DLC Display Co., Limited

德爾西顯示器有限公司

MODEL No:DLC2004CFWC

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Record of Revision

Date	Revision No.	Summary
2010-06-08	1.0	Rev 1.0 was issued

1. Scope

The DLC2004CFWC LCM unit consists of 20x4characters LCD, and ST7066-0B which incorporates LCD controller and common/segment driver.

2. Application

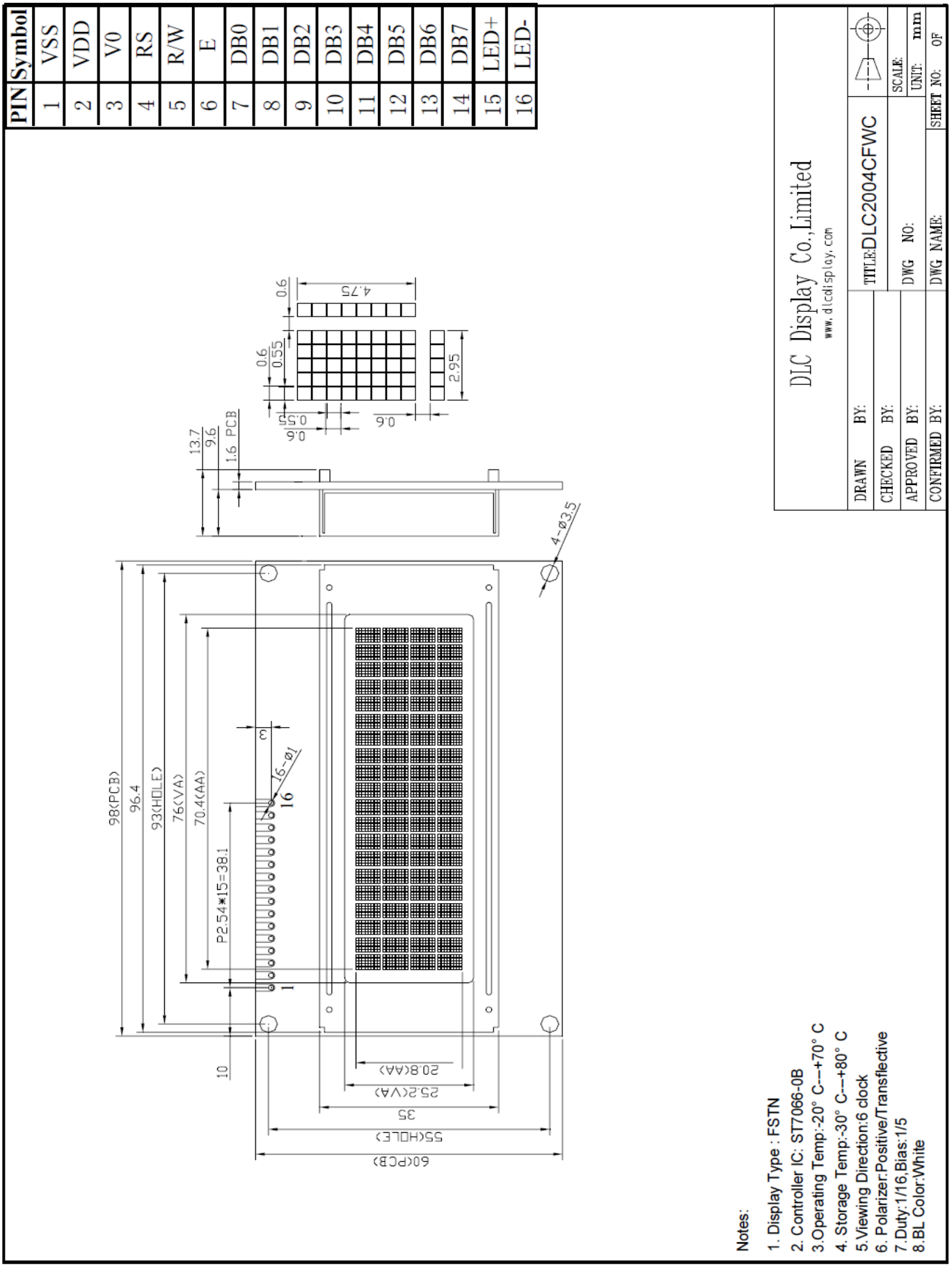
Digital equipments which need display, instrumentation, remote control, electronic product.

3. General Information

Item	Contents	Unit
LCD Type	FSTN	
Polarizer Type	Transflective	
Viewing Direction	6:00	
Interface	8-bit parallel	
Number of Dots/ characters	20X4 characters	
Dot size (W×H)	0.55X0.55	mm
Dot Pitch (W×H)	0.6X0.6	mm
Active Area	70.4×20.8	mm
Outline Dimension (W x H x D)	98.0×60.0×13.7	mm
LCD Controller & Driver	ST7066-0B	
LCD Driving Method	1/16 Duty 1/5 Bias	
Backlight Type	LED	
Backlight Color	White	
Operating Temperature	-20℃~+70℃	
Storage Temperature	-30℃~＋80℃	

4. Outline Drawing

PIN	Symbol
1	VSS
2	VDD
3	V0
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	LED+
16	LED-



5. Interface signals

Pin NO.	Symbol	Level	Function Description
1	VSS	--	Ground
2	VDD	3.3/5.0V	Power supply .
3	V0	--	Bias supply voltage input to drive the LCD.
4	RS	H/L	Serial data input or output with Pull-high resistor
5	/WR	H/L	Select read or write. 0: Write 1: Read
6	E	H/L	Starts data read/write.
7～14	DB0~DB7	H/L	Data bus.
15	LED+	3.3/5.0V	Backlight anode.
16	LED-	--	Backlight cathode.

6. Absolute maximum Ratings

6.1. Electrical Absolute max. ratings

Parameter	Symbol	MIN	MAX	Unit	Remark
Supply Voltage For Logic	VDD	0	5.25	V	
Supply Voltage For LCD	VLCD	0	7.7	V	
Input Voltage	VI	0	VDD	V	

6.2. Environment Conditions

Item	Symbol	MIN	MAX	Unit	Remark
Operating Temperature	TOPR	-20	70	℃	
Storage Temperature	TSTG	-30	80	℃	

6.3. LED Backlight Absolute max. ratings

Item	Symbol	MIN	MAX	Unit	Remark
LED Forward Current	ILED	--	60	mA	VCC =5V

7. Electrical Specifications

7.1 Electrical characteristics

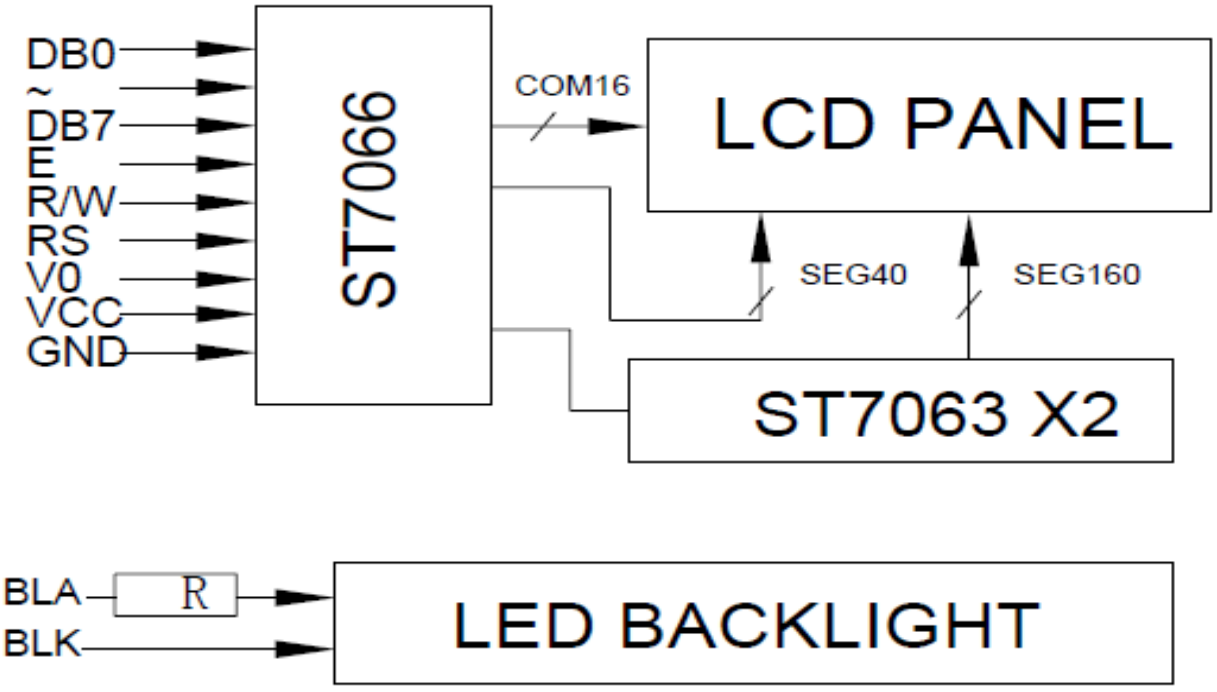
(VCC=5V, GND=0V, Ta=25℃)

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Supply Voltage for Logic	VDD~GND	--	5.0	5.25	V	
LCM Recommend LCD Module Driving Voltage	Vlcd	3.7	4.7	5.7	V	
Power Supply Current for LCM	IDD(B/L OFF)	--	--	0.84	mA	
	ILED(B/L ON)			45	mA	
Input High Voltage	VIL	0	--	0.2VDD	V	
Input Low Voltage	VIH	0.8VDD	--	VDD	V	
Output Low Voltage	VOL	0	--	0.2VCC	V	
Output High Voltage	VOH	0.75VDD	--	VDD	V	

7.2 Backlight

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Forward Voltage	Vf	--	5.0	--	V	

7.3 Block Diagram

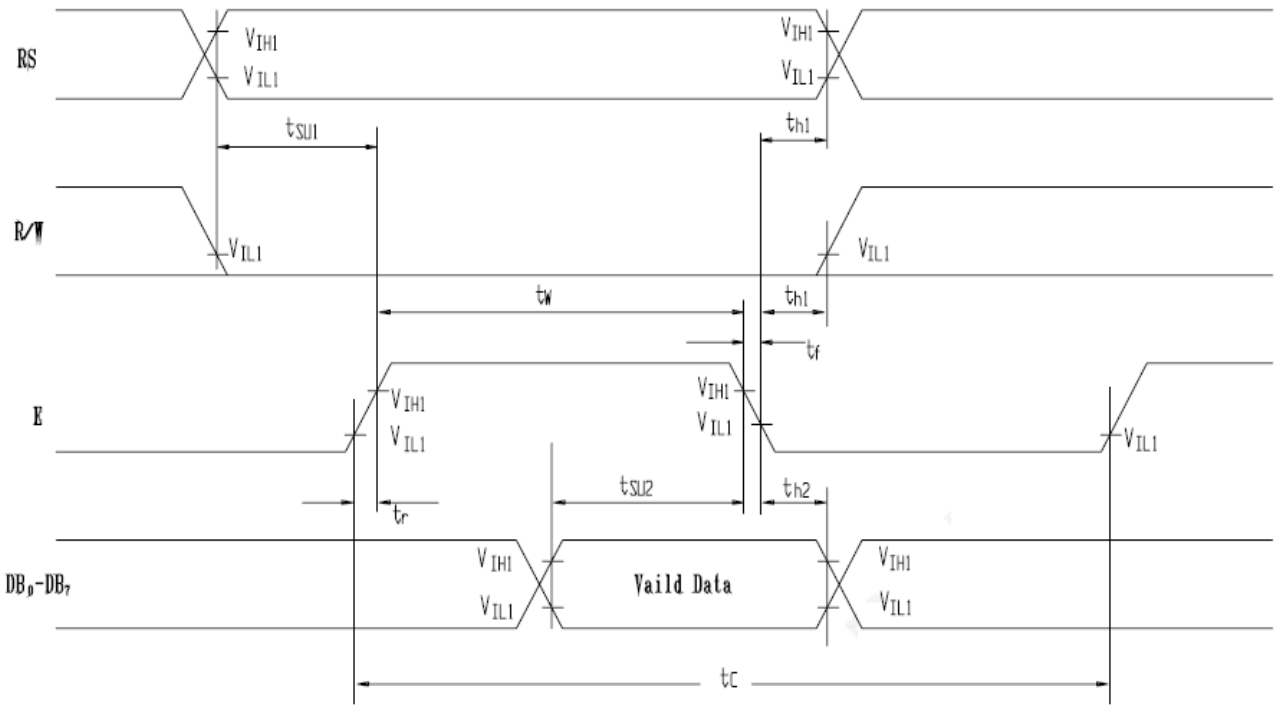


8. Command/AC Timing

8.1 AC Characteristics

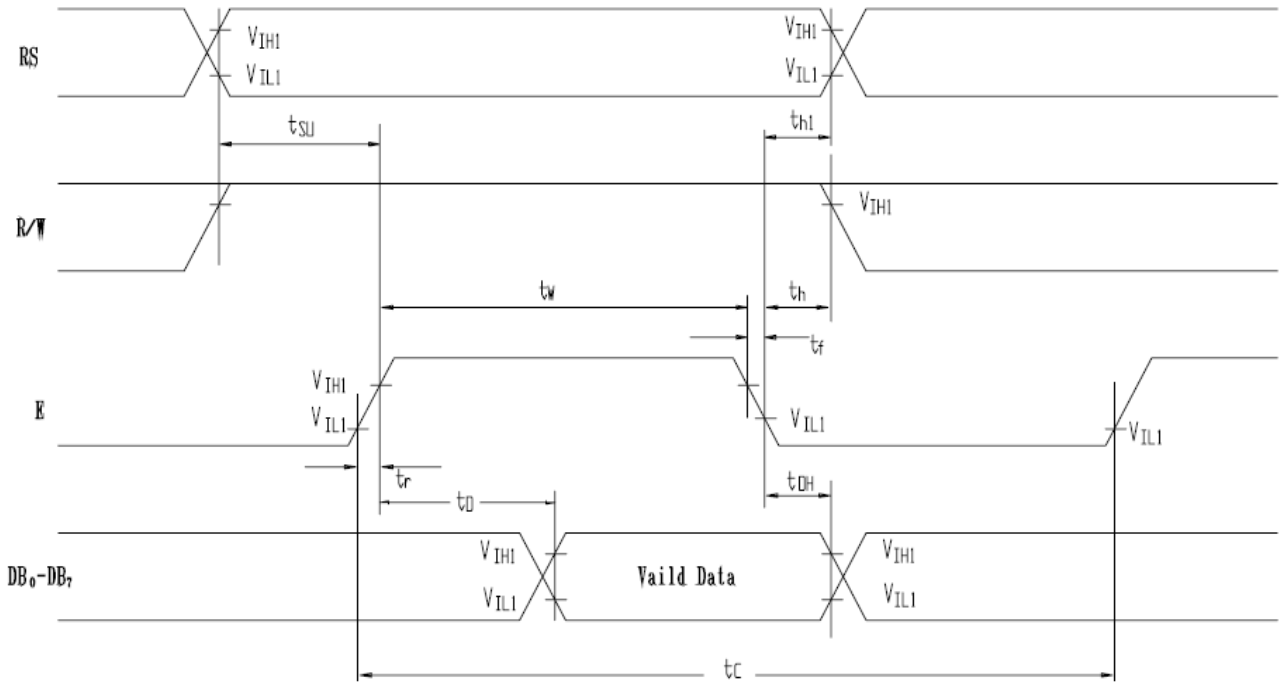
8.1.1 Write Mode (Writing data from MPU to ST7066)

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
T_C	Enable Cycle Time	Pin E	1200	---	---	ns
T_{PW}	Enable Pulse Width	Pin E	140	---	---	ns
T_R,T_F	Enable Rise/Fall Time	Pin E	---	---	25	ns
T_{AS}	Address Setup Time	Pins: RS,RW,E	0	---	---	ns
T_{AH}	Address Hold Time	Pins: RS,RW,E	10	---	---	ns
T_{DSW}	Data Setup Time	Pins: DB0 - DB7	40	---	---	ns
T_H	Data Hold Time	Pins: DB0 - DB7	10	---	---	ns



8.1.2 Read Mode (Reading Data from ST7066 to MPU)

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
Tc	Enable Cycle Time	Pin E	1200	-	-	ns
Tpw	Enable Pulse Width	Pin E	140	-	-	ns
Tr,Tf	Enable Rise/Fall Time	Pin E	-	-	25	ns
Tas	Address Setup Time	Pins: RS,RW,E	0	-	-	ns
Tah	Address Hold Time	Pins: RS,RW,E	10	-	-	ns
Tddr	Data Setup Time	Pins: DB0 - DB7	-	-	100	ns
Th	Data Hold Time	Pins: DB0 - DB7	10	-	-	ns



8.2 OPERATING PRINCIPLES & METHODS

Instruction	Instruction Code											Description Time (270KHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description	
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM. and set DDRAM address to "00H" from AC	1.52 ms
Return Home	0	0	0	0	0	0	0	0	1	x	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.52 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 us
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=1:entire display on C=1:cursor on B=1:cursor position on	37 us
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	x	x	Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	37 us
Function Set	0	0	0	0	1	DL	N	F	x	x	DL:interface data is 8/4 bits N:number of line is 2/1 F:font size is 5x11/5x8	37 us
Set CGRAM address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	37 us
Set DDRAM address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	37 us
Read Busy flag and address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 us
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	37 us
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	37 us

Display Clear

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing “20H” (space code) to all DDRAM address, and set DDRAM address to “00H” into AC (address counter). Return cursor to the original status, hence, bring the cursor to the left edge on first line of the display. Entry mode is set to increment mode (I/D = “1”)

Return Home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	X

Return Home is cursor return home instruction.
Set DDRAM address to “00H” into the address counter. Return cursor to its original site and return display to its original status, if shifted. Contents of DDRAM does not change.

Entry Mode Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	1/D	S

Set the moving direction of cursor and display.
1/D : Increment / decrement of DDRAM address (cursor or blink)
When 1/D = “High”, cursor/blink moves to right and DDRAM address is increased by 1.
When 1/D = “Low”, cursor/blink moves to left and DDRAM address is increased by 1.
*CGRAM operates the same as DDRAM, when read from or write to CGRAM.
S: Shift of entire display
When S = “High”, after DDRAM write, the entire display of all lines is shifted to the right (1/D= “0”) or to the left (1/D = “1”). But it will seem as if the cursor does not move.
When S = “Low”, or DDRAM read, or CGRAM read/write operation, shift of entire display is not performed.

Display ON/OFF Control

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.
D : Display ON/OFF control bit
When D = “High”, entire display is turned on.
When D = “Low”, display is turned off, but display data is remained in DDRAM.
C : Cursor ON/OFF control bit
When C= “High”, cursor is turned on.
When C= “Low’, Cursor is disappeared in current display, but 1/D register remains its data.
B : Cursor Blink ON/OFF control bit
When B = “High”, cursor blink is on, that performs alternate between all the high data and display character at the cursor position. if fosc has 270 kHz frequency, blinking has 370 ms interval.
When B = “Low”, blink is off.

Cursor or Display Shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	S/C	R/L	-	-

Without writing or reading of display data, shift right/left cursor position or display

This instruction is used to correct or search display data. (Refer to Table 6)
During 2-line mode display, cursor moves to the 2nd line after 40th digit of 1st line.
Note that display shift is performed simultaneously in all the line.
When displayed data is shifted repeatedly, each line shifted individually.
When display shift is performed, the contents of address counter are not changed.

Table 6. Shift Patterns According To S/C And R/L Bits

S/C	R/L	Operation
0	0	Shift cursor to the left, Address Counter is decreased by 1
0	1	Shift cursor to the right, Address Counter is increased by 1
1	0	Shift all the display to the left, cursor moves according to the display
1	1	Shift all the display to the right, cursor moves according to the display

Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	X	X	X

DL : Interface data length control bit
When DL = “High”, it means 8-bit bus mode with MPU.
When DL = “Low”, it means 4-bit bus mode with MPU. Hence, DL is a signal to select 8-bit or 4-bit bus mode.
In 4-bit bus mode, it is required to transfer 4-bit data two times.
N : Display line number control bit
When N = “Low”, it means 2-line display mode.
When N = “High”, 4-line display mode is set.
F: Display font type control bit
When F= “0”, 5*7 dots format display mode.
When F= “1”, 5*10 dots format display mode.

Set CGRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM Address to AC.
This instruction makes CGRAM data available from MPU.

Set DDRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction makes CGRAM data available from MPU.
In 1-line display mode (N=0) DDRAM address is from “00H” to “4FH”.
In 2-line display mode (N=1), DDRAM address is from “00H” to “27H” in the 1st line, from “40H” to “67H” in the 2nd line.

Read Busy Flag & Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction shows whether KSOO70B is in internal operation or not. If the resultant BF is High,the internal operation is in progress and you have to wait until BF to be Low. Then the next instruction can be performed. In this instruction you can read the value of address counter.

Write Data To RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write binary 8-bit data to DDRAM/CGRAM.
The selection of RAM from DDRAM, and CGRAM is set by the previous address set instruction : DDRAM address set, and CGRAM address set. RAM set instruction can also determine the AC direction to RAM. After write operation, the address is automatically increased/decreased by 1, according to the entry mode.
Read Data From RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read binary 8-bit data from DDRAM/CGRAM.
The selection of RAM is set by the previous address set instruction. If address set instruction of RAM is not performed before this instruction, the data that read first is invalid, as the direction of AC is not determined. If you read RAM data several times without RAM address set instruction before read operation, the correct RAM data can be from the second, but the first data would be incorrect, as there is no time margin to transfer RAM data. In DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set instruction ; it also transfer RAM data to output data register.
After read operation address counter is automatically increased/decreased by 1 according to the entry mode. After CGRAM read operation, display shift may not be executed correctly.
*In case of RAM write operation, AC is increased/decreased by 1 as in read operation after this. In this time, AC indicates the next address position, but you can read only the previous data can only be read by read instruction.

8.3 The table of DDRAM address and character

8.3.1 DDRAM address table

Display position		1	2	3	.....	18	19	20
DDRAM Address	The first row	00H	01H	02H	.....	11H	12H	13H
	The second row	40H	41H	42H	.....	51H	52H	53H
	The third row	14H	15H	16H	.....	25H	26H	27H
	The forth row	54H	55H	56H	.....	65H	66H	67H

For shift left

Display position		1	2	3	.....	18	19	20
DDRAM Address	The first row	01H	02H	03H	.....	12H	13H	14H
	The second row	41H	42H	43H	.....	52H	53H	54H
	The third row	15H	16H	17H	.....	26H	27H	00H
	The forth row	55H	56H	57H	.....	66H	67H	40H

For shift right

Display position		1	2	3	.....	18	19	20
DDRAM Address	The first row	27H	00H	01H	.....	10H	11H	12H
	The second row	67H	40H	41H	.....	50H	51H	52H
	The third row	13H	14H	15H	.....	24H	25H	26H
	The forth row	53H	54H	55H	.....	64H	65H	66H

8.3.2 Character table*

English and Japanese character table

English and Russian character table

English and Owen character table

9. Optical Specification

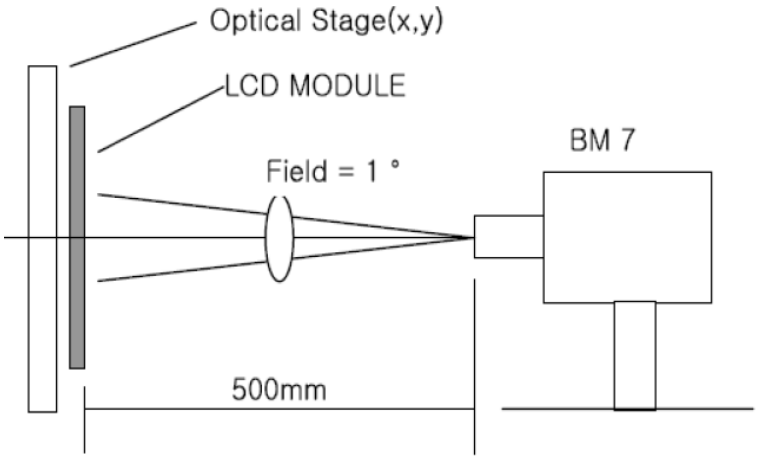
Ta= 23±3℃

Item	Symbol	Condition	Min	Typ.	Max.	Unit	Remark
Contrast Ratio	CR	θ=0°		5.4			Note1 Note2
Response Time	TR	23±3℃		112		ms	Note1 Note3
	TF			250			
View Angles	ΘT	CR≧2	35			Degree	Note 4
	ΘB		30				
	ΘL		30				
	θR		30				

Note 1: Definition of optical measurement system.

Temperature = 25℃(±3℃)

LED back-light: ON, Environment brightness < 150 lx

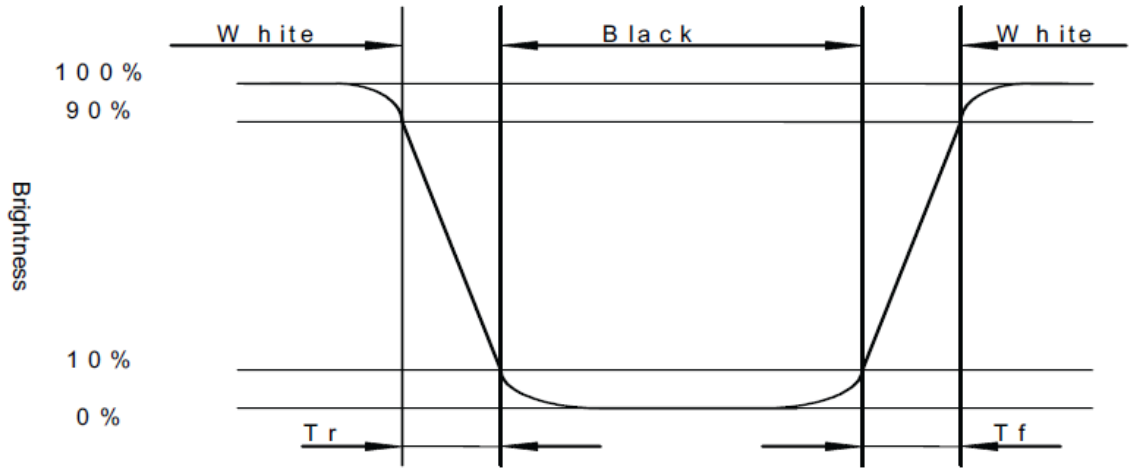


Note 2: Contrast ratio is defined as follow:

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

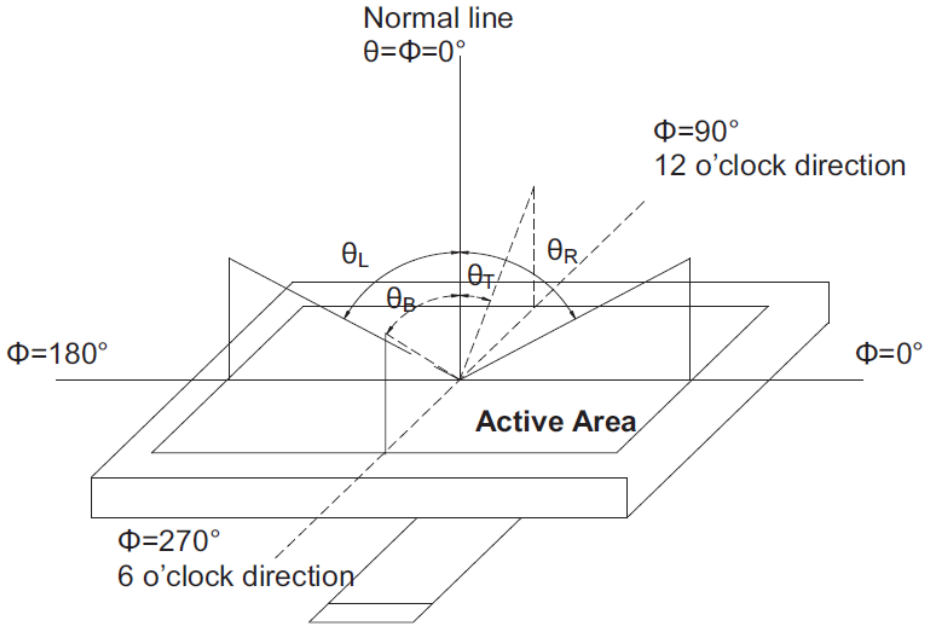
Note 3: Response time is defined as follow:

Response time is the time required for the display to transition from black to white (Rise Time, Tr) and from white to black(Decay Time, Tf).



Note 4: Viewing angle range is defined as follow:

Viewing angle is measured at the center point of the LCD.



10. Environmental / Reliability Tests

No	Test Item	Condition	Judgment criteria
1	High Temp Operation	Ts=+70℃, 120hrs	Per table in below
2	Low Temp Operation	Ta=-20℃, 120hrs	Per table in below
3	High Temp Storage	Ta=+80℃, 120hrs	Per table in below
4	Low Temp Storage	Ta=-30℃, 120hrs	Per table in below
5	High Temp & High Humidity Storage	Ta=+70℃, 90% RH 120 hours	Per table in below (polarizer discoloration is excluded)
6	Thermal Shock (Non-operation)	-10℃ 30 min~+60℃ 30 min, Change time:5min, 10 Cycles	Per table in below
7	ESD (Operation)	C=150pF, R=330Ω，5points/panel Air:±8KV, 5times; Contact:±4KV, 5 times;	Per table in below
8	Vibration (Non-operation)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z.	Per table in below
9	Shock (Non-operation)	60G 6ms, ±X,±Y,±Z 3times, for each direction	Per table in below
10	Package Drop Test	Height:80 cm, 1 corner, 3 edges, 6 surfaces	Per table in below

INSPECTION	CRITERION(after test)
Appearance	No Crack on the FPC, on the LCD Panel
Alignment of LCD Panel	No Bubbles in the LCD Panel No other Defects of Alignment in Active area
Electrical current	Within device specifications
Function / Display	No Broken Circuit, No Short Circuit or No Black line No Other Defects of Display

11. Precautions for Use of LCD Modules

11.1 Safety

The liquid crystal in the LCD is poisonous. Do not put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

11.2 Handling

A. The LCD and touch panel is made of plate glass. Do not subject the panel to mechanical shock or to excessive force on its surface.
B. Do not handle the product by holding the flexible pattern portion in order to assure the reliability
C. Transparency is an important factor for the touch panel. Please wear clear finger sacks, gloves and mask to protect the touch panel from finger print or stain and also hold the portion outside the view area when handling the touch panel.
D. Provide a space so that the panel does not come into contact with other components.
E. To protect the product from external force, put a covering lens (acrylic board or similar board) and keep an appropriate gap between them.
F. Transparent electrodes may be disconnected if the panel is used under environmental conditions where dew condensation occurs.
G. Property of semiconductor devices may be affected when they are exposed to light, possibly resulting in IC malfunctions.
H. To prevent such IC malfunctions, your design and mounting layout shall be done in the way that the IC is not exposed to light in actual use.

11.3 Static Electricity

A. Ground soldering iron tips, tools and testers when they are in operation.
B. Ground your body when handling the products.
C. Power on the LCD module before applying the voltage to the input terminals.
D. Do not apply voltage which exceeds the absolute maximum rating.
E. Store the products in an anti-electrostatic bag or container.

11.4Storage

A. Store the products in a dark place at +25℃±10℃ with low humidity (40% RH to 60% RH). Don't expose to sunlight or fluorescent light.
B. Storage in a clean environment, free from dust, active gas, and solvent.

11.5 Cleaning

A. Do not wipe the touch panel with dry cloth, as it may cause scratch.
B. Wipe off the stain on the product by using soft cloth moistened with ethanol. Do not allow ethanol to get in between the upper film and the bottom glass. It may cause peeling issue or defective operation. Do not use any organic solvent or detergent other than ethanol.

11.6 Cautions for installing and assembling

Bezel edge must be positioned in the area between the Active area and View area. The bezel may press the touch screen and cause activation if the edge touches the active area. A gap of approximately 0.5mm is needed between the bezel and the top electrode. It may cause unexpected activation if the gap is too narrow. There is a tolerance of 0.2 to 0.3mm for the outside dimensions of the touch panel and tail. A gap must be made to absorb the tolerance in the case and connector.