IE-TFT-024320240-00302

1。概述

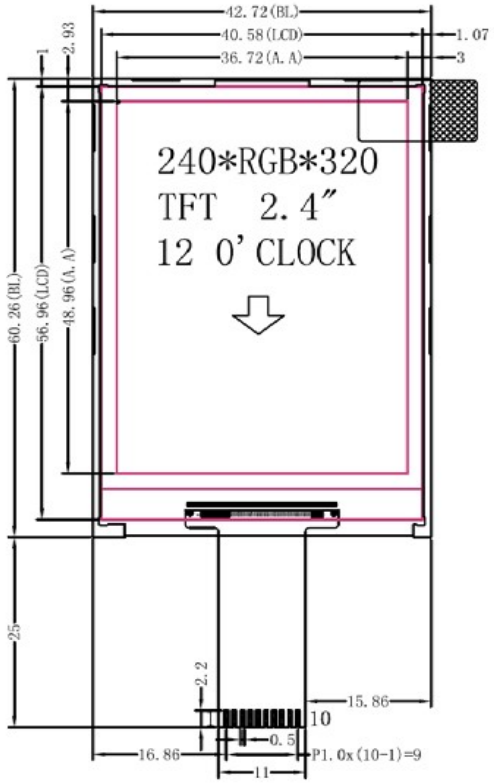
晶联讯电子专注于液晶屏及液晶模块的研发、制造。所生产 IE-TFT-024320240-00302 型液晶模块由于
使用方便、显示清晰，广泛应用于各种人机交流面板。

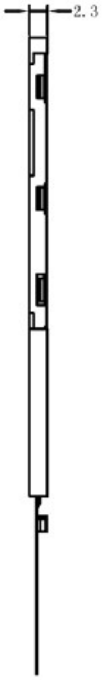
IE-TFT-024320240-00302 可以显示 320 列 *240 行点阵彩色图片，
或显示 20 个 / 行 *15 行 16*16 点阵的
汉字，或显示 40 个 / 行 *30 行 8*8 点阵的英文、数字、符号。

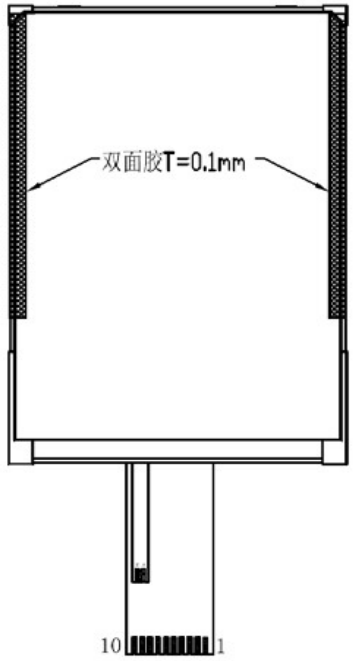
2。 IE-TFT-024320240-00302 彩色图像型点阵液晶模块的特性

2.1 结构轻、薄、带背光。
2.2 IC 采用 ST7789V, 功能强大，稳定性好
2.3 显示内容：
- ●240*320 点阵彩色图片 ;
- ●可选用 32*32 点阵或其他点阵的图片来自编汉字，按照 32*32 点阵汉字来计算可显示 10 个字 / 行 *7 行。
- ●可选用 16*16 点阵或其他点阵的图片来自编汉字，按照 16*16 点阵汉字来计算可显示 20 个字 / 行 *15 行。

2.4 指令功能强：例如可以用指令控制显示内容顺时针旋转 90 、逆时针旋转 90° 或倒立竖放。
2.5 接口简单方便：采用串行接口。
2.6 工作温度宽 :-20℃ - 70℃;



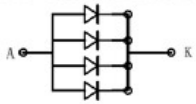




引脚定义：

No:	PIN NAME
1	GND
2	VCC
3	SCK
4	RST
5	CS
6	SDA
7	RS
8	LEDA
9	LEDK
10	NC

1. LED CIRCUIT DIAGRAM:



NOTES:

1. VIEWING DIRECTION : 12:00'CLOCK
2. POLARIZER MODE : TRANSMISSIVE
3. OPERATING TEMP :-20° C~+70° C
4. STORAGE TEMP :-30° C~+80° C
5. DRIVER IC : ST7789V 3.3V
6. LED VOLTAGE : 3.0V
7. GENERAL TOLERANCE : ±0.2

REVISION RECORD		DATE					
1	FIRST	APPROVED				GEN. TOL: ±0.2	
2		Model No:				PEG(3)	
3		Part No: LCM				VER:	A
4		DRAWN		DATE	2017-4-21	SHEET:	1/1
5		CHECKED		DATE		UNIT:	mm
6		APPROVED		DATE		SCALE:	1/1

模块的接口引脚功能

表 1：模块的接口引脚功能

引线号	符号	名称	功能
1	GND	接地	0V
2	VCC	电路电源	3.3V
3	SCK	I/O	串行时钟
4	RST	复位	低电平复位，复位完成后，回到高电平，液晶模块开始工作
5	CS	片选	低电平片选
6	SDA	I/O	串行数据
7	RS	寄存器选择信号	H:数据寄存器 0:指令寄存器（IC 资料上所写为"A0"）
8	LEDA	背光电源	背光电源正极，3.0V
9	LEDK	背光电源	背光电源负极，0V
10	NC	空	空

4.基本原理

4.1 液晶屏（LCD）

在 LCD 上排列着 240×320 点阵，320 个列信号与驱动 IC 相连，240 个行信号也与驱动 IC 相连，IC 邦定在 LCD 玻璃上（这种加工工艺叫 COG）.

4.3 背光参数

该型号液晶模块带 LED 背光源。它的性能参数如下：

工作温度：-20∽+70° C；

存储温度：-30∽+80° C；

背光板是白色。

正常工作电流为：40∽80mA（LED 灯数共 4 颗，每颗灯是 10～20 mA）

工作电压：电压是 3.0V；

5. 技术参数

5.1 最大极限参数（超过极限参数则会损坏液晶模块）

名称	符号	标准值			单位
		最小	典型	最大	
电路电源	VDD	-0.3	3.3	3.3	V
工作温度		-20		+70	℃
储存温度		-30		+80	℃

表 2：最大极限参数

5.2 直流（DC）参数

名 称	符 号	测 试 条 件	标 准 值			单位
			最小	典型值	最大	
工作电压	VDD		2.8	3.0	3.3	V
背光工作电压	VLED		2.9	3.0	3.1	V
背光工作电流	ILED	VLED=3.0V， 共 4 颗 LED 灯并联	40	60	80	mA

表 3：直流（DC）参数

6. 读写时序特性

详见 IC 资料“ST7789V”，请找相关客服人员索要。

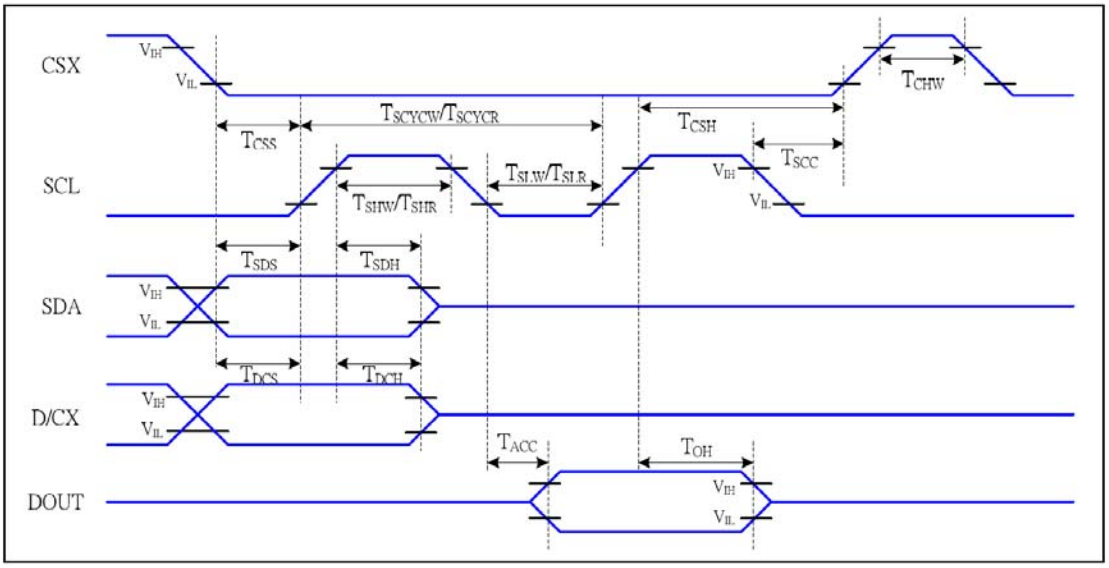


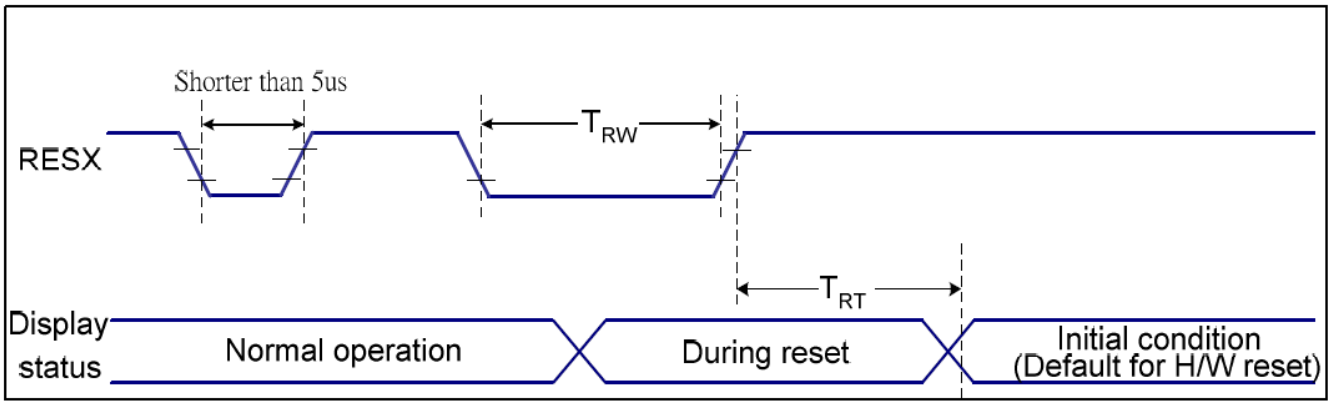
Figure 5 4-line serial Interface Timing Characteristics

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select “H” pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (Write)	66		ns	-write command & data ram
	T_{SHW}	SCL “H” pulse width (Write)	15		ns	
	T_{SLW}	SCL “L” pulse width (Write)	15		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	-read command & data ram
	T_{SHR}	SCL “H” pulse width (Read)	60		ns	
	T_{SLR}	SCL “L” pulse width (Read)	60		ns	
D/CX	T_{DCS}	D/CX setup time	10		ns	
	T_{DCH}	D/CX hold time	10		ns	
SDA (DIN)	T_{SDS}	Data setup time	10		ns	
	T_{SDH}	Data hold time	10		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum CL=30pF
	T_{OH}	Output disable time	15	50	ns	For minimum CL=8pF

Table 6 4-line serial Interface Characteristics

6.1 电源启动后复位的时序要求（RESET CONDITION AFTER POWER UP）：



图为电源启动后复位的时序

表 6：电源启动后复位的时序要求

项 目	符 号	测试条件	极限值			单位
			MIN	TYPE	MAX	
复位保持低电平的时间	t_{Res-L}		5			ms
复位时间	T_{rRES}	引脚： RES			10	us
复位保持高电平的时间	T_{RES-H}		120			ms

7．指令功能：

7.1 指令表

指 令 表 8.

1.

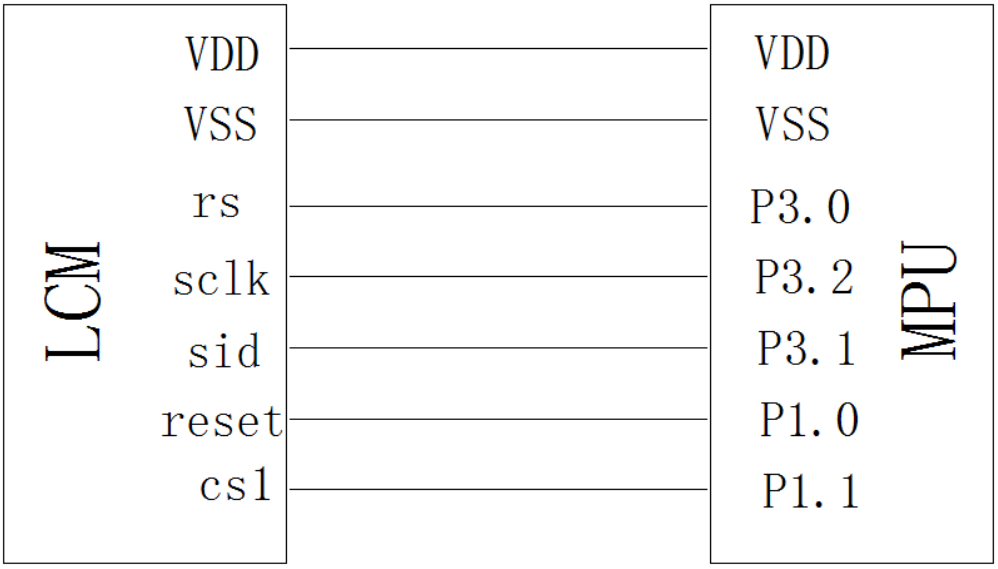
Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
NOP	0	↑	1	-	0	0	0	0	0	0	0	0	(00h)	No operation
SWRESET	0	↑	1	-	0	0	0	0	0	0	0	1	(01h)	Software reset
RDDID	0	↑	1	-	0	0	0	0	0	1	0	0	(04h)	Read display ID
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10		ID1 read
	1	1	↑	-	ID27	ID26	ID25	ID24	ID23	ID22	ID21	ID20		ID2 read
	1	1	↑	-	ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30		ID3 read
RDDST	0	↑	1	-	0	0	0	0	1	0	0	1	(09h)	Read display status
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	BSTON	MY	MX	MV	ML	RGB	MH	ST24		-
	1	1	↑	-	ST23	IFPF2	IFPF1	IFPF0	IDMON	PTLON	SLOUT	NORON		-
	1	1	↑	-	ST15	ST14	INVON	ST12	ST11	DISON	TEON	GCS2		-
	1	1	↑	-	GCS1	GCS0	TEM	ST4	ST3	ST2	ST1	ST0		-
RDDPM	0	↑	1	-	0	0	0	0	1	0	1	0	(0Ah)	Read display power
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	BSTON	IDMON	PTLON	SLPOUT	NORON	DISON	0	0		
RDD MADCTL	0	↑	1	-	0	0	0	0	1	0	1	1	(0Bh)	Read display
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	MY	MX	MV	ML	RGB	MH	0	0		-
RDD COLMOD	0	↑	1	-	0	0	0	0	1	1	0	0	(0Ch)	Read display pixel
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	D6	D5	D4	0	D2	D1	D0		-
RDDIM	0	↑	1	-	0	0	0	0	1	1	0	1	(0Dh)	Read display image
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	VSSON	0	INVON	0	0	GC2	GC1	GC0		-
RDDSM	0	↑	1	-	0	0	0	0	1	1	1	0	(0Eh)	Read display signal
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	1	↑	-	TEON	TEM	0	0	0	0	0	0		-
RDDSDR	0	↑	1	-	0	0	0	0	1	1	1	1	(0Fh)	Read display self-diagnostic result
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	D7	D6	0	0	0	0	0	0		-
SLPIN	0	↑	1	-	0	0	0	1	0	0	0	0	(10h)	Sleep in
SLPOUT	0	↑	1	-	0	0	0	1	0	0	0	1	(11h)	Sleep out
PTLON	0	↑	1	-	0	0	0	1	0	0	1	0	(12h)	Partial mode on
NORON	0	↑	1	-	0	0	0	1	0	0	1	1	(13h)	Partial off (Normal)
INVOFF	0	↑	1	-	0	0	1	0	0	0	0	0	(20h)	Display inversion off
INVON	0	↑	1	-	0	0	1	0	0	0	0	1	(21h)	Display inversion on
GAMSET	0	↑	1	-	0	0	1	0	0	0	0	1	(26h)	Display inversion on
	1	↑	1	-	0	0	0	0	GC3	GC2	GC1	GC0		
DISPOFF	0	↑	1	-	0	0	1	0	1	0	0	0	(28h)	Display off
DISPON	0	↑	1	-	0	0	1	0	1	0	0	1	(29h)	Display on
CASET	0	↑	1	-	0	0	1	0	1	0	1	0	(2Ah)	Column address set
	1	↑	1	-	XS15	XS14	XS13	XS12	XS11	XS10	XS9	XS8		X address start: $0 \leqq XS \leqq X$
	1	↑	1		XS7	XS6	XS5	XS4	XS3	XS2	XS1	XS0		
	1	↑	1		XE15	XE14	XE13	XE12	XE11	XE10	XE9	XE8		X address start: $S \leqq XE \leqq X$
	1	↑	1		XE7	XE6	XE5	XE4	XE3	XE2	XE1	XE0		
RASET	0	↑	1	-	0	0	1	0	1	0	1	1	(2Bh)	Row address set
	1	↑	1	-	YS15	YS14	YS13	YS12	YS11	YS10	YS9	YS8		Y address start: $0 \leqq YS \leqq Y$
	1	↑	1		YS7	YS6	YS5	YS4	YS3	YS2	YS1	YS0		
	1	↑	1		YE15	YE14	YE13	YE12	YE11	YE10	YE9	YE8		Y address start: $S \leqq YE \leqq Y$
	1	↑	1		YE7	YE6	YE5	YE4	YE3	YE2	YE1	YE0		
RAMWR	0	↑	1	-	0	0	1	0	1	1	0	0	(2Ch)	Memory write
	1	↑	1	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Write data
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	↑	1	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
RAMRD	0	↑	1	-	0	0	1	0	1	1	1	0	(2Eh)	Memory read

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Read data
	1	1	↑	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	1	↑	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
PTLAR	0	↑	1	-	0	0	1	1	0	0	0	0	(30h)	Partial sart/end address set
	1	↑	1	-	PSL15	PSL14	PSL13	PSL12	PSL11	PSL10	PSL9	PSL8		Partial start address: (0, 1,2, ..P)
	1	↑	1	-	PSL7	PSL6	PSL5	PSL4	PSL3	PSL2	PSL1	PSL0		
	1	↑	1	-	PEL15	PEL14	PEL13	PEL12	PEL11	PEL10	PEL9	PEL8		Partial end address (0, 1,2, 3, , P)
	1	↑	1	-	PEL7	PEL6	PEL5	PEL4	PEL3	PEL2	PEL1	PEL0		
VSCRDEF	0	↑	1	-	0	0	1	1	0	0	1	1	(33h)	Vertical scrolling definition
	1	↑	1	-	TFA15	TFA14	TFA13	TFA12	TFA11	TFA10	TFA9	TFA8		
	1	↑	1	-	TFA7	TFA6	TFA5	TFA4	TFA3	TFA2	TFA1	TFA0		
	1	↑	1	-	VSA15	VSA14	VSA13	VSA12	VSA11	VSA10	VSA9	VSA8		
	1	↑	1	-	VSA7	VSA6	VSA5	VSA4	VSA3	VSA2	VSA1	VSA0		
	1	↑	1	-	BFA15	BFA14	BFA13	BFA12	BFA11	BFA10	BFA9	BFA8		
	1	↑	1	-	BFA7	BFA6	BFA5	BFA4	BFA3	BFA2	BFA1	BFA0		
TEOFF	0	↑	1	-	0	0	1	1	0	1	0	0	(34h)	Tearing effect line off
TEON	0	↑	1	-	0	0	1	1	0	1	0	1	(35h)	Tearing effect line on
	1	↑	1	-	-	-	-	-	-	-	-	TEM		
MADCTL	0	↑	1	-	0	0	1	1	0	1	1	0	(36h)	Memory data access control
	1	↑	1	-	MY	MX	MV	ML	RGB	0	0	0		-
VSCRSADD	0	↑	1	-	0	0	1	1	0	1	1	1	(37h)	Vertical scrolling start address
	1	↑	1	-	VSP15	VSP14	VSP13	VSP12	VSP11	VSP10	VSP9	VSP8		
	1	↑	1	-	VSP7	VSP6	VSP5	VSP4	VSP3	VSP2	VSP1	VSP0		
IDMOFF	0	↑	1	-	0	0	1	1	1	0	0	0	(38h)	Idle mode off
IDMON	0	↑	1	-	0	0	1	1	1	0	0	1	(39h)	Idle mode on

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
COLMOD	0	↑	1	-	0	0	1	1	1	0	1	0	(3Ah)	Interface pixel format
	1	↑	1	-	0	D6	D5	D4	0	D2	D1	D0		Interface format
RAMWRC	0	↑	1	-	0	0	1	1	1	1	0	0	(3Ch)	Memory write continue
	1	↑	1	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		Write data
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	↑	1	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
RAMRDC	0	↑	1	-	0	0	1	1	1	1	1	0	(3Eh)	Memory read continue
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy Read
	1	1	↑	D1[17:8]	D1[7]	D1[6]	D1[5]	D1[4]	D1[3]	D1[2]	D1[1]	D1[0]		
	1	1	↑	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		
	1	1	↑	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
TESCAN	0	↑	1	-	0	1	0	0	0	1	0	0	(44h)	Set tear scanline
	1	↑	1	-	N15	N14	N13	N12	N11	N10	N9	N8		
	1	↑	1	-	N7	N6	N5	N4	N3	N2	N1	N0		
RDTESCAN	0	↑	1	-	0	1	0	0	0	1	0	1	(45h)	Get scanline
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy Read
	1	1	↑	-	-	-	-	-	-	-	N9	N8		
	1	1	↑	-	N7	N6	N5	N4	N3	N2	N1	N0		
WRDISBV	0	↑	1	-	0	1	0	1	0	0	0	1	(51h)	Write display brightness
	1	↑	1	-	DBV7	DBV6	DBV5	DBV4	DBV3	DBV2	DBV1	DBV0		
RDDISBV	0	↑	1	-	0	1	0	1	0	0	1	0	(52h)	Read display brightness value
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	DBV7	DBV6	DBV5	DBV4	DBV3	DBV2	DBV1	DBV0		
WRCTRLD	0	↑	1	-	0	1	0	1	0	0	1	1	(53h)	Write CTRL display
	1	↑	1	-	0	0	BCTRL	0	DD	BL	0	0		
RDCTRLD	0	↑	1	-	0	1	0	1	0	1	0	0	(54h)	Read CTRL value dsiplay
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	0	BCTRL	0	DD	BL	0	0		

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
WRCACE	0	↑	1	-	0	1	0	1	0	1	0	1	(55h)	Write content adaptive brightness control and Color enhancemnet
	1	↑	1	-	CECTRL	0	CE1	CE0	0	0	C1	C0		
RDCABC	0	↑	1	-	0	1	0	1	0	1	1	0	(56h)	Read content adaptive brightness control
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	0	CECTRL	0	0	0	0	C1	C0		
WRCABCMB	0	↑	1	-	0	1	0	1	1	1	1	0	(5Eh)	Write CABC minimum brightness
	1	↑	1	-	CMB7	CMB6	CMB5	CMB4	CMB3	CMB2	CMB1	CMB0		
RDCABCMB	0	↑	1	-	0	1	0	1	1	1	1	1	(5Fh)	Read CABC minimum brightness
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	CMB7	CMB6	CMB5	CMB4	CMB3	CMB2	CMB1	CMB0		
RDABCSDR	0	↑	1	-	0	1	1	0	1	0	0	0	(68h)	Read Automatic Brightness Control Self-Diagnostic Result
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	D7	D6	0	0	0	0	0	0		-
RDID1	0	↑	1	-	1	1	0	1	1	0	1	0	(DAh)	Read ID1
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID17	ID16	ID15	ID14	ID13	ID12	ID11	ID10		Read parameter
RDID2	0	↑	1	-	1	1	0	1	1	0	1	1	(DBh)	Read ID2
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑	-	ID27	ID26	ID25	ID24	ID23	ID22	ID21	ID20		Read parameter
RDID3	0	↑	1	-	1	1	0	1	1	1	0	0	(DCh)	Read ID3



接口定义

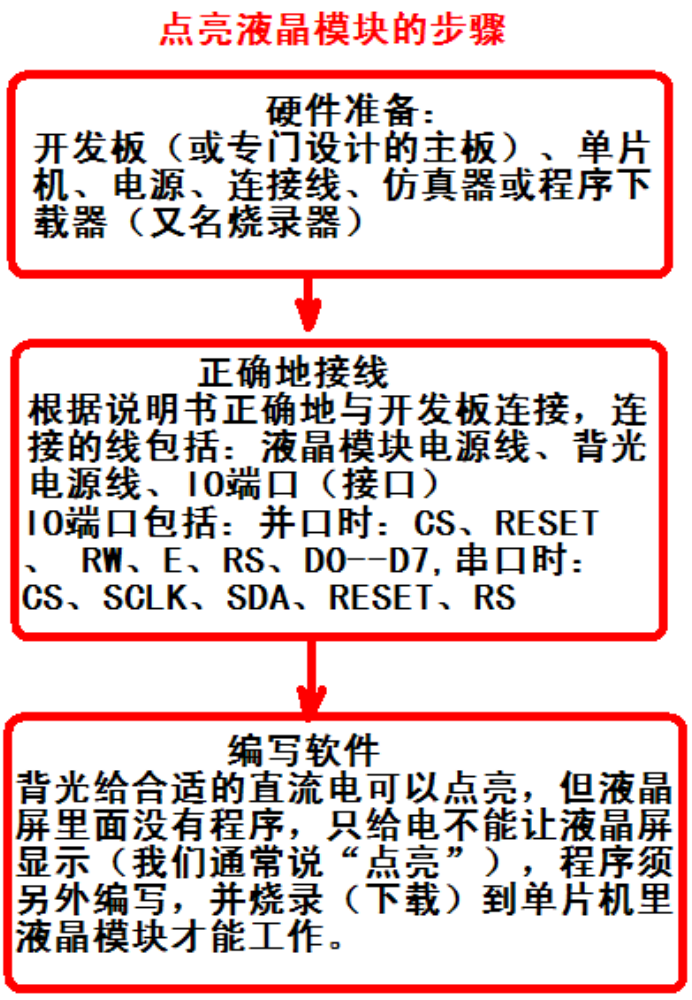
7.5 程序举例：

```
//LCM resolution:240x320,
//driver IC:ST7789V,

#include <reg51.h>
#include <chinese_code.h>

//液晶屏 IC 所需要的信号线的接口定义
sbit cs1=P1^1;
sbit reset=P1^0;
sbit rs=P3^0;
sbit sclk=P3^2;
sbit sid=P3^1;
sbit key=P2^0;        //P2.0 口与 GND 之间接一个按键


/*写指令到 LCD 模块*/
void transfer_command(int data1)
{
    char i;
    cs1=0;
    rs=0;
    for(i=0;i<8;i++)
    {
        sclk=0;
        if(data1&0x80) sid=1;
        else sid=0;
        sclk=1;
        data1=data1<<=1;
    }
}


/*写数据到 LCD 模块*/
void transfer_data(int data1)
```

Instruction	D/CX	WRX	RDX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex	Function
	1	1	↑	-	-	-	-	-	-	-	-	-		Dummy read
	1	1	↑		ID37	ID36	ID35	ID34	ID33	ID32	ID31	ID30		Read parameter

7.4 初始化方法

用户所编的显示程序，开始必须进行初始化，否则模块无法正常显示，过程请参考程序



```
{
    char i;
    cs1=0;
    rs=1;
    for(i=0;i<8;i++)
    {
        sclk=0;
        if(data1&0x80) sid=1;
        else sid=0;
        sclk=1;
        data1=data1<<=1;
    }
}


//===传 16位指令， 16位指令一起赋值
void transfer_command_16(uint com_16bit)
{
    transfer_command(com_16bit >>8);    //先传高8位
    transfer_command(com_16bit );       //再传低8位
}

//连写2 个字节（即 16位）数据到 LCD 模块
void transfer_data_16(uint data_16bit)
{
    transfer_data(data_16bit>>8);
    transfer_data(data_16bit);
}

//===发送1个字节的指令及 1 个字节的数据 ================
void Lcd_Write_Com_Data(uint com,uint val)
{
    transfer_command_16(com);   //先传指令
    transfer_data_16(val);      //再传数据
}

void delay(long i)
{
    int j,k;
    for(j=0;j<i;j++)
    for(k=0;k<110;k++);
}

//void delay_us(long i)
//{
//  int j,k;
//  for(j=0;j<i;j++)
//  for(k=0;k<10;k++);
//}

void Switch()
{
 repeat:
    if (key==1) goto repeat;
    else delay(1000);
    if (key) goto repeat;
    else ;
}

void lcd_initial()
```

```
{
    delay(50);
    reset=0;
    delay(50);
    reset=1;
    delay(50);
//************ Start Initial Sequence **********//
    transfer_command(0x11);
    delay(50);
//--------------------------------display and color format setting--------------------------------//
    transfer_command(0x36);     //行扫描顺序及 RGB，列扫描顺序，横放/竖放
    transfer_data(0x00);
    transfer_data(0x48);

    transfer_command(0xB6);     //显示功能设置：列/行 显示顺序
    transfer_data(0x0A);
    transfer_data(0x82);        //改变 SOURCE 线的方向： 0xa2：左到右， 0x82：右到左

    transfer_command(0x3a);     //256K 16bit/pixel
    transfer_data(0x05);
//--------------------------------ST7789V Frame rate setting----------------------------------//
    transfer_command(0xb2);
    transfer_data(0x0c);
    transfer_data(0x0c);
    transfer_data(0x00);
    transfer_data(0x33);
    transfer_data(0x33);
    transfer_command(0xb7);
    transfer_data(0x35);
//---------------------------------ST7789V Power setting-------------------------------------//
    transfer_command(0xbb);
    transfer_data(0x28);
    transfer_command(0xc0);
    transfer_data(0x2c);
    transfer_command(0xc2);
    transfer_data(0x01);
    transfer_command(0xc3);
    transfer_data(0x10);
    transfer_command(0xc4);
    transfer_data(0x20);
    transfer_command(0xc6);
    transfer_data(0x0f);
    transfer_command(0xd0);
    transfer_data(0xa4);
    transfer_data(0xa1);
//---------------------------------ST7789V gamma setting-------------------------------------//
    transfer_command(0xe0);
    transfer_data(0xd0);
    transfer_data(0x00);
    transfer_data(0x02);
    transfer_data(0x07);
    transfer_data(0x0a);
    transfer_data(0x28);
    transfer_data(0x32);
    transfer_data(0x44);
    transfer_data(0x42);
    transfer_data(0x06);
    transfer_data(0x0e);
    transfer_data(0x12);
    transfer_data(0x14);
```

```
    transfer_data(0x17);

    transfer_command(0xe1);
    transfer_data(0xd0);
    transfer_data(0x00);
    transfer_data(0x02);
    transfer_data(0x07);
    transfer_data(0x0a);
    transfer_data(0x28);
    transfer_data(0x31);
    transfer_data(0x54);
    transfer_data(0x47);
    transfer_data(0x0e);
    transfer_data(0x1c);
    transfer_data(0x17);
    transfer_data(0x1b);
    transfer_data(0x1e);

    transfer_command(0x29);    //打开显示
}

//定义窗口坐标：开始坐标（XS,YS)以及窗口大小（x_total,y_total)
void lcd_address(int XS,int YS,int x_total,int y_total)
{
    int XE,YE;
    XE=XS+x_total-1;
    YE=YS+y_total-1;
    transfer_command(0x2a);     // 设置 X 开始及结束的地址
    transfer_data_16(XS);   // X 开始地址(16 位)
    transfer_data_16(XE);   // X 结束地址(16 位)

    transfer_command(0x2b);     // 设置 Y 开始及结束的地址
    transfer_data_16(YS);   // Y 开始地址(16 位)
    transfer_data_16(YE);   // Y 结束地址(16 位)

    transfer_command(0x2c);     // 写数据开始
}

void mono_transfer_data_16(int mono_data,int font_color,int back_color)
{
    int i;
    for(i=0;i<8;i++)
    {
        if(mono_data&0x80)
        {
            transfer_data_16(font_color);   //当数据是 1 时，显示字体颜色
        }
        else
        {
            transfer_data_16(back_color);   //当数据是 0 时，显示底色
        }
        mono_data<<=1;
    }
}


//全屏显示一种颜色
void display_color(int color_data)
{
    int i,j;
```

```
    lcd_address(0,0,240,320);
    for(i=0;i<240;i++)
    {
        for(j=0;j<320;j++)
        {
            transfer_data_16(color_data);
        }
    }
}


void display_white(void)
{
     int i,j;
    transfer_command(0x2c);
    for(i=0;i<240;i++)
      {
             for(j=0;j<320;j++)
         {
          transfer_data_16(0xffff);
         }

      }
}

void display_black(void)
{
    int i,j,k;
    transfer_command(0x2c);          //  写数据开始
    for(i=0;i<240;i++)
    {
        transfer_data_16(0xffff);
    }
    for(i=0;i<318;i++)
    {
        for(k=0;k<1;k++)
        {
            transfer_data_16(0xffff);
        }
        for(j=0;j<238;j++)
        {
            transfer_data_16(0x0000);
        }
        for(k=0;k<1;k++)
        {
            transfer_data_16(0xffff);
        }
    }
    for(i=0;i<320;i++)
    {
        transfer_data_16(0xffff);
    }
}

//显示 8x16 点阵的字符串
void disp_string_8x16(int x,int y,char *text,int font_color,int back_color)
{
    int i=0,j,k;
    while(text[i]>0x00)
    {
```

```
        if((text[i]>=0x20)&&(text[i]<=0x7e))
        {
            j=text[i]-0x20;
            lcd_address(x,y,8,16);
            for(k=0;k<16;k++)
            {
                mono_transfer_data_16(ascii_table_8x16[j*16+k],font_color,back_color);
//?a??"ascii_table_8x16[]"?a??êy×é?ú"ASCII_TABLE_5X8_8X16_horizontal.h"à?
            }
            x+=8;
            i++;
        }
        else
        i++;
    }
}

void display_string_16x16(int x,int y,uchar *text,int font_color,int back_color)
{
    uchar i,j,k;
    uint address;
    j = 0;
    while(text[j] != '\0')                                  //'\0' 字符串结束标志
    {
        i = 0;
        address = 1;
        while(Chinese_horizontal_text_16x16[i] > 0x7e)    // >0x7f 即说明不是 ASCII 码字符
        {
            if(Chinese_horizontal_text_16x16[i] == text[j])
            {
                if(Chinese_horizontal_text_16x16[i + 1] == text[j + 1])
                {
                    address = i * 16;
                    break;
                }
            }
            i += 2;
        }
        if(y > 240)
        {
            y=0;
            x+=16;
        }

        if(address != 1)// 显示汉字
        {
            lcd_address(x,y,16,16);
            for(i=0;i<2;i++)
            {
                for(k = 0; k <16; k++)
                {

    mono_transfer_data_16(Chinese_horizontal_code_16x16[address],font_color,back_color);
                address++;
                }
            }
            j+=2;
        }
        else              //显示空白字符
        {
```

```
            lcd_address(x,y,16,16);
            for(i = 0; i <2; i++)
            {
            for(k = 0; k < 16; k++)
            {
            mono_transfer_data_16(0x00,font_color,back_color);
            }
            }
            j+=2;
        }
        x=x+16;
    }
}


//显示32x32  点阵的单色的图像
void disp_32x32(int x,int y,char *dp,int font_color,int back_color)
{
    int i,j;
    lcd_address(x,y,32,32);
    for(i=0;i<32;i++)
    {
        for(j=0;j<4;j++)
        {
            mono_transfer_data_16(*dp,font_color,back_color);
            dp++;
        }
    }
}

//显示一幅彩图
void display_image(int x,int y,uchar *dp)
{
    uchar i,j,k=0;
    lcd_address(x,y,120,160);
    for(i=0;i<120;i++)
    {
        for(j=0;j<160;j++)
        {
            transfer_data(*dp);          //传一个像素的图片数据的高位
            dp++;
            transfer_data(*dp);          //传一个像素的图片数据的低位
            dp++;
        }
    }
}

void main(void)
{
    lcd_initial();
    while(1)
    {
        lcd_initial();
        display_color(blue);
        disp_32x32(40+32*0,8,jing_32x32,white,blue);
        disp_32x32(40+32*1,8,lian_32x32,white,blue);
        disp_32x32(40+32*2,8,xun_32x32,white,blue);
        disp_32x32(40+32*3,8,dian_32x32,white,blue);
        disp_32x32(40+32*4,8,zi_32x32,white,blue);
```

```
        display_string_16x16(24,56,"深圳市晶联讯电子有限公司 ",white,blue);

        disp_string_8x16(72,88,"JLX320-00202",white,blue);
        Switch();

        display_image(0,0,pic1);
        display_image(120,0,pic1);
        display_image(0,160,pic1);
        display_image(120,160,pic1);
        Switch();

        display_color(0xf800);
        Switch();
        display_color(0x07e0);
        Switch();
        display_color(0x001f);
        Switch();
        display_black();
        Switch();
        display_color(0xffff);
        Switch();
    }
}
```