



深圳市拓普微科技开发有限公司

SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LMT028ENHFWA

LCD Module User Manual

Prepared by: Li KeKe Date: 2021-07-07	Checked by: Date:	Approved by: Date:
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Rev.	Descriptions	Release Date
0.1	Preliminary New release	2020-01-11
0.2	Update LED Backlight Circuit Characteristics	2021-07-07

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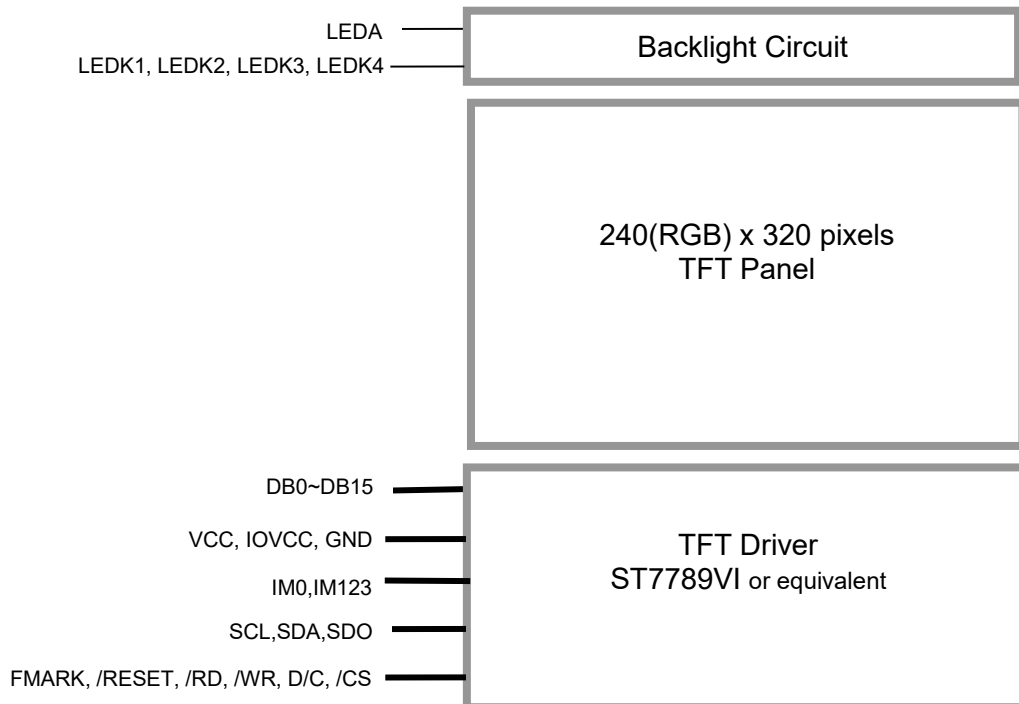
1. Basic Specifications

Screen Size(Diagonal) :	2.8"
Color Depth:	65k colors
Number of dots :	240 (RGB) x 320
Active Area :	43.2x57.6 mm
Dot Pitch :	0.18x0.18 mm
Display Technology :	a-Si TFT active matrix
Display Mode :	Transmissive with Normally black
Pixel Configuration :	RGB Stripe
Viewing Direction :	Full View
Backlight Type:	LEDs
Outline Dimension :	48.4 x 69.2 x 2.5 mm (exclude FPC) (see dwg for details)
Operating Temperature :	-20 ~ +70°C (No Condensation)
Storage Temperature :	-30 ~ +80°C (No Condensation)

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	<table border="1"> <thead> <tr> <th>IM123</th> <th>IM0</th> <th>MPU Interface Mode</th> <th>Data pin</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>80-8bit parallel I/F</td> <td>DB[7:0]</td> </tr> <tr> <td>0</td> <td>1</td> <td>80-16bit parallel I/F</td> <td>DB[15:0]</td> </tr> <tr> <td>1</td> <td>0</td> <td>4-line 8bit serial I/F II</td> <td>SDA:in SDO: out</td> </tr> </tbody> </table>			IM123	IM0	MPU Interface Mode	Data pin	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
IM123	IM0					MPU Interface Mode	Data pin														
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																		
10	IM0																				
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	ould 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}	-20	+70	°C	No Condensation
Storage Temperature	T _{ST}	-30	+80	°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

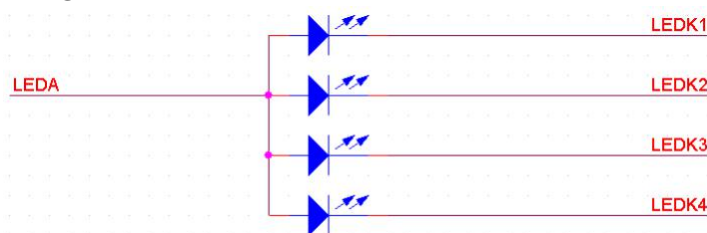
Items	Symbol	MIN.	TYP.	MAX.	Unit	Application Pin
Logic Supply Voltage	IOVCC	3.2	3.3	3.6	V	VCC,IOVCC
Input High Voltage	V _{IH}	0.7 IOVCC	-	IOVCC	V	SDA,/RD,/WR, D/C,/CS,/SCL, IM123,IM0, /RESET, DB0~DB15
Input Low Voltage	V _{IL}	-	-	1.0	V	
Output High Voltage	V _{OH}	0.8 IOVCC	-	IOVCC	V	DB0~DB15, SDO,FMARK,
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	2.8	3.0	3.2	V	For each LED
Forward Current	I _f	-	20	-	mA	For each LED
Operating Life Time	-	-	30,000	-	Hrs	For each LED

Note1:LED CIRCUIT DIAGRAM



No. of LEDs = 4pcs

Note 2:LED: V_F =3.0V, I_F =20mA(TYP)

Note 3:IF 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.

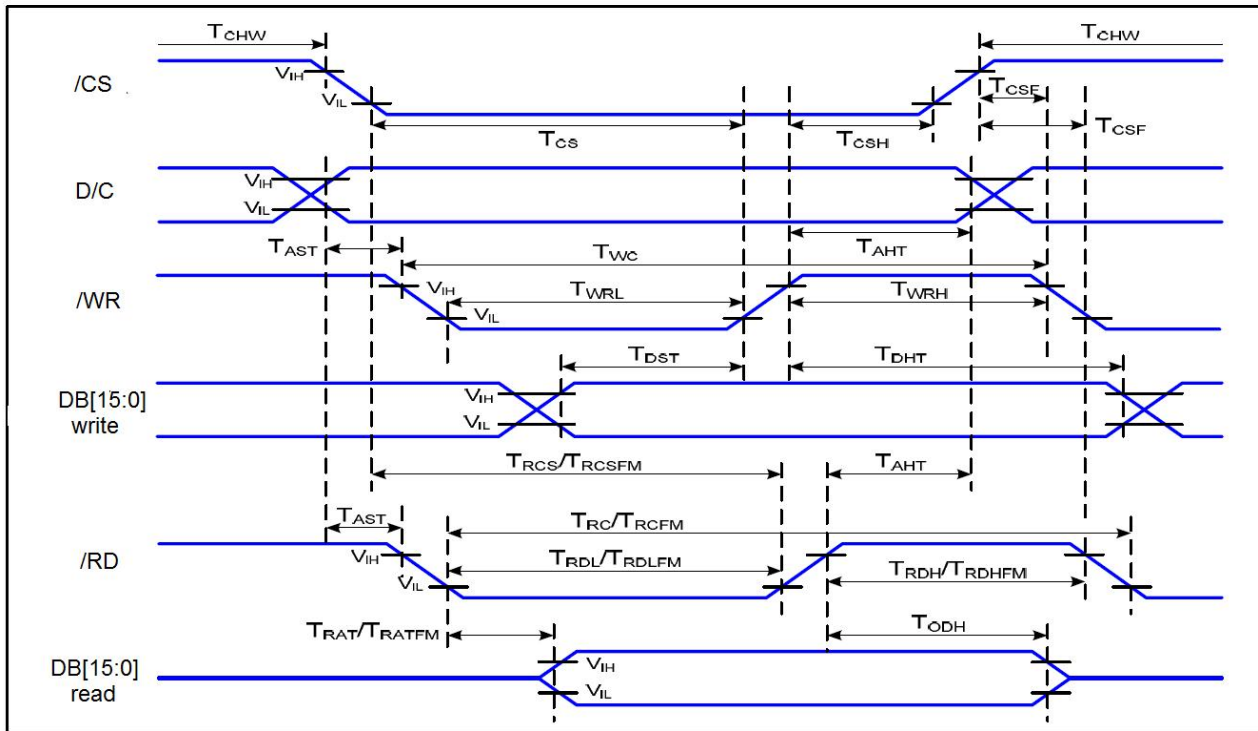
The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness.

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.

3.3 AC Characteristics

8080 Mode System Bus Timing



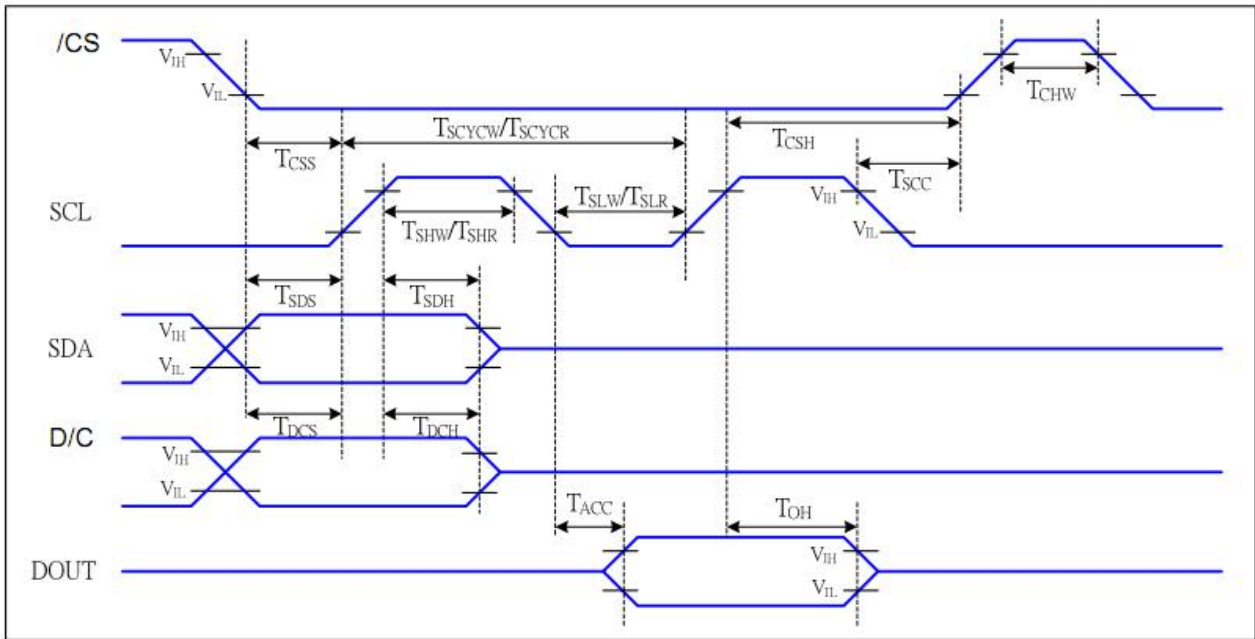
VCC=3.3V, GND=0V, T_{OP}=25°C

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

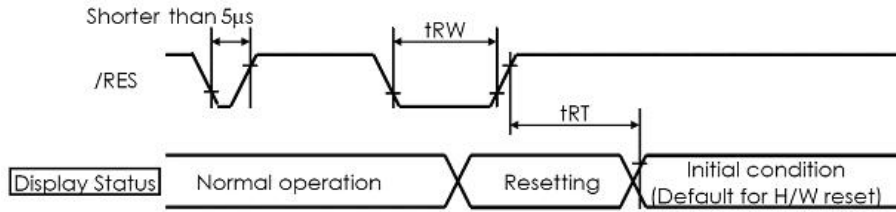


VCC=3.3,GND=0V, TOP=25°C

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_{SCYW}	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_{SCYR}	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 (T_r , T_f) 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	-	-	us
Reset time	T_{RT}	-	-	170	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	GCD		-
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		on
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		0 ≤ 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		0 ≤ 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]		
	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 start/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)
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	W/RX	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 enhancement
	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	↑	-	-	-	-	-	-	-	-	-		Dummy read
	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 S/W or H/W Reset are applied.
2. Please refer to ST7789V1 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°	230	280	-	cd/m ²	Note 7

1. I_{LEDA} = 80mA, and the ambient temperature is 25°C.

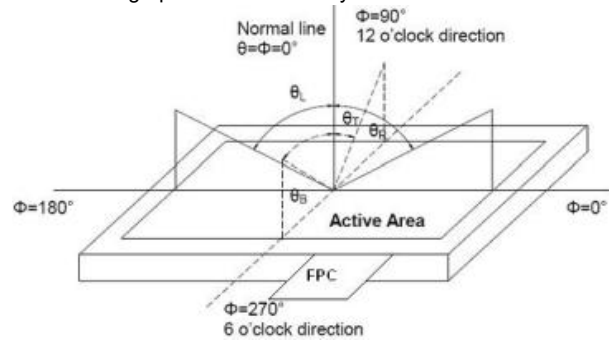
2. The test systems refer to Note 1 and Note 2.

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

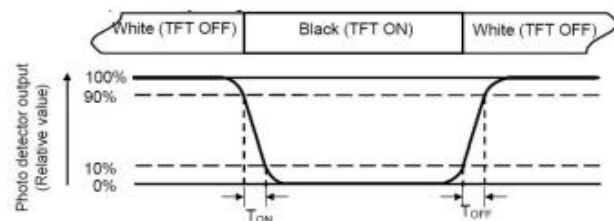


Note 3: Definition of contrast ratio
 The definition of contrast ratio (Test LCM using SR-3A (1°)):

$$\text{Contrast Ratio (CR)} = \frac{\text{Luminance When LCD is at "White" state}}{\text{Luminance When LCD is at "Black" state}}$$

 (Contrast Ratio is measured in optimum common electrode voltage)

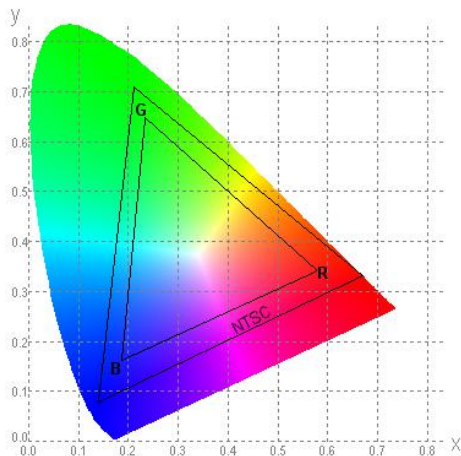
Note 4: Definition of Response time
 Definition of Response time.
 The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (TON) is the time between photo detector output intensity changed from 90% to 10%. And fall time (TOFF) is the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



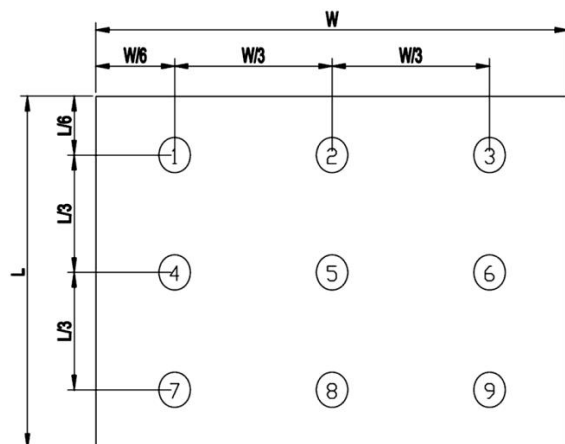
Note 5: Definition of color chromaticity (CIE1931)
 Definition of Color of CIE1931 Coordinate and NTSC Ratio.

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.
 Luminance Uniformity (U) = Lmin/ 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. Precautions for Use of LCD Modules

6.1 Handling Precautions

6.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc

6.1.2 If the display panel is damaged and the liquid crystal substance inside it 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.

6.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

6.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

6.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Ketone
- Water
- Aromatic solvents

6.1.6 Do not attempt to disassemble the LCD Module.

6.1.7 If the logic circuit power is off, do not apply the input signals.

6.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

6.1.8.1 Be sure to ground the body when handling the LCD Modules.

6.1.8.2 Tools required for assembly, such as soldering irons, must be properly ground.

6.1.8.3 To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

6.1.8.4 The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

6.2 Storage precautions

6.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

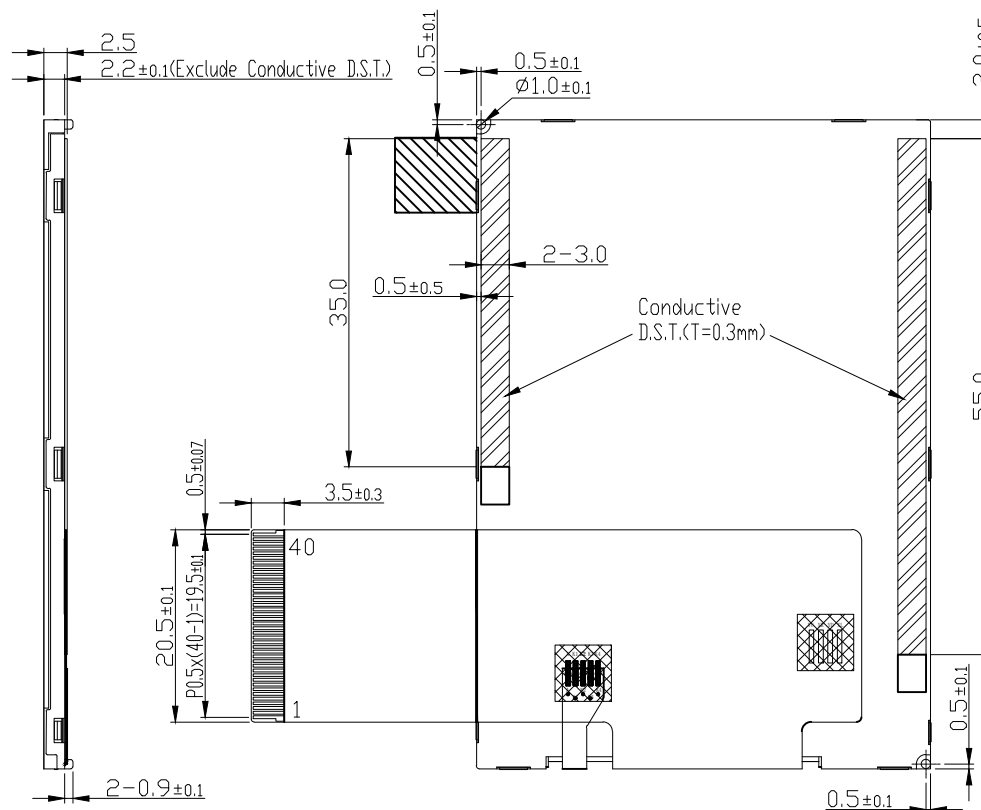
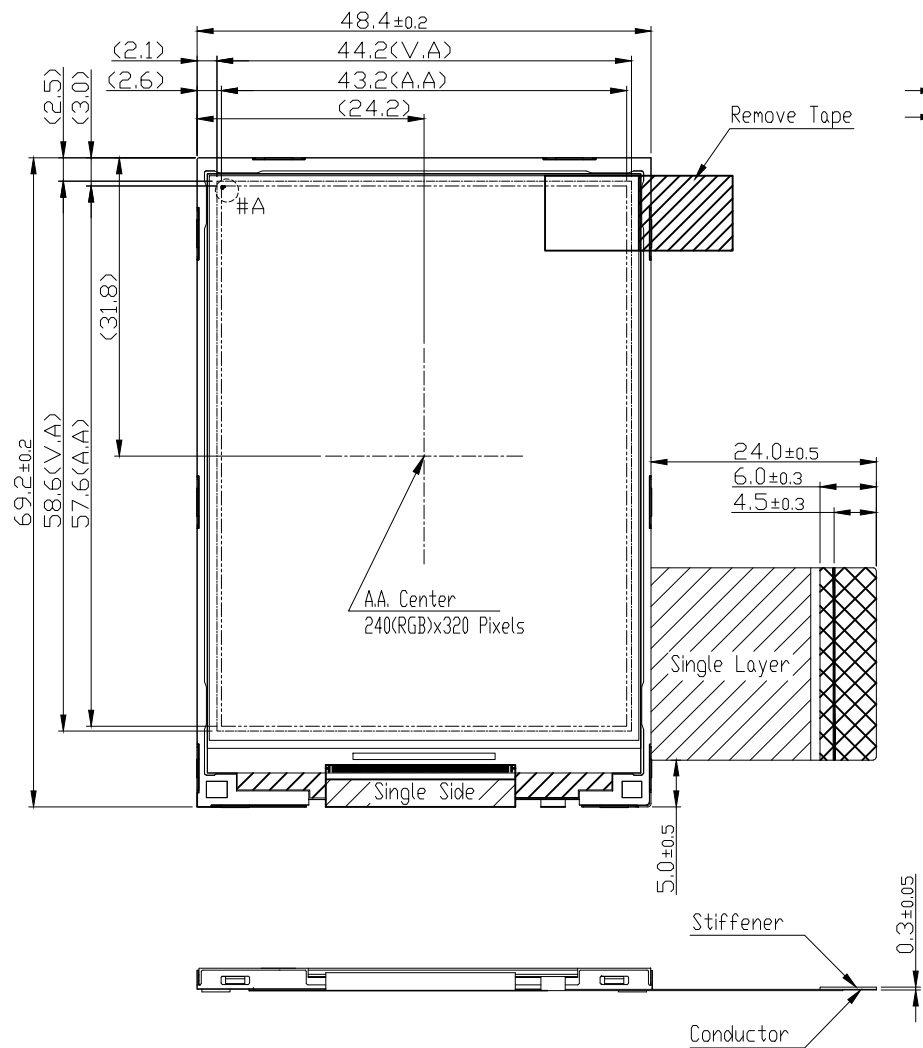
6.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : 0°C~40°C Relatively humidity: ≤80%

6.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

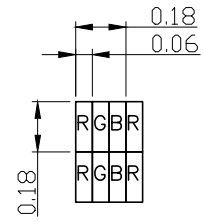
6.3 Transportation Precautions

6.3.1 The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.



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	SDO
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	FMARK
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 : 65k Colors
 - *5. Operating Voltage : 3.3V
 - *6. Logic Voltage : 3.3V
 - *7. Backlight : White LEDs
 - *8. Backlight Supply : 4x20mA (VF=3.0V, TYP)
 - *9. Recommended Connector : FH19SC-40S-0.5SH(HIRDS) Or Equivalent
 - *10. Operating Temperature : -20°C~70°C
 - *11. Storage Temperature : -30°C~80°C



#A Details
Scale=50/1

B		
A	Typing Correction	Luo Lin 2020-01-11
Rev Note		Date
Dwg Title	LMT028ENHFWA Outline Dwg	
Dwg No.	MK-006769a-1-1	Date 2019-11-15
Scale	3/2	Tol. ±0.3
Unit	mm	Paper Size A3
Approved	Checked	Drawn Luo Lin