晶采光電科技股份有限公司
AMPIRE CO., LTD.

SPECIFICATIONS FOR
LCD MODULE

CUSTOMER	
CUSTOMER PART NO.	
AMPIRE PART NO.	**AF-240160EFIQW**
APPROVED BY	
DATE	

☑ **Approved For Specifications**
☐ **Approved For Specifications & Sample**

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RECORD OF REVISION

Revision Date	Contents	Editor
2005/1/21	New Release	Rosaline
2005/5/12	Modify White LED back-light characteristics	Tony
2005/9/5	Modify the module electronic characteristics	Lorry

1 FEATURES

(1) Display format : 240×160 dots, 1/160 duty, 1/13 bias.

(2) Construction : LCD panel, Edge LED White backlight and COF technology.

(3) Display type : FSTN, Transflective, Positive , 6 o' clock view.

(4) Controller : "ULTRACHIP" UC1611

(5) Interface for 8080 or 6800 series family MPU, select by BM0, BM1 setting.

2 MECHANICAL DATA

Parameter	Stand Value	Unit
Dot size	0.23(W) × 0.23(H)	mm
Dot pitch	0.24(W) × 0.24(H)	mm
Active area	57.59(W) × 38.39(H)	mm
Viewing area	63.0(W) × 42.5(H)	mm
Module size	81.0(W) × 115.5(H) × 6.5Max.(T)	mm

3 ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit
Logic Circuit Supply Voltage	VDD-VSS	-0.3	+4.0	V
LCD Driving Voltage	VLCD	-4	+18.0	V
Input Voltage	V_I	-0.3	VDD+0.3	V
Operating Temp.	T_{OP}	0	50	°C
Storage Temp.	T_{STG}	-20	70	°C

4 ELECTRO-OPTICAL CHARACTERISTICS

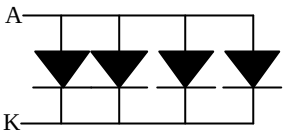
Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
----- Electronic Characteristics -----							
Logic Circuit Supply Voltage	VDD-VSS	--	2.4	2.8	3.3	V	
LCD Driving Voltage (FSTN)	VLCD	-20 ℃	--	--	--	V	* The LCD driving should be decided by real design.
		0 °C	--	--	--		
		25 °C	--	14.5*	--		
		50 °C	--	--	--		
		70 °C	--	--	--		
Input Voltage	VIH	--	0.8VDD	--	VDD	V	
	VIL	--	-0	--	0.2 VDD	V	
Logic Supply Current	IDD	VDD=2.8V	--	0.9	1.2	mA	
----- Optical Characteristics (FSTN) -----							
Contrast	CR	25°C	--	5	--		Note 1
Rise Time	tr	25°C	--	200	--	ms	Note 2
Fall Time	tf	25°C	--	200	--	ms	
Viewing Angle Range	θ f	25°C & CR≥2	--	40	--	Deg.	Note 3
	θ b		--	35	--		
	θ l		--	35	--		
	θ r		--	35	--		
Frame Frequency	fF	25°C	--	70	--	Hz	
----- White LED Back-light Characteristics -----							
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**	**Note**
Forward Voltage	VF	IF=60mA	--	3.2	3.5	V	Supply Voltage between A&K Note 5
Forward Current	IF	VF=3.3V	--	60	80	mA	Note 4
LCM Luminous intensity		IF=60mA	--	20	--	cd/m^2	Note 4
LED C.I.E	X	IF=60mA	0.28	0.31	0.34		Note 6
	Y	IF=60mA	0.29	0.32	0.35		

(NOTE 4): Luminous intensity is decided by forward current of White LED.

(NOTE 5): White LEDs are with voltage tolerance

(NOTE 6): White LEDs are with color tolerance

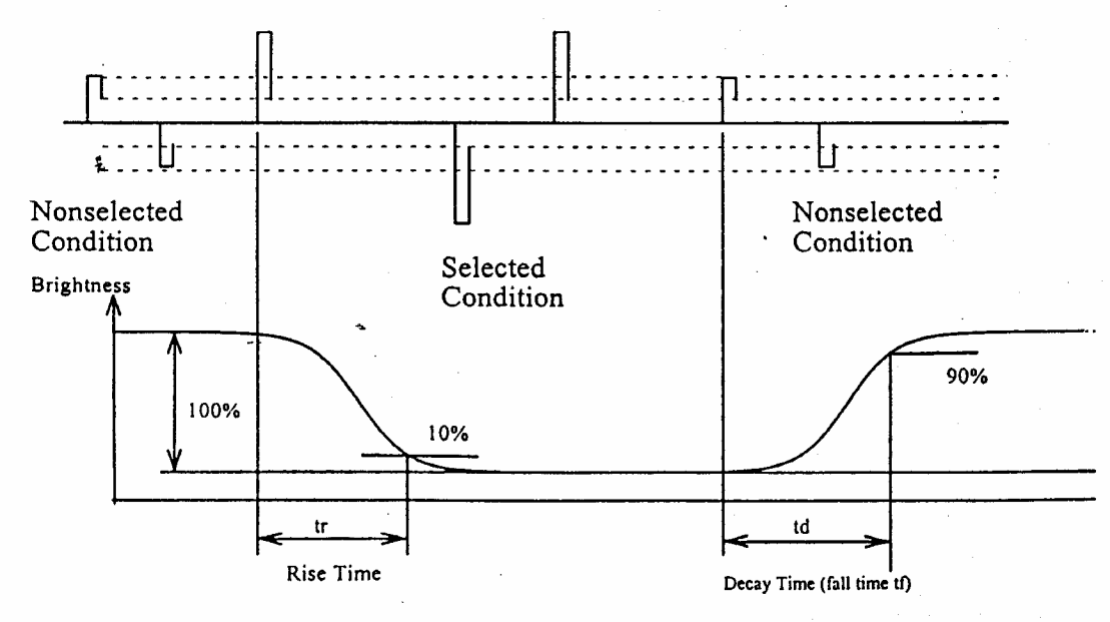
* LED Dice number = 4



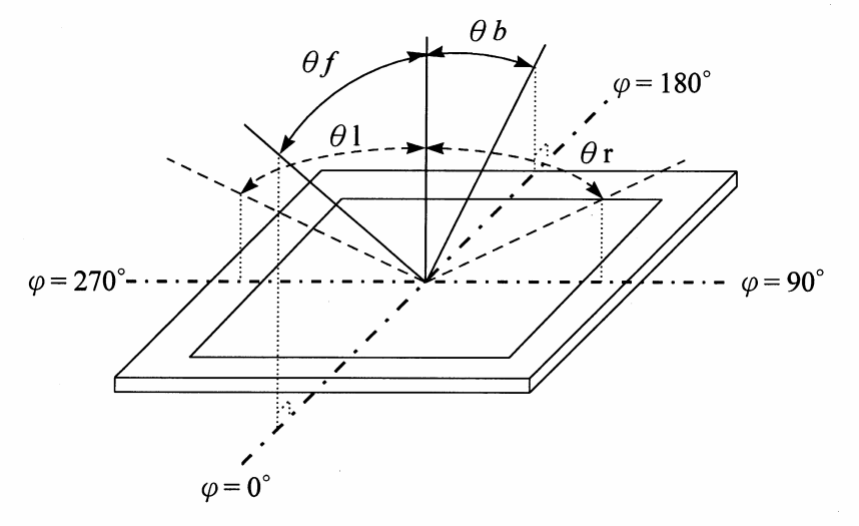
(NOTE 1) Contrast ratio :

CR = (Brightness in OFF state) / (Brightness in ON state)

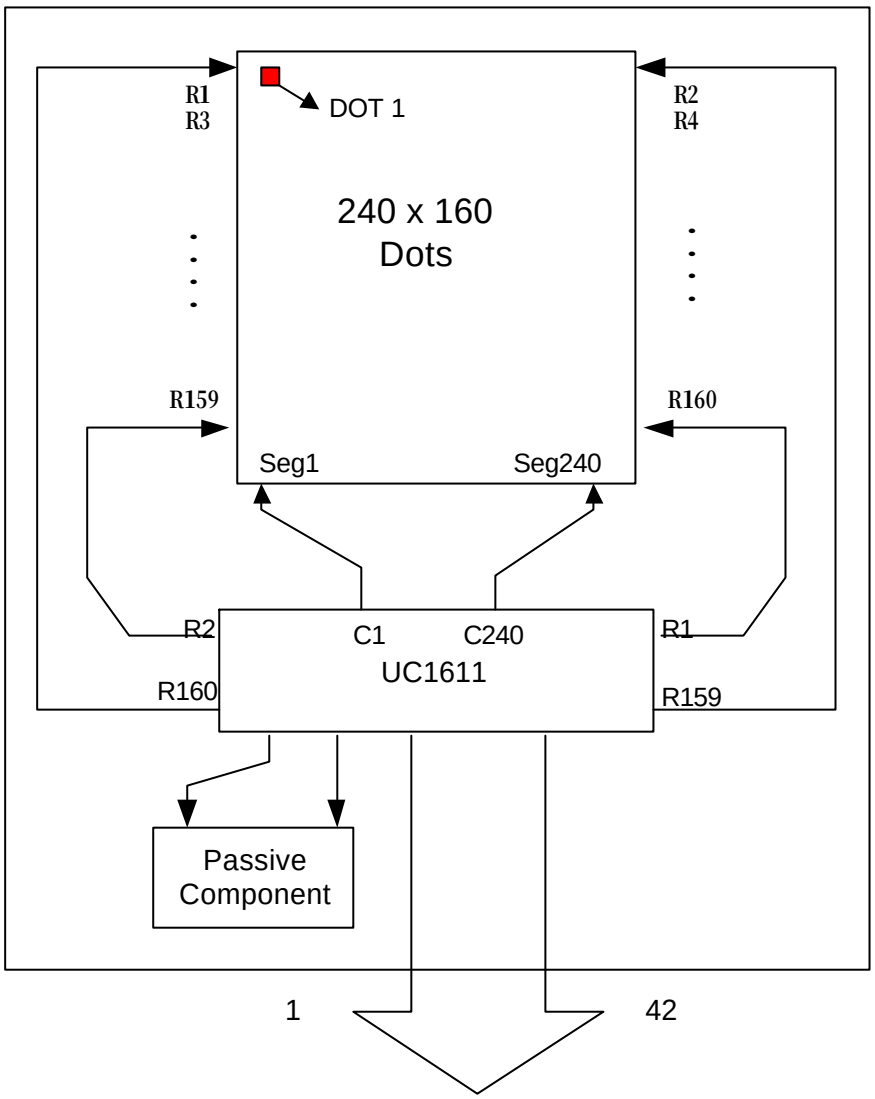
(NOTE 2) Response time :



(NOTE 3) Viewing angle


θb
θf
φ = 180°
θl
θr
φ = 270°
φ = 90°
φ = 0°

5 BLOCK DIAGRAM & POWER SUPPLY



Default Setting:

Symbol	H/L	Description
VCM	OPEN	Leave that pin "open" in single LCM situation.
VS1	OPEN	
VS0	OPEN	
PUMP_DN	OPEN	
DISP_ON	OPEN	
SCLK	OPEN	
SM	L	Master mode or default in other situation

6 INTERFACE

No.	Symbol	Function	
1	NC	No Connection	
2	VDD	Power supply for logic and other analog circuits.	
3	VSS	Ground (0V)	
4	BM0	Bus modes : "HL" : 8 bit 8080 "HH" : 8 bit 6800	
5	BM1	BM[1:0] "LL" : 4 bit 8080 "LH" : 4 bit 6800	
6	WR1	Bus Type : 8080 mode "/RD" ; 68mode "E"	
7	WR0	Bus Type : 8080 mode "/WR" ; 68 mode "R/W"	
8	CD	Select Control data or Display data for read/write operation. ("H": Display data, "L": control data)	
9	CS1	Chip Select. Chip is selected when CS1="H". When the chip is not selected, D[7:0] will be high impedance.	
10	RST	When RST="L", all control register are re-initialized by their default state and/or by their pin configurations if applicable.	
11	D0	8 bits Data Bus for 8080 or 6800 series	4 bits Data Bus for 8080 or 6800 series
12	D1		
13	D2		
14	D3		
15	D4		
16	D5		
17	D6		
18	D7		
19	VSS	Ground (0V)	
20	NC	No Connection	

7 INSTRUCTION SET

The following is a list of host commands support by UC1611

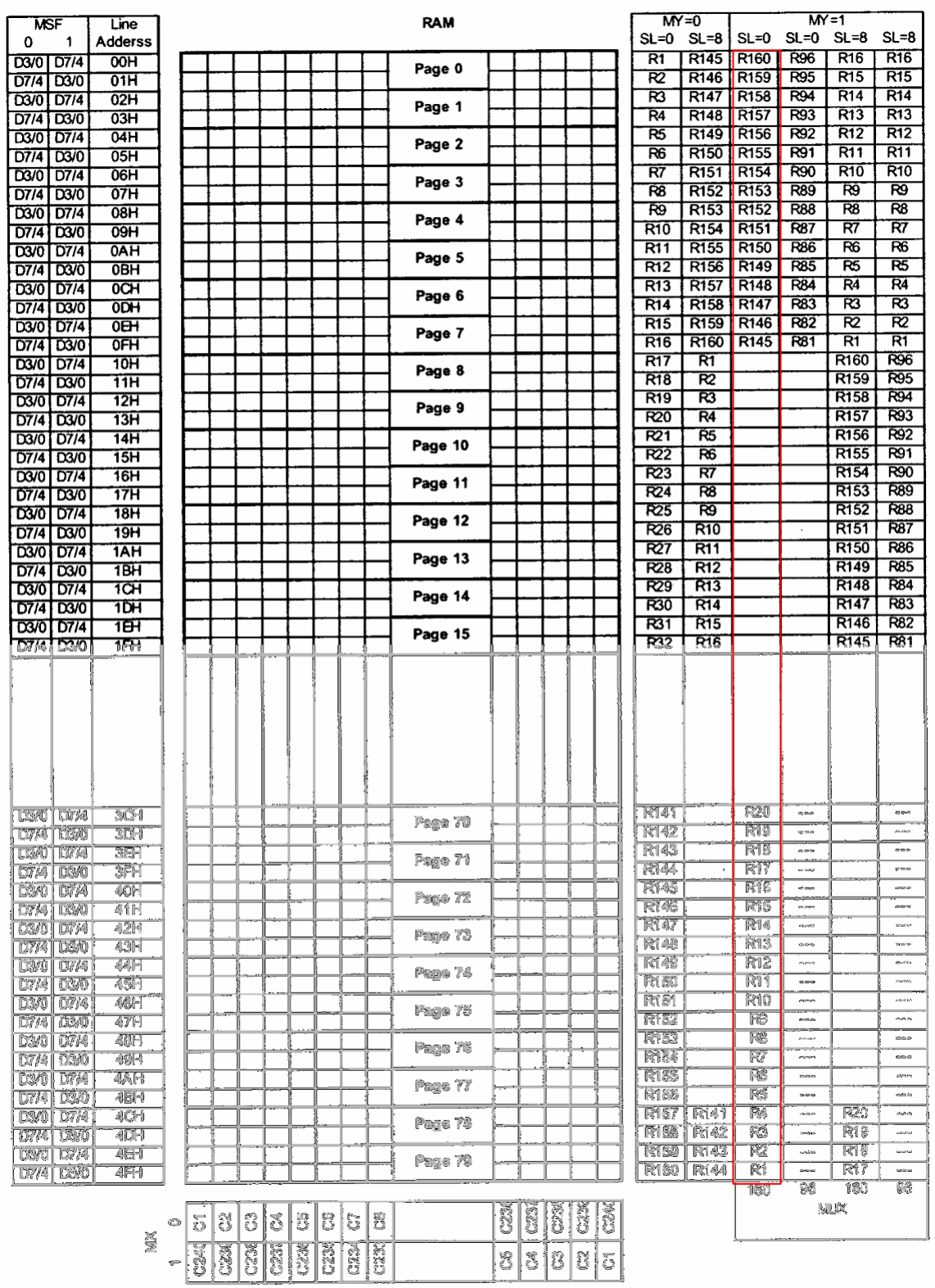
C/D: 0: Control, 1: Data
W/R: 0: Write Cycle, 1: Read Cycle

\# Useful Data bits
– Don't Care

Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action
Write Data Byte	1	0	#	#	#	#	#	#	#	#	Write 1 byte @ PA/CA
Read Data Byte	1	1	#	#	#	#	#	#	#	#	Read 1 byte @ PA/CA
Get Status	0	1	BZ	MX	DE	RS	WA	GN1	GN0	1	Get Status Summary
Set Column Address LSB	0	0	0	0	0	0	#	#	#	#	Set CA[3:0]=D[3:0]
Set Column Address MSB	0	0	0	0	0	1	#	#	#	#	Set CA[7:4] =D[3:0]
Set Mux rate.	0	0	0	0	1	0	0	0	#	#	Set MR[1:0]=D[1:0]
Set Temp. Compensation.	0	0	0	0	1	0	0	1	#	#	Set TC[1:0]=D[1:0]
Set Panel Loading	0	0	0	0	1	0	1	0	#	#	Set PC[1:0]=D[1:0]
Set Pump Control	0	0	0	0	1	0	1	1	#	#	Set PC[3:2]=D[1:0]
Set Adv. Program Control (double byte command)	0 0	0 0	0 #	0 #	1 #	1 #	0 #	0 #	0 #	R #	Set APC[R][7:0]=D[7:0], where R = 0, or 1
Set Max CA (double byte command)	0 0	0 0	0 -	0 #	1 #	1 #	0 #	0 #	1 #	0 #	Set MC = D[6:0]
Set Start Line LSB	0	0	0	1	0	0	#	#	#	#	Set SL[3:0]=D[3:0]
Set Start Line MSB	0	0	0	1	0	1	#	#	#	#	Set SL[7:4]=D[3:0]
Set Page Address LSB	0	0	0	1	1	0	#	#	#	#	Set PA[3:0]=D[3:0]
Set Page Address MSB	0	0	0	1	1	1	#	#	#	#	Set PA[7:4]=D[3:0]
Set V_{REF} potential meter (double-byte command)	0 0	0 0	1 #	0 #	0 #	0 #	0 #	0 #	0 #	1 #	Set PM[5:0]=D[5:0] Set GN[1:0]=D[7:6]
Set RAM Address Control	0	0	1	0	0	0	1	#	#	#	Set AC[2:0]=D[2:0]
Set Fixed Lines	0	0	1	0	0	1	#	#	#	#	Set FL[3:0]=D[3:0]
Set Frame Rate	0	0	1	0	1	0	0	0	#	#	Set LC[4:3]=D[1:0]
Set All-Pixel-ON	0	0	1	0	1	0	0	1	0	#	Set DC[1]=D0
Set Inverse Display	0	0	1	0	1	0	0	1	1	#	Set DC[0]=D0
Set Display Enable	0	0	1	0	1	0	1	#	#	#	Set DC[4:2]=D[2:0]
Set LCD Control	0	0	1	1	0	0	0	#	#	#	Set LC[2:0]=D[2:0]
Set N-Line Inversion	0	0	1	1	0	1	1	#	#	#	Set DC[7:5]=D[1:0]
Set Gray Scale Mode	0	0	1	1	0	1	0	0	#	#	Set LC[6:5] = D[1:0]
System Reset	0	0	1	1	1	0	0	0	1	0	System Reset sequence
NOP	0	0	1	1	1	0	0	0	1	1	No operation
Set LCD Bias Ratio	0	0	1	1	1	0	1	0	#	#	Set BR[1:0]= D[1:0]
Reset Cursor Update Mode	0	0	1	1	1	0	1	1	1	0	Set AC[3]=0, CA=CR;
Set Cursor Update Mode	0	0	1	1	1	0	1	1	1	1	Set AC[3]=1, CR=CA;
Set Test Control (double byte command)	0 0	0 0	1 #	1 #	1 #	0 #	0 #	1 #	TT #	 #	For testing only. Do not use.

* Other than commands listed above, all other bit patterns result in NOP (No Operation).

DATA FORMAT :


MSF
0 1
Line Adderss
00H
01H
02H
03H
04H
05H
06H
07H
08H
09H
0AH
0BH
0CH
0DH
0EH
0FH
10H
11H
12H
13H
14H
15H
16H
17H
18H
19H
1AH
1BH
1CH
1DH
1EH
1FH
3CH
3DH
3EH
3FH
40H
41H
42H
43H
44H
45H
46H
47H
48H
49H
4AH
4BH
4CH
4DH
4EH
4FH
RAM
Page 0
Page 1
Page 2
Page 3
Page 4
Page 5
Page 6
Page 7
Page 8
Page 9
Page 10
Page 11
Page 12
Page 13
Page 14
Page 15
Page 70
Page 71
Page 72
Page 73
Page 74
Page 75
Page 76
Page 77
Page 78
Page 79
MX
0
1
C1
C2
C3
C4
C5
C6
C7
C8
C24
C23
C22
C21
C20
C19
C18
C17
C16
C15
C14
C13
C12
C11
C10
C9
C8
C7
C6
C5
C4
C3
C2
C1
MY=0
MY=1
SL=0 SL=8 SL=0 SL=0 SL=8 SL=8
R1 R145 R160 R96 R16 R16
R2 R146 R159 R95 R15 R15
R3 R147 R158 R94 R14 R14
R4 R148 R157 R93 R13 R13
R5 R149 R156 R92 R12 R12
R6 R150 R155 R91 R11 R11
R7 R151 R154 R90 R10 R10
R8 R152 R153 R89 R9 R9
R9 R153 R152 R88 R8 R8
R10 R154 R151 R87 R7 R7
R11 R155 R150 R86 R6 R6
R12 R156 R149 R85 R5 R5
R13 R157 R148 R84 R4 R4
R14 R158 R147 R83 R3 R3
R15 R159 R146 R82 R2 R2
R16 R160 R145 R81 R1 R1
R17 R1 R160 R96
R18 R2 R159 R95
R19 R3 R158 R94
R20 R4 R157 R93
R21 R5 R156 R92
R22 R6 R155 R91
R23 R7 R154 R90
R24 R8 R153 R89
R25 R9 R152 R88
R26 R10 R151 R87
R27 R11 R150 R86
R28 R12 R149 R85
R29 R13 R148 R84
R30 R14 R147 R83
R31 R15 R146 R82
R32 R16 R145 R81
R141 R20
R142 R19
R143 R18
R144 R17
R145 R16
R146 R15
R147 R14
R148 R13
R149 R12
R150 R11
R151 R10
R152 R9
R153 R8
R154 R7
R155 R6
R156 R5
R157 R141 R4 R20
R158 R142 R3 R19
R159 R143 R2 R18
R160 R144 R1 R17
160 96 160 96
MUX

CONTROL REGISTERS :

UC1611 contains registers which control the chip operation. These registers can be modified by commands. The commands supported by UC1611 are described in the next section.

Name: The Symbolic reference of the register byte.
Note that, some symbol names refers to collection of bits (flags) within one register byte.

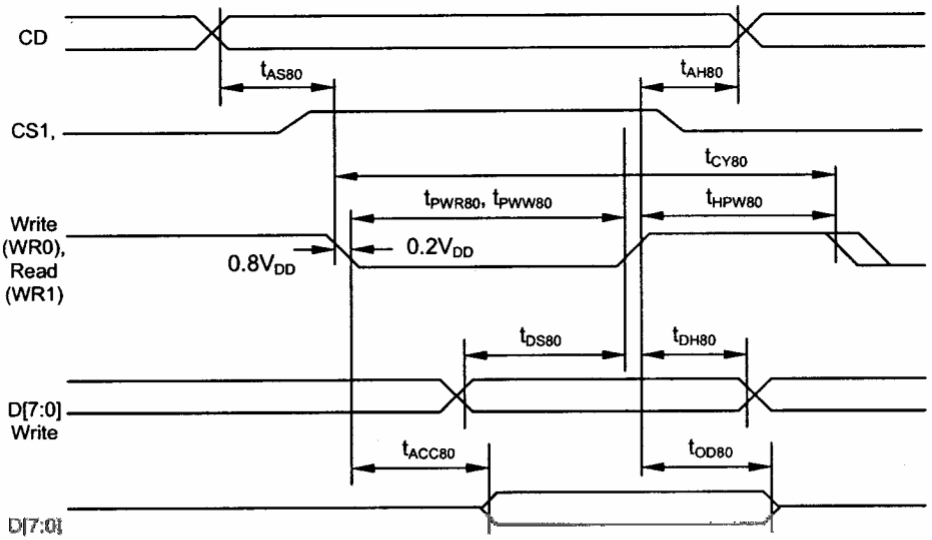
Default: Value after *Power-up-Reset* and *System-Reset*.
"PIN" means default value depends on the connection of associated configuration pin(s).

Name	Bits	Default	Description
SL	8	0H	Scroll Line. Scroll the displayed image up by SL rows. The valid SL value are between 0 (for no scrolling) and (159 – 2xFL). Setting SL outside of this range cause undefined effect on the displayed image.
FL	4	0H	Fixed lines. The first FLx2 lines of each frame are fixed and are not affected by scrolling (SL). When FL is non-zero, the screen is effectively separated into two region: one scrollable, one non-scrollable.
CR	8	0H	Return Column Address.
CA	8	0H	Display Data RAM Column Address (Used in Host to Display Data RAM access)
PA	7	0H	Display Data RAM Page Address (Used in Host to Display Data RAM access)
BR	2	2H	Bias Ratio. The ratio between V_{LCD} and V_D.
TC	2	1H	Temperature Compensation (per °C). 00: 0.0% 01: -0.05% 10: -0.1% 11: -0.2%
GN	2	3H	Gain = V_D / V_{PM}
PM	6	10H	Electronic Potential Meter to generate V_{PM} from V_{REF}
MR	2	3H	Multiplexing Rate: Number of pixel rows: 0: 64 1: 96 2: 128 3: 160
OM	2	0	Operating Modes 10: Sleep 11: Normal 01: (Not used) 00: Reset
BZ	1	–	Busy with internal processes (reset, changing mode, etc.) OK for Display RAM read/write access.
RS	1		Reset in progress, Host Interface not ready
PC	4	0DH	Power Control. PC[1:0]: 00: LCD: <20nF 01: LCD: 20~28nF 10: LCD: 28~40nF 11: LCD: 40~56nF PC[3:2]: 00: External V_{LCD} 01: 6x pump 10: 7x pump 11: 8x pump
APC0	8	00H	Advanced Program Control. Default value should work fine.

Name	Bits	Default	Description
DC	8	0H	Display Control: DC[0]: PXV: Pixels Inverse DC[1]: APO: All Pixels ON DC[4:2]: Display ON/OFF. Each bit controls a set of column drivers (80-80-80). When DC[4:2] is set to "HLH", the chip is turned into a 160x160 controller-driver and the programmers' view of CA becomes 0~159. DC[5]: N-Line inversion. 0: Invert every 17 lines. 1: Invert every 9 lines. DC[6:7]: Idle insertion control when N-Line inversion.
AC	4	1H	Address Control: AC[0]: WA: Automatic column/page Wrap Around AC[1]: Auto-Increment order 0: Column (CA) first 1: Page (PA) first AC[2]: PID: PA (page address) auto increment direction (L:+1 H:-1) AC[3]: CUM: Cursor update mode, when CUM=1, CA increment on write only, wrap around suspended
MC	8	EFH	CA max. CA wrapping boundary: when CA+1 = MC, CA will reset to 0. The proper value range for MC is 0~239 or 0~159, depends on the value of DC[4:2]. The chip's behavior is undefined when MC is out of these ranges.
LC	6	08H	LCD Control: LC[0]: MSF: MSB First mapping Option LC[1]: MX, Mirror X (Column sequence inversion) LC[2]: MY, Mirror Y (Row sequence inversion) LC[4:3]: Frame Rate 0: 135 fps 1: 150 fps 2: 165 fps 1: 185 fps LC[6:5]: Gray Scale selection 00 : 16 gray scale 01 : 8 gray scale 10 : black/white

8 TIMING CHARACTERISTICS

8080-SYSTEM

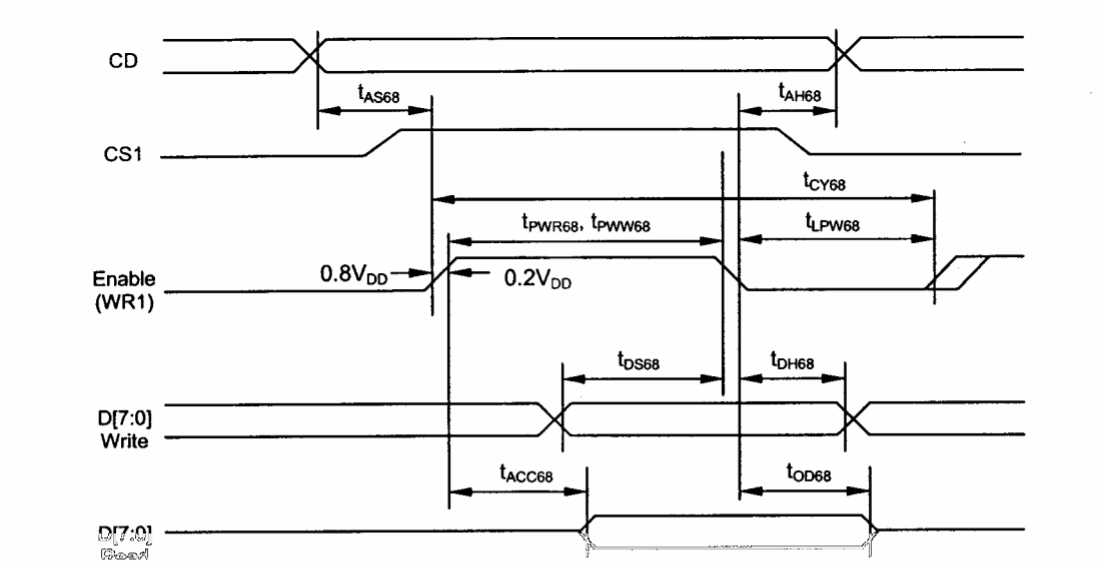


Parallel Bus Timing Characteristics (for 8080 MCU)

(VDD=2.4V to 3.0V, Ta= –30 to +85°C)

Symbol	Signal	Description	Condition	Min.	Max.	Units
t_{AS80} t_{AH80}	CD	Address setup time Address hold time		20 40	–	ns
t_{CY80}		System cycle time		100	–	ns
t_{PWR80}	WR1	Pulse width (read)		45	–	ns
t_{PWW80}	WR0	Pulse width (write)		45	–	ns
t_{HPW80}	WR0, WR1	High pulse width		40	–	ns
t_{DS80} t_{DH80}	D0~D7	Data setup time Data hold time		30 10	–	ns
t_{ACC80} t_{OD80}		Read access time Output disable time	C_L = 100pF	– 10	50 50	ns

6800-SYSTEM



Parallel Bus Timing Characteristics (for 6800 MCU)

(VDD=2.4V to 3.0V, Ta= -30 to +85°C)

Symbol	Signal	Description	Condition	Min.	Max.	Units
t_{AS68} t_{AH68}	CD	Address setup time Address hold time		20 40	–	ns
T_{CY68}		System cycle time		100	–	ns
t_{PWR68}	WR1	Pulse width (read)		45	–	ns
t_{PWW68}		Pulse width (write)		45	–	ns
t_{LPW68}		Low pulse width		40	–	ns
t_{DS68} t_{DH68}	D0~D7	Data setup time Data hold time		30 10	–	ns
t_{ACC68} t_{OD68}		Read access time Output disable time	C_L = 100pF	– 10	50 50	ns

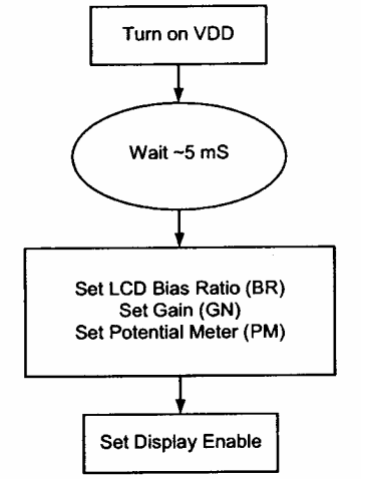
POWER ON/OFF SEQUENCE :

Power-ON Sequence :

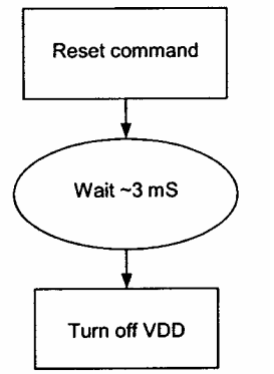
UC1611 power-up sequence is simplified by built-in "Power Ready" flags and by the automatic invocation of System-Reset command after Power-ON-Reset. System programmer are only commands to UC1611. No additional commands or waits are required between enabling of the charge pump, turning on the display drivers, writing to RAM or any other commands.

Power-OFF Sequence :

To prevent the charge stored in capacitors C_{BX+}, C_{BX-}, and C_{LCD} from damaging the LCD when V_{DD} is switched off, use Reset mode to enable the built-in charge draining circuit to discharge these external capacitors.



Reference Power-ON sequence



Reference Power-OFF sequence

9 QUALITY AND RELIABILITY

9.1 TEST CONDITIONS

Tests should be conducted under the following conditions :

Ambient temperature : 25 ± 5°C

Humidity : 60 ± 25% RH.

9.2 SAMPLING PLAN

Sampling method shall be in accordance with MIL-STD-105E , level II, normal single sampling plan .

9.3 ACCEPTABLE QUALITY LEVEL

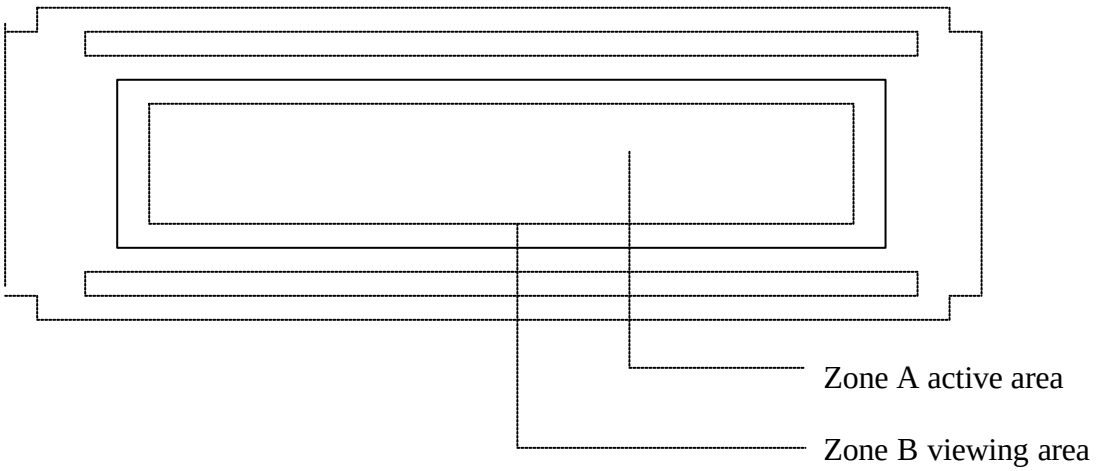
A major defect is defined as one that could cause failure to or materially reduce the usability of the unit for its intended purpose. A minor defect is one that does not materially reduce the usability of the unit for its intended purpose or is an infringement from established standards and has no significant bearing on its effective use or operation.

9.4 APPEARANCE

An appearance test should be conducted by human sight at approximately 30 cm distance from the LCD module under fluorescent light. The inspection area of LCD panel shall be within the range of following limits.

9.5 INSPECTION QUALITY CRITERIA

Item	Description of defects			Class of Defects	Acceptable level (%)
Function	Short circuit or Pattern cut			Major	0.65
Dimension	Deviation from drawings			Major	1.5
Black spots	Ave . dia . D	area A	area B	Minor	2.5
	D≤0.2	Disregard			
	0.2<D≤0.3	3	4		
	0.3<D≤0.4	2	3		
	0.4<D	0	1		
Black lines	Width W, Length L	A	B	Minor	2.5
	W≤0.03	disregard			
	0.03<W≤0.05	3	4		
	0.05<W≤0.07 , L≤3.0	1	1		
	See line criteria				
Bubbles in polarizer	Average diameter D 0.2 < D < 0.5 mm for N = 4 , D > 0.5 for N = 1			Minor	2.5
Color uniformity	Rainbow color or Newton ring.			Minor	2.5
Glass Scratches	Obvious visible damage.			Minor	2.5
Contrast ratio	See note 1			Minor	2.5
Response time	See note 2			Minor	2.5
Viewing angle	See note 3			Minor	2.5



9.6 RELIABILITY

Test Item	Test Conditions	Note
	Extended Temp. type	
High Temperature Operation	70±3°C , t=96 hrs	
Low Temperature Operation	-20±3°C , t=96 hrs	
High Temperature Storage	80±3°C , t=96 hrs	1,2
Low Temperature Storage	-30±3°C , t=96 hrs	1,2
Thermal Shock Test	-20°C ~ 25°C ~ 70°C 30 m in. 5 min. 30 min. (1 cycle) Total 5 cycle	1,2
Humidity Test	40 °C, Humidity 90%, 96 hrs	1,2
Vibration Test (Packing)	Sweep frequency : 10 ~ 55 ~ 10 Hz/1min Amplitude : 0.75mm Test direction : X.Y.Z/3 axis Duration : 30min/each axis	2

Note 1 : Condensation of water is not permitted on the module.

Note 2 : The module should be inspected after 1 hour storage in normal conditions (15-35°C , 45-65%RH).

Definitions of life end point :

- Current drain should be smaller than the specific value.
- Function of the module should be maintained.
- Appearance and display quality should not have degraded noticeably.
- Contrast ratio should be greater than 50% of the initial value.

10 HANDLING PRECAUTIONS

(1) A LCD module is a fragile item and should not be subjected to strong mechanical shocks.

(2) Avoid applying pressure to the module surface. This will distort the glass and cause a change in color.

(3) Under no circumstances should the position of the bezel tabs or their shape be modified.

(4) Do not modify the display PCB in either shape or positioning of components.

(5) Do not modify or move location of the zebra or heat seal connectors.

(6) The device should only be soldered to during interfacing. Modification to other areas of the board should not be carried out.

(7) In the event of LCD breakage and resultant leakage of fluid do not inhale, ingest or make contact with the skin. If contact is made rinse immediately.

(8) When cleaning the module use a soft damp cloth with a mild solvent, such as Isopropyl or Ethyl alcohol. The use of water, ketone or aromatic is not permitted.

(9) Prior to initial power up input signals should not be applied.

(10) Protect the module against static electricity and observe appropriate anti-static precautions.

11 OUTLINE DIMENSION