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Date	July. 21 st 2009

TECHNICAL LITERATURE For TFT-LCD Module
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Model No. **LS013B4DN02**

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Mobile Liquid Crystal Display Group
SHARP CORPORATION

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[For handling and system design]

(1) Handle with care as glass is used in this LCD panel. Dropping or contact against hard object may cause cracks or chips.

(2) Do not scratch the surface of the UV protection film as it is easily damaged.

(3) Water droplets on the UV protection film must be wiped off immediately as they may cause color changes, or other defects if remained for a long time.

(4) To clean LCD panel surface, wipe clean with absorbent cotton or soft cloth. If further cleaning is needed, use IPA (isopropyl alcohol) and wipe clean lightly on surface only. Do not use organic solvents as it may damage the LCD panel terminal area which uses organic material. Also, do not directly touch with finger.

(5) To avoid circuit failure, do not touch panel terminal area.

(6) Do not expose gate driver, etc. on the panel (circuit area outside panel display area) to light as it may not operate properly. Design that shields gate driver, etc. from light is required when mounting the LCD module.

(7) Support for the LCD panel should be carefully designed to avoid stress that exceeds specification on glass surface.

(8) Panel is susceptible to mechanical stress and such stress may affect the display. Place the panel on flat surface to avoid stress caused by twist, bend, etc..

(9) When transporting LCD panels, secure them in LCD panel tray to avoid mechanical stress. The tray should be conductive to protect LCD panels from static charge.

Material used in set or epoxy resin (amine type hardening agent) from packaging, and silicon adhesive (dealcoholized or oxime) all release gas which may affect quality of UV protection film. Do confirm compatibility with user materials.

(10) Do not use chloroprene rubber as it generates chlorine gas and affects reliability in LCD panel connective area.

(11) This LCD module is sensitive to electrostatic discharge of 200V or more. Handle with care using cautions for the followings:

- Operators

Operators must wear anti-static wears to prevent electrostatic charge up to and discharge from human body.

- Equipment and containers

Process equipment such as conveyer, soldering iron, working bench and containers may possibly generate electrostatic charge up and discharge. Equipment must be grounded through 100Mohms resistance. Use ion blower.

- Floor

Floor plays an important role in leaking static electricity generated in human body or equipment. If the floor is made of insulated material (such as polymer or rubber material), such static electricity may charge. Proper measure should be taken to avoid static electricity charge (electrostatic earth: 100Mohms). There is a possibility that the static electricity is charged to them without leakage in case of insulating floor, so the electrostatic earth: $1 \times 10^8 \Omega$ should be made.

- Humidity

Humidity in work area relates to surface resistance of the persons or objects that generate electrostatics, and it can be manipulated to prevent electrostatic charge. Humidity of 40% or lower increases electrostatic earth resistance and promotes electrostatic charging. Therefore, the humidity in the work area should be kept above 40%. Specifically for film peeling process or processes that require human hands, humidity should be kept above 50% and use electricity removal blower.

- Transportation/Storage

Containers and styroform used in transportation and storage may charge electrostatic (from friction and peeling) or electrostatic charge from human body, etc. may cause containers and styroform to have induced charge. Proper electrostatic measure should be taken for containers and storage material.

(12) Protective film is attached to the surface of UV protection film on LCD panel to prevent scratches or other damages. Remove this protective film before use.

[For operating LCD module]

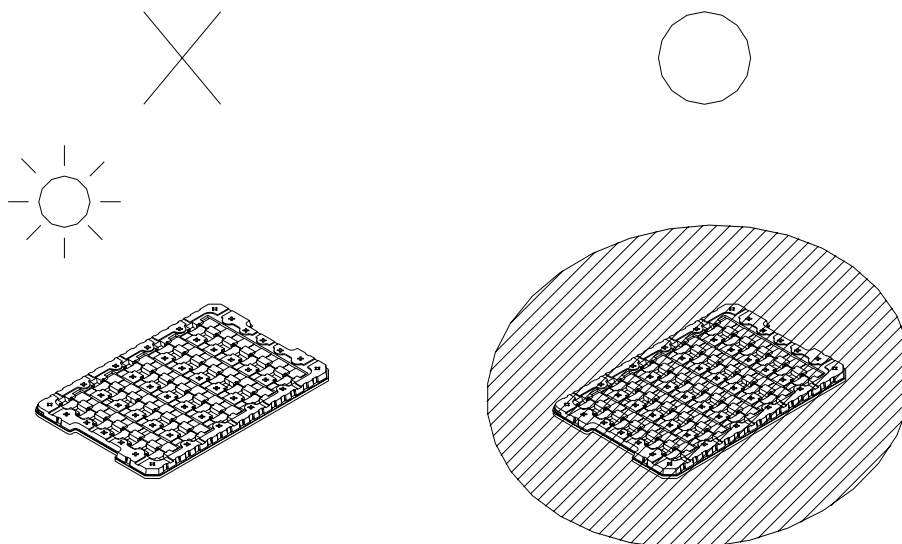
- (1) Do not operate the LCD panel under outside of electrical specification. Otherwise LCD panel may be damaged.
- (2) Do not use the LCD panel under outside of specified driving timing chart. Otherwise LCD panel may not have proper picture quality.
- (3) A still image should be displayed less than two hours, if it is necessary to display still image longer than two hour, display image data must be refreshed in order to avoid sticking image on LCD panel.

[Precautions for Storage]

- (1) After opening the package, do not leave the LCD panel in direct sun or under strong ultraviolet ray. Store in dark place.
- (2) In temperature lower than specified rating, liquid crystal material will coagulate. In temperature higher than specified rating, it isotropically liquifies. In either condition, the liquid crystal may not recover its original condition. Store the LCD panel in at or around room temperature as much as possible.
Also, storing the LCD panel in high humidity will damage the polarizer. Store in normal room temperature as much as possible.

(3) Keeping Method

- a. Don't keeping under the direct sunlight.
- b. Keeping in the tray under the dark place.



[Other Notice]

- (1) Operation outside specified environmental conditions cannot be guaranteed.
- (2) As power supply (VDD-GND, VDDA-GND) impedance is lowered during use, bus controller should be inserted near LCD module as much as possible.
- (3) UV protection film is applied over LCD panel surface. Liquid crystal inside LCD panel deteriorates with ultraviolet ray. The panel should not be left in direct sun or under strong ultraviolet ray for prolonged period of time even with the UV protection film.
- (4) Disassembling the LCD module will cause permanent damage to the module. Do not disassemble the module.
- (5) If LCD panel is broken, do not ingest the liquid crystal from the broken panel. If hand, leg, or clothes come in contact with liquid crystal, wash off immediately with soap.
- (6) ODS (specific chlorofluorocarbon, specific halon, 1-1-1 trichloroethane, carbon tetrachloride) are not used or contained in material or all production processes of this product.
- (7) Observe all other precautionary requirements in handling general electronic components.

Discarding liquid crystal modules

LCD Panel : Dispose of as glass waste. This LCD module contains no harmful substances.

The liquid crystal panel contains no dangerous or harmful substances.

This liquid crystal panel contains only an extremely small amount of liquid crystal (approximately 100mg) and therefore it will not leak even if the panel should break.

Its median lethal dose (LD50) is greater than 2,000 mg/kg and a mutagenetic (Aims test: negative) material is used.

FPC : (1) FPC bend R should be 0.45mm or greater and R should be even.

In LCD panel an connective area, do not bend FPC into UV protection film side.

(2) Do not hang LCD module by FPC or apply force to FPC.



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LS013B4DN02

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1. Outline

This TFT-LCD module is a reflective active matrix memory liquid crystal display module with CG silicone thin film transistor. Module outline is indicated in fig 8-1.

2. Characteristics

- Reflective panel of white and black with aspect ratio of 1:1
- 1.3" screen has 96x 96 resolution. (9216 pixels stripe array)
- Display control by serial data signal communication.
- Arbitrary line data renewable.
- 1bit internal memory for data storage within the panel.
- Thin, light-weight and compact module with monolithic technology.
- Super low power consumption TFT panel.

3. Mechanical Specification

Table 3-1

Item	Specification	unit
Screen size	3.4 (1.3")	cm
Viewing Area	24.192 (H) × 24.192 (V)	mm
Dot configuration	96 (H) × 96 (V)	Dot
Dot pitch	0.252 (H) × 0.252 (V)	mm
Pixel Array	Stripe Array	-
Outline Dimension	28.2 (W) × 32.34 (H) × 1.40 (D)	mm
Mass	3.6 (TYP)	g
Surface Hardness	3H	Pencil hardness

(Note) Detail dimension and tolerance are shown in fig. 8-1

The FPC shape isn't included in the outline dimension.

4. Input terminal names and functions

Table4-1

Terminal	symbol	I/O	Function	Remark
1	SCLK	INPUT	Serial clock signal	
2	SI	INPUT	Serial data input signal	
3	SCS	INPUT	Chip select signal	
4	EXTCOMIN	INPUT	External COM inversion signal input (H: enable)	
5	DISP	INPUT	Display ON/OFF signal	[Remark4-2]
6	VDDA	POWER	Power supply (Analog)	
7	VDD	POWER	Power supply (Digital)	
8	EXTMODE	INPUT	COM inversion select terminal	[Remark4-1]
9	VSS	GND	GND(Digital)	
10	VSSA	GND	GND(Analog)	

[Remark4-1] When it's "H", EXTCOMIN signal is enable. And when it's "L", serial input flag is enable.

[Remark4-1] When it's "H", EXTCOMIN signal is enable. And when it's "L", serial input flag is enable.

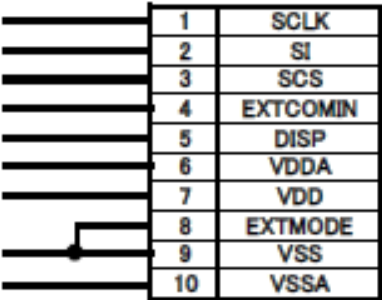
"H"mode; connect the EXTMODE toVDD, "L" mode; connect the EXTMODE to VSS.

[Remark4-2] The display ON/OFF signal is only for display. Data in the memory will be saved at the time of ON/OFF.

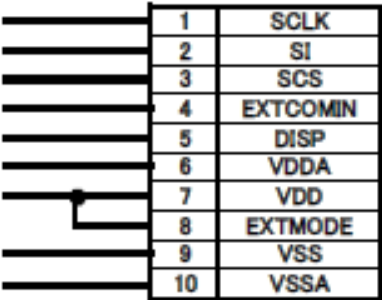
When it's "H", data in the memory will display, when it's "L", white color will diaplay and data in the memory will be saved.

4-2) Recommended circuit;

COM Signal Serial Input
EXTMODE=L



External COM Signal Input
EXTMODE=H



5. Absolute Maximum Rating

Table5-1 (GND=0V)

Item		Symbol	MIN.	MAX.	Unit	Remark
Power supply voltage	Analog	VDDA	-0.3	+5.8	V	
	Logic	VDD	-0.3	+5.8	V	[Remark5-1]
Input signal voltage(high)				VDD	V	[Remark5-2]
Input signal voltage(low)			-0.3		V	
Storage Temperature		Tstg	-30	+80	°C	[Remark5-3,4]
Operation Temperature (at panel surface)		Topr1	-20	+70	°C	[Remark5-5]

[Remark5-1] Applies to EXTMODE.

[Remark5-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.

[Remark5-3] Do not exceed this temperature in any parts of module.

[Remark5-4] Maximum wet bulb temperature is 57°C or lower. No condensation is allowed.

Condensation will cause electrical leak and may cause the module to not meet this specification.

[Remark5-5] Operating temperature is the temperature that guarantees only for the operation.

For contrast, response time, and other display quality determination, use Ta= +25°C.

6. Electrical characteristics

6-1) TFT LCD panel drive

Table6-1 Recommended operating Condition

VSS(GND)=0V, Ta= +25°C

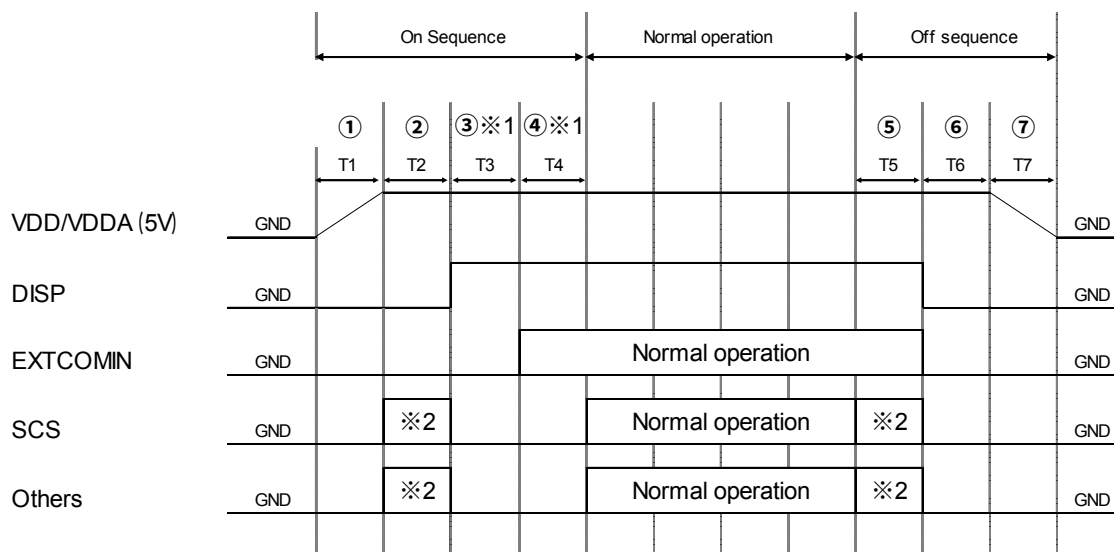
Item		symbol	MIN.	TYP.	MAX.	Unit	Remark
Power supply	Analog	VDDA	+4.8	+5.0	+5.5	V	
	Logic	VDD	+4.8	+5.0	+5.5	V	[Remark6-1]
Input signal voltage	Hi	VIH	+2.70	+3.00	※VDD	V	[Remark6-2]
	Lo	VIL	VSS	VSS	VSS+0.15	V	
Input leak current	Hi	IOH	-	-	TBD	uA	[Remark6-2] VI=3V
	Lo	IOL	-	-	TBD	uA	[Remark6-2] VI=0V

※Can operate below VDD voltage, however, operation around 3V is recommended.

[Remark6-1] Applies to EXTMODE="H"

[Remark6-2] Applies to SCLK, SI, SCS, DISP, EXTCOMIN.

6-2) Power supply sequence



※Refer to timing chart and AC timing characteristics for detail

※1 ③ and ④ may be opposite (however, TCOM polarity inversion will not occur even with EXTCOMIN between DISP="L". Also, when DISP and EXTCOMIN are simultaneously started up, allow 30us or more before SCS starts up (It may be less than 60us).

※2 Setting value for pixel memory initialization

SCS=Driving accordingly to clear pixel internal memory method (use all clear flag or write all screen white)

S1=M2 (all clear flag) = "H" or write white

SCLK: Normal Driving

[ON Sequence]

(1) 5V rise time (depends on IC)

(2) Pixel memory initialization T2: 1V or more Initialize with M2 (all clear flag) or write all screen white

(3) Release time for initialization of TCOM latch T3: 30us or more

Time required to release COM related latch circuit initialization which is initializing using DISP signals

(4) TCOM polarity initialization time T4: 30us or more

Time required initializing TCOM polarity accordingly to EXTCOMIN input

[Normal Operation]

Duration of normal driving

[Off Sequence]

(5) Pixel memory initialization time T5: 1V or more

(6) VA, VB, VCOM initialization time T6: 1V or more

(7) 5V falling time (Depends on IC)

[Remark] Precautions at ehte time of power on and power off.

Remark 1)When power on , VDDand VDDA are same timem or VDD should be faster than the VDDA.

Remark 2) When power off, VDD and VDDA are same time or VDDA should be faster than the VDD.

6-3) Input signal characteristics

Table6-3-1

VDDA=+5.0V, VDD=+5.0V, GND=0V, Ta=25°C

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Frame frequency	fSCS	1	-	60	Hz	
Clock frequency	fSCLK		1	2	MHz	
Vertical Interval	tV	16.66	-	1000	ms	
COM Frequency	fCOM	0.5	-	30	Hz	

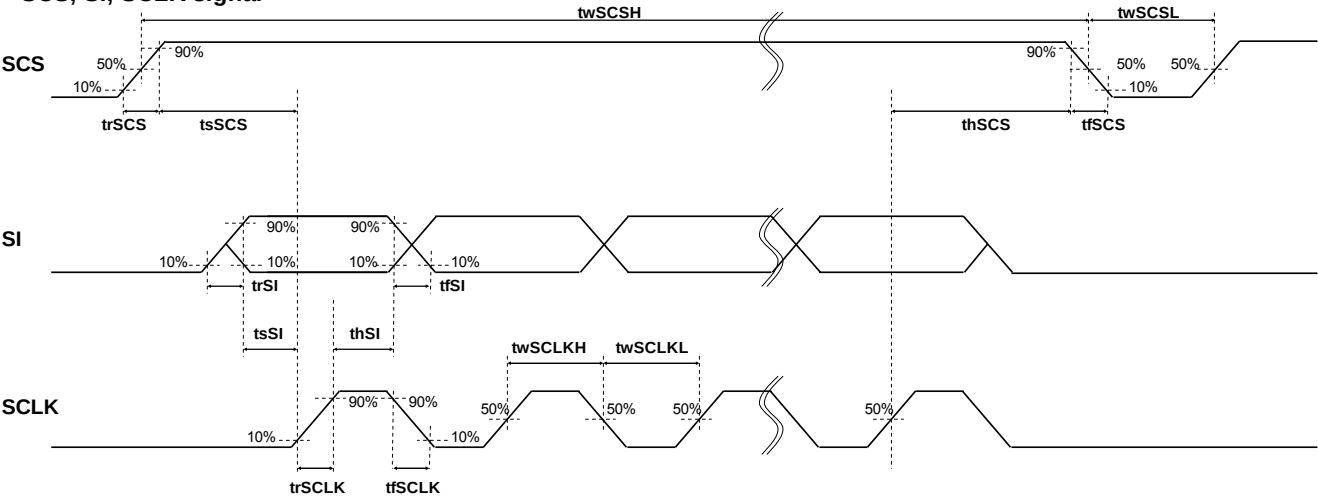
Table 6-3-2

VDDA=+5.0V, VDD=+5.0V, GND=0V, Ta=25°C

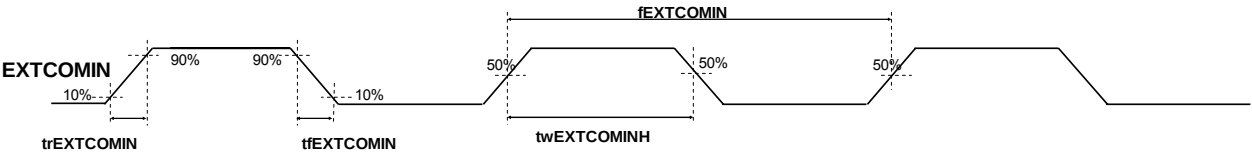
Item	Symbol	MIN	TYP	MAX	Unit	Remark
SCS Rising time	trSCS	-	-	50	ns	
SCS Falling Time	tfSCS	-	-	50	ns	
SCS High duration	twSCSH	68	-	-	us	
		12	-	-	us	
SCS Low duration	twSCSL	1	-	-	us	
SCS set up time	tsSCS	3	-	-	us	
SCS hold time	thSCS	1	-	-	us	
SI frequency	fSI	-	0.5	1	MHz	
SI Rising time	trSI	-	-	50	ns	
SI Folling time	tfSI	-	-	50	ns	
SI set up time	tsSI	120	-	-	ns	
SI hold time	thSI	125	-	-	ns	
SCLK Rising time	trSCLK	-	-	50	ns	
SCLK Folling time	tfSCLK	-	-	50	ns	
SCLK High duration	twSCLKH	200	450	-	ns	
SCLK Low duration	twSCLKL	200	450	-	ns	
EXTCOMIN signal freequency	fEXTCOMIN		1	60	Hz	[Remark6-3]
EXTCOMIN signal rising time	trEXTCOMIN	-	-	50	ns	
EXTCOMIN signal folling time	twEXTCOMIN	-	-	50	ns	
EXTCOMIN signalHigh duration	thIEXTCOMIN	1			us	
DISP Rising time	trDISP	-	-	50	ns	
DISP Folling time	tfDISP	-	-	50	ns	

[Remark 6-3] EXTCOMIN frequency should be made lower than frame frequency.

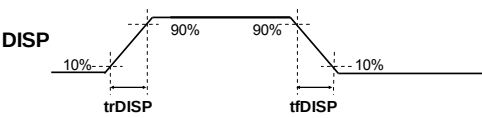
SCS, SI, SCLK signal



EXTCOMIN signal



DISP signal



※SCS,SI,SCLK、 DISP、 EXTCOMIN: 3V input voltage

6-4) Power consumption (Average)

Table6-4

Ta=25°C

Item	Symbol	MIN	TYP	MAX	unit	Remark
Condition1			15		uW	[Remark6-4]
Condition2			30		uW	[Remark6-4]

*** Measurement Condition 1**

Display mode (no display data update), Display pattern: Vertical stripe display

*** Measurement Condition 2**

Data update mode (with display data update: 1Hz)

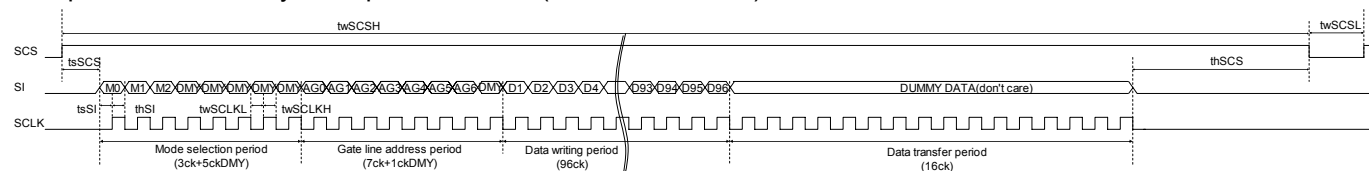
Common inversion with VDD=5V, VDDA=5V, fSCLK=1MHz, fSCS=1Hz, Display pattern: Vertical stripe display

[Remark 6-4] This is value in steady condition, not the value of peak power at the time of COM operation. Some margining for power supply is recommended. We recommend capacitor for VDD and VDDA. (If VDD and VDDA are on separate systems, we recommend capacitor for each.)

6-5) Input Signal Timing Chart

6-5-1 Data update mode (1 line)

Updates data of only one specified line. (M0="H", M2="L")



M0: Mode flag. Set for "H". Data update mode (Memory internal data update)

When "L", display mode (maintain memory internal data).

M1: Frame inversion flag.

When "H", outputs VCOM="H", and when "L", outputs VCOM="L".

When EXTMODE="H", it can be "H" or "L".

M2: All clear flag.

Refer to 6-5-4) All Clear Mode to execute clear.

DUMMY DATA: Dummy data. It can be "H" or "L" ("L" is recommended.)

※ Data write period

Data is being stored in 1st latch block of binary driver on panel.

※ Data transfer period

Data written in 1st latch is being transferred (written) to pixel internal memory circuit.

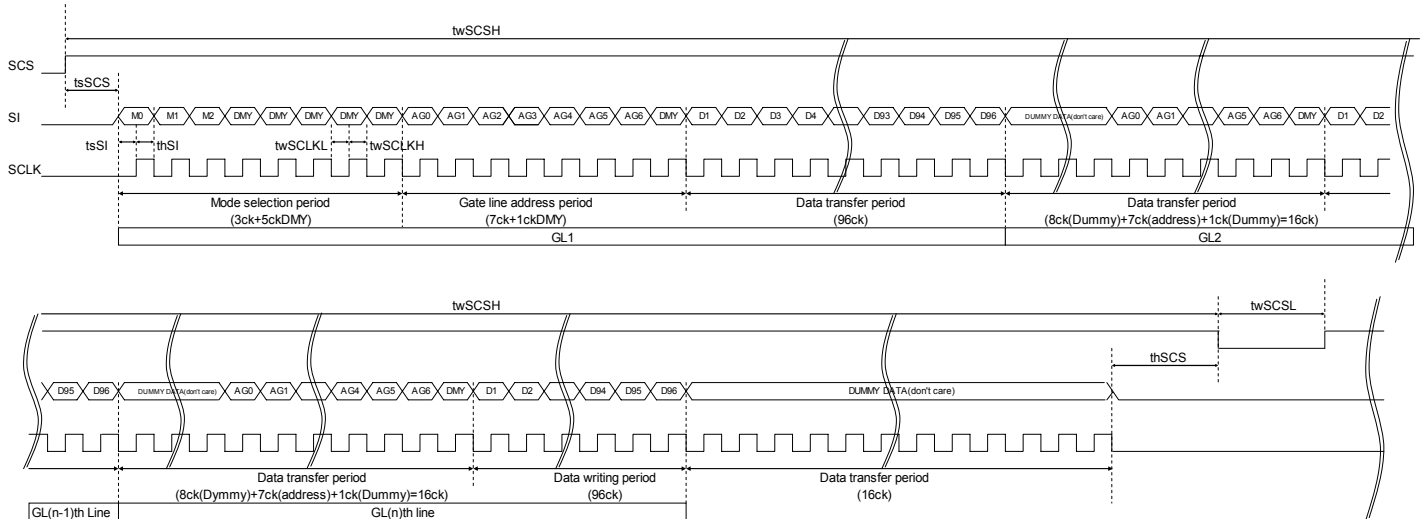
※For gate line address setting, refer to 6-6) Input Signal and Display.

※M1: Frame inversion fl is enabled when EXTMODE="L".

※When SCS becomes "L", M0 and M2 are cleared.

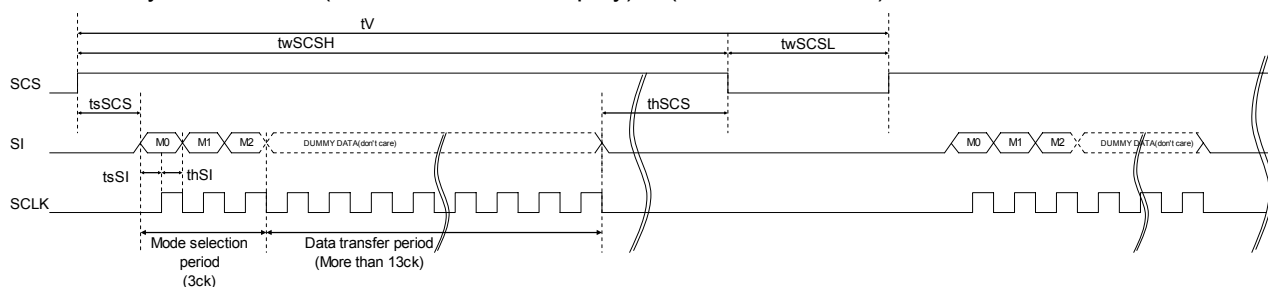
6-5-2 Data Update Mode (Multiple Lines)

Updates arbitrary multiple lines data. (M0="H", M2="L")



6-5-3 Display Mode

Maintains memory internal data (maintains current display). (M0="L", M2="L")



M0: Mode flag. Set for "H". Data update mode (Memory internal data update)

When "L", display mode (maintain memory internal data).

M1: Frame inversion flag.

When "H", outputs VCOM="H", and when "L", outputs VCOM="L".

When EXTMODE="H", it can be "H" or "L".

M2: All clear flag.

Refer to 6-5-4) All Clear Mode to execute clear.

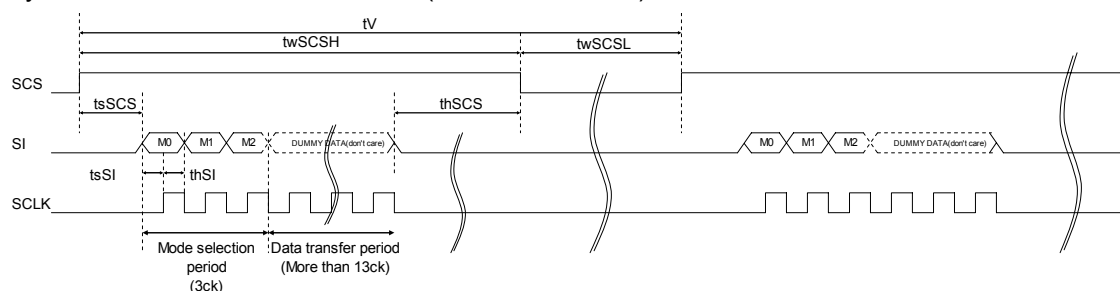
DUMMY DATA: Dummy data. It can be "H" or "L" ("L" is recommended.)

※M1: Frame inversion flag is enabled when EXTMODE="L"

※When SCS becomes "L", M0 and M2 are cleared.

6-5-4 All Clear Mode

Clears memory internal data and writes white. (M0="L", M2="H")



M0: Mode flag.

Set it "L".

M1: Frame inversion flag.

When "H", outputs VCOM="H", and when "L", outputs VCOM="L".

When EXTMODE="H", it can be "H" or "L".

M2: All clear flag.

Set it "H"

DUMMY DATA: Dummy data. It can be "H" or "L" ("L" is recommended.)

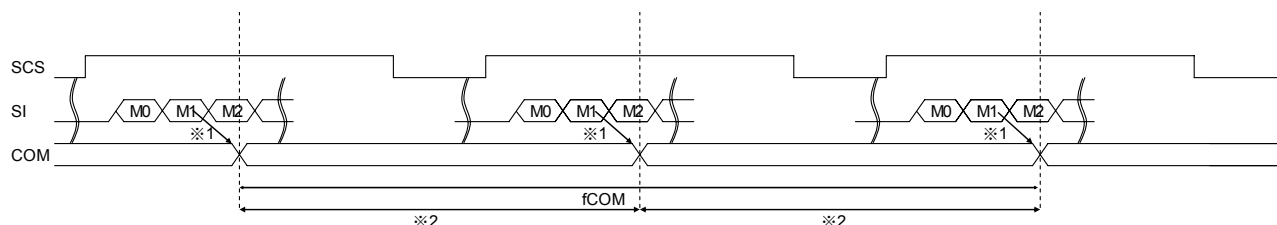
※M1: Frame inversion flag is enabled when EXTMODE="L".

※When SCS becomes "L", M0 and M2 are cleared.

6-5-5 COM Inversion

There are two types of inputs, COM signal serial input (EXTMODE="L") and external COM signal input (EXTMODE="H").

EXTMODE="L"

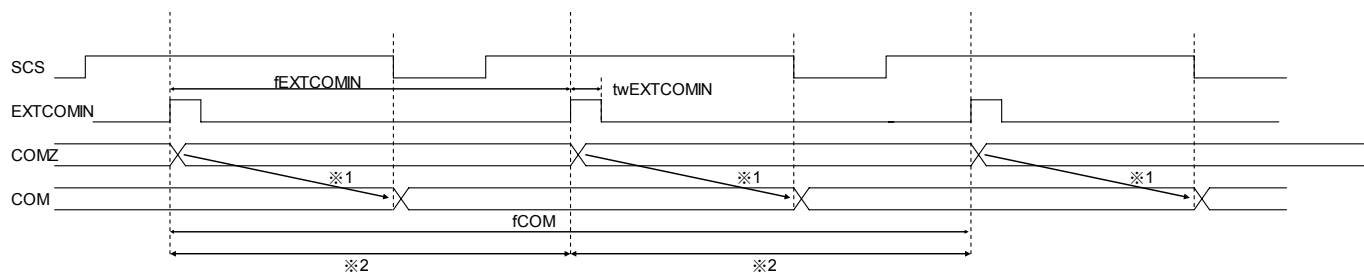


M1:LC polarity inversion flag: If M1is "H" then VCOM="H" is output. If M1 is "L" then VCOM="L" is output.

※1:LC inversion has been changed by M1 flag statement.

※2: The periods of plus polarity and minus polarity should be same length as much as possible.

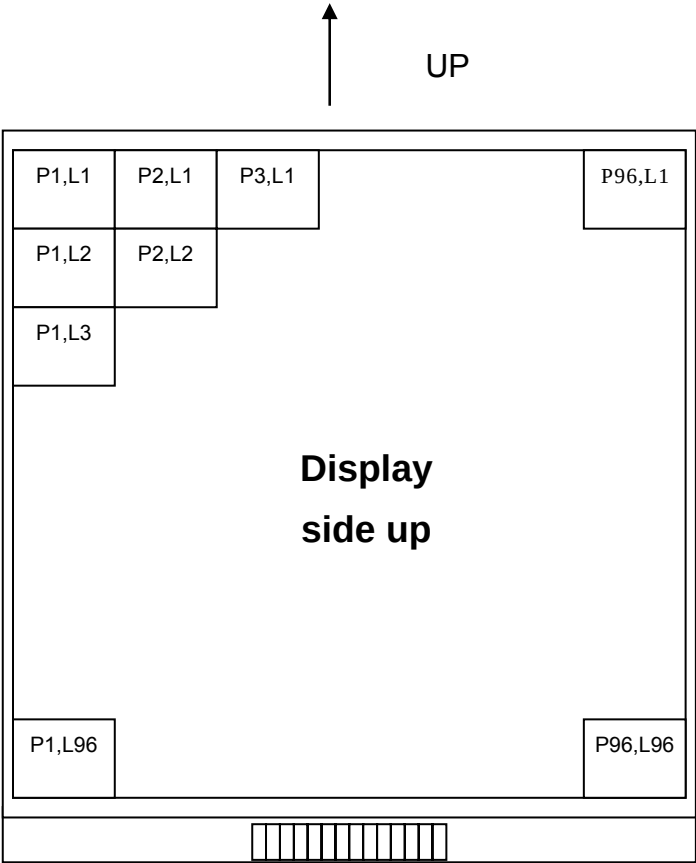
EXTMODE="H"



※1:LC inversion polarity has been set by the rising timing of EXTCOMIN in internal circuit block as COMZ signal,

※2: The period of EXTCOMIN should be constant.

6-6) Input Signal and Display, Gate address(Line) Setting
Data position in display (H,V)



Line	Gate line address setting						
	AG0	AG1	AG2	AG3	AG4	AG5	AG6
L1	H	L	L	L	L	L	L
L2	L	H	L	L	L	L	L
L3	H	H	L	L	L	L	L
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
L94	L	H	H	H	H	L	H
L95	H	H	H	H	H	L	H
L96	L	L	L	L	L	H	H

7. Optical characteristics

Table 7-1

Ta=25°C

Item		Symbol	MIN.	TYP.	MAX.	unit	Remark
Viewing angle CR≥3	H	θ21,θ22	60			°(degree)	[Remark7-1]
	V	θ11	60			°(degree)	
		θ12	60			°(degree)	
Contrast ratio		CR.	5	10			[Remark7-2,3]
Reflecivity ratio		R		50		%	[Remark7-3]
Response time	Rise	tr		50		ms	[Remark 7-3,4]
	Fall	td		50		ms	
Panel Chromaticity	White	x		0.313			[Remark7-3]
		y		0.338			

[Remark7-3] Optical characteristics measurement equipment.

Figure 7-2 is for contrast ratio, reflectivity ratio, and panel chromaticity measurement, and figure 7-3 is for response time measurement. Both are to be conducted in a dark or room equipment to a dark room

Measurement equipment
(CM-2002)

Normal line

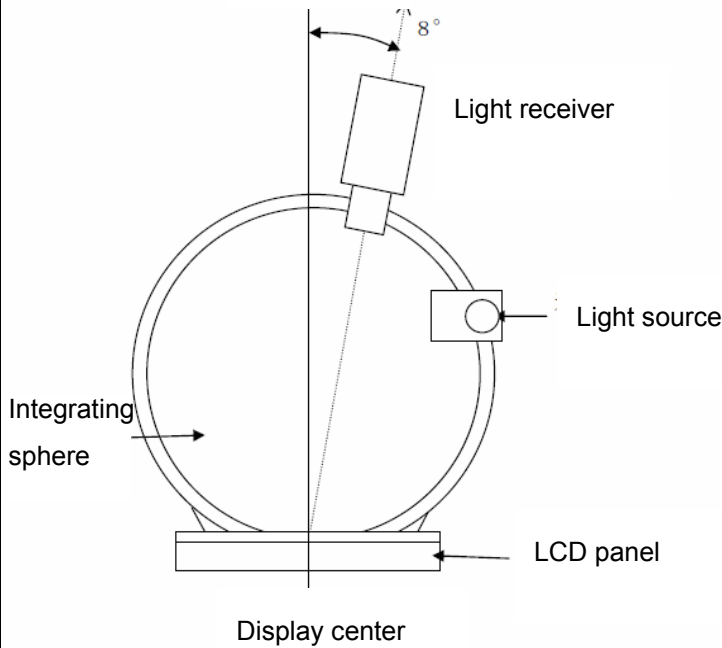


Fig7-2 Contrast ratio, Reflection ratio, Panel chromaticity of white

Measurement equipment
(LCD-5200)

Normal line

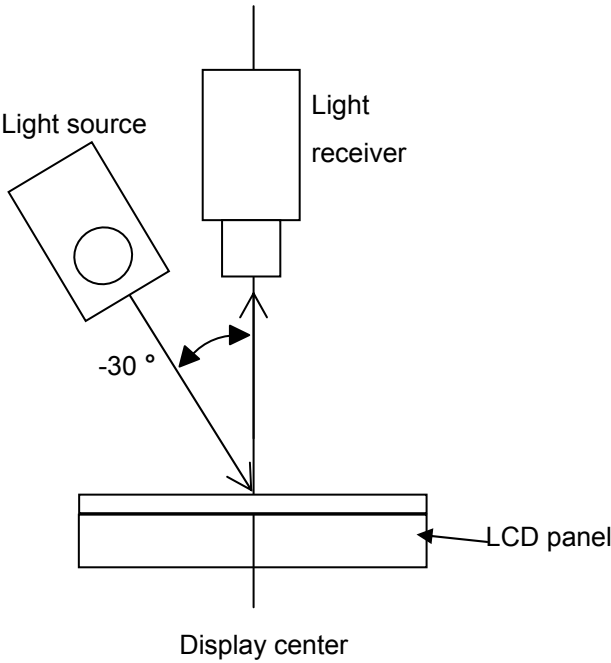
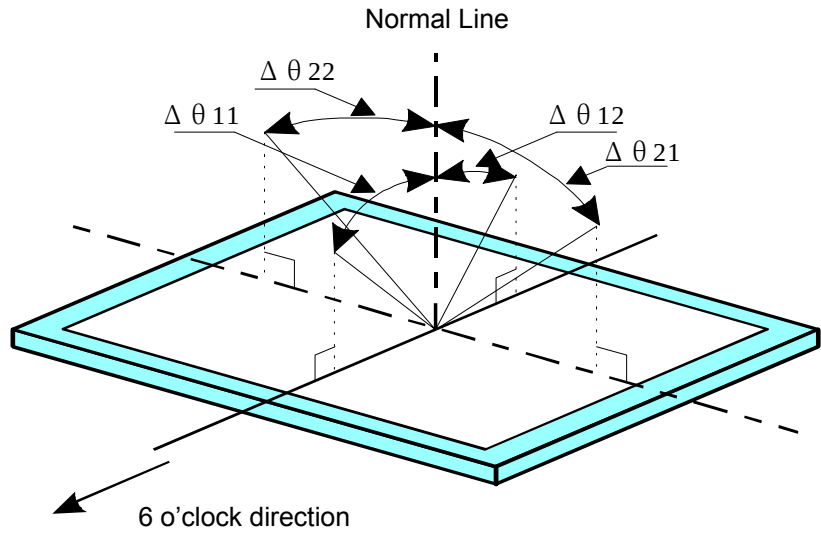


Fig7-3 response time

[Remark7-1] Defintion of Viewint Angle

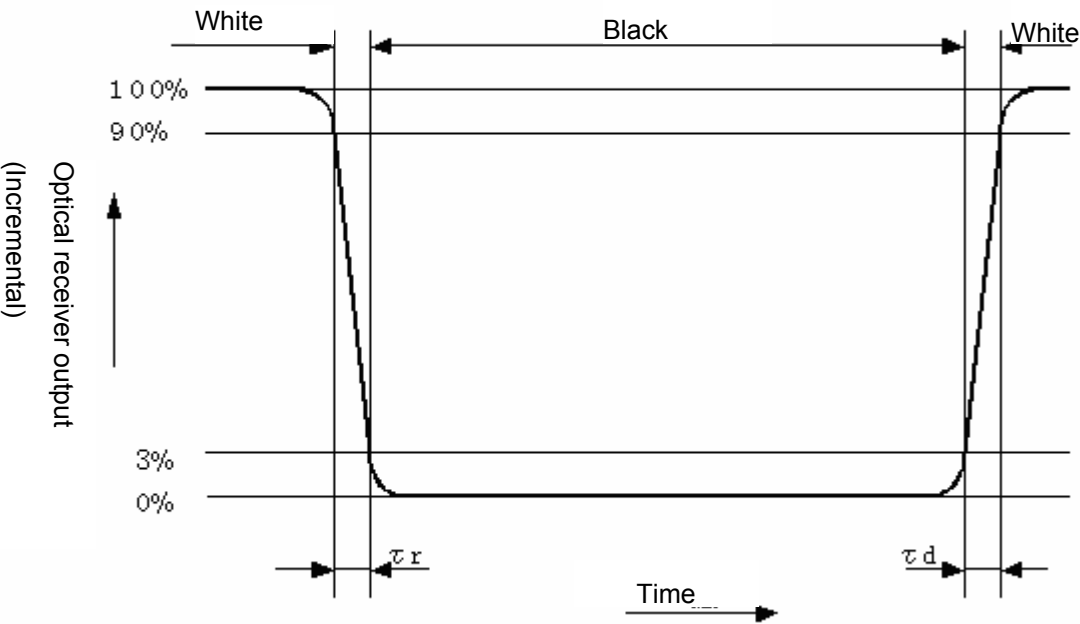


[Remark7-2] Defintion of Contrast Retio

Contrast ratio(CR) = $\frac{\text{Reflection intensity in white display}}{\text{Reflection intensity in black display}}$

[Remark7-4] Respons time (Change in reflection ratio)

It's difined by the time change of optical receiver output when signal is input to display white or black



9. External capacitors

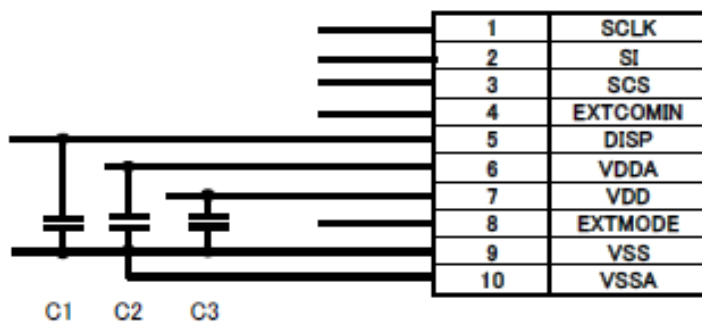


Fig. 9-1 External capacitor recommendation capacity value

<Recommended capacity value>

C1: DISP- VSS: rank B 0.1uF Ceramic capacitor

C2: VDDA- VSS: rank B 1uF Ceramic capacitor

C3: VDD- VSS: rank B 1uF Ceramic capacitor

※Above circuit and parts are only recommendation.

For actual use, please evaluate their conformity with your system and design.

(Capacitor pressure resistance can be larger than resistance indicated above.)

10. External Power Supply Circuit

An external power supply circuit is necessary to drive the Pixel Memory LCD with the 3V battery.

Table 1-1 shows power supply IC of the recommendation.

Table 1-1

Maker	Model Number	Note
SII	S-8821	Charge pump type
National Semiconductor	LM2750	Charge pump type

Refer to specifications of each power supply IC for a detailed specification.

Set the constant value after it evaluating it sufficiently by an actual application when you use it.

Electrical specification

Table 2-1

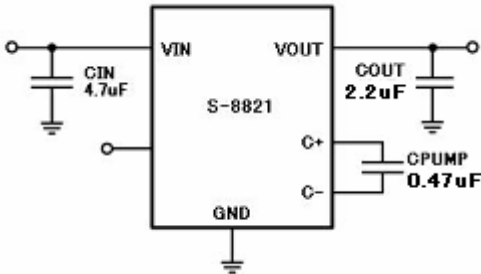
Model Number	Vin [V]		Vout			Iout [A]
	min	max	min	typ	max	
S-8821	2.8	5.0	4.9	5.0	5.1	0.04
LM2750	2.7	5.6	4.8	5.0	5.2	0.04

Refer to specifications of each power supply IC for a detailed specification.

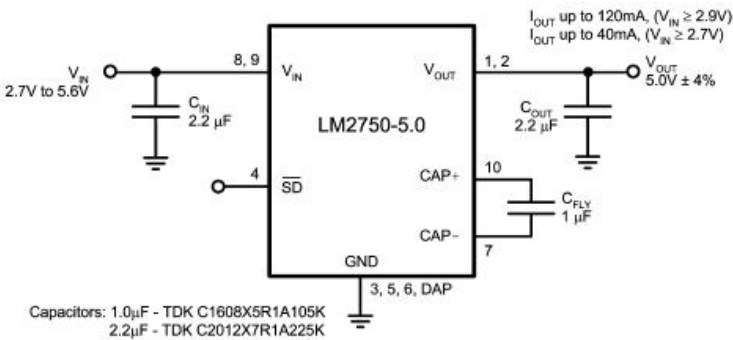
Set the constant value after it evaluating it sufficiently by an actual application when you use it.

Reference circuit

The reference circuit is shown below.



S-8821



LM2750

11. Packaging

11-1) Serial number (Ink-jet print)

Will be indicated on serial number label as indicated in Figure 11-1 outline dimension figure.

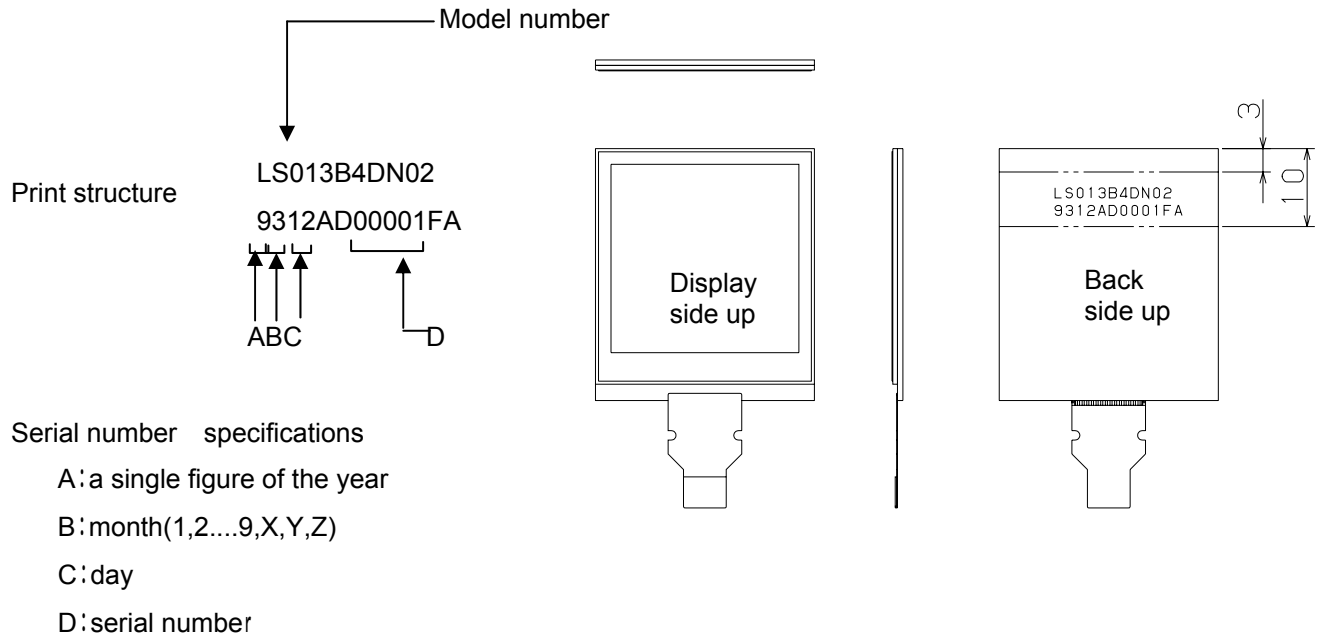


Fig. 11-1 Serial number print position

11-2) Forwarding form

1) Piling number of cartons : Max 12

Package quality in a carton : 800pcs

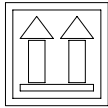
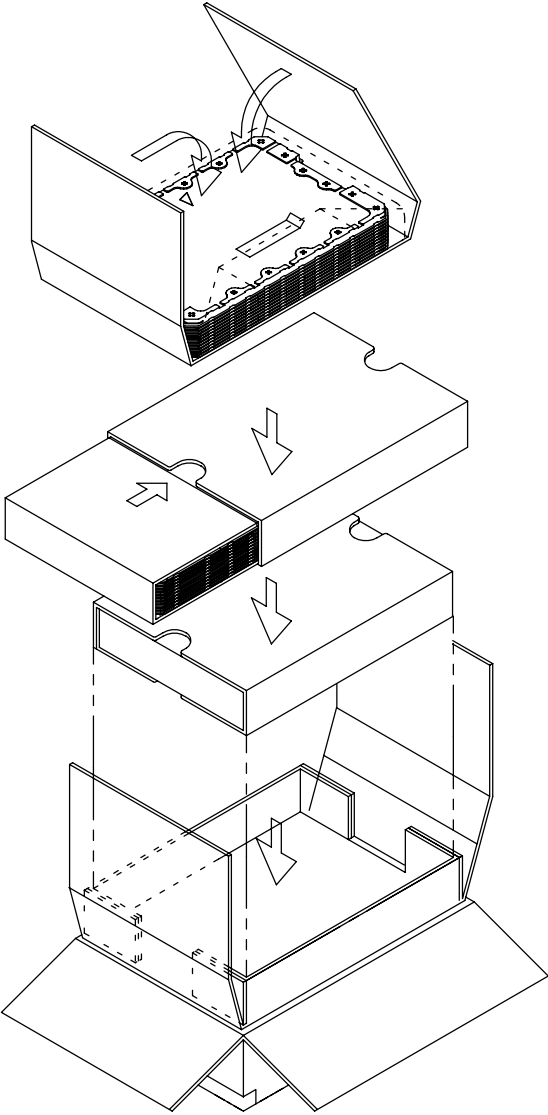
2) Storage condition

- Temperature: 0~40°C
- Humidity: 60%RH or lower (at 40°C)

There should be no condensation at low temperature and high humidity.

- Atmosphere: No harmful gas, such as acid or alkali, which causes severe corrosion on electronic parts and wiring, are to be detected.
- Period: About 3 months
- Opening the package: in order to prevent electrostatic damage to TFT modules, room humidity should be made over 50%RH and take effective measure such as use of earth when opening the package.

11-3) Packaging



FRAGILE
取扱注意



SHARP®
Electronic Components

TYPE		社内品番: (4S) LS013B4DN02
QUANTITY		LotNO. : (1T) 2009. xx, xx
LOT (DATE)		Quantity: (Q) 800 PCS
		ユーザー品番 :
		シャープ物流用ラベルです。 () ()

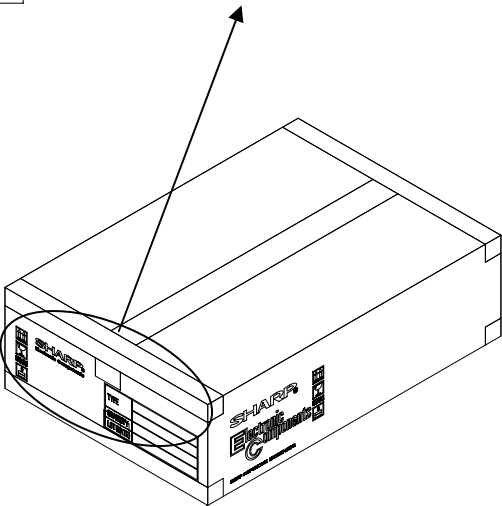


Fig. 12-2 Packaging Form

12. Reliability Test Conditions

12-1) Reliability test items

Table12-1

	Test Item	Test condition	Remark
1	High temperature storage test	Ta=80degrees Celsius 240h	
2	Low temperature storage test	Ta=35degrees Celsius 240h	
3	High temperature and high humidity operating test	Tp=40degrees Celsius/95%RH 240h	
4	High temperature operating test	Tp=70degrees Celsius 240h	
5	Low temperature operating test	Tp=-20degrees Celsius 240h	
6	Shock test (Non operating test)	Ta=-30degrees Celsius (1h)~+80 degrees Celsius (1h) / 5 cycle	
7	Electro static discharge test	±200V, 200pF(0Ω) each terminai: 1 time	

[Remark] Ta = Ambient temperature, Tp = Panel temperature

(Evaluation method)

In the standard condition, there shall be no practical problems that may affect the display function.

12-2) Panel surface stress spesification

Panel surface stress spesification has been defined as a parameter "Force of stress [N]" without no picture failer.

Load testing: Minimum 120[N]

Test condition)

Test stracture : LCD panel with UV protection film
 Press point : Center of LCD panel
 Press Jig : φ10mm column
 Press speed : 1mm／minute
 Support : fixed on stage
 Press time : 5 seconds after achivement of the press strength,then releass it.