深圳市拓普微科技开发有限公司

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T8010

TFT Controller Technical Manual

(V0.1)

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Date: 2012-02-28	Date:	Date:

Table of Content

1. Introduction

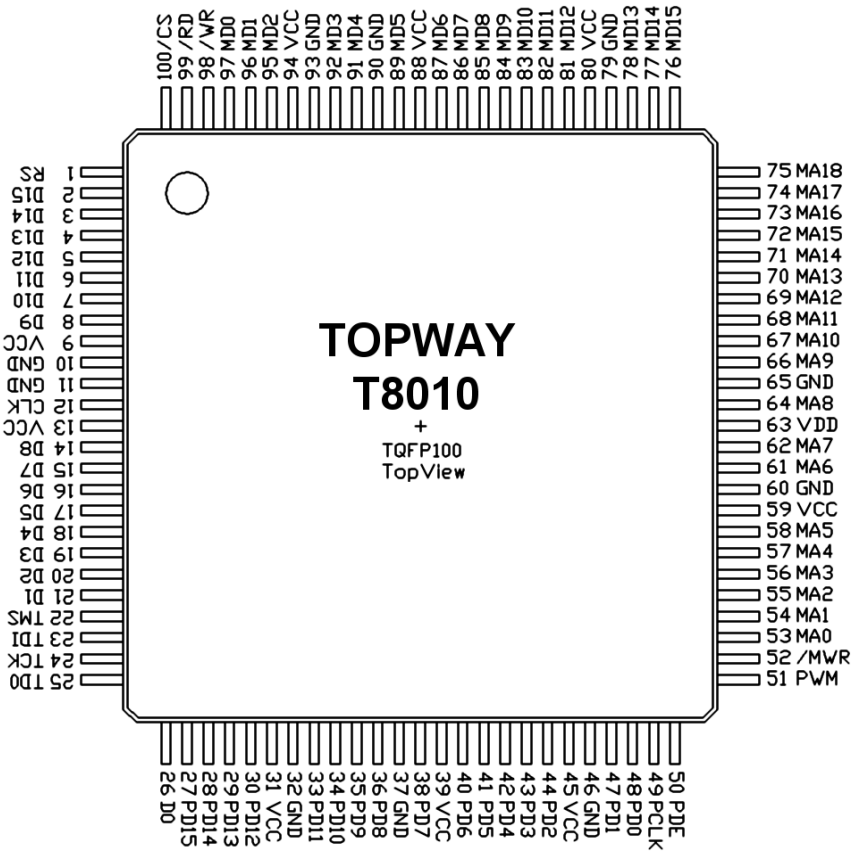
This Technical manual describes the features, options and connections of the T8010 TFT Graphics Controller. T8010 is a high performance graphics controller supporting 800x600 TFT color LCD display. T8010 embed with draw engine to enhance the performance of the system.

2. Features Highlight

- Power Supply
  - Single 3.3V supply voltage
  - 3.3V logic I/O
- Display Support
  - direct interface with AT070TN92 or compatible
  - 64k color, TFT LCD display
  - very high data refresh rate up to 21fps possible (800x480, @66MHz)
- Host Interface
  - 16bit data, 1bit address, 8080 mode
  - fast command execution (single word command down to 122ns @66MHz) general MCU could do continue command write
- Drawing Engine and Functions
  - Fill Windows
  - Fill Pixel
  - Draw Pixel
  - Draw Box (filled)
  - Draw 8Pixels (2 color)
  - Draw 8Pixels (transparence)
  - Clear Screen
  - Address auto increment
- Others
  - State machine architecture, no reset or inti sequence necessary
  - 16 level PWM for backlight control (with full on and full off)

3. IC Layout

3.1 Pads Layout Diagram



3.2 Pins Functions Descriptions

Pin Name	Type	Descriptions
GND	POWER	Power Supply Ground (0V)
VCC	POWER	Positive Power Supply (3.3V)
CLK	INPUT	Chip clock
/WR	INPUT	Host Write control signal
/RD	INPUT	Host Read control signal
/CS	INPUT	Host Chip select signal
RS	INPUT	Host Register Select signal; 0=command, 1=data
D0~D15	I/O	Host Data Bus
PD0~PD15	OUTPUT	TFT data bus
PCLK	OUTPUT	TFT data clock
PDE	OUTPUT	TFT DE signal
PWM	OUTPUT	PWM signal output for backlight driving
/MWR	OUTPUT	Display memory control signal
MA0~MA18	OUTPUT	Display memory address bus
MD0~MD16	I/O	Display memory data bus
TD0	--	reserved, no use leave open
TCK	--	reserved, no use leave open
TDI	--	reserved, no use leave open
TMS	--	reserved, no use leave open

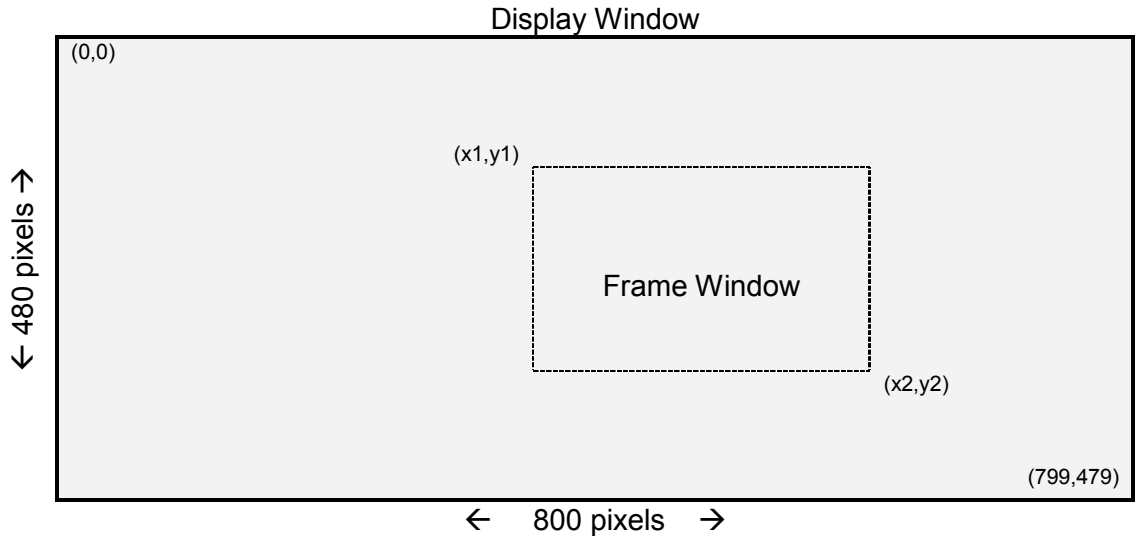
4. Function Specifications

4.1 Command Set

No.	Command	hex	/RD	/WR	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Descriptions
1	set_x0	0040	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	Set pointer x0
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	x0 value
2	set_y0	0041	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	Set pointer y0
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	y0 value
3	set_x1	0042	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	Set register x1
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	x1 value
4	set_y1	0043	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	Set register y1
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	y1 value
5	set_x2	0044	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	Set register x2
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	x2 value
6	set_y2	0045	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	Set register y2
			1	0	1	x	x	x	x	x	x	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	**n**	y2 value
7	set_fg_color	0046	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	Set fg_color register
			1	0	1	**R**	**R**	**R**	**R**	**R**	**G**	**G**	**G**	**G**	**G**	**G**	**B**	**B**	**B**	**B**	**B**	Color value RGB=[5:6:5]
8	set_bg_color	0047	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	Set bg_color register
			1	0	1	**R**	**R**	**R**	**R**	**R**	**G**	**G**	**G**	**G**	**G**	**G**	**B**	**B**	**B**	**B**	**B**	Color value RGB=[5:6:5]
9	set_func	0048	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	Set Func register
						x	x	x	x	x	x	x	x	x	x	**f**	**m**	**p**	**p**	**p**	**p**	Value Fill Window command option f=1: continue fill; f=0: fill once Display ON/OFF m=1: on; m=0: off Backlight PWM driving pppp=0000: fully off; … ; pppp=1111: fully on
10	fill_pixel	0081	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	Fill a Pixel with fg_color at (x0, y0)
			1	0	1	**R**	**R**	**R**	**R**	**R**	**G**	**G**	**G**	**G**	**G**	**G**	**B**	**B**	**B**	**B**	**B**	Pixel Color Value RGB=[5:6:5] (support continue draw)
11	Dwg_pixel	0082	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	Draw a pixel with fg_color at (x0, y0)
12	Dwg_solid8	0083	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	Draw 8 horizontal pixels at (x0, y0)
			1	0	1	0	0	0	0	0	0	0	0	**d**	**d**	**d**	**d**	**d**	**d**	**d**	**d**	(support continue draw) d=1: fill fg_Color d=0: fill bg_color
13	Dwg_tran8	0084	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	Draw 8 horizontal pixels at (x0, y0)
			1	0	1	0	0	0	0	0	0	0	0	**d**	**d**	**d**	**d**	**d**	**d**	**d**	**d**	(support continue draw) d=1: fill fg_color d=0: keep on Screen Color (no change, transparence)
14	Dwg_box	0085	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	Draw Box (x1, y1) to (x2, y2) fill with fg_color (where x1≤x2, y1≤y2)
15	clr_scr	0086	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	Fill the whole screen with bg_color
16	fill_window	0087	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	Fill the area (x1, y1) to (x2, y2)
			1	0	1	**R**	**R**	**R**	**R**	**R**	**G**	**G**	**G**	**G**	**G**	**G**	**B**	**B**	**B**	**B**	**B**	Pixel Color Value RGB=[5:6:5] (accept multi-Pixels data for filling)
17	get_status	--	0	1	0	v	v	v	v	v	v	v	v	b	s	×	×	×	×	×	×	Get Status D[15:12]: firmware version, D[11:8]: sub version D[7]: busy flag b=1, Busy; b=0, Ready D[6]: display on/off flag s=1, ON; s=0： OFF D[5:0]: Reserved

4.2 Memory Addressing

T8010 is for TFT display with 800x480 pixels. It addresses the display memory with a co-ordinate system as follow.



4.3 Memory Address Control Registers

Address Pointer (x0,y0)

- it is a pointer that define the next data location will be access
- It define by (x0, y0)
- x0, y0 should inside the Display Window
- It should be 0≤ x0 ≤479
- It should be 0≤ y0 ≤799

Display Window (0,0)~(799,479)

- It is all of the display area,
- It contain 800x480 dot
- (0,0) is the top-left co-ordinate
- (799,479) is the bottom-right co-ordinate

Frame Window (x1,y1)~(x2,y2)

- It is for some special command like draw_box, fill_window
- It should be locate inside the Display window
- Frame Window setup by (x1,y1) & (x2,y2)
- (x1,y1) is the top-left co-ordinate
- (x2,y2) is the bottom-right co-ordinate
- it should be x1≤x2
- it should be y1≤y2

4.4 Command Details

set_x0

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0040
Parameter:	1	0	1	0x0000 ~ 0x031F

- assign the address pointer x0 (0≤x0≤799)

set_y0

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0041
Parameter:	1	0	1	0x0000 ~ 0x01DF

- assign the address pointer y0 (0≤y0≤479)

set_x1

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0042
Parameter:	1	0	1	0x0000 ~ 0x031f

- assign the Frame Window register x1 (0≤x1≤x2≤799)

set_y1

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0043
Parameter:	1	0	1	0x0000 ~ 0x01DF

- assign the Frame Window register y1 (0≤y1≤y2≤479)

set_x2

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0044
Parameter:	1	0	1	0x0000 ~ 0x031f

- assign the Frame Window register x2 (0≤x1≤x2≤799)

set_y2

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0045
Parameter:	1	0	1	0x0000 ~ 0x01DF

- assign the Frame Window register y2 (0≤y1≤y2≤479)

set_fg_color

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0046
Parameter:	1	0	1	0x0000 ~ 0xFFFF

- set the foreground color register
- color define by 16bit value (R:G:B=5:6:5)
-

set_bg_color

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0047
Parameter:	1	0	1	0x0000 ~ 0xFFFF

- set the foreground color register
- color define by 16bit value (R:G:B=5:6:5)

set_func

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0048
Parameter:	1	0	1	0x0030 ~ 0x003F

- set the func register value
- D3~D0 is for PWM output value,
  0000: full off; 1111: full on

fill_pixel

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0081
Parameter:	1	0	1	0x0000 ~ 0xFFFF
Parameter:	1	0	1	0x0000 ~ 0xFFFF
Parameter:	1	0	1	0x0000 ~ 0xFFFF
:	:	:	:	:

- fill a pixels with following given color
- continue fill support
- suitable for filling the display with bmp data
- color define by 16bit value (R:G:B=5:6:5) as parameter
- first given color will be filled at (x0, y0) location
- after fill, x0=x0+1,
  at the end of the line, x0=0, y0=y0+1
  at the end of the screen, x0=0, y0=0
- next given color will be filled at new (x0, y0) location

dwg_pixel

- draw 1 pixel with color defined by set_fg_color at (x0, y0) location
- after fill, x0=x0+1,
  at the end of the line, x0=0, y0=y0+1
  at the end of the screen, x0=0, y0=0

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0082

dwg_solid8

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0083
Parameter:	1	0	1	0x0000 ~ 0x00FF
Parameter:	1	0	1	0x0000 ~ 0x00FF
Parameter:	1	0	1	0x0000 ~ 0x00FF
:	:	:	:	:

- draw 8 pixel at (x0, y0) location
- continue drawing support
- suitable for quick mono display pattern drawing
- drawn pixel define in 8bit value parameter D7:(x0, y0) ~ D0:((x0+7),y0)
- bit value 1: draw fg_color
  bit value 0: draw bg_color
- after fill, x0=x0+8,
  at the end of the line, x0=0, y0=y0+1
  at the end of the screen, x0=0, y0=0
- next given 8bit value parameter (continue draw) will be drawn at new (x0, y0) location

dwg_tran8

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0084
Parameter:	1	0	1	0x0000 ~ 0x00FF
Parameter:	1	0	1	0x0000 ~ 0x00FF
Parameter:	1	0	1	0x0000 ~ 0x00FF
:	:	:	:	:

- draw 8 pixel at location, with transparence
- continue drawing support
- suitable for quick mono display pattern drawing
- drawn pixel define in 8bit value parameter
- D7:(x0, y0) ~ D0:((x0+7),y0)
- bit value 1: draw fg_color
  bit value 0: no draw (keep original on screen color, looks transparence)
- after fill, x0=x0+8,
  at the end of the line y0=y0+1, x0=x1
  at the end of the screen y0=y1, x0=x1
- next given 8bit value parameter (continue draw) will be drawn at new (x0, y0) location

dwg_box

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0085

- draw a rectangular box with filled color
- draw and fill color defined by fg_color
- box size defined by (x1,y1) to (x2,y2), where x1≤x2, y1≤y2
- could used as line draw, where x1=x2 or y2=y2

clr_scr

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0086

- fill the whole screen with bg_color

fill_window

	/RD	/WR	RS	hex value
Command:	1	0	0	0x0087
Parameter:	1	0	1	0x0000 ~ 0xFFFF
Parameter:	1	0	1	0x0000 ~ 0xFFFF
Parameter:	1	0	1	0x0000 ~ 0xFFFF
:	:	:	:	:

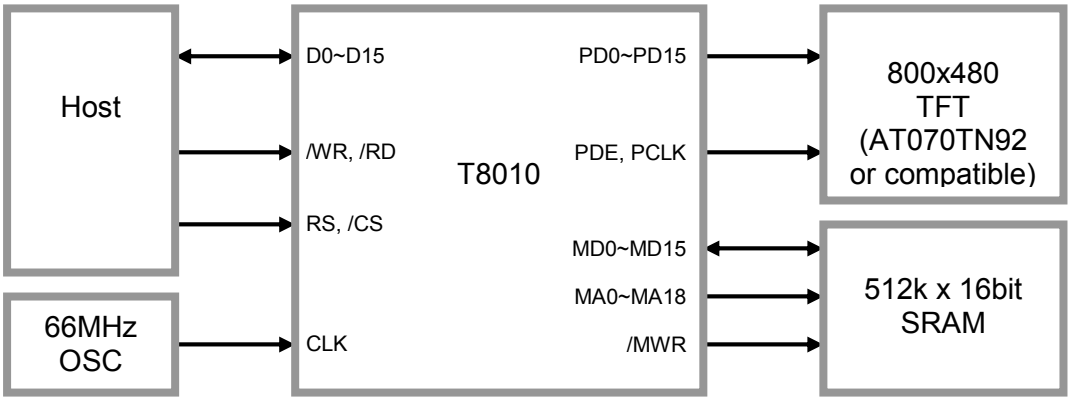
- fill a pixels with following given color within the frame window
- continue fill support
- suitable for filling the display with bmp data in the frame window
- color define by 16bit value (R:G:B=5:6:5) as parameter
- first given color will be filled at (x0, y0) location
  where (x0, y0) should be within the frame window
- after fill, x0=x0+1,
  at the end of the frame line, x0=x1, y0=y0+1
  at the end of the frame window, x0=x1, y0=y1
- next given color (continue draw) will be filled at new (x0, y0) location

get_status

	/RD	/WR	RS	hex value
Command:	0	1	0	Read back value

- get the status register value
- D15~D12 is firmware version
  D11~D08 is firmware sub version
  D7 is busy flag, 1=busy, 0=ready
  D6 is display on/off flag, 1=on, 0=off
- D5~D0 is reserved

4.5 Interface Example



5. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Power Supply voltage	V_{DD}	-0.3	4.0	V	
Backlight Supply voltage	V_{DD_BL}	-0.3	6.0	V	
Operating Temperature	T_{OP}	-20	70	°C	No Condensation
Storage Temperature	T_{ST}	-30	80	°C	No Condensation

Note:
*1. This rating applies to all parts of the module. And should not be exceeded.
*2. The operating temperature only guarantees operation of the circuit. The contrast, response speed, and the other specification related to electro-optical display quality is determined at the room temperature, T_{OP}=25℃
*3. Ambient temperature when the backlight is lit (reference value)
*4. Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

6. Electrical Characteristics

6.1 DC Characteristics

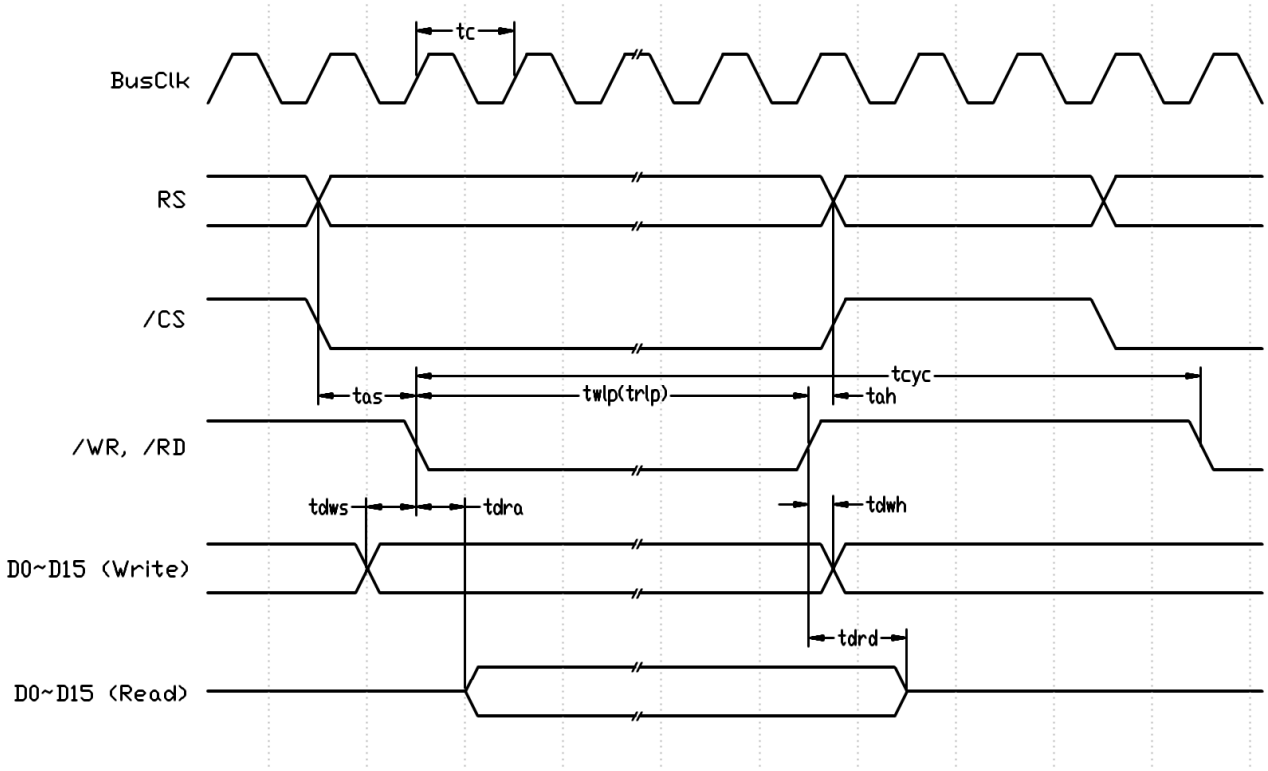
Top=25℃, V_{SS}=0V

Items	Symbol	Min.	Typ.	Max.	Unit	Remark
Power Supply Voltage	V_{DD}	3.1	3.3	3.5	V	*2
Input logic high voltage	V_{IH}	$0.8V_{DD}$	-	V_{DD}	V	*2, *3
Input logic low voltage	V_{IL}	0	-	$0.2V_{DD}$	V	*2, *3
Output logic high voltage	V_{OH}	$0.7V_{DD}$	-	V_{DD}	V	
Output logic low voltage	V_{OL}	0	-	$0.3V_{DD}$	V	
Logic Supply Current (VDD)	I_{DD}	-	TBD	-	mA	

Note:
*1. Never Apply logic signal before the VDD and VDD_BL supply.
*2. VDD setting should match the signals voltage
*3. For all the inputs signals
*4. Clock Freq=66MHz

6.2 AC Characteristics

6.2.1 Host Timing Characteristics



8080 Mode System Bus Timing

V_{SS}=0V, V_{DD}=3.3V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Bus Clock frequency	fbclk	-	66.0	-	MHz
Cycle time	tcyc	9 tc	-	-	ns
Address setup time (*4)	tas	1.5 tc	-	-	ns
Address hold time	tah	0	-	-	ns
/WR LOW pulse width	twlp	4 tc	-	-	ns
/RD LOW pulse width	trlp	2 tc	-	-	ns
Data write setup time	tdws	0	-	-	ns
Data write hold time	tdwh	0	-	-	ns
Data read access time	tdra	0	-	0.5 tc	ns
Data read disable time	tdrd	0	-	0.5 tc	ns

Note:
*1. tc=1/fbclk
*2. Input signal rise/fall time should be less than 15ns
*3. All timing is using 20% and 80% of VDD as the reference
*4. /CS must be active before the read or write access

6.2.2 TFT Output Signal Timing Characteristics

Item	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Horizontal Display Area	thd	-	800	-	DCLK	
DCLK Frequency	fclk	-	33.3	-	MHz	
One Horizontal Line	th	-	1056	-	DCLK	
HS Blanking	thb	-	46	-	DCLK	
HS Front Porch	thfp	-	210	-	DCLK	
Vertical Display Area	tvd	-	480	-	TH	
VS period time	tv	-	525	-	TH	
VS Blanking	tvb	-	23	-	TH	
VS Front Porch	tvfp	-	22	-	TH	

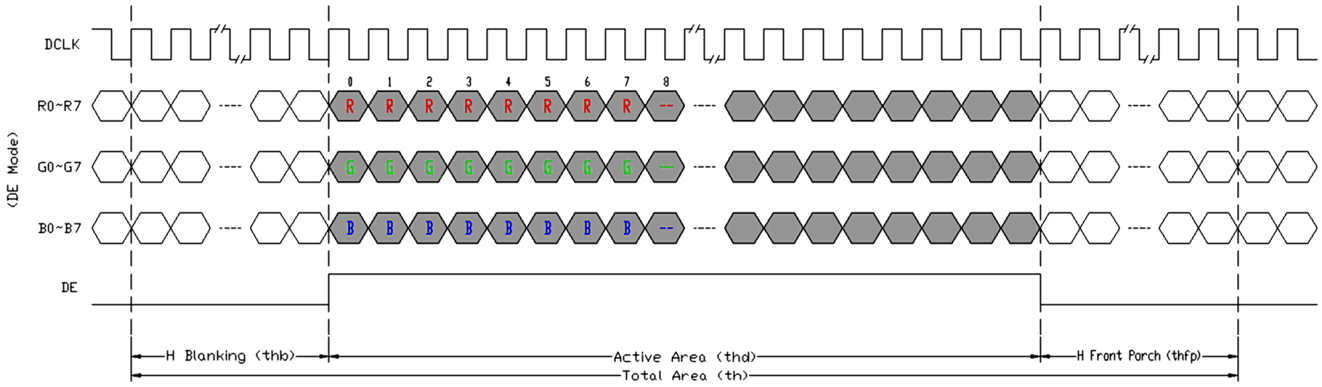


Figure 6-2-1 Horizontal input timing diagram.

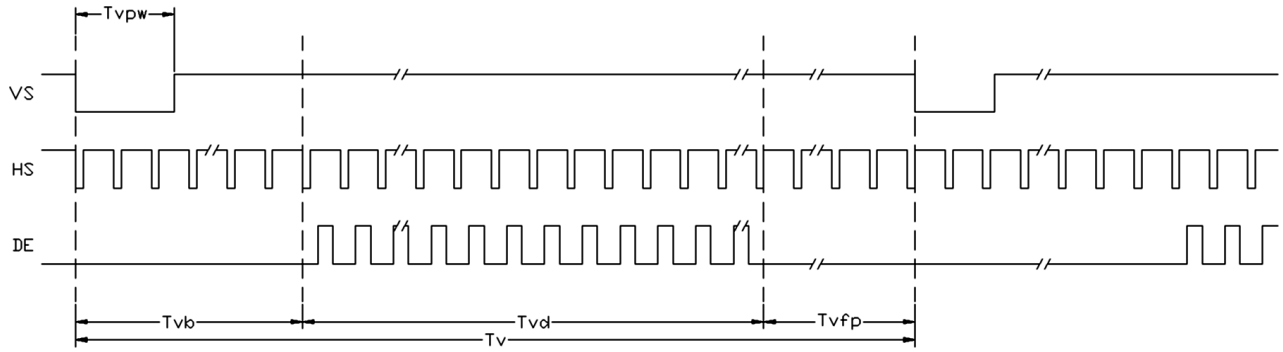


Figure 6-2-2 Vertical input timing diagram.

7. Revision Note

Rev.	Descriptions	Release Date
0.1	- Preliminary Release	2012-02-28