User
Manual

I08D708048AD-V2

Bus type TFT drive module   7”TFTLCD AT070TN83 V.1

User Manual

TFTLCD Type : AT070TN83 V.1

1. Description

MI08D708048AD-V2 is a high performance 16-bit true color TFT controller, the controller integrates 16Mbytes display cache, to provide 8 display pages and support for copying data between the various paging operations. MI08D708048AD-V2 also provides a backlight management, automatic anti-color, image flip and other advanced features, the use of flexible, convenient, and its various parameters such as Table 1.1 , Table 1.2 and Table 1.3 below.。

Table 1.1 MI08D708048AD-V2 basic features

Features	Description
Interface Type	Intel8080-8
Color format	RGB565
Memory Pages	8 block
Memory Capacity	16MBytes
TFT Panel	AT070TN83 V.1

Table 1.2 MI08D708048AD-V2 features

Features	Description
Write data point	Write to the specified coordinates of the specified data
X coordinates automatically accumulate	Write a data point each, the current X coordinate will automatically add a
X coordinate automatically return	Accumulate to the user when the X coordinate of the end of the default X coordinate, the automatic return to the starting Xcoordinate of the user default
Y coordinates automatically accumulate	X coordinate of automatic return, Y coordinates automatically add a
Change the currently displayed page	The data displayed on the screen in the memory of any changeon page 8
Page switching current operation	To 8 as the target of any page in memory, write data
Page Copy	In between any two arbitrary regions of memory data copy operations
Automatic anti-color	For any page, any automatic anti-color operation area
Backlight Control	Adjustable backlight PWM signal 64
Flip mirror	On the TFT display on the horizontal or vertical mirror image flip
State ID	Read through the bus interface controller status bits

Table 1.3 MI08D708048AD-V2 Electrical Characteristics

Features	Description
Power supply voltage	5 ± 0.5V
Power [1]	170mA ~ 730mA
IO Level [2]	3.3V LVTTL

Note 1: 170mA corresponds to the power consumption of the backlight turned off, 730mA corresponds to the brightest backlight power consumption when this data is the supply voltage is 5V, measured, and the practical application of power supply voltage fluctuation due to the slightly change.

Note 2: Generally, if the output driver with 3.3V, 5V, IO IO can be directly driven, if the output driver with 5V,3.3V IO of IO, the IO recommended that you set the 5V weak pull model This avoids the compatibility level is not too much current caused by IO.

1.1 Operating Instructions

MI08D708048AD-V2 External 20-pin, on a detailed description of each pin, see Table 2.1 .

Table 2.1 MI08D708048AD-V2 Pin Description

No.	Name	Help
1	+5 V	5V power input
2	+5 V	5V power input
3	D0	Data bus
4	CE	Chip-select signal Low active
5	D1	Data bus
6	RES	Active-low reset signal
7	D2	Data bus
8	A0	Address signal
9	D3	Data bus
10	WE	Active low write enable signal
11	D4	Data bus
12	RE	Active low read enable signal
13	D5	Data bus
14	A1	Reserved for future expansion addresses
15	D6	Data bus
16	A2	Reserved for future expansion addresses
17	D7	Data bus
18	A3	Reserved for future expansion addresses
19	GND	GND
20	GND	GND

1.2 Interface Timing

MI08D708048AD-V2 uses 8-bit 8080 bus interface, the specific interface timing, such as Figure 2.1, ,Figure 2.2 shows

Figure 2.1 The timing for the bus to write, when the address line A0 is 0, said address register is written, the register of MI08D708048AD-V2 for the various registers in addressing the range of0 to 7. When the address lines A0 to 1 that the value written to the register, on the role of each register, see 2.3.

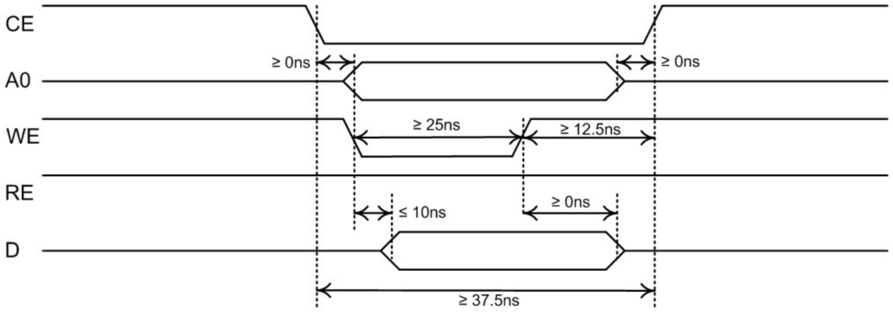


Figure 2.1 Bus Timing Write

Figure 2.2 The timing for the bus read, read in MI08D708048AD-V2 register in only one, so in order to facilitate the operation, any read operation will be automatically point to the register, during the address register A0, and the state of the signal will be ignored。

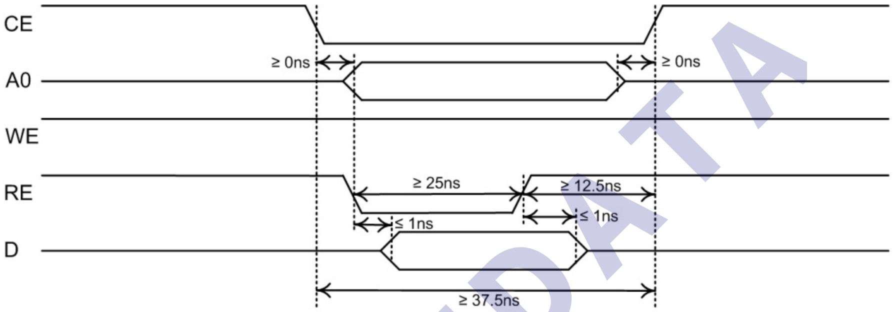


Figure 2.2 Bus Timing Read

1.3 Register Description

MI08D708048AD-V2 register addresses and functions of each profile, such as table 2.2 shows, including seven 16-bit registers and an 8-bit registers, for the 16-bit register write operation requires two to complete a register set, during write operation must be re-written to write low-high eight eight, and the write operation must be in pairs, for 8-bit register, with a single write operation to complete the set

Table 2.2 Features register address and

Operation	Width	Address	Name	Features	Reset value
Write only	16	0x00	CUR_Y	Set the Y coordinate of the screen	0x0000
	16	0x01	CUR_X	Set the X coordinate of the screen	0x0000
	16	0x02	PIXELS	Write pixel data	0x0000
	16	0x03	END_X	Setting automatically returns the coordinates of the X direction, and the page copy when the end X coordinate direction	0x031f
	16	0x04	END_Y	Set the direction of the end of page copy Y coordinates when	0x01df
	16	0x05	PREF	Set the current display page, the current operation page, backlight, etc.	0x0000
	16	0x06	RVS_MASK	Anti-color mask set	0x0000
	8	0x07	MIRROR	Mirror flip and page copy of the start control	0x01
Read-only	8	-	STATE	Status Register	0x00

1.3.1 CUR_Y（0x00）、CUR_X（0x01）

Register CUR_Y and CUR_X used to set the coordinates of pixels to be operating, TFT screen coordinates of the arrangement such as Figure 2.3 shows, when CUR_Y and CUR_X value determined, pixels A location is only determined by the subsequent pixel data is written accurately placed in the A point

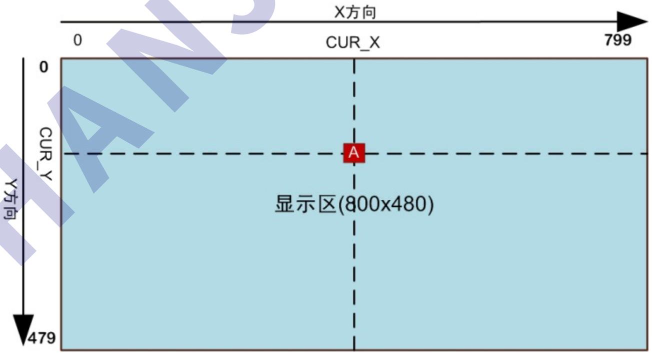


Figure 2.3 Coordinate order

1.3.2 PIXELS（0x02）

PIXELS corresponding to register 16-bit color data, if the current page displayed the same page with the current operation, then the data will be written PIXELS immediately apparent and CUR_Yselected by CUR_X current active point, if the currently displayed page and the current operation not the same page, then writes the data will not be immediately PIXELS presented.MI08D708048AD-V2 color format RGB565, specific Correspondence between the color spaces such as the Table 2.3 below.

Table 2.3 The correspondence between color code

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B4	B3	B2	B1	B0

1.3.3 END_X(0x03)

In order to improve the efficiency of pixel data to write continuously, when the set CUR_X andCUR_Y, each write a pixel, the X coordinate of the current active point will automatically add one, when the activation point is equal to END_X X coordinate, it will automatically returnCUR_X also automatically add a Y coordinate. As Figure 2.4 shows, the assumption CUR_X, CUR_Y, END_X were 400, 200, 500, A point, B point, C point, D point coordinates are (400, 200), (500, 200), (400, 201), (500, 201). Set CUR_X, CUR_Y, the first pixel written to the A point, the first pixel writes B100 points, the first pixel writes C 101 points, the first pixel writes D 200 points, and so on.

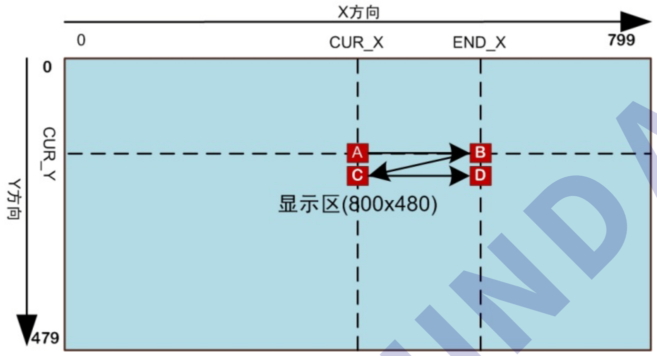


Figure 2.4 X automatically returns indicate

With END_X register, you can simplify the process of writing bulk data MCU, MCU needs to assume(100, 200) for the starting point is to write a 10 × 20 rectangle, then only need to CUR_X set to 100,CUR_Y set to 200, END_X set to 210, then 200 pixels can write, do not need to coordinate during the set operation, all coordinates will be automatically calculated.。

1.3.4 END_Y(0x04)

END_Y registers need to tie CUR_X, CUR_Y and END_X use of color in the page copy and anti-operation, the four registers used to define the operating range, as Figure 2.5 shows, A point of coordinates (CUR_X, CUR_Y), B point coordinates (END_X, CUR_Y), C point coordinates (CUR_X,END_Y), D point coordinates (END_X, END_Y), page copy and the role of anti-color operating range is from the A, B, C, D defined by four points .

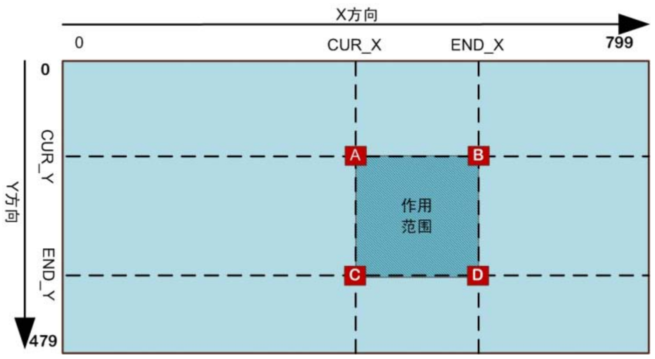


Figure 2.5 define the operating range

1.3.5 PREF(0x05)

PREF register used to set the currently displayed page, the current operation page, the page copy of the source and TFT backlight, the specific meaning of each bit as Table 2.4 below。

Table 2.4 PREF register bit definitions

Bit	Name	Features	Reset value
b5 ~ b0	BK_PWM	Backlight Control	0
b8 ~ b6	COPY_SRC	When a copy of the source page	0
b11 ~ b9	CUR_PAGE	The currently displayed page	0
b14 ~ b12	OPT_PAGE	The current operation of the page	0
b15	Reservations	-	0

1. Control

BK_PWM duty cycle signal for setting the backlight to adjust the brightness of TFT backlight, rang Backlight e from 0 to 63, 0 backlight off, 63 on behalf of the brightest backlight. After power-on reset default value is 0 BK_PWM, that is, backlight off, the MCU on BK_PWM assigned to non-zero value, the backlight on

2. Copy source page

COPY_SRC used to set the data source when the page copy, The range of 0 to 7, corresponding to 8pages in memory, the signal on the page copy operations, such as Figure 2.6 below

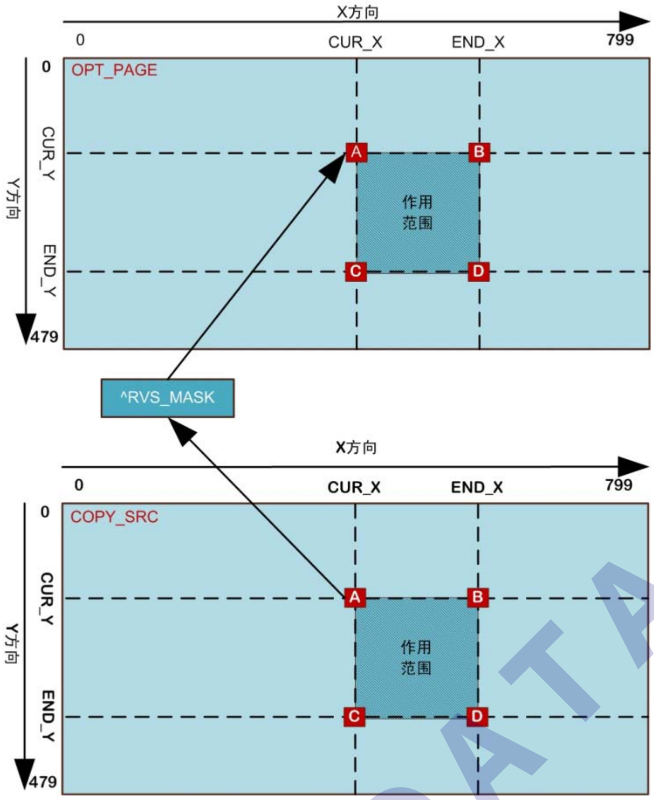


Figure 2.6 copy of the operatingsignal

Figure 2.6 in the hands of two pages, the above page for the OPT_PAGE, that are currently working on the page, the following is COPY_SRC, that stores the data source of the page copy operations, when the copy operation was launched after page, from the master logic COPY_SRC specified page will be A, B, C, D four-point range as defined by the points one by one read out, and RVS_MASKXOR, and then write OPT_PAGE the corresponding position. If RVS_MASK is 0, then this operation simply move the data, if RVS_MASK the value is not 0, then the process of moving data pixel color values for the mask will RVS_MASK anti-color, if OPT_PAGE and COPY_SRC point to the same page, while RVS_MASK is not 0, then the data movement operation has evolved into a pure anti-color operation. Copy operations on the page for further instructions, see 2.3.6

3. The current display / operation page

CUR_PAGE specified by the currently displayed page, said that the actual display on the screen of memory paging, the current operation by the OPT_PAGE specified page, a write data operation, anti-color copying operation, and the corresponding page of memory paging. If CUR_PAGE and OPT_PAGE point to the same memory page, then write data, inversion, such as operating results will be presented on the screen immediately, if CUR_PAGE and OPT_PAGE point to different memory paging, then the operation will not be any OPT_PAGE affect the display on the screen, only to switch to OPT_PAGE after CUR_PAGE, OPT_PAGE the data will be displayed。

1.3.6 RVS_MASK（6）

RVS_MASK 16-bit counter used to set the color mask, the mask is the role of anti-color logo in the operation against the need for reversal color color bit, RVS_MASK bit defined as Table 2.5below。

Table 2.5 RVS_MASK bit definitions

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B4	B3	B2	B1	B0

Anti-color operation of the RVS in the MIRROR bit start register (see 2.3.7). If the anti-color operation is required, then the first point to make OPT_PGAE and COPY_SRC also need anti-color pages, and then set CUR_X, CUR_Y, END_X and END_Y, define the color of the region need to counter anti-color mask to RVS_MASK write, and then RVS in the MIRROR-bit register can be written to 1. Anti-colored mask can specify a specific value, for example, 0xf800 can be used to counter all the red bits color, 0x07e0 green spaces can be used for all anti-color, 0x001f can be used to counter all the blue bit color, and so and so on.

If the page copy operation is needed, then let OPT_PAGE and COPY_SRC point to a different page, and then set the CUR_X, CUR_Y, END_X and END_Y define the area to be copied to the RVS_MASKwrite 0x0000 (can also be a non-zero value), then to the MIRROR RVS-bit register can be written to1. Copy operation is complete, COPY_SRC page data corresponding to the region will be copied to theOPT_PAGE the corresponding area. Note that, you can also write to the RVS_MASK non-zero value, the difference is that the data copied to OPT_PAGE COPY_SRC page is not raw data corresponding to the region, but rather as a mask after RVS_MASK inverted data

1.3.7 MIRROR（7）

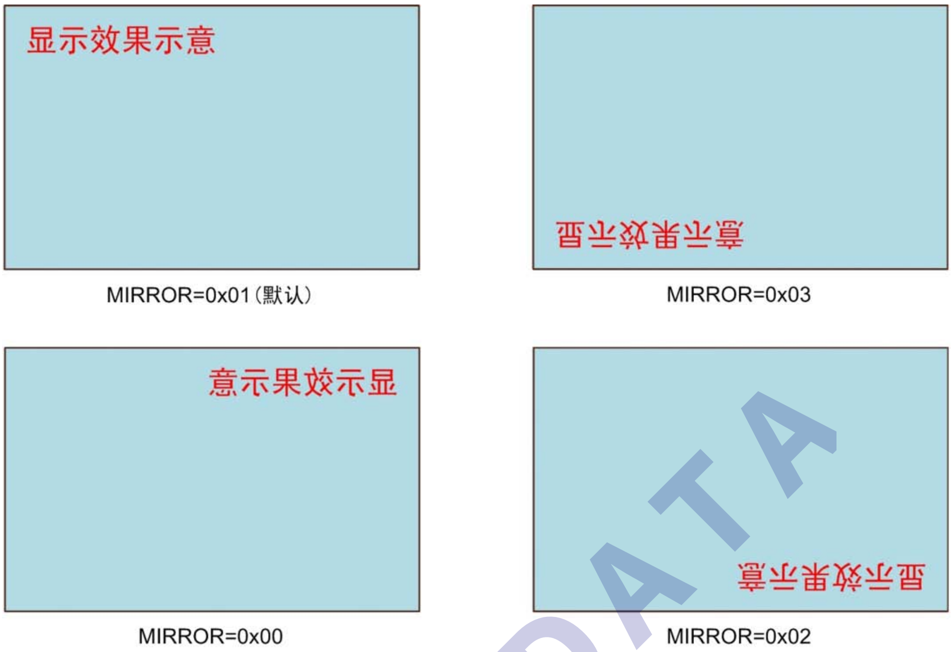
MIRROR register is used to achieve horizontal and vertical mirror image flip, and control and anti-color page copy operation starts, the specific meaning of the register you as Table 2.6below.。

Table 2.6 MIRROR register bit definitions

Bit	Name	Features	Reset value
b7 ~ b3	Reservations	-	0
b2	RVS	Anti-color copying operation, and start position on page	0
b1	UD	Control vertical image flip	0
b0	LR	Flip mirror control level	1

RVS-bit counter is used to start page for color copies and operation, prior to the RVS-bit write 1to the first set CUR_X, CUR_Y, PREF and other registers set the page to be operating until the regional operations and anti-color mask and other parameters . Anti-color pages at startup or after the copy operation, RVS bit is automatically cleared.

UD bit is used to control the display of the vertical flip, LR bit is used to control the level of the display flip operation UD bit and LR bits will affect the position of pixels on the TFTand the memory address mapping data, but not will change the data in memory, different values ofUD and LR corresponding display as Figure 2.7 below



MIRROR=0x01（默认）

MIRROR=0x03

MIRROR=0x00

MIRROR=0x02

图 2.1 显示效果

1.3.8 STATE

STATE MI08D708048AD-V2 is the only register read, so read on the bus were all read by defaultSTATE register A0 during the read signal and the address register will be ignored. STATE width register 8bit, by reading the STATE register, you can learn the current state of the controller, if you read back from the STATE register value of zero, indicating the controller is idle, you can receive and process a new operation, from STATE register read back the value of 1, indicating the controller is the page copying or anti-color operation, then the controller could not receiving any MCU write, otherwise it will lead to anti-page color copy or operating error.

2. MCU Operation Example

2.1 Basic reading and writing

For the 8080 bus compatible MCU, can be MI08D708048AD-V2 mapped to a memory device, read and write access to the pointer the way, is not compatible for the 8080 bus or external bus interface does not have the MCU, analog IO bus can read and write the way operation, the following example to explain in 8051, the port connection, such as Figure 3.1 below

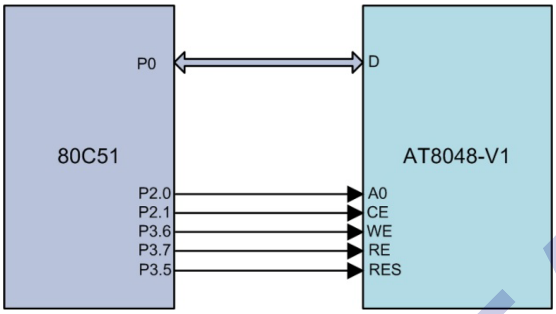


Figure 3.1 port connection diagram

2.1.1 Pointer mode

For Figure 3.1 shows the port connections, the basic read and write operations with pointers such as the sample code in Listing 3.1 below。

Listing 3.1 Basic reading and writing pointers

```
#include "AT89X52.h"
#define RES       P3_5
unsigned char    xdata *pTFT_RegAddr = (unsigned char *)0x0000;
unsigned char    xdata *pTFT_RegData = (unsigned char *)0x0100;
static unsigned char udlr = 0x01;
// Write register address
void TFT_WRegAddr(unsigned char a)
{
        *pTFT_RegAddr = a;
}
// Write register
void TFT_WRegData(unsigned char d)
{
        *pTFT_RegData = d;
}
// Read register
unsigned char TFT_RData()
{
        unsigned char temp;
        temp = *pTFT_RegData;
        return temp;
}
```

2.1.2 I/O Bus

For Figure 3.1 shows the port connections, using I/O bus for read and write basic code as 3.2 shows

3.2 I/O Bus

```
#include "AT89X52.h"
#define CE        P2_1
#define A0        P2_0
#define D         P0
#define WE        P3_6
#define RD        P3_7
#define RES       P3_5
void TFT_WRegAddr(unsigned char a)
{
        CE = 0;
        A0 = 0;
        D = a;
        WE = 0;
        WE = 1;
        CE = 1;
}
void TFT_WRegData(unsigned char d)
{
        CE = 0;
        A0 = 1;
        D = d;
        WE = 0;
        WE = 1;
        CE = 1;
}
unsigned char TFT_RData()
{
        unsigned char temp;
        D = 0xff;
        CE = 0;
        RD = 0;
        temp = D;
        RD = 1;
        CE = 1;
        return temp;
}
```

2.2 Advanced Operation

2.2.1 Setting display parameters

MI08D708048AD-V2 can be easily and backlight on the display buffer management, specific examples, such as Listing 3.3 show

Listing 3.3 Setting the display parameters

```
/******************************************************************************
* Function Name: TFT_SetPref
* Description: Sets the currently displayed page, the current operation page,
                    the page copy of the source and backlight
* Parameters:
        - Cur_page: the currently displayed page
        - Opt_page: the current operation page
        - Copy_src: page copy of the source
        - Bk_pwm: Backlight
* Return Value: None
******************************************************************************/
void TFT_SetPref(       unsigned char cur_page,unsigned char opt_page,
                        unsigned char copy_src,unsigned char bk_pwm       )
{
        int temp;
        temp = bk_pwm | (copy_src<<6) | (opt_page <<12) | (cur_page<<9);
        TFT_WRegAddr(5);                    // Address register points   PREF
        TFT_WRegData(temp>>8);              // write data PREF
        TFT_WRegData(temp);
}
```

2.2.2 Filled rectangle

Making clear the screen, the picture shows and other operations, will use the rectangle filloperations, MI08D708048AD-V2 filled rectangular field operation is optimized, when filling MCU only need to set a good starting point coordinates and end coordinates can be, the process of filling the coordinates of all points will be automatically calculated, the maximum efficiency to ensure that filled rectangle, filled rectangle as an example of Listing 3.4 shows

Listing 3.4 filled rectangle

```
/******************************************************************************
 Function Name: TFT_RectFill
* Description: TFT color fill with the specified rectangle on the specified
* Parameters:
        - Start_x: X coordinate of the starting rectangle
        - Start_y: Y coordinate of the starting rectangle
        - End_x: X coordinate of the end of the rectangular domain
        - End_y: Y coordinate of the end of the rectangular domain
        --- Color: color to be filled
* Return Value: None
*********************************************************************************/
void TFT_RectFill(int start_x,int start_y,int end_x,int end_y,int color)
{
        int i, j, w, h;
        TFT_WRegAddr (0);               / / Address register points CUR_Y
        TFT_WRegData (start_y>> 8);     / / set the starting Y coordinate
        TFT_WRegData (start_y);
        TFT_WRegAddr (1);               / / Address register points CUR_X
        TFT_WRegData (start_x>> 8);     / / Set the starting X coordinate
        TFT_WRegData (start_x);
        TFT_WRegAddr (3);               / / address of register to END_X
        TFT_WRegData (end_x>> 8);       / / set END_X
        TFT_WRegData (end_x);
        TFT_WRegAddr (2);               / / Address register points PIXELS
        h = end_y-start_y +1;           / / calculate height of rectangle
        w = end_x-start_x +1;           / / calculate the width of rectangle
        for(i=0;i<h;i++)
        {
                for(j=0;j<w;j++)
                {                       //   / Loop fill data
                        TFT_WRegData(color>>8);
                        TFT_WRegData(color);
                }
        }
}
```

2.2.3 Page copy operations

MI08D708048AD-V2 offers an 8-page display buffer can be specified in any area between the pages to copy data, the data copy operations in hardware, the copy process without MCU intervention.For low-speed MCU, when the refresh when a large area, the phenomenon appears Curtain, flexible use of page copy operations can effectively avoid this phenomenon, so that the screen displays more fluid, the sample page copy operations, such as Listing 3.5 show

Listing 3.5 copy operations

```
/*********************************************************************************
* Function Name: TFT_PageCopy
* Description: copy data between the page
* Parameters:
        - Start_x: to be copies of X coordinate of the starting area
        - Start_y: to be copies of the starting Y coordinate of the region
        - End_x: to be copies of X coordinate of the end zone
        - End_y: to be copies of Y coordinate of the end zone
        --- Rvs_mask: Anti-colored mask
* Return Value: None
*********************************************************************************/
void TFT_PageCopy(int start_x,int start_y,int end_x,int end_y,int rvs_mask)
{
        unsigned char temp;
        TFT_WRegAddr (0);                / / Address register points CUR_Y
        TFT_WRegData (start_y>> 8);      / / set the starting Y coordinate
        TFT_WRegData (start_y);
        TFT_WRegAddr (1);                / / Address register points CUR_X
        TFT_WRegData (start_x>> 8);      / / Set the starting X coordinate
        TFT_WRegData (start_x);
        TFT_WRegAddr (3);                / / Address register points END_X
        TFT_WRegData (end_x>> 8);        / / set the X coordinate of the end
        TFT_WRegData (end_x);
        TFT_WRegAddr (4);                / / Address register points END_Y
        TFT_WRegData (end_y>> 8);        / / set the Y coordinate of the end
        TFT_WRegData (end_y);
        TFT_WRegAddr (6);                / / Address register points RVS_MASK
        TFT_WRegData (rvs_mask>> 8); / / write the register copy operations start page
        TFT_WRegData (rvs_mask);
        TFT_WRegAddr (7);                / / Address register points MIRROR
        TFT_WRegData (0x04 | udlr)       / / start page copy operations
        while (1)                        / / wait for the end of page copy
        {
                temp = TFT_RData();
                if(temp == 0)
                        break;
        }
}
```

Note that, during page copy operation before the first call TFT_SetPref function, set page and copy the source of the current operation. If you copy the value when the RVS_MASK is not 0, then the copy of the data is the result of past anti-color. Page and copy the source of the current operation can also point to the same page, this time by setting the value of non-zero RVS_MASK,page copy operation can evolve into a simple anti-color operation

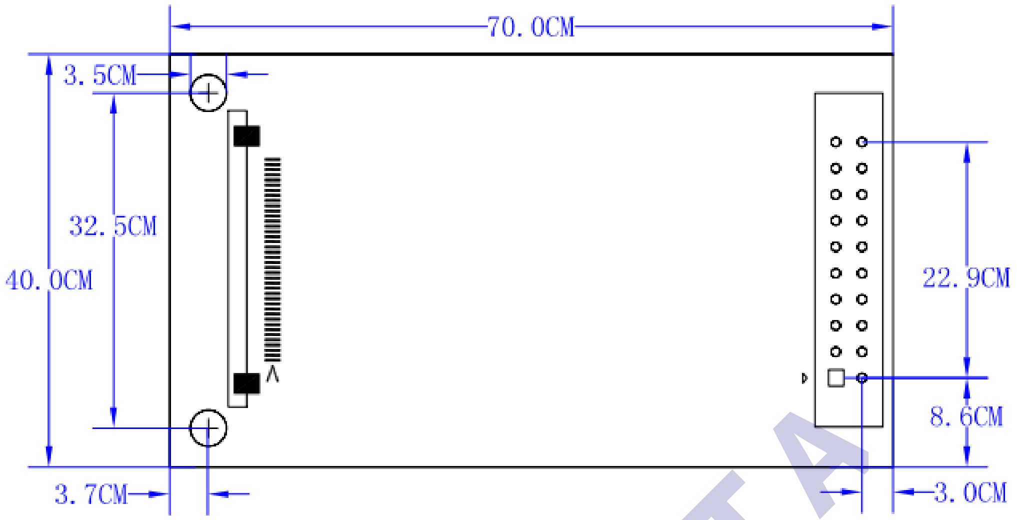
2.2.4 Power-on reset

MI08D708048AD-V2 power-on reset operation is very simple examples, such as power-on reset Listing3.6 shows, the first MCU to MI08D708048AD-V2 of the RES pin down more than 1ms, and then wait 1ms MCU can begin MI08D708048AD-V2 write operation initiated by the other

Listing 3.6 on reset operation

```
/********************************************************************************
 Function Name: TFT_Init
* Description:    initialize power on
* Parameters:     None
* Return Value:   None
********************************************************************************/
void TFT_Init()
{
        unsigned int i;
        RES = 0;
        for(i=0;i<10000;i++);                   // delay 1ms
        RES = 1;
        for(i=0;i<10000;i++);                   // delay 1ms
        TFT_SetPref(0,0,0,63);                  // backlight on
}
```

3. PCB Dimensions


70. 0CM
3. 5CM
32. 5CM
40. 0CM
22. 9CM
8. 6CM
3. 7CM
3. 0CM