

SPECIFICATION FOR LCM MODULE

MODULE NO.: BG160160-03

REVISION NO.: V0

Customer Approval:

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	SIGNATURE
PREPARED BY	Sylar
VERIFIED BY	William
APPROVED BY	Rio

1. REVISION HISTORY

[illegible]

2. CONTENTS

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3. FEATURES

- Window-write, window-skip functions to support flexible video applications such as OSD, dynamic service provider screen saver for cell phone and others.
- One ID pin (ID0) plus two programmable ID flags, totally 4 software-readable ID bits to support configurable vender identification.
- Partial scroll function and programmable data update window to support flexible manipulation of screen data.
- Support both row-ordered and column-ordered display buffer RAM access.
- Support industry standard 4-wire, 3/4-wire, and 3-wire serial buses (S8, S8uc, S9) and 8-bit parallel buses (8080 or 6800).
- No power consumption or image quality penalty when used with video rate STN.
- Fully programmable Mux Rate, partial display window, Bias Ratio and Line Rate allow many flexible power management options.
- Four software programmable temperature compensation coefficients.
- Software programmable, self-configuring 10x charge pump.
- Flexible data addressing/mapping schemes to support wide ranges of software models and LCD layout placements.
- Available MTP trimming supports precise LCD contrast matching.

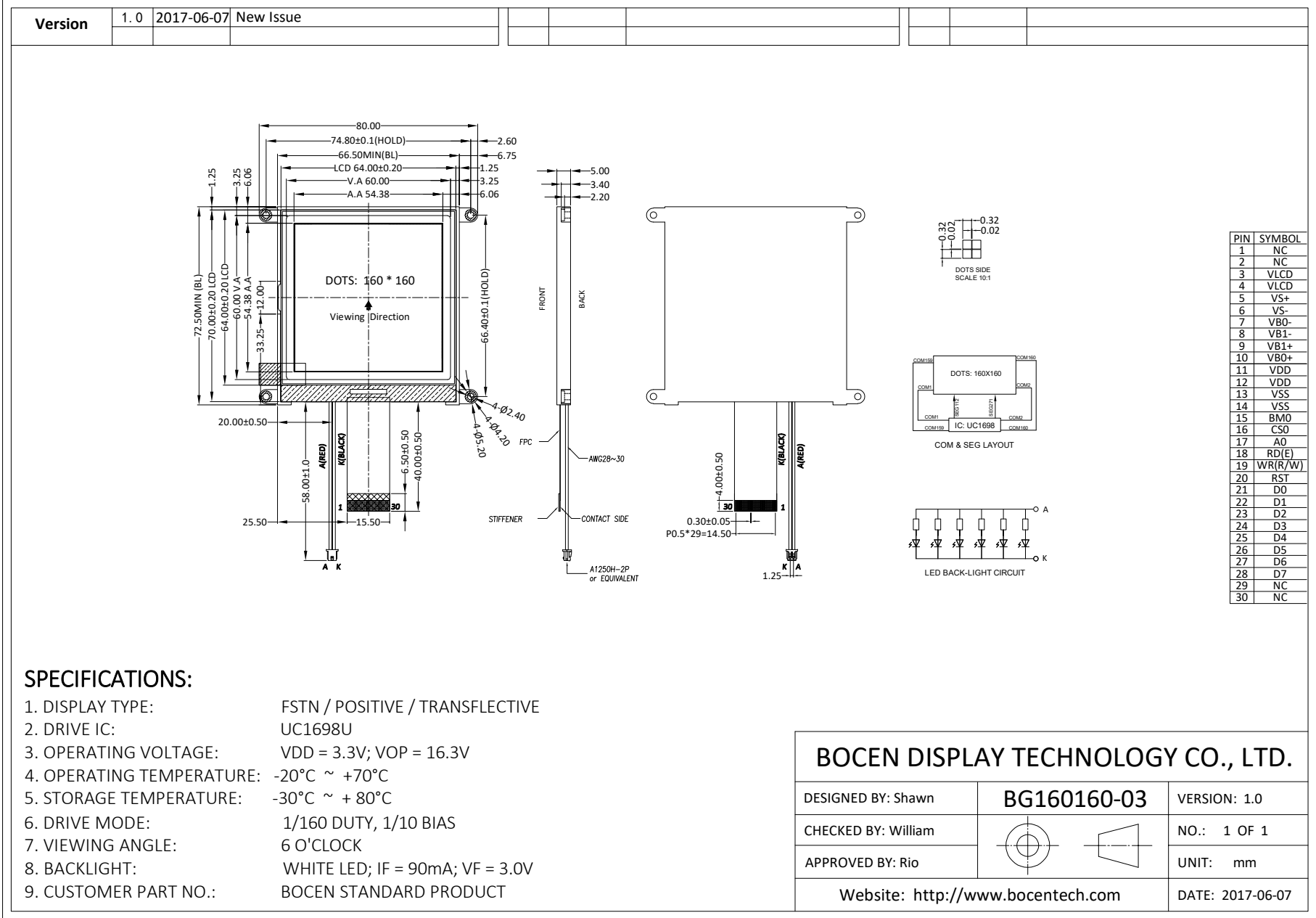
4. GENERAL SPECIFICATIONS

ITEM	DESCRIPTION	UNIT
Outline Size(mm)	80.0(L)×72.5(W)×5.0(T) (Not Include Connector)	mm
LCD Type	FSTN, Transflective/Positive,1/160Duty,1/10Bias	---
Display Type	160×160 dots	---
View Area	60.00×60.00	mm
Display Area	54.38×54.38	mm
Dots Size	0.32×0.32	mm
Dots Pitch	0.34×0.34	mm
Controller & Driver	UC1698U (COG)	---
View Direction	6 O'Clock	---
Interface Mode	8 bit 6800,8 bit 8080	---
VDD&VOP(Type)	3.3 V & 16.3 V	V
Backlight Color	White, 3.0V, 90mA	---
Operation Temp.	-20~+70	°C
Storage Temp.	-30~+80	°C

5. OUTLINE DIMENSIONS

SPECIFICATIONS:

- | | |
|---------------------------|---------------------------------|
| 1. DISPLAY TYPE: | FSTN / POSITIVE / TRANSFLECTIVE |
| 2. DRIVE IC: | UC1698U |
| 3. OPERATING VOLTAGE: | VDD = 3.3V; VOP = 16.3V |
| 4. OPERATING TEMPERATURE: | -20°C ~ +70°C |
| 5. STORAGE TEMPERATURE: | -30°C ~ + 80°C |
| 6. DRIVE MODE: | 1/160 DUTY, 1/10 BIAS |
| 7. VIEWING ANGLE: | 6 O'CLOCK |
| 8. BACKLIGHT: | WHITE LED; IF = 90mA; VF = 3.0V |
| 9. CUSTOMER PART NO.: | BOCEN STANDARD PRODUCT |

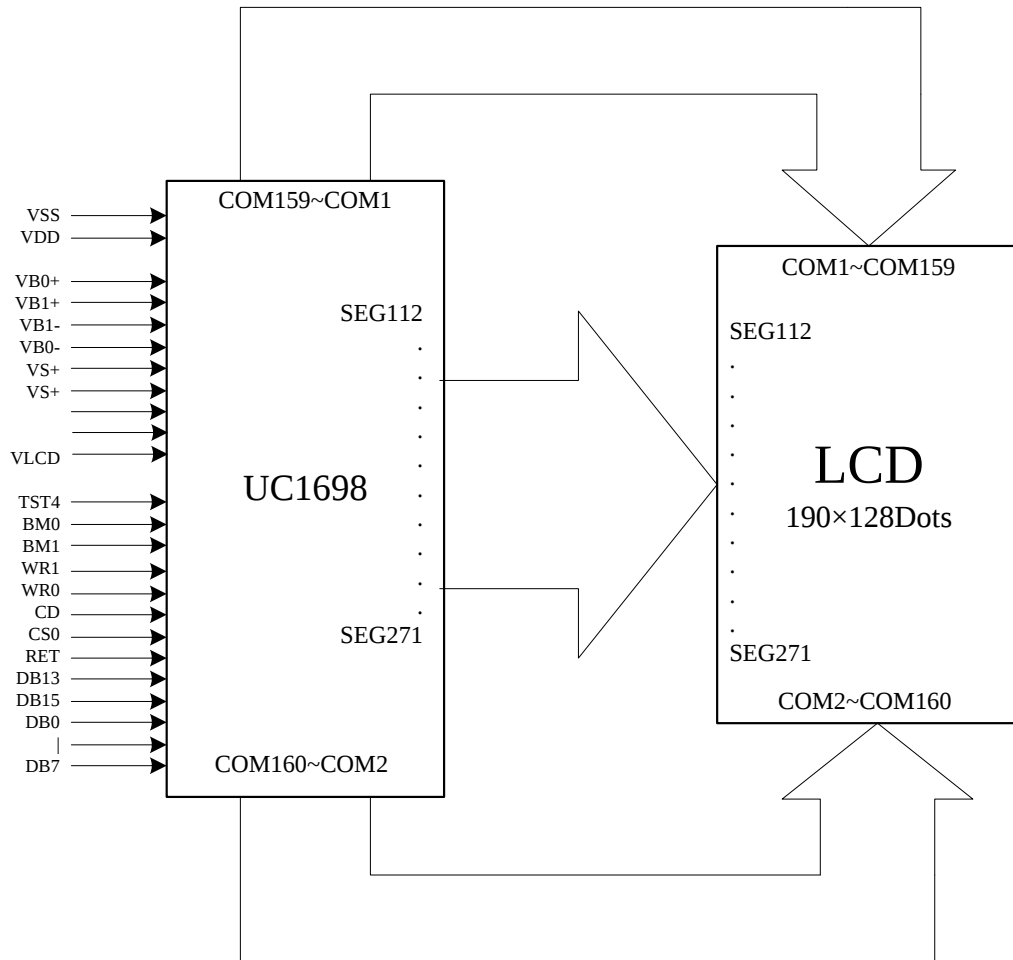


6. PIN CONNECTIONS

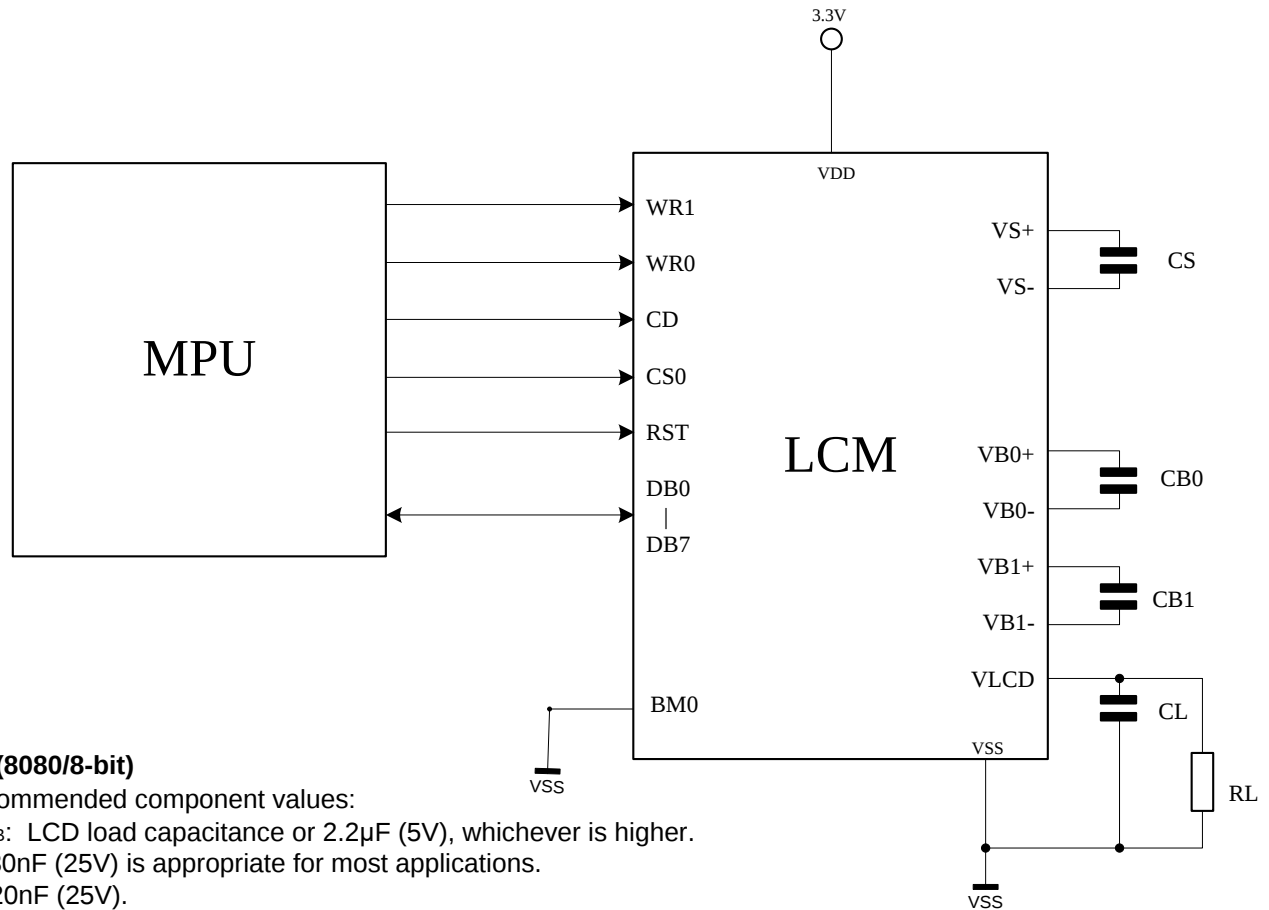
Pin No.	Pin Out	Description						
1-2	NC	No connection.						
3-4	VLCD	High voltage LCD Power Supply. When internal VLCD is used, connect these pins together. When external VLCD source is used, connect external VLCD source to VLCDIN, pins and leave VLCDOUT open.						
5	VS+	LCD Bias Voltages. These are the voltage sources to provide SEG driving currents. These voltages are generated internally. Connect capacitors of CAX / CBX value between VAX+ / VBX+ and VAX– / VBX–, respectively.						
6	VS-							
7	VB0-							
8	VB1-							
9	VB1+							
10	VB0+							
11-12	VDD	Power supply for LCD circuit.						
13-14	VSS	Ground.						
15	BM0	Bus Mode: The interface bus mode is determined by BM0 with the following relationship: <table><tr><td>BM 0</td><td>Mode</td></tr><tr><td>1</td><td>6800/8-bit</td></tr><tr><td>0</td><td>8080/8-bit</td></tr></table>	BM 0	Mode	1	6800/8-bit	0	8080/8-bit
BM 0	Mode							
1	6800/8-bit							
0	8080/8-bit							
16	CS0	Chip Selection. Chip is selected when CS0 = “L”. When the chip is not selected, DB [7:0] will be high impedance.						
17	A0(CD)	Selects Control data or Display data for read/write operation. In S9 mode, CD pin is not used. Connect to VSS when not used. "L": Control data "H": Display data						
18	WR1(RD)	WR[1:0] control the read/write operation of the host interface. See section Host Interface for more detail. In parallel mode, the meaning of WR[1:0] depends on whether the interface is in the 6800 mode or the 8080 mode. In serial interface modes, these two pins are not used, connect them to VSS.						
19	WR0(WR)							
20	RST	When RST="L", all control registers are re-initialized by their default states. Since UC1698u has built-in Power-ON reset and software reset commands, RST pin is not required for proper chip operation. An RC Filter has been included on-chip. There is no need for external RC noise filter. When RST is not used, connect the pin to VDD.						
21	DB0	Bi-directional bus for parallel host interface.						
22	DB1							
23	DB2							
24	DB3							
25	DB4							
26	DB5							
27	DB6							

28	DB7	
29-30	NC	No connection.

7. BLOCK DIAGRAM



8. APPLICATION CIRCUIT EXAMPLE



Note (8080/8-bit)

- Recommended component values:

C_A, C_B : LCD load capacitance or $2.2\mu F$ (5V), whichever is higher.

CL: 330nF (25V) is appropriate for most applications.

C_s: 220nF (25V).

RL: 3.3M ~ 10M Ω Acts as a draining circuit when the power is abnormally shut down.

9. ABSOLUTE MAXIMUN RATING

ELECTRICAL ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN	MAX	UNIT
POWER SUPPLY FOR LOGIC	VDD-VSS	-0.3	4.0	V
POWER SUPPLY FOR LCD DRIVE	VSS-V _{LCD}	-0.3	19.8	V
INPUT VOLTAGE	V _{IN}	-0.4	VDD+0.5	V
POWER SUPPLY FOR LED	VA-VK	-0.3	3.3	V

ENVIRONMENTAL ABSOLUTE MAXIMUM RATINGS

ITEM	OPERATING		STORAGE		UNIT	COMMENT
	MIN	MAX	MIN	MAX		
AMBIENT TEMPERATURE	-20	+70	-30	+80	°C	
VIBRATION (M/S ²)	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
TEMPERATURE CYCLING TEST	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
CORROSIVE GAS	NOT ACCEPTABLE		NOT ACCEPTABLE		--	

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

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Power Supply for Logic & Backlight	V _{DD} -V _{SS}	T _a =25°C	2.8	3.0	3.3	Volt	--
	LED+-LED-		2.6	3.0	3.2	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 Driving Voltage	V _{LCD} -V _{SS}	T _a = 0°C	--	--	--	Volt	--
		T _a = 25°C	16.0	16.3	16.6		
		T _a = 50°C	--	--	--		
Power Supply Current for LCM	I _{DD}	V _{DD} =3.3V T _a =25°C	-	2	3	mA	--
	I _{LED}	V _{LED} = 3.0 V T _a =25°C	--	90	120	mA	--

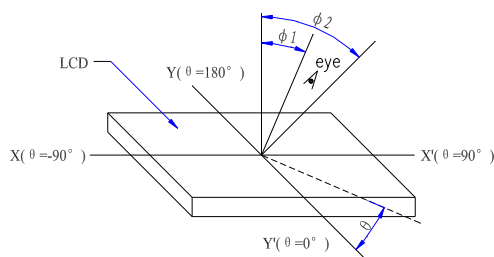
Note1:Backlight Electrical-Optical Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Conditon
Luminance	L _v	600	800	--	CD/m ²	If=90 mA
Range	x	0.26	0.29	0.32	-	
	y	0.26	0.29	0.32	-	
Brightness uniformity	△%	70	-	-	%	min / max * 100%

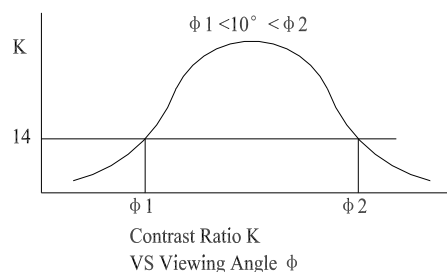
11. ELECTRO-OPTICAL CHARACTERISTICS

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	$T_a=25^\circ\text{C}$	-	150	200	ms	$\Phi=10$ $\Theta=0$ C
		$T_a=0^\circ\text{C}$	-	-	-		
Fall Time	T_f	$T_a=25^\circ\text{C}$	-	180	230		
		$T_a=0^\circ\text{C}$	-	-	-		
Contrast	Cr	$T_a=25^\circ\text{C}$	-	7	-	-	$\Phi=10$ $\Theta=0$ D

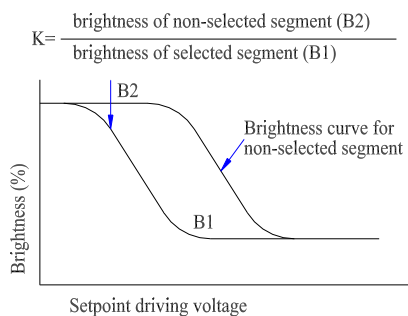
11.1 Definition of angle θ and ϕ



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

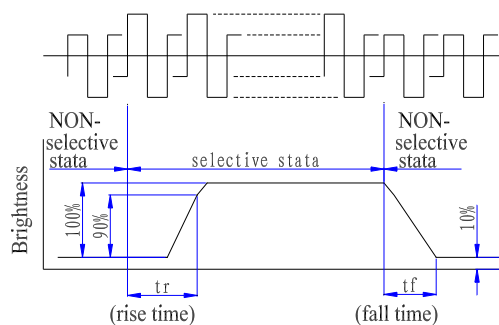


11.3 Definition of contrast "K"



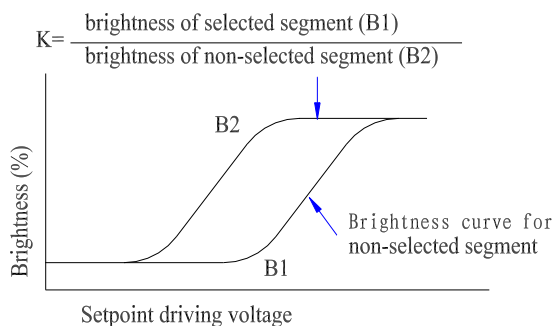
POSITIVE TYPE

11.4 Definition of optical response



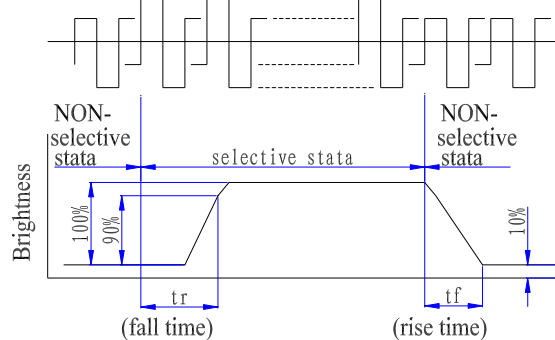
POSITIVE TYPE

11.5 Definition of contrast "K"



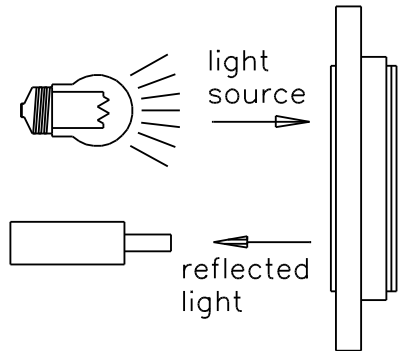
NEGATIVE TYPE

11.6 Definition of optical response

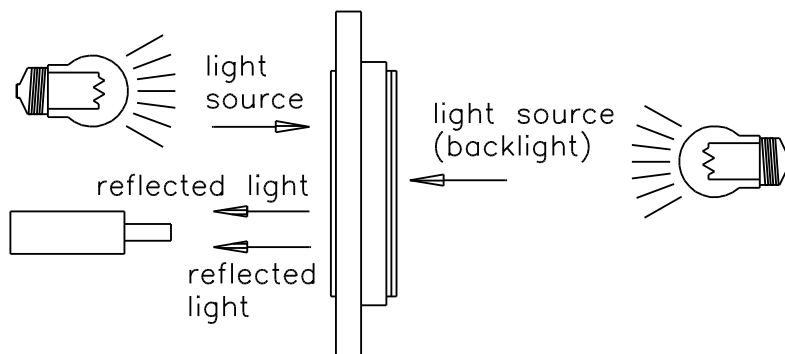


NEGATIVE TYPE

11.7 DESCRIPTION OF MEASURING EQUIPMENT



Reflective type



Transflective type

12. CONTROLLER ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V _{DD}	Supply for digital circuit		1.65		3.465	V
V _{DD2/3}	Supply for bias & pump		2.7		3.465	V
V _{LCD}	Charge pump output	V _{DD2/3} = 2.8V, 25°C		15.2	18	V
V _D	LCD data voltage	V _{DD2/3} = 2.8V, 25°C	1.09		1.95	V
V _{IL}	Input logic LOW				0.2V _{DD}	V
V _{IH}	Input logic HIGH		0.8V _{DD}			V
V _{OL}	Output logic LOW				0.2V _{DD}	V
V _{OH}	Output logic HIGH		0.8V _{DD}			V
I _{IL}	Input leakage current				1.5	μA
I _{SB}	Standby current	V _{DD} = V _{DD2/3} = 3.3V, Temp = 85°C			50	μA
C _{IN}	Input capacitance			5	10	PF
C _{OUT}	Output capacitance			5	10	PF
R _{ON(SEG)}	SEG output impedance	V _{LCD} = 16.5V		850	1100	Ω
R _{ON(COM)}	COM output impedance	V _{LCD} = 16.5V		950	1100	Ω
f _{LINE}	Average line rate	LC[4:3] = 10b, 25°C	-10%	37.0	+10%	Klps

POWER CONSUMPTION

V_{DD} = 2.7 V,
V_{LCD} = 16.5 V,
Mux Rate = 160,
C_B = 2.2 μF,
N-line inversion = 31 lines

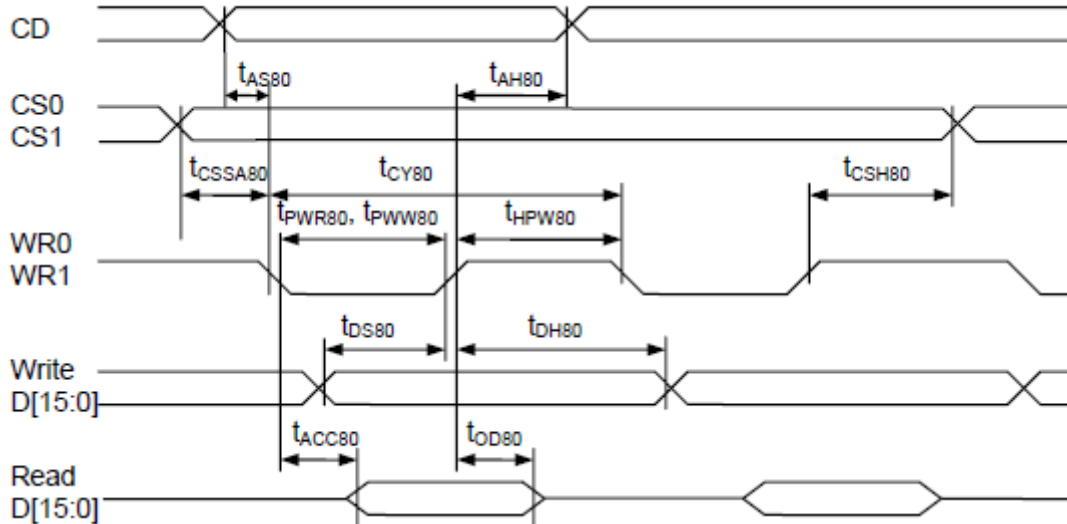
Bias Ratio = 12,
Line Rate = 10b,
Bus mode = 6800,
Temperature = 25°C,
Color Mode = 64K color mode,

PM = 64,
Panel Loading (PC[1:0]) = 0b,
C_L = 330 nF,
MTP=00 H,
All HV outputs are open circuit.

Display Pattern	Conditions	Typ.	Max.	Unit
All-Pixel-OFF	Bus = idle	1764	2470	μA
2-pixel checker	Bus = idle	2468	3455	μA
None	Reset (stand-by current)	<1	5	μA

13. TIMING CHARACTERISTICS

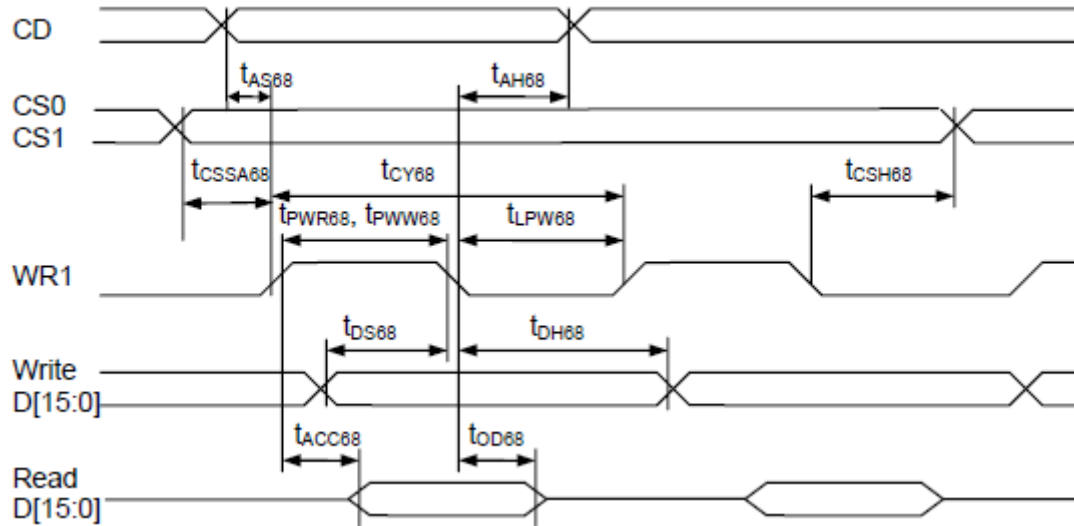
System Bus Read/Write Characteristics 1 (For the 8080 Series MPU)



Symbol	Signal	Description	Condition	Min.	Max.	Unit
(2.5V ≤ V _{DD} ≤ 3.3V, Ta = -30 to +85°C)						
t _{AS80}	CD	Address setup time		0	—	nS
t _{AH80}	CD	Address hold time		0	—	nS
t _{CY80}		System cycle time	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	200 / 160 130 / 110 / 120	—	nS
t _{PWR80} / t _{PWW80}	WR1 / WR0	Pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	85 / 65 50 / 40 / 45	—	nS
t _{HPW80}	WR0, WR1	High pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	85 / 65 50 / 40 / 45	—	nS
t _{DS80}	D15~D0	Data setup time		30	—	nS
t _{DH80}	D15~D0	Data hold time		0	—	nS
t _{ACC80}		Read access time	C _L = 100pF	—	60	nS
t _{OD80}		Output disable time		15	30	nS
t _{CSSA80}	CS1/CS0	Chip select setup time		5	—	nS
t _{CSh80}	CS1/CS0	Chip select hold time		5	—	nS
(1.65V ≤ V _{DD} ≤ 2.5V, Ta = -30 to +85°C)						
t _{AS80}	CD	Address setup time		0	—	nS
t _{AH80}	CD	Address hold time		0	—	nS
t _{CY80}		System cycle time	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	350 / 300 210 / 175 / 250	—	nS
t _{PWR80} / t _{PWW80}	WR1 / WR0	Pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	160 / 135 90 / 73 / 110	—	nS
t _{HPW80}	WR0, WR1	High pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	160 / 135 90 / 72 / 110	—	nS
t _{DS80}	D15~D0	Data setup time		60	—	nS
t _{DH80}	D15~D0	Data hold time		0	—	nS
t _{ACC80}		Read access time	C _L = 100pF	—	120	nS
t _{OD80}		Output disable time		30	60	nS
t _{CSSA80}	CS1/CS0	Chip select setup time		10	—	nS
t _{CSh80}	CS1/CS0	Chip select hold time		10	—	nS

Note: The rising time and the falling time are stipulated to be equal to or less than 15nS.

System Bus Read/Write Characteristics 2 (For the 6800 Series MPU)



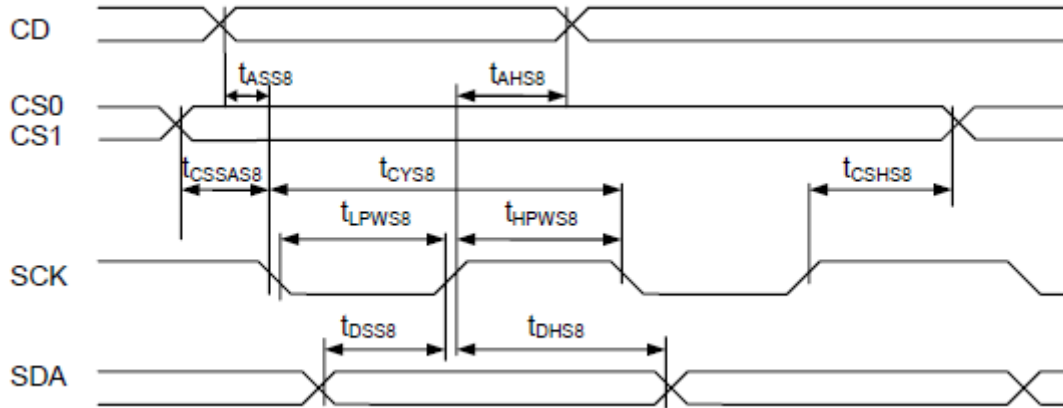
Symbol	Signal	Description	Condition	Min.	Max.	Unit
(2.5V ≤ V _{DD} ≤ 3.3V, Ta = -30 to +85°C)						
t _{AS68}	CD	Address setup time		0	—	nS
t _{AH68}	CD	Address hold time		0	—	nS
t _{CY68}		System cycle time	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	200 / 160 130 / 110 / 120	—	nS
t _{PWR68} / t _{PWW68}	WR1	Pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	85 / 65 50 / 40 / 45	—	nS
t _{LPW68}		Low pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	85 / 65 50 / 40 / 45	—	nS
t _{DS68} t _{DH68}	D15~D0	Data setup time Data hold time		30 0	—	nS
t _{ACC68} t _{OD68}		Read access time Output disable time	C _L = 100pF	— 15	60 30	nS
t _{CSSA68} t _{CSH68}	CS1/CS0	Chip select setup time		5 5		nS
(1.65V ≤ V _{DD} ≤ 2.5V, Ta = -30 to +85°C)						
t _{AS68}	CD	Address setup time		0	—	nS
t _{AH68}	CD	Address hold time		0	—	nS
t _{CY68}		System cycle time	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	350 / 300 210 / 175 / 250	—	nS
t _{PWR68} / t _{PWW68}	WR1	Pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	160 / 135 90 / 73 / 110	—	nS
t _{LPW68}		Low pulse width	16-bit bus 8-bit bus LC[7:6]=10b LC[7:6]=01b	160 / 135 90 / 72 / 110	—	nS
t _{DS68} t _{DH68}	D15~D0	Data setup time Data hold time		60 0	—	nS
t _{ACC68} t _{OD68}		Read access time Output disable time	C _L = 100pF	— 30	120 60	nS
t _{CSSA68} t _{CSH68}	CS1/CS0	Chip select setup time		10 10		nS

Note: The rising time and the falling time are stipulated to be equal to or less than 15nS.

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System Bus Read/Write Characteristics 3 (For the S8/S8uc Series MPU)



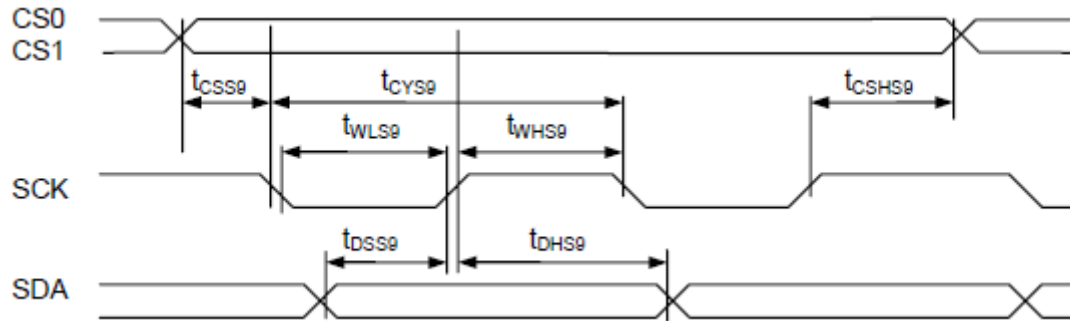
Symbol	Signal	Description	Condition	Min.	Max.	Unit
(2.5V ≤ V _{DD} ≤ 3.3V, Ta = -30 to +85°C)						
(Read / Write)						
t _{ASS8}	CD	Address setup time		0	—	nS
t _{AHS8}	CD	Address hold time		0	—	nS
t _{CSSAS8}	CS1/CS0	Chip select setup time		5	—	nS
t _{CSS8}	CS1/CS0	Chip select setup time		5	—	nS
t _{CYS8}	SCK	System cycle time		70	—	nS
t _{LPWS8}	SCK	Low pulse width		20	—	nS
t _{HPWS8}	SCK	High pulse width		20	—	nS
t _{DSS8}	SDA	Data setup time		15	—	nS
t _{DHS8}	SDA	Data hold time		0	—	nS
(1.65V ≤ V _{DD} ≤ 2.5V, Ta = -30 to +85°C)						
t _{ASS8}	CD	Address setup time		0	—	nS
t _{AHS8}	CD	Address hold time		0	—	nS
t _{CSSAS8}	CS1/CS0	Chip select setup time		10	—	nS
t _{CSS8}	CS1/CS0	Chip select setup time		10	—	nS
t _{CYS8}	SCK	System cycle time		105	—	nS
t _{LPWS8}	SCK	Low pulse width		37	—	nS
t _{HPWS8}	SCK	High pulse width		38	—	nS
t _{DSS8}	SDA	Data setup time		30	—	nS
t _{DHS8}	SDA	Data hold time		0	—	nS

Note: The rising time and the falling time are stipulated to be equal to or less than 15nS.

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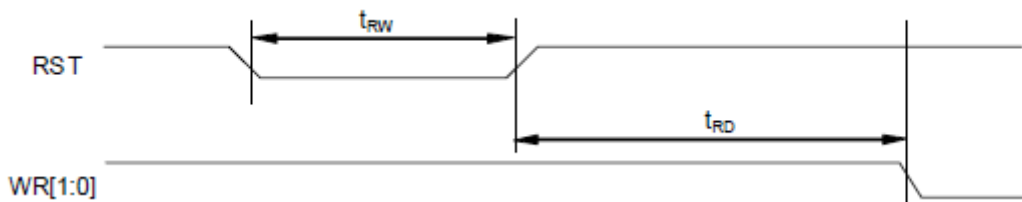
System Bus Read/Write Characteristics 4 (For the S9 Series MPU)



Symbol	Signal	Description	Condition	Min.	Max.	Units
(2.5V ≤ V _{DD} ≤ 3.3V, Ta = -30 to +85°C)						
t _{CSSA9} t _{CSHS9}	CS1/CS0	Chip select setup time		5 5		nS
t _{CYS9}		System cycle time		70	—	nS
t _{LPWS9}	SCK	Low pulse width		20	—	nS
t _{HPWS9}		High pulse width		20	—	nS
t _{DSS9} t _{DHS9}	SDA	Data setup time Data hold time		15 0	—	nS
(1.65V ≤ V _{DD} ≤ 2.5V, Ta = -30 to +85°C)						
t _{CSSA9} t _{CSHS9}	CS1/CS0	Chip select setup time		10 10		nS
t _{CYS9}		System cycle time		105	—	nS
t _{LPWS9}	SCK	Low pulse width		37	—	nS
t _{HPWS9}		High pulse width		38	—	nS
t _{DSS9} t _{DHS9}	SDA	Data setup time Data hold time		30 0	—	nS

Note: The rising time and the falling time are stipulated to be equal to or less than 15nS.

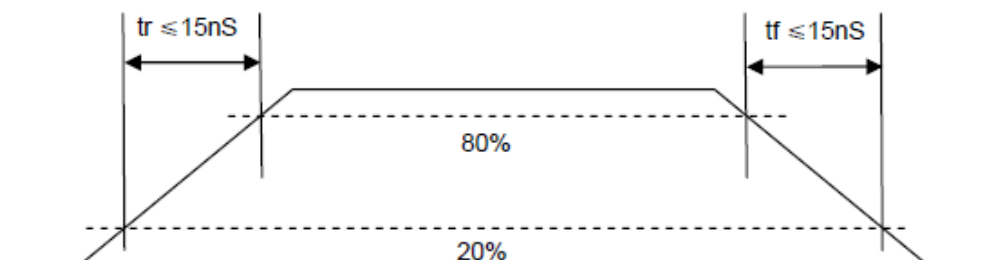
Reset Characteristics



Symbol	Signal	Description	Condition	Min.	Max.	Units
(1.65V ≤ V _{DD} ≤ 3.3V, Ta = -30 to +85°C)						
t _{RW}	RST	Reset low pulse width		3	—	μS
t _{RD}	RST, WR	Reset to WR pulse delay		10	—	mS

Note:

For each mode, the signal's rising time (tr) and falling time (tf) are stipulated to be equal to or less than 15nS each.



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14. DISPLAY COMMANDS

The following is a list of host commands supported by UC1698u

C/D : 0: Control, 1: Data

W/R : 0: Write Cycle, 1: Read Cycle

D7-D0 : # : Useful Data bits - : Don't Care

#	Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action	Default	
1	Write Data Byte	1	0	#	#	#	#	#	#	#	#	Write 1 byte	N/A	
2	Read Data Byte	1	1	#	#	#	#	#	#	#	#	Read 1 byte	N/A	
3	Get Status & PM	0	1	GE	MX	MY	WA	DE	WS	MD	MS	Get {Status, Ver, PMO, Product Code, PID, MID}	Product Code: 8h	
				Ver	PMO[6:0]									
				Product Code			PID[1:0]		MID[1:0]					
4	Set Column Address LSB	0	0	0	0	0	0	#	#	#	#	Set CA[3:0]	0	
	Set Column Address MSB	0	0	0	0	0	1	0	#	#	#	Set CA[6:4]	0	
5	Set Temp. Compensation	0	0	0	0	1	0	0	1	#	#	Set TC[1:0]	0	
6	Set Power Control	0	0	0	0	1	0	1	0	#	#	Set PC[1:0]	10b	
7	Set Adv. Program Control (double-byte command)	0	0	0	0	1	1	0	0	0	R	Set APC[R][7:0], R = 0 or 1	N/A	
		0	0	#	#	#	#	#	#	#	#			
8	Set Scroll Line LSB	0	0	0	1	0	0	#	#	#	#	Set SL[3:0]	0	
	Set Scroll Line MSB	0	0	0	1	0	1	#	#	#	#	Set SL[7:4]	0	
9	Set Row Address LSB	0	0	0	1	1	0	#	#	#	#	Set RA[3:0]	0	
	Set Row Address MSB	0	0	0	1	1	1	#	#	#	#	Set RA[7:4]	0	
10	Set VBIAS Potentiometer (double-byte command)	0	0	1	0	0	0	0	0	0	1	Set PM[7:0]	40H	
		0	0	#	#	#	#	#	#	#	#			
11	Set Partial Display Control	0	0	1	0	0	0	0	1	0	#	Set LC[8]	0	
12	Set RAM Address Control	0	0	1	0	0	0	1	#	#	#	Set AC[2:0]	001b	
13	Set Fixed Lines	0	0	1	0	0	1	0	0	0	0	Set {FLT, FLB}	0	
		0	0	#	#	#	#	#	#	#	#			
14	Set Line Rate	0	0	1	0	1	0	0	0	#	#	Set LC[4:3]	10b	
15	Set All-Pixel-ON	0	0	1	0	1	0	0	1	0	#	Set DC[1]	0	
16	Set Inverse Display	0	0	1	0	1	0	0	1	1	#	Set DC[0]	0	
17	Set Display Enable	0	0	1	0	1	0	1	#	#	#	Set DC[4:2]	110b	
18	Set LCD Mapping Control	0	0	1	1	0	0	0	#	#	#	Set LC[2:0]	0	
19	Set N-Line Inversion	0	0	1	1	0	0	1	0	0	0	Set NIV[4:0]	1DH	
				-	-	-	#	#	#	#	#			
20	Set Color Pattern	0	0	1	1	0	1	0	0	0	#	Set LC[5]	0 (BGR)	
21	Set Color Mode	0	0	1	1	0	1	0	1	#	#	Set LC[7:6]	10b	
22	Set COM Scan Function	0	0	1	1	0	1	1	#	#	#	Set CSF[2:0]	000b	
23	System Reset	0	0	1	1	1	0	0	0	1	0	System Reset	N/A	
24	NOP	0	0	1	1	1	0	0	0	1	1	No operation	N/A	
25	Set Test Control (double-byte command)	0	0	1	1	1	0	0	1	TT		For testing only. Do not use.	N/A	
		0	0	#	#	#	#	#	#	#	#			
26	Set LCD Bias Ratio	0	0	1	1	1	0	1	0	#	#	Set BR[1:0]	11b: 12	
27	Set COM End	0	0	1	1	1	1	0	0	0	1	Set CEN[6:0]	159	
		0	0	-	#	#	#	#	#	#	#			
28	Set Partial Display Start	0	0	1	1	1	1	0	0	1	0	Set DST[6:0]	0	
		0	0	-	#	#	#	#	#	#	#			
29	Set Partial Display End	0	0	1	1	1	1	0	0	1	1	Set DEN[6:0]	159	
		0	0	-	#	#	#	#	#	#	#			
30	Set Window Program Starting Column Address	0	0	1	1	1	1	0	1	0	0	Shared with MTP commands	Set WPC0	0
		0	0	-	#	#	#	#	#	#	#		Set WPP0	0
31	Set Window Program Starting Row Address	0	0	1	1	1	1	0	1	0	1		Set WPC1	127
		0	0	#	#	#	#	#	#	#	#			
32	Set Window Program Ending Column Address	0	0	1	1	1	1	0	1	1	0	Set WPP1	159	
		0	0	-	#	#	#	#	#	#	#			
33	Set Window Program Ending Row Address	0	0	1	1	1	1	0	1	1	1	Set AC[3]	0: Inside	
		0	0	#	#	#	#	#	#	#	#			
34	Window Program Mode	0	0	1	1	1	1	1	0	0	#	Set AC[3]	0: Inside	
35	Set MTP Operation control	0	0	1	0	1	1	1	0	0	0	Set MTPC[4:0]	10H	
		0	0	-	-	-	#	#	#	#	#			

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#	Command	C/D	W/R	D7	D6	D5	D4	D3	D2	D1	D0	Action	Default	
36	Set MTP Write Mask	0 0 0	0 0 0	1 - -	0 # -	1 # -	1 # -	1 # -	0 # -	0 # #	1 # #	Set MTPM[6:0] MTPM1[1:0]	0	
37	Set V _{MTP1} Potentiometer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	0 #	0 #		Shared with Window Program commands	Set MTP1
38	Set V _{MTP2} Potentiometer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	0 #	1 #	Set MTP2		N/A
39	Set MTP Write Timer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	1 #	0 #	Set MTP3		N/A
40	Set MTP Read Timer	0 0	0 0	1 #	1 #	1 #	1 #	0 #	1 #	1 #	1 #	Set MTP4		N/A

NOTE:

- All other bit patterns other than commands listed above may result in undefined behavior.
- The interpretation of commands (36)~(40) depends on the setting of register MTPC[3].
 - Commands (37)~(40) are shared with commands (30)~(33). These two sets of commands share exactly the same code and control registers. When MTPC[3]=0, they are interpreted as Window Program commands and registers. When MTPC[3]=1, they function as MTP Control commands and registers.
- After MTP ERASE or PROGRAM operation, before resuming normal operation, please always
 - Remove TST4 power source,
 - Do a full V_{DD} ON-OFF-ON cycle.
- Under 16-bit bus mode and CD=0, D[15:8] is ignored and only D[7:0] is used. As a result, the bus cycles for commands under 16-bit bus and 8-bit bus are the same, and double-byte commands still need two bus cycles under 16-bit bus mode.

Example:

8-bit bus mode:

Set PL[1:0] = 2'b11 : D[7:0] = 0010 1011

Set PM[7:0] = 8'h8b : 1st D[7:0] = 1000 0001

2nd D[7:0] = 1000 1011

16-bit bus mode:

Set PL[1:0] = 2'b11 : D[15:0] = 0000 0000 0010 1011

Set PM[7:0] = 8'h8b : 1st D[15:0] = 0000 0000 1000 0001

2nd D[15:0] = 0000 0000 1000 1011

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 level1 normal inspection Single sample inspection	1.0
Minor defect	MIL-STD-105D Inspection level1 normal inspection Single sample inspection	2.5

Life time

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

MTBF

$\geq 30,000$ Hrs (25°C in the room without ray of sun)

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	-50°C \ 120 hours	5-10pcs
High temperature/humidity storage test	+80°C, 80% $\pm$ 10% RH \ 120 hours	
High temperature storage test	+80°C \ 120 hours	

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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	Size d (mm)	Acceptable quantity in active area
	d ≤ 0.1	Disregard
	0.1 < d ≤ 0.2	6
	0.2 < d ≤ 0.3	2
	d > 0.3	0
	Note: d = (Length + Width)/2	
Polarizer Bubbles	Size d (mm)	Acceptable quantity in active area
	d ≤ 0.3	Disregard
	0.3 < d ≤ 1.0	3
	1.0 < d ≤ 1.5	1
	d > 1.5	0
	Note: d = (Length + Width)/2	
Lines	Width W (mm) Length L (mm)	Acceptable quantity in active area
	W ≤ 0.02	Disregard
	0.02 < W ≤ 0.05	L ≤ 5.0
		L > 5.0
	0.05 < W ≤ 0.1	L ≤ 2.0
		L > 2.0
	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 60°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.

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

