Crystalfontz America, Inc.

SPECIFICATION

CUSTOMER: ______________________

MODULE NO.: **CFAH1602C-YYH-JPV**

SALES BY	APPROVED BY	CHECKED BY	PREPARED BY
ISSUED DATE:			

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Contents

1. Module Classification Information

CFA H 1 6 0 2 C - Y Y H - JPV

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

①	Brand: CRYSTALFONTZ AMERICA, INCORPORATED		
②	Display Type: **H→ Character Type**, G→ Graphic Type, X→ TAB		
③	Display's logical dimensions: **16 characters, 2 lines**		
④	Model serials no.		
⑤	Backlight Type:	N→ Without backlight B→ EL, Blue green D→ EL, Green W→ EL, White F→ CCFL, White **Y→ LED, Yellow Green**	A→ LED, Amber R→ LED, Red O→ LED, Orange G→ LED, Green
⑥	LCD Mode:	B→ TN Positive, Gray N→ TN Negative, G→ STN Positive, Gray **Y→ STN Positive, Yellow Green** M→ STN Negative, Blue F→ FSTN Positive	T→ FSTN Negative
⑦	LCD Polarizer Type/ Temperature range/ View direction	A→ Reflective, N.T, 6:00 D→ Reflective, N.T, 12:00 G→ Reflective, W. T, 6:00 J→ Reflective, W. T, 12:00 B→ Transflective, N.T,6:00 E→ Transflective, N.T.12:00	**H→ Transflective,W.T,6:00** K→ Transflective,W.T,12:00 C→ Transmissive, N.T,6:00 F→ Transmissive, N.T,12:00 I→ Transmissive, W. T, 6:00 L→ Transmissive,W.T,12:00
⑧	Special Code:	**JP: English and Japanese standard font; V: Negative voltage**	

2.Precautions in use of LCD Modules

(1) Avoid applying excessive shocks to the module or making any alterations or modifications to it.
(2) Don’t make extra holes on the printed circuit board, modify its shape or change the components of LCD module.
(3) Don’t disassemble the LCM.
(4) Don’t operate it above the absolute maximum rating.
(5) Don’t drop, bend or twist LCM.
(6) Soldering: only to the I/O terminals.
(7) Storage: please storage in anti-static electricity container and clean environment.

3.General Specification

Item	Dimension	Unit
Number of Characters	16 characters x 2 Lines	-
Module dimension	85.0 x 36.0 x 13.2(MAX)	mm
View area	66.0 x 16.0	mm
Active area	56.21 x 11.5	mm
Dot size	0.55 x 0.65	mm
Dot pitch	0.60 x 0.70	mm
Character size	2.95 x 5.55	Nmm
Character pitch	3.55 x 5.95	mm
LCD type	STN, Positive, Transflective, Yellow Green	
Duty	1/16	
View direction	6 o’clock	
Backlight Type	LED, Yellow Green	

4.Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_{OP}	-20	-	+70	℃
Storage Temperature	T_{ST}	-30	-	+80	℃
Input Voltage	V_I	V_{SS}	-	V_{DD}	V
Supply Voltage For Logic	V_{DD}-V_{SS}	-0.3	-	7	V
Supply Voltage For LCD	V_{DD}-V_0	-0.3	-	13	V

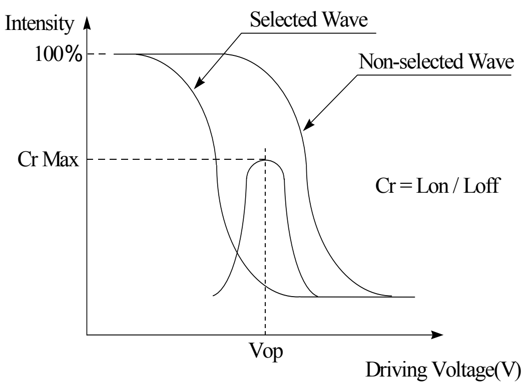
5.Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	V_{DD}-V_{SS}	-	4.5	-	5.5	V
Supply Voltage For LCD	V_{DD}-V_0	Ta=-20℃	-	-	4.8	V
		Ta=25℃	-	3.8	-	V
		Ta=70℃	3.2	-	-	V
Input High Volt.	V_{IH}	-	2.2	-	V_{DD}	V
Input Low Volt.	V_{IL}	-	-	-	0.6	V
Output High Volt.	V_{OH}	-	2.4	-	-	V
Output Low Volt.	V_{OL}	-	-	-	0.4	V
Supply Current	I_{DD}	V_{DD}=5V	-	1.2	-	mA

6.Optical Characteristics

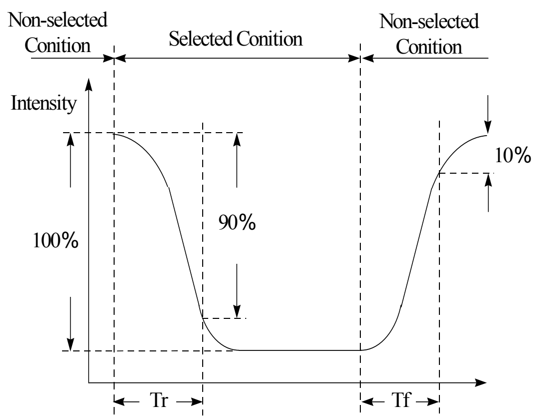
Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V)θ	CR≧ 2	10	-	105	deg
	(H)φ	CR≧ 2	-30	-	30	deg
Contrast Ratio	CR	-	-	3	-	-
Response Time	T rise	-	-	150	200	ms
	T fall	-	-	150	200	ms

Definition of Operation Voltage (Vop)



[positive type]

Definition of Response Time (Tr , Tf)



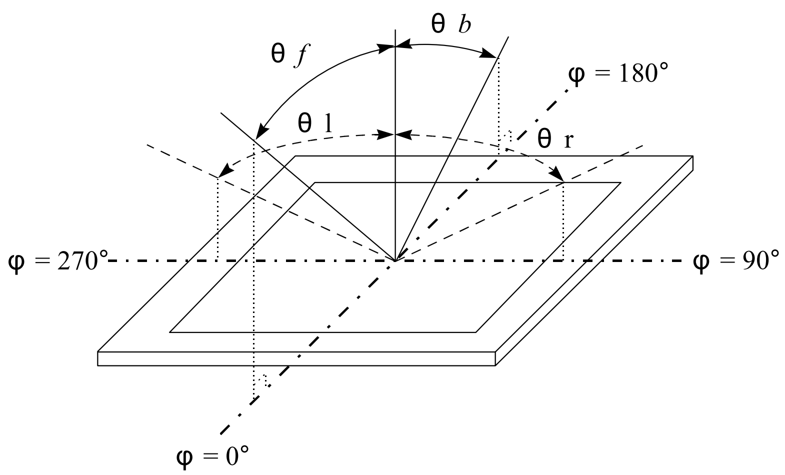
[positive type]

Conditions :

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

Frame Frequency: 64 HZ　　Driving Waveform: 1/N duty, 1/a bias

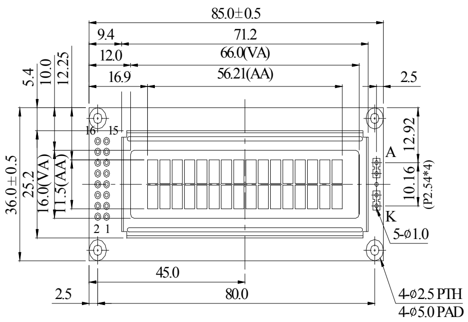
Definition of viewing angle(CR≧ 2)

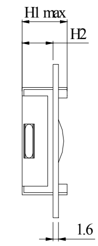


7.Interface Pin Function

Pin No.	Symbol	Level	Description
1	V_{SS}	0V	Ground
2	V_{DD}	5.0V	Supply Voltage for logic
3	VO	(Variable)	Operating voltage for LCD
4	RS	H/L	H: DATA, L: Instruction code
5	R/W	H/L	H: Read(MPU→ Module) L: Write(MPU→ Module)
6	E	H,H→ L	Chip enable signal
7	DB0	H/L	Data bit 0
8	DB1	H/L	Data bit 1
9	DB2	H/L	Data bit 2
10	DB3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DB5	H/L	Data bit 5
13	DB6	H/L	Data bit 6
14	DB7	H/L	Data bit 7
15	A/Vee	-	Negative Voltage (-5V)
16	K	-	LED -

8.Contour Drawing &Block Diagram

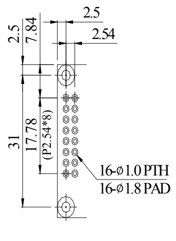




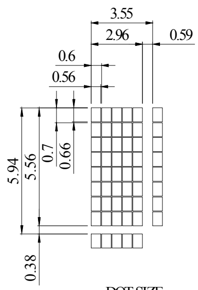
PIN NO.	SYMBOL
1	Vss
2	Vdd
3	Vo
4	RS
5	R/W̄
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	A/Vee
16	K

LED B/L

H1	13.2
H2	8.6

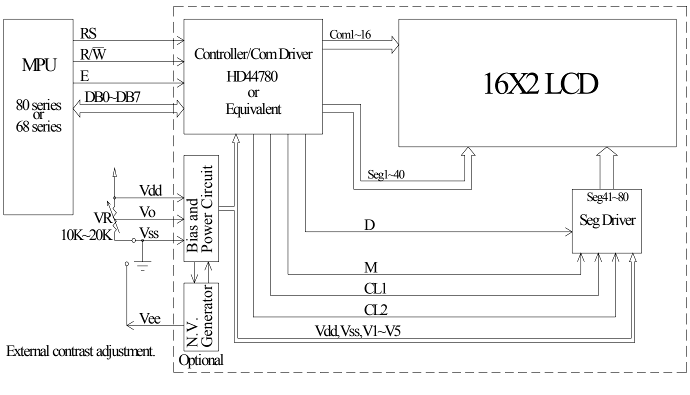


PIN DETAIL



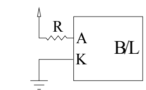
DOT SIZE

The non-specified tolerance of dimension is ±0.3mm.

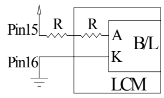


LED B/L Drive Method

1.Drive from A,K



2.Drive from pin15, pin16



(Will never get Vee output from pin15)

Character located	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DDRAM address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
DDRAM address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

9.Function Description

The LCD display Module is built in a LSI controller, the controller has two 8-bit registers, an instruction register (IR) and a data register (DR).
The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the MPU. The DR temporarily stores data to be written or read from DDRAM or CGRAM. When address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM. By the register selector (RS) signal, these two registers can be selected.

RS	R/W	Operation
0	0	IR write as an internal operation (display clear, etc.)
0	1	Read busy flag (DB7) and address counter (DB0 to DB7)
1	0	Write data to DDRAM or CGRAM (DR to DDRAM or CGRAM)
1	1	Read data from DDRAM or CGRAM (DDRAM or CGRAM to DR)

Busy Flag (BF)
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

Address Counter (AC)
The address counter (AC) assigns addresses to both DDRAM and CGRAM

Display Data RAM (DDRAM)

This DDRAM is used to store the display data represented in 8-bit character codes. Its extended capacity is 80×8 bits or 80 characters. Below figure demonstrates the relationships between DDRAM addresses and positions on the liquid crystal display.

High bits Low bits

AC (hexadecimal)

AC6	AC5	AC4	AC3	AC2	AC1	AC0

Example: DDRAM addresses 4E

1	0	0	1	1	1	0

Display position DDRAM address

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

2-Line by 16-Character Display

Character Generator ROM (CGROM)

The CGROM generate 5×8 dot or 5×10 dot character patterns from 8-bit character codes. See Table 2.

Character Generator RAM (CGRAM)

In CGRAM, the user can rewrite character by program. For 5×8 dots, eight character patterns can be written, and for 5×10 dots, four character patterns can be written.

Write into DDRAM the character code at the addresses shown as the left column of table 1. To show the character patterns stored in CGRAM.

Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns

Table 1.

For 5 * 8 dot character patterns

Character Codes (DDRAM data)	CGRAM Address		Character Patterns (CGRAM data)		
7 6 5 4 3 2 1 0 High Low	5 4 3 2 1 0 High Low		7 6 5 4 3 2 1 0 High Low		
		0 0 0	* * *	■ ■ ■ ■ 0	Character pattern(1)
		0 0 1	* * *	■ 0 0 0 ■	
		0 1 0	* * *	■ 0 0 0 ■	
		0 1 1	* * *	■ ■ ■ ■ 0	
0 0 0 0 * 0 0 0	0 0 0	1 0 0	* * *	■ 0 ■ 0 0	
		1 0 1	* * *	■ 0 0 ■ 0	
		1 1 0	* * *	■ 0 0 0 ■	
		1 1 1	* * *	0 0 0 0 0	Cursor pattern
		0 0 0	* * *	■ 0 0 0 ■	Character pattern(2)
		0 0 1	* * *	0 ■ 0 ■ 0	
		0 1 0	* * *	■ ■ ■ ■ ■	
		0 1 1	* * *	0 0 ■ 0 0	
0 0 0 0 * 0 0 1	0 0 1	1 0 0	* * *	■ ■ ■ ■ ■	
		1 0 1	* * *	0 0 ■ 0 0	
		1 1 0	* * *	0 0 ■ 0 0	
		1 1 1	* * *	0 0 0 0 0	Cursor pattern
		0 0 0	* * *		
		0 0 1			
0 0 0 0 * 1 1 1	1 1 1	1 0 0			
		1 0 1			
		1 1 0			
		1 1 1	* * *		

For 5 * 10 dot character patterns

Character Codes (DDRAM data)	CGRAM Address		Character Patterns (CGRAM data)		
7 6 5 4 3 2 1 0 High Low	5 4 3 2 1 0 High Low		7 6 5 4 3 2 1 0 High Low		
		0 0 0 0	* * *	0 0 0 0 0	Character pattern
		0 0 0 1	* * *	0 0 0 0 0	
		0 0 1 0	* * *	■ 0 ■ ■ 0	
		0 0 1 1	* * *	■ ■ 0 0 ■	
		0 1 0 0	* * *	■ 0 0 0 ■	
0 0 0 0 * 0 0 0	0 0	0 1 0 1	* * *	■ 0 0 0 ■	
		0 1 1 0	* * *	■ ■ ■ ■ 0	
		0 1 1 1	* * *	■ 0 0 0 0	
		1 0 0 0	* * *	■ 0 0 0 0	
		1 0 0 1	* * *	■ 0 0 0 0	
		1 0 1 0	* * *	0 0 0 0 0	Cursor pattern
		1 1 1 1	* * *	* * * * *	

■ : " High "

10.Character Generator ROM Pattern

Table.2

Upper 4 bit / Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)															
LLLH	(2)															
LLHL	(3)															
LLHH	(4)															
LHLL	(5)															
LHLH	(6)															
LHHL	(7)															
LHHH	(8)															
HLLL	(1)															
HLLH	(2)															
HLHL	(3)															
HLHH	(4)															
HHLL	(5)															
HHLH	(6)															
HHHL	(7)															
HHHH	(8)															

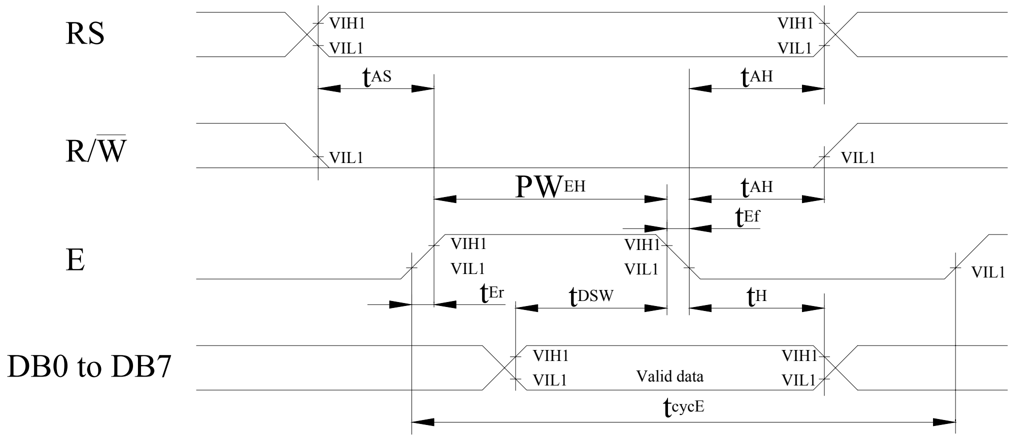
11.Instruction Table

Instruction	Instruction Code										Description	Execution time (fosc=270Khz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write “00H” to DDRAM and set DDRAM address to “00H” from AC	1.53ms
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.	1.53ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor move direction and enable the shift of entire display.	39μ s
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and blinking of cursor (B) on/off control bit.	39μ s
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 of DDRAM data.	39μ s
Function Set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL:8-bit/4-bit), numbers of display line (N:2-line/1-line)and, display font type (F:5×11 dots/5×8 dots)	39μ s
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39μ s
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39μ s
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.	0μ s
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43μ s
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43μ s

* ” - ” : don’t care

12.Timing Characteristics

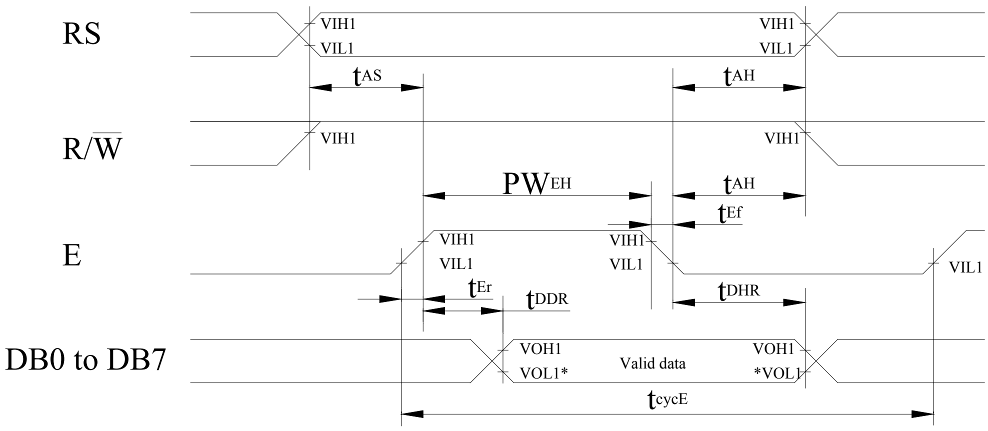
12.1 Write Operation



Ta=25℃, VDD=5.0± 0.5V

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	t_{cycE}	400	-	-	ns
Enable pulse width (high level)	PW_{EH}	150	-	-	ns
Enable rise/fall time	t_{Er},t_{Ef}	-	-	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	30	-	-	ns
Address hold time	t_{AH}	10	-	-	ns
Data set-up time	t_{DSW}	40	-	-	ns
Data hold time	t_H	10	-	-	ns

12.2 Read Operation



NOTE: *VOL1 is assumed to be 0.8V at 2 MHZ operation.

Ta=25℃, VDD=5.0± 0.5V

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	t_{cycE}	400	-	-	ns
Enable pulse width (high level)	PW_{EH}	150	-	-	ns
Enable rise/fall time	t_{Er},t_{Ef}	-	-	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	30	-	-	ns
Address hold time	t_{AH}	10	-	-	ns
Data delay time	t_{DDR}	-	-	100	ns
Data hold time	t_{DHR}	20	-	-	ns

13.Initializing of LCM

Power on

Wait for more than 15 ms after V_{CC} rises to 4.5 V

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

Function set (Interface is 8 bits long.)

Wait for more than 4.1 ms

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

Function set (Interface is 8 bits long.)

Wait for more than 100 μs

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

Function set (Interface is 8 bits long.)

BF can be checked after the following instructions. When BF is not checked , the waiting time between instructions is longer than execution instruction time.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
0	0	0	0	1	1	N	F	*	*	Function set (Interface is 8 bits long. Specify the number of display lines and font.) The number of display lines and character font can not be changed after this point.
0	0	0	0	0	0	1	0	0	0	Display off
0	0	0	0	0	0	0	0	0	1	Display clear
0	0	0	0	0	0	0	1	I/D	S	Entry mode set

Initialization ends

8-Bit Ineterface

Power on

Wait for more than 15 ms after V_{CC} rises to 4.5 V

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4
0	0	0	0	1	1

Function set (Interface is 8 bits long.)

Wait for more than 4.1 ms

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4
0	0	0	0	1	1

Function set (Interface is 8 bits long.)

Wait for more than 100 μs

BF can not be checked before this instruction.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4
0	0	0	0	1	1

Function set (Interface is 8 bits long.)

BF can be checked after the following instructions.
When BF is not checked , the waiting time between instructions is longer than execution instruction time.

RS	R/$\overline{W}$	DB7	DB6	DB5	DB4	
0	0	0	0	1	0	Function set (Set interface to be 4 bits long.) Interface is 8 bits in length.
0	0	0	0	1	0	
0	0	N	F	*	*	Function set (Interface is 4 bits long. Specify the number of display lines and character font.) The number of display lines and character font can not be changed after this point.
0	0	0	0	0	0	
0	0	1	0	0	0	Display off
0	0	0	0	0	0	
0	0	0	0	0	1	Display clear
0	0	0	0	0	0	
0	0	0	1	I/D	S	Entry mode set

Initialization ends

4-Bit Ineterface

14.Quality Assurance

Screen Cosmetic Criteria

Item	Defect	Judgment Criterion	Partition
1	Spots	A) Clear Size: d mm Acceptable Qty in active area d ≦ 0.1 Disregard 0.1<d≦ 0.2 6 0.2<d≦ 0.3 2 0.3<d 0 Note: Including pinholes and defective dots which must be within one pixel size. B) Unclear Size: d mm Acceptable Qty in active area d ≦ 0.2 Disregard 0.2<d≦ 0.5 6 0.5<d≦ 0.7 2 0.7<d 0	Minor
2	Bubbles in Polarize	Size: d mm Acceptable Qty in active area d≦ 0.3 Disregard 0.3<d≦ 1.0 3 1.0<d≦ 1.5 1 1.5<d 0	Minor
3	Scratch	In accordance with spots cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor
4	Allowable Density	Above defects should be separated more than 30mm each other.	Minor
5	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Backlight type should be judged with backlight on state only.	Minor

15.Reliability

Content of Reliability Test

Environmental Test			
Test Item	**Content of Test**	**Test Condition**	**Applicable Standard**
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80℃ 200hrs	——
Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30℃ 200hrs	——
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70℃ 200hrs	——
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 200hrs	——
High Temperature/ Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time.	80℃,90%RH 96hrs	——
High Temperature/ Humidity Operation	Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.	70℃,90%RH 96hrs	——
Temperature Cycle	Endurance test applying the low and high temperature cycle. -30℃ 25℃ 80℃ 30min 5min 30min 1 cycle	-30℃/80℃ 10 cycles	——
Mechanical Test			
Vibration test	Endurance test applying the vibration during transportation and using.	10~22Hz→ 1.5mmp-p 22~500Hz→ 1.5G Total 0.5hrs	——
Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G Half sin wave 11 msec 3 times of each direction	——
Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115mbar 40hrs	——
Others			
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V,RS=1.5kΩ CS=100pF 1 time	——

***Supply voltage for logic system=5V. Supply voltage for LCD system =Operating voltage at 25℃

16.Backlight Information

Specification

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	**ILED**	—	**130**	**260**	**mA**	**V=4.2V**
Supply Voltage	**V**	-	**4.2**	**4.6**	**V**	-
Reverse Voltage	**VR**	-	-	**8**	**V**	-
Luminous Intensity	**IV**	-	**60**	-	**CD/M^2**	**ILED=130mA**
Wave Length	**λ p**	—	**571**	-	**nm**	**ILED=130mA**
Life Time	-	-	**100000**	-	**Hr.**	**V≦ 4.6V**
Color	**Yellow Green**					