▼ TIANMA

MODEL NO　:   **TM028HDHG59**

MODEL VERSION: **01**

SPEC VERSION :   **Ver 1.0**

ISSUED DATE: **2016-07-27**

■**Preliminary Specification**
□**Final Product Specification**

Customer :

Approved by	Notes

TIANMA Confirmed :

Prepared by	Checked by	Approved by

This technical specification is subjected to change without notice

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Record of Revision

Rev	Issued Date	Description	Editor
1.0	2016-07-27	Preliminary Specification Release	Xunqiang Ji

1 General Specifications

Feature		Spec
Display Spec.	Size	2.8 inch
	Resolution	240(RGB)×320
	Technology Type	a-Si
	Pixel Configuration	R.G.B. Vertical Stripe
	Pixel pitch(mm)	0.18X0.18
	Display Mode	Transmissive
	Surface Treatment	AG
	Viewing Direction	6 o'clock
	Gray Scale Inversion Direction	12 o'clock
Mechanical Characteristics	LCM (W x H x D) (mm)	49.9 x 66.1 x 2.7
	Active Area(mm)	43.20×57.60
	With /Without TSP	Without TSP
	Matching Connection Type	ZIF
	LED Numbers	4-Parallel white LED
	Weight (g)	TBD
Electrical Characteristics	Interface	RGB interface / 3-wire SPI
	Color Depth	65K/262K
	Driver IC	ST7789VI

Note 1: Viewing direction for best image quality is different from TFT definition. There is a 180 degree shift.

Note 2: Requirements on Environmental Protection: Q/S0002

Note 3: LCM weight tolerance: ± 5%

2   Input/Output Terminals

Pin No.	Symbol	I/O	Function	Remark
1	NC	-	No connect	
2	NC	-	No connect	
3	NC	-	No connect	
4	NC	-	No connect	
5	GND	P	Power Ground	
6	NC	-	No connect	
7	NC	-	No connect	
8	VDD	P	Power	
9	R5	I	Red data input (MSB)	
10	R4	I	Red data input	
11	R3	I	Red data input	
12	R2	I	Red data input	
13	R1	I	Red data input	
14	R0	I	Red data input (LSB)	
15	G5	I	Green data input (MSB)	
16	G4	I	Green data input	
17	G3	I	Green data input	
18	G2	I	Green data input	
19	G1	I	Green data input	
20	G0	I	Green data input (LSB)	
21	B5	I	Blue data input (MSB)	
22	B4	I	Blue data input	
23	B3	I	Blue data input	
24	B2	I	Blue data input	
25	B1	I	Blue data input	
26	B0	I	Blue data input(LSB)	
27	SDI	I	Serial data input pin and output pin(SDA) in serial bus system interface I. Serial data input pin (SDI) in serial bus system interface II. The data is inputted on the rising edge of the SCL signal. If not used, please let it open or connected to VSSD.	

28	DCLK	I	Dot clock signal for RGB interface operation. Fix to VCC or VSS level when not in use.	
29	GND	P	Ground	
30	DE	I	Data enable signal for RGB interface operation. *Fix to VCC or VSS level when not in use.*	
31	HS	I	Line synchronizing signal for RGB interface operation. Fix to VCC or VSS level when not in use.	
32	VS	I	Frame synchronizing signal for RGB interface operation. Fix to VCC or VSS level when not in use.	
33	SCL	I	Input data effective signal(It is effective for the period of "H")	
34	CS	I	Chip select signal. Low: chip can be accessed; High: chip cannot be accessed. Must be connected to VSSD if not in use	
35	RESET	I	Reset pin	
36	NC	-	No connect	
37	NC	-	No connect	
38	LEDK	P	Backlight cathode	
39	LEDA	P	Backlight anode	

3 Absolute Maximum Ratings

GND=0V

Item	Symbol	MIN	MAX	Unit	Remark
Power Supply Voltage	VDD	-0.3	3.3	V	Note1
Logic Supply Voltage	VCCIO	-0.3	3.3	V	
Logic Input voltage	I/O PINs	-0.3	VCCIO+0.3	V	
Operating Temperature	Top	-20	70	℃	
Storage Temperature	Tst	-30	80	℃	
Relative Humidity Note2	RH	--	≤95	%	Ta≤40℃
		--	≤85	%	40℃＜Ta≤50℃
		--	≤55	%	50℃＜Ta≤60℃
		--	≤36	%	60℃＜Ta≤70℃
		--	≤24	%	70℃＜Ta≤80℃
Absolute Humidity	AH	--	≤70	g/m³	Ta＞70℃

Table 3 Absolute Maximum Ratings

Note1: Input voltage include R0~R5, G0~G5, B0~B5, Dotclk, Hsync, Vsync, Enable, R/L, U/D.

4 Electrical Characteristics

4.1 LCD module

GND=0V,Ta=25℃

Item		Symbol	MIN	TYP	MAX	Unit	Remark
Supply voltage for logic		VDD	2.4	2.8	3.3	V	
Input Signal Voltage	High Level	VIH	0.7*IOVCC	-	IOVCC	V	
	Low Level	VIL	0	-	0.3*IOVCC	V	
Output Voltage	High Level	VOH	0.8VDD	-	VDD		
	Low Level	VOL	Vss	-	0.2VDD		
Current Consumption		ICC1	-	6	9	mA	
		ICC2	-	TBD	-	mA	

Table 4.1 LCD module electrical characteristics

4.2 Backlight Unit

Ta=25℃

Item	Symbol	Min	Typ	Max	Unit	Remark
Forward Current	I_F	-	20	-	mA	For each LED
Forward Voltage	V_F	2.9	3.2	3.4	V	For each LED
Backlight Power Consumption	W_{BL}	-	256	-	mW	4 LEDs
Operating Life Time	-	-	30,000	-	Hrs	For each LED

Note1: Figure below shows the connection of backlight LED.

Vf=3.0~3.4v   If=80ma
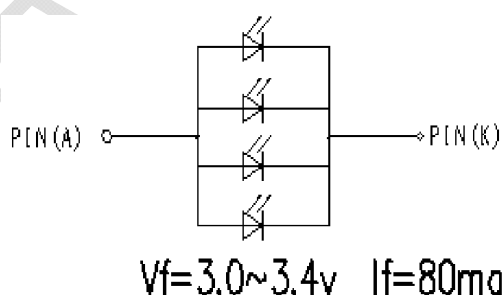
Note 2: 1LED: V_F =3.2V I_F =20mA

Note 3: I_F is defined for one LED.

Optical performance should be evaluated at Ta=25℃ 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.
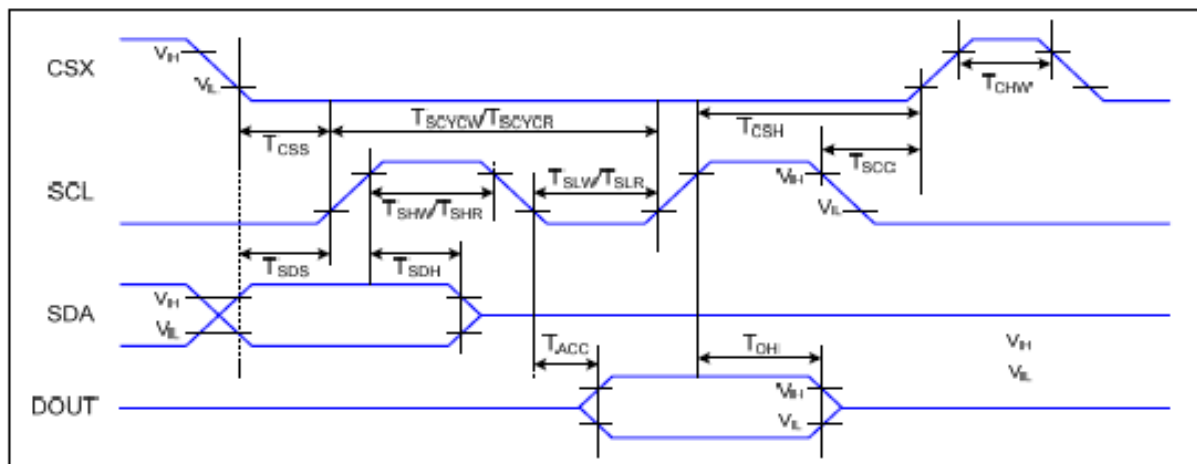
5 Timing Chart

Figure 4 3-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	
	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	
	T_{SHR}	SCL "H" pulse width (Read)	60		ns	
	T_{SLR}	SCL "L" pulse width (Read)	60		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 5 3-line serial Interface Characteristics

INSTRUCTION DESCRIPTION

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:
	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]		
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		Write data
	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]		
	1	1	↑	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		Read data
	1	1	↑	Dn[17:8]	Dn[7]	Dn[6]	Dn[5]	Dn[4]	Dn[3]	Dn[2]	Dn[1]	Dn[0]		
	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
PTLAR	1	↑	1	-	PSL7	PSL6	PSL5	PSL4	PSL3	PSL2	PSL1	PSL0		address: (0, 1,2, ..P)
	1	↑	1	-	PEL15	PEL14	PEL13	PEL12	PEL11	PEL10	PEL9	PEL8		Partial end
	1	↑	1	-	PEL7	PEL6	PEL5	PEL4	PEL3	PEL2	PEL1	PEL0		address (0, 1,2, 3, , P)
	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		
VSCRDEF	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		-
	0	↑	1	-	0	0	1	1	0	1	1	1	(37h)	Vertical scrolling start address
VSCRSADD	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]		
	1	↑	1	Dx[17:8]	Dx[7]	Dx[6]	Dx[5]	Dx[4]	Dx[3]	Dx[2]	Dx[1]	Dx[0]		Write data
	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

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

Table 19 System Function Command List

6 Optical Characteristics

Item		Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angles		θT	CR≧10	60	70	-	Degree	Note2
		θB		50	60	-		
		θL		60	70	-		
		θR		60	70	-		
Contrast Ratio		CR	θ=0°	400	500	-		Note 3
Response Time		T_{ON}	25℃	-	20	30	ms	Note 4
		T_{OFF}						
Chromaticity	**White**	x	Backlight is on	0.2297	0.2797	0.3297		Note 1,5
		y		0.2553	0.3053	0.3553		
	Red	x		0.5754	0.6254	0.6754		Note 1,5
		y		0.2846	0.3346	0.3846		
	Green	x		0.2698	0.3198	0.3698		Note 1,5
		y		0.5795	0.6295	0.6795		
	Blue	x		0.0948	0.1448	0.1948		Note 1,5
		y		0.0131	0.0631	0.1131		
Uniformity		U		75	80	-	%	Note 6
NTSC				60	65	-	%	Note 5
Luminance		L		250	300	-	cd/m^2	Note 7

Test Conditions:

1. I_F= 20 mA(one LED), and the ambient temperature is 25℃.

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.

Photo detector

Field

TFT-LCD Module

LCD Panel

500mm

The center of the screen
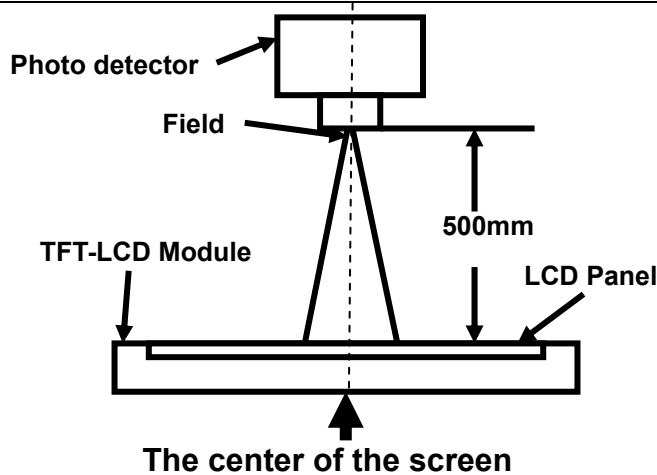
Note 2: Definition of viewing angle range and measurement system.

viewing angle is measured at the center point of the LCD

Normal line
$\theta = \Phi = 0°$

$\Phi = 90°$
12 o'clock direction

θ_L

θ_T

θ_R

θ_B

$\Phi = 180°$

$\Phi = 0°$

Active Area

FPC

$\Phi = 270°$
6 o'clock direction
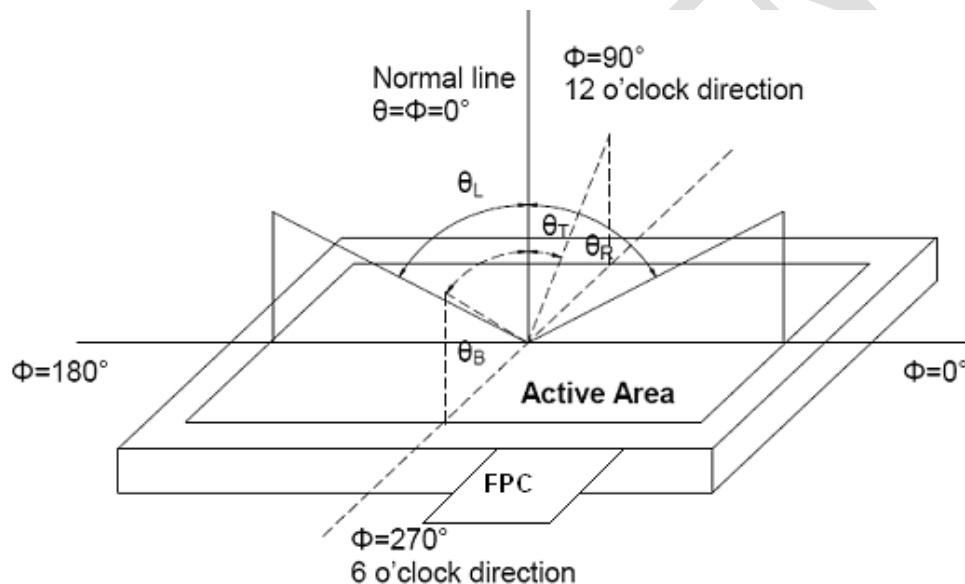
Note 3: Definition of contrast ratio

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

"White state ": The state is that the LCD should drive by Vwhite.

"Black state": The state is that the LCD should drive by Vblack.

Vwhite: To be determined   Vblack: To be determined.

Note 4: Definition of Response time

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (T_{ON}) is the time between photo detector output intensity changed from 90% to 10%. And fall time (T_{OFF}) is the time between photo detector output intensity changed from 10% to 90%.
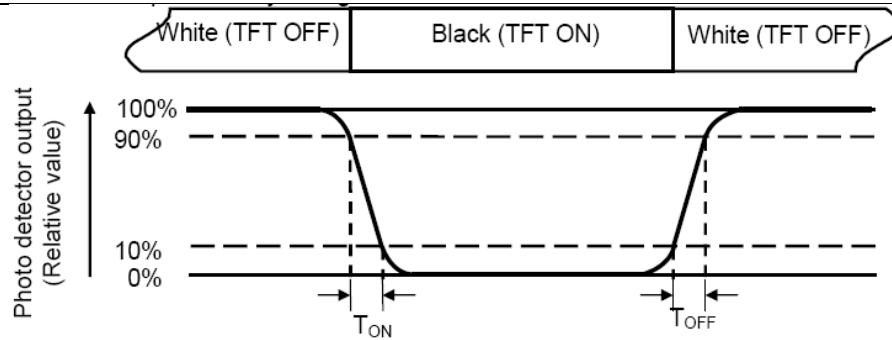
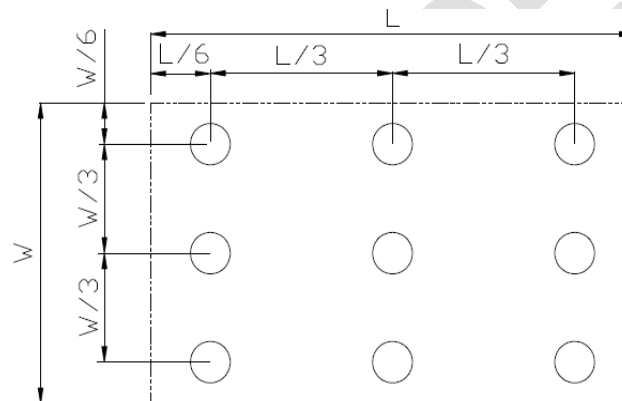Note 5: Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

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: Measure the luminance of white state at center point.

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7 Environmental / Reliability Test

| No	Test Item	Condition	Remarks
1	High Temperature Operation	Ts=+70℃±2℃, 96hrs	IEC60068-2-1:2007 GB2423.2-2008
2	Low Temperature Operation	Ta=-20℃±2℃, 96hrs	IEC60068-2-1:2007 GB2423.1-2008
3	High Temperature Storage	Ta=+80℃±2℃, 96hrs	IEC60068-2-1:2007 GB2423.2-2008
4	Low Temperature Storage	Ta=-30℃±2℃, 96hrs	IEC60068-2-1:2007 GB2423.1-2008
5	Storage at High Temperature and Humidity	Ta=+60℃, 90% RH, 96hrs	IEC60068-2-78 :2001 GB/T2423.3—2006
6	Thermal Shock (non-operation)	–30℃⟷25℃⟷80℃ 30min 5min 30min after 10cycle, Restore 2H at 25℃ Power off	Start with cold temperature, End with high temperature, IEC60068-2-14:1984,GB2423.22-2002
7	Electro Static Discharge (operation)	Contact ±4KV，150PF/330，12times Air ±6KV,150PF/330，12times	IEC61000-4-2:2001 GB/T17626.2-2006
8	Vibration Test	10Hz~150Hz, 100m/s^2, 120min	IEC60068-2-6:1982 GB/T2423.10—1995
9	Mechanical Shock (Non OP)	Half-sine wave,300m/s^2, 11ms	IEC60068-2-27:1987 GB/T2423.5—1995
10	Package Drop Test	800mm, concrete floor,1corner, 3edges, 6 sides each time	IEC60068-2-32:1990 GB/T2423.8—1995

Note1: Ts is the temperature of panel's surface.

Note2: Ta is the ambient temperature of sample.

Note3: Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

Note 4: In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product only guarantees operation, but don't guarantee all of the cosmetic specification.

8 Mechanical Drawing
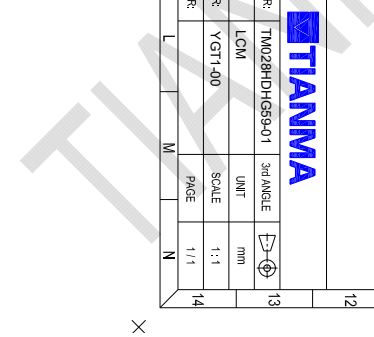
9 Packing Drawing

TBD

10 Precautions for Use of LCD Modules

10.1 Handling Precautions

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

10.1.2 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.

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

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

10.1.5 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:

－ Water

－ Ketone

－ Aromatic solvents

10.1.6   Do not attempt to disassemble the LCD Module.

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

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

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

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

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

10.1.8.4   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.

10.2   Storage precautions

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

10.2.2   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℃ ～ 40℃ Relatively humidity: ≤80%

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

10.3   Transportation Precautions

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