CONTENTS

1. FEATURES

- Display construction ……………… 16 Characters * 2 Lines
- Display mode …………………… FSTN
- Display type …………………… Positive Transmissive
- Backlight ……………………… LED/(RGB)
- Viewing direction ……………… 6 o'clock
- Operating temperature ………… -10 to 60℃
- Storage temperature …………… -30 to 80℃
- Controller ……………………… AIP31068/SGM31323 or Equivalence
- Driving voltage ………………… 3.3V OR 5.0V
- Driving method ………………… 1/16 duty, 1/5 bias
- Type …………………………… COB (Chip On Board)
- Number of data line …………… I2C-bus interface

2. MECHANICAL DATA

ITEM		WIDTH	HEIGHT	THICKNESS	UNIT
Module size		80.0	40.0	13.5(MAX)	mm
Viewing area		64.5	14.5	-	mm
character	Construction	5*7			dots
	Size	2.95	4.75	-	mm
	Pitch	3.65	5.45	-	mm
Dot	Size	0.55	0.55	-	mm
	Pitch	0.60	0.60	-	mm
Diameter of mounting hole		Φ2.3			mm
Weight		About 35			g

3. ABSOLUTE MAXIMUM RATINGS

(TA = 25 , Vss=0V)

Item	Symbol	MIN.	Max.	Unit
Supply Voltage (Logic)	VCC-VSS	0	6	V
Logic Voltage	VDD	-0.3	5.5	V
Operating temperature	Top	-10	60	℃
Storage temperature	Tsto	-30	80	℃

4. ELECTRICAL CHARACTERISTICS

4.1 DC Characteristic（LCD DRIVE)

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Voltage	VDD	-	2.7	-	4.5	V
Supply Current	IDD	Internal oscillation or external clock. (VDD=3.0 V, fosc = 250 kHz)	-	0.2	0.4	mA
Input Voltage (1) (except OSC1)	VIH1	-	0.7VDD	-	VDD	V
	VIL1	-	-0.3	-	0.55	
Input Voltage (2) (OSC1)	VIH2	-	0.7VDD	-	VDD	
	VIL2	-	-	-	0.2VDD	
Output Voltage (1) (SDA)	VOH1	IOH= -0.1 mA	0.75VDD	-	-	V
	VOL1	IOL= 0.1 mA	-	-	0.2VDD	V
Output Voltage (2) (except SDA)	VOH2	IO= -40 mA	0.8VDD	-	-	
	VOL2	IO= 40 mA	-	-	0.2VDD	
Input Leakage Current	IIKG	VIN= 0 V to VDD	-1	-	1	
Input Low Current	IIL	VIN= 0 V, VDD= 3 V (PULL UP)	-10	-50	-120	mA
Internal Clock (external Rf)	fOSC1	Rf = 75 kΩ± 2% (VDD= 3 V)	190	270	350	kHz
External Clock	fOSC2	-	125	270	410	kHz
	duty		45	50	55	%
	tR ,tF		-	-	0.2	ms
COM ON resistance	RCOM	IO = ±50uA, VLCD = 4.0V COM1 - COM16			20	KΩ
SEG ON resistance	RSEG	IO = ±50uA, VLCD = 4.0V SEG1 - SEG40			30	
LCD Driving Voltage	VLCD	VDD-V5 (1/5, 1/4 Bias)	3.0	-	9.0	V

4.2 AC Characteristic （LCD DRIVE ）

Characteristic	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL Cycle Time	tSCYC	Write Mode (Refer to Fig-1)	200	-	-	ns
SCL Pulse Width (High)	tSHW		20	-	-	
SCL Pulse Width (Low)	tSLW		160	-	-	
SCL Rise / Fall Time	tr,tf		-	-	20	
Data Setup Time	tSDS		10	-	-	
Data Hold Time	tSDH		10	-	-	
SCL Cycle Time	tSCYC		20	-	-	
SCL Pulse Width (High)	tSHW		200	-	-	
SCL Frequency	fSCLK	Read Mode (Refer to Fig-2)	-	-	400	KHZ
SCL Pulse Width (High)	tSHW		0.6	-	-	us
SCL Pulse Width (Low)	tSLW		1.3	-	-	
Data Setup Time	tSU:DAT		180	-	-	ns
Data Hold Time	tHD:DAT		0	-	0.9	us
SCL/SDA Rise / Fall Time	tr,tf		20	-	300	ns
START Setup Time	tSU:STA		0.6	-	-	us
START Hold Time	tHD:STA		0.6	-	-	us
STOPSetup Time	tSU:STO		0.6	-	-	us
STOP-START Time	tBUF		1.3	-	-	us

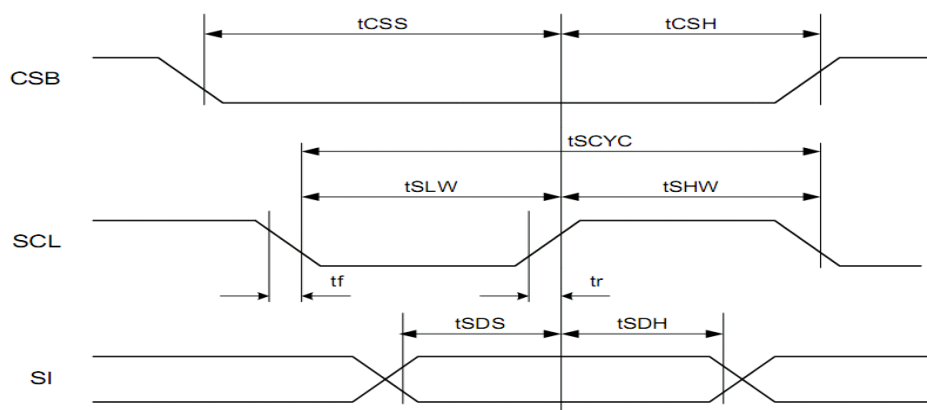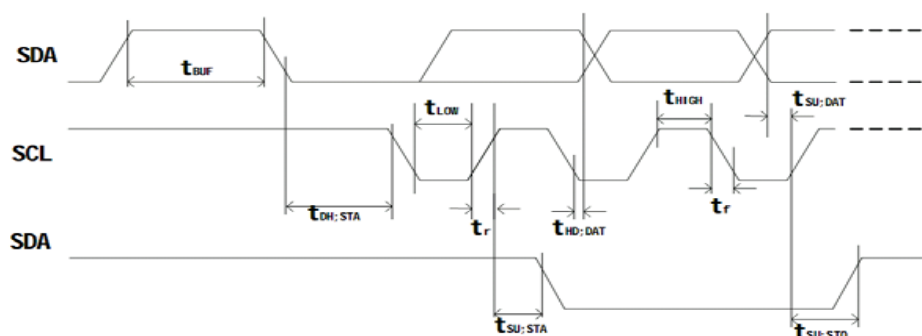**Figure 1 . Timing Diagram of 3-lines interface**

Figure 2 . Timing Diagram of 2-lines interface

4.3 Electrical Characteristic （LED DRIVE ）

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
POWER SUPPLY							
Input Operating Range	V_{IN}		Full	2.5		5.5	V
Sink Pin (Dx) Dropout Voltage (90% of Nominal Current)	V_{D_MIN}	All channels set to 24mA, Reg6-8 = BFh	+25℃		65	90	mV
Output Current Accuracy		All channels set to 10mA, Reg6-8 = 4Fh	+25℃	-5		5	%
Output Current Matching		Max($|I_{Dx} - I_{AVG}|$)/I_{AVG}, all channels set to 10mA, Reg6-8 = 4Fh	+25℃	-5		5	%
Supply Current	I_{IN}	All channels set to 20mA, Reg6-8 = 9Fh	+25℃		280	340	µA
		One channel set to 20mA, other channels off	+25℃		120	150	
Quiescent Current	I_Q	Device on, all LEDs OFF, Reg4 = 0	+25℃		41	52	µA
Shutdown Current	I_{SHDN}	V_{IN} = V_{OUT} = 3.6V, SCL = 0V, SDA = 0V	+25℃		0.3	1	µA
CONTROL AND I²C-COMPATIBLE PIN VOLTAGE SPECIFICATIONS (SCL, SDA) [1]							
Input Logic Low Threshold	V_{IL}	SDA, SCL	+25℃			0.4	V
Input Logic High Threshold	V_{IH}	SDA, SCL	+25℃	1.2			V
I²C-COMPATIBLE TIMING SPECIFICATIONS (SCL, SDA), SEE FIGURE 2							
SCL (Clock Period)	t_1		+25℃	2.5			µs
Low Period of The SCL Clock	t_2		+25℃	1.3			µs
DATA_IN Setup Time to SCL High	t_3		+25℃	350			ns
DATA_IN Hold Time after SCL Low	t_4		+25℃	0		0.8	µs
DATA_OUT Stable after SCL Low	t_5		+25℃	350			ns
SDA Low Setup Time to SCL Low (Start)	t_6		+25℃	600			ns
SCL High Setup Time to SDA High (Stop)	t_7		+25℃	600			ns
THERMAL SHUTDOWN							
Thermal Shutdown Threshold					140		℃
Thermal Shutdown Hysteresis					15		℃
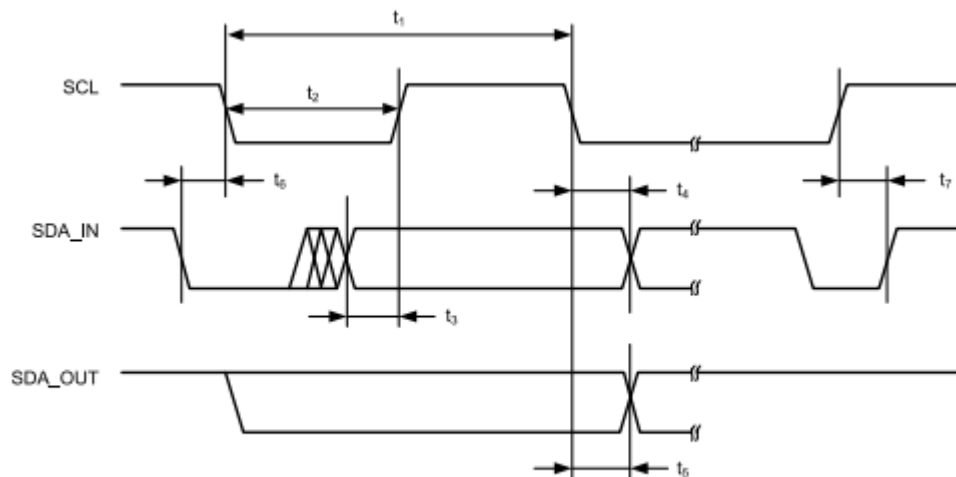
Figure 2. I²C Compatible Interface Timing

5. B/L ELECTRICAL-OPTLCAL CHARACTERISTICS

Item	Symbol	min	typ	max	Unit	Condition
Operating Voltage	VDD	3.3	–	5.5	V	If=20mA
Reverse Current	Ir	–	20	–	uA	Vr=5V
Dominant wave length	λp	–	X=0.29 Y=0.30	–	nm	If=20mA
Spectral Line Half width	Δλ	–	–	–	nm	If=20mA

5.1 B/L ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Condition	Rating	Unit
Reverse Voltage	Vr	Ta=25℃	5	V
Absolute maximum forward current	Ifm	Ta=25℃	25*3	mA
Power description	pd	Ta=25℃	225	mW

5.2 B/L LED ARRAY BLOCK DIAGRAM （ LED DICE 1 dices ）
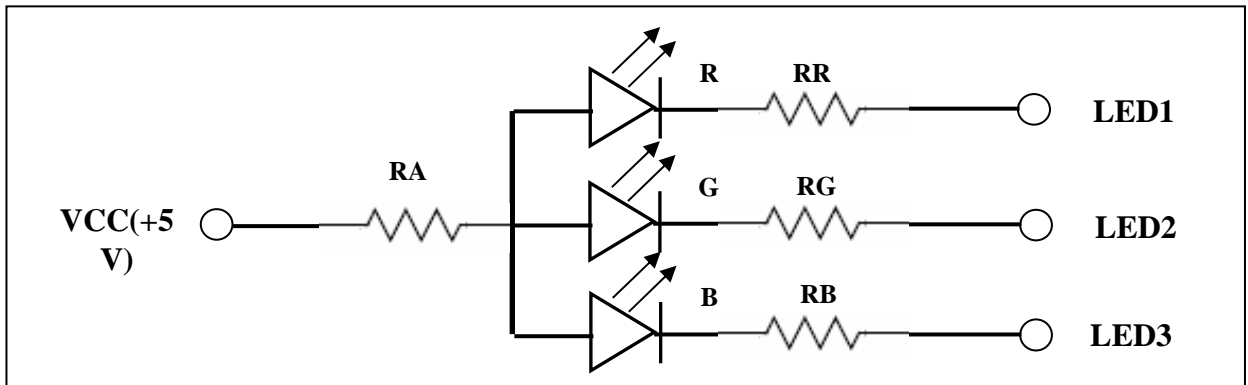
5.3 B/L POWER SOURCE

	Option	Power source	Jumper setting
LED	A	VDD/VSS	RA=0R

6. DISPLAY ELECTRO-OPTICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
Contrast ratio	K	$\Phi=0^0$	1.4	4	-	-	1
Response time (rise)	Tr	$\Phi=0^0 \ \theta=0^0$	-	130	-	ms	2
Response time (fall)	Tf	$\Phi=0^0 \ \theta=0^0$		130	-	ms	2
Viewing angle	Φ	K ≥1.4	-40 -- +40			deg.	3
	θ		-40 -- +15				

Note 1: Definition of Contrast Ratio "K"

$$K=\frac{\text{Brightness of non-selected segment(A)}}{\text{Brightness of selected segment(B)}}$$

Brightness Curve of selected area

Brightness Curve of non-selected area

90%

Brightness

A

B

10%

Vop

Driving Voltage
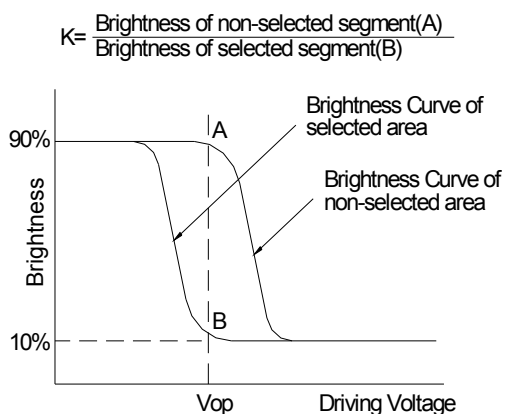
Note 2: Definition of Optical Response Time

Non-selected | Selected | Non-selected

100%

Brightness

90%

10%

0%

Tr

Tf

Rise Time

Fall Time
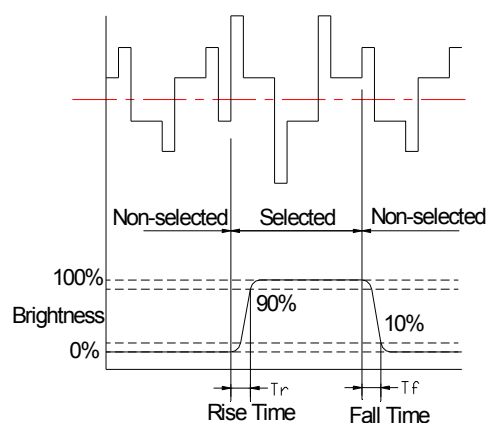
Note 3: Definition of Viewing Angle

Left

Right

$\varnothing$ $\varnothing$

Top

Top Viewing Angle

θ

Viewing Surface

θ

Bottom

Bottom Viewing Angle
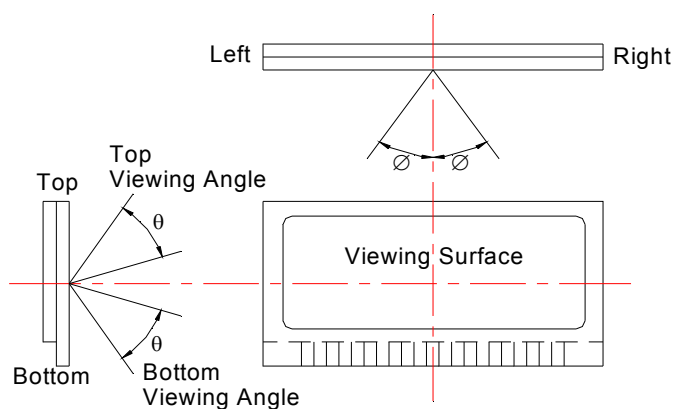
Please select either top or bottom viewing angle

6.BLOCK DIAGRAM

```
GND ─────►
                ┌───────────┐   GND ──────►  ┌─────────────────┐  COM 1-16  ┌────────────────────────────┐
VCC             │   power   │   VDD (3.3V)   │  CONTROLLER:     │            │          LCD               │
(5V/3.3V) ────► │  circuit  │ ─────────────► │                 │            │   16 character × 2 line    │
                └───────────┘                │  AIP31068        │  SEG 1-40  │                            │
                                             │                  │ ─────────► └────────────────────────────┘
SCL ──────────────────────────────────────► │  OR              │                          ▲
                                             │                  │                SEG 41-80 │
SDA ◄─────────────────────────────────────► │  Equivalence     │            ┌─────────────────┐
                                             └──────────────────┘ ─────────► │   SEGMENT       │
                                                     │                       │   DRIVER        │
                                                     ▼                       └─────────────────┘
                                             ┌──────────────┐  VDD   ┌─────────────────┐
                                             │   LED        │  LED1  │     RGB         │
                                             │   DRIVE      │  LED2  │   BACKLIGHT     │
                                             │              │  LED3  │                 │
                                             └──────────────┘        └─────────────────┘
```

8. POWER SUPPLY

```
                                    ┌─────────────────┐
                        ┌───────────┤ VCC             │
                        │           │                 │
          + ○───────────┘           │        LCM      │
3.3V OR 5.0V                        │                 │
          - ○───────────┐           │                 │
                        │           │ VSS             │
                        └───────────┤                 │
                                    └─────────────────┘
```
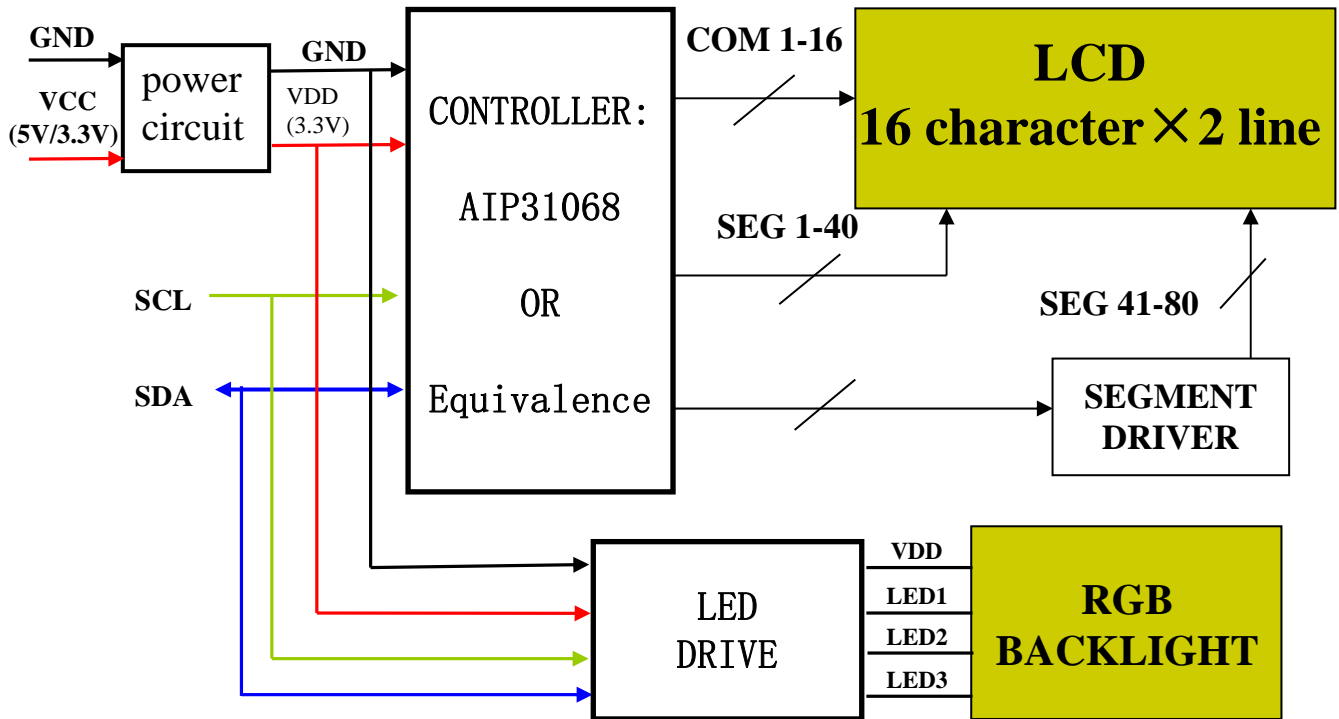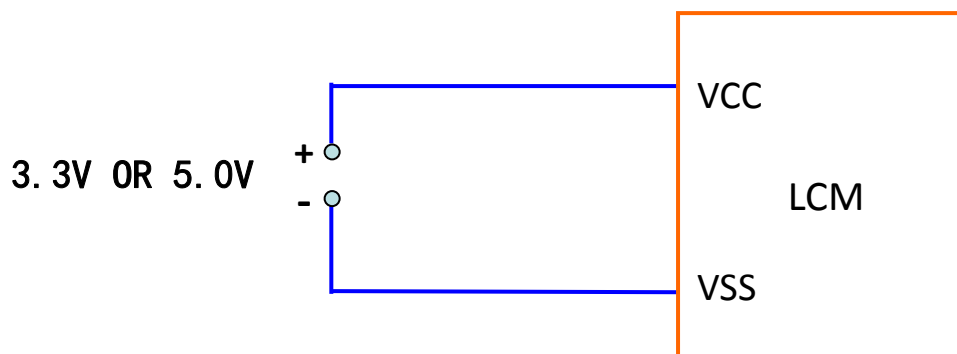
9. INITIALIZATION SEQUENCE

```
Power on
```

```
Wait for more than 15 ms
after VDD rises to 4.5V
```

Function set

RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	1	X	N	F	X	X

```
Wait for more than 39 μs
```

Display ON/OFF Control

RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	1	D	C	B

```
Wait for more than 39 μs
```

Display Clear

RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	0	1

```
Wait for more than 1.53 ms
```

Entry Mode Set

RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	I/D	SH

```
Initialization end
```

N	0	1-line mode
	1	2-line mode

F	0	5*8 dots
	1	5*11 dots

D	0	Display off
	1	Display on

C	0	Cursor off
	1	Cursor on

B	0	Blink off
	1	Blink on

10. INSTRUCTION SET

COMMAND	COMMAND CODE									COMMAND CODE	E-CYCLE f_{osc}=270KHz
	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
SCREEN CLEAR	0	0	0	0	0	0	0	0	1	Screen Clear, Set AC to 0 Cursor Reposition	1.53ms
CURSOR RETURN	0	0	0	0	0	0	0	1	*	DDRAM AD=0, Return, Content Changeless	1.53ms
INPUT SET	0	0	0	0	0	0	1	I/D	S	Set moving direction of Cursor,Appoint if move	39us
DISPLAY SWITCH	0	0	0	0	0	1	D	C	B	Set display on/off,cursor on/off,blink on/off	39us
SHIFT	0	0	0	0	1	S/C	R/L	*	*	Remove cursor and whole display,DDRAM changeless	39us
FUNCTION SET	0	0	0	1	DL	N	F	*	*	Set DL,display line,font	39us
CGRAM AD SET	0	0	1	ACG						Set CGRAM AD, send receive data	39us
DDRAM AD SET	0	1	ADD							Set DDRAM AD, send receive data	39us
CGRAM/ DDRAM DATA WRITE	1	DATA WRITE								Write data from CGRAM or DDRAM	43us
		I/D=1: Increment Mode; I/D=0: Decrement Mode S=1: Shift S/C=1: Display Shift; S/C=0: Cursor Shift R/L=1: Right Shift; R/L=0: Left Shift DL=1: 8D DL=0: 4D N=1: 2R N=0: 1R F=1: 5x10 Style; F=0: 5x7 Style								DDRAM: Display data RAM CGRAM: Character Generator RAM ACG: CGRAM AD ADD: DDRAM AD & Cursor AD AC: Address counter for DDRAM & CGRAM	E-cycle changing with main frequency. Example: If fcp or f_{osc}=270KHz 40us x 250/270 =37us

REGISTER MAP (LED DRIVE)

Table 1. Register Map

	Reg#	NAME	RESET VALUES
Register Bank	0	Reset/Control	0x00
	1	Flash Period	0x00
	2	PWM1 Timer	0x01
	3	PWM2 Timer	0x01
	4	Channel Enable	0x00
	5	t_{RISE}/t_{FALL}	0x00
	6	LED1 I_{OUT}	0x4F
	7	LED2 I_{OUT}	0x4F
	8	LED3 I_{OUT}	0x4F

EN/RST: Reg0	
0 (LSB)	Timer Slot Control/ Reset Control
1	
2	Reset/Offset Cancel
3	Enable Ctrl
4	
5	Rise/Fall Scaling
6	
7 (MSB)	Test Only

FLASH PERIOD: Reg1	
0 (LSB)	
1	
2	
3	Flash Period
4	
5	
6	
7 (MSB)	Ramp Linear

FLASH ON TIME1: Reg2	
0	
1	
2	
3	PWM1 Timer Percentage of Period
4	
5	
6	
7	

FLASH ON TIME2: Reg3	
0	
1	
2	
3	PWM2 Timer Percentage of Period
4	
5	
6	
7	

CHANNEL CONTROL: Reg4	
0 (LSB)	LED1 Enable/Timer1./2
1	
2	LED2 Enable/Timer1./2
3	
4	LED3 Enable/Timer1./2
5	
6	Not Used
7 (MSB)	

RAMP RATE: Reg5	
0	
1	t_{RISE}
2	
3	
4	
5	t_{FALL}
6	
7	

LED1 I_{OUT}: Reg6	
0	
1	
2	
3	I_{OUT} 0.125mA to 24mA in 0.125mA Steps
4	
5	
6	
7	

LED2 I_{OUT}: Reg7	
0 (LSB)	
1	
2	
3	I_{OUT} 0.125mA to 24mA in 0.125mA Steps
4	
5	
6	
7 (MSB)	

LED3 I_{OUT}: Reg8	
0	
1	
2	
3	I_{OUT} 0.125mA to 24mA in 0.125mA Steps
4	
5	
6	
7	

11. FONT TABLE

b7-b4 / b3-b0	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)		0	@	P	`	p		ー	タ	ミ	∝	p
0001	(2)	!	1	A	Q	a	q	。	ア	チ	ム	ä	q
0010	(3)	"	2	B	R	b	r	「	イ	ツ	メ	β	θ
0011	(4)	#	3	C	S	c	s	」	ウ	テ	モ	ε	∞
0100	(5)	$	4	D	T	d	t	、	エ	ト	ヤ	μ	Ω
0101	(6)	%	5	E	U	e	u	・	オ	ナ	ユ	σ	Ü
0110	(7)	&	6	F	V	f	v	ヲ	カ	ニ	ヨ	ρ	Σ
0111	CG RAM (8)	'	7	G	W	g	w	ア	キ	ヌ	ラ	g	π
1000	CG RAM (1)	(	8	H	X	h	x	イ	ク	ネ	リ	√	x̄
1001	(2)	)	9	I	Y	i	y	ウ	ケ	ノ	ル	⁻¹	y
1010	(3)	*	:	J	Z	j	z	エ	コ	ハ	レ	j	千
1011	(4)	+	;	K	[	k	{	オ	サ	ヒ	ロ	×	万
1100	(5)	,	<	L	¥	l	|	ャ	シ	フ	ワ	¢	A
1101	(6)	ー	=	M	]	m	}	ュ	ス	ヘ	ン	Ł	÷
1110	(7)	.	>	N	^	n	→	ョ	セ	ホ	゛	ñ	
1111	CG RAM (8)	/	?	O	_	o	←	ッ	ソ	マ	゜	ö	█

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12. OUTLINE DRAWING

Grove-LCD RGB Backlight
V5.0

1	2	3	4
SCL	SDA	VDD	VSS

13. INTERFACE

PIN NO.	SYMBOL	I/O	FUNCTION
1	SCL	I	I2C-bus serial clock
2	SDA	I/O	I2C-bus serial data
3	VDD	POWER SUPPLY	DC 3.3-5.0V
4	VSS	POWER SUPPLY	0V (GND)

14. QC/QA PROCEDURE

Parts QA Dept.	LCD Mfg. Dept.	LCM QA Dept.

Parts

Parts Acceptance Inspection ········· 1. Function & Appearance & Dimension: Sample Test
2. Reliability: Random Sampling

Soldering

Soldering Inspection ········· Soldering Condition

LCM Assembling ········· 1. Dimension: Sample Test
2. Function: 100% Inspection

Heat Cycle Aging ········· -10~70℃ (1 Cycle=6 Hrs).
2 Cycle: 100% Inspection

High Temp. Test ········· Function & Appearance: 100% Inspection (ex. 50℃)

Inspection ········· 1. Function & Appearance: 100% Inspection
2. Dimension: Random Sampling

Packaging ········· Package Condition & Label: 100% Inspection

1. Function,Appearance & Dimension: Random Sampling
2. Package Product & Label: Random Sampling
3.Electro-optical Characteristic: 100% Inspection
4. Reliability: Random Sampling ········· **Outgoing Inspection**

Storage/Shipping

15. RELIABILITY

•Operating life time:
Longer than 50000 hours (at room temperature without direct irradiation of sunlight)

•Reliability Characteristics:

Item	Test	Criterion
High temp	60℃ / 200 Hrs	■Total current consumption should be below double of initial value ■Contrast ratio should be within initial value±50% ■No defect in cosmetic and operational function is allowable
Low temp.	-10℃ / 200 Hrs	
High humidity	40℃ * 90%RH / 200 Hrs	
Thermal shock	-10℃→25℃→60℃→25℃ /5 Cycles (30min) (5min) (30min) (5min)	
Vibration	1.Operating time: Thirty minutes exposure in each direction (x, y, z) 2.Sweep Frequency (1min):10Hz→ 55Hz →10Hz 3.Amplitude: 0.75mm double amplitude	

16. Handling Precautions

1. Limitation of Application:
Jing Handa products are designed for use in ordinary electronic devices such as business machines, telecommunications equipment,measurement devices and etc. Please handle the products with care. (see below)
Jing Handa products are not designed,intended ,or authorized for use in any application which the failure of the product could result in a situation where personal injury or death may occur . these applications include, but are not limited to . life-sustaining equipment,nuclear control devices , aerospace equipment , devices related to hazardous or flammable materials , etc.[If Buyer intends to purchase or use the Jing Handa Products for such unintended or unauthorized applications , Buyer must secure prior written consent to such use by a responsible officer of Jing Handa Corporation.]Should Buyer purchase or use Jing Handa Products for any such unintended or unauthorized application [without such consent].Buyer shall indemnify and hold Jing Handa and its officers. employees. subsidiaries, affiliates and distributors harmless against all claims, costs, damages and expenses , and reasonable attorney's fees,arising out of , directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Jing Handa was negligent regarding the design or manufacture of the part.
2.Industrial Rights and Patents
Jing Handa shall not be responsible for any infringement of industrial property rights of third parties in any country arising out of the application or use of Jing Handa products, except which directly concern the structure or production of such products.

No Press and Shock!

If pressure to LCD, orientation
  may be disturbed.
LCD will broken by shock!
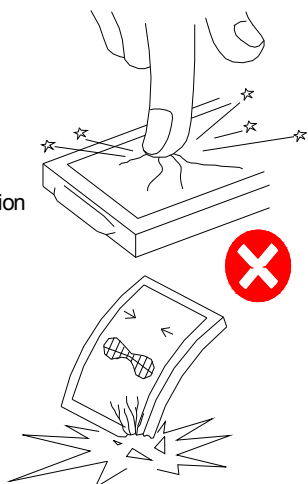
Don't Swallow or Touch Liquid Crystal!

Liquid Crystal may be leaked
  when display is broked.
If it accidentally gets your hands,
  wash then with water!
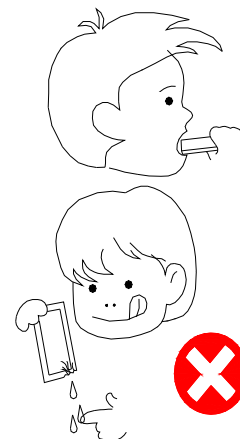
Don't not Scratch!

Polarizer is a soft material
  and can easily be scratched.
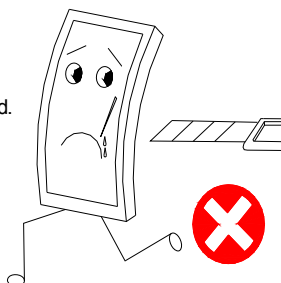
No DC Voltage to LCD!

DC volrage or driveing higher
  than the specified voltage
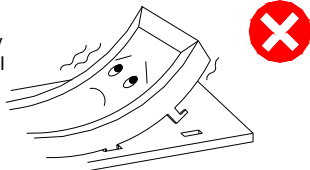 will reduce the lifetime of
  the LCD.
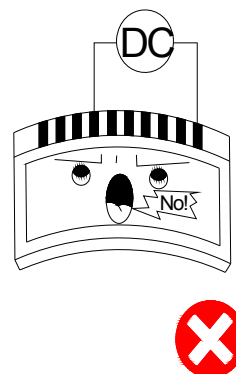
Don't Press the Metallic Frame and Disassemble the LCM

Pressure on the metallic frame and PCB may deform the conductive rubber or break the liquid crystal cell and back light, which will cause defects.
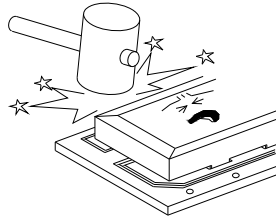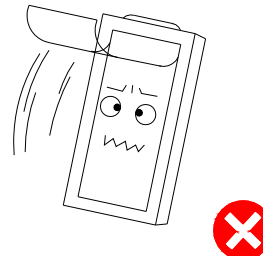
LCD may be shifted or conductive rubber may be reshaped, which will cause defects.

Slowly Peel Off Protective Film!

Avoid static electricity.

Avoid Static Electricity!

Please be sure to ground human body and electric apploances during work.

It is preferable to use conductive mat on table and wear cotton clothes or conduction processed fiber. Synthetic fiber is not recommended.
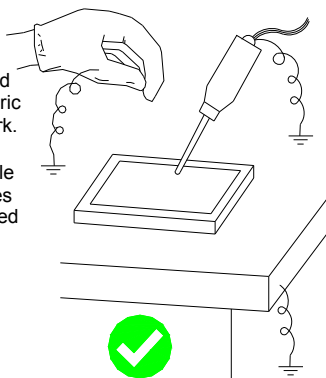
Wear Gloves While Handing!

It is preferable to wear gloves to avoid damaging the LCD.

Please do not touch electrodes with bare hands or make them dirty.

GLOVE
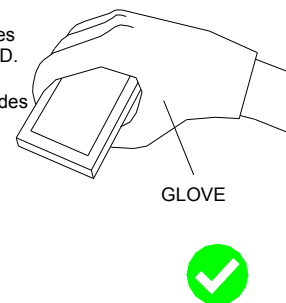
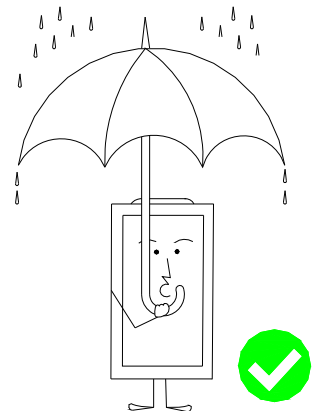## Keep Away From Extreme Heat and Humidity!

LCD deteriorates.
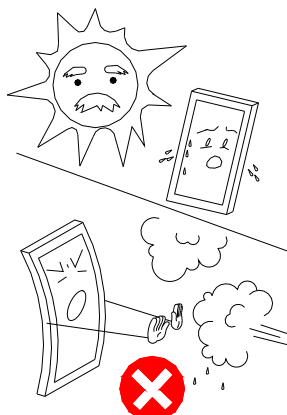
Use Alcohol to Clean Terminals!

Alcohol

When attaching with the heat seal or anisontropically conductive film, wipe off with alcohol before use.
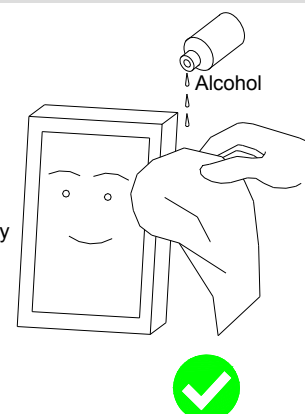
Don't Drop Water on LCD!

Note that the presence of waterdrops or dew in the LCD panel may deteriorate the polarizer or corrade electrode.

Precaution in Soldering LCD Module

Basic instructions: Solder I/O terminals only.
Use soldering iron without leakage.
(1)Soldering condition to I/O terminals
Temperature at tip of the iron: 280±10℃
Soldering time: 3~4 sec.
Type of solder: Eutectic solder (containing colophony-flux)
*Please do not use flux because it may soak into LCD Module or contaminate it.
*It is preferable to peel off protective film on display surface after soldering I/O
terminals is finished.
(2)Remove connector or cable
*When you remove connector or cable soldered to I/O terminals, please confirm
that solder is fully melted. If you remove by force, electrodes at I/O terminals may
be damaged(or stripped off).
*It is recommended to use solder suction machine.

Long-term Storage

If it is necessary to store LCD modules for a long time, please comply with the
following procedures.
If storage condition is not satisfactory, display(especially polarizer) may be deteriorated
or soldering I/O terminals may become difficult(some oxide is generated at I/O
terminals plating).
1.Store as delivered by Optrex
2.If you store as unpacked,put in anti-static bag,seal its opening and store where it is
not subjected to direct sunshine nor fluorescent lamp.
3.Store at temperature 0 to +35℃ and at low humidity.Please refer to our specification
sheets for storage temperature range and humidity condition.

Long-term Storage

Please use power supply with built-in surge protection circuit.