SPECIFICATIONS FOR
LCD MODULE

CUSTOMER	
CUSTOMER PART NO.	
AMPIRE PART NO.	**AM-240320H1TNQW-00H**
APPROVED BY	
DATE	

☐ **Approved For Specifications**
☐ **Approved For Specifications & Sample**

APPROVED BY	CHECKED BY	ORGANIZED BY

RECORD OF REVISION

Revision Date	Page	Contents	Editor
2005/12/23	-	New Release	Eric
2006/01/05	7	Modify LCM brightness to 200cd/m^2 @20mA	Eric
	34	Modify LCM outline dimension.	
2006/01/09	23	Update IC timing characteristics	Eric
	33	Modify LCM outline dimension.	
2006/1/12	33	Modify LCM outline dimension.	Eric
2006/2/20	-	Change Part No. from TF240320-13-3 to AM-240320H1TNQW-00H.	Eric

1 Features

LCD 2.2 inch Amorphous-TFT-LCD (Thin Film Transistor Liquid Crystal Display) for mobile-phone or handy electrical equipments. The LCD adopts one backlight with High brightness 3-lamps white LED.

(1) Construction: 2.2" a-Si color TFT-LCD with White LED Backlight and FPC.
(2) LCD : 2.1 Amorphous-TFT 2.2 inch display, transmissive, Normally white type, 12 o' clock.
2.2 240(RGB)X320 dots Matrix,1/320 Duty.
2.3 LCD controller is HX8312A.
2.4 Real 262K colors display:
Red-5bit, Green-6bit, Blue-5bit (MPU7 mode, 8-bit twice)

(3) 8-bit high speed bus interface and high speed RAM-write function.
(4) Direct data display with display RAM.
LCD Internal RAM capacity: 172,800bytes
(5) MPU interface: 8 bits 80-serise parallel interface is available.

2 Mechanical specifications

Dimensions and weight

Item		Specifications	Unit
External shape dimensions		*1 40.1 (W) x 52.816(H) x 3.995(TMax.)	mm
Main LCD	Pixel pitch	0.1395 (W) x 0.1395(H)	mm
	Active area	33.48 (W) x 44.64 (H)	mm
	Viewing area	35.24 (W) x 46.24 (H)	mm
Weight		10.5	g

*1. This specification is about External shape on shipment from AMPIRE.

3 Absolute max. ratings and environment

3-1 Absolute max. ratings

Ta=25°C GND=0V

Item	Symbol	Min.	Max.	Unit	Remarks
Power Supply for Logic	VDD – GND	-0.3	+4.0	V	
Power Input Voltage	Vci	-0.3	+4.6	V	
Power Supply for LED backlight	LED A – LED K	-0.5	+12	V	
Input voltage	VIN	-0.5	VDD+0.5	V	

3-2 Environment

Item	Specifications	Remarks
Storage temperature	Max. +70 °C Min. –30 °C	Note 1: Non-condensing
Operating temperature	Max. +60 °C Min. -20 °C	Note 1: Non-condensing

Note 1：Ta≦+40 °C? ? ? ? Max.85%RH

Ta＞+40 °C? ? ? ? The max. humidity should not exceed the humidity with 40 °C 85%RH.

4 Electrical specifications

4-1 Electrical characteristics of LCD

(V_{DD}=2.8V, Ta=25°C)

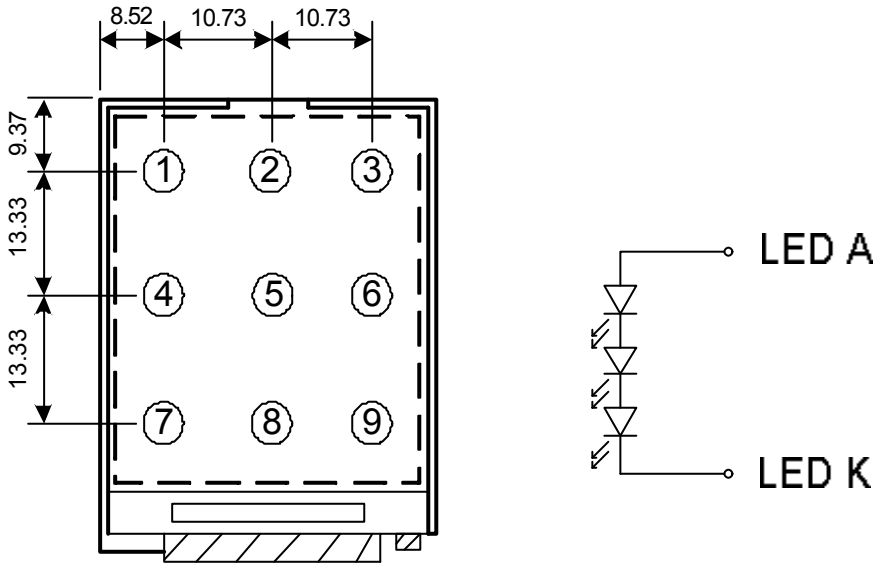
Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
IC power voltage	V_{DD}		2.2	2.8	3.3	V
Power input voltage	Vci		2.5	-	3.3	V
High-level input voltage	V_{IHC}		$0.8V_{DD}$		V_{DD}	V
Low-level input voltage	V_{ILC}		0		$0.2V_{DD}$	V
Consumption current of VDD	I_{DD}		-	2.5	4	mA
Consumption current of LED	I_{LED}	V_{LED}=9.8V	-	15	20	mA

? 1. 1/320 duty

4-2 LED back light specification

Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Forward voltage	V_f	I_f =15mA	9.3	9.8	10.8	V
Reverse voltage	V_r		-	-	12	V
Forward current	I_f	3-chip Serial	12	15	20	mA
Power Consumption	P_{BL}	I_f =20mA	-	196	-	mW
Uniformity (with L/G)	-	I_f=15mA	80% *1	-	-	
Bare LED Luminous intensity	V_f I_f	20mA	3600	-	-	cd/m^2
Luminous color	White					
Chip connection	3 chip serial connection					

LCM measure position:



*1 Uniformity (LT): $\frac{Min(P1 \sim P9)}{Max(P1 \sim P9)} \times 100 \geq 80\%$

5 Optical characteristics

Main LCD

5.1 Optical characteristics

(1/320 Duty in case except as specified elsewhere Ta = 25°C)

LED backlight transmissive module:

Item	Symbol	Temp.	Min.	Std.	Max.	Unit	Conditions
Response time	Tr	25 °C	-	10	25	ms	θ =0 °? , ϕ =0 ° (Note 2)
	Tf	25 °C	-	20	40		
Contrast ratio	CR	25 °C	150	200	-	-	θ =0 °, ϕ =0 ° LED:ON, LIGHT:OFF (Note 4)
Transmittance	T	25 °C	-	6.9	-	%	
Visual angle range front and rear	θ	25 °C	(θ f) 35 (θ b) 60			De-gree	ϕ = 0°, CR≧10 LED:ON LIGHT:OFF (Note 3)
Visual angle range left and right	θ	25 °C	(θ l) 60 (θ r) 60			De-gree	ϕ =90°, CR≧10 LED:ON LIGHT:OFF (Note 3)
Visual angle direction priority			12:00				(Note 5)
Brightness			200			Cd/ m2	I_{LED}=20mA, Full White pattern

5-2 CIE (x, y) chromaticity (1/320 Duty Ta = 25°C)

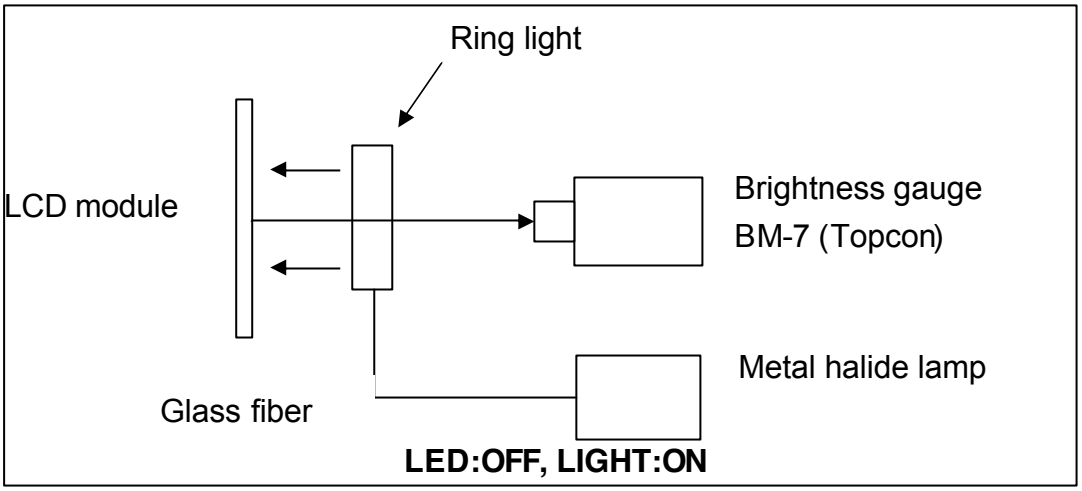
Main LCD: (1/320 Duty Ta = 25°C)

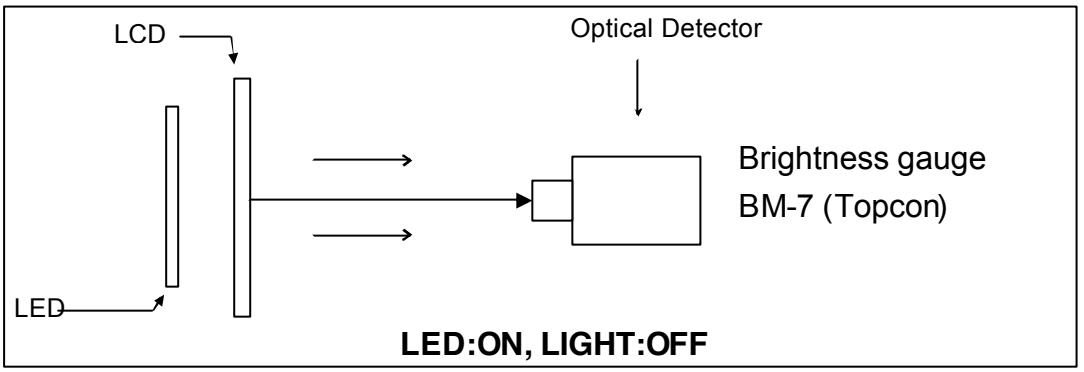
Item	Symbol	Transmissive			Conditions
		Min.	Std.	Max.	
Red	x	0.615	0.645	0.645	θ =0? , ϕ =0?
	y	0.343	0.373	0.373	
Green	x	0.307	0.337	0.337	θ =0? , ϕ =0?
	y	0.563	0.593	0.593	
Blue	x	0.133	0.163	0.163	θ =0? , ϕ =0?
	y	0.150	0.180	0.180	
White	x	0.309	0.339	0.339	θ =0? , ϕ =0?
	y	0.350	0.380	0.380	

Light source

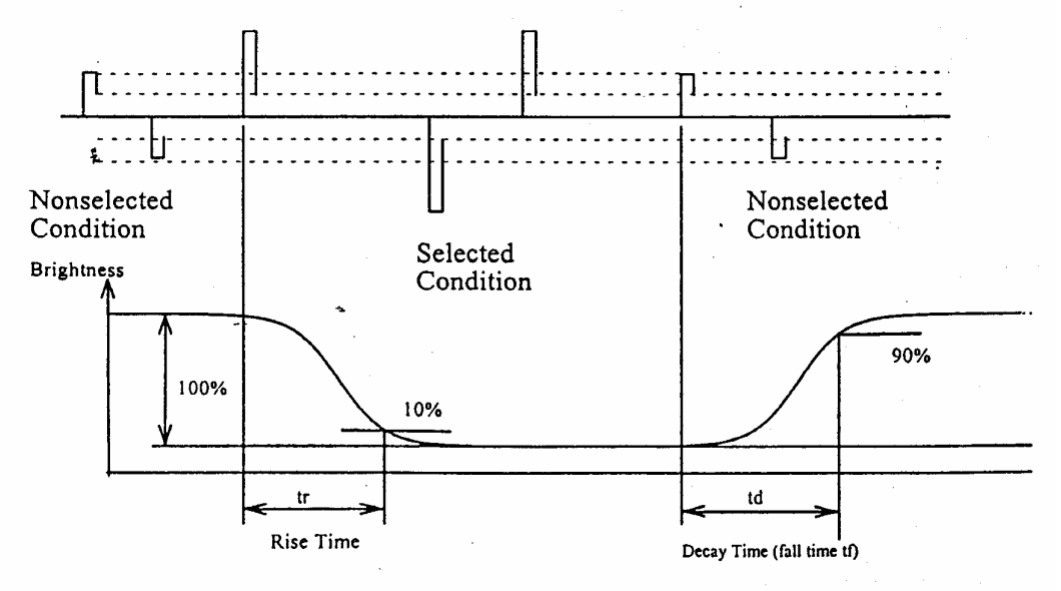
Item	Symbol	Value			Conditions
		Min.	Std.	Max.	
Light source	x	0.28	0.315	0.34	θ =0? , ϕ =0?
	y	0.28	0.305	0.34	
LED brightness		3600	-	-	Unit: cd/m^2 (I_{LED}=20mA)

NOTE 1: Optical characteristic measurement system

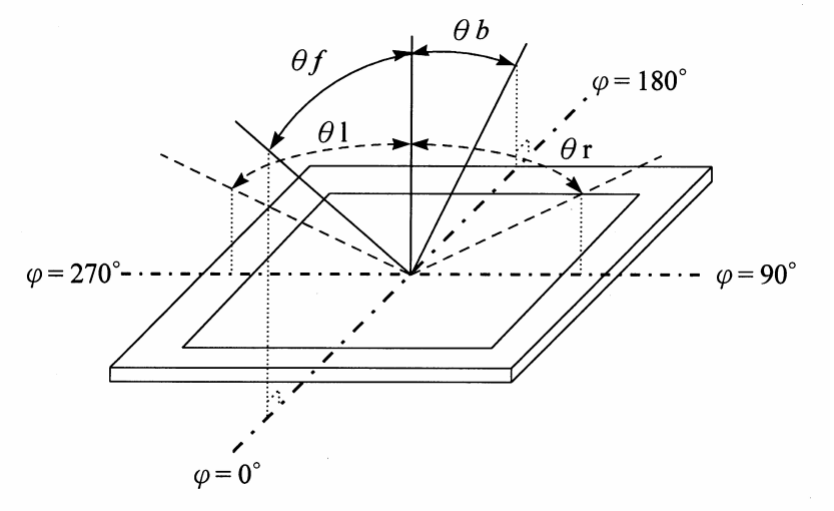




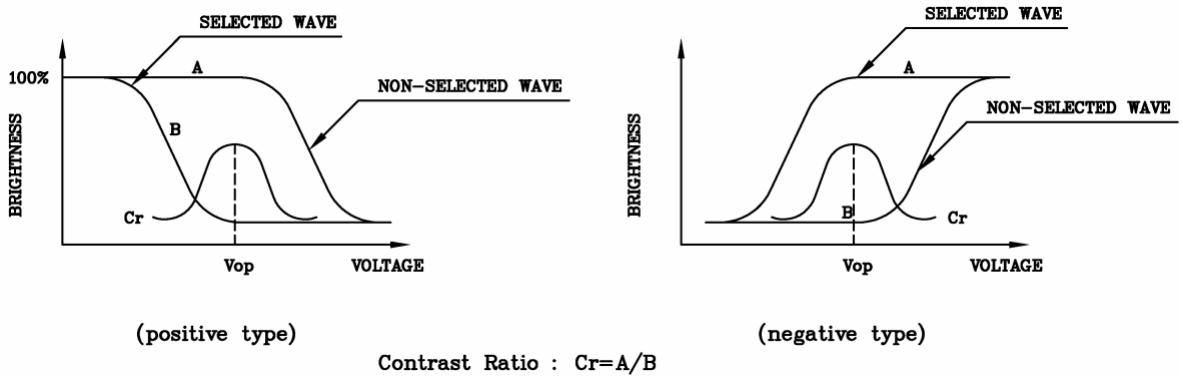
NOTE 2: Response tome definition



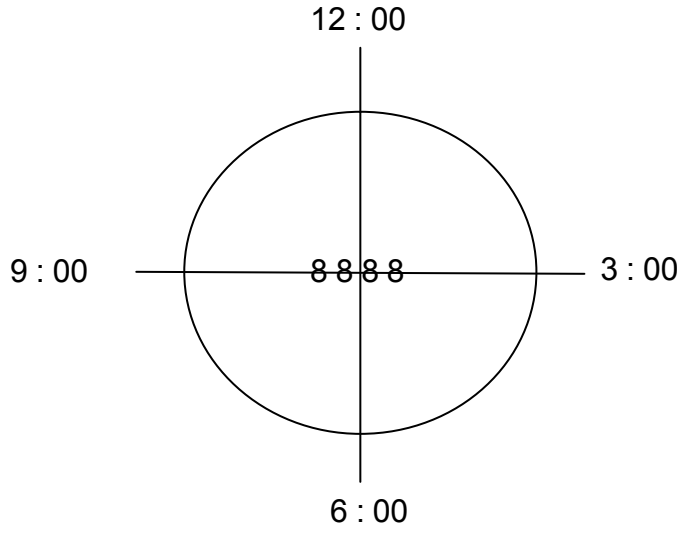
NOTE 3: ϕ 、θ definition



NOTE 4: Contrast definition



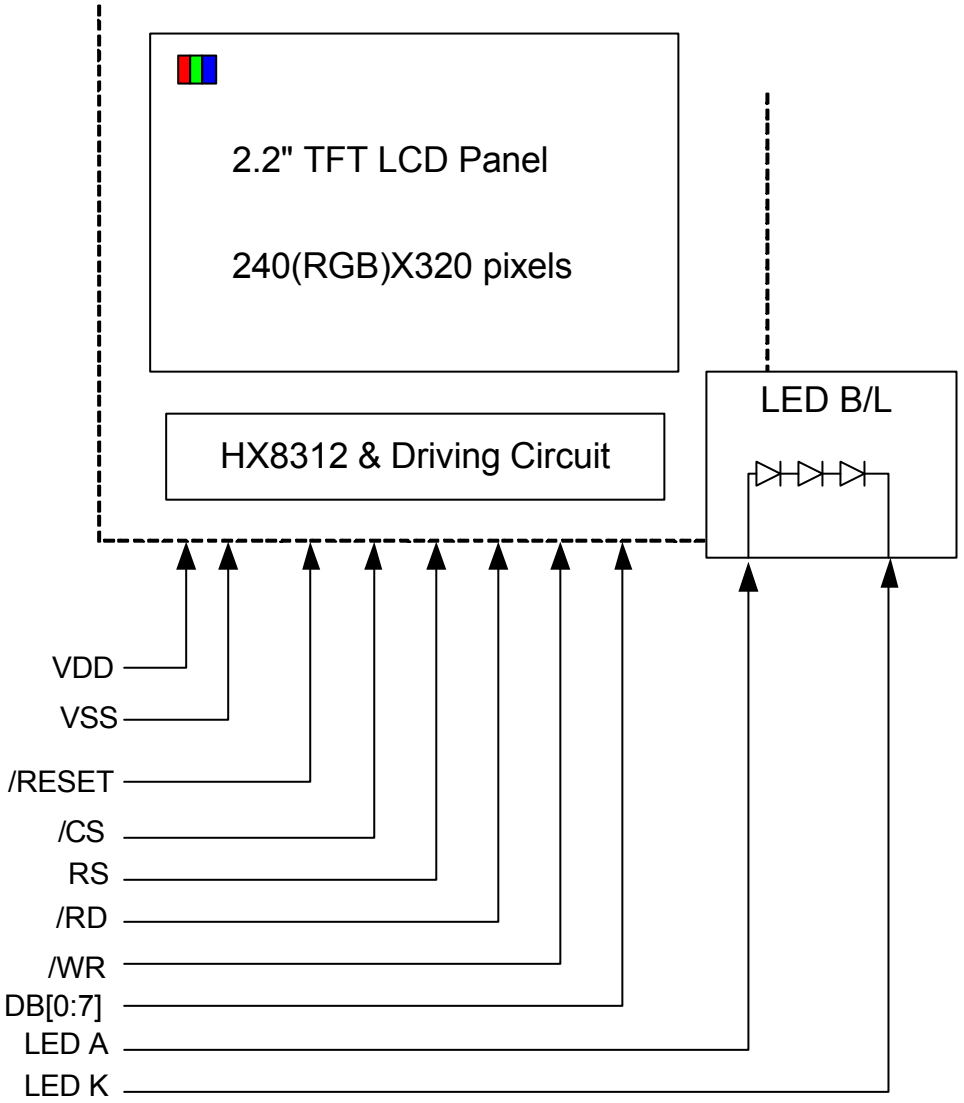
NOTE 5: Visual angle direction priority



6 Block Diagram

Block diagram (Main LCD)

Display format: A-Si TFT transmissive, Normally white type, 12 o' clock.
Display mode: Normally white
Display composition: 240 x RGB x 320 pixels
LCD Driver : HX8312
Back light: White LED x 3 (I_{LED}=20mA)



7 Interface specifications

Pin No.	Terminal	Functions
1	LED_A	LED Backlight anode connection
2	LED_A	
3	LED_K	LED Backlight cathode connection
4	LED_K	
5	NC	No Connection
6	NC	No Connection
7	/RESET	LCD Reset terminal, active “L”
8	DB7	Data Bus for 8-bits, 80-series MPU (MPU7 type)
9	DB6	
10	DB5	
11	DB4	
12	DB3	
13	DB2	
14	DB1	
15	DB0	
16	NC	No Connection
17	NC	
18	NC	
19	NC	
20	NC	
21	NC	
22	NC	
23	NC	
24	NC	
25	NC	
26	/RD	Read clock terminal , active “L” (80 series interface)
27	/WR	Write clock terminal , active “L” (80 series interface)
28	RS	The signal for register index or register command select . Low: Register index or internal status (in read operation); High: Register command.
29	/CS	Chip select signal. Low: chip can be accessed; High: chip cannot be accessed.
30	VCC	Power supply for the internal logic circuit. (VCC=2.2~3.3V)
31	VCC	
32	NC	No Connection
33	VCI	Power supply for Step-up circuit. (VCi=2.5~3.3V)
34	VSS	GND-terminal.
35	VSS	

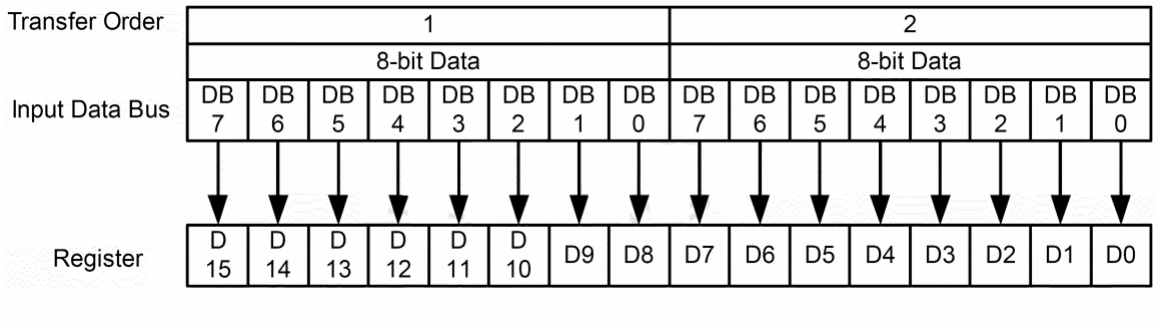
(Continues to Next page)

36	NC	No Connection
37	NC	No Connection
38	NC	No Connection
39	NC	No Connection

7.1 System interface

IM bits setting and the type of system interface for LCD

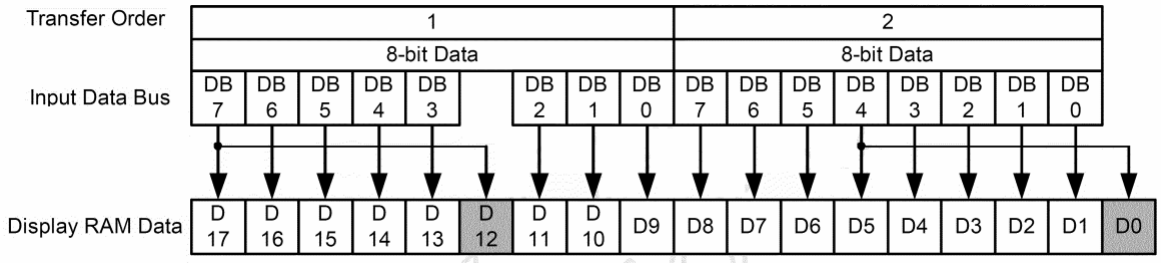
Interface Type	External Setting Pin					Bus Width	Bit number in a pixel	Transferring Method of RAM data	Transferring Method of Command
	PSX	BWS1	BWS0	DTX2	DTX1				
MPU7	0	1	1	1	0	8-bit Parallel	16bits	8-bit twice	8-bit twice



7.2 80-system MPU7 type (8-bitX2)

IN the MPU7 type, The 16-bit data written to display RAM is expanded to 18-bit bus data automatically in the LSI. D12 of the display data RAM is compensated by the data from DB7 in the first transfer and D0 of the display data RAM is compensated by the data from DB4 in the second transfer.

Data format for MPU7 Type



Data format for 8-bit interface

8 INSTRUCTION DESCRIPTIONS

8.1 Register Description (Driver IC: HX8312)

Register	Bit	Symbol	Function	Configuration
			Control register 1	
R0 (R00h) default "A0"h	D7	DISP1	Source output data selection.	All source output as "0" or "1" selection Refer to "10.2 " All "0" or "1" Source Output Display "
	D6	DISP0	Source output data selection.	All source output as "0" or "1" selection Refer to "10.2 " All "0" or "1" Source Output Display "
	D5	ADC	Specifies source output and display RAM address mapping .	Refer to 4.1 "Relation between the Display RAM Address and the Source Output Channel"
	D4	DTY	Specifies partial display mode.	"0" : Normal display mode. "1" : Partial display mode. Refer to "5. Partial Display Mode".
	D3	STBY	Specifies stand-by mode.	"0" : Normal operation. "1" : Stand-by mode.
	D2	COLOR	Specifies color mode.	"0" : 262,144 color mode. "1" : 8 color mode. Refer to "9 8-color Display Mode".
	D1	-	-	-
	D0	GSM	Gate scan selection in partial-off display areas.	"0" : Normal scan in non-display area "1" : Configures the scanning cycle in non-display area by the number of the R52 register.
			Control register 2	
R1 (R01h) default "00"h	D7	ADX	RAM X address increment direction after one write or read operation .	"0" : From X0 to X239 Refer to "4.2. Display RAM Access" "1" : From X239 to X0 *Note : ADX = "1" setting is prohibited when RGB interface circuit is in use.
	D6	ADR	RAM Y address increment direction after one write or read operation .	"0" : Y0 to Y319 Refer to "4.2. Display RAM Access" "1" : Y319 to Y0 *Note : ADR = "1" setting is prohibited when RGB interface circuit is in use.
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	LTS	Specifies setting period of calibration.	"0" : 1line period = tcal "1" : 1 line period = tcal x 2 Refer to "3.3 Internal Clock Mode".
	D0	OSCSTBY	Oscillation control.	"0" : Starts oscillation. "1" : Stops oscillation.
			RGB interface register 2	
R2 (R02h) default "00"h	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	VMODE	Vsync interface selection.	"0" : Normal Refer to "Table 9-1". "1" : Uses Vsync interface.
	D3	WNRGB	RGB interface writing mode selection.	"0" : Requires 1 frame data. "1" : Requires data only for the window area. Refer to "9.1.6 Restriction when using the RGB interface circuit".
	D2	RGBS	RGB interface writing mode selection.	"0" : Capture mode. Refer to "Table 9-1". "1" : Through mode.
	D1	DISPCK	Specifies display timing at RGB interface circuit.	"0" : Internally synchronized display mode by SYSCLK. "1" : Externally synchronized display mode by Vsync and Hsync. Refer to "Table 9-1".
	D0	NWRGB	RGB interface pin control.	"0" : Writes to the display data RAM via the system interface circuit. "1" : Writes to the display data RAM via the RGB interface circuit. Refer to "Table 9-1".

	Reset register 1			
R3 (R03h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
default "00"h	D2	-	-	-
	D1	-	-	-
	D0	RES	Reset command for the HX8312A	"0" : Normal operation. "1" : Reset Operation.
	RAM access control register			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
R5 (R05h)	D4	WAS	Specifies window area access mode.	"0" : Normal writing mode. "1" : Window area access mode. Refer to "4.3. Window Area Access Mode".
	D3	-		
default "00"h	D2	AM	Specifies the address increment direction.	"0" : X address increment, then Y address increment. "1" : Y address increment, then X address increment, *Note: This setting is invalid when RGB interface circuit is in use. Refer to "4.2. Access to the Display Data RAM".
	D1	-	-	-
	D0	-	-	-
	Data reverse register			
	D7	-	-	-
R6 (R06h)	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
default "00"h	D2	-	-	-
	D1	-	-	-
	D0	REV	Reverse the source output data voltage	"0": Data "0000"h; Source output: V63 at VCOML "1": Data "0000"h; Source output V0 at VCOML
	Display size control register			
	D7	-	-	-
R13 (R0Dh)	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
default "00"h	D2	NSO1	Specify source output size.	Refer to "4.1 Relation between the Display RAM Address and the Source Output Channel".
	D1	NSO0		
	D0	-	-	-
	Partial non-display area color register 1			
	D7	-	-	-
	D6	-	-	-
R14 (R0Eh)	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
default "00"h	D1	-	-	-
	D0	PSEL	Specifies the color of the partial non-display area	"0" : Displays the color specified in the R15 register. "1" : Displays the most significant bit of the display RAM data. Refer to "5.2 Display Color Selection and Gate Scan Method in Partial Non-Display Areas".

R15 (“0F“h) default “00“h	**Partial non-display area color register 2**			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	PGR	Specifies display data for pixel R.	"0" : Displays "0". "1" : Displays "1".
	D1	PGG	Specifies display data for pixel G.	"0" : Displays "0". "1" : Displays "1".
	D0	PGB	Specifies display data for pixel B.	"0" : Displays "0". "1" : Displays "1".
R16 (R10h) default “00“h	**First display window area starting register 1 , 2**			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P1SL8	Specify the starting line number of the first display window area.	Set within the range of "000"h - "13F"h.
R17 (R11h) default “00“h	D7	P1SL7		
	D6	P1SL6		
	D5	P1SL5		
	D4	P1SL4		
	D3	P1SL3		
	D2	P1SL2		
	D1	P1SL1		
	D0	P1SL0		
R18 (R12h) default “00“h	**Second display window area starting register 1 , 2**			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P2SL8	Specify the starting line number of the second display window area.	Set within the range of "000"h - "13F"h.
R19 (R13h) default “00“h	D7	P2SL7		
	D6	P2SL6		
	D5	P2SL5		
	D4	P2SL4		
	D3	P2SL3		
	D2	P2SL2		
	D1	P2SL1		
	D0	P2SL0		
R20 (R14h) default “00“h	**First display window area display line number 1 , 2**			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P1AW8	Specify the display line number of the first display window area.	Set within the range of "001"h - "140"h.
R21 (R15h) default “00“h	D7	P1AW7		
	D6	P1AW6		
	D5	P1AW5		
	D4	P1AW4		
	D3	P1AW3		
	D2	P1AW2		
	D1	P1AW1		
	D0	P1AW0		

	Second display window area display line number 1 , 2			
R22 (R16h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
default "00"h	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	P2AW8	Specify the display line number of the second display window area.	Set within the range of 000"h - "13F"h.
R23 (R17h)	D7	P2AW7		
	D6	P2AW6		
	D5	P2AW5		
	D4	P2AW4		
default "00"h	D3	P2AW3		
	D2	P2AW2		
	D1	P2AW1		
	D0	P2AW0		
	Power Supply System Control Register 1			
R24 (R18h)	D7	VR2ON	Controls the VR2 regulator.	"0" : VR2 regulator off. "1" : VR2 regulator on.
	D6	VR1ON	Controls the VR1 regulator.	"0" : VR1 regulator off. "1" : VR1 regulator on.
	D5	VCLON	Controls the step-up circuit 3 for VCL..	"0" : VCL step-up circuit off. "1" : VCL step-up circuit on.
	D4	VGON	Controls the step-up circuit 2.	"0" : Step-up circuit 2 off. "1" : Step up circuit 2 on.
default "00"h	D3			
	D2	DDVDHON	Controls the step-up circuit 1 for DDVDH.	"0" : DDVDH step-up circuit off. "1" : DDVDH step-up circuit on.
	D1			
	D0	DCON	Controls the DC/DC convertor.	"0" : DC/DC converter off. "1" : DC/DC converter on.
	Power Supply System Control Register 2			
R25 (R19h)	D7	VR2SEL2	Specify the output voltage of the VR2 regulator.	-
	D6	VR2SEL1		
	D5	VR2SEL0		
	D4	VR1SEL2	Specify the output voltage of the VR1 regulator.	-
default "00"h	D3	VR1SEL1		
	D2	VR1SEL0		
	D1	-	-	-
	D0	-	-	-
	Power Supply System Control Register 3			
R26 (R1Ah)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
default "05"h	D3	FS3	Specify the step-up circuit 2and 3 frequency	-
	D2	FS2		
	D1	FS1	Specify the step-up circuit 1 frequency	-
	D0	FS0		
	Power Supply System Control Register 4			
R27 (R1Bh)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
default "0A"h	D3	VSEL2	Specify the output voltage of the VS and VDH regulator.	-
	D2	VSEL1		
	D1	VSEL0		
	D0	RGON	Controls the VS and VDH regulator.	"0" : VS and VDH regulator off. "1" : VS and VDH regulator on.

R28 (R1Ch) default "33"h	Power Supply System Control Register 5			
	D7	-	-	-
	D6	SAP2	Source driver circuit operating current control	(SAP2, SAP1, SAP0) = "000": Halt (SAP2, SAP1, SAP0) = "001": 0.5(fixed) (SAP2, SAP1, SAP0) = "010": 0.75(fixed) (SAP2, SAP1, SAP0) = "011": 1.0(fixed) (SAP2, SAP1, SAP0) = "100": 1.25(fixed) (SAP2, SAP1, SAP0) = "101": 1.5(fixed) (SAP2, SAP1, SAP0) = "110": 1.5(fixed) (SAP2, SAP1, SAP0) = "111": Setting disable
	D5	SAP1		
	D4	SAP0		
	D3	-	-	-
	D2	AP2	Step-up circuit operating current control	(AP2, AP1, AP0) = "000": Halt (AP2, AP1, AP0) = "001": Setting disable (AP2, AP1, AP0) = "010": 0.5(fixed) (AP2, AP1, AP0) = "011": 0.75(fixed) (AP2, AP1, AP0) = "100": 1.0(fixed) (AP2, AP1, AP0) = "101": 1.25(fixed) (AP2, AP1, AP0) = "110": 1.5(fixed) (AP2, AP1, AP0) = "111": Setting disable
	D1	AP1		
	D0	AP0		
R29 (R1Dh) default "03"h	Power Supply System Control Register 6			
	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	R/L	Specifies the gate scan direction.	-
	D2	SCN2	Specify gate scan mode.	(SCN2, SCN1, SCN0) = "XX0" : MODE5 (SCN2, SCN1, SCN0) = "011" : MODE2
	D1	SCN1		
	D0	SCN0		
R30 (R1Eh) default "00"h	Power Supply System Control Register 8			
	D7	VCOMEN	Specify the VCOM1 operation.	-
	D6			
	D5	VCOMFX		
	D4	VCOMHI		
	D3	XVCOMG	VCOML output control	"0": VCOML = GND "1": VCOML is setting with VDV and VCM
	D2	-	-	-
	D1	-	-	-
	D0	DDVDHXON	Specifies whether to use or not to use the extra step-up circuit 1 for DDVDH.	"0" : Doesn't use the extra step-up circuit 1. "1" : Uses the extra step-up circuit 1.
R31 (R1Fh) default "00"h	Power Supply System Control Register 9			
	D7	-	Specify the VCOM amplitude.	-
	D6	-		
	D5	-		
	D4	VDV4		
	D3	VDV3		
	D2	VDV2		
	D1	VDV1		
	D0	VDV0		
R32 (R20h) default "00"h	Power Supply System Control Register 10			
	D7	-	Specify the VCOMH voltage level	-
	D6	-		
	D5	-		
	D4	VCM4		
	D3	VCM3		
	D2	VCM2		
	D1	VCM1		
	D0	VCM0		

	ID code register 1			
R49 (R31h)	D7	MCOD3	Manufacturer code.	-
	D6	MCOD2		
	D5	MCOD1		
	D4	MCOD0		
default "10"h	D3	VCOD3	The version of this LSI.	Depends on the version of the product.
	D2	VCOD2		
	D1	VCOD1		
	D0	VCOD0		
	-	-	-	**ID code register 2**
R50 (R32h)	D7	DCOD7	Device code of this LSI.	-
	D6	DCOD6		
	D5	DCOD5		
	D4	DCOD4		
default "03"h	D3	DCOD3		
	D2	DCOD2		
	D1	DCOD1		
	D0	DCOD0		
	D7	**N line inversion register**		
R51 (R33h)	D6	NLINE6	Specify the number of lines for N line inversion.	Set within the range of "01"h - "78"h. Refer to "7 Gate Line Driving Function".
	D5	NLINE5		
	D4	NLINE4		
	D3	NLINE3		
default "01"h	D2	NLINE2		
	D1	NLINE1		
	D0	NLINE0		
	Partial gate register 1			
R52 (R34h)	D7	GSMLN7	Specify the gate scanning cycle of the non-display area	"00"h : Doesn't scan the partial non-display area. "01"h : Scans the partial non-display area every frame. "02"h : Scans the partial non-display area every two frames.
	D6	GSMLN6		
	D5	GSMLN5		
	D4	GSMLN4		
	D3	GSMLN3		
default "01"h	D2	GSMLN2		
	D1	GSMLN1		
	D0	GSMLN0		
	Partial gate register 2			
R53 (R35h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
default "00"h	D2	-	-	-
	D1	-	-	-
	D0	PNFRM	Configures the driving method of the partial non-display area.	"0" : The partial non-display area is driven as that in the partial display area. "1" : The partial non-display area is driven by the frame inversion.
	Gate scan selection register			
R55 (R37h)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
default "00"h	D3	-	-	
	D2	GSCAN2	Select the method of gate scanning.	-
	D1	GSCAN1		
	D0	GSCAN0		
	Gate output control register			
R59 (R3Bh)	D7	-	-	-
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
default "00"h	D2	-	-	-
	D1	-	-	-
	D0	DISPTMG	Controls the gate output	"0" : Fix all gate outputs to VGL level. "1" : Gate scanning normal operation.

Gamma control register 12				
R154 (R9Ah) default “00“h	D7	-	Gamma adjustment register	-
	D6	-		
	D5	-		
	D4	ON14		
	D3	ON13		
	D2	ON12		
	D1	ON11		
	D0	ON10		
Extend mode register				
R157 (R9Dh) default “00“h	D7	-	-	-
	D6	-	-	-
	D5	MON_EN	Specify the V0 and V63 monitor function	“0”: V0 and V63 output monitor is disable. “1”: V0 and V63 output monitor is enable.
	D4	MON_SEL	V0 and V63 monitor selection	“0”: V0 outputs at DS1 pin. “1”: V63 outputs at DS1 pin
	D3	-	-	-
	D2	BPEN	Specify the Enable operation	“0”: Enable control is available. “1”: VBP/HBP control is enable
	D1	EPL	Specify the Enable polarity	“0”: High active “1”: Low active
	D0	MSBF	NWRGB (R2:D0)=”1”	“0” : 18-bit x 1transfer (BWS2=”L”). RGB interface type “0” : 16-bit x 1transfer (BWS2=”H”). RGB interface type “1” : 6-bit x 3 transfer (BWS2=x). RGB interface type
			NWRGB (R2:D0)=”0”	“0” : MPU5 mode A (use lower 6bits). MPU interface type “1” : MPU5 mode B (use upper 6bits). MPU interface type This bit is invalid in other modes.
Off mode register				
R192 (“C0“h) default “00“h	D7	OFFMOD	Specify the Off mode	“0”: Normal mode “1”: Off mode In off mode, only OFFMOD bit can be updated. Other register and the display RAM can not be updated. The display RAM data may not be retained in off mode, and need to rewrite after off mode canceling.
	D6	-	-	-
	D5	-	-	-
	D4	-	-	-
	D3	-	-	-
	D2	-	-	-
	D1	-	-	-
	D0	-	-	-

9 Timing Characteristics

80-system Bus interface Timing Characteristics

Read / Write Characteristics (8080-series MPU)

Bus Timing Characteristics

Please refer to HX8312A specification

<<Normal Write Mode(HWM=0), IoVcc=1.65V-2.4V>>

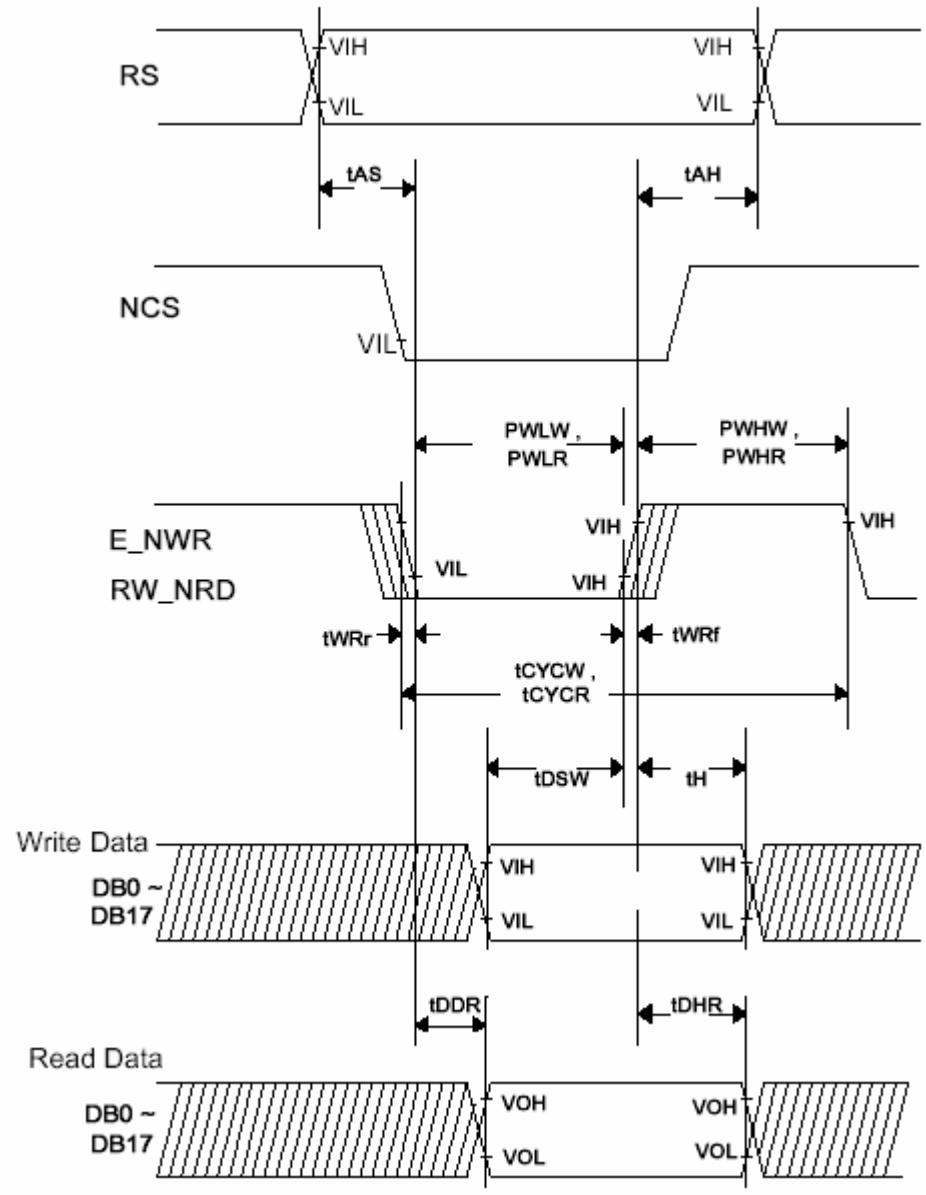
Item		Symbol	Unit	Min	Typ	Max
Bus cycle time	Write	t_{CYCW}	ns	125	-	-
	Read	t_{CYCR}	ns	300	-	-
Write low-level pulse width		PW_{LW}	ns	40	-	-
Read low-level pulse width		PW_{LR}	ns	150	-	-
Write high-level pulse width		PW_{HW}	ns	70	-	-
Read high-level pulse width		PW_{HR}	ns	150	-	-
Write/Read rise/fall time		t_{WRr},t_{WRf}	ns	-	-	25
Set up time	(RS to NCS,E_NWR)	t_{AS}	ns	5	-	-
RS hold time	(NCS,NWR to RS)	t_{AH}	ns	5	-	-
Write data set up time		t_{DSW}	ns	20	-	-
Write data hold time		t_H	ns	15	-	-
Read data delay time		t_{DDR}	ns	-	-	100
Read data hold time		t_{DHR}	ns	5	-	-

<<Normal Write Mode(HWM=0), IoVcc=2.4V-3.3V>>

Item		Symbol	Unit	Min	Typ	Max
Bus cycle time	Write	t_{CYCW}	ns	200	-	-
	Read	t_{CYCR}	ns	300	-	-
Write low-level pulse width		PW_{LW}	ns	40	-	-
Read low-level pulse width		PW_{LR}	ns	150	-	-
Write high-level pulse width		PW_{HW}	ns	70	-	-
Read high-level pulse width		PW_{HR}	ns	150	-	-
Write/Read rise/fall time		t_{WRr},t_{WRf}	ns	-	-	25
Set up time	(RS to NCS,E_NWR)	t_{AS}	ns	5	-	-
RS hold time	(NCS,NWR to RS)	t_{AH}	ns	5	-	-
Write data set up time		t_{DSW}	ns	20	-	-
Write data hold time		t_H	ns	15	-	-
Read data delay time		t_{DDR}	ns	-	-	100
Read data hold time		t_{DHR}	ns	5	-	-

Reset Timing Characteristics

Item	Symbol	Unit	Min	Typ	Max
Reset" low" level width	t_{RES}	ms	1	-	-
Reset rise time	t_{rRES}	us	-	-	10



80-System Bus Timing

Note 1) PWEL is specified during the overlap period. (SC*="Low", WR* or RD*="Low")

Note 2) When using 16-bit bus interface, parallel data can be transferred through DB17-10 pin and DB8-1 and DB0 must be fixed to "Vcc" or "GND".

10 QUALITY AND RELIABILITY

10.1 TEST CONDITIONS

Tests should be conducted under the following conditions :

Ambient temperature : 25 ± 5°C

Humidity : 60 ± 25% RH.

10.2 SAMPLING PLAN

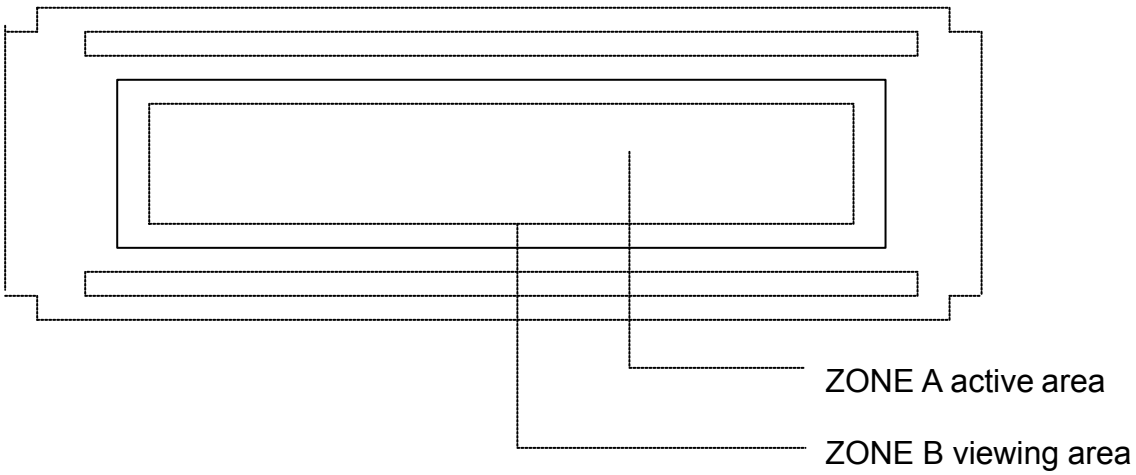
Sampling method shall be in accordance with MIL-STD-105E , level II, normal single sampling plan .

10.3 ACCEPTABLE QUALITY LEVEL

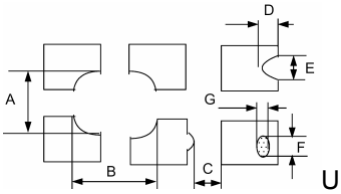
A major defect is defined as one that could cause failure to or materially reduce the usability of the unit for its intended purpose. A minor defect is one that does not materially reduce the usability of the unit for its intended purpose or is an infringement from established standards and has no significant bearing on its effective use or operation.

10.4 APPEARANCE

An appearance test should be conducted by human sight at approximately 30 cm distance from the LCD module under flourescent light. The inspection area of LCD panel shall be within the range of following limits.

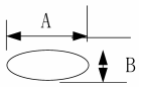


10.5 INSPECTION QUALITY CRITERIA

<table>
<tr><th>No.</th><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>1</td><td>Non display</td><td>No non display is allowed</td><td>Major</td></tr>
<tr><td>2</td><td>Irregular operation</td><td>No irregular operation is allowed</td><td>Major</td></tr>
<tr><td>3</td><td>Short</td><td>No short are allowed</td><td>Major</td></tr>
<tr><td>4</td><td>Open</td><td>Any segments or common patterns that don’ t activate are rejectable.</td><td>Major</td></tr>
<tr><td>5</td><td>Black/White spot (I)</td><td>
<table>
<tr><th>Size D (mm)</th><th>Acceptable number</th></tr>
<tr><td>D ≤ 0.15</td><td>Ignore</td></tr>
<tr><td>0.15 < D ≤ 0.20</td><td>3</td></tr>
<tr><td>0.20 < D ≤ 0.30</td><td>2</td></tr>
<tr><td>0.30 < D</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>6</td><td>Black/White line (I)</td><td>
<table>
<tr><th>Length(mm)</th><th>Width (mm)</th><th>Acceptable number</th></tr>
<tr><td>10 < L</td><td>0.03 < W ≤ 0.04</td><td>5</td></tr>
<tr><td>5.0 < L ≤10</td><td>0.04 < W ≤ 0.06</td><td>3</td></tr>
<tr><td>1.0 < L ≤ 5.0</td><td>0.06 < W ≤ 0.07</td><td>2</td></tr>
<tr><td>L ≤ 1.0</td><td>0.07 < W ≤ 0.09</td><td>1</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>7</td><td>Black/White sport (II)</td><td>
<table>
<tr><th>Size D (mm)</th><th>Acceptable number</th></tr>
<tr><td>D ≤ 0.30</td><td>Ignore</td></tr>
<tr><td>0.30 < D ≤ 0.50</td><td>5</td></tr>
<tr><td>0.50 < D ≤ 1.20</td><td>3</td></tr>
<tr><td>1.20 < D</td><td>0</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>8</td><td>Black/White line (II)</td><td>
<table>
<tr><th>Length (mm)</th><th>Width (mm)</th><th>Acceptable number</th></tr>
<tr><td>20 < L</td><td>0.05 < W ≤ 0.07</td><td>5</td></tr>
<tr><td>10 < L ≤ 20</td><td>0.07 < W ≤ 0.09</td><td>3</td></tr>
<tr><td>5.0 < L ≤ 10</td><td>0.09 < W ≤ 0.10</td><td>2</td></tr>
<tr><td>L ≤ 5.0</td><td>0.10 < W ≤ 0.15</td><td>1</td></tr>
</table>
</td><td>Minor</td></tr>
<tr><td>9</td><td>Back Light</td><td>1. No Lighting is rejectable
2. Flickering and abnormal lighting are rejectable</td><td>Major</td></tr>
<tr><td>10</td><td>Display pattern</td><td>


Unit:mm
<table>
<tr><td>$\frac{A+B}{2} \le 0.30$</td><td>0 < C</td><td>$\frac{D+E}{2} \le 0.25$</td><td>$\frac{F+G}{2} \le 0.25$</td></tr>
</table>
Note: 1. Acceptable up to 3 damages
2. NG if there’ re to two or more pinholes per dot
</td><td>Minor</td></tr>
</table>

<table>
<tr><td>11</td><td>Blemish & Foreign matters

Size:
$D = \frac{A+B}{2}$</td><td><table><tr><th>Size D (mm)</th><th>Acceptable number</th></tr><tr><td>D ≤ 0.15</td><td>Ignore</td></tr><tr><td>0.15 < D ≤ 0.20</td><td>3</td></tr><tr><td>0.20 < D ≤ 0.30</td><td>2</td></tr><tr><td>0.30 < D</td><td>0</td></tr></table></td><td>Minor</td></tr>
<tr><td>12</td><td>Scratch on Polarizer
 
</td><td><table><tr><th>Width (mm)</th><th>Length (mm)</th><th>Acceptable number</th></tr><tr><td>W≤0.03</td><td>Ignore</td><td>Ignore</td></tr><tr><td>0.03<W≤0.05</td><td>L ≤ 2.0</td><td>Ignore</td></tr><tr><td></td><td>L > 2.0</td><td>1</td></tr><tr><td>0.05<W≤0.08</td><td>L > 1.0</td><td>1</td></tr><tr><td></td><td>L ≤ 1.0</td><td>Ignore</td></tr><tr><td>0.08<W</td><td>Note (1)</td><td>Note(1)</td></tr></table>Note(1) Regard as a blemish</td><td>Minor</td></tr>
<tr><td>13</td><td>Bubble in polarizer</td><td><table><tr><th>Size D (mm)</th><th>Acceptable number</th></tr><tr><td>D ≤ 0.20</td><td>Ignore</td></tr><tr><td>0.20 < D ≤ 0.50</td><td>3</td></tr><tr><td>0.50 < D ≤ 0.80</td><td>2</td></tr><tr><td>0.80 < D</td><td>0</td></tr></table></td><td>Minor</td></tr>
<tr><td>14</td><td>Stains on LCD panel surface</td><td>Stains that cannot be removed even when wiped lightly with a soft cloth or similar cleaning too are rejectable.</td><td>Minor</td></tr>
<tr><td>15</td><td>Rust in Bezel</td><td>Rust which is visible in the bezel is rejectable.</td><td>Minor</td></tr>
<tr><td>16</td><td>Defect of land surface contact (poor soldering)</td><td>Evident crevices which is visible are rejectable.</td><td>Minor</td></tr>
<tr><td>17</td><td>Parts mounting</td><td>1. Failure to mount parts
2. Parts not in the specifications are mounted
3. Polarity, for example, is reversed</td><td>Major
Major
Major</td></tr>
<tr><td>18</td><td>Parts alignment</td><td>1. LSI, IC lead width is more than 50% beyond pad outline.
2. Chip component is off center and more than 50% of the leads is off the pad outline.</td><td>Minor
Minor</td></tr>
<tr><td>19</td><td>Conductive foreign matter (Solder ball, Solder chips)</td><td>1. 0.45< ϕ ,N≧1
2. 0.30< ϕ ≤0.45 ,N≧1
ϕ :Average diameter of solder ball (unit: mm)
3. 0.50<L ,N≧1
L: Average length of solder chip (unit: mm)</td><td>Major
Minor
Minor</td></tr>
<tr><td>20</td><td>Faulty PCB correction</td><td>1. Due to PCB copper foil pattern burnout, the pattern is connected, using a jumper wire for repair; 2 or more places are corrected per PCB.
2. Short circuited part is cut, and no resist coating has been performed.</td><td>Minor
Minor</td></tr>
</table>

10.6 RELIABILITY

Test Item	Test Conditions	Note
High Temperature Operation	70±3°C , t=96 hrs	
Low Temperature Operation	-20±3°C , t=96 hrs	
High Temperature Storage	80±3°C , t=96 hrs	1,2
Low Temperature Storage	-30±3°C , t=96 hrs	1,2
Humidity Test	40°C , Humidity 90%, 96 hrs	1,2
Thermal Shock Test	-30°C ~ 25°C ~ 80°C 30 min. 5 min. 30 min. (1 cycle) Total 5 cycle	1,2
Vibration Test (Packing)	Sweep frequency：10~55~10 Hz/1min Amplitude : 0.75mm Test direction : X.Y.Z/3 axis Duration : 30min/each axis	2
Static Electricity	150pF 330 ohm ±8kV, 10times air discharge	

Note 1 : Condensation of water is not permitted on the module.

Note 2 : The module should be inspected after 1 hour storage in normal conditions

(15-35°C , 45-65%RH).

Definitions of life end point :

- Current drain should be smaller than the specific value.
- Function of the module should be maintained.
- Appearance and display quality should not have degraded noticeably.
- Contrast ratio should be greater than 50% of the initial value.

11 USE PRECAUTIONS

11.1 Handling precautions

1) The polarizing plate may break easily so be careful when handling it. Do not touch, press or rub it with a hard-material tool like tweezers.
2) Do not touch the polarizing plate surface with bare hands so as not to make it dirty. If the surface or other related part of the polarizing plate is dirty, soak a soft cotton cloth or chamois leather in benzine and wipe off with it. Do not use chemical liquids such as acetone, toluene and isopropyl alcohol. Failure to do so may bring chemical reaction phenomena and deteriorations.
3) Remove any spit or water immediately. If it is left for hours, the suffered part may deform or decolorize.
4) If the LCD element breaks and any LC stuff leaks, do not suck or lick it. Also if LC stuff is stuck on your skin or clothing, wash thoroughly with soap and water immediately.

11.2 Installing precautions

1) To prevent breaking by static electricity from the human body and clothing, earth the human body properly using the high resistance and discharge static electricity during the operation. In this case, however, the resistance value should be approx. 1MO and the resistance should be placed near the human body rather than the ground surface. When the indoor space is dry, static electricity may occur easily so be careful. We recommend the indoor space should be kept with humidity of 60% or more. When a soldering iron or other similar tool is used for assembly, be sure to earth it.
2) When installing the module and ICs, do not bend or twist them. Failure to do so may crack LC element and cause circuit failure.
3) To protect LC element, especially polarizing plate, use a transparent protective plate (e.g., acrylic plate, glass etc) for the product case.
4) Do not use an adhesive like a both-side adhesive tape to make LCD surface (polarizing plate) and product case stick together. Failure to do so may cause the polarizing plate to peel off.

11.3 Storage precautions

1) Avoid a high temperature and humidity area. Keep the temperature between

0°C and 35°C and also the humidity under 60%.

2) Choose the dark spaces where the product is not exposed to direct sunlight or fluorescent light.
3) Store the products as they are put in the boxes provided from us or in the same conditions as we recommend.

11.4 Operating precautions

1) Do not boost the applied drive voltage abnormally. Failure to do so may break ICs. When applying power voltage, check the electrical features beforehand and be careful. Always turn off the power to the LC module controller before removing or inserting the LC module input connector. If the input connector is removed or inserted while the power is turned on, the LC module internal circuit may break.
2) The display response may be late if the operating temperature is under the normal standard, and the display may be out of order if it is above the normal standard. But this is not a failure; this will be restored if it is within the normal standard.
3) The LCD contrast varies depending on the visual angle, ambient temperature, power voltage etc. Obtain the optimum contrast by adjusting the LC dive voltage.
4) When carrying out the test, do not take the module out of the low-temperature space suddenly. Failure to do so will cause the module condensing, leading to malfunctions.
5) Make certain that each signal noise level is within the standard (L level: 0.2Vdd or less and H level: 0.8Vdd or more) even if the module has functioned properly. If it is beyond the standard, the module may often malfunction. In addition, always connect the module when making noise level measurements.
6) The CMOS ICs are incorporated in the module and the pull-up and pull-down function is not adopted for the input so avoid putting the input signal open while the power is ON.
7) The characteristic of the semiconductor element changes when it is exposed to light emissions, therefore ICs on the LCD may malfunction if they receive light emissions. To prevent these malfunctions, design and assemble ICs so that they are shielded from light emissions.
8) Crosstalk occurs because of characteristics of the LCD. In general, crosstalk

occurs when the regularized display is maintained. Also, crosstalk is affected by the LC drive voltage. Design the contents of the display, considering crosstalk.

11.5 Other

1) Do not disassemble or take the LC module into pieces. The LC modules once disassembled or taken into pieces are not the guarantee articles.
2) The residual image may exist if the same display pattern is shown for hours. This residual image, however, disappears when another display pattern is shown or the drive is interrupted and left for a while. But this is not a problem on reliability.

12 OUTLINE DIMENSION