深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LMT032DNAFWD-NBA-2

LCD Module User Manual

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Date: 2016-05-11	Date:	Date:

Rev.	Descriptions	Release Date
0.1	Preliminary	2016-05-11

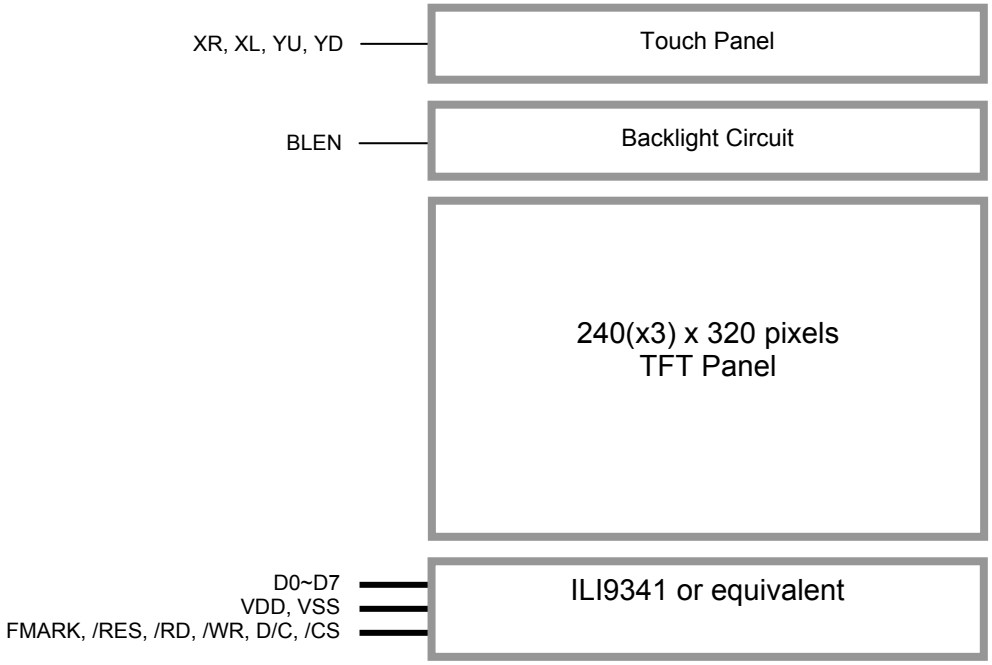
Table of Content

1. General Specification

Screen Size(Diagonal) :	3.2 inch
Resolution :	320(RGB) x 240
Signal Interface :	8-bit MCU Interface
Color Depth :	65k color(16bit)
Pixel Pitch :	0.2025 x 0.2025 (mm)
Pixel Configuration :	Horizontal RGB Stripe
Display Mode :	Transmissive / normal white
Surface Treatment :	Anti-Glare Type
Viewing Direction :	3H(*1)(gray scale inverse) 9H(*2)
Outline Dimension :	90.0 x 58.0 x 5.9 (mm) (see attached drawing for details)
Active Area :	64.8 x 48.6 (mm)
Backlight :	6 LEDs
Operating Temperature :	-20 ~ +70°C
Storage Temperature :	-30 ~ +80°C

Note:
*1. For saturated color display content (eg. pure-red, pure-green, pure-blue, or pure-colors-combinations)
*2. For “color scales” display content.
*3. Color tone may slightly change by Temperature and Driving Condition.

2. Block Diagram



3. Terminal Functions

3.1 Interface

Pin No.	Pin Name	I/O	Descriptions
1	VSS	P	Power Ground (0V)
2	VSS		
3	BLEN	I	BLEN=L, backlight Off BLEN=H, backlight On
4	VDD	P	Positive Power Supply
5	VDD		
6	/RD	I	/WR=H, /RD=L; Data or Status read form the LCD module
7	/WR	I	/WR=L→H, RD=H; Data or Instruction latch into the LCD module
8	D/C	I	Register Select D/C = H, Transferring the Display Data D/C = L, Transferring the Control Data
9	/CS	I	Chip Select /CS=L, enable access to the LCD interface /CS=H, disable access to the LCD interface
10	D0	I	Data Input
:	:	:	:
17	D7	I	Data Input
18	/RES	I	Reset signal /RES = L, Initialization is executed /RES = H, Normal running.
19	FMARK	O	Displaying Timing Frame Signal
20	NC	-	-

3.2 Touch Panel Terminal

Pin No.	Pin Name	I/O	Descriptions
1	YU	Passive	y-axis upper side
2	XL	Passive	x-axis left side
3	YD	Passive	y-axis down side
4	XR	Passive	x-axis right side

4. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	-0.3	+4.0	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.

5. Electrical Characteristics

5.1 DC Characteristics (MCU terminal)

VSS=0V, T_{OP} =25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Operating Voltage	VDD	2.7	3.0	3.3	V	VDD
Input High Voltage	V_{IH}	0.8VDD	-	VDD	V	/RD, /WR, D/C, /CS, D0~D7, /RES
Input Low Voltage	V_{IL}	VSS	-	0.2VDD	V	
Output Signal High Voltage	V_{OH}	0.7VDD	-	VDD	V	D0~D7
Output Signal Low Voltage	V_{OL}	0	-	0.3xVDD	V	
Input High Voltage	V_{IH}	0.8VDD	-	VDD	V	BLEN
Input Low Voltage	V_{IL}	0	-	0.3	V	
Operating Current	I_{DD}	-	190	-	mA	All black, Backlight ON (BLEN=H)
		-	9.5	-	mA	All black, Backlight OFF (BLEN=L)

5.2 Touch Panel Characteristics

T_{OP}=25°C

Items	MIN.	TYP.	MAX.	Unit	Note
Operating Voltage	-	-	5.0	V	XL, XR, YU, YD
Operating Pressure	20	-	100	g	XL, XR, YU, YD
Life time	-	1000000	-	times	XL, XR, YU, YD
Response Time	-	-	10	ms	XL, XR, YU, YD
Linearity	-	-	±1.5	%	XL, XR, YU, YD

6. AC Characteristics

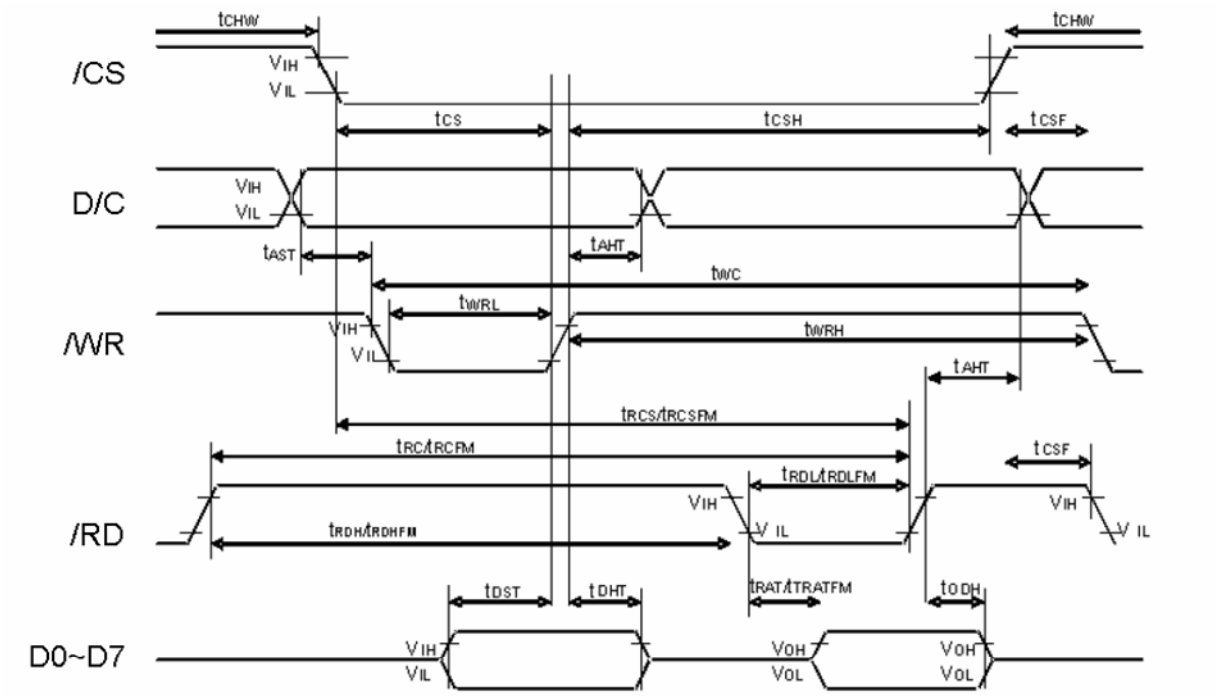
6.1 AC Timing

VDD=3.0V, T_{OP} =25°C

Signal	Symbol	Parameter	Spec.			Unit	Description
			Min.	Typ	Max.		
D/C	tAST	Address setup time	10	-	-	ns	
	tAHT	Address hole time(Write/Read)	10	-	-		
/CS	tCHW	Chip select “H” pulse width	10	-	-	ns	
	tCS	Chip select setup time(Write)	56	-	-		
	tRCSFM	Chip select setup time(Read FM)	440	-	-		
	tCSF	Chip select wait time(Write/Read)	12.5	-	-		
	tCSH	Chip select hold time	12.5	-	-		
/WR	tWC	Write cycle	82.5	-	-	ns	
	tWRH	Control pulse “H” duration	18.75	-	-		
	tWRL	Control pulse “L” duration	18.75	-	-		
/RD (FM)	tRCFM	Read cycle(FM)	560	-	-	ns	When read from frame memory
	tRDHFM	Control pulse “H” duration(FM)	112	-	-		
	tRDLFM	Control pulse “L” duration(FM)	440	-	-		
D[7:0]	tDST	Data setup time	12.5	-	-	ns	For maximum CL=30pF For minimum CL=8pF
	tDHT	Data hold time	8	-	-		
	tRATFM	Read access time(FM)	-	-	425		
	tODH	Output disable time	16	-	64		

Note:
*1. The input signal rise time and fall time(tr , tf)is specified at 15 ns or less
*2. Logic high and low levels are specified as 30% and 70% of VDD for input signals.
*3 .Refer to the ILI9341 datasheet for more details.

6.2 Register Write/Read timing (for CPU 8 Bit)

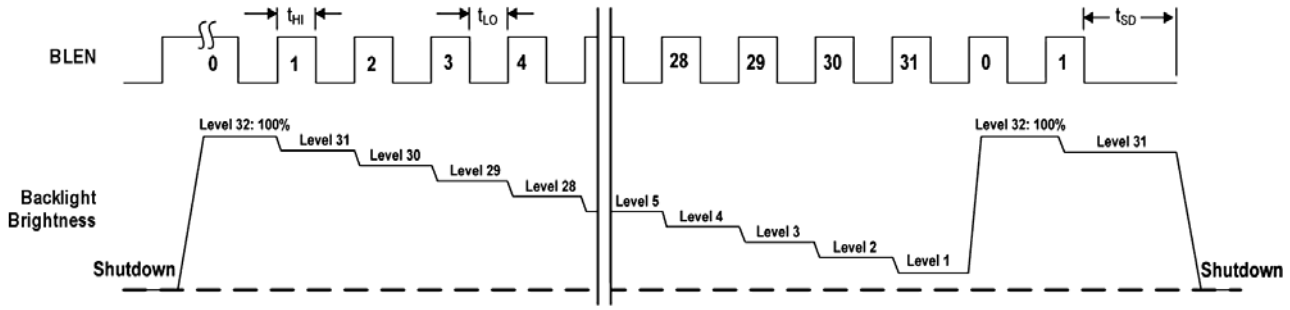


6.3 Backlight control Timing

VDD=3.0V, T_{OP} =25°C

Signal	Symbol	Parameter	Spec.			Unit	Description
			Min.	Typ	Max.		
BLEN	t_{HI}	Time Delay between Steps	2	-	-	us	
	t_{LO}	CTRL LOW Time for Dimming	1	-	250	us	
	t_{SD}	CTRL LOW ,shutdown Pulse Whidth	2	-	-	ms	

Register BLEN timing



7. Commands

Regulative Command Set													
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
No Operation	0	1	↑	XX	0	0	0	0	0	0	0	0	00h
Software Reset	0	1	↑	XX	0	0	0	0	0	0	0	1	01h
Read Display Identification Information	0	1	↑	XX	0	0	0	0	0	1	0	0	04h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	ID1 [7:0]								XX
	1	↑	1	XX	ID2 [7:0]								XX
	1	↑	1	XX	ID3 [7:0]								XX
Read Display Status	0	1	↑	XX	0	0	0	0	1	0	0	1	09h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [31:25]							0	00
	1	↑	1	XX	0	D [22:20]			D [19:16]				61
	1	↑	1	XX	D [15]	0	D [13]	0	0	D [10:8]			00
	1	↑	1	XX	D [7:5]			D [4:1]				0	00
Read Display Power Mode	0	1	↑	XX	0	0	0	0	1	0	1	0	0Ah
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	08
Read Display MADCTL	0	1	↑	XX	0	0	0	0	1	0	1	1	0Bh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Pixel Format	0	1	↑	XX	0	0	0	0	1	1	0	0	0Ch
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	DPI [2:0]			0	DBI [2:0]			06
Read Display Image Format	0	1	↑	XX	0	0	0	0	1	1	0	1	0Dh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	D [2:0]			00
Read Display Signal Mode	0	1	↑	XX	0	0	0	0	1	1	1	0	0Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:2]						0	0	00
Read Display Self-Diagnostic Result	0	1	↑	XX	0	0	0	0	1	1	1	1	0Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	D [7:6]		0	0	0	0	0	0	00
Enter Sleep Mode	0	1	↑	XX	0	0	0	1	0	0	0	0	10h
Sleep OUT	0	1	↑	XX	0	0	0	1	0	0	0	1	11h
Partial Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	0	12h
Normal Display Mode ON	0	1	↑	XX	0	0	0	1	0	0	1	1	13h
Display Inversion OFF	0	1	↑	XX	0	0	1	0	0	0	0	0	20h
Display Inversion ON	0	1	↑	XX	0	0	1	0	0	0	0	1	21h
Gamma Set	0	1	↑	XX	0	0	1	0	0	1	1	0	26h
	1	1	↑	XX	GC [7:0]								01
Display OFF	0	1	↑	XX	0	0	1	0	1	0	0	0	28h
Display ON	0	1	↑	XX	0	0	1	0	1	0	0	1	29h
Column Address Set	0	1	↑	XX	0	0	1	0	1	0	1	0	2Ah
	1	1	↑	XX	SC [15:8]								XX
	1	1	↑	XX	SC [7:0]								XX
	1	1	↑	XX	EC [15:8]								XX
	1	1	↑	XX	EC [7:0]								XX
Page Address Set	0	1	↑	XX	0	0	1	0	1	0	1	1	2Bh
	1	1	↑	XX	SP [15:8]								XX
	1	1	↑	XX	SP [7:0]								XX
	1	1	↑	XX	EP [15:8]								XX
	1	1	↑	XX	EP [7:0]								XX

Commands(continue)

Memory Write	0	1	↑	XX	0	0	1	0	1	1	0	0	2Ch
	1	1	↑	D [17:0]									XX
Color SET	0	1	↑	XX	0	0	1	0	1	1	0	1	2Dh
	1	1	↑	XX	0	0	R00 [5:0]						XX
	1	1	↑	XX	0	0	Rnn [5:0]						XX
	1	1	↑	XX	0	0	R31 [5:0]						XX
	1	1	↑	XX	0	0	G00 [5:0]						XX
	1	1	↑	XX	0	0	Gnn [5:0]						XX
	1	1	↑	XX	0	0	G64 [5:0]						XX
	1	1	↑	XX	0	0	B00 [5:0]						XX
	1	1	↑	XX	0	0	Bnn [5:0]						XX
	1	1	↑	XX	0	0	B31 [5:0]						XX
Memory Read	0	1	↑	XX	0	0	1	0	1	1	1	0	2Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Partial Area	0	1	↑	XX	0	0	1	1	0	0	0	0	30h
	1	1	↑	XX	SR [15:8]								00
	1	1	↑	XX	SR [7:0]								00
	1	1	↑	XX	ER [15:8]								01
	1	1	↑	XX	ER [7:0]								3F
Vertical Scrolling Definition	0	1	↑	XX	0	0	1	1	0	0	1	1	33h
	1	1	↑	XX	TFA [15:8]								00
	1	1	↑	XX	TFA [7:0]								00
	1	1	↑	XX	VSA [15:8]								01
	1	1	↑	XX	VSA [7:0]								40
	1	1	↑	XX	BFA [15:8]								00
	1	1	↑	XX	BFA [7:0]								00
Tearing Effect Line OFF	0	1	↑	XX	0	0	1	1	0	1	0	0	34h
Tearing Effect Line ON	0	1	↑	XX	0	0	1	1	0	1	0	1	35h
	1	1	↑	XX	0	0	0	0	0	0	0	M	00
Memory Access Control	0	1	↑	XX	0	0	1	1	0	1	1	0	36h
	1	1	↑	XX	MY	MX	MV	ML	BGR	MH	0	0	00
Vertical Scrolling Start Address	0	1	↑	XX	0	0	1	1	0	1	1	1	37h
	1	1	↑	XX	VSP [15:8]								00
	1	1	↑	XX	VSP [7:0]								00
Idle Mode OFF	0	1	↑	XX	0	0	1	1	1	0	0	0	38h
Idle Mode ON	0	1	↑	XX	0	0	1	1	1	0	0	1	39h
Pixel Format Set	0	1	↑	XX	0	0	1	1	1	0	1	0	3Ah
	1	1	↑	XX	0	DPI [2:0]			0	DBI [2:0]			66
Write Memory Continue	0	1	↑	XX	0	0	1	1	1	1	0	0	3Ch
	1	1	↑	D [17:0]									XX
Read Memory Continue	0	1	↑	XX	0	0	1	1	1	1	1	0	3Eh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	D [17:0]									XX
Set Tear Scanline	0	1	↑	XX	0	1	0	0	0	1	0	0	44h
	1	1	↑	XX	0	0	0	0	0	0	0	STS [8]	XX
	1	1	↑	XX	STS [7:0]								XX
Get Scanline	0	1	↑	XX	0	1	0	0	0	1	0	1	45h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	0	GTS [9:8]		XX
	1	↑	1	XX	GTS [7:0]								XX
Write Display Brightness	0	1	↑	XX	0	1	0	1	0	0	0	1	51h
	1	1	↑	XX	DBV [7:0]								00

Commands(continue)

Read Display Brightness	0	1	↑	XX	0	1	0	1	0	0	1	0	52h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	DBV [7:0]								00
Write CTRL Display	0	1	↑	XX	0	1	0	1	0	0	1	1	53h
	1	1	↑	XX	0	0	BCTRL	0	DD	BL	0	0	00
Read CTRL Display	0	1	↑	XX	0	1	0	1	0	1	0	0	54h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	BCTRL	0	DD	BL	0	0	00
Write Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	0	1	55h
	1	1	↑	XX	0	0	0	0	0	0	C [1:0]		00
Read Content Adaptive Brightness Control	0	1	↑	XX	0	1	0	1	0	1	1	0	56h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	0	C [1:0]		00
Write CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	1	1	1	0	5Eh
	1	1	↑	XX	CMB [7:0]								00
Read CABC Minimum Brightness	0	1	↑	XX	0	1	0	1	1	1	1	1	5Fh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	CMB [7:0]								00
Read ID1	0	1	↑	XX	1	1	0	1	1	0	1	0	DAh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	Module's Manufacture [7:0]								XX
Read ID2	0	1	↑	XX	1	1	0	1	1	0	1	1	DBh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver Version [7:0]								XX
Read ID3	0	1	↑	XX	1	1	0	1	1	1	0	0	DCh
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	LCD Module / Driver ID [7:0]								XX

Extended Command Set													
Command Function	D/CX	RDX	WRX	D17-8	D7	D6	D5	D4	D3	D2	D1	D0	Hex
RGB Interface Signal Control	0	1	↑	XX	1	0	1	1	0	0	0	0	B0h
	1	1	↑	XX	ByPass_MODE	RCM [1:0]		0	VSPL	HSPL	DPL	EPL	00
Frame Control (In Normal Mode)	0	1	↑	XX	1	0	1	1	0	0	0	1	B1h
	1	1	↑	XX	0	0	0	0	0	0	DIVA [1:0]		00
	1	1	↑	XX	0	0	0	RTNA [4:0]					1B
Frame Control (In Idle Mode)	0	1	↑	XX	1	0	1	1	0	0	1	0	B2h
	1	1	↑	XX	0	0	0	0	0	0	DIVB [1:0]		00
	1	1	↑	XX	0	0	0	RTNB [4:0]					1B
Frame Control (In Partial Mode)	0	1	↑	XX	1	0	1	1	0	0	1	1	B3h
	1	1	↑	XX	0	0	0	0	0	0	DIVC [1:0]		00
	1	1	↑	XX	0	0	0	RTNC [4:0]					1B
Display Inversion Control	0	1	↑	XX	1	0	1	1	0	1	0	0	B4h
	1	1	↑	XX	0	0	0	0	0	NLA	NLB	NLC	02
Blanking Porch Control	0	1	↑	XX	1	0	1	1	0	1	0	1	B5h
	1	1	↑	XX	0	VFP [6:0]							02
	1	1	↑	XX	0	VBP [6:0]							02
	1	1	↑	XX	0	0	0	HFP [4:0]					0A
	1	1	↑	XX	0	0	0	HBP [4:0]					14

Commands(continue)

Display Function Control	0	1	↑	XX	1	0	1	1	0	1	1	0	B6h
	1	1	↑	XX	0	0	0	0	PTG [1:0]		PT [1:0]		0A
	1	1	↑	XX	REV	GS	SS	SM	ISC [3:0]				82
	1	1	↑	XX	0	0	NL [5:0]						27
	1	1	↑	XX	0	0	PCDIV [5:0]						04
Entry Mode Set	0	1	↑	XX	1	0	1	1	0	1	1	1	B7h
	1	1	↑	XX	0	0	0	0	0	GON	DTE	GAS	06
Backlight Control 1	0	1	↑	XX	1	0	1	1	1	0	0	0	B8h
	1	1	↑	XX	0	0	0	0	TH_UI [3:0]				0C
Backlight Control 2	0	1	↑	XX	1	0	1	1	1	0	0	1	B9h
	1	1	↑	XX	TH_MV [3:0]				TH_ST [3:0]				CC
Backlight Control 3	0	1	↑	XX	1	0	1	1	1	0	1	0	BAh
	1	1	↑	XX	0	0	0	0	DTH_UI [3:0]				04
Backlight Control 4	0	1	↑	XX	1	0	1	1	1	0	1	1	BBh
	1	1	↑	XX	DTH_MV [3:0]				DTH_ST [3:0]				65
Backlight Control 5	0	1	↑	XX	1	0	1	1	1	1	0	0	BCh
	1	1	↑	XX	DIM2 [3:0]				0	DIM1 [2:0]			44
Backlight Control 7	0	1	↑	XX	1	0	1	1	1	1	1	0	BEh
	1	1	↑	XX	PWM_DIV [7:0]								0F
Backlight Control 8	0	1	↑	XX	1	0	1	1	1	1	1	1	BFh
	1	1	↑	XX	0	0	0	0	0	LEDONR	LEDONPOL	LEDPWMOPL	00
Power Control 1	0	1	↑	XX	1	1	0	0	0	0	0	0	C0h
	1	1	↑	XX	0	0	VRH [5:0]						21
Power Control 2	0	1	↑	XX	1	1	0	0	0	0	0	1	C1h
	1	1	↑	XX	0	0	0	1	0	BT [2:0]			10
VCOM Control 1	0	1	↑	XX	1	1	0	0	0	1	0	1	C5h
	1	1	↑	XX	0	VMH [6:0]							31
	1	1	↑	XX	0	VML [6:0]							3C
VCOM Control 2	0	1	↑	XX	1	1	0	0	0	1	1	1	C7h
	1	1	↑	XX	nVM	VMF [6:0]							C0
NV Memory Write	0	1	↑	XX	1	1	0	1	0	0	0	0	D0h
	1	1	↑	XX	0	0	0	0	0	PGM_ADR [2:0]			00
	1	1	↑	XX	PGM_DATA [7:0]								XX
NV Memory Protection Key	0	1	↑	XX	1	1	0	1	0	0	0	1	D1h
	1	1	↑	XX	KEY [23:16]								XX
	1	1	↑	XX	KEY [15:8]								XX
	1	1	↑	XX	KEY [7:0]								XX
NV Memory Status Read	0	1	↑	XX	1	1	0	1	0	0	1	0	D2h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	ID2_CNT [2:0]			0	ID1_CNT [2:0]			XX
	1	↑	1	XX	BUSY	VMF_CNT [2:0]			0	ID3_CNT [2:0]			XX

Commands(continue)

Read ID4	0	1	↑	XX	1	1	0	1	0	0	1	1	D3h
	1	↑	1	XX	X	X	X	X	X	X	X	X	XX
	1	↑	1	XX	0	0	0	0	0	0	0	0	00
	1	↑	1	XX	1	0	0	1	0	0	1	1	93
	1	↑	1	XX	0	1	0	0	0	0	0	1	41
Positive Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	0	E0h
	1	1	↑	XX	0	0	0	0	VP0 [3:0]				0F
	1	1	↑	XX	0	0	VP1 [5:0]						16
	1	1	↑	XX	0	0	VP2 [5:0]						14
	1	1	↑	XX	0	0	0	0	VP4 [3:0]				0A
	1	1	↑	XX	0	0	0	VP6 [4:0]					0D
	1	1	↑	XX	0	0	0	0	VP13 [3:0]				06
	1	1	↑	XX	0	VP20 [6:0]							43
	1	1	↑	XX	VP36 [3:0]				VP27 [3:0]				75
	1	1	↑	XX	0	VP43 [6:0]							33
	1	1	↑	XX	0	0	0	0	VP50 [3:0]				06
	1	1	↑	XX	0	0	0	VP57 [4:0]					0E
	1	1	↑	XX	0	0	0	0	VP59 [3:0]				00
	1	1	↑	XX	0	0	VP61 [5:0]						0C
	1	1	↑	XX	0	0	VP62 [5:0]						09
	1	1	↑	XX	0	0	0	0	VP63 [3:0]				08
Negative Gamma Correction	0	1	↑	XX	1	1	1	0	0	0	0	1	E1h
	1	1	↑	XX	0	0	0	0	VN0 [3:0]				08
	1	1	↑	XX	0	0	VN1 [5:0]						2B
	1	1	↑	XX	0	0	VN2 [5:0]						2D
	1	1	↑	XX	0	0	0	0	VN4 [3:0]				04
	1	1	↑	XX	0	0	0	VN6 [4:0]					10
	1	1	↑	XX	0	0	0	0	VN13 [3:0]				04
	1	1	↑	XX	0	VN20 [6:0]							3E
	1	1	↑	XX	VN36 [3:0]				VN27 [3:0]				24
	1	1	↑	XX	0	VN43 [6:0]							4E
	1	1	↑	XX	0	0	0	0	VN50 [3:0]				04
	1	1	↑	XX	0	0	0	VN57 [4:0]					0F
	1	1	↑	XX	0	0	0	0	VN59 [3:0]				0E
	1	1	↑	XX	0	0	VN61 [5:0]						35
	1	1	↑	XX	0	0	VN62 [5:0]						38
	1	1	↑	XX	0	0	0	0	VN63 [3:0]				0F
Digital Gamma Control 1	0	1	↑	XX	1	1	1	0	0	0	1	0	E2h
1st Parameter	1	1	↑	XX	RCA0 [3:0]				BCA0 [3:0]				XX
2nd Parameter	1	1	↑	XX	RCA1 [3:0]				BCA1 [3:0]				XX
3rd Parameter	1	1	↑	XX	RCA2 [3:0]				BCA2 [3:0]				XX
4th Parameter	1	1	↑	XX	RCA3 [3:0]				BCA3 [3:0]				XX
5th Parameter	1	1	↑	XX	RCA4 [3:0]				BCA4 [3:0]				XX
6th Parameter	1	1	↑	XX	RCA5 [3:0]				BCA5 [3:0]				XX
7th Parameter	1	1	↑	XX	RCA6 [3:0]				BCA6 [3:0]				XX
8th Parameter	1	1	↑	XX	RCA7 [3:0]				BCA7 [3:0]				XX
9th Parameter	1	1	↑	XX	RCA8 [3:0]				BCA8 [3:0]				XX
10th Parameter	1	1	↑	XX	RCA9 [3:0]				BCA9 [3:0]				XX
11th Parameter	1	1	↑	XX	RCA10 [3:0]				BCA10 [3:0]				XX
12th Parameter	1	1	↑	XX	RCA11 [3:0]				BCA11 [3:0]				XX
13th Parameter	1	1	↑	XX	RCA12 [3:0]				BCA12 [3:0]				XX
14th Parameter	1	1	↑	XX	RCA13 [3:0]				BCA13 [3:0]				XX
15th Parameter	1	1	↑	XX	RCA14 [3:0]				BCA14 [3:0]				XX
16th Parameter	1	1	↑	XX	RCA15 [3:0]				BCA15 [3:0]				XX

Commands(continue)

Digital Gamma Control 2	0	1	↑	XX	1	1	1	0	0	0	1	1	E3h
1st Parameter	1	1	↑	XX	RFA0 [3:0]				BFA0 [3:0]				XX
2nd Parameter	1	1	↑	XX	RFA1 [3:0]				BFA1 [3:0]				XX
3rd Parameter	1	1	↑	XX	RFA2 [3:0]				BFA2 [3:0]				XX
4th Parameter	1	1	↑	XX	RFA3 [3:0]				BFA3 [3:0]				XX
5th Parameter	1	1	↑	XX	RFA4 [3:0]				BFA4 [3:0]				XX
6th Parameter	1	1	↑	XX	RFA5 [3:0]				BFA5 [3:0]				XX
7th Parameter	1	1	↑	XX	RFA6 [3:0]				BFA6 [3:0]				XX
8th Parameter	1	1	↑	XX	RFA7 [3:0]				BFA7 [3:0]				XX
9th Parameter	1	1	↑	XX	RFA8 [3:0]				BFA8 [3:0]				XX
10th Parameter	1	1	↑	XX	RFA9 [3:0]				BFA9 [3:0]				XX
11th Parameter	1	1	↑	XX	RFA10 [3:0]				BFA10 [3:0]				XX
12th Parameter	1	1	↑	XX	RFA11 [3:0]				BFA [3:0]				XX
13th Parameter	1	1	↑	XX	RFA12 [3:0]				BFA12 [3:0]				XX
14th Parameter	1	1	↑	XX	RFA13 [3:0]				BFA13 [3:0]				XX
15th Parameter	1	1	↑	XX	RFA14 [3:0]				BFA14 [3:0]				XX
16th Parameter	1	1	↑	XX	RFA15 [3:0]				BFA15 [3:0]				XX
17th Parameter	1	1	↑	XX	RFA16 [3:0]				BFA16 [3:0]				XX
18th Parameter	1	1	↑	XX	RFA17 [3:0]				BFA17 [3:0]				XX
19th Parameter	1	1	↑	XX	RFA18 [3:0]				BFA18 [3:0]				XX
20th Parameter	1	1	↑	XX	RFA19 [3:0]				BFA19 [3:0]				XX
21st Parameter	1	1	↑	XX	RFA20 [3:0]				BFA20 [3:0]				XX
22nd Parameter	1	1	↑	XX	RFA21 [3:0]				BFA21 [3:0]				XX
23rd Parameter	1	1	↑	XX	RFA22 [3:0]				BFA22 [3:0]				XX
24th Parameter	1	1	↑	XX	RFA23 [3:0]				BFA23 [3:0]				XX
25th Parameter	1	1	↑	XX	RFA24 [3:0]				BFA24 [3:0]				XX
26th Parameter	1	1	↑	XX	RFA25 [3:0]				BFA25 [3:0]				XX
27th Parameter	1	1	↑	XX	RFA26 [3:0]				BFA26 [3:0]				XX
28th Parameter	1	1	↑	XX	RFA27 [3:0]				BFA27 [3:0]				XX
29th Parameter	1	1	↑	XX	RFA28 [3:0]				BFA28 [3:0]				XX
30th Parameter	1	1	↑	XX	RFA29 [3:0]				BFA29 [3:0]				XX
31st Parameter	1	1	↑	XX	RFA30 [3:0]				BFA30 [3:0]				XX
32nd Parameter	1	1	↑	XX	RFA31 [3:0]				BFA31 [3:0]				XX
33rd Parameter	1	1	↑	XX	RFA32 [3:0]				BFA32 [3:0]				XX
34th Parameter	1	1	↑	XX	RFA33 [3:0]				BFA33 [3:0]				XX
35th Parameter	1	1	↑	XX	RFA34 [3:0]				BFA34 [3:0]				XX
36th Parameter	1	1	↑	XX	RFA35 [3:0]				BFA35 [3:0]				XX
37th Parameter	1	1	↑	XX	RFA36 [3:0]				BFA36 [3:0]				XX
38th Parameter	1	1	↑	XX	RFA37 [3:0]				BFA37 [3:0]				XX

39th Parameter	1	1	↑	XX	RFA38 [3:0]				BFA38 [3:0]				XX
40th Parameter	1	1	↑	XX	RFA39 [3:0]				BFA39 [3:0]				XX
41st Parameter	1	1	↑	XX	RFA40 [3:0]				BFA40 [3:0]				XX
42nd Parameter	1	1	↑	XX	RFA41 [3:0]				BFA41 [3:0]				XX
43rd Parameter	1	1	↑	XX	RFA42 [3:0]				BFA42 [3:0]				XX
44th Parameter	1	1	↑	XX	RFA43 [3:0]				BFA43 [3:0]				XX
45th Parameter	1	1	↑	XX	RFA44 [3:0]				BFA44 [3:0]				XX
46th Parameter	1	1	↑	XX	RFA45 [3:0]				BFA45 [3:0]				XX
47th Parameter	1	1	↑	XX	RFA46 [3:0]				BFA46 [3:0]				XX
48th Parameter	1	1	↑	XX	RFA47 [3:0]				BFA47 [3:0]				XX
49th Parameter	1	1	↑	XX	RFA48 [3:0]				BFA48 [3:0]				XX
50th Parameter	1	1	↑	XX	RFA49 [3:0]				BFA49 [3:0]				XX
51st Parameter	1	1	↑	XX	RFA50 [3:0]				BFA50 [3:0]				XX
52nd Parameter	1	1	↑	XX	RFA51 [3:0]				BFA51 [3:0]				XX
53rd Parameter	1	1	↑	XX	RFA52 [3:0]				BFA52 [3:0]				XX
54th Parameter	1	1	↑	XX	RFA53 [3:0]				BFA53 [3:0]				XX
55th Parameter	1	1	↑	XX	RFA54 [3:0]				BFA54 [3:0]				XX
56th Parameter	1	1	↑	XX	RFA55 [3:0]				BFA55 [3:0]				XX
57th Parameter	1	1	↑	XX	RFA56 [3:0]				BFA56 [3:0]				XX
58th Parameter	1	1	↑	XX	RFA57 [3:0]				BFA57 [3:0]				XX
59th Parameter	1	1	↑	XX	RFA58 [3:0]				BFA58 [3:0]				XX
60th Parameter	1	1	↑	XX	RFA59 [3:0]				BFA59 [3:0]				XX
61st Parameter	1	1	↑	XX	RFA60 [3:0]				BFA60 [3:0]				XX
62nd Parameter	1	1	↑	XX	RFA61 [3:0]				BFA61 [3:0]				XX
63rd Parameter	1	1	↑	XX	RFA62 [3:0]				BFA62 [3:0]				XX
64th Parameter	1	1	↑	XX	RFA63 [3:0]				BFA63 [3:0]				XX
Interface Control	0	1	↑	XX	1	1	1	1	0	1	1	0	F6h
	1	1	↑	XX	MY_EOR	MX_EOR	MV_EOR	0	BGR_EOR	0	0	WEMODE	01
	1	1	↑	XX	0	0	EPF [1:0]		0	0	MDT [1:0]		00
	1	1	↑	XX	0	0	ENDIAN	0	DM [1:0]		RM	RIM	00
Power Control A	0	1	↑	XX	1	1	0	0	1	0	1	1	CBh
	1	1	↑	XX	0	0	1	1	1	0	0	1	39
	1	1	↑	XX	0	0	1	0	1	1	0	0	2C
	1	1	↑	XX	0	0	0	0	0	0	0	0	00
	1	1	↑	XX	0	0	1	1	0	REG_VD[2:0]			30
	1	1	↑	XX	0	0	0	0	0	VBC[2:0]			01
Power Control B	0	1	↑	XX	1	1	0	0	1	1	1	1	CFh
	1	1	↑	XX	0	0	0	0	0	0	0	0	00
	1	1	↑	XX	1	PCEQ	DRV_ena	Power control[1:0]		0	0	1	81
	1	1	↑	XX	DRV_vml[2:1]		1	DC_ena	DRV_vml[0]	DRV_vmh[2:0]			30
Driver timing control A	0	1	↑	XX	1	1	1	0	1	0	0	0	E8h
	1	1	↑	XX	CR/EQ/PC	SDT[1:0]		0	0	1	0	NOW	84
	1	1	↑	XX	0	0	EQ[2:0]			CR[2:0]			11

	1	1	↑	XX	0	1	1	1	1	PC[1:0]			7A
Driver timing control B	0	1	↑	XX	1	1	1	0	1	0	0	1	E9h
	1	1	↑	XX	CRE/EQE /PCE	SDT[1:0]		0	0	1	0	NOWE	04
	1	1	↑	XX	0	0	EQ[2:0]			CR[2:0]			11
	1	1	↑	XX	0	1	1	1	1	PC[1:0]			7A
Driver timing control C	0	1	↑	XX	1	1	1	0	1	0	1	0	EAh
	1	1	↑	XX	VG_SW_T4		VG_SW_T3		VG_SW_T2		VG_SW_T1		66
Power on sequence control	0	1	↑	XX	1	1	1	0	1	1	0	1	EDh
	1	1	↑	XX	0	1	CP1 soft start		0	1	CP23 soft start		55
	1	1	↑	XX	0	0	En_vcl		0	0	En_ddvdh		01
	1	1	↑	XX	0	0	En_vgh		0	0	En_vgl		23
	1	1	↑	XX	DDVDH_ENH		0	0	0	0	0	1	01
Enable 3G	0	1	↑	XX	1	1	1	1	0	0	1	0	F2h
	1	1	↑	XX	0	0	0	0	0	0	1	3G_enb	02

Note:
Please refer to ILI9341 data sheet for details

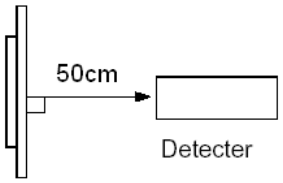
8. Optical Characteristics

Item		Symbol	Condition	MIN.	TYP.	MAX.	UNIT	Note.
Brightness		Bp	θ=0° Φ=0°	-	-	-	Cd/m²	Note 1
Uniformity		△Bp		80%	-	-	-	Note 1,2
Viewing Angle		θ=0°	Cr≥10	-	45	-	Deg	Note 3
		θ=90°		-	45	-		
		θ=180°		-	20	-		
		θ=270°		-	45	-		
Contrast ratio		CR	θ=0° Φ=0° 25℃	-	500	-	-	Note 4
Response Time		T_{on}		-	25	40	msec	Note 5
		T_{off}					msec	
Color of CIE Coordinate	White	X	θ=0° Φ=0°	0.255	0.305	0.355	-	Note 1,6
		Y		0.275	0.325	0.375	-	
	Red	X		0.576	0.626	0.676	-	
		Y		0.284	0.334	0.384	-	
	Green	X		0.227	0.277	0.327	-	
		Y		0.499	0.549	0.599	-	
	Blue	X		0.092	0.142	0.192	-	
		Y		0.072	0.122	0.172	-	
NTSC Ratio		S		-	60%			

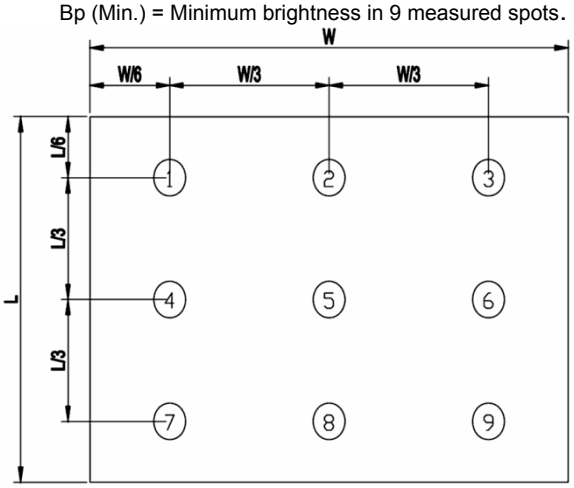
Note：The parameter is slightly changed by temperature, driving voltage and materiel.

Note 1:
The data are measured after LEDs are turned on for 5 minutes. LCM displays full white.
The brightness is the average value of 9 measured spots.
Measurement equipment PR-705 (Φ8mm)
Measuring condition:
- Measuring surroundings: Dark room
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.

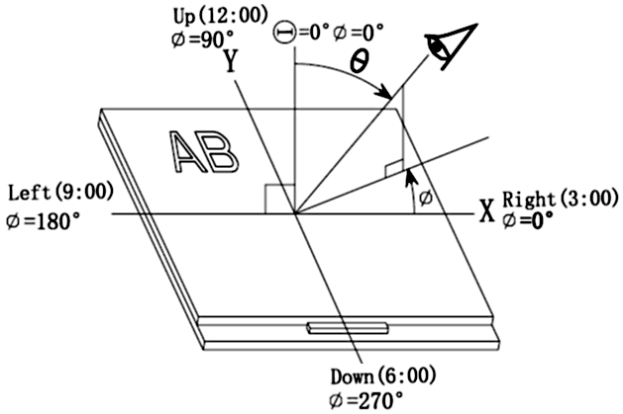
Measured value at the center point of LCD panel after more than 5 minutes while backlight turning on.



Note 2:
The luminance uniformity is calculated by using following formula.
△Bp = Bp (Min.) / Bp (Max.)×100 (%)
Bp (Max.) = Maximum brightness in 9 measured spots
Bp (Min.) = Minimum brightness in 9 measured spots.



Note 3:
The definition of viewing angle:
Refer to the graph below marked by θ and Φ

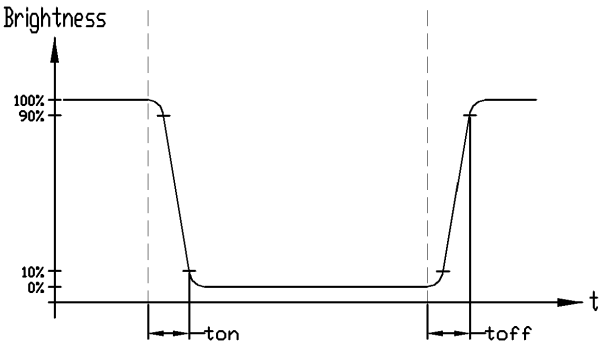


Note 4:
The definition of contrast ratio (Test LCM using PR-705):

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

(Contrast Ratio is measured in optimum common electrode voltage)

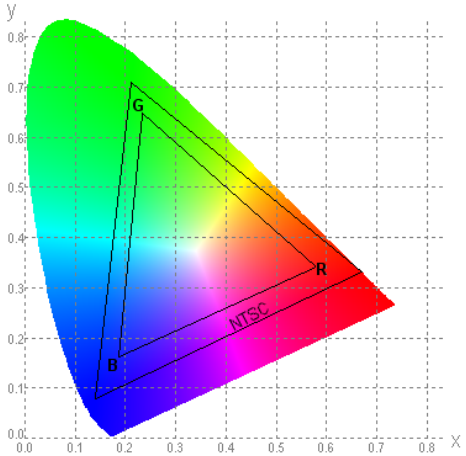
Note 5:
Definition of Response time. (Test LCD using DMS501):
The output signals of photo detector are measured when the input signals are changed from “black” to “white”(falling time) and from “white” to “black”(rising time), respectively.
The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



Note 6:
Definition of Color of CIE1931 Coordinate and NTSC Ratio.

Color gamut:

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



9. Precautions of using LCD Modules

Mounting

- Mounting must use holes arranged in four corners or four sides.
- The mounting structure so provide even force on to LCD module. Uneven force (ex. Twisted stress) should not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- It is suggested to attach a transparent protective plate to the surface in order to protect the polarizer. It should have sufficient strength in order to the resist external force.
- The housing should adopt radiation structure to satisfy the temperature specification.
- Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. Never rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics deteriorate the polarizer.)
- When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer

Operating

- The spike noise causes the mis-operation of circuits. It should be within the ±200mV level (Over and under shoot voltage)
- Response time depends on the temperature.(In lower temperature, it becomes longer.)
- Brightness depends on the temperature. (In lower temperature, it becomes lower.) And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
- Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- When fixed patterns are displayed for a long time, remnant image is likely to occur.
- Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference

Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

Storage

When storing modules as spares for a long time, the following precautions are necessary.

- Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.

Protection Film

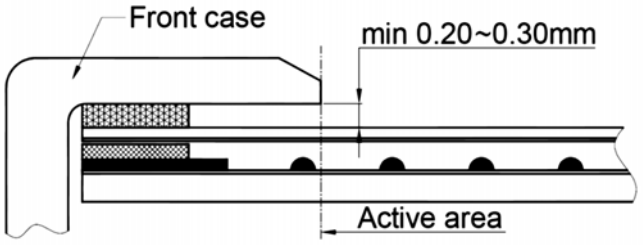
- When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt tore main on the polarizer. Please carefully peel off the protection film without rubbing it against the polarizer.
- When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
- You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

Transportation

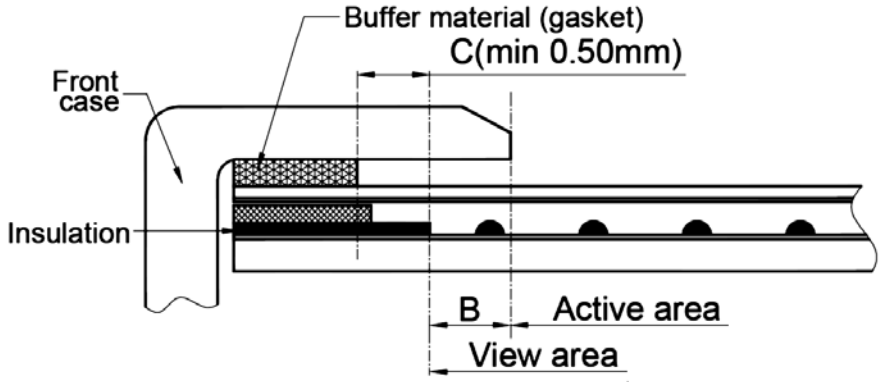
The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

附录：Touch panel Design Precautions

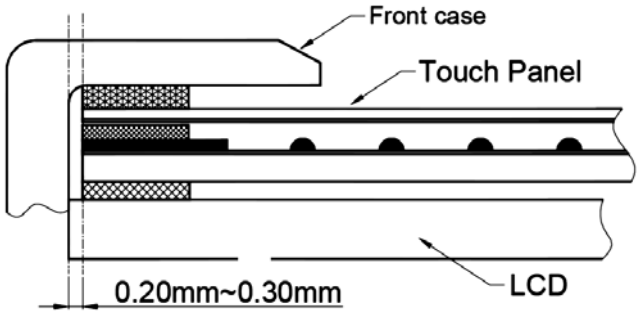
1. It should prevent front case touching the touch panel Active Area (A.A.) to prevent abnormal touch.
   It should left gab (e.g. 0.2~0.3mm) in between.



2. Outer case design should take care about the area outside the A.A.
   Those areas contain circuit wires which is having different thickness. Touching those areas could deform the ITO film. As a result case the ITO cold be damaged and shorten its lifetime.
   It is suggested to protect those areas with gasket (between the front case and the touch panel).
   The suggested figures are B≥0.50mm; C≥0.50mm。



3. The front case side wall should keep space (e.g. 0.2 ~ 0.3mm) from the touch panel.



4. In general design,
   touch panel V.A. should be bigger than the LCD V.A.
   and touch panel A.A. should be bigger than the LCD A.A.