

**SPECIFICATION
FOR
LCM MODULE**

MODULE NO.: BG16032-01

REVISION NO.: V0

Customer Approval:

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	SIGNATURE
PREPARED BY	Shawn
VERIFIED BY	William
APPROVED BY	Rio

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3. FEATURES

Single-chip LCD Controller & Driver

Driver Output Circuits

- ✘ 160-segment / 32-common

On-chip Display Data RAM (DDRAM)

- ✘ Capacity: 160x32= 5120 bits

Microprocessor Interface

- ✘ 8-bit parallel bi-directional interface supports 6800-series MPU

Built-in Oscillation Circuit

- ✘ Oscillator requires no external component
- ✘ Programmable frame frequency

External RST (hardware reset) Pin

Various Display Functions

- ✘ Partial display

Low Power Consumption Analog Circuit

- ✘ Voltage booster with internal capacitor (X6)
- ✘ Wide voltage regulator output range
- ✘ Built-in temperature compensation circuit
Voltage Gradient: -0.06%/°C
- ✘ Built-in voltage follower for LCD bias voltages:
1/6 Bias

4. GENERAL SPECIFICATIONS

ITEM	DESCRIPTION	UNIT
Outline Size	98.0×54.25×10.7 (Not including connectors)	mm
LCD Type	FSTN, Transflective / Positive, 1/32Duty, 1/6Bias	---
Display type	160×32 dots	---
LCD View Area	81.0×18.6	mm
Display Area	75.16×15.00	mm
Dots size	0.43×0.43	mm
Dots pitch	0.47×0.47	mm
Controller & driver	ST7525-G4	---
View Direction	6 O'Clock	---
Interface mode	8 bit 6800	---
VDD&VOP(Type)	5.0 V & 7.0 V	V
Backlight	R-G-B LED, 5.0V; Uniformity ≥ 75%	---
Operation Temp.	-20~+70	°C
Storage Temp.	-30~+80	°C

5. OUTLINE DIMENSIONS

Version	1.0	2022-08-23	New Issue				
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160x32 DOTS
View Direction

FRONT REAR
STIFFENER CONTACT SIDE

DETAIL:A

DETAIL:B

DOT DETAIL

SPECIFICATIONS:

1. DISPLAY TYPE: FSTN / POSITIVE / TRANSFLECTIVE
2. DRIVE IC: ST7525 or EQV.
3. CONNECTOR: FLEX CABLE
4. OPERATING VOLTAGE: VOP = 7.0±0.2V, VDD = 5.0V
5. OPERATING TEMPERATURE: -20 ~ 70°C
6. STORAGE TEMPERATURE: -30 ~ 80°C
7. DRIVE MODE: 1/32 DUTY, 1/6 BIAS
8. VIEWING ANGLE: 6 O'CLOCK
9. BACKLIGHT: 4 PCS RGB LED, Vf = 5.0V, If = 60mA
10. CUSTOMER PART NO.: BOCEN STANDARD PRODUCT

LED BACKLIGHT CIRCUIT

PIN	SYMBOL
1	VSS
2	VDD
3	V0
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	LED-R
16	VSS
17	KN1
18	KN2
19	KN3
20	KN4
21	KN5
22	KN6
23	LED-G
24	LED-B

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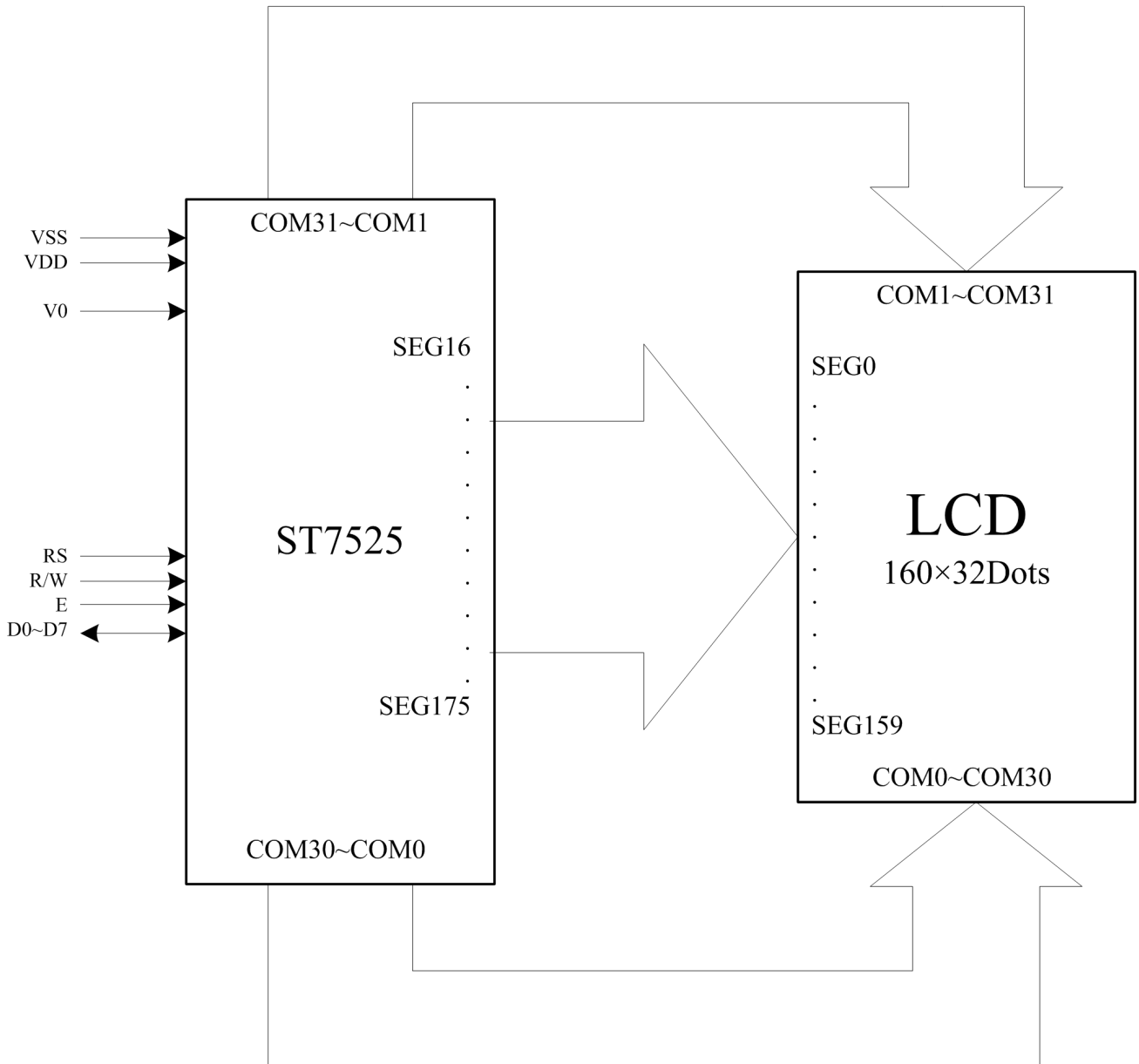
DESIGNED BY: Shawn	BG16032-01	VERSION: 1.0
CHECKED BY: William		NO.: 1 OF 1
APPROVED BY: Rio		UNIT: mm
Website: http://www.bocentech.com		DATE: 2022-08-23

6. PIN CONNECTIONS

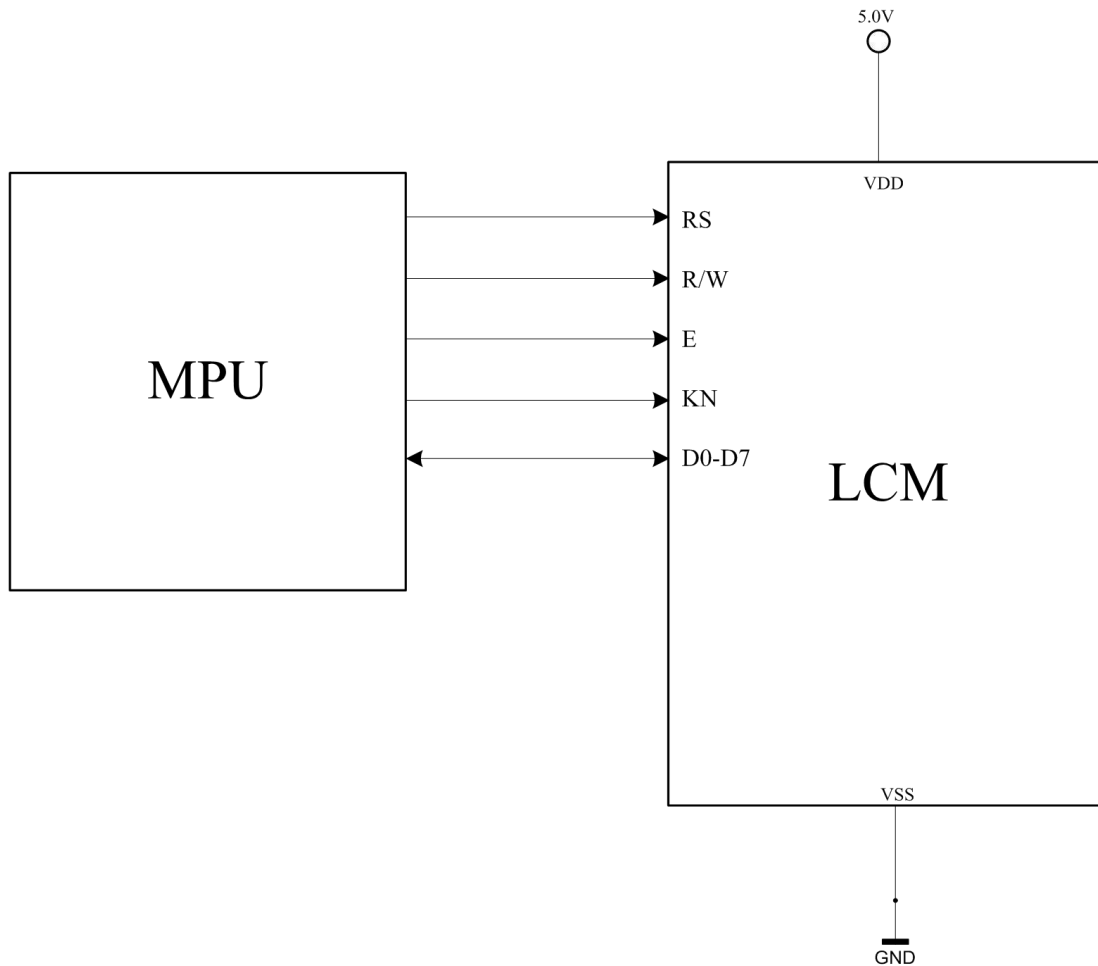
ST7525

Pin No.	Pin Out	Description
1	VSS	Ground.
2	VDD	Power supply for logic circuit.
3	V0	V0 is the LCD driving voltage for common circuits at negative frame.
4	RS	It determines whether the access is related to data or command. RS="H" : Indicates that D[7:0] are display data. RS="L" : Indicates that D[7:0] are control data.
5	R/W	Read/Write control input pin. R/W="H": read. R/W="L": write.
6	E	Read/Write control input pin. R/W="H": When E is "H", D[7:0] are in an output status. R/W="L": Signals on D[7:0] are latched at the falling edge of E signal.
7	DB0	8-bit bi-directional data bus. Connect to the data bus of 8-bit microprocessor.
8	DB1	
9	DB2	
10	DB3	
11	DB4	
12	DB5	
13	DB6	
14	DB7	
15	LED_R	Red LED backlight to LCD and Button.
16	VSS	Ground.
17	KN1	Button 1.
18	KN2	Button 2.
19	KN3	Button 3.
20	KN4	Button 4.
21	KN5	Button 5.
22	KN6	Button 6.
23	LED_G	Green LED backlight to LCD and KEY.
24	LED_B	Blue LED backlight to LCD and KEY.

7. BLOCK DIAGRAM



8. APPLICATION CIRCUIT EXAMPLE



9. ABSOLUTE MAXIMUM RATING

ELECTRICAL ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN	MAX	UNIT
POWER SUPPLY FOR LOGIC	VDD-VSS	-0.3	6.0	V
POWER SUPPLY FOR LCD DRIVE	V0-XV0	-0.3	13.5	V
INPUT VOLTAGE	VIN	-0.3	VDD+0.3	V
POWER SUPPLY FOR LED (RED)	VA-VK	-0.3	5.5	V
POWER SUPPLY FOR LED (GREEN)	VA-VK	-0.3	5.5	V
POWER SUPPLY FOR LED (BLUE)	VA-VK	-0.3	5.5	V

ENVIRONMENTAL ABSOLUTE MAXIMUM RATINGS

ITEM	OPERATING		STORAGE		UNIT	COMMENT
	MIN	MAX	MIN	MAX		
AMBIENT TEMPERATURE	-20	+70	-30	+80	°C	
HUMIDITY	NOTE(1)		NOTE(1)		--	WITHOUT CONDENSATION
VIBRATION (M/S ²)	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
TEMPERATURE CYCLING TEST	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
CORROSIVE GAS	NOT ACCEPTABLE		NOT ACCEPTABLE		--	

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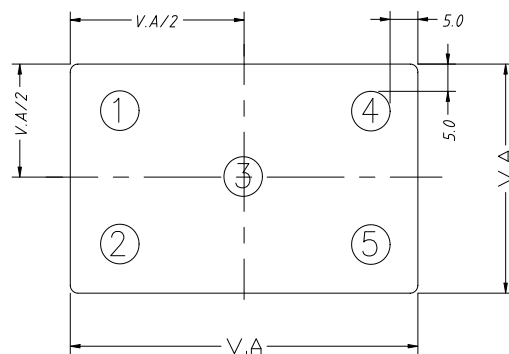
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10. ELECTRICAL CHARACTERISTICS (V_{SS}=0V)

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Power Supply for Logic	V _{IN} -V _{SS}	T _a =0~+50°C	4.5	5.0	5.5	Volt	
Power Supply for Logic	V _{DD} -V _{SS}	T _a =0~+50°C	3.1	3.3	3.5	Volt	
Input Voltage	V _{IL}	V _{DD} =3V±5%	V _{SS}		0.3 V _{DD}	Volt	
	V _{IH}		0.7 V _{DD}	-	V _{DD}	Volt	
Output Voltage	V _{OL}	V _{DD} =3V±5%	V _{SS}	-	0.3 V _{DD}	Volt	
	V _{OH}		0.7 V _{DD}	-	V _{DD}	Volt	
LCD drive Voltage (recommended Voltage)	XV0 -V0	T _a =0°C	--	--	--	Volt	
		T _a =25°C	6.8	7.0	7.2		
		T _a =50°C	--	--	--		
Power Supply Current for LCM	I _{DD}	V _{DD} =5.0V T _a =25°C	--	5	--	mA	-
	R ILED	V _{LED} = 5.0 V	--	100	120	mA	Note1
	G ILED	V _{LED} = 5.0 V	--	120	160	mA	
	B ILED	V _{LED} = 5.0 V		120	160	mA	

Note1: Backlight Electrical-Optical Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Conditon
Luminance	L _v (Red)	-	-	-	CD/m ²	IR=100mA IG=120mA IB=120mA
	L _v (Green)	-	-	-	CD/m ²	
	L _v (Blue)	-	-	-	CD/m ²	
Wavelength Range	Red	620	-	625	nm	
	Green	520	-	525	nm	
	Blue	462	-	467	nm	
Brightness uniformity	△%	75	-	-	%	min / max * 100%

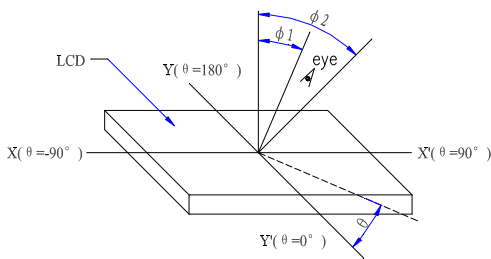


Uniformity Test

11. ELECTRO-OPTICAL CHARACTERISTICS

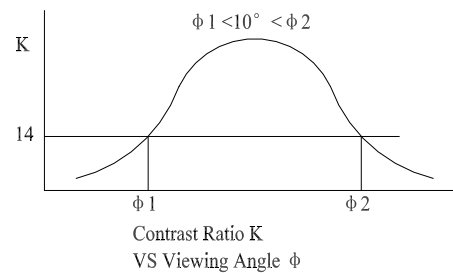
Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Viewing angle range	$\Theta 2 - \Theta 1$	$T_a = 25^\circ\text{C}$	20	-	-	Deg	K=1.4 A,B
	Φ		-	-	-		
Rise Time	T_r	$T_a = 25^\circ\text{C}$	-	200	300	ms	$\Phi = 10$ $\Theta = 0$ C
		$T_a = 0^\circ\text{C}$	-	-	-		
Fall Time	T_f	$T_a = 25^\circ\text{C}$	-	214	300	ms	$\Phi = 10$ $\Theta = 0$ C
		$T_a = 0^\circ\text{C}$	-	-	-		
Contrast	Cr	$T_a = 25^\circ\text{C}$	-	8	-	-	$\Phi = 10$ $\Theta = 0$ D

11.1 Definition of angle θ and ϕ



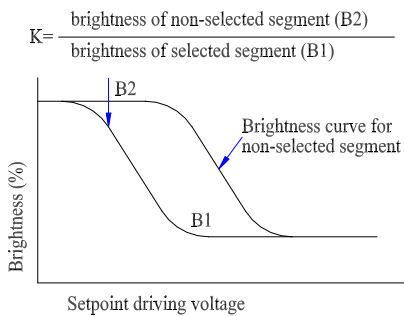
POSITIVE TYPE

11.2 Definition of viewing angle $\phi 1$ and $\phi 2$



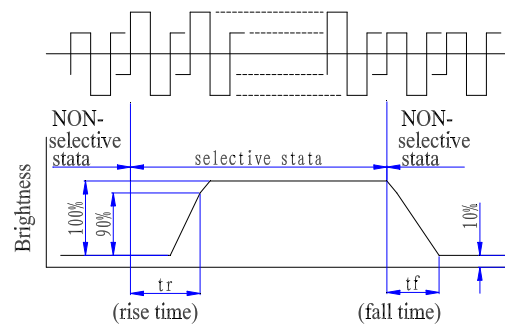
POSITIVE TYPE

11.3 Definition of contrast "K"

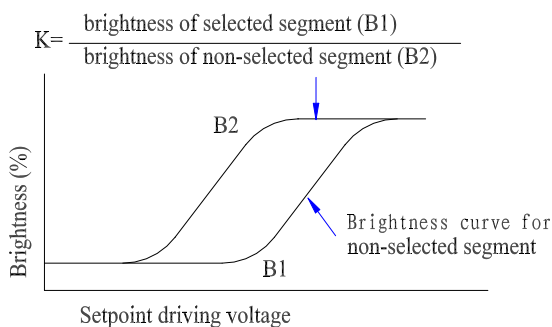


NEGATIVE TYPE

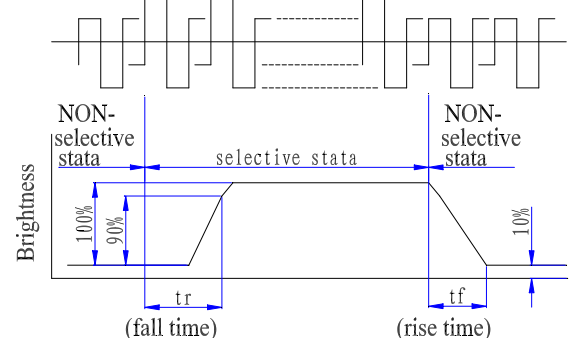
11.4 Definition of optical response



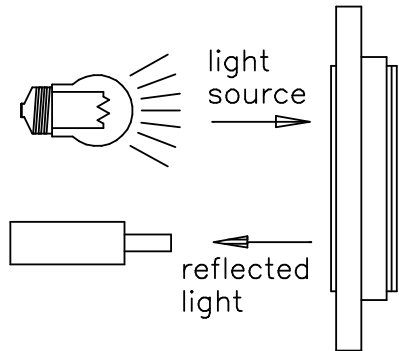
11.5 Definition of contrast "K"



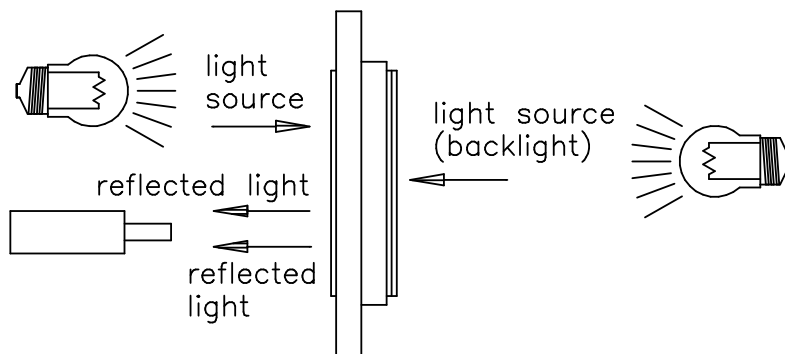
11.6 Definition of optical response



11.7 DESCRIPTION OF MEASURING EQUIPMENT



Reflective type



Transflective type

12. CONTROLLER ELECTRICAL CHARACTERISTICS

DC Characteristics

VSS=VSS1=VSS2=VSS3=0V; Bare chip; Temp. = -30°C to +85°C; unless otherwise specified.

Item	Symbol	Condition	Rating			Unit	Applicable Pin	
			Min.	Typ.	Max.			
Operating Voltage (1)	VDD1		1.65	—	3.6	V	VDD1	
Operating Voltage (2)	VDD2 VDD3		2.4	—	3.6	V	VDD2 VDD3	
LCD Power Supply Voltage	Vop		4.8	—	11.5	V	V0-XV0	
Input High-Level Voltage	V _{IHC}		0.7 x VDD1	—	VDD1	V	MPU Interface	
Input Low-Level Voltage	V _{ILC}		VSS1	—	0.3 x VDD1	V	MPU Interface	
Output High-Level Voltage	V _{OHC}	I _{OUT} =1mA, VDD1=1.8V	0.8 x VDD1	—	VDD1	V	D[7:0]	
Output Low-Level Voltage	V _{OLC}	I _{OUT} =-1mA, VDD1=1.8V	VSS1	—	0.2 x VDD1	V	D[7:0]	
Input Leakage Current	I _{LI}		-1.0	—	1.0	μA	MPU Interface	
LCD Driver ON Resistance	R _{ON}	Ta=25°C Bias=1/9	Vop=10V, ΔV=1V	—	0.7	—	KΩ	COMx
			VG=2.2V, ΔV=0.22V	—	0.7	—	KΩ	SEGx
Frame Frequency	fFR	1/65 Duty, FR[1:0]=(0,0), Ta = 25°C	72	76	80	Hz		

Note:

- The LCD Output Voltage (Vop) range of the measurement environment is as follows:
V0 to XV0 : 1uF
- The maximum possible Vop voltage that may be generated is dependent on voltage, temperature and panel loading.

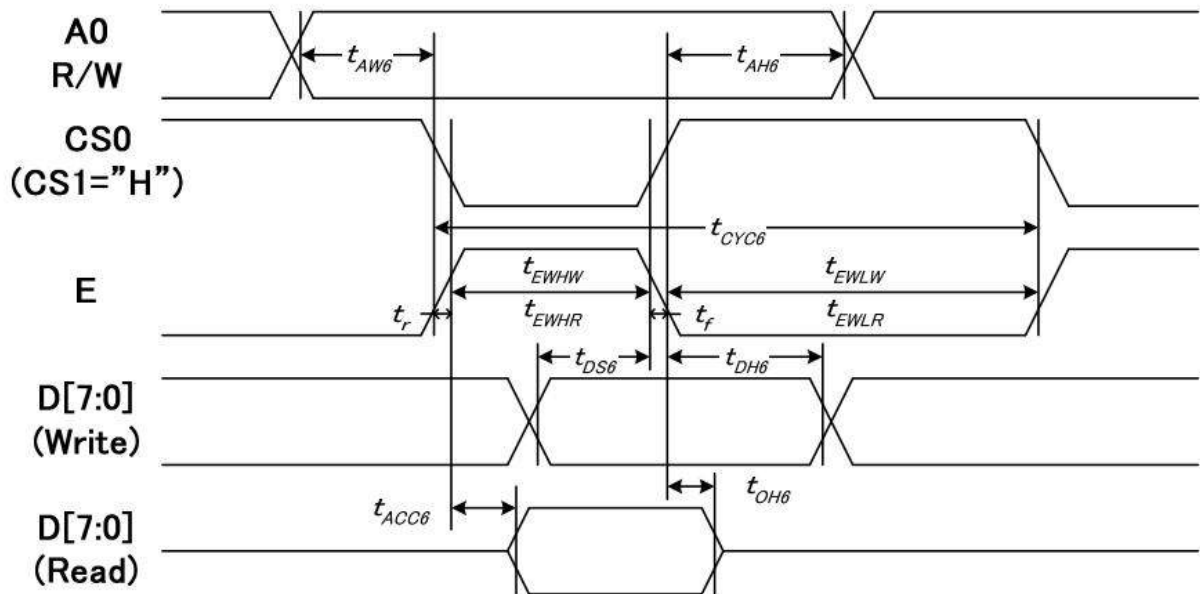
Bare chip current consumption with internal power system:

Test Pattern	Symbol	Condition	Rating			Unit	Note
			Min.	Typ.	Max.		
Display Pattern: SNOW (Static)	ISS	VDD1=VDD2=VDD3=3V, Vop=10V, Bias=1/9, Frame Rate=76Hz, Ta=25°C	—	150	—	μA	
Power Down	ISS	VDD1=VDD2=VDD3=3V, Ta=25°C	—	2	5	μA	

Note:

The Current Consumption is DC characteristics.

13. TIMING CHARACTERISTICS



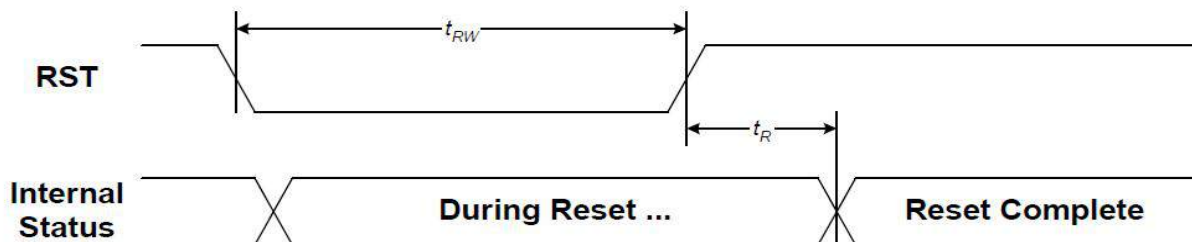
(VDD1 = 1.8V ~ 3.3V, Ta = 25°C)

Item	Signal	Symbol	Condition	Min.	Max.	Unit
Control setup time	A0	t_{AW6}		5	-	ns
Control hold time	R/W	t_{AH6}		10	-	
System cycle time		t_{CYC6}		190	-	
Enable H pulse width (WRITE)	E	t_{EHLW}		80	-	
Enable L pulse width (WRITE)		t_{EHLW}		100	-	
Enable H pulse width (READ)		t_{EHLR}		100	-	
Enable L pulse width (READ)		t_{EHLR}		100	-	
Write data setup time	D[7:0]	t_{DS6}		60	-	
Write data hold time		t_{DH6}		5	-	

Note :

- All timing is specified using 20% and 80% of VDD1 as the reference.
- The input signal rise time and fall time (t_r , t_f) is specified at 15 ns or less. When the system cycle time is extremely fast, $(t_r + t_f) \leq (t_{CYC6} - t_{EHLW} - t_{EHLW})$ for $(t_r + t_f) \leq (t_{CYC6} - t_{EHLR} - t_{EHLR})$ are specified.
- t_{EHLW} and t_{EHLR} are specified as the overlap between CS0 being "L" and E being "H".

RESET TIMING



(VDD1 = 1.8V ~ 3.3V, Ta = 25°C)

Item	Symbol	Condition	Min.	Max.	Unit
Reset time	t_R		-	1	ms
Reset "L" pulse width	t_{RW}		1	-	

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14. DISPLAY COMMANDS

The display commands shown below control the internal state of the LCD driver ICs. Commands are sent from CPU to LCD module for the display control. (please to visit the web: <http://www.sitronix.com.tw>)

COMMAND TABLE												
INSTRUCTION	A0	R/W (RWR)	COMMAND BYTE								DESCRIPTION	
			D7	D6	D5	D4	D3	D2	D1	D0		
Write Data	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data to DDRAM	
Read Data	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from DDRAM Only for parallel interface and I ² C	
Read Status Byte (parallel interface)	0	1	ID0	MX	MY	WA	DE	0	0	0	Read status byte Only for parallel interface	
			0	0	0	0	0	0	0	ID2		ID1
Set Column Address LSB	0	0	0	0	0	0	CA3	CA2	CA1	CA0	Set column address of RAM	
Set Column Address MSB	0	0	0	0	0	1	CA7	CA6	CA5	CA4		
Set Scroll Line	0	0	0	1	SL5	SL4	SL3	SL2	SL1	SL0	Specify line address for the 1 st display line of DDRAM (vertical scrolling)	
Set Page Address	0	0	1	0	1	1	PA3	PA2	PA1	PA0	Set page address of RAM	
Set Contrast	0	0	1	0	0	0	0	0	0	0	1	2-byte instruction. Set Vop voltage
			EV7	EV6	EV5	EV4	EV3	EV2	EV1	EV0		
Set Partial Screen Mode	0	0	1	0	0	0	0	1	0	PS	PS=1: Enable partial mode	
Set RAM Address Control	0	0	1	0	0	0	1	AC2	AC1	AC0	Set column and page address behavior	
Set Frame Rate	0	0	1	0	1	0	0	0	FR1	FR0	Set frame frequency	
Set All Pixel ON	0	0	1	0	1	0	0	1	0	AP	Set all display segments on	
Set Inverse Display	0	0	1	0	1	0	0	1	1	INV	Set inverse display	
Set Display Enable	0	0	1	0	1	0	1	1	1	PD	PD=0: Chip is in power down mode	
Scan Direction	0	0	1	1	0	0	0	MY	MX	0	Set COM and SEG scan direction	
Software Reset	0	0	1	1	1	0	0	0	1	0	Set software reset	
NOP	0	0	1	1	1	0	0	0	1	1	No operation	
Set Bias	0	0	1	1	1	0	1	0	BR1	BR0	Set internal bias circuit	
Set COM End	0	0	1	1	1	1	0	0	0	1	2-byte instruction. Set display duty	
			--	--	CEN5	CEN4	CEN3	CEN2	CEN1	CEN0		
Partial Start Address	0	0	1	1	1	1	0	0	1	0	Set partial start for partial display screen	
			--	--	DST5	DST4	DST3	DST2	DST1	DST0		
Partial End Address	0	0	1	1	1	1	0	0	1	1	Set partial end for partial display screen	
			--	--	DEN5	DEN4	DEN3	DEN2	DEN1	DEN0		
Test Control	0	0	1	1	1	1	0	0	0	0	Set test command table	
			--	--	--	--	--	--	H1	H0		

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Serial Read Command Table (Enabled only in 4 line SPI)											
INSTRUCTION	A0	R/W (RWR)	COMMAND BYTE								DESCRIPTION
			D7	D6	D5	D4	D3	D2	D1	D0	
Read Status Byte	0	0	1	1	1	1	1	1	1	0	Read status byte
	0	1	ID0	MX	MY	WA	DE	0	0	0	
Read Data	0	0	1	1	1	1	1	1	1	1	Read data from DDRAM
	1	1	D7	D6	D5	D4	D3	D2	D1	D0	

Note: 1. Do not use instructions not listed in these tables (Command Table).
 2. "--" = Disabled bit. It can be either logic 0 or 1.

15. QUALITY LEVEL

Inspection conditions

Environmental conditions

The environmental conditions for inspection shall be as follows: Room temperature: 22 ± 3 °C ; Humidity: $50 \pm 10\%$ RH

The external visual inspection

The inspection shall be performed by using a single 20W fluorescent lamp for illumination and the distance from LCD to eyes of the inspector should be 30cm or more.

Classification of defects

A major defect

A major defect refers to A defect which may substantially degrade usability for product applications.

Minor defect

A Minor defect refers to A defect which is not considered to substantially degrade product application or A defect which deviates from existing standards almost unrelated to the effective use of the product or its operation

Sampling procedures for each items acceptance level table

Defect type	Sampling procedures	AQL
Major defect	MIL-STD-105D Inspection level 1 normal inspection Single sample inspection	1.0
Minor defect	MIL-STD-105D Inspection level 1 normal inspection Single sample inspection	2.5

Life time

50,000Hrs(25°C in the room without ray of sun)

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Items of reliability

ITEM	CONDITIONS	CRITERION
High temperature operation test	+70°C \ 120 hours	1. It judged at room temperature after 1 hours to be good as appearance and electrical test is normal after the experiment. 2. Current consumption should within the specification of Approval sheet Electro-optical characteristics
Low temperature operation test	-20°C \ 120 hours	5-10pcs
High temperature/humidity storage test	+80°C, 80%±10%RH \ 120 hours	
High temperature storage test	+80°C \ 120 hours	
Low temperature storage test	-30°C \ 120 hours	
Temperature cycling test	-20°C (30 min) ↓ ↑ 25°C (5 min) ↓ ↑ 70°C (30 min) CYCLES: 10	
Vibration	Random Wave: 10 ~ 50 Hz Each Direction (x, y, z): 30 Min.	

Cosmetic criteria of LCD screen

DEFECT	JUDGEMENT CRITERION		
Spots (黑/白斑点或刺孔)	Size d (mm)	Acceptable quantity in active area	
	d ≤ 0.1	Disregard	
	0.1 < d ≤ 0.2	4	
	0.2 < d ≤ 0.3	2	
	d > 0.3	0	
	Note: d = (Length + Width)/2		
Polarizer Bubbles (偏光片中的气泡)	Size d (mm)	Acceptable quantity in active area	
	d ≤ 0.3	Disregard	
	0.3 < d ≤ 0.5	3	
	d > 0.5	0	
	Note: d = (Length + Width)/2		
Lines (线条状的刮痕或杂质)	Width W (mm) Length L (mm)	Acceptable quantity in active area	
	W ≤ 0.02	Disregard	
	0.02 < W ≤ 0.05	L ≤ 3.0	4
		L > 3.0	0
	0.05 < W ≤ 0.1	L ≤ 2.0	4
		L > 2.0	0
W > 0.1	See criteria for spots		
Testing conditions: 20W fluorescent lamp at 30 cm distance at normal viewing angle			

16. PRECAUTIONS

Static charge

Since this LCD module contains CMOS LSI that are sensitive to static charge, care must be taken when handling it.

Power on sequence

1. Input signals should not be applied to the LCD module before the logic system voltage has reached the specified voltage. If the above sequence is not kept, the LCD module might be permanently damaged.
2. When connecting the power supply, connect the LCD bias voltage after connecting the logic system voltage.
3. When disconnecting the power supply, disconnect the logic system voltage after the LCD bias voltage.
4. It is recommended to connect a serial resistor or fuse to the LCD bias power supply of the system as a current limiter. The value of the resistor depends on the kind of LCD used, but is typically 50~100Ω

Operation

1. It is essential to drive the LCD within the specified voltage limits, since a higher driving voltage than allowed causes a shorter LCD lifetime. Under these circumstances, electrochemical reactions will result in undesirable deterioration of the LCD.
2. The response time of the LC fluid is considerably longer at low temperature than in the normal operating temperature range. On the other hand, the LCD will show a dark blue color at high temperatures. Those phenomena do not indicate a malfunction or defect of the LCD. Back at normal temperatures, the LCD will return to its original behavior.
3. If the display area is pressed hard during operation, some abnormal display patterns might appear. However, the display will resume normal operation after turning the module off and on.
4. Moisture on the terminals could cause an electrochemical reaction resulting in an open terminal connection. If the environmental temperature is higher than 50°C, it is required that the relative humidity is 50% or less.

Long-time storage

For long-term storage the following methods are highly recommended:

1. Store the product in a polyethylene bag with a sealed opening to prevent fresh air entering from the outside. Placing it with a desiccant is not necessary.
2. Store the product in a dark place, with the temperature in the range from -10°C to 50°C.
3. Keep the sensitive polarizer surface of the LCD panels clear of any contact. We recommend using the container that was used by Bocen to deliver the products.

Cleaning of product

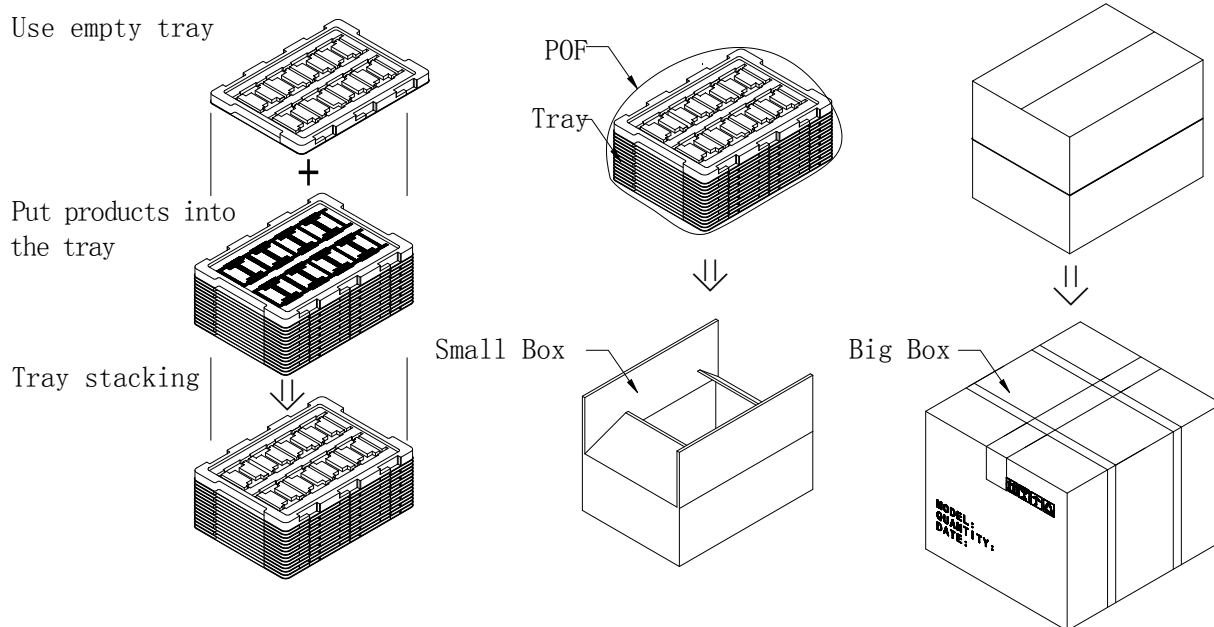
To clean the product make sure to use absorbent cotton cloth or other soft material like chamois. Make sure to rub it gently and do not use chemicals when cleaning.

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17. PACKAGE INFORMATION

Packaging Material				
No.	Item	Model	Dimensions (mm)	Quantity
1	LCM	-	-	--
2	POF	-	-	--
3	TRAY	-	-	--
4	SMALL BOX	-	385.0×315.0×200.0	2
5	BIG BOX	-	398.0×331.0×430.0	1



18. SCHEMATIC DIAGRAM

