De Col Display s.r.l.

SAMSUNG DISPLAY DEVICES

SPECIFICA DEL MODULO LCD

UG-32F11-CCDN4-A

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Partita IVA: 07721060015

CONTENTS

1. Scope

This specification defines general provisions as well as inspection standards for LCD module supplied by SAMSUNG DISPLAY DEVICES.
If the event of unforeseen problem or unspecified items may occur, naturally shall negotiate and agree to solution.

2. Warranty

Module products manufactured to this specification shall be capable of meeting all characteristics for a minimum period of 12 months from the date of shipping from SAMSUNG DISPLAY DEVICES when stored or used as specified under normal conditions within the contents of these sheets.
If module products are not stored or used as specified herein, It will be void the 12 months warranty

3. Features

Display Format : 320(w) x R.G.B x 240(h) full dots

Display Mode : Negative type display
Display data "H" ; ON → Transmission
Display data "L" ; OFF → Light solution

Display Color : Normally black

Multiplexing Ratio : 1/240 ~ 1/244 duty (Dual scan STN LCD)

4. Mechanical specification

ITEM	Specifications	Unit
Dimensional outline	154.6(W) X 114.8(H) X 9.0 max.(t)	mm
Number of dots	320(W) X R · G · B X 240(H) dots	-
Effective viewing area	118.18(W) X 89.38(H)	mm
Active area	115.18(W) X 86.38(H)	mm
Dots pitch	0.12(W) X 0.36(H)	mm
Pixel pitch	0.36(W) X 0.36(H)	mm
Dot, pixel spacing	0.02	mm
Weight	approx. 280	g

5. Maximum rating

[Vss=0V]

ITEM		Symbol	Min.	Max.	Unit	Note
Supply voltage	Logic	Vdd	0	7.0	V	
	LCD drive	Vee-Vss	0	44.0	V	
Input voltage		Vi	0	Vdd	V	
Operating temperature		Top	0	60	℃	1)
Storage temperature		Tstg	-20	70	℃	
Humidity		-	-	90	%RH	2)

Note 1) Due to the characteristics of the LC material, the color will vary with environmental temperature.

Note 2) Ta ≤ 40℃ ····· 90% RH Max.
Ta > 40℃ ····· Absolute humidity shall be less than Ta=40℃/90%RH

6. Electrical characteristics

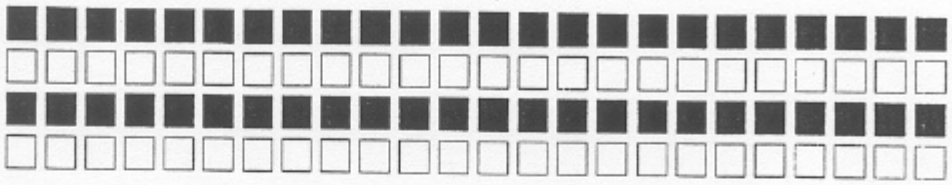
6-1. Electrical Characteristics

ITEM		Symbol	Condition	Min	Typ.	Max.	Unit
Supply voltage	Logic	Vdd-Vss	Note 1	4.75	5.0	5.25	V
	LCD drive	Vee-Vss	-	12.0	-	30.0	
Input voltage	"H" level	ViH	Vdd=5V±5%	0.8Vdd	-	Vdd	V
	"L" level	ViL		0	-	0.2Vdd	
Frame frequency		f flm	Vdd=5V	-	75	-	Hz
Current consumption	Logic	Idd	Note 2	-	13.3	20.0	mA
	LCD drive	Iee		-	9.1	15	
LCD driving voltage (recommended voltage)		Vee-Vss	Ta = 0℃ ϕ=0° , θ=0°	-	-	-	V
			Ta = 25℃ ϕ=0° , θ=0°	25.1	26.1	27.1	
			Ta = 50℃ ϕ=0° , θ=0°	-	-	-	
Power consumption		Pb	-	-	300	400	mW

Note1) Vdd to be applied according to the specifications shall be regulated and sudden fluctuation of Vdd, even if the fluctuation is within the specifications, shall be strictly avoided.

Note2) Display high frequency
Vdd-Vss=5.0V, Vee-Vss=26.1V, f flm=75Hz
Black & White stripe pattern

Display pattern



6-2. Characteristics of CCFL back light

6-2-1 Brightness of LCD surface

Item		Min.	Typ.	Max.	Unit
Brightness	0℃	35	90	-	Cd/㎡
	25℃	80	150	-	

Note) Measurement condition

① Ratings are defined as the average brightness inside the active area specified in the Fig. 6-1

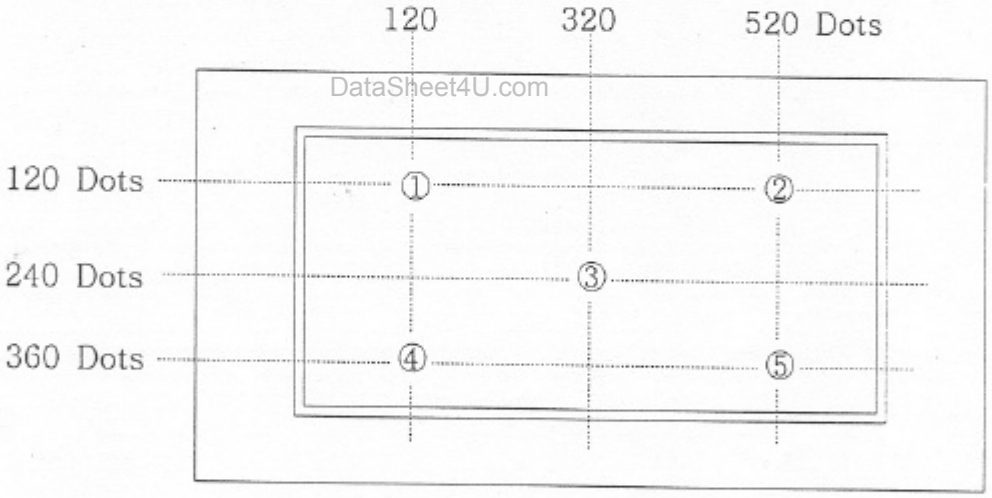


Fig. 6-1 Measuring points

② Measuring equipment : BM-7(TOPCON)
③ Lamp current IL=5mArms (Inverter circuit : CXA-M10L TDK)
④ LCD : All digits white
Vdd=5V, Vee-Vss=Voltage at Max. contrast ratio
D0~D7= "H" (White)
⑤ Ambient temperature : 25℃
⑥ Measured 30 minutes after turning ON.

6-2-2. CCFL rating

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Non-load output voltage	Vs	900	-		Vrms	
Lamp voltage	VL	-	300	-	Vrms	
Lamp current	IL	4.5	5.0	5.5	mArms	
Power consumption	PL	-	1.5	-	W	
Life time	LL	10,000	25,000	-	Hr	
Frequency	FL	20	-	70	KHz	

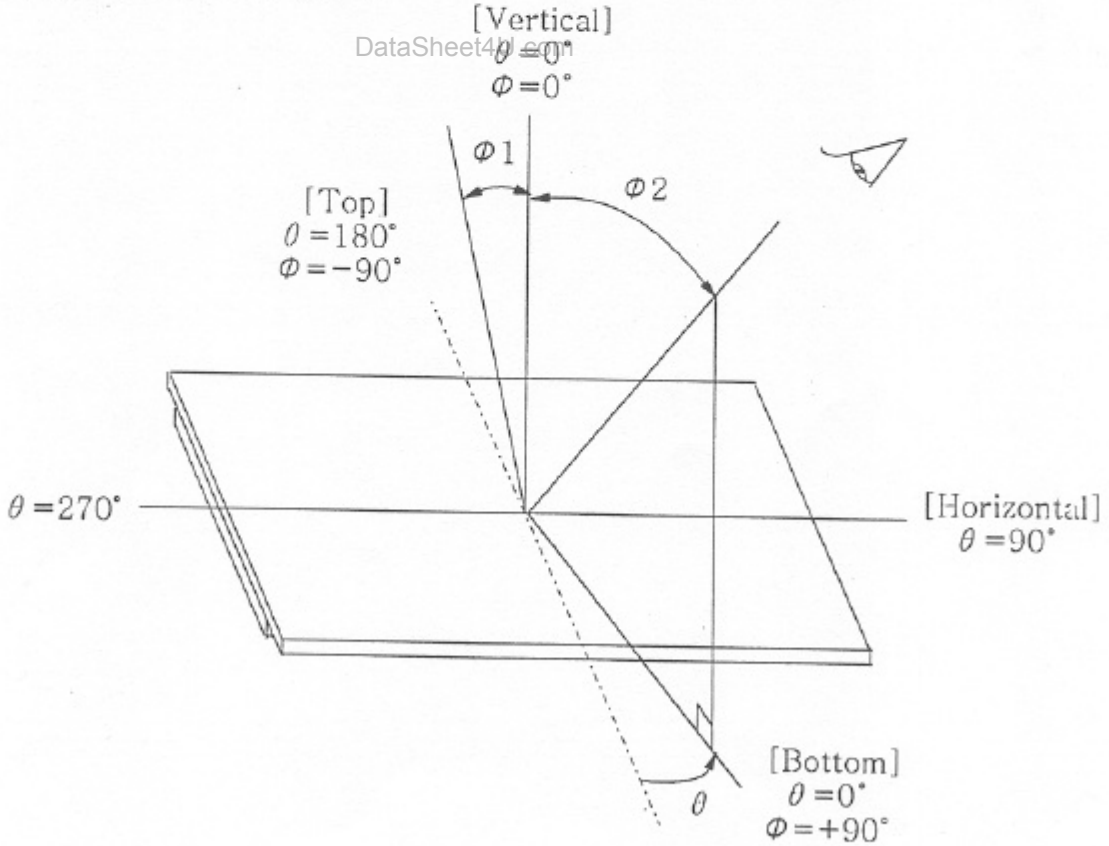
Note) ① It is recommended that IL be not more than 5.5mArms so that heat radiation of CCFL back light may least affect the display quality.
② Power consumption excludes inverter loss.
③ The circuit voltage(Vs) of the inverter should be designed to have some margin(reference value:1200Vrms Min.), because Vs may be increased due to the leak current which may be caused by wiring of CCFL cables.
④ The circuit voltage(Vs) of the inverter should meet sine, symmetric waveform without spike in positive and negative.
⑤ Life time means when the illuminance or quantity of light has decreased to 50% of the initial value.

7. Electro-optical characteristics

ITEM		Symbol	Temp.	Condition	Min.	Typ.	Max.	Unit.	Note
Response time	Rise time	tr	0℃	$\phi=0°$ $\theta=0°$	-	-	-	mS	1,3,6
			25℃		-	150	200		
	Decay time	td	0℃		-	-	-		
			25℃		-	150	200		
Viewing angle		$\Delta\phi$	25℃	$\theta=0°$,K>2	60	90	-	deg.	1,4,6
				$\theta=90°$,K>2	100	140	-		
Contrast ratio		K	0℃	$\phi=0°$ $\theta=0°$	15	30	-	-	1,5,6
			25℃		20	45	-		
			50℃		5	25	-		

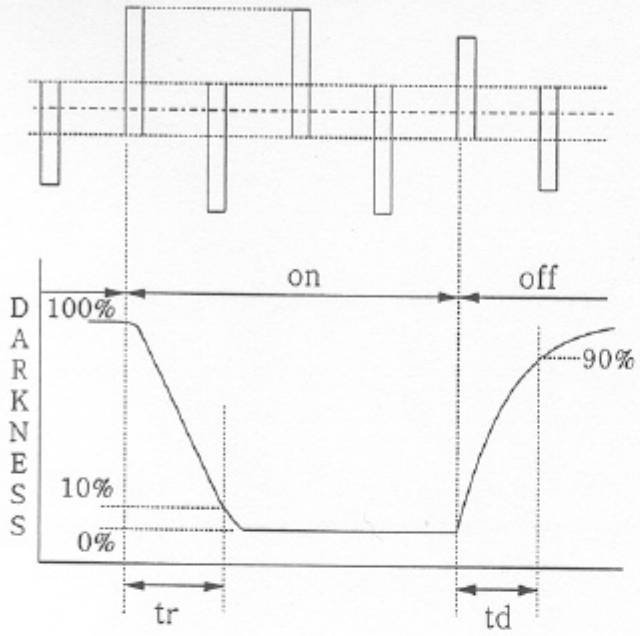
Item		Symbol	Temp.	Condition	Min.	Typ.	Max.	Note
Color of CIE coordinate	White	X	25℃	$\phi=0°$ $\theta=0°$	-	0.30	-	Measuring equipment :BM7 (TOPCON)
		Y			-	0.34	-	
	Black	X			-	0.32	-	
		Y			-	0.29	-	
	Red	X			-	0.57	-	
		Y			-	0.34	-	
	Green	X			-	0.27	-	
		Y			-	0.56	-	
	Blue	X			-	0.16	-	
		Y			-	0.11	-	

Note 1) Definition of Φ and θ



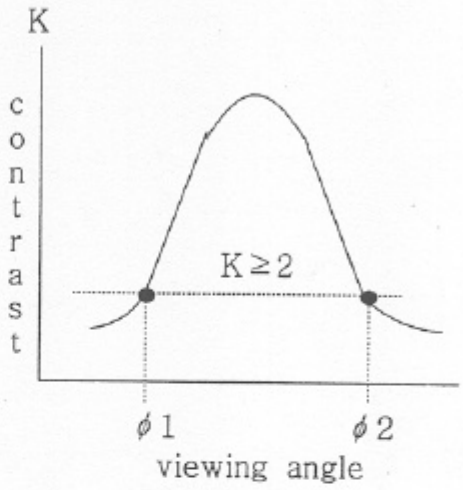
Note 2) Contrast ratio higher than 2 ($K \geq 2$) can be obtained in this voltage range

Note 3) Definition of response time wave form

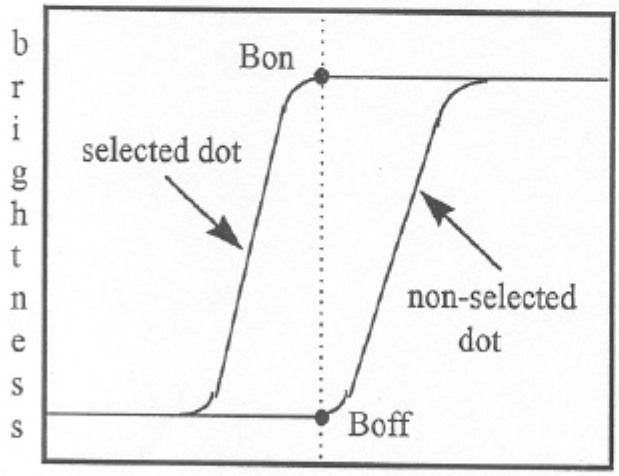


Note 4) Definition of viewing angle ($\Delta\phi$)

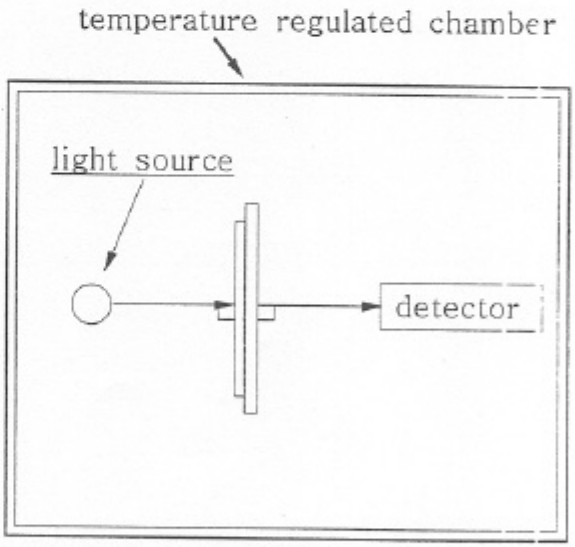
$\Delta\phi = |\phi 1 + \phi 2|$



Note 5) Definition of contrast ratio (K)



Note 6) Optical measuring system



measuring equipment: LCD-5000 made in OTUKA

$$\text{Contrast ratio(K)} = \frac{\text{Brightness all pixels " white" at K max.}}{\text{Brightness all pixels "black" at K max.}}$$

8. I/O terminal

8-1. I/O connection(CN1)

Pin NO.	Symbol	Signal level	Function
1	FLM	H	Scan start-up signal
2	CL1	H→L	Data latch pulse
3	CL2	H→L	Data shift pulse
4	disp	H/L	Display off("H"=on, "L"=off)
5	Vdd	-	Power supply for logic (+5v)
6	Vss	-	Signal ground (GND)
7	Vee	-	Power supply for LCD drive (+V)
8	D7	H/L	Display data
9	D6		
10	D5		
11	D4		
12	D3		
13	D2		
14	D1		
15	D0		

CCFL(CN2)

Pin NO.	Symbol	Signal level	Function
1	HV	-	High voltage line(from inverter)
2	NC	-	No connection
3	GND	-	Ground line(from inverter)

Connector

① Used LCD connector : 53261-1510 (MOLEX)
② Correspond able LCD connector : 51021-1500(MOLEX)

③ Used CCFL connector : BHR-03VS-1 (JST)
④ Correspond able CCFL connector : SM02-(8.0)B-BHS-1(JST)

8-2. Circuit block diagram

The circuit block diagram is shown in Fig. 8-1. The LCD module needs two power source Vdd for logic and Vee for LCD drive.

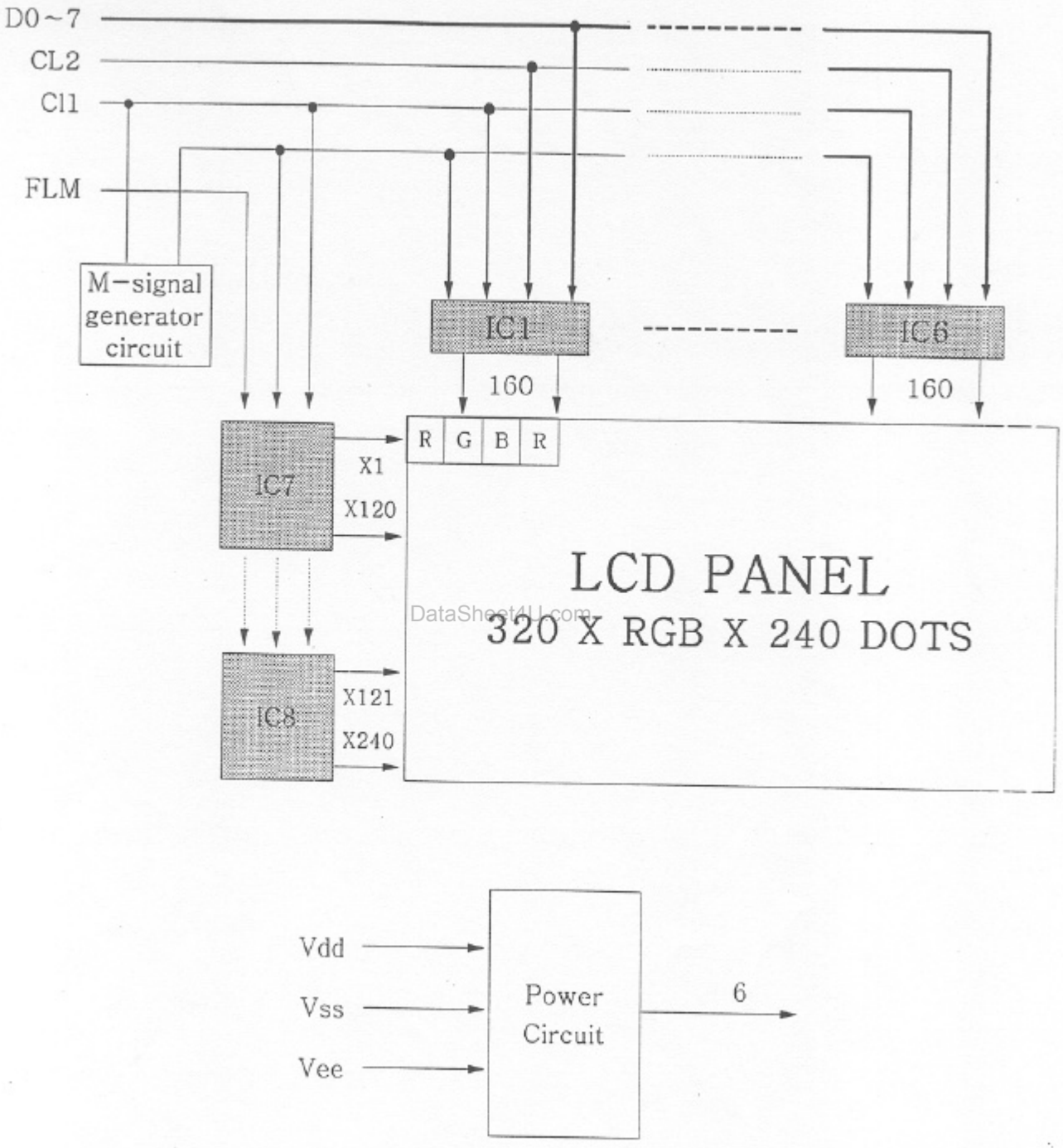


Fig. 8-1 Block diagram

note : It is necessary to guard all signal from external noise as signal lines are directly connected to C-MOS and are not pull-up or pull-down internally.

8-3. Signal timing diagram

Item	Symbol	Condition	Min.	Max.	Unit
Max. clock frequency	f cl2	Vdd=5V±5% Vss=0V Ta=25℃	-	10	nS
CL1 high level pulse width	t wh2		50	-	
CL2 H/L level pulse width	t wcl2		20	-	
Rise/fall time	tr,tf		-	50	
Data set-up time	t dsu		10	-	
Data hold time	t dhd		10	-	
Clock set-up time	t lsu		100	-	
Clock hold time	t lhu		100	-	
Flm set-up time	t fsu		100	-	
Flm hold time	t fh		30	-	

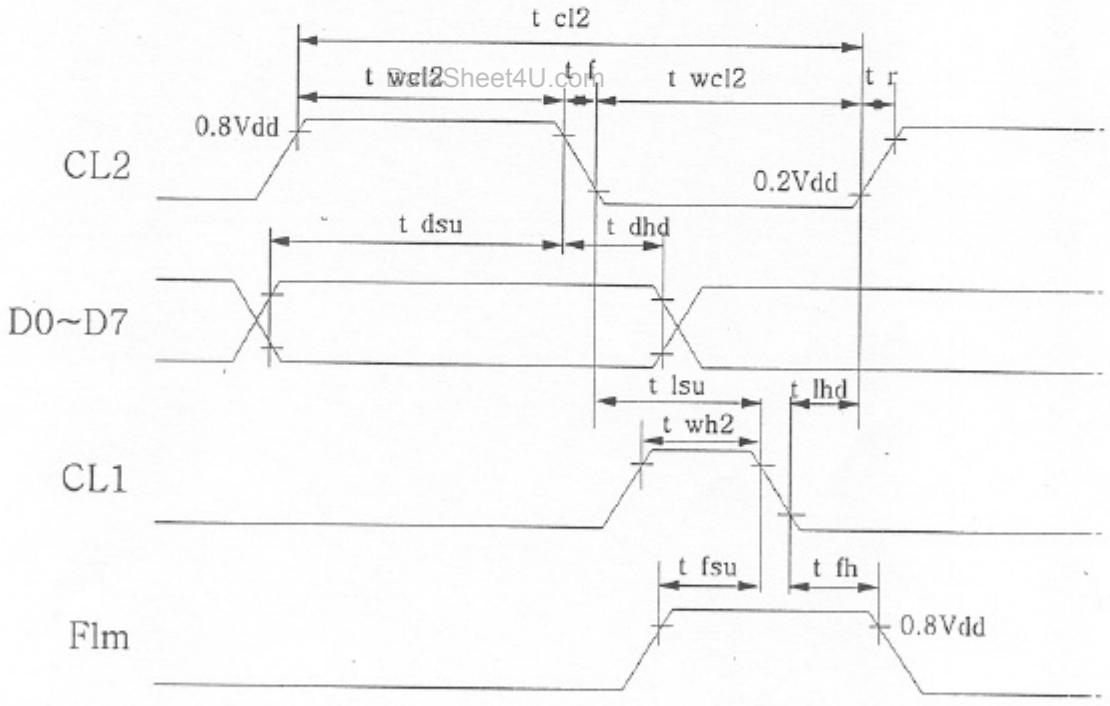


Fig. 8-2 Signal timming (1)

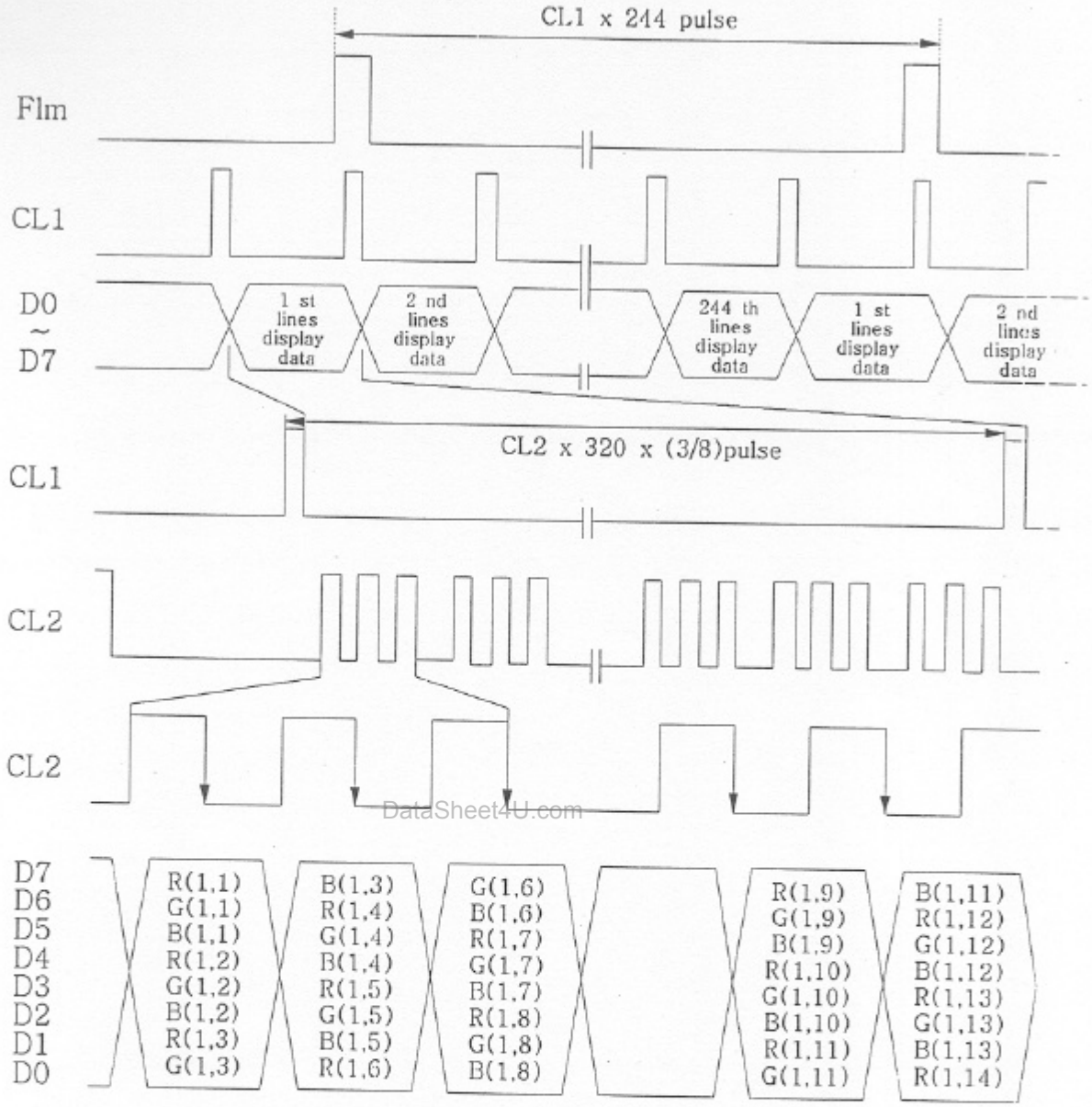
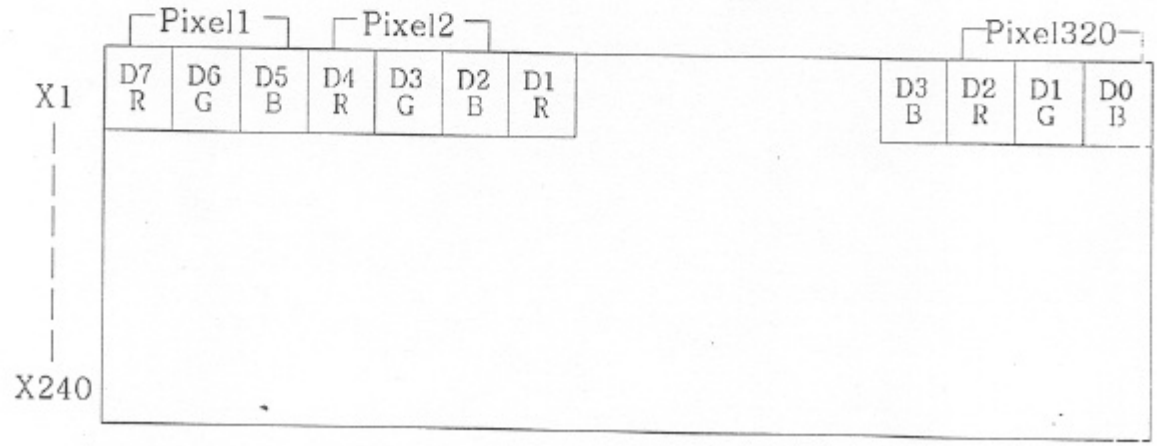


Fig. 8-3 Signal timing (2)



8-4. It is important that the voltage supplies follow the proper power on/off sequence shown in Fig.8-4 in order to prevent latch-up of C-MOS LSI or DC operation of LCD panel.
Do not apply DC voltage to the LCD panel because that induces the electro chemical reaction and reduces its life time.

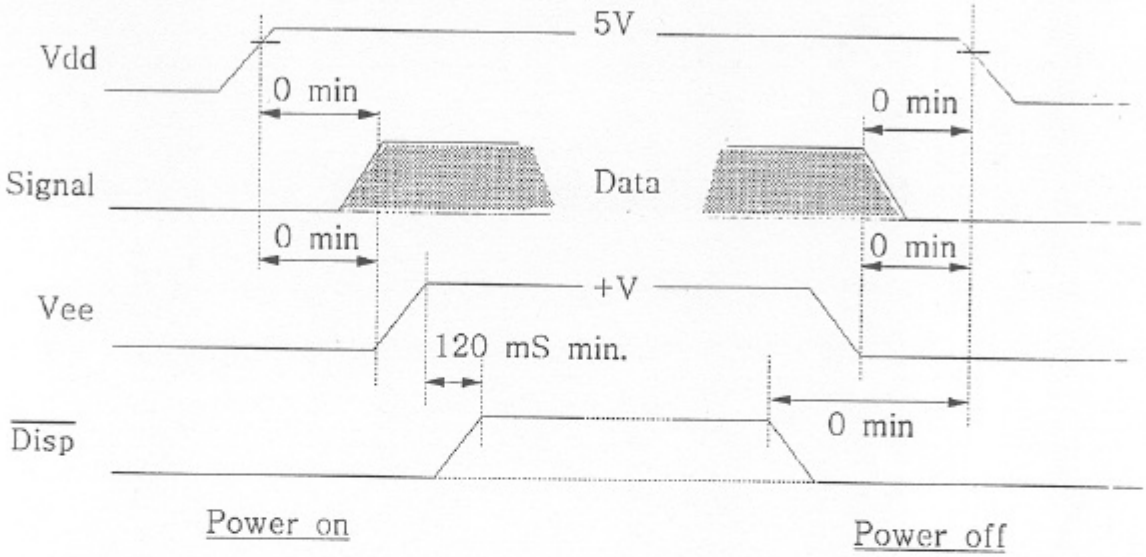


Fig. 8-4 Power on/off sequence

Note) $\overline{Disp}$ rise and fall time should be 100nS Max.

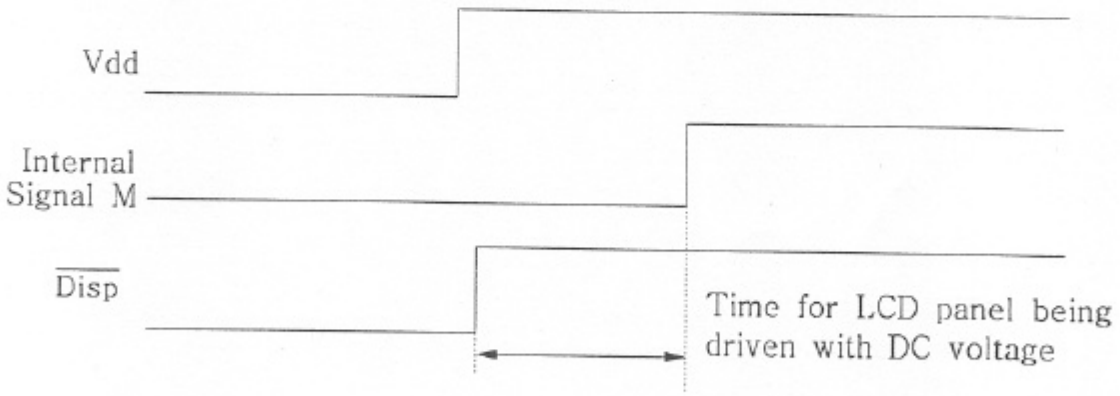


Fig. 8-5 Time for LCD panel being driven with DC voltage

At power on, if " $\overline{Disp}$ " signal is "H" level before LCD panel AC driving signal(M) isn't generated, the LCD panel is driven with DC voltage in the meantime.

Until initialization of LC control LSI is finished after power on, signal(M) isn't generated, so that DC voltage is applied to the LCD panel. During this time, switch " $\overline{Disp}$ " to "L" and force apply voltage to the LCD panel into 0V. After initialization of LC control LSI, switch " $\overline{Disp}$ " to "H", so that the LCD panel is returned to the normal driving voltage.

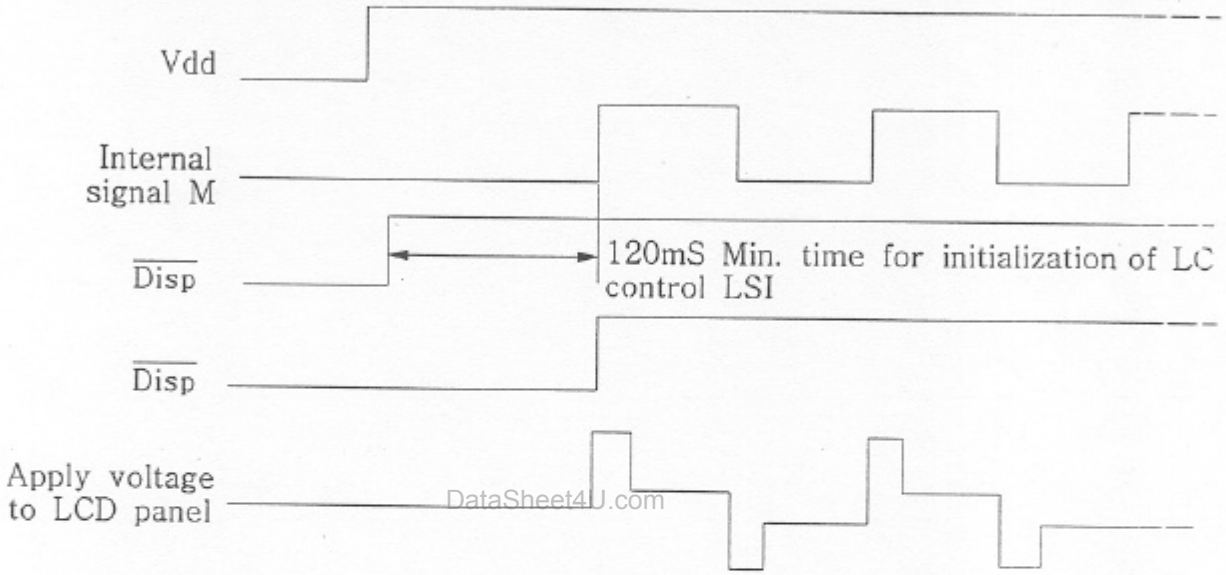


Fig. 8-6 Timing chart without DC apply to the LCD panel

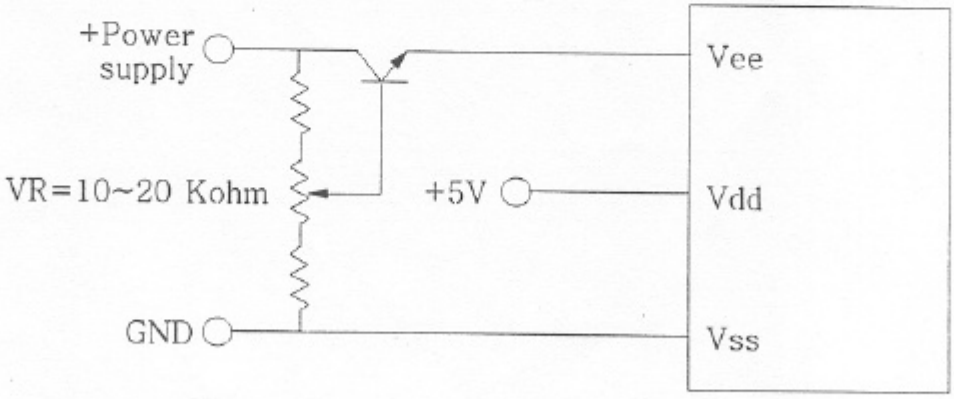


Fig. 8-1 Example of power supply

9. Unit driving method

9-1. Circuit configuration

Fig. 8-1 shows the block diagram of the unit circuitry.

9-2. Input data and control signal

The LCD driver is 160bits LSI, consisting of shift registers, latch circuits and LCD driver circuits.

Display data which are externally divided into data for each row (320 X 3 R,G,B) will be sequentially transferred in the from of 8-bits parallel data through shift registers by clock signal CL2 from the left top of the display face.

When data of one row(320 X 3 R,G,B) have been input, they will be latched in the form of parallel data for 320X3 lines of signal electrodes by latch signal CL1.

Then the corresponding drive signal will be transmitted to the 320X3 lines of column electrodes of the LCD panel by the LCD drive circuits.

At this time, scan start-up signal FLM has been transferred from the scan signal driver to the 1st row of scan electrodes, and the contents of the data signals are displayed on the 1st rows of the display face according to the combinations of voltages applied to the scan and signal electrodes of the LCD.

While the 1st rows of data are being displayed, The 2nd rows of data are entered. When 320X3dots of data have been transferred then latched on the falling edge of CL1 clock.

The display face proceeds to the 2nd rows of display.

Such data input will be repeated up to 244th row of each display segment, from upper to lower rows.

To complete one frame of display by time sharing method.

Then data input proceeds to next display face. Scan start-up signal FLM generates scan signal to drive horizontal electrodes.

The unit shall be driven at the speed 70-85Hz/frame to avoid flickering.

Since DC voltage, If applied to LCD panel, causes chemical reaction which will deteriorate LCD, Drive waveform shall be inverted at every display frame to prevent the generation of such DC voltage. Control signal M plays such role.

Because of the characteristics of the CMOS driver LSI.

The power consumption of the unit goes up as the operating frequency CL2 increases.

This the driver LSI applies the system of transferring 8 bits parallel data through the 8 lines shift registers to reduce the data transfer speed CL2.

Thanks to the LSI, the power consumption of the unit will be minimized. In this circuit configuration, 8 bits display data shall be therefore input to data input pins of D0~7.
Furthermore the LCD unit adopts bus line system for data input to minimize the power consumption. In this system data input terminal of each driver LSI is activated on when relevant data input is fed. Data input for column electrodes of both the upper and the lower display segment and chip select of driver LSI are made as followed;
The driver LSI at the left end of the display face is first selected, and the adjacent LSI of the right side is selected when 160 dots data (20CL2) is fed. This process is sequentially continued until data is fed to the driver LSI's at the right end of the display face.
This process is simultaneously followed at the column driver LSI's of both the upper and lower display segments.
Thus data input both the upper and lower display segments must be fed through 8 bits bus line sequentially from the left end of the display face

10. Quality level

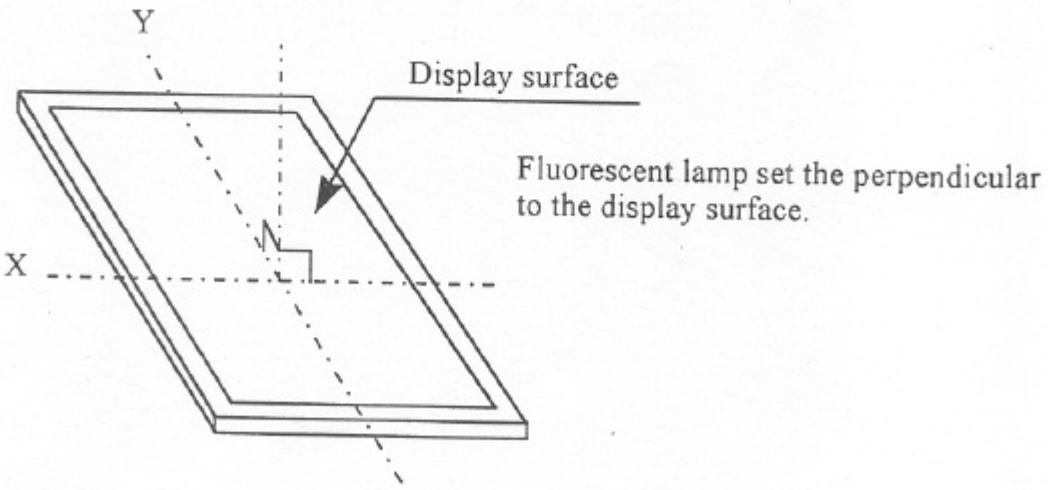
10-1. Inspection conditions

10-1-1. The environmental conditions for inspection shall be as follows.

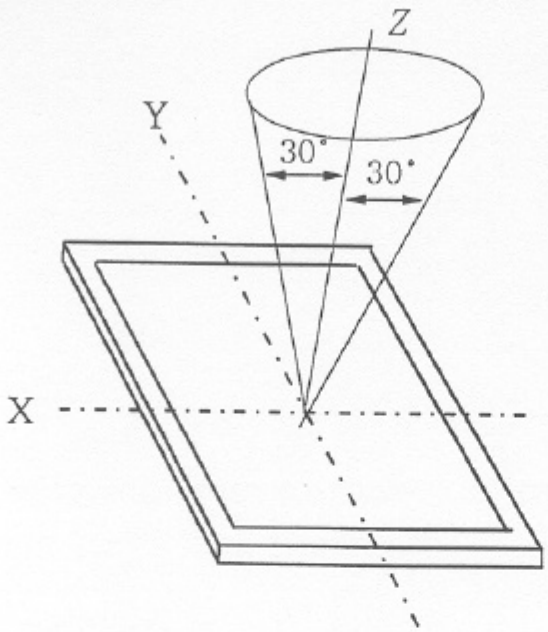
Room temperature	:	25 ± 3℃
Humidity	:	65 ± 20%RH

10-1-2. The external visual inspection
The inspection shall be performed by using a single 20W fluorescent lamp for illumination and the distance from LCD eyes of the inspector should be 30cm or more.

10-1-3. (1) Light method



(2) Inspection distance and angle



Inspection should be performed within Φ (Φ is usually 30°) from Z axis to each X and Y axis.
Inspection distance of any direction within Φ must be kept 30± 5cm to the display surface.

10-2. Sampling procedures for each item's acceptance level table.

Defect type	Sampling procedures	AQL
Major defect	MIL-STD-105D Inspection level I normal inspection single sample inspection	0.65
Minor defect	MIL-STD-105D Inspection level I normal inspection single sample inspection	1.5

10-3. Classification of defects

10-3-1. Major defect

A major defect refers to a defect which is not considered to substantially degrade usability for product applications.

10-3-2. Minor defect

A minor defect refers to a defect which is not considered to substantially degrade product application, or a defect which deviates from existing standards almost unrelated to the effective use of the product or it's operation.

10-4. Inspection standards

10-4-1. Visual operating

Item	Criterion
1) Black spots (I) Black lines (I)	Spots or lines appear dark in display patterns and remain unvaried in terms of size and shade regardless of the LCD operating voltage.
2) Black spots (II) Black lines (II)	Spots or lines appear dark in display patterns and vary in terms of size and shade with the LCD operating voltage.
3) White spots (I) White lines (I)	Spots or lines appear white in display patterns and remain unvaried in terms of size and shade regardless of the LCD operating voltage.
4) White spots (II) White lines (II)	Spots or lines appear white in display patterns and vary in terms of size and shade with the LCD operating voltage.
5) Red sots, Green spots Blue spots	Spots appear Red or Green or Blue in display patterns or out side the view area when each color R, G, B is lighted.

10-4-2. Incoming inspection standards

ITEM	Criterion for defects	Defect type
1) Display on inspection	(1) Non display (2) Alternate lines or some lines light up (3) Predetermined figure and character pattern display (4) Vertical line is deficient (5) Horizontal line is deficient (6) Cross line is deficient	Major Major Major Major Major Major
2) Black/White spot(I) Red,Gray, Blue sport	Size ϕ (mm) / Number $0.20 < \phi \leq 0.35$: $3 \leq N$ $0.35 < \phi \leq 0.60$: $1 \leq N$ $0.60 < \phi$: $1 \leq N$	Minor Minor Minor
3) Black/White line(I)	Length (mm) / width (mm) / Number $5.0 < L \leq 10$: $0.01 < W \leq 0.02$: $2 \leq N$ $10.0 < L$: $0.01 < W \leq 0.02$: $1 \leq N$ $1.0 < L \leq 5.0$: $0.02 < W \leq 0.05$: $2 \leq N$ $5.0 < L$: $0.02 < W \leq 0.05$: $1 \leq N$ $1.0 \leq L$: $0.05 < W$: $1 \leq N$	Minor Minor Minor Minor Minor

<table>
<tr><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>4) Black/white sport(Ⅱ)</td><td><table><tr><th>Size φ (mm)</th><th>Number</th></tr><tr><td>0.85< φ ≤1.20
1.20< φ</td><td>3≤N
1≤N</td></tr></table>(Note) The sports exist within the active area.</td><td>Minor
Minor</td></tr>
<tr><td>5) Black/white line(Ⅱ)</td><td>No black/white line(Ⅱ) are allowed</td><td>Minor</td></tr>
<tr><td>6) Dot width</td><td>When each dot width is compared, there is a different exceeding 0.05mm</td><td>Minor</td></tr>
<tr><td>7) Center line gap</td><td>The center line gap between upper half and lower half screen
W(mm)>0.05</td><td>Minor</td></tr>
<tr><td>8) Ununiformity of LCD panel</td><td>Objectable white lines, black lines or irregular color which may reduce display quality.</td><td>Minor</td></tr>
<tr><td>9) Scratches and dent on the polarizer</td><td>Scratches and dent on the polarizer shall be in accordance with "2) black/white spot(Ⅰ), 3) black/white line(Ⅰ)"</td><td>Minor</td></tr>
<tr><td>10) Bubble in polarizer</td><td><table><tr><th>Size φ (mm)</th><th>Number</th></tr><tr><td>0.50< φ ≤1.00
1.00< φ</td><td>2≤N
1≤N</td></tr></table></td><td>Minor
Minor</td></tr>
<tr><td>11) Stains on LCD panel surface</td><td>Stains which cannot be removed even when wiped lightly with a soft cloth or similar cleaning too.</td><td>Minor</td></tr>
<tr><td>12) Rainbow color</td><td>No rainbow color is allowed in the optimum contrast on state within the active area.</td><td>Minor</td></tr>
<tr><td>13) Bezel appearance</td><td>Rust and deep damage which are visible in the bezel is rejectable.</td><td>Minor</td></tr>
<tr><td>14) Defect of land surface contact (poor soldering)</td><td>Evident crevices which is visible are rejectable.</td><td>Minor</td></tr>
<tr><td>15) Parts mounting</td><td>(1) Failure to mount parts
(2) Parts not in the specifications are mounted
(3) Polarity, for example, is reversed</td><td>Major
Major
Major</td></tr>
</table>

ITEM	Criterion for defects	Defect type
16) Parts alignment	(1) LSI, IC lead width is more then 50% beyond pad outline. (2) Chip component is off center and more then 50% of the leads is off the pad outline.	Minor Minor
17) Conductive foreign matter (Solder ball, Solder chips)	(1) 0.45 < ϕ , N≥ 1 (2) 0.30 < ϕ ≤0.45 , N≥ 1 ϕ: Average diameter of solder ball(unit:mm) (3) 0.50 <L , N≥ 1 L: Average length of solder chip (unit:mm)	Major Minor Minor
18) PWB pattern damage	(1) Deep damage is found on copper foil and the pattern is nearly broken (2) Damage on copper foil other than (1) above	Major Minor
19) Faulty PWB correction	(1) Due to PWB copper foil pattern burnout, the pattern is connected, using a jumper wire for repair; 2 or more places are corrected per PWB. (2) Short circuited part is cut, and no resist coating has been performed.	Minor Minor
20) Bezel claw	Bezel claw missing or not bent	Major
21) Indication of name plate (sampling indication label)	(1) Failure to stamp or label error, or not legible.(all acceptable if legible) (2) The separation is more than 1/3 for indication discoloration, In which the characters can be checked.	Minor Minor
22) Back light	(1) No lighting (2) Flickering and others, abnormal lighting.	Major Major

※ Black spots (Ⅰ) (Ⅱ), white spots (Ⅰ) (Ⅱ), black lines (Ⅰ) (Ⅱ), white lines (Ⅰ) (Ⅱ), Red spots, Green spots, Blue spots and un uniformity of LCD panel is measured by optimum Vop.(At the voltage which gives LCD the optimum contrast)

11. Reliability

11-1. Life time
50,000 Hrs (25℃ in the room without ray of sun)

11-2. Items of reliability

ITEM	Condition	Criterion
1) High temperature operating	40℃ 48 hrs	◎ No cosmetic failure are allowable. Contrast ratio should be between initial value ±10% Total current consumption should be below double of initial value.
2) Low temperature operating	0℃ 48 hrs	
3) Temperature cycle oprating	25℃→40℃→25℃→5℃ 2(hrs) 2(hrs) 4(hrs) 2(hrs) 8 cycle	
4) High temperature storage	60℃ 72 hrs	◎ No cosmetic failure are allowable. Contrast ratio should be between initial value ±20% Total current consumption should be below double of initial value.
5) Low temperature storage	-20℃ 72 hrs	
6) Thermal shock	25℃→60℃→25℃→-20℃ 2(hrs) 2(hrs) 4(hrs) 2(hrs) 8 cycle	
7) Vibration	10~55~10Hz amplitude : 1.5mm 2hrs for each direction (X, Y, Z)	◎ No defent in cosmetic and operational function are allowable. Total current consumption should be below double of initial value.
8) Static electricty	25 ℃ discharge ±4KV of static electricity 4 times to the surface of bezel and 3 times to the LCD panel using the probe. (150ohm, 200pF)	◎ All function should be same with before. No latch-up are allowable.

12. Handling precautions

12-1. Mounting method

The LCD panel of SAMSUNG ELECTRON DEVICES LCD module consists of two this glass plates with polarizes which easily get damaged.

12-2. Caution of LCD handling and cleaning

When cleaning the display surface, Use soft cloth with solvent [recommended below] and wipe lightly

◎ Isopropyl alcohol
◎ Ethyl alcohol
◎ Trichlorotriflorothane

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent:

◎ Water
◎ Ketone
◎ Aroma tics

12-3. Caution against static charge

The LCD module use C-MOS LSI drivers, So we recommended that you; Connect any unused input terminal to Vdd or Vss, Do not input any signals before power is turned on, And ground your body, Work/assembly areas, assembly equipment to protect against static electricity.

12-4. Packing

◎ Module employ LCD elements, and must be treated as such. Avoid intense shock and falls from a height.
◎ To prevent modules from degradation, Do not operate or store them exposed direct to sunshine or high temperature/humidity.

12-5. Caution for operation

◎ It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage then the limit cause the shorter LCD life. An electrochemical reaction due to direct current drive should be avoided.
◎ Response time will be extremely delayed at lower temperature then the operating temperature range and on the other hand at higher temperature LCD's show dark color in them.
However those phenomena do not mean malfunction or out of order with LCD's, Which will come back in the specified operating temperature.
◎ If the display area is pushed hard during operation, Some font will be abnormally displayed but it resumes normal condition after turning off once.

◎ A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit.
Usage under the relative condition of 40℃, 50%RH or less is required.

12-6. Storage

In the case of storing for a long period of time [for instance, for years] for the purpose or replacement use, The following ways are recommended.

◎ Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it. And with no desiccant.
◎ Placing in a dark place where neither exposure to direct sunlight nor light is, Keeping the storage temperature.
◎ Storing with no touch on polarizer surface by the anything else.
[It's recommended to store them as they have been contained in the inner container at the time of delivery from us.]

12-7. Safety

◎ It is recommendable to crash damaged or unnecessary LCD's into pieces and wash off liquid crystal by either of solvents such as acetone and ethanol, Which should be burned up later.
◎ When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water.

13. Precaution for use

13-1. A limit sample should be provided by the both parties on an occasion when the both parties agreed its necessity.
Judgement by a limit sample shall take effect after the limit sample has been established and confirmed by the both parties.

13-2. On the following occasions, The handling of problem should be decided through discussion and agreement between responsible of the both parties.

◎ When a question is arisen in this specifications.
◎ when a new problem is arisen which is not specified in this specifications.
◎ when an inspection specifications change or operating condition change in customer is reported to SDD, and some problem is arisen in this specification due to the change.
◎ When a new problem is arisen at the customer's operating set for sample evaluation in the customer site.

14. Dimensional out line

* See the next page