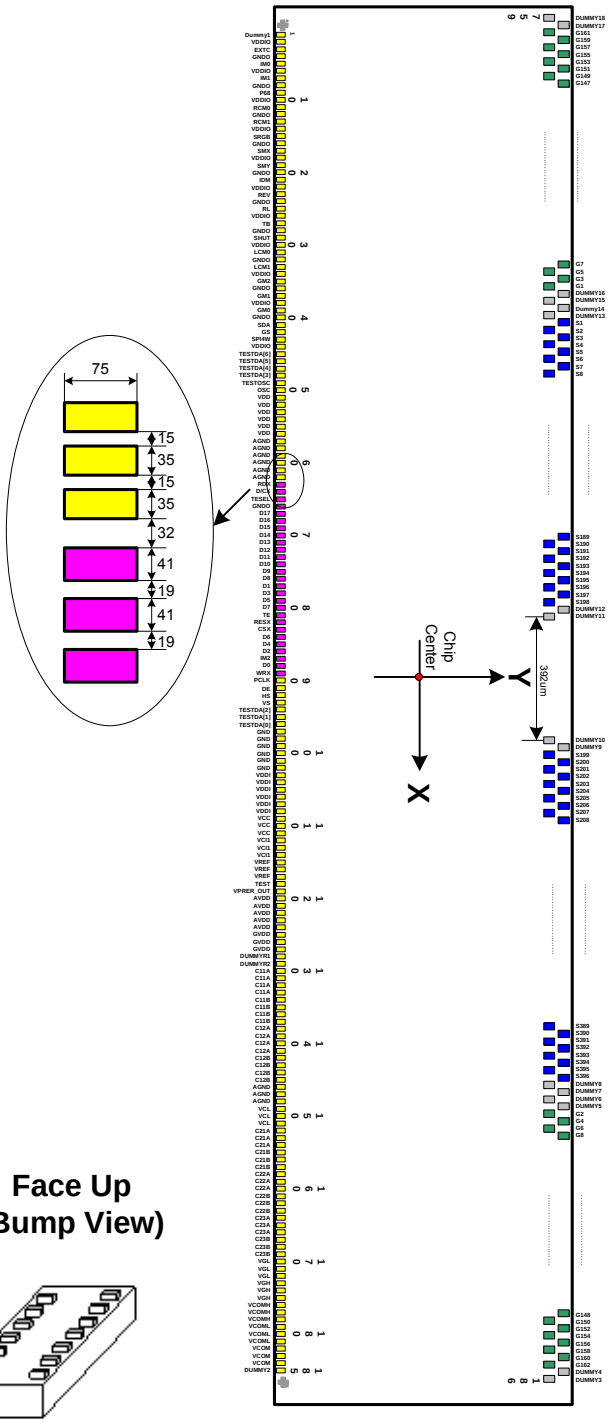
Chip Size: 9900um x 670um

Chip thickness : 300 um (typ.)/400um

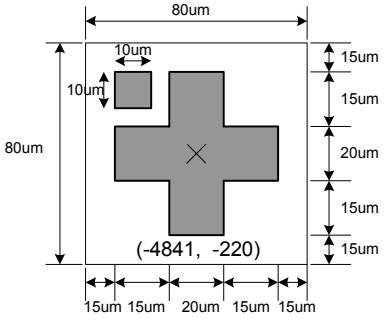
Pad Location: Pad Center.

Coordinate Origin: Chip Center

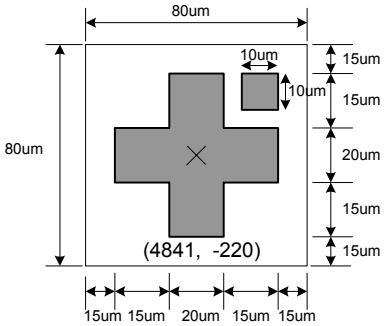
Au bump height: 15 +-3 um



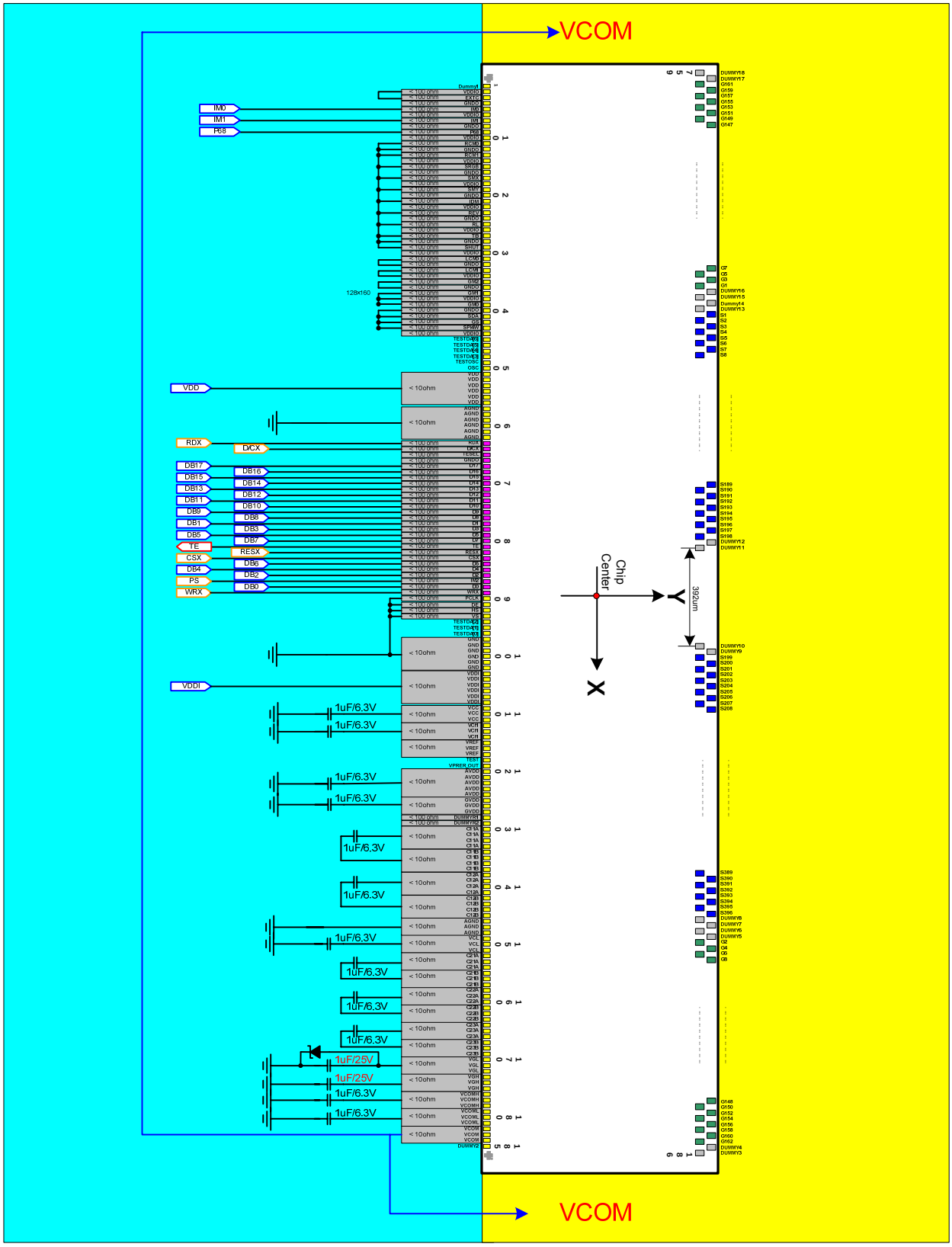
Alignment Mark-Left



Alignment Mark-Right



Face Up (Bump View)


VCOM
IM0
IM1
IM2
128x160
VDD
RDX
DCX
DB17
DB16
DB15
DB14
DB13
DB12
DB11
DB10
DB9
DB8
DB1
DB3
DB5
DB7
TE
RESX
CSX
DB6
DB4
DB2
PS
DB0
WRX
VDDI
1uF/6.3V
1uF/25V
Chip Center
392um
VCOM

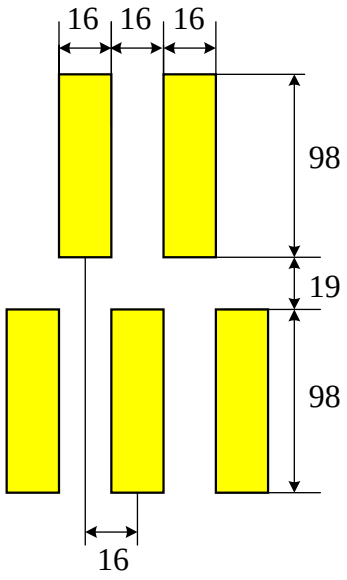
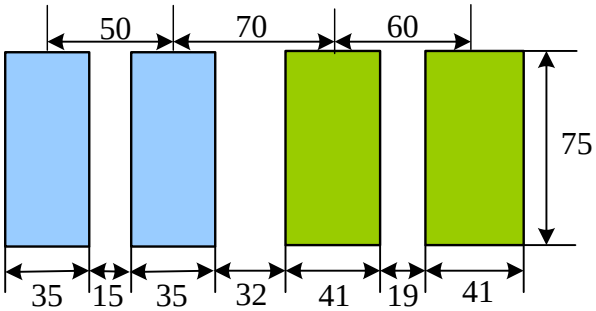
No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y
1	Dummy1	-4750	-238.5	61	AGND	-1750	-238.5	121	AVDD	1550	-238.5	181	VCOML	4550	-238.5	241	G56	3892	227
2	VDDIO	-4700	-238.5	62	AGND	-1700	-238.5	122	AVDD	1600	-238.5	182	VCOM	4600	-238.5	242	G54	3876	110
3	EXTC	-4650	-238.5	63	RDX	-1630	-238.5	123	AVDD	1650	-238.5	183	VCOM	4650	-238.5	243	G52	3860	227
4	GNDO	-4600	-238.5	64	D/CX	-1570	-238.5	124	AVDD	1700	-238.5	184	VCOM	4700	-238.5	244	G50	3844	110
5	IM0	-4550	-238.5	65	TESEL	-1510	-238.5	125	GVDD	1750	-238.5	185	DUMMY2	4750	-238.5	245	G48	3828	227
6	VDDIO	-4500	-238.5	66	GNDO	-1450	-238.5	126	GVDD	1800	-238.5	186	DUMMY3	4772	110	246	G46	3812	110
7	IM1	-4450	-238.5	67	D17	-1390	-238.5	127	GVDD	1850	-238.5	187	DUMMY4	4756	227	247	G44	3796	227
8	GNDO	-4400	-238.5	68	D16	-1330	-238.5	128	DUMMYR1	1900	-238.5	188	G162	4740	110	248	G42	3780	110
9	P68	-4350	-238.5	69	D15	-1270	-238.5	129	DUMMYR2	1950	-238.5	189	G160	4724	227	249	G40	3764	227
10	VDDIO	-4300	-238.5	70	D14	-1210	-238.5	130	C11+	2000	-238.5	190	G158	4708	110	250	G38	3748	110
11	RCM0	-4250	-238.5	71	D13	-1150	-238.5	131	C11+	2050	-238.5	191	G156	4692	227	251	G36	3732	227
12	GNDO	-4200	-238.5	72	D12	-1090	-238.5	132	C11+	2100	-238.5	192	G154	4676	110	252	G34	3716	110
13	RCM1	-4150	-238.5	73	D11	-1030	-238.5	133	C11+	2150	-238.5	193	G152	4660	227	253	G32	3700	227
14	VDDIO	-4100	-238.5	74	D10	-970	-238.5	134	C11-	2200	-238.5	194	G150	4644	110	254	G30	3684	110
15	SRGB	-4050	-238.5	75	D9	-910	-238.5	135	C11-	2250	-238.5	195	G148	4628	227	255	G28	3668	227
16	GNDO	-4000	-238.5	76	D8	-850	-238.5	136	C11-	2300	-238.5	196	G146	4612	110	256	G26	3652	110
17	SMX	-3950	-238.5	77	D1	-790	-238.5	137	C11-	2350	-238.5	197	G144	4596	227	257	G24	3636	227
18	VDDIO	-3900	-238.5	78	D3	-730	-238.5	138	C12+	2400	-238.5	198	G142	4580	110	258	G22	3620	110
19	SMY	-3850	-238.5	79	D5	-670	-238.5	139	C12+	2450	-238.5	199	G140	4564	227	259	G20	3604	227
20	GNDO	-3800	-238.5	80	D7	-610	-238.5	140	C12+	2500	-238.5	200	G138	4548	110	260	G18	3588	110
21	IDM	-3750	-238.5	81	TE	-550	-238.5	141	C12+	2550	-238.5	201	G136	4532	227	261	G16	3572	227
22	VDDIO	-3700	-238.5	82	RESX	-490	-238.5	142	C12-	2600	-238.5	202	G134	4516	110	262	G14	3556	110
23	REV	-3650	-238.5	83	CSX	-430	-238.5	143	C12-	2650	-238.5	203	G132	4500	227	263	G12	3540	227
24	GNDO	-3600	-238.5	84	D6	-370	-238.5	144	C12-	2700	-238.5	204	G130	4484	110	264	G10	3524	110
25	RL	-3550	-238.5	85	D4	-310	-238.5	145	C12-	2750	-238.5	205	G128	4468	227	265	G8	3508	227
26	VDDIO	-3500	-238.5	86	D2	-250	-238.5	146	AGND	2800	-238.5	206	G126	4452	110	266	G6	3492	110
27	TB	-3450	-238.5	87	IM2	-190	-238.5	147	AGND	2850	-238.5	207	G124	4436	227	267	G4	3476	227
28	GNDO	-3400	-238.5	88	D0	-130	-238.5	148	AGND	2900	-238.5	208	G122	4420	110	268	G2	3460	110
29	SHUT	-3350	-238.5	89	WRX	-70	-238.5	149	VCL	2950	-238.5	209	G120	4404	227	269	DUMMY5	3444	227
30	VDDIO	-3300	-238.5	90	PCLK	0	-238.5	150	VCL	3000	-238.5	210	G118	4388	110	270	DUMMY6	3428	110
31	LCM0	-3250	-238.5	91	DE	50	-238.5	151	VCL	3050	-238.5	211	G116	4372	227	271	DUMMY7	3412	227
32	GNDO	-3200	-238.5	92	HS	100	-238.5	152	C21+	3100	-238.5	212	G114	4356	110	272	DUMMY8	3396	110
33	LCM1	-3150	-238.5	93	VS	150	-238.5	153	C21+	3150	-238.5	213	G112	4340	227	273	S396	3380	227
34	VDDIO	-3100	-238.5	94	TESTDA[2]	200	-238.5	154	C21+	3200	-238.5	214	G110	4324	110	274	S395	3364	110
35	GM2	-3050	-238.5	95	TESTDA[1]	250	-238.5	155	C21-	3250	-238.5	215	G108	4308	227	275	S394	3348	227
36	GNDO	-3000	-238.5	96	TESTDA[0]	300	-238.5	156	C21-	3300	-238.5	216	G106	4292	110	276	S393	3332	110
37	GM1	-2950	-238.5	97	GND	350	-238.5	157	C21-	3350	-238.5	217	G104	4276	227	277	S392	3316	227
38	VDDIO	-2900	-238.5	98	GND	400	-238.5	158	C22+	3400	-238.5	218	G102	4260	110	278	S391	3300	110
39	GM0	-2850	-238.5	99	GND	450	-238.5	159	C22+	3450	-238.5	219	G100	4244	227	279	S390	3284	227
40	GNDO	-2800	-238.5	100	GND	500	-238.5	160	C22+	3500	-238.5	220	G98	4228	110	280	S389	3268	110
41	SDA	-2750	-238.5	101	GND	550	-238.5	161	C22-	3550	-238.5	221	G96	4212	227	281	S388	3252	227
42	GS	-2700	-238.5	102	GND	600	-238.5	162	C22-	3600	-238.5	222	G94	4196	110	282	S387	3236	110
43	SPI4W	-2650	-238.5	103	VDDI	650	-238.5	163	C22-	3650	-238.5	223	G92	4180	227	283	S386	3220	227
44	VDDIO	-2600	-238.5	104	VDDI	700	-238.5	164	C23+	3700	-238.5	224	G90	4164	110	284	S385	3204	110
45	TESTDA[6]	-2550	-238.5	105	VDDI	750	-238.5	165	C23+	3750	-238.5	225	G88	4148	227	285	S384	3188	227
46	TESTDA[5]	-2500	-238.5	106	VDDI	800	-238.5	166	C23+	3800	-238.5	226	G86	4132	110	286	S383	3172	110
47	TESTDA[4]	-2450	-238.5	107	VDDI	850	-238.5	167	C23-	3850	-238.5	227	G84	4116	227	287	S382	3156	227
48	TESTDA[3]	-2400	-238.5	108	VDDI	900	-238.5	168	C23-	3900	-238.5	228	G82	4100	110	288	S381	3140	110
49	TESTOSC	-2350	-238.5	109	VCC	950	-238.5	169	C23-	3950	-238.5	229	G80	4084	227	289	S380	3124	227
50	OSC	-2300	-238.5	110	VCC	1000	-238.5	170	VGL	4000	-238.5	230	G78	4068	110	290	S379	3108	110
51	VDD	-2250	-238.5	111	VCC	1050	-238.5	171	VGL	4050	-238.5	231	G76	4052	227	291	S378	3092	227
52	VDD	-2200	-238.5	112	VCI1	1100	-238.5	172	VGL	4100	-238.5	232	G74	4036	110	292	S377	3076	110
53	VDD	-2150	-238.5	113	VCI1	1150	-238.5	173	VGH	4150	-238.5	233	G72	4020	227	293	S376	3060	227
54	VDD	-2100	-238.5	114	VCI1	1200	-238.5	174	VGH	4200	-238.5	234	G70	4004	110	294	S375	3044	110
55	VDD	-2050	-238.5	115	VREF	1250	-238.5	175	VGH	4250	-238.5	235	G68	3988	227	295	S374	3028	227
56	VDD	-2000	-238.5	116	VREF	1300	-238.5	176	VCOMH	4300	-238.5	236	G66	3972	110	296	S373	3012	110
57	AGND	-1950	-238.5	117	VREF	1350	-238.5	177	VCOMH	4350	-238.5	237	G64	3956	227	297	S372	2996	227
58	AGND	-1900	-238.5	118	TEST	1400	-238.5	178	VCOMH	4400	-238.5	238	G62	3940	110	298	S371	2980	110
59	AGND	-1850	-238.5	119	VPRER_OUT	1450	-238.5	179	VCOML	4450	-238.5	239	G60	3924	227	299	S370	2964	227
60	AGND	-1800	-238.5	120	AVDD	1500	-238.5	180	VCOML	4500	-238.5	240	G58	3908	110	300	S369	2948	110

No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y	No.	Name	X	Y
301	S368	2932	227	361	S308	1972	227	421	S248	1012	227	481	S192	-324	110	541	S132	-1284	110
302	S367	2916	110	362	S307	1956	110	422	S247	996	110	482	S191	-340	227	542	S131	-1300	227
303	S366	2900	227	363	S306	1940	227	423	S246	980	227	483	S190	-356	110	543	S130	-1316	110
304	S365	2884	110	364	S305	1924	110	424	S245	964	110	484	S189	-372	227	544	S129	-1332	227
305	S364	2868	227	365	S304	1908	227	425	S244	948	227	485	S188	-388	110	545	S128	-1348	110
306	S363	2852	110	366	S303	1892	110	426	S243	932	110	486	S187	-404	227	546	S127	-1364	227
307	S362	2836	227	367	S302	1876	227	427	S242	916	227	487	S186	-420	110	547	S126	-1380	110
308	S361	2820	110	368	S301	1860	110	428	S241	900	110	488	S185	-436	227	548	S125	-1396	227
309	S360	2804	227	369	S300	1844	227	429	S240	884	227	489	S184	-452	110	549	S124	-1412	110
310	S359	2788	110	370	S299	1828	110	430	S239	868	110	490	S183	-468	227	550	S123	-1428	227
311	S358	2772	227	371	S298	1812	227	431	S238	852	227	491	S182	-484	110	551	S122	-1444	110
312	S357	2756	110	372	S297	1796	110	432	S237	836	110	492	S181	-500	227	552	S121	-1460	227
313	S356	2740	227	373	S296	1780	227	433	S236	820	227	493	S180	-516	110	553	S120	-1476	110
314	S355	2724	110	374	S295	1764	110	434	S235	804	110	494	S179	-532	227	554	S119	-1492	227
315	S354	2708	227	375	S294	1748	227	435	S234	788	227	495	S178	-548	110	555	S118	-1508	110
316	S353	2692	110	376	S293	1732	110	436	S233	772	110	496	S177	-564	227	556	S117	-1524	227
317	S352	2676	227	377	S292	1716	227	437	S232	756	227	497	S176	-580	110	557	S116	-1540	110
318	S351	2660	110	378	S291	1700	110	438	S231	740	110	498	S175	-596	227	558	S115	-1556	227
319	S350	2644	227	379	S290	1684	227	439	S230	724	227	499	S174	-612	110	559	S114	-1572	110
320	S349	2628	110	380	S289	1668	110	440	S229	708	110	500	S173	-628	227	560	S113	-1588	227
321	S348	2612	227	381	S288	1652	227	441	S228	692	227	501	S172	-644	110	561	S112	-1604	110
322	S347	2596	110	382	S287	1636	110	442	S227	676	110	502	S171	-660	227	562	S111	-1620	227
323	S346	2580	227	383	S286	1620	227	443	S226	660	227	503	S170	-676	110	563	S110	-1636	110
324	S345	2564	110	384	S285	1604	110	444	S225	644	110	504	S169	-692	227	564	S109	-1652	227
325	S344	2548	227	385	S284	1588	227	445	S224	628	227	505	S168	-708	110	565	S108	-1668	110
326	S343	2532	110	386	S283	1572	110	446	S223	612	110	506	S167	-724	227	566	S107	-1684	227
327	S342	2516	227	387	S282	1556	227	447	S222	596	227	507	S166	-740	110	567	S106	-1700	110
328	S341	2500	110	388	S281	1540	110	448	S221	580	110	508	S165	-756	227	568	S105	-1716	227
329	S340	2484	227	389	S280	1524	227	449	S220	564	227	509	S164	-772	110	569	S104	-1732	110
330	S339	2468	110	390	S279	1508	110	450	S219	548	110	510	S163	-788	227	570	S103	-1748	227
331	S338	2452	227	391	S278	1492	227	451	S218	532	227	511	S162	-804	110	571	S102	-1764	110
332	S337	2436	110	392	S277	1476	110	452	S217	516	110	512	S161	-820	227	572	S101	-1780	227
333	S336	2420	227	393	S276	1460	227	453	S216	500	227	513	S160	-836	110	573	S100	-1796	110
334	S335	2404	110	394	S275	1444	110	454	S215	484	110	514	S159	-852	227	574	S99	-1812	227
335	S334	2388	227	395	S274	1428	227	455	S214	468	227	515	S158	-868	110	575	S98	-1828	110
336	S333	2372	110	396	S273	1412	110	456	S213	452	110	516	S157	-884	227	576	S97	-1844	227
337	S332	2356	227	397	S272	1396	227	457	S212	436	227	517	S156	-900	110	577	S96	-1860	110
338	S331	2340	110	398	S271	1380	110	458	S211	420	110	518	S155	-916	227	578	S95	-1876	227
339	S330	2324	227	399	S270	1364	227	459	S210	404	227	519	S154	-932	110	579	S94	-1892	110
340	S329	2308	110	400	S269	1348	110	460	S209	388	110	520	S153	-948	227	580	S93	-1908	227
341	S328	2292	227	401	S268	1332	227	461	S208	372	227	521	S152	-964	110	581	S92	-1924	110
342	S327	2276	110	402	S267	1316	110	462	S207	356	110	522	S151	-980	227	582	S91	-1940	227
343	S326	2260	227	403	S266	1300	227	463	S206	340	227	523	S150	-996	110	583	S90	-1956	110
344	S325	2244	110	404	S265	1284	110	464	S205	324	110	524	S149	-1012	227	584	S89	-1972	227
345	S324	2228	227	405	S264	1268	227	465	S204	308	227	525	S148	-1028	110	585	S88	-1988	110
346	S323	2212	110	406	S263	1252	110	466	S203	292	110	526	S147	-1044	227	586	S87	-2004	227
347	S322	2196	227	407	S262	1236	227	467	S202	276	227	527	S146	-1060	110	587	S86	-2020	110
348	S321	2180	110	408	S261	1220	110	468	S201	260	110	528	S145	-1076	227	588	S85	-2036	227
349	S320	2164	227	409	S260	1204	227	469	S200	244	227	529	S144	-1092	110	589	S84	-2052	110
350	S319	2148	110	410	S259	1188	110	470	S199	228	110	530	S143	-1108	227	590	S83	-2068	227
351	S318	2132	227	411	S258	1172	227	471	Dummy9	212	227	531	S142	-1124	110	591	S82	-2084	110
352	S317	2116	110	412	S257	1156	110	472	Dummy10	196	110	532	S141	-1140	227	592	S81	-2100	227
353	S316	2100	227	413	S256	1140	227	473	Dummy11	-196	110	533	S140	-1156	110	593	S80	-2116	110
354	S315	2084	110	414	S255	1124	110	474	Dummy12	-212	227	534	S139	-1172	227	594	S79	-2132	227
355	S314	2068	227	415	S254	1108	227	475	S198	-228	110	535	S138	-1188	110	595	S78	-2148	110
356	S313	2052	110	416	S253	1092	110	476	S197	-244	227	536	S137	-1204	227	596	S77	-2164	227
357	S312	2036	227	417	S252	1076	227	477	S196	-260	110	537	S136	-1220	110	597	S76	-2180	110
358	S311	2020	110	418	S251	1060	110	478	S195	-276	227	538	S135	-1236	227	598	S75	-2196	227
359	S310	2004	227	419	S250	1044	227	479	S194	-292	110	539	S134	-1252	110	599	S74	-2212	110
360	S309	1988	110	420	S249	1028	110	480	S193	-308	227	540	S133	-1268	227	600	S73	-2228	227

No.	Name	X	Y
601	S72	-2244	110
602	S71	-2260	227
603	S70	-2276	110
604	S69	-2292	227
605	S68	-2308	110
606	S67	-2324	227
607	S66	-2340	110
608	S65	-2356	227
609	S64	-2372	110
610	S63	-2388	227
611	S62	-2404	110
612	S61	-2420	227
613	S60	-2436	110
614	S59	-2452	227
615	S58	-2468	110
616	S57	-2484	227
617	S56	-2500	110
618	S55	-2516	227
619	S54	-2532	110
620	S53	-2548	227
621	S52	-2564	110
622	S51	-2580	227
623	S50	-2596	110
624	S49	-2612	227
625	S48	-2628	110
626	S47	-2644	227
627	S46	-2660	110
628	S45	-2676	227
629	S44	-2692	110
630	S43	-2708	227
631	S42	-2724	110
632	S41	-2740	227
633	S40	-2756	110
634	S39	-2772	227
635	S38	-2788	110
636	S37	-2804	227
637	S36	-2820	110
638	S35	-2836	227
639	S34	-2852	110
640	S33	-2868	227
641	S32	-2884	110
642	S31	-2900	227
643	S30	-2916	110
644	S29	-2932	227
645	S28	-2948	110
646	S27	-2964	227
647	S26	-2980	110
648	S25	-2996	227
649	S24	-3012	110
650	S23	-3028	227
651	S22	-3044	110
652	S21	-3060	227
653	S20	-3076	110
654	S19	-3092	227
655	S18	-3108	110
656	S17	-3124	227
657	S16	-3140	110
658	S15	-3156	227
659	S14	-3172	110
660	S13	-3188	227

No.	Name	X	Y
661	S12	-3204	110
662	S11	-3220	227
663	S10	-3236	110
664	S9	-3252	227
665	S8	-3268	110
666	S7	-3284	227
667	S6	-3300	110
668	S5	-3316	227
669	S4	-3332	110
670	S3	-3348	227
671	S2	-3364	110
672	S1	-3380	227
673	Dummy13	-3396	110
674	Dummy14	-3412	227
675	Dummy15	-3428	110
676	Dummy16	-3444	227
677	G1	-3460	110
678	G3	-3476	227
679	G5	-3492	110
680	G7	-3508	227
681	G9	-3524	110
682	G11	-3540	227
683	G13	-3556	110
684	G15	-3572	227
685	G17	-3588	110
686	G19	-3604	227
687	G21	-3620	110
688	G23	-3636	227
689	G25	-3652	110
690	G27	-3668	227
691	G29	-3684	110
692	G31	-3700	227
693	G33	-3716	110
694	G35	-3732	227
695	G37	-3748	110
696	G39	-3764	227
697	G41	-3780	110
698	G43	-3796	227
699	G45	-3812	110
700	G47	-3828	227
701	G49	-3844	110
702	G51	-3860	227
703	G53	-3876	110
704	G55	-3892	227
705	G57	-3908	110
706	G59	-3924	227
707	G61	-3940	110
708	G63	-3956	227
709	G65	-3972	110
710	G67	-3988	227
711	G69	-4004	110
712	G71	-4020	227
713	G73	-4036	110
714	G75	-4052	227
715	G77	-4068	110
716	G79	-4084	227
717	G81	-4100	110
718	G83	-4116	227
719	G85	-4132	110
720	G87	-4148	227

No.	Name	X	Y
721	G89	-4164	110
722	G91	-4180	227
723	G93	-4196	110
724	G95	-4212	227
725	G97	-4228	110
726	G99	-4244	227
727	G101	-4260	110
728	G103	-4276	227
729	G105	-4292	110
730	G107	-4308	227
731	G109	-4324	110
732	G111	-4340	227
733	G113	-4356	110
734	G115	-4372	227
735	G117	-4388	110
736	G119	-4404	227
737	G121	-4420	110
738	G123	-4436	227
739	G125	-4452	110
740	G127	-4468	227
741	G129	-4484	110
742	G131	-4500	227
743	G133	-4516	110
744	G135	-4532	227
745	G137	-4548	110
746	G139	-4564	227
747	G141	-4580	110
748	G143	-4596	227
749	G145	-4612	110
750	G147	-4628	227
751	G149	-4644	110
752	G151	-4660	227
753	G153	-4676	110
754	G155	-4692	227
755	G157	-4708	110
756	G159	-4724	227
757	G161	-4740	110
758	Dummy17	-4756	227
759	Dummy18	-4772	110
	ALK-R	4841	-220
	ALK-L	-4841	-220

S1 ~ S396 G1 ~ G162	
Input Pad	

6. Function Description

6.1. MCU Interface Type Selection

The selection of a given interfaces are done by setting P68, IM2, IM1, and IM0 pins as show in below tables.

Table 6.1.1 MCU Interface Type Selection

P68	IM2	IM1	IM0	Interface	Read back selection
-	0	-	-	Serial interface	Via the read instruction (12-bit, 16-bit and 18-bit read parameter)
0	1	0	0	8080 MCU 8-bit Parallel	RDX strobe(8-bit read data and 8-bit read parameter)
0	1	0	1	8080 MCU 16-bit Parallel	RDX strobe(16-bit read data and 8-bit read parameter)
0	1	1	0	8080 MCU 9-bit Parallel	RDX strobe(9-bit read data and 8-bit read parameter)
0	1	1	1	8080 MCU 18-bit Parallel	RDX strobe(18-bit read data and 8-bit read parameter)
-	0	-	-	Serial interface	Via the read instruction (12-bit, 16-bit and 19-bit read parameter)
1	1	0	0	6800 MCU 8-bit Parallel	E strobe(8-bit read data and 8-bit read parameter)
1	1	0	1	6800 MCU 16-bit Parallel	E strobe(9-bit read data and 8-bit read parameter)
1	1	1	0	6800 MCU 9-bit Parallel	E strobe(16-bit read data and 8-bit read parameter)
1	1	1	1	6800 MCU 18-bit Parallel	E strobe(18-bit read data and 8-bit read parameter)

6.2. Serial Interface

The Module uses a 3-wire 9-bit serial interface or 4-pins/8bits bi-directional interface for communication between the micro controller and the LCD driver chip. The 3-pin serial use: CSX (chip enable), SCL(serial clock) and SDA(serial data input/output) and the 4-pins serial use: CSX(chip enable), D/XC(data/ command select), SCL(serial data input/output). Serial clock (SCL) is used for interface with MCU only, so it can be stopped when no communication is necessary.

Table 7.2.1 Serial Interface Type Selection

IM2	4WSPI	Interface	Read back selection
0	0	3-Pins Serial Interface	Via the read instruction(8-bits, 24-bits and 32-bits read parameter)
0	1	4-Pins Serial Interface	Via the read instruction(8-bits, 24-bits and 32-bits read parameter)

6.2.1 Command Write

The write mode of the interface means the micro controller writes commands and data to the LCD driver. 3-Pins serial data packet contains a control bit D/CX and a transmission byte and in 4-pins serial case, data packet contains just transmission byte and control bit D/CX is transferred by the D/CX pin. If D/CX is “low”, the

transmission byte is interpreted as a command byte. If D/CX is “high”, the transmission byte is stored I the display data RAM (Memory write command), or command register as parameter.

Any instruction can be sent in any order to the Driver. The MSB is transmitted first. The serial interface is initialized when CSX is high status. In this state, SCL clock pulse or SDA data have no effect. A falling edge on CSX enables the serial interface and indicated the start of data transmission.

Figure5: 3-pins Serial Data Stream Format

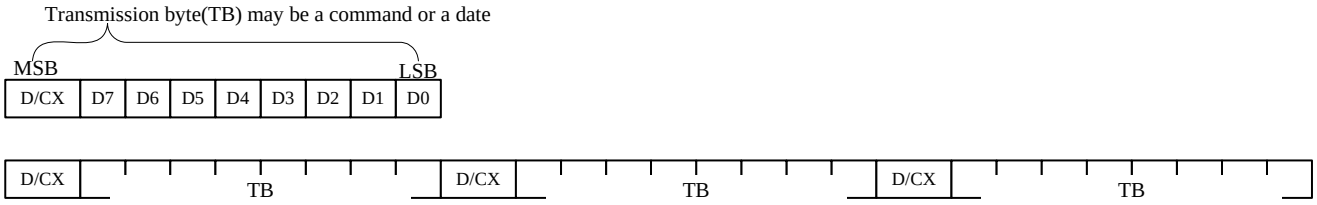
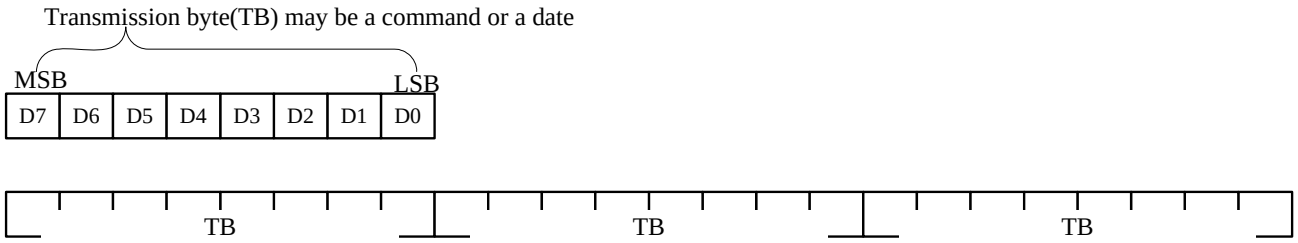


Figure6: 4-pins Serial Data Stream Format



When CSX is “high”, SCL clock is ignored. During the high time of CSX the serial interface is initialized. At the falling edge of CSX, SCL can be high or low. SDA is sampled at the rising edge of CSX. D/CX indicates, whether the byte is command code (D/CX=’0’) or parameter/RAM data (D/CX=’1’). It is sampled when first rising edge of SCL (3-pin serial interface) or 8th rising edge of SCL (4-pins serial interface). If CSX stays low after the last bit of command/data byte, the serial interface expects the D/CX bit (3-pin serial interface) or D7(4-pins serial interface) of the next byte at the next rising edge of SCL.

6.2.2 Read Function

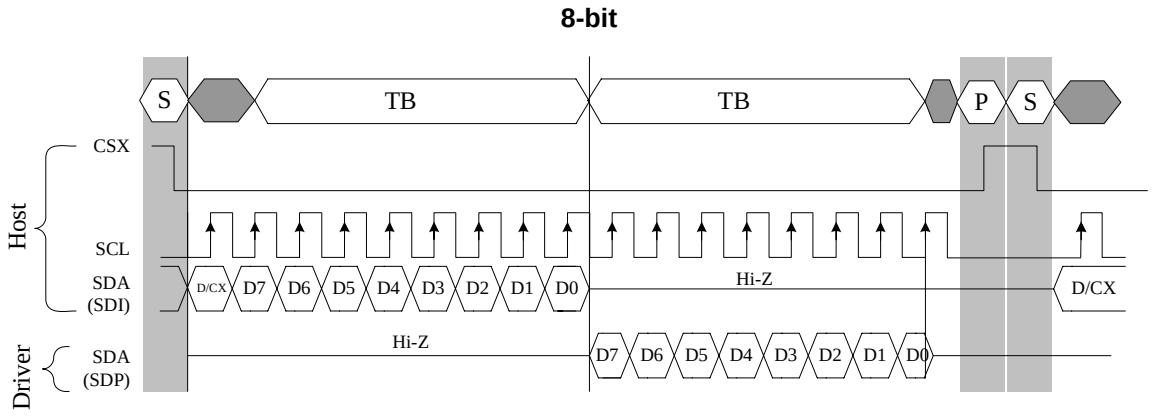


Figure7: 3-Pin Serial Protocol (for RDID1/RDID2/RDID3/0Ah/0Bh/0Ch/0Dh/0Eh/0Fh command:

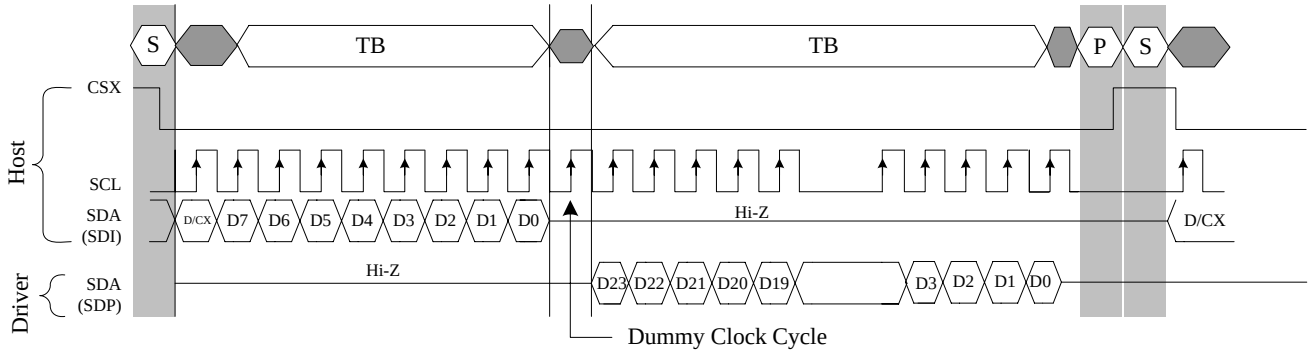


Figure8: 3-Pin Serial Protocol (for RDDID command: 24-bit read)

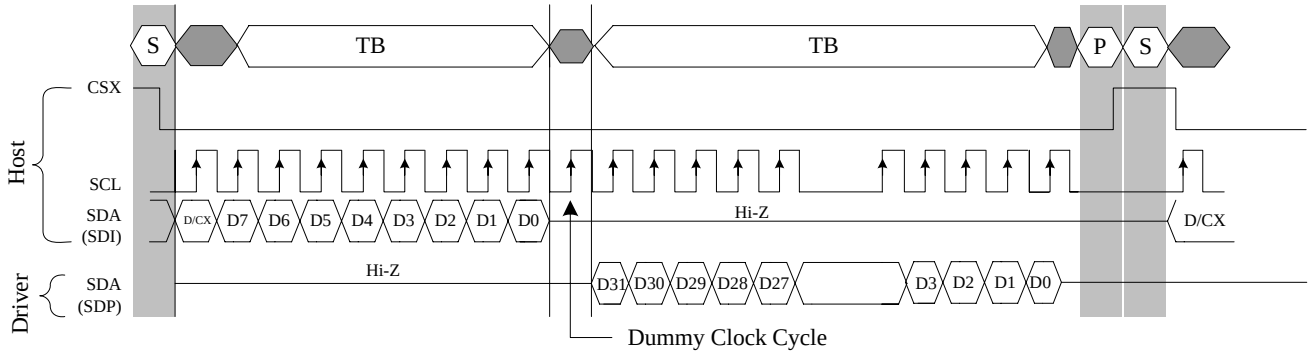


Figure9: 3-Pin Serial Protocol (for RDDST command: 32-bit read)

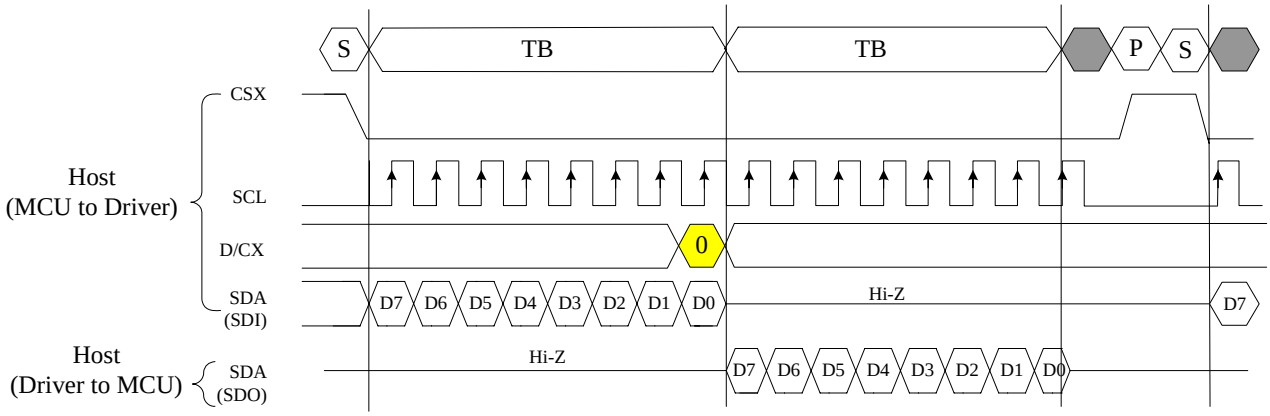


Figure10: 4-pins Serial Protocol (for RDID1/RDID2/RDID3/0AH/0BH/0CH/0DH/0EH/0FH command; 8-bits

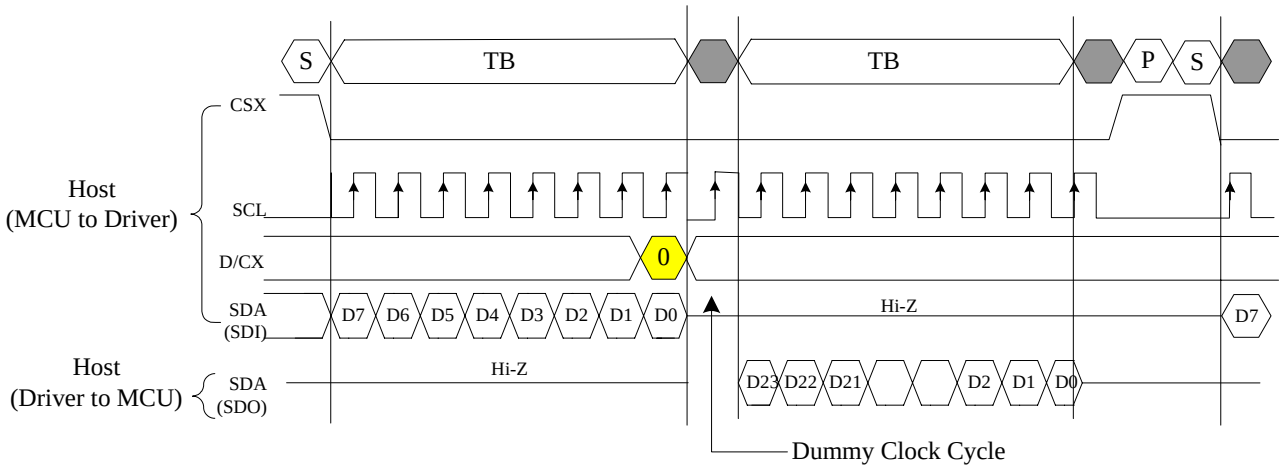


Figure11: 4-pins Serial Protocol (for RDID command: 24-bits read)

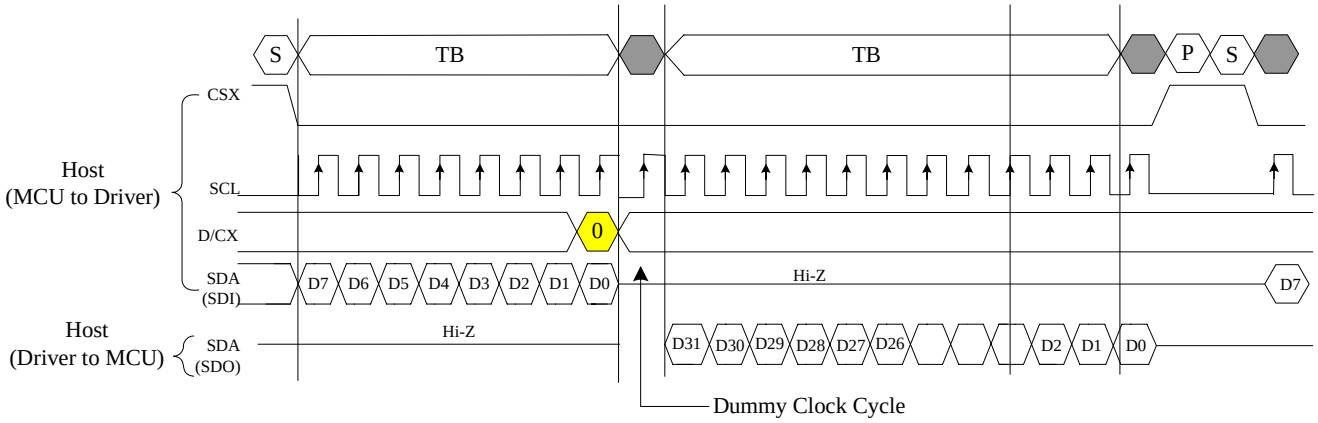


Figure12: 4-pins Serial Protocol (for RDST command: 32-bits read)

6.3. 8080-Series Parallel Interface (P68='0')

The MCU uses a 11-wires 8-data parallel interface or 12-wires 9-data parallel interface or 19-wires 16-data parallel interface or 21-wires 18-data parallel interface. The chip-select CSX (active low) enables and disables the parallel interface. RESX (active low) is an external reset signal. WRX is the parallel data write, RDX is the parallel data read and D[17:0] is parallel data.

The graphics controller chip reads the data at the rising edge of WRX signal. The D/CX is the data/command flag. When D/CX='1', D[17,0] bits are display RAM data or command parameters. When D/C='0', D[17,0] bits are commands.

The 8080-series bi-direction interface can be used for communication between the micro controller and LCD driver chip. The selection of this interface is done when P68 pin is low state (GND). Interface bus width can be selected with IM2, IM1 and IM0. The interface function of 8080-series parallel interface are given in Table 8.2.4

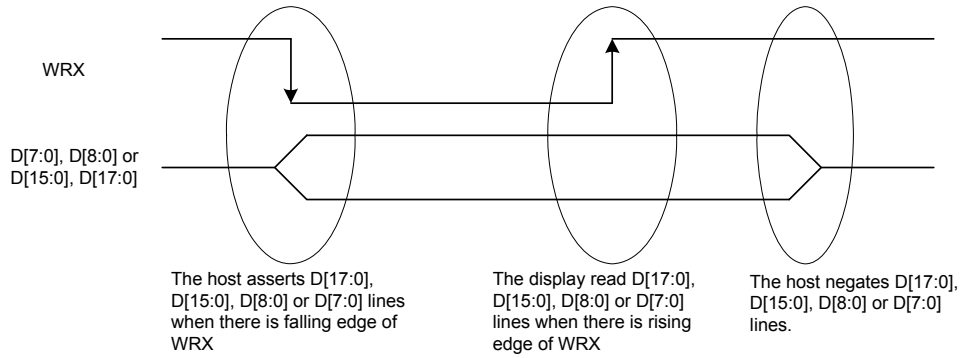
Table 7.2.4The function of 8080-series parallel interface

P68	IM2	IM1	IM0	Interface	D/CX	RDX	WRX	Function
0	1	0	0	8-bit Parallel	0	1	↑	Write 8-bit command(D7 to D0)
					1	1	↑	Write 8-bit display data or 8-bit parameter(D7 to D0)
					1	↑	1	Read 8-bit display data(D7 to D0)
					1	↑	1	Read 8-bit parameter or status(D7 to D0)
0	1	0	1	16-bit Parallel	0	1	↑	Write 8-bit command(D7 to D0)
					1	1	↑	Write 16-bit display data or 8-bit parameter(D15 to D0)
					1	↑	1	Read 16-bit display data(D15 to D0)
					1	↑	1	Read 8-bit parameter or status(D7 to D0)
0	1	1	0	9-bit Parallel	0	1	↑	Write 8-bit command(D7 to D0)
					1	1	↑	Write 9-bit display data or 8-bit parameter(D8 to D0)
					1	↑	1	Read 9-bit display data (D8 to D0)
					1	↑	1	Read 8-bit parameter or status(D7 to D0)
0	1	1	1	18-bit Parallel	0	1	↑	Write 8-bit command(D7 to D0)
					1	1	↑	Write 18-bit display data or 8-bit parameter(D17 to D0)
					1	↑	1	Read 18-bit display data(D17 to D0)
					1	↑	1	Read 8-bit parameter or status(D7 to D0)

Note: applied for command code: Dah, DBh, DCh, 04h, 09h, 0Ah, 0Bh, 0Ch, 0Dh, 0Eh, 0Fh

6.3.1 Write Cycle/Sequence

The write cycle means that the host writes information (command or/and data) to the display via the interface. Each write cycle (WRX high-low-high sequence) consists of 3 control (D/CX, RDX, WRX) and data signals (D[17…0]). D/CX bit is a control signal, which tells if the data is a command or a data. The data signals are a command if the control signal is low (= '0') and vice versa it is data (= '1'). The write cycle is described in the following figure.



Note: WRX is an unsynchronized signal (it can be stopped)

Figure13: 8080-Series WRX Protocol

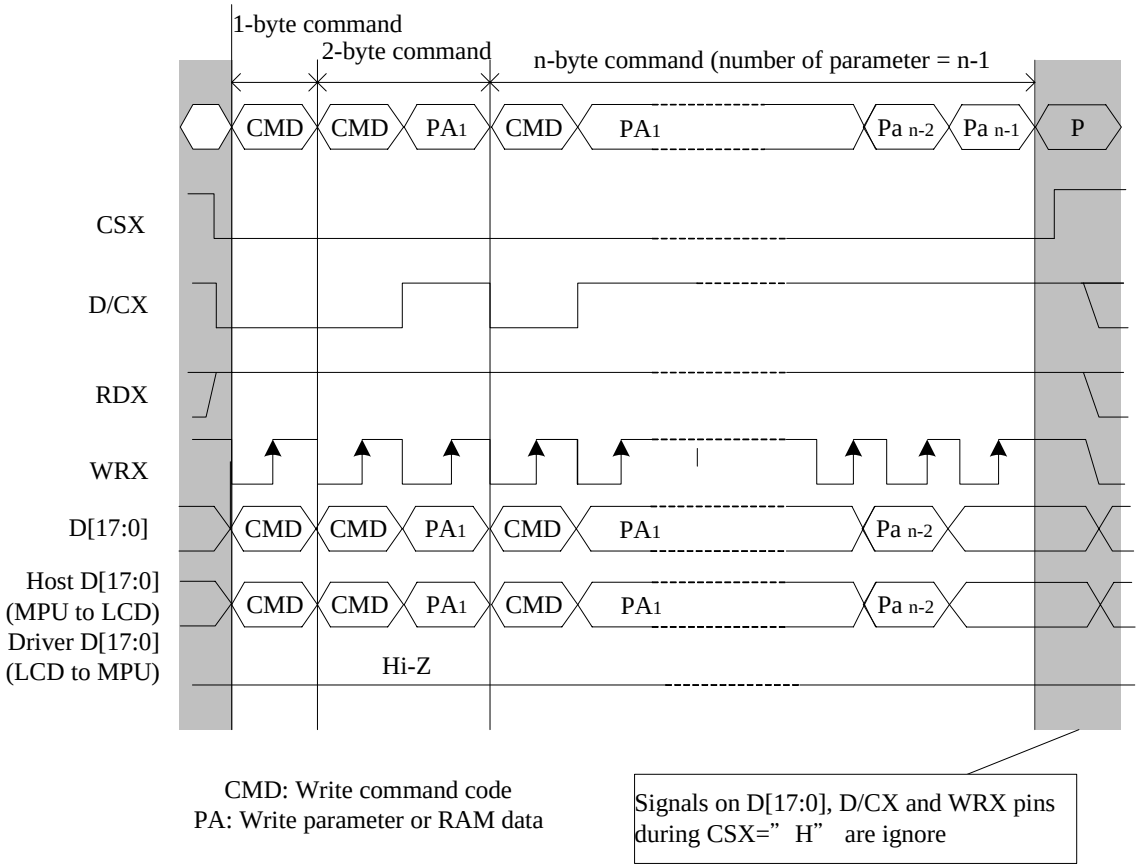
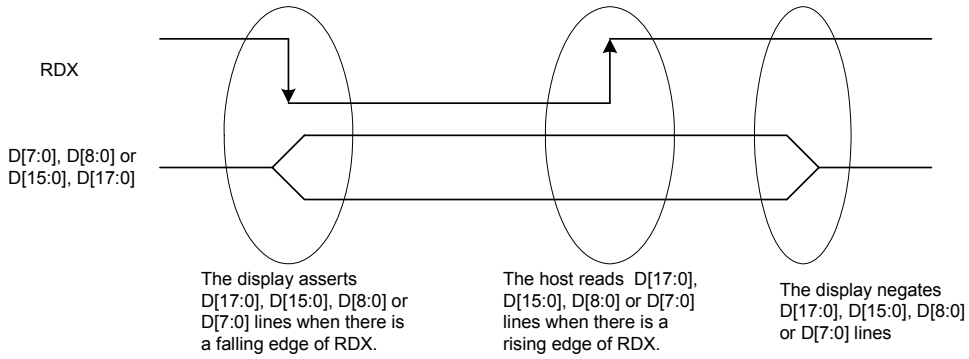


Figure14: 8080-Series Parallel bus protocol (write to register or display RAM)

6.3.2 Read Cycle/Sequence

The read cycle (RDX high-low-high sequence) means that the host reads information from the display via interface. The display sends data (D[17…0]) to the host when there is a falling edge of RDX and the host reads data when there is a rising edge of RDX.



Note: RDX is an unsynchronized signal (It can be stopped).

Figure15: 8080-Series RDX Protocol

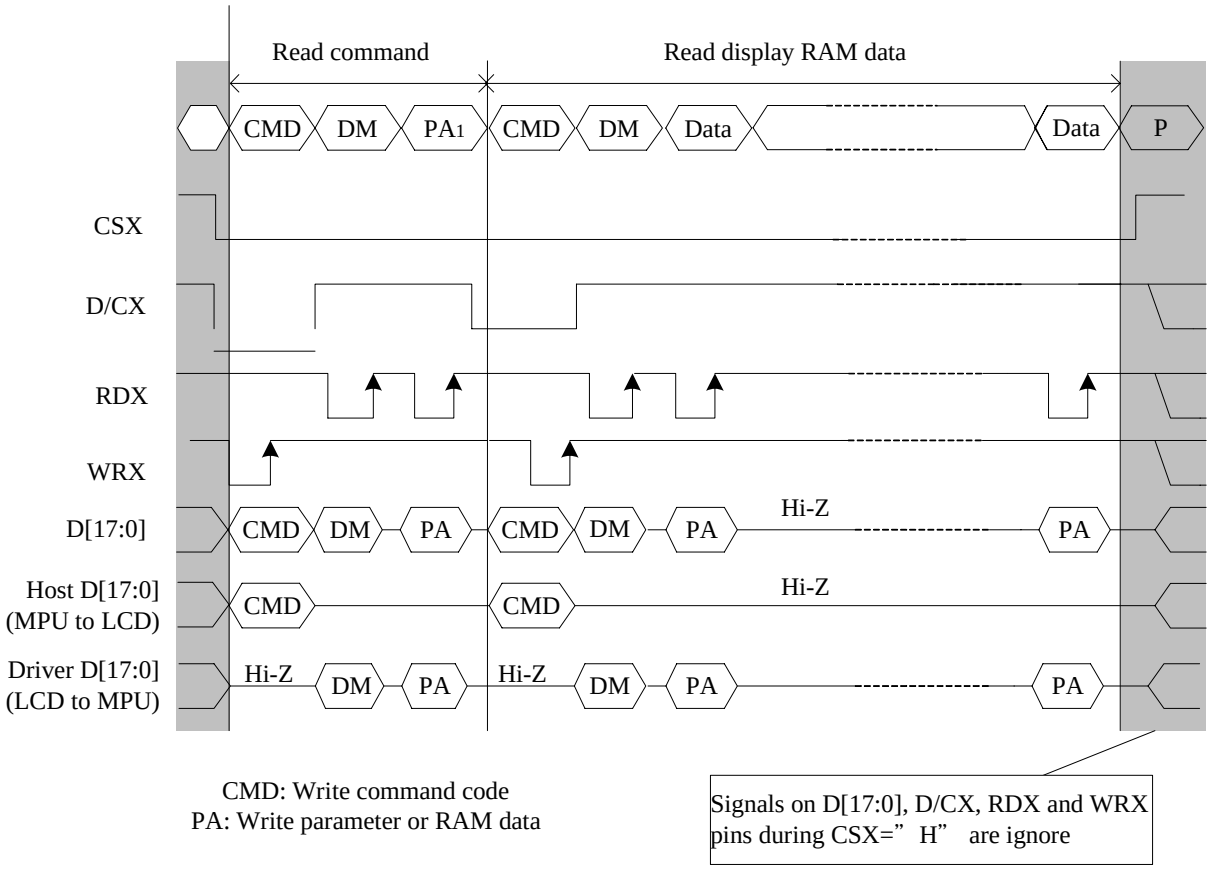


Figure16: 8080-Series parallel bus protocol (Read from register or display RAM)

6.4. 6800-Series Parallel Interface (P68='1')

The MCU uses a 11-wires 8-data parallel interface or 12-wires 9-data parallel interface or 19-wires 16-data parallel interface or 21-wires 18-data parallel interface. The chip-select CSX(active low) enables and disables the parallel interface. RESX(active low) is an external reset signal. WRX is the parallel data write, RDX is the parallel data read and D[17:0] is parallel data.

The Graphics Controller Chip reads the data at the falling edge of E signal when R/WX='1' and writes the data at the falling of the E signal when R/WX='0'. The D/CX is the data/command flag. When D/CX='1', D[17,0] bits are display RAM data or command parameters. When D/C='0', D[17,0] bits are commands.

The 6800-series bi-direction interface can be used for communication between the micro controller and LCD driver chip. The selection of this interface is done when P68 pin is high state (VDDI). Interface bus width can be selected with IM2, IM1 and IM0. The interface function of 6800-series parallel interface are given in Table 8.2.7

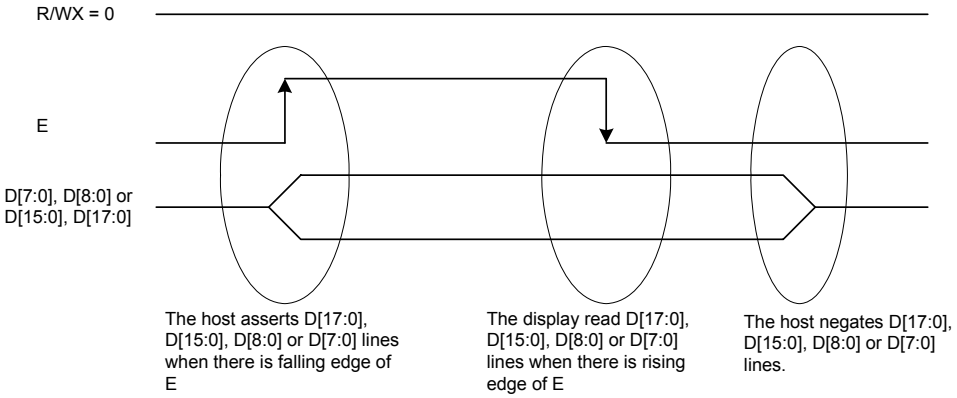
Table 7.2.7 The function of 6800-series parallel interface

P68	IM2	IM1	IM0	Interface	D/CX	RDX	WRX	Function
1	1	0	0	8-bit Parallel	0	1	↓	Write 8-bit command(D7 to D0)
					1	1	↓	Write 8-bit display data or 8-bit parameter(D7 to D0)
					1	↓	1	Read 8-bit display data(D7 to D0)
					1	↓	1	Read 8-bit parameter or status(D7 to D0)
1	1	0	1	16-bit Parallel	0	1	↓	Write 8-bit command(D7 to D0)
					1	1	↓	Write 16-bit display data or 8-bit parameter(D15 to D0)
					1	↓	1	Read 16-bit display data(D15 to D0)
					1	↓	1	Read 8-bit parameter or status(D7 to D0)
1	1	1	0	9-bit Parallel	0	1	↓	Write 8-bit command(D7 to D0)
					1	1	↓	Write 9-bit display data or 8-bit parameter(D8 to D0)
					1	↓	1	Read 9-bit display data (D8 to D0)
					1	↓	1	Read 8-bit parameter or status(D7 to D0)
1	1	1	1	18-bit Parallel	0	1	↓	Write 8-bit command(D7 to D0)
					1	1	↓	Write 18-bit display data or 8-bit parameter(D17 to D0)
					1	↓	1	Read 18-bit display data(D17 to D0)
					1	↓	1	Read 8-bit parameter or status(D7 to D0)

Note : applied for command code : Dah, DBh, DCh, 04h, 09h, 0Ah, 0Bh, 0Ch, 0Dh, 0Eh, 0Fh

6.4.1 Write Cycle/Sequence

The write cycle means that the host writes information (command or/and data) to the display via the interface. Each write cycle (E low-high-low sequence) consists of 3 control (D/CX, E, R/WX) and data signals (D[17…0]). D/CX bit is a control signal, which tells if the data is a command or a data. The data signals are a command if the control signal is low (= ‘0’) and vice versa it is data (= ‘1’). The write cycle is described in the following figure.



Note: E is unsynchronized signal (it can be stopped)

Figure17: 6800-Series Write Protocol

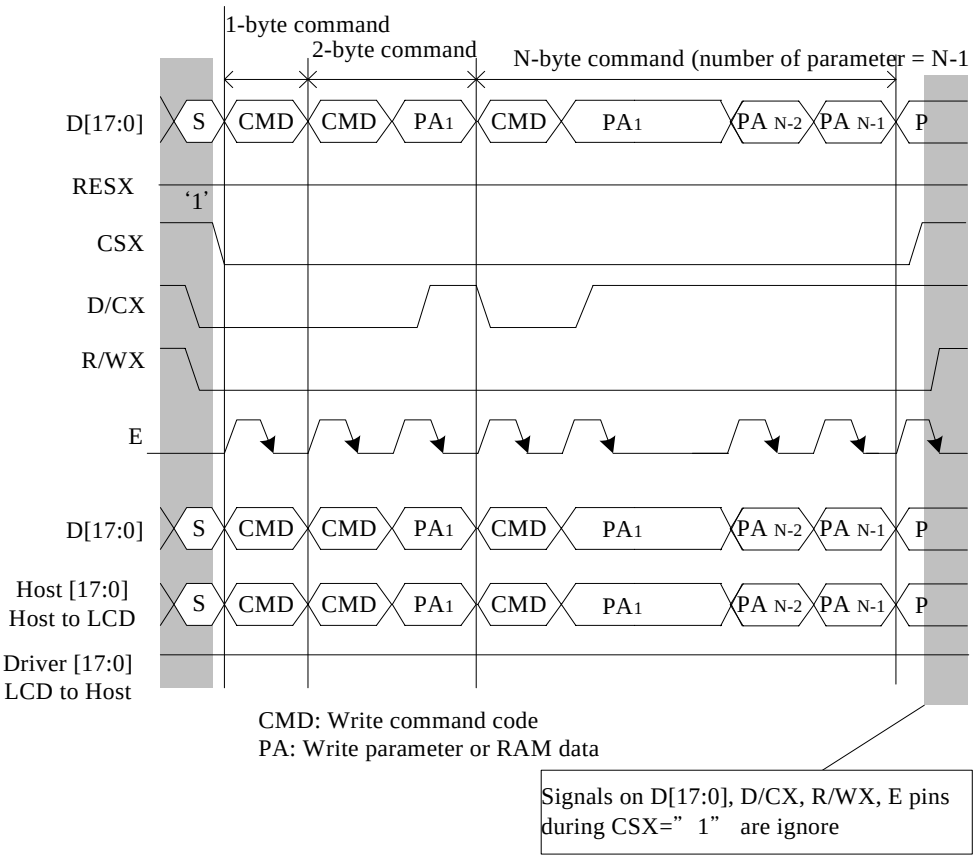
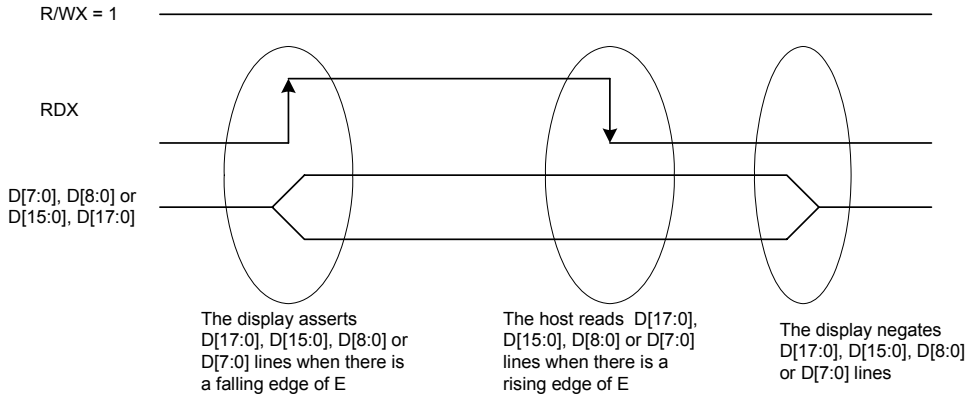


Figure18: 6800-Series parallel bus protocol (write to register or display RAM)

6.4.2 Read Cycle/Sequence

The read cycle means that the host reads information (commend or/and data) to the display via the interface. Each read cycle (E low-high-low sequence) consists of 3 control (D/CX, E, R/WX) and data (D[17…0]). D/CX bit is control signal, which tells if the data is a command or a data. The data signals are the command if the control signal is low (=’0’) and vice versa it is data (=’1’)



Note: E is an unsynchronized signal (It can be stopped).

Figure19: 6800-Series Read Protocol

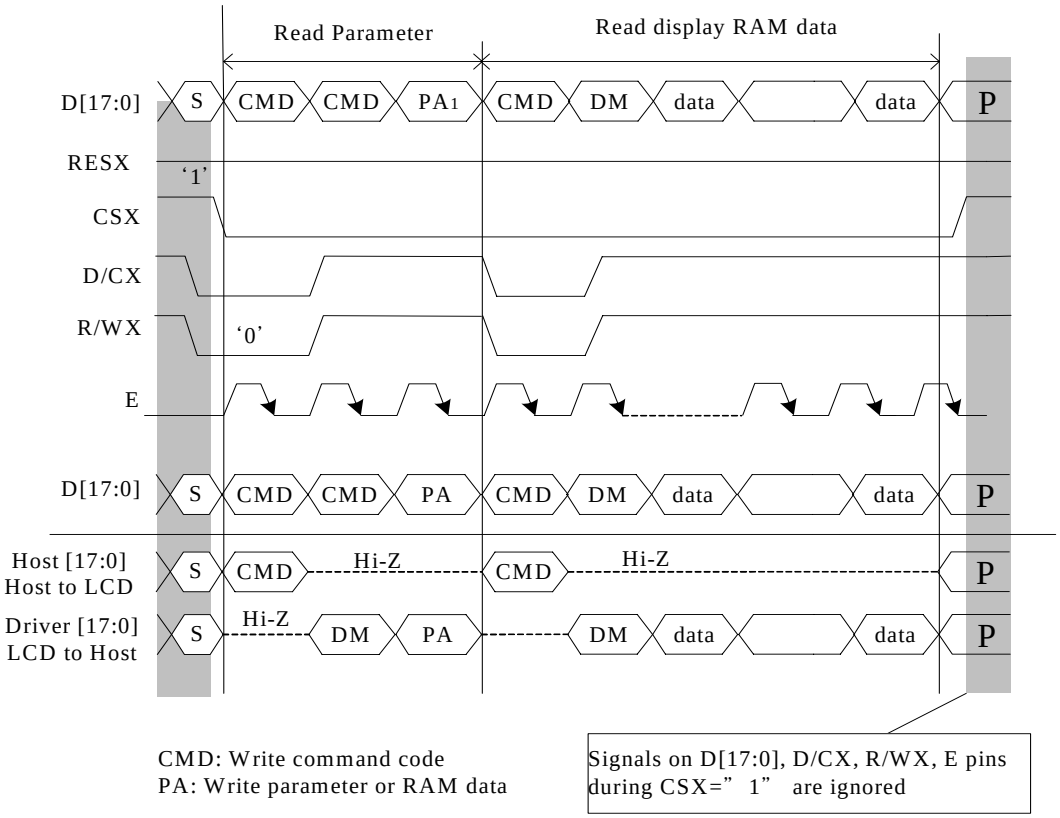


Figure20: 6800-Series Parallel bus protocol (Read from register or display RAM)

6.5. Display Data Transfer Recovery

If there is a break in data transmission by RESX pulse, while transferring a Command or Frame Memory Data or Multiple Parameter command Data, before Bit D0 of the byte has been completed, then DRIVER will reject the previous its and have reset the interface such that it will be ready to receive command data again when the chip select line (CSX) is next activated after RESX have been High state. See the following example.

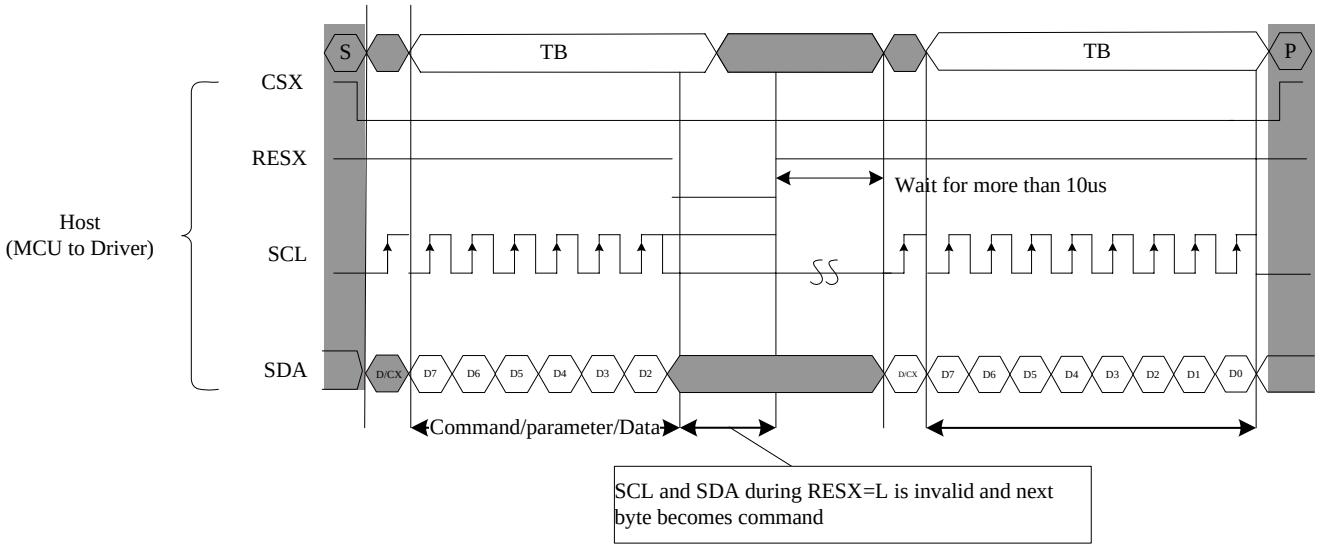


Figure21: Serial bus protocol, write mode – interrupted by RESX

If there is a break in data transmission by CSX pulse, while transferring a Command or Frame Memory Data or Multiple Parameter command data, before Bit D0 of the byte has been completed. Then the DRIVER will reject the previous bits and have reset the interface such that it will be ready to receive the same byte re-transmitted when the chip select line(CSX) is next activated. See the following example.

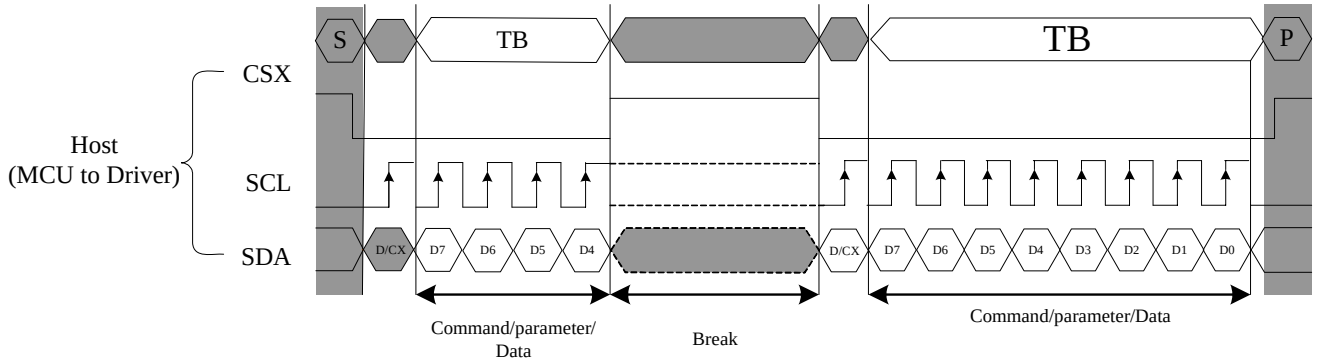


Figure22: Serial bus protocol, write mode – interrupted by CSX

If1, 2 or more parameter command is being sent and a break occurs while sending any parameter before the last one and if the host then sends a new command rather than re-transmitting the parameter that was interrupted, then the parameters that were successfully sent are stored and the parameter where the break occurred is rejected. The inter face is ready to receive next byte as show below.

Note: Break can be e.g. another command or noise pulse.

6.6. Display Data Transfer Pause

It will be possible when transferring a Command, Frame Memory Data or Multiple Parameter Data to invoke a pause in the data transmission. If the Chip Select Line is released after a whole byte of a Frame Memory Data or Multiple Parameter Data has been completed, then the Display Module will wait and continue the Frame Memory Data or Parameter Data Transmission from the point where it was paused. If the Chip Select Line is released after a whole byte of a command has been completed, then the Display Module will receive either the command's parameters (if appropriate) or a new command when the Chip Select Line is next enabled as shown below:

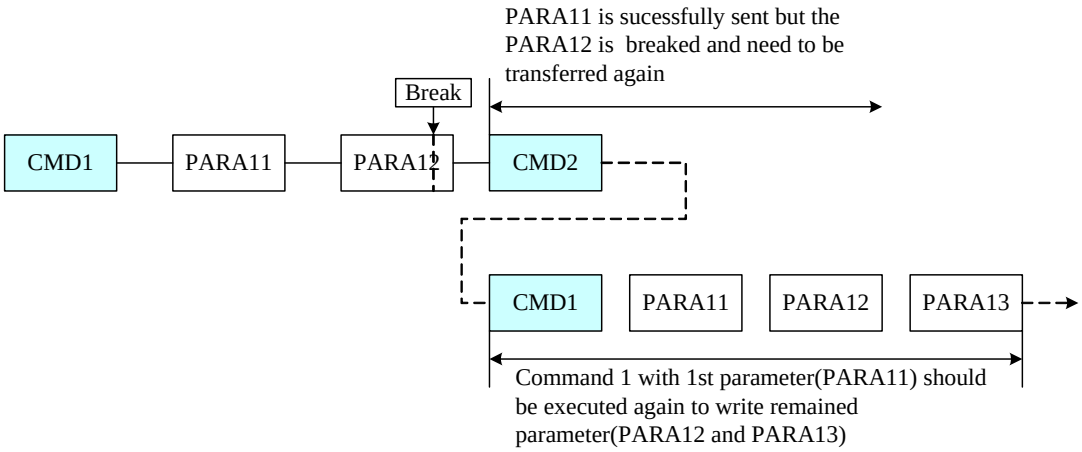


Figure23: Write interrupts recovery (serial interface)

If 1, 2 or more parameter command is being sent and a break occurs by the other command before the last one is sent, then the parameters that were successfully sent are stored and the other parameter of command remains previous value.

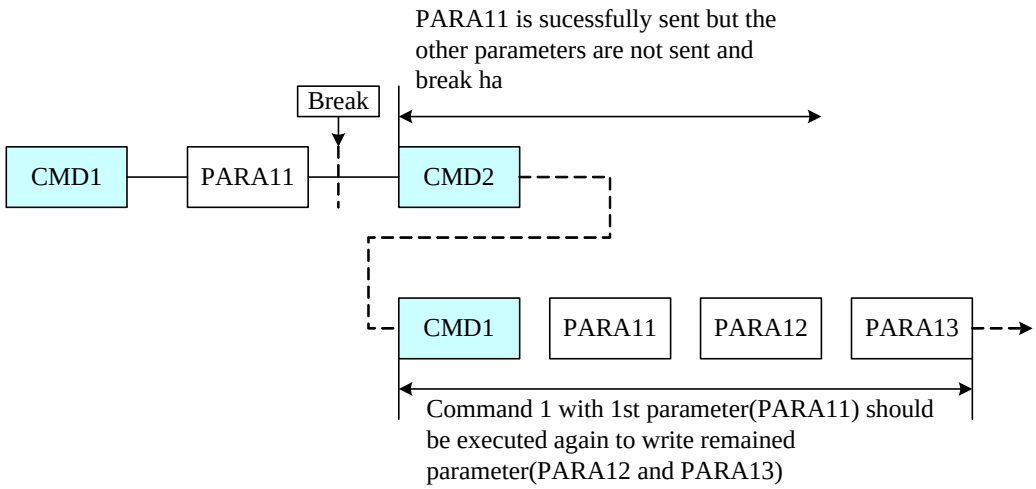


Figure24: Write interrupts recovery (both serial and parallel interface)

6.6.1 Serial Interface Pause

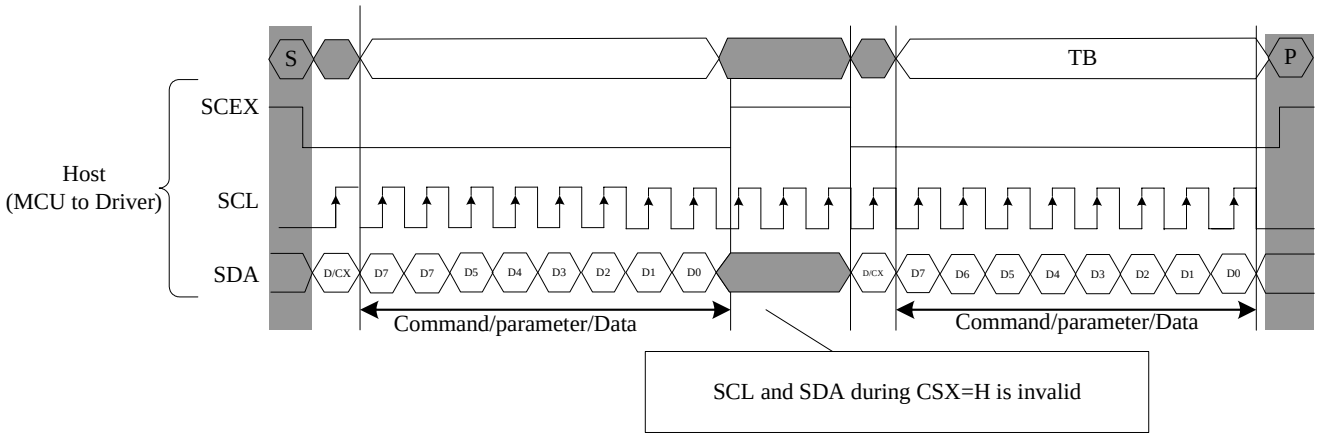


Figure25: Serial interface Pause Protocol (pause by CSX)

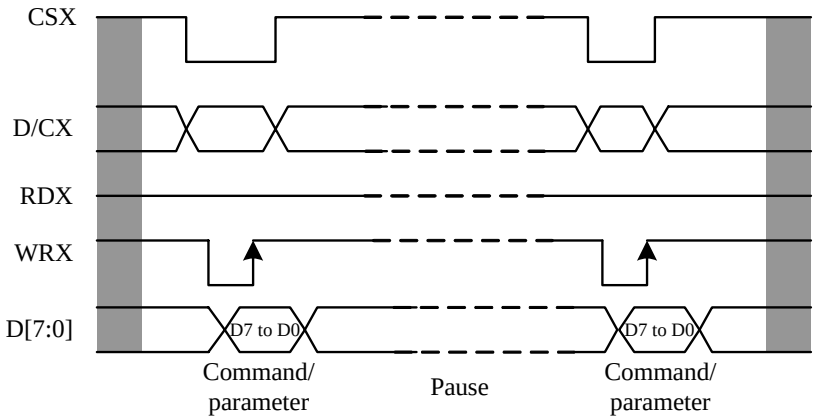


Figure26: Parallel bus Pause Protocol (paused by CSX)

This applies to the following 4 conditions:

1. Command-Pause-Command

2. Command-Pause-Parameter

3. Parameter-Pause-Command

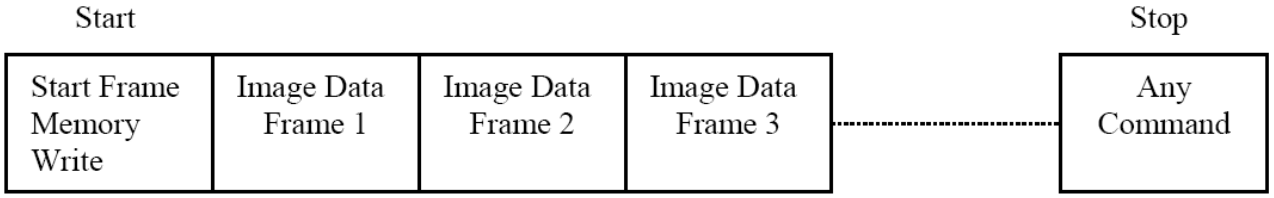
4. Parameter-Pause-Parameter

6.7. Display Data Transfer Mode

The Module has three kinds color modes for transferring data to the display RAM. These are 12-bit color per pixel, 16-bit color per pixel and 18-bit color per pixel. The data format is described for each interface. Data can be downloaded to the Frame Memory by 2 methods.

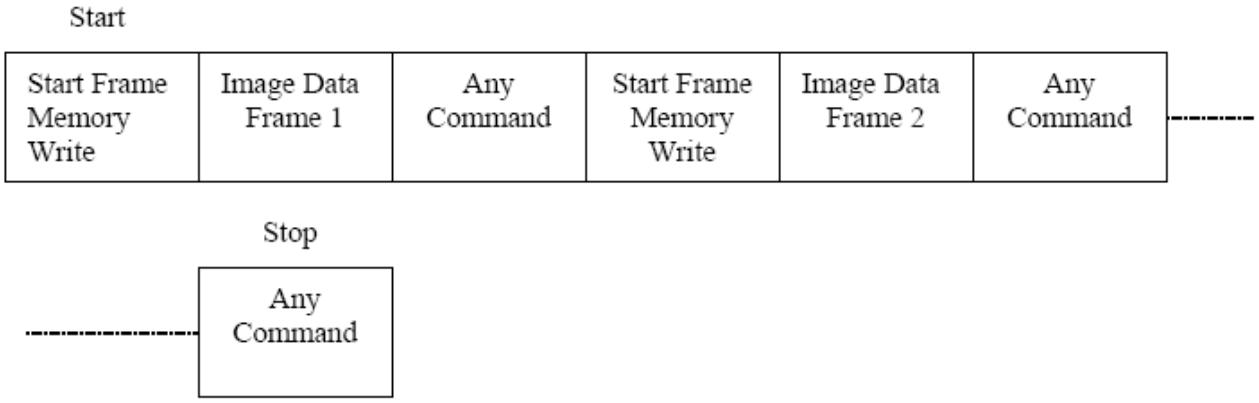
Method 1:

The Image data is sent to the Frame Memory in successive Frame writes, each time the Frame Memory is filled, the Frame Memory pointer is reset to the start point and the next Frame is written.



Method 2:

Image Data is sent and at the end of each Frame Memory download, a command is sent to stop Frame Memory Write. Then Start Memory Write command is sent, and a new Frame is downloaded.



Note:

1. These apply to this Data Transfer Color mode on both Serial and Parallel interfaces.
2. The Frame Memory can contain both odd and even number of pixels for both Methods. Only complete pixel data will be stored in the Frame Memory.

6.8. Display Data Color Coding

6.8.1 Serial Interface

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

- ✧ 4k colors, RGB 4-4-4-bits input
- ✧ 65K colors, RGB 5-6-5-bitsinput
- ✧ 262K colors, RGB 6-6-6-bits input

Note 1: pixel data with the 12-bits color depth information.

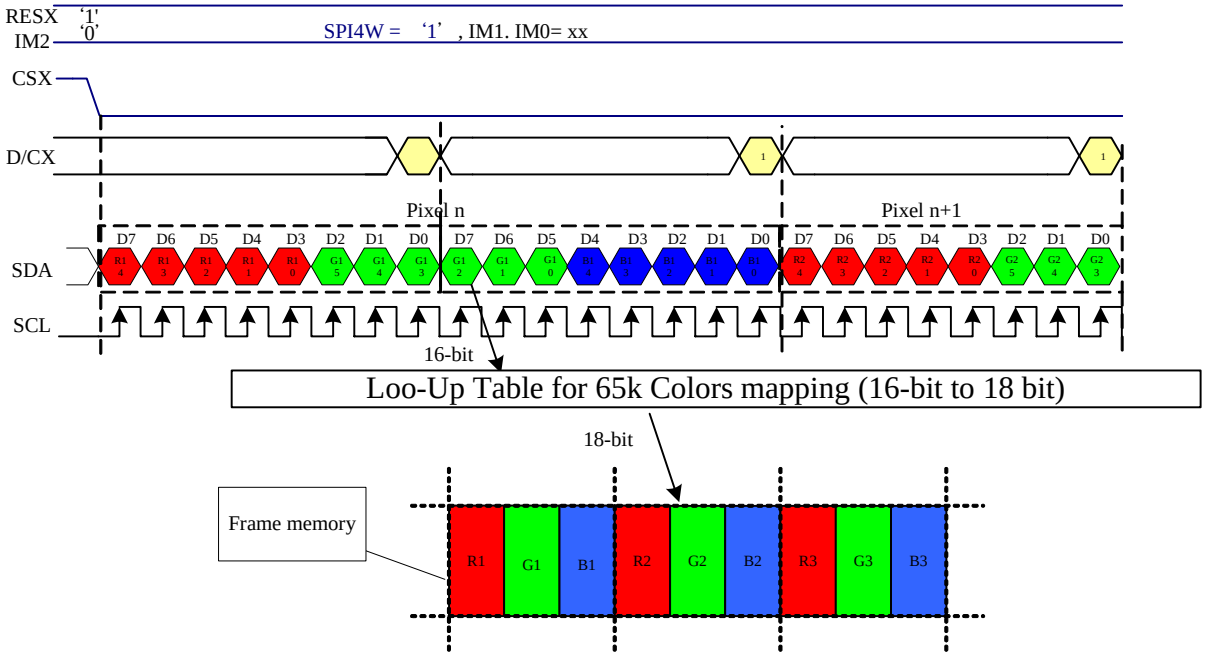
Note 2: The most significant bits are: Rx^3, Gx^3 and Bx^3

Note 3: The least significant bits are:Rx^0, Gx^0 and Bx^0

Note 4: X = don't care – Can be set to '0' or '1'

Figure27: Write data for RGB4-4-4 bits input

4-pin 8-bit Series data protocol



Note 1: pixel data with the 16-bits color depth information.

Note 2: The most significant bits are: Rx4, Gx5 and Bx4

Note 3: The least significant bits are:Rx0, Gx0 and Bx0

Note 4: X = Don't care – Can be set to '0' or '1'

Figure28: Write data fro RGB 5-6-5-bits input

3-pin 9-bit Series data protocol

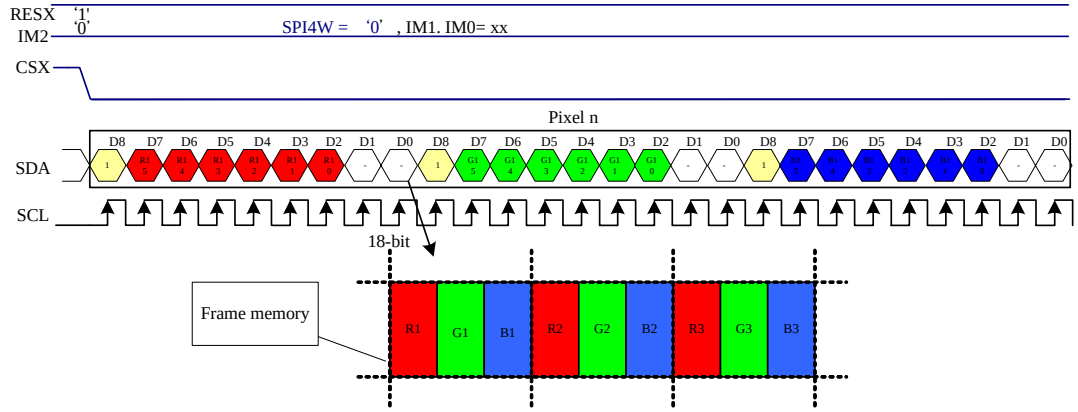
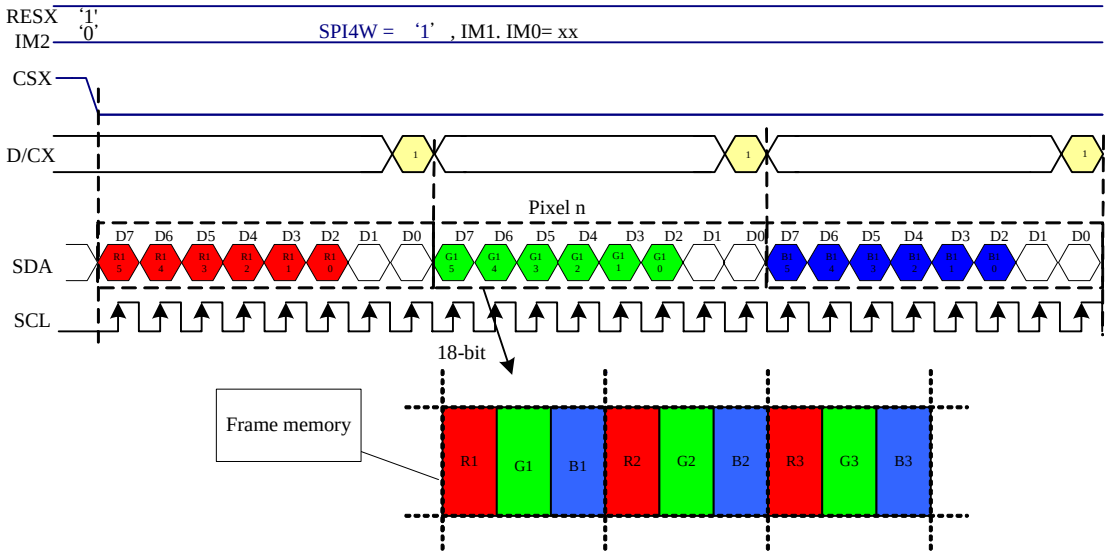


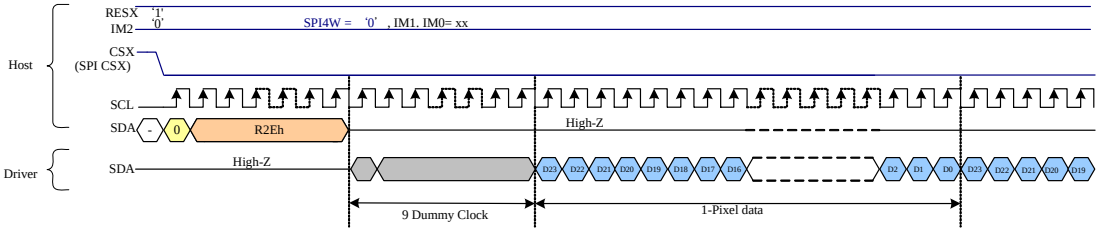
Figure29: Write data for RGB 6-6-6 bits input

4-pin 8-bit Series data protocol



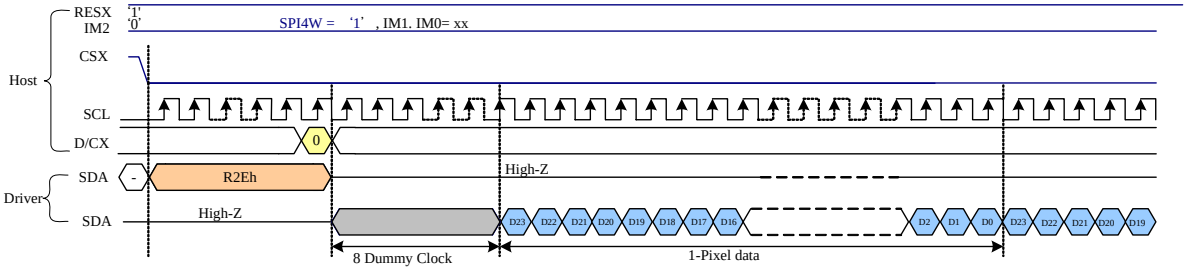
Note 1: pixel data with the 18-bits color depth information.
Note 2: The most significant bits are: Rx^5, Gx^5 and Bx^5
Note 3: The least significant bits are:Rx^0, Gx^0 and Bx^0
Note 4: X = Don't care – Can be set to '0' or '1'

Read data for 3-W SPI RGB



Read Data format as below

Note: X = Don't care – Can be set to '0' or '1'

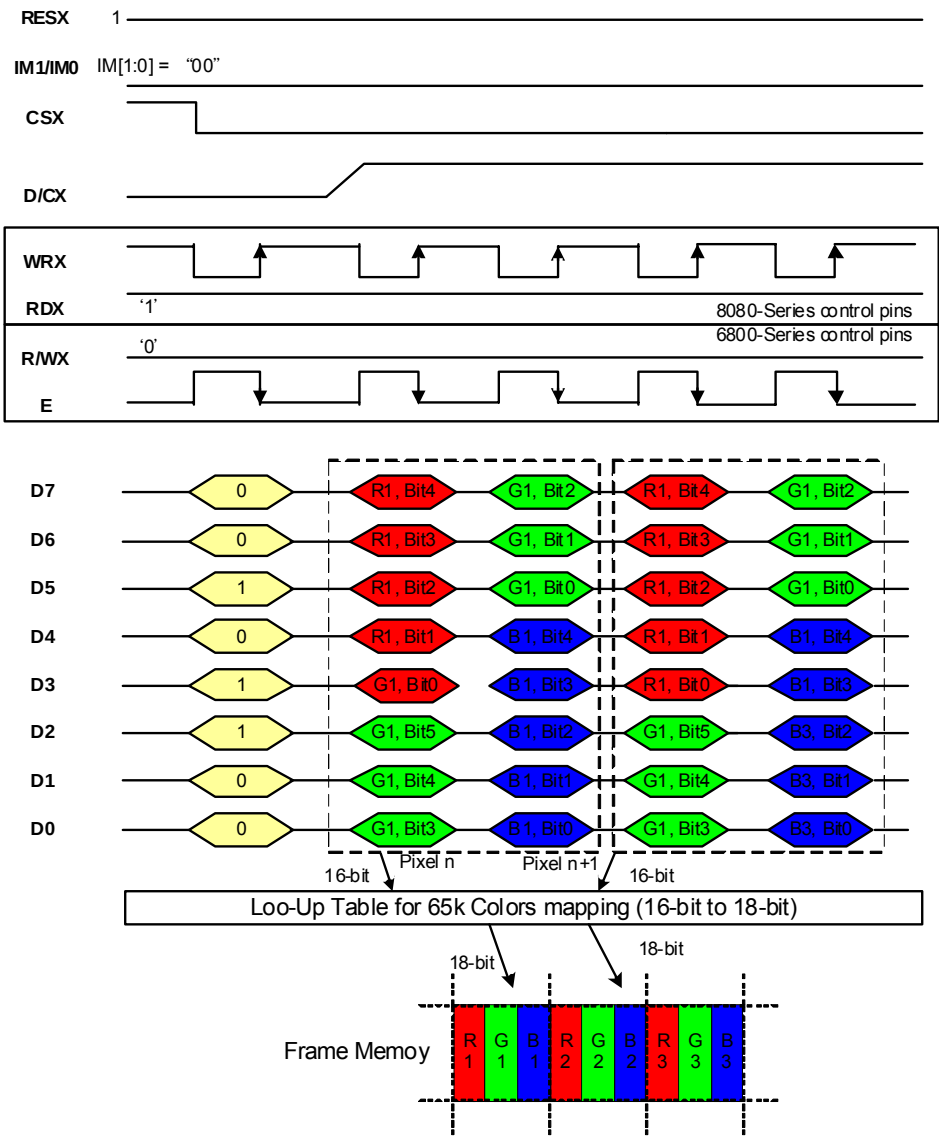


Read Data format as below

Note: X = Don't care – Can be set to '0' or '1'

Figure30: Read data for SPI RGB 6-6-6-bits

1 pixel (3 sub-pixels) per 2 transfer



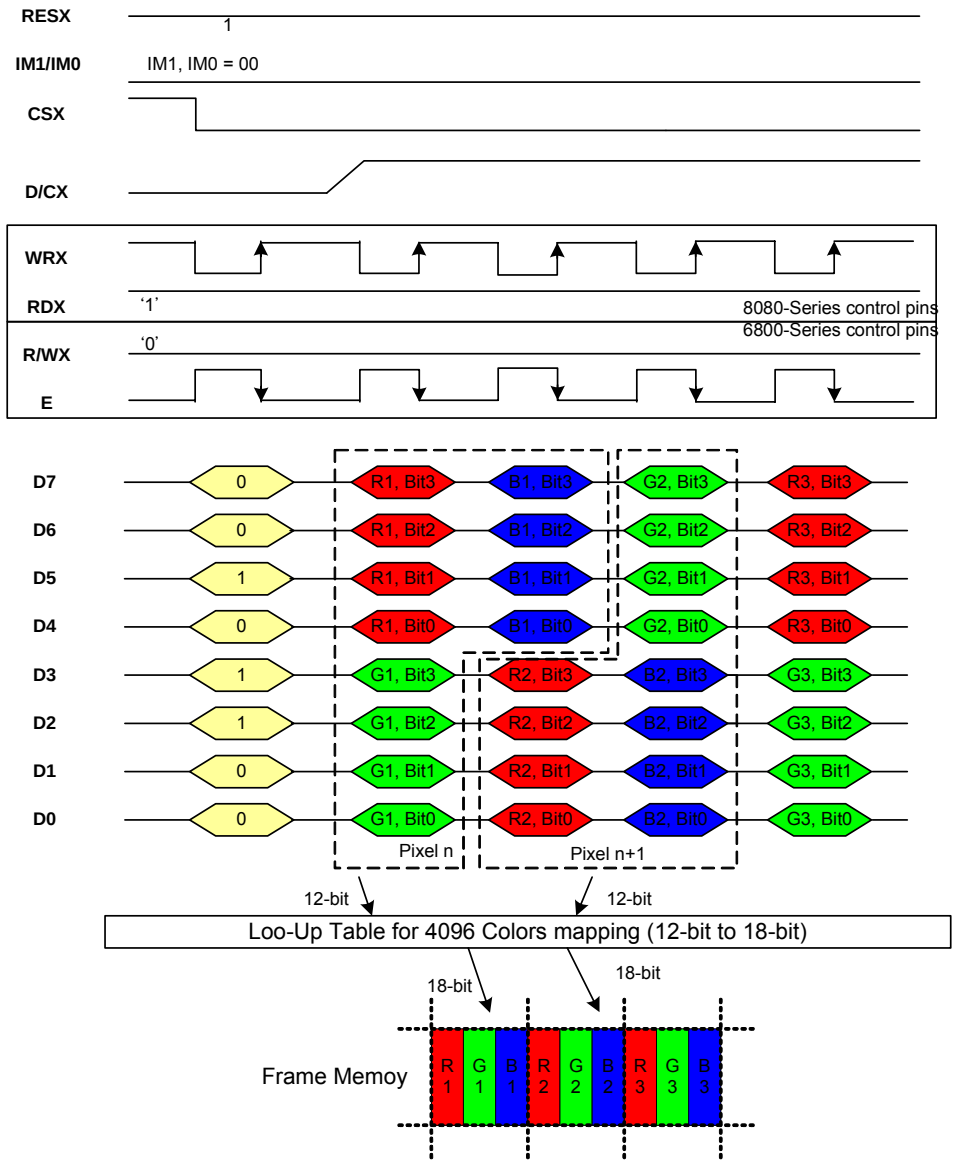
Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit3, LSB=Bit 0 for Green and MSB=Bit4, LSB=Bit0 for Red, Green and Blue data.

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

Note 3: '-' = Don't care – Can be set to '0' or '1'

Figure31: Write 8-bits data for RGB 5-6-5-bits input

2 pixels (6 sub-pixels) per 3 transfer



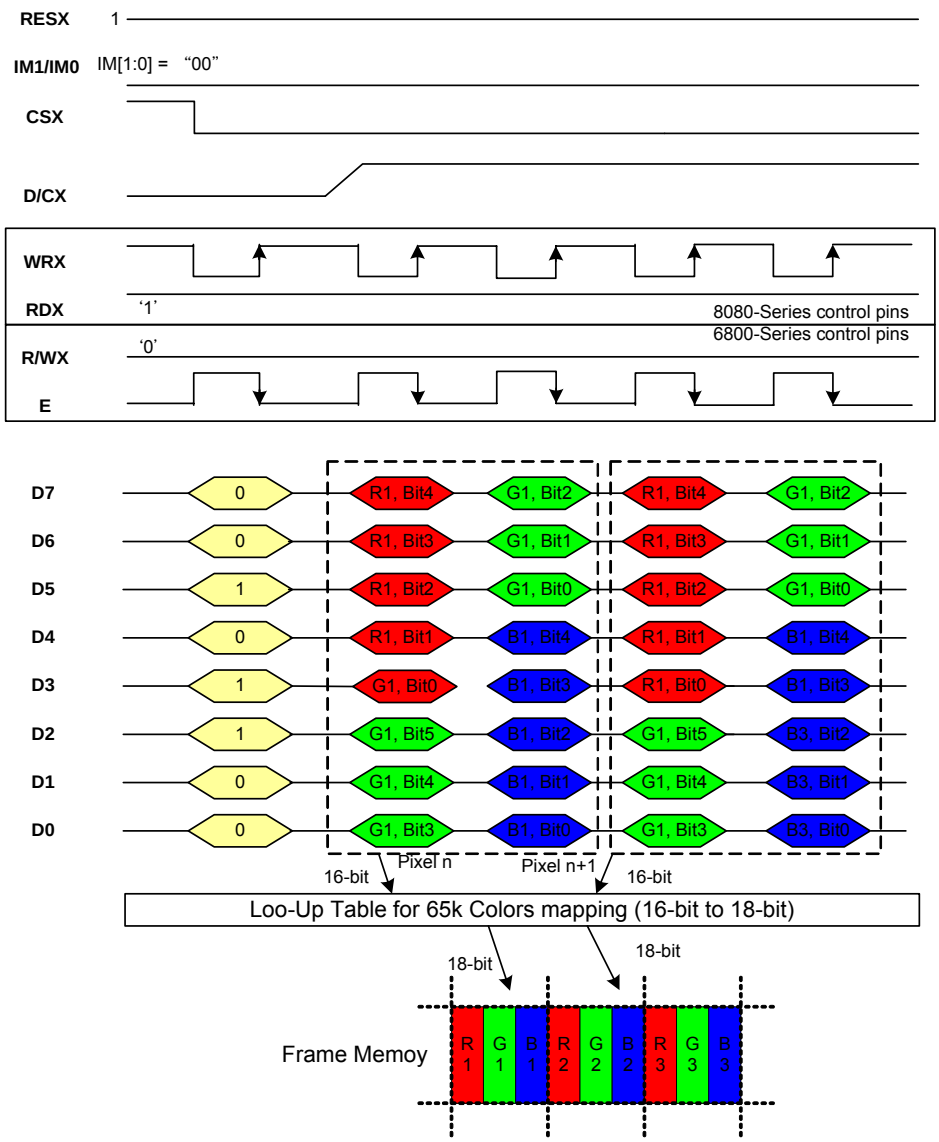
Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit3, LSB=Bit 0 for Red, Green and Blue data.

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

Note 3: '-' = Don't care – Can be set to '0' or '1'

Figure32: Write 8-bit data for RGB 4-4-4-bits input

1 pixel (3 sub-pixels) per 2 transfer



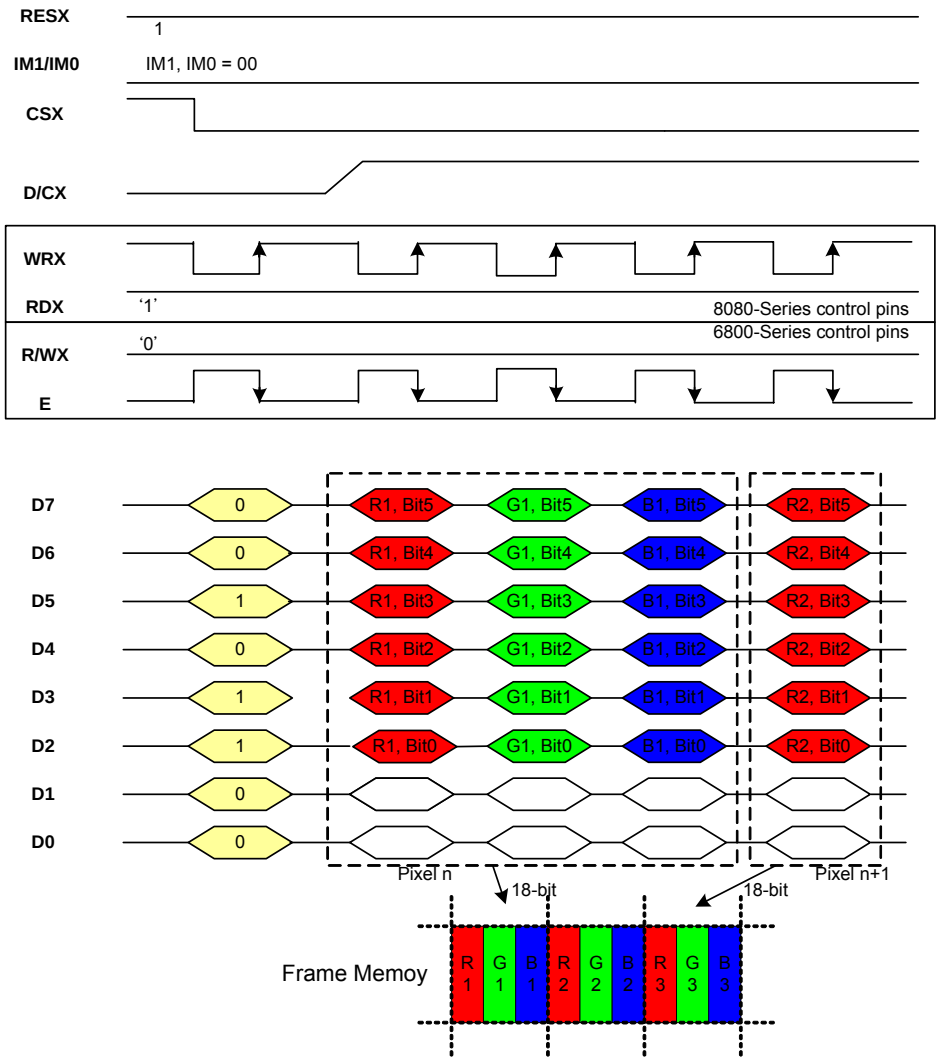
Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit3, LSB=Bit 0 for Green and MSB=Bit4, LSB=Bit0 for Red, Green and Blue data.

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

Note 3: '-' = Don't care – Can be set to '0' or '1'

Figure33: Write 8-bits data for RGB 5-6-5-bits input

1 pixel (3 sub-pixels) per 3 transfer



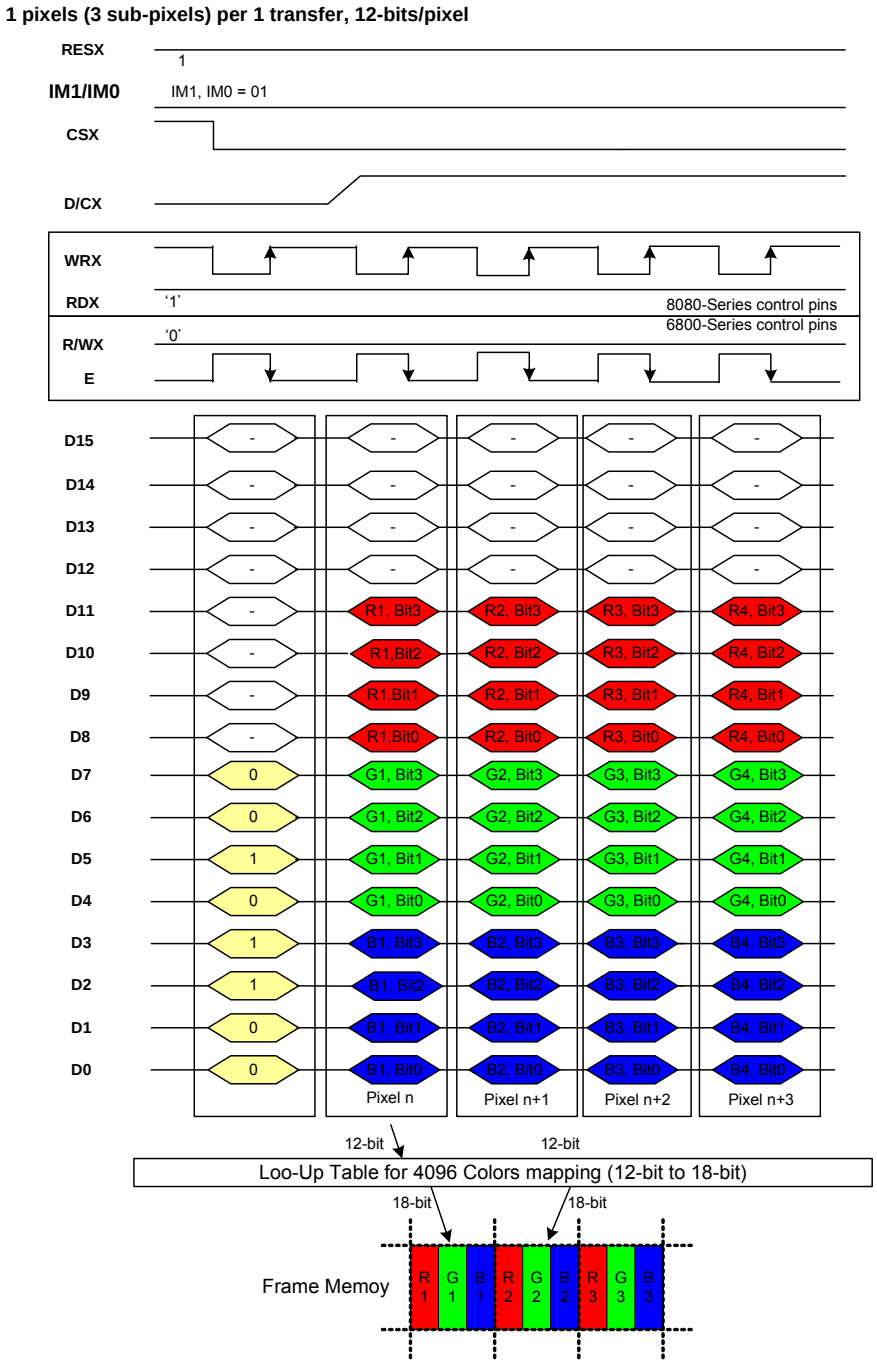
Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit5, LSB=Bit 0 for Red, Green and Blue data.
Note 2: 3-times transfer is used to transmit 1 pixel data with the 18-bits color depth information.
Note 3: '-' = Don't care – Can be set to '0' or '1'

Figure34: Write 8-bit data for RGB 6-6-6-bits input

6.8.3 16-bit Parallel Interface (IM2='1', IM1, IM0="01")

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

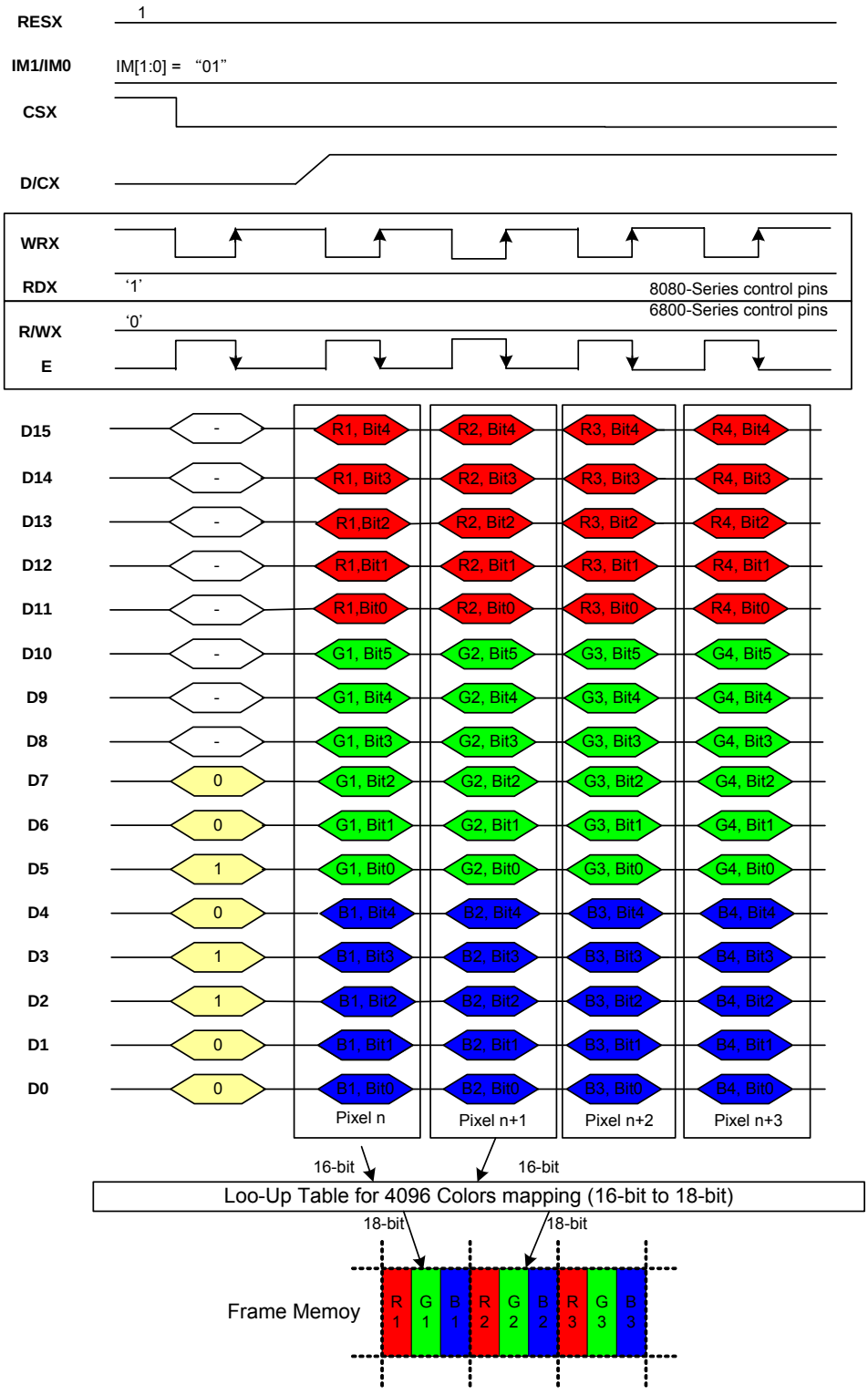
- ✧ 4k colors, RGB 4-4-4-bits input
- ✧ 65K colors, RGB 5-6-5-bits input
- ✧ 262K colors, RGB 6-6-6-bits input



Note1: The data order is as follows, MSB = D15, LSB = D0 and picture data is MSB = Bit3, LSB = Bit0 for Red, Green and Blue data.
Note 2: 1-times transfer (D7 to D0) is used to transmit 1 pixel data with the 12-bit color depth information.
Note 3: '=' Don't care – Can be set to '0' or '1'

Figure35: Write 16-bit data for RGB4-4-4-bits input (4k-color)

1 pixel (3 sub-pixels) per 1 transfer, 16-bits/pixel



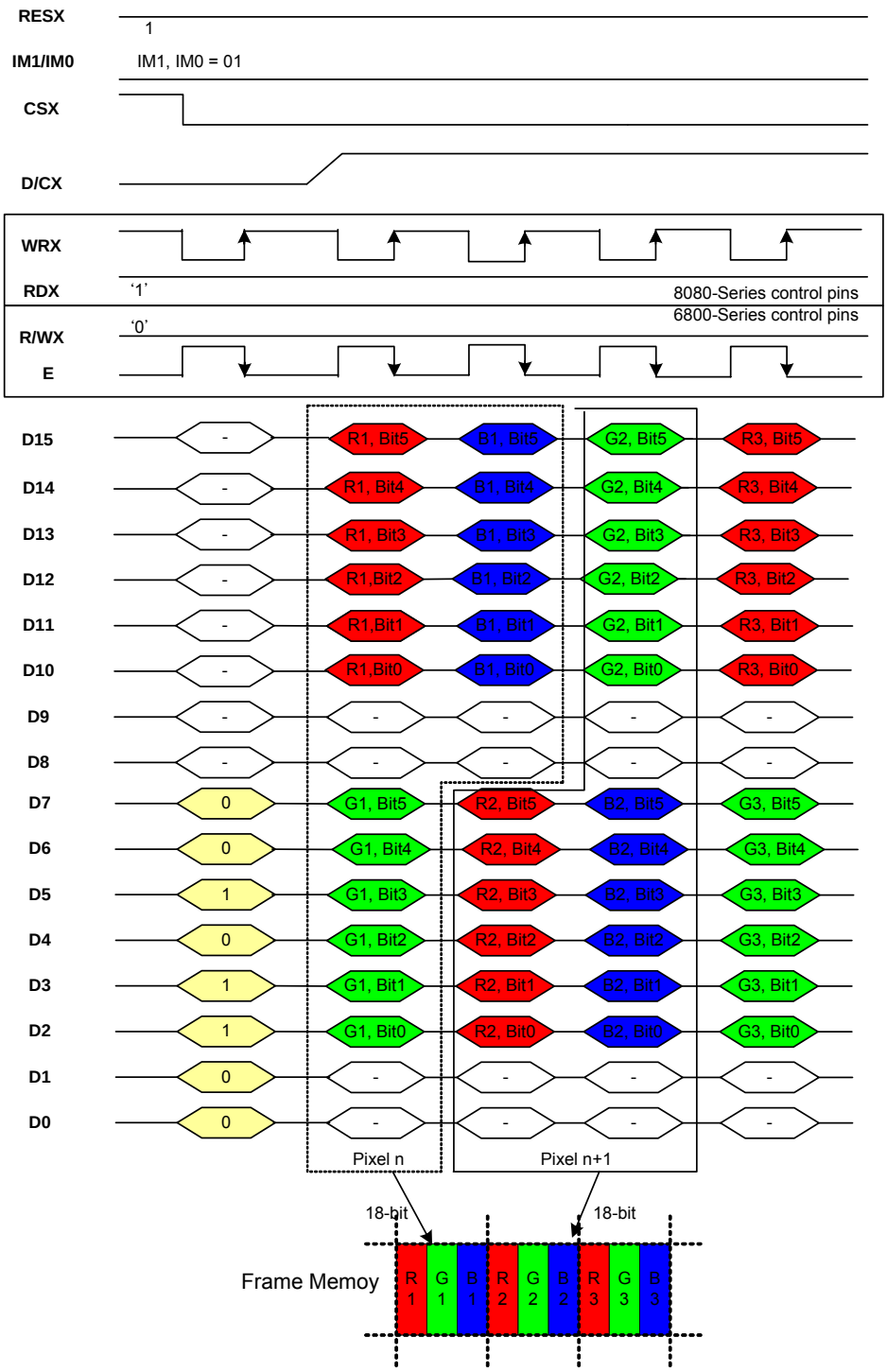
Note1: The data order is as follows, MSB = D15, LSB = D0 and picture data is MSB = Bit5, LSB = Bit0 for Red and Blue and MSB=Bit5, LSB=Bit 0 for Green data.

Note 2: 1-time transfer (D7 to D0) is used to transmit 1 pixel data with the 18-bit color depth information.

Note 3: '=' Don't care – Can be set to '0' or '1'

Figure36: Write 16-bit data for RGB 5-6-5-bits input (65k colors)

2 pixels (6 sub-pixels) per 2 transfer, 18-bits/pixel



Note1: The data order is as follows, MSB = D15, LSB = D0 and picture data is MSB = Bit2, LSB = Bit0 for Red and Green and MSB=Bit1, LSB=Bit 0 for Blue data.

Note 2: 1-time transfer (D7 to D0) is used to transmit 1 pixel data with the 8-bit color depth information.

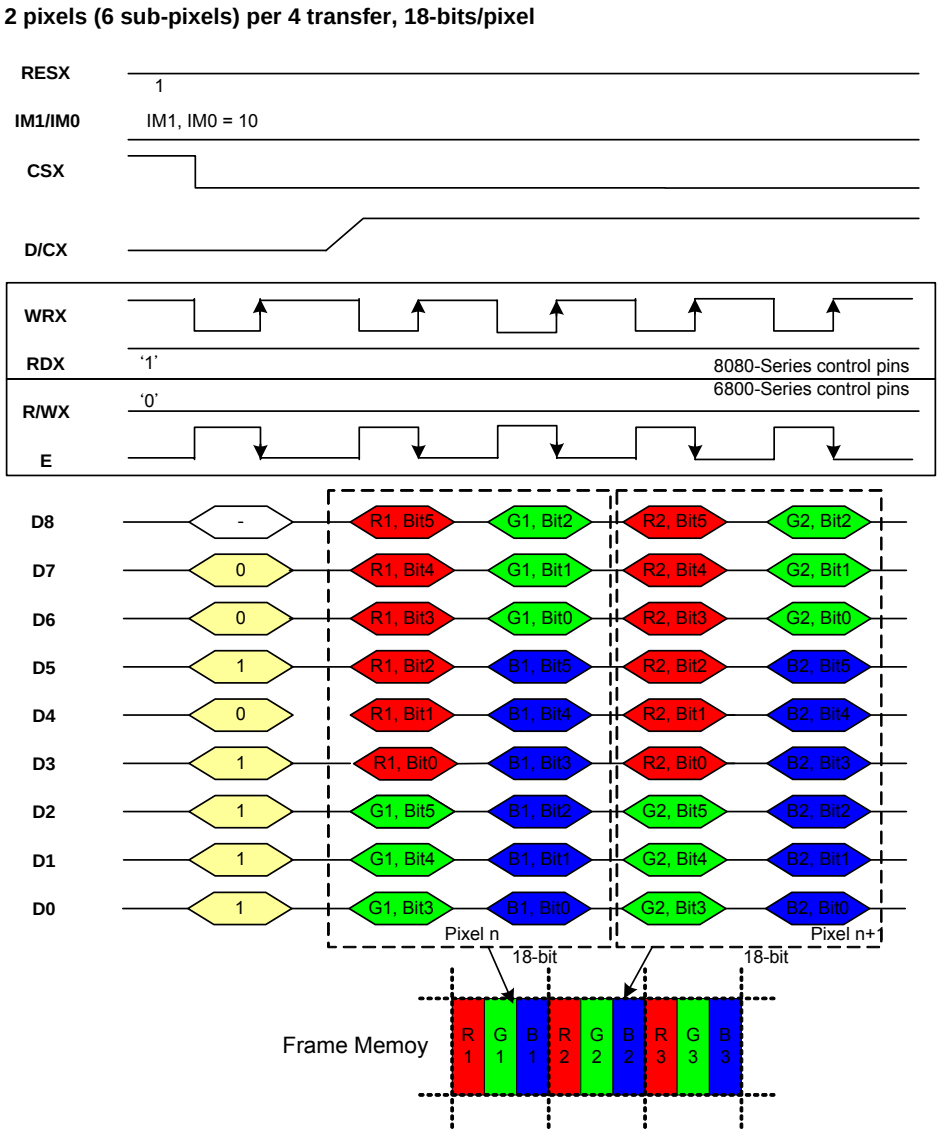
Note 3: '=' Don't care – Can be set to '0' or '1'

Figure37: Write 16-bit data for RGB 6-6-6-bits input (262K colors)

6.8.4 9-bit Parallel Interface (IM2=’2’, IM1, IM0=”10”)

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

- ✧ 262K colors, RGB6-6-6-bits input



Note1: The data order is as follows, MSB = D8, LSB = D0 and picture data is MSB = Bit5, LSB = Bit0 for Red and Green and Blue data.

Note 2: 3-times is used to transmit 1 pixel data with the 18-bit color depth information.

Note 3: ‘=’ Don’t care – Can be set to ‘0’ or ‘1’

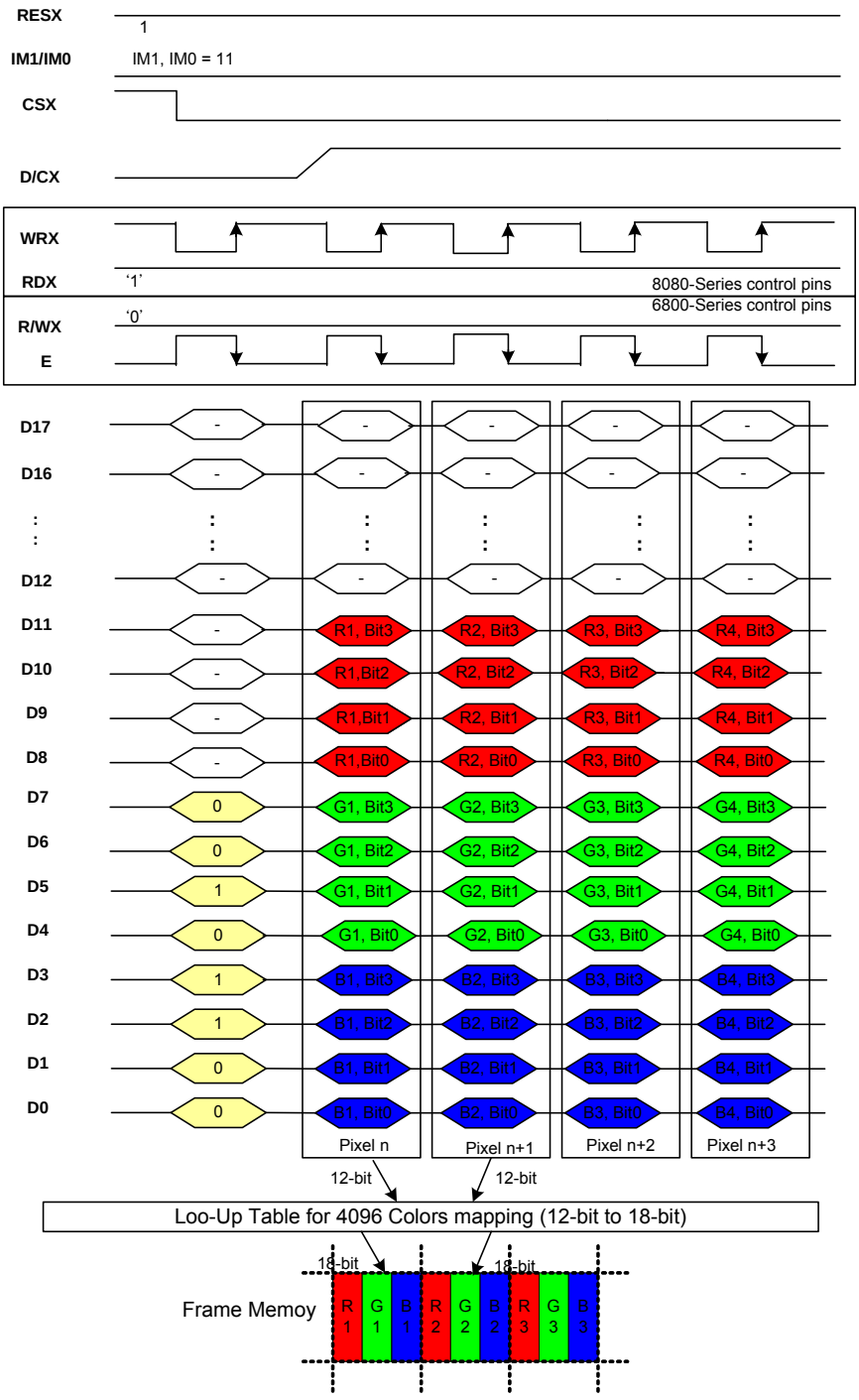
Figure38: Write 9-bit data for RGB 6-6-6-bits input(262k-color)

6.8.5 18-bit Parallel Interface (IM2='1', IM1, IM0="11")

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

- ✧ 4k colors, RGB 4-4-4-bits input
- ✧ 65K colors, RGB 5-6-5-bits input
- ✧ 262K colors, RGB 6-6-6-bits input

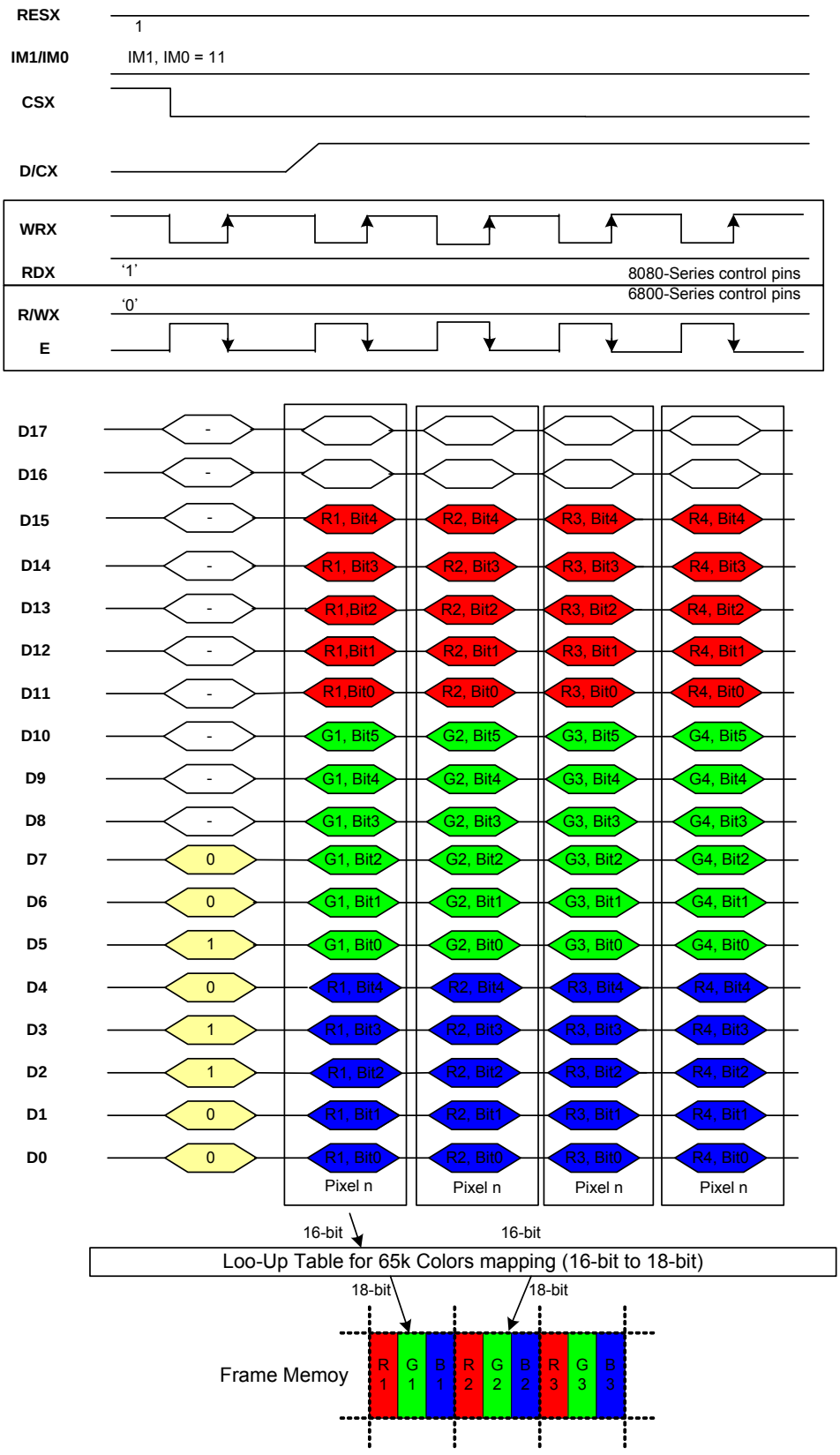
1 pixel (3 sub-pixels) per 1 transfer, 12-bits/pixel



Note1: The data order is as follows, MSB = D11, LSB = D0 and picture data is MSB = Bit3, LSB = Bit0 for Red, Green and Blue data.
Note 2: 1-time is used to transmit 1 pixel data with the 12-bit color depth information.
Note 3: '=' Don't care – Can be set to '0' or '1'

Figure39: Write 18-bits data for RGB 4-4-4-bits input (4k colors)

1 pixel (3 sub-pixels) per 1 transfer, 16-bits/pixel



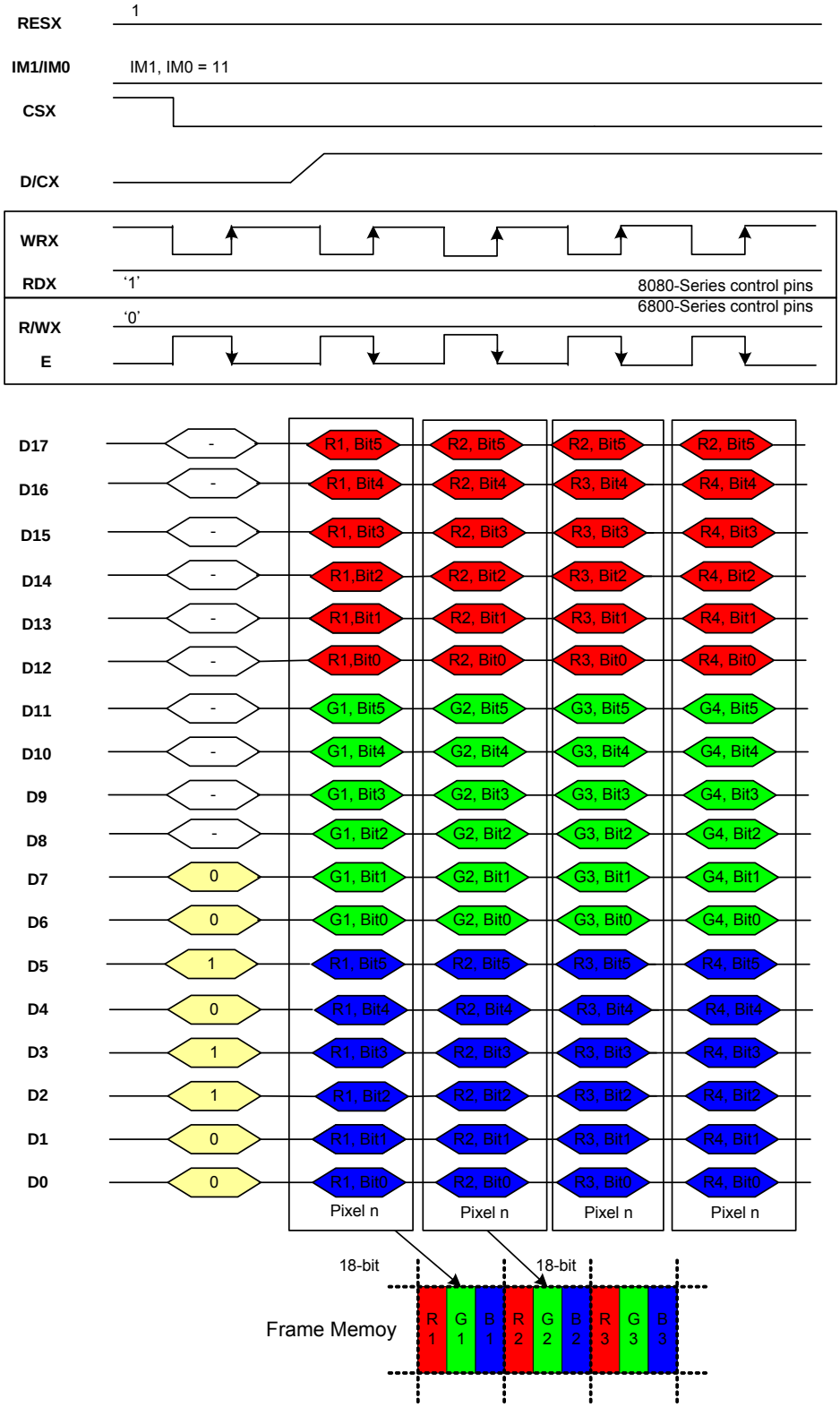
Note1: The data order is as follows, MSB = D15, LSB = D0 and picture data is MSB = Bit5, LSB = Bit0 for Green and MSB=Bit 4, LSB=Bit 0 for Blue data.

Note 2: 1-time is used to transmit 1 pixel data with the 16-bit color depth information.

Note 3: '=' Don't care – Can be set to '0' or '1'

Figure40: Write 18-bits data for RGB 5-6-5-bits input (65k-color)

1 pixel (3 sub-pixels) per 1 transfer, 18-bits/pixel



Note1: The data order is as follows, MSB = D17, LSB = D0 and picture data is MSB = Bit5, LSB = Bit0 for Red, Green and Blue data.

Note 2: 1-time(D17 to D0) is used to transmit 1 pixel data with the 18-bit color depth information.

Note 3: '=' Don't care – Can be set to '0' or '1'

Figure41: Write 18-bit data for RGB 6-6-6-bits input (262K colors)

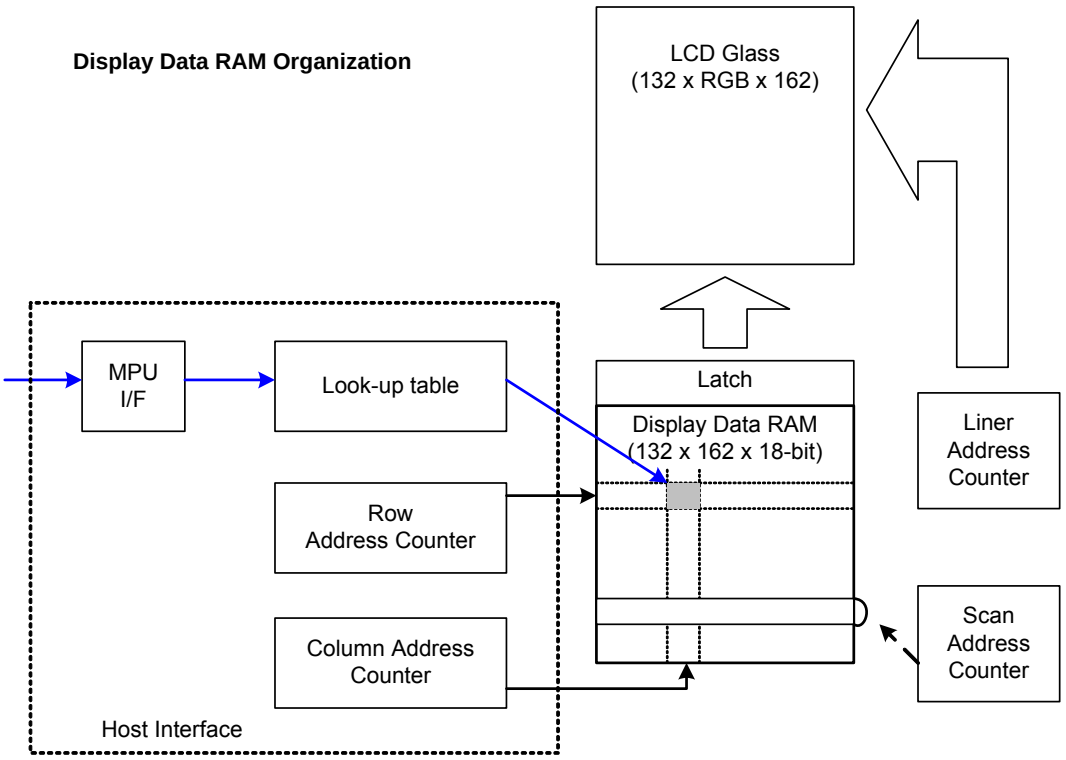
7. Display Data RAM

7.1. Configuration

The display data RAM stores display dots and consists of 384,504 bits (132x18x162 bits). There is no restriction on access to the RAM even when the display data on the same address is loaded to DAC.

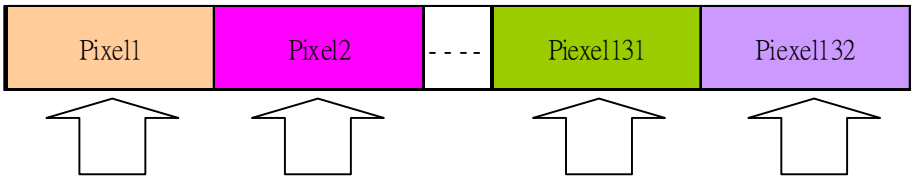
There will be no abnormal visible effect on the display when there is a simultaneous Panel Read and Interface Read or Write to the same location of the Frame Memory.

Display Data RAM Organization



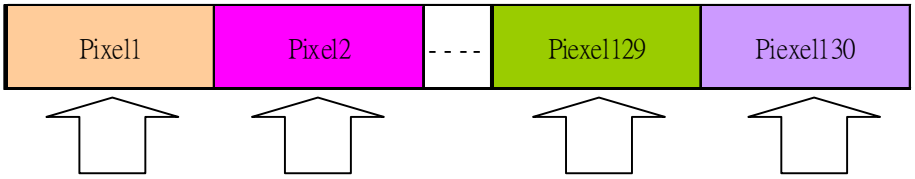
7.2. Memory to Display Address Mapping

7.2.1 132RGB x 132 resolution (GM[2:0] = "101", SMX=SMY=SRGB='0')



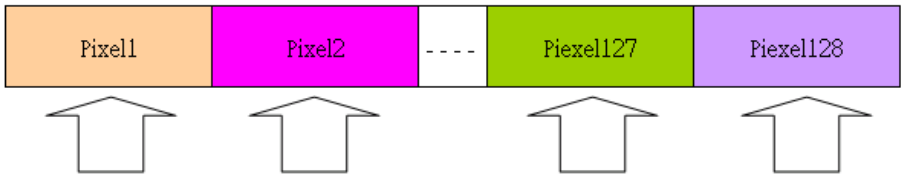
Gate	Source Out		S1	S2	S3	S4	S5	S6	- - - -	S391	S392	S393	S394	S395	S396		
	RA		RGB=0		RGB=1	RGB=0		RGB=1	RGB Order	RGB=0		RGB=1	RGB=0		RGB=1	SA	
	MY=0	MY=1														ML=0	ML=1
1	1	132	R1	G1	B1	R2	G2	B2	- - - -	R131	G131	B131	R132	G132	B132	1	132
2	2	131							- - - -							2	131
3	3	130							- - - -							3	130
4	4	129							- - - -							4	129
5	5	128							- - - -							5	128
6	6	127							- - - -							6	127
7	7	126							- - - -							7	126
8	8	125							- - - -							8	125
9	9	124							- - - -							9	124
10	10	123							- - - -							10	123
11	11	122							- - - -							11	122
12	12	121							- - - -							12	121
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
125	125	8							- - - -							125	8
126	126	7							- - - -							126	7
127	127	6							- - - -							127	6
128	128	5							- - - -							128	5
129	129	4							- - - -							129	4
130	130	3							- - - -							130	3
131	131	2							- - - -							131	2
132	132	1							- - - -							132	1
	CA	MX-0	1			2			- - - -	131			132				
		MX-1	132			131			- - - -	2			1				

7.2.2 130RGB x 130 resolution(GM[2:0] = “100”, SMX=SMY=SRGB=’0’)



Gate	Source Out		S7	S8	S9	S10	S11	S12	- - - -	S391	S392	S393	S394	S395	S396		
	RA		RGB=0		RGB=1	RGB=0		RGB=1	RGB Order	RGB=0		RGB=1	RGB=0		RGB=1	SA	
	MY=0	MY=1														ML=0	ML=1
1	1	130	R1	G1	B1	R2	G2	B2	- - - -	R129	G129	B129	R130	G130	B130	1	130
2	2	129							- - - -							2	129
3	3	128							- - - -							3	128
4	4	127							- - - -							4	127
5	5	126							- - - -							5	126
6	6	125							- - - -							6	125
7	7	124							- - - -							7	124
8	8	123							- - - -							8	123
9	9	122							- - - -							9	122
10	10	121							- - - -							10	121
11	11	120							- - - -							11	120
12	12	119							- - - -							12	119
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
123	123	8							- - - -							123	8
124	124	7							- - - -							124	7
125	125	6							- - - -							125	6
126	126	5							- - - -							126	5
127	127	4							- - - -							127	4
128	128	3							- - - -							128	3
129	129	2							- - - -							129	2
130	130	1							- - - -							130	1
	CA	MX-0	1			2			- - - -	129			130				
		MX-1	130			129			- - - -	2			1				

7.2.3 128RGB x 160 resolution (GM[2:0] = “011”, SMX=SMY=SRGB=’0’)



Gate	Source Out		S7	S8	S9	S10	S11	S12	- - - -	S385	S386	S387	S388	S389	S390		
			RGB=0		RGB=1	RGB=0		RGB=1	RGB Order	RGB=0		RGB=1	RGB=0		RGB=1	SA	
	RA																
	MY=0	MY=1														ML=0	ML=1
1	1	160	R1	G1	B1	R2	G2	B2	- - - -	R127	G127	B127	R128	G128	B128	1	160
2	2	159							- - - -							2	159
3	3	158							- - - -							3	158
4	4	157							- - - -							4	157
5	5	156							- - - -							5	156
6	6	155							- - - -							6	155
7	7	154							- - - -							7	154
8	8	153							- - - -							8	153
9	9	152							- - - -							9	152
10	10	151							- - - -							10	151
11	11	150							- - - -							11	150
12	12	149							- - - -							12	149
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
153	153	8							- - - -							153	8
154	154	7							- - - -							154	7
155	155	6							- - - -							155	6
156	156	5							- - - -							156	5
157	157	4							- - - -							157	4
158	158	3							- - - -							158	3
159	159	2							- - - -							159	2
160	160	1							- - - -							160	1
	CA	MX-0	1			2			- - - -	127			128				
		MX-1	128			127			- - - -	2			1				

Note

RA = Row Address

CA = Column Address

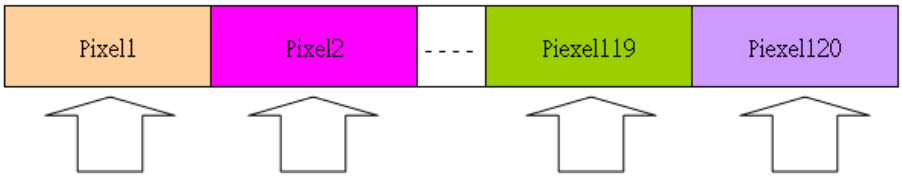
SA = Scan Address

MX = Mirror X-axis (Column address direction parameter), D6 parameter of MADCTL command

ML = Scan direction parameter, D4 parameter of MADCTL command

RGB = Red, Green and Blue pixel position change, D3 parameter of MADCTL command

7.2.4 120RGB x 160 resolution (GM[2:0] = “010”, SMX=SMY=SRGB=’0’)



Gate	Source Out		S7	S8	S9	S10	S11	S12	- - - -	S361	S362	S363	S364	S365	S366		
	RA		RGB=0		RGB=1	RGB=0		RGB=1	RGB Order	RGB=0		RGB=1	RGB=0		RGB=1	SA	
	MY=0	MY=1														ML=0	ML=1
1	1	160	R1	G1	B1	R2	G2	B2	- - - -	R119	G119	B119	R120	G120	B120	1	160
2	2	159							- - - -							2	159
3	3	158							- - - -							3	158
4	4	157							- - - -							4	157
5	5	156							- - - -							5	156
6	6	155							- - - -							6	155
7	7	154							- - - -							7	154
8	8	153							- - - -							8	153
9	9	152							- - - -							9	152
10	10	151							- - - -							10	151
11	11	150							- - - -							11	150
12	12	149							- - - -							12	149
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
153	153	8							- - - -							153	8
154	154	7							- - - -							154	7
155	155	6							- - - -							155	6
156	156	5							- - - -							156	5
157	157	4							- - - -							157	4
158	158	3							- - - -							158	3
159	159	2							- - - -							159	2
160	160	1							- - - -							160	1
	CA	MX-0	1			2			- - - -	119			120				
		MX-1	120			119			- - - -	2			1				

Note

RA = Row Address

CA = Column Address

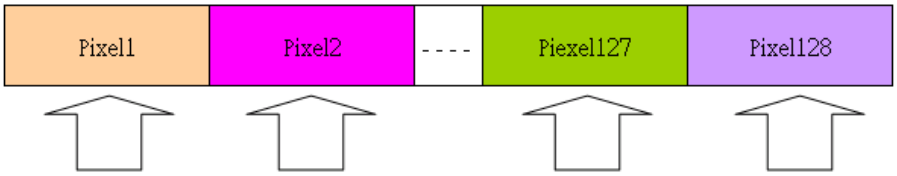
SA = Scan Address

MX = Mirror X-axis (Column address direction parameter), D6 parameter of MADCTL command

ML = Scan direction parameter, D4 parameter of MADCTL command

RGB = Red, Green and Blue pixel position change, D3 parameter of MADCTL command

7.2.5 128RGB x 128 resolution (GM[2:0] = “001”, SMX=SMY=SRGB=’0’)



Gate	Source Out		S7	S8	S9	S10	S11	S12	- - - -	S385	S386	S387	S388	S389	S390		
	RA		RGB=0		RGB=1	RGB=0		RGB=1	RGB Order	RGB=0		RGB=1	RGB=0		RGB=1	SA	
	MY=0	MY=1														ML=0	ML=1
1	1	128	R1	G1	B1	R2	G2	B2	- - - -	R127	G127	B127	R128	G128	B128	1	128
2	2	127							- - - -							2	127
3	3	126							- - - -							3	126
4	4	125							- - - -							4	125
5	5	124							- - - -							5	124
6	6	123							- - - -							6	123
7	7	122							- - - -							7	122
8	8	121							- - - -							8	121
9	9	120							- - - -							9	120
10	10	119							- - - -							10	119
11	11	118							- - - -							11	118
12	12	117							- - - -							12	117
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
121	121	8							- - - -							121	8
122	122	7							- - - -							122	7
123	123	6							- - - -							123	6
124	124	5							- - - -							124	5
125	125	4							- - - -							125	4
126	126	3							- - - -							126	3
127	127	2							- - - -							127	2
128	128	1							- - - -							128	1
	CA	MX-0	1			2			- - - -	127			128				
		MX-1	128			127			- - - -	2			1				

Note

RA = Row Address

CA = Column Address

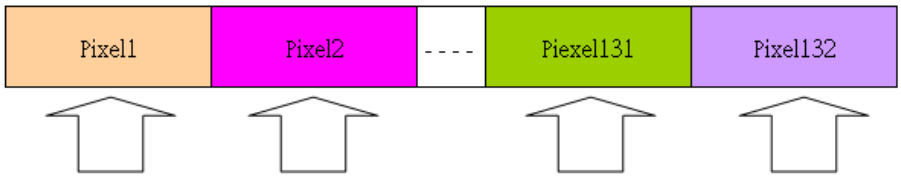
SA = Scan Address

MX = Mirror X-axis (Column address direction parameter), D6 parameter of MADCTL command

ML = Scan direction parameter, D4 parameter of MADCTL command

RGB = Red, Green and Blue pixel position change, D3 parameter of MADCTL command

7.2.6 132RGB x 162 resolution (GM[2:0] = "000", SMX=SMY=SRGB='0')



Gate	Source Out		S1	S2	S3	S4	S5	S6	- - - -	S391	S392	S393	S394	S395	S396		
	RA		RGB=0 / RGB=1						RGB Order							SA	
	MY=0	MY=1														ML=0	ML=1
1	1	162	R1	G1	B1	R2	G2	B2	- - - -	R131	G131	B131	R132	G132	B132	1	162
2	2	161							- - - -							2	161
3	3	160							- - - -							3	160
4	4	159							- - - -							4	159
5	5	158							- - - -							5	158
6	6	157							- - - -							6	157
7	7	156							- - - -							7	156
8	8	155							- - - -							8	155
9	9	154							- - - -							9	154
10	10	153							- - - -							10	153
11	11	152							- - - -							11	152
12	12	151							- - - -							12	151
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	- - - -	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:		:	:	:	:	:	:	:	:
155	155	8							- - - -							155	8
156	156	7							- - - -							156	7
157	157	6							- - - -							157	6
158	158	5							- - - -							158	5
159	159	4							- - - -							159	4
160	160	3							- - - -							160	3
161	161	2							- - - -							161	2
162	162	1							- - - -							162	1
	CA	MX-0	1			2			- - - -	131			132				
		MX-1	132			131			- - - -	2			1				

Note

RA = Row Address

CA = Column Address

SA = Scan Address

MX = Mirror X-axis (Column address direction parameter), D6 parameter of MADCTL command

ML = Scan direction parameter, D4 parameter of MADCTL command

RGB = Red, Green and Blue pixel position change, D3 parameter of MADCTL command

7.3. MCU to memory write/read direction (Address Counter)

The address counter set the addresses of the display data RAM for writing and reading.

Data is written pixel-wise into the RAM matrix of DRIVER. The data for one pixel or two pixels is collected(RGB 6-6-6-bit), according to the data formats. As soon as this pixel-data information is complete the"Write access" is activated on the RAM. The locations of RAM are addressed by the address pointers. When GM=011, 132RGB x 162, the address ranges are X=0 to X=131 (83h) and Y=0 to Y=161 (A1h). Addresses outside these ranges are not allowed. Before writing to the RAM a window must be defined into which will be written. The window is programmable via the command register XS, YS designating the start address and XE, YE designating the end address.

For example the whole display contents will be written, the window is defined by the following values: XS=0(0h) YS=0(0h) and XE=131(83h), YE=161(A1h)

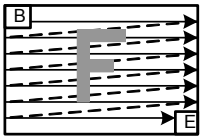
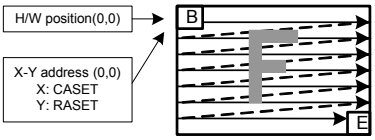
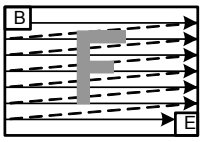
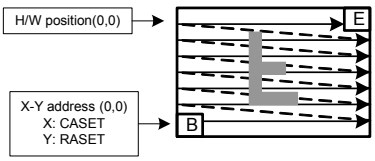
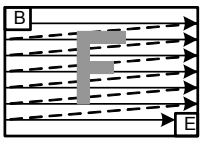
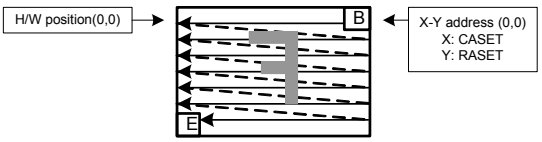
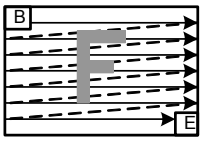
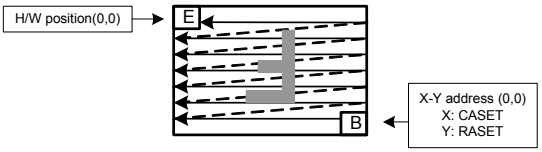
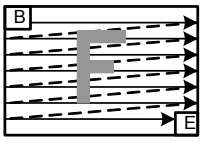
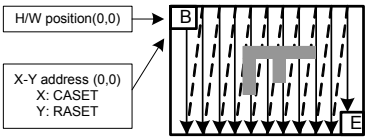
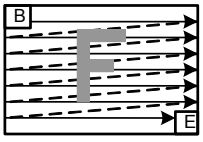
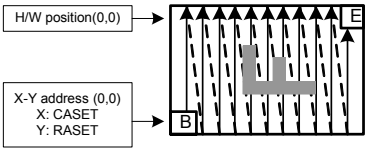
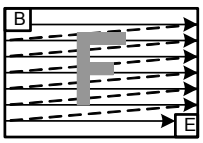
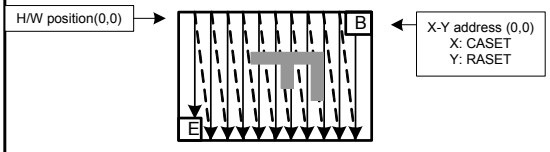
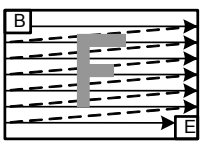
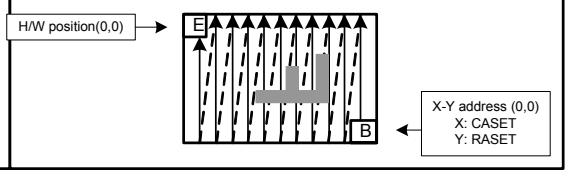
In vertical addressing mode (MV=1), the Y-address increments after each byte, after the last Y-address (Y=YE), Y wraps around to YS and X increments to address the next column. In horizontal addressing mode (V=0), the X-address increments after each byte, after the last X-address(X=XE), X wraps around to XS and Y increments to address the next row. After the every last address (X=XE and Y=YE) the address pointers wrap around to address (X=XS and Y=YS)

For flexibility in handling a wide variety of display architectures, the commands "CASET, RASET" and "MADCTR", define flags MX and MY, which allows mirroring of the X-address and Y-address. All combinations of flags are allowed. Below table shows the available combinations of writing to the display RAM. When MX, MY and MV will be changed the data bust be rewritten to the display RAM.

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

Condition	Column Counter	Row Counter
When RAMWR/RAMRD command is accepted	Return to "Start Column (XS)"	Return to "Start Row (YS)
Complete Pixel Read/Write action	Increment by 1	No change
The Column counter value is larger than "End Column(XE)"	Return to "Start Column (XS)"	Increment by 1
The Column counter value is larger than "End Column (XE)" and the Row counter value is larger than "End Row(YE)"	Return to "Start Column (XS)"	Return to "Start Row (YS)

Figure42: Frame Data Write Direction According to the MADCTR parameters (MV, MX and MY)

Display Data Direction	MADCTR Parameter			Image in the Memory (MPU)	Image in the Driver (DDRAM)
	MV	MX	MY		
Normal	0	0	0		
Y-Mirror	0	0	1		
X-Mirror	0	1	0		
X-Mirror Y-Mirror	0	1	1		
X-Y Exchange	1	0	0		
X-Y Exchange Y-Mirror	1	0	1		
XY Exchange	1	1	0		
XY Exchange	1	1	1		

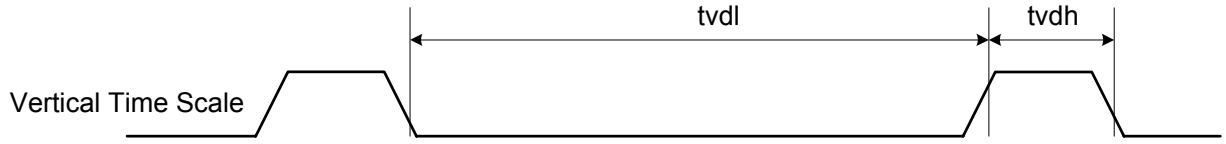
8. Tearing Effect Output Line

The Tearing Effect output line supplies to the MCU a Panel synchronization signal. This signal can be enabled or disabled by the Tearing Effect Line Off & On commands. The mode of the Tearing Effect Signal is defined by the Parameter of the Tearing Effect Line On command.

The signal can be used by the MCU to synchronize Frame Memory Writing when displaying video images.

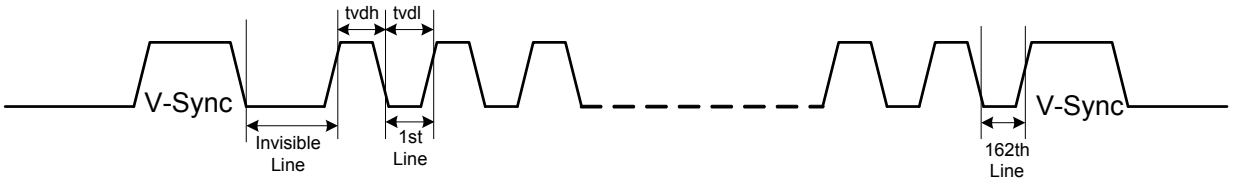
8.1. Tearing Effect Line Modes

Mode 1, the Tearing Effect Output signal consists of V-Sync information only:

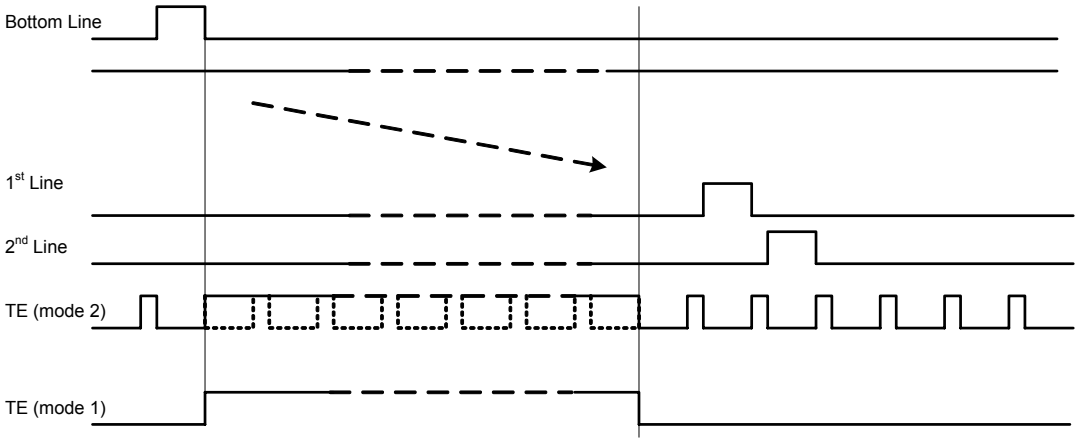


tvdh = The LCD display is not updated from the Frame Memory.
Tvdl = The LCD display is updated from the Frame Memory (except Invisible Line – see below).

Mode 2, the Tearing Effect Output signal consists of V-Sync and H-Sync information, There is one V-sync and 162 H-sync pulses per field:



t^{hdh} = The LCD display is not updated from the Frame Memory.
T^{hdl} = The LCD display is updated from the Frame Memory (except Invisible Line – see above).



Note: During Sleep In Mode, the Tearing Effect Output Pin is active Low.

8.2. Tearing Effect Line Timing

The Tearing Effect signal is described below:

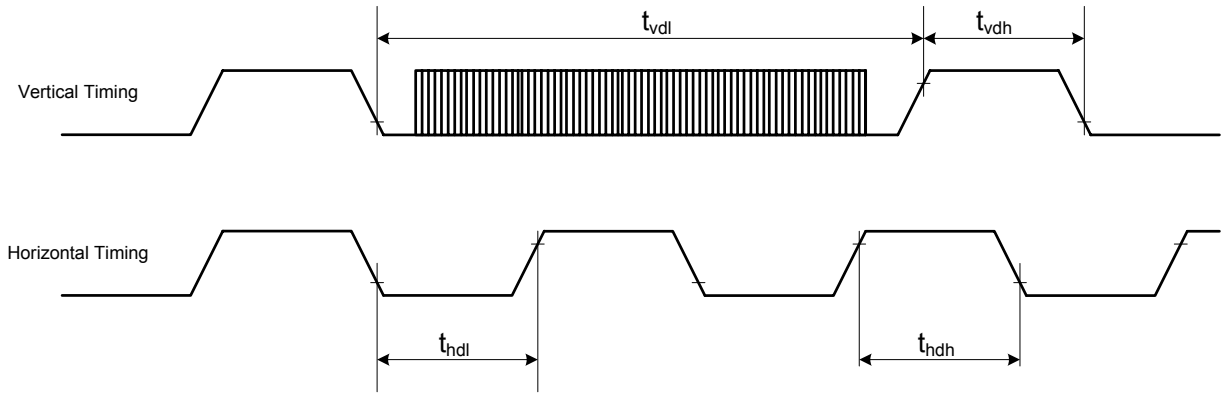


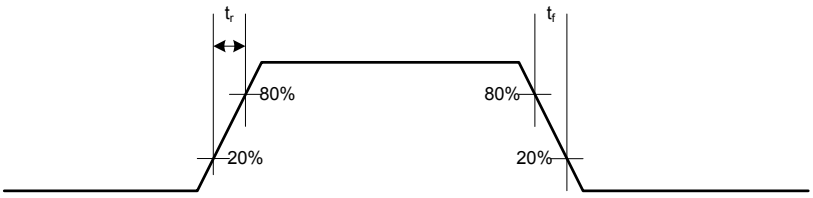
Table 8.2.1 AC characteristics of Tearing Effect Signal Idle Mode Off/On (Frame Rate = 58.9Hz)

Symbol	Parameter	min	max	unit	descritpion
tvdl	Vertical Timing Low Duration	13	-	Ms	
tvdh	Vertical Timing High Duration	1000	-	µs	
thdl	Horizontal Timing Low Duration	33	-	µs	
thdh	Horizontal Timing High Duration	25	500	µs	

Notes:

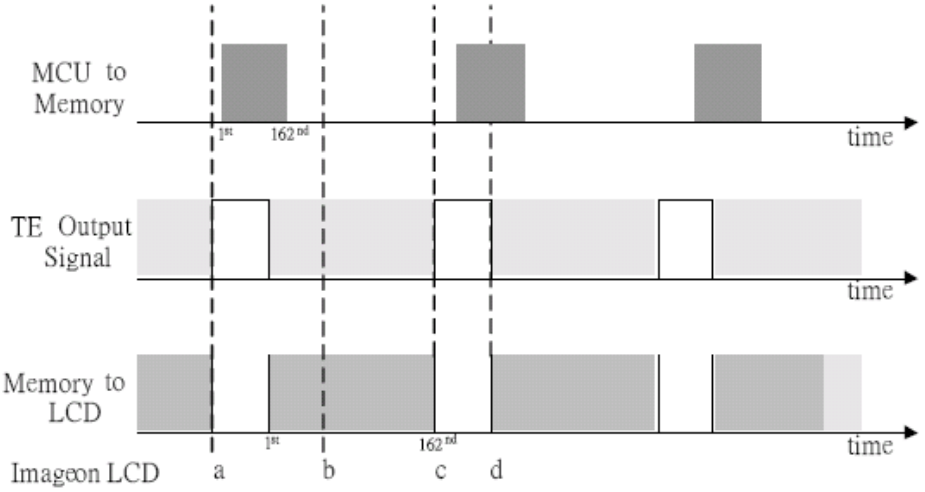
1. The timings in Table 8.3.1 apply when MADCTL B4=0 and B4=1
2. The signal's rise and fall times (tf, tr) are stipulated to be equal to or less than 15ns.

Figure43: Rise and fall times

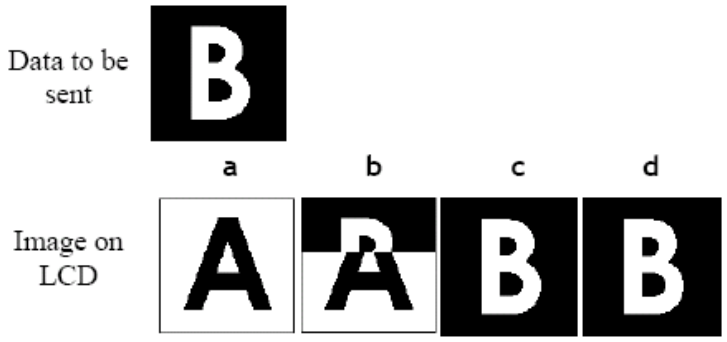


The Tearing Effect Output Line is fed back to the MCU and should be used as shown below to avoid Tearing Effect:

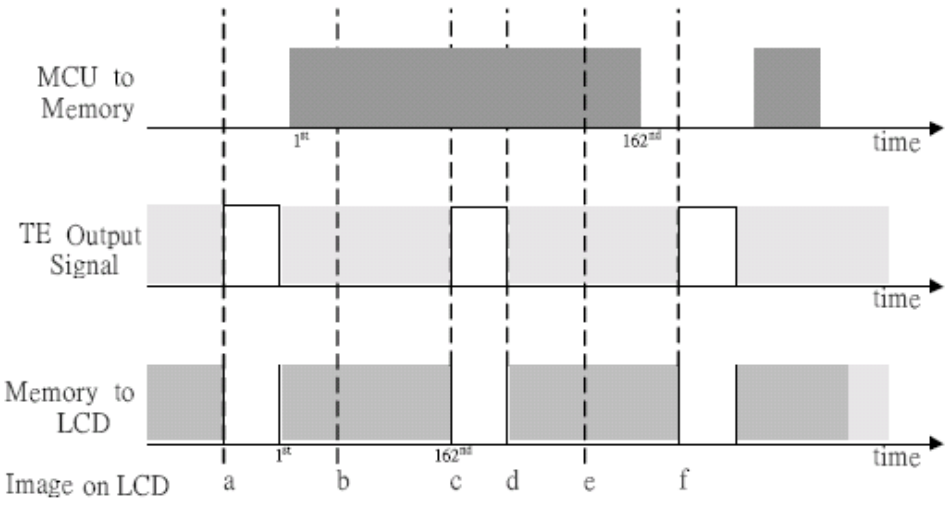
8.2.1 Example 1 MCU Write is Faster than Panel Read



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

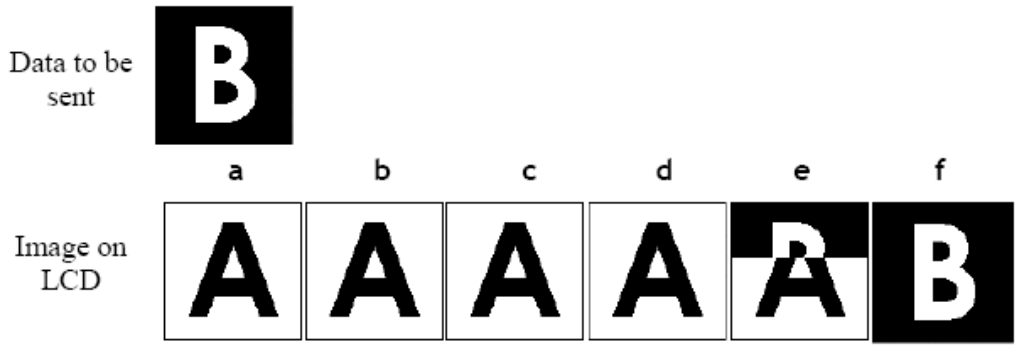


8.2.2 Example 2 MCU Write is slower than Panel Read



The MCU to Frame Memory write begins just after Panel Read has commenced i.e. after one horizontal sync

pulse of the Tearing Effect Output Line. This allows time for the image to download behind the Panel Read pointer and finishing download during the subsequent Frame before the Read Pointer “catches” the MCU to Frame memory write position.



9. Power ON/OFF Sequence

VDDI and VDD can be applied in any order.

VDD and VDDI can be powered down in any order.

During power off, if LCD is in the Sleep Out mode, VDD and VDDI must be powered down minimum 120msec after RESX has been released.

During power off, if LCD is in the Sleep In mode, VDDI or VDD can be powered down minimum 0msec after RESX has been released.

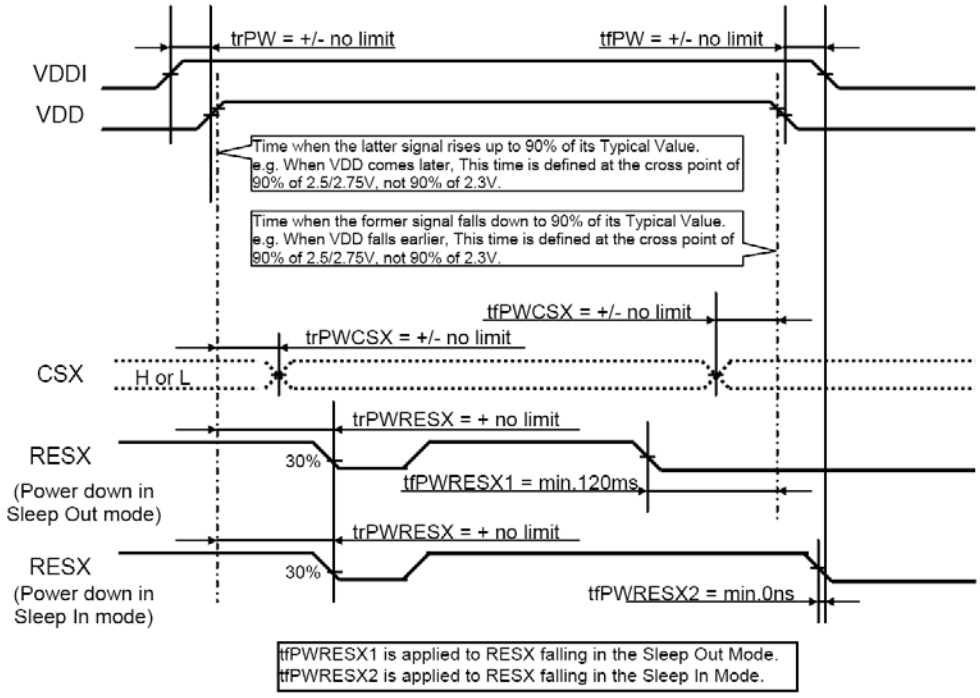
CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

Notes:

1. There will be no damage to the display module if the power sequences are not met.
2. There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.
3. There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out command. Also between receiving Sleep In command and Power Off Sequence.
4. If RESX line is not held stable by host during Power On Sequence as defined in Sections 8.5.1 and 8.5.2, then it will be necessary to apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not guaranteed.

9.1. Case 1 – RESX line is held high or Unstable by Host at Power –On

If RESX line is held high or unstable by the host during Power On, then a Hardware Reset must be applied after both VDD and VDDI have been applied – otherwise correct functionality is not guaranteed. There is no timing restriction upon this hardware reset.

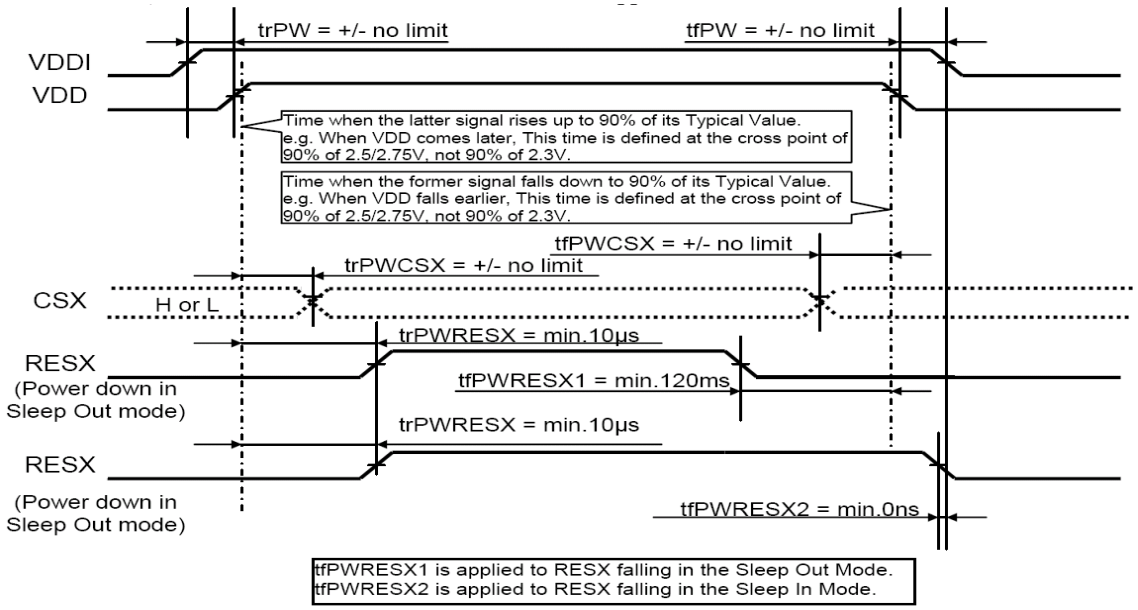


Note: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

9.2. Case 2 – RESX line is held Low by Host at Power On

If RESX line is held Low (and stable) by the host during Power On, then the RESX must be held low for minimum

10µsec after both VDD and VDDI have been applied.



Note: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

9.3. Uncontrolled Power Off

The uncontrolled power off means a situation when e.g. there is removed a battery without the controlled power off sequence. The display module must meet following requirements:

1. There cannot be any damages for the display module or the display module cannot cause any damages for the host or lines of the interface.
2. There cannot be any abnormal visible effects (= Display must be blank) within 1 second on the display and remains blank until “Power On Sequence” powers it up.

10. Power Level Definition

10.1. Power Levels

6 level modes are defined they are in order of Maximum Power consumption to Minimum Power Consumption:

1. Normal Mode On (full display), Idle Mode Off, Sleep Out.
   In this mode, the display is able to show maximum 262,144 colors.
2. Partial Mode On, Idle Mode Off, Sleep Out.
   In this mode part of the display is used with maximum 262,144 colors.
3. Normal Mode On (full display), Idle Mode On, Sleep Out.
   In this mode, the full display area is used but with 8 colors.
4. Partial Mode On, Idle Mode On, Sleep Out.
   In this mode, part of the display is used but with 8 colors.
5. Sleep In Mode.

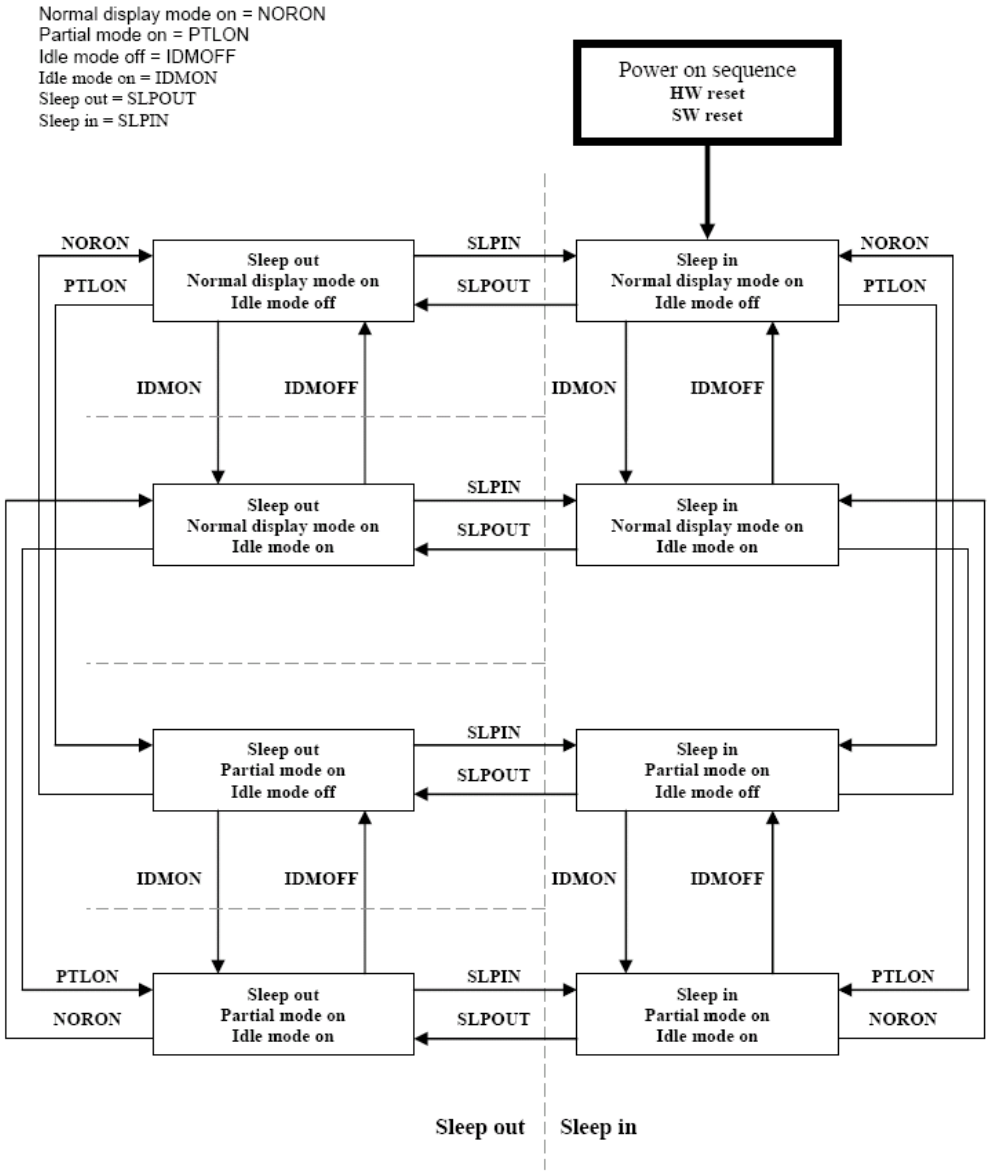
In this mode, the DC:DC converter, Internal oscillator and panel driver circuit are stopped. Only the MCU interface and memory works with VDDI power supply. Contents of the memory are safe.

V. .┐ Power Off Mode.

In this mode, both VDD and VDDI are removed.

Note: Transition between modes 1-5 is controllable by MCU commands. Mode 6 is entered only when both Power supplies are removed.

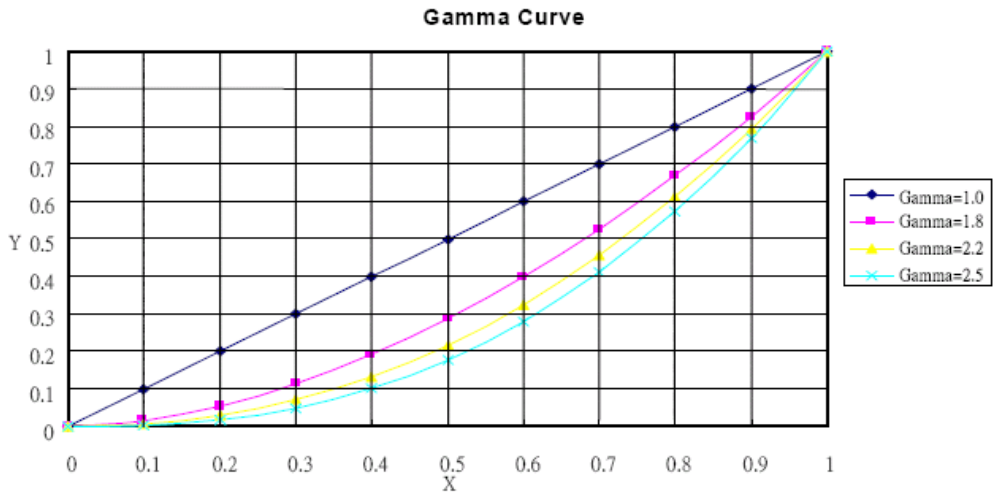
10.2. Power Flow Chart



Note 1: There is not any abnormal visual effect when there is changing from one power mode to another power mode.

Note 2: There is not any limitation, which is not specified by Nokia, when there is changing from one power mode to another power mode.

11. Gamma Curves



12. Reset

12.1. Registers

The registers that are initialized are listed below.

Reset Table (Default Value, GM=000, 128RGB x 160)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	007Fh	007Fh	007Fh(127d) (when MV=0) 009Fh(159d) (when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	009Fh	009Fh	009Fh(159d) (when MV=0) 007Fh(127d) (when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	009Fh	009Fh	009Fh
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	00A0h	00A0h	00A0h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Reset Table (Default Value, GM=010, 120RGB x 160)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	0077h	0077h	0077h(119d) (when MV=0) 0077h(159d) (when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	009Fh	009Fh	009Fh(159d) (when MV=0) 0077h(119d) (when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	009Fh	009Fh	009Fh
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	00A0h	00A0h	00A0h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Reset Table (Default Value, GM=010, 128RGB x 128)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	007Fh	007Fh	007Fh(127d) (when MV=0) 0077h(127d) (when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	007Fh	007Fh	007Fh(127d) (when MV=0) 007Fh(127d) (when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	007Fh	007Fh	007Fh
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	0080h	0080h	0080h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Reset Table (Default Value, GM=011, 132RGB x 162)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	0083h	0083h	0083h(131d) (when MV=0) 00A1h(161d) (when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	00A1h	00A1h	00A1h(161d) (when MV=0) 0083h(131d) (when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	00A1h	00A1h	00A1h
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	00A2h	00A2h	00A2h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Reset Table (Default Value, GM=100, 130RGB x 130)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	0081h	0081h	0081h(when MV=0) 0081h(when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	0081h	0081h	0081h(when MV=0) 0081h(when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	0081h	0081h	0081h
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	0082h	0082h	0082h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Reset Table (Default Value, GM=101, 132RGB x 132)

Item	After Power On	After Hardware Reset	After Software Reset
Frame memory	Random	No Change	No Change
Sleep In/Out	In	In	In
Display In/Out	Off	Off	Off
Display mode(normal/partial)	Normal	Normal	Normal
Display Inversion On/Off	Off	Off	Off
Display Idle Mode On/Off	Off	Off	Off
Column: Start Address(XS)	0000h	0000h	0000h
Column: end Address(XE)	0083h	0083h	0083h(when MV=0) 0083h(when MV=1)
Row: Start Address(YS)	0000h	0000h	0000h
Row: End Address(YE)	0083h	0083h	0083h(when MV=0) 0083h(when MV=1)
Gamma Setting	GC0	GC0	GC0
Color Set	TBD	TBD	No Change
Partial: Start Address(PSL)	0000h	0000h	0000h
Partial: End Address(PEL)	0083h	0083h	0083h
Scroll: Vertical scrolling	Off	Off	Off
Scroll: Top Fixed Area(TFA)	0000h	0000h	0000h
Scroll: Scroll area(VSA)	0084h	0084h	0084h
Scroll: Bottom Fixed Area (BFA)	0000h	0000h	0000h
Scroll Start Address(SSA)	0000h	0000h	0000h
Tearing: On/Off	Off	Off	Off
Tearing Effect Mode*3	0(Mode1)	0(Mode1)	0(Mode1)
Memory Data Access Control (MY/MX/MV/ML/MH/RGB)	0/0/0/0/0/0	0/0/0/0/0/0	No change
Interface Pixel Color Format	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDPM	08h	08h	08h
RDDMADCTR	00h	00h	No change
RDDCOLMOD	6 (18-Bit/Pixel)	6 (18-Bit/Pixel)	No change
RDDIM	00h	00h	00h
RDDSM	00h	00h	00h
RDDSDR	00h	00h	00h
ID1	54h	54h	54h
ID2	MTP Value	MTP Value	MTP Value
ID3	MTP Value	MTP Value	MTP Value

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

12.2. Input/Output Pins

12.2.1 Output Pins, I/O Pins

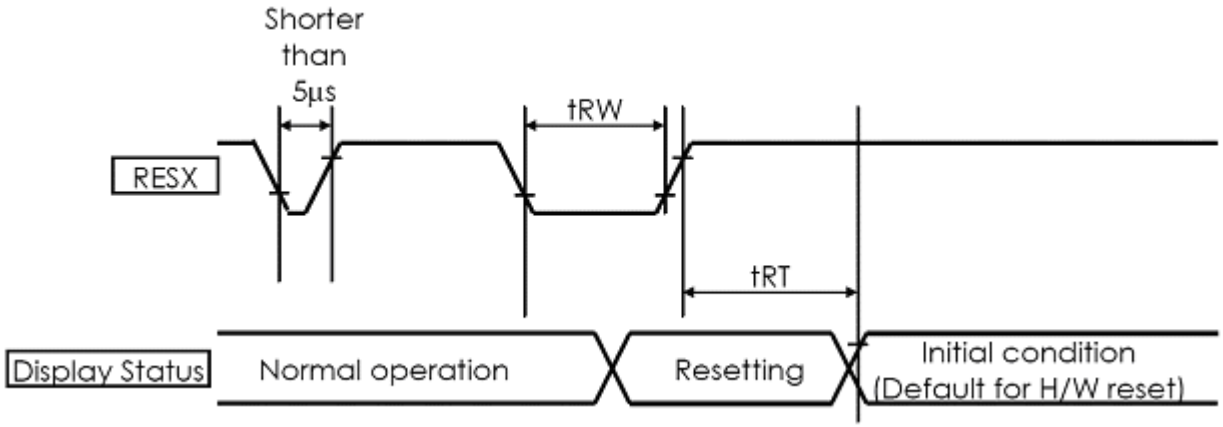
Output or Bi-direction pins	After Power On	After Hardware Reset	After Software Reset
TE	Low	Low	Low
D17to D0(Output driver)	High-Z(Inactive)	High-Z(Inactive)	High-Z(Inactive)

Note: There will be no output from D[7..0] and SDA during Power On/Off sequences, Hardware Reset and Software Reset.

12.2.2 Input Pins

Input pins	During Power On Process	After Power On	After Hardware Reset	After Software Reset	During Power Off Process
RESX	TBD	Input invalid	Input invalid	Input invalid	?
CSX	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid
D/CX	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid
WRX	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid
RDX	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid
D17 to D0	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid
SDA	Input invalid	Input invalid	Input invalid	Input invalid	Input invalid

12.3. Reset Timing



(VSS=0V, VDDI=1.65V to 1.95V, VDD=2.6V to 2.9V, Ta = -30 to 70℃)

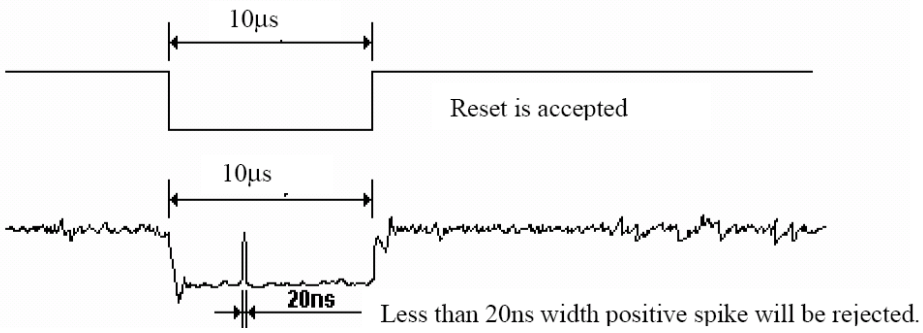
Symbol	Parameter	Related Pins	MIN	TYP	MAX	Note	Unit
tRESW	*1) Reset low pulse width	RESX	10	-	-	-	µs
tREST	*2) Reset complete width	-	-	-	5	When reset applied during Sleep in mode	ms
		-	-	-	120	When reset applied during Sleep out mode	ms

Note

1. Spike due to an electrostatic discharge on RESX line does not cause system reset according to the table below.

RESX Pulse	Action
Shorten than 5μs	Reset Rejected
Longer than 10μs	Reset
Between 5μs and 10μs	Reset starts (It depends on voltage and temperature condtion.)

2. During the resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode) and then return to Default condition for Hardware Reset.
3. During Reset Complete Time, ID2 and VCOMOF value in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 5ms after a rising edge of RESX.
4. Spike Rejection also applies during a valid reset pulse as shown below:



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

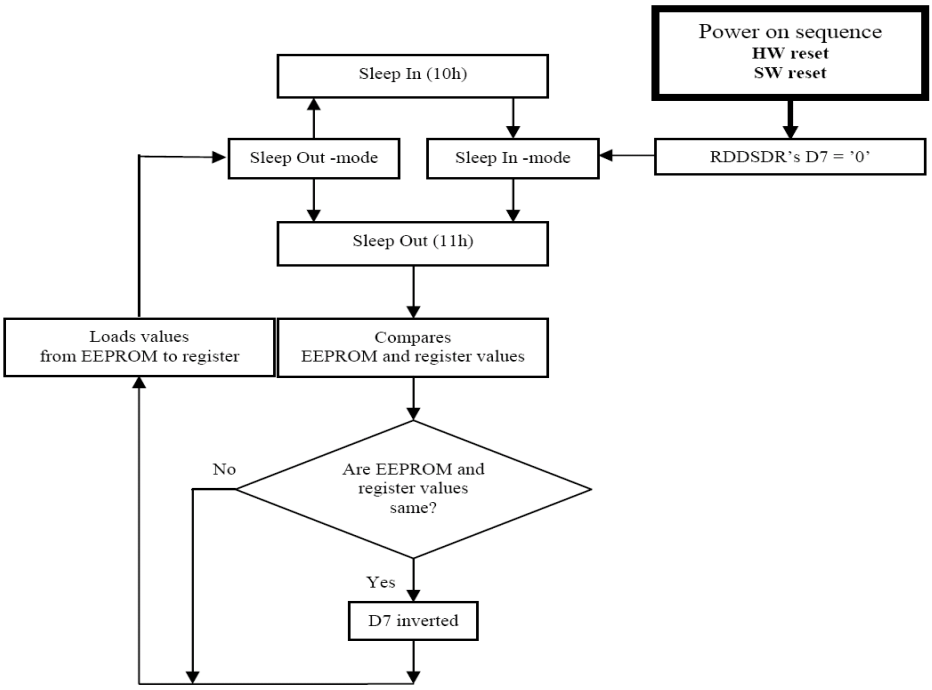
13. SleepOut – Command and Self-Diagnostic Functions of Display

13.1. Register loading Detection

Sleep Out-command (See section 16.1.2.12 Sleep Out (11h)) is a trigger for an internal function of the display module, which indicates, if the display module loading function of factory default values from EEPROM (or similar device) to registers of the display controller is working properly.

There are compared factory values of the EEPROM and register values of the display controller by the display controller. If those both values (EEPROM and register values) are same, there is inverted (= increased by 1) a bit, which is defined in command 16.1.2.10 “Read Display Self-Diagnostic Result (0Fh)” (=RDDSDR) (The used bit of this command is D7). If those both values are not same, the bit(D7) is not inverted (= increased by 1)

The flow chart for this internal function is following:



Note:

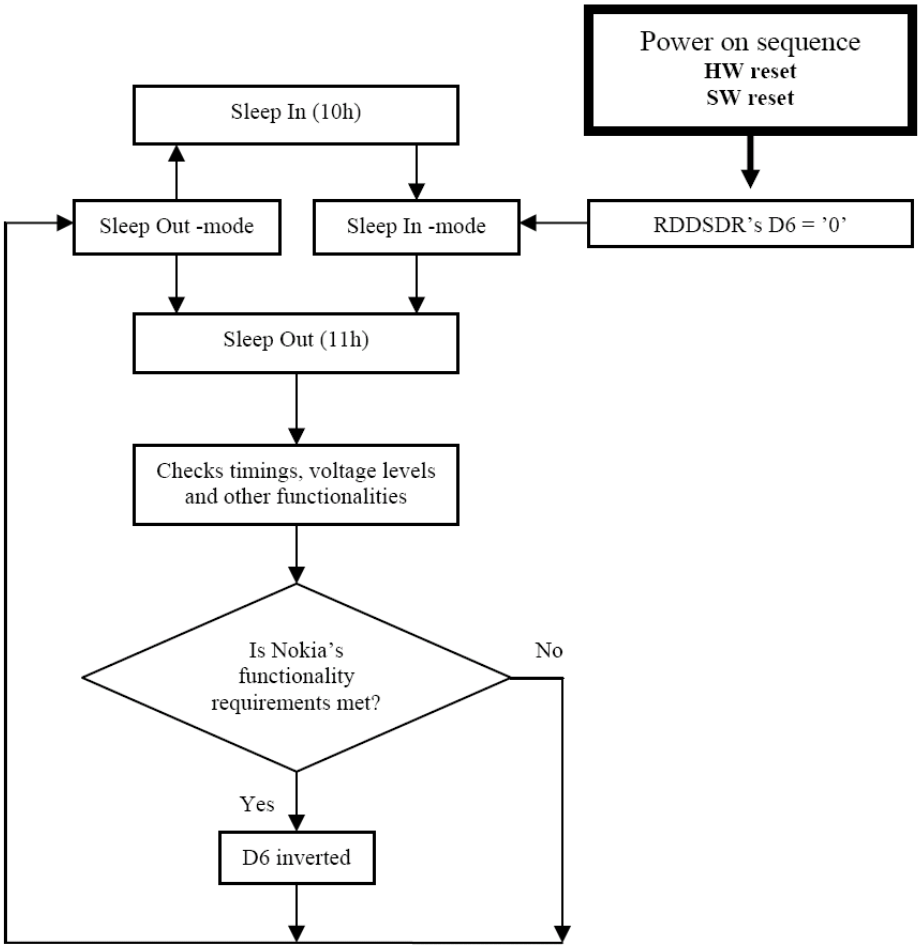
There is not compared and loaded register values, which can be changed by user (00h to Afh and Dah to DDh), by the display module.

13.2. Functionality Detection

Sleep Out-command (See section 16.1.2.12 Sleep Out (11h)) is a trigger for an internal function of the display module, which indicates, if the display module is still running and meets functionality requirements.

The internal function (= the display controller) is comparing, if the display module is still meeting functionality requirements (only Booster voltage level). If functionality requirement is met, there is inverted (= increased by 1) a bit, which defined in command 16.1.2.10 “Read Display Self-Diagnostic Result (0Fh)” (= RDDSDR) (The used bit of this command is D6). If functionality requirement is not same, this bit (D6) is not inverted (=increased by 1).

The flow chart for this internal function is following:



Note: There is needed 120msec after Sleep Out –command, when there is changing from Sleep In –mode to Sleep Out –mode, before there is possible to check if Nokia's functionality requirements are met and a value of RDDSDR's D6 is valid. Otherwise, there is 5msec delay for D6's value, when Sleep Out –command is sent in Sleep Out –mode.

14. Command

14.1. Command List

Hex Code	Command	Description	Number of Parameters	Display Architecture Implementation Requirement		
				Type 1	Type 2	Type 3
00h	nop	No Operation	0	Yes	Yes	Yes
01h	soft_reset	Software Reset	0	Yes	Yes	Yes
06h	get_red_channel	Get the red component of the pixel at (0, 0).	1	No	Yes	Yes
07h	get_green_channel	Get the green component of the pixel at (0, 0).	1	No	Yes	Yes
08h	get_blue_channel	Get the blue component of the pixel at (0, 0).	1	No	Yes	Yes
0Ch	get_pixel_format	Get the current pixel format.	1	Yes	Yes	Yes
0Ah	get_power_mode	Get the current power mode.	1	Yes	Yes	Yes
0Bh	get_address_mode	Get the frame memory to the display panel read order.	1	Yes	Yes	Yes
0Dh	get_display_mode	Get the current display mode from the peripheral.	1	Yes	Yes	Yes
0Eh	get_signal_mode	Get display module signaling mode.	1	Yes	Yes	Yes
0Fh	get_diagnostic_result	Get Peripheral Self-Diagnostic Result	1	Yes	Yes	Yes
10h	enter_sleep_mode	Power for the display panel is off.	0	Yes	Yes	Yes
11h	exit_sleep_mode	Power for the display panel is on.	0	Yes	Yes	Yes
12h	enter_partial_mode	Part of the display area is used for image display.	0	Yes	Yes	No
13h	enter_normal_mode	The whole display area is used for image display.	0	Yes	Yes	No
20h	exit_invert_mode	Displayed image colors are not inverted.	0	Yes	Yes	Yes
21h	enter_invert_mode	Displayed image colors are inverted.	0	Yes	Yes	Yes
26h	set_gamma_curve	Selects the gamma curve used by the display device.	1	Yes	Yes	Yes
28h	set_display_off	Blanks the display device.	0	Yes	Yes	Yes
29h	set_display_on	Show the image on the display device.	0	Yes	Yes	Yes
2Ah	set_column_address	Set the column extent.	4	Yes	Yes	No
2Bh	set_page_address	Set the page extent.	4	Yes	Yes	No
2Ch	write_memory_start	Transfer image data from the Host Processor to the peripheral starting at the location provided by set_column_address and set_page_address.	Variable	Yes	Yes	No
2Dh	write_LUT	Fills the peripheral look-up table with the provided data.	Variable	optional	No	No
2Eh	read_memory_start	Transfer image data from the peripheral to the Host Processor interface starting at the location provided by set_column_address and set_page_address.	Variable	Yes	Yes	No
30h	set_partial_area	Defines the partial display area on the display device.	4	Yes	Yes	No
33h	set_scroll_area	Defines the vertical scrolling and fixed area on display device.	6	Yes	No	No
34h	set_tear_off	Synchronization information is not sent from the display module to the host processor.	0	Yes	No	No
35h	set_tear_on	Synchronization information is sent from the display module to the host processor at the start of VFP.	1	Yes	No	No

36h	set_address_mode	Set the read order from frame memory to the display panel.	1	Yes	Yes	Yes
37h	set_scroll_start	Defines the vertical scrolling starting point.	2	Yes	No	No
38h	exit_idle_mode	Full color depth is used on the display panel.	0	Yes	No	No
39h	enter_idle_mode	Reduced color depth is used on the display panel.	0	Yes	No	No
3Ah	set_pixel_format	Defines how many bits per pixel are used in the interface.	1	Yes	Yes	Yes
3Ch	write_memory_continue	Transfer image information from the Host Processor interface to the peripheral from the last written location.	Variable	Yes	Yes	No
3Eh	read_memory_continue	Read image data from the peripheral continuing after the last read_memory_continue or read_memory_start.	Variable	Yes	Yes	No
44h	set_tear_scanline	Synchronization information is sent from the display module to the host processor when the display device refresh reaches the provided scanline.	2	Yes	No	No
45h	get_scanline	Get the current scanline.	2	Yes	Yes	No
Dah	Read ID1					
DBh	Read ID2					
DCh	Read ID3					

Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10μs after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

14.2. Command Description

14.2.1 NOP (00h)

00H	NOP (No Operation)												
	D/CX	RDX	WRX	D17-D8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	X	0	0	0	0	0	0	0	0	00
Parameter	NO PARAMETER												
Description	This command is an empty command; it does not have any effect on the display module. However it can be used to terminate Frame Memory Write or Read as described in RAMWR (Memory Write) and RAMRD (Memory Read) Commands. X = Don't care.												
Restriction	None												
Register Availability													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	N/A
SW Reset	N/A
HW Reset	N/A

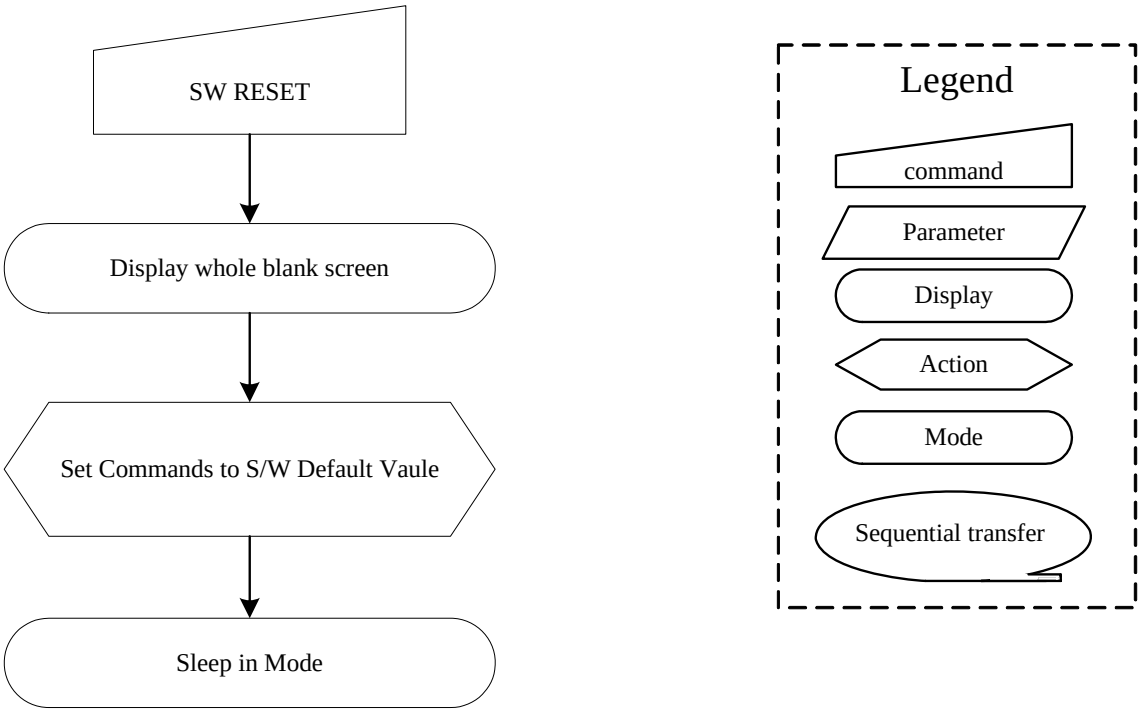
Flow Chart	None

14.2.2 Software Reset (01h)

01H	SWRESET (Software Reset)												
	D/CX	RDX	WRX	D17-D8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	X	0	0	0	0	0	0	0	1	01
Parameter	NO PARAMETER												
Description	When the Software Reset command is written, it causes software reset. It resets the commands and parameters to their S/W Reset default values. (See default tables in each command description.) Note: The Frame Memory contents are affected by this command. X = Don't care												
Register Availability													
Default													
Flow Chart													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Status	Default Value
Power On Sequence	N/A
SW Reset	N/A
HW Reset	N/A



14.2.3 Read Display Identification Information (04h)

00H	RDDIDIF (Read Display Identification Information)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	0	1	0	0	04
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10	54h
3rd Parameter	1	↑	1	x	ID27	ID26	ID25	ID24	ID23	ID22	ID21	ID20	80h
4th Parameter	1	↑	1	x	ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30	66h

Description

This read byte returns 24-bit display identification information.

The 1st Parameter is dummy read.

The 2nd Parameter (ID17 to ID10): LCD module's manufacture ID.

The 3rd Parameter (ID27 to ID20): LCD module/driver version ID

The 4th Parameter (ID37 to ID30): LCD module/driver version ID

Note: Commands RDID1/2/3(Dah, DBh, DCh) read data correspond to the parameters 2,3,4 of command 04h, respectively

Restriction

-

Register Availability

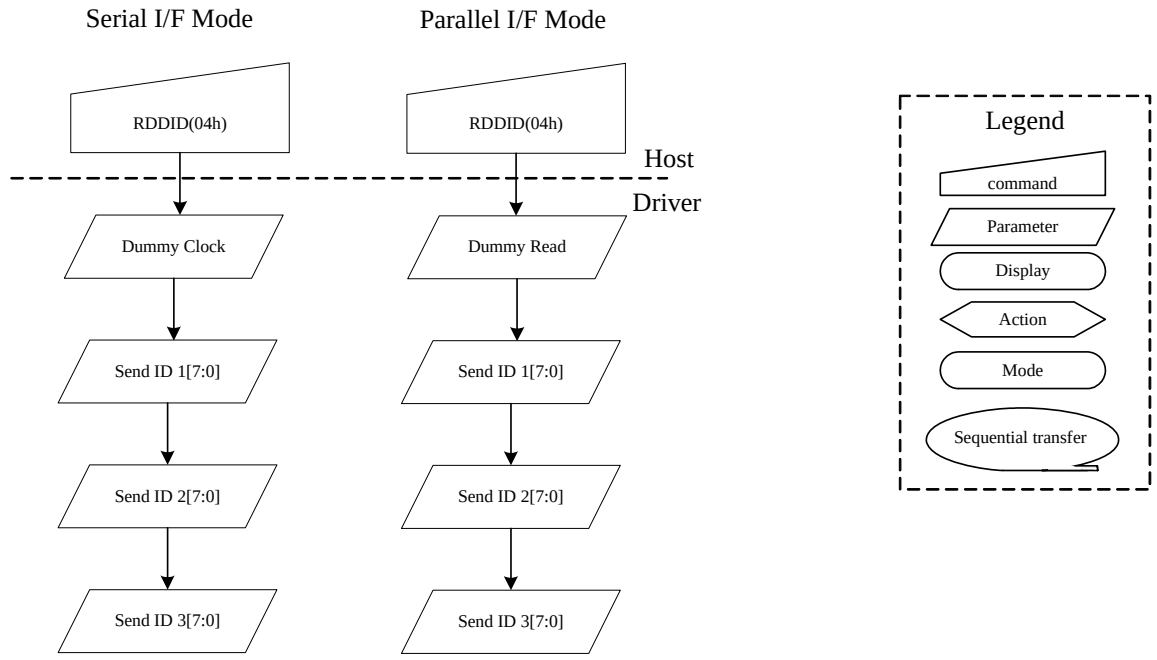
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Note: ID1 can be modified by metal option

Status	Default Value		
	ID1	ID2	ID3
Power On Sequence	54h	80h	66h
SW Reset	54h	80h	66h
HW Reset	54h	80h	66h

Flow Chart



14.2.4 Read Display Status (09h)

09H	RDDIDIF (Read Display Identification Information)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	0	0	1	09h
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	BOTSON	MY	MX	MV	ML	RGB	MH	ST24	x
3rd Parameter	1	↑	1	x	ST23	IFPF2	IFPF1	IFPF0	IDMON	PTLON	SLOUT	NORON	x
4th Parameter	1	↑	1	x	VSSON	ST14	INVON	ST12	ST11	DISON	TEON	GCS2	x
5th Parameter	1	↑	1	x	GCS1	GCS0	TELOM	HSON	VSON	PCKON	DEON	ST0	x

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
BSTON	Booster Voltage Status	“1”=Booster on,”0”=Booster off
MY	Row Address Order(MY)	“1”=Decrement, (Bottom to Top, when MADCTL(36h) D7=’1’) “0”=Increment, (Top to Bottom, when MADCTL(36h) D7=’0’)
MX	Column Address Order(MX)	“1”=Decrement, (Right to Left, when MADCTL(36h) D6=’1’) “0”=Increment, (Left to Right, when MADCTL(36h) D6=’0’)
MV	Row/Column Exchange(MV)	“1”=Row/column exchange, (when MADCTL (36h) D5=’1’) “0”=Normal (MV=0), (when MADCTL(36h)D5=’0’)
ML	Vertical refresh Order(ML)	“1”=Decrement, (LCD refresh Bottom to Top, when

			MADCTL(36h)D4='1') "0"=Increment, (LCD refresh Top to Bottom, when MADCTL(36h)D4='0')
	RGB	RGB/BGR Order(RGB)	"1"=BGR,(When MADCTL(36h)D3='1') "0"=RGB,(When MADCTL(36h)D3='0')
	MH	Horizontal refresh Order(MH)	"1"=Decrement, (LCD refresh Right to Left, when MADCTL(36h) D2='1') "0"=Increment, (LCD refresh Left to Right, when MADCTL(36h) D2='0')
	ST24	Not Used	
	ST23	Not Used	
	IFPF2 IFPF1 IFPF0	Interface Color Pixel Format Definition	"011"=12-bit/pixel "101"=16-bit/pixel "110"=18-bit/pixel
	IDMON	Idle Mode On/Off	"1"=On,"0"=Off
	PTLON	Partial Mode On/Off	"1"=On,"0"=Off
	SLOUT	Sleep In/Out	"1"=On,"0"=Off
	NORON	Display Normal Mode On/Off	"1"=Normal Display, "0"=Normal Display Off
	VSSON	Vertical Scrolling Status	"1"=Scroll on,"0"=Scroll off
	ST14	Horizontal Scroll Status	"0"
	INVON	Inversion Status	"1"=On, "0"=Off
	ST12	All Pixels On(Not Used)	"0"
	ST11	All Pixels On(Not Used)	"0"
	DISON	Display On/Off	"1"=On, "0"=Off
	TEON	Tearing effect line on/off	"1"=On, "0"=Off
	GCS2	Gamma Curve Selection	"000"=GC0 "001"=GC1 "010"=GC2 "011"=GC3 "100" to "111" = Not defined
	GCS1		
	GCS		
	TELOM	Tearing effect line mode	"0"=mode1,"1"=mode2
	STO	For Future Use	"0"

Note: For Bits ST30 to ST28, also refer to Section 8-11

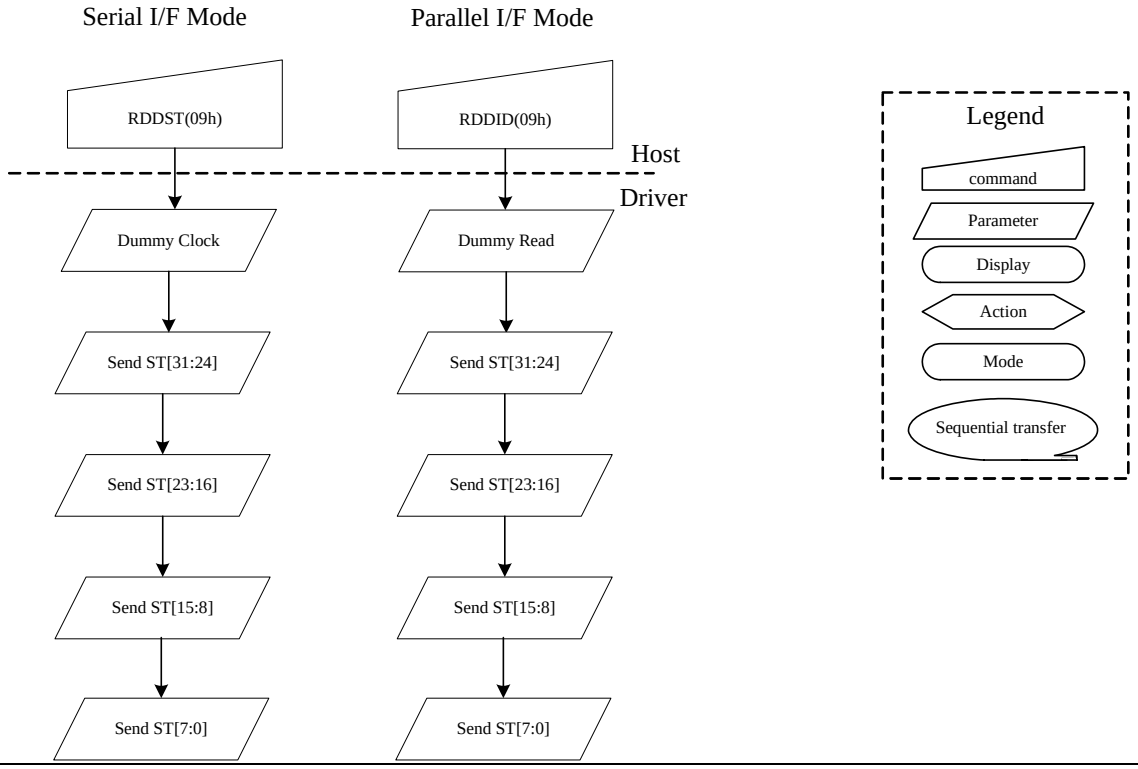
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(ST31 to ST0)			
	ST[31-24]	ST[23-16]	ST[15-8]	ST[7-0]
Power On Sequence	0000-0000	0110-0001	0000-0000	0000-0000
SW Reset	0xxx-xxx0	0xxx-0001	0000-0000	0000-0000
HW Reset	0000-0000	0110-0001	0000-0000	0000-0000

Flow Chart



14.2.5 Read Display Power Mode (0Ah)

0AH	RDDPM (Read Display Power Mode)												
Inst / Para	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	0	1	0	0Ah
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D7	D6	D5	D4	D3	D2	D1	D0	08h

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
D7	Booster Voltage Status	"1"=Booster on, "0"=Booster off
D6	Idle Mode On/Off	"1"=Idle Mode On, "0"=Idle Mode Off
D5	Partial Mode On/Off	"1"=Partial Mode on, "0"=Partial Mode Off
D4	Sleep In/Out	"1"=Sleep Out, "0"=Sleep In
D3	Display Normal Mode On/Off	"1"=Normal Display, "0"=Partial Display
D2	Display On/Off	"1"=Display On, "0"=Display Off
D1	Not Defined	Set to '0'
D0	Not Defined	Set to '0'

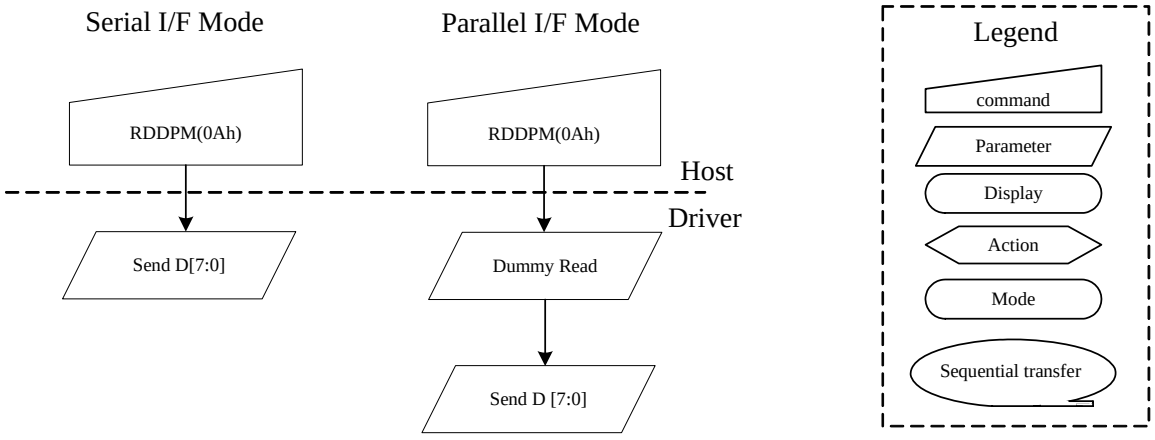
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(D7 to D0)
Power On Sequence	0000_1000(08h)
SW Reset	0000_1000(08h)
HW Reset	0000_1000(08h)

Flow Chart



14.2.6 Read Display MADCTL (0Bh)

0BH	RDDMADCTL (Read Display MADCTL)												
	D/CX	RDX	WRX	D17-0	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	0	1	1	0Bh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D7	D6	D5	D4	D3	D2	D1	D0	00h

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
D7	Page Address Order	"1"=Decrement, "0"=Increment
D6	Column Address Order	"1"=Decrement, "0"=Increment
D5	Page/Column Order	"1"=Row/column exchange(MV=1) "0"=Normal(MV=0)
D4	Line Address Order	"1"=LCD Refresh Bottom to Top "0"=LCD Refresh Top to Bottom
D3	RGB/BGR Order	"1"=BGR, "0"=RGB
D2	Display Data Latch Order	"1"=LCD Refresh right to left "0"=LCD Refresh left to right
D1	Switching between Segment outputs and RAM	Set to '0'
D0	Switching between Common outputs and RAM	Set to '0'

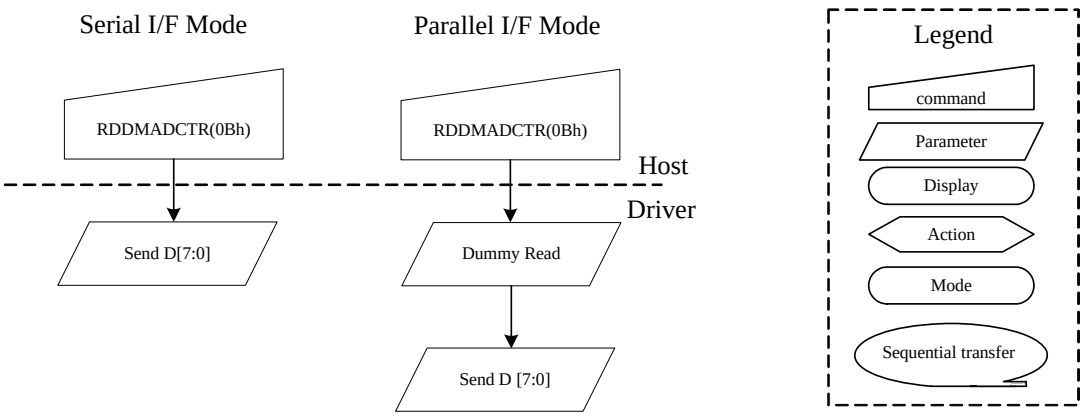
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(D7 to D0)
Power On Sequence	0000_0000(00h)
SW Reset	No Change

Flow Chart



14.2.7 Read Display Pixel Format (0Ch)

0CH	RDDCOLMOD (Read Display COLMOD)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	1	0	0	0Ch
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	x	x	x	x	D3	IFPF2	IFPF1	IFPF0	66h

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
D3		”0” (Not used)
IFPF2	Control Interface Color Format	“011”=12 bit/pixel “101”=16 bit/pixel “110”=18 bit/pixel The others = not defined
IFPF 1		
IFPF 0		

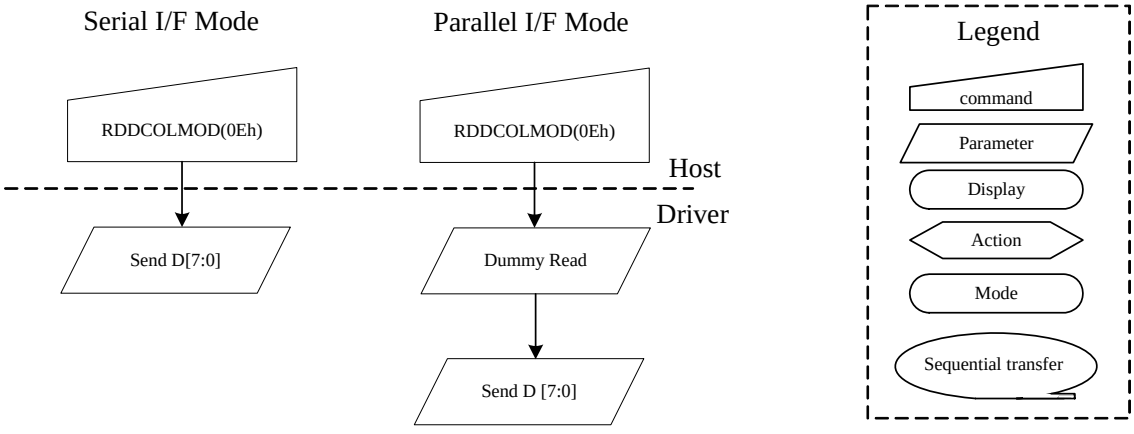
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	0110_0110(18bit/pixel)
SW Reset	**No Change**
HW Reset	0110_0110(18bit/pixel)

Flow Chart



14.2.8 Read Display Image Mode (0Dh)

0DH	RDDIM (Read Display Image Mode)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	1	0	1	0Dh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D7	D6	D5	D4	D3	D2	D1	D0	00h

Description

Bit	Description	Value
D7	Vertical Scrolling On/Off	"1"=Vertical scrolling is On, "0"=Vertical scrolling is Off
D6	Horizontal Scrolling On/Off	"0"(Not used)
D5	Inversion On/Off	"1"=Inversion is On, "0"=Inversion is Off
D4	All Pixels On	"0" (Not used)
D3	All Pixel Off	"0" (Not used)
D2	Gamma Curve Selection	"000"=GC0; "001"=GC1; "010"=GC2; "011"=GC3
D1		"100" to "111" = Not defined
D0		

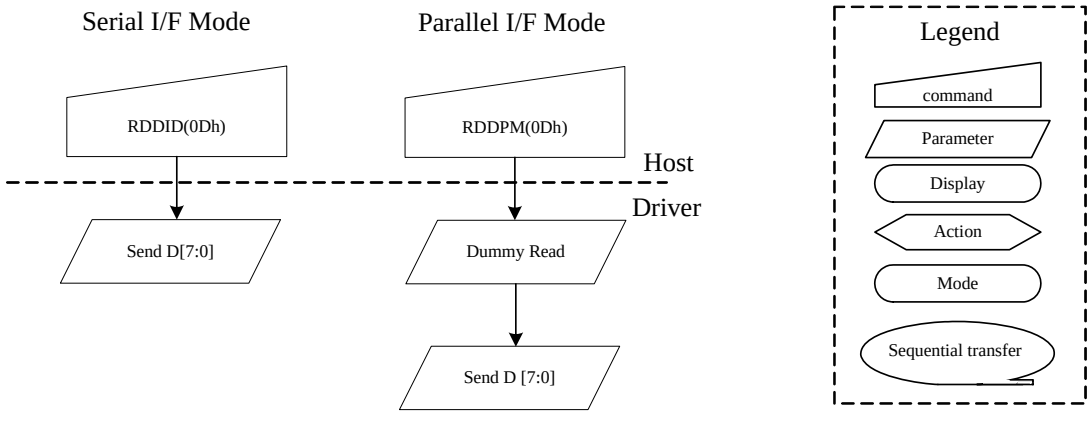
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(D7 to D0)
Power On Sequence	0000_0000(00h)
SW Reset	0000_0000(00h)

Flow Chart



14.2.9 Read Display Signal Mode (0Eh)

0EH	RDDSM (Read Display Signal Mode)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	1	1	0	0Eh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D7	D6	x	x	x	x	0	0	00h

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
D7	Tearing Effect Line On/Off	"1"=On, "0"=Off
D6	Tearing Effect Line Mode	"0"=mode1, "1"=mode2
D1	Not Used	"1"=On, "0"=Off
D0	Not Used	"1"=On, "0"=Off

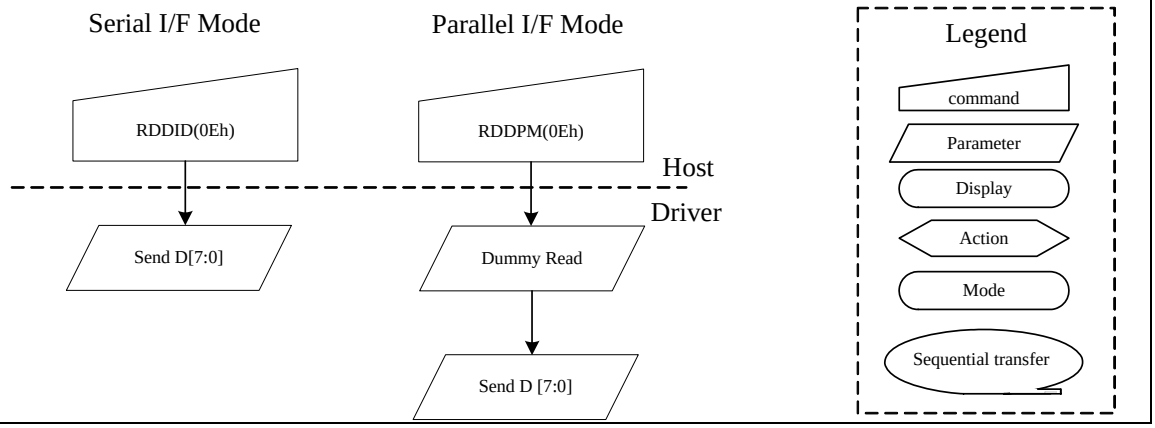
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(D7 to D0)
Power On Sequence	0000_0000(00h)
SW Reset	0000_0000(00h)

Flow Chart



14.2.10 Read Display Signal Mode (0Fh)

0EH	RDDSM (Read Display Signal Mode)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	0	1	1	1	1	0Fh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D7	D6	D5	D4	D3	D2	D1	D0	00h

Description

This command indicates the current status of the display as described in the table below:

Bit	Description	Value
D7	Register Loading Detection	
D6	Functionality Detection	
D5	Not Used	"0"
D4	Not Used	"0"
D3	Not Used	"0"
D2	Not Used	"0"
D1	Not Used	"0"
D0	Not Used	"0"

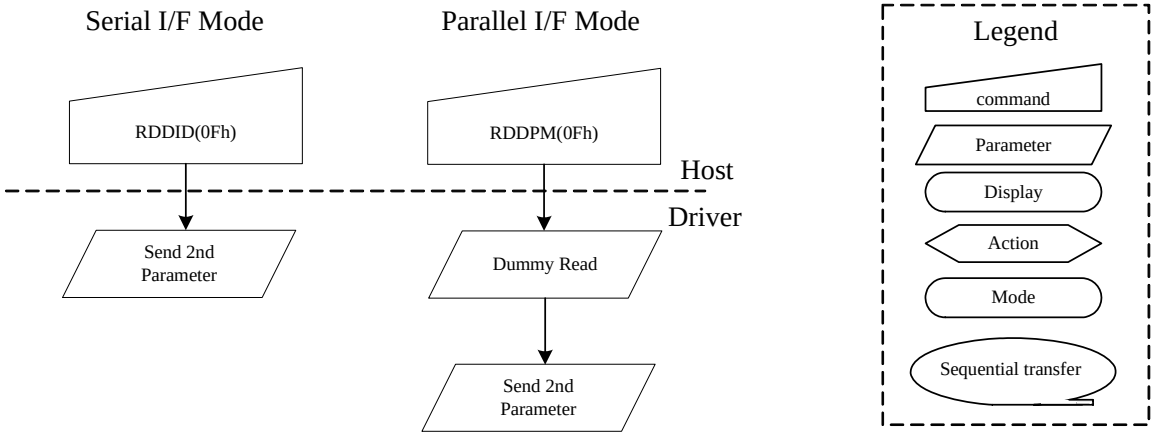
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value(D7 to D0)
Power On Sequence	0000_0000(00h)
SW Reset	0000_0000(00h)

Flow Chart



14.2.11 Sleep In (10h)

10H	SLPIN (Sleep In)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	1	0	0	0	0	10h
Parameter	No Parameter												
Description	This command causes the LCD module to enter the minimum power consumption mode. In this mode e.g. the DC/DC converter is stopped, Internal oscillator is stopped, and panel scanning is stopped. MCU interface and memory are still working and the memory keeps its contents.												
Restriction	This command has no effect when module is already in sleep in mode. Sleep In Mode can only be left by the Sleep Out Command (11h). It will be necessary to wait 5msec before sending next command; this is to allow time for the supply voltages and clock circuits to stabilize. It will be necessary to wait 120msec after sending Sleep Out command (when in Sleep In Mode) before Sleep In command can be sent.												
Register Availability													

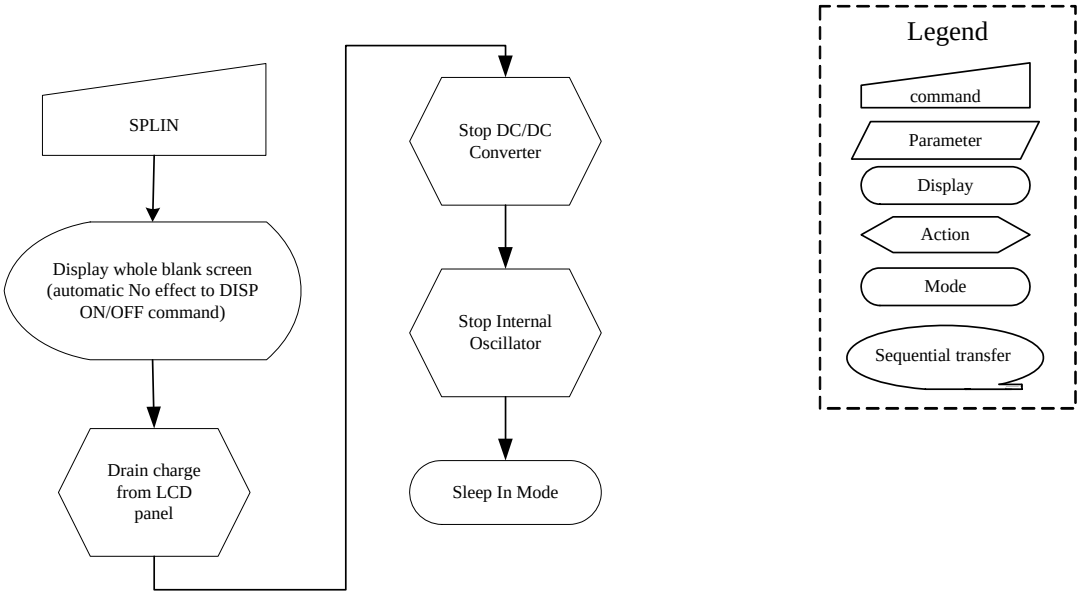
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Sleep In Mode
SW Reset	Sleep In Mode

Flow Chart

It takes 120msec to get into Sleep In mode after SLPIN command issued.



14.2.12 Sleep Out (11h)

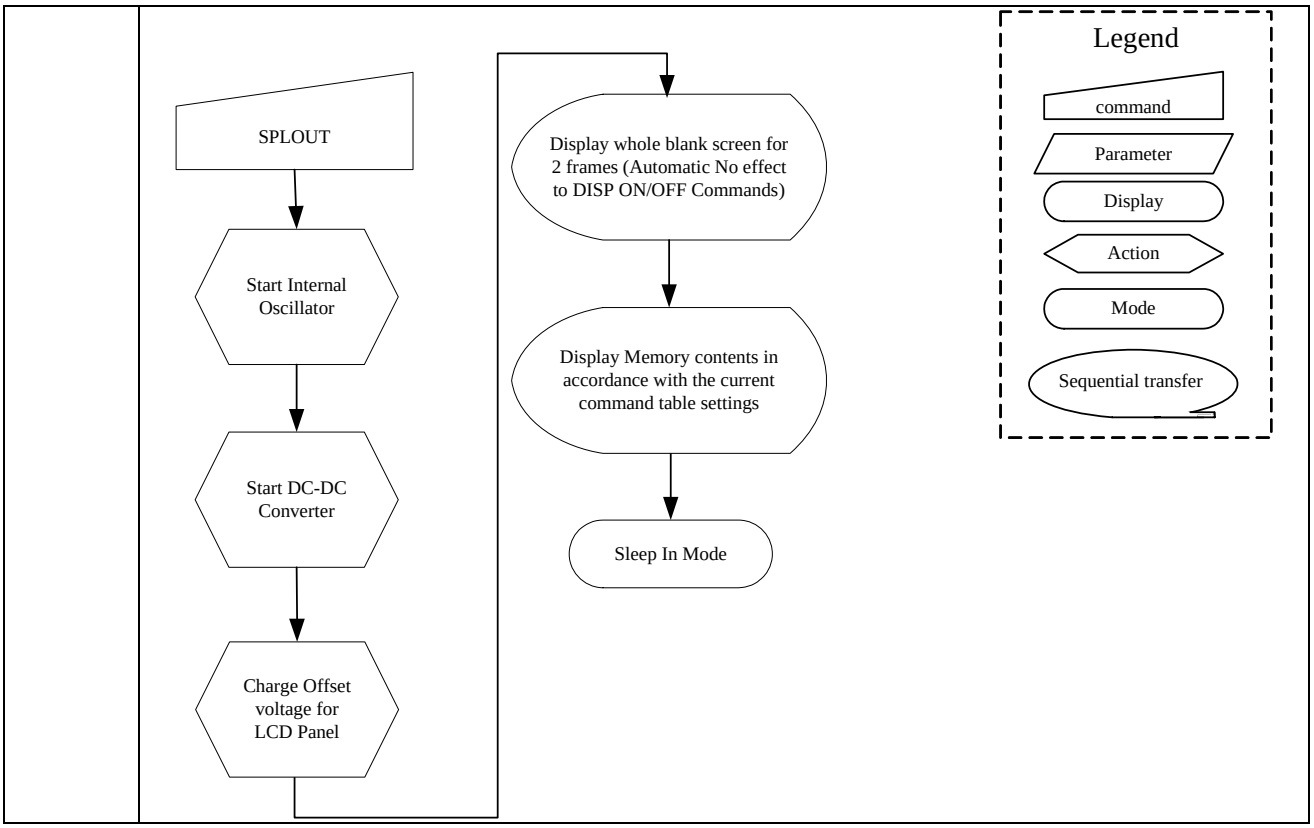
11H	SLPOUT (Sleep Out)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	0	1	0	0	0	1	11h
Parameter	No Parameter												
Description	This command turns off sleep mode. In this mode e.g. the DC/DC converter is enabled, Internal oscillator is started, and panel scanning is started.												
Restriction	This command has no effect when module is already in sleep out mode. Sleep Out Mode can only be left by the Sleep In Command (10h). It will be necessary to wait 5msec before sending next command; this is to allow time for the supply voltages and clock circuits to stabilize. The display module loads all display supplier's factory default values to the registers during this 5msec and there cannot be any abnormal visual effect on the display image if factory default and register values are same when this load is done and when the display module is already Sleep Out –mode. The display module is doing self-diagnostic functions during this 5msec. It will be necessary to wait 120msec after sending Sleep In command (when in Sleep Out mode) before Sleep Out command can be sent. This command has no effect when module is already in sleep out mode. Sleep Out Mode can only be left by HW Reset, Software Reset (01h), Sleep In (10h), or a NMI event trigger.												
Register Availability													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Sleep In Mode
SW Reset	Sleep In Mode
HW Reset	Sleep In Mode

Flow Chart	It takes 120msec to become Sleep Out mode after SLPOUT command issued.


SPLOUT
Start Internal Oscillator
Start DC-DC Converter
Charge Offset voltage for LCD Panel
Display whole blank screen for 2 frames (Automatic No effect to DISP ON/OFF Commands)
Display Memory contents in accordance with the current command table settings
Sleep In Mode
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

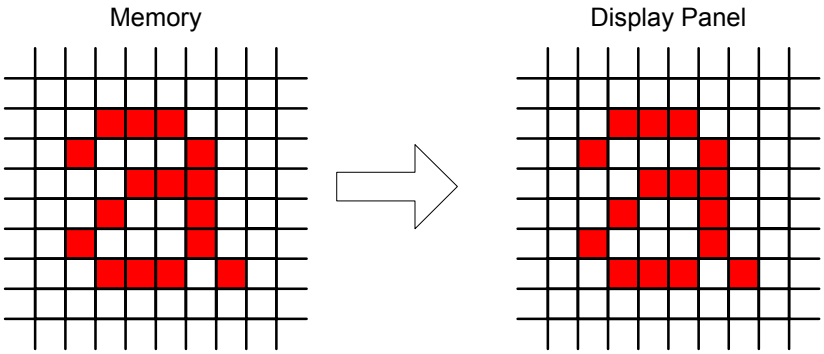
14.2.13 Partial Mode On (12h)

<table>
<tr><th>12H</th><th colspan="13">PTLON (Partial Mode On)</th></tr>
<tr><td></td><td>D/CX</td><td>RDX</td><td>WRX</td><td>D17-8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>HEX</td></tr>
<tr><td>Command</td><td>0</td><td>1</td><td>↑</td><td>x</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>12h</td></tr>
<tr><td>Parameter</td><td colspan="13">No Parameter</td></tr>
<tr><td>Description</td><td colspan="13">This command turns on partial mode. The partial mode is described by the Partial Area command (30h).
To leave Partial mode, the Normal Display On command (13h) should be written.
X = Don’t care
Note: If a command is written in a frame cycle, the command becomes effective from the next frame.</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect during Partial mode is active.</td></tr>
<tr><td>Register Availability</td><td colspan="13"><table><tr><th>Status</th><th>Availability</th></tr><tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Sleep In</td><td>Yes</td></tr></table></td></tr>
<tr><td>Default</td><td colspan="13"><table><tr><th>Status</th><th>Default Value</th></tr><tr><td>Power On Sequence</td><td>Normal Display Mode On</td></tr><tr><td>SW Reset</td><td>Normal Display Mode On</td></tr><tr><td>HW Reset</td><td>Normal Display Mode On</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13">See Partial Area (30h)</td></tr>
</table>

14.2.14 Normal Display Mode On (13h)

<table>
<tr><th>13H</th><th colspan="13">PTLON (Partial Mode On)</th></tr>
<tr><td></td><td>D/CX</td><td>RDX</td><td>WRX</td><td>D17-8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>HEX</td></tr>
<tr><td>Command</td><td>0</td><td>1</td><td>↑</td><td>x</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>13h</td></tr>
<tr><td>Parameter</td><td colspan="13">No Parameter</td></tr>
<tr><td>Description</td><td colspan="13">This command returns the display to normal mode.
Normal display mode on means Partial mode off and Scroll mode Off.
Exit from NORON by the Partial mode On command(12h)
X = Don’t care
Note: If a command is written in a frame cycle, the command becomes effective from the next frame.</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect when Normal Display mode is active.</td></tr>
<tr><td>Register Availability</td><td colspan="13"><table><tr><th>Status</th><th>Availability</th></tr><tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Sleep In</td><td>Yes</td></tr></table></td></tr>
<tr><td>Default</td><td colspan="13"><table><tr><th>Status</th><th>Default Value</th></tr><tr><td>Power On Sequence</td><td>Normal Display Mode On</td></tr><tr><td>SW Reset</td><td>Normal Display Mode On</td></tr><tr><td>HW Reset</td><td>Normal Display Mode On</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13">See Partial Area and Vertical Scrolling Definition Descriptions for details of when to use this command.</td></tr>
</table>

14.2.15 Display Inversion Off (20h)

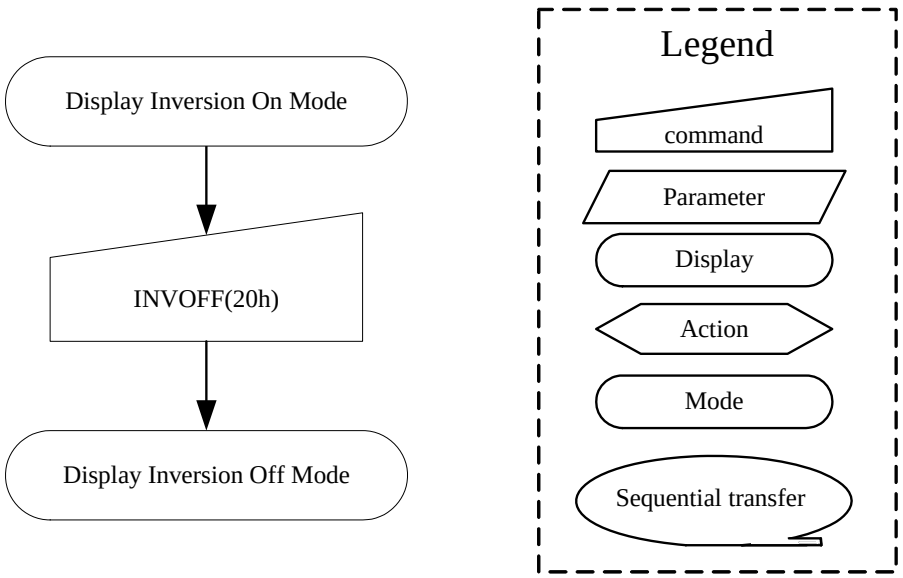
20H	PTLON (Partial Mode On)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	0	0	0	0	20h
Parameter	No Parameter												
Description	This command is used to recover from display inversion mode. This command makes no change of contents of frame memory. This command does not change any other status.  X = don't care												
Restriction	This command has no effect when module is already in inversion off mode.												
Register Availability													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Normal Display Mode Off
SW Reset	Normal Display Mode Off
HW Reset	Normal Display Mode Off

Flow Chart

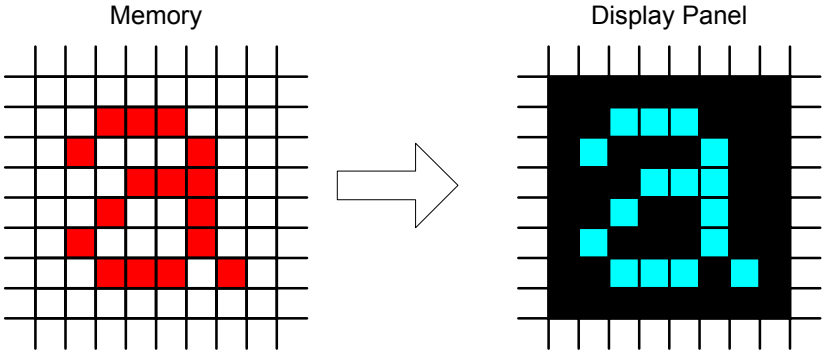


14.2.16 Display Inversion On (21h)

21H	PTLON (Partial Mode On)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	0	0	0	1	21h
Parameter	No Parameter												

Description

This command is used to enter into display inversion mode.
This command makes no change of contents of frame memory. Every bit is inverted from the frame memory to the display.
This command does not change any other status.
To exit from Display inversion On, the Display Inversion Off command(20h) should be written.



X = don't care

Restriction

This command has no effect when module is already in inversion on mode.

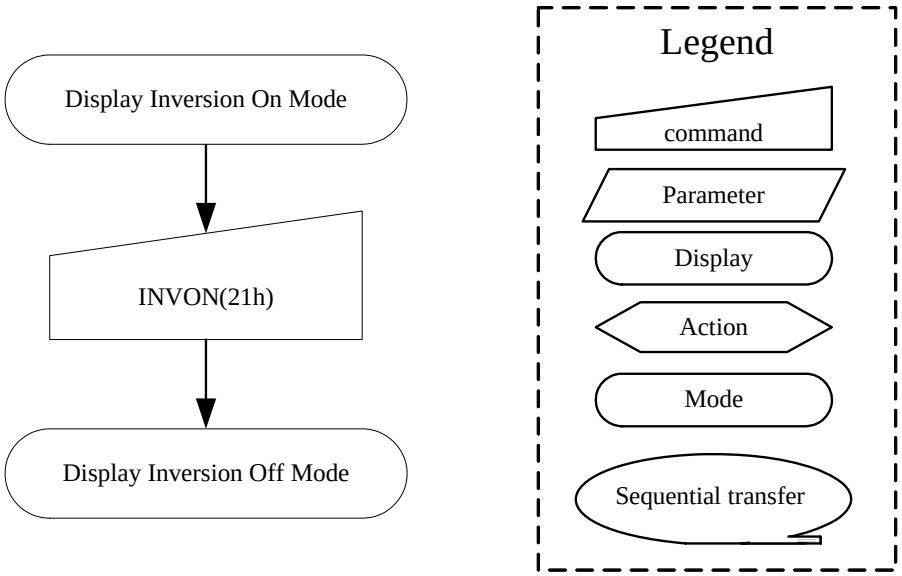
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Normal Display Mode Off
SW Reset	Normal Display Mode Off
HW Reset	Normal Display Mode Off

Flow Chart



14.2.17 Gamma Set (26h)

26H	GAMSET (Gamma Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	0	1	1	0	26h
Parameter	1	1	↑	x	GC7	GC6	GC5	GC4	GC3	GC2	GC1	GC0	01h

Description

This command is used to select the desired Gamma curve for the current display. A maximum of 4 fixed gamma curves can be selected. The curves are defined Gamma Curve Correction Power Supply Circuit. The curve is selected by setting the appropriate bit in the parameter as described in the Table:

GC[7..0]	Parameter	Curve Selected
01h	GC0	Gamma Curve 1
02h	GC1	Gamma Curve 2
04h	GC2	Gamma Curve 3
08h	GC3	Gamma Curve 4

Note: All other values are undefined.

X = don't care

Restriction

Values of GC[7..0] not shown in table above are invalid and will not change the current selected Gamma curve until valid value is received.

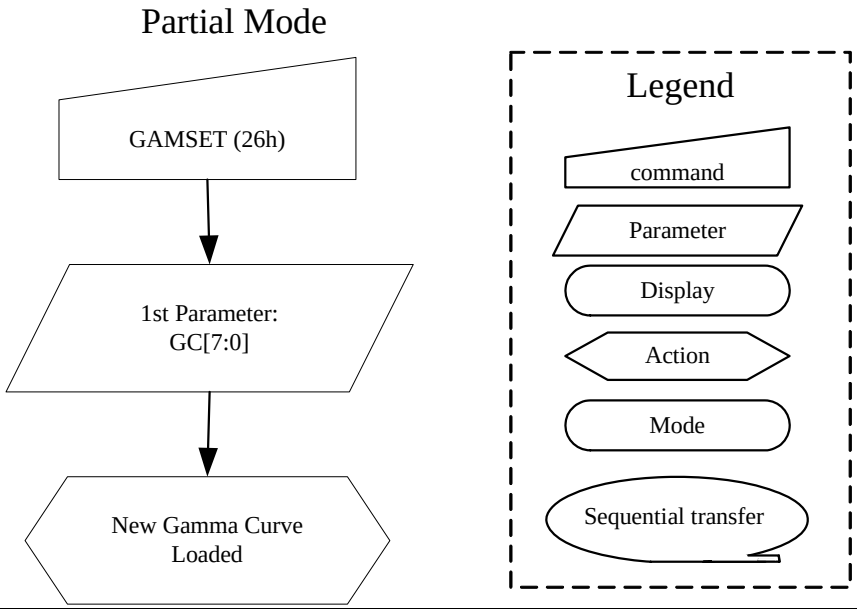
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

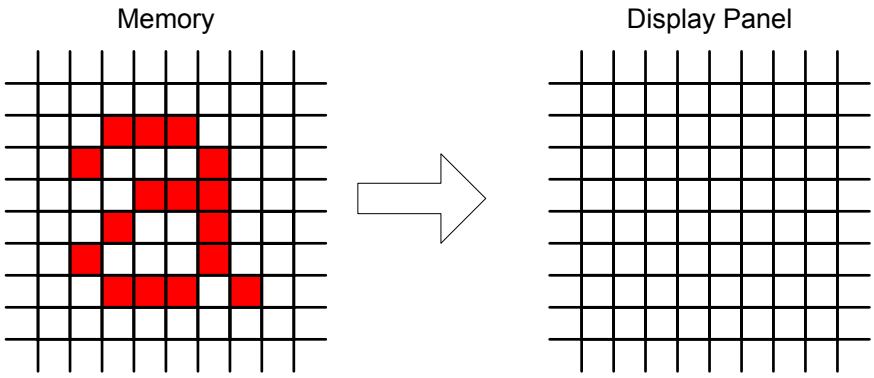
Default

Status	Default Value
Power On Sequence	01h
SW Reset	01h
HW Reset	01h

Flow Chart



14.2.18 Display Off (28h)

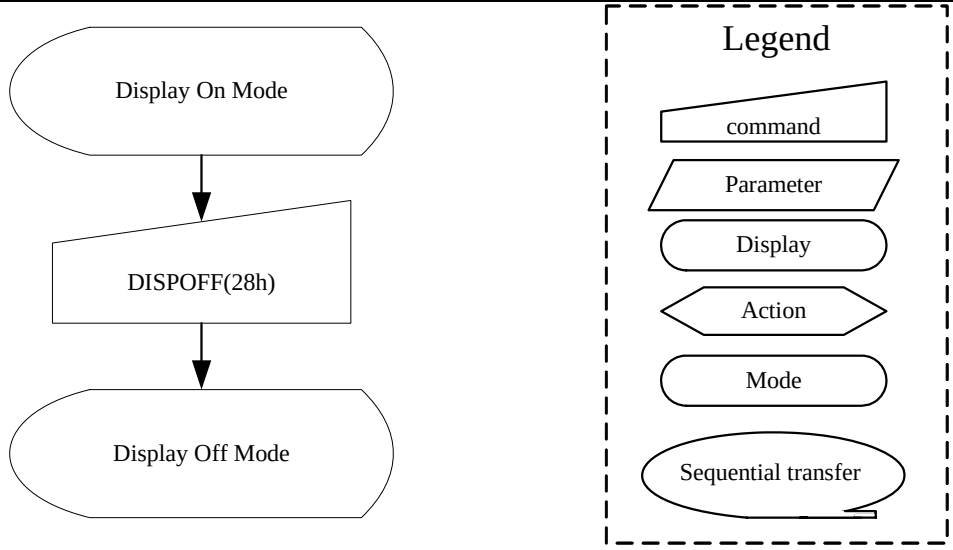
28H	DISPOFF (Display Off)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	0	0	0	28h
Parameter	No Parameter												
Description	This command is used to enter into DISPLAY OFF mode. In this mode, the output from Frame Memory is disabled and blank page inserted. This command makes no change of contents of frame memory. This command does not change any other status. There will be no abnormal visible effect on the display. Exit from this command by Display On(29h)  X = don't care												
Restriction	This command has no effect when module is already in display off mode.												
Register Availability													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

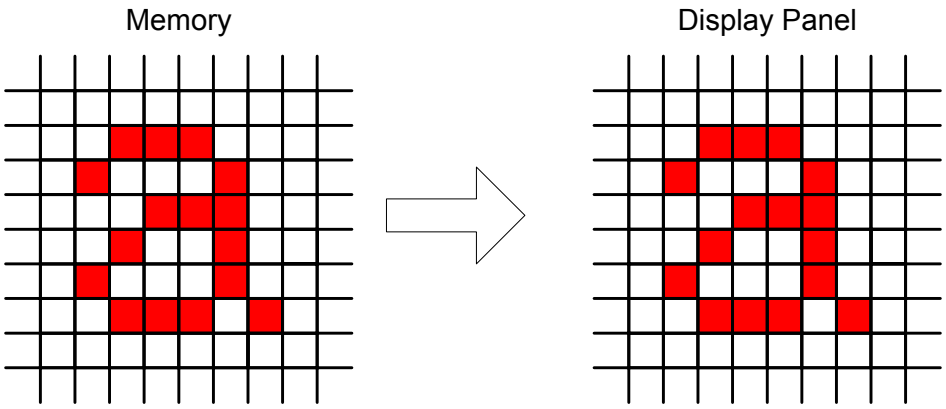
Default

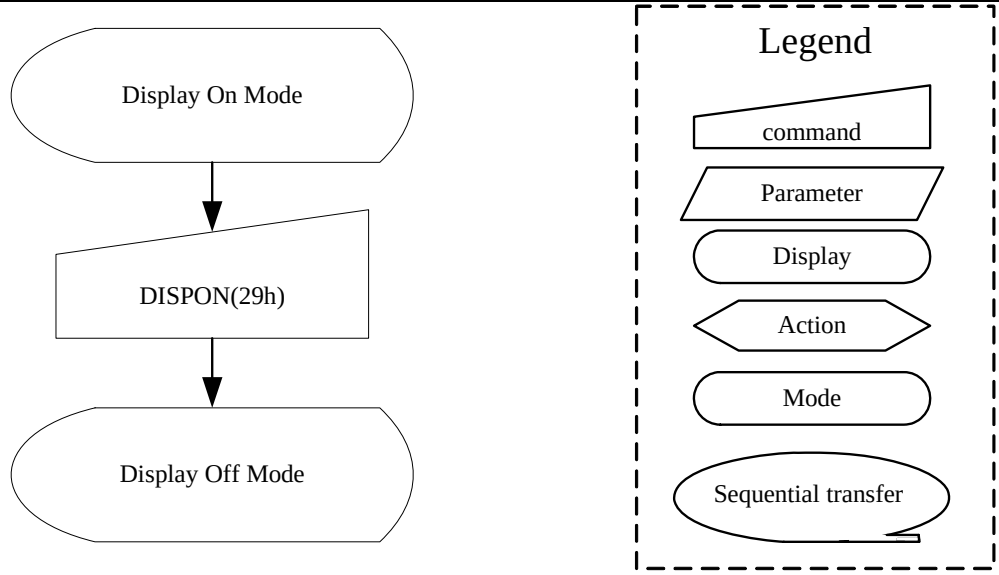
Status	Default Value
Power On Sequence	Display Off
SW Reset	Display Off
HW Reset	Display Off

Flow Chart


Display On Mode
DISPOFF(28h)
Display Off Mode
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.19 Display On (29h)

<table>
<tr><th>29H</th><th colspan="13">DISPON (Display On)</th></tr>
<tr><td></td><td>D/CX</td><td>RDX</td><td>WRX</td><td>D17-8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>HEX</td></tr>
<tr><td>Command</td><td>0</td><td>1</td><td>↑</td><td>x</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>29h</td></tr>
<tr><td>Parameter</td><td colspan="13">No Parameter</td></tr>
<tr><td>Description</td><td colspan="13">This command is used to recover from DISPLAY OFF mode. Output from the Frame Memory is enabled.
This command makes no change of contents of frame memory.
This command does not change any other status.
 
X = don’t care</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect when module is already in display on mode.</td></tr>
<tr><td>Register Availability</td><td colspan="13"><table><tr><th>Status</th><th>Availability</th></tr><tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Sleep In</td><td>Yes</td></tr></table></td></tr>
<tr><td>Default</td><td colspan="13"><table><tr><th>Status</th><th>Default Value</th></tr><tr><td>Power On Sequence</td><td>Display Off</td></tr><tr><td>SW Reset</td><td>Display Off</td></tr><tr><td>HW Reset</td><td>Display Off</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13"></td></tr>
</table>

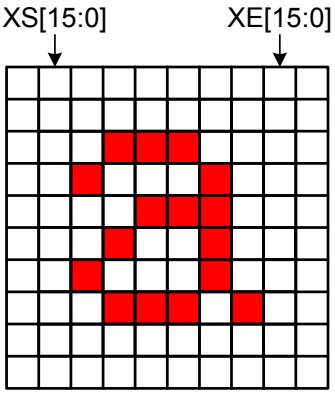

Display On Mode
DISPON(29h)
Display Off Mode
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.20 Column Address Set (2Ah)

2AH	CASET (Column Address Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	0	1	0	2Ah
1st Parameter	1	1	↑	x	XS15	XS14	XS13	XS12	XS11	XS10	XS9	XS8	-
2nd Parameter	1	1	↑	x	XS7	XS6	XS5	XS4	XS3	XS2	XS1	XS0	-
3rd Parameter	1	1	↑	x	XE15	XE14	XE13	XE12	XE11	XE10	XE9	XE8	-
4th Parameter	1	1	↑	x	XE7	XE6	XE5	XE4	XE3	XE2	XE1	XE0	-

Description

This command is used to define area of frame memory where MCU can access.
This command makes no change on the other driver status.
The values of XS[15:0] and XE[15:0] are referred when RAMWR command comes. Each value represents one column line in the Frame Memory.



X = don't care

Restriction

XS [15:0] always must be equal to or less than XE[15:0].

When XS[15:0] or XE[15:0] is greater than maximum address like below, data of out of range will be ignored.

1. 132X132 memory base (GM='101')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦131(0083h):MV="0")

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦131(0083h):MV="1")

2. 130X130 memory base (GM='100')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦129(0081h):MV="0")

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦129(0081h):MV="1")

3. 128X160 memory base (GM='011')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦127(007Fh):MV="0")

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦159(009Fh):MV="1")

4. 120X160 memory base (GM='010')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦119(0077h):MV="0")

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦159(009Fh):MV="1")

5. 128X128 memory base (GM='001')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦127(007Fh):MV="0")

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦127(007Fh):MV="1")

6. 132X162 memory base (GM='000')

   (Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦131(0083h):MV="0")

(Parameter range: 0≦XS[15:0] ≦XE[15:0] ≦127(00A1h):MV="1")

X = Don't care

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

1. 132 x 132 memory base(GM='101')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	0083h(131)	
S/W Reset	0000h	0083h(131)	0083h(131)
HW Reset	0000h	0083h(131)	

2. 130 x 130 memory base(GM='100')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	0081h(129)	
S/W Reset	0000h	0081h(129)	0081h(129)
HW Reset	0000h	0081h(129)	

3. 128 x 160 memory base(GM='011')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	007Fh(127)	
S/W Reset	0000h	007Fh(127)	009Fh(159)
HW Reset	0000h	007Fh(127)	

4. 120 x 160 memory base(GM='010')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	0077h(119)	
S/W Reset	0000h	007Fh(119)	009Fh(159)
HW Reset	0000h	0077h(119)	

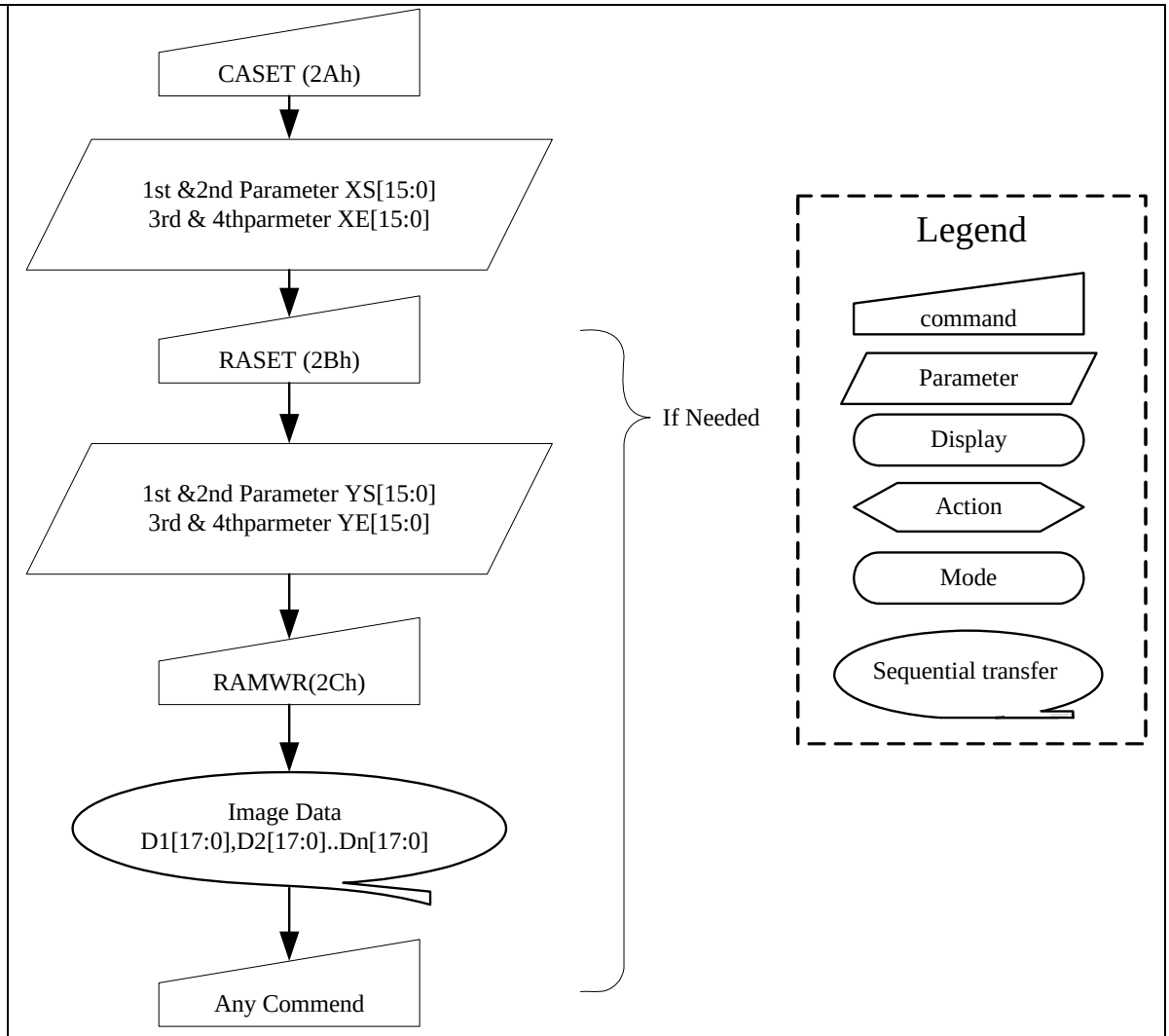
5. 128 x 128 memory base(GM='001')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	007Fh(127)	
S/W Reset	0000h	007Fh(127)	009Fh(127)
HW Reset	0000h	0077h(119)	

6. 132 x 162 memory base(GM='000')

Status	Default Value		
	XS[15:0]	XE[15:0]	EX[15:0] (MV=1)
Power On Sequence	0000h	0083h(131)	
S/W Reset	0000h	0083h(131)	00A1h(161)
HW Reset	0000h	0083h(131)	

Flow Chart


CASET (2Ah)
1st &2nd Parameter XS[15:0]
3rd & 4thparmeter XE[15:0]
RASET (2Bh)
1st &2nd Parameter YS[15:0]
3rd & 4thparmeter YE[15:0]
RAMWR(2Ch)
Image Data
D1[17:0],D2[17:0]..Dn[17:0]
Any Commend
If Needed
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.21 Page Address Set (2Bh)

2BH	PASET (Page Address Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	0	1	1	2Bh
1st Parameter	1	1	↑	x	YS15	YS14	YS13	YS12	YS11	YS10	YS9	YS8	-
2nd Parameter	1	1	↑	x	YS7	YS6	YS5	YS4	YS3	YS2	YS1	YS0	-
3rd Parameter	1	1	↑	x	YE15	YE14	YE13	YE12	YE11	YE10	YE9	YE8	-
4th Parameter	1	1	↑	x	YE7	YE6	YE5	YE4	YE3	YE2	YE1	YE0	-

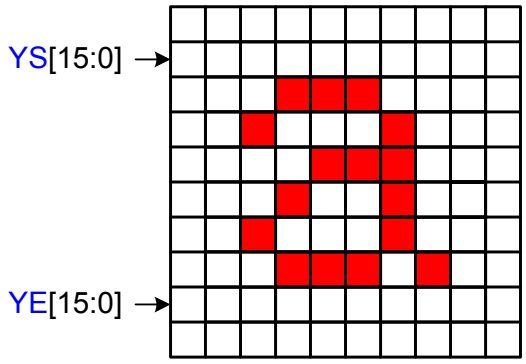
Description

This command is used to define area of frame memory where MCU can access.

This command makes no change on the other driver status.

The value of YS [15:0] and YE [15:0] are referred when RAMWR command comes.

Each value represents one Page line in the Frame Memory.



Restriction

YS [15:0] always must be equal to or less than EP [15:0].

When YS[15:0] or YE[15:0] is greater than maximum row address like below, data of out of range will be ignored.

1. 132X132 memory base (GM='101')

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦131(0083h)):MV="0"

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦131(0083h)):MV="1"

2. 130X130 memory base (GM='100')

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦129(0081h)):MV="0"

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦129(0081h)):MV="1"

3. 128X160 memory base (GM='011')

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦159(009Fh)):MV="0"

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦127(007Fh)):MV="1"

4. 120X160 memory base (GM='010')

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦159(009Fh)):MV="0"

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦119(0077h)):MV="1"

5. 128X128 memory base (GM='001')

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦127(007Fh)):MV="0"

   (Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦127(007Fh)):MV="1"

6. 132X162 memory base (GM='000')

(Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦161(00A1h)):MV="0"

(Parameter range: 0≦YS[15:0] ≦YE[15:0] ≦131(0083h)):MV="1"

X = Don't care

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

1. 132 x 132 memory base(GM='101')

Status	Default Value		
	YS[15:0]	YE[15:0]	YX[15:0] (MV=1)
Power On Sequence	0000h	0083h(131)	
S/W Reset	0000h	0083h(131)	0083h(131)
HW Reset	0000h	0083h(131)	

2. 130 x 130 memory base(GM='100')

Status	Default Value		
	YS[15:0]	YE[15:0]	YX[15:0] (MV=1)
Power On Sequence	0000h	0081h(129)	
S/W Reset	0000h	0081h(129)	0081h(129)
HW Reset	0000h	0081h(129)	

3. 128X160 memory base(GM='011')

Status	Default Value		
	YS[15:0]	YE[15:0] (MV=0)	YE[15:0] (MV=1)
Power On Sequence	0000h	009Fh(159)	
SW Reset	0000h	009Fh(159)	007Fh(127)
HW Reset	0000h	009Fh(159)	

4. 120X160 memory base(GM='010')

Status	Default Value		
	YS[15:0]	YE[15:0] (MV=0)	YE[15:0] (MV=1)
Power On Sequence	0000h	009Fh(159)	
SW Reset	0000h	009Fh(159)	0077h(119)
HW Reset	0000h	009Fh(159)	

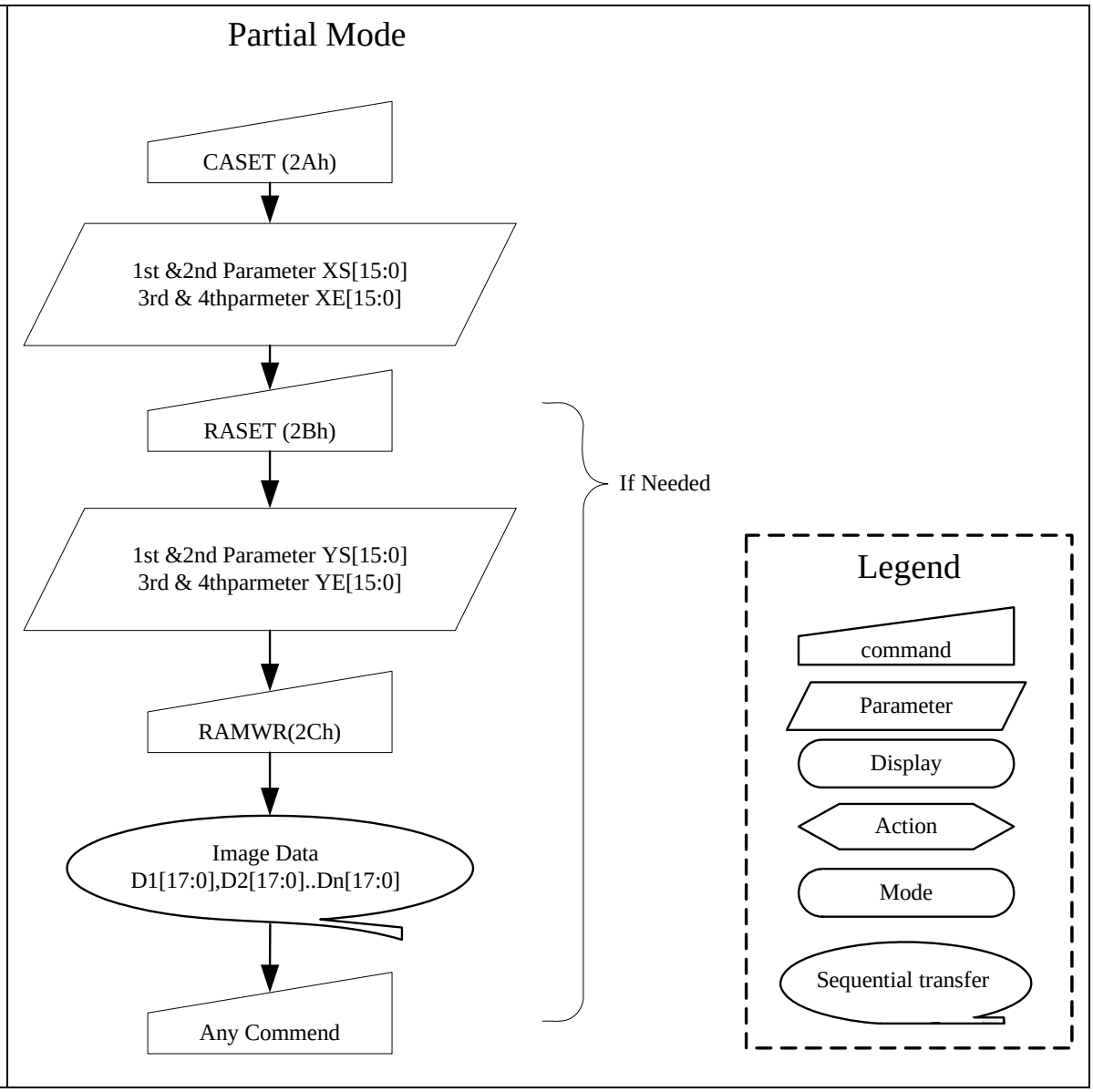
5. 120X160 memory base(GM='001')

Status	Default Value		
	YS[15:0]	YE[15:0] (MV=0)	YE[15:0] (MV=1)
Power On Sequence	0000h	007Fh(127)	
SW Reset	0000h	007Fh(127)	007Fh(127)
HW Reset	0000h	007Fh(127)	

6. 132X162 memory base(GM='000')

Status	Default Value		
	YS[15:0]	YE[15:0] (MV=0)	YE[15:0] (MV=1)
Power On Sequence	0000h	00A1h(161)	
SW Reset	0000h	00A1h(161)	0083h(131)

Flow Chart


Partial Mode
CASET (2Ah)
1st &2nd Parameter XS[15:0]
3rd & 4thparmeter XE[15:0]
RASET (2Bh)
1st &2nd Parameter YS[15:0]
3rd & 4thparmeter YE[15:0]
RAMWR(2Ch)
Image Data
D1[17:0],D2[17:0]..Dn[17:0]
Any Commend
If Needed
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.22 Memory Write (2Ch)

2CH	RAMWR (Memory Write)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	1	0	0	2Ch
1st Parameter	1	1	↑	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	-
:	1	1	↑	x	:	:	:	:	:	:	:	:	:
NTH Parameter	1	1	↑	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	-

Description

This command is used to transfer data from MCU to frame memory.

This command makes no change to the other driver status.

When this command is accepted, the column register and the page register are reset to the Start Column/ Start Page positions.

The Start Column / Start Page positions are different in accordance with MADCTL setting.

Then D[17:0] is stored in frame memory and the column refister and the row register incremented.

Sending any other command can stop frame Write.

X=Don't care

Restriction

In all color modes, there is no restriction on length of parameters.

1. 132X132 memory base (GM='101')

   132X132X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (0083h,083h)

2. 130X130 memory base (GM='100')

   130X130X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (0081h,081h)

3. 128X160 memory base (GM='011')

   128X160X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (007Fh,09Fh)

4. 120X160 memory base (GM='010')

   120X160X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (0077h,09Fh)

5. 128X128 memory base (GM='001')

   120X128X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (007Fh,007Fh)

6. 132X162 memory base (GM='000')

   132X162X18-bit memory can be written by this command.

   Memory range(0000h, 0000h) -> (0083h,00A1h)

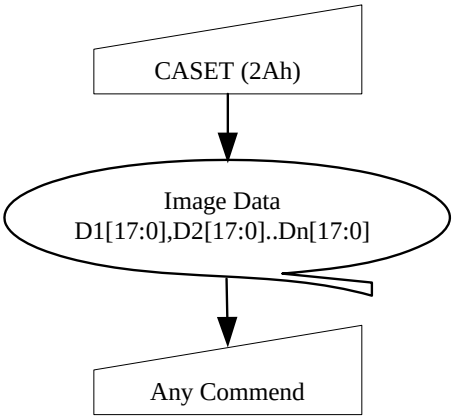
Register Availability

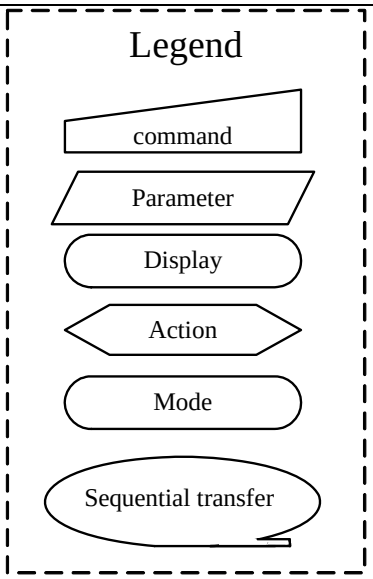
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Contents of memory is set randomly
SW Reset	Contents of memory is not cleared
HW Reset	Contents of memory is not cleared

Flow Chart





14.2.23 Color Setting fro 4K, 65K and 262K (2Dh)

2DH	RAMWR (Memory Write)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	1	0	1	2Dh
1st Parameter	1	1	↑	x	x	x	R005	R004	R003	R002	R001	R000	-
:	1	1	↑	x	x	x	Rnn5	Rnn4	Rnn3	Rnn2	Rnn1	Rnn0	-
32nd Parameter	1	1	↑	x	x	x	R315	R314	R313	R312	R311	R310	-
33rd Parameter	1	1	↑	x	x	x	G005	G004	G003	G002	G001	G000	-
:	1	1	↑	x	x	x	Gnn5	Gnn4	Gnn3	Gnn2	Gnn1	Gnn0	-
96th Parameter	1	1	↑	x	x	x	G635	G634	G633	G632	G631	G630	-
97th Parameter	1	1	↑	x	x	x	B005	B004	B003	B002	B001	B000	
:	1	1	↑	x	x	x	Bnn5	Bnn4	Bnn3	Bnn2	Bnn1	Bnn0	-
128th Parameter	1	1	↑	x	x	x	B315	B314	B313	B312	B311	B310	-

Description

This command is used to define the LUT for 12bit-to-18-bit color depth conversations 128-Bytes must be written to the LUT regardless of the color mode.

In this condition, 4K-color(4-4-4), and 65K-color(5-6-5) data input are transferred 6That-6(G)-6(B) through RGB LUT table.

This command has no effect on other commands/parameters and Contents of frame memory.

Visible change takes effect next time the Frame Memory is written to.

Restriction

Do not send any command before the last data is sent or LUT is not defined correctly.

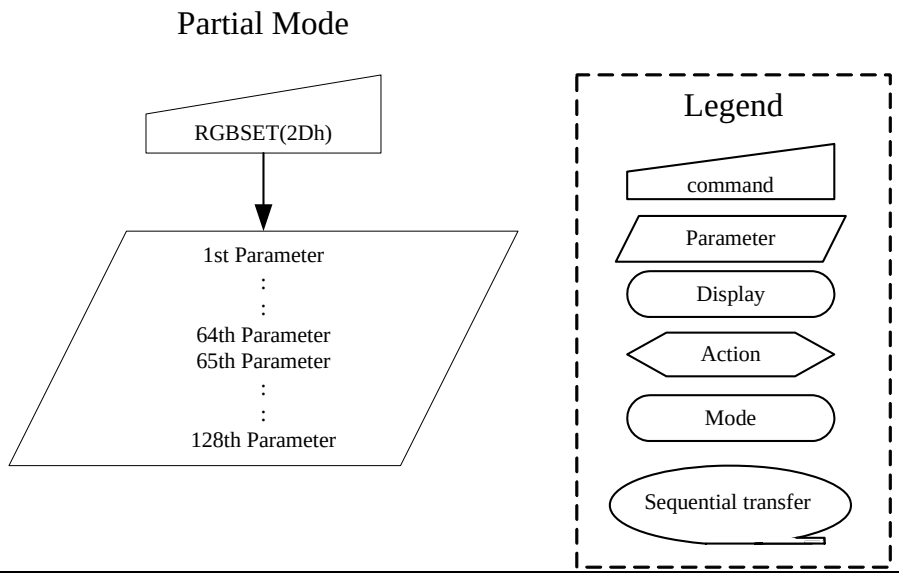
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Contents of memory is set randomly
SW Reset	Contents of memory is not cleared
HW Reset	Contents of memory is not cleared

Flow Chart



14.2.24 Memory Read (2Eh)

2EH	RAMRD (Memory Read)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	0	1	1	1	0	2Eh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	D17	D16	D15	D14	D13	D12	D11	D10	x
:	1	↑	1	x	:	:	:	:	:	:	:	:	x
Nth Parameter	1	↑	1	x	Dn7	Dn6	Dn5	Dn4	Dn3	Dn2	Dn1	Dn0	x

Description

This command is used to transfer data from frame memory to MCU.

This command makes no change to other driver status.

When this command is accepted, the column register and then row register are reset to the Start Column/ Start Row positions.

The Start Column / Start Row positions are different in accordance with MADCTL setting.

Then D [17:0] is read back from the frame memory and the column register and the row register incremented.

Frame Read can be stopped by sending any other command.

"Display Data Format" for color coding(18 bit cases), when there is used 8,9,16 or 18 data lines for image data.

X = Don't care

Restriction

In all color modes, the Frame Read is always 24 bit so there is no restriction on length of parameters.

Note: Memory Read is only possible via the Parallel Interface

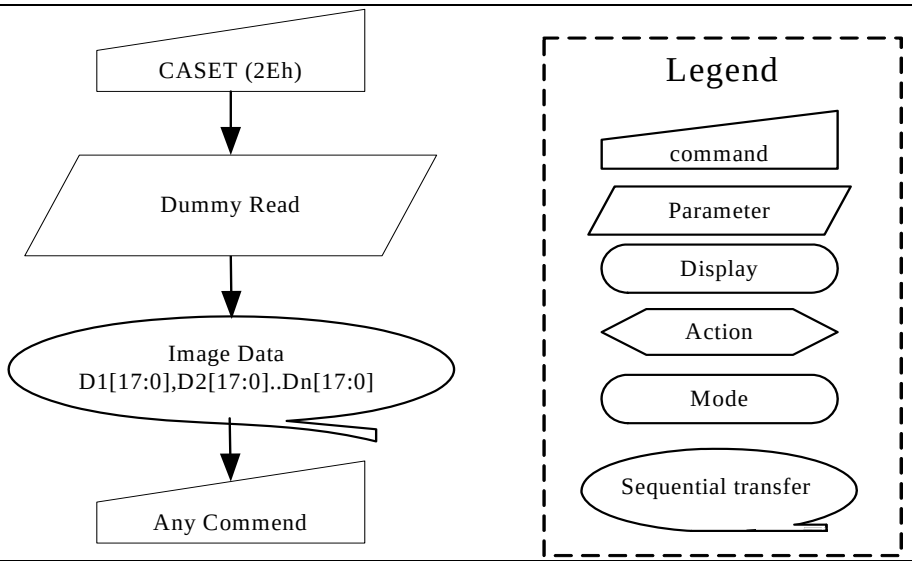
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Contents of memory is set randomly
SW Reset	Contents of memory is not cleared
HW Reset	Contents of memory is not cleared

Flow Chart



14.2.25 Partial Area (30h)

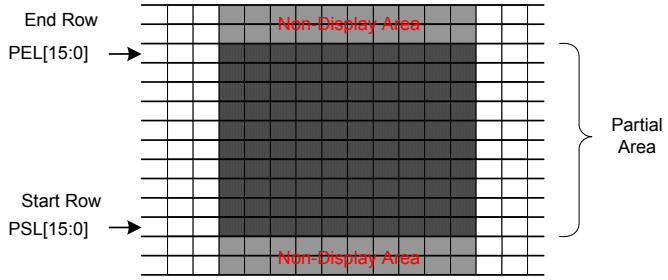
30H	PLTAR (Partial Area)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	0	0	0	0	30h
1st Parameter	1	1	↑	x	PSL15	PSL14	PSL13	PSL12	PSL11	PSL10	PSL9	PSL8	-
2nd Parameter	1	1	↑	x	PSL7	PSL6	PSL5	PSL4	PSL3	PSL2	PSL1	PSL0	-
3rd Parameter	1	1	↑	x	PEL15	PEL14	PEL13	PEL12	PEL11	PEL10	PEL9	PEL8	-
4th Parameter	1	1	↑	x	PEL7	PEL6	PEL5	PEL4	PEL3	PEL2	PEL1	PEL0	-

Description

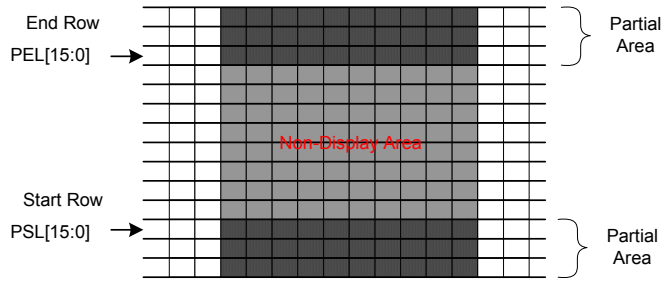
This command defines the partial mode's display area. There are 4 parameters associated with this command, the first defines the Start Row (PSL) and the second the End Row (PEL), as illustrated in the figures below. PSL and PEL refer to the Frame Memory Line Pointer.

If End Row>Start Row when MADCTL B4=0:

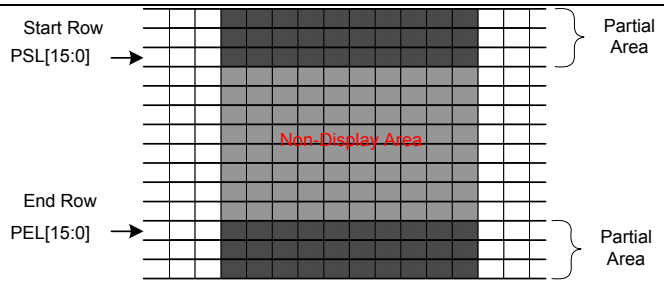
If End Row > Start Row when MADCTL ML=1:



If End Row < Start Row when MADCTL ML=0:



If End Row < Start Row when MADCTL ML=1:



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

Restriction: -

Register Availability

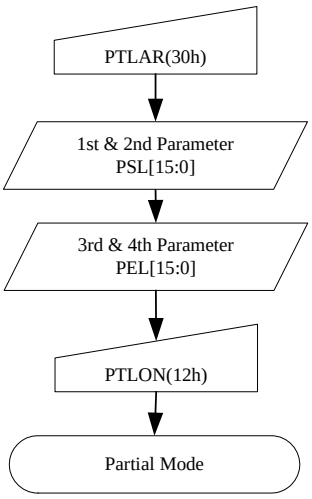
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

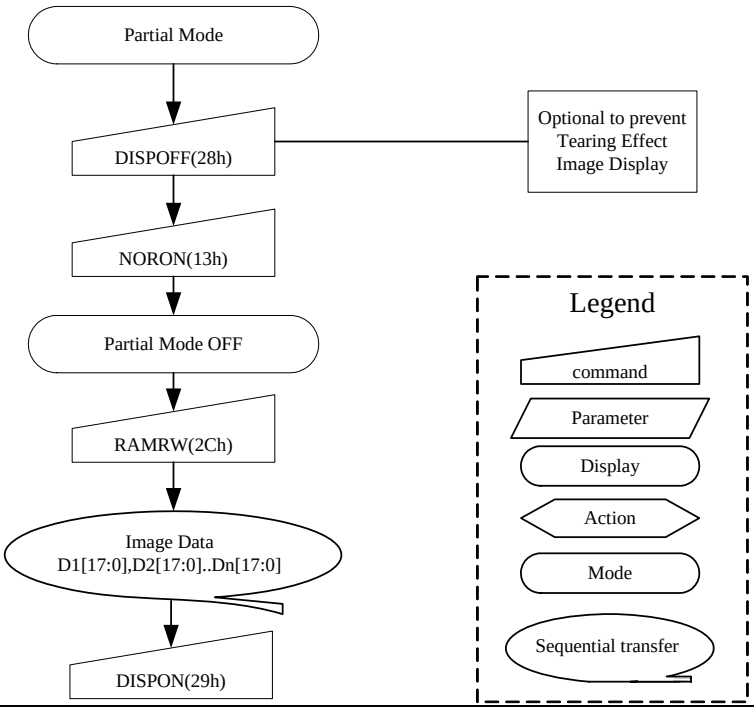
Status	Default Value						
	PSL[15:0]	PEL[15:0]					
GM	"xxx"	"101"	"100"	"011"	"010"	"001"	"000"
Power On Sequence	0000h	0083h	0081h	009Fh	009Fh	007Fh	00A1h
SW Reset	0000h	0083h	0081h	009Fh	009Fh	007Fh	00A1h
HW Reset	0000h	0083h	0081h	009Fh	009Fh	007Fh	00A1h

Flow Chart

1. To Enter partial Mode



2. To Exit Partial Mode



14.2.26 Vertical Scrolling Definition (33h)

33H	VSCRDEF (Vertical Scrolling Definition)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	0	0	1	1	33h
1st Parameter	1	1	↑	x	TFA 15	TFA 14	TFA 13	TFA 12	TFA 11	TFA 10	TFA 9	TFA 8	-
2nd Parameter	1	1	↑	x	TFA 7	TFA 6	TFA 5	TFA 4	TFA 3	TFA 2	TFA 1	TFA 0	-
3rd Parameter	1	1	↑	x	VSA 15	VSA 14	VSA 13	VSA 12	VSA 11	VSA 10	VSA 9	VSA 8	-
4th Parameter	1	1	↑	x	VSA 7	VSA 6	VSA 5	VSA 4	VSA 3	VSA 2	VSA 1	VSA 0	-
5th Parameter	1	1	↑	x	BFA 15	BFA 14	BFA 13	BFA 12	BFA 11	BFA 10	BFA 9	BFA 8	-
6th Parameter	1	1	↑	x	BFA 7	BFA 6	BFA 5	BFA 4	BFA 3	BFA 2	BFA 1	BFA 0	-

Description

This command defines the Vertical Scrolling Area of the display.

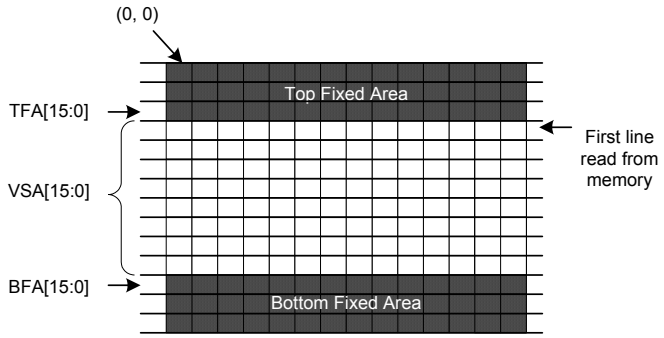
When MADCTL ML=0

The 1st & 2nd parameter TFA[15...0] describes the Top Fixed Area (in No. of lines from Top of the Frame Memory and Display).

The 3rd & 4th parameter VSA[15...0] describes the height of the Vertical Scrolling Area (in No. of lines of the Frame Memory [not the display] from the Vertical Scrolling Start Address). The first line read from Frame Memory appears immediately after the bottom most line of the Top Fixed Area.

The 5th & 6th parameter BFA[15...0] describes the Bottom Fixed Area (in No. of lines from Bottom of the Frame Memory and Display).

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

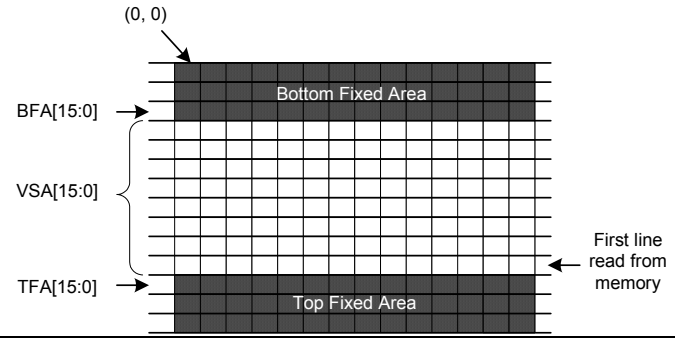


When MADCTL ML=1

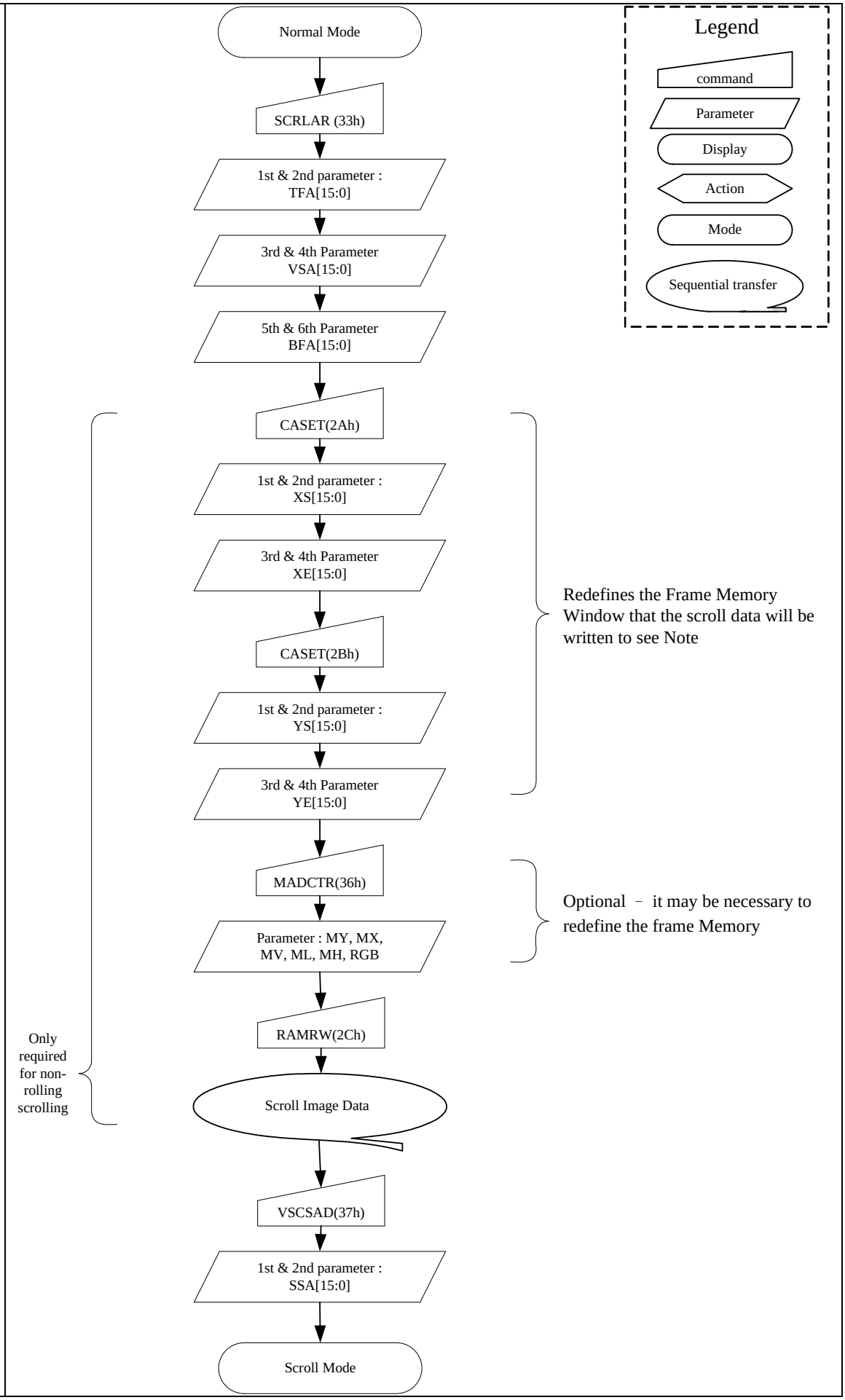
The 1st & 2nd parameter TFA[15...0] describes the Top Fixed Area (in No. of lines from Bottom of the Frame Memory and Display).

The 3rd & 4th parameter VSA[15...0] describes the height of the Vertical Scrolling Area (in No. of lines of the Frame Memory [not the display] from the Vertical Scrolling Start Address). The first line read from Frame Memory appears immediately after the top most line of the Top Fixed Area.

The 5th & 6th parameter BFA[15...0] describes the Bottom Fixed Area (in No. of lines from Top of the Frame Memory and Display).

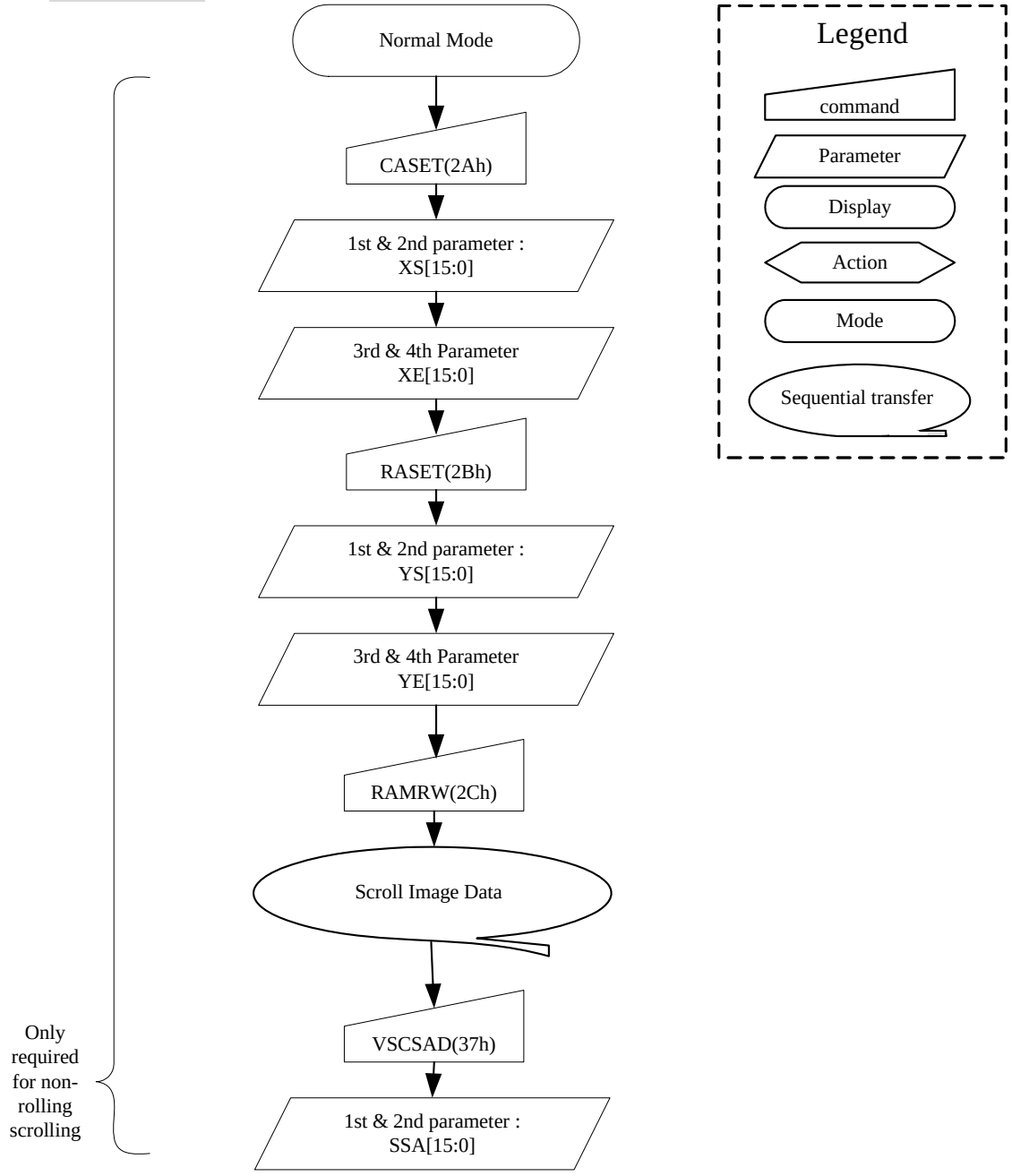


<table>
<tr><td></td><td></td></tr>
<tr><td>Restriction</td><td>The condition is (TFA+VSA+BFA)=128 in 128RGBx128 (GM=”001”)
The condition is (TFA+VSA+BFA)=130 in 130RGBx130 (GM=”100”)
The condition is (TFA+VSA+BFA)=132 in 132RGBx132 (GM=”101”)
The condition is (TFA+VSA+BFA)=160 in 128RGBx160 (GM=”011”) or 120RGBx160(GM=”010”)
The condition is (TFA+VSA+BFA)=162 in 132RGBx162(GM=”000”)
Otherwise Scrolling mode is undefined.
In Vertical Scroll Mode, MADCTL parameter MV should be set to ‘0’ – this affects the Frame memory Write.</td></tr>
<tr><td>Register Availability</td><td><table>
<tr><th>Status</th><th>Availability</th></tr>
<tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Sleep In</td><td>Yes</td></tr>
</table></td></tr>
<tr><td>Default</td><td><table>
<tr><th rowspan="2">Status</th><th colspan="8">Default Value</th></tr>
<tr><td>TFA[15:0]</td><td colspan="6">VSA[15:0]</td><td>BFA[15:0]</td></tr>
<tr><td>GM</td><td>“xx”</td><td>“101”</td><td>“100”</td><td>“011”</td><td>“010”</td><td>“001”</td><td>“000”</td><td>“xx”</td></tr>
<tr><td>Power On Sequence</td><td>0000h</td><td>0083h</td><td>0081h</td><td>00A0h</td><td>00A0h</td><td>0080h</td><td>00A2h</td><td>0000h</td></tr>
<tr><td>SW Reset</td><td>0000h</td><td>0083h</td><td>0081h</td><td>00A0h</td><td>00A0h</td><td>0080h</td><td>00A2h</td><td>0000h</td></tr>
<tr><td>HW Reset</td><td>0000h</td><td>0083h</td><td>0081h</td><td>00A0h</td><td>00A0h</td><td>0080h</td><td>00A2h</td><td>0000h</td></tr>
</table></td></tr>
<tr><td>Flow Chart</td><td>1. To enter Vertical Scroll Mode:</td></tr>
</table>

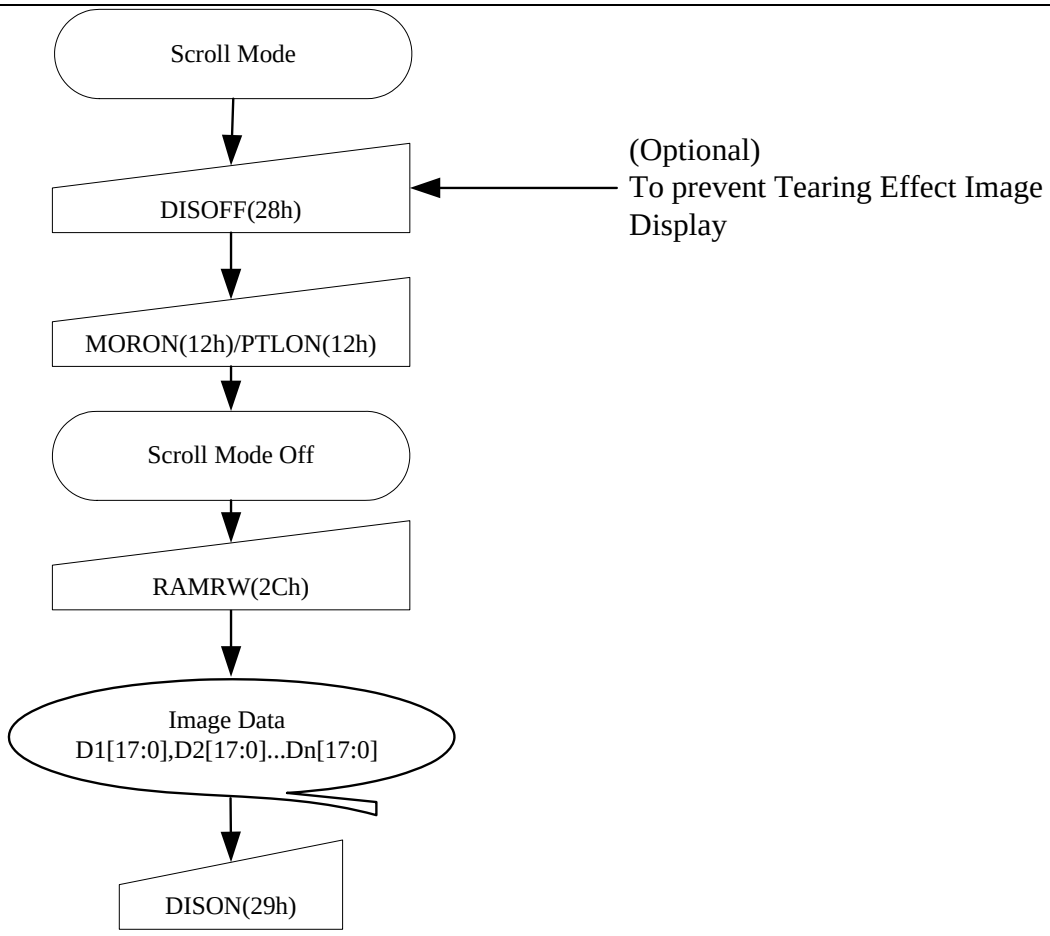

Normal Mode
SCRLAR (33h)
1st & 2nd parameter : TFA[15:0]
3rd & 4th Parameter VSA[15:0]
5th & 6th Parameter BFA[15:0]
CASET(2Ah)
1st & 2nd parameter : XS[15:0]
3rd & 4th Parameter XE[15:0]
CASET(2Bh)
1st & 2nd parameter : YS[15:0]
3rd & 4th Parameter YE[15:0]
MADCTR(36h)
Parameter : MY, MX, MV, ML, MH, RGB
RAMRW(2Ch)
Scroll Image Data
VSCSAD(37h)
1st & 2nd parameter : SSA[15:0]
Scroll Mode
Legend
command
Parameter
Display
Action
Mode
Sequential transfer
Redefines the Frame Memory Window that the scroll data will be written to see Note
Optional – it may be necessary to redefine the frame Memory
Only required for non-rolling scrolling

Note 1
The Frame Memory Window size must be defined correctly otherwise undesirable image will be displayed.

2. Continuous Scroll:

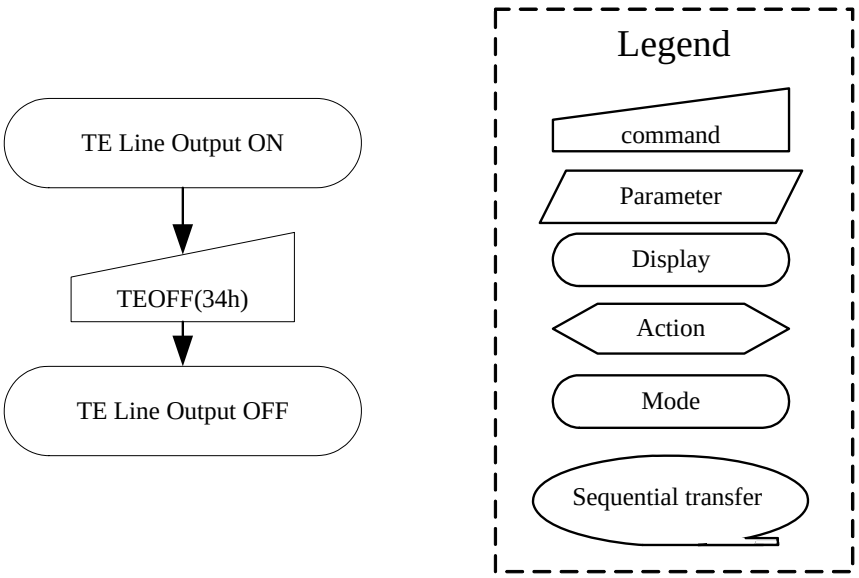


V. .┐ 3. To Leave Vertical Scroll Mode:



Note2: Scroll Mode can be left by both the Normal Display Mode On (13h) and Partial Mode On (12h) commands.

14.2.27 Tearing Effect Line Off (34h)

<table>
<tr><th>34H</th><th colspan="13">TEOFF (Tearing Effect Line OFF)</th></tr>
<tr><td></td><td>D/CX</td><td>RDX</td><td>WRX</td><td>D17-8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>HEX</td></tr>
<tr><td>Command</td><td>0</td><td>1</td><td>↑</td><td>x</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>34h</td></tr>
<tr><td>Parameter</td><td colspan="13">NO PARAMETER</td></tr>
<tr><td>Description</td><td colspan="13">This command is used to turn OFF (Active Low) the Tearing Effect output signal from the TE signal line.</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect when Tearing Effect output is already OFF.</td></tr>
<tr><td>Register Availability</td><td colspan="13"><table><tr><th>Status</th><th>Availability</th></tr><tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Sleep In</td><td>Yes</td></tr></table></td></tr>
<tr><td>Default</td><td colspan="13"><table><tr><th>Status</th><th>Default Value</th></tr><tr><td>Power On Sequence</td><td>OFF</td></tr><tr><td>SW Reset</td><td>OFF</td></tr><tr><td>HW Reset</td><td>OFF</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13"> 
</td></tr>
</table>

14.2.28 Tearing Effect Line On (35h)

35H	TEON (Tearing Effect Line ON)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	0	1	0	1	35h
1st Parameter	1	1	↑	x	x	x	x	x	x	x	x	M	00h

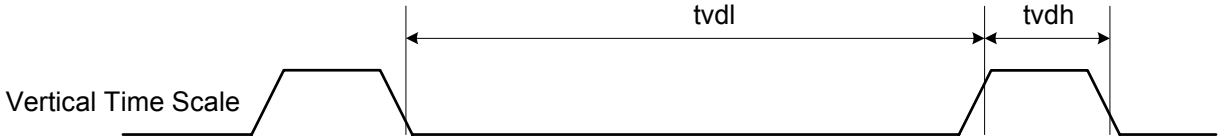
Description

This command is used to turn ON the Tearing Effect output signal from the TE signal line. This output is not affected by changing MADCTL bit ML.

The Tearing Effect Line On has one parameter which describes the mode of the Tearing Effect Output Line. (X=Don't Care).

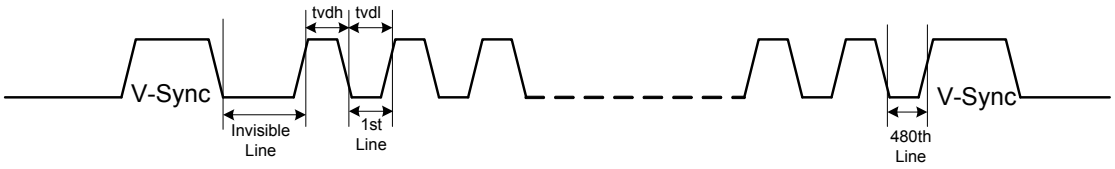
When M=0:

The Tearing Effect Output line consists of both V-Blanking and H-Blanking information.:



When M=1:

The Tearing Effect Output Line consists of both V-Blanking and H-Blanking information:



Note: During Sleep In Mode with Tearing Effect Line On, Tearing Effect Output pin will be active Low.

Restriction

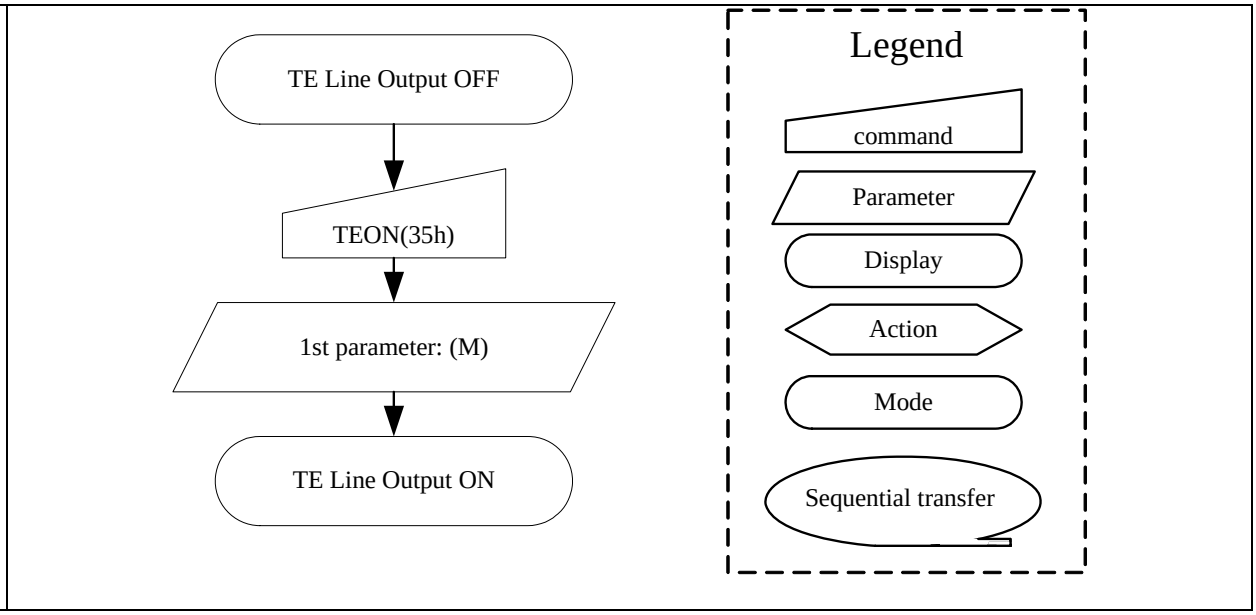
This command has no effect when Tearing Effect output is already OFF.

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Tearing effect off & M=0
SW Reset	Tearing effect off & M=0
HW Reset	Tearing effect off & M=0

Flow Chart	

TE Line Output OFF
TEON(35h)
1st parameter: (M)
TE Line Output ON
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.29 Memory Access Control (36h)

36H	MADCTL (Memory Access Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	0	1	1	0	36h
1st Parameter	1	1	↑	x	MY	MX	MV	ML	RGB	MH	x	x	00h

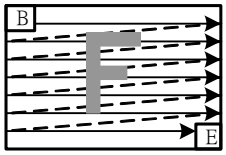
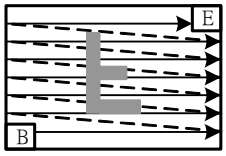
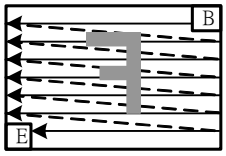
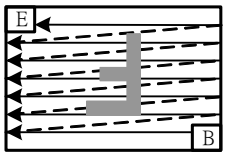
Description

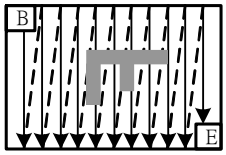
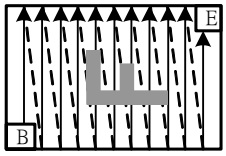
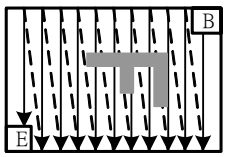
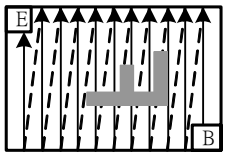
This command defines read/write scanning direction of frame memory.

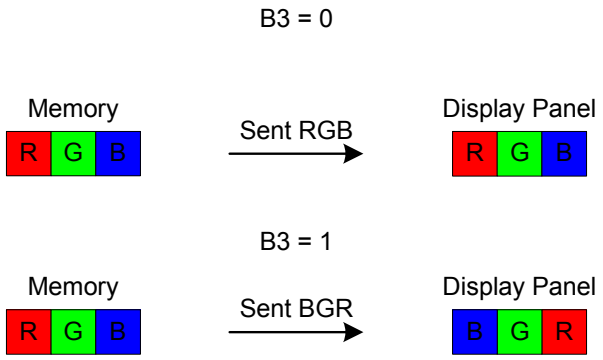
This command makes no change on the other driver status.

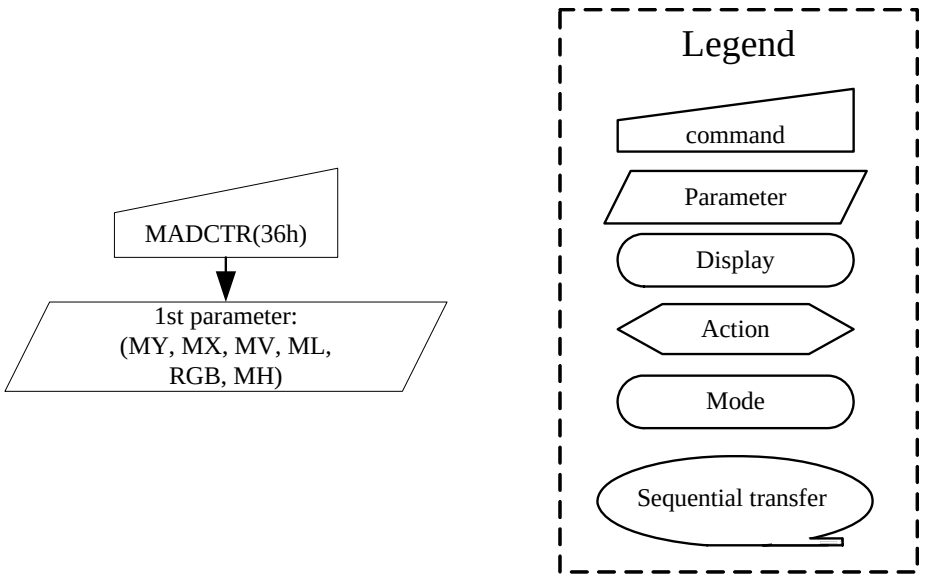
Bit Assignment

Bit	Description	Comment
MY	Row Address Order	These 3 bits controls MPU to memory write/read direction.
MX	Column Address Order	
MV	Page/Column Selection	
ML	Vertical Order	LCD Vertical refresh direction control
RGB	RGB/BGR Order	Color selector switch control 0=RGB color filter panel 1=BGR color filter panel
MH	Display data latch order	'1'=LCD Refresh right to left '0'=LCD Refresh left to right

B5	B6	B7	Image in Frame Memory
0	0	0	
0	0	1	
0	1	0	
0	1	1	

B5	B6	B7	Image in Frame Memory
1	0	0	
1	0	1	
1	1	0	
1	1	1	

<table>
<tr><td></td><td>


</td></tr>
<tr><td>Restriction</td><td>-D1 and D0 of the 1st parameter are set to “00” internally.</td></tr>
<tr><td>Register Availability</td><td>
<table>
<tr><th>Status</th><th>Availability</th></tr>
<tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Sleep In</td><td>Yes</td></tr>
</table>
</td></tr>
<tr><td>Default</td><td>
<table>
<tr><th>Status</th><th>Default Value</th></tr>
<tr><td>Power On Sequence</td><td>MY=0,MX=0,MV=0,ML=0,RGB=0,MH=0</td></tr>
<tr><td>SW Reset</td><td>No Change</td></tr>
<tr><td>HW Reset</td><td>MY=0,MX=0,MV=0,ML=0,RGB=0,MH=0</td></tr>
</table>
</td></tr>
<tr><td>Flow Chart</td><td>


</td></tr>
</table>

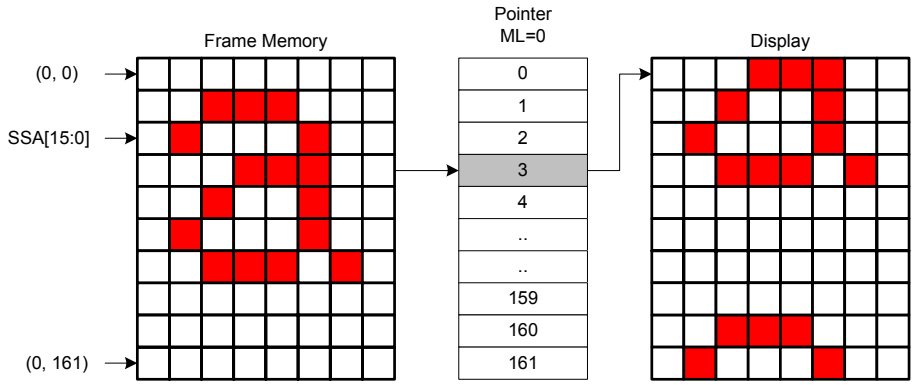
14.2.30 Vertical Scrolling Start Address (37h)

37H	VSCRSADD (Vertical Scrolling Start Address)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	0	1	1	1	37h
1st Parameter	1	1	↑	x	SSA 15	SSA 14	SSA 13	SSA 12	SSA 11	SSA 10	SSA 9	SSA 8	00h
2nd Parameter	1	1	↑	x	SSA 7	SSA 6	SSA 5	SSA 4	SSA 3	SSA 2	SSA 1	SSA 0	00h

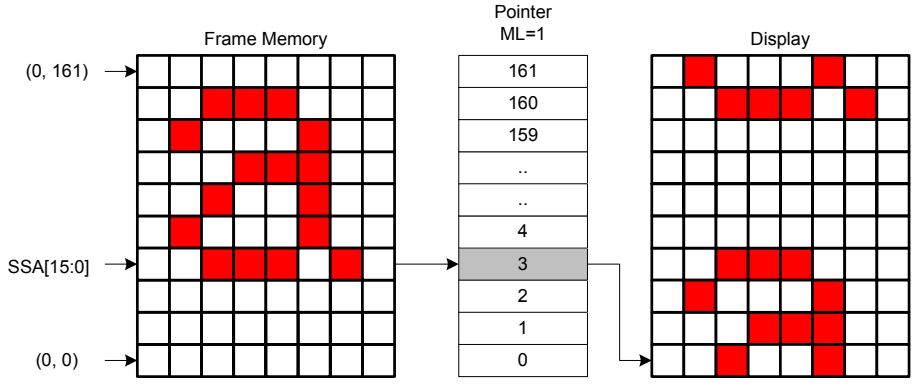
Description

This command is used together with Vertical Scrolling Definition (33h). These two commands describe the scrolling area and the scrolling mode.
The Vertical Scrolling Start Address command has one parameter which describes the address of the line in the Frame Memory that will be written as the first line after the last line of the Top Fixed Area on the display as illustrated below:
This command Start the scrolling.

When MADCTL ML=0
Example: GM=000, 132RGBx162
When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 162 and Vertical Scrolling Pointer SSA='3'.



When MADCTL ML=1
Example: GM=000, 132RGBx162
When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 162 and SSA='3'.



Note:

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

When new Pointer position and Picture Data, internal system works as 128x128 and maximum scan address becomes 127 internal of 161.

X=Don't care

Restriction

Since the value of the Vertical Scrolling Start Address is absolute (with reference to the Frame Memory), it must not enter the fixed area (defined by Vertical Scrolling Definition (33h) – otherwise undesirable image will be displayed on the Panel.
SSA[15:0] is based on 1-line unit.
SSA[15:0] =0000h, 0001h, 0002h, 003h, …, 00A1h

<table>
<tr><td>Register Availability</td><td>
<table>
<tr><th>Status</th><th>Availability</th></tr>
<tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr>
<tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr>
<tr><td>Sleep In</td><td>Yes</td></tr>
</table>
</td></tr>
<tr><td>Default</td><td>
<table>
<tr><th>Status</th><th>Default Value</th></tr>
<tr><td>Power On Sequence</td><td>0000h</td></tr>
<tr><td>SW Reset</td><td>0000h</td></tr>
<tr><td>HW Reset</td><td>0000h</td></tr>
</table>
</td></tr>
<tr><td>Flow Chart</td><td>See Vertical Scrolling Definition (33h) description.</td></tr>
</table>

14.2.31 Idle Mode Off (38h)

38H	IDMOFF (Idle Mode Off)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	1	0	0	0	38h
Parameter	NO PARAMETER												
Description	This command is used to recover from Idle mode on. There will be no abnormal visible effect on the display mode change transition. In the Idle off mode 1. LCD can display maximum 4096, 65K, 262K colors. 2. Normal frame frequency is applied. X = don't care												
Restriction	This command has no effect when module is already in idle off mode.												

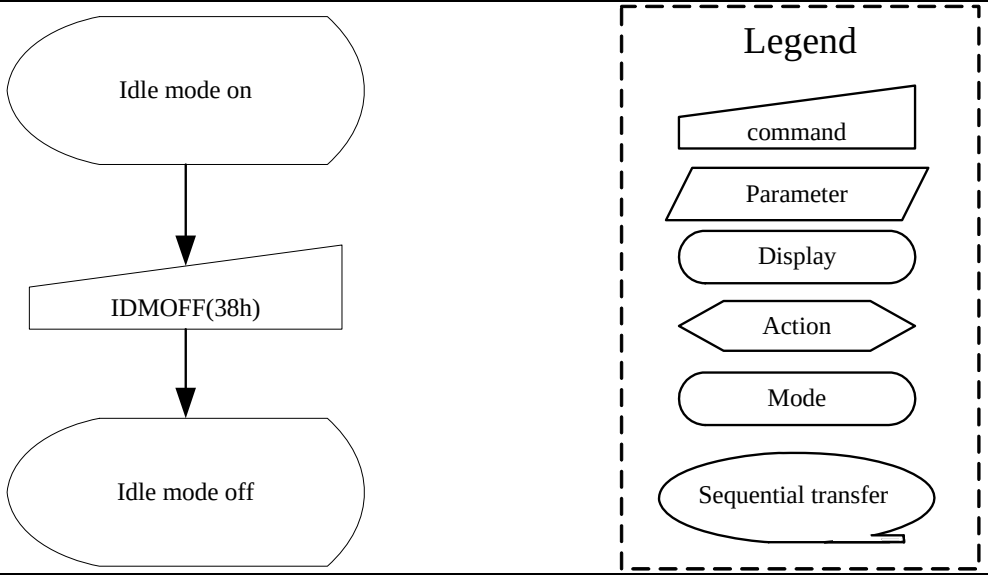
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Idle Mode Off
SW Reset	Idle Mode Off
HW Reset	Idle Mode Off

Flow Chart



14.2.32 Idle Mode On (39h)

39H	IDMON (Idle Mode On)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	1	0	0	1	39h
Parameter	NO PARAMETER												

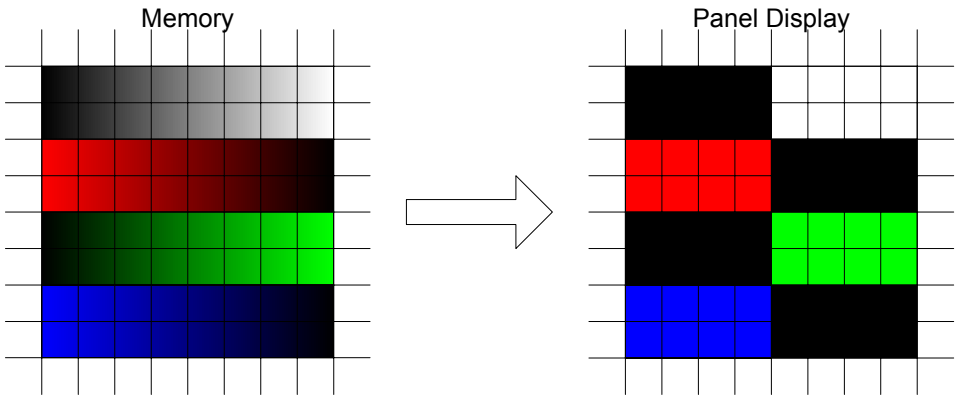
Description

This command is used to enter into Idle mode on.

There will be no abnormal visible effect on the display mode change tranition.

In the Idle mode,

1. Color expression is reduced. The primary and the secondary colors using MSB of each R,G and B in the Frame Memory, 8 color depth data is displayed.
2. 8-Color mode frame frequency is applied.
3. Exit from IDMON by Idle Mode Off(38h) command.



	R5 R4 R3 R2 R1 R0	G5 G4 G3 G2 G1 G0	B5 B4 B3 B2 B1 B0
Black	0XXXXX	0XXXXX	0XXXXX
Blue	0XXXXX	0XXXXX	1XXXXX
Red	1XXXXX	0XXXXX	0XXXXX
Magenta	1XXXXX	0XXXXX	1XXXXX
Green	0XXXXX	1XXXXX	0XXXXX
Cyan	0XXXXX	1XXXXX	1XXXXX
Yellow	1XXXXX	1XXXXX	0XXXXX
White	1XXXXX	1XXXXX	1XXXXX

Restriction

This command has no effect when module is already in idle on mode.

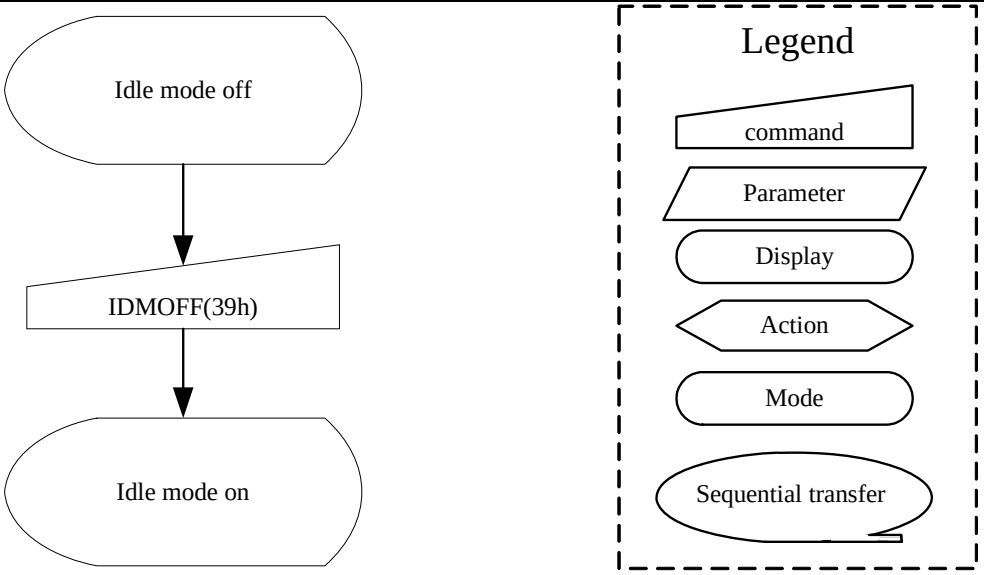
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Idle Mode Off
SW Reset	Idle Mode Off

Flow Chart


Idle mode off
IDMOFF(39h)
Idle mode on
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.33 Interface Pixel Format (3Ah)

39H	IDMON (Idle Mode On)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	0	0	1	1	1	0	1	0	3Ah
1st Parameter	1	1	↑	x					D3	IFPF2	IFPF1	IFPF0	66h

Description

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

Bit	Description	Value
D3		"0" (Not Used)
IFPF2	Control Interface Color Format	"011"=12 bit/pixel
IFPF1		"101"=16 bit/pixel
IFPF0		"110"=18 bit/pixel
		The others = not defined

Note

1. In 12-bits/Pixel, 16-bits/Pixel mode, the LUT is applied to transfer data into the Frame Memory.

X = don't care

Restriction

There is no visible effect until the Frame Memory is written to.

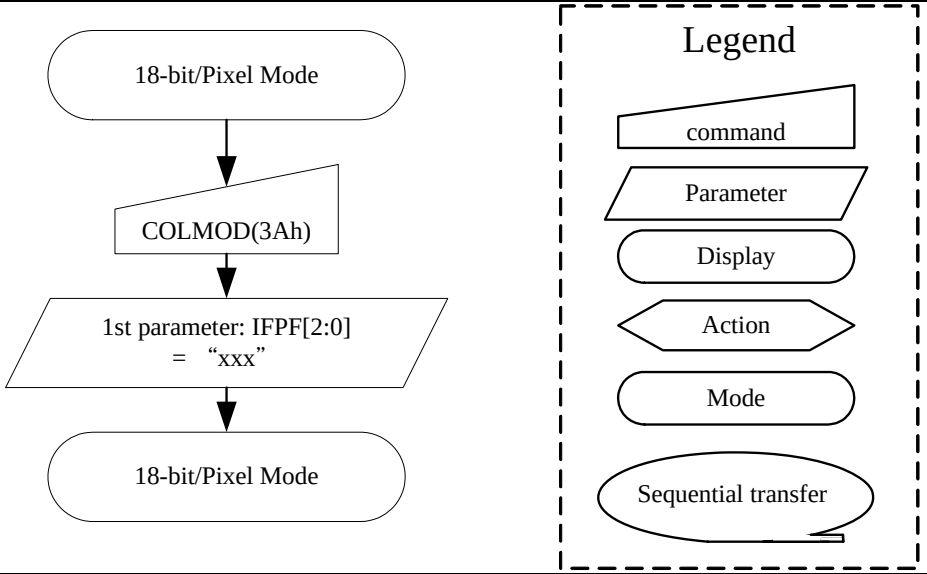
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	18bit/pixel
SW Reset	No change

Flow Chart



14.2.34 Read ID1 (DAh)

DAH	RDID1 (Read ID1)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	1	0	1	0	DAh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10	54h
Description	This read byte return 8-bit LCD module's ID. The 1st parameter is dummy data The 2nd parameter (ID17to ID10): LCD module manufacturer ID X = Don't care												
Restriction													

Register Availability

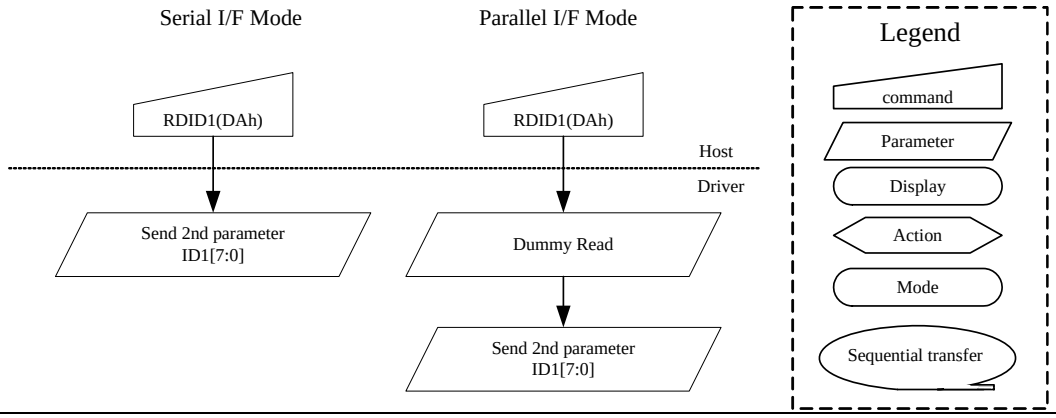
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	54h
SW Reset	54h
HW Reset	54h

Note : ID1 can be modified by metal option

Flow Chart



14.2.35 Read ID2 (DBh)

DBH	RDID2 (Read ID2)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	1	0	1	1	DBh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	1	ID26	ID25	ID24	ID23	ID22	ID21	ID20	80h

Description

This read byte returns 8-bit LCD module/driver version ID

The 1st parameter is dummy data

The 2nd parameter (ID26 to ID20): LCD module/driver version ID

Parameter Range: ID=80h to FFh

Note : See command RDDID(04h), 3rd parameter

D7 to D0	Version	Changes
80h	TBD	TBD
81h	TBD	TBD
82h	TBD	TBD
83h	TBD	TBD
-	TBD	TBD

Restriction

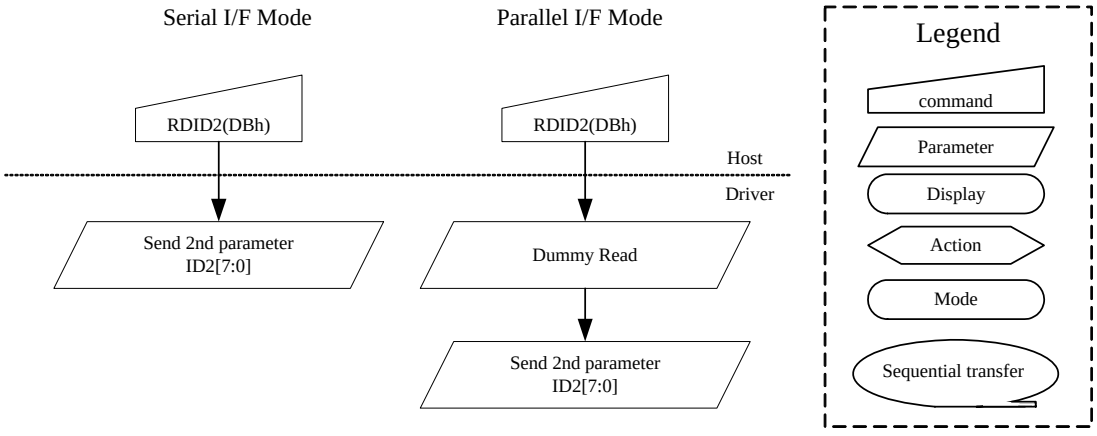
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	See Description
SW Reset	See Description
HW Reset	See Description

Flow Chart



14.2.36 Read ID3 (DCh)

DCH	RDID3 (Read ID3)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	1	1	0	0	DCh
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30	66h
Description	-This read byte return 8-bit LCD module/driver ID -The 1st parameter is dummy data -The 2nd parameter (ID37 to ID30): LCD module/driver ID -Parameter range: ID=00h to FFh Note : See command RDDID(04h)' 4th parameter												
Restriction													

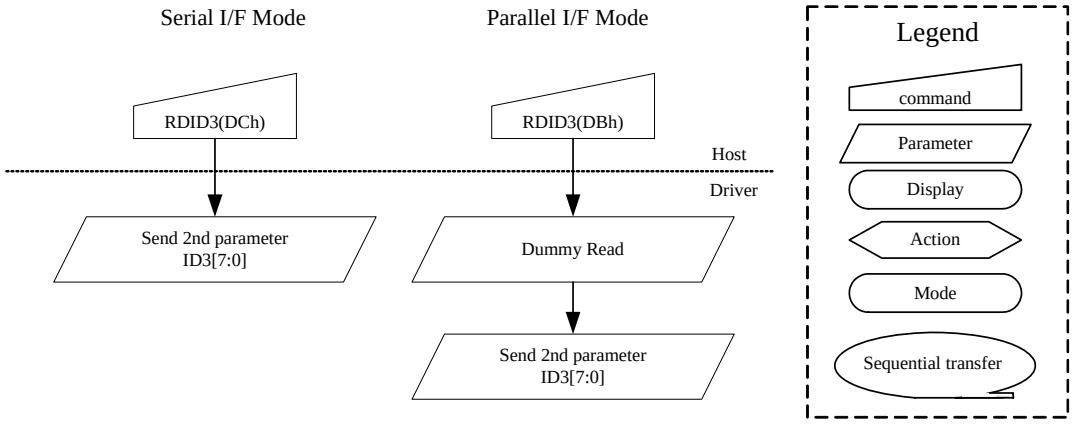
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	66h
SW Reset	66h
HW Reset	66h

Flow Chart



14.2.38 Frame Rate Control(In normal mode/Full colors) (B1h)

B1h	Frame Rate Control(In normal mode/Full colors)											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	0	1	1	0	0	0	1	B1h
1st Parameter	1	1	↑	x	x	x	DIVA4	DIVA3	DIVA2	DIVA1	DIVA0	x
2nd Parameter	1	1	↑	x	x	VPA5	VPA4	VPA3	VPA2	VPA1	VPA0	x

Description

Sets the division ratio for internal clocks of Normal mode at CPU interface mode.

DIVA[4:0]: division ratio for internal clocks when Normal mode.

VPA[5:0]: Vsync porch for internal clocks when Normal mode

$$Frame\_rate = \frac{200kHz}{(Line + VPA[5:0])(DIVA[4:0] + 4)}$$

(1) When GM=101(132*132)

In Normal mode, line=132, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=62.7Hz

(2) When GM=100(130*130)

In Normal mode, line=130, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=63.5Hz

(3) When GM=011(128*160)

In Normal mode, line=160, Default value DIVA[4:0]=14, VPA[5:0]=20, Frame rate=61.7Hz

(4) When GM=010(120*160)

In Normal mode, line=160, Default value DIVA[4:0]=14, VPA[5:0]=20, Frame rate=61.7Hz

(5) When GM=001(128*128)

In Normal mode, line=128, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=64.4Hz

(6) When GM=000(132*162)

In Normal mode, line=162, Default value DIVA[4:0]=14, VPA[5:0]=20, Frame rate=61Hz

Restriction

-

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

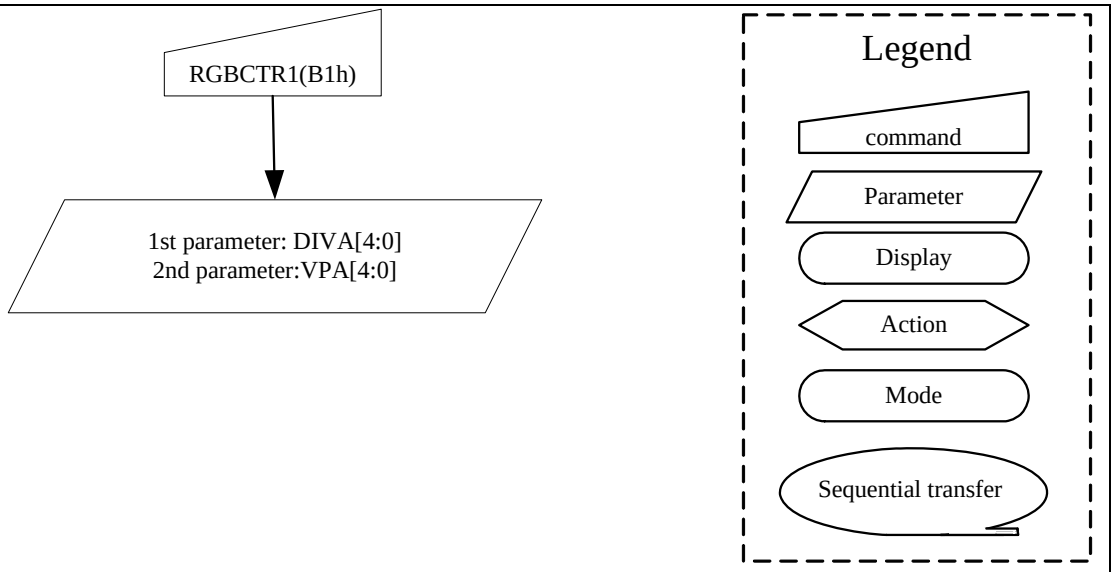
Default

(1) When GM=000(132*162), GM=011(128*160) or GM=010(120*160)

Status	Default Value	
	DIVA[4:0]	VPA[5:0]
Power On Sequence	0Eh/14d	14h/20d
S/W Reset	0Eh/14d	14h/20d
H/W Reset	0Eh/14d	14h/20d

(2) When GM=001(128*128), GM=100(130*130), GM=101(132*132)

Status	Default Value	
	DIVA[4:0]	VPA[5:0]
Power On Sequence	11h/17d	11h/17d
S/W Reset	11h/17d	11h/17d
H/W Reset	11h/17d	11h/17d

Flow Chart	

14.2.39 Frame Rate Control(In Idle mode/8-colors) (B2h)

B2h	Frame Rate Control(In Idle mode/Full colors)											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	0	1	1	0	0	1	0	B2h
1st Parameter	1	1	↑	x	x	x	DIVB4	DIVB3	DIVB2	DIVB1	DIVB0	x
2nd Parameter	1	1	↑	x	x	VPB5	VPB4	VPB3	VPB2	VPB1	VPB0	x

Description

Sets the division ratio for internal clocks of Idle mode at CPU interface mode.

DIVB[4:0]: division ratio for internal clocks when Idle mode.

VPB[5:0]: Vsync porch for internal clocks when Idle mode

$$Frame\_rate = \frac{200kHz}{(Line + VPB[5:0)(DIVB[4:0] + 4)}$$

(1) When GM=101(132*132)

In Normal mode, line=132, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=62.7Hz

(2) When GM=100(130*130)

In Normal mode, line=130, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=63.5Hz

(3) When GM=011(128*160)

In 8-color mode, line=160, Default value DIVB[4:0]=14, VPB[5:0]=20, Frame rate=61.7Hz

(4) When GM=010(120*160)

In 8-color l mode, line=160, Default value DIVB[4:0]=14, VPB[5:0]=20, Frame rate=61.7Hz

(5) When GM=001(128*128)

In 8-color mode, line=128, Default value DIVB[4:0]=17, VPB[5:0]=20, Frame rate=64.4Hz

(6) When GM=000(132*162)

In 8-color mode, line=162, Default value DIVB[4:0]=14, VPB[5:0]=20, Frame rate=61Hz

Restriction	-

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

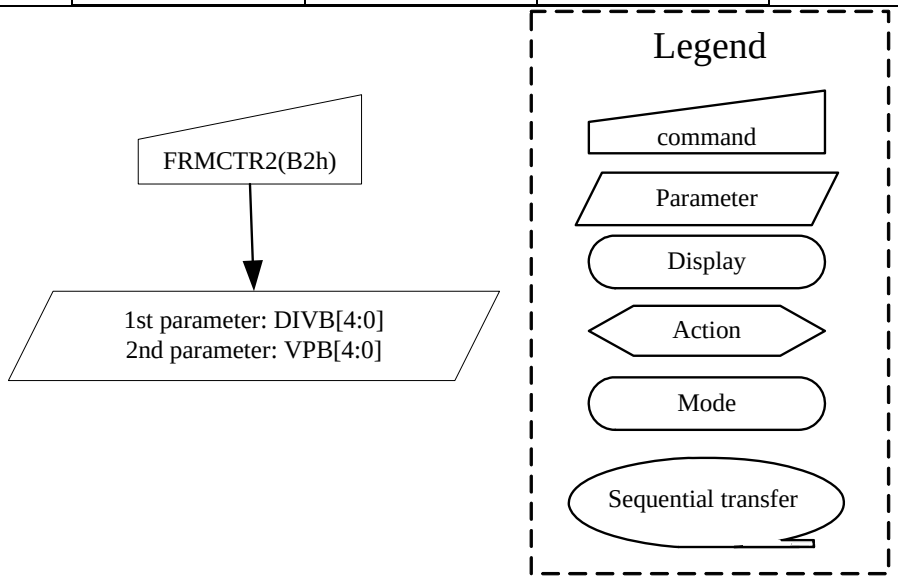
(1) When GM=000(132*162), GM=011(128*160) or GM=010(120*160)

Status	Default Value	
	DIVB[4:0]	VPB[5:0]
Power On Sequence	0Eh/14d	14h/20d
S/W Reset	0Eh/14d	14h/20d
H/W Reset	0Eh/14d	14h/20d

(2) When GM=001(128*128), GM=100(130*130), GM=101(132*132)

Status	Default Value	
	DIVB[4:0]	VPB[5:0]
Power On Sequence	11h/17d	11h/17d
S/W Reset	11h/17d	11h/17d
H/W Reset	11h/17d	11h/17d

Flow Chart



14.2.40 Frame Rate Control(In Partial mode/full colors) (B3h)

B3h	Frame Rate Control(In Partial mode/Full colors)											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	0	1	1	0	0	1	1	B3h
1st Parameter	1	1	↑	x	x	x	DIVC4	DIVC3	DIVC2	DIVC1	DIVC0	x
2nd Parameter	1	1	↑	x	x	VPC5	VPC4	VPC3	VPC2	VPC1	VPC0	x

Description

Sets the division ratio for internal clocks of Partial mode at CPU interface mode.

DIVB[4:0]: division ratio for internal clocks when Partial mode.

VPB[5:0]: Vsync porch for internal clocks when Partial mode

$$Frame\_rate = \frac{200kHz}{(Line + VPC[5:0])(DIVC[4:0] + 4)}$$

(1) When GM=101(132*132)

In Normal mode, line=132, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=62.7Hz

(2) When GM=100(130*130)

In Normal mode, line=130, Default value DIVA[4:0]=17, VPA[5:0]=20, Frame rate=63.5Hz

(3) When GM=011(128*160)

In Partial mode, line=160, Default value DIVC[4:0]=14, VPC[5:0]=20, Frame rate=61.7Hz

(4) When GM=010(120*160)

In Partial mode, line=160, Default value DIVC[4:0]=14, VPC[5:0]=20, Frame rate=61.7Hz

(5) When GM=001(128*128)

In Partial mode, line=128, Default value DIVC[4:0]=17, VPC[5:0]=20, Frame rate=64.4Hz

(6) When GM=000(132*162)

In Partial mode, line=162, Default value DIVC[4:0]=14, VPC[5:0]=20, Frame rate=61Hz

Restriction

-

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

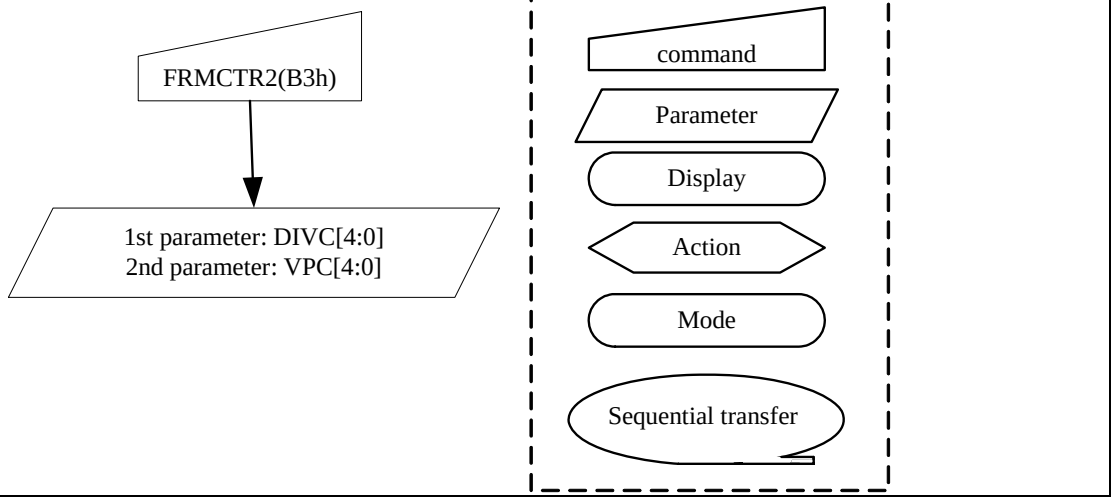
Default

(1) When GM=000(132*162), GM=011(128*160) or GM=010(120*160)

Status	Default Value	
	DIVC4:0]	VPC[5:0]
Power On Sequence	0Eh/14d	14h/20d
S/W Reset	0Eh/14d	14h/20d
H/W Reset	0Eh/14d	14h/20d

(3) When GM=001(128*128), GM=100(130*130), GM=101(132*132)

Status	Default Value	
	DIVB[4:0]	VPB[5:0]
Power On Sequence	11h/17d	11h/17d
S/W Reset	11h/17d	11h/17d
H/W Reset	11h/17d	11h/17d

Flow Chart	 FRMCTR2(B3h) 1st parameter: DIVC[4:0] 2nd parameter: VPC[4:0] Legend command Parameter Display Action Mode Sequential transfer

14.2.41 Display Inversion Control (B4h)

B4h	Display Inversion Control												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	0	1	1	0	1	0	0	B4h
1st Parameter	1	1	↑	x	0	0	0	0	0	NLA	NLB	NLC	02H

Description

-Display Inversion mode control

-NLA: Inversion setting in full colors normal mode(Normal mode on)

NLA	Inversion setting in full colors normal mode
0	Line Inversion
1	Frame Inversion

-NLB: Inversion setting in Idle mode(Idle mode on)

NLA	Inversion setting in Idle mode
0	Line Inversion
1	Frame Inversion

-NLC: Inversion setting in full colors partial mode(Partial mode on/Idle mode off)

NLA	Inversion setting in full colors partial mode
0	Line Inversion
1	Frame Inversion

Restriction: If this register not using the register need be reserved.

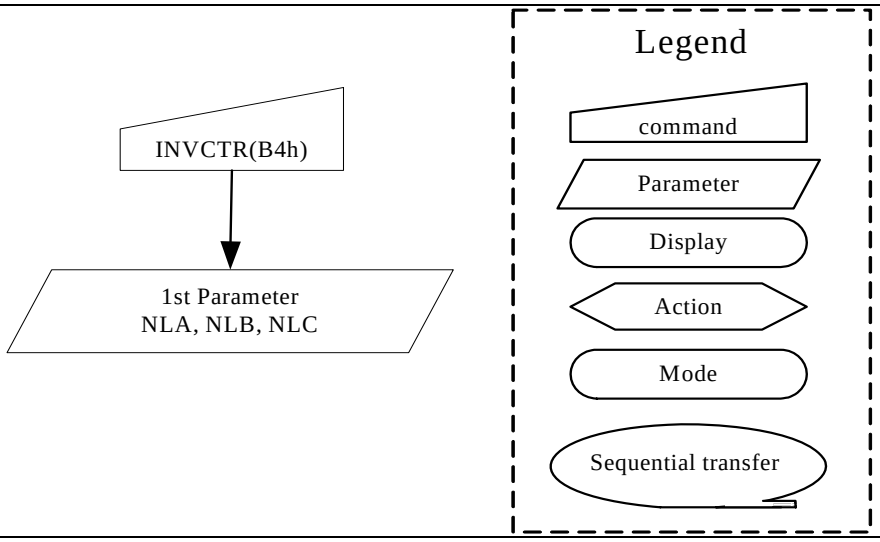
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value			
	NLA	NLB	NLC	D7-0
Power On Sequence	0d	1d	0d	02h
S/W Reset	0d	1d	0d	02h
H/W Reset	0d	1d	0d	02h

Flow Chart



14.2.44 Source Driver Direction Control (B7h)

B7h	Display Inversion Control												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	0	1	1	0	1	1	1	B7h
1st	1	1	↑	x	0	0	0	0	0	0	0	CRL	00h

Description

-CRL: Source output direction select register

CRL	Module source output direction					
	GM='101'	GM='100'	GM='011'	GM='010'	GM='001'	GM='000'
0	S1 -> S396	S7 -> S396	S7 -> S390	S7 -> S366	S7 -> S390	S1 -> S396
1	S1 -> S396	S396 -> S7	S390 ->S7	S366 -> S7	S390 -> S7	S396 -> S1

Restriction

If this register not using the register need be reserved.

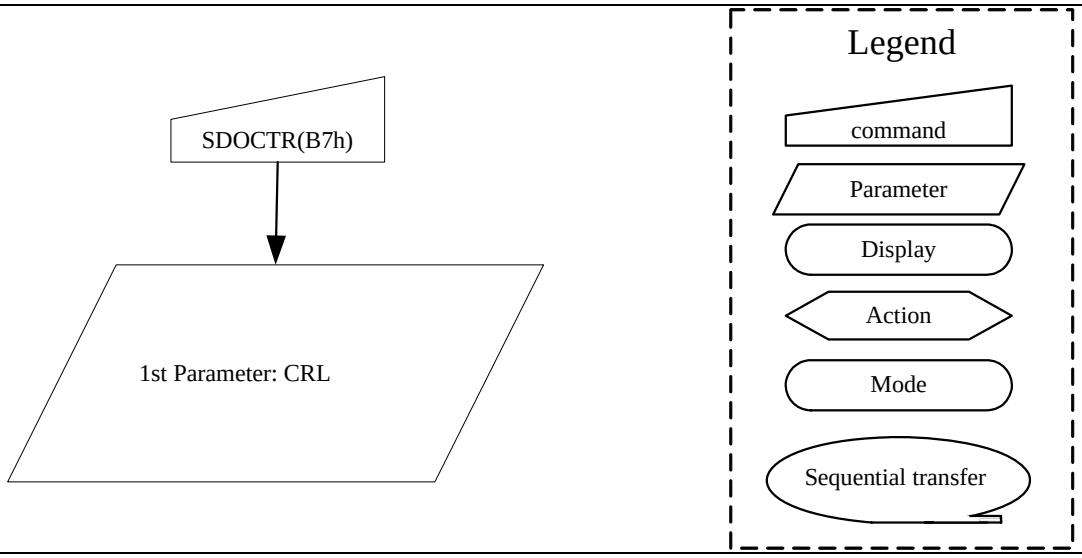
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
	CRL
Power On Sequence	0d
S/W Reset	0d
H/W Reset	0d

Flow Chart



14.2.45 Gate Driver Direction Control (B8h)

B8h	Display Inversion Control												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	0	1	1	1	0	0	0	B8h
1st	1	1	↑	x	0	0	0	0	0	0	0	CTB	00h

Description

-CTB: Gate output direction select register

CTB	Module gate output direction				
	GM='101'	GM='100'	GM='011','010'	GM='011'	GM='000'
0	G2 -> G133	G2 -> G131	G2 -> G161	G2 -> G129	G1 -> G162
1	G133 -> G2	G131 -> G2	G161 ->G2	G129 -> G2	G162 -> G1

Restriction

If this register not using the register need be reserved.

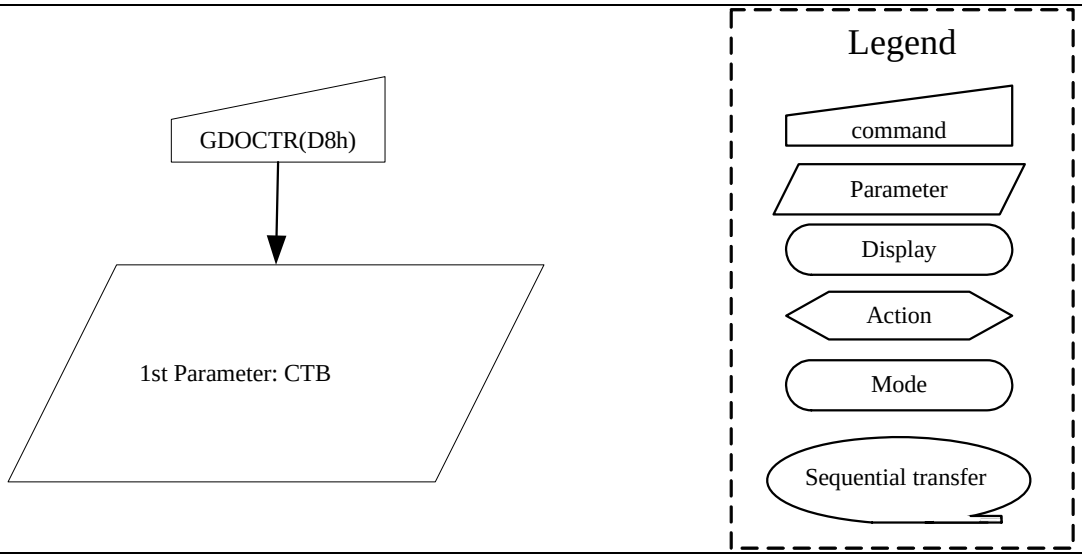
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
	CRL
Power On Sequence	0d
S/W Reset	0d
H/W Reset	0d

Flow Chart



14.2.46 Power_Control1 (C0h)

C0H	Power_Control1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	0	0	0	C0h
1st Parameter	1	1	↑	x	0	0	0	VRH4	VRH3	VRH2	VRH1	VRH0	x
2nd Parameter	1	1	↑	x	0	0	0	0	0	VC2	VC1	VC0	02h

Description

Set the GVDD and voltage

VRH[4:0]		GVDD
00000	0	5.00
00001	1	4.75
00010	2	4.70
00011	3	4.65
00100	4	4.60
00101	5	4.55
00110	6	4.50
00111	7	4.45
01000	8	4.40
01001	9	4.35
01010	10	4.30
01011	11	4.25
01100	12	4.20
01101	13	4.15
01110	14	4.10
01111	15	4.05
10000	16	4.00
10001	17	3.95
10010	18	3.90
10011	19	3.85
10100	20	3.80
10101	21	3.75
10110	22	3.70
10111	23	3.65
11000	24	3.60
11001	25	3.55
11010	26	3.50
11011	27	3.45
11100	28	3.40
11101	29	3.35
11110	30	3.25
11111	31	3.00

VC[2:0]		VCI1
000	0	2.75
001	1	2.70
010	2	2.65
011	3	2.60
100	4	2.55
101	5	2.50
110	6	2.45
111	7	2.40

Restriction

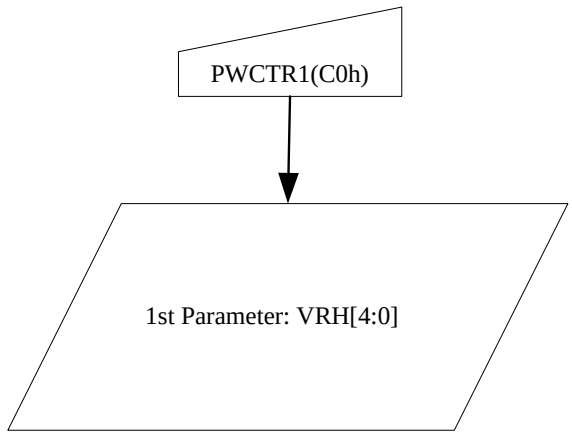
Register Availability

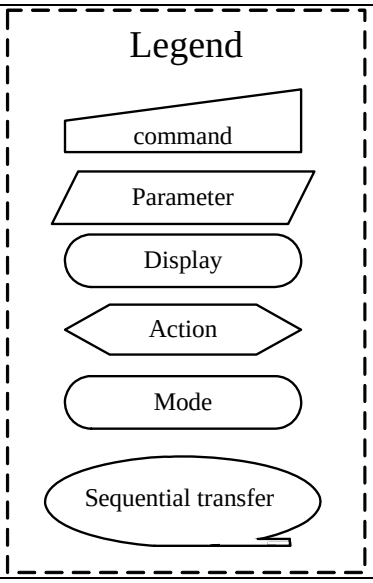
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value			
	LCM="00"	LCM="01"	LCM="10"	LCM="11"
	TN-TR LCD	TN-TM LCD	TN-TM LC Type2	MVA-TR LCD
	VRH[4:0]/VC[2:0]	VRH[4:0]/VC[2:0]	VRH[4:0]/VC[2:0]	VRH[4:0]/VC[2:0]
Power On Sequence	21d/2d	5d/2d	10d/5d	1d/2d
SW Reset	21d/2d	5d/2d	10d/5d	1d/2d
HW Reset	21d/2d	5d/2d	10d/5d	1d/2d

Flow Chart


PWCTR1(C0h)
1st Parameter: VRH[4:0]


Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.47 Power_Control2 (C1h)

C1H	Power_Control2												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	0	0	1	C1h
1st Parameter	1	1	↑	x	0	0	0	0	0	BT2	BT1	BT0	07h

Description

Set the AVDD, VCL, VGH and VGL supply power level.

BT[2:0]		AVDD	VCL	VGH	VGL
000	0	2xVCI1	-1xVCI1	4xVCI1	-3xVCI1
001	1	2xVCI1	-1xVCI1	4xVCI1	-4xVCI1
010	2	2xVCI1	-1xVCI1	5xVCI1	-3xVCI1
011	3	2xVCI1	-1xVCI1	5xVCI1	-4xVCI1
100	4	2xVCI1	-1xVCI1	5xVCI1	-5xVCI1
101	5	2xVCI1	-1xVCI1	6xVCI1	-3xVCI1
110	6	2xVCI1	-1xVCI1	6xVCI1	-4xVCI1
111	7	2xVCI1	-1xVCI1	6xVCI1	-5xVCI1

Restriction

If this register not using the register need be reserved.
The deviation value of VGH/VGL between with Measurement and Specification
VGH-VGL <= 32V

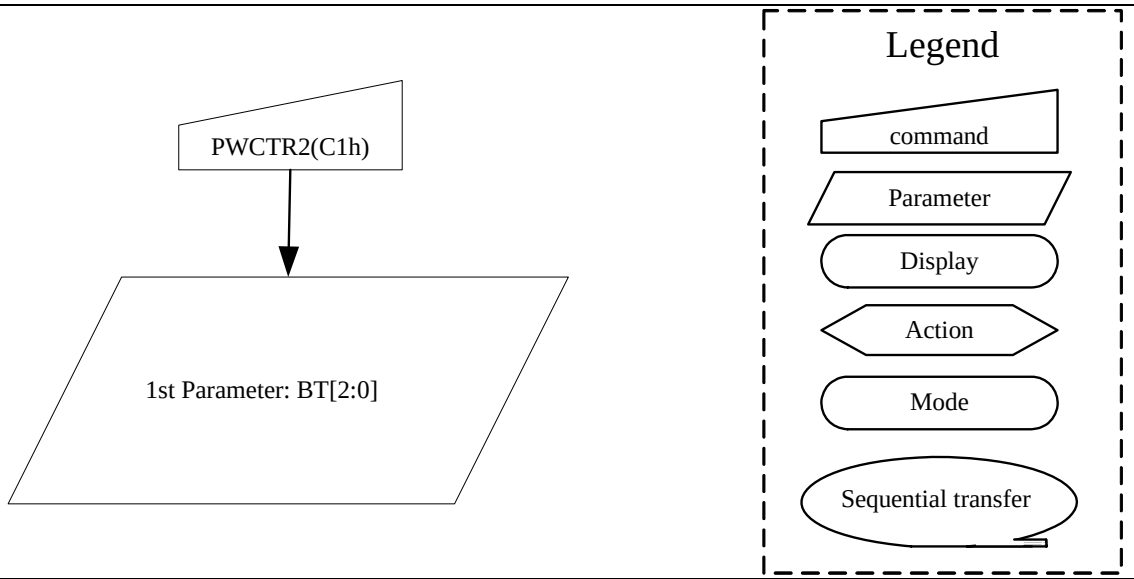
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
	BT[2:0]
Power On Sequence	7d
SW Reset	7d
HW Reset	7d

Flow Chart



14.2.48 Power_Control3 (C2h)

C2H	Power_Control3												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	0	1	0	C2h
1st Parameter	1	1	↑	x	0	0	0	0	0	APA2	APA1	APA0	00h
2nd Parameter	1	1	↑	x	0	0	0	0	0	DCA2	DCA1	DCA0	06h

Description

Set the amount of current in Operation amplifier in normal mode/full colors.

Adjust the amount of fixed current from the fixed current sources in the operational amplifier for the source driver.

APA[2:0]		Amount of Current in Operational Amplifier
000	0	Least
001	1	Small
010	2	Medium Low
011	3	Medium
100	4	Medium High
101	5	Large
110	6	Reserved
111	7	Reserved

Set the Booster circuit Step-up cycle in Normal mode/full colors

DC=A[2:0]		Step-up cycle in Booster circuit 1	Step-up cycle in Booster circuit 2,3
000	0	BCLK/1	BCLK/4
001	1	BCLK/1	BCLK/8
010	2	BCLK/1	BCLK/8
011	3	BCLK/2	BCLK/16
100	4	BCLK/2	BCLK/16
101	5	BCLK/4	BCLK/32
110	6	BCLK/4	BCLK/64
111	7	BCLK/8	BCLK/64

Note: BCLK is Clock frequency for Booster circuit.

Restriction: If some parameter of the register is not use the register need to be reserved.

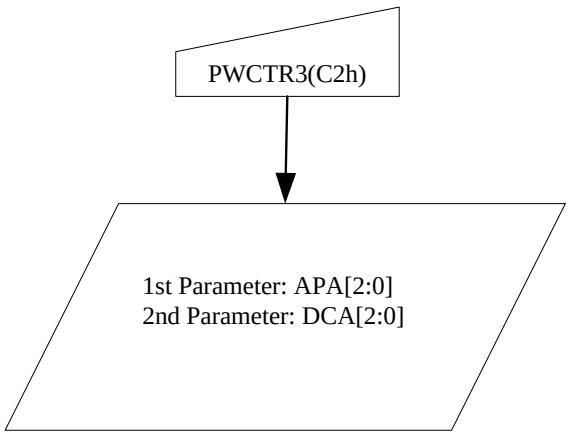
Register Availability

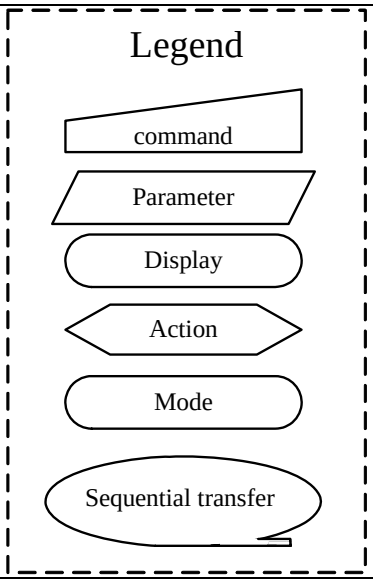
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value	
	APA[2:0]	DCA[2:0]
Power On Sequence	0d	6d
SW Reset	0d	6d
HW Reset	0d	6d

Flow Chart


PWCTR3(C2h)
1st Parameter: APA[2:0]
2nd Parameter: DCA[2:0]


Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.49 Power_Control4 (C3h)

C3H	Power_Control4(in Idle mode/8 colors)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	0	1	1	C3h
1st Parameter	1	1	↑	x	0	0	0	0	0	APB2	APB1	APB0	00h
2nd Parameter	1	1	↑	x	0	0	0	0	0	DCB2	DCB1	DCB0	07h

Description

Set the amount of current in Operational amplifier in Idle mode/8-colors

Adjust the amount of fixed current from the fixed current source in the operational amplifier for the source driver.

APA[2:0]		Amount of Current in Operational Amplifier
000	0	Least
001	1	Small
010	2	Medium Low
011	3	Medium
100	4	Medium High
101	5	Large
110	6	Reserved
111	7	Reserved

Set the Booster circuit Step-up cycle in Normal mode/full colors

DC=A[2:0]		Step-up cycle in Booster circuit 1	Step-up cycle in Booster circuit 2,3
000	0	BCLK/1	BCLK/4
001	1	BCLK/1	BCLK/8
010	2	BCLK/1	BCLK/8
011	3	BCLK/2	BCLK/16
100	4	BCLK/2	BCLK/16
101	5	BCLK/4	BCLK/32
110	6	BCLK/4	BCLK/64
111	7	BCLK/8	BCLK/64

Note: BCLK is Clock frequency for Booster circuit

Restriction

If some parameter of the register not use the register need to be reserved.

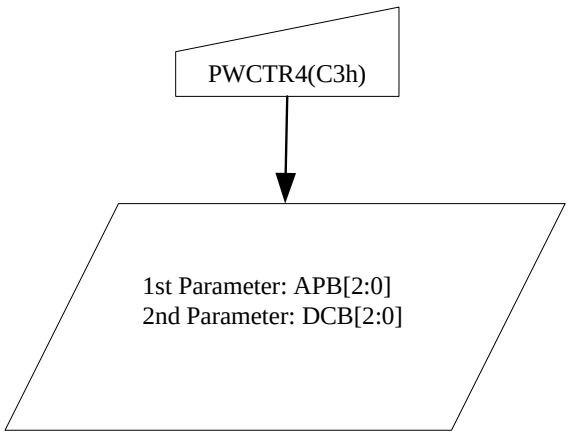
Register Availability

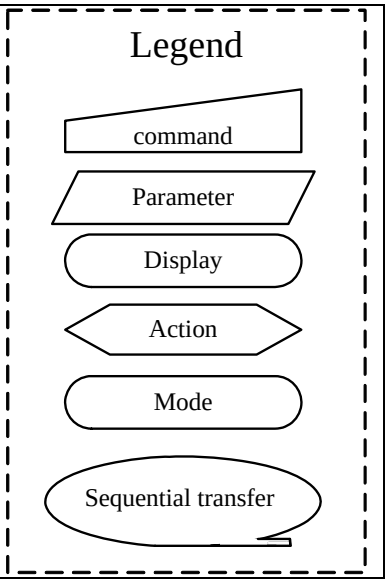
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value	
	APB[2:0]	DCB[2:0]
Power On Sequence	0d	7d
SW Reset	0d	7d
HW Reset	0d	7d

Flow Chart


PWCTR4(C3h)
1st Parameter: APB[2:0]
2nd Parameter: DCB[2:0]


Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.50 Power_Control 5 (C4h)

C4H	Power_Control_5(in Partial mode/full mode)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	1	0	0	C4h
1st Parameter	1	1	↑	x	0	0	0	0	0	APC2	APC1	APC1	01h
2nd Parameter	1	1	↑	x	0	0	0	0	0	DCC2	DCC1	DCC0	07h

Description

Set the amount of current in Operational amplifier in Partial mode/full-colors

Adjust the amount of fixed current from the fixed current source in the operational amplifier for the source driver.

APA[2:0]		Amount of Current in Operational Amplifier
000	0	Least
001	1	Small
010	2	Medium Low
011	3	Medium
100	4	Medium High
101	5	Large
110	6	Reserved
111	7	Reserved

Set the Booster circuit Step-up cycle in Normal mode/full colors

DC=A[2:0]		Step-up cycle in Booster circuit 1	Step-up cycle in Booster circuit 2,3
000	0	BCLK/1	BCLK/4
001	1	BCLK/1	BCLK/8
010	2	BCLK/1	BCLK/8
011	3	BCLK/2	BCLK/16
100	4	BCLK/2	BCLK/16
101	5	BCLK/4	BCLK/32
110	6	BCLK/4	BCLK/64
111	7	BCLK/8	BCLK/64

Note: BCLK is Clock frequency for Booster circuit

Restriction

If some parameter of the register not use the register need to be reserved.

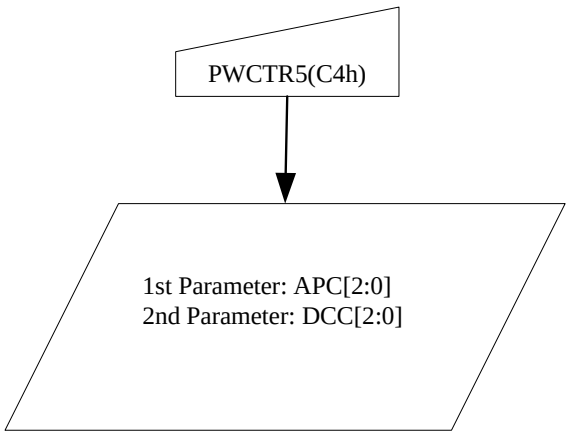
Register Availability

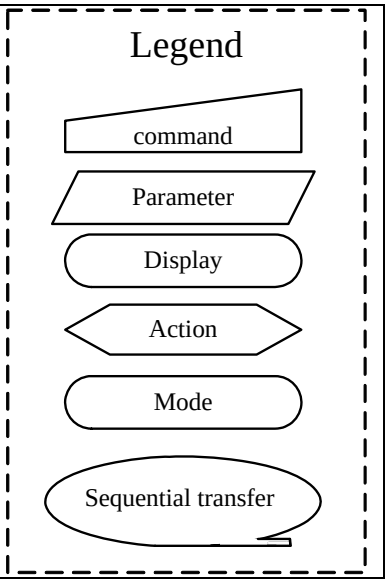
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value	
	APB[2:0]	DCC[2:0]
Power On Sequence	1d	7d
SW Reset	1d	7d
HW Reset	1d	7d

Flow Chart


PWCTR5(C4h)
1st Parameter: APC[2:0]
2nd Parameter: DCC[2:0]


Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.51 VCOM_Control 1 (C5h)

C5H	VCOM_Control1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	1	0	1	C5h
1st Parameter	1	1	↑	x	x	VMH6	VMH5	VMH4	VMH3	VMH2	VMH1	VMH0	-
2nd Parameter	1	1	↑	x	0	VML6	VML5	VML4	VML3	VML2	VML1	VML0	-

Description

Set VCOMH Voltage

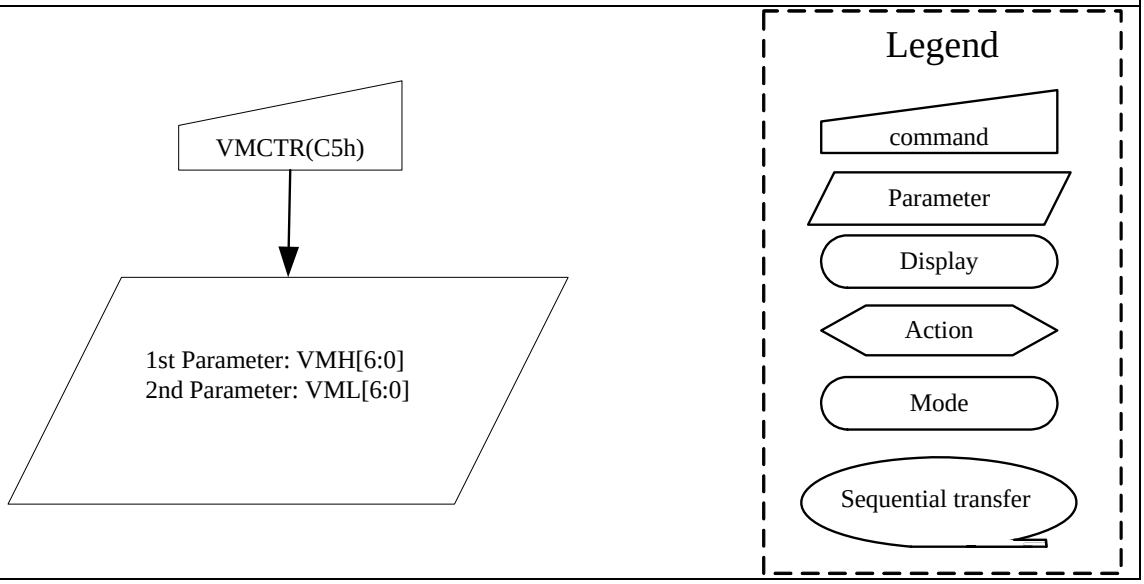
VMH[6:0]		VCOMH	VMH[6:0]		VCOMH	VMH[6:0]		VCOMH	VMH[6:0]		VCOMH
0000000	0	2.500	0011011	27	3.175	0110110	54	3.850	1010001	81	4.525
0000001	1	2.525	0011100	28	3.200	0110111	55	3.875	1010010	82	4.550
0000010	2	2.550	0011101	29	3.225	0111000	56	3.900	1010011	83	4.575
0000011	3	2.575	0011110	30	3.250	0111001	57	3.925	1010100	84	4.600
0000100	4	2.600	0011111	31	3.275	0111010	58	3.950	1010101	85	4.625
0000101	5	2.625	0100000	32	3.300	0111011	59	3.975	1010110	86	4.650
0000110	6	2.650	0100001	33	3.325	0111100	60	4.000	1010111	87	4.675
0000111	7	2.675	0100010	34	3.350	0111101	61	4.025	1011000	88	4.700
0001000	8	2.700	0100011	35	3.375	0111110	62	4.050	1011001	89	4.725
0001001	9	2.725	0100100	36	3.400	0111111	63	4.075	1011010	90	4.750
0001010	10	2.750	0100101	37	3.425	1000000	64	4.100	1011011	91	4.775
0001011	11	2.775	0100110	38	3.450	1000001	65	4.125	1011100	92	4.800
0001100	12	2.800	0100111	39	3.475	1000010	66	4.150	1011101	93	4.825
0001101	13	2.825	0101000	40	3.500	1000011	67	4.175	1011110	94	4.850
0001110	14	2.850	0101001	41	3.525	1000100	68	4.200	1011111	95	4.875
0001111	15	2.875	0101010	42	3.550	1000101	69	4.225	1100000	96	4.900
0010000	16	2.900	0101011	43	3.575	1000110	70	4.250	1100001	97	4.925
0010001	17	2.925	0101100	44	3.600	1000111	71	4.275	1100010	98	4.950
0010010	18	2.950	0101101	45	3.625	1001000	72	4.300	1100011	99	4.975
0010011	19	2.975	0101110	46	3.650	1001001	73	4.325	1100100	100	5.000
0010100	20	3.000	0101111	47	3.675	1001010	74	4.350	1100101	101	
0010101	21	3.025	0110000	48	3.700	1001011	75	4.375			Not Permitted
0010110	22	3.050	0110001	49	3.725	1001100	76	4.400	01111111	127	
0010111	23	3.075	0110010	50	3.750	1001101	77	4.425			
0011000	24	3.100	0110011	51	3.775	1001110	78	4.450			
0011001	25	3.125	0110100	52	3.800	1001111	79	4.475			
0011010	26	3.150	0110101	53	3.825	1010000	80	4.500			

-Set VCOML Voltage

VML[6:0]		VCOML	VML[6:0]		VCOML	VML[6:0]		VCOML	VML[6:0]		VCOML
0000000	0	-2.500	0011011	27	-1.825	0110110	54	-1.150	1010001	81	-0.475
0000001	1	-2.475	0011100	28	-1.800	0110111	55	-1.125	1010010	82	-0.450
0000010	2	-2.450	0011101	29	-1.775	0111000	56	-1.100	1010011	83	-0.425
0000011	3	-2.425	0011110	30	-1.750	0111001	57	-1.075	1010100	84	-0.400
00000100	4	-2.400	0011111	31	-1.725	0111010	58	-1.050	1010101	85	-0.375
0000101	5	-2.375	0100000	32	-1.700	0111011	59	-1.025	1010110	86	-0.350
0000110	6	-2.350	0100001	33	-1.675	0111100	60	-1.000	1010111	87	-0.325
0000111	7	-2.325	0100010	34	-1.650	0111101	61	-0.975	1011000	88	-0.300
0001000	8	-2.300	0100011	35	-1.625	0111110	62	-0.950	1011001	89	-0.275
0001001	9	-2.275	0100100	36	-1.600	0111111	63	-0.925	1011010	90	-0.250
0001010	10	-2.250	0100101	37	-1.575	1000000	64	-0.900	1011011	91	-0.225
0001011	11	-2.225	0100110	38	-1.550	1000001	65	-0.875	1011100	92	-0.200
0001100	12	-2.200	0100111	39	-1.525	1000010	66	-0.850	1011101	93	-0.175
0001101	13	-2.175	0101000	40	-1.500	1000011	67	-0.825	1011110	94	-0.150
0001110	14	-2.150	0101001	41	-1.475	1000100	68	-0.800	1011111	95	-0.125
0001111	15	-2.125	0101010	42	-1.450	1000101	69	-0.775	1100000	96	-0.100
0010000	16	-2.100	0101011	43	-1.425	1000110	70	-0.750	1100001	97	-0.075
0010001	17	-2.075	0101100	44	-1.400	1000111	71	-0.725	1100010	98	-0.050
0010010	18	-2.050	0101101	45	-1.375	1001000	72	-0.700	1100011	99	-0.025
0010011	19	-2.025	0101110	46	-1.350	1001001	73	-0.675	1100100	100	0.000
0010100	20	-2.000	0101111	47	-1.325	1001010	74	-0.650	1100101	101	
0010101	21	-1.975	0110000	48	-1.300	1001011	75	-0.625			Not Permitted
0010110	22	-1.950	0110001	49	-1.275	1001100	76	-0.600	1111111	127	
0010111	23	-1.925	0110010	50	-1.250	1001101	77	-0.575			
0011000	24	-1.900	0110011	51	-1.225	1001110	78	-0.550			
0011001	25	-1.875	0110100	52	-1.200	1001111	79	-0.525			
0011010	26	-1.850	0110101	53	-1.175	1010000	80	-0.500			

Restriction

-If this register not using the register need be reserved.
-The VCOM amplitude: VCOMH-VCOML <=5.5V
-The deviation value of VCOMH/VCOML between with Measurement and Specification: Max <=25mV
-The deviation value of VCOMAC between with Measurement and Specification: Max <= 50mV

Register Availability	<table><tr><th>Status</th><th>Availability</th></tr><tr><td>Normal Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Normal Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode Off, Sleep Out</td><td>Yes</td></tr><tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>Yes</td></tr><tr><td>Sleep In</td><td>Yes</td></tr></table>
Default	<table><tr><th rowspan="2">Status</th><th colspan="5">Default Value</th></tr><tr><th>nVM</th><th>LCM=”00” TN-TR LC type VMH[6:0]/VML[6:0</th><th>LCM=”01” TN-TM LC type VMH[6:0]/VML[6:0</th><th>LCM=”10” TN-TM LC type2 VMH[6:0]/VML[6:0</th><th>LCM=”11” MVA-TR LC type VMH[6:0]/VML[6:0</th></tr><tr><td>Power On Sequence</td><td>0d</td><td>37d/45d</td><td>79d/77d</td><td>67d/77d</td><td>60d/54d</td></tr><tr><td>SW Reset</td><td>0d</td><td>37d/45d</td><td>79d/77d</td><td>67d/77d</td><td>60d/54d</td></tr><tr><td>HW Reset</td><td>0d</td><td>37d/45d</td><td>79d/77d</td><td>67d/77d</td><td>60d/54d</td></tr></table>
Flow Chart	

14.2.52 VCOM_Control 2 (C6h)

C6H	VCOM_Control2												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	1	1	0	C6h
1st Parameter	1	1	↑	x	0	0	VMA5	VMA4	VMA3	VMA2	VMA1	VMA0	13h/06h
Description	-Set VCOMAC Voltage In this case, these registers don’t be used.												
Restriction	-												
Register Availability	-												
Default	-												

14.2.53 VCOM Offset Control (C7h)

C7H	VCOM Offset Control												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	0	0	1	1	1	C7h
1st Parameter	1	1	↑	0	nVM*	VMF6	VMF5	VMF4	VMF3	VMF2	VMF1	VMF0	40h

Description

-Set VCOMH Voltage

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

If "VMH"+xd or "VML"+xd is less than 0d, it becomes 0d

If "VMH"+xd or "VML"+xd is large than 100d, it becomes 100d

VMF[5:0] are stored in NV memoy to contrast

-Select the VMF[6:0]value

nVM	VMF[6:0] value
0	VCOM offset value from NV memory
1	VCOM offset value in the VMF[6:0] registers

Restriction

-If this register not use the register need be reserved.
-To control the VCOM output voltage with VMF[5::0] command, nVM parameter should be set '1'

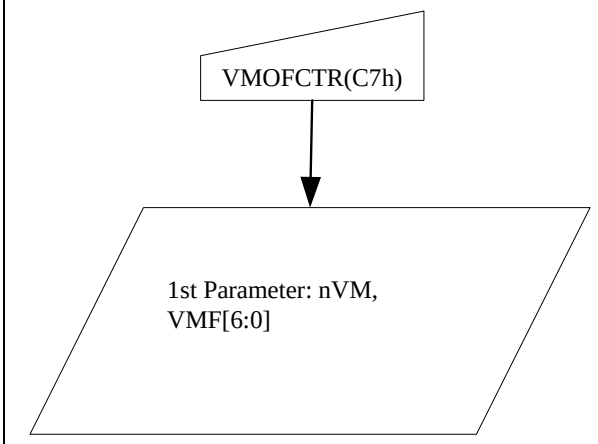
Register Availability

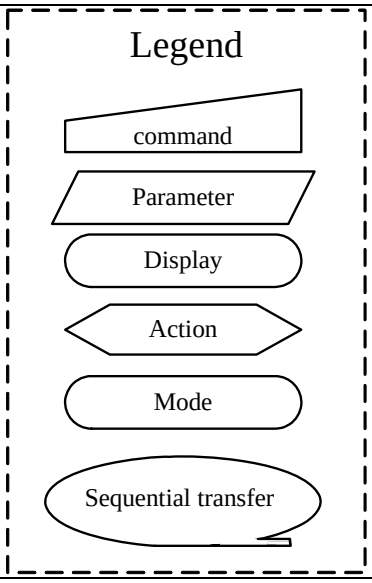
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value VMF[6:0]
Power On Sequence	40h
SW Reset	40h
HW Reset	40h

Flow Chart


VMOFCTR(C7h)
1st Parameter: nVM,
VMF[6:0]


Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.54 Write ID4 Value (D3h)

D3H	Read the ID4 value												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	0	0	1	1	D3h
1st Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x
2nd Parameter	1	↑	1	x	ID417	ID416	ID415	ID414	ID413	ID412	ID411	ID410	01h
3rd Parameter	1	↑	1	x	ID427	ID426	ID425	ID424	ID423	ID422	ID421	ID420	21h
4th Parameter	1	↑	1	x	x	x	x	x	ID433	ID432	ID431	ID430	x
5th Parameter	1	↑	1	x	x	x	x	x	x	x	x	x	x

Description

-Read the Driver IC information from mask value.
-Ignored the EXTC pin.
-The 1st parameter is dummy data
-The 2nd parameter ID41[7:0] is Driver IC ID code. (Default value=01h)
-The value be defined later
-Currently, “01h”, “02h”, “03h”, “05h” can’t be used.
-The 3rd parameter ID42[7:0] is Driver IC Part number ID. (The code be define by Driver IC Vendor, and default value=21h)
-The 4th parameter ID43[7:0] is Driver IC version ID
-When the Driver maker modifies any function it should be modify the parameters at this ID code before sample out also.
-If Driver Maker don’t need 2 parameter if can’t reduce to one parameter.
-If the parameters are not enough Driver makers can add or reduce yourself

Restriction

-

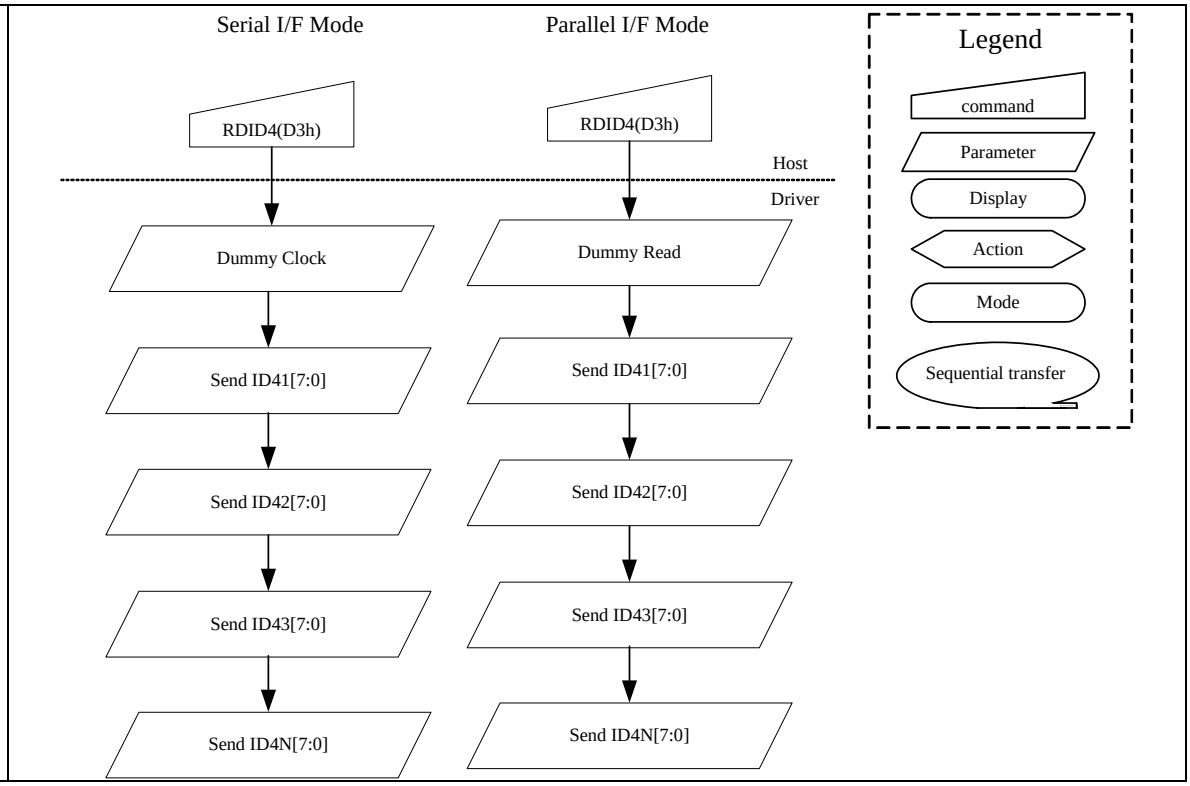
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value		
	ID41[7:0]	ID42[7:0]	ID43[7:0]
Power On Sequence	01h	21h	TBD
SW Reset	01h	21h	TBD
HW Reset	01h	21h	TBD

Flow Chart


Serial I/F Mode
Parallel I/F Mode
RDID4(D3h)
RDID4(D3h)
Host
Driver
Dummy Clock
Dummy Read
Send ID41[7:0]
Send ID41[7:0]
Send ID42[7:0]
Send ID42[7:0]
Send ID43[7:0]
Send ID43[7:0]
Send ID4N[7:0]
Send ID4N[7:0]
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.55 NV Memory Function Controller (D7h)

D7H	NV Memory Function Controller1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	1	0	1	0	D7h
1st Parameter	1	1	↑	x	0	1	0	1	0	1	0	1	55h
2nd Parameter	1	1	↑	x	1	0	1	0	1	0	1	0	AAh
3rd Parameter	1	1	↑	x	0	1	1	0	0	1	1	0	66h
Description	MTP write EPWRITE commend Please see MTP Access sequence for program(Data write) for more detail												
Register Availability													

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	N/A
SW Reset	N/A
HW Reset	N/A

Flow Chart

14.2.56 NV Memory Function Controller 2(DEh)

DEH	NV Memory Function Controller 2												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	x	1	1	0	1	1	0	1	0	DEh
1st Parameter	1	1	↑	x	0	1	0	1	0	1	0	1	55h
2nd Parameter	1	1	↑	x	1	0	1	0	1	0	1	0	AAh
3rd Parameter	1	1	↑	x	0	1	1	0	0	1	1	0	66h
Description	MTP write EPWRITE command Please see MTP Access sequence for program(Data write) for more detail												

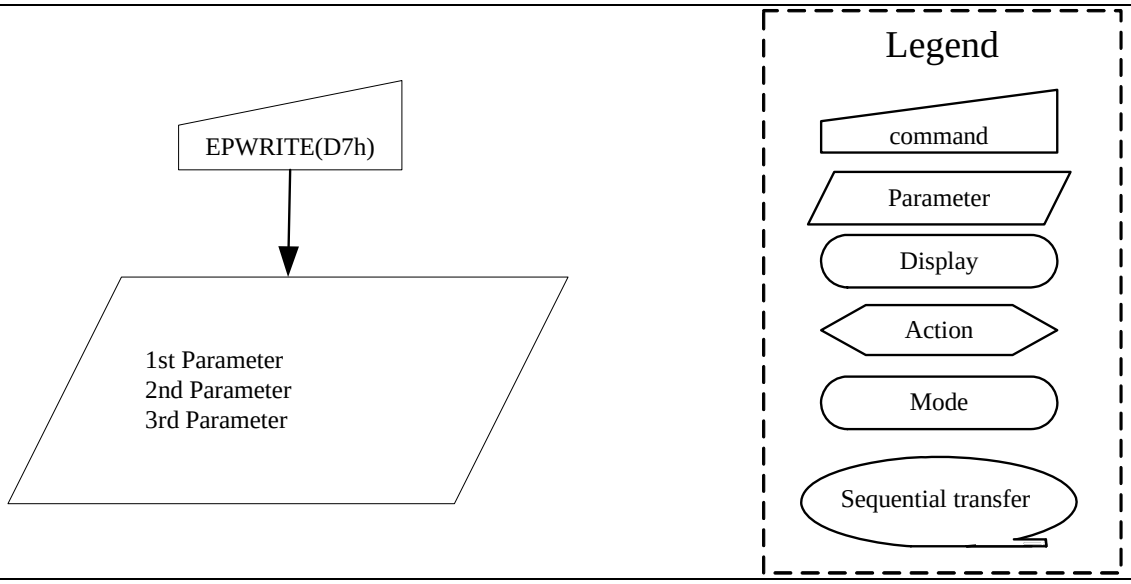
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	N/A
SW Reset	N/A
HW Reset	N/A

Flow Chart



14.2.57 Positive Gamma Correction Setting (E0h)

E1H	Postive Gamma Correction Setting											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	1	1	0	0	0	0	1	E1h
1st Parameter	1	1	↑	x	x	VP0[5:0]						x
2nd Parameter	1	1	↑	x	x	VP1[5:0]						x
3rd Parameter	1	1	↑	x	x	VP2[5:0]						x
4th Parameter	1	1	↑	x	x	VP4[5:0]						x
5th Parameter	1	1	↑	x	x	VP6[5:0]						x
6th Parameter	1	1	↑	x	x	x	VP13[4:0]					x
7th Parameter	1	1	↑	x	x	VP20[6:0]						x
8th Parameter	1	1	↑	VP36[3:0]				VP27[3:0]				x
9th Parameter	1	1	↑	x	VP43[6:0]							x
10th Parameter	1	1	↑	x	x	x	VP50[5:0]					x
11th Parameter	1	1	↑	x	x	VP57[5:0]						x
12th Parameter	1	1	↑	x	x	VP59[5:0]						x
13th Parameter	1	1	↑	x	x	VP61[5:0]						x
14th Parameter	1	1	↑	x	x	VP62[5:0]						x
15th Parameter	1	1	↑	x	x	VP63[5:0]						x
Description	Set the gray scale voltage to adjust the gamma characteristics of the TFT panel. It apply to gamma curve selection for only activate when EXTC=1 and GAM_R_SEL=1											
Restriction	-											

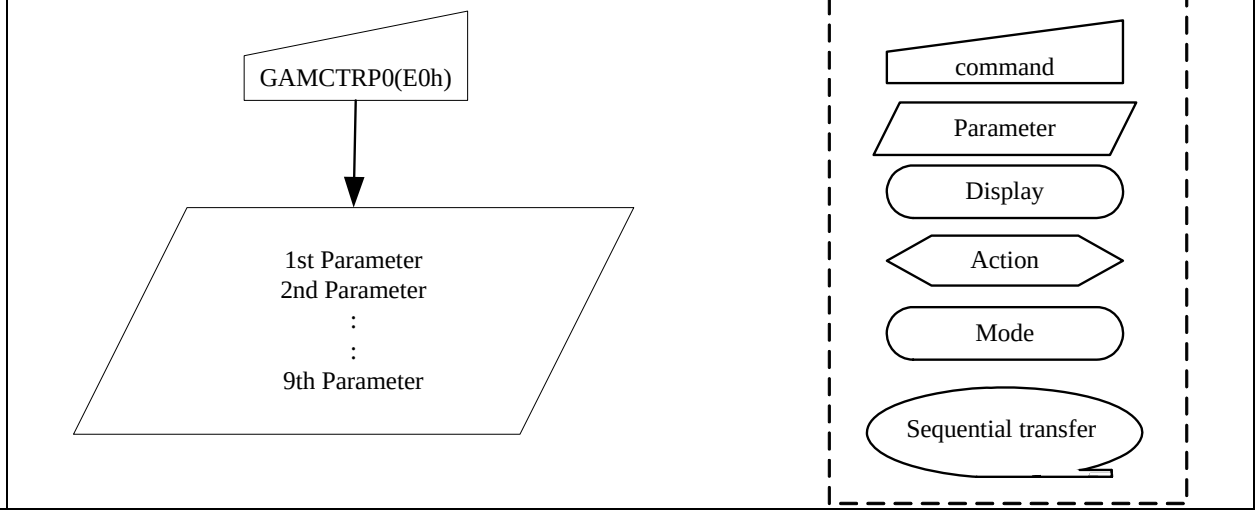
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
	1st ~ 9th Parameter
Power On Sequence	All ”00”
SW Reset	All ”00”
HW Reset	All ”00”

Flow Chart


GAMCTRP0(E0h)
1st Parameter
2nd Parameter
:
:
9th Parameter
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.58 Negative Gamma Correction Setting (E1h)

E1H	Negative Gamma Correction Setting											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	1	1	0	0	0	0	1	E1h
1st Parameter	1	1	↑	x	x	VN0[5:0]						x
2nd Parameter	1	1	↑	x	x	VN1[5:0]						x
3rd Parameter	1	1	↑	x	x	VN2[5:0]						x
4th Parameter	1	1	↑	x	x	VN4[5:0]						x
5th Parameter	1	1	↑	x	x	VN6[5:0]						x
6th Parameter	1	1	↑	x	x	x	VN13[4:0]					x
7th Parameter	1	1	↑	x	x	VN20[6:0]						x
8th Parameter	1	1	↑	VN36[3:0]		VN27[3:0]						x
9th Parameter	1	1	↑	x	VN43[6:0]							x
10th Parameter	1	1	↑	x	x	x	VN50[5:0]					x
11th Parameter	1	1	↑	x	x	VN57[5:0]						x
12th Parameter	1	1	↑	x	x	VN59[5:0]						x
13th Parameter	1	1	↑	x	x	VN61[5:0]						x
14th Parameter	1	1	↑	x	x	VN62[5:0]						x
15th Parameter	1	1	↑	x	x	VN63[5:0]						x
Description	Set the gray scale voltage to adjust the gamma characteristics of the TFT panel. It apply to gamma curve selection for only activate when EXTC=1 and GAM_R_SEL=1											
Restriction	-											

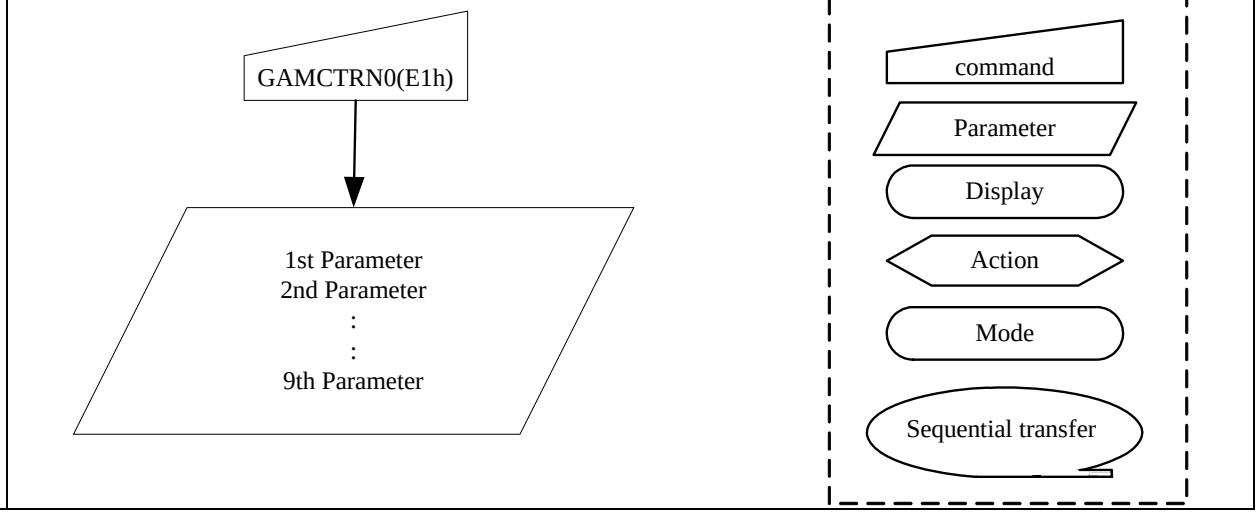
Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
	1st ~ 9th Parameter
Power On Sequence	All ”00”
SW Reset	All ”00”
HW Reset	All ”00”

Flow Chart


GAMCTRN0(E1h)
1st Parameter
2nd Parameter
:
:
9th Parameter
Legend
command
Parameter
Display
Action
Mode
Sequential transfer

14.2.59 GAM_R_SEL (F2h)

F2h	Gamma Setting (Green)											
	D/CX	RDX	WRX	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	1	1	1	1	0	0	1	0	F2h
1st Parameter	1	1	↑	x	x	x	x	x	x	x	GAM_R_SEL	Write
Description	GAM_R_SEL: Gamma adjustment E0h and E1h enable control 0: Disable (Default) 1: Enable											
Restriction	-											

Register Availability

Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

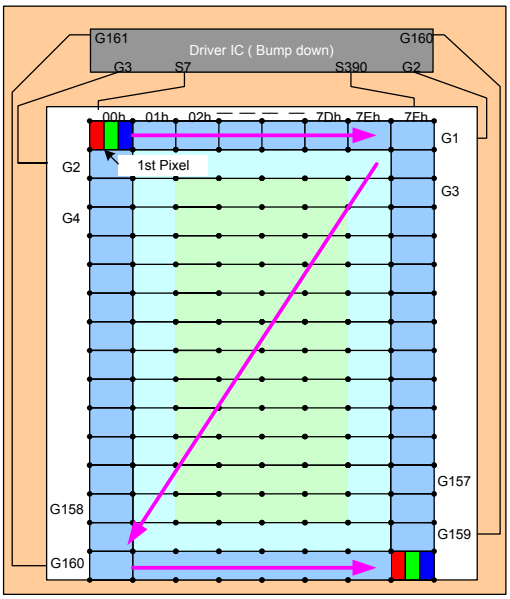
Status	Default Value
Power On Sequence	0h
SW Reset	0h
HW Reset	0h

15. Example Connection with Panel direction and Different Resolution

15.1. Application of connect with panel direction (when GM='011')

Case 1: (This is default case)

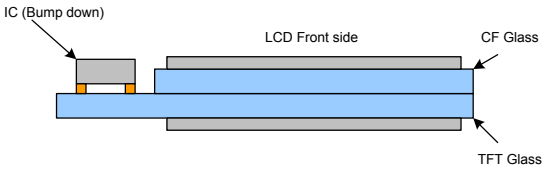
- 1st Pixel is at Left Top of the panle
- RGB filter order = RGB



- Direction default setting(H/W)
SMX = 0
SMY = 0
SRGB = 0

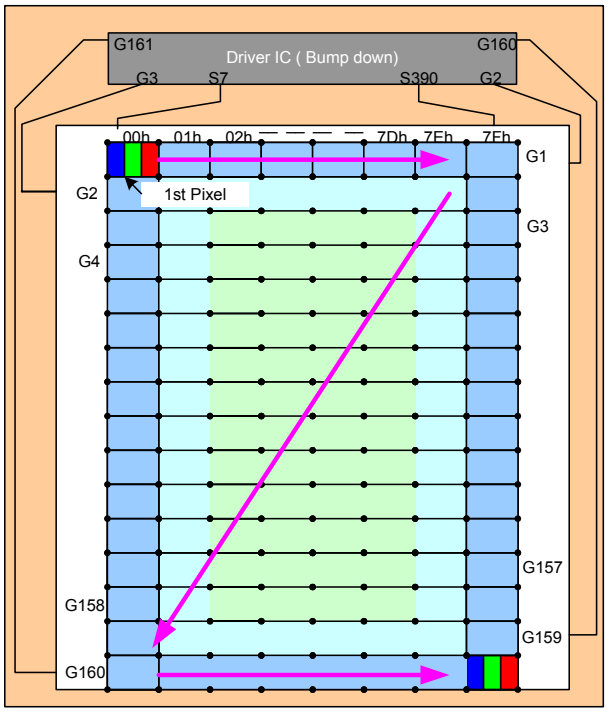
S1 = Filter R
S2 = Filter G
S3 = Filter B

- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
-XY- Exchange control by MV



Case 2:

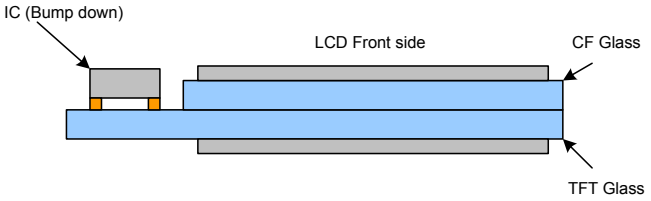
- 1st Pixel is at Left Top of the panel
- RGB filter order = BGR



- Direction default setting(H/W)
SMX = 0
SMY = 0
SRGB = 1

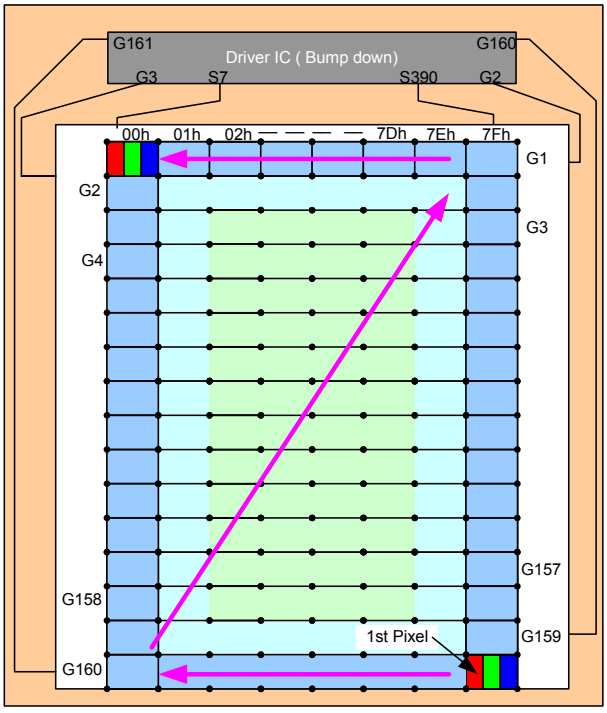
S1 = Filter B
S2 = Filter G
S3 = Filter R

- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
-XY- Exchange control by MV



Case3:

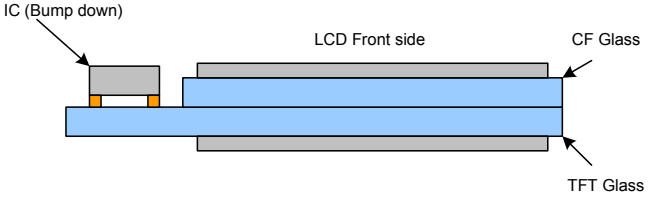
- 1st Pixel is at Right Bottom of the panel
- RGB filter order = “RGB”



- Direction default setting(H/W)
SMX = 0
SMY = 0
SRGB = 0

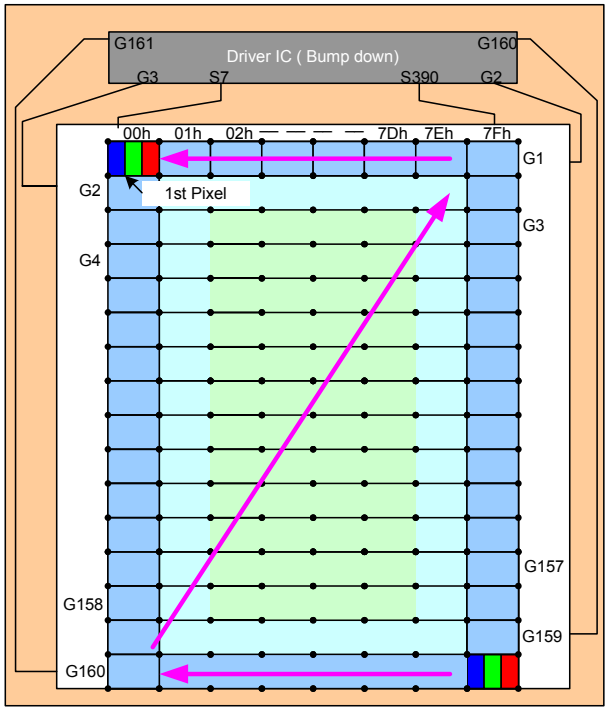
S1 = Filter R
S2 = Filter G
S3 = Filter B

- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
-XY- Exchange control by MV



Case 4:

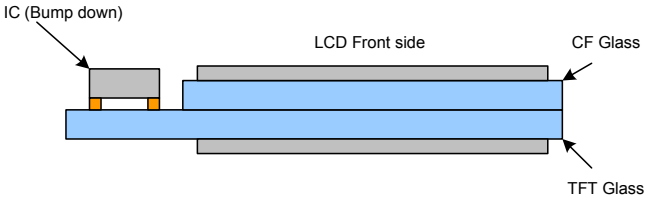
- 1st Pixel is at Right-Bottom of the panel
- RGB filter order = “BGR”



- Direction default setting(H/W)
SMX = 0
SMY = 0
SRGB = 1

S1 = Filter B
S2 = Filter G
S3 = Filter R

- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
-XY- Exchange control by MV

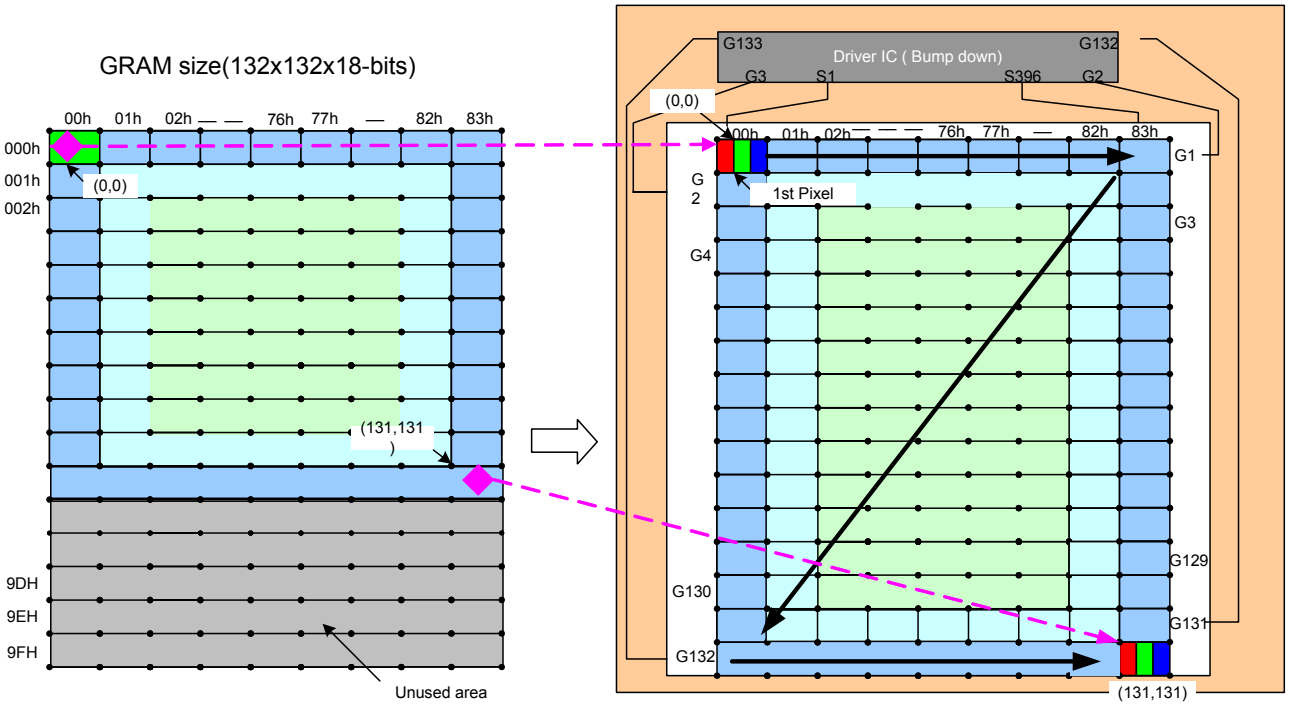


15.2. Application of connection with Different resolution

Case 1 of Resolution (132RGB x 132)(GM[2:0]=”101”) RAM size=132 x 132 x 18-bits(Used)

Display size = 132RGB x 132

1) Example for SMX=SMY=’0’



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

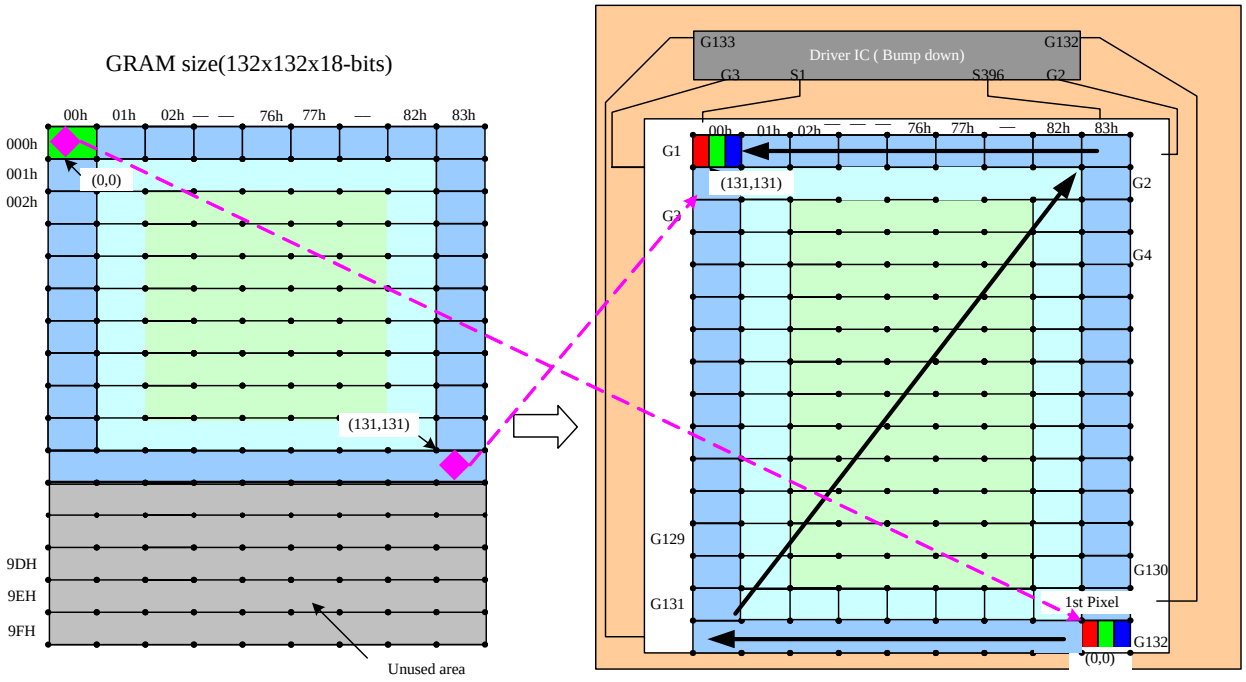
- Direction default setting (H/W)

SMX = 0

SMY = 0

SRGB = 0

2) Example for SMX=SMY='1'



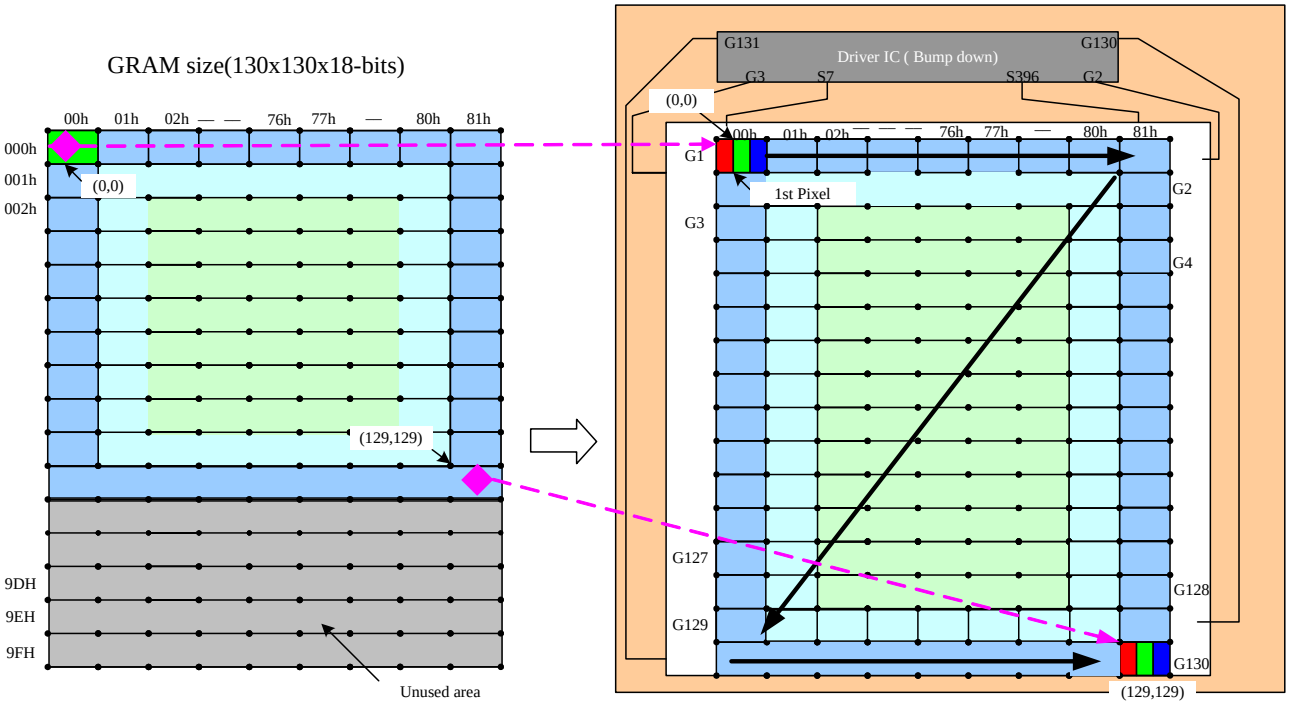
- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 1
SMY = 1
SRGB = 0

Case 2 of Resolution (130RGB x 130)(GM[2:0]="100") RAM size=130 x 130 x 18-bits(Used)

Display size = 130RGB x 130

1) Example for SMX=SMY='0'

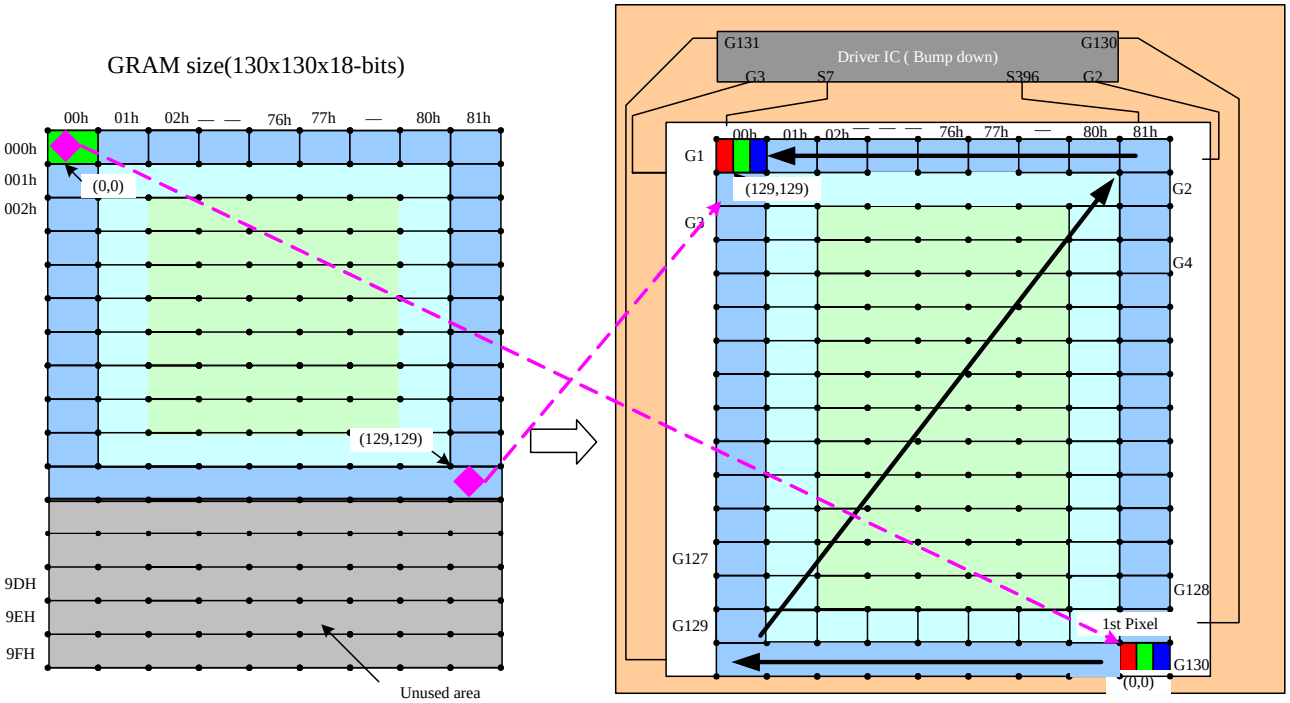


- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)

SMX = 0
SMY = 0
SRGB = 0

2) Example for SMX=SMY='1'



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

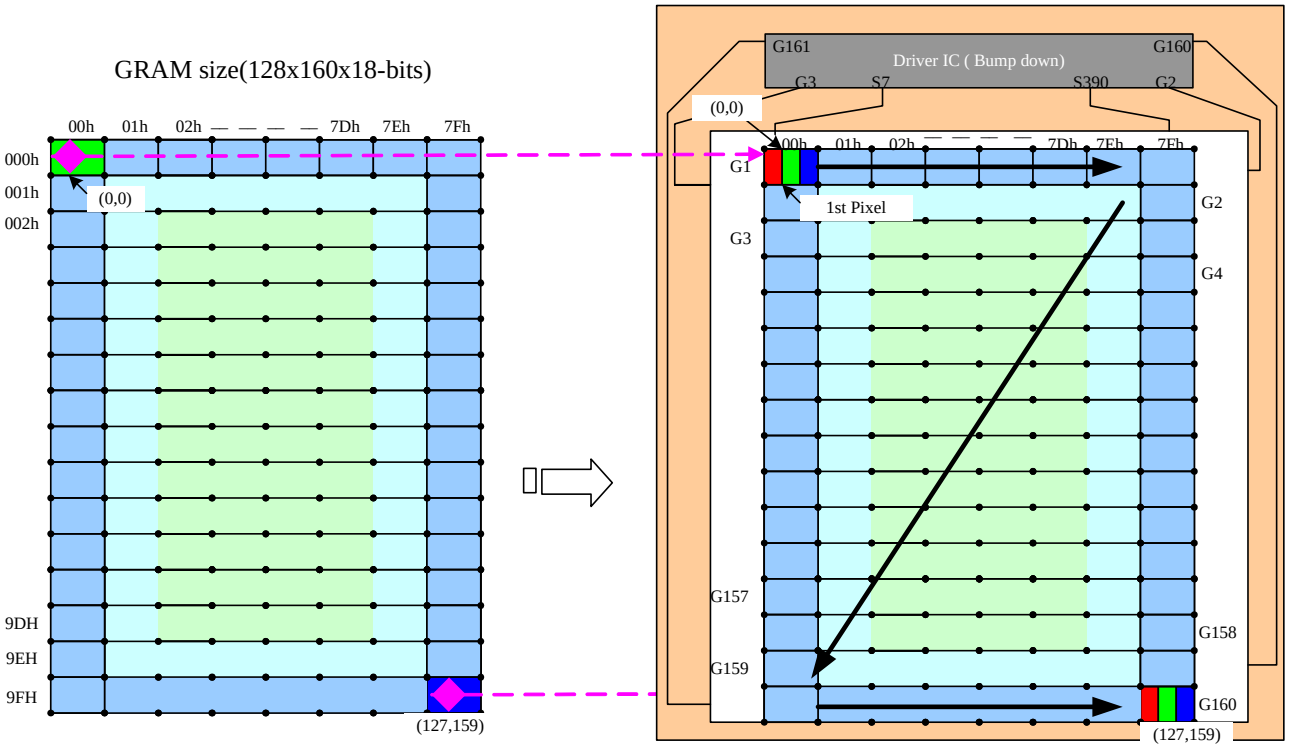
- Direction default setting (H/W)

SMX = 1
SMY = 1
SRGB = 0

Case 3 of Resolution (128RGB x 160)(GM[2:0]=”011”) RAM size=128 x 160 x 18-bits(Used)

Display size = 128RGB x 160

1) Example for SMX=SMY=’0’



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

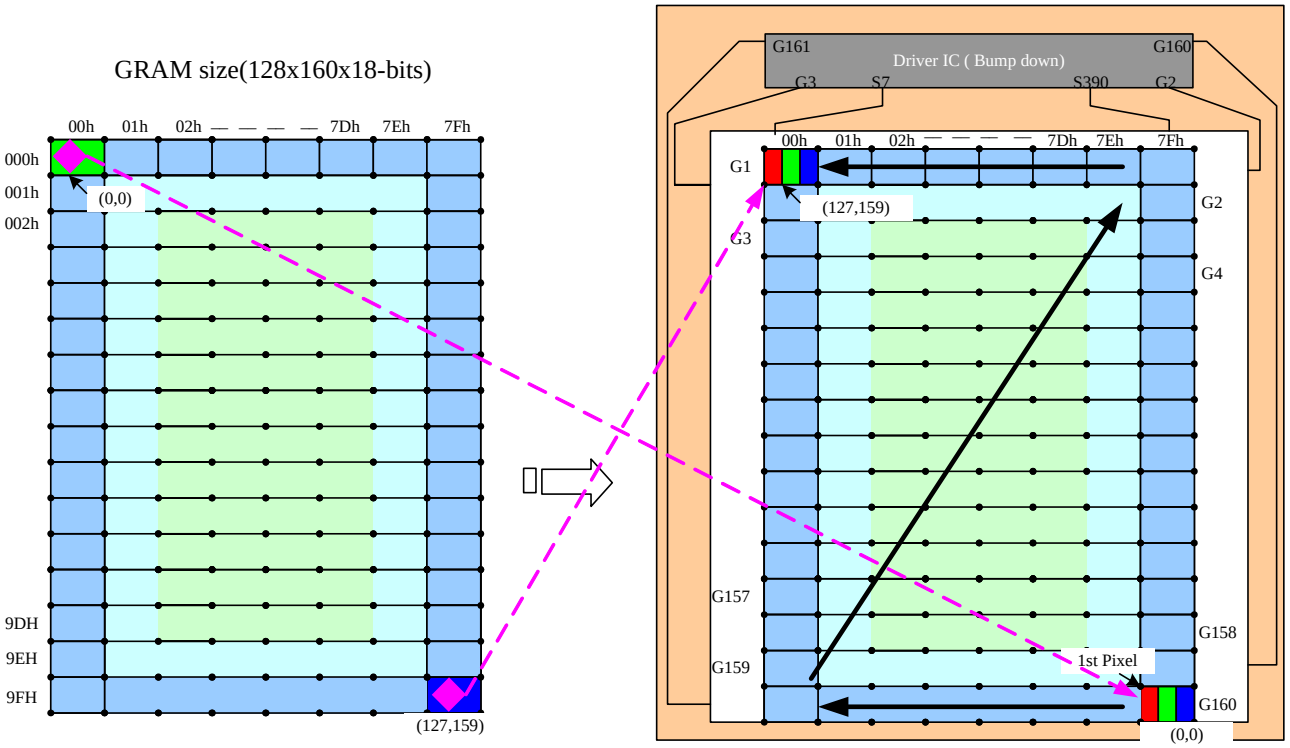
- Direction default setting (H/W)

SMX = 0

SMY = 0

SRGB = 0

2) Example for SMX=SMY=’1’



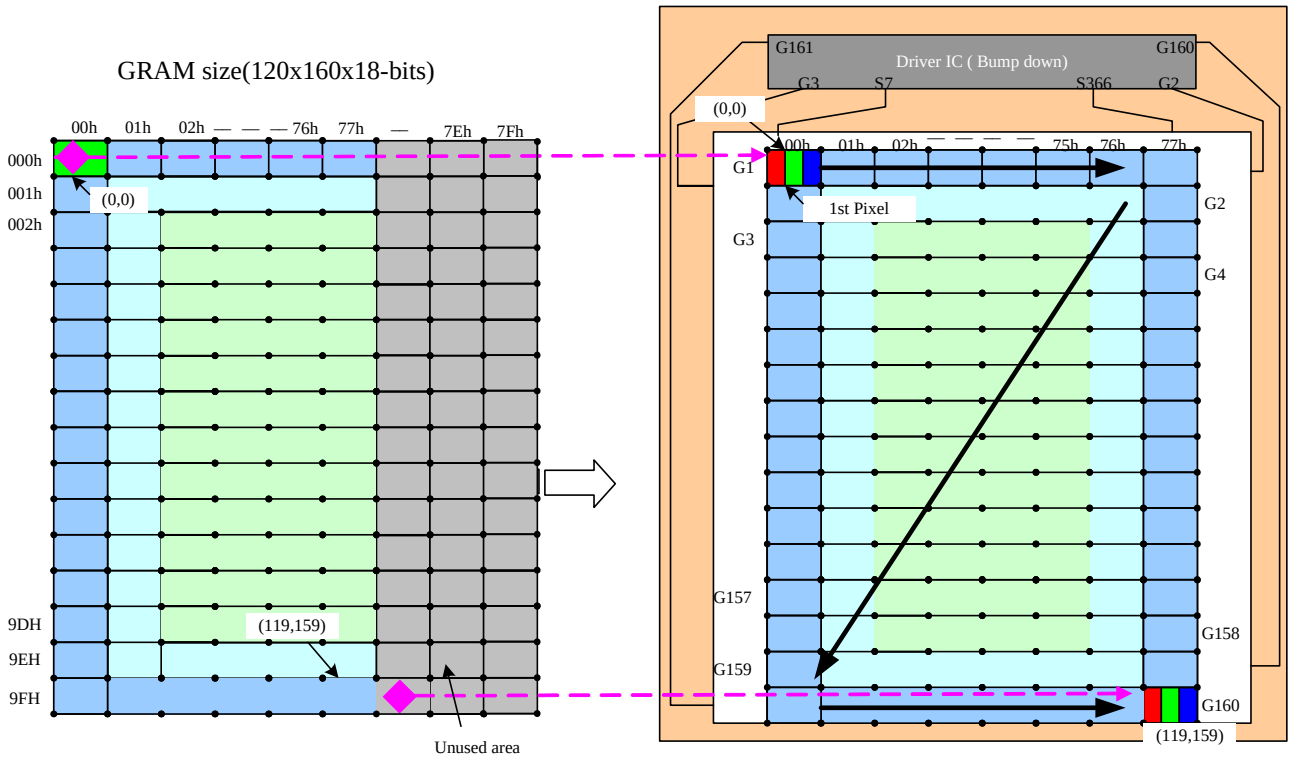
- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 1
SMY = 1
SRGB = 0

Case4 of Resolution (120RGB x 160)(GM[2:0]=”010”) RAM size=120 x 160 x 18-bits(Used)

Display size = 120RGB x 160

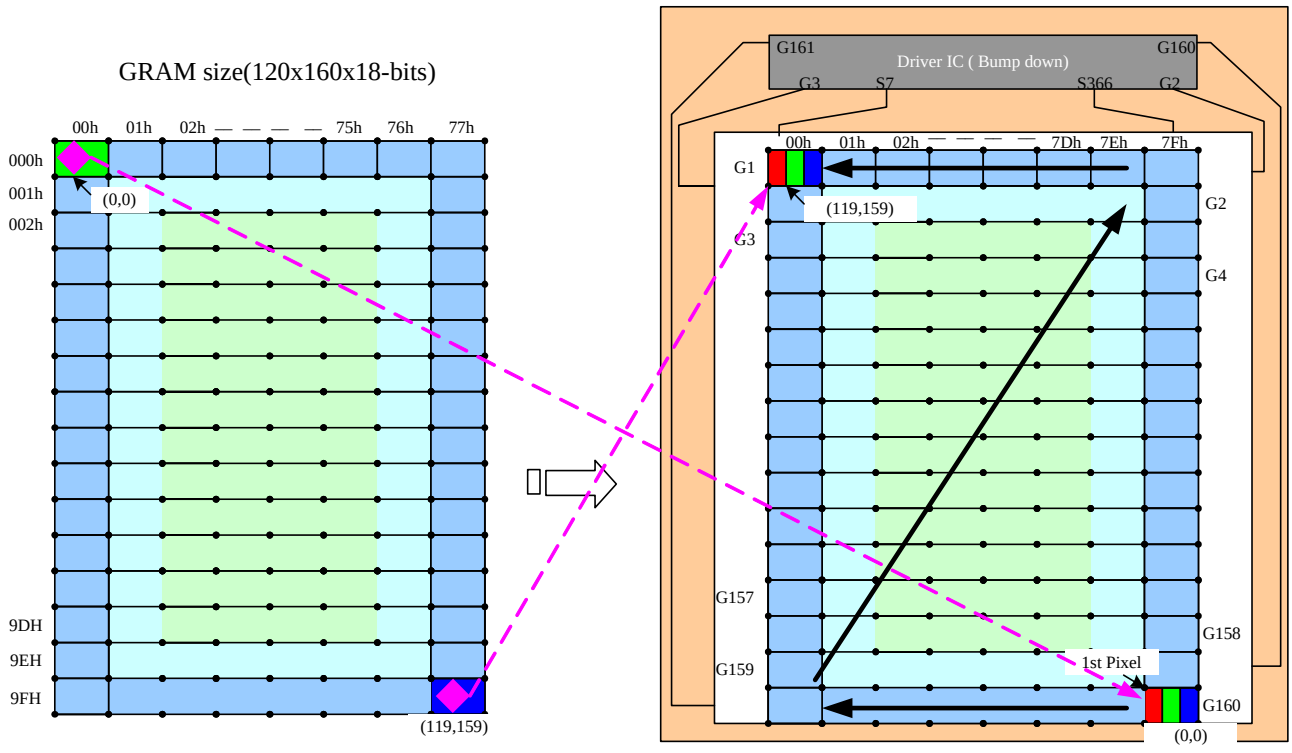
1) Example for SMX=SMY=’0’



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 0
SMY = 0
SRGB = 0

2) Example for SMX=SMY='1'

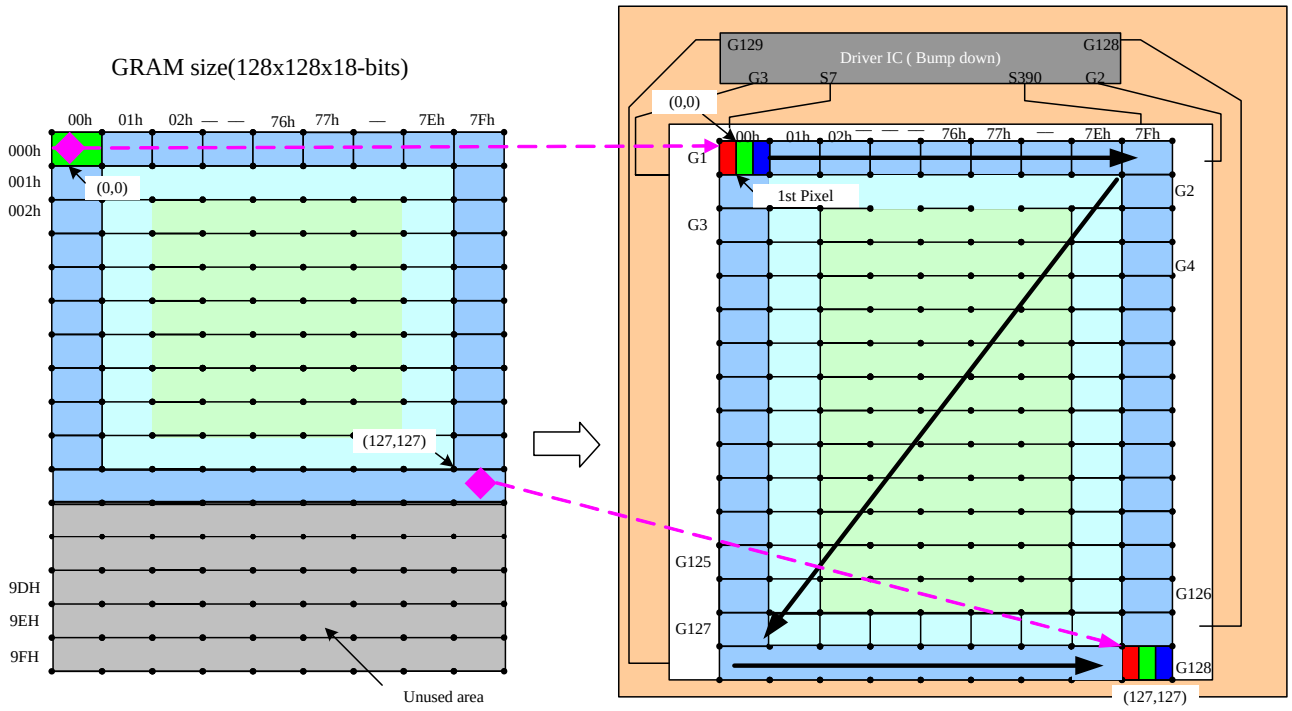


- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 1
SMY = 1
SRGB = 0

Case 5 of Resolution (128RGBx128)(GM[2:0]=”001”) RAM size=128 x 128 x 18-bits(Used)

1) Example for SMX=SMY=’0’

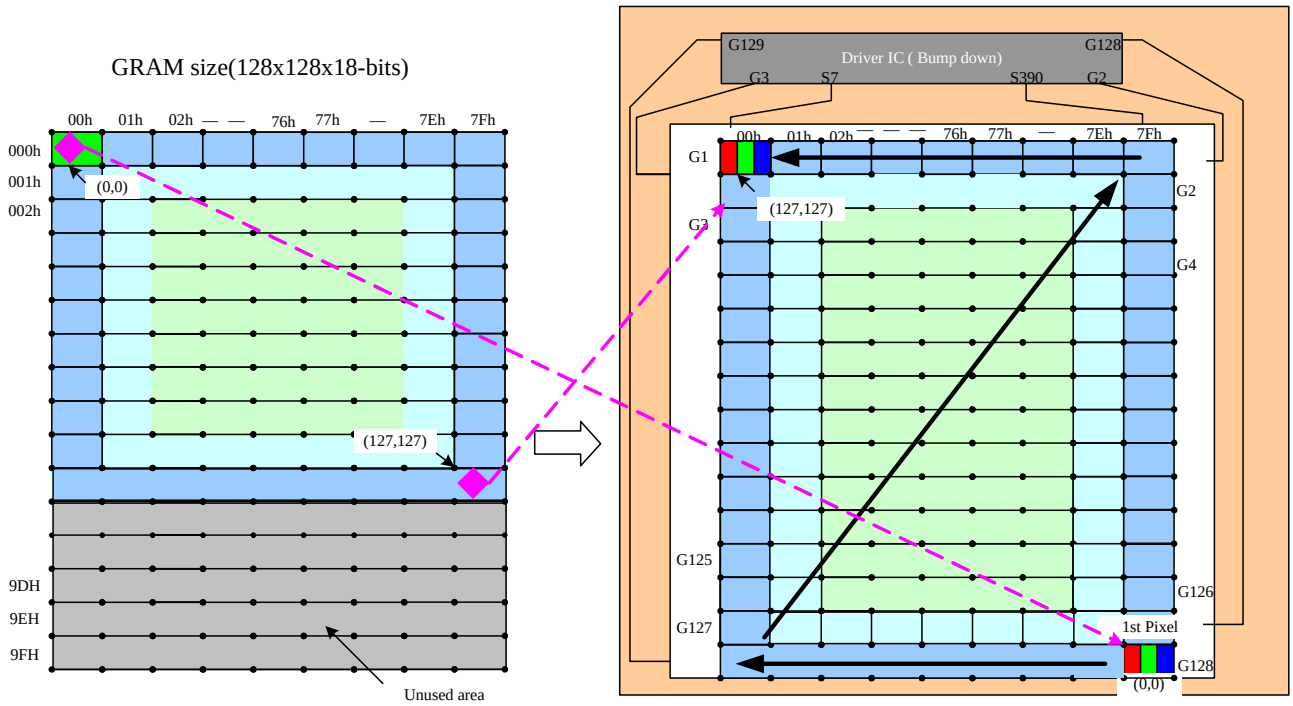


- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)

SMX = 0
SMY = 0
SRGB = 0

2) Example for SMX=SMY=’1’



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

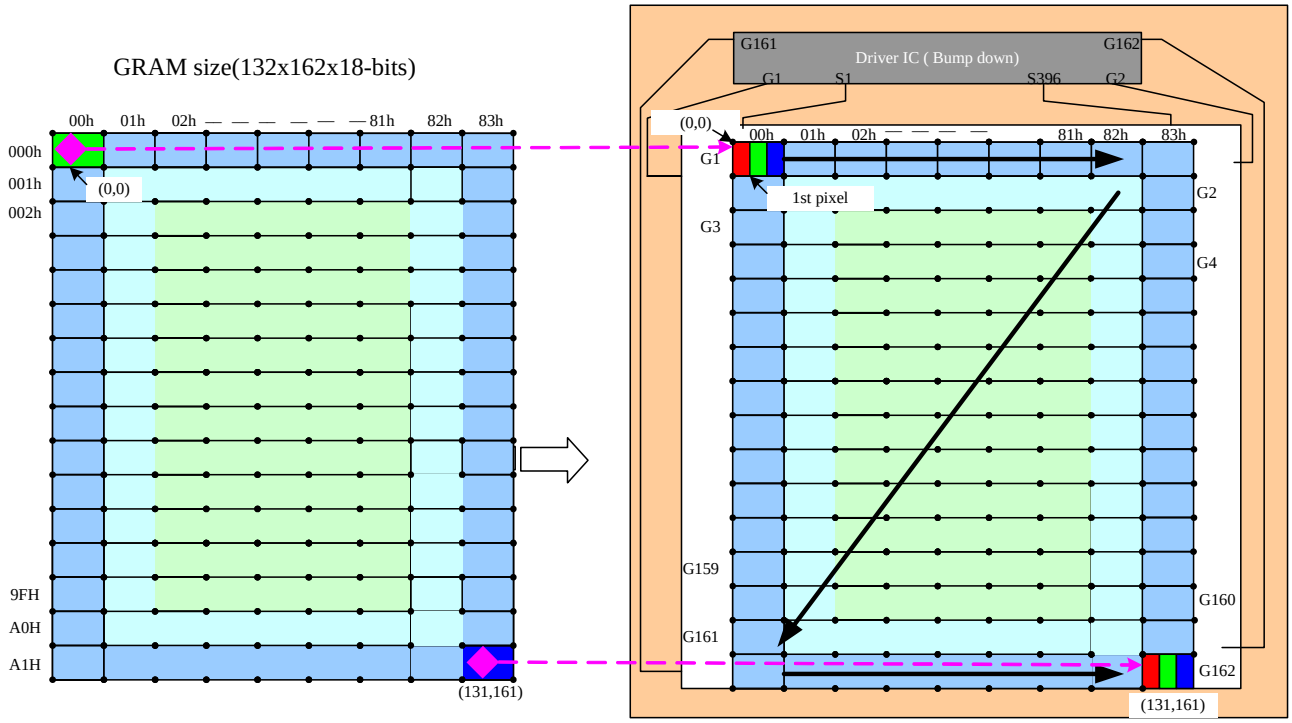
- Direction default setting (H/W)

SMX = 1
SMY = 1
SRGB = 0

Case 6 of Resolution (132RGB x 162)(GM[2:0]=”000”) RAM size = 132 x 162 x 18-bits(Used)

Display size = 132RGB x 162

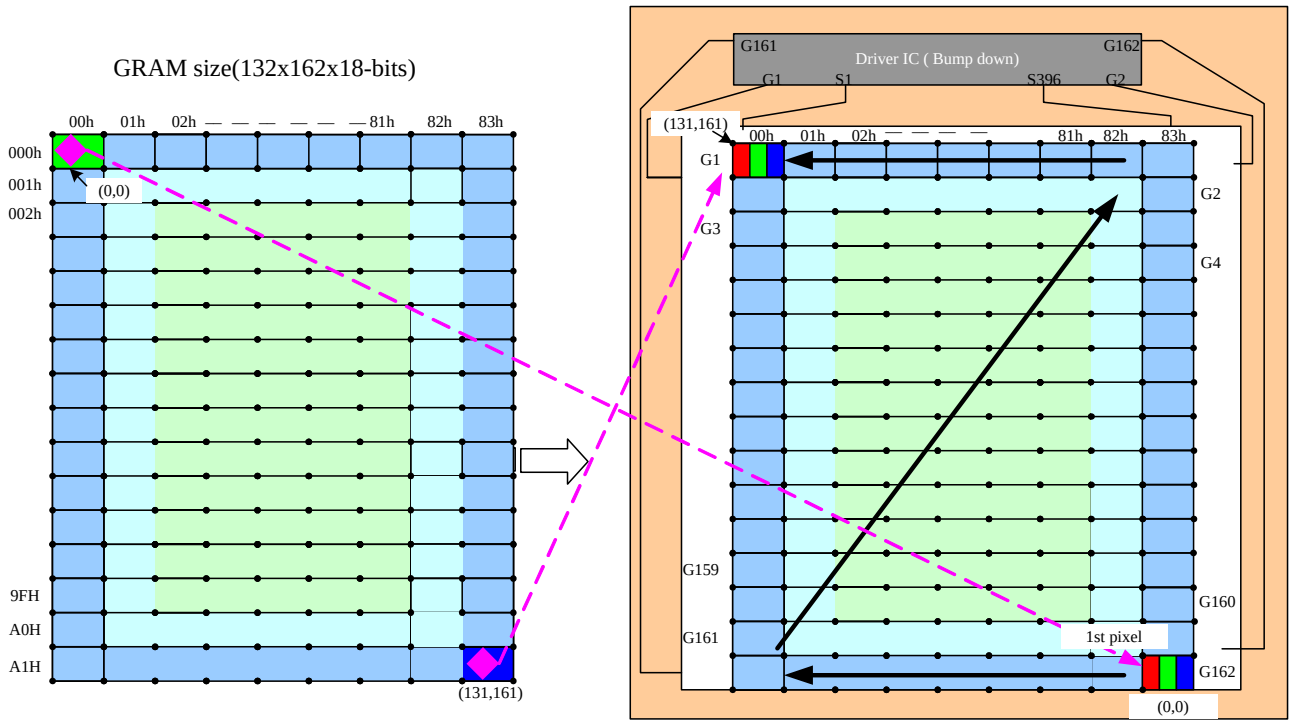
1) Example for SMX=SMY=’0’



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 0
SMY = 0
SRGB = 0

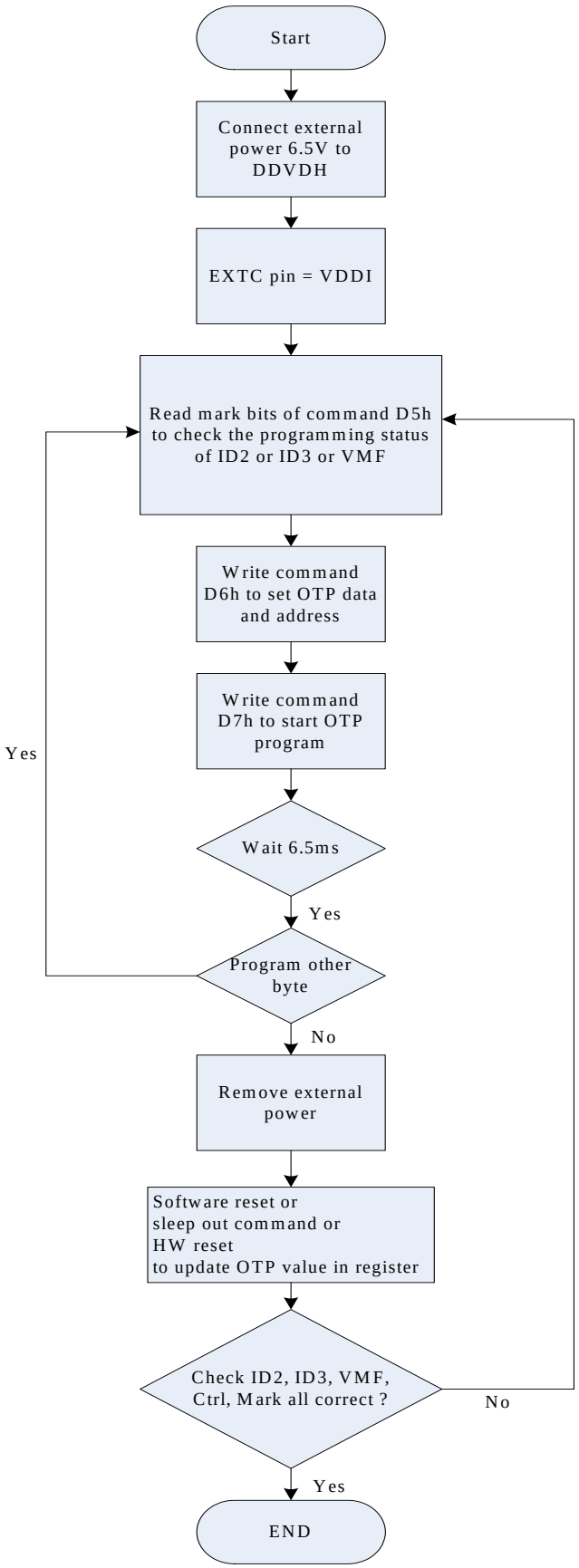
2) Example for SMX=SMY='1'



- Display direction control (S/W)
- X- Mirror control by MX
- Y- Mirror control by MY
- XY- Exchange control by MV

- Direction default setting (H/W)
SMX = 1
SMY = 1
SRGB = 0

16. OTP Programming Flow



17. Electrical Characteristics

17.1. Absolute Maximum Ratings

The absolute maximum rating is listed on following table. When ILI9163 is used out of the absolute maximum ratings, the ILI9163 may be permanently damaged. To use the ILI9163 within the following electrical characteristics limit is strongly recommended for normal operation. If these electrical characteristic conditions are exceeded during normal operation, the ILI9163 will malfunction and cause poor reliability.

Item	Symbol	Unit	Value Note
Supply voltage	VDD	V	-0.3 ~ + 4.6
Supply voltage (Logic)	VDDI	V	-0.3 ~ + 4.6
Supply voltage (Digital)	VCC	V	-0.3 ~ + 2.4
Driver supply voltage	VGH-VGL	V	-0.3 ~ + 33.0
Logic input voltage range	VIN	V	-0.3 ~ VDDI + 0.3
Logic output voltage range	VO	V	-0.3 ~ VDDI + 0.3
Operating temperature	Topr	°C	-40 ~ + 85
Storage temperature	Tstg	°C	-55 ~ + 110
Notes: If the absolute maximum rating of even is one of the above parameters is exceeded even momentarily, the quality of the product may be degraded. Absolute maximum ratings, therefore, specify the values exceeding which the product may be physically damaged. Be sure to use the product within the range of the absolute maximum ratings.			

17.2. DC Characteristics

Item	Symbol	Unit	Condition	Min.	Typ.	Max.	Note
Power & Operation Voltage							
Analog Operating voltage	VDD	V	Operating voltage	2.6	2.78	3.3	Note2
Logic Operating voltage	VDDI	V	I/O supply voltage	1.65	1.8/2.78	3.3	Note2
Digital Operating voltage	VCC	V	Digital supply voltage		1.8		Note2
Gate Driver High voltage	VGH	V		10.0		16.0	Note3
Gate Driver Low voltage	VGL	V		-16.0		-9.0	Note3
Driver Supply voltage		V	|VGH-VGL|	19		32	Note3
Input/Output							
Logic High level input voltage	VIH	V		0.7VDDI		VDDI	Note1,2,3
Logic Low level input voltage	VIL	V		VSS		0.3VDDI	Note1,2,3
Logic High level output voltage	VOH	V	IOH = -1.0mA	0.8VDDI		VDDI	Note1,2,3
Logic High level output voltage	VOL	V	IOL = 1.0mA	VSS		0.2VDDI	Note1,2,3
Logic High level input current	IIH	μA				1	Note1,2,3
Logic Low level input current	IIL	μA		-1			Note1,2,3
Logic input leakage current	IIL	μA	VIN = VDDI or VSS	-0.1		+0.1	Note1,2,3
VCOM Operation							
VCOM High voltage	VCOMH	V	Ccom=12nF	2.5		5.0	Note 3
VCOM Low voltage	VCOML	V	Ccom=12nF	-2.5		0.0	Note 3
VCOM Amplitude voltage	VOMA	V	|VCOMH-VCOML|	4.0		5.5	Note 3
Source Driver							
Source output range	Vsout	V		0.1		AVDD-0.1	Note4
Gamma reference voltage	GVDD	V		3.0		5.0	Note3
Source output setting time	Tr	μS	Below with 99% precision		15	20	Note4,5
Output deviation voltage (Source output channel)	Vdev	mV	Sout >= 4.2V Sout <=0.8V			20	Note4
		mV	4.2V>Sout>0.8V			15	-
Output offset voltage	VOFSET	mV				35	Note8
Booster Operation							
1st Booster (VDDx2) voltage	AVDD	V		4.5*6		6*7	Note3
1st Booster(VDDx2) Drop voltage	VDDx2, drop	%	I loading = 1mA			5	Note3
Liner range	VLinear	V		0.2		AVDD-0.2	

Note 1: VDDI=1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V, Ta=-30 to 70℃ (to +85℃ no damage)

Note2: Please supply digital VDDI voltage equal or less than analog VDD voltage. (VDDI≦VDD)

Note2,3,4: When the measurements are performed with LCD module. Measurement Points are like below.

Note3: CSX, RDX, WRX, D[23:0], D/CX, RESX, TE, PCLK, VS, HS, DE, SDA, SCL, GM2, GM1, GM0, LCM,RCM1, RCM0, P68, IM2, IM1, IM0, SRGB, REV, SMX, SMY, RL, TB, IDM, SHUT, PREG, GS and Test pins.

Note5: Source channel loading = 10pF/channel, Gate channel loading = 50pF/channel

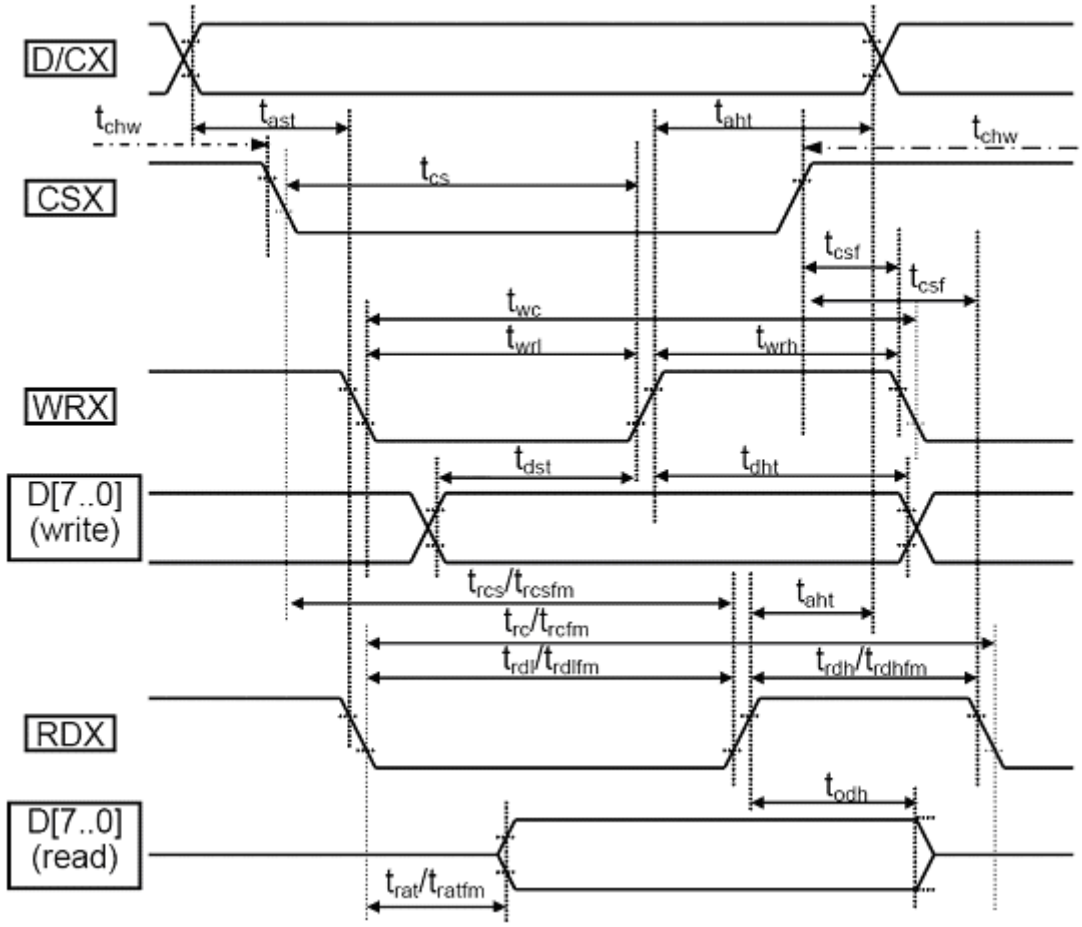
Note6: VDD=2.6V or VCI1=2.6V

Note7: VDD=3.3V or VCI1=3.3V

Note8: The Max. value is between with Note 4 measure point and Gamma setting value.

17.3. AC Characteristics

17.4. Display Module Parallel 18/16/9/8-bit Bus



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

Table 17.4.1 AC characteristics of parallel CPU I/F in asynchronous mode

Signal	Symbol	Parameter	min	max	unit	description
D/CX	tast	Address setup time	0		ns	
	taht	Address hold time(Write/Read)	10		ns	
CSX	tchw	”S””H" Pulse Widtch	0		ns	
	tcs	Chip Select setup time (Write)	10		ns	
	trcs	Chip Select setup time (Read ID)	45		ns	
	trcsfm	Chip Select setup time (Read FM)	355		ns	
	tcsf	Chip Select Wait time(Write/read)	10		ns	

WRX	twc	Write cycle	66		ns	
	twrh	Controlpulse H duration	15		ns	
	twrl	Control pulse L duration	15		ns	
RDX	trc	Read cycle (ID)	160		ns	When read ID data
	trdh	Control pulse H duration(ID)	90		ns	
	trdl	Control pulse L duration(ID)	45		ns	
RDX	trcfm	Read cycle (FM)	450		ns	When read from frame memory
	trdhfm	Control pulse H duration (FM)	90		ns	
	trdlfm	Control pulse L duration (FM)	355		ns	
D[17..0]	tdst	Data setup time	10		ns	For maximum CL = 30pF For minimum CL = 8pF
	tdht	Data hold time	10		ns	
	trat	Read access time (ID)		40	ns	
	tratfm	Read access time (FM)		340	ns	
	todh	Output disable time	20	80	ns	

Note 1: VDDI 1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V, Ta=-30 to 70 °C (to +85°C no damage)

Note 2: This input signal rise time and fall time (tr, tf) is specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for input signals

17.5. Display Serial Interface

17.5.1 3-pin Serial Interface

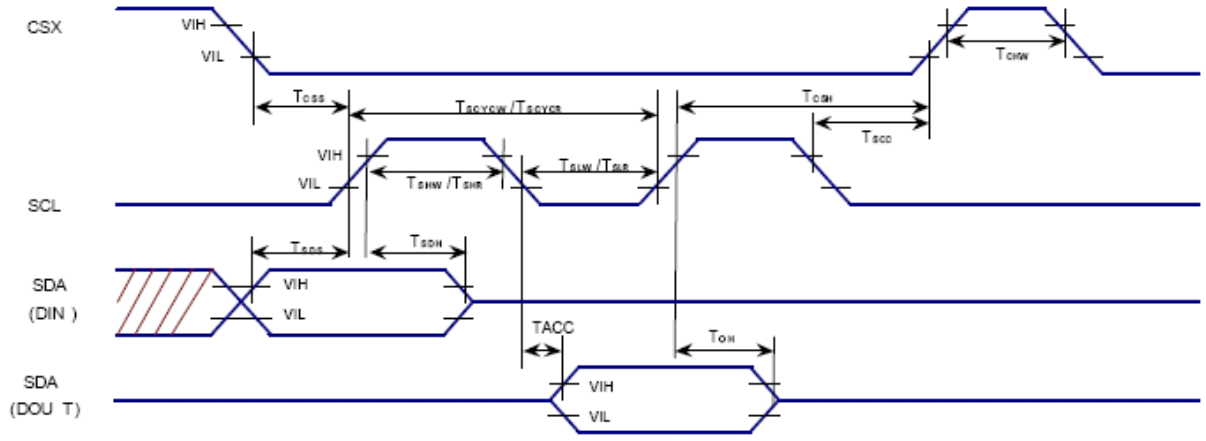


Table 17.5.1.1: 3-pin Serial Interface Characteristics

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	TCSS	Chip select setup time	15		ns	
	TCSH	Chip select hold time	60		ns	
	TCHW	Chip select setup time	40		ns	
SCL	TSCYCW	Serial clock cycle(Write)	66		ns	

	TSHW	S“L”"H" pulse width(Write)	1		ns	
	TSLW	S“L”"L" pulse width(Write)	15		ns	
	TSCYCR	Serial clock cycle(Read)	150		ns	
	TSHR	S“L”"H" pulse width(Read)	60		ns	
	TSLR	S“L”"L" pulse width(Read)	60		ns	
SDA(DIN) (DOUT)	TSDS	Data setup time	10		ns	
	TSDH	Data hold time	10		ns	
	TACC	Access time	10	50	ns	For maximum CL = 30pF
	TOH	Output disable time	15		ns	For minimum CL = 8pF

Note 1: VDDI=1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V. Ta=-30 to 70℃ (to +85℃ no damage)

Note 2 : The input signal rise time and fall time(tr, tf) is specified at 15 ns or less.

Logic high and low levels are specified as 10% and 90% of VDDI for Input signals.

17.5.2 4-pin Serial Interface

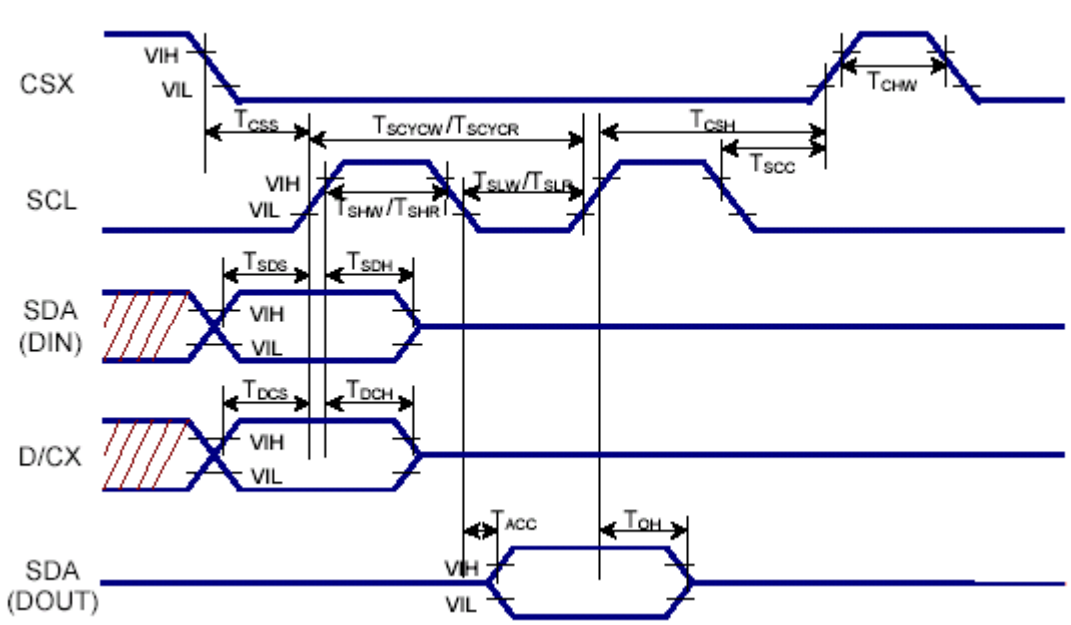


Table 6.1.3.2: 4 pin Serial Interface Characteristics

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	TCSS	Chip select setup time	15		ns	
	TCSH	Chip select hold time	60		ns	
	TCHW	Chip select setup time	40		ns	
SCL	TSCYCW	Serial clock cycle(Write)	66		ns	
	TSHW	S“L”"H" pulse width(Write)	1		ns	
	TSLW	S“L”"L" pulse width(Write)	15		ns	
	TSCYCR	Serial clock cycle(Read)	150		ns	
	TSHR	S“L”"H" pulse width(Read)	60		ns	

	TSLR	S“L”"L" pulse width(Read)	60		ns	
D/CX	TDCS	D/CX setup time	7		ns	
	TDCH	D/CX hold time	7		ns	
SDA(DIN) (DOUT)	TSDS	Data setup time	10		ns	
	TSDH	Data hold time	10		ns	
	TACC	Access time	10	50	ns	For maximum CL = 30pF
	TOH	Output disable time	15		ns	For minimum CL = 8pF

Note 1: VDDI=1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V. Ta=-30 to 70℃ (to +85℃ no damage)

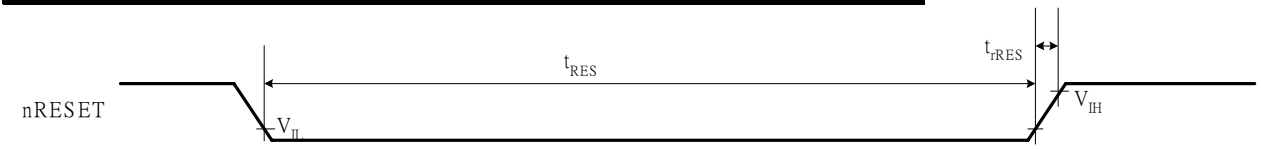
Note 2 : The input signal rise time and fall time(tr, tf) is specified at 15 ns or less.

Logic high and low levels are specified as 10% and 90% of VDDI for Input signals.

17.6. Reset Timing Characteristics

Reset Timing Characteristics (VDDI = 1.65 ~ 3.3 V)

Item	Symbol	Unit	Min.	Typ.	Max.
Reset low-level width	t_{RES}	ms	1	-	-
Reset rise time	t_{rRES}	µs	-	-	10



18. Revision History

Version No.	Date	Page	Description
V.01	2007/08/30		New Created
V0.11	2007/10/8	P177 P151	Add Ch15 : Example Connection with Panel direction and Different Resolution Modify Interanal Oscillator
V0.13	2007/11/01	16, 20	Modify the input pad size and input pad coordination
V0.14	2007/11/28	85,86,89,121 123,166	Modify HEX
		106,146,150	Modify Parameter
		112,135,138, 139,141,143	Modify RDX/WRX
		146	Modify Descirption – internal oscillator 1 Modify PTG[1:0] to PTG[0]
		147	Modify PT[1:0] VCOM output on non-display area
		152,185	Modify AVDD, VCL
		177,178,181 183,	Modify SMX/SMY=1
		184	Add OTP Programming Flow
V0.15	2008/03/17	All	Remove RGB Interface
		14	Modify Chip Thickness 300um → 280um Modify Pad Height 90um → 75um
V0.16	2008/03/28	13,189	Remove VCC
		10,11	Add HS/VS/PCLK/DE/TB/RL Definition
V0.17	2008/05/07	35	Update RGB Interface
V0.18	2008/07/24	All	Remove RGB Interface