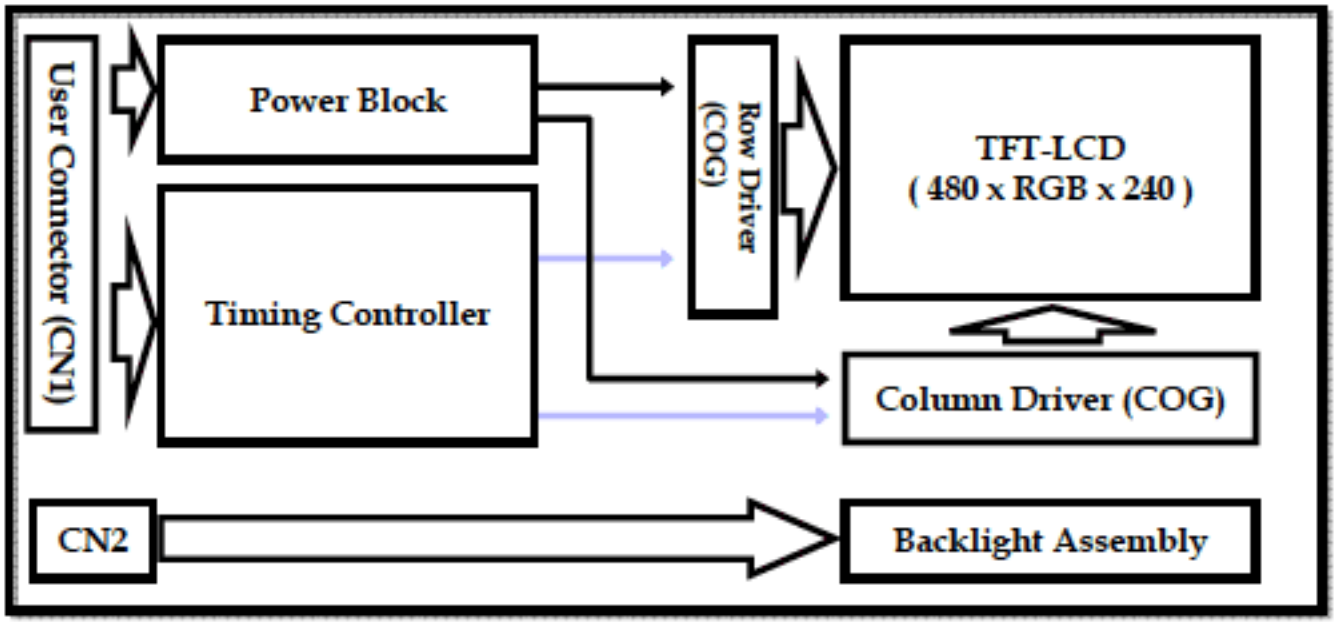
1. General Description

The LB070WQ5 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp (CCFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. This TFT-LCD has 7.0 inches diagonally measured active display area with WQVGA resolution(480 horizontal by 240 vertical pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 6-bit gray scale signal for each dot, thus, presenting a palette of more than 262,144 colors.

The LB070WQ5 is intended to support applications where thin thickness, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LB070WQ5 characteristics provide an excellent flat display.



General Features

Active Screen Size	7.0 inches diagonal
Outline Dimension	168.8 (H) × 93.5 (V) × 7.0(10.4)(D) mm (Typ.)
Pixel Pitch	0.1083 mm[xRGB] × 0.3450 mm
Pixel Format	480 horiz. by 240 vert. Pixels RGB strip arrangement
Color Depth	6-bit, 262,144 colors
Luminance, White	500 cd/m^2 (Typ.)
Power Consumption	4.18 Watt(Typ.)
Weight	210g (Typ.)
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Anti-glare/Anti-reflection treatment of the front polarizer

2. Absolute Maximum Ratings

The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. Absolute Maximum Ratings

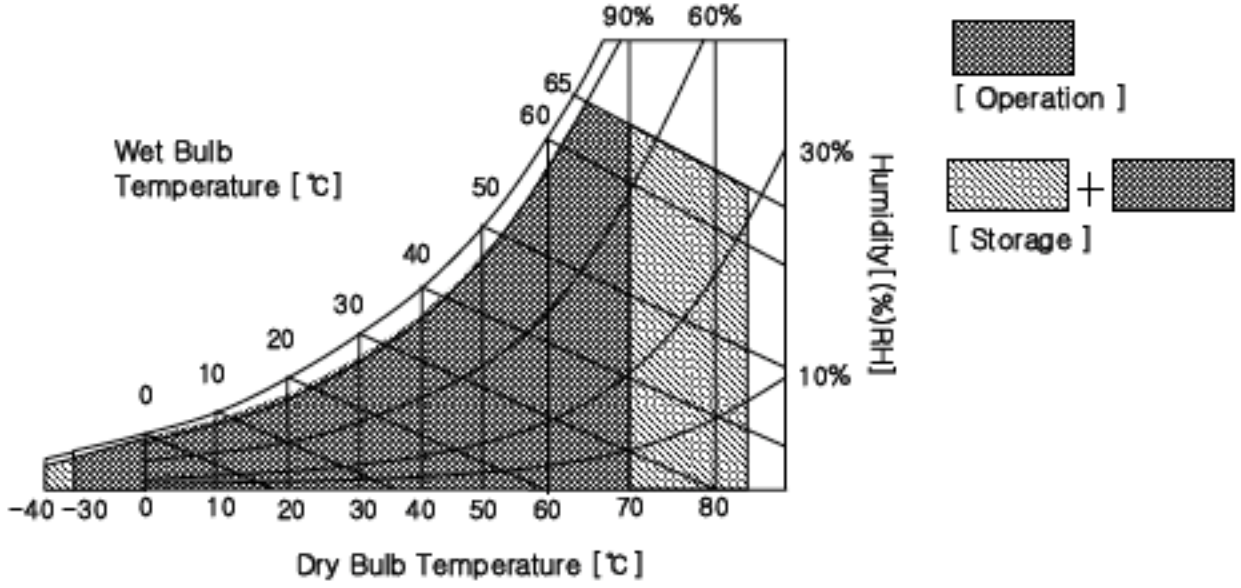
Parameter		Symbol	Values		Units	Notes
			Min	Max		
Power Input Voltage		VCC	0.0	6.5	Vdc	at 25 ± 5°C
Storage Temperature		HST	-40	85	°C	2-1
Operating Temperature	Surface Of Panel	Tp	-30	85	°C	2-1,2-2
	Ambient	Ta	-30	70	°C	2-1,2-2,2-3

Notes :

2-1. Maximum wet-bulb temperature is 65℃. Condensation of dew must be avoided, because it may cause electrical current leakage, and deterioration of performance and quality.

2-2. The operating temperature means that LCD Module guarantees operation of the circuit. All the contents of Electro-optical specifications are guaranteed under the room temperature condition.

2-3. This temperature is ambient temperature with regard to the heat which is generated under operation of circuit and backlight on.(reference value)



3. Electrical Specifications

3-1. Electrical Characteristics

The LB070WQ5 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input which powers the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCD.

Table 2. Electrical Characteristics

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	VCC	4.5	5.0	5.5	V_{DC}	
Power Supply Input Current	I_{CC}	100	140	180	mA	3-1
Power Consumption	Pc		0.7	1	Watt	3-1
LAMP :						
Operating Voltage	V_{BL}	565 (6.5mArms)	580 (6.0mArms)	730 (3.0mArms)	V_{RMS}	3-2
Operating Current	I_{BL}	3.0	6.0	6.5	mA_{RMS}	3-3
Power Consumption	P_{BL}	-	3.48	3.83	W	3-4
Operating Frequency	f_{BL}	40	-	80	kHz	3-5
Discharge Stabilization Time	Ts	-	-	3	Min	3-6
Life Time		12,000	15,000	-	Hrs	3-7
Established Starting Voltage at 25℃ at -30 ℃	Vs	 - -	 - -	 1480 1780	 V_{RMS} V_{RMS}	3-8

Note)

3-1. The specified current and power consumption are under the Vcc = 5.0V , 25℃, fv = 60Hz condition whereas "Vertical Stripe Pattern" is displayed and fv is the frame frequency.
* Vertical Stripe Pattern: alternating 21-Gray-Scale with 42-Gray-Scale every 1 pixel

3-2. The variance of the voltage is ± 10%.

3-3. The typical operating current is for the typical surface luminance (L_{WH}) in optical characteristics.

3-4. The lamp power consumption shown above does not include loss of external inverter. The applied lamp current is a typical one.

3-5. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform.(Asymmetrical ratio is less than 10%) Please do not use the inverter which has asymmetrical voltage and asymmetrical current and spike wave.
Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.

3-6. Define the brightness of the lamp after being lighted for 5 minutes as 100%, Ts is the time required for the brightness of the center of the lamp to be not less than 95%.

3-7. The life time is determined as the time at which brightness of lamp is 50% compare to that of initial value at the typical lamp current.

3-8. The voltage above VS should be applied to the lamps for more than 1 second for start-up. Otherwise, the lamps may not be turned on. The used lamp current is the lamp typical current.

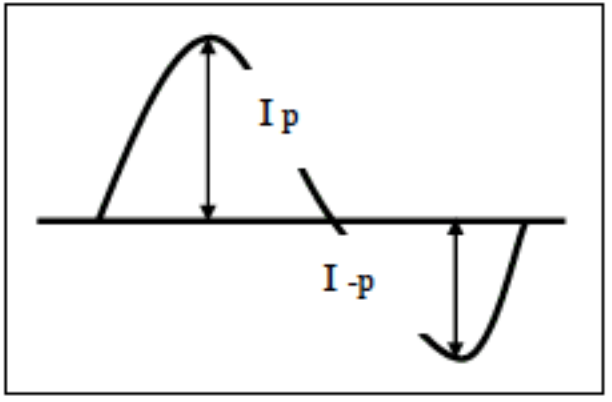
Note)

3-9. Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following.
It shall help increase the lamp lifetime and reduce leakage current.

a. The asymmetry rate of the inverter waveform should be less than 10%.

b. The distortion rate of the waveform should be within $\sqrt{2} \pm 10\%$.

* Inverter output waveform had better be more similar to ideal sine wave.



* Asymmetry rate:

$$| I_p - I_{-p} | / I_{rms} * 100\%$$

* Distortion rate

$$I_p \text{ (or } I_{-p}) / I_{rms}$$

※ Do not attach a conducting tape to lamp connecting wire.
If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.

3-2. Interface Connections

This LCD employs two interface connections, a 40 pin connector is used for the module electronics interface and the other connector is used for the integral backlight system.
The electronics interface connector is a model FH12K-40S-0.5SH, manufactured by HIROSE.

Table 3. Module Connector Pin Configuration (CN1)

Pin No.	Symbol	Description	Notes	Pin No.	Symbol	Description	Notes
1	GND	Ground	-	21	R3	Red Data	-
2	GND	Ground	-	22	GND	Ground	-
3	B5	Blue Data(MSB)	-	23	R2	Red Data	-
4	B4	Blue Data	-	24	R1	Red Data	-
5	B3	Blue Data	-	25	R0	Red Data(LSB)	-
6	GND	Ground	-	26	GND	Ground	-
7	B2	Blue Data	-	27	DE	Data Enable	-
8	B1	Blue Data	-	28	GND	Ground	-
9	B0	Blue Data(LSB)	-	29	HVR	Horizontal & Vertical Reverse	3-10
10	GND	Ground	-	30	N.C.	No Connection	-
11	G5	Green Data(MSB)	-	31	GND	Ground	-
12	G4	Green Data	-	32	DCLK	Data Clock	-
13	G3	Green Data	-	33	RBF	No Connection	-
14	GND	Ground	-	34	GND	Ground	-
15	G2	Green Data	-	35	VCC	Power Input	-
16	G1	Green Data	-	36	VCC	Power Input	-
17	G0	Green Data(LSB)	-	37	VCC	Power Input	-
18	GND	Ground	-	38	VCC	Power Input	-
19	R5	Red Data(MSB)	-	39	GND	Ground	-
20	R4	Red Data	-	40	GND	Ground	-

Note)
3-10 Display Direction
- HVR="HIGH" → Regular Video (A)
- HVR="LOW → Horizontally and Vertically Inverted Video (B)

(A)


(B)

The backlight interface connector is a model **BHSR-02VS-2**, manufactured by JST or Compatible.
The mating connector part number is **SM02B-BHSS-1-TB** or equivalent.

Table 4. Backlight Connector Pin Configuration (CN1)

	Pin	Symbol	Description	Notes
CN1	1	LV	Power supply for lamp (Low voltage side)	3-11
	2	HV	Power supply for lamp (High voltage side)	3-11

Note)
3-11. The high voltage side terminal is colored pink and the low voltage side terminal is **White**.

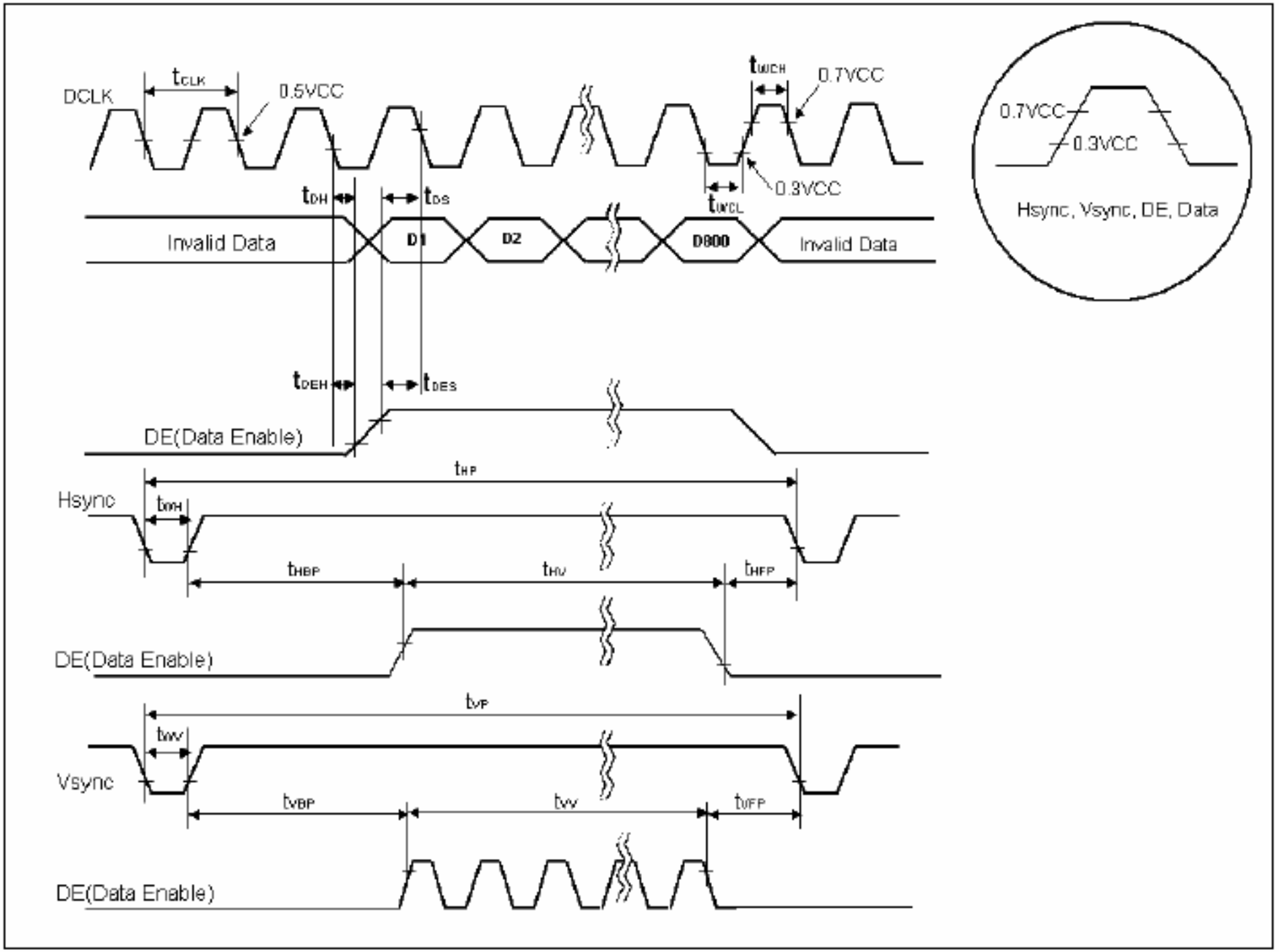
3-3. Signal Timing Specifications

This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications for its proper operation.

Table 5. Timing Table *** 60Hz Frame rate ***

Item		Symbol	Min.	Typ.	Max.	Unit	Remarks
DCLK	Frequency	f_{CLK}	7.6	8.8	11.4	MHz	
	Period	t_{CLK}	87.72	113.64	131.58	ns	
	High Level Width	t_{WCH}	6	-	-	ns	
	Low Level Width	t_{WCL}	6	-	-	ns	
DATA	Setup Time	t_{DS}	4	-	-	ns	
	Hold Time	t_{DH}	4	-	-	ns	
DE	Setup Time	t_{DES}	5	-	-	ns	
	Hold Time	t_{DEH}	5	-	-	ns	
Hsync	Period	t_{HP}	574	592	610	t_{CLK}	
	Width	t_{WH}	8	-	-		
	Horizontal Valid	t_{HV}	-	480	-		
	Horizontal Back Porch	t_{HBP}	8	-	-		
	Horizontal Front Porch	t_{HFP}	8	-	-		
Vsync	Period	t_{VP}	250	259	330	t_{HP}	
	Width	t_{WV}	2	-	-		
	Vertical Valid	t_{VV}	-	240	-		
	Vertical Back Porch	t_{VBP}	5	-	-		
	Vertical Front Porch	t_{VFP}	2	-	-		

3-4. Signal Timing Waveforms



3-5. Color Input Data Reference

The brightness of each primary color (red,green and blue) is based on the 6-bit gray scale data input for the color ; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 6. Color Data Reference

Color		Input Color Data																	
		RED						GREEN						BLUE					
		MSB					LSB	MSB					LSB	MSB					LSB
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (01)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	...				...						...						...		
	RED (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (01)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	...				...						...						...		
	GREEN (62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN (63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE (01)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...				...						...						...		
	BLUE (62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE (63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

3-6. Power Sequence

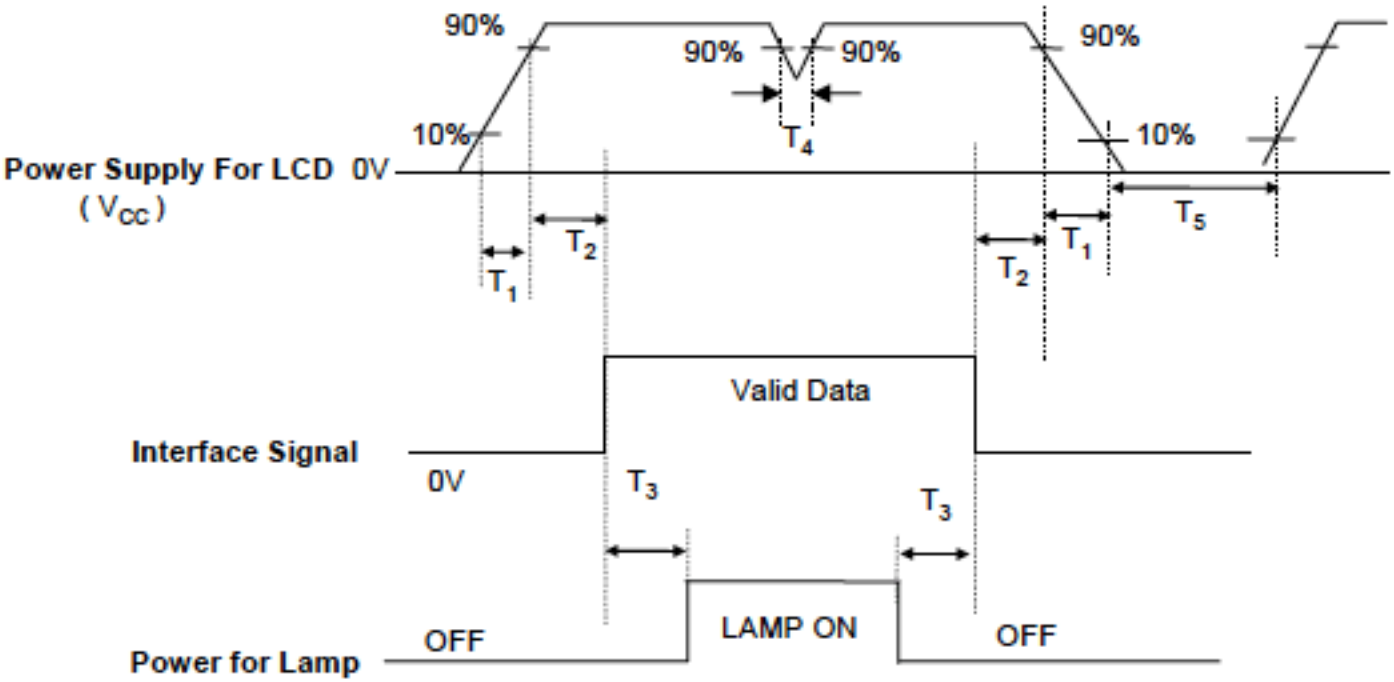


Table 7. Power Sequence Table

Parameter	Value			Units
	Min.	Typ.	Max.	
T_1	0	-	10	(ms)
T_2	0	-	50	(ms)
T_3	200	-	-	(ms)
T_4	-	-	10	(ms)
T_5	400	-	-	(ms)

Note)

3-12. Please avoid floating state of interface signal at invalid period.

3-13. When the interface signal is invalid, be sure to pull down the power supply for LCD VCC to 0V.

3-14. Lamp power must be turn on after power supply for LCD and interface signal are valid.

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25°C. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and Θ equal to 0°.
FIG. 1 presents additional information concerning the measurement equipment and method.

FIG. 1 Optical Characteristic Measurement Equipment and Method

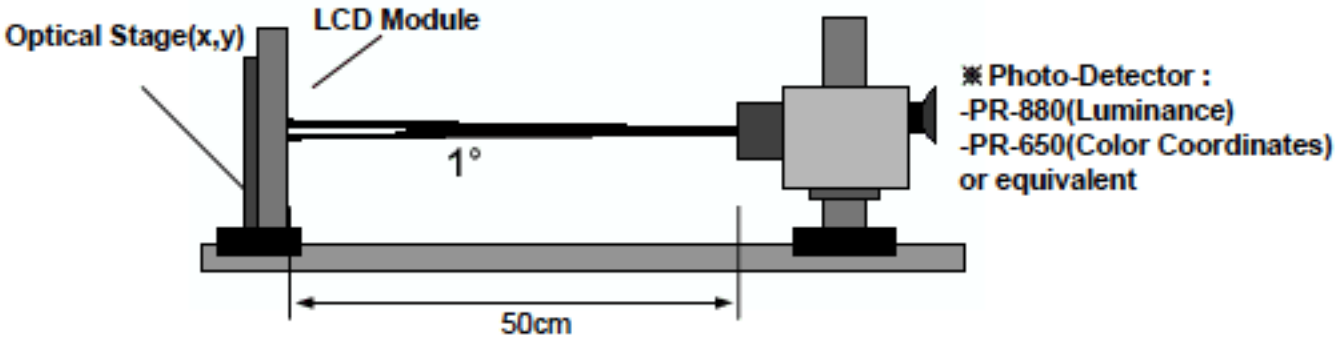


Table 8. Optical Characteristics

Ta=25°C, VCC=5.0V, fv=60Hz, f_{CLK}= 8.8MHz, I_{BL} = 6.0mA_{RMS}

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	100	400	-		4-1
Surface Luminance, white		L_{WH}	400	500	-	cd/m²	4-2
Luminance Non Uniformity		LNU_W	-	-	20	%	4-3
Response Time							4-4
	Rise Time	Tr_R	-	10	12.5	ms	
	Decay Time	Tr_D	-	20	40	ms	
Color Coordinates							4-2
	RED	RX	0.489	0.589	0.689		
		RY	0.247	0.347	0.447		
	GREEN	GX	0.225	0.325	0.425		
		GY	0.440	0.540	0.640		
	BLUE	BX	0.059	0.159	0.259		
		BY	0.045	0.145	0.245		
	WHITE	WX	0.270	0.300	0.330		
		WY	0.290	0.320	0.350		
Viewing Angle							4-5
	x axis, right(Φ=0°)	Θr	60	70	-	degree	
	x axis, left (Φ=180°)	Θl	60	70	-	degree	
	y axis, up (Φ=90°)	Θu	40	50	-	degree	
	y axis, down (Φ=270°)	Θd	50	60	-	degree	
Gray Scale							4-6

Note)

4-1. Contrast Ratio(CR) is defined mathematically as

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

4-2. Surface luminance is measured at the center point(L_1) of the LCD with all pixels displaying white at the distance of 50cm by PR-880. Color Coordinates are measured at the center point(L_1) of the LCD with all pixels displaying red, green, blue and white at the distance of 50cm by PR-650. For more information, refer to the FIG 1 and FIG 2.

4-3. Luminance Non Uniformity is measured for 9 point For more information see FIG 2.

$$LNU_W = \frac{\text{Maximum (L1,L2, ... L9)} - \text{Minimum (L1,L2, ... L9)}}{\text{Average (L1,L2, ... L9)}} \times 100$$

4-4. Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white(Decay Time, Tr_D). For additional information see FIG 3.

4-5. Viewing angle is the angle at which the contrast 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 4.

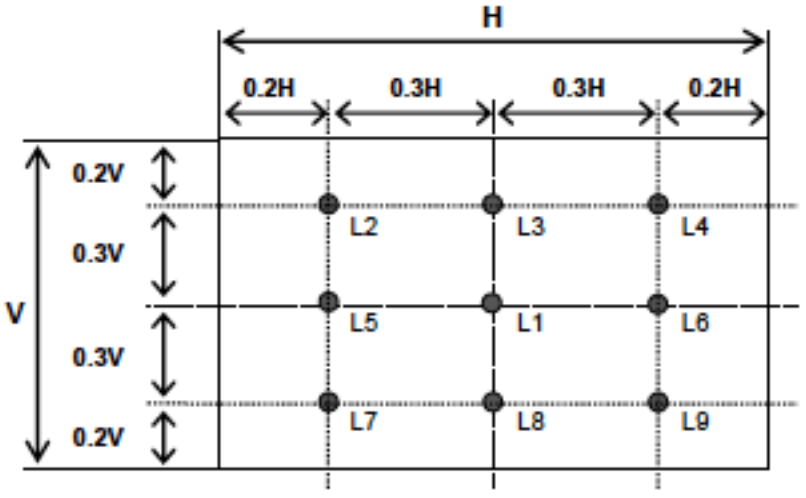
4-6. Gray scale specification

Table 9. Gray Scale Specification

Gray Level	Luminance [%] (Typ)
L0	0.16
L7	0.77
L15	4.40
L23	12.14
L31	23.67
L39	39.50
L47	58.95
L55	80.34
L63	100.00

FIG. 2 Luminance

<measuring point for surface luminance & measuring point for luminance non uniformity>



*H,V : Active Area

FIG. 3 Response Time

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".

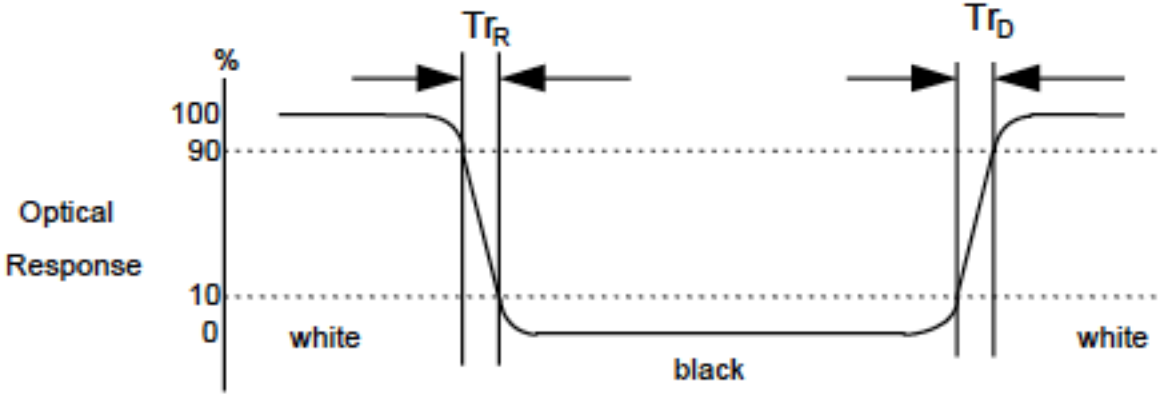
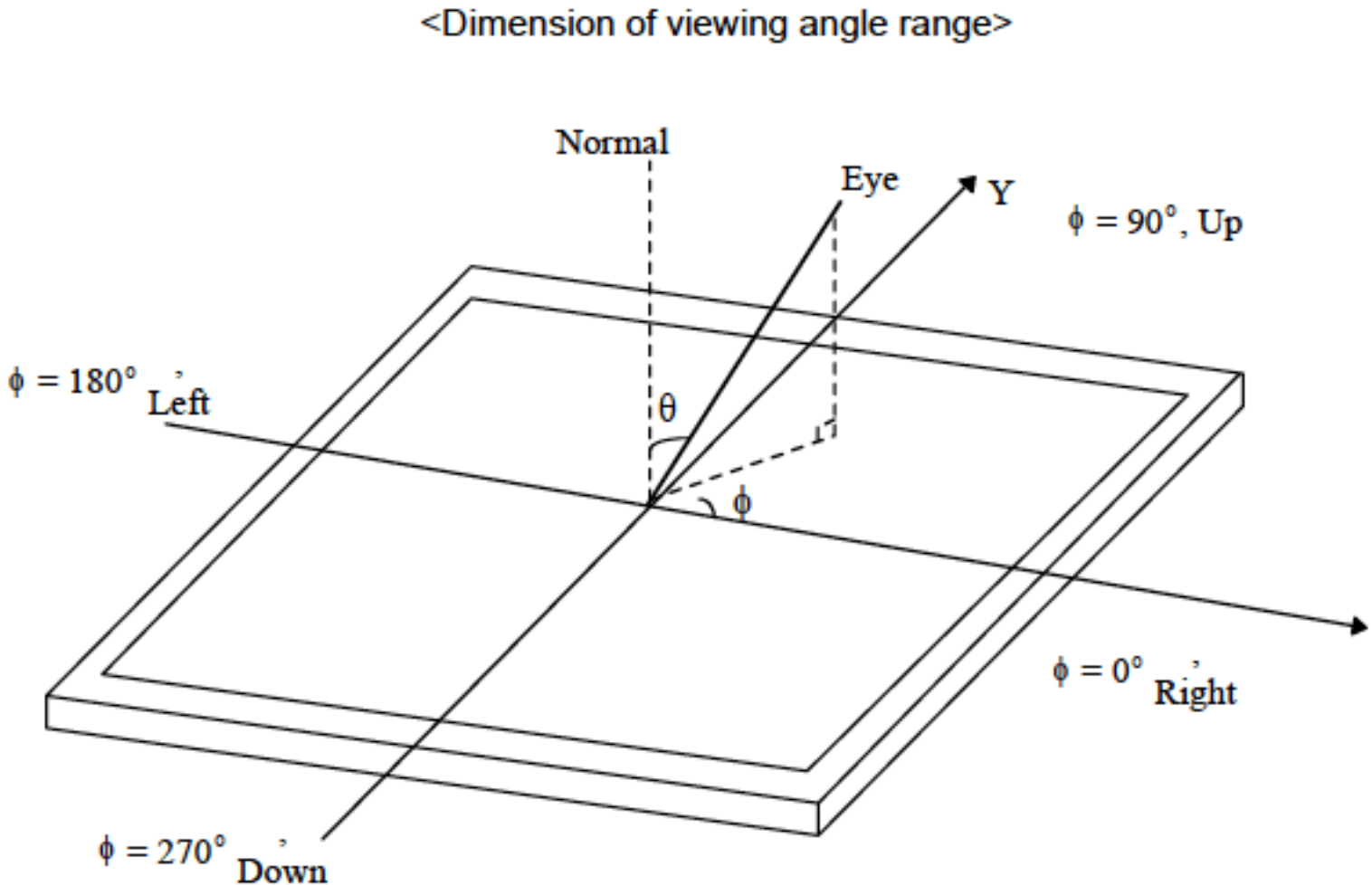


FIG. 4 Viewing angle



5. Mechanical Characteristics

The contents provide general mechanical characteristics for the model LB070WQ5. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Table 10. Mechanical Characteristics

Outline Dimension	Horizontal	168.8 mm (Typ.)
	Vertical	93.5 mm (Typ.)
	Depth	7.0(10.4) mm (Typ.)
Bezel Area	Horizontal	158.4 mm (Typ.)
	Vertical	85.1 mm (Typ.)
Active Display Area	Horizontal	155.952 mm (Typ.)
	Vertical	82.8 mm (Typ.)
Weight	210g(Typ.) / 220g (Max.)	
Surface Treatment	Anti-glare treatment of the front polarizer	

6. Reliability

Environment test condition

No.	Test Item	Condition
1	High Temperature Storage Test	Ta=+85℃ 240h
2	Low Temperature Storage Test	Ta=-40℃ 240h
3	High Temperature Operation Test	Tp=+85℃ 240h
4	Low Temperature Operation Test	Ta=-30℃ 240h
5	High Temperature and High Humidity Operation Test	Tp=+65℃ 90%RH 240h
6	Random Vibration test	- 10Hz, 20$(m/s^2)^2$/Hz, 0.208g^2/Hz - 55Hz, 6.5$(m/s^2)^2$/Hz, 0.0677g^2/Hz - 180Hz, 0.25$(m/s^2)^2$/Hz, 0.0026^2/Hz - 300Hz, 0.25$(m/s^2)^2$/Hz, 0.0026g^2/Hz - 360Hz, 0.14$(m/s^2)^2$/Hz, 0.00146g^2/Hz - 1000Hz, 0.14$(m/s^2)^2$/Hz, 0.00146g^2/Hz - X, Y, Z : 2.84Gms / 8hours
7	Shock test (non-operating)	1. 25G, 15ms, Half Sine Total Number Of Shocks: 132 × 6 = 792 (Each Direction In Each Axis) 2. 100G, 11ms, Half Sine Total Number Of Shocks: 3 × 6 = 18 (Each Direction In Each Axis)
8	Thermal Shock	-40℃(0.5h) ~ 85℃(0.5h) / 100 cycles
9	Power Temperature Cycle	-30℃(10m) ~ 70℃(20m) / 200 cycles

※ Ta= Ambient Temperature, Tp= Panel Temperature

{ Result Evaluation Criteria }

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

7. International Standards

7-1. Safety

a) UL 60950, Third Edition, Underwriters Laboratories, Inc., Dated Dec. 11, 2000.
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
b) CAN/CSA C22.2, No. 60950, Third Edition, Canadian Standards Association, Dec. 1, 2000.
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
c) EN 60950 : 2000, Third Edition
IEC 60950 : 1999, Third Edition
European Committee for Electrotechnical Standardization(CENELEC)
EUROPEAN STANDARD for Safety of Information Technology Equipment Including Electrical Business Equipment.

7-2. EMC

a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHZ to 40GHz. "American National Standards Institute(ANSI), 1992
b) C.I.S.P.R. "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." International Special Committee on Radio Interference.
c) EN 55022 "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." European Committee for Electrotechnical Standardization.(CENELEC), 1998
(Including A1: 2000)