MULTI-INNO TECHNOLOGY CO., LTD.

www.multi-inno.com

LCD MODULE SPECIFICATION

Model : MI160160L-G

For Customer's Acceptance:

Customer	
Approved	
Comment	

Revision	1.0
Engineering	
Date	2012-01-19
Our Reference	

REVISION RECORD

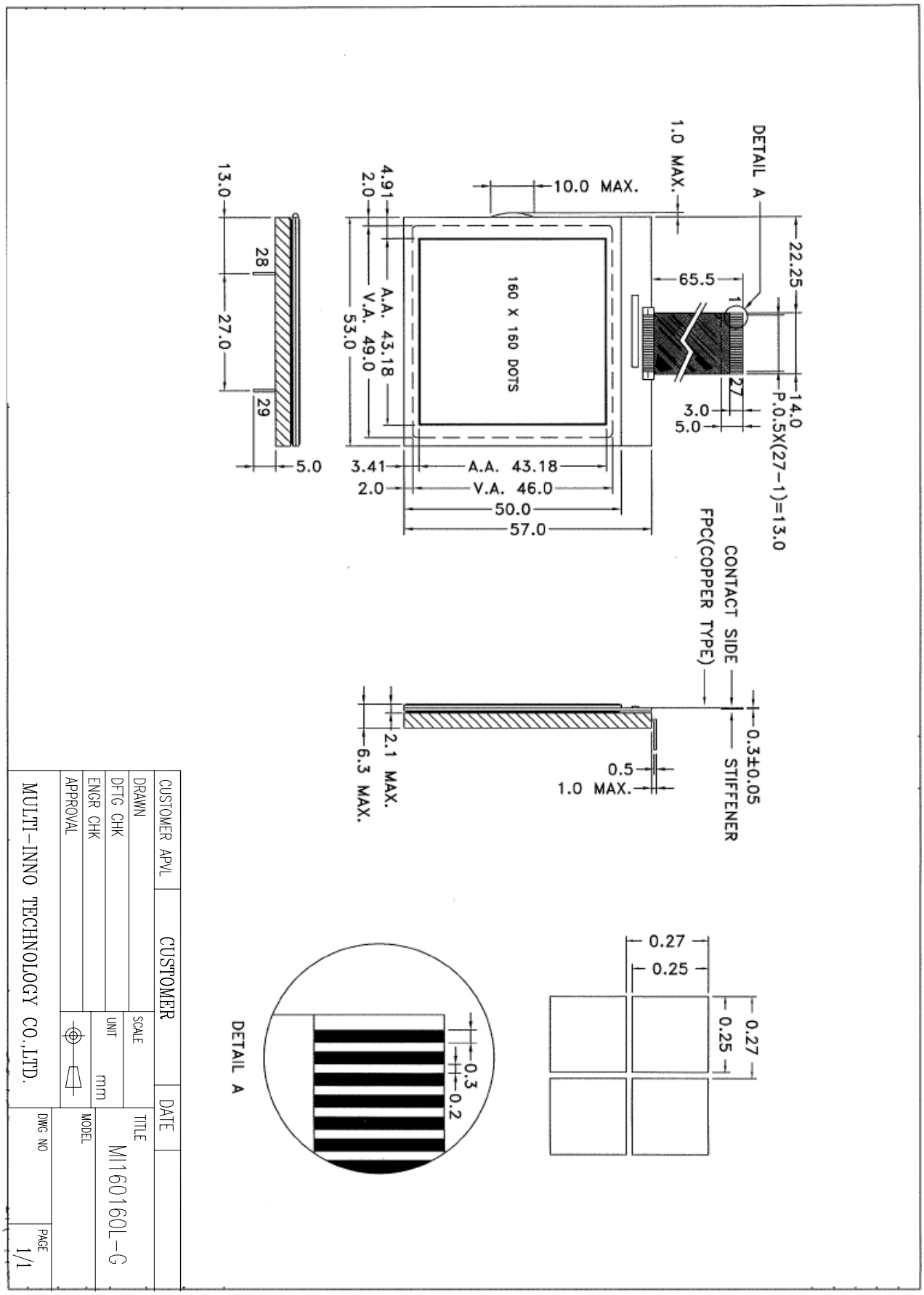
REV NO.	REV DATE	CONTENTS	REMARKS
1.0	2012-01-19	First release	/

CONTENTS

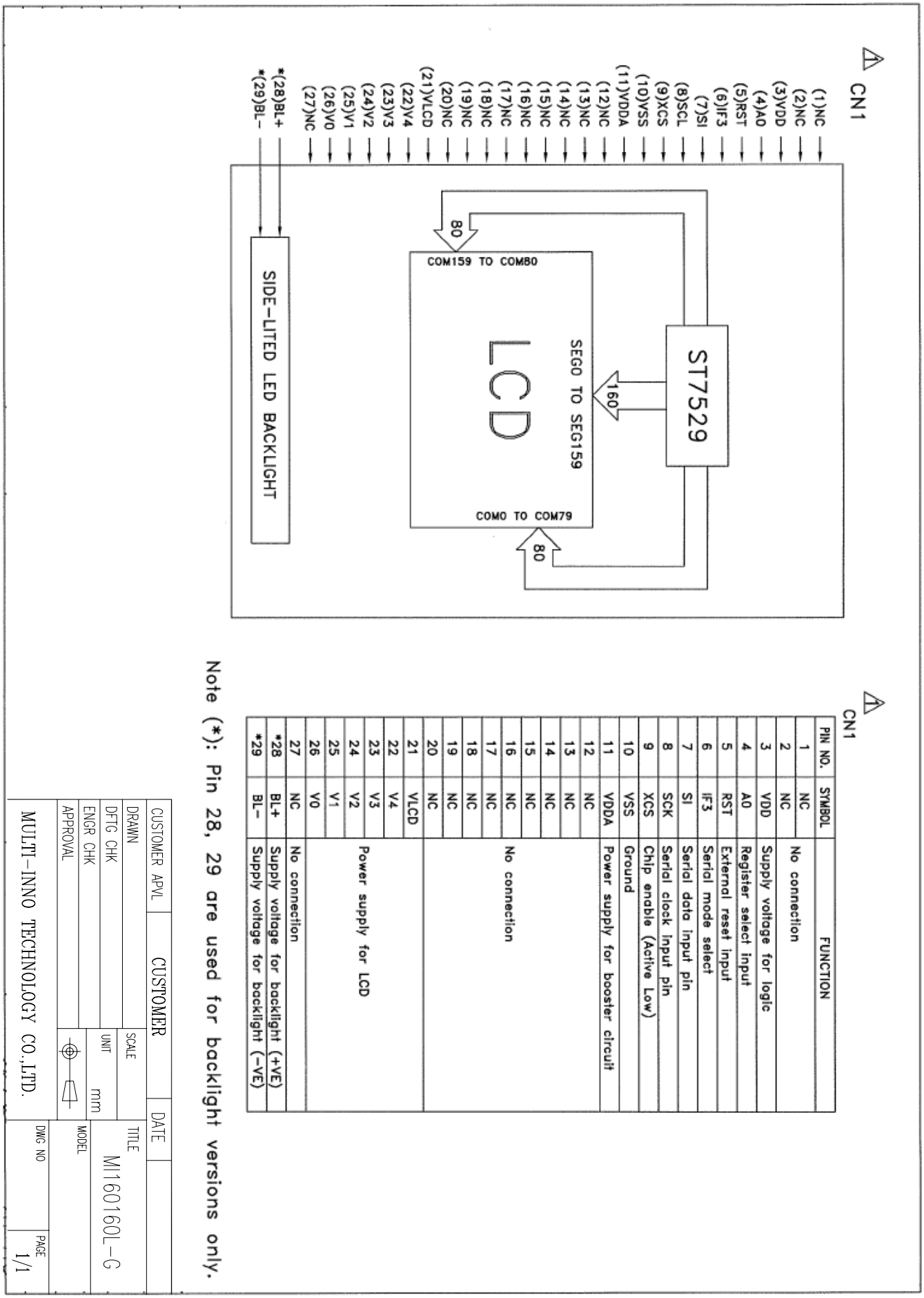
■ GENERAL INFORMATION

Item of general information	Contents	Unit
LCD type	STN mode/Normal	/
Recommended Viewing Direction	6:00	O' Clock
Number of Dots	160×160	/
No backlight (L ×W×H)	53.00×57.00×2.10	mm^3
LED sided backlight (L×W×H)	53.00×57.00×6.30	mm^3
Viewing area (L ×W)	49.00×46.00	mm^2
Dot size (L×W)	0.25×0.25	mm^2
Dot pitch (L × W)	0.27×0.27	mm^2
Driver IC	ST7529	/
Interface Type	Serial / Parallel	/
Input voltage	3.0	V
Module Power consumption	--	mw
Driving method	1/160 duty,1/14 bias	/

■ EXTERNAL DIMENSIONS



■ BLOCK DIAGRAM



CN1

PIN NO.	SYMBOL	FUNCTION
1	NC	No connection
2	NC	
3	VDD	Supply voltage for logic
4	A0	Register select input
5	RST	External reset input
6	IF3	Serial mode select
7	SI	Serial data input pin
8	SCK	Serial clock input pin
9	XCS	Chip enable (Active Low)
10	VSS	Ground
11	VDDA	Power supply for booster circuit
12	NC	No connection
13	NC	
14	NC	
15	NC	
16	NC	
17	NC	
18	NC	
19	NC	
20	NC	
21	VLCD	Power supply for LCD
22	V4	
23	V3	
24	V2	
25	V1	
26	V0	
27	NC	No connection
*28	BL+	Supply voltage for backlight (+VE)
*29	BL-	Supply voltage for backlight (-VE)

Note (*): Pin 28, 29 are used for backlight versions only.

CUSTOMER APVL	CUSTOMER		DATE
DRAWN		SCALE	
DFTG CHK		UNIT mm	TITLE MI160160L-G
ENGR CHK			MODEL
APPROVAL			DWG NO
MULTI-INNO TECHNOLOGY CO.,LTD.			PAGE 1/1

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating (for normal temperature)	Rating (for wide temperature)	Unit
Supply Voltage	VDD	4.0	4.0	V
Input Voltage	VT	-0.5 to VDD +0.5	0.5 to VDD +0.5	V
Operating Temperature	Topr	0 to 50	-20 to 70	℃
Storage Temperature	Tstg	-10 to 60	-30 to 80	℃

■ ELECTRICAL CHARACTERISTICS

Conditions: VSS=0V, Ta=25℃

Item	Symbol	MIN.	TYP.	MAX.	Unit	Item	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage for Logic	VDD	2.75	3.0	3.25	V	“H”Level Input Voltage	VIH	0.7VDD	–	VDD	V
Supply Current for Logic	IDD	–	0.17	0.29	mA	“L”Level Input Voltage	VIL	VSS	–	0.3VDD	V
Power supply for LCD control (*)	VLCD	–	15.0	–	V	Operating voltage for LCD (*)	V0	12.35	13.0	13.65	V
Power supply for LCD control (* for FSTN negative mode)	VLCD	–	18.0	–	V	Operating voltage for LCD (*for FST negative mode)	V0	16.15	17.0	17.8	V

(*) Note: There is tolerance in optimum LCD driving voltage during production and it will be within the specified range.

Side-lited LED backlight:

Constant voltage driving:

Item	Symbol	MIN.	TYP.	MAX.	Unit	Condition
White color	IBL	27	32	37	mA	VBL = 5.0V
Blue color	IBL	60	70	80	mA	VBL = 5.0V

■ ELECTRO-OPTICAL CHARACTERISTICS

Item of electro-optical characteristics	Symbol	Condition	Min	Typ	Max	Unit	Remark	Note
Response time	Tr+ Tf	θ=0° ∅=0° Ta=25℃	–	750	–	ms	Fig.1	4
Contrast ratio	Cr		–	8	–	---	FIG 2.	1
Luminance uniformity	δ WHITE		-	-	–	%	-	-
Surface Luminance	Lv		-	-	–	cd/m^2	-	
Viewing angle range	θ	∅ = 90°	–	35	–	deg	FIG 3.	6
		∅ = 270°	–	55	–	deg	FIG 3.	
		∅ = 0°	–	40	–	deg	FIG 3.	
		∅ = 180°	–	40	–	deg	FIG 3.	

Note1. Contrast Ratio(CR) is defined mathematically by the following formula. For more information see FIG 2.:

$$\text{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels (P 1,P2, P 3,P4, P5)}}{\text{Average Surface Luminance with all black pixels (P1, P2, P 3,P4, P5)}}$$

Note2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information see FIG 2.

Lv = Average Surface Luminance with all white pixels (P1, P2, P 3,P4, P5)

Note3. The uniformity in surface luminance（δ WHITE）is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by minimum luminance of 5 points luminance. For more information see FIG 2.

$$\delta\ \mathbf{WHITE} = \frac{\textbf{Minimum Surface Luminance with all white pixels } (P_1, P_2, P_3, P_4, P_5)}{\textbf{Maximum Surface Luminance with all white pixels } (P_1, P_2, P_3, P_4, P_5)}$$

Note4. Response time is the time required for the display to transition from White to black(Rise Time, Tr) and from black to white(Decay Time, Tf). For additional information see FIG 1..

Note5. CIE (x, y) chromaticity ,The x,y value is determined by screen active area position 5. For more information see FIG 2.

Note6. Viewing angle is the angle at which the contrast ratio is greater than 2. For TFT module the conrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 3.

Note7. For Viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope. Series Instruments. For contrast ratio, Surface Luminance, Luminance uniformity and CIE， the testing data is base on TOPCON's BM-5 photo detector.

Note8. For TFT transmissive module, Gray scale reverse occurs in the direction of panel viewing angle.

FIG.1. The definition of Response Time

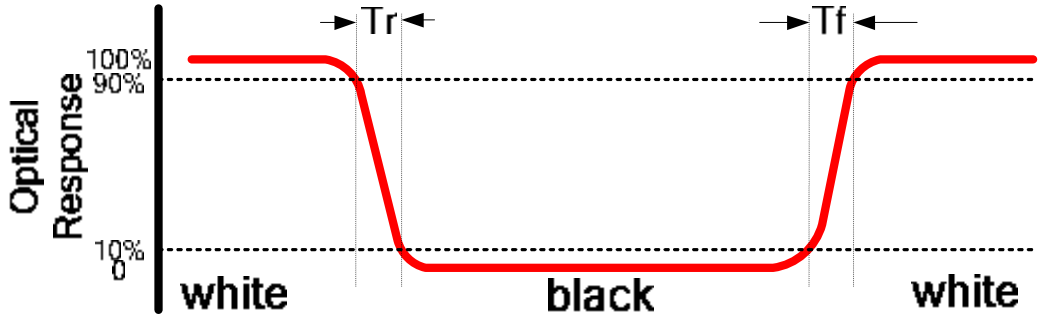


FIG.2. Measuring method for Contrast ratio,surface luminance, Luminance uniformity,CIE (x, y) chromaticity

A : 5 mm
B : 5 mm
H,V : Active Area
Light spot size ∅=5mm, 500mm distance from the LCD surface to detector lens
measurement instrument is TOPCON's luminance meter BM-5

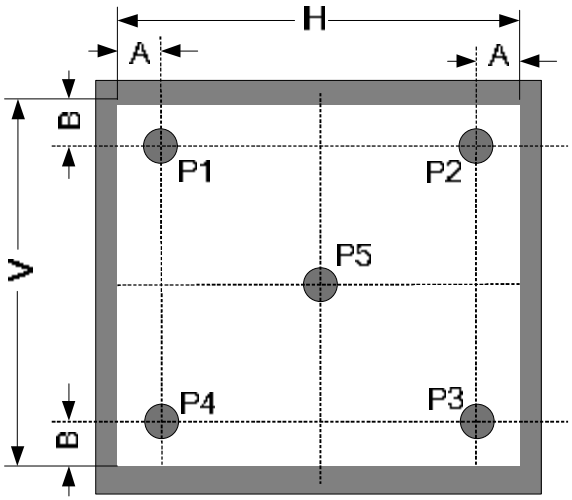
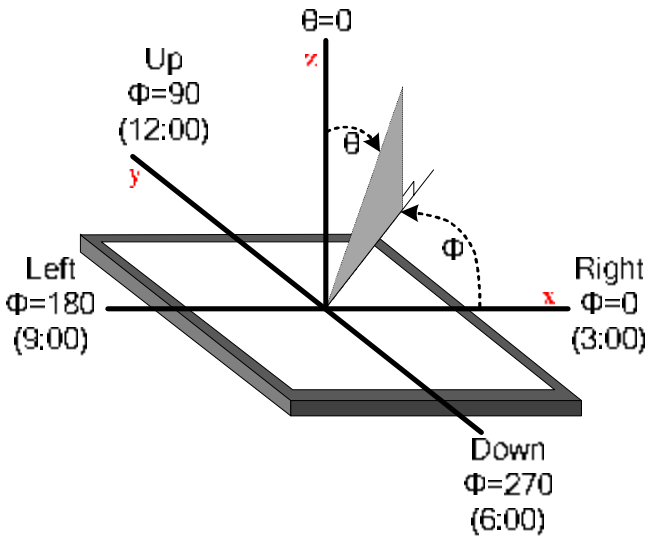


FIG.3. The definition of viewing angle

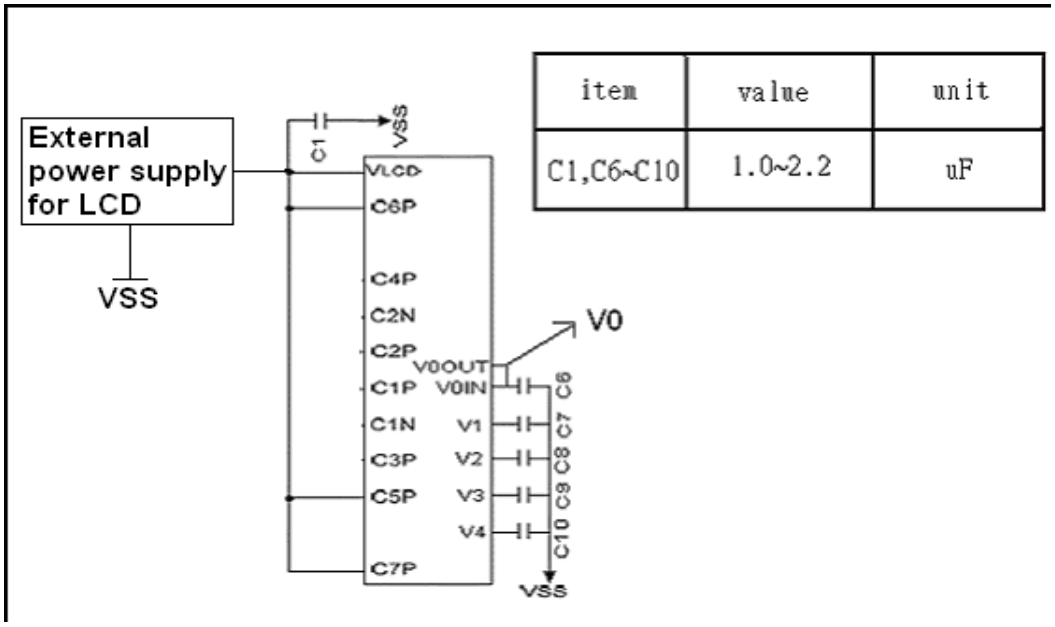


■ INTERFACE DESCRIPTION

Pin No.	Symbol	Function	Pin No.	Symbol	Function
1	NC	No connection	16	NC	No connection
2	NC		17	NC	
3	VDD	Supply voltage for logic	18	NC	
4	A0	Register select input	19	NC	
5	RST	External reset input	20	NC	
6	IF3	Serial mode select	21	VLCD	Power supply for LCD
7	SI	Serial data input pin	22	V4	
8	SCK	Serial clock input pin	23	V3	
9	XCS	Chip enable (Active Low)	24	V2	
10	VSS	Ground	25	V1	
11	VDDA	Power supply for booster circuit	26	V0	
12	NC	No connection	27	NC	No connection
13	NC		* 28	A	Supply voltage for backlight (+VE)
14	NC		* 29	K	Supply voltage for backlight (-VE)
15	NC				

Note (*) : Pin 28, 29 are used for backlight version

■ REFERENCE CIRCUIT EXAMPLE



item	value	unit
C1,C6~C10	1.0~2.2	uF

■ REFERENCE APPLICATION NOTES

1. COMMAND

1.1 Command table

Ext=0 or Ext=1

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
1	Ext In	0	1	0	0	0	1	1	0	0	0	0	Ext=0 Set	30	None
2	Ext Out	0	1	0	0	0	1	1	0	0	0	1	Ext=1 Set	31	None

Ext=0

Index	Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function	Hex	Parameter
1	DISON	0	1	0	1	0	1	0	1	1	1	1	Display On	AF	None
2	DISOFF	0	1	0	1	0	1	0	1	1	1	0	Display Off	AE	None
3	DISNOR	0	1	0	1	0	1	0	0	1	1	0	Normal Display	A6	None
4	DISINV	0	1	0	1	0	1	0	0	1	1	1	Inverse Display	A7	None
5	COMSCN	0	1	0	1	0	1	1	1	0	1	1	COM Scan Direction	BB	1 byte
6	DISCTRL	0	1	0	1	1	0	0	1	0	1	0	Display Control	CA	3 bytes
7	SLPIN	0	1	0	1	0	0	1	0	1	0	1	Sleep In	95	None
8	SLPOUT	0	1	0	1	0	0	1	0	1	0	0	Sleep Out	94	None
9	LASET	0	1	0	0	1	1	1	0	1	0	1	Line Address Set	75	2 bytes
10	CASET	0	1	0	0	0	0	1	0	1	0	1	Column Address Set	15	2 bytes
11	DATSDR	0	1	0	1	0	1	1	1	1	0	0	Data Scan Direction	BC	3 bytes
12	RAMWR	0	1	0	0	1	0	1	1	1	0	0	Writing to Memory	5C	Data
13	RAMRD	0	1	0	0	1	0	1	1	1	0	1	Reading from Memory	5D	Data
14	PTLIN	0	1	0	1	0	1	0	1	0	0	0	Partial display in	A8	2 bytes
15	PTLOUT	0	1	0	1	0	1	0	1	0	0	1	Partial display out	A9	None
16	RMWIN	0	1	0	1	1	1	0	0	0	0	0	Read and Modify Write	E0	None
17	RMWOUT	0	1	0	1	1	1	0	1	1	1	0	RMW end	EE	None
18	ASCSET	0	1	0	1	0	1	0	1	0	1	0	Area Scroll Set	AA	4 bytes
19	SCSTART	0	1	0	1	0	1	0	1	0	1	1	Scroll Start Set	AB	1 byte
20	OSCON	0	1	0	1	1	0	1	0	0	0	1	Internal OSC on	D1	None
21	OSCOFF	0	1	0	1	1	0	1	0	0	1	0	Internal OSC off	D2	None
22	PWRCTRL	0	1	0	0	0	1	0	0	0	0	0	Power Control	20	1 byte
23	VOLCTRL	0	1	0	1	0	0	0	0	0	0	1	EC control	81	2 bytes
24	VOLUP	0	1	0	1	1	0	1	0	1	1	0	EC increase 1	D6	None
25	VOLDOWN	0	1	0	1	1	0	1	0	1	1	1	EC decrease 1	D7	None
26	RESERVED	0	1	0	1	0	0	0	0	0	1	0	Not Use	82	0

27	EPSRRD1	0	1	0	0	1	1	1	1	1	0	0	READ Register1	7C	None
28	EPSRRD2	0	1	0	0	1	1	1	1	1	0	1	READ Register2	7D	None
29	NOP	0	1	0	0	0	1	0	0	1	0	1	NOP Instruction	25	None
30	STREAD	0	0	1	Read Data								Status Read		
31	EPINT	0	1	0	0	0	0	0	0	1	1	1	Initial code(1)	07	1 byte

Ext=1

Index	*Command*	*A0*	*RD*	*WR*	*D7*	*D6*	*D5*	*D4*	*D3*	*D2*	*D1*	*D0*	*Function*	*Hex*	*Parameter*
1	Gray 1 Set	0	1	0	0	0	1	0	0	0	0	0	FRAME 1 Gray PWM Set	20	16 bytes
2	Gray 2 Set	0	1	0	0	0	1	0	0	0	0	1	FRAME 2 Gray PWM Set	21	16 bytes
3	ANASET	0	1	0	0	0	1	1	0	0	1	0	Analog Circuit Set	32	3 bytes
4	SWINT	0	1	0	0	0	1	1	0	1	0	0	Software Initial	34	None
5	EPCTIN	0	1	0	1	1	0	0	1	1	0	1	Control EEPROM	CD	1 byte
6	EPCOUT	0	1	0	1	1	0	0	1	1	0	0	Cancel EEPROM	CC	None
7	EPMWR	0	1	0	1	1	1	1	1	1	0	0	Write to EEPROM	FC	None
8	EPMRD	0	1	0	1	1	1	1	1	1	0	1	Read from EEPROM	FD	None

Note: The table above is for 8-bit interface. For the application of 16-bit interface, fill D15~8 with 0, and other bits are just the same with the table above.

EXT= "0" or "1"

(1) Extension instruction disable (EXT IN) - Parameter Byte: None (30H)

Use the "EXT=0" command table

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	0	0	0

(2) Extension instruction enable (EXT OUT) - Parameter Byte: None (31H)

Use the extended command table EXT="1"

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	0	0	1

EXT= "0"

(1) Display ON (DISON) - Parameter Byte: None (AFH)

It is to turn the display on. When the display is turned on, segment and common outputs are generated at the level corresponding to the display data and display timing. As long as the sleep mode is selected, the display cannot be turned on. Thus, whenever using this command, the sleep mode must be cancelled first.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	1	1	1

(2) Display OFF (DISOFF) - Parameter Byte: None (AEH)

It is to forcibly turn the display off. As long as the display is turned off, every segment and common outputs are forced to VSS level.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	1	1	0

(3) Normal display (DISNOR) - Parameter Byte: None (A6H)

It is to normally highlight the display area without modifying contents of the display data RAM.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	0	1	1	0

(4) Inverse display (DISINV) - Parameter Byte: None (A7)

It is to inversely highlight the display area without modifying contents of the display data RAM. This command does not invert non-display areas in case of using partial display.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	0	1	1	1

(5) Common scan (COMSCN) - Parameter Byte: 1 (BBH)

It is to specify the common output scan direction. This command is for the convenience of wiring on the LCD panel.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	1	1	0	1	1	–
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	CD2	CD1	CD0	Common Scan direction

When 1/160 is selected for the display duty, pins and common output are scanned in the order shown below.

CD2	CD1	CD0	Common scan direction					
			COM0 pin		COM79 pin	COM80 pin		COM159 pin
0	0	0	0	→	79	80	→	159
0	0	1	0	→	79	159	→	80
0	1	0	79	→	0	80	→	159
0	1	1	79	→	0	159	→	80

Original graphic :

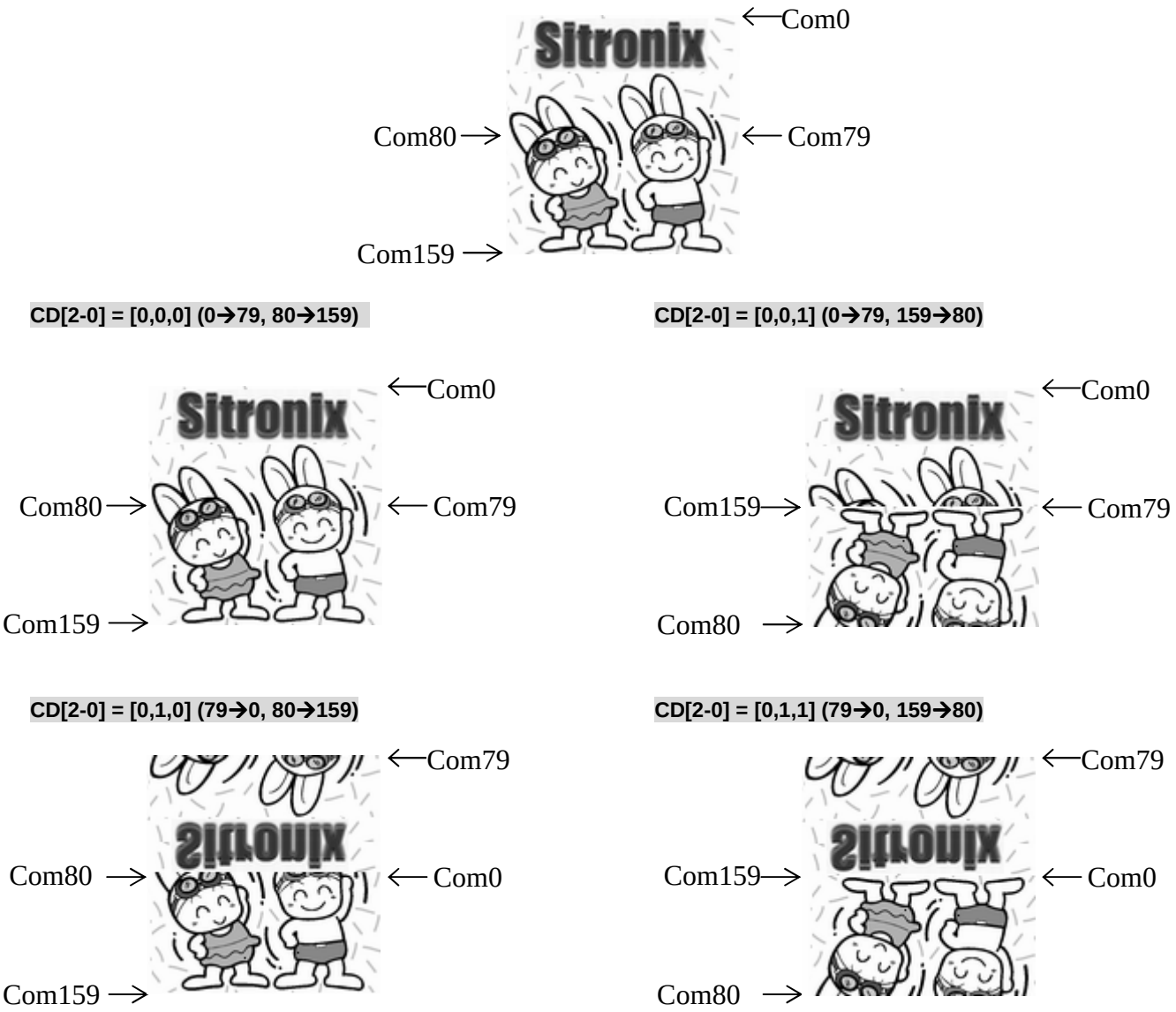


Figure 1.1.1 Common scan direction configuration

(6) Display control (DISCTRL) - Parameter Byte: 3 (CAH)

This command and succeeding parameters are used to perform the display timing-related setups. This command must be selected before using SLPOUT. Do not change this command while the display is turned on.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	1	0	0	1	0	1	0	
Parameter Byte 1 (PB1)	1	1	0	*	*	*	0	0	CLD	0	0	CL dividing ratio, F1 and F2 drive pattern.
Parameter Byte 2 (PB2)	1	1	0	*	*	DT5	DT4	DT3	DT2	DT1	DT0	Drive duty
Parameter Byte 3 (PB3)	1	1	0	*	*	*	FI	LF3	LF2	LF1	LF0	FR inverse-set value

PB1 specifies the CL dividing ratio.

CLD: CL dividing ratio. They are used to change number of dividing stages of external or internal clock.

CLD=0: not divide, CLD=1: 2 divisions.

PB2 specifies the duty of the module on block basis. Initial: 00H

(Numbers of display lines)/4-1 = DT5 x 2^5 + DT4 x 2^4 + DT3 x 2^3 + DT2 x 2^2 + DT1 x 2^1 + DT0 x 2^0

For example, 1/128 duty → 128/4-1=31 → (DT5, DT4, DT3, DT2, DT1, DT0) = (0, 1, 1, 1, 1, 1)

PB3 specifies number of line cycles (range from 2 to 16) in a frame.

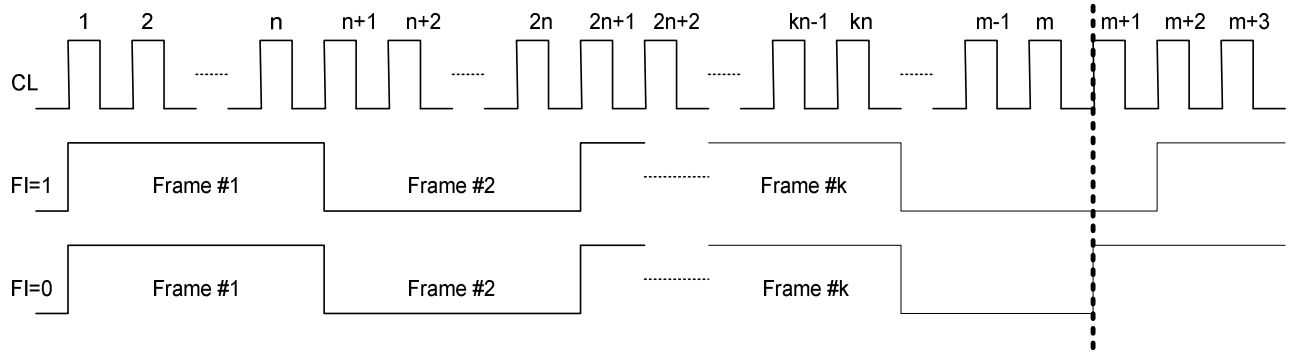
Number of line cycles-1 = LF3 x 2^3 + LF2 x 2^2 + LF1 x 2^1 + LF0 x 2^0

For example, 11 line cycles in a frame → 11-1=10 → (LF3, LF2, LF1, LF0) = (1, 0, 1, 0)

In the default, 11 line cycles in a frame is selected.

FI decides the inversion type of frame at the end of common scan cycle while the number of duty is not divisible by the number of line cycles per frame. For example, in the application of 1/m duty and n line cycles in a frame set, the difference of the choice in FI is shown as the following figure.

m = n x k + r, where m, n, k, and r are all whole numbers, and r is the remainder of m divided by n (r < n).



(7) Sleep in (SLPIN) - Parameter Byte: None (95H)

This command is to enter the SLEEP MODE.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	1	0	1	0	1

(8) Sleep out (SLPOUT) - Parameter Byte: None (94H)

This command is to exit the SLEEP MODE.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	1	0	1	0	0

(9) Line address set (LASET) - Parameter Byte: 2 (75H)

This command is to specify the line address area when MPU makes access to the display data RAM. As the addresses are increased from the start to the end line in the line-direction scan, the column address is increased by 1 and the line address return to the start line. Note that the start and end line must be a pair. Moreover, the relation “start line <end line” must be maintained.

	A0	**RD**	**WR**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**	**Function**
Command	0	1	0	0	1	1	1	0	1	0	1	–
Parameter Byte 1 (PB1)	1	1	0	SL7	SL6	SL5	SL4	SL3	SL2	SL1	SL0	Start Line
Parameter Byte 2 (PB2)	1	1	0	EL7	EL6	EL5	EL4	EL3	EL2	EL1	EL0	End Line

Note: The range of line address is 0 ~ 159.

(10) Column address set (CASET) - Parameter Byte: 2 (15H)

This command is to specify the column address area when MPU makes access to the display data RAM. As the addresses are increased from the start to the end column in the column-direction scan, the line address is incremented by 1 and the column address is returned to the start column. Note that the start and end line must be a pair. Moreover, the relation “start column <end column” must be maintained.

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	0	1	0	1	0	1	–
Parameter Byte 1 (PB1)	1	1	0	SC7	SC6	SC5	SC4	SC3	SC2	SC1	SC0	Start Column
Parameter Byte 2 (PB2)	1	1	0	EC7	EC6	EC5	EC4	EC3	EC2	EC1	EC0	End Column

Note: The range of column address is 0 ~ 84.

(11) Data scan direction (DATSDR) - Parameter Byte: 3 (BCH)

This command is to setup various parameters in the operations of display data stored on the built-in RAM by MPU.

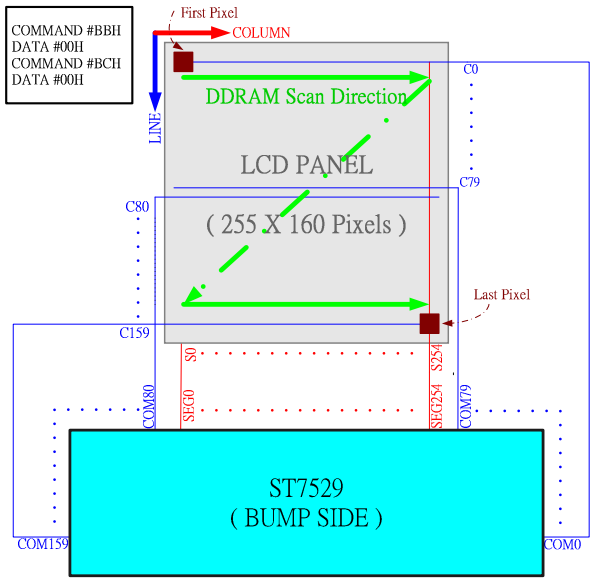
	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	1	1	1	0	0	–
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	C/L	CI	LI	Normal/inverse display of address and address scan direction.
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	*	*	CLR	P1, P2, P3 arrangement
Parameter Byte 3 (PB3)	1	1	0	*	*	*	*	*	GS2	GS1	GS0	Gray-scale setup

PB1 is to specify the normal/inverse display of the line and column address and the address scanning direction.

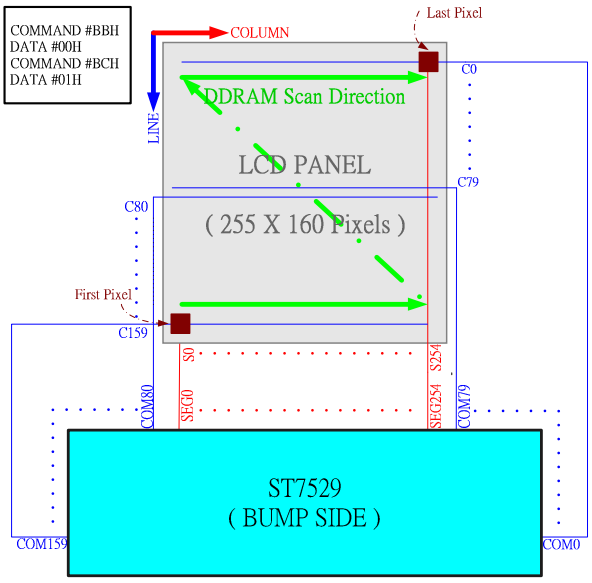
LI: Normal/inverse direction of the line address. LI =0: Normal, LI =1: Inverse

CI: Normal/reverse direction of the column address. CI =0: Normal, CI =1: Reverse

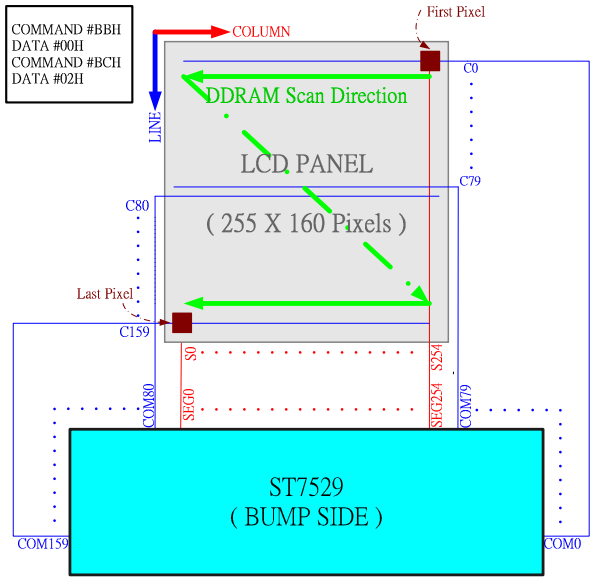
C/L: Address-scan direction. C/L =0: In the column direction, C/L =1: In the line direction



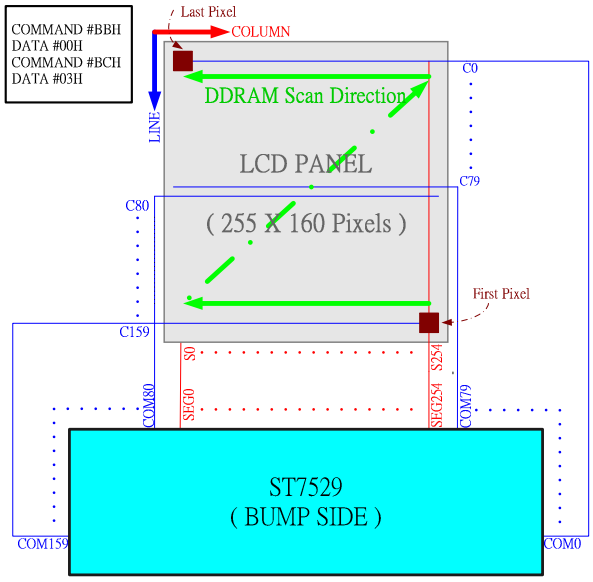
(a) COMMAND #BCH, DATA #00H



(b) COMMAND #BCH, DATA #01H

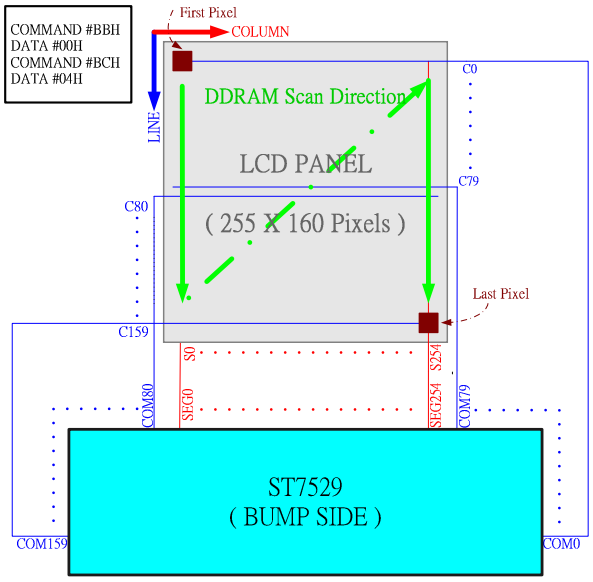


(c) COMMAND #BCH, DATA #02H

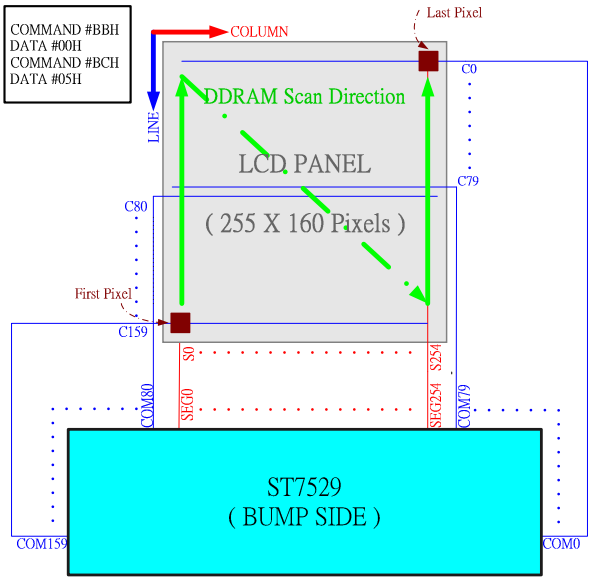


(d) COMMAND #BCH, DATA #03H

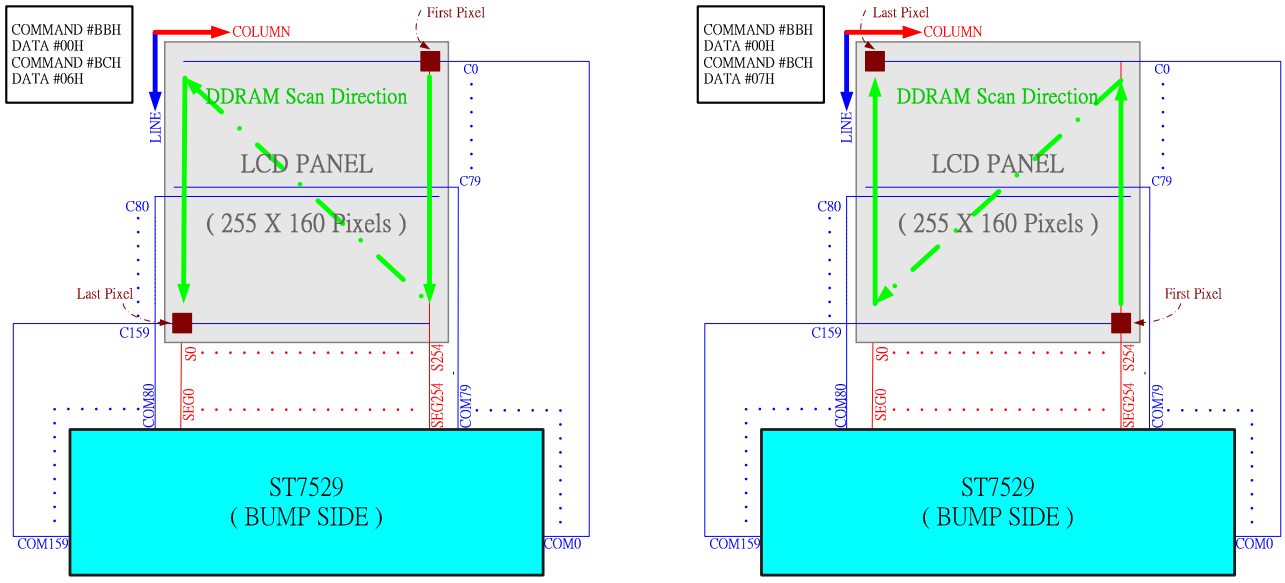
Figure 1.1.2 Different RAM accessing setup under COMMAND #BBH, DATA #00H
(a) COMMAND #BCH, DATA #00H
(b) COMMAND #BCH, DATA #01H
(c) COMMAND #BCH, DATA #02H
(d) COMMAND #BCH, DATA #03H



(e) COMMAND #BCH, DATA #04H



(f) COMMAND #BCH, DATA #05H



(g) COMMAND #BCH, DATA #06H **(h) COMMAND #BCH, DATA #07H**

Figure 1.1.2 Different RAM accessing setup under COMMAND #BBH, DATA #00H (continue)
(e) COMMAND #BCH, DATA #04H
(f) COMMAND #BCH, DATA #05H
(g) COMMAND #BCH, DATA #06H
(h) COMMAND #BCH, DATA #07H

PB2 is to change P1, P2, P3 arrangement of the segment output according to P1, P2, P3 arrangement on the LCD panel.

This command will set the writing position of data (P1, P2, P3) on the display memory to be changed or not.

CLR	SEG0	SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	…	SEG254
0	P1	P2	P3	P1	P2	P3	P1	P2	…	P3
1	P3	P2	P1	P3	P2	P1	P3	P2	…	P1

PB3 is to select desired gray scale display 2B3P mode or 3B3P mode.

GS2	GS1	GS0	Numbers of gray-scale
0	0	1	32 gray-scale 2Byte 3Pixel mode
0	1	0	32 gray-scale 3Byte 3Pixel mode

(12) Memory write (RAMWR) - Parameter Byte: Numbers of data written (5CH)

This command turns on the data entry mode when MPU writes data to the display memory. This command will always sets the line and column address at the start address while executed. The following parameter byte rewrites contents of the display data RAM and increases the line or column address automatically. The write mode is automatically cancelled if any other command is entered.

1. 8-bit bus

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	0	1	1	1	0	0	–
Parameter Byte 1 (PB1)	1	1	0	Data to be written								Data to be written

2. 16-bit bus

	A0	RD	RW	D15	D14	…	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	*	*	…	*	*	0	1	0	1	1	1	0	0	Memory write
Parameter Byte 1 (PB1)	1	1	0	Data to be written													Write date

(13) Memory read (RAMRD) - Parameter Byte: Numbers of data read (5DH)

This command turns on the data read mode when MPU read data from the display memory. This command will always sets the line and column address at the start address while executed. The contents of the display data RAM will be read in the following parameter byte and increases the line or column address automatically. The data read mode is automatically cancelled if any other command is entered.

1. 8-bit bus

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	1	0	1	1	1	0	1	--
Parameter Byte 1 (PB1)	1	0	1	Data to be read								Data to be read

2. 16-bit bus

	A0	RD	RW	D15	D14	….	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	*	*	*	*	*	0	1	0	1	1	1	0	1	Memory read
Parameter Byte 1 (PB1)	1	0	1	Data to be read													Read data

(14) Partial in (PTLIN) - Parameter Byte: 2 (A8H)

This command is to specify the partial display area. It will turn on partial display of the screen (dividing screen by lines) to save power. Since ST7529 processes the liquid crystal display signal on 4-line basis (block basis), the display and no-display areas are also specified on 4-bit line (block basis).

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	0	0	--
Parameter Byte 1 (PB1)	1	1	0	*	*	PTS5	PTS4	PTS3	PTS2	PTS1	PTS0	Start block address
Parameter Byte 2 (PB2)	1	1	0	*	*	PTE5	PTE4	PTE3	PTE2	PTE1	PTE0	End block address

Only the address of the display block can be specified for the partial display. Do not specify an address not to be displayed when scrolled.

(15) Partial out (PTLOUT) - Parameter Byte: none (A9H)

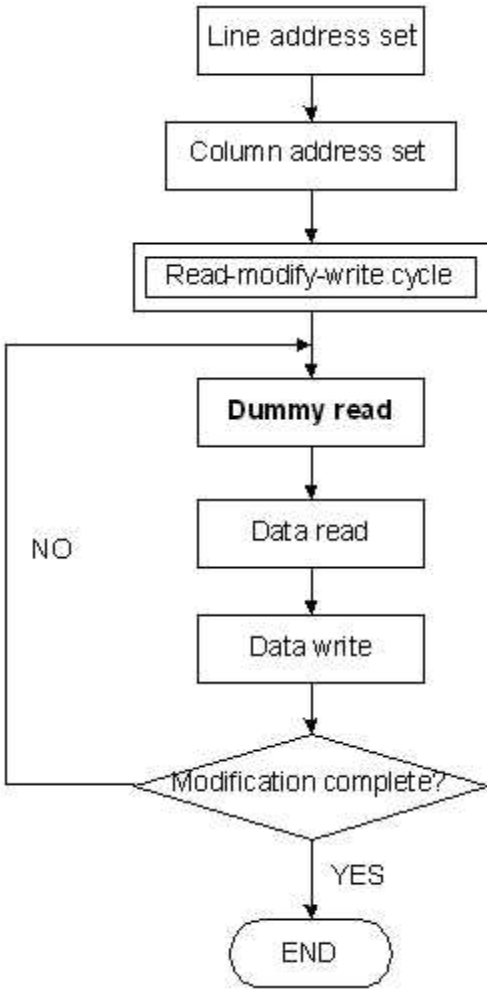
This command is to exit the PARTIAL DISPLAY MODE.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	1	0	1	0	0	1

(16) Read modify write in (RMWIN) - Parameter Byte: none (E0H)

This command is used along with the (9) line address set command (LASET), (10) column address set command (CASET), and (17) read modify write out command (RMWOUT). This function is for frequently modified data on a specific area, such as blinking cursor. First, set a specific display area using the column and line address commands. Then, execute this command to set the column and line addresses as the start address of the specific area. When this operation is complete, the column and line address will not be modified by the display data read command. It is increased only when the display data write command is executed. You can cancel this mode by entering the read modify write out or any other command.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	0	0	0	0	0



(17) Read modify write out (RMWOUT) - Parameter Byte: none (EEH)

This command cancels the read modify write mode.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	0	1	1	1	0

(18) Area scroll set (ASCSET) - Parameter Byte: 4 (AAH)

It is to scroll only the specified portion of the screen (dividing the screen by lines). This command specifies the scrolling type of area, fixed area and scrolled area.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	1	0	--
Parameter Byte 1 (PB1)	1	1	0	*	*	TB5	TB4	TB3	TB2	TB1	TB0	Top block address
Parameter Byte 2 (PB2)	1	1	0	*	*	BB5	BB4	BB3	BB2	BB1	BB0	Bottom block address
Parameter Byte 3 (PB3)	1	1	0	*	*	NSB5	NSB4	NSB3	NSB2	NSB1	NSB0	Number of specified blocks
Parameter Byte 4 (PB4)	1	1	0	*	*	*	*	*	*	SCM1	SCM0	Area scroll mode

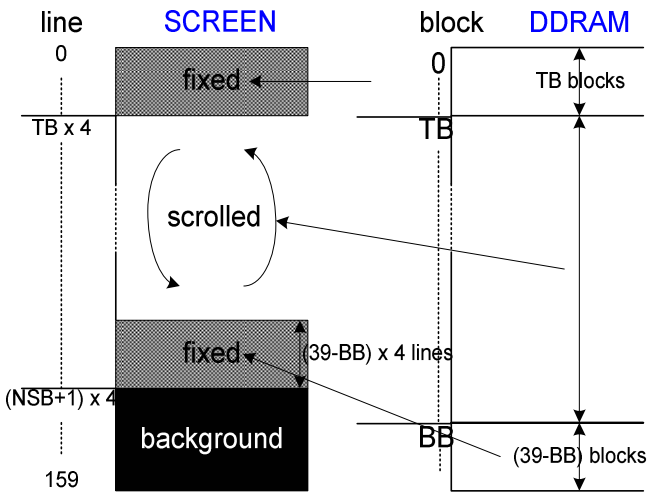
PB4: It is used to specify the scrolling mode.

SCM1	SCM0	Scrolling Mode	Settings		
			Top block address (TB)	**Bottom block address (BB)**	**Number of specified blocks (NSB)**
0	0	Center mode	Top(fixed area) height = Top address	Bottom(fixed area) height = 39-Bottom address	Bottom start address = Specified number
0	1	Top mode	0	Bottom(fixed area) height = 39-Bottom address	Bottom start address = Specified number
1	0	Bottom mode	Top(fixed area) height = Top address	39	39
1	1	Whole mode	0	39	39

Since ST7529 processes the liquid crystal display signals on the four-line basis (block basis), fixed and scrolled areas are also specified on the four-line basis (block basis).

DDRAM address of the top fixed area is set in the block address increasing direction starting with the 0th block.

DDRAM address of the bottom fixed area is set in the block address decreasing direction starting with 39st block. The DDRAM address of other blocks fixed areas are assigned to the scrolled + background areas.



PB1 is to specify the top block address of the scrolled + background areas. Specify the 0th block for the top screen scroll or whole screen scroll.

PB2 specifies the bottom address of the scroll + background areas. Specify the 39th block for the bottom or whole screen scroll. The relation that top block address < bottom block address must be maintained.

PB3 specifies a specific number of blocks {Numbers of (Top fixed area +Scroll area) block-1}. In the case of the bottom scroll or whole screen scroll, the value is identical with PB2.

The user can turn on the area scroll function by executing the area scroll set command first and then specifying the display start block of the scroll area with the scroll start set command.

(19) Scroll start address set (SCSTART) - Parameter Byte: 1 (ABH)

This command is to specify which line address of DDRAM to be the start line content shown on screen. Note that you must execute this command after executing the area scroll set command. Scroll becomes available by dynamically changing the start block address.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	1	0	1	0	1	1	--
Parameter Byte 1 (PB1)	1	1	0	*	*	SB5	SB4	SB3	SB2	SB1	SB0	Start block address

Note : Don't repeat "Area scroll set(AAH)" instruction when "Scroll start address set" is executed.

(20) Internal oscillation on (OSCON) - Parameter Byte: none (D1H)

This command turns on the internal oscillation circuit. It is valid only when the internal oscillation circuit CLS = HIGH.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	0	0	1

(21) Internal oscillation off (OSCOFF) - Parameter Byte: none (D2H)

It turns off the internal oscillation circuit. The circuit is also turned off in the reset mode.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	0	1	0

(22) Power control set (PWRCTRL) - Parameter Byte: 1 (20H)

This command is used to turn on or off the Booster circuit, voltage regulator circuit, and reference voltage.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	1	0	0	1	0	0	0	0	0	--
Parameter Byte 1 (PB1)	1	1	0	*	*	*	0	VB	0	VF	VR	LCD drive power

VR turns on/off the reference voltage generation circuit. VR = "1": ON, VR =" 0": OFF

VF turns on/off the circuit voltage follower. VF = "1": ON, VF =" 0": OFF

VB: It turns on or off the Booster. VB = "1": ON, VB =" 0": OFF

(23) Electronic volume control (VOLCTRL) - Parameter Byte: 2 (81H)

The command is used to program the optimum LCD supply voltage V_0. Refer to 7.10.2.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	1	0	0	0	0	0	0	1	--
Parameter Byte 1 (PB1)	1	1	0	*	*	VPR5	VPR4	VPR3	VPR2	VPR1	VPR0	VPR[5:0]
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	VPR8	VPR7	VPR6	VPR[8:6]

With the VOLUP and VOLDOWN command the V_0 voltage and therewith the contrast of the LCD can be adjusted.

(24) Increment electronic control (VOLUP) - Parameter Byte: none (D6H)

This command increments electronic control offset value of voltage regulator (V0) circuit by 1. Each step is 0.04V.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	1	1	0

If you set the electronic control value to 111111, the control value is set to 000000 after this command has been executed.

(25) Decrement electronic control (VOLDOWN) - Parameter Byte: none (D7H)

This command decrements electronic control offset value of voltage regulator (V0) circuit by 1. Each step is 0.04V.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	1	0	1	1	1

If you set the electronic control value to 000000, the control value is set to 111111 after this command has been executed.

(26) Reserved (82H)

Do not use this command.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	0	0	0	0	0	1	0

(27) Read Register 1 (EPSRRD1) Command: 1 Parameter Byte: none (7CH)

Execute the EPSRRD1 and STREAD (Status Read) commands in succession to read the Electronic Control value.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	1	1	1	1	1	0	0

Execute the Status Read command immediately after this command and execute the NOP command after the STREAD (Status Read) command.

(28) Read Register 2 (EPSRRD2) Command: 1 Parameter Byte: none (7DH)

Execute the EPSRRD2 and STREAD (Status Read) commands in succession to read the built-in resistance ratio.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	1	1	1	1	1	0	1

Execute the Status Read command immediately after this command and execute the NOP(Reset) command after the STREAD (Status Read) command.

(29) Non-operating (NOP) - Parameter Byte: none (25H)

This command does not affect the operation but has the function of canceling the IC test mode. Thus, it is recommended to enter it periodically to prevent malfunctioning due to noise and so on.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	0	0	1	0	1

(30) Status read (STREAD) - Parameter Byte: none

The command is to read the internal condition of the IC. One status can be displayed depending on the setting status after reset or after NOP operation.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	0	1	Status data							

D7: Area scroll mode	Refer to SCM1 (ASCSET)	
D6: Area scroll mode	Refer to SCM0 (ASCSET)	
D5: RMW on/off	0 : Out	1 : In
D4: Scan direction	0 : Column	1 : Line
D3: Display ON/OFF	0 : OFF	1 : ON
D2: EEPROM access	0: OutAccess	1: InAccess
D1: Display normal/inverse	0 : Inverse	1 : Normal
D0: Partial display	0 : OFF	1 : ON

(31) Initial code (1) (EPINT) Command: 1; Parameter: 1 (07H)

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	0	0	0	1	1	1	07H
Parameter(P1)	1	1	0	0	0	0	1	1	0	0	1	19H

This command is used for EEPROM internal ACK signal generating ,suggest using this command before EEPROM read/write operation . This command improve the EEPROM internal ACK signal under unstable power system.

EXT="1"

The ST7529 applies 16-gray level and 2 FRC to achieve 32-gray scale display. Every gray level is in the strength controlled by 31-PWM (5-bit). The following 2 commands are to set the gray scale value.

(1) Set Gray 1 value (Gray 1 set) - Parameter Byte: 16 (20H)

Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Gray1 Set	0	1	0	0	0	1	0	0	0	0	0	ODD FRAME Gray PWM Set
Parameter Byte 1 (PB1)	1	1	0	*	*	*	G0F14	G0F13	G0F12	G0F11	G0F10	Set Gray level 0 at odd frames
Parameter Byte 2 (PB2)	1	1	0	*	*	*	G1F14	G1F13	G1F12	G1F11	G1F10	Set Gray level 1 at odd frames
Parameter Byte 14 (PB14)	1	1	0	*	*	*	G13F14	G13F13	G13F12	G13F11	G13F10	Set Gray level 13 at odd frames
Parameter Byte 16 (PB16)	1	1	0	*	*	*	G15F14	G15F13	G15F12	G15F11	G15F10	Set Gray level 15 at odd frames

(2) Set Gray 2 value (Gray 2 set) - Parameter Byte: 16 (21H)

Command	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Gray1 Set	0	1	0	0	0	1	0	0	0	0	1	EVEN FRAME Gray PWM Set
Parameter Byte 1 (PB1)	1	1	0	*	*	*	G0F24	G0F23	G0F22	G0F21	G0F20	Set Gray level 0 at even frames
Parameter Byte 2 (PB2)	1	1	0	*	*	*	G1F24	G1F23	G1F22	G1F21	G1F20	Set Gray level 1 at even frames
Parameter Byte 14 (PB14)	1	1	0	*	*	*	G13F24	G13F23	G13F22	G13F21	G13F20	Set Gray level 13 at even frames
Parameter Byte 16 (PB16)	1	1	0	*	*	*	G15F24	G15F23	G15F22	G15F21	G15F20	Set Gray level 15 at even frames

(3) Analog circuit set (ANASET) – Parameter Byte: 3 (32H)

	A0	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0	Function
Command	0	1	0	0	0	1	1	0	0	1	0	–
Parameter Byte 1 (PB1)	1	1	0	*	*	*	*	*	OSF2	OSF1	OSF0	OSC frequency Adjustment
Parameter Byte 2 (PB2)	1	1	0	*	*	*	*	*	*	BE1	BE0	Booster Efficiency Set
Parameter Byte 3 (PB3)	1	1	0	*	*	*	*	*	BS2	BS1	BS0	Bias setting

PB1: Oscillator frequency adjustment

OSF2	OSF1	OSF0	Frequency (KHz)
0	0	0	12.7 (Default)
1	0	0	13.2
0	1	0	14.3
1	1	0	15.7
0	0	1	17.3
1	0	1	19.3
0	1	1	21.9
1	1	1	25.4

Condition : 1/160 duty, $f_{CL(Hz)}$ = Frame frequency x (duty + 1dummy)

PB2: Booster Efficiency set

BE1	BE0	Frequency on booster capacitors (Hz)
0	0	3K
0	1	6K (Default)
1	0	12K
1	1	24K

PB3: Select LCD bias ratio of the voltage required for driving the LCD.

BS2	BS1	BS0	LCD bias
0	0	0	1/14
0	0	1	1/13
0	1	0	1/12
0	1	1	1/11
1	0	0	1/10
1	0	1	1/9
1	1	0	1/7
1	1	1	1/5

(4) Software Initial (SWINT) - Parameter Byte: None (34H)

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	0	0	1	1	0	1	0	0

(5) Control EEPROM (EPCTIN) - Parameter Byte: 1 (CDH)

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	0	1	1	0	1
Parameter Byte 1 (PB1)	1	1	0	0	0	EEWR	0	0	0	0	0

When EEWR = “1”, EEPROM will be Write Enable; when EEWR = “0”, EEPROM will be Read Enable.

(6) Cancel EEPROM Command (EPCOUT) - Parameter Byte: None (CCH)

This command is to cancel the EEPROM Read/Write Enable.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	0	0	1	1	0	0

(7) Write data to EEPROM (EPMWR) - Parameter Byte: None (FCH)

This command is to Write data to EEPROM.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	1	1	1	0	0

(8) Read data from EEPROM (EPMRD) - Parameter Byte: None (FDH)

This command is to Read data from EEPROM.

	A0	RD	RW	D7	D6	D5	D4	D3	D2	D1	D0
Command	0	1	0	1	1	1	1	1	1	0	1

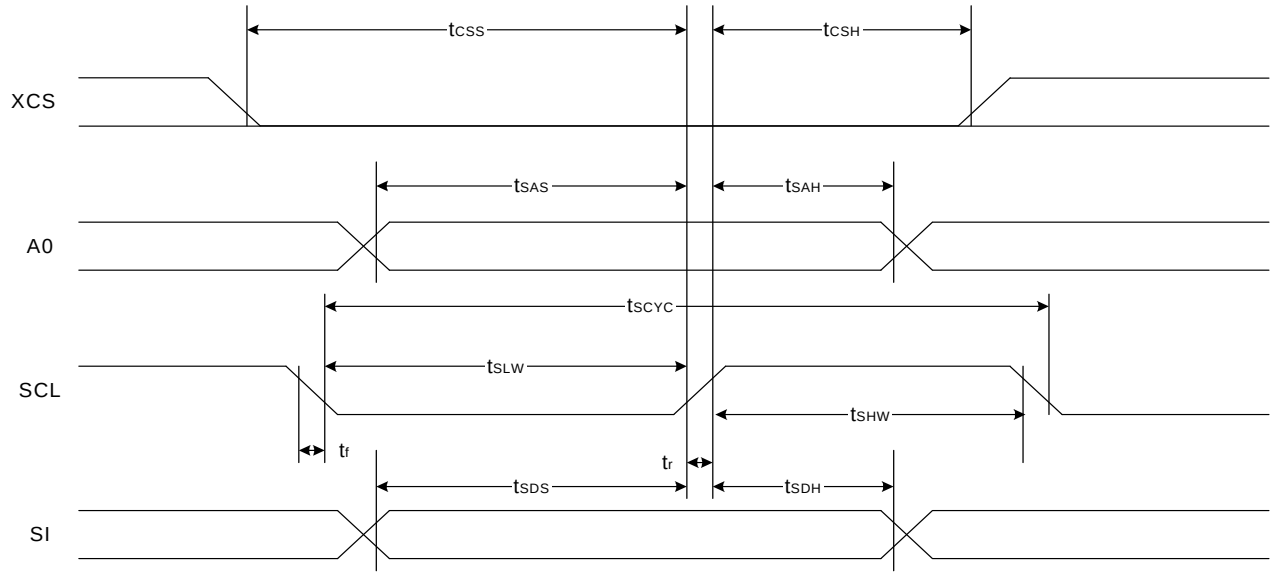
2. TIMING CHARACTERISTICS OF COMPATIBLE CONTROLLER CHIPS

2.1 SERIAL INTERFACE (4-Line Interface)

(V_{DD}=3.3V,Ta= –30 to 85℃,Die)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	tSCYC	-	100	-	ns
SCL “H” pulse width		tSHW	-	50	-	
SCL “L” pulse width		tSLW	-	50	-	
Address setup time	A0	tSAS	-	40	-	
Address hold time		tSAH	-	30	-	
Data setup time	SI	tSDS	-	30	-	
Data hold time		tSDH	-	30	-	
CS-SCL time	XCS	tCSS	-	20	-	
CS-SCL time		tCSH	-	50	-	

Figure 1 Timing Characteristics



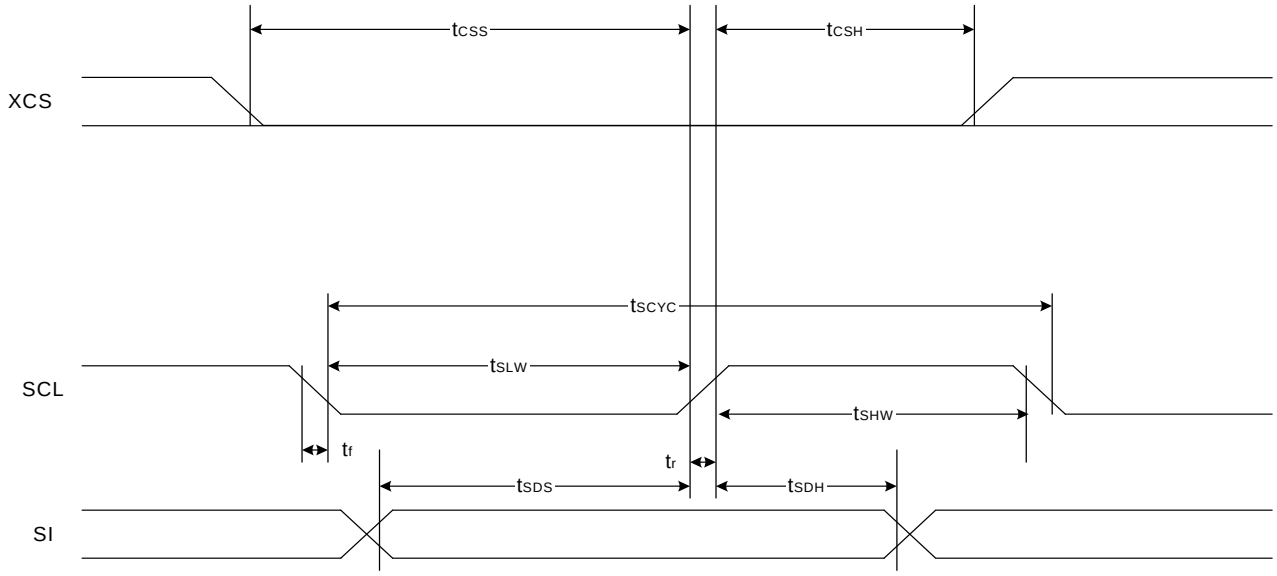
note:*1 The input signal rise and fall time(tr,tf)are specified at 15 ns less.
***2 All timing is specified using 20% and 80% of VDD as the standard.**

2.2 SERIAL INTERFACE (3-Line Interface)

(V_{DD}=3.3V,Ta= –30 to 85℃,Die)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	tSCYC	-	100	-	ns
SCL “H” pulse width		tSHW	-	50	-	
SCL “L” pulse width		tSLW	-	50	-	
Data setup time	SI	tSDS	-	30	-	
Data hold time		tSDH	-	30	-	
CS-SCL time	XCS	tCSS	-	20	-	
CS-SCL time		tCSH	-	50	-	

Figure 2 Timing Characteristics



note:*1 The input signal rise and fall time(tr,tf)are specified at 15 ns less.
***2 All timing is specified using 20% and 80% of VDD as the standard.**

2.3 Power OFF timing

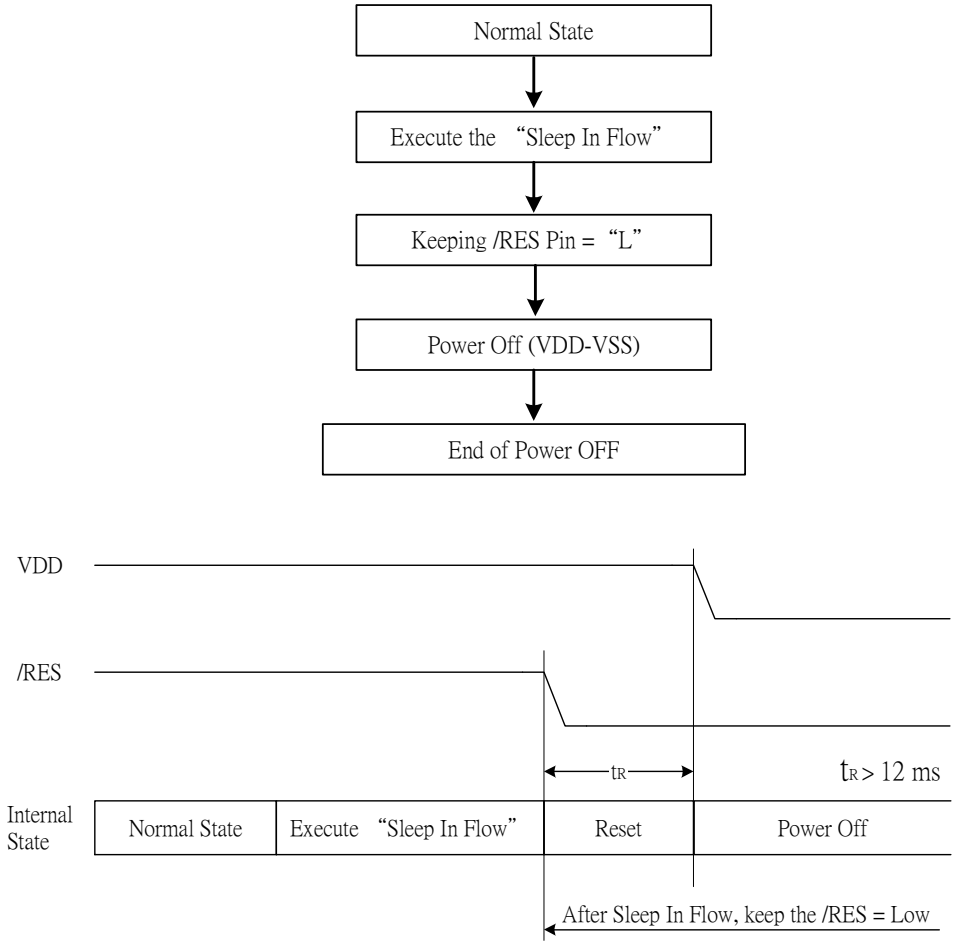


Figure 2.2.3.1 Power off

Note：The sequence is that users must set the VDD to low after keeping the /RES=low time longer than 12ms.

2.4 RESET Timing

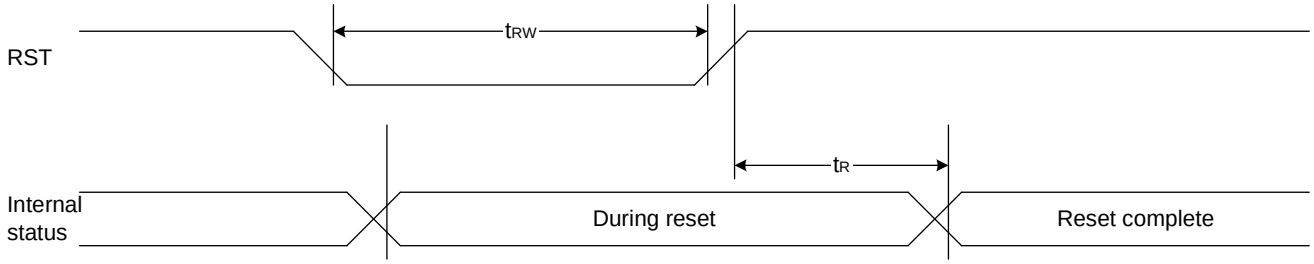


Fig 43.

(VDD =3.3V , Ta = –30 to 85℃,Die)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR	-	-	-	1	us
Reset “L” pulse width	RST	tRW	-	1	-	-	us

(VDD = 2.7V , Ta = –30 to 85℃,Die)

Item	Signal	Symbol	Condition	Rating			Units
				Min.	Typ.	Max.	
Reset time		tR	-	-	-	1.5	us
Reset “L” pulse width	RST	tRW	-	1.5	-	-	us

3.INITIALIZATION METHOD

The module will automatically perform initialization by detecting the rising or falling edge of the RST input after the power is turned on. The following instructions are executed during initialization.

Extension instruction disable:30H
Sleep out:94H
Internal oscillation on:D1H
Power control set:03H
Electronic volume control:2CH,03H
Display control:00H,27H,00H
Inverse display:A7H
Common scan:02H
Data scan direction:00H,00H,02H
Line address set:00H,9FH
Column address set:10H,45H
Extension instruction enable:31H
Analog circuit set:00H,01H,00H
Software Initial:34H
Extension instruction disable:30H
Display ON:AFH

4. DISPLAY DDRAM

Memory Map (2B3P, 8-bit mode)

			Column									
LCD read direction	CI = 0		0			1					84	
	CI = 1		84			83					0	
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		$D7'_{1,0}$ $D6'_{1,0}$ $D5'_{1,0}$ $D4'_{1,0}$ $D3'_{1,0}$	$D2'_{1,0}$ $D1'_{1,0}$ $D0'_{1,0}$ $D7'_{2,0}$ $D6'_{2,0}$	$D4'_{2,0}$ $D3'_{2,0}$ $D2'_{2,0}$ $D1'_{2,0}$ $D0'_{2,0}$	$D7'_{1,1}$ $D6'_{1,1}$ $D5'_{1,1}$ $D4'_{1,1}$ $D3'_{1,1}$	$D2'_{1,1}$ $D1'_{1,1}$ $D0'_{1,1}$ $D7'_{2,1}$ $D6'_{2,1}$	$D4'_{2,1}$ $D3'_{2,1}$ $D2'_{2,1}$ $D1'_{2,1}$ $D0'_{2,1}$		$D7'_{1,84}$ $D6'_{1,84}$ $D5'_{1,84}$ $D4'_{1,84}$ $D3'_{1,84}$	$D2'_{1,84}$ $D1'_{1,84}$ $D0'_{1,84}$ $D7'_{2,84}$ $D6'_{2,84}$	$D4'_{2,84}$ $D3'_{2,84}$ $D2'_{2,84}$ $D1'_{2,84}$ $D0'_{2,84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

Memory Map (2B3P, 16-bit mode)

			Column									
LCD read direction ↓	CI = 0		0			1				84		
	CI = 1		84			83				0		
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		D15'$_0$ D14'$_0$ D13'$_0$ D12'$_0$ D11'$_0$	D10'$_0$ D9'$_0$ D8'$_0$ D7'$_0$ D6'$_0$	D4'$_0$ D3'$_0$ D2'$_0$ D1'$_0$ D0'$_0$	D15'$_1$ D14'$_1$ D13'$_1$ D12'$_1$ D11'$_1$	D10'$_1$ D9'$_1$ D8'$_1$ D7'$_1$ D6'$_1$	D4'$_1$ D3'$_1$ D2'$_1$ D1'$_1$ D0'$_1$		D15'$_{84}$ D14'$_{84}$ D13'$_{84}$ D12'$_{84}$ D11'$_{84}$	D10'$_{84}$ D9'$_{84}$ D8'$_{84}$ D7'$_{84}$ D6'$_{84}$	D4'$_{84}$ D3'$_{84}$ D2'$_{84}$ D1'$_{84}$ D0'$_{84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

Memory Map (3B3P, 8-bit mode)

			Column									
LCD read direction ↓	CI = 0		0			1					84	
	CI = 1		84			83					0	
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		D7'$_{1,0}$ D6'$_{1,0}$ D5'$_{1,0}$ D4'$_{1,0}$ D3'$_{1,0}$	D7'$_{2,0}$ D6'$_{2,0}$ D5'$_{2,0}$ D4'$_{2,0}$ D3'$_{2,0}$	D7'$_{3,0}$ D6'$_{3,0}$ D5'$_{3,0}$ D4'$_{3,0}$ D3'$_{3,0}$	D7'$_{1,1}$ D6'$_{1,1}$ D5'$_{1,1}$ D4'$_{1,1}$ D3'$_{1,1}$	D7'$_{2,1}$ D6'$_{2,1}$ D5'$_{2,1}$ D4'$_{2,1}$ D3'$_{2,1}$	D7'$_{3,1}$ D6'$_{3,1}$ D5'$_{3,1}$ D4'$_{3,1}$ D3'$_{3,1}$		D7'$_{1,84}$ D6'$_{1,84}$ D5'$_{1,84}$ D4'$_{1,84}$ D3'$_{1,84}$	D7'$_{2,84}$ D6'$_{2,84}$ D5'$_{2,84}$ D4'$_{2,84}$ D3'$_{2,84}$	D7'$_{3,84}$ D6'$_{3,84}$ D5'$_{3,84}$ D4'$_{3,84}$ D3'$_{3,84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

Memory Map (3B3P, 16-bit mode)

			Column									
LCD read direction	CI = 0		0			1					84	
	CI = 1		84			83					0	
	Pixel		P0	P1	P2	P3	P4	P5		P252	P253	P254
	Data Line		$D15'_{1,0}$ $D14'_{1,0}$ $D13'_{1,0}$ $D12'_{1,0}$ $D11'_{1,0}$	$D7'_{1,0}$ $D6'_{1,0}$ $D5'_{1,0}$ $D4'_{1,0}$ $D3'_{1,0}$	$D15'_{2,0}$ $D14'_{2,0}$ $D13'_{2,0}$ $D12'_{2,0}$ $D11'_{2,0}$	$D15'_{1,1}$ $D14'_{1,1}$ $D13'_{1,1}$ $D12'_{1,1}$ $D11'_{1,1}$	$D7'_{1,1}$ $D6'_{1,1}$ $D5'_{1,1}$ $D4'_{1,1}$ $D3'_{1,1}$	$D15'_{2,1}$ $D14'_{2,1}$ $D13'_{2,1}$ $D12'_{2,1}$ $D11'_{2,1}$		$D15'_{1,84}$ $D14'_{1,84}$ $D13'_{1,84}$ $D12'_{1,84}$ $D11'_{1,84}$	$D7'_{1,84}$ $D6'_{1,84}$ $D5'_{1,84}$ $D4'_{1,84}$ $D3'_{1,84}$	$D15'_{2,84}$ $D14'_{2,84}$ $D13'_{2,84}$ $D12'_{2,84}$ $D11'_{2,84}$
Block	LI = 0	LI = 1										
0	0	159										
	1	158										
	2	157										
	3	156										
1	4	155										
	5	154										
	6	153										
	7	152										
2	8	151										
	9	150										
38	152	7										
	153	6										
	154	5										
	155	4										
39	156	3										
	157	2										
	158	1										
	159	0										
SEGout			0	1	2	3	4	5		252	253	254

■ RELIABILITY TEST CONDITIONS

ITEM	TEST CONDITION FOR NORMAL TEMPERATURE	TEST CONDITION FOR WIDE TEMPERATURE	TIME
High temperature operating	50°C	70°C	240 hours
Low temperature operating	0°C	-20°C	240 hours
High temperature storage	60°C	80°C	240 hours
Low temperature storage	-10°C	-30°C	240 hours
Temperature-humidity storage	40°C 90% R.H.	60°C 90% R.H.	96 hours
Temperature cycling	-10°C to 60°C 30 Min Dwell	-30°C to 80°C 30 Min Dwell	5 cycle
Vibration Test at LCM Level	Freq 10-55 Hz Sweep rate: 10-55-10 at 1 min Sweep mode Linear Displacement: 2 mm p-p 1 Hour each for X, Y, Z	Freq 10-55 Hz Sweep rate: 10-55-10 at 1 min Sweep mode Linear Displacement: 2 mm p-p 1 Hour each for X, Y, Z	—

■ INSPECTION CRITERION

This specification is made to be used as the standard acceptance/rejection criteria for Normal LCM Product.

1 Sample plan

Sampling plan according to GB/T2828.1-2003/ISO 2859-1：1999 and ANSI/ASQC Z1.4-1993, normal level 2 and based on:

Major defect: AQL 0.65

Minor defect: AQL 1.5

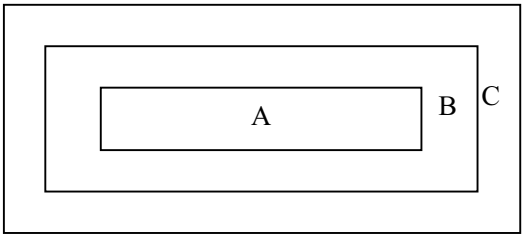
2. Inspection condition

●Viewing distance for cosmetic inspection is about 30cm with bare eyes, and under an environment of 20~40W light intensity, all directions for inspecting the sample should be within 45°against perpendicular line. (Normal temperature 20~25°C and normal humidity 60±15%RH).

● Driving voltage

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

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)

Fig.1 Inspection zones in an LCD.

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.

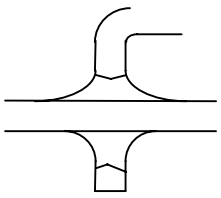
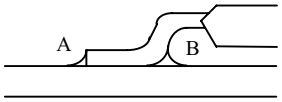
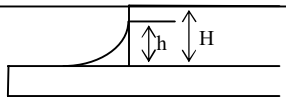
4.Inspection Standard

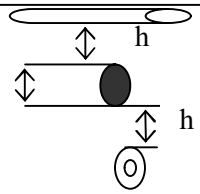
4.1 Major Defect

Item No	Items to be inspected	Inspection Standard	Classification of defects
4.1.1	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
4.1.2	Missing	Missing component	
4.1.3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	

4.2 Cosmetic Defect

4.2.1 Module Cosmetic Criteria

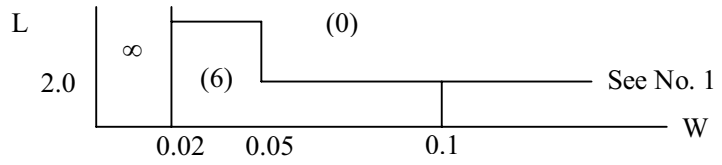
No.	Item	Judgement Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on Printed Circuit Boards	visible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. 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.	Minor
	3. Chips	(3/2) H ≥ h ≥ (1/2) H  	Minor

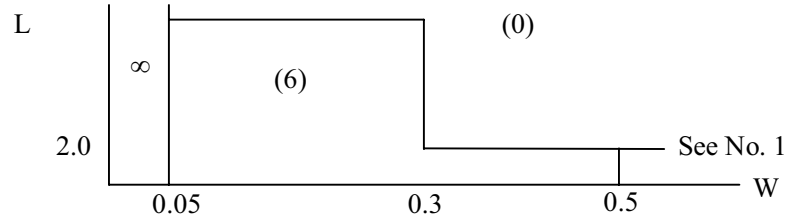
9	Solder ball/Solder splash	a. The spacing between solder ball and the conductor or solder pad h ≥0.13mm The diameter of solder ball d ≤0.15mm.  b. The quantity of solder balls or solder Splashes isn't beyond 5 in 600 mm^2 . c. Solder balls/Solder splashes do not violate minimum electrical clearance. d. Solder balls/Solder splashes must be entrapped/encapsulated Or attached to the metal surface . NOTE: Entrapped/encapsulated/attached is intended to mean that normal service environment of the product will not cause a solder ball to become dislodged.	Minor Minor Major Minor

4.2.2Cosmetic Criteria (Non-Operating)

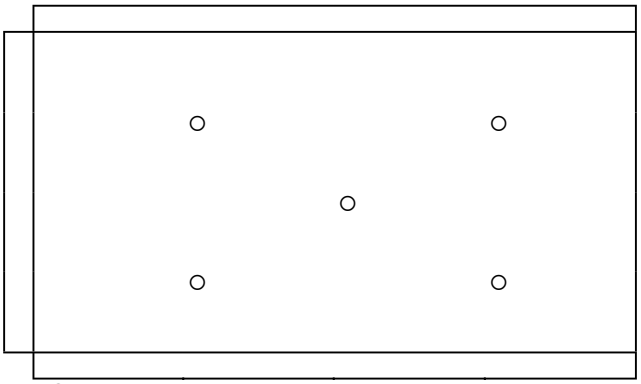
No.	Defect	Judgment Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1*.	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2*.	Minor
3	Bubbles in polarizer	<table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr><tr><td>d ≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d ≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d ≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td>0</td></tr></table>	Minor
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

4.2.3 Cosmetic Criteria (Operating)

<table>
<tr><th>No.</th><th>Defect</th><th>Judgment Criterion</th><th>Partition</th></tr>
<tr><td>1</td><td>Spots</td><td>A) Clear
<table>
<tr><th>Lcd size</th><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td rowspan="4">Lcd size≦8.0'</td><td>d≦0.1</td><td>Disregard</td></tr>
<tr><td>0.1＜d≦0.2</td><td>6</td></tr>
<tr><td>0.2＜d≦0.3</td><td>2</td></tr>
<tr><td>0.3 < d</td><td>0</td></tr>
<tr><td rowspan="4">Lcd size＞8.0'</td><td>d ≦0.1</td><td>Disregard</td></tr>
<tr><td>0.1＜d≦0.3</td><td>10</td></tr>
<tr><td>0.3＜d≦0.5</td><td>5</td></tr>
<tr><td>0.5 < d</td><td>0</td></tr>
</table>
Note : Including pin holes and defective dots which must be within one pixel size; Total defective point shall not exceed 6 pcs no more than 8 inch LCD and 10PCS for more than 8 inch LCD.
B) Unclear
<table>
<tr><th>Lcd size</th><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr>
<tr><td rowspan="4">Lcd size≦ 8.0'</td><td>d≦0.2</td><td>Disregard</td></tr>
<tr><td>0.2＜d≦0.5</td><td>6</td></tr>
<tr><td>0.5＜d≦0.7</td><td>2</td></tr>
<tr><td>0.7＜d</td><td>0</td></tr>
<tr><td rowspan="5">Lcd size ＞8.0'</td><td>d≦0.2</td><td>Disregard</td></tr>
<tr><td>0.2＜d≦0.5</td><td>10</td></tr>
<tr><td>0.5＜d≦0.7</td><td>3</td></tr>
<tr><td>0.7＜d≦1.0</td><td>1</td></tr>
<tr><td>1.0< d</td><td>0</td></tr>
</table>
Note : Total defective point shall not exceed 6 pcs for no more than 8 inch LCD and 10PCS for more than 8 inch LCD.</td><td>Minor</td></tr>
<tr><td>2</td><td>Lines</td><td>A) Clear


Note : ( ) - Acceptable Qty in active area
L - Length (mm)
W - Width (mm)
∞ - Disregard
B) Unclear


‘Clear’ = The shade and size are not changed by V_{op}.
‘Unclear’ = The shade and size are changed by V_{op}.</td><td>Minor</td></tr>
</table>

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 'Spot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.  ○ : Measuring points	Minor

Note :

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

(2) The limit samples for each item have priority.

(3) 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.

(4) 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 ∅5mm.
- 10 or over defects in circle of ∅10mm.
- 20 or over defects in circle of ∅20mm.

■ PRECAUTIONS FOR USING LCD MODULES

1 Handing Precautions

1.1 The display panel is made of glass and polarizer. As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock by dropping it or impact.

1.2 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.

1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degraded insulation between terminals (some cosmetics are determined to the polarizer).

1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on it. 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 in to contact with room temperature air.

1.5 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

Do not scrub hard to avoid damaging the display surface.

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

- Water
- Ketone
- Aromatic solvents

Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contact with oil and fats.

1.7 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.

1.8 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.

1.9 Do not attempt to disassemble or process the LCD module.

1.10 NC terminal should be open. Do not connect anything.

1.11 If the logic circuit power is off, do not apply the input signals.

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

- Before removing LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential. Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded. Make certain the AC power source for the soldering iron does not leak. 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 commutator of the motor.
- To reduce the amount of static electricity generated, do not conduct assembling

and other work under dry conditions. To reduce the generation of static electricity be careful that the air in the work is not too dry. A relative humidity of 50%-60% is recommended. As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.

- 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.

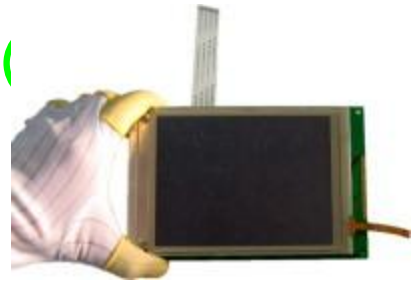
1.13 Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.

- Do not alter, modify or change the shape of the tab on the metal frame.
- Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- Do not damage or modify the pattern writing on the printed circuit board.
- Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- Do not drop, bend or twist the LCM.

2 Handling precaution for LCM

2.1 LCM is easy to be damaged. Please note below and be careful for handling.

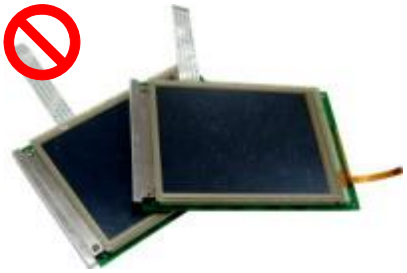
2.2 Correct handling:



As above picture, please handle with anti-static gloves around LCM edges.

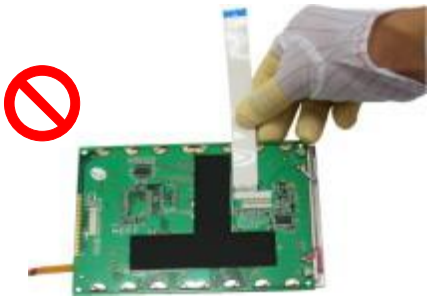
2.3 Incorrect handling:

Please don't touch IC directly.

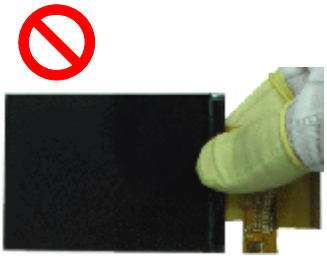


Please don't stack LCM.

Please don't hold the surface of panel.



Please don't stretch interface of output, such as FPC cable.



Please don't hold the surface of IC.

Please don't operate with sharp stick such as pens.

3 Storage Precautions

3.1 When storing the LCD modules, the following precaution are necessary.

3.1.1 Store them in a sealed polyethylene bag. If properly sealed, there is no need for the desiccant.

3.1.2 Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C, and keep the relative humidity between 40%RH and 60%RH.

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

3.2 Others

3.2.1 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.

3.2.2 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.

3.2.3 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.

3.2.3.1 - Exposed area of the printed circuit board.

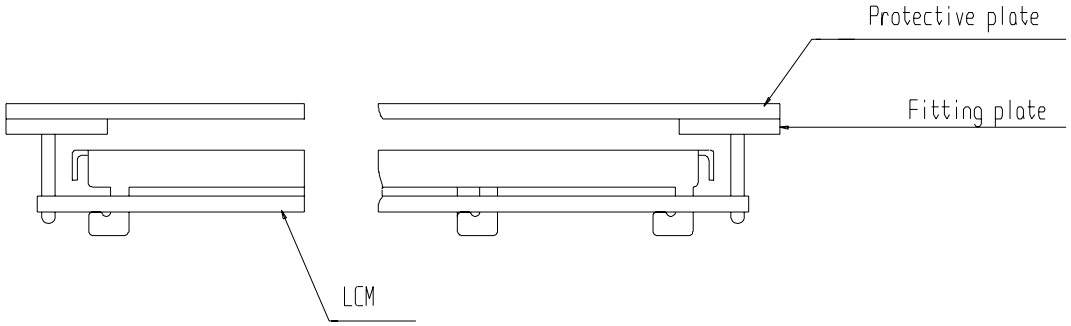
3.2.3.2 -Terminal electrode sections.

4 USING LCD MODULES

4.1 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.

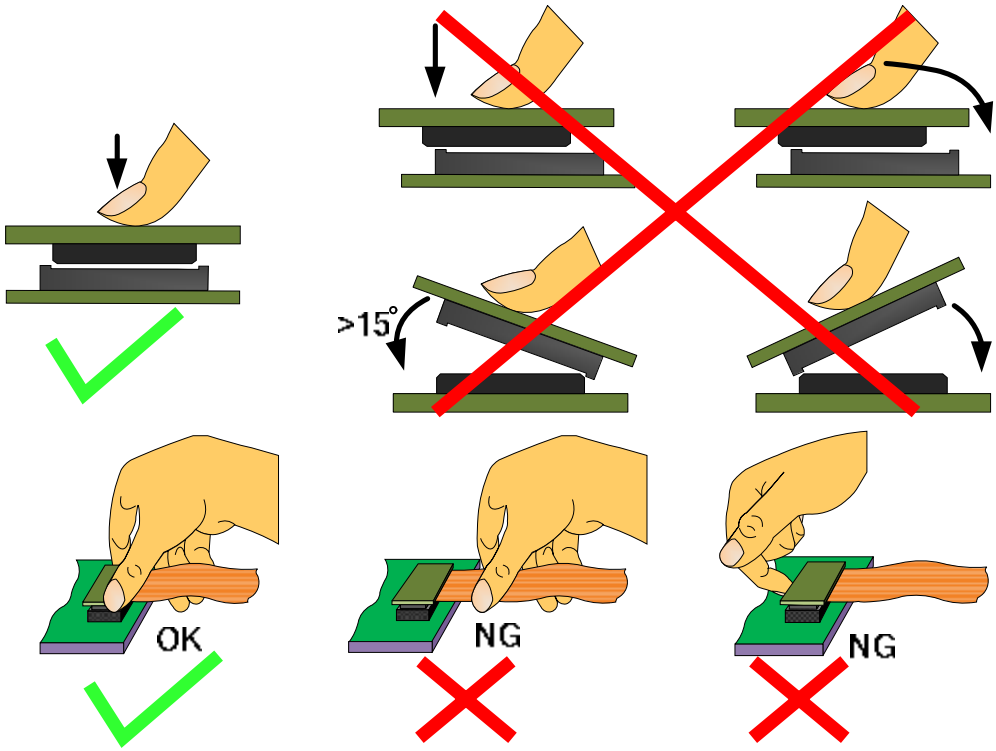
4.1.1 Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



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

4.2 Precaution for assemble the module with BTB connector:

Please note the position of the male and female connector position, don't assemble or assemble like the method which the following picture shows



4.3 Precaution for soldering the LCM

	Manual soldering	Machine drag soldering	Machine press soldering
No RoHS Product	290°C ~350°C. Time : 3-5S.	330°C ~350°C. Speed : 15-17 mm/s.	300°C ~330°C. Time : 3-6S. Press: 0.8~1.2Mpa
RoHS Product	340°C ~370°C. Time : 3-5S.	350°C ~370°C. Speed : 15-17 mm/s.	330°C ~360°C. Time : 3-6S. Press: 0.8~1.2Mpa

4.3.1 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.

4.3.2 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.

4.3.3 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.

4.4 Precautions for Operation

4.4.1 Viewing angle varies with the change of liquid crystal driving voltage (VLCD). Adjust VLCD to show the best contrast.

4.4.2 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 causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.

4.4.3 Response time will be extremely delayed at lower temperature than 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.

4.4.4 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.

4.4.5 A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature, 50%RH or less is required.

4.4.6 Input logic voltage before apply analog high voltage such as LCD driving voltage when power on. Remove analog high voltage before logic voltage when power off the module. Input each signal after the positive/negative voltage becomes stable.

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

4.5 Safety

4.5.1 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.

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

4. 6 Limited Warranty

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

4.7 Return LCM under warranty

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

4.7.1.1 - Broken LCD glass.

4.7.1.2 - PCB eyelet is damaged or modified.

4.7.1.3 -PCB conductors damaged.

4.7.1.4 - Circuit modified in any way, including addition of components.

4.7.1.5 - PCB tampered with by grinding, engraving or painting varnish.

4.7.1.6 - Soldering to or modifying the bezel in any manner.

4.7.2 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.

■ PACKING SPECIFICATION

Please consult our technical department for detail information.

■ PRIOR CONSULT MATTER

1 For Multi-Inno standard products, we keep the right to change material, process ... for improving the product property without prior notice to our customer.

2 For OEM products, if any changes are needed which may affect the product property, we will consult with our customer in advance.

3 If you have special requirement about reliability condition, please let us know before you start the test on our samples.