

**SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY MODULE
MODEL NO. OSDV-20200-S1FBL Y**

APPROVAL SHEET

Customer :

Part Name :

LCD MODULE

Model No.:

OSDV-20200-S1FBL Y

Drawing No. :

Approved By :

Date :

**SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY MODULE
MODEL NO. OSDV-20200-S1FBLV**

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**SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY MODULE
MODEL NO. OSDV-20200-S1FBLY**

1. SCOPE

The OSDV-20200-S1FBLY, dot-matrix LCD unit of a 5 x 7 dot, 20-character x 2-line dot-matrix LCD panel, LCD driver, controller LSI and yellow green LED backlight fabricated on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the unit can efficiently display the desired characters under microprocessor control.

2. PRODUCT SPECIFICATIONS

2.1 General

- The LCD of the unit is STN (Super Twisted Nematic) type.
- Low power consumption with the dot-matrix LCD panel and CMOS LSI.
- Built-in LED backlight with high luminance and stable radiation.
- Thin, lightweight design permits easy installation in a variety of equipment.
- Allowing for being connected at general-purpose CMOS signal level, the unit can be easily interfaced to a microprocessor with common 4-bit and 8-bit parallel inputs and outputs.
- Multiplexing driving : 1/16duty, 1/4bias, 6 o'clock
- Built-in character generator ROM and RAM, and display data RAM:
Character generator ROM
225 different 5 x 7 dot-matrix character patterns (Alphanumeric and symbols)
- Character generator RAM
8 different user programmed 5 x 7 dot-matrix patterns
- Display data RAM
80 x 8 bits
- Numerous instructions
Display clear, Cursor home, Display ON/OFF, Cursor ON/OFF, Blink character, Cursor shift, and Display shift

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2.2 Mechanical Characteristics

Item	Characteristic
Number of Characters	20 x 2
Pixel Dimensions (mm)	0.60 (w) x 0.65 (h)
Pixel Pitch (mm)	0.65 (w) x 0.70 (h)
Character Size (mm)	3.20 (w) x 5.55 (h)
Active Area (mm)	73.50 (w) x 11.50 (h)
View Area (mm)	82.20 (w) x 18.20 (h)
Module Dimensions (mm)	116.0 (w) x 39.0 (h) x 14.5 (t)

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2.3 Electrical Absolute Maximum Ratings (excluding backlight)

Item	Symbol	Rating	Unit
Supply Voltage	V_{DD} (Note 1)	-0.3 to 7.0	V
Input Voltage	V_{LCD} (Note 1)	$V_{DD} - 15.0$ to $V_{DD} + 0.3$	V
Operating Temperature	T_{opr}	0 to 50	°C
Storage Temperature	T_{stg}	-20 to 60	°C

Note 1 : Referenced to $V_{SS} = 0V$ @ 25°C

Voltage greater than above may damage circuit

2.4 Electrical Characteristics (excluding backlight)

ITEM	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Operating Voltage	V_{DD}	---	4.5	5.0	5.5	V
Supply Current	I_{DD}	Internal oscillation or external clock ($V_{DD} = 5.0V$ $f_{OSC} = 270kHz$)	---	0.35	0.60	mA
Input Voltage (1) (except OSC1)	V_{IH1}	---	2.2	---	V_{DD}	V
	V_{IL1}	---	-0.3	---	0.6	V
Input Voltage (2) (OSC1)	V_{IH2}	---	$V_{DD} - 1.0$	---	V_{DD}	V
	V_{IL2}	---	-0.2	---	1.0	V
Output Voltage (1) (DB0 to DB7)	V_{OH1}	$I_{OH} = -0.205$ mA	2.4	---	---	V
	V_{OL1}	$I_{OL} = 1.2$ mA	---	---	0.4	V
Output Voltage (2) (except DB0 to DB7)	V_{OH2}	$I_O = -40$ μA	$0.9V_{DD}$	---	---	V
	V_{OL2}	$I_O = 40$ μA	---	---	$0.1V_{DD}$	V
Voltage Drop	V_{dCOM}	$I_O = \pm 0.1$ mA	---	---	1	V
	V_{dSEG}		---	---	1	
Input Leakage Current	I_{IKG}	$V_{IN} = 0V$ to V_{DD}	-1	---	1	μA
Input Low Current	I_{IL}	$V_{IN} = 0V$, $V_{DD} = 5V$ (Pull up)	-50	-125	-250	μA
Operating Frequency (internal Clock)	f_{OSC1}	$R_f = 91$ k $\Omega \pm 2\%$ ($V_{DD} = 5V$)	190	270	350	kHz
External Clock	f_{OSC}	---	125	270	410	KHz
	duty		45	50	55	%
	t_R , t_F		---	---	0.2	μs
LCD Driving Voltage	V_{LCD}	$V_{DD} - V_5$ ($1/5, 1/4$ Bias)	3.0	---	13.0	V

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2.5 Optical Characteristics Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Maximum Applied Voltage (AC)	V_{AC}	10	V
Maximum Applied Voltage (DC)	V_{DC}	50	mV
Operating Temperature Range	T_{OP}	-20 ~ 70	°C
Storage Temperature Range	T_{ST}	-30 ~ 80	°C

2.6 Optical Characteristics

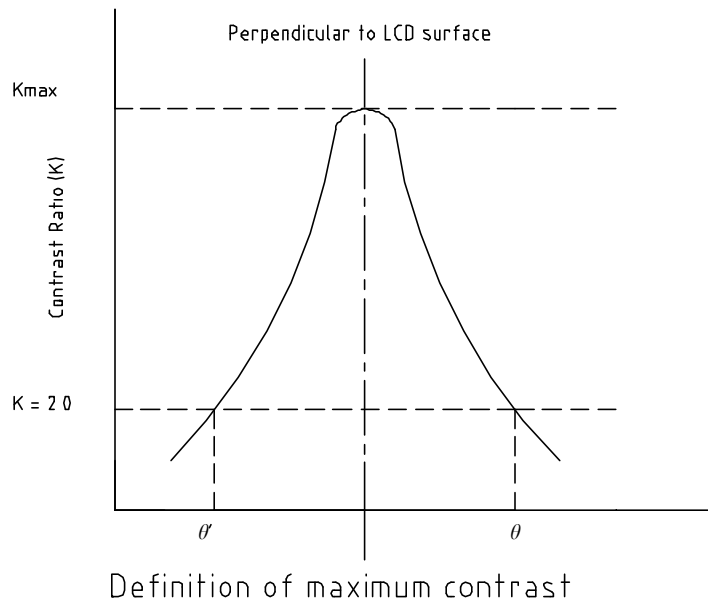
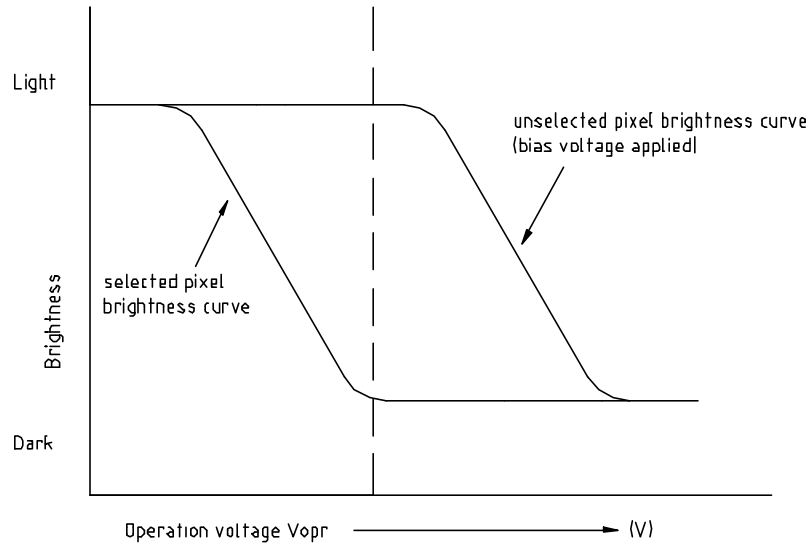
1/16th Duty, 1/4th Bias,

Item	Symbol	Temp.	Min.	Typ.	Max.	Unit
Driving Voltage	V_{OP}	0 °C	---	4.80	---	V
		25 °C	---	4.50	---	
		50 °C	---	4.20	---	
Contrast (Note 4)	K	$\theta = 0^\circ$ $\phi = 0^\circ$	3	5	---	---
Frame Freq.	fF	---	32	64	150	Hz
Viewing Angle (Note 5)	θ	25 °C K ≥ 1.5	-30	---	40	deg.
	ϕ		-30	---	30	
Response Time (Note 6)	t_{on}	25 °C	---	200	300	ms
	t_{off}		---	250	380	

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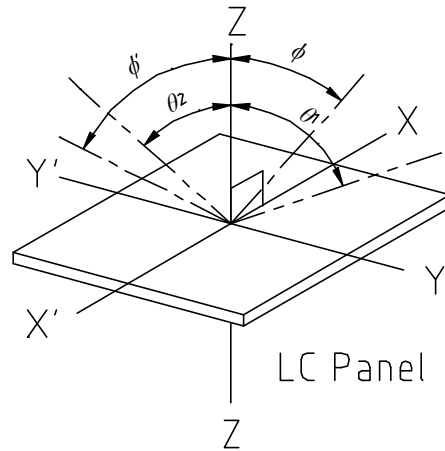
Note 4: Definition of Contrast K

$$K = \frac{B_1}{B_2} = \frac{\text{Brightness of selected pixel}}{\text{Brightness of unselected pixel}}$$

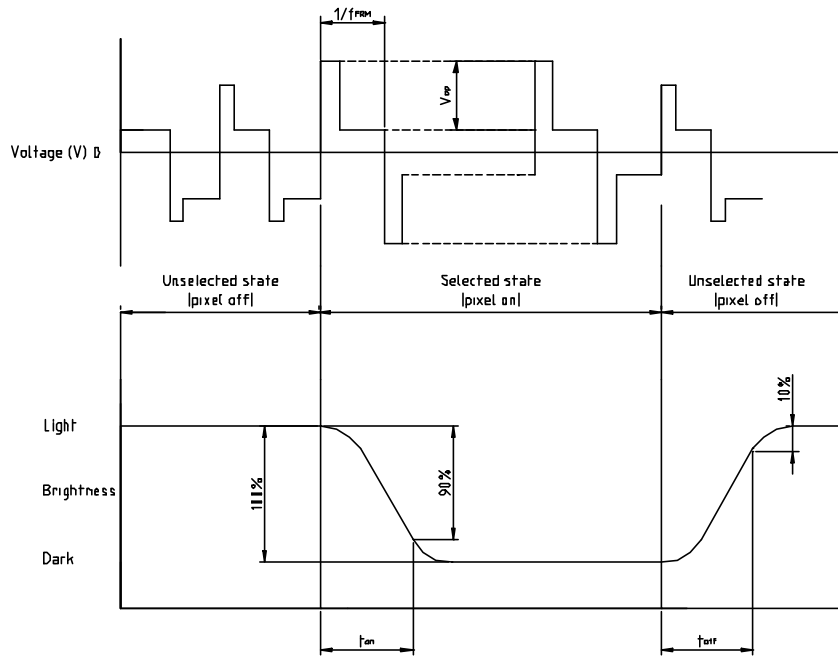


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Note 5: Definition of angles ϕ and θ .



Note 6: Definition of response time.



V_{op} : Operating voltage (V)
 f_{FRM} : Frame frequency (Hz)

t_{on} : Response time (rise) (ms)
 t_{off} : Response time (fall) (ms)

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2.7 LED Electrical Specifications

2.7.1 Electrical Characteristics

Item	Symbol	Condition	Standard			Unit
			Min	Typ	Max	
Forward Voltage	V_F	$I_F = 210\text{mA}$	3.8	4.2	4.4	V
Luminous Intensity	I_V	$I_F = 210\text{mA}$	---	60	---	cd/m ²
Peak Emission Wavelength	λ_P	$I_F = 210\text{mA}$	---	573	---	nm
Spectrum Radiation Bandwidth	$\Delta\lambda$	$I_F = 20\text{mA}$	---	30	---	nm
Reverse Current	I_R	$V_R = 8\text{V}$	---	---	2.1	mA

2.7.3 Absolute Maximum Operating Condition

Item	Symbol	Value	Unit
Power Dissipation	P_{AD}	1.80	W
Forward Current	I_F	410	mA
Reverse Voltage	V_R	8	V

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3. RELIABILITY

Test Item	Test Condition	Evaluation and Assessment
Operation at high temperature and humidity	40°C ± 2°C 90%RH for 500 hours	No abnormalities in functions* and appearance**
Operation at high temperature	60°C ± 2°C for 500 hours	No abnormalities in functions* and appearance**
Heat shock		No abnormalities in functions* and appearance**
Low temperature	-20°C ± 2°C for 500 hours	No abnormalities in functions* and appearance**
Vibration	Sweep for 1 min at 10 Hz, 55 Hz, 10 Hz with amplitude of 1.5mm for 2 hrs in X, Y, Z directions	No abnormalities in functions* and appearance**
Drop shock	Dropped onto a board from a height of 10cm	No abnormalities in functions* and appearance**

* dissipation current, contrast and display functions

** polarizer deterioration or other appearance defects

Expected Liquid Crystal panel service life 100,000 hours minimum at 25°C ± 10°C.

Definition of end of LC panel service life:

- contrast less than 70% of initial value
- current consumption 3 times initial value
- alignment deterioration occurs in LC cell layer
- unusual operation occurs in display functions

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4. OPERATING INSTRUCTIONS

4.1 Input Signal Connections

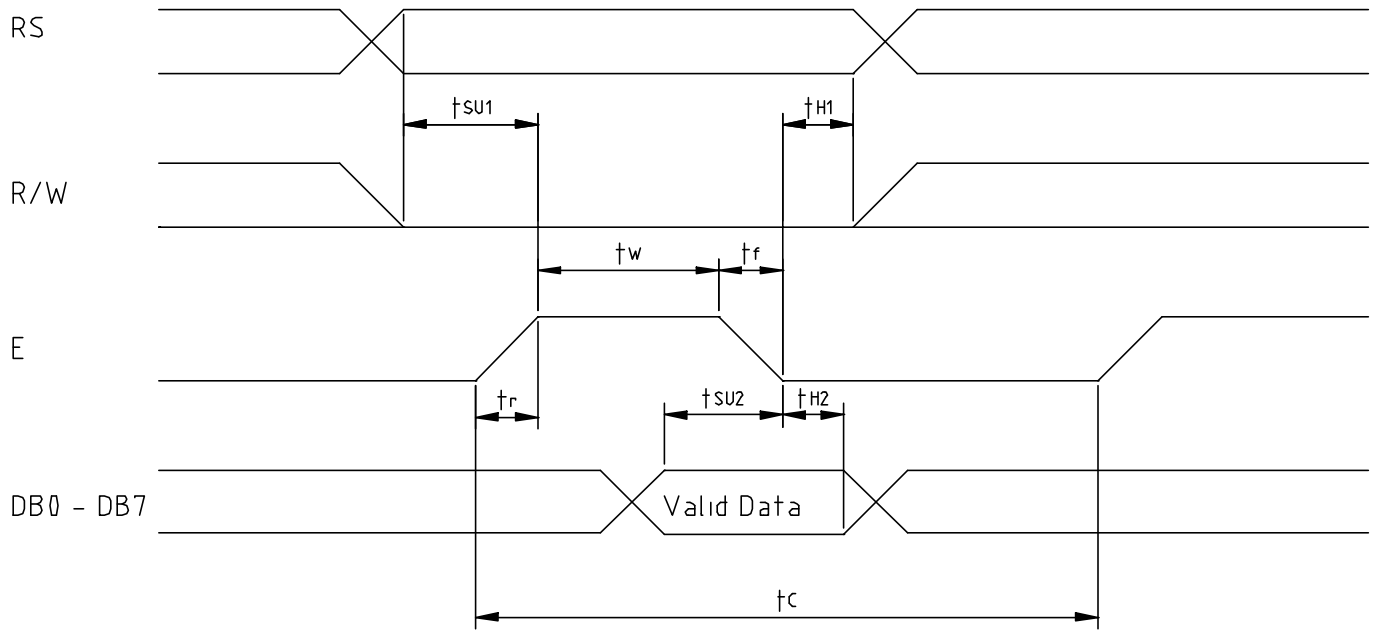
Pin	Symbol	Function
1	V_{SS}	Logic ground
2	V_{CC}	Logic power supply (5V)
3	V_{LCD}	LCD power supply
4	RS	Data / Instruction select
5	W/R	Read / Write select
6	E	Enable signal
7~14	DB0~DB7	Data bus lines
15	LED K	LED power supply
16	LED A	LED power supply

**SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY MODULE
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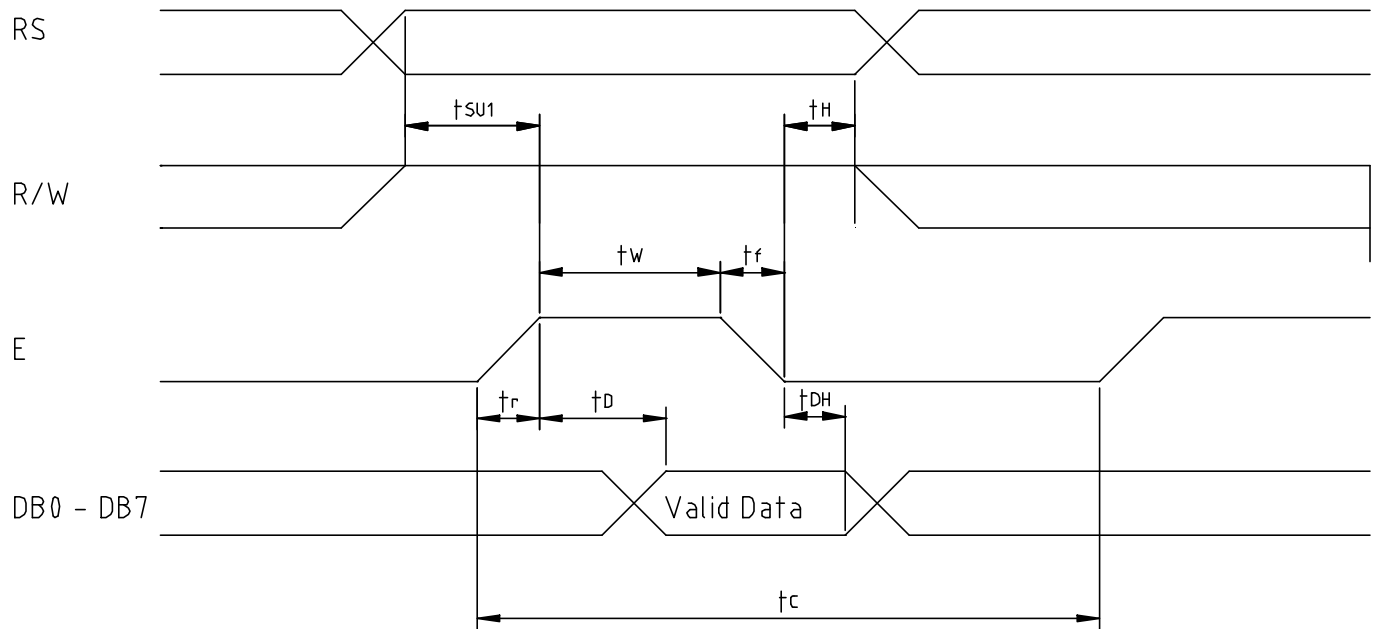
4.2 Timing Characteristics

Mode	Characteristics	Symbol	Min	Typ	Max	Unit
Write Mode	E Cycle Time	t_C	500	---	---	ns
	E Rise / Fall Time	t_{R, t_F}	---	---	20	
	E Pulse Width (High, Low)	t_W	230	---	---	
	R/W and RS Setup Time	t_{SU1}	40	---	---	
	R/W and RS Hold Time	t_{H1}	10	---	---	
	Data Setup Time	t_{SU2}	80	---	---	
	Data Hold Time	t_{H2}	10	---	---	
Read Mode	E Cycle Time	t_C	500	---	---	ns
	E Rise / Fall Time	t_{R, t_F}	---	---	20	
	E Pulse Width (High, Low)	t_W	230	---	---	
	R/W and RS Setup Time	t_{SU}	40	---	---	
	R/W and RS Hold Time	t_H	10	---	---	
	Data Setup Time	t_D	---	---	120	
	Data Hold Time	t_{DH}	5	---	---	

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Write Mode Timing Diagram



Read Mode Timing Diagram

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4.3 Instruction Description

Outline

To overcome the speed difference between the Internal clock of the KS0066U and the MPU clock the KS0066U performs internal operations by storing control information to IP or DR. The internal operation is determined according to the signal from the MPU, composed of read/write and data bus lines. Instructions can be divided into four groups:

1. KS0066U function set instructions (set display methods, set data length, etc.)
2. address set instructions to internal RAM
3. data transfer instructions with internal RAM
4. others

The address of the internal RAM is automatically increased or decreased by 1.

Note: During internal operation, Busy Flag (DB7) is held high. The Busy Flag must be checked before proceeding with the next instruction. When the MPU checks the Busy Flag (DB7) it is necessary to wait $1/F_{OSC}$ before executing the next instruction on the falling edge of the “E” signal after the Busy Flag (DB7) goes low.

Commands

1) Clear Display

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 addresses, and set DDRAM address to “00H” into Address Counter (AC). Return the cursor to the left edge of the first line of the display.

Make the entry mode increment (I/D = “High”).

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2) Return Home

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

- = Don't Care

Return Home is the cursor return home function.

Set the DDRAM address to "00H" into the address counter.

Return cursor to its original site, first line upper left, and return display to its original status, if shifted.

Contents of DDRAM do not change.

3) Entry Mode Set

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

Set the move direction of the cursor and the display.

I/D: Increment/Decrement of DDRAM address (cursor or blink)

When I/D is "High" cursor/blink moves to the right and DDRAM address is increased by 1.

When I/D is "Low" cursor/blink moves to the left and DDRAM is decreased by 1.

(CGRAM operates the same as DDRAM, when reading or writing to CGRAM)

SH: Shift of entire display

When DDRAM read (CGRAM read/write) operation or SH = "Low", shifting of the entire display is not performed. If SH = "High" and DDRAM write operation, shift of the entire display is performed according to I/D value. (I/D= "High" shift left, I/D= "Low" shift right)

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4) 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” the entire display is turned on.

When D = “Low” the display is turned off, but the display data remains in DDRAM.

C: Cursor On/Off control bit

When C = “High” the cursor is turned on.

When C = “Low” the cursor is not displayed, but the I/D register preserves its data.

B: Cursor Blink On/Off control bit

When B = “High” cursor blink is on which alternately shows all pixels and displayed pixels at the cursor location.

When B = “Low” blink is off

5) Cursor or Display shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	-	-

Shifting right/left cursor position or display without writing or reading of the display data. This instruction is used to correct or search the display data. During 2-line mode display, the cursor moves to the 2nd line after the 40th digit of the 1st line. Note that the display shift is performed simultaneously on all lines. When displayed data is shifted repeatedly, each line is shifted individually. When display shift is performed, the contents of the address counter are not changed.

Shift patterns according to S/C and R/L bits

S/C	R/L	Operation
0	0	Shift cursor to the left, AC is decreased by 1
0	1	Shift cursor to the right, AC is increased by 1
1	0	Shift all of the display to the left, cursor moves with the display
1	1	Shift all of the display to the right, cursor moves with the display

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6) Function Set

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

DL: Interface data length control bit

When DL = “High” it means 8-bit bus mode with the MPU

When DL = “Low” it means 4-bit bus mode with the MPU

N: Display line number control bit

When N = “Low” 1-line display mode is set

When N = “High” 2-line display mode is set

F: Display font type control bit

When F = “Low” 5x8 pixel display format is set

When F = “High” 5x11 pixel display format is set

7) 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 the MPU.

8) Set DDRAM Address

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

Set DDRAM address to AC. This instruction makes DDRAM data available from MPU.

When 1-line display mode (N = Low), DDRAM address is from ‘00H’ to ‘4FH’. In 2-line mode (N = High) DDRAM address in the 1st line is from ‘00H’ to ‘27H’ and DDRAM address in the 2nd line is from ‘40H’ to ‘67H’.

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9) 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 the KS0066U is in internal operation or not. If the resultant BF is “High” internal, operation is in progress and the next cannot be performed until BF returns to “Low”. This instruction also reads the current value of the Address Counter (AC).

10) 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 (DRAM address set, 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.

11) 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 the address set of RAM is not performed before this instruction, the data that has been read first is invalid, as the direction of the AC is not yet determined. If RAM data is read several times without RAM address instructions set before the read operation the correct RAM can be obtained from the second. The first data would be invalid as there is not time to transfer RAM data. In case of DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set instruction it also transfers RAM data to the output data register. After the read operation, the address counter is automatically increased or decreased by 1 according to the entry mode. After CGRAM read, operation display shift may not execute correctly.

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Note: In case of RAM write operation AC is increased/decreased by 1 as in read operation. At this time, AC indicates the next address position but only the previous data can be read by the instruction.

4.4 Instruction Table

Instruction	Instruction Code										Description	Execution time f _{OSC} =270kHz	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear Display	0	0	0	0	0	0	0	0	0	0	1	Write '20H' to DDRAM and set DDRAM address to '00H' from AC	1.53 ms
Return Home	0	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to '00H' from AC and return cursor to its original position if shifted. The contents of the DDRAM are not changed	1.53 ms
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor movement direction and enable shift of the entire display	39 μs
Display On/Off Control	0	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking (B) control bit	39 μs
Cursor or Display Shift	0	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display shift control bit, and the direction without changing the DDRAM data	39 μs
Function Set	0	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL:8-bit/4-bit)number of display lines(N:1/2) and display font type(F:5x8/5x11)	39 μs
Set CGRAM Address	0	0	0	1	AC 5	AC 4	AC 3	AC 2	AC 1	AC 0		Set CGRAM address in address counter	39 μs
Set DDRAM Address	0	0	1	AC 6	AC 5	AC 4	AC 3	AC 2	AC 1	AC 0		Set DDRAM address in address counter	39 μs
Read Busy Flag and Address	0	1	BF	AC 6	AC 5	AC 4	AC 3	AC 2	AC 1	AC 0		Check for internal operation and read contents of the address counter	0 μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0		Write data into internal RAM (DDRAM/CGRAM)	43 μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0		Read data from internal RAM (DDRAM/CGRAM)	43 μs

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5. NOTES

Safety

- If the LCD breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

Handling

- Avoid static electricity as this can damage the CMOS LSI.
- The LCD panel is plate glass, do not hit or crush it.
- Do not remove the panel or frame from the module.
- The polarizing plate of the display is very fragile, handle it very carefully.

Mounting and Design

- Mount the module by using the specified mounting part and holes.
- To protect the module from external pressure, leave a small gap by placing transparent plates (e.g. acrylic or glass) on the display surface, frame and polarizing plate.
- Design the system so that no input signal is given unless the power supply voltage is applied.
- Keep the module dry. Avoid condensation; this can cause the transparent electrodes to fail.

Storage

- Store the module in a dark place where the temperature is $25^{\circ}\text{C}\pm 10^{\circ}\text{C}$ and the relative humidity is below 65%.
- Do not store the module near organic solvents or corrosive gases.
- Do not crush, shake, or jolt the module (including accessories).

Cleaning

- Do not wipe the polarizing plate with a dry cloth, it may scratch the surface.
- Do not use ketonic solvent (ketone and acetone) or aromatic solvents (tolulene and xylene); they may damage the polarizing plate.
- Wipe the module surface gently using a soft cloth soaked with petroleum benzene.

