




深圳市华远显示器件有限公司
SHENZHEN HUAYUAN DISPLAY CO.,LTD.

液晶显示模块规格书

Specification for Liquid Crystal Display Module


HYG1603201C-YF62L-VA

Prepared By	Reviewed By	Approved By
Date:	Date:	Date:

	Title HYG1603201C-YF62L-VA.doc SPECIFICATION	DOC#:	Rev. : R00
		Effective Date: 2011-05-05	

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1.0 GENERAL DESCRIPTION

The HYG1603201C-YF62L-VA is a 160x32 dots dot-matrix LCD module. It has a STN panel composed of 160 segments and 32 commons. The LCM can be easily accessed by microcontroller via 6800 series 8-bit parallel interface.

2.0 FEATURES

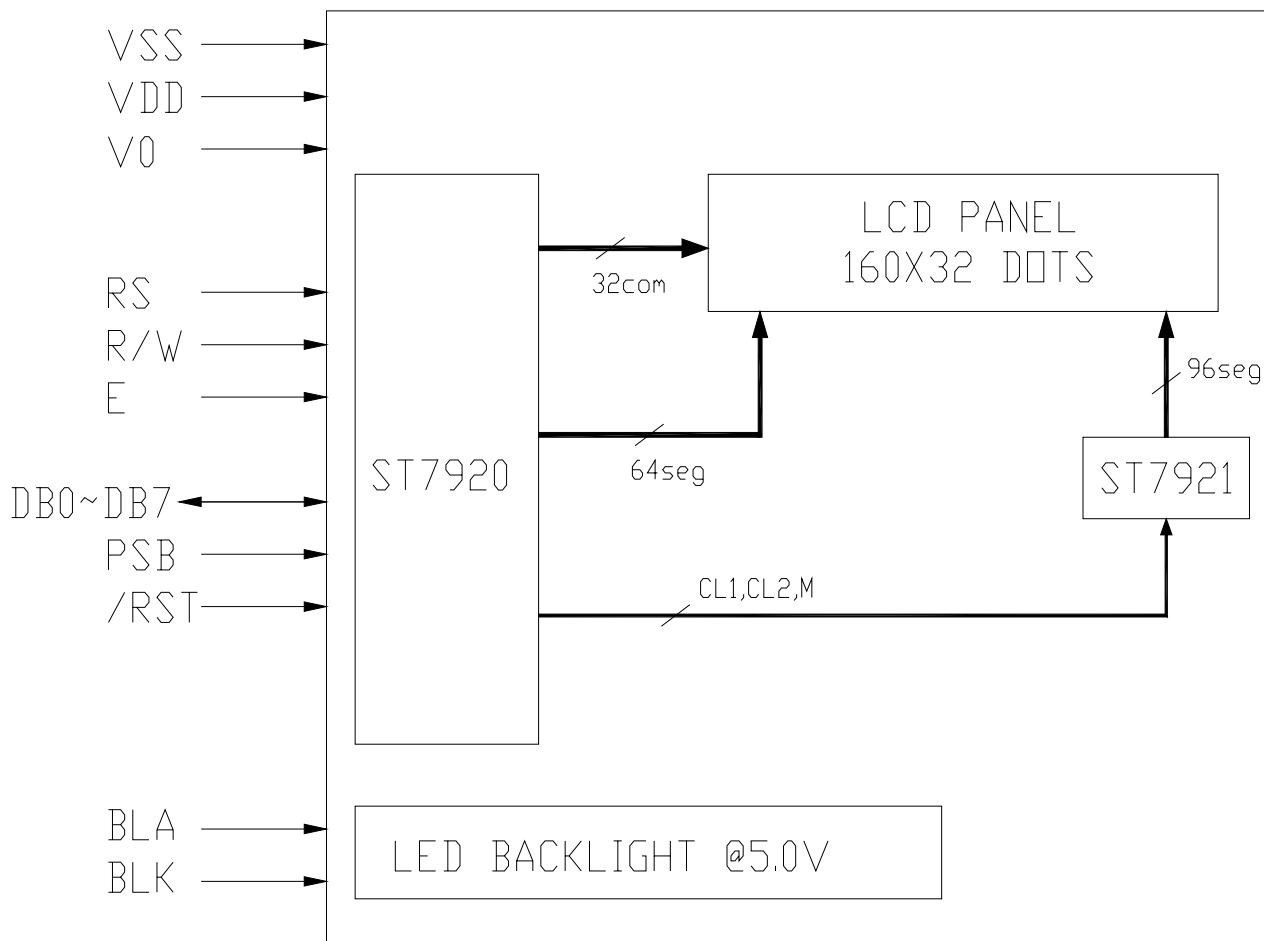
Display Format	160 x 32 dots
LCD Type	STN-Y/G-POSITIVE
Polarizer Mode	TRANSFLECTIVE
Drive Method	1/32 Duty, 1/6 Bias
Viewing Direction	6 O'clock
Controller	ST7920-0B With GB code simplified character set
Interface	6800 Series 8-Bit Parallel Interface or Serial Interface
Backlight	Y/G LED Backlight

3.0 MECHANICAL SPECIFICATION

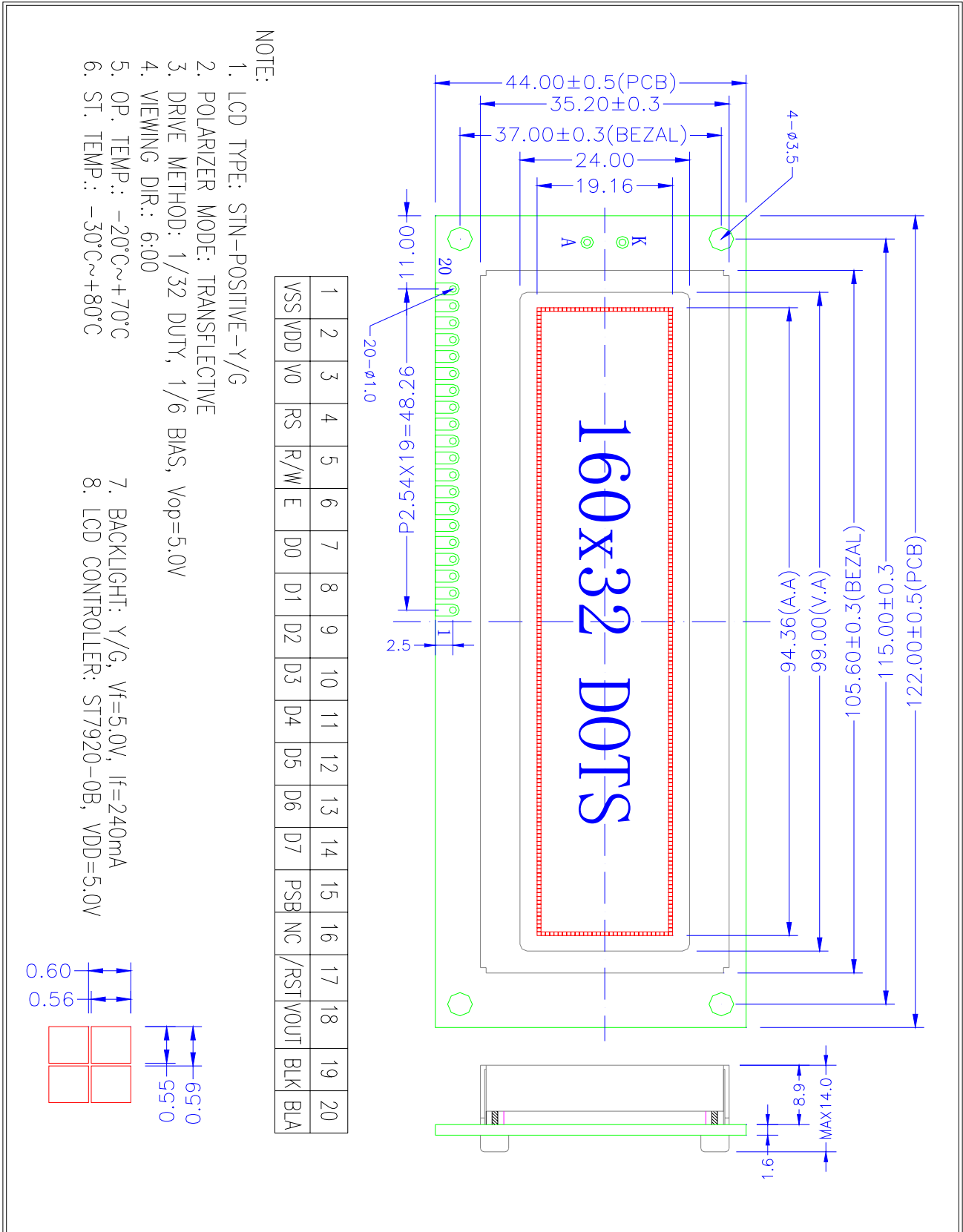
Item	Description	Unit
Module Dimension	122.0(W) × 44.0(H) × 14.0(Max)(T)	mm
Viewing Area	99.0(W) × 24.0(H)	mm
Active Area	94.36(W) × 19.16(H)	mm
Dot Size	0.55(W) × 0.56(H)	mm
Dot Pitch	0.59(W) × 0.60(H)	mm
Character Size	——	mm



4.0 BLOCK DIAGRAM



5.0 EXTERNAL DIMENSIONS





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6.0 INTERFACE PIN DESCRIPTIONS

PIN No.	Symbol	Level	Description
1	V _{SS}	P	Ground
2	V _{DD}	P	Power supply for logic(+5.0V)
3	V ₀	P	Power supply for LCD
4	RS(CS)	H/L	Parallel Mode: Register select. 0: Select instruction register (write) or busy flag, address counter (read); 1: Select data register (write/read). Serial mode: Chip select. 1: chip enabled; 0: chip disabled.
5	R/W(SID)	H/L	Parallel Mode: Read/Write control. 0: Write; 1: Read. Serial Mode: Serial data input.
6	E(SCLK)	H,H→L	Parallel Mode: 1: Enable trigger. Serial Mode: Serial clock input.
7	DB0	H/L	Data Bit0
8	DB1	H/L	Data Bit1
9	DB2	H/L	Data Bit2
10	DB3	H/L	Data Bit3
11	DB4	H/L	Data Bit4
12	DB5	H/L	Data Bit5
13	DB6	H/L	Data Bit6
14	DB7	H/L	Data Bit7
15	PSB	H/L	Interface selection: 0: serial mode; 1: 8/4-bit parallel bus mode.
16	NC	---	No Connection
17	/RST	H/L	System reset input (Low active).
18	VOUT	P	LCD voltage doubler output. ($\cong 7V$)
19	BLK	P	Power supply for LED Backlight (0V)
20	BLA	P	Power supply for LED Backlight (+5.0V)



7.0 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic)	V_{DD}	-0.3	6.0	V
Supply Voltage (LCD)	V_0	-0.3	7.0	V
Input Voltage	V_I	-0.3	$V_{DD}+0.3$	V
Operating Temperature	T_{opr}	-20	70	°C
Storage Temperature	T_{stg}	-30	80	°C

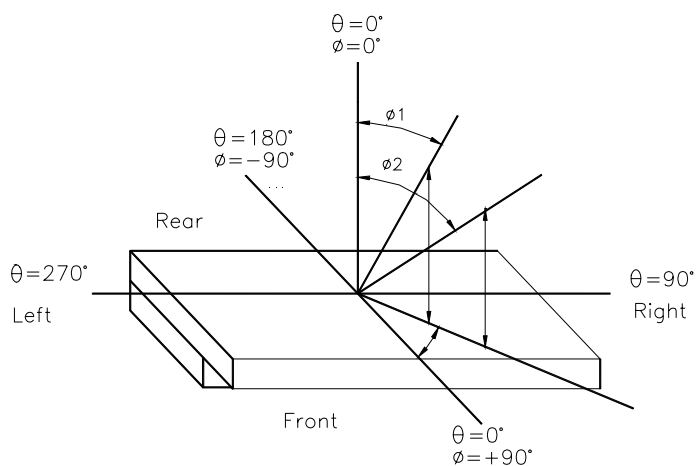
8.0 ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for Logic	V_{DD}	--	4.8	5.0	5.2	V
Supply current for Logic	I_{DD}	fOSC =540KHz, $V_{DD}=5.0V$ $R_f=33K\ \Omega$	--	0.45	0.75	mA
LCD Operating Voltage	V_0	-20°C				V
		+25°C	4.8	5.0	5.2	V
		+70°C				V
Input voltage H level	V_{IH}	For all inputs	$0.7V_{DD}$	---	V_{DD}	V
Input voltage L level	V_{IL}	For all inputs	-0.3	---	0.6	V
Output High Voltage (DB0~DB7)	V_{OH1}	$I_{OH} = -0.1mA$	$0.8V_{DD}$	---	V_{DD}	V
Output Low Voltage (DB0~DB7)	V_{OL1}	$I_{OL} = 0.1mA$	---	---	0.4	V
Output High Voltage (Except DB0 - DB7)	V_{OH1}	$I_{OH} = -0.04mA$	$0.8V_{DD}$	---	V_{DD}	V
Output Low Voltage (Except DB0 - DB7)	V_{OL1}	$I_{OL} = 0.04mA$	---	---	$0.1V_{DD}$	V
OSC Frequency	F_{osc}	$R_f = 33K\ \Omega$	480	540	600	KHz

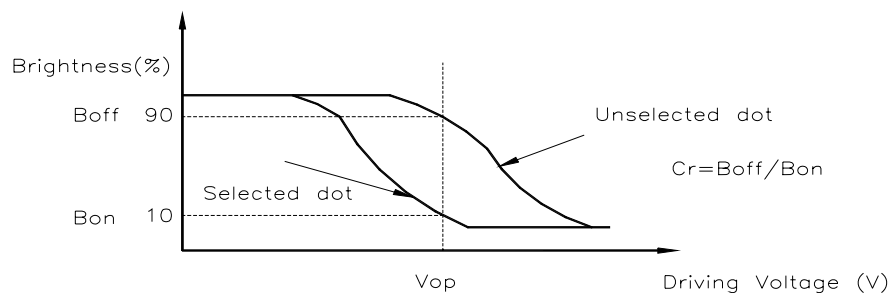
9.0 OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min	Typ	Max	Unit
Response time	Ton	$\theta=0^\circ$ and $T_a=-20^\circ\text{C}$		--		ms
		$\theta=0^\circ$ and $T_a=+25^\circ\text{C}$		--		ms
		$\theta=0^\circ$ and $T_a=+70^\circ\text{C}$		--		ms
	Toff	$\theta=0^\circ$ and $T_a=-20^\circ\text{C}$		--		ms
		$\theta=0^\circ$ and $T_a=+25^\circ\text{C}$		--		ms
		$\theta=0^\circ$ and $T_a=+70^\circ\text{C}$		--		ms
Contrast ration	CR(MAX)	$T_a=25^\circ\text{C}$	5	10		---
Viewing Angle	θ	Deg $\theta=0^\circ$	CR \geq 2.0 $T_a=25^\circ\text{C}$	50		Deg
		Deg $\theta=90^\circ$		35		
		Deg $\theta=180^\circ$		30		
		Deg $\theta=270^\circ$		35		
Crosstalk		$T_a=25^\circ\text{C}$		1.2		---

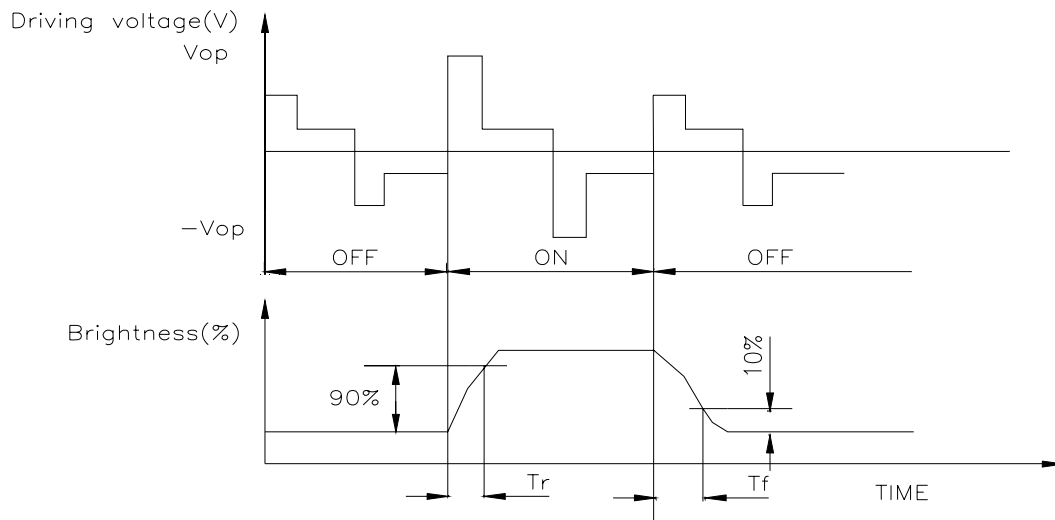
9.1 Viewing Angle θ , ϕ and Viewing Angle Range: $\Delta\theta = |\theta_2 - \theta_1|$



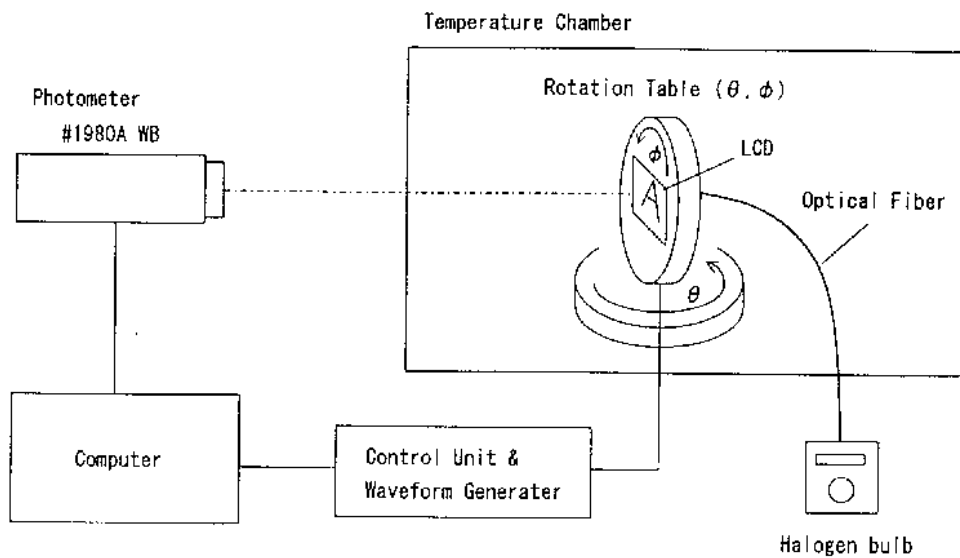
9.2 Contrast ratio(CR)



9.3 Response Time

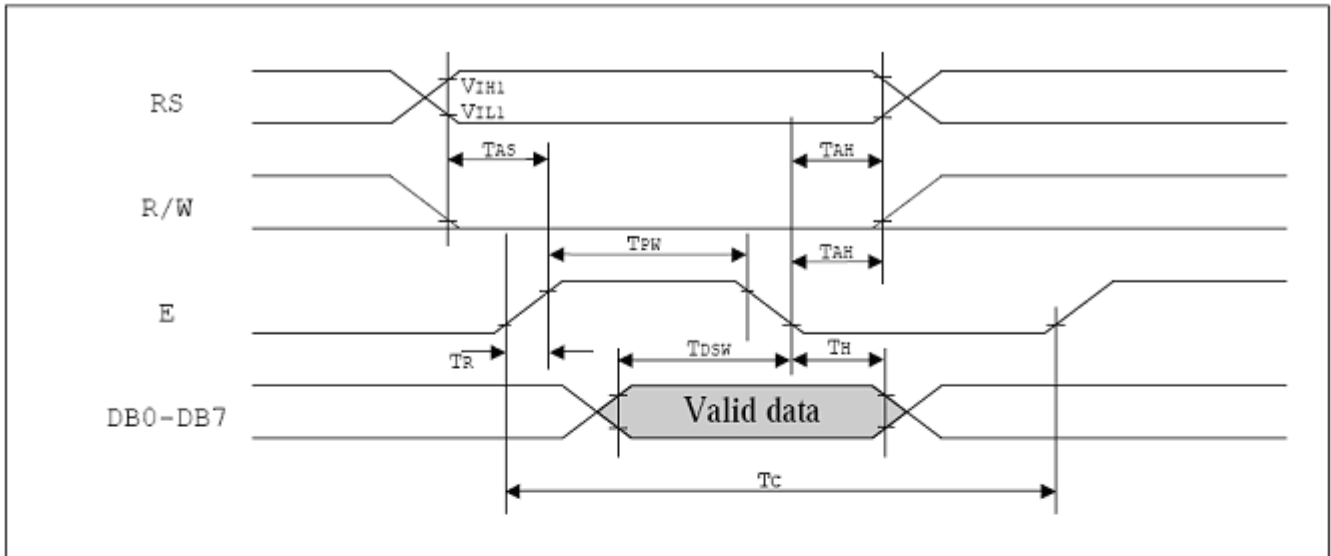


9.4 Optical Measurement System

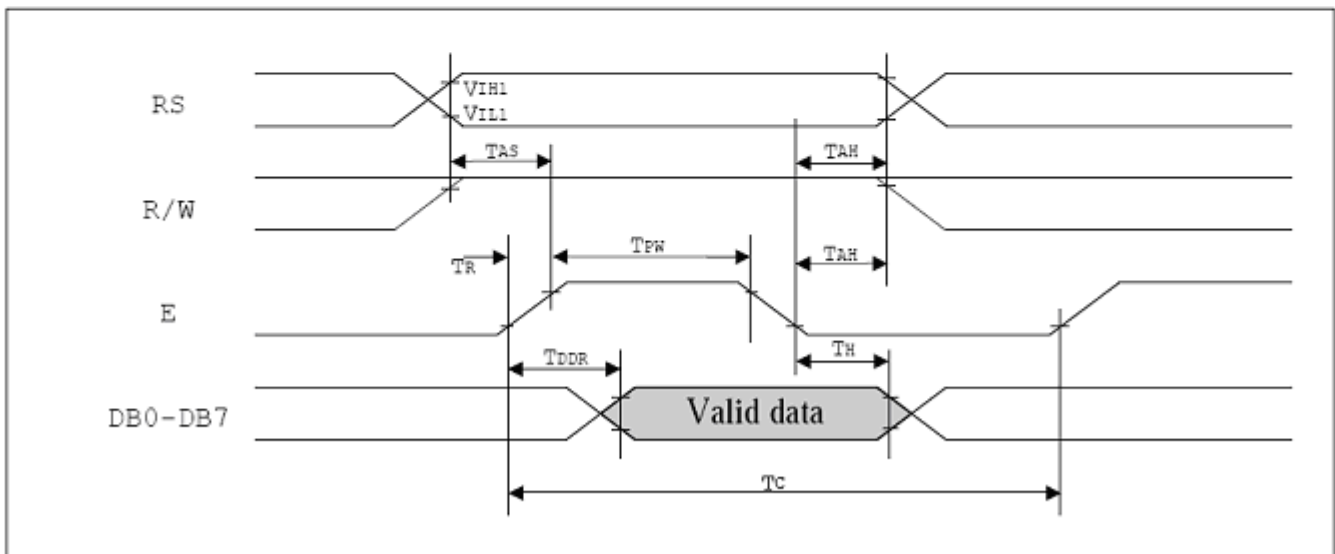


10.0 TIMING CHARACTERICS

10.1 8-bit interface timing diagram



Write data timing diagram

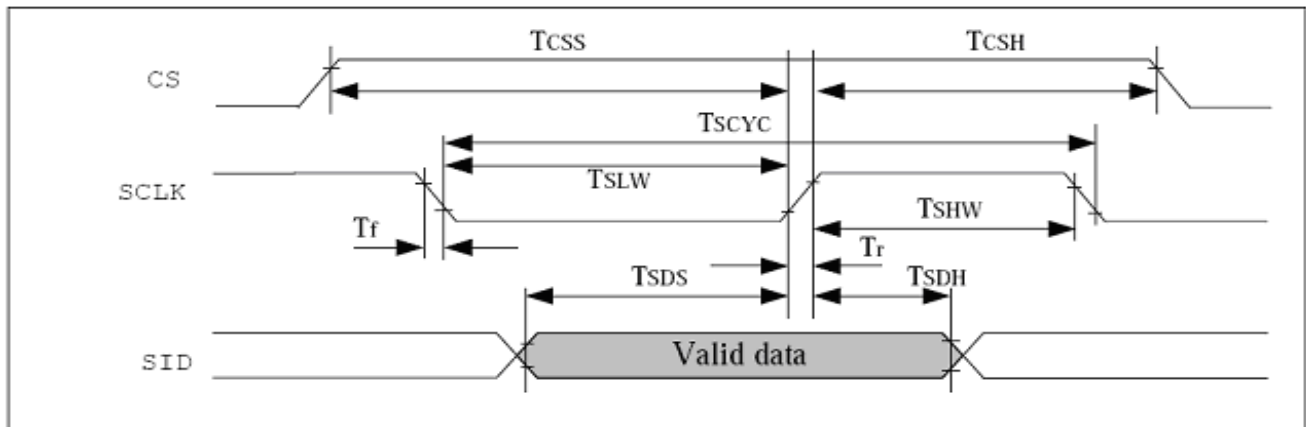


Read data timing diagram



Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
Write Mode						
TC	Enable Cycle Time	Pin E	1200	-	-	ns
TPW	Enable Pulse Width	Pin E	140	-	-	ns
TR,TF	Enable Rise/Fall Time	Pin E	-	-	25	ns
TAS	Address Setup Time	Pins: RS,RW,E	10	-	-	ns
TAH	Address Hold Time	Pins: RS,RW,E	20	-	-	ns
TDSW	Data Setup Time	Pins: DB0 - DB7	40	-	-	ns
TH	Data Hold Time	Pins: DB0 - DB7	20	-	-	ns
Read Mode						
TC	Enable Cycle Time	Pin E	1200	-	-	ns
TPW	Enable Pulse Width	Pin E	140	-	-	ns
TR,TF	Enable Rise/Fall Time	Pin E	-	-	25	ns
TAS	Address Setup Time	Pins: RS,RW,E	10	-	-	ns
TAH	Address Hold Time	Pins: RS,RW,E	20	-	-	ns
TDDR	Data Delay Time	Pins: DB0 - DB7	-	-	100	ns
TH	Data Hold Time	Pins: DB0 - DB7	20	-	-	ns

10.2 Serial interface timing diagram



Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
TR,TF	Rise/Fall Time	-	-	-	0.2	ms
TSCYC	Serial clock cycle	Pin E	400	-	-	ns
TSHW	SCLK high pulse width	Pin E	200	-	-	ns
TSLW	SCLK low pulse width	Pin E	200	-	-	ns
TSDS	SID data setup time	Pins RW	40	-	-	ns
TSDH	SID data hold time	Pins RW	40	-	-	ns
TCSS	CS setup time	Pins RS	60	-	-	ns
TCSH	CS hold time	Pins RS	60	-	-	ns



11.0 BACKLIGHT CHARACTERISTICS

11.1 ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

Item	Symbol	Condition	Rating	Unit
Reverse Voltage	Vr		10.0V	V
Absolute maximum forward current	Ifm		480	mA
Forward current	If	Vf=5.0V	240	mA
Power Description	Pd		960	mW
Operating temperature range	Topr		-20~+70	°C
Storage temperature range	Tst		-30~+80	°C

11.2 ELECTRICAL/OPTICAL CHARACTERISTICS

(Ta=25°C)

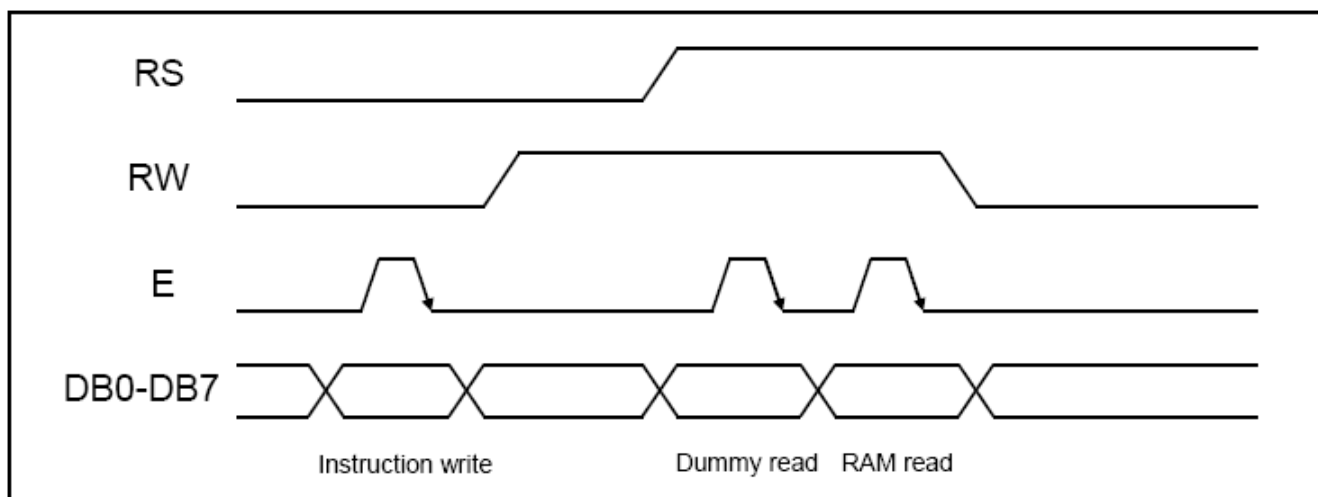
Item	Symbol	Min	Typ	Max	Unit	Condition
Forward Voltage	Vf	4.8	5.0	5.1	V	If=240mA
Reverse Current	Ir		240		uA	Vr=10.0 V
Dominant wave length	λ_p	570		575	nm	If=240mA
Spectral Line Half width	$\Delta \lambda$		--			If=240 mA
Luminance	Lv		--		cd/m ²	If=240 mA
Color Coordinate	X		Y/G			If=240 mA
	Y					

12.0 OPERATING PRINCIPLES & METHODS

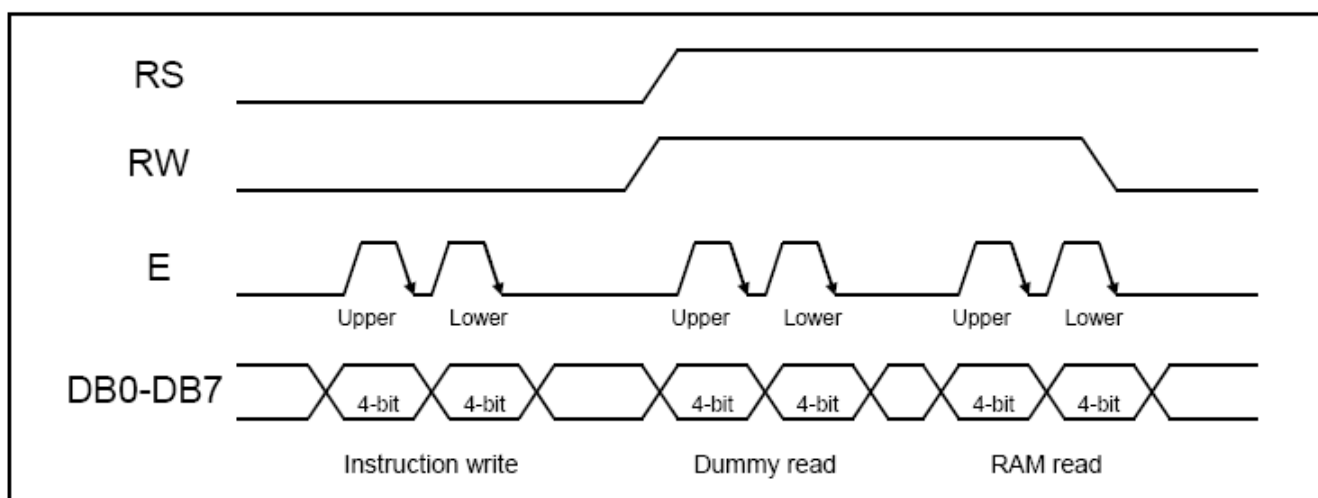
12.1 Parallel interface

ST7920 is in parallel mode by pulling up PSB pin. ST7920 can select 8-bit or 4-bit bus interface by setting the DL control bit in “Function Set” instruction. MPU can control RS, RW, E and DB0...DB7 pins to complete the data transmission.

In 4-bit transfer mode, every 8-bit data or instruction is separated into 2 parts. The higher 4 bits (bit-7~bit-4) data will be transferred first through data pins (DB7~DB4). The lower 4 bits (bit-3~bit-0) data will be transferred second through data pins (DB7~DB4). The (DB3~DB0) data pins are not used during 4-bit transfer mode.



Timing Diagram of 8-bit Parallel Bus Mode Data Transfer



Timing Diagram of 4-bit Parallel Bus Mode Data Transfer

12.2 Serial interface

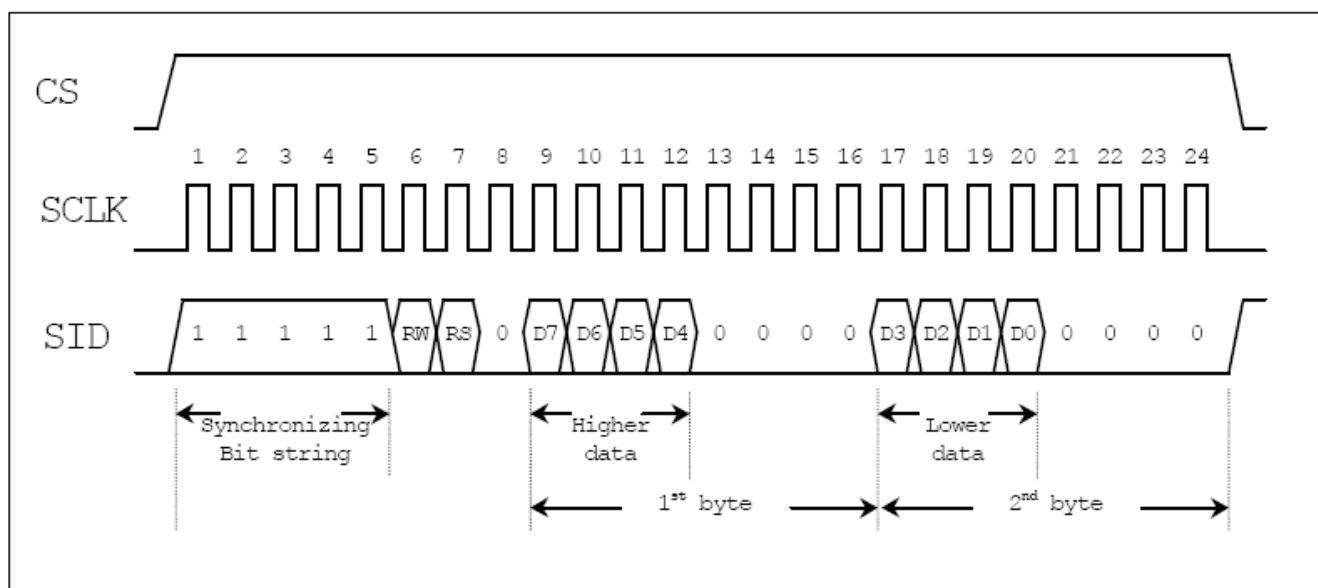
ST7920 is in serial interface mode when pulling down PSB pin. Two pins (SCLK and SID) are used to complete the data transfer. Only write data is available in the serial interface mode.

When connecting several ST7920, chip select (CS) must be used. Only when (CS) is high the serial clock (SCLK) can be accepted. On the other hand, when chip select (CS) is low ST7920 serial counter and data will be reset. Transmission will be terminated and data will be cleared. Serial transfer counter is set to the first bit. For a minimal system with only one ST7920 and one MPU, only SCLK and SID pins are necessary. CS pin should pull to high.

ST7920's serial clock (SCLK) is asynchronous to the internal clock and is generated by MPU. When multiple instruction/data is transferred, the instruction execution time must be considered. MPU must wait till the previous instruction is finished and then send the next instruction. ST7920 has no internal instruction buffer area.

When starting a transmission, a start byte is required. It consists of 5 consecutive "1" (sync character). Serial transfer counter will be reset and synchronized. Followed by 2-bit flag that indicates: read/write (RW) and register/data selected (RS) operation. Last 4 bits are filled by "0".

After receiving the sync character, RW and RS bits, every 8 bits instruction/data will be separated into 2 groups. Higher 4 bits (DB7~DB4) will be placed in the first section followed by 4 "0"s. And lower 4 bits (DB3~DB0) will be placed in the second section followed by 4 "0"s.



Timing Diagram of Serial Mode Data Transfer



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12.3 Display Data RAM (DDRAM)

There are 64x2 bytes RAM spaces for the Display Data RAM. It can store display data such as 16 characters (16x16) by 4 lines or 32 characters (8x16) by 4 lines. However, only 2 character-lines (maximum 32 common outputs) can be displayed at one time. Character codes stored in DDRAM will refer to the fonts specified by CGROM, HCGROM and CGRAM.

ST7920 can display half-width HCGROM fonts, user-defined CGRAM fonts and full 16x16 CGROM fonts. The character codes in 0000H~0006H will use user-defined fonts in CGRAM. The character codes in 02H~7FH will use half-width alpha numeric fonts. The character code larger than A1H will be treated as 16x16 fonts and will be combined with the next byte automatically. The 16x16 BIG5 fonts are stored in A140H~D75FH while the 16x16 GB fonts are stored in A1A0H~F7FFH. In short:

1. To display HCGROM fonts:

Write 2 bytes of data into DDRAM to display two 8x16 fonts. Each byte represents 1 character. The data is among 02H~7FH.

2. To display CGRAM fonts:

Write 2 bytes of data into DDRAM to display one 16x16 font. Only 0000H, 0002H, 0004H and 0006H are acceptable.

3. To display CGROM fonts:

Write 2 bytes of data into DDRAM to display one 16x16 font. A140H~D75FH are BIG5 code, A1A0H~F7FFH are GB code.

The higher byte (D15~D8) is written first and the lower byte (D7~D0) is the next.

CGRAM fonts and CGROM fonts can only be displayed in the start position of each address

80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
S	i	t	r	o	n	i	x	.	.	S	T	7	9	2	0
矽	創	電	子	.	.	中	文	編	碼	(正	確)		
矽	創	電	子	.	.	.	中	文	編	碼					

Table 4

Incorrect start position



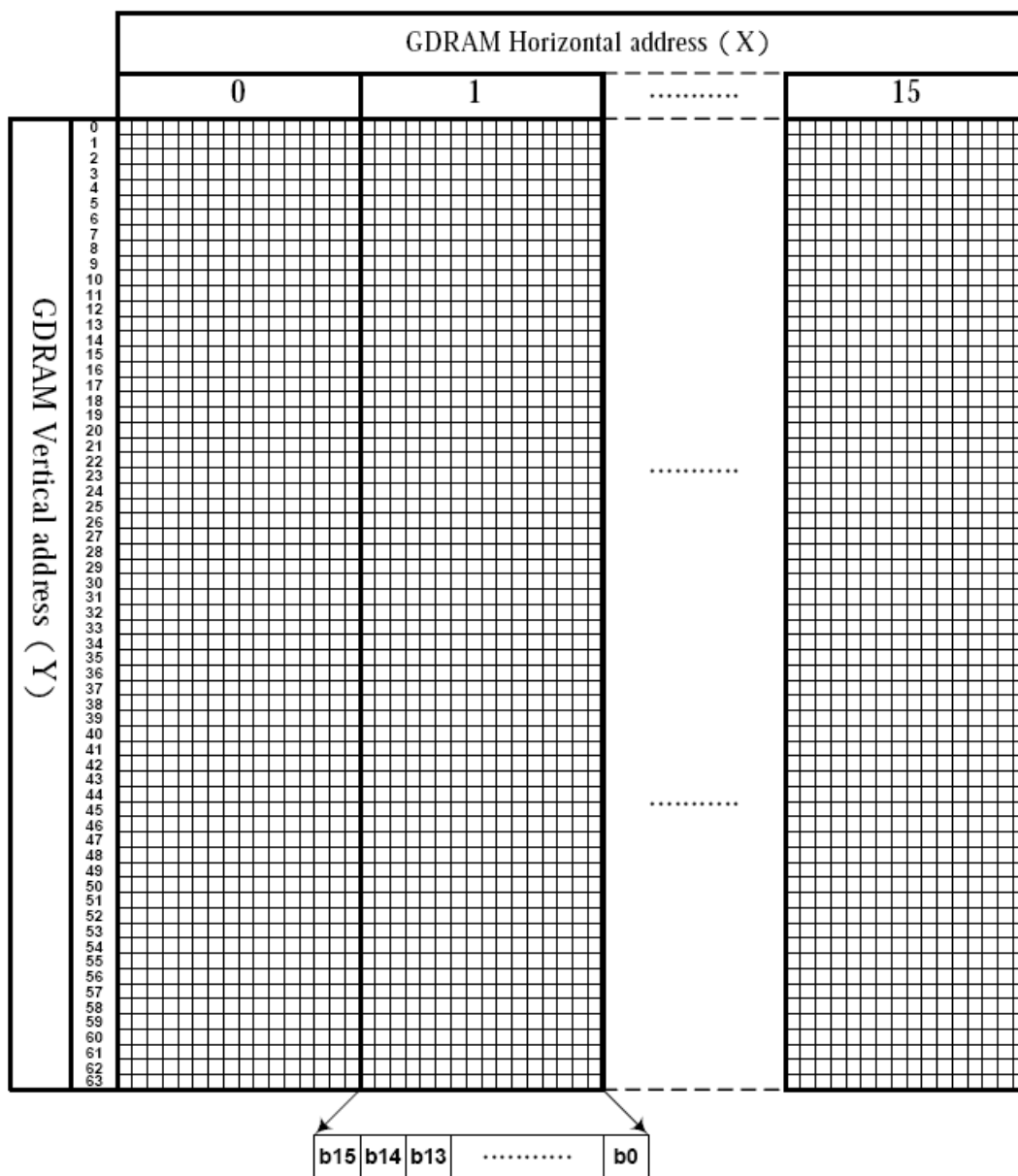
12.4 Graphic RAM (GDRAM)

Graphic Display RAM has 64x256 bits bit-mapped memory space. GDRAM address is set by writing 2 consecutive bytes of vertical address and horizontal address. Two-byte data (16 bits) configures one GDRAM horizontal address.

The Address Counter (AC) will be increased by one automatically after receiving the 16-bit data for the next operation.

After the horizontal address reaching 0FH, the horizontal address will be set to 00H and the vertical address will not change. The procedure is summarized below:

1. Set vertical address (Y) for GDRAM
2. Set horizontal address (X) for GDRAM
3. Write D15~D8 to GDRAM (first byte)
4. Write D7~D0 to GDRAM (second byte)





13.0 INSTRUCTION DESCRIPTION

13.1 INSTRUCTION TABLE

■ Instruction Set 1: (RE=0: Basic Instruction)

Inst.	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Display Clear	0	0	0	0	0	0	0	0	0	1	Fill DDRAM with "20H" and set DDRAM address counter (AC) to "00H".
Return Home	0	0	0	0	0	0	0	0	1	X	Set DDRAM address counter (AC) to "00H", and put cursor to origin ; the content of DDRAM are not changed
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Set cursor position and display shift when doing write or read operation
Display Control	0	0	0	0	0	0	1	D	C	B	D=1: Display ON C=1: Cursor ON B=1: Character Blink ON
Cursor Display Control	0	0	0	0	0	1	S/C	R/L	X	X	Cursor position and display shift control ; the content of DDRAM are not changed
Function Set	0	0	0	0	1	DL	X	0 RE	X	X	DL=1 8-bit interface DL=0 4-bit interface RE=1: extended instruction RE=0: basic instruction
Set CGRAM Address.	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address to address counter (AC) Make sure that in extended instruction SR=0 (scroll or RAM address select)
Set DDRAM Address.	0	0	1	0 AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address to address counter (AC) AC6 is fixed to 0
Read Busy Flag & AC.	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Read busy flag (BF) for completion of internal operation, also Read out the value of address counter (AC)
Write RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data to internal RAM (DDRAM/CGRAM/GDRAM)
Read RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM/GDRAM)



■ Instruction set 2: (RE=1: extended instruction)

Inst.	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Standby	0	0	0	0	0	0	0	0	0	1	Enter standby mode, any other instruction can terminate. COM1...32 are halted.
Scroll or RAM Address. Select	0	0	0	0	0	0	0	0	1	SR	SR=1: enable vertical scroll position SR=0: enable CGRAM address (basic instruction)
Reverse (by line)	0	0	0	0	0	0	0	1	R1	R0	Select 1 out of 4 line (in DDRAM) and decide whether to reverse the display by toggling this instruction R1,R0 initial value is 0,0
Extended Function Set	0	0	0	0	1	DL	X	1 RE	G	0	DL=1 :8-bit interface DL=0 :4-bit interface RE=1: extended instruction set RE=0: basic instruction set G=1 :graphic display ON G=0 :graphic display OFF
Set Scroll Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	SR=1: AC5~AC0 the address of vertical scroll
Set Graphic Display RAM Address	0	0	1	0 0	0 AC5	0 AC4	AC3 AC3	AC2 AC2	AC1 AC1	AC0 AC0	Set GDRAM address to address counter (AC) Set the vertical address first and followed the horizontal address by consecutive writings Vertical address range: AC5...AC0 Horizontal address range: AC3...AC0

Note:

1. Make sure that ST7920 is not in busy state by reading the busy flag before sending instruction or data. If using delay loop instead, please make sure the delay time is enough. Please refer to the instruction execution time.
2. "RE" is the selection bit of basic and extended instruction set. After setting the RE bit, the value will be kept. So that the software doesn't have to set RE every time when using the same instruction set



■ Initial Setting (Register flag) (RE=0: basic instruction)

Inst.	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Entry Mode Set	0	0	0	0	0	0	0	0	0	1	Cursor move to right ,DDRAM address counter (AC) plus 1
									1	0	
Display Control	0	0	0	0	0	0	1	D	C	B	Display, cursor and blink are ALL OFF
								0	0	0	
Cursor Display Control	0	0	0	0	0	1	S/C	R/L	X	X	No cursor or display shift operation
							X	X			
Function Set	0	0	0	0	1	DL	X	0 RE	X	X	8-bit MPU interface , basic instruction set
						1		0			

■ Initial Setting (Register flag) (RE=1: extended instruction set)

Inst.	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
Scroll or RAM Address. Select	0	0	0	0	0	0	0	0	1	SR	Allow IRAM address or set CGRAM address
										0	
Reverse	0	0	0	0	0	0	0	1	R1	R0	Begin with normal and toggle to reverse
									0	0	
Extended Function Set	0	0	0	0	1	DL	X	1 RE	G	0	Graphic display OFF
									0		



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13.2 DESCRIPTION OF INSTRUCTION

1) Display Clear

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

This instruction will change the following items:

1. Fill DDRAM with "20H"(space code).
2. Set DDRAM address counter (AC) to"00H".
3. Set Entry Mode I/D bit to be "1". Cursor moves right and AC adds 1 after write or read operation.

2) Return Home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	X

Set address counter (AC) to "00H". Cursor moves to origin. Then content of DDRAM is not changed.

3) Entry Mode Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	S

Set the cursor movement and display shift direction when doing write or read operation.

I/D: Address Counter Control: (Increase/Decrease)

When I/D = "1", cursor moves right, address counter (AC) is increased by 1.

When I/D = "0", cursor moves left, address counter (AC) is decreased by 1.

S: Display Shift Control: (Shift Left/Right)

S	I/D	DESCRIPTION
H	H	Entire display shift left by 1
H	L	Entire display shift right by 1

4) Display Control

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Controls display, cursor and blink ON/OFF.

D: Display ON/OFF control bit



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When D = "1", display ON

When D = "0", display OFF, the content of DDRAM is not changed

C: Cursor ON/OFF control bit

When C = "1", cursor ON.

When C = "0", cursor OFF.

B: Character Blink ON/OFF control bit

When B = "1", cursor position blink ON. Then display data (character) in cursor position will blink.

When B = "0", cursor position blink OFF

5) Cursor/Display Shift Control

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	X	X

This instruction configures the cursor moving direction or the display shifting direction. The content of DDRAM is not changed.

S/C	R/L	Description	AC Value
L	L	Cursor moves left by 1 position	AC=AC-1
L	H	Cursor moves right by 1 position	AC=AC+1
H	L	Display shift left by 1, cursor also follows to shift.	AC=AC
H	H	Display shift right by 1, cursor also follows to shift.	AC=AC

6) Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	X	RE	X	X

DL: 4/8-bit interface control bit

When DL = "1", 8-bit MPU bus interface

When DL = "0", 4-bit MPU bus interface

RE: extended instruction set control bit

When RE = "1", extended instruction set

When RE = "0", basic instruction set

In same instruction cannot alter DL and RE at once. Make sure that change DL first then

RE

7) Set CGRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address into address counter (AC)



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AC range is 00H...3FH

Make sure that in extended instruction SR=0 (scroll address or RAM address select)

8) Set DDRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address into address counter (AC).

First line AC range is 80H...87H

Second line AC range is 90H...97H

Third line AC range is 88H...8FH

Fourth line AC range is 98H...9FH

9) Read Busy Flag (BF) and Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Read busy flag (BF) can check whether the internal operation is finished or not. At the same time, the value of address counter (AC) is also read. When BF = "1", further instruction(s) will not be accepted until BF = "0".

10) Write Data to RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write data to the internal RAM and increase/decrease the (AC) by 1

Each RAM address (CGRAM, DDRAM and GDRAM...) must write 2 consecutive bytes for 16-bit data. After receiving the second byte, the address counter will increase or decrease by 1 according to the entry mode set control bit.

11) Read RAM Data

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read data from the internal RAM and increase/decrease the (AC) by 1

After the operation mode changed to Read (CGRAM, DDRAM and GDRAM...), a "Dummy Read" is required.

There is no need to add a "Dummy Read" for the following bytes unless a new address set instruction is issued.



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12) Standby

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

This Instruction will set ST7920 entering the standby mode. Any other instruction follows this instruction will terminate the standby mode.

The content of DDRAM remains the same.

13) Vertical Scroll or RAM Address Select

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	SR

When SR = "1", the Vertical Scroll mode is enabled.

When SR = "0", "Set CGRAM Address" instruction (**basic instruction**) is enabled.

14) Reverse

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	R1	R0

Select 1 out of 4 lines to reverse the display and to toggle the reverse condition by repeating this instruction.

R1, R0 initial vale is 00. The first time issuing this instruction, the display will be reversed while the second time will return the display become normal.

R1	R0	Description
L	L	First line normal or reverse
L	H	Second line normal or reverse
H	L	Third line normal or reverse
H	H	Fourth line normal or reverse

15) Extended Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	X	RE	G	0

DL: 4/8-bit interface control bit

When DL = "1", 8-bit MPU interface.

When DL = "0", 4-bit MPU interface.

RE: extended instruction set control bit



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When RE = "1", extended instruction set

When RE = "0", basic instruction set

G: Graphic display control bit

When G = "1", Graphic Display ON

When G = "0", Graphic Display OFF

In same instruction cannot alter DL, RE and G at once. Make sure that change DL or G first and then RE.

16) Set Scroll Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

SR=1: AC5~AC0 is vertical scroll displacement address

17) Set Graphic RAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	AC5	AC4	AC3	AC2	AC1	AC0

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	0	0	AC3	AC2	AC1	AC0

Set GDRAM address into address counter (AC). This is a 2-byte instruction.


The first instruction sets the vertical address while the second one sets the horizontal address (write 2 consecutive bytes to complete the vertical and horizontal address setting).

Vertical address range is AC5...AC0

Horizontal address range is AC3...AC0

The address counter (AC) of graphic RAM (GRAM) will be increased automatically after the vertical and horizontal addresses are set. After horizontal address is increased upto 0FH, it will automatically return to 00H.

However, the vertical address will not increase as the result of the same action.

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14.0 QUALITY GUARANTEE

14.1 ACCEPTABLE QUALITY LEVEL

Inspection items	Sampling procedures	AQL
Visual-operating (Electro-optical)	GB2828-81 Inspection level II Normal inspection Single sample inspection	0.65
Visual-not operating	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5
Dimension measurement	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5

14.2 Conditions of Cosmetic Inspection

- Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

- Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

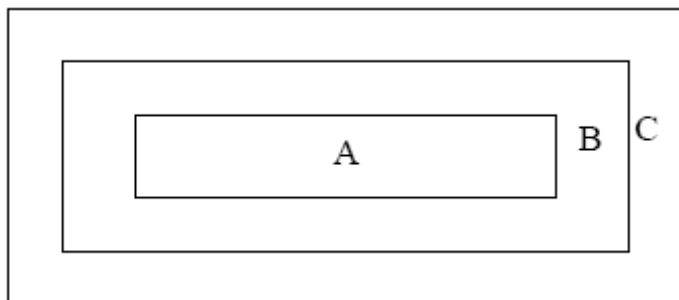
The V0 value which the most optimal contrast can be obtained near the specified V0 in the specification. (Within ±0.5V of the typical value at 25°C.).

14.3 Definition of inspection zone in LCD


Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA + ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)



Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

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14.4 Inspection Standard

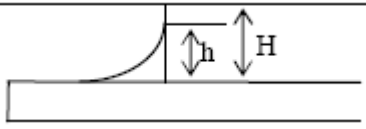
● Major Defect

Item No	Items to be inspected	Inspection Standard	Classification of defects
1	All functional defects	1) No display 2) Display abnormally 3) Missing vertical, horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting.	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	

● Module Cosmetic Criteria

No.	Item	Judgment Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil ($\varnothing 0.5\text{mm}$ or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed $\varnothing 0.2\text{mm}$)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	1. Solder amount Lead parts	a. Soldering side of PCB Solder to form a 'Filet' all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of 'Through Hole PCB') Solder to reach the Components side of PCB.	Minor
	2. Flat packages	Either 'Toe' (A) or 'Seal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder.	

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No.	Item	Judgment Criterion	Partition
8	3. Chips	$(3/2) H \geq h \geq (1/2) H$ 	Minor

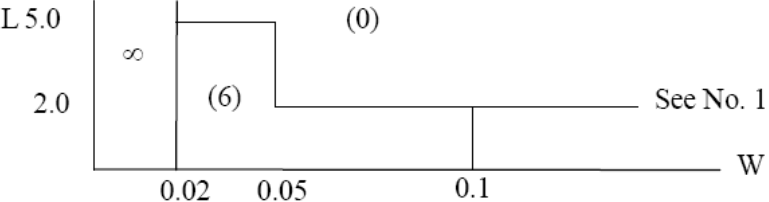
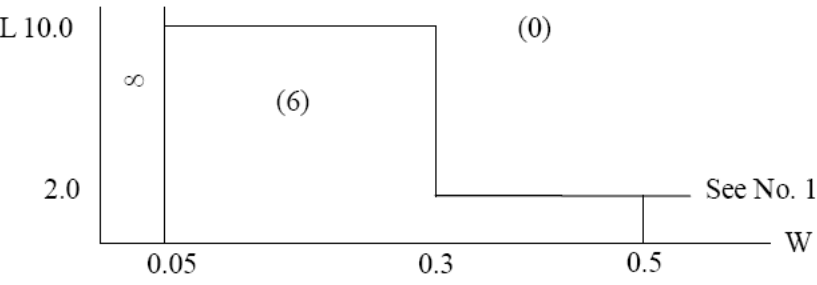
● **Screen Cosmetic Criteria (Non-Operating)**

No.	Defect	Judgment Criterion	Partition															
1	Spots	In accordance with <i>Screen Cosmetic Criteria (Operating) No.1.</i>	Minor															
2	Lines	In accordance with <i>Screen Cosmetic Criteria (Operating) No.2.</i>	Minor															
3	Bubbles in polarizer	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size : d</th> <th>mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>d</td> <td>≤ 0.3</td> <td>Disregard</td> </tr> <tr> <td>0.3 < d</td> <td>≤ 1.0</td> <td>3</td> </tr> <tr> <td>1.0 < d</td> <td>≤ 1.5</td> <td>1</td> </tr> <tr> <td>1.5 < d</td> <td></td> <td>0</td> </tr> </tbody> </table>	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
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																
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor															
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor															
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor															
7	Contamination	Not to be noticeable.	Minor															

Note: Size : d = (long length + short length) / 2

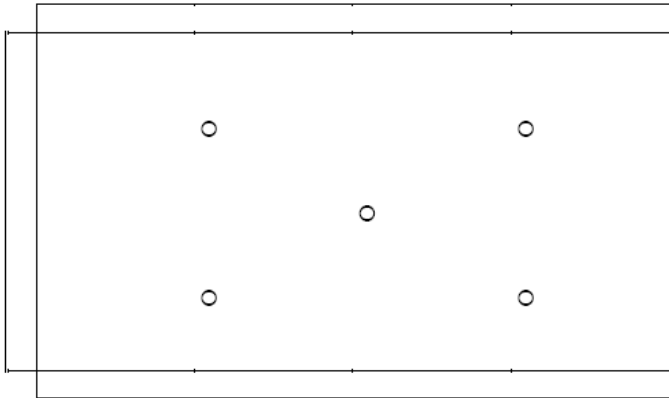


● Screen Cosmetic Criteria (Operating)

No.	Defect	Judgment Criterion	Partition																				
1	Spots	<p>A) Clear</p> <table border="1" data-bbox="421 443 1197 654"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>$d \leq 0.1$</td> <td>Disregard</td> </tr> <tr> <td>$0.1 < d \leq 0.2$</td> <td>6</td> </tr> <tr> <td>$0.2 < d \leq 0.3$</td> <td>2</td> </tr> <tr> <td>$0.3 < d$</td> <td>0</td> </tr> </tbody> </table> <p>Note : Including pin holes and defective dots which must be within one pixel size.</p> <p>B) Unclear</p> <table border="1" data-bbox="421 779 1197 990"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>$d \leq 0.2$</td> <td>Disregard</td> </tr> <tr> <td>$0.2 < d \leq 0.5$</td> <td>6</td> </tr> <tr> <td>$0.5 < d \leq 0.7$</td> <td>2</td> </tr> <tr> <td>$0.7 < d$</td> <td>0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	$d \leq 0.1$	Disregard	$0.1 < d \leq 0.2$	6	$0.2 < d \leq 0.3$	2	$0.3 < d$	0	Size : d mm	Acceptable Qty in active area	$d \leq 0.2$	Disregard	$0.2 < d \leq 0.5$	6	$0.5 < d \leq 0.7$	2	$0.7 < d$	0	Minor
Size : d mm	Acceptable Qty in active area																						
$d \leq 0.1$	Disregard																						
$0.1 < d \leq 0.2$	6																						
$0.2 < d \leq 0.3$	2																						
$0.3 < d$	0																						
Size : d mm	Acceptable Qty in active area																						
$d \leq 0.2$	Disregard																						
$0.2 < d \leq 0.5$	6																						
$0.5 < d \leq 0.7$	2																						
$0.7 < d$	0																						
2	Lines	<p>A) Clear</p>  <p>Note :</p> <ul style="list-style-type: none"> () - Acceptable Qty in active area L - Length (mm) W - Width (mm) ∞ - Disregard <p>B) Unclear</p>  <p>‘Clear’ = The shade and size are not changed by Vop. ‘Unclear’ = The shade and size are changed by Vop.</p>	Minor																				


Note: Size : d = (long length + short length) / 2

● Screen Cosmetic Criteria (Operating) (Continued)

No.	Defect	Judgment Criterion	Partition
3	Rubbing line	Not to be noticeable.	Minor
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as pot'. (see <i>Screen Cosmetic Criteria (Operating) No.1</i>)	Minor
7	Uneven brightness (only back-lit type module)	<p>Uneven brightness must be $B_{MAX} / B_{MIN} \leq 2$</p> <ul style="list-style-type: none"> - B_{MAX} : Max. value by measure in 5 points - B_{MIN} : Min. value by measure in 5 points <p>Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.</p>  <p>○ : Measuring points</p>	Minor

Note :


- (1) The limit samples for each item have priority.
- (2) Complex defects are defined item by item, but if the numbers of defects are defined in above table, the total number should not exceed 10.
- (3) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.
 - 7 or over defects in circle of $\varnothing 5\text{mm}$.
 - 10 or over defects in circle of $\varnothing 10\text{mm}$.
 - 20 or over defects in circle of $\varnothing 20\text{mm}$.

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15.0 RELIABILITY

15.1 Content of Reliability Test

No.	Test Item	Test Condition	Inspection after test
1	High Temperature Storage	+80°C±2°C/200 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1. Air bubble in the LCD; 2. Sealleak; 3. Non-display; 4. missing segments; 5. Glass crack; 6. Current Idd is twice higher than initial value.
2	Low Temperature Storage	-30°C±2°C/200 hours	
3	High Temperature Operating	+70°C±2°C/120 hours	
4	Low Temperature Operating	-20°C±2°C/120 hours	
5	Temperature Cycle	-20°C±2°C~25~+70°C±2°C×10cycles (30min.) (5min.) (30min.)	
6	High Temperature / Humidity operation	50°C±5°C×90%RH/120 hours	
7	Vibration Test	Frequency : 10Hz~55Hz~10Hz Amplitude: 1.5mm, X, Y, Z direction for total 3hours (Packing condition)	
8	Drooping test	Drop to the ground from 1m height, one time, and every side of carton. (Packing condition)	
9	Static electricity test	Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time	
Remark: 1. The test samples should be applied to only one test item. 2. Sample size for each test item is 5~10pcs. 3. For Damp Proof Test, Pure water(Resistance> 10MΩ) should be used. 4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part. 5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has. 6. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.			

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16.0 PRECAUTIONS FOR USING LCD MODULES

16.1 Handling Precautions

(1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :

- Isopropyl alcohol
- Ethyl alcohol

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.


(11) If the logic circuit power is off, do not apply the input signals.

(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

16.2 Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below 0°C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

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16.3 Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

17.0 USING LCD MODULES

17.1 About Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizer and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

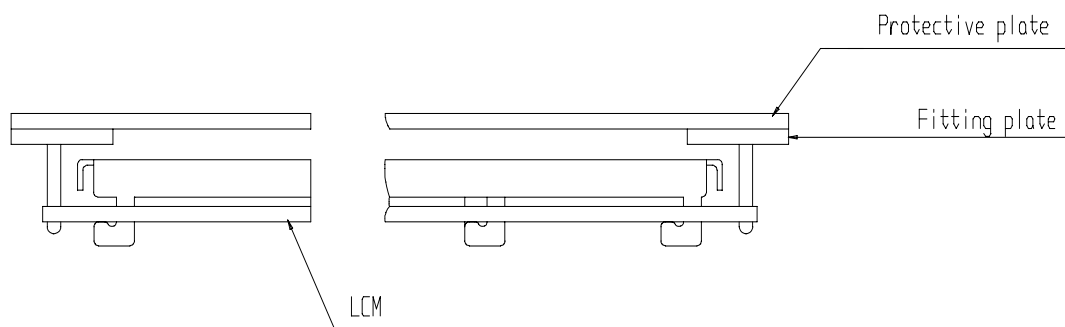
(9) Do not touch the display with bare hands. This will stain the display area and degradate insulation between terminals (some cosmetics are determinate to the polarizer).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.


17.2 Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the

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individual specifications for measurements. The measurement tolerance should be ± 0.1 mm.

17.3 Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

- (1) Make certain that you are grounded when handing LCM.
- (2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.
- (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.
- (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutation of the motor.
- (5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.
- (6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

17.4 Soldering to the LCM

- (1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.
 - Soldering iron temperature : $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$.
 - Soldering time : 3-4 sec.
 - Solder : eutectic solder.

If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

- (2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.
- (3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

17.5 Operation

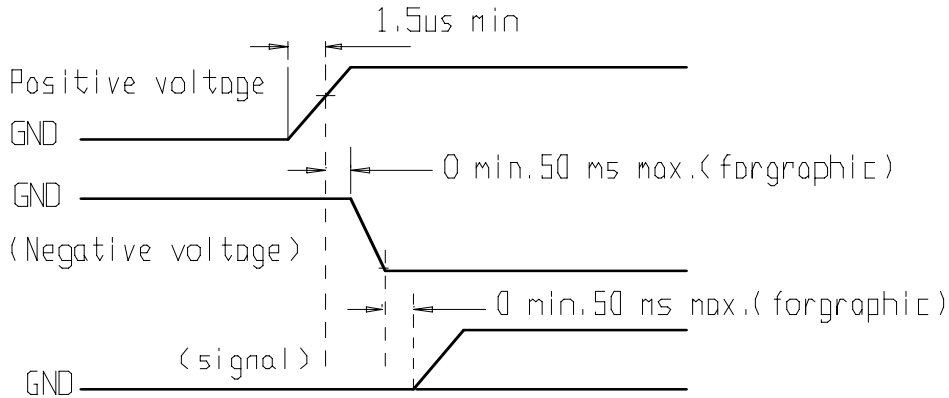
- (1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.
- (2) Driving the LCD in the voltage above the limit shortens its life.
- (3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.
- (4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.



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(5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it must be used under the relative condition of 40°C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.



17.6 Storage

When storing LCDs as spares for some years, the following precaution are necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for desiccant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

(4) Environmental conditions :

- Do not leave them for more than 168hrs. at 60°C.
- Should not be left for more than 48hrs. at -20°C.


17.7 Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

17.8 Limited Warranty

Unless agreed between HYDISPLAY and customer, HYDISPLAY will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with HYDISPLAY LCD/LCM acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to HYDISPLAY within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of HYDISPLAY limited to repair and/or replacement on the terms set forth above. HYDISPLAY will not be responsible for any subsequent or consequential events.


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17.9 Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

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18.0 APPENDIX

18.1 Initialization Code

```
//Write Instruction Code
#pragma disable
void wr_cmd(uchar cmd)
{
    LCD_E = 0;

    LCD_RS=0;

    LCD_RW=0;

    LCD_E=1;

    DataPort=cmd;

    LCD_E=0;

    delay(5);
}
```

```
//Write Display RAM Data
#pragma disable
void wr_dat(uchar dat)
{
    LCD_E = 0;

    LCD_RS=1;

    LCD_RW=0;

    LCD_E=1;

    DataPort=dat;

    LCD_E=0;

    delay(5);
}
```



/Display Control Setup

#pragma disable

void Initialization(void)

```

{
    wr_cmd(0x30); //DL=1:8-BIT interface
    wr_cmd(0x30); //RE=0:basic instruction
    wr_cmd(0x06); //Entire display shift right by 1
    wr_cmd(0x08); //Display OFF,Cursor OFF,Cursor position blink OFF
    wr_cmd(0x01); //CLEAR DDRAM
    delay(250);

    wr_cmd(0x34); //DL=1:8-BIT interface
    wr_cmd(0x34); //RE=0:Extend instruction
    wr_cmd(0x03);
}

```

18.2 LCM Application Circuit Diagram

