深圳市拓普微科技开发有限公司
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LMT050DNCFWU-NCN

LCD Module User Manual

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Date: 2014-07-03	Date:	Date:

Rev.	Descriptions	Release Date
0.1	Preliminary	2012-11-15
0.2	Update Section 7	2013-07-20
0.3	Add Function Specifications & Touch Panel Controller Timing Characteristics	2013-10-08
0.4	Refine Interface Pin name	2013-10-11
0.5	Revise section1 general specification	2014-07-03

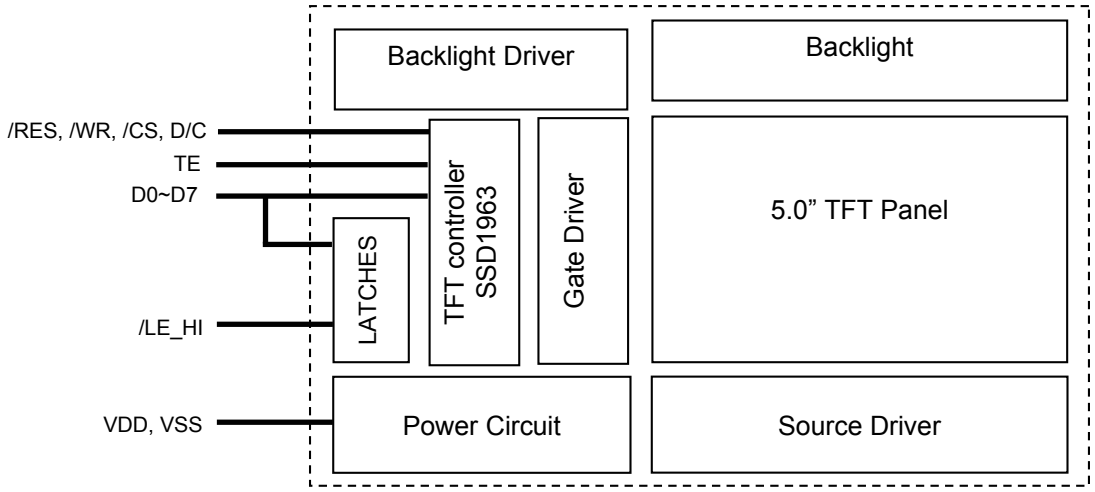
Table of Content

1. General Specification

Signal Interface :	8 bit parallel interface
Display Mode :	Transmissive / normal white
Screen Size(Diagonal) :	5.0 inch
Outline Dimension :	142.0 x 79.0 x 9.9 (mm) (see attached drawing for details)
Active Area :	108 x 64.8 (mm)
Color Depth :	65,535 color (16bit)
Resolution :	800(RGB) x 480
Pixel Pitch :	0.135 x 0.135 (mm)
Pixel Configuration :	RGB Stripe
Backlight :	LED
Surface Treatment :	Anti-Glare
Viewing Direction :	6 o'clock (*1) (gray scale inverse) 12 o'clock (*2)
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



Note:
LATCHES on board expend the host 8bit data for SSD1963 16bit Interface.

3. Terminal Functions

3.1 Interface

No.	Pin Name	I/O	Descriptions
1	VSS	P	Power Supply GND (0V)
2			
3	VDD	P	Positive Power Supply (5.0V)
4			
5	D/C	I	Register Select D/C=0, command D/C=1, data or parameter
6	/CS	I	Chip Select signal
7	/RES	I	Reset signal, /RES=1, normal /RES=0, reset execute
8	D0(D8)	I	8bit Data bus
:	:		
15	D7(D15)		
16	TE	O	Tear Signal (*1)
17	NC	--	No Connection
18	/WR	I	Write signal
19	VSS	P	Power Supply GND (0V)
20	/LE_HI	I	LATCH the high byte data; /LE_HI=1, transparent; /LE_HI=0, LATCHED
21	NC	--	No Connection
22			
23			
24			
25			
26			

Note.
*1. Tear signal may leave open when not use

4. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	-0.3	+6.0	V	VSS = 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, V_{DD} =5.0V, T_{OP} =25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Operating Voltage	VDD	4.8	5.0	5.5	V	VDD
Input High Voltage	V_{IH}	3.0	-	3.6	V	Input pins
Input Low Voltage	V_{IL}	VSS	-	0.3	V	Input pins
Output Signal Low Voltage	V_{OL}	-	-	VSS+0.4	V	
Output Signal High Voltage	V_{OH}	3.3	-	-	V	
Operating Current (*1,)	I_{DD}	-	260	-	mA	60%PWM
			390			100%PWM

Note.
*1. For different LCM, the value may have a bit of difference.
*2. To test the current dissipation, use “all Black Pattern”.

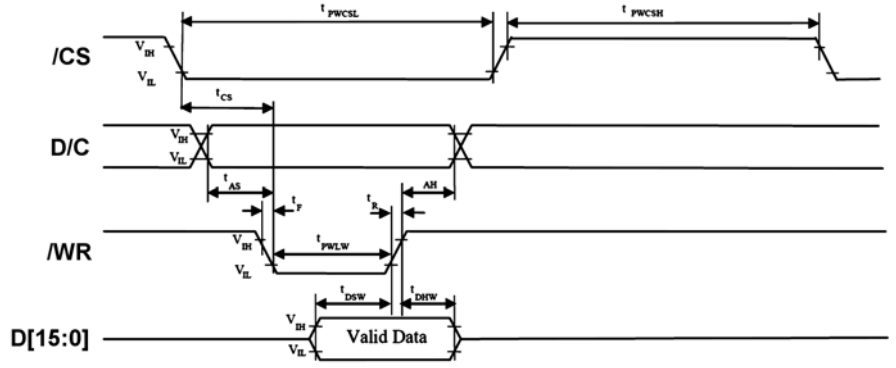
6. AC Characteristics

6.1 TFT Controller Timing Characteristics

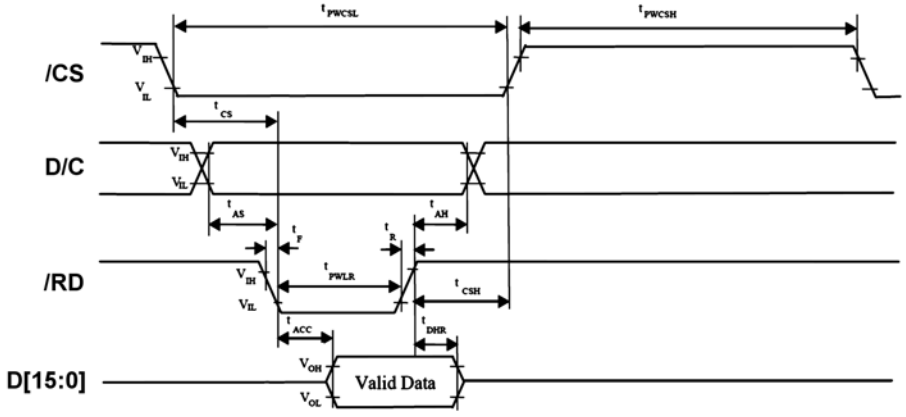
V_{SS}=0V, V_{DD}=5.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
System Clock Period(*1)	t_{MCLK}	$1/f_{MCLK}$	-	-	ns
Control Pulse High Width Write Read	t_{PWCSL}	16 38	$1.5*t_{MCLK}$ $1.3*t_{MCLK}$	- -	ns ns
Control Pulse Low Width Write (next write cycle) Write (next read cycle) Read	t_{PWCSH}	16 100 100	$1.5*t_{MCLK}$ $9*t_{MCLK}$ $9*t_{MCLK}$	- - -	ns ns ns
Address Setup Time	t_{AS}	1.3	-	-	ns
Address Hold Time	t_{AH}	2.5	-	-	ns
Write Data Setup Time	t_{DSW}	5	-	-	ns
Write Data Hold Time	t_{DHW}	1.3	-	-	ns
Write Low Time	t_{PWLW}	15	-	-	ns
Read Data Hold Time	t_{DHR}	1.3	-	-	ns
Access Time	t_{ACC}	40	-	-	ns
Read Low Time	t_{PWLR}	45	-	-	ns
Rise Time	t_R	-	-	0.4	ns
Fall Time	t_F	-	-	0.4	ns
Chip select setup time	t_{CS}	2.5	-	-	ns
Chip select hold time to read signal	t_{CSH}	4	-	-	ns

Note:
*1. t_{MCLK} is the System Clock Period, which may config by internal PLL setting
*2. LMT050DNCFWU is driving by external 10MHz, and clock up by enabling the SSD1963 internal PLL
*3. Suggested PLL clock setting is 200MHz



8080 Mode Write Timing

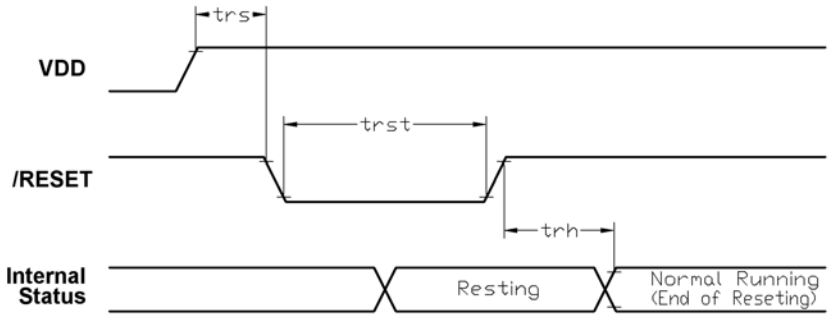


8080 Mode Read Timing

6.2 TFT Controller Reset Timing

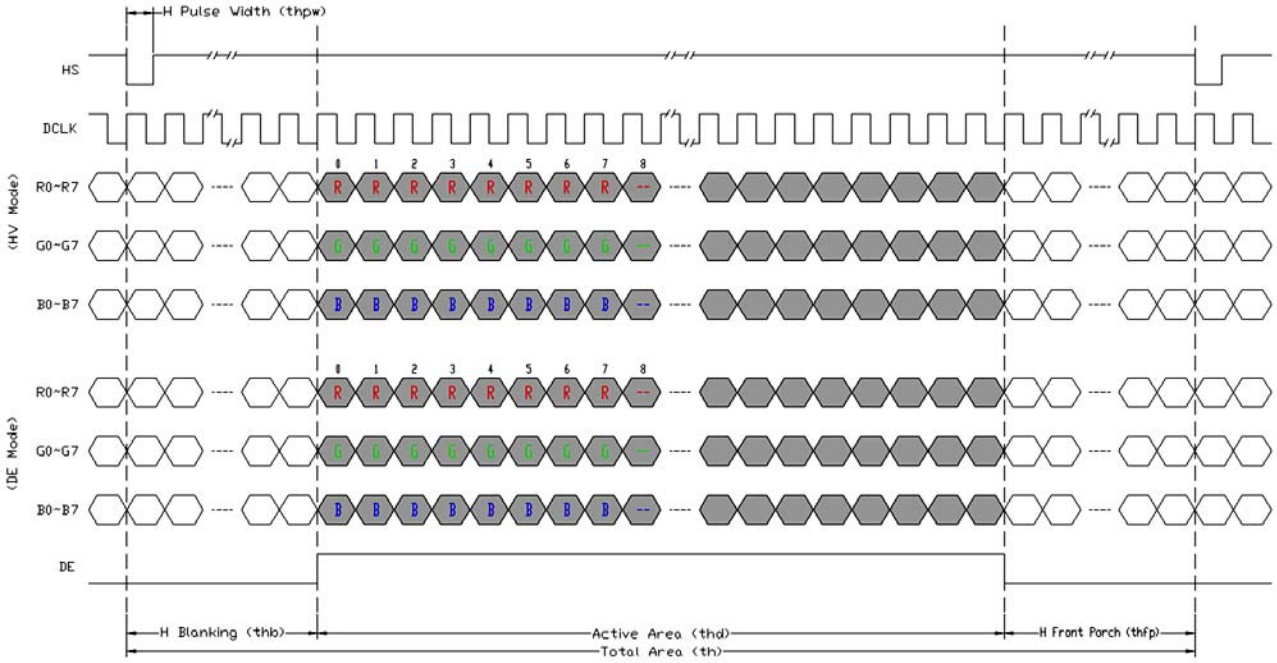
V_{SS}=0V, V_{DD}=5.0V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset setup time	trs	2	-	-	ms
Reset pulse	trst	0.2	-	-	ms
Reset hold time	trh	2	-	-	ms

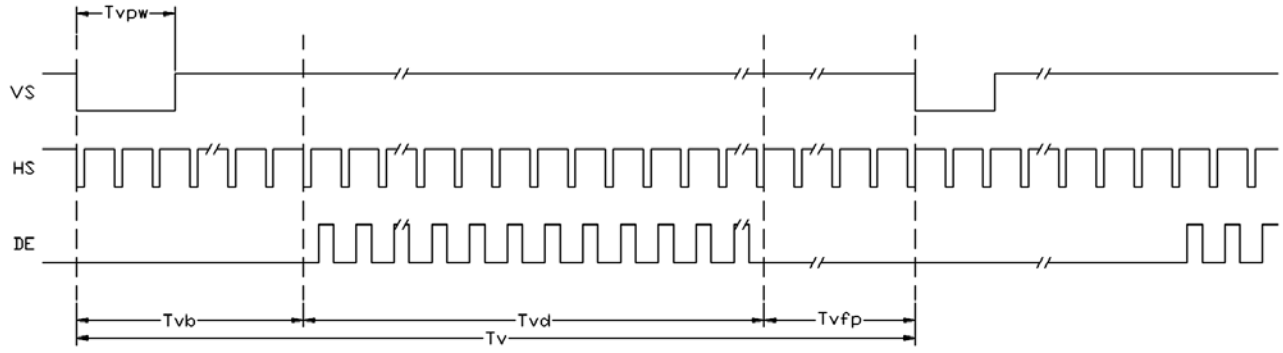


6.3 TFT Timing

Item	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Horizontal Display Area	thd		800		DCLK	
CLKIN Frequency	fclk	-	30	50	MHz	
One Horizontal Line	th	889	928	1143	CLKIN	
HSD pulse width	thpw	1	48	255	CLKIN	
HSD Blanking	thb		88		CLKIN	
HSD Front Porch	thfp	1	40	255	CLKIN	
Vertical Display Area	tvd		480		TH	
VSD period time	tv	513	525	767	TH	
VSD pulse width	tvpw	3	3	255	TH	
VSD Blanking	tvb		32		TH	
VSD Front Porch	tvfp	1	13	255	TH	



Horizontal timing diagram

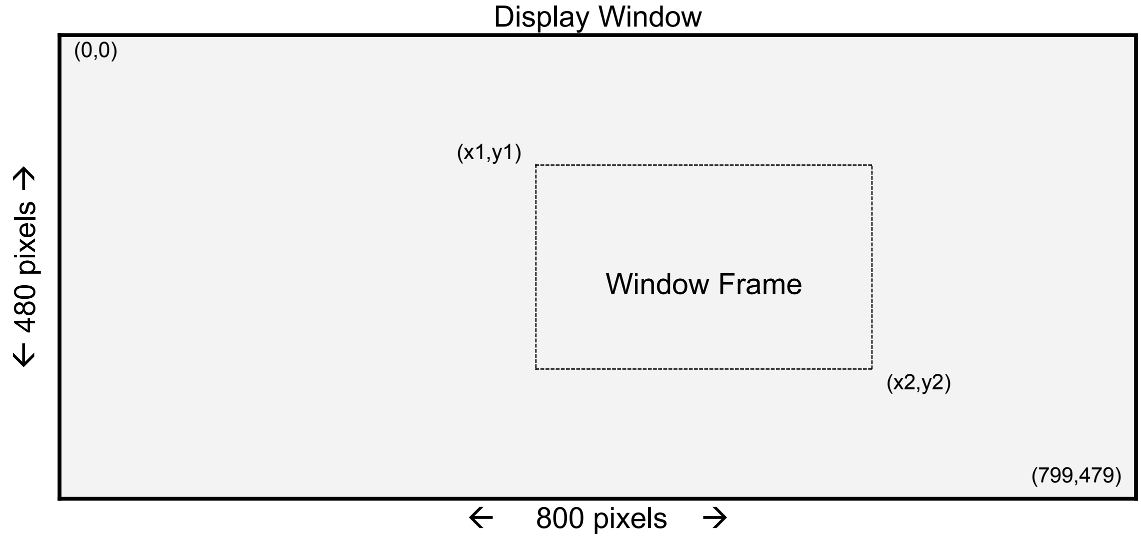


Vertical timing diagram

7. TFT Controller Functions Specifications

7.1 Display Memory Addressing

TFT module with 800x480 pixels, using SSD1963, address the display memory with a co-ordinate system as follow.



7.2 Command Packet

- Command Packet organizes with “Command Code” followed by “Parameter”
- Command Code and Parameters are 8bit only
- Number of Parameters is depends on Command type
  some of the command followed with no parameter.

Seq.	D/C	/LE_HI	/RD	/WR	Data bus (D7:D0)
1	0	0	1	↑	Command code
2	1	0	1	↑	Parameter 1
3	1	0	1	↑	Parameter 2
4	1	0	1	↑	Parameter 3
:	:	:	:	:	:

7.3 Data Format

- Display Data is in 16bit format (R:G:B=5:6:5)
- 16bit data built one pixel
- Use the /LE_HI to latched the high-8bit into the LCD module
  then provide the low-8bit on onto the data bus and write
- Display Data could be continue write (depends on command and configuration)

D/C	/LE_HI	/RD	/WR	Data bus (D7:D0)							
1	↓	1	1	R4	R3	R2	R1	R0	G5	G4	G3
1	0	1	↑	G2	G1	G0	B4	B3	B2	B1	B0
1	↓	1	1	R4	R3	R2	R1	R0	G5	G4	G3
1	0	1	↑	G2	G1	G0	B4	B3	B2	B1	B0
1	↓	1	1	R4	R3	R2	R1	R0	G5	G4	G3
1	0	1	↑	G2	G1	G0	B4	B3	B2	B1	B0
:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:

7.4 Hardware Related Parameter

Booster and Power circuit

Internal TFT standBY and Backlight driver are controlled by SSD1963 GPIO0 and GPIO1 respectively. It is necessary to enable them for normal operation via command

Backlight Brightness PWM control

It is suggested to config the backlight brightness control signal as 3kHz PWM signal for best performance.

7.5 Command Table

Code (hex)	Command	Description
0x00	nop	No operation
0x01	soft_reset	Software Reset
0x0A	get_power_mode	Get the current power mode
0x0B	get_address_mode	Get the frame buffer to the display panel read order
0x0C	Reserved	Reserved
0x0D	get_display_mode	The SSD1963 returns the Display Image Mode.
0x0E	get_tear_effect_status	Get the Tear Effect status
0x0F	Reserved	Reserved
0x10	enter_sleep_mode	Turn off the panel. This command will pull low the GPIO0. If GPIO0 is configured as normal GPIO or LCD miscellaneous signal with command set_gpio_conf, this command will be ignored.
0x11	exit_sleep_mode	Turn on the panel. This command will pull high the GPIO0. If GPIO0 is configured as normal GPIO or LCD miscellaneous signal with command set_gpio_conf, this command will be ignored.
0x12	enter_partial_mode	Part of the display area is used for image display.
0x13	enter_normal_mode	The whole display area is used for image display.
0x20	exit_invert_mode	Displayed image colors are not inverted.
0x21	enter_invert_mode	Displayed image colors are inverted.
0x26	set_gamma_curve	Selects the gamma curve used by the display panel.
0x28	set_display_off	Blanks the display panel
0x29	set_display_on	Show the image on the display panel
0x2A	set_column_address	Set the column address
0x2B	set_page_address	Set the page address
0x2C	write_memory_start	Transfer image information from the host processor interface to the SSD1963 starting at the location provided by set_column_address and set_page_address
0x2E	read_memory_start	Transfer image data from the SSD1963 to the host processor interface starting at the location provided by set_column_address and set_page_address
0x30	set_partial_area	Defines the partial display area on the display panel
0x33	set_scroll_area	Defines the vertical scrolling and fixed area on display area
0x34	set_tear_off	Synchronization information is not sent from the SSD1963 to the host processor
0x35	set_tear_on	Synchronization information is sent from the SSD1963 to the host processor at the start of VFP
0x36	set_address_mode	Set the read order from frame buffer to the display panel
0x37	set_scroll_start	Defines the vertical scrolling starting point
0x38	exit_idle_mode	Full color depth is used for the display panel
0x39	enter_idle_mode	Reduce color depth is used on the display panel.
0x3A	Reserved	Reserved
0x3C	write_memory_continue	Transfer image information from the host processor interface to the SSD1963 from the last written location
0x3E	read_memory_continue	Read image data from the SSD1963 continuing after the last read_memory_continue or read_memory_start
0x44	set_tear_scanline	Synchronization information is sent from the SSD1963 to the host processor when the display panel refresh reaches the provided scanline
0x45	get_scanline	Get the current scan line
0xA1	read_ddb	Read the DDB from the provided location
0xA8	Reserved	Reserved

Command Table (continue)

Code (hex)	Command	Description
0xB0	set_lcd_mode_	Set the LCD panel mode and resolution
0xB1	get_lcd_mode	Get the current LCD panel mode, pad strength and resolution
0xB4	set_hori_period	Set front porch
0xB5	get_hori_period	Get current front porch settings
0xB6	set_vert_period	Set the vertical blanking interval between last scan line and next LFRAME pulse
0xB7	get_vert_period	Set the vertical blanking interval between last scan line and next LFRAME pulse
0xB8	set_gpio_conf	Set the GPIO configuration. If the GPIO is not used for LCD, set the direction. Otherwise, they are toggled with LCD signals.
0xB9	get_gpio_conf	Get the current GPIO configuration
0xBA	set_gpio_value	Set GPIO value for GPIO configured as output
0xBB	get_gpio_status	Read current GPIO status. If the individual GPIO was configured as input, the value is the status of the corresponding pin. Otherwise, it is the programmed value.
0xBC	set_post_proc	Set the image post processor
0xBD	get_post_proc	Set the image post processor
0xBE	set_pwm_conf	Set the image post processor
0xBF	get_pwm_conf	Set the image post processor
0xC0	set_lcd_gen0	Set the rise, fall, period and toggling properties of LCD signal generator 0
0xC1	get_lcd_gen0	Get the current settings of LCD signal generator 0
0xC2	set_lcd_gen1	Set the rise, fall, period and toggling properties of LCD signal generator 1
0xC3	get_lcd_gen1	Get the current settings of LCD signal generator 1
0xC4	set_lcd_gen2	Set the rise, fall, period and toggling properties of LCD signal generator 2
0xC5	get_lcd_gen2	Get the current settings of LCD signal generator 2
0xC6	set_lcd_gen3	Set the rise, fall, period and toggling properties of LCD signal generator 3
0xC7	get_lcd_gen3	Get the current settings of LCD signal generator 3
0xC8	set_gpio0_rop	Set the GPIO0 with respect to the LCD signal generators using ROP operation. No effect if the GPIO0 is configured as general GPIO.
0xC9	get_gpio0_rop	Get the GPIO0 properties with respect to the LCD signal generators.
0xCA	set_gpio1_rop	Set the GPIO1 with respect to the LCD signal generators using ROP operation. No effect if the GPIO1 is configured as general GPIO.
0xCB	get_gpio1_rop	Get the GPIO1 properties with respect to the LCD signal generators.
0xCC	set_gpio2_rop	Set the GPIO2 with respect to the LCD signal generators using ROP operation. No effect if the GPIO2 is configured as general GPIO.
Hex Code	Command	Description
0xCD	get_gpio2_rop	Get the GPIO2 properties with respect to the LCD signal generators.
0xCE	set_gpio3_rop	Set the GPIO3 with respect to the LCD signal generators using ROP operation. No effect if the GPIO3 is configured as general GPIO.
0xCF	get_gpio3_rop	Get the GPIO3 properties with respect to the LCD signal generators.
0xD0	set_dbc_conf	Set the dynamic back light configuration
0xD1	get_dbc_conf	Get the current dynamic back light configuration
0xD4	set_dbc_th	Set the threshold for each level of power saving
0xD5	get_dbc_th	Get the threshold for each level of power saving
0xE0	set_pll	Start the PLL. Before the start, the system was operated with the crystal oscillator or clock input
0xE2	set_pll_mn	Set the PLL
0xE3	get_pll_mn	Get the PLL settings
0xE4	get_pll_status	Get the current PLL status
0xE5	set_deep_sleep	Set deep sleep mode
0xE6	set_lshift_freq	Set the LSHIFT (pixel clock) frequency
0xE7	get_lshift_freq	Get current LSHIFT (pixel clock) frequency setting
0xE8	Reserved	Reserved
0xE9	Reserved	Reserved
0xF0	set_pixel_data_interface	Set the pixel data format of the parallel host processor interface
0xF1	get_pixel_data_interface	Get the current pixel data format settings
0xFF	Reserved	Reserved

Note. Please Refer to SSD1963 datasheet for details.

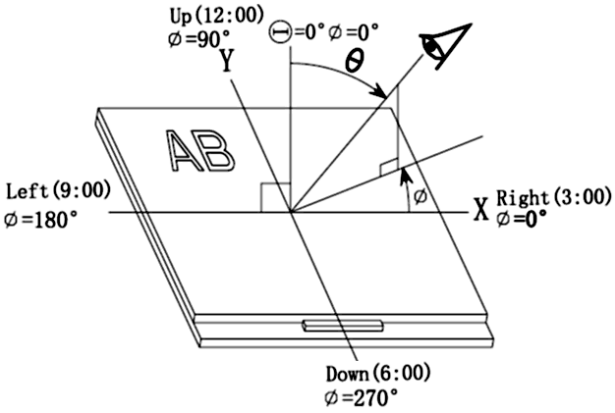
8. Optical Characteristics

Item		Symbol	Condition	MIN.	TYP.	MAX.	UNIT	Note.
Viewing angle		θ_T	(CR≥10)	40	50	-	degree	Note 2
		θ_B		60	70	-		
		θ_L		60	70	-		
		θ_R		60	70	-		
Contrast ratio		CR	θ=0°	500	600	-	-	Note 1,3
Response Time		T_{on}	25℃	-	20	30	msec	Note 1,4
		T_{off}					msec	
Chromaticlty	White	X	Backlight is on	0.260	0.310	0.360		Note 1,5
		Y		0.280	0.330	0.380		
	Red	X		0.540	0.590	0.640		
		Y		0.300	0.350	0.400		
	Green	X		0.298	0.348	0.398		
		Y		0.520	0.570	0.620		
	Blue	X		0.095	0.145	0.195		
		Y		0.060	0.110	0.160		
Luminance		L		200	250	-	cd/m^2	Note 1,6
NTSC				-	50		%	Note 5
Luminance uniformity		U		75	80	-	%	Note 1,7

Test Conditions:
1. IF= 40mA, VF=21.7V, no touch panel, and the ambient temperature is 25 ℃.
2. The test systems refer to Note 1 and Note 2.

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 SR-3A (1°)
Measuring condition:
- Measuring surroundings: Dark room
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.

Note 2:
The definition of viewing angle:
Refer to the graph below marked by θ and Φ

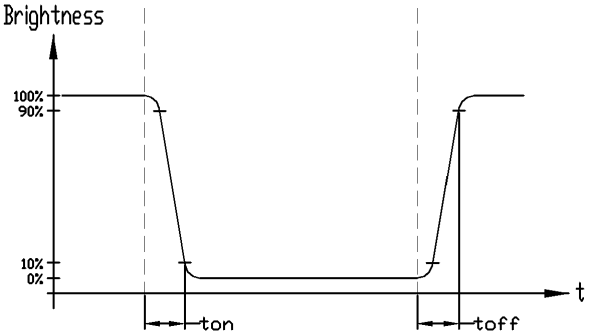


Note 3:
The definition of contrast ratio (Test LCM using SR-3A (1°)):

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

(Contrast Ratio is measured in optimum common electrode voltage)

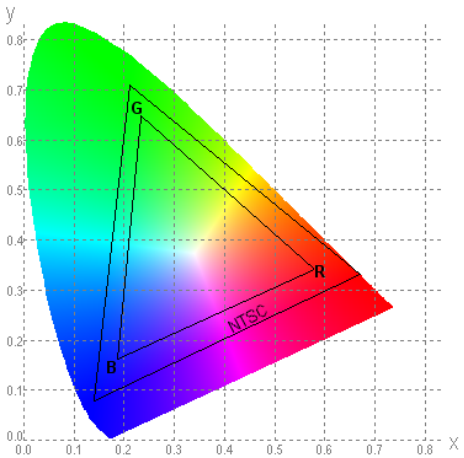
Note 4:
Definition of Response time. (Test LCD using BM-7A(2°)):
The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



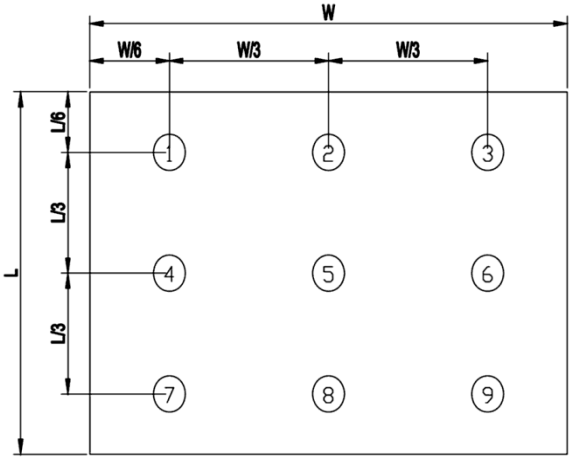
Note 5:
Definition of Color of CIE1931 Coordinate and NTSC Ratio.

Color gamut:

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



Note 6:
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 7:
Measured the luminance of white state at center point

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.