



深圳市拓普微科技开发有限公司

SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LMT028FNHFWA

LCD Module User Manual

Prepared by: Caiwei Date: 2024-03-07	Checked by: Date:	Approved by: Date:
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Rev.	Descriptions	Edit	Release Date
0.1	Preliminary New release	Caiwei	2023-11-14
0.2	Update Operating Temperature and Storage Temperature of 1.and 2. 、 Luminance of 5.Optical Characteristics and Outline 、 Change Vf of 3.2 note2 and TFT Driver IC to ST7789VI	Caiwei	2024-03-07

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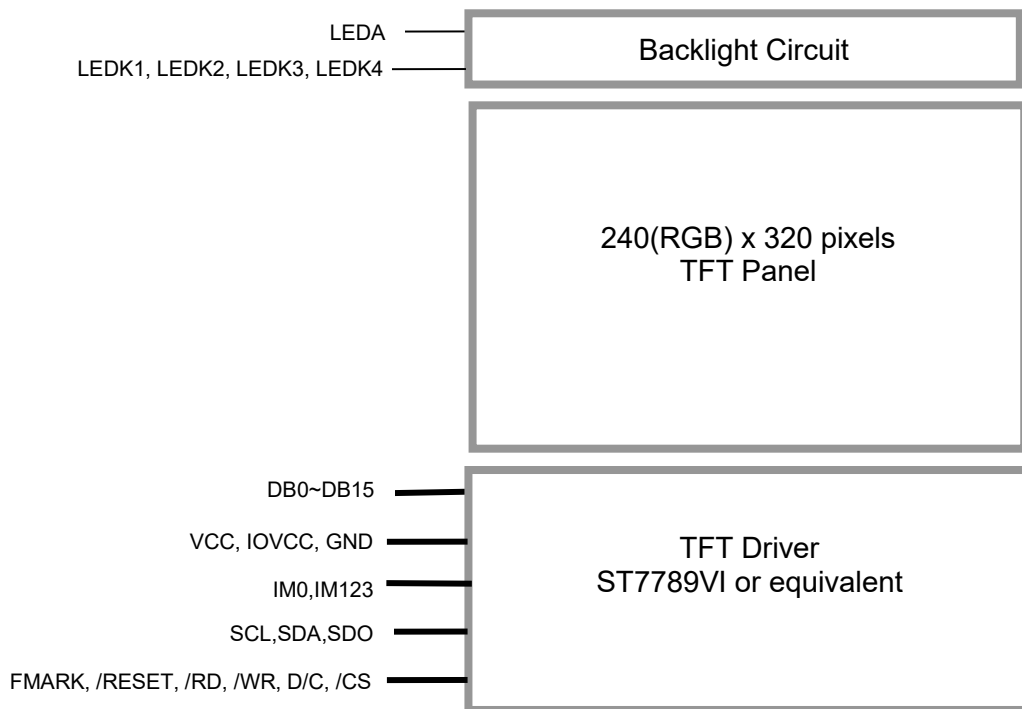
1. Basic Specifications

Screen Size(Diagonal) :	2.8"
Active Area :	43.2x57.6 (mm)
Number of dots :	240 (RGB) x 320
Pixel Pitch:	0.18x0.18 mm
Color Depth:	65k/262K colors
Display Technology :	a-Si TFT active matrix
Display Mode :	Normally black,Transmissive
Display Interface :	MCU_8/16bit/4-SPI
Viewing Direction :	Full
Surface Treatment :	HC
Operating Temperature :	-30 ~ +85°C
Storage Temperature :	-30 ~ +85°C

Note:

1. Color tone may slightly change by temperature and driving condition.

1.1 Block Diagram



1.2 Terminal Functions

Pin No.	Pin Name	I/O	Descriptions			
			80-16bit		80-8bit	4-SPI
1	LEDA	P	LED Anode			
2	LEDK1	P	LED Cathode1			
3	LEDK2		LED Cathode2			
4	LEDK3		LED Cathode3			
5	LEDK4		LED Cathode4			
6	GND	P	Power Ground			
7	VCC	P	Analog and Logic power supply			
8	IOVCC	P	Interface power supply			
9	IM123	I	IM123	IM0	MPU Interface Mode	Data pin
10	IM0		0	0	80-8bit parallel I/F	DB[7:0]
			0	1	80-16bit parallel I/F	DB[15:0]
			1	0	4-line 8bit serial I/F II	SDA:in SDO: out
11	/RESET	I	Reset signal: active Low			
12	/CS	I	Chip Select /CS=L, enable access to the LCD interface /CS=H, disable access to the LCD interface			
13	D/C(SCL)	I	Register Select D/C = H, Transferring the Display Data D/C = L, Transferring the Control Data			
14	/WR(D/C)	I	/WR=L→H, /RD=H; Data or Instruction latch into the LCD module			Display data/command selection pin in 4-line serial interface
15	/RD	I	/WR=H,/ RD=L; Data or Status read form the LCD module			Please fix this pin at VCC or GND
16	SDA	I	Please fix this pin at VCC or GND level			The data is latched on the rising edge of the SCL signal
17	SDO	O	Could leave open			SPI interface output pin. The data is output on the rising edge of the SCL signal
18	DB0	I/O	Data Bus	DB0		Please fix this pin at VCC or GND level
19	DB1			DB1		
20	DB2			DB2		
21	DB3			DB3		
22	DB4			DB4		
23	DB5			DB5		
24	DB6			DB6		
25	DB7			DB7		
26	DB8			Connect GND		
:	:					
33	DB15					
34	FMARK	O	Frame mark Output signal(could leave open)			
35	GND	P	Power Ground			
36	NC/VPP	-	No connect			
37	NC(YU)					
38	NC(XR)					
39	NC(YD)					
40	NC(XL)					

2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	VCC	-0.3	+4.6	V	GND = 0V
Logic Voltage	IOVCC	-0.3	+4.6	V	GND = 0V
Operating Temperature	T _{OP}	-30	+85	°C	No Condensation
Storage Temperature	T _{ST}	-30	+85	°C	No Condensation

Cautions:

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.

3. Electrical Characteristics

3.1 DC Characteristics

VCC=3.3V, GND=0V, T_{OP}=25°C

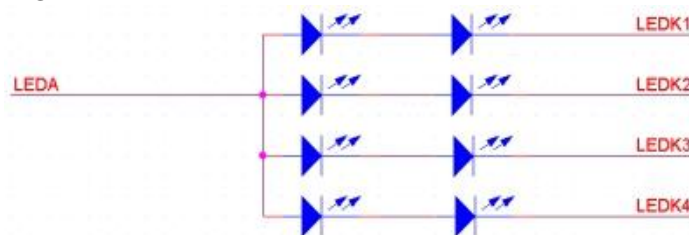
Items	Symbol	MIN.	TYP.	MAX.	Unit	Application Pin
Supply voltage for logic	VCC	3.2	3.3	3.4	V	VCC
Logic Supply voltage	IOVCC	3.2	3.3	3.4	V	IOVCC
Input High Voltage	V _{IH}	0.7 IOVCC	-	IOVCC	V	SDA,/RD,/WR,D/C, /CS,/SCL,IM123,IM0, /RESET,DB0~DB15
Input Low Voltage	V _{IL}	-	-	0.3 IOVCC	V	
Output High Voltage	V _{OH}	0.8 IOVCC	-	IOVCC	V	DB0~DB15,SDO, FMARK
Output Low Voltage	V _{OL}	GND	-	0.2 IOVCC	V	
Operating Current	I _{VCC}	-	8.6	21.5	mA	VCC

3.2 LED Backlight Circuit Characteristics

T_{OP}=25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Forward Voltage	V _F	3.0	3.2	3.4	V	For each LED
Forward Current	I _F	-	20	-	mA	For each LED
LED Life Time	-	-	30,000	-	Hrs	For each LED

Note1: LED CIRCUIT DIAGRAM



No. of LEDs = 2x4pcs

Note 2: LED: V_F =3.2V, I_F =20mA(TYP)

Note 3: I_F is defined for one LED.

Optical performance should be evaluated at Ta=25°C only.

If LED is driven by high current, high ambient temperature & humidity condition.

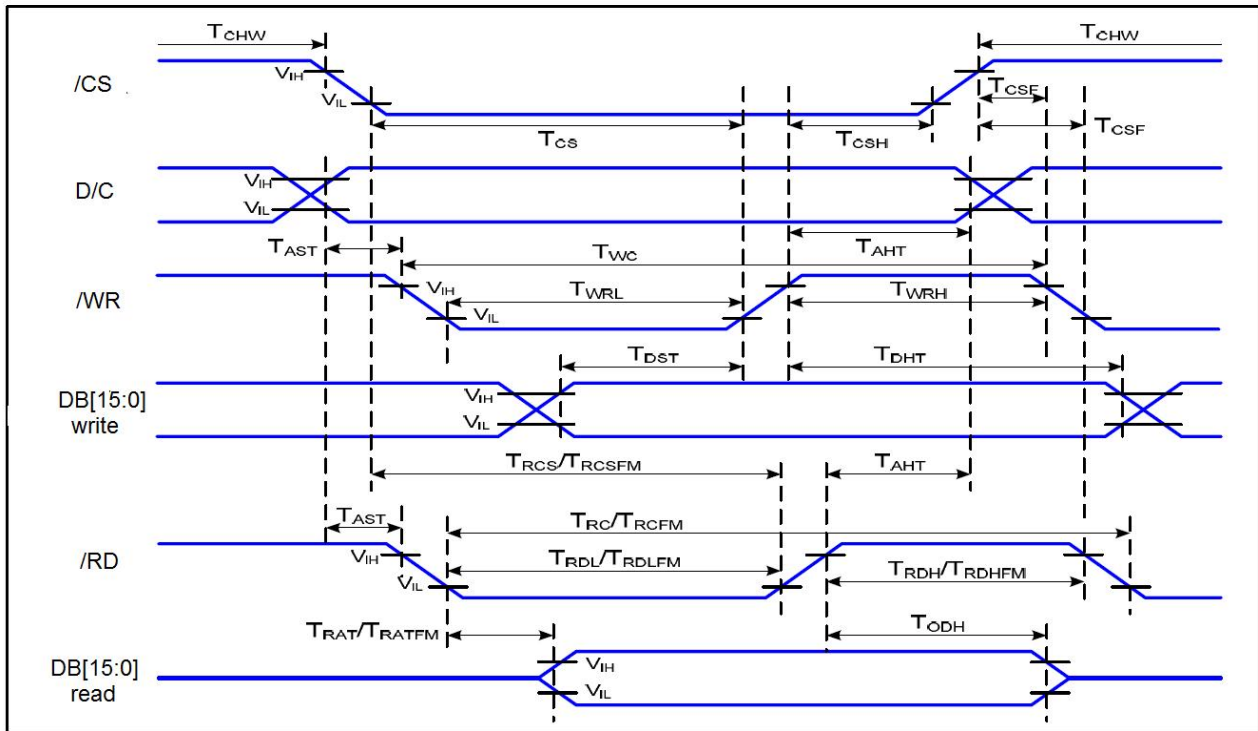
The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness.

Typical operating life time is estimated data.

Note 4: Under LCM operating, the stable forward current should be inputted. And forward voltage is for reference only.

Note 5: The LED driving condition is defined for each LED module.

3.3 AC Characteristics
8080 Mode System Bus Timing



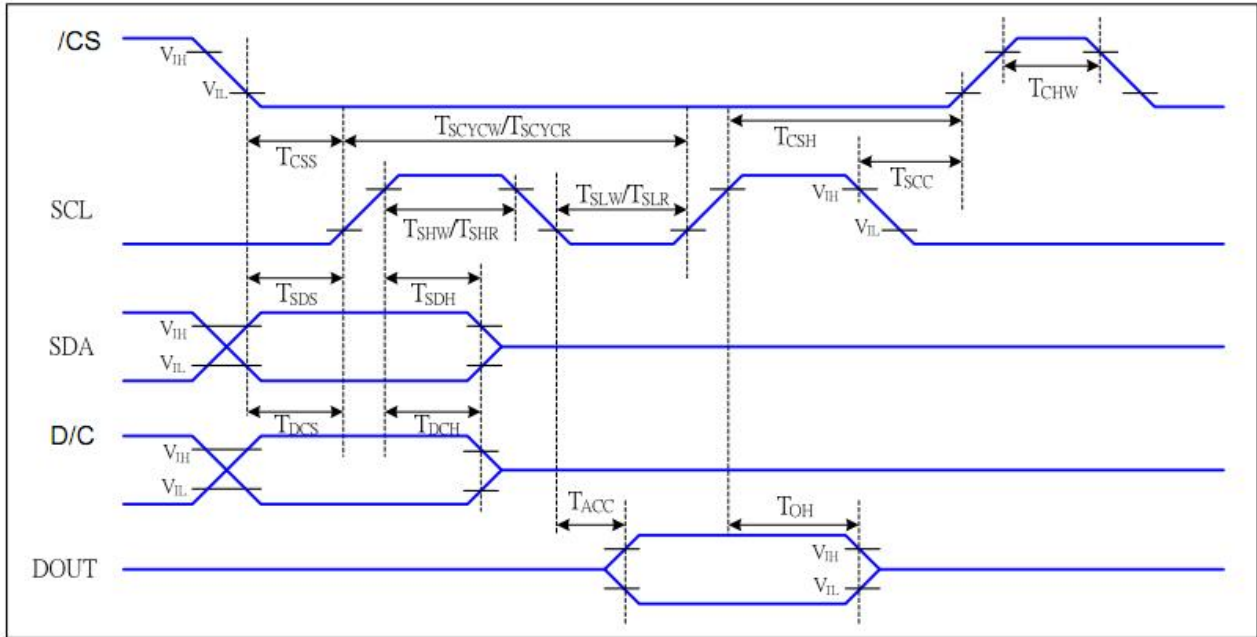
VCC=3.3V, GND=0V, T_{OP}=25°C

Signal	Symbol	Parameter	Spec.		Unit	Description
			Min.	Max.		
D/C	T _{AST}	Address setup time	5	-	ns	-
	T _{AHT}	Address hole time(Write/Read)	13	-		
/CS	T _{CHW}	Chip select "H" pulse width	5	-	ns	-
	T _{CS}	Chip select setup time(Write)	20	-		
	T _{RCS}	Chip select setup time(Read ID)	60	-		
	T _{RCSFM}	Chip select setup time(Read FM)	460	-		
	T _{CSF}	Chip select wait time(Write/Read)	13	-		
	T _{CSH}	Chip select hold time	13	-		
/WR	T _{WC}	Write cycle	86	-	ns	-
	T _{WRH}	Control pulse "H" duration	20	-		
	T _{WRL}	Control pulse "L" duration	20	-		
DB[15:0]	T _{DST}	Data setup time	13	-	ns	For maximum CL=30pF For minimum CL=8pF
	T _{DHT}	Data hold time	13	-		
	T _{RAT}	Read access time(ID)	-	52		
	T _{RATFM}	Read access time(FM)	-	442		
	T _{ODH}	Ouput disable time	14	104		
/RD(ID)	T _{RC}	Read cycle(ID)	208	-	ns	When read ID data
	T _{RDH}	Control pulse "H" duration(ID)	120	-		
	T _{RDL}	Control pulse "H" duration(ID)	60	-		
/RD(FM)	T _{RCFM}	Read cycle(FM)	585	-	ns	When read from frame memory
	T _{RDHFM}	Control pulse "H" duration(FM)	120	-		
	T _{RDLFM}	Control pulse "H" duration(FM)	460	-		

Note:

- *1. Input signal rise/fall time should be less than 15ns .
- *2. All timing is using 20% and 80% of VDD as the reference.
- *3. Please refer to ST7789VI datasheet for details

4 line SPI Timing

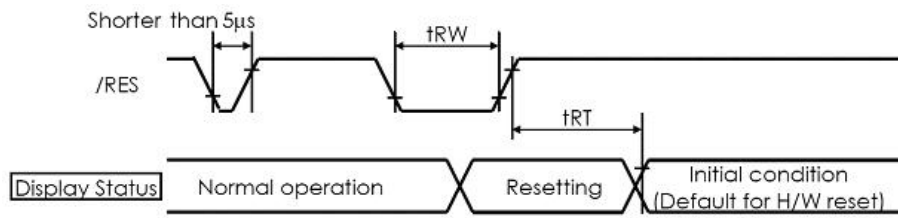


VCC=3.3V, GND=0V, T_{OP}=25°C

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
/CS	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)	16		ns	-write command & data ram
	T_{SHW}	SCL "H" pulse width (Write)	7		ns	
	T_{SLW}	SCL "L" pulse width (Write)	7		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/C	T_{DCS}	D/CX setup time	10		ns	
	T_{DCH}	D/CX hold time	10		ns	
SDA (DIN)	T_{SDS}	Data setup time	7		ns	
	T_{SDH}	Data hold time	7		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

Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for input signals.

3.4 Reset Timing



VCC=3.3V, GND=0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset LOW pulse width	t_{RW}	10	-	-	µs
Reset time	T_{RT}	-	-	120	ms

4. Functions

4.1 Display Commands

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		-
RDOSDR	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:
	1	↑	1		XS7	XS6	XS5	XS4	XS3	XS2	XS1	XS0		0 ≤ XS ≤ X
	1	↑	1		XE15	XE14	XE13	XE12	XE11	XE10	XE9	XE8		X address start:
	1	↑	1		XE7	XE6	XE5	XE4	XE3	XE2	XE1	XE0		S ≤ XE ≤ X
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:
	1	↑	1		YS7	YS6	YS5	YS4	YS3	YS2	YS1	YS0		0 ≤ YS ≤ Y
	1	↑	1		YE15	YE14	YE13	YE12	YE11	YE10	YE9	YE8		Y address start:
	1	↑	1		YE7	YE6	YE5	YE4	YE3	YE2	YE1	YE0		S ≤ YE ≤ Y
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]		
PTLAR	0	↑	1	-	0	0	1	1	0	0	0	0	(30h)	Partial start/end address set
	1	↑	1	-	PSL15	PSL14	PSL13	PSL12	PSL11	PSL10	PSL0	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)
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		-
VSCRSAADD	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		
RDISBV	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 display
	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

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

Notes:

1. There will be no abnormal visible effects on the display when SW or HW Reset are applied.
2. Please refer to ST7789VI datasheet for details.

4.2 Power off the LCD Module

It recommends that enter Sleep Mode before power off the LCD module.

4.3 Refreshing The LCD Module

It recommends that the operating modes and display contents be refreshed periodically to prevent the effect of unexpected noise.

5. Optical Characteristics

VCC=3.3V, GND=0V, T_{OP}=25°C

Item	Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angles	θT	CR ≥ 10	70	80	-	Degree	Note 2,3
	θB		70	80	-		
	θL		70	80	-		
	θR		70	80	-		
Contrast Ratio	CR	θ = 0°	600	800	-		Note 3
Response Time	T _{ON}	25°C	-	25	35	ms	Note 4
	T _{OFF}						
Chromaticity	White	Backlight is on	x	0.237	0.287	0.337	Note 1,5
			y	0.265	0.315	0.365	
	Red		x	0.586	0.636	0.686	
			y	0.286	0.336	0.386	
	Green		x	0.285	0.335	0.385	
			y	0.564	0.614	0.664	
	Blue		x	0.099	0.149	0.199	
			y	0.021	0.071	0.121	
Uniformity	U		75	80	-	%	Note 6
NTSC	S	θ = 0°	65	70	-	%	Note 5
Luminance	L	Φ = 0°	900	1000	-	cd/m ²	Note 7

1. I_{LEDA} = 20mA, and the ambient temperature is 25°C.

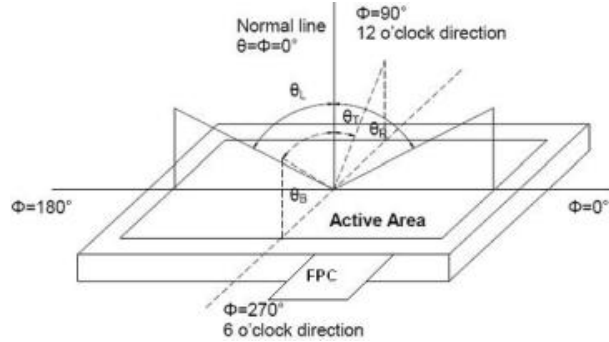
2. The test systems refer to Note 1 and Note 2.

Note 1: Definition of optical measurement system.
 The optical characteristics should be measured in dark room.
 After 5 Minutes operation, the optical properties are measured at the center point of the LCD screen.
 All input terminals LCD panel must be ground when measuring the center area of the panel.

Measuring surroundings: Dark room

Measuring temperature: Ta=25°C.

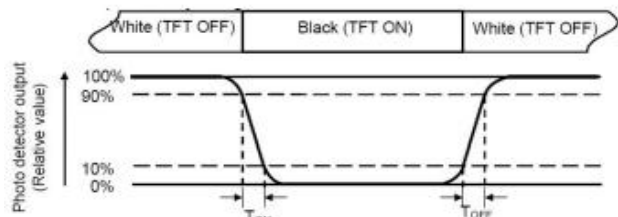
Note 2: Definition of viewing angle range and measurement system.
 The definition of viewing angle:
 Refer to the graph below marked by θ and ϕ



Note 3: Definition of contrast ratio
 The definition of contrast ratio (Test LCM using SR-3A (1°):

$$\text{Ratio(CR)} = \frac{\text{Luminance When LCD is at "White" state}}{\text{Luminance When LCD is at "Black" state}}$$
 (Contrast Ratio is measured in optimum common electrode voltage)

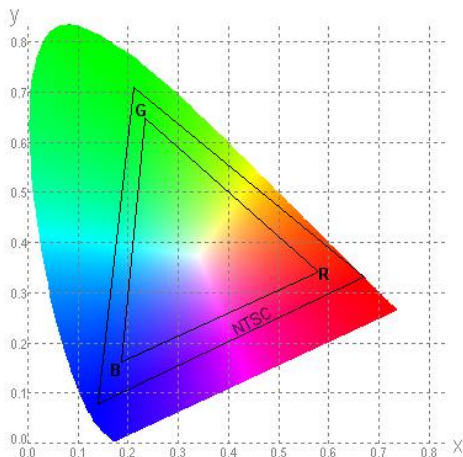
Note 4: Definition of Response time
 Definition of Response time.
 The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (TON) is the time between photo detector output intensity changed from 90% to 10%. And fall time (TOFF) is the time between photo detector output intensity changed from 10% to 90%.



Note 5: Definition of color chromaticity (CIE1931)
 Definition of Color of CIE1931 Coordinate and NTSC Ratio.

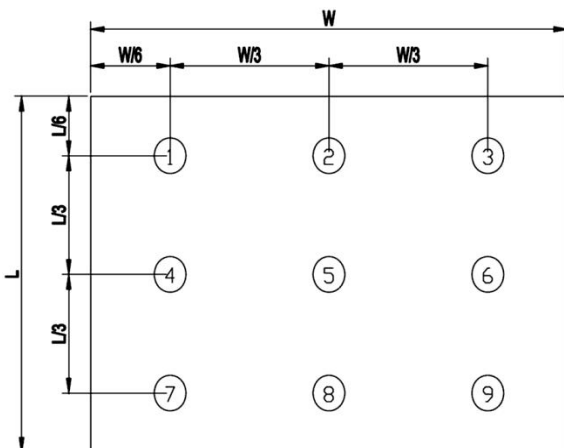
Color gamut:

$$S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$



Note 6: Definition of Luminance Uniformity
 Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

$$\text{Luminance Uniformity (U)} = \text{Lmin} / \text{Lmax}$$
 L-----Active area length W----- Active area width
 Lmax: The measured Maximum luminance of all measurement position.
 Lmin: The measured Minimum luminance of all measurement position.



Note 7: Definition of Luminance:
 Measured the luminance of white state at center point

6. LCD Module Design and Handling Precautions

- Please ensure V0, VCOM is adjustable, to enable LCD module get the best contrast ratio under different temperatures, view angles and positions.
- Normally display quality should be judged under the best contrast ratio within viewable area. Unexpected display pattern may come out under abnormal contrast ratio.
- Never operate the LCD module exceed the absolute maximum ratings.
- Never apply signal to the LCD module without power supply.
- Keep signal line as short as possible to reduce external noise interference.
- IC chip (e.g. TAB or COG) is sensitive to light. Strong light might cause malfunction. Light sealing structure casing is recommended.
- Make sure there is enough space (with cushion) between case and LCD panel, to prevent external force passed on to the panel; otherwise that may cause damage to the LCD and degrade its display result.
- Avoid showing a display pattern on screen for a long time (continuous ON segment).
- LCD module reliability may be reduced by temperature shock.
- When storing and operating LCD module, avoids exposure to direct sunlight, high humidity, high or low temperature. They may damage or degrade the LCD module.
- Never leave LCD module in extreme condition (max./min storage/operate temperature) for more than 48hr.
- Recommend LCD module storage conditions is 0 C~40 C <80%RH.
- LCD module should be stored in the room without acid, alkali and harmful gas.
- Avoid dropping & violent shocking during transportation, and no excessive pressure press, moisture and sunlight.
- LCD module can be easily damaged by static electricity. Please maintain an optimum anti-static working environment to protect the LCD module. (eg. ground the soldering irons properly)
- Be sure to ground the body when handling LCD module.
- Only hold LCD module by its sides. Never hold LCD module by applying force on the heat seal or TAB.
- When soldering, control the temperature and duration avoid damaging the backlight guide or diffuser which might degrade the display result such as uneven display.
- Never let LCD module contact with corrosive liquids, which might cause damage to the backlight guide or the electric circuit of LCD module.
- Only clean LCD with a soft dry cloth, Isopropyl Alcohol or Ethyl Alcohol. Other solvents (e.g. water) may damage the LCD.
- Never add force to components of LCD module. It may cause invisible damage or degrade the module's reliability.
- When mounting LCD module, please make sure it is free

6. 液晶显示模块设计和使用须知

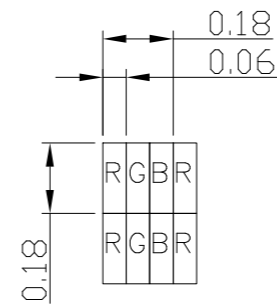
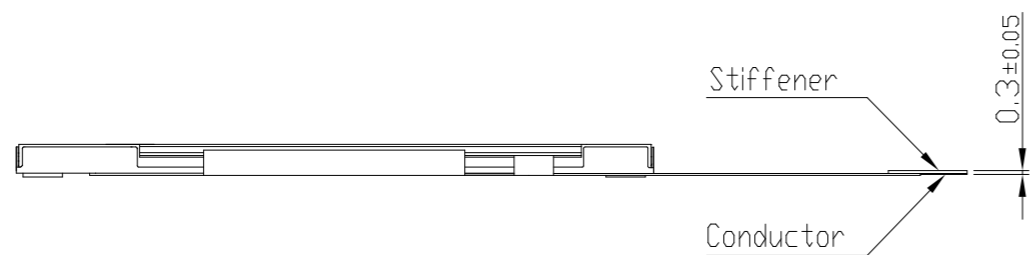
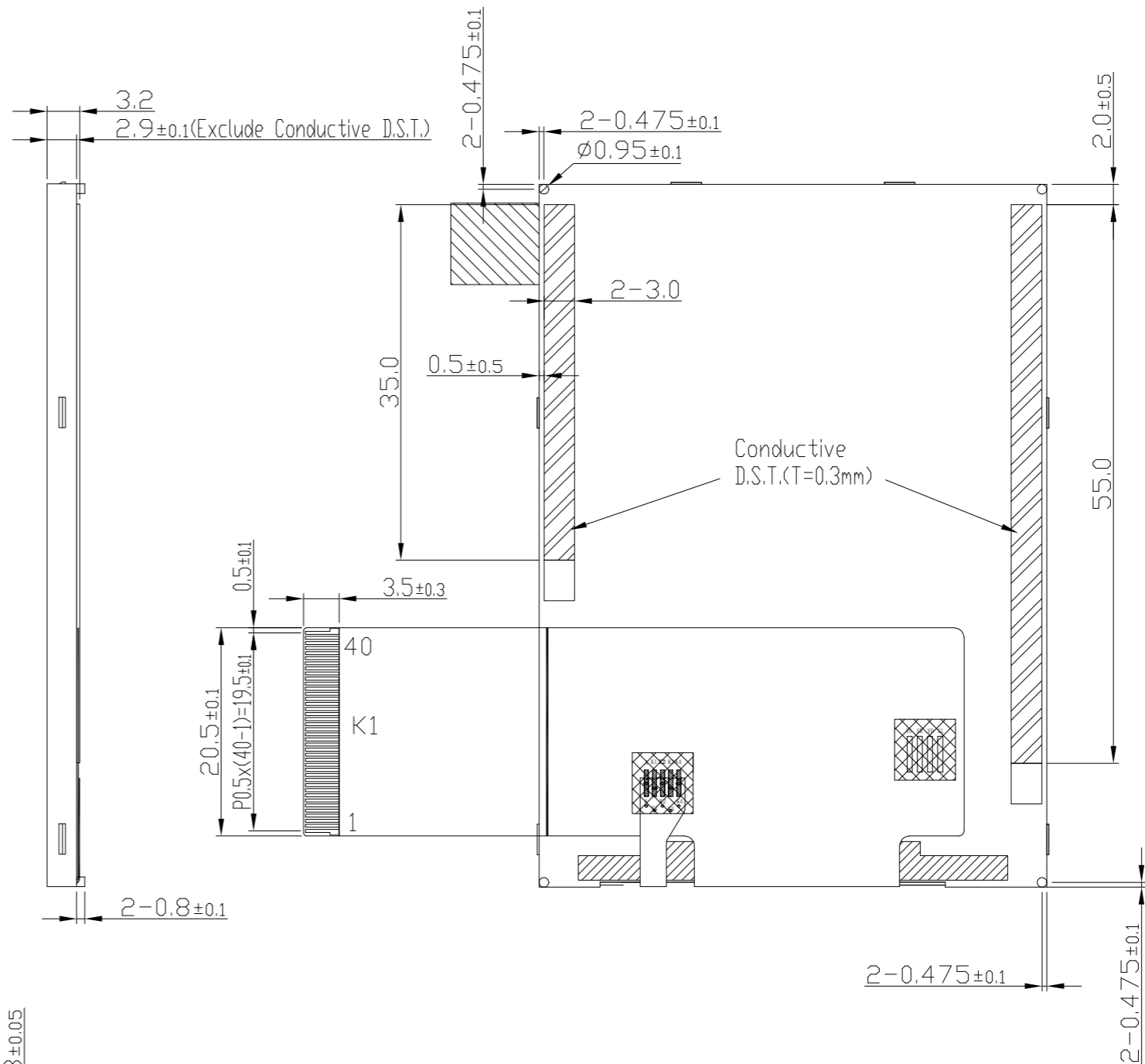
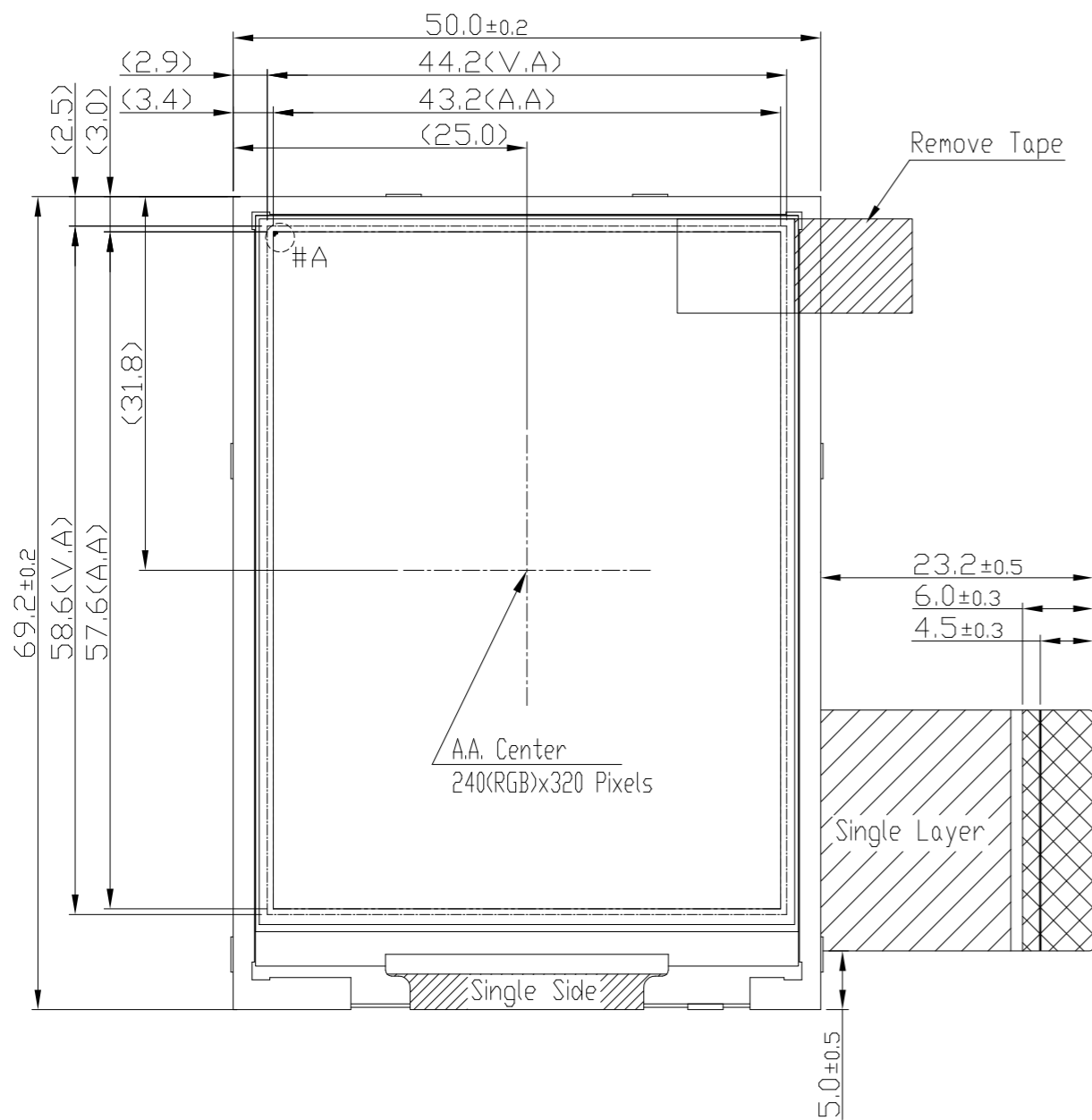
- 请注意 V0, VCOM 的设定, 以确保液晶显示模块在不同的使用温度下以及在不同的视角和位置观察模块显示, 均能达到最佳对比度, 请务必将应用电路上设置为对比度可调。
- 请注意液晶显示模块的显示品质判定是指在正常对比度下以及视窗 (V. A) 范围内进行的, 非正常对比度下液晶可能会出现非预期的显示不良, 应注意区分。
- 请勿在最大额定值以外使用液晶显示模块。
- 请勿在没有接通电源的条件下, 给液晶显示模块输送信号。
- 请尽可能缩短信号线的连接, 以避免对液晶显示模块的信号干扰。
- 集成电路因 IC 芯片 (如 TAB 或 COG) 对紫外线极为敏感, 强光环境下可能会引起液晶显示模块功能失效, 故应采用不透光的外壳。
- 请在液晶显示模块与外壳之间保留足够的空间 (可使用衬垫), 以缓冲外力对液晶显示模块的损坏或因受力不均而产生的显示不匀等异常现象。
- 避免液晶显示屏在某一画面下长时间点亮, 否则有出现残影的风险; 请通过软件每隔一段时间改变一次画面。
- 液晶显示模块的可靠性可能因温度冲击而降低。
- 请勿在阳光直射、高湿、高温或低温下储存和使用液晶显示模块, 这将造成液晶显示模块的损坏或失效。
- 请勿在极限环境 (最大/最小存储/工作温度) 下使用或放置液晶显示模块超过 48 小时以上。
- 液晶显示模块建议存储条件为: 0 C~40 C <80%RH。
- 请勿让液晶显示模块存储于带有 酸性, 碱性, 有害气体环境之中。
- 在运输过程中, 请勿让液晶显示模块跌落与猛烈震动, 同时避免异常挤压, 高湿度, 与阳光照射。
- 液晶显示模块极易受静电损坏, 请务必保证液晶显示模块在防静电的工作环境中使用或保存。(如: 烙铁正确接地, 等)
- 拿取液晶显示模块时需注意操作人员的接地情况。
- 请手持液晶显示模块的边沿取放模块, 防止热压纸或 TAB 部位受力。
- 焊接液晶模块时, 请注意控制烙铁的温度、焊接时间, 以免烫坏导光板或偏光片, 导致显示不匀等不良现象发生。
- 请勿使用洗板水等腐蚀性液体接触液晶模块, 以免腐蚀导光板或模块电路。
- 仅可使用柔软的干布, 异丙醇或乙醇清洁液晶屏表面, 其他任何溶剂 (如: 水) 都有可能损坏液晶模块。
- 请勿挤压液晶显示模块上的元器件, 以避免产生潜在的损坏或失效而影响产品可靠性。
- 装配液晶显示模块时, 请务必注意避免液晶显示模块的

- from twisting, warping and bending.
 - Do not add excessive force on surface of LCD, which may cause the display color change abnormally.
 - LCD panel is made with glass. Any mechanical shock (e.g. dropping from high place) will damage the LCD module.
 - Protective film is attached on LCD screen. Be careful when peeling off this protective film, since static electricity may be generated.
 - Polarizer on LCD gets scratched easily. If possible, do not remove LCD protective film until the last step of installation.
 - When peeling off protective film from LCD, static charge may cause abnormal display pattern. The symptom is normal, and it will turn back to normal in a short while.
 - LCD panel has sharp edges, please handle with care.
 - Never attempt to disassemble or rework LCD module.
 - If display panel is damaged and liquid crystal substance leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes promptly wash it off using soap and water.
- 扭曲或变形。
 - 请勿挤压液晶显示屏表面，这将导致显示颜色的异常。
 - 液晶屏由玻璃制作而成，任何机械碰撞（如从高处跌落）均有可能损坏液晶显示模块。
 - 液晶屏表面带有保护膜，揭除保护膜时需要注意可能产生的静电。
 - 因液晶显示屏表面的偏光片极易划伤，安装完成之前请尽量不要揭下保护膜。
 - 请缓慢揭除保护膜，在此过程中液晶显示屏上可能会产生静电，此为正常情况，可在短时间内消失。
 - 请注意避免被液晶显示屏的边缘割伤。
 - 请不要试图拆卸或改造液晶显示模块。
 - 当液晶显示屏出现破裂，内部液晶液体可能流出；相关液体不可吞吃，绝对不可接触嘴巴，如接触到皮肤或衣服，请使用肥皂与清水彻底清洗。

Warranty

This product has been manufactured to our company's specifications as a part for use in your company's general electronic products. It is guaranteed to perform according to delivery specifications. For any other use apart from general electronic equipment, we cannot take responsibility if the product is used in medical devices, nuclear power control equipment, aerospace equipment, fire and security systems, or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required. If the product is to be used in any of the above applications, we will need to enter into a separate product liability agreement.

- We cannot accept responsibility for any defect, which may arise from additional manufacturing of the product (including disassembly and reassembly), after product delivery.
- We cannot accept responsibility for any defect, which may arise after the application of strong external force to the product.
- We cannot accept responsibility for any defect, which may arise due to the application of static electricity after the product has passed our company's acceptance inspection procedures.
- When the product is in CCFL models, CCFL service life and brightness will vary according to the performance of the inverter used, leaks, etc. We cannot accept responsibility for product performance, reliability, or defect, which may arise.
- We cannot accept responsibility for intellectual property of a third part, which may arise through the application of our product to our assembly with exception to those issues relating directly to the structure or method of manufacturing of our product.



#A Details
Scale=50/1

K1 Terminal No.	Pin Name
1	LEDA
2	LEDK1
3	LEDK2
4	LEDK3
5	LEDK4
6	GND
7	VCC
8	IDVCC
9	IM123
10	IM0
11	/RESET
12	/CS
13	D/C(/SCL)
14	/WR(D/C)
15	/RD
16	SDA
17	SDI
18	DB0
19	DB1
20	DB2
21	DB3
22	DB4
23	DB5
24	DB6
25	DB7
26	DB8
27	DB9
28	DB10
29	DB11
30	DB12
31	DB13
32	DB14
33	DB15
34	F MARK
35	GND
36	NC/VPP
37	NC(YU)
38	NC(XR)
39	NC(YD)
40	NC(XL)

Note:

- *1. LCD Display Type : TFT,Transmissive (Full View)
- *2. Pixel Arrangement : RGB-STRIPE
- *3. Signal Interface : MCU (8/16bit)/SPI
- *4. Color Depth : 262k Colors
- *5. Operating Voltage : 3.3V(typ)
- *6. Logic Voltage : 3.3V(typ)
- *7. Backlight : White LEDs
- *8. Backlight Supply : 4x20mA (VF=3.2V, TYP)
- *9. Matched Connector :
K1 FH19SC-40S-0.5SH(HIROS) Or Equivalent
- *10. Operating Temperature : -30°C~85°C Δ
- *11. Storage Temperature : -30°C~85°C Δ

B		
A	Update Top & Tst	2024-03-06 Tao qingwen
Rev	Note	Date
Dwg	Title	LMT028FNHFWA Outline Dwg
Dwg No.	MK-008240a-1-1	Date 2023-11-14
Scale	3/2	Tol. ±0.3
Unit	mm	Paper Size A3
Approved	Checked	Drawn Tao qingWen

