



SPECIFICATIONS

CUSTOMER : _____

SAMPLE CODE : _____

(This Code will be changed while mass production)

MASS PRODUCTION CODE : **PG9832LRS-ANN-H
(VER.0)**

Customer Approved

Date:

Sales Sign	QC Confirmed	Checked By	Designer
		Tom 2003/08/03 Newberry's 2003/08/03	郭曉琴 2003/08/03

Approval For Specifications Only.

* This specification is subject to change without notice.

Please contact Powertip or it's representative before designing your product based on this specification.

Approval For Specifications and Sample.

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Note : For detailed information please refer to IC data sheet : [SED1520](#)

1. SPECIFICATIONS

1.1 Features

Item	Standard Value
Display Type	98 * 32 dots
LCD Type	STN, GRAY, Transflective, Positive, Extended Temp.
Driver Condition	1/32 Duty , 1/6 Bias
Viewing Direction	6O' clock
Backlight	YG LED B/L
Weight	28.0 g
Interface	-
Other	-

1.2 Mechanical Specifications

Item	Standard Value	Unit
Outline Dimension	52.0(L) * 44.0(w) * 13.5(H)(Max)	mm
Viewing Area	46.0(L) * 18.5(w)	mm
Active Area	43.08(L) * 15.64(w)	mm
Dot Size	0.40(L) * 0.45(w)	mm
Dot Pitch	0.44(L) * 0.49(w)	mm

Note : For detailed information please refer to LCM drawing

1.3 Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V _{DD}	-	-0.3	8.0	V
LCD Driver Supply Voltage	V _{DD} -V _{EE}	-	-0.3	16.5	V
Input Voltage	V _{IN}	-	-0.3	V _{DD} +0.3	V
Operating Temperature	T _{OP}	Excluded B/L	-20	70	
Storage Temperature	T _{ST}	Excluded B/L	-30	80	
Storage Humidity	H _D	T _a < 40	-	90	%RH

1.4 DC Electrical Characteristics

$V_{DD} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = 0\text{V}$, $T_a = 25$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic Supply Voltage	V_{DD}	-	4.5	5.0	5.5	V
“H” Input Voltage	V_{IH}	-	$V_{DD}+0.2$	-	V_{DD}	V
“L” Input Voltage	V_{IL}	-	V_{SS}	-	$V_{DD}+0.8$	V
“H” Output Voltage	V_{OH}	-	$V_{DD}+2.4$	-	-	V
“L” Output Voltage	V_{OL}	-	-	-	$V_{DD}+2.4$	V
Supply Current	I_{DD}	$V_{DD} = 5.0 \text{ V}$ $f_{OSC}=3.0\text{MHz}$	-	0.5	-	mA
LCM Driver Voltage	V_{OP}	$V_{DD} - V_O (-20^\circ\text{C})$	-	-	-	V
		$V_{DD} - V_O (25^\circ\text{C})$	-	6.5	-	
		$V_{DD} - V_O (70^\circ\text{C})$	-	-	-	

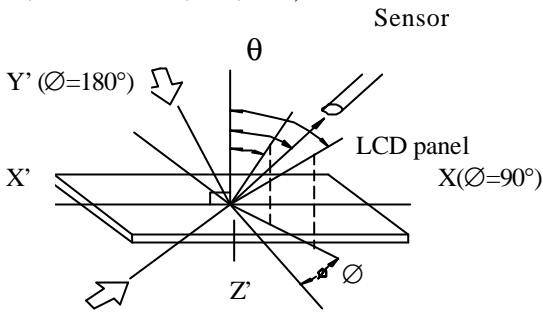
1.5 Optical Characteristics

LCD Panel : 1/64 Duty , 1/6 Bias , $V_{LCD} = 6.36\text{V}$, $T_a = 25$

Item	Symbol	Conditions	Min.	Typ.	Max.	Reference
View Angle	θ	$C \geq 2.0$, $\varnothing = 0^\circ$	40°	-	-	Notes 1 & 2
Contrast Ratio	C	$\theta = 5^\circ$, $\varnothing = 0^\circ$	5	7	-	Note 3
Response Time(rise)	t_r	$\theta = 5^\circ$, $\varnothing = 0^\circ$	-	150ms	-	Note 4
Response Time(fall)	t_f	$\theta = 5^\circ$, $\varnothing = 0^\circ$	-	280 ms	-	Note 4

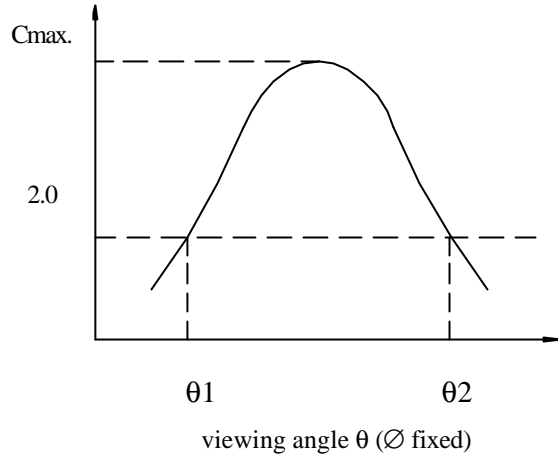
Note 1: Definition of angles θ and \varnothing

Light (when reflected) $z (\theta=0^\circ)$



Light (when transmitted) $Y (\varnothing=0^\circ)$
 $(\theta=90^\circ)$

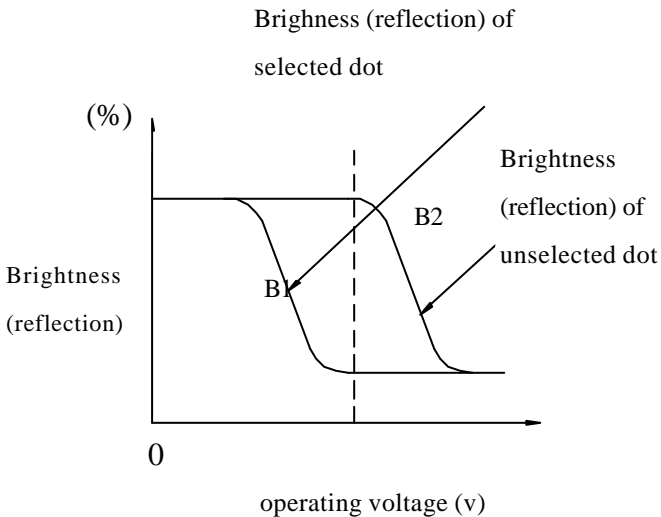
Note 2: Definition of viewing angles θ_1 and θ_2



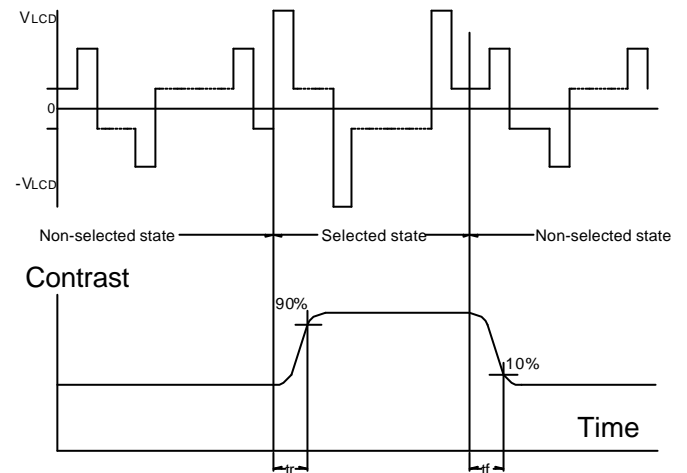
Note : Optimum viewing angle with the naked eye and viewing angle θ at C_{max} . Above are not always the same

Note 3: Definition of contrast C

$$C = \frac{\text{Brightness (reflection) of unselected dot (B2)}}{\text{Brightness (reflection) of selected dot (B1)}}$$



Note 4: Definition of response time



Note: Measured with a transmissive LCD panel which is displayed 1 cm^2

V_{LCD} : Operating voltage f_{FRM} : Frame frequency
 t_r : Response time (rise) t_f : Response time (fall)

1.6 Backlight Characteristics

LCD Module with LED Backlight

Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Forward Current	IF	Ta =25	-	300	mA
Reverse Voltage	VR	Ta =25	-	8	V
Power Dissipation	PO	Ta =25	-	1.38	W
Operating Temperature	T _{OP}	-	-20	70	
Storage Temperature	T _{ST}	-	-30	80	
Solder Temp. for 3 Second	-	-	-	260	

Electrical / Optical Characteristics

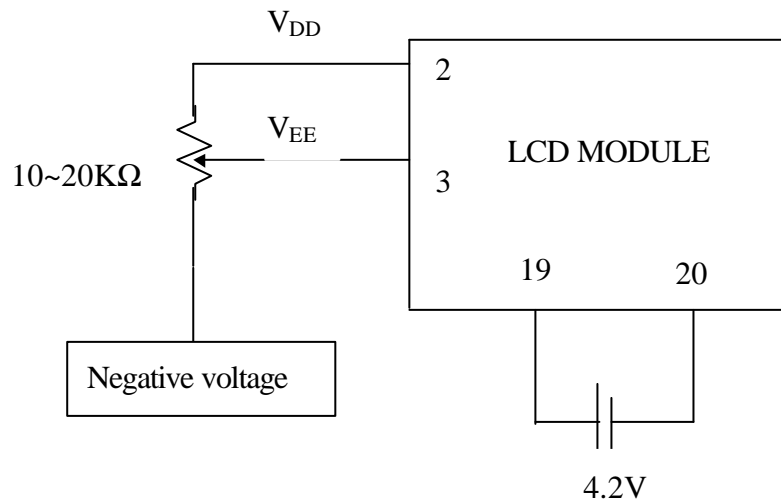
Ta =25

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward Voltage	VF	IF= 120 mA	3.8	4.2	4.6	V
Reverse Current	IR	VR= 8 V	-	-	0.2	mA
Average Brightness (with LCD)	IV	IF= 120 mA	-	-	-	cd/m ²
Wavelength	p	IF= 120 mA	571	-	576	nm
Luminous Intensity (without LCD)	IV	IF=120 mA	200	250	-	cd/m ²
Color	Yellow-green					

2.2 Interface Pin Description

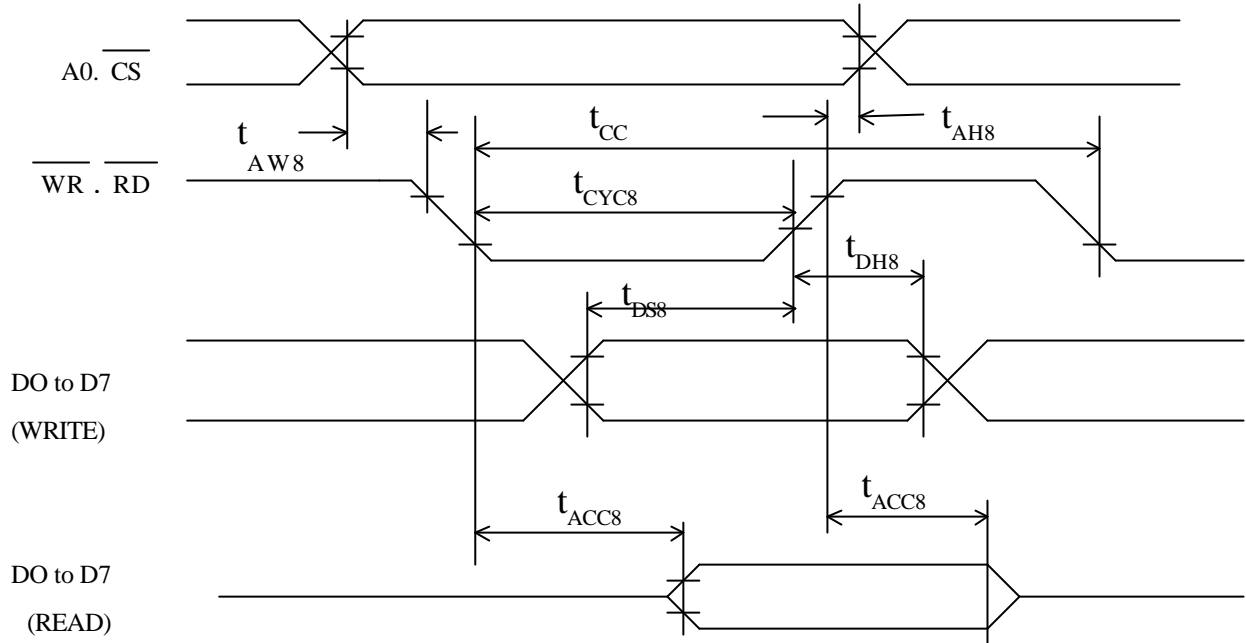
Pin No	Symbol	Function
1	VSS	Power Supply ($V_{SS}=0$)
2	VDD	Power Supply ($V_{DD}>V_{SS}$)
3	$V_{EE}(V_O)$	Operating voltage for LCD (variable)
4	A0	“L” is instruction “H” is data
5	CS1	Chip enable active “L”, segment 0~segment 61
6	CS2	Chip Enable active “L”, segment 62~segment 98
7	CL	Clock input 2KHZ
8	$\overline{/CS(E)}$	Data read (68-family MPU : Enable Signal)
9	$\overline{/WR(R/W)}$	Data write (68-family MPU : Data read and write)
10-13	DB0~DB3	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCD module. These four are not used during 4-bit operation.
14-17	DB4~DB7	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCD module. DB7 can be used as a busy flag.
18	\overline{RES}	Reset the system
19	A	Power supply for LED backlight (+)
20	K	Power supply for LED backlight (-)

Contrast Adjust

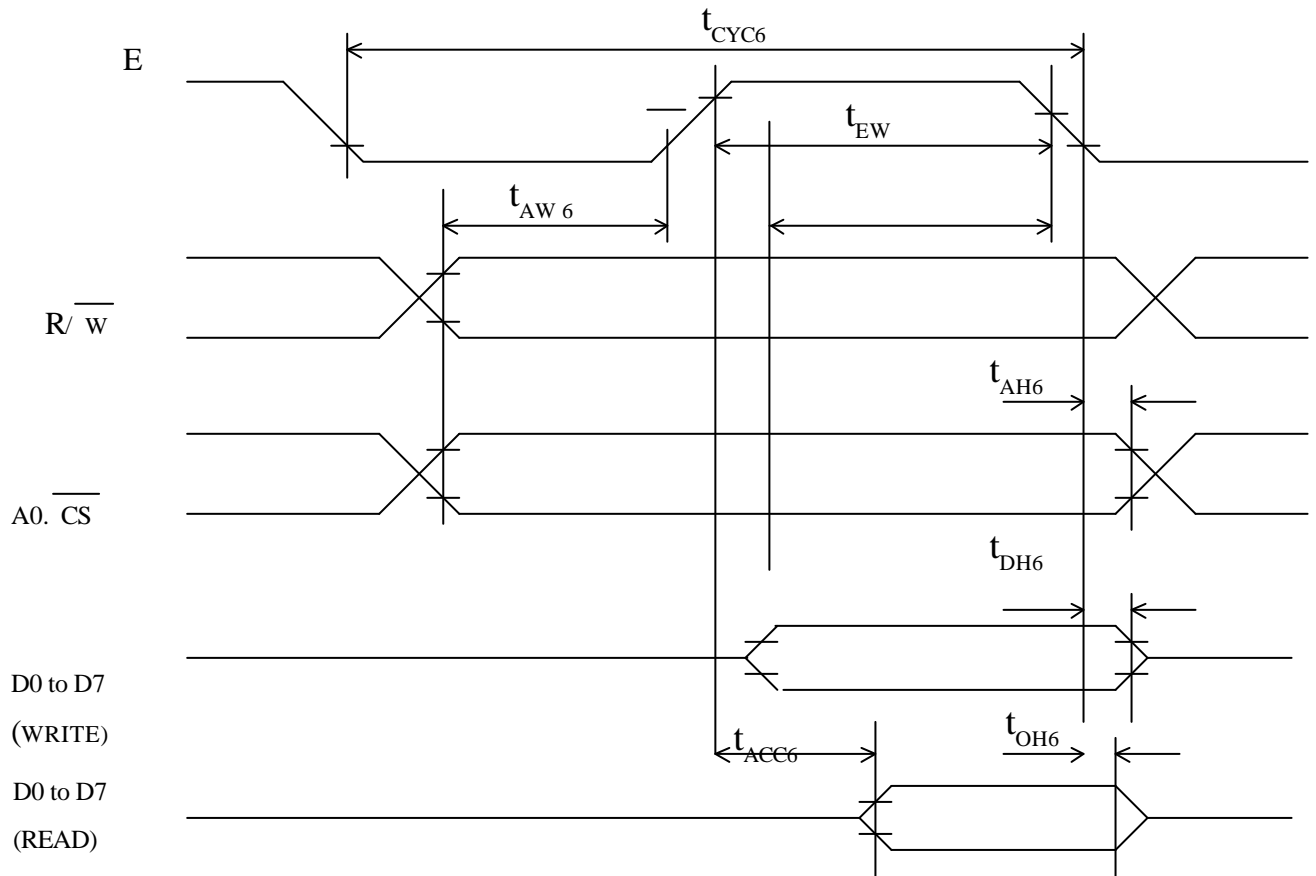


2.3 Timing Characteristics

• MPU Bus Read/Write I (80-family MPU)



• MPU Bus Read/Write II (68-family MPU)



•MPU Bus Read/Write I (80-family MPU)

VDD=+5V±10%, VSS=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
Address hold time	tAH8	-	10	-	ns
Address setup time	tAW8	-	20	-	ns
System cycle time	tCYC8	-	1000	-	ns
Control pulse width	tCC	-	200	-	ns
Data setup time	tDS8	-	80	-	ns
Data hold time	tDH8	-	10	-	ns
RD access time	tACC8	CL=100 PF	-	90	ns
Output disable time	tCH8		10	60	ns

•MPU Bus Read/Write II (68-family MPU)

VDD=+5V±10%, VSS=0V, Ta=25°C

Item	Symbol	Conditions	Min.	Max.	Unit
System cycle time	tcyc6	-	1000	-	ns
Address setup time	tAW6	-	20	-	ns
Address hold time	tAH6	-	10	-	ns
Data hold time	tDS6	-	80	-	ns
Data hold time	tDH6	-	10	-	ns
Output disable time	tOH6	CL=100 PF	10	60	ns
Access time	tACC6		-	90	ns
Enable pulse width	Read	tEW	-	100	ns
	Write		-	80	ns

2.4 Display Command Summary

Command	Code											Function
	A0	\overline{RD}	\overline{WR}	D7	D6	D5	D4	D3	D2	D1	D0	
Display On/Off	0	1	0	1	0	1	0	1	1	1	0/1	Turns display on or off. 1: ON, 0:OFF
Display start line	0	1	0	1	1	0	Display start address(o to 31)					Specifies RAM line corresponding to top line of display.
Set page address	0	1	0	1	0	1	1	1	0	Page(o to 3)		Set s display RAM page in page address register.
Set column (segment) address	0	1	0	0	Column address (o to 79)							Sets display RAM column address in column address register.
Read status	0	0	1	Busy	ADC	ON/OFF	Reset	0	0	0	0	Reads the following status: BUSY 1: Busy 0: Ready ADC 1: CW output 0: CCW output ON/OFF 1: Display off 0: Display on RESET 1: Being reset 0: Normal
Write display data	1	1	0	Write data							Write data from data bus into display RAM.	

Read display data	1	0	1	Read data								Reads data from display RAM onto data bus.
Select ADC	0	1	0	1	0	1	0	0	0	0	0/1	0: CW output, 1:CCW output
Statis drive ON/OFF	0	1	0	1	0	1	0	0	1	0	0/1	Selects static driving operation. 1:static drive, 0: Normal driving
Select duty	0	1	0	1	0	1	0	1	0	0	0/1	Selects LCD duty cycle 1: 1/32, 0: 1/16
Read-Modify-Write	0	1	0	1	1	1	0	0	0	0	0	Read-modify-write ON
End	0	1	0	1	1	1	0	1	1	1	0	Read-modify-write OFF
Reset	0	1	0	1	1	1	0	0	0	1	0	Software reset

Command description

Table 3 is the command table. The SED1520 series identifies a data bus using a combination of A0 and $\overline{R/\overline{W}}$ (RD or \overline{WR}) signals. As the MPU translates a command in the internal timing only (independent from the external clock). Its speed is very high. The busy check is usually not required.

Display ON/OFF

A0	\overline{RD}	$\overline{R/\overline{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	0	1	0	1	1	1	D	AEH , AFH

This command turns the display on and off.

- D=1: Display ON
- D=0: Display OFF

Display Start Line

This command specifies the line address shown if Figure 3 and indicates the display line that corresponds to COM0.

The display area begins at the specified line address and continues in the line address increment direction. This area having the number of lines of the specified display duty is displayed. If the line address is changed dynamically by this command the vertical smooth scrolling and paging can be used.

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	1	0	A4	A3	A2	A1	A0	C0H to DFH

This command loads the display start line register.

A4	A3	A2	A1	A0	Line Address
0	0	0	0	0	0
0	0	0	0	1	1
		:			:
		:			:
1	1	1	1	1	31

See Figure 2.

Set Page Address

This command specifies the page address that corresponds to the low address of the display data RAM when it is accessed by the MPU. Any bit of the display data RAM can be accessed when its page address and column address are specified. The display status is not changed even when the page address is changed.

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	0	1	1	1	0	A1	A0	B8H to BBH

This command loads the page address register.

A1	A0	Page
0	0	0
0	1	1
1	0	2
1	1	3

Set column Address

This command specifies a column address of the display data RAM. When the display data RAM is accessed by the MPU continuously, the column address is incremented by 1 each time it is accessed from the set address. Therefore, the MPU can access to data continuously. The column address stops to be incremented at address 80, and the page address is not changed continuously.

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	0	A6	A5	A4	A3	A2	A1	A0	00H to 4FH

This command loads the column address register.

A6	A5	A4	A3	A2	A1	A0	Line Address
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
			:				:
			:				:
1	0	0	1	1	1	1	79

Read Status

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0
0	0	1	BUS Y	ADC	ON/O F	RESE T	0	0	0	0

Reading the command I/O register (A0=0) yields system status information.

- The busy bit indicates whether the driver will accept a command or not.
 Busy=1: The driver is currently executing a command or is resetting. No new command will be accepted.
 Busy=0: The driver will accept a new command.
- The ACD bit indicates the way column addresses are assigned to segment drivers.
 ADC=1: Normal. Column address n → segment driver n.
 ADC=0: Inverted. Column address 79-u → segment driver u.

- The ON/OFF bit indicates the current status of the display.
It is the inverse of the polarity of the display ON/OFF command.

ON/OFF=1: Display OFF

ON/OFF=0: Display ON

- The RESET bit indicates whether the driver is executing a hardware or software reset or if it is in normal operating mode.

RESET=1: Currently executing reset command.

RESET=0: Normal operation

Write Display Data

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0
1	1	0	Write data							

Writes 8-bit of data into the display data RAM, at a location specified by the contents of the column address and page address registers and then increments the column address register by one.

Read Display Data

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0
1	0	1	Read data							

Reads 8-bits of data from the data I/O latch, updates the contents of the I/O latch with display data from the display data RAM location specified by the contents of the column address and page address registers and then increments the column address register.

After loading a new address into the column address register one dummy read is required before valid data is obtained.

Select ADC

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	0	1	0	0	0	0	D	A0H, A1H

This command selects the relationship between display data RAM column addresses and segment drivers.

D=1: SEG0 ← column address 4FH,...(inverted)

D=0: SEG0 ← column address 00H,...(normal)

This command is provided to reduce restrictions on the placement of driver ICs and routing of traces during printed circuit board design. See Figure 2 for a table of segments and column addresses for the two values of D.

Static Drive ON/OFF

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	0	1	0	0	1	0	D	A4H, ,A5H

Forces display on and all common outputs to be selected.

D=1: Static drive on

D=0: Static drive off

Select Duty

A0	$\overline{\text{RD}}$	$\text{R}/\overline{\text{W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	0	1	0	1	0	0	D	A8H, ,A9H

This command sets the duty cycle of the LCD drive and is only valid for the SED1520F and SED1522F. it is invalid for the SED1521F which performs passive operation. The duty cycle of the SED1521F is determined

by the externally generated FR signal.

SED1520 SED1522

D=1: 1/32 duty cycle 1/16 duty cycle

D=0: 1/16 duty cycle 1/8 duty cycle

When using the SED1520F0A, SED1522F0A (having a built-in oscillator) and the SED1521F0A continuously, set the duty as follows:

		SED1521FOA
SED1520FOA	1/32	1/32
	1/16	1/16
SED1522FOA	1/16	1/32
	1/8	1/16

Read-Modify-Write

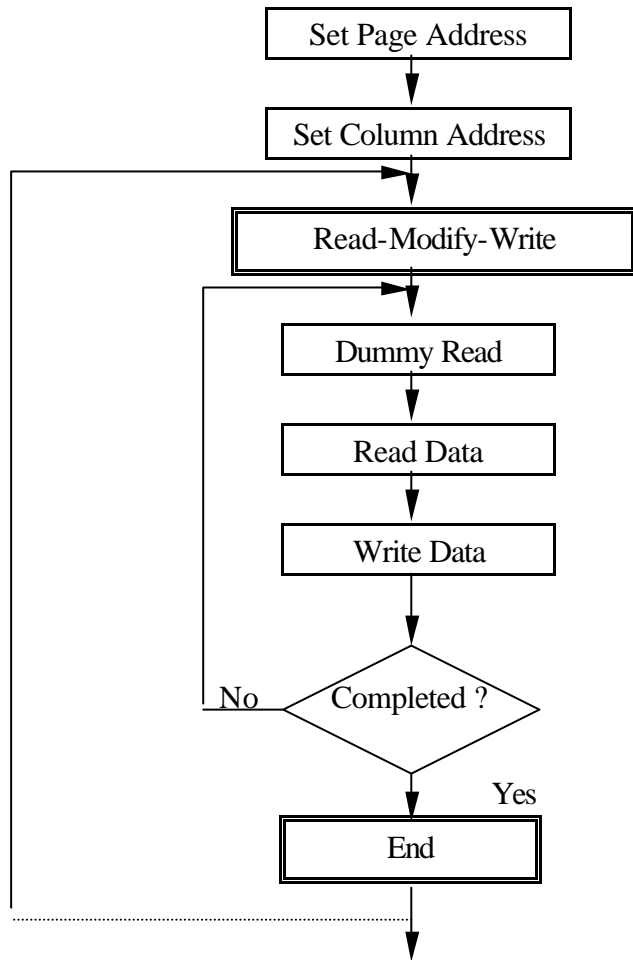
A0	$\overline{\text{RD}}$	$\overline{\text{R/W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	1	1	0	0	0	0	0	EOH

This command defeats column address register auto-increment after data reads. The current contents of the column address register are saved. This mode remains active until an End command is received.

- Operation sequence during cursor display

When the End command is entered, the column address is returned to the one used during input of Read-Modify-Write command. This function can reduce the load of MPU when data change is repeated at a specific display area (such as cursor blinking).

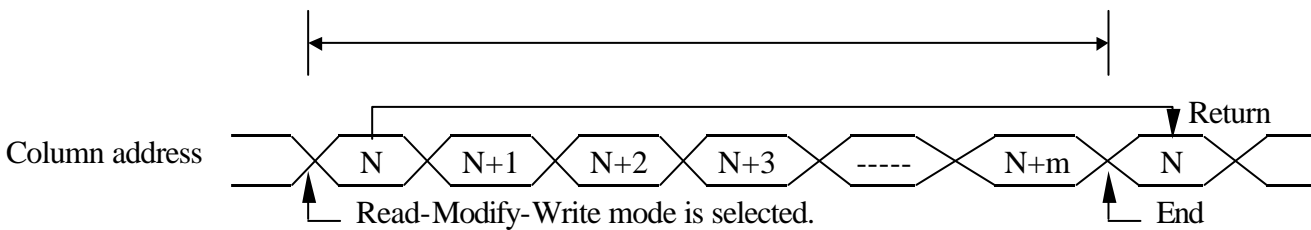
* Any command other than Data Read or Write can be used in the Read-Modify-Write mode. However, the Column Address Set command cannot be used.



End

A0	$\overline{\text{RD}}$	$\overline{\text{R/W}}$	D7	D6	D5	D4	D3	D2	D1	D0	EEH
0	1	0	1	1	1	0	1	1	1	0	

This command cancels read-modify-write mode and restores the contents of the column address register to their value prior to the receipt of the Read-Modify-Write command.



Reset

A0	$\overline{\text{RD}}$	$\overline{\text{R/W}}$	D7	D6	D5	D4	D3	D2	D1	D0	
0	1	0	1	1	1	0	0	0	1	0	E2H

This command clears

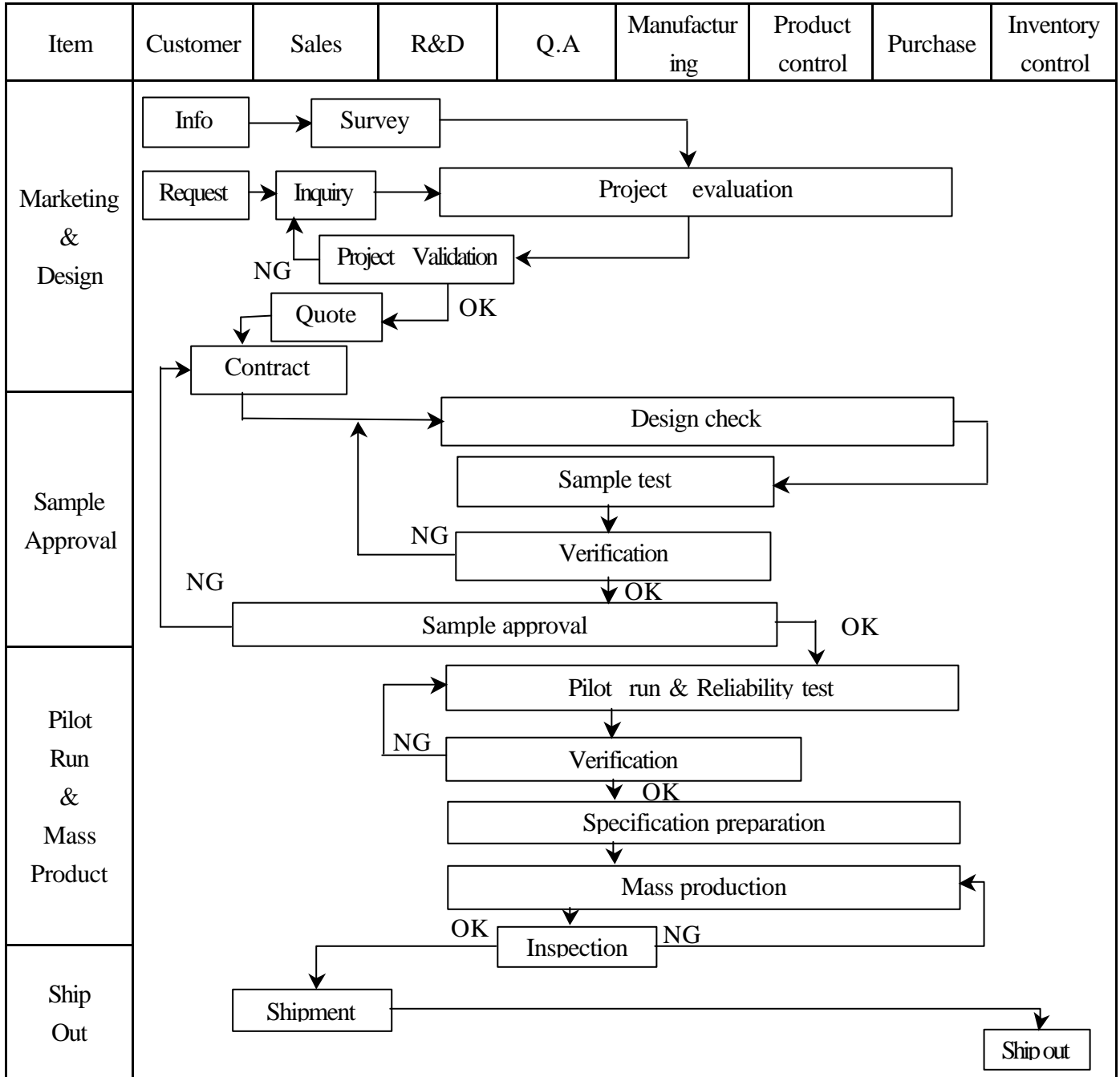
- the display start line register.
- and set page address register to 3 page.

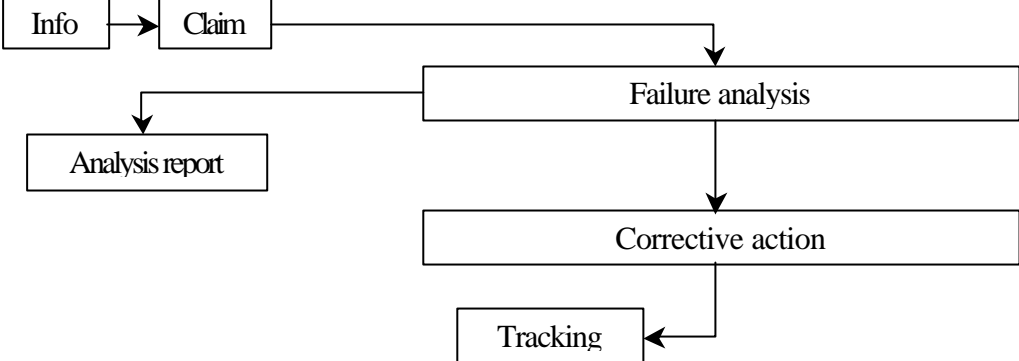
It does not affect the contents of the display data RAM.

When the power supply is turned on, a Reset signal is entered in the RES pin. The Reset command cannot be used instead of this Reset signal.

3. QUALITY ASSURANCE SYSTEM

3.1 Quality Assurance Flow Chart



Item	Customer	Sales	R&D	Q.A	Manufacturing	Product control	Purchase	Inventory control
Sales Service	 <pre> graph TD Info[Info] --> Claim[Claim] Claim --> Failure[Failure analysis] Claim --> Report[Analysis report] Failure --> Action[Corrective action] Action --> Tracking[Tracking] </pre>							
Q.A Activity	1. ISO 9001 Maintenance Activities 3. Equipment calibration 5. Standardization Management				2. Process improvement proposal 4. Education And Training Activities			

3.2 Inspection Specification

Inspection Standard : MIL-STD-105E Table Normal Inspection Single Sampling Level

Equipment : Gauge, MIL-STD, Powertip Tester, Sample.

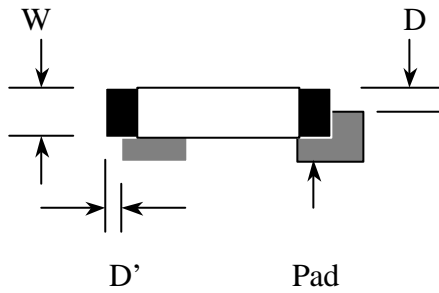
IQC Defect Level : Major Defect AQL 0.4; Minor Defect AQL 1.5.

FQC Defect Level : 100% Inspection.

OUT Going Defect Level : Sampling.

Specification :

NO	Item	Specification	Judge	Level
1	Part Number	The part number is inconsistent with work order of production	N.G.	Major
2	Quantity	The quantity is inconsistent with work order of production	N.G.	Major
3	Electronic characteristics of LCM $A = (L + W) \div 2$	The display lacks of some patterns.	N.G.	Major
		Missing line.	N.G.	Major
		The size of missing dot, A is $> 1/2$ Dot size	N.G.	Major
		There is no function.	N.G.	Major
		Output data is error	N.G.	Major
4	Appearance of LCD $A = (L + W) \div 2$ Dirty particle (Including scratch, bubble)	Material is different with work order of production	N.G.	Major
		LCD is assembled in inverse direction	N.G.	Major
		Bezel is assembled in inverse direction	N.G.	Major
		Shadow is within LCD viewing area + 0.5 mm	N.G.	Major
		The diameter of dirty particle, A is > 0.4 mm	N.G.	Minor
		Dirty particle length is > 3.0 mm, and 0.01 mm $<$ width 0.05mm	N.G.	Minor
		Display is without protective film	N.G.	Minor
		Conductive rubber is over bezel 1mm	N.G.	Minor
		Polarizer exceeds over viewing area of LCD	N.G.	Minor
		Area of bubble in polarizer, A > 1.0 mm, the number of bubble is > 1 piece.	N.G.	Minor
		0.4 mm $<$ Area of bubble in polarizer, A < 1.0 mm, the number of bubble is > 4 pieces.	N.G.	Minor
5	Appearance of PCB $A = (L + W) \div 2$	Burned area or wrong part number is on PCB	N.G.	Major
		The symbol, character, and mark of PCB are unidentifiable.	N.G.	Minor
		The stripped solder mask, A is > 1.0 mm	N.G.	Minor
		0.3 mm $<$ stripped solder mask or visible circuit, A < 1.0 mm, and the number is 4 pieces	N.G.	Minor
		There is particle between the circuits in solder mask	N.G.	Minor
		The circuit is peeled off or cracked	N.G.	Minor
		There is any circuits risen or exposed.	N.G.	Minor
		0.2 mm $<$ Area of solder ball, A is 0.4mm	N.G.	Minor
		The number of solder ball is 3 pieces	N.G.	Minor
The magnitude of solder ball, A is > 0.4 mm.	N.G.	Minor		

NO	Item	Specification	Judge	Level
6	Appearance of molding $A=(L+W) \div 2$	The shape of modeling is deformed by touching.	N.G.	Major
		Insufficient epoxy: Circuit or pad of IC is visible	N.G.	Minor
		Excessive epoxy: Diameter of modeling is $> 20\text{mm}$ or height is $> 2.5\text{mm}$	N.G.	Minor
		The diameter of pinhole in modeling, A is $> 0.2\text{mm}$.	N.G.	Minor
7	Appearance of frame $A=(L+W) \div 2$	The folding angle of frame must be $> 45 +10$	N.G.	Minor
		The area of stripped electroplate in top-view of frame, A is $> 1.0\text{mm}$.	N.G.	Minor
		Rust or crack is (Top view only)	N.G.	Minor
		The scratched width of frame is $> 0.06\text{mm}$. (Top view only)	N.G.	Minor
8	Electrical characteristic of backlight $A=(L+W) \div 2$	The color of backlight is nonconforming	N.G.	Major
		Backlight can't work normally.	N.G.	Major
		The LED lamp can't work normally	N.G.	Major
		The unsoldering area of pin for backlight, A is $> 1/2$ solder joint area.	N.G.	Minor
		The height of solder pin for backlight is $> 2.0\text{mm}$	N.G.	Minor
10	Assembly parts $A=(L+W) \div 2$	The mark or polarity of component is unidentifiable.	N.G.	Minor
		The height between bottom of component and surface of the PCB is floating $> 0.7\text{mm}$	N.G.	Minor
		$D > 1/4W$ 	N.G.	Minor
		End solder joint width, D' is $> 50\%$ width of component termination or width of pad	N.G.	Minor
		Side overhang, D is $> 25\%$ width of component termination.	N.G.	Minor
		Component is cracked, deformed, and burned, etc.	N.G.	Minor
		The polarity of component is placed in inverse direction.	N.G.	Minor
		Maximum fillet height of solder extends onto the component body or minimum fillet height is $< 0.5\text{mm}$.	N.G.	Minor

5. PRECAUTION RELATING PRODUCT HANDLING

5.1 SAFETY

- 5.1.1 If the LCD panel breaks , be careful not to get the liquid crystal to touch your skin.
- 5.1.2 If the liquid crystal touches your skin or clothes , please wash it off immediately by using soap and water.

5.2 HANDLING

- 5.2.1 Avoid any strong mechanical shock which can break the glass.
- 5.2.2 Avoid static electricity which can damage the CMOS LSI—When working with the module , be sure to ground your body and any electrical equipment you may be using.
- 5.2.3 Do not remove the panel or frame from the module.
- 5.2.4 The polarizing plate of the display is very fragile. So , please handle it very carefully ,do not touch , push or rub the exposed polarizing with anything harder than an HB pencil lead (glass , tweezers , etc.)
- 5.2.5 Do not wipe the polarizing plate with a dry cloth , as it may easily scratch the surface of plate.
- 5.2.6 Do not touch the display area with bare hands , this will stain the display area.
- 5.2.7 Do not use ketonics solvent & aromatic solvent. Use with a soft cloth soaked with a cleaning naphtha solvent.
- 5.2.8 To control temperature and time of soldering is 280 ± 10 and 3-5 sec.
- 5.2.9 To avoid liquid (include organic solvent) stained on LCM .

5.3 STORAGE

- 5.3.1 Store the panel or module in a dark place where the temperature is 25 ± 5 and the humidity is below 65% RH.
- 5.3.2 Do not place the module near organics solvents or corrosive gases.
- 5.3.3 Do not crush , shake , or jolt the module.

5.4 TERMS OF WARRANTY

- 5.4.1 Applicable warrant period
The period is within thirteen months since the date of shipping out under normal using and storage conditions.
- 5.4.2 Unaccepted responsibility
This product has been manufactured to your company' s specification as a part for use in your company' s general electronic products. It is guaranteed to perform according to delivery specifications. For any other use apart from general electronic equipment , we cannot take responsibility if the product is used in nuclear power control equipment , aerospace equipment , fire and security systems or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required.