Laurel Electronics Co., Ltd.

LCD Module Specification

Model No.: LT070C-33A

7”, 800 (RGB) x 480 TFT LCM WITH MCU INTERFACE

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RECORD OF REVISION

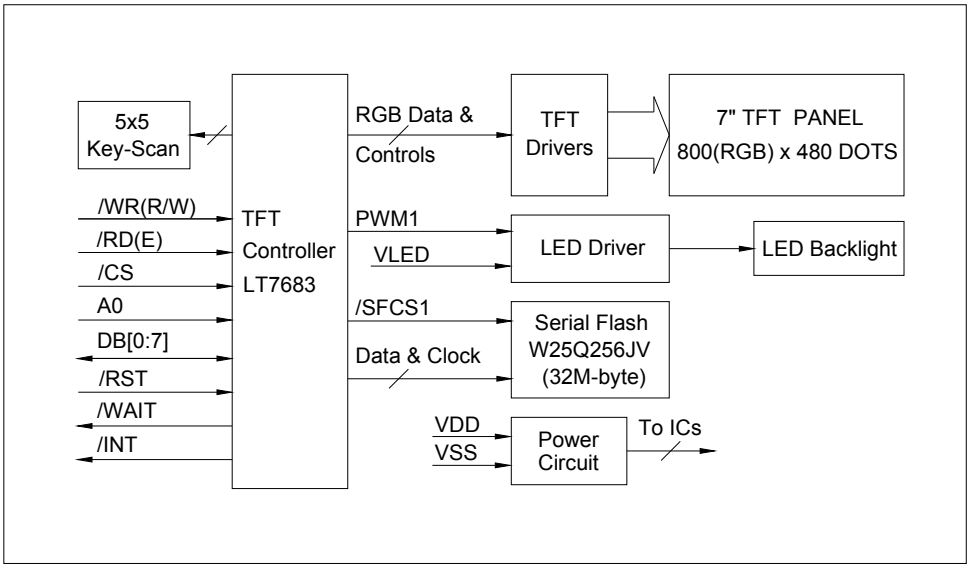
Rev.	Date	Page	Item	Description
0.1	2018/08/22	-	-	New release
0.2	2019/03/08	9, 10 13	3.9, 3.12 5	1. Change SPI flash from 16MB to 32MB 2. Update dimensional outline

1. BASIC SPECIFICATIONS

1.1 Features

Item	Specifications	Unit
Screen Size	7 (Diagonal)	inch
Resolution	800 (RGB) x 480	dot
Display Mode	Normally white, transmissive TFT	-
Color Configuration	RGB-Stripe	-
Color Depth	16-bit (RGB=565), 65K colors	-
Viewing Direction	6:00 o'clock (Gray scale inversion direction)	
Outline Dimension (WxHxT)	190.0 x 105.0 x 12.5	mm
Viewing Area (WxH)	156.4 x 89.0	mm
Active Area (WxH)	154.08 x 85.92	mm
Dot Pitch (WxH)	0.0642 x 0.179	mm
Display RAM (Frame Buffer)	16M	byte
Serial (SPI) Flash Memory	32M	byte
Touch Panel	None	-
Weight	240	g
LCD Controller	LT7683	-
Interface Mode	8-bit 8080/6800 parallel, 3/4-wire SPI or I2C	-
Power Supply (V_{DD})	3.3	V
Power Supply (V_{LED})	4.5 to 9.0	V

1.2 Block Diagram



1.3 Terminal Functions for LCD Control (CN1: Thru-holes; CN2: FFC)

Pin No.	Symbol	Level	Function
1	VSS	0V	Ground (connects to frame ground via jumper J5)
2	VSS	0V	Ground (connects to frame ground via jumper J5)
3	VDD	3.3V	Power supply for logic
4	VLED	4.5V to 9V	Power supply for LED backlight driver
5	/RST	L	Reset signal. Active “L”.
6	/WAIT	L	Wait signal output. Active “L”. When /WAIT is “H”, it indicates that LT7683 is ready to transfer data. When /WAIT is “L”, it indicates that LT7683 is in busy state. Keep /WAIT open when it is not used.
7	/INT	L	Interrupt signal output. Active “L”. The interrupt output for MCU to indicate the status of LT7683.
8	NC	-	No connection
9	DB7 (SCLK)	H/L	1. For parallel mode: DB[7:0] are 8-bit bi-directional data bus 2. For 3-wire or 4-wire SPI mode: DB7 is serial clock (SCLK) DB6 is serial data input (SDI) for 4-wire SPI DB6 is not used for 3-wire SPI. Connect it to VDD. DB5 is bi-directional data (SD) for 3-wire SPI DB5 is serial data output (SDO) for 4-wire SPI DB4 is serial chip selection (/SCS) DB[3:0] are not used for SPI mode. Connect them to VDD. 3. For I2C mode: DB7 is serial clock (SCLK) DB6 is bi-directional data (SDA) DB[5:0] are device address A[5:0] 4. DB[7:0] are pulled up by on-board 10KΩ resistors
10	DB6 (SDI/SDA)		
11	DB5 (SD/SDO/ I2CA[5])		
12	DB4 (/SCS, I2CA[4])		
13	DB3 (I2CA[3])		
14	DB2 (I2CA[2])		
15	DB1 (I2CA[1])		
16	DB0 (I2CA[0])		
17	A0	H/L	Data or instruction selection A0=“L”: DB0 to DB7 are Instruction code; A0=“H”: DB0 to DB7 are display data. Keep A0 open in serial mode.
18	/WR (R/W)	H/L	/WR signal for 8080 series MPU. Write data at rising edge of /WR. R/W signal for 6800 series MPU. R/W=“H”: Read; R/W=“L”: Write. Keep /WR(R/W) open in serial mode.
19	/RD(E)	H/L	/RD signal for 8080 series MPU. Read data when /RD is “L” Enable signal for 6800 series MPU. Read data when E is “H”, write data at falling edge of E. Keep /RD(E) open in serial mode.
20	/CS	L	Chip selection signal for parallel mode. Active “L”. Keep /CS open in serial mode.

Note: /WAIT, /INT, A0, /WR(R/W), /RD(E) and /CS are pulled up by on-board 10KΩ resistors.

1.4 Terminal Functions for Key-Scan (CN3: Thru-holes; CN4: FFC)

Pin No.	Symbol	I/O	Function
1	KI0	I	Keypad data inputs with internal pull-up resisters. Keep un-used inputs open.
2	KI1	I	
3	KI2	I	
4	KI3	I	
5	KI4	I	
6	KO0	O	Keypad strobe data outputs with open-drain. Keep un-used outputs open.
7	KO1	O	
8	KO2	O	
9	KO3	O	
10	KO4	O	

1.5 Terminal Functions for Programming SPI Flash W25Q256JV (CN5: Thru-holes)

Pin No.	Symbol	Level	Function
1	VSS	0V	Ground
2	VDD	3.3V	Power supply for logic
3	SFCLK	-	Serial clock input for SPI flash
4	DI (IO0)	-	Data input (data input output 0) for SPI flash
5	DO (IO1)	-	Data output (data input output 1) for SPI flash
6	/SFCS1	L	Chip selection for SPI flash. Active “L”.
7	TEST1	-	TEST1 pin of LT7683. It is pulled down by on-board 10KΩ resistor. TEST1 must be connected to VDD when programming the SPI flash.

Note: CN5 is only used to program SPI flash. Keep CN5 terminals open during normal operation.

1.6 Set Bus Mode by on Board Jumpers

The interface bus mode is determined by PSM[2:0]. The relationship between jumper status, PSM[2:0] levels and interface bus mode is below.

Jumper Status (C=Close; O=Open; X=Don’t Care)			PSM[2:0] Level	Interface Bus Mode
J3	J2	J1		
O	O	X	00X	8080 8-bit **<Default>**
O	C	X	01X	6800 8-bit
C	O	O	100	3-wire SPI
C	O	C	101	4-wire SPI
C	C	X	11X	I2C

Note: Bit0 of Register REG[01h] must be set to “0” to select 8-bit data for parallel mode.

2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic)	VDD	-0.3	4.0	V
Supply Voltage (LED)	VLED	-0.3	9.0	V
Input Voltage	VIN	-0.4	VDD + 0.3	V
Operating Temperature	Topr	-20	+70	°C
Storage Temperature	Tstg	-30	+80	°C

Cautions: Stresses above those listed as 'absolute maximum ratings' may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

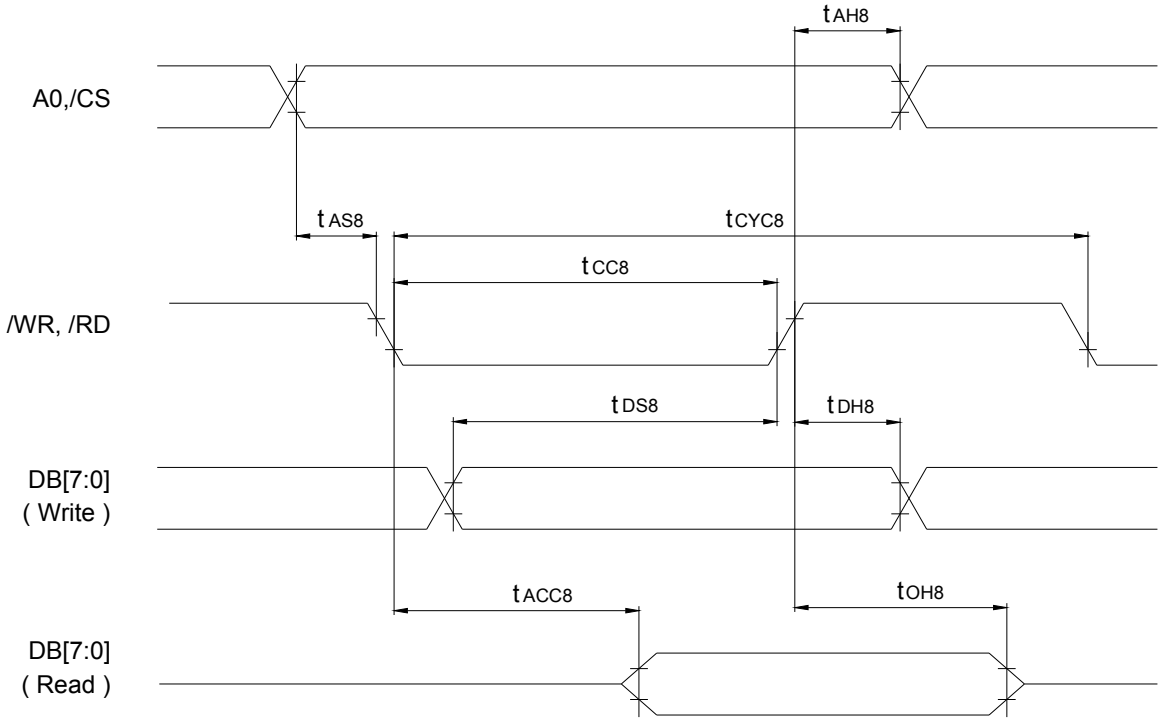
3. ELECTRICAL CHARACTERISTICS

3.1 DC Characteristics (Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage (Logic)	VDD		3.0	3.3	3.6	V
Supply Voltage (LED)	VLED		4.5	5.0	9.0	V
Input High Voltage	VIH		2.0	-	VDD	V
Input Low Voltage	VIL		-0.3	-	0.8	V
Output High Voltage	VOH		2.4	-	VDD	V
Output Low Voltage	VOL		0	-	0.4	V
Supply Current (Logic)	IDD	VDD = 3.3V	-	100.0	125.0	mA
Supply Current (LED)	ILED	VLED = 5.0V	-	300.0	360.0	mA
		VLED = 9.0V	-	160.0	190.0	mA
Oscillator Clock	FOSC	VDD = 3.3V	-	10.0	-	MHz

3.2 8080 8-bit Interface Mode Timing (VDD=3.0V to 3.6V, Ta=25°C)

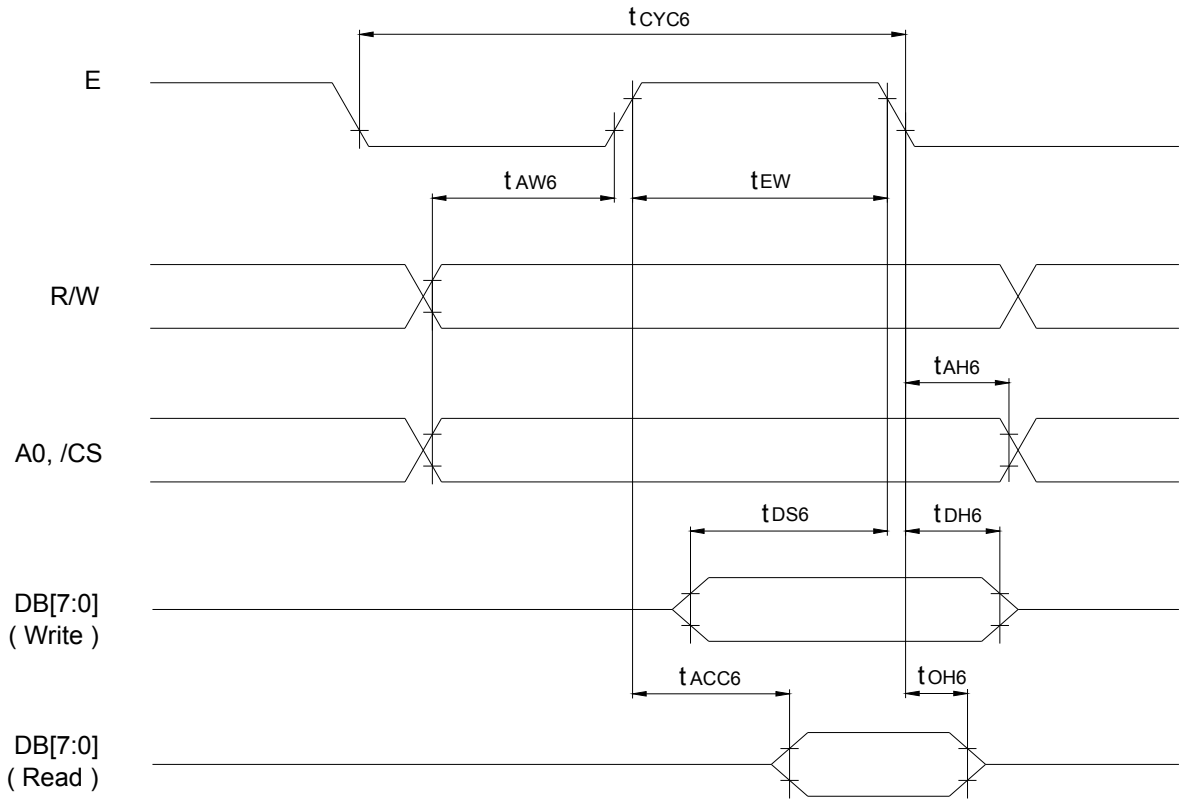
Characteristic	Symbol	Min.	Max.	Unit
Cycle Time	t_{CYC8}	50	-	ns
Strobe Pulse Width	t_{CC8}	20	-	ns
Address Setup Time	t_{AS8}	0	-	ns
Address Hold Time	t_{AH8}	10	-	ns
Data Setup Time	t_{DS8}	20	-	ns
Data Hold time	t_{DH8}	10	-	ns
Data Output Access Time	t_{ACC8}	0	20	ns
Data Output Hold Time	t_{OH8}	0	20	ns



Bus Read/Write Timing(8080 Series MPU)

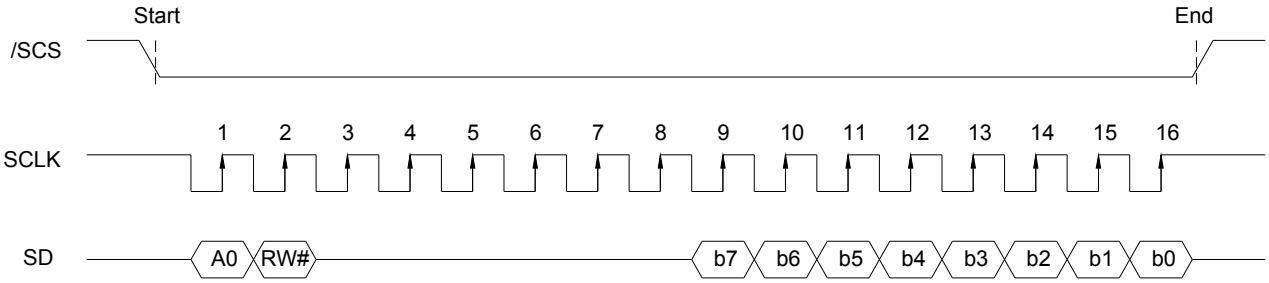
3.3 6800 8-bit Interface Mode Timing (3.0V to 3.6V, Ta=25°C)

Characteristic	Symbol	Min.	Max.	Unit
Cycle Time	t_{CYC6}	50	-	ns
Strobe Pulse Width	t_{EW}	20	-	ns
Address Setup Time	t_{AW6}	0	-	ns
Address Hold Time	t_{AH6}	10	-	ns
Data Setup Time	t_{DS6}	20	-	ns
Data Hold Time	t_{DH6}	10	-	ns
Data Output Access Time	t_{ACC6}	0	20	ns
Data Output Hold Time	t_{OH6}	0	20	ns

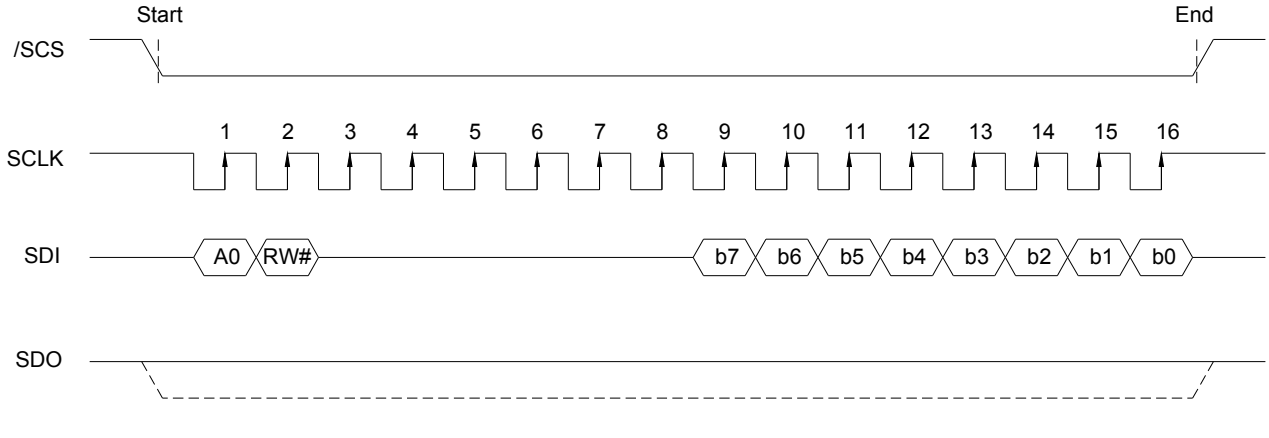


Bus Read/Write Timing(6800 Series MPU)

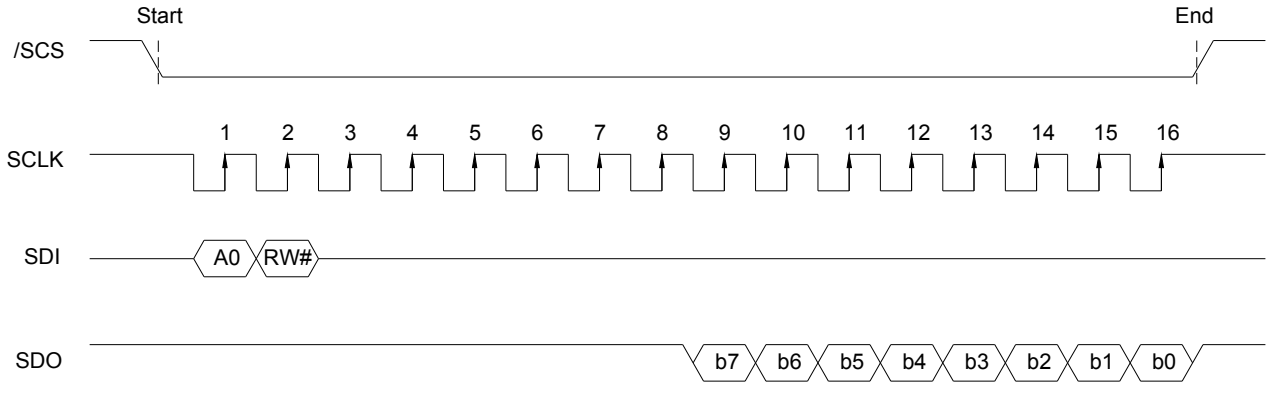
3.4 3-wire SPI Interface Mode Timing (3.0V to 3.6V, Ta=25°C, Max. SCLK=50MHz)



3.5 4-wire SPI Interface Mode Timing (3.0V to 3.6V, Ta=25°C, Max. SCLK=50MHz)

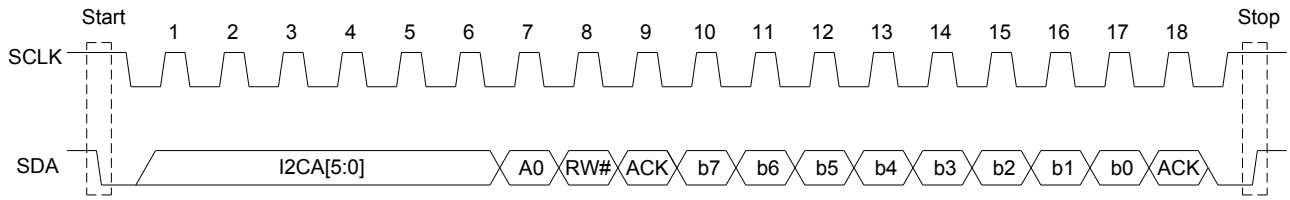


4-wire SPI Write



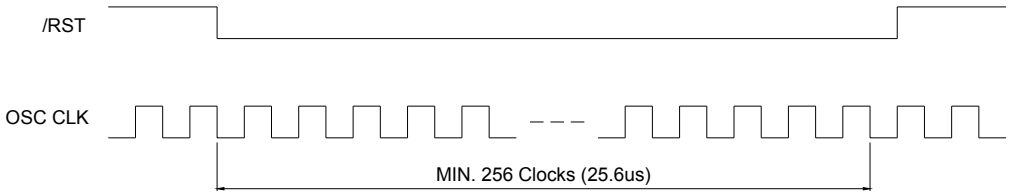
4-wire SPI Read

3.6 I2C Interface Mode Timing (3.0V to 3.6V, Ta=25°C, SCLK=100kbps to 400kpbs)



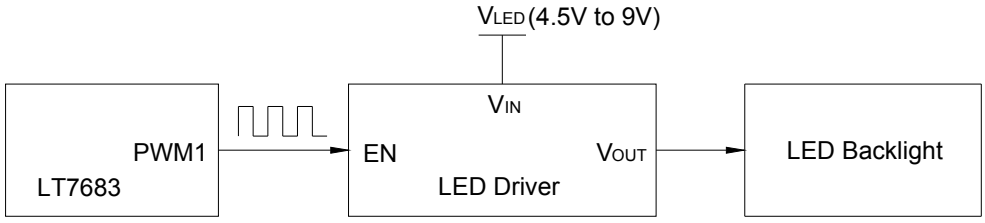
3.7 Reset Timing

The reset terminal /RST allows LT7683 to synchronize with external systems. The /RST signal must stabilize at least 256 crystal (OSC) clocks (25.6μs) to be recognized. The MCU should check the BIT1-working mode status indication bit of the state register STSR before starting to set LT7683 to ensure that LT7683 is currently in "Normal Running State".



3.8 LED Backlight Control

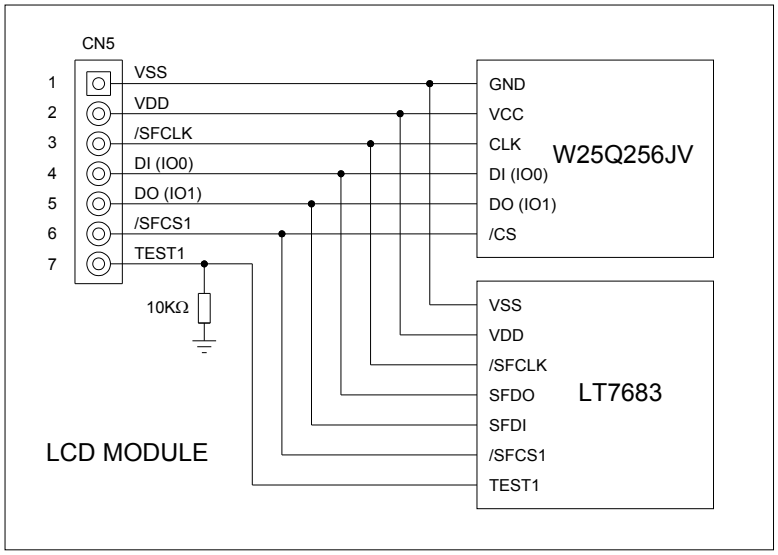
The LED backlight is driven by a LED driver IC. The enable signal of the LED driver is connected to PWM1 of LT7683. The LED driver is enabled when PWM1=”1” or disabled when PWM1=”0”. The LED backlight operates at either zero or full current. The average LED backlight current increases proportionally with the duty cycle of the PWM1 signal. A 0% duty cycle will turn off the LED driver and corresponds to zero LED current. A 100% duty cycle corresponds to full current. The typical frequency range of the PWM1 signal can be 1 KHz or less. The oscillator clock of LT7683 is 10MHz (Fosc).



PWM1=1: LED B/L On
PWM1=0: LED B/L Off

VLED : Power supply for LED driver

3.9 Connection for SPI Flash W25Q256JV (U2)



3.10 LT_IMAGE_TOOL.EXE

Levetop provides a dedicated PC program LT_IMAGE_TOOL.EXE that can be used to make BIN file of pictures, BIN file of Chinese font, BIN file of GIF, graphical cursor, the program code for the "Power-on Display" and the integration tool of BIN files. Please refer to LT7683 Application Notes for details.

3.11 Power-on Display

LT7683's “Power-on Display” circuit embedded a small microprocessor unit. The main function is to quickly display the screen at boot time by executing the program code stored in the SPI Flash memory in the absence of Host, or when the Host is still in its start-up phase.

The PWM0 pin of LT7683 is pulled up by on-board 10K resistor, and the "Power-on Display" function is enabled. Since the first 1K-byte data (address 00000000h to 000003FFh) of SPI flash is filled with “00h” (factory default setting), the “Power-on Display” function will not be identified and the master control will be transferred to Host after power-on.

Users can use the LT_IMAGE_TOOL.EXE program on PC side to generate the program code for the power-on display.

3.12 Factory default Settings for SPI Flash W25Q256JV (32M-byte)

The on-board SPI Flash Memory is used as the source of image data, font libraries, and the program code for the "Power-on Display" function.

Address	Size (Byte)	Description
00000000h to 000003FFh	1K	Filled with “00h”
00000400h to 000417FFh	261K	GB2312 Simplified Chinese font, font size 16x16 pixels
00041800h to 000D44FFh	587.25K	GB2312 Simplified Chinese font, font size 24x24 pixels
000D4500h to 001D94FFh	1044K	GB2312 Simplified Chinese font, font size 32x32 pixels
001D9500h to 00294CFFh	750K	Picture 1 image data (16bpp)
00294D00h to 003504FFh	750K	Picture 2 image data (16bpp)
00350500h to 0040BCFFh	750K	Picture 3 image data (16bpp)
0040BD00h to 004C74FFh	750K	Picture 4 image data (16bpp)
004C7500h to 00582CFFh	750K	Picture 5 image data (16bpp)
00582D00h to 0063E4FFh	750K	Picture 6 image data (16bpp)
0063E500h to 006F9CFFh	750K	Picture 7 image data (16bpp)
006F9D00h to 0075C03Fh	392.8125K	Image data for 8 icons (16bpp)
0075C040h to 00AA7C3Fh	3375K	Image data for GIF (320x180@16bpp, total 30 frames)
00AA7C40h to 00FFFFFFh	5472.9375K	Filled with “FFh”
01000000h to 01FFFFFFh	16M	Filled with “FFh”

3.13 Setting LCD Parameters

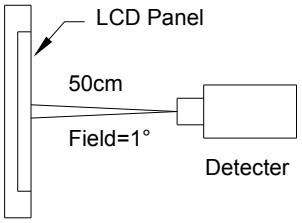
Please refer to the table below to set the LCD panel parameters.

Parameters	Symbol	Value	Unit	Active Level	Remark
DCLK Frequency	fclk	33.3	MHz	PCLK_Falling	
Horizontal Display Area	thd	800	DCLK		LCD_XSIZE_TFT
HS Pulse Width	thpw	8	DCLK	HSYNC_Low_Active	LCD_HSPW
HS Back Porch (Blanking)	thb	38	DCLK		LCD_HBPD
HS Front Porch	thfp	210	DCLK		LCD_HFPD
Vertical Display Area	tvd	480	TH		LCD_YSIZE_TFT
VS Pulse Width	tvpw	1	TH	VSYNC_Low_Active	LCD_VSPW
VS Back Porch (Blanking)	tvb	22	TH		LCD_VBPD
VS Front Porch	tvfp	22	TH		LCD_VFPD
DE/SYNC Mode Selection	SYNC Mode			DE_High_Active	
LCD Interface	16bit TFT				
LCD Interface RGB	RGB				
Main Window Color	16bpp				

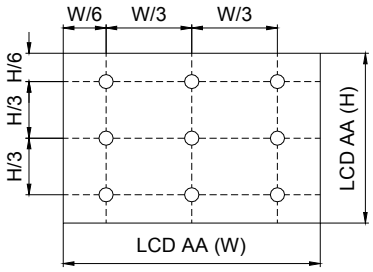
4. ELECTRO-OPTICAL CHARACTERISTICS (Ta=25°C)

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note
Brightness	Bp		Θ=0° Φ=0°	-	250	-	cd/m^2	1
Uniformity	△Bp			70%	-	-	-	1, 2
Viewing Angle	Hor	ΘR	Cr ≥10	-	70	-	Degree	3
		ΘL		-	70	-		
	Ver	ΘU		-	50	-		
		ΘD		-	70	-		
Contrast Ratio	Cr		Θ=0° Φ=0°	400	500	-	-	4
Response Time	Tr			-	10	20	ms	5
	Tf			-	15	30		
Color Coordinate	Wx			0.26	0.31	0.36	-	1, 6
	Wy			0.28	0.33	0.38	-	

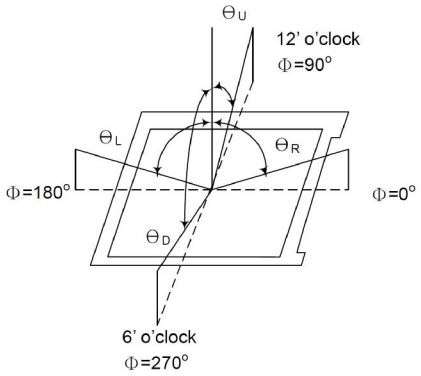
Note 1: The optical characteristics should be measured by BM-7 in dark room after 15 minutes operation. The optical properties are measured at the center point of the LCD.



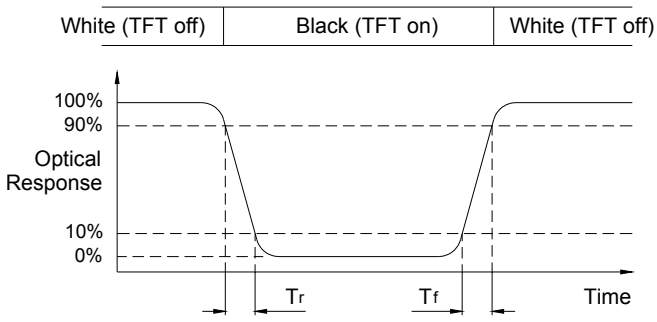
Note 2: △ Bp=Bp (Min.) / Bp (Max.) × 100 (%)
Bp(Max.)=Maximum brightness in 9
Bp(Min.)=Minimum brightness in 9



Note 3: Definition of Viewing Angle



Note 5: Definition of Response Time

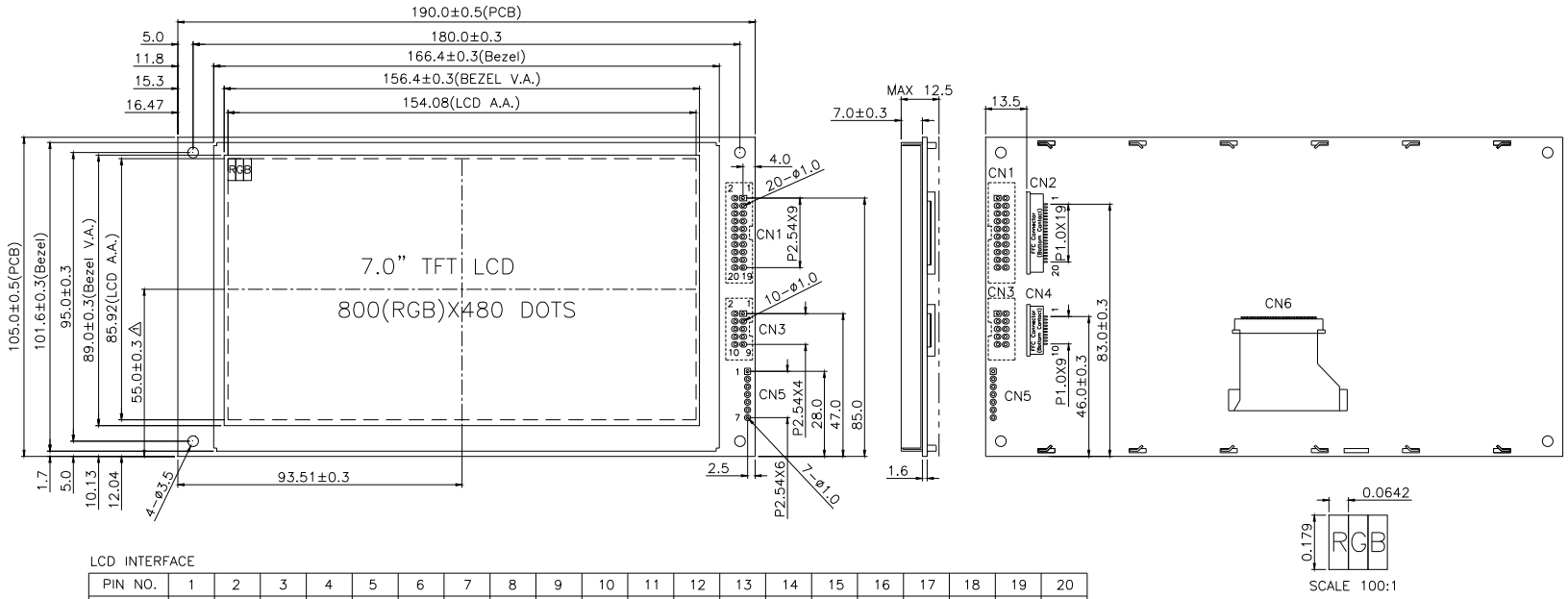


Note 4: Definition of Contrast Ratio

$$\text{Contrast Ratio (Cr)} = \frac{\text{Brightness measured when LCD on "White" State}}{\text{Brightness measured when LCD on "Black" state}}$$

Note 6: Definition of color chromaticity (CIE1931)
Color coordinates measured at center point of LCD.

5. DIMENSIONAL OUTLINE



LCD INTERFACE

PIN NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CN1,CN2	Vss	Vss	VDD	VLED	/RST	/WAIT	/INT	NC	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	A0	/WR	/RD	/CS

KEY-SCAN INTERFACE

PIN NO.	1	2	3	4	5	6	7	8	9	10
CN3,CN4	KI0	KI1	KI2	KI3	KI4	KO0	KO1	KO2	KO3	KO4

SPI FLASH PROGRAMMING INTERFACE

PIN NO.	1	2	3	4	5	6	7
CN5	Vss	VDD	SFCLK	DI(IO0)	DO(IO1)	/SFCS1	TEST1

Notes:
1. 7.0" TFT, Transmissive, 800(RGB)*480 Pixels
2. Viewing Direction: 6:00
3. LCD Controller: LT7683
4. Interface: 8-Bit Parallel/SPI/I2C
5. Operation Temp.: -20°C to 70°C
6. Storage Temp.: -30°C to 80°C
7. VDD=3.3V, VLED=4.5V to 9.0V

REV.	DESCRIPTION	DATE	DWN.	LY	TITLE	LCM OUTLINE DIMENSION		
			CHK.	LYJ	PART NO.	LT070C		
B	Change LCD center line position ⚠	2019.03.08	APPD.		DWG. NO.	LT070C-WXB		
A	New issue	2018.07.20	REV.	B	UNIT	mm	PROJECTION	
			DATE	2019.03.08	SCALE	NTS	SHEET	1 OF 1

6. PRECAUTIONS FOR USE OF LCD MODULE

6.1 Handing Precautions

1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
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.
3) Do not apply excessive force on the surface of display or the adjoining areas of LCD module since this may cause the color tone to vary.
4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
5) If the display surface of LCD module becomes contaminated, blow on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, 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
6) When mounting the LCD module make sure that it is free of twisting, warping, and distortion. Distortion has great influence upon display quality. Also keep the stiffness enough regarding the outer case.
7) Be sure to avoid any solvent such as flux for soldering never stick to Heat-Seal. Such solvent on Heat-Seal may cause connection problem of heat-Seal and TAB.
8) Do not forcibly pull or bend the TAB I/O terminals.
9) Do not attempt to disassemble or process the LCD module.
10) NC terminal should be open. Do not connect anything.
11) If the logic circuit power is off, do not apply the input signals.
12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
   · Be sure to ground the body when handling the LCD module.
   · Tools required for assembly, such as soldering irons, must be properly grounded.
   · To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
   · The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

6.2 Storage Precautions

1) When storing the LCD module, avoid exposure to direct sunlight or to the light of fluorescent lamps and high temperature/high humidity. Whenever possible, the LCD module should be stored in the same conditions in which they were shipped from our company.
2) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets or a current flow in a high humidity environment.

6.3 Design Precautions

1) The absolute maximum ratings represent the rated value beyond which LCD module can not exceed. When the LCD modules are used in excess of this rated value, their operating characteristics may be adversely affected.

2) To prevent the occurrence of erroneous operation caused by noise, attention must be paid to satisfy VIL, VIH specification values, including taking the precaution of using signal cables that are short.
3) The liquid crystal display exhibits temperature dependency characteristics. Since recognition of the display becomes difficult when the LCD is used outside its designated operating temperature range, be sure to use the LCD within this range. Also, keep in mind that the LCD driving voltage levels necessary for clear displays will vary according to temperature.
4) Sufficiently notice the mutual noise interference occurred by peripheral devices.
5) To cope with EMI, take measures basically on outputting side.
6) If DC is impressed on the liquid crystal display panel, display definition is rapidly deteriorated by the electrochemical reaction that occurs inside the liquid crystal display panel. To eliminate the opportunity of DC impressing, be sure to maintain the AC characteristics of the input signals sent to the LCD Module.

6.4 Others

1) Liquid crystals solidify under low temperatures (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the LCD module is subjected to a strong shock at a low temperature.
2) If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
3) To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity, etc., exercise care to avoid touching the following sections when handling the module:
   · Terminal electrode sections.
   · Part of pattern wiring on TAB, etc.