






SPECIFICATIONS

CUSTOMER : _____
MODEL NO. : **GFOC1602D-WG**
VERSION : **C**
DATE : **2022.09.26**
CERTIFICATION : **ROHS**

Customer Sign	Approved By	Prepared By	Prepared By
			

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Contents

1. Basic Specifications	4~5
1.1 Display Specifications	4
1.2 Mechanical Specifications	4
1.3 Active Area / Address Mapping & Character Construction	4
1.4 Pin Definition	5
2. Absolute Maximum Ratings	6
3. Optics & Electrical Characteristics	7~8
3.1 Optics Characteristics	7
3.2 DC Characteristics	7
3.3 AC Characteristics	8
3.3.1 68XX-Series MPU Parallel Interface Timing Characteristics	8
4. Functional Specification	9~14
4.1 Commands	9
4.2 Power down and Power up Sequence	10
4.2.1 Power up Sequence	10
4.2.2 Power down Sequence	10
4.3 Actual Application Example	12
4.4 Built-in CGROM (Character Generator ROM)	14
5. Reliability	15
6. Note	16
7. Operation Precautions	16
8. Mechanical Drawing	17
9. Outgoing Quality Control Specifications	18



1. Basic Specifications

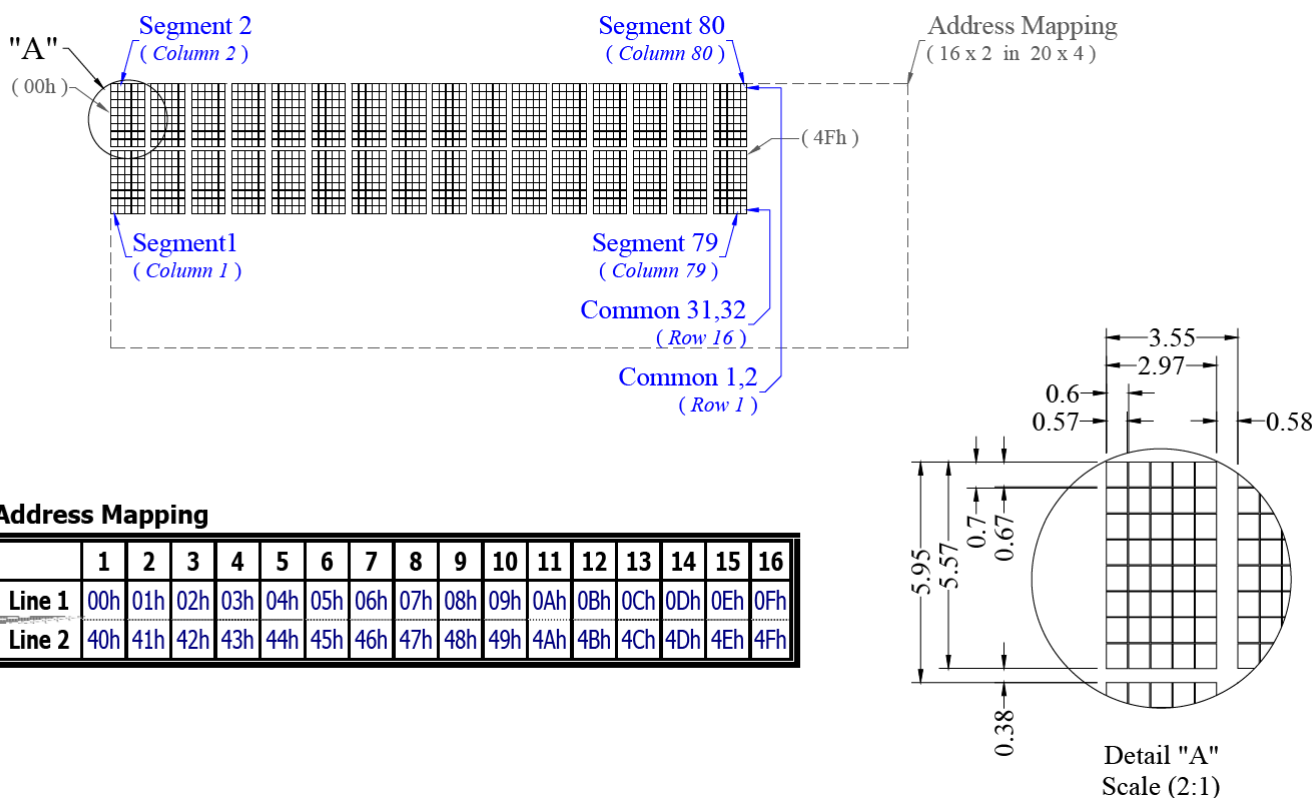
1.1 Display Specifications

- 1) Display Mode : Passive Matrix
- 2) Display Color : Monochrome (White)
- 3) Drive Duty : 1/16 Duty

1.2 Mechanical Specifications

- 1) Outline Drawing : According to the annexed outline drawing
- 2) Number of Characters : 16 Characters (5 × 8) × 2 Lines
- 3) Module Size : 80.0 × 36.0 × 9.10 (mm)
- 4) Panel Size : 66.10 × 16.70 × 2.00 (mm)
- 5) Active Area : 56.22 × 11.52 (mm)
- 6) Character Pitch : 3.55 × 5.95 (mm)
- 7) Character Size : 2.97 × 5.57 (mm)
- 8) Pixel Pitch : 0.60 × 0.70 (mm)
- 9) Pixel Size : 0.57 × 0.67 (mm)
- 10) Weight: TBD (g)

1.3 Active Area / Address Mapping & Character Construction





1.4 Pin Definition

NO.	Symbol	Function
1	VSS	Ground (0V)
2	VDD	Power supply for Logic circuit
3	NC	No Connection
4	RS	Data / Instruction select
5	R/W	Read / Write select
6	E	Enable signal
7-14	DB0-DB7	Data Input/Output Bus
15	NC	No Connection
16	NC	No Connection



2. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage for Logic	V_{DD1}	-0.3	5.6	V	1, 2
Supply Voltage for DC/DC convertor	V_{DD2}	-0.3	5.6	V	1, 2
Supply Voltage for Display	V_{PP}	0	14.5	V	1, 2
Operating Temperature	T_{OP}	-40	85	°C	3
Storage Temperature	T_{STG}	-40	90	°C	3
Life Time (80 cd/m ²)		50,000	-	hour	4
Life Time (60 cd/m ²)		70,000	-	hour	

Note 1: All the above voltages are on the basis of "GND = 0V".

Note 2: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur. Also, for normal operations, it is desirable to use this module under the conditions according to Section 3. "Optics & Electrical Characteristics". If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.

Note 3: The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.

Note 4: $V_{DD1} = V_{DD2} = 5.0V$, V_{PP} generated by internal DC/DC convertor. $T_a = 25^\circ C$, 50% Checkerboard. Software configuration follows Section 4.5 Initialization.

End of lifetime is specified as 50% of initial brightness reached. The average operating lifetime at room temperature is estimated by the accelerated operation at high temperature conditions.



3. Optics & Electrical Characteristics

3.1 Optics Characteristics

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Brightness	L_{br}	Note 8	60	80	-	cd/m ²
C.I.E. (White)	(x)	C.I.E. 1931	0.25	0.29	0.33	
	(y)		0.27	0.31	0.35	
Dark Room Contrast	CR		-	>10,000:1	-	
View Angle			-	Free	-	degree

*Software configuration follows Section 4.3 Initialization.

3.2 DC Characteristics

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage for Logic	V_{DD1}	V1_OTP set "H"	3.5	-	5.5	V
		V1_OTP set "L"	2.2	-	3.5	V
Supply Voltage for Analog	V_{DD2}		2.7	-	5.5	V
Supply Voltage for Display	V_{PP}	Note 5	11.2	12.0	12.5	V
High Level Input	V_{IH}		$0.7 \times V_{DD1}$	-	V_{DD1}	V
Low Level Input	V_{IL}		0	-	$0.3 \times V_{DD1}$	V
High Level Output	V_{OH}	$I_{OH} = -0.5mA$	$0.7 \times V_{DD1}$	-	V_{DD1}	V
Low Level Output	V_{OL}	$I_{OL} = 0.5mA$	0	-	$0.3 \times V_{DD1}$	V
Operating Current for V_{DD1}	I_{DD1}		-	-	200	μA
Operating Current for V_{DD2}	I_{DD2}	Note 6	-	17.0	21.3	mA
		Note 7	-	26.2	32.8	mA
		Note 8	-	45.0	56.3	mA
Sleep Mode Current for V_{DD1}	$I_{DD1, SLEEP}$		-	-	10	μA
Sleep Mode Current for V_{DD2}	$I_{DD2, SLEEP}$		-	-	10	μA

Note 5: Brightness (L_{br}) and Supply Voltage for Display (V_{PP}) are subject to the change of the panel characteristics and the customer's request.

Note 6: $V_{DD1} = V_{DD2} = 5.0V$, V_{PP} generated by internal DC/DC convertor, 30% Display Area Turn on.

Note 7: $V_{DD1} = V_{DD2} = 5.0V$, V_{PP} generated by internal DC/DC convertor, 50% Display Area Turn on.

Note 8: $V_{DD1} = V_{DD2} = 5.0V$, V_{PP} generated by internal DC/DC convertor, 100% Display Area Turn on.

*Software configuration follows Section 4.3 Initialization.

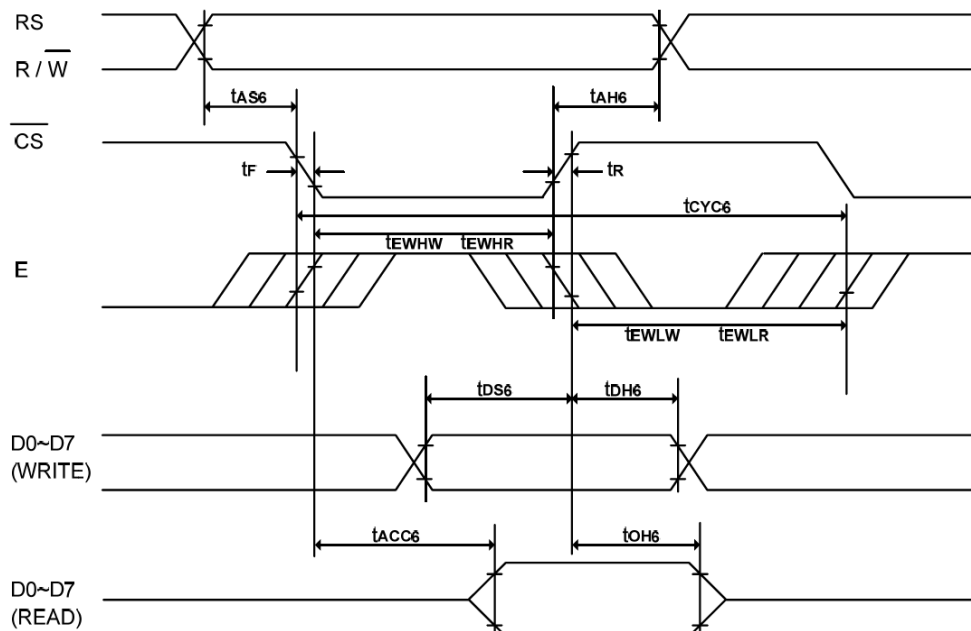


3.3 AC Characteristics

3.3.1 68XX-Series MPU Parallel Interface Timing Characteristics:

Symbol	Description	Min	Max	Unit
tCYC6	System cycle time	500	-	ns
tAS6	Address setup time	0	-	ns
tAH6	Address hold time	0	-	ns
tDS6	Data setup time	66	-	ns
tDH6	Data hold time	25	-	ns
tOH6	Output disable time ($C_L = 100\text{pF}$)	16	140	ns
tACC6	Access time ($C_L = 100\text{pF}$)	-	280	ns
tEWHW	Enable H pulse width (Write)	166	-	ns
tEWHR	Enable H pulse width (Read)	200	-	ns
tEWLW	Enable L pulse width (Write)	166	-	ns
tEWLR	Enable L pulse width (Read)	166	-	ns
tR	Rise time	-	25	ns
tF	Fall time	-	25	ns

* ($V_{DD1} = 2.2 - 5.5\text{V}$, $T_A = +25^\circ\text{C}$)





4. Functional Specification

4.1. Commands

Command	Code										Function
	RS	WR	D7	D6	D5	D4	D3	D2	D1	D0	
1. Display Clear	0	0	0	0	0	0	0	0	0	1	Clear entire display area. (POR = 01H)
2. Display/ Cursor Home	0	0	0	0	0	0	0	0	1	*	Counter with DDRAM address 00H. (POR = 10H)
3. Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Specify direction of cursor movement and display shift mode. This operation takes place after each data transfer (read/write). (POR = 06H)
4. Display ON/OFF	0	0	0	0	0	0	1	D	C	B	Specify activation of display (D) cursor and blinking of character at cursor position (B). (POR = 08H),
5. Display/Cursor Shift	0	0	0	0	0	1	S/C	R/L			Shift display or move cursor.
6. Function Set	0	0	0	0	1	DL	N	F			Set number of display line (N), and character font (F). (POR = 30H)
7. CGRAM Address Set	0	0	0	1	ACG						Load the address counter with a CG RAM address. Subsequent data access is for CG RAM data. (POR = 00H)
8. DD RAM Address Set	0	0	1	ADD[6:0]						Load the address counter with a DDRAM address. Subsequent data access is for DD RAM data. (POR = 00H)	
9. Busy Flag & Address Counter Read	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Read Busy Flag (BF) and Address Counter (POR = 00H)
10. CG RAM/ DD RAM/ Data Write	1	0	Write Dada								Write data to CG RAM or DD RAM. (POR = 00H)
11. CG RAM/ DD RAM/ Data Read	1	1	Read Data								Read data from CG RAM or DD RAM. (POR = 00H)

Entry or Exit Extend Command Table2 Sequence:

12. Enter Extend Command Table2	0	0	1	1	1	0	1	1	1	1	Enter extend Command Table2 mode. (POR = EFH)
	0	0	1	1	1	1	1	0	1	0	Entry Sequence (POR = FAH)
13. Exit Extend Command Table2	0	0	1	1	1	1	1	1	1	0	Exit from extend Command Table2. (POR = FEH)
	0	0	1	1	1	0	1	0	1	1	Exit Sequence (POR = EBH)



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Command	Code										Function
	RS	WR	D7	D6	D5	D4	D3	D2	D1	D0	
14. Divide Ratio/Oscillator Frequency Data Set	0	0	0	0	0	1	0	0	0	0	Double Byte command: Set the frequency of the internal display clocks. (POR = 51H)
			Oscillator Frequency				Divide Ratio				
15. Contrast Out Level	0	0	0	1	0	0	0	0	0	0	Double Byte command: Set Contrast out level (PDCVS=0, POR = 80H)
Set	0	0	CT(=BVR)								
16. VPP & Com/Segment Direction	0	0	0	1	0	1	0	0	0	0	Double Byte command: (POR = 03H)
Set	0	0	0	0	CM S	SHL	0	DCS	VPP[1:0]		
17. Font Table & Cursor Blinking Duty Control	0	0	1	0	0	0	0	0	0	0	Double Byte command: (POR = 20H)
Set	0	0	0	BD[2:0]			0	FTE	FTS[1:0]		
18. Read US2011 ID	0	1	0	ON/OFF	ID					Return ID : 010001 (11H)	

Note:

1. Do not use any others command, otherwise it will cause system malfunction.

FOR INTERNAL USE ONLY

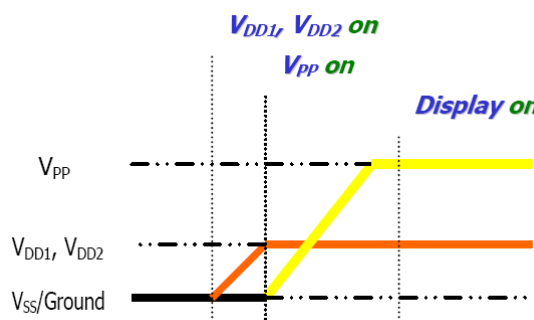


4.2 Power down and Power up Sequence

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.

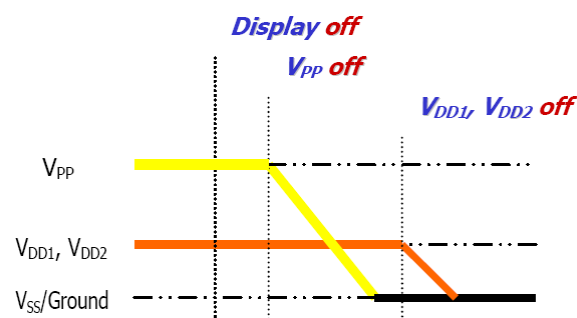
4.2.1 Power up Sequence:

1. Power up V_{DD1} & V_{DD2}
2. Send Display off command
3. Initialization
4. Clear Screen
5. Power up V_{PP}
6. Delay 100ms
(When V_{PP} is stable)
7. Send Display on command



4.2.2 Power down Sequence:

1. Send Display off command
2. Power down V_{PP}
3. Delay 100ms
(When V_{PP} is reach 0 and panel is completely discharges)
4. Power down V_{DD1} & V_{DD2}



Note 9:

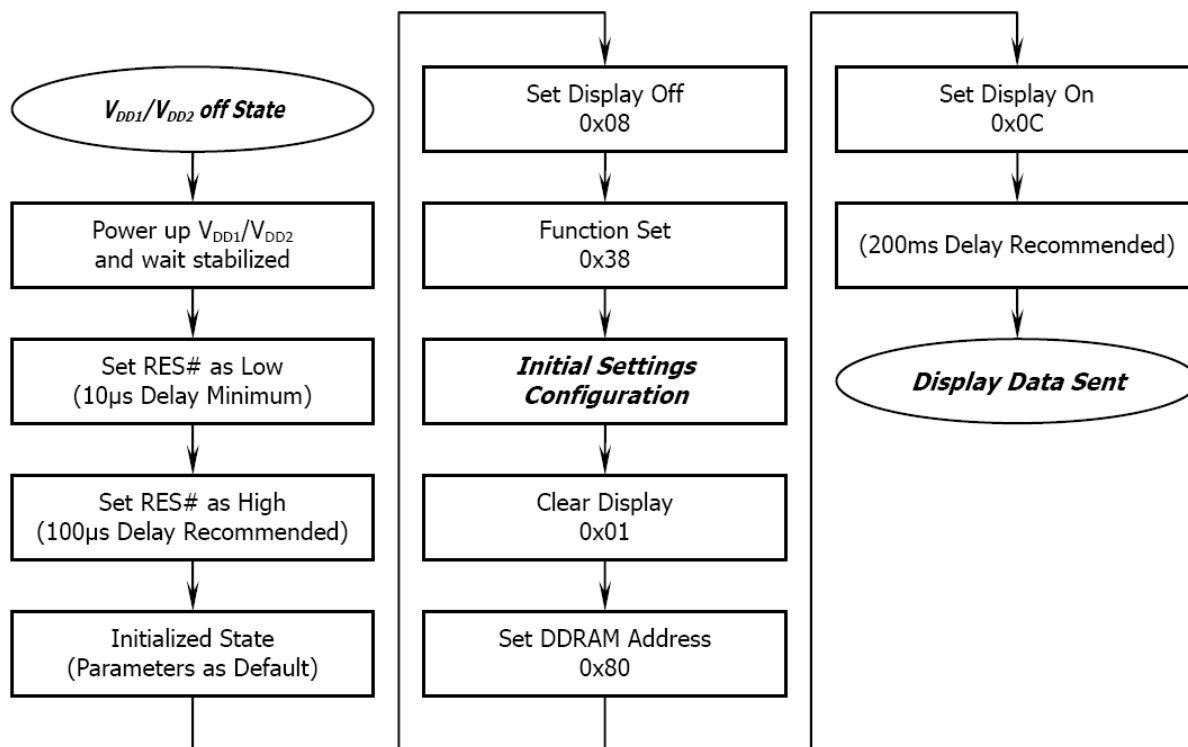
- 1) Since an ESD protection circuit is connected between V_{DD1} , V_{DD2} and V_{PP} inside the driver IC, V_{CC} becomes lower than V_{DD1} & V_{DD2} whenever V_{DD1} & V_{DD2} is ON and V_{PP} is OFF.
- 2) V_{CC} should be kept float (disable) when it is OFF.
- 3) Power Pins (V_{DD1} , V_{DD2} , V_{PP}) can never be pulled to ground under any circumstance.
- 4) V_{DD1} & V_{DD2} should not be power down before V_{PP} power down.



4.3 Actual Application Example

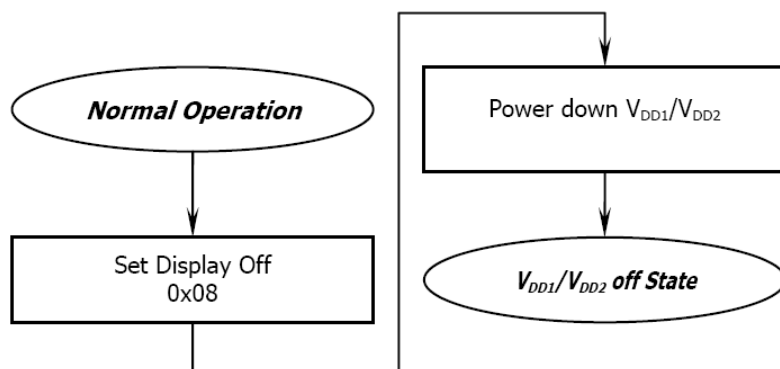
Command usage and explanation of an actual example

<Power up Sequence>



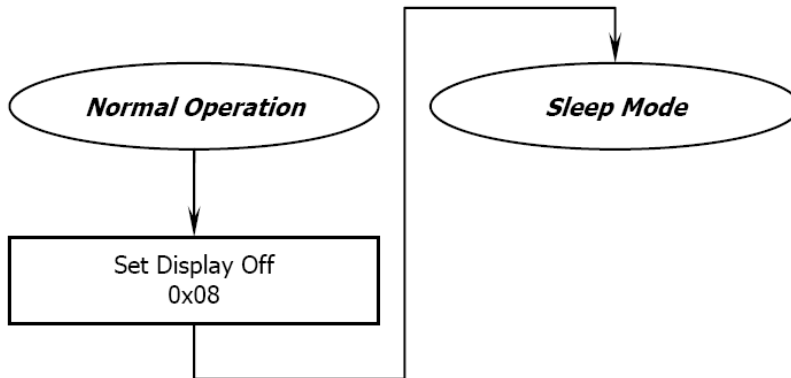
If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.

<Power down Sequence>

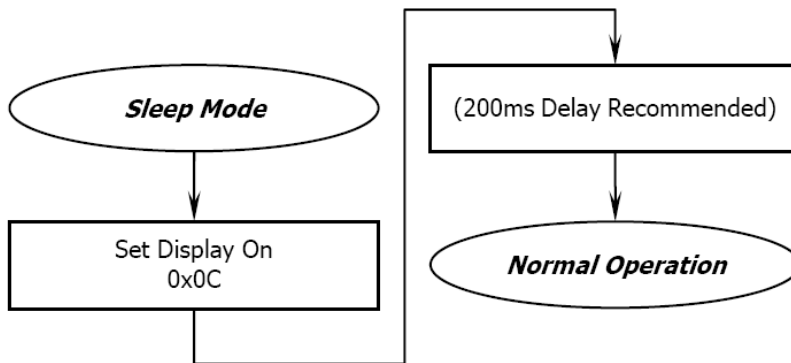




<Entering Sleep Mode>



<Exiting Sleep Mode>



WORLDWIDE



4.4 Built-in CGROM (Character Generator ROM)

ENGLISH_JAPANESE CHARACTER FONT TABLE (FT[1:0] = [0:0])

Upper 4bit Lower 4bit	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)	ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	一	夕	三	四	五
0001	CG RAM (2)	キ	ク	ケ	コ	サ	シ	ス	セ	ソ	タ	チ	ツ	テ	ト	ナ
0010	CG RAM (3)	ナ	ニ	ノ	ハ	ヒ	フ	ヘ	ホ	マ	ミ	ム	メ	モ	ヤ	ユ
0011	CG RAM (4)	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ	ヰ
0100	CG RAM (5)	ヰ	ヱ	ヰ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ	タ	チ
0101	CG RAM (6)	チ	ツ	テ	ト	ナ	ニ	ノ	ハ	ヒ	フ	ヘ	ホ	マ	ミ	ム
0110	CG RAM (7)	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ	ヰ
0111	CG RAM (8)	ヰ	ヱ	ヰ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ	タ	チ
1000	CG RAM (1)	チ	ツ	テ	ト	ナ	ニ	ノ	ハ	ヒ	フ	ヘ	ホ	マ	ミ	ム
1001	CG RAM (2)	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ	ヰ
1010	CG RAM (3)	ヰ	ヱ	ヰ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ	タ	チ
1011	CG RAM (4)	チ	ツ	テ	ト	ナ	ニ	ノ	ハ	ヒ	フ	ヘ	ホ	マ	ミ	ム
1100	CG RAM (5)	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ	ヰ
1101	CG RAM (6)	ヰ	ヱ	ヰ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ	タ	チ
1110	CG RAM (7)	チ	ツ	テ	ト	ナ	ニ	ノ	ハ	ヒ	フ	ヘ	ホ	マ	ミ	ム
1111	CG RAM (8)	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ	ヰ



5. Reliability

NO.	ITEM	CONDITION		STANDARD	NOTE
1	High Temp. Storage	40°C	120 hrs	Appearance Without defect	
2	Low Temp. Storage	-90°C	120 hrs	Appearance Without defect	
3	High Temp. & High Humi. Storage	40°C 90% RH	120 hrs	Appearance Without defect	
4	High Temp. Operating Display	85°C	120 hrs	Appearance Without defect	
5	Low Temp. Operating Display	-40°C	120 hrs	Appearance Without defect	
6	Thermal Shock	-40°C, 30min. → 85°C, 30min. 		Appearance Without defect	10 cycles

** Dissipation current, contrast and display functions

** Polarizing filter deterioration, other appearance defects

** The function test shall be conducted after 4hours storage at the normal temperature and humidity after remove from the test chamber.



6. NOTES

▪ Safety

- If the LCD panel breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Handling

- Avoid static electricity as this can damage the CMOS LSI.
- The LCD panel is plate glass; do not hit or crush it.
- Do not remove the panel or frame from the module.
- The polarizing plate of the display is very fragile; handle it very carefully

Mounting and Design

- Mount the module by using the specified mounting part and holes.
- To protect the module from external pressure, leave a small gap by placing transparent plates (e.g. acrylic or glass) on the display surface, frame, and polarizing plate
- Design the system so that no input signal is given unless the power-supply voltage is applied.
- Keep the module dry. Avoid condensation, otherwise the transparent electrodes may break.

Storage

- Store the module in a dark place where the temperature is $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and the humidity below 65% RH.
- Do not store the module near organic solvents or corrosive gases.
- Do not crush, shake, or jolt the module (including accessories).

Cleaning

- Do not wipe the polarizing plate with a dry cloth, as it may scratch the surface.
- Wipe the module gently with soft cloth soaked with a petroleum benzine.
- Do not use ketonic solvents (ketone and acetone) or aromatic solvents (toluene and xylene), as they may damage the polarizing plate.

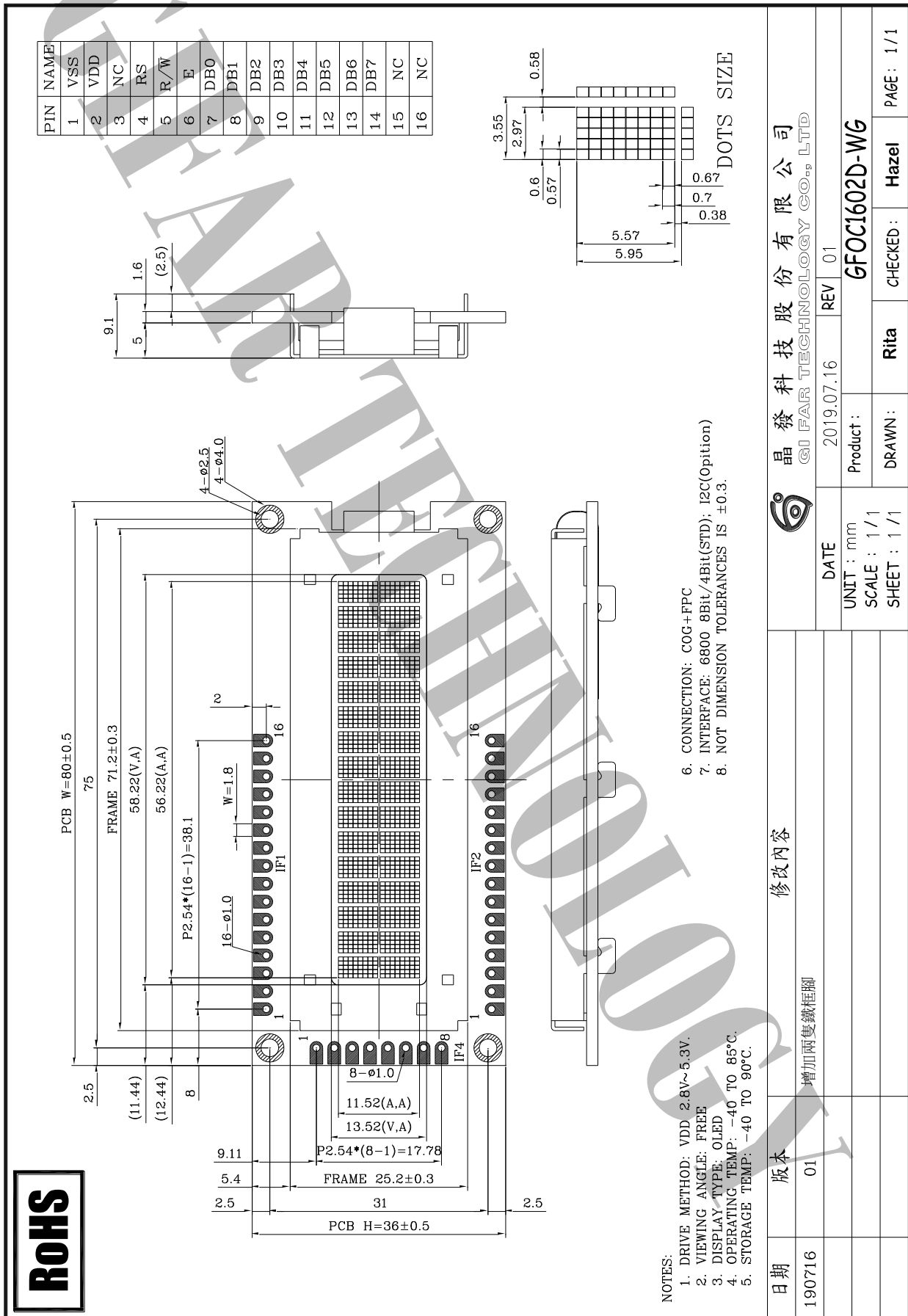
7. OPERATION PRECAUTIONS

Any changes that need to be made in this specification or any problems arising from it will be dealt with quickly by discussion between both companies.

Quality warranty period: Within one year after shipment date (excluding abnormal usage way and abnormal environments.)



8. Mechanical Drawing





9. Outgoing Quality Control Specifications

9.1 Environment Required

Customer's test & measurement are required to be conducted under the following conditions:

Temperature:	23 ± 5°C
Humidity:	55 ± 15 %RH
Fluorescent Lamp:	30W
Distance between the Panel & Lamp:	≥ 50 cm
Distance between the Panel & Eyes of the Inspector:	≥ 30 cm
Finger glove (or finger cover) must be worn by the inspector.	
Inspection table or jig must be anti-electrostatic.	

9.2 Sampling Plan

Level II, Normal Inspection, Single Sampling, MIL-STD-105E

9.3 Criteria & Acceptable Quality Level

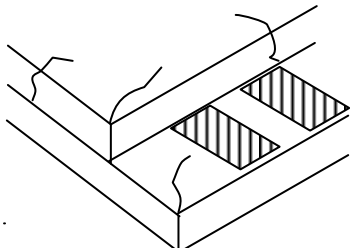

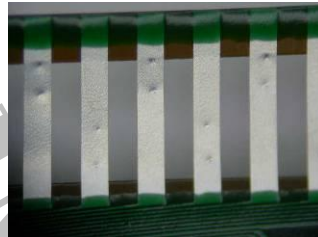
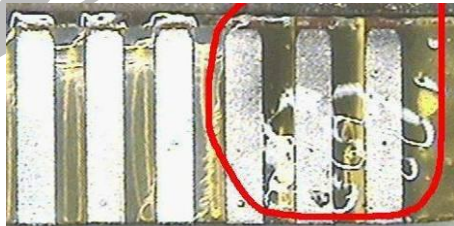
Partition	AQL	Definition
Major	0.65	Defects in Pattern Check (Display On)
Minor	1.0	Defects in Cosmetic Check (Display Off)

9.3.1 Cosmetic Check (Display Off) in Non-Active Area

Check Item	Classification	Criteria
Panel General Chipping	Minor	<p>X > 6 mm (Along with Edge) Y > 1 mm (Perpendicular to edge)</p>

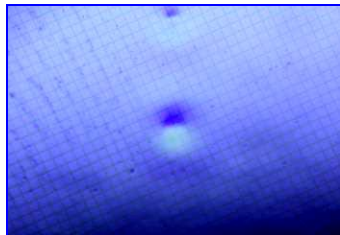


9.3.1 Cosmetic Check (Display Off) in Non-Active Area (Continued)

Check Item	Classification	Criteria
Panel Crack	Minor	Any crack is not allowable. 
Copper Exposed (Even Pin or Film)	Minor	Not Allowable by Naked Eye Inspection
Film or Trace Damage	Minor	
Terminal Lead Prober Mark	Acceptable	
Glue or Contamination on Pin (Couldn't Be Removed by Alcohol)	Minor	
Ink Marking on Back Side of panel (Exclude on Film)	Acceptable	Ignore for Any

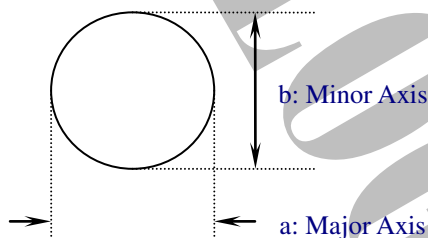
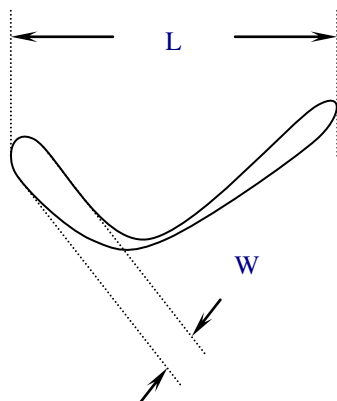


9.3.2 Cosmetic Check (Display Off) in Active Area

Check Item	Classification	Criteria
Any Dirt & Scratch on Polarizer's Protective Film	Acceptable	Ignore for not Affect the Polarizer
Scratches, Fiber, Line-Shape Defect (On Polarizer)	Minor	$W \leq 0.1$ Ignore $W > 0.1,$ $L \leq 2$ $n \leq 1$ $L > 2$ $n = 0$
Dirt, Black Spot, Foreign Material, (On Polarizer)	Minor	$\Phi \leq 0.1$ Ignore $0.1 < \Phi \leq 0.25$ $n \leq 1$ $0.25 < \Phi$ $n = 0$
Dent, Bubbles, White spot (Any Transparent Spot on Polarizer)	Minor	$\Phi \leq 0.5$ → Ignore if no Influence on Display $0.5 < \Phi$ $n = 0$ 
Fingerprint, Flow Mark (On Polarizer)	Minor	Not Allowable

* Protective film should not be tear off when cosmetic check.

** Definition of W & L & Φ (Unit: mm): $\Phi = (a + b) / 2$





9.3.3 Pattern Check (Display On) in Active Area

Check Item	Classification	Criteria
No Display	Major	
Missing Line	Major	
Pixel Short	Major	
Darker Pixel	Major	
Wrong Display	Major	
Un-uniform	Major	