MULTI-INNO TECHNOLOGY CO., LTD.

www.multi-inno.com

LCD MODULE SPECIFICATION

Model : MI0283QT-11

For Customer's Acceptance:

Customer	
Approved	
Comment	

Revision	1.2
Engineering	
Date	2012-11-26
Our Reference	

REVISION RECORD

REV NO.	REV DATE	CONTENTS	REMARKS
1.0	2011-06-22	First release	
1.1	2012-02-03	Update interface description	
1.2	2012-11-26	Update power consumption	

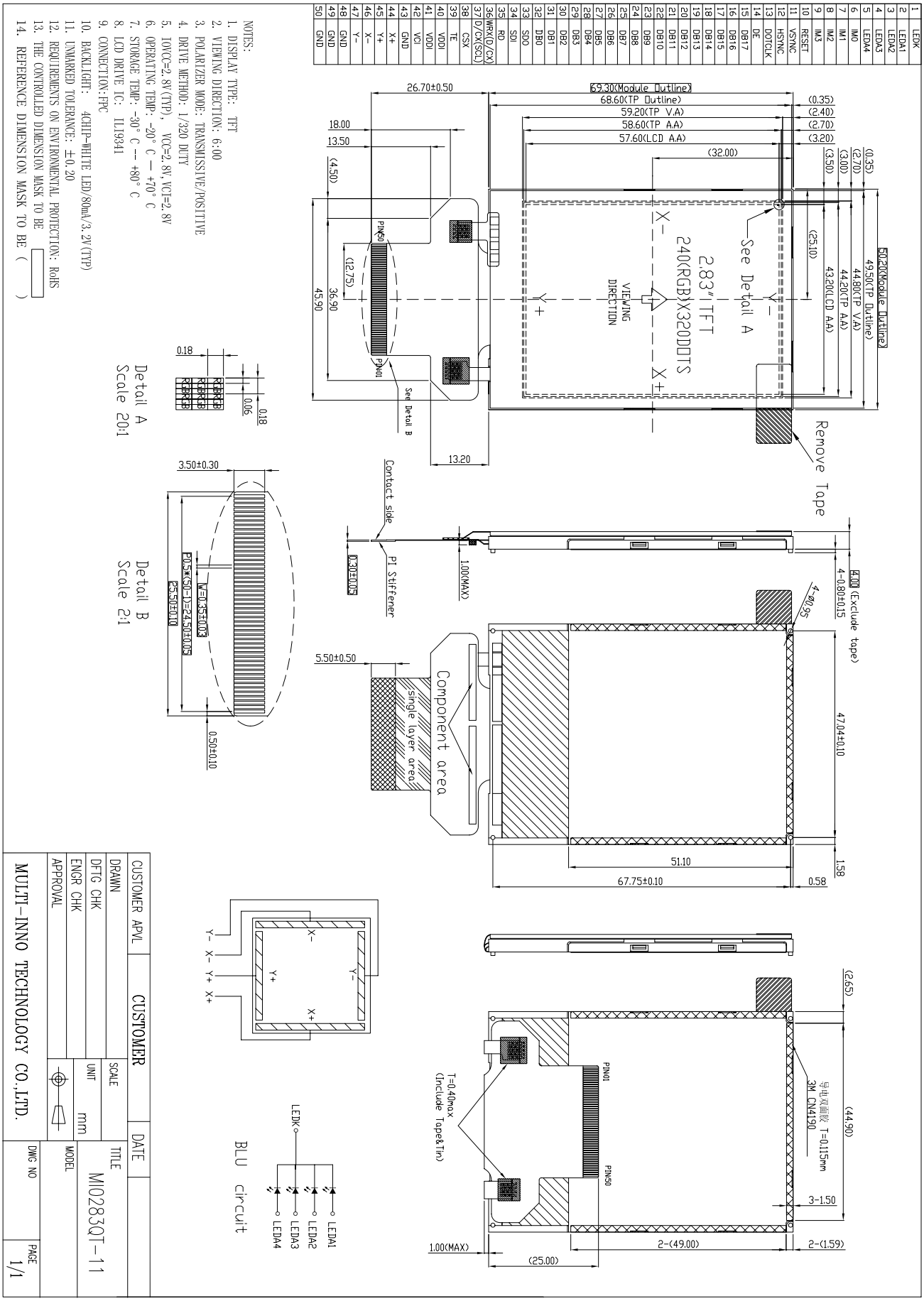
CONTENTS

■ GENERAL INFORMATION

Item	Contents	Unit/Note
LCD type	TFT/TRANSMISSIVE/POSITIVE	/
Viewing direction	6:00	O'Clock
Gray scale inversion direction	12:00	O'Clock
Module area (W × H)	50.2×69.3×4.0	mm^2
Active area (W×H)	43.2×57.6	mm^2
Number of Dots	240(RGB)×320	/
Pixel pitch(W × H)	0.18 × 0.18	mm^2
DriverIC	ILI9341	/
Colors	65K/262K	/
Backlight Type	4 LEDs	/
Module Power consumption	220	mw
InterfaceType	CPU/RGB	/
Input voltage	2.8	V
With/Without TSP	With TSP	/
Weight	24.16	g

Note 1:Viewing direction for best image quality is different from TFT definition, there is a 180 degree shift.
Note 2 : RoHS compliant;
Note 3: LCM weight tolerance: ± 5% .

■ EXTERNAL DIMENSIONS



■ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit
Power supply voltage	VCI	-0.3	4.6	V
Logic signal voltage	VDDI	-0.3	4.6	V
Operatingtemperature	Top	-20	70	°C
Storagetemperature	TST	-30	80	°C
Humidity	RH	-	90%(Max60 °C)	RH

■ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

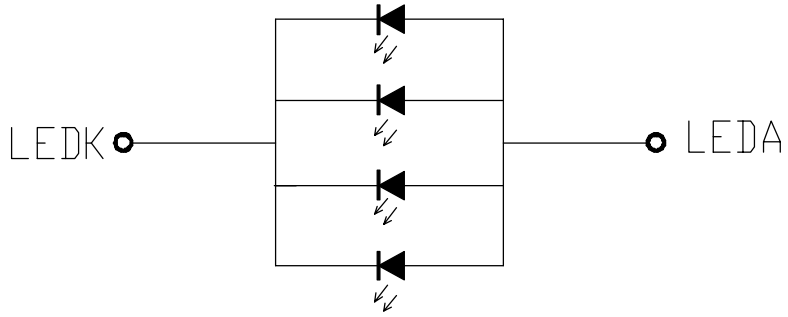
Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage	VCI	2.5	2.8	3.3	V
Logic signalI/O voltage	VDDI	1.65	2.8	3.3	V
Inputvoltage'H'level	VIH	0.7VDDI	-	VDDI	V
Inputvoltage'L'level	VIL	VSS	-	0.3VDDI	V
Outputvoltage'H'level	VOH	0.8VDDI	-	VDDI	V
Outputvoltage'L'leve	VOL	VSS0	-	0.2VDDI	V

Note:
1: Display full white. Backlight on state.
2: IC on standby mode.
3: the default voltage is 2.8V, for N lights in series, the power is that the current multiply N.

■ BACKLIGHT CHARACTERISTICS

Item		Symbol	Condition	Min	Typ	Max	Unit	Note
Supply voltage		Vf	If=80mA	-	3.2	3.4	V	
Supply current		-	-	-	-	-	mA	
Reverse voltage		V_r	-	-	-	-	V	
Forward current	Normal	I_{pn}	4-chip Parallel		80	-	mA	1
	Dimming	I_{pd}						
Reverse Current		I_r	-	-	-	-	μA	
Uniformity		△Bp	I_f=80mA	80%				
Color coordinate*		X		0.270	-	0.315	-	
		Y		0.270	-	0.315	-	

White LED CIRCUIT DIAGRAM:



CIRCUIT DIAGRAM
If=80mA,Constant Current

NOTE:

1 The LED 's driver mode needs to be constant current mode.

2 Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded .Functional operation should be restricted to the conditions described under normal operating conditions.

■ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min	Typ	Max	Unit	Remark	Note
Response time	Tr +Tf	θ=0° ∅=0° Ta=25℃	-	25	30	ms	Fig.1	4
Contrastratio	Cr		-	500	-	—	FIG 2.	1
Luminance uniformity	δ WHITE		80	90.8	-	%	FIG 2.	3
Surface Luminance	Lv		150	240	-	cd/m^2	FIG 2.	2
Viewing angle range	θ	∅ = 90°	-	70	-	deg	FIG 3.	6
		∅ = 270°	-	57	-	deg	FIG 3.	
		∅ = 0°	-	70	-	deg	FIG 3.	
		∅ = 180°	-	70	-	deg	FIG 3.	
CIE (x, y) chromaticity	Red x	θ=0° ∅=0° Ta=25℃	-	0.6368	-		FIG 2.	5
	Red y		-	0.3329	-			
	Green x		-	0.3397	-			
	Green y		-	0.6138	-			
	Blue x		-	0.1433	-			
	Blue y		-	0.0807	-			
	White x		-	0.2886	-			
	White y		-	0.3194	-			
NTSC Ratio	S		55	67	-	%		

Note 1. Contrast Ratio(CR) is defined mathematically as For more information see FIG 2.:

$$\textbf{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels } (P_1, P_2, P_3, P_4, P_5)}{\text{Average Surface Luminance with all black pixels } (P_1, P_2, P_3, P_4, P_5)}$$

Note 2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information see FIG 2.

Lv = Average Surface Luminance with all white pixels $(P_1, P_2, P_3, P_4, P_5)$

Note 3. The uniformity in surface luminance , δ WHITE is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by minimum luminance of 5 points luminance. For more information see FIG 2.

$$\delta\ \textbf{WHITE} = \frac{\textbf{Minimum Surface Luminance with all white pixels } (P_1, P_2, P_3, P_4, P_5)}{\textbf{Maximum Surface Luminance with all white pixels } (P_1, P_2, P_3, P_4, P_5)}$$

Note 4. Response time is the time required for the display to transition from White to black(Rise Time, Tr) and from black to white(Decay Time, Tf). For additional information see FIG 1. The test equipment is Autronic-Melchers's ConoScope. Series

Note 5. CIE (x, y) chromaticity,The x,y value is determined by measuring luminance at each test position 1 through 5,and then make average value

Note 6. Viewing angle is the angle at which the contrast ratio is greater than 2. For TFT module the conrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 3.

Note 7. For Viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope. Series Instruments. For contrast ratio, Surface Luminance, Luminance uniformity,CIE The test data is base on TOPCON's BM-5 photo detector.

Note 8. For TFT module, Gray scale reverse occurs in the direction of panel viewing angle.

FIG.1. The definition of Response Time

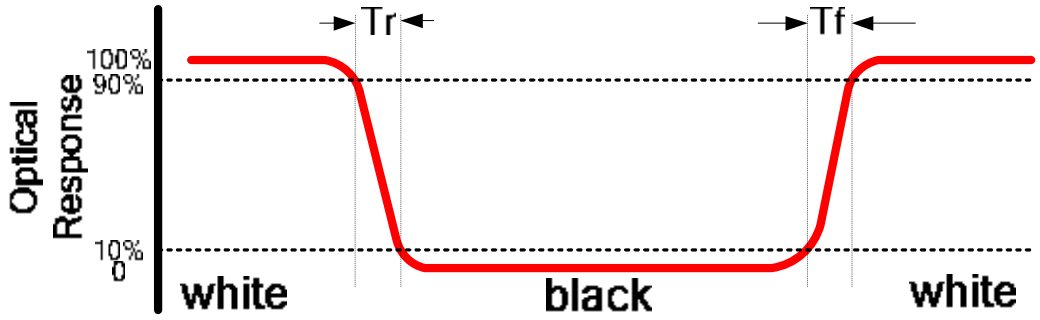


FIG.2. Measuring method for Contrast ratio,surface luminance, Luminance uniformity ， CIE (x, y) chromaticity

A : 5 mm
B : 5 mm
H,V : Active Area
Light spot size ∅=5mm, 500mm distance from the LCD surface to detector lens
measurement instrument is TOPCON's luminance meter BM-5

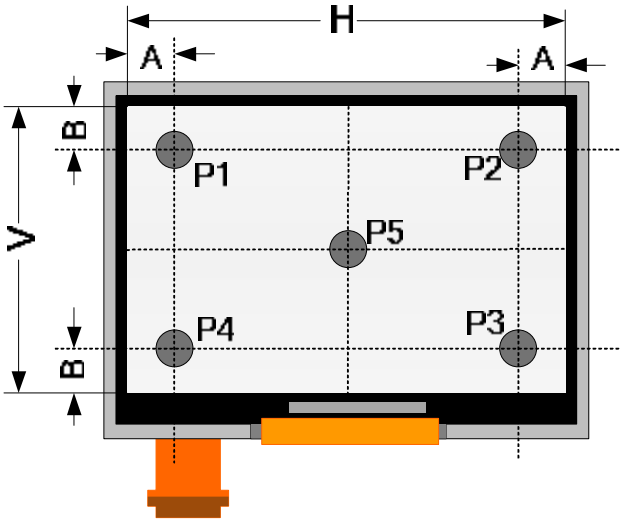
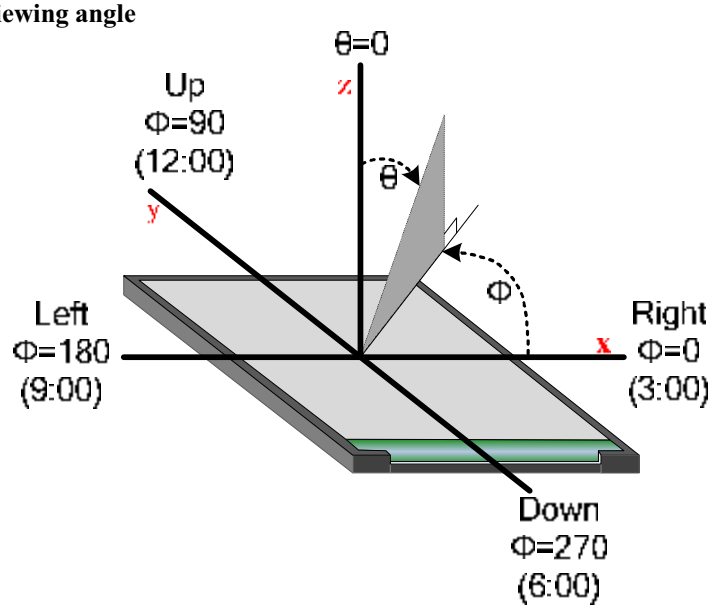


FIG.3. The definition of viewing angle



■ INTERFACE DESCRIPTION

Pin No.	Symbol	I/O	Function
1	LEDK	I	Cathode for LED backlighting
2	LEDA1	I	Anode No.1 for LED backlighting
3	LEDA2	I	Anode No.2 for LED backlighting
4	LEDA3	I	Anode No.3 for LED backlighting
5	LEDA4	I	Anode No.4 for LED backlighting
6	IM0	I	Select Interface Mode ;Note1
7	IM1	I	
8	IM2	I	
9	IM3	I	
10	RESET	I	Reset pin
11	VSYNC	IO	Frame Synchronizing Signal For RGB Interface
12	HSYNC	IO	Line Synchronizing Signal For RGB Interface
13	DOTCLK	IO	Dot Clock Signal For RGB Interface
14	DE	IO	Data Enable Signal For RGB Interface
15 | 32	DB17 | DB0	IO	DATA BUS
33	SDO	IO	Serial Output Signal
34	SDI	IO	Serial Input Signal
35	RD	IO	Read execution control pin
36	WRX(D/CX)	IO	Write execution control pin ; Serial Register select s Signal
37	D/CX(SCL)	IO	Register select signal; Serial Interface Clock
38	CSX	IO	Chip Select Signal
39	TE	IO	Tearing effect out pin synchronize MPU to frame writng
40	VDDI	P	Power Supply to the interface pins ,provide with 2.8V
41	VDDI	P	Power Supply to the interface pins ,provide with 2.8V
42	VCI	P	Logic power ,provide with 2.8V
43	GND	G	Ground
44	X+	O	Touch panel output
45	Y+	O	Touch panel output
46	X-	O	Touch panel output
47	Y-	O	Touch panel output
48	GND	O	Ground
49	GND	O	Ground
50	GND	-	Ground

NOTE1:

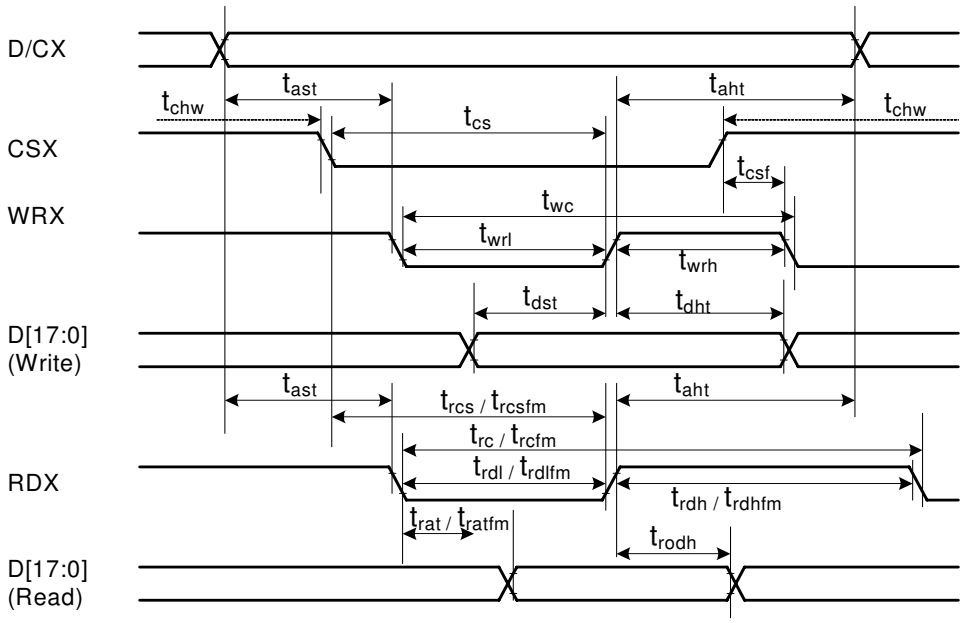
IM3	IM2	IM1	IM0	MCU-Interface Mode	Pins in use	
					Register/Content	GRAM
0	0	0	0	8080 MCU 8-bit bus interface Ⅰ	D[7:0]	D[7:0],WRX,RDX,CSX,D/CX
0	0	0	1	8080 MCU 16-bit bus interface Ⅰ	D[7:0]	D[15:0],WRX,RDX,CSX,D/CX
0	0	1	0	8080 MCU 9-bit bus interface Ⅰ	D[7:0]	D[8:0],WRX,RDX,CSX,D/CX
0	0	1	1	8080 MCU 18-bit bus interface Ⅰ	D[7:0]	D[17:0],WRX,RDX,CSX,D/CX
0	1	0	1	3-wire 9-bit data serial interface Ⅰ	SCL,SDA,CSX	
0	1	1	0	4-wire 8-bit data serial interface Ⅰ	SCL,SDA,D/CX,CSX	
1	0	0	0	8080 MCU 16-bit bus interface Ⅱ	D[8:1]	D[17:10],D[8:1],WRX,RDX,CSX,D/CX
1	0	0	1	8080 MCU 8-bit bus interface Ⅱ	D[17:10]	D[17:10],WRX,RDX,CSX,D/CX
1	0	1	0	8080 MCU 18-bit bus interface Ⅱ	D[8:1]	D[17:0],WRX,RDX,CSX,D/CX
1	0	1	1	8080 MCU 9-bit bus interface Ⅱ	D[17:10]	D[17:9],WRX,RDX,CSX,D/CX
1	1	0	1	3-wire 9-bit data serial interface Ⅱ	SCL,SDI,SDO, CSX	
1	1	1	0	4-wire 8-bit data serial interface Ⅱ	SCL,SDI,D/CX,SDO, CSX	

■ APPLICATION NOTES

1.1 Interface Timing Chart

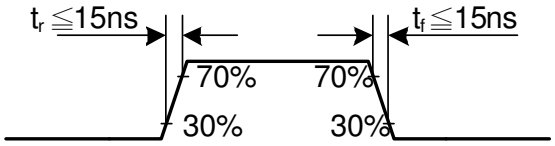
Note: Please refer to ILITEK's ILI9341 data sheet for more details.

ILITEK's ILI9341 INTERFACE PROTOCOL Inter 80 system CPU interface



Signal	Symbol	Parameter	min	max	Unit	Description
DCX	tast	Address setup time	0	-	ns	
	taht	Address hold time (Write/Read)	0	-	ns	
CSX	tchw	CSX "H" pulse width	0	-	ns	
	tcs	Chip Select setup time (Write)	15	-	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	Write Control pulse H duration	15	-	ns	
	twrl	Write Control pulse L duration	15	-	ns	
RDX (FM)	trcfm	Read Cycle (FM)	450	-	ns	
	trdhfm	Read Control H duration (FM)	90	-	ns	
	trdlfm	Read Control L duration (FM)	355	-	ns	
RDX (ID)	trc	Read cycle (ID)	160	-	ns	
	trdh	Read Control pulse H duration	90	-	ns	
	trdl	Read Control pulse L duration	45	-	ns	
D[17:0], D[17:10]&D[8:1], D[17:10], D[17:9]	tdst	Write data setup time	10	-	ns	For maximum CL=30pF For minimum CL=8pF
	tdht	Write data hold time	10	-	ns	
	trat	Read access time	-	40	ns	
	tratfm	Read access time	-	340	ns	
	trod	Read output disable time	20	80	ns	

Note: Ta = -30 to 70 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, VSS=0V.



INSTRUCTION DESCRIPTION(ILITEK's ILI9341

Regulative Command Set													
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
No Operation	0	1	↑	XX	0	0	0	0	0	0	0	0	00h
Software Reset	0	1	↑	XX	0	0	0	0	0	0	0	1	01h
Read Display Identification Information	0	1	↑	XX	0	0	0	0	0	1	0	0	04h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	ID1 [7:0]								XX
	1	↑	1	XX	ID2 [7:0]								XX
	1	↑	1	XX	ID3 [7:0]								XX
Read Display Status	0	1	↑	XX	0	0	0	0	1	0	0	1	09h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [31:25]							X	00
	1	↑	1	XX	X	D [22:20]			D [19:16]				61
	1	↑	1	XX	X	X	X	X	X	D [10:8]			00
	1	↑	1	XX	D [7:5]			X	X	X	X	X	00
Read Display Power Mode	0	1	↑	XX	0	0	0	0	1	0	1	0	0Ah
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	08
Read Display MADCTL	0	1	↑	XX	0	0	0	0	1	0	1	1	0Bh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Pixel Format	0	1	↑	XX	0	0	0	0	1	1	0	0	0Ch
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	RIM	DPI [2:0]			X	DBI [2:0]			06
Read Display Image Format	0	1	↑	XX	0	0	0	0	1	1	0	1	0Dh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	D [2:0]			00
Read Display Signal Mode	0	1	↑	XX	0	0	0	0	1	1	1	0	0Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Self-Diagnostic Result	0	1	↑	XX	0	0	0	0	1	1	1	1	0Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:6]		X	X	X	X	X	X	00
Enter Sleep Mode	0	1	↑	XX	0	0	0	1	0	0	0	0	10h
Sleep OUT	0	1	↑	XX	0	0	0	1	0	0	0	1	11h
Partial Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	0	12h
Normal Display Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	1	13h
Display Inversion OFF	0	1	↑	XX	0	0	1	0	0	0	0	0	20h
Display Inversion ON	0	1	↑	XX	0	0	1	0	0	0	0	1	21h
Gamma Set	0	1	↑	XX	0	0	1	0	0	1	1	0	26h
	1	1	↑	XX	GC [7:0]								01
Display OFF	0	1	↑	XX	0	0	1	0	1	0	0	0	28h
Display ON	0	1	↑	XX	0	0	1	0	1	0	0	1	29h
Column Address Set	0	1	↑	XX	0	0	1	0	1	0	1	0	2Ah
	1	1	↑	XX	SC [15:8]								XX
	1	1	↑	XX	SC [7:0]								XX
	1	1	↑	XX	EC [15:8]								XX
	1	1	↑	XX	EC [7:0]								XX
Page Address Set	0	1	↑	XX	0	0	1	0	1	0	1	1	2Bh
	1	1	↑	XX	SP [15:8]								XX
	1	1	↑	XX	SP [7:0]								XX
	1	1	↑	XX	EP [15:8]								XX
	1	1	↑	XX	EP [7:0]								XX

Memory Write	0	1	↑	XX	0	0	1	0	1	1	0	0	2Ch
	1	1	↑	D [17:0]									XX
Color SET	0	1	↑	XX	0	0	1	0	1	1	0	1	2Dh
	1	↑	1	XX			R00 [5:0]						XX
	1	↑	1	XX			Rnn [5:0]						XX
	1	↑	1	XX			R31 [5:0]						XX
	1	↑	1	XX			G00 [5:0]						XX
	1	↑	1	XX			Gnn [5:0]						XX
	1	↑	1	XX			G64 [5:0]						XX
	1	↑	1	XX			B00 [5:0]						XX
	1	↑	1	XX			Bnn [5:0]						XX
	1	↑	1	XX			B31 [5:0]						XX
Memory Read	0	1	↑	XX	0	0	1	0	1	1	1	0	2Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Partial Area	0	1	↑	XX	0	0	1	1	0	0	0	0	30h
	1	1	↑	XX	SR [15:8]								00
	1	1	↑	XX	SR [7:0]								00
	1	1	↑	XX	ER [15:8]								01
	1	1	↑	XX	ER [7:0]								3F
Vertical Scrolling Definition	0	1	↑	XX	0	0	1	1	0	0	1	1	33h
	1	1	↑	XX	TFA [15:8]								00
	1	1	↑	XX	TFA [7:0]								00
	1	1	↑	XX	VSA [15:8]								01
	1	1	↑	XX	VSA [7:0]								40
	1	1	↑	XX	BFA [15:8]								00
	1	1	↑	XX	BFA [7:0]								00
Tearing Effect Line OFF	0	1	↑	XX	0	0	1	1	0	1	0	0	34h
Tearing Effect Line ON	0	1	↑	XX	0	0	1	1	0	1	0	1	35h
	1	1	↑	XX	X	X	X	X	X	X	X	M	00
Memory Access Control	0	1	↑	XX	0	0	1	1	0	1	1	0	36h
	1	1	↑	XX	MY	MX	MV	ML	BGR	MH	X	X	00
Vertical Scrolling Start Address	0	1	↑	XX	0	0	1	1	0	1	1	1	37h
	1	1	↑	XX	VSP [15:8]								00
	1	1	↑	XX	VSP [7:0]								00
Idle Mode OFF	0	1	↑	XX	0	0	1	1	1	0	0	0	38h
Idle Mode ON	0	1	↑	XX	0	0	1	1	1	0	0	1	39h
Pixel Format Set	0	1	↑	XX	0	0	1	1	1	0	1	0	3Ah
	1	1	↑	XX	X	DPI [2:0]			X	DBI [2:0]			66
Write Memory Continue	0	1	↑	XX	0	0	1	1	1	1	0	0	3Ch
	1	1	↑	D [17:0]									XX
Read Memory Continue	0	1	↑	XX	0	0	1	1	1	1	1	0	3Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Set Tear Scanline	0	1	↑	XX	0	1	0	0	0	1	0	0	44h
	1	1	↑	XX	X	X	X	X	X	X	X	STS [8]	00
	1	1	↑	XX	STS [7:0]								00
Get Scanline	0	1	↑	XX	0	1	0	0	0	1	0	1	45h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	X	GTS [9:8]		00
	1	↑	1	XX	GTS [7:0]								00
Write Display Brightness	0	1	↑	XX	0	1	0	1	0	0	0	1	51h
	1	1	↑	XX	DBV [7:0]								00

Read Display Brightness	0	1	↑	XX	0	1	0	1	0	0	1	0	52h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	DBV [7:0]								00
Write CTRL Display	0	1	↑	XX	0	1	0	1	0	0	1	1	53h
	1	1	↑	XX	X	X	BCTRL	X	DD	BL	X	X	00
Read CTRL Display	0	1	↑	XX	0	1	0	1	0	1	0	0	54h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	BCTRL	X	DD	BL	X	X	00
Write Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	0	1	55h
	1	1	↑	XX	X	X	X	X	X	X	C [1:0]		00
Read Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	1	0	56h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	X	C [1:0]		00
Write CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	1	1	1	0	5Eh
	1	1	↑	XX	CMB [7:0]								00
Read CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	0	1	1	1	5Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	CMB [7:0]								00
Read ID1	0	1	↑	XX	1	1	0	1	1	0	1	0	DAh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	Module's Manufacture [7:0]								XX
Read ID2	0	1	↑	XX	1	1	0	1	1	0	1	1	DBh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver Version [7:0]								XX
Read ID3	0	1	↑	XX	1	1	0	1	1	1	0	0	DCh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver ID [7:0]								XX

Extended Command Set												
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
RGB Interface Signal Control	0	1	↑	XX	1	0	1	1	0	0	0	0	B0h
	1	1	↑	XX	ByPass_MODE	RCM [1:0]		X	VSPL	HSPL	DPL	EPL	40
Frame Control (In Normal Mode)	0	1	↑	XX	1	0	1	1	0	0	0	1	B1h
	1	1	↑	XX	X	X	X	X	X	X	DIVA [1:0]		00
	1	1	↑	XX	X	X	X	RTNA [4:0]					1B
Frame Control (In Idle Mode)	0	1	↑	XX	1	0	1	1	0	0	1	0	B2h
	1	1	↑	XX	X	X	X	X	X	X	DIVB [1:0]		00
	1	1	↑	XX	X	X	X	RTNB [4:0]					1B
Frame Control (In Partial Mode)	0	1	↑	XX	1	0	1	1	0	0	1	1	B3h
	1	1	↑	XX	X	X	X	X	X	X	DIVC [1:0]		00
	1	1	↑	XX	X	X	X	RTNC [4:0]					1B
Display Inversion Control	0	1	↑	XX	1	0	1	1	0	1	0	0	B4h
	1	1	↑	XX	X	X	X	X	X	NLA	NLB	NLC	02
Blanking Porch Control	0	1	↑	XX	1	0	1	1	0	1	0	1	B5h
	1	1	↑	XX	0	VFP [6:0]							02
	1	1	↑	XX	0	VBP [6:0]							02
	1	1	↑	XX	0	0	0	HFP [4:0]					0A
	1	1	↑	XX	0	0	0	HBP [4:0]					14

Display Function Control	0	1	↑	XX	1	0	1	1	0	1	1	0	B6h
	1	1	↑	XX	X	X	X	X	PTG [1:0]		PT [1:0]		0A
	1	1	↑	XX	REV	GS	SS	SM	ISC [3:0]				82
	1	1	↑	XX	X	X	NL [5:0]						27
	1	1	↑	XX	X	X	PCDIV [5:0]						XX
Entry Mode Set	0	1	↑	XX	1	0	1	1	0	1	1	1	B7h
	1	1	↑	XX	X	X	X	X	DSTB	GON	DTE	GAS	07
Backlight Control 1	0	1	↑	XX	1	0	1	1	1	0	0	0	B8h
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	X	X	X	X	TH_UI [3:0]				04
Backlight Control 2	0	1	↑	XX	1	0	1	1	1	0	0	1	B9h
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	TH_MV [3:0]				TH_ST [3:0]				B8
Backlight Control 3	0	1	↑	XX	1	0	1	1	1	0	1	0	BAh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	X	X	X	X	DTH_UI [3:0]				04
Backlight Control 4	0	1	↑	XX	1	0	1	1	1	0	1	1	BBh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	DTH_MV [3:0]				DTH_ST [3:0]				C9
Backlight Control 5	0	1	↑	XX	1	0	1	1	1	1	0	0	BCh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	DIM2 [3:0]				X	DIM1 [2:0]			44
Backlight Control 7	0	1	↑	XX	1	0	1	1	1	1	1	0	BEh
	1	1	↑	XX	PWM_DIV [7:0]								0F
Backlight Control 8	0	1	↑	XX	1	0	1	1	1	1	1	1	BFh
	1	1	↑	XX	X	X	X	X	X	LEDONR	LEDONPOL	LEDPWMOPL	00
Power Control 1	0	1	↑	XX	1	1	0	0	0	0	0	0	C0h
	1	1	↑	XX	X	X	VRH [5:0]						26
Power Control 2	0	1	↑	XX	1	1	0	0	0	0	0	1	C1h
	1	1	↑	XX	X	X	X	X	X	BT [2:0]			00
VCOM Control 1	0	1	↑	XX	1	1	0	0	0	1	0	1	C5h
	1	1	↑	XX	X	VMH [6:0]							31
	1	1	↑	XX	X	VML [6:0]							3C
VCOM Control 2	0	1	↑	XX	1	1	0	0	0	1	1	1	C7h
	1	1	↑	XX	nVM	VMF [6:0]							C0
NV Memory Write	0	1	↑	XX	1	1	0	1	0	0	0	0	D0h
	1	1	↑	XX	X	X	X	X	X	PGM_ADR [2:0]			00
	1	1	↑	XX	PGM_DATA [7:0]								XX
NV Memory Protection Key	0	1	↑	XX	1	1	0	1	0	0	0	1	D1h
	1	1	↑	XX	KEY [23:16]								55
	1	1	↑	XX	KEY [15:8]								AA
	1	1	↑	XX	KEY [7:0]								66
NV Memory Status Read	0	1	↑	XX	1	1	0	1	0	0	1	0	D2h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	ID2_CNT [2:0]			X	ID1_CNT [2:0]			XX
	1	↑	1	XX	BUSY	VMF_CNT [2:0]			X	ID3_CNT [2:0]			XX

Read ID4	0	↑	1	XX	1	1	0	1	0	0	1	1	D3h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	0	0	0	00
	1	↑	1	XX	1	0	0	1	0	0	1	1	93
	1	↑	1	XX	0	1	0	0	0	0	0	1	41
Positive Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	0	E0h
	1	1	↑	XX	X	X	X	X	VP0 [3:0]				08
	1	1	↑	XX	X	X	VP1 [5:0]						0E
	1	1	↑	XX	X	X	VP2 [5:0]						12
	1	1	↑	XX	X	X	X	X	VP4 [3:0]				05
	1	1	↑	XX	X	X	X	VP6 [4:0]					03
	1	1	↑	XX	X	X	X	X	VP13 [3:0]				09
	1	1	↑	XX	X	VP20 [6:0]							47
	1	1	↑	XX	VP36 [3:0]				VP27 [3:0]				86
	1	1	↑	XX	X	VP43 [6:0]							2B
	1	1	↑	XX	X	X	X	X	VP50 [3:0]				0B
	1	1	↑	XX	X	X	X	VP57 [4:0]					04
	1	1	↑	XX	X	X	X	X	VP59 [3:0]				00
	1	1	↑	XX	X	X	VP61 [5:0]						00
	1	1	↑	XX	X	X	VP62 [5:0]						00
	1	1	↑	XX	X	X	X	X	VP63 [3:0]				00
Negative Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	1	E1h
	1	1	↑	XX	X	X	X	X	VN0 [3:0]				08
	1	1	↑	XX	X	X	VN1 [5:0]						1A
	1	1	↑	XX	X	X	VN2 [5:0]						20
	1	1	↑	XX	X	X	X	X	VN4 [3:0]				07
	1	1	↑	XX	X	X	X	VN6 [4:0]					0E
	1	1	↑	XX	X	X	X	X	VN13 [3:0]				05
	1	1	↑	XX	X	VN20 [6:0]							3A
	1	1	↑	XX	VN36 [3:0]				VN27 [3:0]				8A
	1	1	↑	XX	X	VN43 [6:0]							40
	1	1	↑	XX	X	X	X	X	VN50 [3:0]				04
	1	1	↑	XX	X	X	X	VN57 [4:0]					18
	1	1	↑	XX	X	X	X	X	VN59 [3:0]				0F
	1	1	↑	XX	X	X	VN61 [5:0]						3F
	1	1	↑	XX	X	X	VN62 [5:0]						3F
	1	1	↑	XX	X	X	X	X	VN63 [3:0]				0F
Digital Gamma Control 1	0	1	↑	XX	1	1	1	0	0	0	1	0	E2h
1st Parameter	1	1	↑	XX	RCA0 [3:0]				BCA0 [3:0]				XX
:	1	1	↑	XX	RCAx [3:0]				BCAx [3:0]				XX
16th Parameter	1	1	↑	XX	RCA15 [3:0]				BCA15 [3:0]				XX
Digital Gamma Control 2	0	1	↑	XX	1	1	1	0	0	0	1	1	E3h
1st Parameter	1	1	↑	XX	RFA0 [3:0]				BFA0 [3:0]				XX
:	1	1	↑	XX	RFAx [3:0]				BFAx [3:0]				XX
64th Parameter	1	1	↑	XX	RFA63 [3:0]				BFA63 [3:0]				XX
Interface Control	0	1	↑	XX	1	1	1	1	0	1	1	0	F6h
	1	1	↑	XX	MY_EOR	MX_EOR	MV_EOR	X	BGR_EOR	X	X	WEMODE	01
	1	1	↑	XX	X	X	EPF [1:0]		X	X	MDT [1:0]		00
	1	1	↑	XX	X	X	ENDIAN	X	DM [1:0]		RM	RIM	00

Note 1: Undefined commands are treated as NOP (00h) command.

Note 2: B0 to D9 and DE to FF are for factory use of display supplier. USER can decide if these commands are available or they are treated as NOP (00h) commands before shipping to USER. Default value is NOP (00h).

Note 3: Commands 10h, 12h, 13h, 26h, 28h, 29h, 30h, 36h (Bit B4 only), 38h and 39h are updated during V-SYNC when ILI9341 is in Sleep OUT mode to avoid abnormal visual effects. During Sleep IN mode, these commands are updated immediately. Read status (09h), Read display power mode (0Ah), Read display MADCTL (0Bh), Read display pixel format (0Ch), Read display image mode (0Dh), Read display signal mode (0Eh) and Read display self diagnostic result (0Fh) of these commands are updated immediately both in Sleep IN mode and Sleep OUT mode.

■ INITIAL CODE

```
code void INIT()
{
        write_cmd(0x01);    //software reset
          delay(5);
          write_cmd(0x28);      // display off
//------------------------------------------------------------
          write_cmd(0xcf);
           write_data16(0x00,0x00);
          write_data16(0x00,0x83);
          write_data16(0x00,0x30);

            write_cmd(0xed);
           write_data16(0x00,0x64);
          write_data16(0x00,0x03);
          write_data16(0x00,0x12);
          write_data16(0x00,0x81);

          write_cmd(0xe8);
           write_data16(0x00,0x85);
          write_data16(0x00,0x01);
          write_data16(0x00,0x79);

          write_cmd(0xcb);
           write_data16(0x00,0x39);
          write_data16(0x00,0x2c);
          write_data16(0x00,0x00);
          write_data16(0x00,0x34);
          write_data16(0x00,0x02);

          write_cmd(0xf7);
           write_data16(0x00,0x20);

          write_cmd(0xea);
           write_data16(0x00,0x00);
          write_data16(0x00,0x00);


//------------power control-------------------------------
          write_cmd(0xc0);    //power control
          write_data16(0x00,0x26);

          write_cmd(0xc1);    //power control
          write_data16(0x00,0x11);
//--------------VCOM设定不符合开机会闪烁  ---------
          write_cmd(0xc5);    //vcom control
         write_data16(0x00,0x35);//35
          write_data16(0x00,0x3e);//3E

          write_cmd(0xc7);    //vcom control
          write_data16(0x00,0xbe); //     0x94
//------------memory access control------------------------
          write_cmd(0x36);      // memory access control
          write_data16(0x00,0x48); //0048        my,mx,mv,ml,BGR,mh,0.0

          write_cmd(0x3a);      // pixel format set
          write_data16(0x00,0x55);//16bit /pixel
//---------------- frame rate----------------------------
          write_cmd(0xb1);      //    frame rate
          write_data16(0x00,0x00);
          write_data16(0x00,0x1B);    //70

//----------------Gamma---------------------------------
          write_cmd(0xf2);    // 3Gamma Function Disable
          write_data16(0x00,0x08);

          write_cmd(0x26);
          write_data16(0x00,0x01); //    gamma set 4 gamma curve 01/02/04/08
```

```
                write_cmd(0xE0);    //positive gamma correction
                write_data16(0x00,0x1f);
                write_data16(0x00,0x1a);
                write_data16(0x00,0x18);
                write_data16(0x00,0x0a);
                write_data16(0x00,0x0f);
                write_data16(0x00,0x06);
                write_data16(0x00,0x45);
                write_data16(0x00,0x87);
                write_data16(0x00,0x32);
                write_data16(0x00,0x0a);
                write_data16(0x00,0x07);
                write_data16(0x00,0x02);
                write_data16(0x00,0x07);
                write_data16(0x00,0x05);
                write_data16(0x00,0x00);

                write_cmd(0xE1);    //negamma correction
                write_data16(0x00,0x00);
                write_data16(0x00,0x25);
                write_data16(0x00,0x27);
                write_data16(0x00,0x05);
                write_data16(0x00,0x10);
                write_data16(0x00,0x09);
                write_data16(0x00,0x3a);
                write_data16(0x00,0x78);
                write_data16(0x00,0x4d);
                write_data16(0x00,0x05);
                write_data16(0x00,0x18);
                write_data16(0x00,0x0d);
                write_data16(0x00,0x38);
                write_data16(0x00,0x3a);
                write_data16(0x00,0x1f);
//--------------ddram ---------------------
          write_cmd(0x2a);       // column set
             write_data16(0x00,0x00);
            write_data16(0x00,0x00);
            write_data16(0x00,0x00);
            write_data16(0x00,0xEF);

               write_cmd(0x2b);      // page address set
        write_data16(0x00,0x00);
             write_data16(0x00,0x00);
             write_data16(0x00,0x01);
             write_data16(0x00,0x3F);

           // write_cmd(0x34);      // tearing effect off
             //write_cmd(0x35);      // tearing effect on

              //write_cmd(0xb4);      // display inversion
              //write_data16(0x00,0x00);

              write_cmd(0xb7);    //entry mode set
              write_data16(0x00,0x07);
//-----------------display---------------------
              write_cmd(0xb6);      //    display function control
              write_data16(0x00,0x0a);
              write_data16(0x00,0x82);
             write_data16(0x00,0x27);
              write_data16(0x00,0x00);

                    write_cmd(0x11);    //sleep out
              delay(100);
                 write_cmd(0x29);      // display on
               delay(T00);
            write_cmd(0x2c);      //memory write
}
```

■ RELIABILITY TEST

No.	Test Item	Test Condition	Inspection after test
1	High Temperature Storage	80±2℃/96 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack; 6.Current Idd is twice higher than initial value. 7. The surface shall be free from damage. 8.Linearity must be no more than 1.5% by the linearity tester. 9..The Electric charact eristics requirements shall be satisfied.
2	Low Temperature Storage	-30±2℃/96 hours	
3	High Temperature Operating	70±2℃/96 hours	
4	Low Temperature Operating	-20±2℃/96 hours	
5	Temperature Cycle	-30±2℃~25~80±2℃×10cycles	
6	Damp Proof Test	60℃±5℃×90%RH/96 hours	
7	Vibration Test	Frequency：10Hz~55Hz~10Hz Amplitude：1.5mm, X，Y，Z direction for total 3hours (Packing condition)	
8	Drooping test	Drop to the ground from 1m height, one time, every side of carton. (Packing condition)	
9	ESD test	Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time	
10	Hitting test	1,000,000 times in the same point, Hitting pad: tip R3.75 mm,Silicone rubber, Hardness:40 deg.; Load: 2.45N; Hitting speed: Twice/sec; Electric load: None; Test area should be at 1.8 mm inside of insulation.	
11	Pen sliding durability test	100, 000 times minimum Hitting pad: tip R0.8 mm Plastic pen; Load: 1.47N; Sliding speed: 60 mm/sec; Electric load: None Test area should be at 1.8 mm inside of insulation.	

Remark:
1.The test samples should be applied to only one test item.
2.Sample size for each test item is 5~10pcs.
3.For Damp Proof Test, Pure water(Resistance＞10MΩ) should be used.
4.In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part.
5.EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.
6.Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

■ INSPECTION CRITERION

OUTGOING QUALITY STANDARD	PAGE 1 OF 7
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA	

This specification is made to be used as the standard acceptance/rejection criteria for Color mobile phone LCM with touch panel.

1 Sample plan

Sampling plan according to GB/T2828.1-2003/ISO 2859-1：1999 and ANSI/ASQC Z1.4-1993, normal level 2 and based on:

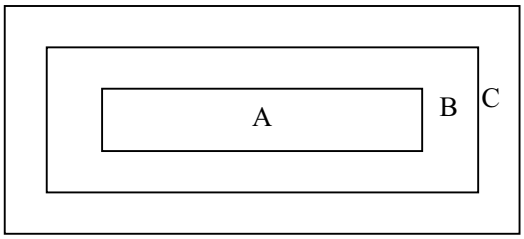
Major defect: AQL 0.65

Minor defect: AQL 1.5

2. Inspection condition

Viewing distance for cosmetic inspection is about 30cm with bare eyes, and under an environment of 20~40W light intensity, all directions for inspecting the sample should be within 45° against perpendicular line.

3. Definition of inspection zone in LCD.



Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)

Fig.1 Inspection zones in an LCD.

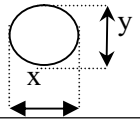
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

4. Inspection standards

4.1 Major Defect

Item No	Items to be inspected	Inspection Standard	Classification of defects
4.1.1	All functional defects	1) No display 2) Display abnormally 3) Missing vertical，horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting.	Major
4.1.2	Missing	Missing component	
4.1.3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	
4.1.4	linearity	No more than 1.5%	

4.2 Cosmetic Defect

Item No	Items to be inspected	Inspection Standard	Classification of defects
4.2.1	**Clear Spots** Black and white Spot defect Pinhole, Foreign Particle, polarizer Dirt	For dark/white spot, size Φ is defined as $\Phi = \frac{(x+y)}{2}$ 	Minor

1.

Zone / Size(mm)	Acceptable Qty A	B	C
Φ≤0.1	Ignore		
0.10<Φ≤0.15	**2**		Ignore
0.15<Φ≤0.20	**1**		
0.20<Φ	0		

4.2.1	**Clear Spots** TP Dirt	2.	Minor

2.

Zone / Size(mm)	Acceptable Qty A	B	C
Φ≤0.1	Ignore		
0.10<Φ≤0.15	**3**		Ignore
0.15<Φ≤0.25	**2**		
0.25<Φ	0		

	Dim Spots Circle shaped and dim edged defects	3. 2. Zone / Size(mm) | Acceptable Qty: A | B | C Φ≤0.2 | Ignore | Ignore 0.20<Φ≤0.40 | 2 | Ignore 0.40<Φ≤0.60 | 1 | Ignore 0.60<Φ | 0 | Ignore	Minor

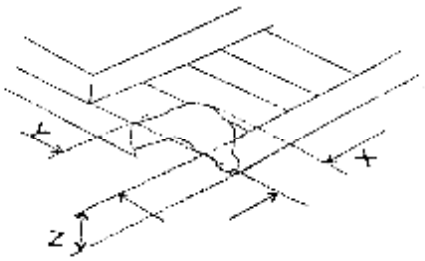
4.2 Cosmetic Defect

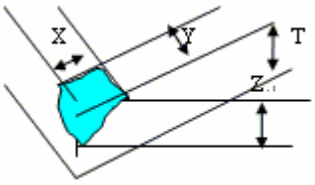
Item No	Items to be inspected	Inspection Standard	Classification of defects
4.2.2	**Line defect** Black line, White line, Foreign material on polarizer	size(mm): L(Length) | W(Width); Acceptable Qty: zone A | B | C Ignore | W≤0.02 | Ignore | Ignore | Ignore L≤3.0 | 0.02<W≤0.03 | 2 L≤2.0 | 0.03<W≤0.05 | 1 | 0.05<W | Define as spot defect	Minor
	Foreign material on TP film	The line can be seen after mobile phone in the operating condition: size(mm): L(Length) | W(Width); Acceptable Qty: zone A | B | C Ignore | W≤0.03 | Ignore | Ignore | Ignore L≤5.0 | 0.03<W≤0.05 | 3 | 0.05<W | Define as spot defect	
		If the scratch can be seen after mobile phone cover assembling or in the operating condition, judge by the line defect of 4.2.2. If the scratch can be seen only in non-operating condition or some special angle, judge by the following.	

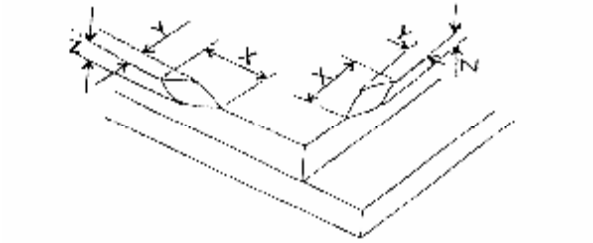
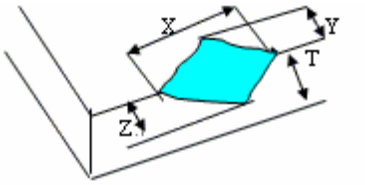
<table>
<tr><td>4.2.3</td><td>Dim line defect

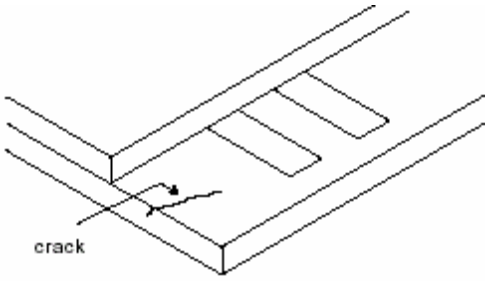
Polarizer scratch
TP film scratch</td><td>
<table>
<tr><td colspan="2">Size(mm)</td><td colspan="3">Acceptable Qty</td></tr>
<tr><td rowspan="2">L(Length)</td><td rowspan="2">W(Width)</td><td colspan="3">Zone</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>Ignore</td><td>W≤0.03</td><td colspan="2">Ignore</td><td rowspan="4">Ignore</td></tr>
<tr><td>5.0＜L≤10.0</td><td>0.03＜W≤0.05</td><td colspan="2">2</td></tr>
<tr><td>L≤5.0</td><td>0.05＜W≤0.08</td><td colspan="2">1</td></tr>
<tr><td></td><td>0.08＜W</td><td colspan="2">0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>4.2.4</td><td>Polarize
Air bubble</td><td>Air bubbles between glass & polarizer
<table>
<tr><td>2. Zone
Size(mm)</td><td colspan="3">Acceptable Qty</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>Φ≤0.2</td><td colspan="2">Ignore</td><td rowspan="4">Ignore</td></tr>
<tr><td>0.20＜Φ≤0.30</td><td colspan="2">2</td></tr>
<tr><td>0.30＜Φ≤0.50</td><td colspan="2">1</td></tr>
<tr><td>0.50＜Φ</td><td colspan="2">0</td></tr>
</table>
</td><td>Minor</td></tr>
</table>

4.3. Cosmetic Defect

<table>
<tr><td>Item No</td><td>Items to be inspected</td><td>Inspection Standard</td><td>Classification of defects</td></tr>
<tr><td></td><td></td><td>(i) Chips on corner
A:LCD Glass defect
 
<table>
<tr><td>X</td><td>Y</td><td>Z</td></tr>
<tr><td>≤2.0</td><td>≤S</td><td>Disregard</td></tr>
</table>
Notes: S=contact pad length
Chips on the corner of terminal shall not be allowed to extend into the ITO pad or expose perimeter seal.</td><td>Minor</td></tr>
</table>

<table>
<tr><td>4.3.5</td><td>Glass defect</td><td>B:TP Glass defect
 

<table>
<tr><th>X(mm)</th><th>Y(mm)</th><th>Z(mm)</th></tr>
<tr><td>≤3.0</td><td>≤3.0</td><td>Disregard</td></tr>
</table></td><td></td></tr>
<tr><td></td><td></td><td>(ii)Usual surface cracks
A:LCD Glass defect
 
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>≤3.0</td><td><Inner border line of the seal</td><td>Disregard</td></tr>
</table>
B:TP Glass defect
 

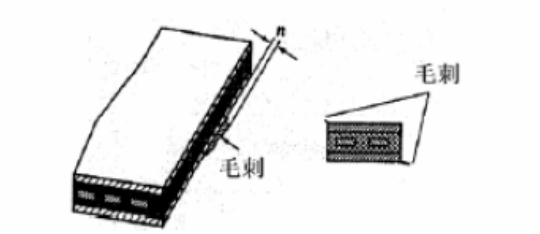
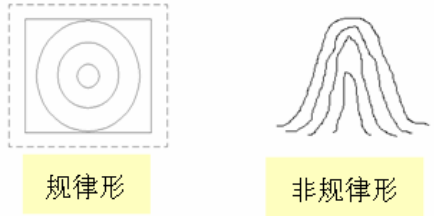
<table>
<tr><th>X(mm)</th><th>Y(mm)</th><th>Z(mm)</th></tr>
<tr><td>≤6.0</td><td><2.0</td><td>Disregard</td></tr>
</table></td><td>Minor</td></tr>
<tr><td></td><td></td><td>(iii) Crack
Cracks tend to break are not allowed.
 
</td><td>Major</td></tr>
</table>

OUTGOING QUALITY STANDARD	PAGE 6 OF 7
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA	

4.4 Parts Defect

Item No	Items to be inspected	Inspection Standard	Classification of defects
	4.4.1 Parts contraposition	1、Not allow IC and FPC/heat-seal lead width is more than 50% beyond lead pattern. 2、Not allow chip or solder component is off center more than 50% of the pad outline.	Major
	4.4.2 SMT	According to the <Acceptability of electronic assemblies> IPC-A-610C class 2 standard. Component missing or function defect are Major defect, the others are Minor defect.	

	OUTGOING QUALITY STANDARD	PAGE 7 OF 7
TITLE: FUNCTIONAL TEST & INSPECTION CRITERIA		

	4.4.3 TP Defect	1、 Pattern font： Pattern fonts are clear and symmetrical， pattern fonts filter lightly are allowed; The fort line is not allow to thinner or thicker than 1/3of normal size, and swing is not more than 0.1mm. the line is smooth and not broken.  图案字体 Pattern font 2、The wing forward in the side of Visual Area： The length of wing forward inside of the Visual Area: n≤0.2mm; Not excess 3 point， and the distanceD≥20mm。  3、Film impression:With operation, must be invisibility. 4、Touch panel knob：if writing function normally,it could be allowed.  TP鼓 TP knob 5、 Newton ring Without operation, the color circle of Regularity or Non-regularity from the normal or slope angle of view. 1、**Regularity：** The area of the newton ring is less than 1/3 area of the touch panel; and no character affected and line distorted after touch panel lightening. It’s ok. 2、 **Non-regularity** ： The area of the Newton ring is less than the 1/2 area of touch panel with lightening. And no character affected and line  规律形 非规律形	Minor

■ PRECAUTIONS FOR USING LCD MODULES

Handing Precautions

(1) The display panel is made of glass and polarizer. As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock by dropping it or impact.

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

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degraded insulation between terminals (some cosmetics are determined to the polarizer).

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on. Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

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

- Isopropyl alcohol
- Ethyl alcohol

Do not scrub hard to avoid damaging the display surface.

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contacting oil and fats.

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

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

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

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

(12) Electro-Static Discharge Control，Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC. To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential. Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded. make certain the AC power source for the soldering iron does not leak. When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions. To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended. As far as possible make the electric potential of your work clothes and that of the work bench the ground potential
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated

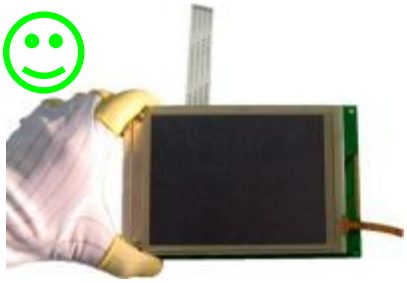
（13）Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.

- Do not alter, modify or change the shape of the tab on the metal frame.
- Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- Do not damage or modify the pattern writing on the printed circuit board.
- Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- Do not drop, bend or twist LCM.

Handling precaution for LCM

LCM is easy to be damaged. Please note below and be careful for handling.

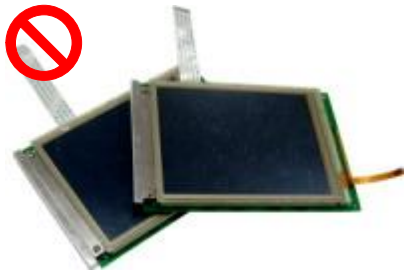
Correct handling:



As above picture, please handle with anti-static gloves around LCM edges.

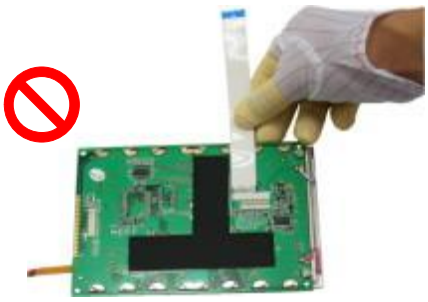
Incorrect handling:

Please don't touch IC directly.

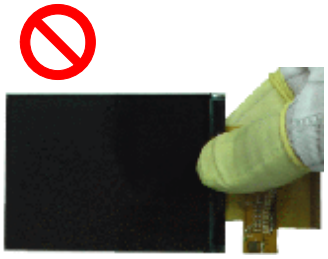


Please don't stack LCM.

Please don't hold the surface of panel.



Please don't stretch interface of output, such as FPC cable.



Please don't hold the surface of IC.

Please don't operate with sharp stick such as pens.

Storage Precautions

When storing the LCD modules, the following precaution is necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for the dessicant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C, and keep the relative humidity between 40%RH and 60%RH.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the anti-static electricity container in which they were shipped.

Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

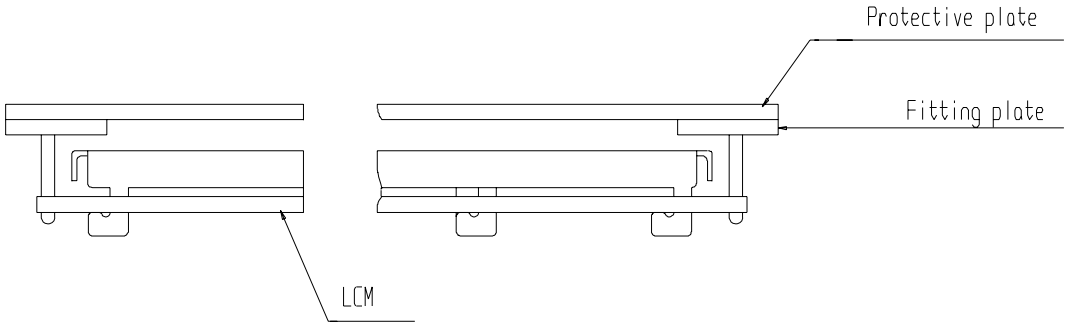
- Exposed area of the printed circuit board.
-Terminal electrode sections.

■ USING LCD MODULES

Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

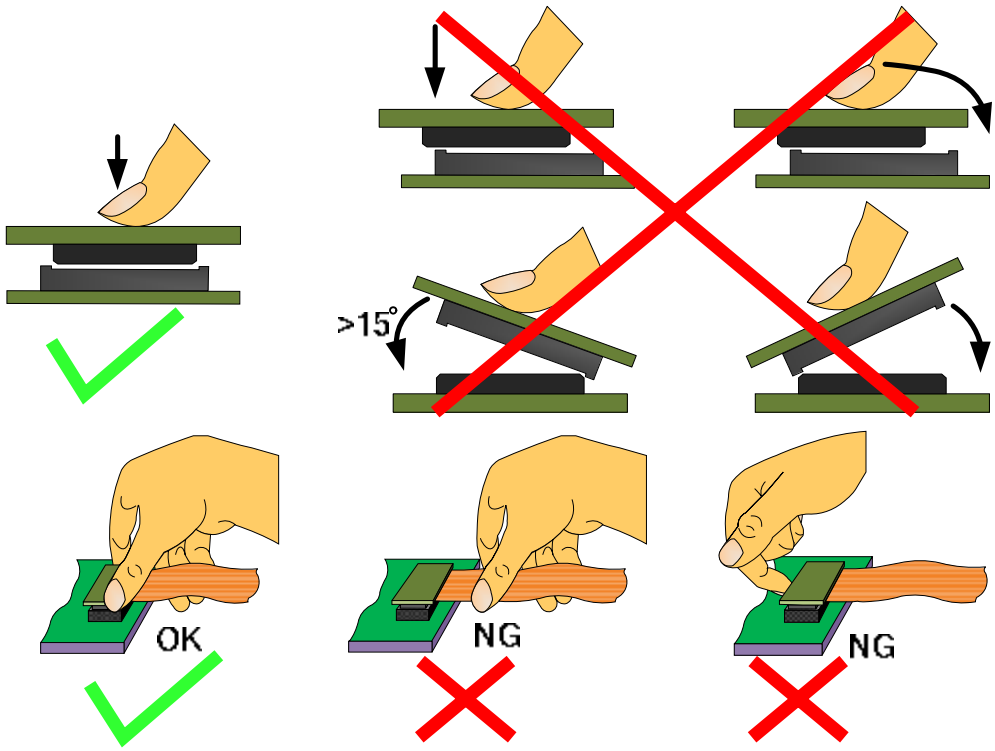
(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ±0.1mm.

Precaution for assemble the module with BTB connector:

Please note the position of the male and female connector position, don't assemble or assemble like the method which the following picture shows



Precaution for soldering the LCM

	Manual soldering	Machine drag soldering	Machine press soldering
No RoHS product	290°C ~350°C. Time : 3-5S.	330°C ~350°C. Speed : 4-8 mm/s.	300°C ~330°C. Time : 3-6S. Press: 0.8~1.2Mpa
RoHS product	340°C ~370°C. Time : 3-5S.	350°C ~370°C. Time : 4-8 mm/s.	330°C ~360°C. Time : 3-6S. Press: 0.8~1.2Mpa

(1) If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

Precautions for Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VLCD). Adjust VLCD to show the best contrast.

(2) It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage then the limit cause the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.

(3) Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, Which will come back in the specified operating temperature.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature, 50%RH or less is required.

(6) Input logic voltage before apply analog high voltage such as LCD driving voltage when power on. Remove analog high voltage before logic voltage when power off the module. Input each signal after the positive/negative voltage becomes stable.

(7) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

Limited Warranty

Unless agreed betweenMulti-Inno and customer,Multi-Inno will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with Multi-Inno LCD acceptance standards (copies available upon request) for a period of one year from date of production. Cosmetic/visual defects must be returned to Multi-Inno within 90 days of shipment. Confirmation of such date shall be based on data code on product. The warranty liability of Multi-Inno limited to repair and/or replacement on the terms set forth above. Multi-Inno will not be responsible for any subsequent or consequential events.

Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet is damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

■ PRIOR CONSULT MATTER

1.①For Multi-Inno standard products, we keep the right to change material, process ... for improving the product property without notice on our customer.

②For OEM products, if any change needed which may affect the product property, we will consult with our customer in advance.

2. If you have special requirement about reliability condition, please let us know before you start the test on our samples.

ILITEK
I Love Innovation

ILI9341

a-Si TFT LCD Single Chip Driver
240RGBx320 Resolution and 262K color

Specification
Preliminary

Version: V1.02
Document No.: ILI9341_DS_V1.02.pdf

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Table of Contents

1. Introduction

ILI9341 is a 262,144-color single-chip SOC driver for a-TFT liquid crystal display with resolution of 240RGBx320 dots, comprising a 720-channel source driver, a 320-channel gate driver, 172,800 bytes GRAM for graphic display data of 240RGBx320 dots, and power supply circuit.

ILI9341 supports parallel 8-/9-/16-/18-bit data bus MCU interface, 6-/16-/18-bit data bus RGB interface and 3-/4-line serial peripheral interface (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.

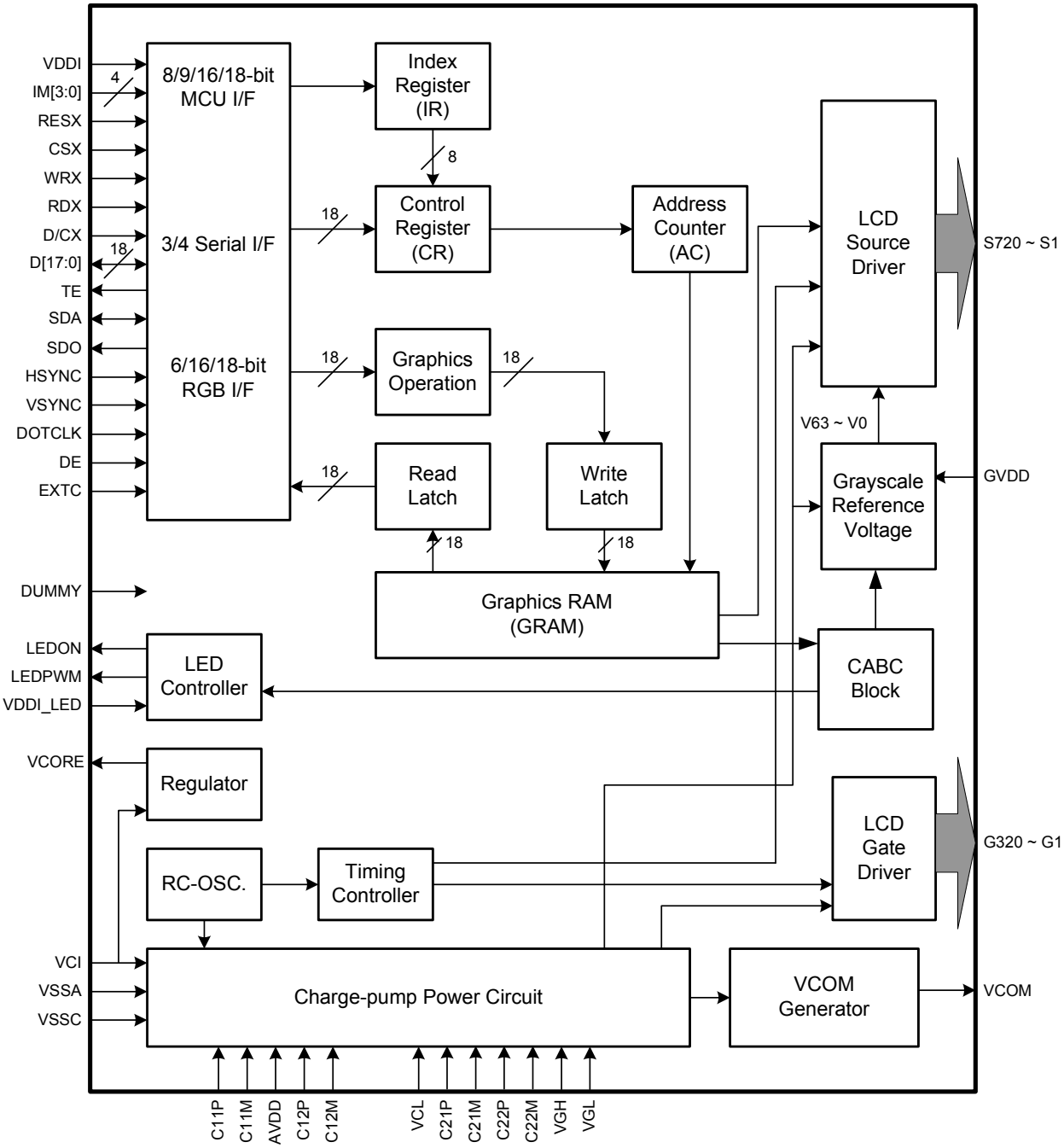
ILI9341 can operate with 1.65V ~ 3.3V I/O interface voltage and an incorporated voltage follower circuit to generate voltage levels for driving an LCD. ILI9341 supports full color, 8-color display mode and sleep mode for precise power control by software and these features make the ILI9341 an ideal LCD 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: [240xRGB](H) x 320(V)
- Output:
  - 720 source outputs
  - 320 gate outputs
  - Common electrode output (VCOM)
- a-TFT LCD driver with on-chip full display RAM: 172,800 bytes
- System Interface
  - 8-bits, 9-bits, 16-bits, 18-bits interface with 8080-Ⅰ/8080-Ⅱ series MCU
  - 6-bits, 16-bits, 18-bits RGB interface with graphic controller
  - 3-line / 4-line serial interface
- Display mode:
  - Full color mode (Idle mode OFF): 262K-color (selectable color depth mode by software)
  - Reduce color mode (Idle mode ON): 8-color
- Power saving mode:
  - Sleep mode
  - Deep standby mode
- On chip functions:
  - VCOM generator and adjustment
  - Timing generator
  - Oscillator
  - DC/DC converter
  - Line/frame inversion
  - 1 preset Gamma curve with separate RGB Gamma correction
- Content Adaptive Brightness Control
- MTP (3 times):
  - 8-bits for ID1, ID2, ID3
  - 7-bits for VCOM adjustment

- Low -power consumption architecture
  - Low operating power supplies:
    - VDDI = 1.65V ~ 3.3V (logic)
    - VCI = 2.5V ~ 3.3V (analog)
- LCD Voltage drive:
  - Source/VCOM power supply voltage
    - AVDD - GND = 4.5V ~ 5.5V
    - VCL - GND = -2.0V ~ -3.0V
  - Gate driver output voltage
    - VGH - GND = 10.0V ~ 20.0V
    - VGL - GND = -5.0V ~ -15.0V
    - VGH - VGL ≦ 32V
  - VCOM driver output voltage
    - VCOMH = 3.0V ~ (AVDD – 0.5)V
    - VCOML = (VCL+0.5)V ~ 0V
    - VCOMH - VCOML ≦ 6.0V
- Operate temperature range: -40℃ to 85℃
- a-Si TFT LCD storage capacitor : Cst on Common structure only

3. Block Diagram



4. Pin Descriptions

Power Supply Pins			
Pin Name	**I/O**	**Type**	**Descriptions**
VDDI	I	P	Low voltage power supply for interface logic circuits (1.65 ~ 3.3 V)
VDDI_LED	I		Power supply for LED driver interface. (1.65 ~ 3.3 V) If LED driver is not used, fix this pin at VDDI.
VCI	I	Analog Power	High voltage power supply for analog circuit blocks (2.5 ~ 3.3 V)
Vcore	O	Digital Power	Regulated Low voltage level for interface circuits Connect a capacitor for stabilization. Don't apply any external power to this pad
VSS3	I	I/O Ground	System ground level for I/O circuits.
VSS	I	Digital Ground	System ground level for logic blocks
VSSA	I	Analog Ground	System ground level for analog circuit blocks Connect to VSS on the FPC to prevent noise.
VSSC	I	Analog Ground	System ground level for analog circuit blocks Connect to VSS on the FPC to prevent noise

Interface Logic Signals			
Pin Name	**I/O**	**Type**	**Descriptions**
IM[3:0]	I	(VDDI/VSS)	- Select the MCU interface mode

IM3	IM2	IM1	IM0	MCU-Interface Mode	DB Pin in use	
					Register/Content	GRAM
0	0	0	0	80 MCU 8-bit bus interface Ⅰ	D[7:0]	D[7:0]
0	0	0	1	80 MCU 16-bit bus interface Ⅰ	D[7:0]	D[15:0]
0	0	1	0	80 MCU 9-bit bus interface Ⅰ	D[7:0]	D[8:0]
0	0	1	1	80 MCU 18-bit bus interface Ⅰ	D[7:0]	D[17:0]
0	1	0	1	3-wire 9-bit data serial interface Ⅰ	SDA: In/OUT	
0	1	1	0	4-wire 8-bit data serial interface Ⅰ	SDA: In/OUT	
1	0	0	0	80 MCU 16-bit bus interface Ⅱ	D[8:1]	D[17:10], D[8:1]
1	0	0	1	80 MCU 8-bit bus interface Ⅱ	D[17:10]	D[17:10]
1	0	1	0	80 MCU 18-bit bus interface Ⅱ	D[8:1]	D[17:0]
1	0	1	1	80 MCU 9-bit bus interface Ⅱ	D[17:10]	D[17:9]
1	1	0	1	3-wire 9-bit data serial interface Ⅱ	SDI: In SDO: Out	
1	1	1	0	4-wire 8-bit data serial interface Ⅱ	SDI: In SDO: Out	

MPU Parallel interface bus and serial interface select

If use RGB Interface must select serial interface.

* : Fix this pin at VDDI or VSS.

RESX	I	MCU (VDDI/VSS)	This signal will reset the device and must be applied to properly initialize the chip. Signal is active low.
EXTC	I	MCU (VDDI/VSS)	Extended command set enable. Low: extended command set is discarded. High: extended command set is accepted. Please connect EXTC to VDDI to read/write extended registers (RB0h~RCFh, RE0h~RFFh)
CSX	I	MCU (VDDI/VSS)	Chip select input pin (“Low” enable). This pin can be permanently fixed “Low” in MPU interface mode only. * note1,2
D/CX (SCL)	I	MCU (VDDI/VSS)	This pin is used to select “Data or Command” in the parallel interface or 4-wire 8-bit serial data interface. When DCX = ’1’, data is selected. When DCX = ’0’, command is selected. This pin is used serial interface clock in 3-wire 9-bit / 4-wire 8-bit serial data interface. If not used, this pin should be connected to VDDI or VSS.
RDX	I	MCU (VDDI/VSS)	8080-Ⅰ/8080-Ⅱ system (RDX): Serves as a read signal and MCU read data at the rising edge. *Fix to VDDI level when not in use.*
WRX (D/CX)	I	MCU (VDDI/VSS)	- 8080-Ⅰ/8080-Ⅱ system (WRX): Serves as a write signal and writes data at the rising edge. - 4-line system (D/CX): Serves as command or parameter select. *Fix to VDDI level when not in use.*
D[17:0]	I/O	MCU (VDDI/VSS)	18-bit parallel bi-directional data bus for MCU system and RGB interface mode *Fix to VSS level when not in use*
SDI/SDA	I/O	MCU (VDDI/VSS)	When IM[3] : Low, Serial in/out signal. When IM[3] : High, Serial input signal. The data is applied on the rising edge of the SCL signal. If not used, fix this pin at VDDI or VSS.
SDO	O	MCU (VDDI/VSS)	Serial output signal. The data is outputted on the falling edge of the SCL signal. If not used, open this pin
TE	O	MCU (VDDI/VSS)	Tearing effect output pin to synchronize MPU to frame writing, activated by S/W command. When this pin is not activated, this pin is low. If not used, open this pin.
DOTCLK	I	MCU (VDDI/VSS)	Dot clock signal for RGB interface operation. *Fix to VDDI or VSS level when not in use.*
VSYNC	I	MCU (VDDI/VSS)	Frame synchronizing signal for RGB interface operation. *Fix to VDDI or VSS level when not in use.*
HSYNC	I	MCU (VDDI/VSS)	Line synchronizing signal for RGB interface operation. *Fix to VDDI or VSS level when not in use.*
DE	I	MCU (VDDI/VSS)	Data enable signal for RGB interface operation. *Fix to VDDI or VSS level when not in use.*

Note.

1. If CSX is connected to VSS in Parallel interface mode, there will be no abnormal visible effect to the display module. Also there will be no restriction on using the Parallel Read/Write protocols, Power On/Off Sequences or other functions. Furthermore there will be no influence to the Power Consumption of the display module.

2. When CSX='1', there is no influence to the parallel and serial interface.

LCD Driver Input/Output Pins			
Pin Name	**I/O**	**Type**	**Descriptions**
S720~S1	O	Source	Source output signals.. *Leave the pin to open when not in use.*
G320~G1	O	Gate	Gate output signals. *Leave the pin to open when not in use.*
AVDD	O	Power Stabilizing capacitor	Output voltage of 1st step up circuit (2 x VCI). Input voltage to 2nd step up circuit. Generated power output pad for source driver block. Connect this pad to the capacitor for stabilization.
VGH	O	Power Stabilizing capacitor	Power supply for the gate driver. Adjust the VGH level with the BT[2:0] bits. Connect this pad with a stabilizing capacitor.
VGL	O	Power Stabilizing capacitor	Power supply for the gate driver. Adjust the VGL level with the BT[2:0] bits. Connect this pad with a stabilizing capacitor.
VCL	0	Power Stabilizing capacitor	Power supply for VCOML. VCL = 0~ - VCI Connect this pad with a stabilizing capacitor.
C11P, C11M C12P, C12M	P	Stabilizing capacitor	Connect the charge-pumping capacitor for generating AVDD level.
C21P, C21M C22P, C22M	P	Stabilizing capacitor	Connect the charge-pumping capacitor for generating VGH, VGL level.
GVDD	O		High reference voltage for grayscale voltage generator. Internal register can be used to adjust the voltage.
VCOM	O		Power supply pad for the TFT- display counter electrode. Charge recycling method is used with VCI and VSSA voltage. Connect this pad to the TFT-display counter electrode.
LEDPWM	O		Output pin for PWM (Pulse Width Modulation) signal of LED driving. If not used, open this pad.
LEDON	O		Output pin for enabling LED driving. If not used, open this pad.

Test Pins			
Pin Name	**I/O**	**Type**	**Descriptions**
DUMMY	-	Open	Input pads used only for test purpose at IC-side. During normal operation, leave these pads open.

Liquid crystal power supply specifications Table

No.	Item		Description
1	TFT Source Driver		720 pins (240 x RGB)
2	TFT Gate Driver		320 pins
3	TFT Display's Capacitor Structure		Cst structure only (Cs on Common)
4	Liquid Crystal Drive Output	S1 ~ S720	V0 ~ V63 grayscales
		G1 ~ G320	VGH - VGL
		VCOM	VCOMH - VCOML: Amplitude = electronic volumes
5	Input Voltage	VDDI	1.65V ~ 3.30V
		VCI	2.50V ~ 3.30V
6	Liquid Crystal Drive Voltages	AVDD	4.5V ~ 5.5V
		VGH	10.0V ~ 20.0V
		VGL	-5.0V ~ -15.0V
		VCL	-1.9V ~ -3.0V
		VGH - VGL	Max. 32.0V
7	Internal Step-up Circuits	AVDD	VCI x2,
		VGH	VCI x6, x7
		VGL	VCI x-5, x-6,
		VCL	VCI x-1

5. Pad Arrangement and Coordination

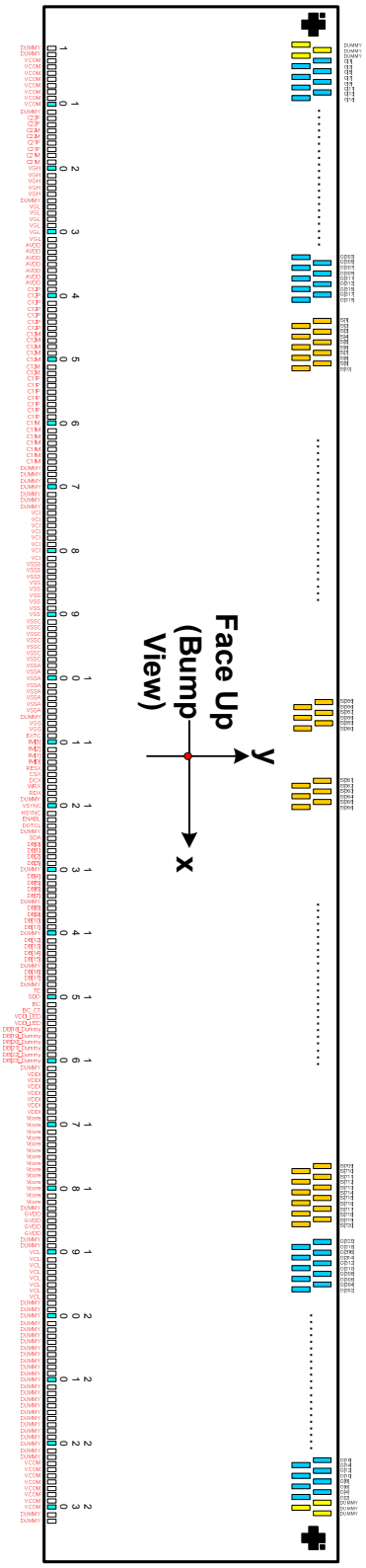
Chip Size: 15560um x 650um

Chip thickness : 280um (typ.)

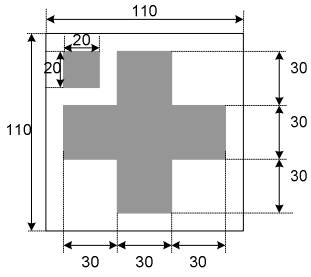
Pad Location: Pad Center.

Coordinate Origin: Chip center

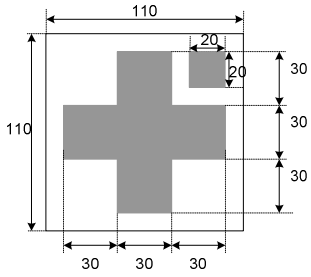
Au bump height: 12um (typ.)



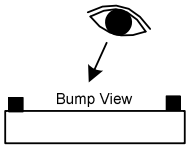
Alignment Marks



Alignment Mark: A1



Alignment Mark: A2



No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1	DUMMY	-7292.5	-248	51	C12M	-4292.5	-248	101	VSSA	-1292.5	-248	151	LEDPWM	2245	-248
2	DUMMY	-7232.5	-248	52	C12M	-4232.5	-248	102	VSSA	-1232.5	-248	152	LEDON	2330	-248
3	VCOM	-7172.5	-248	53	C11P	-4172.5	-248	103	VSSA	-1172.5	-248	153	VDDI_LED	2402.5	-248
4	VCOM	-7112.5	-248	54	C11P	-4112.5	-248	104	VSSA	-1112.5	-248	154	VDDI_LED	2462.5	-248
5	VCOM	-7052.5	-248	55	C11P	-4052.5	-248	105	VSSA	-1052.5	-248	155	DB[18]_Dummy	2535	-248
6	VCOM	-6992.5	-248	56	C11P	-3992.5	-248	106	DUMMY	-992.5	-248	156	DB[19]_Dummy	2620	-248
7	VCOM	-6932.5	-248	57	C11P	-3932.5	-248	107	VGS	-932.5	-248	157	DB[20]_Dummy	2705	-248
8	VCOM	-6872.5	-248	58	C11P	-3872.5	-248	108	VGS	-872.5	-248	158	DB[21]_Dummy	2790	-248
9	VCOM	-6812.5	-248	59	C11P	-3812.5	-248	109	EXTC	-812.5	-248	159	DB[22]_Dummy	2875	-248
10	VCOM	-6752.5	-248	60	C11M	-3752.5	-248	110	IM<3>	-752.5	-248	160	DB[23]_Dummy	2960	-248
11	DUMMY	-6692.5	-248	61	C11M	-3692.5	-248	111	IM<2>	-692.5	-248	161	DUMMY	3032.5	-248
12	C22P	-6632.5	-248	62	C11M	-3632.5	-248	112	IM<1>	-632.5	-248	162	VDDI	3092.5	-248
13	C22P	-6572.5	-248	63	C11M	-3572.5	-248	113	IM<0>	-572.5	-248	163	VDDI	3152.5	-248
14	C22M	-6512.5	-248	64	C11M	-3512.5	-248	114	RESX	-512.5	-248	164	VDDI	3212.5	-248
15	C22M	-6452.5	-248	65	C11M	-3452.5	-248	115	CSX	-452.5	-248	165	VDDI	3272.5	-248
16	C21P	-6392.5	-248	66	C11M	-3392.5	-248	116	DCX	-392.5	-248	166	VDDI	3332.5	-248
17	C21P	-6332.5	-248	67	(GND)	-3332.5	-248	117	WRX	-332.5	-248	167	VDDI	3392.5	-248
18	C21M	-6272.5	-248	68	(GND)	-3272.5	-248	118	RDX	-272.5	-248	168	VDDI	3452.5	-248
19	C21M	-6212.5	-248	69	(GND)	-3212.5	-248	119	DUMMY	-212.5	-248	169	Vcore	3512.5	-248
20	VGH	-6152.5	-248	70	(GND)	-3152.5	-248	120	VSYNC	-152.5	-248	170	Vcore	3572.5	-248
21	VGH	-6092.5	-248	71	(GND)	-3092.5	-248	121	HSYNC	-92.5	-248	171	Vcore	3632.5	-248
22	VGH	-6032.5	-248	72	(GND)	-3032.5	-248	122	ENABL	-32.5	-248	172	Vcore	3692.5	-248
23	VGH	-5972.5	-248	73	(GND)	-2972.5	-248	123	DOTCLK	27.5	-248	173	Vcore	3752.5	-248
24	VGH	-5912.5	-248	74	VCI	-2912.5	-248	124	DUMMY	87.5	-248	174	Vcore	3812.5	-248
25	DUMMY	-5852.5	-248	75	VCI	-2842.5	-248	125	SDA	160	-248	175	Vcore	3872.5	-248
26	VGL	-5792.5	-248	76	VCI	-2792.5	-248	126	DB[0]	245	-248	176	Vcore	3932.5	-248
27	VGL	-5732.5	-248	77	VCI	-2732.5	-248	127	DB[1]	330	-248	177	Vcore	3992.5	-248
28	VGL	-5672.5	-248	78	VCI	-2672.5	-248	128	DB[2]	415	-248	178	Vcore	4052.5	-248
29	VGL	-5612.5	-248	79	VCI	-2612.5	-248	129	DB[3]	500	-248	179	Vcore	4112.5	-248
30	VGL	-5552.5	-248	80	VCI	-2552.5	-248	130	DUMMY	572.5	-248	180	Vcore	4172.5	-248
31	VGL	-5492.5	-248	81	VCI	-2492.5	-248	131	DB[4]	645	-248	181	Vcore	4232.5	-248
32	AVDD	-5432.5	-248	82	VSS3	-2432.5	-248	132	DB[5]	730	-248	182	Vcore	4292.5	-248
33	AVDD	-5372.5	-248	83	VSS3	-2372.5	-248	133	DB[6]	815	-248	183	DUMMY	4352.5	-248
34	AVDD	-5312.5	-248	84	VSS3	-2312.5	-248	134	DB[7]	900	-248	184	GVDD	4412.5	-248
35	AVDD	-5252.5	-248	85	VSS	-2252.5	-248	135	DUMMY	972.5	-248	185	GVDD	4472.5	-248
36	AVDD	-5192.5	-248	86	VSS	-2192.5	-248	136	DB[8]	1045	-248	186	GVDD	4532.5	-248
37	AVDD	-5132.5	-248	87	VSS	-2132.5	-248	137	DB[9]	1130	-248	187	GVDD	4592.5	-248
38	AVDD	-5072.5	-248	88	VSS	-2072.5	-248	138	DB[10]	1215	-248	188	DUMMY	4652.5	-248
39	C12P	-5012.5	-248	89	VSS	-2012.5	-248	139	DB[11]	1300	-248	189	DUMMY	4712.5	-248
40	C12P	-4952.5	-248	90	VSS	-1952.5	-248	140	DUMMY	1372.5	-248	190	VCL	4772.5	-248
41	C12P	-4892.5	-248	91	VSSC	-1892.5	-248	141	DB[12]	1445	-248	191	VCL	4832.5	-248
42	C12P	-4832.5	-248	92	VSSC	-1832.5	-248	142	DB[13]	1530	-248	192	VCL	4892.5	-248
43	C12P	-4772.5	-248	93	VSSC	-1772.5	-248	143	DB[14]	1615	-248	193	VCL	4952.5	-248
44	C12P	-4712.5	-248	94	VSSC	-1712.5	-248	144	DB[15]	1700	-248	194	VCL	5012.5	-248
45	C12P	-4652.5	-248	95	VSSC	-1652.5	-248	145	DUMMY	1772.5	-248	195	VCL	5072.5	-248
46	C12M	-4592.5	-248	96	VSSC	-1592.5	-248	146	DB[16]	1845	-248	196	VCL	5132.5	-248
47	C12M	-4532.5	-248	97	VSSC	-1532.5	-248	147	DB[17]	1930	-248	197	VCL	5192.5	-248
48	C12M	-4472.5	-248	98	VSSA	-1472.5	-248	148	DUMMY	2002.5	-248	198	DUMMY	5252.5	-248
49	C12M	-4412.5	-248	99	VSSA	-1412.5	-248	149	TE	2075	-248	199	DUMMY	5312.5	-248
50	C12M	-4352.5	-248	100	VSSA	-1352.5	-248	150	SDO	2160	-248	200	DUMMY	5372.5	-248

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
201	DUMMY	5432.5	-248	251	G32	7147	224	301	G132	6447	224	351	G232	5747	224
202	DUMMY	5492.5	-248	252	G34	7133	93	302	G134	6433	93	352	G234	5733	93
203	DUMMY	5552.5	-248	253	G36	7119	224	303	G136	6419	224	353	G236	5719	224
204	DUMMY	5612.5	-248	254	G38	7105	93	304	G138	6405	93	354	G238	5705	93
205	DUMMY	5672.5	-248	255	G40	7091	224	305	G140	6391	224	355	G240	5691	224
206	(GND)	5732.5	-248	256	G42	7077	93	306	G142	6377	93	356	G242	5677	93
207	(GND)	5792.5	-248	257	G44	7063	224	307	G144	6363	224	357	G244	5663	224
208	(GND)	5852.5	-248	258	G46	7049	93	308	G146	6349	93	358	G246	5649	93
209	(GND)	5912.5	-248	259	G48	7035	224	309	G148	6335	224	359	G248	5635	224
210	(GND)	5972.5	-248	260	G50	7021	93	310	G150	6321	93	360	G250	5621	93
211	(GND)	6032.5	-248	261	G52	7007	224	311	G152	6307	224	361	G252	5607	224
212	(GND)	6092.5	-248	262	G54	6993	93	312	G154	6293	93	362	G254	5593	93
213	(GND)	6152.5	-248	263	G56	6979	224	313	G156	6279	224	363	G256	5579	224
214	DUMMY	6212.5	-248	264	G58	6965	93	314	G158	6265	93	364	G258	5565	93
215	DUMMY	6272.5	-248	265	G60	6951	224	315	G160	6251	224	365	G260	5551	224
216	DUMMY	6332.5	-248	266	G62	6937	93	316	G162	6237	93	366	G262	5537	93
217	DUMMY	6392.5	-248	267	G64	6923	224	317	G164	6223	224	367	G264	5523	224
218	DUMMY	6452.5	-248	268	G66	6909	93	318	G166	6209	93	368	G266	5509	93
219	DUMMY	6512.5	-248	269	G68	6895	224	319	G168	6195	224	369	G268	5495	224
220	DUMMY	6572.5	-248	270	G70	6881	93	320	G170	6181	93	370	G270	5481	93
221	DUMMY	6632.5	-248	271	G72	6867	224	321	G172	6167	224	371	G272	5467	224
222	DUMMY	6692.5	-248	272	G74	6853	93	322	G174	6153	93	372	G274	5453	93
223	VCOM	6752.5	-248	273	G76	6839	224	323	G176	6139	224	373	G276	5439	224
224	VCOM	6812.5	-248	274	G78	6825	93	324	G178	6125	93	374	G278	5425	93
225	VCOM	6872.5	-248	275	G80	6811	224	325	G180	6111	224	375	G280	5411	224
226	VCOM	6932.5	-248	276	G82	6797	93	326	G182	6097	93	376	G282	5397	93
227	VCOM	6992.5	-248	277	G84	6783	224	327	G184	6083	224	377	G284	5383	224
228	VCOM	7052.5	-248	278	G86	6769	93	328	G186	6069	93	378	G286	5369	93
229	VCOM	7112.5	-248	279	G88	6755	224	329	G188	6055	224	379	G288	5355	224
230	VCOM	7172.5	-248	280	G90	6741	93	330	G190	6041	93	380	G290	5341	93
231	DUMMY	7232.5	-248	281	G92	6727	224	331	G192	6027	224	381	G292	5327	224
232	DUMMY	7292.5	-248	282	G94	6713	93	332	G194	6013	93	382	G294	5313	93
233	DUMMY	7399	224	283	G96	6699	224	333	G196	5999	224	383	G296	5299	224
234	DUMMY	7385	93	284	G98	6685	93	334	G198	5985	93	384	G298	5285	93
235	DUMMY	7371	224	285	G100	6671	224	335	G200	5971	224	385	G300	5271	224
236	G2	7357	93	286	G102	6657	93	336	G202	5957	93	386	G302	5257	93
237	G4	7343	224	287	G104	6643	224	337	G204	5943	224	387	G304	5243	224
238	G6	7329	93	288	G106	6629	93	338	G206	5929	93	388	G306	5229	93
239	G8	7315	224	289	G108	6615	224	339	G208	5915	224	389	G308	5215	224
240	G10	7301	93	290	G110	6601	93	340	G210	5901	93	390	G310	5201	93
241	G12	7287	224	291	G112	6587	224	341	G212	5887	224	391	G312	5187	224
242	G14	7273	93	292	G114	6573	93	342	G214	5873	93	392	G314	5173	93
243	G16	7259	224	293	G116	6559	224	343	G216	5859	224	393	G316	5159	224
244	G18	7245	93	294	G118	6545	93	344	G218	5845	93	394	G318	5145	93
245	G20	7231	224	295	G120	6531	224	345	G220	5831	224	395	G320	5131	224
246	G22	7217	93	296	G122	6517	93	346	G222	5817	93	396	S720	5075	93
247	G24	7203	224	297	G124	6503	224	347	G224	5803	224	397	S719	5061	224
248	G26	7189	93	298	G126	6489	93	348	G226	5789	93	398	S718	5047	93
249	G28	7175	224	299	G128	6475	224	349	G228	5775	224	399	S717	5033	224
250	G30	7161	93	300	G130	6461	93	350	G230	5761	93	400	S716	5019	93

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
401	S715	5005	224	451	S665	4305	224	501	S615	3605	224	551	S565	2905	224
402	S714	4991	93	452	S664	4291	93	502	S614	3591	93	552	S564	2891	93
403	S713	4977	224	453	S663	4277	224	503	S613	3577	224	553	S563	2877	224
404	S712	4963	93	454	S662	4263	93	504	S612	3563	93	554	S562	2863	93
405	S711	4949	224	455	S661	4249	224	505	S611	3549	224	555	S561	2849	224
406	S710	4935	93	456	S660	4235	93	506	S610	3535	93	556	S560	2835	93
407	S709	4921	224	457	S659	4221	224	507	S609	3521	224	557	S559	2821	224
408	S708	4907	93	458	S658	4207	93	508	S608	3507	93	558	S558	2807	93
409	S707	4893	224	459	S657	4193	224	509	S607	3493	224	559	S557	2793	224
410	S706	4879	93	460	S656	4179	93	510	S606	3479	93	560	S556	2779	93
411	S705	4865	224	461	S655	4165	224	511	S605	3465	224	561	S555	2765	224
412	S704	4851	93	462	S654	4151	93	512	S604	3451	93	562	S554	2751	93
413	S703	4837	224	463	S653	4137	224	513	S603	3437	224	563	S553	2737	224
414	S702	4823	93	464	S652	4123	93	514	S602	3423	93	564	S552	2723	93
415	S701	4809	224	465	S651	4109	224	515	S601	3409	224	565	S551	2709	224
416	S700	4795	93	466	S650	4095	93	516	S600	3395	93	566	S550	2695	93
417	S699	4781	224	467	S649	4081	224	517	S599	3381	224	567	S549	2681	224
418	S698	4767	93	468	S648	4067	93	518	S598	3367	93	568	S548	2667	93
419	S697	4753	224	469	S647	4053	224	519	S597	3353	224	569	S547	2653	224
420	S696	4739	93	470	S646	4039	93	520	S596	3339	93	570	S546	2639	93
421	S695	4725	224	471	S645	4025	224	521	S595	3325	224	571	S545	2625	224
422	S694	4711	93	472	S644	4011	93	522	S594	3311	93	572	S544	2611	93
423	S693	4697	224	473	S643	3997	224	523	S593	3297	224	573	S543	2597	224
424	S692	4683	93	474	S642	3983	93	524	S592	3283	93	574	S542	2583	93
425	S691	4669	224	475	S641	3969	224	525	S591	3269	224	575	S541	2569	224
426	S690	4655	93	476	S640	3955	93	526	S590	3255	93	576	S540	2555	93
427	S689	4641	224	477	S639	3941	224	527	S589	3241	224	577	S539	2541	224
428	S688	4627	93	478	S638	3927	93	528	S588	3227	93	578	S538	2527	93
429	S687	4613	224	479	S637	3913	224	529	S587	3213	224	579	S537	2513	224
430	S686	4599	93	480	S636	3899	93	530	S586	3199	93	580	S536	2499	93
431	S685	4585	224	481	S635	3885	224	531	S585	3185	224	581	S535	2485	224
432	S684	4571	93	482	S634	3871	93	532	S584	3171	93	582	S534	2471	93
433	S683	4557	224	483	S633	3857	224	533	S583	3157	224	583	S533	2457	224
434	S682	4543	93	484	S632	3843	93	534	S582	3143	93	584	S532	2443	93
435	S681	4529	224	485	S631	3829	224	535	S581	3129	224	585	S531	2429	224
436	S680	4515	93	486	S630	3815	93	536	S580	3115	93	586	S530	2415	93
437	S679	4501	224	487	S629	3801	224	537	S579	3101	224	587	S529	2401	224
438	S678	4487	93	488	S628	3787	93	538	S578	3087	93	588	S528	2387	93
439	S677	4473	224	489	S627	3773	224	539	S577	3073	224	589	S527	2373	224
440	S676	4459	93	490	S626	3759	93	540	S576	3059	93	590	S526	2359	93
441	S675	4445	224	491	S625	3745	224	541	S575	3045	224	591	S525	2345	224
442	S674	4431	93	492	S624	3731	93	542	S574	3031	93	592	S524	2331	93
443	S673	4417	224	493	S623	3717	224	543	S573	3017	224	593	S523	2317	224
444	S672	4403	93	494	S622	3703	93	544	S572	3003	93	594	S522	2303	93
445	S671	4389	224	495	S621	3689	224	545	S571	2989	224	595	S521	2289	224
446	S670	4375	93	496	S620	3675	93	546	S570	2975	93	596	S520	2275	93
447	S669	4361	224	497	S619	3661	224	547	S569	2961	224	597	S519	2261	224
448	S668	4347	93	498	S618	3647	93	548	S568	2947	93	598	S518	2247	93
449	S667	4333	224	499	S617	3633	224	549	S567	2933	224	599	S517	2233	224
450	S666	4319	93	500	S616	3619	93	550	S566	2919	93	600	S516	2219	93

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
601	S515	2205	224	651	S465	1505	224	701	S415	805	224	751	S365	105	224
602	S514	2191	93	652	S464	1491	93	702	S414	791	93	752	S364	91	93
603	S513	2177	224	653	S463	1477	224	703	S413	777	224	753	S363	77	224
604	S512	2163	93	654	S462	1463	93	704	S412	763	93	754	S362	63	93
605	S511	2149	224	655	S461	1449	224	705	S411	749	224	755	S361	49	224
606	S510	2135	93	656	S460	1435	93	706	S410	735	93	756	S360	-49	93
607	S509	2121	224	657	S459	1421	224	707	S409	721	224	757	S359	-63	224
608	S508	2107	93	658	S458	1407	93	708	S408	707	93	758	S358	-77	93
609	S507	2093	224	659	S457	1393	224	709	S407	693	224	759	S357	-91	224
610	S506	2079	93	660	S456	1379	93	710	S406	679	93	760	S356	-105	93
611	S505	2065	224	661	S455	1365	224	711	S405	665	224	761	S355	-119	224
612	S504	2051	93	662	S454	1351	93	712	S404	651	93	762	S354	-133	93
613	S503	2037	224	663	S453	1337	224	713	S403	637	224	763	S353	-147	224
614	S502	2023	93	664	S452	1323	93	714	S402	623	93	764	S352	-161	93
615	S501	2009	224	665	S451	1309	224	715	S401	609	224	765	S351	-175	224
616	S500	1995	93	666	S450	1295	93	716	S400	595	93	766	S350	-189	93
617	S499	1981	224	667	S449	1281	224	717	S399	581	224	767	S349	-203	224
618	S498	1967	93	668	S448	1267	93	718	S398	567	93	768	S348	-217	93
619	S497	1953	224	669	S447	1253	224	719	S397	553	224	769	S347	-231	224
620	S496	1939	93	670	S446	1239	93	720	S396	539	93	770	S346	-245	93
621	S495	1925	224	671	S445	1225	224	721	S395	525	224	771	S345	-259	224
622	S494	1911	93	672	S444	1211	93	722	S394	511	93	772	S344	-273	93
623	S493	1897	224	673	S443	1197	224	723	S393	497	224	773	S343	-287	224
624	S492	1883	93	674	S442	1183	93	724	S392	483	93	774	S342	-301	93
625	S491	1869	224	675	S441	1169	224	725	S391	469	224	775	S341	-315	224
626	S490	1855	93	676	S440	1155	93	726	S390	455	93	776	S340	-329	93
627	S489	1841	224	677	S439	1141	224	727	S389	441	224	777	S339	-343	224
628	S488	1827	93	678	S438	1127	93	728	S388	427	93	778	S338	-357	93
629	S487	1813	224	679	S437	1113	224	729	S387	413	224	779	S337	-371	224
630	S486	1799	93	680	S436	1099	93	730	S386	399	93	780	S336	-385	93
631	S485	1785	224	681	S435	1085	224	731	S385	385	224	781	S335	-399	224
632	S484	1771	93	682	S434	1071	93	732	S384	371	93	782	S334	-413	93
633	S483	1757	224	683	S433	1057	224	733	S383	357	224	783	S333	-427	224
634	S482	1743	93	684	S432	1043	93	734	S382	343	93	784	S332	-441	93
635	S481	1729	224	685	S431	1029	224	735	S381	329	224	785	S331	-455	224
636	S480	1715	93	686	S430	1015	93	736	S380	315	93	786	S330	-469	93
637	S479	1701	224	687	S429	1001	224	737	S379	301	224	787	S329	-483	224
638	S478	1687	93	688	S428	987	93	738	S378	287	93	788	S328	-497	93
639	S477	1673	224	689	S427	973	224	739	S377	273	224	789	S327	-511	224
640	S476	1659	93	690	S426	959	93	740	S376	259	93	790	S326	-525	93
641	S475	1645	224	691	S425	945	224	741	S375	245	224	791	S325	-539	224
642	S474	1631	93	692	S424	931	93	742	S374	231	93	792	S324	-553	93
643	S473	1617	224	693	S423	917	224	743	S373	217	224	793	S323	-567	224
644	S472	1603	93	694	S422	903	93	744	S372	203	93	794	S322	-581	93
645	S471	1589	224	695	S421	889	224	745	S371	189	224	795	S321	-595	224
646	S470	1575	93	696	S420	875	93	746	S370	175	93	796	S320	-609	93
647	S469	1561	224	697	S419	861	224	747	S369	161	224	797	S319	-623	224
648	S468	1547	93	698	S418	847	93	748	S368	147	93	798	S318	-637	93
649	S467	1533	224	699	S417	833	224	749	S367	133	224	799	S317	-651	224
650	S466	1519	93	700	S416	819	93	750	S366	119	93	800	S316	-665	93

No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
801	S315	-679	224	851	S265	-1379	224	901	S215	-2079	224	951	S165	-2779	224
802	S314	-693	93	852	S264	-1393	93	902	S214	-2093	93	952	S164	-2793	93
803	S313	-707	224	853	S263	-1407	224	903	S213	-2107	224	953	S163	-2807	224
804	S312	-721	93	854	S262	-1421	93	904	S212	-2121	93	954	S162	-2821	93
805	S311	-735	224	855	S261	-1435	224	905	S211	-2135	224	955	S161	-2835	224
806	S310	-749	93	856	S260	-1449	93	906	S210	-2149	93	956	S160	-2849	93
807	S309	-763	224	857	S259	-1463	224	907	S209	-2163	224	957	S159	-2863	224
808	S308	-777	93	858	S258	-1477	93	908	S208	-2177	93	958	S158	-2877	93
809	S307	-791	224	859	S257	-1491	224	909	S207	-2191	224	959	S157	-2891	224
810	S306	-805	93	860	S256	-1505	93	910	S206	-2205	93	960	S156	-2905	93
811	S305	-819	224	861	S255	-1519	224	911	S205	-2219	224	961	S155	-2919	224
812	S304	-833	93	862	S254	-1533	93	912	S204	-2233	93	962	S154	-2933	93
813	S303	-847	224	863	S253	-1547	224	913	S203	-2247	224	963	S153	-2947	224
814	S302	-861	93	864	S252	-1561	93	914	S202	-2261	93	964	S152	-2961	93
815	S301	-875	224	865	S251	-1575	224	915	S201	-2275	224	965	S151	-2975	224
816	S300	-889	93	866	S250	-1589	93	916	S200	-2289	93	966	S150	-2989	93
817	S299	-903	224	867	S249	-1603	224	917	S199	-2303	224	967	S149	-3003	224
818	S298	-917	93	868	S248	-1617	93	918	S198	-2317	93	968	S148	-3017	93
819	S297	-931	224	869	S247	-1631	224	919	S197	-2331	224	969	S147	-3031	224
820	S296	-945	93	870	S246	-1645	93	920	S196	-2345	93	970	S146	-3045	93
821	S295	-959	224	871	S245	-1659	224	921	S195	-2359	224	971	S145	-3059	224
822	S294	-973	93	872	S244	-1673	93	922	S194	-2373	93	972	S144	-3073	93
823	S293	-987	224	873	S243	-1687	224	923	S193	-2387	224	973	S143	-3087	224
824	S292	-1001	93	874	S242	-1701	93	924	S192	-2401	93	974	S142	-3101	93
825	S291	-1015	224	875	S241	-1715	224	925	S191	-2415	224	975	S141	-3115	224
826	S290	-1029	93	876	S240	-1729	93	926	S190	-2429	93	976	S140	-3129	93
827	S289	-1043	224	877	S239	-1743	224	927	S189	-2443	224	977	S139	-3143	224
828	S288	-1057	93	878	S238	-1757	93	928	S188	-2457	93	978	S138	-3157	93
829	S287	-1071	224	879	S237	-1771	224	929	S187	-2471	224	979	S137	-3171	224
830	S286	-1085	93	880	S236	-1785	93	930	S186	-2485	93	980	S136	-3185	93
831	S285	-1099	224	881	S235	-1799	224	931	S185	-2499	224	981	S135	-3199	224
832	S284	-1113	93	882	S234	-1813	93	932	S184	-2513	93	982	S134	-3213	93
833	S283	-1127	224	883	S233	-1827	224	933	S183	-2527	224	983	S133	-3227	224
834	S282	-1141	93	884	S232	-1841	93	934	S182	-2541	93	984	S132	-3241	93
835	S281	-1155	224	885	S231	-1855	224	935	S181	-2555	224	985	S131	-3255	224
836	S280	-1169	93	886	S230	-1869	93	936	S180	-2569	93	986	S130	-3269	93
837	S279	-1183	224	887	S229	-1883	224	937	S179	-2583	224	987	S129	-3283	224
838	S278	-1197	93	888	S228	-1897	93	938	S178	-2597	93	988	S128	-3297	93
839	S277	-1211	224	889	S227	-1911	224	939	S177	-2611	224	989	S127	-3311	224
840	S276	-1225	93	890	S226	-1925	93	940	S176	-2625	93	990	S126	-3325	93
841	S275	-1239	224	891	S225	-1939	224	941	S175	-2639	224	991	S125	-3339	224
842	S274	-1253	93	892	S224	-1953	93	942	S174	-2653	93	992	S124	-3353	93
843	S273	-1267	224	893	S223	-1967	224	943	S173	-2667	224	993	S123	-3367	224
844	S272	-1281	93	894	S222	-1981	93	944	S172	-2681	93	994	S122	-3381	93
845	S271	-1295	224	895	S221	-1995	224	945	S171	-2695	224	995	S121	-3395	224
846	S270	-1309	93	896	S220	-2009	93	946	S170	-2709	93	996	S120	-3409	93
847	S269	-1323	224	897	S219	-2023	224	947	S169	-2723	224	997	S119	-3423	224
848	S268	-1337	93	898	S218	-2037	93	948	S168	-2737	93	998	S118	-3437	93
849	S267	-1351	224	899	S217	-2051	224	949	S167	-2751	224	999	S117	-3451	224
850	S266	-1365	93	900	S216	-2065	93	950	S166	-2765	93	1000	S116	-3465	93

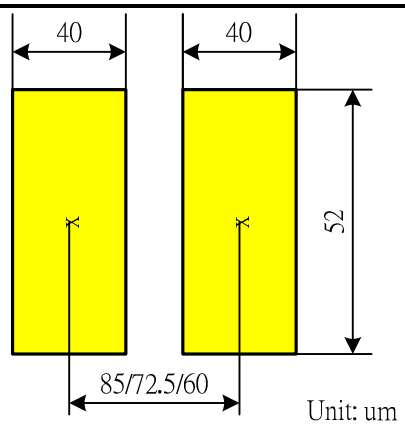
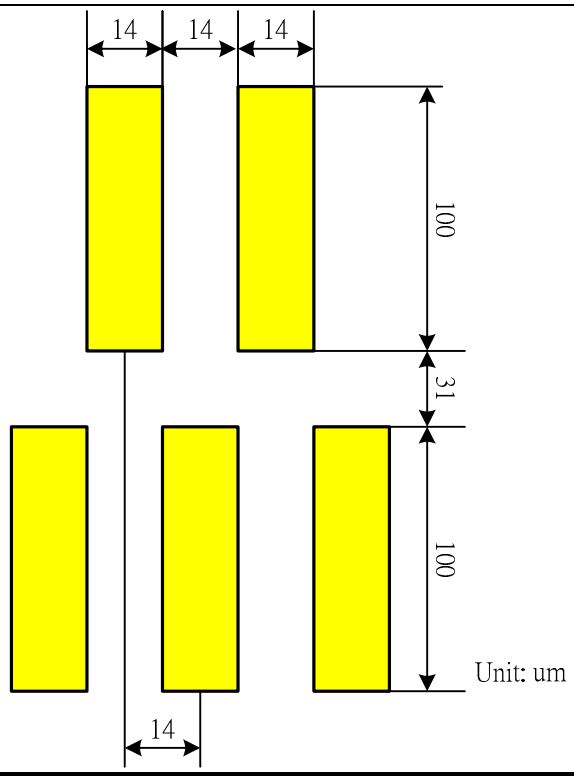
No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y	No.	Pad name	X	Y
1001	S115	-3479	224	1051	S65	-4179	224	1101	S15	-4879	224	1151	G249	-5621	224
1002	S114	-3493	93	1052	S64	-4193	93	1102	S14	-4893	93	1152	G247	-5635	93
1003	S113	-3507	224	1053	S63	-4207	224	1103	S13	-4907	224	1153	G245	-5649	224
1004	S112	-3521	93	1054	S62	-4221	93	1104	S12	-4921	93	1154	G243	-5663	93
1005	S111	-3535	224	1055	S61	-4235	224	1105	S11	-4935	224	1155	G241	-5677	224
1006	S110	-3549	93	1056	S60	-4249	93	1106	S10	-4949	93	1156	G239	-5691	93
1007	S109	-3563	224	1057	S59	-4263	224	1107	S9	-4963	224	1157	G237	-5705	224
1008	S108	-3577	93	1058	S58	-4277	93	1108	S8	-4977	93	1158	G235	-5719	93
1009	S107	-3591	224	1059	S57	-4291	224	1109	S7	-4991	224	1159	G233	-5733	224
1010	S106	-3605	93	1060	S56	-4305	93	1110	S6	-5005	93	1160	G231	-5747	93
1011	S105	-3619	224	1061	S55	-4319	224	1111	S5	-5019	224	1161	G229	-5761	224
1012	S104	-3633	93	1062	S54	-4333	93	1112	S4	-5033	93	1162	G227	-5775	93
1013	S103	-3647	224	1063	S53	-4347	224	1113	S3	-5047	224	1163	G225	-5789	224
1014	S102	-3661	93	1064	S52	-4361	93	1114	S2	-5061	93	1164	G223	-5803	93
1015	S101	-3675	224	1065	S51	-4375	224	1115	S1	-5075	224	1165	G221	-5817	224
1016	S100	-3689	93	1066	S50	-4389	93	1116	G319	-5131	93	1166	G219	-5831	93
1017	S99	-3703	224	1067	S49	-4403	224	1117	G317	-5145	224	1167	G217	-5845	224
1018	S98	-3717	93	1068	S48	-4417	93	1118	G315	-5159	93	1168	G215	-5859	93
1019	S97	-3731	224	1069	S47	-4431	224	1119	G313	-5173	224	1169	G213	-5873	224
1020	S96	-3745	93	1070	S46	-4445	93	1120	G311	-5187	93	1170	G211	-5887	93
1021	S95	-3759	224	1071	S45	-4459	224	1121	G309	-5201	224	1171	G209	-5901	224
1022	S94	-3773	93	1072	S44	-4473	93	1122	G307	-5215	93	1172	G207	-5915	93
1023	S93	-3787	224	1073	S43	-4487	224	1123	G305	-5229	224	1173	G205	-5929	224
1024	S92	-3801	93	1074	S42	-4501	93	1124	G303	-5243	93	1174	G203	-5943	93
1025	S91	-3815	224	1075	S41	-4515	224	1125	G301	-5257	224	1175	G201	-5957	224
1026	S90	-3829	93	1076	S40	-4529	93	1126	G299	-5271	93	1176	G199	-5971	93
1027	S89	-3843	224	1077	S39	-4543	224	1127	G297	-5285	224	1177	G197	-5985	224
1028	S88	-3857	93	1078	S38	-4557	93	1128	G295	-5299	93	1178	G195	-5999	93
1029	S87	-3871	224	1079	S37	-4571	224	1129	G293	-5313	224	1179	G193	-6013	224
1030	S86	-3885	93	1080	S36	-4585	93	1130	G291	-5327	93	1180	G191	-6027	93
1031	S85	-3899	224	1081	S35	-4599	224	1131	G289	-5341	224	1181	G189	-6041	224
1032	S84	-3913	93	1082	S34	-4613	93	1132	G287	-5355	93	1182	G187	-6055	93
1033	S83	-3927	224	1083	S33	-4627	224	1133	G285	-5369	224	1183	G185	-6069	224
1034	S82	-3941	93	1084	S32	-4641	93	1134	G283	-5383	93	1184	G183	-6083	93
1035	S81	-3955	224	1085	S31	-4655	224	1135	G281	-5397	224	1185	G181	-6097	224
1036	S80	-3969	93	1086	S30	-4669	93	1136	G279	-5411	93	1186	G179	-6111	93
1037	S79	-3983	224	1087	S29	-4683	224	1137	G277	-5425	224	1187	G177	-6125	224
1038	S78	-3997	93	1088	S28	-4697	93	1138	G275	-5439	93	1188	G175	-6139	93
1039	S77	-4011	224	1089	S27	-4711	224	1139	G273	-5453	224	1189	G173	-6153	224
1040	S76	-4025	93	1090	S26	-4725	93	1140	G271	-5467	93	1190	G171	-6167	93
1041	S75	-4039	224	1091	S25	-4739	224	1141	G269	-5481	224	1191	G169	-6181	224
1042	S74	-4053	93	1092	S24	-4753	93	1142	G267	-5495	93	1192	G167	-6195	93
1043	S73	-4067	224	1093	S23	-4767	224	1143	G265	-5509	224	1193	G165	-6209	224
1044	S72	-4081	93	1094	S22	-4781	93	1144	G263	-5523	93	1194	G163	-6223	93
1045	S71	-4095	224	1095	S21	-4795	224	1145	G261	-5537	224	1195	G161	-6237	224
1046	S70	-4109	93	1096	S20	-4809	93	1146	G259	-5551	93	1196	G159	-6251	93
1047	S69	-4123	224	1097	S19	-4823	224	1147	G257	-5565	224	1197	G157	-6265	224
1048	S68	-4137	93	1098	S18	-4837	93	1148	G255	-5579	93	1198	G155	-6279	93
1049	S67	-4151	224	1099	S17	-4851	224	1149	G253	-5593	224	1199	G153	-6293	224
1050	S66	-4165	93	1100	S16	-4865	93	1150	G251	-5607	93	1200	G151	-6307	93

No.	Pad name	X	Y
1201	G149	-6321	224
1202	G147	-6335	93
1203	G145	-6349	224
1204	G143	-6363	93
1205	G141	-6377	224
1206	G139	-6391	93
1207	G137	-6405	224
1208	G135	-6419	93
1209	G133	-6433	224
1210	G131	-6447	93
1211	G129	-6461	224
1212	G127	-6475	93
1213	G125	-6489	224
1214	G123	-6503	93
1215	G121	-6517	224
1216	G119	-6531	93
1217	G117	-6545	224
1218	G115	-6559	93
1219	G113	-6573	224
1220	G111	-6587	93
1221	G109	-6601	224
1222	G107	-6615	93
1223	G105	-6629	224
1224	G103	-6643	93
1225	G101	-6657	224
1226	G99	-6671	93
1227	G97	-6685	224
1228	G95	-6699	93
1229	G93	-6713	224
1230	G91	-6727	93
1231	G89	-6741	224
1232	G87	-6755	93
1233	G85	-6769	224
1234	G83	-6783	93
1235	G81	-6797	224
1236	G79	-6811	93
1237	G77	-6825	224
1238	G75	-6839	93
1239	G73	-6853	224
1240	G71	-6867	93
1241	G69	-6881	224
1242	G67	-6895	93
1243	G65	-6909	224
1244	G63	-6923	93
1245	G61	-6937	224
1246	G59	-6951	93
1247	G57	-6965	224
1248	G55	-6979	93
1249	G53	-6993	224
1250	G51	-7007	93

No.	Pad name	X	Y
1251	G49	-7021	224
1252	G47	-7035	93
1253	G45	-7049	224
1254	G43	-7063	93
1255	G41	-7077	224
1256	G39	-7091	93
1257	G37	-7105	224
1258	G35	-7119	93
1259	G33	-7133	224
1260	G31	-7147	93
1261	G29	-7161	224
1262	G27	-7175	93
1263	G25	-7189	224
1264	G23	-7203	93
1265	G21	-7217	224
1266	G19	-7231	93
1267	G17	-7245	224
1268	G15	-7259	93
1269	G13	-7273	224
1270	G11	-7287	93
1271	G9	-7301	224
1272	G7	-7315	93
1273	G5	-7329	224
1274	G3	-7343	93
1275	G1	-7357	224
1276	DUMMY	-7371	93
1277	DUMMY	-7385	224
1278	DUMMY	-7399	93

Alignment mark	X	Y
Left COG Align	-7480	225
Right COG Align	7480	225

BUMP Size

Input Pad (1 ~ 232)	
Output Pad (233 ~ 1278)	

6. Block Function Description

MCU System Interface

ILI9341 provides four kinds of MCU system interface with 8080-Ⅰ/8080-Ⅱ series parallel interface and 3-/4-line serial interface. The selection of the given interfaces are done by external IM [3:0] pins and shown as below:

IM3	IM2	IM1	IM0	MCU-Interface Mode	Pins in use	
					Register/Content	GRAM
0	0	0	0	8080 MCU 8-bit bus interface Ⅰ	D[7:0]	D[7:0],WRX,RDX,CSX,D/CX
0	0	0	1	8080 MCU 16-bit bus interface Ⅰ	D[7:0]	D[15:0],WRX,RDX,CSX,D/CX
0	0	1	0	8080 MCU 9-bit bus interface Ⅰ	D[7:0]	D[8:0],WRX,RDX,CSX,D/CX
0	0	1	1	8080 MCU 18-bit bus interface Ⅰ	D[7:0]	D[17:0],WRX,RDX,CSX,D/CX
0	1	0	1	3-wire 9-bit data serial interface Ⅰ	SCL,SDA,CSX	
0	1	1	0	4-wire 8-bit data serial interface Ⅰ	SCL,SDA,D/CX,CSX	
1	0	0	0	8080 MCU 16-bit bus interface Ⅱ	D[8:1]	D[17:10],D[8:1],WRX,RDX,CSX,D/CX
1	0	0	1	8080 MCU 8-bit bus interface Ⅱ	D[17:10]	D[17:10],WRX,RDX,CSX,D/CX
1	0	1	0	8080 MCU 18-bit bus interface Ⅱ	D[8:1]	D[17:0],WRX,RDX,CSX,D/CX
1	0	1	1	8080 MCU 9-bit bus interface Ⅱ	D[17:10]	D[17:9],WRX,RDX,CSX,D/CX
1	1	0	1	3-wire 9-bit data serial interface Ⅱ	SCL,SDI,SDO, CSX	
1	1	1	0	4-wire 8-bit data serial interface Ⅱ	SCL,SDI,D/CX,SDO, CSX	

In 8080-Ⅰ/8080-Ⅱ series parallel interface, the registers are accessed by the D[17:0] data pins.

8080-Ⅰ Series				8080-Ⅱ Series				Operation
CSX	D/CX	RDX	WRX	CSX	D/CX	RDX	WRX	
"L"	"L"	"H"	↑	"L"	"L"	"H"	↑	Write command
"L"	"H"	↑	"H"	"L"	"H"	↑	"H"	Read parameter
"L"	"H"	"H"	↑	"L"	"H"	"H"	↑	Write parameter

Parallel RGB Interface

ILI9341 also supports the RGB interface for displaying a moving picture. When the RGB interface is selected, display operation is synchronized with externally signals, VSYNC, HSYNC, and DOTCLK and input display data is written in synchronization with these signals according to the polarity of enable signal (DE).

Graphic RAM (GRAM)

GRAM is a graphic RAM to store display data. GRAM size is 172,800 bytes with 18 bits per pixel for a maximum 240(RGB) x320 dot graphic display.

Grayscale Voltage Generating Circuit

Grayscale voltage generating circuit generates a liquid crystal drive voltage, which corresponds to grayscale level set in the gamma correction register. ILI9341 can display maximum 262,144 colors.

Power Supply Circuit

The LCD drive power supply circuit generates the voltage levels as GVDD, VGH, VGL and VCOM for driving TFT LCD panel.

Timing controller

The timing controller generates all the timing signals for display and GRAM access.

Oscillator

ILI9341 incorporates RC oscillator circuit and output a stable output frequency for operation.

Panel Driver Circuit

Liquid crystal display driver circuit consists of 720-output source driver (S1~S720), 320-output gate driver (G1~G320), and VCOM signal.

7. Function Description

7.1. MCU interfaces

ILI9341 provides the 8-/9-/16-/18-bit parallel system interface for 8080-Ⅰ/8080-Ⅱ series, and 3-/4-line serial system interface for serial data input. The input system interface is selected by external pins IM [3:0] and the bit formal per pixel color order is selected by DBI [2:0] bits of 3Ah register.

7.1.1. MCU interface selection

The selection of interface is done by setting external pins IM [3:0] as shown in the following table.

IM3	IM2	IM1	IM0	MCU-Interface Mode	Pins in use	
					Register/Content	GRAM
0	0	0	0	8080 MCU 8-bit bus interface Ⅰ	D[7:0]	D[7:0],WRX,RDX,CSX,D/CX
0	0	0	1	8080 MCU 16-bit bus interface Ⅰ	D[7:0]	D[15:0] ,WRX,RDX,CSX,D/CX
0	0	1	0	8080 MCU 9-bit bus interface Ⅰ	D[7:0]	D[8:0] ,WRX,RDX,CSX,D/CX
0	0	1	1	8080 MCU 18-bit bus interface Ⅰ	D[7:0]	D[17:0] ,WRX,RDX,CSX,D/CX
0	1	0	1	3-wire 9-bit data serial interface Ⅰ	SCL,SDA,CSX	
0	1	1	0	4-wire 8-bit data serial interface Ⅰ	SCL,SDA,D/CX,CSX	
1	0	0	0	8080 MCU 16-bit bus interface Ⅱ	D[8:1]	D[17:10],D[8:1],WRX,RDX,CSX,D/CX
1	0	0	1	8080 MCU 8-bit bus interface Ⅱ	D[17:10]	D[17:10],WRX,RDX,CSX,D/CX
1	0	1	0	8080 MCU 18-bit bus interface Ⅱ	D[8:1]	D[17:0],WRX,RDX,CSX,D/CX
1	0	1	1	8080 MCU 9-bit bus interface Ⅱ	D[17:10]	D[17:9],WRX,RDX,CSX,D/CX
1	1	0	1	3-wire 9-bit data serial interface Ⅱ	SCL,SDI,SDO, CSX	
1	1	1	0	4-wire 8-bit data serial interface Ⅱ	SCL,SDI,D/CX,SDO, CSX	

7.1.2. 8080-Ⅰ Series Parallel Interface

ILI9341 can be accessed via 8-/9-/16-/18-bit MCU 8080-Ⅰ series parallel interface. The chip-select CSX (active low) is used to enable or disable ILI9341 chip. The RESX (active low) is an external reset signal. WRX is the parallel data write strobe, RDX is the parallel data read strobe and D[17:0] is parallel data bus.

ILI9341 latches the input data at the rising edge of WRX signal. The D/CX is the signal of data/command selection. When D/CX='1', D [17:0] bits are display RAM data or command's parameters. When D/CX='0', D [17:0] bits are commands.

The 8080-Ⅰ series bi-directional interface can be used for communication between the MCU controller and LCD driver chip. The 8080-Ⅰ Interface selection is done when IM3 pin is low state (VSS level). Interface bus width can be selected by IM [2:0] bits.

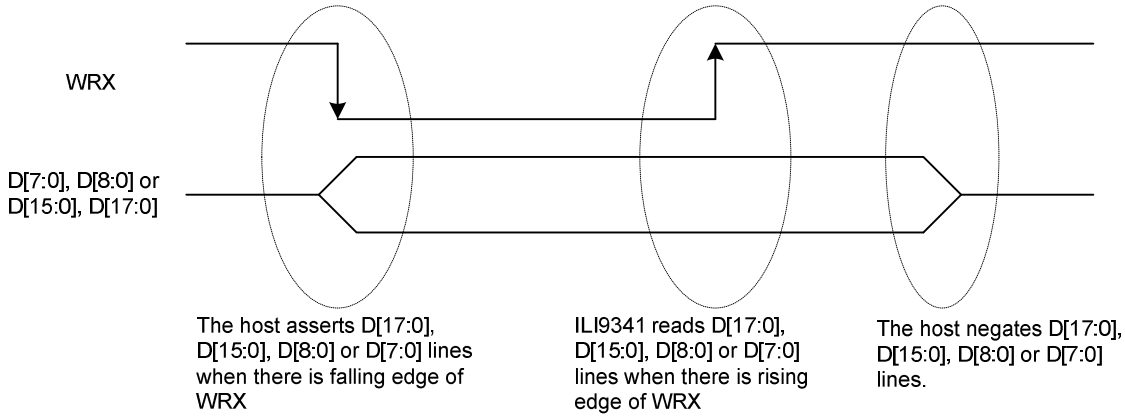
The selection of 8080-Ⅰ series parallel interface is shown as the table in the following.

IM3	IM2	IM1	IM0	MCU-Interface Mode	CSX	WRX	RDX	D/CX	Function
0	0	0	0	8080 MCU 8-bit bus interface Ⅰ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
0	0	0	1	8080 MCU 16-bit bus interface Ⅰ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
0	0	1	0	8080 MCU 9-bit bus interface Ⅰ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
0	0	1	1	8080 MCU 18-bit bus interface Ⅰ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.

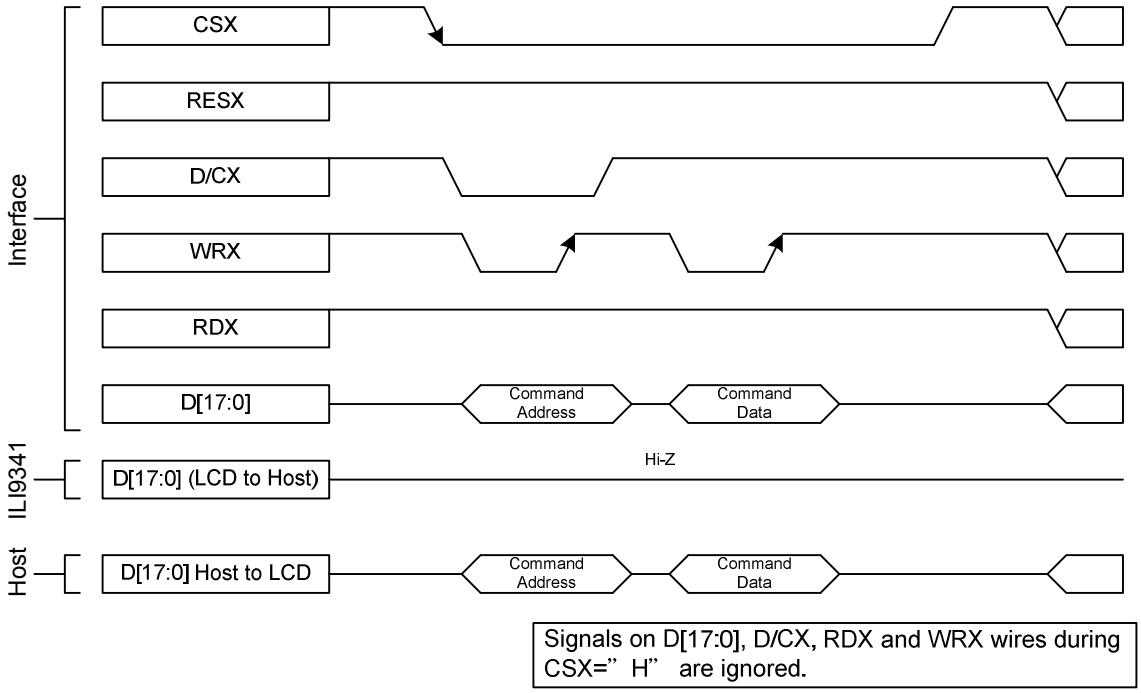
7.1.3. Write Cycle Sequence

The WRX signal is driven from high to low and then be pulled back to high during the write cycle. The host processor provides information during the write cycle when the display module captures the information from host processor on the rising edge of WRX. When the D/CX signal is driven to low level, then input data on the interface is interpreted as command information. The D/CX signal also can be pulled high level when the data on the interface is RAM data or command's parameter.

The following figure shows a write cycle for the 8080-Ⅰ MCU interface.



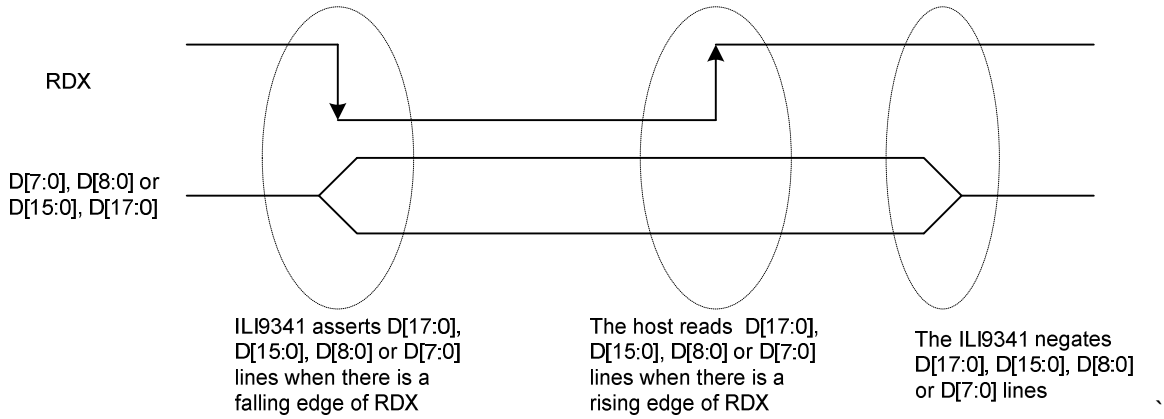
Note: WRX is an unsynchronized signal (It can be stopped)



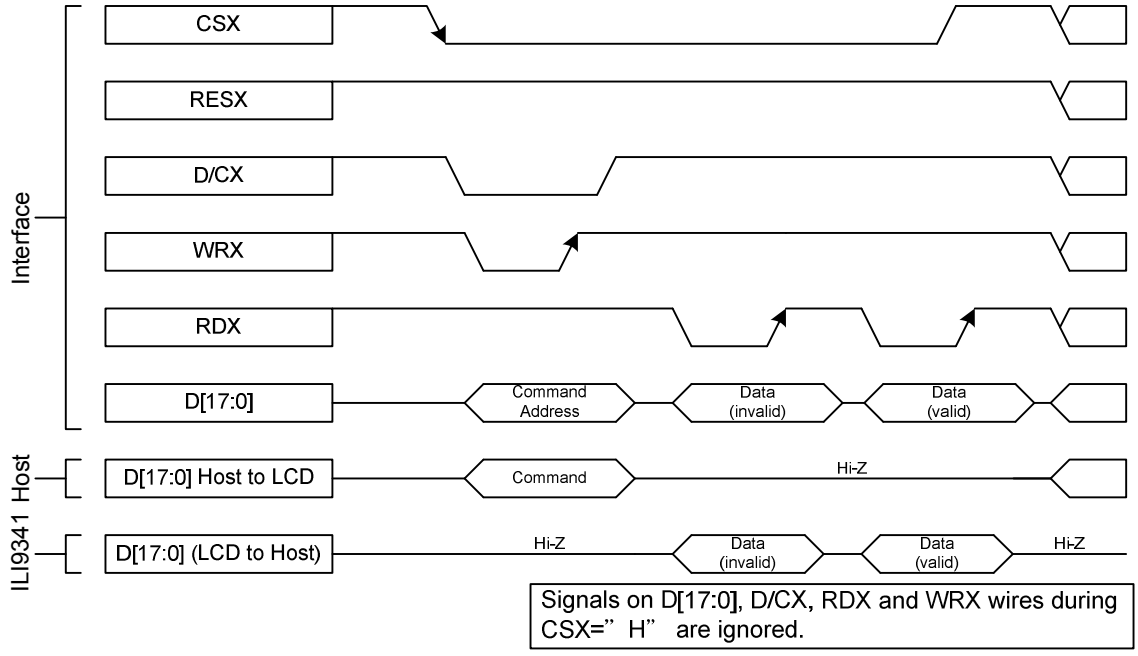
7.1.4. Read Cycle Sequence

The RDX signal is driven from high to low and then allowed to be pulled back to high during the read cycle. The display module provides information to the host processor during the read cycle while the host processor reads the display module information on the rising edge of RDX signal. When the D/CX signal is driven to low level, then input data on the interface is interpreted as command. The D/CX signal also can be pulled high level when the data on the interface is RAM data or command parameter.

The following figure shows the read cycle for the 8080- Ⅰ MCU interface.



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



Note: Read data is only valid when the D/CX input is pulled high. If D/CX is driven low during read then the display information outputs will be High-Z.

7.1.5. 8080-Ⅱ Series Parallel Interface

ILI9341 can be accessed via 8-/9-/16-/18-bit MCU 8080-Ⅱ series parallel interface. The chip-select CSX (active low) is used to enable or disable ILI9341 chip. The RESX (active low) is an external reset signal. WRX is the parallel data write strobe, RDX is the parallel data read strobe and D[17:0] is parallel data bus.

ILI9341 latches the input data at the rising edge of WRX signal. The D/CX is the signal of data/command selection. When D/CX='1', D [17:0] bits are display RAM data or command's parameters. When D/CX='0', D [17:0] bits are commands.

The 8080-Ⅱ series bi-directional interface can be used for communication between the MCU controller and LCD driver chip. The 8080-Ⅱ Interface selection is done when IM3 pin is high state (VDDI level). Interface bus width can be selected by IM [2:0] bits.

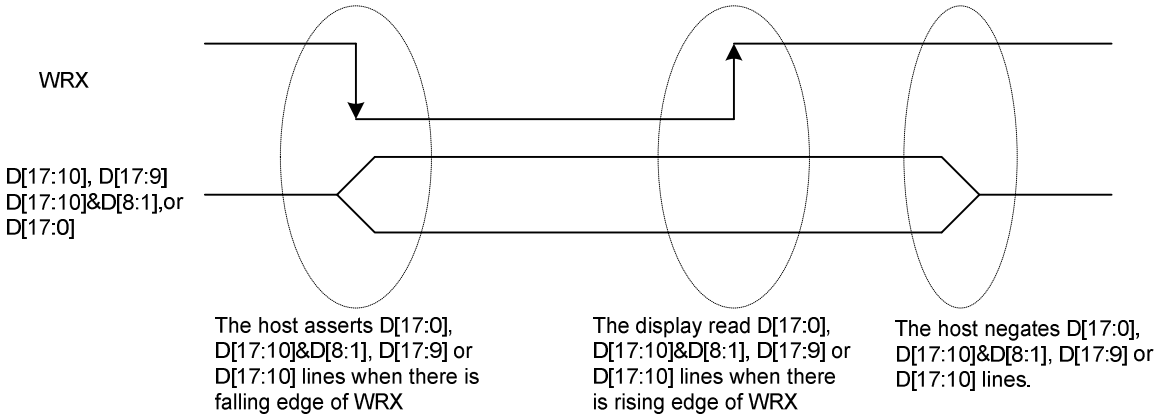
The selection of 8080-Ⅱ series parallel interface is shown as the table in the following.

IM3	IM2	IM1	IM0	MCU-Interface Mode	CSX	WRX	RDX	D/CX	Function
1	0	0	0	8080 MCU 16-bit bus interface Ⅱ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
1	0	0	1	8080 MCU 8-bit bus interface Ⅱ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
1	0	1	0	8080 MCU 18-bit bus interface Ⅱ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.
1	0	1	1	8080 MCU 9-bit bus interface Ⅱ	"L"	↑	"H"	"L"	Write command code.
					"L"	"H"	↑	"H"	Read internal status.
					"L"	↑	"H"	"H"	Write parameter or display data.
					"L"	"H"	↑	"H"	Reads parameter or display data.

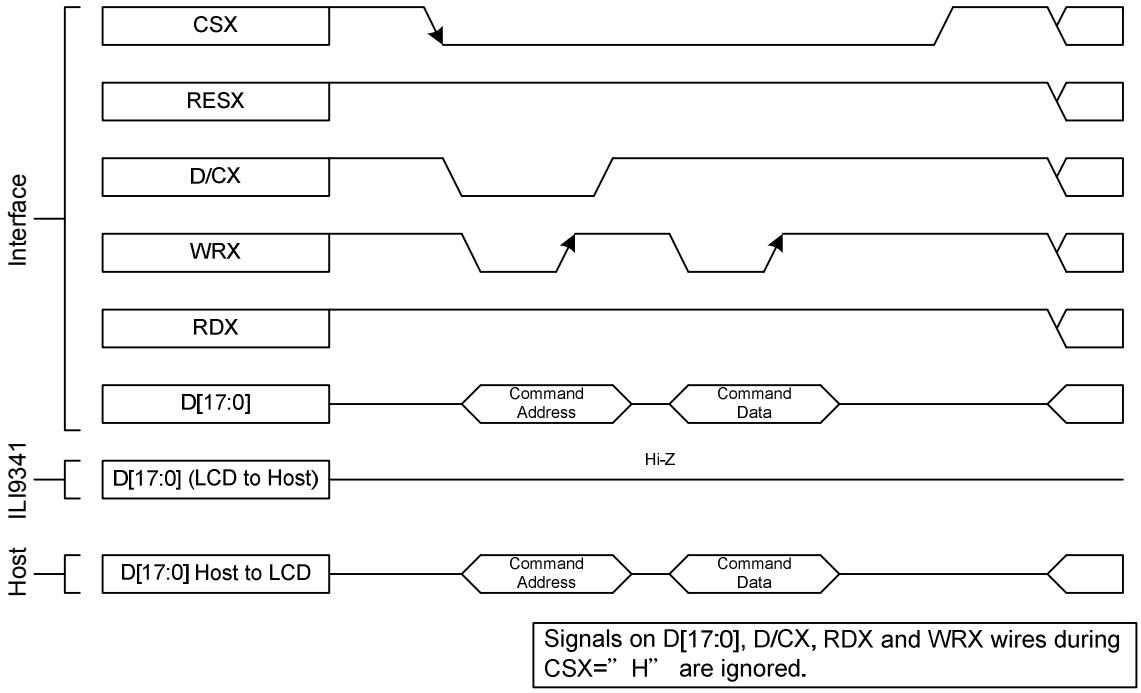
7.1.6. Write Cycle Sequence

The WRX signal is driven from high to low and then be pulled back to high during the write cycle. The host processor provides information during the write cycle when the display module captures the information from host processor on the rising edge of WRX. When the D/CX signal is driven to low level, then input data on the interface is interpreted as command information. The D/CX signal also can be pulled high level when the data on the interface is RAM data or command's parameter.

The following figure shows a write cycle for the 8080-Ⅱ MCU interface.



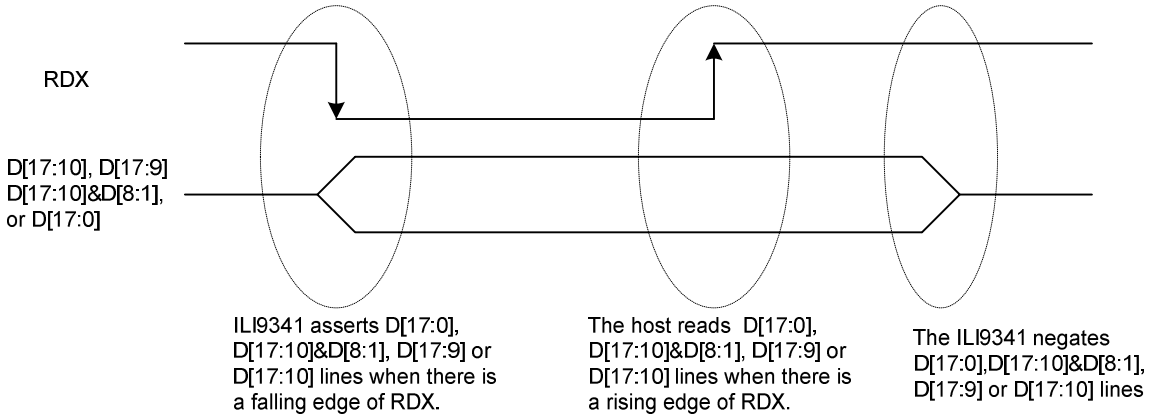
Note: WRX is an unsynchronized signal (It can be stopped)



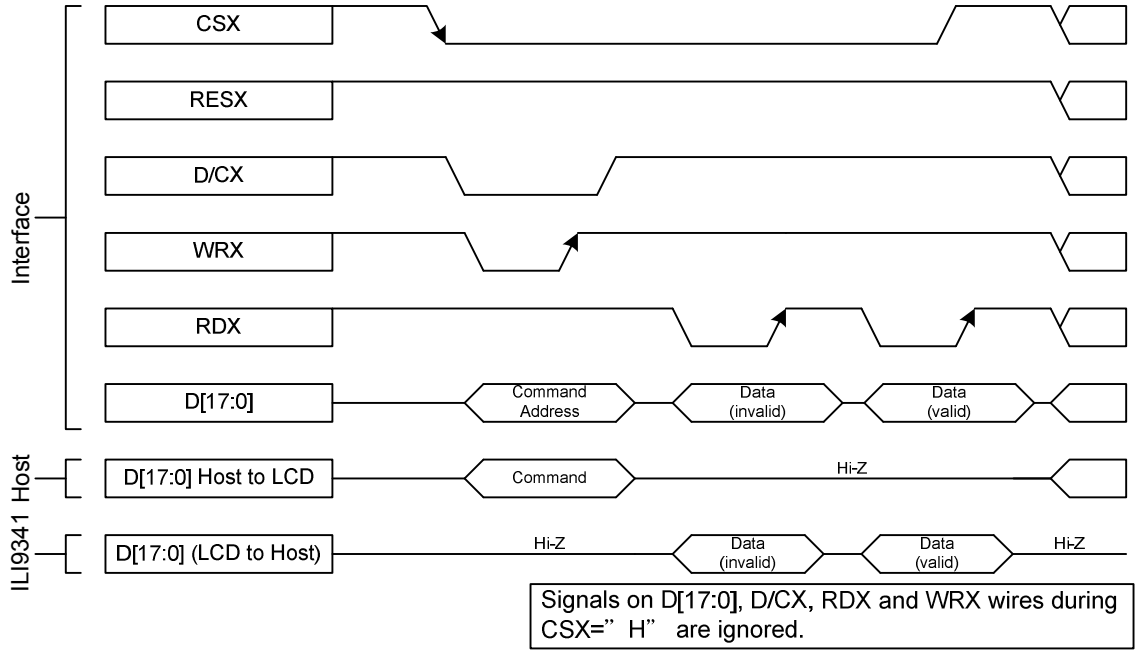
7.1.7. Read Cycle Sequence

The RDX signal is driven from high to low and then allowed to be pulled back to high during the read cycle. The display module provides information to the host processor during the read cycle while the host processor reads the display module information on the rising edge of RDX signal. When the D/CX signal is driven to low level, then input data on the interface is interpreted as command. The D/CX signal also can be pulled high level when the data on the interface is RAM data or command parameter.

The following figure shows the read cycle for the 8080-Ⅱ MCU interface.



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



Note: Read data is only valid when the D/CX input is pulled high. If D/CX is driven low during read then the display information outputs will be High-Z.

7.1.8. Serial Interface

The selection of interface is done by IM [3:0] bits. Please refer to the Table in the following.

IM3	IM2	IM1	IM0	MCU-Interface Mode	CSX	D/CX	SCL	Function
0	1	0	1	3-line serial interface	"L"	-	⎍	Read/Write command, parameter or display data.
0	1	1	0	4-line serial interface	"L"	'H/L"	⎍	Read/Write command, parameter or display data.
1	1	0	1	3-line serial interface	"L"	-	⎍	Read/Write command, parameter or display data.
1	1	1	0	4-line serial interface	"L"	'H/L"	⎍	Read/Write command, parameter or display data.

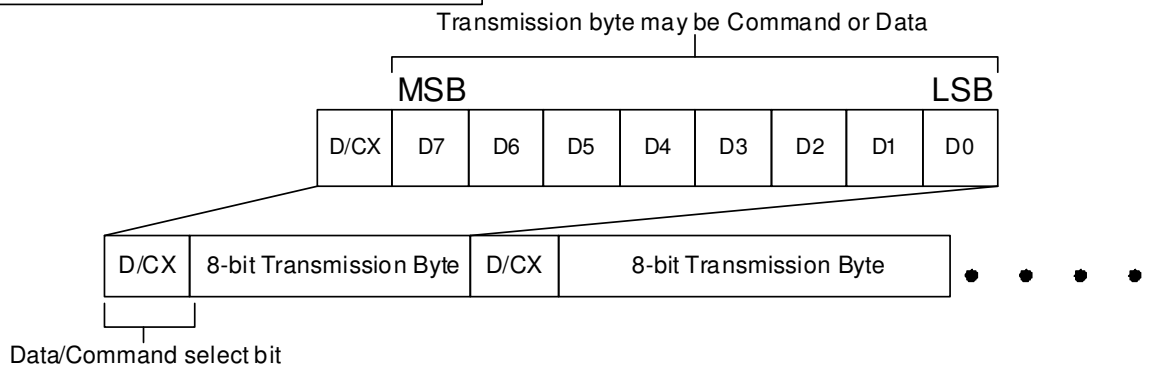
ILI9341 supplies 3-lines/ 9-bit and 4-line/8-bit bi-directional serial interfaces for communication between host and ILI9341. The 3-line serial mode consists of the chip enable input (CSX), the serial clock input (SCL) and serial data Input/Output (SDA or SDI/SDO). The 4-line serial mode consists of the Data/Command selection input (D/CX), chip enable input (CSX), the serial clock input (SCL) and serial data Input/Output (SDA or SDI/SDO) for data transmission. The data bus (D [17:0]), which are not used, must be connected to GND. Serial clock (SCL) is used for interface with MCU only, so it can be stopped when no communication is necessary.

7.1.9. Write Cycle Sequence

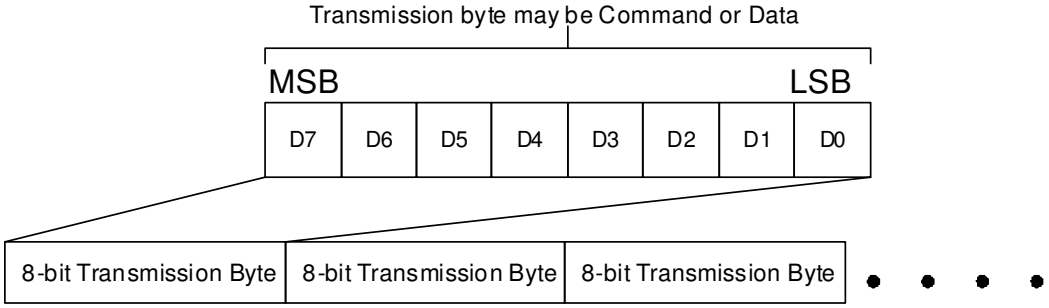
The write mode of the interface means that host writes commands or data to ILI9341. The 3-lines serial data packet contains a data/command select bit (D/CX) and a transmission byte. If the D/CX bit is "low", the transmission byte is interpreted as a command byte. If the D/CX bit is "high", the transmission byte is stored as the display data RAM (Memory write command), or command register as parameter.

Any instruction can be sent in any order to ILI9341 and the MSB is transmitted first. The serial interface is initialized when CSX is high status. In this state, SCL clock pulse and SDA data are no effect. A falling edge on CSX enables the serial interface and indicates the start of data transmission. See the detailed data format for 3-/4-line serial interface.

Data Format for 3-line Serial Interface

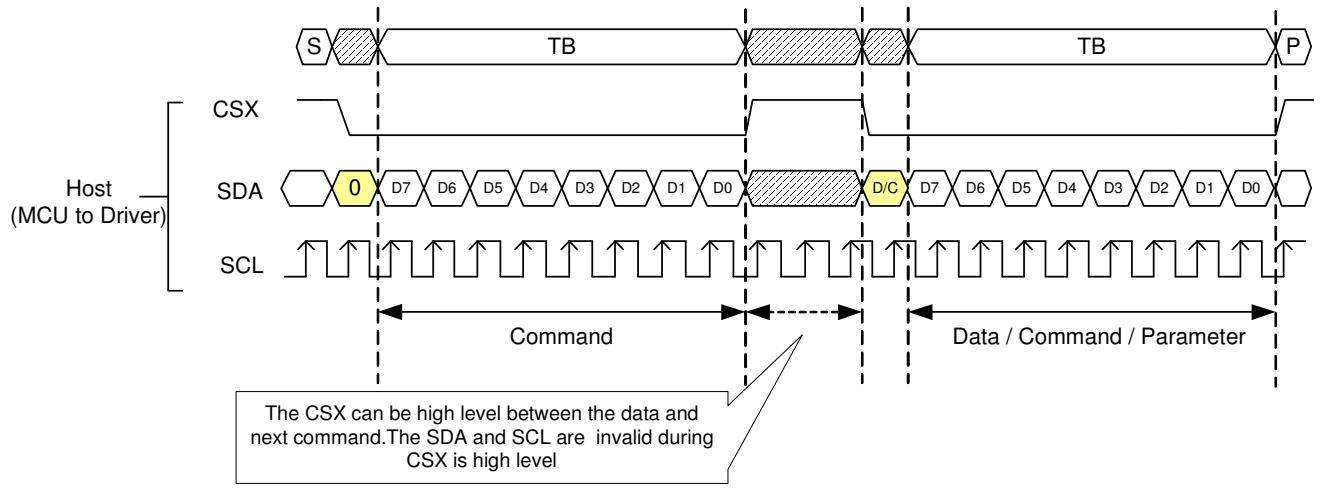


Data Format for 4-line Serial Interface

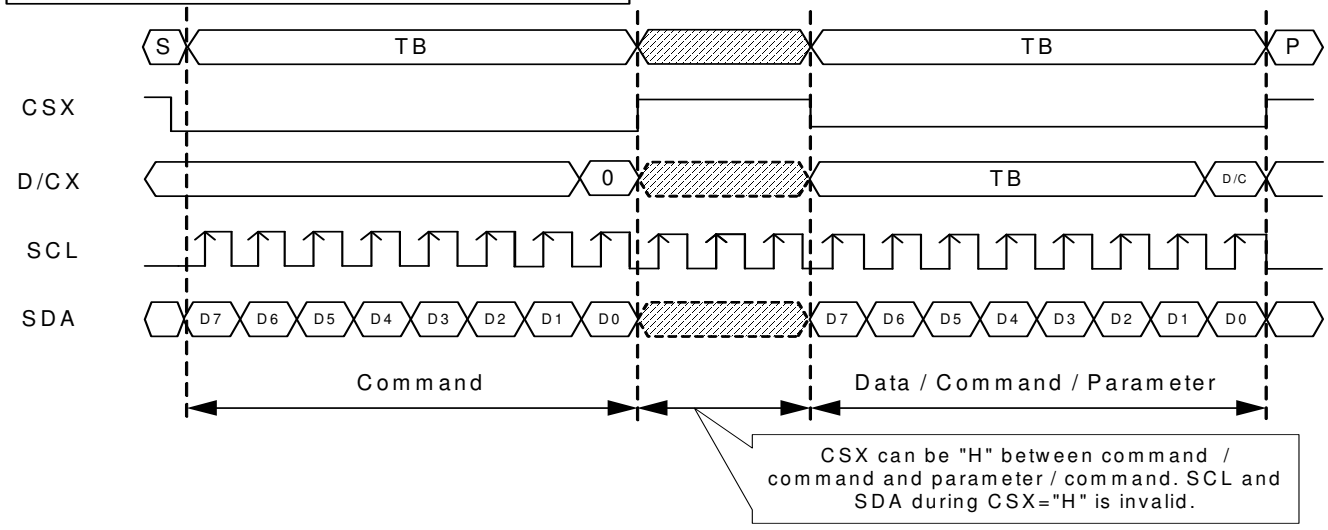


Host processor drives the CSX pin to low and starts by setting the D/CX bit on SDA. The bit is read by ILI93401 on the first rising edge of SCL signal. On the next falling edge of SCL, the MSB data bit (D7) is set on SDA by the host. On the next falling edge of SCL, the next bit (D6) is set on SDA. If the optional D/CX signal is used, a byte is eight read cycle width. The 3/4-line serial interface writes sequence described in the figure as below.

3-line Serial Interface Protocol



4-line Serial Interface Protocol

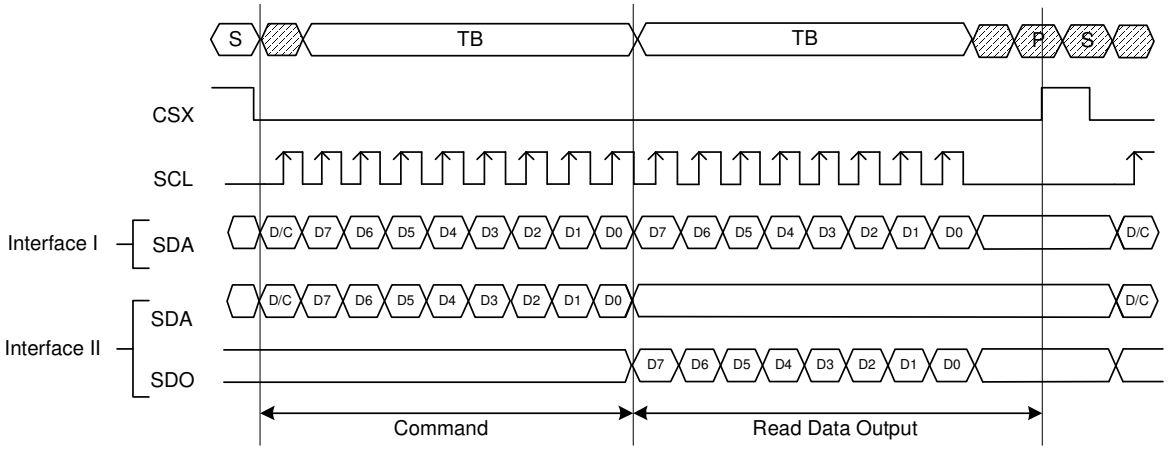


7.1.10. Read Cycle Sequence

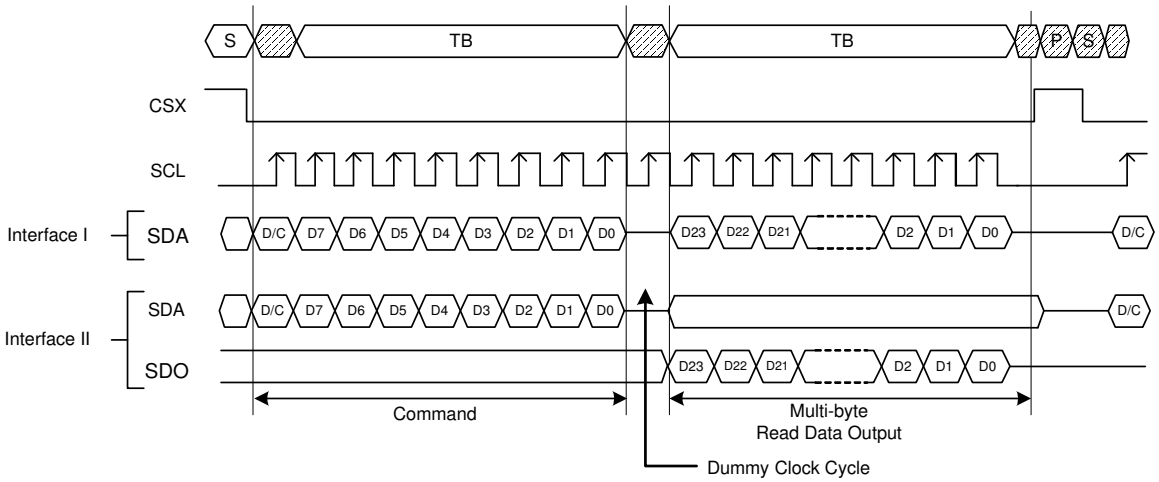
The read mode of interface means that the host reads register's parameter or display data from ILI9341. The host has to send a command (Read ID or register command) and then the following byte is transmitted in the opposite direction. ILI9341 latches the SDA (input data) at the rising edges of SCL (serial clock), and then shifts SDA (output data) at falling edges of SCL (serial clock). After the read status command has been sent, the SDA line must be set to tri-state and no later than at the falling edge of SCL of the last bit. The read mode has three types of transmitted command data (8-/24-/32-bit) according command code.

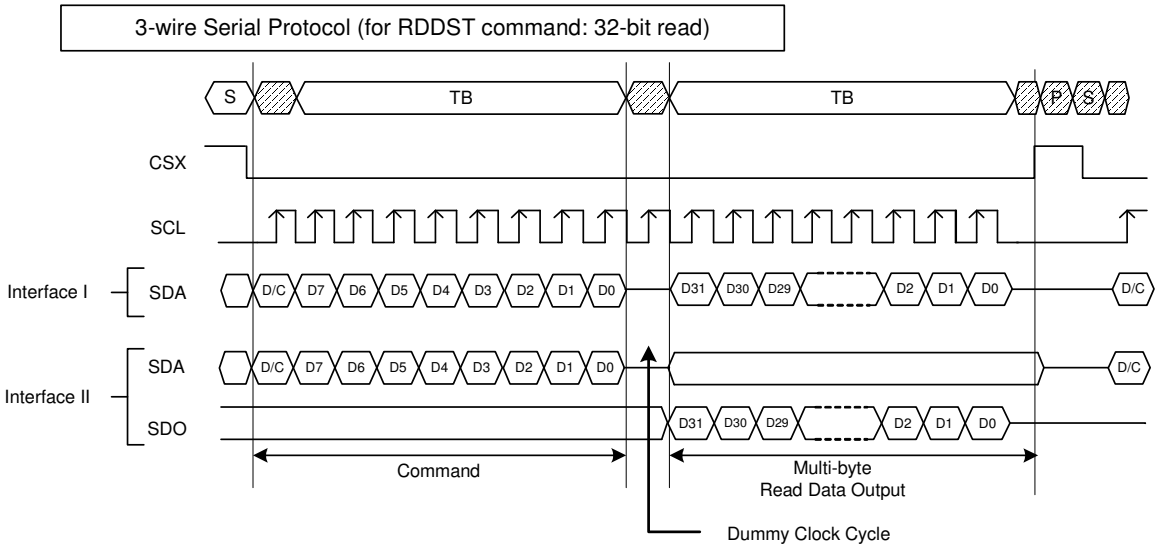
3-wire Serial Interface Protocol

3-wire Serial Protocol (for RDID1/RDID2/RDID3/0Ah/0Bh/0Ch/0Dh/0Eh/0Fh command: 8-bit read)



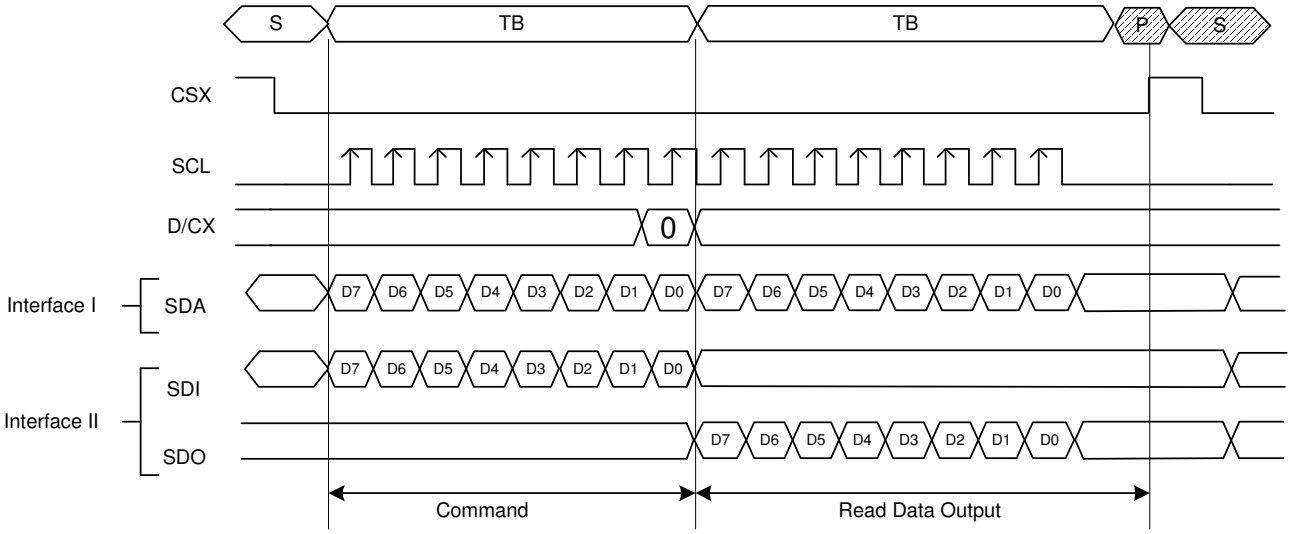
3-wire Serial Protocol (for RDDID command: 24-bit read)



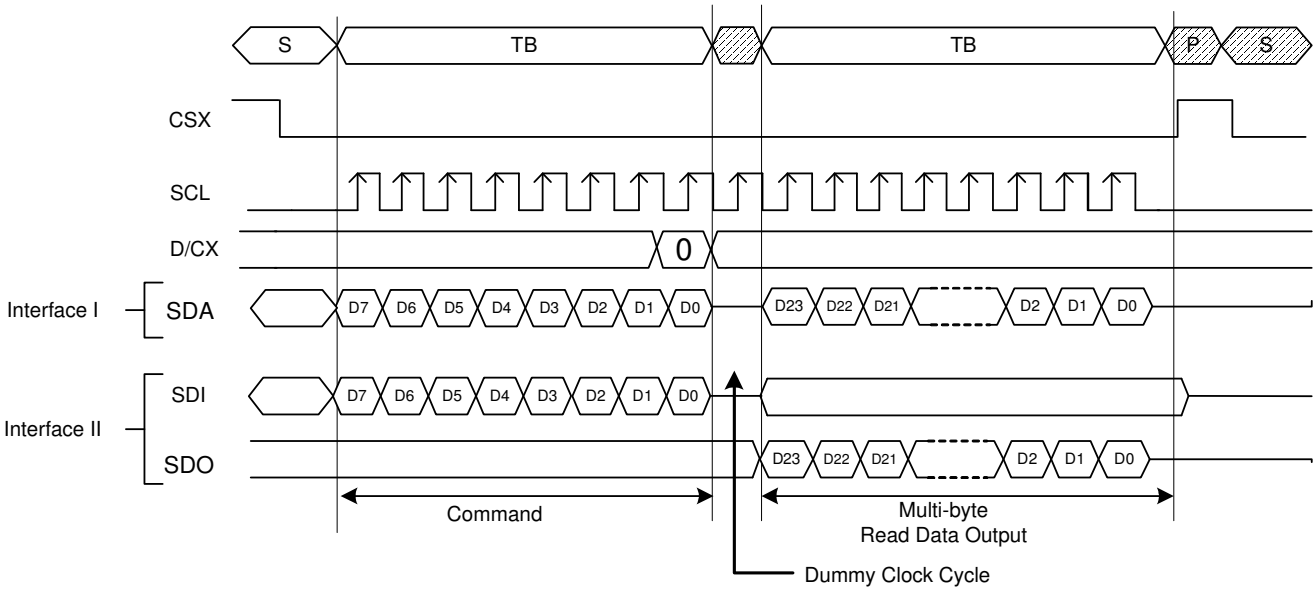


4-wire Serial Interface Protocol

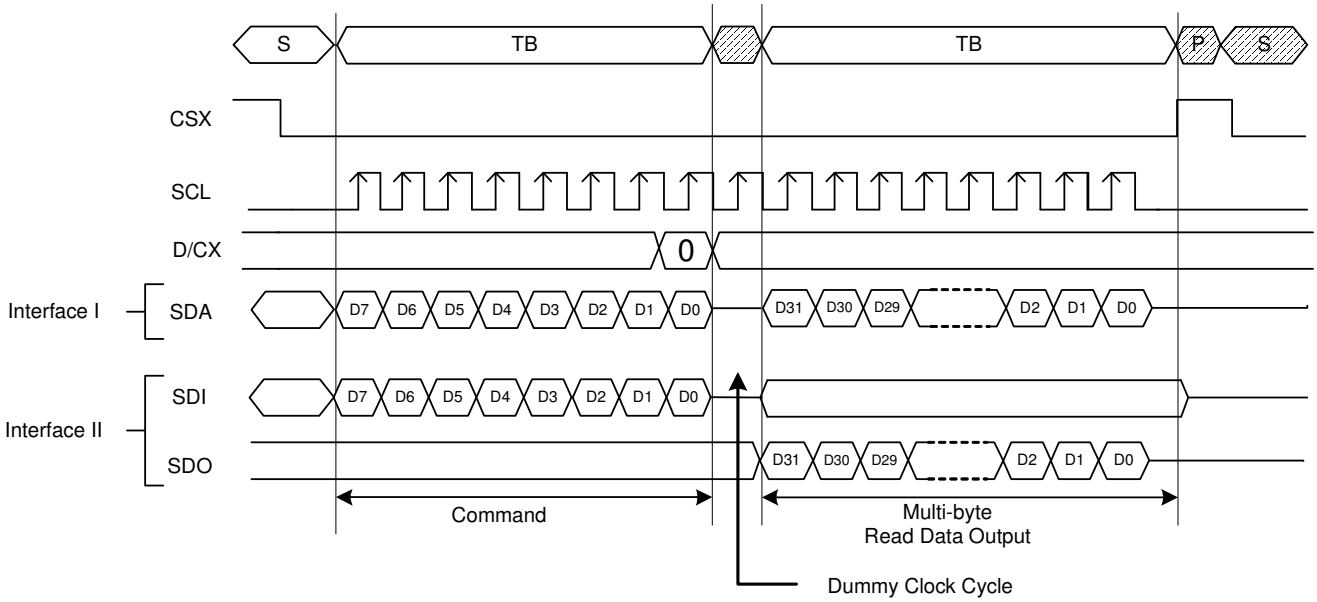
4-wire Serial Protocol (for RDID1/RDID2/RDID3/0Ah/0Bh/0Ch/0Dh/0Eh/0Fh command: 8-bit read)



4-wire Serial Protocol (for RDDID command: 24-bit read)

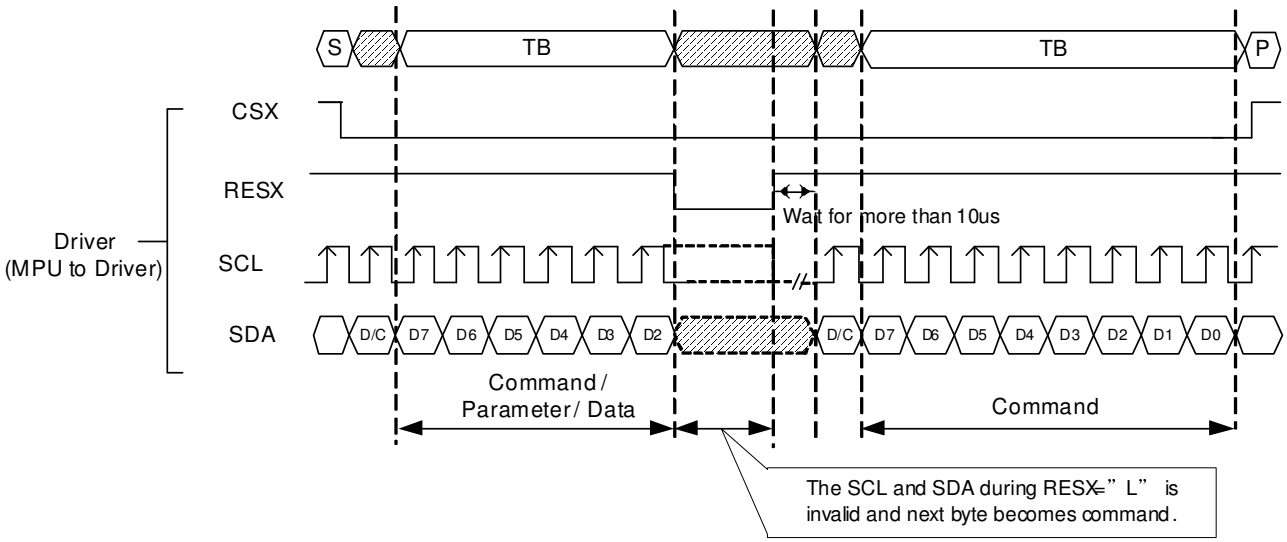


4-wire Serial Protocol (for RDDST command: 32-bit read)

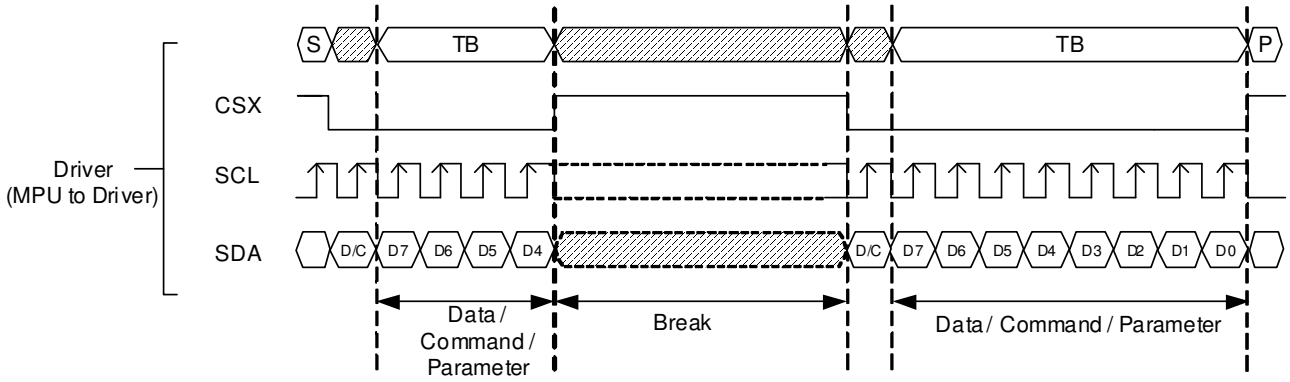


7.1.11. Data Transfer Break and Recovery

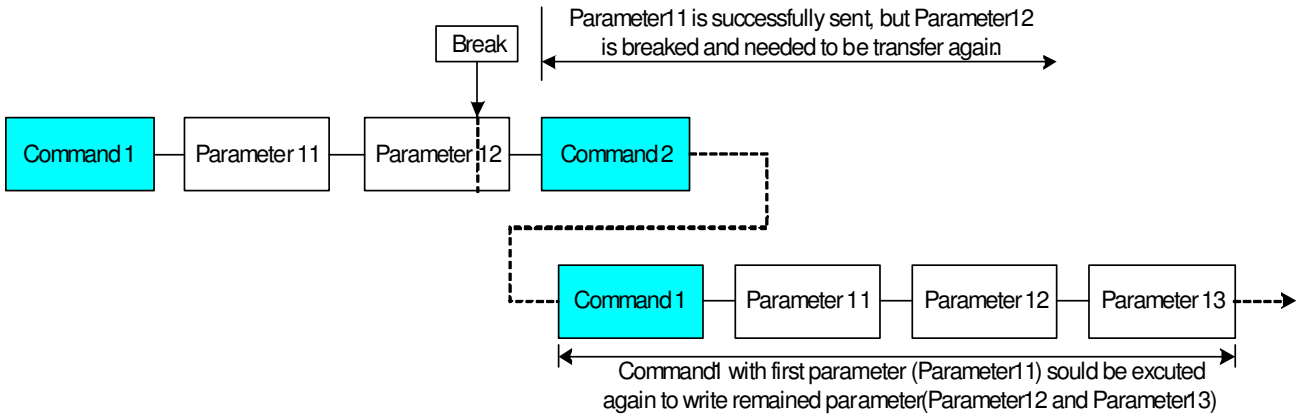
If there is a break in data transmission by RESX pulse, while transferring a command or frame memory data or multiple parameter command data, before Bit D0 of the byte has been completed, then the driver will reject the previous bits and have reset the interface such that it will be ready to receive command data again when the chip select pin (CSX) is activated after RESX have been high state.



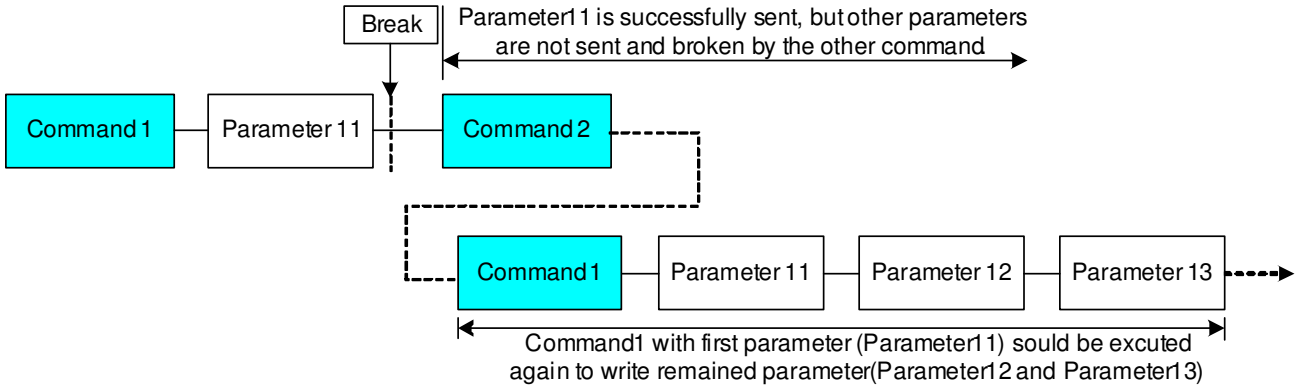
If there is a break in data transmission by CSX pulse, while transferring a command or frame memory data or multiple parameter command data, before Bit D0 of the byte has been completed, then the driver will reject the previous bits and have reset the interface such that it will be ready to receive the same byte re-transmitted when the chip select pin (CSX) is next activated.



If a two 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 continue to send the remained parameters that was interrupted, then the parameters which had been successfully sent are stored and the parameter where the break occurred is rejected. The interface is ready to receive next byte as shown below.



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



7.1.12. 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 pin (CSX) is released to high state after a whole byte of a frame memory data or multiple parameter data has been completed, then ILI9341 will wait and continue the frame memory data or parameter data transmission from the point where it was paused. If the chip select pin 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 pin is next enabled as shown below.

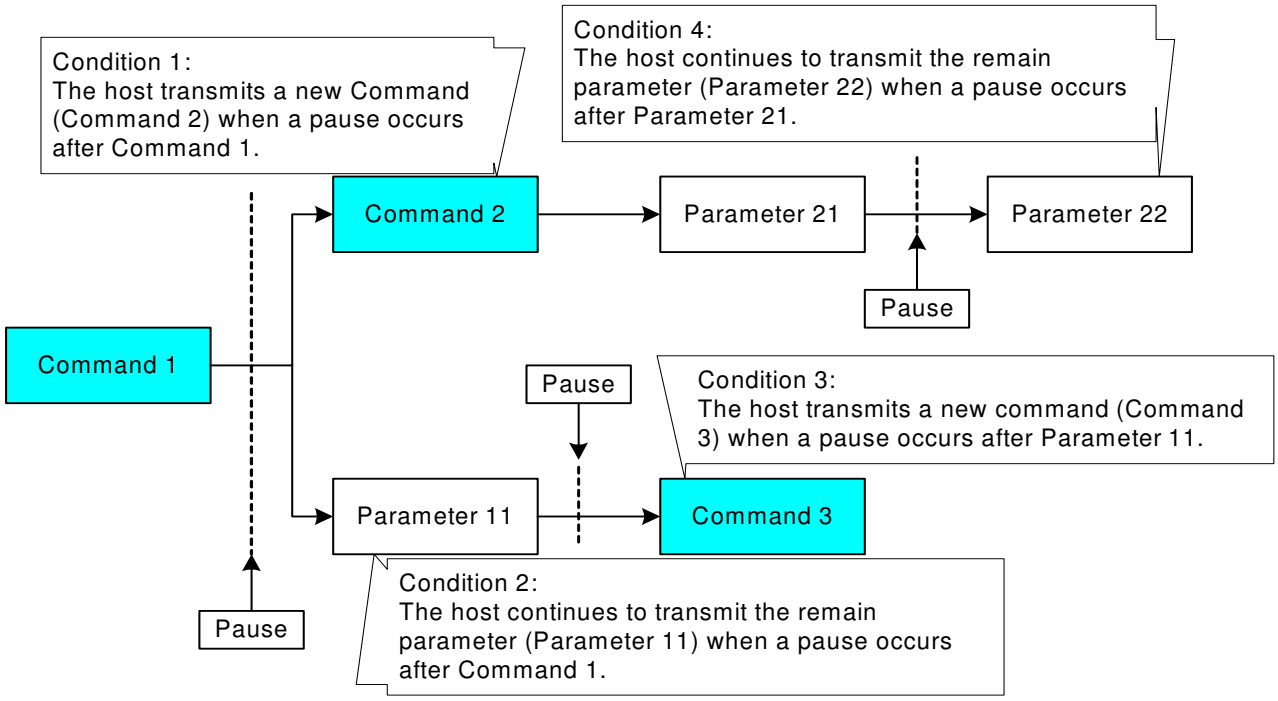
This applies to the following 4 conditions:

1) Command-Pause-Command

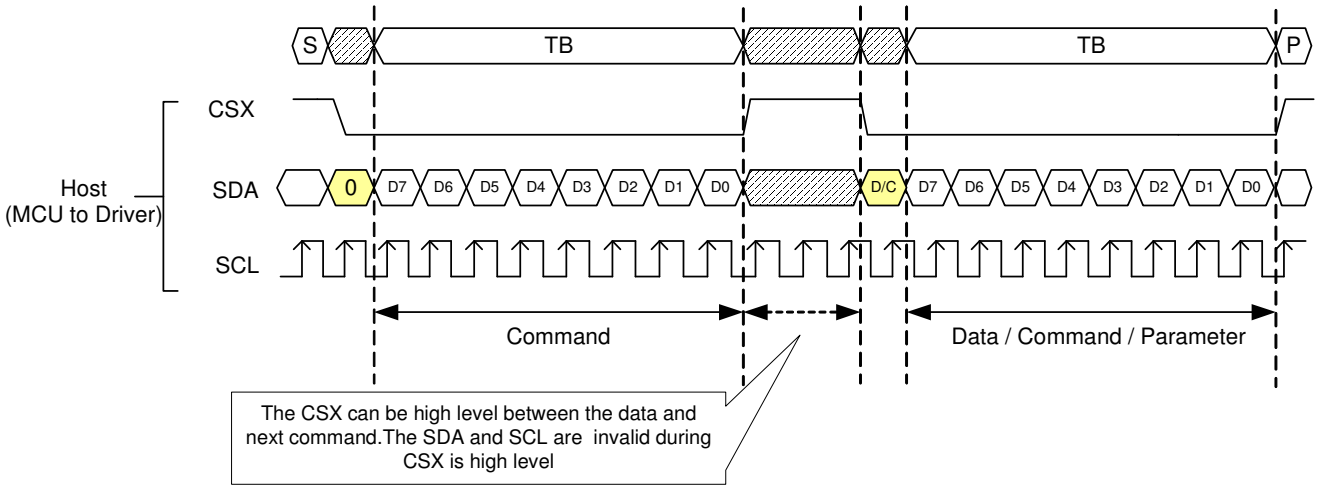
2) Command-Pause-Parameter

3) Parameter-Pause-Command

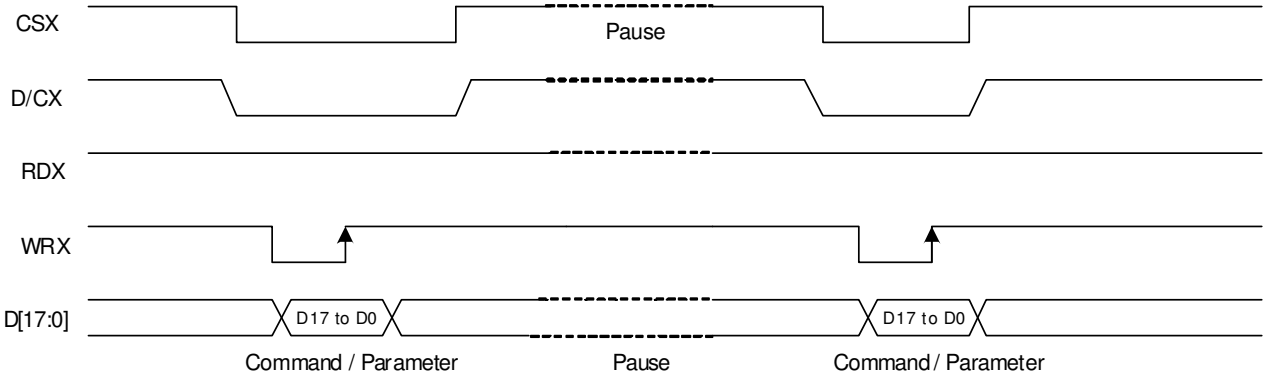
4) Parameter-Pause-Parameter



7.1.13. Serial Interface Pause (3_wire)



7.1.14. Parallel Interface Pause

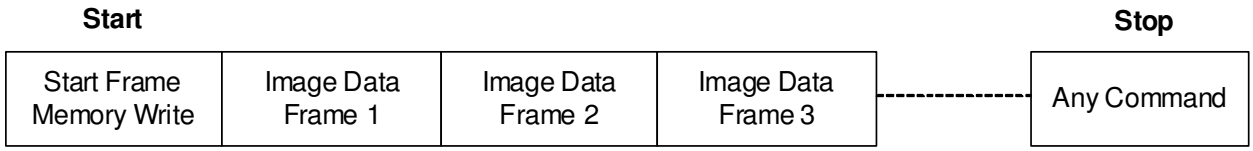


7.1.15. Data Transfer Mode

ILI9341 can provide two different kinds of color depth (16-bit/pixel and 18-bit/pixel) display data to the graphic RAM. The data format is described for each interface. Data can be downloaded to the frame memory by 2 methods.

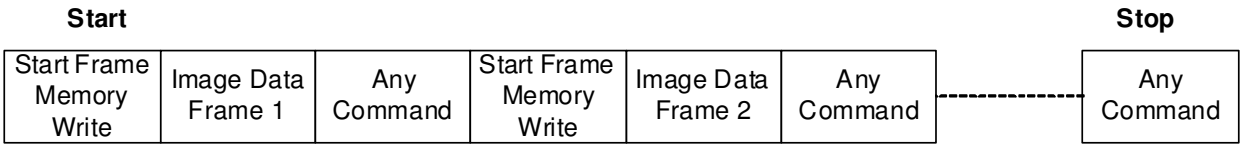
7.1.16. Data Transfer Method 1

The image data is sent to the frame memory in the successive frame writing, each time the frame memory is filled by image data, the frame memory pointer is reset to the start point and the next frame is written.



7.1.17. Data Transfer Method 2

Image data is sent and at the end of each frame memory download, a command is sent to stop frame memory writing. Then start memory write command is sent, and a new frame is downloaded.



Note 1: These methods are applied to all data transfer color modes on both serial and parallel interfaces.

Note 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.

7.2. RGB Interface

7.2.1. RGB Interface Selection

ILI9341 has two kinds of RGB interface and these interfaces can be selected by RCM [1:0] bits. When RCM [1:0] bits are set to “10”, the DE mode is selected which utilizes VSYNC, HSYNC, DOTCLK, DE, D [17:0] pins; when RCM [1:0] bits are set to “11”, the SYNC mode is selected which utilizes which utilizes VSYNC, HSYNC, DOTCLK, D [17:0] pins. Using RGB interface must selection serial interface.

ILI9341 supports several pixel formats that can be selected by DPI [2:0] bits of “Pixel Format Set (3Ah)” and RIM bit of RF6h command. The selection of a given interfaces is done by setting RCM [1:0] and DPI [2:0] as show in the following table.

RCM[1:0]		RIM	DPI[2:0]			RGB Interface Mode	RGB Mode	Used Pins
1	0	0	1	1	0	18-bit RGB interface (262K colors)	**DE Mode** Valid data is determined by the DE signal	VSYNC, HSYNC, DE, DOTCLK,D[17:0]
1	0	0	1	0	1	16-bit RGB interface (65K colors)		VSYNC, HSYNC, DE, DOTCLK, D[17:13] & D[11:1]
1	0	1	1	1	0	6-bit RGB interface (262K colors)		VSYNC, HSYNC, DE, DOTCLK, D[5:0]
1	0	1	1	0	1	6-bit RGB interface (65K colors)		VSYNC, HSYNC, DE, DOTCLK, D[5:0]
1	1	0	1	1	0	18-bit RGB interface (262K colors)	**SYNC Mode** In SYNC mode, DE signal is ignored; blanking porch is determined by B5h command.	VSYNC, HSYNC, DOTCLK, D[17:0]
1	1	0	1	0	1	16-bit RGB interface (65K colors)		VSYNC, HSYNC, DOTCLK, D[17:13] & D[11:1]
1	1	1	1	1	0	6-bit RGB interface (262K colors)		VSYNC, HSYNC, DOTCLK, D[5:0]
1	1	1	1	0	1	6-bit RGB interface (65K colors)		VSYNC, HSYNC, DOTCLK, D[5:0]

18-bit data bus interface (D[17:0] is used) , DPI[2:0] = 110, and RIM=0

	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
18bpp Frame Memory Write	R[5]	R[4]	R[3]	R[2]	R[1]	R[0]	G[5]	G[4]	G[3]	G[2]	G[1]	G[0]	B[5]	B[4]	B[3]	B[2]	B[1]	B[0]

16-bit data bus interface (D[17:13] & D[11:1] is used) , DPI[2:0] = 101, and RIM=0

	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
16bpp Frame Memory Write	R[4]	R[3]	R[2]	R[1]	R[0]		G[5]	G[4]	G[3]	G[2]	G[1]	G[0]	B[4]	B[3]	B[2]	B[1]	B[0]	

The LSB data of red/blue color depends on the EPF[1:0] setting.

6-bit data bus interface (D[5:0] is used) , DPI[2:0] = 110, and RIM=1

	D5	D4	D3	D2	D1	D0	D5	D4	D3	D2	D1	D0	D5	D4	D3	D2	D1	D0
18bpp Frame Memory Write	R[5]	R[4]	R[3]	R[2]	R[1]	R[0]	G[5]	G[4]	G[3]	G[2]	G[1]	G[0]	B[5]	B[4]	B[3]	B[2]	B[1]	B[0]

6-bit data bus interface (D[5:0] is used) , DPI[2:0] = 101, and RIM=1

	D5	D4	D3	D2	D1	D0	D5	D4	D3	D2	D1	D0	D5	D4	D3	D2	D1	D0
16bpp Frame Memory Write	R[4]	R[3]	R[2]	R[1]	R[0]		G[5]	G[4]	G[3]	G[2]	G[1]	G[0]	B[4]	B[3]	B[2]	B[1]	B[0]	

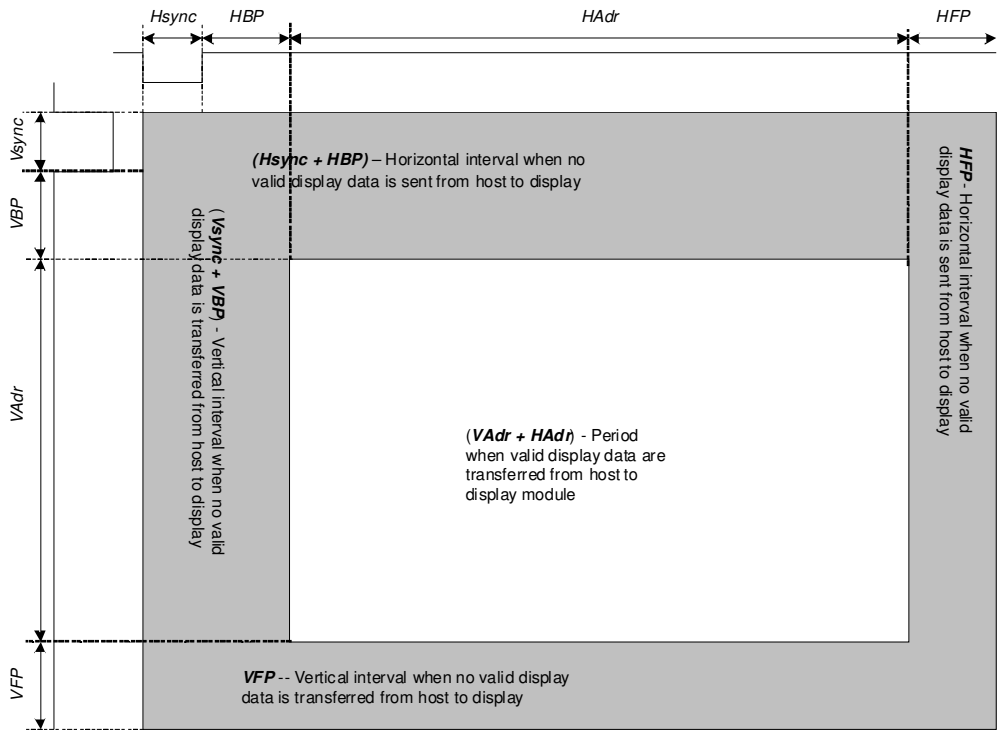
The LSB data of red/blue color depends on the EPF[1:0] setting.

Pixel clock (DOTCLK) is running all the time without stopping and used to enter VSYNC, HSYNC, DE and D [17:0] states when there is a rising edge of the DOTCLK. Vertical synchronization (VSYNC) is used to tell when

there is received a new frame of the display. This is low enable and its state is read to the display module by a rising edge of the DOTCLK signal.

Horizontal synchronization (HSYNC) is used to tell when there is received a new line of the frame. This is low enable and its state is read to the display module by a rising edge of the DOTCLK signal.

In DE mode, Data Enable (DE) is used to tell when there is received RGB information that should be transferred on the display. This is a high enable and its state is read to the display module by a rising edge of the DOTCLK signal. D [17:0] are used to tell what is the information of the image that is transferred on the display (When DE= '0' (low) and there is a rising edge of DOTCLK). D [17:0] can be '0' (low) or '1' (high). These lines are read by a rising edge of the DOTCLK signal. In SYNC mode, the valid display data in inputted in pixel unit via D [17:0] according to HFP/HBP settings of HSYNC signal and VFP/VBP setting of VSYNC. In both RGB interface modes, the input display data is written to GRAM first then outputs corresponding source voltage according the gray data from GRAM.



Parameters	Symbols	Condition	Min.	Typ.	Max.	Units
Horizontal Synchronization	Hsync		2	10	16	DOTCLK
Horizontal Back Porch	HBP		2	20	24	DOTCLK
Horizontal Address	HAdr		-	240	-	DOTCLK
Horizontal Front Porch	HFP		2	10	16	DOTCLK
Vertical Synchronization	Vsync		1	2	4	Line
Vertical Back Porch	VBP		1	2	-	Line
Vertical Address	VAdr		-	320	-	Line
Vertical Front Porch	VFP		3	4	-	Line

Typical values are setting example when used with panel resolution 240 x 320 (QVGA), clock frequency 6.35MHz and frame

frequency about 70Hz.

Notes:

1. Vertical period (one frame) shall be equal to the sum of Vsync + VBP + VAdr + VFP.
2. Horizontal period (one line) shall be equal to the sum of Hsync + HBP + HAdr + HFP.
3. Control signals PCLK and Hsync shall be transmitted as specified at all times while valid pixels are transferred between the host processor and the display module.

Also make sure that

(Number of PCLK per 1 line) ≥ (Number of RTN clock) x Division ratio (DIV) x PCDIV

Setting Example for Display Control Clock in RGB Interface Operation

Register Display operation using DPI is in synchronization with internal clock PCLKD which is generated by dividing DOTCLK.

PCDIV [5:0]: Number of DOTCLK during internal clock PCLKD's high / low period. In units of 1 clock.

PCDIV specifying DOTCLK's division ratio, are determined so that difference between PCLKD's frequency and internal oscillation clock 615KHz is the smallest. Set PCDIV follow the restriction

(Number of PCLK in 1H) ≥ (Number of RTN clock) x Division ratio (DIV) x PCDIV.

Setting Example: To set frame frequency to 70Hz:

Internal Clock

Internal Oscillation Clock: 615KHz

DIV[1:0] = 2'b0 (x 1/1)

RTN[4:0] = 5'h1b (27 clocks)

FP = 7'h2 (2 lines), BP = 7'h2 (2 lines), NL = 6'h27 (320 lines)

Frame Rate → 70.30Hz

DOTCLK

HSYNC = 10 CLK

HBP = 20 CLK

HFP=10 CLK

70Hz x (2 + 320 + 2) lines x (10 + 20 + 240 + 10) clocks = 6.35MHz

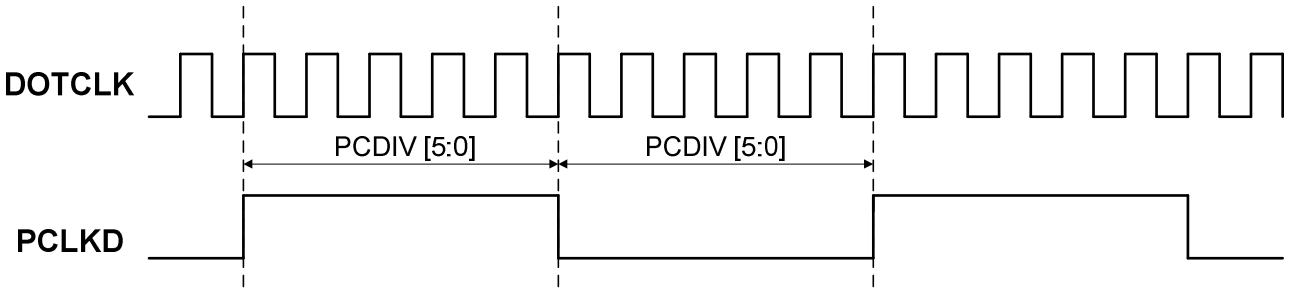
DOTCLK frequency = 6.35MHz

6.35 MHz / 615KHz = 10.32 □ Set PCDIV so that PCLK is divided by 10.

external fosc = 6.35 MHz / 10 = 635KHz

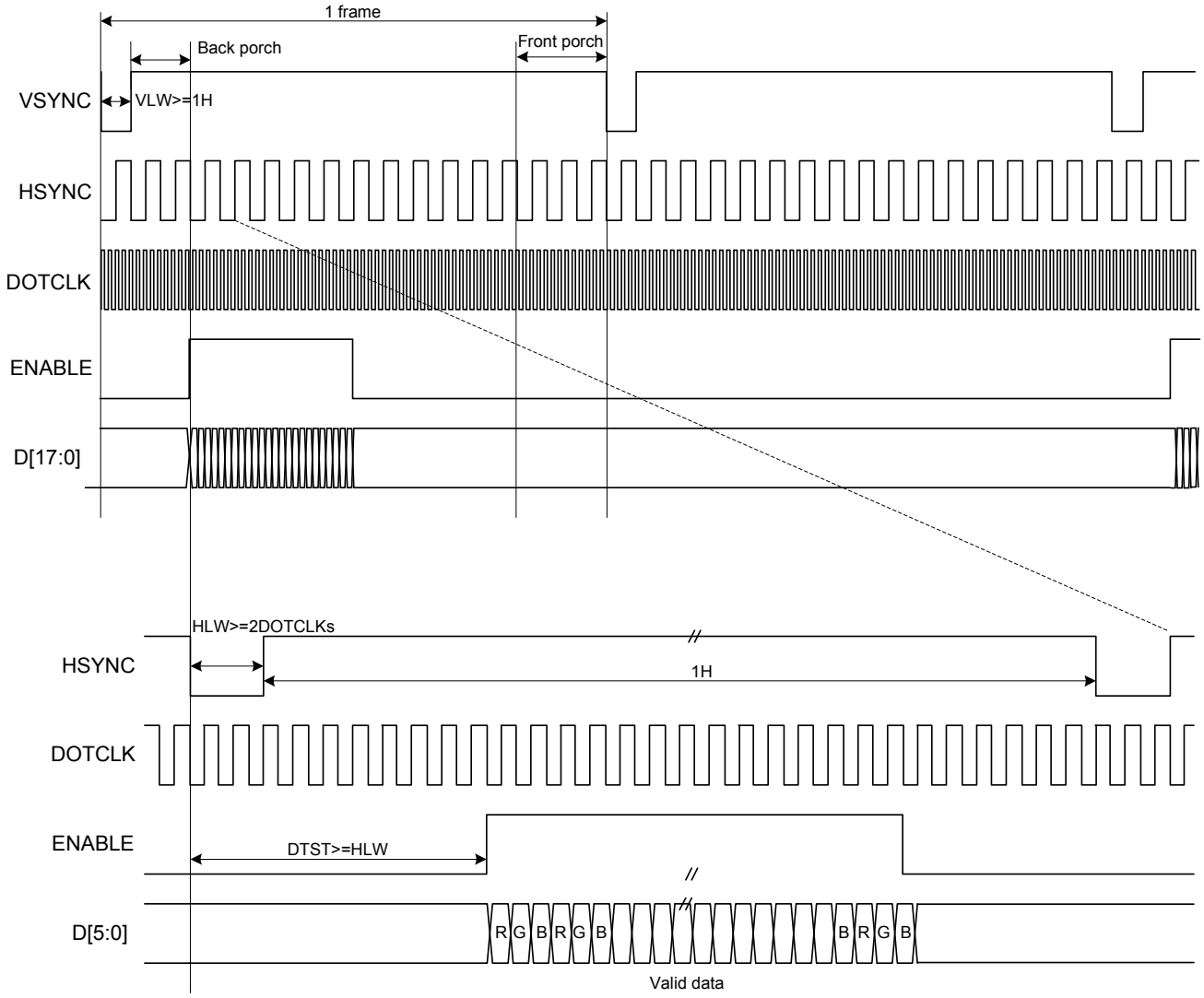
PCDIV = [6.35MHz / 635KHz) / 2] - 1 = 4

PCDIV[5:0] = 6'h04 (10 DOTCLK)

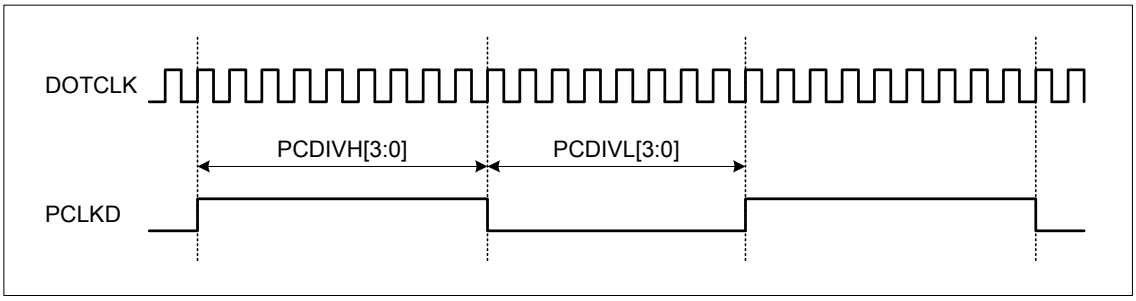


7.2.2. RGB Interface Timing

The timing chart of 18-/16-bit RGB interface mode is shown as below.



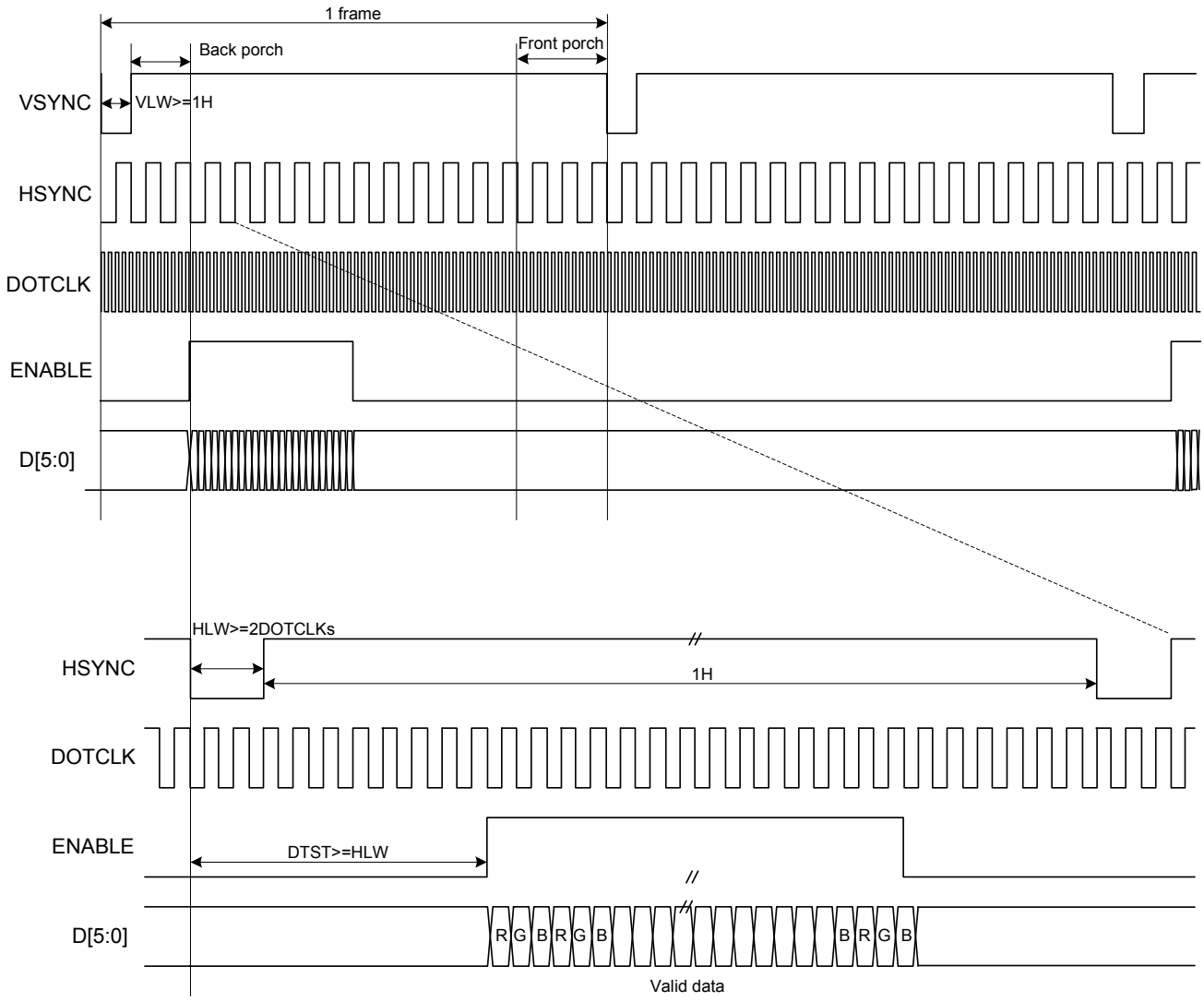
VLW : VSYNC Low Width
HLW : HSYNC Low Width
DTST : Data Transfer Startup Time



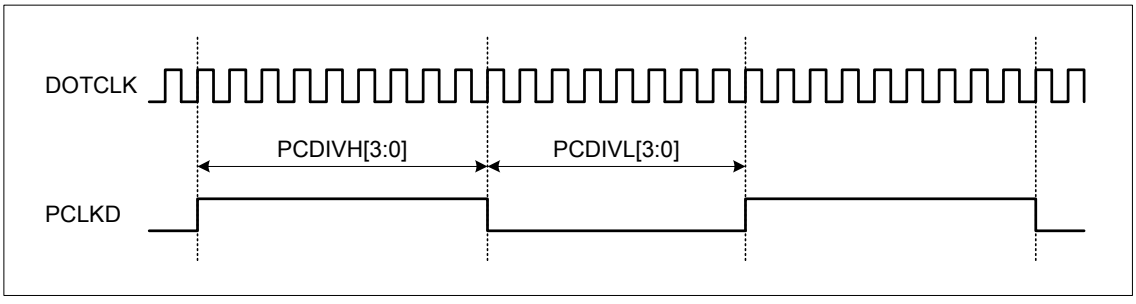
Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='0' of "Interface Mode Control (B0h)" command.

The timing chart of 6-bit RGB interface mode is shown as below:



VLW : VSYNC Low Width
HLW : HSYNC Low Width
DTST : Data Transfer Startup Time



Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

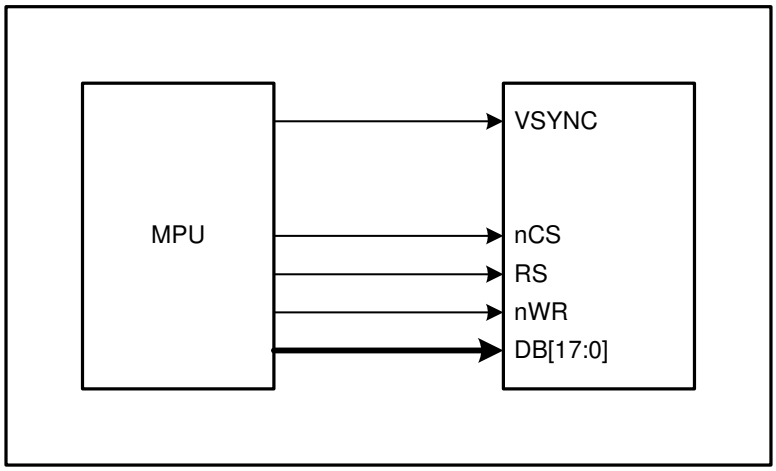
Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='0' of "Interface Mode Control (B0h)" command.

Note 3: In 6-bit RGB interface mode, each dot of one pixel (R, G and B) is transferred in synchronization with DOTCLK.

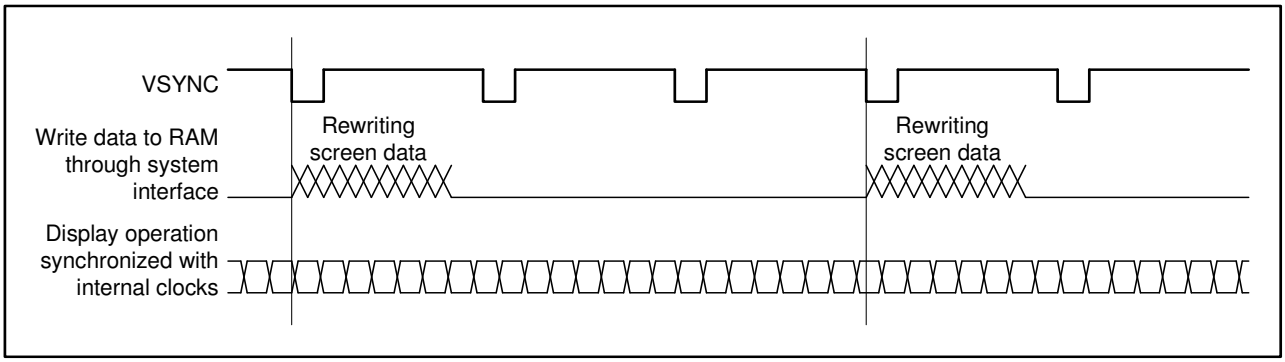
Note 4: In 6-bit RGB interface mode, set the cycles of VSYNC, HSYNC and DE to 3 multiples of DOTCLK.

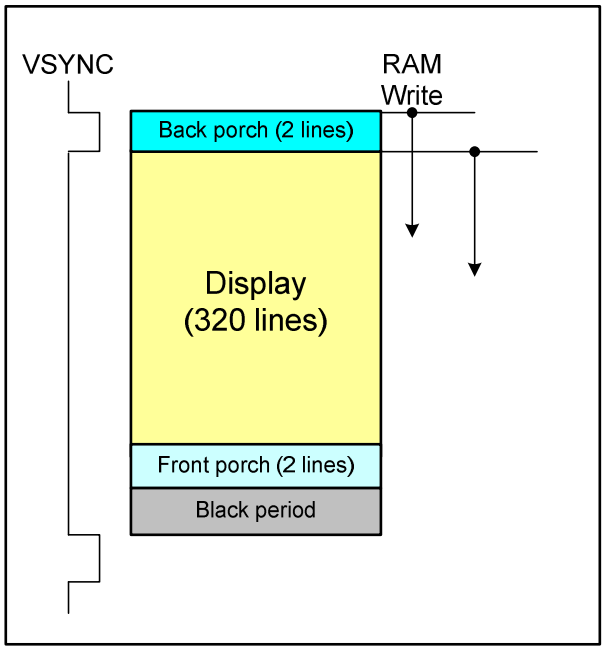
7.3. VSYNC Interface

ILI9341 supports the VSYNC interface in synchronization with the frame-synchronizing signal VSYNC to display the moving picture with the 8080-Ⅰ/8080-Ⅱ system interface. When the VSYNC interface is selected to display a moving picture, the minimum GRAM update speed is limited and the VSYNC interface is enabled by setting DM[1:0] = “10” and RM = “0”.



In the VSYNC mode, the display operation is synchronized with the internal clock and VSYNC input and the frame rate is determined by the pulse rate of VSYNC signal. All display data are stored in GRAM to minimize total data transfer required for moving picture display.





The VSYNC interface has the minimum speed limitation of writing data to the internal GRAM via the system interface, which are calculated from the following formula.

Internal clock frequency (fosc.) [Hz] = FrameFrequency x (DisplayLine (NL) + FrontPorch (VFP) + BackPorch (VBP)) x ClockCyclePerLines (RTN) x FrequencyFluctuation.

$$\textit{Minimum RAM write speed [Hz]} > \frac{240 \times DisplayLines(NL)}{[BackPorch(VBP) + DisplayLines(NL) - margins] \times Clocks\ per\ line \times (1/fosc)}$$

Note: When the RAM write operation does not start from the falling edge of VSYNC, the time from the falling edge of VSYNC until the start of RAM write operation must also be taken into account.

An example of minimum GRAM writing speed and internal clock frequency in VSYNC interface mode is as below.

[Example]

Display size: 240 RGB × 320 lines

Lines: 320 lines (NL = 100111)

Back porch: 2 lines (VBP = 0000010)

Front porch: 2 lines (VFP = 0000010)

Frame frequency: 70 Hz

Frequency fluctuation: 10%

Internal oscillator clock (fosc.) [Hz] = 70 x [320+ 2 + 2] x 27 clocks x (1.1/0.9) ≒ 748KHz

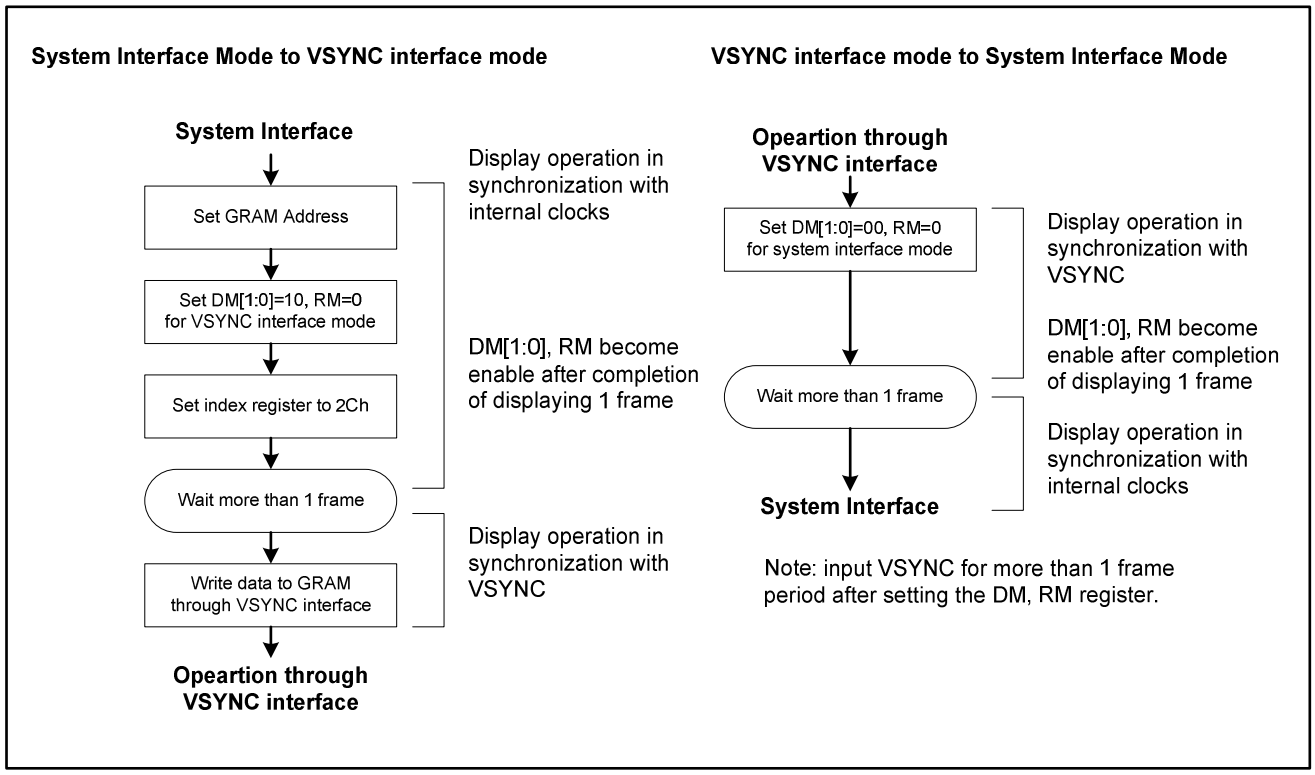
When calculate the internal clock frequency, the oscillator variation is needed to be taken into consideration. In the above example, the calculated internal clock frequency with ±10% margin variation is considered and ensures to complete the display operation within one VSYNC cycle. The causes of frequency variation come from fabrication process of LSI, room temperature, external resistors and VCI voltage variation.

Minimum speed for RAM writing [Hz] > 240 x 320 x 748K / [(2 + 320 – 2)lines x 27clocks] ≒ 6.65 MHz

The above theoretical value is calculated based on the premise that the ILI9341 starts to write data into the internal GRAM on the falling edge of VSYNC. There must at least be a margin of 2 lines between the physical display line and the GRAM line address where data writing operation is performed. The GRAM write speed of 6.65MHz or more will guarantee the completion of GRAM write operation before the ILI9341 starts to display the GRAM data on the screen and enable to rewrite the entire screen without flicker.

Notes in using the VSYNC interface

1. The minimum GRAM write speed must be satisfied and the frequency variation must be taken into consideration.
2. The display frame rate is determined by the VSYNC signal and the period of VSYNC must be longer than the scan period of an entire display.
3. When switching from the internal clock operation mode (DM[1:0] = “00”) to the VSYNC interface mode or inversely, the switching starts from the next VSYNC cycle, i.e. after completing the display of the frame.
4. The partial display, vertical scroll, and interlaced scan functions are not available in VSYNC interface mode.



7.4. Color Depth Conversion Look Up Table

When ILI9341 operates in parallel 16-bit interface, the color depth conversion is done by look-up table and extend input data format to 18-bit. See the detailed for look-up table of color depth conversion.

R input (5-bit) 16-bit/pixel –mode 65,536 colors	R output (6-bit) 18-bit/pixel –mode 262,144 colors	Command Code (0x2Dh) RGBSET Parameter
00000	R_{005} R_{004} R_{003} R_{002} R_{001} R_{000}	1
00001	R_{015} R_{014} R_{013} R_{012} R_{011} R_{010}	2
00010	R_{025} R_{024} R_{023} R_{022} R_{021} R_{020}	3
00011	R_{035} R_{034} R_{033} R_{032} R_{031} R_{030}	4
00100	R_{045} R_{044} R_{043} R_{042} R_{041} R_{040}	5
00101	R_{055} R_{054} R_{053} R_{052} R_{051} R_{050}	6
00110	R_{065} R_{064} R_{063} R_{062} R_{061} R_{060}	7
00111	R_{075} R_{074} R_{073} R_{072} R_{071} R_{070}	8
01000	R_{085} R_{084} R_{083} R_{082} R_{081} R_{080}	9
01001	R_{095} R_{094} R_{093} R_{092} R_{091} R_{090}	10
01010	R_{105} R_{104} R_{103} R_{102} R_{101} R_{100}	11
01011	R_{115} R_{114} R_{113} R_{112} R_{111} R_{110}	12
01100	R_{125} R_{124} R_{123} R_{122} R_{121} R_{120}	13
01101	R_{135} R_{134} R_{133} R_{132} R_{131} R_{130}	14
01110	R_{145} R_{144} R_{143} R_{142} R_{141} R_{140}	15
01111	R_{155} R_{154} R_{153} R_{152} R_{151} R_{150}	16
10000	R_{165} R_{164} R_{163} R_{162} R_{161} R_{160}	17
10001	R_{175} R_{174} R_{173} R_{172} R_{171} R_{170}	18
10010	R_{185} R_{184} R_{183} R_{182} R_{181} R_{180}	19
10011	R_{195} R_{194} R_{193} R_{192} R_{191} R_{190}	20
10100	R_{205} R_{204} R_{203} R_{202} R_{201} R_{200}	21
10101	R_{215} R_{214} R_{213} R_{212} R_{211} R_{210}	22
10110	R_{225} R_{224} R_{223} R_{222} R_{221} R_{220}	23
10111	R_{235} R_{234} R_{233} R_{232} R_{231} R_{230}	24
11000	R_{245} R_{244} R_{243} R_{242} R_{241} R_{240}	25
11001	R_{255} R_{254} R_{253} R_{252} R_{251} R_{250}	26
11010	R_{265} R_{264} R_{263} R_{262} R_{261} R_{260}	27
11011	R_{275} R_{274} R_{273} R_{272} R_{271} R_{270}	28
11100	R_{285} R_{284} R_{283} R_{282} R_{281} R_{280}	29
11101	R_{295} R_{294} R_{293} R_{292} R_{291} R_{290}	30
11110	R_{305} R_{304} R_{303} R_{302} R_{301} R_{300}	31
11111	R_{315} R_{314} R_{313} R_{312} R_{311} R_{310}	32

G input (6-bit) 16-bit/pixel –mode 65,536 colors	G output (6-bit) 18-bit/pixel –mode 262,144 colors	Command Code (0x2Dh) RGBSET Parameter
000000	G_{005} G_{004} G_{003} G_{002} G_{001} G_{000}	33
000001	G_{015} G_{014} G_{013} G_{012} G_{011} G_{010}	34
000010	G_{025} G_{024} G_{023} G_{022} G_{021} G_{020}	35
000011	G_{035} G_{034} G_{033} G_{032} G_{031} G_{030}	36
000100	G_{045} G_{044} G_{043} G_{042} G_{041} G_{040}	37
000101	G_{055} G_{054} G_{053} G_{052} G_{051} G_{050}	38
000110	G_{065} G_{064} G_{063} G_{062} G_{061} G_{060}	39
000111	G_{075} G_{074} G_{073} G_{072} G_{071} G_{070}	40
001000	G_{085} G_{084} G_{083} G_{082} G_{081} G_{080}	41
001001	G_{095} G_{094} G_{093} G_{092} G_{091} G_{090}	42
001010	G_{105} G_{104} G_{103} G_{102} G_{101} G_{100}	43
001011	G_{115} G_{114} G_{113} G_{112} G_{111} G_{110}	44
001100	G_{125} G_{124} G_{123} G_{122} G_{121} G_{120}	45
001101	G_{135} G_{134} G_{133} G_{132} G_{131} G_{130}	46
001110	G_{145} G_{144} G_{143} G_{142} G_{141} G_{140}	47
001111	G_{155} G_{154} G_{153} G_{152} G_{151} G_{150}	48
010000	G_{165} G_{164} G_{163} G_{162} G_{161} G_{160}	49
010001	G_{175} G_{174} G_{173} G_{172} G_{171} G_{170}	50
010010	G_{185} G_{184} G_{183} G_{182} G_{181} G_{180}	51
010011	G_{195} G_{194} G_{193} G_{192} G_{191} G_{190}	52
010100	G_{205} G_{204} G_{203} G_{202} G_{201} G_{200}	53
010101	G_{215} G_{214} G_{213} G_{212} G_{211} G_{210}	54
010110	G_{225} G_{224} G_{223} G_{222} G_{221} G_{220}	55
010111	G_{235} G_{234} G_{233} G_{232} G_{231} G_{230}	56
011000	G_{245} G_{244} G_{243} G_{242} G_{241} G_{240}	57
011001	G_{255} G_{254} G_{253} G_{252} G_{251} G_{250}	58
011010	G_{265} G_{264} G_{263} G_{262} G_{261} G_{260}	59
011011	G_{275} G_{274} G_{273} G_{272} G_{271} G_{270}	60
011100	G_{285} G_{284} G_{283} G_{282} G_{281} G_{280}	61
011101	G_{295} G_{294} G_{293} G_{292} G_{291} G_{290}	62
011110	G_{305} G_{304} G_{303} G_{302} G_{301} G_{300}	63
011111	G_{315} G_{314} G_{313} G_{312} G_{311} G_{310}	64
100000	G_{325} G_{324} G_{323} G_{322} G_{321} G_{320}	65
100001	G_{335} G_{334} G_{333} G_{332} G_{331} G_{330}	66

G input (6-bit) 16-bit/pixel –mode 65,536 colors	G output (6-bit) 18-bit/pixel –mode 262,144 colors	Command Code (0x2Dh) RGBSET Parameter
100010	G_{345} G_{344} G_{343} G_{342} G_{341} G_{340}	67
100011	G_{355} G_{354} G_{353} G_{352} G_{351} G_{350}	68
100100	G_{365} G_{364} G_{363} G_{362} G_{361} G_{360}	69
100101	G_{375} G_{374} G_{373} G_{372} G_{371} G_{370}	70
100110	G_{385} G_{384} G_{383} G_{382} G_{381} G_{380}	71
100111	G_{395} G_{394} G_{393} G_{392} G_{391} G_{390}	72
101000	G_{405} G_{404} G_{403} G_{402} G_{401} G_{400}	73
101001	G_{415} G_{414} G_{413} G_{412} G_{411} G_{410}	74
101010	G_{425} G_{424} G_{423} G_{422} G_{421} G_{420}	75
101011	G_{435} G_{434} G_{433} G_{432} G_{431} G_{430}	76
101100	G_{445} G_{444} G_{443} G_{442} G_{441} G_{440}	77
101101	G_{455} G_{454} G_{453} G_{452} G_{451} G_{450}	78
101110	G_{465} G_{464} G_{463} G_{462} G_{461} G_{460}	79
101111	G_{475} G_{474} G_{473} G_{472} G_{471} G_{470}	80
110000	G_{485} G_{484} G_{483} G_{482} G_{481} G_{480}	81
110001	G_{495} G_{494} G_{493} G_{492} G_{491} G_{490}	82
110010	G_{505} G_{504} G_{503} G_{502} G_{501} G_{500}	83
110011	G_{515} G_{514} G_{513} G_{512} G_{511} G_{510}	84
110100	G_{525} G_{524} G_{523} G_{522} G_{521} G_{520}	85
110101	G_{535} G_{534} G_{533} G_{532} G_{531} G_{530}	86
110110	G_{545} G_{544} G_{543} G_{542} G_{541} G_{540}	87
110111	G_{555} G_{554} G_{553} G_{552} G_{551} G_{550}	88
111000	G_{565} G_{564} G_{563} G_{562} G_{561} G_{560}	89
111001	G_{575} G_{574} G_{573} G_{572} G_{571} G_{570}	90
111010	G_{585} G_{584} G_{583} G_{582} G_{581} G_{580}	91
111011	G_{595} G_{594} G_{593} G_{592} G_{591} G_{590}	92
111100	G_{605} G_{604} G_{603} G_{602} G_{601} G_{600}	93
111101	G_{615} G_{614} G_{613} G_{612} G_{611} G_{610}	94
111110	G_{625} G_{624} G_{623} G_{622} G_{621} G_{620}	95
111111	G_{635} G_{634} G_{633} G_{632} G_{631} G_{630}	96

B input (5-bit) 16-bit/pixel –mode 65,536 colors	B output (6-bit) 18-bit/pixel –mode 262,144 colors	Command Code (0x2Dh) RGBSET Parameter
00000	B_{005} B_{004} B_{003} B_{002} B_{001} B_{000}	97
00001	B_{015} B_{014} B_{013} B_{012} B_{011} B_{010}	98
00010	B_{025} B_{024} B_{023} B_{022} B_{021} B_{020}	99
00011	B_{035} B_{034} B_{033} B_{032} B_{031} B_{030}	100
00100	B_{045} B_{044} B_{043} B_{042} B_{041} B_{040}	101
00101	B_{055} B_{054} B_{053} B_{052} B_{051} B_{050}	102
00110	B_{065} B_{064} B_{063} B_{062} B_{061} B_{060}	103
00111	B_{075} B_{074} B_{073} B_{072} B_{071} B_{070}	104
01000	B_{085} B_{084} B_{083} B_{082} B_{081} B_{080}	105
01001	B_{095} B_{094} B_{093} B_{092} B_{091} B_{090}	106
01010	B_{105} B_{104} B_{103} B_{102} B_{101} B_{100}	107
01011	B_{115} B_{114} B_{113} B_{112} B_{111} B_{110}	108
01100	B_{125} B_{124} B_{123} B_{122} B_{121} B_{120}	109
01101	B_{135} B_{134} B_{133} B_{132} B_{131} B_{130}	110
01110	B_{145} B_{144} B_{143} B_{142} B_{141} B_{140}	111
01111	B_{155} B_{154} B_{153} B_{152} B_{151} B_{150}	112
10000	B_{165} B_{164} B_{163} B_{162} B_{161} B_{160}	113
10001	B_{175} B_{174} B_{173} B_{172} B_{171} B_{170}	114
10010	B_{185} B_{184} B_{183} B_{182} B_{181} B_{180}	115
10011	B_{195} B_{194} B_{193} B_{192} B_{191} B_{190}	116
10100	B_{205} B_{204} B_{203} B_{202} B_{201} B_{200}	117
10101	B_{215} B_{214} B_{213} B_{212} B_{211} B_{210}	118
10110	B_{225} B_{224} B_{223} B_{222} B_{221} B_{220}	119
10111	B_{235} B_{234} B_{233} B_{232} B_{231} B_{230}	120
11000	B_{245} B_{244} B_{243} B_{242} B_{241} B_{240}	121
11001	B_{255} B_{254} B_{253} B_{252} B_{251} B_{250}	122
11010	B_{265} B_{264} B_{263} B_{262} B_{261} B_{260}	123
11011	B_{275} B_{274} B_{273} B_{272} B_{271} B_{270}	124
11100	B_{285} B_{284} B_{283} B_{282} B_{281} B_{280}	125
11101	B_{295} B_{294} B_{293} B_{292} B_{291} B_{290}	126
11110	B_{305} B_{304} B_{303} B_{302} B_{301} B_{300}	127
11111	B_{315} B_{314} B_{313} B_{312} B_{311} B_{310}	128

7.5. Display Data RAM (DDRAM)

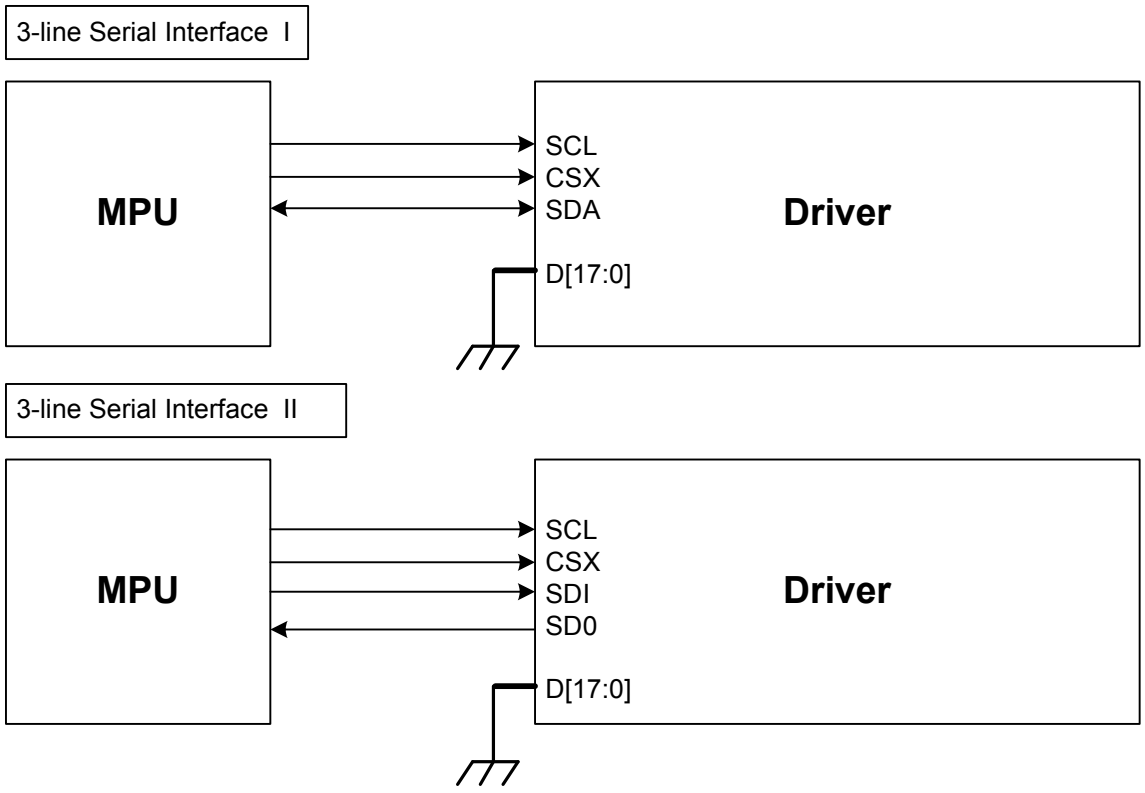
ILI9341 has an integrated 240x320x18-bit graphic type static RAM. This 172,800-byte memory allows storing a 240xRGBx320 image with an 18-bit resolution (262K-color). There is no abnormal visible effect on the display when there are simultaneous panel display read and interface read/write to the same location of the frame memory.

7.6. Display Data Format

ILI9341 supplies 18-/16-/9-/8-bit parallel MCU interface with 8080-Ⅰ/8080-Ⅱ series, 3-/4-line serial interface and 6-/16-18-bit parallel RGB interface. The parallel MCU interface and serial interface mode can be selected by external pins IM [3:0] and RGB interface mode can be selected by software command parameters RCM[1:0].

7.6.1. 3-line Serial Interface

The 3-line/9-bit serial bus interface of ILI9341 can be used by setting external pin as IM [3:0] to “0101” for serial interface I or IM [3:0] to “1101” for serial interface II. The shown figure is the example of 3-line SPI interface.

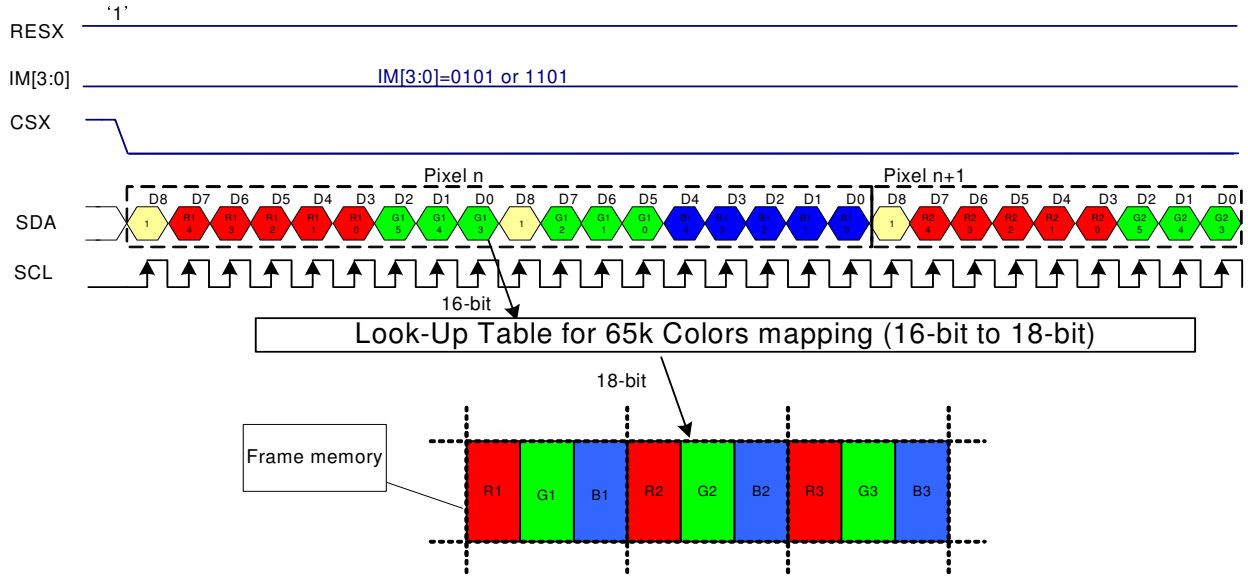


In 3-line serial interface, different display data format is available for two color depths supported by the LCM listed below.

-65k colors, RGB 5, 6, 5 -bits input

-262k colors, RGB 6, 6, 6 -bits input.

16 bit/pixel color order (R:5-bit, G:6-bit, B:5-bit), 65,536 colors



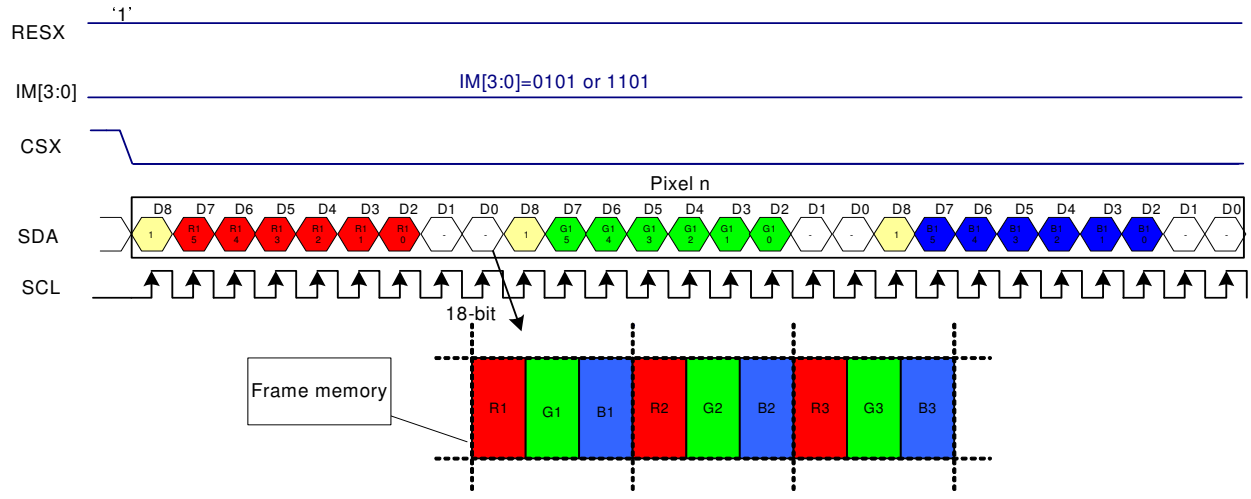
Note 1: The pixel data with 16-bit color depth information.

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

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

Note 4: '-'= Don't care –Can be set "0" or "1".

18 bit/pixel color order (R:6-bit, G:6-bit, B:6-bit), 262,144 colors



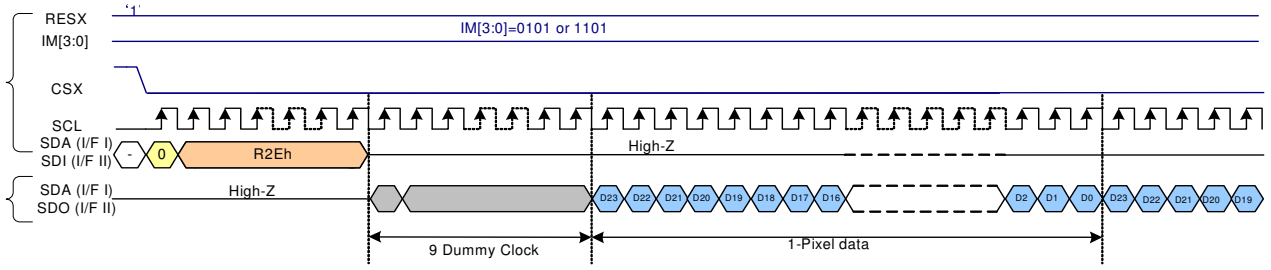
Note 1: The pixel data with 18-bit color depth information.

Note 2: The most significant bits are: Rx5, Gx5 and Bx5.

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

Note 4: '-'= Don't care - Can be set "0" or "1".

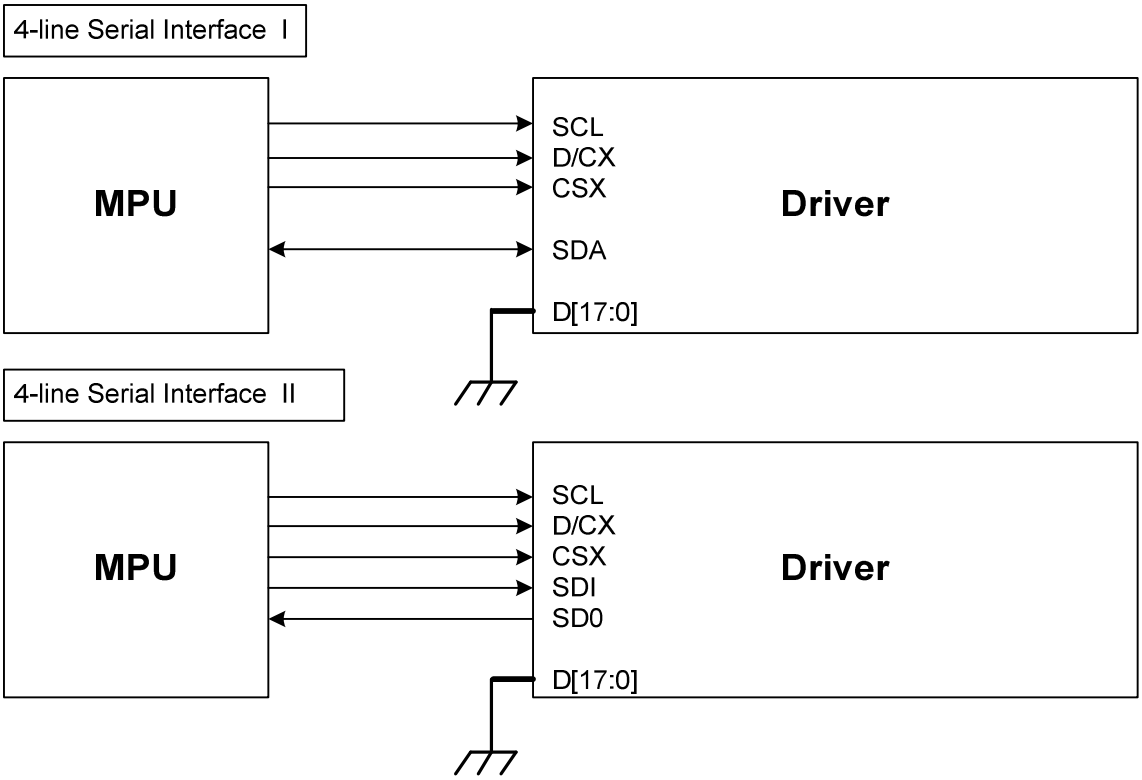
Read data through 3-line SPI mode



Note 1: '-'= Don't care –Can be set "0" or "1".

7.6.2. 4-line Serial Interface

The 4-line/8-bit serial bus interface of ILI9341 can be used by setting external pin as IM [3:0] to “0110” for serial interface I or IM [3:0] to “1110” for serial interface II. The shown figure is the example of 4-line SPI interface.

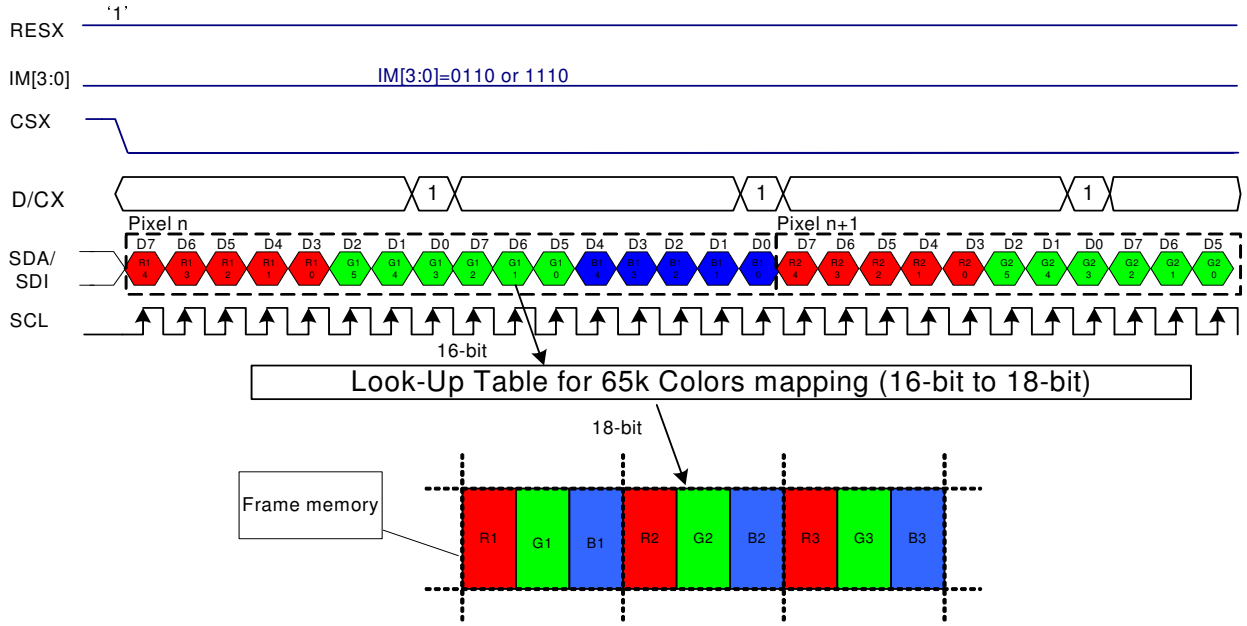


In 4-line serial interface, different display data format is available for two color depths supported by the LCM listed below.

-65k colors, RGB 5, 6, 5 -bits input.

-262k colors, RGB 6, 6, 6 -bits input.

16 bit/pixel color order (R:5-bit, G:6-bit, B:5-bit), 65,536 colors



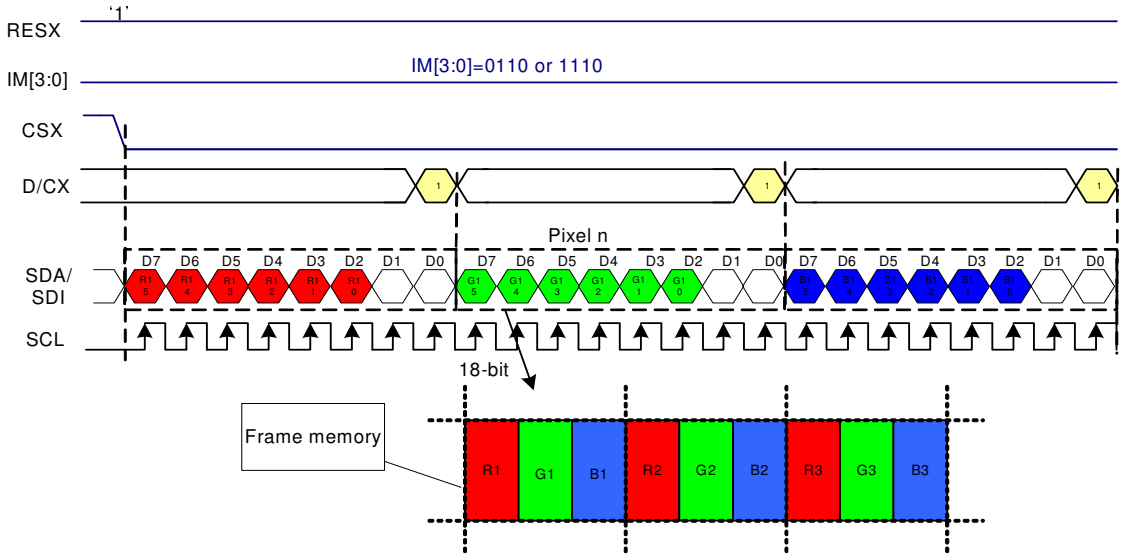
Note 1: The pixel data with 16-bit color depth information.

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

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

Note 4: '-'= Don't care –Can be set "0" or "1".

18 bit/pixel color order (R:6-bit, G:6-bit, B:6-bit), 262,144 colors



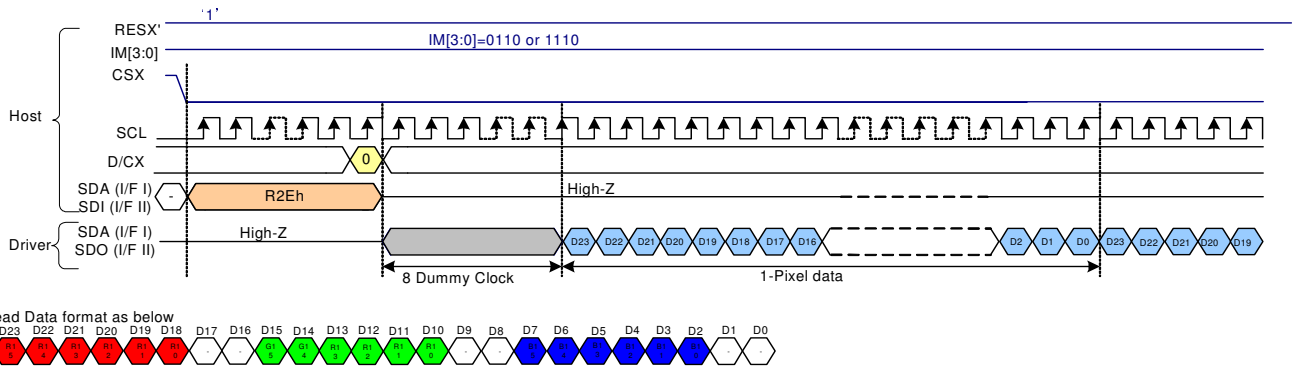
Note 1: The pixel data with 18-bit color depth information.

Note 2: The most significant bits are: Rx5, Gx5 and Bx5.

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

Note 4: '-'= Don't care –Can be set "0" or "1".

Read data through 4-line SPI mode

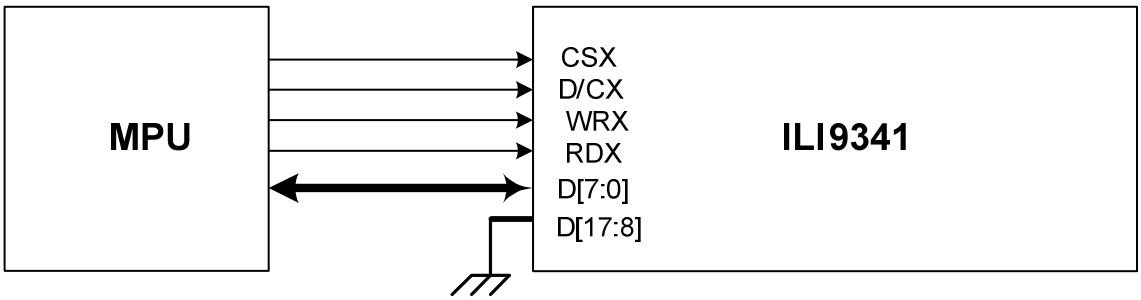


Read Data format as below

Note 1: '-'= Don't care – Can be set "0" or "1".

7.6.3. 8-bit Parallel MCU Interface

The 8080-Ⅰ system 8-bit parallel bus interface of ILI9341 can be used by setting external pin as IM [3:0] to "0000".The following shown figure is the example of interface with 8080-Ⅰ MCU system interface.



Different display data formats are available for two color depths supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 2 byte transfers when DBI [2:0] bits of 3Ah register are set to "101".

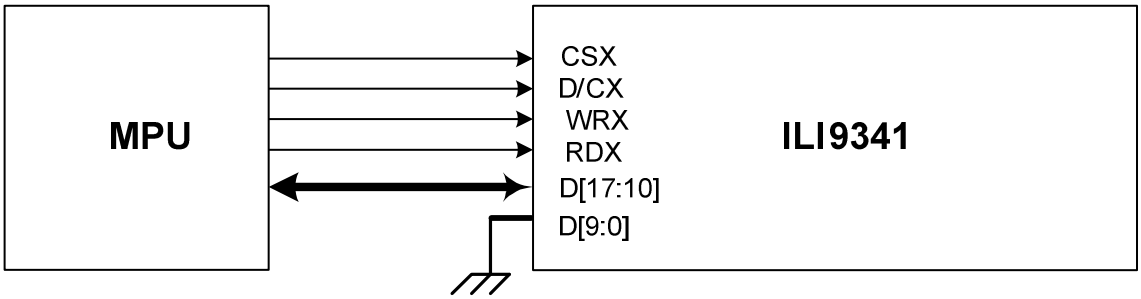
Count	0	1	2	3	4	…	477	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D7	C7	0R4	0G2	1R4	1G2	…	238R4	238G2	239R4	239G2
D6	C6	0R3	0G1	1R3	1G1	…	238R3	238G1	239R3	239G1
D5	C5	0R2	0G0	1R2	1G0	…	238R2	238G0	239R2	239G0
D4	C4	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D3	C3	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D2	C2	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D1	C1	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D0	C0	0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

One pixel (3 sub-pixels) display data is sent by 3 bytes transfer when DBI [2:0] bits of 3Ah register are set to "110".

Count	0	1	2	3	…	718	719	720
D/CX	0	1	1	1	…	1	1	1
D7	C7	0R5	0G5	0B5	…	239R5	239G5	239B5
D6	C6	0R4	0G4	0B4	…	239R4	239G4	239B4
D5	C5	0R3	0G3	0B3	…	239R3	239G3	239B3
D4	C4	0R2	0G2	0B2	…	239R2	239G2	239B2
D3	C3	0R1	0G1	0B1	…	239R1	239G1	239B1
D2	C2	0R0	0G0	0B0	…	239R0	239G0	239B0
D1	C1				…			
D0	C0				…			

The 8080-Ⅱ system 8-bit parallel bus interface of ILI9341 can be used by settings as IM [3:0] ="1001". The following shown figure is the example of interface with 8080-Ⅱ MCU system interface.



Different display data formats are available for two color depths supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 2 byte transfers when DBI [2:0] bits of 3Ah register are set to "101".

Count	0	1	2	3	4	…	477	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D17	C7	0R4	0G2	1R4	1G2	…	238R4	238G2	239R4	239G2
D16	C6	0R3	0G1	1R3	1G1	…	238R3	238G1	239R3	239G1
D15	C5	0R2	0G0	1R2	1G0	…	238R2	238G0	239R2	239G0
D14	C4	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D13	C3	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D12	C2	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D11	C1	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D10	C0	0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

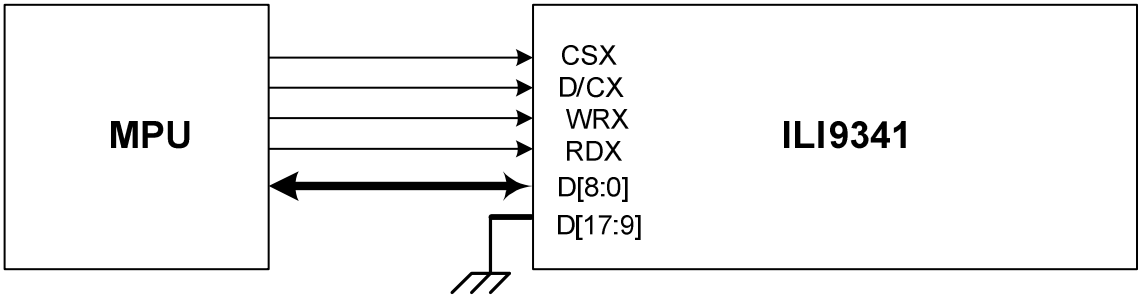
262K color: 18-bit/pixel (RGB 6-6-6 bits input)

One pixel (3 sub-pixels) display data is sent by 3 bytes transfer when DBI [2:0] bits of 3Ah register are set to "110".

Count	0	1	2	3	…	718	719	720
D/CX	0	1	1	1	…	1	1	1
D17	C7	0R5	0G5	0B5	…	239R5	239G5	239B5
D16	C6	0R4	0G4	0B4	…	239R4	239G4	239B4
D15	C5	0R3	0G3	0B3	…	239R3	239G3	239B3
D14	C4	0R2	0G2	0B2	…	239R2	239G2	239B2
D13	C3	0R1	0G1	0B1	…	239R1	239G1	239B1
D12	C2	0R0	0G0	0B0	…	239R0	239G0	239B0
D11	C1				…			
D10	C0				…			

7.6.4. 9-bit Parallel MCU Interface

The 8080-Ⅰ system 9-bit parallel bus interface of ILI9341 can be selected by setting hardware pin IM [3:0] to "0010". The following shown figure is the example of interface with 8080-Ⅰ MCU system interface.



65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 2 transfers when DBI [2:0] bits of 3Ah register are set to "101".

Count	0	1	2	3	4	…	477	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D8										
D7	C7	0R4	0G2	1R4	1G2	…	238R4	238G2	239R4	239G2
D6	C6	0R3	0G1	1R3	1G1	…	238R3	238G1	239R3	239G1
D5	C5	0R2	0G0	1R2	1G0	…	238R2	238G0	239R2	239G0
D4	C4	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D3	C3	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D2	C2	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D1	C1	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D0	C0	0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

There are 2 pixels (6 sub-pixels) display data is sent by 4 transfers, when DBI [2:0] bits of 3Ah register are set to "110".

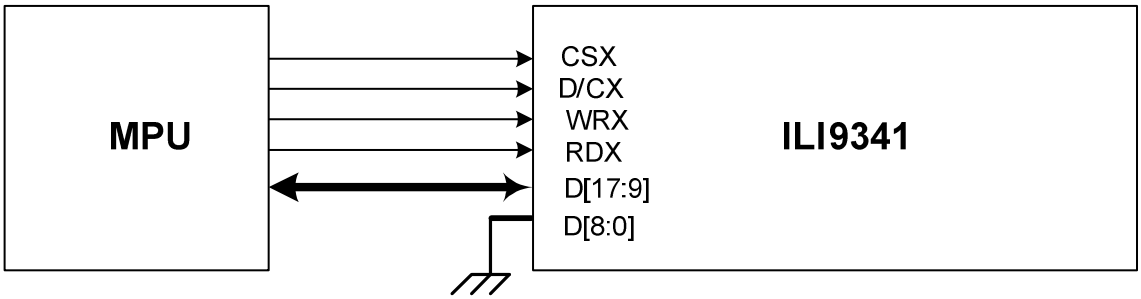
MDT[1:0]="00"

Count	0	1	2	3	4	…	478	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D8		0R5	0G2	1R5	1G2		238R5	238G2	239R5	239G2
D7	C7	0R4	0G1	1R4	1G1	…	238R4	238G1	239R4	239G1
D6	C6	0R3	0G0	1R3	1G0	…	238R3	238G0	239R3	239G0
D5	C5	0R2	0B5	1R2	1B5	…	238R2	238B5	239R2	239B5
D4	C4	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D3	C3	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D2	C2	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D1	C1	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D0	C0	0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

MDT[1:0]="01"

Count	0	1	2	3	…	718	719	720
D/CX	0	1	1	1	…	1	1	1
D8								
D7	C7	0R5	0G5	0B5	…	239R5	239G5	239B5
D6	C6	0R4	0G4	0B4	…	239R4	239G4	239B4
D5	C5	0R3	0G3	0B3	…	239R3	239G3	239B3
D4	C4	0R2	0G2	0B2	…	239R2	239G2	239B2
D3	C3	0R1	0G1	0B1	…	239R1	239G1	239B1
D2	C2	0R0	0G0	0B0	…	239R0	239G0	239B0
D1	C1				…			
D0	C0				…			

The 8080-Ⅱ system 9-bit parallel bus interface of ILI9341 can be selected by setting hardware pin IM [3:0] to "1011". The following shown figure is the example of interface with 8080-Ⅱ MCU system interface.



65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 2 transfers when DBI [2:0] bits of 3Ah register are set to "101".

Count	0	1	2	3	4	…	477	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D17	C7									
D16	C6	0R4	0G2	1R4	1G2	…	238R4	238G2	239R4	239G2
D15	C5	0R3	0G1	1R3	1G1	…	238R3	238G1	239R3	239G1
D14	C4	0R2	0G0	1R2	1G0	…	238R2	238G0	239R2	239G0
D13	C3	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D12	C2	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D11	C1	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D10	C0	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D9		0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

There are 2 pixels (6 sub-pixels) display data is sent by 4 transfers, when DBI [2:0] bits of 3Ah register are set to "110".

MDT[1:0]="00"

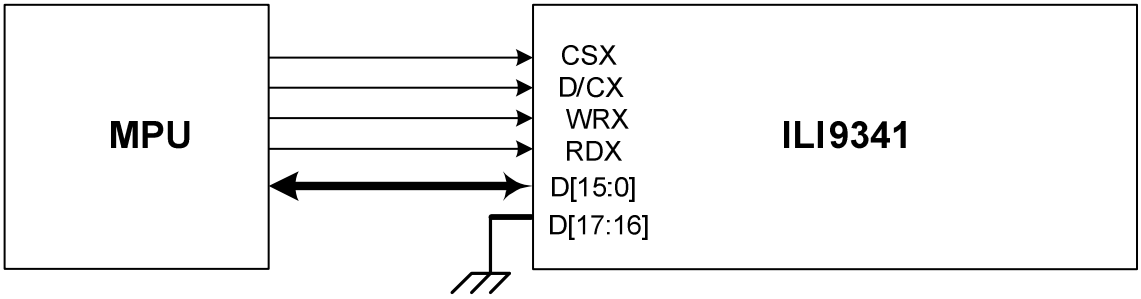
Count	0	1	2	3	4	…	478	478	479	480
D/CX	0	1	1	1	1	…	1	1	1	1
D17	C7	0R5	0G2	1R5	1G2		238R5	238G2	239R5	239G2
D16	C6	0R4	0G1	1R4	1G1	…	238R4	238G1	239R4	239G1
D15	C5	0R3	0G0	1R3	1G0	…	238R3	238G0	239R3	239G0
D14	C4	0R2	0B5	1R2	1B5	…	238R2	238B5	239R2	239B5
D13	C3	0R1	0B4	1R1	1B4	…	238R1	238B4	239R1	239B4
D12	C2	0R0	0B3	1R0	1B3	…	238R0	238B3	239R0	239B3
D11	C1	0G5	0B2	1G5	1B2	…	238G5	238B2	239G5	239B2
D10	C0	0G4	0B1	1G4	1B1	…	238G4	238B1	239G4	239B1
D9		0G3	0B0	1G3	1B0	…	238G3	238B0	239G3	239B0

MDT[1:0]="01"

Count	0	1	2	3	…	718	719	720
D/CX	0	1	1	1	…	1	1	1
D17	C7							
D16	C6	0R5	0G5	0B5	…	239R5	239G5	239B5
D15	C5	0R4	0G4	0B4	…	239R4	239G4	239B4
D14	C4	0R3	0G3	0B3	…	239R3	239G3	239B3
D13	C3	0R2	0G2	0B2	…	239R2	239G2	239B2
D12	C2	0R1	0G1	0B1	…	239R1	239G1	239B1
D11	C1	0R0	0G0	0B0	…	239R0	239G0	239B0
D10	C0				…			
D9					…			

7.6.5. 16-bit Parallel MCU Interface

The 8080-Ⅰ system 16-bit parallel bus interface of ILI9341 can be selected by setting hardware pin IM[3:0] to "0001".The following shown figure is the example of interface with 8080-Ⅰ MCU system interface.



Different display data format is available for two colors depth supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to "101".

Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D15		0R4	1R4	2R4	…	237R4	238R4	239R4
D14		0R3	1R3	2R3	…	237R3	238R3	239R3
D13		0R2	1R2	2R2	…	237R2	238R2	239R2
D12		0R1	1R1	2R1	…	237R1	238R1	239R1
D11		0R0	1R0	2R0	…	237R0	238R0	239R0
D10		0G5	1G5	2G5	…	237G5	238G5	239G5
D9		0G4	1G4	2G4	…	237G4	238G4	239G4
D8		0G3	1G3	2G3	…	237G3	238G3	239G3
D7	C7	0G2	1G2	2G2	…	237G2	238G2	239G2
D6	C6	0G1	1G1	2G1	…	237G1	238G1	239G1
D5	C5	0G0	1G0	2G0	…	237G0	238G0	239G0
D4	C4	0B4	1B4	2B4	…	237B4	238B4	239B4
D3	C3	0B3	1B3	2B3	…	237B3	238B3	239B3
D2	C2	0B2	1B2	2B2	…	237B2	238B2	239B2
D1	C1	0B1	1B1	2B1	…	237B1	238B1	239B1
D0	C0	0B0	1B0	2B0	…	237B0	238B0	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

One pixel (3 sub-pixels) display data is sent by 2 transfers when DBI [2:0] bits of 3Ah register are set to “110”.

MDT[1:0]=”00”

Count	0	1	2	3	…	358	359	360
D/CX	0	1	1	1	…	1	1	1
D15		0R5	0B5	1G5	…	238R5	238B5	239G5
D14		0R4	0B4	1G4	…	238R4	238B4	239G4
D13		0R3	0B3	1G3	…	238R3	238B3	239G3
D12		0R2	0B2	1G2	…	238R2	238B2	239G2
D11		0R1	0B1	1G1	…	238R1	238B1	239G1
D10		0R0	0B0	1G0	…	238R0	238B0	239G0
D9					…			
D8					…			
D7	C7	0G5	1R5	1B5	…	238G5	239R5	239B5
D6	C6	0G4	1R4	1B4	…	238G4	239R4	239B4
D5	C5	0G3	1R3	1B3	…	238G3	239R3	239B3
D4	C4	0G2	1R2	1B2	…	238G2	239R2	239B2
D3	C3	0G1	1R1	1B1	…	238G1	239R1	239B1
D2	C2	0G0	1R0	1B0	…	238G0	239R0	239B0
D1	C1				…			
D0	C0				…			

MDT[1:0]=”01”

Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D15		0R5	0B5	1R5	1B5	…	238R5	238B5	239R5	239B5
D14		0R4	0B4	1R4	1B4	…	238R4	238B4	239R4	239B4
D13		0R3	0B3	1R3	1B3	…	238R3	238B3	239R3	239B3
D12		0R2	0B2	1R2	1B2	…	238R2	238B2	239R2	239B2
D11		0R1	0B1	1R1	1B1	…	238R1	238B1	239R1	239B1
D10		0R0	0B0	1R0	1B0	…	238R0	238B0	239R0	239B0
D9						…				
D8						…				
D7	C7	0G5		1G5		…	238G5		239G5	
D6	C6	0G4		1G4		…	238G4		239G4	
D5	C5	0G3		1G3		…	238G3		239G3	
D4	C4	0G2		1G2		…	238G2		239G2	
D3	C3	0G1		1G1		…	238G1		239G1	
D2	C2	0G0		1G0		…	238G0		239G0	
D1	C1					…				
D0	C0					…				

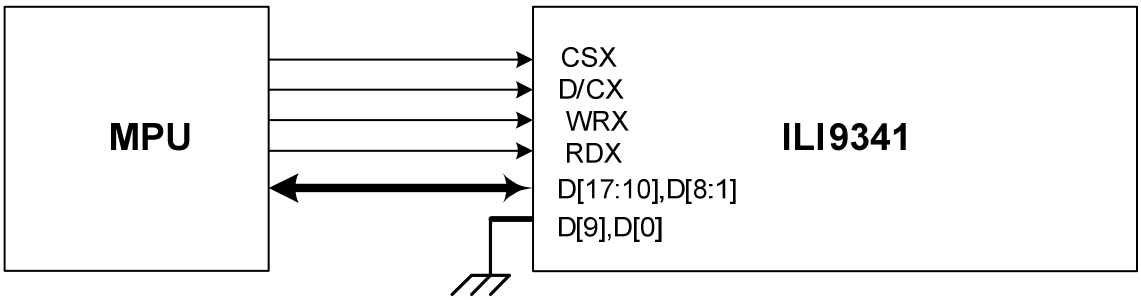
MDT[1:0]=”10”

Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D15		0R5	0B1	1R5	1B1	…	238R5	238B1	239R5	239B1
D14		0R4	0B0	1R4	1B0	…	238R4	238B0	239R4	239B0
D13		0R3		1R3		…	238R3		239R3	
D12		0R2		1R2		…	238R2		239R2	
D11		0R1		1R1		…	238R1		239R1	
D10		0R0		1R0		…	238R0		239R0	
D9		0G5		1G5		…	238G5		239G5	
D8		0G4		1G4		…	238G4		239G4	
D7	C7	0G3		1G3		…	238G3		239G3	
D6	C6	0G2		1G2		…	238G2		239G2	
D5	C5	0G1		1G1		…	238G1		239G1	
D4	C4	0G0		1G0		…	238G0		239G0	
D3	C3	0B5		1B5		…	238B5		239B5	
D2	C2	0B4		1B4		…	238B4		239B4	
D1	C1	0B3		1B3		…	238B3		239B3	
D0	C0	0B2		1B2		…	238B2		239B2	

MDT[1:0]=”11”

Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D15			0R3		1R3	…		238R3		239R3
D14			0R2		1R2	…		238R2		239R2
D13			0R1		1R1	…		238R1		239R1
D12			0R0		1R0	…		238R0		239R0
D11			0G5		1G5	…		238G5		239G5
D10			0G4		1G4	…		238G4		239G4
D9			0G3		1G3	…		238G3		239G3
D8			0G2		1G2	…		238G2		239G2
D7	C7		0G1		1G1	…		238G1		239G1
D6	C6		0G0		1G0	…		238G0		239G0
D5	C5		0B5		1B5	…		238B5		239B5
D4	C4		0B4		1B4	…		238B4		239B4
D3	C3		0B3		1B3	…		238B3		239B3
D2	C2		0B2		1B2	…		238B2		239B2
D1	C1	0R5	0B1	1R5	1B1	…	238R5	238B1	239R5	239B1
D0	C0	0R4	0B0	1R4	1B0	…	238R4	238B0	239R4	239B0

The 8080-Ⅱ system 16-bit parallel bus interface of ILI9341 can be selected by settings IM [3:0] =”1000”. The following shown figure is the example of interface with 8080-Ⅱ MCU system interface.



Different display data format is available for two colors depth supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to “101”.

Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D17		0R4	1R4	2R4	…	237R4	238R4	239R4
D16		0R3	1R3	2R3	…	237R3	238R3	239R3
D15		0R2	1R2	2R2	…	237R2	238R2	239R2
D14		0R1	1R1	2R1	…	237R1	238R1	239R1
D13		0R0	1R0	2R0	…	237R0	238R0	239R0
D12		0G5	1G5	2G5	…	237G5	238G5	239G5
D11		0G4	1G4	2G4	…	237G4	238G4	239G4
D10		0G3	1G3	2G3	…	237G3	238G3	239G3
D8	C7	0G2	1G2	2G2	…	237G2	238G2	239G2
D7	C6	0G1	1G1	2G1	…	237G1	238G1	239G1
D6	C5	0G0	1G0	2G0	…	237G0	238G0	239G0
D5	C4	0B4	1B4	2B4	…	237B4	238B4	239B4
D4	C3	0B3	1B3	2B3	…	237B3	238B3	239B3
D3	C2	0B2	1B2	2B2	…	237B2	238B2	239B2
D2	C1	0B1	1B1	2B1	…	237B1	238B1	239B1
D1	C0	0B0	1B0	2B0	…	237B0	238B0	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

One pixel (3 sub-pixels) display data is sent by 2 transfers when DBI [2:0] bits of 3Ah register are set to “110”.

MDT[1:0]=”00”

Count	0	1	2	3	…	358	359	360
D/CX	0	1	1	1	…	1	1	1
D17		0R5	0B5	1G5	…	238R5	238B5	239G5
D16		0R4	0B4	1G4	…	238R4	238B4	239G4
D15		0R3	0B3	1G3	…	238R3	238B3	239G3
D14		0R2	0B2	1G2	…	238R2	238B2	239G2
D13		0R1	0B1	1G1	…	238R1	238B1	239G1
D12		0R0	0B0	1G0	…	238R0	238B0	239G0
D11					…			
D10					…			
D8	C7	0G5	1R5	1B5	…	238G5	239R5	239B5
D7	C6	0G4	1R4	1B4	…	238G4	239R4	239B4
D6	C5	0G3	1R3	1B3	…	238G3	239R3	239B3
D5	C4	0G2	1R2	1B2	…	238G2	239R2	239B2
D4	C3	0G1	1R1	1B1	…	238G1	239R1	239B1
D3	C2	0G0	1R0	1B0	…	238G0	239R0	239B0
D2	C1				…			
D1	C0				…			

MDT[1:0]=”01”

Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D17		0R5	0B5	1R5	1B5	…	238R5	238B5	239R5	239B5
D16		0R4	0B4	1R4	1B4	…	238R4	238B4	239R4	239B4
D15		0R3	0B3	1R3	1B3	…	238R3	238B3	239R3	239B3
D14		0R2	0B2	1R2	1B2	…	238R2	238B2	239R2	239B2
D13		0R1	0B1	1R1	1B1	…	238R1	238B1	239R1	239B1
D12		0R0	0B0	1R0	1B0	…	238R0	238B0	239R0	239B0
D11						…				
D10						…				
D8	C7	0G5		1G5		…	238G5		239G5	
D7	C6	0G4		1G4		…	238G4		239G4	
D6	C5	0G3		1G3		…	238G3		239G3	
D5	C4	0G2		1G2		…	238G2		239G2	
D4	C3	0G1		1G1		…	238G1		239G1	
D3	C2	0G0		1G0		…	238G0		239G0	
D2	C1					…				
D1	C0					…				

MDT[1:0]=”10”

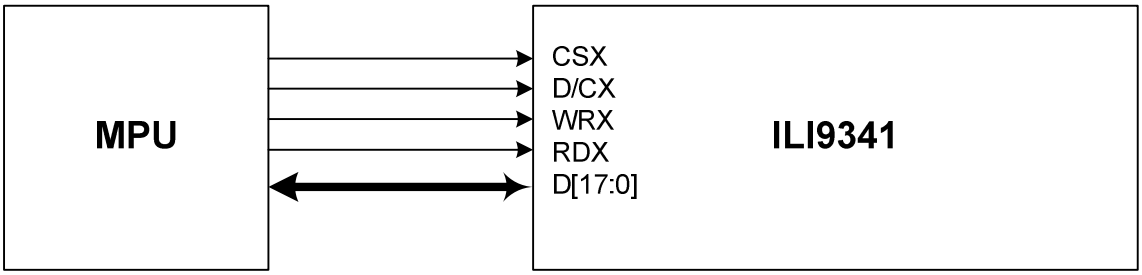
Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D17		0R5	0B1	1R5	1B1	…	238R5	238B1	239R5	239B1
D16		0R4	0B0	1R4	1B0	…	238R4	238B0	239R4	239B0
D15		0R3		1R3		…	238R3		239R3	
D14		0R2		1R2		…	238R2		239R2	
D13		0R1		1R1		…	238R1		239R1	
D12		0R0		1R0		…	238R0		239R0	
D11		0G5		1G5		…	238G5		239G5	
D10		0G4		1G4		…	238G4		239G4	
D8	C7	0G3		1G3		…	238G3		239G3	
D7	C6	0G2		1G2		…	238G2		239G2	
D6	C5	0G1		1G1		…	238G1		239G1	
D5	C4	0G0		1G0		…	238G0		239G0	
D4	C3	0B5		1B5		…	238B5		239B5	
D3	C2	0B4		1B4		…	238B4		239B4	
D2	C1	0B3		1B3		…	238B3		239B3	
D1	C0	0B2		1B2		…	238B2		239B2	

MDT[1:0]=”11”

Count	0	1	2	3		…	357	358	479	480
D/CX	0	1	1	1		…		1	1	1
D17			0R3		1R3	…		238R3		239R3
D16			0R2		1R2	…		238R2		239R2
D15			0R1		1R1	…		238R1		239R1
D14			0R0		1R0	…		238R0		239R0
D13			0G5		1G5	…		238G5		239G5
D12			0G4		1G4	…		238G4		239G4
D11			0G3		1G3	…		238G3		239G3
D10			0G2		1G2	…		238G2		239G2
D8	C7		0G1		1G1	…		238G1		239G1
D7	C6		0G0		1G0	…		238G0		239G0
D6	C5		0B5		1B5	…		238B5		239B5
D5	C4		0B4		1B4	…		238B4		239B4
D4	C3		0B3		1B3	…		238B3		239B3
D3	C2		0B2		1B2	…		238B2		239B2
D2	C1	0R5	0B1	1R5	1B1	…	238R5	238B1	239R5	239B1
D1	C0	0R4	0B0	1R4	1B0	…	238R4	238B0	239R4	239B0

7.6.6. 18-bit Parallel MCU Interface

The 8080-Ⅰ system 18-bit parallel bus interface of ILI9341 can be selected by setting hardware pin IM[3:0] to "0011".The following shown figure is the example of interface with 8080-Ⅰ MCU system interface.



Different display data format is available for one color depth only supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to "101".

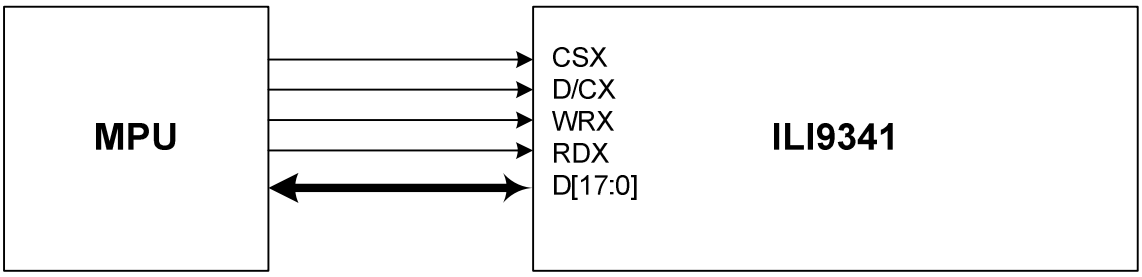
Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D17								
D16								
D15		0R4	1R4	2R4	…	237R4	238R4	239R4
D14		0R3	1R3	2R3	…	237R3	238R3	239R3
D13		0R2	1R2	2R2	…	237R2	238R2	239R2
D12		0R1	1R1	2R1	…	237R1	238R1	239R1
D11		0R0	1R0	2R0	…	237R0	238R0	239R0
D10		0G5	1G5	2G5	…	237G5	238G5	239G5
D9		0G4	1G4	2G4	…	237G4	238G4	239G4
D8		0G3	1G3	2G3	…	237G3	238G3	239G3
D7	C7	0G2	1G2	2G2	…	237G2	238G2	239G2
D6	C6	0G1	1G1	2G1	…	237G1	238G1	239G1
D5	C5	0G0	1G0	2G0	…	237G0	238G0	239G0
D4	C4	0B4	1B4	2B4	…	237B4	238B4	239B4
D3	C3	0B3	1B3	2B3	…	237B3	238B3	239B3
D2	C2	0B2	1B2	2B2	…	237B2	238B2	239B2
D1	C1	0B1	1B1	2B1	…	237B1	238B1	239B1
D0	C0	0B0	1B0	2B0	…	237B0	238B0	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to “110”.

Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D17		0R5	1R5	2R5	…	237R5	238R5	239R5
D16		0R4	1R4	2R4	…	237R4	238R4	239R4
D15		0R3	1R3	2R3	…	237R3	238R3	239R3
D14		0R2	1R2	2R2	…	237R2	238R2	239R2
D13		0R1	1R1	2R1	…	237R1	238R1	239R1
D12		0R0	1R0	2R0	…	237R0	238R0	239R0
D11		0G5	1G5	2G5	…	237G5	238G5	239G5
D10		0G4	1G4	2G4	…	237G4	238G4	239G4
D9		0G3	1G3	2G3	…	237G3	238G3	239G3
D8		0G2	1G2	2G2	…	237G2	238G2	239G2
D7	C7	0G1	1G1	2G1	…	237G1	238G1	239G1
D6	C6	0G0	1G0	2G0	…	237G0	238G0	239G0
D5	C5	0B5	1B5	2B5	…	237B5	238B5	239B5
D4	C4	0B4	1B4	2B4	…	237B4	238B4	239B4
D3	C3	0B3	1B3	2B3	…	237B3	238B3	239B3
D2	C2	0B2	1B2	2B2	…	237B2	238B2	239B2
D1	C1	0B1	1B1	2B1	…	237B1	238B1	239B1
D0	C0	0B0	1B0	2B0	…	237B0	238B0	239B0

The 8080-Ⅱ system 18-bit parallel bus interface mode can be selected by settings IM [3:0] ="1010". The following shown figure is the example of interface with 8080-Ⅱ MCU system interface.



Different display data format is available for one color depth only supported by listed below.

- 65K-Colors, RGB 5, 6, 5 -bits input data.
- 262K-Colors, RGB 6, 6, 6 -bits input data.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)

One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to "101".

Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D17								
D16								
D15		0R4	1R4	2R4	…	237R4	238R4	239R4
D14		0R3	1R3	2R3	…	237R3	238R3	239R3
D13		0R2	1R2	2R2	…	237R2	238R2	239R2
D12		0R1	1R1	2R1	…	237R1	238R1	239R1
D11		0R0	1R0	2R0	…	237R0	238R0	239R0
D10		0G5	1G5	2G5	…	237G5	238G5	239G5
D9		0G4	1G4	2G4	…	237G4	238G4	239G4
D8	C7	0G3	1G3	2G3	…	237G3	238G3	239G3
D7	C6	0G2	1G2	2G2	…	237G2	238G2	239G2
D6	C5	0G1	1G1	2G1	…	237G1	238G1	239G1
D5	C4	0G0	1G0	2G0	…	237G0	238G0	239G0
D4	C3	0B4	1B4	2B4	…	237B4	238B4	239B4
D3	C2	0B3	1B3	2B3	…	237B3	238B3	239B3
D2	C1	0B2	1B2	2B2	…	237B2	238B2	239B2
D1	C0	0B1	1B1	2B1	…	237B1	238B1	239B1
D0		0B0	1B0	2B0	…	237B0	238B0	239B0

262K color: 18-bit/pixel (RGB 6-6-6 bits input)

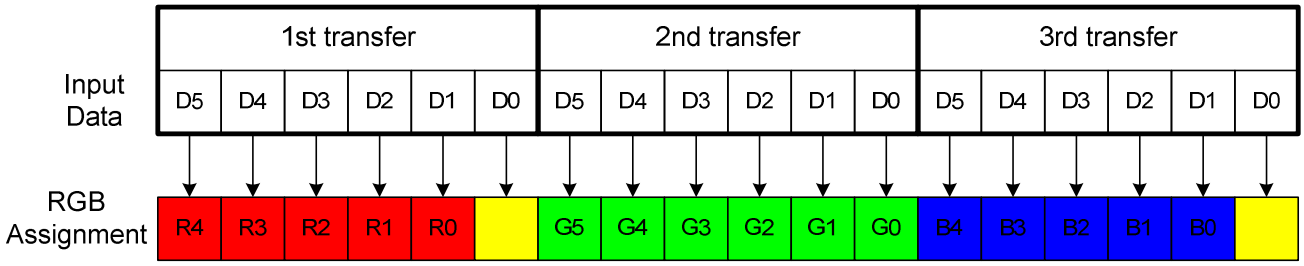
One pixel (3 sub-pixels) display data is sent by 1 transfer when DBI [2:0] bits of 3Ah register are set to “110”.

Count	0	1	2	3	…	238	239	240
D/CX	0	1	1	1	…	1	1	1
D17		0R5	1R5	2R5	…	237R5	238R5	239R5
D16		0R4	1R4	2R4	…	237R4	238R4	239R4
D15		0R3	1R3	2R3	…	237R3	238R3	239R3
D14		0R2	1R2	2R2	…	237R2	238R2	239R2
D13		0R1	1R1	2R1	…	237R1	238R1	239R1
D12		0R0	1R0	2R0	…	237R0	238R0	239R0
D11		0G5	1G5	2G5	…	237G5	238G5	239G5
D10		0G4	1G4	2G4	…	237G4	238G4	239G4
D9		0G3	1G3	2G3	…	237G3	238G3	239G3
D8	C7	0G2	1G2	2G2	…	237G2	238G2	239G2
D7	C6	0G1	1G1	2G1	…	237G1	238G1	239G1
D6	C5	0G0	1G0	2G0	…	237G0	238G0	239G0
D5	C4	0B5	1B5	2B5	…	237B5	238B5	239B5
D4	C3	0B4	1B4	2B4	…	237B4	238B4	239B4
D3	C2	0B3	1B3	2B3	…	237B3	238B3	239B3
D2	C1	0B2	1B2	2B2	…	237B2	238B2	239B2
D1	C0	0B1	1B1	2B1	…	237B1	238B1	239B1
D0		0B0	1B0	2B0	…	237B0	238B0	239B0

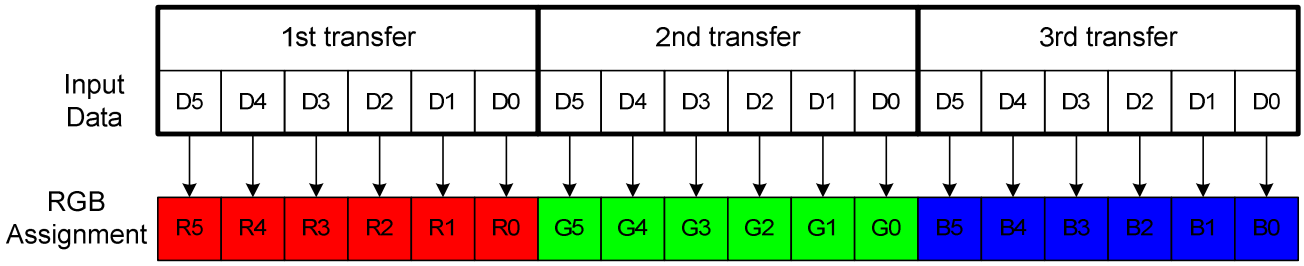
7.6.7. 6-bit Parallel RGB Interface

The 6-bit RGB interface is selected by setting the DPI [2:0] bit to “110”. When RCM [1:0] are set to “10” and DE mode is selected, the display operation is synchronized with VSYNC, HSYNC and DOTCLK signals. The display data are transferred to the internal GRAM in synchronization with the display operation via 6-bit RGB data bus (D [5:0]) according to the data enable signal (DE) when RCM [1:0] are set to “10”. The RGB interface SYNC mode is selected by setting the RCM [1:0] to “11”, the valid display data is inputted in pixel unit via D [5:0] according to the VFP/VBP and HFP/HBP settings. Unused pins must be connected to GND to ensure normally operation. Registers can be set by the SPI system interface.

65K color: 16-bit/pixel (RGB 5-6-5 bits input)



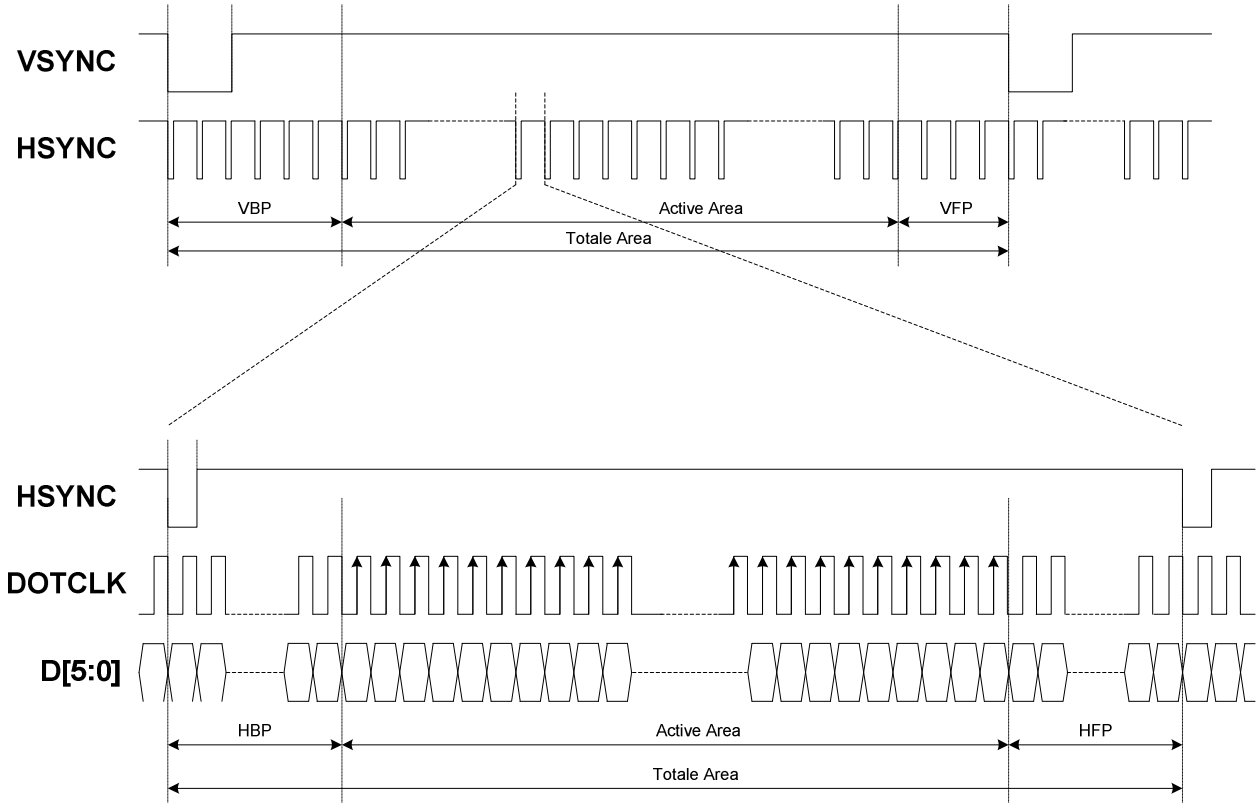
262K color: 18-bit/pixel (RGB 6-6-6 bits input)



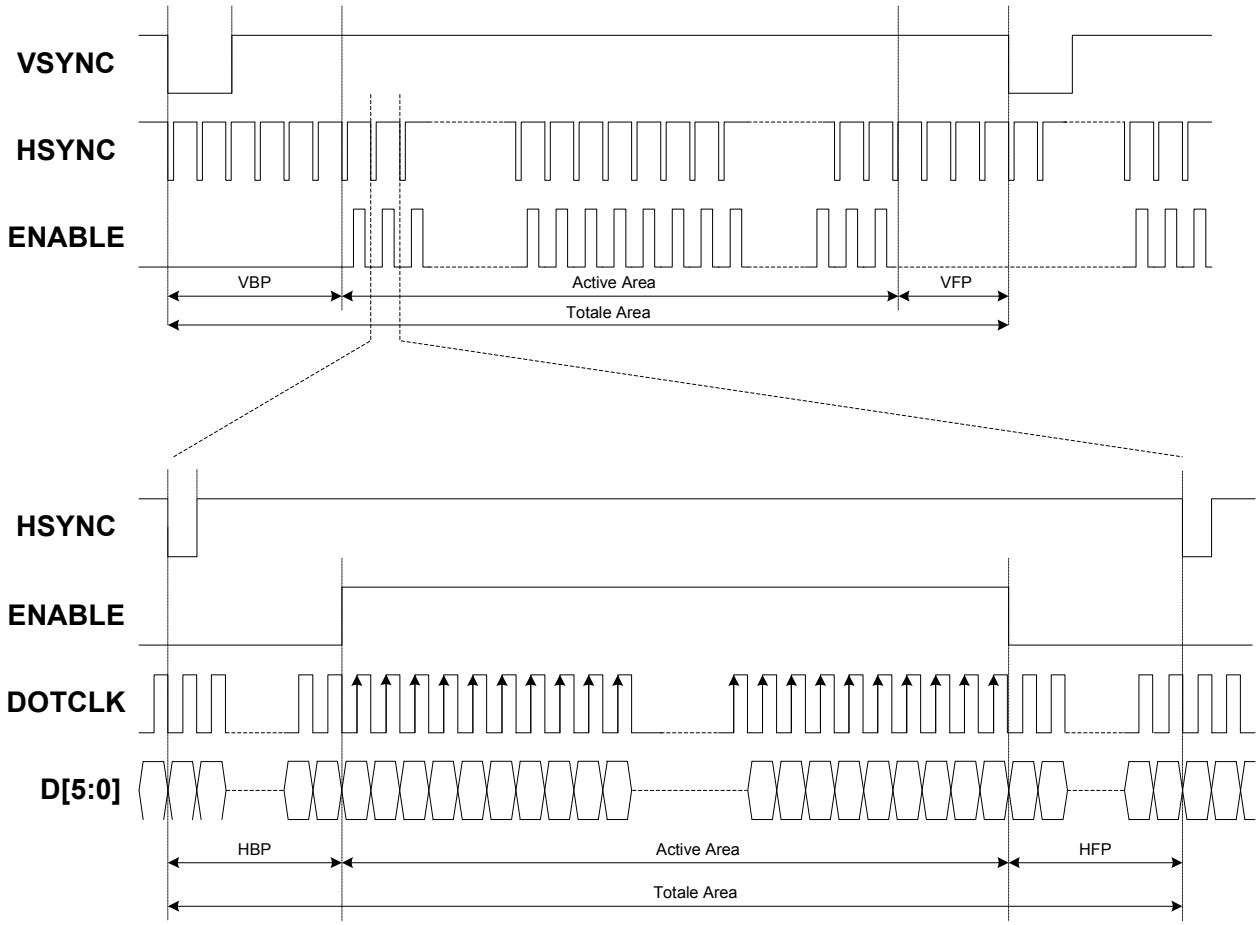
ILI9341 has data transfer counters to count the first, second, third data transfer in 6-bit RGB interface mode. The transfer counter is always reset to the state of first data transfer on the falling edge of VSYNC. If a mismatch arises in the number of each data transfer, the counter is reset to the state of first data transfer at the start of the frame (i.e. on the falling edge of VSYNC) to restart data transfer in the correct order from the next frame. This function is expedient for moving picture display, which requires consecutive data transfer in light of minimizing effects from failed data transfer and enabling the system to return to a normal state.

Note that internal display operation is performed in units of pixels (RGB: taking 3 inputs of DOTCLK). Accordingly, the number of DOTCLK inputs in one frame period must be a multiple of 3 to complete data transfer correctly. Otherwise it will affect the display of that frame as well as the next frame.

SYNC Mode, RCM[1:0]="11"

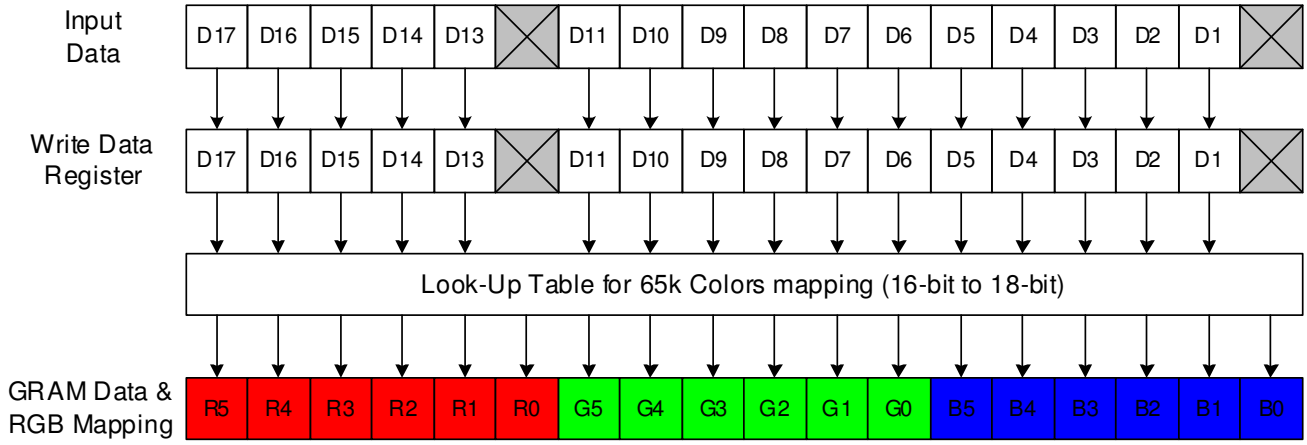


DE Mode, RCM[1:0]="10"



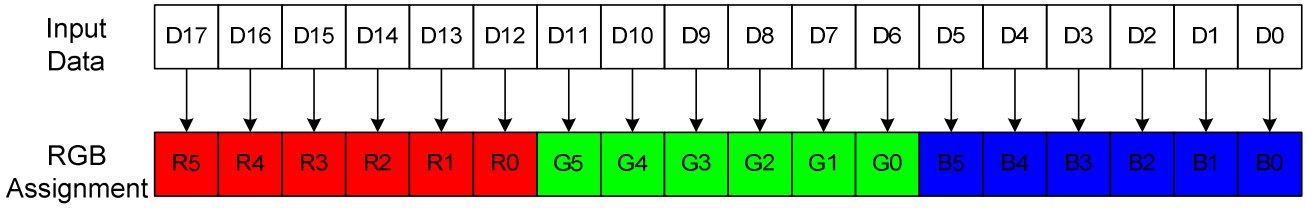
7.6.8. 16-bit Parallel RGB Interface

The 16-bit RGB interface is selected by setting the DPI [2:0] bits to “101”. When RCM [1:0] are set to “10” and DE mode is selected, the display operation is synchronized with VSYNC, HSYNC and DOTCLK signals. The display data is transferred to the internal GRAM in synchronization with the display operation via 16-bit RGB data bus (D [17:13] & D [11:1]) according to the data enable signal (DE). The RGB interface SYNC mode is selected by setting the RCM [1:0] to “11”, the valid display data is inputted in pixel unit via D [17:13] and D [11:1] according to the VFP/VBP and HFP/HBP settings. The unused D12 and D0 pins must be connected to GND for ensure normally operation. Registers can be set by the SPI system interface.



7.6.9. 18-bit Parallel RGB Interface

The 18-bit RGB interface is selected by setting the DPI [2:0] bits to “110”. When RCM [1:0] are set to “10” and DE mode is selected, the display operation is synchronized with VSYNC, HSYNC and DOTCLK signals. The display data are transferred to the internal GRAM in synchronization with the display operation via 18-bit RGB data bus (D [17:0]) according to the data enable signal (DE) when RCM [1:0] are set to “10”. The RGB interface SYNC mode is selected by setting the RCM [1:0] to “11”, the valid display data is inputted in pixel unit via D [17:0] according to the VFP/VBP and HFP/HBP settings. Registers can be set by the SPI system interface.



8. Command

8.1. Command List

Regulative Command Set													
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
No Operation	0	1	↑	XX	0	0	0	0	0	0	0	0	00h
Software Reset	0	1	↑	XX	0	0	0	0	0	0	0	1	01h
Read Display Identification Information	0	1	↑	XX	0	0	0	0	0	1	0	0	04h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	ID1 [7:0]								XX
	1	↑	1	XX	ID2 [7:0]								XX
	1	↑	1	XX	ID3 [7:0]								XX
Read Display Status	0	1	↑	XX	0	0	0	0	1	0	0	1	09h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [31:25]							X	00
	1	↑	1	XX	X	D [22:20]			D [19:16]				61
	1	↑	1	XX	X	X	X	X	X	D [10:8]			00
	1	↑	1	XX	D [7:5]			X	X	X	X	X	00
Read Display Power Mode	0	1	↑	XX	0	0	0	0	1	0	1	0	0Ah
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	08
Read Display MADCTL	0	1	↑	XX	0	0	0	0	1	0	1	1	0Bh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Pixel Format	0	1	↑	XX	0	0	0	0	1	1	0	0	0Ch
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	RIM	DPI [2:0]			X	DBI [2:0]			06
Read Display Image Format	0	1	↑	XX	0	0	0	0	1	1	0	1	0Dh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	D [2:0]			00
Read Display Signal Mode	0	1	↑	XX	0	0	0	0	1	1	1	0	0Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Self-Diagnostic Result	0	1	↑	XX	0	0	0	0	1	1	1	1	0Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:6]		X	X	X	X	X	X	00
Enter Sleep Mode	0	1	↑	XX	0	0	0	1	0	0	0	0	10h
Sleep OUT	0	1	↑	XX	0	0	0	1	0	0	0	1	11h
Partial Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	0	12h
Normal Display Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	1	13h
Display Inversion OFF	0	1	↑	XX	0	0	1	0	0	0	0	0	20h
Display Inversion ON	0	1	↑	XX	0	0	1	0	0	0	0	1	21h
Gamma Set	0	1	↑	XX	0	0	1	0	0	1	1	0	26h
	1	1	↑	XX	GC [7:0]								01
Display OFF	0	1	↑	XX	0	0	1	0	1	0	0	0	28h
Display ON	0	1	↑	XX	0	0	1	0	1	0	0	1	29h
Column Address Set	0	1	↑	XX	0	0	1	0	1	0	1	0	2Ah
	1	1	↑	XX	SC [15:8]								XX
	1	1	↑	XX	SC [7:0]								XX
	1	1	↑	XX	EC [15:8]								XX
	1	1	↑	XX	EC [7:0]								XX
Page Address Set	0	1	↑	XX	0	0	1	0	1	0	1	1	2Bh
	1	1	↑	XX	SP [15:8]								XX
	1	1	↑	XX	SP [7:0]								XX
	1	1	↑	XX	EP [15:8]								XX
	1	1	↑	XX	EP [7:0]								XX

Memory Write	0	1	↑	XX	0	0	1	0	1	1	0	0	2Ch
	1	1	↑	D [17:0]									XX
Color SET	0	1	↑	XX	0	0	1	0	1	1	0	1	2Dh
	1	↑	1	XX			R00 [5:0]						XX
	1	↑	1	XX			Rnn [5:0]						XX
	1	↑	1	XX			R31 [5:0]						XX
	1	↑	1	XX			G00 [5:0]						XX
	1	↑	1	XX			Gnn [5:0]						XX
	1	↑	1	XX			G64 [5:0]						XX
	1	↑	1	XX			B00 [5:0]						XX
	1	↑	1	XX			Bnn [5:0]						XX
	1	↑	1	XX			B31 [5:0]						XX
Memory Read	0	1	↑	XX	0	0	1	0	1	1	1	0	2Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Partial Area	0	1	↑	XX	0	0	1	1	0	0	0	0	30h
	1	1	↑	XX	SR [15:8]								00
	1	1	↑	XX	SR [7:0]								00
	1	1	↑	XX	ER [15:8]								01
	1	1	↑	XX	ER [7:0]								3F
Vertical Scrolling Definition	0	1	↑	XX	0	0	1	1	0	0	1	1	33h
	1	1	↑	XX	TFA [15:8]								00
	1	1	↑	XX	TFA [7:0]								00
	1	1	↑	XX	VSA [15:8]								01
	1	1	↑	XX	VSA [7:0]								40
	1	1	↑	XX	BFA [15:8]								00
	1	1	↑	XX	BFA [7:0]								00
Tearing Effect Line OFF	0	1	↑	XX	0	0	1	1	0	1	0	0	34h
Tearing Effect Line ON	0	1	↑	XX	0	0	1	1	0	1	0	1	35h
	1	1	↑	XX	X	X	X	X	X	X	X	M	00
Memory Access Control	0	1	↑	XX	0	0	1	1	0	1	1	0	36h
	1	1	↑	XX	MY	MX	MV	ML	BGR	MH	X	X	00
Vertical Scrolling Start Address	0	1	↑	XX	0	0	1	1	0	1	1	1	37h
	1	1	↑	XX	VSP [15:8]								00
	1	1	↑	XX	VSP [7:0]								00
Idle Mode OFF	0	1	↑	XX	0	0	1	1	1	0	0	0	38h
Idle Mode ON	0	1	↑	XX	0	0	1	1	1	0	0	1	39h
Pixel Format Set	0	1	↑	XX	0	0	1	1	1	0	1	0	3Ah
	1	1	↑	XX	X	DPI [2:0]			X	DBI [2:0]			66
Write Memory Continue	0	1	↑	XX	0	0	1	1	1	1	0	0	3Ch
	1	1	↑	D [17:0]									XX
Read Memory Continue	0	1	↑	XX	0	0	1	1	1	1	1	0	3Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Set Tear Scanline	0	1	↑	XX	0	1	0	0	0	1	0	0	44h
	1	1	↑	XX	X	X	X	X	X	X	X	STS [8]	00
	1	1	↑	XX	STS [7:0]								00
Get Scanline	0	1	↑	XX	0	1	0	0	0	1	0	1	45h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	X	GTS [9:8]		00
	1	↑	1	XX	GTS [7:0]								00
Write Display Brightness	0	1	↑	XX	0	1	0	1	0	0	0	1	51h
	1	1	↑	XX	DBV [7:0]								00

Read Display Brightness	0	1	↑	XX	0	1	0	1	0	0	1	0	52h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	DBV [7:0]								00
Write CTRL Display	0	1	↑	XX	0	1	0	1	0	0	1	1	53h
	1	1	↑	XX	X	X	BCTRL	X	DD	BL	X	X	00
Read CTRL Display	0	1	↑	XX	0	1	0	1	0	1	0	0	54h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	BCTRL	X	DD	BL	X	X	00
Write Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	0	1	55h
	1	1	↑	XX	X	X	X	X	X	X	C [1:0]		00
Read Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	1	0	56h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	X	X	X	X	X	C [1:0]		00
Write CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	1	1	1	0	5Eh
	1	1	↑	XX	CMB [7:0]								00
Read CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	0	1	1	1	5Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	CMB [7:0]								00
Read ID1	0	1	↑	XX	1	1	0	1	1	0	1	0	DAh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	Module's Manufacture [7:0]								XX
Read ID2	0	1	↑	XX	1	1	0	1	1	0	1	1	DBh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver Version [7:0]								XX
Read ID3	0	1	↑	XX	1	1	0	1	1	1	0	0	DCh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver ID [7:0]								XX

Extended Command Set													
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
RGB Interface Signal Control	0	1	↑	XX	1	0	1	1	0	0	0	0	B0h
	1	1	↑	XX	ByPass_MODE	RCM [1:0]		X	VSPL	HSPL	DPL	EPL	40
Frame Control (In Normal Mode)	0	1	↑	XX	1	0	1	1	0	0	0	1	B1h
	1	1	↑	XX	X	X	X	X	X	X	DIVA [1:0]		00
	1	1	↑	XX	X	X	X	RTNA [4:0]					1B
Frame Control (In Idle Mode)	0	1	↑	XX	1	0	1	1	0	0	1	0	B2h
	1	1	↑	XX	X	X	X	X	X	X	DIVB [1:0]		00
	1	1	↑	XX	X	X	X	RTNB [4:0]					1B
Frame Control (In Partial Mode)	0	1	↑	XX	1	0	1	1	0	0	1	1	B3h
	1	1	↑	XX	X	X	X	X	X	X	DIVC [1:0]		00
	1	1	↑	XX	X	X	X	RTNC [4:0]					1B
Display Inversion Control	0	1	↑	XX	1	0	1	1	0	1	0	0	B4h
	1	1	↑	XX	X	X	X	X	X	NLA	NLB	NLC	02
Blanking Porch Control	0	1	↑	XX	1	0	1	1	0	1	0	1	B5h
	1	1	↑	XX	0	VFP [6:0]							02
	1	1	↑	XX	0	VBP [6:0]							02
	1	1	↑	XX	0	0	0	HFP [4:0]					0A
	1	1	↑	XX	0	0	0	HBP [4:0]					14

Display Function Control	0	1	↑	XX	1	0	1	1	0	1	1	0	B6h
	1	1	↑	XX	X	X	X	X	PTG [1:0]		PT [1:0]		0A
	1	1	↑	XX	REV	GS	SS	SM	ISC [3:0]				82
	1	1	↑	XX	X	X	NL [5:0]						27
	1	1	↑	XX	X	X	PCDIV [5:0]						XX
Entry Mode Set	0	1	↑	XX	1	0	1	1	0	1	1	1	B7h
	1	1	↑	XX	X	X	X	X	DSTB	GON	DTE	GAS	07
Backlight Control 1	0	1	↑	XX	1	0	1	1	1	0	0	0	B8h
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	X	X	X	X	TH_UI [3:0]				04
Backlight Control 2	0	1	↑	XX	1	0	1	1	1	0	0	1	B9h
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	TH_MV [3:0]				TH_ST [3:0]				B8
Backlight Control 3	0	1	↑	XX	1	0	1	1	1	0	1	0	BAh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	X	X	X	X	DTH_UI [3:0]				04
Backlight Control 4	0	1	↑	XX	1	0	1	1	1	0	1	1	BBh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	DTH_MV [3:0]				DTH_ST [3:0]				C9
Backlight Control 5	0	1	↑	XX	1	0	1	1	1	1	0	0	BCh
	1	1	↑	XX	X	X	X	X	X	X	X	X	XX
	1	1	↑	XX	DIM2 [3:0]				X	DIM1 [2:0]			44
Backlight Control 7	0	1	↑	XX	1	0	1	1	1	1	1	0	BEh
	1	1	↑	XX	PWM_DIV [7:0]								0F
Backlight Control 8	0	1	↑	XX	1	0	1	1	1	1	1	1	BFh
	1	1	↑	XX	X	X	X	X	X	LEDONR	LEDONPOL	LEDPWMOPL	00
Power Control 1	0	1	↑	XX	1	1	0	0	0	0	0	0	C0h
	1	1	↑	XX	X	X	VRH [5:0]						26
Power Control 2	0	1	↑	XX	1	1	0	0	0	0	0	1	C1h
	1	1	↑	XX	X	X	X	X	X	BT [2:0]			00
VCOM Control 1	0	1	↑	XX	1	1	0	0	0	1	0	1	C5h
	1	1	↑	XX	X	VMH [6:0]							31
	1	1	↑	XX	X	VML [6:0]							3C
VCOM Control 2	0	1	↑	XX	1	1	0	0	0	1	1	1	C7h
	1	1	↑	XX	nVM	VMF [6:0]							C0
NV Memory Write	0	1	↑	XX	1	1	0	1	0	0	0	0	D0h
	1	1	↑	XX	X	X	X	X	X	PGM_ADR [2:0]			00
	1	1	↑	XX	PGM_DATA [7:0]								XX
NV Memory Protection Key	0	1	↑	XX	1	1	0	1	0	0	0	1	D1h
	1	1	↑	XX	KEY [23:16]								55
	1	1	↑	XX	KEY [15:8]								AA
	1	1	↑	XX	KEY [7:0]								66
NV Memory Status Read	0	1	↑	XX	1	1	0	1	0	0	1	0	D2h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	X	ID2_CNT [2:0]			X	ID1_CNT [2:0]			XX
	1	↑	1	XX	BUSY	VMF_CNT [2:0]			X	ID3_CNT [2:0]			XX

Read ID4	0	↑	1	XX	1	1	0	1	0	0	1	1	D3h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	0	0	0	00
	1	↑	1	XX	1	0	0	1	0	0	1	1	93
	1	↑	1	XX	0	1	0	0	0	0	0	1	41
Positive Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	0	E0h
	1	1	↑	XX	X	X	X	X	VP0 [3:0]				08
	1	1	↑	XX	X	X	VP1 [5:0]						0E
	1	1	↑	XX	X	X	VP2 [5:0]						12
	1	1	↑	XX	X	X	X	X	VP4 [3:0]				05
	1	1	↑	XX	X	X	X	VP6 [4:0]					03
	1	1	↑	XX	X	X	X	X	VP13 [3:0]				09
	1	1	↑	XX	X	VP20 [6:0]							47
	1	1	↑	XX	VP36 [3:0]				VP27 [3:0]				86
	1	1	↑	XX	X	VP43 [6:0]							2B
	1	1	↑	XX	X	X	X	X	VP50 [3:0]				0B
	1	1	↑	XX	X	X	X	VP57 [4:0]					04
	1	1	↑	XX	X	X	X	X	VP59 [3:0]				00
	1	1	↑	XX	X	X	VP61 [5:0]						00
	1	1	↑	XX	X	X	VP62 [5:0]						00
	1	1	↑	XX	X	X	X	X	VP63 [3:0]				00
Negative Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	1	E1h
	1	1	↑	XX	X	X	X	X	VN0 [3:0]				08
	1	1	↑	XX	X	X	VN1 [5:0]						1A
	1	1	↑	XX	X	X	VN2 [5:0]						20
	1	1	↑	XX	X	X	X	X	VN4 [3:0]				07
	1	1	↑	XX	X	X	X	VN6 [4:0]					0E
	1	1	↑	XX	X	X	X	X	VN13 [3:0]				05
	1	1	↑	XX	X	VN20 [6:0]							3A
	1	1	↑	XX	VN36 [3:0]				VN27 [3:0]				8A
	1	1	↑	XX	X	VN43 [6:0]							40
	1	1	↑	XX	X	X	X	X	VN50 [3:0]				04
	1	1	↑	XX	X	X	X	VN57 [4:0]					18
	1	1	↑	XX	X	X	X	X	VN59 [3:0]				0F
	1	1	↑	XX	X	X	VN61 [5:0]						3F
	1	1	↑	XX	X	X	VN62 [5:0]						3F
	1	1	↑	XX	X	X	X	X	VN63 [3:0]				0F
Digital Gamma Control 1	0	1	↑	XX	1	1	1	0	0	0	1	0	E2h
1st Parameter	1	1	↑	XX	RCA0 [3:0]				BCA0 [3:0]				XX
:	1	1	↑	XX	RCAx [3:0]				BCAx [3:0]				XX
16th Parameter	1	1	↑	XX	RCA15 [3:0]				BCA15 [3:0]				XX
Digital Gamma Control 2	0	1	↑	XX	1	1	1	0	0	0	1	1	E3h
1st Parameter	1	1	↑	XX	RFA0 [3:0]				BFA0 [3:0]				XX
:	1	1	↑	XX	RFAx [3:0]				BFAx [3:0]				XX
64th Parameter	1	1	↑	XX	RFA63 [3:0]				BFA63 [3:0]				XX
Interface Control	0	1	↑	XX	1	1	1	1	0	1	1	0	F6h
	1	1	↑	XX	MY_EOR	MX_EOR	MV_EOR	X	BGR_EOR	X	X	WEMODE	01
	1	1	↑	XX	X	X	EPF [1:0]		X	X	MDT [1:0]		00
	1	1	↑	XX	X	X	ENDIAN	X	DM [1:0]		RM	RIM	00

Note 1: Undefined commands are treated as NOP (00h) command.

Note 2: B0 to D9 and DE to FF are for factory use of display supplier. USER can decide if these commands are available or they are treated as NOP (00h) commands before shipping to USER. Default value is NOP

(00h).

Note 3: Commands 10h, 12h, 13h, 26h, 28h, 29h, 30h, 36h (Bit B4 only), 38h and 39h are updated during V-SYNC when ILI9341 is in Sleep OUT mode to avoid abnormal visual effects. During Sleep IN mode, these commands are updated immediately. Read status (09h), Read display power mode (0Ah), Read display MADCTL (0Bh), Read display pixel format (0Ch), Read display image mode (0Dh), Read display signal mode (0Eh) and Read display self diagnostic result (0Fh) of these commands are updated immediately both in Sleep IN mode and Sleep OUT mode.

8.2. Description of Level 1 Command

8.2.1. NOP (00h)

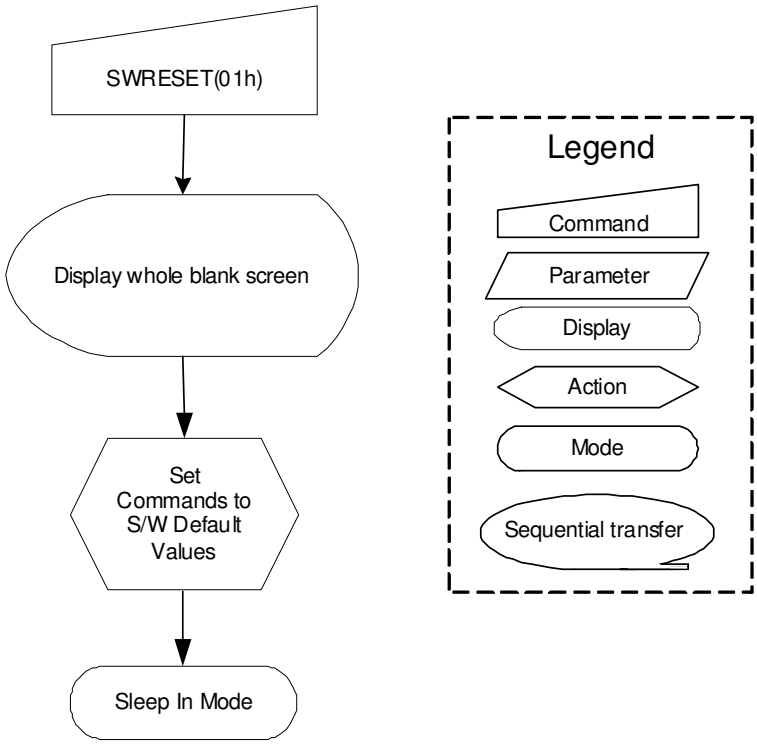
<table>
<tr><th>00h</th><th colspan="12">NOP (No Operation)</th></tr>
<tr><td></td><td>D/CX</td><td>RDX</td><td>WRX</td><td>D17-8</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>HEX</td></tr>
<tr><td>Command</td><td>0</td><td>1</td><td>↑</td><td>XX</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>00h</td></tr>
<tr><td>Parameter</td><td colspan="13">No Parameter.</td></tr>
<tr><td>Description</td><td colspan="13">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.</td></tr>
<tr><td>Restriction</td><td colspan="13">None</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>N/A</td></tr><tr><td>SW Reset</td><td>N/A</td></tr><tr><td>HW Reset</td><td>N/A</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13">None</td></tr>
</table>

8.2.2. Software Reset (01h)

01h	SWRESET												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	0	0	0	1	01h
Parameter	No Parameter.												
Description	When the Software Reset command is written, it causes a 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 unaffected by this command X = Don't care.												
Restriction	It will be necessary to wait 5msec before sending new command following software reset. The display module loads all display supplier factory default values to the registers during this 5msec. If Software Reset is applied during Sleep Out mode, it will be necessary to wait 120msec before sending Sleep out command. Software Reset Command cannot be sent during Sleep Out sequence.												
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



8.2.3. Read display identification information (04h)

04h	RDDIDIF (Read Display Identification Information)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	0	1	0	0	04h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2ndParameter	1	↑	1	XX	ID1 [7:0]								XX
3rd Parameter	1	↑	1	XX	ID2 [7:0]								XX
4th Parameter	1	↑	1	XX	ID3 [7:0]								XX
Description	This read byte returns 24 bits display identification information. The 1st parameter is dummy data. The 2nd parameter (ID1 [7:0]): LCD module's manufacturer ID. The 3rd parameter (ID2 [7:0]): LCD module/driver version ID. The 4th parameter (ID3 [7:0]): LCD module/driver ID.												
Restriction													

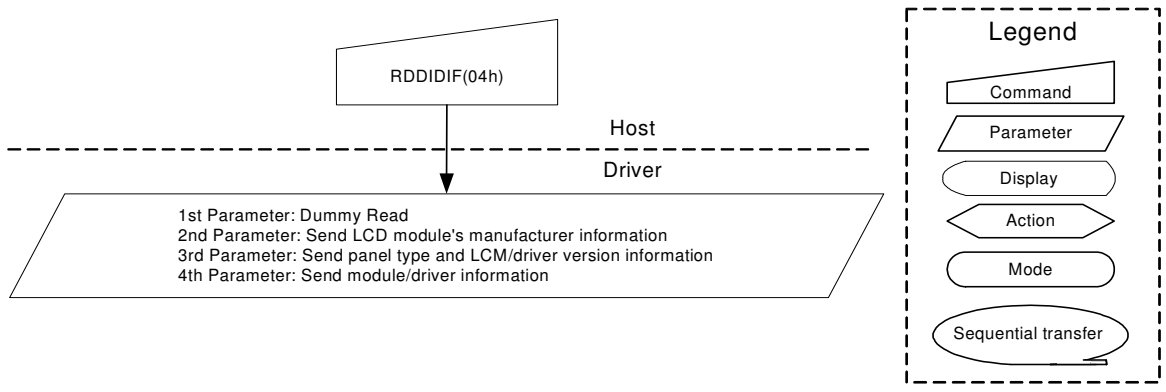
Register Availability

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



8.2.4. Read Display Status (09h)

09h	RDDST (Read Display Status)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	1	0	0	1	09h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	D [31:25]							0	00
3rd Parameter	1	↑	1	XX	0	D [22:20]			D [19:16]				61
4th Parameter	1	↑	1	XX	0	0	0	0	0	D [10:8]			00
5th Parameter	1	↑	1	XX	D [7:5]			0	0	0	0	0	00

Description

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

Bit	Description	Value	Status
D31	Booster voltage status	0	Booster OFF
		1	Booster ON
D30	Row address order	0	Top to Bottom (When MADCTL B7='0')
		1	Bottom to Top (When MADCTL B7='1')
D29	Column address order	0	Left to Right (When MADCTL B6='0').
		1	Right to Left (When MADCTL B6='1').
D28	Row/column exchange	0	Normal Mode (When MADCTL B5='0').
		1	Reverse Mode (When MADCTL B5='1').
D27	Vertical refresh	0	LCD Refresh Top to Bottom (When MADCTL B4='0')
		1	LCD Refresh Bottom to Top (When MADCTL B4='1').
D26	RGB/BGR order	0	RGB (When MADCTL B3='0')
		1	BGR (When MADCTL B3='1')
D25	Horizontal refresh order	0	LCD Refresh Left to Right (When MADCTL B2='0')
		1	LCD Refresh Right to Left (When MADCTL B2='1')
D24	Not used	0	---
D23	Not used	0	---
D22	Interface color pixel format definition	101	16-bit/pixel
D21			
D20		110	18-bit/pixel
D19	Idle mode ON/OFF	0	Idle Mode OFF
		1	Idle Mode ON
D18	Partial mode ON/OFF	0	Partial Mode OFF
		1	Partial Mode ON.
D17	Sleep IN/OUT	0	Sleep IN Mode
		1	Sleep OUT Mode.
D16	Display normal mode ON/OFF	0	Display Normal Mode OFF.
		1	Display Normal Mode ON.
D15	Vertical scrolling status	0	Scroll OFF
D14	Not used	0	---
D13	Inversion status	0	Not defined
D12	All pixel ON	0	Not defined
D11	All pixel OFF	0	Not defined
D10	Display ON/OFF	0	Display is OFF
		1	Display is ON
D9	Tearing effect line ON/OFF	0	Tearing Effect Line OFF
		1	Tearing Effect ON
D[8:6]	Gamma curve selection	000	GC0
		001	---
		010	---
		011	---
		other	Not defined

	D5	Tearing effect line mode	0	Mode 1, V-Blanking only
			1	Mode 2, both H-Blanking and V-Blanking.
	D4	Not used	0	---
	D3	Not used	0	---
	D2	Not used	0	---
	D1	Not used	0	---
	D0	Not used	0	---

X = Don't care

Restriction

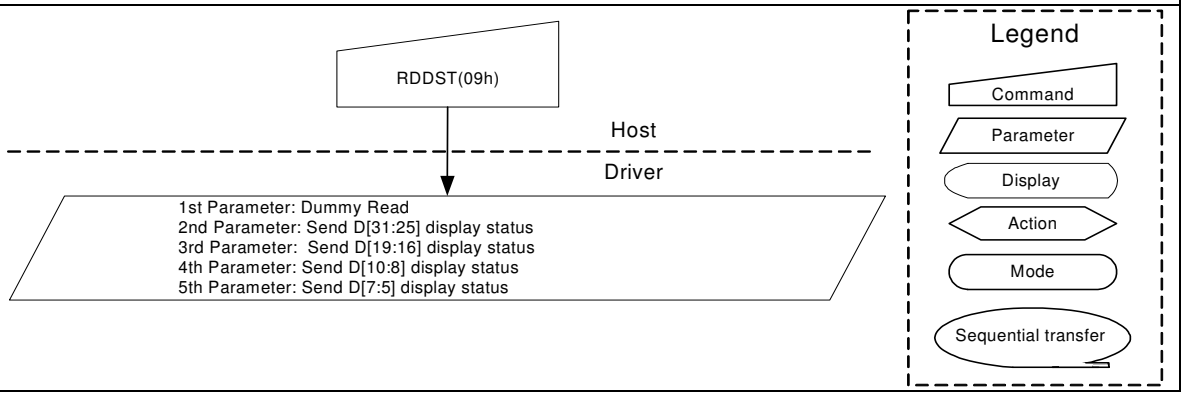
Register Availability

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	32'h00610000h
SW Reset	32'h00610000h
HW Reset	32'h00610000h

Flow Chart



8.2.5. Read Display Power Mode (0Ah)

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

Description

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

Bit	Value	Description	Comment
D7	0	Booster Off or has a fault.	---
	1	Booster On and working OK	---
D6	0	Idle Mode Off.	---
	1	Idle Mode On.	---
D5	0	Partial Mode Off.	---
	1	Partial Mode On.	---
D4	0	Sleep In Mode	---
	1	Sleep Out Mode	---
D3	0	Display Normal Mode Off.	---
	1	Display Normal Mode On	---
D2	0	Display is Off.	---
	1	Display is On	---
D1	--	Not Defined	Set to '0'
D0	--	Not Defined	Set to '0'

X = Don't care

Restriction

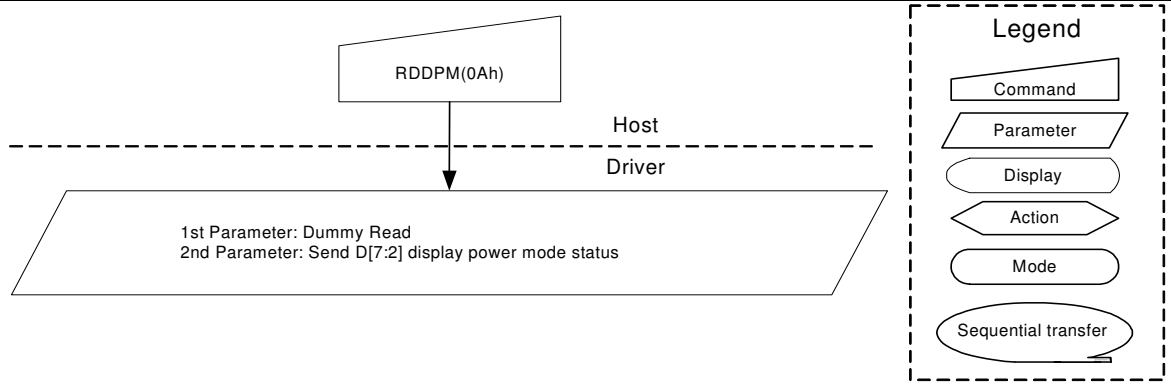
Register Availability

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	8'h08h
SW Reset	8'h08h
HW Reset	8'h08h

Flow Chart



8.2.6. Read Display MADCTL (0Bh)

0Bh	RDDMADCTL (Read Display MADCTL)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	1	0	1	1	0Bh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	D7	D6	D5	D4	D3	D2	D1	D0	00

Description

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

Bit	Value	Description	Comment
D7	0	Top to Bottom (When MADCTL B7='0').	---
	1	Bottom to Top (When MADCTL B7='1').	---
D6	0	Left to Right (When MADCTL B6='0')	---
	1	Right to Left (When MADCTL B6='1')	---
D5	0	Normal Mode (When MADCTL B5='0').	---
	1	Reverse Mode (When MADCTL B5='1')	---
D4	0	LCD Refresh Top to Bottom (When MADCTL B4='0')	---
	1	LCD Refresh Bottom to Top (When MADCTL B4='1').	---
D3	0	RGB (When MADCTL B3='0')	---
	1	BGR (When MADCTL B3='1').	---
D2	0	LCD Refresh Left to Right (When MADCTL B2='0').	---
	1	LCD Refresh Right to Left (When MADCTL B2='1').	---
D1	--	Switching between Segment outputs and RAM	Set to '0'
D0	--	Switching between Segment outputs and RAM	Set to '0'

X = Don't care

Restriction

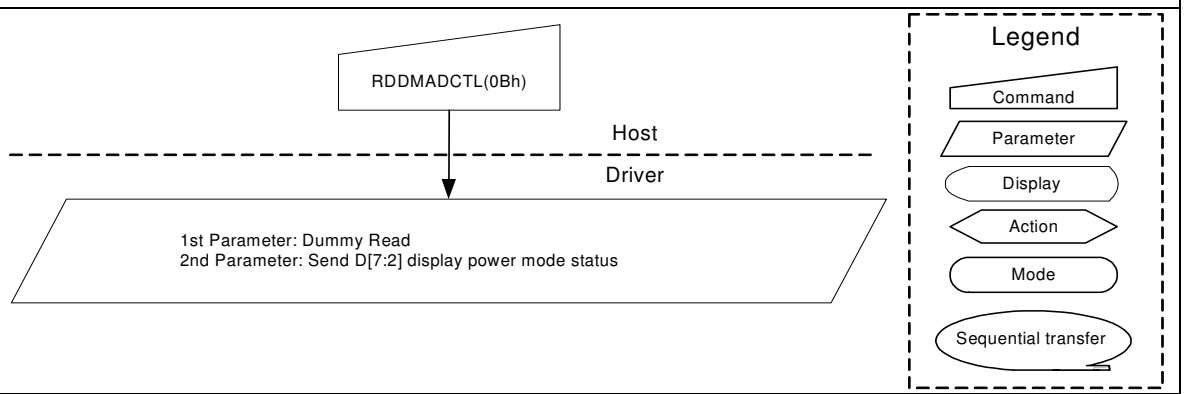
Register Availability

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	8'h00h
SW Reset	No Change
HW Reset	8'h00h

Flow Chart



8.2.7. Read Display Pixel Format (0Ch)

0Ch	RDDCOLMOD (Read Display Pixel Format)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	1	1	0	0	0Ch
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	RIM	DPI [2:0]			0	DBI [2:0]			06

Description

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

RIM	DPI [2:0]			RGB Interface Format
0	0	0	0	Reserved
0	0	0	1	Reserved
0	0	1	0	Reserved
0	0	1	1	Reserved
0	1	0	0	Reserved
0	1	0	1	16 bits / pixel
0	1	1	0	18 bits / pixel
0	1	1	1	Reserved
1	1	0	1	16 bits / pixel (6-bit 3 times data transfer)
1	1	1	0	18 bits / pixel (6-bit 3 times data transfer)

DBI [2:0]			MCU Interface Format
0	0	0	Reserved
0	0	1	Reserved
0	1	0	Reserved
0	1	1	Reserved
1	0	0	Reserved
1	0	1	16 bits / pixel
1	1	0	18 bits / pixel
1	1	1	Reserved

X = Don't care

Restriction

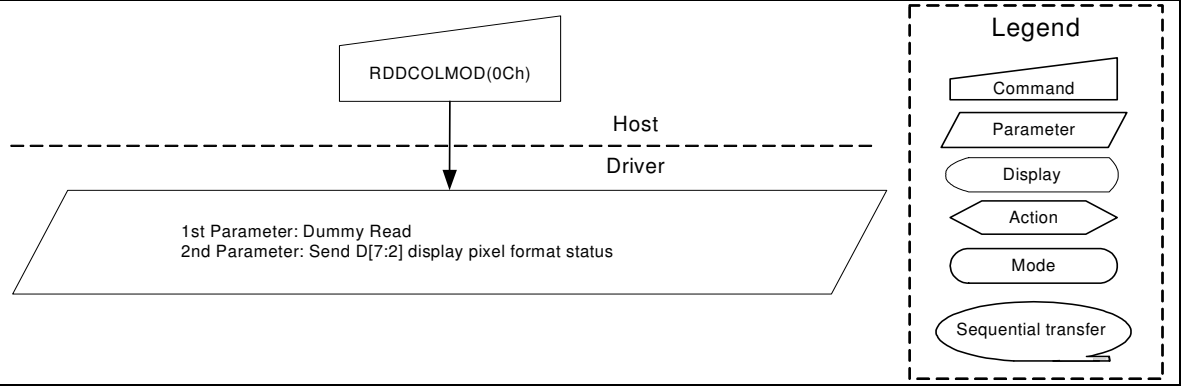
Register Availability

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

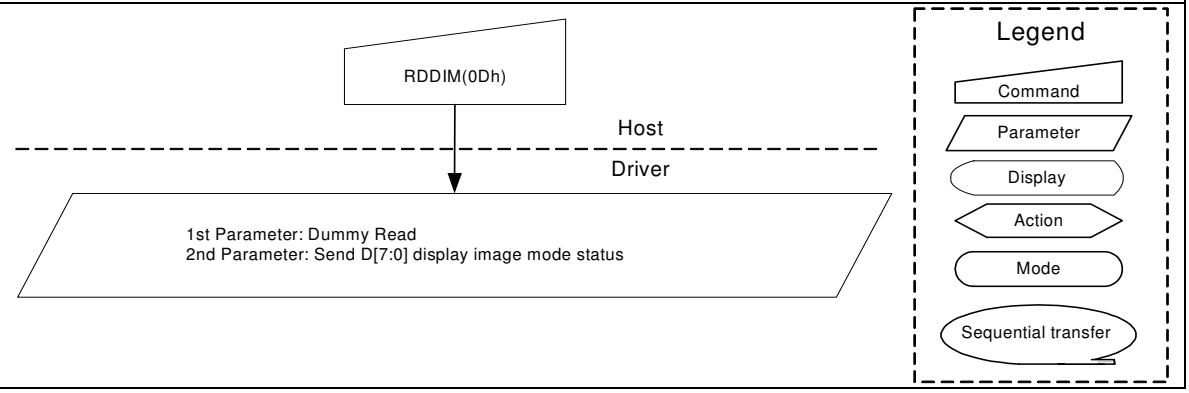
Default

Status	Default Value		
	RIM	DPI [2:0]	DBI [2:0]
Power On Sequence	1'b0	3'b000	3'b110
SW Reset	No Chang	No Chang	No Chang
HW Reset	1'b0	3'b000	3'b110

Flow Chart



8.2.8. Read Display Image Format (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	↑	XX	0	0	0	0	1	1	0	1	0Dh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	0	0	0	0	0	D [2:0]			00
Description	This command indicates the current status of the display as described in the table below: D [2:0] / Description: 000 Gamma curve 1 (G2.2); 001 ---; 010 ---; 011 ---; Other Not defined 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 — 3'b000; SW Reset — 3'b000; HW Reset — 3'b000												
Flow Chart													

8.2.9. 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	↑	XX	0	0	0	0	1	1	1	0	0Eh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	D7	D6	D5	D4	D3	D2	D1	D0	00

Description

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

Bit	Value	Description
D7	0	Tearing effect line OFF
	1	Tearing effect line ON
D6	0	Tearing effect line mode 1
	1	Tearing effect line mode 2
D5	0	Horizontal sync. (RGB interface) OFF
	1	Horizontal sync. (RGB interface) ON
D4	0	Vertical sync. (RGB interface) OFF
	1	Vertical sync. (RGB interface) ON
D3	0	Pixel clock (DOTCLK, RGB interface) OFF
	1	Pixel clock (DOTCLK, RGB interface) ON
D2	0	Data enable (DE, RGB interface) OFF
	1	Data enable (DE, RGB interface) ON
D1	0	Reserved
D0	0	Reserved

X = Don't care

Restriction

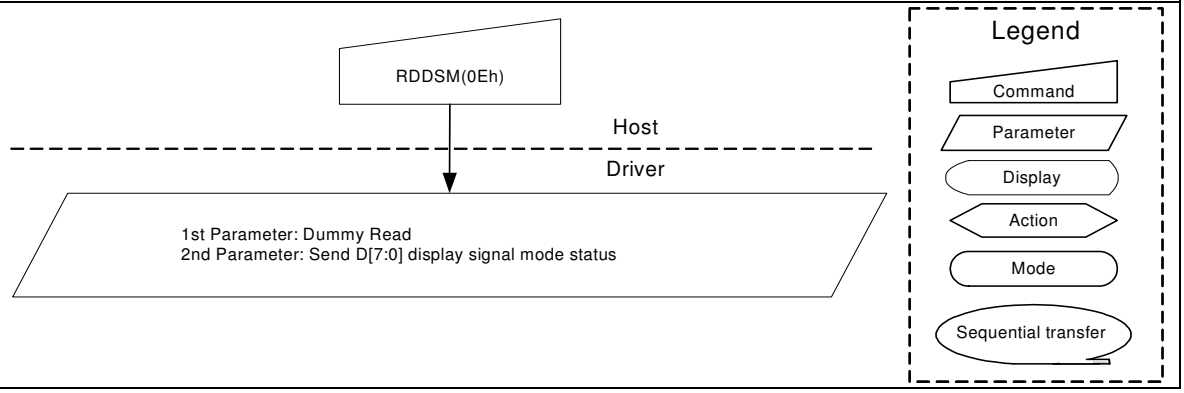
Register Availability

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	8'h00h
SW Reset	8'h00h
HW Reset	8'h00h

Flow Chart



8.2.10. Read Display Self-Diagnostic Result (0Fh)

0Fh	RDDSDR (Read Display Self-Diagnostic Result)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	0	1	1	1	1	0Fh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	D7	D6	0	0	0	0	0	0	00

Description

Bit	Description	Action
D7	Register Loading Detection	Invert the D7 bit if register values loading work properly.
D6	Functionality Detection	Invert the D6 bit if the display is functionality
D5	Not Used	'0'
D4	Not Used	'0'
D3	Not Used	'0'
D2	Not Used	'0'
D1	Not Used	'0'
D0	Not Used	'0'

Restriction

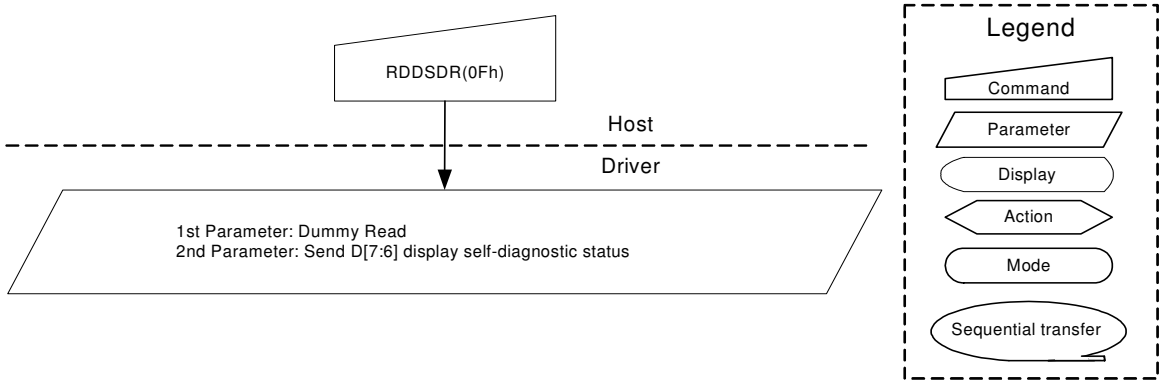
Register Availability

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	8'h00h
SW Reset	8'h00h
HW Reset	8'h00h

Flow Chart



8.2.11. Enter Sleep Mode (10h)

10h	SPLIN (Enter Sleep Mode)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	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. X = Don't care												
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 to 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

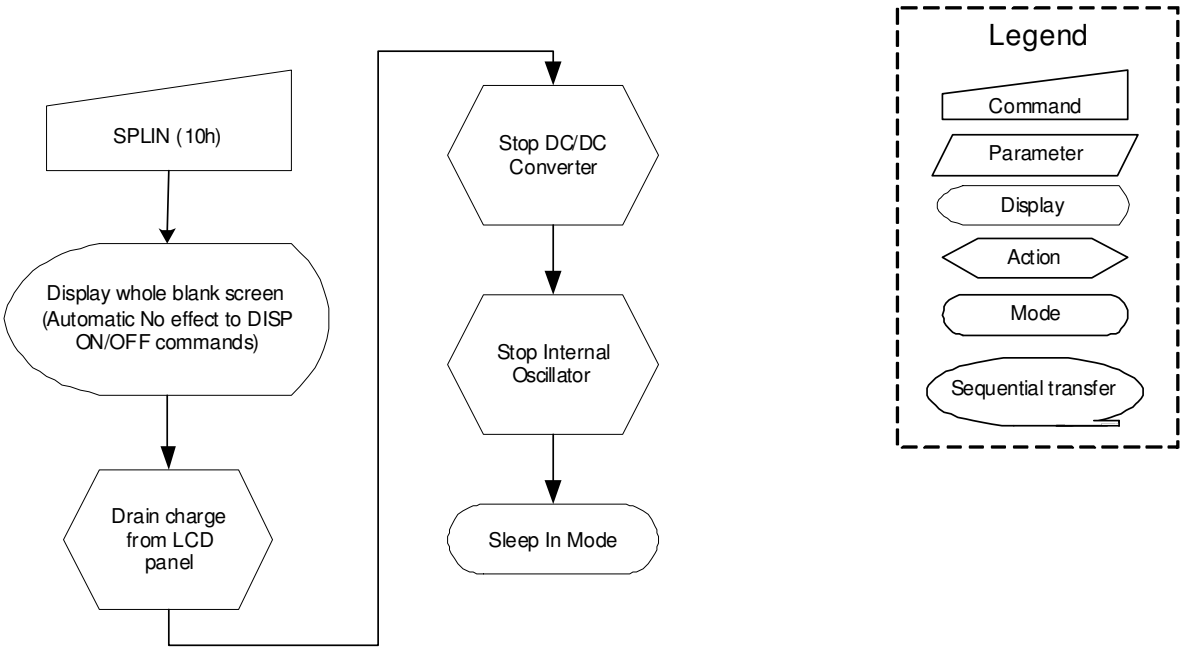
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

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

Flow Chart

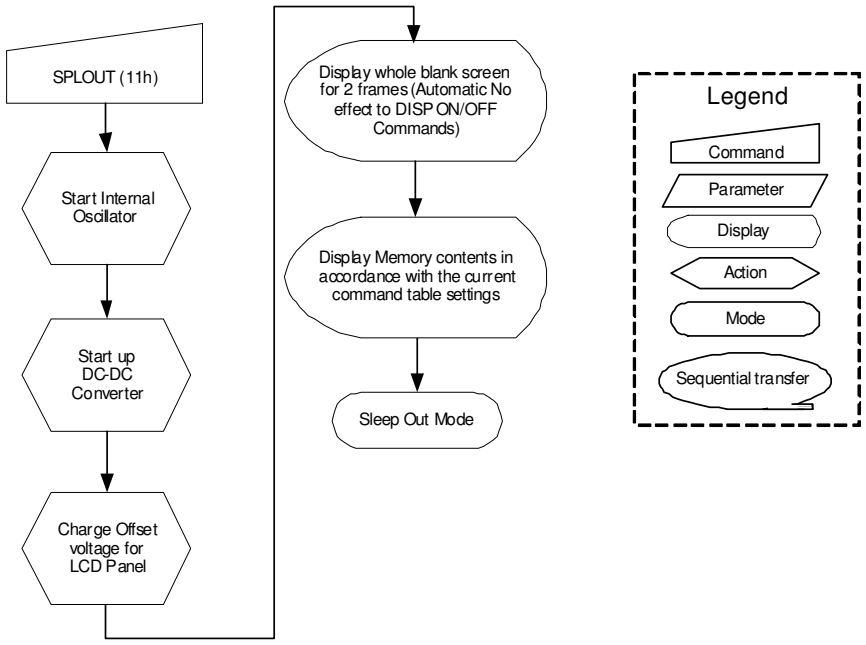
It takes 120msec to get into Sleep In mode after SLPIN command issued.



8.2.12. Sleep Out (11h)

<table>
<tr><th>11h</th><th colspan="13">SLPOUT (Sleep Out)</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>XX</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>11h</td></tr>
<tr><td>Parameter</td><td colspan="13">No Parameter</td></tr>
<tr><td>Description</td><td colspan="13">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.

X = Don’t care</td></tr>
<tr><td>Restriction</td><td colspan="13">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 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.</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>Sleep IN Mode</td></tr><tr><td>SW Reset</td><td>Sleep IN Mode</td></tr><tr><td>HW Reset</td><td>Sleep IN Mode</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13">It takes 120msec to become Sleep Out mode after SLPOUT command issued.</td></tr>
</table>



8.2.13. 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>XX</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 window is described by the Partial Area command (30H). To leave Partial mode, the Normal Display Mode On command (13H) should be written.
X = Don’t care</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect when 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>

8.2.14. Normal Display Mode ON (13h)

13h	NORON (Normal Display Mode On)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	0	1	0	0	1	1	13h
Parameter	No Parameter												
Description	This command returns the display to normal mode. Normal display mode on means Partial mode off. Exit from NORON by the Partial mode On command (12h) X = Don't care												
Restriction	This command has no effect when Normal Display mode is active.												
Register Availability													

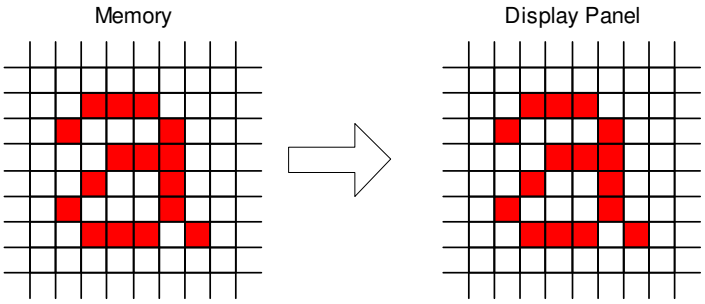
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

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

Flow Chart	See Partial Area (30h)

8.2.15. Display Inversion OFF (20h)

20h	DINVOFF (Display Inversion OFF)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	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 the content of frame memory. This command doesn't change any other status.  X = Don't care												
Restriction	This command has no effect when module already is inversion OFF mode.												

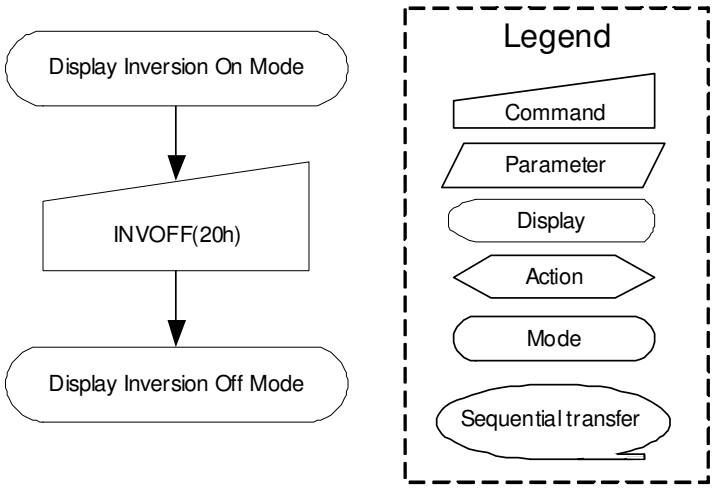
Register Availability

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	Display Inversion OFF
SW Reset	Display Inversion OFF
HW Reset	Display Inversion OFF

Flow Chart



8.2.16. Display Inversion ON (21h)

21h	DINVON (Display Inversion ON)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	0	0	0	0	1	21h
Parameter	No Parameter												

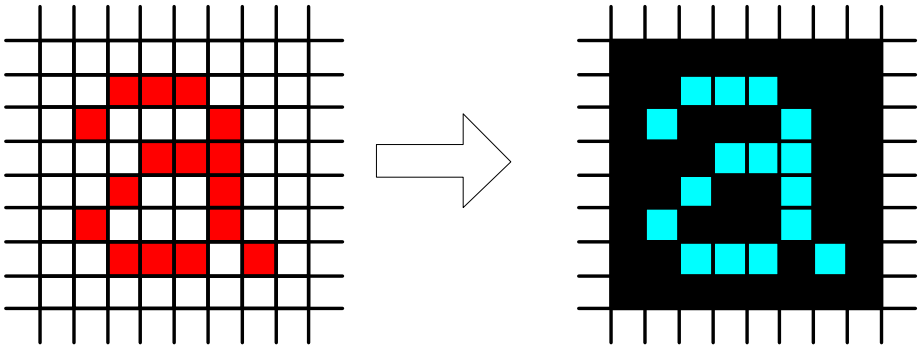
Description

This command is used to enter into display inversion mode.

This command makes no change of the content of frame memory. Every bit is inverted from the frame memory to the display.

This command doesn't change any other status.

To exit Display inversion mode, the Display inversion OFF command (20h) should be written.



X = Don't care

Restriction

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

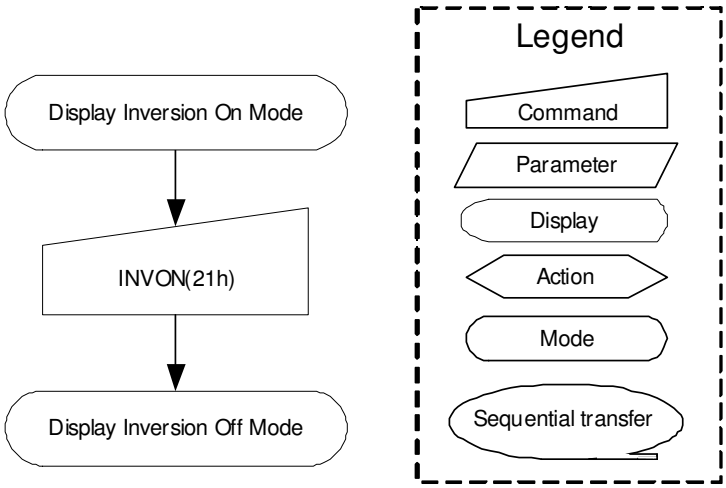
Register Availability

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	Display Inversion OFF
SW Reset	Display Inversion OFF
HW Reset	Display Inversion OFF

Flow Chart



8.2.17. 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	↑	XX	0	0	1	0	0	1	1	0	26h
Parameter	1	1	↑	XX	GC [7:0]								01

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 curve is selected by setting the appropriate bit in the parameter as described in the Table:

GC [7:0]	Curve Selected
01h	Gamma curve 1 (G2.2)
02h	---
04h	---
08h	---

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.

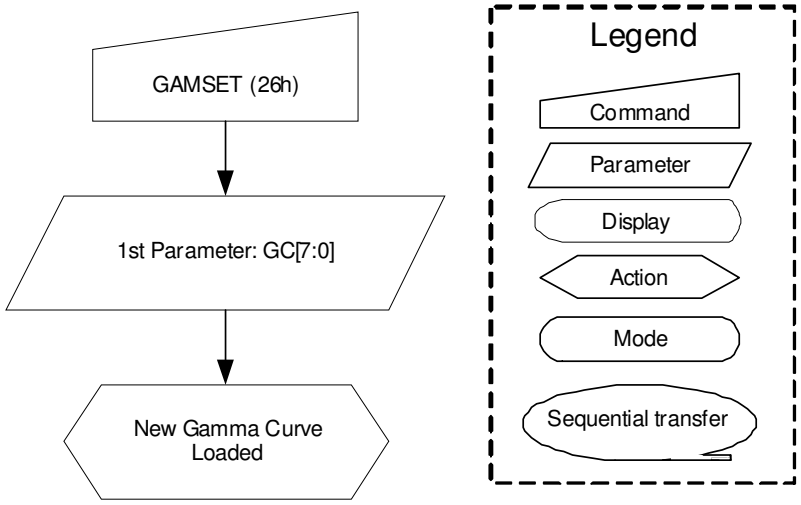
Register Availability

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

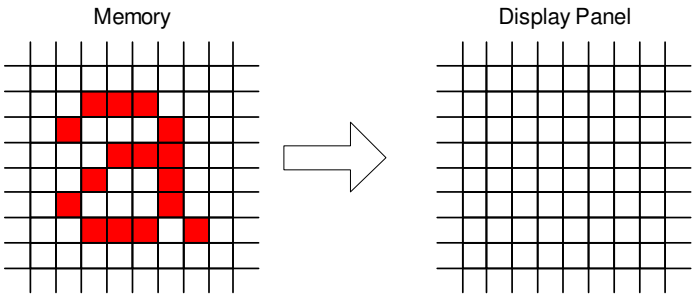
Default

Status	Default Value
Power On Sequence	8'h01h
SW Reset	8'h01h
HW Reset	8'h01h

Flow Chart



8.2.18. 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	↑	XX	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.  X = Don't care.												
Restriction	This command has no effect when module is already in display off mode.												

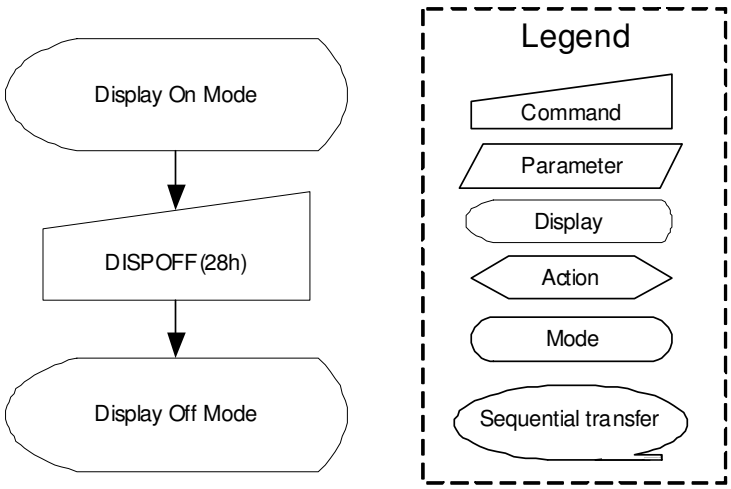
Register Availability

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



8.2.19. Display ON (29h)

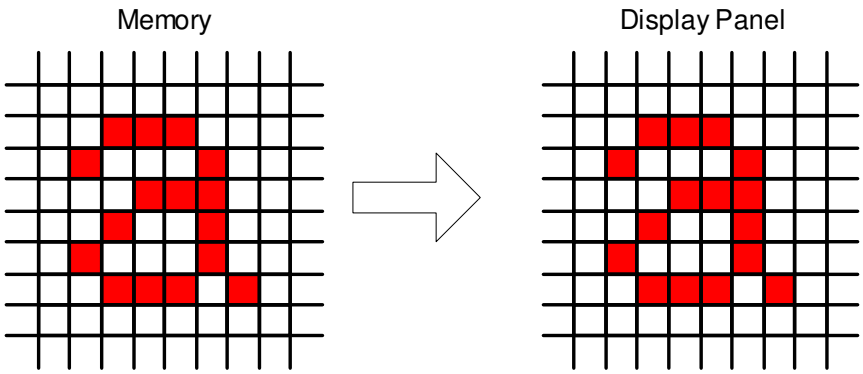
29h	DISPON (Display ON)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	0	1	0	0	1	29h
Parameter	No Parameter												

Description

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.

Restriction

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

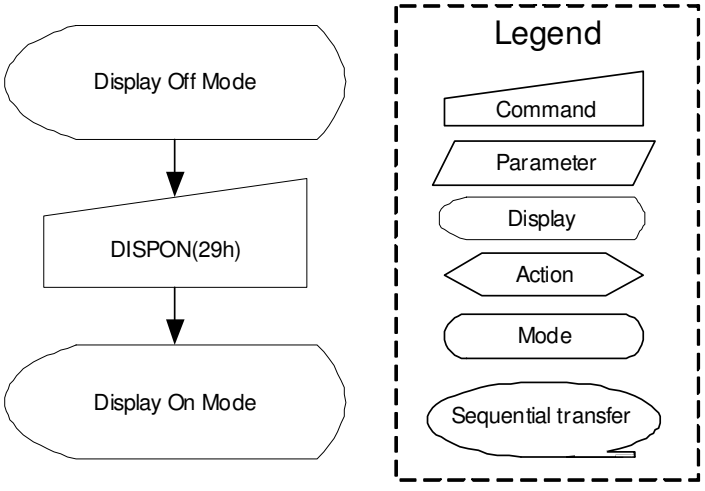
Register Availability

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	Display OFF
SW Reset	Display OFF
HW Reset	Display OFF

Flow Chart

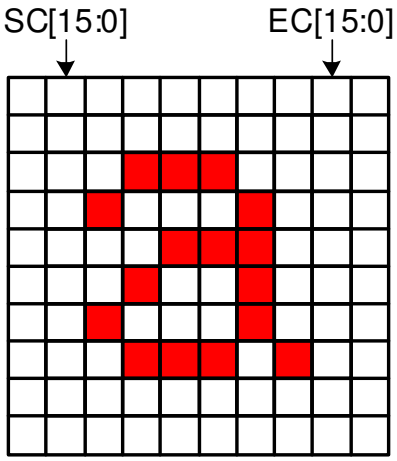


8.2.20. Column Address Set (2Ah)

2Ah	CASET (Column Address Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	0	1	0	1	0	2Ah
1st Parameter	1	1	↑	XX	SC15	SC14	SC13	SC12	SC11	SC10	SC9	SC8	Note1
2ndParameter	1	1	↑	XX	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0	
3rd Parameter	1	1	↑	XX	EC15	EC14	EC13	EC12	EC11	EC10	EC9	EC8	Note1
4th Parameter	1	1	↑	XX	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0	

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 SC [15:0] and EC [15:0] are referred when RAMWR command comes. Each value represents one column line in the Frame Memory.



X = Don't care

Restriction

SC [15:0] always must be equal to or less than EC [15:0].

Note 1: When SC [15:0] or EC [15:0] is greater than 00EFh (When MADCTL's B5 = 0) or 013Fh (When MADCTL's B5 = 1), data of out of range will be ignored

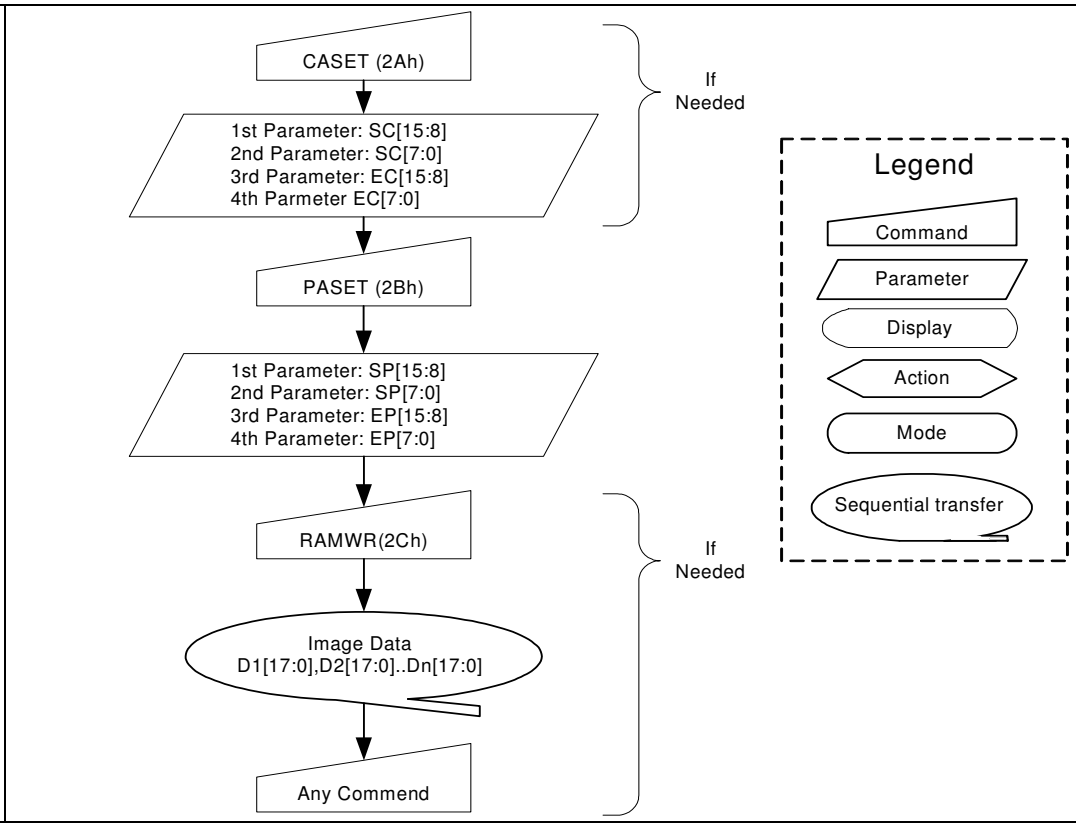
Register Availability

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	SC [15:0]=0000h	EC [15:0]=00EFh
SW Reset	SC [15:0]=0000h	If MADCTL's B5 = 0: EC [15:0]=00EFh If MADCTL's B5 = 1: EC [15:0]=013Fh
HW Reset	SC [15:0]=0000h	EC [15:0]=00EFh

Flow Chart

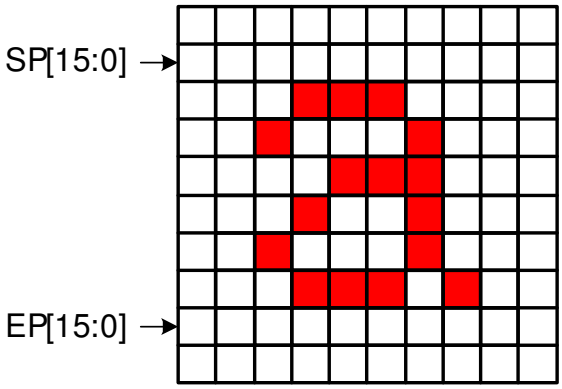


8.2.21. Page Address Set (2Bh)

2Bh	PASET (Page Address Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	0	1	0	1	1	2Bh
1st Parameter	1	1	↑	XX	SP15	SP14	SP13	SP12	SP11	SP10	SP9	SP8	Note1
2ndParameter	1	1	↑	XX	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	
3rdParameter	1	1	↑	XX	EP15	EP14	EP13	EP12	EP11	EP10	EP9	EP8	Note1
4th Parameter	1	1	↑	XX	EP7	EP6	EP5	EP4	EP3	EP2	EP1	EP0	

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 SP [15:0] and EP [15:0] are referred when RAMWR command comes. Each value represents one Page line in the Frame Memory.



X = Don't care

Restriction

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

Note 1: When SP [15:0] or EP [15:0] is greater than 013Fh (When MADCTL's B5 = 0) or 00EFh (When MADCTL's B5 = 1), data of out of range will be ignored.

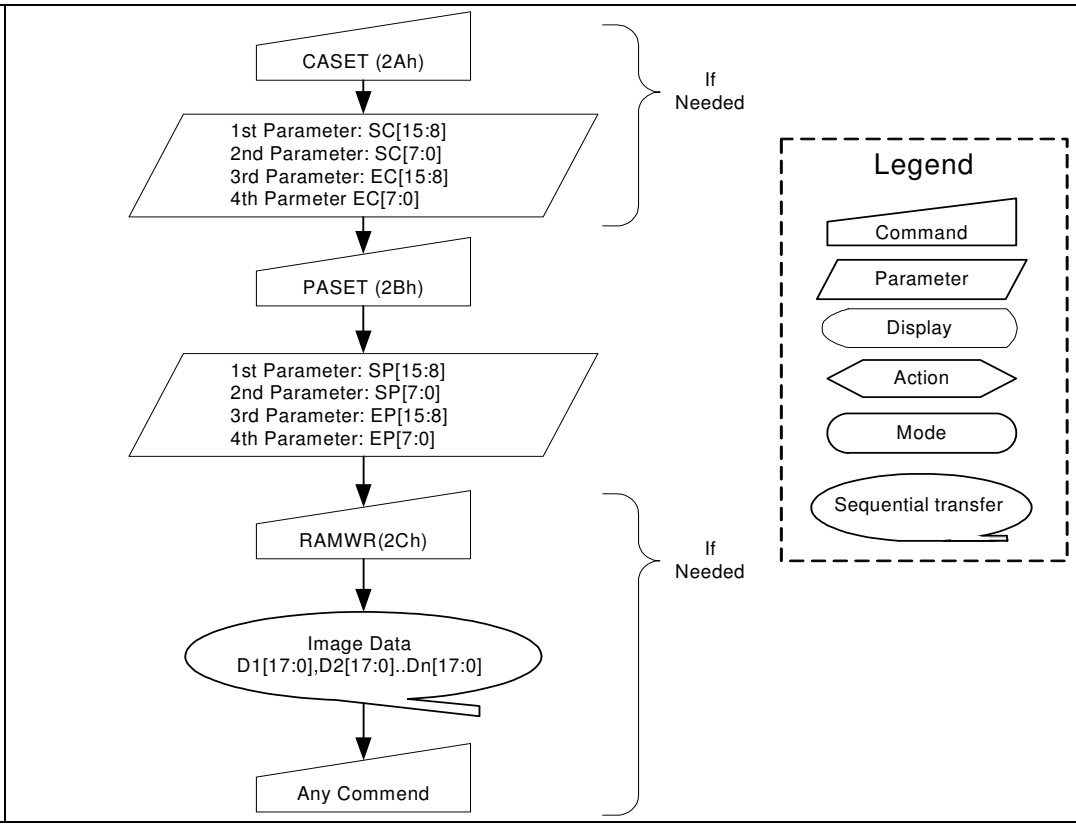
Register Availability

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	SP [15:0]=0000h	EP [15:0]=013Fh
SW Reset	SP [15:0]=0000h	If MADCTL's B5 = 0: EP [15:0]=013Fh If MADCTL's B5 = 1: EP [15:0]=00EFh
HW Reset	SP [15:0]=0000h	EP [15:0]=013Fh

Flow Chart



8.2.22. 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	↑	XX	0	0	1	0	1	1	0	0	2Ch
1st Parameter	1	1	↑	D1 [17:0]									XX
:	1	1	↑	Dx [17:0]									XX
Nth Parameter	1	1	↑	Dn [17:0]									XX
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 register and the page 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.												

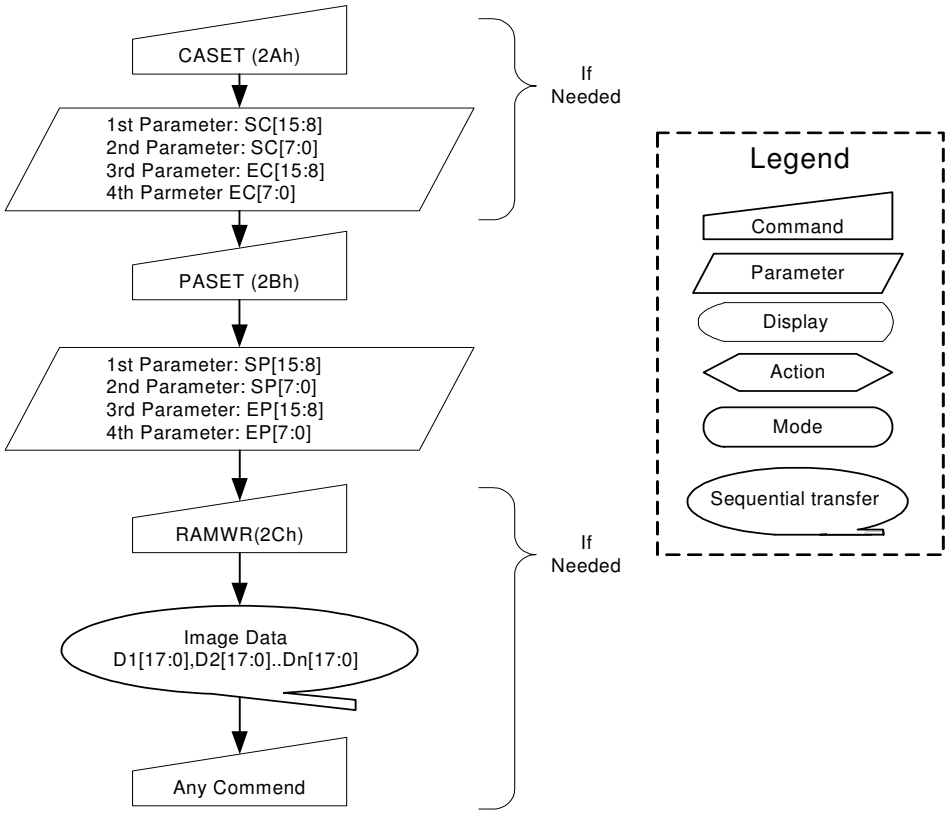
Register Availability

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



8.2.23. Color Set (2Dh)

2Dh	RGBSET (Color Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	0	1	1	0	1	2Dh
1st Parameter	1	1	↑	XX	0	0	R00 [5:0]						XX
nth Parameter	1	1	↑	XX	0	0	Rnn [5:0]						XX
32ndParameter	1	1	↑	XX	0	0	R31 [5:0]						XX
33rdParameter	1	1	↑	XX	0	0	G00 [5:0]						XX
nth Parameter	1	1	↑	XX	0	0	Gnn [5:0]						XX
96thParameter	1	1	↑	XX	0	0	G64 [5:0]						XX
97thParameter	1	1	↑	XX	0	0	B00 [5:0]						XX
nth Parameter	1	1	↑	XX	0	0	Bnn [5:0]						XX
128thParameter	1	1	↑	XX	0	0	B31 [5:0]						XX

Description

This command is used to define the LUT for 16-bit to 18-bit color depth conversion.

128 bytes must be written to the LUT regardless of the color mode. Only the values in Section 7.4 are referred.

This command has no effect on other commands, parameter and contents of frame memory. Visible change takes effect next time the frame memory is written to.

Restriction

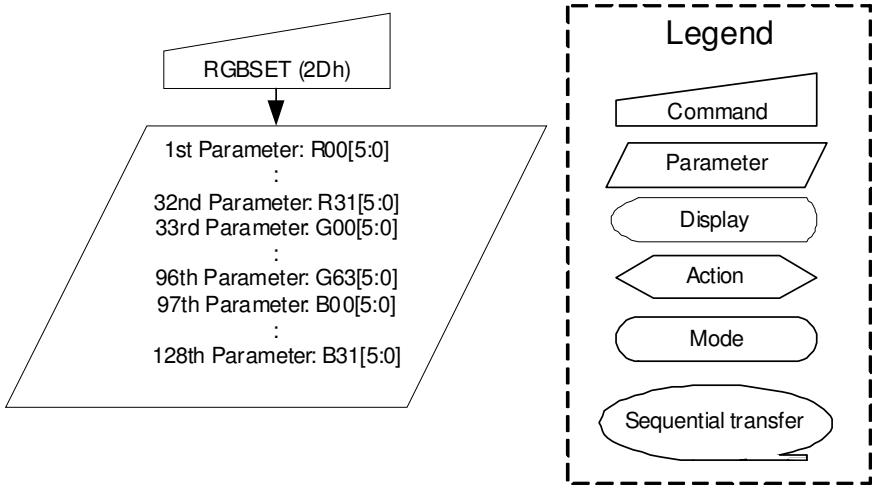
Register Availability

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	Random values
SW Reset	Contents of LUT protected
HW Reset	Random values

Flow Chart



8.2.24. 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	↑	XX	0	0	1	0	1	1	1	0	2Eh
1st Parameter	1	1	↑	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	1	↑	D1 [17:0]									XX
:	1	1	↑	Dx [17:0]									XX
(N+1)th Parameter	1	1	↑	Dn [17:0]									XX

Description

This command transfers image data from ILI9341's frame memory to the host processor starting at the pixel location specified by preceding set_column_address and set_page_address commands.

If Memory Access control B5 = 0:

The column and page registers are reset to the Start Column (SC) and Start Page (SP), respectively. Pixels are read from frame memory at (SC, SP). The column register is then incremented and pixels read from the frame memory until the column register equals the End Column (EC) value. The column register is then reset to SC and the page register is incremented. Pixels are read from the frame memory until the page register equals the End Page (EP) value or the host processor sends another command.

If Memory Access Control B5 = 1:

The column and page registers are reset to the Start Column (SC) and Start Page (SP), respectively. Pixels are read from frame memory at (SC, SP). The page register is then incremented and pixels read from the frame memory until the page register equals the End Page (EP) value. The page register is then reset to SP and the column register is incremented. Pixels are read from the frame memory until the column register equals the End Column (EC) value or the host processor sends another command.

Restriction

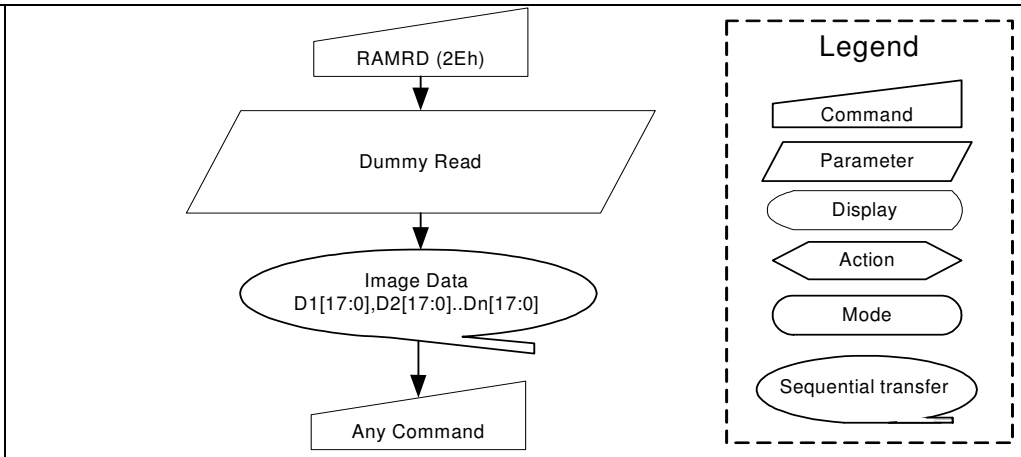
There is no restriction on length of parameters.

Register Availability

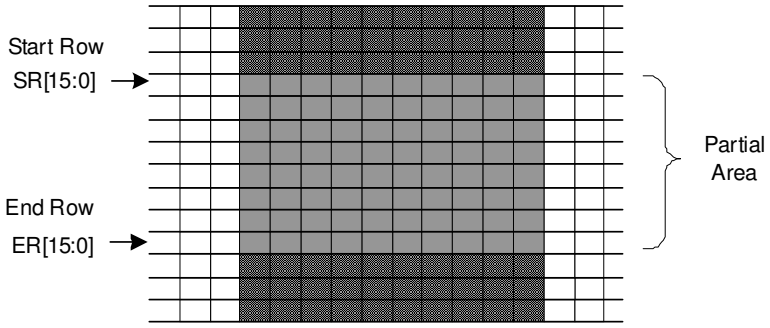
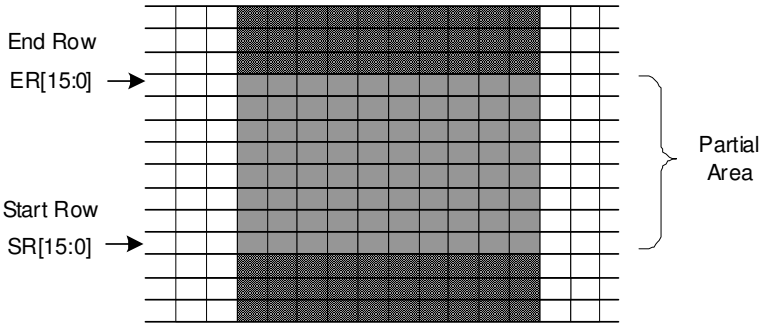
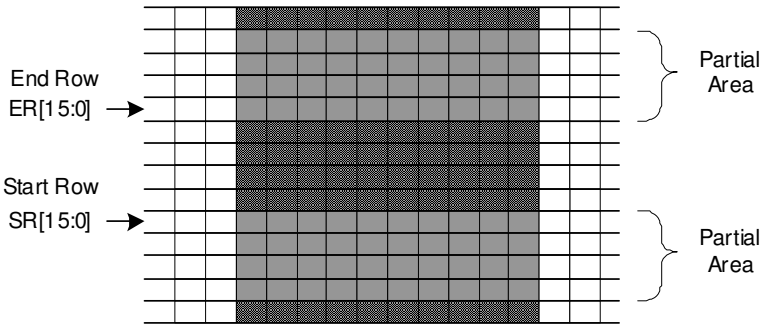
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	Contents of memory is set randomly
SW Reset	Contents of memory is set randomly
HW Reset	Contents of memory is set randomly

Flow Chart	

8.2.25. 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	↑	XX	0	0	1	1	0	0	0	0	30h
1st Parameter	1	1	↑	XX	SR15	SR14	SR13	SR12	SR11	SR10	SR9	SR8	00
2nd Parameter	1	1	↑	XX	SR7	SR6	SR5	SR4	SR3	SR2	SR1	SR0	00
3rd Parameter	1	1	↑	XX	ER15	ER14	ER13	ER12	ER11	ER10	ER9	ER8	01
4th Parameter	1	1	↑	XX	ER7	ER6	ER5	ER4	ER3	ER2	ER1	ER0	3F
Description	This command defines the partial mode's display area. There are 2 parameters associated with this command, the first defines the Start Row (SR) and the second the End Row (ER), as illustrated in the figures below. SR and ER refer to the Frame Memory Line Pointer. If End Row>Start Row when MADCTL B4=0:-  If End Row>Start Row when MADCTL B4=1:-  If End Row<Start Row when MADCTL B4=0:-  If End Row = Start Row then the Partial Area will be one row deep. X = Don't care.												
Restriction	SR [15…0] and ER [15…0] cannot be 0000h nor exceed 013Fh.												

Register Availability

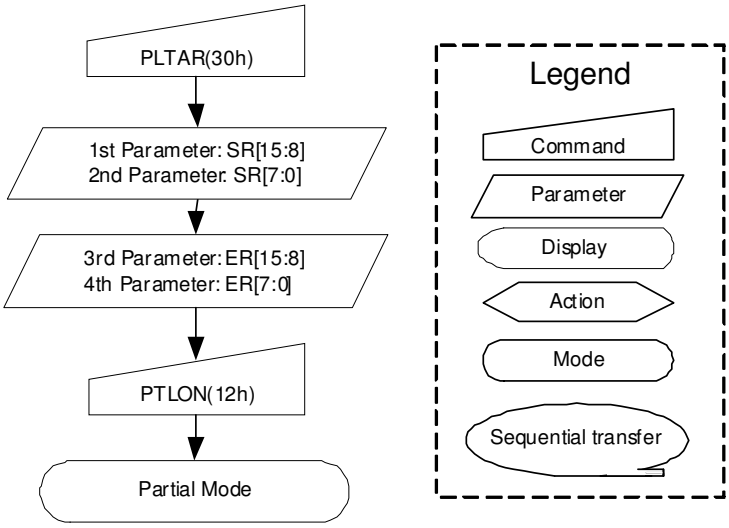
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

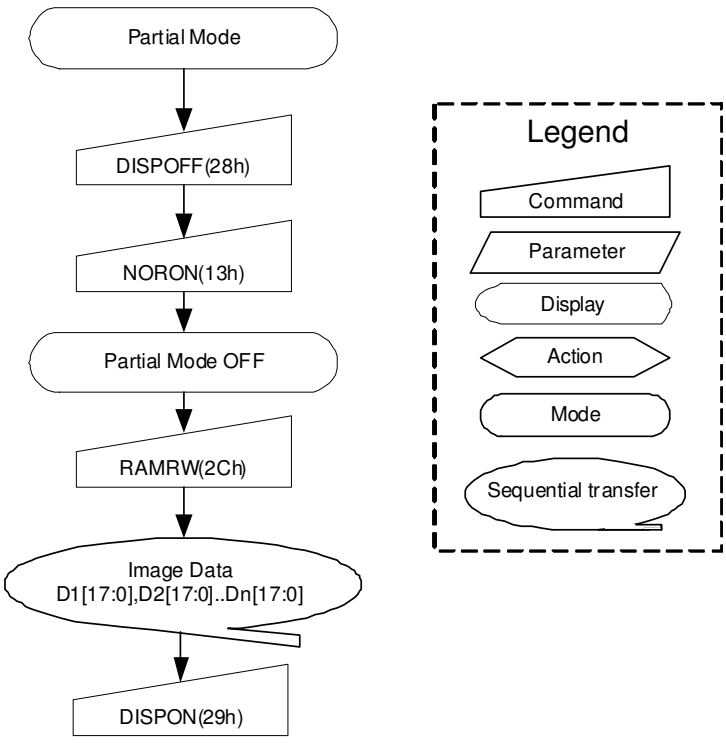
Status	Default Value	
	SR [15:0]	ER [15:0]
Power On Sequence	16'h0000h	16'h013Fh
SW Reset	16'h 0000h	16'h 013Fh
HW Reset	16'h 0000h	16'h 013Fh

Flow Chart

1. To Enter Partial Mode



2. To Leave Partial Mode



8.2.26. 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	↑	XX	0	0	1	1	0	0	1	1	33h
1st Parameter	1	↑	1	XX	TFA [15:8]								00
2nd Parameter	1	↑	1	XX	TFA [7:0]								00
3rd Parameter	1	↑	1	XX	VSA [15:8]								01
4th Parameter	1	↑	1	XX	VSA [7:0]								40
5th Parameter	1	↑	1	XX	BFA [15:8]								00
6th Parameter	1	↑	1	XX	BFA [7:0]								00

Description

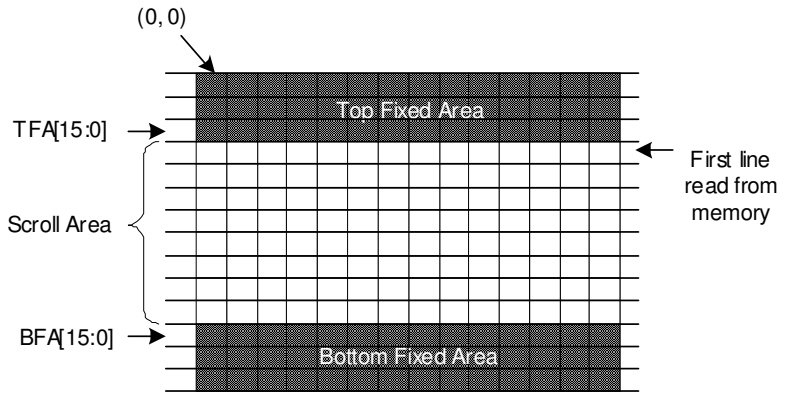
This command defines the Vertical Scrolling Area of the display.

When MADCTL B4=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.

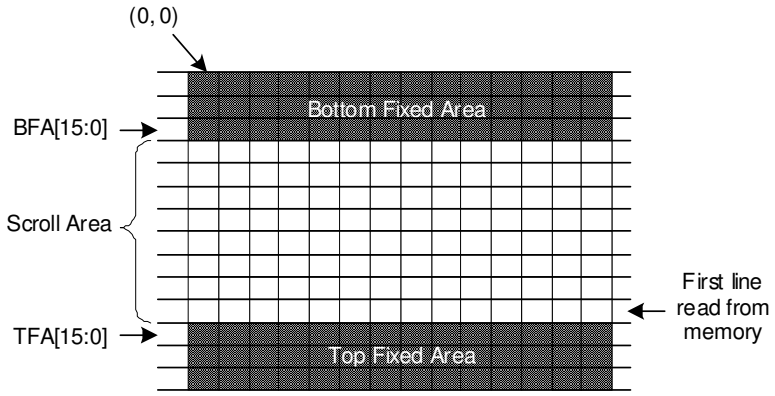


When MADCTL B4=1

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).



X = Don't care

Restriction

Register Availability

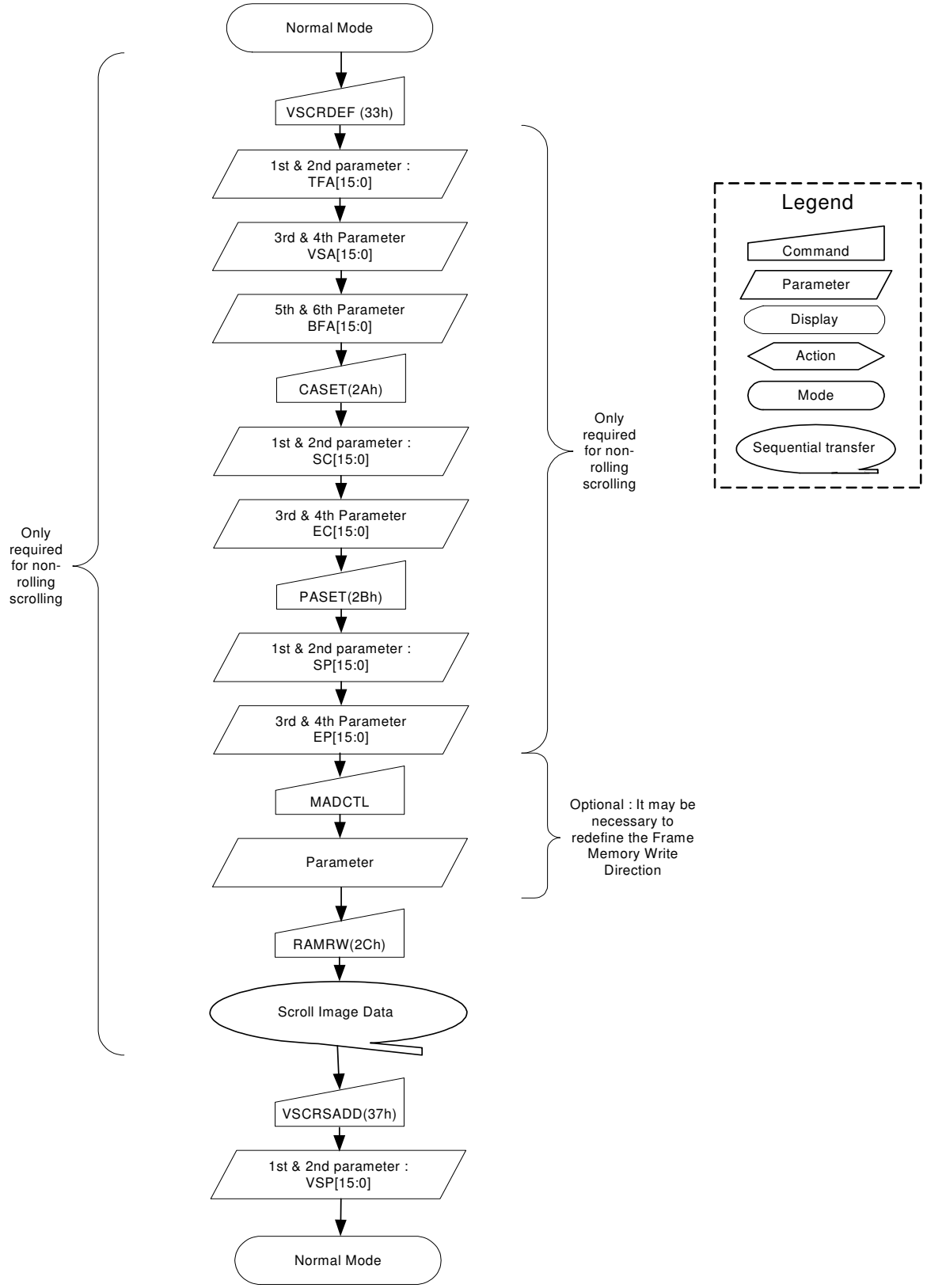
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value		
	TFA [15:0]	VSA [15:0]	BFA [15:0]
Power On Sequence	16'h0000h	16'h0140h	16'h0000h
SW Reset	16'h0000h	16'h0140h	16'h0000h
HW Reset	16'h0000h	16'h0140h	16'h0000h

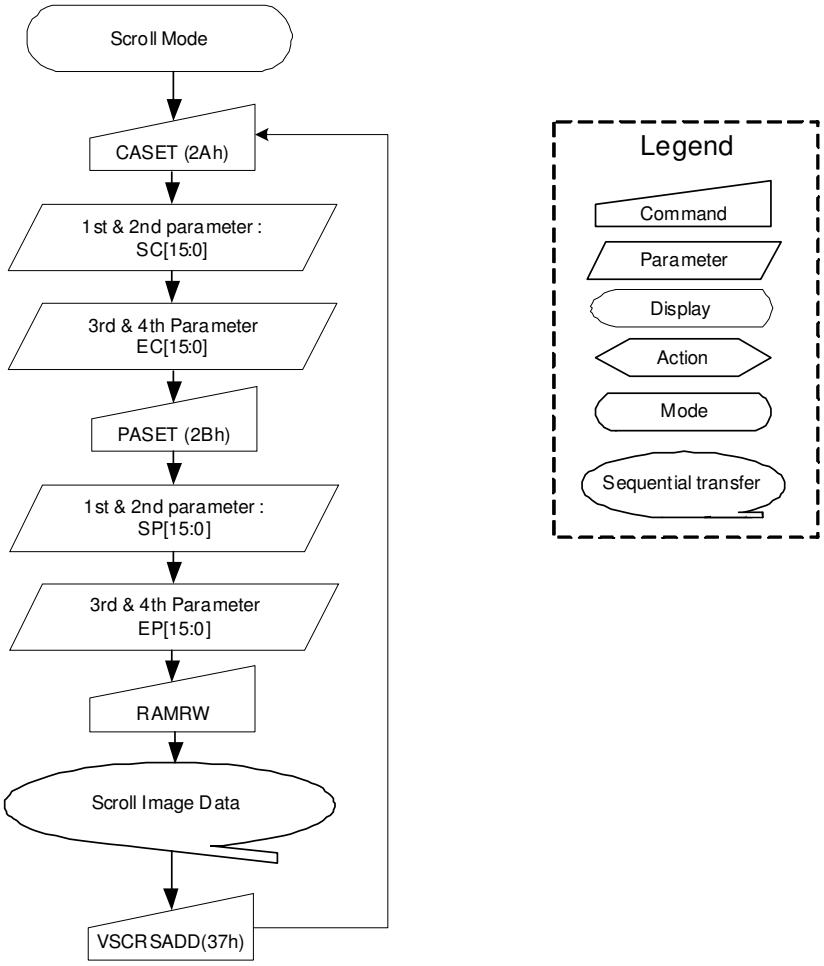
Flow Chart

1. To enter Vertical Scroll Mode :

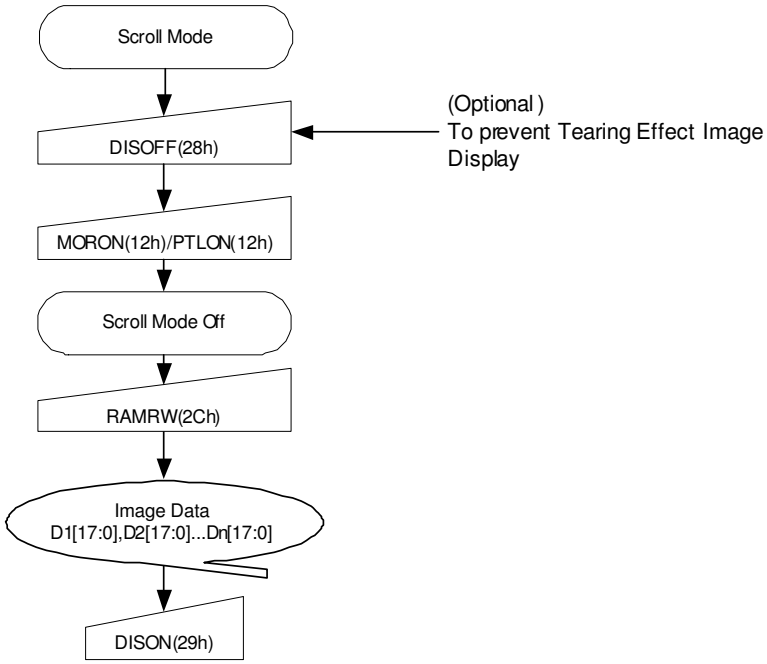


Note : The Frame Memory Window size ,must be defined correctly otherwise undesirable image will be displayed.

2. Continuous Scroll :



3.To Leave Vertical Scroll Mode:



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

8.2.27. Tearing Effect Line OFF (34h)

34h	TEOFF (Tearing Effect Line OFF)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	0	1	0	0	34h
Parameter	No Parameter												
Description	This command is used to turn OFF (Active Low) the Tearing Effect output signal from the TE signal line. X = Don't care.												
Restriction	This command has no effect when Tearing Effect output is already OFF.												

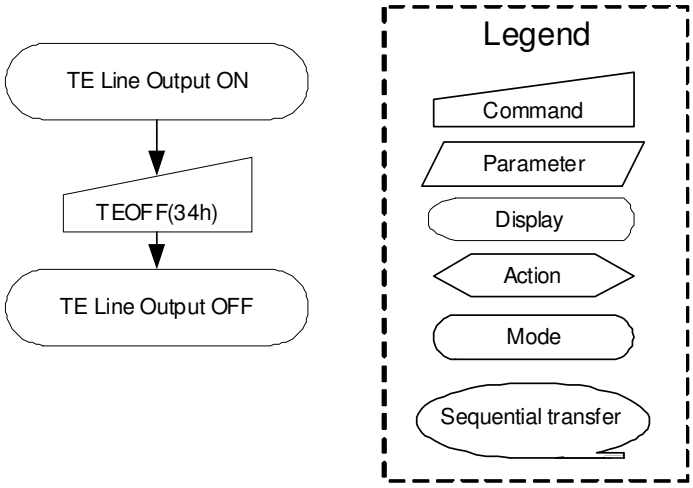
Register Availability

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	OFF
SW Reset	OFF
HW Reset	OFF

Flow Chart



8.2.28. Tearing Effect Line ON (35h)

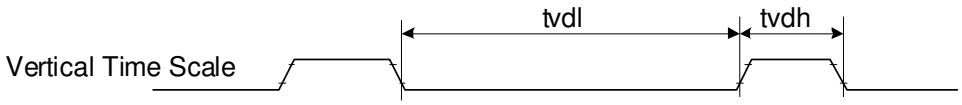
35h	TEON (Tearing Effect Line ON)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	0	1	0	1	35h
Parameter	1	1	↑	XX	0	0	0	0	0	0	0	M	00

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 B4. The Tearing Effect Line On has one parameter which describes the mode of the Tearing Effect Output Line.

When **M=0**:

The Tearing Effect Output line consists of V-Blanking information only:



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.

X = Don't care.

Restriction

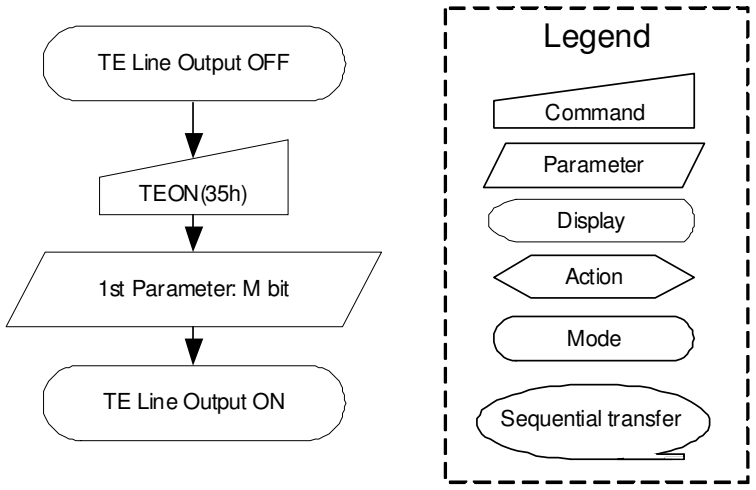
This command has no effect when Tearing Effect output is already ON

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	OFF
SW Reset	OFF
HW Reset	OFF

Flow Chart	

8.2.29. 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	↑	XX	0	0	1	1	0	1	1	0	36h
Parameter	1	1	↑	XX	MY	MX	MV	ML	BGR	MH	0	0	00

Description

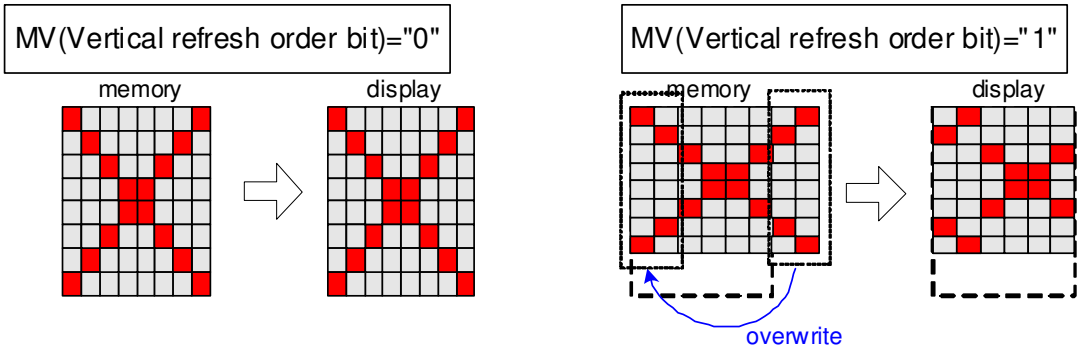
This command defines read/write scanning direction of frame memory.

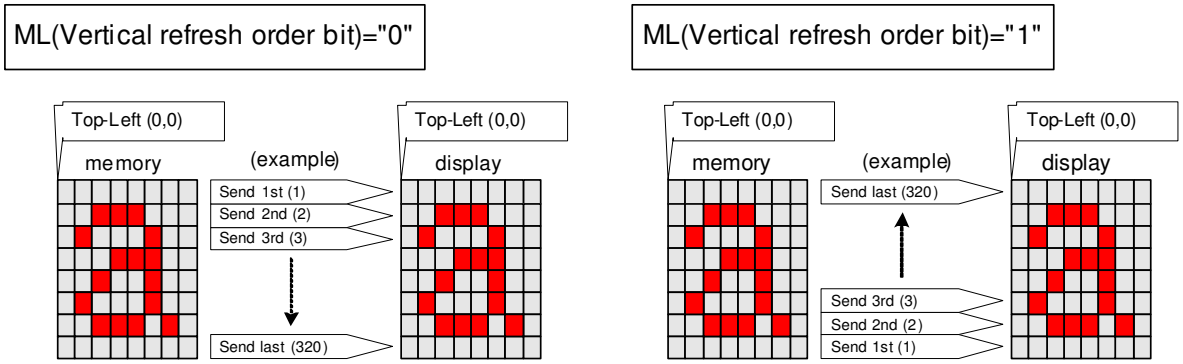
This command makes no change on the other driver status.

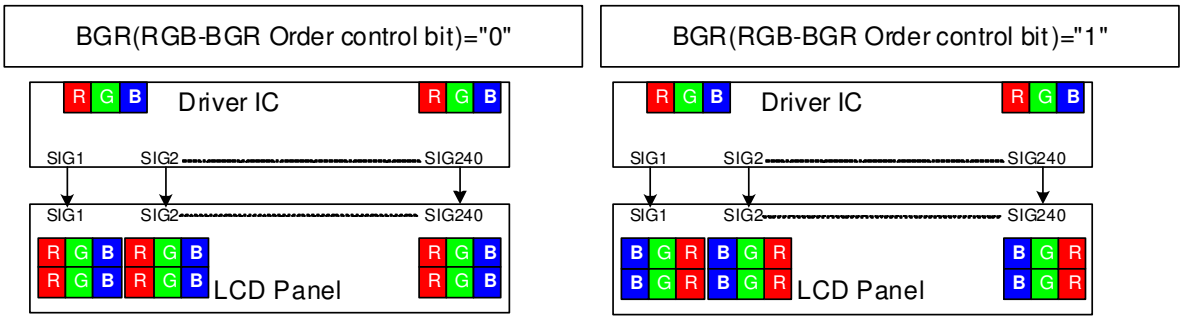
Bit	Name	Description
MY	Row Address Order	These 3 bits control MCU to memory write/read direction.
MX	Column Address Order	
MV	Row / Column Exchange	
ML	Vertical Refresh Order	LCD vertical refresh direction control.
BGR	RGB-BGR Order	Color selector switch control (0=RGB color filter panel, 1=BGR color filter panel)
MH	Horizontal Refresh ORDER	LCD horizontal refreshing direction control.

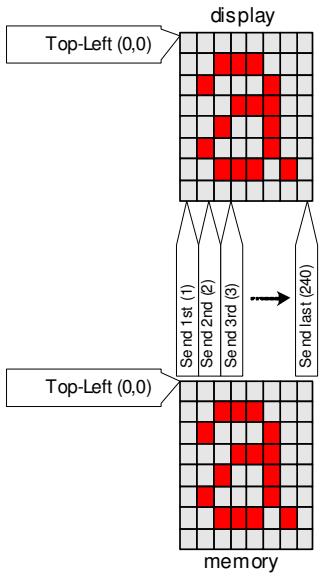
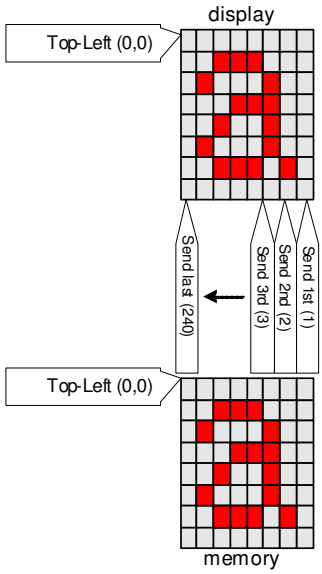
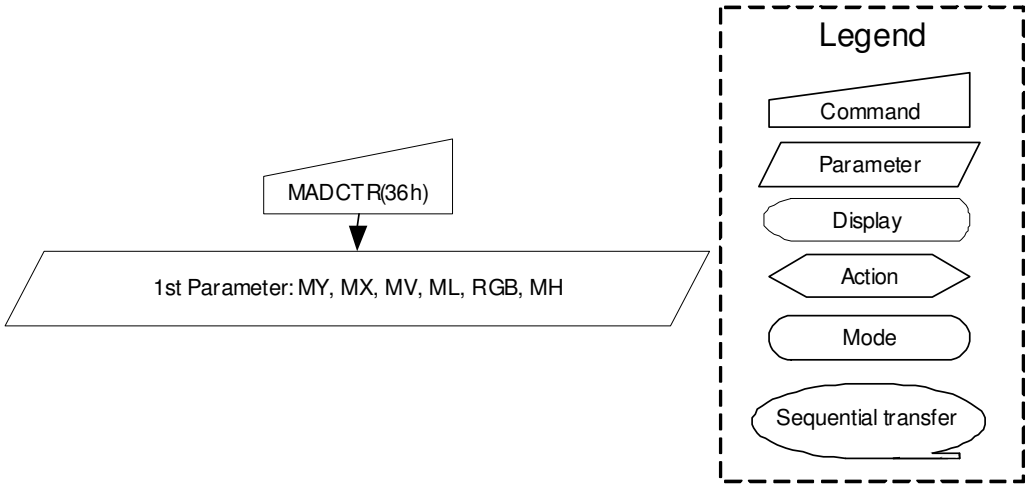
Note: When BGR bit is changed, the new setting is active immediately without update the content in Frame Memory again.

X = Don't care.







<table>
<tr><td></td><td>
<table>
<tr><td>MH(Horizontal refresh order control bit)="0"</td><td>MH(Horizontal refresh order control bit)="1"</td></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>
Note: Top-Left (0,0) means a physical memory location.
</td></tr>
<tr><td>Restriction</td><td></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>8’h00h</td></tr>
<tr><td>SW Reset</td><td>No change</td></tr>
<tr><td>HW Reset</td><td>8’h00h</td></tr>
</table>
</td></tr>
<tr><td>Flow Chart</td><td> 
</td></tr>
</table>

8.2.30. 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	↑	XX	0	0	1	1	0	1	1	1	37h
1st Parameter	1	↑	1	XX	VSP [15:8]								00
2nd Parameter	1	↑	1	XX	VSP [7:0]								00

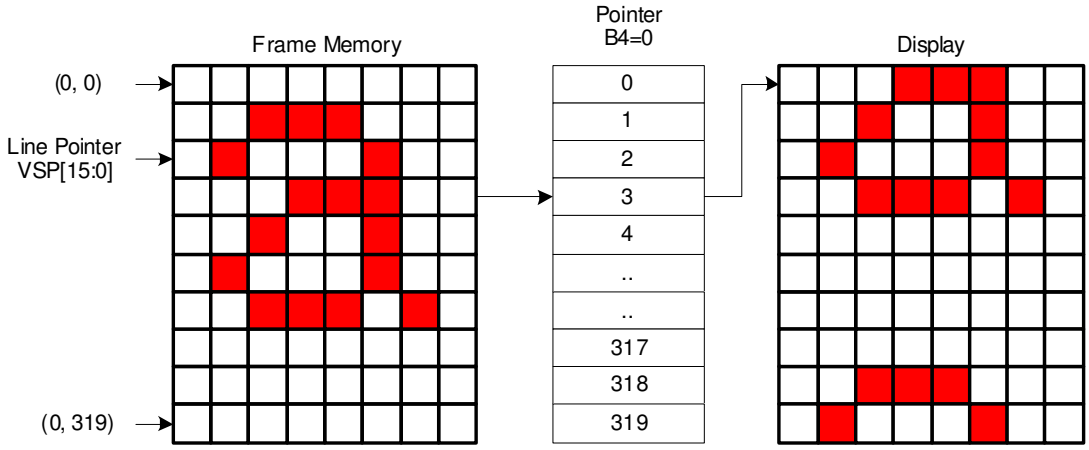
Description

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:-

When MADCTL B4=0

Example:

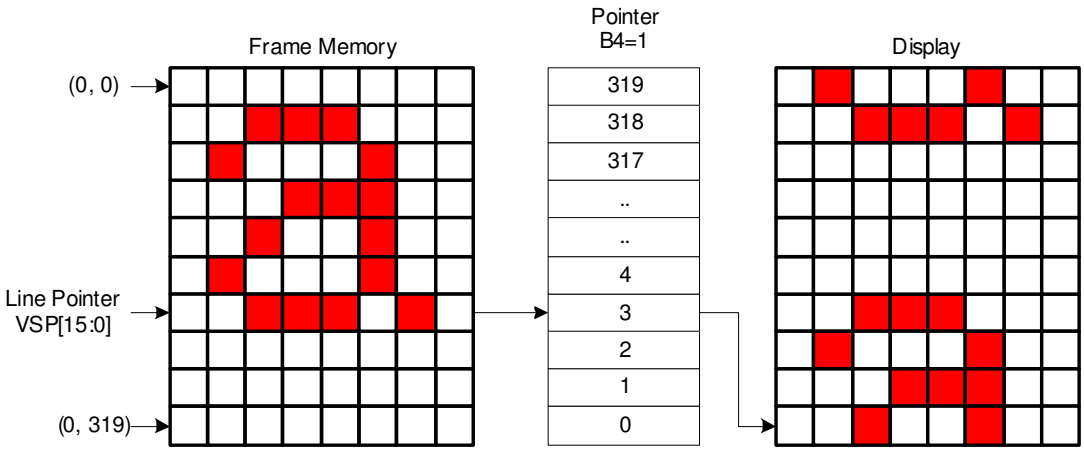
When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 320 and VSP='3'.



When MADCTL B4=1

Example:

When Top Fixed Area = Bottom Fixed Area = 00, Vertical Scrolling Area = 320 and VSP='3'.



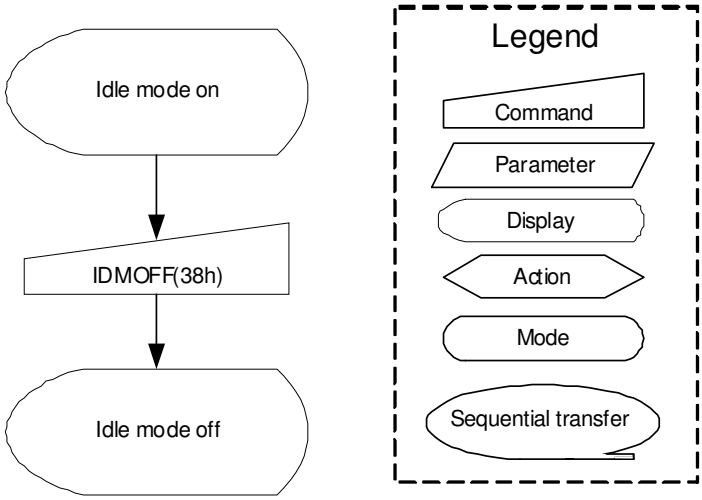
Note: (1) When new Pointer position and Picture Data are sent, the result on the display will happen at the next Panel Scan to avoid tearing effect. VSP refers to the Frame Memory line Pointer.

(2) This command is ignored when the ILI9341 enters Partial mode.

X = Don't care

<table>
<tr><td>Restriction</td><td></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>No</td></tr>
<tr><td>Partial Mode On, Idle Mode On, Sleep Out</td><td>No</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>Default Value</th></tr>
<tr><th>VSP [15:0]</th></tr>
<tr><td>Power On Sequence</td><td>16’h0000h</td></tr>
<tr><td>SW Reset</td><td>16’h0000h</td></tr>
<tr><td>HW Reset</td><td>16’h0000h</td></tr>
</table>
</td></tr>
<tr><td>Flow Chart</td><td>See Vertical Scrolling Definition (33h) description.</td></tr>
</table>

8.2.31. Idle Mode OFF (38h)

<table>
<tr><th>38h</th><th colspan="12">IDMOFF (Idle Mode 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>XX</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>38h</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 Idle mode on.
In the idle off mode, LCD can display maximum 262,144 colors.
X = Don’t care.</td></tr>
<tr><td>Restriction</td><td colspan="13">This command has no effect when module is already in idle off 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>Idle mode OFF</td></tr><tr><td>SW Reset</td><td>Idle mode OFF</td></tr><tr><td>HW Reset</td><td>Idle mode OFF</td></tr></table></td></tr>
<tr><td>Flow Chart</td><td colspan="13"> 
</td></tr>
</table>

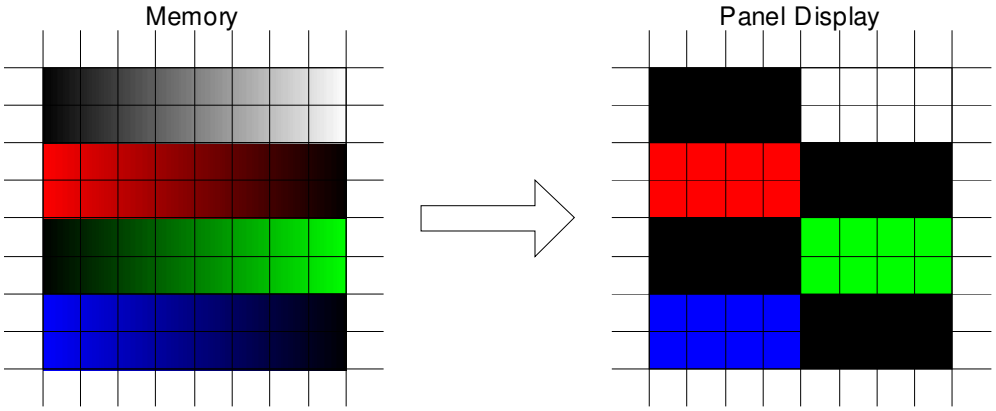
8.2.32. Idle Mode ON (39h)

39h	IDMON (Idle Mode ON)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	1	0	0	1	39h
Parameter	No Parameter												

Description

This command is used to enter into Idle mode on.

In the idle on mode, 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.



Memory Contents vs. Display Color			
	$R_5\ R_4\ R_3\ R_2\ R_1\ R_0$	$G_5\ G_4\ G_3\ G_2\ G_1\ G_0$	$B_5\ B_4\ B_3\ B_2\ B_1\ B_0$
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

X = Don't care.

Restriction

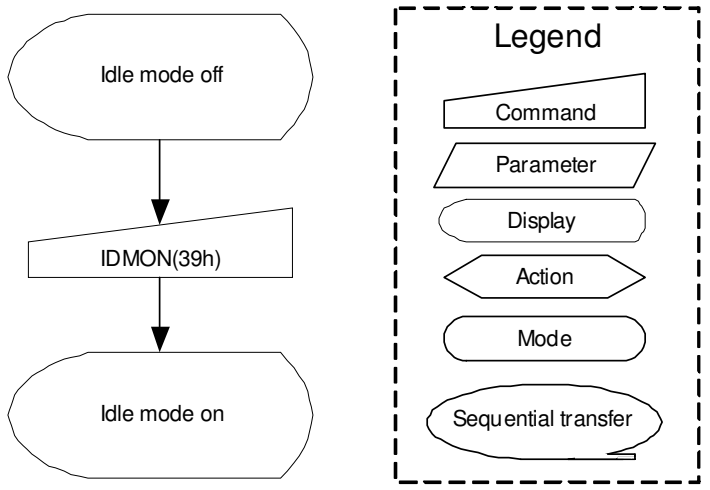
This command has no effect when module is already in idle off mode.

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	

8.2.33. COLMOD: Pixel Format Set (3Ah)

3Ah	PIXSET (Pixel Format Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	1	0	1	0	3Ah
Parameter	1	1	↑	XX	0	DPI [2:0]			0	DBI [2:0]			66

Description

This command sets the pixel format for the RGB image data used by the interface. DPI [2:0] is the pixel format select of RGB interface and DBI [2:0] is the pixel format of MCU interface. If a particular interface, either RGB interface or MCU interface, is not used then the corresponding bits in the parameter are ignored. The pixel format is shown in the table below.

DPI [2:0]			RGB Interface Format
0	0	0	Reserved
0	0	1	Reserved
0	1	0	Reserved
0	1	1	Reserved
1	0	0	Reserved
1	0	1	16 bits / pixel
1	1	0	18 bits / pixel
1	1	1	Reserved

DBI [2:0]			MCU Interface Format
0	0	0	Reserved
0	0	1	Reserved
0	1	0	Reserved
0	1	1	Reserved
1	0	0	Reserved
1	0	1	16 bits / pixel
1	1	0	18 bits / pixel
1	1	1	Reserved

If using RGB Interface must selection serial interface.

X = Don't care

Restriction

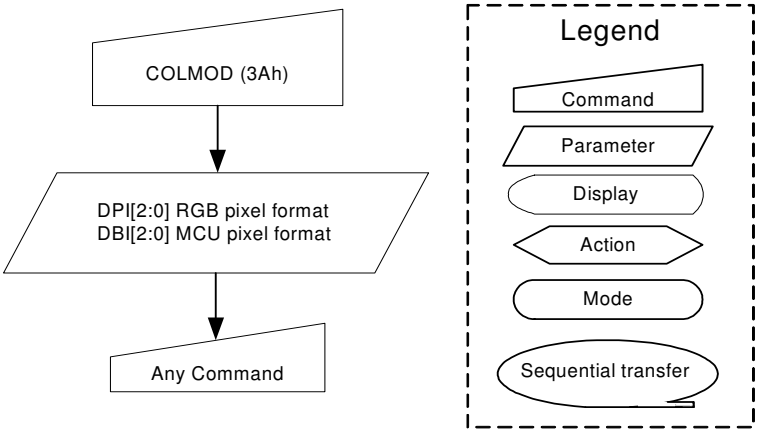
Register Availability

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	
	DPI [2:0]	DBI [2:0]
Power On Sequence	3'b110	3'b110
SW Reset	No Change	No Change
HW Reset	3'b110	3'b110

Flow Chart



8.2.34. Write_Memory_Continue (3Ch)

3Ch	Write_Memory_Continue												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	1	1	0	0	3Ch
1st Parameter	1	1	↑	D1 [17..8]	D1 [7]	D1 [6]	D1 [5]	D1 [4]	D1 [3]	D1 [2]	D1 [1]	D1 [0]	000 3FF
Xth Parameter	1	1	↑	Dx [17..8]	Dx [7]	Dx [6]	Dx [5]	Dx [4]	Dx [3]	Dx [2]	Dx [1]	Dx [0]	000 3FF
Nth Parameter	1	1	↑	Dn [17..8]	Dn [7]	Dn [6]	Dn [5]	Dn [4]	Dn [3]	Dn [2]	Dn [1]	Dn [0]	000 3FF
Description	This command transfers image data from the host processor to the display module's frame memory continuing from the pixel location following the previous write_memory_continue or write_memory_start command. **If set_address_mode B5 = 0:** Data is written continuing from the pixel location after the write range of the previous write_memory_start or write_memory_continue. The column register is then incremented and pixels are written to the frame memory until the column register equals the End Column (EC) value. The column register is then reset to SC and the page register is incremented. Pixels are written to the frame memory until the page register equals the End Page (EP) value and the column register equals the EC value, or the host processor sends another command. If the number of pixels exceeds (EC – SC + 1) * (EP – SP + 1) the extra pixels are ignored. **If set_address_mode B5 = 1:** Data is written continuing from the pixel location after the write range of the previous write_memory_start or write_memory_continue. The page register is then incremented and pixels are written to the frame memory until the page register equals the End Page (EP) value. The page register is then reset to SP and the column register is incremented. Pixels are written to the frame memory until the column register equals the End column (EC) value and the page register equals the EP value, or the host processor sends another command. If the number of pixels exceeds (EC – SC + 1) * (EP – SP + 1) the extra pixels are ignored. Sending any other command can stop frame Write. Frame Memory Access and Interface setting (B3h), WEMODE=0 When the transfer number of data exceeds (EC-SC+1)*(EP-SP+1), the exceeding data will be ignored. Frame Memory Access and Interface setting (B3h), WEMODE=1 When the transfer number of data exceeds (EC-SC+1)*(EP-SP+1), the column and page number will be reset, and the exceeding data will be written into the following column and page.												
Restriction	A write_memory_start should follow a set_column_address, set_page_address or set_address_mode to define the write address. Otherwise, data written with write_memory_continue is written to undefined addresses.												

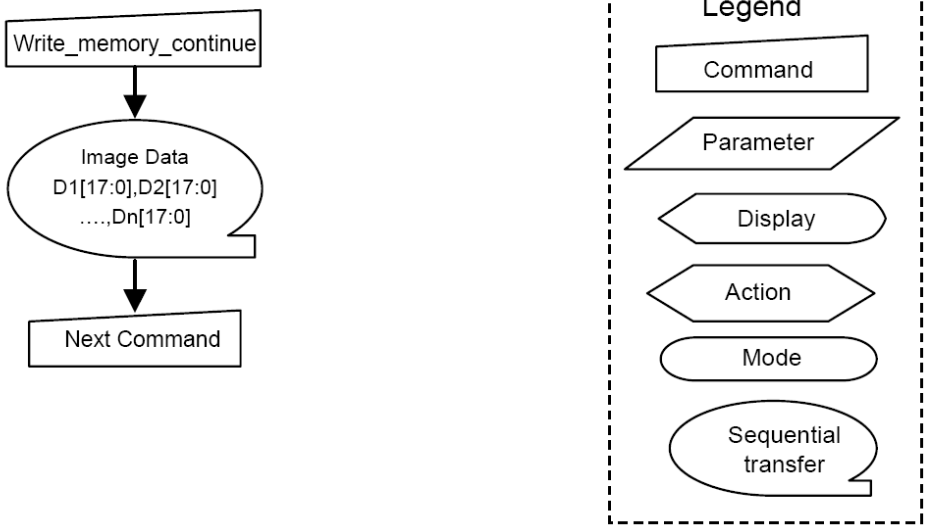
Register Availability

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	No

Default

Status	Default Value
Power On Sequence	Random value
SW Reset	No change
HW Reset	No change

Flow Chart



8.2.35. Read_Memory_Continue (3Eh)

3Eh	Read_Memory_Continue												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	0	1	1	1	1	1	0	3Eh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	D1 [17..8]	D1 [7]	D1 [6]	D1 [5]	D1 [4]	D1 [3]	D1 [2]	D1 [1]	D1 [0]	000 3FF
xst Parameter	1	↑	1	Dx [17..8]	Dx [7]	Dx [6]	Dx [5]	Dx [4]	Dx [3]	Dx [2]	Dx [1]	Dx [0]	000 3FF
Nst Parameter	1	↑	1	Dn [17..8]	Dn [7]	Dn [6]	Dn [5]	Dn [4]	Dn [3]	Dn [2]	Dn [1]	Dn [0]	000 3FF

Description

This command transfers image data from the display module's frame memory to the host processor continuing from the location following the previous read_memory_continue (3Eh) or read_memory_start (2Eh) command.

If set_address_mode B5 = 0:

Pixels are read continuing from the pixel location after the read range of the previous read_memory_start or read_memory_continue. The column register is then incremented and pixels are read from the frame memory until the column register equals the End Column (EC) value. The column register is then reset to SC and the page register is incremented. Pixels are read from the frame memory until the page register equals the End Page (EP) value and the column register equals the EC value, or the host processor sends another command.

If set_address_mode B5 = 1:

Pixels are read continuing from the pixel location after the read range of the previous read_memory_start or read_memory_continue. The page register is then incremented and pixels are read from the frame memory until the page register equals the End Page (EP) value. The page register is then reset to SP and the column register is incremented. Pixels are read from the frame memory until the column register equals the End Column (EC) value and the page register equals the EP value, or the host processor sends another command.

This command makes no change to the other driver status.

Restriction

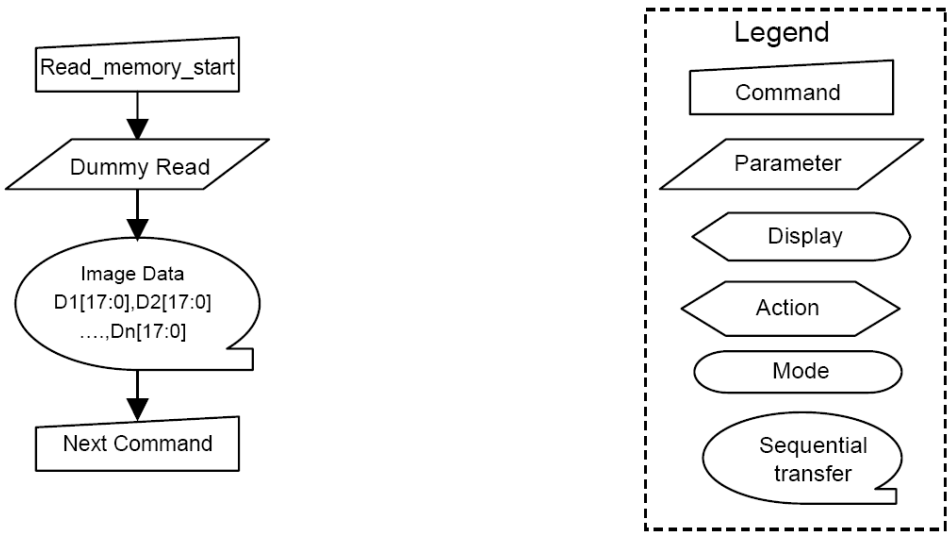
A read_memory_start should follow a set_column_address, set_page_address or set_address_mode to define the read location. Otherwise, data read with read_memory_continue is undefined.

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	Random data
SW Reset	No change
HW Reset	No change

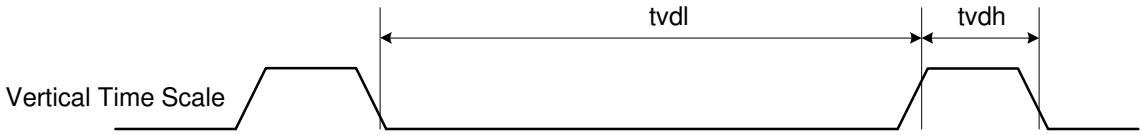
Flow Chart	

8.2.36. Set_Tear_Scanline (44h)

44h	Set_Tear_Scanline												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	0	0	1	0	0	44h
1st Parameter	1	1	↑	XX	0	0	0	0	0	0	0	STS [8]	00
2nd Parameter	1	1	↑	XX	STS [7]	STS [6]	STS [5]	STS [4]	STS [3]	STS [2]	STS [1]	STS [0]	00

Description

This command turns on the display Tearing Effect output signal on the TE signal line when the display reaches line STS. The TE signal is not affected by changing set_address_mode bit B4. The Tearing Effect Line On has one parameter that describes the Tearing Effect Output Line mode.



Note that set_tear_scanline with STS=0 is equivalent to set_tear_on with M=0.

The Tearing Effect Output line shall be active low when the display module is in Sleep mode.

Restriction

-

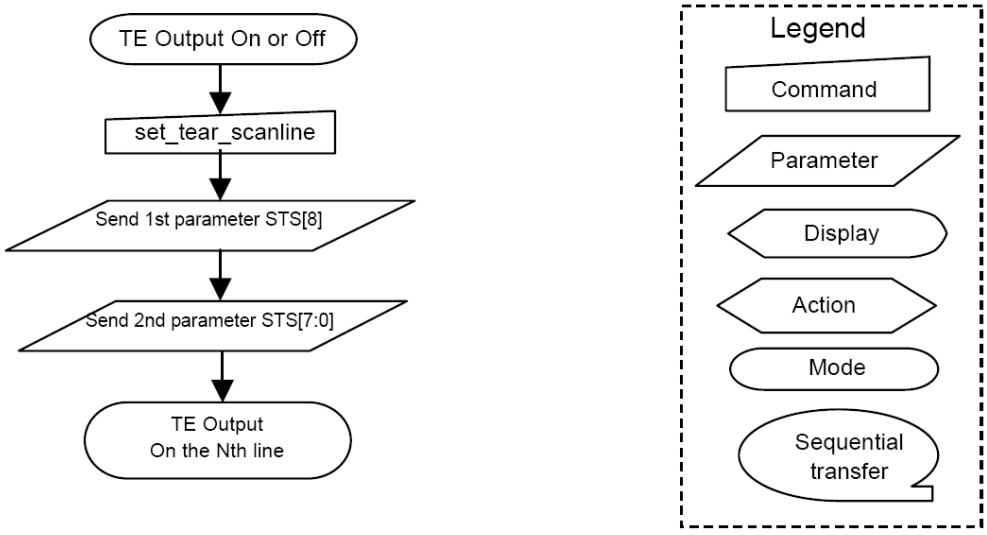
Register Availability

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	STS [8:0]=0000h
SW Reset	STS [8:0]=0000h
HW Reset	STS [8:0]=0000h

Flow Chart



8.2.37. Get_Scanline (45h)

45h	Get_Scanline												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	0	0	1	0	1	45h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	0	0	0	0	0	0	GTS [9]	GTS [8]	00
3rd Parameter	1	↑	1	XX	GTS [7]	GTS [6]	GTS [5]	GTS [4]	GTS [3]	GTS [2]	GTS [1]	GTS [0]	00

Description

The display returns the current scan line, GTS, used to update the display device. The total number of scan lines on a display device is defined as VSYNC + VBP + VACT + VFP. The first scan line is defined as the first line of V-Sync and is denoted as Line 0.

When in Sleep Mode, the value returned by get_scanline is undefined.

Restriction

None

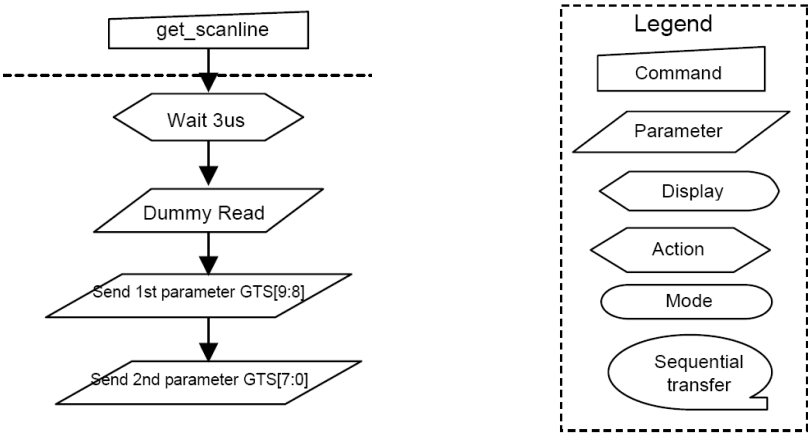
Register Availability

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
	GTS [9:0]
Power On Sequence	GTS [9:0]=0000h
SW Reset	GTS [9:0]=0000h
HW Reset	GTS [9:0]=0000h

Flow Chart



8.2.38. Write Display Brightness (51h)

51h	WRDISBV (Write Display Brightness)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	0	0	1	51h
Parameter	1	1	↑	XX	DBV[7]	DBV[6]	DBV[5]	DBV[4]	DBV[3]	DBV[2]	DBV[1]	DBV[0]	00
Description	This command is used to adjust the brightness value of the display. It should be checked what is the relationship between this written value and output brightness of the display. This relationship is defined on the display module specification. In principle relationship is that 00h value means the lowest brightness and FFh value means the highest brightness.												
Restriction	None												

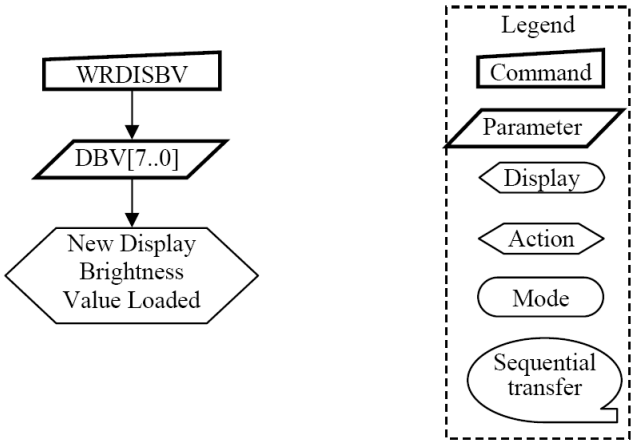
Register Availability

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
	DBV [7:0]
Power On Sequence	8'h00h
SW Reset	8'h00h
HW Reset	8'h00h

Flow Chart



8.2.39. Read Display Brightness (52h)

52h	RDDISBV (Read Display Brightness Value)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	0	1	0	52h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	DBV[7]	DBV[6]	DBV[5]	DBV[4]	DBV[3]	DBV[2]	DBV[1]	DBV[0]	00

Description

This command returns the brightness value of the display.

It should be checked what the relationship between this returned value and output brightness of the display. This relationship is defined on the display module specification.

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

Restriction

The display module is sending 2nd parameter value on the data lines if the MCU wants to read more than one parameter (= more than 2 RDX cycle) on DBI Mode.

Only 2nd parameter is sent on DSI (The 1st parameter is not sent).

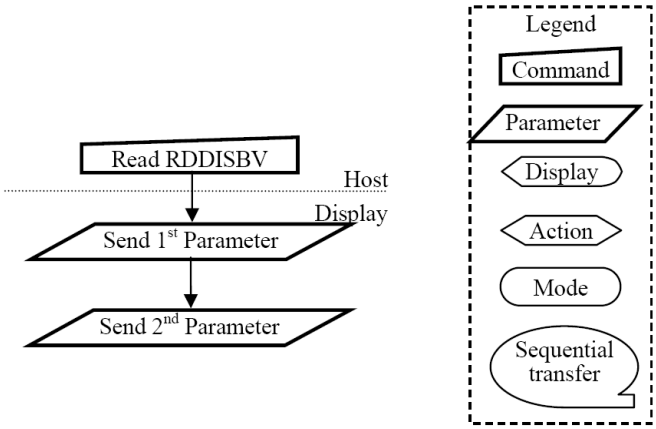
Register Availability

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
	DBV [7:0]
Power On Sequence	8'h00h
SW Reset	8'h00h
HW Reset	8'h00h

Flow Chart



8.2.40. Write CTRL Display (53h)

53h	WRCTRLD (Write Control Display)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	0	1	1	53h
Parameter	1	1	↑	XX	0	0	BCTRL	0	DD	BL	0	0	00

Description

This command is used to control display brightness.

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

0 = Off (Brightness registers are 00h, DBV[7..0])

1 = On (Brightness registers are active, according to the other parameters.)

DD: Display Dimming, only for manual brightness setting

DD = 0: Display Dimming is off

DD = 1: Display Dimming is on

BL: Backlight Control On/Off

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

1 = On

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

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

Restriction

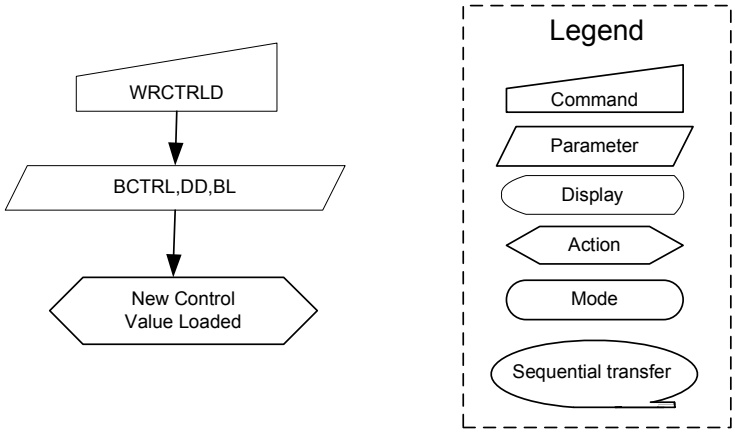
None

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		
	BCTRL	DD	BL
Power On Sequence	1'b0	1'b0	1'b0
SW Reset	1'b0	1'b0	1'b0
HW Reset	1'b0	1'b0	1'b0

Flow Chart	

8.2.41. Read CTRL Display (54h)

54h	RDCTRLD (Read Control Display)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	1	0	0	54h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
2nd Parameter	1	↑	1	XX	0	0	BCTRL	0	DD	BL	0	0	00

Description

This command is used to return brightness setting.

BCTRL: Brightness Control Block On/Off,

'0' = Off (Brightness registers are 00h)

'1' = On (Brightness registers are active, according to the DBV[7..0] parameters.)

DD: Display Dimming

'0' = Display Dimming is off

'1' = Display Dimming is on

BL: Backlight On/Off

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

'1' = On

Restriction

The display module is sending 2nd parameter value on the data lines if the MCU wants to read more than one parameter (= more than 2 RDX cycle) on DBI.

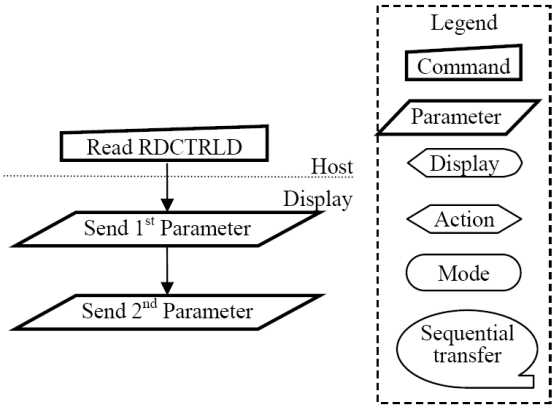
Only 2nd parameter is sent on DSI (The 1st parameter is not sent).

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		
	BCTRL	DD	BL
Power On Sequence	1'b0	1'b0	1'b0
SW Reset	1'b0	1'b0	1'b0
HW Reset	1'b0	1'b0	1'b0

Flow Chart	

8.2.42. Write Content Adaptive Brightness Control (55h)

55h	WRCABC (Write Content Adaptive Brightness Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	1	0	1	55h
Parameter	1	1	↑	XX	0	0	0	0	0	0	C [1]	C [0]	00

Description

This command is used to set parameters for image content based adaptive brightness control functionality.

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

C [1:0]	Default Value
2'b00	Off
2'b01	User Interface Image
2'b10	Still Picture
2'b11	Moving Image

Restriction

None

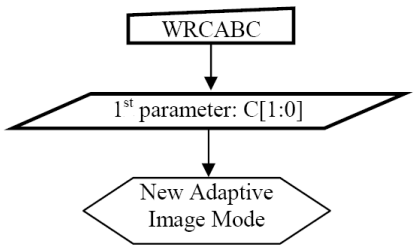
Register Availability

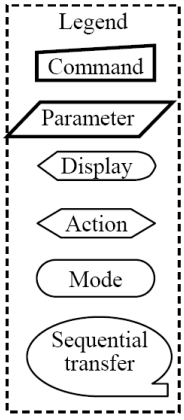
Status	Availability
Normal Mode On, Idle Mode Off, Sleep Out	Yes
Normal Mode On, Idle Mode On, Sleep Out	Yes
Partial Mode On, Idle Mode Off, Sleep Out	Yes
Partial Mode On, Idle Mode On, Sleep Out	Yes
Sleep In	Yes

Default

Status	Default Value
Power On Sequence	C [1:0]=00h
SW Reset	C [1:0]=00h
HW Reset	C [1:0]=00h

Flow Chart





8.2.43. Read Content Adaptive Brightness Control (56h)

56h	RDCABC (Read Content Adaptive Brightness Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	0	1	1	0	56h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
2nd Parameter	1	↑	1	XX	0	0	0	0	0	0	C [1]	C [0]	00

Description

This command is used to read the settings for image content based adaptive brightness control functionality.

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

C [1:0]	Default Value
2'b00	Off
2'b01	User Interface Image
2'b10	Still Picture
2'b11	Moving Image

Restriction

The display module is sending 2nd parameter value on the data lines if the MCU wants to read more than one parameter (= more than 2 RDX cycle) on DBI.

Only 2nd parameter is sent on DSI (The 1st parameter is not sent).

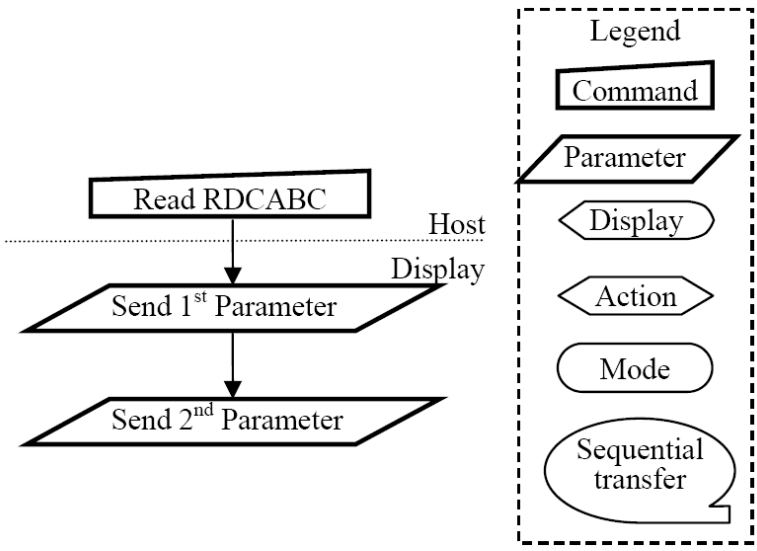
Register Availability

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	C [1:0]=00h
SW Reset	C [1:0]=00h
HW Reset	C [1:0]=00h

Flow Chart



8.2.44. Write CABC Minimum Brightness (5Eh)

5Eh	Backlight Control 1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	1	1	1	0	5Eh
Parameter	1	1	↑	XX	CMB [7]	CMB [6]	CMB [5]	CMB [4]	CMB [3]	CMB [2]	CMB [1]	CMB [0]	00
Description	This command is used to set the minimum brightness value of the display for CABC function. CMB[7:0]: CABC minimum brightness control, this parameter is used to avoid too much brightness reduction. When CABC is active, CABC cannot reduce the display brightness to less than CABC minimum brightness setting. Image processing function is worked as normal, even if the brightness cannot be changed. This function does not affect to the other function, manual brightness setting. Manual brightness can be set the display brightness to less than CABC minimum brightness. Smooth transition and dimming function can be worked as normal. When display brightness is turned off (BCTRL=0 of "Write CTRL Display (53h)"), CABC minimum brightness setting is ignored. In principle relationship is that 00h value means the lowest brightness for CABC and FFh value means the highest brightness for CABC.												
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
	CMB [7:0]
Power On Sequence	8'h00h
SW Reset	No Change
HW Reset	8'h00h

8.2.45. Read CABC Minimum Brightness (5Fh)

5Fh	Backlight Control 1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	0	1	0	1	1	1	1	1	5Fh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	CMB [7]	CMB [6]	CMB [5]	CMB [4]	CMB [3]	CMB [2]	CMB [1]	CMB [0]	00

Description

This command returns the minimum brightness value of CABC function.

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

CMB[7:0] is CABC minimum brightness specified with "Write CABC minimum brightness (5Eh)" command. In principle relationship is that 00h value means the lowest brightness for CABC and FFh value means the highest brightness for CABC.

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
	CMB [7:0]
Power On Sequence	8'h00h
SW Reset	No Change
HW Reset	8'h00h

8.2.46. 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	↑	XX	1	1	0	1	1	0	1	0	DAh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	ID1 [7:0]								XX
Description	This read byte identifies the LCD module's manufacturer ID and it is specified by User The 1st parameter is dummy data. The 2nd parameter is LCD module's manufacturer ID. X = Don't care												
Restriction													

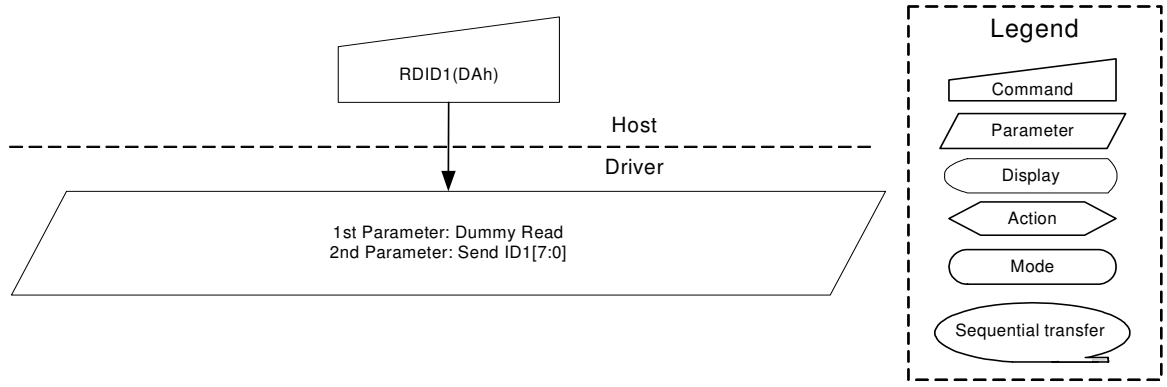
Register Availability

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 (Before MTP program)	Default Value (After MTP program)
Power On Sequence	8'h00h	MTP value
SW Reset	8'h00h	MTP value
HW Reset	8'h00h	MTP value

Flow Chart



8.2.47. 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	↑	XX	1	1	0	1	1	0	1	1	DBh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2ndParameter	1	↑	1	XX	1	ID2 [6:0]							XX
Description	This read byte is used to track the LCD module/driver version. It is defined by display supplier (with User's agreement) and changes each time a revision is made to the display, material or construction specifications. The 1st parameter is dummy data. The 2nd parameter is LCD module/driver version ID and the ID parameter range is from 80h to FFh. The ID2 can be programmed by MTP function. X = Don't care												
Restriction													

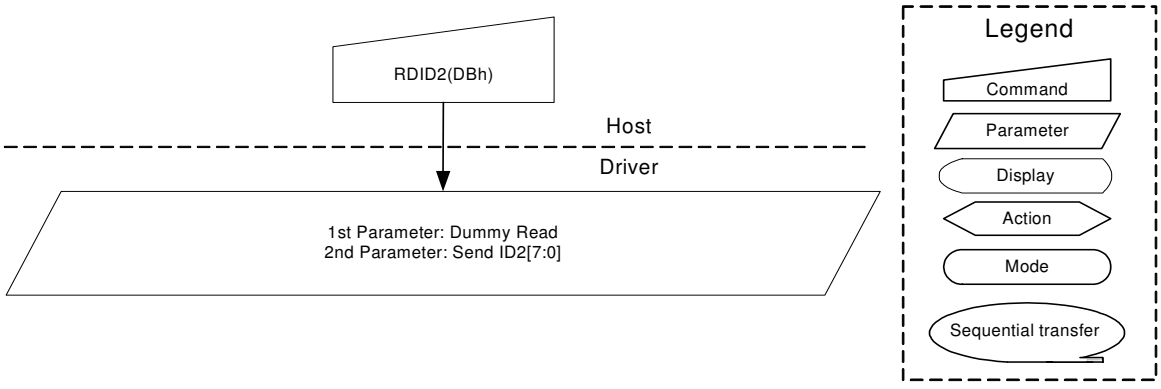
Register Availability

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 (Before MTP program)	Default Value (After MTP program)
Power On Sequence	8'h80h	MTP value
SW Reset	8'h80h	MTP value
HW Reset	8'h80h	MTP value

Flow Chart



8.2.48. 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	↑	XX	1	1	0	1	1	1	0	0	DCh
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	ID3 [7:0]								XX
Description	This read byte identifies the LCD module/driver and It is specified by User. The 1st parameter is dummy data. The 2nd parameter is LCD module/driver ID. The ID3 can be programmed by MTP function. X = Don't care												
Restriction													

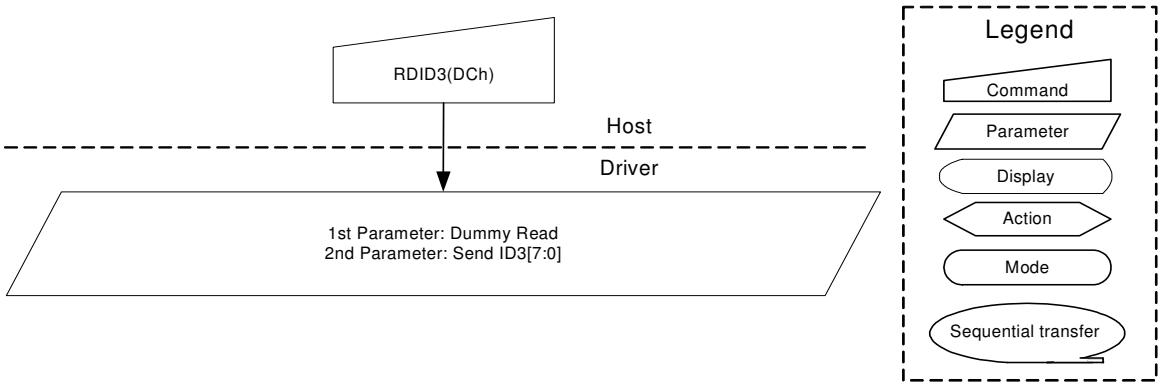
Register Availability

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 (Before MTP program)	Default Value (After MTP program)
Power On Sequence	8'h00h	MTP value
SW Reset	8'h00h	MTP value
HW Reset	8'h00h	MTP value

Flow Chart



8.3. Description of Level 2 Command

8.3.1. RGB Interface Signal Control (B0h)

B0h	IFMODE (Interface Mode Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	0	0	0	B0h
Parameter	1	1	↑	XX	ByPass_MODE	RCM [1]	RCM [0]	0	VSPL	HSPL	DPL	EPL	40

Description

Sets the operation status of the display interface. The setting becomes effective as soon as the command is received.

EPL: DE polarity ("0"= High enable for RGB interface, "1"= Low enable for RGB interface)

DPL: DOTCLK polarity set ("0"= data fetched at the rising time, "1"= data fetched at the falling time)

HSPL: HSYNC polarity ("0"= Low level sync clock, "1"= High level sync clock)

VSPL: VSYNC polarity ("0"= Low level sync clock, "1"= High level sync clock)

RCM [1:0]: RGB interface selection (refer to the RGB interface section).

ByPass_MODE: Select display data path whether Memory or Direct to Shift register when RGB Interface is used.

ByPass_MODE	Display Data Path
0	Direct to Shift Register (**default**)
1	Memory

Restriction

EXTC should be high to enable this command

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					
	ByPass_MODE	RCM [1:0]	VSPL	HSPL	DPL	EPL
Power ON Sequence	1'b0	2'b10	1'b0	1'b0	1'b0	1'b1
SW Reset	1'b0	2'b10	1'b0	1'b0	1'b0	1'b1
HW Reset	1'b0	2'b10	1'b0	1'b0	1'b0	1'b1

8.3.2. Frame Rate Control (In Normal Mode/Full Colors) (B1h)

B1h	FRMCTR1 (Frame Rate Control (In Normal Mode / Full colors))												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	0	0	1	B1h
1st Parameter	1	1	↑	XX	0	0	0	0	0	0	DIVA [1:0]		00
2nd Parameter	1	1	↑	XX	0	0	0	RTNA [4:0]					1B

Description

Formula to calculate frame frequency:

$$\text{Frame Rate} = \frac{\text{fosc}}{\text{Clocks per line x Division ratio x (Lines + VBP + VFP)}}$$

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

fosc : internal oscillator frequency

Clocks per line : RTNA setting

Division ratio : DIVA setting

Lines : total driving line number

VBP : back porch line number

VFP : front porch line number

RTNA [4:0]					Frame Rate (Hz)
1	0	0	0	0	119
1	0	0	0	1	112
1	0	0	1	0	106
1	0	0	1	1	100
1	0	1	0	0	95
1	0	1	0	1	90
1	0	1	1	0	86
1	0	1	1	1	83

RTNA [4:0]					Frame Rate (Hz)
1	1	0	0	0	79
1	1	0	0	1	76
1	1	0	1	0	73
1	1	0	1	1	70(default)
1	1	1	0	0	68
1	1	1	0	1	65
1	1	1	0	1	63
1	1	1	1	1	61

DIVA [1:0] : division ratio for internal clocks when Normal mode.

DIVA [1:0]		Division Ratio
0	0	fosc
0	1	fosc / 2
1	0	fosc / 4
1	1	fosc / 8

RTNA [4:0] : RTNA[4:0] is used to set 1H (line) period of Normal mode at MCU interface.

RTNA [4:0]					Clock per Line
0	0	0	0	0	Setting prohibited
0	0	0	0	1	Setting prohibited
0	0	0	1	0	Setting prohibited
0	0	0	1	1	Setting prohibited
0	0	1	0	0	Setting prohibited
0	0	1	0	1	Setting prohibited
0	0	1	1	0	Setting prohibited
0	0	1	1	1	Setting prohibited
0	1	0	0	0	Setting prohibited
0	1	0	0	1	Setting prohibited
0	1	0	1	0	Setting prohibited

RTNA [4:0]					Clock per Line
0	1	0	1	1	Setting prohibited
0	1	1	0	0	Setting prohibited
0	1	1	0	1	Setting prohibited
0	1	1	1	0	Setting prohibited
0	1	1	1	1	Setting prohibited
1	0	0	0	0	16 clocks
1	0	0	0	1	17 clocks
1	0	0	1	0	18 clocks
1	0	0	1	1	19 clocks
1	0	1	0	0	20 clocks
1	0	1	0	1	21 clocks

RTNA [4:0]					Clock per Line
1	0	1	1	0	22 clocks
1	0	1	1	1	23 clocks
1	1	0	0	0	24 clocks
1	1	0	0	1	25 clocks
1	1	0	1	0	26 clocks
1	1	0	1	1	27 clocks
1	1	1	0	0	28 clocks
1	1	1	0	1	29 clocks
1	1	1	1	0	30 clocks
1	1	1	1	1	31 clocks

<table>
<tr><td>Restriction</td><td>EXTC should be high to enable this command</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="2">Default Value</th></tr>
<tr><th>DIVA [1:0]</th><th>RTNA [4:0]</th></tr>
<tr><td>Power ON Sequence</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>SW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>HW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
</table>
</td></tr>
</table>

8.3.3. Frame Rate Control (In Idle Mode/8 colors) (B2h)

B2h	FRMCTR2 (Frame Rate Control (In Idle Mode / 8l colors))												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	0	1	0	B2h
1st Parameter	1	1	↑	XX	0	0	0	0	0	0	DIVB [1:0]		00
2nd Parameter	1	1	↑	XX	0	0	0	RTNB [4:0]					1B

Description

Formula to calculate frame frequency

$$\text{Frame Rate} = \frac{\text{fosc}}{\text{Clocks per line x Division ratio x (Lines + VBP + VFP)}}$$

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

fosc : internal oscillator frequency

Clocks per line : RTNB setting

Division ratio : DIVB setting

Lines : total driving line number

VBP : back porch line number

VFP : front porch line number

RTNB [4:0]					Frame Rate (Hz)
1	0	0	0	0	119
1	0	0	0	1	112
1	0	0	1	0	106
1	0	0	1	1	100
1	0	1	0	0	95
1	0	1	0	1	90
1	0	1	1	0	86
1	0	1	1	1	83

RTNB [4:0]					Frame Rate (Hz)
1	1	0	0	0	79
1	1	0	0	1	76
1	1	0	1	0	73
1	1	0	1	1	70(default)
1	1	1	0	0	68
1	1	1	0	1	65
1	1	1	0	1	63
1	1	1	1	1	61

DIVB [1:0]: division ratio for internal clocks when Idle mode.

DIVB [1:0]		Division Ratio
0	0	fosc
0	1	fosc / 2
1	0	fosc / 4
1	1	fosc / 8

RTNB [4:0]: RTNB[4:0] is used to set 1H (line) period of Idle mode at MCU interface.

RTNB [4:0]					Clock per Line
0	0	0	0	0	Setting prohibited
0	0	0	0	1	Setting prohibited
0	0	0	1	0	Setting prohibited
0	0	0	1	1	Setting prohibited
0	0	1	0	0	Setting prohibited
0	0	1	0	1	Setting prohibited
0	0	1	1	0	Setting prohibited
0	0	1	1	1	Setting prohibited
0	1	0	0	0	Setting prohibited
0	1	0	0	1	Setting prohibited
0	1	0	1	0	Setting prohibited

RTNB [4:0]					Clock per Line
0	1	0	1	1	Setting prohibited
0	1	1	0	0	Setting prohibited
0	1	1	0	1	Setting prohibited
0	1	1	1	0	Setting prohibited
0	1	1	1	1	Setting prohibited
1	0	0	0	0	16 clocks
1	0	0	0	1	17 clocks
1	0	0	1	0	18 clocks
1	0	0	1	1	19 clocks
1	0	1	0	0	20 clocks
1	0	1	0	1	21 clocks

RTNB [4:0]					Clock per Line
1	0	1	1	0	22 clocks
1	0	1	1	1	23 clocks
1	1	0	0	0	24 clocks
1	1	0	0	1	25 clocks
1	1	0	1	0	26 clocks
1	1	0	1	1	27 clocks
1	1	1	0	0	28 clocks
1	1	1	0	1	29 clocks
1	1	1	1	0	30 clocks
1	1	1	1	1	31 clocks

<table>
<tr><td>Restriction</td><td>EXTC should be high to enable this command</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="2">Default Value</th></tr>
<tr><th>DIVB [1:0]</th><th>RTNB [4:0]</th></tr>
<tr><td>Power ON Sequence</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>SW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>HW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
</table>
</td></tr>
</table>

8.3.4. Frame Rate control (In Partial Mode/Full Colors) (B3h)

B3h	FRMCTR3 (Frame Rate Control (In Partial Mode / Full colors))												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	0	1	1	B3h
1st Parameter	1	1	↑	XX	0	0	0	0	0	0	DIVC [1:0]		00
2ndParameter	1	1	↑	XX	0	0	0	RTNC [4:0]					1B

Description

Formula to calculate frame frequency:

$$\text{Frame Rate} = \frac{\text{fosc}}{\text{Clocks per line x Division ratio x (Lines + VBP + VFP)}}$$

Sets the division ratio for internal clocks of Partial mode (Idle mode off) at MCU interface.

fosc : internal oscillator frequency

Clocks per line : RTNC setting

Division ratio : DIVC setting

Lines : total driving line number

VBP : back porch line number

VFP : front porch line number

RTNC [4:0]					Frame Rate (Hz)
1	0	0	0	0	119
1	0	0	0	1	112
1	0	0	1	0	106
1	0	0	1	1	100
1	0	1	0	0	95
1	0	1	0	1	90
1	0	1	1	0	86
1	0	1	1	1	83

RTNC [4:0]					Frame Rate (Hz)
1	1	0	0	0	79
1	1	0	0	1	76
1	1	0	1	0	73
1	1	0	1	1	70(default)
1	1	1	0	0	68
1	1	1	0	1	65
1	1	1	0	1	63
1	1	1	1	1	61

DIVC [1:0]: division ratio for internal clocks when Partial mode.

DIVC [1:0]		Division Ratio
0	0	fosc
0	1	fosc / 2
1	0	fosc / 4
1	1	fosc / 8

RTNC [4:0]: RTNC [4:0] is used to set 1H (line) period of Partial mode at MCU interface.

RTNC [4:0]					Clock per Line
0	0	0	0	0	Setting prohibited
0	0	0	0	1	Setting prohibited
0	0	0	1	0	Setting prohibited
0	0	0	1	1	Setting prohibited
0	0	1	0	0	Setting prohibited
0	0	1	0	1	Setting prohibited
0	0	1	1	0	Setting prohibited
0	0	1	1	1	Setting prohibited
0	1	0	0	0	Setting prohibited
0	1	0	0	1	Setting prohibited
0	1	0	1	0	Setting prohibited

RTNC [4:0]					Clock per Line
0	1	0	1	1	Setting prohibited
0	1	1	0	0	Setting prohibited
0	1	1	0	1	Setting prohibited
0	1	1	1	0	Setting prohibited
0	1	1	1	1	Setting prohibited
1	0	0	0	0	16 clocks
1	0	0	0	1	17 clocks
1	0	0	1	0	18 clocks
1	0	0	1	1	19 clocks
1	0	1	0	0	20 clocks
1	0	1	0	1	21 clocks

RTNC [4:0]					Clock per Line
1	0	1	1	0	22 clocks
1	0	1	1	1	23 clocks
1	1	0	0	0	24 clocks
1	1	0	0	1	25 clocks
1	1	0	1	0	26 clocks
1	1	0	1	1	27 clocks
1	1	1	0	0	28 clocks
1	1	1	0	1	29 clocks
1	1	1	1	0	30 clocks
1	1	1	1	1	31 clocks

<table>
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<tr><th>Status</th><th>Availability</th></tr>
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<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="2">Default Value</th></tr>
<tr><th>DIVC [1:0]</th><th>RTNC [4:0]</th></tr>
<tr><td>Power ON Sequence</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>SW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
<tr><td>HW Reset</td><td>2’b00</td><td>5’h1Bh</td></tr>
</table>
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</table>

8.3.5. Display Inversion Control (B4h)

<table>
<tr><th>B4h</th><th colspan="12">INVTR (Display Inversion Control)</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>XX</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>B4h</td></tr>
<tr><td>1st Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>NLA</td><td>NLB</td><td>NLC</td><td>02</td></tr>
<tr><td>Description</td><td colspan="13">Display inversion mode set
NLA: Inversion setting in full colors normal mode (Normal mode on)
NLB: Inversion setting in Idle mode (Idle mode on)
NLC: Inversion setting in full colors partial mode (Partial mode on / Idle mode off)
<table><tr><th>NLA / NLB / NLC</th><th>Inversion</th></tr><tr><td>0</td><td>Line inversion</td></tr><tr><td>1</td><td>Frame inversion</td></tr></table></td></tr>
<tr><td>Restriction</td><td colspan="13">EXTC should be high to enable this command</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 rowspan="2">Status</th><th colspan="3">Default Value</th></tr><tr><th>NLA</th><th>NLB</th><th>NLC</th></tr><tr><td>Power ON Sequence</td><td>1’b0</td><td>1’b1</td><td>1’b0</td></tr><tr><td>SW Reset</td><td>1’b0</td><td>1’b1</td><td>1’b0</td></tr><tr><td>H/W Reset</td><td>1’b0</td><td>1’b1</td><td>1’b0</td></tr></table></td></tr>
</table>

8.3.6. Blanking Porch Control (B5h)

B5h	PRCTR (Blanking Porch)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	1	0	1	B5h
1st Parameter	1	1	↑	XX	0	VFP [6:0]							02
2nd Parameter	1	1	↑	XX	0	VBP [6:0]							02
3rd Parameter	1	1	↑	XX	0	0	0	HFP [4:0]					0A
4th Parameter	1	1	↑	XX	0	0	0	HBP [4:0]					14

Description

VFP [6:0] / **VBP [6:0]:** The VFP [6:0] and VBP [6:0] bits specify the line number of vertical front and back porch period respectively.

VFP [6:0] VBP [6:0]	Number of HSYNC of front/back porch	VFP [6:0] VBP [6:0]	Number of HSYNC of front/back porch
0000000	Setting inhibited	1000000	64
0000001	Setting inhibited	1000001	65
0000010	2	1000010	66
0000011	3	1000011	67
0000100	4	1000100	68
0000101	5	1000101	69
0000110	6	1000110	70
0000111	7	1000111	71
0001000	8	1001000	72
0001001	9	1001001	73
0001010	10	1001010	74
0001011	11	1001011	75
0001100	12	1001100	76
0001101	13	1001101	77
: :	: :	: :	: :
0111101	61	1111101	125
0111110	62	1111110	126
0111111	63	1111111	127

Note: VFP + VBP ≦ 254 HSYNC signals

HFP [4:0] / **HBP [4:0]:** The HFP [4:0] and HBP [4:0] bits specify the line number of horizontal front and back porch period respectively.

HFP [4:0] HBP [4:0]	Number of DOTCLK of the front/back porch	HFP [4:0] HBP [4:0]	Number of DOTCLK of front/back porch
00000	Setting prohibited	10000	16
00001	Setting prohibited	10001	17
00010	2	10010	18
00011	3	10011	19
00100	4	10100	20
00101	5	10101	21
00110	6	10110	22
00111	7	10111	23
01000	8	11000	24
01001	9	11001	25
01010	10	11010	26
01011	11	11011	27
01100	12	11100	28
01101	13	11101	29
01110	14	11110	30
01111	15	11111	31

<table>
<tr><td>Restriction</td><td>EXTC should be high to enable this command</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="4">Default Value</th></tr>
<tr><th>VFP [6:0]</th><th>VBP [6:0]</th><th>HFP [4:0]</th><th>HBP [4:0]</th></tr>
<tr><td>Power ON Sequence</td><td>7’h02h</td><td>7’h02h</td><td>5’h0Ah</td><td>5’h14h</td></tr>
<tr><td>SW Reset</td><td>7’h02h</td><td>7’h02h</td><td>5’h0Ah</td><td>5’h14h</td></tr>
<tr><td>HW Reset</td><td>7’h02h</td><td>7’h02h</td><td>5’h0Ah</td><td>5’h14h</td></tr>
</table>
</td></tr>
</table>

8.3.7. Display Function Control (B6h)

B6h	DISCTRL (Display Function Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	1	1	0	B6h
1st Parameter	1	1	↑	XX	0	0	0	0	PTG [1:0]		PT [1:0]		0A
2nd Parameter	1	1	↑	XX	REV	GS	SS	SM	ISC [3:0]				82
3rd Parameter	1	1	↑	XX	0	0	NL [5:0]						27
4th Parameter	1	1	↑	XX	0	0	PCDIV [5:0]						XX

Description

PTG [1:0]: Set the scan mode in non-display area.

PTG1	PTG0	Gate outputs in non-display area	Source outputs in non-display area	VCOM output
0	0	Normal scan	Set with the PT [2:0] bits	VCOMH/VCOML
0	1	Setting prohibited	---	---
1	0	Interval scan	Set with the PT [2:0] bits	
1	1	Setting prohibited	---	---

PT [1:0]: Determine source/VCOM output in a non-display area in the partial display mode.

PT [1:0]		Source output on non-display area		VCOM output on non-display area	
		Positive polarity	Negative polarity	Positive polarity	Negative polarity
0	0	V63	V0	VCOML	VCOMH
0	1	V0	V63	VCOML	VCOMH
1	0	AGND	AGND	AGND	AGND
1	1	Hi-Z	Hi-Z	AGND	AGND

SS: Select the shift direction of outputs from the source driver.

SS	Source Output Scan Direction
0	S1 → S720
1	S720 → S1

In addition to the shift direction, the settings for both SS and BGR bits are required to change the assignment of R, G, and B dots to the source driver pins.

To assign R, G, B dots to the source driver pins from S1 to S720, set SS = 0.

To assign R, G, B dots to the source driver pins from S720 to S1, set SS = 1.

REV: Select whether the liquid crystal type is normally white type or normally black type.

REV	Liquid crystal type
0	Normally black
1	Normally white

ISC [3:0]: Specify the scan cycle interval of gate driver in non-display area when PTG [1:0] ="10" to select interval scan.

Then scan cycle is set as odd number from 0~29 frame periods. The polarity is inverted every scan cycle.

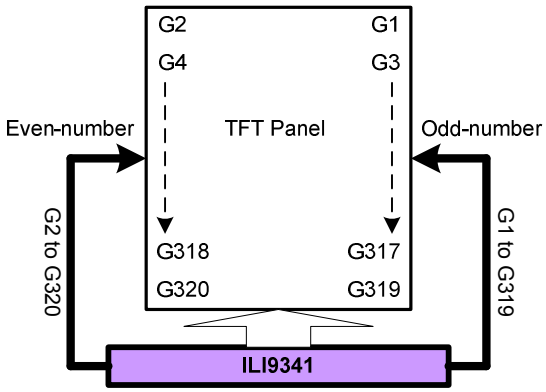
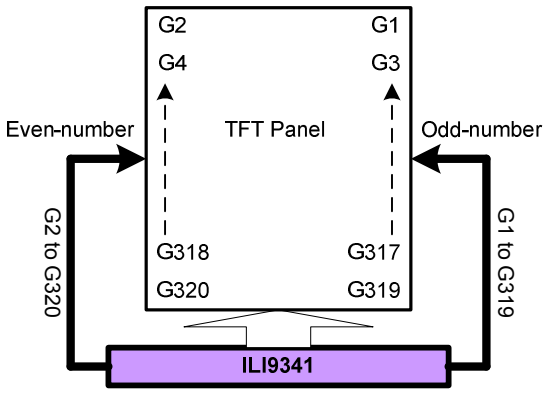
ISC [3:0]	Scan Cycle	f_{FLM} = 60Hz
0000	1 frame	17ms
0001	3 frames	51ms
0010	5 frames	85ms
0011	7 frames	119ms
0100	9 frames	153ms
0101	11 frames	187ms
0110	13 frames	221ms
0111	15 frames	255ms

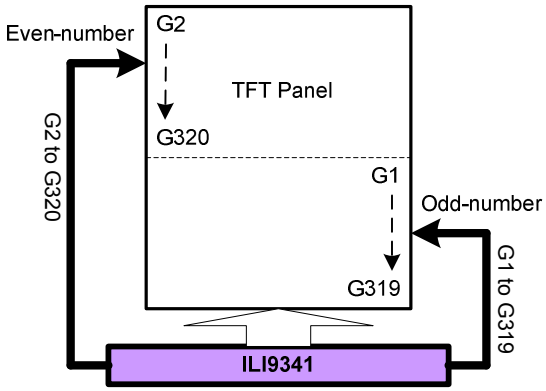
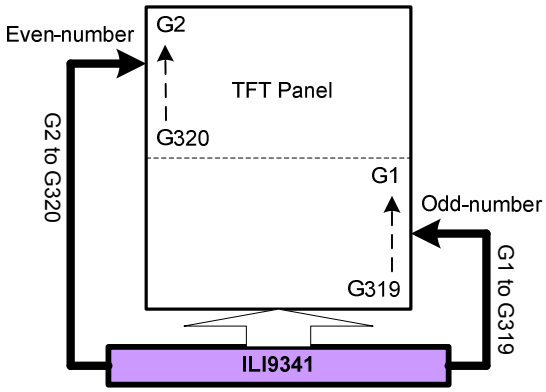
1000	17 frames	289ms
1001	19 frames	323ms
1010	21 frames	357ms
1011	23 frames	391ms
1100	25 frames	425ms
1101	27 frames	459ms
1110	29 frames	493ms
1111	31 frames	527ms

GS: Sets the direction of scan by the gate driver in the range determined by SCN [4:0] and NL [4:0]. The scan direction determined by GS = 0 can be reversed by setting GS = 1.

GS	Gate Output Scan Direction
0	G1 → G320
1	G320 → G1

SM: Sets the gate driver pin arrangement in combination with the GS bit to select the optimal scan mode for the module.

SM	GS	Scan Direction	Gate Output Sequence
0	0		G1→G2→G3→G4→ …… ….→G317→G318→G319→G320
0	1		G320→G319->G318→G317→…… …. →G4→G3→G2→G1

1	0		G1→G3→…….→G317→G319→ G2→G4→…….→G318→G320
1	1		G320→G318→…….→G4→G2→ G319→G317→…….→G3→G1

NL [5:0]: Sets the number of lines to drive the LCD at an interval of 8 lines. The GRAM address mapping is not affected by the number of lines set by NL [5:0]. The number of lines must be the same or more than the number of lines necessary for the size of the liquid crystal panel.

NL [5:0]						LCD Drive Line
0	0	0	0	0	0	Setting prohibited
0	0	0	0	0	1	16 lines
0	0	0	0	1	0	24 lines
0	0	0	0	1	1	32 lines
0	0	0	1	0	0	40 lines
0	0	0	1	0	1	48 lines
0	0	0	1	1	0	56 lines
0	0	0	1	1	1	64 lines
0	0	1	0	0	0	72 lines
0	0	1	0	0	1	80 lines
0	0	1	0	1	0	88 lines
0	0	1	0	1	1	96 lines
0	0	1	1	0	0	104 lines
0	0	1	1	0	1	112 lines
0	0	1	1	1	0	120 lines
0	0	1	1	1	1	128 lines
0	1	0	0	0	0	136 lines
0	1	0	0	0	1	144 lines
0	1	0	0	1	0	152 lines
0	1	0	0	1	1	160 lines
0	1	0	1	0	0	168 lines

NL [5:0]						LCD Driver Line
0	1	0	1	0	1	176 lines
0	1	0	1	1	0	184 lines
0	1	0	1	1	1	192 lines
0	1	1	0	0	0	200 lines
0	1	1	0	0	1	208 lines
0	1	1	0	1	0	216 lines
0	1	1	0	1	1	224 lines
0	1	1	1	0	0	232 lines
0	1	1	1	0	1	240 lines
0	1	1	1	1	0	248 lines
0	1	1	1	1	1	256 lines
1	0	0	0	0	0	264 lines
1	0	0	0	0	1	272 lines
1	0	0	0	1	0	280 lines
1	0	0	0	1	1	288 lines
1	0	0	1	0	0	296 lines
1	0	0	1	0	1	304 lines
1	0	0	1	1	0	312 lines
1	0	0	1	1	1	320 lines
Others						Setting inhibited

PCDIV [5:0]:

external fosc= $\frac{DOTCLK}{2\times(PCDIV+1)}$

Restriction: EXTC should be high to enable this command

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							
	PTG [1:0]	PT [1:0]	REV	GS	SS	SM	ISC [3:0]	NL [5:0]
Power ON Sequence	2'b10	2'b10	1'b1	1'b0	1'b0	1'b0	4'b0010	6'h27h
SW Reset	2'b10	2'b10	1'b1	1'b0	1'b0	1'b0	4'b0010	6'h27h
HW Reset	2'b10	2'b10	1'b1	1'b0	1'b0	1'b0	4'b0010	6'h27h

8.3.8. Entry Mode Set (B7h)

B7h	ETMOD (Entry Mode Set)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	0	1	1	1	B7h
Parameter	1	1	↑	XX	0	0	0	0	DSTB	GON	DTE	GAS	06

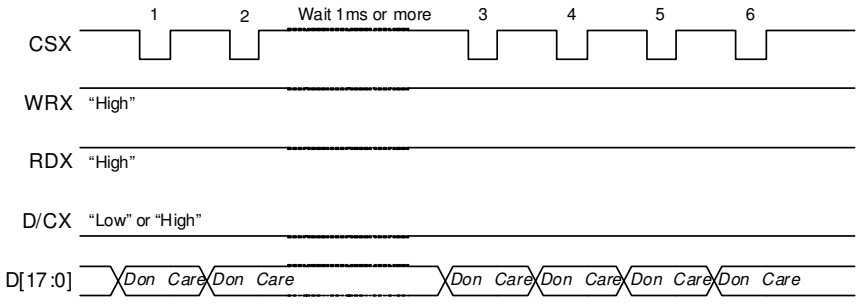
Description

DSTB: The ILI9341 driver enters the Deep Standby Mode when DSTB is set to high ("1"). In Deep Standby mode, both internal logic power and SRAM power are turn off, the display data stored in the Frame Memory and the instructions are not saved. Rewrite Frame Memory content and instructions after the Deep Standby Mode is exited.

Note: ILI9341 provides two ways to exit the Deep Standby Mode:

(1) Exit Deep Standby Mode by pull down CSX to low ("0") 6 times.

(2) Input a RESX pulse with effective low level duration to start up the inside logic regulator and makes a transition to the initial state.



GAS: Low voltage detection control.

GAS	Low voltage detection
0	Enable
1	Disable

GON/DTE: Set the output level of gate driver G1 ~ G320 as follows

GON	DTE	G1~G320 Gate Output
0	0	VGH
0	1	VGH
1	0	VGL
1	1	Normal display

Restriction: EXTC should be high to enable this command

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			
	DSTB	GON	DTE	GAS
Power ON Sequence	1'b0	1'b1	1'b1	1'b0
SW Reset	1'b0	1'b1	1'b1	1'b0
HW Reset	1'b0	1'b1	1'b1	1'b0

8.3.9. Backlight Control 1 (B8h)

B8h	Backlight Control 1												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	0	0	0	B8h
Parameter		1	↑	XX	0	0	0	0	TH_UI [3]	TH_UI [2]	TH_UI [1]	TH_UI [0]	0C

Description

TH_UI [3:0]: These bits are used to set the percentage of grayscale data accumulate histogram value in the user interface (UI) mode. This ratio of maximum number of pixels that makes display image white (=data "255") to the total of pixels by image processing.

TH_UI [3:0]	Description
4'0h	99%
4'1h	98%
4'2h	96%
4'3h	94%
4'4h	92%
4'5h	90%
4'6h	88%
4'7h	86%

TH_UI [3:0]	Description
4'8h	84%
4'9h	82%
4'Ah	80%
4'Bh	78%
4'Ch	76%
4'Dh	74%
4'Eh	72%
4'Fh	70%

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
	TH_UI [3:0]
Power On Sequence	4'b0110
SW Reset	No change
HW Reset	4'b0110

8.3.10. Backlight Control 2 (B9h)

B9h	Backlight Control 2												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	0	0	1	B9h
Parameter	1	1	↑	XX	TH_MV [3]	TH_MV [2]	TH_MV [1]	TH_MV [0]	TH_ST [3]	TH_ST [2]	TH_ST [1]	TH_ST [0]	CC

Description

TH_ST [3:0]: These bits are used to set the percentage of grayscale data accumulate histogram value in the still picture mode. This ratio of maximum number of pixels that makes display image white (=data “255”) to the total of pixels by image processing.

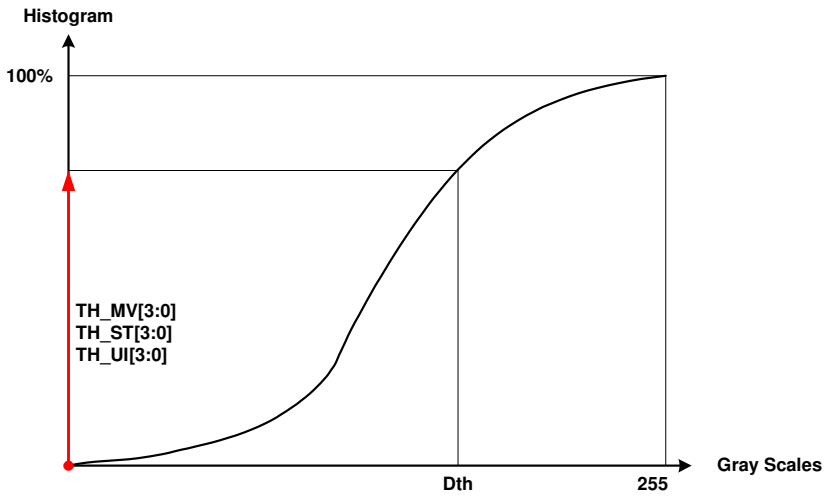
TH_ST [3:0]	Description
4’0h	99%
4’1h	98%
4’2h	96%
4’3h	94%
4’4h	92%
4’5h	90%
4’6h	88%
4’7h	86%

TH_ST [3:0]	Description
4’8h	84%
4’9h	82%
4’Ah	80%
4’Bh	78%
4’Ch	76%
4’Dh	74%
4’Eh	72%
4’Fh	70%

TH_MV [3:0]: These bits are used to set the percentage of grayscale data accumulate histogram value in the moving image mode. This ratio of maximum number of pixels that makes display image white (=data “255”) to the total of pixels by image processing.

TH_MV [3:0]	Description
4’0h	99%
4’1h	98%
4’2h	96%
4’3h	94%
4’4h	92%
4’5h	90%
4’6h	88%
4’7h	86%

TH_MV [3:0]	Description
4’8h	84%
4’9h	82%
4’Ah	80%
4’Bh	78%
4’Ch	76%
4’Dh	74%
4’Eh	72%
4’Fh	70%



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	
	TH_MV [3:0]	TH_ST [3:0]
Power On Sequence	4'b1100	4'b1100
SW Reset	No change	No change
HW Reset	4'b1100	4'b1100

8.3.11. Backlight Control 3 (BAh)

BAh	Backlight Control 3												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	0	1	0	BAh
Parameter	1	1	↑	XX	0	0	0	0	DTH_UI [3]	DTH_UI [2]	DTH_UI [1]	DTH_UI [0]	04

Description

DTH_UI [3:0]: This parameter is used set the minimum limitation of grayscale threshold value in User Icon (UI) image mode. This register setting will limit the minimum Dth value to prevent the display image from being too white and the display quality is not acceptable.

DTH_UI [3:0]	Description
4'0h	252
4'1h	248
4'2h	244
4'3h	240
4'4h	236
4'5h	232
4'6h	228
4'7h	224

DTH_UI [3:0]	Description
4'8h	220
4'9h	216
4'Ah	212
4'Bh	208
4'Ch	204
4'Dh	200
4'Eh	196
4'Fh	192

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
	DTH_UI [3:0]
Power On Sequence	4'b0100
SW Reset	No change
HW Reset	4'b0100

8.3.12. Backlight Control 4 (BBh)

BBh	Backlight Control 4												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	0	1	1	BBh
Parameter	1	1	↑	XX	DTH_MV [3]	DTH_MV [2]	DTH_MV [1]	DTH_MV [0]	DTH_ST [3]	DTH_ST [2]	DTH_ST [1]	DTH_ST [0]	65

Description

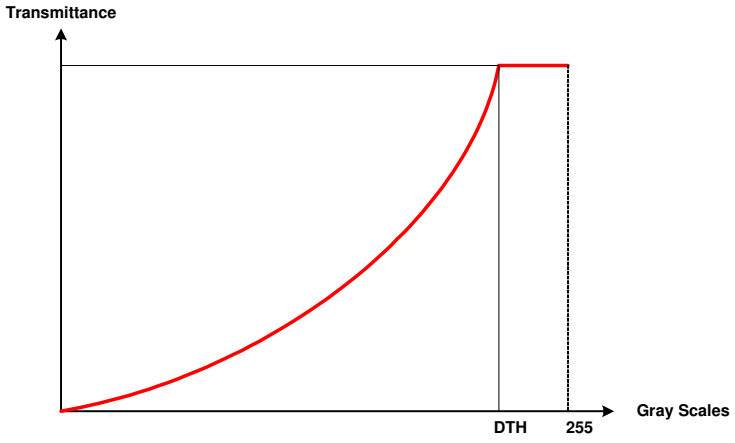
DTH_ST [3:0]/DTH_MV [3:0]: This parameter is used set the minimum limitation of grayscale threshold value. This register setting will limit the minimum Dth value to prevent the display image from being too white and the display quality is not acceptable.

DTH_ST [3:0]	Description
4'0h	224
4'1h	220
4'2h	216
4'3h	212
4'4h	208
4'5h	204
4'6h	200
4'7h	196

DTH_ST [3:0]	Description
4'8h	192
4'9h	188
4'Ah	184
4'Bh	180
4'Ch	176
4'Dh	172
4'Eh	168
4'Fh	164

DTH_MV [3:0]	Description
4'0h	224
4'1h	220
4'2h	216
4'3h	212
4'4h	208
4'5h	204
4'6h	200
4'7h	196

DTH_MV [3:0]	Description
4'8h	192
4'9h	188
4'Ah	184
4'Bh	180
4'Ch	176
4'Dh	172
4'Eh	168
4'Fh	164



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	
	DTH_MV [3:0]	DTH_ST [3:0]
Power On Sequence	4'b0110	4'b0101
SW Reset	No change	No change
HW Reset	4'b0110	4'b0101

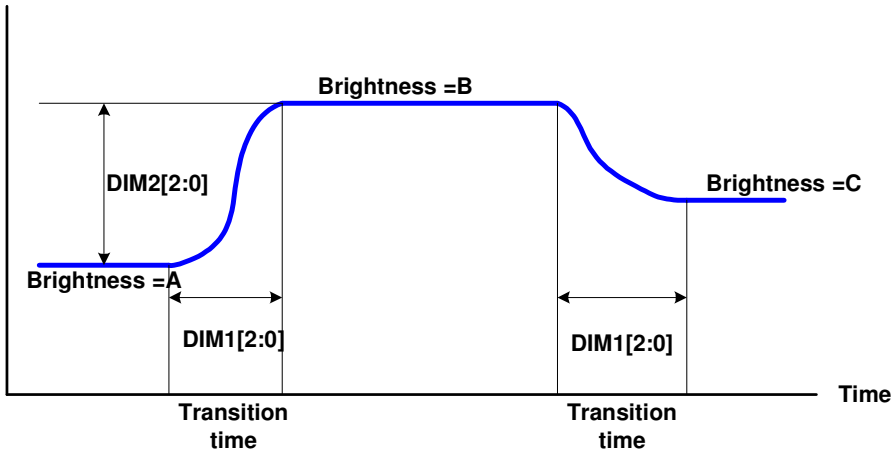
8.3.13. Backlight Control 5 (BCh)

BCh	Backlight Control 5												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	1	0	0	BCh
Parameter	1	1	↑	XX	DIM2 [3]	DIM2 [2]	DIM2 [1]	DIM2 [0]	0	DIM1 [2]	DIM1 [1]	DIM1 [0]	44

Description

DIM1 [2:0]: This parameter is used to set the transition time of brightness level to avoid the sharp brightness transition on vision.

DIM1 [2:0]	Description
3'0h	1 frame
3'1h	1 frame
3'2h	2 frames
3'3h	4 frames
3'4h	8 frames
3'5h	16 frames
3'6h	32 frames
3'7h	64 frames



DIM2 [3:0]: This parameter is used to set the threshold of brightness change.

When the brightness transition difference is smaller than DIM2 [3:0], the brightness transition will be ignored.

For example:

If | brightness B – brightness A| < DIM2 [2:0], the brightness transition will be ignored and keep the brightness A.

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	
	DIM2 [3:0]	DIM1 [2:0]
Power On Sequence	4'b0100	4'b0100
SW Reset	No change	No change
HW Reset	4'b0100	4'b0100

8.3.14. Backlight Control 7 (BEh)

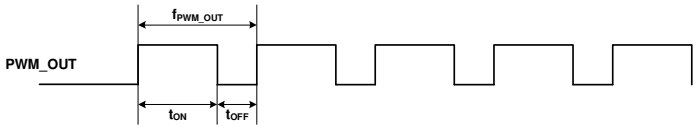
BEh	Backlight Control 7												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	1	1	0	BEh
Parameter	1	1	↑	XX	PWM_ DIV[7]	PWM_ DIV[6]	PWM_ DIV[5]	PWM_ DIV[4]	PWM_ DIV[3]	PWM_ DIV[2]	PWM_ DIV[1]	PWM_ DIV[0]	0F

Description

PWM_DIV [7:0]: PWM_OUT output frequency control. This command is used to adjust the PWM waveform frequency of PWM_OUT. The PWM frequency can be calculated by using the following equation.

$$f_{PWM\_OUT} = \frac{16MHz}{(PWM\_DIV[7:0]+1)\times 255}$$

PWM_DIV [7:0]	f_{PWM_OUT}
8'h0	62.74 KHz
8'h1	31.38 KHz
8'h2	20.915KHz
8'h3	15.686KHz
8'h4	12.549 KHz
…	…
8'hFB	249Hz
8'hFC	248Hz
8'hFD	247Hz
8'hFE	246Hz
8'hFF	245Hz



Note: The output frequency tolerance of internal frequency divider in CABC is ±10%

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	PWM_DIV [7:0]=0Fh
SW Reset	No change
HW Reset	PWM_DIV [7:0]=0Fh

8.3.15. Backlight Control 8 (BFh)

BFh	Backlight Control 2												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	0	1	1	1	1	1	1	BFh
Parameter	1	1	↑	XX	0	0	0	0	0	LEDONR	LEDONPOL	LEDPWMPOL	00

Description

LEDPWMPOL: The bit is used to define polarity of LEDPWM signal.

BL	LEDPWMPOL	LEDPWM pin
0	0	0
0	1	1
1	0	Original polarity of PWM signal
1	1	Inversed polarity of PWM signal

LEDONPOL: This bit is used to control LEDON pin.

BL	LEDONPOL	LEDON pin
0	0	0
0	1	1
1	0	LEDONR
1	1	Inversed LEDONR

LEDONR: This bit is used to control LEDON pin.

LEDONR	Description
0	Low
1	High

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		
	LEDONR	LEDONPOL	LEDPWMPOL
Power On Sequence	1'b0	1'b0	1'b0
SW Reset	No change	No change	No change
HW Reset	1'b0	1'b0	1'b0

8.3.16. Power Control 1 (C0h)

C0h	PWCTRL 1 (Power Control 1)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	0	0	0	0	0	C0h
1st Parameter	1	1	↑	XX	0	0	VRH [5:0]						21

Description

VRH [5:0]: Set the GVDD level, which is a reference level for the VCOM level and the grayscale voltage level.

VRH [5:0]						GVDD
0	0	0	0	0	0	Setting prohibited
0	0	0	0	0	1	Setting prohibited
0	0	0	0	1	0	Setting prohibited
0	0	0	0	1	1	3.00 V
0	0	0	1	0	0	3.05 V
0	0	0	1	0	1	3.10 V
0	0	0	1	1	0	3.15 V
0	0	0	1	1	1	3.20 V
0	0	1	0	0	0	3.25 V
0	0	1	0	0	1	3.30 V
0	0	1	0	1	0	3.35 V
0	0	1	0	1	1	3.40 V
0	0	1	1	0	0	3.45 V
0	0	1	1	0	1	3.50 V
0	0	1	1	1	0	3.55 V
0	0	1	1	1	1	3.60 V
0	1	0	0	0	0	3.65 V
0	1	0	0	0	1	3.70 V
0	1	0	0	1	0	3.75 V
0	1	0	0	1	1	3.80 V
0	1	0	1	0	0	3.85 V
0	1	0	1	0	1	3.90 V
0	1	0	1	1	0	3.95 V
0	1	0	1	1	1	4.00 V
0	1	1	0	0	0	4.05 V
0	1	1	0	0	1	4.10 V
0	1	1	0	1	0	4.15 V
0	1	1	0	1	1	4.20 V
0	1	1	1	0	0	4.25 V
0	1	1	1	0	1	4.30 V
0	1	1	1	1	0	4.35 V
0	1	1	1	1	1	4.40 V

VRH [5:0]						GVDD
1	0	0	0	0	0	4.45 V
1	0	0	0	0	1	4.50 V
1	0	0	0	1	0	4.55 V
1	0	0	0	1	1	4.60 V
1	0	0	1	0	0	4.65 V
1	0	0	1	0	1	4.70 V
1	0	0	1	1	0	4.75 V
1	0	0	1	1	1	4.80 V
1	0	1	0	0	0	4.85 V
1	0	1	0	0	1	4.90 V
1	0	1	0	1	0	4.95 V
1	0	1	0	1	1	5.00 V
1	0	1	1	0	0	5.05 V
1	0	1	1	0	1	5.10 V
1	0	1	1	1	0	5.15 V
1	0	1	1	1	1	5.20 V
1	1	0	0	0	0	5.25 V
1	1	0	0	0	1	5.30 V
1	1	0	0	1	0	5.35 V
1	1	0	0	1	1	5.40 V
1	1	0	1	0	0	5.45 V
1	1	0	1	0	1	5.50 V
1	1	0	1	1	0	5.55 V
1	1	0	1	1	1	5.60 V
1	1	1	0	0	0	5.65 V
1	1	1	0	0	1	5.70 V
1	1	1	0	1	0	5.75 V
1	1	1	0	1	1	5.80 V
1	1	1	1	0	0	5.85 V
1	1	1	1	0	1	5.90 V
1	1	1	1	1	0	5.95 V
1	1	1	1	1	1	6.00 V

Note1: Make sure that VC and VRH setting restriction: GVDD ≦ (AVDD - 0.5) V.

Restriction: EXTC should be high to enable this command

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
	VRH [5:0]
Power ON Sequence	6'h21h
SW Reset	6'h21h
HW Reset	6'h21h

8.3.17. Power Control 2 (C1h)

<table>
<tr><th>C1h</th><th colspan="13">PWCTRL 2 (Power Control 2)</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>XX</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>C1h</td></tr>
<tr><td>Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td colspan="3">BT [2:0]</td><td>10</td></tr>
<tr><td>Description</td><td colspan="13">BT [2:0]: Sets the factor used in the step-up circuits.

Select the optimal step-up factor for the operating voltage. To reduce power consumption, set a smaller factor.

<table>
<tr><th colspan="3">BT [2:0]</th><th>AVDD</th><th>VGH</th><th>VGL</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td rowspan="4">VCI x 2</td><td rowspan="2">VCI x 7</td><td>-VCI x 4</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>-VCI x 3</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td rowspan="2">VCI x 6</td><td>-VCI x 4</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>-VCI x 3</td></tr>
</table>

Note1: Make sure that AVDD setting restriction: AVDD ≦ 5.5 V.

2: Make sure that VGH and VGL setting restriction: VGH -VGL≦ 32 V.</td></tr>
<tr><td>Restriction</td><td colspan="13">EXTC should be high to enable this command</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 rowspan="2">Status</th><th>Default Value</th></tr>
<tr><th>BT [2:0]</th></tr>
<tr><td>Power ON Sequence</td><td>3’b000</td></tr>
<tr><td>SW Reset</td><td>3’b000</td></tr>
<tr><td>HW Reset</td><td>3’b000</td></tr>
</table>
</td></tr>
</table>

8.3.18. VCOM Control 1(C5h)

C5h	VMCTRL1 (VCOM Control 1)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	0	0	1	0	1	C5h
1st Parameter	1	1	↑	XX	0	VMH [6:0]							31
2nd Parameter	1	1	↑	XX	0	VML [6:0]							3C

Description

VMH [6:0] : Set the VCOMH voltage.

VMH [6:0]	VCOMH(V)	VMH [6:0]	VCOMH(V)	VMH [6:0]	VCOMH(V)	VMH [6:0]	VCOMH(V)
0000000	2.700	0100000	3.500	1000000	4.300	1100000	5.100
0000001	2.725	0100001	3.525	1000001	4.325	1100001	5.125
0000010	2.750	0100010	3.550	1000010	4.350	1100010	5.150
0000011	2.775	0100011	3.575	1000011	4.375	1100011	5.175
0000100	2.800	0100100	3.600	1000100	4.400	1100100	5.200
0000101	2.825	0100101	3.625	1000101	4.425	1100101	5.225
0000110	2.850	0100110	3.650	1000110	4.450	1100110	5.250
0000111	2.875	0100111	3.675	1000111	4.475	1100111	5.275
0001000	2.900	0101000	3.700	1001000	4.500	1101000	5.300
0001001	2.925	0101001	3.725	1001001	4.525	1101001	5.325
0001010	2.950	0101010	3.750	1001010	4.550	1101010	5.350
0001011	2.975	0101011	3.775	1001011	4.575	1101011	5.375
0001100	3.000	0101100	3.800	1001100	4.600	1101100	5.400
0001101	3.025	0101101	3.825	1001101	4.625	1101101	5.425
0001110	3.050	0101110	3.850	1001110	4.650	1101110	5.450
0001111	3.075	0101111	3.875	1001111	4.675	1101111	5.475
0010000	3.100	0110000	3.900	1010000	4.700	1110000	5.500
0010001	3.125	0110001	3.925	1010001	4.725	1110001	5.525
0010010	3.150	0110010	3.950	1010010	4.750	1110010	5.550
0010011	3.175	0110011	3.975	1010011	4.775	1110011	5.575
0010100	3.200	0110100	4.000	1010100	4.800	1110100	5.600
0010101	3.225	0110101	4.025	1010101	4.825	1110101	5.625
0010110	3.250	0110110	4.050	1010110	4.850	1110110	5.650
0010111	3.275	0110111	4.075	1010111	4.875	1110111	5.675
0011000	3.300	0111000	4.100	1011000	4.900	1111000	5.700
0011001	3.325	0111001	4.125	1011001	4.925	1111001	5.725
0011010	3.350	0111010	4.150	1011010	4.950	1111010	5.750
0011011	3.375	0111011	4.175	1011011	4.975	1111011	5.775
0011100	3.400	0111100	4.200	1011100	5.000	1111100	5.800
0011101	3.425	0111101	4.225	1011101	5.025	1111101	5.825
0011110	3.450	0111110	4.250	1011110	5.050	1111110	5.850
0011111	3.475	0111111	4.275	1011111	5.075	1111111	5.875

VML [6:0] : Set the VCOML voltage

VML [6:0]	VCOML(V)	VML [6:0]	VCOML(V)	VML [6:0]	VCOML(V)	VML [6:0]	VCOML(V)
0000000	-2.500	0100000	-1.700	1000000	-0.900	1100000	-0.100
0000001	-2.475	0100001	-1.675	1000001	-0.875	1100001	-0.075
0000010	-2.450	0100010	-1.650	1000010	-0.850	1100010	-0.050
0000011	-2.425	0100011	-1.625	1000011	-0.825	1100011	-0.025
0000100	-2.400	0100100	-1.600	1000100	-0.800	1100100	0
0000101	-2.375	0100101	-1.575	1000101	-0.775	1100101	Reserved
0000110	-2.350	0100110	-1.550	1000110	-0.750	1100110	Reserved
0000111	-2.325	0100111	-1.525	1000111	-0.725	1100111	Reserved
0001000	-2.300	0101000	-1.500	1001000	-0.700	1101000	Reserved
0001001	-2.275	0101001	-1.475	1001001	-0.675	1101001	Reserved
0001010	-2.250	0101010	-1.450	1001010	-0.650	1101010	Reserved
0001011	-2.225	0101011	-1.425	1001011	-0.625	1101011	Reserved
0001100	-2.200	0101100	-1.400	1001100	-0.600	1101100	Reserved
0001101	-2.175	0101101	-1.375	1001101	-0.575	1101101	Reserved
0001110	-2.150	0101110	-1.350	1001110	-0.550	1101110	Reserved
0001111	-2.125	0101111	-1.325	1001111	-0.525	1101111	Reserved
0010000	-2.100	0110000	-1.300	1010000	-0.500	1110000	Reserved
0010001	-2.075	0110001	-1.275	1010001	-0.475	1110001	Reserved
0010010	-2.050	0110010	-1.250	1010010	-0.450	1110010	Reserved
0010011	-2.025	0110011	-1.225	1010011	-0.425	1110011	Reserved

0010100	-2.000	0110100	-1.200	1010100	-0.400	1110100	Reserved
0010101	-1.975	0110101	-1.175	1010101	-0.375	1110101	Reserved
0010110	-1.950	0110110	-1.150	1010110	-0.350	1110110	Reserved
0010111	-1.925	0110111	-1.125	1010111	-0.325	1110111	Reserved
0011000	-1.900	0111000	-1.100	1011000	-0.300	1111000	Reserved
0011001	-1.875	0111001	-1.075	1011001	-0.275	1111001	Reserved
0011010	-1.850	0111010	-1.050	1011010	-0.250	1111010	Reserved
0011011	-1.825	0111011	-1.025	1011011	-0.225	1111011	Reserved
0011100	-1.800	0111100	-1.000	1011100	-0.200	1111100	Reserved
0011101	-1.775	0111101	-0.975	1011101	-0.175	1111101	Reserved
0011110	-1.750	0111110	-0.950	1011110	-0.150	1111110	Reserved
0011111	-1.725	0111111	-0.925	1011111	-0.125	1111111	Reserved

Restriction: EXTC should be high to enable this command

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	
	VMH [6:0]	VML [6:0]
Power ON Sequence	7'h31	7'h3C
SW Reset	7'h31	7'h3C
HW Rest	7'h31	7'h3C

8.3.19. VCOM Control 2(C7h)

C7h	VMCTRL1 (VCOM Control 1)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	0	0	1	1	1	C7h
Parameter	1	1	↑	XX	nVM	VMF [6:0]							C0

Description

nVM: nVM equals to "0" after power on reset and VCOM offset equals to program MTP value. When nVM set to "1", setting of VMF [6:0] becomes valid and VCOMH/VCOML can be adjusted.

VMF [6:0]: Set the VCOM offset voltage.

VMF[6:0]	VCOMH	VCOML	VMF[6:0]	VCOMH	VCOML
0000000	VMH	VML	1000000	VMH	VML
0000001	VMH – 63	VML – 63	1000001	VMH + 1	VML + 1
0000010	VMH – 62	VML – 62	1000010	VMH + 2	VML + 2
0000011	VMH – 61	VML – 61	1000011	VMH + 3	VML + 3
0000100	VMH – 60	VML – 60	1000100	VMH + 4	VML + 4
0000101	VMH – 58	VML – 58	1000101	VMH + 5	VML + 5
0000110	VMH – 58	VML – 58	1000110	VMH + 6	VML + 6
0000111	VMH – 57	VML – 57	1000111	VMH + 7	VML + 7
0001000	VMH – 56	VML – 56	1001000	VMH + 8	VML + 8
0001001	VMH – 55	VML – 55	1001001	VMH + 9	VML + 9
0001010	VMH – 54	VML – 54	1001010	VMH + 10	VML + 10
0001011	VMH – 53	VML – 53	1001011	VMH + 11	VML + 11
0001100	VMH – 52	VML – 52	1001100	VMH + 12	VML + 12
0001101	VMH – 51	VML -51	1001101	VMH + 13	VML + 13
0001110	VMH – 50	VML – 50	1001110	VMH + 14	VML + 14
0001111	VMH – 49	VML – 49	1001111	VMH + 15	VML + 15
0010000	VMH – 48	VML – 48	1010000	VMH + 16	VML + 16
0010001	VMH – 47	VML – 47	1010001	VMH + 17	VML + 17
0010010	VMH – 46	VML – 46	1010010	VMH + 18	VML + 18
0010011	VMH – 45	VML – 45	1010011	VMH + 19	VML + 19
0010100	VMH – 44	VML – 44	1010100	VMH + 20	VML + 20
0010101	VMH – 43	VML – 43	1010101	VMH + 21	VML + 21
0010110	VMH – 42	VML – 42	1010110	VMH + 22	VML + 22
0010111	VMH – 41	VML – 41	1010111	VMH + 23	VML + 23
0011000	VMH – 40	VML – 40	1011000	VMH + 24	VML + 24
0011001	VMH – 39	VML – 39	1011001	VMH + 25	VML + 25
0011010	VMH – 38	VML – 38	1011010	VMH + 26	VML + 26
0011011	VMH – 37	VML – 37	1011011	VMH + 27	VML + 27
0011100	VMH – 36	VML – 36	1011100	VMH + 28	VML + 28
0011101	VMH – 35	VML – 35	1011101	VMH + 29	VML + 29
0011110	VMH – 34	VML – 34	1011110	VMH + 30	VML + 30
0011111	VMH – 33	VML – 33	1011111	VMH + 31	VML + 31
0100000	VMH – 32	VML – 32	1100000	VMH + 32	VML + 32
0100001	VMH – 31	VML – 31	1100001	VMH + 33	VML + 33
0100010	VMH – 30	VML – 30	1100010	VMH + 34	VML + 34
0100011	VMH – 29	VML – 29	1100011	VMH + 35	VML + 35
0100100	VMH – 28	VML – 28	1100100	VMH + 36	VML + 36
0100101	VMH – 27	VML – 27	1100101	VMH + 37	VML + 37
0100110	VMH – 26	VML – 26	1100110	VMH + 38	VML + 38
0100111	VMH – 25	VML – 25	1100111	VMH + 39	VML + 39
0101000	VMH – 24	VML – 24	1101000	VMH + 40	VML + 40
0101001	VMH – 23	VML – 23	1101001	VMH + 41	VML + 41
0101010	VMH – 22	VML – 22	1101010	VMH + 42	VML + 42
0101011	VMH – 21	VML – 21	1101011	VMH + 43	VML + 43
0101100	VMH – 20	VML – 20	1101100	VMH + 44	VML + 44
0101101	VMH – 19	VML – 19	1101101	VMH + 45	VML + 45
0101110	VMH – 18	VML – 18	1101110	VMH + 46	VML + 46
0101111	VMH – 17	VML – 17	1101111	VMH + 47	VML + 47
0110000	VMH – 16	VML – 16	1110000	VMH + 48	VML + 48
0110001	VMH – 15	VML – 15	1110001	VMH + 49	VML + 49
0110010	VMH – 14	VML – 14	1110010	VMH + 50	VML + 50
0110011	VMH – 13	VML – 13	1110011	VMH + 51	VML + 51
0110100	VMH – 12	VML – 12	1110100	VMH + 52	VML + 52

		0110101	VMH – 11	VML – 11	1110101	VMH + 53	VML + 53
		0110110	VMH – 10	VML – 10	1110110	VMH + 54	VML + 54
		0110111	VMH – 9	VML – 9	1110111	VMH + 55	VML + 55
		0111000	VMH – 8	VML – 8	1111000	VMH + 56	VML + 56
		0111001	VMH – 7	VML – 7	1111001	VMH + 57	VML + 57
		0111010	VMH – 6	VML – 6	1111010	VMH + 58	VML + 58
		0111011	VMH – 5	VML – 5	1111011	VMH + 59	VML + 59
		0111100	VMH – 4	VML – 4	1111100	VMH + 60	VML + 60
		0111101	VMH – 3	VML – 3	1111101	VMH + 61	VML + 61
		0111110	VMH – 2	VML – 2	1111110	VMH + 62	VML + 62
		0111111	VMH – 1	VML – 1	1111111	VMH + 63	VML + 63
Restriction	EXTC should be high to enable this command						
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	
	nVM	VMF [6:0]
Power ON Sequence	1'b1	7'h40h
SW Reset	1'b1	7'h40h
HW Reset	1'b1	7'h40h

8.3.20. NV Memory Write (D0h)

D0h	NVMWR (NV Memory Write)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	1	0	0	0	0	D0h
1st Parameter	1	1	↑	XX	0	0	0	0	0	PGM_ADR [2:0]			00
2nd Parameter	1	1	↑	XX	PGM_DATA [7:0]								XX

Description

This command is used to program the NV memory data. After a successful MTP operation, the information of PGM_DATA [7:0] will programmed to NV memory.

PGM_ADR [2:0]: The select bits of ID1, ID2, ID3 and VMF [6:0] programming.

PGM_ADR [2:0]			Programmed NV Memory Selection
0	0	0	ID1 programming
0	0	1	ID2 programming
0	1	0	ID3 programming
1	0	0	VMF [6:0] programming
Others			Reserved

PGM_DATA [7:0]: The programmed data.

Restriction

EXTC should be high to enable this command

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	
	PGM_ADR [2:0]	PGM_DATA [7:0]
Power ON Sequence	3'b000	MTP value
SW Reset	3'b000	MTP value
HW Reset	3'b000	MTP value

8.3.21. NV Memory Protection Key (D1h)

<table>
<tr><th>D1h</th><th colspan="13">NVMPKEY (NV Memory Protection Key)</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>XX</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>D1h</td></tr>
<tr><td>1st Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="8">KEY [23:16]</td><td>55h</td></tr>
<tr><td>2nd Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="8">KEY [15:8]</td><td>AAh</td></tr>
<tr><td>3rd Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="8">KEY [7:0]</td><td>66h</td></tr>
<tr><td>Description</td><td colspan="13">KEY [23:0]: NV memory programming protection key. When writing MTP data to D1h, this register must be set to 0x55AA66h to enable MTP programming. If D1h register is not written with 0x55AA66h, then NV memory programming will be aborted.</td></tr>
<tr><td>Restriction</td><td colspan="13">EXTC should be high to enable this command</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>KEY [23:0]=55AA66h</td></tr>
<tr><td>SW Reset</td><td>KEY [23:0]=55AA66h</td></tr>
<tr><td>HW Reset</td><td>KEY [23:0]=55AA66h</td></tr>
</table>
</td></tr>
</table>

8.3.22. NV Memory Status Read (D2h)

D2h	RDNVM (NV Memory Status Read)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	1	0	0	1	0	D2h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2nd Parameter	1	↑	1	XX	0	ID2_CNT [2:0]			0	ID1_CNT [2:0]			XX
3rd Parameter	1	↑	1	XX	BUSY	VMF_CNT [2:0]			0	ID3_CNT [2:0]			XX

Description

ID1_CNT [2:0] / **ID2_CNT [2:0]** / **ID3_CNT [2:0]** / **VMF_CNT [2:0]:** NV memory program record. The bits will increase "+1" automatically after writing the PGM_DATA [7:0] to NV memory.

ID1_CNT [2:0] / ID2_CNT [2:0] ID3_CNT [2:0] / VMF_CNT [2:0]			Description
Status			Availability
0	0	0	No Programmed
0	0	1	Programmed 1 time
0	1	1	Programmed 2 times
1	1	1	Programmed 3 times

BUSY: The status bit of NV memory programming.

BUSY	The Status of NV Memory
0	Idle
1	Busy

Restriction

EXTC should be high to enable this command

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				
	ID3_CNT	ID2_CNT	ID1_CNT	VMF_CNT	BUSY
Power ON Sequence	X	X	X	X	X
SW Reset	X	X	X	X	X
HW Reset	X	X	X	X	X

8.3.23. Read ID4 (D3h)

D3h	RDID4 (Read ID4)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	0	1	0	0	1	1	D3h
1st Parameter	1	↑	1	XX	X	X	X	X	X	X	X	X	X
2ndParameter	1	↑	1	XX	0	0	0	0	0	0	0	0	00h
3rdParameter	1	↑	1	XX	1	0	0	1	0	0	1	1	93h
4th Parameter	1	↑	1	XX	0	1	0	0	0	0	0	1	41h
Description	Read IC device code. The 1st parameter is dummy read period. The 2nd parameter means the IC version. The 3rd and 4th parameter mean the IC model name.												
Restriction	EXTC should be high to enable this command												
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	24'h009341h
SW Reset	24'h009341h
HW Reset	24'h009341h

8.3.24. Positive Gamma Correction (E0h)

E0h	PGAMCTRL (Positive Gamma Control)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	1	0	0	0	0	0	E0h
1st Parameter	1	1	↑	XX	0	0	0	0	VP63 [3:0]				08
2ndParameter	1	1	↑	XX	0	0	VP62 [5:0]						
3rdParameter	1	1	↑	XX	0	0	VP61 [5:0]						
4th Parameter	1	1	↑	X	0	0	0	0	VP59 [3:0]				05
5th Parameter	1	1	↑	XX	0	0	0	VP57 [4:0]					
6th Parameter	1	1	↑	XX	0	0	0	0	VP50 [3:0]				09
7th Parameter	1	1	↑	XX	0	VP43 [6:0]							
8th Parameter	1	1	↑	XX	VP27 [3:0]				VP36 [3:0]				
9th Parameter	1	1	↑	XX	0	VP20 [6:0]							
10thParameter	1	1	↑	XX	0	0	0	0	VP13 [3:0]				0B
11thParameter	1	1	↑	XX	0	0	0	VP6 [4:0]					
12thParameter	1	1	↑	XX	0	0	0	0	VP4 [3:0]				00
13thParameter	1	1	↑	XX	0	0	VP2 [5:0]						
14thParameter	1	1	↑	XX	0	0	VP1 [5:0]						
15thParameter	1	1	↑	XX	0	0	0	0	VP0 [3:0]				00
Description	Set the gray scale voltage to adjust the gamma characteristics of the TFT panel.												
Restriction	EXTC should be high to enable this command												

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

8.3.25. Negative Gamma Correction (E1h)

E1h	NGAMCTRL (Negative Gamma Correction)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	1	0	0	0	0	1	E1h
1st Parameter	1	1	↑	XX	0	0	0	0	VN63 [3:0]				08
2ndParameter	1	1	↑	XX	0	0	VN62 [5:0]						
3rdParameter	1	1	↑	XX	0	0	VN61 [5:0]						
4th Parameter	1	1	↑	XX	0	0	0	0	VN59 [3:0]				07
5th Parameter	1	1	↑	XX	0	0	0	VN57 [4:0]					
6th Parameter	1	1	↑	XX	0	0	0	0	VN50 [3:0]				05
7th Parameter	1	1	↑	XX	0	VN43 [6:0]							
8th Parameter	1	1	↑	XX	VN36 [3:0]				VN27 [3:0]				
9th Parameter	1	1	↑	XX	0	VN20 [6:0]							
10thParameter	1	1	↑	XX	0	0	0	0	VN13 [3:0]				04
11thParameter	1	1	↑	XX	0	0	0	VN6 [4:0]					
12thParameter	1	1	↑	XX	0	0	0	0	VN4 [3:0]				0F
13thParameter	1	1	↑	XX	0	0	VN2 [5:0]						
14thParameter	1	1	↑	XX	0	0	VN1 [5:0]						
15thParameter	1	1	↑	XX	0	0	0	0	VN0 [3:0]				0F
Description	Set the gray scale voltage to adjust the gamma characteristics of the TFT panel.												
Restriction	EXTC should be high to enable this command												
Register Availability													
Default													

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

8.3.26. Digital Gamma Control 1 (E2h)

E2h	DGAMCTRL (Digital Gamma Control 1)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	1	0	0	0	1	0	E2h
1st Parameter	1	1	↑	XX	RCA0 [3:0]				BCA0 [3:0]				XX
:	1	1	↑	XX	RCAx [3:0]				BCAx [3:0]				XX
16th Parameter	1	1	↑	XX	RCA15 [3:0]				BCA15 [3:0]				XX
Description	**RCAx [3:0]:** Gamma Macro-adjustment registers for red gamma curve. **BCAx [3:0]:** Gamma Macro-adjustment registers for blue gamma curve.												
Restriction	EXTC should be high to enable this command												
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	
	RCAx [3:0]	BCAx [3:0]
Power ON Sequence	TBD	TBD
SW Reset	TBD	TBD
HW Reset	TBD	TBD

8.3.27. Digital Gamma Control 2(E3h)

<table>
<tr><th>E3h</th><th colspan="13">DGAMCTRL (Digital Gamma Control 2)</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>XX</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>E3h</td></tr>
<tr><td>1st Parameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="4">RFA0 [3:0]</td><td colspan="4">BFA0 [3:0]</td><td>XX</td></tr>
<tr><td>:</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="4">RFAx [3:0]</td><td colspan="4">BFAx [3:0]</td><td>XX</td></tr>
<tr><td>64rdParameter</td><td>1</td><td>1</td><td>↑</td><td>XX</td><td colspan="4">RFA63 [3:0]</td><td colspan="4">BFA63 [3:0]</td><td>XX</td></tr>
<tr><td>Description</td><td colspan="14">RFAx [3:0]: Gamma Micro-adjustment register for red gamma curve.
BFAx [3:0]: Gamma Micro-adjustment register for blue gamma curve.</td></tr>
<tr><td>Restriction</td><td colspan="14">EXTC should be high to enable this command</td></tr>
<tr><td>Register Availability</td><td colspan="14">
<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="14">
<table>
<tr><th rowspan="2">Status</th><th colspan="2">Default Value</th></tr>
<tr><th>RFAx [3:0]</th><th>BFAx [3:0]</th></tr>
<tr><td>Power ON Sequence</td><td>TBD</td><td>TBD</td></tr>
<tr><td>SW Reset</td><td>TBD</td><td>TBD</td></tr>
<tr><td>HW Reset</td><td>TBD</td><td>TBD</td></tr>
</table>
</td></tr>
</table>

8.3.28. Interface Control (F6h)

F6h	IFCTL (16bits Data Format Selection)												
	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	1	↑	XX	1	1	1	1	0	1	1	0	F6h
1st Parameter	1	1	↑	XX	MY_ EOR	MX_ EOR	MV_ EOR	0	BGR_ EOR	0	0	WE MODE	01
2nd Parameter	1	1	↑	XX	0	0	EPF [1]	EPF [0]	0	0	MDT [1]	MDT [0]	00
3rd Parameter	1	1	↑	XX	0	0	ENDIAN	0	DM [1]	DM [0]	RM	RIM	00

Description

MY_EOR / MX_EOR / MV_EOR / BGR_EOR:

The set value of MADCTL is used in the IC is derived as exclusive OR between 1st Parameter of IFCTL and MADCTL Parameter.

MDT [1:0]: Select the method of display data transferring.

WEMODE: Memory write control

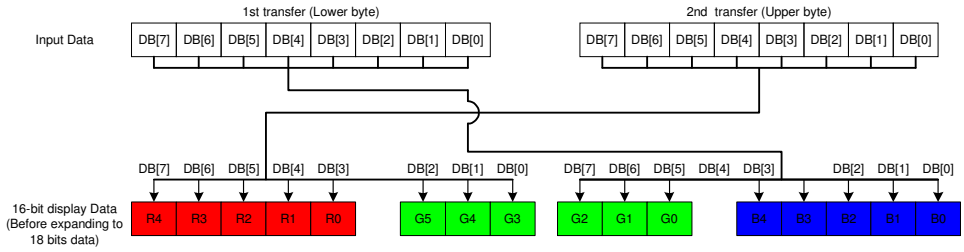
WEMODE=0: When the transfer number of data exceeds (EC-SC+1)*(EP-SP+1), the exceeding data will be ignored.

WEMODE=1: When the transfer number of data exceeds (EC-SC+1)*(EP-SP+1), the column and page number will be reset, and the exceeding data will be written into the following column and page.

ENDIAN: Select Little Endian Interface bit. At Little Endian mode, the host sends LSB data first.

ENDIAN	Data transfer Mode
0	Normal (MSB first, default)
1	Little Endian (LSB first)

Note: Little Endian is valid on only 65K 8-bit and 9-bit MCU interface mode.



DM [1:0]: Select the display operation mode.

DM [1]	DM [0]	Display Operation Mode
0	0	Internal clock operation
0	1	RGB Interface Mode
1	0	VSYNC interface mode
1	1	Setting disabled

The DM [1:0] setting allows switching between internal clock operation mode and external display interface operation mode.

However, switching between the RGB interface operation mode and the VSYNC interface operation mode is prohibited.

RM: Select the interface to access the GRAM.

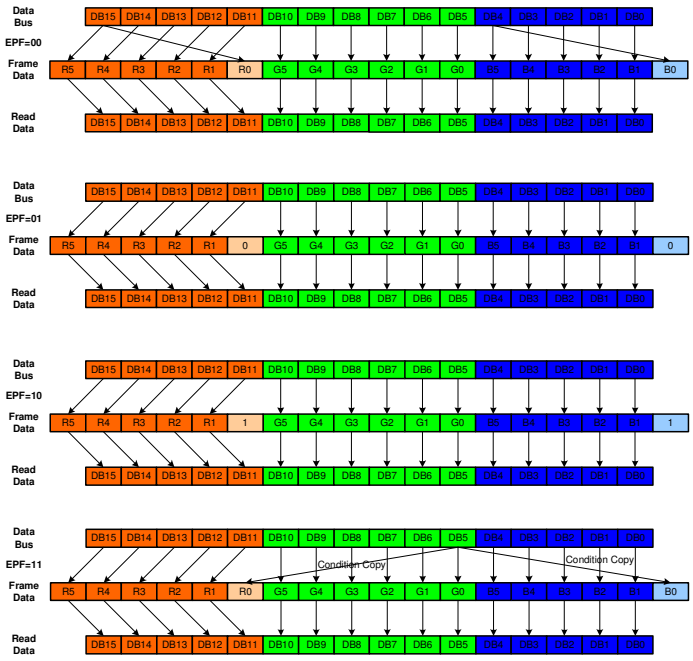
Set RM to "1" when writing display data by the RGB interface.

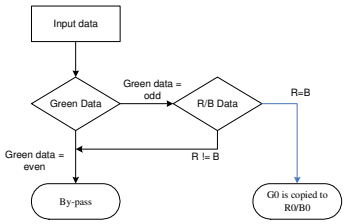
RM	Interface for RAM Access
0	System interface/VSYNC interface
1	RGB interface

RIM: Specify the RGB interface mode when the RGB interface is used. These bits should be set before display operation through the RGB interface and should not be set during operation.

RIM	COLMOD [6:4]	RGB Interface Mode
0	110 (262K color)	18- bit RGB interface (1 transfer/pixel)
	101 (65K color)	16- bit RGB interface (1 transfer/pixel)
1	110 (262K color)	6- bit RGB interface (3 transfer/pixel)
	101 (65K color)	6- bit RGB interface (3 transfer/pixel)

EPF [1:0]: 65K color mode data format.





EPF [1:0]	Expand 16 bbp (R,G,B) to 18bbp (R,G,B)
00	MSB is inputted to LSB r [5:0] = {R [4:0], R [4]} g [5:0] = {G [5:0]} b [5:0] = {B [4:0], B [4]}

	01	"0" is inputted to LSB r [5:0] = {R [4:0], 0} g [5:0] = {G [5:0]} b [5:0] = {B [4:0], 0} Exception: R [4:0], B[4:0] = 5'h1F → r [5:0], b[5:0] = 6'h3F
	10	"1" is inputted to LSB r [5:0] = {R [4:0], 1} g [5:0] = {G [5:0]} b [5:0] = {B [4:0], 1} Exception: R [4:0], B[4:0] = 5'h00 → r [5:0], b[5:0] = 6'h00
	11	Compare R [4:0], G [5:1], B [4:0] case: Case 1: R=G=B → r [5:0] = {R [4:0], G [0]}, g [5:0] = {G [5:0]}, b [5:0] = {B [4:0], G [0]} Case 2: R=B≠G → r [5:0] = {R [4:0], R [4]}, g [5:0] = {G [5:0]}, b [5:0] = {B [4:0], B [0]} Case 3: R=G≠B → r [5:0] = {R [4:0], G [0]}, g [5:0] = {G [5:0]}, b [5:0] = {B [4:0], B [0]} Case 4: B=G≠R → r [5:0] = {R [4:0], R [4]}, g [5:0] = {G [5:0]}, b [5:0] = {B [4:0], G [0]}

Restriction: EXTC should be high to enable this command

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

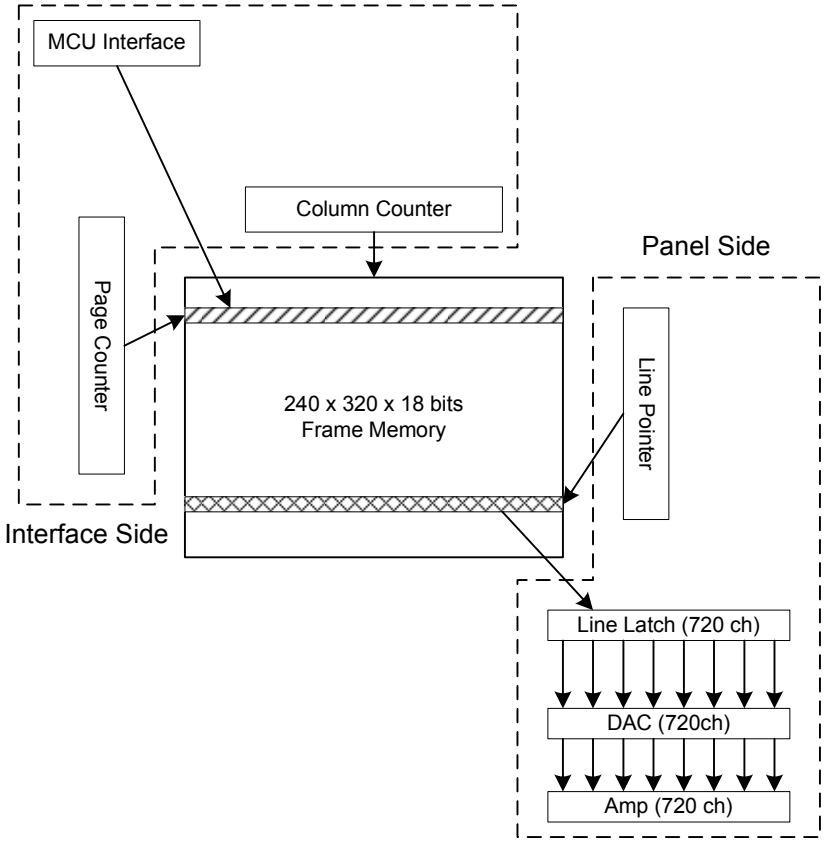
Default

Status	Default Value						
	EPF [1:0]	MDT [1:0]	ENDIAN	WEMODE	DM [1:0]	RM	RIM
Power ON Sequence	2'b00	2'b00	1'b0	1'b1	2'b00	1'b0	1'b0
SW Reset	2'b00	2'b00	1'b0	1'b1	2'b00	1'b0	1'b0
HW Reset	2'b00	2'b00	1'b0	1'b1	2'b00	1'b0	1'b0

9. Display Data RAM

9.1. Configuration

The display data RAM stores display dots and consists of 1,382,400 bits (240x18x320 bits). There is no restriction on access to the RAM even when the display data on the same address is loaded to DAC. There will be no abnormal visible effect on the display when there is a simultaneous panel read and interface read or write display data to the same location of the frame memory.

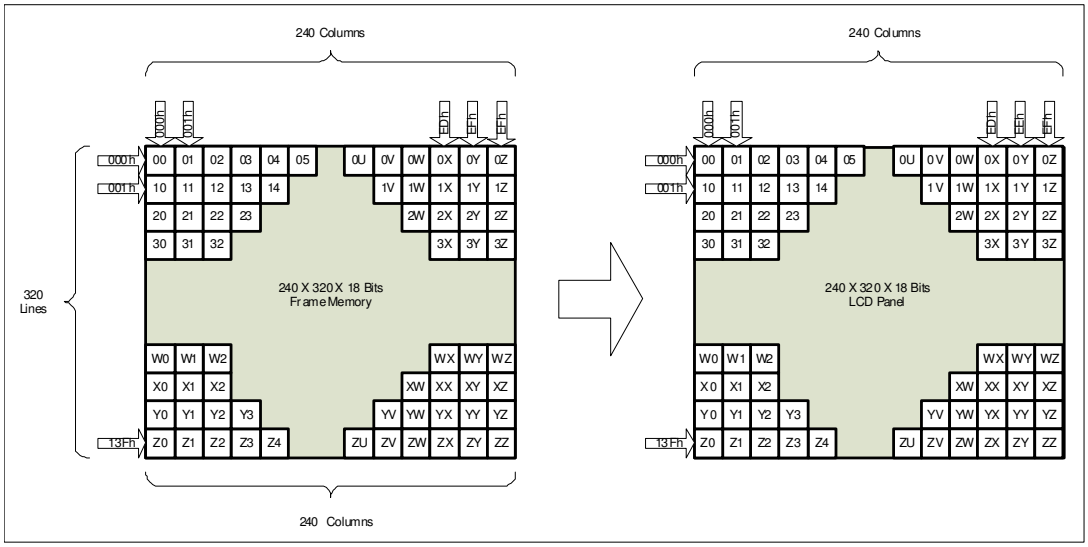


9.2. Memory to Display Address Mapping

9.2.1. Normal Display ON or Partial Mode ON, Vertical Scroll Mode OFF

In this mode, the content of frame memory within an area where column pointer is 0000h to 00EFh and page pointer is 0000h to 013Fh is displayed.

To display a dot on leftmost top corner, store the dot data at (column pointer, page pointer) = (0, 0)

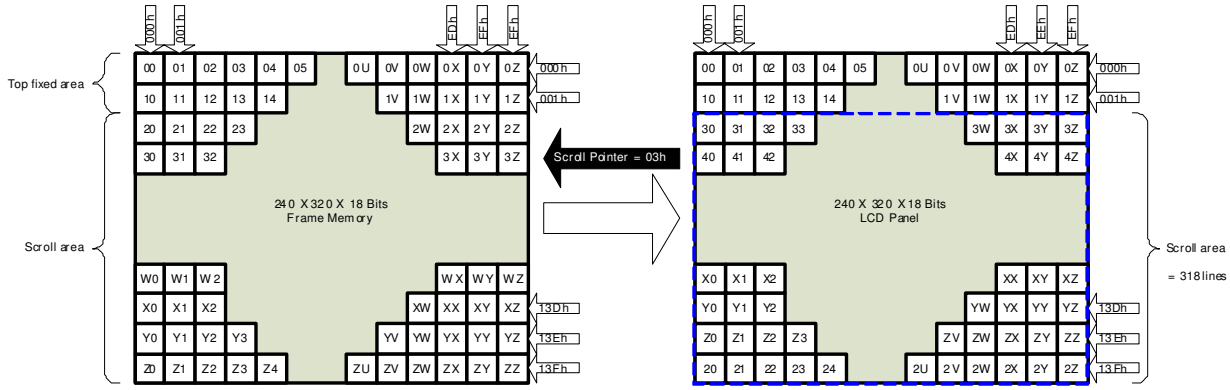


9.2.2. Vertical Scroll Mode

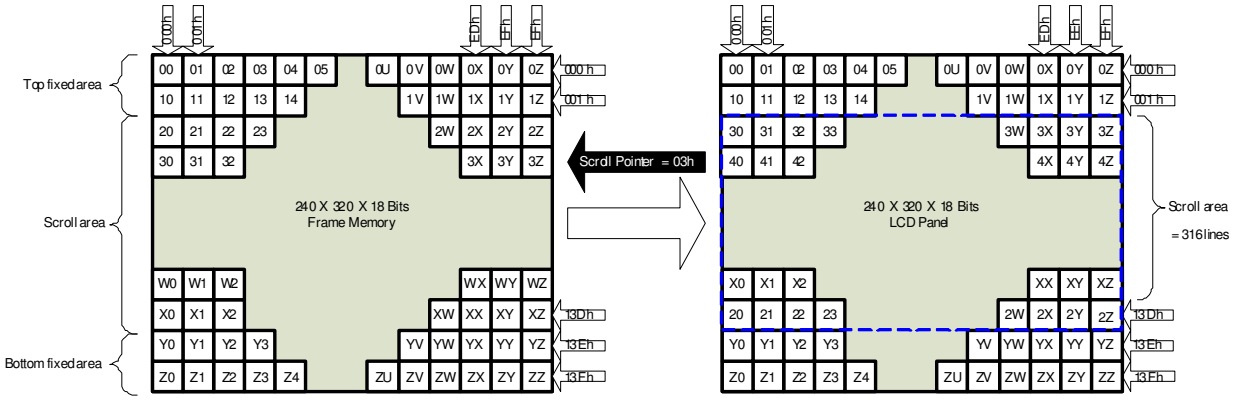
There is a vertical scrolling mode, which is determined by the commands “Vertical Scrolling Definition” (33h) and “Vertical Scrolling Start Address” (37h).

The Vertical Scroll Mode function is explained by these examples in the following.

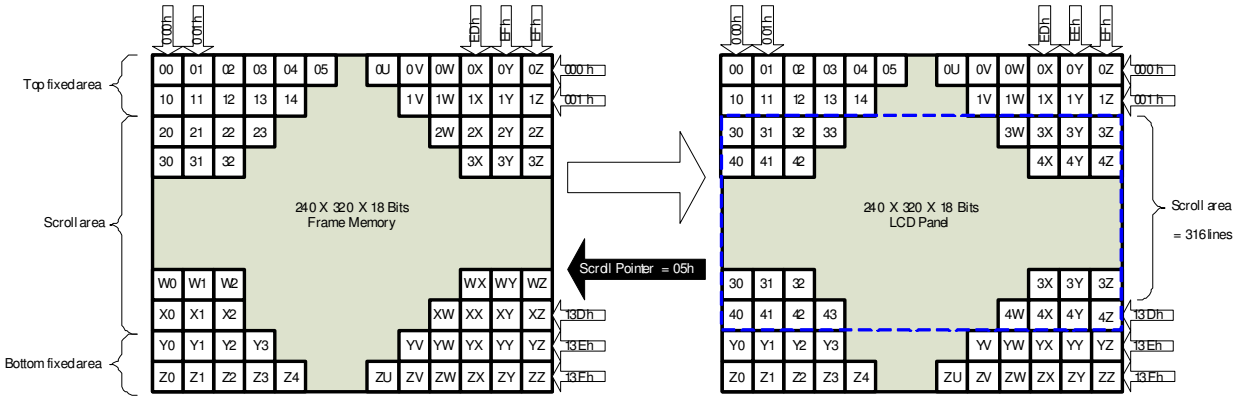
TFA=2, VSA=318, BFA=0 when MADCTL ML bit = 0



TFA=2, VSA=316, BFA=2 when MADCTL ML bit = 0



TFA=2, VSA=316, BFA=4 when MADCTL ML bit = 0



Note: When Vertical Scrolling Definition Parameters (TFA+VSA+BFA) ≠ 320, Scrolling Mode is undefined.

9.2.3. Vertical Scroll Example

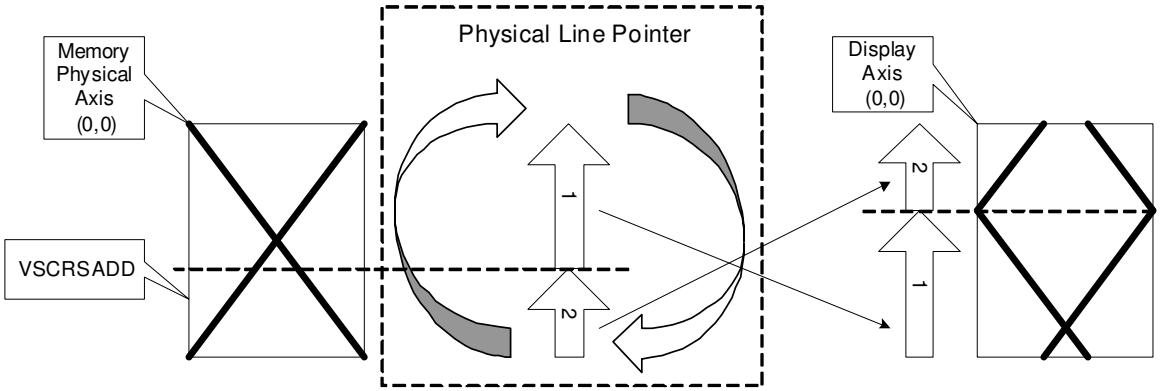
9.2.4. Case1: TFA+VSA+BFA < 320

This setting is prohibited, unless unexpected picture will be shown.

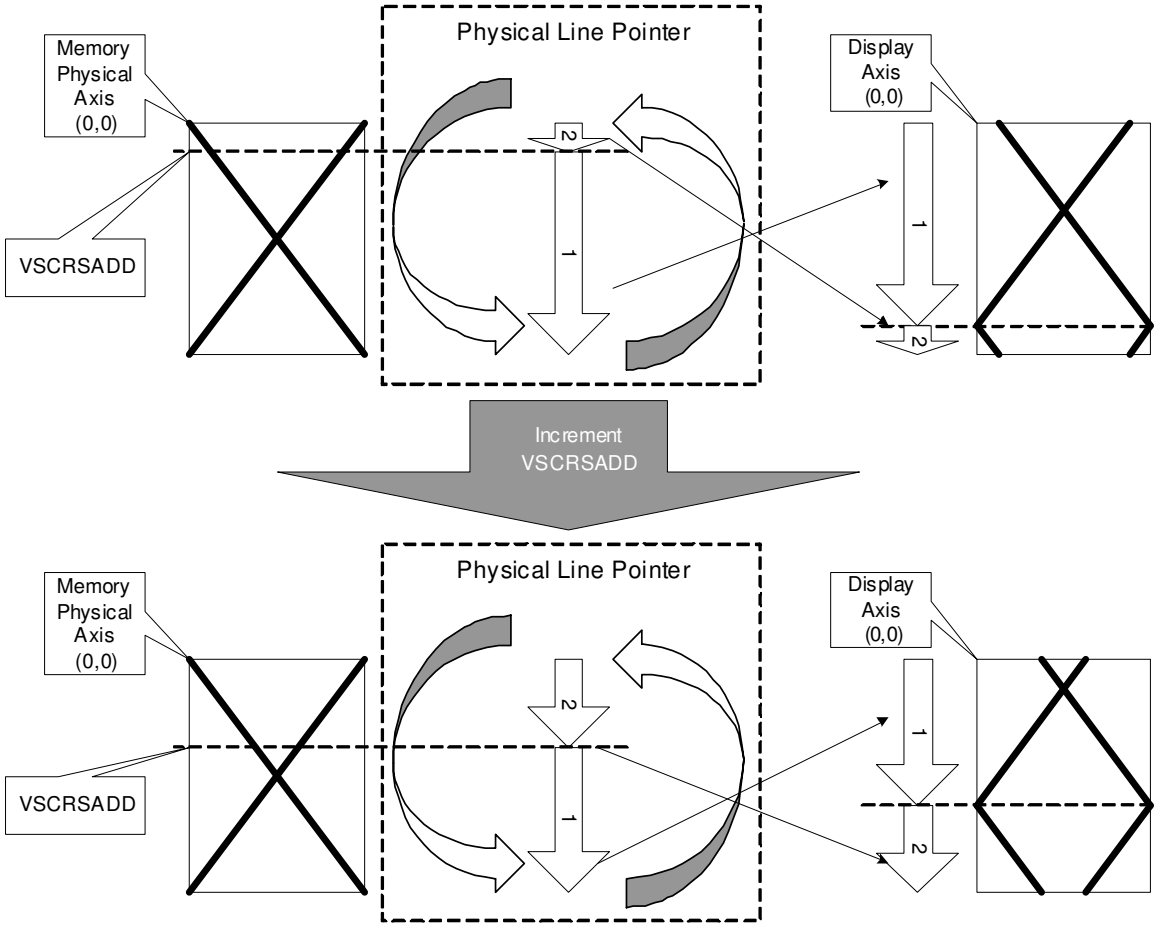
9.2.5. Case2: TFA+VSA+BFA = 320 (Rolling Scrolling)

The operation of Rolling Scrolling is explained by these examples in the following.

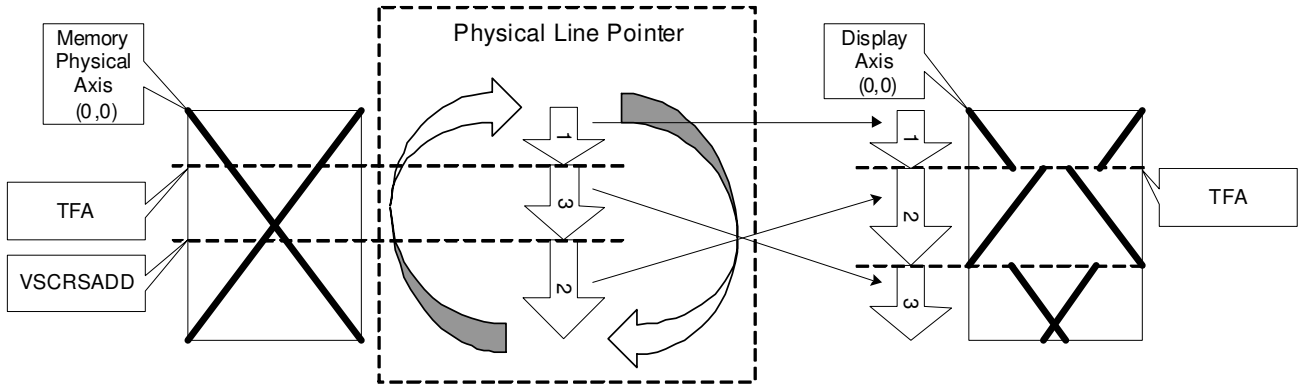
When TFA=0, VSA=320, BFA=0, VSCRSADD=40 and MADCTL ML bit = 1



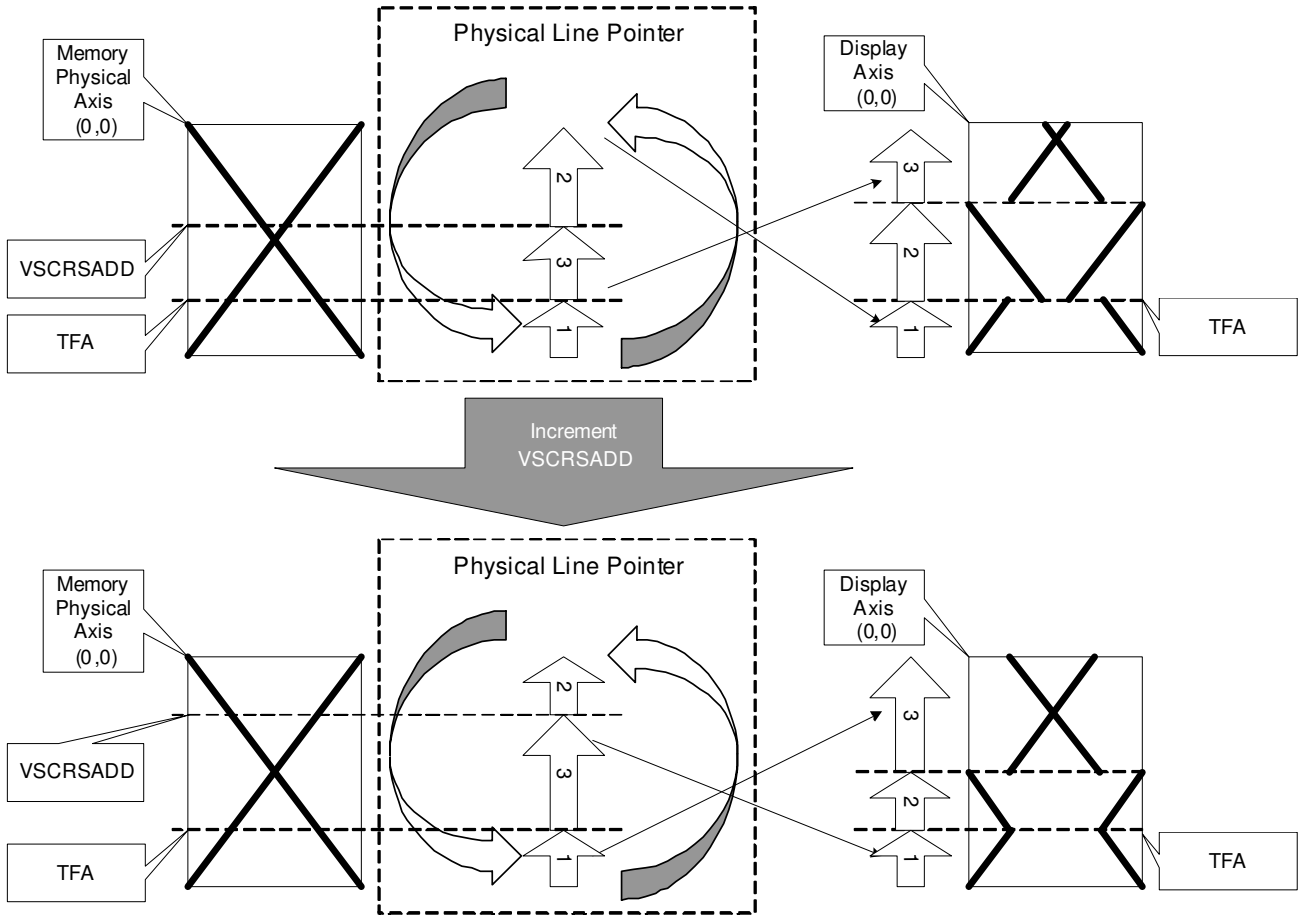
When TFA=0, VSA=320, BFA=0, VSCRSADD=40 and MADCTL ML bit = 0



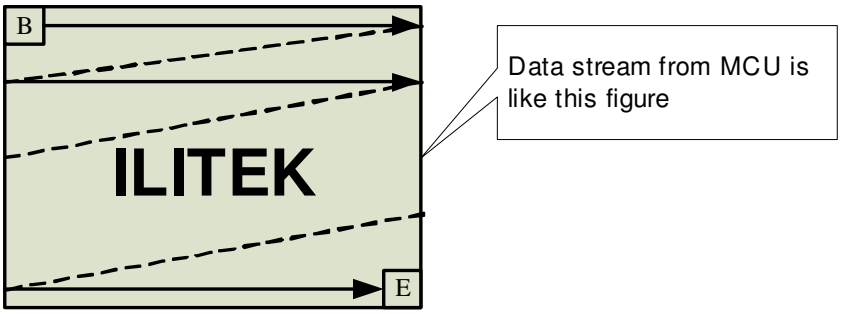
When TFA=30, VSA=290, BFA=0, VSCRSADD=80 and MADCTL ML bit = 0



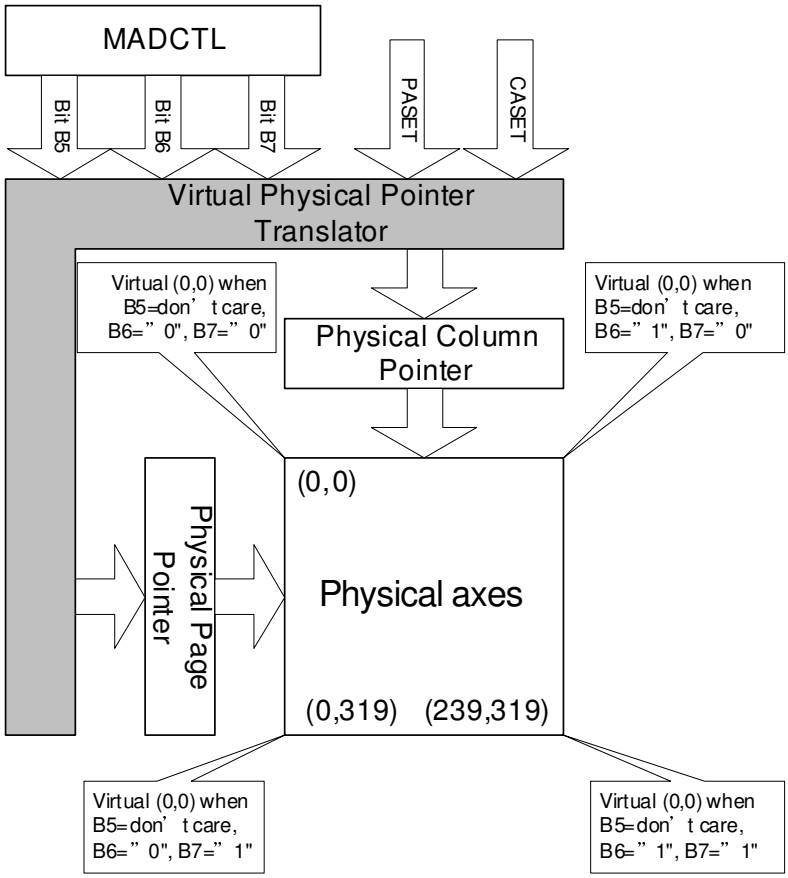
When TFA=30, VSA=290, BFA=0, VSCRSADD=80 and MADCTL ML bit = 1



9.3. MCU to memory write/read direction



The data is written in the order illustrated above. The Counter which dictates where in the physical memory the data is to be written is controlled by “Memory Data Access Control” Command, Bits B5, B6, and B7 as described below.



B5	B6	B7	CASET	PASET
0	0	0	Direct to Physical Column Pointer	Direct to Physical Page Pointer
0	0	1	Direct to Physical Column Pointer	Direct to (319-Physical Page Pointer)
0	1	0	Direct to (239-Physical Column Pointer)	Direct to Physical Page Pointer
0	1	1	Direct to (239-Physical Column Pointer)	Direct to (319-Physical Page Pointer)
1	0	0	Direct to Physical Page Pointer	Direct to Physical Column Pointer
1	0	1	Direct to (319-Physical Page Pointer)	Direct to Physical Column Pointer
1	1	0	Direct to Physical Page Pointer	Direct to (239-Physical Column Pointer)
1	1	1	Direct to (319-Physical Page Pointer)	Direct to (239-Physical Column Pointer)

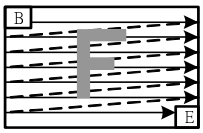
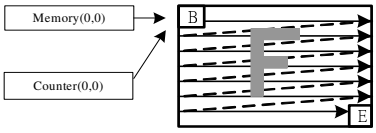
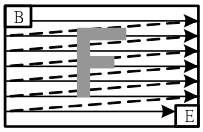
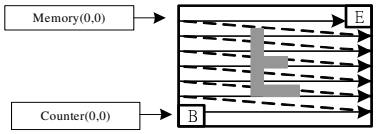
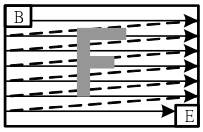
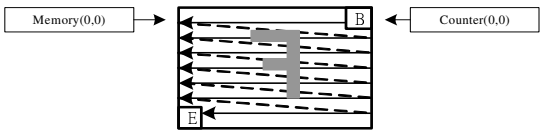
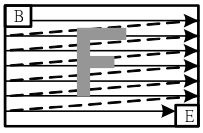
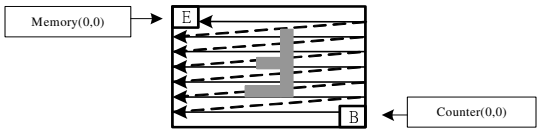
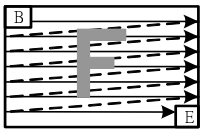
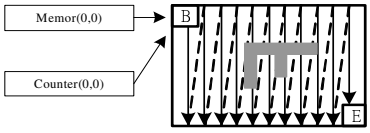
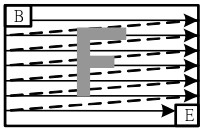
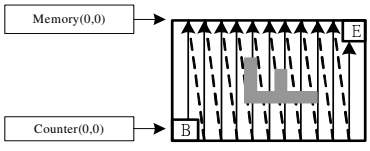
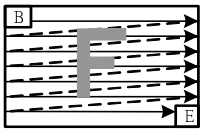
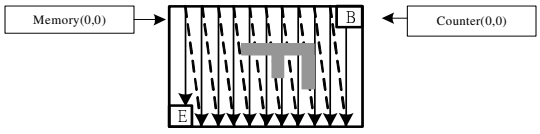
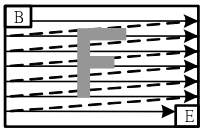
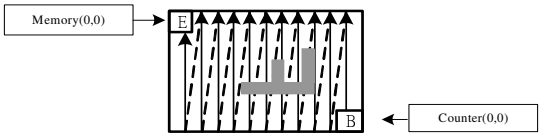
Condition	Column Counter	Page counter
When RAMWR/RAMRD command is accepted	Return to “Start column”	Return to “Start Page”
Complete Pixel Read/Write action	Increment by 1	No change
The Column values is large than “End Column”	Return to “Start column”	Increment by 1
The Page counter is large than “End Page”	Return to “Start column”	Return to “Start Page”

Note:

Data is always written to the Frame Memory in the same order, regardless of the Memory Write Direction set by MADCTL bits B7, B6 and B5. The write order for each pixel unit is

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

One pixel unit represents 1 column and 1 page counter value on the Frame Memory.

Display Data Direction	MADCTR Parameter			Image in the Memory (MPU)	Image in the Driver (Frame Memory)
	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 X-Mirror	1	1	0		
XY Exchange XY-Mirror	1	1	1		

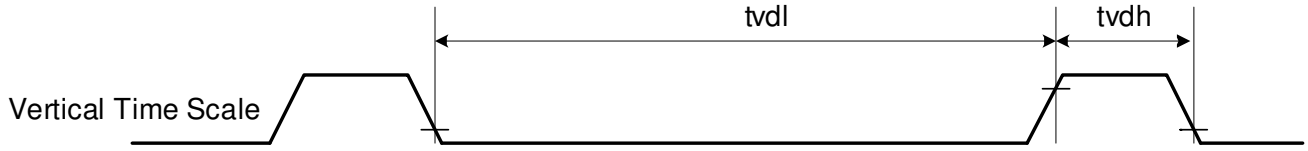
10. Tearing Effect Output

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 Off & On commands.

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

10.1. Tearing Effect Line Modes

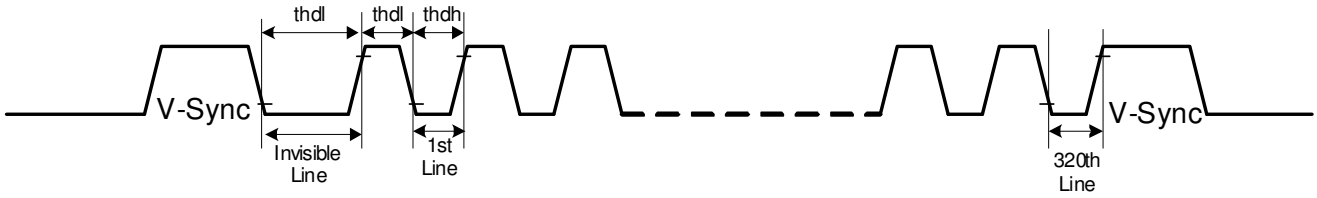
Mode 1, the Tearing Effect Output signal consists of V-Sync information only:



tvdh = The LCD display is not updated from the Frame Memory.

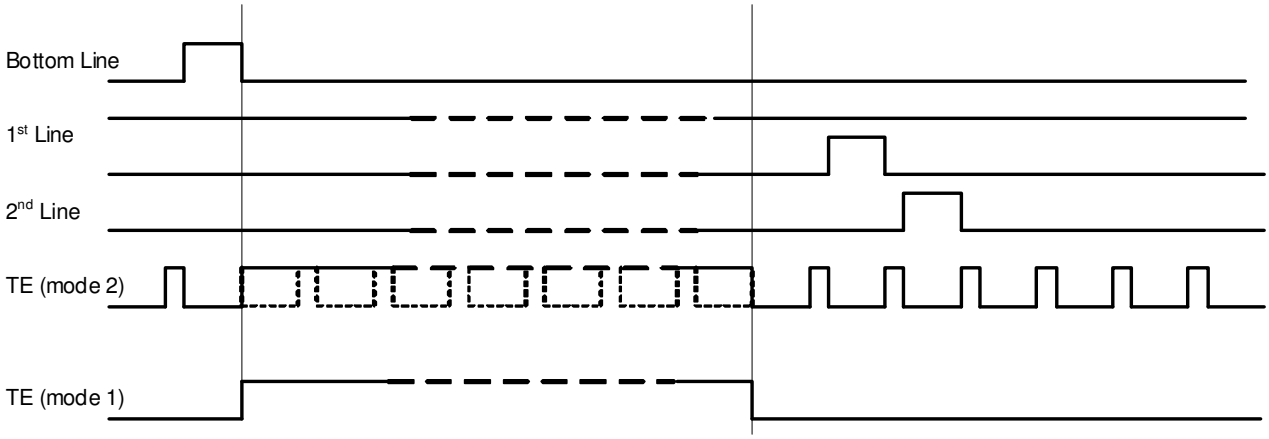
tvdl = The LCD display is updated from the Frame Memory (except Invisible Line – see below).

Mode 2, the tearing effect output signal consists of V-Sync and H-Sync information; there is one V-sync and 320 H-sync pulses per field:



thdh = The LCD display is not updated from the Frame Memory.

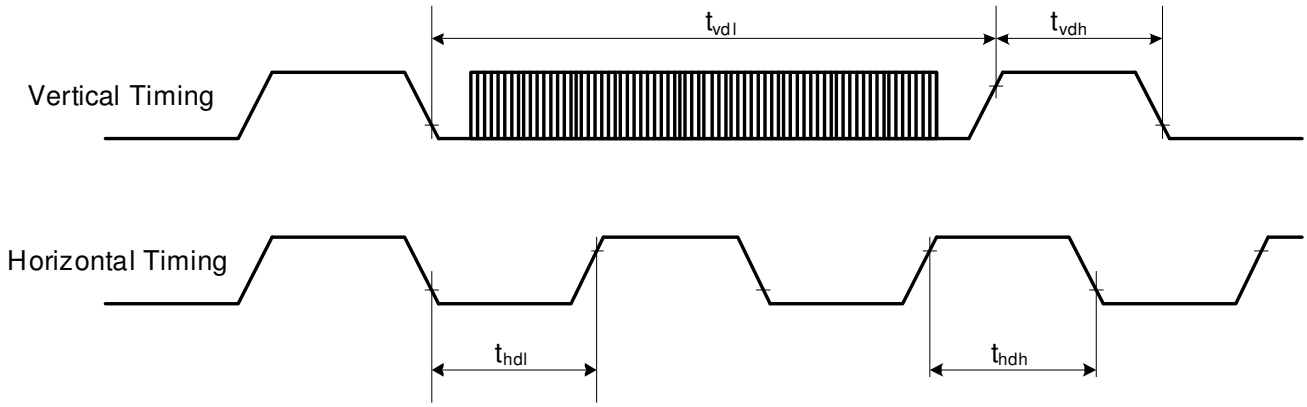
thdl = The LCD display is updated from the Frame Memory (except Invisible Line – see above).



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

10.2. Tearing Effect Line Timings

The tearing effect signal is described below:

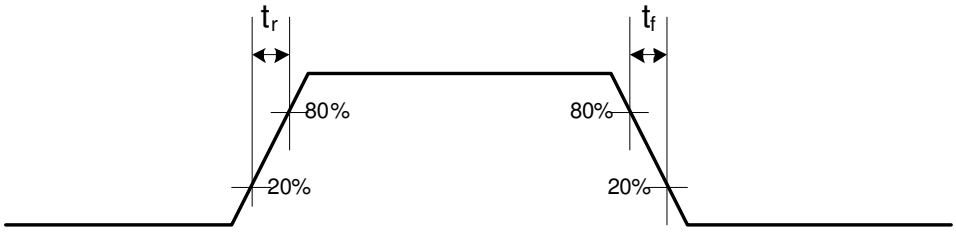


AC characteristics of Tearing Effect Signal (Frame Rate = 60Hz)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Description
t_{vdl}	Vertical timing low duration	--	--	--	ms	
t_{vdh}	Vertical timing high duration	1000	--	--	us	
t_{hdl}	Horizontal timing low duration	--	--	--	us	
t_{hdh}	Horizontal timing high duration	--	--	500	us	

Note:

1. The timings in Table as above 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.



The Tearing Effect Output Line is fed back to the MCU and should be used to avoid Tearing Effect.

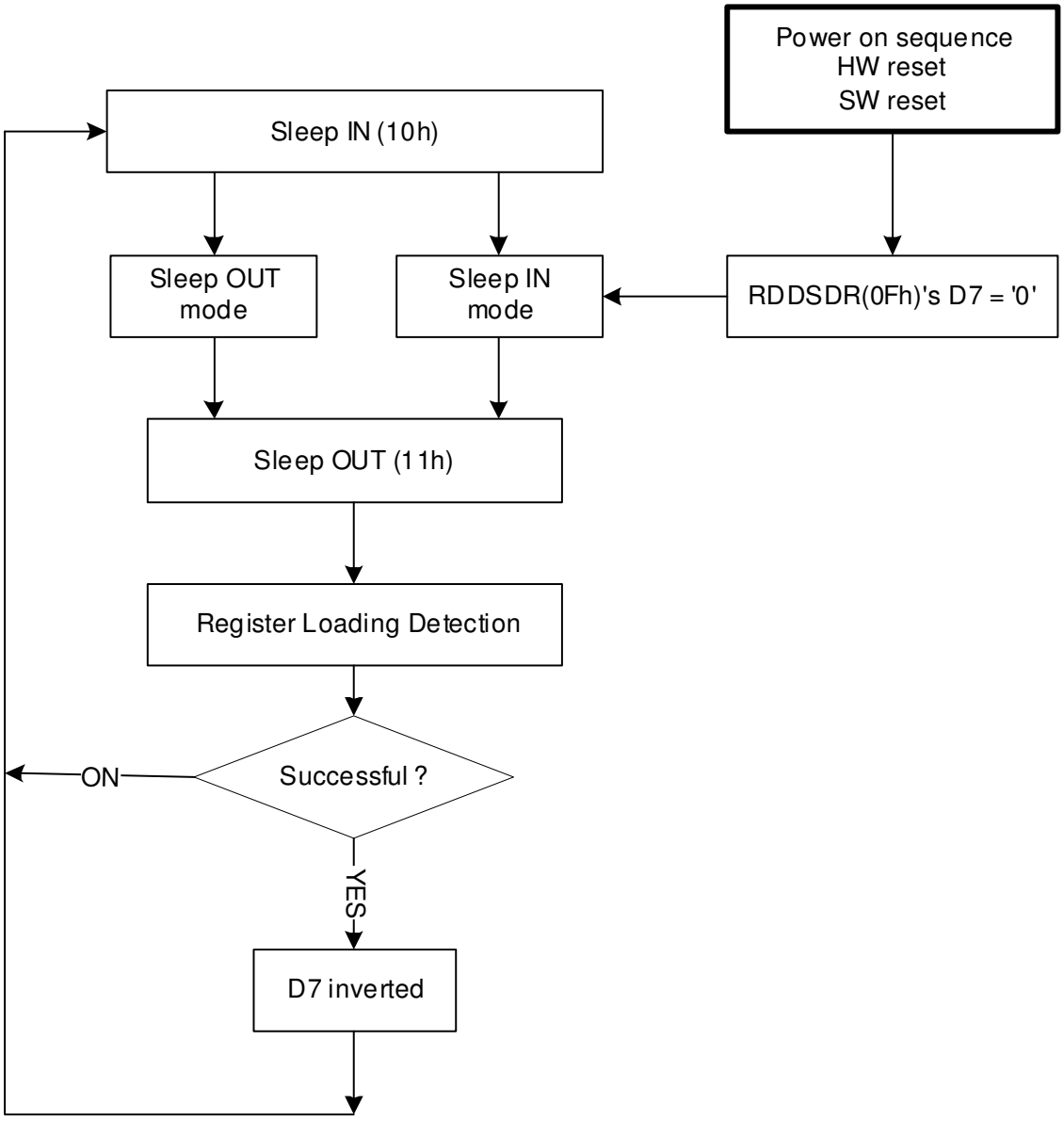
11. Sleep Out – Command and Self-Diagnostic Functions of the Display Module

11.1. Register loading Detection

Sleep Out-command (Command “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 EV Memory(or similar device) to registers of the display controller is working properly.

If the register loading detection is successfully, there is inverted (= increased by 1) a bit, which is defined in command “Read Display Self-Diagnostic Result (0Fh)” (= RDDSDR) (The used bit of this command is D7). If it is failure, this bit (D7) is not inverted (= not increased by 1).

The flow chart for this internal function is following:

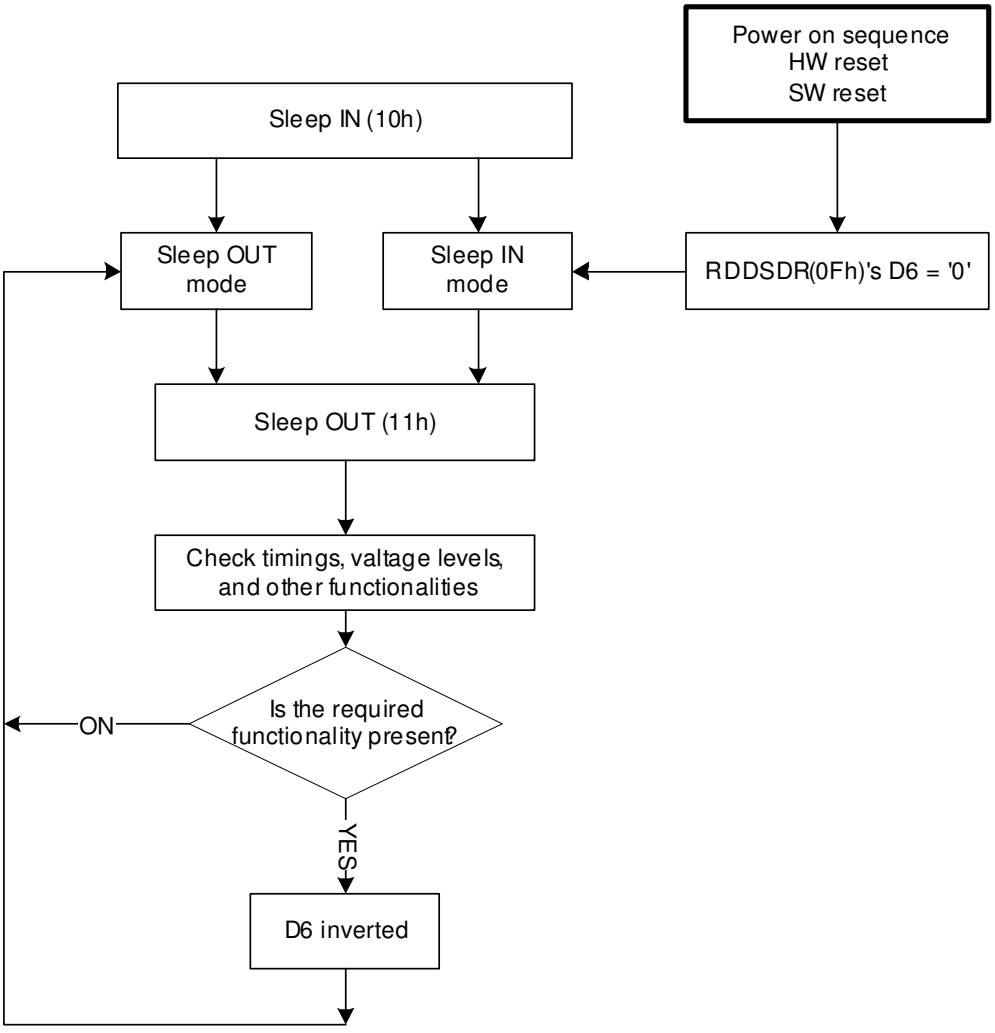


11.2. Functionality Detection

Sleep Out-command (Command “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 (e.g. booster voltage levels, timings, etc.) If functionality requirement is met, there is an inverted (= increased by 1) bit, which defined in command “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 shown as below.

The flow chart for this internal function is following:



Note 1: 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 User’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.

12. Power ON/OFF Sequence

VDDI and VCI can be applied in any order.

VCI and VDDI can be powered down in any order.

During power off, if LCD is in the Sleep Out mode, VCI 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 VCI 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.

Note 1: There will be no damage to the display module if the power sequences are not met.

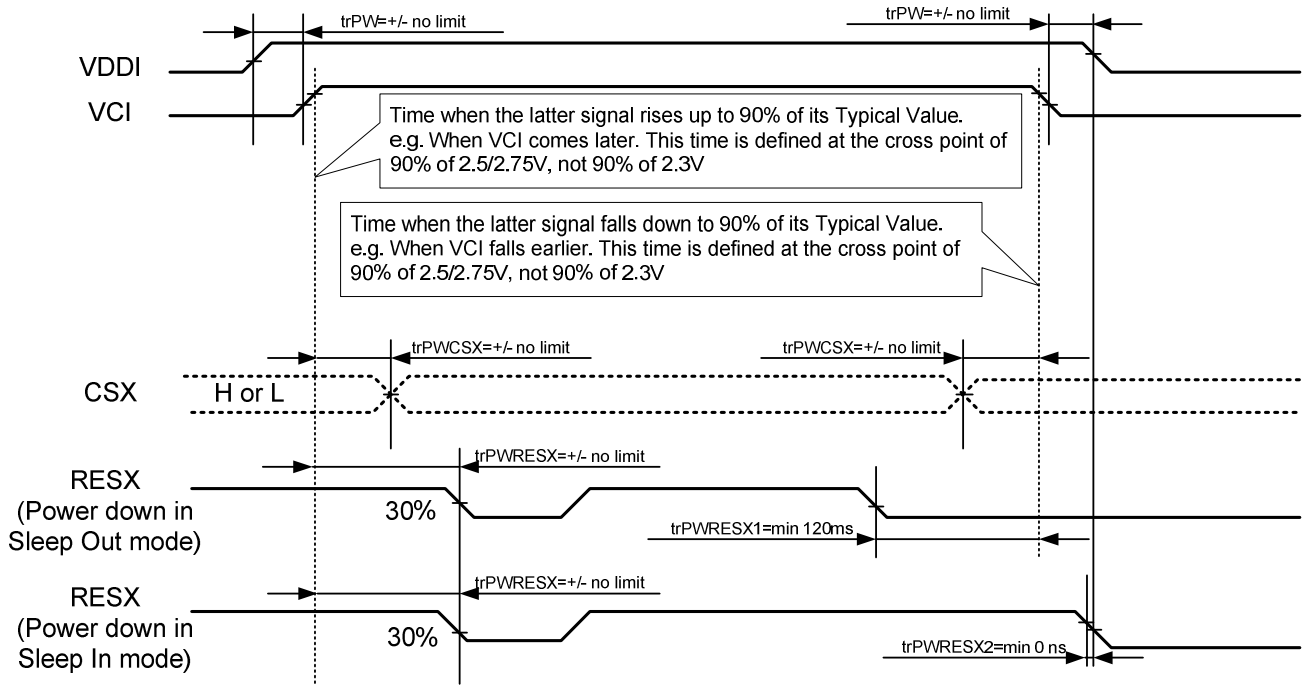
Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.

Note 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.

Note 4: If RESX line is not held stable by host during Power On Sequence as defined in Sections 12.1 and 12.2, 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.

12.1. 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 VCI and VDDI have been applied – otherwise correct functionality is not guaranteed. There is no timing restriction upon this hardware reset.

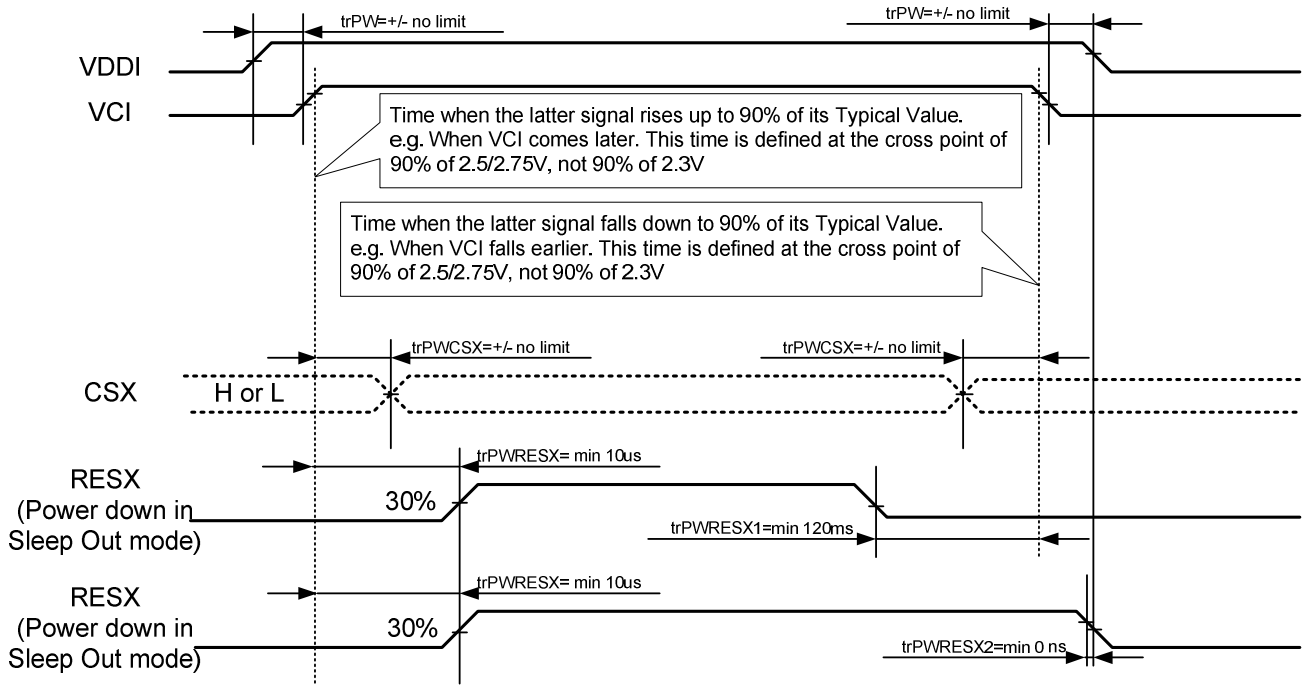


trPWRESX1 is applied to RESX falling in the Sleep Out Mode
trPWRESX2 is applied to RESX falling in the Sleep In Mode

Note 1: Unless otherwise specified, timings herein show cross point at 50% of signal power level.

12.2. 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 VCI and VDDI have been applied.



trPWRESX1 is applied to RESX falling in the Sleep Out Mode
trPWRESX2 is applied to RESX falling in the Sleep In Mode

Note 1: Unless otherwise specified, timings herein show cross point at 50% of signal power level.

12.3. Uncontrolled Power Off

The uncontrolled power off means a situation when e.g. there is removed a battery without the controlled power off sequence. There will not be any damages for the display module or the display module will not cause any damages for the host or lines of the interface. At an uncontrolled power off event, ILI9341 will force the display to blank and will not be any abnormal visible effects with in 1 second on the display and remains blank until “Power On Sequence” actives.

13. Power Level Definition

13.1. Power Levels

7 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.

6. Deep Standby Mode.

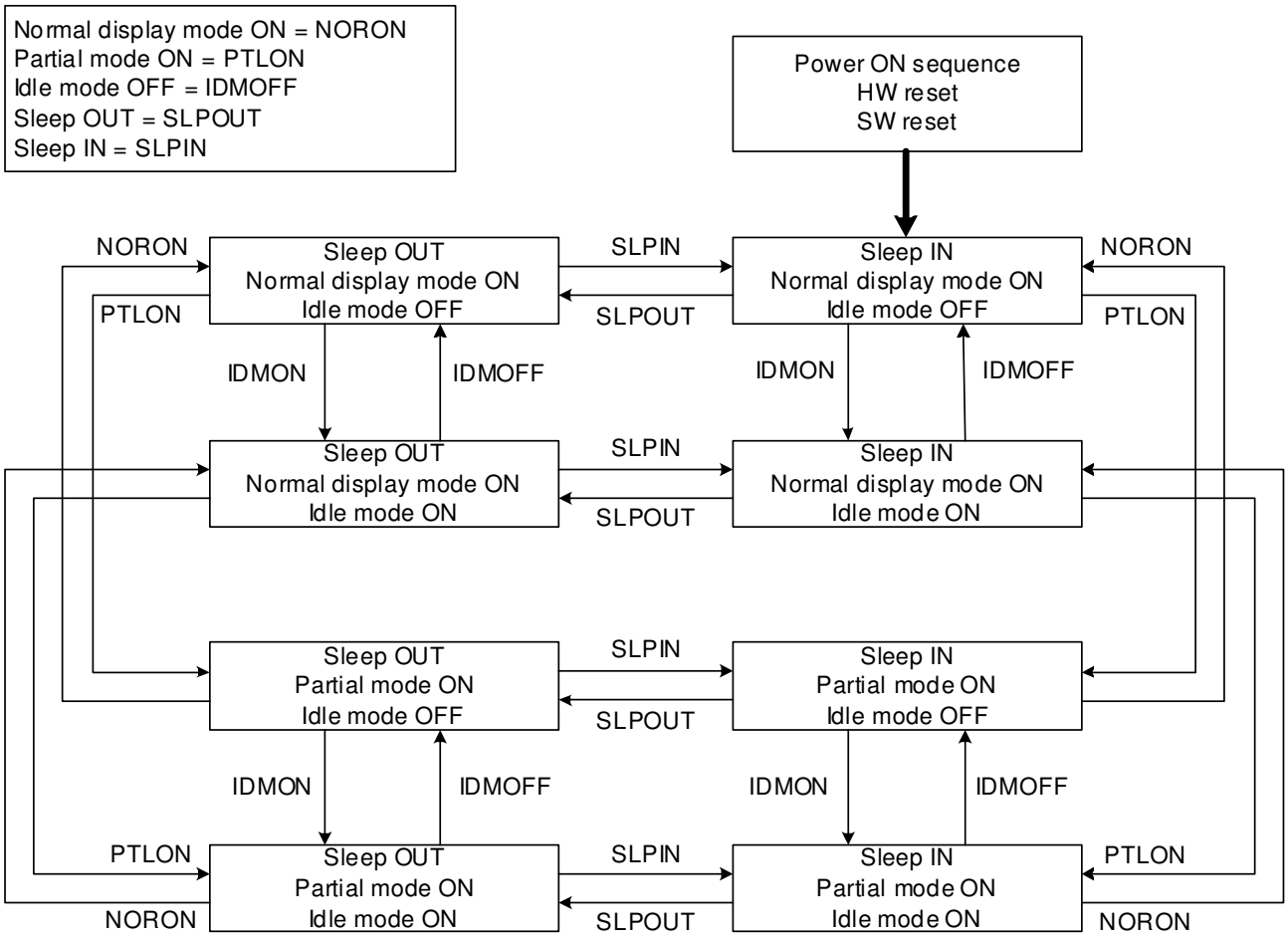
   In Deep Standby mode, both internal logic power and SRAM power are turn off, the display data stored in the Frame Memory and the instructions are not saved. Rewrite Frame Memory content and instructions after the Deep Standby Mode is exited.

7. Power Off Mode.

   In this mode, both VCI and VDDI are removed.

Note1: Transition between modes 1-5 is controllable by MCU commands. Mode 6 is entered only when both Power supplies are removed.

13.2. 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 User, when there is changing from one power mode to another power mode.

14. Gamma Curves Selection

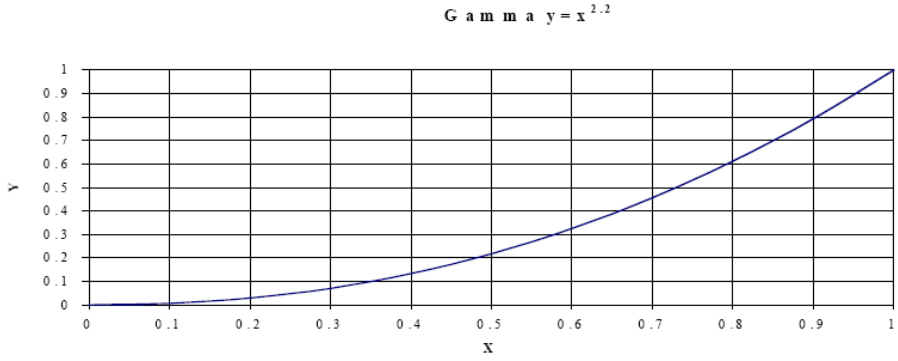
ILI9341 provide one gamma curve Gamma2.2. The gamma curve can be selected by the GC0 settings.

14.1. Gamma Default Values (for NW type LC)

Data	Output Voltage			
	VCOM = Low		VCOM = High	
	Gamma	2.2	Gamma	2.2
0	V0P	4.084	V0N	0.277
1	V1P	4.015	V1N	0.346
2	V2P	3.843	V2N	0.482
3	V3P	3.681	V3N	0.629
4	V4P	3.518	V4N	0.776
5	V5P	3.445	V5N	0.924
6	V6P	3.371	V6N	1.071
7	V7P	3.285	V7N	1.157
8	V8P	3.199	V8N	1.242
9	V9P	3.128	V9N	1.314
10	V10P	3.056	V10N	1.385
11	V11P	2.985	V11N	1.456
12	V12P	2.928	V12N	1.513
13	V13P	2.871	V13N	1.570
14	V14P	2.802	V14N	1.619
15	V15P	2.733	V15N	1.668
16	V16P	2.674	V16N	1.710
17	V17P	2.615	V17N	1.753
18	V18P	2.557	V18N	1.795
19	V19P	2.508	V19N	1.830
20	V20P	2.458	V20N	1.865
21	V21P	2.425	V21N	1.899
22	V22P	2.391	V22N	1.932
23	V23P	2.357	V23N	1.966
24	V24P	2.323	V24N	2.000
25	V25P	2.289	V25N	2.034
26	V26P	2.256	V26N	2.068
27	V27P	2.222	V27N	2.102
28	V28P	2.193	V28N	2.129
29	V29P	2.165	V29N	2.155
30	V30P	2.136	V30N	2.182
31	V31P	2.108	V31N	2.208
32	V32P	2.080	V32N	2.235
33	V33P	2.051	V33N	2.262
34	V34P	2.023	V34N	2.288
35	V35P	1.994	V35N	2.315
36	V36P	1.966	V36N	2.342
37	V37P	1.942	V37N	2.368
38	V38P	1.917	V38N	2.395
39	V39P	1.893	V39N	2.421
40	V40P	1.869	V40N	2.448
41	V41P	1.845	V41N	2.475
42	V42P	1.820	V42N	2.501
43	V43P	1.796	V43N	2.528
44	V44P	1.776	V44N	2.549
45	V45P	1.755	V45N	2.571
46	V46P	1.730	V46N	2.597
47	V47P	1.706	V47N	2.623
48	V48P	1.681	V48N	2.649
49	V49P	1.653	V49N	2.679
50	V50P	1.624	V50N	2.710
51	V51P	1.598	V51N	2.735
52	V52P	1.573	V52N	2.761
53	V53P	1.541	V53N	2.793
54	V54P	1.508	V54N	2.825
55	V55P	1.476	V55N	2.857
56	V56P	1.438	V56N	2.895
57	V57P	1.400	V57N	2.933
58	V58P	1.359	V58N	2.982
59	V59P	1.319	V59N	3.031
60	V60P	1.246	V60N	3.109
61	V61P	1.173	V61N	3.186
62	V62P	1.070	V62N	3.289
63	V63P	0.279	V63N	4.083

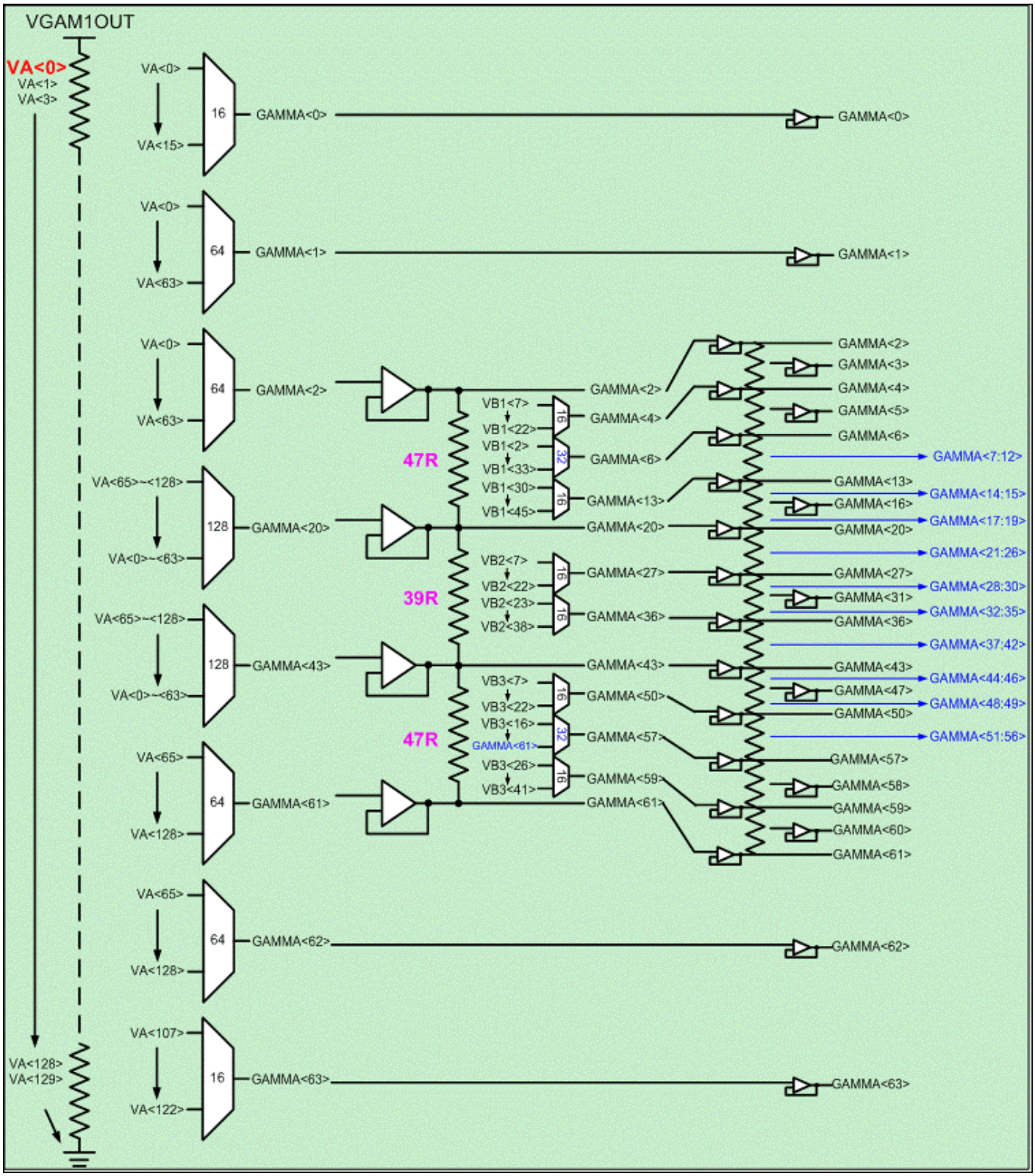
14.2. Gamma Curves

14.2.1. Gamma Curve 1 (GC0), applies the function $y=x^{2.2}$



14.3. Gamma Curves

14.3.1. Grayscale Voltage Generation



14.3.2. Positive Gamma Correction

Gamma Level	Value "X" in Formula	Formula	
VP0	VP0[3:0]	(VREG1-VGS)*(130R-X*R)/130R	
VP1	VP1[5:0]	(VREG1-VGS)*(130R-X*R)/130R	
VP2	VP2[5:0]	(VREG1-VGS)*(130R-X*R)/130R	
VP3	—	(VP2-VP4)*35R/(35R*2)+VP4	
VP4	VP4[3:0]	(VP2-VP20)*(47R-X*R-7R)/47R+VP20	
VP5	—	(VP4-VP6)*35R/(35R*2)+VP6	
VP6	VP6[4:0]	(VP2-VP20)*(47R-X*R-2R)/47R+VP20	
VP7	—	(VP6-VP13)*(12R+10R*3+8R*2) /(12R*2+10R*3+8R*2)+VP13	
VP8	—	(VP6-VP13)*(10R*3+8R*2)/(12R*2+10R*3+8R*2)+VP13	
VP9	—	(VP6-VP13)*(10R*2+8R*2)/(12R*2+10R*3+8R*2)+VP13	
VP10	—	(VP6-VP13)*(10R+8R*2)/(12R*2+10R*3+8R*2)+VP13	
VP11	—	(VP6-VP13)*(8R*2)/(12R*2+10R*3+8R*2)+VP13	
VP12	—	(VP6-VP13)*8R/(12R*2+10R*3+8R*2)+VP13	
VP13	VP13[3:0]	(VP2-VP20)*(47R-X*R-30R)/47R+VP20	
VP14	—	(VP13-VP20)*(14R+12R*3+10R*2)/(14R*2+12R*3+10R*2)+VP20	
VP15	—	(VP13-VP20)*(12R*3+10R*2)/(14R*2+12R*3+10R*2)+VP20	
VP16	—	(VP13-VP20)*(12R*2+10R*2)/(14R*2+12R*3+10R*2)+VP20	
VP17	—	(VP13-VP20)*(12R+10R*2)/(14R*2+12R*3+10R*2)+VP20	
VP18	—	(VP13-VP20)*(10R*2)/(14R*2+12R*3+10R*2)+VP20	
VP19	—	(VP13-VP20)*10R/(14R*2+12R*3+10R*2)+VP20	
VP20	VP20[6:0]	<64	(VREG1-VGS)*(130R-X*R)/130R
		>=64	(VREG1-VGS)*(130R-X*R-1R)/130R
VP21	—	(VP20-VP27)*(12R*6)/(12R*7)+VP27	
VP22	—	(VP20-VP27)*(12R*5)/(12R*7)+VP27	
VP23	—	(VP20-VP27)*(12R*4)/(12R*7)+VP27	
VP24	—	(VP20-VP27)*(12R*3)/(12R*7)+VP27	
VP25	—	(VP20-VP27)*(12R*2)/(12R*7)+VP27	
VP26	—	(VP20-VP27)*12R/(12R*7)+VP27	
VP27	VP27[3:0]	(VP20-VP43)*(39R-X*R-7R)/39R+VP43	
VP28	—	(VP27-VP36)*(8R*8)/(8R*9)+VP36	
VP29	—	(VP27-VP36)*(8R*7)/(8R*9)+VP36	
VP30	—	(VP27-VP36)*(8R*6)/(8R*9)+VP36	
VP31	—	(VP27-VP36)*(8R*5)/(8R*9)+VP36	
VP32	—	(VP27-VP36)*(8R*4)/(8R*9)+VP36	
VP33	—	(VP27-VP36)*(8R*3)/(8R*9)+VP36	
VP34	—	(VP27-VP36)*(8R*2)/(8R*9)+VP36	
VP35	—	(VP27-VP36)*8R/(8R*9)+VP36	
VP36	VP36[3:0]	(VP20-VP43)*(39R-X*R-23R)/39R+VP43	
VP37	—	(VP36-VP43)*(12R*6)/(12R*7)+VP43	
VP38	—	(VP36-VP43)*(12R*5)/(12R*7)+VP43	
VP39	—	(VP36-VP43)*(12R*4)/(12R*7)+VP43	
VP40	—	(VP36-VP43)*(12R*3)/(12R*7)+VP43	
VP41	—	(VP36-VP43)*(12R*2)/(12R*7)+VP43	
VP42	—	(VP36-VP43)*12R/(12R*7)+VP43	
VP43	VP43[6:0]	<64	(VREG1-VGS)*(130R-X*R)/130R
		>=64	(VREG1-VGS)*(130R-X*R-1R)/130R
VP44	—	(VP43-VP50)*(14R*2+12R*3+10R)/(14R*2+12R*3+10R*2)+VP50	
VP45	—	(VP43-VP50)*(14R*2+12R*3)/(14R*2+12R*3+10R*2)+VP50	
VP46	—	(VP43-VP50)*(14R*2+12R*2)/(14R*2+12R*3+10R*2)+VP50	
VP47	—	(VP43-VP50)*(14R*2+12R)/(14R*2+12R*3+10R*2)+VP50	
VP48	—	(VP43-VP50)*(14R*2)/(14R*2+12R*3+10R*2)+VP50	
VP49	—	(VP43-VP50)*14R/(14R*2+12R*3+10R*2)+VP50	
VP50	VP50[3:0]	(VP43-VP61)*(47R-X*R-7R)/47R+VP61	
VP51	—	(VP50-VP57)*(12R*2+10R*3+8R)/(12R*2+10R*3+8R*2)+VP57	
VP52	—	(VP50-VP57)*(12R*2+10R*3)/(12R*2+10R*3+8R*2)+VP57	
VP53	—	(VP50-VP57)*(12R*2+10R*2)/(12R*2+10R*3+8R*2)+VP57	
VP54	—	(VP50-VP57)*(12R*2+10R)/(12R*2+10R*3+8R*2)+VP57	
VP55	—	(VP50-VP57)*(12R*2)/(12R*2+10R*3+8R*2)+VP57	
VP56	—	(VP50-VP57)*12R/(12R*2+10R*3+8R*2)+VP57	
VP57	VP57[4:0]	(VP43-VP61)*(47R-X*R-16R)/47R+VP61	
VP58	—	(VP57-VP59)*35R/(35R*2)+VP59	
VP59	VP59[3:0]	(VP43-VP61)*(47R-X*R-26R)/47R+VP61	
VP60	—	(VP59-VP61)*35R/(35R*2)+VP61	
VP61	VP61[5:0]	(VREG1-VGS)*(65R-X*R)/130R	
VP62	VP62[5:0]	(VREG1-VGS)*(65R-X*R)/130R	
VP63	VP63[3:0]	(VREG1-VGS)*(23R-X*R)/130R	

14.3.3. Negative Gamma Correction

Gamma Level	Value "X" in Formula	Formula	
VN63	VN63[3:0]	(VREG1-VGS)*(130R-X*R)/130R	
VN62	VN62[5:0]	(VREG1-VGS)*(130R-X*R)/130R	
VN61	VN61[5:0]	(VREG1-VGS)*(130R-X*R)/130R	
VN60	—	(VN61-VN59)*35R/(35R*2)+VN59	
VN59	VN59[3:0]	(VN61-VN43)*(47R-X*R-7R)/47R+VN43	
VN58	—	(VN59-VN57)*35R/(35R*2)+VN57	
VN57	VN57[4:0]	(VN61-VN43)*(47R-X*R-2R)/47R+VN43	
VN56	—	(VN57-VN50)*(12R+10R*3+8R*2)/(12R*2+10R*3+8R*2)+VN50	
VN55	—	(VN57-VN50)*(10R*3+8R*2)/(12R*2+10R*3+8R*2)+VN50	
VN54	—	(VN57-VN50)*(10R*2+8R*2)/(12R*2+10R*3+8R*2)+VN50	
VN53	—	(VN57-VN50)*(10R+8R*2)/(12R*2+10R*3+8R*2)+VN50	
VN52	—	(VN57-VN50)*(8R*2)/(12R*2+10R*3+8R*2)+VN50	
VN51	—	(VN57-VN50)*8R/(12R*2+10R*3+8R*2)+VN50	
VN50	VN50[3:0]	(VN61-VN43)*(47R-X*R-30R)/47R+VN43	
VN49	—	(VN50-VN43)*(14R+12R*3+10R*2)/(14R*2+12R*3+10R*2)+VN43	
VN48	—	(VN50-VN43)*(12R*3+10R*2)/(14R*2+12R*3+10R*2)+VN43	
VN47	—	(VN50-VN43)*(12R*2+10R*2)/(14R*2+12R*3+10R*2)+VN43	
VN46	—	(VN50-VN43)*(12R+10R*2)/(14R*2+12R*3+10R*2)+VN43	
VN45	—	(VN50-VN43)*(10R*2)/(14R*2+12R*3+10R*2)+VN43	
VN44	—	(VN50-VN43)*10R/(14R*2+12R*3+10R*2)+VN43	
VN43	VN43[6:0]	<64	(VREG1-VGS)*(130R-X*R)/130R
		>=64	(VREG1-VGS)*(130R-X*R-1R)/130R
VN42	—	(VN43-VN36)*(12R*6)/(12R*7)+VN36	
VN41	—	(VN43-VN36)*(12R*5)/(12R*7)+VN36	
VN40	—	(VN43-VN36)*(12R*4)/(12R*7)+VN36	
VN39	—	(VN43-VN36)*(12R*3)/(12R*7)+VN36	
VN38	—	(VN43-VN36)*(12R*2)/(12R*7)+VN36	
VN37	—	(VN43-VN36)*12R/(12R*7)+VN36	
VN36	VN36[3:0]	(VN43-VN20)*(39R-X*R-7R)/39R+VN20	
VN35	—	(VN36-VN27)*(8R*8)/(8R*9)+VN27	
VN34	—	(VN36-VN27)*(8R*7)/(8R*9)+VN27	
VN33	—	(VN36-VN27)*(8R*6)/(8R*9)+VN27	
VN32	—	(VN36-VN27)*(8R*5)/(8R*9)+VN27	
VN31	—	(VN36-VN27)*(8R*4)/(8R*9)+VN27	
VN30	—	(VN36-VN27)*(8R*3)/(8R*9)+VN27	
VN29	—	(VN36-VN27)*(8R*2)/(8R*9)+VN27	
VN28	—	(VN36-VN27)*8R/(8R*9)+VN27	
VN27	VN27[3:0]	(VN43-VN20)*(39R-X*R-23R)/39R+VN20	
VN26	—	(VN27-VN20)*(12R*6)/(12R*7)+VN20	
VN25	—	(VN27-VN20)*(12R*5)/(12R*7)+VN20	
VN24	—	(VN27-VN20)*(12R*4)/(12R*7)+VN20	
VN23	—	(VN27-VN20)*(12R*3)/(12R*7)+VN20	
VN22	—	(VN27-VN20)*(12R*2)/(12R*7)+VN20	
VN21	—	(VN27-VN20)*12R/(12R*7)+VN20	
VN20	VN20[6:0]	<64	(VREG1-VGS)*(130R-X*R)/130R
		>=64	(VREG1-VGS)*(130R-X*R-1R)/130R
VN19	—	(VN20-VN13)*(14R*2+12R*3+10R)/(14R*2+12R*3+10R*2)+VN13	
VN18	—	(VN20-VN13)*(14R*2+12R*3)/(14R*2+12R*3+10R*2)+VN13	
VN17	—	(VN20-VN13)*(14R*2+12R*2)/(14R*2+12R*3+10R*2)+VN13	
VN16	—	(VN20-VN13)*(14R*2+12R)/(14R*2+12R*3+10R*2)+VN13	
VN15	—	(VN20-VN13)*(14R*2)/(14R*2+12R*3+10R*2)+VN13	
VN14	—	(VN20-VN13)*14R/(14R*2+12R*3+10R*2)+VN13	
VN13	VN13[3:0]	(VN20-VN2)*(47R-X*R-7R)/47R+VN2	
VN12	—	(VN13-VN6)*(12R*2+10R*3+8R)/(12R*2+10R*3+8R*2)+VN6	
VN11	—	(VN13-VN6)*(12R*2+10R*3)/(12R*2+10R*3+8R*2)+VN6	
VN10	—	(VN13-VN6)*(12R*2+10R*2)/(12R*2+10R*3+8R*2)+VN6	
VN9	—	(VN13-VN6)*(12R*2+10R)/(12R*2+10R*3+8R*2)+VN6	
VN8	—	(VN13-VN6)*(12R*2)/(12R*2+10R*3+8R*2)+VN6	
VN7	—	(VN13-VN6)*12R/(12R*2+10R*3+8R*2)+VN6	
VN6	VN6[4:0]	(VN20-VN2)*(47R-X*R-16R)/47R+VN2	
VN5	—	(VN6-VN4)*35R/(35R*2)+VN4	
VN4	VN4[3:0]	(VN20-VN2)*(47R-X*R-26R)/47R+VN2	
VN3	—	(VN4-VN2)*35R/(35R*2)+VN2	
VN2	VN2[5:0]	(VREG1-VGS)*(65R-X*R)/130R	
VN1	VN1[5:0]	(VREG1-VGS)*(65R-X*R)/130R	
VN0	VN0[3:0]	(VREG1-VGS)*(23R-X*R)/130R	

15. Reset

15.1. Registers

The registers that are initialized are listed as below:

	After Powered ON	After Hardware Reset	After Software Reset
Frame Memory	Random	Repair data	No Change
Sleep	In	In	In
Display Mode	Normal	Normal	Normal
Display	Off	Off	Off
Idle	Off	Off	Off
Column Start Address	0000 h	0000 h	0000 h
Column End Address	00EF h	00EF h	If MADCTL's B5=0:00EF h If MADCTL's B5=1:013F h
Page Start Address	0000 h	0000 h	0000 h
Page End Address	013F h	013F h	If MADCTL's B5 = 0:013F h If MADCTL's B5=1:00EF h
Gamma Setting	GC0	GC0	GC0
Partial Area Start	0000 h	0000 h	0000 h
Partial Area End	013F h	013F h	013F h
Memory Data Access Control	00 h	00 h	No Change
RDDPM	08 h	08 h	08 h
RDDMADCTL	00 h	00 h	No Change
RDDCOLMOD	06 h	06 h	06 h
RDDIM	00 h	00 h	00 h
RDDSM	00 h	00 h	00 h
RDDSDR	00 h	00 h	00 h
TE Output Line	Off	Off	Off
TE Line Mode	Mode 1 (Note 3)	Mode 1 (Note 3)	Mode 1 (Note 3)

Note 1: There will be no abnormal visible effects on the display when S/W or H/W Resets are applied.

Note 2: After Powered-On Reset finishes within 10µs after both VCI *& VDDI are applied.*

Note 3: Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

Note 4: When a RESX input is entered into the ILI9341 while it is in deep standby mode, the ILI9341 starts up the inside logic regulator and makes a transition to the initial state. During this period, the state of the interface pins may become unstable.

15.2. Output Pins, I/O Pins

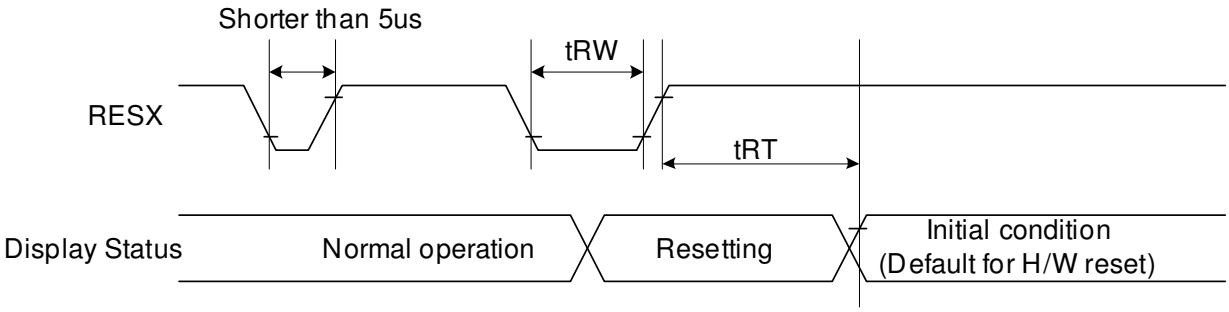
	After Power ON	After Hardware Reset	After Software Reset
TE line	Low	Low	Low
D[17:0] (output driver)	Hi-Z (Inactive)	Hi-Z (Inactive)	Hi-Z (Inactive)

Note 1: There will be no output from D [17:0] during Power ON/OFF sequence, hardware reset and software reset.

15.3. Input Pins

	During Power ON Process	After Power ON	After Hardware Reset	After Software Reset	During Power OFF Process
RESX	See Chapter 12	Input valid	Input valid	Input valid	See Chapter 12
CSX	Input invalid	Input valid	Input valid	Input valid	Input invalid
D/CX	Input invalid	Input valid	Input valid	Input valid	Input invalid
WRX	Input invalid	Input valid	Input valid	Input valid	Input invalid
RDX	Input invalid	Input valid	Input valid	Input valid	Input invalid
D[17:0] (input driver)	Input invalid	Input valid	Input valid	Input valid	Input invalid

15.4. Reset Timing



Signal	Symbol	Parameter	Min	Max	Unit
RESX	tRW	Reset pulse duration	10		uS
	tRT	Reset cancel		5 (note 1,5)	mS
				120 (note 1,6,7)	mS

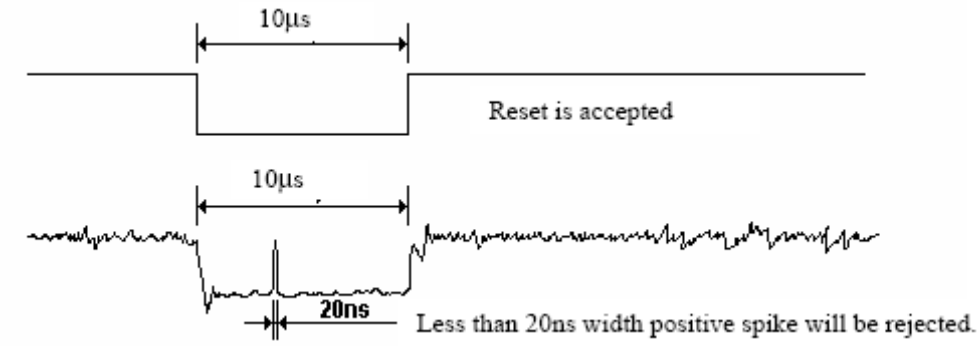
Note 1: The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NV memory to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

Note 2: Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below: -

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 10us	Reset
Between 5us and 10us	Reset starts

Note 3: 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.

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

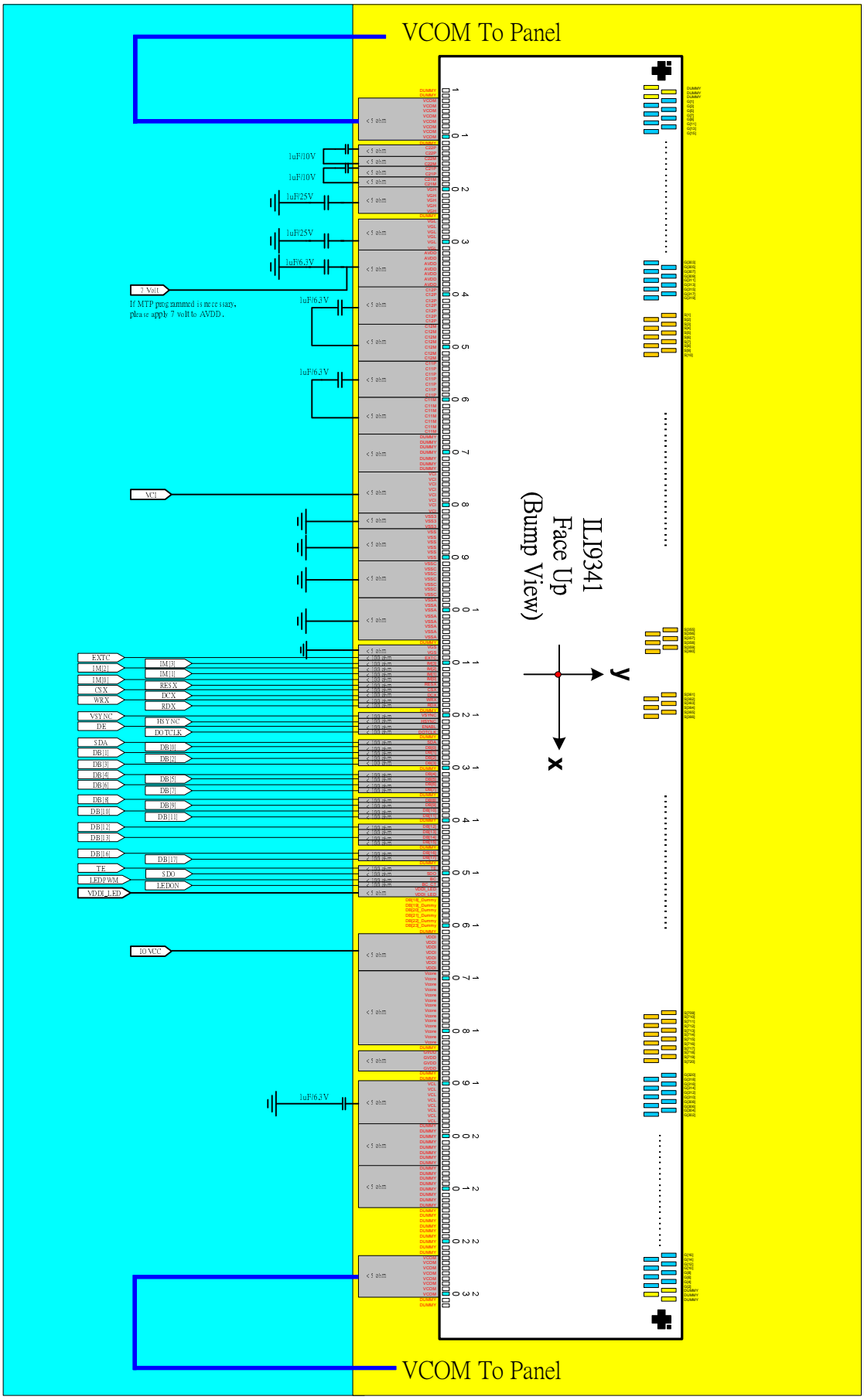


Note 5: When Reset applied during Sleep In Mode.

Note 6: When Reset applied during Sleep Out Mode.

Note 7: It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

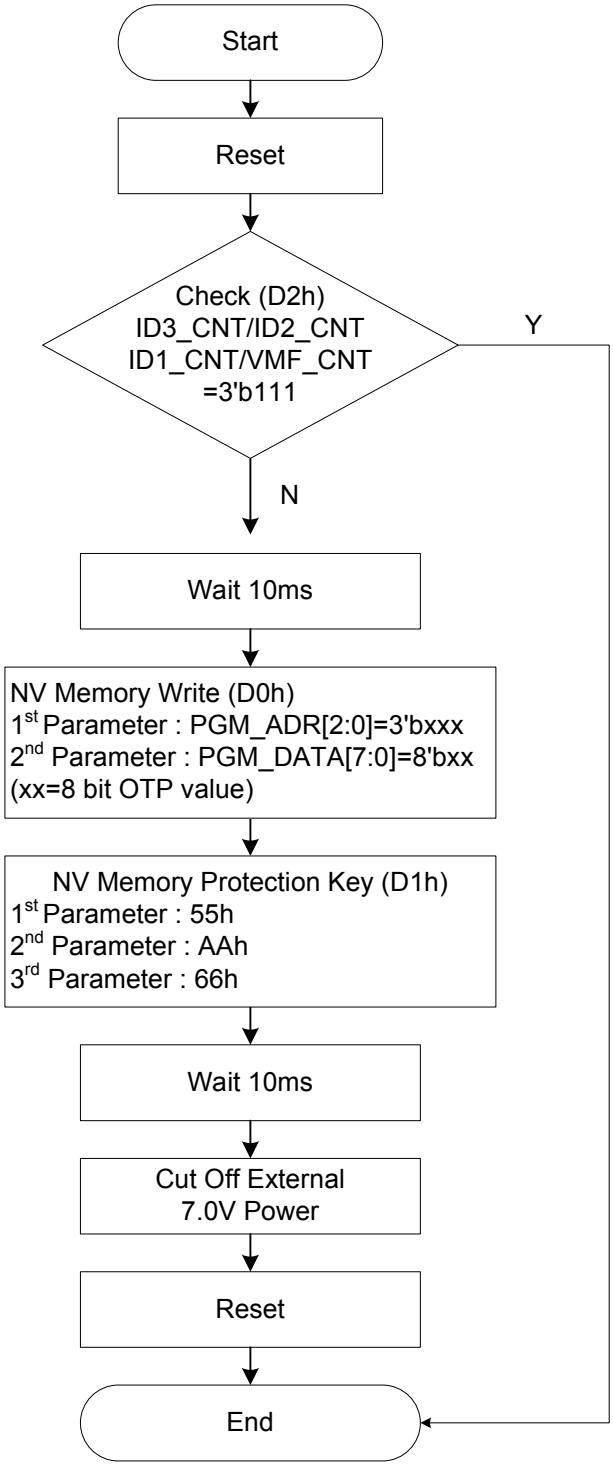
16. Configuration of Power Supply Circuit



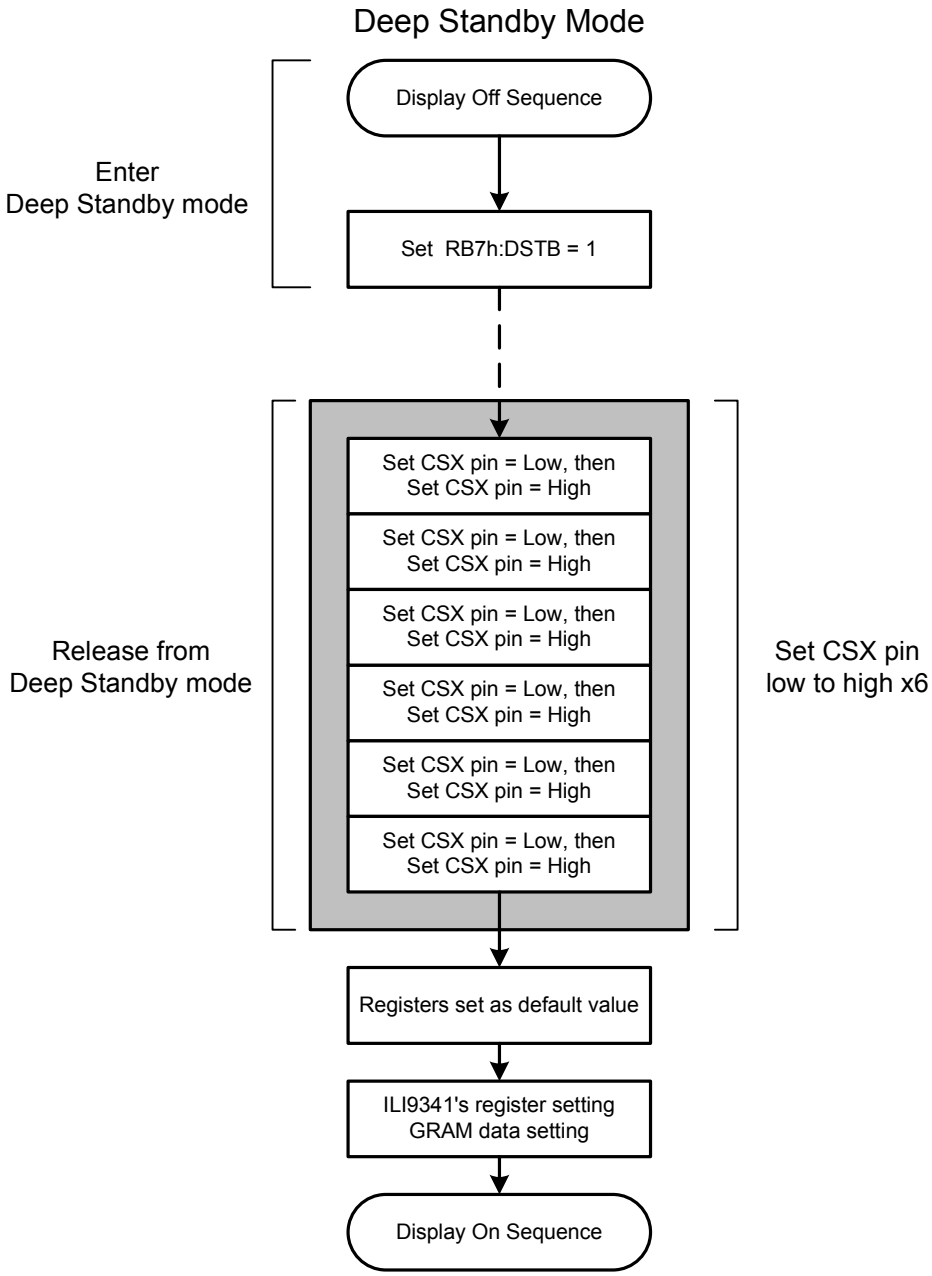
The Following tables shows specifications of external elements connected to the ILI9341's power supply circuit.

Items	Recommended Specification	Pin connection
Capacity 1 µF (B characteristics)	6.3V	AVDD ,VCL,C11P/M,C12P/M,
	10V	C21P/M,C22P/M
	25V	VGL, VGH

17. NV Memory Programming Flow



18. Deep Standby Mode Setting



Note: (1) To Return display mode according to normal display ON sequence when ILI9341 exits Deep standby mode to Sleep mode.

(2) Leave at lease 1ms between the 2nd and 3rd inputs of CSX=Low.

(3) This sequence must be completed before writing data to GRAM.

(4) ILI9341 exits deep standby mode and enters to sleep mode when an effective RESX pulse is inputted during Deep Standby mode.

19. Electrical Characteristics

19.1. Absolute Maximum Ratings

The absolute maximum rating is listed on following table. When ILI9341 is used out of the absolute maximum ratings, ILI9341 may be permanently damaged. To use ILI9341 within the following electrical characteristics limitation is strongly recommended for normal operation. If these electrical characteristic conditions are exceeded during normal operation, ILI9341 will malfunction and cause poor reliability.

Item	Symbol	Unit	Value
Supply voltage	VCI	V	-0.3 ~ +4.6
Supply voltage (Logic)	VDDI	V	-0.3 ~ +4.6
Supply voltage (Digital)	VCORE	V	-0.3 ~ +2.0
Driver supply voltage	VGH-VGL	V	-0.3 ~ +32.0
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	℃	-40 ~ +85
Storage temperature	Tstg	℃	-55 ~ +110
Note: 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.			

19.2. DC Characteristics

19.2.1. General DC Characteristics

Item	Symbol	Unit	Condition	Min.	Typ.	Max.	Note
Power and Operation Voltage							
Analog Operating Voltage	VCI	V	Operating voltage	2.5	2.8	3.3	Note2
Logic Operating Voltage	VDDI	V	I/O supply voltage	1.65	2.8	3.3	Note2
Digital Operating voltage	VCORE	V	Digital supply voltage	-	1.5	-	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 and Output							
Logic High Level Input Voltage	VIH	V	-	0.7*VDDI	-	VDDI	Note1,2,3
Logic Low Level Input Voltage	VIL	V	-	VSS	-	0.3*VDDI	Note1,2,3
Logic High Level Output Voltage	VOH	V	IOL=-1.0mA	0.8*VDDI	-	VDDI	Note1,2,3
Logic Low Level Output Voltage	VOL	V	IOL=1.0mA	VSS	-	0.2*VDDI	Note1,2,3
Logic High Level Input Current	IIH	uA	-	-	-	1	Note1,2,3
Logic Low Level input Current	IIL	uA	-	-1	-	-	Note1,2,3
Logic Input Leakage Current	ILEA	uA	VIN=VDDI or VSS	-0.1	-	+0.1	Note1,2,3
VCOM Operation							
VCOM High Voltage	VCOMH	V	Ccom=12nF	2.5	-	5.0	Note3
VCOM Low Voltage	VCOML	V	Ccom=12nF	-2.5	-	0.0	Note3
VCOM Amplitude Voltage	VCOMA	V	|VCOMH-VCOML|	4.0	-	5.5	Note3
Source Driver							
Source Output Range	Vsout	V	-	0.1	-	AVDD-0.1	Note4
Gamma Reference Voltage	GVDD	V	-	3.0	-	5.0	Note3
Output Deviation Voltage (Source Output channel)	Vdev	mV	Sout>=4.2V Sout<=0.8V	-	-	20	Note4
			4.2V>Sout>0.8V	-	-	15	-
Output Offset Voltage	VOFSET	mV	-	-	-	35	Note7
Booster Operation							
1st Booster (VCIx2) Voltage	AVDD	V	-	4.95 (Note 5)	-	5.5 (Note 6)	Note3
1st Booster (VCIx2 Drop Voltage	VCIx2 drop	%	loading=1mA	-	-	5	Note3
Liner Range	Vliner	V	-	0.2	-	AVDD-0.2	

Note 1: VDDI=1.65 to 3.3V, VCI=2.5 to 3.3V, AGND=VSS=0V, Ta=-30 to 70 (to +85 no damage) ℃.

Note2: Please supply digital VDDI voltage equal or less than analog VCI voltage.

Note3: CSX, RDX, WRX, D[17:0], D/CX, RESX, TE, DOTCLK, VSYNC, HSYNC, DE, SDA, SCL, IM3, IM2, IM1, IM0, and Test pins.

Note4: When the measurements are performed with LCD module. Measurement Points are like Note3.

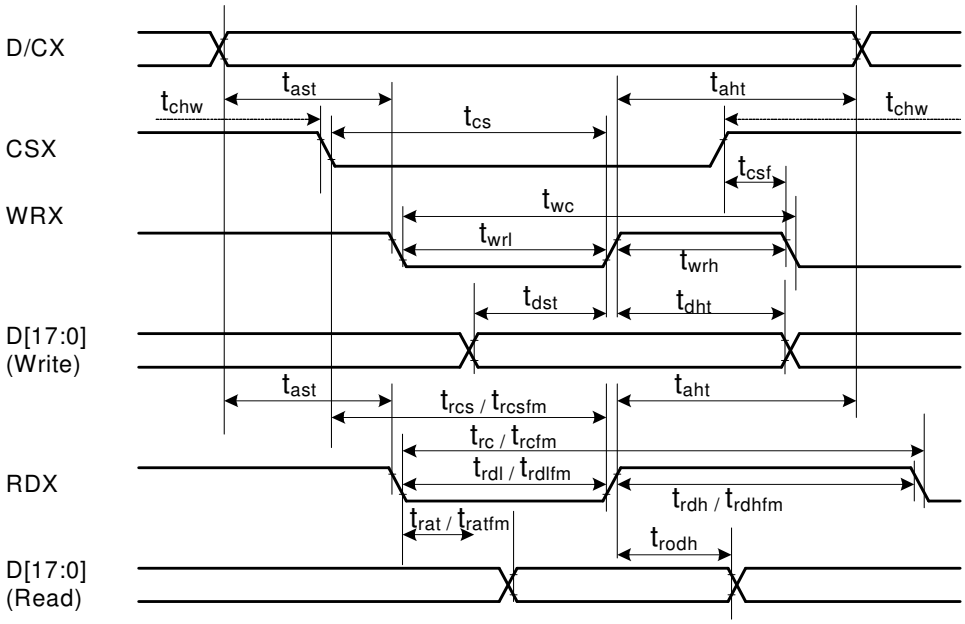
Note5: VCI=2.6V

Note6: VCI=3.3V

Note7: The Max. Value is between with Note 4 measure point and Gamma setting value

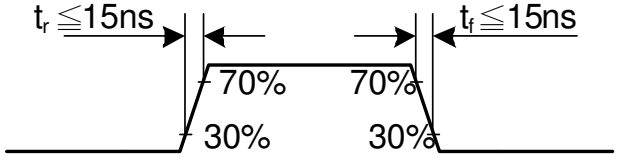
19.3. AC Characteristics

19.3.1. Display Parallel 18/16/9/8-bit Interface Timing Characteristics (8080- Ⅰ system)

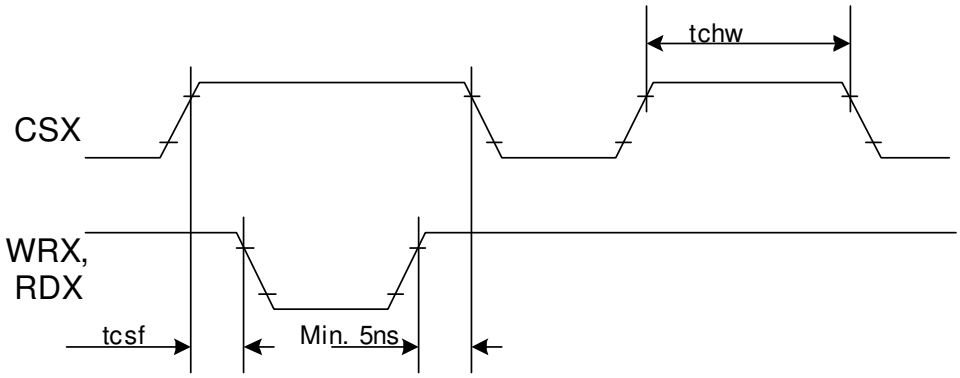


Signal	Symbol	Parameter	min	max	Unit	Description
DCX	tast	Address setup time	0	-	ns	
	taht	Address hold time (Write/Read)	0	-	ns	
CSX	tchw	CSX “H” pulse width	0	-	ns	
	tcs	Chip Select setup time (Write)	15	-	ns	
	trcs	Chip Select setup time (Read ID)	45	-	ns	
	trcsfm	Chip Select setup time (Read FM)	355	-	ns	
	tcsf	Chip Select Wait time (Write/Read)	10	-	ns	
WRX	twc	Write cycle	66	-	ns	
	twrh	Write Control pulse H duration	15	-	ns	
	twrl	Write Control pulse L duration	15	-	ns	
RDX (FM)	trcfm	Read Cycle (FM)	450	-	ns	
	trdhfm	Read Control H duration (FM)	90	-	ns	
	trdlfm	Read Control L duration (FM)	355	-	ns	
RDX (ID)	trc	Read cycle (ID)	160	-	ns	
	trdh	Read Control pulse H duration	90	-	ns	
	trdl	Read Control pulse L duration	45	-	ns	
D[17:0], D[15:0], D[8:0], D[7:0]	tdst	Write data setup time	10	-	ns	For maximum CL=30pF For minimum CL=8pF
	tdht	Write data hold time	10	-	ns	
	trat	Read access time	-	40	ns	
	tratfm	Read access time	-	340	ns	
	trod	Read output disable time	20	80	ns	

Note: Ta = -30 to 70 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, VSS=0V

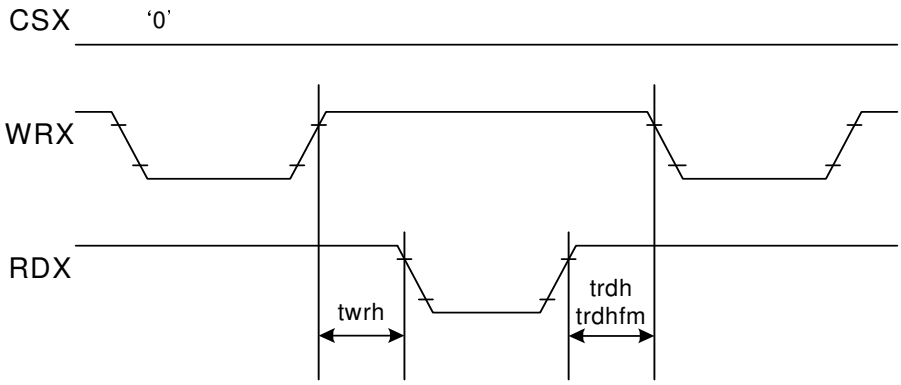


CSX timings :



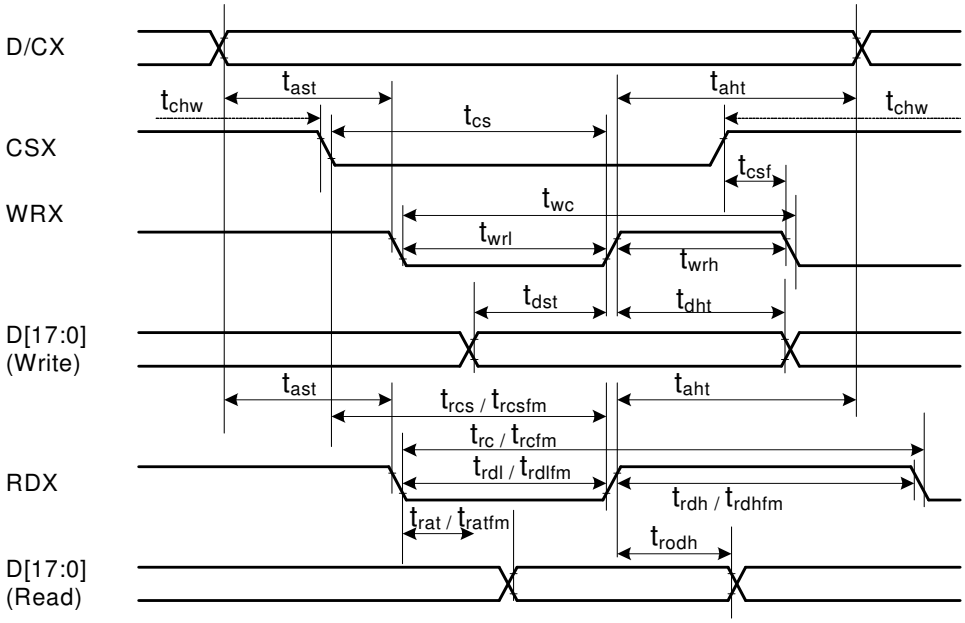
Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

Write to read or read to write timings:



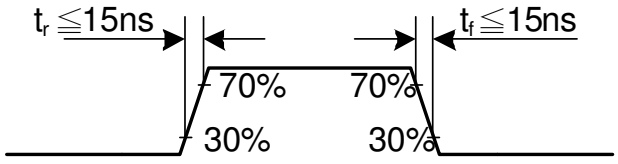
Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

19.3.2. Display Parallel 18/16/9/8-bit Interface Timing Characteristics(8080-Ⅱ system)

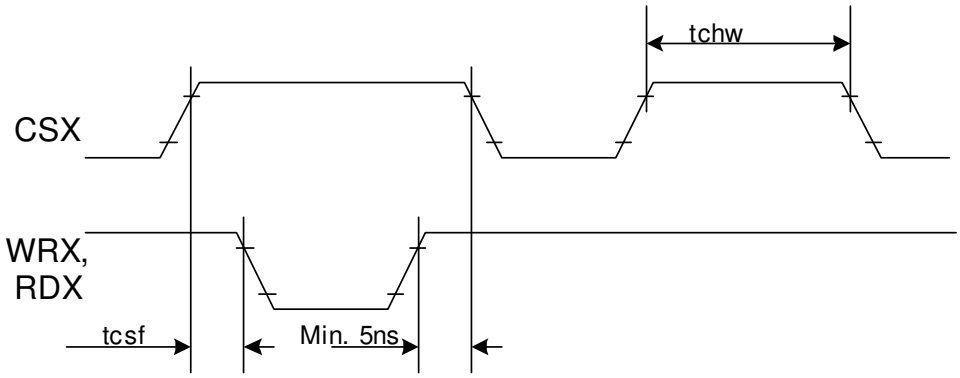


Signal	Symbol	Parameter	min	max	Unit	Description
DCX	tast	Address setup time	0	-	ns	
	taht	Address hold time (Write/Read)	0	-	ns	
CSX	tchw	CSX "H" pulse width	0	-	ns	
	tcs	Chip Select setup time (Write)	15	-	ns	
	trcs	Chip Select setup time (Read ID)	45	-	ns	
	trcsfm	Chip Select setup time (Read FM)	355	-	ns	
	tcsf	Chip Select Wait time (Write/Read)	10	-	ns	
WRX	twc	Write cycle	66	-	ns	
	twrh	Write Control pulse H duration	15	-	ns	
	twrl	Write Control pulse L duration	15	-	ns	
RDX (FM)	trcfm	Read Cycle (FM)	450	-	ns	
	trdhfm	Read Control H duration (FM)	90	-	ns	
	trdlfm	Read Control L duration (FM)	355	-	ns	
RDX (ID)	trc	Read cycle (ID)	160	-	ns	
	trdh	Read Control pulse H duration	90	-	ns	
	trdl	Read Control pulse L duration	45	-	ns	
D[17:0], D[17:10]&D[8:1], D[17:10], D[17:9]	tdst	Write data setup time	10	-	ns	For maximum CL=30pF For minimum CL=8pF
	tdht	Write data hold time	10	-	ns	
	trat	Read access time	-	40	ns	
	tratfm	Read access time	-	340	ns	
	trod	Read output disable time	20	80	ns	

Note: Ta = -30 to 70 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, VSS=0V.

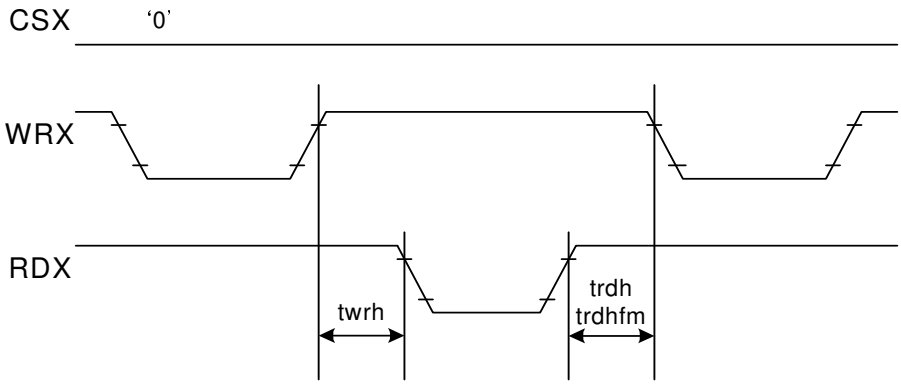


CSX timings :



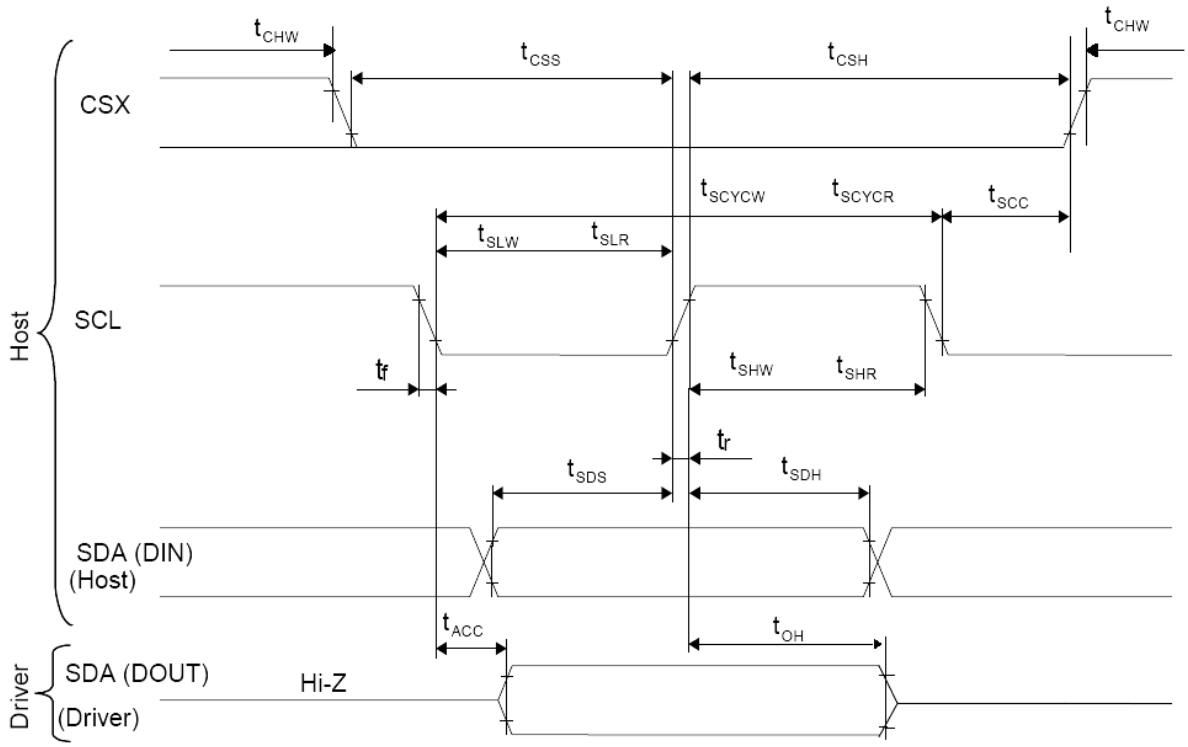
Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

Write to read or read to write timings:



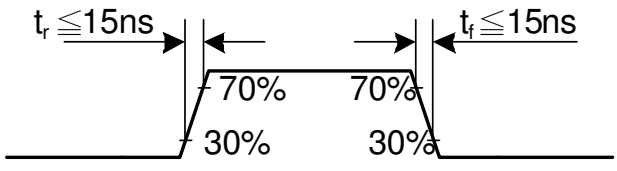
Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

19.3.3. Display Serial Interface Timing Characteristics (3-line SPI system)

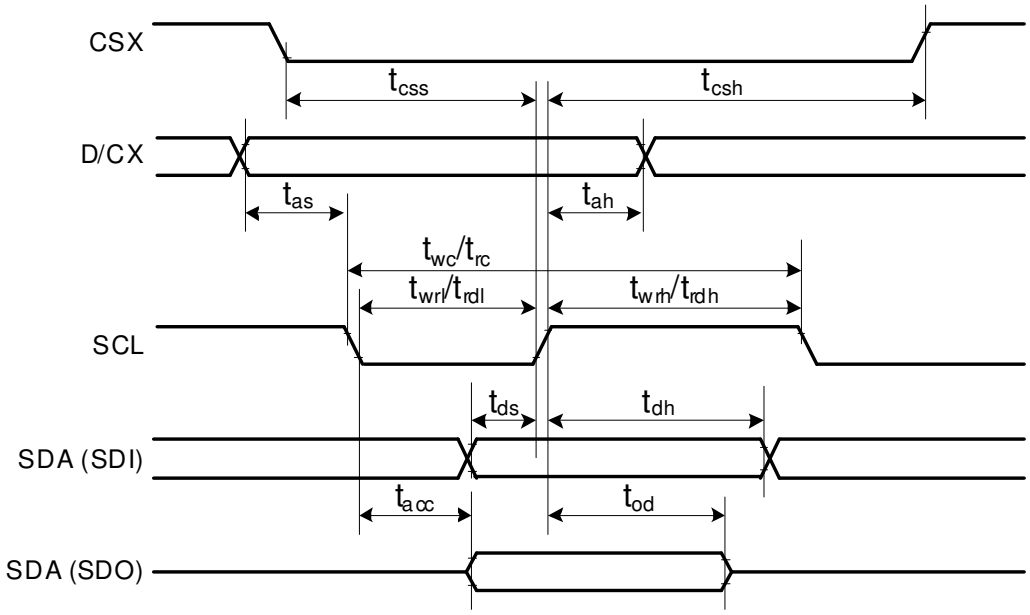


Signal	Symbol	Parameter	min	max	Unit	Description
SCL	tscycw	Serial Clock Cycle (Write)	100	-	ns	
	tshw	SCL “H” Pulse Width (Write)	40	-	ns	
	tslw	SCL “L” Pulse Width (Write)	40	-	ns	
	tscycr	Serial Clock Cycle (Read)	150	-	ns	
	tshr	SCL “H” Pulse Width (Read)	60	-	ns	
	tslr	SCL “L” Pulse Width (Read)	60	-	ns	
SDA / SDI (Input)	tsds	Data setup time (Write)	30	-	ns	
	tsdh	Data hold time (Write)	30	-	ns	
SDA / SDO (Output)	tacc	Access time (Read)	10	-	ns	
	toh	Output disable time (Read)	10	50	ns	
CSX	tscc	SCL-CSX	20	-	ns	
	tchw	CSX “H” Pulse Width	40	-	ns	
	tcss	CSX-SCL Time	60	-	ns	
	tcsh		65	-	ns	

Note: Ta = 25 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V

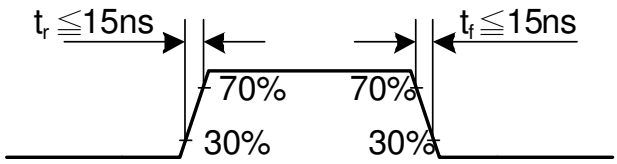


19.3.4. Display Serial Interface Timing Characteristics (4-line SPI system)

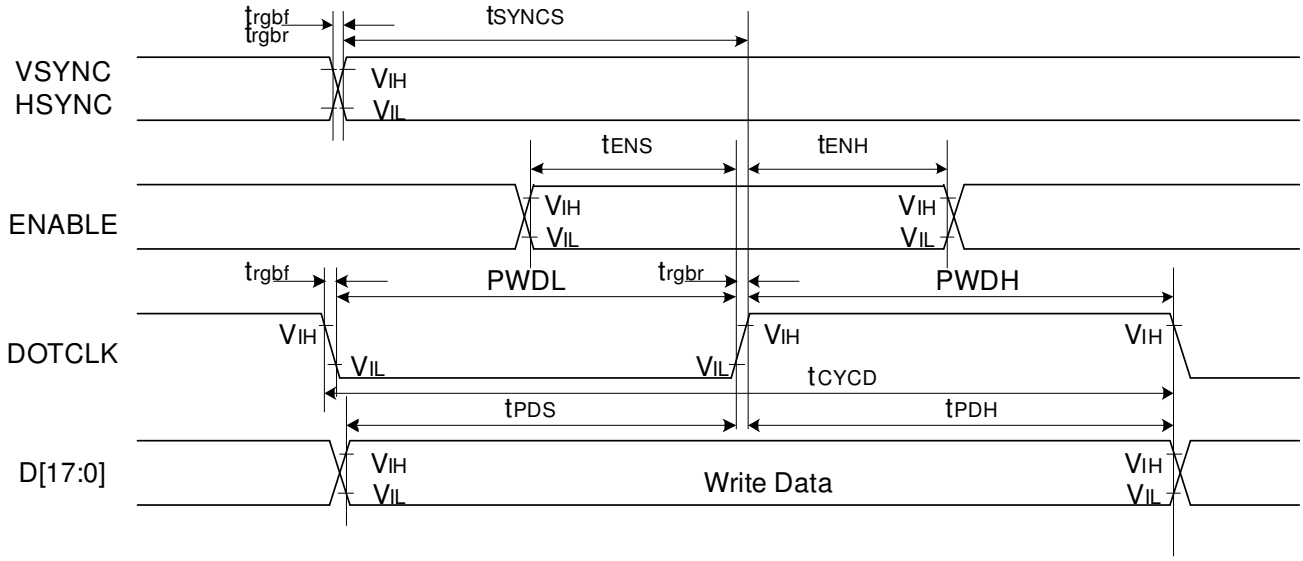


Signal	Symbol	Parameter	min	max	Unit	Description
CSX	tcss	Chip select time (Write)	40	-	ns	
	tcsh	Chip select hold time (Read)	40	-	ns	
SCL	twc	Serial clock cycle (Write)	100	-	ns	
	twrh	SCL “H” pulse width (Write)	40	-	ns	
	twrl	SCL “L” pulse width (Write)	40	-	ns	
	trc	Serial clock cycle (Read)	150	-	ns	
	trdh	SCL “H” pulse width (Read)	60	-	ns	
	trdl	SCL “L” pulse width (Read)	60	-	ns	
D/CX	tas	D/CX setup time	10	-		
	tah	D/CX hold time (Write / Read)	10	-		
SDA / SDI (Input)	tds	Data setup time (Write)	30	-	ns	
	tdh	Data hold time (Write)	30	-	ns	
SDA / SDO (Output)	tacc	Access time (Read)	10	-	ns	For maximum CL=30pF
	tod	Output disable time (Read)	10	50	ns	For minimum CL=8pF

Note: Ta = 25 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V

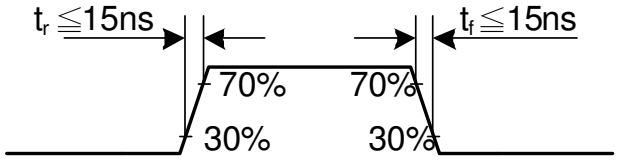


19.3.5. Parallel 18/16/6-bit RGB Interface Timing Characteristics



Signal	Symbol	Parameter	min	max	Unit	Description
VSYNC / HSYNC	t_{SYNCS}	VSYNC/HSYNC setup time	15	-	ns	18/16-bit bus RGB interface mode
	t_{SYNCH}	VSYNC/HSYNC hold time	15	-	ns	
DE	t_{ENS}	DE setup time	15	-	ns	
	t_{ENH}	DE hold time	15	-	ns	
D[17:0]	t_{POS}	Data setup time	15	-	ns	
	t_{PDH}	Data hold time	15	-	ns	
DOTCLK	PWDH	DOTCLK high-level period	15	-	ns	
	PWDL	DOTCLK low-level period	15	-	ns	
	t_{CYCD}	DOTCLK cycle time	100	-	ns	
	t_{rgbr} , t_{rgbf}	DOTCLK,HSYNC,VSYNC rise/fall time	-	15	ns	
VSYNC / HSYNC	t_{SYNCS}	VSYNC/HSYNC setup time	15	-	ns	6-bit bus RGB interface mode
	t_{SYNCH}	VSYNC/HSYNC hold time	15	-	ns	
DE	t_{ENS}	DE setup time	15	-	ns	
	t_{ENH}	DE hold time	15	-	ns	
D[17:0]	t_{POS}	Data setup time	15	-	ns	
	t_{PDH}	Data hold time	15	-	ns	
DOTCLK	PWDH	DOTCLK high-level pulse period	15	-	ns	
	PWDL	DOTCLK low-level pulse period	15	-	ns	
	t_{CYCD}	DOTCLK cycle time	100	-	ns	
	t_{rgbr} , t_{rgbf}	DOTCLK,HSYNC,VSYNC rise/fall time	-	15	ns	

Note: Ta = -30 to 70 ℃, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V



20. Revision History

Version No.	Date	Page	Description
V1.00	2010/10/12	All	New Created.
V1.01	2010/10/12	179	Update charge pump ratio
V1.02	2010/1206	All	Rename 9341

STMPE610

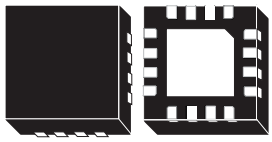
S-Touch®: advanced touchscreen controller with 6-bit port expander

Features

- 6 GPIOs
- 1.8 - 3.3 V operating voltage
- Integrated 4-wire touchscreen controller
- Interrupt output pin
- Wakeup feature on each I/O
- SPI and I^2C interface
- Up to 2 devices sharing the same bus in I^2C mode (1 address line)
- 6-input 12-bit ADC
- 128-depth buffer touchscreen controller
- Touchscreen movement detection algorithm
- 25 kV air-gap ESD protection (system level)
- 4 kV HBM ESD protection (device level)

Applications

- Portable media players
- Game consoles
- Mobile and smartphones
- GPS



QFN16
(3 x 3 mm)

Description

The STMPE610 is a GPIO (general purpose input/output) port expander able to interface a main digital ASIC via the two-line bidirectional bus (I^2C). A separate GPIO expander is often used in mobile multimedia platforms to solve the problems of the limited amount of GPIOs typically available on the digital engine.

The STMPE610 offers great flexibility, as each I/O can be configured as input, output or specific functions. The device has been designed with very low quiescent current and includes a wakeup feature for each I/O, to optimize the power consumption of the device.

A 4-wire touchscreen controller is built into the STMPE610. The touchscreen controller is enhanced with a movement tracking algorithm to avoid excessive data, 128 x 32 bit buffer and a programmable active window feature.

Table 1. Device summary

Order code	Package	Packaging
STMPE610QTR	QFN16	Tape and reel

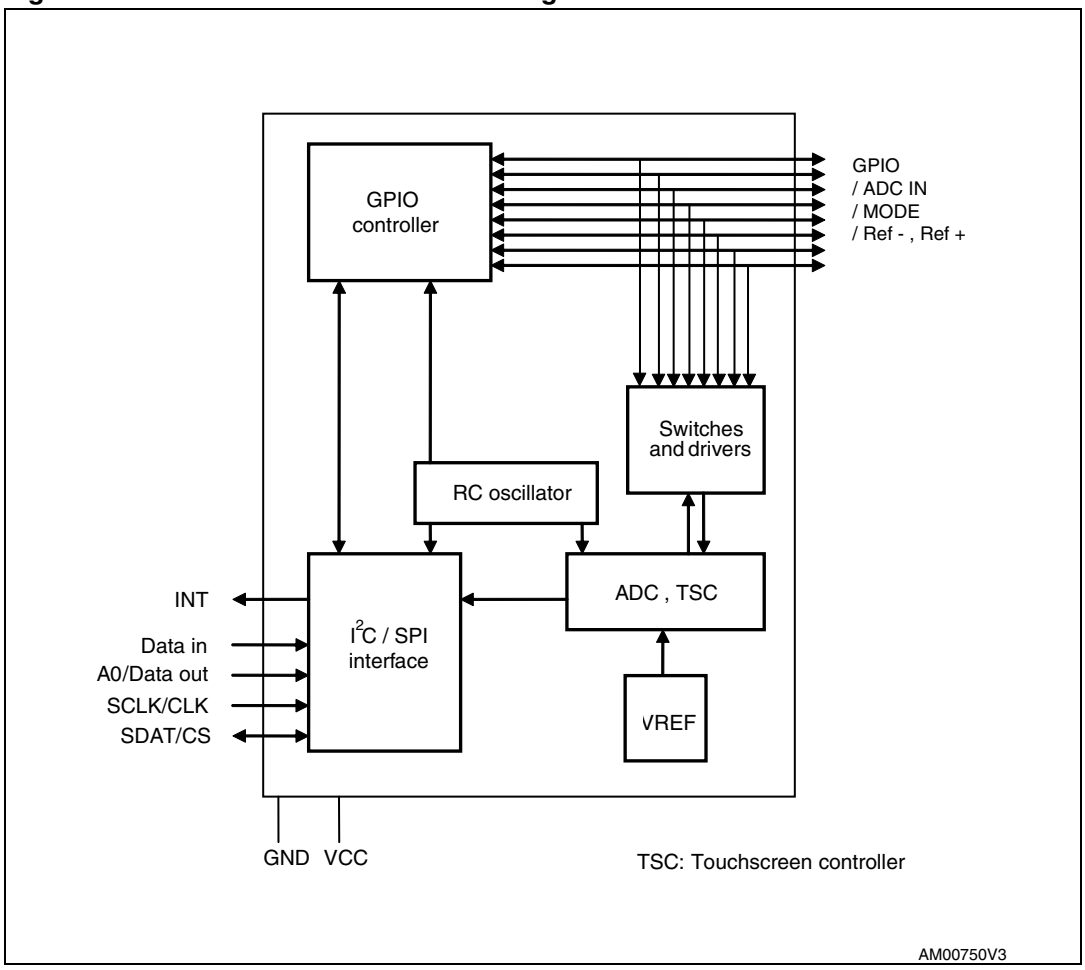
Contents

1 STMPE610 functional overview

The STMPE610 consists of the following blocks:

- I^2C and SPI interface
- Analog-to-digital converver (ADC)
- Touchscreen controller (TSC)
- Driver and switch control unit
- GPIO controller

Figure 1. STMPE610 functional block diagram



2 Pin configuration and functions

Figure 2. STMPE610 pin configuration (top through view)

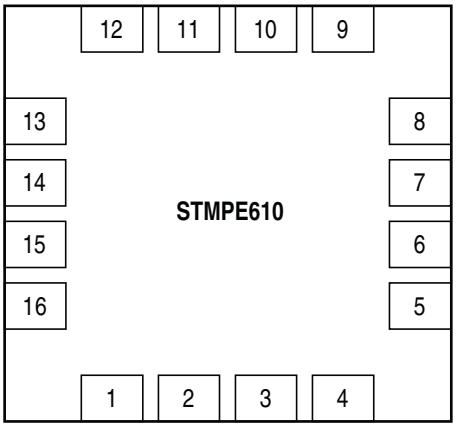


Table 2. Pin assignments

Pin	Name	Function
1	Y-	Y-/GPIO-7
2	INT	Interrupt output (V_{CC} domain, open drain)
3	A0/Data Out	I^2C address in Reset, Data out in SPI mode (V_{CC} domain)
4	SCLK	I^2C/SPI clock (V_{CC} domain)
5	SDAT	I^2C data/SPI CS (V_{CC} domain)
6	V_{CC}	1.8 –3.3 V supply voltage
7	Data in	SPI Data In (V_{CC} domain)
8	NC	–
9	Mode	MODE In RESET state, MODE selects the type of serial interface "0" - I^2C "1" - SPI
10	GND	Ground
11	IN2	IN2/GPIO-2
12	IN3	IN3/GPIO-3
13	X+	X+/GPIO-4
14	Vio	Supply for touchscreen driver and GPIO
15	Y+	Y+/GPIO-5
16	X-	X-/GPIO-6

2.1 Pin functions

The STMPE610 is designed to provide maximum features and flexibility in a very small pin-count package. Most of the pins are multi-functional. The following table shows how to select the pin's function.

Table 3. IN2, IN3 pin configuration

Pin / control register	GPIO_AF = 1	GPIO_AF = 0	
	ADC control 1 bit 1 = don't care	ADC control 1 bit 1 = 0	ADC control 1 bit 1 = 1
IN2	GPIO-2	ADC	External reference +
IN3	GPIO-3	ADC	External reference -

Table 4. X, Y pin configuration

Pin / control register	GPIO_AF = 1	GPIO_AF = 0	
	TSC control 1 bit 0 = don't care	TSC control 1 bit 0 = 0	TSC control 1 bit 0 = 1
X+	GPIO-4	ADC	TSC X+
Y+	GPIO-5	ADC	TSC Y+
X-	GPIO-6	ADC	TSC X-
Y-	GPIO-7	ADC	TSC Y-

3 I²C and SPI interface

3.1 Interface selection

The STMPE610 interfaces with the host CPU via a I²C or SPI interface. The pin IN_1 allows the selection of interface protocol at reset state.

Figure 3. STMPE610 interface

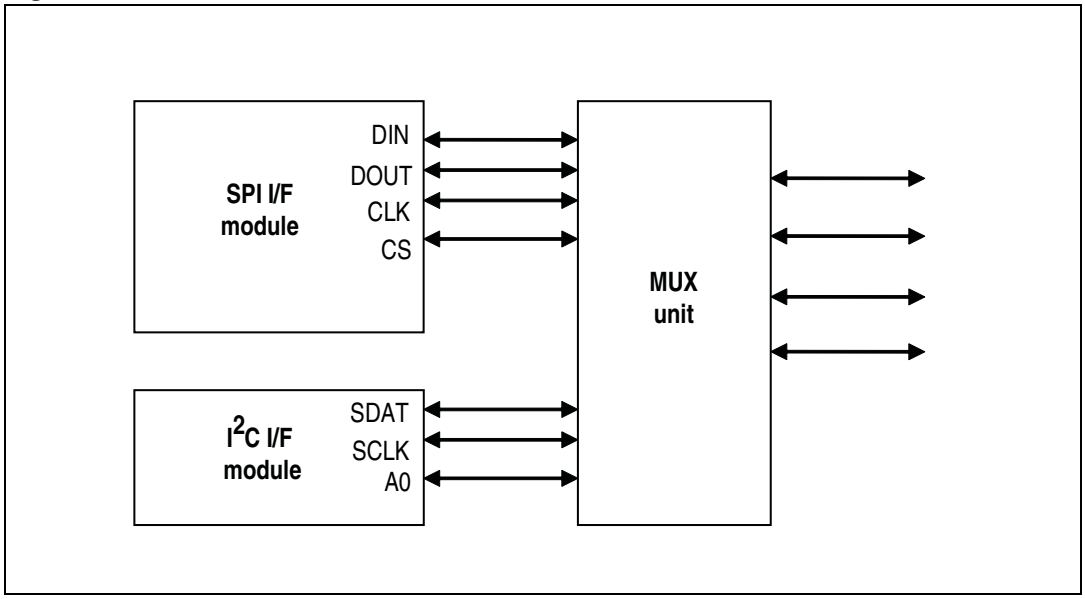


Table 5. Interface selection pins

Pin	I²C function	SPI function	Reset state
3	Address 0	Data out	CPHA for SPI
4	Clock	Clock	–
5	SDATA	CS	CPOL_N for SPI
7	–	Data in	–
9	MODE	I²C set to '0'	Set to '1' for SPI

4 I²C interface

The addressing scheme of STMPE610 is designed to allow up to 2 devices to be connected to the same I²C bus.

Figure 4. STMPE610 I²C interface

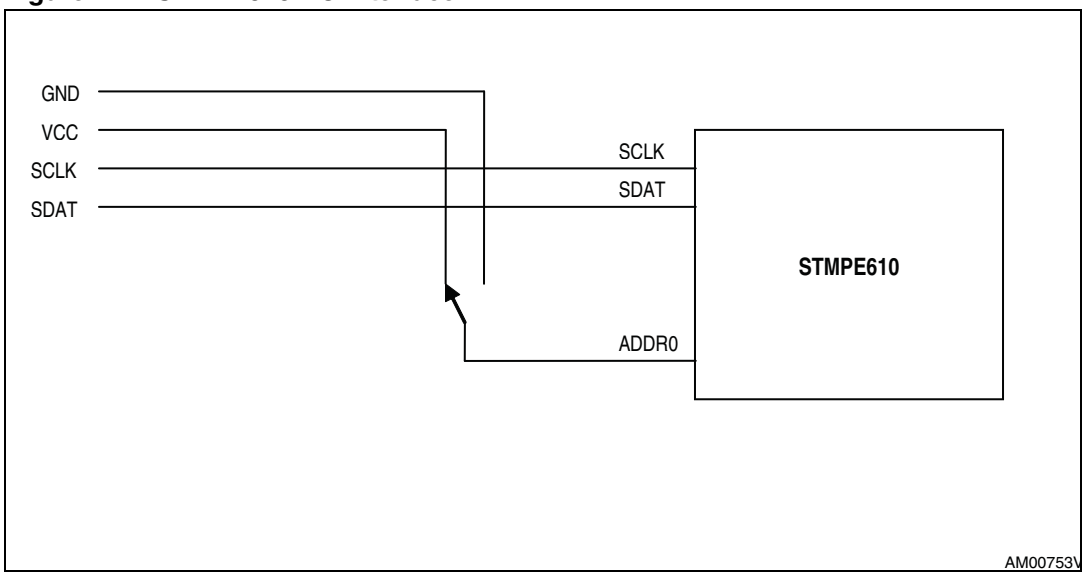


Table 6. I²C address

ADDR0	Address
0	0 x 82
1	0 x 88

For the bus master to communicate to the slave device, the bus master must initiate a Start condition and be followed by the slave device address. Accompanying the slave device adress, is a read/write bit (R/$\overline{W}$). The bit is set to 1 for read and 0 for write operation. If a match occurs on the slave device address, the corresponding device gives an acknowledge on the SDA during the 9th bit time. If there is no match, it deselects itself from the bus by not responding to the transaction.

Figure 5. I²C timing diagram

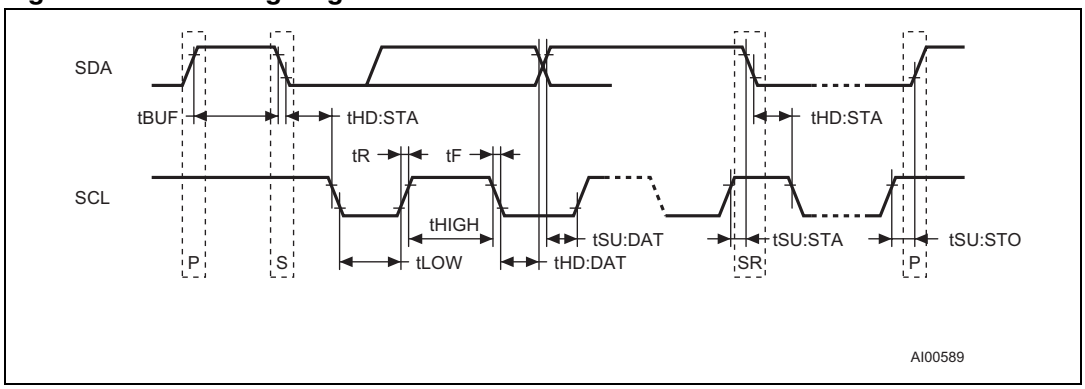


Table 7. I^2C timing

Symbol	Parameter	Min	Typ	Max	Unit
f_{SCL}	SCL clock frequency	0	–	400	kHz
t_{LOW}	Clock low period	1.3	–	–	µs
t_{HIGH}	Clock high period	600	–	–	ns
t_F	SDA and SCL fall time	–	–	300	ns
$t_{HD:STA}$	START condition hold time (after this period the first clock is generated)	600	–	–	ns
$t_{SU:STA}$	START condition setup time (only relevant for a repeated start period)	600	–	–	ns
$t_{SU:DAT}$	Data setup time	100	–	–	ns
$t_{HD:DAT}$	Data hold time	0	–	–	µs
$t_{SU:STO}$	STOP condition setup time	600	–	–	ns
t_{BUF}	Time the bus must be free before a new transmission can start	1.3	–	–	µs

4.1 I^2C features

The features that are supported by the I^2C interface are listed below:

- I^2C slave device
- Operates at 1.8 V
- Compliant to Philips I^2C specification version 2.1
- Supports standard (up to 100 Kbps) and fast (up to 400 Kbps) modes

Start condition

A Start condition is identified by a falling edge of SDATA while SCLK is stable at high state. A Start condition must precede any data/command transfer. The device continuously monitors for a Start condition and does not respond to any transaction unless one is encountered.

Stop condition

A Stop condition is identified by a rising edge of SDATA while SCLK is stable at high state. A Stop condition terminates communication between the slave device and the bus master. A read command that is followed by NoAck can be followed by a Stop condition to force the slave device into idle mode. When the slave device is in idle mode, it is ready to receive the next I^2C transaction. A Stop condition at the end of a write command stops the write operation to registers.

Acknowledge bit

The acknowledge bit is used to indicate a successful byte transfer. The bus transmitter releases the SDATA after sending eight bits of data. During the ninth bit, the receiver pulls

the SDATA low to acknowledge the receipt of the eight bits of data. The receiver may leave the SDATA in high state if it does not acknowledge the receipt of the data.

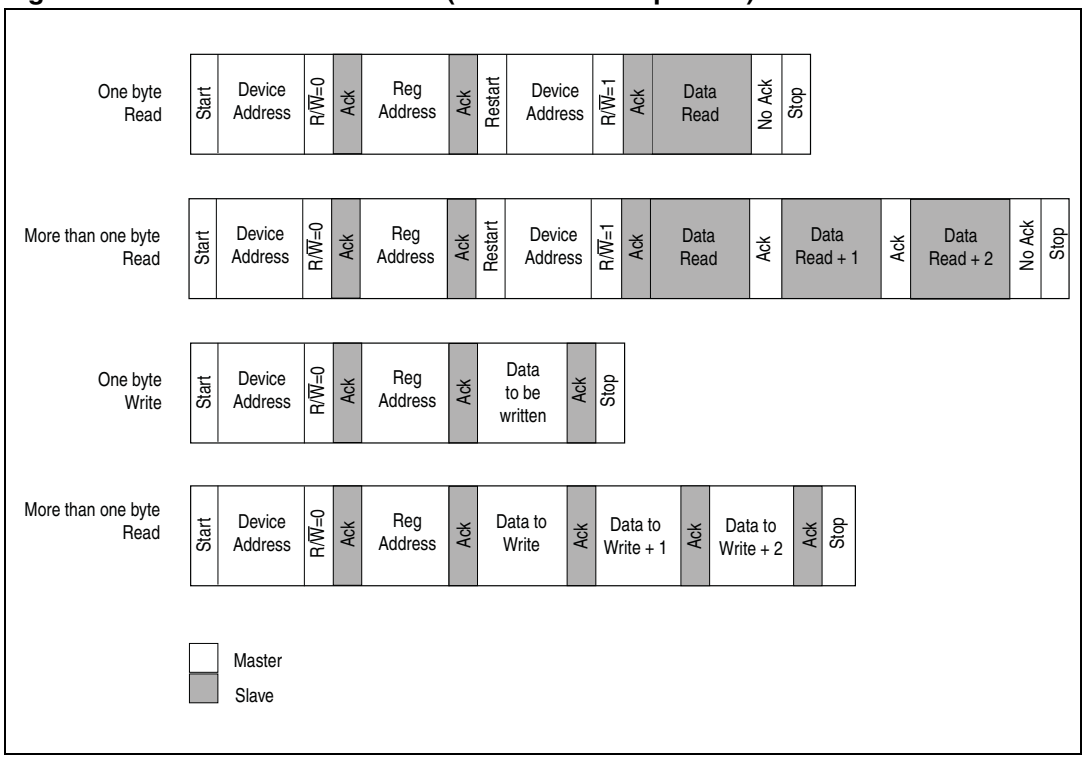
4.2 Data input

The device samples the data input on SDATA on the rising edge of the SCLK. The SDATA signal must be stable during the rising edge of SCLK and the SDATA signal must change only when SCLK is driven low.

Table 8. Operating modes

Mode	Byte	Programming sequence
Read	≥1	Start, Device address, R/$\overline{W}$ = 0, Register address to be read
		Restart, Device address, R/$\overline{W}$ = 1, Data Read, Stop
		If no Stop is issued, the Data Read can be continuously performed. If the register address falls within the range that allows an address auto-increment, then the register address auto-increments internally after every byte of data being read.
Write	≥1	Start, Device address, R/$\overline{W}$ = 0, Register address to be written, Data Write, Stop
		If no Stop is issued, the Data Write can be continuously performed. If the register address falls within the range that allows address auto-increment, then the register address auto-increments internally after every byte of data being written in. For those register addresses that fall within a non-incremental address range, the address will be kept static throughout the entire write operation. Refer to the memory map table for the address ranges that are auto and non-increment.

Figure 6. Read and write modes (random and sequential)



4.3 Read operation

A write is first performed to load the register address into the Address Counter but without sending a Stop condition. Then, the bus master sends a reStart condition and repeats the Device Address with the R/W bit set to 1. The slave device acknowledges and outputs the content of the addressed byte. If no additional data is to be read, the bus master must not acknowledge the byte and terminates the transfer with a Stop condition.

If the bus master acknowledges the data byte, then it can continue to perform the data reading. To terminate the stream of data bytes, the bus master must not acknowledge the last output byte, and be followed by a Stop condition. If the address of the register written into the Address Counter falls within the range of addresses that has the auto-increment function, the data being read will be coming from consecutive addresses, which the internal Address Counter automatically increments after each byte output. After the last memory address, the Address Counter 'rolls-over' and the device continues to output data from the memory address of 0x00. Similarly, for the register address that falls within a non-increment range of addresses, the output data byte comes from the same address (which is the address referred by the Address Counter).

Acknowledgement in read operation

For the above read command, the slave device waits, after each byte read, for an acknowledgement during the ninth bit time. If the bus master does not drive the SDA to a low state, then the slave device terminates and switches back to its idle mode, waiting for the next command.

4.4 Write operations

A write is first performed to load the register address into the Address Counter without sending a Stop condition. After the bus master receives an acknowledgement from the slave device, it may start to send a data byte to the register (referred by the Address Counter). The slave device again acknowledges and the bus master terminates the transfer with a Stop condition.

If the bus master needs to write more data, it can continue the write operation without issuing the Stop condition. Whether the Address Counter autoincrements or not after each data byte write depends on the address of the register written into the Address Counter. After the bus master writes the last data byte and the slave device acknowledges the receipt of the last data, the bus master may terminate the write operation by sending a Stop condition. When the Address Counter reaches the last memory address, it 'rolls-over' to the next data byte write.

5 SPI interface

The SPI interface in STMPE610 uses a 4-wire communication connection (DATA IN, DATA OUT, CLK, CS). In the diagram, “Data in” is referred to as MOSI (master out slave in) and “DATA out” is referred to as MISO (master in slave out).

5.1 SPI protocol definition

The SPI (serial peripheral interface) follows a byte sized transfer protocol. All transfers begin with an assertion of CS_n signal (falling edge). The protocol for reading and writing is different and the selection between a read and a write cycle is dependent on the first captured bit on the slave device. A '1' denotes a read operation and a '0' denotes a write operation. The SPI protocol defined in this section is shown in Figure 3.

The following are the main features supported by this SPI implementation.

- Support of 1 MHz maximum clock frequency.
- Support for autoincrement of address for both read and write.
- Full duplex support for read operation.
- Daisy chain configuration support for write operation.
- Robust implementation that can filter glitches of up to 50 ns on the CS_n and SCL pins.
- Support for all 4 modes of SPI as defined by the CPHA, CPOL bits on SPICON.

5.1.1 Register read

The following steps need to be followed for register read through SPI.

1. Assert CS_n by driving a '0' on this pin.
2. Drive a '1' on the first SCL launch clock on MOSI to select a read operation.
3. The next 7 bits on MOSI denote the 7-bit register address (MSB first).
4. The next address byte can now be transmitted on the MOSI. If the autoincrement bit is set, the following address transmitted on the MOSI is ignored. Internally, the address is incremented. If the autoincrement bit is not set, then the following byte denotes the address of the register to be read next.
5. Read data is transmitted by the slave device on the MISO (MSB first), starting from the launch clock following the last address bit on the MOSI.
6. Full duplex read operation is achieved by transmitting the next address on MOSI while the data from the previous address is available on MISO.
7. To end the read operation, a dummy address of all 0's is sent on MOSI.

5.1.2 Register write

The following steps need to be followed for register write through SPI.

1. Assert CS_n by driving a '0' on this pin.
2. Drive a '0' on the first SCL launch clock on MOSI to select a write operation.
3. The next 7 bits on MOSI denote the 7-bit register address (MSB first).
4. The next byte on the MOSI denotes data to be written.
5. The following transmissions on MOSI are considered byte-sized data. The register address to which the following data is written depends on whether the autoincrement bit in the SPICON register is set. If this bit has been set previously, the register address is incremented for data writes.

5.1.3 Termination of data transfer

A transfer can be terminated before the last launch edge by deasserting the CS_n signal. If the last launch clock is detected, it is assumed that the data transfer is successful.

5.2 SPI timing modes

The SPI timing modes are defined by CPHA and CPOL,CPHA and CPOL are read from the "SDAT" and "A0" pins during power-up reset. The following four modes are defined according to this setting.

Table 9. SPI timing modes

CPOL_N (SDAT pin)	CPOL	CPHA (ADDR pin)	Mode
1	0	0	0
1	0	1	1
0	1	0	2
0	1	1	3

The clocking diagrams of these modes are shown in ON reset. The device always operates in mode 0. Once the bits are set in the SPICON register, the mode change takes effect on the next transaction defined by the CS_n pin being deasserted and asserted.

5.2.1 SPI timing definition

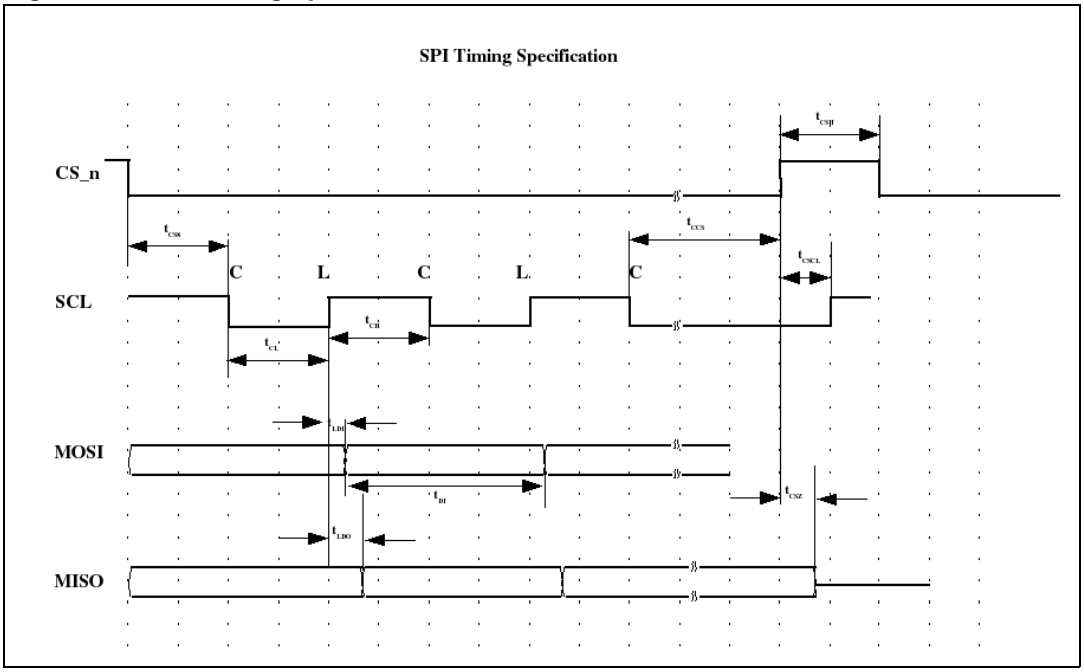
Table 10. SPI timing specification

Symbol	Description	Timing			Unit
		Min	Typ	Max	
t_{CSS}	CS_n falling to first capture clock	1	–	–	µs
t_{CL}	Clock low period	500	–	–	ns
t_{CH}	Clock high period	500	–	–	ns

Table 10. SPI timing specification (continued)

Symbol	Description	Timing			Unit
		Min	Typ	Max	
t_{LDI}	Launch clock to MOSI data valid	–	–	20	ns
t_{LDO}	Launch clock to MISO data valid	–	–	330	µs
t_{DI}	Data on MOSI valid	1	–	–	µs
t_{CCS}	Last clock edge to CS_n high	1	–	–	µs
t_{CSH}	CS_n high period	2	–	–	µs
t_{CSCL}	CS_n high to first clock edge	300	–	–	ns
t_{CSZ}	CS_n high to tri-state on MISO	1	–	–	µs

Figure 7. SPI timing specification



6 STMPE610 registers

This section lists and describes the registers of the STMPE610 device, starting with a register map and then provides detailed descriptions of register types.

Table 11. Register summary map table

Address	Register name	Bit	Type	Reset value	Function
0x00	CHIP_ID	16	R	0x0811	Device identification
0x02	ID_VER	8	R	0x03	Revision number 0x01 for engineering sample 0x03 for final silicon
0x03	SYS_CTRL1	8	R/W	0x00	Reset control
0x04	SYS_CTRL2	8	R/W	0x0F	Clock control
0x08	SPI_CFG	8	R/W	0x01	SPI interface configuration
0x09	INT_CTRL	8	R/W	0x00	Interrupt control register
0x0A	INT_EN	8	R/W	0x00	Interrupt enable register
0x0B	INT_STA	8	R	0x10	interrupt status register
0x0C	GPIO_EN	8	R/W	0x00	GPIO interrupt enable register
0x0D	GPIO_INT_STA	8	R	0x00	GPIO interrupt status register
0x0E	ADC_INT_EN	8	R/W	0x00	ADC interrupt enable register
0x0F	ADC_INT_STA	8	R	0x00	ADC interrupt status register
0x10	GPIO_SET_PIN	8	R/W	0x00	GPIO set pin register
0x11	GPIO_CLR_PIN	8	R/W	0x00	GPIO clear pin register
0x12	GPIO_MP_STA	8	R/W	0x00	GPIO monitor pin state register
0x13	GPIO_DIR	8	R/W	0x00	GPIO direction register
0x14	GPIO_ED	8	R/W	0x00	GPIO edge detect register
0x15	GPIO_RE	8	R/W	0x00	GPIO rising edge register
0x16	GPIO_FE	8	R/W	0x00	GPIO falling edge register
0x17	GPIO_AF	8	R/W	0x00	Alternate function register
0x20	ADC_CTRL1	8	R/W	0x9C	ADC control
0x21	ADC_CTRL2	8	R/W	0x01	ADC control
0x22	ADC_CAPT	8	R/W	0xFF	To initiate ADC data acquisition
0x30	ADC_DATA_CH0	16	R	0x0000	ADC channel 0
0x32	ADC_DATA_CH1	16	R	0x0000	ADC channel 1

Table 11. Register summary map table (continued)

Address	Register name	Bit	Type	Reset value	Function
0x38	ADC_DATA_CH4	16	R	0x0000	ADC channel 4
0x3A	ADC_DATA_CH5	16	R	0x0000	ADC channel 5
0x3C	ADC_DATA_CH6	16	R	0x0000	ADC channel 6
0x3E	ADC_DATA_CH7	16	R	0x0000	ADC channel 7
0x40	TSC_CTRL	8	R/W	0x90	4-wire touchscreen controller setup
0x41	TSC_CFG	8	R/W	0x00	Touchscreen controller configuration
0x42	WDW_TR_X	16	R/W	0x0FFF	Window setup for top right X
0x44	WDW_TR_Y	16	R/W	0x0FFF	Window setup for top right Y
0x46	WDW_BL_X	16	R/W	0x0000	Window setup for bottom left X
0x48	WDW_BL_Y	16	R/W	0x0000	Window setup for bottom left Y
0x4A	FIFO_TH	8	R/W	0x00	FIFO level to generate interrupt
0x4B	FIFO_STA	8	R/W	0x20	Current status of FIFO
0x4C	FIFO_SIZE	8	R	0x00	Current filled level of FIFO
0x4D	TSC_DATA_X	16	R	0x0000	Data port for touchscreen controller data access
0x4F	TSC_DATA_Y	16	R	0x0000	Data port for touchscreen controller data access
0x51	TSC_DATA_Z	8	R	0x0000	Data port for touchscreen controller data access
0x52	TSC_DATA_XYZ	32	R	0x00000000	Data port for touchscreen controller data access
0x56	TSC_FRACT_XYZ	8	RW	0x00	Select the range and accuracy of the pressure measurement
0x57	TSC_DATA	8	R	0x00	Data port for touchscreen controller data access
0x58	TSC_I_DRIVE	8	R/W	0x00	Touchscreen controller drive I
0x59	TSC_SHIELD	8	R/W	0x00	Touchscreen controller shield

7 System and identification registers

Table 12. System and identification registers map

Address	Register name	Bit	Type	Reset	Function
0x00	CHIP_ID	16	R	0x0811	Device identification
0x02	ID_VER	8	R	0x03	Revision number 0x01 for engineering sample 0x03 for final silicon
0x03	SYS_CTRL1	8	R/W	0x00	Reset control
0x04	SYS_CTRL2	8	R/W	0x0F	Clock control
0x08	SPI_CFG	8	R/W	0x01	SPI interface configuration

CHIP_ID — Device identification

Address: 0x00

Type: R

Reset: 0x0811

Description: 16-bit device identification

ID_VER — Revision number

Address: 0x02

Type: R

Reset: 0x03

Description: 16-bit revision number

SYS_CTRL1 — Reset control

7	6	5	4	3	2	1	0
RESERVED						SOFT_RESET	HIBERNATE

Address: 0x03

Type: R/W

Reset: 0x00

Description: The reset control register enables to reset the device

[7:2] RESERVED

[1] SOFT_RESET: Reset the STMPE610 using the serial communication interface

[0] HIBERNATE: Force the device into hibernation mode.
Forcing the device into hibernation mode by writing ‘1’ to this bit would disable the hot-key feature. If the hot-key feature is required, use the default auto-hibernation mode.

SYS_CTRL2 Clock control

7	6	5	4	3	2	1	0
-	-	-	-	RESERVED	GPIO_OFF	TSC_OFF	ADC_OFF

Address: 0x04

Type: R/W

Reset: 0x0F

Description: This register enables to switch off the clock supply

[7:3] RESERVED

[2] GPIO_OFF: Switch off the clock supply to the GPIO
1: Switches off the clock supply to the GPIO

[1] TSC_OFF: Switch off the clock supplyto the touchscreen controller
1: Switches off the clock supply to the touchscreen controller

[0] ADC_OFF: Switch off the clock supply to the ADC
1: Switches off the clock supply to the ADC

SPI_CFG SPI interface configuration

7	6	5	4	3	2	1	0
RESERVED					AUTO_INCR	SPI_CLK_MOD1	SPI_CLK_MOD0

Address: 0x08

Type: R/W

Reset: 0x01

Description: SPI interface configuration register

[7:3] RESERVED

[2] AUTO_INCR:
This bit defines whether the SPI transaction follows an addressing scheme that internally autoincrements or not

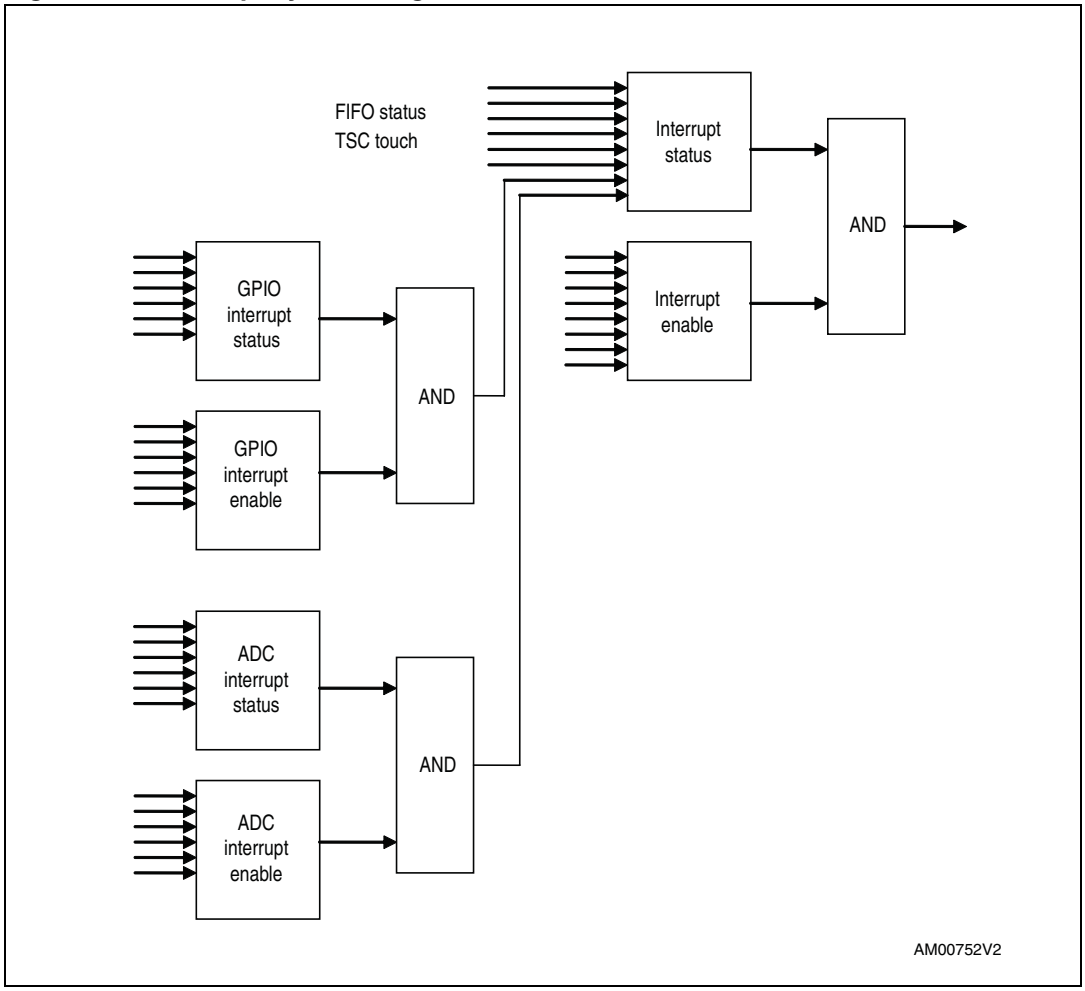
[1] SPI_CLK_MOD1:
This bit reflects the value of the SCAD/A0 pin during power-up reset

[0] SPI_CLK_MOD0:
This bit reflects the value of the SCAD/A0 pin during power-up reset

8 Interrupt system

The STMPE610 uses a 2-tier interrupt structure. The ADC interrupts and GPIO interrupts are ganged as a single bit in the “interrupt status register”. The interrupts from the touchscreen controller can be seen directly in the interrupt status register.

Figure 8. Interrupt system diagram



INT_CTRL Interrupt control register

7	6	5	4	3	2	1	0
RESERVED					INT_POLARITY	INT_TYPE	GLOBAL_INT

Address: 0x09

Type: R/W

Reset: 0x00

Description: The interrupt control register is used to enable the interruption from a system-related interrupt source to the host.

[7:3] RESERVED

[2] INT_POLARITY: This bit sets the INT pin polarity
1: Active high/rising edge
0: Active low/falling edge

[1] INT_TYPE: This bit sets the type of interrupt signal required by the host
1: Edge interrupt
0: Level interrupt

[0] GLOBAL_INT: This is master enable for the interrupt system
1: Global interrupt
0: Stops all interrupts

INT_EN Interrupt enable register

7	6	5	4	3	2	1	0
GPIO	ADC	RESERVED	FIFO_EMPTY	FIFO_FULL	FIFO_0FLOW	FIFO_TH	TOUCH_DET

Address: 0x0A

Type: R/W

Reset: 0x00

Description: The interrupt enable register is used to enable the interruption from a system related interrupt source to the host.

[7] GPIO: Any enabled GPIO interrupts

[6] ADC: Any enabled ADC interrupts

[5] RESERVED

[4] FIFO_EMPTY: FIFO is empty

[3] FIFO_FULL: FIFO is full

[2] FIFO_OFLOW: FIFO is overflowed

[1] FIFO_TH: FIFO is equal or above threshold value

[0] TOUCH_DET: Touch is detected

INT_STA Interrupt status register

7	6	5	4	3	2	1	0
GPIO	ADC	RESERVED	FIFO_EMPTY	FIFO_FULL	FIFO_OFLOW	FIFO_TH	TOUCH_DET

Address: 0x0B

Type: R

Reset: 0x10

Description: The interrupt status register monitors the status of the interruption from a particular interrupt source to the host. Regardless of whether the INT_EN bits are enabled, the INT_STA bits are still updated. Writing '1' to this register clears the corresponding bits. Writing '0' has no effect.

[7] GPIO: Any enabled GPIO interrupts

[6] ADC: Any enabled ADC interrupts

[5] RESERVED

[4] FIFO_EMPTY: FIFO is empty

[3] FIFO_FULL: FIFO is full

[2] FIFO_OFLOW: FIFO is overflowed

[1] FIFO_TH: FIFO is equal or above threshold value.
This bit is set when FIFO level equals to threshold value. It will only be asserted again if FIFO level drops to < threshold value, and increased back to threshold value.

[0] TOUCH_DET: Touch is detected

GPIO_INT_EN GPIO interrupt enable register

7	6	5	4	3	2	1	0
IEG[x]							

Address: 0x0C

Type: R/W

Reset: 0x10

Description: The interrupt status register monitors the status of the interruption from a particular interrupt source to the host. Regardless of whether the IER bits are enabled, the ISR bits are still updated. Writing '1' to this register clears the corresponding bits. Writing '0' has no effect.

[7:0] IEG[x]: Interrupt enable GPIO mask (where x = 7 to 0)
1: Writing ‘1’ to the IE[x] bit enables the interruption to the host

GPIO_INT_STA GPIO interrupt status register

7	6	5	4	3	2	1	0
ISG[x]							

Address: 0x0D

Type: R/W

Reset: 0x00

Description: The GPIO interrupt status register monitors the status of the interruption from a particular GPIO pin interrupt source to the host. Regardless of whether or not the GPIO_STA bits are enabled, the GPIO_STA bits are still updated. The ISG[7:0] bits are the interrupt status bits corresponding to the GPIO[7:0] pins. Writing '1' to this register clears the corresponding bits. Writing '0' has no effect.

[7:0] ISG[x]: GPIO interrupt status (where x = 7 to 0)
Read:
Interrupt status of the GPIO[x]. Reading the register will clear any bits that have been set to '1'
Write:
Writing to this register has no effect

9 Analog-to-digital converter

An 8-input,12-bit analog-to-digital converter (ADC) is integrated in the STMPE610. The ADC can be used as a generic analog-to-digital converter, or as a touchscreen controller capable of controlling a 4-wire resistive touchscreen.

Table 13. ADC controller register summary table

Address	Register name	Size	Description
0x20	ADC_CTRL1	8	ADC control
0x21	ADC_CTRL2	8	ADC control
0x22	ADCCapture	8	To initiate ADC data acquisition
0x30	ADC_DATA_CH0	8	ADC channel 0 (IN3/GPIO-3)
0x32	ADC_DATA_CH1	8	ADC channel 1 (IN2/GPIO-2)
0x38	ADC_DATA_CH4	8	ADC channel 4 (TSC)
0x3A	ADC_DATA_CH5	8	ADC channel 5 (TSC)
0x3C	ADC_DATA_CH6	8	ADC channel 6 (TSC)
0x3E	ADC_DATA_CH7	8	ADC channel 7 (TSC)

ADC_CTRL1 ADC control 1

7	6	5	4	3	2	1	0
RESERVED	SAMPLE_TIME2	SAMPLE_TIME1	SAMPLE_TIME0	MOD_12B	RESERVED	REF_SEL	RESERVED

Address: 0x20

Type: R/W

Reset: 0x9C

Description: ADC control register

[7] RESERVED

[6:4] SAMPLE_TIMEn: ADC conversion time in number of clock
000: 36
001: 44
010: 56
011: 64
100: 80
101: 96
110: 124
111: Not valid

[3] MOD_12B: Selects 10 or 12-bit ADC operation
1: 12 bit ADC
0: 10 bit ADC

[2] RESERVED

[1] REF_SEL: Selects between internal or external reference for the ADC
1: External reference
0: Internal reference

[0] RESERVED

ADC_CTRL2 ADC control 2

7	6	5	4	3	2	1	0
RESERVED						ADC_FREQ_1	ADC_FREQ_0

Address: 0x21

Type: R/W

Reset: 0x01

Description: ADC control.

[7] RESERVED

[6] RESERVED

[5] RESERVED

[4] RESERVED

[3] RESERVED

[2] RESERVED

[1:0] ADC_FREQ: Selects the clock speed of ADC
00: 1.625 MHz typ.
01: 3.25 MHz typ.
10: 6.5 MHz typ.
11: 6.5 MHz typ.

ADC_CAPT ADC channel data capture

7	6	5	4	3	2	1	0
CH[7:0]							

Address: 0x22

Type: R/W

Reset: 0xFF

Description: To initiate ADC data acquisition

[7:0] CH[7:0]: ADC channel data capture
Write '1' to initiate data acquisition for the corresponding channel. Writing '0' has no effect.
Reads '1' if conversion is completed. Reads '0' if conversion is in progress.

ADC_DATA_CHn ADC channel data registers

11	10	9	8	7	6	5	4	3	2	1	0
DATA[11:0]											

Address: Add address

Type: R/W

Reset: 0x0000

Description: ADC data register 0-7 (DATA_CHn=0 -7)

[11:0] DATA[11:0]: ADC channel data
If TSC is enabled, CH3-0 is used for TSC and all readings to these channels give 0x0000

The ADC in STMPE610 operates on an internal RC clock with a typical frequency of 6.5 MHz. The total conversion time in ADC mode depends on the "SampleTime" setting, and the clock division field 'Freq'.

The following table shows the conversion time based on 6.5 MHz, 3.25 MHz and 1.625 MHz clock.

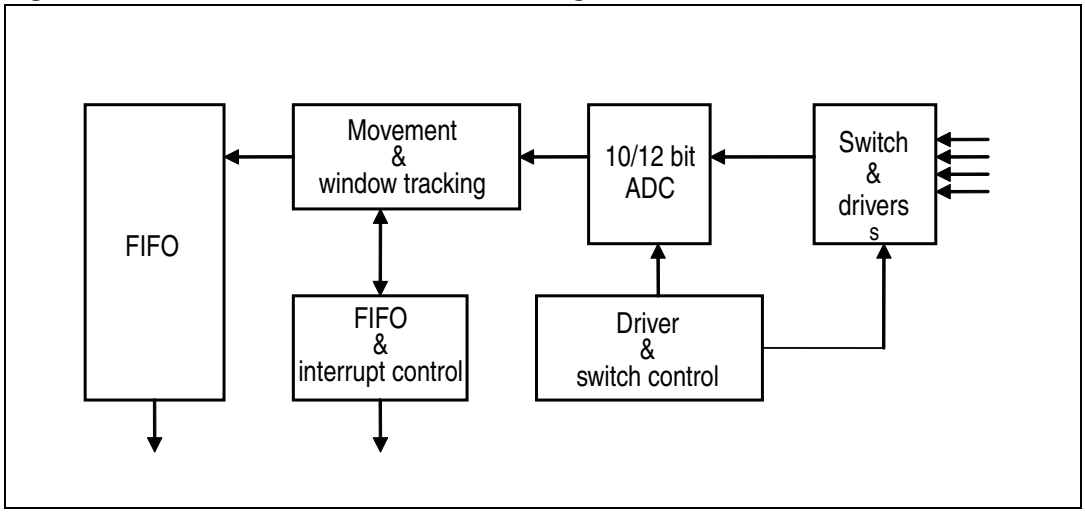
Table 14. ADC conversion time

Sample time setting	Conversion time in ADC clock	6.5 MHz (154 ns)	3.25 MHz (308 ns)	1.625 MHz (615 ns)
000	36	5.5 µs (180 kHz)	11 µs (90 kHz)	22 µs (45 kHz)
001	44	6.8 µs (147 kHz)	13.6 µs (74 kHz)	27 µs (36 kHz)
010	56	8.6 µs (116 kHz)	17.2 µs (58 kHz)	34.4 µs (29 kHz)
011	64	9.9 µs (101 kHz)	19.8 µs (51 kHz)	39.6 µs (25 kHz)
100	80	12.3 µs (81.5 kHz)	24.6 µs (41 kHz)	49.2 µs (20 kHz)
101	96	14.8 µs (67.6 kHz)	28.8 µs (33 kHz)	59.2 µs (17 kHz)
110	124	19.1 µs (52.3 kHz)	38.2 µs (26 kHz)	56.4 µs (13 kHz)

10 Touchscreen controller

The STMPE610 is integrated with a hard-wired touchscreen controller for 4-wire resistive type touchscreen. The touchscreen controller is able to operate completely autonomously, and will interrupt the connected CPU only when a pre-defined event occurs.

Figure 9. Touchscreen controller block diagram



10.1 Driver and switch control unit

The driver and switch control unit allows coordination of the ADC and the MUX/switch. With the coordination of this unit, a stream of data is produced at a selected frequency.

The touchscreen drivers can be configured with 2 current ratings: 20 mA or 50 mA. In the case where multiple touch-down on the screen is causing a short, the current from the driver is limited to these values. Tolerance of these current setting is +/- 25%.

Movement tracking

The "Tracking Index" in the TSC_CTRL register specifies a value, which determines the distance between the current touch position and the previous touch position. If the distance is shorter than the tracking index, it is discarded.

The tracking is calculated by summation of the horizontal and vertical movement. Movement is only reported if:

(Current X - Previously Reported X) + (Current Y - Previously Reported Y) > Tracking Index

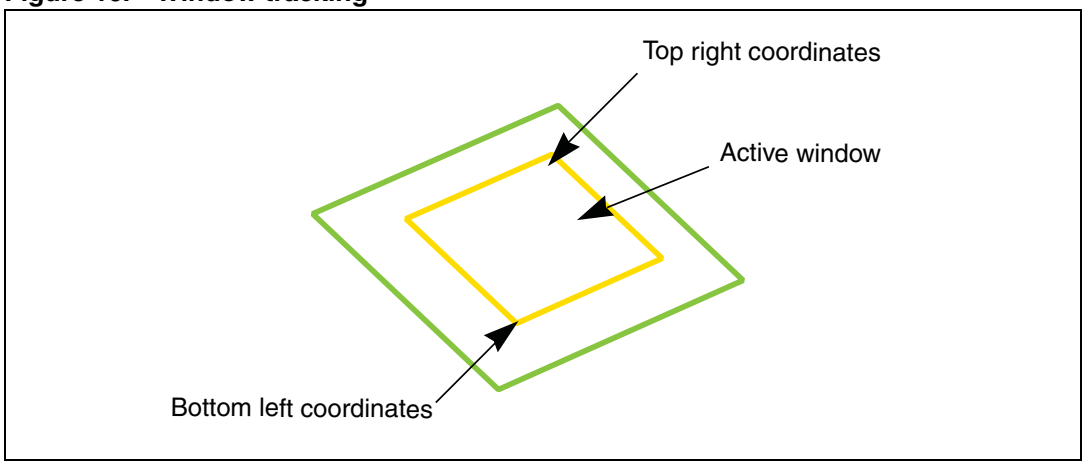
If pressure reporting is enabled (X/Y/Z), an increase in pressure will override the movement tracking and report the new data set, even if X/Y is within the previous tracking index. This is to ensure that a slow touch will not be discarded.

If pressure data is not used, select X/Y mode in touchscreen data acquisition. (Opmode field in TSCControl register).

Window tracking

The -WDW_X and WDW_Y registers allow to pre-set a sub-window in the touchscreen such that any touch position that is outside the sub-window will be discarded.

Figure 10. Window tracking



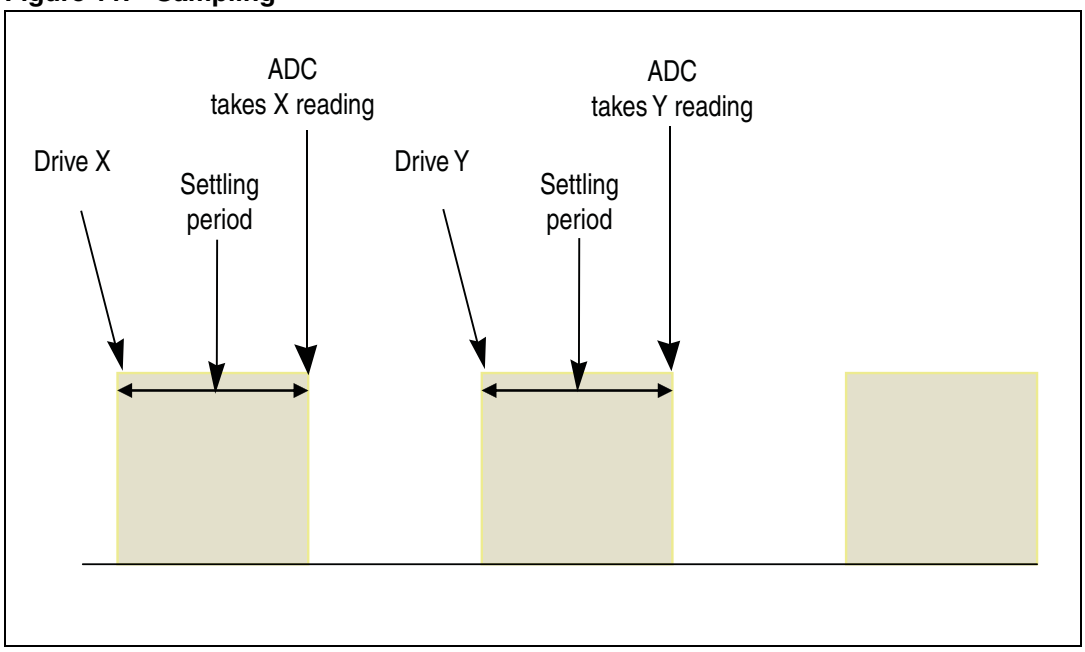
FIFO

FIFO has a depth of 128 sectors. This is enough for 128 sets of touch data at maximum resolution (2 x 12 bits). FIFO can be programmed to generate an interrupt when it is filled to a pre-determined level.

Sampling

The STMPE610 touchscreen controller has an internal 180 kHz, 12-bit ADC able to execute autonomous driving/sampling. Each "sample" consists of 4 ADC readings that provide the X and Y locations, as well as the touch pressure.

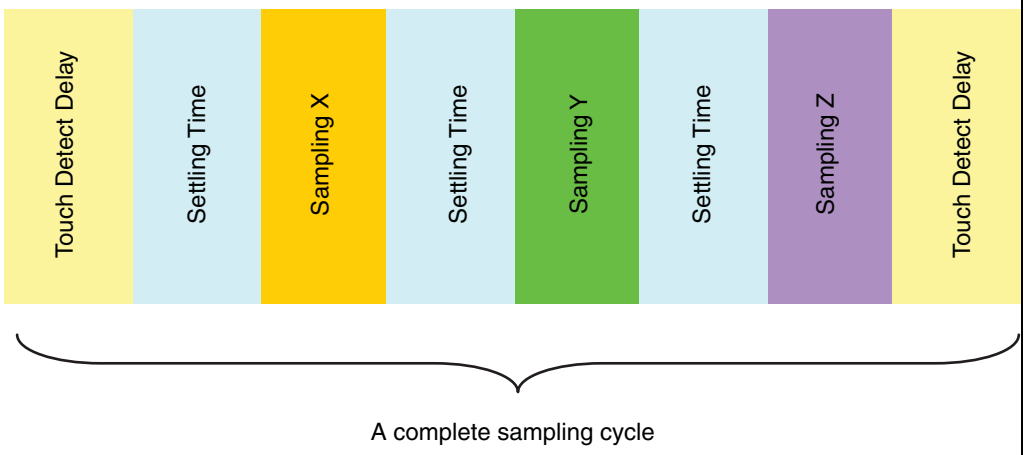
Figure 11. Sampling



Sampling time calculation

The equation for a complete sampling cycle is described below.

Figure 12. Sampling time calculation



Time taken for sampling;
- Touch Detect Delay x 2 + Settling Time x 3 + (AVE_CTRL x ADC_SAMPLE_TIME) x 3 for X/Y/Z mode
- Touch Detect Delay x 2 + Settling Time x 2 + (AVE_CTRL x ADC_SAMPLE_TIME) x 2 for X/Y mode

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Oversampling and averaging function

The STMPE610 touchscreen controller can be configured to oversample by 2/4/8 times and provide the averaged value as final output. This feature helps to reduce the effect of surrounding noise.

Table 15. Touchscreen controller register summary table

Address	Register name	Bit	Type	Function
0x40	TSC_CTRL	8	R/W	4-wire touchscreen controller setup
0x41	TSC_CFG	8	R/W	TSC configuration register
0x42	WDW_TR_X	16	R/W	Window setup for top right X
0x44	WDW_TR_Y	16	R/W	Window setup for top right Y
0x46	WDW_TR_X	16	R/W	Window setup for bottom left X
0x48	WDW_TR_Y	16	R/W	Window setup for bottom left Y
0x4A	FIFO_TH	8	R/W	FIFO level to generate interrupt
0x4B	FIFO_CTRL_STA	8	R/W	Current status of FIFO
0x4C	FIFO_SIZE	8	R	Current filled level of FIFO
0x4D	TSC_DATA_X	16	R	Data port for TSC data access
0x4F	TSC_DATA_Y	16	R	Data port for TSC data access

Table 15. Touchscreen controller register summary table

Address	Register name	Bit	Type	Function
0x51	TSC_DATA_Z	8	R	Data port for TSC data access
0x52	TSC_DATA_XYZ	32	R	Data port for TSC data access
0x56	TSC_FRACT_Z	8	R/W	TSC_FRACT_Z
0x57	TSC_DATA	8	R	TSC data access port
0x58	TSC_I_DRIVE	8	R/W	TSC_I_DRIVE
0x59	TSC_SHIELD	8	R/W	TSC_SHIELD

TSC_CTRL Touchscreen controller control register

7	6	5	4	3	2	1	0
TSC_STA	TRACK			OP_MOD			EN

Address: 0x40

Type: R/W

Reset: 0x90

Description: 4-wire touchscreen controller (TSC) setup.

[7] TSC_STA: TSC status
Reads '1' when touch is detected
Reads '0' when touch is not detected
Writing to this register has no effect

[6:4] TRACK: Tracking index
000: No window tracking
001: 4
010: 8
011: 16
100: 32
101: 64
110: 92
111: 127

[3:1] OP_MOD: TSC operating mode
000: X, Y, Z acquisition
001: X, Y only
010: X only
011: Y only
100: Z only
This field cannot be written on, when EN = 1

[0] EN: Enable TSC

TSC_CFG Touchscreen controller configuration register

7	6	5	4	3	2	1	0
AVE_CTRL_1	AVE_CTRL_0	TOUCH_DET _DELAY_2	TOUCH_DET _DELAY_1	TOUCH_DET _DELAY_0	SETTLING_2	SETTLING_1	SETTLING_0

Address: 0x41

Type: R/W

Buffer:

Reset:

Description: Touchscreen controller configuration register.

[7:6] AVE_CTRL_1/0: Average control
00=1 sample
01=2 samples
10=4 samples
11=8 samples

[5:3] TOUCH_DET_DELAY_2/1/0: Touch detect delay
000 - 10 µs
001 - 50 µs
010 = 100 µs
011 = 500 µs
100 = 1 ms
101 = 5 ms
110 = 10 ms
111 = 50 ms

[2:0] SETTLING: Panel driver settling time(1)
000 = 10 µs
001 = 100 µs
010 = 500 µs
011 =1 ms
100 = 5 ms
101 = 10 ms
110 = 50 ms
111 =100 ms

1. For large panels (> 6”), a capacitor of 10 nF is recommended at the touchscreen terminals for noise filtering. In this case, settling time of 1 ms or more is recommended.

10.2 Touch detect delay

Touch Detect Delay is an additional method used to compensate for the time it takes for the panel voltage to be pulled high during a non-touch condition.

For example, the way it works to detect a touch:

X+ is pulled high and Y+ is driven low. After Touch Detect Delay is expired the level of X+ is read. If no touch, X+ is high. If there is a touch, X+ is low.

If the initial voltage of X+ is low before being pulled high by the internal resistor, especially if a filtering capacitor is connected, this time needs to be compensated. The Touch Delay setting provides time for the voltage to be pulled high in a non-touch condition and avoids a false report of a touch condition.

Normally the Touch Detect Delay needs to be long enough to allow the voltage to rise to V+ in a non-touch condition and this will depend on the presence of external filtering capacitors. For more details on recommendation of Touch Detect delay register setting, refer to STMPE811 Application Note (AN2825 ST document).

WDW_TR_X Window setup for top right X

7	6	5	4	3	2	1	0
TR_X [11:0]							

Address: 0x42

Type: R/W

Reset: 0x0FFF

Description: Window setup for top right X coordinates

[11:0] TR_X: bit 11:0 of top right X coordinates

WDW_TR_Y Window setup for top right Y

7	6	5	4	3	2	1	0
TR_Y [11:0]							

Address: 0x44

Type: R/W

Reset: 0x0FFF

Description: Window setup for top right Y coordinates

[11:0] TR_X: bit 11:0 of top right Y coordinates

WDW_BL_X Window setup for bottom left X

7	6	5	4	3	2	1	0
BL_X [11:0]							

Address: 0x46

Type: R/W

Reset: 0x0000

Description: Window setup for bottom left X coordinates

[11:0] BL_X: bit 11:0 of bottom left X coordinates

WDW_BL_Y Window setup for bottom left Y

7	6	5	4	3	2	1	0
BL_Y [11:0]							

Address: 0x48

Type: R/W

Reset: 0x0000

Description: Window setup for bottom left Y coordinates

[11:0] **BL_X**: bit 11:0 of bottom left Y coordinates

FIFO_TH FIFO threshold

7	6	5	4	3	2	1	0
FIFO_TH							

Address: 0x4A

Type: R/W

Reset: 0x00

Description: Triggers an interrupt upon reaching or exceeding the threshold value. This field must not be set as zero.

[7:0] FIFO_TH: Touchscreen controller FIFO threshold

FIFO_CTRL_STA FIFO threshold

7	6	5	4	3	2	1	0
FIFO_OFLOW	FIFO_FULL	FIFO_EMPTY	FIFO_TH_TRIG	RESERVED			FIFO_RESET

Address: 0x4B

Type: R/W

Reset: 0x20

Description: Current status of FIFO..

[7] FIFO_OFLOW:
Reads 1 if FIFO is overflow

[6] FIFO_FULL:
Reads 1 if FIFO is full

[5] FIFO_EMPTY:
Reads 1 if FIFO is empty

[4] FIFO_TH_TRIG:
0 = Current FIFO size is still below the threshold value
1 = Current FIFO size is at or beyond the threshold value

[3:1] RESERVED

[0] FIFO_RESET:
Write '0' : FIFO put out of reset mode
Write '1' : Resets FIFO. All data in FIFO will be cleared.
When TSC is enabled, FIFO resets automatically.

FIFO_SIZE — FIFO size

7	6	5	4	3	2	1	0
RESERVED	FIFO_SIZE						

Address: 0x4C

Type: R

Reset: 0x00

Description: Current number of samples available

[7:0] FIFO_SIZE: Number of samples available

TSC_DATA_X — TSC_DATA_X

11	10	9	8	7	6	5	4	3	2	1	0
DATAY[11:0]											

Address: 0x4D

Type: R

Reset: 0x0000

Description: Bit 11:0 of Y dataTSC_DATA_Y

[11:0] DATAY[11:0]: Bit 11:0 of Y data

TSC_DATA_Y

11	10	9	8	7	6	5	4	3	2	1	0
DATAY[11:0]											

Address: 0x4F

Type: R

Reset: 0x0000

Description: Bit 11:0 of Y data

[11:0] DATAY[11:0]: bit 11:0 of Y data

TSC_DATA_Z — TSC_DATA_Z

7	6	5	4	3	2	1	0
DATAZ[7:0]							

Address: 0x51

Type: R

Reset: 0x0000

Description: Bit 7:0 of Z data

[7:0] DATAZ[7:0]: bit 7:0 of Z data

TSC_DATA Touchscreen controller DATA

7	6	5	4	3	2	1	0
DATA							

Address: 0x57 (auto-increment), 0xD7 (non-auto-increment)

Type: R

Reset: 0x00

Description: Data port for TSC data access

[11:0] DATA: data bytes from TSC FIFO

The data format from the TSC_DATA register depends on the setting of "OpMode" field in TSC_CTRL register. The samples acquired are accessed in "packed samples". The size of each "packed sample" depends on which mode the touchscreen controller is operating in.

The TSC_DATA register can be accessed in 2 modes:

- Autoincrement
- Non autoincrement

To access the 128-sets buffer, the non autoincrement mode should be used.

Table 16. Touchscreen controller DATA register

TSC_CTRL in operation mode	Number of bytes to read from TSC_DATA	Byte0	Byte1	Byte2	Byte3
000	4	[11:4] of X	[3:0] of X [11:8] of Y	[7:0] of Y	[7:0] of Z
001	3	[11:4] of X	[3:0] of X [11:8] of Y	[7:0] of Y	-
010	2	[11:4] of X	[3:0] of X	-	-
011	2	[11:4] of Y	[3:0] of Y	-	-
100	1	[7:0] of Z	-	-	-

TSC_FRACTION_Z — Touchscreen controller FRACTION_Z

7	6	5	4	3	2	1	0
RESERVED					FRACTION_Z		

Address: 0x56

Type: R

Reset: 0x00

Description: This register allows to select the range and accuracy of the pressure measurement

[7:3] RESERVED

[2:0] FRACTION_Z:
000: Fractional part is 0, whole part is 8
001: Fractional part is 1, whole part is 7
010: Fractional part is 2, whole part is 6
011: Fractional part is 3, whole part is 5
100: Fractional part is 4, whole part is 4
101: Fractional part is 5, whole part is 3
110: Fractional part is 6, whole part is 2
111: Fractional part is 7, whole part is 1

TSC_I_DRIVE — Touchscreen controller drive I

7	6	5	4	3	2	1	0
RESERVED							DRIVE

Address: 0x58

Type: R/W

Reset: 0x00

Description: This register sets the current limit value of the touchscreen drivers

[7:1] RESERVED

[0] DRIVE: maximum current on the touchscreen controller (TSC) driving channel
0: 20 mA typical, 35 mA max
1: 50 mA typical, 80 mA max

TSC_SHIELD Touchscreen controller shield

7	6	5	4	3	2	1	0
RESERVED				X+	X-	Y+	Y-

Address: 0x59

Type: R

Reset: 0x00

Description: Writing each bit would ground the corresponding touchscreen wire

[7:4] RESERVED

[3:0] SHIELD[3:0]:
Write 1 to GND X+, X-, Y+, Y- lines

11 Touchscreen controller programming sequence

The following are the steps to configure the touchscreen controller (TSC):

a) Disable the clock gating for the touchscreen controller and ADC in the SYS_CFG2 register.

b) Configure the touchscreen operating mode and the window tracking index.

c) A touch detection status may also be enabled through enabling the corresponding interrupt flag. With this interrupt, the user is informed through an interrupt when the touch is detected as well as lifted.

d) Configure the TSC_CFG register to specify the “panel voltage settling time”, touch detection delays and the averaging method used.

e) A windowing feature may also be enabled through TSCWdwTRX, TSCWdwTRY, TSCWdwBLX and TSCWdwBLY registers. By default, the windowing covers the entire touch panel.

f) Configure the TSC_FIFO_TH register to specify the threshold value to cause an interrupt. The corresponding interrupt bit in the interrupt module must also be enabled. This interrupt bit should be masked off during data fetching from the FIFO in order to prevent an unnecessary trigger of this interrupt. Upon completion of the data fetching, this bit can be re-enabled

g) By default, the FIFO_RESET bit in the TSC_FIFO_CTRL_STA register holds the FIFO in Reset mode. Upon enabling the touchscreen controller (through the EN bit in TSC_CTRL), this FIFO reset is automatically deasserted. The FIFO status may be observed from the TSC_FIFO_CTRL_STA register or alternatively through the interrupt.

h) Once the data is filled beyond the FIFO threshold value, an interrupt is triggered (assuming the corresponding interrupt is being enabled). The user is required to continuously read out the data set until the current FIFO size is below the threshold, then, the user may clear the interrupt flag. As long as the current FIFO size exceeds the threshold value, an interrupt from the touchscreen controller is sent to the interrupt module. Therefore, even if the interrupt flag is cleared, the interrupt flag will automatically be asserted, as long as the FIFO size exceeds the threshold value.

i) The current FIFO size can be obtained from the TSC_FIFO_Sz register. This information may assists the user in how many data sets are to be read out from the FIFO, if the user intends to read all in one shot. The user may also read a data set by a data set.

j) The TSC_DATA_X register holds the X-coordinates. This register can be used in all touchscreen operating modes.

k) The TSC_DATA_Y register holds the Y-coordinates. TSC_DATA_Y register holds the Y-coordinates.

l) The TSC_DATA_Z register holds the Z value. TSC_DATA_Z register holds the Z-coordinates.

m) The TSCDATA_XYZ register holds the X, Y and Z values. These values are packed into 4 bytes. This register can only be used when the touchscreen operating mode is 000 and 001. This register is to facilitate less byte read.

n) For the TSC_FRACT_Z register, the user may configure it based on the touchscreen panel resistance. This allows the user to specify the resolution of the

Z value. With the Z value obtained from the register, the user simply needs to multiply the Z value with the touchscreen panel resistance to obtain the touch resistance.

o) The TSC_DATA register allows facilitation of another reading format with minimum I^2C transaction overhead by using the non autoincrement mode (or equivalent mode in SPI). The data format is the same as TSC_DATA_XYZ, with the exception that all the data fetched are from the same address.

p) Enable the EN bit of the TSC_CTRL register to start the touch detection and data acquisition.

q) During the auto-hibernate mode, a touch detection can cause a wake-up to the device only when the TSC is enabled and the touch detect status interrupt mask is enabled.

r) In order to prevent confusion, it is recommended that the user not mix the data fetching format (TSC_DATA_X, TSC_DATA_Y, TSC_DATA_Z, TSC_DATA_XYZ and TSC_DATA) between one reading and the next.

s) It is also recommended that the user should perform a FIFO reset and TSC disabling when the ADC or TSC setting are reconfigured.

12 GPIO controller

A total of 6 GPIOs are available in the STMPE610 port expander device. Most of the GPIOs share physical pins with some alternate functions. The GPIO controller contains the registers that allow the host system to configure each of the pins into either a GPIO, or one of the alternate functions. Unused GPIOs should be configured as outputs to minimize power consumption.

A group of registers are used to control the exact function of each of the 6 GPIOs. The registers and their respective addresses are listed in the following table.

Table 17. GPIO control registers

Address	Register name	Size (bit)	Function
0x10	GPIO_SET_PIN	8	Set pin register
0x11	GPIO_CLR_PIN	8	Clear pin state
0x12	GPIO_MP_STA	8	Monitor pin state
0x13	GPIO_DIR	8	Set pin direction
0x14	GPIO_ED	8	Edge detect status
0x15	GPIO_RE	8	Rising edge detection enable
0x16	GPIO_FE	8	Falling edge detection enable
0x17	GPIO_ALT_FUNCT	8	Alternate function register

All GPIO registers are named as GPIO-x, where x represents the functional group.

7	6	5	4	3	2	1	0
GPIO-7	GPIO-6	GPIO-5	GPIO-4	GPIO-3	GPIO-2	RESERVED	RESERVED

GPIO_SET_PIN GPIO set pin register

Address: 0x10

Type: R/W

Reset: 0x00

Description: GPIO set pin register.

Writing 1 to this bit causes the corresponding GPIO to go to 1 state.

Writing 0 has no effect.

GPIO_CLR_PIN Clear pin state register

Address: 0x11

Type: R/W

Reset: 0x00

Description: GPIO clear pin state register.

Writing ‘1’ to this bit causes the corresponding GPIO to go to 0 state.

Writing ‘0’ has no effect.

GPIO_MP_STA GPIO monitor pin state register

Address: 0x12

Type: R/W

Reset: 0x00

Description: GPIO monitor pin state.

Reading this bit yields the current state of the bit. Writing has no effect.

GPIO_DIR GPIO set pin direction

Address: 0x13

Type: R/W

Reset: 0x00

Description: GPIO set pin direction register.

Writing ‘0’ sets the corresponding GPIO to input state, and ‘1’ sets it to output state. All bits are ‘0’ on reset.

GPIO_ED_STA GPIO edge detect status

Address: 0x14

Type: R/W

Reset: 0x00

Description: GPIO edge detect status register. An edge transition has been detected.

GPIO_RE Rising edge register

Address: 0x15

Type: R/W

Reset: 0x00

Description: GPIO rising edge detection enable register.

Setting this bit to '1' would enable the detection of the rising edge transition.

The detection would be reflected in the GPIO edge detect status register.

GPIO_FE Falling edge detection enable register

Address: 0x16

Type: R/W

Reset: 0x00

Description: Setting this bit to '1' would enable the detection of the falling edge transition.

The detection would be reflected in the GPIO edge detect status register.

GPIO_ALT_FUNCT Alternate function register

Address: 0x17

Type: R/W

Reset: 0x0F

Description: Alternate function register. "'0' sets the corresponding pin to function as touchscreen/ADC, and '1' sets it into GPIO mode.

On power-up reset, all GPIOs are set as input.

Power supply

The STMPE610 GPIO operates from a separate supply pin (V_{IO}). This dedicated supply pin provides a level-shifting feature to the STMPE610. The GPIO remains valid until V_{IO} is removed.

The host system may choose to turn off V_{cc} supply while keeping V_{IO} supplied. However it is not allowed to turn off supply to V_{IO}, while keeping the Vcc supplied.

The touchscreen is always powered by V_{IO}. For better resolution and noise immunity, V_{IO} above 2.8 V is advised.

12.0.1 Power-up reset (POR)

The STMPE610 is equipped with an internal POR circuit that holds the device in reset state, until the V_{IO} supply input is valid. The internal POR is tied to the V_{IO} supply pin.

13 Maximum rating

Stressing the device above the ratings listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 18. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	4.5	V
V_{IO}	GPIO supply voltage	4.5	V
ESD	ESD protection on each GPIO pin (air discharge)	4	kV
T	Operating temperature	-40 - 85	°C/W
T_{STG}	Storage temperature	-65 - 155	°C/W
T_J	Thermal resistance junction-ambient	96	°C/W

13.1 Recommended operating conditions

Table 19. Power consumption

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
Vcc	I/O supply voltage	Vio >= Vcc	1.65	–	3.6	V
V_{IO}	Core supply voltage		1.65	–	3.6	V
$I_{CC\text{-}active}$	Core supply current	Touchscreen controller at 100 Hz sampling V_{CC}= 1.8 – 3.3 V	–	0.5	1.0	uA
$I_{IO\text{-}active}$	I/O supply current	Touchscreen controller at 100 Hz sampling V_{IO} = 1.8 V	–	0.8	1.2	mA
$I_{IO\text{-}active}$	I/O supply current	Touchscreen controller at 100 Hz sampling V_{IO} = 3.3 V	–	2.0	2.8	mA
$I_{CC\text{-}hibernate}$	Core supply current	Hibernate state, no I2C/SPI activity V_{CC} = 1.8 V	–	0.5	1	uA

Table 19. Power consumption (continued)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
$I_{IO\text{-}hibernate}$	I/O supply current	Hibernate state, no I2C/SPI activity V_{IO} = 1.8 – 3.3 V	–	0.5	1	µA
		Hibernate state, no I2C/SPI activity V_{IO} = 3.3 V	–	1.0	3.0	µA

14 Electrical specifications

Table 20. DC electrical characteristics (-40 °C to 85 °C, all GPIOs comply to JEDEC standard JESD-8-7)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
V_{IL}	Input voltage low state	V_{IO} = 1.8 – 3.3 V	-0.3 V	–	0.20 V_{IO}	V
V_{IH}	Input voltage high state	V_{IO} = 1.8 – 3.3 V	0.80 V_{IO}	–	V_{IO} + 0.3 V	V
V_{OL}	Output voltage low state	V_{IO} = 1.8 V, I_{OL} = 4 mA	-0.3 V	–	0.15 V_{IO}	V
V_{OH}	Output voltage high state	V_{IO} = 3.3 V, I_{OL} = 8 mA	0.85 V_{IO}	–	–	V
V_{OL} (I^2C/SPI)	Output voltage low state	V_{CC} = 1.8 V, I_{OL} = 4 mA	-0.3 V	–	0.15 V_{CC}	V
V_{OH} (I^2C/SPI)	Output voltage high state	V_{CC} = 3.3 V, I_{OL} = 8 mA	0.85 V_{CC}	–	V_{CC} +0.3V	V

Table 21. AC electrical characteristics (-40 °C to 85 °C)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
$CLKI2C_{max}$	I^2C maximum SCLK	V_{CC} = 1.8 - 3.3 V	400	–	–	kHz
$CLKSPI_{max}$	SPI maximum clock	V_{CC} = 1.8 V	800	–	–	kHz
		V_{CC} = 3.3 V	1000	–	–	kHz

Table 22. ADC specification (-40 °C to 85 °C)

Parameter	Test condition	Value			Unit
		Min	Typ	Max	
Full-scale input span		0	–	V_{ref}	V
Absolute input range		–	–	V_{CC} +0.2	V
Input capacitance		–	25	–	pF
Leakage current		–	0.1	–	µA
Resolution		–	12	–	bits
No missing codes		11		–	bits
Integral linearity error		–	±4	±6	bits
Offset error		–	±5	±7	LSB
Gain error		–	±14	±18	LSB
Noise	Including internal V_{ref}	–	70	–	µVrms
Power supply rejection ratio		–	50	–	dB
Throughput rate		–	180	–	ksps

Table 23. Switch drivers specification

Parameter	Test condition	Value			Unit
		Min	Typ	Max	
ON resistance X+, Y+		–	5.5	–	Ω
ON resistance X-, Y-		–	7.3	–	Ω
Drive current	Duration 100 ms	–	–	50	mA

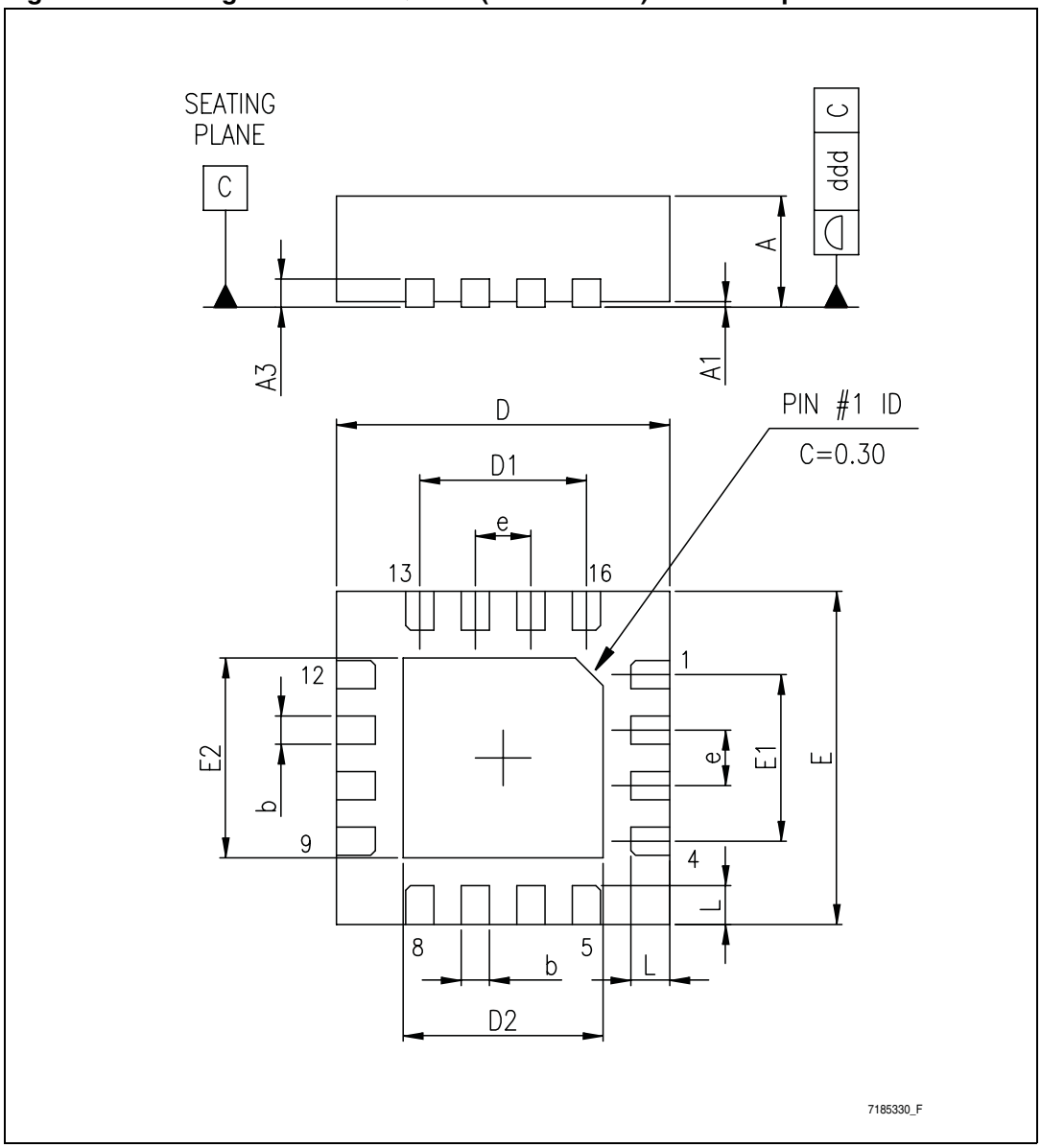
Table 24. Voltage reference specification

Parameter	Test condition	Value			Unit
		Min	Typ	Max	
Internal reference voltage		2.45	2.50	2.55	V
Internal reference drift		–	25	–	Ppm/C
Output impedance	Internal reference ON	–	300	–	Ω
	Internal reference OFF	–	1	–	GΩ

15 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Figure 13. Package outline for QFN16 (3 x 3 x 1 mm) - 0.50 mm pitch



1. Drawing not to scale.

Table 25. Package mechanical data for QFN16 (3 x 3 x 1 mm) - 0.50 mm pitch

Symbol	Millimeters		
	Min	Typ	Max
A	0.80	0.90	1.00
A1	–	0.02	0.05
A3	–	0.20	–
b	0.18	0.25	0.30
D	–	3.00	–
D2	1.55	1.70	1.80
E	–	3.00	–
E2	1.55	1.70	1.80
e	–	0.50	–
K	–	0.20	–
L	0.30	0.40	0.50
r	0.09	–	–

Figure 14. Recommended footprint for QFN16 (3 x 3 x 1 mm) - 0.50 mm pitch

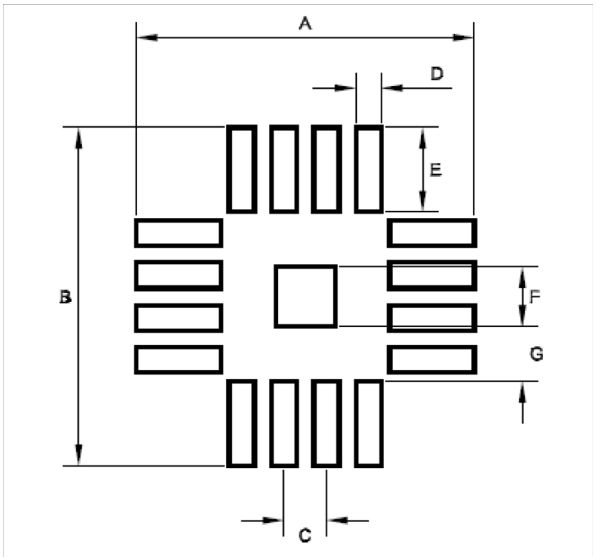


Table 26. Footprint dimensions

Symbol	Millimeters		
	Min	Typ	Max
A	–	3.8	–
B	–	3.8	–
C	–	0.5	–
D	–	0.3	–
E	–	0.8	–
F	–	1.5	–
G	–	0.35	–

Figure 15. Carrier tape for QFN16 (3 x 3 x 1 mm) - 0.50 mm pitch

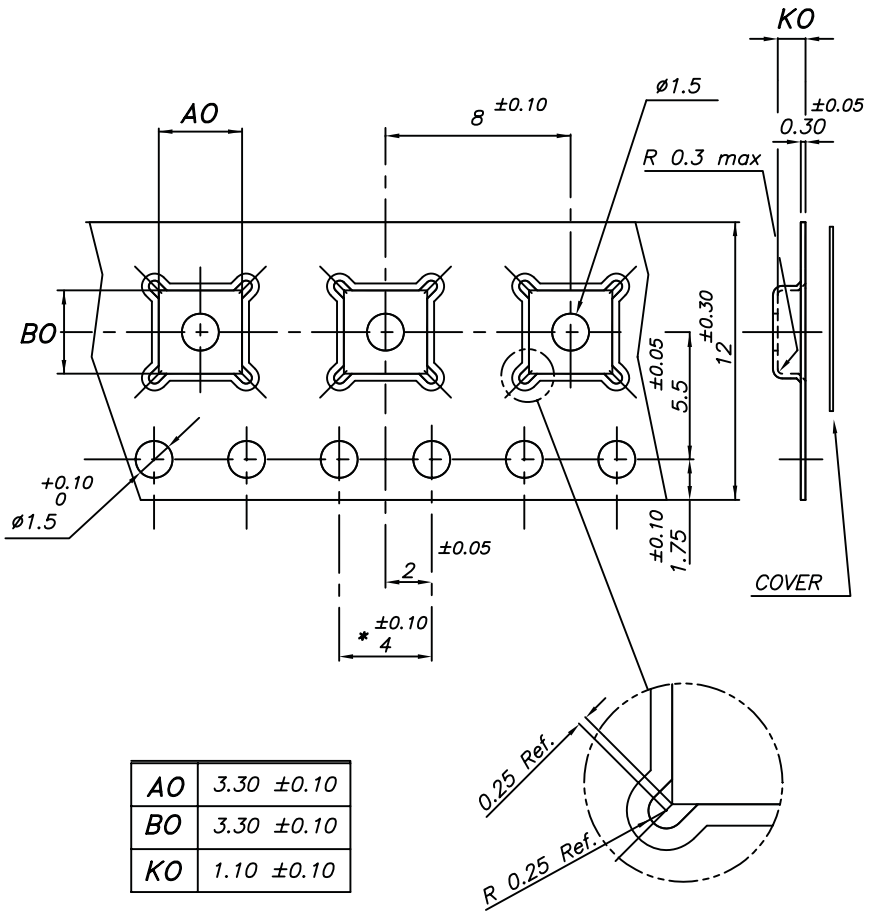


Figure 16. Reel information for QFN16 (3 x 3 x 1 mm) - 0.50 mm pitch

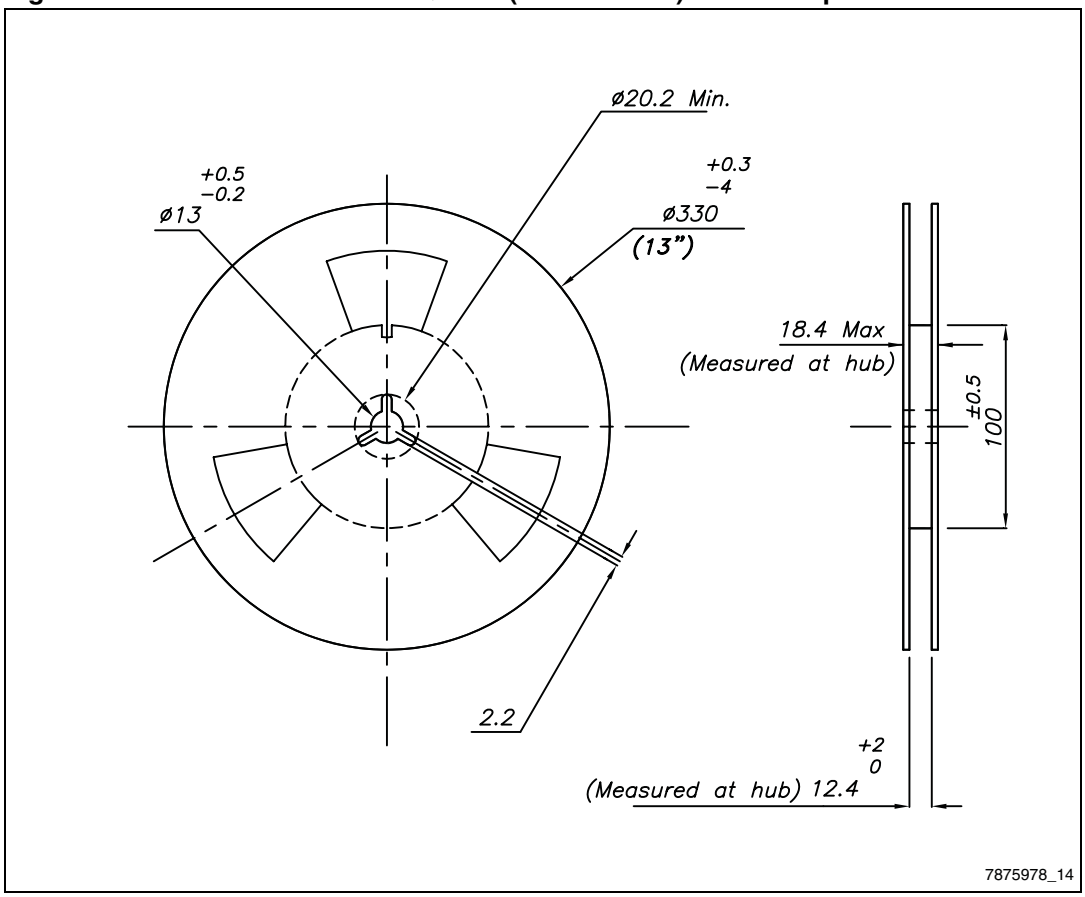
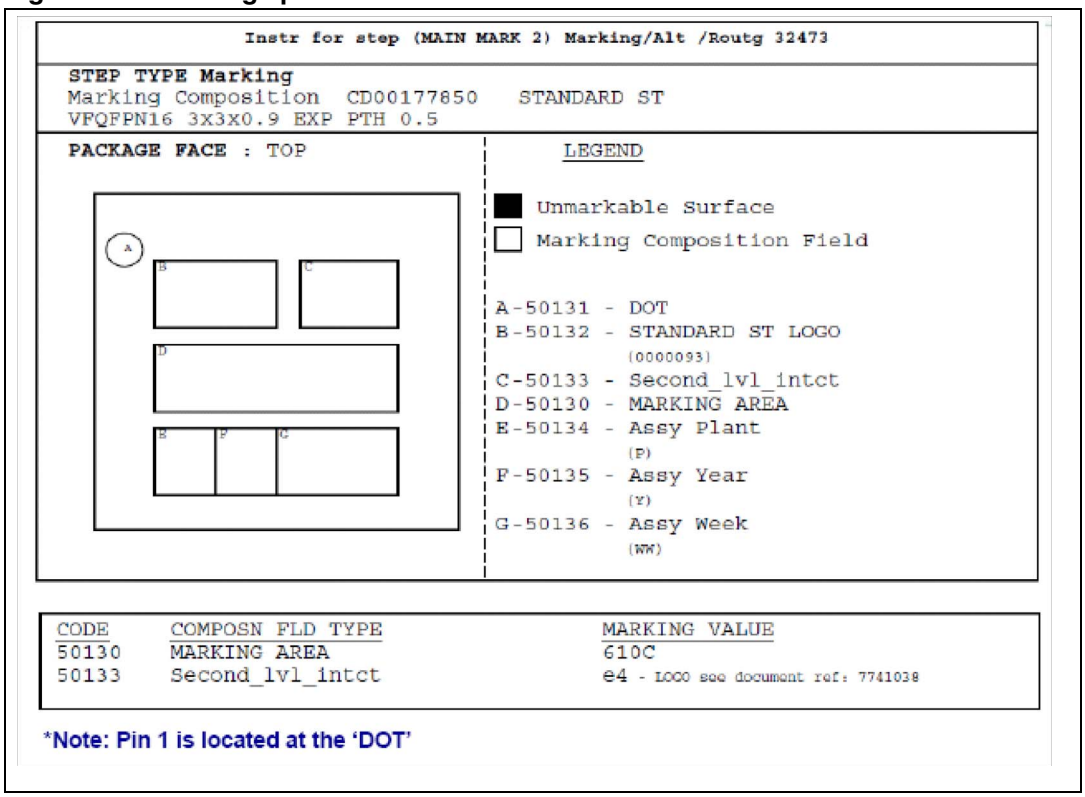


Figure 17. Marking specifications



16 Revision history

Table 27. Document revision history

Date	Revision	Changes
07-Apr-2009	1	Initial release.
23-Sep-2009	2	Removed “Temperature sensor” from *Section 1*, *Figure 1* and *Figure 8*. Updated: In the SYS_CTRL2 register, the 3rd bit is reserved.
12-Mar-2010	3	Updated: Title of the document and ESD value in *Table 18*.
09-Sep-2011	4	Added new section: *Section 10.2: Touch detect delay* Updated V_{CC} parameter description: *Table 19*

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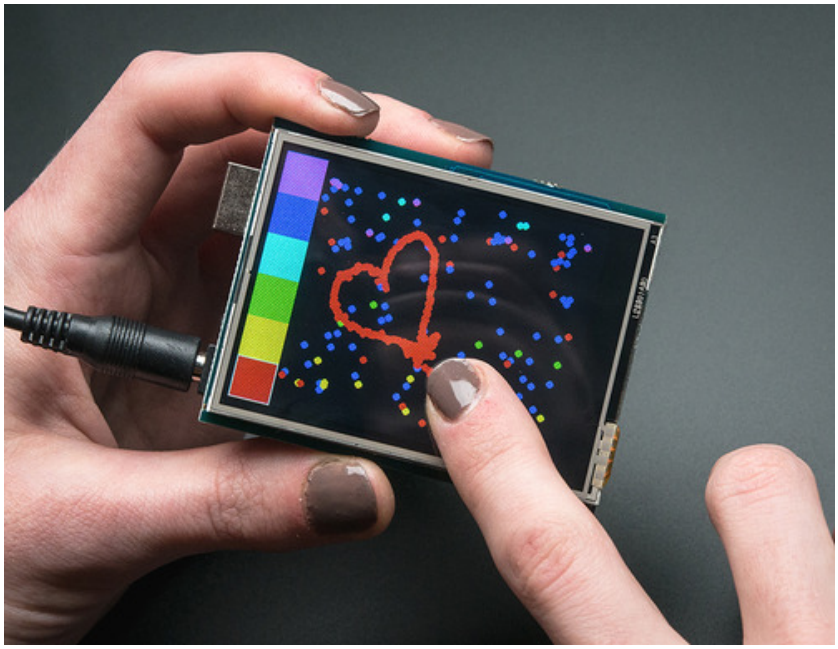
Adafruit 2.8" TFT Touch Shield v2 - Capacitive or Resistive

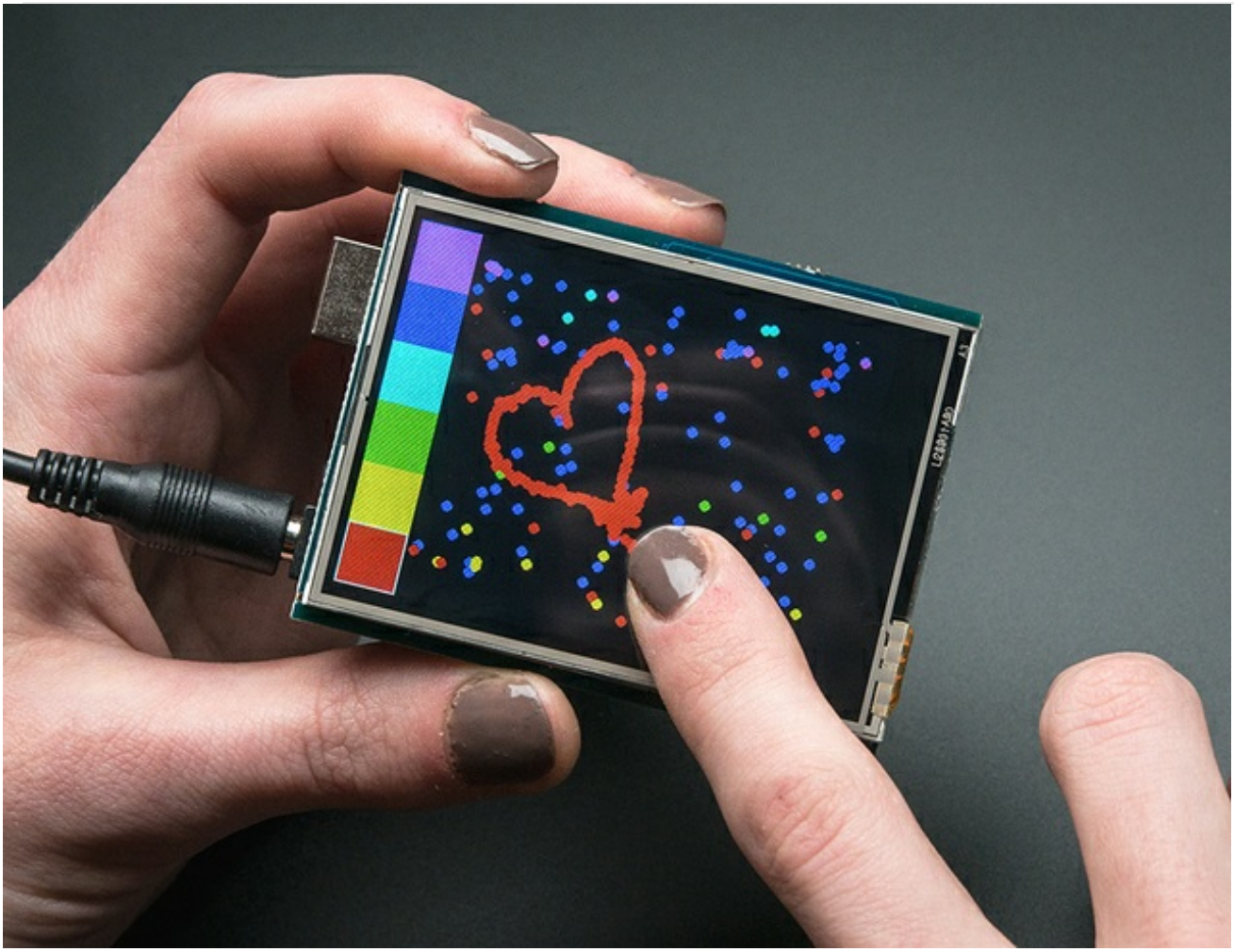
Created by lady ada



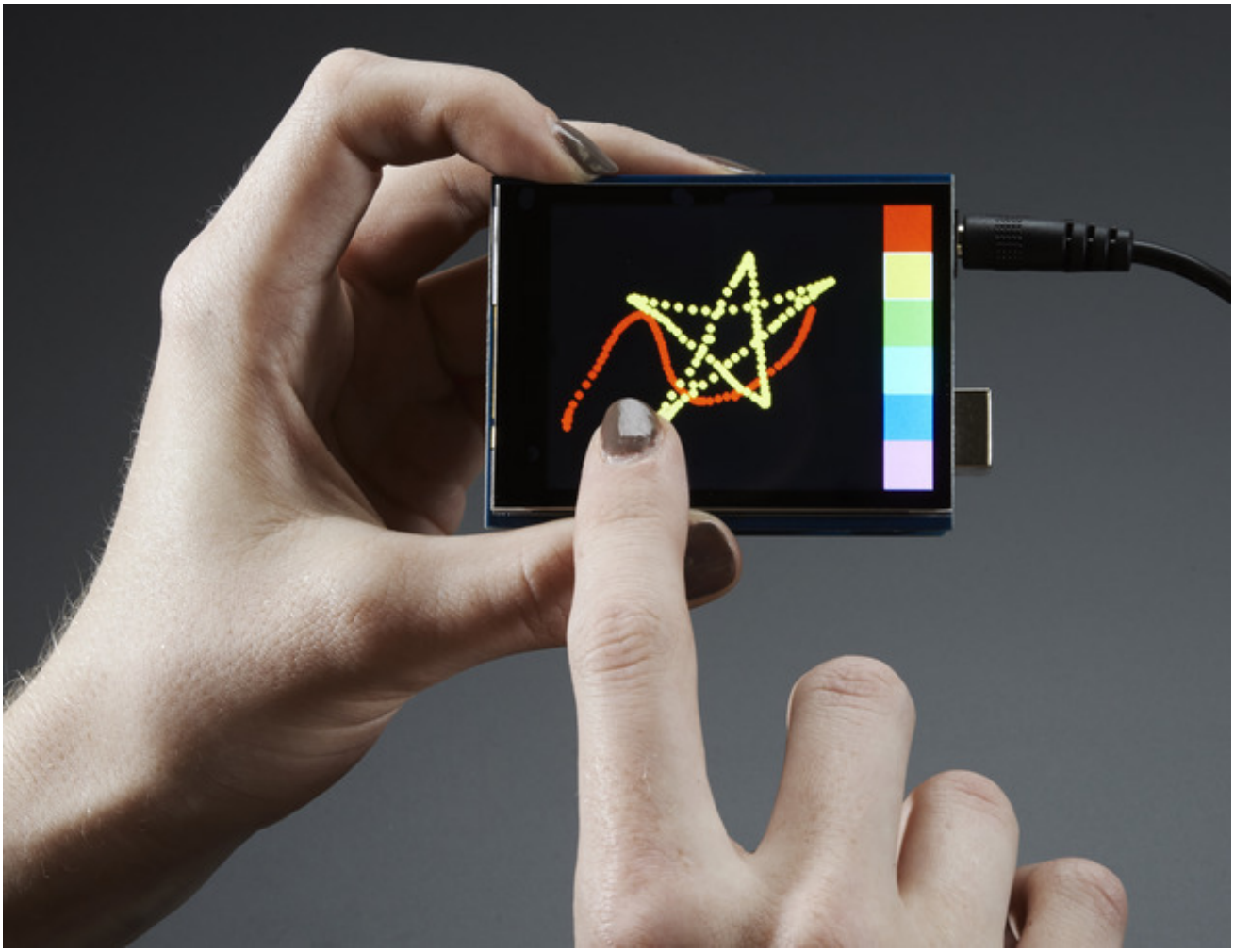
Last updated on 2015-08-06 07:30:08 AM EDT

Guide Contents

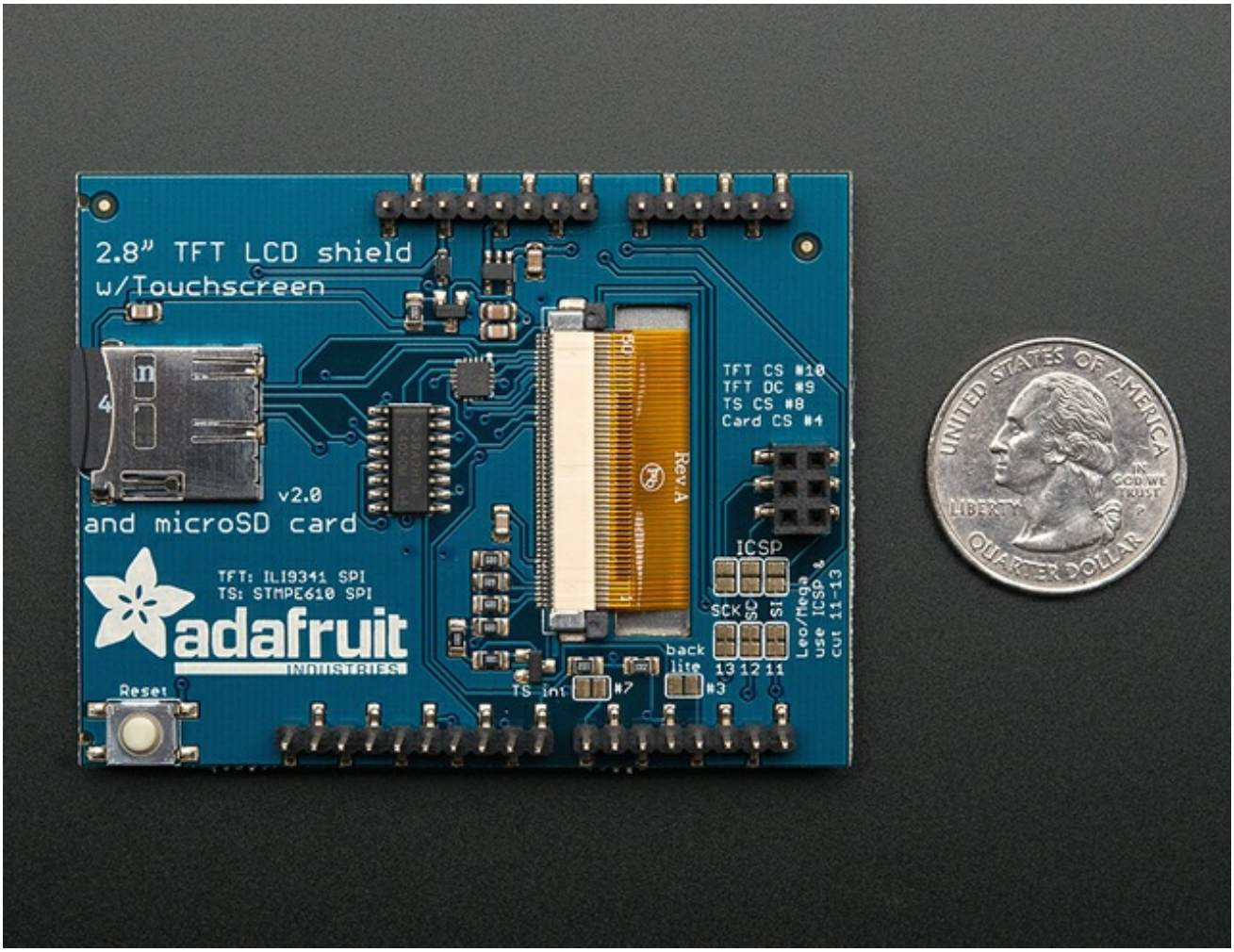
Overview



Spice up your Arduino project with a beautiful large touchscreen display shield with built in microSD card connection. This TFT display is big (2.8" diagonal) bright (4 white-LED backlight) and colorful (18-bit 262,000 different shades)! 240x320 pixels with individual pixel control. It has way more resolution than a black and white 128x64 display. As a bonus, this display comes with a **resistive or capacitive** touchscreen attached to it already, so you can detect finger presses anywhere on the screen.



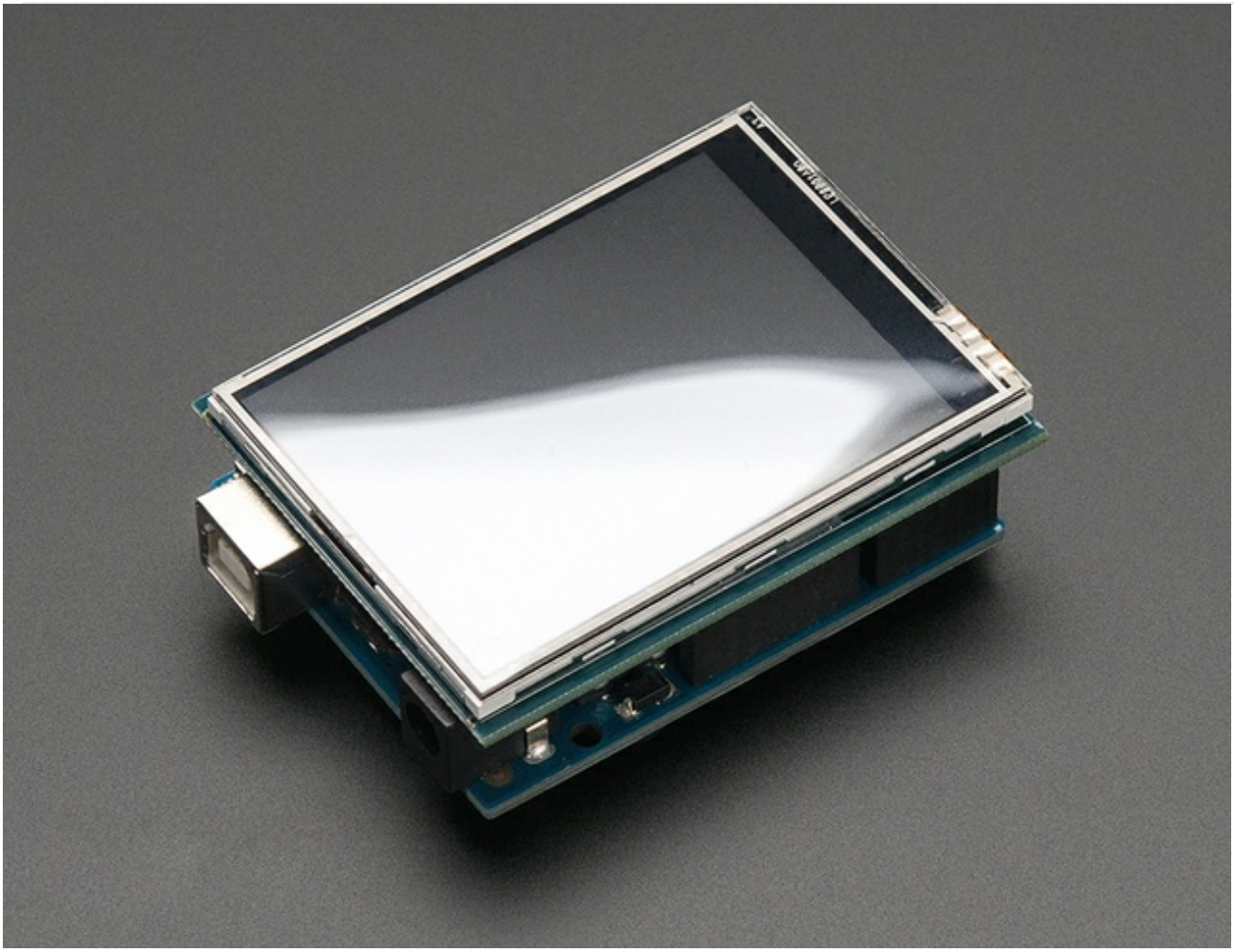
This shield uses a SPI display - its much easier to use with Mega & Leonardo than our v1 shield. We also include an SPI resistive touchscreen controller or a I2C capacitive touch screen controller so you only need one or two additional pins to add a high quality touchscreen controller. Even with all the extras, the price is lower thanks to our parts sourcing & engineering skillz!

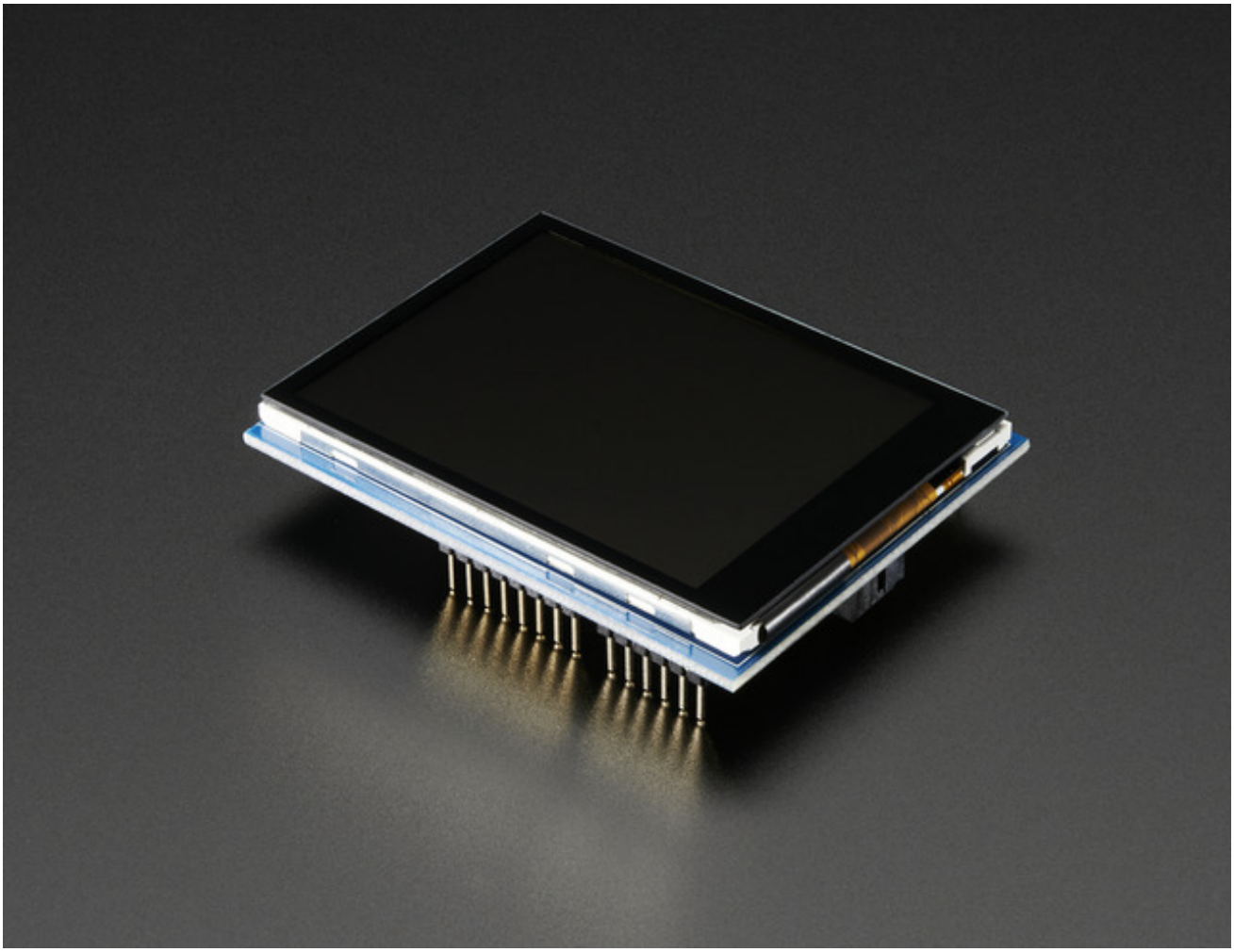


The shield is fully assembled, tested and ready to go. No wiring, no soldering! Simply plug it in and load up our library - you'll have it running in under 10 minutes! Works best with any classic Arduino (UNO/Duemilanove/Diecimila). Solder three jumpers and you can use it at full speed on a Leonardo or Mega as well.

This display shield has a controller built into it with RAM buffering, so that almost no work is done by the microcontroller. This shield needs fewer pins than our v1 shield, so you can connect more sensors, buttons and LEDs: 5 SPI pins for the display, another pin or two for the touchscreen controller and another pin for uSD card if you want to read images off of it.

Connecting





Pinouts

There's two versions of the shield. One has a resistive touch screen, one has a capacitive one. The *TFT display* and pinouts is the same for both. The microSD card is the same too. The differences come in on the touch screen controller

TFT Screen Pins

- **Digital #13 *or* ICSP SCLK** - This is the hardware SPI clock pin. By default its digital #13. By cutting a jumper and soldering another on the back, you can move this line from #13 to the ICSP clock pin. This pin is used for the TFT, microSD and resistive touch screen data clock
- **Digital #12 *or* ICSP MISO** - This is the hardware SPI master-in-slave-out pin. By default its digital #12. By cutting a jumper and soldering another on the back, you can move this line from #12 to the ICSP MISO pin. This pin is used for the TFT, microSD and resistive touch screen data
- **Digital #11 *or* ICSP MOSI** - This is the hardware SPI master-out-slave-in pin. By default its digital #11. By cutting a jumper and soldering another on the back, you can move this line from #11 to the ICSP MOSI pin. This pin is used for the TFT, microSD and resistive touch

screen data
- **Digital #10** - This is the TFT CS (chip select pin). It's used by the Arduino to tell the TFT that it wants to send/receive data from the TFT only
- **Digital #9** - This is the TFT DC (data/command select) pin. It's used by the Arduino to tell the TFT whether it wants to send data or commands

Resistive Touch Controller Pins

- **Digital #13 *or* ICSP SCLK** - This is the hardware SPI clock pin. By default its digital #13. By cutting a jumper and soldering another on the back, you can move this line from #13 to the ICSP clock pin. This pin is used for the TFT, microSD and resistive touch screen data clock
- **Digital #12 *or* ICSP MISO** - This is the hardware SPI master-in-slave-out pin. By default its digital #12. By cutting a jumper and soldering another on the back, you can move this line from #12 to the ICSP MISO pin. This pin is used for the TFT, microSD and resistive touch screen data
- **Digital #11 *or* ICSP MOSI** - This is the hardware SPI master-out-slave-in pin. By default its digital #11. By cutting a jumper and soldering another on the back, you can move this line from #11 to the ICSP MOSI pin. This pin is used for the TFT, microSD and resistive touch screen data
- **Digital #8** - This is the STMPE610 Resistive Touch CS (chip select pin). It's used by the Arduino to tell the Resistive controller that it wants to send/receive data from the STMPE610 only

Capacitive Touch Pins

- **SDA** - This is the I2C data pin used by the FT6206 capacitive touch controller chip. It can be shared with other I2C devices. On UNO's this pin is also known as Analog 4.
- **SCL** - This is the I2C clock pin used by the FT6206 capacitive touch controller chip. It can be shared with other I2C devices. On UNO's this pin is also known as Analog 5.

MicroSD card Pins

- **Digital #13 *or* ICSP SCLK** - This is the hardware SPI clock pin. By default its digital #13. By cutting a jumper and soldering another on the back, you can move this line from #13 to the ICSP clock pin. This pin is used for the TFT, microSD and resistive touch screen data clock
- **Digital #12 *or* ICSP MISO** - This is the hardware SPI master-in-slave-out pin. By default its digital #12. By cutting a jumper and soldering another on the back, you can move this line from #12 to the ICSP MISO pin. This pin is used for the TFT, microSD and resistive touch screen data
- **Digital #11 *or* ICSP MOSI** - This is the hardware SPI master-out-slave-in pin. By default its digital #11. By cutting a jumper and soldering another on the back, you can move this line from #11 to the ICSP MOSI pin. This pin is used for the TFT, microSD and resistive touch screen data

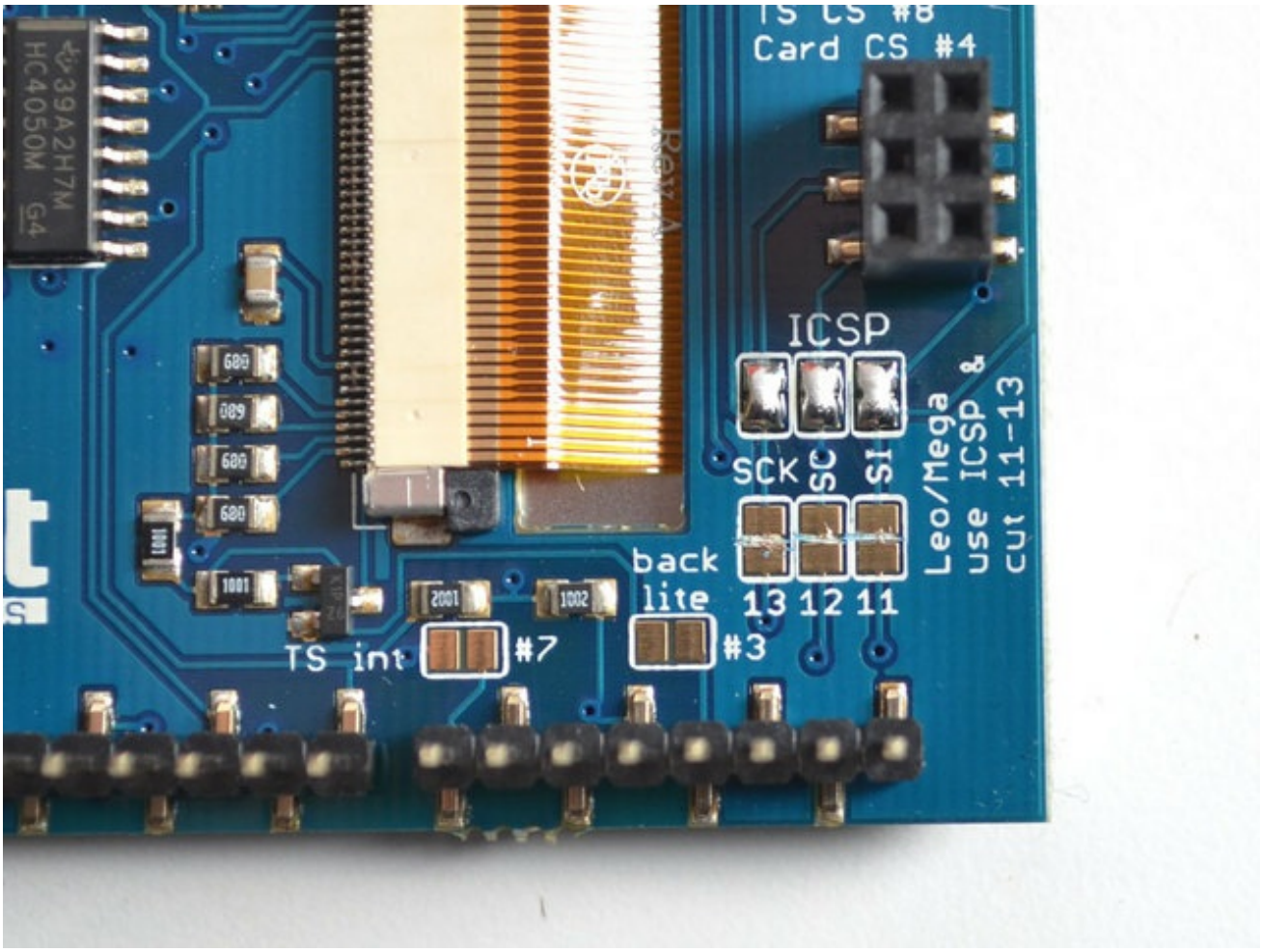
- **Digital #4** - This is the uSD CS (chip select pin). It's used by the Arduino to tell the uSD that it wants to send/receive data from the uSD only

Using with an Uno

Because the TFT is about the same size as an Arduino, we pre-assemble the shield in the factory. To use, simply place it onto your Arduino Uno/Duemilanove/compatible. No wiring, no soldering! **Bam!**

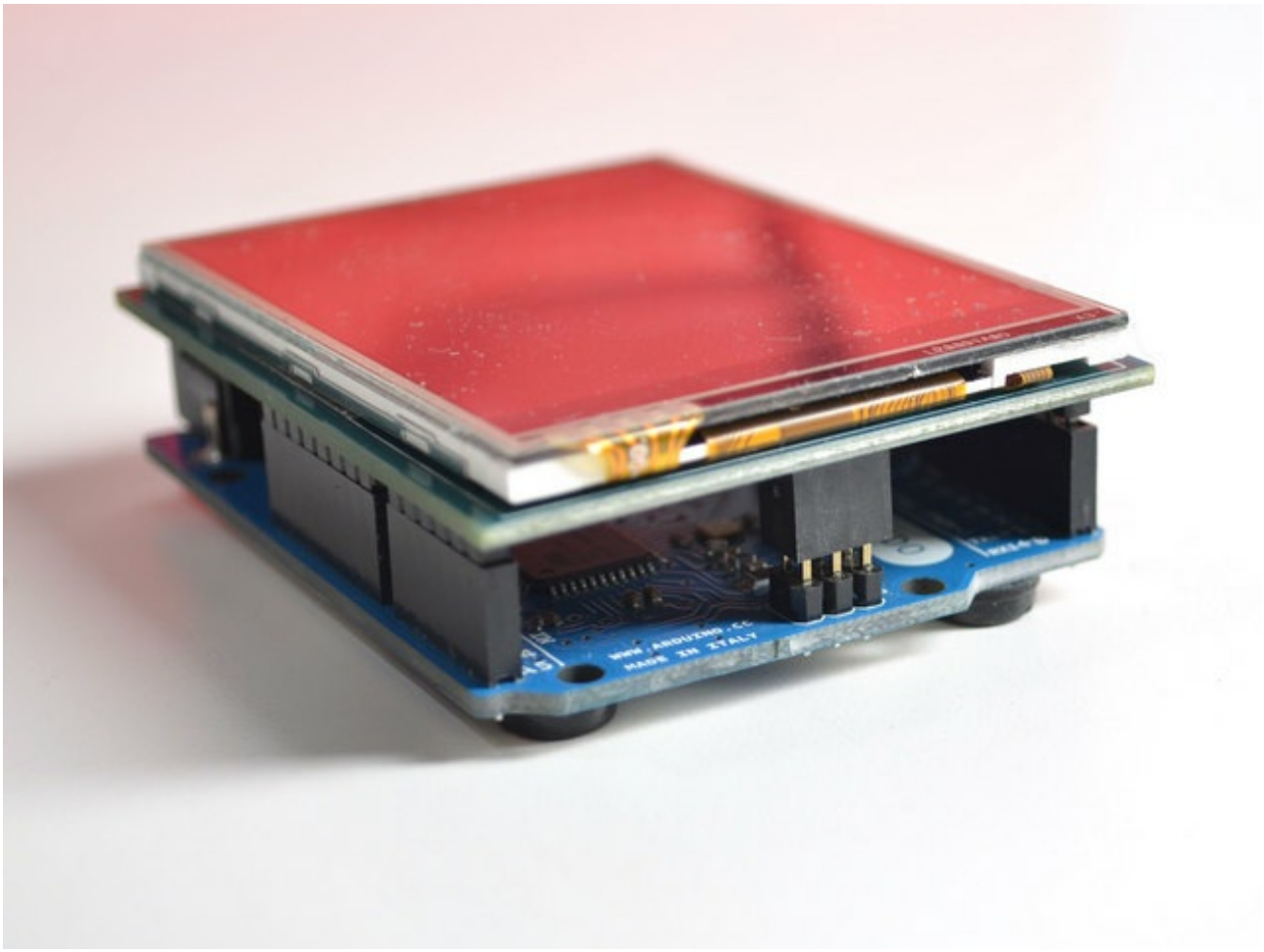
Using with a Mega/Leonardo

With just a little effort you can make this shield plug-n-play with the Mega/Leonardo. Look at the bottom of the shield and find the area with the 6 jumpers. Three of them are closed, and three are open. Solder close the three ICSP jumpers.



You can then cut the small line in between the #11, #12, #13 pads. This will free up digital #11, 12, and 13 for you to use on the Leo or Mega.

That's it! No software or firmware hacking other than that is required.



With this mod, the shield uses the ICSP header for data so make sure your duino (or stack of shields) has a ICSP plugged into the socket as above!

Graphics Test

We have a library with example code ready to go for use with these TFTs. The library is not incredibly fast and optimized but its a good start and can easily be ported to other micrcontrollers. However, we'll assume you're using an Arduino.

Our github repository (http://adafru.it/d4d) contains all the code and examples you'll need for driving the TFT. You can download the latest ZIP by clicking the button below

Download the Adafruit ILI9341 Library

http://adafru.it/d4e

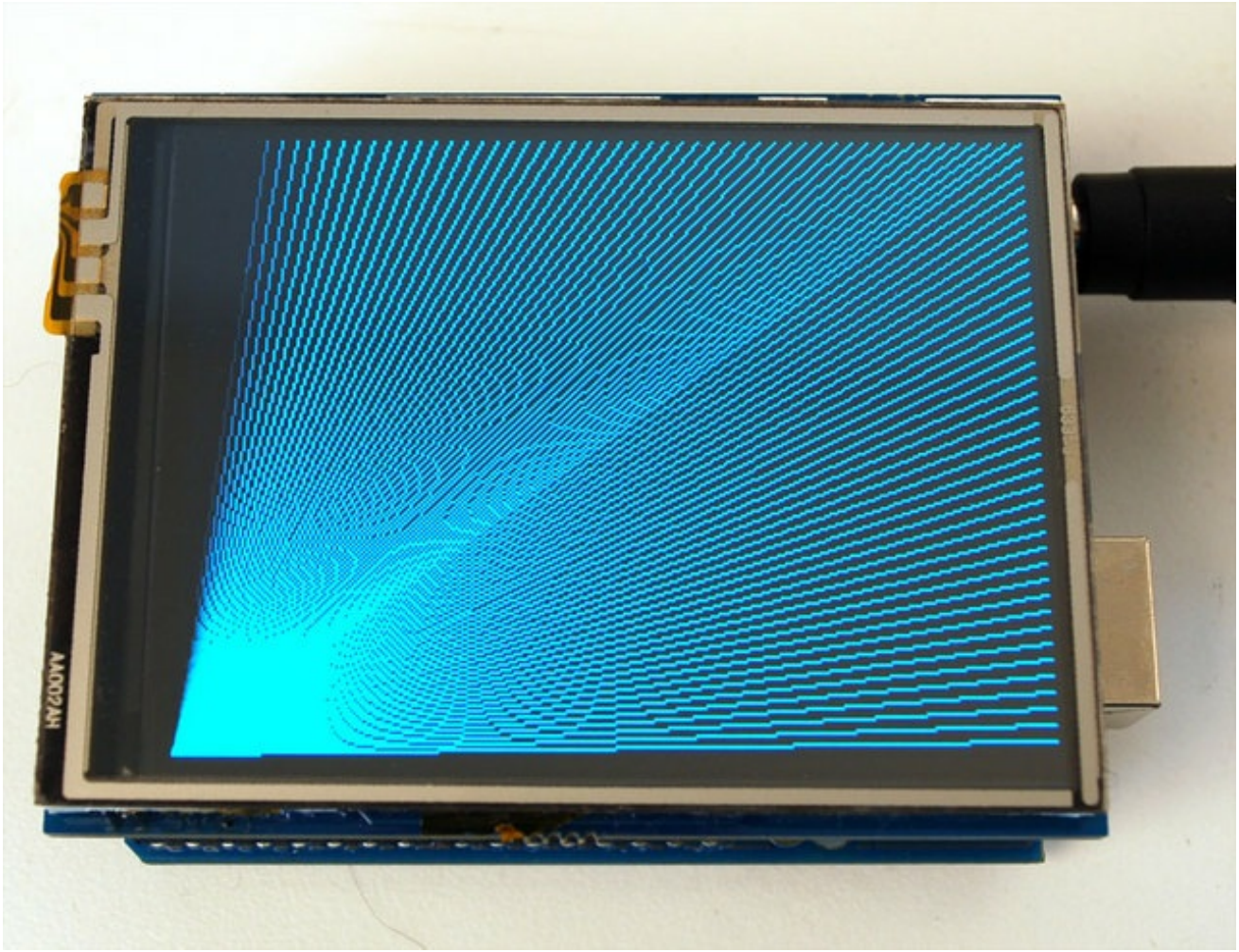
Uncompress the folder and rename it **Adafruit_ILI9341** make sure that inside that folder is the **Adafruit_ILI9341.cpp** and **Adafruit_ILI9341.h** files. Then copy it to your arduinosketchfolder/libraries folder. For more details, especially for first-time library installers, check out our great tutorial at http://learn.adafruit.com/adafruit-all-about-arduino-libraries-install-use (http://adafru.it/aYM)

You're not done yet! You will also need to get the Adafruit GFX graphics core (http://adafru.it/aJa) - this is the general purpose graphics drawing library (the ILI9341 library just handles the low level stuff). Click this button to grab it if you don't have it yet

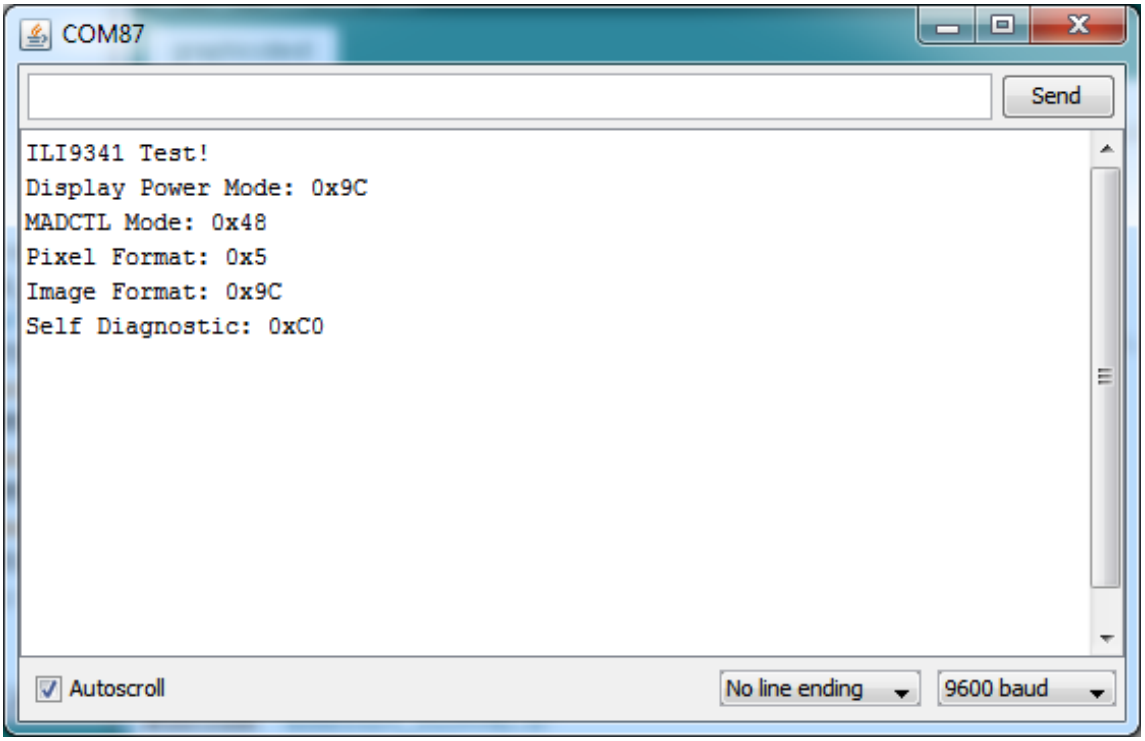
Download Adafruit GFX Library

http://adafru.it/cBB

Uncompress the folder and rename it **Adafruit_GFX** make sure that inside that folder is the cpp and .h files. Then copy it to your arduinosketchfolder/libraries folder like before



Restart the Arduino software. You should see a new **example** folder called **Adafruit_ILI9341** and inside, an example called **graphicstest**. Upload that sketch to your Arduino! You should see a collection of graphical tests draw out on the TFT.


COM87
Send
ILI9341 Test!
Display Power Mode: 0x9C
MADCTL Mode: 0x48
Pixel Format: 0x5
Image Format: 0x9C
Self Diagnostic: 0xC0
Autoscroll
No line ending
9600 baud

Adafruit GFX library

The TFT LCD library is based off of the Adafruit GFX graphics core library. GFX has many ready to go functions that should help you start out with your project. Its not exhaustive and we'll try to update it if we find a really useful function. Right now it supports pixels, lines, rectangles, circles, round-rects, triangles and printing text as well as rotation.

Check out the GFX tutorial for detailed information about what is supported and how to use it (http://adafru.it/aPx)!

Resistive Touchscreen Paint Demo

This page is for the Resistive Touch Screen version of the Shield!

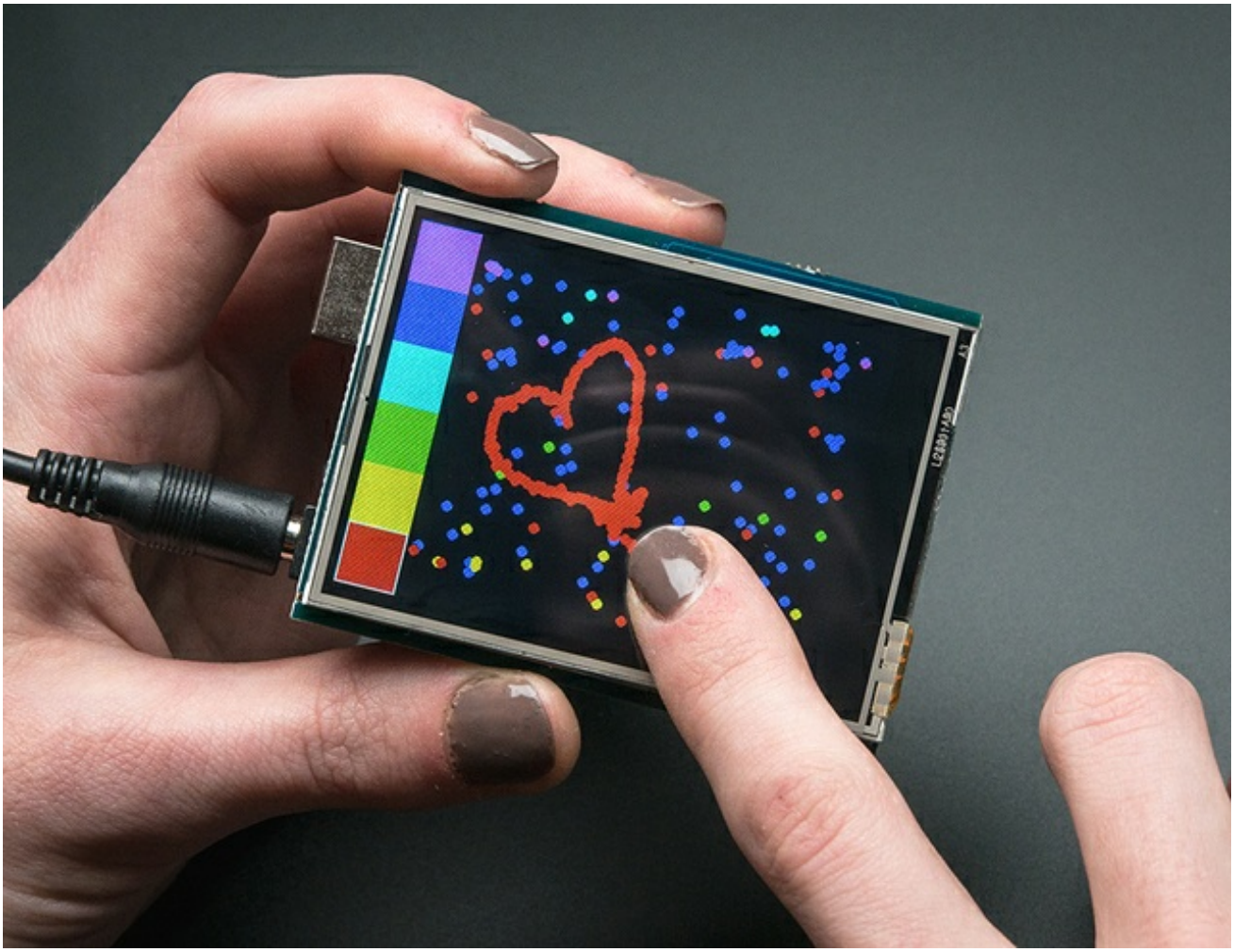
The LCD has a 2.8" 4-wire resistive touch screen glued onto it. You can use this for detecting finger-presses, stylus', etc. Normally, you'll need 4 pins to talk to the touch panel **but** we decided to go all snazzy and put a dedicated touch screen driver onto the shield. The driver shares the SPI pins with the TFT and SD card, so only one extra pin is needed (digital #8) This allows you to query the controller when you're ready to read touchscreen data, and saves 3 pins.

To control the touchscreen you'll need one more library (http://adafru.it/d4f) - the STMPE610 controller library which does all the low level chatting with the STMPE610 driver chip. Click below to download and then install it as before.

Download the STMPE610 Library

http://adafru.it/d4g

Once you have the library installed, restart the IDE. Now from the **examples->Adafruit_ILI9341** menu select **touchpaint** and upload it to your Arduino.



The touch screen is made of a thin glass sheet, and its very fragile - a small crack or break will make the entire touch screen unusable. Don't drop or roughly handle the TFT and be especially careful of the corners and edges. When pressing on the touchscreen, sometimes people can use the tip of their fingers, or a fingernail. If you don't find the touchscreen responds well to your fingers, you can use a rounded stylus which will certainly work. Do not press harder and harder until the screen cracks!

Getting data from the touchscreen is fairly straight forward. Start by creating the touchscreen object with

```
Adafruit_STMPE610 ts = Adafruit_STMPE610(STMPE_CS);
```

We're using hardware SPI so the clock, mosi and miso pins are not defined here. For the shield, CS is #8 always.
Then you can start the touchscreen with

```
ts.begin()
```

Check to make sure this returns a True value, which means the driver was found. If it wasn't, make sure you have the hardware SPI jumpers set up right: for Leonardo/Mega the ICSP jumpers get closed.

Now you can call

```
if (! ts.bufferEmpty())
```

to check if there's any data in the buffer. The touchscreen driver will store touchpoints at all times. When you're ready to get the data, just check if there's any data in the buffer. If there is, you can call

```
TS_Point p = ts.getPoint();
```

To get the oldest point from the buffer. TS_Point has **.x .y** and .**z** data points. The **x** and **y** points range from 0 to 4095. The STMPE610 does not store any calibration data in it and it doesn't know about rotation. **So if you want to rotate the screen you'll need to manually rotate the x/y points!** The z point is 'pressure' and ranges from 0 to 255, we don't use it here but you can experiment with it on your own, the harder you press, the lower the number.

Since data from the STMPE610 comes in 0-4095 but our screen is 320 pixels by 240 pixels, we can use **map** to convert 0-4095 to 0-320 or 0-240. Something like

```
p.x = map(p.x, 0, 4095, 0, tft.width());
p.y = map(p.y, 0, 4095, 0, tft.height());
```

However, the touchscreen is a bit bigger than the screen, so we actually need to ignore presses beyond the touchscreen itself. We found that these numbers reflected the true range that overlaps the screen

```
#define TS_MINX 150
#define TS_MINY 130
#define TS_MAXX 3800
#define TS_MAXY 4000
```

So we use

```
p.x = map(p.x, TS_MINX, TS_MAXX, 0, tft.width());
p.y = map(p.y, TS_MINY, TS_MAXY, 0, tft.height());
```

instead.

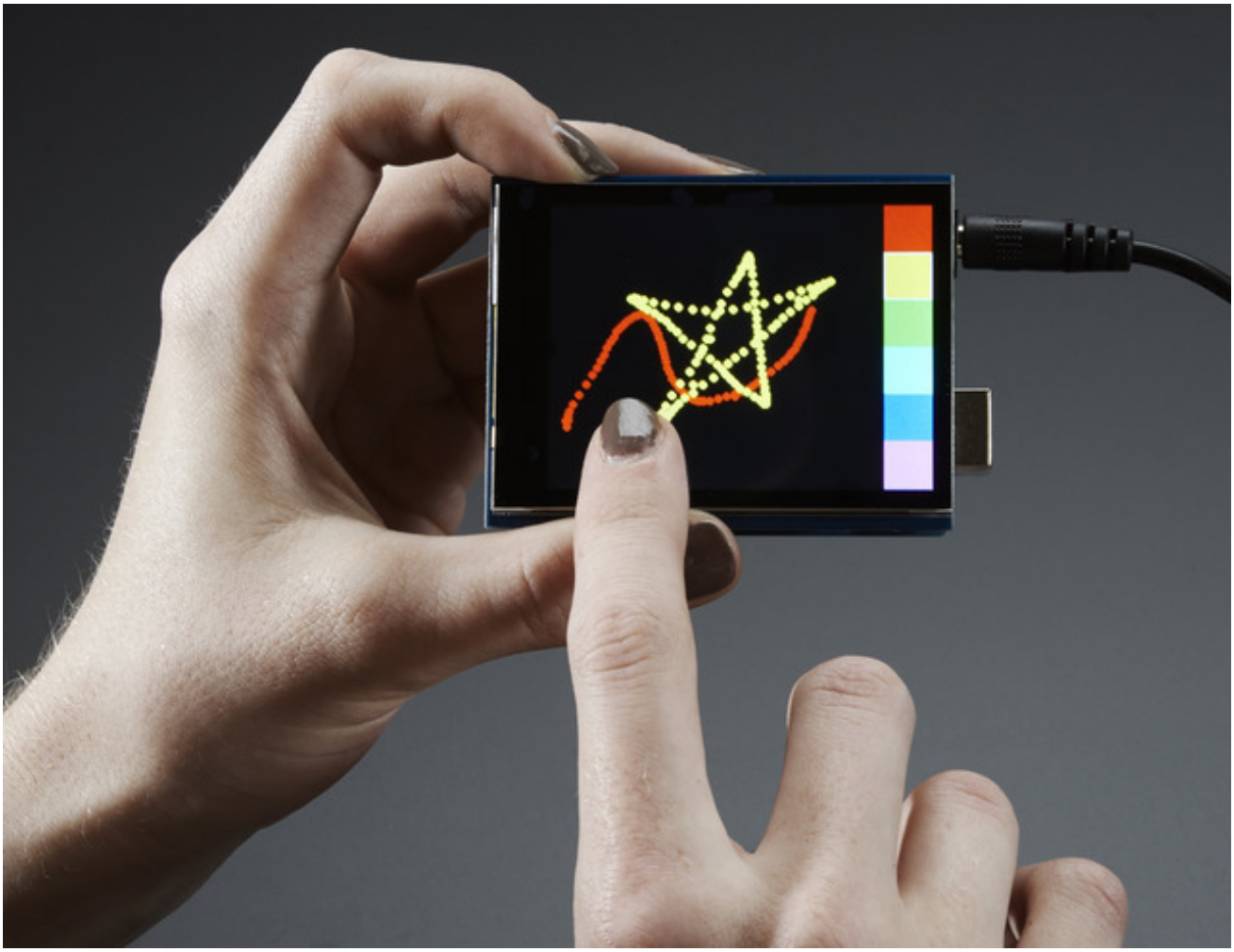
One last point (pun intended!) since the touchscreen driver stores points in a buffer, you may want

to ask the driver "is the touchscreen being pressed RIGHT NOW?" You can do that with

> **if (ts.touched())**

Capacitive Touchscreen Paint Demo

This page is for the Capacitive Touch Screen version of the Shield!



We now have a super-fancy capacitive touch screen version of this shield. Instead of a resistive controller that needs calibration and pressing down, the capacitive has a hard glass cover and can be used with a gentle fingertip. It is a single-touch capacitive screen only!

The capacitive touch screen controller communicates over I2C, which uses two hardwire pins. However, you can share these pins with other sensors and displays as long as they don't conflict with I2C address 0x38.

Download the FT6206 Library

To control the touchscreen you'll need one more library (http://adafru.it/dGG) - the FT6206 controller library which does all the low level chatting with the FT6206 driver chip. Click below to download and then install it as before.

Download Adafruit FT6206 Library

http://adafru.it/dGH

Once you have the library installed, restart the IDE. Now from the **examples->Adafruit_FT6206** menu select **CapTouchPaint** and upload it to your Arduino.

The touch screen is made of a thin glass sheet, and its very fragile - a small crack or break will make the entire touch screen unusable. Don't drop or roughly handle the TFT and be especially careful of the corners and edges. When pressing on the touchscreen, remember you cannot use a fingernail, it must be a fingerpad. Do not press harder and harder until the screen cracks!

FT6206 Library Reference

Getting data from the touchscreen is fairly straight forward. Start by creating the touchscreen object with

```
Adafruit_FT6206 ts = Adafruit_FT6206();
```

We're using hardware I2C which is fixed in hardware so no pins are defined.
Then you can start the touchscreen with

```
ts.begin()
```

Check to make sure this returns a True value, which means the driver was found. You can also call **begin(threshvalue)** wish a number from 0-255 to set the touch threshhold. The default works pretty well but if you're having too much sensitivity (or not enought) you can try tweaking it

Now you can call

```
if (ts.touched())
```

to check if the display is being touched, if so call:

```
TS_Point p = ts.getPoint();
```

To get the touch point from the controller. TS_Point has **.x** and **.y** data points. The **x** and **y** points range from 0 to 240 and 0 to 320 respectively. This corresponds to each pixel on the display. The FT6206 does not need to be 'calibrated' but it also doesn't know about rotation. **So if you want to rotate the screen you'll need to manually rotate the x/y points!**

Drawing Bitmaps

There is a built in microSD card slot into the shield, and we can use that to load bitmap images! You will need a microSD card formatted **FAT16 or FAT32** (they almost always are by default).

Its really easy to draw bitmaps. Lets start by downloading this image of pretty flowers (pix by johngineer)

Copy **purple.bmp** into the base directory of a microSD card and insert it into the microSD socket in the shield. Now upload the **file->examples->Adafruit_ILI9341->spitftbitmap** example to your Arduino + shield. You will see the flowers appear!

To make new bitmaps, make sure they are less than 240 by 320 pixels and save them in **24-bit BMP format**! They must be in 24-bit format, even if they are not 24-bit color as that is the easiest format for the Arduino. You can rotate images using the **setRotation()** procedure

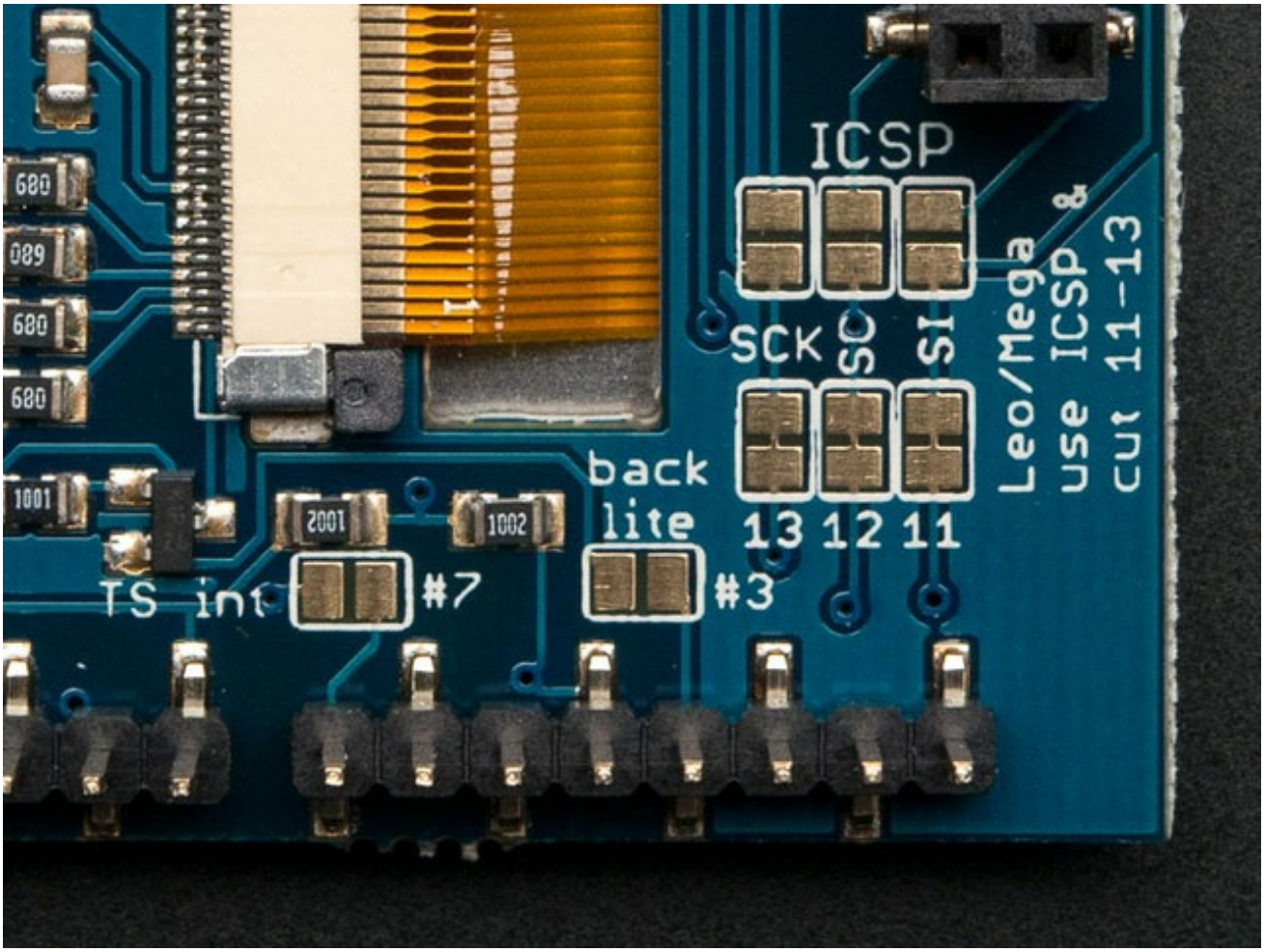
You can draw as many images as you want - dont forget the names must be less than 8 characters long. Just copy the BMP drawing routines below loop() and call

> **bmpDraw(bmpfilename, x, y);**

For each bitmap. They can be smaller than 320x240 and placed in any location on the screen.

Backlight & Touch IRQ

Both the resistive and capacitive versions of this shield have the ability to dim the backlight and get an interrupt from the resistive or capacitive touch controller chip on-board.



Controlling the Backlight

By default, we assume you'll want the backlight on all the time. However, you may want to PWM control or otherwise turn off the LED backlight to save power. You can do this with a simple hack. On the back, look for the **backlight** jumper.

On the resistive TFT touch shield

Solder the jumper labeled **Pin 3**. Then you can use Digital 3 to control the backlight.

On the capacitive TFT touch shield

Solder the jumper labeled **Pin 5**. Then you can use Digital 5 to control the backlight.

Touchscreen Interrupt pin

Advanced users may want to get an interrupt on a pin (or even, just test a pin rather than do a full SPI query) when the touchscreen is pressed. You can do that by jumpering the #7 solder jumper labeled **TS int**. We didn't want it to connect to #2 or #3 since those are the Leonardo I2C pins. You can use pin change interrupts to get an interrupt callback on #7. (http://adafru.it/d4h)Or, with a little blue wire, advanced users can connect a wire from the TS interrupt pad to any pin they choose. We find that querying/polling the chip is fast enough for most beginner Arduino projects!

Downloads

Datasheets:

- STMPE610 (http://adafru.it/d4k)
- ILI9341 (TFT controller) (http://adafru.it/d4l)
- Raw 2.8" TFT datasheet (http://adafru.it/d4m)
- FT6206 Datasheet (http://adafru.it/dRm) & App note (http://adafru.it/dRn) (capacitive chip)

Schematic of the v2 Resistive touchshield

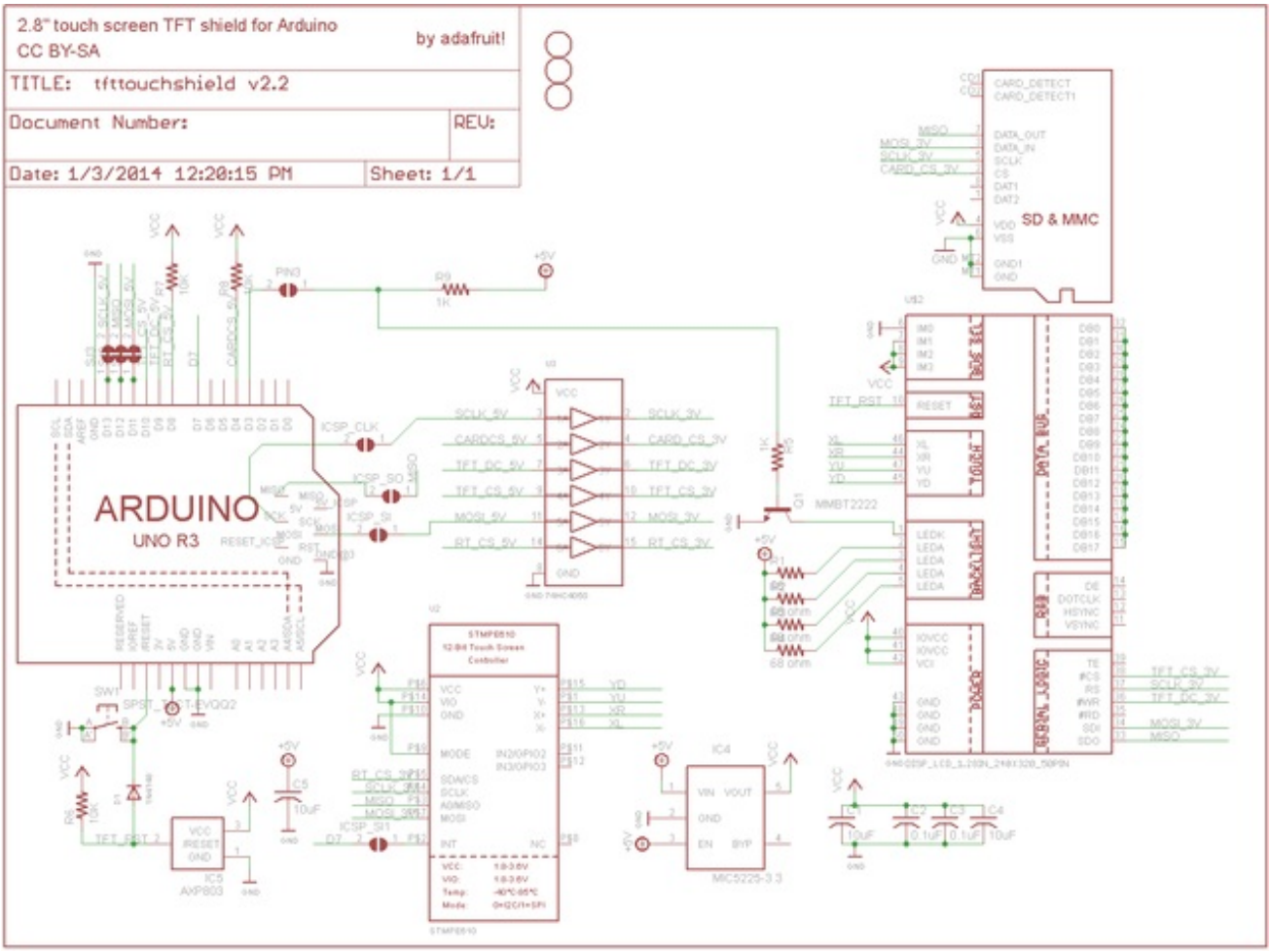
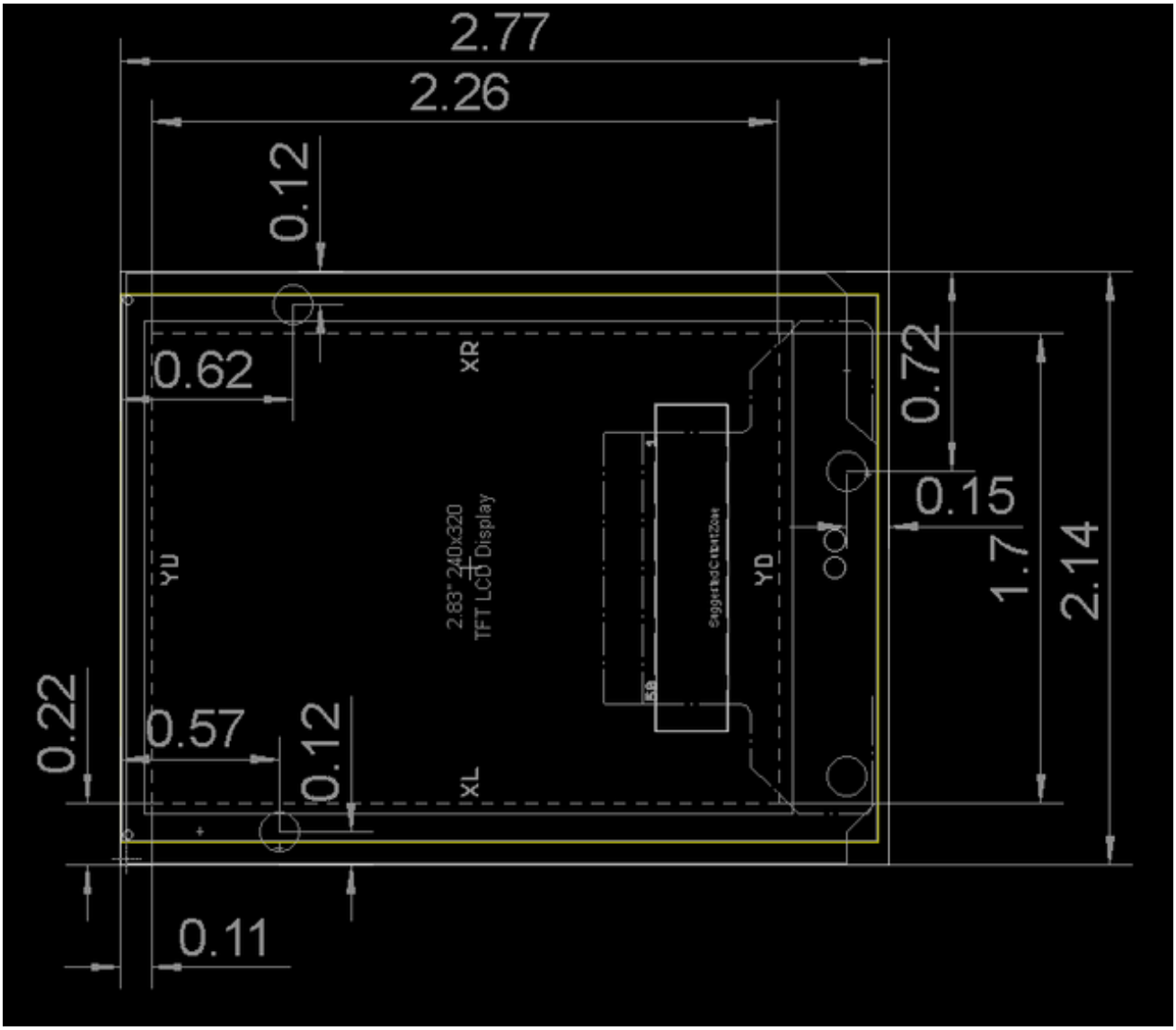
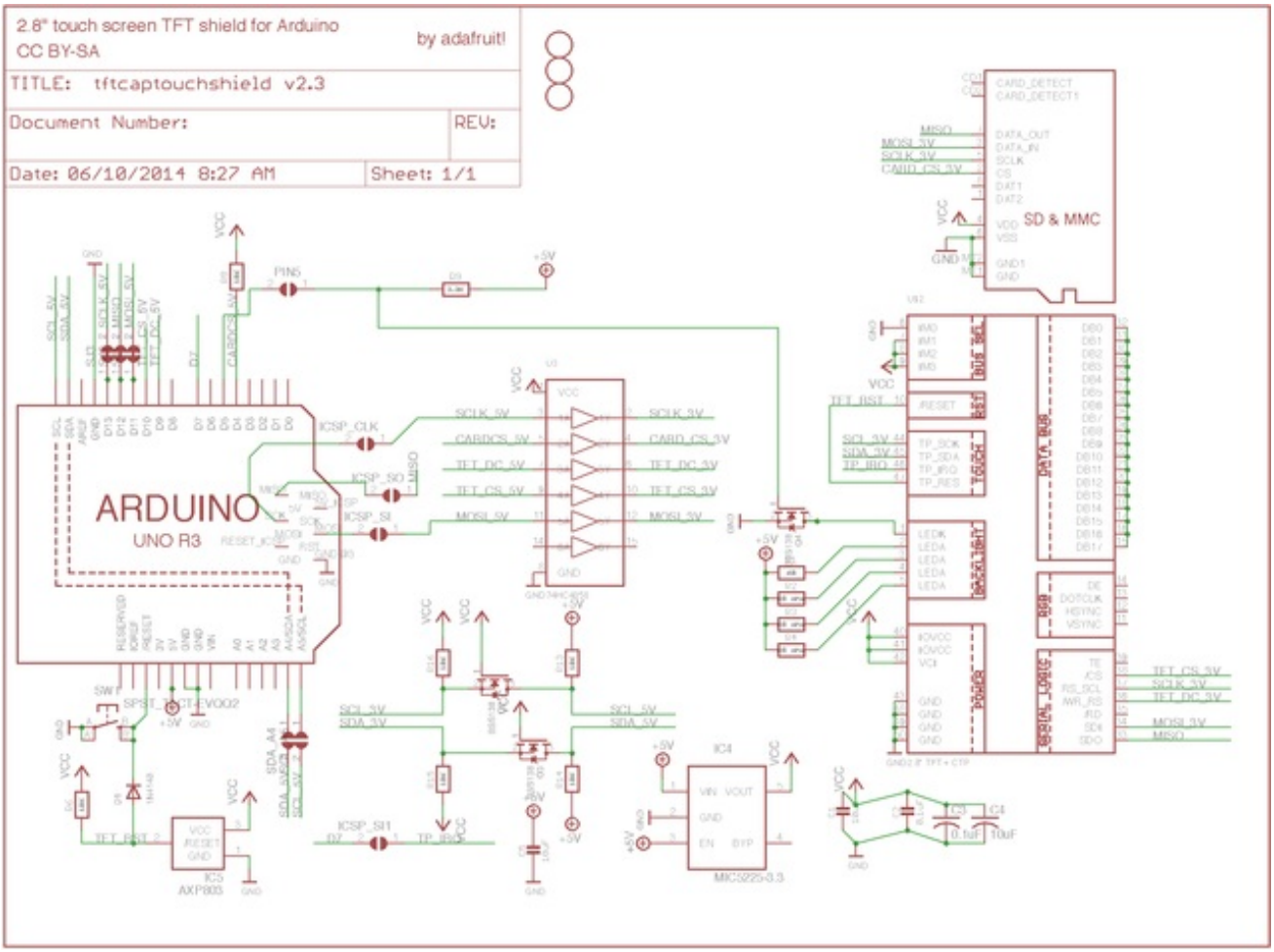


Diagram showing the TFT (yellow outline) underlying Arduino mounting holes (thin white line), PCP outline (rectangular thin white line) and 'visible portion' of the TFT (dashed inner line)



Schematic of the v2 Capacitive touchscreen


2.8" touch screen TFT shield for Arduino
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by adafruit!
TITLE: tftcaptouchshield v2.3
Document Number:
REV:
Date: 06/10/2014 8:27 AM
Sheet: 1/1
ARDUINO
UNO R3
SD & MMC
AXP803
MIC5225-3.3