SPECIFICATIONS FOR
LIQUID CRYSTAL DISPLAY MODULE

MODEL NO : SO1602AWGB-UC-WB-U

CUSTOMER : AKZUKI

APPROVED SIGNATURE

DSGD :

CHKD : Gili Wang

APPD : Chuan-Lin Hsu

DATE : Sep.12.2014

SUNLIKE DISPLAY TECHNOLOGY CO .

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Revision Record

No.	Date	Model No.	Version	Remarks
1	Mar.31.2014	SO1602AWGB-UC-WB-U	REV.0	Smaple RoHS-Compliant
2	Aug.11.2014	SO1602AWGB-UC-WB-U	REV.1	SPE Change P7 SDA_in /SDA_out
3	Aug.18.2014	SO1602AWGB-UC-WB-U	REV.2	SPE Change P7 SDA_in/SDA_out are tied together.
4	Sep.12.2014	SO1602AWGB-UC-WB-U	REV.3	SPE Change P12 Serial Interface Timing IO = SCL / SDA = 2.4-3.6V

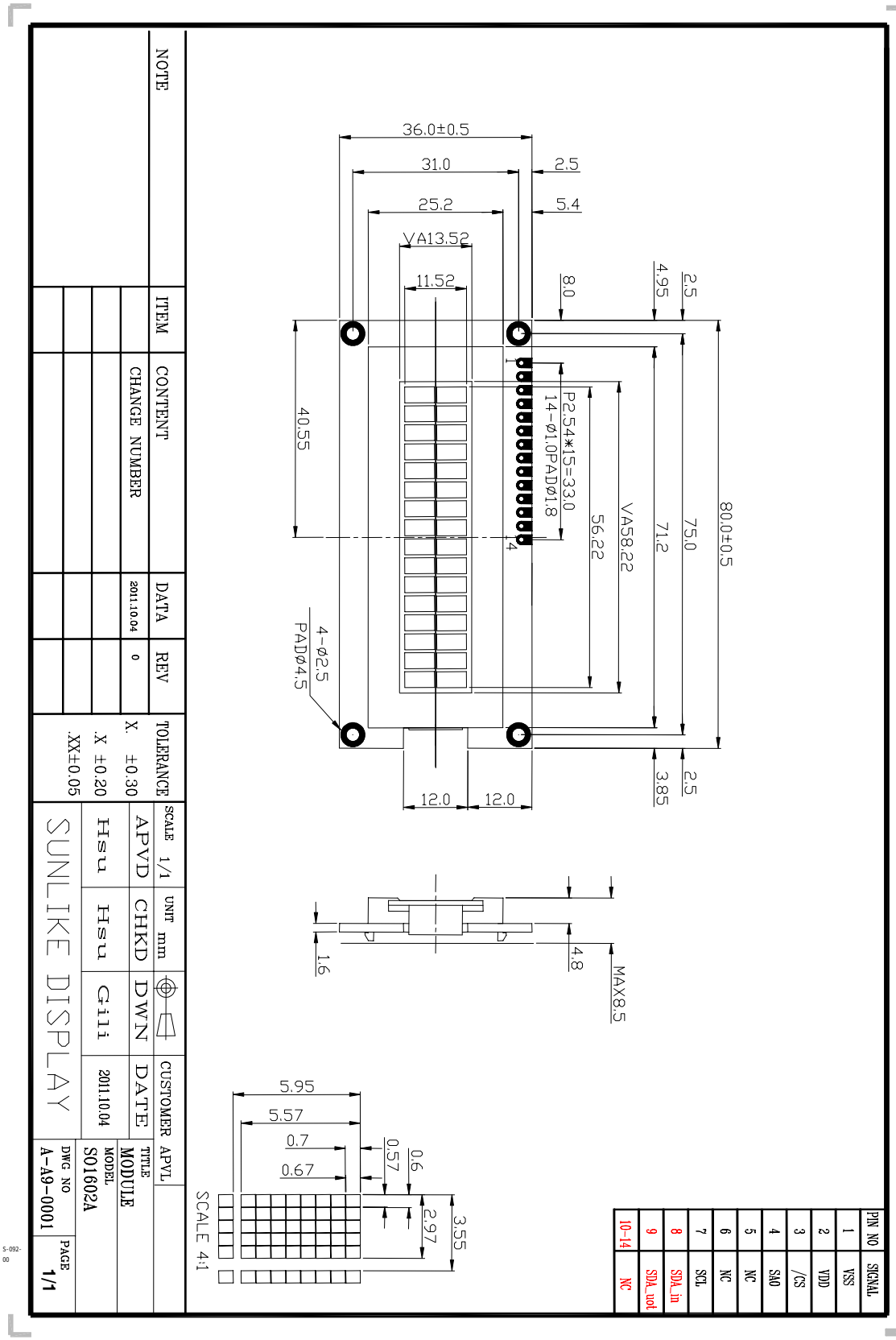
GENERAL SPECIFICATION

ITEM	DESCRIPTION				
Product No	SO1602AWGB-UC-WB-U				
OLED Type	■ OLED White & Black				
Rear Polarizer	■ Reflective / Positive				
Backlight Type	■ OLED				
OLED Color	☐ Yellow	■ Green	☐ Amber	☐ White	☐
Temperature Range	■ Wide Temp., 3.3V, Single Supply Voltage				
Frame	■ Black				

TO BE VERY CAREFUL !

The OLED driver ICs are made by CMOS process, which are very easy to be damaged by static charge, make sure the user is grounded when handling the LCM.

※This parts comply with RoHs


36.0±0.5
31.0
25.2
2.5
5.4
VA13.52
11.52
8.0
4.95
2.5
40.55
P2.54*15=33.0
14-Ø1.0PADØ1.8
VA58.22
56.22
71.2
75.0
80.0±0.5
4-Ø2.5
PADØ4.5
12.0
12.0
3.85
2.5
1.6
4.8
MAX8.5
5.95
5.57
0.7
0.67
0.57
0.6
2.97
3.55
SCALE 4:1
NOTE
ITEM
CONTENT
DATA
REV
CHANGE NUMBER
2011.10.04
0
TOLERANCE
X. ±0.30
.X ±0.20
.XX±0.05
SCALE 1/1
UNIT mm
CUSTOMER APVL
APVD
CHKD
DWN
DATE
Hsu
Hsu
Gili
2011.10.04
SUNLIKE DISPLAY
TITLE MODULE
MODEL SO1602A
DWG NO A-A9-0001
PAGE 1/1
5-092-00
PIN NO SIGNAL
1 VSS
2 VDD
3 /CS
4 SA0
5 NC
6 NC
7 SCL
8 SDA_in
9 SDA_out
10-14 NC

ABSOLUTE MAXIMUM RATING

(1) Electrical Absolute Ratings

Item	Symbol	Min.	Max.	Unit	Note
Power Supply for Logic	V_{DD}-V_{SS}	-0.3	5.5	Volt	
Power Supply for OLED	V_{DD}-V_{CC}	-0.3	13.0	Volt	
Input Voltage	V_I	-0.3	V_{DD}	Volt	
Life Time (100 cd/m2)	V_{CC} = 7.25V T_a = 25°C 50% RH	50,000	---	Hour	

(2) Environmental Absolute Maximum Ratings

Item	Wide Temperature			
	Operating		Storage	
	Min,	Max.	Min,	Max.
Ambient Temperature	-40℃	+70℃	-40℃	+85℃
Humidity(without condensation)	Note 4,5		Note 4,6	

Note 2 Ta≦50℃: 80% RH max
Ta>50℃: Absolute humidity must be lower than the humidity of 85%RH at 50℃

Note 3 Ta at -20℃ will be<48hrs at 70℃will be <120hrs when humidity is higher than 70%.

Note 4 Background color changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 5 Ta≦70℃: 75RH max
Ta>70℃: absolute humidity must be lower than the humidity of 75%RH at 70℃

Note 6 Ta at -30℃ will be <48hrs, at 80 ℃ will be <120hrs when humidity is higher than 70%.

ELECTRICAL CHARACTERISTICS

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Power Supply for Logic	V_{DD}-V_{SS}	-	2.4	3.3	3.6	Volt	
Power Supply for OLED	V_{CC}-V_{SS}	-	11.5	12.0	12.5	Volt	
Input Voltage	V_{IL}	L level	0	-	0.2 V_{DD}	Volt	
	V_{IH}	H level	0.8 V_{DD}	-	V_{DD}	Volt	
Onput Voltage	V_{OL}	L level	0	-	0.1 V_{DD}		
	V_{OH}	H level	0.9 V_{DD}	-	V_{DD}		
LCM Recommend OLED Module Driving Voltage	V_O –V_{SS}	Ta＝0℃	-	-	-	Volt	
		Ta＝25℃	9.0	10.0	11.5		
		Ta＝50℃	-	-	-		
Power Supply Current for OLED	I_{DD}	V_{DD} =3.3V V_O-V_{SS} =10.0V	-	50.0	80.0	mA	

OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Viewing angle range	Φf(12 o'clock)	When Cr≧ 20	-	75	-	Degree	9,10
	Φb(6 o'clock)		-	75	-		
	Φl(9 o'clock)		-	65	-		
	Φr(3 o'clock)		-	65	-		
Rise Time	Tr	V_O-V_{SS} =10.0V Ta=25℃	-	40		mS	
Fall Time	Tf		-	40			
Frame frequency	Frm		-	64	-	Hz	8,10
Dark Room Contrast	Cr		-	2000:1	-		7
Brightness	L		120	150	-	cd/㎡	
Peak Emission Wavelength	C.I.E (Green)	CIE1931	X=0.27 Y=0.58	X=0.31 Y=0.62	X=0.35 Y=0.66	nm	

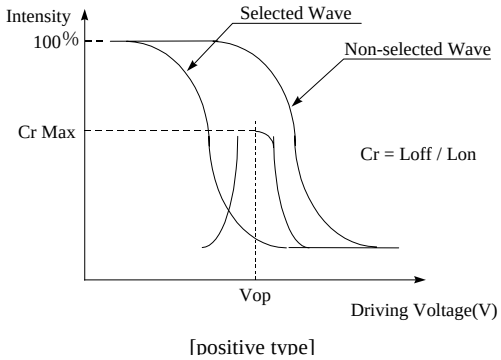
MECHANICAL SPECIFICATION

ITEM	DESCRIPTION
Product No.	SO1602A
Viewing Area	58.22(W)mm×13.52(H)mm
Module Size	80.0(W)×36.0(H)×8.5 max(D)
Dot Size	0.57(W)mm×0.67(H)mm
Dot Pitch	0.60(W)mm×0.70(H)mm
Display Format	16 characters (W)×2 lines (H)
Duty Ratio	1/16 Duty
Interface	I^2C Serial
Controller	US2066 or Equivalent

INTERFACE PIN ASSIGNMENT

Pin No.	Pin Out	Level	Description
1	VSS	0V	Power Supply Ground
2	VDD	3.3V	Power Supply Voltage
3	/CS	L	Chip Select Signal
4	SA0	-	Slave address
5	NC	---	No Connection
6	NC	---	No Connection
7	SCL	H/L	IIC Bus Serial Clock Input
8	SDA_in	H/L	IIC Bus Serial Data "SDA in" and "SDA out" are tied together and serve as SDA.
9	SDA_out	H/L	
10 14	NC	---	No Connection

[Note 7] Definition of Operation Voltage (Vop)



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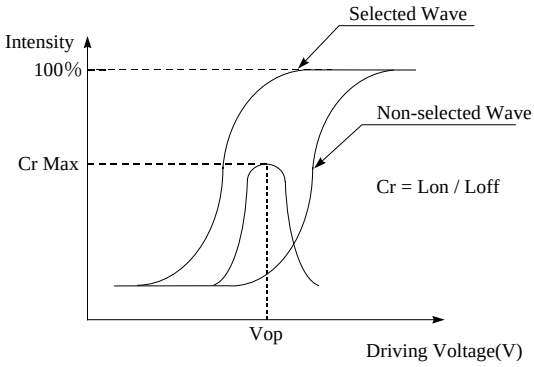
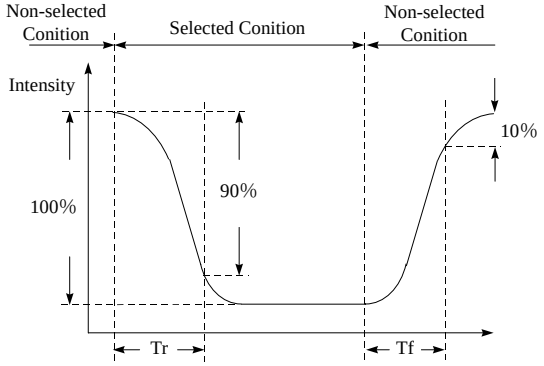
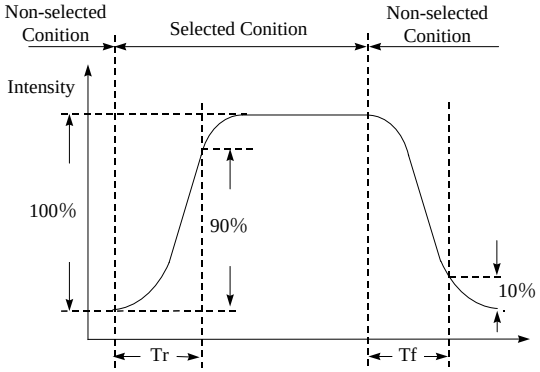


[Negative type]

[Note 8] Definition of Response Time (Tr, Tf)



[positive type]



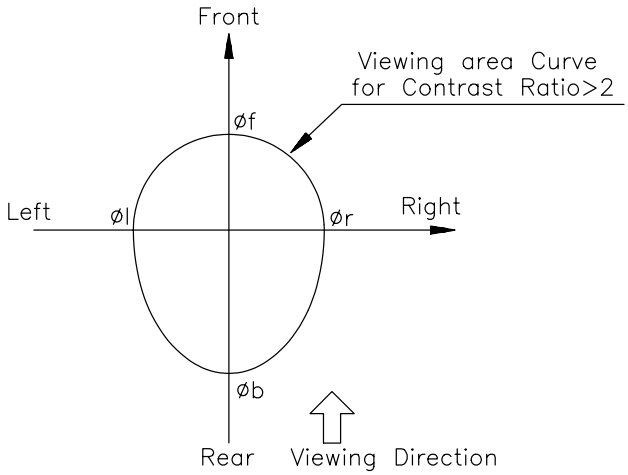
[Negative type]

Conditions:

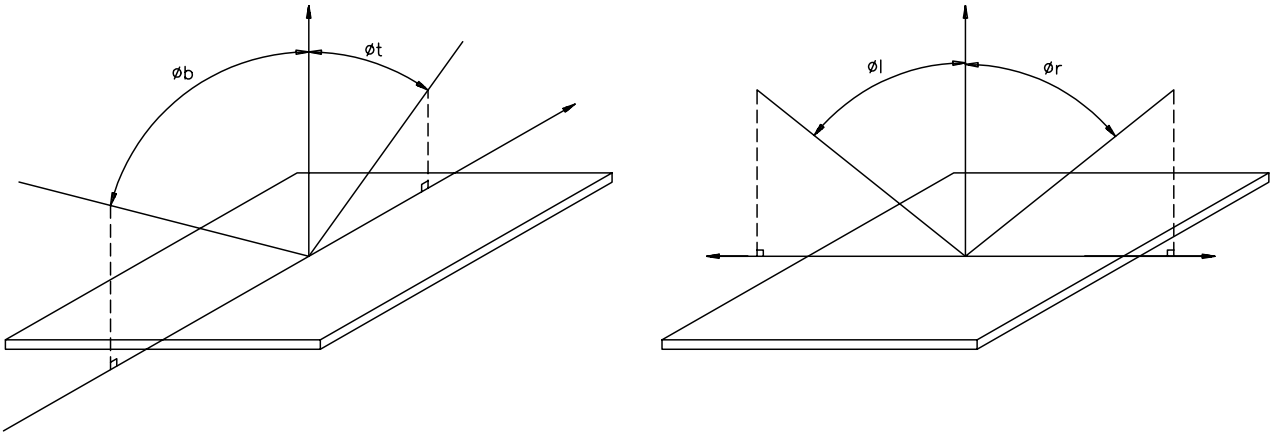
Operating Voltage : Vop **Viewing Angle(θ , ϕ): 0° , 0°**

Frame Frequency : 64 Hz **Driving Wave form : 1/N duty, 1/a bias**

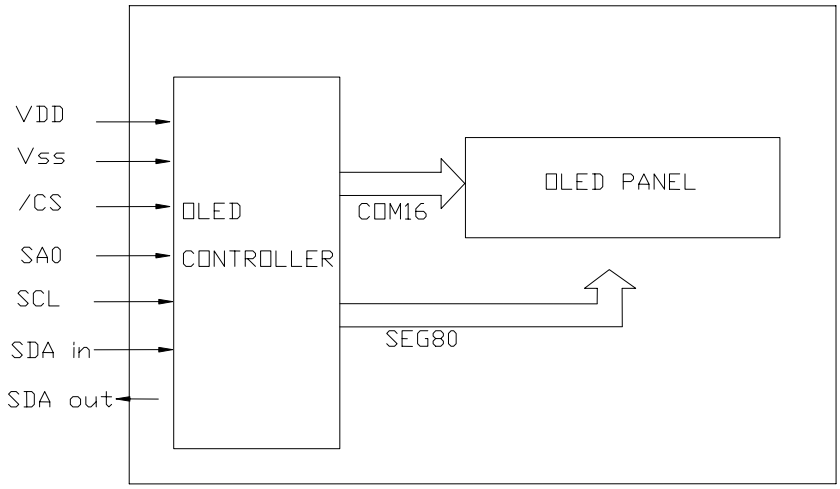
[Note 9] Definition of Viewing Direction



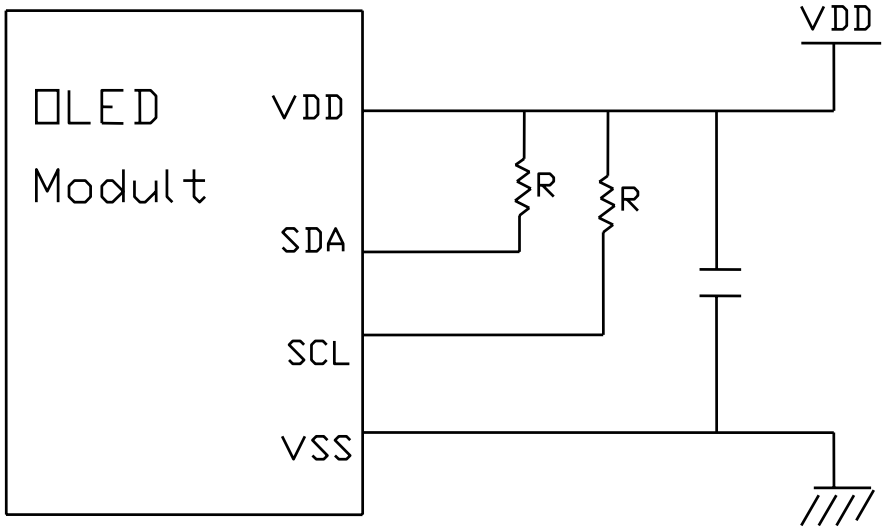
[Note 10] Definition of viewing angle



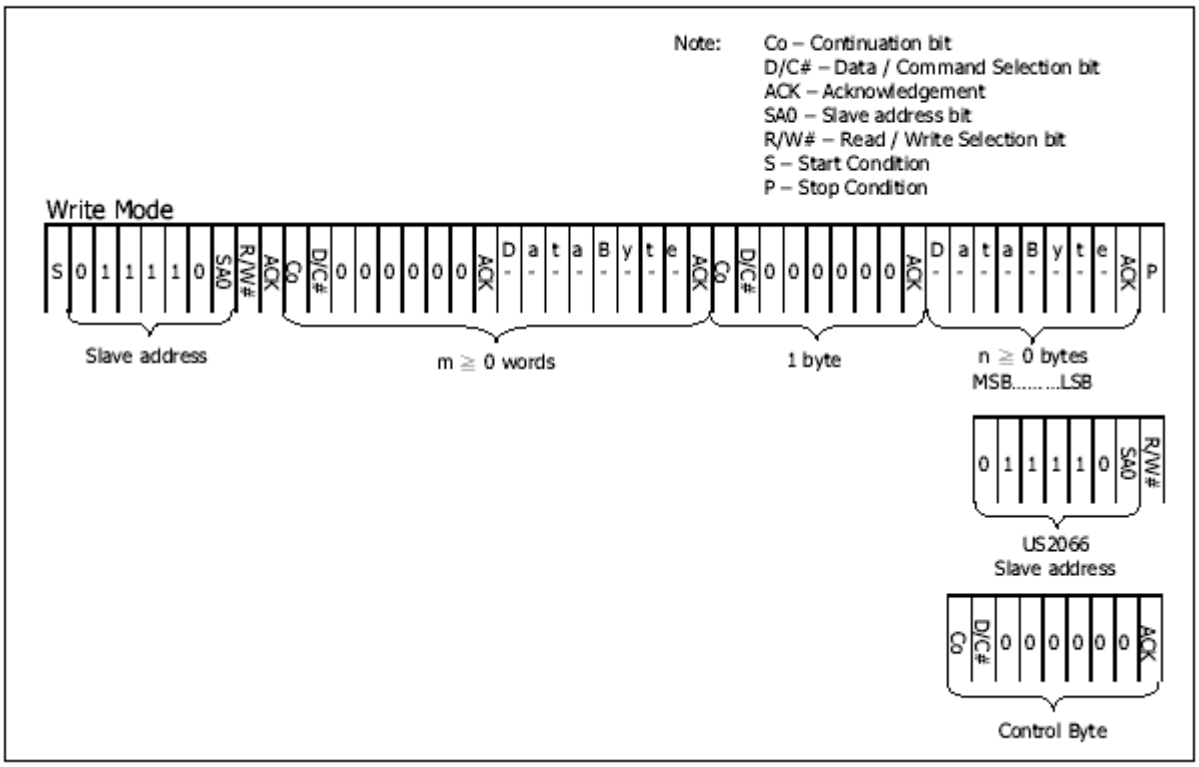
BLOCK DIAGRAM



POWER SUPPLY



I²C-bus data format



I²C Timing Characteristics

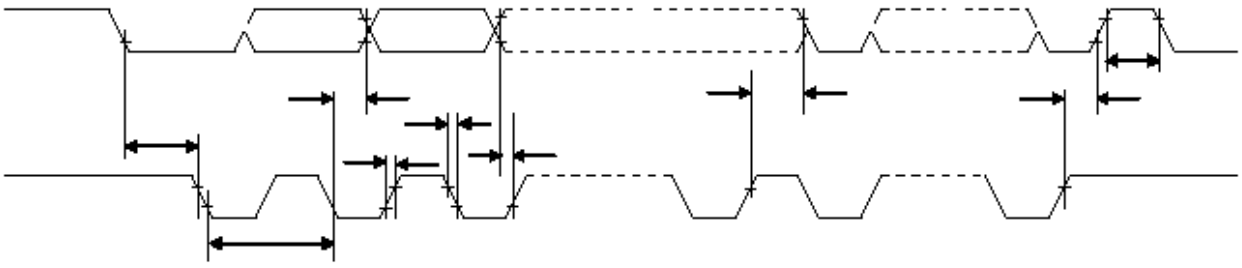
I²C Timing Characteristics

(T_A = 25°C, V_{DDIO} = 2.4-3.6V, V_{SS} =0V)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	2.5	-	-	us
t_{HSTART}	Start condition Hold Time	0.6	-	-	us
t_{HD}	Data Hold Time (for "SDA_{OUT}" pin)	5	-	-	ns
	Data Hold Time (for "SDA_{IN}" pin)	300	-	-	ns
t_{SD}	Data Setup Time	100	-	-	ns
t_{SSTART}	Start condition Setup Time (Only relevant for a repeated Start condition)	0.6	-	-	us
t_{SSTOP}	Stop condition Setup Time	0.6	-	-	us
t_R	Rise Time for data and clock pin	-	-	300	ns
t_F	Fall Time for data and clock pin	-	-	300	ns
t_{IDLE}	Idle Time before a new transmission can start	1.3	-	-	us

Note: All timings are based on 20% to 80% of V_{DDIO}-V_{SS}

I2C Timing Characteristics



FUNCTIONAL SPECIFICATION

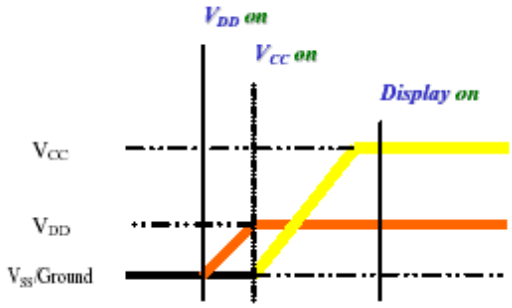
Commands

Power down and Power up Sequence

To protect OEL panel and extend the panel life time, the driver IC power up/down routine should include a delay period between high voltage and low voltage power sources during turn on/off. It gives the OEL panel enough time to complete the action of charge and discharge before/after the operation.

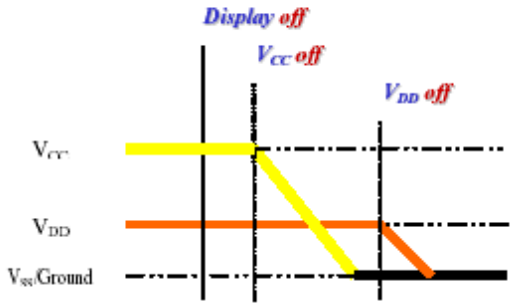
Power up Sequence:

1. Power up V_{DD}
2. Send Display off command
3. Initialization
4. Clear Screen
5. Power up V_{CC}
6. Delay 100ms
   (When V_{CC} is stable)
7. Send Display on command



Power down Sequence:

1. Send Display off command
2. Power down V_{CC}
3. Delay 100ms
   (When V_{CC} is reach 0 and panel is completely discharges)
4. Power down V_{DD}



Note :

1) Since an ESD protection circuit is connected between V_{DD} and V_{CC} inside the driver IC, V_{CC} becomes lower than V_{DD} whenever V_{DD} is ON and V_{CC} is OFF.
2) V_{CC} should be kept float (disable) when it is OFF.
3) Power Pins (V_{DD}, V_{CC}) can never be pulled to ground under any circumstance.
4) V_{DD} should not be power down before V_{CC} power down.

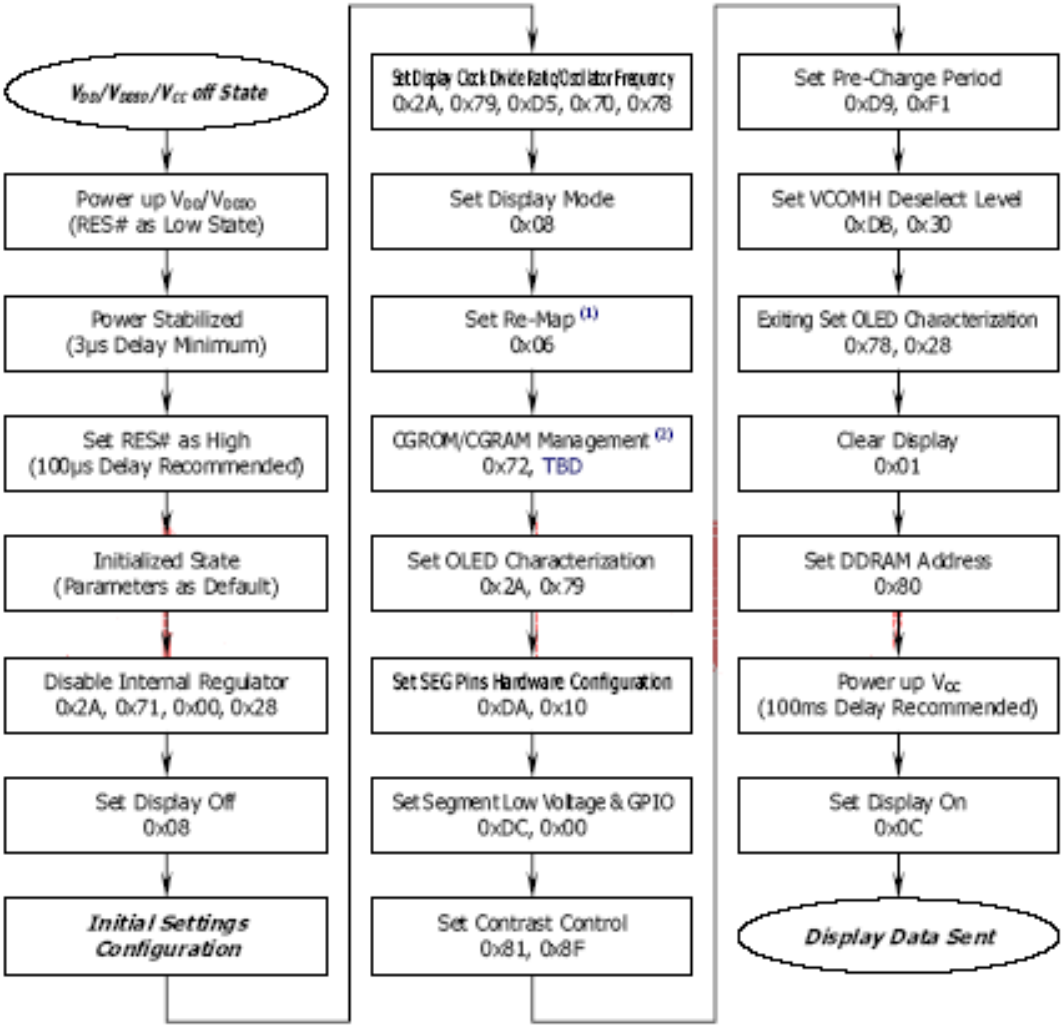
RESET CIRCUIT

When RES# input is low, the chip is initialized with the following status:

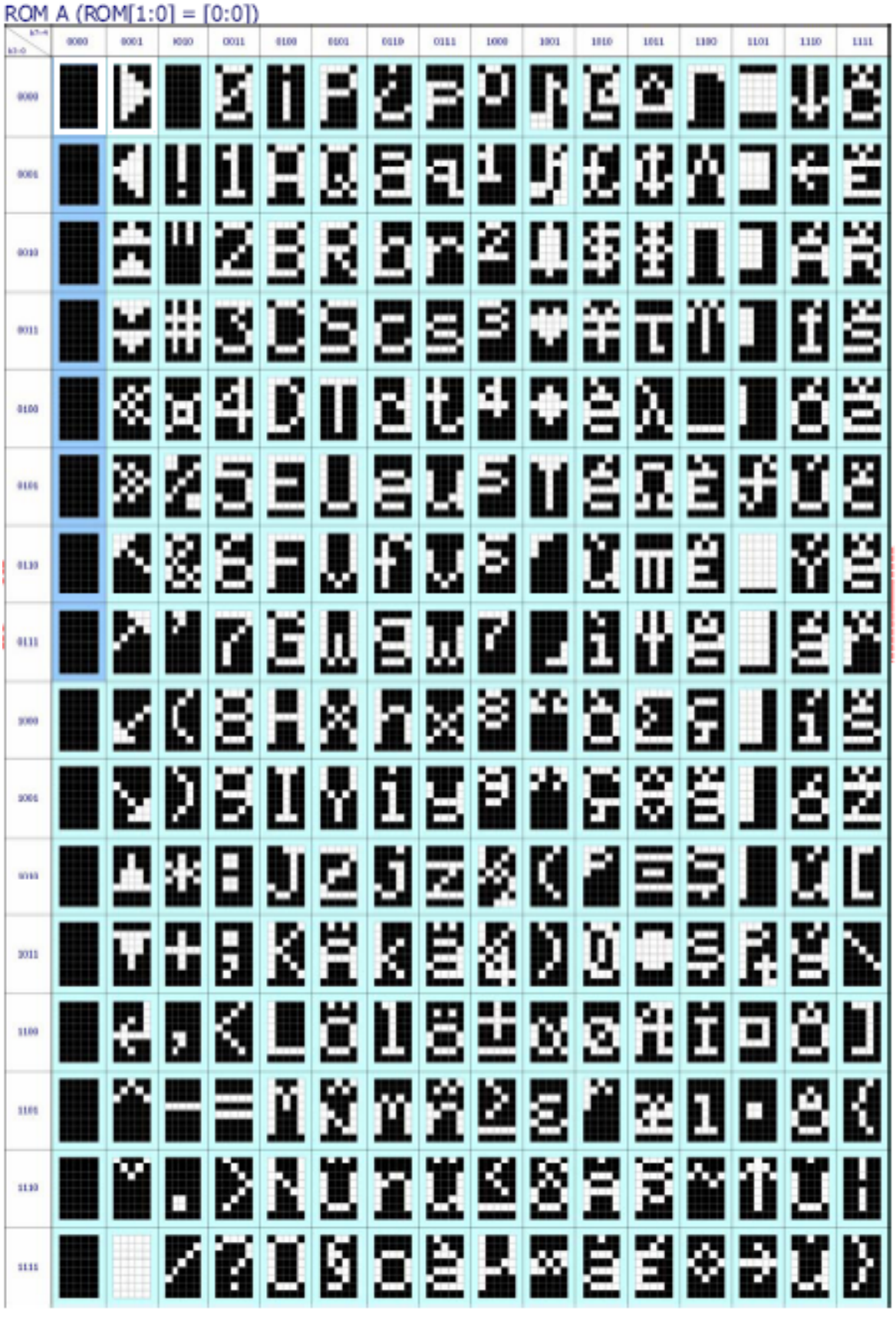
1. Display off, Cursor off, Blink off.
2. Power Down off.
3. 5-dot font is default.
4. Display Shift Disable.
5. CGRAM address is 00h. SEGRAM address is 00h.
6. DDRAM address is 00h.
7. Display start line is set at display RAM address 0
8. Column address counter is set at 0
9. Normal scan direction of the COM outputs
10. Contrast control register is set at 7Fh

ACTUAL APPLICATION EXAMPLE

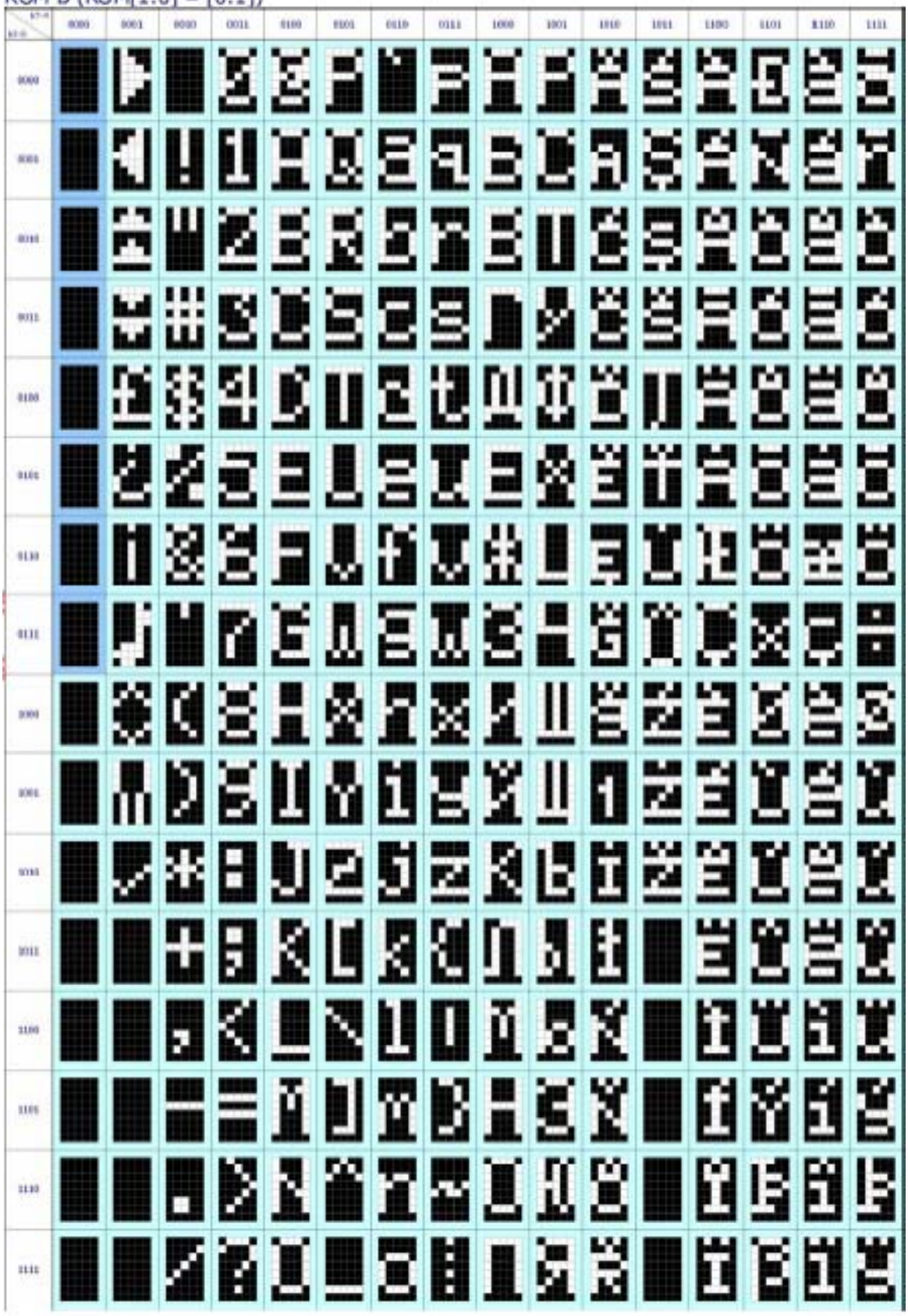
<Power up Sequence>



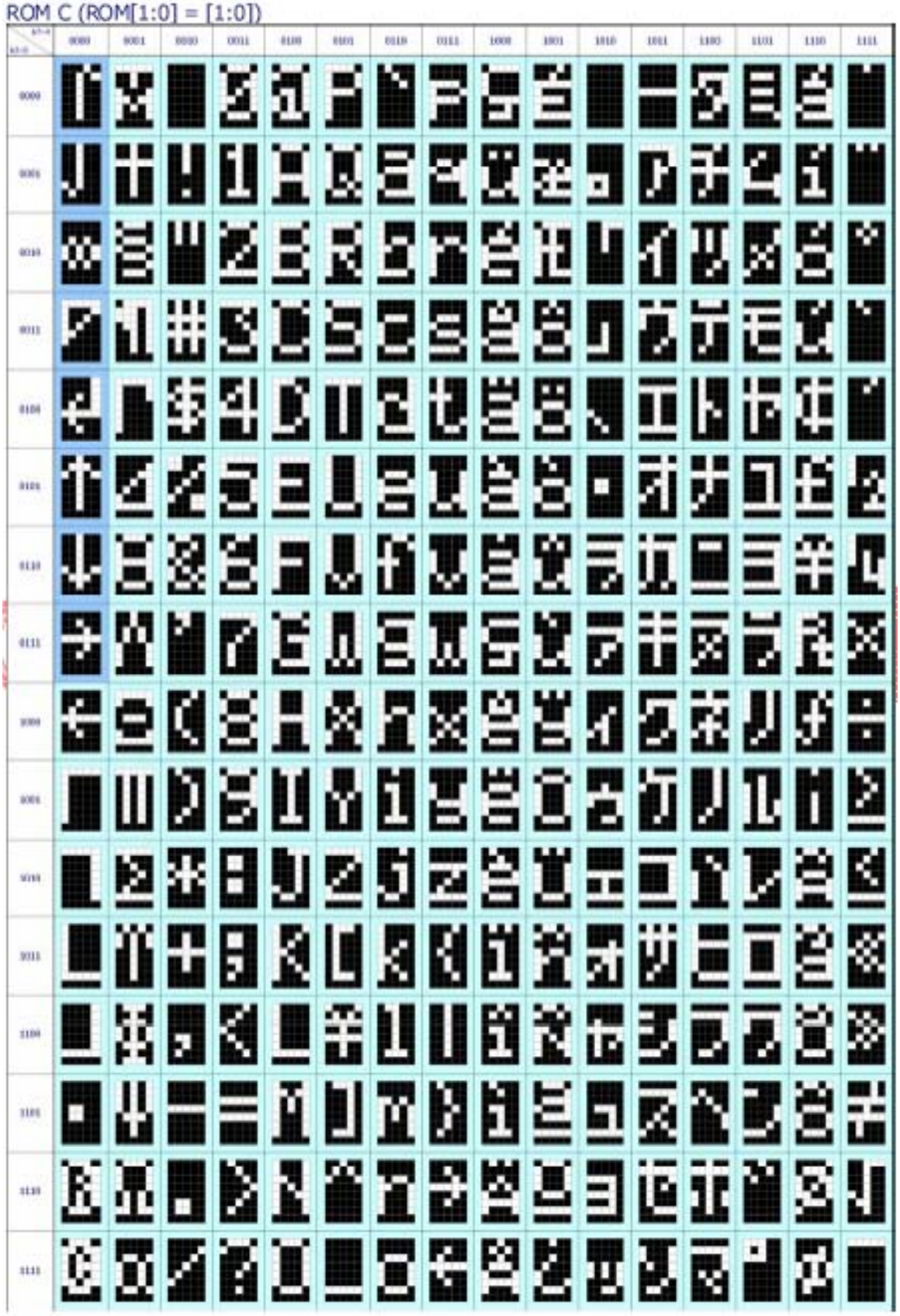
US2066 CGROM CHARACTER CODE



ROM B (ROM[1:0] = [0:1])



ROM C (ROM[1:0] = [1:0])



Commands

Instruction	Instruction code										Description	Execution Time(Fosc is 540 kHz)	POR Hex
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
IS=X , RE=X , SD=0													
Clear Display	0	0	0	0	0	0	0	0	0	1	Write"20H"toDDRAM.and set DDRAM address to"00H" from AC	**1.52 mS**	
IS=X , RE=0 , SD=0													
Return Home	0	0	0	0	0	0	0	0	1	*	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	**1.52 mS**	
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	**37 µS**	**06H**
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=1：entire display on C=1：cursor on B=1：blink on	**37 µS**	**08H**
Function Set	0	0	0	0	1	*	N	DH	RE (0)	IS	N：number of line is 2/1 DH：Double height font control for 2-line mode enable/disable Extension register RE Extension register IS	**37 µS**	**20H**
IS=0 , RE=0 , SD=0													
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	**37 µS**	**10H**
Set CG RAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	**37 µS**	
IS=0 , RE=X , SD=0													
Set DDRAM RAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	**37 µS**	
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	**0 µS**	
Write Data	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	**37 µS**	
Read Data	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	**37 µS**	

Instruction	Instruction code										Description	Execution Time(Fosc is 540 kHz)	POR Hex
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
IS=0 , RE=1 , SD=0													
Function Set	0	0	0	0	1	*	N	BE	RE (1)	REV	N：Number of line is 2/1 BE：CGRAM blink enable RE(1)：Extension register REV：Reverse bit	37 µS	20H
Entry Mode Set	0	0	0	0	0	0	0	1	BDC	BDS	Common bi-direction function BDC= ”0”：COM31->COM0 BDC= ”1”：COM0-> COM31 Segment bi-direction function BDS= ”0”： SEG99-> SEG0 BDS= ”1”： SEG0-> SEG99	37 µS	06H
Set Scroll Quantity	0	0	1	*	SQ5	SQ4	SQ3	SQ2	SQ1	SQ0	Set the quantity of horizontal dot scroll. Scroll Quantity (0 - 48)	37 µS	80H
OLED Characterization	0	0	0	1	1	1	1	0	0	SD	SD=0：Normal register SD=1：Extension register	37 µS	78H
Double Height (4-line)/ Display-dot shift	0	0	0	0	0	1	UD2	UD1	*	DH’	UD2, UD1: Assign different double height formats, DH’: Display shift enable selection bit.	37 µS	1CH
IS=1 , RE=1 , SD=0													
Shift / Scroll Enable	0	0	0	0	0	1	DS4/ HS4	DS3/ HS3	DS2/ HS2	DS1/ HS1	**When DH’=1 Shift Enable** DS：Display shift per line enable **When DH’=0 Scroll Enable** HS：Horizontal scroll per line enable	37 µS	1FH

<table>
<tr><th rowspan="2">Instruction</th><th colspan="10">Instruction code</th><th rowspan="2">Description</th><th rowspan="2">Execution Time(Fosc is 540 kHz)</th><th rowspan="2">POR Hex</th></tr>
<tr><th>RS</th><th>R/W</th><th>DB7</th><th>DB6</th><th>DB5</th><th>DB4</th><th>DB3</th><th>DB2</th><th>DB1</th><th>DB0</th></tr>
<tr><td colspan="14">IS=X , RE=1 , SD=0</td></tr>
<tr><td>Extended Function Set</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>FW</td><td>B/W</td><td>NW</td><td>FW：Font Width control
B/W：Black/White Inversion enable bit
NW：4 Line mode enable bit</td><td>37 µS</td><td>08H</td></tr>
<tr><td>Function Selection A</td><td>0
1</td><td>0
0</td><td>0
A7</td><td>1
A6</td><td>1
A5</td><td>1
A4</td><td>0
A3</td><td>0
A2</td><td>0
A1</td><td>1
A0</td><td>This double byte command enable or disable the internal VDD</td><td>37 µS</td><td>71H
[5CH]</td></tr>
<tr><td>Function Selection B</td><td>0
1</td><td>0
0</td><td>0
*</td><td>1
*</td><td>1
*</td><td>1
*</td><td>0
RO1</td><td>0
RO0</td><td>1
OP1</td><td>0
OP0</td><td>Beside using CGROM
<table><tr><th>OP[1:0]</th><th>CGROM</th><th>CGRAM</th></tr><tr><td>00b</td><td>240</td><td>8</td></tr><tr><td>01b</td><td>248</td><td>8</td></tr><tr><td>10b</td><td>250</td><td>6</td></tr><tr><td>11b</td><td>256</td><td>0</td></tr></table>
Select character ROM
<table><tr><th>RO[1:0]</th><th>ROM</th></tr><tr><td>00b</td><td>A</td></tr><tr><td>01b</td><td>B</td></tr><tr><td>10b</td><td>C</td></tr><tr><td>11b</td><td>Invalid</td></tr></table></td><td>37 µS</td><td>72H
[0FH]</td></tr>
<tr><td>Set Contrast Control</td><td>0
0</td><td>0
0</td><td>1
A7</td><td>0
A6</td><td>0
A5</td><td>0
A4</td><td>0
A3</td><td>0
A2</td><td>0
A1</td><td>1
A0</td><td>This command sets the Contrast Setting of the display.</td><td>37 µS</td><td>81H
[7FH]</td></tr>
<tr><td>Set Display Clock Divide Ratio/Oscillator Frequency</td><td>0
0</td><td>0
0</td><td>1
A7</td><td>1
A6</td><td>0
A5</td><td>1
A4</td><td>0
A3</td><td>1
A2</td><td>0
A1</td><td>1
A0</td><td>Display Clock Divide Ratio (A[3:0])
Oscillator Frequency (A[7:4])</td><td>37 µS</td><td>D5H
[70H]</td></tr>
<tr><td>Set Phase Length</td><td>0
0</td><td>0
0</td><td>1
A7</td><td>1
A6</td><td>0
A5</td><td>1
A4</td><td>1
A3</td><td>0
A2</td><td>0
A1</td><td>1
A0</td><td>This double byte command sets the length of phase 1 and 2 of segment waveform of the driver.</td><td>37 µS</td><td>D9H
[78H]</td></tr>
<tr><td>Set SEG Pins Hardware Configuration</td><td>0
0</td><td>0
0</td><td>1
0</td><td>1
0</td><td>0
A5</td><td>1
A4</td><td>1
0</td><td>0
0</td><td>1
0</td><td>0
0</td><td>This double byte command changes the mapping between the display</td><td>37 µS</td><td>DAH
[10H]</td></tr>
<tr><td>Set VCOMH Deselect Level</td><td>0
0</td><td>0
0</td><td>1
0</td><td>1
A6</td><td>0
A5</td><td>1
A4</td><td>1
0</td><td>0
0</td><td>1
0</td><td>1
0</td><td><table><tr><th>A [6:4]</th><th>Hex code</th><th>VCOMH deselect level</th></tr><tr><td>000b</td><td>00h</td><td>0.65xVcc</td></tr><tr><td>001b</td><td>10h</td><td>0.71xVcc</td></tr><tr><td>010b</td><td>20h</td><td>0.77xVcc</td></tr><tr><td>011b</td><td>30h</td><td>0.83xVcc</td></tr><tr><td>100b</td><td>40h</td><td>1xVcc</td></tr></table></td><td>37 µS</td><td>DBH
[40H]</td></tr>
<tr><td>Function Selection C</td><td>0
0</td><td>0
0</td><td>1
0</td><td>1
A7</td><td>0
0</td><td>1
0</td><td>1
0</td><td>1
0</td><td>0
A1</td><td>0
A0</td><td>This double byte command consists of two functions</td><td>37 µS</td><td>DCH
[00H]</td></tr>
<tr><td>Crosstalk Compensation</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>TBD</td><td>37 µS</td><td>DFH</td></tr>
</table>

Note
(1) POR stands for Power On Reset Values
(2) “*”and ”x” stand for ”Don’t care”
(3) The locked OLED driver IC MCU interface prohibits all commands access except logic bit SD is set to 1b
(4) Refer to Table 0-1 and
(5) Table 0-2 for the details of logic bits IS , RE and SD.
(6) Cursor & Blink is ON, that performs alternate between all the high data and display character at the cursor position.
If fosc has 540kHz frequency, blinking has 370 ms interval.

HANDLING PRECAUTION

1. Mounting Method

The panel of the OLED Module consists of two thin glass plates with polarizes which easily get damaged since the Module is fixed by utilizing fitting holes in the printed circuit board. Extreme care should be taken when handling the OLED Modules.

2. Caution of OLED handling & cleaning

When cleaning the display surface, use soft cloth with solvent (recommended below) and Wipe lightly.

-Isopropyl alcohol

-Ethyl alcohol

-Trichlorotriflorothane

Do not wipe the display surface with dry or hard materials that will damage the polarize surface.

Do not use the following solvent：

-Water

-Kettle

-Aromatics

3. Caution against static charge

The OLED Module use C-MOSLSI drivers, so we recommend end that you connect any unused input terminal to VDD or VSS, do not input any signals before power is turned on. And ground your body, Work/assembly table. And assembly equipment to protect against static electricity.

4. Packaging

-Modules use OLED elements, and must be treated as such. Avoid in tense shock and falls from a height.

-To prevent modules from degradation. Do not operate or store them exposed directly to sunshine or high temperature/humidity.

5. Caution for operation

-It is indispensable to drive LCD’s with in the specified voltage limit since the higher voltage than the limit shorten LCD life.

An electrochemical reaction due to direct current causes LCD deterioration, Avoid the use of direct current drive.

-Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them. However those phenomena do not mean malfunction or out of order with LCD's. Which will come back in the specified operating temperature range.

- If the display area is pushed hard during operation, some font will be abnormally displayed but it resumes normal condition after turning off once.

- A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the relative condition of 40 ℃, 50%RH or less is required.

6. Storage

In the case of storing for a long period of time (for instance. For years) for the purpose or replacement use, The following ways are recommended.

- Storage in a polyethylene bag with sealed so as not to enter fresh air outside in it, And with no desiccant.

- Placing in a dark place where neither exposure to direct sunlight nor light is. Keeping temperature in the specified storage temperature range.

-Storing with no touch on polarizer surface by the anything else. (It is recommended to store them as they have been contained in the inner container at the time of delivery)

7. Safety

- It is recommendable to crash damaged or unnecessary LCD into pieces and wash off liquid crystal by using solvents such as acetone and ethanol. Which should be burned up later.

- When any liquid crystal leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water.