

SPECIFICATIONS

CUSTOMER : CEFRA
SAMPLE CODE (Ver.) :
MASS PRODUCTION CODE (Ver.) : PG12864LRF-NRA-B-Q (Ver.0)
DRAWING NO. (Ver.) : PG-99003

Customer Approved

Date:

Approved	QC Confirmed	Designer

☐ Approval For Specifications Only.

* This specification is subject to change without notice.

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

☒ Approval For Specifications and Sample.

POWERTIP TECH. CORP.

Headquarters: No.8, 6th Road, Taichung Industrial Park,
 Taichung, Taiwan
 台中市 407 工業區六路 8 號

TEL: 886-4-2355-8168
 FAX: 886-4-2355-8166

E-mail: sales@powertip.com.tw
[Http://www.powertip.com.tw](http://www.powertip.com.tw)

RECORDS OF REVISION

Date	Rev.	Description	Note	Page
2006/01/15	0	PG12864LRF-NRA-B-Qis the ROHS compliant part number based on Powertip's standard PG12864LRF-NRA-B		

Total : 38 Page

Contents

1. SPECIFICATIONS

- 1.1 Features**
- 1.2 Mechanical Specifications**
- 1.3 Absolute Maximum Ratings**
- 1.4 DC Electrical Characteristics**
- 1.5 Optical Characteristics**
- 1.6 Backlight Characteristics**

2. MODULE STRUCTURE

- 2.1 Counter Drawing**
- 2.2 Interface Pin Description**
- 2.3 Timing Characteristics**
- 2.4 Display Command**

3. QUALITY ASSURANCE SYSTEM

- 3.1 Quality Assurance Flow Chart**
- 3.2 Inspection Specification**

4. RELIABILITY TEST

- 4.1 Reliability Test Condition**

5. PRECAUTION RELATING PRODUCT HANDLING

- 5.1 Safety**
- 5.2 Handling**
- 5.3 Storage**
- 5.4 Terms of Warranty**

Note : For detailed information please refer to IC data sheet : **LH155BA5**

1. SPECIFICATIONS

1.1 Features

Item	Standard Value
Display Type	128 * 64 dots
LCD Type	FSTN, White, Transflective, Positive, Normal Temp.
Driver Condition	1/64 Duty, 1/9 Bias
Viewing Direction	6 O'clock
Backlight	YG LED B/L
Weight	15 g
Interface	—
Other	—

1.2 Mechanical Specifications

Item	Standard Value	Unit
Outline Dimension	55.2(L) * 39.8(w) * 6.5(H)(Max)	mm
Viewing Area	45.2(L) * 27.0(w)	mm
Active Area	40.92(L) * 24.28(w)	mm
Dot Size	0.28(L) * 0.34(w)	mm
Dot Pitch	0.32(L) * 0.38(w)	mm

Note : For detailed information please refer to LCM drawing

1.3 Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V _{DD}	—	-0.3	6.0	V
LCD Driver Supply Voltage	V _{LCD}	—	-0.3	15.0	V
Input Voltage	V _{IN}	—	-0.3	V _{DD} +0.3	V
Operating Temperature	T _{OP}	Excluded B/L	0	50	°C
Storage Temperature	T _{ST}	Excluded B/L	-20	70	°C
Storage Humidity	H _D	Ta < 40 °C	-	90	%RH

1.4 DC Electrical Characteristics

$V_{DD} = 3.3 \text{ V} \pm 10\%$, $V_{SS} = 0\text{V}$, $T_a = 25^\circ\text{C}$

Item	Symbol	Condition	Min.	Type	Max.	Unit
Logic Supply Voltage	V_{DD}	—	3.0	3.3	3.6	V
“H” Input Voltage	V_{IH}	—	$0.8 V_{DD}$	-	V_{DD}	V
“L” Input Voltage	V_{IL}	—	0	-	$0.2V_{DD}$	V
Supply Current	I_{DD}	$V_{DD} = 3.3 \text{ V}$	-	0.5	1.0	mA
LCM Driver Voltage	V_{OP}	0°C	-	-	-	V
		25°C *1	9.5	9.8	10.1	
		50°C	-	-	-	

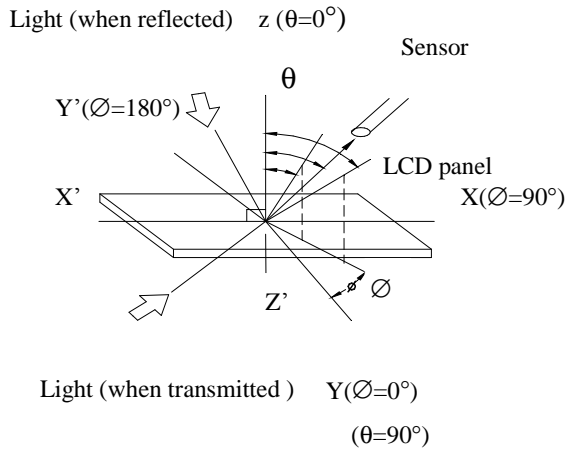
Note: *1. THE V_{OP} TEST POINT IS C1 – V_{SS} .

1.5 Optical Characteristics

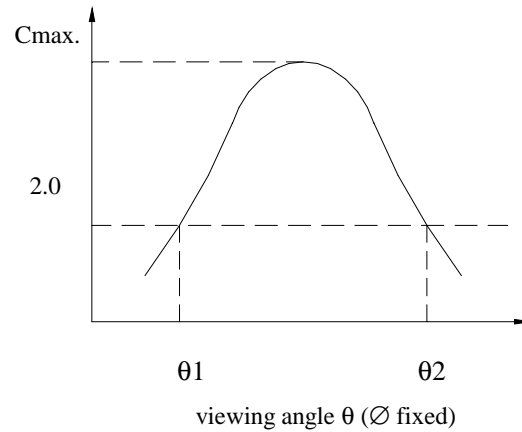
LCD Panel : 1/64 Duty , 1/9 Bias , $V_{LCD} = 9.7\text{V}$, $T_a = 25^\circ\text{C}$

Item	Symbol	Conditions	Min.	Type	Max.	Reference
View Angle	θ	$C \geq 2.0, \varnothing = 0^\circ$	40°	-	-	Notes 1 & 2
Contrast Ratio	C	$\theta = 5^\circ, \varnothing = 0^\circ$	4	6	-	Note 3
Response Time(rise)	t_r	$\theta = 5^\circ, \varnothing = 0^\circ$	-	200ms	300ms	Note 4
Response Time(fall)	t_f	$\theta = 5^\circ, \varnothing = 0^\circ$	-	150ms	225ms	Note 4

Note 1: Definition of angles θ and \varnothing



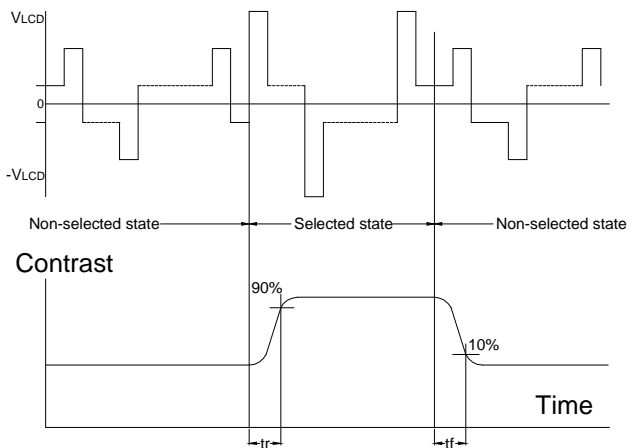
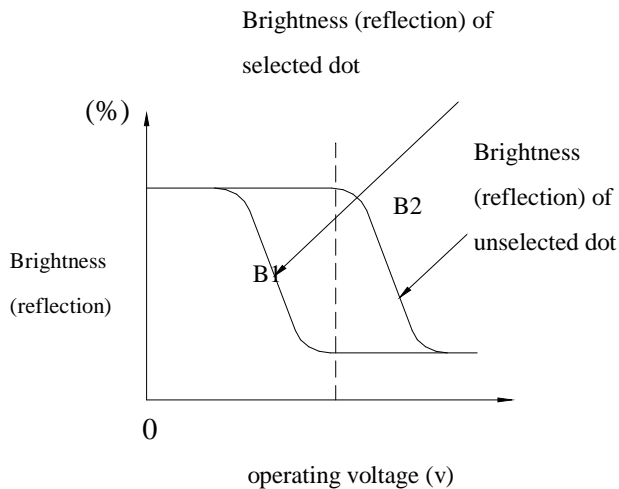
Note 2: Definition of viewing angles θ_1 and θ_2



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

Note 3: Definition of contrast C

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



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

V_{LCD} : Operating voltage f_{FRM} : Frame frequency

t_r : Response time (rise) t_f : Response time (fall)

1.6 Backlight Characteristics

LCD Module with LED Backlight

Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Forward Current	IF	Ta =25°C	-	100	mA
Reverse Voltage	VR	Ta =25°C	-	4	V
Power Dissipation	PO	Ta =25°C	-	0.25	W
Operating Temperature	T _{OP}	-	-20	60	°C
Storage Temperature	T _{ST}	-	-30	60	°C
Solder Temp. for 3 Second	-	-	310	330	°C

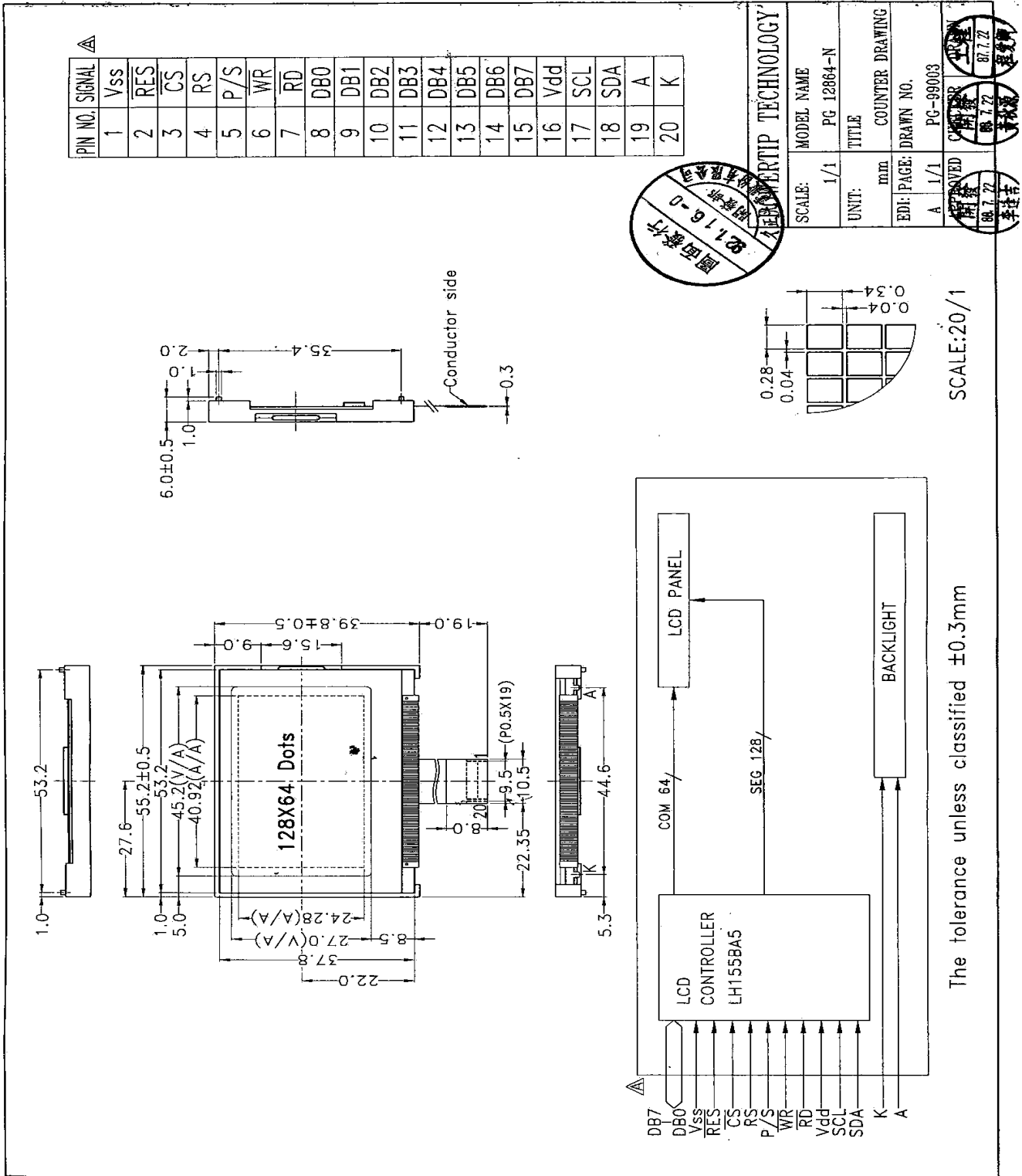
Electrical / Optical Characteristics

Ta =25°C

Item	Symbol	Conditions	Min.	Type	Max.	Unit
Forward Voltage	VF	IF= 40 mA	-	2.1	2.5	V
Reverse Current	IR	VR= 4 V	-	-	0.2	mA
Wavelength	λ _p	IF= 40 mA	569	-	576	nm
Luminous Intensity (without LCD)	IV	IF=40 mA	5	6	-	cd/m ²
Color	Yellow-green					

2. MODULE STRUCTURE

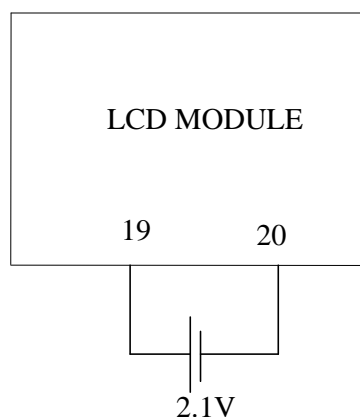
2.1 Counter Drawing



2.2 Interface Pin Description

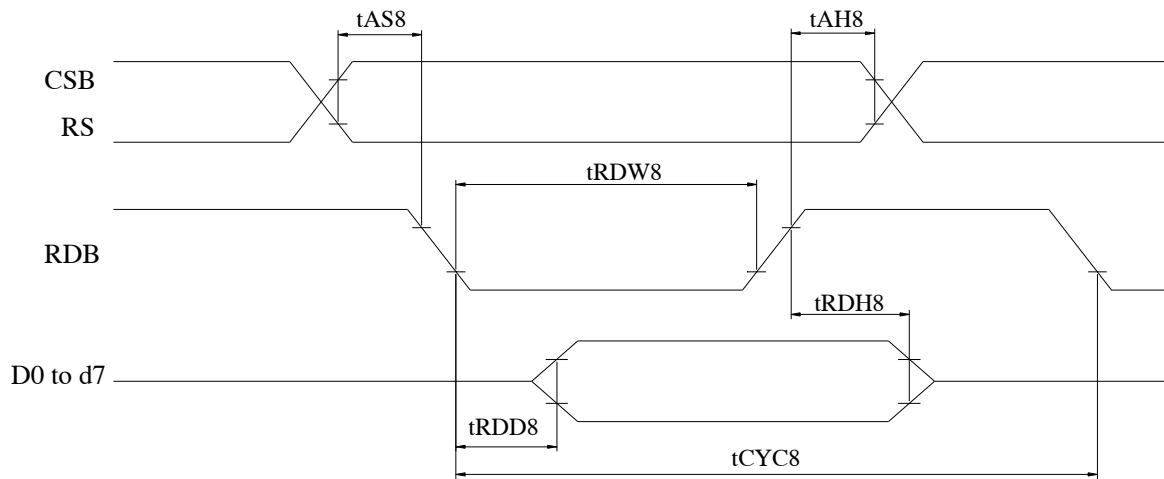
Pin No.	Symbol	Function																		
1	<u>V_{SS}</u>	Signal ground (GND)																		
2	<u>RES</u>	Controller reset (module reset)																		
3	<u>CS</u>	Chip enable																		
4	RS	Used to identify data sent by MPU at D0 to D7.																		
5	P/S	Used to switch between parallel and serial interface.																		
		<table><tr><td>P/S</td><td>Chip select</td><td>Data identification</td><td>Data</td><td>Read/Write</td><td>Serial clock</td></tr><tr><td>“H”</td><td>CSB</td><td>RS</td><td>S0-D7</td><td>RDB,WRB</td><td>-</td></tr><tr><td>“L”</td><td>CSB</td><td>RS</td><td>SDA</td><td>Write only</td><td>SCL</td></tr></table>	P/S	Chip select	Data identification	Data	Read/Write	Serial clock	“H”	CSB	RS	S0-D7	RDB,WRB	-	“L”	CSB	RS	SDA	Write only	SCL
		P/S	Chip select	Data identification	Data	Read/Write	Serial clock													
		“H”	CSB	RS	S0-D7	RDB,WRB	-													
		“L”	CSB	RS	SDA	Write only	SCL													
P/S= ”H”: Fixes SDA and SCL at “H” or “L”.																				
P/S= “L” : Fixes D7 to D0 at HI-Z : RDB and WRB at “H” or “L”.																				
6	<u>WR</u>	Data write (write data to the module at “L”)																		
7	<u>RD</u>	Data read (read data from the module at “L”)																		
8~15	DB0~DB7	Data bus																		
16	<u>V_{DD}</u>	Power supply (+3.3V)																		
17	SCL	Used as data transfer clock pin when serial interface is selected. The SDA data is shifted at rising edge of the SCL. Internal serial/parallel conversion to 8-bit data is performed by the rising edge at 8 th clock of the SCL. Be sure to set this pin at “L” after completion of transfer or at not accessing.																		
18	SDA	Used as serial data input pin when serial interface is selected.																		
19	A	LED Backlight (+)																		
20	K	LED Backlight (-)																		

Contrast Adjust

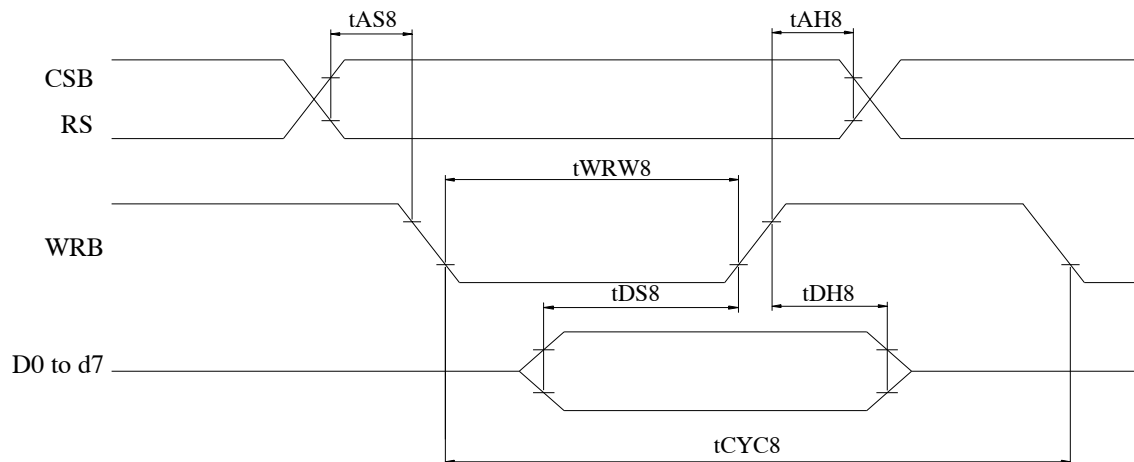


2.3 Timing Characteristics

2.3.1 system Bus Read/Write Timing (80 Family MPU)



- Read timing
- Write timing



MPU timing characteristics

(VDD=2.7 to 5.5V, Ta=-30 to +85°C)

Item	Symbol	condition	MIN	MAX	Unit	Applicable pin
Address hold time	tAH8		60		ns	CSB
Address setup time	tAS8		40		ns	RS
System cycle time	tCYC8		450		ns	RDB
Road pulse width (READ)	tRDW8		270		ns	WRB
Write pulse width (WRITE)	tWRW8		100		ns	
Data setup time	tDS8	CL=15pF	100		ns	D0 to D7
Data hold time	tDH8		40		ns	
Read data output delay time	tRDD8			220	ns	D0 to D7
Read data hold time	tRDH8		10		ns	
Input signal rise and fall time	tr,tf			30	ns	All of above pins

(VDD=2.4 to 2.7V, Ta=-30 to +85°C)

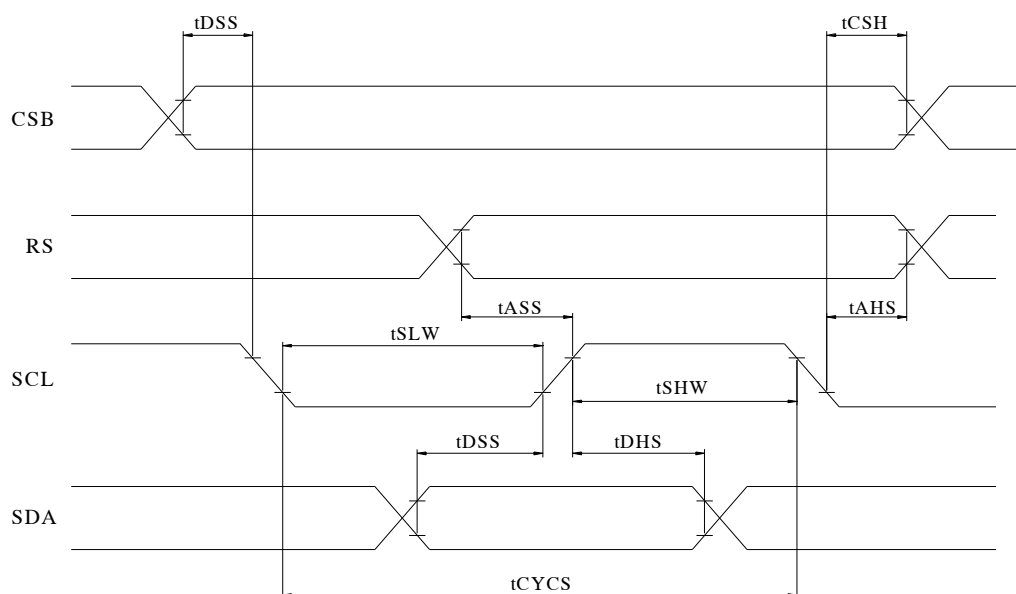
Item	Symbol	M condition	MIN	MAX	Unit	Applicable pin
Address hold time	tAH8		80		ns	CSB
Address setup time	tAS8		80		ns	RS
System cycle time	tCYC8		900		ns	RDB
Road pulse width (READ)	tRDW8		500		ns	WRB
Write pulse width (WRITE)	tWRW8		200		ns	
Data setup time	tDS8	CL=15pF	200		ns	D0 to D7
Data hold time	tDH8		80		ns	
Read data output delay time	tRDD8			320	ns	D0 to D7
Read data hold time	tRDH8		10		ns	
Input signal rise and fall time	tr,tf			30	ns	All of above pins

(VDD=1.8 to 2.4V, Ta=-30 to +85°C)

Item	Symbol	condition	MIN	MAX	Unit	Applicable pin
Address hold time	tAH8		160		ns	CSB
Address setup time	tAS8		160		ns	RS
System cycle time	tCYC8		1800		ns	RDB
Read pulse width (READ)	tRDW8		1000		ns	WRB
Write pulse width (WRITE)	tWRW8		400		ns	
Data setup time	tDS8	CL=15pF	400		ns	D0 to D7
Data hold time	tDH8		160		ns	
Read data output delay time	tRDD8			640	ns	D0 to D7
Read data hold time	tRDH8		10		ns	
Input signal rise and fall time	tr,tf			30	ns	All of above pins

Note: All the timings must be specified relative to 20% and 80% of VDD voltage

2-3.2 Serial Interface Timing



(VDD=2.4~5.5V, Ta=-30 to +85°C)

Item	Symbol	condition	MIN	MAX	Unit	Applicable pin
Serial clock period	tCYCS		1000		ns	SCL
SCL “H” pulse width	tSHW		400		ns	
SCL “L” pulse width	tSLW		400		ns	
Address setup time	tASS		80		ns	RS
Address hold time	tAHS		80		ns	
Data set up time	tDSS		400			SDA
Data hold time	tDHS		400		ns	
DSB to SCL time	tCSS		80		ns	CSB
CSB hold time	tCSH		80		ns	
Input signal rise and fall time	tr,tf			30	ns	All of above pins

(VDD=1.8~2.4V, Ta=-30 to +85°C)

Item	Symbol	condition	MIN	MAX	Unit	Applicable pin
Serial clock period	tCYCS		2000		ns	SCL
SCL “H” pulse width	tSHW		800		ns	
SCL “L” pulse width	tSLW		800		ns	
Address setup time	tASS		160		ns	RS
Address hold time	tAHS		160		ns	
Data set up time	tDSS		800			SDA
Data hold time	tDHS		800		ns	
DSB to SCL time	tCSS		160		ns	CSB
CSB hold time	tCSH		160		ns	
Input signal rise and fall time	tr,tf			30	ns	All of above pins

Note: All the timings must be specified relative to 20% and 80% of VDD voltage.

2.3 Command Function

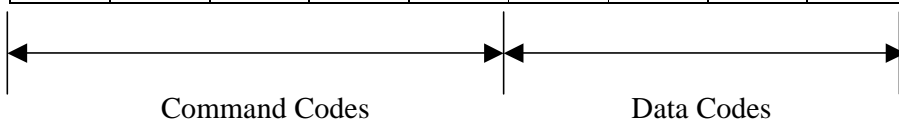
The LH155BA has a lot of commands as shown in a list of command and each command is example in detail as follows.

Data codes and command codes are defined as follows and execution of commands must be made in the state of chip select

(CSB=“L”)

(For example X address)

RS	D7	D6	D5	D4	D3	D2	D1	D0
e※	0	0	0	0	AX3	AX2	AX1	AX0



※RS = “0” : RAM Data Access (7-1,7-2)

RS = “1” : Register Access (7-3~7-16)

The undefined command codes are inhibited.

2-4.1 Data Write to Display RAM

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	Display RAM write data							

The Display RAM data of 8-bit are written in the designated X and Y address.

2-4.2 Data Read to Display RAM

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	0	Display RAM read data							

The 8-bit contents of Display RAM designated in X and Y address and read out immediately after data are set in X and Y address, dummy read is necessary once.

2-4.3 X Address Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	0	0	0	AX3	AX2	AX1	AX0

(At the time of reset AX3~AX0 = 0H, read address : 0H)

Addresses of Display RAM's X direction are set. The values of AX3 to AX0 are usable up to 00H-0FH, but 10H-FFH are inhibited. When the register setting SEG output normal/reverse is REF = “0”, the data of AX3~AX0 are addressed to Display RAM as they are.

When REF = “1”, the data of 0FH-(AX3~AX0)H are addressed to Display RAM.

2-4.4 Y Address Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	0	1	0	AY3	AY2	AY1	AY0

(At the time of reset AX3~AX0 = 0H, read address : 2H)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	0	1	1	※	AY6	AY5	AY4

※ mark shows “Don't care”

(At the time of reset:AY6~AY4=0H, read address:3H)

Addresses of Display RAM's Y direction are set. In data setting, lower place and upper place are divided with 4 bit and 3 bit respectively.

When data set, lower place must be set first and upper place must be set second.

The values of AY6 to AY0 are usable up to 00H-42H, but 43H-FFH are inhibited.

The addresses of 40H to 42H are for the Segment Display RAM.

2-4.5 Display Starting Line Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	1	0	0	LY3	LY2	LY1	LY0

(At the time of reset AX3~AX0 = 0H, read address: 4H)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	1	0	1	※	※	LA5	LA4

※ mark shows "Don't care" (At the time of reset :LA4,LA5 = 0H, read address: 5H)

The display line address is required to designate, and the designated address become the display line of COM0.

The display of LCD panel is indicated in the increment direction of the designated display starting address to the line address.

LA5	LA4	LA3	LA2	LA1	LA0	LINE ADDRESS
0	0	0	0	0	0	0
0	0	0	0	0	1	1
1	1	1	1	1	1	63

2-4.6 n Line Alternated Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	1	1	0	N3	N2	N1	N0

(At the time of reset: N3~N0 = 0H, read address: 6H)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	0	1	1	1	※	※	N5	N4

※ mark shows "Don't care"(At the time of reset: N5~N4 = 0H, read address: 7H)

The reverse line number of LCD alternated drive is required to set in the register. The line number possible to set is 2-64 lines.

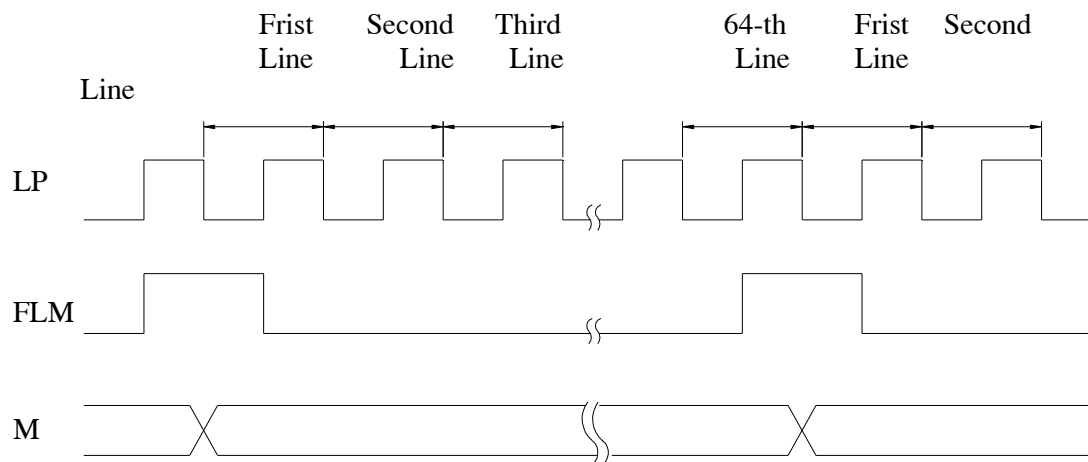
The values set up by the n-line alternated register become enable when the n line alternated drive command of ON. (NLIN="1")

When the n line alternated drive command is OFF (NLIN="0"), alternated drive waveform which reverses by frame cycle is generated.

LA5	LA4	LA3	LA2	LA1	LA0	LINE ADDRESS
0	0	0	0	0	0	-
0	0	0	0	0	1	2
1	1	1	1	1	1	64

2-4.7 Alternated Timing

At the Time of n Line Alternated OFF (in case of 1/64 DUTY Display)



2-4.8 Display Control(1) Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	0	0	0	SHIFT	SEGMENT	ALLON	ON/OFF

(At the time of reset: (SHIFT, SEGON, ALLON, ON/OFF)=0H, read address: 8H)

Various control of display is set up.

(I) ON/OFF Command (For the Graphic Display only)

To control ON/OFF of the Graphic Display

ON/OFF = "0": display OFF

ON/OFF = "1" : display ON

(II) ALLON Command (For the Graphic Display only)

Regardless of the data of the Graphic Display RAM, the Graphic Display are on.

This command has priority over display normal/reverse commands.

SEGON="0":display OFF

The terminals are specified VSS level.

SEGON="1":display ON

(III) SEGMENT Command (For the Segment Display only)

To control ON/OFF of the Segment Display

SEGON="0":display OFF

The terminals are specified VSS level.

SEGON="1":display ON

(IV) SHIFT Command (For the Graphic Display only)

The shift direction of the Graphic Display scanning data in the common driver output is selected.

SHIFT="0":COM0->COM63 shift-scan

SHIFT="1":COM63->COM0 shift-scan

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	0	0	0	※	※	ER	IR

※ mark shows "Don't care"(At the time of reset: (ER,IR)=0H,read address:8H)

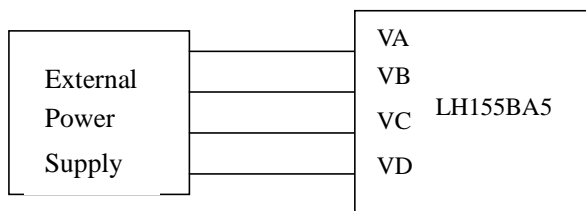
(i) IR Command (For the Segment Display only)

IR command is not available now. When using the Segment Display, please set "0"

(ii) ER Command (For the Segment Display only)

ER command is not available now. When using the Segment Display, please set "1"

And when using the Segment Display, please input VA, VB, VC and VD level externally.



2-4.9 Display Control(2) Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	0	0	1	REV	NLIN	SWAP	REF

(At the time of reset: (REV, NLIN, SWAP, REF)=0H, read address: 9H)

Various control of display is set up.

(I) REF Command

When MPU accesses to the Graphic Display RAM, the relationship between X address and write data is normalized or reversed.

Therefore, the order of segment driver output can be reversed by register setting, lessening the limitation of IC location in assembling into the LCD panel.

REF	ACCESS FROM MPU		INTERNAL ACCESS		DDRRESPONDING SEG OUTPUT
	X ADDRESS	D7~D0	X ADDRESS	D7-D0	
0	NH	D0(LSB) D7(MSB)	NH	(LSB) (MSB)	SEG(8*NH) Output SEG(8*NH+7) Output
1	NH	D0(LSB) D7(MSB)	0FH-NH	(MSB) (LSB)	SEG(8*(0F-NH)+7) Output SEG(8*(0F-NH)) Output

When using this command. Output of Segment Display Circuits are set as below.

However the order of D0->D7 are not changed.

REF	ACCESS FROM MPU		INTERNAL ACCESS		DDRRESPONDING SEG OUTPUT
	X ADDRESS	D7~D0	X ADDRESS	D7-D0	
0	00H	D0(LSB) D7(MSB)	00H	D0(LSB) D7(MSB)	D7->D0 SEGS0->SEGS7
0	01H	D0(LSB) D3(MSB)	01H	D0(LSB) D3(MSB)	D0~D3 SEGS8->SEGS11
1	0FH	D0(LSB) D7(MSB)	00H	D0(LSB) D7(MSB)	D0->D7 SEGS0->SEGS7
1	H0E	D0(LSB) D3(MSB)	01H	D0(LSB) D3(MSB)	D0->D3 SEGS8->SEGS11

When REF="1", please set X address of Segment Display Circuits like below.

00H->0FH

01H->0EH

(II) SWAP Command (For the Graphic Display only)

When data to the Graphic Display RAM are written, the write data are swapped.

SWAP="1": Normal mode. In data-writing, the data of D7~D0 can be written to the Graphic Display RAM.

SWAP="1": SWAP mode ON. In data-writing, the swapped data of D7~D0 can be written to the Graphic Display RAM.

	SWAP="0"	SWAP="1"
EXTERNAL DATA	D7 D6 D5 D4 D3 D2 D1 D0	D7 D6 D5 D4 D3 D2 D1 D0
INTERNAL DATA	d7 d6 d5 d4 d3 d2 d1 d0	d0 d1 d2 d3 d4 d5 d6 d7

(III) NLIN Command (For the Graphic Display only)

The ON/OFF control of n-line alternated drive is performed.

NLIN="0" : n line alternated drive OFF. By using frame cycle, the alternated signals (M) are reversed.

NLIN="1" : n line alternated drive ON. According to data set up in n line alternated register, the alternation is made.

(IV) REV Command (For the Graphic Display only)

Corresponding to the data of the Graphic Display RAM, the lighting or not-lighting of the display is set up.

REV="0": When RAM data at "H", LCD at ON voltage (normal)

REV="1": When RAM data at "L", LCD at ON voltage (reverse)

2-4.10 Increment Control Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	0	1	0	※	AIM	AY1	AX1

※ mark shows "Don't care"(At the time of reset: (AIM, AY1, AX1)= 0H, read address :AH)

The increment mode is set up when accessing to the Graphic Display RAM. (The Graphic Display RAM only)

By AIM, AY1 and AX1 registers, the setting-up of increment operation /non-operation for the X-address counter and the Y-address counter every write access of every read access to the Graphic Display RAM is possible.

In setting to this control register, the increment operation of address can be made without setting successive addresses for writing data or for reading data to the Graphic Display RAM from MPU.

After setting this register be sure to set the X and Y Address Register.

Because it is not assuring the data of X and Y Address Register after setting increment Control Register.

The increment control of X and Y address by AIM, AY1 and AX1 registers is as follows.

ALM	SELECTION OF INCREMENT TIMING	REFERENCE
0	When writing to Graphic Display RAM or reading from Graphic Display RAM	<1>
1	Only when writing to Graphic Display RAM (read modify)	<2>

<1> This is effective when subsequently writing and reading the successive address area.

<2> This is effective in the case that after reading and writing the successive address area every address, the read data are modified to write.

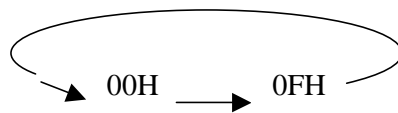
AY1	AX1	SELECTION OF INCREMENT ADDRESS	REFERENCE
0	0	Increment is not made	<1>
0	1	X address automatic increment	<2>
1	0	Y address automatic increment	<3>
1	1	X and Y address cooperative, automatic increment	<4>

<1> Regardless of AIM, no increment for X and Y address.

<2> According to the setting-up of AIM, increment or decrement for only X address.

In accordance with the REF conditions of SEG normal/reverse output setting register, X address become as follows.

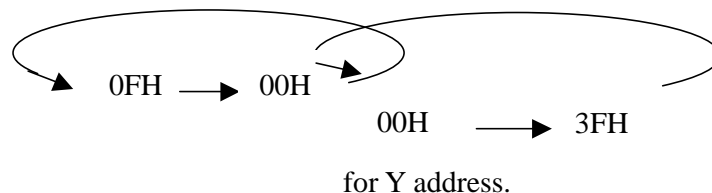
- At REF="0" (normal output), increment by loop of



- At REF="1" (reverse output), decrement by loop of

<3> According to the setting-up of AIM, increment for only Y address.

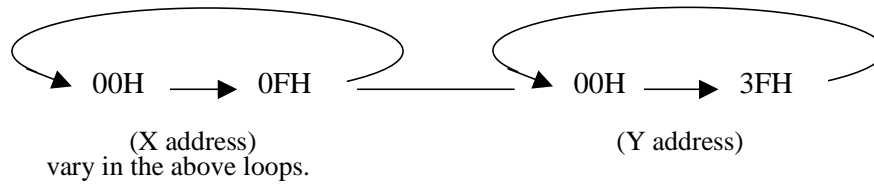
Regardless of REF, increment by loop of



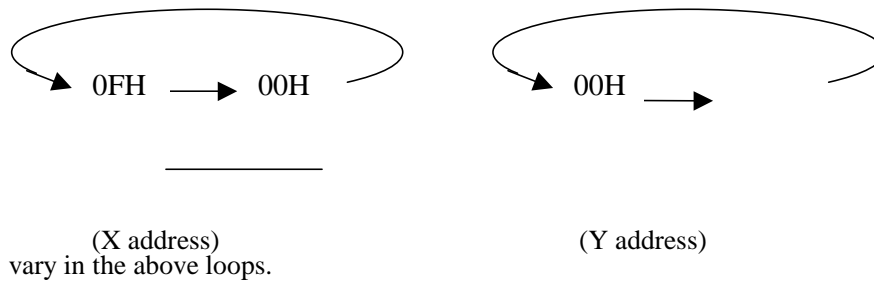
<4> According to the setting-up of AIM, cooperative variation for X and Y address.

When the access of X address is made up to 0FH, Y address increment occurs.

- At REF="0" (normal output)



- At REF="1" (reverse output)



2-4.11 Power Control Register Set (1)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	0	1	1	BIAS	HALT	PON	ACL

(At the time of reset: BIAS, HALT, PON, ACL)=0H, read address: BH)

(1) ACL Command

The internal circuit can be initialized. This command is enabled only at Master operation mode.

ACL="0": Normal operation

ACL="1": Initialization ON

If the power control register is read out immediately after executing ACL command (ACL=1), the D0 bit becomes "0".

In executing ACL command, the internal reset signals are internally generated by using display-clock master oscillation (oscillation by OSC1 and OSC0, or clock input at CK pin).

Therefore, after executing ACL command, allow WAIT period having at least two cycle portion of the original oscillation clock before the next processing is made.

(2) PON Command

The internal power supply for the Graphic Display circuit is set ON/OFF.

PON="0": Power supply for the Graphic Display circuit OFF

PON="1": Power supply for the Graphic Display circuit ON

At PON="1": the booster and voltage converter for the Graphic Display circuit function.

In accordance with the setting conditions of PMODE pin, the operative circuit part changes. See the Function Description in details

(3) HALT Command

The conditions of power-saving are set ON/OFF by this command.

HALT="0": Normal operation

HALT="1": Power-saving operation

When setting in the power-saving state, the consumed current can be reduced to a value near to the standby current. The internal conditions at power-saving are as follows.

(a) The oscillating circuit and power supply circuit are stopped.

(b) The LCD drive is stopped, and output of the segment drive and common driver are VSS level.

(c) The clock input from CK pin is inhibited.

(d) The contents of the Display RAM data are maintained.

(e) The operational mode maintains the state of command execution before executing power-saving command.

(4) BIAS Command

The internal bias value for the Graphic display can be set by this command.

BIAS="0": 1/9 bias

BIAS="1": 1/7 bias

(Bias value for the Segment Display is 1/3 Fixed)

2-4.12 Power Control Register Set (2)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	1	0	1	MSS	LSB	

(At the time of reset: DVOL)=0H, read address: DH

The LCD drive voltage V0 output from the built-in power circuit can be controlled and the display controlled and the display tone on the LCD can be also controlled.

The LCD drive V0 takes one out of 16 voltage values by setting 4 bit data register.

MSB	...	LSB		V0/SV0
0	0	0	0	Smaller
1	1	1	1	Larger

If the electronic control is not used, specify(1,1,1,1) in the 4-bit data register.

After the LH155BA is reset, the 4-bit data register is automatically set to (1,1,1,1)

2-4.13 Power Control register Set (3)

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	1	1	0	SEGPON	※	EXA	ICON

※mark show “Don’t care” (At the time of reset: (SEGPON, EXA, ICON)=0H, read address: EH)

(1) ICON Command

ICON Display ON/OFF

ICON =”0”: ICON is OFF

ICON = “1”: ICON is ON, See the Function Description in detail.

(2) EXA Command

Clock for ICON Display External/Internal

EXA=”0”: Internal Clock

EXA=”1”: External Clock from EXA terminal

(3) SEGPON Command

A power supply for the Segment Display is set ON/OFF

SEGPON=”0”: Power supply circuit OFF

SEGPON=”1”: Power supply circuit ON

At SEGPON =”1”, the sub-voltage converter for Segment Display function.

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	1	1	0	DU1	DU0	BS1	BS0

(At the time of reset: (DU1,DU0,BS1,BS0)=0H, read address: EH)

(1) BS Command

Select boost voltage level below.

BS		BOOST VOLTAGE LEVEL
BS1	BS0	
0	0	PROHIBITION
0	1	3 TIMES
1	0	2 TIMES
1	1	PROHIBITION

(2) Duty Command

Select Duty ratio below..

DUTY		DUTY RATIO
D3	D2	
0	0	1/64
0	1	1/48
1	0	1/32
1	1	1/16

This module is 1/64 duty.

2-4.14 RE Register Set

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0/1	1	1	1	1	0	※	※	※	RE

※mark show “Don’t care” (At the time of reset: (RE)=0H, read address: FH)

RE Command

RE=”0”: the below register cannot be accessed.

RE=”1”: the extended function set, electric volume for the Segment

Display, Duty ratio select and boost voltage level select can be accessed.

2-4.15 Address Set for Internal Register Read

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	1	1	0	0	RA3	RA2	RA1	RA0

(At the time of reset: (RA3, RA2, RA1, RA0)=CH)

Then data set up in the internal registers are read out, set the address for Read allotted to each register by this command before executing the Read command of the internal registers.

For example, when the data of the command register in the display control (1) are read out, set the values of (RA3, RA2, RA1, RA0)=8H.

Refer to the Function description of each command or at list of commands on the address for Read allotted to each command register.

2-4.16 Internal Register Read

RE	RS	D7	D6	D5	D4	D3	D2	D1	D0
0	1	※	※	※	※	Internal register read data			

※ mark shows “Don’t care”

Command for reading out the data of the internal registers.

When this command is executed, the address for read in the internal registers to be read must be read must be preset.

2.5 Function Description

2.5.1 MPU Interface

2.5.1-1 Interface Type Selection

The LH155BA performs data transfer via the 8-bit data bus or the serial data input (the SDA or SCL pin). The parallel or serial interface is selected by setting the polarity of the P/S pin to “H” or “L”. When selecting serial interface, data-reading cannot be performed.

but only data writing can.

P/S	I/F type	CSB	RS	RDB	WRB	M86	SDA	SCL	Data
H	Parallel	CSB	RS	RDB	WRB	M86	-	-	D0 to D7
L	Serial	CSB	RS	-	-	-	SDA	SCL	-

2.5.1-2 Parallel input

The LH155BA allows parallel data transfer by connecting the data bus to an 8-bit MPU if the parallel interface is selected with the P/S pin.

For this 8-bit MPU, the 80-family or 68-family MPU type interface can be selected with the M86 pin.

M86	MPU type	CSB	RS	RDB	WRB	Data
L	80-family MPU	CSB	RS	RDB	WRB	D0 to D7

2.5.1-3 Data identification

The LH155BA identifies the data types over the 8-bit data bus by combinations of RS,RDB and WRB signals.

RS	80-family		FUNCTION
	WRB	RDB	
1	0	1	Read internal register
1	1	0	Write internal register
0	0	1	Read display data
0	1	0	Write display data

2.5.1-4 Serial interface

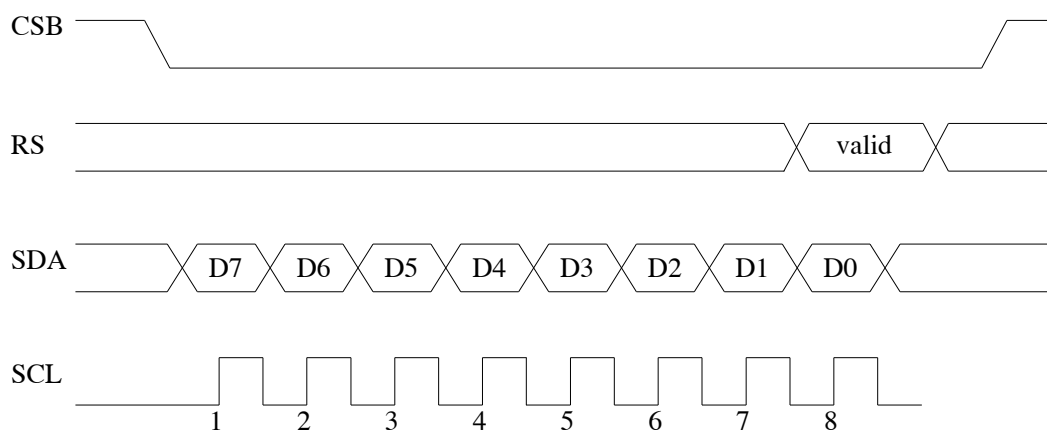
The serial interface for the LH155BA is enabled to accept the SDA and SCL inputs when the chip is selected. If the chip is not selected, the internal shift register and counter are reset to the initial state.

The data input is taken in the order of D7...D1, and D0 starting with the serial data input SDA when the serial clock (SCL) rises. At the leading edge of the 8th serial clock, the serial data is converted into 8-bit parallel data and then processed according to its type.

The serial data input (SDA) is identified with input at the RS pin.

The serial clock input (SCL) must be set to "L" if it is not accessed. After 8-bit data transfer is finished, it must be also set to "L".

For the SDA and SCL signals, sufficient care must be taken for external noise. In order to prevent continuous error recognition of transferred data occurring from external noise, the chip selected must be released (CSB="H") whenever 8-bit data transfer is finished.



2.5.2 Access to Display RAM and Internal Register

The LH155BA makes access to Display RAM, and internal register register by data bus D0~D7, chip select CSB is at "H", it is in non-selective state and cannot make access to Display RAM and internal registers, in making access to them, set CSB to "L".

The access to either Display RAM or internal registers can be shifted by RS input.

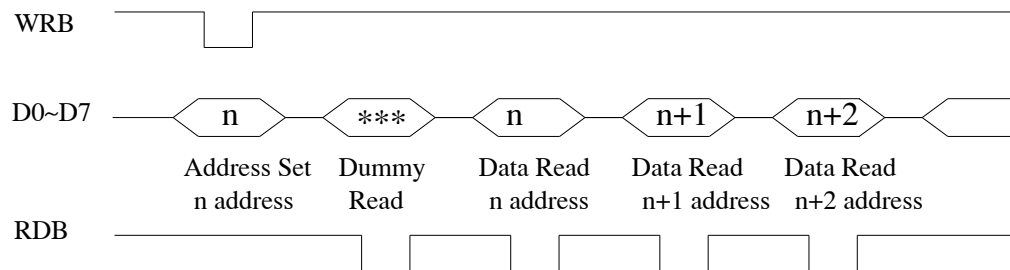
RS="L": Display RAM data

RS="H": Internal command register

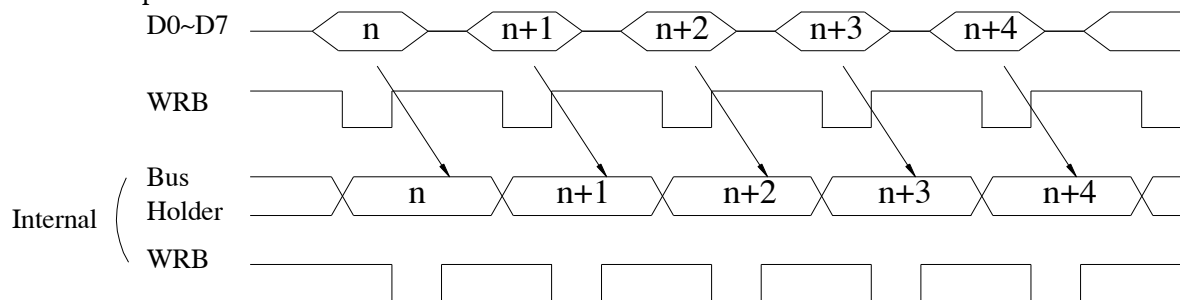
The data of 8-bit data bus D0~D7 are written by write operation after address setting through MPU. The timing of Write is at the rising of WRB for 80 family MPU and at the falling of E for 68 family MPU respectively.

Write is internally processed by placing intermediately the bus holder in the internal data bus .In case of writing data from MPU, the data are temporally held in the bus holder before they are written by the time of the next cycle. Since the Read sequence of Display RAM data is limited, note that when Address Set is made, the designated address data are not output to Read Command immediately after the Address Set, but are output when the second data Read, resulting in requiring dummy Read one time. Dummy Read is always required one time after Address Set

Data Read Operation



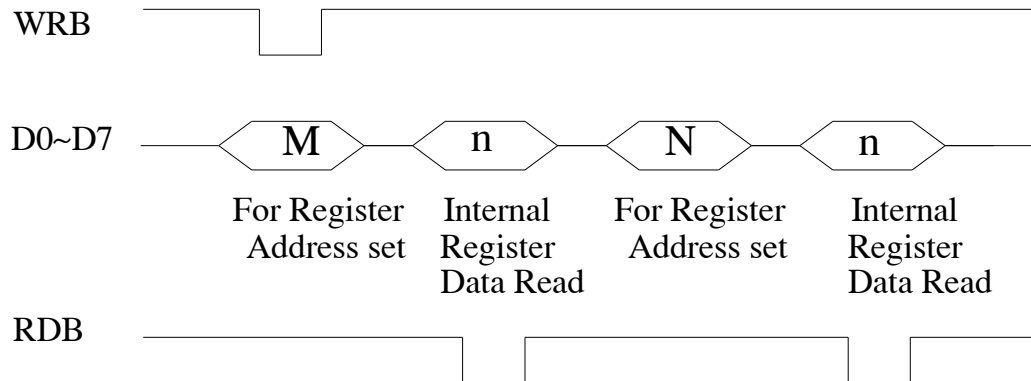
Data Write Operation



2.5.3 Read of internal Register

The LH155BA reads not only Display RAM, but also the internal registers.

Addresses for Read (0.2~E[hex])are allotted to each internal register. In reading the internal registers, the addresses of internal registers allotted to read are written in the register Read and then are read.



2.5.4 Display Mode

The LH155BA have 3 Display modes.

One is for Graphic Display mode and one is for Segment display mode and the other is for icon Display. 3 mode are independent of each other, so each mode can function alone. That can drive a minimum circuit each display mode. A suitable mode for lower current consumption is selectable.

2.5.4-1 Graphic Display Mode

This mode enable 64x128 bits- in SRAM and 64 command x 128 segment output terminal.

Graphic Display's Memory map is below.

When Stand-by mode and Sleep mode, power supply circuit is stopped and output terminal is specified VSS level.

The Memory for Graphic Display is accessed by 8 bits at one time.

X address is from 00H to 0FH and Y address is from 00H to 3FH. (See table A)

2.5.5 Display Starting Line Register

This register is for determining display start line (usually the most upper line)

Corresponding to COM0 in case of display the Display data RAM.

The register is also used in picture-scrolling.

The 6-bit display starting address is set in this register by display starting-line setting command.

The register are preset every timing of FLM signal variation in the display line counter. The line counter counts up being synchronized with LP input and generates line addressed which read out sequentially 128-bit data from Display RAM to LCD driver circuit.

2.5.6 Addressing of Display RAM

Display RAM consists of 128 x 64 bit memory, and makes access in 8 bit unit to an address specified by X address and Y address from MPU.

The address, X and Y are possible to be set up so that can increment automatically with the address control register. The increment is made every time Display RAM is read or written from MPU.

Though the X direction side is selected by X address while the Y direction side by Y address, 10H-FFH in the X address are inhibited and do not have the X address set in these addresses.

In the Y direction side, the 128-bit display data are internally read the display data latch circuit at the rising of LP every one line cycle, and are output from the display data latch circuit at the falling of LP.

43H-FFH in the Y address are inhibited and do not have the Y address set in these addresses.

When FLM signals being output in one frame cycle are at "H", the value in the display starting line register are preset in the line counter and the line counter counts up at the falling of LP signals.

The display line address counter is synchronized with each timing signal of the LCD system to operate and is independent of address counters, X and Y.

2.5.7 Display RAM Data and LCD

One bit of Display RAM data corresponds to one dot of LCD. Normal display and reverse display by REV register are set up as follows.

- Normal display (REV=0) : RAM data="0" not lighted
RAM data="1" lighted
- Reverse display (REV=1) : RAM data="0" lighted
RAM data="1" not lighted

2.5.8 Segment Display Output Order/Reverse Set Up

The order of display outputs, SEG0~SEG127 can be reversed by reversing access to Display RAM from MPU by using REF register, lessen the limitation in placing IC when assembling a LCD panel module.

[illegible]

2.5.9 Display Timing Generator

The display timing generator generates a timing clock necessary for internal operation and timing pulses (LP, FLM, and M) by inputting the original oscillating clock CK or by the oscillating circuit of OSC1 and OSC0.

By setting up Master/Slave mode(M/S), the state of timing pulse pins and the timing generator changes.

2.5.10 Signal Generation to Display Line Counter, and Display Data Latching Circuit

Both the clock to the line counter and latching signals to display data latching circuit from the display clock (LP) are generated.

Synchronized with the display clock, the line addresses of Display RAM are generated and 128-bit display data are latched to display-data latching circuit to output to the LCD driver circuit (SEG output).

2.5.11 Generation of the Alternated Signal (M) and the Synchronous Signal (FLM)

LCD alternated signal (M) and synchronous signal (FLM) are generated by the display clock (LP). The FLM generates alternated drive waveform to the LCD driver circuit. Normally the FLM generates alternated driver drive waveform every frame unit.

(M-signal level is reversed every one frame).

But by setting up data (n-1) in an n-line reverse register and n-line alternated command (NLIN) at “H”, n-line reverse waveform is generated.

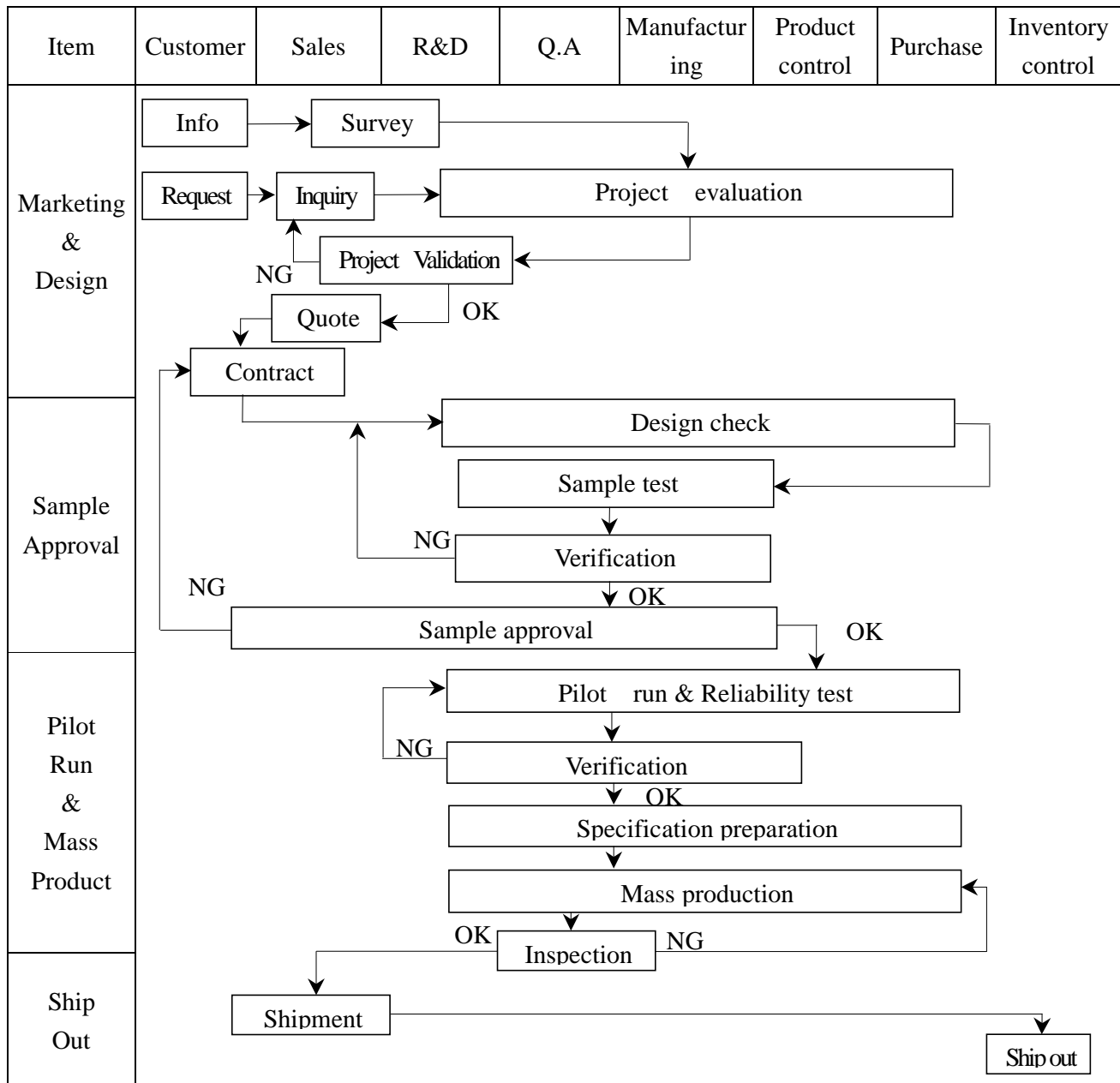
When the LH155BA is used in multi-chip, the signals of LP, FLM, and M must be sent from Master side in the Slave operation.

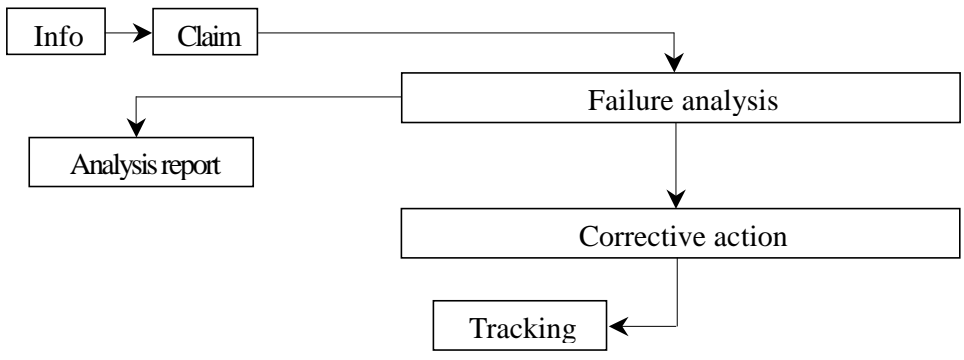
2.5.12 Display Data Latching Circuit

Display Data Latching Circuit temporary latches display data that is output display data to LCD driver circuit from Display RAM every one common period. Normal display /reverse display, display ON/OFF, and display all on command are operated by controlling data in the latch. And no data within Display RAM changes.

3. QUALITY ASSURANCE SYSTEM

3.1 Quality Assurance Flow Chart



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

3.2 Inspection Specification

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

Equipment : Gauge 、MIL-STD 、Powertip Tester 、Sample °

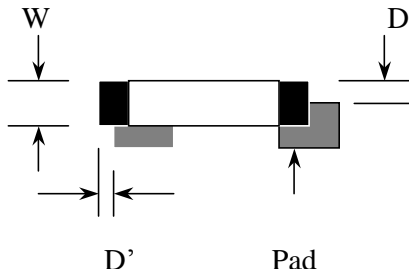
IQC Defect Level : Major Defect AQL 0.4; Minor Defect AQL 1.5 °

FQC Defect Level : 100% Inspection °

OUT Going Defect Level : Sampling °

Specification :

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

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

4. RELIABILITY TEST

4.1 Reliability Test Condition

NO	Item	Test Condition	
1	High Temperature Storage	Storage at 70 $\pm 2^{\circ}\text{C}$ 96~100 hrs Surrounding temperature, then storage at normal condition 4hrs	
2	Low Temperature Storage	Storage at -20 $\pm 2^{\circ}\text{C}$ 96~100 hrs Surrounding temperature, then storage at normal condition 4hrs	
3	High Temperature /Humidity Storage	1.Storage 96~100 hrs 60 $\pm 2^{\circ}\text{C}$, 90~95%RH surrounding temperature, then storage at normal condition 4hrs. (Excluding the polarizer). or 2.Storage 96~100 hrs 40 $\pm 2^{\circ}\text{C}$, 90~95%RH surrounding temperature, then storage at normal condition 4 hrs.	
4	Temperature Cycling	$ \begin{array}{c} -20^{\circ}\text{C} \rightarrow 25^{\circ}\text{C} \rightarrow 70^{\circ}\text{C} \rightarrow 25^{\circ}\text{C} \\ \leftarrow (30\text{mins}) (5\text{mins}) (30\text{mins}) (5\text{mins}) \rightarrow \\ 10 \text{ Cycle} \end{array} $	
5	Vibration	10~55Hz (1 minute) 1.5mm X,Y and Z direction * (each 2hrs)	
6	ESD Test	Air Discharge: Apply 6 KV with 5 times discharge for each polarity +/-	Contact Discharge: Apply 250V with 5 times discharge for each polarity +/-
		Testing location: Around the face of LCD	Testing location: 1.Apply to bezel. 2.Apply to Vdd, Vss.
7	Drop Test	Packing Weight (Kg)	Drop Height (cm)
		0 ~ 45.4	122
		45.4 ~ 90.8	76
		90.8 ~ 454	61
		Over 454	46

5. PRECAUTION RELATING PRODUCT HANDLING

5.1 SAFETY

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

5.2 HANDLING

- 5.2.1 Avoid any strong mechanical shock which can break the glass.
- 5.2.2 Avoid static electricity which can damage the CMOS LSI—When working with the module , be sure to ground your body and any electrical equipment you may be using.
- 5.2.3 Do not remove the panel or frame from the module.
- 5.2.4 The polarizing plate of the display is very fragile. So , please handle it very carefully ,do not touch , push or rub the exposed polarizing with anything harder than an HB pencil lead (glass , tweezers , etc.)
- 5.2.5 Do not wipe the polarizing plate with a dry cloth , as it may easily scratch the surface of plate.
- 5.2.6 Do not touch the display area with bare hands , this will stain the display area.
- 5.2.7 Do not use ketonics solvent & aromatic solvent. Use with a soft cloth soaked with a cleaning naphtha solvent.
- 5.2.8 To control temperature and time of soldering is $320\pm 10^{\circ}\text{C}$ and 3-5 sec.
- 5.2.9 To avoid liquid (include organic solvent) stained on LCM .

5.3 STORAGE

- 5.3.1 Store the panel or module in a dark place where the temperature is $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and the humidity is below 65% RH.
- 5.3.2 Do not place the module near organics solvents or corrosive gases.
- 5.3.3 Do not crush , shake , or jolt the module.

5.4 TERMS OF WARRANTY

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